Appendix F Troubleshooting Basics

When troubleshooting a field wiring problem, it will become necessary to verify that the wires and connections are reliable and secure.

Wires must be checked for continuity using an appropriate tester or instrument. The continuity of a wire refers to its ability to conduct electrical current throughout the entire length of the wire. When a wire successfully delivers current flow from a source to a destination, it is referred to as a complete or closed circuit. If a wire becomes broken somewhere along the line, the continuity is destroyed, therefore the wire is said to be open. This condition is defined as an open circuit.

The instrument most commonly used to check continuity is the ohmmeter. In addition to continuity, this meter also measures resistance of wires or electronic components. The ohmmeter is available in either analog or digital design. The analog version uses a basic meter needle movement whereas the digital version provides a digital readout display. The meter may also feature a buzzer or beeper used for easily checking continuity by listening for an audible sound to verify a complete circuit. A more simplified device is the continuity checker, which only provides an audible tone and does not measure resistance.

The ohmmeter is generally part of a three-in-one type of instrument called a multimeter. The multimeter measures voltage, current or resistance. The multimeter is also referred to as a Voltage Ohm Meter (VOM). Each function has its own set of measurement scales and ranges, which are used independently from each other.

The type of instrument you choose depends on your application and requirements, however, the multimeter is recommended for its overall versatility. The multimeter can be a useful tool in diagnosing approximately 90% of all electrical problems.

Analog Multimeters

The following pictorial diagram illustrates a typical analog multimeter. The face of the meter displays a resistance scale on the top and a DC voltage scale below (the AC voltage scales are not shown for simplification). The resistance is measured in units called Ohms. The full scale ranges from 0 Ohms to 5 thousand Ohms (5K=5 thousand) (K=Kilo). The ohmmeter scale usually reads from right to left.
The symbol for Ohm is the Omega Greek letter Ω .

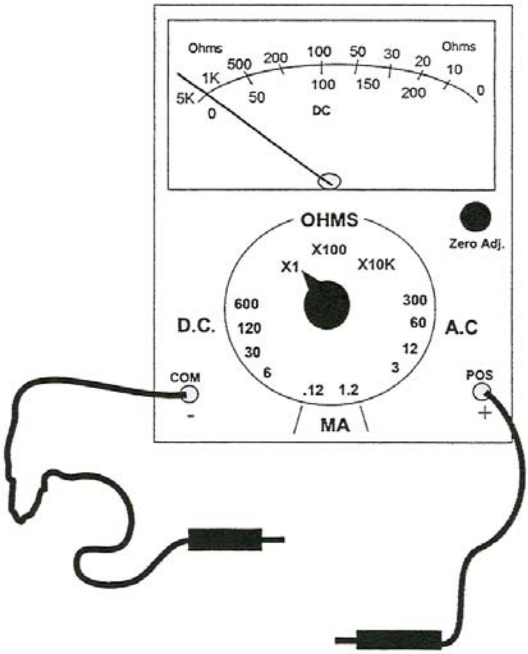

Figure 235: Analog Multimeter

Resistance Scale

The actual resistance reading is determined by the Range Selector Knob, which is illustrated in the X1 (times 1) position. The X1 means that any registered reading on the Ohms scale should be multiplied by 1. The X100 range means that any reading on the Ohms scale should be multiplied by 100. The x10K means that any reading on the Ohms scales should be multiplied by 10,000.

The illustration is reading approximately 3K (3,000) Ohms, because the selector knob is set to the X1 scale. This reading, however, for all practical purposes, is erroneous because the meter leads are not connected to anything (open circuit).
The two meter leads are generally black for common (negative or ground) and red for positive. If you touch the two leads together, the needle should go to the 0 (zero) reading, which indicates continuity (zero resistance) between the positive and negative terminals.

If the needle does not completely go to zero, adjust the Zero Adj. knob to set the needle to 0. Due to the internal meter battery, this is often necessary to maintain reasonable calibration of the meter resistance readings. As a general rule, you should always zero the meter prior to making resistance measurements or when checking continuity.

Voltage Scale

The voltage measurements operate in a similar manner as the resistance measurements. The scales, however read left to right with 0 volts at the extreme left. The Selector knob is set to the appropriate DC or AC scale and the measurement is read out directly. A prime consideration when making DC voltage measurements is the polarity of the leads. You should be aware that a positive (+) voltage must be measured with the positive lead on the voltage point and the negative (-) lead connected to ground.

Digital Multimeters

The digital multimeter is the meter of choice in today's technical world. These instruments are easy to use, highly accurate and offer features, such as automatic ranging, built-in continuity beeper, diode test and automatic polarity sensing.
Resistance measurements are easily made by merely switching to the Ohm position and measuring. The measurement is displayed directly or may be accompanied by a K or an M, indicating Kilohms (thousand) or Megohms (million).

Voltage measurements are displayed regardless of polarity. If the voltage is negative, the display will be indicated with a - (minus) sign.

Switching to the continuity position provides a continuous tone in continuity checks. This allows for quick continuity checks without looking at the digital display.

Troubleshooting

This discussion will consider the most commonly used wiring configuration, which is the two conductor cable. The two conductor cable contains two individual insulated wires enclosed inside a shielded common outside insulation covering. This type of cable is used in the installation of field valve solenoids, flow sensors, moisture sensors; hardwire communications, wind anemometers, rain gauges, ET Weather Computers and many others.

Cable Checkout Procedure

The following procedure is a recommended method in troubleshooting a wiring continuity problem using an ohmmeter or a continuity checker.

Step 1 Disconnect both wires of the cable from the controller Station Output Board, Master/Valve Power Board or Sensor Terminal Board.

Step 2 Separate the wires making sure that they do not touch each other.

Step 3 Locate the other end of the cable and disconnect the two wires from either the valve solenoid, sensor or any other device. Separate the wires making sure that they do not touch each other.
The cable should now be isolated from the system and the wires isolated from each other.

Step 4 Locate the two wires at one end of the cable. Using an ohmmeter or a continuity checker, connect one meter lead to one wire and the other meter lead to the other wire.

Step 5 Verify that there is no reading or audible tone. A reading at this point indicates that a short exists between the two wires.

If this is the case, examine the wires carefully at both ends to determine where they may be touching (shorted). If the cable also connects to a terminal block, check for shorts in the terminal block.
If the short cannot be located, replace the cable.

Step 6 If no short exists; connect the two wires at one end by twisting the wires together. At the other end of the cable, connect one meter lead to one wire and the other meter lead to the other wire, as depicted in Figure F-1.

The meter should indicate a reading, which verifies continuity. The reading will most likely not be zero, since there is an expected amount of resistance in the wire. A reading of 20 ohms or less would be acceptable.

Step 7 If no reading is displayed, the cable is open and should be checked or replaced. Further checkout of a cable depends on the cable location and installation conditions. If the cable is not buried and only a short distance from one end to the other, the two ends of a single wire may be brought together for a continuity check.

If this is possible, disconnect the two wires that were twisted together earlier. Connect one meter lead to one end of a single wire and the other lead to the other end of the same wire. Check the remaining wire in the same manner. Verify the continuity of each wire.

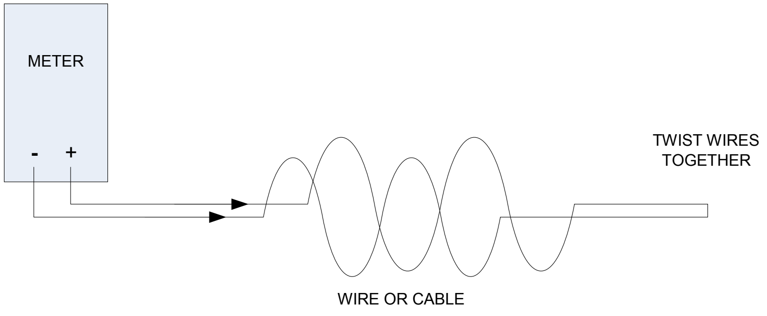

Figure 236: Cable Continuity Check

Polarity Checkout Procedure

In some cases, it will become necessary to identify the polarity of two wires in an installation to prevent possible damage to your equipment. This is when a positive wire must be connected to the positive terminal and the negative wire must be connected to the negative terminal. If the wires are colored or easily identified, polarity is no problem. The standard Rain Master cables are easy to identify because one wire is copper and the other is tinned (silver).

However, there may be custom installations where the wire colors may be the same, which will make identification very difficult. The following procedures offer two methods of checking polarity.

This procedure assumes two wires of the same color are twisted together into one installation cable extending from a controller to an on-site location of a sensor (flow, rain, or anemometer).

Required Equipment

1 Volt Meter (VOM)
1 Flashlight Battery (1.5 Volts)

Procedure

Step 1 Verify that the cable is not connected at either end.

Step 2 At one end of the cable, connect the flashlight battery between the two wires. At the other end, connect one meter lead to one wire and the other lead to the other wire, as depicted in Figure F-2.

Step 3 Set the meter to DC volts. If the meter has a DC scale selection, set it to the lowest scale.

Step 4 Observe the meter for a reading of approximately 1.5 volts. If the voltage reads negative; a digital meter will display a minus (-) sign, an analog meter needle will travel in the opposite direction going off the scale. If your meter indicates a negative reading, reverse the meter leads on the wires.

Step 5 With the meter leads properly polarized, the reading should now be positive 1.5 volts. The wire connected to the positive (red) meter lead may now be identified as positive. The wire connected to the negative (black) meter lead may now be identified as negative.
Identify each wire using a colored pen, tape, or label.

Step 6 Identify, label, or mark the two wires at the other end of the cable. The battery end with the extended tip is the positive side (+).

Step 7 The cable may now be connected to the appropriate terminals and device. Be sure to observe polarity when making connections.

Step 8 This completes the polarity checkout procedure.

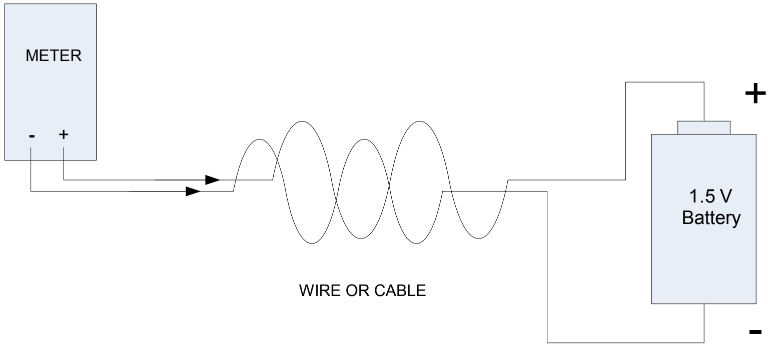

Figure 237: Polarity Check

Alternate Polarity Checkout Procedure

This procedure assumes that an Evolution DX2 Controller, equipped with a Sensor Terminal Board is available and may be used for testing. The four sensor inputs on the Sensor Terminal Board (labeled as Input 1 through Input 4) may be used as a source voltage to test the polarity of a cable. This procedure applies +8 volts to the cable under test, allowing the voltage to be read at the other end.

Required Equipment

1 Volt Meter (VOM)

Procedure

Step 1 Connect one wire of the cable to the negative (-) terminal of Input 1 on the Sensor Terminal Board. Connect the remaining wire to the positive (+) terminal of Input 1.

Step 2 Turn on the controller, if not already on.

Step 3 Set the volt meter to the DC scale and select a voltage range, if necessary, to read approximately +8 volts.

Step 4 Connect the volt meter to the Input 1 terminals with the negative (black) lead to the negative side and the positive (red) lead to the positive side. Verify a meter reading of approximately +8 volts.

Step 5 Disconnect the meter and connect the meter leads to the other end of the cable. Read the voltage on the meter, as depicted in Figure F-3.

If the voltage reads negative; a digital meter will display a minus (-) sign, an analog meter needle will travel in the opposite direction going off the scale. If your meter indicates a negative reading, reverse the meter leads on the wires.

Step 6 With the meter leads properly polarized, the reading should now be positive +8 volts. The wire connected to the positive (red) meter lead may now be identified as positive. The wire connected to the negative (black) meter lead may now be identified as negative.

Step 7 Identify each wire using a colored pen, tape, or label. To avoid any future confusion, identify and label or mark the two wires at the sensor board end of the cable.

Step 8 With the wires properly identified, the cable may now be connected to the appropriate sensor terminals and to the sensor device. Be sure to observe polarity when making final connections.

Step 9 This completes the Alternate Polarity Checkout procedure.

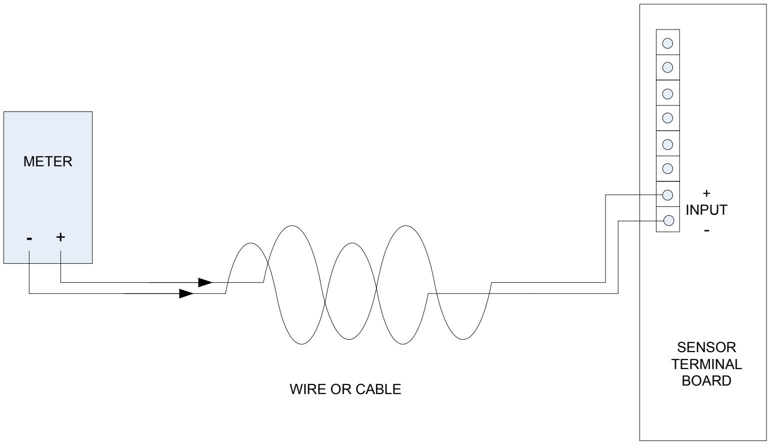

Figure 238: +8 Volt Polarity Check

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