Using the Continuity mode to find faults

In this mode a very small amount of current is allowed to flow without resistance (or at least a very small resistance) between probes of the mutimeter and this can be used to safely debug a circuit being used with a microcontroller. Use the probes to poke at the ground pins on a breadboard, you should hear a tone indicating that they are connected. Poke the probes from the VCC pin on a microcontroller to VCC on your power supply. It should emit a tone indicating that power is free to flow from the VCC pin to the microcontroller. If it does not emit a tone, then you can begin to trace the route that net takes and tell if there are breaks in the line, wire, breadboard, or breaks on the PCB trace.

When a system is not working, continuity is one more thing to help trouble shoot the system.

1. If the system is on, carefully check VCC and GND to make sure the voltage is the correct level. If the 5V system is running at 4.2V check your regulator carefully, it could be very hot indicating the system is pulling too much current.

2. Power the system down and check continuity between VCC and GND. If there is continuity (you hear a beep when poking '+' and '-'), then you've got a short somewhere.

3. Power the system down and with continuity, check that VCC and GND are correctly wired to the pins on the microcontroller and other devices. The system may be powering up, but the individual ICs may be wired wrong.

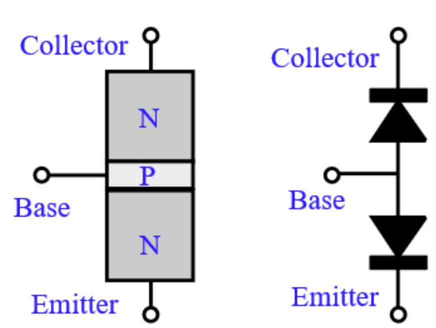
4. Assuming you can get the microcontroller running set the multimeter aside and move on to serial debugging or use a logic analyzer to inspect the digital signals.

Remember: In general, turn OFF the system before checking for continuity.

Testing Transistors using a Multimeter

The diode test using an analogue multimeter can be extended to give a simple and straightforward confidence check for bipolar transistors. Again the test using a multimeter only provides a confidence check that the device has not blown, but it is still very useful.

The test relies on the fact that a transistor can be considered to comprise of two back to back diodes, and by performing the diode test between the base and collector and the base and emitter of the transistor using an analogue multimeter, the basic integrity of the transistor can be ascertained.



Transistor equivalent circuit with diodes for multimeter test.

It should be noted that **a transistor cannot be functionally replicated using two separate diodes** because the operation of the transistor depends upon the base which is the junction of the two diodes, being one physical layer, and also very thin.

Step by step instructions:

The instructions are given primarily for an NPN transistor as these are the most common types in use. The variations are shown for PNP varieties - these are indicated in brackets (.. .. ..):

1. Set the meter to its ohms range - any range should do, but the middle ohms range if several are available is probably best.
2. Connect the base terminal of the transistor to the terminal marked positive (usually coloured red) on the multimeter
3. Connect the terminal marked negative or common (usually coloured black) to the collector and measure the resistance. It should read open circuit (there should be a deflection for a PNP transistor).
4. With the terminal marked positive still connected to the base, repeat the measurement with the positive terminal connected to the emitter. The reading should again read open circuit (the multimeter should deflect for a PNP transistor).
5. Now reverse the connection to the base of the transistor, this time connecting the negative or common (black) terminal of the analogue test meter to the base of the transistor.
6. Connect the terminal marked positive, first to the collector and measure the resistance. Then take it to the emitter. In both cases the meter should deflect (indicate open circuit for a PNP transistor).
7. It is next necessary to connect the meter negative or common to the collector and meter positive to the emitter. Check that the meter reads open circuit. (The meter should read open circuit for both NPN and PNP types.
8. Now reverse the connections so that the meter negative or common is connected to the emitter and meter positive to the collector. Check again that the meter reads open circuit.
9. If the transistor passes all the tests then it is basically functional and all the junctions are intact.

Testing and troubleshooting sensors

1. Disconnect the wires for the sensor at its power source (Point A in the diagram).
2. Plug the black probe into the COM (common) port on your multimeter. Plug the red probe into the VΩ port.
3. Set your multimeter to Continuity - the symbol looks a bit like this: •))).
4. Connect the red probe to the + wire going to the sensor, and connect the black probe to the ground wire going to the sensor.

Note: Communication wiring is often more complicated than a + wire and a – wire, and will vary according to the output of your sensor, and your control system. Please consult your sensor’s user manual or manufacturer for more information.

5. If the multimeter registers a reading, your circuit wiring is intact. If the multimeter does not register a reading, then there is something wrong with the wiring. Repeat these steps along the various sections of the circuit between the source and sensor to isolate the problem.
6. This process can (and should!) also be performed with your sensor’s communication wiring.

Having established the continuity of the circuit, let’s check the source voltage, but not at the source.

1. Reconnect the sensor’s power source.

2. Disconnect the power wires at the sensor (Point C in the diagram) or connection point closest to the sensor (Point B, if the cable to your sensor cannot be disconnected at the sensor).
3. Maintain the same probe – multimeter connections.
4. Connect the red probe to the incoming + wire, pin, or terminal, and the black probe to the ground wire/pin/terminal.
5. Select the DCV value on the multimeter that is closest to, yet bigger than, the source voltage.
6. Turn on the power source.
7. Verify that the voltage at the sensor is within the range suggested in your user manual. If so, we've eliminated source voltage as the problem. If not, the voltage source is at least a problem, if not the problem. (And either way, turn the power source back off!)

Next, we'll check circuit impedance or resistance*. In general, circuit impedance is only critical for communication circuits (Modbus, Hart, etc.), but checking can still be instructive for other circuits.

1. Reconnect the power wires at the sensor.
2. Disconnect the communication wires for the sensor at the source (Point A).
3. Maintain the same probe – multimeter connections.
4. As before, connect the red probe to the + wire going to the sensor, and connect the black probe to the ground wire going to the sensor.
5. Many sensors that use communication protocols require a minimum of 150Ω to 180Ω, so choose the Ohm value on the multimeter that is closest to, yet bigger than, 200Ω. If the circuit impedance is less than that recommended by your user manual, then add an appropriate amount of resistance to the circuit.
6. If the multimeter doesn't register the impedance, select the next highest denomination of Ohms. If the circuit's impedance is too high (and not infinite), something will need to be removed from the circuit (switch to a smaller wire size, too many intermediate junctions, etc)

TROUBLESHOOTING H-BRIDGES

The purpose of a motor driver is to control a motor, and the purpose of the motor is to convert electrical energy into motion. The motor driver's performance can be measured by how much power it delivers to the motor versus how much is wasted in the motor driver electronics.

The amount of power delivered to the motor is crucial to a robot. The amount of motor power directly impacts the torque (pushing strength) and speed (RPMs). Furthermore, since most robots are powered by batteries, it is important to avoid wasting electricity on the H-bridge components.

A very simple technique for approximating the efficiency of a motor H-bridge is to measure the battery voltage with a multimeter while simultaneously measuring the voltage on the motor wires with another multimeter. For example, if the battery measures 5 volts (during usage) and the motor voltage measures 2.5 volts, then only half of the voltage is reaching the motor!

To test an H bridge, say L293D, follow these steps

1. Open the data sheet of the component and always keep it handy while troubleshooting.

2. Place the IC on a breadboard. Select the continuity mode on the multimeter and test continuity between the pins and holes of the breadboard. This ensures there is no discontinuity in the board you are using.
3. Now apply 5V to the VSS pin of your component. (Pin 16 for L293D)
4. Connect the GND pins to a **common** ground. (Pins 4,5,12 and 13)
5. Make sure VSS is in the range 4V to 7V at any given instance using your multimeter.
6. Now enable 5V to Enable Pins (Pins 1,9)
7. Now apply VCC (3V-30V). (Pin 8)
8. Using multimeter you should always make sure (VCC>=VSS).
9. Assuming 5V-> 'High' and gnd->'Low'.
   Keep both Input 1(pin 2) and Input 2 (pin 7) at low and connect multimeter to OUTPUT 1 (pin 3) and GND.
10. Now test the Output 2 (pin 6) Voltage in a similar fashion.
11. Both these voltages should be 0.
12. Now put Input 1 at high and Input 2 at low. Check Output 1 and 2.

Note: One of the leads is always connected to GND.

Output 1 should be equal to Vcc and output 2 should be at low.

13. Keep Input 1 at low and input 2 at high. In this case motor should turn in opposite direction with respect to the previous case. Therefore Output 1 should be low and output 2 high.
14. Keep both inputs at high.
15. This is the braking case. Both outputs are at high state.

Commonly found errors:

1. Component not inserted properly. Orientation can cause misinterpretation in pin No.
2. Absence of a common ground.
3. Motors may not be able to draw enough current.