

Power Management for Power over Ethernet Devices/implementation

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Executive Summary

Power over Ethernet (PoE) is a widely adopted technology used to transfer both data and electrical power over an RJ-45 cable. PoE has many applications ranging from commercial to industrial. The need to have a standard for getting power down the cable became widely debated issue in PoE solutions. There are three elements to PoE technology when it comes to Power management. The power source (PSE), the device to be powered (PD) and the cable. This application note will be discussing the management and the delivery of power in PoE Solutions.

Keywords:

Power, Power managements, Power over Ethernet, Power delivery, Low Power Devices

Introduction

Powering field devices such as sensors or controllers has been one of the interesting puzzles posed to engineers and network developers. And then, along came power over Ethernet (PoE). The Power delivery system in PoE technology is composed of 3 elements that all work and communicate to each other in a smart way. These three elements are power sourcing equipment (PSE) and the powered device (PD) and CAT5 Cable. The PSE is a separate device typically installed in the wiring closet near the Ethernet switch or hub and the PD is usually installed inside the PoE system. The IEEE's PoE standard defines the power sourcing equipment (PSE) and the powered device (PD) that is used. The IEEE standardization is a long process that involves experts in the field of networking and PoE technology.

Overview

- Identify the three elements and devices for power implementations
- Explains how each element works
- Demonstrate how all power equipments in PoE Solutions communicate

Procedure and Implementation of Power in PoE Solutions

The procedures that power is implemented in PoE technology is not much of a complicated. The system designer has only three elements to worry about as mentioned above, the PSE, PD and the CAT5 Cable.

A. CAT5 Cable

The Standard CAT5 Ethernet cable structure has four twisted pairs of wires, but only half of the four wires are used for 10BASE-T and 100BASE-T, when PoE system is not in place. The system designer for PoE Implementation has two options to take advantage in order to use the CAT5 cable for power delivery as well as data transfer. Both approach can not be used together and the system designers should choose one or the other.

1. If the two spare pairs of wires on the CAT5 cable is used, as explained on figure 1 below, The pair on pins 4 and 5 connected together and forming the positive supply, and the pair on pins 7 and 8 connected and forming the negative supply.

POWER SOURCING EQUIPMENT (PSE)

POWERED DEVICE (PD)

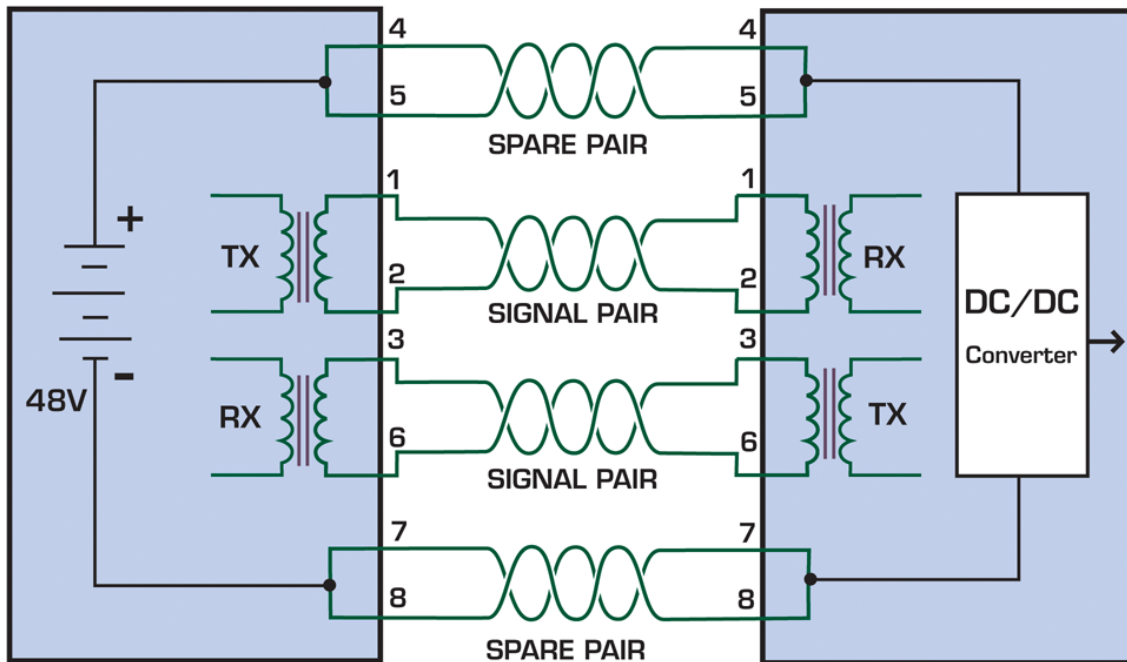


Figure 1 - Power through the Cable on the Spare Pairs

2. If the data pairs of the CAT5 cable are to be used to transfer the power, the pair on pins 3 and 6 and the pair on pins 1 and 2 (either polarity) can be used as showed in figure 2 below. This approach can be achieved without interruption to the data transfer. Since the Ethernet pairs are transformers coupled at each end, we can apply a DC power at the center tap of the isolation transformer.

POWER SOURCING EQUIPMENT (PSE)

POWERED DEVICE (PD)

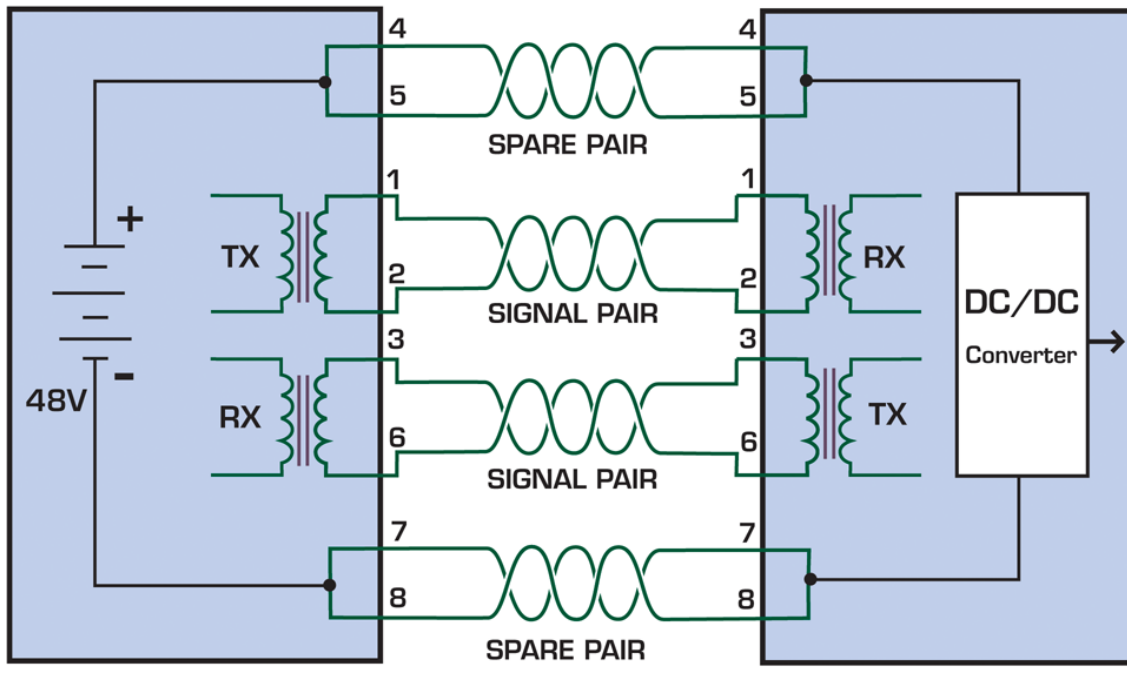


Figure 2 - Power through the Cable on the Data Pairs

B. Power Sourcing equipment (PSE)

A +48V is supplied to the PSE from the wall and around 13W of power is to be delivered to the PD. A DC-DC converter is to be used to lower the +48V that the PSE gets in order to make it suitable for the other Powered device electronics equipments. The PSE then injects the converted DC voltage into the twisted pairs of the CAT5 cable by either using the process for midspan or endpoint. An endpoint PSE is one that contains both the data communication capabilities and the power-delivery mechanism. A midspan only contains the power delivery mechanism and is inserted in the network between the legacy, non-PoE-capable Ethernet switch and the PD. The midspan provides the ability to add PoE to

the network without replacing the existing infrastructure. The PSE has smart sensors that can check for the existing spec requirements in order not to damage the existing Ethernet equipments. It has a “discovery mode” that will check for the Ethernet CAT5 cable if it complies with the PoE specifications. This check is done by applying a small current that will not damage the other electronics that are integrated on the system and check for a 25kΩ resistance in the remote device. After it verifies the existence of the 25kΩ resistance then,, it will use the whole +48V while still maintaining the limited-current in order to make sure that it does not damage the CAT5 cable and other connected electronics. Figure 3 shows a typical connection for the PSE, Note how power is distributed on the RJ45 cables. The PSE uses the formula below to determine how much power to supply to the access points.

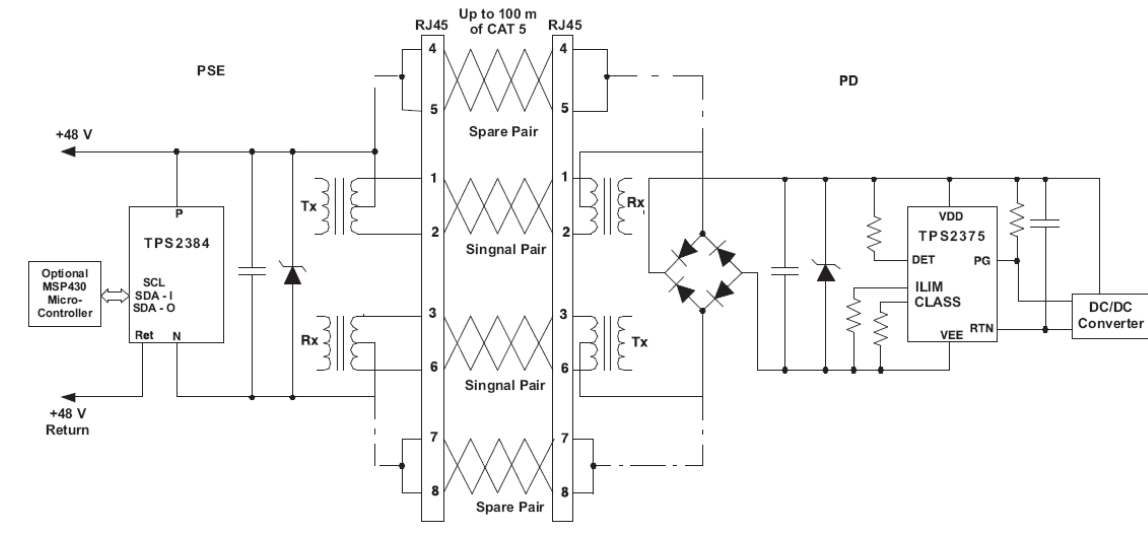


Figure 3 – PSE connections of a typical application

$$\text{PowerPSE} = \frac{V^2 - \sqrt{V^4 - (4 \cdot R \cdot V^2 \cdot \text{PowerPD})}}{2 \cdot R}$$

Figure 4: Power Calculation formula for PSE

V = voltage, R = resistance of cable (Ohms), PowerPD = power Consumed by the access point (W)

The worst case for this equation is when the voltage is 40V. The resistance of the CAT 5 cabling is in Ohms which will be less than 25k Ω and there will be no detection of PD. So, good practice is to check the power specification of the PSE (switch, mid-span power, or injector) and confirm that it can support all the access points that are being deployed.

Sometimes when the PSE cannot supply enough power to the PD the access point radios maybe disabled since the PD could be drawing more power than the PSE can supply.

This imbalance trips the breaker causing it to reset as the breaker cools down and causes the access point to appear to be cycling or rebooting.

C. Powered Device (PD)

The Powered device is system that detects the PSE and receives the power from the PSE. It steps down the +48V that the PSE supplies by using DC-DC conversion so the smaller PoE electronics can be powered. The PD has all the necessary circuitry needed to be detected by the PSE which makes the PSE and PD communications easy. The IEEE 802.3af specification allows the option for the PD to provide classifications of how much power is needed by the PD module. Figure 5 shows a sample of a PD device connections.

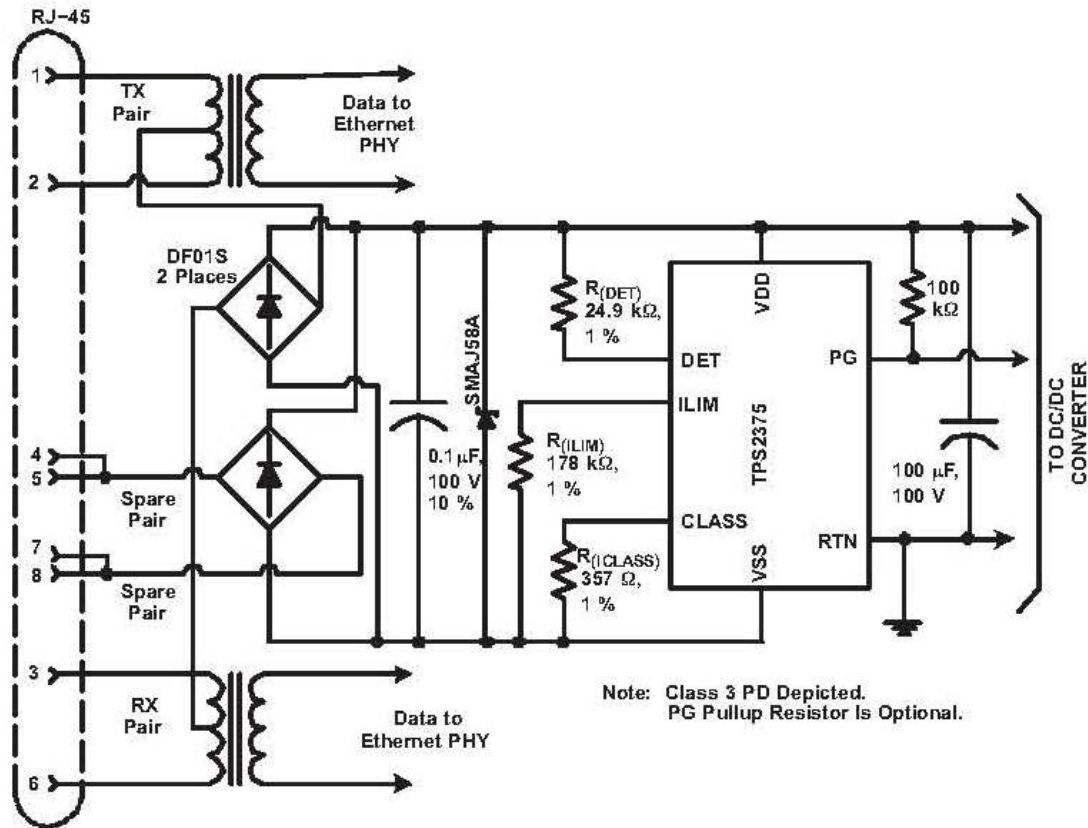


Figure 5 – sample of Powered Device connections

Conclusion

Power over Ethernet is about to change in ways that most of us cannot imagine. The increase in the power available to a PD from 12.95 Watts to 59 Watts will transform the RJ45 connector in the first universal power plug. Although it has many limitations, PoE designers are constantly reviewing the standards for the PSE and PD so PoE technology can be applied to high power devices in everyday use.

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