What is The PoE Powering Process?

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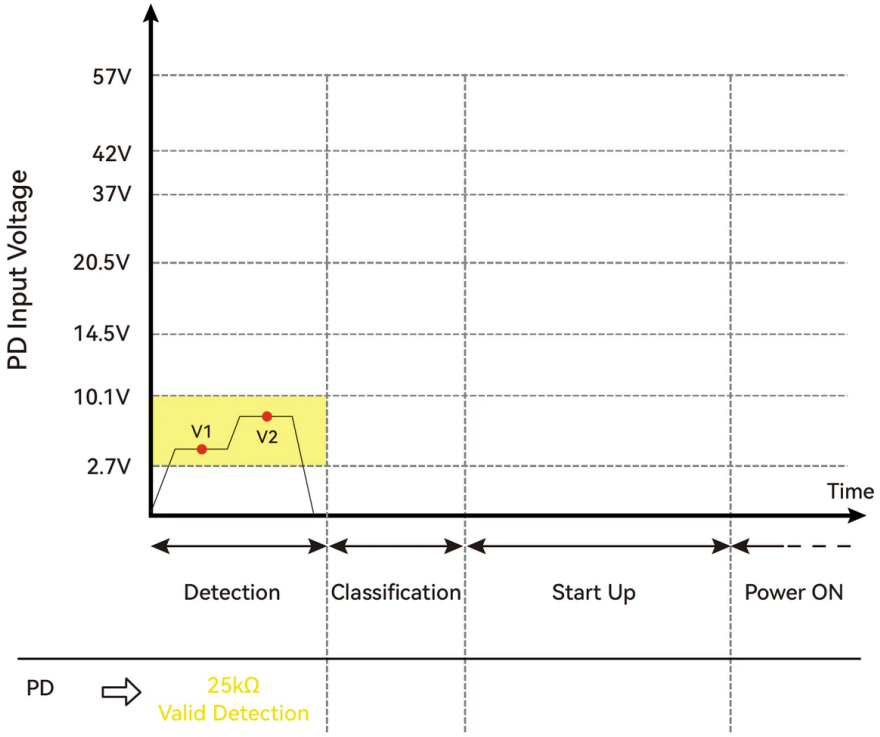
Overview

According to the IEEE 802.3af/at/bt standards, the PoE power on process between standard PSE (Standard PoE Switch or Active PoE Switch) and PD (Powered Device) involves a four-step **negotiation**. The first step is **detection** of standard PD. PSE will not provide power to non-IEEE802.3af/at/bt devices, it is a necessary step to avoid damaging non-PoE devices. Then PSE will try to recognize the Power Class Type of PD , and allocate the appropriate amount of power. After PoE power classification, the PSE begins delivering power with an initial low voltage. The last step is to Power On at appropriate power.

This four-step "handshake" ensures that PDs receive the correct amount of power without damaging or overloading the PDs. This entire process is automatically conducted by the PoE chipset hardware, without human intervention, and the whole process typically completes in just a few seconds.

Step 1： Detection



PSE checks whether the connected device is an IEEE802.3af/at/bt compliant PDs. For non-standard PDs, PSE will not provide power, which prevents damaging a non-PoE device.

During detection, the PSE supplies a low voltage power (2.7V to 10.1V) and measures the current to determine if the PD has a PoE characteristic resistance (R(DET)) within the specified range of the PoE standard. If the measured resistance is within the acceptable limits (typically around 25kΩ for IEEE 802.3af), the device is confirmed as PoE-compatible and can move on to the next step of power negotiation.

2.7V/25K=0.1mA 10.1/25K=0.4mA

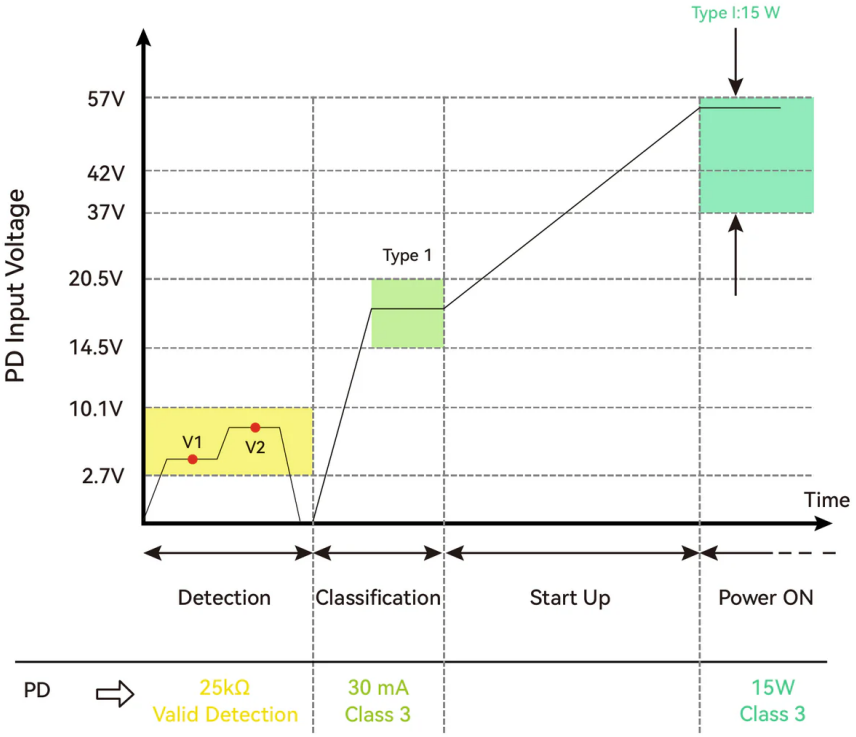
Step 2：Classification

After detecting a valid PD, the PSE and the PD engage in a simulated handshake called **"classification"**. During this process, the PD requests a specific power **class**, and the PSE responds by granting the requested class.

In PoE, the **“type”** refers to how the handshake is conducted, while the **“class”** indicates the amount of power the PSE is supplying and the maximum power the PD can draw. Since PoE follows the Ethernet standard, which allows cable lengths up to 100 meters, some power loss occurs over the cable.
Below is PoE Types and Power Levels reference table.

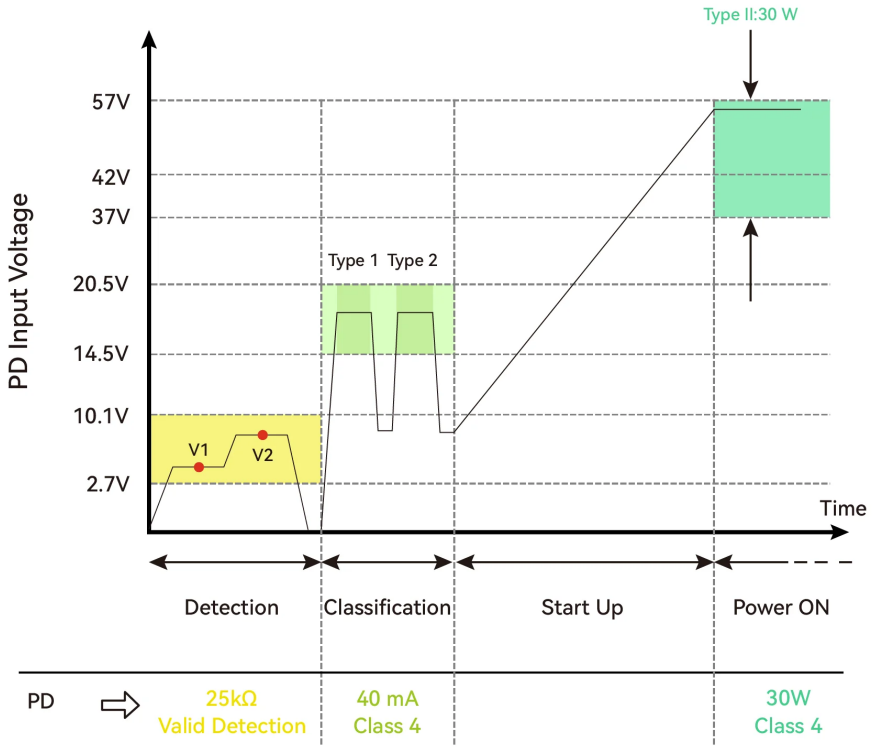
	Type 1 802.3af			Type 2 802.3at	Type 3 802.3bt		Type 4 802.3bt	
Power Class	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
Power from PSE	4 W	7 W	15.4 W	30 W	45 W	60 W	75 W	90 W
Power delivered to PD	3.84 W	6.49 W	13 W	25.5 W	40 W	51 W	62 W	71.3 W

PoE Classification for Type 1 PD device



The PSE sends a voltage between 15.5V and 20.5V and measures the current drawn by the PD. Based on this, the PSE assigns a power class to the PD. The PD receives between 14.5V and 20.5V, accounting for cable losses.

PoE Classification for Type 2 PD device



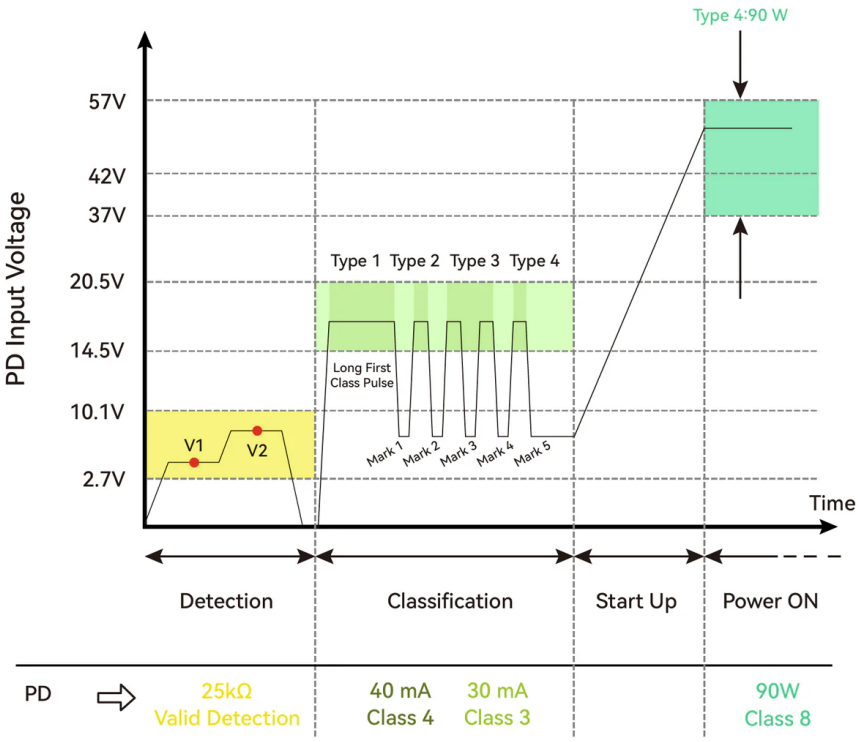
Type 2 adds a second classification pulse based on Type 1. The PD sends a higher current (40mA) to the Class 4 signal. A Type 1 PSE treats this as a Class 3 request, while a Type 2 PSE responds by reducing the voltage and sending two pulses to assign Class 4 power.

PoE Classification for Type 3 and Type 4 PD device

These types introduce additional classification pulses to allow for higher power delivery.

- **Type 3** uses 4 classification pulses, which enable the PSE to assign a power class of up to 60W.
- **Type 4** uses 5 classification pulses and supports the highest power delivery, allowing for up to 100W.

The number of pulses in these types helps the PSE determine the appropriate power level to grant, based on the capabilities of both the PSE and the PD.



When a Powered Device (PD) requests Type 3 or Type 4 power, it initially draws 40mA (classification signature 4 current) for the first two pulses. After that, it lowers its current draw to the classification signature 3, 2, 1, or 0 level for the subsequent pulses. This lower current tells the Power Sourcing Equipment (PSE) how much power the PD is requesting. In fact, after the third pulse, the PSE has already determined the amount of power the PD needs, and the remaining pulses simply inform the PD of how much power is being granted by the PSE.

If the PSE generates four classification pulses, the PD is granted Type 3 power. Five classification pulses signal that Type 4 power is being granted. In other words, if the PD requests class 7 or 8 power and the PSE grants Type 4, the PD will receive the requested power. Similarly, if the PD requests class 5 or 6 power and the PSE grants Type 3, the PD will also receive the power it requested.

Power Demotion and Underpower

Power Demotion is a mechanism in the POE power supply protocol whereby when a powered device (PD) requests more power than the maximum power that the power supplying equipment (PSE) is able to provide, the PSE automatically reduces the amount of power it provides to avoid overloading. This process occurs during the power negotiation phase, when the PD reports the power it requires, the PSE adjusts its output according to its own power capability.

For example, if a PD requests Class 8 power but the PSE only supports Class 6, the PSE will downgrade the PD to Type 3 and supply it with Class 6 power.

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Power delivered to PD	3.84 W	6.49 W	13 W	25.5 W	40 W	51 W	62 W	71.3 W

However, when the PD's power request is reduced, it may be in an underpowered state, which may then affect the normal operation of the PD.

Step 3 Start-up

After the classification phase is completed, the PSE begins supplying power to the PD at a low voltage. This initial power-up phase lasts for a configurable startup time, typically less than 15μs, during which the voltage gradually increases until it reaches the required 48V DC.

Step 4 Power ON

Once the voltage reaches 48V DC, the PSE enters a stabilized phase. At this point, the PoE power supply is fully operational and can reliably and continuously provide a stable 48V DC output to the PD.

Benefits of 4-stage PoE power up process

The process ensures PD devices receive power in a controlled and safe manner, preventing potential damage.

For example, if you connect an IEEE 802.3af 15W device to an IEEE 802.3bt 90W PoE port, the PSE (e.g. PoE switch) will automatically adjust and negotiate the power supply to operate in 802.3af mode. This means that even though the port is capable of supplying higher power, the PD will only receive the appropriate power for its needs — in this case, 15W — without the risk of overloading or damaging the device.

If a non-PoE device is connected to a standard PoE PSE, the 4-Step process ensures that the PSE automatically detects the device and operates in non-PoE mode. This means you can safely connect both PoE and non-PoE devices to the PoE ports without the risk of damage.

However, the situation can be quite different with Passive PoE switches (non-standard PSE). Passive PoE switches skip the detection and classification process, which means a PD could receive the full, unregulated power from the port, potentially causing damage. This makes Passive PoE switches much riskier compared to IEEE 802.3af/at/bt compliant PoE switches.

In addition, some budget PoE switches use software-based simulations for the PoE power-up process instead of dedicated hardware chipsets. While these software-driven solutions can handle basic tasks like detection and classification, they often struggle with compatibility and stability. As a result, devices may not be consistently recognized, and the power supply can be less reliable and more prone to fluctuations compared to switches that use standard hardware-based PoE chipsets.

Limitations

For a non-standard PD, it is highly recommended to use a passive PoE switch, as standard PoE switches will not provide power to non-standard PDs. Standard PoE switches require PDs to follow the IEEE 802.3af/at/bt protocols for power detection and classification, and non-standard PDs may not be recognized, resulting in no power being supplied.

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