Easy to build projects for everyone

Everyday ELECTRONICS

AUG. 82
70p

Quiz MASTER

WHO WAS FIRST ON THE BUTTON ?

CB ROGER BLEEPER

TWO-TONE DOORBELL

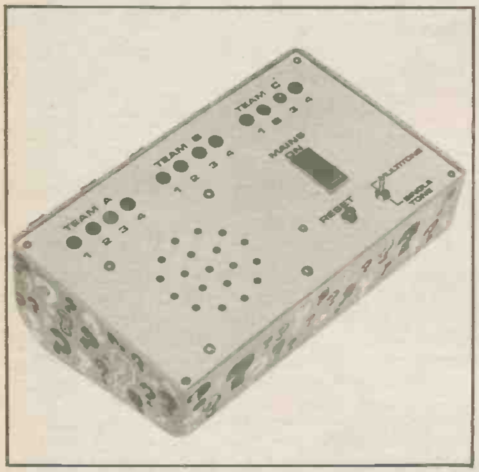
TEMPERATURE INTERFACE for TRS-80/1 MICROCOMPUTER

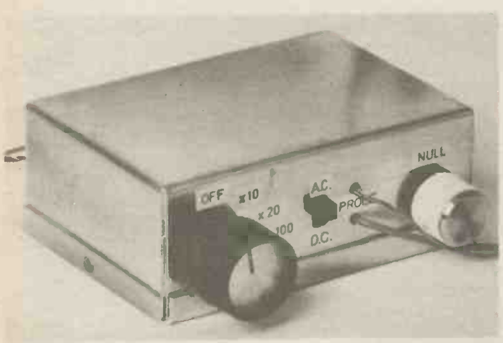
Australia $1·35 New Zealand $1·60 Malaysia $4·95 IR £1·06 (inc. V.A.T.)

VOL. 11 NO. 8 AUGUST 1982

Everyday ELECTRONICS

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .





SCHOOLS
Electronic Design Award
COMPETITION

Winners of this competition were announced at a special Prizegiving Ceremony held at Mullard House, London on Tuesday June 29, 1982.

A full report will appear next month.

PROJECTS

SERIES

FEATURES

Our September issue will be published on Friday, August 20. See page 511 for details.

VOL. 11 NO. 8 AUGUST 1982

Everyday ELECTRONICS

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COMPUTER ADD-ON'S

Are you getting the most out of your computer?

With tens of thousands of personal computers in private hands, this is quite a reasonable question and one that will be highly relevant to an appreciable proportion of our readership.

Those computer owners who are experienced in circuit construction are indeed in an enviable position. Using this practical expertise they will find new fields to conquer and added zest given to that hobby in the process of extending further their computing interests in a worth-while manner, as we hope to demonstrate.

There are many intriguing uses for the personal computer beyond conventional "hands on" computing; uses that will help justify the capital outlay for a fairly expensive piece of equipment. Moreover such uses need not in any way interfere with normal operation, be it playing games or more serious computing tasks.

As an example, remotely sited sensors could be connected to an available address on the computer and a program produced to display stored temperature readings in the form of graphs, upon demand. Such an application would make sense to anyone interested in monitoring temperature in some important and sensitive area—a greenhouse possibly. The add-on *Temperature Interface Unit* described this month was designed to suit the Tandy TRS-80 microcomputer but is capable of modification for application to other computers.

Continuing on this theme, we will be publishing further designs for computer add-on's in the coming months. So if you want to employ your personal computer fully, to explore and exploit those latent (and possibly unsuspected) capabilities, don't miss an issue of EVERYDAY ELECTRONICS.

GOOD GAME

Television has encouraged growth of "The Quiz". This kind of interrogative game provides good entertainment and tests one's general knowledge, and is a popular favourite at family parties and larger social gatherings, as well as at scholastic functions.

To give that touch of professionalism and to ensure the proceedings are smoothly conducted, an electronic system that registers indisputably which contestant first "hit the button" is a desirable prop. We have just the thing in the *Quiz Master* described in this issue. It is a versatile system that can accommodate various numbers of teams and contestants and will give finesse to any game.

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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TEMPERATURE INTERFACE FOR THE TANDY TRS-80

BY O.N. BISHOP

THE Temperature Interface described here allows you to use your microcomputer as a thermometer. With this device attached to the computer and a suitable program running, the computer displays room temperature in degrees Celsius or Fahrenheit.

The unit described here has been tailored for use with the TRS-80 Model I Microcomputer, but could be used with other computers provided there is access to the required signals and suitable software is developed. The 19 lines to the computer will need to be re-arranged and terminated in a plug/socket to suit the particular computer.

MEMORY

An ordinary thermometer can only show the temperature as it is at the moment. A computer has memory, so it can store away the details of all the temperatures it has measured. It can find the maximum and minimum temperatures and it can work out rates of change.

In this way it has several applications in connection with weather recording. A series of temperatures can be plotted out later as a graph on the monitor screen or a printer.

There is even more it can do. Having measured the temperature, the computer can take appropriate action. For example, it can control the domestic heating system. It can sound an alarm when the greenhouse is getting too hot, or when there is danger of frost. It can be programmed to sound a fire alarm when it registers an excessively high temperature.

PRINCIPLE OF OPERATION

The sensor used in this circuit has a range of 0 to 70 degrees Celsius, which is wide enough for most home applications. It has the advantage that the reading is not affected by the length of wire between the sensor and the main circuit. This makes it ideal for remote sensing, which is a useful feature, since the computer is likely to be located centrally (for example, in the living room or study) with one or more sensors scattered around the house and possibly outdoors as well.

Fig. 1 shows a block diagram of the links between the temperature which is to be measured and the computer which is to register that temperature.

Temperature is what is known as an *analogue* quantity. It can take any value over a given range and changes smoothly from one value to another. For example, as it changes from 15 to 16 degrees it passes through *all* intermediate values (15·01, 15·02, . . . 15·98 degrees and 15·99 degrees C). By contrast, a computer deals with values expressed in binary *digital* form.

The computer recognises that a key is pressed or *not* pressed — a half-pressed key has no meaning. Similarly, one of its input lines may be at 0V or at 5V. Voltages close to 0V are read as 0V, while values close to +5V are read as if they were 5V. A voltage of 4·56V is not recognised as 4·56V, but as 5V (or "high"). The conversion of analogue

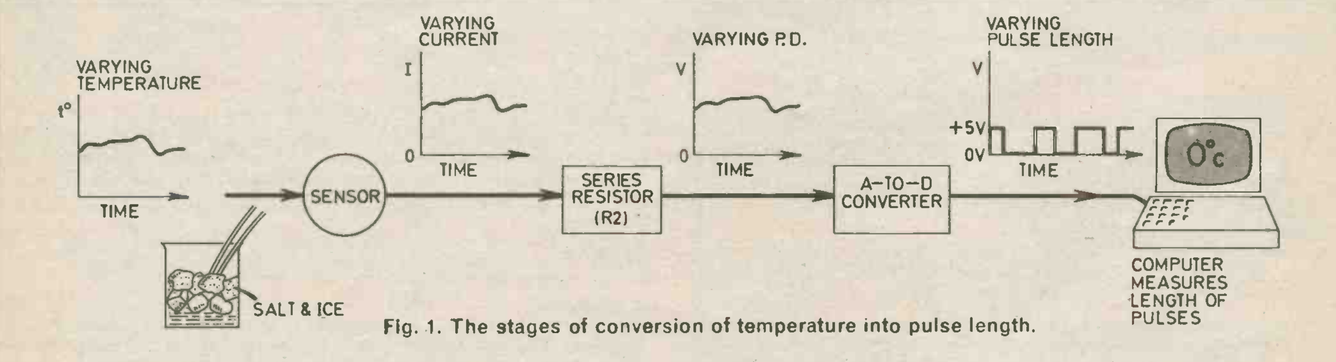


Fig. 1. The stages of conversion of temperature into pulse length.

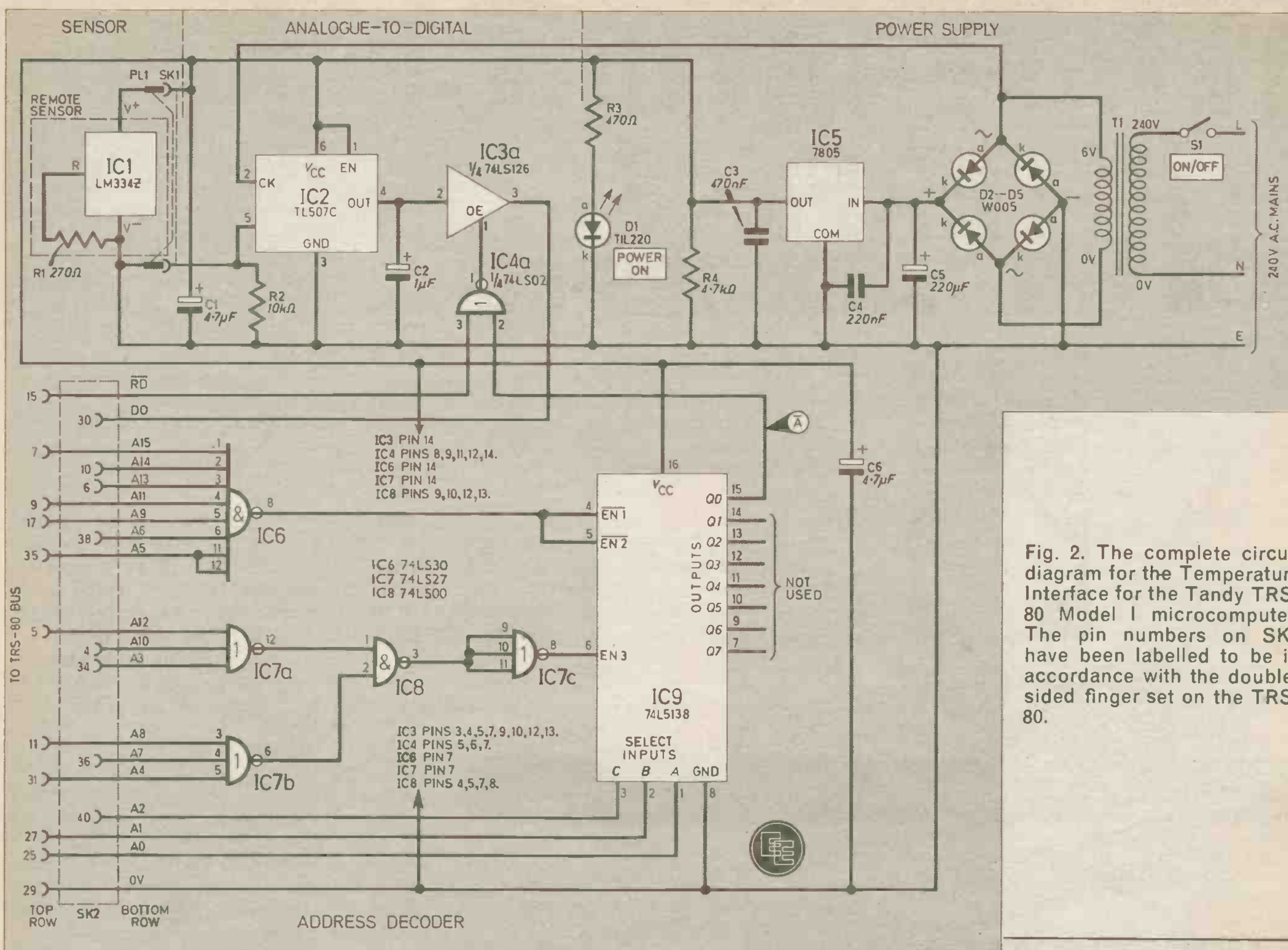


Fig. 2. The complete circuit diagram for the Temperature Interface for the Tandy TRS-80 Model I microcomputer. The pin numbers on SK2 have been labelled to be in accordance with the double-sided finger set on the TRS-80.

data into digital form is an essential step in the operation of the interface.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Interface appears in Fig. 2.

The sensor is a constant current generator i.c. IC1 in Fig. 2. At a fixed temperature it produces a constant current, provided that a voltage is applied to it. The size of the current is determined by the resistor R1. At 25 degrees Celsius the constant current I may be calculated from:

$$I = 67{\cdot}7/\mathrm{R1}$$

where R1 is in ohms and I is in mA. In this circuit, $I = 67.7/270 = 0.25$ mA or 250μA. The current is proportional to the *absolute temperature* of the sensor (the Kelvin scale):

$$I = (227 \times T)/\mathrm{R1}$$

where I is in μA and T is in degrees Kelvin. Zero degrees C corresponds to 273 degrees K, so at that temperature the constant current is $(227 \times 273)/270 = 230\mu$A.

As temperature increases, the current increases in proportion, so that at 70 degrees C, for example, the current is 288μA.

The current flowing through IC1 depends only on the temperature and the fixed value of R1. The resistance of the wires joining IC1 to the rest of the circuit make no difference to the current, which is why the sensor may be used remotely without loss of accuracy.

The next stage of conversion is done by a single resistor, R2. As the current from IC1 flows through R2 to the 0V line, a p.d. is generated across R2, according to the well-known equation: $V = IR$. Thus at 0 degrees C, the p.d. is $V = 230 \times 10^{-6} \times 10^4 = 2{\cdot}3$V. At 70 degrees C the p.d. is 2.88V.

We have now converted temperature to current, and current to voltage. All of these are analogue quantities.

The conversion of the analogue voltage to digital form is done by IC2. The 507C is much cheaper than most A-to-D converter i.c.s. A further advantage is that it has only one output, so only one line is needed to connect it to the computer, so helping to simplify the wiring. The disadvantage is that the computer has to do a little more work in order to read the temperature, but this is no problem in this application.

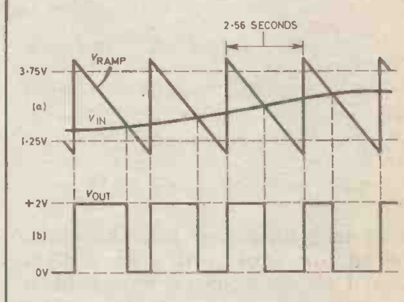


Fig. 3. Waveform in the analogue-to-digital converter, IC2, for supply voltage of +5V.

IC2 is a *voltage-to-time* converter. Fig. 3 shows how it operates. It contains a voltage generator which produces a *ramp voltage*. This starts at a value equal to three-quarters of the supply voltage and decreases at steady rate until it reaches one-quarter of the supply voltage. Then it instantly returns to its highest value again. Actually it is not a smooth ramp down, but a series of 128 small steps down.

The rate at which the voltage decreases is controlled by a clock input. For simplicity, we use an alternating signal (50Hz) taken from the power supply board. This gives a relatively slow ramp and hence a relatively long conversion time, but it is fast enough for almost all applications.

Whenever the ramp voltage is greater than the input voltage (that is, the p.d. across R2) the output of the i.c. is high (+5V). At other times it is low (0V). This means that we get a series of pulses at 0·39Hz (50/128). The length of its low period is proportional to the input voltage.

In Fig. 3 the length of the low period increases steadily in proportion to the value of V_{IN}. A new reading is available every 2·56 seconds. The job of the computer is to measure the length of the low period and use this to calculate the corresponding temperature.

POWER SUPPLY

Since the circuit requires only 20mA, it is feasible to take its power supply from the 5V rail of the computer itself. However, many computers, including the Level II TRS-80, for which this project was designed, do not give access to the 5V line, so an external power supply is essential.

The power supply section is a conventional mains derived 5V supply circuit, based on a regulator i.c. (IC5). (D1 indicates that power is turned on.)

If your computer has a 5V output there is no need for you to build this section of the circuit, but you will need a source of alternating current (maximum ± 20V) to drive the clock input of the A-to-D converter (see later). On the other hand, if you are contemplating building more computer interfaces, you are likely to need more power than most computers can spare, so the power supply board will ultimately prove to be essential. It can supply up to 500mA, which is enough for operating several interfaces simultaneously.

DECODER

The decoder section is the means by which the computer activates the temperature-measuring circuit to read its output. The temperature interface is allocated an address in the computer memory. This must be an address that is not already allocated to its ROM or RAM, its monitor

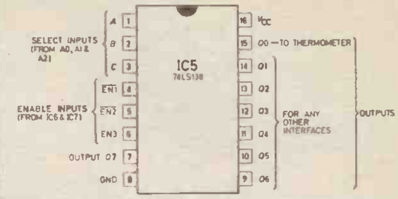


Fig. 4. The 3-to-8-line decoder I.c. (IC9) which may be used to select other interfaces at addresses 60001 to 60007 using Q1 to Q7.

screen, or to any other peripheral device. The address chosen for the temperature interface is 60,000 (decimal). Most computers (even small ones) can address up to 64K bytes of memory so this address falls within that range. Unless you actually have 64K of RAM, you are not likely to have anything else already occupying that address. If by any rare chance you have already used that address, it is a simple matter to modify the decoding circuit to change its address to another one.

The address 60,000 is written in binary form as 1110 1010 0110 0000. The address bus of the computer has 16 lines (A0 to A15) and, when the address is present on the bus, lines A15, A14, A13, A11, A9, A6, and A5 are all at +5V, while the others are at 0V. The 8-input NAND gate (IC6) receives its inputs from the seven lines listed above. When all of these are high (5V) the output of this gate goes low (0V). This provides low inputs to $\overline{EN1}$ and $\overline{EN2}$ of IC9.

The remaining lines of the address bus, except A0-A2, go to three-input NOR gates (IC7). When all these are low (0V) the outputs of the NOR gates go high. Their outputs go to IC8 a NAND gate, the output of which then goes low. This is inverted by a NOR gate IC7c wired as an inverter. The output of this goes high, taking input EN3 of IC9 high too.

The result of this decoding to $\overline{EN1}$, $\overline{EN2}$ and EN3 is to enable the outputs of IC9. The i.c. has 8 outputs. only one of which is used in this application. When the i.c. is not enabled, all of these outputs are high. When it is enabled, *one* of the outputs goes low, depending on the inputs to the three SELECT inputs *A*, *B* and *C*. For the address 60 000, the three inputs are all low. This selects output *Q0* to be made low. We call the signal from this output $\overline{A}$, to indicate that it goes low when (and only when) the required address (60,000) is present on the address bus. This output is used to inform the analogue-to-digital section that it is to be read by the computer.

SELECT INPUTS

Depending upon the states of the "select inputs", any one of the 8 outputs of IC5 can be made low. For example, if A0 is high, while A1 and

COMPONENTS

Resistors

- R1 270Ω ⅛W hi-stability ± 2%
- R2 10kΩ hi-stability ± 2%
- R3 470Ω
- R4 4·7kΩ

All ¼W carbon ±5% except where stated otherwise

Capacitors

- C1 4·7μF 6V tantalum bead
- C2 1μF 6V tantalum bead
- C3 470nF polyester type C280
- C4 200nF polyester type C280
- C5 220μF 10V elect
- C6 4·7μF 6V tantalum bead

COMPONENTS approximate cost £16

Semiconductors

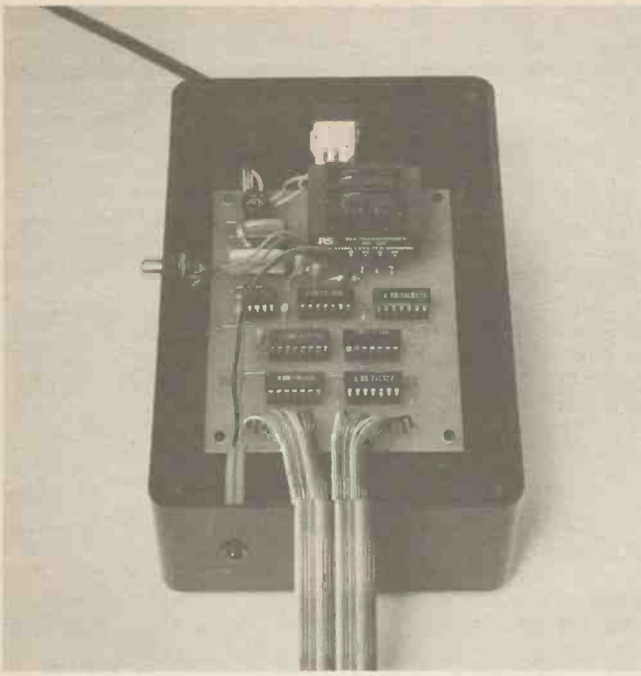
- D1 TIL220 0·2 inch red l.e.d.
- D2-D5 W005 50V 1A bridge rectifier
- IC1 LM334Z programmable current source
- IC2 TL507C analogue-to-digital converter
- IC3 74LS126 TTL quad buffers, tri-state output
- IC4 74LS02 TTL quad 2-input NOR gates
- IC5 7805 5V regulator TO-220 case style
- IC6 74LS30 TTL 8-input NAND gates
- IC7 74LS27 TTL triple 3-input NOR gates
- IC8 74LS00 TTL quad 2-input NAND gates
- IC9 74LS139 TTL 3-to-8 line decoder

See Shop Talk page 523

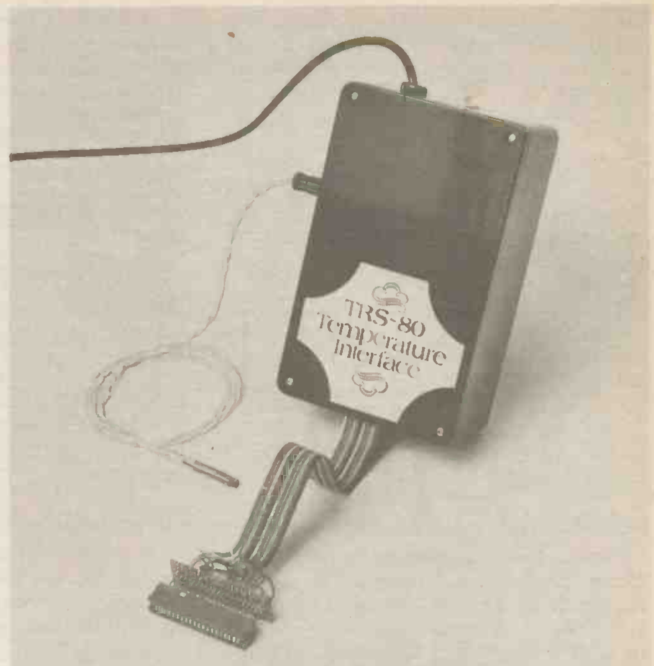
Miscellaneous

- T1 mains primary/0–6V, 0–6V 250mA secondaries p.c.b. mounting (RS 207-829)
- SK1 panel mounting phono socket
- SK2 20 + 20 way edge connector with wire-wrap pins
- PL1 phono plug
- S1 s.p. on/off rocker suitable for mains use

Printed circuit board, single-sided size 112 × 81mm; stripboard: 0·1 inch pitch size 20 strips × 7 holes; plastic stand-off pillars 6mm (Vero type 203-21321K)—(4 off); plastic case size 100 × 110 × 55 (Vero type 202-21391A); 20-way ribbon cable, 20cm; d.i.l. i.c. sockets 8-pin (1 off), 14-pin (5 off), 16-pin (1 off); mains cable, approx 1 metre 3-core; bush and clip for D1; ribbon cable clips 20-way (2 off); length of twisted wire to connect sensor to unit; strain relief bush to suit mains cable; rubber feet for case (4 off).



Interior view of the fully assembled prototype built on a single p.c.b.



The completed unit ready for plugging into the expansion slot on the TRS-80.

A2 are low (001), the output *Q1* goes low (Fig. 4). This could be connected to a second analogue-to-digital section or some other interface board. This low output occurs only when the address on the bus is 60 001. The decoder board can be used for any address from 60 000 to 60 007. Later, you may wish to connect other interfaces to your computer, you can use this board to decode their addresses.

ANALOGUE TO DIGITAL

The way IC1 and IC2 work has already been described. They operate continuously, with IC2 sending out a steady stream of pulses. When the computer is to measure the length of a pulse, the output from IC2 must be fed to one of the lines of the computer data bus. Line D0 is used here.

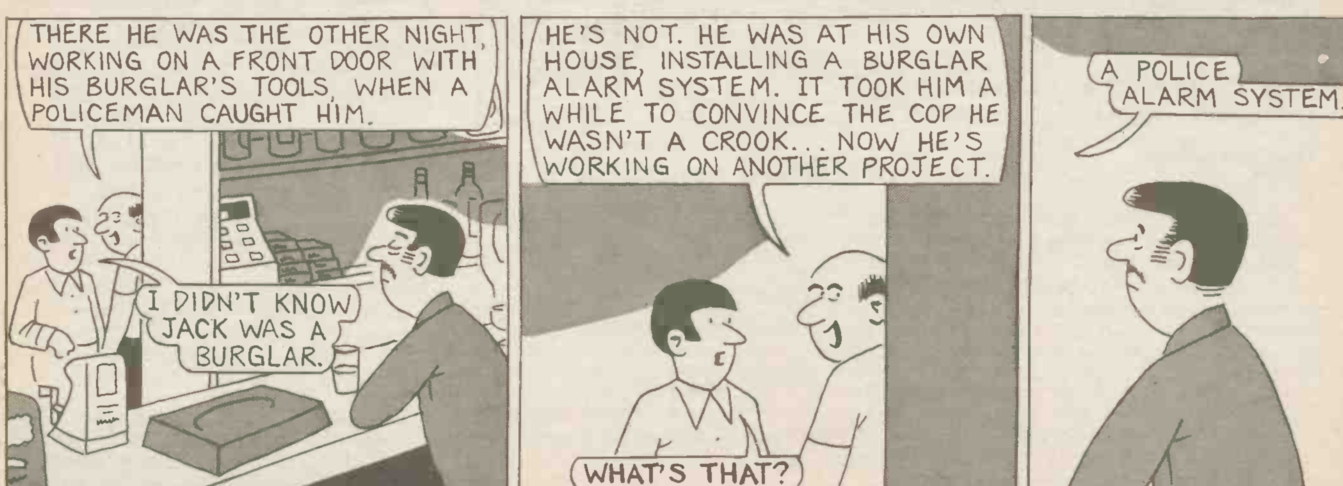
The data bus is used for transferring data between the various parts of the computer, including the microprocessor, and the ROM and RAM. Since all these other devices need to use the data bus, too, the signal from the thermometer must not be present on the bus except when it is to be read. The signal is fed to a buffer gate (IC3a) with tri-state output.

The meaning of the term "tri-state" or "3-state" is that the output can be high or low when the gate is enabled, but when the gate is disabled, it is in effect disconnected from the data bus and there is no output. This is the "high impedance" state.

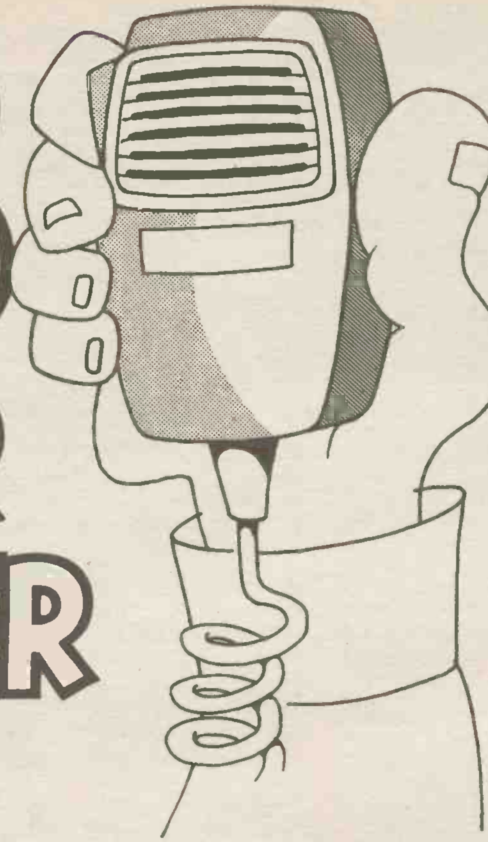
The gate is enabled by a high input to its "strobe" terminal (pin 1) labelled OE. This is controlled by a 2-input NOR gate (IC4a). One input of this gate is the $\overline{A}$ signal (meaning "address 60 000 present"), the other is the $\overline{RD}$ signal. The computer has a control line called $\overline{RD}$, which is normally high, but which is made low whenever the microprocessor is to receive data *and* the address it is to receive it from is already present on the address bus. So when $\overline{A}$ is low, and $\overline{RD}$ is low, the output of IC4a goes high and the tri-state buffer is enabled.

Signals from IC2 are then transferred to the data bus (D0) and read by the computer.

JACK PLUG & FAMILY... BY DOUG BAKER



CB ROGER BLEEPER



BY R.A.PENFOLD

A ROGER BLEEPER is a useful device which is featured on some of the more expensive citizens band transceivers. The purpose of the Roger Bleeper is simply to produce a brief audio tone at the end of each transmission, making it clear to other operators that the transmission has ceased.

This facility can easily be added to a citizens band transceiver that does not have a built-in bleeper, and there is no need to modify the transceiver in any way. The add-on Roger Bleeper circuit is simply fitted between the microphone and the transceiver. The add-on Roger Bleeper described here operates from an internal 9 volt (PP3 size) battery, and as it has a current consumption of only about 1mA the battery life is very long indeed.

OPERATING PRINCIPLE

Citizens band transceivers normally have the transmit/receive switch on the microphone in the form of a P.T.T. (Push To Talk) switch. The P.T.T. microphone usually has two switches, as shown in the circuit diagram of Fig. 1, and one of these (S1a) simply disconnects the non-earthy lead of the microphone when the switch is in the "receive" position.

The other switch (S1b) is a double throw type, and it produces a short circuit across leads "2" and "4" when the switch is in the "transmit" position. This short circuit is used to operate the transmit/receive switching circuit of the transceiver, and this is almost invariably some form of electronic switching these days rather than mechanical switching via a relay.

Lead "1" is not always used, but it is often connected to the loudspeaker and provides a path to earth for this in the "receive" mode, but not in the "transmit" mode. This ensures that there can be no breakthrough of the audio modulation to the loudspeaker if the transmit/receive switching of the transceiver does not mute the audio output stage.

AUDIO TONE

The Roger Bleeper must generate an audio tone and mix it with the microphone output signal. This is easily achieved in practice and simply requires an audio oscillator with its output fed to lead "3" via a high value resistor. The only slight complication here is that the oscillator must be muted while the P.T.T. switch is in the "transmit" position so that the audio tone is not mixed with the voice modulation, and this is not difficult to arrange in practice. There is no need to mute the oscillator during "receive" since the tone will not break through to the output.

The other function the unit must fulfil is to hold the transmit/receive switching in the "transmit" mode for about 100 to 200 milliseconds after the P.T.T. switch has been released. This means that the switch in the microphone can no longer directly control the transmit/receive switching, but must instead control it via circuitry within the Roger Bleeper that gives the required brief hold on.

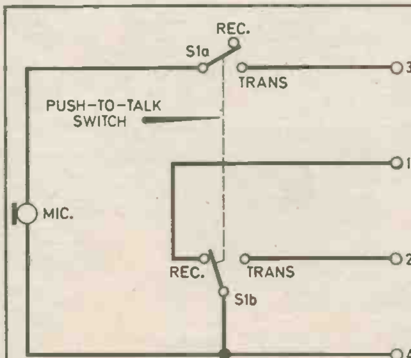


Fig. 1. The circuit of a CB P.T.T. Microphone.

THE CIRCUIT

Refer to Fig. 2 for the circuit diagram of the Roger Bleeper.

COMPONENTS

Resistors
- R1 10kΩ
- R2 100kΩ
- R3 8·2Ω
- R4 1·8MΩ
- R5 10kΩ
- R6 1·2MΩ
- R7 12kΩ
- R8 12kΩ
- All ¼W carbon ±5%

See Shop Talk page 523

Capacitors
- C1 33μF 10V tantalum
- C2 2·2nF ceramic
- C3 3·3nF ceramic
- C4 3·3nF ceramic
- C5 3·3nF ceramic
- C6 10μF elect. 25V

Semiconductors
- TR1 BC109 *npn* silicon
- TR2 BC109 *npn* silicon
- TR3 BC109 *npn* silicon
- D1 1N4148 signal diode

Switch
- S1 miniature toggle type d.p.d.t.

Miscellaneous
- B1 PP3 9V battery and connector to suit
- PL1 4-way chassis inverting plug } pair of audio connectors (Maplin YX53H)
- SK1 4-way line socket }

Metal case type AB7 or similar. Four-way screened lead. Stripboard 0·1in. matrix 21 holes by 14 strips.

Approx. cost Guidance only **£6·70**

A phase shift oscillator is used to generate the audio tone, and this uses TR3 in the usual configuration. This transistor is used as a high gain common emitter amplifier with feedback applied between the collector and base terminals by way of the three section phase shift network which comprises C3 to C5, R7, and R8.

Although the collector and base of TR3 are 180 degrees out-of-phase, at a certain frequency there is a 60 degree phase shift through each section of the phase shift network, giving a total shift of 180 degrees and bringing TR3 collector and base effectively in-phase with one another. As the voltage gain of TR3 is greater than the losses through the phase shift network the circuit oscillates at the frequency where the 180 degree phase shift occurs, which is about 1·5kHz with the specified component values.

OSCILLATOR MUTING

When S1 is in the "on" position S1a connects the cathode (+) terminal of D1 to the transmit/receive switch in the microphone, and D1 cathode is connected to the negative supply rail during transmissions. This taps off most of TR3 base bias and mutes the oscillator during transmissions.

The output signal from the collector of TR3 is far larger than the microphone signal, and R4 is therefore used to attenuate the signal to a suitable level and feed it to the input of the transmitter. The high value of R4 ensures that adding the Roger Bleeper unit does not significantly shunt the input impedance of the transmitter.

TRANSMIT MODE

When the unit is switched on the transmit/receive switch in the microphone also connects to the base of TR2 via R3, and in the transmit mode it holds TR2 in the off state. TR1 is therefore biased hard into conduction by R1, and the low collector to emitter impedance of TR1 is coupled to the output lead and used to hold the transceiver in the transmit mode.

When the P.T.T. switch is released, C1 soon charges via R2 to the point where TR2 is biased into conduction and TR1 is switched off. There is a brief delay of about 100 to 200 milliseconds before this happens, and before TR1 switches the transceiver to the receive mode.

During this period the oscillator is "enabled" and the "bleep" tone is transmitted. R3 provides current limiting when the P.T.T. switch is operated again, so that the current surge as C1 discharges is not so high that it causes sparking at the switch contacts and possible damage after numerous operations.

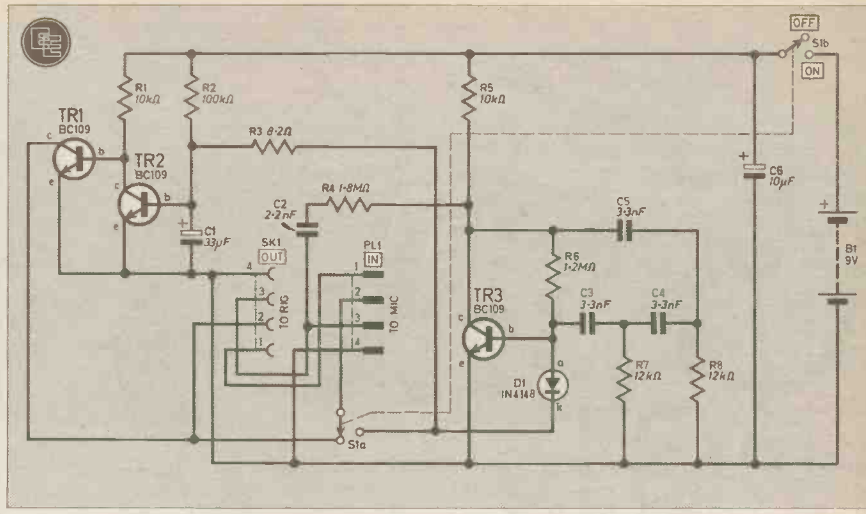


Fig. 2. The complete circuit diagram for the CB Roger Bleeper.

SOCKET CONNECTIONS

Most of the terminals on the input plug connect straight through to their respective pins on the output socket, only exception being pin 2 which, as explained earlier, must normally control the transmit/receive switching via a delay circuit. However, when the unit is switched off S1a connects pin 2 of the input plug straight through to pin 2 of the output socket, and the transceiver then operates normally without the "bleep" tone being transmitted.

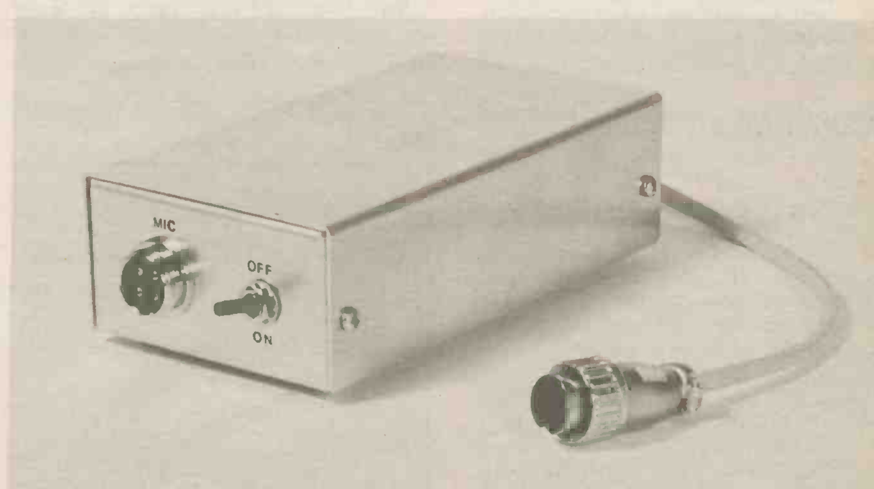
It should be noted that with sets where the loudspeaker is muted during transmissions, the P.T.T. switch will in fact reconnect the loudspeaker when the "bleep" tone is transmitted. This is of no great importance though, and the resultant short burst of tone from the loudspeaker could be regarded as desirable as it helps to confirm that everything is working properly.

CONSTRUCTION starts here

CIRCUIT BOARD

All the components are assembled on a 0·1in stripboard 21 holes by 14 strips according to the layout of Fig. 3. There is only one break in the copper strips, and this can be made using a cutter or a few turns of a small twist drill bit will make a neat cut. Make quite sure that the strip is fully cut through. The two mounting holes are drilled for 6BA or M3 clearance, and a diameter of 3·3mm is suitable in either case.

The completed "bleeper" showing the front panel chassis mounted Mic. plug and the 4-way line socket, with lead attached.



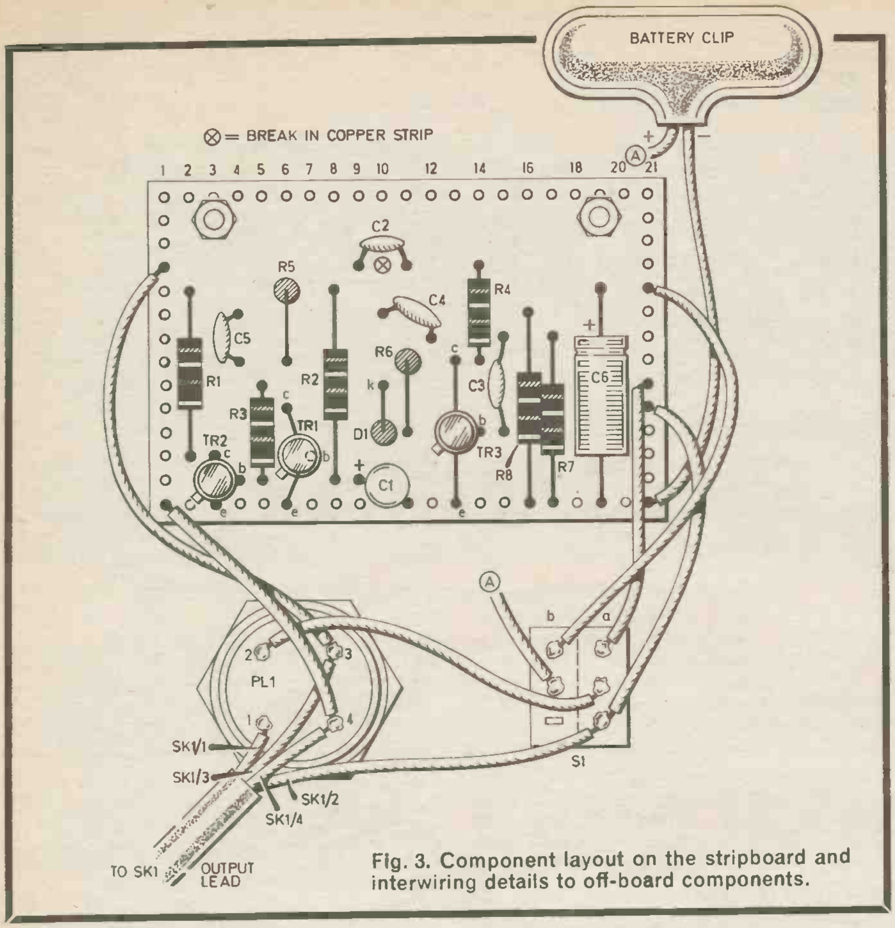


Fig. 3. Component layout on the stripboard and interwiring details to off-board components.

Mount the components one at a time, trimming the leadout wires and then soldering them in place. Then wire the negative battery clip lead to the board and connect flying leads about 50mm long to (eventually) take the connections to S1 and PL1.

HOUSING

The case can be any small metal box which is able to accommodate all the parts, and a box measuring approximately 133×70×38mm houses the prototype. This is somewhat larger than is absolutely necessary and the unit could easily be made a little smaller than this if desired.

One of the end panels of the case is used here as the front panel, and PL1 and S1 are fitted on this panel. PL1 is a four-way locking audio connector of the type used on P.T.T. microphones, and a 16mm diameter mounting hole will be needed for this. A hole for the output lead is drilled in the rear panel of the case, and this should be fitted with a p.v.c. grommet to protect the cable.

OUTPUT CABLE

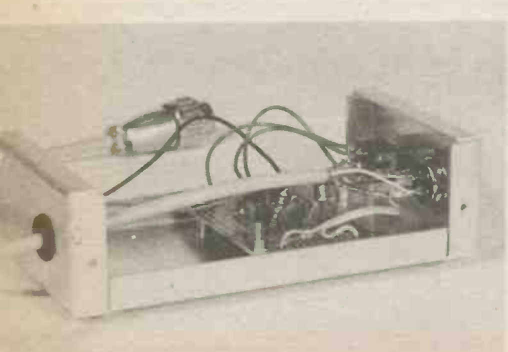
A four-way screened output cable is used, and this can be either an overall screened or individually screened type. One of the inner conductors and the screen (or screens) are used to carry the earth connection (lead 4), and the other three inner conductors are used to carry the remaining three connections.

The output lead is fitted with a four-way locking line socket, and a note should be made of which colour wire connects to which pin of the plug so that there is no confusion when the free end of the wire is connected into circuit. Note that PL1 and SK1 are obtainable as a pair—see component list.

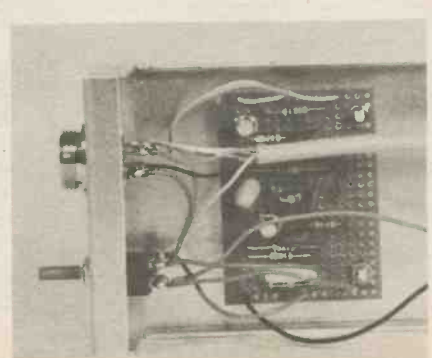
The component panel is bolted to the base panel of the case just to the rear of S1 and PL1, and extra nuts or spacers are used so that the underside of the board does not come into contact with the case.

After the remaining connections have been completed the unit is ready for use. There is plenty of space for the battery to the rear of the component panel, and a piece of foam material or an aluminium bracket can be used to hold the battery in place.

Case cover removed showing the board mounted on spacers.



Close-up of the circuit board mounted in the case.



CHECKING OUT

Give all the wiring a thorough check prior to connecting the unit to the system and switching on. Initially the unit should be tried in the "off" mode to ensure that the system operates normally. If it does not, check the wiring to S1, PL1, and the output lead very carefully as the fault will almost certainly be in this wiring.

When the unit is functioning properly in this mode, switch on and check with a contact that the "bleep" tone is produced properly. If the transmit/receive switching fails to operate properly check the circuitry around TR1 and TR2. If the tone is not produced check the circuitry associated with TR3.

NON-STANDARD SETS

Unfortunately there are a few CB transceivers which do not use the standard four-pin locking connector, but are of European design and use a five-way DIN type.

It is also possible that not all equipment using a four-way locking connector uses the method of connection shown here. In such cases a few tests with a multimeter set to a low ohms range should reveal the method of connection and enable the "bleeper" unit to be wired into the microphone lead correctly.

The only problem is differentiating between the lead carrying the output of the microphone and the one which is short circuited to the earth lead when the P.T.T. switch is operated (leads 1 and 3 respectively of Fig. 1). There will be a resistance of a few hundred ohms or more between the microphone lead and the earth lead when the P.T.T. switch is operated, and not a true short circuit, so that there should be no great difficulty in deciding which lead is which. ⌑

Everyday ELECTRONICS

SEPTEMBER FEATURES

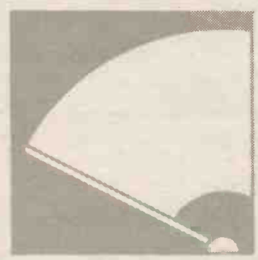
SEPTEMBER 1982 ISSUE ON SALE FRIDAY AUGUST 20

SOUND SPLITTER

A musical effects "pedal" device with a wide range of applications. Combines an improved pseudo-stereo effect (frequency split mode) with two other useful functions, switcher mode and crossmix mode.

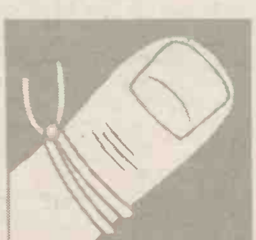
SCREEN WASHER DELAY

Operates the electric screenwashers of a car for a period of up to ten seconds or so after a single press of the switch. A most useful aid for the motorist. Simple but effective.



AUTOMATIC CHARGER FOR Ni Cad BATTERIES

Designed to charge a battery of ten AA size Ni-Cad cells as used in CB portable rigs. The constant current is progressively reduced thus preventing any overcharging of Ni-Cads.



MONTHLY PLANNER

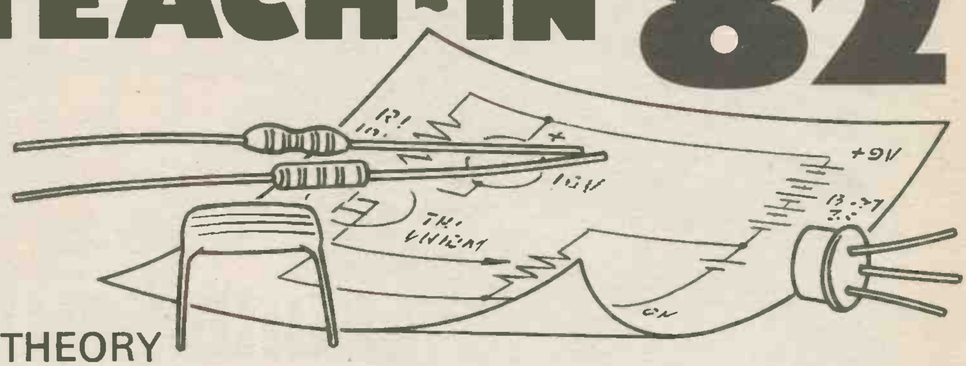
This electronic calendar displays the date and a particular event due to occur on that day. Nine possible events can be stored, one of which can be selected for a particular day. Uses two simple 64-bit RAM memories, these are easily programmed using DIP switches.

SEDAC RESULTS—List of winners and report of Prizegiving Ceremony

EE TEACH-IN 82

PART 11

BY O.N. BISHOP



BASIC ELECTRONIC THEORY WITH EXPERIMENTS

POWER SUPPLIES

THIS month we look at ways of obtaining power for operating electronic circuits. The power supply to *Minilab* comes from a number of cells connected in series to make a battery. A battery is able to provide a steady current which flows around a circuit in one direction only, from the positive terminal to the negative terminal of the battery. Such a steady, one-way current is called **direct current (d.c.)**.

MAINS CURRENT

The current which we obtain from a mains socket is quite different from this. If we measure the current that is passing through a mains-powered electric light bulb, for example, we find that it is far from steady. Fig. 11.1 shows how it varies.

It changes both in size and direction in a regular manner. At one moment the current is a maximum in a given direction. Then it decreases until there is no current at all. Following this, it increases again, but in the opposite direction. After it has reached its maximum in this direction it decreases to zero, then increase in its original direction.

It repeats this cycle 50 times per second. We say the mains frequency is 50Hz. Such a current is called **alternating current (a.c.)**.

The mains supply is generated as alternating current at the power station. The e.m.f. of the generator may be 10kV or more. In Fig. 11.2 we see what would happen if we connected a heavy-duty resistor across the terminals. When the current is at its maximum, the p.d. across *R* is also a maximum. One of the mains power lines, called the **Neutral** line is connected to a large metal plate buried in the soil at the power station. We take the Earth's potential as our reference, so the Neutral line is at 0V and the **Live** line is at 10kV. One hundredth of a second later the polarity of the e.m.f. has reversed, making the Live line 10kV negative of Earth.

The Neutral line is always at 0V, while the voltage of the Live line alternates between +10kV and −10kV. At all stages $V=IR$ and, since *R* is a constant, the graph of Live voltage against time has the same shape as Fig. 11.1.

TRANSFORMERS

When a current passes through a coil of wire a magnetic field is generated. This is the principle of the electromagnet, as used in the electric bell and the relay. The reverse effect, the generation of an electric current in a coil which is in a magnetic field, also occurs, provided that the field around the coil is *changing*.

If we connect a battery to the primary coil of the transformer shown in Fig. 11.3 and switch on the current, the primary coil generates a magnetic field. There is a sudden increase in the field in the soft iron core and also in the secondary coil which is wound around the coil.

The *sudden increase* in field induces a current in the secondary coil. This is only a short pulse of current because once the switch is closed, a steady (direct) current is flowing. Once the field has been produced it is steady too. No change means no further current in the secondary coil.

When we switch the primary current off again, the sudden removal of the magnetic

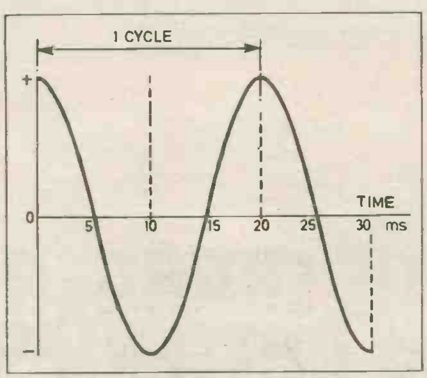
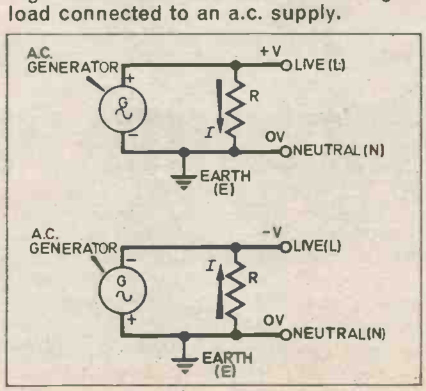


Fig. 11.1. Variation of current flow through a mains powered electric light bulb.

Fig. 11.2. Current flow direction through a load connected to an a.c. supply.



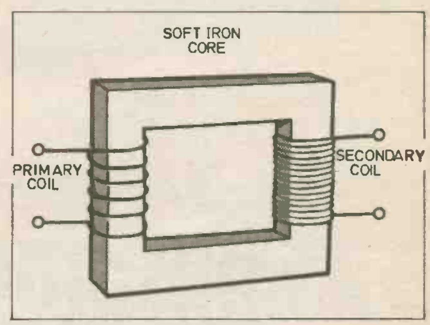
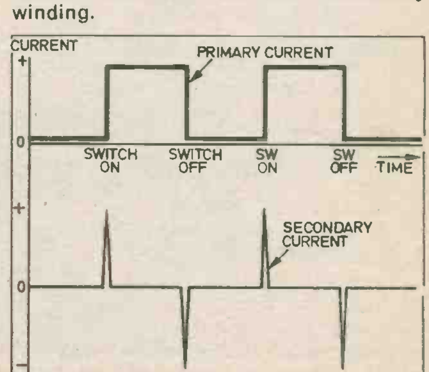


Fig. 11.3. An iron-cored step-up transformer showing the primary and secondary windings.

Fig. 11.4. Upper trace shows the current waveform in the transformer primary winding; lower trace shows resulting current waveform in the secondary winding.



field induces another current in the secondary coil, in the opposite direction. If we switch the primary current on and off in rapid succession, we obtain an alternating series of pulses of current in the secondary coil (Fig. 11.4).

We can do better than this by supplying an alternating current to the primary coil instead of switching a direct current on and off. The a.c. is continually changing, so there is always a changing magnetic field, inducing an alternating current in the secondary coil.

The relative sizes of the primary currents depends on the numbers of turns in the two coils. If the primary coil has N_P turns and the secondary coil has N_S turns, and if the voltage across two coils at any instant are V_P and V_S, we find that:

$$\frac{V_P}{V_S}=\frac{N_P}{N_S}$$

This equation indicates that when N_S is greater than N_P the voltage across the secondary coil at any instant is greater than the voltage across the primary. For example if $N_P=200$, $N_S=2000$ and $V_P=5$, then $V_S=V_P\times N_S/N_P=50$ volts. Such a transformer is called a **step-up transformer**. If N_S is less than N_P, we have a **step-down transformer.**

POWER

Although we gain voltage with a step-up transformer, we do not gain power. There is little power loss in a well-designed transformer so that we can consider input power and output power to be approximately equal. For this reason we can say that:

$$\text{Power}=I_P V_P=I_S V_S$$

If the voltage is stepped up by 10 times, as above, the current in the secondary coil is only a tenth of that in the primary coil.

The power rating of a transformer is usually stated as so many "VA".

For example, a 20V transformer rated at 50VA can deliver a current of up to 2·5A from its secondary coil. Often it may have two coils (Fig. 11.5) each delivering 10V. Connected in parallel, they deliver 10V, but since the rating is 50VA, up to 5A can be safely drawn. Connected in series they give 20V, but only up to 2.5A. In short, if you multiply the volts by the amps, the products must not exceed the VA rating.

MEAN VOLTAGES

The equations for transformers given above refer to the voltage across the secondary coil at any one instant of time. The situation is made more complicated because the voltages are always changing. We need to define some kind of mean (or average) voltage. We could take a simple mean, measuring the voltage at, say, 100 equally spaced instants during 1 cycle and dividing their total by 100. As Fig. 11.1 shows, every positive value has an equal but opposite negative value to balance it. The total of the voltage readings is zero, and so is the mean. A simple mean is no use.

Instead of finding a simple mean we could take 100 readings, square them, add them, divide the sum by 100, then take the square root of the result. Squaring the values gets rid of the negative signs, for the square of a negative number is always positive. We do not want to finish up with "square volts", so we take the square root at the end to get back to our original units. This figure is called the **root mean square voltage, or r.m.s.** voltage, for short.

When we refer to an a.c. voltage it is usually the r.m.s. value, not the value at any particular instant. If the form of the a.c. is a sine wave, the r.m.s. voltage V_{rms} and the peak voltage (V_{PEAK}, the maximum in either direction) are related by the equation:

$V_{PEAK}=\sqrt{2}\times V_{rms}=1.414\times V_{rms}$.

Thus for a nominal mains voltage of 240V, the peak voltage is about $\pm$339V. This point must be remembered when specifying components that are to be used at mains voltages.

MAINS TRANSMISSION

When a current flows through a wire, the resistance of the wire causes electrical energy to be converted to heat energy. This energy is lost to the surroundings. Although mains power lines use cables with low resistance, there is still an appreciable loss of energy between the generating station and the places where the current is used.

The heating effect of a current is proportional to the square of the current. If we transmit at a given power and make the voltage very high, the current can be relatively small. This is why the power from the generator is fed to a step-up transformer before it leaves the station, and is distributed at high voltage (400kV or more). In each area where power is to be used there is a sub-station with a transformer to step down the voltage to the normal mains level, 240V.

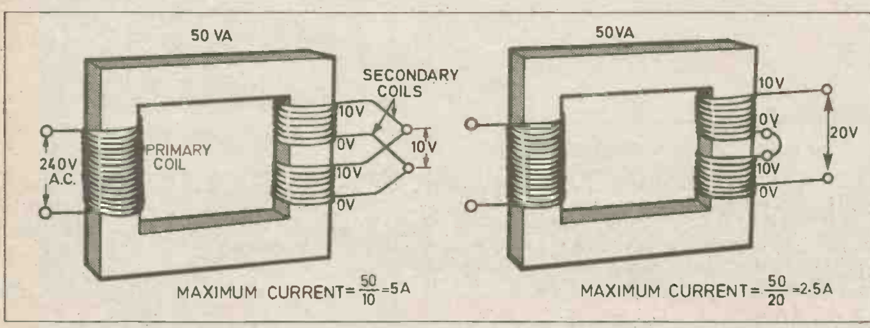
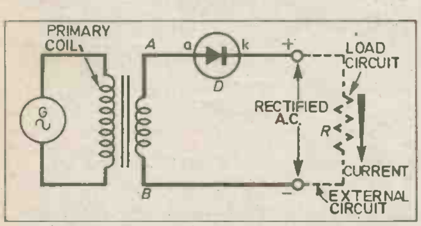


Fig. 11.5. Power rating of a transformer. The transformer shown is a step-down type.



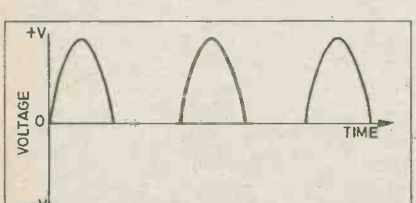


Fig. 11.6 (left). Half-wave rectification circuit. The diode allows current flow from *a* to *k* only.

Fig. 11.7 (bottom left). Waveform of half-wave rectified sinewave.

TEACH-IN ERRATA

In Fig. 10.1 the emitter terminal has been incorrectly labelled with a "c". It should be "e".

In Fig. 10.4, there should be no connection at location J19.

In Fig. 10.9, the output waveform should be out of phase with the input waveform. Invert the output waveform.

POWER FOR ELECTRONICS

Even when the mains supply has been transformed down to 240V, the voltage is still too high for most electronic circuits. Most of these operate at voltages lower than 20V. Microcomputer circuits usually require 5V.

The first stage of supplying power from the mains is to use a transformer to reduce the voltage still further. It is because it is so easy to transform voltages, with little loss of power, that a.c. is used in power distribution.

However, when we have eventually transformed voltage to a suitable level we are faced with the problem that most electronic circuits do not work on an a.c. supply. They require d.c., such as is obtained from the battery of *Minilab*. The next stage is to convert a.c. into d.c., in other words to **rectify** the a.c.

RECTIFIERS

The semiconductor diode allows current to pass in only one direction, as explained in Part 3 (E.E., Dec. 1981). If we put a diode in the output circuit of a transformer (Fig. 11.6), it allows current to flow only when terminal *A* is positive with respect to terminal *B*. When *B* is positive with respect to *A* the diode blocks the flow. The waveform of this rectified a.c. is shown in Fig. 11.7. It is easy to see why this is called *half-wave* rectification.

EXPERIMENT 11.1
Half-wave rectification

Consider the experimental circuit in Fig. 11.8. Although we do not normally use a light-emitting diode as a rectifier, it is helpful in this demonstration, for you can tell when the diode is conducting and when it is not. R23 acts as a load, to conduct current rectified by the diode. The a.c. is obtained from the *Astable module*, operating at 1Hz, so that you can follow the working of the circuit. This is a square-wave a.c. not a sine wave, but this does not affect the demonstration.

The output of the module (OSC O/P) swings from 0V to +6V and back. If we take the +3V battery terminal as our reference, and call it 0V, the output of the module can be taken as an alternating current with $V_{PEAK} = \pm 3V$.

The layout of these components on the Verobloc is shown in Fig. 11.9. Watch the motion of the needle of ME1. Note how this corresponds with the light and dark phases of D1. The diode is conducting for only half the time, so half of the power is not being used. Also the voltage across the load varies wildly, from 0V to V_{PEAK}, that it would be quite unsuitable for powering an electronic circuit. The voltage is less than +3V due to a drop across the diode; this is why the 100μA input of the meter is used. If your meter has a 4kΩ coil, a reading of 100μA corresponds to 0·4V.

Replace R23 with a 100kΩ resistor. The load draws less current than before, making it too small to light the l.e.d., but the meter still shows when it is flowing. Depending on the type of meter used, the needle flicks backward and forward across the full range of the scale.

Now plug a 220μF capacitor into sockets *E20*(+) and *E26*(−) on the Verobloc. Watch the needle now. Its swing is much reduced, showing that the variations in voltage are being smoothed out. When the voltage is at its highest, the capacitor stores charge. When the voltage is zero, the capacitor supplies charge to the circuit, keeping a current flowing. The smoothing

EXPERIMENT 11.1

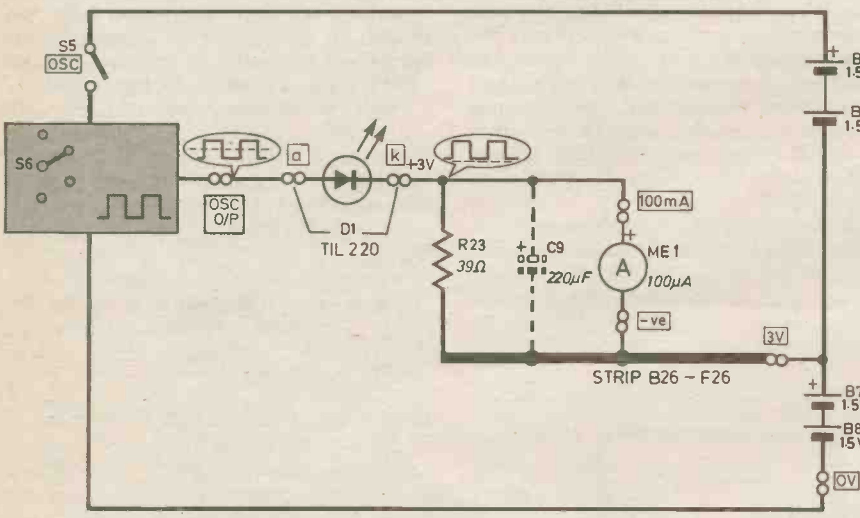


Fig. 11.8. Circuit diagram for the Experiment to demonstrate half-wave rectification.

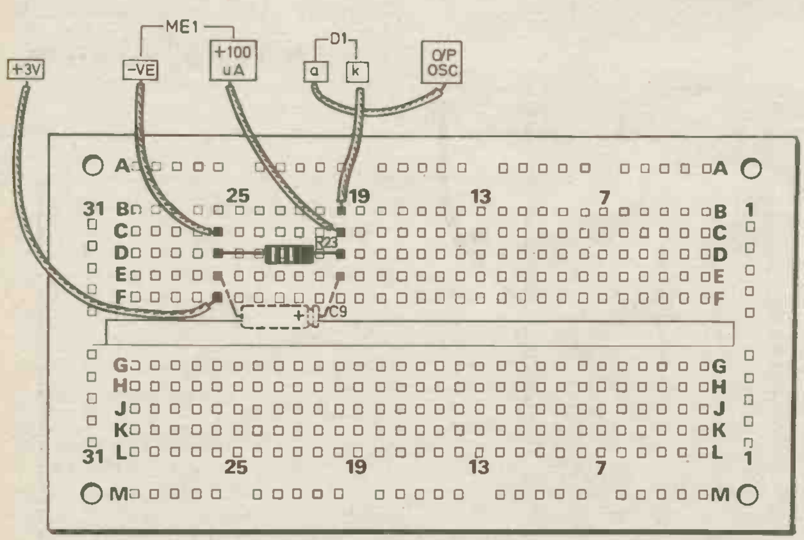


Fig. 11.9. Layout of the components on the Verobloc for the circuit in Fig. 11.8.

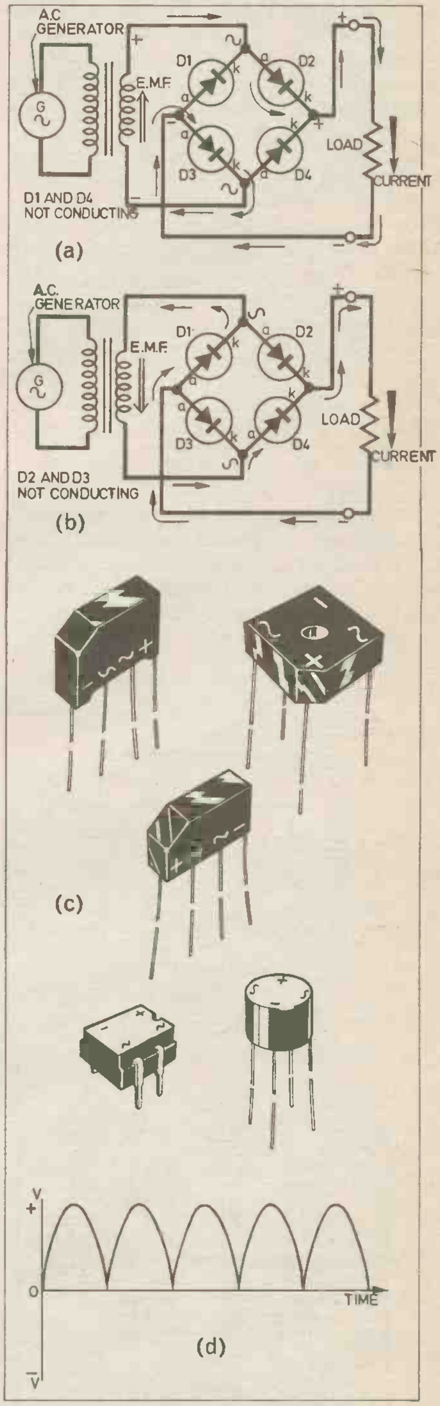


Fig. 11.10. (a) and (b) Fullwave rectification showing current flow paths during the opposite phases of the a.c. source. (c) five common bridge rectifier packages. (d) Fullwave rectified a.c. waveform.

effect would be even greater with largre capacitance.

FULL-WAVE RECTIFIER

A capacitor helps smooth out the voltage fluctations of a half-wave rectifier, but does not make it any more efficient.

A **full-wave rectifier** has four diodes, connected in a **bridge arrangement** (Fig. 11.10). One pair of diodes conducts when the other pair is not conducting, so feeding the full output of the transformer to the load circuit. With a smoothing capacitor added, the voltage is reasonably steady. Such a circuit is adequate for powering many kinds of load circuit.

When the output voltage at the diode is near V_{PEAK} the smoothing capacitor must store enough charge to supply the load while the voltage is near zero. If the load requires a large current, then the capacitance must be correspondingly large. Even with a capacitor of large value, and a load which draws low current, the smoothed voltage shows a certain degree of **ripple** (Fig. 11.11) at 100Hz. If the load circuit is an amplifier, this ripple may result in an audible "mains hum".

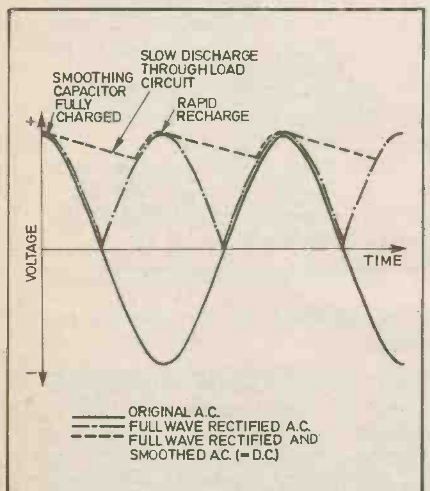


Fig. 11.11. The stages in producing a smoothed d.c. from a.c.

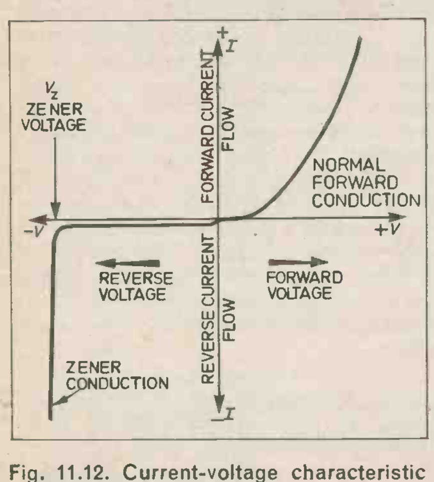


Fig. 11.12. Current-voltage characteristic curve for a Zener diode.

STABILIZATION

The output voltage from a rectifying circuit depends upon the amount of current being drawn. The greater the current, the lower the voltage. The current drawn by a circuit may vary from time to time. If the supply voltage varies because of this, the operation of the circuit may be upset. We need to be able to stabilize the voltage so that it is independent of the load.

A common way of doing this is to use a **Zener diode.** If we apply a small reverse voltage to a Zener diode, it behaves like an ordinary diode and does not conduct. But if the reverse voltage exceeds a fixed value, the **Zener voltage,** it begins to conduct readily (Fig. 11.12). The p.d. across the diode remains steady at the fixed value.

Zener diodes are manufactured for a range of Zener voltages. The next experiment shows how we use them.

EXPERIMENT 11.2
Using a Zener diode

The circuit for Expt. 11.2 is shown in Fig. 11.13. Here we are using the battery as if it were the smoothed output from a full-wave rectifier. We need to begin with a voltage which is appreciably higher than the voltage we wish to stabilize. R23 is a dropping resistor to reduce the voltage across the load (R24) to approximately the required level.

Without D4 in position, try varying the load by using resistors of different values, ranging from 470Ω to 10kΩ. With a 10kΩ load there is about 10V across it. Thus the load current is about 1mA. With loads of lower resistance the voltage falls appreciably as the current through the load increases. This is to be expected, since R23 and R24 act as a potential divider. If the supply came from a rectifier circuit the effect would be even more pronounced.

Now plug the Zener diode into Verobloc sockets *K28* (cathode, banded end) and *M28* (the anode). This is a 5.1V Zener, so, if the p.d. across it exceeds 5.1V, it conducts. You will see that the meter reading has fallen to about 5.1V, though it might be slightly more or less than this, depending on the diode. Once again, try a range of resistors from 470Ω to 10kΩ.

The voltage changes very little now, staying within a few tenths of a volt of its stabilized value. When a Zener diode was tested, the voltage was 5.9V when R24 was 10kΩ and fell only to 5.5V when R24 was 560Ω. Fig. 11.15 shows why this happened.

First we calculate I_D and I_{LOAD}. I_Z is the difference between them. Increasing the load current from 0·5mA to 9.8mA (a 1630 per cent increase), decreased voltage by only 0.4V (a 7 per cent decrease).

EXPERIMENT 11.2

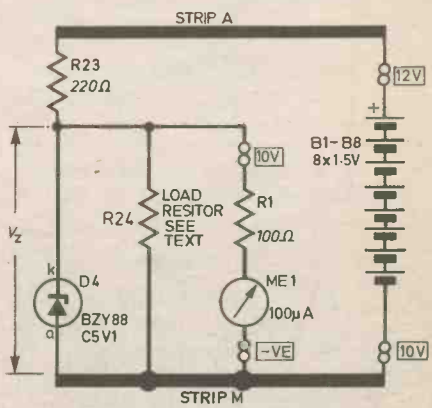


Fig. 11.13. Circuit diagram for investigating the action of a Zener diode for voltage stabilisation.

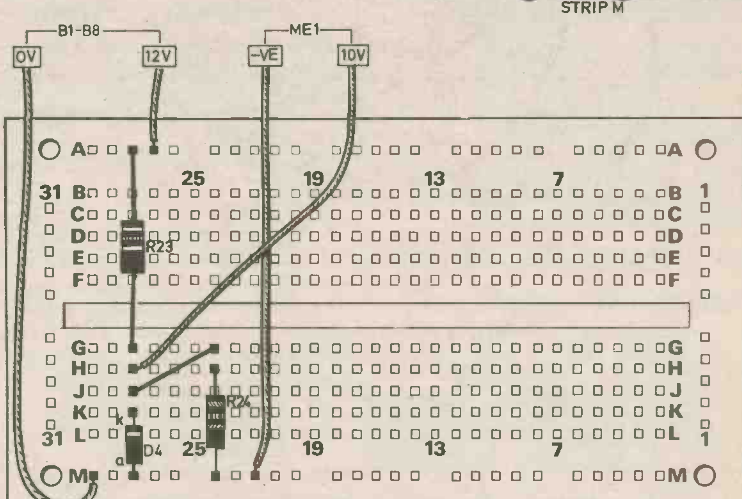


Fig. 11.14. The experimental layout for the circuit in Fig. 11.13.

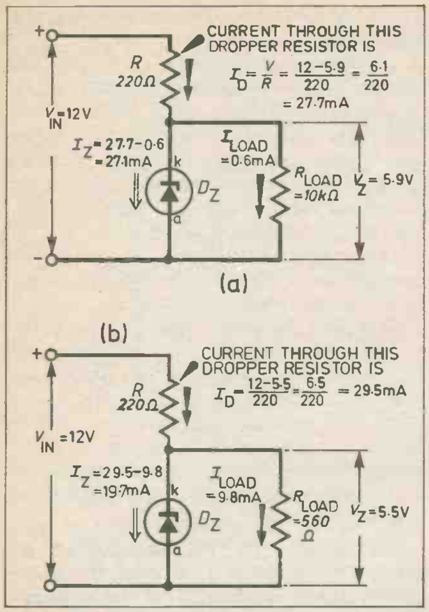


Fig. 11.15. Currents in a Zener diode circuit with (a) high and (b) low load resistances. In (a) the Zener diode passes the excess current not taken by the load.

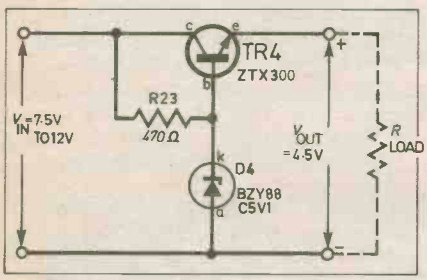


Fig. 11.16. A circuit to provide a larger current at a stabilised voltage.

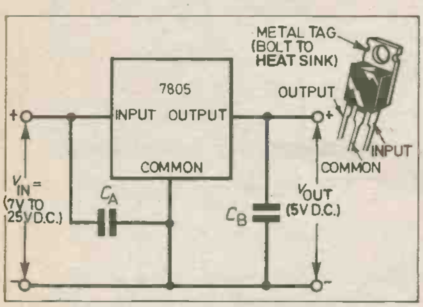


Fig. 11.17. A voltage regulator i.c., the μA7805. One of the available packages is shown, style TO-220.

Use a 3·3kΩ resistor for R24; measure the voltage. Next connect the circuit to the +9V terminal of the battery instead of the +12V terminal. You have reduced the input voltage by 25 per cent. What is the percentage reduction of the stabilized voltage? A Zener circuit like this enables us to obtain a fixed voltage in spite of changes in the loading and changes in the input voltage (including the mains voltage supplied to a transformer).

LARGER CURRENTS

If the load normally requires a large current, but at other times needs only a small current, the Zener diode must be able to carry the large surplus current at such times. Zener diodes of high power rating are available, but it is wasteful of power to shunt current through the Zener when it is not being used by the load. A better solution is to use a circuit such as that in Fig. 11.16. You could set up such a circuit on the *Minilab* yourself and test its action. TR4 would normally be a power transistor, but a ZTX300 can be used to supply up to 500mA.

The Zener diode holds the base of the transistor at a steady 5.1V. Allowing for base-emitter voltage drop of 0.6V, the output voltage is stabilized at 4·5V. If you compare this circuit with Fig. 7.2 (E.E., April 1982), you can see that it is really an emitter-follower amplifier. The base voltage is held fixed by the Zener diode, so the emitter voltage (that is the output) must also remain fixed. Being an emitter-follower, it has high input impedance (*small* currents to base and in the Zener diode) but low output impedance (it can supply a *large* current to the load circuit).

VOLTAGE REGULATORS

Many power supply circuits make use of voltage regulator i.c.s (Fig. 11.17). These give even better stabilization than the single Zener diode, but are relatively more expensive. Some of them incorporate current-limiting circuitry. If the load draws excessive current, the output voltage is sharply reduced. This prevents damage to the load and also to the power supply circuit.

Answers to Part 10

10.1 Harmonic.
10.2 Saw-tooth, spike.
10.3 Frequency is precisely determined and accurately maintained.
10.4. Hartley.
10.5. 3.
10.6. Positive.

QUESTION TIME

11.1. Why is a.c. favoured for mains power transmission?
11.2. Why is mains power transmitted at very high voltage?
11.3. What is the potential of the Neutral mains line, relative to Earth potential?
11.4. What is the maximum potential of the Live mains line relative to Earth, on a 240V a.c. supply?
11.5. If the primary coil of a transformer has 4,800 turns and its secondary coil has 300 turns, what input voltage is necessary to provide an output r.m.s voltage of 9V?
11.6. With the transformer of Q.11.5, if the load draws 100mA from the transformer, what current flows through the secondary coil?
11.7. If the transformer of Q.11.5 is rated at 10VA, what is the maximum current which may safely be drawn from it?
11·8 If the Zener diode in Fig. 11·14 was rated at 9V, what would be the stabilized output voltage?
11.9. What is the r.m.s. value for an alternative current for which peak V_{PEAK}=5V?
11.10. What happens to the ripple current as the load on a power-supply circuit is increased?

SWITCHED-MODE SUPPLIES

Switched mode supplies operate on a different principle from those already described. The stages in a typical circuit are illustrated in Fig. 11.18. The mains is rectified *without* transforming it first.

The rectified current is switched on and off at high frequency by circuits using transistors or thyristors (see Part 7, E.E., April 1982). This high-frequency a.c. supply is then transformed to lower voltages as required. Since the frequency is so high (10 to 20kHz) the transformer can be small. This means that the power supply circuit is altogether much more compact and lighter in weight than those previously described. The higher frequency means that the smoothing capacitors can be small too.

The voltage is regulated by switching the current on for a greater or lesser fraction of each switching cycle. The current is switched at the high-voltage stage, where the currents are correspondingly lower; so less power is wasted and little heat is given off.

The chief disadvantage of this kind of supply is that the high frequencies are liable to cause radio-frequency interference on nearby equipment.

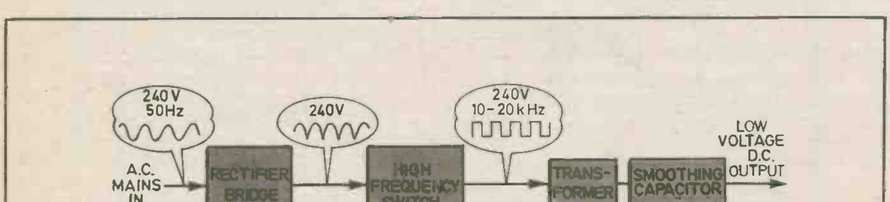


Fig. 11.18. Block diagram of a switched-mode power supply.

To be continued

TWO-TONE DOORBELL ALARM

BY W. ENGLISH

WHEN the old front door bell started to show the signs of age, it was decided to design and build a replacement using TTL i.c.s. Experimentation soon showed that a continuous two-tone signal penetrated the various household distractions far better than an intermittent pip-tone or a constant pitch.

In fact, the tone generator part of this circuit could also be used in an alarm system with a higher power audio amplifier and speaker being added if necessary.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1 and is based around two 7400 TTL quad 2-input NAND gate i.c.s.

Gates IC1a and IC1b form a clock oscillator operating at about two cycles per second. Capacitors C1 and C2 and resistors R1 and R2 govern this operating frequency.

There are two anti-phase output signals from this clock, from pins 3 and 6, and these alternately enable two additional oscillators consisting of IC1c/IC1d and IC2a/IC2b. When pin 3 is high, oscillator IC1c/IC1d will operate at approximately 1kHz and when pin 6 is high (pin 3 will now be low) oscillator IC2a/IC2b operates at approximately 2kHz.

The net result is two alternating tones of 1 and 2kHz, each sounding one after the other, and these are coupled to the amplifier section via gate IC2d and capacitor C7.

IC2c is unused, and in accordance with the recommended guidelines for using TTL logic, the unused inputs are commoned to the positive supply rail via R7. This eliminates distributed capacity associated with floating inputs and ensures no degradation of propagation delay times.

AMPLIFIER

The audio amplifier section is of simple design. In the absence of a signal, TR1 is biased so that the collector voltage is about half the supply voltage. A positive going signal on the base of TR1 will cause the collector current to increase, resulting in the collector voltage falling thus turning on TR3 and turning off TR2.

A negative going signal on the base of TR1 will have the opposite effect.

VR1 is adjusted to bias TR1 midway between the positive supply rail and 0V for economical current consumption and in practice is set to give the best compromise between tonal quality and current consumption.

Negative feedback via R10 improves the quality of the amplifier. The completed prototype drew just over

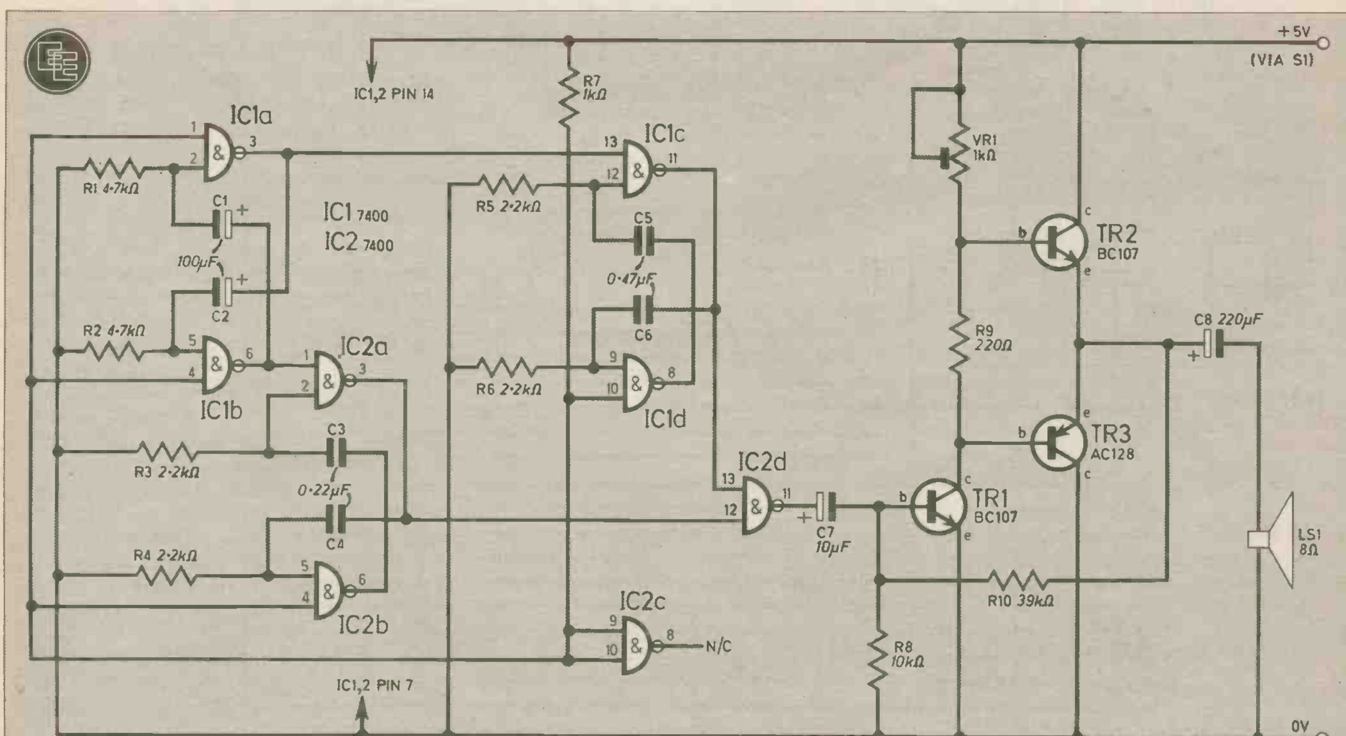


Fig. 1. Circuit diagram of the Two-Tone Doorbell Alarm unit.

100mA from the 5V supply and delivered sufficient volume from a 125mm diameter 8 ohm loudspeaker.

POWER SUPPLY

It was decided to utilise the existing bell transformer and this type of transformer supplies 8V a.c., so a regulator circuit was necessary to provide 5V for the TTL and this is shown in Fig. 2. The power supply is wired to the bell push (S1) as shown and then connected to the main circuit.

The system only consumes power when the bell push is pressed.

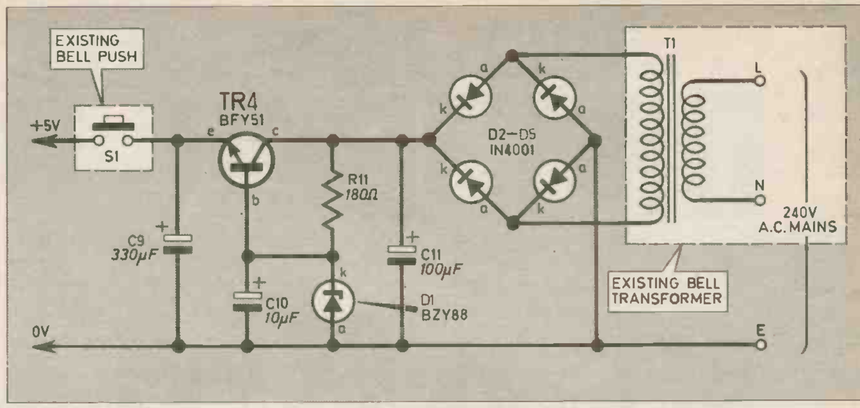


Fig. 2. The circuit diagram of the power supply section of the unit utilising a standard bell transformer and bell push.

CONSTRUCTION starts here

CIRCUIT BOARD

The Two-Tone Door bell was constructed on the large piece of stripboard and the layout is shown in Fig. 3.

Special caution must be exercised when positioning the component, as many are vertically mounted.

Note that capacitors C3 to C6 require preforming to fit the layout and this must be done with caution as this type of polyester capacitor is quite fragile where the leads join the body.

The two i.c.s are mounted into Soldercon strip sockets and not standard 14 pin d.i.l. holders. The reason for this being that access is required beneath the i.c.s to fit links.

The layout is quite complicated and as such, great care must be taken when inserting and positioning both the components and the track breaks (also shown on Fig. 3). It is recommended that where links and component leads cross over one another or they are very close that p.v.c. sleeving be used to prevent short-circuits.

Space has been left on tracks *M*, *N*, *O* and *P* for the positioning of two mounting holes.

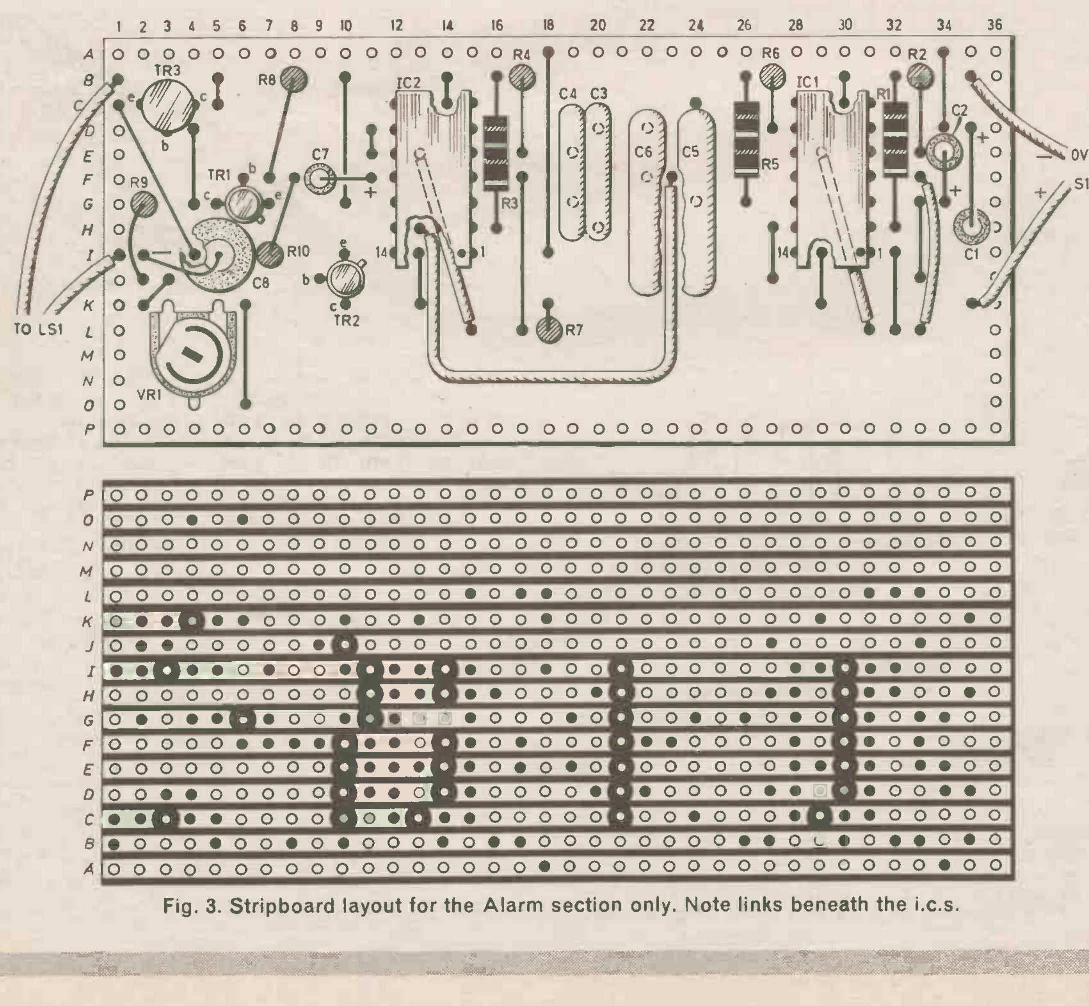


Fig. 3. Stripboard layout for the Alarm section only. Note links beneath the i.c.s.

COMPONENTS

Resistors
- R1, 2 4·7kΩ (2 off)
- R3-6 2·2kΩ (4 off)
- R7 1kΩ
- R8 10kΩ
- R9 220Ω
- R10 39kΩ
- R11 180Ω
- All ¼W carbon ± 10%

See Shop Talk P.523

Capacitors
- C1, 2 100μF 6V elect (2 off)
- C3, 4 0·22μF polyester type C280 (2 off)
- C5, 6 0·47μF polyester type C280 (2 off)
- C7, 10 10μF 10V elect (2 off)
- C8 220μF 6V elect
- C9 330μF 16V elect
- C11 100μF 16V elect

Semiconductors
- D1 BZY88 C5V6 5·6V, 400mW Zener diode
- D2-5 1N4001 silicon diode (4 off)
- TR1, 2 BC107 *npn* silicon (2 off)
- TR3 AC128 *pnp* gormanium
- TR4 BFY51 *npn* silicon
- IC1, 2 7400 TTL quad 2-input NAND gate (2 off)

Miscellaneous
- LS1 8Ω loudspeaker, 125mm diameter
- VR1 1kΩ miniature horizonal preset
- S1 Bell-push (see text)
- T1 Bell transformer (see text)

Stripboard, 0·1in. matrix, 16 strips by 36 holes and 10 strips by 18 holes (2 pieces); case to suit; 28 way Solderon strip socket; 7/0·2 equipment wire; tinned copper wire; p.v.c. sleeving; twin cored bell wire.

Guidance only Approx. cost £6.50 excluding case

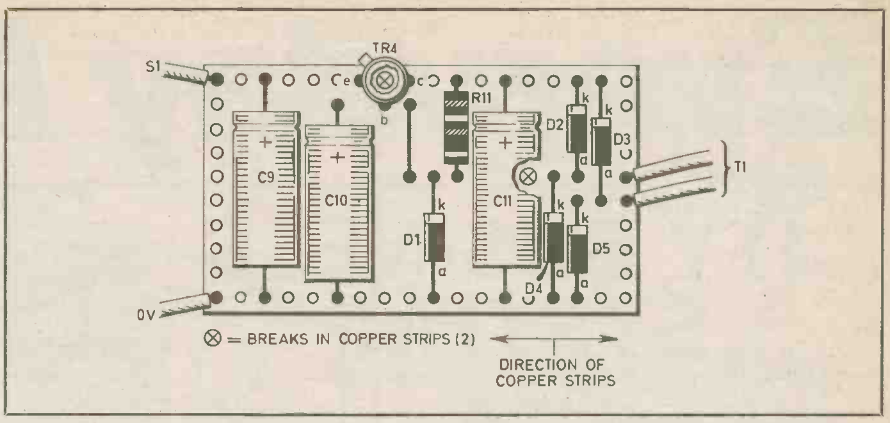


Fig. 4. Component assembly diagram for the power supply section. Note the two breaks in the copper tracks.

REGULATOR CIRCUIT

The smaller piece of board is used to construct the power supply on and the layout for this is shown in Fig. 4.

This board only requires two breaks in the copper track so these are also indicated on the component side view (unlike Fig. 3, which has an additional underside view).

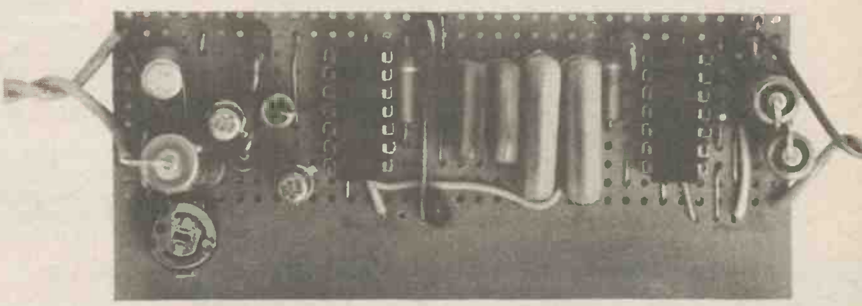
All the usual precautions regarding the orientation of polarised capacitors, diodes and transistors are to be taken.

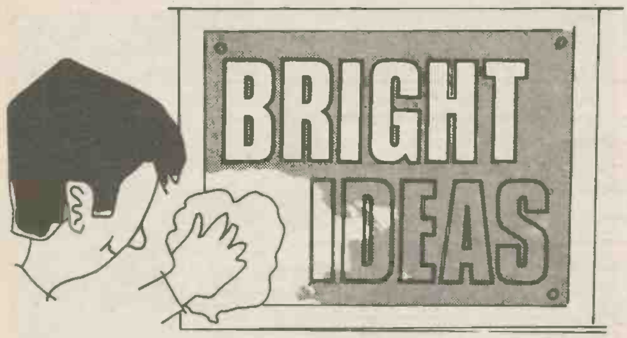
INSTALLATION

When the two boards are completed, the system can be installed. No cases have been specified, however, it is suggested that the power supply board is mounted in an *insulated* plastic case adjecent to the bell transformer. The enclosure for the Bell unit must be large enough for LS1.

To wire the two units and the door push (S1) together, twin-cored bell wire is ideal. ⌑

Actual size photograph of the prototype unit circuit board.





Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

I.C. REMOVAL TOOL

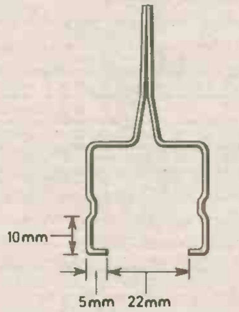
Removing i.c.s from their sockets can be done in various ways, with a screwdriver, with a pair of pliers or by hand.

It is almost impossible to use a screwdriver on a densely packed circuit board and using pliers can often result in the cracking of the package. Using the fingers can also harm the device by bending the pins or quite often they can become embedded in the person's skin.

To overcome all these problems, the following tool was made up from an old pair of tweezers. By bending the tweezers as shown in the diagram, a very useful removal tool can be made with the added advantage that it can also be used in confined spaces.

Because the tweezers are metal, it is possible to attach a connecting wire to them, this can then be connected to an earthed point such as a radiator or a coldwater tap. By earthing this tool, it is possible to then use it for the removal of CMOS devices.

This tool has been in constant use for several weeks and has always been reliable and done its job perfectly.



OTHER DIMENSIONS DEPEND ON SIZE OF TWEEZERS USED

N. Kendrick,
West Sussex.

Everyday News

CITY BUSINESS SYSTEM

British Telecom (London) unveiled its unique Multi-Line Communications Unit on May 17 at Williams & Glyn's Bank in the City of London. This City Business System gives instant access to hundreds of private circuits, exchange lines and private switchboards at the touch of a VDU screen.

The "Dealer Board", as it is known, has been designed to cater specifically for the needs of dealers and brokers in the heart of London's financial world who constantly require fast and direct telephone links to stock, commodity and currency brokers all over the world. It has been developed by BT in close co-operation with Williams & Glyn's Bank over the past three years and now represents the most advanced system available anywhere in the world in this highly specialised market.

The City Business System provides a maximum of 512 dealer boards, and each position has a VDU and two telephone handsets. The user has access to 5,000 pages of stored information as well as access to information held in the company's own computer. The 1,000 telephone lines to which the system can be connected to are accessed from a "touch sensitive" keypad on the VDU screen.

This keypad, presented in an eight by eight matrix format and stored on as many pages as required, is one of the most interesting features of the system. Running above the glass VDU screen is a criss-cross matrix of infra-red beams, two of which will be broken when the user touches a "key" on the screen thus involving no moving parts to break or wear out.

Mr Tony Booth, Director of BT London, said of the system "The interest it has aroused in the last few weeks has been phenomenal", and added that orders worth more than £1¼ million were now being processed.

The new Central Treasury at Williams & Glyn's Bank in London holds the world's first British Telecom City Business System.

Complete Fluke . . .

Fluke's latest 4½ digit multimeter, the 8060A, has so many microprocessor controlled measurement functions that it is virtually a complete test laboratory in one package claims the manufacturer. 'Brain' of the instrument is an advanced chip developed in Fluke's own microelectronics plant with an investment of £20 million US dollars.

Three meters . . .

Three famous instrument companies are being centred in the Avo factory at Dover in a new company, Thorn EMI Instruments. They are Avo, Evershed & Vignoles, and H. W. Sullivan. Together they will produce 150 product lines generating £10 million p.a. turnover with 50 per cent exports. The well known trade names Avo, Megger, Sullivan and Foster will be retained.

DESIGN ADVISORY SERVICE

Mr Patrick Jenkin, MP, Secretary of State for Industry, announced that the Government is committing £3 million over the next three years to a scheme to make manufacturers aware of the benefits of good design. The scheme is to be operated by the Design Council, under contract to the Department of Industry.

The money is to be made available to extend the operations of the Design Advisory Service (DAS), originally set up in 1976 to help manufacturers improve the design of their product and become more competitive in world markets.

Under the extended scheme, manufacturers employing between 60 and 1,000 people will be able to obtain 15 days free consultancy from the DAS.

BBC TRAINING PACKAGE

The BBC's Engineering Training Department have recently developed a new technique for training students in the fundamentals of television engineering.

Based on the "packaged-learning" concept, the system uses special demonstration equipment accompanied by a set of learning texts. The overall package consists of two main racks of equipment, including colour and black and white monitors, an oscilloscope, a VHS cassette tape and four supporting books.

The course is divided into three parts, covering the fundamentals of television engineering, picture processing, colorimetry and finally, the coding and decoding of PAL and NTSC signals. It is estimated that the whole course should take about five days to complete.

The package may be made available to colleges, industry and other broadcasting organisations in the near future.

Engineers at the BBC's Training Department in Evesham teach themselves the fundamentals of colour television engineering using the packaged learning concept.

The British Standards Institution has introduced a new standard governing printed circuit boards (referred to as printed *wiring* boards in the new document). This new standard, denoted BS 6221, replaces the outdated BS 4025 and BS 4579 and complements the very high standard BS 9760 (used mainly in professional and military applications).

This is an extremely useful reference for anyone involved in, or interested in, the manufacture of quality p.c.b.s.

The Inland Revenue's new computer network to automate Pay-As-You-Earn accounts is planned to have 18,000 terminals in 600 local offices linked to 44 large computers.

The flight simulator for Boeing's latest airliner, the 767, has obtained the US Federal Administration approval ahead of the actual aircraft. The simulator was built by Rediffusion at Crawley, Sussex.

R. S. Components is to move to a 300,000sq ft warehouse in the Weldon Enterprise Zone, near Corby. The move will be in stages, completed by mid-1984. C & K Components of Kettering has a new factory opened by Cyril Smith, M.P., employing 130 people producing 29,000 switches of various types per day.

A third of the Queen's Awards to Industry in the technology section went to companies in electronics this year and electronics was also a high scorer in the exports section.

The Midland Bank has set up a special division to deal with cash-hungry young electronics companies needing to borrow. The division is headed by Colin Amies with experience as a top executive in the electronics industry.

TV and radio programmes will be available in the remotest areas of the Australian bush when a new domestic communications satellite is launched in 1985.

Radio Help-for-Aged

Relaxation of power restriction on VHF radio links enable implementation of radio-alarm systems for elderly people normally under warden care.

A typical system can have up to 10,000 alarms on a Radio Linked Warden-call system to a central computer-controlled base to handle emergency calls when wardens are off-duty.

The Plessey Company announce a 32 per cent increase in pre-tax profits for the year ended April 2, 1982. Profits increased from £84·5 million to £111·4 million with sales increasing to £963·1 million from the previous year's figure of £844·5 million. Export sales rose by 27 per cent.

Telecommunications had a successful year, showing a 19 per cent increase in sales with the Electronic Systems and Equipment sales following closely behind, recording an 18 per cent rise.

Both the Microelectronics and Aerospace divisions showed increases in profits, the only business to actually incur a loss was the USA based Computer Peripherals, this being due to a marked reduction in demand in both home and European markets.

Weighing machine manufacturer W. & T. Avery claim to be the first in the weighing industry to install computerised automation in the manufacture of printed circuit boards for its products.

Automatic insertion equipment inserts 100,000 components into 2,000 p.c.bs every week, supplemented by automatic testing.

A microprocessor-controlled "ring main" local area network called Planet has self-healing properties. The network, to which as many as 500 separate pieces of equipment can be connected automatically reroutes data or digitised voice if the main cable is cut or damaged. The system has been developed by Racal-Milgo.

Ex(H)am!

Readers in the North London area may be interested to know that Hendon College of Further Education are once again running a course for the Radio Amateurs Exam, to begin some time in September.

Further information can be obtained by contacting Chris Holford at the Hendon College of Further Education, The Burroughs, Hendon, NW4 4BT. His telephone number is 01-202 3811, extension 147.

Phone in the Sky

Latest gimmick to attract airline passengers in the USA is to offer an in-flight telephone service. American Airlines and Republic Airlines are first in the field.

Research has revealed that some 60 per cent of passengers are travelling business people and they are expected to welcome the service. But only outgoing calls from the aircraft are provided. You can call the office but the office can't call you.

—ANALYSIS

THE NEW ELITE

Rapid expansion of manufacturing industry in developing countries inevitably poses new threats to those already industrialised. The newcomers, rightly anxious to secure market share, tend to work longer hours for less pay. As newcomers, many use the latest production machinery. So in a number of products, and they are increasing, it is even more difficult to compete in price. Such global shifts of activity, together with a general trade recession have intensified unemployment in the United Kingdom as in other industrialised countries.

Our only effective response, other than trade embargoes, is to stay ahead in technology and today this means electronic-based technology spearheaded by electronic engineers.

These men, and an increasing number of women, are the new elite of the Second Industrial Revolution. In an era of high unemployment they are the only group where demand for their expertise continues to grow.

They are privileged in many ways, particularly in mobility. Whereas, for example, miners can only work where there is coal, shipbuilders at coastal or estuary sites, electronics engineers have a wide choice of locations and an equally wide choice of industries and specialisations in which to exercise their skill. And because they are in demand they are able to change jobs more frequently in search of promotion, wider experience or merely a change of scene. The largest number of jobs is still in the technological South East but the demand in other regions is growing.

Remuneration, like life itself, is often unfair or seemingly so. Sales engineers often enjoy higher pay than innovative engineers in laboratories and the more interesting jobs frequently pay less than boring ones. But the engineer can make his own choice.

Elitism, of course, is discouraged by those radicals who would have us all equal. And strangely, the loudest voices in favour of egalitarianism, are often those with an elitist education without which they would remain unknown and unheard. The egalitarians are wrong. We need more, not fewer, elite people exercising their talents in centres of excellence. They benefit not only themselves but the whole nation.

Brian G. Peck.

For your ENTERTAINMENT

By BARRY FOX

To BT, a bouquet

Having taken several swipes over recent years against the Post Office and British Telecom, how nice it is to be able now to offer a bouquet.

British Telecom has recently opened an exhibition, called "Telecom Technology Showcase" at Baynard House, in Queen Victoria Street, near the Mermaid Theatre. Baynard House is the centre for telecommunications in the City of London and houses the first System X exchange in England. The new public exhibition stretches over two floors and there's also a reference library for study. The Showcase is open every Monday, Tuesday, Wednesday and Thursday from 10am to 4.30pm, with admission free. It could well become world famous as a technical exhibition centre.

The idea is to trace the development of telecommunication technology, from the 1837 Cooke and Wheatstone electric telegraph, through the invention of the telephone and radio to modern day telecoms. Almost every exhibit on show is an original because, with commendable foresight, telephone engineers over the last century have been storing away in mint condition equipment for posterity. Only Alexander Graham Bell's first prototype telephone, of 1875, is a replica, because no available original can now be traced.

Working Models

There are plenty of working models, for instance to show how old telegraph links worked. Many of the telephones on display are working sets connected up to a small Strowger exchange. This clatters and chatters into life when you dial a number from one exhibition telephone to another. The captions of the exhibits are very informative. Anyone with a serious interest in telecommunication technology, will need several visits to take them all in. No one could fail to learn something.

For those with long memories, many of the exhibits come from the old Post Office exhibition which used to be housed in the Fleet Building exchange, off Farringdon Road and Shoe Lane. When it was closed, in 1975, all the exhibits were shunted off to warehouses. Since then they have been meticulously cared for and catalogued in readiness for the opening of the new, permanent exhibition centre at Baynard House.

The next time you feel angry or frustrated with the Post Office or British Telecom, try treating yourself to a free visit to Baynard House. It makes a good antidote.

Outrageous One

By now you'll doubtless have read numerous reports on "The Last One" computer program. So you'll know that The Last One was advertised in advance as "a computer program that writes computer programs".

Quite a claim! In fact, DJ "AI" Systems, the firm backing The Last One, adopted a deliberate policy of stirring up both interest and cynicism by some pretty outrageous advance publicity, with absolutely no technical back up.

No copies of the program were made available to the press in advance of the formal launch. Even the public relations firm handling the launch didn't know, until the day of the press conference, whether the whole thing was a hoax or not.

The pre-launch hype certainly seemed to succeed. The company claimed six million dollars in advance orders, and the press conference was packed. What's more because no-one had got their hands on a program in advance, no-one had had an opportunity to pirate it.

In the event it turned out that although The Last One is a very clever concept it's really just a program generator which translates plain English instructions into Basic code language. It doesn't have artificial intelligence and the user still needs to analyse problems. Probably the best way of summing up what The Last One can and cannot do, is to quote the pitfall into which one of the DJ A1 spokesmen fell at the press conference.

Noughts and Crosses

To illustrate the need for a program like The Last One, he mentioned that several years ago his firm had bought an Apple computer and after a year they still "couldn't play noughts and crosses on it". But, he implied, The Last One would of course change all that.

So I asked the obvious question. "How do you use The Last One to program an Apple computer to play noughts and crosses?" Awkward silence!

Of course, there's no simple answer. You have to analyse, for yourself, the logical steps in a noughts and crosses game, tell the computer how to draw the board, give the computer the questions and options and answers, and explain the difference between winning and losing.

Once you've analysed the system and worked out your instructions, then The Last One will make it relatively easy to write the program because you won't have to translate your instructions into Basic. But The Last One doesn't have any intelligence of its own. Anyone expecting otherwise is in for a rude shock.

Plug in to Moscow!

Some oriental electronics firms have finally found out to their cost why it is that Japanese hi-fi and video equipment will work perfectly in almost every country but in Britain it becomes mysteriously far more susceptible to mains-born interference. The interference spikes from a thyristor dimmer switch, or from a refrigerator thermostat, or an electric drill or even a simple mains lighting switch, will often cause noise on audio and blips on video and throw electronic timers into confusion. But in foreign countries the same equipment copes with exactly the same kind of interference perfectly well.

The reason is in our mains system. It goes back to the days when sockets were individually fused. After World War II we went over to the modern system where the sockets are no longer fused and there are just a few main fuses. Local fusing is taken care of at the plug.

In the old days we needed a ring mains system to ensure that when one socket fuse blew it didn't take out every other socket downstream of the fault. In other words, with a ring system the mains has both upstream and downstream access to the sockets.

But with modern fused-plug system, we don't need a ring mains. Nevertheless, and for who knows exactly what reason, we stuck with the ring main principle. It's not only unnecessary, it creates very real problems. For one thing the ring main loop can serve as a radio aerial; one householder found himself receiving Radio Moscow because his ring main loop just matched the transmission frequency!

The other problem is that the ring main loop, together with any motor, transformer or fluorescent light choke coils in the circuit, acts as an inductance. So any interference spike or pulse that gets into the mains isn't damped. Instead it resonates, or rings, as it would in any inductive system. This is why mains interference that is innocuous in other countries, plays havoc with the same equipment in Britain.

By Dave Barrington

Soldering—An Art

Strange as it may seem nearly all the soldering irons on sale in this country are British manufactured and the standards are so high that the chances of failure are very rare.

With such a record, the only excuse for bad solder joints can only be because of bad "habits" or incorrect procedure. So, before we introduce the latest range of irons and soldering aids we should like to give a brief guide to successful soldering. Many manufacturers also include "good soldering" instruction booklets with their irons, these should be read carefully.

Irons are classified by their power rating or heat capacity measured in Watts. One rated between 15 and 25 watts will be suitable for all projects in EE. A good selection of bit sizes would be 1.5, 3 and 4mm diameter—Go for one of the iron plated types.

Once a suitable iron has been selected, the tip should be tinned before use.—When the bit is hot melt some solder onto the tip so that it flows evenly and then "wipe" clean with a damp sponge or rag. This should be carried out at fairly regular intervals during use.

Most important both surfaces of the intended joint must be cleaned and free from grease.—Lightly scrape or rub with abrasive paper.

When soldering, the hot iron must be offered up to both surfaces of the joint *simultaneously* and solder fed to the joint.

The solder should always be melted around the contact area, not on the iron, and allowed to flow.

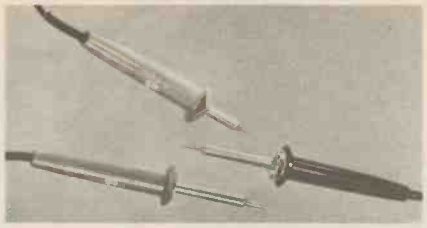
Finally, remove iron from joint and hold joint steady for a few seconds to cool.—A good joint should be nice and bright.

New Irons

As a result of a marketing co-operation agreement, a new range of soldering irons are being manufactured by Adcola Products for OK Machine & Tool (UK).

The range consists of two thermostatically controlled and thermally balanced instruments plus one temperature controlled iron, each up to international safety standards.

The OK-001 operates from 240V and features a short heating element barrel for effective tip control and a temperature range up to 380°C. The OK-002 has a



lengthened barrel for long reach work and a temperature range up to 400°C.

The model OK-003, with proportional control, operates from a 24V 50Hz supply and has a variable temperature range of 250 to 450°C. This is achieved by the use of an i.c. control unit in the handle. The tool can be totally earthed and has a burn-proof cable.

For more details and prices contact OK Machine & Tool (UK) Ltd., Dept EE, Dutton Lane, Eastleigh, Hants SO5 4AA.

Desoldering

One of the methods of desoldering components from circuit boards is by means of a spring-loaded suction pump. This draws molten solder away from the re-heated joint and sucks it up the barrel of the gun.

Two new desolder guns are the latest additions to the Tele-Production Tools range of equipment.

These precision made tools are available in two sizes, one for standard work and the other for fine joints. The miniature desolder gun, measuring 14mm dia. × 165mm long, is ideal for the small circuit board projects published in EE.

Both desolder guns have plunger guards and claim one hand operation. Each gun claims a powerful suction and a low recoil action which leaves joints clean and tidy. The solidified solder is automatically ejected when the gun is re-set for the next operation.

Replacement Teflon tips are available for both guns at 70p each and the guns cost £5·95 each or £10 for the pair. All prices include VAT and carriage.

More information may be obtained from Tele-Production Tools Ltd., Dept EE, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW.

CONSTRUCTIONAL PROJECTS

Quiz Master

The large console case for the *Quiz Master* can be supplied by Maplin, part number M1006. (Order no. LH64U.)

The multiway plugs and sockets are RS Components "QM Multipole" connectors. The sockets SK1, 2 and 3 are 12-way rectangular chassis shells (although only seven ways are used), RS part number 466-755 and the plugs on the response units are 12-way rectangular cable shells, RS part number 466-747.

These moulded connectors have separate inserts so you will also require one packet of sockets (RS part no. 466-832) for the chassis shells and one packet of pins (RS part no. 466-804) for the cable shells. Any RS Component supplier should be able to obtain these.

A seven-way cable may prove to be a little difficult to locate, so any multiway cable with more than seven conductors may have to be used.

Finally, the trunking for the response units is of the type used by electricians for house and office wiring and should be available from electrical supply shops. It is an extruded plastic, square section trunking with a clip-on lid and comes in two metre lengths.

Doorbell Alarm

No case is specified for the *Doorbell Alarm* so this is left to the constructor to choose one to match his home decor!

If a new bell-push or transformer is required, the high street electrical shop or large chain store will stock these, along with the twin-core bell wire.

CB Roger Bleeper

Nearly all components required to build the *CB Roger Bleeper* are common types avilaable from many sources. The author used $\frac{1}{3}$W resistors in his model, but the more common $\frac{1}{4}$W types may be used instead.

The pair of connectors PL1 and SK1 may be obtained from Maplin Electronic Supplies. Both parts (plug and socket) are sold as one item, order No. YX53H (Audio Conn 4-way).

Instrument Pre-Amp

The design for the *Instrument Pre-Amp* calls for 1 per cent resistors. If you have any supply difficulties, we can tell you that 1 per cent types of the required values are stocked by Maplin, Rapid Electronics and Watford Electronics.

A single-pole, single-throw slide switch is specified in the component list, but these are difficult to obtain. You can use one side of the very common d.p.d.t. slide switch.

The f.e.t. input op-amp, CA3140 should not be excessively handled. Static electricity can quite easily damage this device, so try not to touch the legs of this device when inserting it in its socket.

TRS-80 Interface

A couple of special i.c.s are required for the *TRS-80 Interface* project: LM334Z adjustable current source used as a remote temperature sensor and the TL507C single slope analogue to digital converter. The LM334Z is available from Maplin Electronic Supplies, order No. WQ32K. The TL507 may be obtained from Tandy, stock No. 276-1789.

The printed circuit board has been designed to accommodate a specific transformer, stock No. 207-829 available through your component dealer from RS Components Ltd. RS Components will only supply to registered account holders. Other types of suitably rated transformers may be fitted to the case and wired to the appropriate p.c.b. locations.

The double-sided (20 + 20 way) wire-wrap-pin edge connector is difficult to obtain and may need to be cut from a longer connector. Watford Electronics sell a 23 + 23 way connector for use with the ZX81 which may be cut for this purpose. It is also reasonably priced. The plastic stand-off pillars may be obtained from Maplin, order No. FW16S (stand-off short).

Quiz MASTER

BY C. J. BOWES

IF YOU are associated with an organisation which regularly holds quiz competitions, it is most likely that you will have, at one time or another, wished you had an electronic machine to tell who was ready to answer first.

One of the problems with such a machine is that for each contestant to have his or her own individual push button unit, it can become costly to provide the boxes, plugs sockets and cables necessary. The unit described here overcomes this problem by providing the push buttons for the whole team mounted in a single piece of plastic trunking, thus reducing the number of sockets necessary and greatly simplifying the interconnections required.

The prototype unit illustrated here was constructed for use by three teams of four contestants but the circuit can be adapted for use by a greater or smaller number of teams with different numbers of members.

CIRCUIT DESCRIPTION

The circuit of the unit falls into two sections, the contestant's response unit and the circuitry which prevents other players from triggering their indicators after the first contestant has responded. This section also provides an audio signal to indicate that a response has been made. These are shown in the circuit diagrams Figs. 1 and 2.

COMPETITOR'S RESPONSE UNIT

The competitor's response unit is shown in Fig. 1 and one circuit is required for each team. Each response unit contains four identical sections, one for each player, so only one need be described. The heart of the circuit is the thyristor CSR1.

In order to reduce the cost of each competitor's unit, the switch, S4, is a simple push-to-make momentary action switch. Some form of latching is therefore necessary to maintain the lamp on after this push-switch has been released.

The thyristor is driven from a d.c. power source. Under this condition, a positive voltage, with respect to the cathode (k) applied to the gate (g) triggers the device and a current will flow for as long as a load is present. Once the device has been triggered, the gate potential may be removed without unlatching the thyristor. The lamp LP1 presents a fairly substantial load and it is therefore convenient to incorporate the latching action of CSR1 and switching action of S4.

Both the gate current and the gate voltage are extremely small so the gate is therefore connected via R29 to switch S4. This switch is connected (through pin 6 on PL1) to a supply which is gated by the logic in the master unit. This switching potential is only available as long as *none* of the response units are operated.

When the prototype was constructed, trouble was experienced with false triggering which occurred as the result of the extreme sensitivity of the thyristors to voltage spikes which were picked up by the gates and triggered the devices lighting the lamps

This was overcome by the use of an additional resistor R30. This is connected so as to ground the gate except for when a potential is connected to it through R29. The value shown is that *calculated* to provide the correct voltage to the gate when S4 is operated. However, due to manufacturing tolerances within components, this may not always be the correct value and it may be necessary to make adjustments to this resistor when testing the unit. Selecting an alternative gate resistor is described later.

In this way, when the first contestant presses his button, both the lamp, LP1, and the l.e.d, D20 will illuminate. R28 limits the current through D20.

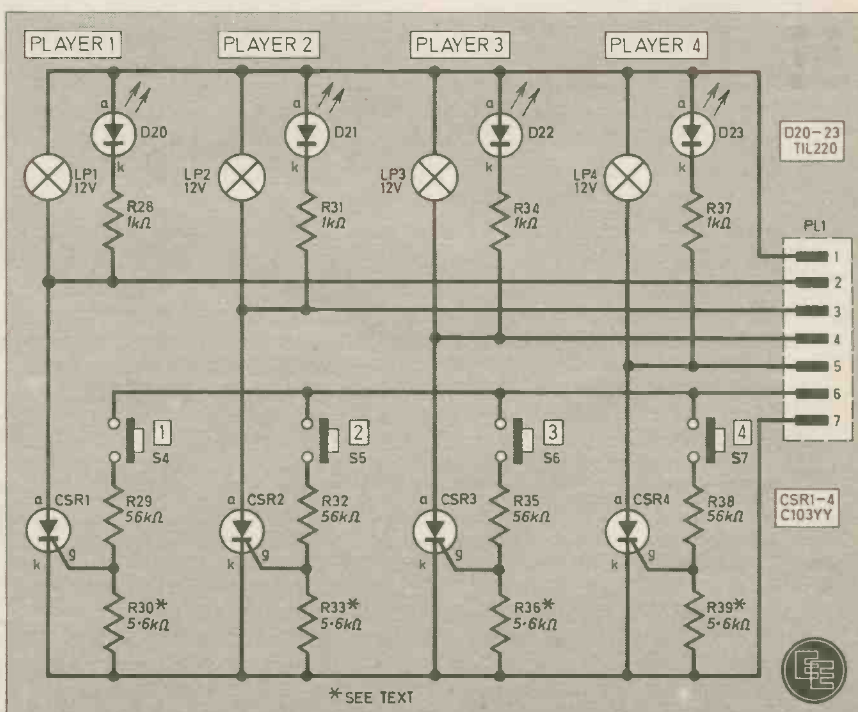
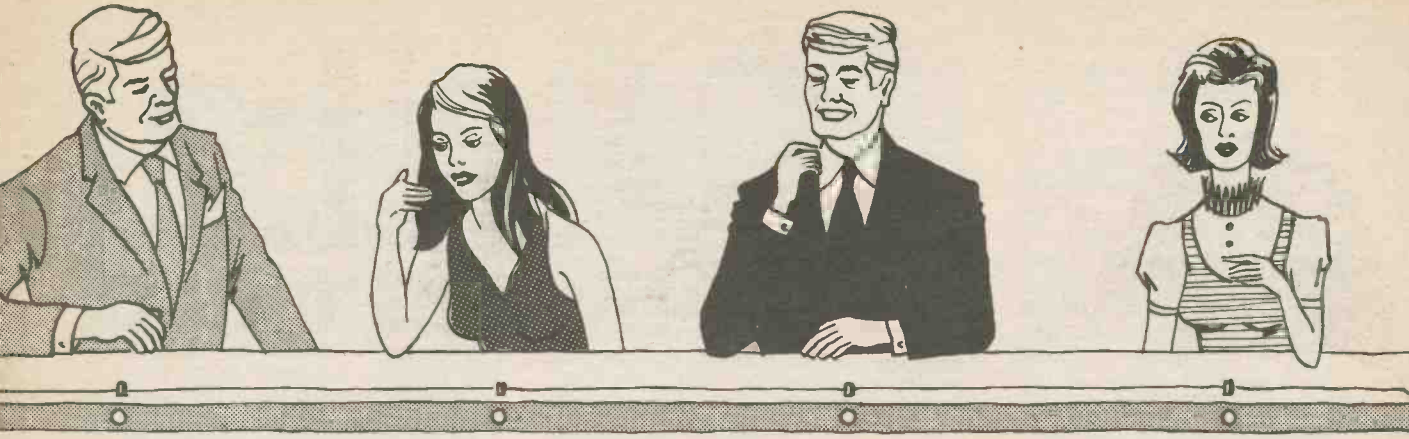


Fig. 1. Circuit diagram of the Competitors response unit for four beam members.



MAIN UNIT

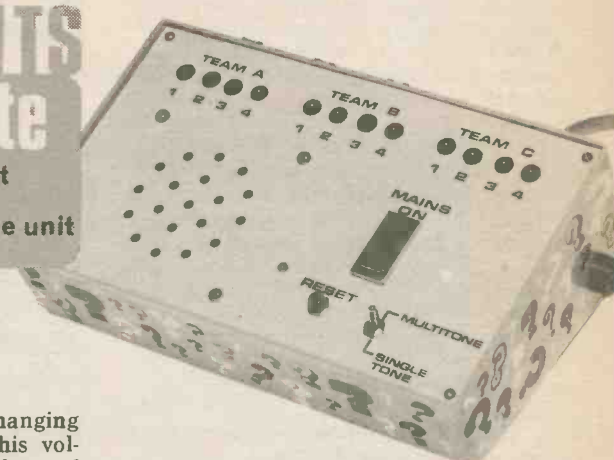
The complete circuit diagram of the main unit is shown in Fig. 2.

To prevent any competitor from indicating a response once the first contestant has pressed, it is necessary to disconnect the power to the reponse switches once the first indicator light is illuminated.

The latching action of the thyristor is used, together with a logic circuit, to achieve this function. Outputs from the response units are taken from the anodes of the thyristors and connected to the inputs of three 4-input NAND gates. When CSR1 is not conducting, the anode potential is almost that of the positive supply rail. When CSR1 is triggered, the anode voltage falls to 0 volts.

So with the thyristor anodes all at logic 1 (with no repsonse buttons pressed), the outputs of the three NAND gates will be at logic 0.

COMPONENTS approximate cost
£25 Main unit
£17 Each Response unit



As soon as one reresponse button is pressed, a logic 0 will be presented to one of the inputs on the corresponding NAND gate, hence changing the output state to logic 1. This voltage is fed through R14 to the base of TR1 and causes it to conduct. When this transistor is not conducting current flows through R1 to the response switches in the competitors' units. When TR1 conducts, the voltage at the collector is pulled down to 0 volts, thus grounding the response switches and preventing the gates of the thyristors from being activated.

Note that a separate NAND gate is used for each team in order to provide a different audible signal to distinguish between each team.

The outputs from the NAND gates are combined by the three diodes, D13, 14 and 15 wired as an OR gate. When any of the NAND gates are activated, a logic 1 appears at the combined cathodes of the three diodes but the action of the diodes prevents this from leaking back to the NAND gates whose outputs are still at logic 0.

ADDITIONAL INDICATORS

In addition to the indicator on the competitors' response units, a panel of l.e.d.s, D1 to D12 are provided on the main unit console. This enables the Quiz Master to see who has pressed first without having to look at the competitors' indicator lamps.

These l.e.d.s are grouped on the console so as to correspond to the arrangement of the teams and are also coloured red, yellow and green for team A, B and C respectively.

Resetting the system is achieved by simply disconnecting the 0 volt supply to the cathodes of the

COMPONENTS

Resistors

R28, 31, 34, 37	1kΩ (4 off)
R29, 32, 35, 38	56kΩ (4 off)
R30, 33 36, 39	5·6kΩ (4 off) see text

All ¼W carbon ± 10%

Semiconductors

D20-23	TIL220 0·2in. red l.e.d. (4 off)
CSR1-4	C103YY *p*-gate thyristor (4 off)

Miscellaneous

S4-8	Miniature push-to-make momentary action (4 off)
LP1-4	12V, 2·2W M.E.S. filament lamps (4 off)
PL1	12-way free plug (to mate with SK1)

Single sided glass fibre p.c.b. 70 × 30mm; stand-off insulators (4 off); M.E.S. panel lampholders, red (4 off, for LP1-4); 7-way cable; 7/0·2 equipment wire; l.e.d. mounting clip (4 off, for D20-23); plastic trunking with cover, 38mm square, 2 × 2m lengths required; mounting hardware.

NOTE

These components are for *one* Competitors Response Unit only. Three units are required in total, and the components list is the same for each with the following exceptions:
Team B—D20 to D23 will be TIL 222 yellow l.e.ds (4 off) and the M.E.S. lampholders will also be yellow (4 off).
Team C—D20 to D23 will be TIL 221 green l.e.ds (4 off) and the M.E.S. lampholders will also be green (4 off).

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thyristors by opening switch S1. This removes the load and allows the thyristors to return to their off state.

AUDIBLE SIGNAL

The remainder of the circuit is concerned with providing an audible signal. This signal is produced by IC4, a 556 dual timer i.c., connected as a tone generator. One half of this i.c. (IC4a) is connected as a monostable which is triggered by the output from the response units. The output from the monostable is used to gate the other half (1C4b) of the 556 timer, connected as an astable which provides the audible tone for the duration of the monostable pulse. The length of the tone is governed by the values of R19 and C2 and provide a burst of about 2 seconds.

The frequency of the tone is governed by the values of R20, R21, R22, R23 and C5. This might seem to be a complex arrangement and needs some explanation. This circuit has been designed to give three distinctive tones, one for each team.

This is achieved by the use of transistors TR4 and TR5, to short out sections of the resistor network and hence alter the output tone. These transistors are connected so that when their base voltages are higher than the emitter voltage, the transistor saturates and in effect creates a short circuit between its collector and emitter. This shorts out the appropriate section of the resistor network. The base of TR4 is connected to the output of IC1a through R26 and S2a.

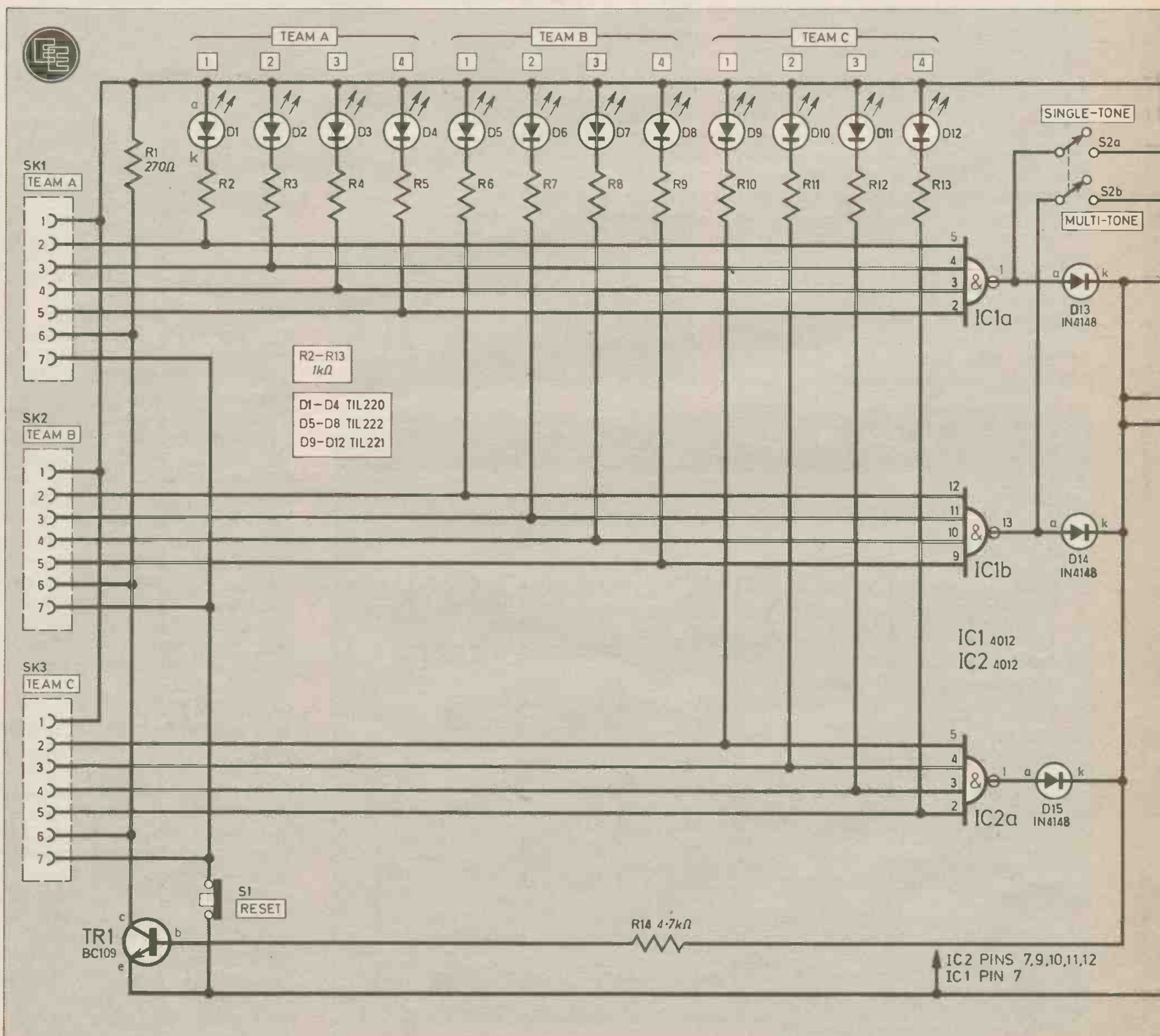
MULTITONE

With S2a in the MULTITONE position, a logic 1 from IC1a, caused by a response from team A, resulting in R21 and R22 shorted out, producing a high pitched tone. The base of TR5 is similarly connected via R25 and S2b to the output of IC1b so that if the unit is activated by a member of team B, a mid range tone is produced since only R21 is shorted.

The output of IC2a is not connected to short out any section of the resistor network so a reponse by a member of team C will produce a low pitched tone.

S2 is provided so that the unit may, if required, be set to produce the low tone only when any response unit is operated.

Fig. 2. The Quiz Master main unit circuit diagram. Note that each of the three competitors response



PULSE GENERATOR

The tone generator circuit requires a short, negative going pulse to trigger it. This pulse must be shorter in duration than the output pulse of monostable IC4a to avoid retriggering the tone generator. The signal to initiate the tone burst is derived from the logic 1 output from the diode OR gate when any one of the contestant's response units is triggered.

A logic 1 input to inverter IC3a results in a logic 0 which is connected via R16 to the base of TR3 causing it to conduct and charge C1 through R18. This voltage is sensed by the input to inverter IC3b. When the voltage on C1 rises above the threshold of the gate it switches and the output changes from logic 1 to logic 0.

The output of the diode OR gate and the output from IC3b are gated by IC3c to give a pulse. Before a response is made, the output of the diode OR gate is at logic 0 and the output from IC3b is at logic 1, so the output from IC3c is at logic 1, preventing IC4a from being triggered.

When a contestant responds, the diode OR gate output goes to logic 1 and starts the charging of C1. During the time between the triggering of the system and the change of output of IC3b, the inputs to IC3c are both at logic 1, therefore the output is at logic 0 and triggers the IC4a.

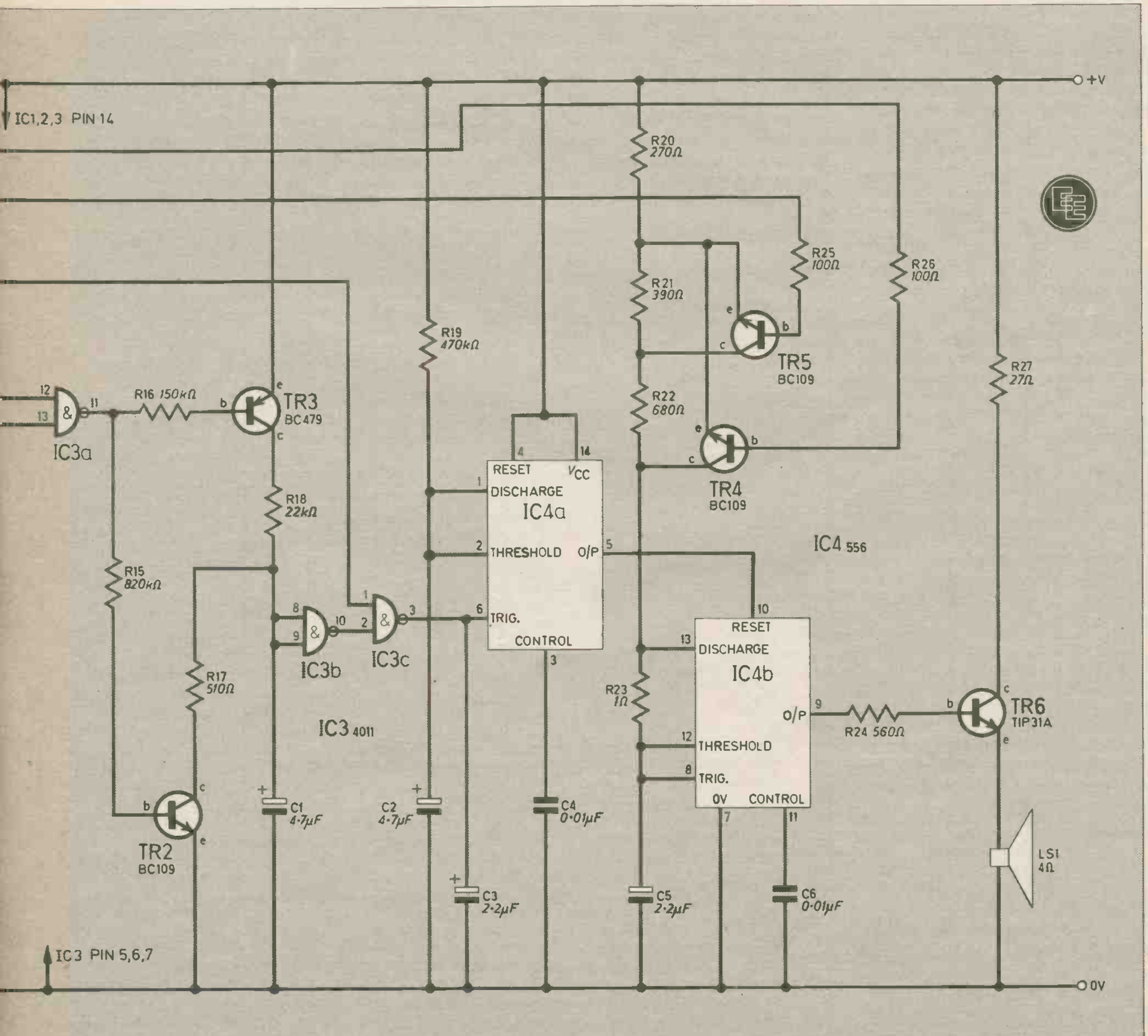
As soon as C1 reaches a voltage above the trigger voltage of IC3b, the output is switched to logic 0. The inputs to IC3c are now at logic 1 and logic 0, resulting in a logic 1 output. The time constant of R18 and C1 governs the duration of the trigger pulse which is of a shorter duration than that of the tone burst.

AUDIO OUTPUT

The tone generated by the tone burst generator is fed via R24 to the base of transistor TR6. This is a simple amplifier to drive LS1.

R27 prevents the loudspeaker current exceeding that for which it was designed. However, TR6 does draw a sizeable current when the tone burst is being produced and it is therefore necessary to heat sink it by mounting it in thermal contact with the control panel. If a metal control panel is not used for the unit it will be necessary to provide this transistor with a heat sink.

units plug into sockets SK1, 2 and 3. The power supply section of the unit is shown in Fig. 3.



POWER SUPPLY

The power supply, shown in Fig. 3, for this unit is extremely simple. The incoming mains supply is fused and switched and fed to transformer T1. The 9 volt output from the transformer is rectified by D16-19 and smoothed by C7 and C8. S3 contains an integral neon indicator which is used to indicate that the unit is switched on.

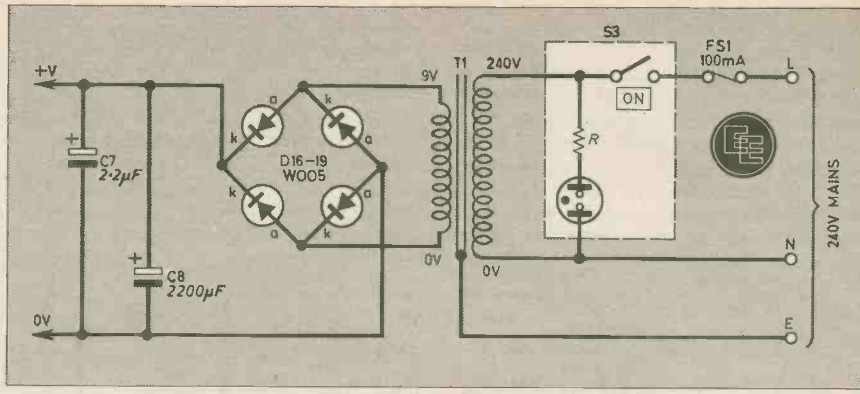


Fig. 3. Power supply unit circuit diagram.

CONSTRUCTION starts here

MAIN UNIT ASSEMBLY

The bulk of the components are mounted on the printed circuit board. The track and component layout for this is shown in Fig. 4. After etching, the board should be drilled and carefully checked for broken or shorted tracks *before* fitting and soldering the components. The integrated circuits should not, however, be fitted until last.

The switches, l.e.d.s, loudspeaker and TR6 are mounted on the front panel of the unit and the transformer, fuseholder and three multiway sockets are mounted in the case of the unit. Care must be taken when assembling the case and front panel to ensure that the components will fit into the space available. It is advisable to lay out the case mounted components and check for clearances before commencing to cut the case and panel.

Particular care is necessary where the bare contacts of S3 are concerned since contact between these and the components on the p.c.b. could cause the unit to become dangerous. For this reason it is necessary to check the clearances with the p.c.b. mounted on its standoff pillars.

HEATSINKING

Transistor TR6 is mounted onto the metal front panel to provide heat sinking and space should be left for this component with a suitable mounting hole drilled for it when constructing the front panel. The precise dimensions will be determined by the component used.

This component should be mounted with an insulating mica washer, to which silicon grease has been applied on both sides. The washer is placed between the transistor and the panel before the transistor is bolted to the case. An insulating bush is also used to insulate the nut from contact with the metal tab of the transistor.

After cutting and drilling, the panel is then painted and rub-down lettering applied. The lettering can then be protected with several coats of spray-on clear varnish.

After the panel and case have been cut and prepared the components can then be mounted and wired up according to Fig. 5. To provide an adequate earth connection to a metal control unit front panel, a substantial wire from the earth in the mains lead should be connected to a solder tag and then be clamped to the front panel by means of one of the case fixing screws.

Once the unit has been completed and connected to the power supply, the integrated circuits can be installed in their sockets. A suitable temporary testing lead should be connected to the negative power supply line and the unit connected to the mains and switched on.

The system should be tested by applying this test lead to the input connections (pins 2, 3, 4 and 5 on the multiway sockets) from the competitors' response units. When each input in turn is tested, its associated l.e.d. should light and an audible tone should be produced by the tone generator. The duration of the tone should be the same on each occasion.

COMPONENTS

Resistors

R1, 20	270Ω (2 off)	R17	510Ω	R23	1Ω
R2-13	1kΩ (12 off)	R18	22kΩ	R24	560Ω
R14	4·7kΩ	R19	470kΩ	R25, 26	100Ω (2 off)
R15	820kΩ	R21	390Ω	R27	27Ω 5W
R16	150kΩ	R22	680Ω		

All ¼W carbon ± 10% unless otherwise stated.

Capacitors

C1, 2	4·7µF 16V tantalum (2 off)
C3, 5, 7	2·2µF 16V tantalum (3 off)
C4, 6	0·01µF disc ceramic (2 off)
C8	2,200µF 16V elect radial lead

Semiconductors

D1-4	TIL220 0·2in. red l.e.d. (4 off)
D5-8	TIL222 0·2in. yellow l.e.d. (4 off)
D9-12	TIL221 0·2in. green l.e.d. (4 off)
D13-15	1N4148 signal diode (3 off)
D16-19	W005 1A, 50V bridge rectifier
TR1, 2, 4, 5	BC109C *npn* silicon (4 off)
TR3	BC479 *pnp* silicon
TR6	TIP31A *npn* silicon, TO-220 case
IC1, 2	4012B CMOS dual 4-input NAND gate (2 off)
IC3	4011B CMOS quad 2-input NAND gate
IC4	556 dual timer

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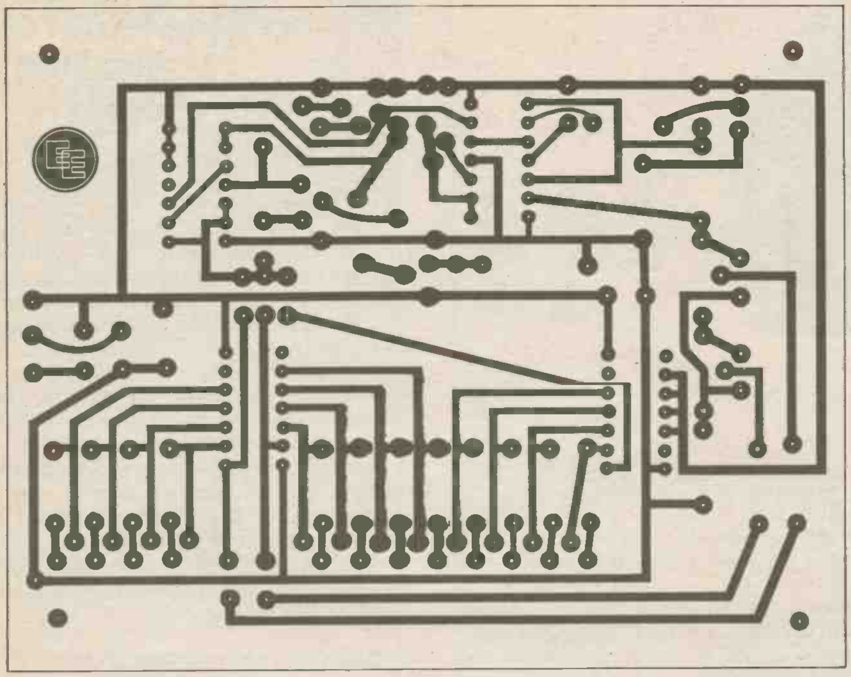
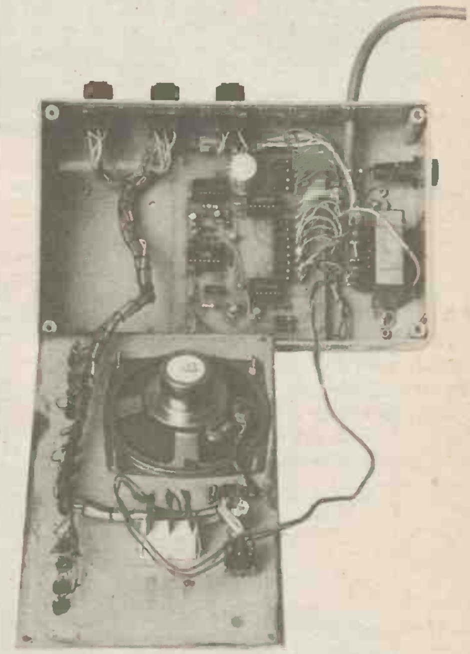
Miscellaneous

S1	Miniature push-to-break momentary action
S2	Miniature d.p.s.t. toggle
S3	Mains rocker switch with integral neon
SK1-3	Chassis mounting 12-way socket (3 off)
FS1	100mA quick blow fuse, 20mm long
LS1	4Ω, 1W miniature loudspeaker
T1	Mains transformer, 9V, 0·6A secondary

Single sided glass fibre p.c.b. 110 × 90mm; console type case, 215 × 130 × 78 (rear) × 47mm (front); fuse holder (for FS1); TO-220 mounting kit (for TR6); l.e.d. mounting kit (12 off, for D1-12); 14-pin d.i.l. holders (4 off); mains lead; P clip; grommet; 7/0·2 equipment wire (assorted colours); stand-off insulators (4 off); mounting hardware.



Quiz MASTER



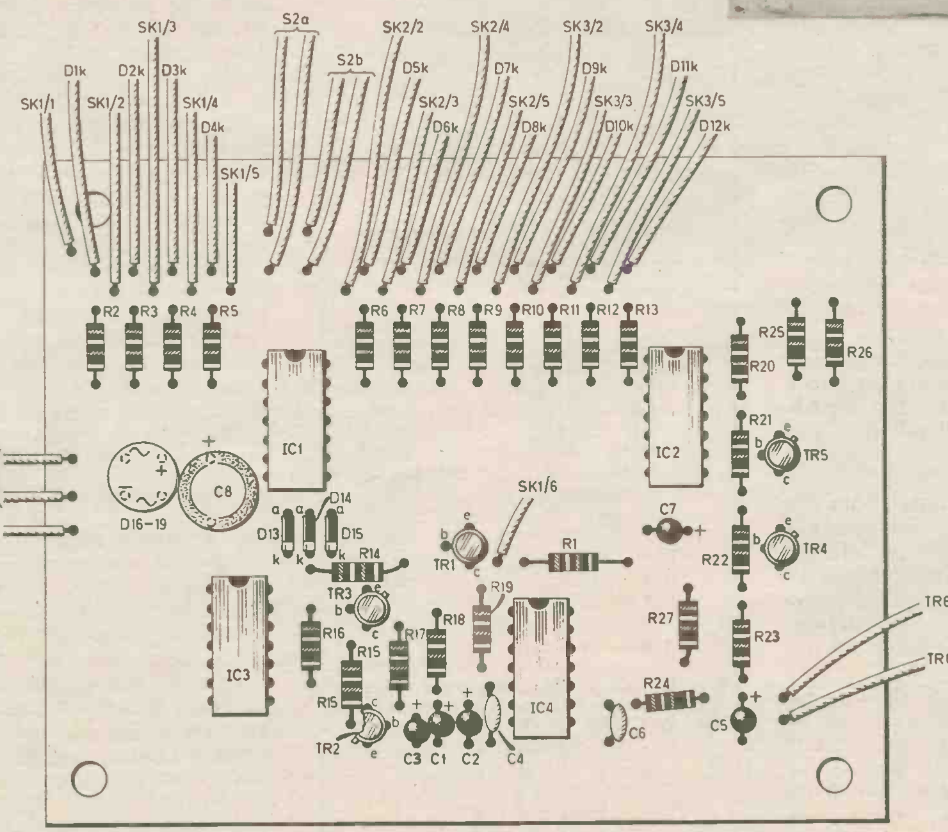
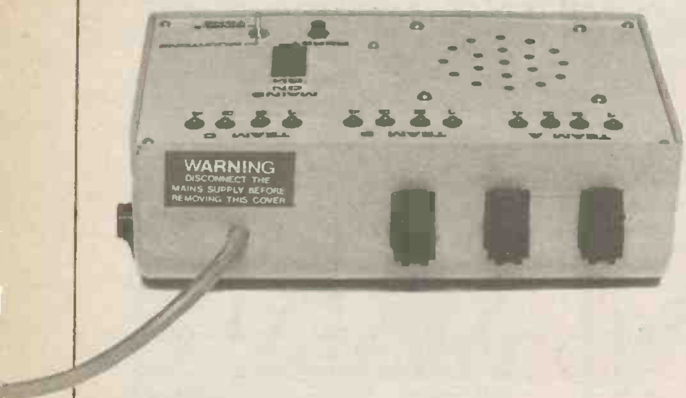


Fig. 4. Printed circuit board assembly and track layout of the main unit (shown actual size).



Rear view of the main unit console showing sockets SK1, 2 and 3, the "QM multipole" 12-way connectors as used on the prototype.

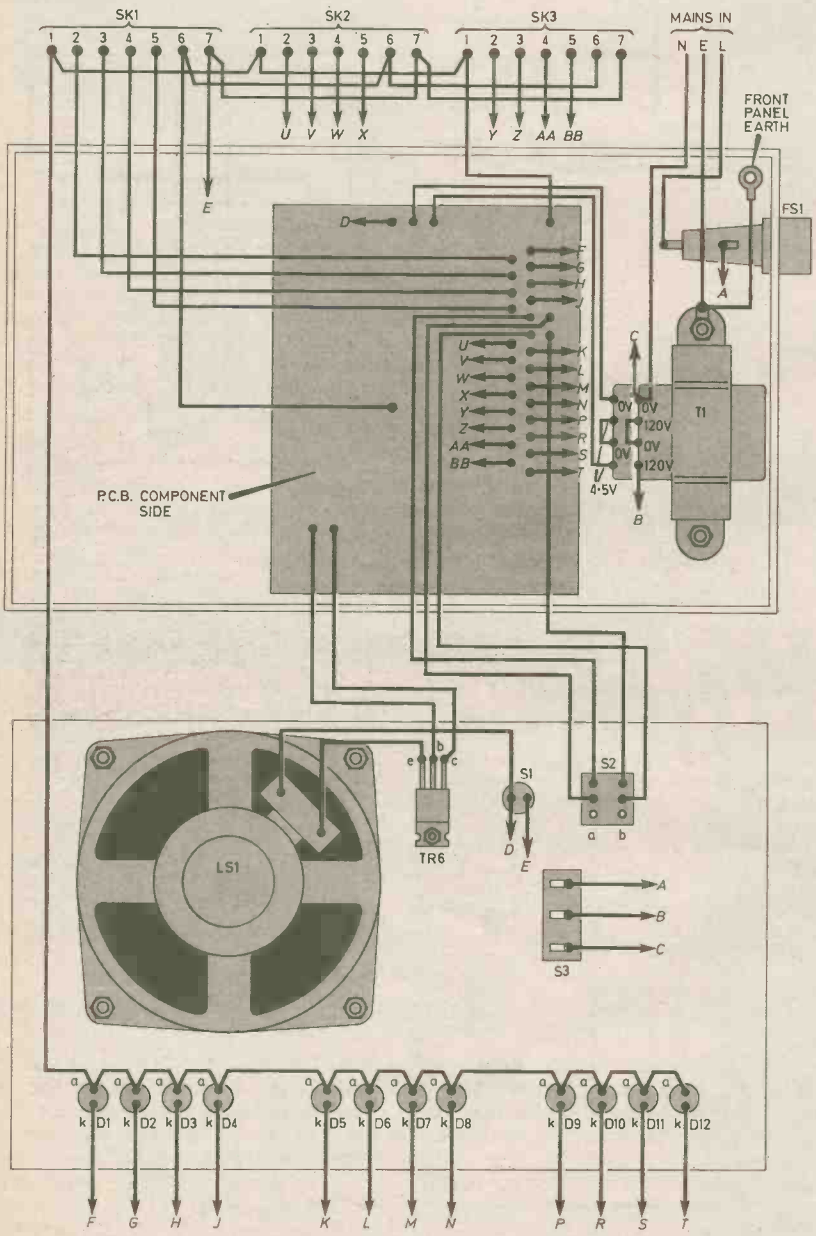


Fig. 5. Quiz Master main unit console wiring diagram.

CONTESTANT'S RESPONSE UNIT

The response units are each mounted in the plastic electrical trunking described earlier. This trunking consists of a three-sided U-section extrusion with a clip-on cover.

The units are constructed using the lid of the trunking as the base of the response unit. The indicator lamps are mounted on the front face of the trunking and their positions should be marked and holes of the correct size cut out with a hole cutter. The lampholders are rather large and are likely to extend across most of the width of the trunking and it is therefore necessary to mount the push-to-make switch and repeater l.e.d. slightly to one side of the lamp.

The position of the push-to-make switch can be marked in the centre of the top of the unit and a hole of the appropriate size drilled. The same procedure, on the contestant's side of the unit, can be repeated for the l.e.d.

CONTESTANT'S P.C.B.

The remainder of the electronics for the contestant's unit is mounted on the printed circuit board as shown in Fig. 6. The track layout for this is also shown in Fig. 6. The printed circuit board should present no manufacturing problems and can be made by any of the many methods available for p.c.b. making.

The p.c.b. should be partly assembled by mounting and soldering into place the thyristors CSR1-4 and resistors R28 to 39. R30, 33, 36 and 39 should *not* be permanently mounted at this stage but temporarily tacked into place on the *underside* of the p.c.b.

The position of the mounting holes for the p.c.b. in the top of the trunking should be marked and drilled.

After all the components have been mounted the unit can be wired up as shown in Fig. 7, but it is necessary to allow sufficient wire to remove the p.c.b. from its mountings and to replace the lamps in the lampholders.

GATE RESISTOR SELECTION

A multiway cable should be made to connect the contestant's unit to the master unit. The mains switch should be turned on and a note taken of which, if any, of the contestant's lamps light. The gate resistors connected to those thyristors must be adjusted so that the l.e.d.s extinguish. This continues until no lamps light without their push-to-make switch being first operated. The test should be repeated after triggering one of the lamp units and operating the reset button. It is likely that this might cause any oversensitive thyristors to trigger because of an induced spike in the wiring.

Quiz MASTER

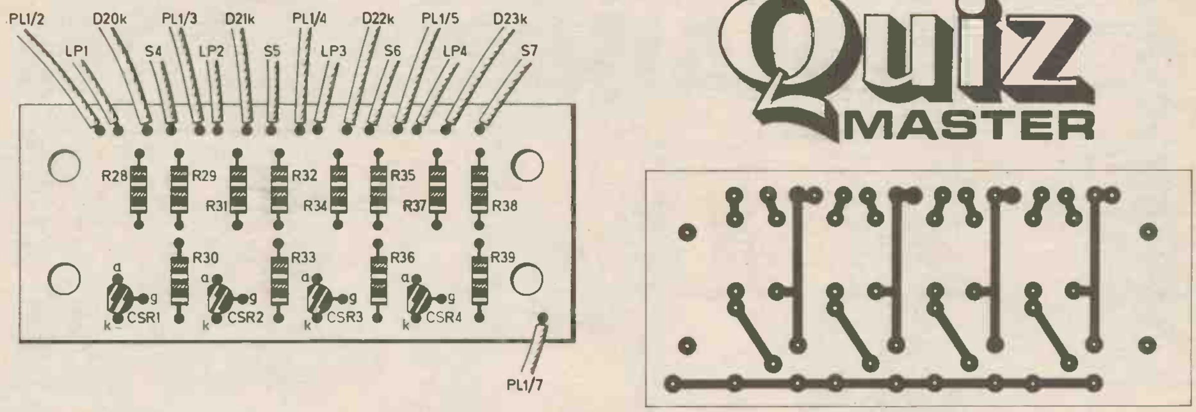


Fig. 6. Component layout and p.c.b. track pattern for each competitors response unit.

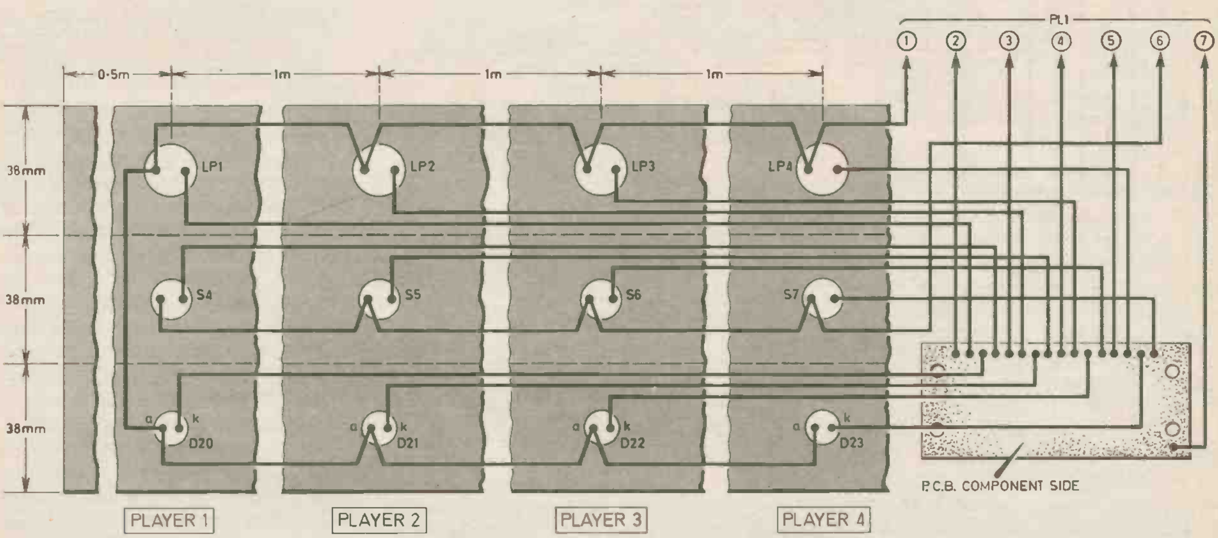
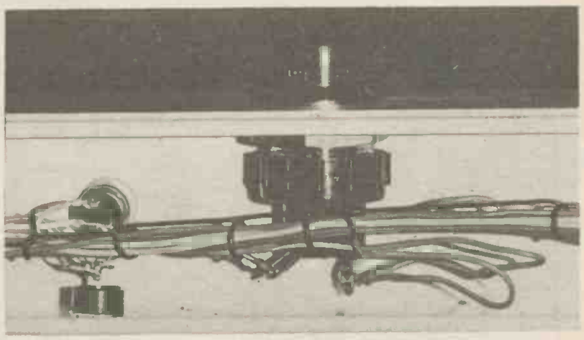


Fig. 7. The interwiring diagram for a competitors response unit. The wires to the PL1 are via the 7-way cable and this cable must be of sufficient length to reach the main unit console. The dimensions shown are for a four metre long response unit (that is, utilising two lengths of plastic trunking).



Photograph showing a single response position. Note that the large lamp holder has been slightly staggered to allow for the l.e.d. and switch. When completed, the wires are laced together-

If a lamp fails to be switched on by its associated push switch then the circuit should be traced through with a voltmeter to ensure that the gate voltage presented to the gate of the appropriate thyristor is sufficient to trigger the triac. Typical values are 0·8V.

If this voltage cannot be obtained with 12V available at the output of the switch then the value of the gate resistor or the resistor in series with the push-button should be adjusted to produce about 1V at the gate of the thyristor with respect to the cathode.

OPERATION

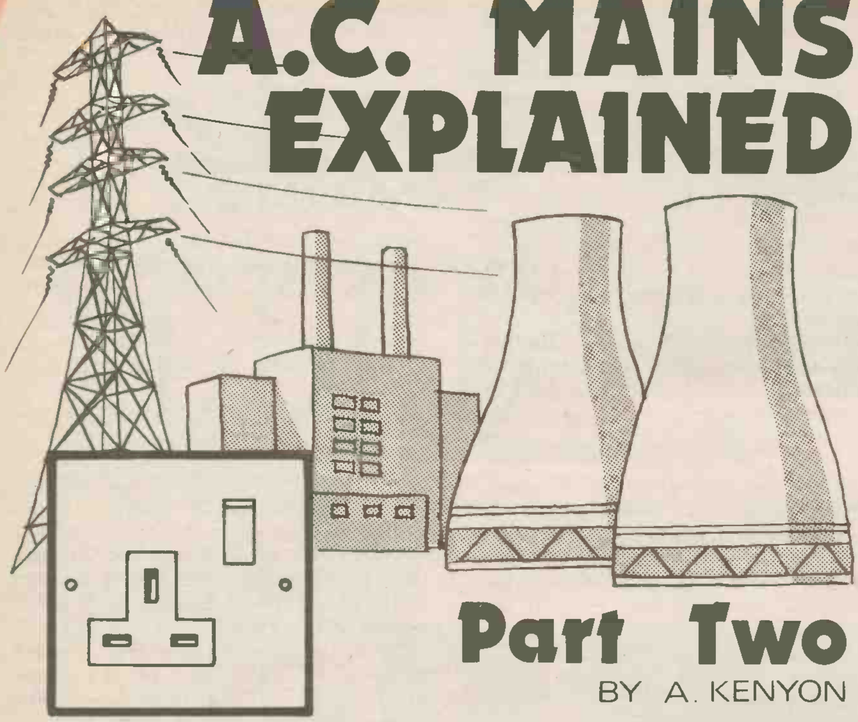
When completed and tested out the system should operate as follows:

When any one of the contestant's push-to-make switches is operated the associated indicator on the front of the trunking should light, as should the l.e.d. on the contestant's side of the trunking and the appropriate l.e.d. on the control panel. The audio signal should produce the appropriate tone, depending on which team operated their buttons.

The audible tone should cease after about two seconds but the contestant's light should remain on, together with the l.e.d.s until the RESET button is operated. If the RESET button is operated before the audio tone has ceased then the lights will go out and the tone of the audio signal will drop to the low tone but the audio signal will continue for the preset duration.

When any of the contestant's lamps are on it should be impossible for any other contestant to illuminate their lamp.

A.C. MAINS EXPLAINED



Part Two

BY A. KENYON

In the last article it was stated that the a.c. generator is called an alternator. Most alternators are driven by steam turbines and since the turbine and the alternator are usually supplied as one generation unit, called **Turbo-alternators**.

Throughout the UK there are many power stations in which are installed numerous Turbo-alternators. The modern standard British Turbo-alternator generates a three-phase voltage of 28 kilovolts and produces 660 megawatts of power while running at 3000 r.p.m. (to produce 50Hz).

NATIONAL GRID

All the state-owned power stations (CEGB—Central Electricity Generating Board) are interconnected by a **National Grid** network which enables electrical energy to be transferred from one station to another in case of emergency breakdown, overloading or seasonal maintenance. There are three tiers of grid networks having transmission voltages of 132kV, 275kV and 400kV.

Even higher voltages are being tested since the higher the voltage, the lower the current and hence less copper required for transmitting the electrical energy.

The grid networks also allow the supply to be transmitted to transformer switching stations which, in turn, supply high voltage to distribution substations where it is transformed to standard distribution voltages of 240V single-phase and 415V three-phase before being carried by underground cables to consumers premises.

Fig. 2.1 shows how this is done. The Main fuses and the kilowatt-hour meters are the property of the supply authority and should not be tampered with.

In the UK the three phases are referred to as **L1**, **L2** and **L3** and N (Neutral) or sometimes Red, Yellow, Blue and N. The Continental identification is referred to as R, S, T and N (or Mp). Note also that the "live phases" are fused whereas the neutral is "solid" (not fused).

Note that the Neutral conductor is earthed at the substation so that at all times the ground forms one of the supply conductors, which is the reason why, when standing on the "ground" and inadvertently touching a "live" conductor, you receive an electric shock.

WHY EARTH THE NEUTRAL?

Refer to Fig. 2.2 which shows a one bar electric fire connected to a single phase 240V supply via a 13A outlet socket. The three cases shown are that with the Neutral line switched, the Live line switched and the Neutral line fused.

From Fig. 2.2a, with the mains switch incorrectly in the Neutral side, it can be seen that even when the electric fire is switched OFF, the element is *still* Live and anyone accidently touching the element would receive an electric shock.

Fig. 2.2b shows the switch in the Live conductor which, when switched OFF, assuming the element is undamaged, leaves the element connected to the Neutral conductor which, being earthed, is at the same potential as the user, hence even if the element is inadvertently touched, the user will not receive a shock.

This diagram also shows what happens should the element break and touch the metal framework (the reflector). Since the metal framework of the fire is earthed, when the element touches the earthed frame it will overload the circuit and "blow" the Live fuse, which immediately disconnects the Live supply

Even if the Live fuse did not "blow", anyone touching the metalwork of the fire would not receive a shock since the Earth conductor short circuits their body.

Fig. 2.2c shows what would happen if the Neutral was fused and the fuse were to blow. As in Fig. 2.2a, anyone touching the element would receive a shock. So by making the Neutral *solid* only a Live fuse can blow under fault conditions thus removing the Live conductor from the appliance.

PORTABLE ELECTRICAL APPLIANCES

Most portable electrical appliances are supplied with a three core flexible cable, one of which, the yellow/green,

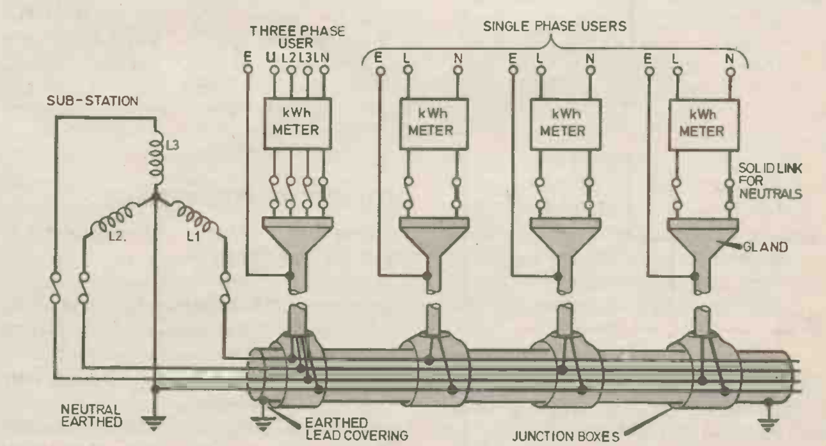


Fig. 2.1. Distribution of a four wire, three phase a.c. supply from the sub-station to both industrial and domestic consumers.

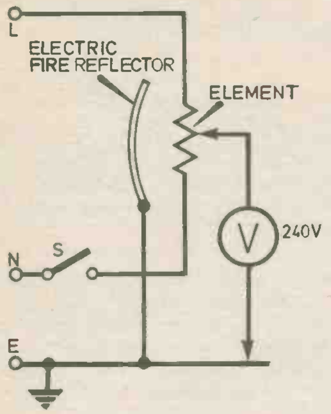


Fig. 2.2a. Mains connected one bar electric fire with the on-off switch *incorrectly* wired in the neutral. When switched off, the element is still live.

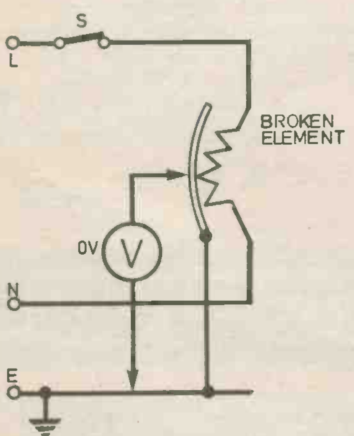


Fig. 2.2b. The same fire but with the element broken so as to touch the metalwork. The frame would still be at earth potential.

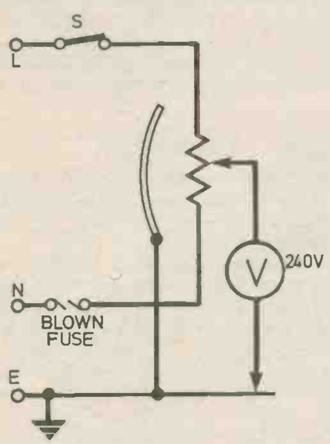


Fig. 2.2c. A fused neutral line, even when blown, does not prevent the element from being live although the fire will stop working.

is the Earth safety conductor. When in use, should either the Live or Neutral conductor break, the appliance fails to function thus giving warning. However, should the Earth conductor break, the appliance continues to function normally and it is only under fault conditions when the user receives an electric shock that it is discovered that the Earth conductor is broken. **Therefore it is essential that the continuity of earth conductors be checked at frequent intervals.**

An exception to this rule is **Double Insulated** equipment. This type of appliance is indicated by a symbol of two squares, one within the other, and is in fact a two wire system. That is, it only has the Live and Neutral connections as no earth is required. The reason no earth is necessary is that the appliance case or housing will be made entirely from plastic (an insulator) with no exposed metal, therefore removing the risk of an electric shock.

IMPEDANCE

When an a.c. voltage is applied to a piece of equipment, the current flow is limited, or *impeded*, by three properties given by:

(1) **Resistance** (R), measured in ohms (Ω).

(2) **Inductive reactance** (X_L), again measured in ohms (Ω) and is the impedance due to an inductive load.

(3) **Capacitive reactance** (X_C), measured in ohms (Ω) and is the impedance due to a capacitive load.

The unit of inductance is the henry (H). A more practical and usable unit is the millihenry (mH) which equals one thousandth of a henry.

The unit of capacitance is the farad (F) and in practice, is usually quoted in microfarads (μF), equal to one millionth of a farad.

RESISTANCE

Pure resistance (R) in ohms is the same for an a.c. current as it is for a d.c. current. So the a.c. impedance of a resistor can be calculated in exactly the same way, that is, by the application of Ohms law, where $R = V/I$.

INDUCTIVE REACTANCE

Inductive reactance, (X_L) in ohms is given by the formula:

$$X_L = 2\pi fL$$

where f = frequency in hertz (Hz).
L = inductance in henries (H).
$\pi = 3{\cdot}142$ (pi)—always constant.

For example, a 76mH inductor would have an inductive reactance at 50Hz of $2\times3{\cdot}142\times50\times0{\cdot}076=24\Omega$. (Note that 76mH = 0·076H.)

CAPACITIVE REACTANCE

Capacitive reactance, (X_C) in ohms is given by the formula:

$$X_C = \frac{1}{2\pi fC}$$

where f = frequency in hertz (Hz).
C = capacitance in farads (F).
$\pi = 3{\cdot}142$ (pi)—always constant.

For example, a 132·6μF capacitor at 50Hz has a capacitive reactance of

$$\frac{1}{2\times3{\cdot}142\times50\times0{\cdot}0001326}=24\Omega.$$

(Note that 132·6μF = 0·0001326F.)

METERING ELECTRICITY

The electricity meter installed into users premises registers the electrical energy consumed in *units*. One unit is equal to one *kilowatt-hour* (kWh) and this is equivalent to one thousand watts of electrical energy used for a period of one hour.

In order to calculate the number of units consumed, multiply the power in kilowatts by the time in hours. For example, 2kW for 30 minutes uses $2\times0{\cdot}5=1$ unit and 6kW for two hours uses $6\times2=12$ units.

Since the supply authority charge for electricity by the number of units consumed, the kilowatt-hour meter is a very important piece of equipment when assessing the individual consumers electricity bill and for this reason they are accurate meters.

APPARENT POWER

With reference to Fig. 2.3a, b and c, we are going to study the effect of

QUESTION TIME

2.1. For a 40μF capacitor rated at 350V, answer the following:
(a) What would be its capacitive reactance (*Xc*) on a 2,000Hz supply?
(b) What current would flow through it when connected to a 240V, 50Hz supply?

2.2. You notice that the rotating disc on an electricity meter (used to indicate that power is being used) is stationary yet your ammeter in circuit reads 0·4A. What would you assume?

PART I ANSWERS

1.1. 115V × 1·73 = 200V.

1.2. Line to earth = 33,000V ÷ 1·73 = 19,075V (r.m.s.). Therefore peak = 19,075V × 1·414 = 26,970V.

1.3. Form the conductor into a loop (a single turn coil) which has the effect of rotating two conductors in the magnetic field, thus doubling the output voltage.

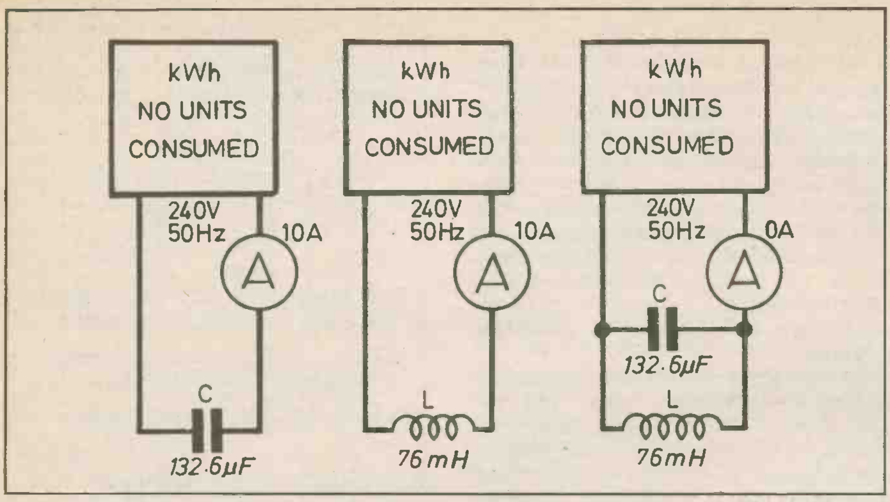


Fig. 2.3a (left). A capacitive load across a 240V, 50Hz mains supply. The ammeter in the circuit reads 10A giving an apparent power of 2400W. The kilowatt-hour meter indicates that no units of electricity are being consumed, therefore the true power is zero.

Fig. 2.3b (centre). Here the load is inductive, and once again the ammeter shows that 10A are flowing so it follows that the apparent power is also 2400W for this circuit. However, the kilowatt-hour meter still does not indicate the use of any units.

Fig. 2.3c (right). If the two reactive loads are combined in parallel, the ammeter shows that no current is now flowing and the kilowatt-hour meter indicates no units being consumed, therefore both the apparent power and true power equal zero.

a reactive load (capacitive or inductive) on an a.c. supply. From the previous calculations, it has been determined that a 132·6μF capacitor, a 76mH inductor and a 24Ω resistor all have an impedance (a.c. resistance) of 24Ω at 50Hz.

The first diagram, Fig. 2.3a, shows the capacitor across a 240V a.c., 50Hz mains supply and according to Ohms law, 10A will flow and this is indicated on the ammeter in the circuit. As power is equal to voltage multiplied by current, this capacitor would appear to be taking 2400 watts. Similarly with Fig. 2.3b, the inductor would *appear* to be using 2400 watts of power as it too has 10A flowing in the circuit.

However, in both cases the kilowatt-hour meters *do not* register any power at all! The reason for this, and this will be explained in detail next month, is that the product of the voltage and the current in Fig. 2.3a and b is known as the **apparent power.** So each of these systems has an apparent power of 2400 watts and a **true power** of zero watts, as registered on the kilowatt-hour meters.

In Fig. 2.3c, where both the capacitor and the inductor are connected in parallel across the 240V a.c. supply, the expected current would be 20A through the ammeter (10A through each branch of the circuit) but in fact the ammeter indicates that no current is flowing at all!

As the kilowatt-hour meter shows that no units are being used, in this circuit, both the apparent power and the true power are zero. Again, this will be dealt with next month when we shall explain why this is so with the aid of **phasor** diagrams.

To be continued

COUNTER INTELLIGENCE

By PAUL YOUNG

Any Old Clothes?

I seem fated lately to bump into Citizens Band radio in some form or other. The other day I was in the offices of my Insurance Company, when a pleasant looking lady approached me smiling and said, "Have you any old Clothes?" I replied gravely, "Indeed I have madam, I am wearing them," and I held out my cap hopefully, in case she felt she would like to rectify the matter.

"No, no" she cried, "I want them for a jumble sale I am holding for my CB Club."

My attention was instantly fixed on what she had to tell me, and although I assured her that I had nothing I could part with, without literally feeling the draught, my wife on the other hand, having to conform to the whims of fashion to some degree, could undoubtedly help.

In return this good lady promised to tell me more about her club. Her name is Mrs. Megan Hardway, and her "Handle" is "Blue Eyes". She told me, that although there are many CB Clubs for grown ups, there are none for children. So about a month ago she started one, and called it, "The Ankle Biters Club". (Ankle Biters being the CB code name for children.)

They hold a meeting every Saturday morning between 10 am and 12 midday in the Parish rooms. The club is open to any child between the ages of five and 15 who has access to a CB radio. Disabled children are particularly welcome.

Already there is a membership of 93. Mrs. Hardway hopes to arrange for speakers to give the children instruction in the correct use of CB radio and has already managed to persuade "Buzby" and the local Police to give some useful talks to the children. This is a very worthwhile scheme and I shall follow their progress with interest.

Desert Island Inventions

I wonder how many of our readers watch a programme on BBC 2 called "The Great Egg Race"? The title is now rather a misnomer. Although in the original series it was a competition to design a vehicle to transport an egg the greatest distance using a rubber band and a few pins, it has now developed into a competition between three teams, who are required to design a piece of equipment for a specific requirement from ordinary materials in a limited time.

So far they have had to build a wide variety of items such as a boat, a bridge, a machine for automatically measuring liquids, and an acoustic gramophone.

To date, no one has asked them to design a radio receiver! I think it would be fun to let the teams imagine they were prisoners of war and see what they could produce from a few old cocoa tins, some rusty razor blades, a nail or two and a piece of coke. I think we would have to let them have a high impedance earphone, so we will imagine they were able to bribe the guards to get one. I wonder how our readers would fare in such a competition? I would expect them to come out top!

I frequently ask the question, "What does one do with a Home Computer?" In the last few weeks the BBC have put on an excellent series in ten fortnightly parts, called appropriately "The Computer Program" and designed to explain to duffers like P.Y. what it is all about. Naturally, like all good programmes, it is put on at an hour when most hard-working people are sound asleep—11.30 pm!

Dodgem's Department

Electronics has now become an integral part of the car and some of the innovations such as delayed action wipers, have been pioneered by the amateur. There is still one electronic gadget I would dearly love to have to assist me when parking.

Imagine a display on your dashboard. It would show a small rectangle, this would represent your car. There would be four small windows. One above, one below, and one either side. In these windows would appear figures, which would represent the exact distance in inches your car is from the nearest object. It would prevent me from breaking the glass in my reversing lamp, or the reversing light of the chap in front, or cutting my tyres to pieces. Now you inventors, what about it?

SQUARE one FOR BEGINNERS

THE DRY CELL battery is the cheapest and most convenient power source available for portable electronic equipment. It is also the safest and so ideal for the beginner.

Dry cells were invented by Georges Leclanché in 1866 and it is a development of his first cell that forms the basis of the batteries we use today. Three basic types are now on the market, and these are the zinc-carbon cell (used in most torches and cassette players), the alkaline manganese cell (the Duracell very high power type) and the rechargeable nickel-cadmium battery.

The table shown below gives the most popular type numbers in each of these three categories and lists the key dimensions for each. Note that a "battery" is a collection of dry cells, and as a single cell has a voltage 1·5V, a battery will have a multiple of this, for example a PP3 battery has six cells giving 9V.

The alkaline manganese batteries have an advantage over standard zinc-carbon batteries in that they last much longer and can supply more current. This does however, make them considerably more expensive.

The rechargeable nickel-cadmium cells have a cell voltage of only 1·2V but have the advantage of being reusable. A constant current recharger is required. They are not as powerful as the alkaline manganese batteries.

When using dry cell batteries in electronic equipment, remember:

(1) Where a set is utilised, use the *same type* of battery throughout.

(2) Remove batteries if the equipment is not to be used for some time.

(3) When batteries have run down and reached the end of their useful life, remove them carefully and dispose of them. Do not throw on a fire.

(4) Zinc-carbon and alkaline manganese batteries are *not* rechargeable and do not attempt to do so.

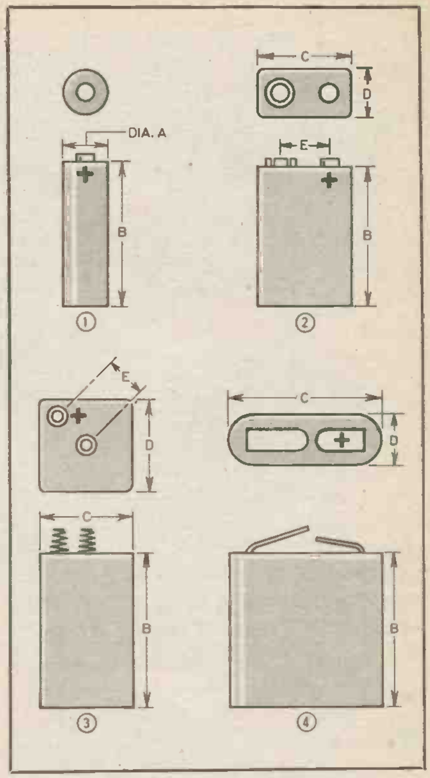


Fig. 1. Some common battery outlines.

ZINC-CARBON BATTERY DATA

TYPE	VOLTAGE	CASE SIZE	OUTLINE DRAWING	A	B	C	D	E	CAPACITY*	TYPICAL APPLICATION
SP11	1·5V	C	1	26·2	50·0	—	—	—	—	Standard power (torches, etc.)
SP2	1·5V	D	1	34·2	61·8	—	—	—	—	
HP16	1·5V	AAA	1	10·5	44·5	—	—	—	—	High power (motor driven equipment)
HP7	1·5V	AA	1	14·4	50·5	—	—	—	—	
HP11	1·5V	C	1	26·2	50·0	—	—	—	—	
HP2	1·5V	D	1	34·2	61·8	—	—	—	—	
R6PP	1·5V	AA	1	14·4	50·5	—	—	—	—	Ever Ready "Power Plus" range
R14PP	1·5V	C	1	26·2	50·0	—	—	—	—	
R20PP	1·5V	D	1	34·2	61·1	—	—	—	—	
PP3	9V	—	2	—	48·5	26·5	17·5	12·7	—	Transistor equipment
PP3-C	9V	—	2	—	48·5	26·5	17·5	12·7	—	Calculators
PP3-P	9V	—	2	—	48·5	26·5	17·5	12·7	—	Extra power equipment
PP6	9V	—	2	—	70·0	36·0	34·5	12·7	—	Transistor equipment
PP9	9V	—	2	—	81·0	66·0	52·0	35·0	—	
PJ996	6V	—	3	—	102	67·0	67·0	25·5	—	Handlamps
1289	4·5V	—	4	—	67·0	22·0	62·0	—	—	Cycle lighting

ALKALINE MANGANESE BATTERY DATA

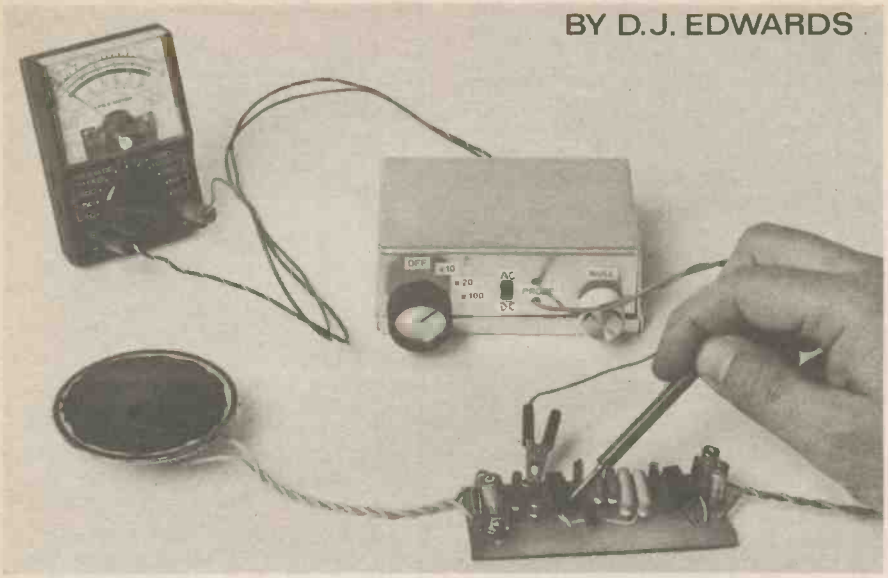
TYPE	VOLTAGE	CASE SIZE	OUTLINE DRAWING	A	B	C	D	E	CAPACITY	TYPICAL APPLICATION
MN2400	1·5V	AAA	1	10·5	44·5	—	—	—	0·8Ah	High power, long life (flashguns, toys, etc.)
MN1500	1·5V	AA	1	14·4	50·5	—	—	—	1·8Ah	
MN1400	1·5V	C	1	26·2	50·0	—	—	—	5·5Ah	
MN1300	1·5V	D	1	34·2	61·8	—	—	—	10Ah	
MN1604	9V	(PP3)	2	—	48·5	26·5	17·5	12·7	0·5Ah	
MN1203	4·5V	—	4	—	67·0	22·0	62·0	—	4·4Ah	Cycle lighting

RECHARGABLE NICKEL-CADMIUM BATTERY DATA

TYPE	VOLTAGE	CASE SIZE	OUTLINE DRAWING	A	B	C	D	E	CAPACITY	TYPICAL APPLICATION
**	1·2V	AAA	1	10·5	44·5	—	—	—	0·2Ah	Portable equipment with high current consumption
RX6	1·2V	AA	1	14·4	50·5	—	—	—	0·5Ah	
RX14	1·2V	C	1	26·2	50·0	—	—	—	2Ah	
RX20	1·2V	D	1	34·2	61·8	—	—	—	4Ah	
RX22	8·4V	(PP3)	2	—	48·5	26·5	17·5	12·7	0·1Ah	
**	8·4V	(PP9)	2	—	81·0	66·0	52·0	35·0	1·2Ah	

* *No capacity figure is quoted for zinc-carbon batteries as this varies greatly and is dependent upon the current drawn, temperature, period of use per day and the voltage at which the host equipment ceases to function.*

** *Type numbers given for rechargable batteries are Ever Ready numbers and where no number is quoted, the battery may be specified by its case size only. Type numbers for all other batteries listed are now fairly standard and used by most major manufacturers, including: Ever Ready, Chloride Exide, Vidor and Duracell. Varta, however, use different numbers but can still supply.*



BY D.J. EDWARDS

INSTRUMENT PRE-AMP

This unit was designed to extend the low voltage ranges of multimeters by a factor of 10, 20 or 100 as selected. The output of the unit plugs into the test prod sockets of the meter and the voltage to be measured is applied to the high resistance input of the Pre-Amp. The f.s.d. of the meter is now given by the range selected on the meter divided by the amplification factor of the unit. It can also be used as a pre-amp for an oscilloscope.

The input impedance is 2·2MΩ ensuring very little loading on the circuit under test. The maximum output of the unit is 7 volts in the d.c. mode and 14 volts peak-to-peak on the a.c. range. The meter range chosen must therefore be within these limits.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1 and is based on two operational amplifiers.

IC1, a f.e.t. amp, is used purely as a buffer. Due to the output being strapped to the inverting input, its gain is unity. However, its impedance at the non-inverting pin is extremely high and in practice is determined by the value given to R1. C1 in the input lead blocks d.c. voltages when measuring a.c., but can be bypassed by closing S1 for d.c. operation.

R2, R3 and VR1 connected between pins 1 and 5 provide an output offset null function to allow the output of the unit to be made exactly equal to earth potential under no-input conditions.

IC2 and associated components form the amplifier proper. The ratio of the feedback resistor to R4 determines the amplification factor. By having a choice of feedback resistor (R6, R7 and R8) and making the resistors 1 per cent tolerance, this factor can be accurately selected.

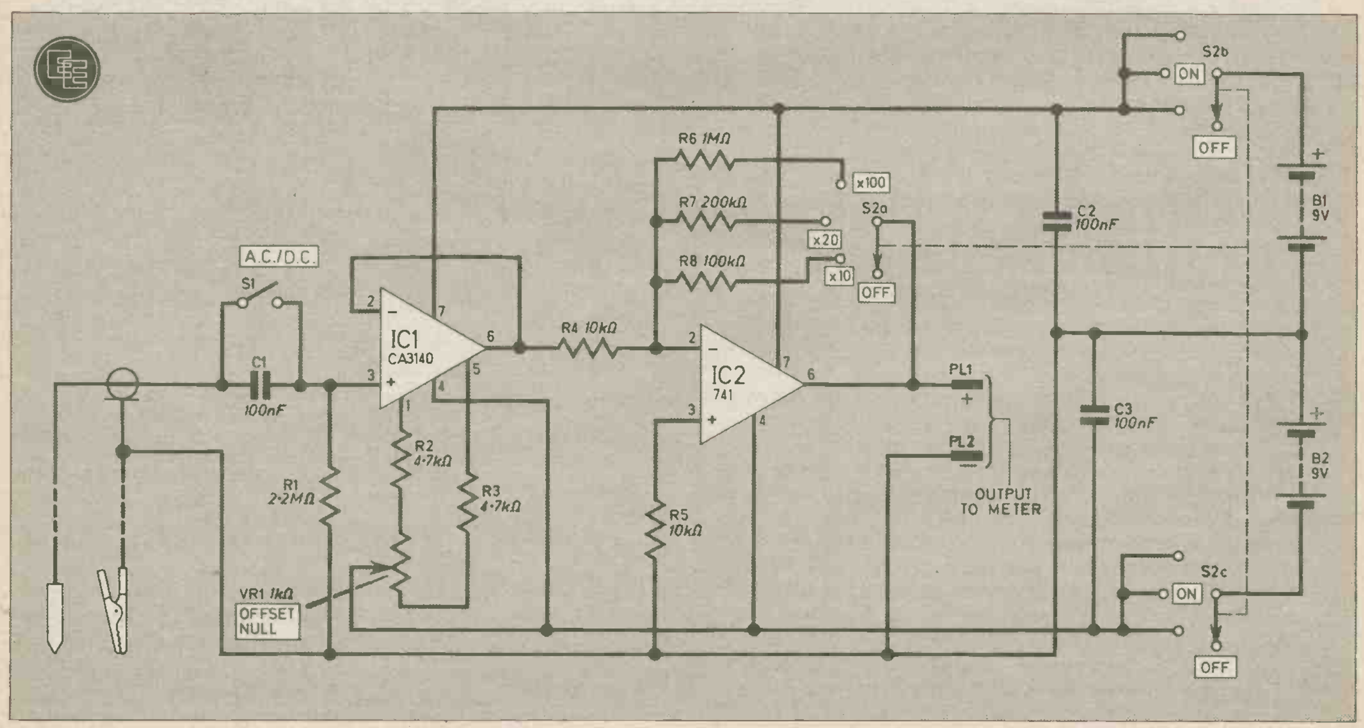
R5 helps reduce the effect of input bias currents on the output voltage. C2 and C3 provide supply line decoupling.

LAYOUT

All components, with the exception of R6 to R8 and C1, are mounted on a piece of 0·1 inch matrix stripboard, size 18 strips by 13 holes, see Fig. 2. Sockets should be used for the i.c.s. The only breaks on the board are underneath the i.c.s to prevent opposite pins from being shorted together. C1 is mounted across the switch contacts of S1 and R6 to R8 are mounted on the tags of S2a.

Because we are dealing with a high gain amplifier the case should be aluminium to provide screening from

Fig. 1. The complete circuit diagram of the Instrument Pre-amplifier.



stray signals. For the same reason the input lead should be a length of screened cable.

At the back of the unit there are three solder tags bolted to the case. This is a common earthing point for the negative lead of B1, the positive lead of B2, the input and output earth leads, the input lead screen and the earth lead to the circuit board. A piece of card was placed behind the circuit board, which is free standing, to prevent shorting against the metal case. Alternately, a spacer, nut and bolt could be used.

TESTING

On switch on, with a multimeter on an appropriate range connected to the output, the output should be approximately 0V and should be made exactly 0V by adjusting VR1. There is no calibration required and the instrument should be ready to use immediately.

To check that the unit is amplifying correctly, construct a potential divider using two resistors, R_a and R_b, and use them to reduce the voltage from a 9V battery to the voltage necessary to give full scale deflection on the meter when amplified by the Pre-Amp. The voltage is measured across R_b, the lower section of the divider, and this can be assigned a convenient value such as 1 kilohm.

The value of R_a is given by:

$$R_a = \frac{(V_B \times R_b \times \text{Amp. factor})}{\text{f.s.d. of meter}} - R_b$$

Thus for f.s.d. of 5V, V_B=9V, Amp. factor=10 and R_b=1kΩ.

$$R_a = \frac{(9 \times 1000 \times 10)}{5} - 1000 = 17\text{k}\Omega$$

Exact f.s.d.s will not be obtained due to the tolerances of the resistors (1 per cent types will give more accurate results) but it will be close enough to check that the unit is working satisfactory.

IN USE

There is no reason why the amplification factors used in the prototype should be rigorously adhered to. These can be altered to suit personal requirements by changing the values of R6 to R8. For instance, if the unit needs to be used only to provide a high impedance input for a meter with low sensitivity, R6 could be made equal to 10kΩ, giving unity gain.

Bear in mind that if the gain of the unit is to be increased, the high frequency response will suffer. On the x100 range the response of the 741 begins to roll off at 10kHz. If this presents a problem the 741 could be replaced by a 748 op-amp which has a better frequency response. A 10pF will need to be fitted between pins 1 and 8 on the 748 device.

The CA3140 f.e.t. op-amp has a maximum differential input voltage of only ±8 volts so care should be taken to ensure that the input voltage does not exceed this limit. Alternatively, two Zener diodes connected opposite polarity could be wired in parallel with the input of the unit. ⌑

COMPONENTS

Resistors

R1	2·2MΩ	R5	10kΩ
R2	4·7kΩ	R6	1MΩ 1%
R3	4·7kΩ	R7	200kΩ 1%
R4	10kΩ 1%	R8	100kΩ 1%

All ¼ watt carbon, ±5% except where stated otherwise

Capacitors

C1 100nF plastic or ceramic
C2 100nF plastic or ceramic
C3 100nF plastic or ceramic

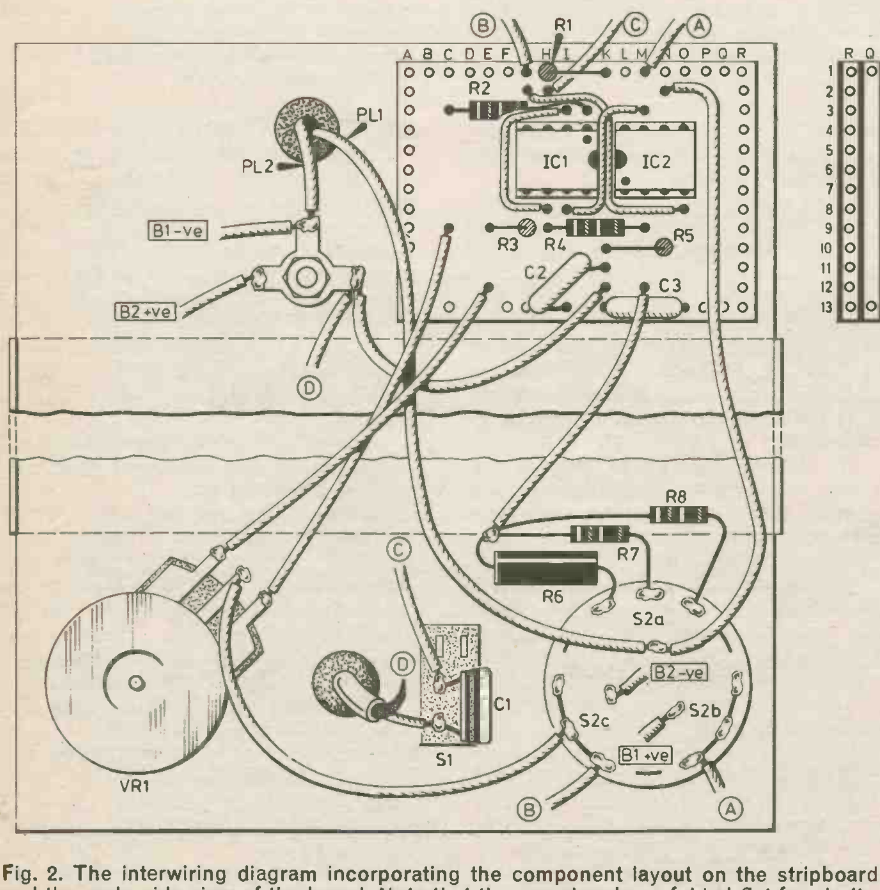
Semiconductors

IC1 CA3140 f.e.t. Op-Amp, 8-pin d.i.l.
IC2 741 Op-Amp, 8-pin d.i.l.

Miscellaneous

VR1 1kΩ linear carbon potentiometer
S1 s.p.s.t. slide switch
S2 3-pole, 4-way rotary switch
PL1, PL2 Plugs to suit meter sockets (1 red, 1 black)
B1, B2 9V PP3 battery (2 off)
Stripboard: 0·1 inch matrix size 18 strips by 13 holes; PP3 battery connectors (2 off); aluminium case size 101 × 70 × 38mm (AB9); knobs (2 off), screened cable, length to suit; 8-pin d.i.l. sockets (2 off); 6BA nut, bolt; 6BA soldertags (3 off); flexible wire for PL1, PL2; probe and crocodile clip.

Guidance only Approx. cost £6 excluding batteries



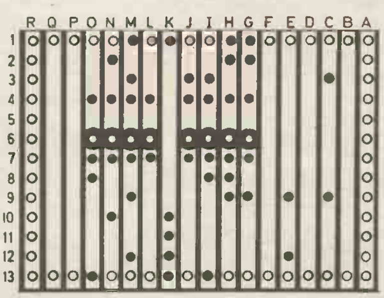
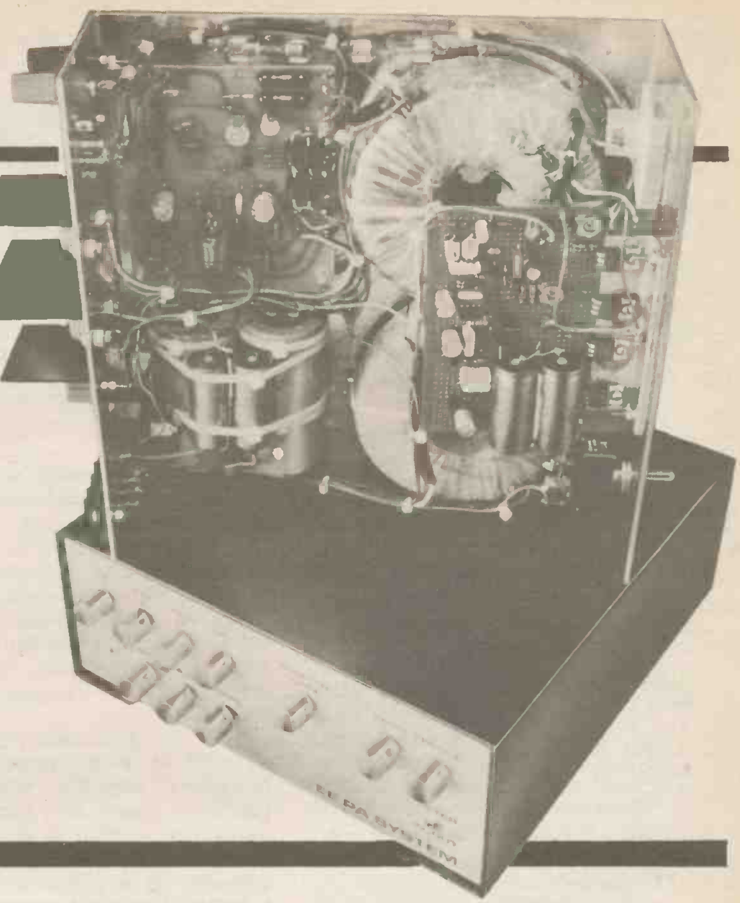


Fig. 2. The interwiring diagram incorporating the component layout on the stripboard and the underside view of the board. Note that the case has been folded flat for clarity.

PUBLIC ADDRESS SYSTEM

PART 4

By E.A.Rule



THIS concluding article is concerned with the testing and setting up of the Public Address System. Important information concerning its operation and use is included.

POWER AMPLIFIER— TESTING AND SETTING UP

It is probable that many builders of this Public Address amplifier will have access to a fair range of test equipment, including signal generators, c.r.o.s and harmonic distortion meters. The application of such equipment in checking out the performance of the P.A. amplifier will be fully understood by its users, and so it is not intended to describe detailed test procedures here.

Instead, a basic procedure is given, that should be followed first, in any event. It calls for the very minimum of equipment: a multirange meter and two 33 ohm wire wound resistors.

MAINS OPERATION TESTS

Before proceeding, first set the mains switch to the OFF position and remove the mains lead connector. Disconnect the wires from terminal pins 11 and 12 and connect the 33 ohm wirewound resistors in series between the wires and the pins (one resistor in each lead). *Do not* connect any load to the output terminals at this stage.

Check that the correct fuses have been fitted, a 1 amp slo-blow in the mains fuse holder and a 15 amp in the battery fuse holder.

Connect the mains supply and switch on (S1 to MAINS). Watch for any sign of a fault condition, such as overheating or other signs.

If all seems well, connect the multirange meter, switched to read around 50 volts mid-scale, to each supply rail in turn, pin 7 (NEG) pin 10 (POS). The voltage should be around plus and minus 48/52 volts.

If this voltage is reasonable, check the voltage at pins 11 and 12, this should be similar to the first test except for a slight voltage drop (one or two volts).

If correct, check the voltage between the 8 ohm output terminal and chassis, this should not be more than a few millivolts (normally around plus or minus 50/100 millivolts).

Having checked these voltages and found all of them correct, the amplifier may be switched off and a loudspeaker or headphones connected across the 8 ohm output.

Switch on, touch pin 5 on the input socket with your finger, a loud hum should be heard from the speaker and will show that the amplifier is working. Switch off.

Remove the two 33 ohm resistors and reconnect the two wires to their respective pins. Remove the load connected to the 8 ohm terminals.

Connect a 12 volt car battery (fully charged) to the battery terminals. **Do not use a bench power supply for this, it may cause damage.**

BATTERY OPERATION TESTS

Connect the meter across the positive 50 volt rail and chassis. Disconnect terminal pin 26 and insert a 1 or 2 ohm wirewound resistor in series.

Switch S1 to BATTERY. A 14kHz note may be heard coming from the transformer. The meter should read somewhere between 40 and 60 volts.

Adjust VR2 until reading is 48/50 volts (assuming the battery voltage is fully charged at 13·8 volts). Switch off.

Remove low value resistor from terminal pin 26 and reconnect lead from extra winding on T2.

Switch S1 to BATTERY and recheck voltage on supply rail. If battery is up to 13·8 volts set final supply rail voltage for 52 volts. If battery is low at around 11·5 volts, set rail voltage for 46 volts.

NOTE: the low value resistor is used to limit the current through the Darlingtons during initial tests and may burn out if a fault exists. Care should be taken while testing on batteries as under fault conditions quite large currents can flow. Be ready to switch off at all times until you have proved the circuit is working normally.

This completes the basic power amplifier and power supply tests.

CONTROL UNIT— TESTING AND SETTING UP

Before testing the Control Unit turn all controls fully anti-clockwise.

Connect the two power sockets (5 pin DIN 240 degree) together via the interconnecting lead. Switch the power supply on. Measure the voltages present on pin 2 (positive) and pin 4 (negative) of the power socket with respect to chassis. Each pin should be at around 15 volts plus and minus. Make sure that pin 2 is in fact the positive. The l.e.d. fitted on the control unit front panel should be alight. Switch off.

Connect a loudspeaker to the 8 ohm terminal of the power amplifier. Connect a signal source (tape recorder, radio or generator) to the TAPE socket. Switch on. Turn the TAPE GAIN control to maximum, adjust the MASTER GAIN control towards maximum, a signal should be heard in the loudspeaker.

Check each input in turn by repeating the test in each case. The DISC input will need to be tested on an actual pickup or a generator set for a low level signal.

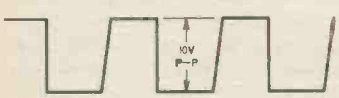


Fig. 4.1. Inverter waveform at collector of TR10. TR11. 14kHz.

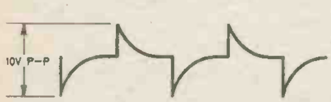


Fig. 4.2. Inverter waveform on pin 2 of IC1. 14kHz.

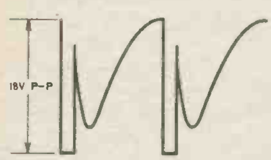


Fig. 4.3. Inverter waveform at collectors of TR16, TR17, TR18, TR19. 14kHz (standby condition).

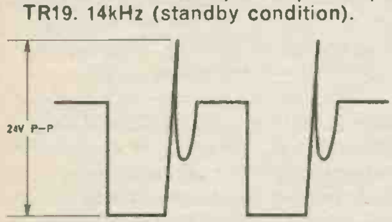


Fig. 4.4. Inverter waveform at collectors of TR16, TR17, TR18, TR19. 14kHz (full power condition).

Feeding a music signal into one of the inputs, check the action of the BASS and TREBLE controls and also the music/speech FILTER.

To set up the VU meter a constant 1kHz tone signal is required. Connect a 8 ohm resistor across the output of the amplifier in place of the speaker. Connect an a.c. reading meter across the load. Adjust the signal level for 20 volts across the a.c. meter, set VR1 (power amplifier) for a VU reading of 0dB. Remove signal and test on actual music or speech. Meter will indicate the peaks of signal and show when output is reaching 50 watts into 8 ohms.

Remove the 8 ohm load and connect a 166 ohm load across the 100 volt line output. Inject a constant tone (1kHz) and measure the a.c. voltage across the line, it should reach 100 volts when the VU meter is showing approximately 0dB.

The complete system is now ready for use, assuming no faults have been found.

If the appropriate test equipment is available one can compare the results with those obtained on the prototype by referring to the full technical specification (Part 1). A full voltage check list is given in Tables 4.1 and 2 as an aid to fault finding. A number of these amplifiers have been made and the design fully proven. Any faults experienced will be due either to faulty components or incorrect assembly.

100 VOLT LINE SYSTEM

For long wire runs, the amount of power loss in a low impedance speaker system is significant especially for the smaller wire sizes. The power at the output terminals is divided between the resistance of the wire and the impedance of the speaker and if the resistance of the wire becomes a high percentage of the total load, considerable power will be lost.

For this reason the 100 volt line system was decided on as standard for public address installations. Loudspeakers designed for use with this system are all matched to deliver rated power when fed from a 100 volt source. This makes calculation of total power easy. Simply add the wattage of the speakers together until the total equals the rated output of the amplifier. No involved calculations with impedances!

Many of the 100 volt line speaker systems available have a switch for different power outputs from the speaker. These can be used to match a system so that the maximum power output is always available. For example, if you have a 60 watt line (which ours is) you could connect one 60 watt speaker, or twelve 5 watt speakers. The load could also be made up of, say, two 20 watts outdoors and four 5 watts inside a tent for example.

The speaker power will depend on how much actual audio is required for the job and it is simply a matter of adding the total powers up to find the power required from the amplifier. If, for example, you had decided that you needed three 20 watt and four 5 watt speakers for a particular installation you would need a total of 80 watts from the amplifier. In our case you would need an extra "slave" amplifier giving you a total of 120 watts, leaving 40 watts "spare".

When using the 100 volt line output, the 8 ohm terminals are left "open circuit". The maximum power

TABLE 4.1
CONTROL UNIT VOLTAGES

Device	†1	2	3	4	5	6	7	8
IC1, IC2, IC3, IC4	-	4·6	0·7	-	1·1	-	1·6	-
IC5, IC6	-	-	-	−12	-	-	-	+12

Device	*emitter*	*base*	*collector*
TR1	−0·6	0	12·5
TR2	−0·6	0	12·5
TR3	13	12·5	∓0·2
TR4	0	−1·4	0
	0	+0·7	0*
TR5	−0·6	0	12·5
TR6	−0·6	0	12·5
TR7	13	12·5	∓0·2

* *Mute circuit activated.*
† IC pin No's.

TABLE 4·2
POWER AMPLIFIER VOLTAGES

Device	*emitter*	*base*	*collector*
TR1	0·7	0	−40·5
TR2	0·7	0	−40·5
TR3	−41	−40·3	18
TR4	−41	−40·3	∓0·1
TR5	41	40·3	0·7
TR6	41	41·7	42·5
TR7	−41	−41·7	−42·5
	source	*gate*	*drain*
TR8	0	0·7	42·5
TR9	0	0·1	−42·5

BATTERY OPERATION

Battery volts=12 POSITIVE earth

Device	†1	2	3	4	5	6	7	8
IC1	−12	−1·3	−12	−1	−8	−3	−12	−1

Device	*emitter*	*base*	*collector*
TR10, 11	−12	−11·3	−7
TR12	−12	−11·3	−2·5
TR13	−1·8	−2·5	−7·8
TR14	−1	−0·3	0
TR15	−11·8	−12	0
TR16, 17, 18, 19	−12	−12	0

Transformer T2 secondary
Mains 32-0-32 a.c.
Battery 34-0-34 a.c.
measured with a peak reading meter calibrated in r.m.s. volts.

NOTE: When working from the mains supply there will be a small voltage on some parts of the inverter circuit; this may be ignored.

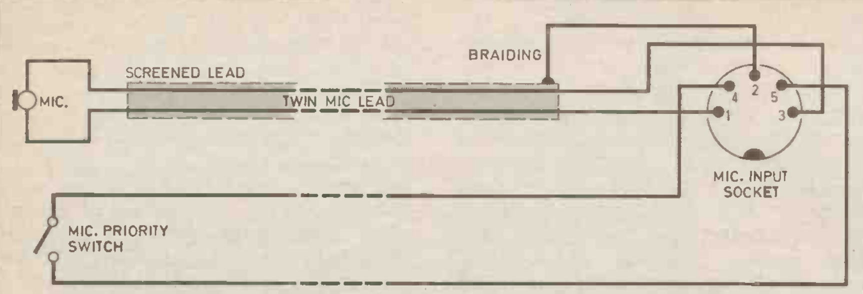


Fig. 4.5. Quasi-balanced microphone connections. Note, screening is NOT connected at microphone end.

available from the 100 volt line is 60 watts (load of 166 ohms) and loudspeakers with a total wattage up to this figure may be used.

Whenever possible the 100 volt line output should be used in the balanced condition. This is achieved by linking a wire between the common output terminal and the CT terminal. The line is then connected to the +50 and −50 terminals. For unbalanced line working, connect a wire link between the common output terminal and either the +50 or −50 terminal. The CT terminal is left disconnected.

USING BATTERIES

The amplifier should be earthed when used outdoors from a battery supply by connecting a lead from the earth terminal fitted on the chassis to a suitable earth rod pushed into the ground. If a vehicle battery is used for the supply ensure that it has a POSITIVE earth otherwise a short circuit across the battery will result if the amplifier chassis or wiring make contact with the vehicle chassis. A completely separate battery should always be used if at all possible.

Under NO circumstances may batteries with a higher voltage than 14 volts (fully charged 12 volt) be connected. Severe damage may result if this precaution is not observed.

SEPARATION OF UNITS

For optimum signal to noise ratios, always keep the maximum practical distance between the power amplifier unit and the control unit. Do not be tempted to stand one unit on top of the other.

If used alongside each other, the power amplifier should be on the right looking from the front and this will maintain the maximum distance between the mains transformer and microphone inputs.

Do NOT let the two chassis make electrical contact with each other, otherwise earth loops may be formed.

EARTH LEADS

Do NOT use a separate earth on the microphone leads or other inputs.

Do NOT use a separate earth on loudspeaker lines.

The ONLY earth connection should be either via the mains earth or a separate earth to the earth terminal provided.

Keep microphone lines away from loudspeaker lines, especially in the open on damp or wet days.

These precautions will help avoid instability when installations using long cable runs are in use.

MICROPHONE INPUTS

Whenever possible the microphones should have "twin" leads which are also screened and should be connected as shown in Fig. 4.5. One of the inner leads is the live and connected to pin 3 on the 5-pin DIN microphone socket. The other inner lead is the "return" and connects to pin 1.

The screening is not connected at the microphone end but the amplifier end is connected to pin 2.

Any "mute" switch fitted to the microphone is connected between pins 4 (earth) and 5 (mute).

This method of connection will provide the minimum of interference pickup and ensure optimum signal to noise ratio.

The signal voltage levels from typical low ohm impedance microphones can vary over a very wide range, from around 160 microvolts (quiet speech from a low output microphone) to as high as 350 millivolts (0·35 volts) with someone singing loudly into a high output microphone.

This is a dynamic range of some 66dB and many commercial public address amplifier microphone inputs just cannot handle this wide range of signal levels. If they are sensitive enough they overload on strong signals and if they can handle the strong signals they tend to be insensitive. A typical input may be 200 microvolts with its overload point at 20 millivolts, a range of only 40dB and fitting an attenuator to improve the overload figure would clearly reduce the sensitivity.

Because of this problem the writer spent considerable time developing the circuit used in the EVERYDAY ELECTRONICS Public Address Amplifier and the simple circuit resulting belies the effort which went into it!

This circuit will handle signals over a range in excess of 109dB. With a basic sensitivity of 70 microvolts PD its overload point is around 20 volts. This means of course that it can handle any signal likely to be found in practice and also used for other types of inputs other than microphones, see Table 1.1. All this and a −58dB signal to noise ratio too!

As the basic sensitivity of the microphone input is 70 microvolts PD and its input impedance is 200 ohms (at maximum gain) we can calculate the input e.m.f. required for different impedances.

$$\text{e.m.f. input millivolts} = \frac{0\cdot07 \times \text{source impedance} + 200\ \text{ohms}}{200\ \text{ohms}}$$

Some examples are given in Table 1.1. However certain signal sources do not like being fed into a low impedance and where this is the case a resistor equal to the source impedance should be wired in series with the microphone input. This will provide correct matching and the new e.m.f. figure will be twice that shown in Table 1.1.

For example, a tuner with a 100 kilohm output impedance. Wiring 100 kilohm in series with the input will give correct matching and an e.m.f. of 35×2=70 millivolts, still with an overload point of around 20 volts.

From all this it can be seen that the circuit used is very versatile and can be used for almost any type of signal source likely to be found in practice.

DISC INPUT

Either mono or stereo pickups may be used with the DISC input, although the stereo type will of course be used as mono because both channels are wired in parallel. Only magnetic cartridges can be used and these will normally be matched correctly with the 47 kilohm load fitted in the preamplifier input. The input is sensitive enough (3·5 millivolts) for most type of magnetic cartridge available but not suitable for moving coil (although some of the more recent types have a high output and may be suitable, they have not been tried). The overload point for the DISC input is 120 millivolts for 0·1 per cent distortion.

If it is required to use a crystal cartridge it is suggested that the microphone input is used with a suitable series resistor (*see section on microphone inputs*).

AUXILIARY AND TAPE INPUT

The AUXILIARY input is fed directly into the 100 kilohm gain control and no overload problems should arise. The TAPE input has a similar arrangement. A signal for feeding to a recorder is available from the TAPE socket (pin 1) at a signal level of 100

Part 2, page 399,
BATTERY OPERATION

Third paragraph, last sentence, *should read*—

The output pulses from these transistors are fed into two extra windings on T2 which are in parallel and form the primary when working from a battery supply.

millivolts (assuming at least an input equal to rated sensitivity), this signal is at low impedance.

MASTER GAIN CONTROL

All inputs are affected by the MASTER GAIN control and it is suggested that this control be set at around the 3 o'clock position for normal operation and each of the four other input gain controls adjusted for the required VU meter reading. The MASTER GAIN can then be used to either increase or decrease all signals as required.

Alternatively the MASTER GAIN can be used to limit the maximum power output by referring to the VU meter reading. Each 3dB reduction from 0dB reduces the power by 50 per cent. That means -3db = 25 watts, -6dB = 12·5 watts, -12dB = 3 watts, and so on.

The BASS and TREBLE tone controls and FILTER are used as required depending on type of installation and signal in use.

One final point. When operating from a battery supply ALWAYS turn the MASTER GAIN control to minimum BEFORE switching on. This will give the supply time to stabilise and avoid instability. Once the unit is stabilised (a few seconds only required) there is no further restriction on control settings. ⌑

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HOMOGENOUS WHIP

Already successfully marketed in Europe and North America, the latest car aerial from Comsintra should appeal to all motorists and CB'ers who have had the unhappy experience of returning to their car to find the aerial snapped off.

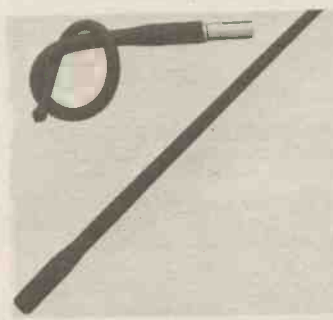
The antenna is a base-loaded ¼ wave type measuring only 38cm (15in) in length. The whip is constructed from an homogenous rubber compound impregnated with metal particles.

Due to the tough, flexible nature of the compound the antenna is claimed to be highly resistant to accidental damage. It can also tolerate extreme weather conditions and is unaffected by the usual causes of corrosion.

Several models are available for use with AM/FM car radios and have a variety of mounting options. A replacement whip specifically designed to fit over the remaining stub of a broken metal aerial is included in the range.

Two CB models are available, one for mobile use the other for fitting to hand-held walkie-talkies, both are tuned to the UK frequencies. Custom modifications can be made for other frequencies such as taxi, radio telephone or local authority allocations.

Comsintra, P.O. Box 7, Dept EE, Holmfirth, Huddersfield, HD7 7NT.



DISPLAY MONITOR

A new UK manufactured 12 inch monochrome Data Display Monitor has been introduced by Chable Electronics.

Claiming a new standard in low cost monitors, it achieves a display of 24 by 80 characters whilst not suffering the usual lack of stability and bandwidth problems associated with some portable TV sets.

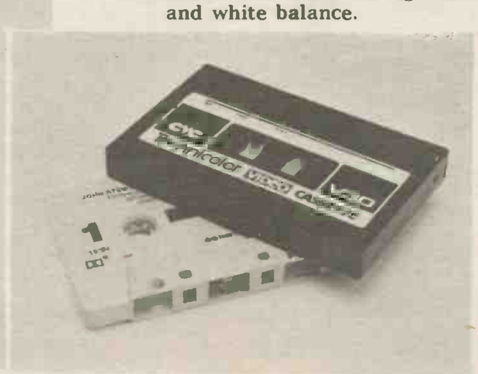
Costing £69·50 plus VAT, the monitor operates from 12V d.c. or 240V a.c. and is intended for business and scientific users, educational establishments and also for home computing.

Chable Electronics Ltd, Dept EE, 3A Commercial Street, Batley, West Yorkshire WF17 5HJ.

CASSETTE VIDEO

"Walk-about video" has finally reached these shores with the announcement that Sulkin (UK) has been appointed distributors of the revolutionary ¼in Microvideo system from Technicolor Inc of America.

Using cassette cartridges slightly bigger than the present audio tapes, the recorder weighs only 7lb, including battery, and plays ¼in video cassettes. Despite its size the Technicolor video cassette claims a picture quality comparable to conventional portable VCRs.



The tapes are currently of 30 and 45 minute duration, and 1 hour versions will be available soon. A 2 hour version and a range of pre-recorded cassettes are being planned. All Technicolor tapes can be played back through conventional television sets using the portable unit. Of particular significance to the home market is the fact that anything recorded on to the Technicolor system can be simply transferred on to VHS, Betamax or others.

The recorder has a compatible Technicolor camera, although almost any other video camera can be used via a simple adaptor. The Technicolor camera has a 6 × Zoom lens and an electronic viewfinder for immediate on-location playback via viewfinder/monitor. The camera weighs only 4·2lb. Features include a built-in mike with boom, illuminated indicators for light intensity, video start, battery life and white balance.

The Technicolor video recorder will retail at approximately £600, with the camera slightly less and 30 minute blank tapes will be around £6 each.

After seeing a demonstration of the system being operated by a teenager on roller skates, the primary aim of taking over the 8mm Super 8 home movie market will find itself redirected to the young scene. Of course, the price will have to come down.

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.

INVADER LANDING GAME

This circuit is a game for one player and is entitled "Invader Landing".

When an invader lands, it buries itself in the ground so that it cannot be seen (at D12). Also, the invader can counter-attack any attack on itself, so the invader must be taken by surprise. This is done by having large bombs hidden at ground level (D11).

The 555 timer i.c., IC3, is wired up in the astable mode and feeds pulses to IC4, a 4017 1-of-10 decoder. The invader lands as D3-D12 light up in turn.

At D11, if the FIRE button is pressed, and AND gate (made from two NANDS in the 4011) IC1 detects that there has been a "hit", and feeds a trigger pulse to pin 8 of the 4047 monostable IC2. Pin 11 of IC2, the $\overline{Q}$ output, then goes low and stops the 555 using pin 4, the reset.

Meanwhile, the Q output of IC2 has gone high and this is fed into a second AND gate along with the output of the first AND gate. The output of the second AND gate is fed to pin 15 of IC4 and resets the line of l.e.d.s to D3. If this did not happen the invader would merely stop at D11 for the length of the monostable pulse and then move on to D12, registering a "miss".

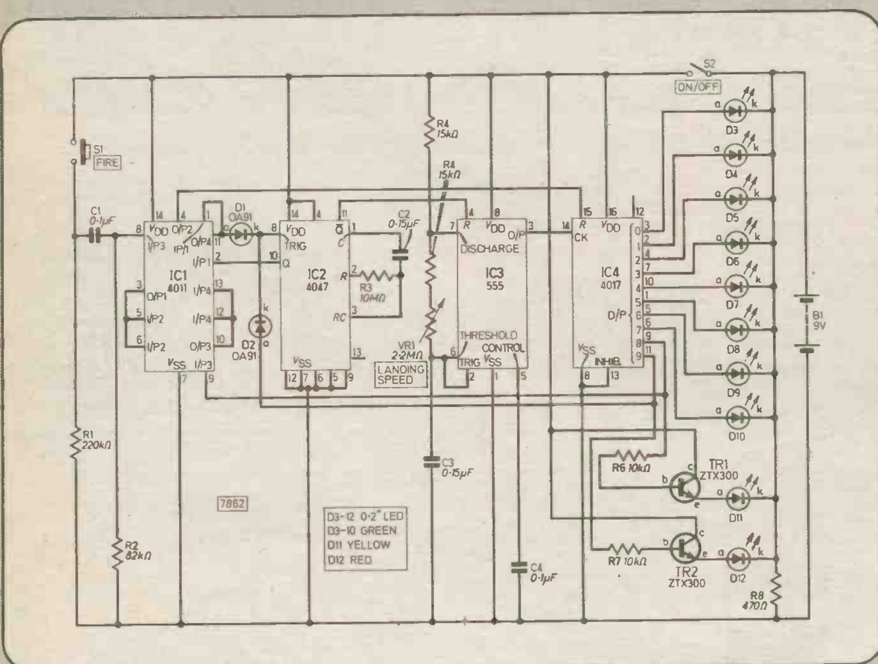
Capacitor C1, resistors R1 and R2 are wired in such a way that only a small pulse gets to pin 8 of IC1 when the FIRE button is first pushed. Therefore, it is useless to continually hold down the FIRE button.

In the event of a miss, the monostable is triggered when the invader gets to D12. The second AND gate does not reset IC4 this time because although the monostable is on, the hit detecting AND is low, and therefore the output of the AND gate is low.

The invader was made to stop at D12 because if the invader reset to D3 as in the case of a hit, it may not be clear in some cases whether a player missed or hit. However, in the case of a hit or miss, IC2 stops IC3. The speed at which the invader lands is decided by VR1, a linear variable resistor.

Using mainly CMOS i.c.s current consumption is low, around 15mA. Most of this current is used up by the l.e.d.s not the i.c.s. The length of the monostable pulse can be altered by changing R3 and C2, but in the circuit the timing is set for about 4 seconds.

C. Stops,
Bridgwater,
Somerset.



TOUCH ALARM

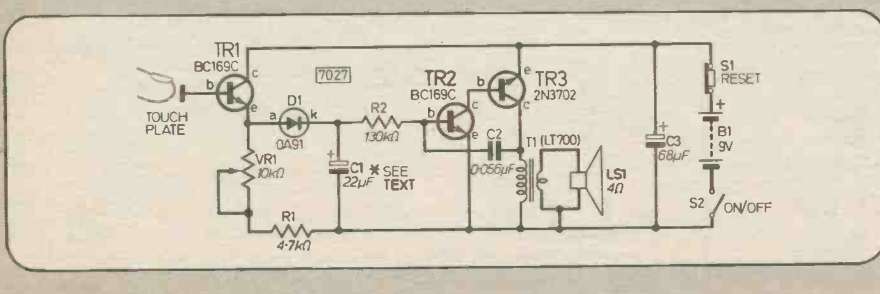
I should like to pass on my circuit idea for a simple touch alarm. When the touch plate is touched the alarm is sounded and will remain on until the reset push switch S1 is operated.

Touching the sensing plate switches the transistor TR1 and allows TR2/3 to drive the loudspeaker LS1 via the transformer T1.

The action of C1 keeps the alarm switched on until the reset button is pressed. Sensitivity of the circuit is controlled by VR1.

By leaving out capacitor C1 the circuit will only sound the alarm while the sensing plate is touched. Removing the contact from the touch plate extinguishes the alarm.

Gary Partis,
Bedlington,
Northumberland.



CIRCUIT EXCHANGE

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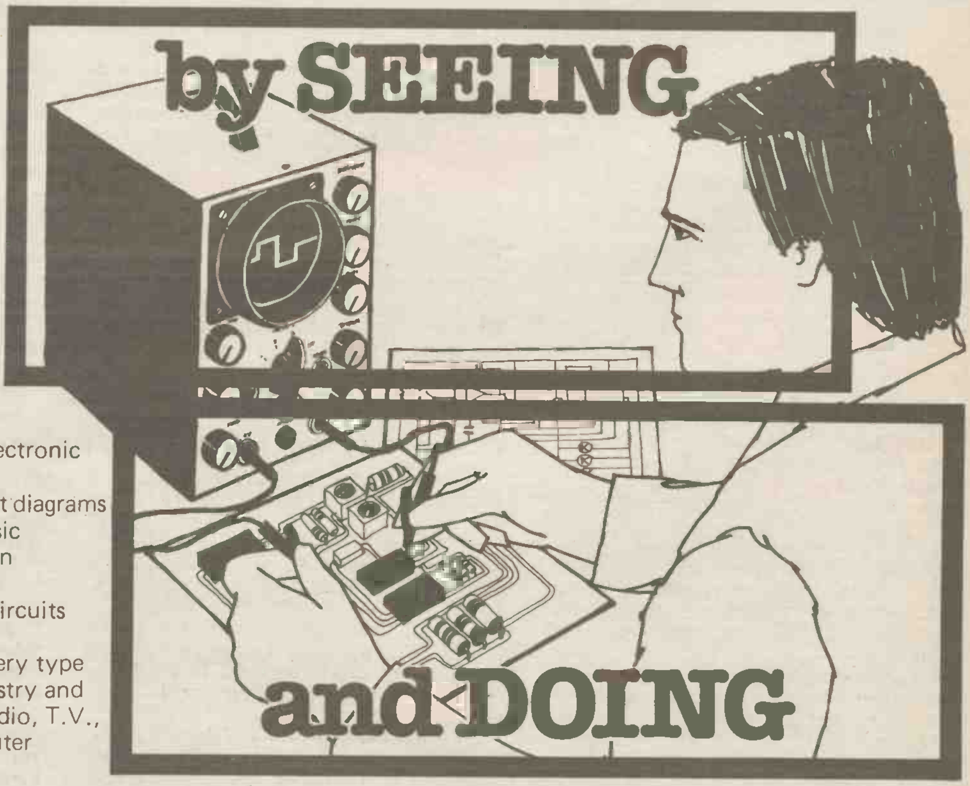

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RADIO WORLD

By Pat Hawker, G3VA

Home entertainment centres

Almost 20 years ago, the American audio industry sought to develop the concept of "home entertainment centres" in which a stereo audio system, a disc player and a tape player were housed in the same console as a television set. But is was an idea in advance of its time, with television very much out on a limb. Now however the TV screen has itself become the display unit for VCR machines (and more recently video disc), video games, teletext, home computers and so on.

This seems to be encouraging some firms to take another look at the home entertainment centre concept, but this time in the form of mix-and-match video, audio, TV and radio units—on the lines of the "component audio" systems that have long been a standard approach to hi-fi.

At the recent trade-exhibition, Cetex, at least two firms, Philips and Sony, were displaying "component television" and from the USA come reports of several other manufacturers, including Zenith and several Japanese firms, jumping into this market with "colour monitors", separate TV tuners, high-power stereo amplifiers, etc. In Japan already more than a quarter of colour TV sales are reported to take the form of component-TV, encouraged by the introduction of stereo sound on television. Stereo-TV is available in Germany and on some of the VCR and video discs; in the UK we may have to wait for direct-broadcast-satellites to give us multi-channel sound.

Cetex also showed some other new ideas in home entertainment electronics though some of these were still prototypes of uncertain cost. For example Philips had a teletext printer as an integral part of a TV receiver, and were forecasting voice-operated channel-changing in which you simply tell the set which channel you want. Cetex was also putting emphasis on video discs, both the Laser Disc and VHD systems.

A number of 27MHz CB equipments were shown, though I noticed only Binatone were making a real feature of these. Inside the TV sets, more and more special-purpose LSI (large scale integration) chips are being used including complete PAL decoder on a single chip, a two-chip PAL/SECAM decoder and some further advances in low-cost digital frequency synthesis.

Cetex was also looking to the future with many mentions of direct broadcast satellites and the now almost obligatory display of Russian television pictures.

Eurikon international TV

Recently for four evenings I watched a special experimental "Eurikon" television channel with programme contributions from a number of different countries and distributed for closed-circuit viewing in some 13 European and North African countries by means of the OTS2 satellite and the IBA's transportable up-link terminal near Winchester.

This was the first of a series of five weeks of "Eurikon" programmes due this year; the first co-ordinated by the IBA and drawing on simultaneous translation facilities for six different language channels provided by Visnews. RAI Italy, ORF Austria, NOS Holland and ARD Germany will also each co-ordinate a week of international programmes this year.

It is part of an investigation being carried out under the European Broadcasting Union to determine the feasibility of a pan-European DBS channel in a few years time—though there are many questions about finance, copyright etc still to be determined.

Eurikon was certainly a worthwhile experiment in screening notable examples of European television programmes, including ballet, concerts, opera, documentaries etc as well as language courses and some in lighter vein. It showed that a worthwhile additional programme channel could be assembled from international contributions, though I for one was left wondering what share of the total television audience would for long be attracted to a "cultural" diet that at times seemed determined to outdo the old "Third Programme" on BBC Radio.

Technically the most significant item was the digital six-channel sound system that provided a choice of six different languages for those of us unable to follow the original sound tracks.

Australian UHF CB

During the long debate that preceded the introduction of legal 27MHz CB in the UK, a good deal was said about the misuse or abuse of the 27MHz allocation in Australia a reputation reflected in the term "Chicken Brained band".

However it is only fair to report that this does *not* apply to operation on the UHF band 476 to 477MHz with 40 channels and mandatory FM. A recent letter from an Australian user of this band points out that ever since its inception the UHF band has maintained a high standard of orderly and sensible operation, of a type more commonly associated with the amateur radio bands than with CB. Those not willing to conform to such standards are cold-shouldered by the majority. The use of high power linear amplifiers is not tolerated, even if economically possible.

Power is restricted to 5 watts. The Australian authorities appear to turn a blind eye to the use of high-gain aerials (up to about 14dB gain), although legally this is restricted to 6dB gain. At least three firms are supplying UHF CB equipment Philips, Apollo and Sawtron.

My correspondent, Norman Burton of Revesby, N.S.W., ascribes part of the reason why 476MHz is much more orderly than 27MHz to the fact that UHF equipment is more expensive and tends to be acquired by older, or at least more mature, enthusiasts who are often "fugitives from the chicken band."

While I for one would certainly hesitate to criticise 27MHz CB on account of its low cost, there is little doubt that there is always the danger of the whole thing being turned into toy radio, and it may well be an attempt to overcome this problem that has led the FCC to encourage the use of 49MHz rather than 27MHz for the extremely low-cost (no licence necessary) milliwatt hand helds in the USA.

Satellite Broadcasting

Broadcasters are already receiving a steady trickle of enquiries from viewers who have read items about satellite broadcasting and are wondering if they could already receive extra programmes if they built or bought a suitable receiver. In North America a small but growing number of viewers are picking up directly the low-power distribution satellites used to feed the many channels on their cable networks.

Apart from questions of legality one should stress that these satellites tend to be located well to the west of the areas they serve and cannot be picked up in the UK even with a large dish aerial and very sensitive receiver. There are rumours that an American TV channel intended for US personnel in Germany is being sent via a military satellite and has been successfully intercepted in the UK though I have no details. What certainly can be received is the Russian satellite "Ghorisont" on 3·7GHz, although this uses the SECAM colour system and you need to understand Russian to get full benefit from the programmes.

Direct Broadcasting via Satellite (DBS) is due in Europe about 1985-86, but it is still not possible to finalise the design of a suitable 12GHz adaptor/receiver as the transmission characteristics of both vision and sound channels have not yet been determined.

Some engineers believe it essential that in order to overcome the problems of viewing across national frontiers there should be only one single standard, both vision and sound, throughout Europe, and that any system adopted for DBS now should be capable of remaining equally suitable for the high-resolution, large-screen displays that it is believed will become available during the next decade.

These are among the arguments used by IBA engineers in advocating MAC ("multiplexed analogue component") although not apparently accepted by the BBC who are backing their own "extended PAL" proposals.

As an interested party, it is not for me to advocate here which system(s) I feel the UK and Europe should adopt—but clearly a decision needs to be made very soon. Both BBC and IBA agree that multichannel digital sound should be adopted, though this is bound to add quite a bit to DBS receiver/adaptor costs.

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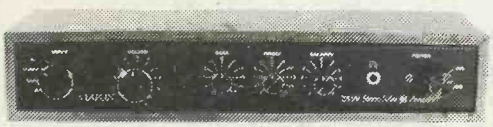

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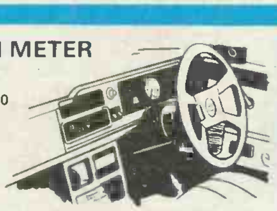

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