BATTERY TESTER KIT

MEASURE THE REMAINING CAPACITY OF AA BATTERIES WITH THIS

Kitronik

ESSENTIAL INFORMATION

BUILD INSTRUCTIONS
CHECKING YOUR PCB & FAULT-FINDING
MECHANICAL DETAILS
HOW THE KIT WORKS

Version 2.0
Build Instructions

Before you start, take a look at the Printed Circuit Board (PCB). The components go in the side with the writing on and the solder goes on the side with the tracks and silver pads.

**PLACE RESISTORS**

Start with the eleven resistors:
The text on the PCB shows where R1, R2 etc go.
Ensure that you put the resistors in the right place.

<table>
<thead>
<tr>
<th>PCB Ref</th>
<th>Value</th>
<th>Colour Bands</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>680Ω</td>
<td>Blue, grey, brown</td>
</tr>
<tr>
<td>R2, R3, R4 &amp; R5</td>
<td>22KΩ</td>
<td>Red, red, orange</td>
</tr>
<tr>
<td>R6</td>
<td>100KΩ</td>
<td>Brown, black, yellow</td>
</tr>
<tr>
<td>R7, R8, R9, R10 &amp; R11</td>
<td>220Ω</td>
<td>Red, red, brown</td>
</tr>
</tbody>
</table>

**5 band resistors**

Some high tolerance resistors use 5 bands, not 4. These instructions relate to four band resistors. If your kit has 5 band resistors, it will have a black band in the centre and the multiplier band will be one colour lower.

i.e. 22K (tolerance not shown)
4 band = Red, red, orange
5 band = Red, red, black, red

**SOLDER THE DIODE**

Place the diode into the PCB where it is labelled D1. The diode has to go in the correct way around. You will see that there is a silver line around one end. This matches the corresponding line on the PCB. Solder into place once you are happy that it’s correct.

**SOLDER THE IC HOLDER**

Solder the Integrated Circuit (IC) holder into IC1. When putting this into the board, be sure to get it the right way around. The notch on the IC holder should line up with the notch on the lines marked on the PCB.

**SOLDER THE LEDs**

Solder the four Light Emitting Diodes (LEDs) into LED1 – LED4. It does not matter which goes where, but the battery tester won’t work if they don’t go in the right way around. If you look carefully one side of the LED has a flat edge, which must line up with the flat edge on the lines on the PCB.
The battery connector should be soldered into the ‘CONN1 Power’ terminal. The red wire must go to the ‘+’ terminal and the black wire must go to the ‘–’ terminal.

The single test battery holder should be soldered into the ‘CONN2 Test bat’ terminal. The red wire must go to the ‘+’ terminal and the black wire must go to the ‘–’ terminal.

The IC can be put into the holder, ensuring that the notch on the chip lines up with the notch on the holder.
Checking Your Battery Tester PCB

Check the following before you insert the batteries:

**Check the bottom of the board to ensure that:**
- All holes (except the 4 large 3mm holes) are filled with the lead of a component.
- All these leads are soldered.
- Pins next to each other are not soldered together.

**Check the top of the board to ensure that:**
- The notch on the IC and the IC holder are in the same orientation as the markings on the printed circuit board.
- All of the resistors are in the correct places.
- The four LEDs are in the right way around.
- The red wire on the battery connector goes to the ‘+’ terminal on the power terminals and the black wire goes to the ‘−’ terminal.
- The red wire on the test battery holder goes to the ‘+’ terminal on the test battery terminals and the black wire goes to the ‘−’ terminal.

Testing the PCB

Make sure that the battery tester is powered up. Using a power supply or the battery tester, clip the black lead onto the spring section of the test battery holder and the red lead to the other end. Start at zero Volts and vary the voltage upward to 1.5 Volts. Do not exceed 1.5 Volts. Check that the LEDs light at approximately the voltages listed in the table below. If this is not the case, use the fault finding flow chart to fix the problem.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Number of LEDs that light</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 0.9</td>
<td>1</td>
</tr>
<tr>
<td>0.9 – 1.1</td>
<td>2</td>
</tr>
<tr>
<td>1.1 – 1.3</td>
<td>3</td>
</tr>
<tr>
<td>1.3 – 1.5</td>
<td>4</td>
</tr>
</tbody>
</table>
Adding an On / Off Switch

If you wish to add a power switch, don’t solder both ends of the battery clip directly into the board, instead:

1. Solder one end of the battery clip to the PCB, either black to ‘-’ or red to ‘+’.

2. Solder the other end of the battery clip to the on / off switch.

3. Using a piece of wire, solder the remaining terminal on the on / off switch to the remaining power connection on the PCB.
Fault finding flow chart - page 1

Start
Power the board up

Is LED1 on?
No
Yes

Set the test battery voltage to 0.7V (either on the power supply, or turn the tester dial fully anti clockwise)

Check
• The batteries are good and in the right way around
• The power clip is in the right place and connected the right way around and soldered
• R7 is the right value and for dry joints
• LED1 is in the right way around, for dry joints and shorts
• IC1 pins 3 & 4 for a short

LED2 is always on - Check
• IC1 for a dry joint or short on pin 10
• R5 & R6 are in the right place

LED3 is always on - Check
• IC1 for a dry joint on pin 12

LED4 is always on - Check
• IC1 for a dry joint on pin 5
• R5 for a dry joint

LED2 & LED 3 is always on - Check
• IC1 for a short on pins 5 & 6 and 12 & 13
• R2 & R4 for a dry joint
• R1 - R3 & R6 are the right value

All LEDs on - Check
• IC1 for a dry joint on pin 1 & 2
• R1, R2 & R11 for dry joints
• R1, R3 & R11 are the right value

Are LEDs 2 - 4 all off?
Yes
No

Set the test battery voltage to 1.5V (either on the power supply, or turn the tester dial fully clockwise)

Go to page 2
Designing the Enclosure

When you design the enclosure, you will need to consider:

- The size of the PCB (below right, four mounting holes are 3.3mm).
- Where the LEDs are situated (diameter 5mm).
- Access to the batteries to allow them to be changed (below left).
- Where the battery holder for the test battery will be located (below centre).

Technical drawings of these items are illustrated on this page, which should help you to design your enclosure. All dimensions are in mm. The depth of both battery holders is 14mm.

Mounting the PCB to the enclosure

The drawing to the left shows how a hex spacer can be used with two bolts to fix the PCB to the enclosure.

*Your PCB has four mounting holes designed to take M3 bolts.*
How the Battery Tester Works

Comparators are used to compare one signal to another. They have two inputs: one labelled with a ‘-’ and the other with a ‘+’. If the voltage on the ‘+’ input is greater than that on the ‘-’, then the output (the point of the triangle) will be 4.5V. If the signal on the ‘-’ input is larger than the ‘+’ input, then the output becomes zero.

Each of the three operational amplifiers (op amps) on the right of the diagram are operating as comparators as described above. The ‘+’ input to each comes directly from the battery under test. The ‘-’ inputs are held at predetermined levels that equate to the different stages of decay in battery voltage. As the battery gets flatter, the voltage falls. As this becomes lower than the pre-determined levels, the corresponding LED goes out.

To produce the pre-determined levels, you require a consistent voltage reference. This is produced as follows. The diode and 680Ω resistor on the left of the diagram produce a reference voltage of 0.65V (which is the drop over the diode). This is fed into the ‘+’ input on the op amp (on the left). The gain or amplification of the op amp in this circuit is 2 (given by, 1+ (22K÷22K)). Therefore the output of the op amp will be at 2 x 0.65V = 1.3V.

This 1.3V is the first pre-determined level. The other (lower) levels are produced by applying a potential divider across this 1.3V and 0V.

The 220Ω between the op amp and the LEDs limit the flow of electricity into the LED. This controls the brightness and stops the LED from burning out.
Using the battery tester

- To turn the battery tester on, connect the battery holder to the battery clip (unless you have added an on/off switch).
- When the battery tester is turned on, LED1 will light up.
- The test battery should be placed in the ‘test battery’ holder.
- The LEDs will light to indicate the state of the battery as follows.
  - LED 1 only = very flat
  - LED 1 + LED 2 = battery capacity low
  - LED 1 + LED 2 + LED 3 = battery capacity above half
  - All LEDs = battery full
- The circuit will gradually flatten the batteries even when it is not being used to test a battery so the batteries should be left unconnected when not in use.
Online Information

Two sets of information can be downloaded from the product page where the kit can also be reordered from. The ‘Essential Information’ contains all of the information that you need to get started with the kit and the ‘Teaching Resources’ contains more information on soldering, components used in the kit, educational schemes of work and so on and also includes the essentials. Download from:

www.kitronik.co.uk/2102

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