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Everyday ELECTRONICS

MARCH 83
80p

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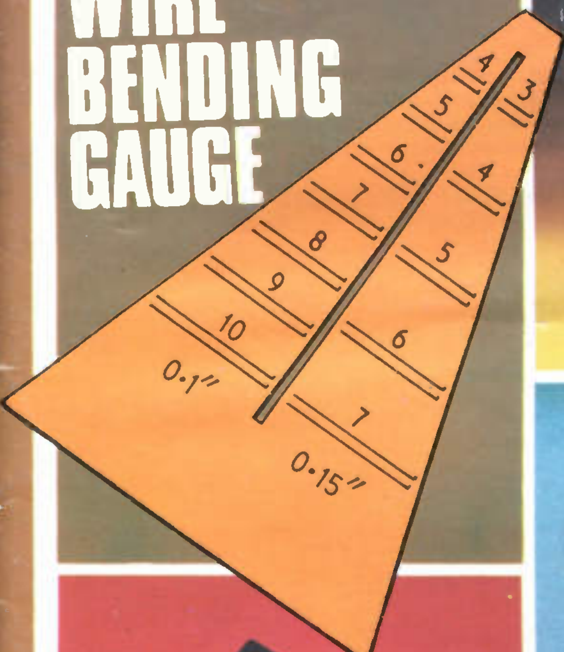

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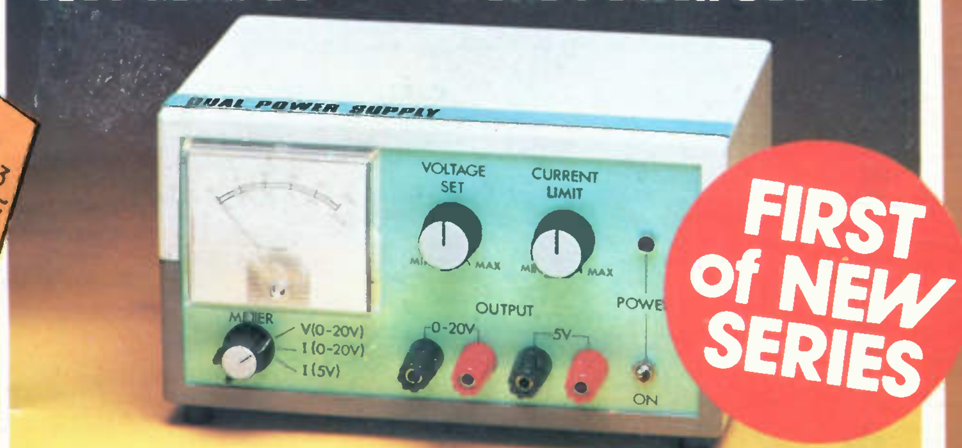

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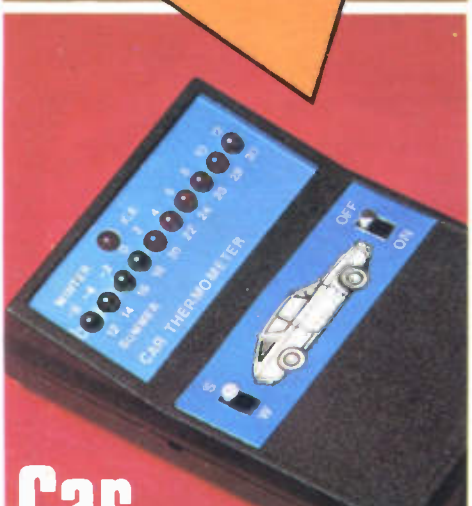
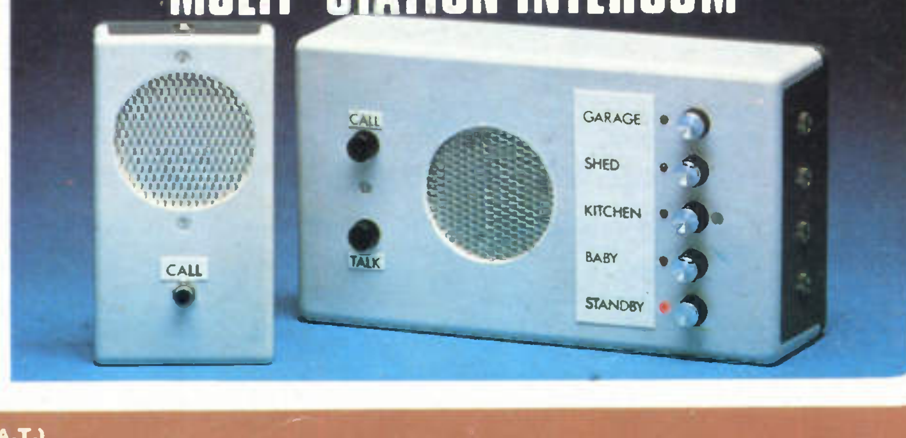


Car Thermometer

MULTI-STATION INTERCOM



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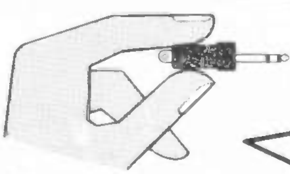

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VOL. 12 NO. 3 MARCH 1983

Everyday ELECTRONICS

PROJECTS . . . THEORY . . . NEWS . . .
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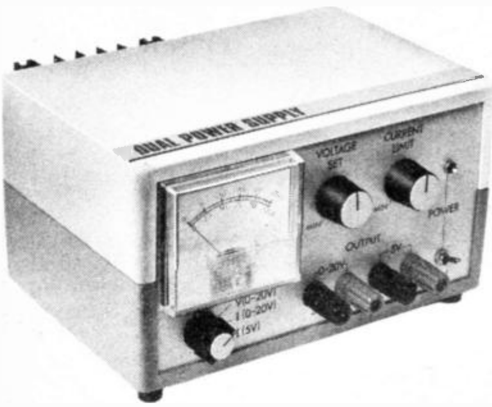

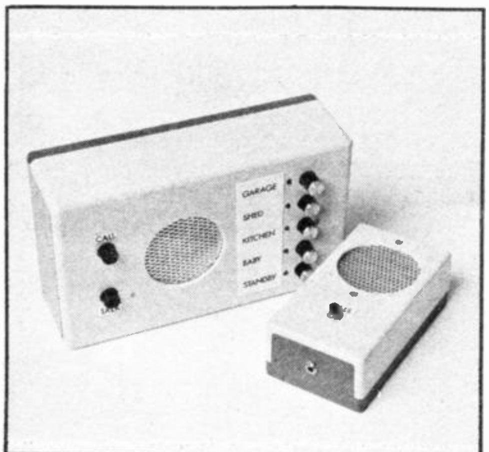

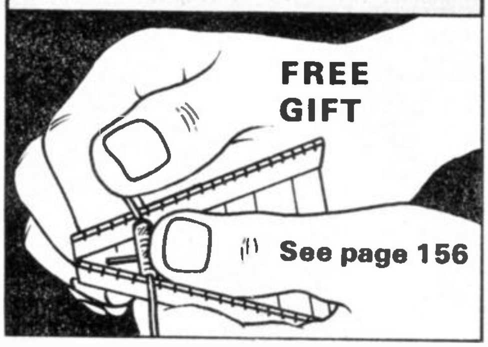

PROJECTS

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FEATURES

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Our April 1983 issue will be published on Friday, March 18. See page 157 for details.

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These units are as used in the "Big Trak" computerized vehicle, and offer the experimenter in robotics the opportunity to purchase the electro-mechanical parts required in building remote controlled vehicles. The unit comprises:

(a) 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle;

(b) A gearbox contained within the black ABS housing reducing the final drive speed to approx. 50rpm.

Data is supplied with the unit showing various options on driving the motors, as well as a direction controller circuit, enabling the unit to turn right, left or go straight ahead.

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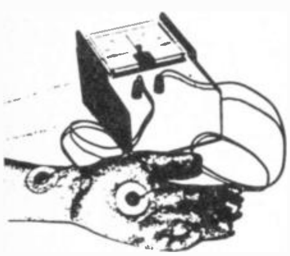

LIE DETECTOR

Not a toy, this precision instrument was originally part of an "Open University" course, used to measure a change in emotional balance, or as a lie detector. Full details of how to use it are given, and a circuit diagram. Supplied complete with probes, leads and conductive jelly. Needs 2 4½V batts. Overall size 155×100×100mm. **Only £9.95**—worth that for the case and meter alone!!

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BRAND NEW VEROBLOC KIT!!!

Just published by Babani, Mr. R. A. Penfolds new book, "30 SOLDERLESS BREADBOARD PROJECTS" – this book features 30 different projects for assembly on a Verobloc, and the kit contains all parts necessary to make:

- Audio Amplifiers
- Light & Dark Activated Switches & Alarms
- Timers
- Metronome
- Oscillators & Tone Generators
- Warbling Door Buzzer
- Two-tone Train Horn
- Touch Switch
- Reaction Game
- Sound Activated Switch
- Radio Receivers
- Fuzz Unit . . . + lots more!!

The introduction shows all the different components and explains how to use the breadboard. The Verobloc layout is shown for every project together with the circuit diagram and an explanation of how it works. Ideal for beginners in electronics, but also suitable for more advanced students.

The complete kit is contained in an attractive plastic case, which can be divided up into 15 compartments in which your components may be stored.

Complete Kit, including book, Verobloc & all parts **£24.95;** Book only **£2.25;** Kit without Verobloc **£20.45.**

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a.c. I 3mA, 10mA, 30mA, 100mA, 1.0A, 10A.
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Dimensions: 105 × 130 × 40mm.

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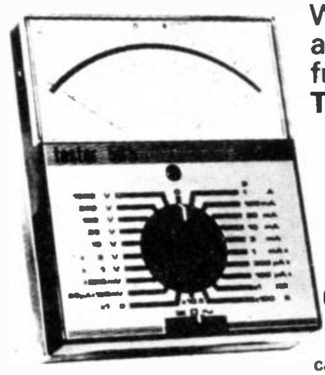

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a.c. V 10V, 30V, 100V, 300V, 1000V;
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VOL. 12 NO. 3 MARCH 1983

Everyday ELECTRONICS

TEST GEAR 83

IT was as far back as 1974 that we published a comprehensive set of test instruments under the title *EE Test Gear Five.* This series proved to be very popular and instruments built to these designs will have been giving good service in workshops and dens up and down the country over the last nine years or so. Equipment of this kind generally has a long life. The devoted constructor or experimenter treats his equipment with respect and it is not likely to suffer misuse in the hands of others.

Electronic technology has of course been developing over these nine years and some different needs have arisen in regard to test equipment used in pursuance of our hobby. Such needs have been recognised and covered by individual items of equipment presented in our pages from time to time. Now the time seems right to present a new set of instruments. There is another reason also, that is to satisfy the needs of a new generation of readers. Over a period most hobbyists will acquire or build individual items of test gear, but acquisition on this casual basis is not the most ideal arrangement. Far better to have a set of co-ordinated units planned to give comprehensive facilities.

With the introduction of *Test Gear 83* constructors now have the opportunity to build a set of matching instruments designed to meet practically all requirements of the average hobbyist in the light of the present state of the art. The first instrument is covered in this issue and the remaining instruments will be published one per month in the following issues of EE.

The completed instruments will add distinction to the hobbyist's workshop and provide lasting evidence of their builder's skill. But far more important, this collection of test gear will be of incalculable value in the years ahead. *Test Gear 83* will prove a sound investment of time and money.

A GIFT FOR CONSTRUCTORS

Despite its simple appearance, the tool attached to our front cover will be an important accessory for the constructor's work bench. Anyone who assembles circuits will quickly discover how useful this wire bending gauge is in forming resistor and capacitor leads to suit horizontal or vertical mounting of these components and with a spacing to suit a selected number of holes on an 0·1 inch matrix board.

Fred Bennett

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

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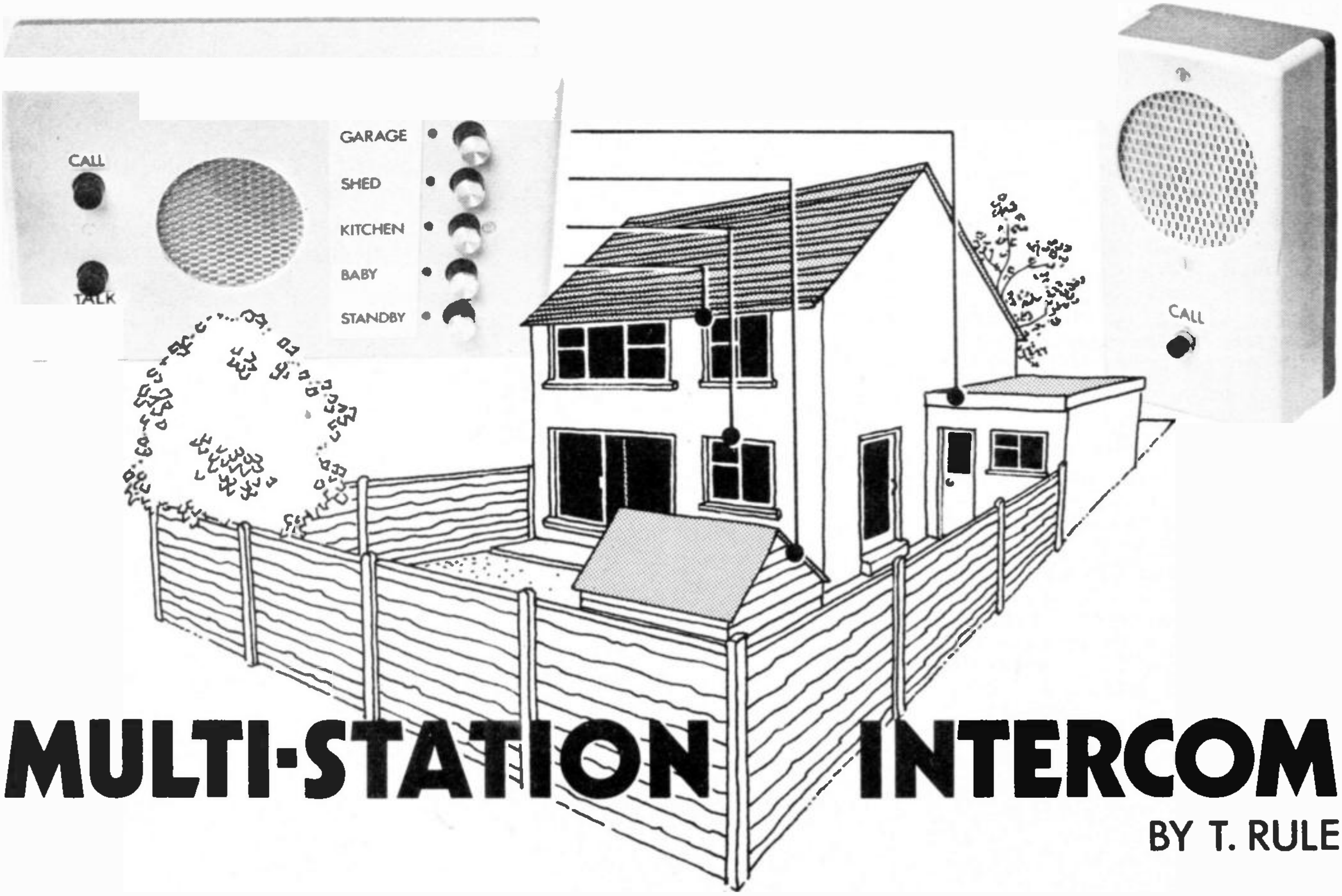


MULTI-STATION INTERCOM

BY T. RULE

THE unit to be described can be built to connect to any number of slave units via a two-wire interconnecting lead. Designed to provide private intercommunication between the master unit and any slave, it can also be used as a baby alarm or a general security system, and provides a means of listening into the slave units. For example, if a slave unit is mounted outside somewhere in the grounds of the property, it is possible to listen in on that unit for any intruders who may be nearby.

The basic unit described here has been built to supply four slave units and operate from a PP3 battery, and be used for simple intercom purposes. If it is intended for use as a baby alarm or security system a simple mains power supply should be used instead of the battery, but with a suitable switch to change over in the event of mains supply failure. A circuit for this is suggested.

DESCRIPTION OF SYSTEM

The unit is simple to construct and all parts are available from a number of advertisers. Fig. 1 shows a block diagram of the basic circuit. One speaker (LS2) is connected to the amplifier input via the PRESS TO TALK switch S1, and the other speaker LS1 is connected to the amplifier output. Pressing the switch to change over the two speakers enables communication from one to the other, depending on which one is used as the microphone at any time. The PRESS TO TALK switch is mounted on the master unit. In the standby position the slave speaker is used as a microphone and can be listened into by the master unit.

With a intercom system it is important to be able to "call" a selected slave or conversely for a slave to be able to "call" the master unit. This is made possible here by connecting some of the output back to the input via a phase-shift

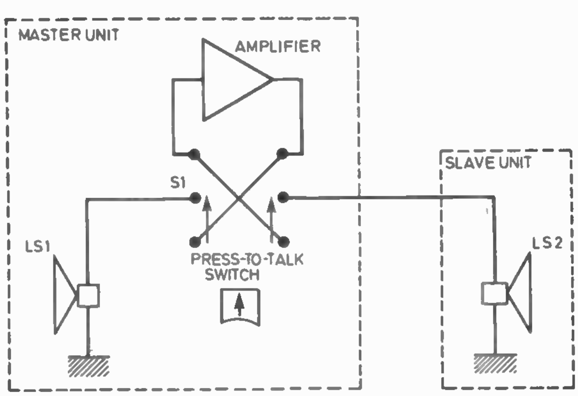


Fig. 1. Block schematic of the basic intercom circuit.

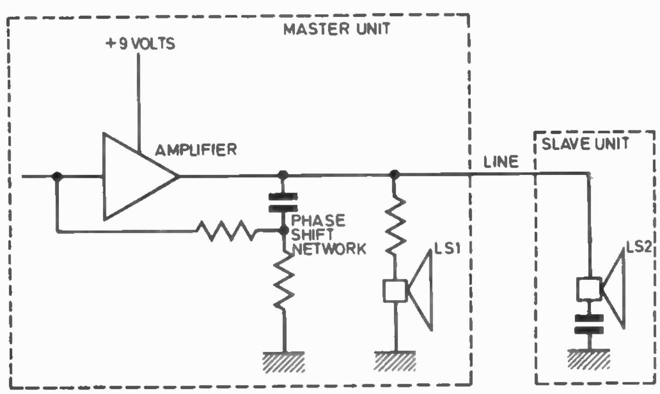


Fig. 2. Basic circuit when the master "calls".

network, so that oscillation at a suitable frequency takes place. Fig. 2 shows the basic arrangement when the master unit makes a call (no switching is shown).

When the slave unit calls, the circuit is slightly different and this is shown in Fig. 3. Closing the CALL switch on the slave connects the positive supply to the basic amplifier via the speaker voice coil and the diode rectifier. This enables the unit to oscillate as before and as the speaker is in series with the supply under calling conditions there is enough output for the calling tone to be heard at the slave position.

Once a call has been made in either direction the switching changes the circuit back to the basic arrangement shown in Fig. 1.

IDENTIFICATION OF CALLER

With a multi-slave intercom system some means of identification is needed so that the particular slave calling can be selected. This is achieved by the use of thyristors, the gates of which are connected to the lines so that when a slave unit calls and the positive supply is connected it also connects to the thyristor and turns it "on". An l.e.d. in its anode will then light and indicate which slave has called.

If a call is already in progress and another slave calls, the l.e.d. for that line will light indicating that a call is waiting, and it will stay alight until the line is selected. These additional calls do not interrupt the conversation already taking place, further, it is impossible for any slave to listen in on other lines.

THE COMPLETE CIRCUIT

The complete circuit is shown in Fig. 4 and at first glance may seem complicated. However much of the circuit is repeated from each slave line used. The number of lines which can be used is only limited by the amount of switching available and the size of the case used.

The circuit of Fig. 4 shows four slave units and this was felt to be the most which the average household would require. The switches are shown in the "standby" position (S3 depressed) and in this position the supply is disconnected.

COMPONENTS

Resistors

R1	1kΩ	R18	10kΩ
R2	68kΩ	R19	10kΩ
R3	100kΩ	R20	10kΩ
R4	4·7kΩ	R21	10kΩ
R5	390kΩ	R22	2·7kΩ
R6	47Ω	R23	2·7kΩ
R7	47kΩ	R24	2·7kΩ
R8	4·7kΩ	R25	2·7kΩ
R9	100kΩ		
R10	39kΩ		
R11	22Ω		
R12	820Ω		
R13	2·7kΩ		
R14	820Ω		
R15	820Ω		
R16	820Ω		
R17	820Ω		

All $\frac{1}{4}$W carbon film ±5%

See Shop Talk page 145

Potentiometer

VR1 10kΩ skeleton preset

Capacitors

C1	0·22μF polyester
C2	0·047μF polyester
C3	330pF polystyrene
C4	0·1μF 16V elect.
C5	22μF 16V elect.
C6	2·2μF 16V elect.
C7	100μF 16V elect.
C8	100μF polyester
C9	0·01μF 16V elect.
C10	100μF polyester
C11	100μF 16V elect.

All electrolytics are the small single-ended p.c.b. type

Semiconductors

TR1	BC414, BC109 or similar *npn* transistor
IC1	LM380 a.f. amplifier, 2W output 8Ω
D1–5	TIL209 l.e.d. (5 off)
D6–9	1N4148 diode (4 off)
CSR1-4	C103YY thyristor, gate current 0·2mA (4 off)

Loudspeakers

LS1,2 miniature, 8Ω, 70mm dia. approx. (2 off)

Sockets

SK1–5	jack socket, miniature (RS type 478-497) (5 off)
PL1–5	jack plug, miniature screened (RS type 478–380) (5 off)

Switches

S1,2	d.p.d.t. miniature push-button, momentary action (RS type 339–235) (2 off)
S3–7	d.p.c.o. push-button, break-before-make (RS type 388-434) (5 off) 5-switch latching assembly for interlocking operation (see text) (RS type 388–614). Push-button knobs (7 off) (RS type 339–263)
S8	s.p. miniature push-button, momentary make (RS type 337–914)

Miscellaneous

B1 PP3 battery

Printed circuit board; support pillars (2 off) (RS type 543–737); terminal pins; master unit case 188 × 110 × 60mm (RS type 509–585); slave unit case 120 × 65 × 40mm (RS type 509–579); plastic feet (for spacing sub-panel from case) (4 off) 12·7mm (RS type 543–327); connecting wire 7/0·2mm p.v.c. covered; screws; nuts; washers; solder tag; speaker mounting clips; battery connector.

COMPONENTS approximate cost £28 includes only one Slave

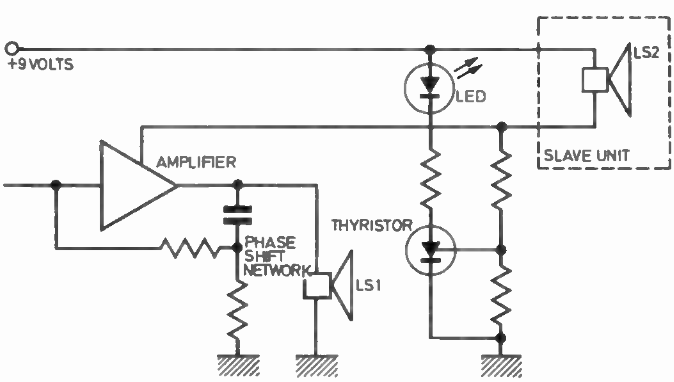


Fig. 3. Basic circuit when the slave "calls".

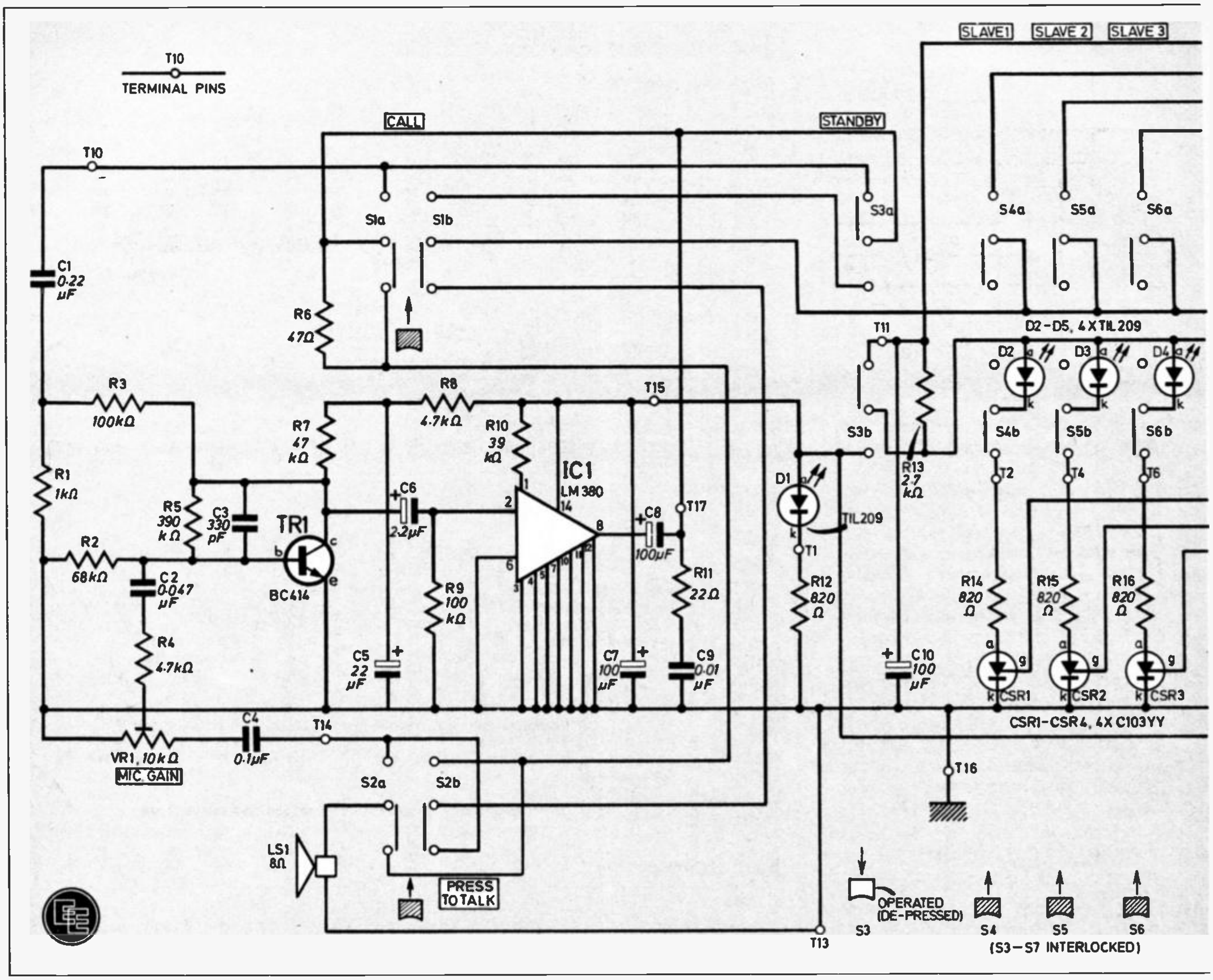


Fig. 4. Complete circuit diagram for the Multi-Station Intercom. All switches are shown in the standby position. The circuit for the slave unit is shown in the panel on the far right.

Switches S3 to S7 are interlocked push-button types and only one can be depressed at a time. Depressing a button automatically releases any other that may have been depressed.

The basic amplifier uses the LM380 integrated circuit IC1 but as this has a fixed gain an extra transistor stage TR1 has been added to improve the sensitivity.

If a slave is selected (assuming Slave 1) the speaker unit on that line will act as a microphone and is connected via S4a, S1b, and S2b to the input of TR1. The output of IC1 connects to the master speaker via S1a and S2a.

When S2 is pressed to change over the connections the two speaker systems are reversed and the master speaker becomes the microphone and the slave the speaker.

CALLING A SLAVE

A slave is selected by pressing S4, S5, S6 or S7. The slave is then called by pressing switch S1. The power supply is then connected via S3b (now in the lower position) and some of the output of IC1 is connected to its input via C7, S1a, C1, R1, R2, C5, causing the amplifier to oscillate. At the same time the slave speaker is connected to the output of IC1 via S1b and S3a (now in its lower position). The master speaker is also connected to the output but via a limiting resistor R3 to reduce the volume of the calling tone.

Releasing S1 reverts the circuit back to its normal mode and two-way communication can take place. The PRESS TO TALK switch S2 MUST be pressed each time the master speaks in order that its speaker becomes the microphone and the slave the loudspeaker.

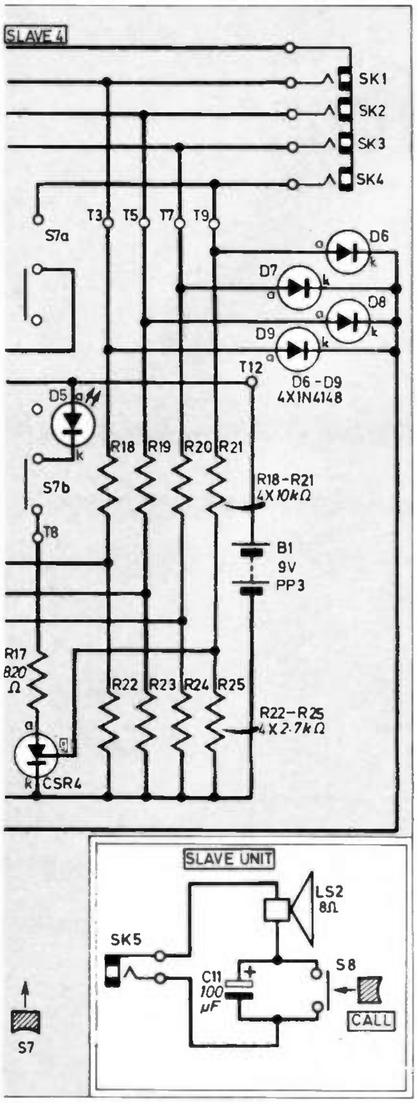
SLAVE TO MASTER

With all switches in the standby position, if a slave calls the positive supply is connected to the amplifier IC1 via the slave speaker voice coil, and D9 (assuming Slave 1 is calling). The supply is also connected to the gate of CSR1 via R18 turning it "on" and so lighting up D2.

As some of the output from IC1 is connected to its input via S3a in the "standby" position the circuit will oscillate and put a tone onto the master unit speaker. This tone will also be heard at the slave due to its speaker being in series with the supply to IC1.

The master unit then selects the line calling and the circuit again reverts back as shown in Fig. 1.

Selecting the calling line also disconnects the supply to the thyristor CSR1 via S4b and switches off the l.e.d. indicator D2. An l.e.d. indicator D1 is also connected to the IC1 supply and indicates when the unit is "on". To check that the whole system is "off" with no calls waiting it is only necessary to check that all the l.e.d.s are extinguished.



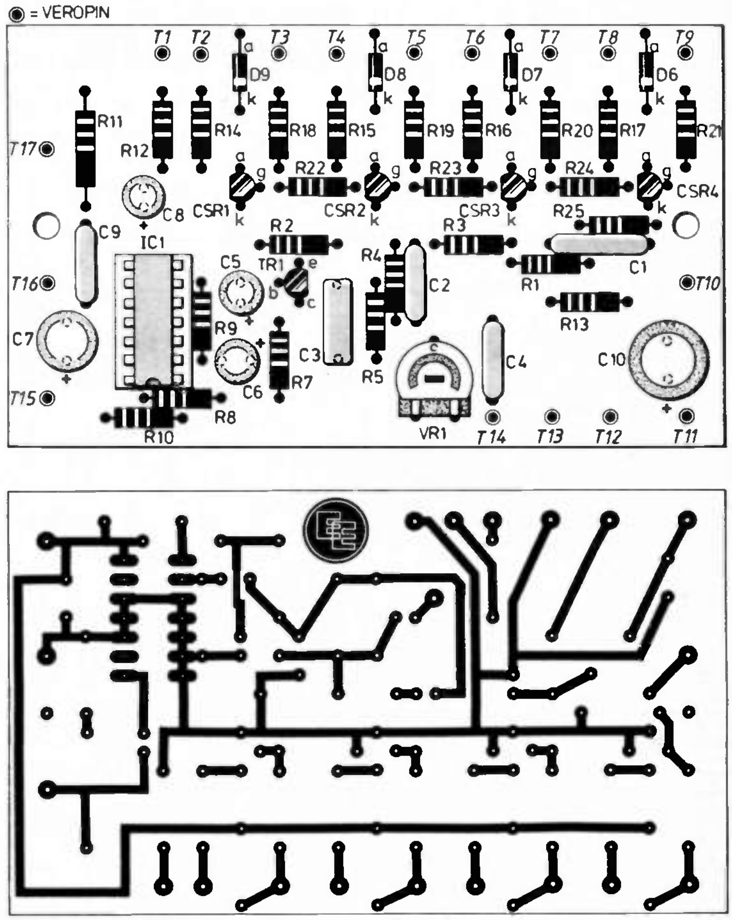


Fig. 5. Component layout on the topside of the circuit board and full size printed circuit board master.

SENSITIVITY CONTROL

A preset potentiometer VR1 is provided so that the sensitivity can be adjusted to a suitable level, however this control will normally be used in its maximum position if monitoring of a slave is desired.

The actual audio frequency of the calling tone will be dependent on a number of things, for example, the type of speakers used, state of the battery voltage, etc. The frequency can be modified by changing the values of C1 and/or R1. In any event the tone produced when called by a slave will be lower in pitch than when the master unit calls and C1 and/or R1 may need adjusting for the most suitable sound.

Note that R13 is shorted out when in the "standby" position. This enables the full supply voltage to be applied to IC1 (for calling) via the line and slave unit. When the line is selected this resistor maintains voltage on the line to operate the thyristors should another line call, but allows an "audio earth" via C10 for the slave speaker/microphone. If the audio earth was via the supply line, instability would result.

CONSTRUCTION

One printed circuit board is used and this carries the bulk of the components. The full-size pattern appears in Fig. 5. Be careful to maintain the correct polarity of all electrolytics and diodes and also check the position of pin 1 of the LM380 before soldering it into place or plugging into a socket.

WIRING

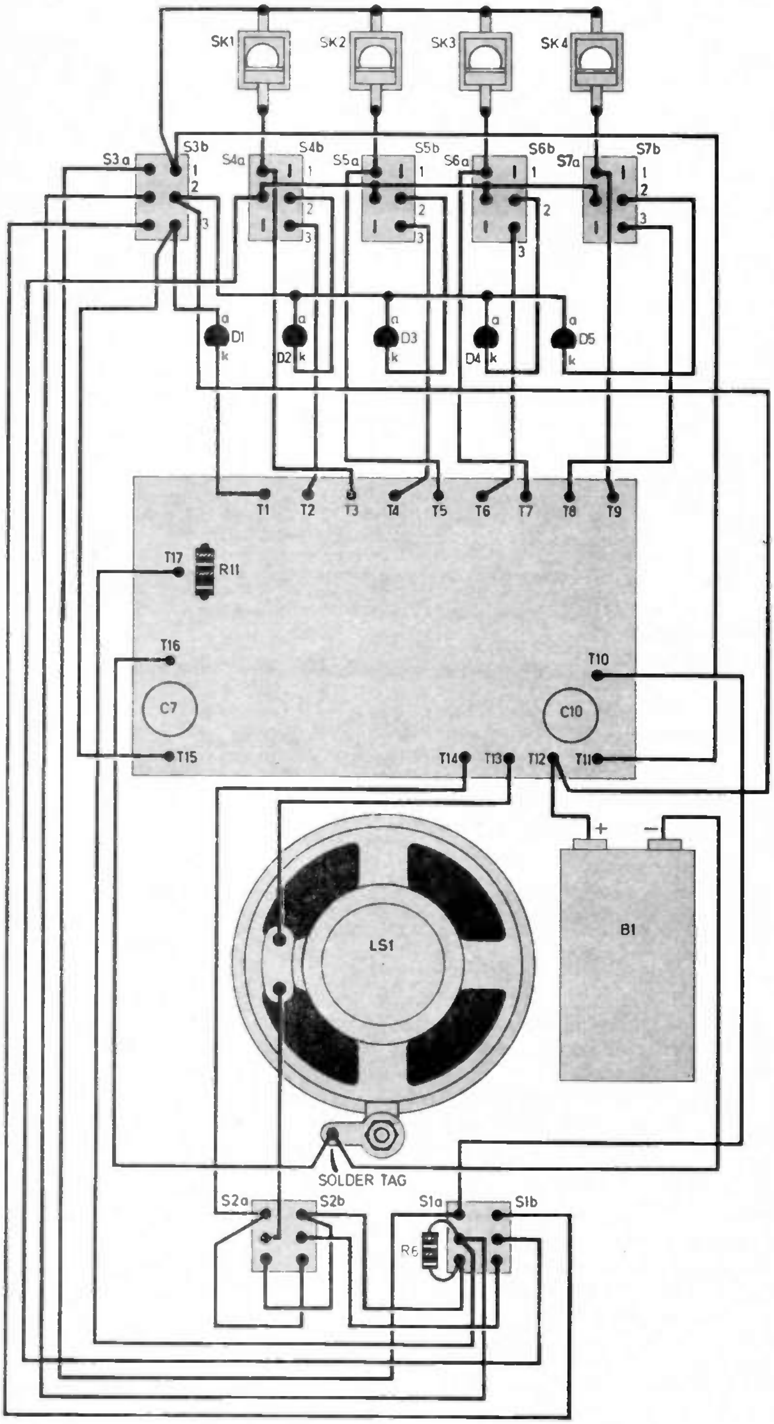
There is a considerable amount of hard wiring on this project and, although the actual layout is not critical, care should be taken regarding connections to the various switches. It is suggested that suitable coloured leads be wired to the switches first and then the p.c.b. placed into position and its terminal pins connected up. Leave the leads long enough so that the board can be lifted clear for any servicing that may be required at a later date. The full interwiring is shown in Fig. 6.

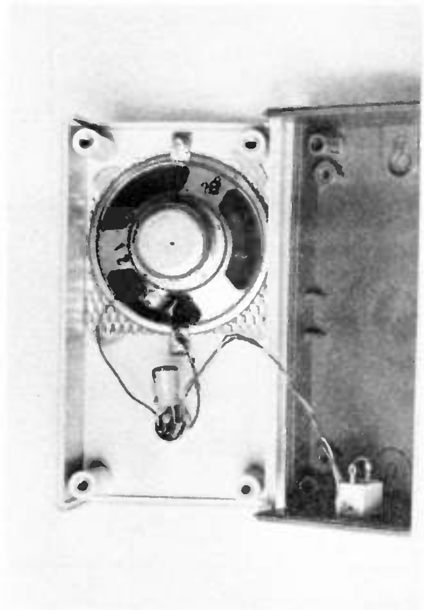
SUB-PANEL

All components are mounted on a sub-panel as shown in Fig. 7. Mark out the aluminium accurately but only pilot drill in the first instance with a 1mm drill. By doing this the sub-panel can be used as a marking template for the front panel of the case, thus ensuring exact register of the two sets of holes.

Note that certain holes are NOT required in the front panel, these are holes lettered "A" and "E".

MULTI-STATION INTERCOM





Wiring and component layout inside the completed slave unit.

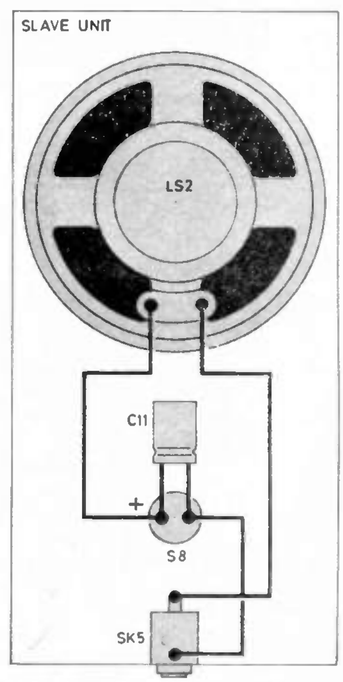


Fig. 6. Interwiring details for the master control and one slave unit. The case mounted components have been laid "flat" for clarity of wiring.

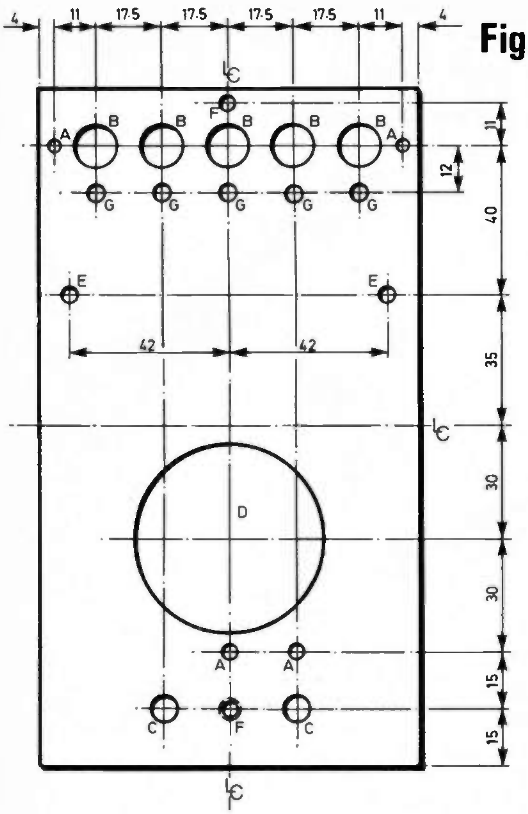
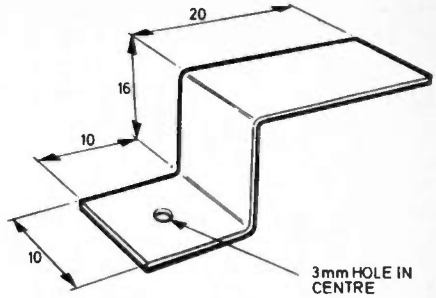


Fig. 7

HOLE mm	A	B	C	D	E	F	G
SUB PANEL	3	11	6·5	50	4	3	SEE TEXT 1
FRONT OF CASE	–	11	11	50	–	3 C' SUNK	TO SUIT LED SEE TEXT

NOTES: DRILL ALL HOLES 1mm DIA & USE AS FRONT PANEL TEMPLATE BEFORE MAKING FULL SIZE
HOLES 'G' TO FRONT PANEL ONLY



MATERIAL: 18 SWG ALUMINIUM
ALL DIMNS IN mm

Fig. 8

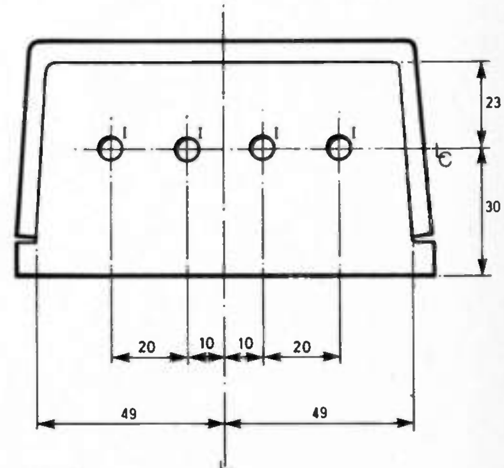
Fig. 7. Measurement and drilling details for the sub-panel.

Fig. 8. Details of the battery bracket.

Fig. 9. Drilling details for the end panel of the master unit case.

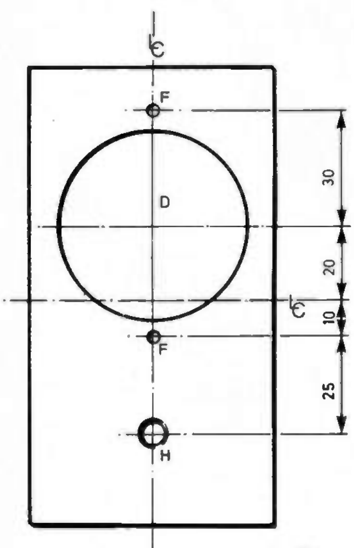
Fig. 10. Slave panel drilling details. A 6·2mm hole should be made in the centre of the end panel for the slave jack socket.

Fig. 11. Suggested sub-assembly for the five indicator l.e.d.s.



HOLE DATA
4 'I' HOLES 6·2mm DIA

Fig. 9



HOLE DATA
1 'D' HOLE 50mm DIA
2 'F' HOLES 3mm DIA
1 'H' HOLE 7mm DIA

1 JACK (SK5) HOLE 6·2mm DIA
(IN CENTRE OF END PANEL)

Fig. 10

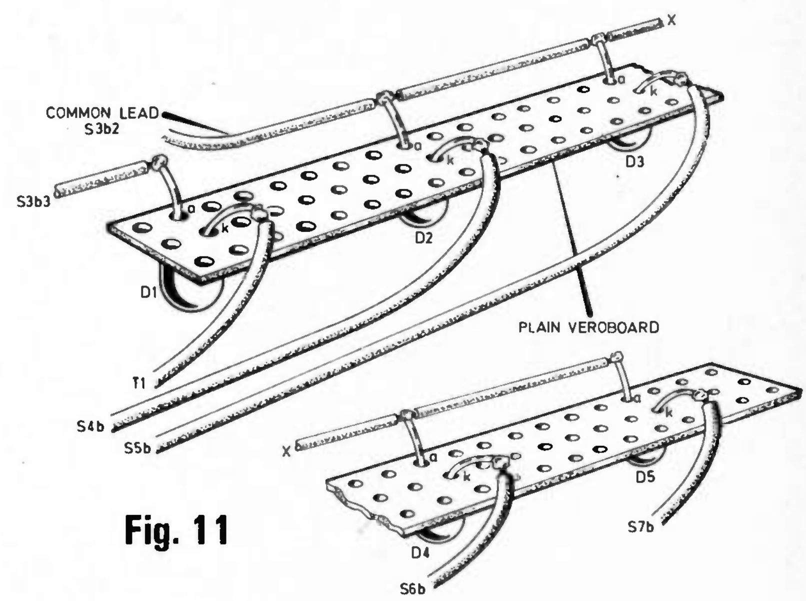


Fig. 11

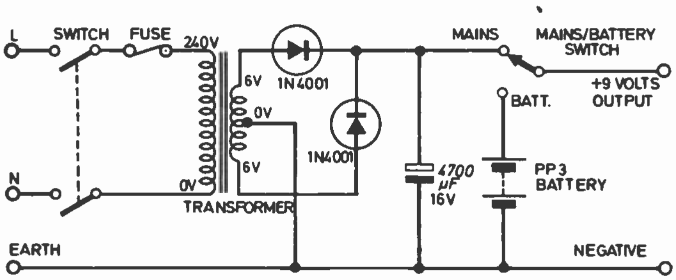


Fig. 12. Suggested circuit diagram for a mains/battery power supply.

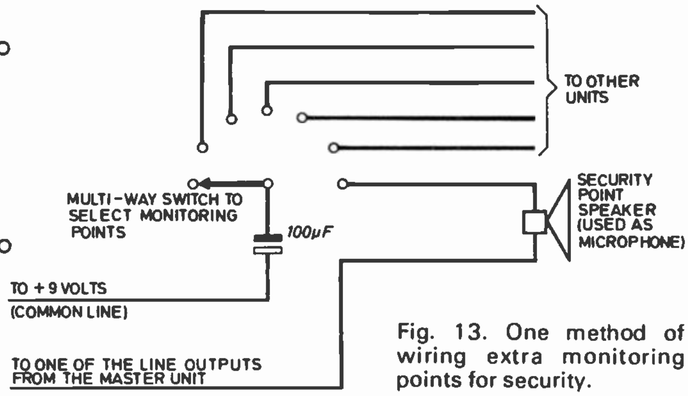


Fig. 13. One method of wiring extra monitoring points for security.

Four plastic feet are fitted to the inside of the case to maintain the correct distance between the sub-panel and case. Two 6BA screws with nuts for spacers are also used to hold the sub-panel in position.

A small metal bracket holds the PP3 battery in place and this is made as shown in Fig. 8. This bracket is not required if a mains power supply is used.

CASE DRILLING

Fig. 9 shows the holes required in the end of the case for the miniature jack sockets and Fig. 10 shows the drilling required for the slave units. When cutting the 50mm hole in the cases a "Q" Max cutter can be used but warm the case to about 20°C before cutting (warm the cutter as well); this will enable the plastics case to be cut cleanly without splitting. If cutting is attempted with the plastic very cold it *will* split.

LED ASSEMBLY

The l.e.d.s are held in place by first mounting onto a strip of plain perforated board, Fig. 11, and a strip of foam mounted along its back. This sub-assembly is then sandwiched between the case and sub-panel. Using a 0·1in. board the l.e.d.s will be spaced every seven holes, that is, six holes between each l.e.d. In any event the l.e.d.s should be a firm fit into the holes in the case, but the use of this extra mounting strip makes for easy handling during wiring and assembly, or when servicing, as the five l.e.d.s can be handled as a single assembly.

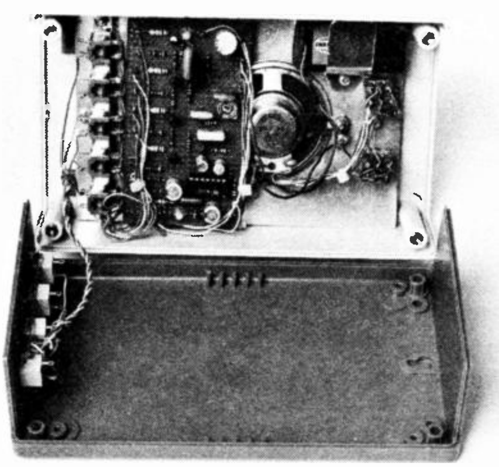
The loudspeaker apertures are covered with a suitable fret before final assembly and this may be either a metal or cloth type. Metal is preferred as it will provide greater protection for the speaker units. The fret is held in place by the use of white Bostik (the writer uses Bostik 4 multi-tile adhesive).

The cases specified have special mouldings in the backs which can be knocked out to provide holes for fixing the units to a wall. Depending on the labelling, the units can be mounted either way round.

MOUNTING THE SUB-PANEL

When mounting the five-way push-button unit onto the sub-panel, space it away from the panel approximately 7mm, by using 6BA screws with nuts as spacers. This ensures the actual buttons will be at the same height as the "call" and "PT" buttons. To ensure smooth operation of the buttons it is important that all burrs are removed from the holes in both the sub-panel and case.

Completed prototype of the master unit. The plain perforated board has been replaced by a printed circuit board.



INSTALLATION

No problems should be encountered here as the "lines" are low impedance and only passing a very low current, a few milliamps. Standard type bell wire may be used for indoor wiring but if cable runs are made outdoors bell wire will be unsuitable as it is not weather-proof. For outdoor cable runs p.v.c. covered cable should be used. On NO account must any direct connection be made between these "lines" and the mains or telephone wires, they may however be laid alongside such cables if this is unavoidable. In this event some mains borne interference may be heard on the intercom system. Each end of a "line" should be terminated with a 3·5mm miniature jack plug which is then plugged into the slave unit.

OPERATION

Select the line required, sounds should be heard from the slave unit (assuming that someone is there). Press the CALL button, a tone should be heard at both ends of the line. When the slave answers, press the PRESS TO TALK button before speaking and release it to listen.

When on standby, a "slave" may be called by pressing the CALL button. Again a tone should be heard at both ends. Select the line that is calling and press the PRESS TO TALK button to answer, release to listen again.

As each slave calls, the appropriate l.e.d. should indicate which line has called. If a conversation is in progress and another slave calls, the l.e.d. will indicate that a call is waiting, and this can be answered by selecting that line and either dealing with the call or asking them to wait until you can call back. If a conversation is already in progress, no tone will be heard if additional lines call in.

MAINS POWER SUPPLY

If several slave units are being used, it would be wise to operate the system from the mains. A suggested circuit for this is shown in Fig. 12. An extra jack socket should be fitted to the master unit and the battery connections taken to this with a suitable lead then going to the power supply.

USE AS A SECURITY UNIT

By using the circuit shown in Fig. 13 any number of extra "microphones" can be selected so that it is possible to listen in to a number of positions. It is not possible for these to call the master, although the master can call them if required and engage in normal two-way communication. This facility could also be useful where, for example, a number of children's rooms need to be monitored. Other uses will no doubt come to mind. □

By Dave Barrington

Screened Plastic Boxes

The complete BIM2000 range of plastic multi-purpose cases from Boss are now available internally coated with 0·05mm thick, black EMI/RFI conductive shielding.

Having all the normal electrical screening protection facilities associated with steel or diecast aluminium enclosures, it is claimed that these ABS boxes also have the added advantage of light weight and easy drilling.

Available initially in black only, the deep profile lids are firmly secured to the base by screws running into brass hank bushes which not only ensure a good electrical connection for total screening but also provide protection against the ingress of moisture.

The cases are moulded in seven sizes ranging from 100 × 50 × 25mm to 190 × 110 × 90mm. For further details of the complete range contact: Boss Industrial Mouldings Ltd., Dept EE, James Carter Road, Mildenhall Suffolk IP28 7DE.

Catalogue

A new shortform hobbyist catalogue featuring a wide range of products for the electronics enthusiast has just been issued by the Retail Division of BICC-Vero.

Products covered in the 6-page colour catalogue include circuit boards, solderless breadboards, boxes, tools and a wide range of accessories.

Copies of the "The Hobby Herald" catalogue are available Free from BICC-Vero Packaging, Dept EE, Retail Department, Industrial Estate, Chandlers Ford, Eastleigh, Hants SO5 3ZR. A large stamped addressed envelope would be appreciated.

Coloured Knobs

A new range of control knobs, with coloured caps and "skirts", are now being stocked by Ambit International.

These knobs are from the well-known Ritel of Switzerland range and at present consist of matt black bodies with a selection of different coloured caps, pointers, skirts and dials. They also feature push-fit brass collet fixing.

Another ten finishes are available to special order. For more details of the complete range contact: Ambit International.

CONSTRUCTIONAL PROJECTS

Car Thermometer

The most expensive item in the *Car Thermometer* is the temperature sensing device and could cause purchasing problems.

The case of this device is stamped with the type number 590kH and as far as we have been able to establish is only stocked by RS Components (order code 308-809). This is an expensive item.

We would point out that RS Components will only supply to *bona fide* traders and readers will have to order through their local component supplier. If any readers are able to "throw" any further light on a source of supply, or equivalent, for the temperature sensor we will be pleased to hear from them.

This project has been specially designed to fit into a small hand-held case with sloping display panel. This case is available from Lascar Electronics Ltd., Dept EE, Module House, Whiteparish, Salisbury. It is also available from Verospeed, Dept EE, Boyatt Wood, Eastleight, Hants SO5 4ZY, and is listed as a hand-held case for digital panel meter (stock no. 89-25463J).

Dual Power Supply

The mains transformer used in the prototype *Dual Power Supply* was custom-made by Samson's (Electronics) Ltd., Dept EE, 9 Chapel Street, London NW1. A similar mains transformer with 24V 1·5A and 9V 1·5A secondaries could be used but, because of physical size, may require altering the layout within the case.

The heatsink and meter were purchased from Ambit International and the Sifram front panel knobs are stocked by Electrovalue and Marshall's.

It is quite in order to use 0·47Ω 3W wire-wound resistors for R1 and R8.

Multi-Station Intercom

The two-tone moulded plastics cases called for in the *Multi-Station Intercom* are Verobox types and should be available from most component suppliers. Stockists include Bi-Pak, Maplin, Magenta, Electrovalue, and Verospeed.

The sockets SK1 to SK5 are 3·5mm miniature types with normal closed contacts. All the interlocking switches (S3 to S7), mounting plate and knobs are available from Maplin.

The thyristors (CSR1 to CSR4), type C103YY, appear to be only available from RS Components.

Expanded Add-On Keyboard for the ZX81

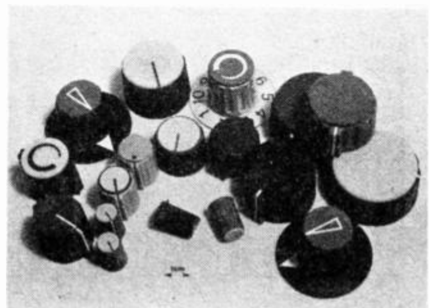
It is quite possible that many of the add-on keyboards now on the market could benefit from the *Expanded Add-On Keyboard for the ZX81* project, however, these have not been investigated by us. The keyboard used in the prototype was obtained from Redditch Electronics (Dept. EE), 21 Ferney Hill Avenue, Redditch, Worcs B97 4RU.

The additional keyboard switches and switch "tops" are available from Redditch or Maplin. The Verostrip is available from Vero Electronics.

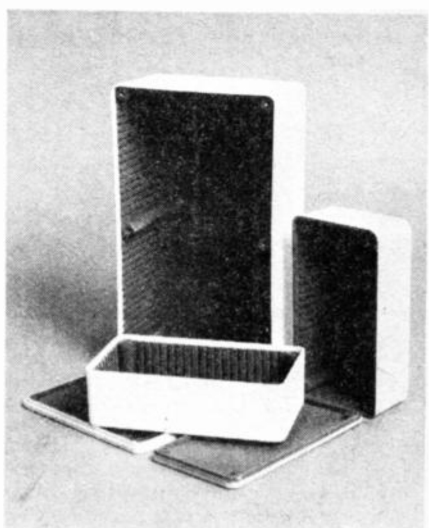
Buzz Off

The 12V audible warning device used in the prototype of the *Buzz Off!* model was obtained from RS Components, stock number 248-808. However, most of the solid-state buzzers on the market are rated from 6V to 20V operation and could be used.

These devices appear to be about half the price of the RS item. Stockists of these buzzers include Electrovalue, Maplin, Magenta, TK Electronics and Ambit.



Selection of control knobs from Ambit International.



New range of "screened" plastic cases from Boss Industrial Mouldings Ltd.

A NEW SERIES FEATURING A TEARLESS TABLETOP TECHNIQUE BY GEORGE HYLTON

INTRODUCING ELECTRONICS

Part 6 DIGITAL ELECTRONICS

In this, the last of the present series, we'll take a quick look at digital electronics. Since this topic includes practically the whole of computing and much of modern communications, it will have to be a rather superficial look. However, interested readers can obtain more detailed knowledge, in a painless way, by following *The Electronics of Information Technology* now running in this magazine.

DIGITS: WE ALL KNOW THEM

There's nothing strange about digits. We have five on each hand. Most of us learn to count on them, thereby gaining our first practice in digital computing! We are also familiar with the idea of sending messages in Morse Code, an early form of digital communication.

BACON AND BINARY

It all started long before the electrical age. When the Spanish Armada appeared in the Channel, warning beacons were lit on hilltops to send the message across the country. A beacon is either lit or not. This *on-or-off* feature is characteristic of digital communications.

Of course, you can light one beacon for an early warning, two for a more urgent one and three for imminent danger—but the on-off nature of the individual fire remains.

This is in distinction from *analogue* signals, where the intensity of the signal is varied in step with the information to be conveyed, as in a.m. radio where the strength of the transmitter is made to change in step with the sounds at the studio microphone.

The trouble with analogue signals is that they are very susceptible to interference. Imagine how difficult it would have been to signal with beacons by varying their brightness in an *analogue* way. Even if it could have been accomplished at the transmitting end, how difficult it would have been for a watcher many miles away to read the variations, perhaps through mist or haze, even though he had no doubt that a beacon was lit.

SIMPLER WITH DIGITS

The "all-or-nothing" nature of digital signals makes the problem so much simpler.

Morse Code is only partly digital. The lengths of the digits vary (dots or dashes) and this is an analogue feature. True digital codes, with all the elements or "bits" the same length, are used in machine telegraph systems like teletype, but in fact the basic five-bit code of early teleprinters and teletypes pre-dates the electrical age by several centuries. It was invented by Shakespeare's contemporary, Francis Bacon, for use as a diplomatic code.

Bacon showed how a code message could be hidden in a plain language message. The example he gives shows how the sentence:

STAY TILL I COME TO YOU

can be made to conceal the very different one:

FLY!

The trick is to modify the letters of the plain message in some unobtrusive way; for example, to write some a tiny bit above the line and others a tiny bit below. Each letter can then have one of two positions, high or low. The intended reader then groups the letters of the plain message into lots of five and rewrites them as "highs" (H) or "lows" (L). So STAY TILL I COME TO YOU may become, say, HHLLH LHHLL LLLHH LLL.

The LLL at the end are spares, because the first three groups are all that are needed. The decoder looks up his code book and finds that HHLLH means "F", LHHLL = "L", and LLLHH = "Y". Message read, he packs his bags and leaves!

DIGITAL ELECTRONIC CODES

Bacon's code is a true binary code, with the essential "all-or-nothing" character of the individual elements. In transistor terms, we may agree to say that there is a "high" (H) when a transistor collector goes positive and a "low" (L) when it falls to zero.

These two states, which in practice correspond to, say, transistor off, and passing no current, and transistor hard on, passing so much current that all the supply voltage is dropped across a collector load resistance, can also be designated "1" and "0". So HHLLH could be written 11001. This looks like a number and can indeed be treated as one. Thus, doing subtraction, we could say that 11110−01110=10000.

We have now arrived at a strange state of affairs where 0's and 1's can signify either letters or numbers, and having turned letters into numbers we can then add or subtract them! In fact, anything that can be turned into an electrical signal can be "digitised" and the digits manipulated.

If you watch TV, then practically every day you see some of the tricks which can be performed by digitising the TV picture then manipulating the digits as numbers. The picture can be made to expand, contract, change shape, split into several identical pictures, even fold over like the page of a book or wrap itself round a cylinder. All done by digits.

PULSE CODE MODULATION

In the communications field, an important development is the now widespread use of digitised speech. Many years ago, long before the transistor, a British engineer worked out the basic principles. Last month we noted how in an a.m. radio receiver the detector in effect produces a string of samples of the original programme. So long as there are enough samples, the gaps can be filled in and the original programme waveforms recreated.

In *Pulse Code Modulation* the speech is sampled at a high rate (at least 8000 times a second). This gives a sequence of samples whose size depends on the intensity of the speech at the instant of sampling (Fig. 6.1). Instead of transmitting these as variable-amplitude analogue signals, each sample is digitised, that is turned into a string of 0's and 1's. This is transmitted (with the usual advantages of a binary system) and turned back into analogue signals at the receiver.

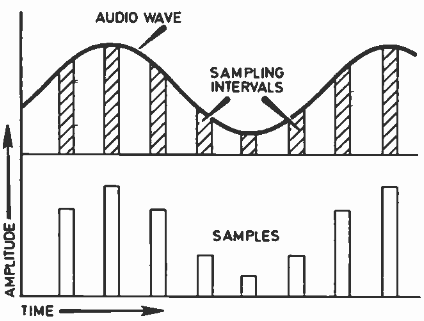


Fig. 6.1. Sampling an audio signal.

If the sampling time is short (say one microsecond), then the gap in time which comes before the next sample is due can be filled with samples of other speech waveforms. In this way a number of different conversations can be interleaved in time. At the receiving end, accurate timing circuits sort them out again.

In this way, many speech channels can be interleaved in time, transmitted over the same cable, and sorted out again. In the new telephone exchanges, all the speakers' voices will travel along the same "highway". To connect two speakers together, timing "gates" will be opened just long enough to let through the samples of their voices, then closed to exclude everybody else's.

NOT, OR, AND, NAND, NOR

The basic digital circuits are rather boring. They are either the equivalent of switches which open to let signals pass (Fig. 6.2) or "inverters" which turn 1's into 0's, and vice-versa.

A single *npn* transistor with a collector load resistance can act as an inverter. A large positive input to its base causes the collector voltage to fall from a positive value (= "1", say) to zero (= "0", say).

In computer jargon, a "1" at the input becomes a "not 1" at the output. An inverter is often called a NOT circuit.

Fig. 6.2a is an OR gate because signals are passed on if switch A *or* B *or* C is closed. Fig. 6.2c is an AND gate because no signal is passed on unless A *and* B *and* C are closed.

The common transistor equivalents such as (b) and (d) also invert, so they are NOT OR (= NOR) gates and NOT AND (= NAND) gates. In this example they are 3-input gates but other numbers of inputs can be catered for.

Gates in integrated circuits are more complicated but their function is the same. Combinations of these simple circuits are all that is needed to form the hardware of computers, capable, when programmed, of adding and subtracting binary numbers. Multiplication and division can be performed by repeated addition or subtraction.

It may be inexpressibly tedious for a human being to work out 7 × 3 as 3 + 3 + 3 + 3 + 3 + 3 + 3 = 21, but a computer never complains. Of course, there is no such thing as 3 in binary codes. But combinations of 1's and 0's can be made to stand for any number. Thus 3 becomes 11 in binary. It looks complicated, but that's merely because of unfamiliarity.

FLIP-FLOPS AND THINGS

Let's look at some slightly less boring binary circuits. In Fig. 6.3, provided the resistances are correct, TR1 is turned hard on when S1 is in position 1, and off in position 2. The l.e.d. lights or not, accordingly.

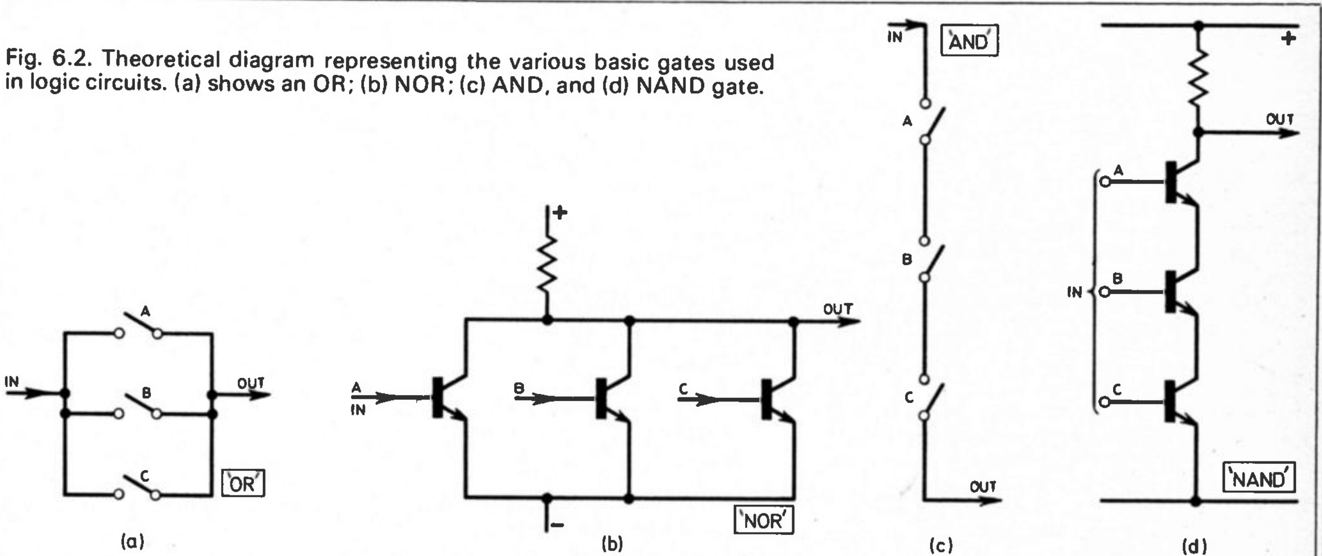
In real life binary circuits, the transistors are controlled mostly by voltages or currents from other circuits rather than by switches. The next circuit (Fig. 6.4) illustrates the point.

Here, each transistor is controlled by the collector voltage of the other. If TR1 is on, its collector voltage is low so there is no voltage to drive current through R2 to turn on TR2. This in turn means that TR2 collector voltage is high, which is just what is needed to turn on TR1.

Unless you do something about it, the circuit will stay in this state for ever. What you do is move the bit of wire which serves as S1 from its central, neutral position to position 1. This shorts out TR1 base current, turning TR1 off. Its collector voltage goes high and this turns TR2 on. The circuit has "changed state". It stays that way when S1 is returned to neutral (2). This is memory, of a sort. The circuit remembers what state it has been put into.

To reverse the state, move S1 to 3. And so on. You can also reverse the state by touching your switch wire on to the collector of whichever transistor is NOT conducting. In these ways the circuit can be made to "flip" out of one state and "flop" into the other, as often as you like.

Fig. 6.2. Theoretical diagram representing the various basic gates used in logic circuits. (a) shows an OR; (b) NOR; (c) AND, and (d) NAND gate.



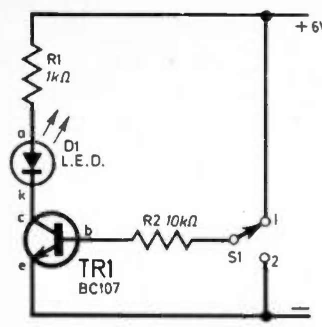
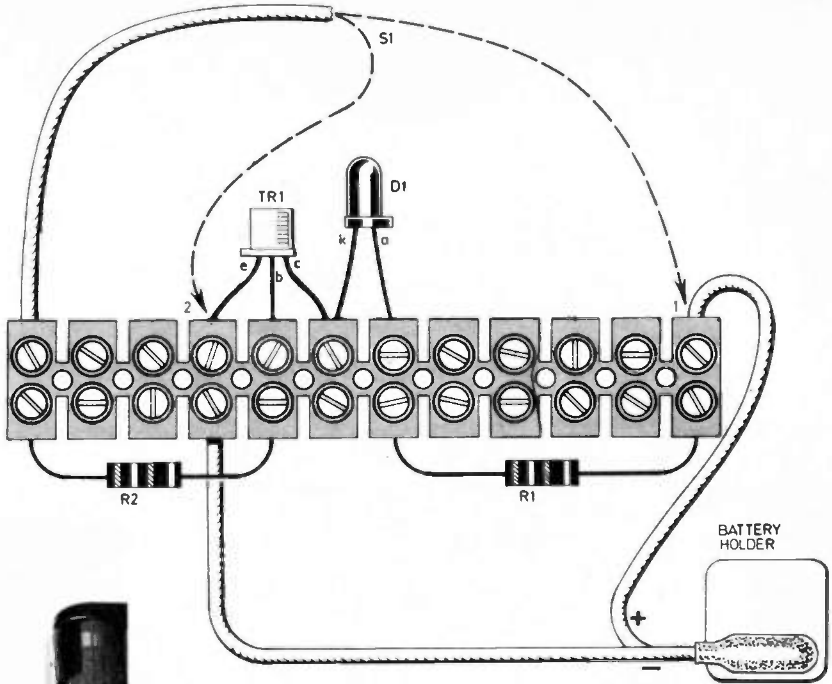
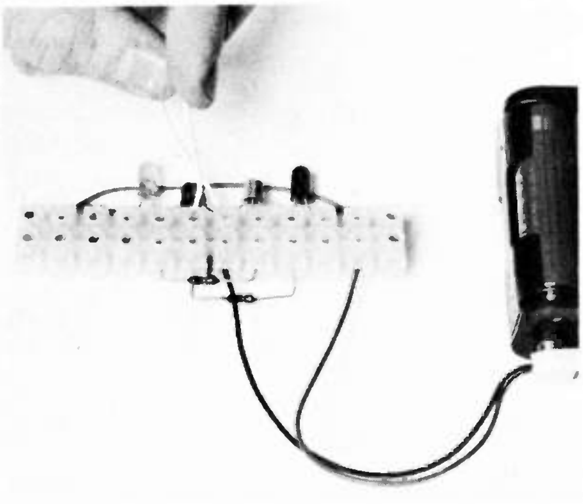
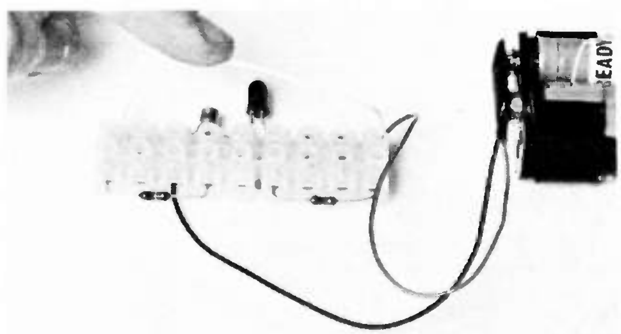


Fig. 6.3. Simple "flip-flop" circuit and demonstration model wiring (right). Photo on the right shows TR1 being switched on by the "wire" switch S1.







Shorting out TR1 base to switch on TR2, see Fig. 6.4.

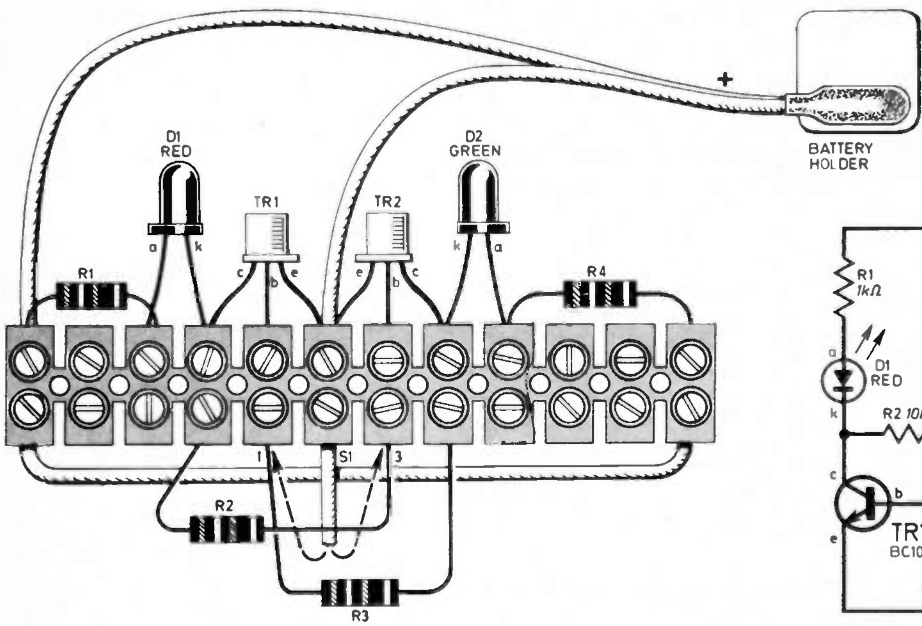
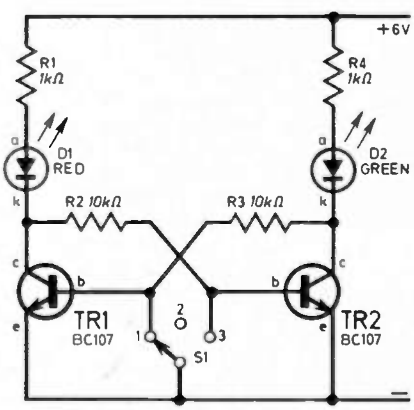


Fig. 6.4. Circuit diagram and demonstration model using another transistor to control the flip-flop circuit of Fig. 6.3.



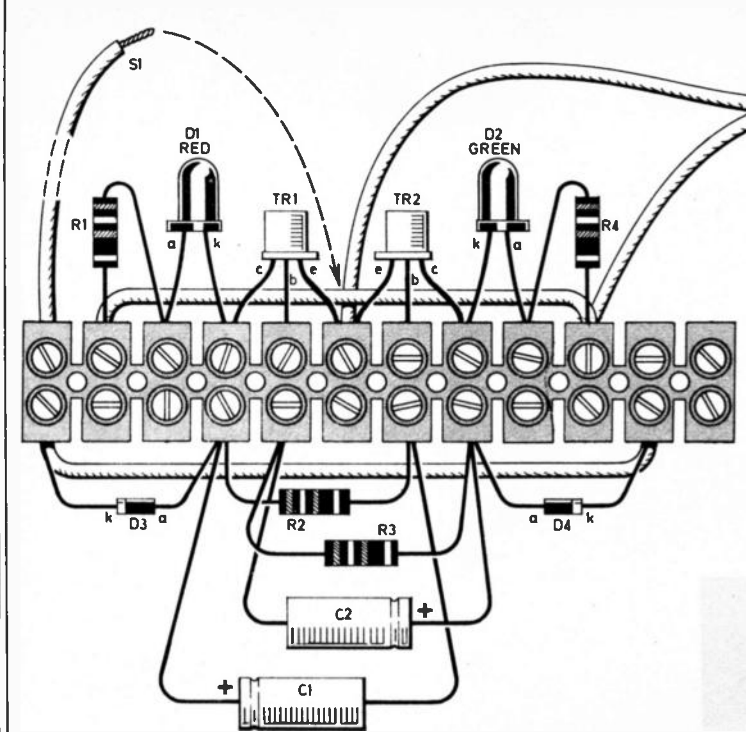
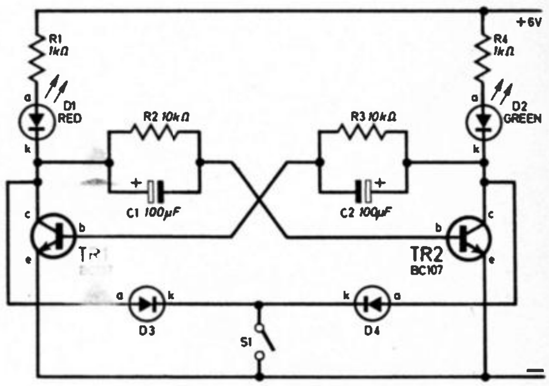
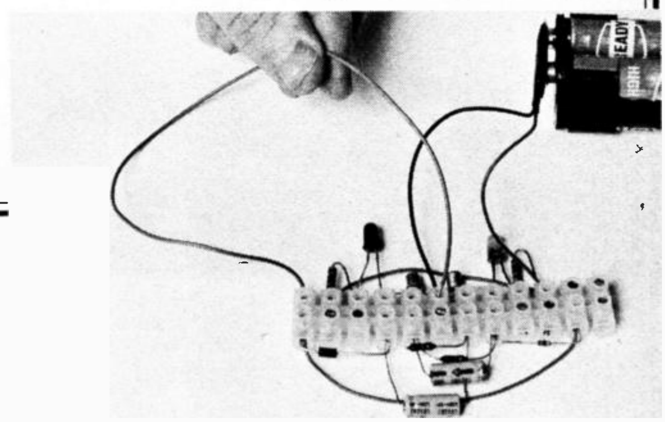


Fig. 6.5. Circuit diagram and demonstration model for a bistable circuit. Photo below shows S1 "pulsed" to alternate the switching of the two l.e.d.s.





BISTABLES

Circuits like this, which can be put into either of two states and stay there are called *bi-stable* circuits, or just *bistables* for short. There is obviously something very binary about them, and they become of use for computing when modified so that they change state every time an input pulse is applied, even though it is applied simultaneously to both transistors.

You can do the trick by adding two capacitors and two diodes (Fig. 6.5). A diode allows current to pass only in the direction of its "arrowhead" triangle. With S1 open, whichever way current tries to flow it is blocked by one diode. But when S1 is closed, current can flow through both diodes, to the negative line. In effect, this connects the collectors to negative and turns off both transistors.

But with S1 open, one collector is "high". Its associated capacitor charges.

It takes time to discharge a capacitor, as you know. If S1 is given just a quick flip, some charge remains, and it is always of the correct polarity to reverse the state of the circuit. So, by repeatedly flipping S1 the state can be changed again and again. In a real-life circuit S1's job might be performed by another transistor, turned on by pulses to its base. These pulses could be derived from one of the collectors of another bistable.

Note that any *one* transistor, say TR2, changes state every alternate time S1 is closed. If output pulses are taken from TR2, there are only half as many output pulses as operations of S1. If S1 is replaced by a pulse-driven transistor, the bistable divides the number of input pulses by two. Two bistables, one driven from the other, divide by 4. Three divide by 8 . . . and so on. Chains of bistables like this form *counters.*

Such is the art of i.c. manufacture that a chain of 14 bistable or "flip-flops", each in fact containing several transistors, can be bought for about 50 pence. The i.c. also contains a circuit which resets the whole thing to zero when required. A four-stage counter, which is capable of counting up to 16, is often arranged to reset every time it reaches 10. This makes it into a *decade counter.*

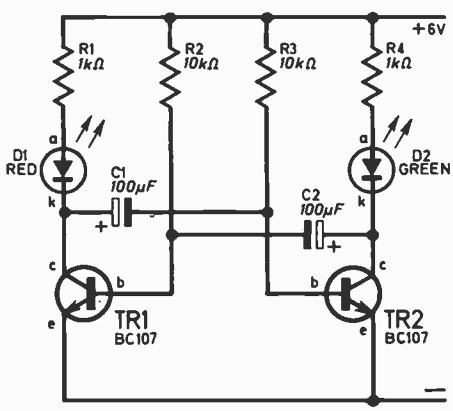


Fig. 6.6. Circuit diagram for an "astable" oscillator which can be built from components from Fig. 6.5.

Bistables can also be connected in such a way that they act as stores or registers which remember a string of digits. The string can be moved along the chain, to emerge eventually at the other end. This is a *shift register,* or moving store. Bistables can also be used as static stores or memories. Most pocket calculators nowadays have such memories. Computers have very large ones capable of storing thousands of digits.

WINKER

If you want to experiment with computer i.c.s you will be well advised to buy one of the many excellent multi-socket "breadboards" now available for the purpose. I.C.s and components can be plugged in at will and linked up with pushed-in wires. For about £8 you can get a breadboard big enough for nearly all the projects you'll want to try out.

I hope you have enjoyed this series. If so, keep reading, because there are plans for some follow-up articles using the terminal-block solderless technique.

As a final experiment you might like to convert your bistable into an *astable,* that is an oscillator (Fig. 6.6). I'll leave you to work out the changes in connections from the earlier circuit! □

Car Thermometer

BY M. PLANT

TODAY'S driver could well profit from a knowledge of the air temperature around the car, especially if used to provide a warning of possible ice formation on the road surface.

So, what kind of thermometer would be suitable for use in a car to meet this need and yet also have sufficient range to measure anticipated maximum summer temperatures?

ANALOGUE OR DIGITAL?

To keep the thermometer small and rugged, a digital circuit design using l.e.d. or l.c.d. displays is called for, since a moving coil meter for an analogue display would make a bulkier and less durable thermometer. Digital design also makes the inclusion of an alarm function easier.

However, 7-segment displays are expensive, and one solution is to use discrete l.e.d.s in a bargraph display of the type used for VU meters. Such a display of, say, ten l.e.d.s in a horizontal format functions as an analogue display but they light in discrete steps.

BARGRAPH

The 3914 i.c. is purpose-designed to drive a ten l.e.d. bargraph to give an analogue display of the voltage it senses. It is housed in an 18-pin package and the l.e.d.s are normally mounted in-line to give a bar or moving dot display. Its principal advantages compared with a con-

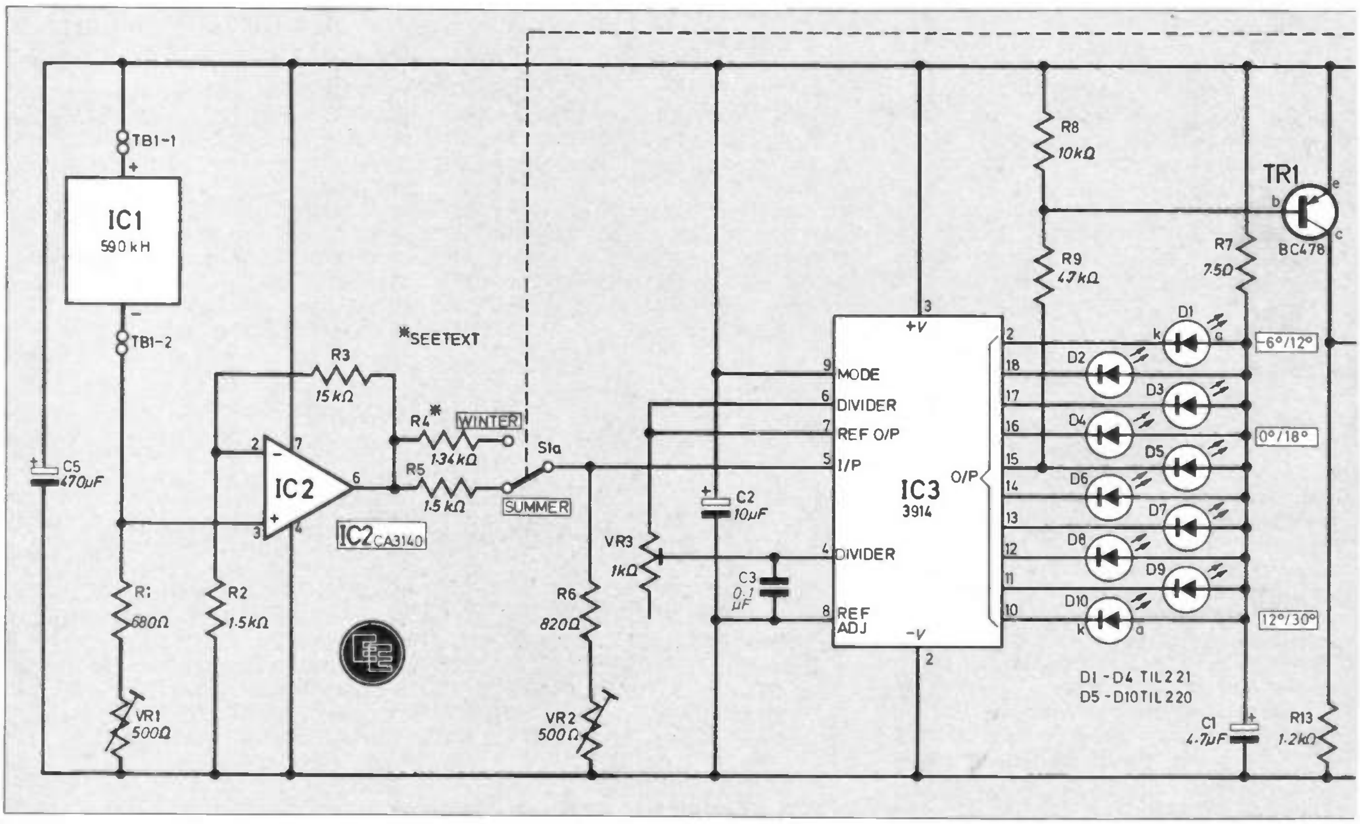


Fig. 1. Complete circuit diagram of the Car Thermometer. Note that the temperature sensor, IC1, is connected to the terminal

ventional moving coil meter are: it can be used in any position; it can be seen in the dark; it has a fast response; and it is unaffected by knocks and vibrations.

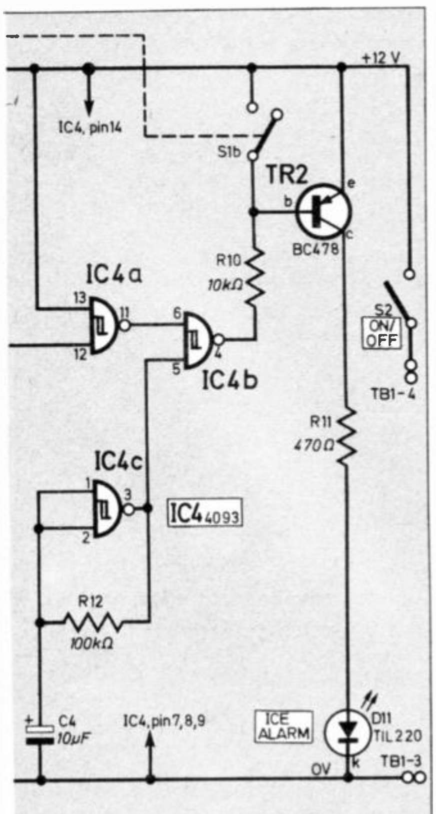
The device contains a precision voltage reference and internal logic which enables the user to choose bar or moving dot display operation. The 3914 also contains current limit resistors for the l.e.d.s.

VOLTAGE COMPARATORS

There are ten voltage comparators. The non-inverting input of each comparator is taken to a precision voltage divider chain made up of ten one kilohm resistors connected in series. All the inverting inputs of these comparators are connected together and taken to the output of the buffer stage which receives the input signal.

By using the internal voltage reference, a stabilised voltage can be set across the voltage divider chain so that an increasing step voltage is set on the non-inverting inputs of the comparators, from the lower one to the upper one. As the output voltage from the buffer stage increases in response to an analogue input voltage, the voltage on the commoned inverting inputs increases.

When the voltage on the inverting input of a comparator exceeds the voltage on its non-inverting input, its output voltage goes low and the l.e.d. connected to this output lights. Each of the ten outputs can sink a current of 30mA and this current is programmed by an external resistor.



block by up to three metres of wire.

CIRCUIT DESCRIPTION

Four i.c.s are utilised in the design of the Car Thermometer circuit shown in Fig. 1. The CMOS op-amp, IC2, is wired as a non-inverting voltage amplifier with a voltage gain of about 11, that is, the ratio of resistor values (R3 + R2) to R2.

The temperature sensor IC1, acts as a high impedance current source which passes about 1µA per Kelvin (1 Kelvin equals 1°C), through resistors R1 and VR1 when it is supplied with a voltage between 4V and 30V d.c. across it. Due to its high impedance, the sensor current is virtually insensitive to voltage drops which might occur on long cables connecting it to the amplifier.

R1 and VR1 are adjusted so that a voltage varying by about 0·91mV per Kelvin occurs at pin 3 of IC2. This variation is set so that, after amplification, the voltage at pin 6 varies by 0·1V/K. This condition makes it easy to calibrate the thermometer, since voltage at this point may be read directly as Kelvin. For example, a voltage of 2·67V occurs when the temperature of the sensor is 267K, or −6°C (273K corresponds to 0°C).

Thus, over the full range of temperature measured by the thermometer, the voltage changes from 267mV to 303mV (30°C). Note that a temperature of x degrees Celsius is equivalent to a temperature of 273 + x degrees absolute or Kelvin.

The total variation in voltage at pin 6 of IC2 is, therefore, 0·18V. A fraction of this voltage is applied to the input of IC3, pin 5, via the voltage dividers R5 (or R4) and R6 + VR2. The internal reference voltage of 3914 is available at pin 7 and is nominally equal to 1·2V. Pin 6 is connected to pin 7 so that the voltage at the "top" end of the internal voltage divider is 1·2V.

The voltage at the "bottom" end of the voltage divider is set on pin 4 by VR3 which selects a fraction of the internal reference voltage. Thus a stable voltage is set across the internal voltage divider which enables an accurate expanded scale thermometer to be designed using the 3914.

Capacitors C1, C2 and C3 are required to ensure that the 3914 is stable in operation. Resistor R7 is connected in series with the anodes of the ten l.e.d.s to reduce the power dissipation inside the 3914 by bringing its output transistors further into saturation.

ALARM CIRCUIT

The logic circuit which operates the flashing l.e.d. when the temperature of the sensor is below 2°C is centred on the CMOS device, IC4. Three of the four 2-input Schmitt NAND gates are used.

When the temperature is 2°C or above, D5 connected to pin 15 of IC3 is on and the voltage drop across it lowers the voltage at pin 15. TR1, in association with the voltage divider R8 and R9, inverts this low and places a logic high on pin 12 of IC4a. Since the voltage on pin 13 is also high, the output at pin 11 is low. This low applied to pin 6 of IC4b ensures that its output stays high and TR2 holds off the alarm D11.

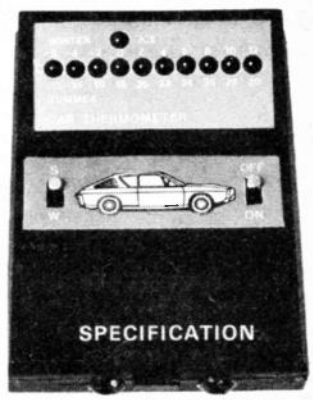
If D5 goes off, the voltage at pin 15 of IC3 goes high and transistor TR1 switches off which places a logic low on pin 13, IC4. Thus, the output of this gate is now high and this high is placed on pin 6 of IC4b.

SCHMITT OSCILLATOR

Pin 5 of IC4b is connected to the output of a simple Schmitt oscillator designed around IC4c using C4 and R12. Thus pin 5 of IC4b receives square-wave pulses at a frequency of about 1Hz.

Every time pin 5 receives a low from the oscillator, pin 4 goes from low to high. Thus pin 4 of IC4b passes a series of pulses to transistor TR2 which drives D11 on and off at the oscillator frequency.

To avoid the alarm operating at temperatures below 20°C when the selector switch S1a is on SUMMER, S1b holds the base of TR2 high hence preventing D11 from flashing.



SPECIFICATION

Range:	Summer 12°C to 30°C Winter − 6°C to 12°C
Display:	10 l.e.d.s in bar format plus alarm l.e.d.
Resolution:	2°C per l.e.d.
Alarm:	Ice warning operates flashing l.e.d. at temperatures below 2°C.
Sensor:	Semiconductor temperature sensor with nominal temperature coefficient of 1µA/°C
Power supply:	Suitable for in-car use since Thermometer operates over a 7V to 16V range without affecting calibration
Max. current:	150mA at 12V supply voltage with all l.e.d.s on

Car Thermometer

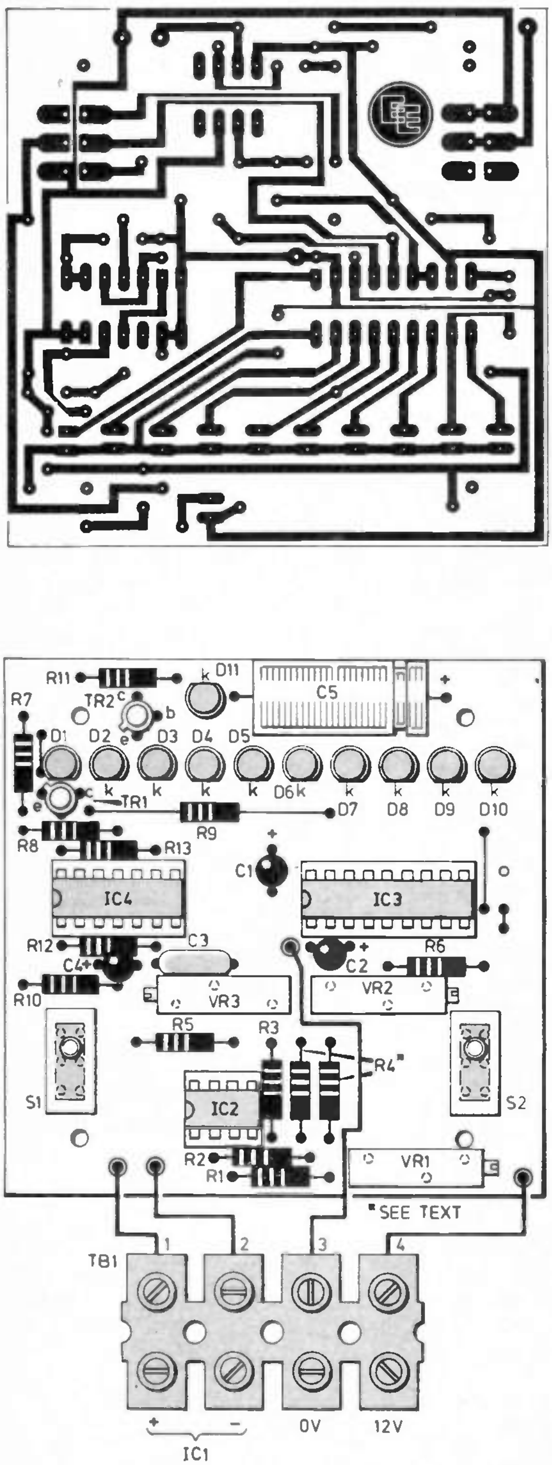


Fig. 2. Full size p.c.b. artwork and component layout. All the l.e.d.s are soldered into the board at the same height of approximately 20mm (to the top of the lens).

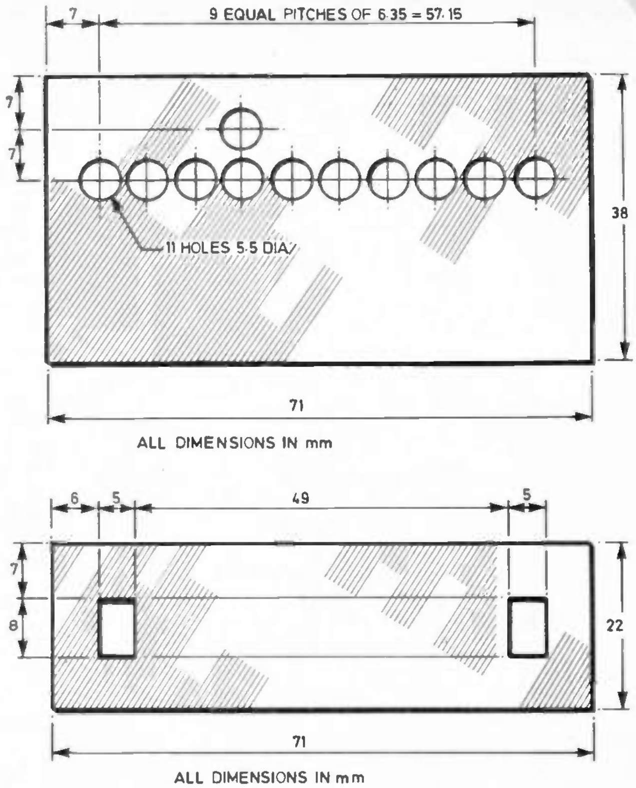
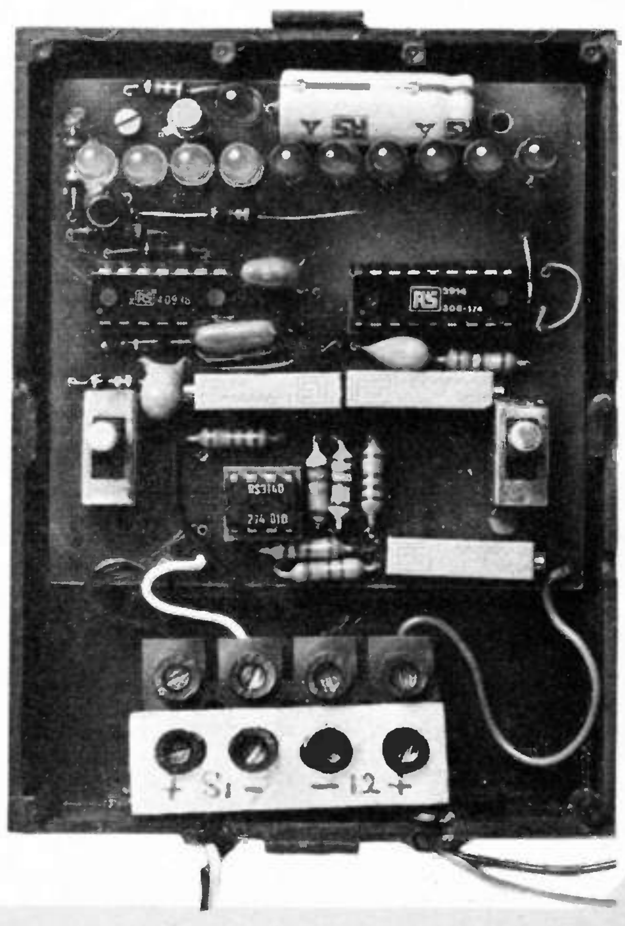


Fig. 3. Drilling details for the display panel and switch label. Both are specifically designed for the Lascar hand-held case.



CONSTRUCTION starts here

CIRCUIT BOARD

The p.c.b. layout shown in Fig. 2 makes circuit assembly of the thermometer straightforward. This board is designed to fit inside the lower half of the hand-held case. The l.e.d.s are soldered direct to the p.c.b., the height being chosen so that they just pass through holes drilled into the display plate when the unit is assembled.

The ice warning l.e.d. is mounted by the side of the 0°C l.e.d. The first four l.e.d.s which indicate below freezing on the WINTER scale are green and the rest red.

All the components except the temperature sensor are mounted on the p.c.b. There are a few problems which might arise in using the 3914 and these were anticipated in the component layout. One problem is that the l.e.d. currents sum at the 0V terminal (pin 2) of this i.c. and any resistance between pin 2 and the battery terminal will cause voltage drops which can make the 3914 oscillate.

Oscillation in the 3914 is usually manifested by a slow turning on and off of the display. Thus the battery negative lead is taken direct to pin 2 and C4 decouples the power supply close to the 3914. Similarly, C1 between the l.e.d. anode common and pin 2 has a decoupling role and reduces the possibility of oscillation due to any resistance between pin 3 and anode common.

Resistor R4 has a calculated value of 1·34 kilohms, and is made up from two resistors connected in series, nominal values of 510 ohms and 820 ohms. The precise value of this resistor is determined by the value of the internal reference voltage of the 3914 and corresponds to the internal reference voltage of 1·26V. The resistors were selected using a digital ohmmeter.

Constructors are advised to select a value close to 1·34 kilohms assuming their 3914 has the same internal reference voltage. Should, in subsequent use after calibration, the scale be inaccurate, a change to one of the two resistors making up R4 can be made.

The four external connections to the unit (to power supply and sensor) are made via a four-way terminal block, TB1. It is important to check that correct polarities are observed to the sensor. A pair of leads two or three metres long, if necessary, can be used to connect the sensor to the terminal block and care should be taken to ensure that the soldered joints close to the sensor are insulated from each other, and from any exposure to external water.

The sensor should be glued with epoxy resin into the end of a plastic ball point pen tube for protection as shown in Fig 4. Note that pin 3 (case) of IC1 is not used and should be cut off close to the case.

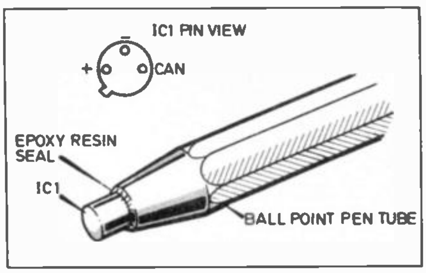


Fig. 4. Method of mounting the temperature sensor, IC1, in a plastic ball point pen tube.

CALIBRATION

This exercise necessitates the adjustment of VR1, VR2 and VR3 with a possible change to the value of R4 or R5. However, the procedure is quite straightforward and you only need some glasses of water at 12°C and 30°C, measured using an accurate thermometer, and some melting ice in another glass.

Connect the unit to a 9V, PP7 battery or to a 12V d.c. power supply and put the sensor in the water at 12°C, using the thermometer to keep the water well stirred. Switch on the unit and select the SUMMER range. Use a digital voltmeter (if available) to measure the voltage at pin 6 of IC2 and adjust VR1 until a reading of 285mV is obtained. This reading corresponds to an absolute temperature of 285K (12°C). Move the sensor to water at 30°C and you should find that the voltmeter now reads 303mV. VR1 should not now be touched again.

Note that the sensor, amplifier and digital voltmeter constitute a digital thermometer whose scale is linear and reads in degrees absolute (Kelvin).

Adjust VR2 until all the l.e.d.s are on making sure that D10 just comes on. Put the sensor in water at 12°C again, and adjust VR3 so that D1 just comes on. Move the sensor back to water at 30°C and once again check that D10 is just on. No further adjustment to VR2 and VR3 should be necessary. They have set the scale of the thermometer to a 18°C span.

Switch S1 to WINTER and put the sensor in melting ice at 0°C. The first four (green) l.e.d.s should be on, and the ice alarm D11 should begin to flash on and off. Remove the sensor from the melting ice and allow it to warm up. As it does so D5 will light and the alarm will go off.

Place the sensor in the water at 12°C and the last l.e.d. in the scale will just come on. If it does not, a change to one of the resistors R4 or R5 is necessary. Select another resistor to correct the error using the fact that reducing the value of R4 (or R5) causes the scale to over-read and increasing the value causes the scale to under-read.

COMPONENTS

Resistors

R1	680Ω ±2%
R2,5	1·5kΩ ±2% (2 off)
R3	15kΩ ±2%
R4	1·34kΩ (see text)
R6	820Ω ±2%
R7	7·5Ω
R8,10	10kΩ (2 off)
R9	4·7kΩ
R11	470Ω
R12	100kΩ
R13	1·2kΩ

See Shop Talk page 145

All ±2% resistors are metal oxide, all other types are ±5% carbon

Capacitors

C1	4·7μF 25V tantalum bead
C2,4	10μF 25V tantalum bead (2 off)
C3	0·1μF polyester
C5	470μF 25V elect.

Semiconductors

D1-4	TIL221 0·2in. green l.e.d. (4 off)
D5-11	TIL220 0·2in. red l.e.d. (7 off)
TR1,2	BC478 silicon *npn* (2 off)
IC1	590kH temperature sensor TO-5 package
IC2	CA3140 CMOS op-amp
IC3	3914 linear bargraph display driver
IC4	4093 CMOS quad 2-input NAND Schmitt trigger

Miscellaneous

S1,2	d.p.d.t. sub-miniature slide switch with chrome tang (2 off)
VR1,2	500Ω multiturn preset (2 off)
VR3	1kΩ multiturn preset
TB1	4-way terminal block

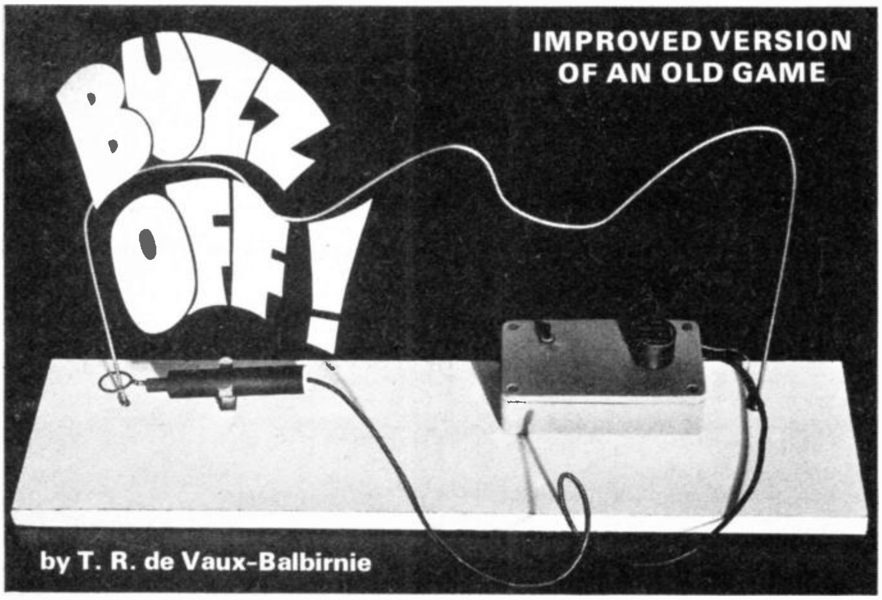
Hand-held instrument case; single sided p.c.b. 70 x 70mm; 18-pin d.i.l. holder; 14-pin d.i.l. holder; 8-pin d.i.l. holder; 7/0·2mm wire; used ball point pen tube; epoxy resin adhesive.

Approx. cost Guidance only **£16**

INSTALLATION

The thermometer is now ready to use in the car. Connect the unit to the car battery via the ignition switch, carefully observing to polarity, and mount the unit in a position not illuminated by direct sunlight otherwise the scale will be difficult to read.

The sensor should be located away from engine or exhaust heat but able to sense the ambient air temperature without being directly exposed to the airstream; or to rain and road spray. A good position for the sensor is behind the front bumper guard but fit the sensor inside a short length of tube open at one end and mounted with its open end pointing earthwards. □



At village fêtes up and down the country you will see this time-honoured game. No-one seems to know what it is really called but the idea is simple enough. If you can guide the hand-held loop around a bent wire obstacle course without touching it, you win. If you touch the wire with the loop a bell rings and you lose!

ORIGINAL SYSTEM

The circuit normally used is extremely simple—just a battery and bell connected in series, Fig. 1. The bent wire and hand-held loop form a "switch" so that the circuit is completed when the two touch.

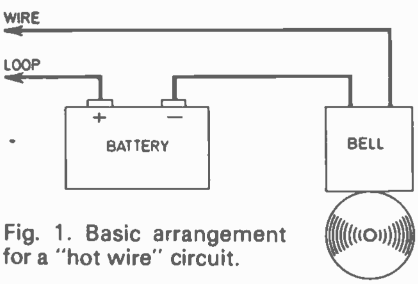


Fig. 1. Basic arrangement for a "hot wire" circuit.

Although satisfactory, this system suffers from two defects. Firstly, if the player touches the wire *momentarily* then the bell might fail to ring due to its rather slow response time. Secondly, since the current required to operate the bell flows through the wire and loop, poor contact between the two will prevent the circuit from working. It is therefore necessary to keep the wire and loop very clean to avoid erratic operation.

RAPID RESPONSE

The author examined the basic circuit and improved it while still preserving the traditional form of the game.

The first improvement was to ensure that the device would sound for a definite time even after *momentary* contact between wire and loop. This avoids disputes as to whether the player actually touched the wire or not. The second improvement makes sure that the circuit works reliably even where very poor contact exists.

In the prototype, the bell was replaced by an audible warning device. This consumes less current than a bell, is cheaper, more reliable and gives a louder sound. Experiments with the prototype were unsuccessful when an ordinary bell or buzzer was used.

CIRCUIT DESCRIPTION

The circuit diagram for the Buzz Off! is shown in Fig. 2.

The main part of the circuit consists of the ever popular 555 timer i.c. This is connected as a monostable—that means it remains off until triggered whereupon it switches on for a predetermined time then reverts to its original state. The *trigger* referred to is provided by contact between the wire and hand-held loop.

The time during which the circuit is on depends on the values of R1 and C1. Using the component values suggested this time will be about half a second and this was thought appropriate. For a longer time, R1 could be increased and for a shorter time reduced.

The output of the i.c. is obtained at pin 3 and is connected to the base of TR1 which does the actual job of operating the audible warning device. VR1 matches the output from the i.c. to the transistor.

For the prototype, three type 1289 4·5V batteries were connected in series, Fig. 3, and these gave excellent results. The suggested audio-warning device does not perform well on less than a 12-volt supply although a 9V battery will do for testing. The current requirement is about 10mA on standby and 100mA whilst actually sounding.

COMPONENTS

See Shop Talk page 145

Resistors
R1 5·6MΩ
R2 47kΩ
R3 220Ω
All ¼W carbon ±5%

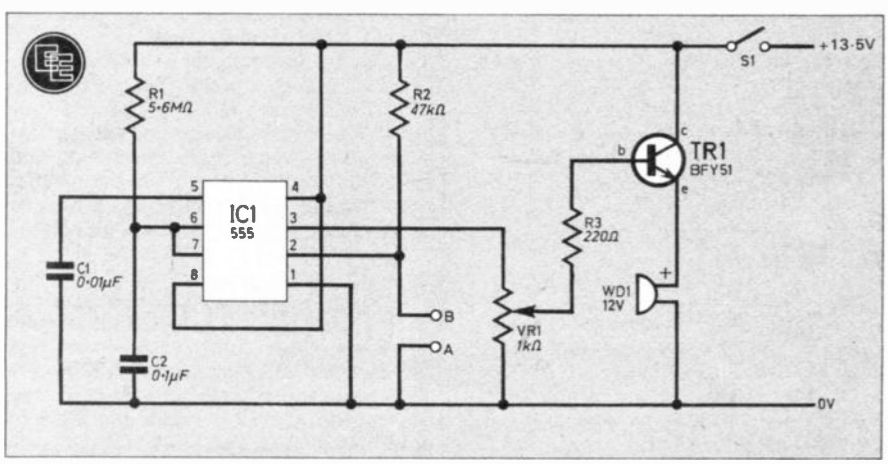
Capacitors
C1 0·01µF polyester
C2 0·1µF polyester

Semiconductors
TR1 BFY51 *npn* silicon
IC1 NE555 timer

Miscellaneous
VR1 1kΩ miniature horizontal preset
S1 s.p.s.t. miniature toggle
WD1 12V buzzer (see text)
B1 13½V (see text)
0·1 inch matrix stripboard 9 strips by 22 holes; plastics case 115 × 95 × 37mm (ABS box MB3); 8-pin d.i.l. i.c. socket; chipboard: 460 × 110 × 15mm; 100mm tinned copper wire 16 s.w.g.; 800mm flexible wire; connecting wire; wire coat hanger.

Approx. cost Guidance only £7

Fig. 2. Complete circuit diagram for the Buzz Off!



CONSTRUCTION starts here

CIRCUIT BOARD

The circuit is built on a small piece of 0·1 inch matrix stripboard 9 strips by 22 holes in size. Use an 8-pin i.c. socket and do not insert the i.c. until all assembly work is completed. Cut the copper tracks in the places indicated on the underside diagram, Fig. 4, especially not forgetting the row between the pins of the i.c. socket.

Although any small plastics box may be used to house the project, the suggested one has convenient slots for easy mounting of the circuit panel.

POWER SUPPLY

The audio-warning device may be placed inside the box with only the top part protruding through a hole cut in the lid. If this is made a tight fit then no further support will be needed. Holes need to be drilled in the case for S1, external battery leads, and for connections to the loop and wire. If the box is large enough, the batteries may be placed inside, but a better plan is to use external batteries especially where heavy use is anticipated.

WARNING DEVICE

The alternative audible warning device will operate from a 9-volt supply. It may be mounted on top of the case using small nuts and bolts. Although much smaller it is also quieter in operation so, for loudest results, the recommended audio-warning device should be used. Whichever device is chosen, it is essential to observe the polarity. The recommended audio-warning device has spade type connectors marked "+" and "−". The alternative has flying leads—red for positive and black for negative. Soldered connections may be made to spade connectors so long as they are made quickly. On the other hand, the proper connectors are cheap and may be obtained from a motor accessory shop.

The switch S1 is mounted in the hole in the lid and wired into the positive battery lead. Some connections need to be made to the copper strip side of the circuit panel. These should be made with great care to avoid short circuits.

LOOP HANDLE

The hand-held loop consists of a piece of thick (16 s.w.g.) copper wire bent around a wooded dowel and twisted tightly around it using pliers or a vice. The diameter of the loop is left to the constructor since it is this which determines the difficulty of the game.

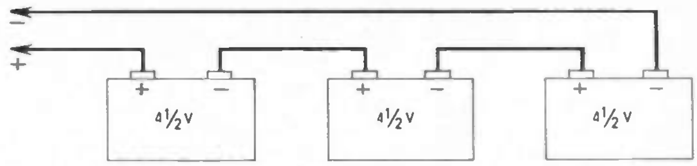


Fig. 3. Connecting three batteries in series to power the Buzz Off! circuit.

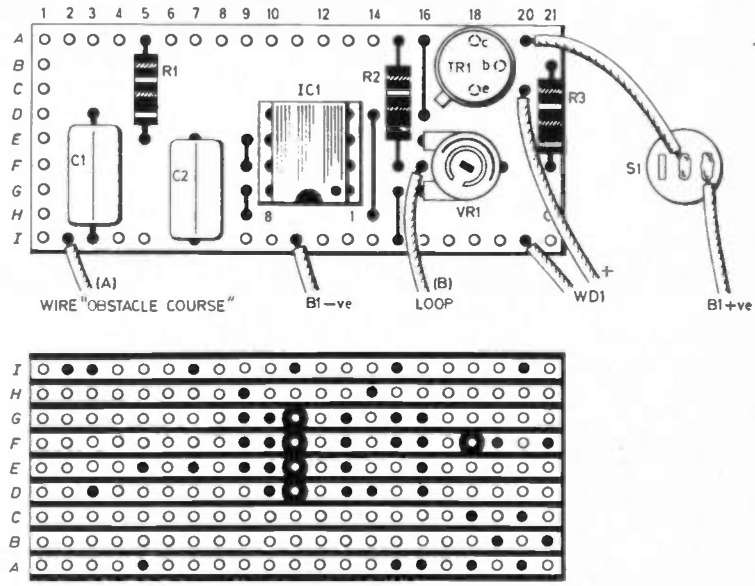
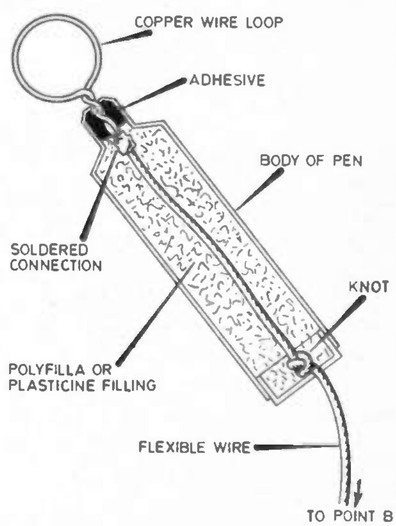
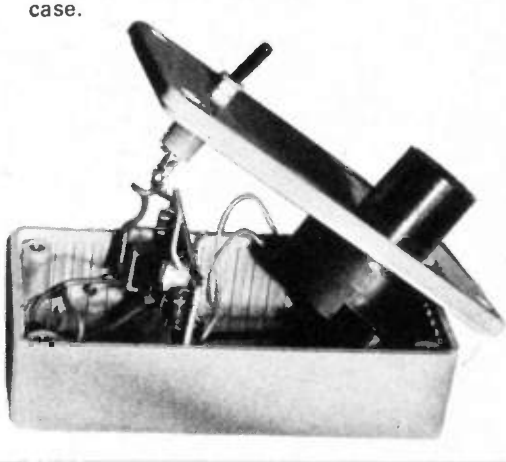


Fig. 4 (Above). Component layout, interwiring details and underside of the stripboard showing breaks (5 off) in the copper strips. Note that there should be 22 holes not 21 as shown.

Fig. 5 (Right). Suggested method of construction for the hand-held loop.



Completed prototype of the Buzz Off! The siren protrudes through a cut-out in the case lid. The circuit board slides into slots in the side of the case.



BUZZ OFF!

The handle consists of an old felt tip pen. After dismantling this and washing it out, the copper loop has a length of flexible wire soldered to it and adhesive used to secure the parts together, see Fig. 5. The wire is knotted and passed through a hole drilled in the base of the pen body. This knot will protect the soldered connection from the rough service which the loop is likely to receive.

The best wire to use is the "extra flexible" variety. This resists bending very well. If it is not available, ordinary stranded wire will give reasonable service. When the project has been finally tested, the body of the pen may be filled with Plasticine to give a pleasant feel to the handle. The free end of the wire is taken to point B on the circuit panel and soldered into position.

COAT HANGER

The wire *obstacle course* is made from an old wire coat hanger mounted on a chipboard base. The baseboard used for the prototype was made from 15mm thick chipboard about 460mm long by 110mm wide. After untwisting the coat hanger and bending the wire into a suitable shape, the hand-held loop is threaded onto it.

The ends of the wire are then secured through holes in the baseboard. If BA taps and dies are available, the ends of the wire may be threaded and secured using two nuts and washers at each end. A solder tag may be used at one end to make the connection to point A. The wire may also be secured in the holes by using epoxy resin adhesive. A soldered or tightly twisted connection may then be used for connection to point A.

If sharp ends of wire protrude through the baseboard, rubber feet may be used to keep it clear of the table. Finally, a spring clip on the baseboard may be used to keep the hand-held loop tidy while the game is not being used.

CIRCUIT TEST

Testing may be carried out using a 9V battery. Set VR1 to approximately mid-travel, keep the loop clear of the wire and switch on. The audio-warning device may give a single "bleep" which may be ignored. Now touch the loop against the wire for an instant. There should be a short bleep. Some adjustment to VR1 may be needed for best results. If the circuit tends to trigger falsely—to bleep even when the loop and wire have not touched—then R2 may need to be altered in value.

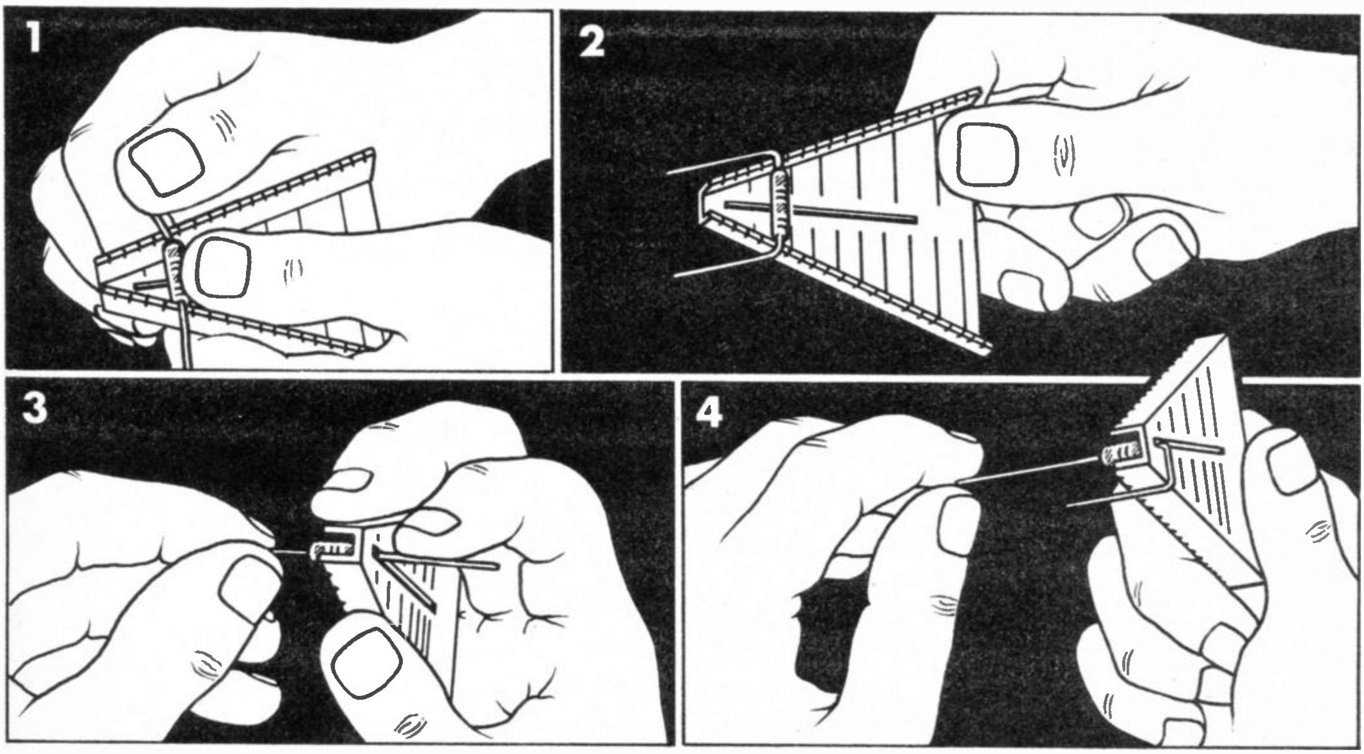
If the length of the bleep is too short, R1 may be increased in value and vice-versa.

This game is certainly good for fund-raising. You are sure to be in demand when word gets around! □

HOW TO USE YOUR WIRE BENDING GAUGE

The Wire Bending Gauge given free with this issue is intended to be used for bending the leads on small components such as resistors and axial lead capacitors. It provides a quick, accurate and safe means of bending the leads to span an exact number of holes on perforated circuit boards. There are guides for both horizontal and vertically mounted components on 0·1 and 0·15 inch pitch boards. The numbers represent the number of holes to be spanned, including mounting holes.

Horizontal mounting. **(1)** Place the component in the notches to span the requisite number of holes for the appropriate pitch. Hold component body and bend one lead at a time to make the leads parallel; **(2)** ready for insertion. ***Vertical mounting.*** **(3)** Place component in slot and bend protruding lead through 90 degrees. Slide component along slot to required span guide lines and bend once again through 90 degrees over gauge edge as shown in **(4)**. Move component to tip of gauge to remove.



Everyday ELECTRONICS

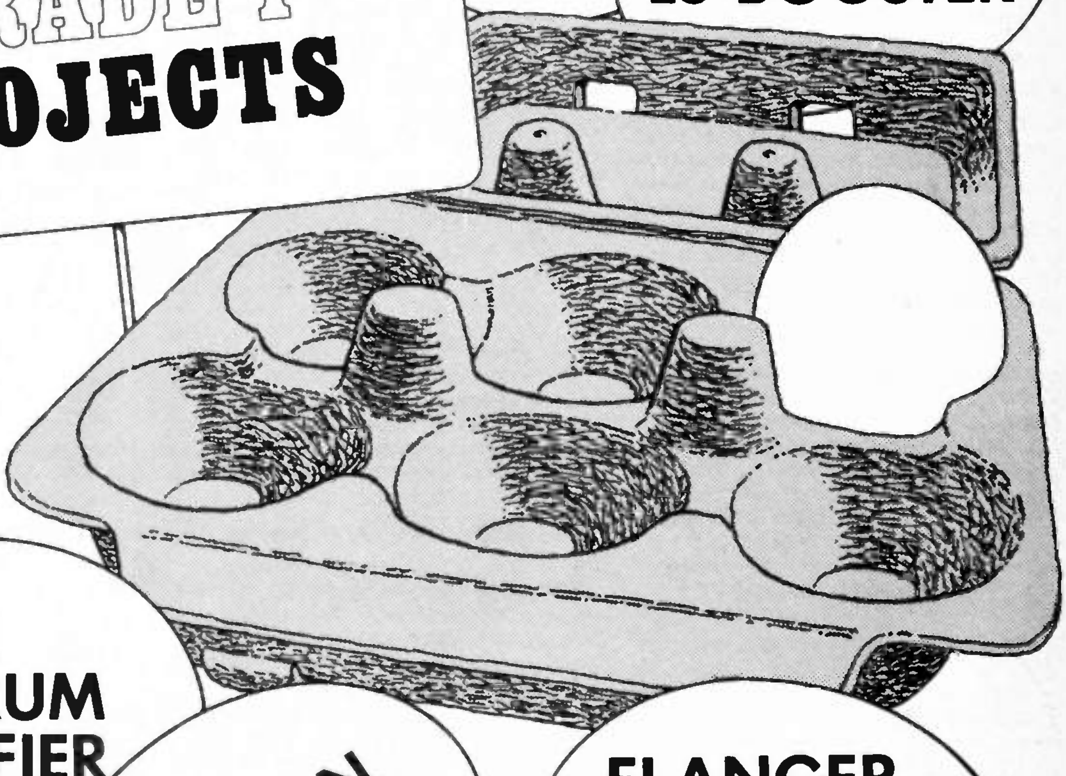
APRIL 1983 ISSUE ON SALE FRIDAY, MARCH 18

APRIL ISSUE

GO TO WORK ON THESE GRADE 1 PROJECTS

EGG TIMER

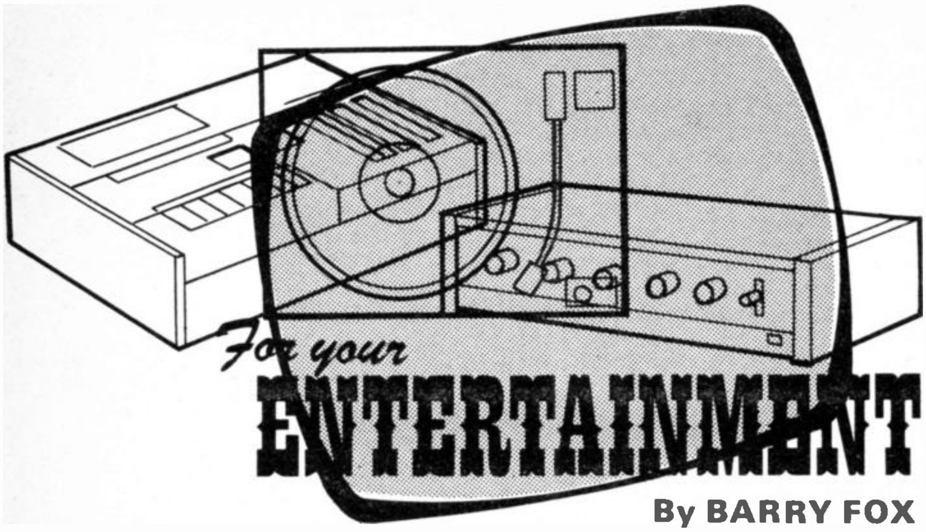
CAR RADIO LS BOOSTER



ZX SPECTRUM AMPLIFIER

FUNCTION GENERATOR

FLANGER SOUND EFFECT



For your ENTERTAINMENT

By BARRY FOX

Why Markets Are Lost

Over the last 15 years I've watched the British consumer electronics industry be decimated by Far Eastern competition. But I'm sorry to say that many firms, now out of business, have reaped no more than they deserved. They didn't plan ahead, they didn't keep in touch with what their customers wanted and they didn't keep up to date with technology, production efficiency and quality control. So they went out of business when better, cheaper and more reliable products from Japan started to flood in. Now exactly the same thing is beginning to happen to the motor industry.

Recently, partly out of national loyalty, I bought British when I needed a new car. I chose an MG Metro because I admired some of its elegant design features. Like, for instance, the way the driver's switch panel has a blanked off socket into which the owner can push-fit Leyland switches to add optional extras, such as front fog lamps. As the switch pushes home it mates with contacts on the edge of a printed circuit board which is connected to the main wiring loom. As the Leyland circuit diagram for the car shows, it is then only necessary to connect a relay and fog lights at the free end of the wire, near the front radiator.

The Missing Wire

Thinking to myself, at last we're learning from the Japanese, I bought and fitted the necessary switch, relay and fog lights. But then I found that, although the switch mated with the p.c.b., the fog lamp wire shown on the circuit diagram wasn't anywhere to be seen. The dealer who had sold me the car was puzzled and suggested I contact the service division of British Leyland. Two months later I had still not solved the problem but I'd learned an awful lot about the problems Leyland must face in the future. What I found out could also, incidentally, be very useful for anyone else who has recently bought a Metro car, and for dealers who are selling them.

The Supercover guarantee department of British Leyland referred my query to the BL Customer Service Department. Unfortunately they couldn't read a circuit diagram, and told me that the wire was missing because it was shown in the circuit diagram only as a dotted line, meaning that it was optional. In fact, it's clearly shown in Leyland's own circuit as a hard wire. I persisted and my query was then passed to another customer relations person at British Leyland. He ducked the issue altogether. "Your best course of action will be to consult your local dealer". So I wrote back again explaining that it was only because the dealer was puzzled that I had written to British Leyland for advice in the first place.

Do It Yourself

I heard nothing, so phoned British Leyland Customer Relations to try and sort things out once and for all. At first they tried to tell me that the wire was there but I couldn't see it. Then they finally owned up. The wire which makes it easy for Metro owners to fit their own fog lights has been omitted from the wiring loom to save money. Dealers hadn't been told and the circuit diagram hadn't been changed. "It is necessary to supply and fit the necessary wiring yourself," wrote Leyland, enclosing a scrappy Xeroxed sheet showing where the missing wire should be fitted to the p.c.b.

My mind boggling, I asked the British Leyland Press Office how much money the company was saving by omitting one metre of low current wire at the production stage, and leaving the customer to rebuild it into the car after purchase. The press officer came back to me (or more accurately waited until I got impatient and phoned her), to tell me that she had been assured by BL's electrical engineers and product planners that the wire wasn't missing after all!

After yet more phone calls and letters I finally got something approaching the full story. The wire in question was in all the original Metro range, but is now being omitted. With curious logic it's been omitted first from the most expensive cars, the MG Metro and the Van den Plas. No-one could say for sure who had made the decision.

Incomprehensible

So, if you want to fit fog lamps to a new Metro car by using the standard switches that interface with the p.c.b., then don't doubt your sanity if you can't find the wire that is shown on the circuit diagram.

Meanwhile, British Leyland is getting £990 million of public money over two years. That's nearly £10 million a week. This money is intended to help the company fight off Japanese competition. When I was in Japan recently, at a trade seminar, I told the story of the missing Metro wire. The Japanese press and businessmen present looked at me as if I was mad. The idea of treating a customer that way is totally alien to Japanese industry. And that's why they are winning the trade war.

Buying A Home Computer

The national press carried a report of boom sales in home computers in the last Christmas shopping rush. This is doubtless because home computers are now cheaper than a computer controlled home TV game.

Despite all the fancy talk about home computers making domestic life and business more efficient, there's no doubt that most people who buy them end up using them mainly to play games. A friend in America recently told me that although many businessmen now feel obliged to buy and install a computer system in their office, to look "on the ball", most of them only use their impressive installations to play exotic TV games.

I also heard recently of problems some users are having with their home computer disc drives. It's easy to forget that although the microprocessor inside a computer is a wonder of modern technology, and can in theory last forever, the same is certainly not true of disc drives.

These are complicated mechanical beasts, that will eventually go wrong or wear out. In some cases they may only last a few months, and if the drive is built into the main computer housing, then you'll have to return the whole system for repair. The cost of the strip down and replacement of a drive can be well over £100.

Don't rely on the guarantee to help you. Often you'll find it offers only three month's free parts and labour. You may be able to contest this under the British consumer laws, but you could well end up with a fight on your hands.

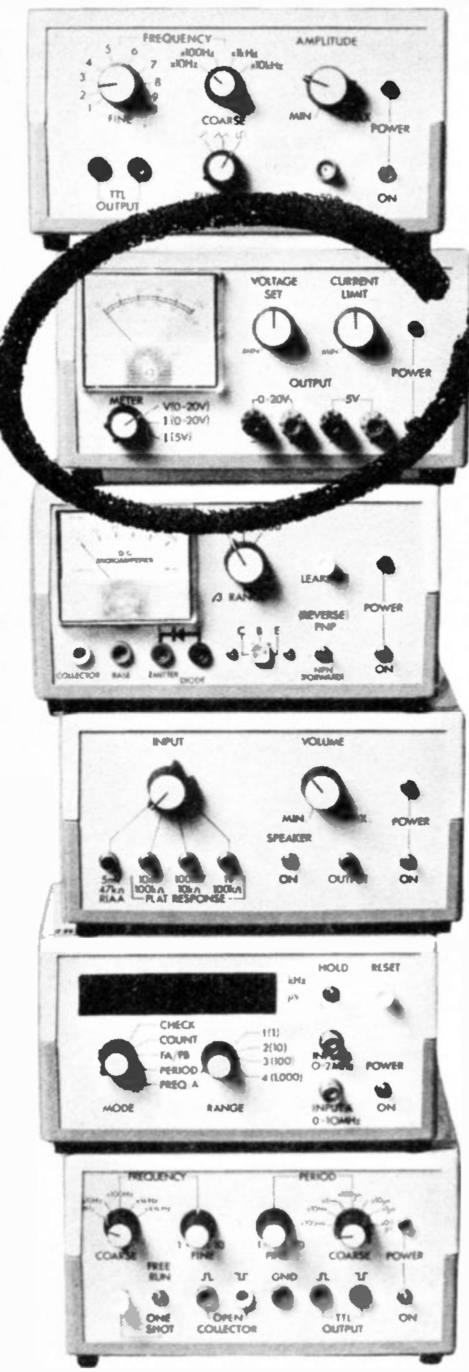
So, before buying a computer ask yourself three questions. Do I really want one; how easy will it be to repair or replace a disc drive; and am I getting a good guarantee.

TEST GEAR 83 DUAL POWER SUPPLY

UNIT ONE **BY J. R. W. BARNES**

THE TEST GEAR 83 SERIES CONSISTS OF:

DUAL POWER SUPPLY ● FUNCTION GENERATOR ● TRANSISTOR TESTER PULSE GENERATOR ● LABORATORY AMPLIFIER ● FREQUENCY METER



IN 1974 EVERYDAY ELECTRONICS published a series of articles, *E.E. Test Gear Five* specially designed for the constructor.

Since 1974 there have been many major advances in the world of electronics and we now introduce a new series of six instruments, under the title *Test Gear 83*.

TEST GEAR 83

This new generation of test equipment reflects the upward trend in technology. Of the original five, two have been kept, the Power Supply and the Transistor Tester, both being new and considerably updated designs. The A.F. Oscillator has been abandoned in favour of a Function Generator, and the R.F. Generator has gone completely. In addition, there is a Laboratory Amplifier, a Pulse Generator and Digital Frequency Meter.

The reasons for building your own test equipment, however, remain the same. Electronics is a craft, and with widely available integrated circuits, sometimes likened to building blocks, most of the old terrors of electronics have disappeared. The average man (or woman) in the street can be as happily engaged in building and experimenting, as the technically trained expert. It is the nature of electronics that allows useful and satisfying involvement at all levels.

Throughout the design of the Test Gear 83 projects, emphasis has been placed on two main areas; firstly, the price/performance ratio while at the same time designing units that will provide a sufficiently high specification, so they will be of use for many years. The other area of concern is on ease of construction.

All the units will be built on printed circuit boards, whilst this adds to the construction time it has been the authors experience that constructional errors are less likely to occur, and the project works first time.

DUAL POWER SUPPLY

A power supply is a key component in any electronic system. Although batteries may be used to supply the finished project they are not flexible enough for development work. Also, with batteries becoming increasingly more expensive the idea of running projects from the mains becomes attractive. This unit has been designed to supply the essential requirements of a home constructor's workshop at a reasonable cost. It provides two stable, well regulated outputs, with low ripple.

The main output provides 0 to 20V and has constant current overload protection which can be set in the range 0 to 1·2A.

The second output provides a fixed 5V output and is primarily intended for experimenting with TTL logic. The maximum current available is fixed at 1A.

A meter is provided for measuring the output voltage, current on the main output and the current drawn from the 5V output. Both supplies are short-circuit protected.

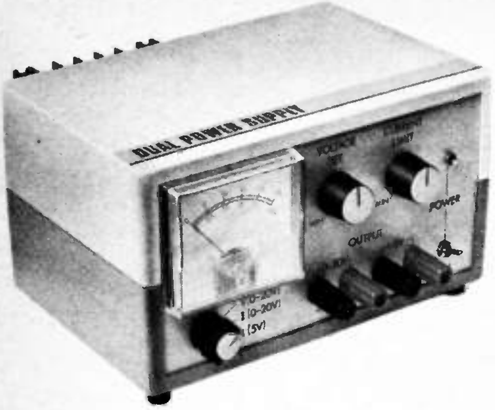
CIRCUIT DESCRIPTION

The circuit diagram of the unit is shown in Fig. 1. The circuit can be split into sections, the main output and the secondary output. The secondary output will be considered first.

The circuit is very conventional in the fact that all the work is done by the three terminal regulator integrated circuit, IC1.

SPECIFICATION

Variable output		Fixed output	
Range:	0 to 20V d.c.	**Output:**	5V d.c.
Max. current:	1·2A	**Max. current:**	1A
Ripple:	10mV peak-to-peak (supplying 15V at 1A)	**Ripple:**	8mV (supplying 1A)
Load regulation:	0·08% (measured at 20V between 0 and 1A)	**Load regulation:**	1·5% (between 0 and 1A)
Line regulation:	0·0065% (input voltage varied between 230V and 250V)	**General**	
		Meter:	3 ranges V(0–20V), I(0–20V), I(5V)
		Terminals:	4mm banana sockets



The a.c. input is provided by the transformer and is rectified and smoothed by the bridge rectifier D1–D4, and capacitor C1, respectively. The low value resistor R1 is used to sense the output current for the meter.

With an output current of 1A, half a volt is developed across R1. R2 is chosen to make the meter 0·625V full scale. The capacitors C2 and C10 are to prevent high frequency oscillations.

The main output is more complex, rather than use another monolithic regulator i.c. the higher stability of a LM723 was sought. The reason for this is because in a simple series regulated supply, a large amount of power is dissipated in the output transistor causing it to run hot. In a monolithic regulator this raises the temperature of the voltage reference and causes it to drift.

EXTERNAL AMPLIFIER

In a design using a discrete output transistor, the transistor and the reference are in thermal isolation. A very stable reference is provided by IC2. Readers familiar with the LM723 regulator will know of its inability to regulate at low output voltages, that is less than two volts. This limitation arises from the error amplifier, so in this design an external amplifier is used, a CA3140, IC3.

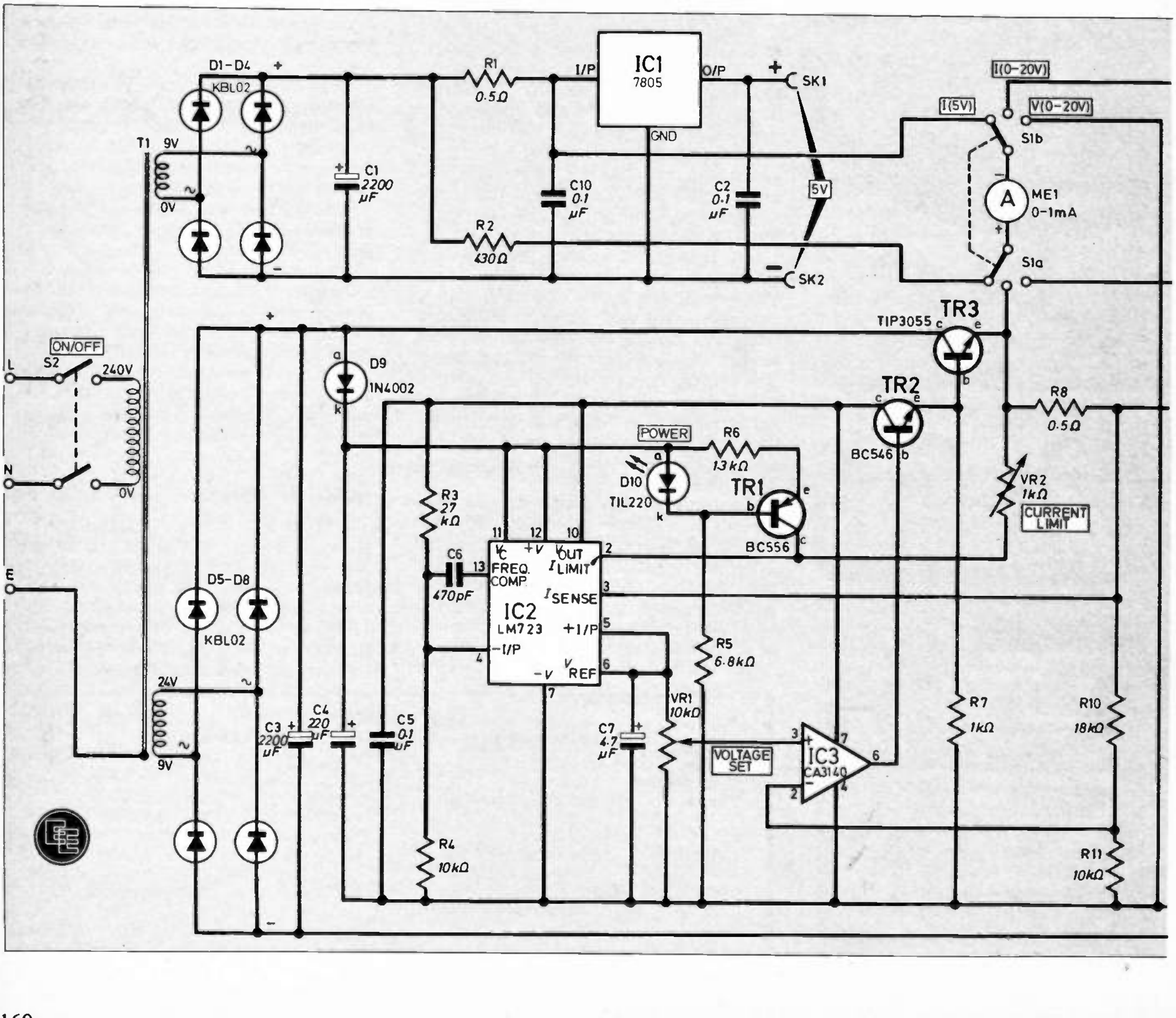
This amplifier will work with its input close to 0V. The voltage reference from pin 6, IC2 is fed via the voltage control potentiometer VR1 to the non-inverting input of IC3. A portion of the output voltage is fedback to the inverting input via the potential divider R10, R11. This feedback loop keeps the output voltage constant. The output of IC3 is used to drive the series pass Darlington pair made of transistors TR2 and TR3.

CURRENT LIMITING

The error amplifier in IC2 and its associated output transistor are used to limit the supply to IC3 to a maximum of 27V. The output current is sensed by resistor R8, when the current flowing through this is 1·2A, 0·625V is developed across it. If this were directly connected to pins 2 and 3 of IC2 this would result in the supply to the op-amp being reduced thus keeping the output current constant.

The current limit circuit is biased by

Fig. 1. Complete circuit diagram for Unit One, the Dual Power Supply. The main output provides 0 to 20V with constant current overload protection within range 0 to 1·2A. The second output provides a fixed 5V 1A supply specifically for experimenting with TTL logic.



driving a constant current of 0·75mA from the current source TR1 and its associated components, through VR2. The voltage across VR2 is added to that across the sense resistor, increasing the current limits sensitivity.

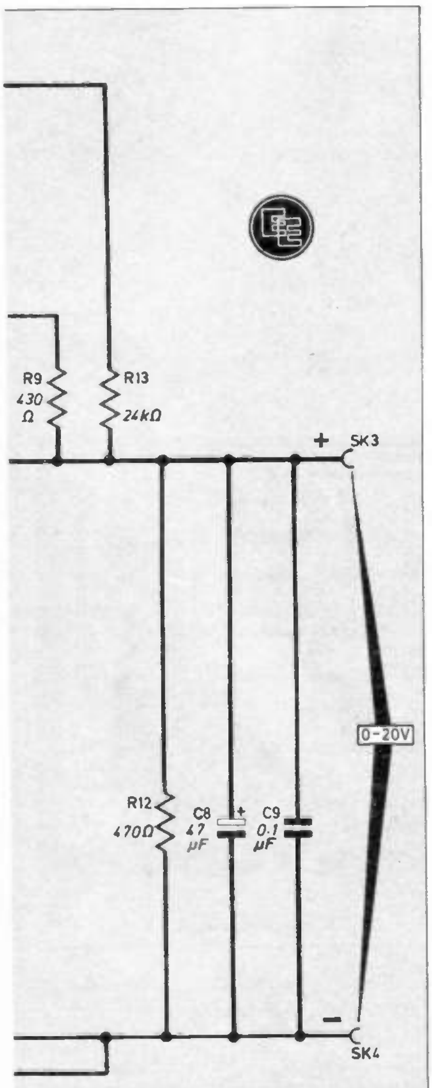
The sense resistor is also used by the metering circuit to display output current.

The d.c. is provided by the 24V secondary from T1, bridge rectifier D5–D8 and capacitor C3.

CONSTRUCTION starts here

CIRCUIT BOARDS

The prototype was housed in a Vero case type 202-21036C. This case will be used throughout the *Test Gear 83* series



COMPONENTS

Resistors

R1,8	0·5Ω (2 off) 3W wire-wound	R6	1·3kΩ
R2,9	430Ω (2 off)	R7	1kΩ
R3	27kΩ	R10	18kΩ
R4,11	10kΩ (2 off)	R12	470Ω 3W wire-wound
R5	6·8kΩ	R13	24kΩ

All $\frac{1}{4}$W carbon ±5% unless otherwise stated

Capacitors

C1	2200μF 25V elect.
C2,5,10	0·1μF 160V Siemens (3 off)
C3	2200μF 40V elect.
C4	220μF 40V elect.
C6	470pF disc ceramic
C7	4·7μF 10V tantalum bead
C8	47μF 25V elect.
C9	0·1μF ceramic

See Shop Talk page 145

Semiconductors

D1–4	KBLO2 200V, 4A bridge rectifier
D5–8	KBLO2 200V, 4A bridge rectifier
D9	1N4002
D10	TIL220 red l.e.d.
TR1	BC556 *pnp* silicon
TR2	BC546 *npn* silicon
TR3	TIP3055 *npn* silicon plastic power
IC1	7805 5V, 1A regulator
IC2	LM723 adjustable voltage regulator
IC3	CA3140 MOSFET op-amp

COMPONENTS approximate cost £35

Miscellaneous

T1	mains transformer with 24V, 1·5A and 9V, 1·5V secondaries
ME1	1mA f.s.d. panel meter with 120Ω coil (type ML52)
S1	2-pole, 6-way midget rotary with adjustable stop
S2	d.p.d.t. miniature mains toggle
VR1	10kΩ control potentiometer
VR2	1kΩ control potentiometer
SK1,3	insulated terminal post red
SK2,4	insulated terminal post black

Verocase type 202-21036C; single-sided p.c.b. size 120 × 85mm and 85 × 75mm; heatsink size 89 × 75 × 51mm rated at 1·5°C/W; control knob (3 off); l.e.d. holder; Veropins; 7/0·2mm wire; 14/0·2mm wire; mains cable; grommet; P-clip; 14-pin d.i.l. holder; 8-pin d.i.l. holder; mounting hardware (M2·5 or 6BA).

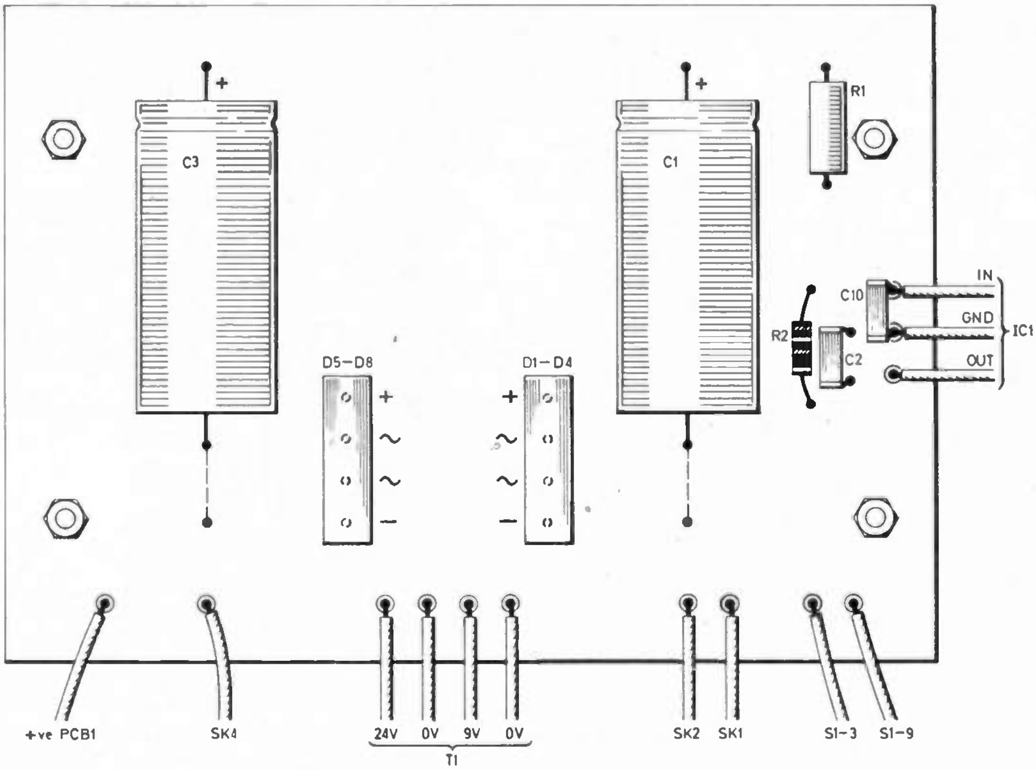
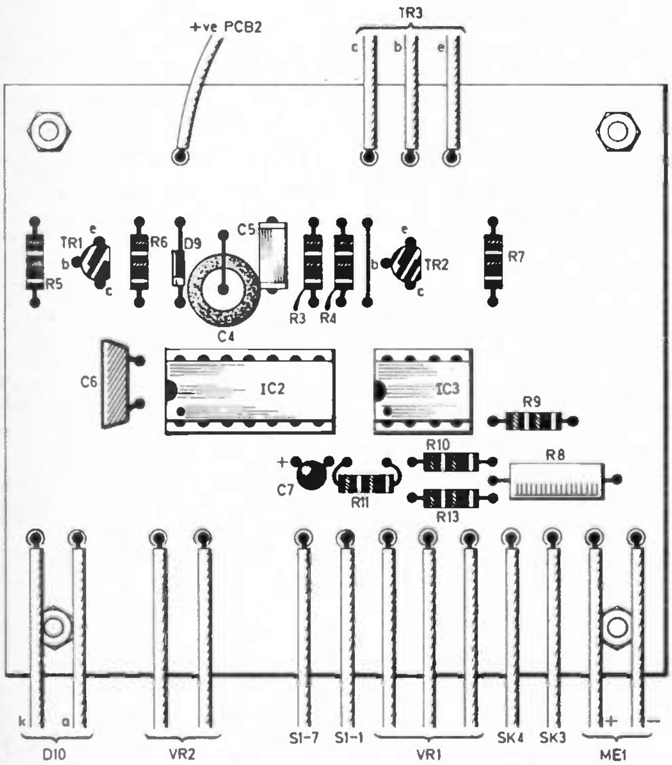


Fig. 2. Component layout and full size printed circuit board master (opposite page) for the 0–20V variable supply.



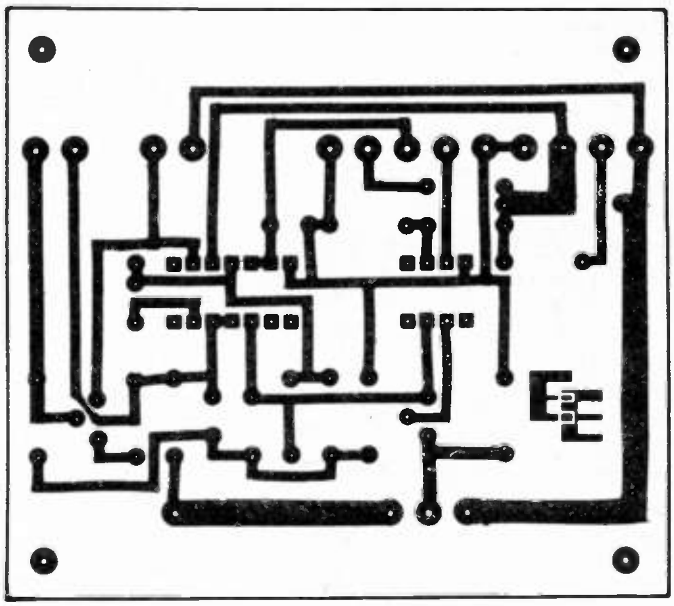
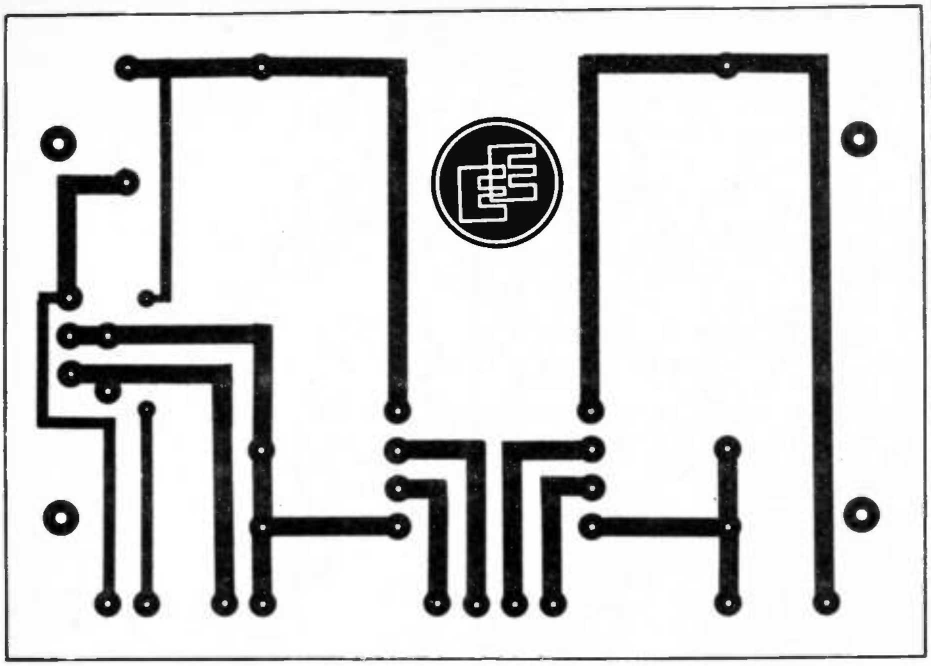


Fig. 3. Component layout and full size printed circuit board master for the 5V fixed supply.



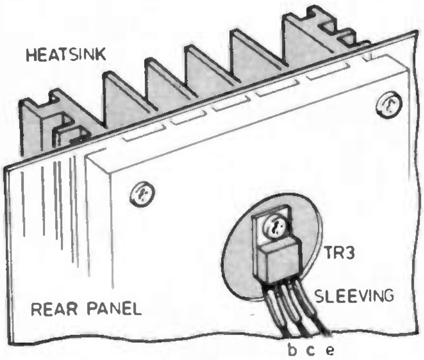
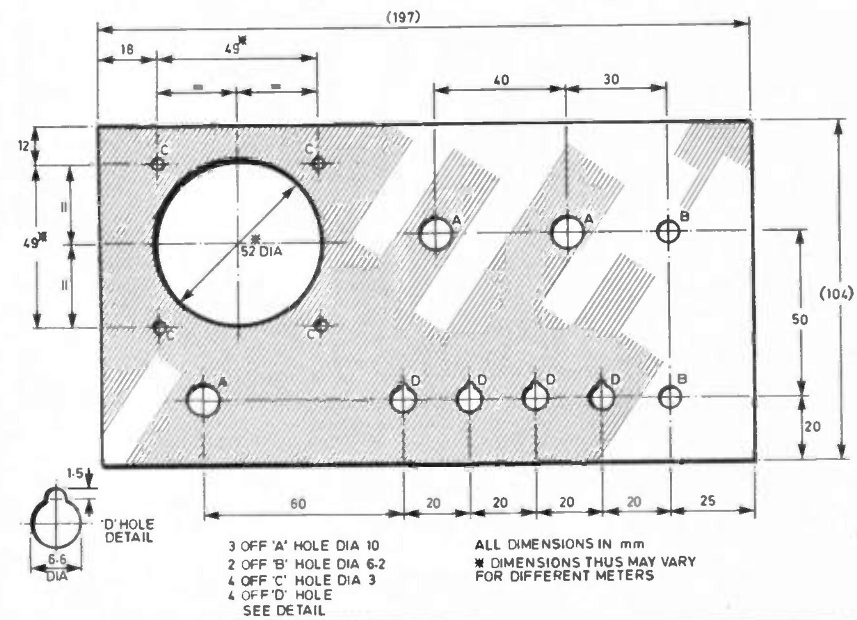


Fig. 5 (Left). Mounting details for transistor TR3. Note that no insulating kit is used on this transistor so the rear panel and the heatsink are connected to the collector and should not be "earthed".

Fig. 4 (Below). Drilling details for the front aluminium panel.



and should be available through the normal Vero distributors.

Begin construction with the circuit boards. If you are making the boards yourself pay special attention to their external dimensions. The prototype boards were laid out with etch resistant dry transfers. The p.c.b. artworks and component layout diagrams are shown in Fig. 2 and Fig. 3.

Solder the components to the board in the normal manner beginning with the passive components and the wire link, working through to the transistors and the diode. It will be found helpful if Veropins are inserted in the board where the flying leads leave it. Note that additional holes have been provided to allow for different sizes of capacitors, particularly C1 and C3 the smoothing capacitors.

CASE

Once the circuit boards are complete, the case can be prepared. Remove the four screws at the corners of the base, allowing the two halves to be separated. Remove the front and rear panels. To assist in marking out and to protect the panels from scratches it is advisable to fasten a piece of graph paper with double-sided tape. Mark the centre of the holes according to the dimensions given in Fig. 4 and then lightly centre-punch them. Without removing the protective paper, drill the holes. For the large holes it is better to drill a small hole (about 3mm) first and then drill the hole to the right size.

The large circular hole for the meter can be made two ways: either drill a series of small holes round the circumference and punch out the middle, then finish with a file; or use an Abra file in a hacksaw frame.

REAR PANEL

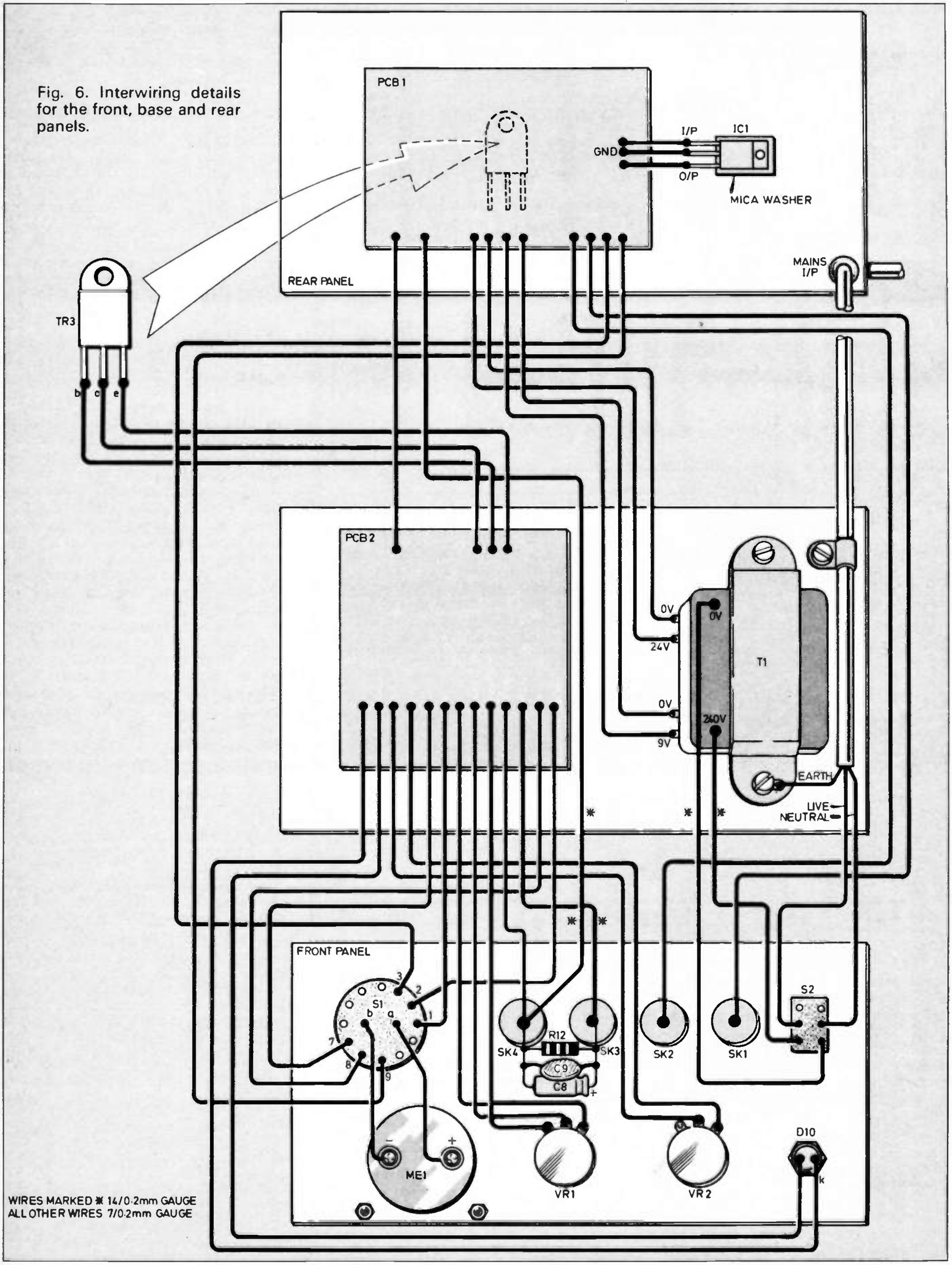
The rear panel holds the heatsink. The heatsink used on the prototype is available from Ambit International, Part 21-08030.

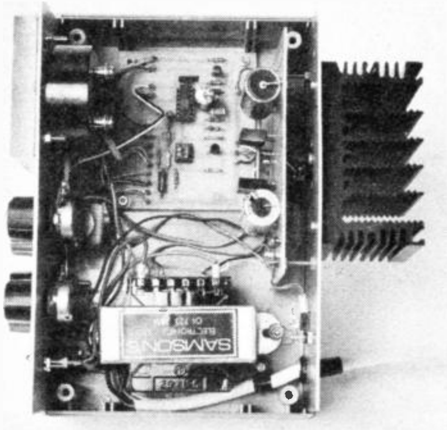
A 30mm diameter hole was cut to be the centre of the heatsink in the rear panel to allow the transistor TR3 to be mounted, see Fig. 5. Note that no insulating kit is used on this transistor so the rear panel and the heatsink are connected to the collector of the transistor and should not be earthed. The 5V regulator is mounted with a mica washer and an insulating bush. To aid heat transfer, a thin smear of heatsink compound should be applied to both sides of the washer and the power transistor.

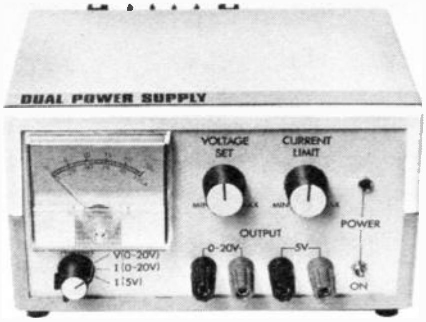
Solder three wires to the leads of TR3, before mounting the rear p.c.b. on standoffs over the transistor. The rear panel assembly can now be replaced in the lower half of the case.

Screw all the front panel components in place having first cut to size the spindles on the potentiometers and the switch. At this stage it is best to attach wires to the panel mounting components, paying

Fig. 6. Interwiring details for the front, base and rear panels.





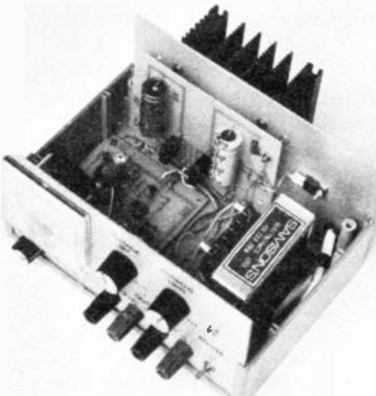


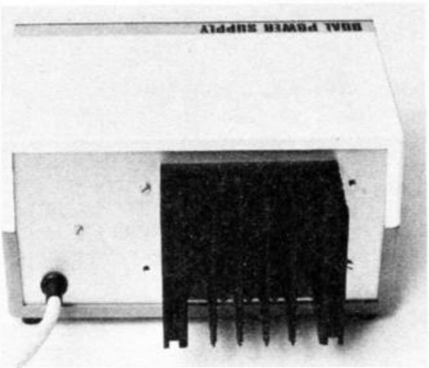
Front panel layout and lettering.

(Left). Positioning of mains transformer, and circuit boards within the case. The boards are held "proud" by their mounting nuts and bolts.

(Bottom left). Circuit board and TR3 on the rear panel.

The heatsink mounted on the exterior of the rear panel.





attention to the two thick wires, see Fig. 6. These wires must be thick or poor regulation will result. Once this has been done the panel can be slid into its mounting slots and the other ends of the wires be soldered.

IN USE

The power supply can be used to replace the power supply of a circuit under test. Turn the METER switch to voltage V (0–20V) and with no load connected and the current control turned up set the required voltage. Switch to the current setting I (0–20V) and turn the current control to zero. The load can now be connected and the CURRENT LIMIT control can now be increased. When the current stops rising the power supply is then operating in the constant voltage mode.

Should the load try and draw more current than the threshold, the supply will limit the current by reducing the voltage, that is, go into the constant current mode. The supply may be used in the constant current mode for recharging Ni-Cad batteries, take care though, not to exceed the manufacturers rated current.

When the supply is delivering a small output, a large voltage is developed across the series transistor and it will dissipate a lot of power. To avoid overheating the supply should not be operated in this condition for excessive lengths of time. The prototype was short circuited for a quarter of an hour with no ill-effects, although this is not recommended! □

COUNTER INTELLIGENCE

By PAUL YOUNG

Computer Holiday

Earlier this year I found myself, probably like the rest of you, bombarded with alluring holiday literature. There was no escaping it, the newspapers, the radio, the television, all combined to part you from your money in exchange for a fortnight's sunshine.

Unable to withstand the pressure I went to see my bank manager and tried to lull him into a sense of false security with talks of luxury cruises. "Yes, Young, I agree with you in principal, but I think I would be a lot happier if you went for a row round the Serpentine, it would be more in keeping with your present financial status."

Encouraged by his friendly remarks I had another look at the brochures and the following caught my eye. It was a picture of a young man and a young woman sunbathing, and the caption below said, "Don't just lie there, do something". It was an advertisement for a holiday on the shores of the Mediterranean, and thrown in at no extra cost was a course on computer programming. The idea being that when you were bored stiff with doing nothing you could learn something useful. Alas, the nearest I shall get to it is lying under my Solarium with my minicomputer, and trying to persuade my friends I have been away on one of these specials.

Paranormal

I think most readers will know I have a slight interest in the paranormal. I don't dabble in it but when a story comes along that has a slight electronic flavour about it, I unhesitatingly pass it on to my readers. Such an opportunity occurred recently and I seized it with both hands.

A short time ago I watched a programme on television. It concerned an old Inn situated in Wales. It had been there since before the Norman Conquest. Many people who had lived there testified that it was haunted, voices and footsteps, and even an organ had been heard playing.

An electronics expert became interested and examined the building, particularly the stone it was made of. It was a coarse local stone, but it had thin streaks running through it which he decided were metal or silicon.

Would it be possible, he thought, for these stones to act as a tape-recorder, and would it be possible to drive out the sound by applying a high voltage to the wall? With the permission of the Inn keeper, he and a friend drove long nails into the wall and arranged a time switch to apply a high voltage at 2.30am. A tape-recorder was left running to record the results.

At this point in the programme the commentator said, "I will now play you the tape". For the next few seconds there was silence and then a babel of strange voices and an organ playing weird music. It was really eerie and quite uncanny to listen to.

I thought I would try this experiment myself. I was just about to drive a six-inch nail into the wall when my better half said, "I shouldn't do that if I were you". I expostulated that I was interested in science and wanted to hear these strange voices and language. My spouse came back, "If you knock that nail in you will hear some unusual language without any voltage being applied."

Oh well, perhaps she is right; anyway, one shouldn't dabble in this kind of thing— there may be something in it.

THE ELECTRONICS OF it INFORMATION TECHNOLOGY

PART FIVE

BY T.E. IVALL C.Eng., M.I.E.R.E.

WE encounter information as a measurable quantity most straightforwardly in storage systems. Their storage capacities are specified in units called **bits** (short for binary digits, to be explained below). A small random access memory, for example, might have a capacity of 1,024 bits. A magnetic disc store might have a capacity of 10 megabytes (where 1 **byte** is a group of 8 bits).

Another type of hardware for which a measure of information is used is data transmission equipment. Here, of course, we are concerned with a *rate* of flow of information from one terminal to another and this rate is measured in **bits per second.** British Telecom's Prestel service, for example, sends information over telephone circuits at 1,200 bits/second in one direction and at 75 bits/second in the other direction. A much faster system used by British Telecom, for data and other information, works at 2,048 kilobits/second.

UNIT OF INFORMATION

The need for a universally accepted unit of information is as important as the need for universally accepted units of length, mass, time, electric current and the many others derived from them. Without agreement on these units throughout the world—even though conversions between different systems of units may sometimes be necessary—not only science and engineering but the practical affairs of everyday life would come to a messy halt.

In a telecommunications system, for example, to make sure that a physical channel like a coaxial cable will actually convey information at the rate you wish to supply it from a given type of terminal, you must be able to measure the transmission capacity of the channel and the generating capacity of the terminal in the same units.

ORIGIN OF BINARY CODE

But why have we chosen the bit, or binary digit, as the unit for measuring information?

Just as the foot as a unit of length originally came from the adult human foot, so there is an historical background to the newer unit as well. The whole history of signalling, whether by light, sound, mechanical movement or electricity, shows that methods using **two opposing states** have been both practical and effective. They are simple and unambiguous.

We have used light/darkness in lamps and heliographs, sound/silence in sirens and foghorns, left/right positions of galvanometer needles in telegraph instruments, hole/no-hole in punched paper tape and on/off in various electrical systems.

Samuel Morse devised his now famous code with its two symbols, long and short, to make use of the two positions of the armature, and the resulting black/white inked pattern, in his electromagnetic telegraph. In turn, the code was utilised in later signalling systems. In modern communications and electronics, of course, there are various techniques for providing the two states—for example, two different voltage levels of two different frequencies.

So the development over the years of a useful technology for sending information in terms of two states has been a strong incentive for us to consider information as being reducible to this simple binary form. But apart from the practical considerations there is also a good theoretical basis for the binary digit as a unit of information.

SELECTION OF SIGNS

The communication of information is fundamentally a selection of signs from a fixed and agreed set of signs. This is so whether we are concerned with selecting sounds from a vocabulary, letters from an alphabet or words from a dictionary.

When we write in English we successively select letters from a set limited to 26. In another language the total number in the set might well be different. One might invent a written language with an alphabet of only 12 characters, or 7, or 4—or only two, say ■ and ▲. It would be

Optical fibre cable (left) that will replace the old style metal conductor and metal sheathed coaxial cable (right) in modern telecommunications networks are shown for comparison in this British Telecom picture. Optical fibres have a much greater transmission capacity than traditional coaxial cables. Pulse rates in excess of 140 million per second have been achieved over distances of 100km without intermediate amplification.

perfectly feasible to provide enough combinations of ■s and ▲s to signify all the meanings we wanted (though most of the words would have large numbers of these signs).

Two signs are, of course, the smallest possible "alphabet". Below that no choice is available. Thus a selection from two possible signs—a binary choice—is the elemental choice. In the numeration of binary arithmetic the two signs are conventionally written as 1 and 0, but the actual characters used are quite unimportant.

So, if the **binary choice** is the basic element of selection it is also the basic element of information, on the principle of selecting from a set discussed above. When we make a choice of one sign in a binary system of notation we are automatically implying "one out of two". For historical reasons the two written numerals of binary arithmetic have become well established, so it is now conventional to describe the choice as being one out of two *digits*. Hence the **binary digit, or bit**.

A store designed to hold binary information is a group of two-state elements (electronic devices or magnetic cells), one for each binary digit. The capacity of the store is simply the number of two-state elements available to hold the digits. But what about information that is not already in binary digital form, such as sound or vision signals?

SUCCESSIVE BINARY CHOICES

By making a succession of binary choices we can make selections from much larger sets than just two signs—as large as we want, in fact. Fig. 5.1 shows how a selection can be made of one sign (the letter F) from an eight-character alphabet by a series of three binary choices. Therefore the number of bits of information contained in the knowledge that one letter has been selected from an alphabet of eight* is 3. If this whole selection were made in, say, a tenth of a second the information rate would be 30 bits per second.

Now let us see how this principle can be applied to information in electrical signals. First, in place of the eight letters write a set of eight voltages on a scale. Then add a horizontal time scale to allow a signal to be represented as a voltage/time graph. The result is Fig. 5.2.

We can now select by a series of binary choices any one voltage from a group of eight voltages, and the information contained in the knowledge that this particular voltage has been selected is 3 bits. This signal is not actually drawn as a continuous voltage/time graph but is defined approximately by an invisible line passing through the points marked at the different voltage levels.

If we doubled the number of voltages in the set to 16 the signal would be defined more accurately by more points, as shown in Fig. 5.3, but because more binary choices would be required to allow this, the information content of any one point on the graph would become 4 bits.

In theory, to define any signal perfectly would require an infinite number of voltage level points, infinitely close together (see Part 1 on "Representing information electrically"). In practice, it does not have to be all that great; for example, a good quality television signal calls for a minimum of eight binary choices (8 bits) which means selections from a set of 256 voltage levels.

*The generalised formula is: number of bits = $\log_2 N$, where N is the number of signs in the set.

INFORMATION RATE

The information *rate* of the signal in Fig. 5.2 is determined by the time intervals between the voltage points defining the graph. This varies between 60 milliseconds (giving 16·6 bits/second) and 360 milliseconds (giving 2·8 bits/second).

In practice we have to allow for the highest information rate necessary for the class of signal we are dealing with. A television signal, for example, calls for a maximum information rate of about 11 million bits/second, while a telephone voice signal requires a maximum rate of about 8,000 bits/second.

INFORMATION CHANNELS

A channel is a means of transmitting an individual, recognisable signal or train of information—say a voice signal or telex message—from one place to another. Usually this transmission is in one direction only, but sometimes the term "channel" implies bi-directional transmission. The physical means of transmission ranges from a simple pair of wires, as used for the domestic telephone line, to coaxial cables, radio links, waveguides and optical fibres.

By using carriers (Part 3) or time-sharing methods (Part 4) we can accommodate a whole group of channels within a single transmission system such as a coaxial cable, without the individual trains of information interfering with each other. This is **multi-channel transmission.**

What mainly matters in information technology is the capacity of a channel to convey information—the maximum flow rate in bits per second that it will handle. This depends on a number of physical quantities in the transmission system. One is the electrical power in the **signal;** another is the electrical power in the **noise** (unwanted random fluctuations) introduced by the transmission system itself.

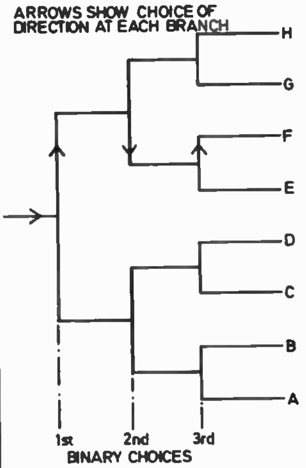


Fig. 5.1. This "tree" diagram shows how one sign may be selected from a fixed set of signs by making a series of binary choices (of direction at the branching points). Three binary choices are required to select any sign from a set of eight.

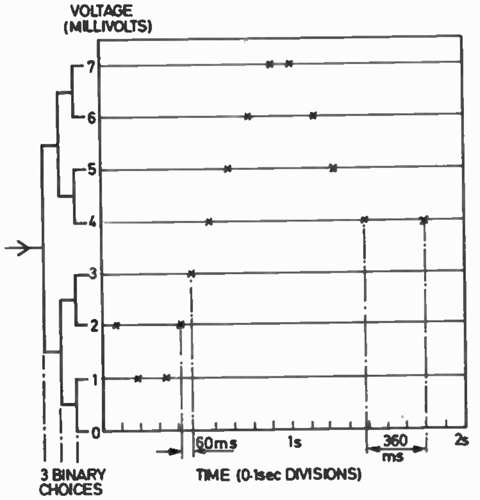


Fig. 5.2. The binary selection process of Fig. 5.1 applied to a set of discrete voltage values forming a signal. Here the signal is defined by selections from a set of eight possible voltage levels.

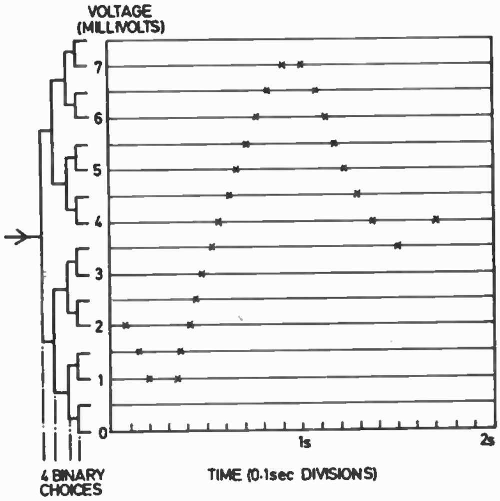


Fig. 5.3. The same signal as in Fig. 5.2 but here defined more precisely in terms of 16 possible voltage levels.

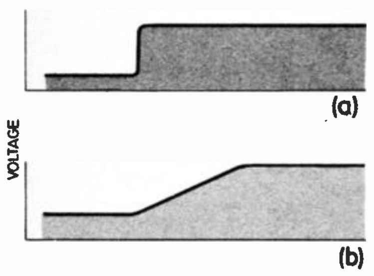


Fig. 5.4. Parts of two signals, illustrating different rates of change of voltage with time.

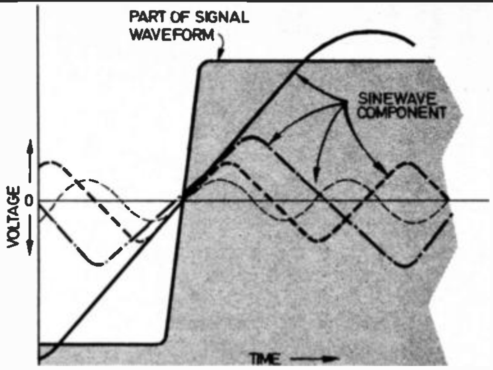


Fig. 5.5. How a signal waveform may be analysed into a set of sine-wave components (Fourier analysis). Not all of the components that make up this signal waveform are shown here.

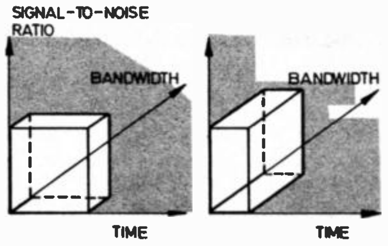


Fig. 5.6. Three-dimensional analogy in which the box is a quantity of information (bits). In transmitting a given quantity of information (the volume of the box), the time taken, bandwidth and signal-to-noise ratio may be exchanged with each other. These two examples illustrate an exchange of time and bandwidth (signal-to-noise ratio remaining constant).

SIGNAL-TO-NOISE RATIO

The presence of noise sets a limit to the number of distinct levels in a signal waveform that can be detected, Fig. 5.2 and Fig. 5.3). Sufficient power in the signal will make the effect of this noise insignificant, but there are practical limits to the amount of power that can be transmitted. The relationship of these two (average) powers—the signal-to-noise ratio—is therefore important in determining the accuracy of the information received at the end of the channel.

Another factor determining the accuracy of signal transmission is the ability of the channel to convey the variations of the electrical quantity (Part 1) that represent information—more specifically, the *rate of change* of these variations. For example, Fig. 5.4 shows parts of two signal waveforms, each of which is a transition between two steady voltages. In (a) the rate of change of voltage with time is higher than the corresponding rate of change in (b).

In a channel using, say, a wire cable as a transmission medium, the resistance and reactance of the wire together limit the rate of change of an electrical quantity that can be sent along it. Consequently, if the signal waveform at the input of the channel contains higher rates of change than the medium can transmit, the waveform received at the end will be distorted and hence the information will contain errors.

For example, the transition at (a) in Fig. 5.4 could be considered as part of a signal fed to the input of a channel. If the channel were incapable of transmitting this rate of change the transition as received at the end of the channel would be something like (b).

BANDWIDTH

The ability of a channel to convey such rates of change is determined by its **bandwidth,** measured in hertz (Hz). This term may require some explanation. Any signal waveform can be analysed into a number of sine-wave components of different magnitudes, frequencies and phases.* This is illustrated in Fig. 5.5 which shows some, but by no means all, of the sine-wave components which, when added together, constitute the signal waveform shown.

Each component has a maximum rate of change. A channel will convey a limited range of these sine-wave components, and the bandwidth of the channel is the extent of the continuous range, in Hz, over which the channel transmits a specified proportion of the original signal power. The bandwidth of a typical telephone voice channel, for example, is about 4,000Hz.

The channel's bandwidth therefore indicates the rates of change that can be transmitted and, as a result, the number of independent levels of a waveform that can be conveyed by it in a given time. It is therefore a factor in determining the maximum information rate in bits/second.

THREE QUANTITIES

So signal power, noise power and bandwidth together determine the highest rate at which a channel can convey information. The exact relationship of the three quantities to this maximum rate is given by an expression* which enables the channel to be matched to a given source of information, or vice-versa.

In some IT systems it is possible to adjust the rate at which information is generated at the source—to alter the length of time available to convey a given number of bits. This enables us to alter the bandwidth and/or signal-to-noise ratio required. A graphical analogy of this inter-dependence is given by the "box" diagrams in Fig. 5.6.

The volume of the box, the triple product of time, bandwidth and signal-to-noise ratio, is proportional to a given number of bits of information. Obviously it is possible, as shown by the two examples, to change the time available, the bandwidth and the signal-to-noise ratio (actually it is $\log_2$), in various ways that will maintain constant the volume representing the quantity of information.

A good example of this, known to some experimenters, is slow-scan television. If you increase the length of time available to send a given quantity of information in a picture, you can transmit the picture in a channel of smaller bandwidth than would otherwise be possible.

To be continued

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* Mathematically inclined readers will know this as **Fourier analysis.** The sine-wave components are expressible mathematically as the terms of a Fourier series (named after the French mathematician and physicist J. P. J. Fourier).

* Derived by C. E. Shannon. $C = W \log_2(1 + S/N)$, where C = maximum capacity of channel in bits/second, W = bandwidth in hertz, S = mean signal power in watts, and N = mean noise power in watts.

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74LS20	13
74LS30	12
74LS32	13
74LS37	14
74LS38	14
74LS42	28
74LS47	36
74LS51	14
74LS73	18
74LS74	16
74LS75	18
74LS76	15
74LS85	40
74LS86	16
74LS90	22
74LS92	30
74LS93	22
74LS107	20
74LS112	20
74LS123	34
74LS125	24
74LS126	25
74LS132	34
74LS136	23
74LS137	90
74LS138	25
74LS139	27
74LS145	70
74LS148	75
74LS151	40
74LS153	40
74LS153	40
74LS155	30
74LS156	36
74LS157	27

74LS161	36
74LS163	36
74LS164	30
74LS165	50
74LS166	60
74LS173	55
74LS174	45
74LS175	40
74LS191	36
74LS193	40
74LS195	39
74LS196	48
74LS197	60
74LS221	48
74LS240	55
74LS241	55
74LS242	55
74LS243	55
74LS244	55
74LS245	70
74LS251	30
74LS253	30
74LS257	30
74LS259	55
74LS266	20
74LS273	55
74LS279	30
74LS299	150
74LS367	30
74LS368	28
74LS373	60
74LS374	55
74LS378	60
74LS393	45

7400

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7413	18
7414	20
7420	15
7430	14
7440	14
7442	32
7443	60
7444	60
7447	36
7448	40
7450	14
7451	14
7453	14
7454	14
7460	14
7470	24
7472	24
7473	26
7474	30
7475	25
7476	25
7480	35
7482	65
7482	65
7483	38
7485	60
7486	18
7489	159
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	34
74100	80
74104	45
74107	20
74121	24
74123	34
74125	34
74126	33
74141	51
74151	40
74154	60
74155	39
74156	40
74157	30
74190	45
74191	45
74192	45
74193	45
74393	95

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4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	11
4012	16
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	39
4023	14
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4041	40
4042	40
4043	40
4044	40
4046	46
4049	23
4050	23
4060	45
4069	13
4070	13
4071	13
4072	13
4081	13
4082	13
4093	20
4510	45
4511	45
4514	110
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741C8	16
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741C14	47
747C14	65
748C8	35
741S	56
1458C5	62
1458C14	40
7106	450
7107	500N
555	10N
7555	80N
556	45
CA3046	70N
CA3080E	80N
CA3130E	90N
CA3140E	45N
LM301AN	25N
LM308N	60
LM317K	295N
LM324N	32
LM348N	65
LM380N	66
LM380N8	80
LM381N	145
LM382N	115
LM3900N	50
LM3914N	250
LM3915N	200
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NE556A	45
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S041P	121
S042E	364
S042P	138
S89	11.23
S178B	31.00
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S566B	214
S576A	235
S576B	235
S576C	235
S576D	225
S1469	468
SAB0600	302
SAB3209	429
SAB3210	311
SAB3211	168
SAB3271	329
SAB4209	497
SAB8256C	35.40
SAD1024	9.00N
SAJ131	238
SAJ141	278
SAJ205	810
SAS231W	261
SAS251	142
SAS580	198
SAS590	196
SDA5680A	15.55
TAA761	104
TAA761A	62
TAA765A	49
TAA861	103
TAA865A	59
TAA2761A	72
TAA4761A	113
TAA4765A	120
TAB1041K	187
TBA120AS	62
TBA120U	72
TBA800	75
TBA10S	75
TBA820	75
TBB1458	62
TBB1458B	40
TCA105	120
TCA105B	108
TCA105G	140
TCA250A	185
TCA205K	200
TCA335A	66
TCA345A	109
TCA345W	177
TCA671	131
TCA780	211
TCA871	114
TCA955	228
TCA965	136
TCA965K	170
TCA971	92
TCA991	80
TCA991K	100
TDA2002	120
TDA2003	126
TDA2030	150
TDA4050B	144
TDA4290	169
TDA4600	184
TDA4700A	546
TDA4713A	435
TFA1001W	252
TL071CP	45
TL072CP	75
TL074CN	120
TL081CP	46
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UAA170L	152
UAA180	165
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Ceramic Very small 1.8, 2.2, 2.7 etc. up to 1n 5p each. 1n5, 2n2, 3n3, 4n7, 6n8, 5p; 10n, 22n 6p; 33n, 47, 7p, 100n, 8p
Polyester, Siemens Layer Type 7.5mm lead spacing 100V
1n, 1n5, 2n2, 3n3m 6p; 4n7, 6n8, 8n2, 10n 12n, 15n, 18n, 22n, 33n, 47n, 7p 56n, 68n, 7p, 82n, 100n, 9p 120n, 150n 15p; 180n 220n, 12p, 270n, 330n, 330n 390n 470n, 15p, 560n, 680n, 24p, 10mm spacing 1uF 25p, 15mm spacing 2u2 35p, 22.5mm spacing 1uF 400V 50p; 3.33uF 100V 69p; in depth stocks

CRYSTALS

(in MHz)		4.433	128
0.032768	102	4.915	157
0.100000	453	5.000	157
1.000	453	5.026	128
1.8432	320	5.000	157
2.000	268	6.144	157
2.4576	268	6.5536	128
3.2768	188	8.000	1.88
3.579	128	8.867	128
4.000	102	10.000	157
4.194	128	18.432	188

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3	14p	8p
4	17p	14p
5 (180°)	17p	11p
5 (240°)	20p	8p
6	18p	20p
7	19p	30p

IDC Connectors

DIL

14 way	103p
16 way	117p
24 way	170p
40 way	265p

PARALLEL TYPE

	plug	skt
16 way	1.10	1.30
20 way	1.25	1.45
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34 way	1.65	1.95
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plastic	P2	32p	14p	20p
STEREO ¼				
chrome	P3	81p		52p
plastic	P4	60p	15p	20p
MONO 3.5mm		18p		14p
Stereo		23p		42p

IC SOCKETS

Pins	Each	25 for
8	6	120N
14	8	160N
16	9	180N
18	11	220N
20	12	240N
22	14	280N
24	15	300N
28	18	360N
40	25	500N

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9	78p	104p	92p
15	106p	140p	96p
25	141p	205p	110p
37	199p	298p	122p

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7805	40	7905	50	7824	40	7924	50
7806	40	7906	50	78L05	32	79L05	50
7808	40	7908	50	78L12	32	79L12	50
7812	40	7912	50	78L15	32	79L15	50
7815	40	7915	50	78L24	32	79L24	50

ELECTROLYTICS

1/63	9	1000/10	19
2.2/25	13	1000/16	26
2.2/63	9	1000/25	36
4.7/63	9	1000/40	44
4.7/100	14	1000/63	76
6.8/40	9	2200/6	9
10/6	13	2200/16	44
10/25	10	2200/25	60
10/40	11	2200/40	73
10/63	12	4700/16	72
10/100	15	4700/25	90
22/10	10		
22/25	11	**TANTALUM**	
22/40	14	**BEADS**	
22/63	15	0.1/35	13
22/100	16	0.22/35	13
47/3	3	0.47/35	13
47/10	11	1.0/35	13
47/25	10	2.2/16	13
47/40	15	2.2/35	16
47/63	15	4.7/16	16
47/100	18	4.7/35	18
100/3	3	6.8/16	16
100/10	12	6.8/25	24
100/16	12	10/6.3	16
100/25	12	10/16	18
100/40	15	10/25	18
100/63	20	22/6.3	19
100/100	27	22/16	30
220/10	16	22/25	30
220/16	16	33/6.3	24
220/25	16	33/10	30
220/40	20	47/6.3	30
220/28	28	100/10	66
220/100	42	For full ranges	
470/10	19	of very many	
470/16	19	other types	
470/25	19	please see	
470/40	27	Cat 82 and/or	
470/63	45	current price	
470/100	73	list	

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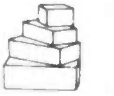

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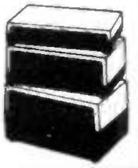

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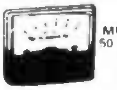

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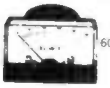

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2N1303	58
2N1304	62
2N1305	62
2N1306	90
2N1307	67
2N1308	147
2N1309	99
2N1599	100
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2N1711	25
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2N2222A	25
2N2369A	21
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2N3819	22
2N3820	48
3823	60
2N3904	15
2N3906	15
2N4036	46
2N4058-62	09
2N4124	25
2N4126	25
2N4284	30
2N4286	30
2N4289	23
2N4291	24
2N4292	21
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2N5062	32
2N5192	110
2N5195	106
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2N5458	32
2N5459	38
2N6050	380
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6F40	152
16F40	186
40HF40	226
40361	DIS
40362	65
40406	71
40408	95
40412	106
40430	100
40594	123
40595	123
40636	147
40673	146
A9903	16
AA113	13
AA116	9
AA117	13
AA118	14
AA119	13
AC126	25
AC127	25
AC128	25
AC151R	55
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ACY17	156
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ACY20	90
ACY21	85
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AD136	530
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AD161	35
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BC122Y	100
BC125	20
BC125	20
BC140	25
BC141	30
BC147A	10
BC149	10
BC154	25
BC160	25
BC161	30
BC167A	09
BC167B	09
BC168A	09
BC168B	09
BC169B	09
BC169C	09
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BC178B	16
BC179B	18
BC182	09
BC182L	09
BC183	09
BC183L	09
BC184	09
BC184L	09
BC202Y	120
BC212	09
BC212L	09
BC213	09
BC213L	09
BC214	09
BC214L	09
BC238C	09
BC239C	09
BC2589	09
BC2678	16
BC300	32
BC301	24
BC303	30
BC327	16
BC328	11
BC337	14
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BC546	10
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BC556	10
BC557	09
BC558	09
BC559	09
BC560	10
BC879	38
BC880	43
BCY31A	157
BCY58	18
BCY70	18
BCY71	18
BCY72	18
BD130	46N
BD131	48
BD132	48
BD135	27
BD136	27
BD139	30
BD140	30
BD644	42N
BD679	62
BD680	64
BF115	36
BF167	25
BF173	25
BF177	28
BF178	25
BF244B	40
BF254	14
BF255	14
BF420	31
BF421	34
BF457	35
BF458	35
BF459	35
BF597	12N
BFR34A	84
BFR39-41	23
BFR79-81	23
BFT65	119
BFT66	192
BFX29	24
BFX84	24
BFX85	24
BFX87	28
BFX88	26
BFY50	24
BFY51	24
BFY52	24
BFY90	143
BR34	70
BR64	110
BRY39	46
BSX20	22
BSX26	22
BSX63	769N
BT106	147
BT108	136
BU105	170
BU124	86
BU208	180
BUX26	350N
BUX28	546
BUX81	744
BUX85	249
BUZ10A	478
BUZ15	12.27
BUZ20	523
BUZ23	787
BUZ24	12.50
BUZ32	625
BUZ33	844
BUZ41A	637
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BY164	46
C106D1	46
C0326	460N4
C0340	490N4
C407	17
C0546	126N1
C762	40
C1406	77
D4 clip	for
C1406	and
E2506	10
D1046	88
E1110	76
E1210	76
E2506	154
E8383	20
MJ2955	90
MJE340	56
MJE2955	96
MJE3055	70
MPF102	40
MPS6531	40
MPS6534	42
MPSA12	38
MPSA63	38
NAS206S5	81
OA47	12
OA90	10
OA91	10
OA95	DIS
OA202	14
OC28	75
OC29	75
OC35	75
OC36	90
OC84	25
PM7A2	373
PN70	10
PN72	05
Q4006LT	104
Q4010LT	115
Q4025H	460
T2700D	189
T2800D	104
TAG3-400	100
TAG209-400	86
TAG209-600	130
TIC106D	48
TIC106M	56
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EXPANDED ADD-ON KEYBOARD *for the* ZX81

BY J. M. STEJSKAL

THIS project describes the circuitry and its construction for extending the ZX81 add-on keyboard to provide a number of single stroke entry functions. These functions would normally be entered using SHIFT with another key. For example, to enter TO, SHIFT is held down while 4 is pressed.

The add-on keyboard seen here is that available from Redditch Electronics. We expect that the additions described here will be suitable for use with keyboards from other suppliers. We have not tried these, however.

Since the ZX81 user is no longer obliged to hold down the SHIFT key for much of the time, the typing becomes more comfortable and speedier with these additions.

ZX81 KEYBOARD

The relevant section of the ZX81 keyboard circuit is shown in Fig. 1. The 40 key-switch positions are arranged on a 5 × 8 grid. There is no contact between column and row until the key at their intersection is pressed. When doing this the information on the column line is transferred to the appropriate row line(s).

The ZX81 keyboard routine uses the upper half of the CPU address bus to repeatedly shift a logic 0 along address lines A8 to A15. This strobing happens very rapidly. The information appearing on the KBD bus (0 to 4) when a key is pressed tells the system which key has been pressed. If no key has been pressed, all logic 1's are on the bus resulting from the 10kΩ pull-up resistors to +5V.

If, say, the "1" key is pressed, then when A11 next goes low, KBD0 will also go low with the remainder of this bus staying high. This information is read into ICA by a scanning routine and the pressed key determined.

How the low gets on the KBD line happens in the following way. When the address line goes low, and the key makes contact, a series circuit across the +5V and logic 0 is made with one of the 10kΩ resistors and the diode. It is the junction of these two components which is read on the KBD line. Since the forward drop across a diode such as those in the ZX81 is about 0·7V, it is below the logic 1 threshold and is thus read as a 0 as required.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Expanded Add-On Keyboard for ZX81 is shown in Fig. 2. There are three different circuit configurations according to the position of the switch on the keyboard matrix, see Fig. 1. The add-on keyboard is in parallel with this using KBD0 to KBD4 and A8 to A15.

Fig. 2 (opposite). The complete circuit diagram for the extra keys to be fitted to the proprietary add-on keyboard.

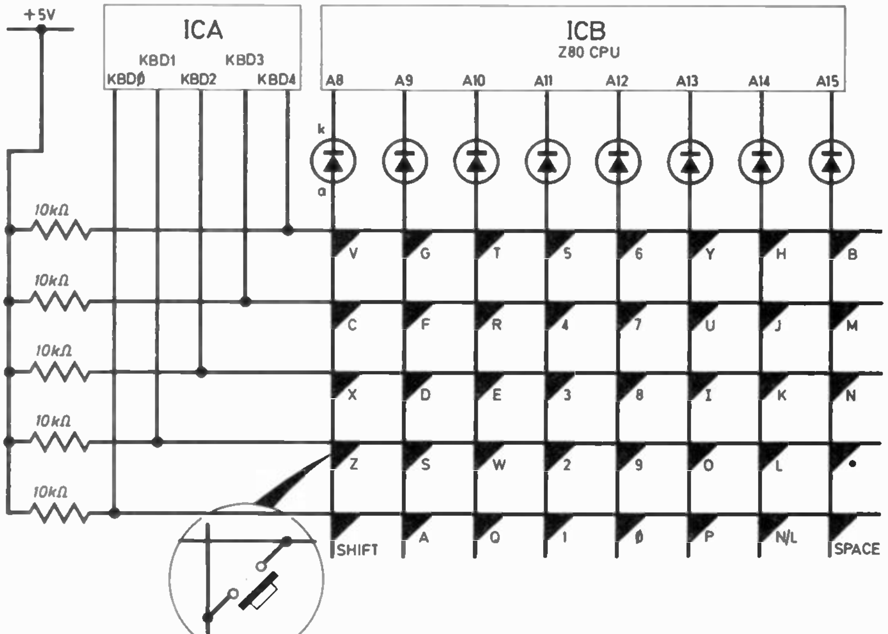
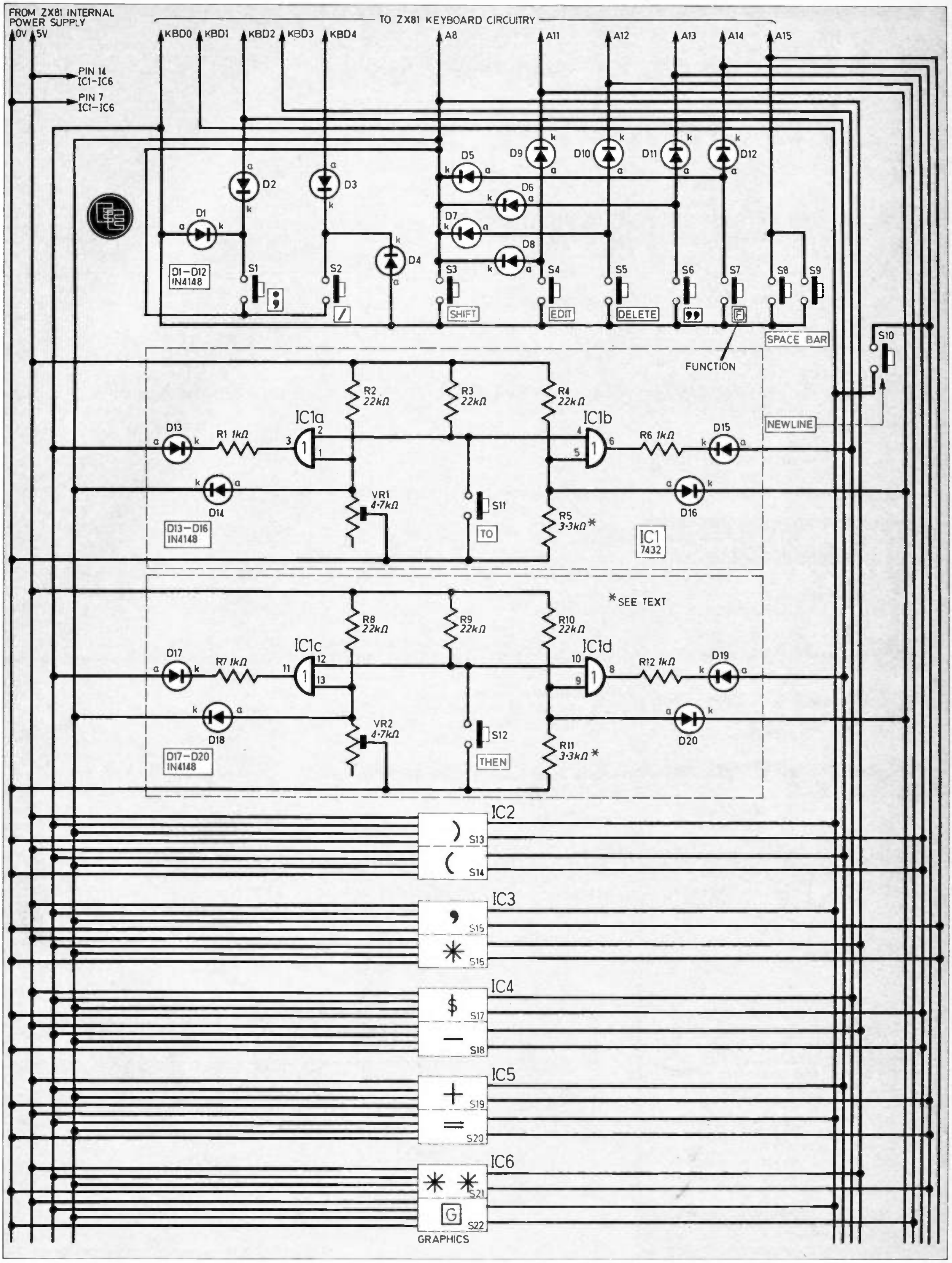


Fig. 1. The ZX81 internal keyboard circuitry.


FROM ZX81 INTERNAL POWER SUPPLY
0V
5V
TO ZX81 KEYBOARD CIRCUITRY
KBD0
KBD1
KBD2
KBD3
KBD4
A8
A11
A12
A13
A14
A15
PIN 14 IC1-IC6
PIN 7 IC1-IC6
D1–D12 IN4148
SHIFT
EDIT
DELETE
FUNCTION
SPACE BAR
NEWLINE
R2 22kΩ
R3 22kΩ
R4 22kΩ
R1 1kΩ
R6 1kΩ
VR1 4·7kΩ
R5 3·3kΩ*
TO
IC1a
IC1b
IC1 7432
D13–D16 IN4148
*SEE TEXT
R8 22kΩ
R9 22kΩ
R10 22kΩ
R7 1kΩ
R12 1kΩ
VR2 4·7kΩ
R11 3·3kΩ*
THEN
IC1c
IC1d
D17–D20 IN4148
IC2
IC3
IC4
IC5
IC6
GRAPHICS

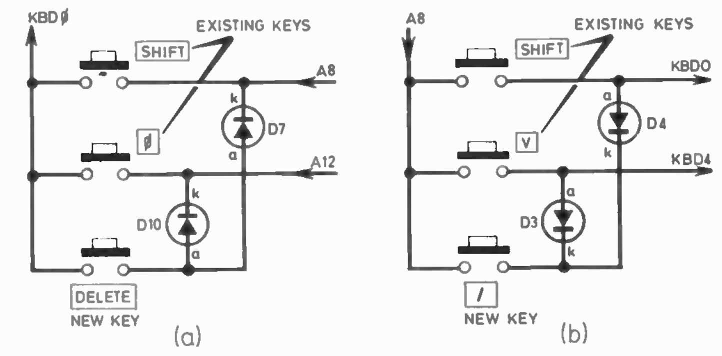


Fig. 3. Two of the three different switch-circuits used in the design, re-drawn for clarity.

The operation of two of these three different circuit arrangements is best explained by means of the re-drawn sections in Fig. 3.

The circuit in Fig. 3a is for use with any, or all, characters on line KBD0 which connects them to the SHIFT key, but where their address lines are different.

COMPONENTS

Resistors

R1,R6,R7, R12	1kΩ (6 off each)
R2,R3,R4, R8,R9,R10	22kΩ (6 off each)
R5,R11	3·3kΩ (6 off each)

All ¼W or ⅛W carbon ±5%

Potentiometers

VR1,VR2	4·7kΩ sub-miniature vertical skeleton presets (6 off each)

Semiconductors

D1–D12	1N4148, 1N914 or similar switching diodes (12 off)
D13–D20	1N4148 or similar (12 off each)
IC1–IC6	7432 TTL Quad 2-input OR gates (6 off)

Miscellaneous

S1–S22	p.c.b. mounting momentary action push-to-make keyboard switch (22 off)

Verostrip: 64 strips, 36 strips (2 off); fibre glass board (uncoppered, for board D) size 207 × 30mm; top caps for above switches: single (18 off), double (2 off), treble (1 off, or separate space bar, see text); 14-pin d.i.l. i.c. sockets (6 off); lightweight stranded p.v.c. covered wire—selection of colours; metal for brackets and fixing hardware as required.

Approx. cost Guidance only £17.50

The characters that can be used with this circuit are: A,Q,1,0,P,NEWLINE, SPACE. The following are used here: 1(EDIT), θ(RUBOUT), P(""), NEWLINE(FUNCTION). As an example, Fig. 3a shows the circuit for the DELETE key. Both switches, SHIFT and 0, work independently as before, the two diodes D7 and D10 preventing any interconnections between the two. When the commoning key DELETE (RUBOUT) is pressed, then the logic levels on A8 and A12 are successively passed to KBD0, thus producing the same effect as a "SHIFTed 1", that is, DELETE.

As already mentioned, only the frequently used characters have been selected here: EDIT, DELETE, ", FUNCTION (F). Although there is no special arrangement for any delay, the SHIFT always comes on first, without fail, making the circuit reliable and cheap.

The other circuit, in Fig. 3b, is suitable for keys: Z(:), X(;), C(?) and V(/). Two of these have been selected here: X(;) and V(/). The example shown is for the division sign "/".

The circuit in Fig. 3(b) is similar to that in (a) but this time it is the address line which is common to two keyboard lines: A8 is commoneed with SHIFT and V to realise /. If when / is pressed, a logic low is placed on A8 it will be transferred to both KBD0 and KBD4 which is the required condition for SHIFTed V.

Three of the extra key-switches are connected in parallel with existing keys, moving them to more convenient positions. Like all other extra keys, they can still be used in their original position. They are: SHIFT on the right-hand side of the keyboard, SPACE on a long space-bar and NEWLINE at the bottom left-hand corner. The space-bar shown here is from an old ASCII keyboard and is fitted with a key-switch at each end.

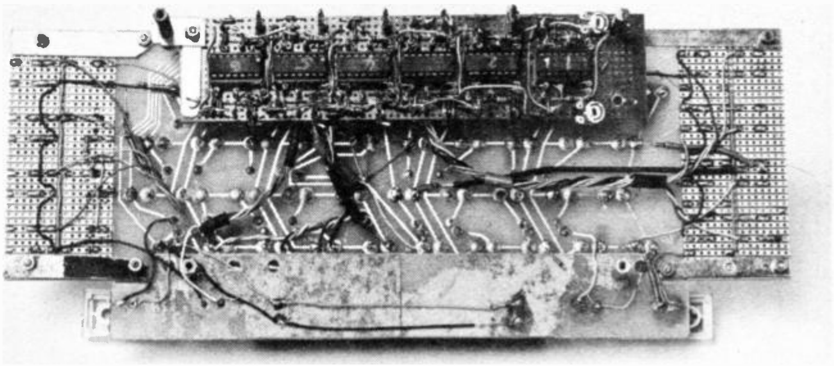
Although the remaining 28 key-switches do not have a common line with SHIFT key, all or any may be connected for single shifted-key operation by using a pair of logic gates for each function. Twelve keys were selected to appear on the prototype keyboard, any of which may be substituted by those of the constructor's choice. The twelve are: 4(TO), 3(THEN), 0()), I(( ), .(,), B(*), U( ), J(–), K(+), L(=), H(**) 9 (GRAPHICS) G.

Two separate sections to produce TO and THEN are shown in detail in Fig 2. Each is made up from two OR gates and are seen to be identical.

The components in the other circuits are identical, the only difference being that the b and d gates in each pair of gates might be connected to a different KBD-line and/or A-line. One gate in every pair operates the SHIFT. VR1 and R5 arrange the delay required for SHIFT to operate first.

With S11 not pressed, a logic high (1) reaches one input of each of the two OR gates IC1a and IC1b causing each output to be at logic 1. The other input to each gate is held at logic 0 by the potential divide effect of R2/VR1 and R4/R5. When S11 is pressed the outputs of IC1a and IC1b drop to logic 0.

Now each keyboard line is strapped to +5V by its own resistor (in the ZX81). The ZX81 internal circuitry looks for a logic 0 appearing on one of the lines at the appropriate time when being strobed by A8 to A15 outputs. When the output of IC1 goes low, a low is read in on KBD0. This, together with the low logic reaching A8 from pin 1, simulates SHIFT being pressed. IC1b goes low also at the same time, with a logic 0 being placed on KBD3 and A11. The values of VR1 and R5 are chosen so that SHIFT acts before 3, giving SHIFTed 3. This is TO, the required result. **(To be continued)**



CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised.

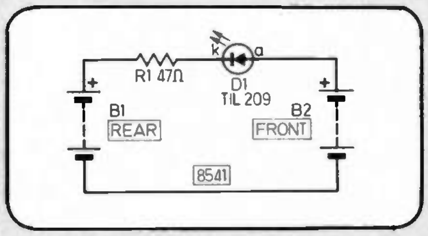
Payment is made for all circuits published in this feature.

Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

REAR-LIGHT FAILURE INDICATOR

The question of whether or not the rear light is working is a constant worry for cyclists riding at night.

This simple circuit lights an l.e.d. if the rear-light battery is flat. The circuit uses the front-light battery as the power source for the l.e.d., and the l.e.d. is mounted on the steering column of the cycle. If the rear-light battery is flat there is a potential difference across the l.e.d. and it will glow, informing the cyclist of the urgent need to change the battery.



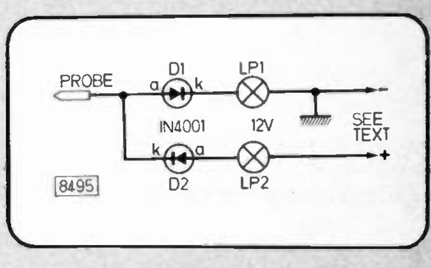
Andrew Marshall,
Old Basford,
Nottingham.

QUICK POLARITY TESTER

In the prototype of the Quick Polarity Tester the connections to the battery were for negative earth vehicles, as shown in the circuit diagram, but for positive earth vehicles the connections to the battery *must* be reversed.

To test this, connect up the battery terminals to the car cigarette lighter (+ to pin, – to chassis). It was found best to use "Christmas Tree" bulbs as these were small, although other bulbs could be used.

Alexis Landa,
Ilfracombe,
Devon.



SPEED CHESS AND DRAUGHTS TIMER

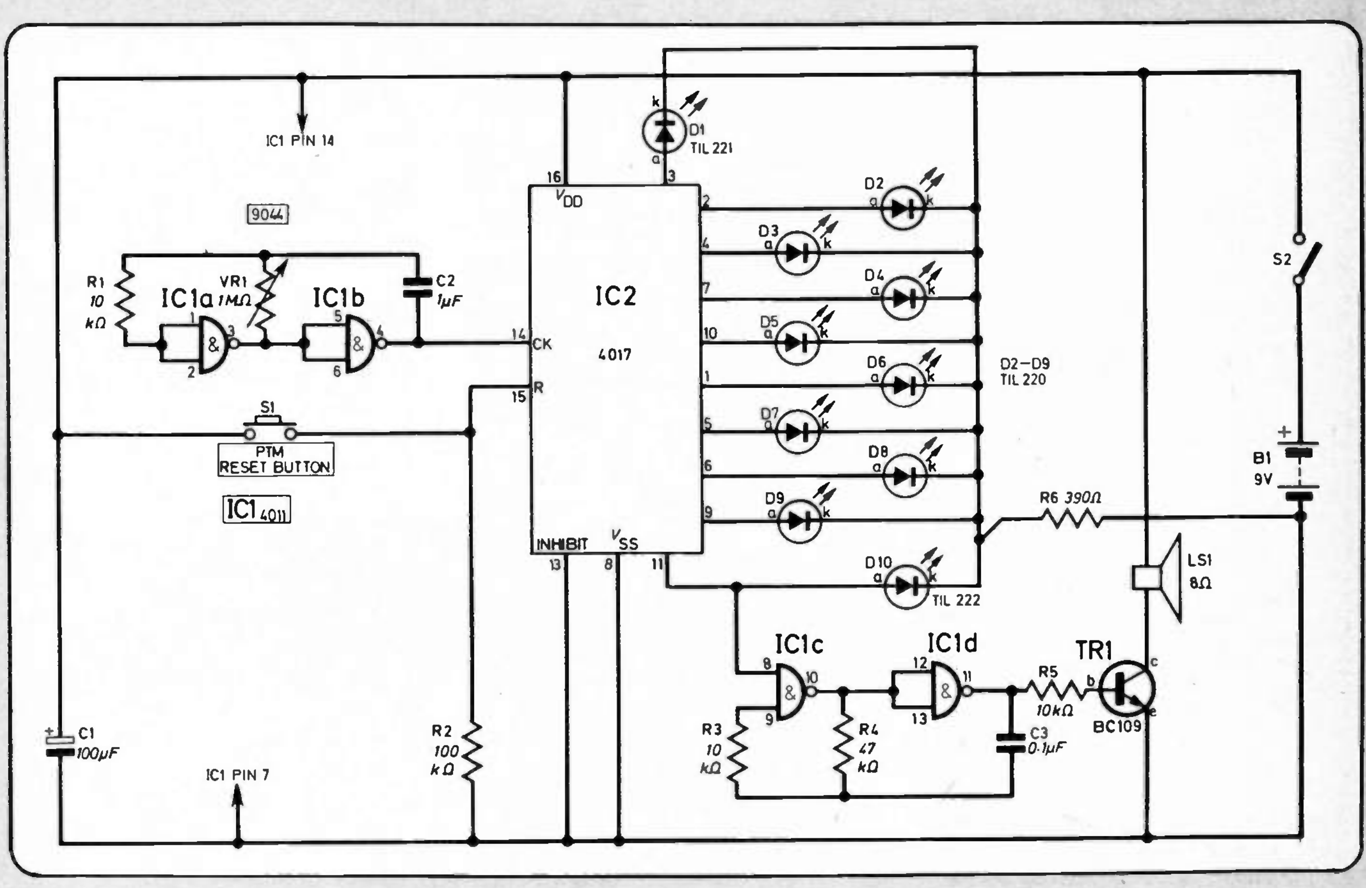
Stimulated by the Lightning Chess Buzzer featured in an earlier issue of *EE*, I have designed another timer based on the 4017 CMOS chip.

A NAND gate oscillator formed by IC1a and IC1b feeds the clock of the decade counter IC2. This causes the line of l.e.d.s D1 to D10 to light in sequence unless the reset switch S1 is operated.

If a player fails to complete his move within the time set by potentiometer VR1 then the yellow l.e.d. D10 will light and an alarm will sound. This alarm is triggered by the oscillator IC1c/IC1d and indicates a time fault.

As shown, the maximum time is adjustable up to 15 seconds, by increasing the value of C2 the time maximum may be increased in proportion.

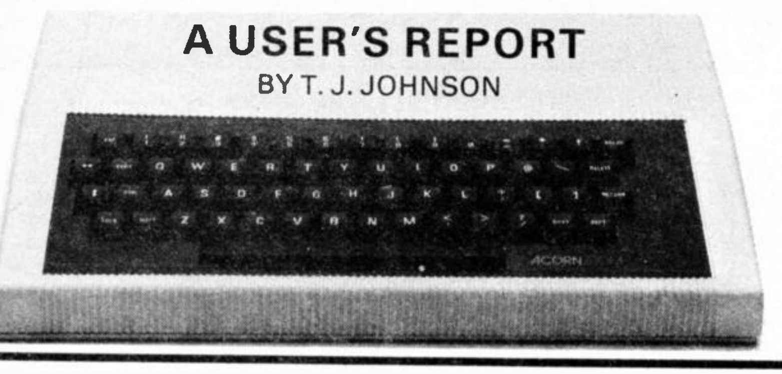
Andrew Knight,
Langley,
Southampton.



ACORN ATOM

A USER'S REPORT

BY T. J. JOHNSON



THERE are two basic versions of the Acorn Atom home computer and both are available as kits or ready made. The first, commonly referred to as the "minimum" system, has 8K of ROM and 2K of RAM. The second, often called the "expanded" system, has 12K of ROM and 12K of RAM. The one point to note is that the expanded system has the optional floating point ROM fitted—a most valuable addition.

I purchased the minimum system in kit form for really only one reason, and that was to save money. I found that there was nothing particularly instructive about constructing the kit, so unless you have very shallow pockets it is better to purchase the assembled and tested version.

THE KIT

The Atom kit comes complete with concise and very compact assembly instructions, and was obviously written with the more experienced constructor in mind. Although the kit is remarkably easy to construct, it is definitely not recommended for beginners who lack experience in soldering.

I experienced no great difficulties in assembling the kit, and found that the Atom was complete and ready for use in a little over three hours. The one frustrating moment came when fitting the keyboard.

The construction of the keyboard is such that you have to insert the fine gold-plated contact wires (over 100!) into the large diameter p.c.b. holes. This may sound easy but it can prove frustrating, especially when you think you have the keyboard fitted and are just about to solder the wires to the p.c.b., then you discover that a single contact wire has become trapped under the keyboard, with the result that you have to remove it and start all over again. This is the one major criticism I have with the kit.

A short lead also needs to be made which connects the Atom cassette interface socket with your recorder. The manual shows the required connections for the Atom end. For the recorder end you should either refer to its manual and/or solve the connections by trial and error.

When trying out the Atom for the first time, be sure to check each key, and every key, in turn. I found when power was first applied that, whichever key I pressed the figure "8" appeared on the VDU. After much fault-tracing it turned out to be the "8" key at fault with a permanent short across it. The fault was cleared, of course, but it does illustrate the point earlier about the difficulty of fitting the keyboard.

EXPANSION

The expandability of the Atom is perhaps one of its major assets. The minimum system can be expanded in a variety of ways. For example: by adding extra RAM—here 10K may be fitted on the board with a further 64K as an additional "card"; a colour encorder card and extra ROM in the form of two further i.c.s. All these additions may be mounted inside the case of the Atom.

The usual printer and floppy discs may also be connected to the Atom by way of the various expansion sockets on the rear. These expansion sockets also carry the Address, Data and Control lines of the CPU as well as various control signals which may be used for further expansion, for example, extra RAM and ROM.

[The Atom is also equipped with latched ports. These have been employed in the design of an Eprom Programmer, *see page 178].*

CASSETTE FILING

The cassette operating system of the Atom is exceptionally good, despite its very slow transfer rate of 300 bits per second, when compared with other machines. I use a Ferguson model 3240 recorder of some 10 years vintage and well-worn heads, and apart from the initial troubles when first setting the system up, have experienced no difficulties in saving or loading programs on tape.

The cassette operating system is very tolerant of input/output levels from the recorder and thus probably makes it one of the better systems available.

THE LANGUAGE

The language used on the Acorn Atom is of course Basic—with a few variations on the "standard" Basic.

It would be impracticable in a short report such as this to list all the variations, and in the long run it would be of no practical use, unless you intend to translate one form of Basic program to another. If you have some sort of electronics background or a logical mind you should have no trouble in getting to grips with the language. I will confess that before I bought the Atom I had no previous knowledge of Basic apart from the many programs I had seen in magazines. Providing you have had a similar experience it will not be difficult to progress through the Basic manual supplied with the unit.

Possibly one area of programming which is difficult to understand is Assembler Programming using mnemonics. The Atom manual gives an introduction to assembler programming, but from my point of view is very lacking in detailed explanations of the various instructions.

GRAPHICS

Most home computers have some form of graphics capabilities, either black and white and/or colour. The Atom has both, providing the colour encoder card is used. In its lowest graphics mode the resolution is 64 × 48 pixels and in the highest mode is 256 × 192 pixels (slightly lower when colour is used).

I found the graphics quite difficult to grasp at first, particularly the fifteen PLOT commands, and also when incorporating these instructions in a games program. The graphics are, however, very good and should not prove difficult after a certain amount of practice.

It is worthwhile to point out that the VDU is memory mapped, that is, each of the 512 points on the screen may be POKED with any desired character, thus providing an additional graphics mode.

CONCLUSIONS

Obviously, since this is the first and only home computer I am likely to buy, I am slightly biased in favour of the Atom.

Since owning the Atom for some 12 months, I have had the opportunity to try several other machines, both "home" types and "commercial" types of computer. In nearly every case, I prefer the Atom for its simplicity and ease of use.

I believe the computing power of the Atom is somewhat under-estimated and consider the Atom a most worthwhile investment. It is very simple to use, its language is easy to learn, and it is very easily expandable. For a relatively small outlay I have a very powerful computing machine that I do not consider will be obsolete in ten years' time. □

Everyday News

PERSONAL PAYPHONE

MANY small businesses would like to provide their customers or staff with a payphone service, but the current wall-mounted model may not suit their particular situation. Now, British Telecom have introduced a push-button payphone only nine inches square and seven inches high and weighing less than 7lb that also doubles as a private phone.

Called the Payphone 100, it can be left permanently coin-operated or, at the turn of a key, switched from a payphone to an ordinary phone and back again. When used as a payphone it accepts 2p, 5p, 10p and 50p coins and will refund unused coins at the end of a call.

Renters of the Payphone 100 will be billed for calls at the normal rate but people using the phone will have to insert coins at the higher coinbox rate. The renter retains the extra cash.

The user is warned of "credit expiry" by a flashing l.e.d. and a warning tone. A cash-box full sensor helps to prevent jammed coin slots.

The table-top payphone is particularly useful for small businesses who want to provide their customers or visitors with the use of a phone but who do not want to give away free calls. Typical users will be hairdressers, pubs, clubs, wine bars, garages, surgeries and shops. Another possibility could be for the person who has a "friendly neighbour".

Designed for use with the new socket system, it is ideal for those businesses who have only one telephone line. A single payphone allows this line to be used for both private and customer use.

When operating in the payphone mode, local trunk and international calls can be made but calls to or via the operator, except for 999 emergency calls, are not possible. When switched to "private" use all services are available.

The annual Leeds Electronics Show will take place from 5 to 7 July in the Departments of Electrical and Electronic Engineering, University of Leeds.

Training for the Micro

An advanced microprocessor training course, that can be used for "distance learning", has been developed at the IBA's Harman Engineering Training College, Seaton, Devon. The initial requirement was to provide theoretical and practical training for field engineers maintaining the microprocessor-based transmission equipment used in the new Regional Operations Centres and Channel 4 transmitting installations, including control and telemetry systems.

The programme is broken down into three stages: Microprocessor basics using a modified version of the M6800 D2 kit. Digital diagnostics for broadcast systems, including signature analysis. High-level language programming, using the Apple II microcomputer.

Inventer's Workshop

In a bid to attract local inventers with new ideas into the field of microelectronics, the Microelectronics Applications Research Institute (MARI), Newcastle upon Tyne, has set up a Microelectronics Innovation Workshop.

The innovation centre supports the use of the workshop and individuals are closely supervised by MARI staff. It is claimed that this facility is unique in that individuals receive assistance at the early stages of the invention which, at present, no other organisation provides. People can experiment and test their ideas without having to set up their own expensive production facilities, and at the same time attract customers or backers.

Japanese Buy British

Logic analysers made by British instrumentation specialists, Thandar Electronics, are being exported to Japan.

The initial order, worth £100,000, is claimed to represent a classic "reverse technology coup" for the St Ives, Huntingdon-based company which exports over 50 per cent of its output.

SHIP-SHAPE

A contract to provide a combined radar and electro-optic weapons control system, to be installed in one of the Royal New Zealand Navy's Leander Class Frigates, has been awarded to RCA Missile and Surface Radar.

This contract is part of plans to modernise and improve the Royal New Zealand Navy ships capabilities.

In addition to weapons control, the radar can be used for navigation, surveillance, aircraft control, drone control, and in search and rescue missions.

CLUB SPOT

The ACC National Prestel Committee, acting in its role as the national body representing the computer hobbyist, has linked up with Micronet 800 to create Club Spot 800, a new service to involve ordinary computer enthusiasts in Prestel editing.

Club Spot 800 will contain news and ideas about micros and micro clubs, plus programs, sales and wants, and general views.

To introduce the new service a conference is being held on February 26, starting at 2pm, at the Institute of Grocery Distribution, Grange Lane, Letchmore Heath, Watford. Registration is free in advance or £5 for those turning up on the day (subject to space being available).

For more details contact: R. Steele, ACC National Prestel Committee Secretary, St John's College, Oxford OX1 3JP.

● The Pontefract & District Amateur Radio Society is holding its annual "Component Fair" on Sunday, March 13, at the Carleton Grange Community Centre, Carleton, Pontefract. Time: 11am to 4.30pm (10.30am for the disabled).

For more information contact: Mr P. N. Butterfield, G4AAQ, Pontefract & District ARS, 43 Lynwood Crescent, Pontefract WF8 3QT.

—ANALYSIS

BELTS AND BRACES

When the first experimental communications satellites, *Telstar* and *Relay*, flew into orbit in 1962 many experts forecasted that the days of submarine cable in international traffic were numbered. When, three years later, *Early Bird* was launched into geostationary orbit 23,000 miles out in space earlier fears seemed confirmed. The submarine cable was doomed.

What a pity, we thought, so soon after the big technological breakthrough in 1956, the year when repeater technology had improved to the point when it was possible to use telephony by cable across the Atlantic Ocean, 90 years after the laying of the first successful transatlantic telegraph cable.

And yet here we are in 1983, two decades after *Telstar*, with more submarine cables than ever and new ones being laid on the ocean beds every year. What the experts didn't see was that a mature technology was still capable of "stretch". Or that new, however exciting at first sight, is not necessarily better or even cheaper.

Two main developments saved the submarine cable from extinction. One was the development of solid-state wide-band repeaters which enabled many more simultaneous telephone conversations. Thus, in a single decade, cost per telephone channel fell by a factor of 20. The other was the phenomenal growth of world telecommunications traffic now shared by both cable and satellite.

A political factor, not to be ignored, is that communications satellites are vulnerable to destruction by killer satellites which, for all we know, may already be deployed ready for action. Safety lies in both belts and braces to keep our communications trousers up, with terrestrial h.f. radio as an emergency piece of string in our pocket should belts and braces be shot away.

While cable has not only miraculously survived but actually flourished it is to have a change of character. Next year a UK-Netherlands cable will be completed at a cost of £85 million. It will carry 4200 simultaneous telephone conversations to bring the southern North Sea network to a total capacity of some 14,000 circuits. It will be the most up-to-date in the world.

But it is also expected to be the last of its type to find a land-fall in the UK, using analogue speech over wires. All subsequent submarine cables, say British Telecom, are being planned to use digital speech transmitted through optical fibre. This doesn't mean a threat to satellites. Both systems are needed and can live happily side-by-side, belted and braced in mutual support.

Brian G. Peck

INFORMATION DEGREE

British Telecom is to help two Universities produce information technology experts who will run the advanced telecommunications systems of tomorrow.

In partnership with the Universities of Aston and York, British Telecom will develop new degree courses for training 60 students to become electronic engineers with skills in telecommunications and computing.

British Telecom will pay the Universities £100,000 a year for new equipment and additional teaching staff. This support will be guaranteed for five years.

Most of the places on the courses will go to school-leavers with good "A" level grades, but some may be given to suitably qualified technicians already in Telecom's employment. The new courses will begin in 1984.

Lord of the Spectrum

The Hobbit, a full-colour adventure simulation based on J. R. R. Tolkien's fantasy land, is amongst new software for the ZX Spectrum and ZX81 personal computers announced by Sinclair Research.

The player assumes the role of Bilbo and undertakes a series of adventures in which he will meet and interact with all the novel's other leading characters. Depending on his decisions each game will develop differently.

Compiled by Melbourne House to use the full potential of the 48K Spectrum, features include original artist-designed graphics and a built-in 500 word "inglish" vocabulary to instruct the computer. The package, price £14.95, comes complete with a copy of the novel.

JUST THE TICKET

Government approval of British Rail's plans to invest £21 million in new ticket issuing machines will soon bring BR's ticket offices into the micro age. Up to £17 million of the investment is for a new all-purpose ticket issuing system and the remaining £4 million is for PORTIS, a portable version of the main system for use by guards on pay trains.

Subject to satisfactory evaluation of the prototypes, the new machines should come into operation in mid-1984 and be fully established by the middle of 1986.

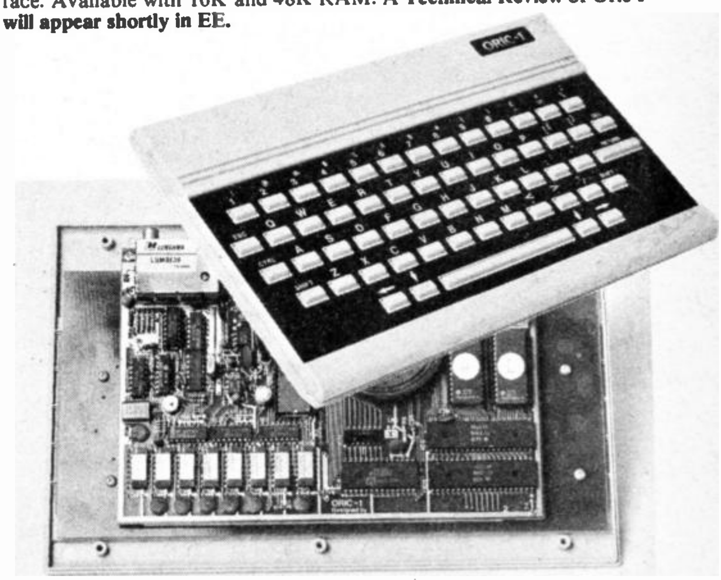
ORIC GOES INTO PRODUCTION

A new computer named Oric I has just gone into mass production. Over 250,000 of these machines are expected to be sold in its first year. Its market will be that at present enjoyed by the ZX Spectrum and will be the first competitor to a Sinclair computer.

Based on our impressions of a pre-production model we received, the company responsible for the Oric, **Oric Products International Ltd.** have a machine to be proud of in both appearance and performance.

The computer is equipped with a unique type of keyboard with space bar forming one of the 57 positive action keys on a qwerty arrangement, extensive colour, music and sound effects capabilities.

There is an r.g.b. output as well as u.h.f. The cassette tape in/out runs at 2400 Baud (!!!). There is access to the bus at the rear of the computer and an output suitable for driving a Centronics-type interface. Available with 16K and 48K RAM. **A Technical Review of Oric I will appear shortly in EE.**



EPROM PROGRAMMER FOR THE ACORN ATOM

PART TWO **BY D. C. GRINDROD**

THE second and final part of this project deals with the construction, software and testing.

CIRCUIT BOARDS

Two circuit boards are used in the construction of the Eprom Programmer, one to hold the power supply components and the other for the EPROM socket and d.i.l. connection sockets for connecting to the Atom.

Begin with the power supply board, this is shown in Fig. 3. The layout of the components on the topside is shown together with the breaks to be made on the underside. The prototype used a p.c.b. mounting type transformer. If this is not available, a chassis mounting type may be used, suitably positioned on the case with its leads connected to T1 fixing location as shown.

Make the required breaks in the copper strips and then solder the components in place as shown in Fig. 3. The leads on the i.c.s need to be formed to fit the board.

A small piece of adhesive paper stuck to the board should be used to identify the pins on *PL6*. If the voltages become transposed, then the EPROM would become permanently damaged.

When you are satisfied that all components are correctly wired up the power supply board may be tested. Temporarily connect a mains cable and plug across the primary of T1. Set VR2 to its midway position.

Fix a length of 4-way ribbon cable to SK5. Label the positions of the individual sockets in SK5: 0V, 5V, 25V and *B* as appropriate. Plug into *PL6* on the board and with a voltmeter, check that the +5V supply is present. It may vary a little from +5V but should never exceed 5·25V else the EPROM will become damaged.

The 25V supply at this time should read between 15 and 30 volts. Adjust VR2 until the reading is 25 volts, exactly. Next adjust VR1 until the voltage at *B* is about 22 volts with respect to the 0V rail. It may be trimmed in later.

Since the 7805 regulator incurrs a 20V drop it will get hot. If the Eprom Programmer is expected to be in use for prolonged periods at a time the use of a heatsink is recommended or use a reduced secondary tapping such as 9V.

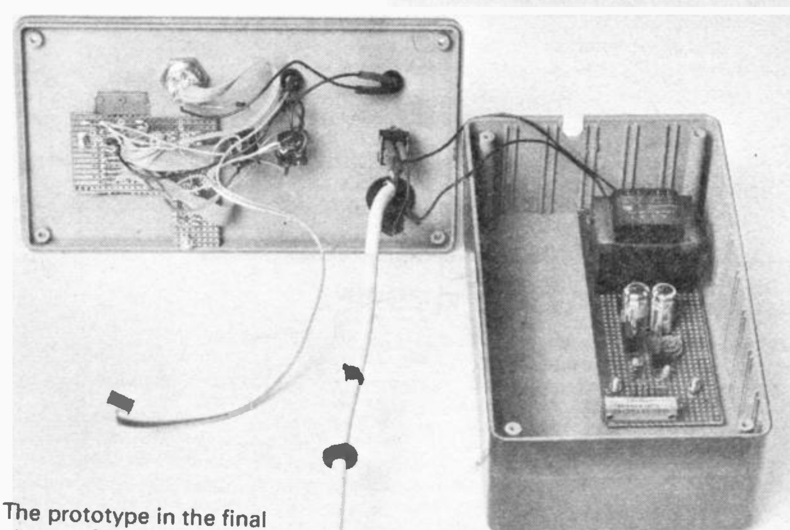
The topboard connects ports A, B and C to the EPROM socket and control switches.

Dual-in-line sockets were used for ports A and B due to their cheapness and reliability. A standard 5-way 270° DIN socket was used for port C. There is no reason why a different connector system could not be used.

The topboard is shown in Fig. 4. It has been drawn as in the prototype but a square piece of stripboard could be used.

In the prototype the SK5 was a 24-pin Zero Insertion Force (z.i.f.) socket. As its name implies it exerts no force on the pins of the EPROM being programmed or read. It drops into holes in the socket and moving the lever to a horizontal position causes the socket contacts to grip the EPROM pins. Move the lever to a vertical position to release the grip and allow the EPROM to be removed.

The z.i.f. socket was plugged into a low profile 24-pin socket soldered to the board, but it may be soldered to the board direct if desired.



The prototype in the final stages of construction.

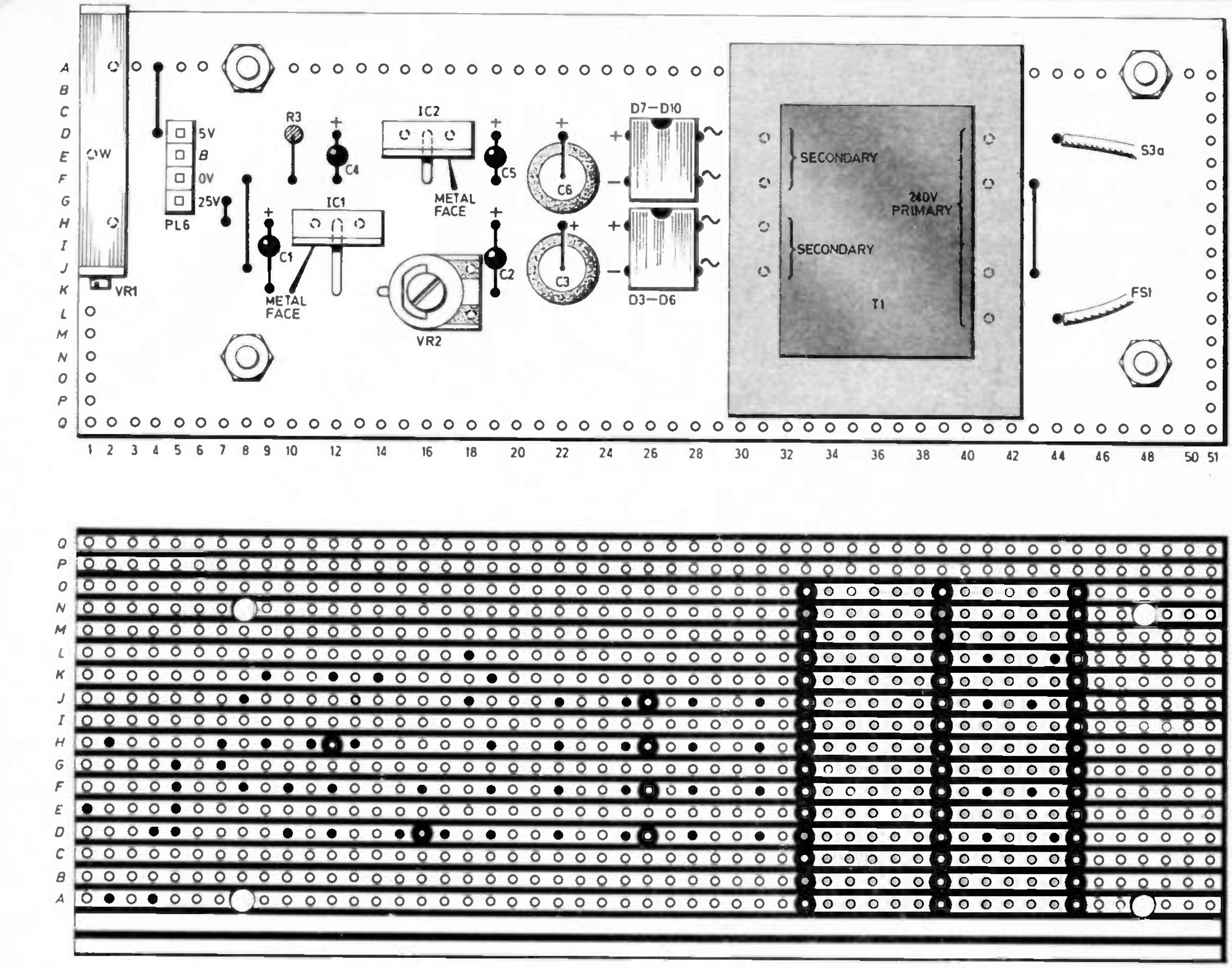
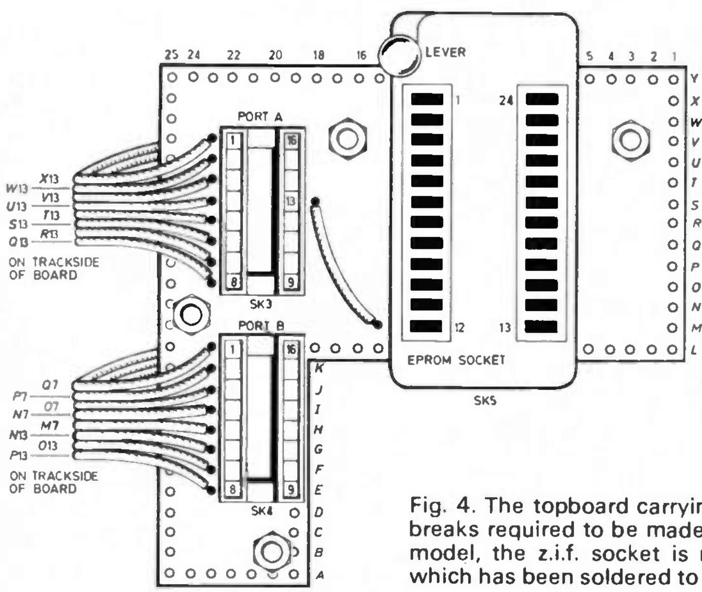


Fig. 3. The layout of the components for the power supply section of the Eprom Programmer and the breaks to be made on the copper side of the board, with drilling details.



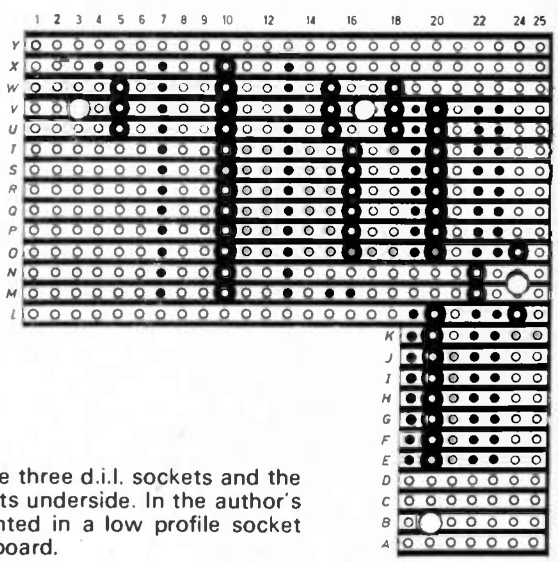


Fig. 4. The topboard carrying the three d.i.l. sockets and the breaks required to be made on its underside. In the author's model, the z.i.f. socket is mounted in a low profile socket which has been soldered to the board.

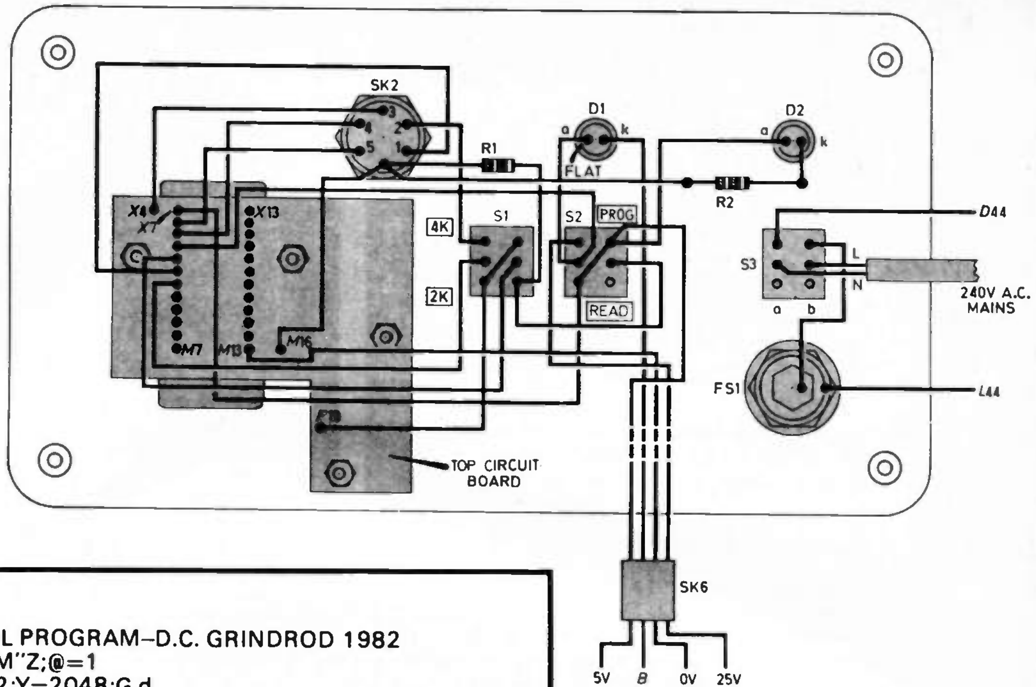


Fig. 5. Complete interwiring details and suggested component layout on the lid of the case.

PROGRAM A

```
  1 REM BASIC CONTROL PROGRAM–D.C. GRINDROD 1982
 2bIN. "2K OR 4K EPROM"Z;@=1
  3 IF Z=2 U=224;X=192;Y=2048;G.d
  4 IF Z=4 U=192;X=224;Y=4096;G.d
  5 G.b
 6d?£B80C=X;?£B802=255;?£B803=255
  7 P.$12, "SET SWITCHES TO PROGRAM AND "Z"K" '
10aIN. "RAM START ADDRESS"C,"RAM END ADDRESS"D
 15 IF D–C+1>Y P. "PROGRAM EXCEEDS "Z"K.START AGAIN"; G.a
 16 P. "PROGRAM LENGTH IS "D–C+1"BYTES" '
20cIN. "EPROM START ADDRESS"E
 25 IF E+D–C+1>Y P. "PROGRAM WILL NOT FIT IN EPROM" ';G.c
 26 P. "EPROM END ADDRESS" E+D–C
 30 F=E&£FF;G=E&£FFFF/256
 35 ?£B002=G
 39 P. "PROGRAMMING STARTED" '
 40 F.A=C TO D
 50 ?£B801=f;?£B800=?A
 53 ?£B80C=U;F.B=0 TO 109;N.;?£B80C=X
 55 F=F+1
 60 IF F=256 G=G+1;F=0;?£B002=G
 70 N.
 80 P.$11,"PROGRAMMING COMPLETE",
          $7,$7',"SET MODE SWITCH TO READ" '
 90 E.
```

PROGRAM B

```
  1 DIM LL4
  2 F.D=0 to 4;LLD=–1;N
  5 F.X=1 TO 2
 10 P=£2890
 20(/FULLY RELOCATABLE M/C D.C. GRINDROD 1982
 30:LL4 LDX @192; LDY @0; LDA @255
 40 STX £B80C;STY £B802;STA £B803
 50 LDX £33D;LDY £33E;STX £B002
 60 STY £81;STX £83
 70 LDX £322;LDY £323
 80 LDA @0;STA £80
 90:LLO STX £B801
100 LDA £B800;STA (£80),Y
110 LDA £33F;CMP £83;BNE LL1;CPX £324;BEQ LL2
120:LL1 INX;INY;CPX @0;BNE LL3; INC £B002;INC £83
130:LL3 CPY @0;BNE LLO;INC £81
140 CLC;BCC LLO
150:LL2 RTS
160);N.
170 E.
```

Grey ribbon cable (Speedbloc cable) was used in preference to the "rainbow" type as it is lighter and more pliable.

TOP PANEL

First of all prepare the lid of the chosen case to accept the case mounted components. Make the cut-out to accommodate the z.i.f. socket. Fix all the components in place. Fit the board fixing screws to the case lid and hold in position with full nuts. These also act as spacers. Position and solder the sockets to the board, make the link wire connection on the board topside and then attach 120mm lengths of 8-way ribbon cable to the non-copper side as shown.

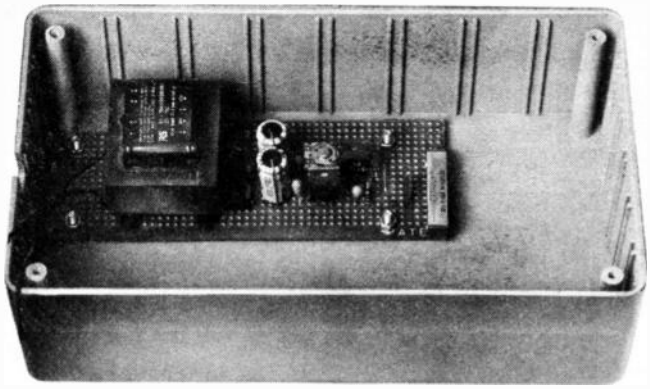
Now fit this board in place and secure. The remainder of the wiring to this board is soldered directly to the copper trackside of the board. The complete wiring of the panel mounted components is shown in Fig. 5. The wiring should all be carried out with p.v.c. covered lightweight wire. Note that R1 is directly wired between SK2 and S2, and R2 directly to the leg of D2. Sleeve all mains input connections for reasons of safety.

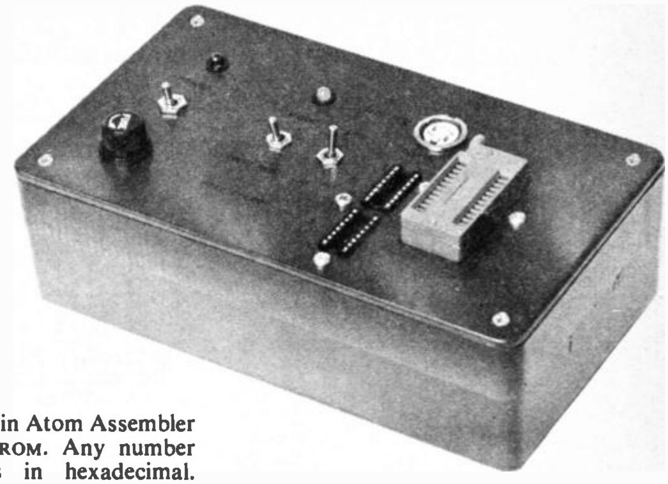
Do not attach the ribbon cable from the topside of the board to the underside until last. Carefully check all wiring and make sure there are no bridges across adjacent copper tracks. Attach SK6, check and label its connections.

LEAD SET

A set of leads need to be made up to connect the Eprom Programmer to the Atom. One will be terminated at one end with a 64-way (a+b) DIN indirect connector, with the other end fitted with two separate 14-pin d.i.l. header plugs.

The second lead will have a 7-way DIN plug at one end (Atom cassette port) and a 5-way DIN plug at the other to





(Left). Early stage of assembly. Power supply board in position in base of case. (Above). The completed unit.

match with the socket on the Programmer. Full pinning details are provided in Fig. 2 to allow these leads to be constructed.

SETTING UP

The power supply board will not at this stage be mounted in the case. After all interconnections have been made check that there are no solder bridges between adjacent tracks on the upper circuit board.

Next check for continuity between the EPROM socket SK5 and the input sockets, SK2, SK3 and SK4. Check the routes for both positions of S1. Check also for continuity of the supply lines from SK6 to the SK5 positions pin 12, 21 and 24, for all combinations of S1 and S2. Remember that A11 floats for 2K EPROMs and that CB2 is on pin 18 for 2K types and pin 20 for 4K types.

Plug SK6 into *PL6*, plug the unit into the mains and switch on. The power on l.e.d. D2 should light up. The bi-coloured l.e.d. should be lit either red or green according to the setting of S2. Operate S2 and adjust VR1 until both green and red are of equal brightness. Check that the +5V rail is still within limits as VR1 does lift its level by 0·1V or so. If all is well, switch off at the mains and secure in the case.

Switch on again and check the power supply pins on SK5. You should read 5V (5·25V max.) between pins 24 and 12, and 25V between pins 21 and 12 for S2 in PROG mode and 5V when in the READ mode.

A final check should be made using an ohmmeter between adjacent pins on SK5. Shorted tracks on the data or address busses could cause the 6522 (VIA) or 8255 to source too much current and possibly become damaged.

It is good practice to leave the MODE switch in the READ position until the program wants it changed. This prevents any accidental programming by erroneous port values before they are initialised.

SOFTWARE

The software for the Eprom Programmer is in two parts: Program A, the control program in Basic for programming the EPROM; and Program B, a machine code program written in Atom Assembler form to read the EPROM. Any number prefixed by "£" is in hexadecimal. Characters in lower-case represent inverse video characters.

TESTING

Connect the Eprom Programmer to the Atom and switch on the latter. The computer should function normally. Turn on the Programmer.

First of all load the byte £AA into RAM at say £8200, then enter the Basic control program, Program A. Set mode switch to PROG and run the program without an EPROM in place. When asked for EPROM start and end address, type in 00F. After "PROGRAMMING COMPLETE" message is received, measure address bus and data bus voltage levels at SK5. The voltage level from D0 to D7 should alternatively read 0V and 5V or very near these values. A0 to A3 should read 5V and the remaining address lines, 0V. If not, find out why not before proceeding.

With the Programmer turned off, insert an EPROM. Set S2 to READ S1 to appropriate size and then switch on.

Load a small program into RAM at say £8200 then enter Program A. Now run the program and follow the instructions. On completion, remember to set mode switch to READ. Enter Program B and run it to get the program assembled.

As mentioned earlier the variables are passed to the machine code routine via the integer variables *A*, *B* and *C*.

A = EPROM start address
B = RAM start address
C = EPROM end address

If we want to load the EPROM contents into RAM at say £8200 then we type:

A=0;B£8200;C=end address of eprom*; LINK £2890

followed by return. This address is given by the Basic control program.

The cursor will reappear almost instantly. (The execution times are 45μs (2K) 165μs (4K).) To check this set TOP (?18=£82) and type E.; RUN. If all is well then save the machine code on tape thus:

*SAVE "EPROM READ" 2890 28DF

A2	C0	A0	00	A9	FF	8E	0C
88	8C	02	88	8D	03	88	AE
3D	03	AC	3E	03	8E	02	B0
84	81	86	83	AE	22	03	AC
23	03	A9	00	85	80	8E	01
B8	AD	00	88	91	80	AD	3F
03	C5	83	D0	05	EC	24	03
F0	14	E8	C8	E0	00	D0	05
EE	02	B0	E6	83	C0	00	D0
DD	E6	81	18	90	D8	60	

Hex dump of the program.

Table 2: Allocation of ports

PORT	ADDRESS	USE
PORT A	£8800	ADDRESS LINES A0 TO A7
PORT 8	£B801	DATA BUS TO/ FROM EPROM
PORT C	£B002	ADDRESS LINES A8 TO A11

CONCLUSION

This article has outlined the essentials of programming EPROMS and reading their contents. If more serious applications are required the machine code routine could be modified to be called by the burning program, and compare memory and EPROM for verification by changing the STA instruction in line 100 to a CMP instruction and writing an error routine for mismatch of contents.

Erasure of the EPROM is achieved by exposure to ultraviolet light of wavelength 2537°A with minimum integrated dose of $15W/sec/cm^{-2}$.

The author found an 8W Sylvania germicidal lamp at 2cm a suitable eraser. Erasure takes about 15 minutes. In the erased state each EPROM location contains 255. □

RADIO WORLD

By Pat Hawker, G3VA

The Electronics Epoch

The development of radio and electronics over the past 100 years has had a profound effect on everyday life, though I am not sure that I go along with those who say that information technology will prove to be the coming of the second industrial revolution.

Despite the impact of electronics on our whole way of life—for better or for worse—the subject has not been very well served by the historians. There are few books that treat the subject analytically and dispassionately and too many that are concerned with claiming credit for particular persons and countries.

Baird did not "invent" television. Marconi, although he himself invented very little, still has the best claim to have developed radio communication despite the, in some ways, valid claims on behalf of Popov, Loomis, Tesla, Hughes, Jackson and others.

Watson-Watt certainly developed radar in the UK, but there were others working on similar lines in other countries, and it can be argued that the greatest British contribution was the 1940 development at the University of Birmingham by H. A. H. Boot and J. T. Randall of the cavity magnetron as a high-power generator of centimetric waves.

However, even this device owed something to the arrival in England, in May 1940, of the French scientist Maurice Ponte who brought across the Channel his resonating segment magnetrons which the British team recognised as having saved them six months of work.

International Help

The need for international co-operation on the writing of scientific and technical history has been brought home to me by receiving a much-appreciated copy of the magnificently-produced book "The Electronic Epoch". This has been written by the talented Elizabeth Antebi, a writer and producer with French broadcasting, supported by an impressive international team of scientific advisers. The UK is represented by Dr William Gosling, formerly Professor at Bath University and now research director of Plessey.

This large, heavily-illustrated book, printed in Japan, with the English-language version published by the Van Nostrand Reinhold Company, must be the first time that a serious attempt has been made to produce an international synthesis of the whole electronic epoch in both words and pictures. Subjects covered include communications, television, consumer electronics, medical electronics, radar and radio navigation.

Elizabeth Antebi has gone to enormous trouble to collect a vast number of historical photographs and to ensure that the text comes at least as close to historical truth as is possible in an industry where "not invented here" is still too often a reason for condemning new technology.

Electronic Umpiring

This year has seen the first live television transmission of a Test Match direct from Australia though once again the midnight start emphasised the unsolvable problem of large time differences. But the recent Test series also underlined the problem presented by instant slow-motion replay on television where the audience can see all-too-clearly that umpires sometimes make mistakes.

Clearly the ability of television to undermine confidence in umpiring decisions is something that needs to be considered seriously. In tennis one has seen the growing tendency to question the judgement of linesmen, although this has not been entirely solved by introducing a degree of electronic instrumentation. Yet for horse-racing few would dispute the value of the camera for close finishes—and the value of the special television recordings when objections are raised.

Action Replay

There would seem little logical reason why in cricket, the umpire in cases of doubt should not ask a clubhouse "referee" to advise him on the basis of an action replay, using perhaps a pocket radio. To prevent too many hold-ups to the game some rules would have to be worked out on how often, or just when, this facility could be used, otherwise we might have more attempts to intimidate umpires by players! But it seems absurd if the television audience can see so clearly that decisions made in good faith by the umpires are wrong.

Crystal-Ball Gazing

If at times historians get things wrong so do those who attempt to predict the future of developing technology. I have been amused to discover from various compilations (including R. L. Weber's "A random walk in science", published by The Institute of Physics) some predictions that the experts concerned must have come to wish they had never made:

"There is no plea which will justify the use of high-tension and alternating currents, either in a scientific or a commercial sense . . . I can see no justification for the introduction of a system which has no element of permanency and every element of danger to life and property"—Thomas Edison, 1889, in advocating d.c. mains.

"As far as sinking a ship with a bomb is concerned, you just can't do it"—US Rear-Admiral Clark Woodward (1939) on bombing from aircraft.

"Wireless is totally unsuited for war; the enemy could either hear all conversations, or could jam transmissions so nothing can be heard"—an earlier American rear-admiral in 1903.

"That is the biggest fool thing we have ever done. The bomb will never go off, and I speak as an expert on explosives"—yet another US admiral: William Leahy to President Truman, 1945, on the atomic bomb.

When in 1913, Lee de Forest, who first put a grid into a diode valve, was charged with fraudulently using the US mail to persuade the public to invest in his company, the District Attorney claimed: "De Forest has said . . . it would be possible to transmit the human voice across the Atlantic before many years. Based on these absurd and deliberately misleading statements, the misguided public has been persuaded to buy stock". It was only two years later, 1915, that the first radio transmission of speech across the Atlantic was accomplished!

On the other hand, it is easy to be a little over-confident. The French engineer Edouard Belin, in January 1926, said: "I am certain that before the end of 1926 an orator speaking into the microphone will have both his voice and his image transmitted simultaneously all over the globe". He was roughly 40 years out—the first genuine world programme by satellite on television was in 1965.

The Chinese have a proverb that the fish are the last to discover water; and Nicholas Butler once said: "An expert is one who knows more and more about less and less".

um

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Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

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The potential is enormous, and the module will be available in the early part of 1983 for around £30.

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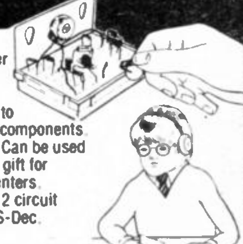

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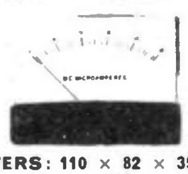

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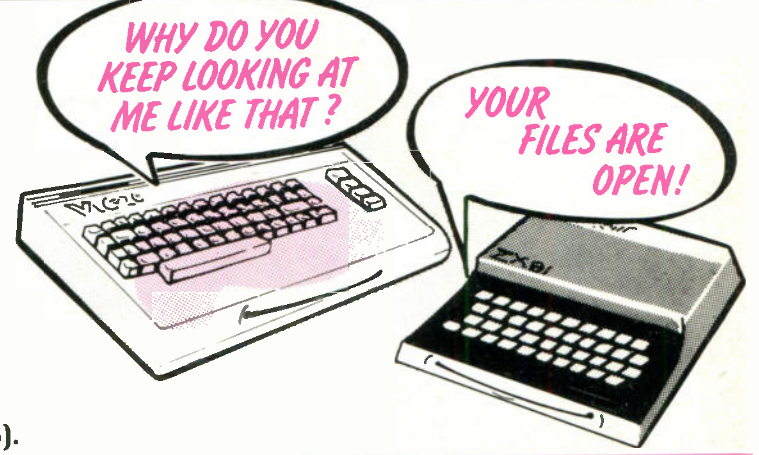

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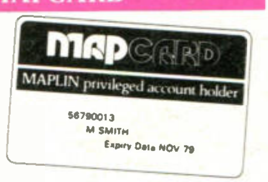

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