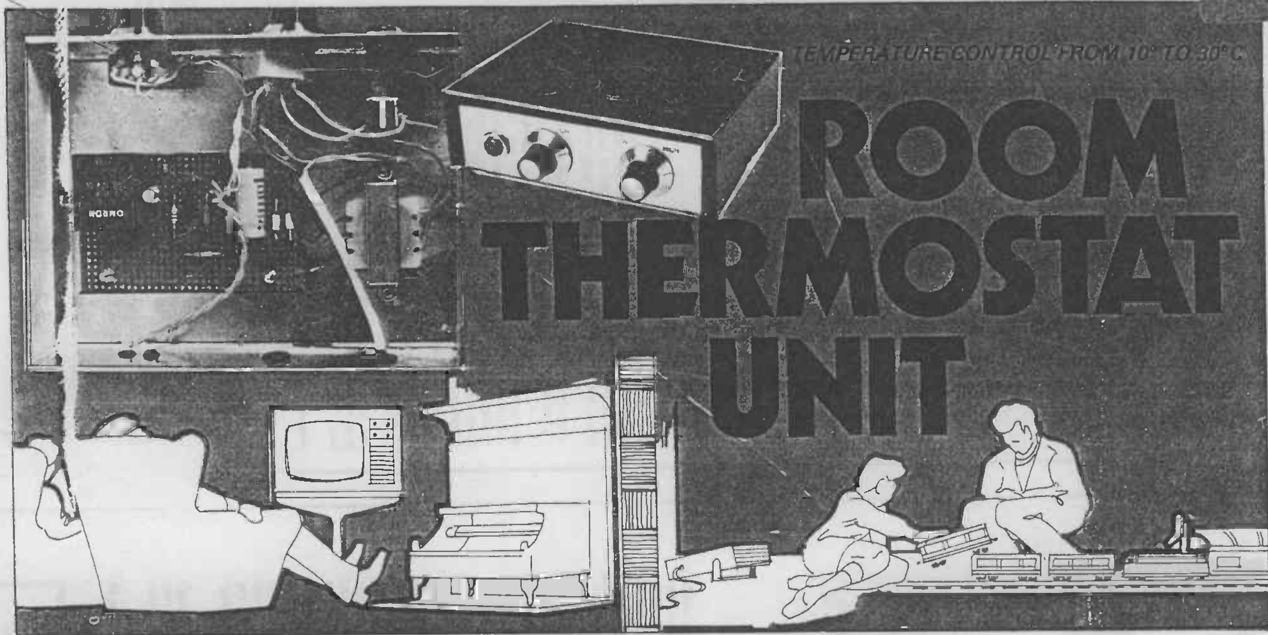
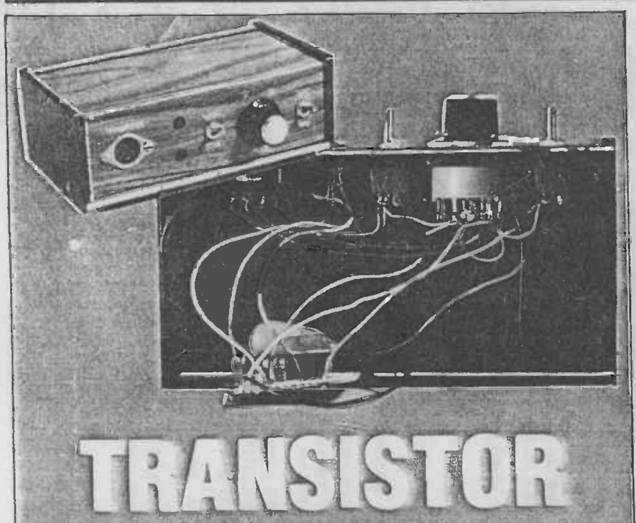
RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1981





NI-CAD BATTERY CHARGER

DIODE EVALUATOR

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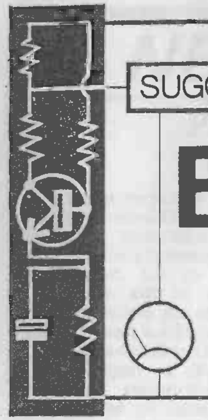


SUGGESTED CIRCUIT

EVALUATOR DIODE

By G. A. French

The markings on many modern electronic components are only required to withstand a limited amount of handling, as occurs when, for instance, they are inserted into a printed circuit board in a factory and are then left alone. Electronic experimenters, on the other hand, frequently employ components over and over again in different circuits and it is not long before the markings on some of these components become completely obliterated. Typical of the components whose markings become erased are rectifier diodes in the 1N4000 series, and these soon lose the white band which indicates the cathode lead-out. It can also often be difficult to determine the polarity of surplus diodes and of diodes which are not listed in component catalogues or readily available manufacturers' data.

The circuit to be described in this article is for an inexpensive diode evaluator which indicates diode polarity in an unmistakable and striking manner. It also shows whether the diode being checked is short-circuit or open-circuit.

ALTERNATOR

The diode evaluator circuit is given in Fig. 1. IC1 is a standard 555 astable multivibrator oscillating at a frequency of about 150Hz. Because R1 has a value which is much lower than that of R2 the charge and discharge periods of C1 are nearly equal and the 555 output is close to being a 50:50 square wave. This output is applied to pins 2 and 6 of IC2, another 555 which functions as an inverter. When pin 3 of IC1 is high, pin 3 of IC2 is low, and vice versa. The two i.c.'s function as an alternator and their outputs feed the l.e.d. circuit and R3.

If a test diode is connected to the test terminals with the polarity illustrated in Fig.2(a) it prevents current flowing through any of the l.e.d.'s when the upper alternator rail is negative. In consequence no l.e.d. lights up. When the upper alternator rail is positive, as shown, current (which is assumed to flow from positive to negative) passes through R3, LED2, the test diode and LED4, whereupon LED2 and LED4 light up. No current flows through LED1 and LED3 because these are reverse biased.

Fig.2(b) shows the situation when the test diode is connected with opposite polarity. In this case the test diode prevents the flow of current when the upper alternator rail is positive, but allows it to flow when the upper alternator rail is negative. This time current flows from the lower rail through LED3, the test diode, LED1 and R3, with the result that LED3 and LED1 light up. LED2 and LED4 are extinguished.

Thus, connecting the test diode into circuit causes a red l.e.d. near the terminal to which its cathode connects to light up, as well as a green l.e.d. near the terminal to which its anode connects. The colour red is associated with "positive" or "plus" and thereby indicates the "plus end" of the diode. Green is similarly, although more loosely, associated with "negative". The l.e.d.'s which light up are, in fact, being turned on and off 150 times per second by the 555 alternator, but persistence of vision makes them appear to be steadily illuminated.

If the test diode is faulty and has a short-circuit all four l.e.d.'s light up. And, of course, if the test diode is open-circuit the l.e.d.'s all remain extinguished.

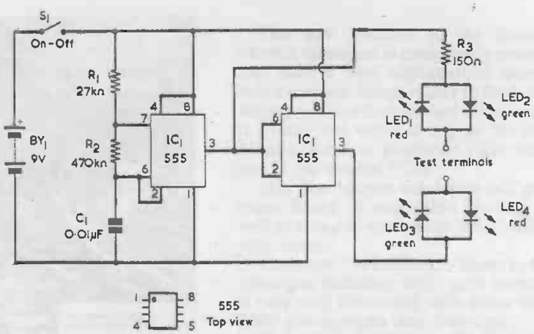


Fig. 1. The circuit of the diode evaluator. IC1 and IC2 form an alternator whose output feeds the l.e.d. section

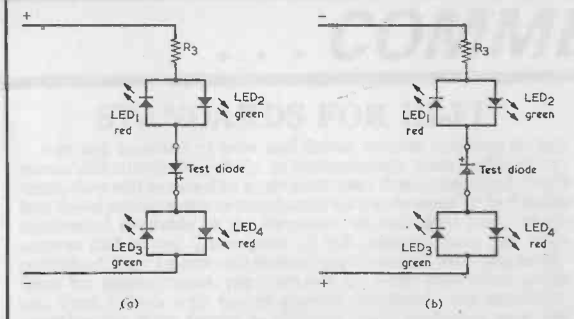


Fig. 2(a). When the test diode has its cathode connected to the lower test terminal, LED2 and LED4 light up on half-cycles when the upper alternator rail is positive

(b). Connecting the test diode the other way round causes LED3 and LED1 to light up when the lower alternator rail is positive

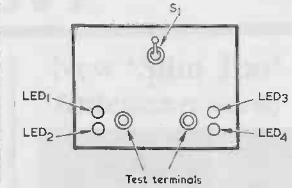


Fig. 3. A suggested front panel layout. The main point to observe is that each pair of l.e.d.'s is positioned close to the terminal with which it corresponds.

CONSTRUCTION

The diode evaluator can be assembled in any small plastic case which can accommodate the components and battery, and a suggested front panel layout is shown in Fig.3. The two terminals can be insulated types with an open socket at the top so that, in most instances, it is merely necessary to touch the test diode lead-outs against the sockets to obtain a polarity indication. Short test leads can be connected to the terminals to check diodes which do not have conveniently placed lead-outs. LED1 and LED2 are mounted close to the left-hand terminal, which is the upper terminal in Fig.1, and LED3 and LED4 are positioned close to the other terminal.

The three resistors in the circuit are ¼ watt 5% and the l.e.d.'s are any standard red and green types. The current drawn from the 9 volt battery is approximately 10mA with no diodes alight. This rises to about 18mA with two l.e.d.'s lit up, and to some 26mA with all four l.e.d.'s illuminated. A suitable battery will be a PP6 or PP7.

In addition to rectifier diodes the circuit will check signal diodes. It can also be used to determine the polarity of light-emitting diodes! ■

'MAN AND SPACE'

A successful exhibition of 85 selected works on the theme 'Young Europeans and Spacelab', by young artists from twelve European countries, was held in Paris from 29th November to 14th December 1980.

The exhibition attracted a large number of visitors who voted for the twelve prize winners (one from each country), each of whom will receive an invitation from the European Space Agency to visit the Kennedy Space Center in Florida:

The UK winner was Glenn Johnson (aged 18).

NEWS . . . AND

PROJECT ENCOURAGING USE OF PROGRAMMABLE CALCULATORS

A major project to encourage computer aided design of gearing is being undertaken by the Machine Tool Industry Research Association. Up to about 40 companies will be visited by MTIRA before the close of the project which is scheduled to run through to October 1981.

The object of the scheme, which is supported by the Department of Industry, is to encourage non-specialist designers of gears and gearing to take full advantage of the potential of scientific programmable calculators and microcomputers. This is achieved by demonstrating the value of programmable calculators with sample gear design programs.

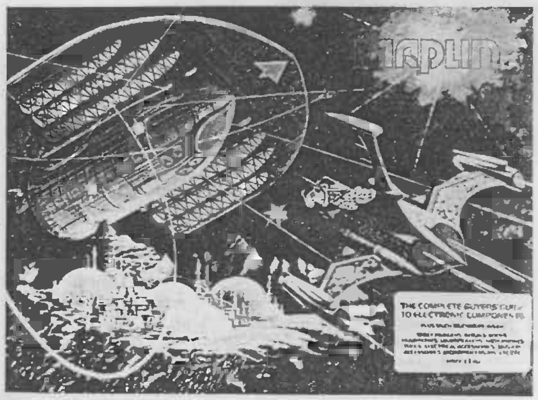
MTIRA, which has three Texas Instruments TI-59 calculators and print cradles in continuous use in its research and design offices, says that their experience so far is that many of the firms participating in the project had not fully appreciated just how powerful the new breed of scientific programmable calculators such as the TI-59 have become and that quite sophisticated programs can readily be implemented.

A major project to encourage computer aided design of gearing is being undertaken by the Machine Tool Industry Research Association. Seen here is the TI-59 programmable calculator and print cradle in use by MTIRA employees.

Whenever applicable, the Association gives help and advice on programming to the participating companies. This does not take the form of a programming service because it is felt this would detract from one of the programmable calculators main advantages – its ease of programming. What is offered is a get-you-started service.

A sample batch of nine companies have participated in the initial trials, and so far the response and interest of the firms concerned has been very encouraging.

MAPLIN CATALOGUE 1981



This new addition of the famous Maplin catalogue is completely revised and uses a new alphabetical thumb index to make things easier to find. It is 40 pages larger than the last edition and is exactly ten times as big as the first Maplin catalogue published eight years ago in November 1972.

This new Maplin catalogue will give many hours of enjoyable reading as well as being an extremely useful reference book.

There are 5540 different items in the catalogue including 1022 new lines. It is very well illustrated with more than 2000 photographs and drawings.

The price is £1.00 from W. H. Smith & Son Ltd., or £1.25 by post from Maplin Electronic Supplies Ltd., P.O. Box 3, Rayleigh, Essex SS6 8LR.

. . . COMMENT

STANDARDS FOR HI-FI

Are you troubled by wow and flutter, rumble and hum or harmonic distortion? Hopefully, in commercially made audio equipment, they will be eased by a new multi-part British Standard, which lays down performance requirements for a wide range of hi-fi audio equipment available to the consumer as individual units, music centres and so on. Three parts of this standard have just been published: Part 1 deals with general requirements, including conditions for measurement, requirements for interconnections, safety etc. Part 2 deals with record playing equipment and cartridges, covering the drive system in terms of speed deviation, wow and flutter, signal-to-rumble and signal-to-hum ratio, etc, as well as with the performance of the cartridge. Part 6 covers amplifiers – frequency response, harmonic distortion, output power, thermal and electrical stability and other important aspects of the product.

Other parts of BS 5942 are due to be published during 1980-81 and will cover tape recording and playback equipment, magnetic tape, radio tuners, loudspeakers and headphones. When complete, the standard should comprise ten parts.

The address of the British Standards Institution is 2 Park Street, London.

WORLD RADIO CLUB

It is rather sad to have to comment on the fact that the BBC Overseas weekly programme, World Radio Club, made its final broadcast on 31st December.

In its thirteen years existence it became a great favourite with many listeners, especially S.W.L.'s. Competitions were frequently held for which pennants were given as prizes, each week the experienced Henry Hatch dealt with some technical aspect of amateur radio and much useful information on the short waves was given.

Well known radio amateurs would from time to time make guest appearances and reports were also often given on, and from, places of radio interest. Listeners would be invited to join **World Radio Club** and its membership exceeded 40,000 drawn from many countries.

The final programme took the form of a party which enabled Peter Barsby to interview a number of those associated with the programme over the years. More than one expressed the hope that one day the programme would return, a sentiment with which we heartily concur.

QUOTATIONS

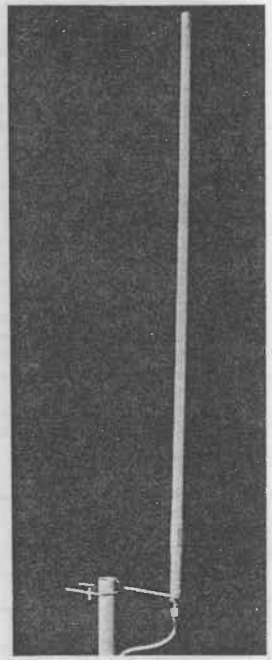
"In the decade during which I have known broadcasting closely the hopes have triumphed over the fears; and I have little doubt that this will be true of the coming decade also. Independent Broadcasting looks forward to it with confidence."

Lady Plowden, who had been chairman of the IBA since 1975 (she was previously Vice-Chairman of the BBC) completed her term of office at the end of December. (We understand that now that Lady Plowden has retired from the chairmanship of the IBA she intends studying for the Radio Amateurs Examination).

"Frankly in my opinion, the rate of growth of the worldwide semiconductor market, which has been something like 15% compounded in the past 20 years, is going to continue up to the end of the century. As a matter of fact I would even say that if it were not for the shortage of engineers capable of exploiting technologies the growth rate would be even higher." – Pasquale Pistorio managing director SGS-ATES.

"I find television very educational. Every time it's turned on I go into the next room and read a book." – Groucho Marx.

New 'Slim Jim' Antenna (2 metres)



Designed by F. C. Judd, this new version of the famous 'Slim Jim' antenna is only 42 inches long and so slim it is now available for mobile operation as well as for base station and ideal for portable use.

Being a free-space antenna it does not rely on the "ground-plane" effect and can be used on vehicles with fibre glass bodies or roof tops at full efficiency. The small dimensions and extremely high efficiency have been made possible by a unique high 'Q' helical stub matching system.

On the base station model the helical stub and main element is completely enclosed in a ¾ inch diameter housing giving full protection against all weathers.

Manufactured by: Wrenpro Systems of Reedham, Norfolk. Under licence from: ZL Communications, Cantley, Nr. Norwich, Norfolk, NR13 3RT.

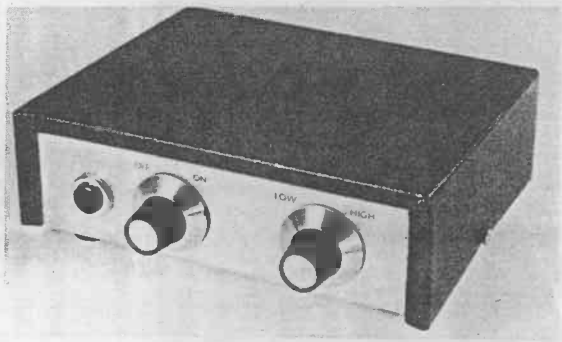
ROOM THERMOSTAT UNIT

By R. A. Penfold

Temperature control from 10° to 30°C.

Switches currents up to 8 amps.

Uncomplicated robust circuitry.



The thermostat unit is assembled in a small metal case

This thermostat is designed to control a bar type electric fire, convection heater or any other type of electric fire which does not have a built-in thermostat. Maximum loading is 1.9kW. Although the circuit of the unit is very simple quite a high level of performance is attained, and a temperature stabilisation of within plus or minus 1 degree Centigrade is possible. The temperature range is slightly greater than 10 to 30 degrees Centigrade (50 to 86 degrees Fahrenheit) which should be adequate for all normal domestic requirements.

THE CIRCUIT

The complete circuit of the room thermostat is given in Fig. 1, and is based on a CA3140 operational amplifier and a thermistor which is employed as the temperature sensing element.

Power for the control circuit is obtained from a simple unregulated mains power supply. As will be seen later, wide variations in the supply voltage do not affect the accuracy of the unit at all, and an unregulated supply is perfectly satisfactory. The mains supply is coupled to the primary winding of isolation and step-down transformer T1 by way of on-off switch S1. PL1 is the mains indicator neon lamp, and this must be a type which has an integral series resistor. The centre-tapped secondary of T1 feeds the full-wave rectifier consisting of D1 and D2, and reservoir capacitor C1. The d.c. output is a little over 17 volts off load, and approximately 14 volts on load.

IC1 is a CA3140 operational amplifier employed as a voltage comparator. Its output is low when its non-inverting input is negative of the inverting input, and is high when the non-inverting input is positive of the inverting input. The inverting input is provided with a reference voltage tapped off from the potential divider given by R1, VR1 and R2. Applied to the non-inverting input is the voltage at the junction of R3 and the thermistor TH1. The resistance of the thermistor decreases as its temperature increases.

Basic circuit operation takes place in the following manner. Before switching on at S1, VR1 will have previously been set up in the manner described at the end of this article. Because the unit has been switched off the relay contacts will have been open and the electric fire or heater will have been turned off. The room temperature, in consequence, will be lower than the desired level. TH1 will have a relatively high resistance and the non-inverting intput of IC1 will be

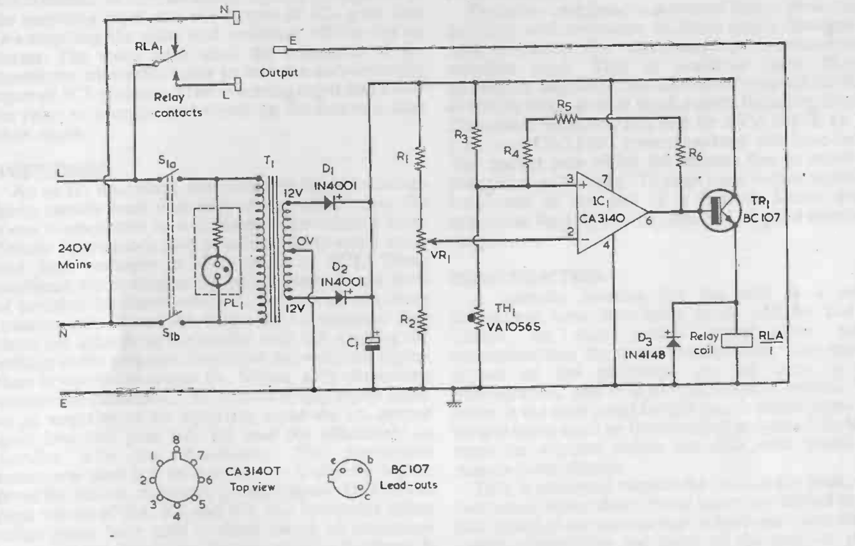
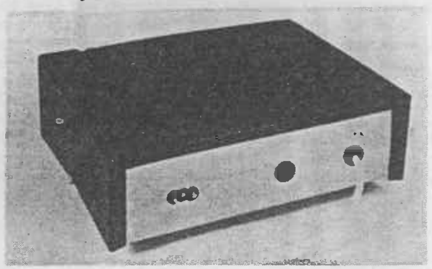


Fig. 1. The circuit of the thermostat unit. The temperature sensing device is TH1. The positive feedback around IC1 provided by R6, R5 and R4 gives snap-action triggering with hysteresis



The thermistor temperature sensing device is fitted outside the rear panel at the left, as seen in this view. The 3-core mains output lead, which passes through the centre grommet, was not fitted when these photographs were taken

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)

R1 15kΩ
R2 15kΩ
R3 56kΩ
R4 10MΩ 10%
R5 10MΩ 10%
R6 10MΩ 10%
VR1 10kΩ potentiometer, linear

Capacitor
C1 220μF electrolytic, 25V. Wkg.

Transformer
T1 mains transformer, secondary 12-0-12V at 100mA

Switch
S1 d.p.s.t. rotary toggle

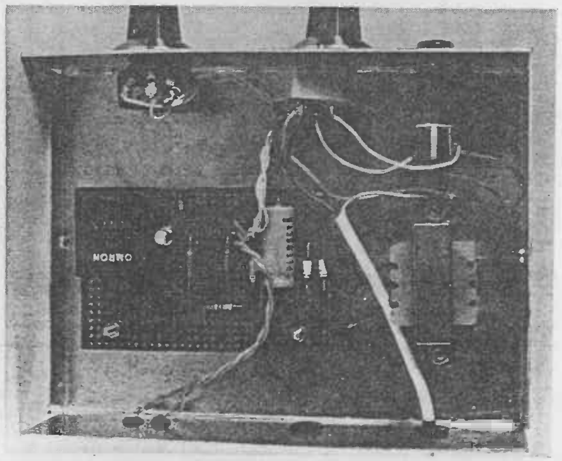
Pilot Lamp
PL1 panel mounting neon indicator with integral series resistor

Semiconductors
IC1 CA3140E or CA3140T
TR1 BC107
D1 1N4001
D2 1N4001
D3 1N4148

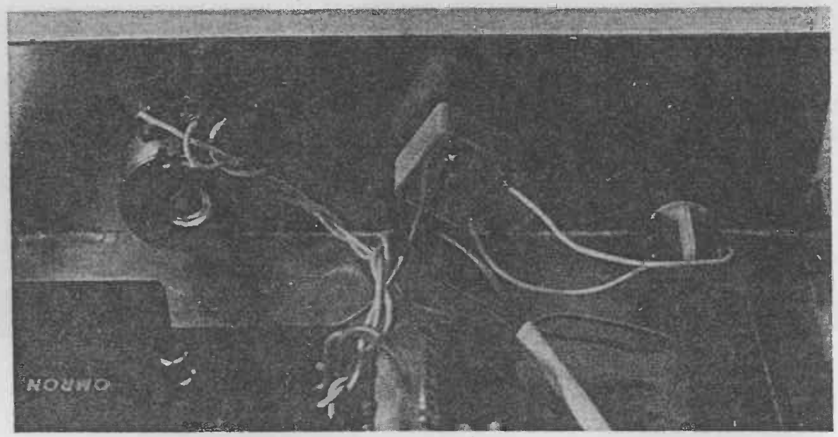
Thermistor
TH1 VA1056S

Relay
RLA relay (see text)

Miscellaneous
Metal instrument case (see text)
Plain perforated board, 0.1in. matrix
2 control knobs
Trailing 13A 3-way mains socket
3-core mains wire
Nuts, bolts, wire, etc.



The internal layout of the prototype unit. Ensure that both the input and output earth wires are reliably connected to the metal case



Rear view showing the wiring to the front panel components

positive of the inverting input. The i.c. output is thus high and emitter follower TR1 causes relay RLA to energise. Its contacts close, turning on the fire or heater, which connects to the unit by way of a 3-way mains plug and socket. The temperature in the room rises and this rise is sensed by the thermistor, whose resistance decreases. When the room temperature reaches the desired level (which has been pre-set by VR1) the resistance of the thermistor falls to a value which causes the non-inverting input to be negative of the inverting input and the output of IC1 goes low, de-energising the relay and switching off the fire or heater. The room cools until the resistance of the thermistor rises sufficiently to take the non-inverting input of IC1 positive of the inverting input and cause the relay to energise and switch on the fire or heater once again.

HYSTERESIS

As so far described, the circuit is liable to switch fairly rapidly from one state to the other when the room temperature is at or around the desired level. Erratic operation is also possible due to small noise and hum voltages at the inputs of IC1. These problems are overcome by introducing a small level of positive feedback over IC1 by way of the three resistors R6, R5 and R4. When the i.c. output is high these are effectively in parallel with R3, causing the voltage at the non-inverting input to be slightly higher than it would otherwise be. When, with decreasing thermistor resistance, the non-inverting input starts to go negative of the inverting input the i.c. output goes low and puts R6, R5 and R4 effectively in parallel with the thermistor. The thermistor resistance now has to increase to a slightly higher level for the i.c. output to go high again. Due to the high values of R6, R5 and R4, this hysteresis effect takes place over only a small range of resistance change in the thermistor, but the positive feedback is sufficient to cause rapid energising and de-energising of the relay, and to make the circuit impervious to noise and hum pick-up at the i.c. inputs.

Variations in the rectified supply voltage do not have any significant effect on circuit operation because fractions of that voltage are applied to both the inverting and non-inverting inputs of IC1. An unregulated supply is therefore quite satisfactory.

D3 is the usual protective diode which prevents the formation of high back-e.m.f. voltages across the relay coil when the relay de-energises.

COMPONENTS

The relay employed is a printed circuit power type having a coil resistance of 306Ω and a changeover contact rated at 250 volts 8 amps a.c. maximum for a resistive load. This is available from Maplin Electronic Supplies. The thermistor type VA1056S is available from several retail outlets including Maplin Electronic Supplies. IC1 can be a CA3140E (8 pin d.i.l.) or a CA3140T (round package with lead-outs). The socket into which the electric fire or heater is plugged is a "trailing" 13 amp 3-pin socket normally employed at the end of a flexible 3-core mains extension lead. It can be obtained at good electrical shops.

CONSTRUCTION

A suitable housing for the unit is a metal instrument case measuring about 152 by 114 by 51mm, or any similar metal case which accommodates the parts comfortably. The general layout of the prototype can be seen in the photographs, and it is not particularly critical. The holes in the rear panel for the 3-core mains input and output leads must be fitted with grommets. The leads must be secured inside the case with plastic or plastic-faced clamps.

TH1 is mounted outside the case at the back, and two small holes about 8mm apart are drilled in the rear panel of the case so that its lead-out wires can be passed through to the inside of the case. A small grommet is fitted into each hole to insulate the lead-out wires from the metal case. In the prototype the leads from the component board were soldered to the thermistor leads just inside the grommets, and these held the thermistor in position. Constructors desiring a more secure form of mounting can fit a small 2-way tagstrip inside the rear panel, and the thermistor leads and the component panel leads can be soldered to the tags.

Transformer T1 is mounted on the base panel of the case on the left hand side using two 4BA or M4 mounting bolts. A solder tag, to provide a chassis connection, is secured under one of the nuts on these bolts.

COMPONENT PANEL

Most of the components are assembled on a plain perforated panel of 0.1in. matrix having 31 by 20 holes. Details of this panel are given in Fig. 2.

Commence construction of the panel by carefully cutting out a piece of the specified size using a hacksaw. The components are then mounted in the appropriate positions with their lead-out wires bent flat against the underside of the panel, after which they are soldered together in the manner shown in Fig. 2. The component lead-out wires should be long enough to permit most of this wiring to be completed but, if necessary, tinned copper wire of about 22 s.w.g. can be used to bridge any gaps.

It should be noted that IC1 has a PMOS input stage, and that the normal MOS handling precautions should be taken when dealing with this device. It should be soldered into circuit with an iron having a reliably earthed bit.

The completed component panel is mounted on the base panel of the case on the right hand side using 6BA mounting bolts. Spacers about 12.5mm long are used to ensure that the panel underside wiring is held well clear of the metal case. The component panel can be employed as a template with which the positions of the two mounting holes are located.

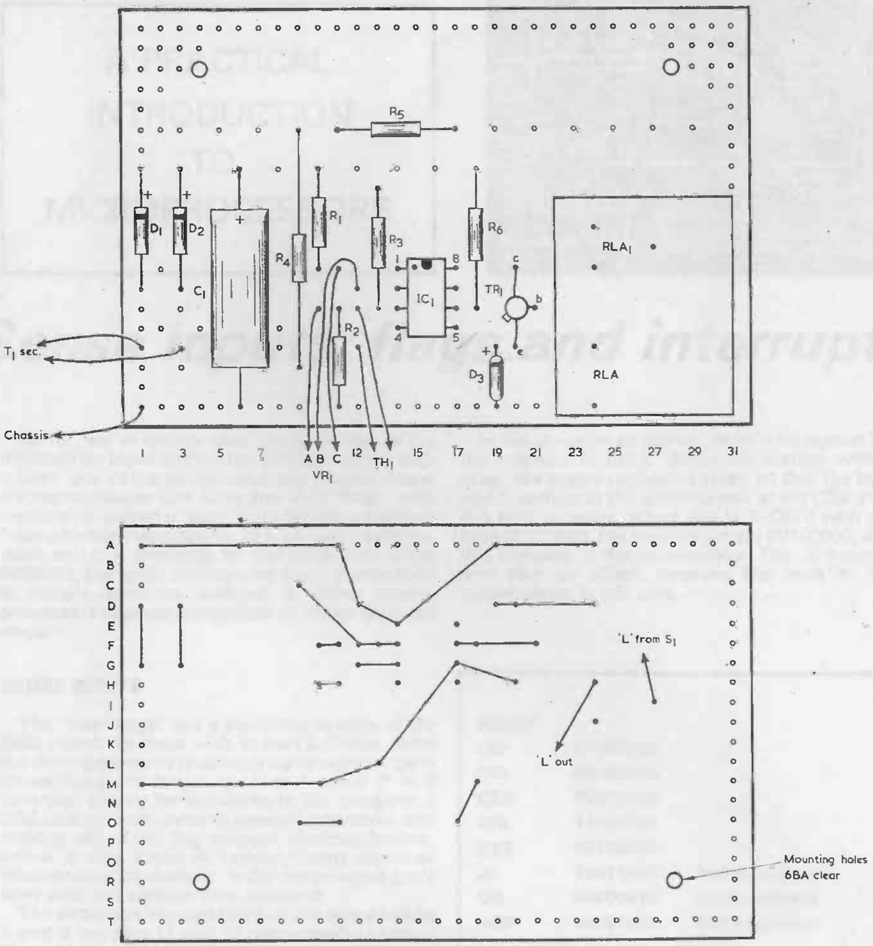
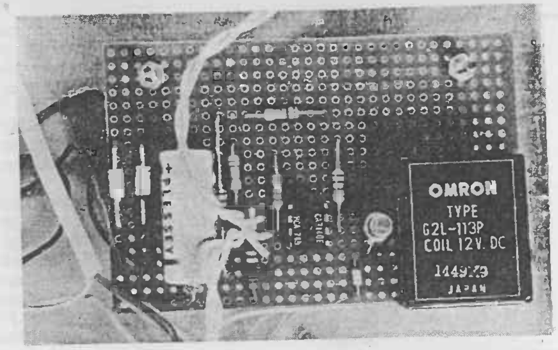


Fig. 2. Most of the components are assembled on a plain perforated board. The upper view shows component layout and the lower view shows underside wiring



The component panel. Spacing washers on the two mounting bolts ensure that its underside is kept well clear of the metal surface of the case

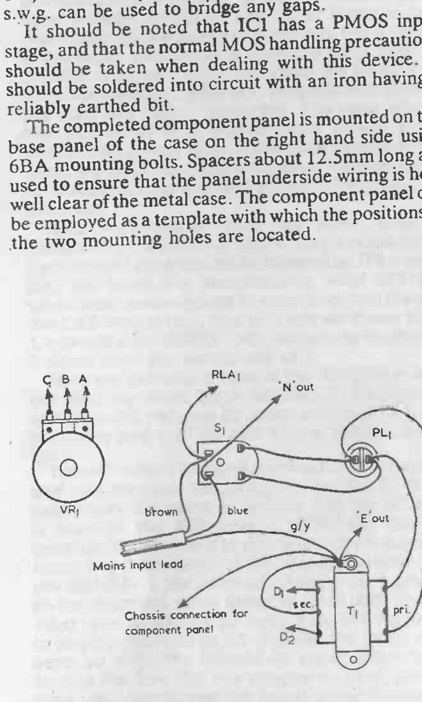
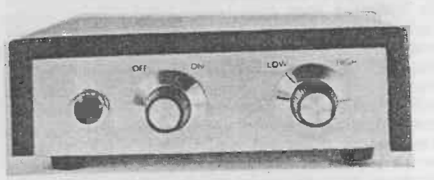


Fig. 3. Wiring to the front panel components. The "L" output from Fig. 2, and the "N" and "E" outputs shown here, pass into a 3-core mains lead terminated in a trailing 13 amp mains socket. Confirm the tags of S1 with a continuity tester before wiring to this component

Before the panel is finally mounted it must be wired up to the rest of the unit, and this wiring is detailed in Figs. 2 and 3. The latter also shows the remaining point-to-point wiring. The earth leads of the mains input and output cables must be reliably connected to the case of the unit for reasons of safety.

It must always be borne in mind that some of the connections in the unit are at mains potential and that all precautions against accidental shock must be observed. The metal case should have a cover which is secured by two or more bolts and the cover should always be in place when the unit is in use.



On the front panel are mounted the neon pilot lamp, at the left, the on-off switch and the temperature control potentiometer at the right

USING THE UNIT

The positioning of the thermostat unit in the room is not especially critical, except that it should not be placed where TH1 will directly pick up the heat from the electric fire or heater. This would result in TH1 quickly heating up when the fire switched on, so that the fire would be switched off again almost immediately and a proper regulation of the room's temperature would not be achieved.

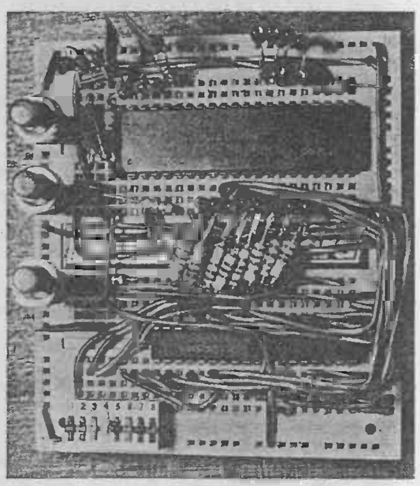
In order to set the desired temperature in the room, initially set VR1 fully clockwise for maximum temperature. When the room has reached the desired temperature, VR1 is turned anti-clockwise just sufficiently to cause the fire to be switched off. ■

The INStructor

Part 8
(Conclusion)

By Ian Sinclair

A PRACTICAL INTRODUCTION TO MICROPROCESSORS



Sense inputs, flags and interrupts

So far, we've mainly used the data lines of the INS8060 for input and output of information, with a brief look at the serial input and output. Many microprocessors use only the data lines, with another i.c. (called a "port") connected to the data lines which is then used for all inputs and outputs. Such an i.c. is available for the 8060. This is the INS8054, but quite a lot can be done, particularly in simple systems, without it. Other microprocessors depend completely on these "support chips."

SENSE INPUTS

The "user flags" are a particular feature of the 8060 which we dealt with in Part 5. These allow the microprocessor to control up to eight outputs (three lines which can be 0 or 1 allow $2^3 = 8$ controls) simply by including in the program a CAS (copy accumulator to status) instruction, and making use of the flag outputs. Another feature, which is also found in various forms on other microprocessor designs, is the sense input. Let's start with the simpler one, sense–B.

The circuit we've used has had the sense inputs A and B (on pins 17 and 18 respectively) earthed permanently, but for the following examples, we'll be making use of inputs to these pins. For the moment, though, take a look at the program of Fig. 1. Run this one through and watch the address l.e.d.'s as you go. It should step steadily from 0001 to its end with 1001 displayed.

In the program as shown, there's no reason for the address to jump. Since we started with a reset, the status register is clear, so that the byte which arrives in the accumulator at the CSA step is a byte of zeros. When this is X–OR'd with the byte 00100000, the result is simply 00100000, and this remains in the accumulator. The JZ instruction has no effect, because the byte in the accumulator is not zero.

RESET		
LDI	11000100	
OO	00000000	
CSA	00000110	
XRI	11100100	
BYT	00100000	
JZ	10011000	Note address
O3	00000011	Note address
NOP	00001000	Note address

Now try again with the SENSE–B input high; then earth SENSE–B again.

Fig. 1.

Now switch off and remove the earth connection from the SENSE–B input at line B3 of the Eurobreadboard. To do this remove the links from B3 to B1 and from B3 to B4, then plug in a new link from B4 to earth on the Y2 line. When removing a link, remove the earth end last. Similarly, when plugging in a link plug in the earth end first. This will ensure that an unconnected link wire is not plugged in to any input.

Next connect line B3 to the 5 volt positive rail at line X1, plugging the link into X1 first. Now that SENSE–B is high, try the program again. What happens to the address after the JZ displacement? This time, the logic 1 on the SENSE–B input has caused bit number 5 (numbering from bit 0) in the status register to be set to 1. At the XRI step this has filled the accumulator with zeros so that the jump has occurred this time.

This action can be used as a form of interrupt, which causes the microprocessor to shift to a new part of program whenever a 1 appears on the SENSE–B input. It's not normally used in this way, however, because the SENSE–A input is better for the purpose, as we'll see. The important point about the SENSE–B input is that it can be used independently of any other input to command anything we care to program. For example, if we were designing a musical door bell, the SENSE–B input might be used to jump to an auto-indexed load address. This address could be the start of a "tune" program. The next input on the SENSE–B line would then index a new address for a new tune. If the tune program were long, we could use the indexing address simply to contain a new starting address from the tune program.

Note incidentally, that we can't alter the SENSE–A or SENSE–B bits – they are controlled by the input pins and by nothing else. If for example, we load the accumulator with 00110000 when both sense inputs are earthed, and then use the CAS instruction, this will not set these bits to 1, nor will a 00000000, CAS, sequence set them to 0 when both pin inputs are at 1.

Now we can take a look at the SENSE–A input, but first we must earth SENSE–B. Remove the link from B3, remove its other end from X1, plug the other end into Y2 and return the first end to B3.

We will keep SENSE–A earthed for the moment and run through the program in Fig. 2. This is essentially the same as before, but the bit which is used in the XRI step is 00010000 this time because it's intended to detect a 1 on bit number 4 (counting from zero) of the status register. With the SENSE–A pin earthed, there's no 1 present, so the program steps steadily from 0001 to 1001. Next take SENSE–A to logic 1 by linking line B4 to supply positive at X1. Follow the same sequence as with the SENSE–B input when transferring the link. Try the program again, and this time you should see the jump occur because of the effect of the 1 in the status register caused by the positive connection to SENSE–A.

This way, you can see the SENSE–A input working in the same way as the SENSE–B. They're not identical, though, because the SENSE–A can be used to start a sequence of steps which otherwise would need several program steps. It's called the interrupt sequence, and it's a most important feature of any microprocessor system.

RESET		
LDI	11000100	
OO	00000000	
CSA	00000110	
XRI	11100100	
BYT	00010000	
JZ	10011000	Note address
O3	00000011	Note address
NOP	00001000	Note address

Now try again with the SENSE–A input high.

Fig. 2.

INTERRUPT ENABLE

The program of Fig. 3 gives some indication of what this does. Start with SENSE–A earthed, following the procedure already established for changing link wire connections. Now switch on, reset, and program as shown. The program loads a number into the high byte of P3, so that the A11 l.e.d. will light when the addresses exchange, and then continues with a few instructions which are arranged to increment the addresses normally; what they do in this case is not important. Note the sequence of addresses. Next, switch off, take SENSE–A to the positive rail and try again, remembering to reset. Things go very differently now after the IEN step!

IEN is the mnemonic for INTERRUPT ENABLE, and it means just that – it arms the interrupt mechanism. You are allowed to carry out just one more "real" instruction (but any number of NOP's) after the IEN, but at the end of that instruction, if SENSE–A is high the program counter is exchanged with the bytes in P3, then the new address increments before being placed on the address lines. The result we see is that the A11 l.e.d. lights, and the address on the lower lines is 0001, rather than the 0000 which was present (because of the reset) in P3. At the same time, the bit in the status register which controls interrupts, and which was set by the IEN instruction, is reset again, so that no more interrupts are possible until after another IEN instruction.

RESET		
LDI	11000100	
HBYT	00001000	
XPAH(3)	00110111	Note address
NOP	00001000	Note address
CSA	00000110	Note address
IEN	00000101	Note address
CSA	00000110	Note address
CSA	00000110	Note address
NOP	00001000	Note address

Try this out, first with SENSE–A earthed, then with SENSE–A high.

Fig. 3.

This is the fully-fledged interrupt procedure of the INS8060. When IEN has been carried out the system is ready, and after a breathing-space of one instruction, will be armed, prepared to exchange addresses when SENSE–A goes high. The address which is stored in pointer P3 is the starting address for a program, called the interrupt service routine, which has to be written to deal with the interrupt. Since the designer has presumably wired SENSE–A to some device which causes the interrupt, he now has to write the program to deal with it! When the interrupt call comes, the addresses are exchanged, so that P3 contains the address of the part of the main program which was being carried out when the interrupt arrived. This, as we shall see, allows the microprocessor to pick up where it left off, because the resuming address has been saved in P3. At the same time, the IEN instruction is cancelled.

MEMORY STACK

That's the automatic part of it, but it still leaves a lot for the programmer to do. One essential is to preserve the bytes which may be present in the accumulator, the extension register and even in the status register (such as the carry) since they will have to be used again unchanged when the main program restarts. This is done by using part of the memory (called the stack when it is used in this way) to store these quantities whenever an interrupt occurs. The first part of any interrupt service program must therefore be to arrange for the storage of these bytes on the stack; on the INS8060 these are conventional store-to-memory (usually using P2 as index) instructions; other microprocessors use a special instruction called PUSH.

The other important point is that if the interrupt is to be used again another IEN step is necessary, and we also need a method of restoring the correct starting address in P3. We could, of course, go through the whole re-loading procedure again, but this would be very tedious, and it's much easier to restore the correct address by a jump. Two neat points of detail make this possible. One is the fact an interrupt is not armed immediately after the IEN instruction but one instruction later. The other is that an interrupt service routine can have XPPC(3) as its first instruction, at the address stored in P3, but this instruction will be skipped when the interrupt occurs because of the way in which the program counter increments after exchanging addresses.

Fig. 4 should help to make this a bit clearer. It's not intended to be tried out on the INStructor board, only as an example of the sort of programming which is needed in a full-scale INS8060 system. Unusually, the example addresses have been written in decimal, not binary, and only a few data mnemonics are shown; this is a general example, not a particular case.

The important point is that the first instruction in the interrupt service routine is XPPC(3), and this is placed at the address which is stored in P3. When the interrupt occurs, which can be in any part of the main program after the IEN instruction, the INS8060 completes the instruction it is working on, and then exchanges addresses. The address of the instruction which has just been completed goes into P3, and the start address of the interrupt routine – the XPPC(3) address – goes into the program counter. The program counter now increments, so that the XPPC(3) instruction is NOT implemented; instead, the routine starts with the instruction after XPPC(3), which will usually be the first of a set intended to preserve the contents of the registers.

The rest of the subroutine deals with the interrupt, and then restores the contents of the registers. The penultimate instruction is IEN. When the interrupt originally occurred, remember, it reset the bit in the status register which arms the interrupt system. This is essential, because a second interrupt would be a disaster; it would restore the main program while the microprocessor was in the middle of the service routine. The interrupt system has to be re-armed by the IEN instruction, but we have, remember, a breathing-space of one instruction after that. The next instruction is a jump back to the XPPC(3) code at the start of the routine. This returns the program counter to the starting address of the interrupt service routine, and then causes the addresses to exchange again. The program counter will now have the address of the last complete step of the main program, and the pointer P3 will have the address of the start of the interrupt, as it had originally. The program counter now increments, so that the next instruction whch is carried out is the main program step which would have been carried out if the interrupt had never occurred.

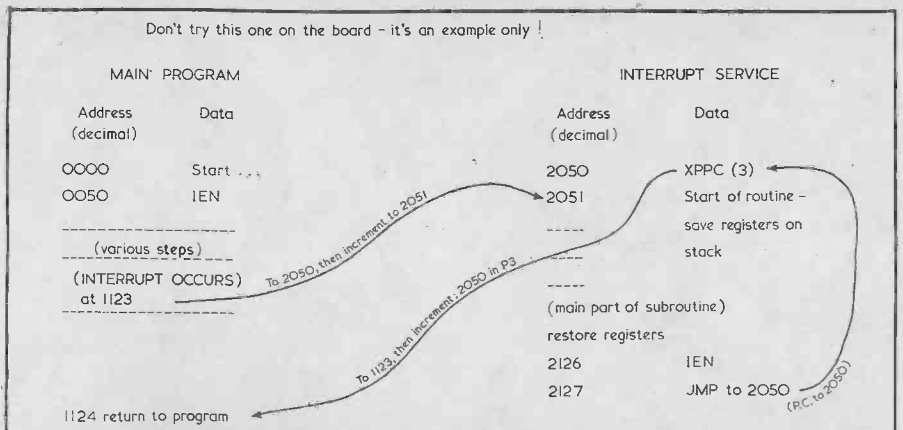


Fig. 4

KEYBOARD READING

Two odd features of all this are not noted anywhere in the literature about the INS8060. One is that NOP steps following IEN are not counted as instructions, the other is that two IEN steps, one after the other will cause an interrupt.

One very common use of an interrupt of the type we've described is for a keyboard. Instead of having the microprocessor continually scanning the keyboard, the keyboard is arranged so that pressing any key will cause the SENSE–A line to go high. The keyboard is then read and decoded by the interrupt service routine and control returned to the main program.

We've now completed our journey through the action of the INS8060, and we've used a sufficient sample of the instructions to get a fair idea of what programming methods can be used. What's the next step? That depends very much on your own tastes and needs. If this series has aroused your interest and started you on the fatal fascination that microprocessors always seem to exert, you'll probably want to start using a microprocessor which has a memory system, so that you can run more lengthy programs and see how the instruction set anables all sorts of problems to be solved. If you would like to stick with the INS8060, then there are two options open to you at the time of writing. One is the Science of Cambridge Mk. 14, a unit which I use myself to check programs written for the INS8060. The other is a more "free-range" approach, using the printed circuit boards produced by Kemitron and sold by Greenbank Electronics. If you want to use the 8060 you already have, then S. of C. will sell you the Mk. 14 kit (at a reduced price with no INS8060 included) and, of course, the Greenbank boards come with no other components unless you order them.

Another route you can take is to use the INStructor Eurobreadboard as a testbed for other microprocessor i.c.'s. It's well suited for this job, and it looks likely, again at the time of writing, that there will be a whole range of Eurobreadboards produced to cater for all sorts of microprocessor experiments, including projects with memory chips. This way, all the microprocessor chips that are obtainable are at your service – one very popular candidate is the 6502 as used in the PET..

Whatever route you take – happy microprocessing.

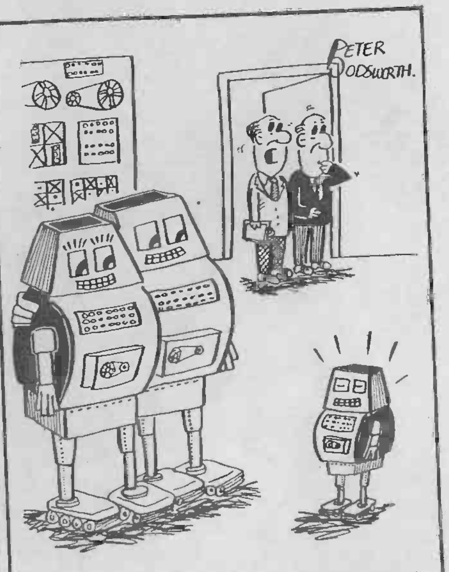
(Concluded)

Greenweld 1981 Catalogue

Now available is the new 1981 catalogue of Greenweld, 443 Millbrook Road, Southampton, SO1 0HX. Featuring 54 large pages measuring more than 11½ by 8 in. the catalogue lists virtually all components likely to be required by the home-constructor, ranging from rechargeable batteries to printed circuit transfers. Also included are tools and soldering irons, and 7 pages are devoted to books on electronics.

New additions to Greenweld stocks include more kits, r.f. connectors, new Vero products, keyboard switches, new multimeters and many more transistors and integrated circuits. Despite inflation, many prices are unchanged and some prices have even been reduced. Provided with the catalogue is a first class reply paid envelope, an order form and a Bargain List offering surplus lines at greatly reduced prices.

There are five vouchers, each worth 12p when used as directed, on the back page of the catalogue. This 1981 catalogue can be obtained direct from Greenweld for 50p plus 25p postage.



"It wasn't there at five o'clock las night!"

BATTERY **** VOLTAGE **** MONITOR

By

M. V. Hastings

Low cost circuit for car or boat batteries.

This inexpensive battery voltage monitor is intended for use in a car or boat having a 12 volt electrical system, and it gives warning if the battery is not holding its charge properly or is not charging, whereupon the battery voltage falls to an unacceptable level. The unit has two light-emitting diodes, one of which turns on when the battery voltage is above a certain threshold level. whilst the other lights up when the voltage is below that level. The nominal threshold level is 11 volts. By changing one of the components the threshold can be easily altered to 10 or 12 volts if preferred.

CIRCUIT OPERATION

The monitor employs three transistors in the circuit shown in Fig. 1. TR3 is a silicon device which requires about 0.6 volt across its base-emitter junction if it is to pass collector current, and its emitter couples via the 10 volt zener diode, D3, to the negative rail. The base couples to the positive rail through R6, whereupon TR3 is cut off if the supply voltage is lower than 10.6 volts. If the supply voltage is raised above 10.6 volts the transistor will begin to pass collector current. In practice, due to the small voltage drop in R6, TR3 passes a significant collector current only when the

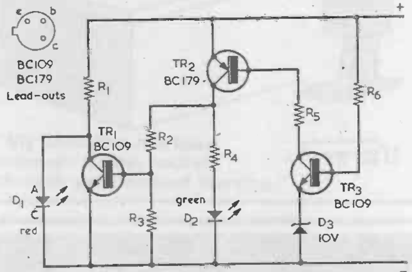


Fig. 1. The circuit of the battery voltage monitor. This connects to the battery whose voltage is being monitored, and the red l.e.d. lights up when the voltage is below the threshold level. The green l.e.d. is illuminated at voltages above the level.

supply voltage is a little less than 11 volts. It continues to pass collector current for higher supply voltages.

The collector current from TR3 passes through current limiting resistor R5 to the base-emitter junction of TR2 and causes this transistor to turn on as well, thereby lighting up l.e.d. D2 in its collector circuit. Thus, D2 lights up for supply voltages of 11 volts or more and extinguishes with supply voltages lower than 11 volts.

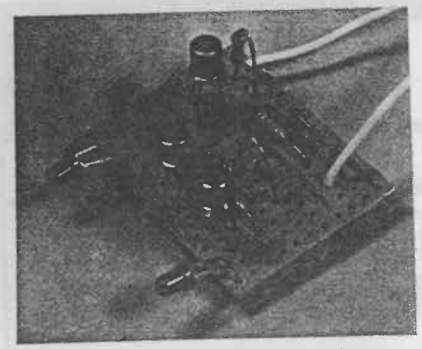
When the supply voltage is lower than 11 volts, and TR2 is not passing a collector current, l.e.d. D1 is turned on by reason of the current flowing through R1. At supply voltages above 11 volts TR2 is turned on, with its collector coupling to the base of TR1 by way of the potential divider formed by R2 and R3, whereupon TR1 is also turned on and short-circuits D1, which then extinguishes. In consequence, D1 is only alight for supply voltages below 11 volts and it acts as a warning light to indicate that the battery voltage is below the threshold level.

The circuit does not incorporate triggering to give rapid switching from one l.e.d. to the other and it is possible for the battery voltage to be such that both l.e.d.'s are alight at reduced brilliance. This only occurs when the voltage is at the centre of the cross-over range and a shift of a fraction of a volt in either direction causes the appropriate l.e.d. to be turned fully on with the other l.e.d. fully extinguished. This mode of operation represents no shortcoming in performance and, indeed, has the advantage of indicating when the battery voltage is actually at the threshold level. There would be no point in adding triggering to the circuit.

The supply current is about 6mA when D1 is alight and increases to around 12mA when D2 turns on. The current increases proportionately as battery voltage rises further. These currents are insignificant when the large capacity of a car or boat battery is considered. Very much higher currents are drawn by other components in the electrical system.

CONSTRUCTION

The circuit is assembled on a piece of 0.1 in. Veroboard having 13 copper strips by 11 holes, and the component layout is illustrated in Fig. 2. There are no breaks in the copper strips, but be careful not to omit the two link wires. The two l.e.d.'s are mounted direct



The battery voltage monitor is assembled on a small piece of 0.1 in. Veroboard. Note how the l.e.d. lead-outs are bent through 90 degrees, causing the diodes to face horizontally away from the board.

to the Veroboard, their lead-out wires being carefully bent through 90 degrees so that they face out away from the board. The board is very light and it can be secured in place by passing the two l.e.d.'s through panel-mounting bushes fitted to the panel behind which the board is to be situated.

The manner in which the unit is fitted in the car or boat depends upon individual circumstances. It might be possible to mount the unit behind a dashboard, or it might be necessary to fit it in a small plastic case. The centres of the two panel-mounting bushes for the l.e.d.'s should be spaced 1.1 in. apart. The wires from the battery which connect immediately to the Veroboard should be fairly thin and flexible. More robust methods of mounting the board can be readily devised if it is likely to be subjected to a high level of vibration. In the car application the unit should be

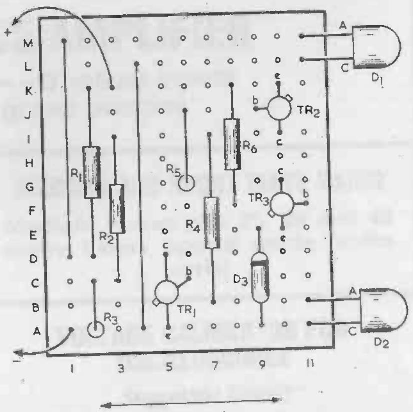
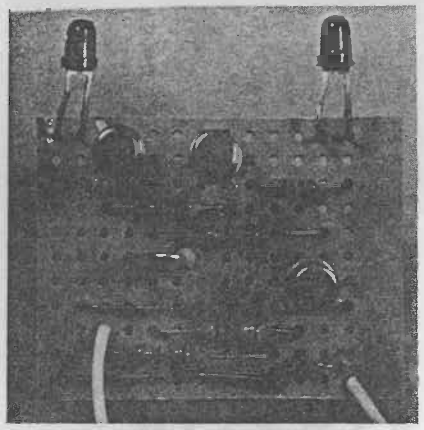


Fig. 2. Component layout and wiring on the Veroboard panel. There are no breaks in the copper strips.



Looking down on the Veroboard assembly. The circuit is quite simple and only a few components are required.

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 1.8kΩ
R2 33kΩ
R3 33kΩ
R4 1.8kΩ
R5 3.3kΩ
R6 33kΩ

Semiconductors
TR1 BC109
TR2 BC179
TR3 BC109
D1 red l.e.d.
D2 green l.e.d.
D3 BZY88C10V

Miscellaneous
2 l.e.d. panel-mounting bushes
Veroboard, 0.1 in. matrix
Wire, solder, etc.

kept well clear and insulated from car metalwork, which will be common with one of the supply rails.

The supply for the monitor unit can be taken after the ignition switch. However, the current drawn by the unit is so low that it is quite feasible to connect it directly across the battery so that it operates continuously.

As was mentioned at the start of this article, the threshold voltage can be readily altered. Using a 9.1 volt zener diode gives a threshold voltage of approximately 10 volts, whilst an 11 volt diode gives a threshold voltage of just under 12 volts. A 12 volt zener diode could also be employed and this would result in a threshold voltage of slightly less than 13 volts.

"K" TONE GENERATOR

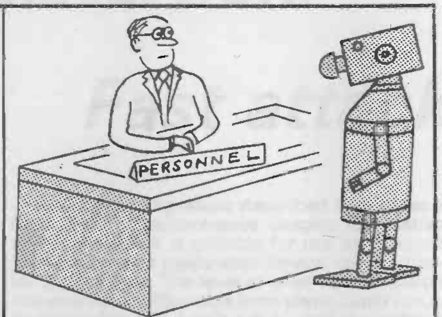
With reference to the above article, which appeared in the December issue, we are advised by the Radio Society of Great Britain that the "K" tone is not permitted by the Home Office for holders of the amateur licence B. There exists agreement with the Home Office for the use of a "T" tone with time duration and frequencies suggested.

"ELECTRONIC DOOR BUZZER"

In this article, which appeared in the February issue, the ceramic resonator was incorreectly quoted as being a type PBN-2720. The correct part number for the resonator employed is PB-2720.

1981 CATALOGUE DELAYED

Messrs. T. & J. Electronic Components of 98 Burrow Road, Chigwell, Essex IG7 4HB, have asked us to inform readers that owing to production difficulties their catalogue will not be available until the latter part of February – they regret any inconvenience this may cause.



"My education has been achieved almost entirely through programmed learning."

HIGH QUALITY COMPRESSOR

By
John Baker

Variable compression threshold.

High compression ratio without distortion.

Fast attack, slower decay.

The prototype compressor is assembled in a small metal instrument case.

An audio compressor is a form of automatic gain control, roughly similar to the well-known a.g.c. circuits which are employed in superhet radio receivers. However, a compressor operates purely at audio frequencies and not at intermediate and radio frequencies, as does an a.g.c. system. Probably the most common application of a compressor appears in inexpensive cassette recorders having automatic recording level control. Such a control reduces amplifier gain with high level inputs and thus prevents the recording head from being overloaded. Many of the more sophisticated cassette recorders and decks have a similar feature which is known as a recording level limiter. This has no effect on amplifier gain for input signals below the maximum acceptable level, and it reduces the gain for input signals above that level.

Audio compressors can be used with radio transmitters to prevent overmodulation. They can also be employed with public address or hi-fi systems to prevent output stage overloading with its consequent clipping and high distortion.

The audio compressor described here gives a high level of performance despite its relative simplicity, and it is suitable for use as a record level limiter, as a modulation limiter, and for similar applications. The level at which compression commences is adjustable from about 25mV r.m.s. to approximately 1 volt r.m.s., and the voltage gain of the unit without compression has a nominal value of unity. It should therefore be quite simple to fit the compressor into most set-ups, and it will quite readily fit between, say, a hi-fi tuner and a cassette deck.

OPERATION

The block circuit diagram of Fig.1 shows the various stages of the compressor. The input signal is applied to a unity gain amplifier, and the output signal is obtained from the output of this amplifier. A cadmium sulphide photocell is connected in the negative feedback circuit of the amplifier. When the photocell is in a dark condition it has a very high resistance and has no effect on amplifier operation. The unity gain amplifier output is passed to a second amplifier which feeds a rectifier and l.e.d. driver stage. The l.e.d. is in close proximity with the photocell. At low input signal levels the l.e.d. driver output is insufficient to turn on the l.e.d., and the photocell maintains its very high resistance. When the input signal rises to the level at which compression is required the l.e.d. driver stage turns on the l.e.d. which illuminates the photocell, causing its resistance to reduce and the gain of the amplifier to become less than unity. Increasing input signal level results in brighter illumination of the l.e.d. and further reduced gain in the amplifier. Thus the required stabilization of the output level is

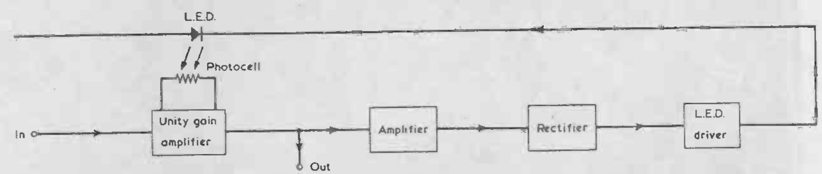
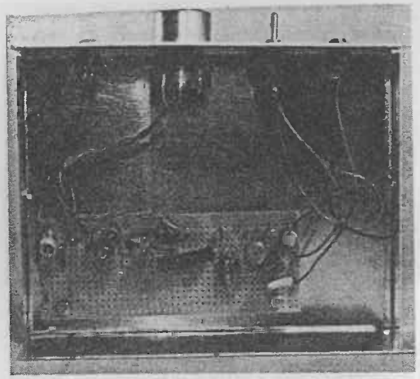


Fig.1. Block diagram illustrating the stages of the compressor. The first amplifier has unity gain for signals below the compression threshold, and this gain reduces with signals above the threshold.



The Veroboard assembly is secured to the bottom of the case by two 6BA bolts and nuts with spacing washers.

achieved. When the l.e.d. is fully illuminated the amplifier gain falls to about −26dB, or 0.05 (one-twentieth) times.

This opto-isolator approach has two main advantages over most alternative methods of obtaining compression, such as using a Jfet as a voltage controlled resistor. First, the circuitry involved has no complications since there are no direct connections between the l.e.d. and the photocell. Second, and probably of greater importance, the photocell provides a true resistance which is not affected by the voltage across it. Unlike other methods, including those employing a Jfet, the photocell introduces negligible distortion.

THE CIRCUIT

The full circuit of the compressor is given in Fig.2.

The input signal is applied via C2 and R1 to the inverting input of IC1, with negative feedback from the output to the input being given by R4 and the photocell in parallel. Assuming a relatively low signal source resistance, the voltage gain of the amplifier is equal to the feedback resistance divided by R1. In the dark condition the photocell resistance has a minimum value of 200MΩ and, since R1 and R4 are both 1MΩ, the amplifier gain is unity. R2 and R3 bias the non-inverting input of IC1 to half supply voltage, and C2 and C5 provide d.c. blocking at the input and output respectively.

C4 is the compensation capacitor for IC1, and it has a much larger value than would normally be necessary. This is because most circuits require an operational amplifier to have a voltage gain of unity or more, whereas in this application the voltage gain can drop to well below unity. This necessitates the use of a large capacitor to ensure good stability.

As well as being passed to the output socket, the output of IC1 is also coupled via C6 to the common emitter amplifier, TR1. The resistance in the emitter circuit is not bypassed, and the voltage gain of the transistor can be varied by adjusting VR1. The gain is roughly equal to R6 divided by the emitter resistance, whereupon the gain is approximately unity when VR1 inserts maximum resistance, and is about 26dB (20 times) when VR1 inserts minimum resistance into circuit.

The gain control provided by VR1 permits adjustment of the input threshold level at which compression commences, with maximum gain corresponding to minimum threshold level.

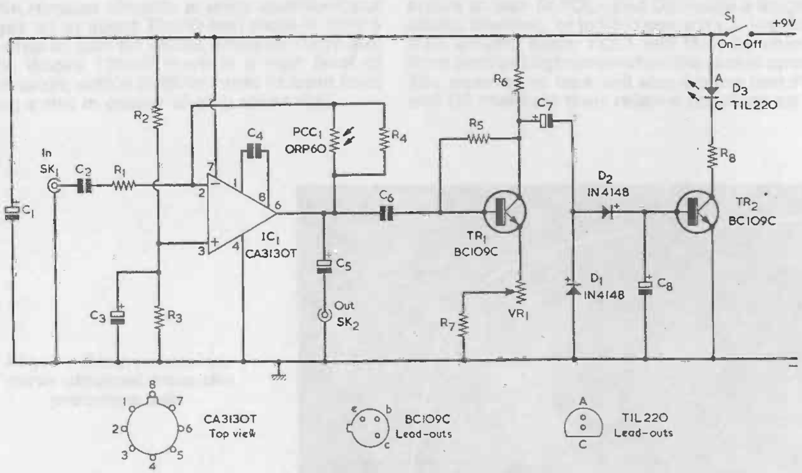


Fig.2. The circuit of the high quality compressor. D3 and PCC1 couple together optically so that increasing brightness in the l.e.d. causes reduced resistance in the photocell.

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)

- R1 1MΩ
- R2 33kΩ
- R3 33kΩ
- R4 1MΩ
- R5 1.8MΩ 10%
- R6 4.7kΩ
- R7 220Ω
- R8 100Ω ½ watt
- VR1 4.7kΩ potentiometer, linear

Capacitors

- C1 100μF electrolytic, 10V. Wkg.
- C2 0.047μF polyester type C280.
- C3 10μF electrolytic, 10V. Wkg.
- C4 1,000pF ceramic plate.
- C5 10μF electrolytic, 10V. Wkg.
- C6 0.1μF polyester type C280.
- C7 1μF electrolytic, 10V. Wkg.
- C8 2.2μF electrolytic, 10V. Wkg.

Semiconductors

- IC1 CA3130T
- TR1 BC109C
- TR2 BC109C
- D1 1N4148
- D2 1N4148
- D3 TIL220

Photocell

- PCC1 ORP60

Switch

- S1 s.p.s.t. sub-miniature toggle

Sockets

- SK1 3.5mm. jack socket
- SK2 3.5mm. jack socket

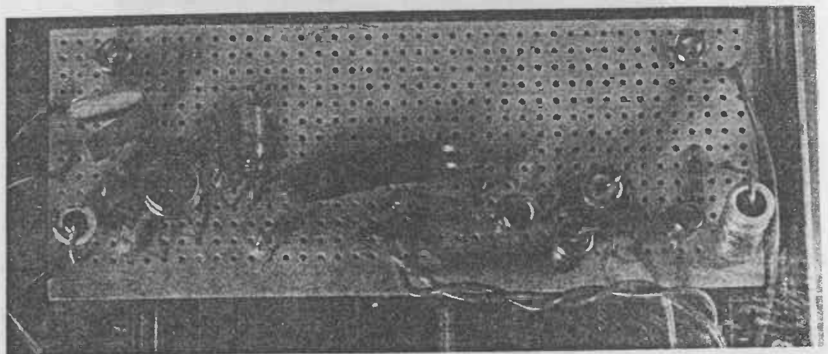
Miscellaneous

- Metal case (see text)
- Control knob
- Veroboard, 0.1in. matrix
- 9 volt battery type PP6 (see text)
- Battery connector
- Nuts, bolts, wire, etc.

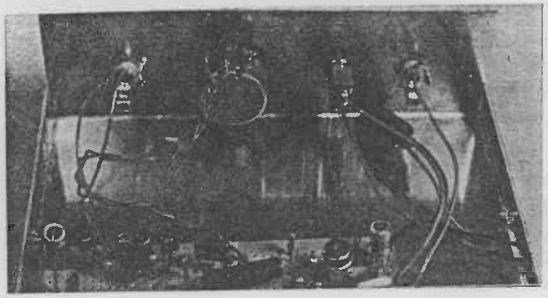
D1 and D2 rectify the output from TR1, and the rectified signal is applied to the base of the l.e.d. driver, TR2. When the rectified signal has sufficient amplitude it turns TR2 on and causes the l.e.d. to light up. If the output from TR2 increases, the rectified current flowing into TR2 base rises and the l.e.d. brightness is made greater, thereby producing the required compression effect. The cadmium sulphide photocell responds fairly quickly to increases in illumination, and significantly more slowly to decreases in illumination. Because of the slow decay time it provides integration and, for low compression levels, the circuit would function with the l.e.d. passing the pulses given by the rectified audio signal. However, it was found that the integration given by the photocell was not sufficient to prevent distortion with sine wave input signals at high compression levels, and further integration is given by the inclusion of smoothing capacitor C8.

It is normal for compression units to respond quickly to increases in input level and to react more slowly to decreases in input level. C8, which prevents waveform distortion, has little effect on the attack and decay times, and the required timing here is automatically provided by the response characteristics of the photocell itself.

S1 is the on-off switch and C1 is the supply bypass capacitor. The quiescent current consumption of the circuit is about 2mA only, but this can rise to as much as 30mA or so at high compression levels. It is therefore advisable to power the compressor from a reasonably large battery, such as a PP6 size.



Close-up view of the Veroboard panel.



This shot shows the wiring to the front panel components.

The two low value electrolytic capacitors, C7 and C8, are quoted as having a working voltage of 10 volts in the Components List. This is a minimum figure and it will be perfectly in order to use capacitors having a much higher working voltage, such as 63 volts. The two 10μF capacitors can also have a working voltage higher than 10 volts if they are thereby easier to obtain. The ORP60 photocell is available from several suppliers, including Maplin Electronic Supplies. The TIL220 is a red l.e.d. with a diameter of 0.2in.

PERFORMANCE

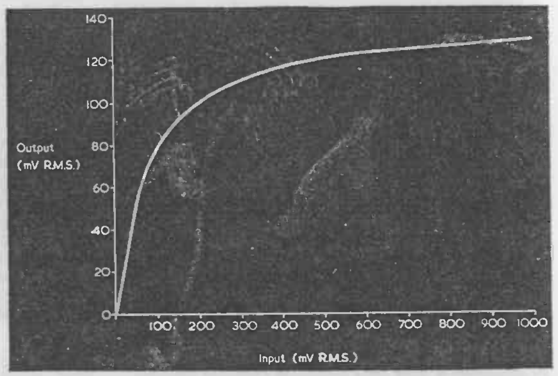
The compression curve provided by the unit obviously depends on the setting of VR1, but the curve shown in Fig.3 gives an idea of the level of performance provided. The curve was obtained from the prototype with VR1 adjusted for an output level of about 100mV r.m.s. As can be seen the gain remains virtually at unity level for input voltages up to about 70mV, and there is only a small drop in gain for inputs between 70mV and 100mV. Above 100mV there is a high level of compression, with a 20dB increase in input level causing a rise in output of only about 4dB.

CONSTRUCTION

The compressor can be built as an integral part of some item of audio equipment, or it can be constructed as a separate unit having its own case. The prototype is made up as a separate unit and it is housed in a metal instrument case having dimensions of 152 by 114 by 44mm. This is a case type TP2, available from Maplin Electronic Supplies.

Fig.4 shows the layout of the compressor on a piece of 0.1in. Veroboard having 41 holes by 14 copper strips. Construction is quite straightforward except for PCC1 and D3. These should be positioned with their ends facing each other and as close as possible, so that PCC1 receives the maximum amount of light from D3. PCC1 must, of course, be sheltered from ambient light, and this will be achieved if the Veroboard assembly is housed in a light-proof case. However, it is preferable to also fit PCC1 and D3 inside a length of plastic sleeving, or to bind some p.v.c. insulating tape around them. PCC1 will then be shielded from ambient light even when the case is opened. The sleeving or tape will also ensure that PCC1 and D3 maintain their relative positions so that

Fig.3. Compression curve obtained from the prototype unit.



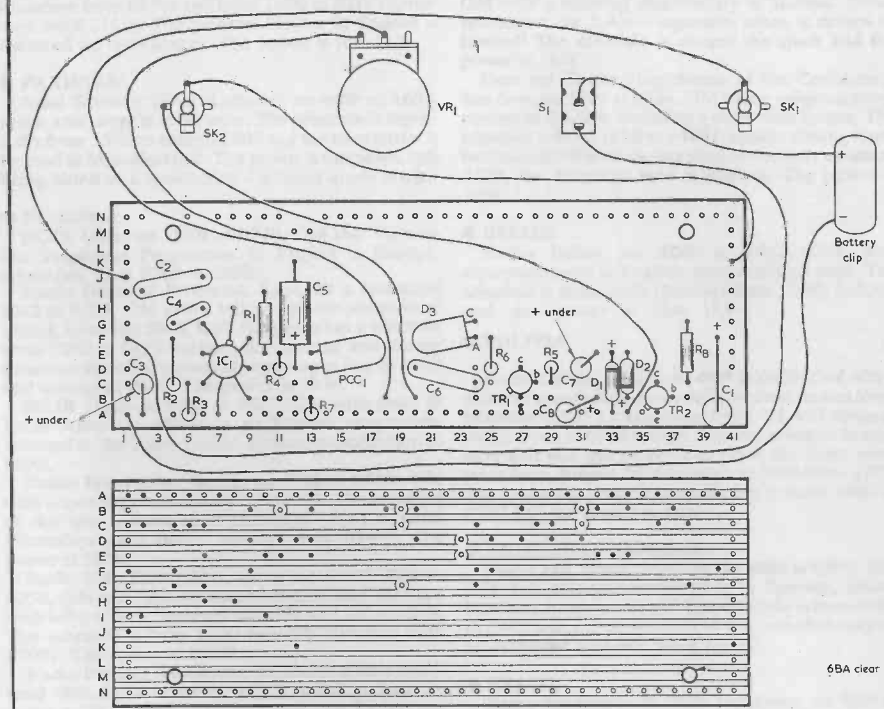
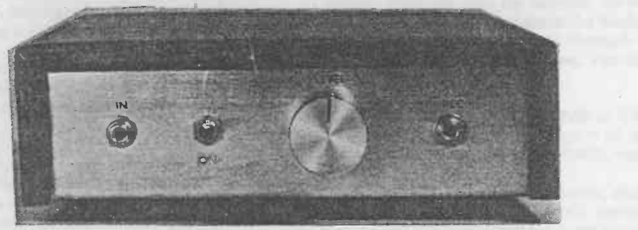


Fig.4. Apart from the battery and the front panel components, all the parts are assembled on a Veroboard panel. IC1 should be soldered into circuit with an iron having a reliably earthed bit.



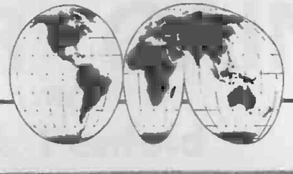
On the front panel, from left to right, are SK1, S1, VR1 and SK2.

reliable and consistent results are obtained.

The input and output jack sockets should both be open (i.e. not insulated) types. The metal case is then connected to the negative supply rail by way of the mounting bush and nut of SK2. SK1 takes its chassis connection from its own mounting bush and nut.

■

SHORT WAVE NEWS



FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

All items included in this article are intended as a general guide for both the short wave listener and the Dxer. The transmission details published here are correct at the time of writing.

● **TURKEY**
TRT Ankara on **15220** at 1915, local music and songs in the Turkish programme for Turks abroad, scheduled on this channel from 0425 to 1930.

● **KUWAIT**
KBS Kuwait on **21545** at 0640, continuous pops in the English programme intended for the Arabian Gulf, East and South East Asia, scheduled on this frequency from 0500 through to 0800.

● **U.S.A.**
WINB Red Lion on **15185** at 2050, OM with a religious programme in English.

● **ROMANIA**
Bucharest on **9690** at 2111, YL with a newscast in the English programme for Europe, scheduled on this channel from 2100 to 2130.

● **CONGO**
RTV Congolaise, Brazzaville, on **3265** at 1845, OM with announcements in French, songs in vernacular. The schedule is from 0400 to 0700 and from 1700 to 2300 but the closing time is variable. The power is 50kW.

● **ZIMBABWE**
Gwelo on **3396** at 1814, OM with a talk in English about the developing countries and their technological requirements at the present time. This is the General Service which is scheduled from 0350 (Sundays from 0500) to 0545 and from 1500 to 2200 (Sundays until 2105) all on 100kW. From 0545 to 0615 the power is 10kW.

● **LIBERIA**
ELWA (Eternal Love Winning Africa) Monrovia on **4770** at 2005, OM in vernacular with interludes of African music, a good signal on a clear channel. Schedule of the Home Service in English is from 0555 to 0900, from 1655 to 1800 and from 1900 to 2300 on weekdays. On Sunday from 0655 to 0900, 1655 to 1800 and from 1900 to 2240. The power is 10kW and programmes in West African vernaculars are timed from 1800 to 1900 daily according to the schedule – which doesn't agree with my logging!

● **GABON**
Libreville on a measured **4777** at 2011, OM announcer in French then local-style music rendered on a xylophone-like instrument. The schedule is from 0430 (Sundays from 0530) to 0630 and from 1630 to 2400. The power is 100kW.

● **NAMIBIA**
Windhoek on **4965** at 2032, OM with a talk in Afrikaans. The schedule is from 0300 to 0615 and from 1515 to 2200. The power is 20kW.

● **NIGERIA**
Lagos on **4990** at 0535, OM announcer, OM ballad, all in English, a good clear signal at this time. The schedule is from 0430 to 1000 and from 1700 to 2310 in English and vernaculars in the National Programme. The power is 20kW.

● **GHANA**
Accra on **4915** at 2034, OM in vernacular. This is GBC 1, operating from 0530 to 0800 (Sundays until 2300) and from 1200 to 2305 in English and vernaculars. The power is 10kW.

● **BENIN**
Cotonou on **4870** at 2039, OM with a talk in vernacular in the Home Service, scheduled from 0415 (Sundays from 0550) to 0800 (Saturdays until 1100) and from 1300 to 2400. Sundays from 0415 through to 2400 (variable closing time). The power is 30kW and programmes are in French and vernaculars.

● **CAMEROON**
Bafoussam on **4000** at 2046, OM chanting in vernacular, African-type orchestra. Bafoussam radiates both local and the National programmes, the schedule being from 0427 to 0830 and from 1630 to 2230 with an English newscast timed from 1830 to 1845. The power is 20kW.

● **MAURITANIA**
Nouakchott on **4845** at 2053, OM with a talk in Arabic. The schedule is from 0600 (Sundays from 0800) to 0900 and from 1758 (Sundays from 1700) to 2400. The power is 100kW.

● **RWANDA**
Radio Rwanda, Kigali, on 3330 at 1744, YL in vernacular, harp interval signal, OM with "Radio Rwanda, Kigali" repeated. The schedule of the Home Service is from 0300 to 0600 (Sundays until 0900), from 0900 to 1200 (Saturdays and Sundays until 2100) and from 1700 to 2100. The power is 5kW.

● **KENYA**
Nairobi on **4804** at 1804, OM with a newscast in English. A difficult channel, receiver in LSB position to resolve this one, signal sandwiched between teletype and CW. The schedule is from 0255 to 0630 (Sundays from 0330) and from 1300 to 2010 (Saturdays until 2110). The General Service in English is featured on this channel. The power is just 1kW.

● **PAKISTAN**
Azad Kashmir (Free Kashmir) on **4980** at 1608, music and songs in local-style. The schedule is reportedly from 1500 to around 1800 and the transmitter is located in Muzaffarabad. The power is unknown, this being listed as a clandestine – at least in my book!

● **ECUADOR**
HCJB Quito on **11835** at 0740, OM and YL with the 'Happiness Programme' in English to Europe, scheduled from 0700 to 0830.
Radio Nacional Progresso, Loja, on a measured **5062** at 0125, OM with a talk in Spanish about local affairs. Listed on **5060**, R.N. Progresso has a schedule from 1000 to 0415 but both the opening and closing times are variable, reportedly opening as late as 1100 and closing at 0648. The power is 5kW.
HCJB Quito on **9745** at 0827, OM with news of Latin American affairs in an English programme directed to the South Pacific. Station identification at 0830.
Radio Federacion, Sucua, on **4960** at 0319, OM with a sporting commentary in Spanish. The schedule of this one is from 1030 (Sundays 1100) to 0300 (Saturdays until 0400, Sundays until 0100). The power is 5kW.
Radio Iris, Esmeraldas, on a measured **3381** at 0256, OM announcements and station identification with echo-effect, National Anthem and off at 0259. The schedule is from 1100 to 0400 (Sundays until 0300). The power is 10kW.
Radio Popular Independiente, Cuenca, on a measured **4801.5** at 0359, OM with a ballad in Spanish, guitar music. A weak but clear signal after Radio Lara signs off. The schedule is from 1000 to 0530 but the frequency can vary from **4800** to **4802**.

● **COLOMBIA**
Radio Super, Medellin, on **4875** at 0530, OM with station identification then into a programme of Latin American pops. A fair signal in the clear at this time. The schedule is on a 24-hour basis and the power is 2kW.
Radio Guatapuri, Valledupar, on **4815** at 0250, marimba music, OM song in Spanish, OM announcer. The schedule is from 0930 to 0600 and the power is 10kW.

● **HONDURAS**
La Voz Evangelica, Tegucigalpa, on **4820** at 0301, OM with station identification in English, programme announcements, time and frequency details. Programmes in Spanish are scheduled from 1100 to 0300 and in English from 0300 to 0500. The power is 5kW.

● **COSTA RICA**
Emisora Radio Reloj, San Jose, on **4832** at 0257, OM with a sporting commentary in Spanish. Great sportsmen the LA's – especially when it comes to futebol! The schedule is around the clock and the power is 1kW.
Faro del Caribe (Lighthouse of the Caribbean), San Jose, on **5055** at 0334, OM with a religious programme in English, including a choir with hymns. The schedule is from 1030 to 0400 (variable closing time) but from 0300 until closing time, reportedly as late as 0430, the language used is English. The power is 5kW.

● **BELIZE**
Radio Belize on **3285** at 0442, OM with announcements in English, recorded local pops. The schedule is from 1100 (Sundays from 1200) to 0510 and the power is just 1kW.

● **BOLIVIA**
Radio Cobija, Cobija, on **4855** at 0406, OM with a political speech in Spanish, full and clear station identification at 0415 and again at 0418. YL with songs at 0420. Gone at 0500 retune. This one operates irregularly and was not reported at all in the short wave press from August 1978 through to November 1979. The schedule, when it is on the air, is from 1000 to 0300 and the power is 1kW.

● **DOMINICAN REPUBLIC**
Radio Mil, Santo Domingo, on **4930** at 0500, OM with full station identification in Spanish, choral National Anthem and off. The schedule is from 0900 to 0400 and the power is 5kW but was obviously on an extended schedule when logged.

● **BRAZIL**
Radio Inconfidencia, Belo Horizonte, on **6000** at 2328, OM song in Portuguese, OM station identification at 2330. The schedule is from 0700 to 0300 and the power is 25kW.
Radio Excelsior, Sao Paulo on **9585** at 2246, OM with a sporting commentary in Spanish. The schedule is around the clock and the power is 7.5kW.
Radio Relogio, Rio de Janeiro, on **4905** at 0005, OM in Portuguese, time pips in the background. This one has a schedule from 0800 through to 0300 with time signals over the programme. The power is 5kW.

● **VENEZUELA**
Radio Valera, Valera, on **4840** at 0305, OM and YL alternate with announcements of local interest. The schedule is from 0900 to 0400, variable closing time, and the power is 1kW.
Radio Reloj Continente, Caracas, on **5030** at 0323, OM with both local and world news in Spanish, chimes between items and frequent station identifications. The schedule is from 0900 to 0500 and the power is 10kW.

TRANSISTOR GAIN TESTER

By R. A. Penfold

Indicates four current gain levels

Simple polarity switching

Also checks leakage and diodes

Some means of testing newly acquired transistors and suspected faulty transistors removed from equipment being serviced can be of considerable help to the electronics enthusiast. The tester described here is suitable for go/no-go testing on most bipolar transistors and also gives a rough indication of the current gain of the device under test. The circuit is simple and inexpensive, and is based on a bargraph driver i.c.

BARGRAPH I.C.

Before proceeding to a description of the tester circuit operation it would be worth-while considering the functioning of the bargraph i.c., which is a very interesting and useful device. The bargraph used is a U237B and it is capable of driving up to five l.e.d.'s. A bargraph, incidentally, merely consists of a row or "bar" of l.e.d.'s, the number of l.e.d.'s which are switched on depending upon the input voltage to the circuit. In the case of the U237B the threshold voltages for turning on the five l.e.d.'s are 0.2 volt, 0.4 volt, 0.6 volt, 0.8 volt and 1 volt. Thus, an input voltage of 0.5 volt would cause the first two l.e.d.'s in the row to be switched on.

The completed transistor tester in its plastic case with woodgrain finish.

Fig. 1 shows the internal arrangement of the U237B and its pin numbers. The device is encapsulated in a standard 8 pin d.i.l. plastic package. D1 to D5 are discrete l.e.d.'s, and are not part of the i.c.

The basis of the i.c. is five voltage comparators, and the input signal is taken to the inverting inputs of all of these. The non-inverting inputs are fed from a stable 1 volt voltage source, but only comparator 5 is fed from direct from this source. The other four are fed from a potential divider which consists of five equal-value resistors, and which therefore provides additional reference voltages of 0.8, 0.6, 0.4 and 0.2 volt. These are fed to the non-inverting inputs of comparators 4, 3, 2 and 1 respectively.

The output of each comparator is low (virtually at the negative supply rail potential) if the inverting input is positive of the non-inverting input, or high (at virtually the full positive supply potential) if the comparative input levels are reversed. The comparators are similar to operational amplifiers, but differ slightly in that the output can only exist between the high and low states during the rapid transition between the two states due to input signal triggering. This ensures that each l.e.d. is either turned on or turned off. The comparators also have a small amount of hysteresis, so that when the input voltage goes above the threshold potential for an l.e.d. indicator, it has to fall slightly below that threshold voltage (about 10mV less with the U237B) before the l.e.d. turns off again. The hysteresis prevents flickering of an l.e.d. indicator when the input voltage is hovering close to its threshold voltage.

With the input voltage at zero, the non-inverting inputs of all five comparators in Fig. 1 will be at higher potentials than the inverting inputs. All five outputs therefore go high, and the transistors driven from these outputs are all turned on. The five l.e.d.'s are connected in series and fed from a 20mA constant current source, but as TR1 is turned on it will divert the full 20mA current and prevent any of the l.e.d.'s from lighting up.

If the input voltage is taken above 0.2 volt, the inverting input of comparator 1 will then be at a higher voltage than its non-inverting input, taking its output low and turning off TR1. A current then flows through D1 and TR2 from the current source, and D1 lights up. However, TR2 diverts current away from the other four l.e.d.'s, which remain extinguished.

Should the input voltage be taken above 0.4 volt, the output of comparator 2 goes low and turns off TR2. TR3 remains turned on, and so a current from the current source flows through D1, D2 and TR3, with D1 and D2 being turned on in consequence. TR3 effectively short-circuits D3 to D5, and these do not light up.

The circuit operation should now be clear, and it will be apparent that, as the input voltage goes above 0.6, 0.8 and 1 volt, TR3 to TR5 are in turn switched off and D3 to D5 are in consequence switched on. Thus, the required circuit action is provided.

An interesting feature is that the current consumption of the circuit remains virtually constant regardless of the number of l.e.d.'s which are turned on. This is due to the series operation of the l.e.d.'s

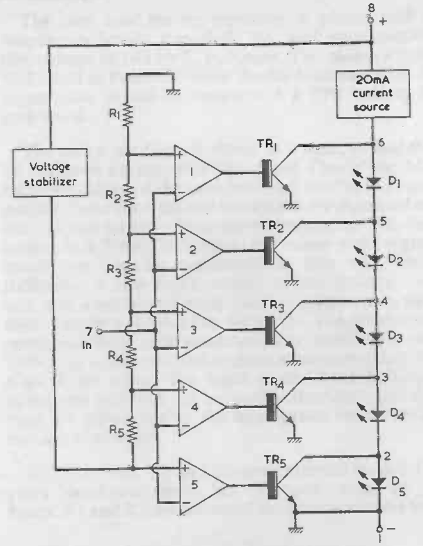


Fig. 1. The internal circuitry of the U237B. The five resistors all have the same value.

COMPONENTS

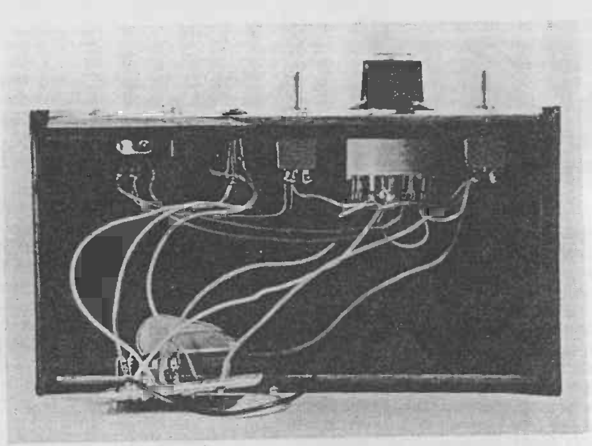
Resistors
(All ¼ watt 5% unless otherwise stated)
R1 1.2MΩ 10%
R2 120kΩ
R3 330Ω

Capacitor
C1 0.22μF polyester type C280

Semiconductors
IC1 U237B
D1 1N4148
D2 1N4148
D3 TIL209
D4 TIL209

Switches
S1 3-pole 2-way (3-pole 4-way rotary with adjustable end stop set for 2-way)
S2 s.p.d.t. subminiature toggle
S3 s.p.s.t. subminiature toggle

Miscellaneous
Plastic case (see text)
Veroboard, 0.1in matrix
9-volt battery type PP3 (see text)
Battery connector
Control knob
3-way DIN socket
Panel holders for D3 and D4
3-way DIN plug
3 miniature crocodile clips
Wire, solder, etc.



A small Veroboard panel takes the U237B and four other components.

and the fact that TR1 consumes the 20mA constant current when none of the l.e.d.'s is alight. Most bargraph drivers operate the l.e.d.'s in parallel, and an equivalent parallel bargraph circuit would have a consumption of only about 2 or 3mA with no l.e.d.'s lit up, but over 100mA with all five turned on. Series operation therefore gives quite good supply current economy, but it does mean that a low supply voltage cannot be used. This is due to the fact that nearly 2 volts is developed across each l.e.d., and a further 2 volts is dropped in the constant current source. A supply potential of at least 12 volts is therefore needed if a display with five l.e.d.'s is to be used.

It is not essential to employ all five l.e.d.'s, and the transistor tester uses only two, these being D1 and D5 as represented in Fig. 1. The l.e.d.'s which are not required can simply be replaced by a short-circuiting link, and any superfluous outputs of the U237B can be left unconnected.

TEN L.E.D. DISPLAY

A ten l.e.d. display can be obtained by using a U237B with a U247B device. The U247B is basically the same as the U237B, the only difference being that it provides l.e.d. threshold voltages of 0.1, 0.3, 0.5, 0.7 and 0.9 volt. By employing two circuits, one based on a U237B and the other based on a U247B, and connecting the two inputs together, l.e.d. threshold voltages from 0.1 to 1 volt in 0.1 volt steps are obtained.

Of course, using two devices doubles the supply current as well as the maximum number of l.e.d.'s, giving a typical current consumption of 50mA instead of the 25mA (20mA constant current plus some 5mA operating current) consumed by a single device.

There are two other similar i.c.'s, namely the U257B and U267B. These give a logarithmic rather than a linear scale, with l.e.d. threshold voltages of 0.1, 0.18, 0.32, 0.5, 0.71, 0.84, 1.0, 1.19, 1.41 and 2.0 volts. They are mainly intended for use in l.e.d. VU meters, and the threshold levels can correspond to VU levels of –20, –15, –10, –6, –3, –1.5, 0, +1.5, +3 and +6dB respectively.

All these devices are available from Ambit International.

TESTER CIRCUIT

The full circuit diagram of the transistor tester is provided in Fig. 2.

As mentioned earlier, only two l.e.d.'s are used, and these are D3 and D4. R3 couples the input of the U237B to the negative supply rail so that there is zero input voltage when no test transistor is connected.

We can first consider the circuit with S1 switched to the "P.N.P." position and with S2 selecting R2. The emitter of the p.n.p. test transistor is connected to the positive rail and the collector to the negative rail via R3. The base couples to the negative rail via R1 or R2, and D1 and D2. A collector current of about 3mA must flow through R3 to make the voltage across this resistor equal to 1 volt and cause D3 and D4 to turn on. About 0.6mA is needed in order to give an input voltage to the U237B of 0.2 volt and cause D3 to light up on its own.

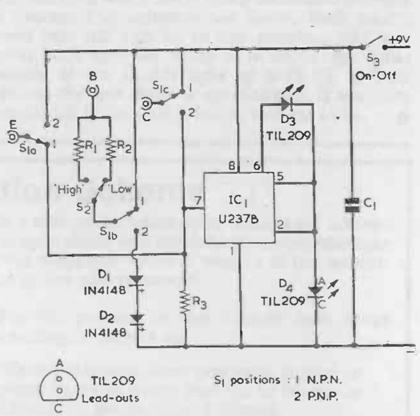


Fig. 2. The circuit of the transistor tester. IC1 is a bargraph driver connected to respond to two input voltage levels.

A total of about 1.8 volts is dropped in D1, D2 and the base-emitter junction of the test transistor (assuming that this is silicon), and the remaining 7.2 volts causes a base current of approximately 60μA to flow in R2. If the test transistor has a gain of 10 or more D3 will light up, and if it has a gain of 50 or more both D3 and D4 will be turned on. If S2 is set to select R1, the base current is 6μA and a current gain of 100 turns on D3 and one of 500 causes D3 and D4 to light up.

Putting S1 to the "N.P.N." position connects the test transistor collector to the positive rail and its emitter to R3. The base couples to the positive rail via R1 or R2 according to the position of S2. The test transistor now functions as an emitter follower with the emitter current flowing through R3 and producing the input voltage for the U237B. Diodes D1 and D2 are not now needed as the voltage drops in R3 and the base bias resistor give roughly the same base currents for the test transistor. Gain checks are carried out in the same way as with a p.n.p. transistor.

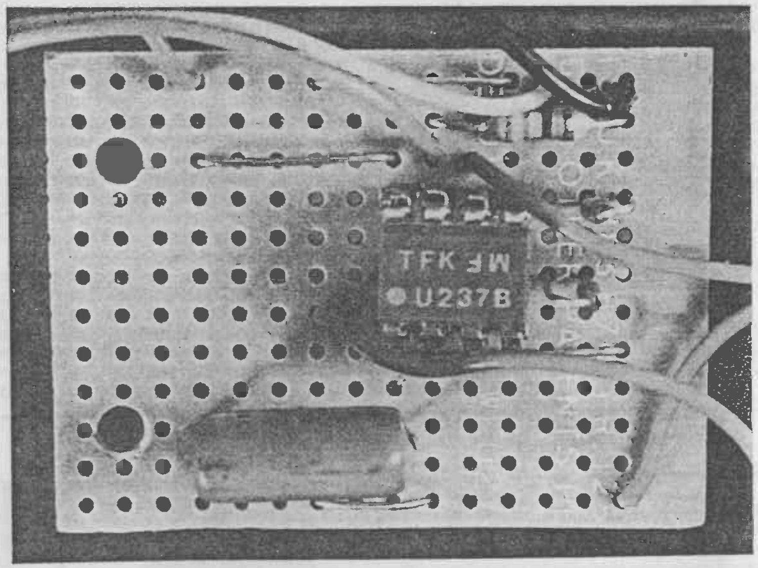
S3 is the on-off switch and C1 the supply bypass capacitor. The current consumption of the tester is quite high, at about 25mA, but a 9 volt battery type PP3 can be employed as the tester will probably only be used for short periods. If, however, frequent and prolonged use of the tester is envisaged a larger battery, such as a PP9, should be employed instead.

ASSEMBLY

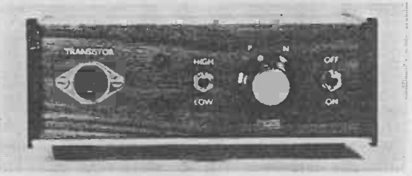
The case used for the prototype is plastic with a woodgrain finish, a push-fit lid, and approximate dimensions of 145 by 72 by 50mm. This case is a type MB5 and is available from Ambit International. A larger case would be required if a PP9 battery is employed.

The case is used upside-down, as it were, so that the lid becomes a removable base panel. One of the 145 by 50mm sides of the case becomes the front panel, and the three controls and test socket are mounted on this, as can be seen from the photographs. The test socket is a 3-way DIN type, and many small-signal transistors can be connected to this with little difficulty. A few types, mainly power devices, will not, and a set of test leads must be made up so that these can be connected to the tester. The set merely consists of three short insulated leads fitted to a 3-way DIN plug at one end and to three miniature crocodile clips at the other. The leads should have different colours so that they can be readily identified, and the clips are connected to the appropriate terminals of the test transistor.

C1, IC1, D1, D2 and R3 are mounted on a 0.1in pitch Veroboard which has 15 copper strips by 12 holes. R1 and R2 are mounted direct between the test



The Veroboard panel wired to the front panel components and ready to be mounted in place.



On the front panel, from left to right, are the test transistor socket, D3 and D4, S2, S1 and S3.

socket and S2. Fig. 3 provides details of both the Veroboard panel and the other wiring of the tester. Be careful not to omit the four breaks in the copper strips or any of the link wires. The mounting holes in the component panel are 3.3mm in diameter and will accept either 6BA or M3 screws. The completed component panel is mounted at any convenient place on the base panel of the case after all the wiring has been completed.

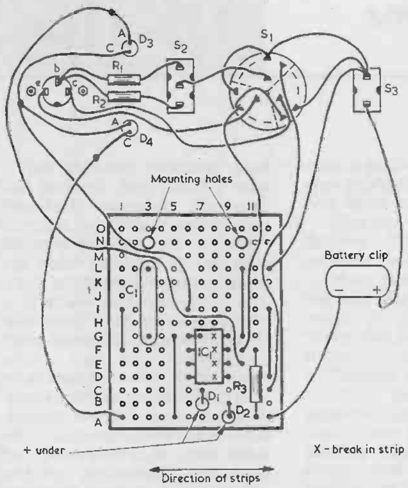


Fig. 3. Wiring and layout on the Veroboard panel. Also shown are the connections to the front panel components.

USING THE TESTER

The tester is very straightforward to use. With the unit switched on by means of S3, S1 is set to the appropriate mode for the device under test (p.n.p. or n.p.n.) and the emitter and collector leads of the test transistor are connected to the tester. Only the leakage current of the device will then flow, and for silicon devices this should be too small to cause either D3 or D4 to switch on. Germanium transistors tend to have rather high leakage currents and a perfectly satisfactory device may well cause D3 to turn on. However, it is unlikely that the test device will be a serviceable component if both D3 and D4 light up. It should be borne in mind that a rather optimistic indication of a device's gain will be obtained if it has a high leakage current, due to the fact that the leakage current flows in addition to any collector current produced by a base bias current. It is only germanium transistors which are liable to cause any serious leakage current difficulties.

To test normal transistors for gain, S2 is set to the "Low" position and the base lead of the test transistor is connected to the tester. D3 then lights up if the device has a current gain of more than 10 times, and D4 will additionally switch on if the current gain is in excess of 50. For high gain devices such as the BC109, BC169, etc., S2 can be switched to the "High" position, and the nominal gain threshold levels of D3 and D4 then become 100 and 500 respectively. If neither of the l.e.d. indicators turns on when S2 is in the "Low" position, then the test device either has an extremely low gain or, more probably, it is open-circuit. In either case it is unlikely to be of any practical value.

In order to check a diode, this is connected between the emitter and collector test leads. Both l.e.d.'s should turn off with S1 in one position, and they should both turn on when it is set to the other position. If the l.e.d.'s light up with S1 in both positions the test diode is short-circuit. It has gone open-circuit if the l.e.d.'s fail to turn on at all. ■

Mail Order Protection Scheme

The publishers of this magazine have given to the Director General of Fair Trading an undertaking to refund money sent by readers in response to mail order advertisements placed in this magazine by mail order traders who have become the subject of liquidation or bankruptcy proceedings and who fail to supply goods or refund money. These refunds are made voluntarily and are subject to proof that payment was made to the advertiser for goods ordered through an advertisement in this magazine. The arrangement does not apply to any failure to supply goods advertised in a catalogue or direct mail solicitation.

If a mail order trader fails, readers are advised to lodge a claim with the Advertisement Manager of this magazine within 3 months of the appearance of the advertisement.

For the purpose of this scheme, mail order advertising is defined as:

"Direct response advertisements, display or postal bargains where cash has to be sent in advance of goods being delivered."

Classified and catalogue mail order advertising are excluded.

TRADE NEWS

GOLD MEDAL FOR BRITISH COMPANY AT CZECHOSLOVAKIAN TRADE FAIR

The Thandar SC110 portable oscilloscope from Sinclair Electronics Ltd., of London Road, St. Ives, Huntingdon, was the only British product to win a gold medal at the 1980 BRNO Trade Fair in Czechoslovakia.

The BRNO exhibition is the largest trade fair held in eastern europe, and from the several thousand exhibitors, only 40 gold medals were awarded.

The SC110 is a truly portable professional oscilloscope, fitting easily into a briefcase or toolkit, and weighing less than 2½ lbs, with a 2 in. C.R.T. The basic specification of single trace, 10MHz bandwidth and 10mV sensitivity combined with attractive styling, low power consumption, mains or battery operation make the SC110 one of the most flexible pieces of test equipment on the market, equally suitable for use in field service, laboratory, technical education, or amateur electronics.

PRESTEL MADE CHEAPER

An adaptor costing under £200 that will turn an ordinary TV set into a Prestel terminal is being marketed by Zycor Limited of 33 Fortess Road, London, NW5 1AD.

"This means that users can get the complete Prestel computer-based information service with full colour display for about £400 less than with a purpose-built set," claims Ken Williams, the company's managing director.

He believes that the microprocessor based adaptor, developed at a cost of over £100,000 exclusive of Department of Industry support, will help open up the market for Prestel. At present there are only 6,700 UK Prestel users, mainly business, who have access to 170,000 pages of information. The adaptor will also reduce the cost of setting up private viewdata systems.

An ordinary TV receiver is simply converted by connecting the Post Office approved unit to the set aerial socket. As the adaptor is portable it can be taken home from the office at evenings and weekends for use with an existing domestic TV receiver. Conforming to Issue 6 Prestel Terminal Specification, it can be used with any size of screen.

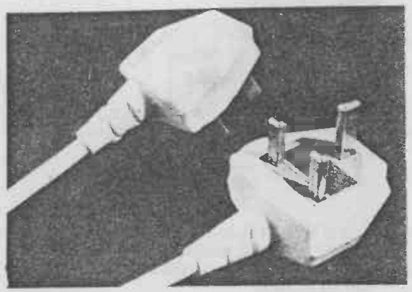
The adaptor, designated Teledek 2000, has also been designed for export. Information can be displayed in German and Swedish and it will produce vhf signals and a range of uhf signals in addition to those used in the UK. It accepts UK, European, US and Australasian mains supply voltages.

Sockets are provided to connect the unit to a printer that will reproduce both characters and graphics and to any domestic type tape recorder for recording and replaying displayed information. A socket is also provided to allow the adaptor to be connected to TV monitors and the emerging range of TV receivers, such as the Thorn TX, which allow the TV tube to be connected directly to the adaptor.

When switched on, Teledek 2000 displays a "menu" of telephone numbers. The user may select any of these numbers by pressing one button on his keypad and he is then automatically connected to the selected Prestel/viewdata computer.

The Teledek 2000 cabinet has a finish similar to rosewood, designed to suit both home and office environments. It can be put on top of a TV set, on a desk or table.

THE "RELIANCE" MOULDED PLUG LEAD



BICC General Cables Limited exhibited the new 13 amp "Reliance" moulded plug lead at the International Domestic Electrical Appliance Trade Fair held at the NEC Birmingham from 13 – 15 January 1981.

The availability of moulded plug leads from BICC represents a major step forward to both user and manufacturer in terms of safety and convenience, since goods may be supplied ready for mains connection without risk of faulty plug fitting by the consumer.

In addition, BICC showed a range of moulded plug leads to European, American and Australian standards and an extensive range of flexible cables and Stretchiflex – 16 in. of flex that extends to over 5 ft.

In your workshop

OHM'S LAW REVISITED

Always read the small print

The Monday morning post had arrived, and Smithy was cheerfully working his way through the bills, invoices and delivery advices, all of which had been safely delivered as a result of the dedicated labours of manual letter sorters, old-fashioned mail train staff and stout honest postmen, none of whom had any connection whatsoever with this new-fangled all-electronic data processing breakaway called British Telecommunications. Put a first class stamp on your letter and its addressee may well receive it no later than the following day (or the following week, fortnight, month or year). Good steady plodding handling and direction of correspondence, with not even a thought about megabauds or megabits per second.

Smithy opened up two very large envelopes and looked at their contents with satisfaction.

FULL CABINET

"Here we are, Dick," he called out. "Two more service manuals! Could you put them in the filing cabinet for me?"

Dick turned round from his bench, on which rested a shiny multi-knobbed stereo music centre.

"Put in two more manuals?" he repeated. "You've got to be joking. That filing cabinet of ours is so jam-packed with service manuals that you need a tyre lever just to get one *out!*"

"Nonsense," retorted Smithy. "The contents just need to be rearranged a bit."

"You can't rearrange what has become a solid monolithic mass of paper," said Dick. "Why the heck do we want so many manuals anyway?"

"Service manuals," intoned Smithy pompously, "are essential for the proper execution of our servicing duties. A service manual tells you the circuit and layout of the set you're fixing. For instance, have you got out the manual for that music centre you're repairing?"

"As it happens," admitted Dick, "I have. And I needed two long-nosed pliers to pull it out of the tight-packed wad in that cupboard!"

"Well then," said Smithy, ignoring Dick's comment, "that shows that you are relying on the manual to sort out your fault."

Smithy missed the gleam that suddenly arose in Dick's eyes and which was just as quickly suppressed.

"Are you saying," Dick asked innocently, "that we should rely on the service manual for *all* the information in the circuit of a particular set?"

"I am," confirmed Smithy.

"Very well then," said Dick, "come and take a look at the a.f. amplifier and output circuitry for this music centre."

Obligingly, Smithy rose from his stool and crossed over to his assistant's side. Dick pulled the service manual for the music centre to a clear part of his bench and pointed at the a.f. amplifying stages for the right hand channel. (Fig.1.)

"That," commented Smithy, "looks nice and straightforward to me. TR5 and TR6 are the output transistors, and they are preceded by TR3 and TR4. TR3 and TR5 are in a composite circuit with 100% negative feedback and they act like a single emitter follower having a very high level of current gain. TR4 and TR6 are in the same sort of composite circuit but with polarities reversed, and these two transistors also act like a single, very high current gain, emitter follower. The output transistors couple through the two 1Ω resistors and C11 to the right hand speaker."

"Via the phone socket."

"Via the phone socket," agreed Smithy. "The phone socket does rather a complicated bit of switching which causes both speakers to be silenced when a stereo headphone plug is inserted. The two stereo phones then connect to the amplifier outputs by way of 270Ω resistors."

"TR2 will be the driver transistor?"

"It will be, said Smithy. "It acts as a common emitter amplifier and its collector load, above the two bias diodes, D1 and D2, consists of the resistors R9 and R10. You'll note that the output of the amplifier couples back to the bottom of the electrolytic capacitor, C5. This connects into the junction of R9 and R10 and gives a bootstrap effect for the collector of TR2."

NEGATIVE FEEDBACK

"The output also couples back to R8," put in Dick, "which then goes to the emitter of TR1."

"True," confirmed Smithy. "There's a negative feedback loop there. TR1 collector connects to the base of TR2. Because of this, TR1 emitter is out of phase with the amplifier output. If TR1 emitter goes positive so also does its collector and the base of TR2. Since TR2 is a common emitter amplifier, its collector then goes negative and causes the amplifier output to go negative, too. In consequence the emitter of TR1 can be looked upon as an inverting input for the whole amplifier. The electrolytic capacitor, C3, has very low impedance at audio frequencies and the voltage gain of the amplifier is equal to R8 divided by R7, or 1.5kΩ divided by 15Ω."

Dick reached forward and drew a pocket calculator towards him.

"Let's see now," he frowned, as he punched the buttons. "That's 1,500 divided by 15. Why, it's exactly 100!"

"Of course it is, you blithering idiot," snorted Smithy. "You don't need a calculator to tell you that. So okay then, the voltage gain of the whole amplifier is 100 times. The a.f. input from the volume control is taken to the base of TR1, which acts as a non-inverting input. Since C3 can be assumed to have a very high resistance at d.c., the amplifier d.c. negative feedback is 100%."

"What does that mean?"

Smithy looked away from the circuit and glanced at his assistant.

"It means," he said, "that you can set up the quiescent output voltage of the amplifier to a mid-supply voltage by applying a suitable voltage to the base of TR1."

"Well," said Dick blandly, "that seems to cover everything. Did you notice that this circuit diagram also shows voltages?"

"Does it?" remarked Smithy absent-mindedly as he peered down at the circuit again. "Why, so it does. The voltages are given inside little rectangles at the various parts of the circuit, and they will doubtless be with respect to the negative rail. Which only goes to show how very useful service manuals can be. Not only does this one give details of the circuit but it also shows you the voltages you should get in it."

"I suppose," stated Dick in a guileless voice, "that you can also find out the currents which flow in the circuit by looking at these voltages."

Had this not been Monday morning (and, let's face it, *nobody* can be at their best on *any* Monday morning) the warning bells would have been ringing loud and clear for Smithy by this time. But he

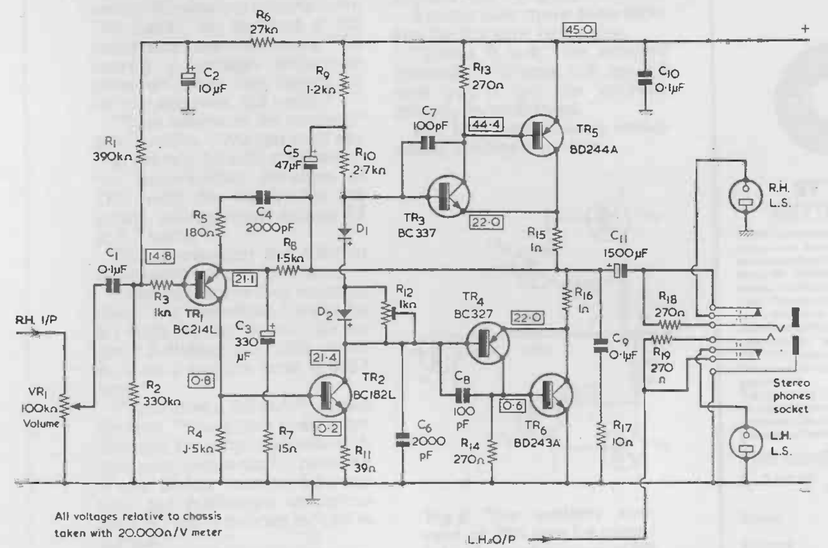


Fig.1. The right hand a.f. amplifier and output stages of the music centre under repair by Dick. The figures in rectangles are voltage indications under quiescent conditions. This is a slightly simplified version of the corresponding stages in the Ultra 6921 Stereo Music Centre.

$$\text{RESISTANCE (R)} = \frac{\text{VOLTAGE (E)}}{\text{CURRENT (I)}}$$

$$\text{CURRENT (I)} = \frac{\text{VOLTAGE (E)}}{\text{RESISTANCE (R)}}$$

Fig.2. Two equations for Ohm's Law.

blundered on, headed straight for Dick's little trap.

"Yes," he agreed, "you can tell the currents which flow from the voltages. But only if there is a resistance for the current to flow through. After that it's straightforward Ohm's Law."

OHM'S LAW

"Which states," said Dick, "that resistance is equal to voltage divided by current."

"Precisely," responded Smithy, "and if you move the quantities in the equation round a bit, Ohm's Law also says that current is equal to voltage divided by resistance." (Fig.2.)

"How about finding the collector current of TR4 from the voltage dropped across the 270Ω resistor R14? The manual says that there's 0.6 volt dropped across that resistor." (Fig.3.)

"That one's no good," replied Smithy. "The base-emitter junction of TR6 is connected across R14 and that 0.6 volt is merely the forward voltage dropped across this junction."

"Then," said Dick, "the current flowing in the resistor must be the current required to cause 0.6 volt to appear across it. Let's just try it for size anyway – 0.6 divided by 270."

Dick pressed the buttons on his calculator.

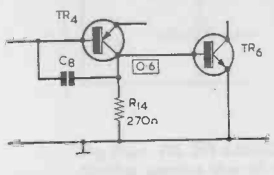


Fig.3. The base-emitter junction of TR6 causes the voltage across R14 to be 0.6 volt.

"Well, blow me," he remarked. "Another simple answer."

"What does the calculator say?"

"0.0022222!"

"For goodness sake," grated Smithy, "just because a calculator has a lot of figures in its display it doesn't mean that you have to use them all. That 270Ω resistor will be a 5% component and so an answer to 2 significant figures is more than near enough. Let's say the current is 0.0022."

"0.0022 what?"

"Amps, of course. We're using volts and ohms and so the answer comes out in amps. 0.0022 amps is the same as 2.2mA, and so we can say that the current in the 270Ω resistor has to be 2.2mA for 0.6 volt to appear across it. This means that the collector current of TR4 has to be at least 2.2mA. Any current above that level flows through the base-emitter junction of TR6."

"Let's try another one," said Dick. "Let's find the collector current of TR1 from the voltage dropped across R4. The manual says that this is 0.8 volt." (Fig.4.)

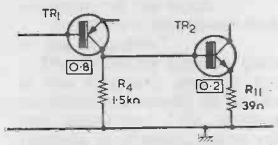


Fig.4. The voltages at the emitter of TR2 and the collector of TR1.

"We've got problems with another base-emitter junction here," responded Smithy. "As you can see, the voltage dropped across R11 is 0.2 volt, and the voltage across R4 is just that 0.2 volt plus the 0.6 volt dropped across the base-emitter junction of TR2. However, we *can* find the current which flows in R11, and this will be the emitter current of TR2. Try it out, Dick, 0.2 divided by 39."

"Righty-ho," said Dick. He manipulated the buttons on his calculator. "The answer, to 2 significant figures, is 0.0051."

"Which," chimed in Smithy, "is 5.1mA."

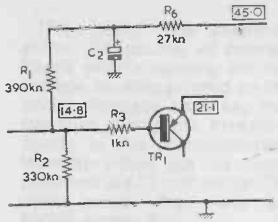


Fig.5. The voltage figures here point to a potential difference of 6.3 volts between the emitter of TR1 and the end of R3 which is remote from TR1 base.

"There's another resistor," said Dick in a tone of excessive chattiness, "which doesn't have a base-emitter junction across it. But it does have a base-emitter junction in series with it."

"Which one," asked the unwitting Smithy, "is that?"

Gesturing with a contrived carelessness, Dick pointed to R3. (Fig.5.)

"There's 21.1 volts on the emitter of TR1," he stated, "and there's 14.8 volts at the end of R3 which is remote from TR1 base." He stabbed at the calculator keys once more. "So there's a voltage difference between those two points of, let me see now, 6.3 volts."

"That seems to be correct," said Smithy. "We can next say that there's 0.6 volt dropped in the base-emitter junction of TR1, with the result that the actual voltage drop across R3 is 5.7 volts."

Dick succeeded manfully in maintaining a straight face.

"The current in that resistor, then," he remarked, "must be 5.7 volts divided by 1kΩ. So we get 5.7 divided by 1,000 which is, wait a minute now, 0.0057 amp."

"And that's 5.7mA," stated Smithy. "You didn't need to go through the amp business with this one, incidentally, because if you divide volts by kilohms you get milliamps straightaway. 5.7 volts divided by 1kΩ is 5.7mA."

"And that's the current in R3?"

"Of course it is," said Smithy, irritated. "We've just worked it out, haven't we?"

"Using the voltages indicated in the service manual?"

"What else? If they're in the manual they *must* be correct."

Dick smiled cheerfully.

"What are you grinning at?" asked Smithy suspiciously.

Dick continued to smile.

"For goodness' sake," exploded Smithy. "It's like talking to a Cheshire cat having you in front of me."

"5.7mA?"

"5.7mA," repeated Smithy firmly.

"Where," asked Dick sweetly, "is that 5.7mA going to come from?"

Smithy looked down at the circuit, examined it closely and frowned.

"There's something funny here," he stated slowly. "That 5.7mA is the base bias current for TR1 but, looking at the value of R1, it's far, far higher than the actual base current possibly could be."

"We can at least find the emitter current for TR1," put in Dick quickly. "The amplifier output voltage is 22 volts and the voltage at TR1 emitter is the 21.1 volts we've already seen. So there's 0.9 volt dropped across the 1.5kΩ feedback resistor, R8." (Fig.6.)

Smithy was more than stricken by the turn of events.

"Check it out," he ordered hollowly. "Divide 0.9 by 1.5 and you'll get an answer directly in milliamps."

But Dick had already anticipated Smithy's wishes.

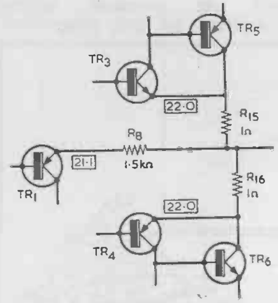


Fig.6. The emitter current of TR1 can be calculated from the value of R8 and the voltage across this resistor.

"The answer," he said, pressing the "equals" key on his calculator, "is 0.6mA."

"Then how in blazes," queried Smithy desperately, "can that transistor take a base current of 5.7mA when its emitter current is only 0.6mA?"

He looked closely at the service manual circuit diagram. This included the identical left hand channel amplifier as well as the right hand channel which Smithy had been working with. TR1 appeared in precisely the same configuration. Printed in the left hand channel circuit against the emitter was the number 21.1, and printed against the remote end of the base resistor was the number 14.8. Smithy gazed unbelievingly at the figures nested in their little rectangles.

MYSTERY SOLVED

"Is the service manual wrong?"

"It can't be," said Smithy. There was a note of despair in his voice.

"Well, you're the service manual buff," continued Dick relentlessly. "You're the one who says we should use service manuals all the time."

"Don't keep on," said Smithy.

"You're miffed," accused Dick. "You're miffed because that base current is all wrong."

"I'm *not* miffed," snapped Smithy. "Now belt up whilst I think about it. The emitter current of TR1 is 0.6mA and this transistor is bound to have a current gain of around, say, 200 times, and so the base current will be quite tiny, at around 3μA. And yet I've just worked it out as being no less than 5.7mA!"

He scowled down at the amplifier circuit.

"Let's work out the voltage at the remote end of R3," he said wearily, "assuming that there's *no* base current to TR1."

"How do we do that?"

"We look at the potential divider given by R6, R1 and R2. These resistors are 27kΩ, 390kΩ and 330kΩ. I don't need your calculator to tell me that this lot adds up to 747kΩ. And across all three resistors is the supply voltage of 45 volts. The voltage across R2 will then be equal to 45 divided by 747 and multiplied by 330. Try that out on your calculator." (Fig.7(a).)

Obediently, Dick carried out the calculation.

"The answer," he said, "is just short of 20 volts."

"Which is what we'd expect," sighed Smithy miserably. "Why, oh why, does the service manual say 14.8 volts?"

Dick decided to let the Serviceman off the hook.

"Just take a look lower down in the diagram."

The unhappy Smithy gazed at the diagram, and his eyes suddenly narrowed as he read the sentence: "All voltages relative to chassis, taken with 20,000Ω/volt meter".

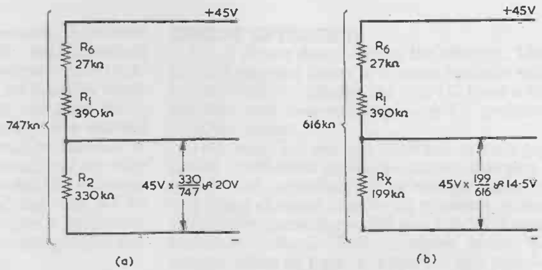


Fig.7(a). R6, R1 and R2 effectively form a potential divider across the 45 volt supply. With no current drawn from R2, the voltage across it calculates at approximately 20 volts.

(b). In this potential divider, RX is the resistance given by 330kΩ and 500kΩ in parallel.

"Ye gods," he breathed softly, "of course, of *course! That's* what's causing the low voltage reading printed on the circuit diagram. Let's say that the chap taking the measurements in the manufacturer's laboratory had got his meter switched to a 25 volt range. The meter would then have put 500kΩ across R2."

Smithy grabbed Dick's calculator and pushed the buttons furiously.

"330kΩ and 500kΩ in parallel," he went on, "give 199kΩ. Now let's work out what the voltage would be if the bottom resistance in the potential divider was 199kΩ instead of 330kΩ." (Fig.7(b).)

Smithy continued to work at the problem.

"The calculated voltage," he said, "is 14.5 volts. Which is near enough to the figure in the service manual to make sense. The low voltage indication in the manual was simply due to the resistance of the meter which took the voltage reading!"

"So the service manual is correct?"

"Of course it's correct," replied Smithy shortly. "You can always trust a service manual."

"You were beginning to have your doubts about this one, though."

"All right," admitted Smithy. "I slipped up. Fancy me slipping up on a basic thing like that!"

A thought occurred to him and he turned a stony eye on his assistant.

"You set me up," he fumed. "You knew about this all the time and you just kept leading me on."

"I'd never do a thing like that," protested Dick. "But I must say it was nice to see you all steamed up over a simple voltage reading. You were really going up and down the agony column. What makes things especially pleasant is that it's normally you who comes out with all the right answers whilst it's me who makes the mistakes."

"Don't keep on about it."

Dick piled it on.

"I spotted the reason for low voltage reading straig way," he remarked patro ingly. "After all, if you're go to take voltage measureme you must always bear in m the input resistance of the v meter."

"All right, all right."

"And I did!"

THE NODDING OF HOMER

Thus, for once, we have unhappy experience of witr sing the discomfiture of Serviceman friend at hands of his usually one-do assistant. But we can still pa maintain the image beca Dick was guilty of a lie which say the least, was a little white. He had in fact enco tered the seemingly anon ous voltage indication before he finished work on preceding Friday and taken the music centre serv manual home to study over weekend. And it was only a devoting all his spare time solving the puzzle that he finally discovered the ansv Late on Sunday evening.

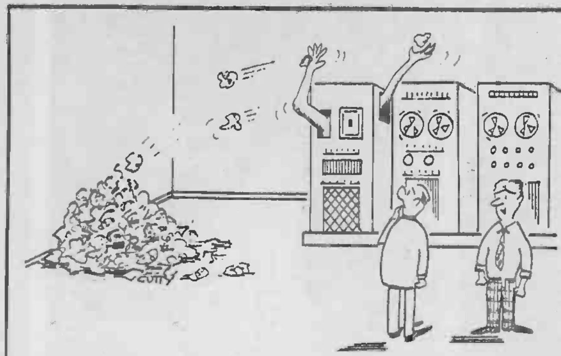
TROPO CHANNELS

Two of the most northerly oil production platforms in the British North Sea area are to have their 72 channel Marconi tropospheric scatter communications systems uprated by Marconi Communications Systems Limited.

The links, between the British Telecom Landstation at Scousburgh in the Shetlands and BNOC's Thistle platform, established in 1977, and between Scousburgh and Shell's Cormorant platform, established in 1979, are now to be uprated to 132 channels.

Thistle and Cormorant are linked by a line-of-sight microwave system and this is interfaced with the tropospheric scatter systems linking the two platforms with Scousburgh in a triangulated system. Normally, one of the tropospheric scatter links carries the communication circuits for both platforms, whilst the second tropospheric link is held in reserve. Not only does this represent very considerable savings in operational costs but it also provides the inherent reliablity demanded by British Telecom and the oil industry for communications with the mainland.

Marconi trophospheric scatter systems are in world-wide use for defence, telecommunications commercial purposes. In British North Sea se Marconi have provided o currently providing all tropospheric scatter li connecting product platforms to the mainla telecommunication networ

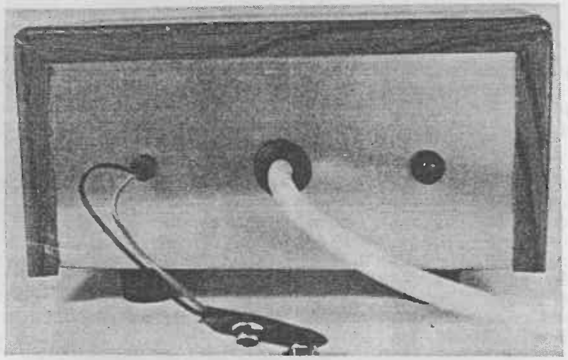


"I can't understand it. The computer is throwing it all out."

NICAD BATTERY CHARGER

By P. R. Arthur

Run your radio at almost negligible cost. Easy to build charger for PP3 size NiCad batteries



The front of the charger. The lead on the left is terminated in a standard PP3 connector for clipping to the NiCad battery being charged. The mains lead passes through the grommet in the centre. To the right is an l.e.d. which is lit up by the charging current.

With the price of 9 volt batteries soaring, the cost of running the family transistor radio was becoming excessive, and so the author investigated the possibility of using a rechargeable NiCad battery. Since the current consumption of the set was only 8mA, rising somewhat at high volume levels, it was decided that a PP3 size NiCad battery would be suitable in place of the PP9 battery normally used, and the only modification required in the radio would be a change of battery connector. It was found that the NiCad battery had a life of only about six days with normal usage of the radio but, since it is rechargeable, this short life is of no real consequence.

The NiCad version of the PP3 battery is several times the price of ordinary 9 volt batteries but the initial outlay is well worth while because the NiCad battery should last for many years. NiCad batteries require a special charger, and this article describes a simple and inexpensive charging unit which is specifically intended for use with a PP3 size NiCad battery.

CIRCUIT OPERATION

Fig. 1 shows the circuit of the charger. The mains input is stepped down to a more suitable voltage by transformer T1. Diodes D1 and D2 form a full-wave rectifier with reservoir capacitor C1 smoothing the rectified output.

TR1 and TR2 are in a constant current generator circuit which ensures that the correct charging current is provided regardless of the voltage across the battery being charged. Due to the presence of the potential divider consisting of R2 and R3, TR1 produces a stabilized voltage. This transistor passes collector current when its base is about 0.6 volt positive of its emitter, with the result that the collector voltage stabilizes at about 1.8 volts. R1 is the feed resistor for the stabilizer circuit.

The stabilized voltage of 1.8 volts is applied to the base of TR2 whereupon, due to the voltage drop of 0.6 volt in its base-emitter junction, about 1.2 volt appears across the emitter resistor, R4. From Ohm's

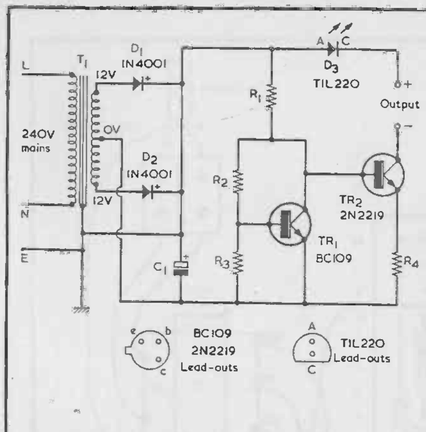


Fig. 1. The circuit of the NiCad battery charger. This is specifically intended for charging PP3 size batteries.

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)
R1 6.8kΩ
R2 5.6kΩ
R3 2.7kΩ
R4 110Ω ½ watt 2%

Capacitor
C1 100μF electrolytic, 25V. Wkg

Transformer
T1 mains transformer, secondary 12-0-12V 50mA

Semiconductors
TR1 BC109
TR2 2N2219
D1 1N4001
D2 1N4001
D3 TIL220

Miscellaneous
Metal instrument case (see text)
Veroboard, 0.1in. matrix
PP3 battery connector
Panel-mounting bush (for D3)
2-way connector block
3-core mains lead
Nuts, bolts, wire, etc.

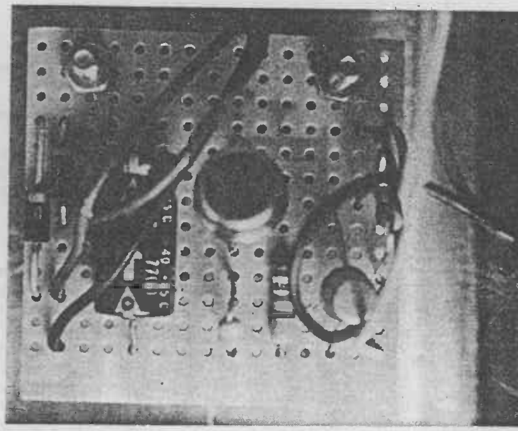
Law the current flowing in R4 is 1.2 volt divided by 110Ω, which calculates as 0.011 amp, or 11mA. The collector current of TR2 is the same as the emitter current less the very much smaller base current, and so the collector current will also be 11mA. This collector current will flow through the NiCad battery being charged, and is the normal recommended maximum charging current for a PP3 size NiCad battery. Note that only the constant current of 11mA will flow even if the output terminals are short-circuited.

The light-emitting diode, D3, is also in the charging circuit and this lights up to confirm that the NiCad battery is being charged. The l.e.d. is a TIL220, which is red with a diameter of 0.2 in. It is available from a number of suppliers.

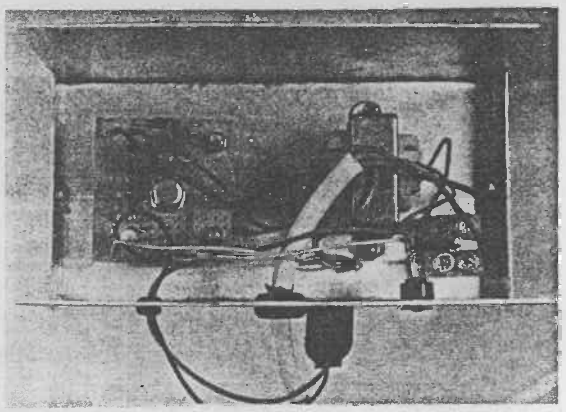
CONSTRUCTION

A small metal instrument case measuring 1[illegible] 63.5 by 57mm. makes an excellent housing fo[illegible] charger. This is a case type TP1, available from [illegible]lin Electronic Supplies. The layout can be seen [illegible] accompanying photographs, and is not critica[illegible] mains input lead passes through a grommet i[illegible] centre of the front panel and should be secured [illegible] the case with a plastic or plastic-faced clip. [illegible]ection to the battery being charged is made by m[illegible] of an ordinary PP3 battery connector, and the [illegible] for this pass through another hole, also fitted w[illegible] grommet, in the front panel. Mounted on the [illegible] panel to the right is the l.e.d., which is fitted [illegible] panel-mounting bush.

The rectifiers and the constant current components are assembled on a Veroboard panel.



There is ample space inside the case for the mains transformer and the Veroboard panel.

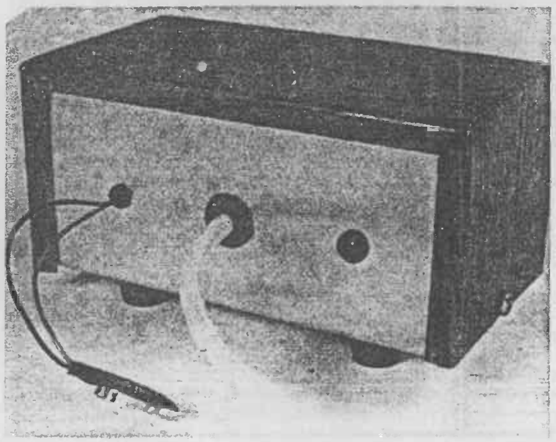


The mains transformer is bolted in place with two M3 bolts and nuts, a solder tag being secured under one of the nuts. The earth wire of the 3-core mains lead is soldered to this tag to ensure that the metal case and the charger circuitry is safely earthed. The transformer used for T1 will almost certainly have flying leads rather than solder tags and the two primary leads are connected to the live and neutral wires of the mains lead by means of a 2-way connector block. Connector blocks are usually sold in 12-way lengths, and the 2-way block can be cut from one of these with a sharp knife. The block is secured to the bottom of the case near the mains transformer by a nut and bolt of suitable size. Take great care to see that the mains wiring is properly carried out, with all precautions observed to ensure that there is no risk of accidental shock. When the charger has been completed and checked out, it should always be used with the case lid securely screwed in place.

COMPONENT BOARD

Most of the components are assembled on a piece of 0.1in. Veroboard having 13 copper strips by 15 holes. This is shown in Fig. 2. The two mounting holes are drilled out to take M3 bolts, and there are no breaks in the copper strips.

The finished board is wired up to T1, D3 and the battery connector before it is finally bolted to the bottom of the case. Spacing washers are used on the M3 mounting bolts to keep the board underside well clear of the metal surface of the case. D3 is held in place by its panel mounting bush and it is satisfactory to simply solder the wire from the Veroboard and the positive battery lead to its lead-outs. Constructors desiring a more secure means of connection can fit a small 2-way insulated tagstrip to the back of the front panel just below the l.e.d., and the wires from the board and the battery connector, and the l.e.d. lead-



Another view of the NiCad charger unit. The use of a ready made metal case simplifies construction.

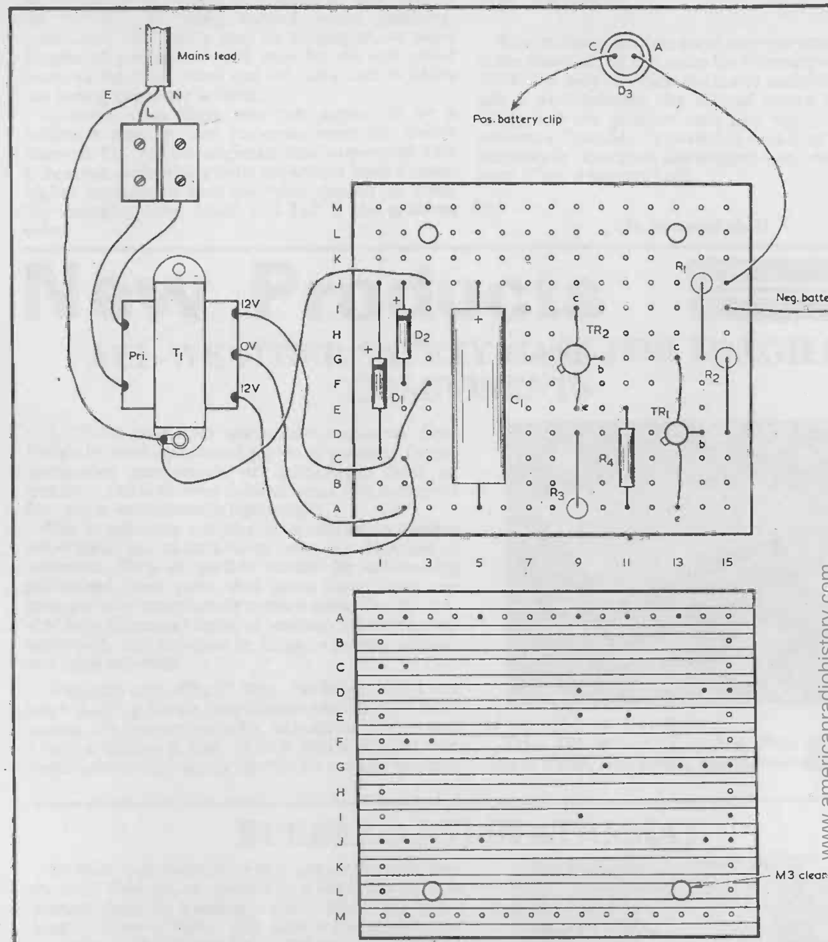


Fig. 2. Wiring of the charger. The use of a Veroboard panel permits a neat layout to be achieved.

outs, can be soldered at this tagstrip. Be careful to connect the l.e.d. correct way round. Also, make quite sure that the polarity of the connections to the battery connector is correct.

USING THE CHARGER

After the charger has been completed and the wiring carefully checked, it can be tested to see that the output current is correct. Apply the mains supply and momentarily connect a multimeter switched to a high current range to the battery connector terminals. If the initial reading shows that it is safe to do so, switch the multimeter to a lower current range and check the output current. This should be approximately 11mA. The reason for starting the check with the multimeter switched to a high current range is to protect the meter in case a wiring error c[...] excessive current to flow.

In use the NiCad battery to be charged [...] connected to the battery connector and th[...] supply is switched on at the mains socket. [...] will withstand a short-circuit across the[...] because this will only cause the constant cu[...] 11mA to flow. Similarly, no damage will [...] either of the battery connector terminals sho[...] pen to come in contact with the metal of th[...] any other metal object which is connecte[...] mains earth. This is because the earth an[...] connections are made common with the pos[...] tified rail rather than the negative rectified

Further Notes on Some Recent Receiver articles

By Sir Douglas Hall, Bt., K.C.M.G.

Part 1

Modifications which can enhance the performance of three recently published receivers.

The object of these two short articles is to give details of a few modifications I have made to some of the receivers which I have described in this magazine during the last three or four years. In each case the prototype has been in constant use, and small changes have been made as they suggested themselves in the light of experience. Component numbers referred to are those used in the original articles.

THE "M5"

This small medium wave receiver was described in the copies for April and May 1977. On pages 546 and 547 it was pointed out that selectivity was controlled to some extent by the value of C1, which provides the capacitance tap for reaction. This capacitor is wired between the moving vanes of the tuning capacitor and one of the tags on the reaction potentiometer. It was said that 1,000pF gave slightly greater signal strength while very good selectivity was obtained with 470pF, and so a compromise value of 680pF was recommended. Selectivity on the medium wave band is now more important than ever, and in the prototype C1 has been changed to 470pF with beneficial results. Reaction control remains satisfactory at the higher frequencies and, with the great majority of transistor samples that may be used, is likely to be so with other receivers built to the design.

THE "JUBILEE"

Construction of this receiver was described in copies of the magazine for July and August 1977, and it has been built in large numbers. Several small modifications can be made with advantage.

First, some constructors will have noticed that, if a station has been received on the long wave band with reaction well advanced, there is sometimes a particularly noisy form of audio oscillation when the wavechange switch is turned to medium waves. This can be prevented by connecting a 2.2MΩ resistor so that it is across the tuned circuit coil when the receiver is switched to medium waves. Reception on the medium wave band is virtually unaffected, and the audio frequency howl is eliminated. The resistor is added at the wavechange switch as shown in Fig. 1.

Some readers may have found that the tuning control is noisy when the receiver is switched to the f.m. band. The position is improved by connecting a wire between the moving vanes of the tuning capacitor and the bolt anchoring the slow motion drive.

If the receiver is used near mains wiring, hum may sometimes be induced when the fingers grip the knob on the tuning control. This effect can be reduced by using a knob without a brass bush at its centre. It is an advantage to stiffen the "chassis" since noise or mistuning can be evident on medium or long waves if the receiver is being carried whilst listening. Additional 4BA bolts may be employed, or short lengths of polystyrene rod may be cut and glued between the front panel and the sub-panel to which the tuning capacitor is fitted.

In some cases there may not appear to be a sufficient drop in bass response when the switch shown in Fig. 7 of the original article is operated. This is because some electrolytic capacitors have a much higher capacitance than the value quoted on them. Try changing from 10μF to 4.7μF if the problem exists.

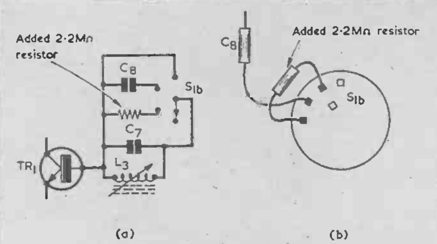


Fig. 1(a). In the "Jubilee" receiver an audio oscillation which is present under some circumstances may be cleared by adding a 2.2MΩ resistor.

(b). The resistor is wired across two of the tags of the wavechange switch.

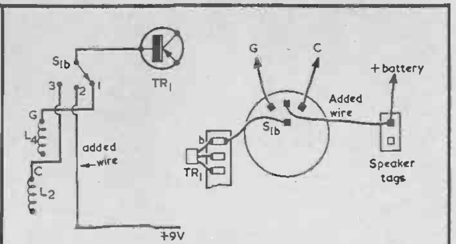


Fig. 2(a). Oscillation at switch-off with the "Cascade" portable can be prevented by adding the wire shown here.

(b). The wire connects between the unused centre contact of S1(b) and the positive battery rail at the speaker tag.

THE "CASCADE"

This medium and long wave receiver was d
in the issues of the magazine for February an
1978. The only modification found useful has
add a wire between the unused centre co
S1(b) and the positive rail. See Fig. 2. T
prevent a "banshee" howl when switching o
electrolytic capacitors discharging – an emba
even if not a serious fault.

(To be concluded)

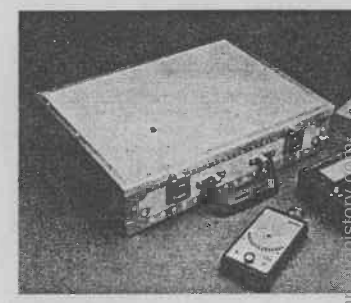
New Products

ALL-WEATHER SAFETY CASE FOR FRAGILE COMPONENTS

A "brief case" for electronics engineers from Nefab in steel reinforced plywood protects fragile electronics components or instruments from all weathers and is claimed to be unbreakable in normal use, yet is exceptionally lightweight.

The tough 4mm surfaces in an attractive natural wood finish are as durable as twice the thickness of softwood. They are further bonded by self-riveting galvanized steel plate that gives four times the strength of conventionally riveted steel. Double treated with thermoset resin, all surfaces are rust proof, anti-static, and resistant to flame, weather, alcohol and most solvents.

Weighing only 4¾lbs (2.2kg), the hinge-lidded box has a carrying handle, two catches and can be readily locked for greater security. Measuring a compact 17ins. x 13¼ins. x 4ins. (420 x 340 x 95mm), the Nefab all-weather safety case looks equally in place in the office or workshop.



Price £25 incl. VAT, p & p, from Nef
Osyth Close, Brackmills, Northampton N

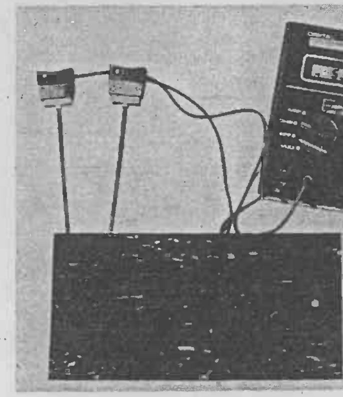
RUBBER ANTI-STATIC MAT

Rubber anti-static mats that are electrically conductive? That can be touched by a hot soldering iron without instantly burning a hole? Mats that won't buckle, creep or flake? Yes, such materials are now available. Called "Stati-Ex" (TM) mats, they can be ordered in widths of 1 metre, lengths to 10 metres, and thicknesses of either 1 or 2mm. The mats are smooth on one side and serrated on the other.

High-conductivity rubber mats are ideal for electronic assembly areas where static charges must be bled off before they can damage the product. CMOS chips, for example, are highly sensitive to voltage spikes, and are best processed on the new rubber charge-eliminator mats that also offer a gentle, cushioning work surface.

Stati-Ex mats are also well-suited for high-precision measurement laboratories, where static build-up could annul the accuracy of critical readings, or cause false inputs on computer terminals.

Stati-Ex mats have an extreme high wear resistance and a stable conductivity level. Their volume resistivity is 10^5 ohm-cm. Unlike the plastic mats generally in use, the Stati-Ex rubber mats do not readily burn. A match will not ignite the material or char it, and a hot ball of solder can be melted on the mat without



leaving the slightest trace of damage. Stati-
conform to British Standards Institution spec
number BS 2050 (1978).