CB RADIO – News and views inside

Hobby Electronics

February '81
ISSN 0142-6192
60p

For A Down-To-Earth Approach To Electronics

OSCILLOSCOPE FEATURE –

How they work & how to use them

Heartbeat Monitor

– a project to put your pulse on display

Two simple bench instruments to build

High-impedance Voltmeter
Audio Signal Generator
– see inside

Low-cost Personal Radio

SPECIAL OSCILLOSCOPE OFFER

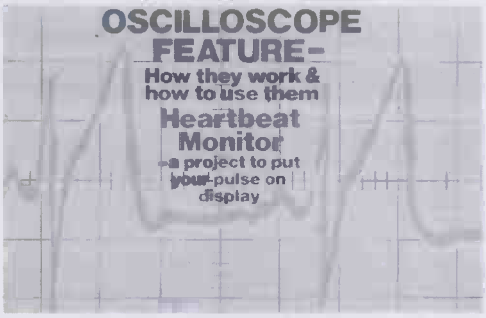
MHz scope f
only £95

Ever wondered
who buys electronics today?
You'd be surprised!
ectronics market is rapidly expanding. Whether it's
equipment, accessoiries or what have you,
it's increasingly to keep up with the latest
nts. Or to get them.
where we come in. We probably have just what you're
looking and a lot more besides. We stock all the top makes...
at prices will just make you love us. Simply phone, write or telex
Y Ltd., 103 High Street, Shepperton, TW 17 9 BL,
England, Tel. Walton-on-Thames (STD 09322) and find out.
simply call us.
TON AHLERS
ELEKTRONIKA B.V.
Aalsmeerderdijk 349, 1436 BH Rijsenhout -
Holland, tel. 010 31 2977-2 86 11 (4 lines),
telex 15181 tonel nl. (near Schiphol Airport).
Even the old boys circuit is getting electronicized. With our help.

Hobby Electronics

FEBRUARY 1981
Vol. 3 No. 4

Editor: Hugh Davies
Assistant Editor: Rick Maybury **Editorial Assistant:** Tina Boylan **Project Editor:** Keith Brindley
Drawing Office Manager: Paul Edwards **Group Art Editor:** Paul Wilson-Patterson B.A.
Managing Editor: Ron Harris B. Sc.



Hearty thanks are due to the Physics Dept. of Hammersmith General Hospital for allowing us to take pictures of the cardiograms shown on this month's cover. These waveforms were reproduced from those displayed on a cardiac monitor. *See first part of our Heartbeat Monitor project on page 13.*

PROJECTS

FEATURES

NEWS & INFO

Advertisement Manager: Stephen Rowe **Advertisement Representative:** Roy Perryment
Creative Director: Diego Rincón
Managing Director: T. J. Connell

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.
Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE, 01-437 1002. **Published by** Modmags Ltd. **Distributed by** Argus Distribution Ltd, 12-18 Paul St., London EC2A 4JS. **Printed by** QB Ltd., Colchester. Covers printed by Alabaster Passmore.

ILP

SIMPLY AHEAD and staying there

The range grows bigger...better...

New Profile Amplifiers - Two New Series

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

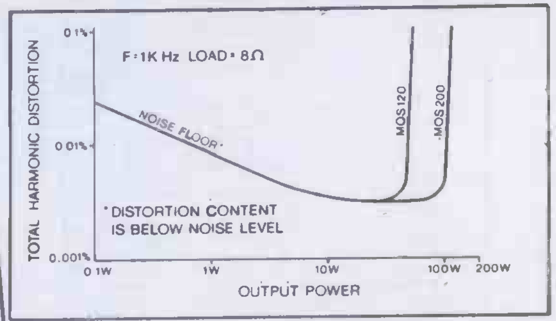
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR

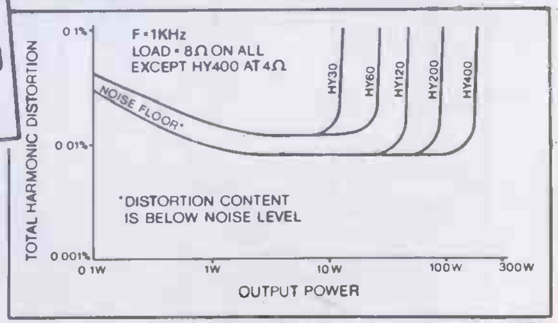
CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

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

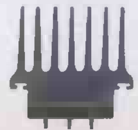
ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



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



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



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

Monitor

Philips-Simply Sears Ahead

YOU MAY WELL remember our major feature on video discs a couple of months ago. If you do then you may recall that at that time Philips was referring to its system with the rather uninspiring title of VLP (video long play). Well, the powers that be at Philips have decided to re-name their product 'Laservision' which they hope will lead to a new market identity. The worrying thing of course with the term laser is its unfortunate connection with the science fiction death ray. We just hope people will realise that the laser in the disc player is only a few milliwatts.

Still with Philips, they have also announced that the Laservision will be one of the first video playback systems to have a deal with the good old BBC. You can imagine how much material the BBC must have just sitting about doing nothing!

Recent Books

This month's selection concerns electronics and sound recording.

Parr, E.A. 'Practical computer experiments' Bernard Babani (Publishing) Ltd., November 1980 (£1.75)

It is made clear from the outset that this book is *not* about the microprocessor (although it does have a small section on this beast). Instead it is about discrete logic circuits. Main divisions are Control circuits, Digital arithmetic and Computer architecture. Readers do not have to wade through deep discussions on computer theory: rather (in common with most books of this type) they are brought quickly to practical applications and simple circuits to build. Although some appreciation of electronics is required, the book provides a good introduction to the building blocks of computer systems.

Penfold R.A., 'Popular electronic circuits — book 1' Bernard Babani (Publishing) Ltd., November 1980 (£1.95)

Definitely a book for the enthusiast looking for more circuits to build or the person looking for a simple circuit to fit an application. A total of 73 are provided, covering general categories of audio, radio, test gear, music and the household. Miscellaneous circuits include those for a touch switch, a sound-triggered flash and a rapid Ni-Cad charger.

One miscellaneous circuit of interest is for an 'LED pendant' — a novel way of introducing flashing LEDs to an item of jewellery.

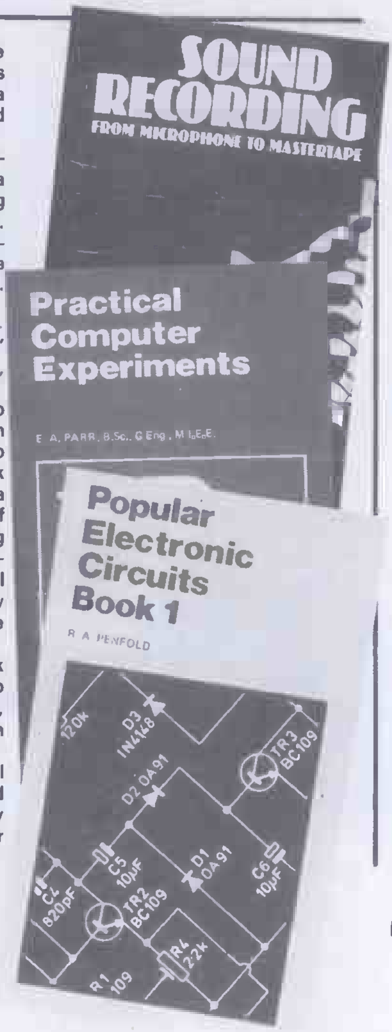
Back-up descriptions of the circuits are clear and concise in the well-accepted style of the author.

Tombs, D. 'Sound recording — from microphone to master tape' David & Charles, Newton Abbot, Devon, November 1980 (£7.95)

If you are about to launch into sound recording, or have just been disappointed with your results so far then this could be the book you've been waiting for. It gives a comprehensive coverage of microphones, recording machines, mono and stereo recording and techniques. The final chapter provides guidance on how to set up a recording studio in the home.

Definitely an easy-to-read book to have to hand for tips on how to solve specific recording problems, such as those encountered with drama and wildlife.

The author is a professional sound recordist who has worked with the BBC's Natural History Unit to pioneer techniques for stereo recordings of wildlife.



Technical Queries

TIME FOR ANOTHER one of our reminders about technical enquiries. As you may well know by now we will answer any technical query you may have regarding a project that has been published in Hobby Electronics. We can answer your question in two ways. The first is by telephone on Tuesdays between 3.15 and 5.00 pm. The second method is by post, but, and here's the important part: we can only answer it if you enclose a stamped addressed envelope. We will only answer questions regarding projects that we have published: we cannot advise you on any modifications and unfortunately we cannot undertake to do any design work. Sorry if that sounds a little harsh but we really do have our work cut out producing the magazine each month. If you do send in a postal technical enquiry then please mark your envelope with the name of the project and the month that it appeared and please allow up to 28 days for a reply.

Five Simple-to-build Kits

'You're about to start building an interesting and practical electronic kit'. Or at least that's what the instructions say in a new set of simple electronic kits from OK Machine & Tool U.K. Ltd.

Known as Electronic Hobby Assembly Kits, each one comes in a plastic box 3⅜ by 4½ by 1⅜" (86 by 115 by 35 mm), and contains all the components (resistors, capacitors, transistors, etc) and accessories (wire, screws, terminals, etc). The plastic box is not wasted either: this doubles as a case for the kit.

HE was given samples of the first five to be launched in the UK:

EK1 Quick Reaction (£5.80)
EK2 Electronic Organ (£6.70)
EK3 Digital Roulette (£8.80)
EK4 Electronic Dice (£7.98)
EK5 Morse Code Practice (£3.99)

These prices include post and packing.

We couldn't resist trying one out and opted for the Electronic Organ. Armed with a self-adjusting wire-stripper, we went for the fastest assembly time (around ¾ hour). The only extras we required were some solder and a 9 V battery. And yes — it worked first time, producing very loud tones picked out by a 'probe' over an eight-tone scale.

Despite translation from Japanese, the instructions were easy to follow, and contained passable descriptions of the components used, and the electrical units ('The farad is a large amount of electricity' amused us). Also given was a list of components (including details of component markings), hints on soldering technique, step-by-step instructions and a 'Here's how it works' paragraph.

Construction was aided greatly by the clear printing on the pre-drilled PCB.

According to James Dornan, Marketing Manager of OK Machine & Tool UK Ltd., more projects of this type are due for release in the UK. The five mentioned above made their first public appearance at this year's Breadboard exhibition.

Kits EK1 to 5 are available from OK Machine & Tool Ltd., Dutton Lane, Eastleigh SO5 4AA.

Winner of the Vero 4.30

The day — 27 November: the time — 4.30pm: the place—this year's Breadboard Show, London.

Here we have Mr. M. Clift, of Halesowen, West Midlands, being presented with first prize in Vero's draw of the day by Brian Gay, Sales Director of Vero Electronics.

Hugh Davies, HE's Editor, who was invited to draw the winning ticket, is seen standing on the right of Mr. Clift.

The prize, a Verowrap Hobby wirewrap tool kit (worth £39.50 + VAT) should be useful to Mr. Clift, who is a radio amateur (callsign G3VDM).

See page 10 for report on this year's exhibition.

Do-it-yourself PCBs

A new range of 'pre-sensitised' PCBs called 'Fotoboards' is available from Marshall Electronics. The boards, designed by Fotomechanics, have a coating of photo-resist which is protected from light by a peel-off plastic sheet.

The printed-circuit pattern (mask) is reproduced on a sheet of clear plastic film by means of a transfer (such as a Hobbyprint), a tape master, photographic film or by other methods such as strip or scribing. With the backing sheet removed and the mask placed in close contact with the board, the exposed areas of photo-resist are flooded with ultraviolet light.

After exposure, the board is dunked in developer and washed in water: it is then ready for etching, washing and use.

Marshall is offering the following items:

- Fotoboards, in standard Eurocard sizes (for example, 100 by 220 mm: £1.95 single-sided and £2.05 double-sided)
- Kit for UV exposure unit for developing Fotoboards. Cost is £34.50., or £19.50 without box and glass screen
- Developer (½-litre) for £1.95 (this developer cannot be sent through the post)
- Drafting kit (grid, layout sheet and three plain sheets) for £1.80
- Reel of layout track (86p) and developing trays (£1 each)

According to Norman Mallett, Fotoboard's designer, it is important for constructors to learn how to make PCBs in a 'commercial way'.

'Fotoboard', he said, 'is for anybody who is interested in the elctronic technology'.

The UV exposure kit comprises two UV lamps and the components to make a 12 VDC inverter to drive the lamps. It is possible to run the unit from two 6 V lantern-type batteries. Lamp life is claimed to be in excess of 1000 hours.

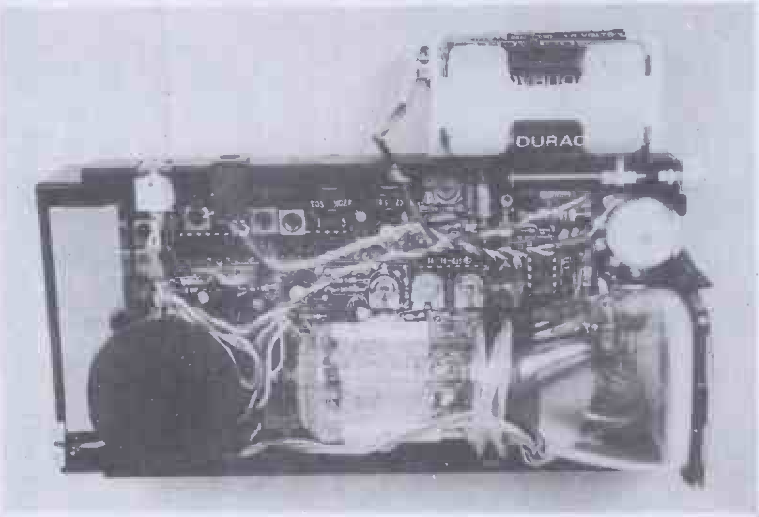
According to Mallett, developing time is about 4 to 5 minutes with this unit, but a UV sun-ray lamp could also be used, and would require an exposure time of about 10 minutes. Apparently, even sunlight can be used — but it takes about a day!

The need to warn users about the hazards of exposing the eyes to UV light was raised with Marshall, and assurances were received that the instructions supplied with the kit would contain such warnings.

XT MONTH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MO

ON SALE FEBRUARY 13th

Hobby Electronics



Beginnings Of Real TV

How did modern TV, something we tend to take for granted these days, originate? Did it have a single inventor? Many of you will not be aware that some of the research work behind TV dates back to 1817! For an explanation of how electrons took over from the 'wheels' used in the very early receivers you'll have to wait until the coming issue.

PA Amplifier

If you're planning a Spring fête or an outside gathering this year then you'll no doubt need a public address amplifier (or a very loud mouth) to speak to the millions. Look no further — with this project all you need is a car battery strapped on your back (or mounted on a skate board) and people will hear you for miles.

Photo Timer

You are in the darkroom (or bathroom, loo, or wherever else you do your developing) and you need to count developing or exposure time — in the dark. The luminous second hand has fallen off yor timepiece, so how do you do it? The answer is to use this simple-to-build project from HE.

Trainsound Project

This is the third and final project in this series for the model train enthusiast. (There *must* be more than *one* reading this!) But, as in last month's issue, we're keeping quiet about what it is. (Yes, we *do* know what it is!)

Fuzz Box

This is a project which is guaranteed to ruin the sound from your electric guitar. (Mind you, some people *love* fuzzed music.) So if you want distortion — produced in a novel way — then build this one.

Bike Speedo

Ever been pacing your 10-speed Tour-de-France ultra-lightweight bicycle with, say, a Jaguar XJS and been annoyed that you can't read the Jag's speedo? With this project this problem is a thing of the past: it gives you a digital display of MPH, and is robust into the bargain.

Wiper Control

Does this electronic wiper control arrange for the *inside* of the windscreen to be wiped? Unfortunately it doesn't but it does offer some wiping options that you won't find as standard on some up-market cars.

Items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

BREADBOARD 80

Were *you* at Breadboard 80? Hugh Davies gives a quick pictorial round-up of November's exhibition for the hobbyist

Overwhelming isn't too strong a word to use about the 1980 Breadboard exhibition — at least that's how it felt for us. It was held, as in the previous year, at the Royal Horticultural Halls, London SW1.

Total attendance was in excess of 17,000, with around 2500 crowding the stands on the first day, Wednesday 26 November. The peak of the five-day event was, of course, on Saturday, with an estimated 5500 visitors. Even Sunday wasn't a day of rest for our exhibitors!

One thing was certain — with so many people the corridors between the stands were rather crowded, as many of you must have experienced. We plan to widen the corridors in this year's exhibition.

Business was brisk on most stands, and the Modmags stand was no exception. Despite the din of synthesisers, rhythm generators and numerous other electronic gadgets it was good to meet and talk to so many of our readers. Some of the suggestions that we received from you face-to-face will help us to shape up future issues: thanks to all those who made their views known.

We hope that the pictures below help to capture a little of the atmosphere of Breadboard. One of its main aims is to bring electronics — as a hobby — to more people. Judging by the response there is no doubt that it achieved that aim in 1980.

1 Breadboard: a time to look, ask, listen . . . and buy. Visitors had the opportunity to see some of the latest products and to take advantage of the many special offers

2 A view down one of the corridors between the stands (see comments above)

3 An indication of the many different electronic games on sale. Incidentally, the notice in the foreground reads: 'Faulty Stereo's . . . Radio/Cass £20.00 ea'. Wonder *how* faulty?

4 It's amazing how some exhibitors can remain so calm under battle conditions! Stands like this one with trays containing hundreds of small items proved to be big attractions.

5 A multitude of electronic musical instruments were on show and visitors had the chance to try them out for themselves. This portable organ on one of Maplin's stands appeared to have solved the problem of background noise

6 If portability wasn't your style then you could have visited the Heath stand. This organ deserves more than a pair of headphones

7 Just to prove that Breadboard wasn't a male domain, here's a lady on the left trying to catch the attention of one of the exhibitors. On reflection, though, well over 95% of those attending the exhibition *were* male — so it's time more women became turned on to electronics

8 Right in the thick of it on the Modmags stand, the line up behind the counter is Peter Green (Assistant Editor, Electronics Today International), Jim Connell (Managing Director), Hugh Davies and Tina Boylan (Editorial Assistant)

9 'Big ones, small ones, some as big as yer 'ead' according to the old song, and that was certainly true of the many different types of antenna on display. One of our exhibitors came to our stand with a tale of woe: his special CB antenna — the only one of its type in the country — appeared to have been stolen from his stand. He told us later that one of his staff had sold it by mistake

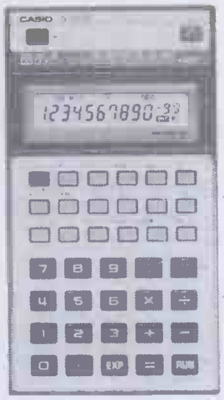
10 Near the end of the day, when the crowds subsided a little, this inflatable robot would go out on patrol from the Wintjoy stand. The fellow in the background appears to be in control

HE

A PROGRAMMABLE THAT THINKS IT'S A COMPUTER

For the price of a good scientific

CASIO'S AMAZING NEW FX-3500P



Statistical regression and integrals. Non-volatile memories and stores.

38 functional (non-volatile) steps. 2 programme storage capability. Unconditional and conditional jumps. 7 (non-volatile) memories; one independent, 6 constant memories. 18 pairs of parentheses, nestable in 6 levels.

61 built-in functions, including: Integrals (Simpson's rule). Linear regression, logarithmic regression, exponential regression and power regression.

Hyperbolics, sexagesimal and co-ordinates conversions. 10 digit mantissa or 10+2 exponent. Two silver oxide batteries give approximately 1,000 hours continuous use with power-saving automatic cut-off, with data and memory protection.

Dims: 9/32 x 2⅞ x 5¼ inches. Supplied with leatherette wallet.

ALL THIS FOR ONLY £22.95

CASIO FX-2700P

Similar to the FX-3500P but without regressional analysis and integrals. Single program storage. 8 digit mantissa or 8 digit mantissa and 2 digit exponent. 50 built-in functions including cube roots. RRP £22.95. **ONLY £19.95.**

CASIO'S SUPERCALCS! FX-8100

Our best selling scientific

46 scientific functions, clock, calendar, alarm, countdown alarm, interval alarm timer, 1/100 second stopwatch with lap timing.

Clock. Hours, minutes, seconds, am/pm.
Calendar. Pre-programmed to 1999. Day, date, month and year.
Alarm. 24-hour alarm with hourly chimes.
Countdown alarm. Can be set up to 10 hours, or,
Interval alarm timer up to 10 hours, or,
Stopwatch. Measuring net, lap and first and second place times in units of 1/100 second to 10 hours.
Calculator. 8 digits or 8+2. 5 level parentheses, full access memory. Trigs, logs, hyperbolics, standard deviations, co-ordinates and sexagesimal conversions, fractions, %, cube roots, pi, sign change, register exchange, etc.
Two silver oxide batteries last approx. 1 year (continuous). Dims: ¼ x 2¾ x 5⅛ inches. Leatherette wallet.

ONLY £24.95. (RRP £27.95)

FX-6100. Latest model
Similar to the FX-8100 but without the calendar function, interval alarm timer, hyperbolics or fractions. 8 digit mantissa or 6+2 digit exponent. Powered by two AA size batteries. Dims: ¾x3x5⅝ inches. R.R.P. £22.95 **£19.95**

FX-7100.
Credit card version of FX-6100 with kiss-touch keys. Two silver oxide batteries give approx 1 year continuous use. 3/16 x 2⅛ x 3⅝ inches. Wallet. R.R.P. £27.95 **£24.95**

FREE! A gentleman's high quality digital watch worth at least **£24.95** on request with every order for a Casio **FX-502P Programmable calculator** at **£74.95** or you can have a MASTERPACK software kit worth **£17.95.** Offers subject to availability.

DID YOU MISS OUT ON THE SPACE INVADERS?

Perhaps the best space game ever fits easily in your pocket for only **£10.95**
Also a very useful melody calculator that plays "When The Saints Go Marching In." Full memory. %. auto power off facility. ¼x2⅝x4½in. **MG-880.**
MG-770. Credit card version of above 5/32x3½x2⅛in. Kiss keys **£12.95**

CASIOTONE KEYBOARDS

NEW MODEL. CT-301

Provisional specifications: As CT201 below but with 14 instruments and 16 rhythm voices.

Provisional price; under £300

The revolutionary CT-201 **ONLY £245** (rrp £285)

A remarkable new concept in electronic keyboard Instruments using a totally new technology. Pitch, timbre and harmonics of 29 instruments have been measured, digitalised and stored in electronic chip memory for faithful reproduction. A 4-sound memory function allows switching between any 4 pre-selected instruments.

This polyphonic instrument can play full chords of up to 8 notes on its 29 white and 20 black keys spanning 4 octaves. Vibrato and tone switches. Foot volume and sustain pedal options. Echo jacks. 3x33½x9⅛ inches. Weight 15lb. Black or woodgrain finish. AC only.

PRICES Include VAT and post and packing. **Remember,** we will beat any lower advertised price by **5%** providing the advertiser has stocks and we still make a small profit! Just send details and your remittance for the lower amount.

CASIO'S ULTIMATE WATCHES

★ STAR BUY FOR 1981 ★

AA81 Analogue Display

AA82 Digital Display

Our best selling watch

LCD ANALOGUE/DIGITAL

Alarm Chronograph with countdown

Analogue. Independent hours and minutes with synchronous digital seconds. Dual time ability.
Digital. Hours, minutes, seconds, day and date.
Stopwatch. 1/100 second to 12 hours. Net lap and 1st and 2nd place. Start/stop and 10 minute signals.
Alarm. For 30 seconds with carousel display.
Countdown Alarm. Normal and net times to 1 hour with amazing "Star Burst" flashing display.
Time Signal. Half-hourly and hourly chimes. Tone control. Lithium battery. Light. Water-resistant case. 8.65mm thick. Mineral glass.

AA81 Chrome plated £29.95
AA81G Gold plated £49.95
AA82 Stainless Steel £39.95
AA83 Dress watch, s/s £44.95

12 MELODY ALARM CHRONOGRAPHS

Countdown alarm
Date memories

Hours, minutes, seconds, am-pm, 12 or 24 hour. Day, date and month auto calendar.
Alarm. 7 melodies, one for each day of the week.
Hourly time signal. With "Big Ben" type tune.
Date memory. Select either "Wedding March" or "Trinklied" to be played.
Birthday and Christmas Memory.
Countdown alarm. From 1 second to 1 hour. After zero count continues positively.
Stopwatch. 1/10 second to 1 hour. Net, lap, etc.
Picturesque moving display of notes played.
Light. Lithium. Glass. Water-resistant cases.
M-12 resin, s/s trim. **M-1200** all s/s 9.0 mm thick.

£24.95 £29.95

£19.95 £32.50

100 METRE WATER RESISTANT

Alarm chronographs with countdown
Amazing 5-year lithium battery life. Hours, minutes, seconds, am/pm, day, date and month. 12 or 24 hour. Time is always visible regardless of display mode.
Stopwatch. 1/100 second to 1 hour. Net, lap, and 1st and 2nd. Start/stop signal. 10-minute signal.
Alarm. Sounds for 30 seconds.
Countdown Alarm. Normal and net times to 12 hours. Start/stop and 10-minute signals.
Time signal. Half-hourly and hourly chimes.
W-100. All resin. **W-150B** All s/s. **W-150C** (not illustrated) s/s case/resin strap. **£29.95**

C80 CALCULATOR/STOPWATCH

Finger touch keyboard. Hours, minutes, seconds, am/pm and day. Day, date, month, calendar pre-programmed to 2001. Professional 24-hour stopwatch measuring net, lap and first and second place times to 1/100 second. Dual time (24-hour). 8 digit calculator. Backlight. Water resistant black resin case **£18.95**

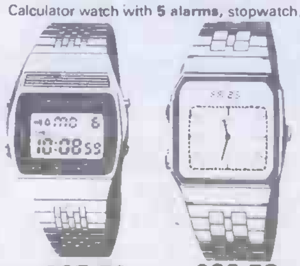
A250. As above but with standard water-resistant case **£24.95**

S220. As above but with dual tune in lieu of alarms and chimes **£25.00**

SEIKO from £37.50

NEW MODEL. DFK018

Calculator watch with **5 alarms**, stopwatch, etc. **£69.95**



£37.50 £62.50

JET 010 Duo display (left). Independent analogue time. Digital time. Calendar, alarm, hourly chimes, 1/100th second stopwatch. Stainless steel

DFT 048 Alarm chrono (far left). Full time and calendar display. Alarm and hourly time signal. Countdown alarm timer. Backlight. Stainless steel. Water resistant.

Many other models including solar powered and 100m water resistant.

Price includes VAT, P&P. Send your company order, cheque, P.O. or phone your ACCESS or BARCLAYCARD number to:

TEMPUS

Dept. H.E., FREEPOST, 164-167 East Road, Cambridge CB1 1DB. Tel. 0223 312866

Project

Heartbeat Monitor

Is your heart pounding as you read this? Here's a project that enables you to measure its rate

IMAGINE — your heart rate directly on display. Our Heartbeat Monitor samples a signal corresponding to your pulse and transforms it into a meter display of beats per minute (BPM). In addition to the meter, a LED flashes each time a beat is received.

In this issue we describe the circuit and a simple method of sampling heart rate: you operate a small push-switch each time your heart beats. In a future issue we will describe a sensor which, when it is attached to the body, will enable heart-rate to be detected automatically.

Construction

The PCB is only 2¾ by 2¼" (70 by 57 mm) and very compact so great care should be taken when building it up. Integrated circuit sockets are advised for all four ICs. Remember that IC3 and 4 are fairly expensive but because they are not CMOS types, no special handling precautions are necessary.

Construct the board as you would any PCB, resistors first followed by capacitors (none are polarised) and finally semiconductors (these *are* polarised, so check carefully that you have them the correct way round, as shown in the overlay in Fig.4).

For initial test purposes LED1 should be hard-wired straight onto the board. Connect the meter, checking its polarity and set RV1 to mid-position. Now, connect a push-button switch as shown in the overlay diagram. You are now ready for testing.

Testing

Connect a new 9 V battery and turn on the unit — the meter needle should jump to the right and stay there. Push the button once a second (an ideal timing aid is a watch fitted with a secondhand). At this rate (ie 60 BPM) the needle of the meter should settle at about ⅓ scale. Adjust preset RV1 clockwise or anti-clockwise until this is so. (Confirmation of pulse rate is also provided by LED1).

Now, double the rate at which you press the button to twice a second (120 BPM) and the needle should now move up to about ⅔ scale. If so, all is well.

Calibration

The above method of testing is suitable for rough calibration of the monitor, and is fine for most applications. However, if you require a more exact calibration you will need a calibrated signal generator set at various frequencies:

Sig. Gen. setting (Hz)	Meter Calibration (BPM)
0.8	48
1	60
1.2	72
1.5	90
2	120
3	180

Table 1. Spot frequencies and equivalent beats per minute for calibrating meter against signal generator.

Heartbeat Monitor

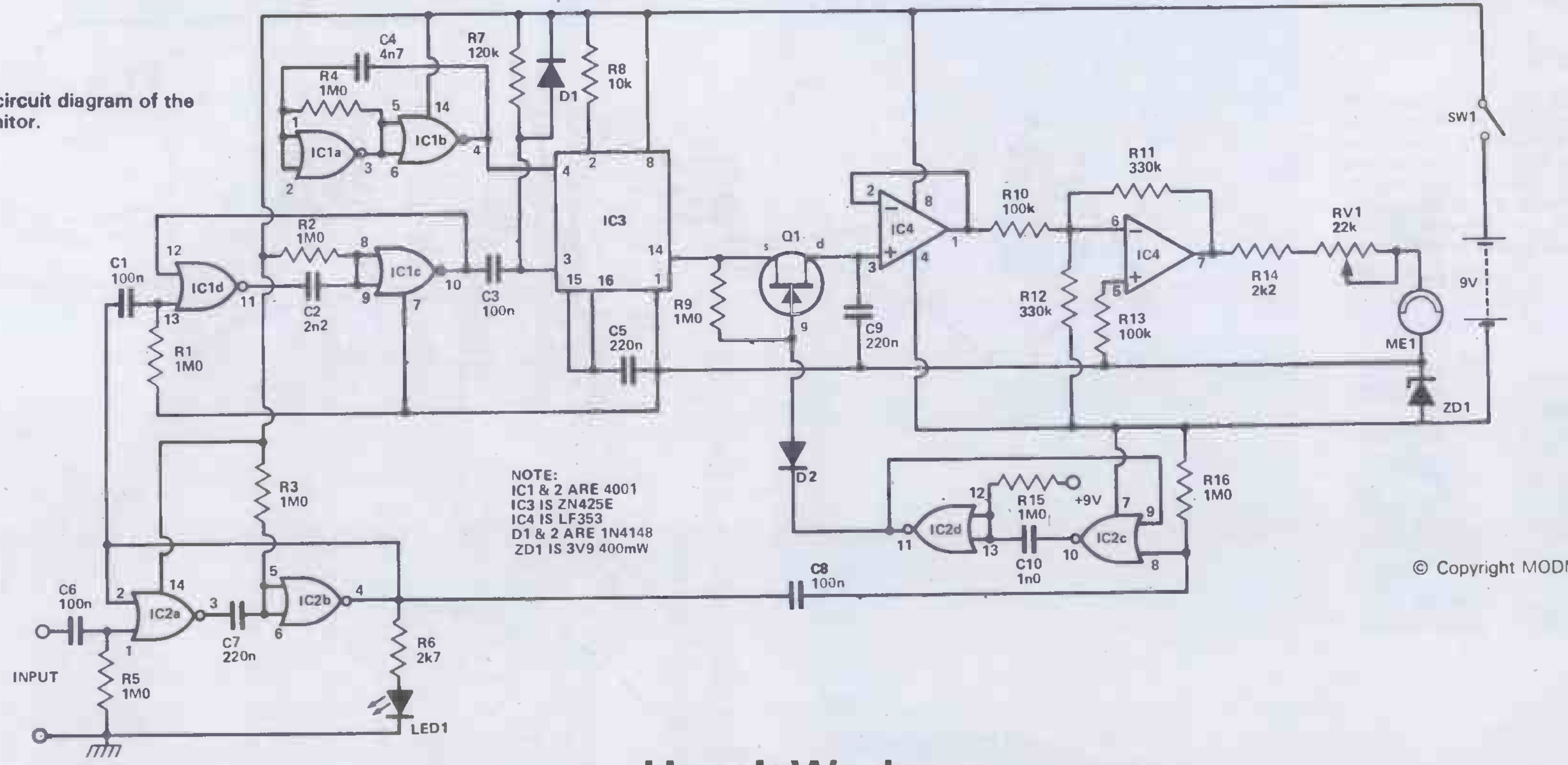


Figure 1. The circuit diagram of the Heartbeat Monitor.

How It Works

There are a number of problems associated with electronic measurement of heart-rate, the main being the slow nature of beats; ie only once or twice per second. For a *quick* display of heart-rate we cannot simply count the number of beats over, say a minute — this is the standard way of checking your own heart-rate by feeling your pulse.

The HE Heartbeat Monitor uses a different method to obtain a quick reading. Figure 3 shows the principal parts of the system: an oscillator producing a square wave with an approximate frequency of 200 Hz, a digital counter which counts the square wave and gives the counted output in binary code, a digital-to-analogue converter (DAC) which converts the digital binary output of the counter to an analogue (ie DC) voltage; and a meter to measure the DC voltage. The first heartbeat resets the counter to zero and then starts it. The second beat stops the counter. If the heart-rate is say, 60BPM, there will be one second between pulses and so 200 square waves will be counted and the output of the counter will be the number 200, in binary. This is converted by the DAC to an analogue voltage and is displayed on the meter.

To produce a continuous display on the meter certain things have to be taken into account.

- The counter in the above sequence was stopped by the pulse of the second heartbeat, but to obtain a reading over more than just one beat, this second heartbeat must also reset and restart the counter ready for the next beat. Control circuits need to be included for this task.
- As the counter counts the number of squarewave pulses, the binary output will be constantly changing. This would produce a constantly changing meter reading.

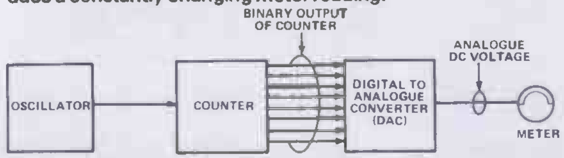


Figure 3. Principal parts of the circuit.

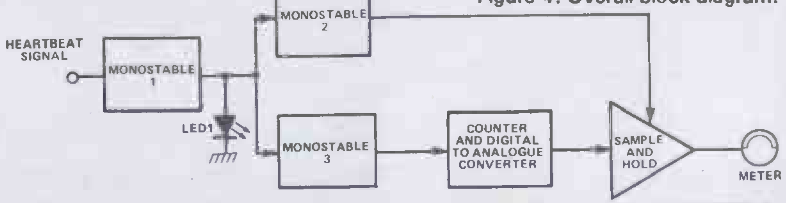
By sampling the output *once* per heartbeat and metering only that sampled voltage a continuous reading can be obtained — we use a circuit called a sample-and-hold for this function.

The overall block diagram of the circuit is shown in Fig.4. The counter and DAC are contained within one device, IC3, in the circuit diagram. The oscillator is formed by an astable multivibrator comprising IC1 a and b, R4, C4. The sample-and-hold circuit is built around Q1 and IC4a and the control circuits comprise three monostable multivibrators. The complete project works in the following manner:

An electrical signal corresponding to the heartbeat triggers Monostable 1 (IC2a and b) which illuminates LED1, to show its 'on' state. The on state of this multivibrator triggers both monostables 2 and 3. Monostable 2 (IC2c and d) triggers the sample-and hold, and Monostable 3 resets the counter to zero allowing it to start counting again. Every heartbeat signal repeats the operation, producing a reading which corresponds to the heart-rate.

The final stage of the circuit is a simple amplifier, IC4b, to drive the meter.

Figure 4. Overall block diagram.



Suitable input test points for a generator are shown on the overlay. Mark the meter scale at the above rates and the project is complete.

By finding a strongly-defined pulse and pressing the push-button after every beat, the meter will show the corresponding heart-rate (in BPM) after a response of about three seconds. A suitable pulse can be found at either side of the neck in one of the two carotid arteries — by feeling the pulse with one hand and pressing the button with your other you should have success.

Parts List

RESISTORS (All ¼ W, 5%)

R1,2,3,4 5,9,15,16	1M0
R6	2k7
R7	120k
R8	10k
R10,13	100k
R11,12	330k
R14	2k2

POTENTIOMETER

RV1	22k miniature horizontal preset

CAPACITORS

C1,3,6,8	100n polyester
C2	2n2 ceramic
C4	4n7 ceramic
C5	220n polycarbonate
C7,9	220n polyester
C10	1n0 ceramic

SEMICONDUCTORS

IC1,2	4001, quad NOR gate
IC3	ZN425E, DAC
IC4	LF353, dual JFET operational amplifier
Q1	2N3819, N-channel FET
D1,2	1N4148, diode
ZD1	3V9, 400 mW zener diode
LED1	0.125″ green LED

MISCELLANEOUS

SW1	single-pole, single-throw toggle switch
ME1	200 uA meter (see Buylines)

IC sockets (2 x 14 pin, 1 x 16 pin, 1 x 8 pin)
Push button switch
Battery (type PP6) + clip

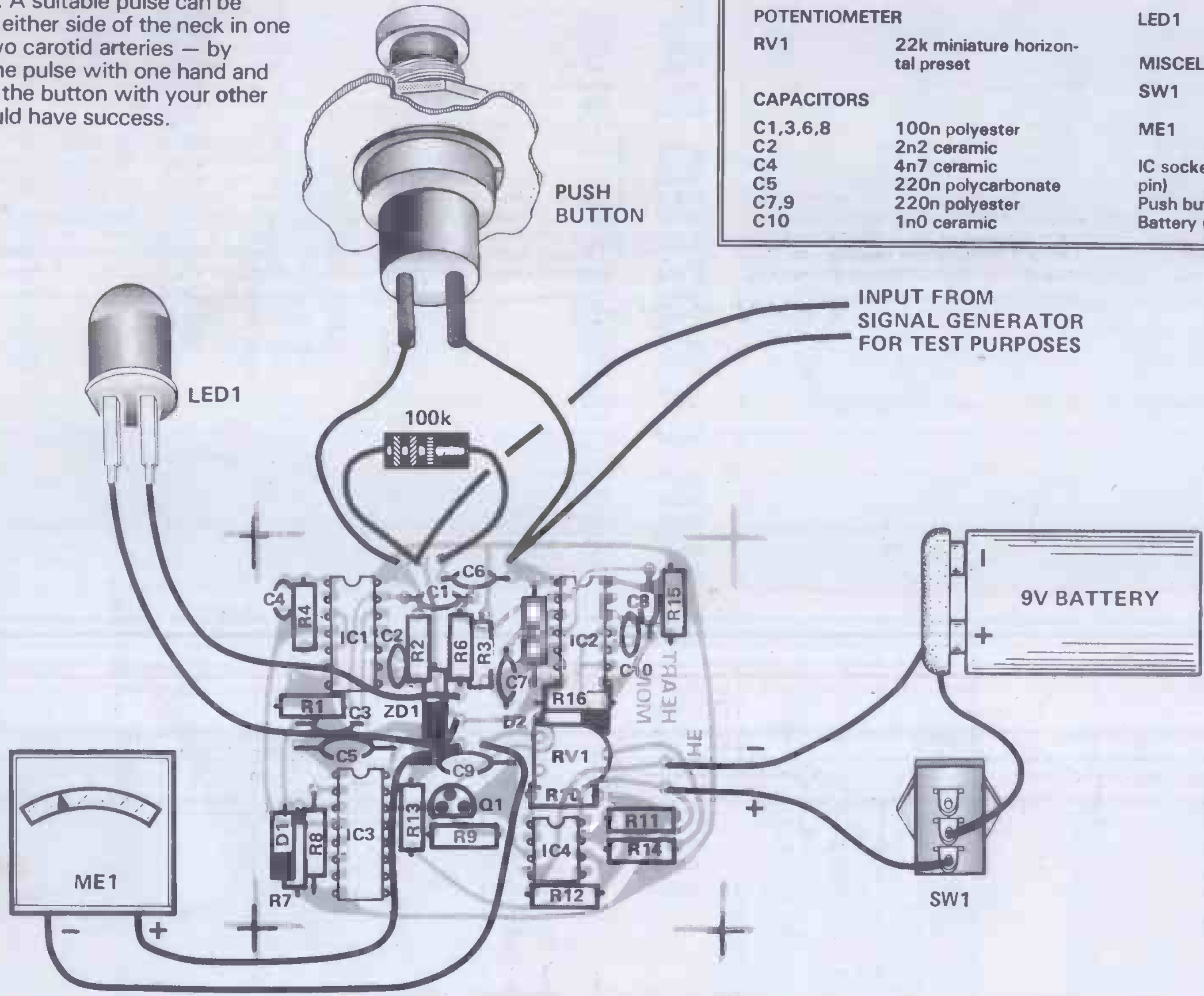
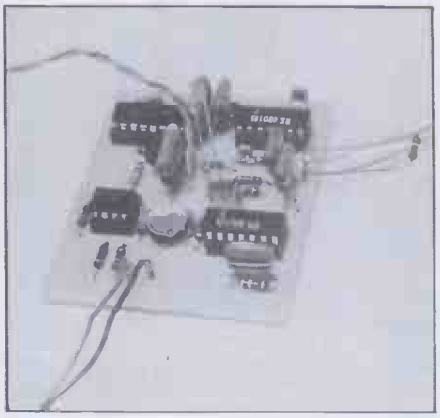
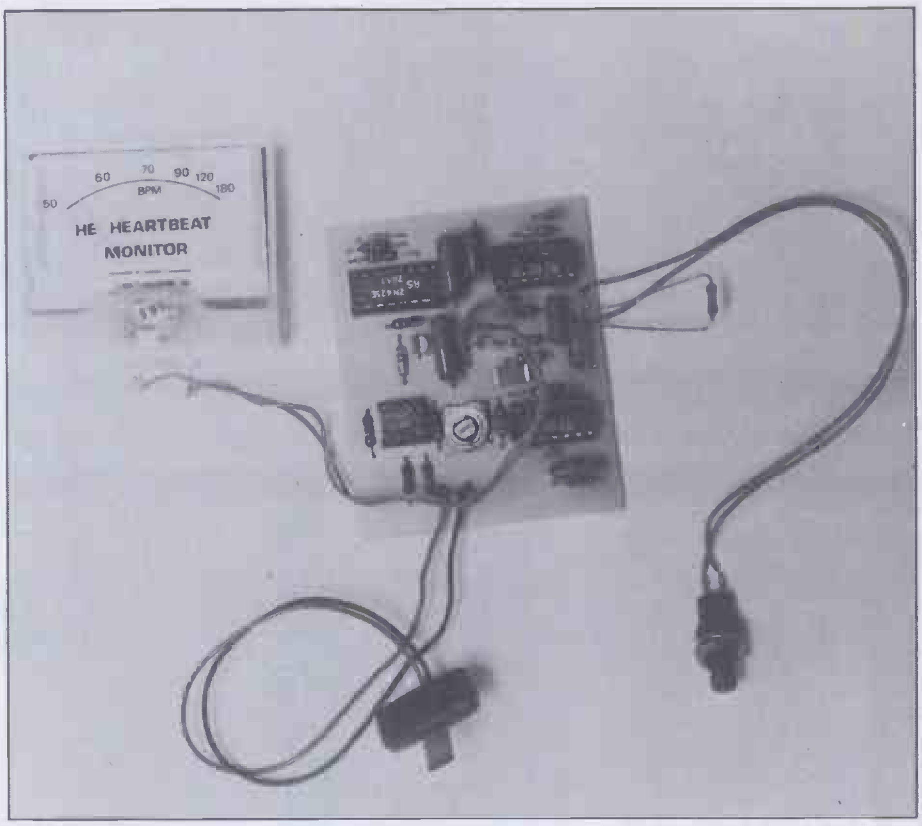


Figure 2. PCB overlay with connection details to calibrate the Monitor and use it. The resistor is not used for calibration.

Important Note

The complete circuit of the Heartbeat Monitor operates from a single 9 V battery. We stress that the circuit must not be connected to a mains-operated supply. This warning is particularly important when the Monitor is to be used with a sensor attached to the body, as will be described in a future issue.





The Heartbeat Monitor board shown above and right with all connections.

Buylines

The meter we used in this project comes from AMBIT INTERNATIONAL and the type number is 920. Integrated circuits IC3 and 4 may not be easily obtainable from your local stockist but one or two of the mail order companies advertising in HE have them listed (eg Technomatic or Watford).

The approximate price of components (excluding PCB and case) will be £20.

TTLs by TEXAS	
7400	11p
74S00	60p
7401	12p
7402	12p
7403	14p
7404	14p
7405	18p
7406	36p
7407	36p
7408	17p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	40p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	35p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	75p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	38p
7476	32p
7480	50p
7481	100p
7482	84p
7483a	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	30p
7491	80p
7492A	46p
7493A	36p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74107	34p
74109	55p
74116	200p
74118	130p
74119	210p
74120	110p
74121	34p
74122	48p
74123	60p
74125	70p
74126	60p
74128	75p
74132	75p
74136	75p
74137	50p
74141	50p
74142	200p
74145	90p
74147	190p
74148	150p
74150	130p
74151A	70p
74153	70p
74154	120p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	95p
74181	160p
74182	90p
74184A	150p
74185	150p
74186	500p
74188	325p
74190	120p
74191	120p
74192	100p
74193	100p
74194	120p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74251	140p
74259	250p
74278	290p
74279	110p
74283	140p
74284	360p
74285	360p
74290	150p
74293	150p
74298	200p
74365	100p
74366	100p
74367	100p
74368	100p
74390	200p
74393	200p
74490	225p

74LS SERIES	
74LS00	14p
74LS02	16p
74LS03	18p
74LS04	16p
74LS05	25p
74LS08	22p
74LS09	21p
74LS10	20p
74LS11	40p
74LS13	40p
74LS14	50p
74LS20	20p
74LS21	40p
74LS27	38p
74LS30	20p
74LS32	27p
74LS37	30p
74LS38	38p
74LS42	70p
74LS47	75p
74LS51	24p
74LS55	30p
74LS73	50p
74LS74	27p
74LS75	36p
74LS76	45p
74LS83	70p
74LS85	80p
74LS86	40p
74LS90	40p
74LS92	70p
74LS93	60p
74LS96	110p
74LS107	45p
74LS109	80p
74LS112	40p
74LS113	90p
74LS114	45p
74LS122	80p
74LS123	60p
74LS124	180p
74LS125	50p
74LS126	50p
74LS132	60p
74LS133	30p
74LS136	55p
74LS138	65p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	80p
74LS153	60p
74LS154	200p
74LS155	80p
74LS156	90p
74LS157	60p
74LS158	60p
74LS160	90p
74LS161	75p
74LS162	140p
74LS163	100p
74LS164	90p
74LS165	140p
74LS166	180p
74LS173	110p
74LS174	100p
74LS175	100p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
74LS197	90p
74LS221	120p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	150p
74LS245	250p
74LS247	140p
74LS251	140p
74LS253	90p
74LS257	90p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	170p
74LS279	90p
74LS283	90p
74LS298	150p
74LS323	400p
74LS324	200p
74LS348	200p
74LS365	48p
74LS367	70p
74LS368	100p
74LS373	150p
74LS374	150p
74LS375	120p
74LS377	150p
74LS378	140p
74LS390	120p
74LS393	120p
74LS399	200p
74LS445	140p
74LS670	400p

4000 SERIES	
4000	15p
4001	22p
4002	20p
4006	95p
4007	20p
4008	80p
4009	40p
4010	50p
4011	20p
4012	25p
4013	50p
4014	84p
4015	84p
4016	45p
4017	70p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	27p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4034	200p
4035	110p
4036	295p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	45p
4050	45p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	50p
4067	450p
4068	27p
4069	20p
4070	30p
4071	25p
4072	25p
4073	25p
4075	25p
4076	107p
4081	27p
4082	27p
4086	72p
4089	150p
4093	70p
4094	250p
4095	95p
4096	95p
4097	340p
4098	120p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	120p
40106	90p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	120p
4512	80p
4514	250p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	100p
4532	140p
4534	550p
4536	375p
4538	120p
4543	180p
4553	320p
4556	72p
4560	200p
4569	250p
4572	40p
4583	110p
4584	90p
4585	150p
4724	250p
40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p

INTERFACE ICs	
AD536A	£13
AD561J	1400p
AD7524	600p
DM8123	175p
DM8131	375p
DP8304	450p
DS8835	250p
DS8836	160p
DS8838	225p
MC1488	75p
MC1489	75p
25S10	350p
75107	160p
75110	325p
75150	175p
75154	175p
75182	230p
75322	300p
75324	375p
75325	375p
75361	300p
75363	400p
75365	200p
75451/2	72p
75491/2	70p
8T26	160p
8T28	250p
8T95	180p
8T97	180p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9602	220p

93 SERIES		74S SERIES			
9301	160p	74S00	60p	74S114	120p
9302	175p	74S04	60p	74S124	300p
9308	316p	74S05	75p	74S132	160p
9310	275p	74S08	75p	74S133	75p
9311	275p	74S10	60p	74S138	225p
9312	160p	74S20	60p	74S139	225p
9314	165p	74S30	60p	74S157	250p
9316	225p	74S32	90p	74S174	250p
9321	225p	74S37	90p	74S175	320p
9322	150p	74S64	60p	74S194	350p
9334	360p	74S74	90p	74S241	450p
9368	250p	74S85	300p	74S260	70p
9370	300p	74S86	180p	74S373	500p
9374	200p	74S112	120p	74S374	500p

LINEAR ICs			
AY1-0212	600p	LM13600	125p
AY1-1313	668p	MB3712	150p
AY1-1320	320p	MC1310P	150p
AY1-5050	140p	MC1458	48p
AY3-1270	840p	MC1495L	350p
AY3-8912	650p	MC1496	70p
AY5-1224A	240p	MC3340P	120p
AY5-1315	600p	MK50398	750p
AY5-1317A	775p	ML920	775p
AY5-4007D	520p	MM57160	620p
CA3019	80p	NE531	150p
CA3046	70p	NE555	20p
CA3048	225p	NE556	70p
CA3080E	72p	NE562B	425p
CA3086	48p	NE564	420p
CA3089E	225p	NE565	130p
CA3090AO	375p	NE566	155p
CA3130E	90p	NE567	140p
CA3140E	50p	NE571	425p
CA3160E	100p	NE5534A	250p
CA3161E	140p	RC4136	120p
CA3162E	450p	S566B	270p
CA3189E	300p	SAD1024A	1250p
CA3280	160p	SFF96364	1100p
DAC1408-8	200p	SL490	400p
FX209	750p	SN76477	175p
HA1388	260p	SP8515	750p
ICL7106	850p	TA7205	140p
ICL8038	300p	TAA621	275p
ICM7555	80p	TBA641B11	300p
LF13331	310p	TBA651	200p
LF351	48p	TBA800	90p
LF356P	95p	TBA810	100p
LM10C	425p	TBA820	90p
LM301A	27p	TBA950	300p
LM311	70p	TCA220	350p
LM318	200p	TCA940	175p
LM319	225p	TDA1004	300p
LM324	45p	TDA1008	320p
LM339	75p	TDA1010	225p
LM348	95p	TDA1022	570p
LM358P	50p	TDA1024	120p
LM377	175p	TDA1034B	250p
LM380	75p	TDA1170	300p
LM381AN	180p	TDA2002V	325p
LM386	95p	TDA2020	320p
LM393	100p	TL071/81	45p
LM709	36p	TL072/82	75p
LM710	50p	TL074	130p
LM725	350p	TL084	110p
LM733	100p	TL170	50p
LM741	18p	UAA170	175p
LM747	70p	UDN6118	320p
LM748	35p	UDN6184	320p
LM2917	250p	ULN2003	100p
LM3302	140p	XR2206	300p
LM3900	70p	ZN414	90p
LM3909	70p	ZN419C	225p
LM3911	130p	ZN424E	135p
LM3914	225p	ZN425E	400p
LM3915	225p	ZN427E	750p
		ZN1034	200p

VOLTAGE REGULATORS

Fixed Plastic TO-220				
1A	+ve		−ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS			
LM309K	135p	78HGKC	600p
LM317T	200p	78H05KC	550p
LM323K	500p	78MGT2C	135p
LM723	37p	TL497	300p

OPTO-ELECTRONICS			
2N5777	45p	ORP60	120p
OCP71	90p	ORP61	120p
ORP12	120p	TIL78	55p
OPTO-ISOLATORS			
ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p
LEDS			
0.125"		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular	
TIL216 Red	18p	LEDs (R, G, Y)	30p
		NSB5881	570p
		TIL311	600p
		TIL312/3	110p
		TIL321/2	130p
		TIL330	140p
		7750/60	200p

DISPLAYS		DRIVERS	
3015F	200p		
DL704	140p		
DL707 Red	140p		
FND357	120p		
FND500	110p	9368	250p
FND507	110p	9370	300p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

TRANSISTORS							
AC126	25p	BFR40	25p	TIP30A	48p	2N3055	48p
AC127/8	20p	BFR41	25p	TIP30C	60p	2N3442	140p
AC176	25p	BFR79	25p	TIP31A	58p	2N3553	240p
AC187/8	25p	BFR80	25p	TIP31C	62p	2N3565	30p
AF116	50p	BFR81	25p	TIP32A	68p	2N3584	250p
AD149	70p	BFX29	40p	TIP32C	82p	2N3643/4	48p
AD161/2	45p	BFX30	34p	TIP33A	90p	2N3702/3	12p
AU107	200p	BFX84/5	40p	TIP33C	114p	2N3704/5	12p
BC107/8	11p	BFX86/7	30p	TIP34A	115p	2N3706/7	14p
BC109	11p	BFX88	30p	TIP34C	160p	2N3708/9	12p
BC117	20p	BFW10	90p	TIP35A	225p	2N3773	300p
BC147/8	9p	BFY50	30p	TIP35C	290p	2N3819	25p
BC149	10p	BFY51/2	30p	TIP36A	270p	2N3820	50p
BC157/8	10p	BFY56	33p	TIP36C	340p	2N3823	70p
BC159	11p	BFY90	90p	TIP41A	65p	2N3866	90p
BC169C	12p	BRY39	45p	TIP41C	78p	2N3902	700p
BC172	12p	BSX19/20	20p	TIP42A	70p	2N3903/4	18p
BC177/8	17p	BU104	225p	TIP42C	82p	2N3905/6	20p
BC179	18p	BU105	190p	TIP54	160p	2N4037	65p
BC182/3	10p	BU108	250p	TIP120	120p	2N4058/9	12p
BC184	11p	BU109	225p	TIP122	130p	2N4060	12p
BC187	30p	BU126	150p	TIP142	130p	2N4061/2	18p
BC212/3	11p	BU180A	120p	TIP147	130p	2N4123/4	27p
BC214	12p	BU205	200p	TIP2955	78p	2N4125/6	27p
BC237	15p	BU208	200p	TIP4055	70p	2N4401/3	27p
BC327	16p	BU406	145p	TIS43	45p	2N4427	90p
BC337	16p	E300	50p	TIS93	30p	2N4871	60p
BC338	16p	E308	50p	ZTX108	12p	2N5087	27p
BC461	36p	E310	50p	ZTX300	13p	2N5089	27p
BC477/8	30p	MJ2501	225p	ZTX500	15p	2N5172	27p
BC516/7	40p	MJ2955	90p	ZTX502	18p	2N5179	90p
BC547B	16p	MJ3001	225p	ZTX504	30p	2N5191	90p
BC548C	16p	MJE340	50p	2N457A	250p	2N5194	90p
BC549C	18p	MJE2955	100p	2N696	35p	2N5245	40p
BC557B	16p	MJE3055	70p	2N697	25p	2N5296	55p
BC559C	18p	MPF102	45p	2N698	45p	2N5401	50p
BCY70	18p	MPF103/4	40p	2N706A	30p	2N5457/8	40p
BCY71/2	22p	MPF105/6	40p	2N708	30p	2N5459	40p
BD131/2	50p	MPS6531	50p	2N918	45p	2N5460	60p
BD135/6	54p	MPS6534	50p	2N930	18p	2N5485	44p
BD139	56p	MPSA06	30p	2N1131/2	36p	2N5875	250p
BD140	60p	MPSA12	50p	2N1613	25p	2N6027	48p
BD189	60p	MPSA13	50p	2N1711	25p	2N6041	160p
BD232	95p	MPSA20	50p	2N2102	70p	2N6044	160p
BD233	75p	MPSA42	50p	2N2160	350p	2N6052	300p
BD235	85p	MPSA43	50p	2N2219A	30p	2N6059	325p
BD241	70p	MPSA56	32p	2N2222A	30p	2N6107	65p
BD242	70p	MPSA70	50p	2N2369A	25p	2N6247	190p
BDY56	200p	MPSU06	63p	2N2484	30p	2N6254	130p
BF200	32p	MPSU07	60p	2N2646	45p	2N6290	65p
BF244B	35p	MPSU45	90p	2N2904/5	30p	2N6292	65p
BF256B	70p	MPSU65	78p	2N2906A	30p	2SC1172	150p
BF257/8	32p	OC28	130p	2N2907A	30p	3N128	120p
BF259	36p	OC35	130p	2N2926	9p	3N140	120p
BFR39	25p	TIP29A	40p	2N3053	30p	3N141	110p
		TIP29C	65p	2N3054	65p	3N201	110p

3N204	120p
40290	250p
40360	40p
40361/2	75p
40364	120p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40841	90p
40871/2	100p

DIODES	
BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

HEAT SINKS	
For TO220 Voltage Regs and Transistors	22p
For TO5	12p

BRIDGE RECTIFIERS		
1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

ZENERS	
2.7V-33V	
400mW	9p
1W	15p

TRIACS PLASTIC	
3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS	
1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

LOUD-SPEAKERS		
Size		
2¼"	64R	80p
2¼"	8R	80p
2"	8R	90p
1¼"	8R	100p

MODULATORS	
6MHz UHF	375p
8MHz UHF	450p

MEMORIES	
2101-4L	400p
2102-2L	120p
2107B	500p
2111-4	400p
2112-4	300p
2114	225p
2114-2L	450p
4027-3	375p
4044	900p
4116	350p
4118-4	£1200
5101	400p
6810	325p
74S201	400p
82516	325p
ROM/PROMs	
71301	700p
74S188	225p
74S387	350p
74S470	650p
74S471	650p
74S571	650p
CPUs	
1600	1200p
1802CE	750p
2650A	£16
6502	650p
6800	600p
6802	950p
6809	£20
8080A	450p
8085A	1100p
INS8060	1000p
TMS9980A	£20
Z80	600p
Z80A	800p
EPROMS	
1702A	500p
2708	450p
2716 (+5V)	£7
2532	£16
2732	£16
SUPPORT DEVICES	
3242	800p
3245	450p
6522	650p
6532	825p
6820	375p
6821	340p
6845	£16
6850	300p
6852	370p
8155	1100p
8205	320p
8212	200p
8216	200p
8224	275p
8226	280p
8228	525p
8251	475p
8253	1000p
8255	450p
8257	900p
8259	950p

TMS9918	POA
Z80PIO	600p
Z80AP10	700p
Z80CTC	600p
Z80ACTC	700p
Z80ADART	£15
Z80S10-1	£24
MC1441L	1100p
UART	
AY-3-1015P	450p
AY-5-1013A	400p
IM6402	450p
CHARACTER GENERATORS	
3257ADC	990p
RO-3-2513 U C	600p
RO-3-2513 L C	700p
SN74S262AN	£10
KEYBOARD ENCODER	
AY-5-2376	700p
CRYSTALS	
32.768KHz	250p
100KHz	300p
200KHz	370p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	325p
2.00MHz	325p
2.45760MHz	325p
3.276MHz	300p
3.579MHz	175p
4.00MHz	290p
4.194MHz	POA
4.43MHz	125p
5.0MHz	325p
6.0MHz	300p
6.144MHz	300p
7.0MHz	300p
7.168MHz	300p
8.00MHz	300p
8.867MHz	300p
10.00MHz	310p
10.7MHz	300p
12.0MHz	350p
16.00MHz	350p
18.00MHz	350p
18.432	350p
19.968MHz	390p
26.690MHz	350p
27.145MHz	325p
38.6667MHz	350p
48.0MHz	300p
55.5MHz	400p
116.0MHz	350p

LOW PROFILE DIL SOCKETS BY TEXAS					
8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	20p	28 pin	30p
16 pin	11p	22 pin	22p	40 pin	40p

ZERO INSERTION FORCE SKT 24 pin £7

WIRE WRAP SOCKETS BY TEXAS					
8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

HEADER PLUGS	
14 pin	50p
16 pin	60p
24 pin	100p

SOFTY: Ideal Software/Hardware Development tool. Using SOFTY you can develop your Programmes, Debug/Verify and then commit them to EPROM
KIT £100 BUILT AND TESTED £125
Also available Expansion Board for Programming single rail (+5v) EPROMS. **Ready built £40**

MINI FLOPPY DISC DRIVE MECHANISM: Teac Type FD-50A 40 track 5¼" Double/Single Density drives **£150**

FLOPPY DISC CONTROLLER: FD1771 **£24**, FD1791 **£36**

EPROM ERASERS: Type UV140. Will erase up to 14 EPROMS in approx. 20 mins. Has slide-in tray for safe use. MAINS and ERASE Indicators **£61.50**

MICROPROCESSOR TRAINER (as described in current issue). A complete kit of all parts available (excluding PCB and the case). Will include Pre-programmed 2716. Price on application.

Packing and Postage on all above £3.00 min. per item. All prices exclusive of VAT.

VEROBOARDS 0.1 (copper clad)	
2.5×3.75"	65p
2.5×5"	75p
3.75×3.75"	75p
3.75×5"	86p
3.75×17"	340p
4.75×17.9"	420p
Pkt of 100 pins	50p
Spot face cutter	86p
Pin insertion tool	118p
Vero Wiring Pen	

ANTEX SOLDERING IRONS	
C-15W	415p
CX-17W	425p
CCN-15W	425p
X25	440p
SPARE BITS	
C/CX/CCN	50p
X25	50p
SPARE ELEMENTS	
C/CX/X25	180p
CCN	200p

COUNTERS		TTL & ECL	
74C925	550p	MC4024	325p
74C928	600p	MC4044	325p
ICM7216B	2000p	10116	70p
ICM7217A	850p	10231	350p
ZN1040E	700p		

★ SPECIAL OFFERS ★

	1-24	25-99	100
2114-4L (450ns)	2.00	1.80	1.60
2708	3.90	3.75	3.50
2716 (+5V)	5.00	4.50	4.00
4116-2L (200ns)	2.00	1.80	1.60

BOOKS by TEXAS INSTRUMENTS

TTL Data Book (700 pages)	£6.80
Power Semiconductor Data Book (600 pages)	£4.50
Linear Control Data Book (368 pages)	£3.00
Software Design for Microprocessors (400 pages)	£11.00
The Great Int'l Maths on Keys (208 pages)	£3.50
Understanding Microprocessors (240 pages)	£3.50
Understanding Solid State Electronics (240 pages)	£3.50
Understanding Digital Electronics (240 pages)	£3.50
Understanding Communications Systems	P.D.A.
Others: TTL Cook Book	£7.25
CMOS Cook Book	£7.75
Microprocessor Interfacing Techniques	£9.95

Please add 70p P&P on each book (NO VAT)

BREADBOARDS	
EXP300	£575p
EXP350	315p
EXP600	630p
EXP650	360p
PB6	920p
PB100	1180p
PB102	2295p
PB103	3445p

THANDOR TEST EQUIPMENT

DM235 Digital Multimeter	£50
DM350 Digital Multimeter	£69
TM352 Hand Held DMM	£48
TF200 Frequency Meter	£145
TG105 Pulse Generator	£81

P&P £2.50 per item + VAT

We carry a large stock of 74 and 74LS TTLs, CMOS, Linears, Memories, etc. and can normally offer ex-stock deliveries. We welcome inquiries for volume quantities both from local and overseas buyers.

NEW RETAIL SHOP
367 Edgware Road, W2
Open: 9.30—5.30

Please add 30p P&P & VAT 15%.
Government, Colleges, etc. Orders accepted.
CALLERS WELCOME
Mon Fri 9.30-5.30
Saturday 10.30-4.30

TECHNOMATIC LTD.

17 BURNLEY ROAD, LONDON NW10
(2 minutes Dollis Hill tube station) (ample street parking)
Tel: 01-452 1500/01-450 6597 Telex: 922800

The Oscilloscope

There's no substitute for 'looking inside' a circuit when you really want to know what's going on. The oscilloscope must surely be the most versatile electronic instrument ever invented. Les Bell and Roger Harrison take you on a guided tour, from how they work to what type to buy

ONE OF THE BIGGEST barriers people face when they take up electronics is cultivating the ability to visualise what is happening in a circuit. It is fairly easy to work out the DC conditions in a circuit, but electronic circuits are generally dynamic in nature; that is, the voltages and currents in a circuit change according to an applied signal or function of the particular circuit (as in amplifiers and oscillators, respectively).

The problem is, you can't *see* what's happening! The "good books" may tell you what happens *ideally*, but the real world is very often quite different.

What's needed is some kind of 'window' into the circuit, to enable you to 'see' what's happening, to get that intuitive 'feel' which will make understanding that much easier. The window is, of course, the oscilloscope. Without it, the circuit designer may very well be 'blinded'.

Oscilloscope Basics

The heart of a Cathode Ray Oscilloscope (CRO) is the *cathode ray tube* (**Fig. 1**). It consists of an evacuated, tubular glass envelope, flared at one end. In the tubular portion, or the neck, is an "electron gun". This generates a narrow, focused beam of fast-moving electrons which are directed towards the flared end, past a set of parallel plates (the deflection plates), the large end of the tube being covered in a special coating (on the *inside*) called the 'phosphor'. When the electrons strike the phosphor, it emits light ('fluoresces') and you see a spot. Spot deflection is achieved by varying the electrostatic field between the deflection plates. Some CRTs use electromagnetic coils around the neck of the tube for spot deflection (TV tubes for example!)

The electron gun contains a *heated cathode* (K) which 'boils' off electrons. These are attracted to an *anode* (A_1) which is very much more positive than the cathode, at least several thousand volts. As they accelerate towards the anode, the electrons pass through a *control grid* (G), which is a cap of metal around the cathode and somewhat negative with respect to it. This electrode is used to control the brightness of the spot. If the negative potential on G (with respect to K) is increased, fewer electrons will pass and the spot brightness will decrease, and vice-versa.

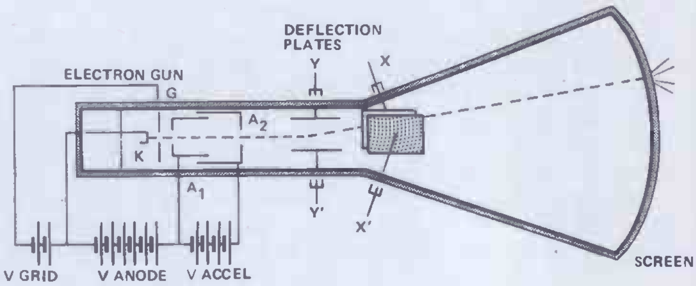


Figure 1. The internal structure of a typical cathode ray tube.

Between the control grid and the focusing grid there may be a second grid, the *screen grid*, which is usually around 300 V positive. Following the *focusing anode* (A_1) there is usually a *second anode* (A_2). Voltage on the final anode is very high — usually several thousand kV. Alternatively, between the control grid and the second anode, there may be an *Accelerator* electrode (sometimes called a 'pre-accelerator') at the full final anode voltage. This arrangement constitutes a focusing scheme called an 'einzel lens'. Varying the potential between K and A_1 will vary the spot size. This is used to focus the spot.

The result of all this accelerating and focusing is a well-focused, high energy beam of electrons travelling straight down the centre of the tube. To deflect the electron beam and create a display, a pair of electrostatic deflection plates are provided for each axis (X and Y). An electric field will deflect the electron beam, providing spot movement over the face of the tube.

The electron beam passes between the plates in order to be deflected, but after the first set of plates the beam can be anywhere in quite a large area. This means the second set of plates must be larger, with an associated increase in capacitance. Usually, the vertical deflection plates come first, since the Y channels require greater bandwidth, while the X channel or timebase requires a lower bandwidth.

Following the deflection electrodes, many electrostatic CRTs have a *post-deflection accelerator* which usually takes the form of a graphite spiral around the envelope funnel between the neck and the face of the tube.

Tube Types

Electrostatic deflection types are commonly employed in measuring instruments as they offer much greater bandwidth operation than magnetic deflection tubes which are principally limited by yoke inductance. On the other hand, electrostatic deflection tubes are limited to beam deflection angles less than 20° off axis while electromagnetic systems can achieve a maximum deflection of ± 55°. This is why oscilloscope tubes (electrostatic types) are so much slimmer than TV tubes (which use magnetic deflection) of similar length.

Some demonstration and teaching oscilloscopes use standard TV tubes with magnetic deflection. Whilst the display is much larger than a standard oscilloscope, the bandwidth limitations allow them to display only signals generally less than 100 kHz. Oscilloscopes using electrostatic CR tubes may have bandwidths of 10 MHz commonly, and up to 100 MHz without using special techniques.

The general purpose of an oscilloscope is to examine voltages (or sometimes currents) as they change with time. There are other modes of operation, but as this is the fundamental one, let's start with it.

In order to display a waveform that is varying with time, we must draw the 'spot' across the face of the tube, from left to right, return to the starting point and repeat. To do all this, the voltage impressed on the X deflection plates is increased at a linear rate with time, to draw the spot from left to right, then reduced to zero (or the starting voltage) suddenly to return the spot to the starting point, and so on. This establishes a 'time base' as the spot takes a known amount of time to travel from left to right across the screen.

At the same time, the waveform to be examined (suitably amplified) is applied to the Y direction plates. The spot will then trace out a graph of the waveform on the CR tube screen as shown in **Fig. 2**.

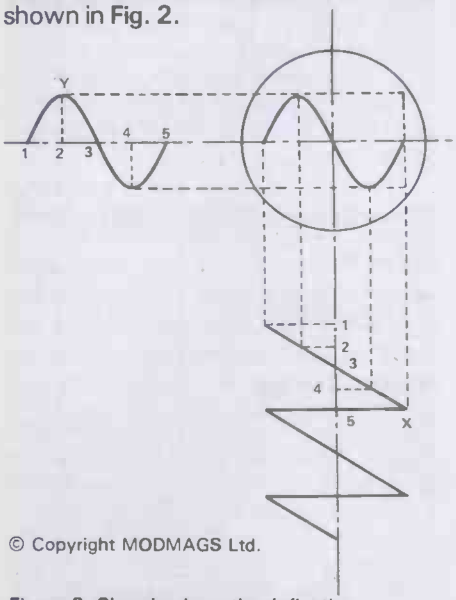


Figure 2. Showing how the deflection waveforms applied to the X and Y plates of a cathode ray tube cause the electron beam spot to trace out a faithful replica of the Y-input waveform.

If the time taken for the spot to travel across the screen has a definite relationship to the frequency of the waveform being examined and if the start of the trace (at the left-hand side) is arranged to commence at some definite point on the waveform (ie synchronised), then a stable trace will result on the screen.

For example, say we wish to display two cycles of a 50 Hz mains voltage. The horizontal deflection, or timebase, would have to 'sweep' the spot from left to right in the length of time it takes to complete two cycles at 50 Hz — 40 mS. The timebase would make 25 sweeps per second: that is, it would be running at 25 Hz.

In a practical oscilloscope, during the 'return' sweep of the X deflection (the 'flyback'), the electron beam of the CR tube is turned off, or 'blanked', so that it is not displayed — otherwise, the resultant sqiggle would become confused with the desired display!

The signal applied to the X deflection plates of the CR tube is often referred to as the 'sweep' voltage, or just 'the sweep', although the term 'timebase' is generally more common.

Oscilloscope manufacturers include a 'graticule' on the screen of their instruments as a convenient reference, enabling quite accurate time and amplitude measurements to be made. The graticule may be a transparent plastic cover placed over the CR tube face, scored with grid lines at convenient intervals (generally 10 mm) or, as in the more expensive types, it may be scanned directly on the face of the CR tube during manufacture. The latter provides a more accurate reference than having a separate, external graticule.

The general form of most general-purpose oscilloscopes is shown in **Fig. 3**. As you can see, there are four basic components: the Cathode Ray Tube, the Vertical Circuits, the Horizontal Timebase Circuits and the Power Supplies.

The Timebase and X Amp

So that waveforms of widely varying frequencies can be displayed, the timebase must be variable over a very wide frequency range. Accordingly, oscilloscopes are made with the timebase 'range' switched at convenient increments. The actual ranges included on an instrument depend on the applications for which it is intended, but typically the minimum sweep rate may be 20 s for a full sweep (generally 2 s/division) ranging up to a maximum of 1 us for a full sweep (0.1 us/division). The range steps generally go in intervals of 5, 2, 1. A vernier control is always provided so that a display may be varied for some convenient purpose.

The timebase generator provides a 'sawtooth' waveform (that's what it resembles) for the X deflection. This is amplified and applied to the X plates of the CRT. The 'width' of the timebase deflection on the CRT depends on the amplitude of the sweep waveform. Thus a *width* control may be provided by having a potentiometer to control the gain of the X amp. A DC voltage or bias applied to the X plates will determine the horizontal *position* of the trace on the CRT face. Thus, a potentiometer to vary the DC bias on the X plates is provided as a *horizontal position* control.

So that the timebase generator may be synchronised to the waveform being examined (to provide a stable trace as explained previously), a 'trigger' circuit is included. The timebase may be triggered internally by sampling some of the signal going to the Y deflection plates or from an external signal. This is very convenient in particular applications which are explained later.

For some particular applications (phase measurement, frequency comparison) a sawtooth sweep is undesirable for X deflection, so that direct access to the X amp is required. For this purpose the input of the X amp can be switched to a front panel socket generally marked *horizontal input* or an abbreviation of the same.

The Vertical Or Y Amp

The signals one may wish to examine might range from microvolts to hundreds of volts! The lower level signals will require amplification (as the deflection voltages required may be tens of hundreds of volts), the higher level signals will require attenuation. Accordingly, a *sensitivity* switch is provided ahead of a high gain, low distortion amplifier — the Y amplifier.

The most sensitive range of common oscilloscopes is typically 5 mV to 10 mV per centimetre (one graticule division). More expensive types may have a maximum sensitivity as high as 10 uV/cm. The insensitive end of the range will generally be around 50 V/cm for run-of-the-mill CROs but special instruments (eg: those used for electrical supply applications) provide for levels as much as ten times higher. As with the timebase range control, sensitivity steps are generally 5, 2, 1 intervals. A *vernier* sensitivity control is provided for convenience.

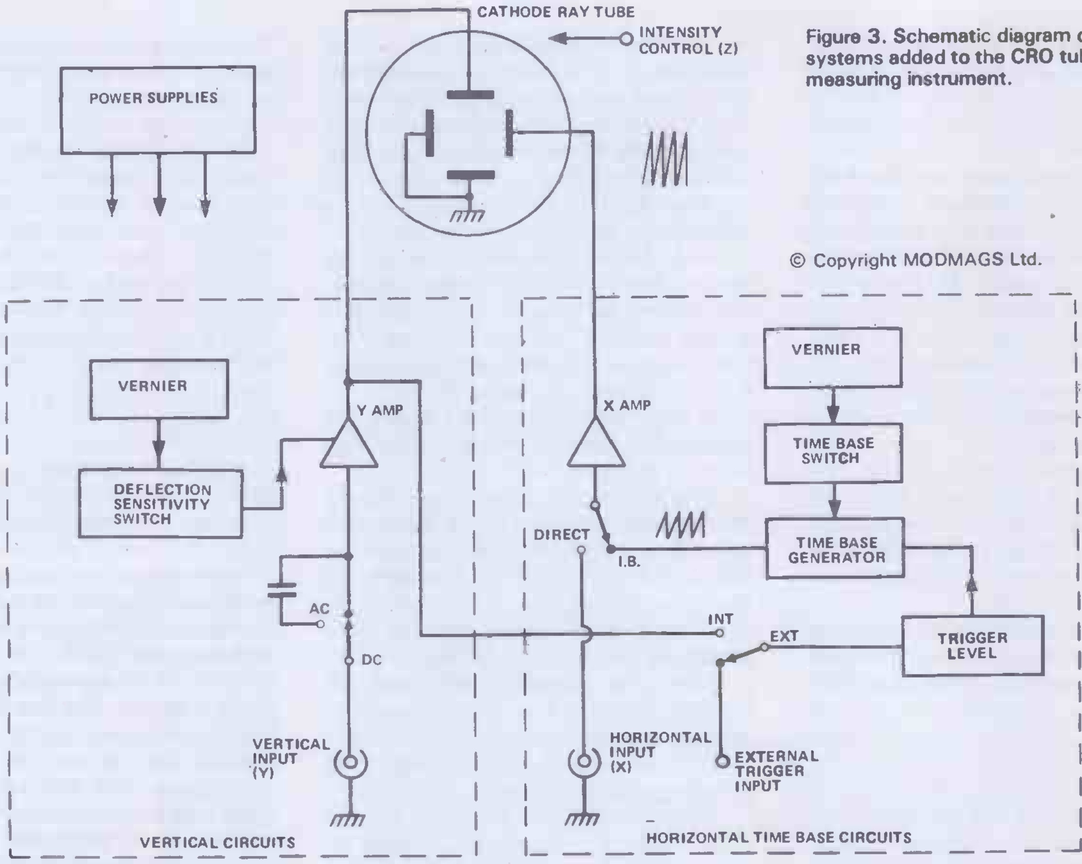


Figure 3. Schematic diagram of essential sub-systems added to the CRO tube to make it a measuring instrument.

The bandwidth of the Y amp is an important factor in the selection and application of an oscilloscope. A general purpose instrument may have a bandwidth extending from DC to 10 MHz or 15 MHz. Inexpensive units may only extend to 3 MHz. Magnetic deflection units (generally for demonstration or teaching applications) may only reach 20-50 kHz, few struggle as high as 100 kHz. High quality instruments (££££!) may have bandwidths as great as 350 MHz. Special instruments, using 'sampling' techniques, may reach 1 GHz (1000 MHz!).

To examine AC waveforms superimposed on a DC voltage, the Y amp must be AC-coupled. Accordingly, a switch is provided that inserts a capacitor in series with the input.

The range of input sensitivity may be extended by the use of *probes* which can provide such facilities as very high voltage attenuation and increased input impedance.

The *vertical position* of the trace is determined by a DC bias applied to the Y plates of the CRT, in the same manner as for the X plates.

The Z Input

If 'Y' represents the vertical axis and 'X' represents the horizontal (time) axis, then what on earth is the 'Z' axis?

The only thing left to vary on a CRT display, after moving the spot vertically and horizontally, is the intensity of the spot. Accordingly, most CROs will include a *Z input*. In general this allow for *blanking* and brightening of the display or for making particular types of measurements.

That completes the description of your 'basic' oscilloscope.

Dual-Trace Operation

It is often helpful to be able to display two waveforms at the same time — for example, to measure the phase change on a signal passing through an amplifier stage. This can be achieved in two different ways.

One can simply build two completely separate guns and two sets of deflection plates into a single CRT envelope. These dual-beam CRTs are complex and expensive, and they require two completely separate sets of drive amplifiers — more expense.

The alternative used in most modern dual-beam scopes is 'dual-trace' operation in which a single-beam tube is used to display two traces by switching between them. Two methods of beam-switching are used; one can either switch between traces at the end of each sweep, which is suitable for high-frequency waveforms, or at lower frequencies one can switch alternately between the waveforms as the sweep progresses across the display. The first method is called *alternate trace*, the second is *chopped trace* operation.

These basic principles apply to all oscilloscopes, except some types which are intended for specialised applications. Of course, oscilloscopes are more complex than this in practice. Perhaps the best way to see some of the more sophisticated facilities is through the controls on the front panel of an oscilloscope of medium complexity.

Choosing (Not Using) A Scope

There comes a time in every young man's life when he can't figure out what on earth the circuit's doing, so he decides to buy an oscilloscope. Of course everyone has different requirements — digital circuitry, RF, high fidelity, process control, computer equipment — these applications all have widely varying characteristics — so what should one look for when evaluating the performance of a CRO?

The most obvious consideration is bandwidth. The bandwidth of a general purpose oscilloscope is the frequency at which the total gain of the oscilloscope is 3 dB down on its mid-band performance. There are several limitations on the bandwidth of an oscilloscope, ranging from the bandwidth of the amplifier stages themselves to the time which the electron beam takes to pass between the deflection plates and the amount of energy required to make the phosphor glow. For example, if the input waveform goes through a complete cycle during the time that an electron is passing between the plates, then the deflections will average out, giving a net deflection of zero!

In the DC mode, there is no problem with low frequencies right down to DC, particularly when using long-persistence phosphors. The bandwidth figure given in specifications is therefore the upper frequency limit of the scope.

Closely related to bandwidth is the risetime of the scope. This is the time taken for an input square (really square) wave edge to go from 10% to 90% of its value on the screen. Unfortunately, on high performance CROs, this is well nigh impossible to measure. It is usually calculated from the bandwidth instead, using the formula:

$$\tau = 0.35/BW$$

The vertical amplifier system of a scope should ideally have a risetime five or more times faster than the risetime of the fastest signal it is intended to examine. In this case risetimes measured on the scope will have less than 2% error.

It is generally important to get the highest bandwidth and fastest risetime your money will allow. When examining a square wave signal, for example, Fourier analysis tells us that the square wave is actually composed of a series of harmonics of the fundamental frequency.

If the vertical amplifier and tube of a scope lop off the fifth and higher harmonics, the square wave will be noticeably rounded. In this case, risetime measurements will be virtually meaningless.

Glitches in digital circuitry will virtually disappear on the narrow bandwidth CRO rendering it almost useless for digital troubleshooting. Thus, although you may be working with quite slow logic, a high speed scope is still very useful. For a typical hobbyist, with no specific requirements or interests, a 15 MHz oscilloscope would probably be ideal.

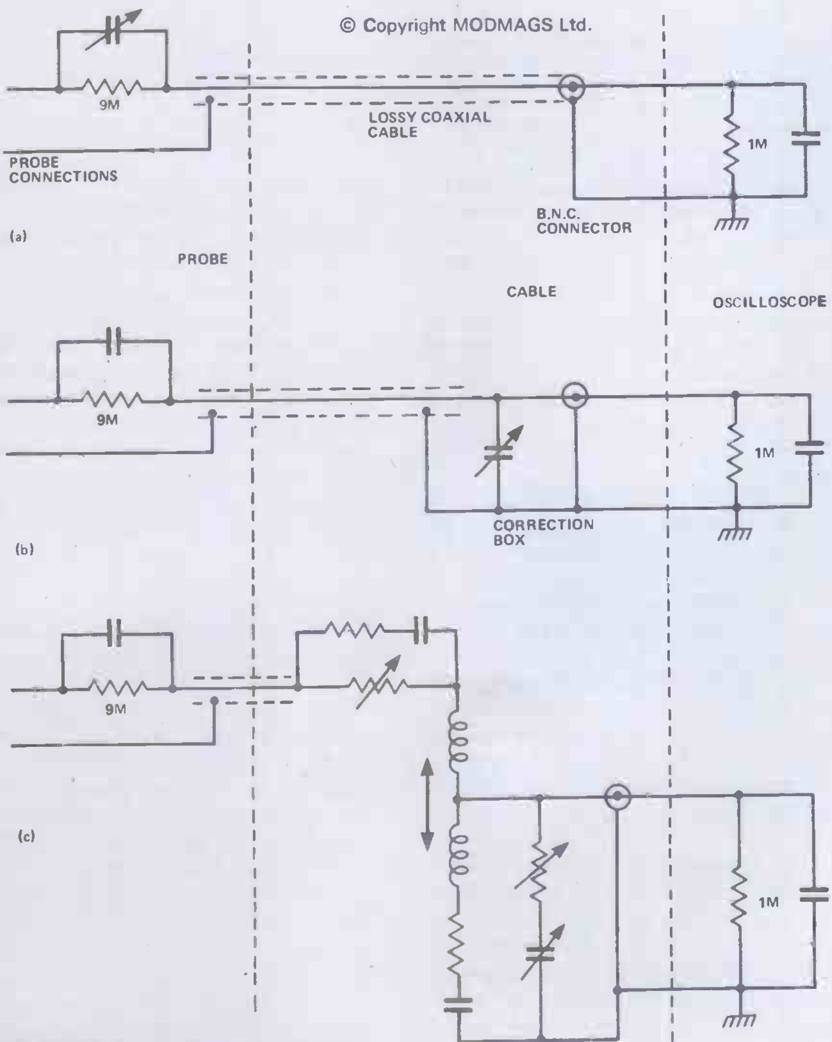


Figure 4. Schematic of attenuator probes (a) simplest concept (b) capacitive loading to extend bandwidth (c) inductive.

Probes

A point to watch for, particularly with high frequency scopes is the selection of suitable probes. The capacitance of the probe leads can severely limit the bandwidth of an instrument so it is essential to use the appropriate probes.

Most oscilloscopes have an input resistance of 1MO and x1 probes will give this resistance at the probe tip plus a capacitance which is in parallel with the scope input capacitance (usually around 20-30pF). For higher input resistance, x10 probes are available. They include a 9MO resistor, thus raising the input resistance to 10M.

Probes require compensation for capacitance effects which limit their bandwidth. For very wide bandwidth operation, complex compensation networks may be used. Typical probe circuits are illustrated in Fig. 4.

Sensitivity and Accuracy

The sensitivity of an oscilloscope is usually expressed in mV/cm or mV/div, and in general, a higher sensitivity scope is more useful than an insensitive one.

Accuracy, in the absolute sense, is probably less important than with other pieces of test equipment, as an oscilloscope is generally used for qualitative analysis. Most oscilloscopes have an accuracy of ± 5%, but as one moves into a laboratory, as opposed to service/general purpose machines, ± 3% accuracy is more common. It is tempting to suppose that by buying a more accurate oscilloscope, one could save money on other test equipment, but this is not the case. Modern digital test equipment is now quite cheap, while accurate oscilloscopes are not, even leaving aside the inconvenience of making measurements by counting divisions on the graticule.

Other Facilities

In deciding on an oscilloscope, several other factors ought to be taken into consideration. The obvious question is:

will I need a dual-trace scope? There is very little to be said about this choice; you pays your money (as much as you can afford) and you takes your choice. Single-trace scopes are becoming quite rare beasties, in fact, as the dual-trace types are considerably more versatile.

The triggering facilities of a prospective purchase should also be carefully examined. It's probably true to say that poor triggering on a scope can render it the greatest bugbear of the user's life — virtually useless, in fact.

Unfortunately, there is no universal way to specify the triggering performance of an oscilloscope. It is best to arrange a demonstration, either by the dealer or by an associate or friend who has used the oscilloscope in question. In any case, it is generally wise to ask around for other users' impressions when considering such a major purchase.

A useful facility on some oscilloscopes is the provision of two timebases with delayed sweep facility. In this mode of operation, for the first timebase, the delaying sweep is triggered by the trigger circuitry, and continues for selected delay time. When this time is reached, the second timebase takes over (usually at a higher speed), providing accurate resolution of an event which can occur some time after the trigger event.

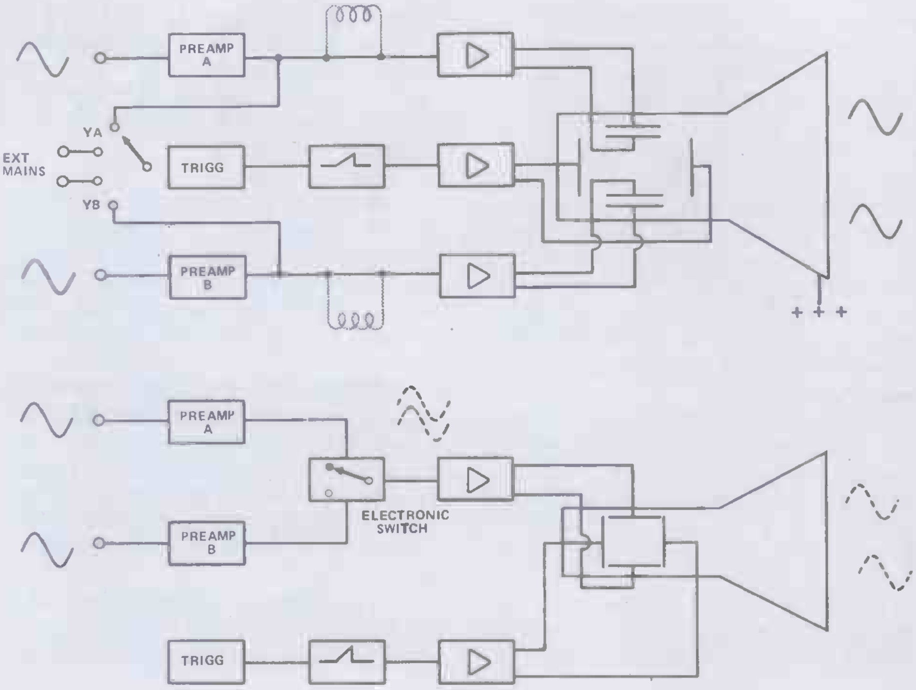
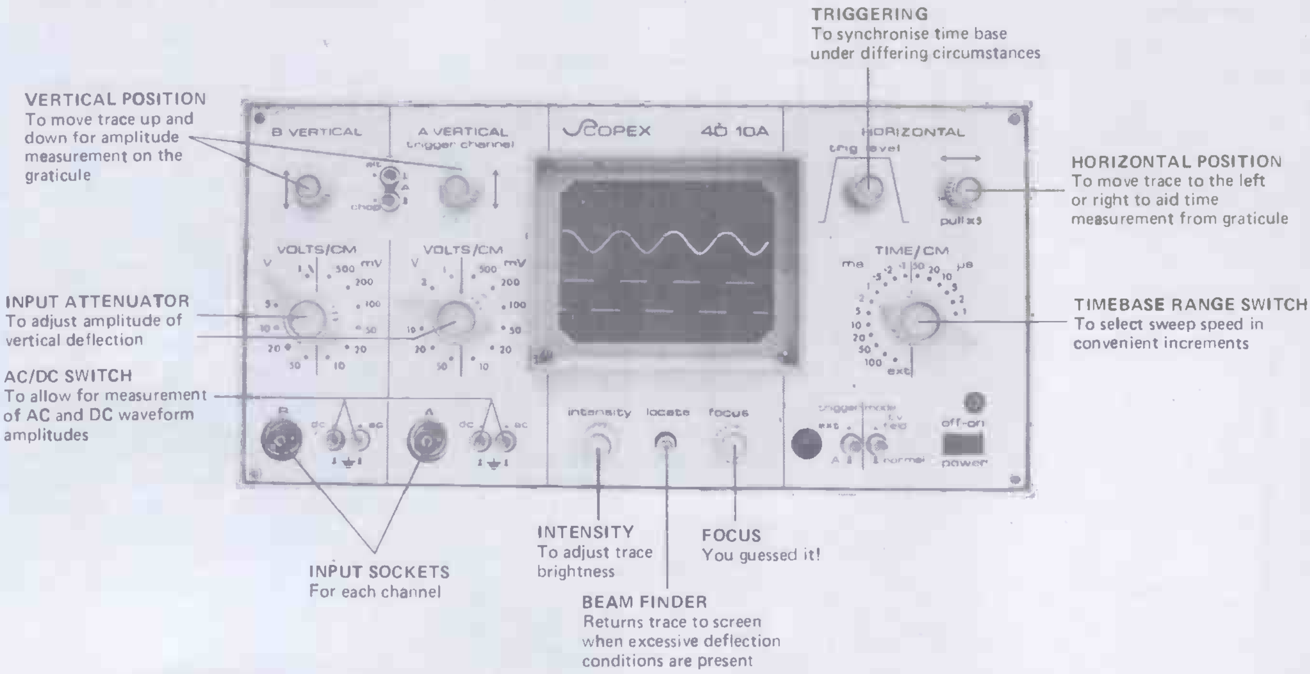


Figure 5. Dual-trace oscilloscopes can be implemented in two ways: using a dual beam cathode ray tube or using a single beam tube and electronic switching of the trace. The block diagram at the top is of a Philips model 3232 and is typical of dual-beam types. The block diagram at the bottom shows the electronic switching technique of obtaining dual-trace operation with a single beam cathode ray tube.



A typical oscilloscope front panel layout, showing the positions of the major controls.

HE

OSCILLOSCOPE
EXCLUSIVE OFFER for HE readers

NOW'S your chance to own the most valuable aid to the electronics hobbyist — AN OSCILLOSCOPE. With a screen size of 75 mm and a bandwidth of DC to 5 MHz the Kikusui 538A will enable you to 'see' how circuits are working *instantly*.

Apart from the CRT, semiconductors are used throughout the circuit: the 'scope is ready to operate in under 20 seconds. It comes complete with operating manual containing full details of operation, maintenance, calibration and circuits. All-inclusive cost of the 538A, *delivered to your door*, is only **£95**.

Don't miss this chance to own a high-quality 'scope . . . and choose between TWO methods of payment: Barclaycard or cheque

BRIEF SPECIFICATION

Vertical Deflection	
Voltage sensitivity	< 10 mV/division
Bandwidth	**AC** 2 Hz to 5 MHz **DC** DC to 5 MHz within – 3dB
Input impedance	1M0 ± 5% within 35 pF
Ext. Horizontal Amplifier	
Voltage sensitivity	< 250 mV/division
Input impedance	1M0 10% within 35pF
CRT	75 mm (2.95") round screen, green phosphor
Power Requirements	
Voltage	100, 110, 117, 220, 230, or 240 VAC, 50 to 60 Hz
Wattage	about 10 VA
Dimensions	202 mm wide by 160 mm high by 305 mm deep. (7.9 by 6.3 by 12")

Enter your Barclaycard number in the space provided on the coupon, add your signature, name and address — and we'll do the rest

Enter your name, address and the amount in the coupon and send it with your cheque, made payable to Modmags Ltd.

Please also specify the number of 'scopes you require

SEND ALL ORDERS TO:
HE Scope Offer,
Modmags Ltd.,
145 Charing Cross Road,
LONDON WC2H 0EE

Please note that the offer applies to UK mainland only: allow 28 days for delivery

I WISH TO PAY
BY BARCLAYCARD
PLEASE CHARGE TO MY ACCOUNT
MY BARCLAYCARD NUMBER IS:

I enclose a cheque for . . . .
for . . . . Kikusui 538A Oscilloscope/s

SIGNATURE . . . .

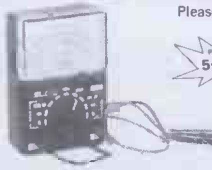
NAME . . . .
(BLOCK CAPITALS)
ADDRESS . . . .

. . . .

Multitesters 100,000 opv

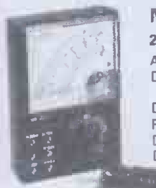
AC volts:- 0 — 5 — 10 — 250 — 1000
DCvolts:- 0 — 05 — 25 — 10 — 50 — 250 — 1000
DCcurrent:- 0 — 10ua — 25ua — 500ua — 0 — 5 ma — 50 ma — 500 ma — 10 amp
AC current:- 10 amp
Resistance:- 0 — 20 ohms — 200 ohms — 5 K ohms — 200 K ohms — 50 K ohms — 200 K ohms — 5 meg ohms — 50 meg ohms
As a transistor tester
HFE:- 0 — 5 (NPN) — PNP)
ICO:- 0 — 5 ua (NPN — PNP)
Dims:- 178x 140 x 70 mm
Please add 30p P.P. per unit order as MT 20

PRICE



PRICE 5·95 INC VAT

Multitester
1,000 opv
AC volts:- 0 — 5 — 150 — 500 — 1000
DC volts:- 0 — 15 — 150 — 500 — 1000
DC current:- 0 — 1 ma — 150 ma
Resistance:- 0 — 25 K ohms — 100 K ohms
Dims:- 90 x 61 x 30 mm
Please add 30p P.P. per unit order as MT



Multitester
20,000 opv
AC volts:- 0 — 10 — 50 — 100 — 250 — 500 — 1000
DC volts:- 0 — 0.5 — 5 — 25 — 125 — 250 — 500 — 1000
DC current:- 0 — 50 ma — 0.5 ma — 250 ma
Resitance:- 0 — 3 K ohms — 300 K ohms — 3 meg ohms
Deibels:- — 20 to +63 db
Dims:- 127 x 90 x 32 mm
Please add 30p P.P. per unit order as MT 7

PRICE 13·50 INC VAT

Headphones
High velocity mylar diaphragms. Coiled lead.
Finished in a combination of bright aluminium.

Impedence:- 8 ohms
Frequency response:- 15 — 22000 HZ
Weight:- 350 gms

Please add 30p P.P. per unit order as PH 12

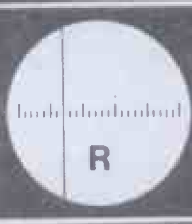
PRICE 9·95 INC VAT

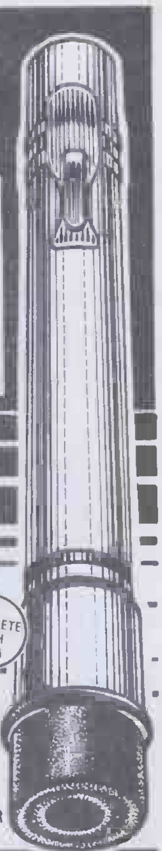
ARROW AUDIO CENTRE

20 NORTH BAR BANBURY OXON OX16 OTF.
TELEPHONE BANBURY (0295) 3677
TERMS: CHEQUE/PO WITH ORDER. CALLERS WELCOME

RADIATION DETECTORS

QUARTZ FIBRE DOSIMETER





Recommended for CIVIL DEFENCE ● FIRE SERVICES ● MEDICAL ● HOSPITAL & General use.

- RADIATION CANNOT BE HEARD, SEEN OR SMELT.
- THIS DOSIMETER WILL AUTOMATICALLY DETECT THE AMOUNT OF RADIATION IN THE AIR.
- UNIT IS SIZE OF FOUNTAIN PEN AND WILL CLIP IN TOP POCKET.
- PRECISION INSTRUMENT, METAL CASED, WEIGHT 40 GRAMS.
- CONTAINS 3 LENSES. ■ RUGGED CONSTRUCTION.
- MANUFACTURERS CURRENT PRICE OF A SIMILAR MODEL OVER £25 EACH.

COMPLETE WITH DATA

British design and manufacture. Tested, calibrated and guaranteed. Ex-stock delivery by return.

Be prepared, buy whilst available.

Standard model
£6.95 inc.VAT
Post & Packing 60p
Industrial model O-150R £10.95 incl. Post Paid

HENRY'S

404 EDGWARE ROAD, LONDON W2 1ED
Tel: 01-723 5095 Telex: 262284 Ref 1400

MOTORS. 1.5V Model motors 22P. Sub. min. "Big Inch" 115V DC 3 rpm motor 32p. Replacement 8 track 12V DC motors 55p. 115V AC 4 rpm motor 95p. 9V DC Cassette motors 95p. 6V Cassette motors, new standard jap. type £1.25.

BUZZERS. Miniature solid state type, 2 voltages available, 6 or 12 vdc 75p each. LOUD 12 volt buzzer 50×30mm 63p. Carters 12V DC Mosinite alarm sirens £7.65. 12V DC SIREN, all metal rotary type, high pitched wail, £8.50. Rotary alarm siren, 12V DC, red plastic unit with mounting bracket, 68 × 75mm £4.50.

RELAYS. 2 types both operate on 12V DC, sealed plastic cased types. 1—350 ohm with 2 make 5 amp contacts 75p. 2—1,600 ohm with 2 changeover 1 amp contacts 75p.

SPECIAL OFFER SEMICONDUCTORS. 2N5062 SCRs 18p. BX504 opto isolator 25p. CA3130 95p. CA3020 45p. TDA1151 25p. 741 22p. 723 35p. NE555 24p. NE556 50p. CD4069 15p. IN4005 10 for 35p. BD238 28p. 60438 28p. 741S 35p. ZN414 75p. MANSA 3mm LED displays 45p. Min. LDRs 30p. LEDS 0.2" CLEAR 15p. GREEN 12p. RED 10p. Infra-red clear LED 30p. MPU131 PUTs. 40V, 200ma, 375mW 15p. 2N3773 £1.70. Texas R1038 (TO3) Power trans. 50p. TAG4443 SCR 45p.

NEW STOCK ITEM — We are now stocking Expo mini hand-held drills, these are a precision British-made tool, ideal for P.C. board drilling, model makers etc. They operate on 12V DC. Drill kit supplied in plastic hinged case, with drill and 21 accessories, drills, sanders, reamers, buffers, etc. complete kit only £14.25. Drill only £7.25. Drill stand to suit vertical drill press £12.95 (postage 65p).

S.W.R./FIELDSTRENGTH + POWER METRES. S.W.R. 1:1 to 1:3. R.F. power 0-100 watts freq. range 1.5 MHZ to 144 MHZ. 52 Ω IMPEDANCE. PL256 terminations size 6" × 2" × 2" £9.95
JACKSONS C804 50 PF variable tuning condensers. Standard ¼" spindle 50p each.

TOOLS. SOLDER Sucker, good suction, teflon nozzle, £4.99. Side cutters 5" £1.45. Pliers 5" £1.45. **NEON DRIVER** 8" LONG 59p. **MIYAMA** 16 pin IC TEST clip £1.85. **5 PIECE** precision screwdriver sets, individual handles, £1.05. **JUMPER TEST LEAD SETS** 10 pairs of leads with insulated crocs each end 90p. **CRIMPING TOOL**, a combination type for crimping red, blue and yellow terminations also incorporates a wire stripper (6 gauges) and wire cutter, insulated handles, only £2.30.

MICROPHONES. Min. Tie pin. Omi, uses deaf aid battery (supplied) £4.85. Low cost condenser: **ECM105** Omni. 600ohms, on/off switch standard jack plug £2.95. **EM507** Condenser, uni, 600ohms, 30-18kHz, highly polished metal body, £7.95. **EM704** stereo condenser mike, UNI-DIR, 600Ohms, 50-16000 HZ, internal windshield, 212 m/m long £12.25. **EM506** Condenser, cardiod, uni, 600ohms or 50k, heavy chromed copper case, £12.95. **DYNAMIC P.A.** Mike, mobile radio etc., thumb switch 50k imp. £3.75. **CASSETTE** replacement microphone with 2.5/3.5 plugs £1.35. **INSERT** crystal replacement 35×10mm 40p. **GRUNDIG** Electret inserts, with built in FET preamp 3-6V DC, £1.00.

LEO VU METERS. Utilise sophisticated logic control circuit with adjustable rise and decay times via external capacitor. Spec: Response —20Hz to 100kHz. Tolerance within ±1DB, operates on 12-15V DC, 82mm long, 54mm high.
MONO VERSION £6.95
STEREO VERSION £10.95

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

SURPLUS P.C. BOARD with 15 C106 8-CR's 4 reed relays, 22 numbered transistors, various diodes, resistors, etc. £1.10.

COPPER LAMINATED PRINTED CIRCUIT BOARD. Fibreglass Single Sided type (approx. 2mm thick) 150x95mm 40p. 200x90mm 55p. Double-sided Fibreglass 1mm thick, 180x135mm 45p. **PAXOLIN BASED TYPE:** (2mm thick), 180x135mm 40p. 280x200mm 50p.

TAPE HEADS. Mono cassette, £1.75. Stereo cassette £3.90. Standard 8 track stereo £1.95. BSR MM 1330 ½ track 50p. BSR SRP90 ¼ track £2.10. TD10 dual head assembly 2 heads both ½ track R/P with built in erase £1.25.

SWITCHES. Sub. min. Toggles. SPST 8×5×7mm. 42p. DPDT (8×7×7) 55p. DPDT Centre off (12×11×9mm) 77p.

PUSH SWITCHES (16×6mm), red top, push to make 15p each, push on break version black vinyl 17p each.

SLIDE SWITCHES all DPDT 15×8×12mm 13p. 16×11×9mm 13p. 22×13×8mm 13p. 22×13×8 centre off 14p. Multipole slider double achea (12 tags) 29×9×11mm 25p.

ROTARY SWITCHES (wafer) 3P4W, 4P3W, 2P6W and 1P12W all 35p each.

10 pin D.I.L. SWITCHES only 42p each.

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

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

MOTOROLA PIEZO ELECTRIC TWEETERS
3" direct radiating type £3.65

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

SUPER HORN version, flush flange 3½". £4.50.

RANK ARENA stereo cartridge preamplifier modules, suitable for magnetic cartridges, new, supplied with connection details, £1.95.

FINNED HEATSINKS. Supplied undrilled 4mm thick, 27mm high, 75×124mm 60p. 150×124mm 95p. Smaller version 2.7mm thick, 75×108mm 48p. **TRANSISTOR SOCKETS** TO5 or TO18 9p each, TO3 type 15p each.

ALUMINIUM PROJECT BOXES. 18 S.W.G. with fitted lid and screws. AB1 3×2×1 52p. AB2 4×3×1.5in 62p. AB3 4×3×2in 66p. AB4 6×4×2in 74p. AB5 6×4×3in 92p. AB6 8×6×2in £1.05. AB7 8×6×3in £1.25.

ANTEX SOLDERING IRONS. All 240V AC. Model C 15 watts £3.95. Model ICX 17 watts £3.95p. Model X25 25 watts £3.95p. ST3 SOLDERING IRON STAND, suits all Antex irons £1.65.

TRANSDUCERS. REC/SENDER, 40KHZ £3.50 pair.

TRANSFORMERS. All 240V DC primary (postage per transformer is shown in brackets after price). MINIATURE RANGE, 6-0-6V 100ma, 9-0-9V 75ma, 12-0-12V 50ma all 79p each (15p). 12V 200ma 75p (15p). 0-6 0-5 280ma £1.20 (20p). 6V 500ma £1.10. (22p) 12V 2A £2.35 (45p). 12-0-12 2A £2 75 (60p). 15-0-15V 1A £2.25 (45p). 30-0-30V 1A £2.85 (54p). 20-0-20V 2A £3.65 (54p). 0-12-15-20-30V 2A £4.75 (54p)

TRIAC XENON PULSE TRANSFORMERS. 11 (GPO style) 32p. 11plus 1 sub. min. pcb mounting 65p.

PROJECT BOXES. Sturdy ABS black plastic boxes with brass inserts and lid. 75×56×35mm 65p 95×7×35mm 75p 115×9×37mm 87p.

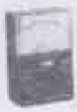
VERO HAND HELD BOX. White ABS. 24in × 3.7 in tapered, with screws 68p each.

VERO POTTING PLASTIC Boxes with lid and screws 70×50×20mm, black, 43p each.

35 WATT RMS STEREO SPEAKER SYSTEM. Woofer, Squawker, Tweater (controlled) in black heavy alloy cabinets. 7½"×4½"×4" £35.75 pair P&P £1.95.

SPECIAL OFFER DEMAGNETIZER. Curved probe type, suitable for reel to reel or cassette machines, operates on 240V AC only £1.95.

POWER SUPPLIES. Switched type plugs into a 13 amp socket has 3-4, 5-6, 7.5 and 9 volts 0 c out at either 100 or 400ma switchable £3.45. HC244R stabilised power supply 3-6-7.5-9V DC at 400ma, has polarity reversing and on off switch and is fully regulated to give exact voltage from no load to maximum current £5.50.



KRT101 M/Meter. 1,000 opv. IKV AC/DC Volts. 150ma DC current. Resistance 0-2.5k. 0-100K. £4.35.

NH55 M/METER. 2,000 opv IKV AC/DC Volts. 100ma DC., Resistance 0-10K. 0-1 MEG. £5.50.

YN360 M/METER. 20,000 opv., IKV AC/DC Volts. 250ma DC. 4 resistance ranges to 20 Meg., also has built-in transistor tester with leakage and gain ranges £12.50.

HANDY BENCH VICE. 1" jaw opening £2.95. 6"

MOTORISED ALARM BELLS, 65mA. 88dB £7.95.

AUDIOSONIC CAR STEREO CASSETTE PLAYERS. 3 watts per channel output. 4Ω output imp., autostop mechanism (Japanese) £12.50.

Terms. Cash with order (official orders welcomed from colleges etc) 30p postage please unless otherwise shown. VAT inclusive prices. S.A.E. for illustrated lists.

PROGRESSIVE RADIO

31 CHEAPSIDE, LIVERPOOL L2 2JD
ALL ORDERS DESPATCHED BY RETURN POST

Clever Dick

Potholers and nut cases, they're all here in this month's Clever Dick

WELCOME to the very first Clever Dick of 1981. May I take this opportunity (somewhat belatedly I fear) to wish you all the very best for the coming year and hope that you continue to keep your amazing letters coming.

So now, without more ado here's this year's first letter from W.Blackledge.

Dear CD,

Despite being impressed by the possibilities of the HE Minisynth, as a musician I am concerned with its limitations.

Is it necessary to programme all 32 notes of the sequence? If this is the case, only time signatures which divide evenly into 32 (or certain added combinations) will be possible. This imposes a limit on tune structuring, 5/4 and 9/8 time signatures being impossible (for example).

Therefore, is there any way in which the sequence may be reset after a chosen number of notes have been played?
W. Blackledge
Leeds

I think that possibly you have misunderstood the workings of the Minisynth. In the first place the memory facility can store *up to* 32 notes and spaces. You can of course make the sequence as long or as short as you need. The second point is that we never intended the Minisynth to be a serious musical instrument. Of course how it is ultimately used is up to the individual but to talk of its limitations is a little unfair. Remember this though, a semi-professional synthesiser will cost several hundred pounds. Ours, whilst nowhere near as complex as a commercial instrument costs under £30 to build youself.

Still with the Minisynth we have another letter in the same vein, this time from C.L.Hutchinson.

Dear Clever Dick,

After taking your mag from the start in November 1978, I have been waiting for a keyboard project in which the chords could be played, instead of these one note at a time things that keep cropping up. If there isn't one in the near future, could you tell me where I can get hold of a project that was in your sister mag (ETI) in July 1979, called 'String Thing'.
Yours every month.
C.L. Hutchinson
Rotherham

Firstly thanks for being a regular reader, you must be a man of taste. Your main point concerns our lacking of polyphonic musical instruments. There is a very good reason for this: in general it would be impossible for us to design one that would cost less to build than a commercially-available instrument. Our sister mag ETI does publish such designs, usually in conjunction with a manufacturer: the String Thing was a case in point. Backnumbers are sometimes available but it's always best to check by ringing the backnumbers department on 01-437 1002.

Our sister mag gets another free mention, this time from M. Broughton who has a problem.

Dear CD,

A couple of weeks ago I was feeling rich and silly and I was walking past my newsagents where I noticed an exceptionally large pile of ETIs (the one with the free PCB on the cover). On impulse I decided to buy sixty. I am now lumbered with fifty seven circuit boards (and three working projects) and I was wondering if anyone would like to buy them back. Please . . . Help!
M Broughton
Barnsley

Either you are a nutter or you're having us on. If you are a nut case then next time you're feeling rich and silly send your money to the Clever Dick Beer Fund c/o the usual address. Just in case you're serious if anyone writes to us asking for 57 November ETIs, we'll give them your address.

Oh well, back to more down to earth matters. (that's a rather feeble joke but you won't get it until you read the next letter from Pete Czerwinski).

Dear CD,

Here's a nice idea if I do say so myself (and I do).

I go potholing, and I use a lamp known as a carbide lamp. This lamp burns a gas called acetylene. The lamp, whilst giving a good light has some nasty disadvantages. It won't work underwater and is easily extinguished by drips of water and draughts. This leaves the poor potholer in the dark, and is, to put it mildly, a pain in the nether regions. My idea therefore is to use a small back up electric lamp controlled by a light (oops, lack of light) sensing switch. Thus when the carbide lamp goes out the circuit would sense the dramatic loss of light and switch on the back-up light. Suitable positioning of the photocell would be needed so as to only sense light from the carbide lamp. This would save potholers many an embarrassing situation. Do I get a binder?

PS. I use the HE Slave Flash Trigger when I go on photographic trips down caves. So far the unit has survived a trip down Pipkin Pot proving that HE projects go where no circuit has gone before. OK, so its a long letter, shoot me!
Pete Czerwinski
Sheffield

Wouldn't dream of shooting you, you've got enough problems without us adding to them. Now, I'm the first to admit that I know nothing about potholing but I find it difficult to believe that potholers rely on acetylene lamps — I thought these holes filled with gas. Oh well, I'll have to take your word for it. Your suggestion for an automatic back-up lamp sounds very sensible, the only modification I would suggest is to replace the opto sensor with a thermal sensor as the lamp could be prone to spurious triggering and the heat of the gas flame would provide a much more positive switching.

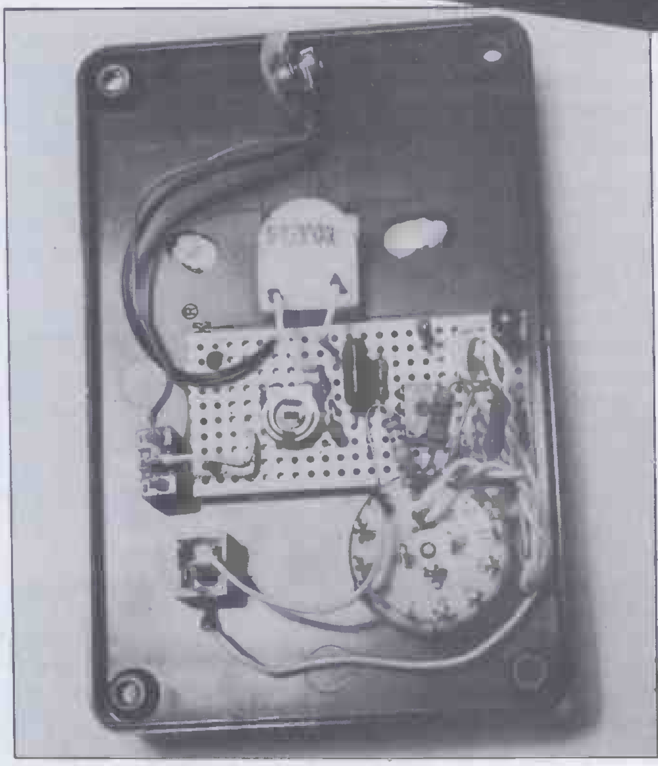
Before I go, I must remind you that we can't give written replies — unless it's life-or-death. Until next month, take care. **HE**

High-Impedance Voltmeter

A simple-to-construct and useful piece of test gear from HE

ALTHOUGH AN ordinary multimeter can normally be relied upon to tell the whole truth, complete truth, and nothing but the truth, it can sometimes give misleading results when making DC voltage measurements. The problem arises when making measurements on high-impedance circuits where there is a current flow of only a few uA or less. With most multimeters requiring about 50 uA to produce full scale deflection (FSD) of the meter, the current in the circuit under test is obviously inadequate to drive the meter. Thus there might be 6 V at the test point until the multimeter is connected, when the voltage could fall to less than a volt because of the loading effect of the meter. The meter would truthfully record this low reading, misleading the user.

This problem can be overcome by using our high-impedance voltmeter. This uses a current amplifier ahead of the meter circuit to reduce the input current requirement to a level that ensures reliable results when testing any normal circuit. It has three measuring ranges of 1, 10, and 100 V FSD and the input impedance is over 11 megohms.



Internal view of the project — everything fits on the inside of the case lid

Construction

The circuit is easily accommodated on one of our standard (24 by 10 holes 0.1" matrix) Veroboards using the component layout shown in **Fig. 2**. Resistors R1 to R3 are not mounted on the board as it is more convenient to mount them directly on SW1, as shown in the diagram.

The two mounting holes and breaks in the copper strips should be made before fitting the components and link wire to the board. As IC1 has a MOS input stage and is vulnerable to damage by large static charges it should be connected last, and should be left in its protective packaging until then. It should either be fitted in a socket or soldered in place using an iron having an earthed bit.

A large mounting hole in the case is needed for the meter, and plastic or aluminium cases can usually be cut quite easily using a fretsaw, or a coping saw. Another method is to drill a series of closely-spaced holes with an ⅛" drill within a pencilled outline of the hole. The centre piece is then removed with the aid of a small round file, which is also used to provide a smooth rim to the hole.

To calibrate the unit, switch SW1 to the 10 V range, adjust RV1 for maximum resistance (fully clockwise) and connect the positive input to the positive supply rail. Use a multimeter to measure the supply voltage, and then adjust RV1 to give the same reading on ME1. The unit is then ready to use.

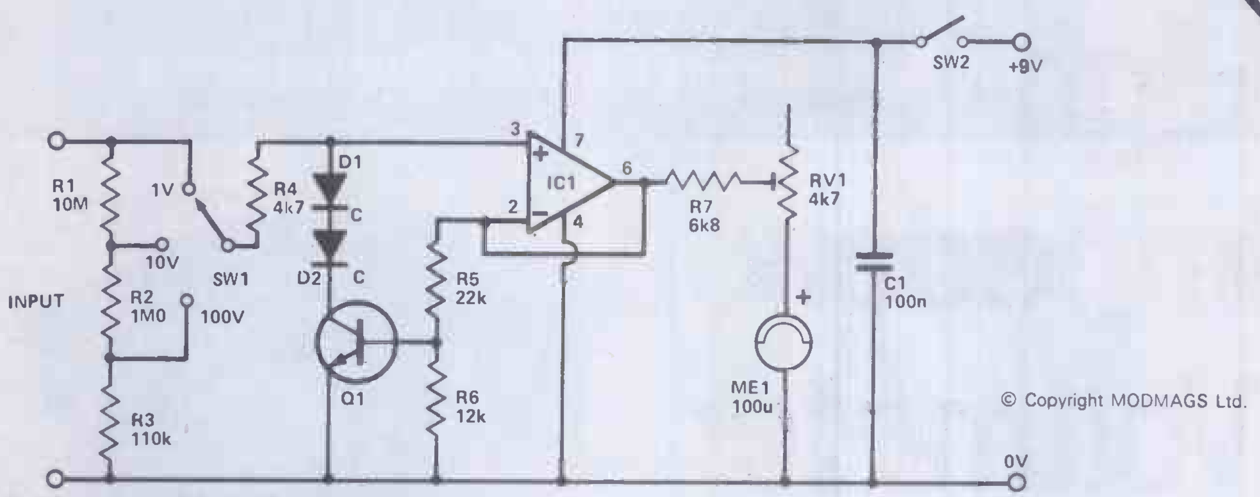


Figure 1. Circuit diagram of the High-Impedance Voltmeter

How It Works

The unit is based on an operational amplifier, and has its circuit shown in Fig.1. Operational amplifier IC1 has 100% feedback from its output to its inverting input, and therefore gives unity voltage gain. Resistor R7, preset RV1 and meter ME1 form a voltmeter at the output of IC1, and RV1 is adjusted for a full scale sensitivity of 1 V. Thus an input of 1 V is needed at the non-inverting input of IC1 to produce an FSD on ME1, but IC1 has a MOS input stage that consumes no significant input current.

Most of the input current drawn by the unit is that which flows through input attenuator R1-R2-R3. By means of SW1 this provides three switched attenuation settings of 1, 10, and 100, giving the unit its three measuring ranges.

Normally Q1 is switched off, but if the circuit is overloaded and much more than about 1 V appears at the output of IC1, the voltage fed to Q1's base is sufficient to switch this device on. Diodes D1 and D2 are then effectively connected as a low-voltage zener across the input to IC1, which limits the input voltage to only about 1.3 V. This method of overload protection does not interfere with the accuracy of the unit in normal use, but prevents the meter from being overloaded by more than about 30% (which is nowhere near enough to do it any harm). The protection circuitry also prevents an excessive input voltage to IC1.

The circuit has a current consumption of only about 1.2 mA.

Parts List

RESISTORS (All ¼ W,5% unless stated)

R1	10M
R2	1M 2% or better
R3	110k 2% or better
R4	4k7
R5	22k
R6	12k
R7	6k8

POTENTIOMETER

RV1	4k7 miniature horizontal preset

CAPACITOR

C1	100n polyester

SEMICONDUCTORS

IC1	CA3140E op amp
Q1	BC207 NPN transistor (see Buylines)
D1, D2	1N4148 diode

MISCELLANEOUS

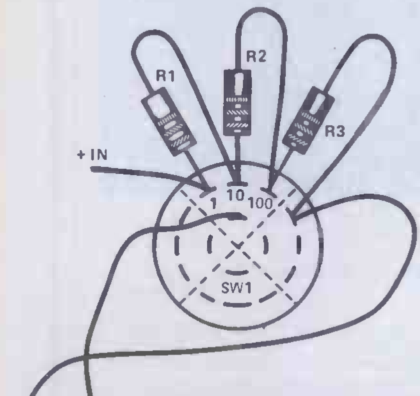
SW1	four-pole, three-way rotary switch
SW2	single-pole, single-throw toggle switch
ME1	100 uA moving-coil panel meter

10 strip by 24 hole, 0.1" Veroboard
Battery and clip
2 x 4mm sockets

Buylines

Any of the larger component retailers should be able to supply all the components. Transistor Q1 can be any high-gain silicon NPN device (BC107, BC108, BC109, etc) if you can't obtain a BC207.

You should find that the cost of this project is about £6 (excluding the case) depending on where you buy the meter.



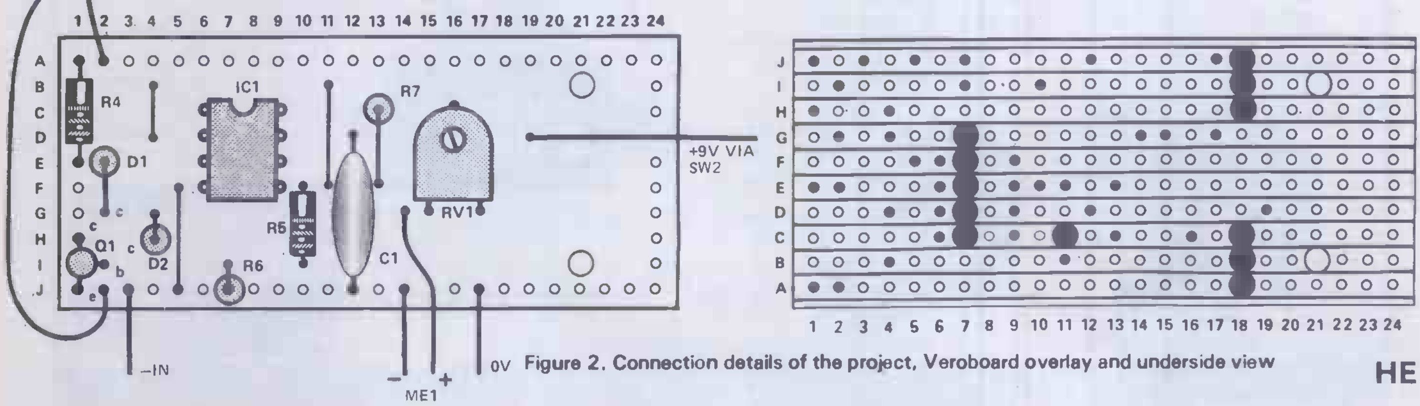


Figure 2. Connection details of the project, Veroboard overlay and underside view

HE

Please send an SAE with all enquiries. Phone orders by ACCESS - but minimum £5 Callers welcome

CATALOGUES 60p ea., all three for £1.60
POST/PACKAGE CHARGE NOW 35p

ambit INTERNATIONAL

CWO PLEASE : Commercial MA terms on application. Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt.

CATALOGUES
2 & 3....60p ea
4............75p
(4 inc. rev. of part 1)

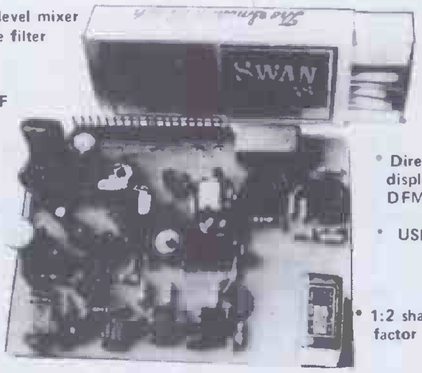
ALL PARTS : ....£1.75......

200 North Service Road, Brentwood, Essex

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

SSB transceiver module - based on G4CLF designs

* High level mixer
* 8 pole filter
* 1 W AF on the PCB
* Direct freq. display with DFM7
* USB/LSB
* 1:2 shape factor



Add an LO and the RF selectivity, and you have a very simple yet high performance signal processing 'heart' of an SSB transceiver in the range 100kHz to 1000MHz (with the correct LO/RF stages).
The Ambit 91600 costs just £44 +vat, and includes an 8 pole SSB crystal filter, SL1600 signal processing circuitry, double balanced schottky diode mixer and full USB/LSB electronic switching.
The use of 10.7MHz, instead of 9MHz (as in the original unit) now enable direct connection to an AMBIT DF7 for 1kHz frequency readout with far greater ease and accuracy than can be achieved with mechanical dial systems. Buy them both and save 15%..DFM7+91600= £69.46 inc.

The AMBIT catalogue - now with the new Part 4 for 1981
The most complete range of specialist radio components in Europe.

* VHF tunerheads
* Stereo decoders
* Frequency synthesis
* Block LPFs
* keyswitches
* DC audio control ICs
* Ultimate HiFi

The state of the art in radio and audio

* Crystal filters (& theory)
* Ceramic filters for AM/FM
* Mechanical filters
* Fixed chokes
* MC meters
* CMOS/TTL
* NBFM IFs
* WBFM IFs
* flat top LEDs
* Variable chokes
* Piezo sounders
* potentiometers
* 24 bit NC plotters
* low noise RIAA ICs
* UHF Helical filters
* miniature electrolytics
* 30Mb hard disks

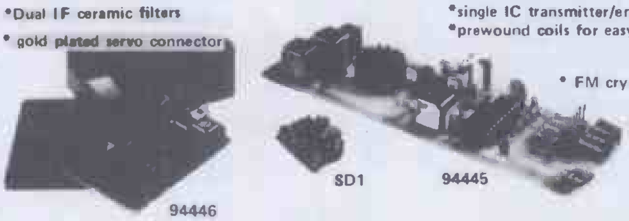
You need all three sections for a complete picture. Each section is revised on a triennial cycle - so this year the part 4 contains the revised remnants of the original part 1 - plus all the many new items for 1981. £1.75 for the lot, or 60p each for parts 2 &3, and £0.75p for the bumper part four section. (prices include postage).

Special Offers... each catalogue is supplied with a 'special offer' order form that will enable you to save the cost of the catalogues with your first few purchases.

Radio Control Systems

As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receivers and transmitters (now including hardware). Only state-of-the-art FM systems, readily adapted to 35MHz if required.

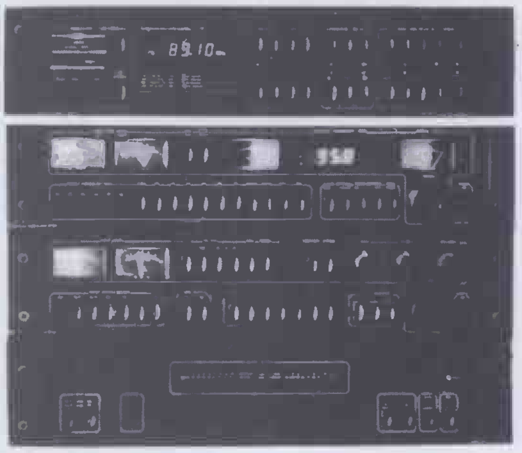
* Dual IF ceramic filters
* gold plated servo connector
* single IC transmitter/encoder
* prewound coils for easy alignment
* FM crystals extra



SD1 94445 94446

The RCRX4	8 channel FM receiver with triple ceramic filtering, complete with case..	£16.10
94445	4 channel FM transmitter based on ETI October 1980 system	£8.57
94446	5 channel FM receiver, based on ETI October 1980 system (inc case)	£14.26
TX Case	Complete transmitter case hardware, with two joystick controllers	£26.62
SD1	NE544 based servo driver electronics kit (no mechanics)	£3.28

The Mark III Series of DIY HiFi.



The Mark III series of HiFi is the ultimate DIY audio system. There are probably more features and facilities to the square inch of front panel than any other commercial HiFi around - let alone DIY systems. From the twin 500VA PSUs of the HMOSFET 100W power amp, to the 1dB tracking of the DC controlled preamp and the versatility of the CMOS MPU controlled tuner, there is no match for performance, style or sound quality - come and hear for yourself in our foyer.

Mark III synthesised tuner	£175.00 + vat
Mark III B FM-only tuner	£185.00 + vat
Mark III DC controlled signal preamp	£175.00 + vat
Mark III 100W rms/channel MOS PA	£160.00 + vat

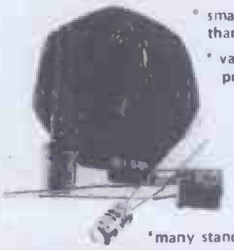
* Matching 'Signal', 'Tune' and 'VU' scales.
* Custom scales OA

* Signal level
* 'tuning'
* VU

Moving coil indicator meters: over 10,000 in stock for immediate delivery. The new part 4 catalogue lists many of the stock designs, but a much wider range is available to order (subject to minimum requirements). Meters for nearly all occasions, including precision voltmeter and ammeters.

NEW:
Miniature electrolytics 0.01CV leakage

* smaller than tants
* vastly lower priced
* many standard types



Miniature PC mounting 12v relays 2A/24v contacts, single or dual changeover types available

SPDT: £1.65
DPDT: £1.85

* sealed against flux
* ideal antenna changeover etc
* Clock timer switching

LCD modules: including various clock/timer/alarm systems, DVM, serial data decoder/displays. The clock shown is the CM161 - 12/24 hrs, day/date, alarm, backlight. All for just £11.44 including VAT.

The FC177 (alongside) displays AM LO's up to 3.9999MHz directly - and with the prescalar unit (DFM7) the system displays SW and VHF in 1kHz and 10kHz resolution resp. FC177: £26.16; DFM7: £36.22 (prices include VAT)

What's In A Name

Listen to Rick Maybury as he discusses devices for detecting sound

OVER THE PAST FEW MONTHS we have been looking at electronic components that duplicate our own human senses. Last month we began to look at electroacoustic devices starting with an introduction to the loudspeaker. Our theme this month is the exact opposite, we will be looking at the microphone, a device that changes sound waves into electrical signals.

It was Alexander Graham Bell who first devised the microphone, or to be more precise, the telephone, as he could hardly have used the microphone on its own. His prototype microphone used the principle of magnetic induction — similar to the principle of operation of the loudspeaker we described last month. Without doubt though, the most common type of microphone in use today is the carbon microphone — found almost universally inside telephone mouthpieces. The carbon mike usually consists of a thin metal diaphragm covering a small cavity filled with carbon granules. Inside the cavity there are two electrodes in constant contact with the carbon granules. Under silent conditions the carbon granules are quite static and exhibit a resistance of a few hundred ohms between the electrodes. When the diaphragm vibrates as a result of being struck by a sound wave the spacing between the granules changes and consequently the resistance between the electrodes changes. Thus the resistance of the microphone changes in sympathy with the sound.

In a Lo-Fi application like telephones the carbon microphone is ideal. Sound is converted into large changes in voltage, which means that no amplification is required (over a few miles, that is) between the microphone and the distant earpiece. But frequency response, although fine for the 'phone, is severely limited. Where a little more quality is needed (such as for music and high quality speech) then a variety of different types of electroacoustic devices become possible, all requring amplification of the signals they produce. Next to the carbon microphone the most common type of microphone in use today is the piezo-electric mike.

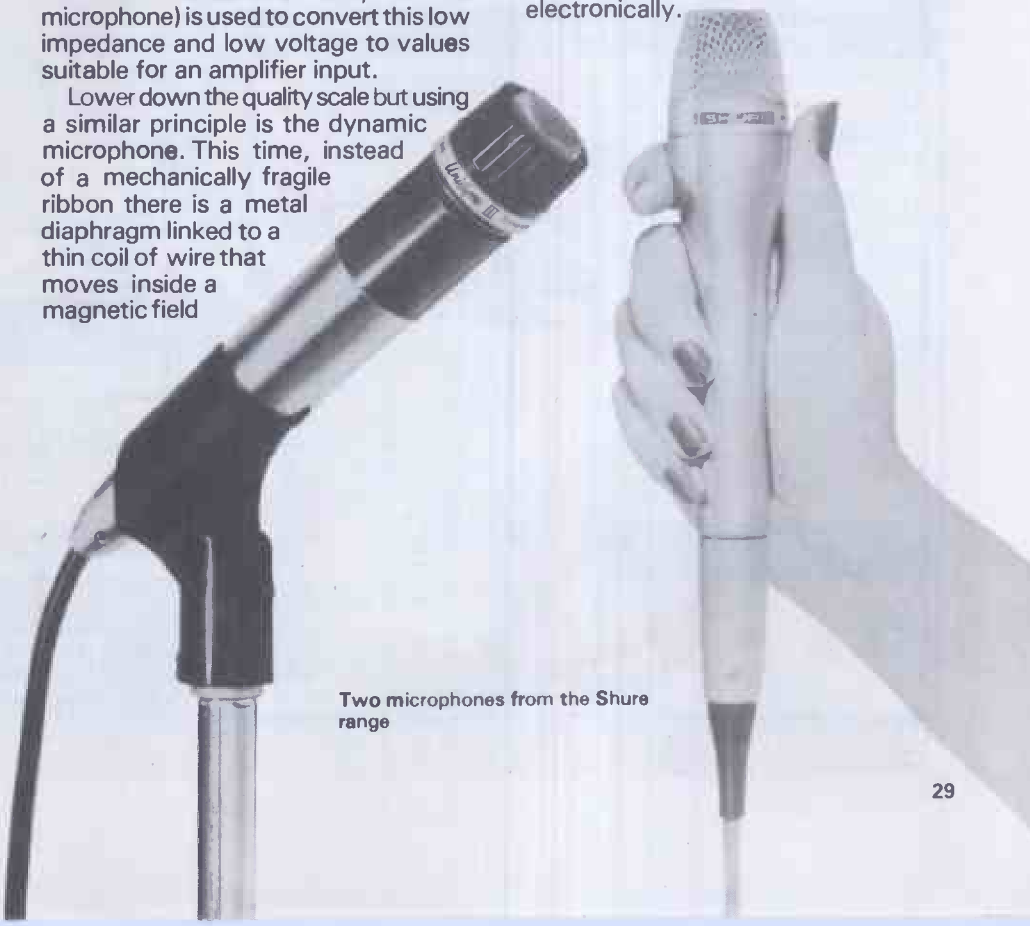
Referring back to last month's What's In A Name you'll remember that we said that piezo-electric crystals (usually quartz) will physically distort when a voltage is applied across the face of a crystal. Well, the opposite is also true. If piezo-electric crystal is bent, distorted or vibrated then the electrons within the structure become dislodged and appear as a voltage across the face of the crystal. If we mechanically link the crystal to a thin metal diaphragm then any sound wave striking the diaphragm willl cause the crystal to vibrate thus generating a small voltage in sympathy with the vibrations.

In practice the crystal microphone has a very high treble response, too high in most cases to be used in serious Hi-Fi applications. For true Hi-Fi the most common type of microphone is the ribbon mike. This consists of a thin metallic ribbon suspended between two permanent magnets. Wires coupled to either end of the ribbon will have a very small voltage developed across them as the ribbon moves between the magnetic fields. The voltage is low because the impedance (AC resistance) of the ribbon is very small compared with that of the connecting leads. In fact the voltage would disappear over a long length of wire! For this reason, a small transformer (usually mounted inside the body of the microphone) is used to convert this low impedance and low voltage to values suitable for an amplifier input.

Lower down the quality scale but using a similar principle is the dynamic microphone. This time, instead of a mechanically fragile ribbon there is a metal diaphragm linked to a thin coil of wire that moves inside a magnetic field similar, of course, to the loudspeaker we described last month. This type of microphone is also called moving coil.

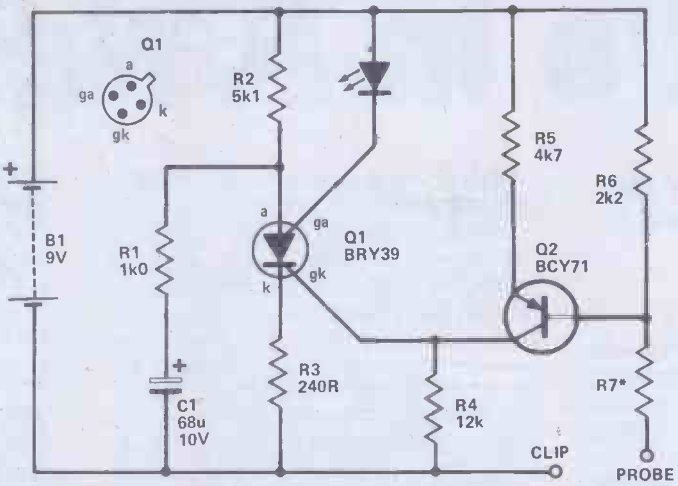
The last family of microphones we'll look at are usually known as capacitor or condenser mikes. They operate in exactly the same manner as a capacitor. Two thin metal plates placed very close to each other will exhibit a capacitance between their facing surfaces. When one plate is vibrated by an incident sound wave then the gap between the two plates will alternately increase and decrease causing the capacitance to rise and fall in sympathy. The main disadvantage for ordinary condenser microphones is the necessity of a high bias voltage across the plates, and this problem is solved in the electret microphone. The electret microphone is also a condenser microphone but the high voltage charge is provided by an 'electret' material that has the strange property of possessing a permanent static charge. Although the quality of the electret microphone is not as good as the condenser microphone it does cost about one tenth of the price. This is one reason why many portable cassette recorders have electret microphones built-in.

Well, that about covers sound: next month we shall be looking at the sense of touch and how we go about duplicating it electronically.



Two microphones from the Shure range

Short Circuit



Suppressor Tester

Few motorists think of checking ignition leads or caps, yet these resistive components can be notoriously unreliable. For adequate interference suppression (required by law) the resistance between distributor cap and spark plug must be at least 10k. However, for most efficient operation of the system the resistance should not exceed 20k. Also, any open circuit will allow arcing, causing high levels of interference and rapid deterioration of the suppression components.

The circuit is based upon a programmable unijunction transistor (PUJT) oscillator which flashes a red LED when the suppressor resistance is correct. The osillator will function only when the voltage on the cathode-gate of Q1 is within its operating range. This voltage is determined by the current flowing through Q2, which is controlled by the suppressor resistance connected across the input wires of the tester. Since the position of the working range is determined by component tolerances and by the gain of Q2 it is necessary to select a value for R7 (between 100R and 10k).

With an 8k2 resistor across the input wires, D1 should give a steady light. With 22k it should not light. Alter the value of R7 until the range of suppressor values which allows D1 to flash is centred about 15k. The probe can be made from a brass screw and an old spark plug top. A crocodile clip is used to make the connection inside the distributor cap. No on/off switch is required as current drain is negligible with D1 'off'.

WARNING: the engine *must not* be running while the suppressor components are being tested.

ANOTHER ADVENTURE WITH THE PROFESSOR
HI THERE H.E. MEN! HERE'S THE FIRST IN OUR SERIES OF PERSONAL VISITS TO SEE READER'S INVENTIONS
..AS YOU CAN SEE, WE'RE DEEP IN THE HEART OF DARKEST WALES...
WELCOME TO LLANLLANLLANLLANLLANLLANLLAN
...AND I'M HERE TO PRESENT MR. DAI NEVERSAY WITH HIS HOBBY ELECTRONICS AWARD~ A SUPER DE-LUXE OSCILLOSCOPE!
TAXI
THIS LOOKS LIKE THE SPOT...
HI BOY~ NICE DOGGY
SNARL
GRR
HELLO MR. NEVERSAY
I'M THE PROFESSOR FROM HOBBY ELECTRONICS AND I'VE BROUGHT YOU YOUR AWARD FOR THE MOST INGENIOUS INVENTION OF THE MONTH
I SAID NICE DOGGY
COULD YOU TELL US SOMETHING ABOUT IT?
TELL YOU? I CAN SHOW YOU
FOLLOW ME
NICE?
SNARL
GROWL
AN' STOP BOTHERING MY DOG!
WELL I'M A WRITER, YOU SEE, AND I FOUND THAT I HADN'T GOT ENOUGH TIME TO WRITE AND LOOK AFTER MY SHEEP TOO. YOU SEE...
GRAR
GROWL
Y WRK SIOP
SO I DEVELOPED...
MY 'DAI NEVERSAY' COMBINATION TYPEWRITER AND SHEEP~DIPPER!
WHAT D'YOU THINK OF THAT, BOYO?
HUH?
ARGHH!
GRRR
SNARL
LEEKS
BEAST OF POWYS
IN
OUT
LOOK AT THAT... ALL THIS WAY AND WHAT DOES HE DO? LIES DOWN ON THE JOB! I TELL YOU THESE CITY BLOKES ARE ALL THE SAME
CISSIES!
FLETCH

O Level Q & A

At last — we've arrived at transistors. Nick Walton gives you a gentle introduction to these clever little devices

AFTER FIVE ARTICLES we now come to the little beast at the heart of it all and our London Board Syllabus makes it necessary for us to examine the NPN transistor, to explain its action and to sort out some of the technical terms you might meet. If this is all new, you would be well advised to take it a bit at a time.

Last month we saw that by taking a single crystal of pure semiconductor like silicon and diffusing into its crystal lattice certain impurities which had either a valency of three or five it was possible to alter its conduction properties pretty drastically.

The presence of traces of the three-valent substance gives rise to the p-type semiconductor with its excess of positive holes, and the n-type doped with its five-valent impurities gives rise to an excess of conduction electrons. Put p-type next to n-type (in a single crystal, remember) and you have a PN junction which allows conventional current to flow one way only, in fact P to N.

A transistor takes things a step further by adding one more layer (see **Fig. 1**). So it can either have an n-type layer at each end with a p-type layer sandwiched in the middle (called an npn transistor, the more common sort today) or the n-layer can be sandwiched in the middle with a p-layer either side, called a PNP transistor. A connection is made to each layer and that to the middle is called the base while those to the outside are called the emitter and collector.

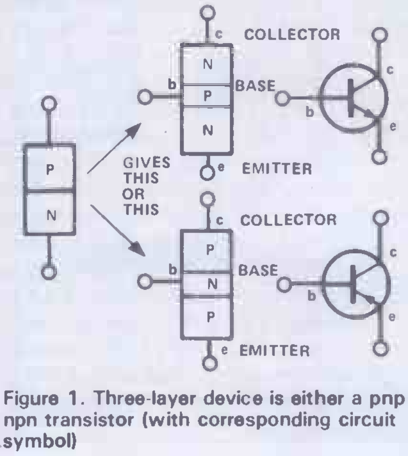


Figure 1. Three-layer device is either a pnp or npn transistor (with corresponding circuit symbol)

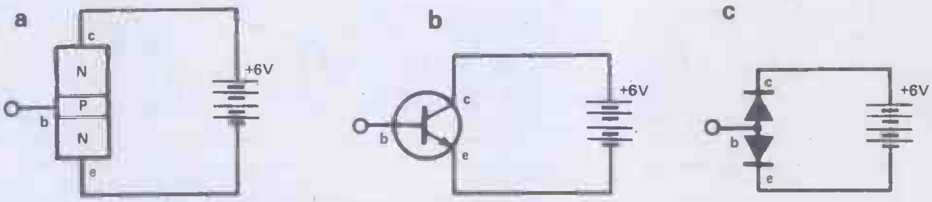


Figure 2. Transistor connected unhelpfully to a 6 V battery: a) the device, b) the circuit symbol, c) showing it to be equivalent to two pn-junction diodes

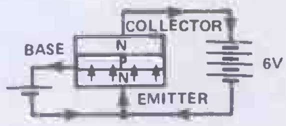


Figure 3. Transistor conducting because the left-hand battery is giving the base-emitter junction a forward bias (arrows indicate electron flow)

Transistor In A Circuit

At this stage you might wonder how on earth this makes it one of the most useful devices ever invented. This is not easy to see at first sight, so let us try to examine more closely how it behaves. Put in series with a battery (of, say, 6 V) we seem to be little further on. **Figure 2a** shows the device connected, **Fig. 2b** the circuit diagram and **Fig. 2c** suggests that it is equivalent to two PN diodes in opposition. Whichever way you connect the battery one of the diodes will block any current flow. There is, however, one vital difference between a pair of diodes like this and a transistor. It is that the base layer is made as thin as possible. Starting with **Fig. 2a** we add a small battery (the left-hand one in **Fig.3**) which now puts the base-emitter junction into forward bias. This makes it conduct with electrons moving into the p-region as shown by the array of arrows. But because the base region is made so thin, the electrons which rush across this emitter-base junction under the influence of our small forward-biasing battery have mostly rushed on into the collector region before they realise what was happening. Electrons in this collector region are attracted to the positive pole of the 6 V battery and thus current flows round the right-hand circuit. Indeed the size of this current (called the collector current, I_C) is determined by the much smaller current flowing out of the base (called the base current I_B). In practice the small base current is controlling a much larger collector current and this is the basic principle on which an amplifier relies for its operation: it controls a large current by means of a small one. **Figure 4** shows how this can be achieved. **Figure 4a** shows how it could theoretically be set up and **Fig. 4b** shows how it is often done in practice. The transistor can be any old small-signal general-purpose NPN transistor, and the resistor value can be anything from about 1k0 to 20k. The bulb is just a very simple and

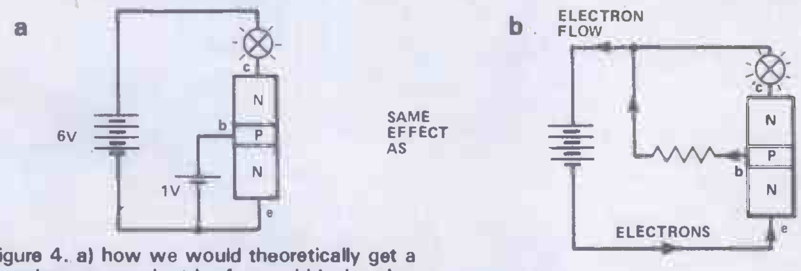


Figure 4. a) how we would theoretically get a transistor to conduct by forward-biasing the emitter-base junction, b) how it is usually achieved in practice (note arrows indicate electron flow)

crude way of showing whether a current is flowing through the transistor. The small base current provided will allow a sufficiently large collector current to flow to light the bulb. The vital thing is to keep your base-emitter junction in forward bias and the collector at a more positive voltage than the base. (Note that since we have been talking about what the electrons have been up to, on this occasion the arrowheads are taken to indicate electron flow).

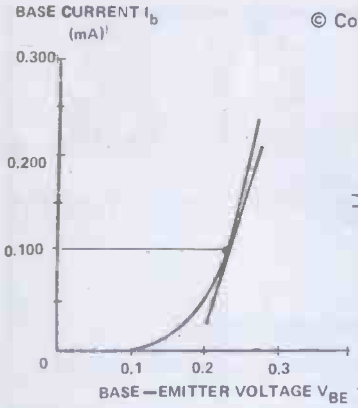
So what it all comes down to is this: fact number one is that if you just put a voltage between collector and emitter you get no current flow, so the transistor appears to have a very high resistance. Fact number two is that with a forward-biased emitter-base junction (or if you like, the appropriate base current) the transistor will conduct (between collector and emitter) displaying an apparently much lower resistance.

Transistors As Switches?

At this stage it is worth noting one further point. With no base current a transistor does not allow current to flow between collector and emitter and so can be regarded as being a switch in the 'off' (or open) position. Give it the necessary base current and it now conducts. So it can be regarded as being a switch in the 'on' (or closed) position. Indeed descriptions of how circuits work often talk about a transistor being switched on or switched off for just this reason. Actually it is rather a clever sort of switch because it can be switched on and off with no moving parts in the conventional sense; and if you think that the guts of a computer or your calculator consist of a huge number of switches it is good to have all those switches operating with no moving parts (except, of course, the electrons that we cannot see). If you accept that, you might begin to see how the transistor comes in so useful.

Gain And h_{FE}

If you make a serious study of transistors you will not be able to avoid sooner or later coming across the concept of current gain for a transistor. This is how many times the collector current is bigger than the base current. Looking at **Fig. 5**, let us suppose that we have a base current (I_B) of 0.1 mA and that this results in a collector current (I_C) of 5 mA. Thus the collector current is 50 times the base current



and so we say that the current gain is 50. This current gain is most properly referred to as h_{FE}. Thus:

$$h_{FE} = \frac{I_C}{I_B}$$

The FE subscript is written in capital letters when dealing with DC. The h_{FE} is still frequently referred to as a ß (beta, the Greek letter 'b') and its full title is the magnificent mouthful 'the common emitter static value of the forward current transfer ratio'. The phrase 'common emitter' means that the emitter is involved in the input end of the circuit as well as the output end. If you are feeling clever you might try applying Ohm's law to parts of this circuit. If we suppose (still looking at **Fig.5**) our NPN transistor is silicon, then the voltage between emitter and base could have a value of 0.7 V. Check that this fits with the 0.1 mA base current and the marked value of 53k for the base resistor (not a preferred value but never mind). If that presents no difficulty how about finding the value of the collector-base voltage? This is often ignored but it does in fact have a small value which you can find once you have calculated the voltage across the 1k0 collector resistor. You know the emitter-base voltage is 0.7 V, so what is left . . . ? If you enjoy this sort of analysis of circuits, you might enjoy being an electronic engineer — it's one of the things he or she does.

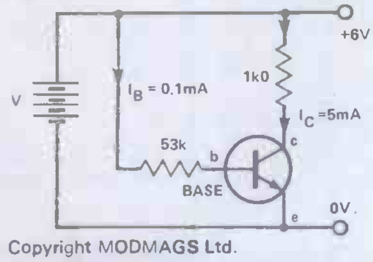


Figure 5. Circuit to illustrate h_{FE}. The base current is 0.1 mA and the collector current is 5 mA; that is, 50 times larger: so h_{FE} = 50

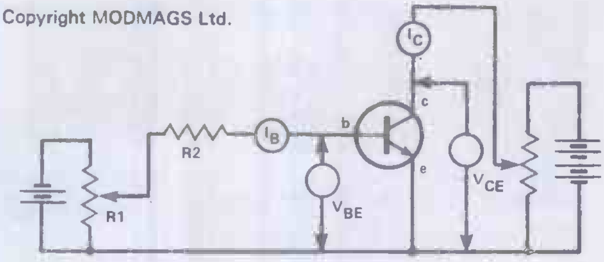


Figure 7. How to measure V_{BE} and V_{CE}

Figure 6. Common-emitter input characteristic

AC Conditions

A closely related quantity is one called h_{fe} (where the convention of having lower-case letters refers to the fact that we are considering AC). If we put an AC signal into the base we are effectively increasing the base current as the input signal hits maximum. This in turn produces a change in the collector current and this ratio of collector current change to base current change is the way h_{fe} is defined.

The third quantity we have to knock off is called h_{ie}, and it is the input resistance. Very loosely this is the resistance you 'see' at the input. It is the input voltage (ie base-emitter voltage, V_{BE}) divided by the input current I_B (remember resistance is voltage over current — volts per amps is ohms). Its full title is the 'small-signal short-circuit input resistance'. It is termed short circuit because where we had a collector resistance before (ie, the 1k0 resistor in **Fig.5**) we now have nothing. Instead we have a short circuit; that is, no resistor on the collector in **Fig. 7**. It can perhaps best be understood by reference to the graph shown in **Fig. 6** which is called the common-emitter input characteristic. It shows how the base current (I_b) and the base-emitter voltage (V_{BE}) depend on each other. It might help to refer back to **Fig. 3** and suppose that we are somehow increasing the base-emitter voltage and seeing how the base current changes as a result. Actually, the full details of the circuitry that achieves this are shown in **Fig. 7**. At, say, a base current value of 0.1 mA we can define the input resistance as a small change in the base-emitter voltage divided by the corresponding small change in base current. Or if you are familiar with graphs, look at the slope (the change in the vertical per unit change in the horizontal) in **Fig. 6** at 0.1 mA base current. The slope is in terms of amps per volt, so taking the reciprocal of the slope you have volts per amp or input resistance.

Summary

DC current gain $h_{FE} = \frac{I_C}{I_B} = \frac{\text{Value of collector current}}{\text{Value of base current}}$

AC current gain $h_{fe} = \frac{\delta I_C}{\delta I_B} = \frac{\text{Small change in collector current}}{\text{Corresponding small change in base current}}$

Input resistance (impedance) $h_{ie} = \frac{\delta V_{BE}}{\delta I_B} = \frac{\text{Small change in base-emitter voltage}}{\text{Corresponding small change in base current}}$

Load On The Line

The last thing we need to look at is the concept of the load line. To understand this we need to know what we mean by the output characteristic. We can again use the circuit in **Fig. 7** to see how the current *through* the transistor (I_C) varies with the voltage *across* it (V_{CE}). A graph can be plotted of I_C against V_{CE} and the result depends on the base current used. So for a series of base currents we get a series of graphs, as shown in **Fig. 8**.

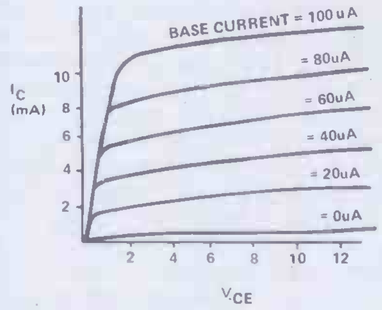


Figure 8. Collector current (I_C) plotted against collector voltage (V_{CE}) for different values of base current (I_B)

If you now had a typical single transistor amplifier you could well have the bit of circuit you see in **Fig. 9**. Note that there is now a resistor R (called a load resistor) between the collector and the positive terminal of the supply. Now, if you draw a graph of how the voltage across the transistor (V_{CE}) varies with the collector current I_C for

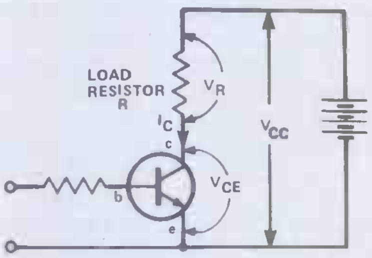


Figure 9. Circuit appropriate to load line (arrows show conventional flow)

a fixed supply voltage, you get the line shown in **Fig. 10**. As the collector current, which is the same as the current in R, goes up, the voltage across R will also go up giving a smaller voltage remaining across the transistor itself (V_{CE}).

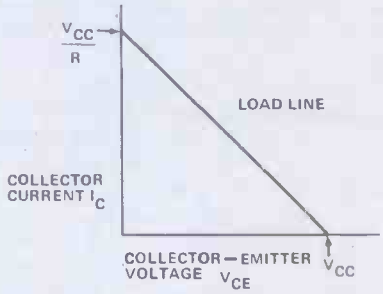


Figure 10. Load line on a graph of collector current (I_C) against collector-emitter voltage (V_{CE})

Skip the maths if you must, but it is not really all that desperate. It is all based on the idea that the supply voltage (V_{CC}) is shared between the load resistor and the transistor. Mathematically this is expressed as:

$$V_{CC} = V_R + V_{CE}$$

and since by Ohm's Law:

$$V_R = I_C R,$$

then:

$$V_{CC} = I_C R + V_{CE}$$

which with rearrangement gives:

$$I_C R = V_{CC} - V_{CE},$$

so:

$$I_C = -\frac{1}{R} V_{CE} + \frac{V_{CC}}{R}.$$

We can see from the straight line graph theory (y = mx + c) that if you plot I_C against V_{CE} for constant R and V_{CC} you get a straight line with the slope $-1/R$. The negative slope shows that I_C increases as V_{CE} decreases. It cuts the I_C axis at V_{CC}/R when $V_{CE} = 0$. This means that in the extreme case of $V_{CE} = 0$ (and the transistor conducting so well that there is theoretically no voltage across it) all the voltage of the supply is across R. The current I_C is given by

$$I_C = \frac{V_{CC}}{R}$$

This is the greatest current that goes through the transistor under these circumstances and it is now said to be saturated (or with no voltage across it to be 'bottomed').

What this really all comes down to is that when we are using the transistor as a simple amplifier the collector current I_C will vary under the influence of the changing base current and the corresponding voltage V_{CE} across the transistor will just move up and down the load line.

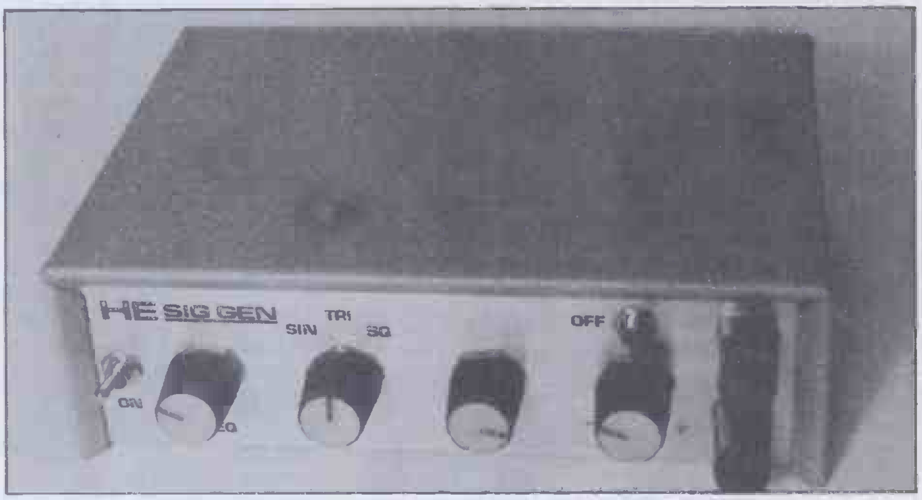
Don't spoil your appetite!

I hope you have not found it all too heavy going. The nice thing about transistors is that they still function whether or not you understand what they are really doing. Don't forget the famous mathematician who made the same point by asking: 'Shall I refuse to eat my dinner just because I do not understand the process of digestion?' Even if you have not understood a circuit design, you can still solder in the trannies and they work (you hope!). Talking of which, there is that practical project you should have thought about starting — and you need not look much further than the pages of HE. More next month — keep forward biased. Cheers!

HE

Audio Signal Generator

Our second do-it-yourself test gear project is a simple-to-build signal generator with many features found on expensive designs



THERE IS NO doubt — if you dabble in electronics much and build more than just the odd project, then test gear of all descriptions is a must. Furthermore, if the project is in the audio category, then somewhere along the line you will need an audio source.

Of course, using a bit of ingenuity, the clever HE reader might use the auxiliary output of his stereo system as a signal but there are disadvantages with such a method: neither the amplitude (size) nor the frequency (pitch) of the signal can be accurately specified. What you really need is a signal generator like this project — providing a selection of waveforms (sine, triangular or square) with fully variable amplitudes with the added facility of a controllable DC bias to the output signal. All this is achieved with only a two-IC circuit which operates from two 9 V batteries.

Construction

There is nothing critical in the construction of this project if you use our design of printed circuit board. Everything is quite straightforward. Solder in resistors first, followed by capacitors and IC sockets and finally insert the two ICs.

Following the connection diagram in **Fig.2** you should now connect the switches, potentiometers, battery clips and output sockets and test out the project before insertion into its case. Set all presets and pots to mid-position and switch on. By connecting the output to a suitable amplifier (eg your stereo system or last month's Bench Amplifier project), adjust the output to a suitable level using the amplitude control, RV6.

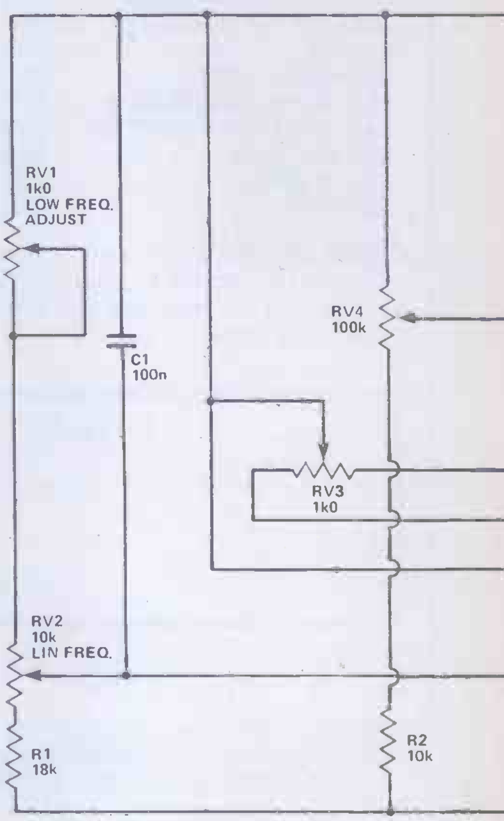
Now, turn SW1 to 'sine' and open SW3 (ie switch off the DC bias). Adjustment of RV4 and RV5 should remove any distortion and a perfectly 'clean' note should be heard. Turn the frequency control RV2 fully anti-clockwise to its lowest frequency setting and adjust RV1 until the lowest note possible from the generator is heard. One further adjustment can be made with RV3 if you have an oscilloscope — varying the preset will alter the duty cycle (best observed on square wave) which should be 50%; ie, high for half the wavelength and low for the other half. If you don't have the use of a 'scope leave this preset at mid-position — the adjustment won't be far out.

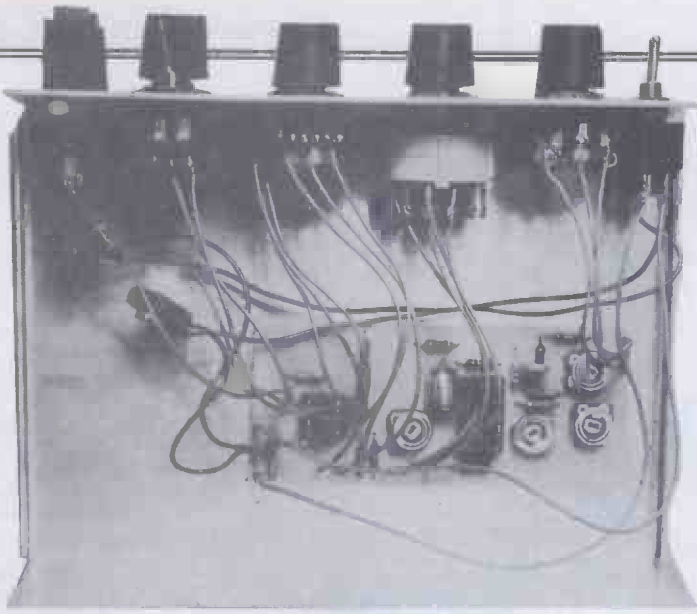
Finally the project can be housed in a suitable case.

Buylines

Integrated circuit IC1 may be difficult to obtain at your local component stockist but most mail order companies will be able to supply it. All other components should be easily obtained.

The price for this project (excluding the usual case and PCB) should be around £11.





How It Works

Integrated circuit IC1 is a purpose-built device, capable of generating sine, triangular or square waveforms (or derivations of these), to a high accuracy. The frequency of the waveforms is primarily defined by the charge and discharge rate of capacitor C2. This capacitor should be, ideally, a type whose value is very stable with temperature — so we specify a mica variety — although others are usable, with a lower accuracy.

The charge rate of the capacitor is also a function of the value of resistor R3. Likewise R4 controls the discharge rate. For a symmetrical waveform R3 and R4 should be of equal value. Preset RV3 allows adjustment of these two resistors to ensure that the charge rate of the capacitor exactly equals the discharge rate and so the waveform is symmetrical.

The voltage at pin 8 of the integrated circuit also controls the frequency of the generated waveform (over a 1000:1 range). Thus, by sweeping the control voltage on this pin between Vcc and (⅔ Vcc + 2 V) ie 5 to 9 V, the frequency of the waveform varies from 20 Hz to 20 kHz. The control voltage is derived from potential divider RV1,2 and R1.

Presents RV4 and 5 allow sine wave distortion to be minimised to only 0.5% and this is best achieved by listening to the sine wave and adjusting the two presets until distortion is no longer audible.

The outputs of this integrated circuit are found at pins 2 (sine), 3 (triangular) and 9 (square). Switch SW1 selects one of the wave shapes and connects it to the amplifier circuit of IC2, via RV6, the amplitude control. The amplifier is configured as a mixer although in its simplest mode (ie with SW3 open) the IC is just an inverting amplifier, whose output is centred symmetrically about 0 V. However, with SW3 closed, a DC bias voltage is mixed with the waveform and the output can be moved up or down in voltage, still having the same AC amplitude.

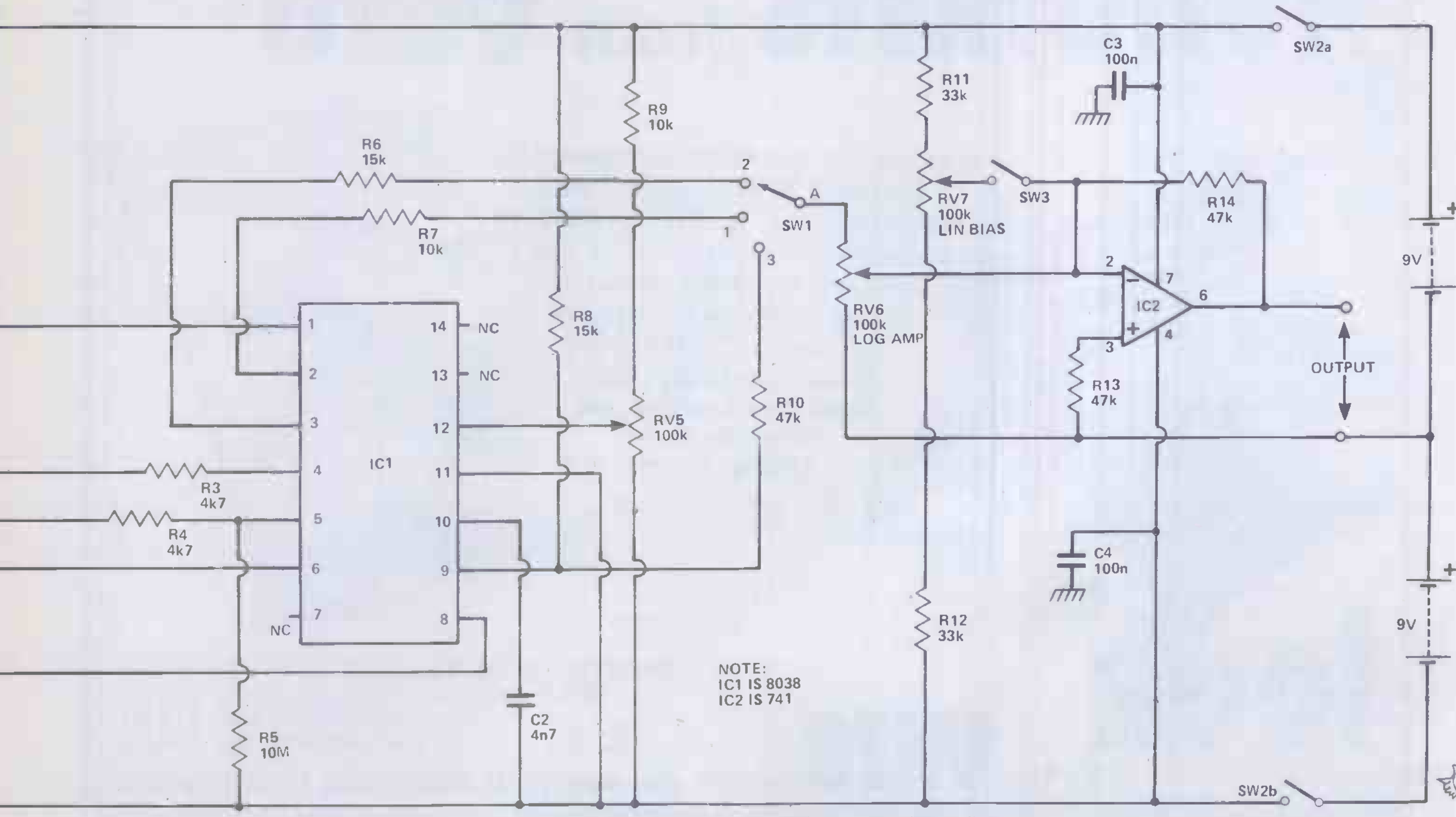


Figure 1. The HE Audio Signal Generator circuit diagram.

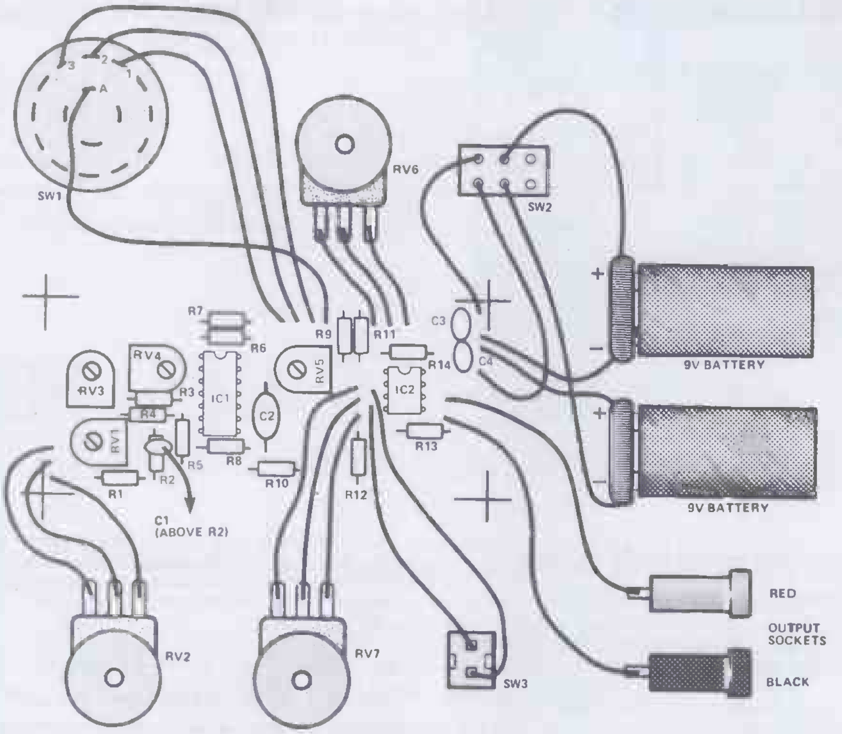


Figure 2. Overlay of the PCB and connection details of the Aud. Signal Generator.

Parts List

RESISTORS (All ¼W, 5%)

R1	18k
R2,7,9	10k
R3,4	4k7
R5	10M
R6,8	15k
R10,13,14	47k

POTENTIOMETERS

RV1,3	1k0 miniature horizontal preset
RV2	10k linear potentiometer
RV4,5	100k miniature horizontal preset
RV6	100k logarithmic potentiometer

CAPACITORS

C1,3,4,	100n ceramic
C2	4n7 mica

SEMICONDUCTORS

IC1	8038 waveform generator
IC2	741 operational amplifier

MISCELLANEOUS

SW1	single-pole, three-way rotary switch
SW2	double-pole, single-throw toggle switch
SW3	single-pole, single-throw toggle switch

Case to suit
Battery clips and batteries
Knobs, output sockets, IC sockets

HE

NEXT MONTH

electronics today INTERNATIONAL

Look out for the March issue on sale February 6th

Sound Analyser

Turn your volts and waves into six columns of flashing lights with ETI's Visual Complex Sound Analyser. Plug our six bar display (10 LEDs per bar) into your loudspeaker and transform Tony Blackburn into three bars of instantaneous amplitude in three different bands and three bars of instantaneous frequency in three different bands. Use it as a pretty sound to light display or for amplitude/frequency signal analysis of tape/radio/record programmes.

Noiseless Power Switch

Switch up to 15 A noiselessly with our zero volts switching power switch design. You're probably familiar with that characteristic crack as the fridge or the immersion heater thermostat switches on or off and ruins your tape recording of the 'The Archers'. Our NOISELESS power switch will switch loads from a 10 W light bulb to a 3 kW fire. In addition, the unit can be interfaced to a number of remote control modules, which we're also publishing next month (differential temperature, under temperature and dark activated).

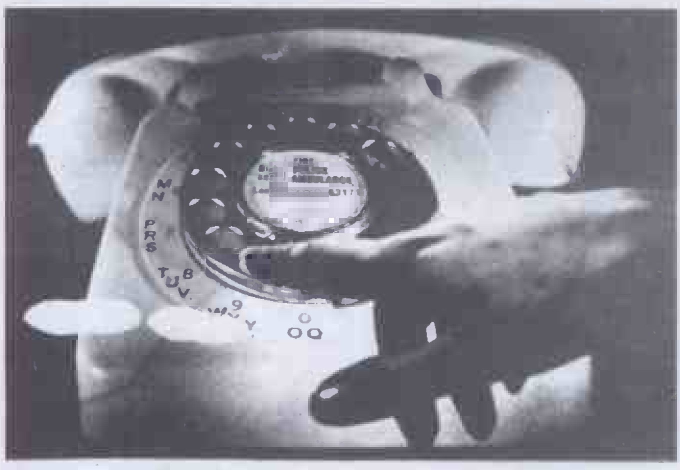
Keypad Security System

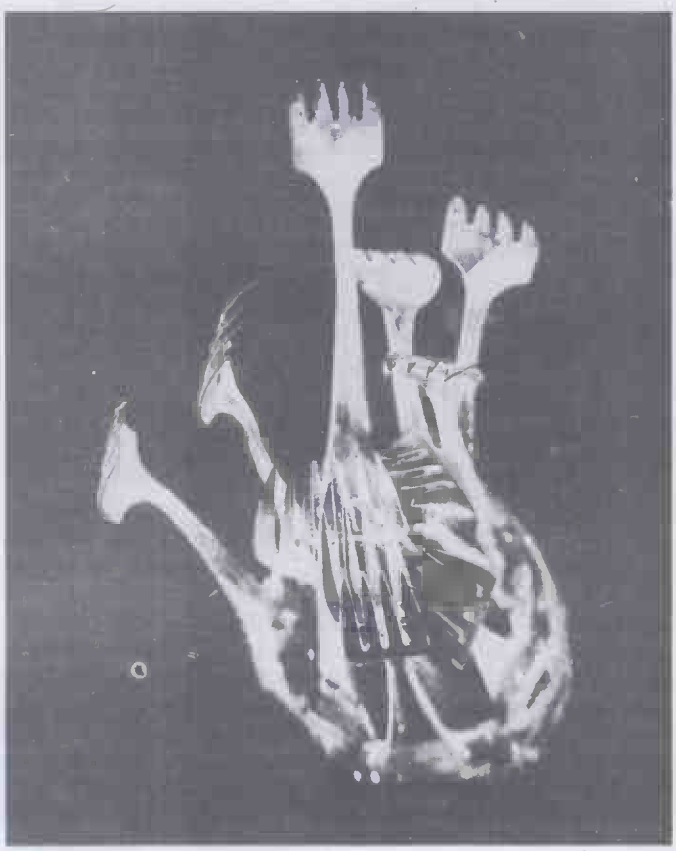
Baffle the intelligencia of the local criminal fraternity with the ETI Keypad Security System. Use it to protect your valuables in car, office and home. If you don't know the correct combination, try punching in random numbers at your peril. Get it wrong and an on-board alarm sounds. Persevere and still get it wrong and the relay output will sound an external alarm. As the system runs from a 12 V supply the external alarm could be your car horn if you use the system as a car alarm. If you're really persistent, the unit will shut down for half a minute while you tire yourself out.

Holography

Normally when you look behind a photograph all you will see is a bill for the processing and printing. However, wander around a hologram and you will find yourself peering behind the image on the plate. You could have a look behind our jumbo-size forks. The hand is real but it hasn't realised yet that the telephone is a hologram. Read Anne Sullivan's explanation of the light fantastic to find out how it's all done. It's simple when you know how.

PHOTO ©BICHAJIAN

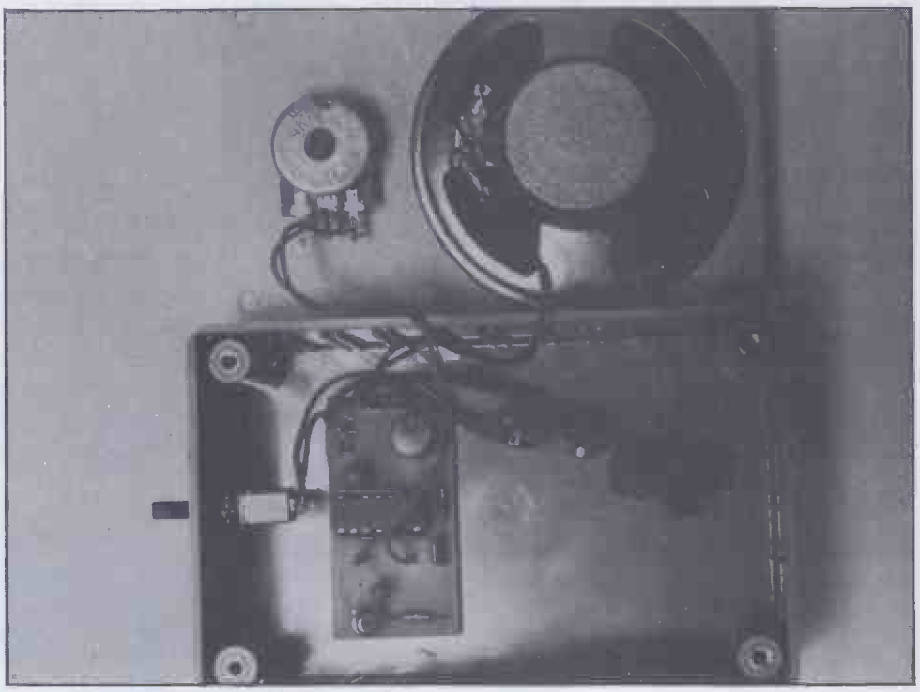




Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

Background Noise Simulator

At last — a psycho-physical project, which helps you concentrate and relax



IT IS A medical fact that human concentration operates in short bursts (up to about 20 minutes) after which the individual requires a few seconds of relaxation before continuing with the work at hand. You can see this effect yourself when reading a book or studying: every now and again you break from concentration and look up, perhaps simply to see what time it is or to make a cup of coffee.

It is also known (and fairly obvious) that the level of background noise can affect the *length* of concentration bursts — for instance, too much noise prevents you from working at all (just try concentrating when workmen are digging up the road outside!). Not so obvious is the effect caused by too *little* background noise. Concentration under such a condition becomes very difficult and can be impossible with absolutely *no* background noise.

Well, the HE Background Noise Simulator has been designed to deal with the last problem. After building this project readers who suffer from lack of concentration, due to lack of background noise, can breathe sighs of relief. Of course, we can't guarantee that you will all be transformed into geniuses able to rewrite relativity theories, but we can promise that you should be able to experiment with some interesting psychological effects. For instance we tried the project out with our colleagues, along the corridor in the Electronics Today International offices and they told us that if we didn't go drown our machine in the nearest bucket of water and let them get back to sleep, they wouldn't invite us to next year's Christmas party. With that threat in mind we left them to it.

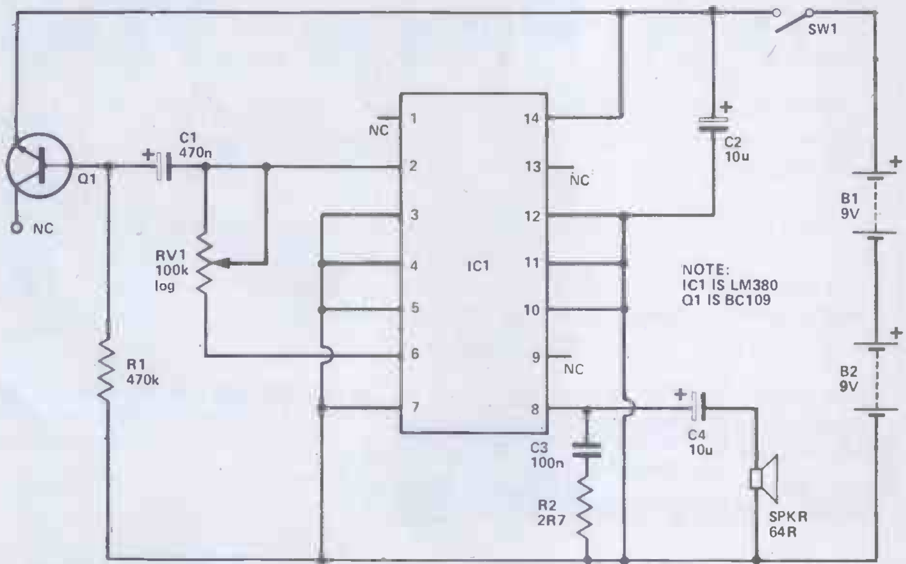


Figure 1. From this circuit diagram you can see the unusual way Q1 is in circuit.

Construction

This project offers a choice of construction techniques: either Veroboard or PCB can be used to build it up. Overlay and connection details are given for them both in **Figs. 2 and 3.**

When using Veroboard, remember to break the tracks where necessary, as indicated in the underside view of the board in **Fig. 2** and check that no short circuits are formed by loose swarf or solder bridges between tracks. Track breaks can be made using either the correct tool or simply a hand-held ⅛" drill bit, by holding it on the hole in question and twisting gently clockwise.

Insert resistors first, followed by capacitors and finally semiconductors. The diagrams show component position and connection details. Follow them carefully, making sure all polarised components are inserted the same way round as indicated.

After connection of the speaker and a suitable power supply, the project should work satisfactorily first time. It then only remains to build the board into a suitable case.

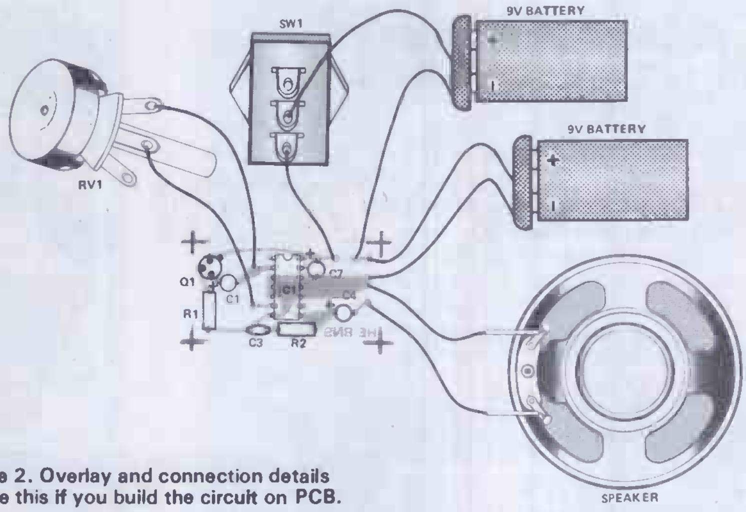


Figure 2. Overlay and connection details — use this if you build the circuit on PCB.

Buylines

All parts for this project will be easily obtained and should cost you around £4 (excluding the case and PCB).

How It Works

The heart of this project is none other than our old friend the LM380. The IC has all the necessary circuitry to form an amplifier with over 2 W of output power. Of course we don't need all of that power in this application — in fact only ¼ W is ample — but the LM380 remains one of the cheapest amplifier ICs around (regardless of output power) so we stuck with it.

Transistor Q1 forms the noise generator. It is connected in a rather unusual manner (see the circuit diagram in Fig. 1), with its emitter positive relative to its base. In this mode, a transistor is transmogrified into what is essentially a zener diode — a noisy one at that, providing a fairly large amplitude (50 mV) of noise at its base. Integrated circuit IC1 amplifies the noise (RV1 acting as a volume control) to drive the speaker and give the background noise.

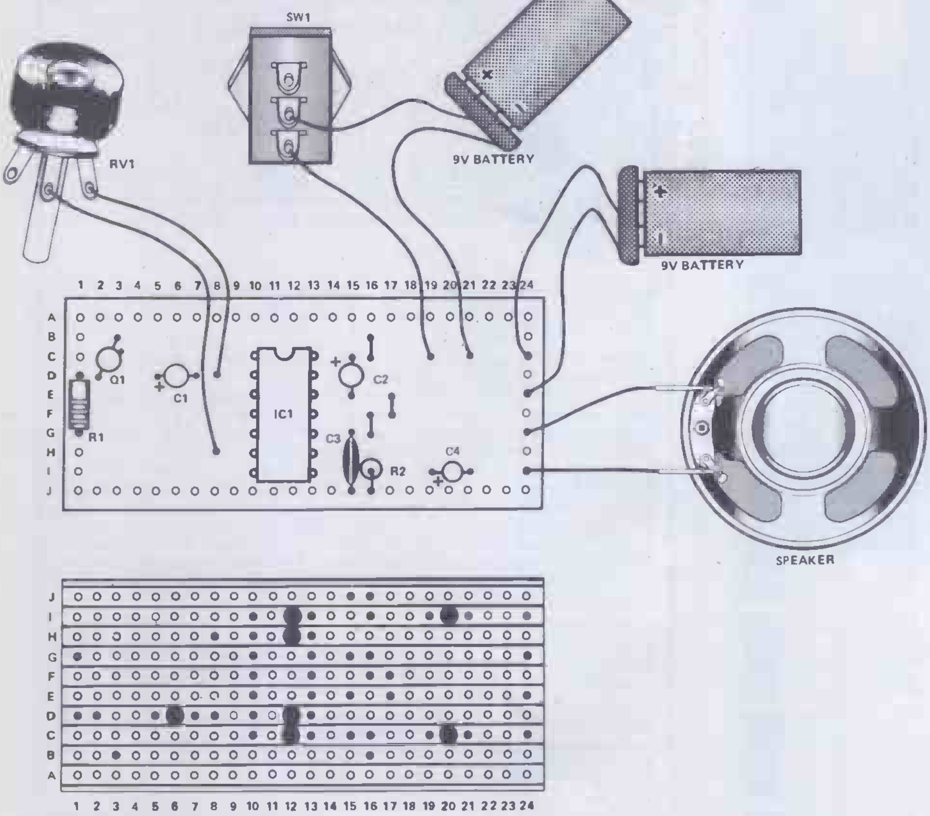


Figure 3. Veroboard layout and connections along with underside view.

Parts List

RESISTORS
R1 470k
R2 2R7

POTENTIOMETER
RV1 100k logarithmic potentiometer

CAPACITORS
C1 470n, 16 V tantalum
C2,3 100n polyester
C4 10u, 16 V printed circuit mounted electrolytic

SEMICONDUCTORS
IC1 LM380 2 W power amplifier
Q1 BC109 NPN transistor

MISCELLANEOUS
SW1 single-pole, single-throw toggle switch
IC socket (14-pin)
Miniature speaker — 64R
Batteries + clips

HE

Building Site

More ways of how to do it from HE's Master Builder — Keith Brindley

If ever there was a project which has generated enthusiastic interest from readers it's the Jack Lead Tester in the December issue. We've received numerous letters from you suggesting ways in which it could be adapted to test other types of leads. Perhaps the most comprehensive piece of advice came from a Mr. Blair of Lancashire who supplied us with a circuit diagram (see Fig. 1) complete with explanatory text.

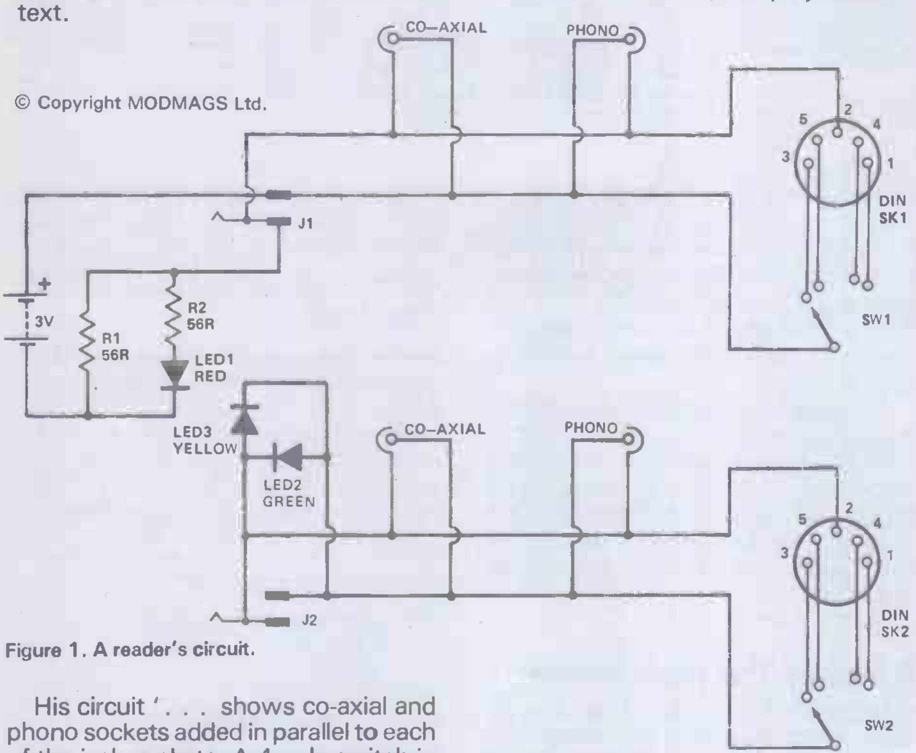


Figure 1. A reader's circuit.

His circuit '. . . shows co-axial and phono sockets added in parallel to each of the jack sockets. A 4-pole switch in each part of the circuit also allows a similar connection to a DIN socket. By switching SW1 and 2, the four leads in a DIN cable placed between the two DIN sockets can be tested separately and when there is a DIN cable ending horribly in a co-axial or four phono plugs do not despair. For the latter SW2 is left at position 3 (DIN) and each phono plug is inserted in its turn in the adjacent phono socket and then connected to the appropriate pin of the DIN plug in DIN socket 1 by switching SW1. All you have to remember is which switch does what.'

Well, Mr. Blair's suggestion seems fine to us!

I want to talk in detail this month about the fundamentals of project construction using Veroboard or printed circuit (PCB) — and show you one or two hints worth knowing.

Starting right at the beginning, your empty PCB must be spotless and greasefree. This point cannot be overstressed — there is nothing like a dirty circuit board to cause a dry joint and then — wham, the project won't work. You can clean your board easily with a clean rag and some methylated spirits. Tinning the board (see Building Site in the December issue) is also helpful but not essential. Incidentally, Veroboard is coated with a solder flux so unless the board is really filthy you needn't clean it at all.

Missing Link

Quite often, links across the board may be necessary and these are best made using short lengths of single-strand tinned copper wire (uninsulated). Carefully bend the end of the link ¼" or so at right-angles, using a pair of snipe-nosed pliers and insert this end into its hole in the board. Now, the other end, at the point where it is to be bent to re-enter the board, can be held again with the pliers. Carefully remove the wire without releasing the pliers and bend the link again at right angles (in the same direction as the previous bend). You will now have a link of exactly the right size to fit the board — solder it in, flush to the board.

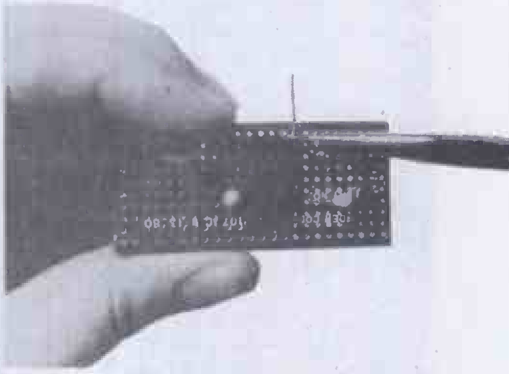


Figure 2. Making a link exactly the right size for the circuit board.

The technique of using snipe-nosed pliers can also be used successfully to insert passive components (resistors and capacitors!). Their leads should never be bent simply by hand. As a point of good practice the component lead should be held with pliers close to its body and the lead bent on the far side of the pliers — this prevents body fracture.

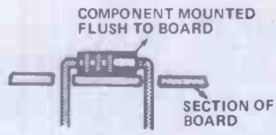


Figure 3. Make sure your components don't have longer leads above the board than necessary.

Generally speaking, the component should be soldered into circuit flush to the board. If the device needs to be mounted slightly free of the board (to allow for increased heat dissipation) then we'll say so in the construction section of the project.

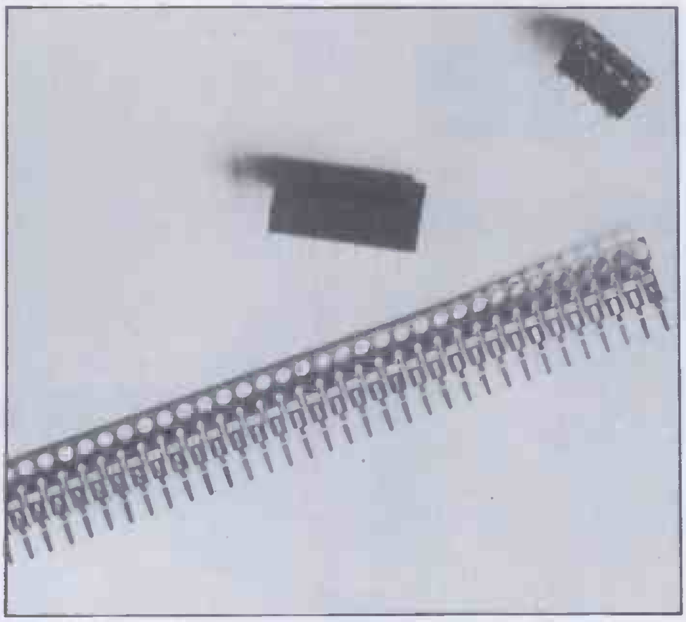


Figure 4. Typical sizes and types of IC sockets including the 'do-it-yourself' kind.

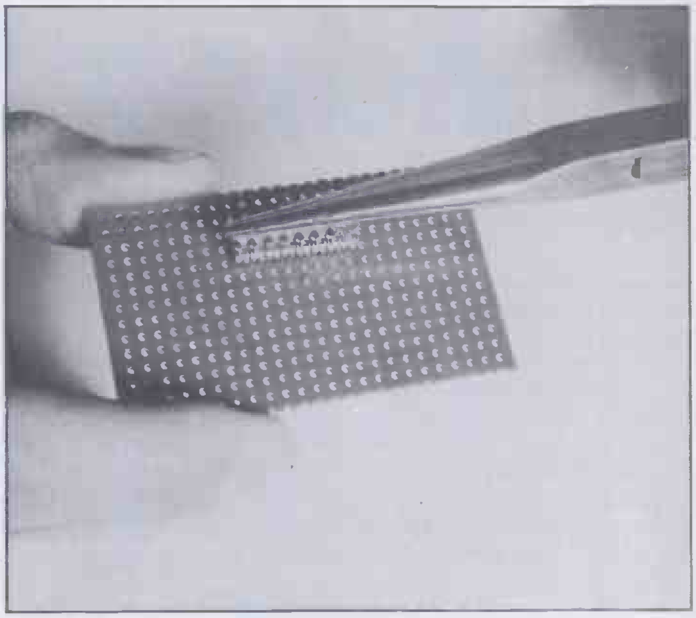


Figure 5. Break off the top common connector using your snipe-nosed pliers. This leaves one side of a ready-made IC socket.

Semiconductors

Sockets of some description are advised for ICs, for two reasons. The first is that ICs can be the most expensive items in a project so a socket system allows their re-use in future projects (saving your money!) The second reason is purely to prevent damage to the chip either by excess heat or static discharge when soldering.

The most common varieties of IC socket consist of a thin body, made of some insulating material, with a number of pins (8, 14, 16 etc) underneath at the correct spacing (ie two rows 0.3" apart spaced at 0.1"), which are simply soldered into the board where the IC would have gone. On the top of the body the pins open out to small clips which the IC pushes into and is firmly held by.

Socket to me

Now, such IC sockets can be quite expensive, depending on the method of manufacture and materials used — in fact they can cost more than some of the cheaper ICs available. A cheaper method (only a couple of pence per IC) is a system of 'pins and clips', as above, but without the insulating body. The pins and clips are bought in strips of 60 on a common connector which runs along the top. To use them, first cut off the number you need, say a block of seven (for a 14-pin IC) and solder this block of seven into the board in the IC holes. Now with a pair of snipe-nosed pliers (handy tools these pliers, aren't they?), carefully grip the top common connector and twist it from side to side till it breaks off leaving the seven individual pins in the board. Do the same for the other side of seven pins and hey presto — you've got yourself a cheap IC socket.

One word of warning if you use this sort of socket system — remember that the pins are not housed in an insulating body and therefore may accidentally touch each other if bent over. Check that no such short-circuits occur after you insert your IC and before you switch on.

Keeping The Heat Down

Of course, ICs can be soldered directly into circuits (as are other semiconductors such as transistors, diodes etc.) but it's advisable to solder only *one* lead at a time, letting it cool before moving on to the next — some semiconductors are easily damaged by excess heat and this simple procedure will help prevent unnecessary harm.

My final constructional hint this month is to use circuit board pins to make all offboard connections (eg to pots, switches, batteries etc). This allows you to mount the PCB into its final position in the case before you start wiring up. With the board and all case hardware in position it becomes a fairly simple job to neatly wire up your project with leads of exactly the right length — preventing a 'bird's-nest' arrangement. It's much neater and it's easier trace through if you are fault-fiding too!

The Last Word

Remember that 'neatness is the key' when you're building your project. Make that your motto and at least there's less chance that you'll go wrong. Well, time's run out again so I'll just wish you the best of luck with this month's projects and say — see you next month.

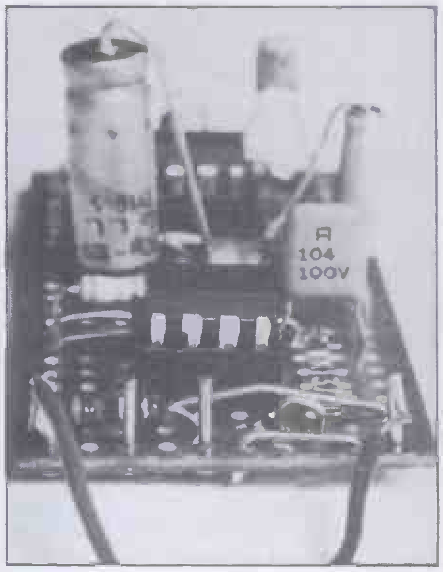


Figure 6. PCB pins are useful to make off-board connections.

HE

POPULAR KITS

SUB-MIN MICROPHONE

Size only ½" × ¾" × 3/16" so small enough for a bugging device, ex-hearing-aids but guaranteed. Price **£1.50.**

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox—all electronic parts and circuit. **£2.30.**

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6.90.**

SAFE BLOCK
Mains quick connector will save you valuable time Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit **£1.95.**

LIGHT CHASER
Gives a brilliant display — a psychedelic light show for discos, parties and pop groups. These have three modes of flashing , two chase-patterns and a strobe effect. Total output power 750 watts per channel. Complete kit. **Price £16. Ready made up £4 extra.**

FISH BITE INDICATOR enables anglers to set up several lines then sit down and read a book As soon as one has a bite the loudspeaker emits a shrill note. Kit. **Price £4.90.**

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit, includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones, Price **£11.95.**

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price **£2.30.** Crystal earpiece **65p. High resistance headphones** (give best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find — start at the aerial and work towards the speaker — when signal stops you have found the fault. **Complete kit** £4.95.

INTERRUPTED BEAM KIT
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2.30.

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £11.50 + £2.50** post.

G.P.O HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (700B) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp etc. **An absolute bargain at only £1.85.** Suitable 80 ohmn earpiece 69p

MAINS ADAPTORS
Why use expensive batteries — operate your radios and equipment from the mains with these units,
—**Sinclair** gives 9v-100mA — £2.95
—**Aktai** gives 6v 7.5 or 9v-300mA — **£3.95**
—**Crown** gives 6v at 300mA — £2.95
—**Nixie** gives 12v-750mA — **£3.95**
These are all made up complete with mains lead in plastic cases. We can also supply Mains Transistor Power Pack Kit for Voltage output anything from 3v to 16v up to 300mA — complete kit with double insulated mains transformer and full instructions — £1.95

2½ ROUND PANEL METERS. All flush mounting through 2½in round hole, with flange makes item 3in wide approx Made to stringent Ministry specifications We have the following types in stock All are moving coil unless otherwise stated **MICRO AMMETER** 500UA, scaled 0.5 **Price £2.80. MILLIAMP METER** 500 MA, scaled 0 500 mA **Price £2.30. AMPERE METER.** Hot wire, scaled 0-9 amp **Price £2.30. DUAL RANGE VOLT METER.** Scale calibrated 0-10v and 0-250v **Price £3.45. 0-1 MA METER** IMA f.s d centre zero, scaled 100-0-100 **Price £3.45.**

VU METER. Edgewise mounting, through hole size 1⅝in x ⅛in approx These are 100 micro amp f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. **Price £2.88.**

BALANCE METER. Edgewise mounting 100 UA centre zero. **Price £2.30.**

1⅞in SQUARE PANEL METER. Eagle full vision plastic front, 50 UA, **Price £4.60.** 1mA **Price £4.03.**

WATERPROOF HEATING WIRE. 60 ohms per yard This is a heating element wound on a fibre glass coil and then covered with p v c Dozens of uses — around water pipes, under grow boxes, in gloves and socks. **23p metre.**

DIAL INDICATOR. As used in tool making and other precision measuring operations, the famous John Bull accurately shows differences of 01mm A beautifully made precision instrument, price in most toolshops would be £12-£15. We have a fair quantity **Price £9.20.**

COMPONENT BOARD. Ref. W0998 This is a modern fibre glass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including four 3 amp 400v types (made up in a bridge), 8 transistors, type BC107 and 2 type BFY51, electrolytic condensers, SCR ref. 2N 5062 25 0uf 100v DC and 100uf 25v DC and over 100 other parts including variable fixed and wire wound resistors electrolytic and other condensers. A real snip at **£1.15.**

FRUIT MACHINE HEART. 4 wheels with all fruits motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot" **£9.95 + £4** carriage

DESOLDERING PUMP
Ideal for removing components from computer boards as well as for service work generally Price **£6.35.**

4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc 10 metres **£2,** 100 metres **£15.** Other multicore cable in stock

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector Will scare away any villain and bring help. **£2.50** complete kit

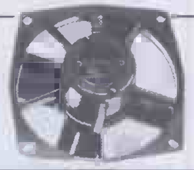
HUMIDITY SWITCH
American made by Honeywell The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch Very sensitive breathing on it for instance will switch it on Micro 3 amp at 250V a c Only **£1.15.**

MULLARD UNILEX

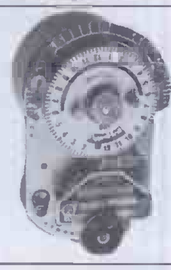
A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£16** including V.A.T. and postage.

FREE GIFT—Buy this month and you will receive a pair of **Goodman's** elliptical 8" × 5" speakers to match this amplifier.

EXTRACTOR FANS



Ex-Computer made by Woods of Colchester; ideal also as blower; central heating systems, fume extraction, etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" **£5.50,** 6" **£6.50;** post **£1** per fan.



VENNER TIME SWITCH mains operated with 20-amp switch, one on and one off per 24 hours 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 new but without case, but we can supply plastic cases (base and cover) **£1.75** or metal case with window **£2.95.** Also available is adaptor kit to convert this into a normal 24-hour time switch but with the added advantage of up to 12 on/offs per 24 hours. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.**

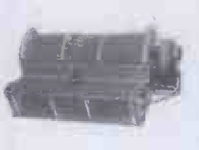
3-CHANNEL SOUND TO LIGHT KIT

Complete kit of parts for a three-channel sound to light unit controlling over 2,000 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 snip price is **£13.50** in kit form or **£16.50** assembled and tested.

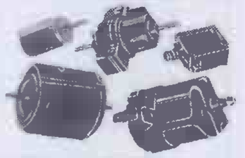
DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3.45.**
Made-up model **£1** extra.

PUNCH TAPE CONSOLES. Complete units mounted on very well built desks. The tape punch and the tape reader are set in the top, below in the cupboard is stored the power units and electronics. The keyboard is separate but plugs in and rests on the top of the desk. This is an 8 bit paper tape system. The keyboard is a standard computer type using reed switches ASCII coded. The keyboard has 72 encoded keys. Offered complete with the data, at only a fraction of original cost. **£115 each** + carriage at cost. Used but believed in good order — any section not so would be replaced. Please telephone before calling to collect.



TANGENTIAL HEATER UNIT
A most efficient and quiet running blower-heater by Solatron — standard replacement in many famous name heaters — comprises mains induction motor, long turbo fan, split heating element and thermostatic safety trip. Simply connect to the mains for immediate heat. Mount in a simple wooden or metal case or mount direct into base of, say, kitchen unit. Price **£5.95,** post £1.50. Control switch to give 2kw, 1kw, cold blow or off available 60p extra. 3kw model **£6.95.** Control Switch **95p.**



8 POWERFUL BATTERY MOTORS.
For models, meccanos, drills, remote control planes, boats, etc. **£2.**

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant ranges measure:
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 only **£6.75 + 50p** post and insurance.

FREE Amps ranges 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.**

TERMS Cash with order—but orders under **£10** must add **50p** to offset packing etc
BULK ENQUIRIES INVITED - PHONE HAYWARDS HEATH 54563
ACCESS & BARCLAYCARD ACCEPTED

J. BULL (Electrical) LTD.

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

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful break-down parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find: over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensors, multi turn pots, rectifiers, SCR etc. etc. for only £8.50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. **+ £1.27 VAT** + £2 post (it's a big parcel)

THIS MONTH'S SNIP. A 3 wave band radio with stereo amplifier. Made for incorporation in a high-class radiogram, this has a quality of output which can only be described as superb It is truly hi-fi. The chassis size is approximately 14in Push buttons select long, medium, short and gram. Two dial lights for a scale, the pointer being moved by cord drive. The other controls are balance, volume, treble and bass. The chassis is ready built with its own mains power supply The output is 6 + 6 watts. Brand new and in perfect working order, offered at less than value of stereo amp alone, namely **£6.90.** Post £2 00.

SUPER HI-FI SPEAKER CABINETS. Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free cut-outs for 8in woofer and 4in tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black Supplied in pairs. **Price £6.90 per pair.** (this is probably less than the original cost of one cabinet). Carriage £3.

OCTOBER/NOVEMBER CONSTRUCTORS' SNIP. Here's a super bargain for you 100 twist drills, regular tool shop price over £50, yours for **only £11.50.** With these you will be able to drill metal, wood, plastic etc from the tiniest holes in P.C.B. right up to about ¼in. Don't miss this snip — send your order today.

UNILEX OWNERS. Excellent PM speakers, European made, extremely good quality and 15 ohms, the correct impedance for the Unilex. Half regular price only **£2.30 per pair** + £1 post

MAINS ADAPTORS. Why use expensive batteries — operate your radios and equipment from the mains Save yourself pounds, with our bargain range of power packs Sinclair gives you 9v100mA **£2.99.** Altai gives 6v 7.5 or 9 v 300 mA **£4.10.** Crown gives 6v 300mA **£2.90.** Nixie gives 12v 750mA **£3.99.** All made up in plastic cases complete with mains lead. We can also supply Mains Transistor Power Pack Kit for Voltage output anything from 3v to 16v up to 300mA — complete kit with double insulated mains transformer and full instructions **£1.95.**

ENAMELLED COPPER WIRE. We stock this on 1lb reels and ¼lb reels

Gauge	1lb	¼lb
10-29	£2.50 + 37p	£0.90 + 13p
30-34	£3.00 + 45p	£1.00 + 15p
35-39	£3.50 + 52p	£1.10 + 16p

Thinner gauges are available — we will be pleased to quote you

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 blower 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 would cost around about £15.00 - however, you can have the parcel for **£2.50.**

SUPPRESSOR CONDENSER. Made by famous **Philips** company, this is a 3 section condenser Main section 2 mfd Other 2 sections each 5000 P F Ideal for suppressing electrical drills and similar devices **57p.** Ditto .1 mfd 250v AC metal cased with fixing lug **57p.**

HIGH VOLTAGE CONDENSERS. .1 mfd 2.5 kv **£1.15.** 0.5 mfd 5 kv **£1.15.** .001 mfd 28 kv **£2.30.**

HIGH VOLTAGE CERAMIC DISC CAPACITORS. 47 pf 68 pf 100 pf 150 pf 220 pf, all **£10.00** per 100, **£1.50 for 10**

AC CONDENSERS. In addition to the normal uses as motor starters, power factor correction etc. These make very good voltage droppers for working low voltage appliances from mains. The voltage working quoted is AC RMS, so these condensers are usually suitable for working on DC at 2½ times the quoted AC voltages.

1 5 mfd 440V	**64p**	6 25 mfd 250V	**£1.00**	12 mfd 440V	**£2.78**
2 5 mfd 440V	**87p**	8 mfd 250V	**£1.27**	13 mfd 275V	**£1.65**
3 4 mfd 440V	**£1.00**	8 mfd 440V	**£1.89**	15 mfd 230V	**£1.65**
3 5 mfd 250V	**77p**	11 mfd 275V	**£1.52**	15 mfd 325V	**£1.77**
5 mfd 570V	**£1.52**	12 mfd 250V	**£1.52**	20 mfd 275V	**£1.77**
				32 mfd 250V	**£2.89**

THIS MONTH'S NEW KITS

1 **STUDENT'S FIRST MULTI-TESTER.** Kit contains panel meter 12 way rotary wafer switch, resistors, rectifier battery connector and case with pointer knob and terminals The multi-tester, when completed, will measure DC volts 4 ranges, DC current, 3 ranges, AC volts 3 ranges, resistance 2 ranges. The main value of the kit is educational, but properly completed it will prove a most useful instrument. **Price £4.99.**

2 **MULTI OPTION SOUND PRODUCER.** Also called a sensational sonichsiren, with it you can reproduce, for instance, American Police Siren, World War II Air Raid Alerts, and a universe of other effects Some possible applications include burglar alarms sound effect units, noise box to amuse the kids or to play it through your stereo to frighten away the birds and annoy your neighbours! 4 independently adjustable parameters give finger tip control **Complete kit, less case £6.90.** Case £2 50

MERCURY BATTERIES. Bank of 7 mercury cells type 625 which are approximately ⅜in dia in plastic tube, giving a total voltage of 10 7 Being a plastic tube it is very easy to break up the battery into separate cells which could be used for radio control and similar equipment Carton of 25 batteries £1.15 + 85p post

HALF-PRICE CABLE OFFERS. We have good stocks of

Size mm	Type	Price 100 metres	Carriage
1.5	Single	£4.00	£1.75
1.5	Flat twin	£6.50	£2.75
1.5	Flat 3-core & E	£9.75	£3.50
4	Single	£7.50	
4	Flat twin	£11.50	£4.00
6	Flat 3-core	£32.50	£5.00
16	Twin & E	£79.00	£10.00

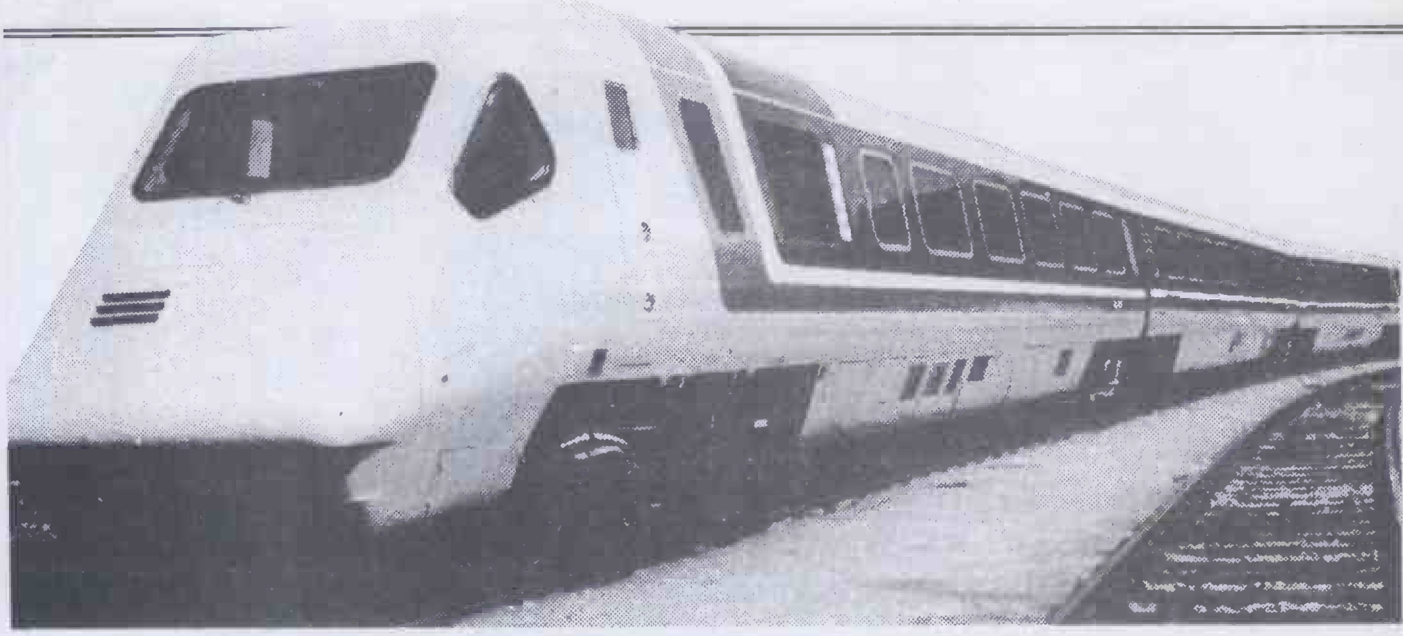
THERMOSTATS, WALL MOUNTING. The Danfoss, a handsome 2 tone intended for living rooms but is just as efficient in a greenhouse or store It is suitable for normal air temperature range 32F-80F **Price £4.60.**

WATER HEATER THERMOSTATS. These push into the pocket in immersion heater Adjustable setting 80F-190F Available as follows: 7in **£2.87; 12in £3.45,** 18in **£4.05.**

PRESET POTS. Just arrived a consignment of over ½ million covering horizontal, vertical sub-min, min and standard types Values from 50 ohms to 10 Meg ohms We have not completely sorted these and are making a special pre "putting into stock" offer of 100 for **£9.50,** types and values to your choice, but not less than 10 of any one Sample 10 our assortment **£1.15.**

AC MAINS BUZZERS. Open construction Size 1⅝in x 1in x 1in **£69.**

BUZZER. 9v, nice tone, electronic with tappings for loud, medium and soft Suitable for instrument test equipment, morse trainer etc **£1.15.**



Two-Tone Train Horn

We've had more fun with our train set this month, designing yet another sound

THIS SECOND project in our series of model train sound effects allows you to electronically simulate, with fair realism, the noise of a diesel-train horn. The so is triggered automatically as the train reaches a desired place on the track so you can produce the sound as the train approaches stations, level crossings etc.

The two-IC circuit is simple-to-build and uses readily obtainable parts. Both ICs are 555s, one of the most common types of integrated circuits available and this accounts for the circuit's simplicity: with only a couple of component changes the 555 adapts to many different applications.

Output power from the HE Two-Tone Train Horn is adequate to drive a miniature loudspeaker directly so all that is required is a single 9 V battery to get your circuit up and running.

Construction

Veroboard construction on a standard sized 10 strip by 24 hole board means that this project is quite easy to build. The usual procedures and precautions should be followed but you will find that very few of the components are critical. In fact you may like to experiment with different values to get other sounds.

Make your track breaks first with either the purpose-made tool or simply a hand-held ⅛" drill bit. Next, insert all links and IC sockets, followed by resistors, capacitors and finally semiconductors.

Figure 2 shows connection details of the project along with overlay and underside-board views and you should follow it carefully.

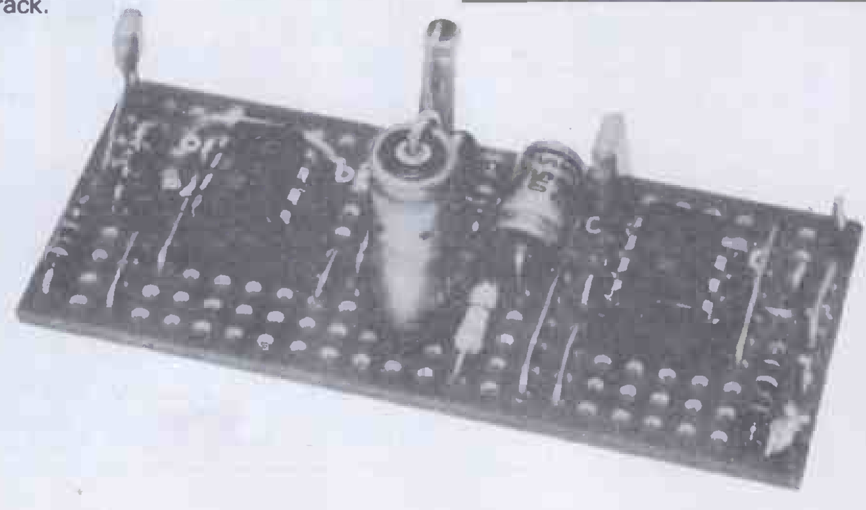
To generate the two-tone sound automatically, mount a reed switch under the track at whatever location you require. A magnet attached to the bottom of the train will operate the reed switch as it passes. You can connect as many reed switches as you wish, in parallel, to trigger the sound at various places around the track.

How It Works

The sound generating part of this circuit is formed by IC2, a 555 connected as an astable multivibrator. The frequency of the sound varies with the overall charge and discharge times of capacitor C4. So, when the junction of D1 and 2 is high, the frequency of oscillation is set by the current through R4 plus that through R5, charging the capacitor. Similarly, when the junction of D1,2 is low the frequency is set by the current through R5 (no current can flow through R4). When the charge current is less, therefore, the frequency is lower.

Integrated circuit IC1, another 555, forms a monostable multivibrator with an 'on' time of about 2 s. The multivibrator output (pin 3) is connected directly to the junction of D1,2 and hence when the monostable is 'on' the frequency is higher than when it is 'off'.

A reed switch under the track is operated by a magnet attached to the train as it passes and this triggers IC1 into its 'on' state thus generating the two-tone horn sound.



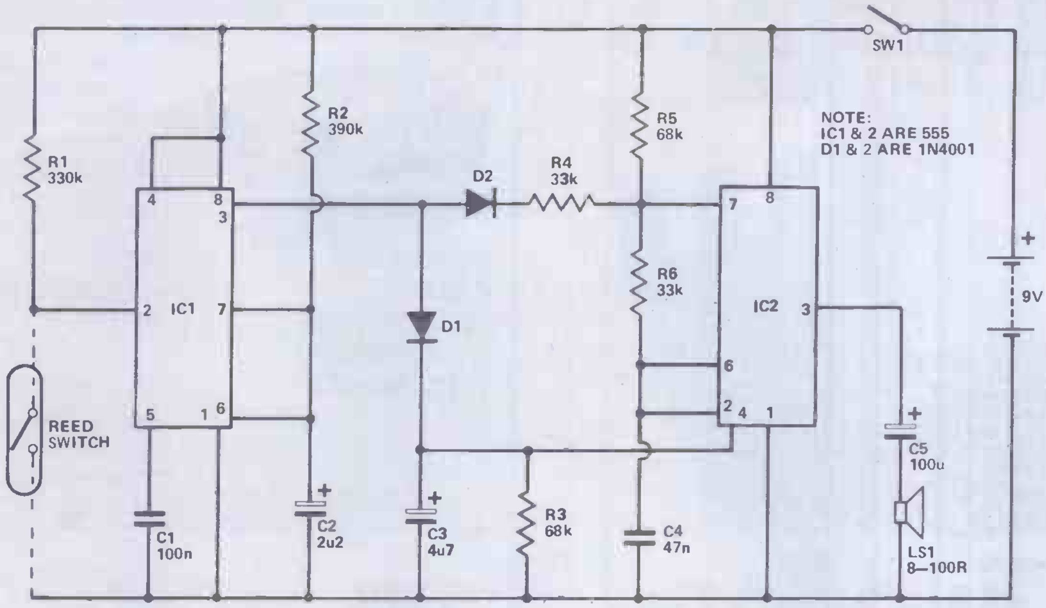
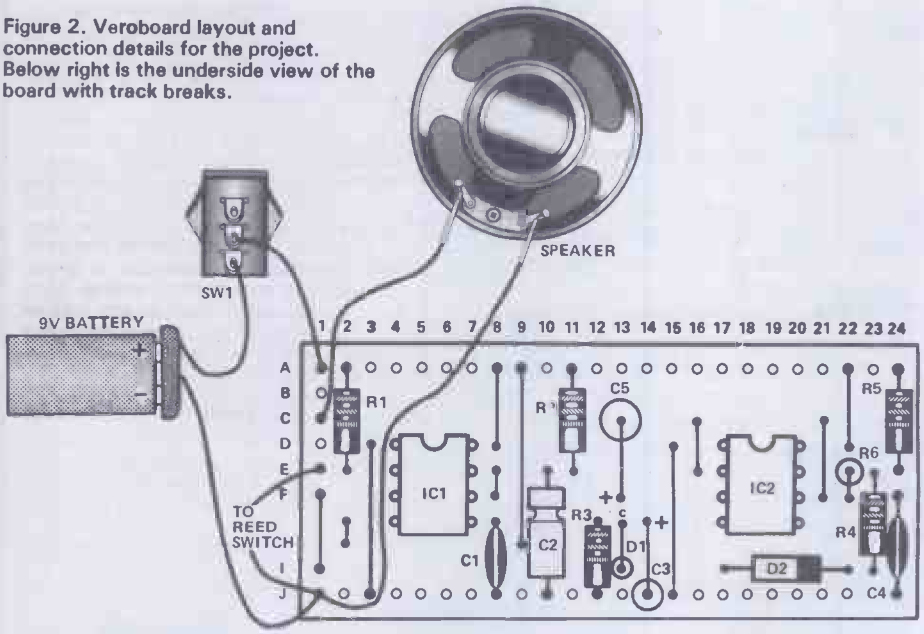


Figure 1. The HE Two-Tone Train Horn circuit diagram.

Figure 2. Veroboard layout and connection details for the project. Below right is the underside view of the board with track breaks.



Parts List

RESISTORS (All ¼W, 5%)

R1	330k
R2	390k
R3,5	68k
R4,6	33k

CAPACITORS

C1	100n ceramic
C2	2u2, 10 V electrolytic
C3	4u7, 10 V electrolytic
C4	47n ceramic
C5	100u, 10 V electrolytic

SEMICONDUCTORS

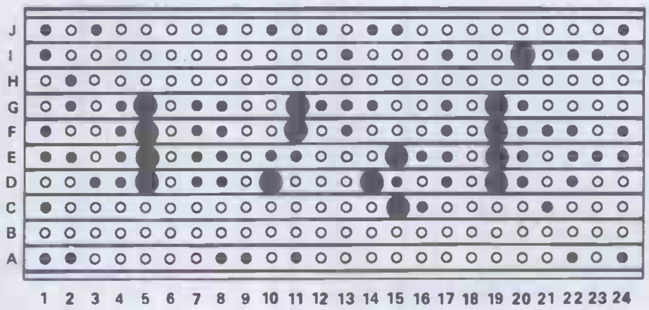
IC1,2	555 timer
D1,2	1N4001 diode

MISCELLANEOUS

SW1 single-pole, single-throw toggle switch
Reed switches + magnets
2 x 8-pin IC sockets
10 strip x 24 hole, 0.1" matrix Veroboard
Miniature speaker (8 to 100 R)
Battery + clip

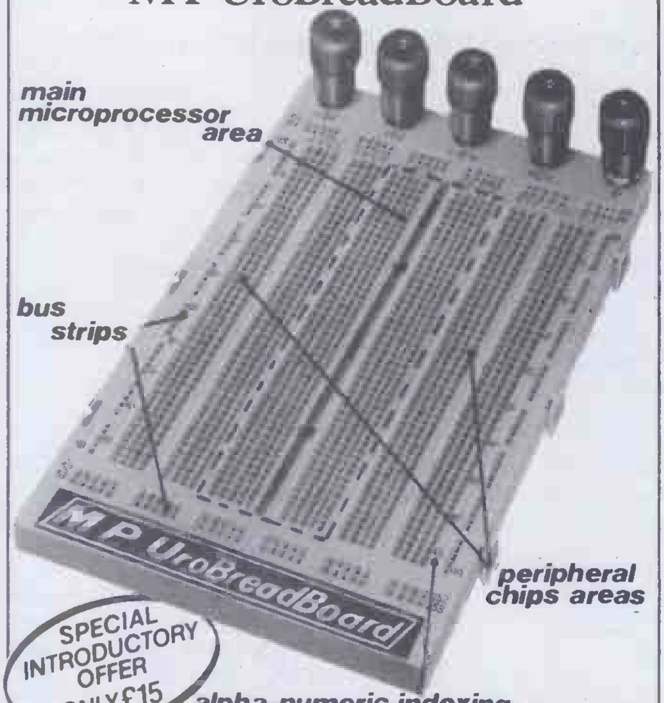
Buylines

The components used in this project are all easily obtainable and should cost approximately £5.



HE

If you're into MICROPROCESSORS then they should be into an M P UroBreadBoard



* MPU Section accepts 24, 28, 40 & 64 pin DIL microprocessors
* Auxiliary Areas accept any .3" or .6" RAM, ROM or peripheral chip
* Power Bus Strips on all sides
* 5 incoming turret Power Terminals
* Component Support Bracket included
* Over 1400 contact points
* Alpha-Numeric column and row indexing
* Eurocard size (160mm x 100mm)
* Slots onto all BIMBOARDS
* Non-Slip rubber backing
* Ideal for schools and colleges
* Long life, <10m.ohms, nickel silver contacts

The PROFESSIONALS breadboard that BEGINNERS can start on

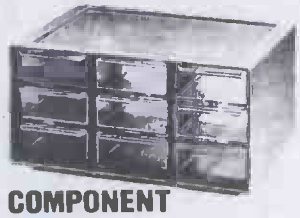
BOSS INDUSTRIAL MOULDINGS LTD
2 Herne Hill Rd, London SE24 0AU, England
Telephone 01-737 2383 Telex 919693
Cables & Telegrams: LITZEN LONDON SE24

Please send me .... MPUroBreadBoard(s) at the special, limited period, introductory offer price of £15.00.
This price includes VAT & PP, is applicable from Sept 1 1980 but please add 15% for Overseas Orders, make cheques/P.O. payable to BOSS Industrial Mouldings Ltd and allow 10 days for order processing and cheque clearance etc.
I enclose a cheque/P.O. to the value of £..........................

Name . . . .
Company . . . .
Address . . . .
. . . .
. . . .
Telephone Number HE/2/81

GREENWELD

443F MILLBROOK ROAD, SOUTHAMPTON SO1 0HX
All prices include VAT—just add 40p post. Tel (0703) 772501



COMPONENT CABINET IDEAL FOR THE NEWCOMER TO ELECTRONICS

Contains hundreds of brand new resistors, capacitors, transistors, diodes and I.C.s. All useful values carefully chosen to help the new constructor pursue his hobby without finding himself short of some vital parts. All parts contained in clearly marked bags in a plastic storage cabinet 232 x 121 x 165mm with 9 drawers into which all parts can be neatly located. If bought individually parts plus case would cost over £50 but we are offering this for ONLY **£33.95 + £1** p. & p. Simply send a cheque or P.O. for **£34.95** for immediate despatch.

CONTENTS:
200 ¼ watt resistors
20 Wire wound resistors
70 Ceramic Capacitors
70 Mylar Capacitors
50 Polyester Capacitors
56 Electrolytic Capacitors
61 Transistors
12 ICs
20 LEDs
55 Diodes and rectifiers
Altogether 614 components.
Plus **FREE** surprise gift.

P.C. ETCHING KIT Mk V

The best value in etching kits on the market — contains 100 sq ins copper clad board, Ferric Chloride, Etch resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. **All for £4.95.**

CALC CHIPS 60p!!

New full spec, supplied with data. Type MK50321 — full function inc. memory. **Only 60p**

DISPLAYS

8 and 9 digit 7-segment bubble type for above chips — most have minor faults, dud segment, etc. Mixture of 2 or 3 different types with data. 5 for £1.

EX-COMPUTER PANELS

Z527 2 x 6V reed relays, 6 x 2S030 or 2S230 6 x 400V rects. + Rs. **Only 50p.**
Z529 TTL pack — Panels with 74 series on, together with code sheet. From simple gates to complex counters, 20 ICs £1; 100 ICs £4.

BUZZERS, MOTORS & RELAYS

Z401 Powerful 6V DC buzzer, all metal construction. 50mm dia x 20mm **85p.**
Z402 Miniature type buzzer, 6, 9 or 12V, only 22x15x16mm. Very neat **65p.**
-450 Miniature 6V DC motor, high quality type 32mm dia x 25mm high, with 12mm spindle. Only £1.
Z459 115-230V ac high torque motor with geared reduction down to 60 rpm. Sturdy construction. 70mm dia x 20mm. Spindle 6mm dia x 20mm long. **Only £2.**
W892 Heavy Duty 12V relay, ideal for car use — single 15A make contact. Coil 25R in sealed metal can with mounting bracket **85p.**
W890 DIL Reed relay SPCO 2.4-10V. 200R coil. Only **£2.20.**
W847 Low profile PC mntg 10 x 33 x 20 mm 6V coil, SPCO 3A contacts. **93p.**

VEROBLOC BREADBOARD

New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocs can be joined together. Bus strips on X & Y axis — total 360 connexion points for just £4.15.

ELECTRONICS
A NEW AND EXCITING HOBBY!!

BIG WELL ILLUSTRATED BOOK

Ideal for beginners — gives lots of general information — explains how to build lots of projects : Intercom, Rain Alarm, Radios, Organ, Parking Light etc. All parts supplied and can be re-used on special deck provided, so NO SOLDERING is required. Just needs 4½V battery.

£17·50 inc. VAT & Post

Also
ADVENTURES WITH MICROELECTRONICS — Explore the world of silicon chips —
All components & Deck, £27.95 inc VAT & Post.

THE SPECTACULAR 1981 GREENWELD Component Catalogue

Bigger and better than ever!!!

★ 60p discount vouchers
★ First Class reply paid envelope
★ Free Bargain List
★ Priority Order Form
★ VAT inclusive prices
★ Quantity prices for bulk buyers
★ Free IC Data Sheet
★ **SEND 75p (inc. post) FOR YOUR COPY NOW!!**

BUY A COMPLETE RANGE OF COMPONENTS AND THESE PACKS WILL HELP YOU

ALL PACKS CONTAIN FULL SPEC. BRAND NEW MARKED DEVICES — SENT BY RETURN OF POST. VAT INCLUSIVE PRICES.

K001 50V ceramic plate capacitors. 5%, 10 of each value 22pF to 1,000pF, total 210. **£4.80.**
K002 Extended range 22pF to 0.1μF, 330 values **£7.66.**
K003 Polyester capacitors, 10 each of these values: 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, 0.15, 0.22, 0.33, 0.47μ, 110 altogether for **£5.40.**
K004 Mylar capacitors, min 100V type 10 each all values from 1,000pF to 10,000pF. Total 130 for **£4.70.**
K007. Electrolytic capacitors 25V working small physical size. 10 each of these popular values 1, 2.2, 4.7, 10, 22, 47, 100μF. Total 70 for **£3.59.**
K008 Extended range, as above, also including 220, 470 and 1000μF. Total of 100 for **£6.35.**
K021 Miniature carbon film 5% resistors CR25 or similar. 10 of each value from 10R to 1M, E12 series Total 610 resistors **£5.95.**
K022 Extended range. Total 850 resistors from 1R to 10M **£8.20.**
K041 Zener diodes 400mW 5% BZY88, etc. 10 of each value from 2.7V to 36V, E24 series. Total 280 for **£15.95.**
NEW K051 LEDs — 10 each red, green & yellow 3mm & 5mm, with clips. Total 60 LEDs for **£8.95**

REGULATED PSU PANEL

Exclusive Greenweld design — better spec. than anything on the market being offered at the price. Panel 110x82x33mm high contains all components including bridge rectifier and smoothing capacitor. Ready built and tested — just add a 30V 2A transformer and two pots for a fully variable voltage and current supply.

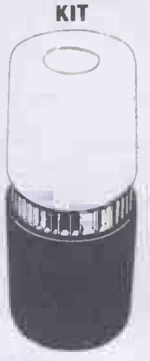
SPEC: Output voltage 0-28V
Output current 20mA-2A
Source Impedance 0R1
Open circuit ripple 10mV

Send SAE for full details of the many ways this useful module can be used, together with price list of parts for various options. Only **£7.75**

TRANSISTOR PACK K516

Take advantage of this unbelievable offer!!
Small signal NPN/PNP transistors in plastic package at an incredibly low, low price!! Almost all are marked with type number — almost all are full spec. devices. Some have bent leads. Over 30 different types have been found by us including BC184/212/238/307/328. BF196/7; 2Nx107/8/9/34Z/450/550, etc. Only available as a mixed pack at **£3** per 100, **£7** per 250, **£25** per 1,000.

ELECTRONIC AIR FRESHENER KIT



* **Battery Operated**
* **Replaceable Fragrance**
* **Continuous Air Freshening**
* **Robust Construction**

This novel kit contains everything you need to make one of the most advanced air fresheners of its kind. Styled to take its place in any room in your home and do its job quietly and unobtrusively.
The automatic timing circuit switches on a fan for a few seconds at regular intervals to send an odour neutralising fragrance into every corner of your room.
The kit includes components for EITHER a 4 or 15 minute timing circuit, miniature D.C. motor and moulded parts in high impact styrene to provide an easily maintained, elegant appearance.

ONLY £7.95.

Into Digital Electronics

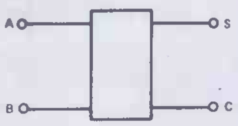
It's adders and other digital reptiles this month. Ian Sinclair takes you from the simplest adders through algorithms to microprocessors

THE GATES AND flip-flops that we've used so far will make a variety of circuits but for some types of circuits which need a lot of gates to construct, an IC which contains all the gates in one chip is easier to use.

One type of gate circuit which is well worth the trouble of making in IC form is the BCD-to-seven-segment decoder which we used last month. Another is the *adder*, and adders are the circuits we shall start off with this month.

Half An Adder

The simplest adder is called the half-adder, and its truth table is shown in **Fig.6.1**. It has two inputs, labelled A and B, and two outputs, labelled S (for sum) and C (for carry). Two ways of making a half-adder are shown in **Fig.6.2**. One uses standard gate units, the other makes use of an AND gate along with a type of gate called the exclusive-OR (X–OR). The X–OR gate has almost the same logic as the OR gate, but does NOT give 1 at its output when both inputs are at 1 (that's what is excludes). Its symbol and truth table are shown in **Fig.6.3**. The X–OR gates are available in IC form: an example is the 74LS86 quad X–OR gate.



A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Figure 6.1 Half-adder symbol and truth table

The action of the half-adder is quite simple. Bits at the two inputs A and B are gated so as to produce outputs at S and C. The bits aren't actually *added* in the sense of being joined up, but the outputs are the values you expect from binary addition. For example, with both inputs zero, S and C are also zero. If either input bit is 1, then S = 1 and C = 0. If both inputs are 1, then S = 0 and C = 1 because in binary 1 + 1 = 10 (C is 1 and S is 0).

A half adder can be used only for the lowest bit of two numbers, because for each other pair of bits, there is a third bit to add in, the carry from the previous addition. For example, when we add 11 and 11, then the lowest bits add to give a sum of 0 and a carry of 1. The next addition is of bits 1 and 1 with a carry of 1, so that the final result is 110. In denary, just in case you're wondering, these numbers are 3, 3 and 6.

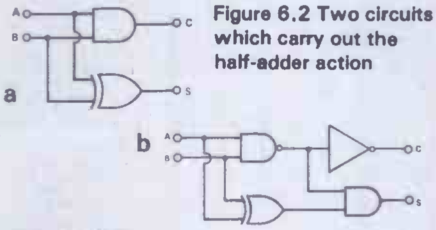


Figure 6.2 Two circuits which carry out the half-adder action

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

Figure 6.3 X OR gate symbol and truth table

A circuit which carries out the function of a full adder is a bit more complicated than the simple half-adder. **Figure 6.4** shows a full adder circuit, one half of the circuitry inside the 7482 adder. Each half consists of seven AND gates, an OR gate and an inverter. The inputs are the binary digits A and B, with a carry-in C0; the outputs are the sum S and carry-out C1. The truth table for the full-adder is shown in **Fig.6.5**.

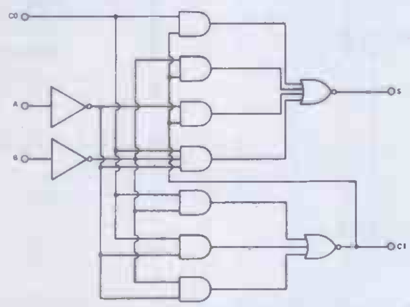


Figure 6.4 Circuitry for a full adder. Inputs are the bits to be added, plus a carry from the previous stage: ouputs are the usual sum and carry bits

We can set up an adding circuit on the Eurobreadboard, with the help of the usual range of switches and LEDs. The 74LS82 two-bit adder is a suitable gentle introduction to binary arithmetic; if the 74LS82 is hard to come by then the old fashioned 7482 can be used in place, though it takes a higher current (about 17 mA). When it's the only chip on the board, that doesn't matter too much, even if you're using battery supplies.

A	B	C0	S	C1
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Figure 6.5 Truth table for a full-adder

In the circuit (**Fig.6.6**) each switch contributes a binary digit. Switches SW1 and 2 give one number, with SW1 giving the higher digit and SW2 the lower. Switches SW3 and 4 are used for the second binary number, with SW3 for the higher digit. The outputs are indicated by the LEDs — LED2 shows the highest digit, the carry from the second stage of addition, with LED3 showing S2 and LED4 showing S1. The LEDs will therefore indicate the binary output if you read them from left to right.

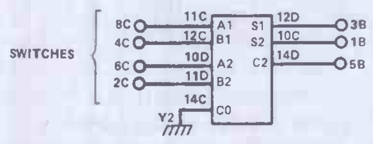


Figure 6.6 Using the 74LS82 full-adder. The switches provide the inputs, and the LEDs provide the outputs. The 74LS132 can be removed if desired

Set 'em up, Joe, and adjust the switches as shown in **Table 6.1**, completing the table of outputs for C = 0, which will be the truth table for two bits of addition, with no carry-in. Once you've completed that, change the link at line 14C transferring it from Y2 to X1 so that C0 is at logic 1. Now try the truth table again, filling in the columns under C0 = 1 this time. If you want to see the results in decimal form, you can plug the 74LS48 decoder and the seven-segment

WORD A	WORD B	SWITCHES 1	2	3	4	C0 = 0 C2 LED3	S2 LED2	S1 LED1	C0 = 1 S1 LED1	C2 LED3	S1 LED1
0 0	0 0	L	L	L	L						
0 0	0 1	L	L	L	H						
0 0	1 0	L	L	H	L						
0 0	1 1	L	L	H	H						
0 1	0 0	L	H	L	L						
0 1	0 1	L	H	L	H						
0 1	1 0	L	H	H	L						
0 1	1 1	L	H	H	H						
1 0	0 0	H	L	L	L						
1 0	0 1	H	L	L	H						
1 0	1 0	H	L	H	L						
1 0	1 1	H	L	H	H						
1 1	0 0	H	H	L	L						
1 1	0 1	H	H	L	H						
1 1	1 0	H	H	H	L						
1 1	1 1	H	H	H	H						

display on to the board (replacing the 74132 and the 74LS76) and connect the lower (A, B) pins of the decoder inputs to the S1 and S2 outputs of the 7482, with input C coming from C2, as shown in **Fig.6.7**.

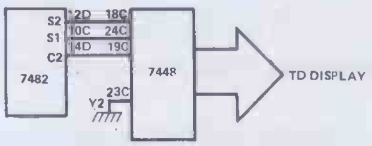


Figure 6.7 Connecting the adder outputs to the 74LS48 decoder so that results can be displayed in denary if wanted. The D input of the decoder must be earthed

Multiplexing

There are two other types of circuits that are worth knowing about, though we're not going to use them in this set of exercises. They are both combinational circuits, using gates, and they have a wide range of uses. **Figure 6.8** shows the internal circuit of the 74LS157, which is a quad two-to-one line selector or multiplexer. The inputs consist of pairs of binary digits 1A, 1B or 2A, 2B or 3A, 3B or 4A, 4B. There is also a select input and a strobe input.

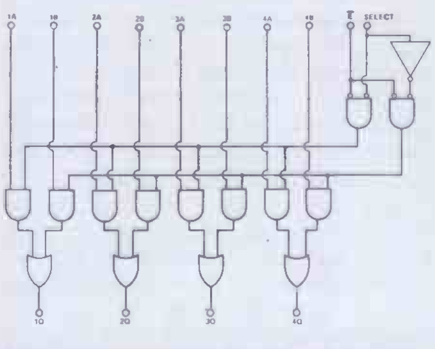


Figure 6.8 Internal circuitry of the 74LS157. This is why we use ICs!

The strobe input is a 'shut-off' input. With the strobe input high, the outputs are low whatever the input voltages are, so that this can be used to select a zero output. With the strobe input low, the select input can be used to decide which input is connected to the corresponding output. With the select input low, each Q output is the same as the corresponding A input, and the B inputs are ignored. When the select input is high each Q output is the same as the corresponding B input, and the A inputs are ignored. We can use this circuit to select either one of the two four-bit numbers to appear on the output pins, or we can reset the outputs to zero by making the strobe input high. The 74LS157 is a comparatively simple multiplexer, and some of the more complex types are even more interesting. The truth table and pinout of the 8230 are shown in **Fig.6.9**. This IC uses eight inputs, any one of which can be selected by the voltages of three 'address' lines, A0 to A2, to appear at the output. An inhibit 1 input will cause the output to be zero for any other inputs. The idea of using three address lines to switch the output eight ways is an important one, and it's used a lot in microprocessor circuits.

ADDRESS A2	A1	A0	DATA INPUTS I7	I6	I6	I4	I3	I2	I1	I0	INH	OUTPUTS I	$\overline{I}$
0	0	0	x	x	x	x	x	x	x	1	0	1	0
0	0	1	x	x	x	x	x	x	1	x	0	1	0
0	1	0	x	x	x	x	x	1	x	x	0	1	0
0	1	1	x	x	x	x	1	x	x	x	0	1	0
1	0	0	x	x	x	1	x	x	x	x	0	1	0
1	0	1	x	x	1	x	x	x	x	x	0	1	0
1	1	0	x	1	x	x	x	x	x	x	0	1	0
1	1	1	1	x	x	x	x	x	x	x	0	1	0
0	0	0	x	x	x	x	x	x	x	0	0	0	1
0	0	1	x	x	x	x	x	x	0	x	0	0	1
0	1	0	x	x	x	x	x	0	x	x	0	0	1
0	1	1	x	x	x	x	0	x	x	x	0	0	1
1	0	0	x	x	x	0	x	x	x	x	0	0	1
1	0	1	x	x	0	x	x	x	x	x	0	0	1
1	1	0	x	0	x	x	x	x	x	x	0	0	1
1	1	1	0	x	x	x	x	x	x	x	0	0	1
x	x	x	x	x	x	x	x	x	x	x	1	0	1

x = EITHER 1 OR 0 (DON'T CARE STATE)

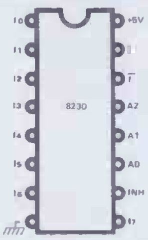


Figure 6.9 Pinout and truth table for the 8230 (Signetics) multiplexer

Demultiplexing

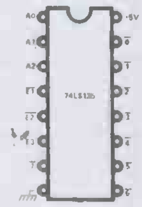
A demultiplexer does exactly the opposite. It has a few inputs which can be switched to a large number of outputs. The 74LS138 is our example, whose pinout and truth table is shown in **Fig.6.10**. The inputs labelled A_0, A_1, A_2 are address or select inputs, and the inputs labelled $\overline{E_1}$, $\overline{E_2}$, E_3 are enable inputs. When either of the E inputs is high, all of the eight outputs will be high, no matter what voltages (0 or 1) are placed on the address/select pins. Similarly, if E_3 is low, the outputs will all be at logic 1. With E_3 high and both of the E inputs ($\overline{E_1}$ and $\overline{E_2}$) low, one of the outputs will go low. Which one? That depends on the voltages on the address pins, and the truth table shows which output pin will go low for various addresses. Notice that the address pins have been labelled so that the binary number represented by taking the pin signals in A_2, A_1 A_0 order is also the number of the output. For example, with $A_2 = 0$, $A_1 = 1$, $A_0 = 0$, the binary number is 010, decimal 2, and it is 2 which is low when this address is selected. Similarly when $A_2 = 1$ $A_1 = 0$ $A_0 = 1$ (decimal 5), 5 is selected as the low output.

The demultiplexer is a very useful decoder of binary numbers into single lines: the most common numbers of lines are four (two address lines), eight (three address lines) and sixteen (four address lines). There is also a BCD version, the 74LS42, which converts BCD signals on four lines to decimal outputs (0 to 9) on ten lines.

ENABLE $\overline{E1}$	$\overline{E2}$	E3	ADDRESS A0	A1	A2	OUTPUTS $\overline{0}$	$\overline{1}$	$\overline{2}$	$\overline{3}$	$\overline{4}$	$\overline{5}$	$\overline{6}$	$\overline{7}$
1	x	x	x	x	x	1	1	1	1	1	1	1	1
x	1	x	x	x	x	1	1	1	1	1	1	1	1
x	x	0	x	x	x	1	1	1	1	1	1	1	1
0	0	1	0	0	0	0	1	1	1	1	1	1	1
0	0	1	1	0	0	1	0	1	1	1	1	1	1
0	0	1	0	1	0	1	1	0	1	1	1	1	1
0	0	1	1	1	0	1	1	1	0	1	1	1	1
0	0	1	0	0	1	1	1	1	1	0	1	1	1
0	0	1	1	0	1	1	1	1	1	1	0	1	1
0	0	1	0	1	1	1	1	1	1	1	1	0	1
0	0	1	1	1	1	1	1	1	1	1	1	1	0

x = 1 OR 0

Figure 6.10 Pinout and truth table for the 74LS138 demultiplexer



Take it away, Ramsbottom

So far, arithmetic has consisted of addition, using the full adder circuits. In fact, binary arithmetic starts and finishes with addition — there's nothing else! Now, before you write in saying that your calculators can add, subtract, multiply, divide, find square roots and the number you first thought of, hold everything! I didn't say those actions weren't done, what I said was that addition is done in binary and no other action is. The reason is that all arithmetic can be fiddled so that only addition needs to be done, and the only other processes which are needed are the use of shift registers.

I know what the next question is. If you can multiply and divide, take square roots and find sines of angles all by simple addition, why don't we do this in everyday life? The answer is speed. Doing a multiplication or a square root by addition might involve several hundred additions, and it's too tedious for a human. For a brainless machine operating as fast as its clock pulse rate will let it, though, there's nothing to it.

Algorithms And Two's Complement

There's nothing to it — at least for the machine. For the guy who designs the machine, though, there's a lot to it. The routines which are used to break down comparatively complicated processes like finding sines of angles into simple additions are called algorithms, and there's nothing simple about most algorithms. They're not new: many of them have been known for centuries and were used long before multiplication tables or other aids to mental calculations existed. We'll look at just two simple algorithms here.

Subtraction is the top priority, because it's a process which is needed just as often as addition. Straightforward binary subtraction (on paper) is illustrated in **Fig.6.11**, and it would be simple enough to devise a gate circuit which gave the necessary outputs from the two binary number inputs. The reason we don't do this is that we don't need to.

```
  1 1 0 0 1 0 1 0        0—1=1 BORROW 1
 -0 0 1 1 0 1 0 1
 ----------------
  1 0 0 1 0 1 0 1
```

Figure 6.11 Binary subtraction: 1 from 1 gives 0, 0 from 1 gives 1, and 1 from 0 gives 1 borrow 1. The technique is the same as in scale-of-ten subtraction

By using a subtraction algorithm, we can simply add two numbers in an adding circuit, ending up with the same answer as a subtraction would have given. The algorithm is called 'two's complement' addition.

Two's complement goes something like this. To start with, you must have an agreed size of binary number — four digits, eight, sixteen or whatever. Suppose we settle on eight, which is the number of digits that a microprocessor handles (pocket calculators usually use four). That means we'll always write eight digits even if most of them are zeros. For example, binary 1 will be 00000001 and 2 (binary 10) will be 00000010. Both numbers are written in this form. The number which is to be subtracted or taken away from the other one is now complemented. That means writing 0 for each 1, and 1 for each zero: it's the action which an inverter carries out. The complement of 00000101 is 11111010 for example. Then 1 is added to the

```
a                       1 1 0 0 1 0 1 0
          SUBTRACT      0 0 1 1 0 1 0 1
              COMP      1·1 0 0 1 0 1 0
                +1                    1
                      -----------------
                        1 1 0 0 1 0 1 1
 ADD ORIGINAL           1 1 0 0 1.0 1 0
                      -----------------
 DISCARD CARRY (1)      1 0 0 1 0 1 0 1

b                   1 1 0 1 0 1
          SUB           1 1 1 0
          PAD       0 0 1 1 1 0
          COMP      1 1 0 0 0 1
            +1                1
                    -----------
                    1 1 0 0 1 0
          ADD       1 1 0 1 0 1
                    -----------
DISCARD CARRY (1)   1 0 0 1 1 1

c                     1 0 1 1 0
          SUB       1 0 1 0 1 1
          COMP      0 1 0 1 0 0
            +1                1
                    -----------
                    0 1 0 1 0 1
          ADD       0 1 0 1 1 0
                    -----------
                    1 0 1 0 1 1

               NEGATIVE NUMBER
```

Figure 6.12 Two's complement subtraction. The number to be subtracted is put into two's complement form, equivalent to placing a negative sign in front. The numbers are then added, and the carry is discarded

lowest bit of the complement. For example, the complement 11111010 becomes 11111011 when the extra 1 is added, and a complement which was 11111011 would become 11111100 (remember your addition 1 + 1 = 0 and carry 1).

This last figure is called the 2's complement, and is *added* to the other number. The result is the number we should expect if a subtraction were carried out. Notice that we deal with 8-digit numbers only. If there is a carry-out from the eighth place, we ignore it, we don't make the carry into a ninth digit. **Fig.6.12** shows some examples of subtractions done using the two's complement algorithm.

Now there's one point you'll notice from all these examples. When you take a large number away from a small one, the result is negative in ordinary decimal numbers, but there's no sign visible in the binary numbers. That's because binary doesn't have signs, only 0 and 1. Looking a bit more closely, though, you'll see that when a subtraction of this sort has been carried out, the highest order digit (the one on the left, lad, on the left) is always a 1. This is, in fact, how we indicate sign. A zero in the left indicates positive sign, a 1 indicates negative sign.

Simple, isn't it? But what if the number you are using happens to be positive and yet big enough to have a 1 on the left-hand side (any number between 127 and 255, for example)? Incredibly enough, it doesn't matter! The arithmetic works out correctly no matter how the numbers are arranged, and it's possible to use a few additional gates to signal to you if there's a booboo going on somewhere, like a number which is positive but has a 1 on the left-hand side or a number which should be negative but has a 0 on the left hand side. For the moment, we'll leave that one.

A number which uses the highest order digit to indicate the sign (+ or −) is called a *signed* binary number, and it's the assistance of such numbers which makes binary subtraction possible with only adder circuits. If, by the way, you need to use larger numbers than eight bits can cope with (+122 to −128 for signed numbers, 0 to 255 for unsigned) then another eight bits can be used, so that signed numbers up to 32,768 or unsigned numbers up to 65,536 can be used. If that's not enough, a third group of eight can be used, and so on. For very large numbers, scientific notation is used, with each number represented as a binary fraction and a power of two so that it isn't necessary to use a large number of digits to represent very large numbers. Scientific notation in decimal numbers is illustrated in **Fig.6.13**: binary representation follows the same scheme.

1300 IN SCIENTIFIC NOTATION IS 1.3×10^3
(BECAUSE 1300 IS 1.3×1000 AND $1000 = 10^3$)
SIMILARLY 101101 CAN BE WRITTEN AS
1.01101×2^5
OR $.101101 \times 2^6$

Figure 6.13 Scientific notation. Any number can be expressed as a small number (or fraction) multiplied by some power of the base. In denary (ten) scale, the base is ten, in binary it is 2. Scientific notation enables us to work easily with very large or very small numbers

Multiplying The Species

Binary multiplication can also be carried out using adding circuits, but with the addition of shift registers. All multiplication is addition anyhow: when we say 5 by 7 (or 5 sevens), we mean the number we get by adding five sevens together. Even for a machine, this is a bit tedious, and binary multiplication is carried out very simply by adding a shift. The number of adds and shifts is equal to the number of digits in one of the two numbers being multiplied.

Take, for example, the multiplication of 1101 by 101 (13 by 5 = 65) which is shown in conventional form in **Fig.6.14**. The numbers are

```
      1 1 0 1
        1 0 1
  -----------
      1 1 0 1
    0 0 0 0
  1 1 0 1
  -----------
1 0 0 0 0 0 1
```

Figure 6.14 Multiplying two binary numbers. When a 1 is used as a multiplier, the number being multiplied is written down, when a 0 is used the result is 0. These lines are shifted left for each new digit of the multiplier, and then added

multiplied on paper by using exactly the same scheme as we use when we're multiplying two large scale-often numbers, multiplying by the units digit, shifting one place and multiplying by the next digit and so on.

What makes this so much easier in binary scale is that the digits must be 0 or 1. If the multiplication is by 0, then the result is 0, if the multiplication is by 1 then the result is a copy of the number which is being multiplied.

For the next digit along, the procedure is the same, except that each digit is shifted one place to the left. The result is added to the first result. This is repeated for each digit of the number which is the multiplier, and the sum of all these steps is the final answer.

Practical Multiplication

It's easy enough on paper, less easy to do in practical terms. **Figure 6.15** gives an example of the sort of hardware that is needed — the registers must be large enough to cope with all the figures in the answer. For our example, we've used 8-bit registers, since this is a very common register size these days. The procedure goes something like this. The number to be multiplied is contained in one register, labelled R1 and the number we shall multiply by in another register R2.

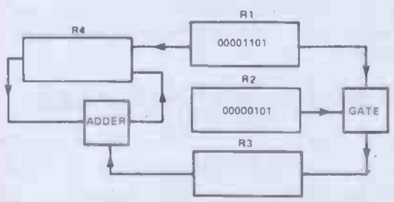


Figure 6.15 An arrangement of registers which could be used to multiply two numbers, provided that the correct sequence of control pulses could be obtained

Register R2 is now shifted right by a clock pulse and the digit which comes out is used to control a gate. If this digit is 1 (and in this example it is) then the number in R1 is gated into another register, R3. If the digit from R2 is 0, then register R3 is cleared, so that it contains 0000000.

The next clock pulse shifts R1 one place left and latches the contents of R4, one empty register into an adder. At the same time, the number in R3 is also latched to the adder. At the next clock pulse the sum (still 1101) is fed back into R4.

Now that R4 contains 00001101, the process starts again. The digit which comes from R2 on the next clock pulse is zero, so that R3 is cleared, and R1 is then left-shifted again. With R3 cleared, the adder adds 0000000 from R1 and 00001101 from R4, and places the result, still 00001101 back into R4.

The next clock pulse feeds out another 1 from R2 so that R1 delivers 00110100 (remember it has been shifted twice) into R3 and the adder. This is added to the sum so far, giving 01000001. When R2 is an 8-bit register, the shifting will continue until eight bits have been shifted out of R2, but since the next five bits are 0 in our example, there will be no change in the final answer which is stored in R4.

This, of course, is just one possible way of arranging a multiplication, and there are many others. In particular, one way shifting is more desirable on each register so that a rotation of seven places may have to be used in place of a left shift if only right shift and rotation are possible. The principles are the important things here, though, namely that multiplication can be carried out using only addition and shifting, and that the same is true of division, though the process is a little more complicated.

Other Tricks

Once you can carry out division and multiplication, all other processes can be done using repeated steps. Just to give an example, **Fig.6.16** shows how a square root can be found using division and addition. You make a guess at the root — quarter or one-third of the number is as good as any — and then add the guess number to the result of dividing the original number by the guess. Take half of the sum, and use this as a guess again,

FORMULA: $R1 = \frac{1}{2}\left(\frac{N}{R} + R\right)$

$R2 = \frac{1}{2}\left(\frac{N}{R1} + R1\right)$

$R3 = \frac{1}{2}\left(\frac{N}{R2} + R2\right)$

etc.

N = NUMBER WHOSE ROOT IS NEEDED
R = 1st GUESS AT ROOT
R1 = BETTER APPROXIMATION
R2 = CLOSER APPROXIMATION
etc.

EXAMPLE: FIND $\sqrt{30}$ GUESS 7

$R1 = \frac{1}{2}\left(\frac{30}{7} + 7\right) = 5.6428$

$R2 = \frac{1}{2}\left(\frac{30}{5.6428} + 5.6428\right) = 5.4796$

$R3 = \frac{1}{2}\left(\frac{30}{5.4796} + 5.4796\right) = 5.4772$

$(\sqrt{30} = 5.4772255)$

Figure 6.16 An algorithm for the square root. Unlike some series of this kind, this one converges rapidly, which means that only a few repetitions are needed to obtain a quite accurate result

going through the same procedure. After a few repetitions, you find that the 'guess' is almost unchanged form one attempt to the next, and so the 'guess' is now a very close approximation to the square root.

This is a good example of an algorithm in action — this example is a good algorithm which ends up with a correct value after only a few repetitions. Similar methods, called iterative (meaning repeating) methods are used for all the other functions which a calculator uses, from squares through sine, cosine, tangent and their inverses, to logarithms and powers of numbers.

Another Process?

Looking back, we've now used or mentioned quite a large number of digital ICs — enough to construct most of the digital circuits you're likely to come across. Wouldn't it be useful if someone could just make all these chips into one large device which you could connect in any way for any sort of digital circuit?

That's not an original thought, and the answer is that such a chip would have so many pins and need so many interconnections that the job would be impossible. The idea of a 'universal' digit chip is not such an impossible dream, though. It's been done, and the device is called the *microprocessor.*

How can a chip with only forty pins carry out the job of any number of digital ICs? The answer is one at a time! If you're only carrying out one action at a time, you only have to feed in one group of digits at a time, and all the connections inside the unit can be made or broken by gates. The way we decide what is done is by a program, a set of instructions which cause gates to be opened or closed inside the microprocessor. At each step in a program, bits will be transferred into or out of the microprocessor, or from one shift register to another. These bits can pass through adders, be complemented, gated by AND, OR or XOR gates, shifted or rotated in registers and under go all the various actions which should now be familiar. The important difference which makes it all possible is that the action is always sequential. For example, a microprocessor which is programmed to AND three bits will not carry out the operation in one step the way a three-input AND gate would. Instead, one bit is put into a register and stored. The next bit is then taken in and ANDed with the first, with the result stored in the same register. Finally, the third bit is taken in (or *read*) and ANDed with the bit in the register. If this is done fast enough, the results are as useful as those produced by a three-input gate, with the added advantage that most microprocessors can handle eight bits at a time, so that eight lots of AND-ing can be 'ANDled!

Enough of this, though. We're almost MICROPROCESSING — and I haven't written that yet! **HE**

BI-AND SAVE SALE-81

GERM. DIODES

200 Mixed Diodes – mainly Germ OA81-91-1N34/60 GC61/62 etc. Case DO-7. Coded and uncoded – You to test – **Value all the way!**

O/No. SJ127. £1.00 per Pak.

SIL DIODES

200 Mixed Diodes – mainly SILICON case DO-7 OA200/202 General purpose 200mA marked and uncoded – you to sort & test – **Outstanding Value!**

O/No. SJ128. £1.00 per Pak.

AUDIO AMPLIFIER

5 watt Audio Amplifier Module.

Special Clearance Offer

O/No. AL20. £2.50

HEADPHONES

NEW Improved Lightweight Stereo Headphones including double headband and padded earcups – Impedance 8 ohms – Frequency 30-18000Hz ALL Black.

O/No. 885. £4.00

As above but with coiled lead and rotary volume controls.

O/No. 884. £7.00

HEADPHONE ACCESSORIES

7 metre Headphone Extension Lead.

O/No. 136. £1.50

ANTEX

Antex X25 Iron – 25 watt soldering iron. **OUR SUPER SALE PRICE.** Great reduction.

O/No. 1931. £4.00

ST3 Iron Stand – Suitable for above – **OUR Sale Price**

O/No. 1939. £1.25 each

POPULAR (CMOS)

CD4001, CD4007, CD4011, CD4017, CD4081 – 1 of each, normal price £1.80 for 5 — Our price **£1.30** for 5

O/No. SJ1245

PLUGS & SOCKETS

Set of 4 1-metre Colour coiled leads with phono plug ends– ideal for audio and test use. **Outstanding Value.**

O/No. SJ122. £1.00 per Pak

1mm Plugs & Sockets in Red & Black.

O/No. SJ123. 5 prs £1.00

CAPACITORS

SJ11	150 Caps. mixed types & values.	£0.50
SJ12	60 Electrolitics all sorts mixed.	£0.50
SJ13	40 Polyester/polystyrene capacitors mixed.	£0.50
SJ14	50 C280 type capacitors mixed.	£1.00
	15 Polyester Caps. 1, 160v	£0.50
SJ16	40 Low volts electrolitics mixed values up to 10v.	£0.50

TRANSFORMERS

MINIATURE MAINS Primary 240v

No.	Secondary	
2021	6v-0-6v 100mA	£0.75
2023	12v-0-12v 100mA	£0.95
2035	240v Primary 0-55v 2A Secondary	£5.50

BC108 FALLOUTS

50 NPN BC107/108 SJ124 £1

Manufacturers out of spec on volts or gain or neither – Metal TO18 case – You test.

50 PNP BC177/178 SJ1244 £1

DIODES

300 IN4148 Type – uncoded Silicon Diodes Case DO-35 – **you to test.**

O/No. SJ129. £1.00 per Pak

Silicon Fast Switch

NPN – like 2N706/2N2369 **You select by test!**

O/No. SJ125. 50 for £1.00

Special Introductory Offer

COMPUTER IC's

EPROM 2708 @ **£3.00**

EPROM 2516/ 2716 @ **£6.00**

D.RAMS 4116 @ **£2.25**

SPECIAL OFFER LINEAR IC's

NE555	5 for £0.90
741P	5 for £0.80
NE556	5 for £2.50
LM380	5 for £3.50
72723 14 pin	5 for £1.75

NPN

BD131 TO-126-NPN untested.

O/No. SJ84. 25 for £1.00

SCR's

TO66 SCRs 5 Amp — ALL good — untested for volt — **good yield 400.**

O/No. SJ130. 10 for £1.00

AERIALS

FM Indoor Tape/Ribbon Aerial

O/No. 107. 40p each

HI-FI CAR AERIAL

4-section fully retractable & locking **SPECIAL PRICE.**

O/No. 109. £1.40 each

BI-PAK'S OPTO BARGAIN!

Valued at over £10 – Normal Retail

We offer you a pack of 25 Opto devices to include LED's large and small in Red, Green, Yellow and Clear. 7 segment Displays both Common Cathode and Common Anode PLUS bubble type displays – like DL-33. Photo Transistors – similar to OCP71 and Photo Detectors – like MEL11-12. This whole pack of 25 devices will cost you just . . .

£4.00!

and we guarantee your money back if you are not completely satisfied.

Full data etc included

O/No. SJ120.

IC SOCKET PACKS

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

ALL AT ONLY £1.00 each

VOLTAGE REGULATORS

Cast TO220

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

MICRO E

NPN silicon transistors plastic case, perfect and coded C108 BC108 TO-18.

O/No. SJ29. 50 off £2.50

100 off £4.00, 1,000 off £25.00

AUDIO ACCESSORIES

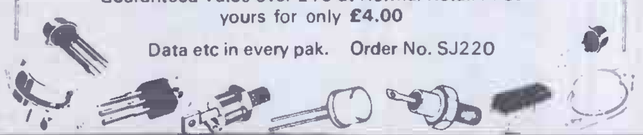
SJ75	FM coax cable – plain copper conduction cellular polythene insulated & plain copper braided PVC sheath – impedance 75 ohms	£0.10 per metre
SJ76	1 Board containing 2x5 pin DIN sockets 180° 02-2 pin DIN loudspeaker sockets	£0.30
SJ77	A 5-pin DIN 180° chassis/normal socket incl. DPDT switch	£0.20

Semiconductors from Around the World

100 A collection of Transistors, Diodes, Rectifiers, Bridges, IC's, SCR's, Triacs both Logic and Linear + Opto's all of which are current everyday usable devices **100**

Guaranteed Value over £10 at Normal Retail Price yours for only **£4.00**

Data etc in every pak. Order No. SJ220



DISC CERAMIC CAP

100 Disc Ceramic Cap. Mixed values covering complete range 3PF-4,700PF.

SUPER VALUE

O/No. SJ121. £1.00

SWITCHES

Push-to-make. 6mm panel mounting.

O/No. SJ131. 5 for £0.50

Push-to-break as above.

O/No. SJ132. 4 for £0.50

Silicon Heat Sink Compound

3mL in syringe £0.25

SILICON TRANS.

SJ25	100 Silicon NPN transistors all perfect & coded – mixed types with data – equivalent sheet – no rejects	£2.50
SJ26	100 Silicon PNP transistors all pefect & coded – mixed types and cases, data & equivalent sheet	£2.50
SJ27	50 Assorted pieces of SCR's, diodes & rectifiers incl. stud types, all perfect – no rejects, fully coded – data incl.	£2.50

PRECISION VOM MULTIMETER

20,000 ohms/volts DC. Complete with test leads & Instructions.

OUR SPECIAL OFFER PRICE £11.00 each.

O/No. 1323

Use your Barclay or Access Card!

L.E.D.

2nd Quality Paks

1507	10 Assorted colours & sizes	£0.65
S122	10.125 RED	£0.50
S123	10.2 RED	£0.50

LED CLIPS

1508/125 .125	5 for £0.10
1508/2 .2	5 for £0.12

TTL's

SJ28	20 TTL74 series gates – assorted 7401-7460	£1.00
SJ53	Mammoth IC Pak. Approx 200 pcs assorted fall-out integrated circuits including logic 74 series – Linear audio and DTL. Many coded devices but some unmarked – you to identify	£1.00

NPN TRANSISTORS

SJ68	30 ZTX300 type transistors NPN pre-formed for P/C Board colour coded Blue – all perfect.	£1.00
SJ70	25 BC107 NPN TO106 case perfect transistors code Green Spot.	£1.00
SJ71	25 BC177 PNP TO106 case perfect transistors code C1395.	£1.00
SJ72	4 2N3055 silicon power NPN transistors TO3	£1.00

MISCELLANEOUS

SJ20	2 Large croc clips 25A rated – ideal for battery chargers etc.	£0.30
SJ21	Large 7½" Mains Neon Tester – screwdriver chrome finish.	£0.85
SJ22	Small pocket size Mains Neon Tester screwdriver.	£0.55
SJ23	Siemens 220v AC relay DPDT contacts 10 amp rating – housed in plastic case.	£1.00

RESISTORS

SJ1	200 Resistors mixed values.	£0.50
SJ2	200 Carbon resistors ⅛-¼ watt preformed.	£0.50
SJ3	100 ⅛ watt miniature resistors mixed values.	£0.50
SJ4	60 ½ watt resistors mixed values	£0.50
SJ5	50 1-2 watt resistors mixed pot values.	£0.50
SJ7	30 2-10 watt wirewound resistors mixed.	£0.50

POTENTIOMETERS

16173	15 Assorted Pots	£0.50
SJ54	20 Assorted Slider Pots	£1.00
SJ56	10 100 K Lin Slider Pots 40mm	£0.50
16186	25 Pre-sets Assorted	£0.50
SJ49	8 Dual gang carbon pots log and lin mixed values	£1.00
SJ50	20 Assorted slider knobs – chrome/black	£1.00

ODDMENTS

16170	50 metres asst. colours single strand wire.	£0.50
16187	30 metres stranded wire mixed colours.	£0.50
16178	5 Main slider switches assorted.	£0.50
SJ76	1 Board containing 2x5-pin DIN sockets 180° & 2x2-pin DIN loudspeaker sockets.	£0.30

CASSETTES

SUPER VALUE & A GREAT SAVING!!!

C120 Dindy Cassettes – Low noise – astounding value and sound.

O/No. SJ32. 10 for £3.50

TRIACS

4A 400v TO-202 non-isolated TAG136D	£0.40
8A 400v TO-220 isolated TAG425	£0.60
Diac D32/BR100	£0.15
SCR C106D plastic case	£0.30

KNOBS

SJ62	5 15mm chrome knobs standard push fit.	£0.50
SJ63	Instrument knob – black winged (29x20mm) with pointer. ¼" standard screw fit.	£0.15
SJ64	Instrument knob – black/silver aluminium top (17x15mm). ¼" standard screw fit.	£0.12

BI-PAK

Send your orders to: **Dept HE 2, BI-PAK, PO BOX 6, WARE HERTS.**

SHOP AT: 3 BALDOCK ST, WARE, HERTS.

TERMS: CASH WITH ORDER, SAME DAY DESPATCH, ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL: (0920) 3182. GIRO 388 7006

ADD 15% VAT AND 50p PER ORDER POSTAGE AND PACKING.

Medium Wave Radio

Comb the airwaves with our pocket-sized, low cost personal medium wave radio

THERE HAS BEEN no shortage of designs for simple medium wave personal radios over the past few years, and these almost invariably seem to be based on the popular Ferranti ZN414 device. One could be forgiven for thinking that there is no viable alternative to the use of this IC, but it is in fact possible to produce a simple medium wave receiver circuit that will give good results using just a couple of transistors as the active devices. Just for a change then, we decided to use *transistors* in the present design.

The set provides good reception of reasonably strong signals, and by adding a couple of leads to purposely introduce positive feedback the sensitivity can be boosted to the point where numerous stations can be received at a good volume. The output is for a crystal earpiece — magnetic types are not suitable for use with the set.

Construction

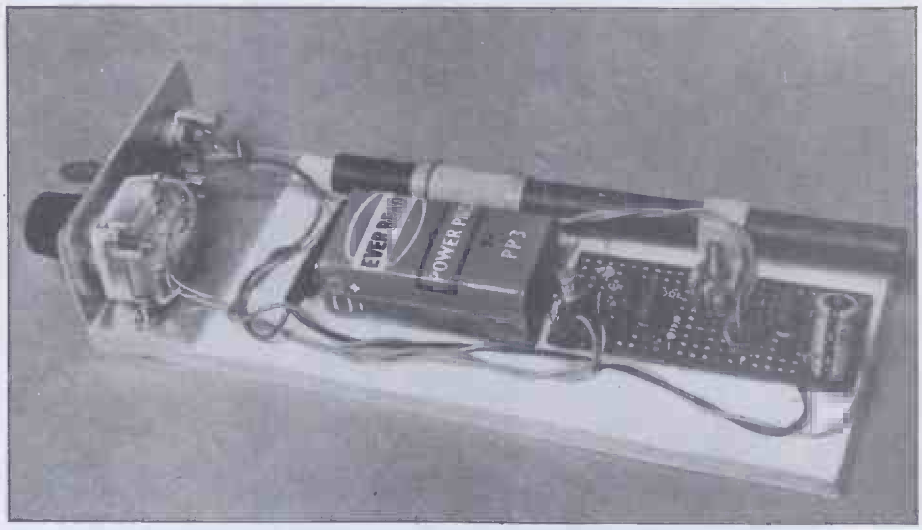
Most of the components, including the ferrite aerial, are mounted on one of our standard size (24 holes by 10 strips) 0.1" matrix Veroboards. Details of the component layout and wiring of the receiver are shown in **Fig.2**.

A P-style cable grip is used to mount the ferrite aerial on the component panel, and apart from this the board is assembled in the usual manner. Be careful that you do not overlook the single break in the copper strips, and it is advisable to make this before fitting the components into place. The leadout wires of T1 are made of a special type of wire called Litz wire (which has a very low resistance at radio frequencies) and have ready-prepared ends. It is recommended that these leads should be left full length as Litz wire can be difficult to tin with solder, and you may find it difficult to connect these leads if you trim off the prepared ends!

There are a number of plastic cases available which will comfortably accommodate the set, but be careful not to underestimate the size of the case required. The ferrite rod is about 125 mm long and the case must obviously have an internal dimension of at least this figure. A metal case is not suitable as it would screen the ferrite aerial and no stations would be received!

The set should cover the entire MW band if the aerial coil is positioned almost right at the end of the ferrite rod, and it should be glued or taped in place here. The set has a slight excess of coverage and so the position of the coil on the rod is not too critical.

It should be possible to receive a few stations quite well when the set is first tested, but improved results can be obtained by adding the two single-strand insulated leads, as shown in **Fig.2**. These will increase the feedback applied over the RF amplifier and, up to a point, the closer together the wires are brought, the better the performance of the set. However, bringing them too close will result in the set oscillating and blocking proper reception. The two wires should therefore be positioned as close together as possible without this occurring at any setting of CV1. Once the optimum position has been found, the leads should be secured with insulating tape. If moving the two leads closer together results in reduced performance the phasing of T1 is incorrect, and the two leads from the small winding of T1 should be transposed.



By mounting the project on a suitable board it can be carefully inserted into a case — such as the one we used for a Keystone camera

How It Works

Figure 1 shows the circuit diagram of the radio, and the circuit breaks down into three basic stages: an RF (radio frequency) amplifier, a detector, and a single audio amplifier stage.

The RF amplifier uses Q1 as a straightforward common-emitter amplifier which gives high gain. T1 is the ferrite aerial, with tuning capacitor CV1 giving coverage of slightly more than the whole of the standard medium wave broadcast band. The tuned winding of T1 has quite a high impedance, and signals from this winding cannot be fed directly to the relatively low-input impedance of Q1 as this would give a very inefficient signal transfer and unacceptable results. A low-impedance coupling winding on T1 is therefore used to match the output of the aerial to the input of Q1.

Coil T1 is connected so that a phase inversion of the signal is produced, and a further phase inversion takes place through Q1. This brings the collector of Q1 and the hot end of T1's main winding in phase, and there is inevitably a certain amount of stray feedback between these two points. This feedback results in some of the output of Q1 being fed back to the input where it is amplified once again. This boosts the sensitivity and selectivity of the receiver. By purposely encouraging this feedback it is possible to obtain a very substantial increase in performance, although excessive feedback (or 'regeneration' as it is often called in this application) must be avoided. Otherwise the circuit will break into oscillation and the set will not function properly.

The output of Q1 is fed to a simple detector circuit which uses diode D1 to provide rectification and C2 to give RF filtering. Resistor R3 gives D1 a slight forward bias which gives improved detection efficiency.

Capacitor C3 couples the audio output of the detector to a second common-emitter stage which uses Q1 and directly feeds the crystal earphone. The current consumption of the circuit is only about 2.5 mA, and a PP3 size battery is sufficient to give many hours of use.

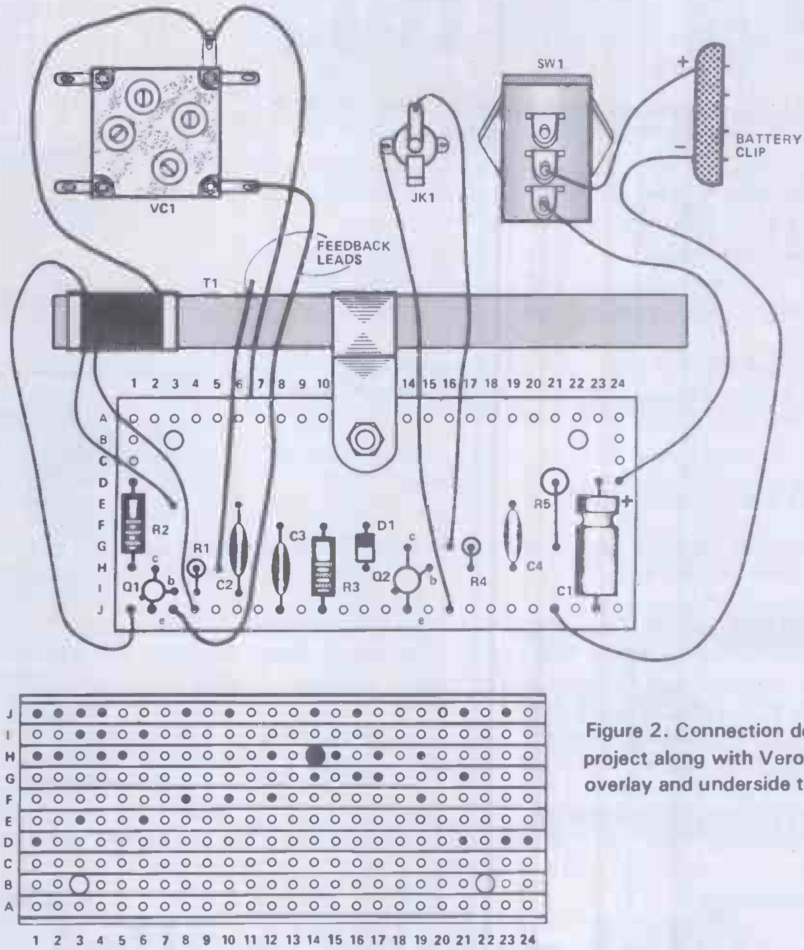


Figure 2. Connection details of the project along with Veroboard overlay and underside track break.

Buylines

The only unusual components are T1 and CV1. Ferrite aerial T1 can be obtained from Watford Electronics and the variable capacitor CV1 from Ambit International. An outlay of only £7 should buy you the parts for this project.

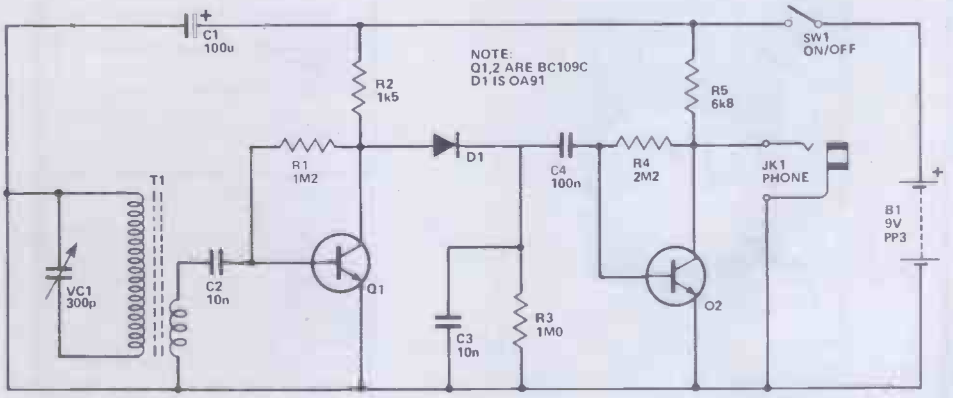


Figure 1. The circuit diagram of the HE Miniature MW Radio

Parts List

RESISTORS
(All ¼ W, 5%)

R1	1M2
R2	1k5
R3	1M0
R4	2M2
R5	6k8

CAPACITORS

C1	100u, 10 V electrolytic
C2, C3	10n polyester
C4	100n polyester
CV1	266p polyvaricon variable capacitor

SEMICONDUCTORS

Q1, Q2	BC109C
D1	0A91

MISCELLANEOUS

SW1	single-pole, single-throw toggle
T1	Denco MW5FR ferrite aerial
JK1	3.5mm Jack socket

10 strip x 24 hole Veroboard
Crystal earphone
Case to suit
Battery and clip
Knob to suit, P-clip

HE

FREE
BURGLAR ALARM BOOKLET

Our new FREE booklet entitled, 'Planning, Installing and Maintaining Home Intruder Alarm Systems', gives advice on how to do just that.

At Linton Electronics we do not assume that because you are concerned about Home Security you are automatically a leading authority on the subject of Intruder Detection Equipment and Systems.

Our new FREE booklet takes you step by step through the maze of all the different equipments available, explains their various functions, advantages and disadvantages, and does it all in language you can understand.

Our new FREE booklet also gives pointers as to how an intruder in your home might operate, so indicating how your Intruder Alarm System can not only be effective, but cost effective too.

In short, our new FREE booklet has been written to give you confidence in the system you install. As a mail order supplier of Intruder Alarm Equipment we feel that that is important.

Write, or telephone our answering service NOW for your free booklet. We will send your copy by return of post.

LINTON ELECTRONICS

4 HELSTON CLOSE, LINTON,
BURTON ON TRENT, STAFFS.
DE12 6PN

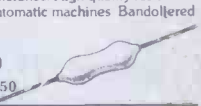
PHONE: BURTON (0283) 761877
24 Hour Phone Answering Service

ACCESS ORDERS WELCOME

PARNDON ELECTRONICS LTD.

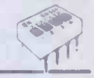
Dept. No. 23, 44 Paddock Mead, Harlow, Essex CM18 7RR. Tel. 0279 32700

RESISTORS: 1/4 Watt Carbon Film E24 range ± 5% tolerance. High quality resistors made under strictly controlled conditions by automatic machines. Bandollered and colour coded.
£1·00 per hundred mixed. (Min 10 per value)
£8·50 per thousand mixed. (Min 50 per value)
Special stock pack 60 values, 10 off each £5·50



DIODES: IN4148 3p each. Min order quantity – 15 items.
£1·60 per hundred

DIL SWITCHES: Gold plated contact in fully sealed base – solve those programming problems.
4 Way 86p each. 6 Way £1·00 each. 8 Way £1·20 each.



DIL SOCKETS: High quality, low profile sockets:
8 pin – 10p. 14 pin – 13p. 16 pin – 15p. 18 pin – 19p. 20 pin – 25p.
22 pin – 29p. 24 pin – 35p. 28 pin – 39p. 40 pin – 57p.

ALL PRICES INCLUDE V.A.T. & POST & PACKING — NO EXTRAS
MIN. ORDER – U.K. £1·00. OVERSEAS £5 CASH WITH ORDER PLEASE

GLOBAL ELECTRONIC ENTERPRISES

ELECTRONIC CONSTRUCTION KITS

SUPER CHIP 2
Full M/W coverage, uses I.C. ZN414+2 transistors, easy to build diagrams. Good beginners project complete with case and loudspeaker.
£8.25+P&P 65p

SUPER CHIP 1
Pocket earpiece radio. Performance and looks as above, complete with easy build plans.
£6.95+P&P 55p

CRYSTAL RADIO
For beginners, no batteries required, complete with case and easy build plans.
£2.25+P&P 50p

Money refunded if not satisfied provided goods are returned undamaged.
Post and packing included unless stated.
All units are checked and tested prior to despatch.

CAR RADIO Manual with speaker/fixing kit £9.25
OCEANCAR STEREO, with built-in auto stop £15.95
STEREO Headphones, 8 ohm £4.95
POCKET RADIO AM/FM/AIR band with speaker £7.75
POCKET RADIO AM/FM with speaker and E/P £6.95
HAND ELECTRONIC Football Game £10.95
QUARTZ HALOGEN Handheld spotlamps £8.75
800 watts Mains Dimmer with magic eye facility £4.95
SITCO CASSETTE Recorder D/C, small size £17.95
B.S.R. C179 Auto Turntable with ceramic cartridge £19.95
B.S.R. C182 with A.O.C. cartridge plinth and cover £38.50
LLOYTRON Professional Headphones 4-16 ohm coiled cord, vol./control £12.95

P/Os and Cheques made payable to:
GLOBAL ELECTRONIC ENTERPRISES
St. John's Works, St. John's, Bedford

Marshall's

A. Marshall (London) Ltd., Kingsgate House, Kingsgate Place, London NW6 4TA
Industrial Sales: 01-328 1009
Mail Order: 01-624 8582 24hr. service
Also retail shops 325 Edgware Road, London W2
40 Cricklewood Broadway, London NW2 85 West Regent St., Glasgow
108A Stokes Croft, Bristol

We now supply the extremely reliable and cost conscious LEADER range of testgear.

SINGLE TRACK OSCILLOSCOPES
LBO 510A 5in. 4MHz 20mV £125.00
LBO 512A 5in. 10MHz 10mV £170.00
LBO 513A 5in. 10MHz 10mV £215.00
LBO 507A 5in. 20MHz 10mV £239.00

DUAL TRACE OSCILLOSCOPES
LBO 208S 3in. 20MHz 2mV £419.00
LBO 508A 5in. 20MHz 10mV £299.00
LBO 520A 5in. 35MHz 5mV £475.00
LNO 514 5in. 10MHz 5mV £255.00

TV RADIO TEST GEAR
LSG 16 Signal Generator £55.00
LSG 231 FM Stereo Signal Generator £184.00
LCG 392U PAL B Pattern Generator £125.00

AUDIO TEST GEAR
LAG 26 Audio Generator £64.00
LAG 120A Audio Generator £127.00
LDM 170 Distortion Meter £245.00
LFM 39A Wow/Flutter Meter (Din) £315.00
LAV 191 Audio Tester £260.00
LAG 125 Low Distortion Audio Gen'ator £238.00

GENERAL TEST GEAR
LCR 740 LCR Bridge £149.00
LTC 906A Transistor Checker £97.00
LVT 72 Fet Transistor Checker £128.00
LTC 907 Transistor Checker £151.00
LAT 47 Attenuator £151.00
LAT 45 Attenuator £78.00
LFG 1300 Sweep/Function Generator £311.00

AMATEUR RADIO
LOM 815 DIP Meter £45.00
LIM 870A Antenna Impedance Meter £44.00
LPM 880 RF Power Meter £73.00
LPM 885 SWR/Watt Meter £47.00
LAC 895 Antenna Coupler £88.00
LAC 896 Antenna Coupler £44.00
LAC 897 Antenna Coupler £44.00

Please send large SAE for special catalogue. All prices exclusive VAT/carriage.

The new Marshall's 80/81 catalogue is now available. A veritable treasure house of components, test gear, tools, etc.

Lots of old friends, but also many new products including leader test gear, Crimson Hi Fi Modules, Rechargeable NI Cad batteries and chargers (very competitive). More components including SN74ALS series, new tools etc. Available by post, UK 75p post paid: Europe 95p post paid: Rest of world £1.35 post paid.

SINCLAIR INSTRUMENTS
Digital Multimeter
PDM35 £ 34.50
" " DM235 £ 52.50
" " DM350 £ 72.50
" " DM450 £ 99.00
Digital Frequency Meter
PFM200 £ 49.80
Low Power Oscilloscope
SC110 £139.00

NEW
TF200 Frequency Meter
£145.00
TGF105 Pulse Generator
£ 85.00

CRIMSON ELEKTRIK HI FI MODULES
CE608 Power Amp £20.09
CE1004 " " £23.43
CE1008 " " £26.30
CE1704 " " £33.48
CE1708 " " £33.48
CPS1 Power Unit £19.52
CPS3 " " £23.52
CPS6 " " £30.00
CPR1 Pre Amp £32.17
CPR1S Pre Amp £42.52
All Prices + VAT + postage/packaging
Don't forget! We also carry an impressive range of semi conductors, passive components, electro mechanical components, tools etc.

Books from the HE Book Service

SPECIAL OFFER TO READERS OF HOBBY ELECTRONICS ONLY
ELEMENTS OF ELECTRONICS
Book I £2.60
Book II £2.60
Book III £2.60
Usual price is £7.80 inc post and packing for 3 volume set. OUR PRICE £7.00 + FREE slip case for 3 volumes + FREE Resistor Colour Code Disc.

28 TESTED TRANSISTOR PROJECTS by R. Torrens .. £1.50
The author has designed developed and built some completely new circuits.

BEGINNERS GUIDE TO BUILDING ELECTRONIC PROJECTS by R. A. Penfold £1.50
Enables the complete beginner to tackle the practical side of electronics.

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST by G. T. Rabaroe £1.50
Supplies the hobbyist with a background knowledge.

50 PROJECTS USING RELAYS, SCR'S & TRIACS by F. G. Rayer £1.50
Gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct.

HOW TO BUILD YOUR OWN METAL AND TREASURE LOCATORS by F. G. Rayer £1.25
Contains complete electronic and practical details on the simple and inexpensive construction of Heterodyne Metal Locators.

HOW TO MAKE WALKIE-TALKIES by F. G. Rayer £1.75
IC555 PROJECTS by E. A. Parr £2.00
Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

PRACTICAL ELECTRONIC CALCULATIONS AND FORMULAE by F. A. Wilson ... £2.50
Units and Constants, Direct Current Circuits, Passive Components, Alternating Current Circuits, Networks and Theorems, Measurements.

ELECTRONIC SECURITY DEVICES by R. A. Penfold £1.70
Includes both simple and more sophisticated burglar alarm circuits using light, infra-red and ultrasonics gas and smoke detectors, flood alarms doorphone and baby alarms, etc.

ELECTRONIC PROJECTS FOR BEGINNERS by F. G. Rayer £1.60
A newcomer to electronics finds a wide range of easily made projects.

POPULAR ELECTRONIC PROJECTS by R. A. Penfold £1.70
Radio Projects, Audio Projects Household Projects and Test Equipment.

HOW TO BUILD YOUR OWN SOLID STATE OSCILLOSCOPE by F. G. Rayer £1.75
Enables the enthusiast to simply and inexpensively build his own oscilloscope.

ELECTRONIC GAMES by R. A. Penfold £2.00
In this book the author has designed and developed a number of interesting electronic game projects using modern integrated circuits.

COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS by F. G. Rayer .. £2.00
Author discusses and features many applications and projects using various types of numeral displays, popular counter and driver IC's etc.

BEGINNERS GUIDE TO MICROPROCESSORS AND COMPUTING by E. F. Scott £2.00
Introduction to the basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming.

ELECTRONIC HOUSEHOLD PROJECTS by R. A. Penfold £2.00
Circuits range from such things as '2 tone door buzzer' Intercom through Smoke or Gas Detectors to Baby and Freezer Alarms.

A MICROPROCESSOR PRIMER by E. A. Parr .. £2.00
A newcomer to electronics tends to be overwhelmed when first confronted with articles or books on microprocessors. This small book will start by designing a simple computer and because of its simplicity and logical structure the language is hopefully easy to learn and understand.

50 CIRCUITS USING 7400 SERIES IC'S by R. N. Soar £1.65
The author has compiled 50 interesting and useful circuits and applications covering different aspects of electronics using these devices.

POPULAR ELECTRONICS BOOKS
Sinclair, I. R., Introducing Electronic Systems £3.10
Sinclair, I. R., Introducing Amateur Electronics £3.10
Sinclair, I. R., Electronic Fault Diagnosis £4.00
Sinclair I. R., Repairing Pocket Transistor Radios £2.90
Sinclair, I. R., Oscilloscope In Use £4.00
Sinclair, I. R., Understanding Electronic Components £5.10
Sinclair, I. R. Understanding Electronic Circuits £5.10
Kitchen, H. T., Handtools For Electronic Workshop £3.25
Kitchen, H. T., Electronic Test Equipment £6.20
Capel, V., How To Build Electronic Kits £3.25
Darr, J., How to test almost everything electronic £3.75
Brown, R. M., How to read electronic circuit diagrams ... £5.60

AUDIO
Earl, J., Audio Technicians Bench Manual £5.00
Earl, J., Pickups and Loudspeakers £5.00
Earl, J., Tuners and Amplifiers £4.00
Earl, J., Cassette Tape Recorders £6.00
Earl, J., ABC of Hi-Fi £6.00
Capel, V., Microphones in Action £6.00

Capel, V., Improving Your Hi-Fi £5.00
Capel, V., Creative Tape Recording £5.00
Hellyer, H. W., Tape Recorders £5.00
Sinclair, I. R., Audio Amplifiers For Home Construction £6.00

RADIO CONTROL
Drake, J., Radio Controlled Helicopter Models £4.95
Jeffries, C. R., Radio Control For Model Yachts £3.85
Safford, E. L., Radio Control Manual £3.00

COOKBOOKS
Tracton, K., BASIC Cookbook £4.10
Lancaster, D., TTL Cookbook £7.55
Lancaster, D., RTL Cookbook £4.65
Lancaster, D., CMOS Cookbook £8.20
Jong, W., IC Op Amp Cookbook £10.00
Lancaster, D., T.V. Typewriter Cookbook £7.75
Lancaster, D., Cheap Video Cookbook £7.00
Jong, W., IC Timer Cookbook £7.65
Lancaster, D., Incredible Secret Money Machine (a how to cook book for setting up your computer or technical business) ... £4.95

QUESTIONS AND ANSWERS
SIMPLE AND CONCISE ANSWERS TO MANY QUESTIONS WHICH PUZZLE THE BEGINNER.
Coker, A. J., Q & A On Electric Motors £2.50
Hellyer, H., Q & A On Radios and T.V. £2.50
Hibberd, R., Q & A On Integrated Circuits £2.50
Jackson, K., Q & A On Electricity £2.50
Brown, C., Q & A On Hi-Fi £2.50
Brown, C., Q & A On Transistors £2.50
Brown, C., Q & A On Electronics £2.50
Reddihough, J., Q & A On Colour T.V. £2.50
Miller, H., Q & A On Electric Wiring £2.50

CONSTRUCTOR GUIDES
Graham, P., Simple Circuit Building £3.40
Colwell, M., Electronic Diagrams £3.40
Colwell, M., Electronic Components £3.40
Colwell, M., Printed Circuit Assembly £3.40
Ainslee, A., Practical Electronic Project Building £3.40
Colwell, M., Project Planning and Building £3.40

BEGINNER'S GUIDE
Sinclair, I. R., Beginner's Guide To Tape Recording £4.25
Sinclair, I. R., Beginner's Guide To Integrated Circuits £4.25
Sinclair, I. R., Beginner's Guide to Audio £4.25
King, G. J., Beginner's Guide To Radio £4.25
King, G. J., Beginner's Guide To Television £4.25
King, G. J. Beginner's Guide To Colour T.V. £4.25
Guilou, F., Beginner's Guide To Electric Wiring £4.25

PROJECT BOOKS
Marston, R. M., 110 Cosmos Digital IC Projects For The Home Constructor £4.95
Marston, R. M., 110 Wave Form Projects For The Home Constructor £4.95
Marston, R. M., 110 Op Amp Projects For The Home Constructor £4.95
Marston, R. M. 110 Semiconductor Projects For The Home Constructor £4.95
Marston, R. M., 110 Thyristor/SCR Projects For The Home Constructor £4.95
Marston, R. M., 110 Electronic Alarm Projects For The Home Constructor £4.95
Marston, R. M., 110 Integrated Circuits Projects For The Home Constructor £4.95
Marston, R. M., 20 Solid State Projects For The Car and Garage £4.95
Marston, R. M., 20 Solid State Projects For The Home .. £4.95

Note that all prices include postage and packing. Please make cheques, etc. payable to Hobby Electronics Book Service (in sterling only please) and send to:

Hobby Electronics Book Service
Modmags Ltd
145 Charing Cross Road
London WC2H 0EE

★ Prices may be subject to change without notice.

CB Breaker One Four

The publishers of HOBBY ELECTRONICS would like to point out that it is at present a contravention of the Wireless Telegraphy Act of 1949 and 1968 to use, manufacture, install or import CB transmitting equipment. It is not the intention of Modmags Ltd to incite, encourage or condone the use of such equipment.

We've heard a lot of rumours about official CB proposals, but we're still no nearer knowing the truth. Rick Maybury cogitates on recent events

THERE'S AN old joke about the way they measure time in South America: they count in revolutions per minute. In the last few weeks I've been tempted to reckon in demonstrations per month, there have been so many lately I'm beginning to wonder if anyone's taking any notice. Largest one for some time was on the 6th of December, organised by the UBA. It consisted of a couple of hundred cars doing their best to bring central London to a standstill on a Saturday afternoon. Apart from the obvious annoyance it caused the pre-Christmas shoppers it was largely ignored by the national press and TV. Oh well, it was a nice try.

We've finally heard from the Home Office about the replies to the Open Channel document. It appears that some 11,000 submissions were made and that, according to an official source, was the second biggest response they've ever had. The biggest was to the abortion bill some time ago. The result of the paper will not be made public for some time but an informed source has made it known that they are seriously reconsidering the wisdom of 928 megs as a viable frequency for public two-way radio.

Apart from demonstrations, this month has produced more that the average number of silly rumours. Favourite so far is the one about the licence application forms that someone somewhere claims to have seen. Apparently we are to have CB on 27 megs, with 22 channels FM at 2 watts output. One day we're going to ignore one rumour too many! Please, next time someone comes up to you with a rumour like that telephone the Home Office to check it out before you call us. We really do feel that it is more likely to know the truth.

Club Call

Quite a few new clubs for your notebooks this month but for the most up-to-date club information refer to the club section in Citizens Band magazine.

PLYMOUTH CB CLUB, 'SINGING WHEELS'
Correspondent: P Williamson
354 Blandford Road,
Plymouth,
PL3 6HZ
Devon

ISLE OF MAN CB CLUB
Secretary: J Dalrymple
Lower Ballaclucas Farm
Marown,
Isle of Man

BRITISH SIDEBAND NETWORK
For details enc SAE to:
15 Carman Walk,
Broadfields,
Crawley,
West Sussex

DAVENTRY BREAKERS CLUB
Chairman: Gavin Foster
33 The Wye,
Daventry
(Phone 3113)

BURY CB CLUB
Secretary: Shady Lady
c/o Ripley House Hotel,
Northgate Avenue,
Bury St Edmunds,
Suffolk

HE MICROBE R/C

Basic Kit £19.90
(2 PCB's and all PCB components)

EVERCO

Multiband Receiver plus 40-channel CB Monitor. Frequency coverage:

54- 87 MHz
88-108 MHz
108-145 MHz
145-176 MHz
Plus H1 40 CB Channels.

This unit has a telescopic antenna and squelch control, sockets for earphone and external DC power source. £21.95 inc. VAT.

The latest from the U.S.A.

PINBALL WIZARD

★Still available★
Featured in Nov. issue of E.T.I.
Home TV Game — B/W Kit
Basic Kit **£28.90**
Contains everything except box and controls
Box & Controls **£6.50.** P.S.U. **£3.90**
CEH Car Alarm Kit **£18.90**
Chroma Chime 24 tune door chimes kit **£10.75.** Built **£15.95**

SINCLAIR SC110 10MHz scope	£145.25
PFM 200 Digital Frequency Meter	£52.00
3" 5 MHz Oscilloscope	£113.85
4" 5 MHz Oscilloscope	£139.90
5" 10 MHz Oscilloscope	£169.90

ATARI £138

ELECTRONIC GAMES

Star Chess T/V game	£63.35
Database Prog T/V game	£89.95
Chess Challenger 7	£99.00
Chess Challenger 10	£160.00
Voice Challenger	£230.00
Chessmate 8 level	£59.95
Zodiac Astrology Computer	£29.95
Electronic Mastermind	£14.90
Supersonic Mastermind. New	£21.00
Mattel Subchase. New	£17.90
Mattel Armor Battle. New	£17.90
Enterprise 4 in 1	£22.90
Galaxy Invaders. New	£22.95
Radio Control Models—Various	

Ball Clock as H.E. offer. Kit **£24.95,** or ready-built **£29.95.**

COMPUTERS—HOME BUSINESS, ETC

Pet 8k	£458.85
Pet 16K	£573.85
Pet 32K	£790.00
Superboard 11 4K	£172.45
UK101 kit 4K	£228.85
UK 101 Built 4K	£286.35
Superboard/UK101 case	£33.80
Nascom 2 kit	£339.25
TRS80 16K Level II	£409.40
H14 line printer kit	£410.00
5¼" disc drive for TRS80	£271.40
Computer Books	S.a.e.
Software - Pet/TRS80/Superboard, etc.	
Exody Sorceror 16/32/48K from	£860.00
Renumber prog. 101	£4.00

Free — Advice/Demonstrations/Coffee

S.a.e. enquiries. Please allow up to 21 days for delivery. ALL PRICES INCLUSIVE

Buy it with Access

UNIT 6 **N.I.C**
61 BROAD LANE, LONDON N.15 4DJ
Day 01-808 0377; Eve 01-889 9736

BARCLAYCARD

ELECTRONIC GAMES

ATARI

SPECIAL PRICE

£86 + VAT

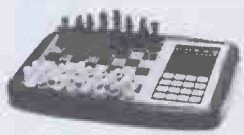
INTELLIVISION MATTEL

Available August 1980
This is the most advanced TV game in the world.
Expandable next year into a full microcomputer.
COLOUR CATALOGUE AVAILABLE WITH DETAILS ON ALL THE CARTRIDGES

£173.87 + VAT

CHESS

COMPUTERS



NEW RANGE AVAILABLE AUGUST 1980
We specialise in computer chess machines & stock over 13 different models from £20 to £300

Send for further details.

TELETEXT

RADOFIN TELETEXT
Add on Adaptor

£173 + VAT

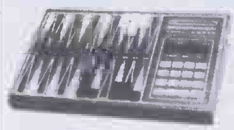
BRIDGE

COMPUTER

★ Plays 1/2/3 or 4 Hands
★ Problem Mode
★ Audio Feedback
★ Instant Response
★ Auto scorekeeping

BACKGAMMON

COMPUTERS



OMAR 1
OMAR 2
CHALLENGER
GAMMONMASTER

From £38 to £108. Send for further details.

SPACE INVADERS

HAND HELDS + CARTRIDGES
ATARI · ACETRONIC · PRINZTRONIC
RADOFIN · DATABASE etc.
We keep a full range!
Send for cartridge lists stating which machine you own.

DRAUGHTS

COMPUTER

★ Solves Problems
★ Rejects illegal moves
2 level machine
£43 + VAT
4 level machine
£77.78 + VAT

LEISURE

* CHEAP TV GAMES
* TELEPHONE ANSWERING MACHINES
* AUTO DIALLERS
* CALCULATORS
* DIGITAL WATCHES
* PRESTEL
* HAND HELD GAMES

24-TUNE DOOR BELL

£13.65
+ VAT

FREE CATALOGUE
For a free copy of our 32 page catalogue, send a 12p stamp to Silica Shop Ltd or Telephone 01-301 1111

MAIL ORDER SERVICE — Free postage & Packing
TELEPHONE & MAIL ORDERS · accepted on:
Access ★ Barclaycard ★ American Express ★ Diners Club
CALLERS WELCOME — at our shop in Welling — Demonstrations daily
Open from 9am-5pm Mon-Sat (9am-1pm Wed)
GUARANTEE — Full 12 months + After Sales Support!

SILICA SHOP
SILICA SHOP LTD., Dept. HE2
1-4 The Mews, Hatherley Road
Sidcup, Kent, DA14 4DX
Tel: 01-301 1111

We have comprehensive brochures on all products. Please let us know what you are interested in and we will send you detailed brochures AND our own 32 page catalogue covering most games on the market.

CANVEY ISLAND BREAKERS
Vice President: D Nairn
15 South Parade,
Canvey Island,
Essex

BAT BREAKERS (UBA)
Chairman: C Tugby
6 Woodlands Close,
Tring,
Herts

CB CRUISERS CLUB
Secretary: H Kendall-Jackson
Brackenrigg,
Gannock Park,
Deganwy,
Llandudno,
Gwynedd,
N. Wales

BOTTLE CITY BREAKERS
Secretary: Barry Hatton
22 Robinson Place,
St Helens,
Merseyside

SOUTH MANCHESTER BREAKERS CLUB
Chairman: R2D2
'El-Pateo'
Stretford Arndale Centre,
Stretford,
Manchester

Full reports from all of these clubs appear in the club directory section of the February issue of Citizens Band.

New Monitor

We've seen just about every CB monitor on the market in the last few months but the one we have pictured here is probably the best yet! It's made by a company called Everco and covers the full 40 CB channels. As well as CB it will receive a wide range of other 'specialist' transmissions ranging from minicabs, amateur radio and aircraft landing approach control. All in all this little unit is several times more sensitive and selective than many other so-called monitors. Our review sample was quite capable of resolving individual CB channels, which is the most severe test imaginable, considering the usual congestion. One little touch that sets this monitor apart from other, lesser, receivers is the inclusion of a very useful 'squelch' control that actually works, albeit slowly.

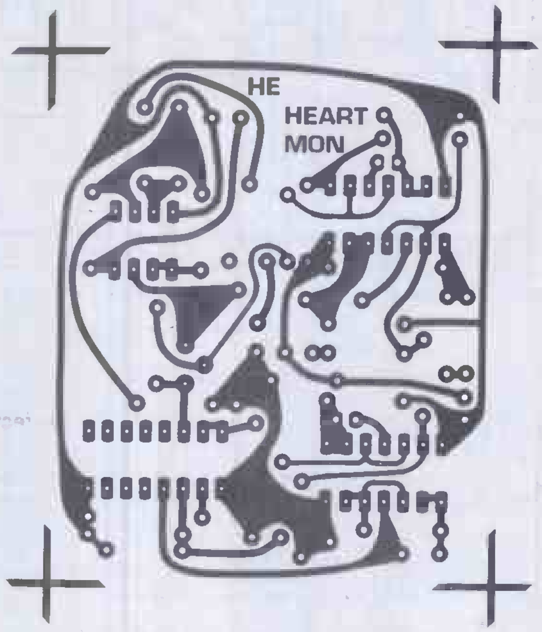
If you would like to examine an example of this monitor then get yourself round to NIC at 61 Broad Lane, Tottenham. If you press £21.95 into Nick's hot little hand then one of these excellent receivers will be yours.

More Demos

We return to the subject of demonstrations for our last item this month. On the 22nd of November the Plymouth CB Club organised a CB 'Convoy' for about 100 cars, lorries and even a cement mixer. Representatives from as far afield as Exeter, St Austell and London took part on the 30 mile cruise and according to the organiser everything went very smoothly. As you can see from the photograph Andy Donovan (Disco One) was in attendance to keep and eye on things. According to a press cutting from a local paper one local businessman, incensed by the demo, urged the local Customs and Excise to take action against anyone using a CB transmitter during the demonstration. The ironic thing about this man's protest is the fact that he is a national spokesman for the Car Radio Independent Specialists Association and owns a shop called Car Radio in Plymouth itself. I would have thought that a shop like that stood to benefit from the introduction of CB.

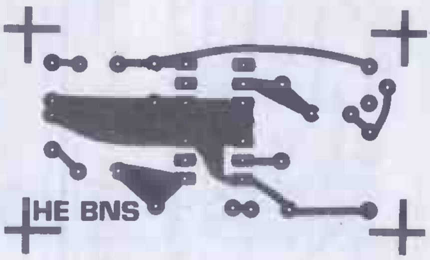
HE

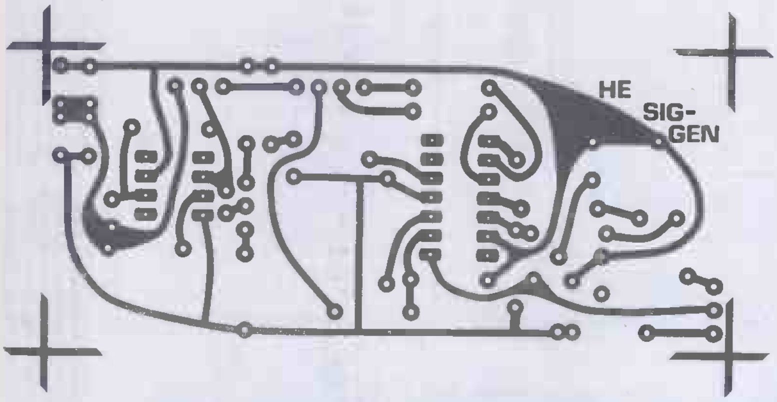
PCB FOIL PATTERNS



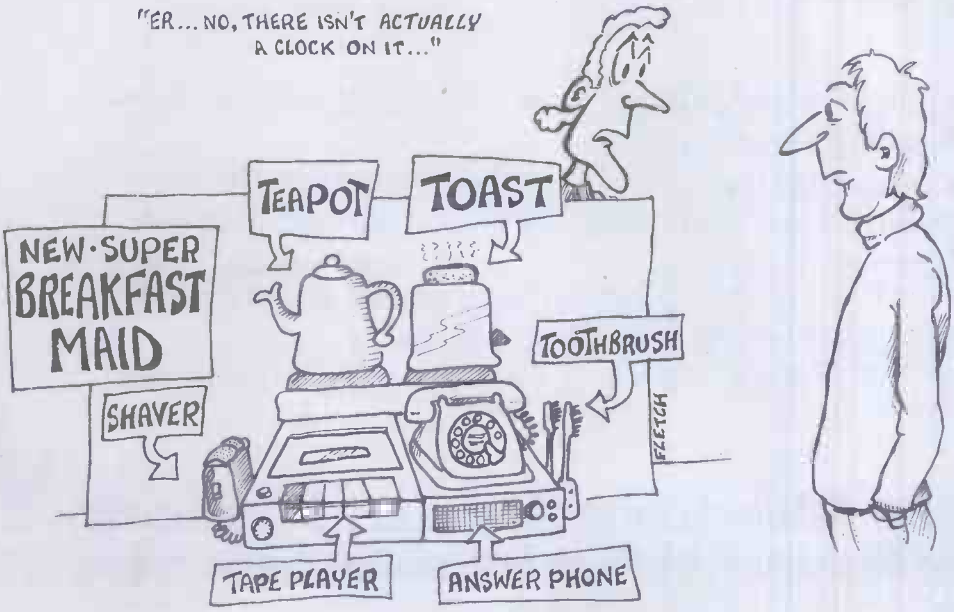
Above: The printed circuit board of the Heartbeat Monitor

Below: The Background Noise Simulator





The foil pattern of the Audio Signal Generator



CLASSIFIEDS

RATES

1-3 insertions £5 per scc
4-11 insertions £4.50 per scc
12 insertions £4 per scc
18p per word (Min. 15 words)
Box No on application

All advertisements in this section must be pre-paid
Closing Date:- 1st Fri. month preceding publication

Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

SEND TO: HE CLASSIFIED. 145, CHARING CROSS ROAD, LONDON WC2H 0EE. TEL: 01-437 1002 Ext. 26

£1 BARGAIN PACKS
All packs **£1 each; any 12 for £10.** Post 25p
All top grade new components—no rubbish

PC1 12 BC107	PC9 10 TO3 sockets
PC2 14 BC108	PC10 15 0.1/35V tants
PC3 12BBC109	PC11 14 3mm red LED's
PC4 3 2N3055	PC12 12 5mm red LED's
PC5 7 BFY51	PC13 8 741
PC6 16 BC182	PC14 6 555
PC7 60 1N4148	PC15 15 12V zeners
PC8 25 1N4003	PC16 100 1k ¼W 5% R's

Send s.a.e. for 8-page list/enquiries. Mail only.

PC ELECTRONICS, 2 Thornhill, Romsey Road Whiteparish, Salisbury SP5 2SD

GLOBAL ELECTRONIC CONSTRUCTION KITS

SUPER CHIP 1

Construct this easy-to-build one-chip radio using the Ferranti ZN414 integrated circuit plus one transistor. This highly sensitive radio giving full m/w coverage works for months on a 1.5v. battery, and its own ready-wound ferrite rod aerial means no external aerial req. Case measures only 10.5 cm × 7 cm. × 4 cm. and comes complete with Xtal earpiece and all necessary parts to build it including Easy Build Plans and instructions. Total cost **£6.95; p.p. 55p.**

SUPER CHIP 2

As above, but with loudspeaker, **£8.25** + 65p p.p.

Catalogue on request 55p

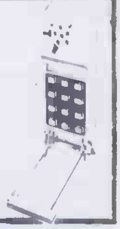
Cheques and P O s payable to
GLOBAL ELECTRONIC ENTERPRISES
Dept. H.E., St. John's Works, St. John's, Bedford

PRINTED CIRCUITS. Make your own simply cheaply and quickly! Golden Fotolak Light Sensitive Lacquer—now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric Chloride 55p. Clear Acetate sheet for master 14p. Copper-clad Fibre-glass Board, approx. 1mm thick £1.75 sq. ft. Post/packing 60p.—White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall.

£99 SYNTHESISER D.I.Y. Professional results, easy-build.—S.A.E.: Dewtron, 254 Ringwood Road, Ferndown, Dorset BH22 9AR.

BURGLAR ALARM EQUIPMENT, top quality, brand new. Free catalogue and price list. Sigma Security Systems, 13 St. John's Street, Oulton, Leeds LS26 8JT.

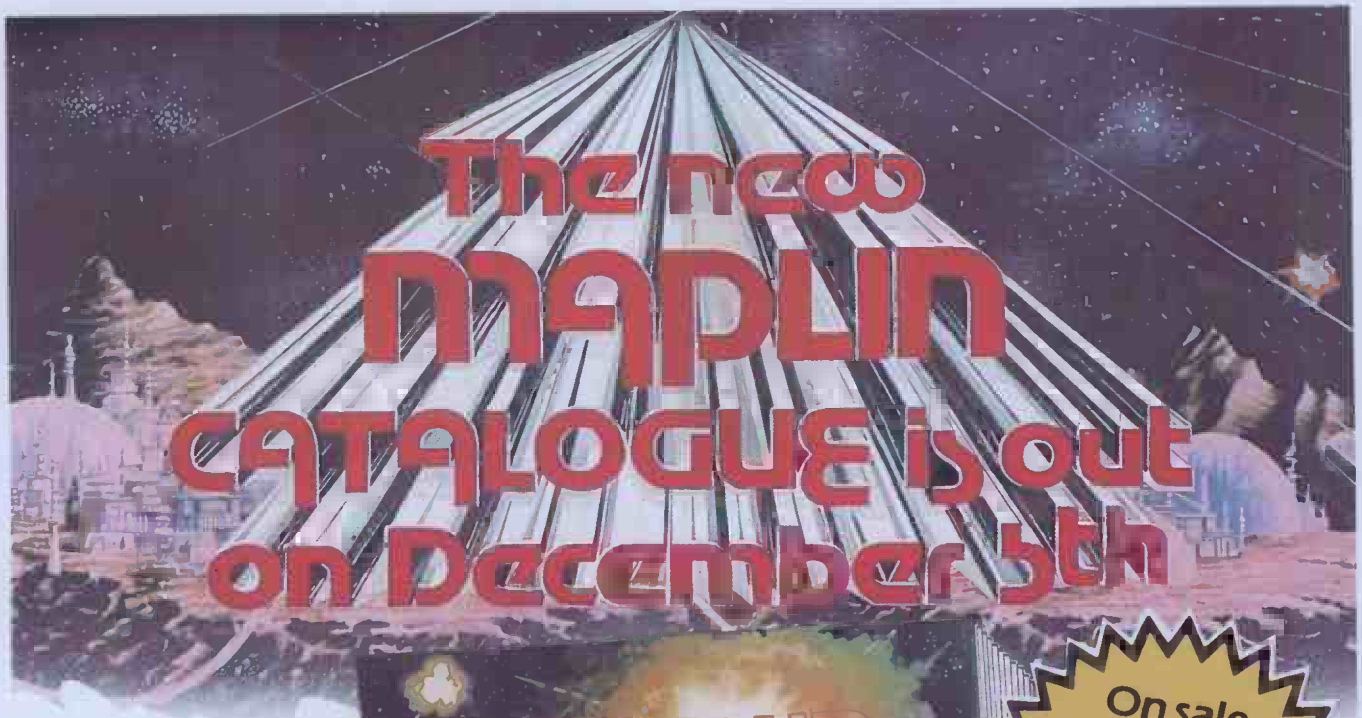
Earn £20-£100 p.w. in your spare time
by introducing the revolutionary new **Flip-Caller** telephone to your friends. Features micro-chip controlled push-button dialling and memory recall. Sells itself. Generous commission. For details write to Dept. ETI



DL SUPERPHONE
P.O. Box 31, Twickenham TW2 5RL

SPARE PARTS
SERVICE MANUALS
PHONE ORDERS NOW
Most makes inc. Sony, J.V.C., Hitachi etc.
HI-FI HOSPITAL (GRS) LTD.
100 Uxbridge Road, W7
01-840 1890

AD INDEX



A massive new catalogue from Maplin that's bigger and better than ever before. If you ever buy electronic components this is the one catalogue you must not be without. Over 300 pages, it's a comprehensive guide to electronic components with thousands of photographs and illustrations and page after page of invaluable data. We stock just about every useful component you can think of. In fact, well over 5000 different lines, many of them hard to get from anywhere else. Hundreds and hundreds of fascinating new lines, more data, more pictures and a new layout to help you find things more quickly.

PLUS
LOW PRICES
such as
Resistors from 1½p
Multimeters from £4.25
Ni-Cads from £1.15
Stereo Headphones from £3 49
Radios from £2.95
Over 300 Books
21 Different ranges
of capacitors, etc.,
etc., etc.,

Post this coupon now for your copy of our 1981 catalogue price £1.

Please send me a copy of your 320 page catalogue. I enclose £1 (Plus 25p p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the UK send £1.68 or 12 International Reply Coupons.

I enclose £1.25

Name ______________________

Address ______________________

______________________ HE281

MAPLIN

Maplin Electronic Supplies Ltd.
All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 554155. Sales (0702) 552911.
Shops:
159-161 King Street, Hammersmith, London W6. Telephone: (01) 748 0926.
284 London Road, Westcliff-on-Sea, Essex. Telephone: Southend (0702) 554000.
Both shops closed Mondays.