Power over Ethernet (PoE) Power Supply Process Across IEEE 802.3af/at/bt Protocol

Introduction

Although there are various power supply types, this article will focus on Power over Ethernet (PoE) power supplies. In particular, PoE power supplies where the power sourcing equipment (PSE) supplies power to the powered device (PD) terminal equipment through the network cable. Figure 1 shows common PoE power supply equipment, including the PoE switch as well as power-receiving equipment (e.g. wireless AP, IP cameras, and IP phones).

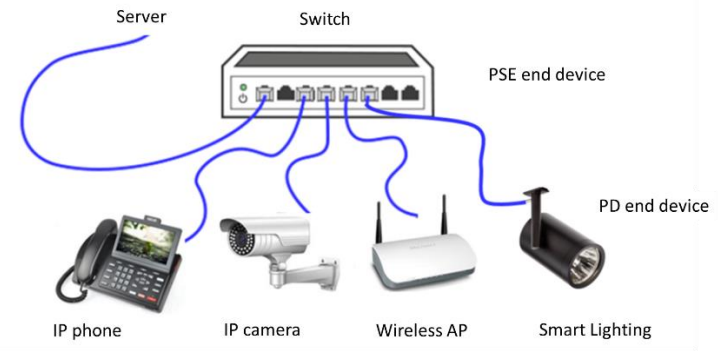

Figure 1: Common PoE Power Supply Equipment

More and more applications utilize PoE power supplies because they offer three key advantages:

1. Simplified layout and reduced cost
2. Multi-device remote management
3. Safe and reliable

Network Port's Power Supply Mode Under Different Power Levels

Figure 2 shows the cable structure inside the network port.

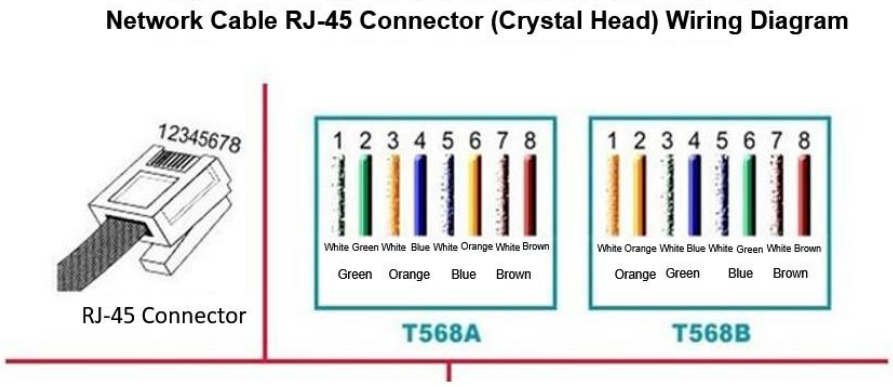

Figure 2: Cable Structure Inside Network Port

There are four twisted wire pairs within the network cable: wires 1 and 2 — as well as 3 and 6 — transmit data signals, while wires 4 and 5 — as well as 7 and 8 — are idle.

Figure 3 shows the schematic of the PSE and PD connection.

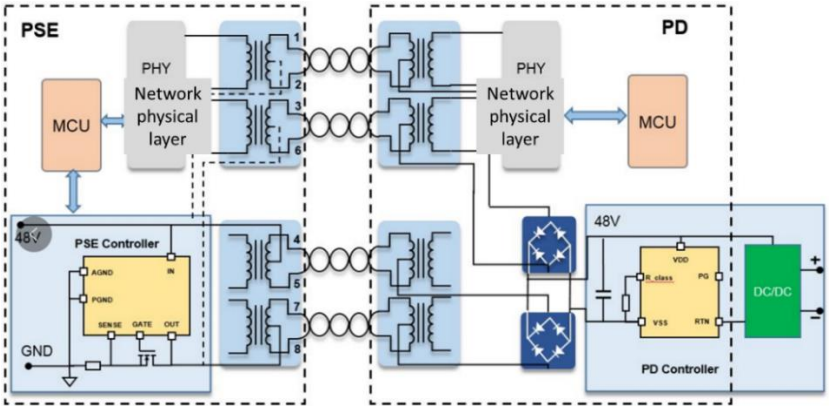

Figure 3: PSE and PD Network Schematic

IEEE802.3af/IEEE802.3at

For IEEE802.3af and IEEE802.3at, there are two power supply options using two 2-wire pairs, described below:

- Alternative A (mid-span): Use signal lines 1, 2, 3, and 6 to simultaneously transmit data signals and 48V power
- Alternative B (end-span): Use the idle lines 4, 5, 7, and 8 to transmit the 48V power supply

IEEE 802.3bt

For the 2-wire or 4-wire pair power supply, any power supply exceeding 30W is powered by a 4-wire pair.

Standard PoE Power Supply Process

There are three stages before powering a standard PoE device: detection, classification, and start-up. Each of these stages are discussed in greater detail below.

Stage 1: Detection

The first stage detects whether the device being powered is standard PoE power supply equipment. The detection stage ensures that the 48V voltage is not directly applied to non-PD equipment, which ensures that the device safely receives power.

The PSE provides two sets of 2.7V to 10.1V voltages, and uses the measured current to determine whether the PD's characteristic resistance (R_{DET}) is within the scope of the protocol. If R_{DET} is within the scope of the protocol standard, the device is considered able to support the PoE power supply and can enter the next stage (see Figure 4).

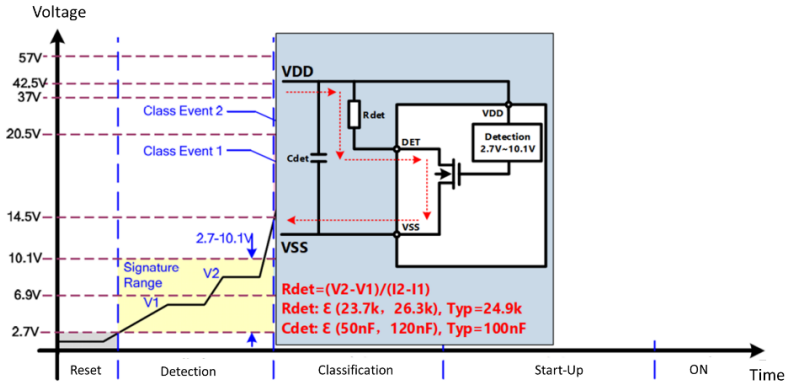

Figure 4: Detection of Characteristic Resistance

Stage 2: Classification

The second stage determines the PD equipment's power level. The PSE provides a 14.5V to 20.5V voltage to the PD terminal and uses the detected current to classify the PD equipment's power level. Class 0, Class 1, Class 2, and Class 3 only detect the power level for a set of voltages before initiating the start-up process. Class 4 determines the power level for two sets of voltages before initiating the subsequent power supply process.

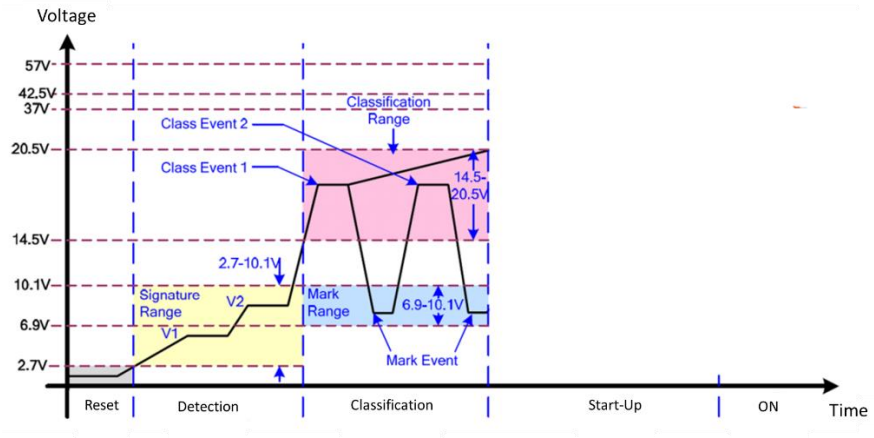

Figure 5: Classification Process of PD Equipment's Power Level

Stage 3: Start-Up

The third stage charges the capacitance between VDD and RTN. Since the protocol limits the maximum allowable inrush current during start-up, the MOSFET (pass switch) current between RTN and VSS is limited to achieve soft start. The pass switch from RTN to VSS remains fully open for the normal PoE power supply until the capacitance between VDD and RTN is charged to the target value.

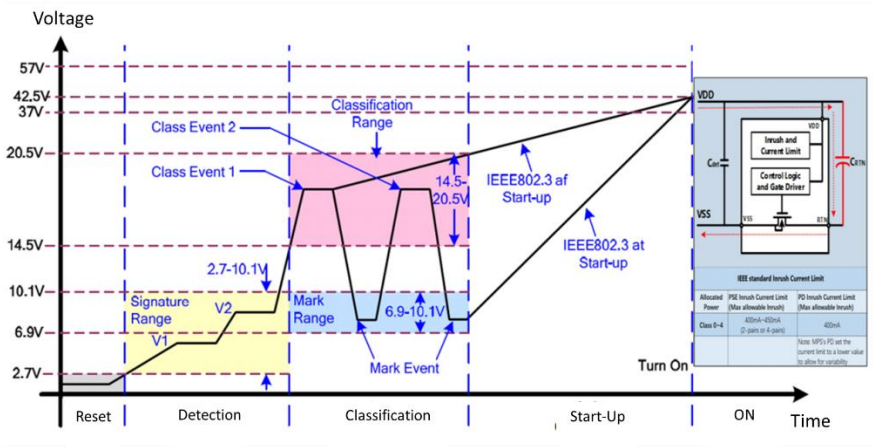

Figure 6: PoE Start-Up

Comparison of IEEE 802.3 af/at/bt Handshake Protocol

The classification stage is the main difference between the bt and at protocols. Since the bt protocol includes 8 class levels, the classification stage performs multiple classification processes to determine the PD terminal's power level.

Figure 7 shows a circuit diagram where the bt protocol has two class resistors, while the af/at protocol has only one class resistor. The other stages are similar.

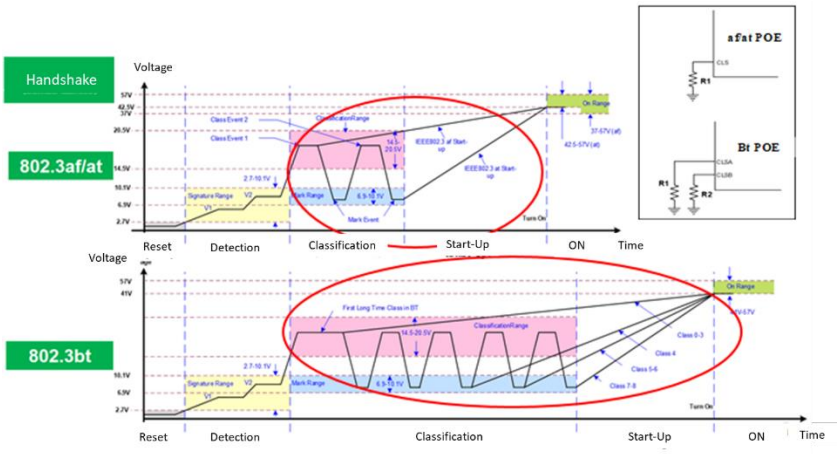

Figure 7: Comparison of af/at/bt Protocols

MPS PoE PD Interfaces for IEEE 802.3 af/at/bt

MPS offers a wide selection of PoE PD interfaces that support the IEEE 802.3 af/at/bt protocols, including the MP8007, MP8017, MP8009, and MP8030.

The MP8007 and MP8017 are IEEE 802.3 af-compliant PoE PDs designed for 13W applications, such as security cameras and internet-of-things (IoT) devices. The MP8007 supports a DC/DC converter that uses fixed peak current and variable frequency discontinuous conduction mode (DCM) to regulate constant output voltage. The MP8017 is specifically designed for active-clamp primary-side regulation (PSR) and secondary-side regulation (SSR) in a flyback topology.

The MP8009 is a IEEE 802.3af/at-compliant PoE PD that is well-suited for cost-effective, space-constrained isolated solutions. It provides PSR for flyback applications and highly efficient SSR for active-clamp forward applications. It is recommended for WLAN access points, security cameras, and video telephones.

The MP8030 is compliant with IEEE 802.3af/at/bt specifications. Its high power level means it can be used in >51W designs. Like the MP8009, the MP8030 features PSR for flyback applications and SSR for active-clamp forward applications, but its higher power levels means it is also recommended for pico base stations.

Figure 8 compares these PoE PD interfaces across the different protocols and standard applications.

Figure 8: MPS's PoE PDs

Conclusion

This article reviewed PoE power supplies and the cable structure inside the network port, then described the standard PoE power supply process. MPS offers a variety of PoE PD interfaces for the IEEE 802.3 af/at/bt protocol, including the MP8007, MP8017, MP8009, and MP8030.