How the Continuity Tester Works

The heart of the Continuity Tester is the LM311 voltage comparator, U1 in the schematic diagram. The LM311 compares two analog voltages and outputs a digital state depending upon which of the two input voltages is higher. The voltage on the inverting input (U1 pin 3) is the reference voltage, and the voltage on the non-inverting input (U1 pin 2) is the sample voltage. If the voltage on the non-inverting input is greater than the voltage on the inverting input, then the output will assume a logical high state. If the voltage on the non-inverting input is less than the voltage on the inverting input, the output will assume a logical low state.

Diode D1 prevents current from flowing in the circuit with the battery connected backwards. Provided the battery is connected properly, the circuit will receive power when switch S1 is held closed. D1 will drop about 0.7 volts when conducting, so the supply voltage (U1 pin 8) will be the battery voltage minus the diode drop, or about 8.3 volts with a new battery.

Resistors R2 and R3 form a voltage divider, establishing the reference voltage at a fixed fraction of the supply voltage. Likewise, the Device Under Test (DUT, between J1 and J2) and R1 form a voltage divider, establishing the sample voltage at some fraction of the supply voltage. If we call the DUT’s resistance R, then the LM311 output will be high (the sample voltage will exceed the reference voltage) when \( \frac{R}{R1} > \frac{R3}{R2} \). Likewise, the LM311 output will be low when \( \frac{R}{R1} < \frac{R3}{R2} \). When the LM311 output is low, current is low, current will flow from the supply, through the current limiting resistor R4 and the Light Emitting Diode (LED) D2, into the LM311 output, and then to ground. This current through the LED causes the LED to light. Since \( \frac{R3}{R2} = \frac{100}{100k} = 0.01 \), the DUT’s resistance R must be less than 0.01 R1 in order to light the LED. Thus, the continuity threshold is 0.01 R1 = 0.01 (2k ohm) = 20 ohm. This 20-ohm threshold assumes R1, R2, and R3 are exactly the values shown on the schematic diagram. With 5% tolerance resistors, the actual continuity threshold may be between 17 and 23 ohms.

In summary, if the DUT between J1 and J2 has a resistance below 17 ohms, the LED will light when the switch is on.
# Bill of Materials

*Project: Continuity Tester*

*Date: April 28, 2011*

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Reference designator</th>
<th>Description</th>
<th>Value/Part #</th>
<th>Package</th>
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<td>D1</td>
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<td>Fairchild</td>
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<td>D2</td>
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PC Board

Continuity Tester

RED
IMAG
24V-
24V+
R1
R2
R3
R4
R5
J2
LED
D1
BLK
Cal Poly

[Image of a green circuit board with labels and components]
Layout

Continuity Tester

R5

J2

RED

BLK

Cal Poly

D1
Assembly