Troubleshooting PoE Systems with a Voltmeter

By George Mallard, P.E. KMS Systems

Troubleshooting the wiring

As Ethernet makes its way into more industrial applications, troubleshooting becomes more important.

Ethernet basics - the crazy eight

The first item to understand is the use of the four pairs within the CAT-5 cable. I call these the crazy eights because some wires are shorted at both ends and some wires carry balanced data. Each pair in the cable is made up of a major (background) and minor (stripe) color. So the orange pair has two wires, one orange with a white stripe and one white with a orange stripe. The pairs have 36 twists per foot for CAT-5.

For the purposes of this article I assume you are using the T568B wiring standard. This is the one commonly used for purchased patch cables and most Ethernet installations. The T568A just switches the transmit and receive pairs. The T568B version will be used at both ends of a straight through cable. A crossover cable will use the T568A on one end and the T568B on the other.

The data pairs

The orange pair (pins 1 and 2) carries data from the remote device and the green pair (pins 3 and 6) carries data to the remote device.

The power pairs

For most POE implementations the brown pair (pins 7 and 8) are tied together and carries -48 volts DC and the blue pair (pins 4 and 5) carries the +48 volts DC. Some switches put the power over the data pair but the devices must be able to accept power from either method.

Link Light

The link light on the switch means that link-data is being carried from the remote device into the switch. For a POE device that would typically mean that the brown, blue, and orange pairs are good. It does not mean that data is getting from the switch to the remote device. The green pair carries this.

VOM as a troubleshooting tool

I prefer a Volt Ohm Meter (VOM) to troubleshoot wiring problems. Easy, cheap, and effective the ohm meter will reveal many secrets hidden from the untrained. I also use the CAT-5 tap by Paladin Tools. It taps the pairs and survives my toolkit, which is no easy thing. These reading are done at the switch end with the switch disconnected.

Unless the designers did something unusual the POE pairs should be shorted at the device end. So the brown/white and the white/brown should read somewhere less than 20 ohms looking from the switch toward the device. This is the resistance of the wire for the round trip from the device. You should read the exact same for the blue/white and white/blue pair.

The typical data transformer used for Ethernet has a DC resistance of about 1 ohm. Measuring the resistance between the orange/white and white/orange should give a reading of less than 21 ohms. Ideally, this reading should be 1 ohm more than the readings taken for the power pairs. You should see infinite (or very high) resistance between any pairs, like the orange and blue pairs.

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Power Over Ethernet

The better switches that provide Power Over Ethernet to the Powered Devices (PDs) are a little more difficult to troubleshoot than one might expect. The reason is the switch and the device follows an analog protocol to determine if the switch is in fact looking at a Powered Device. This is done to prevent damage to either the switch or an ordinary Ethernet device on the other end of the wire.

Power is 48 Volts DC and typically appears on the brown and blue pairs. However a Powered Device must be able to accept power over the data pairs, so in an operating system you may see the voltage across the orange and green pairs.

The first thing to realize is significant power will not be applied until the powered device responds properly to a specific analog protocol. The switch sends a series of higher and higher voltages out the port and measures the resistance it sees. This means that just looking at the powered pins without a Powered Device attached will show little or no voltage. If the switch is not continually satisfied that a proper Powered Device is attached then it will remove power from that port. If you disconnect or short the power to the Powered Device, the port will shut down.

Again the Paladin breakout device is very useful in troubleshooting because you can easily measure the voltages on the wiring while powered up. If you don't see your 48 volts then I would try a Powered Device right there at the switch. This will show if that port on the switch is good. Then move this device out to the remote location and try again. If you see the 48 Volts, the Powered Device in the field is bad. If not you have a problem in the cabling.

If the Powered Device (or the wiring because of a short) draws more that 270 milliamps, the switch will shut down that port. A useful technique to find this problem is to use a Ethernet power injector. This device simply sends 48 volts down the cable on the brown and blue pairs. Sometimes this will highlight the problem area, like a near short to ground or other unusual problem. You should not see more than a six volts drop from one end of the cable to the other. I am careful to disconnect the switch before starting to troubleshooting with this technique. This eliminates a potential sources of confusion and switch damage that could arise from connecting the powered output of the injector to a powered switch port.