Introduction

Since the first release of IEEE802.3 specification in 2003, the relevance and importance of PoE as a technology has grown significantly, with more and more end applications and connected devices adopting PoE. Despite this, however, some applications have been restricted by the power available. The first version of the specification, called IEEE802.3af, allowed up to 12.95W at the Powered Device (PD) and the second, released in 2009 and called IEEE802.3at, allowed up to 25.5W. This allowed for 100m of cable between the Power Sourcing equipment (PSE) and the PD. The power could be supplied on the spare pair or the data pair which was referred to as Mode A or B.

Standard	Min power available from PSE (W)	Power at PD	Current (Imax) mA	Cable type	Mode
IEEE802.3af	15.4	12.95	350	Cat 3 Or 5	A or B
IEEE802.3at	30	25.5	600	Cat 5	A or B

It is important to note that the standards are backwards compatible, i.e. an IEEE802.3af PD can be used with an IEEE802.3at PSE and an IEEE802.3at PD can be used with an IEEE802.3af PSE but with the power limited by what the PSE can supply. PoE can also be defined by the Type where a Type 1 is an IEEE802.3af device and Type 2 is IEEE802.3at device. Within each Type there are various classes that the PD presents to the PSE which defines the minimum power delivered to the PD and would allow the PSE to manage its power available, as shown in the table below.

PoE Type	Class	Current (mA)	PD per pair (W)	PSE Power Per Pair (W)
1	0	0-4	Up to 12.94	15.4
1	1	9-12	Up to 3.84	4
1	2	17-20	Up to 6.49	7
1	3	26-30	Up to 12.95	15.4
2	4	36-44	Up to 25.5	30

Then, in September 2018, the IEEE802.3bt standard, also known as PoE++ or Hi-PoE, was officially launched after being ratified by the IEEE. This standard enables the delivery of higher Power over Ethernet cables, opening up a whole new range of end applications to be powered by PoE.

What are the benefits of IEEE802.3bt ?

- **More Power**

  This new standard allows the transfer of at least 71W to the PD with the maximum cable length. This extra power is delivered across all four pairs which minimizes the losses in the cable. The extra power available also opens a whole new range of end applications to use PoE at higher power such as Smart LED Lighting, Cameras with AI, Sound Systems and Digital Displays. However with higher power and faster data speeds, it is important to remember that the cable quality and electronic design

of the end application are very important factors when trying to achieve maximum power and error free data transmission.

- **Connected Devices**

  The new standard allows for this higher total power to be split across two separate PD devices from a single IEEE802.3bt PSE output. The PSE will check both pair sets to see if it's connected to single or dual signature PD. A single signature PD connection will operate as you would expect, monitoring the overall power consumption and imbalance between pair sets. A dual signature connection allows the designer to have two individual PD devices within their system, monitored by a single IEEE802.3bt PSE, thus giving them the opportunity for 2 independent rails within their system whilst only using a single Cat5e cable. The independent monitoring on each pair set also allows for power saving in the end users device where one of the rails may choose to go into standby mode whilst the other rail may need to continue to operate at full power.

- **New Classes and Types**

  The increase of power is not implemented in one step; the standard brings 2 new PoE types and 4 new classes for effective power management as detailed in the table below.

PoE Type	Class	PD Requested Power (W)	PSE Minimum Output Power (W)
3	4	25.5W	30W
3	5	40W	45W
3	6	51W	60W
4	7	62W	75W
4	8	71.3W	90W

- **Lower Standby Power**

  After powering the port, the PSE monitors that the current draw is above a set limit, known as the Maintain Power Signature (MPS), to detect if the PD has been disconnected. The IEEE802.3bt standard is more energy conscious and has improved its MPS to allow a lower standby power which is ideal to meet the needs of many of today's applications.

  In order to keep the port active, an IEEE802.3af or IEEE802.3at PD must draw approximately 10mA or a duty cycle of 30% from the PSE. With most systems, we would expect to see about 150mW of loss per port, so if we had multiple lighting systems on multiple ports, for example 10, this would equate to 1.5W of lost power when unit is in standby. The new IEEE802.3bt standard has changed this and the PSE will now only require a very conservative duty cycle of ~2%. This reduces the amount of power lost per port by a factor of 15 and is particularly beneficial where devices can be put into sleep mode i.e. PoE lighting systems or security systems that may only be needed to be active during certain times of the day.

- **Automatic Classification**

  Auto classification is a new system in which the PSE can automatically detect the actual maximum power drawn by the PD. The PSE will measure the maximum power drawn by the PD over a set amount of time and then assign this power to that port plus some margin.

- **Backwards Compatibility**

  As with IEEE802.3at, the IEEE802.3bt standard will be fully backwards compatible with the previous standards of PoE. This system, in theory, should work automatically with any PD (as long as the PSE has the means to supply the required power). In the scenario where an IEEE802.3bt PD is plugged into a lower standard PSE, the device may turn on if the power consumed is within the PSE power limitations but will fail to start or shutdown if its power is much greater than the PSE's power capability.

- **End Applications**

  Due to the increase in power the IEEE802.3bt standard opens a whole new range of possibilities as far as integrating PoE into end applications is concerned. Some examples include:

IEEE802.3bt Example Applications

- LED Lighting - Automated Teller Machine (ATM) – Edge Computing – Access Control - IoT
- LED Displays - POS Terminals - Smart IP Cameras – Smart Speaker Systems – Digital Signage
- PTZ Cameras – Access points - Automation Control Systems – Industrial Sensors - IIoT

Considerations – When using higher power applications

As with every advanced electronic product there are important considerations to be made at each stage of the design cycle. As the use of the new standard increases and we start to see an influx of new designs, one important factor to consider is the thermal requirements of the PD. In this new age of technology, size is everything. Products and devices are getting smaller and slimmer, and this will have an impact on the thermal characteristics of the application, thus it is important to monitor and apply adequate thermal management practices. With the amount of power almost tripling, internal temperatures of devices will rise much quicker. PD placement within the enclosure also becomes a vital factor in being able to operate the device at its maximum operating power, such that maximum airflow and heatsinking can be achieved.

Summary

In conclusion, the latest IEEE802.3bt standard will bring a whole new avenue of opportunity to the world of PoE. Introducing new ways to improve LED lighting, IoT, Smart and many other connected devices. We will see new and more advanced security systems taking advantage of the new power limit, and as the world continues to evolve and we develop more energy efficient devices, the list of applications for PoE will only increase. However, designers will also need to ensure that the implementation of this new standard is managed carefully to ensure that maximum performance is achieved.

Silvertel's long history of PoE design and engineering support, and wide range of small form factor, High Efficiency (94%), and Surface-Mount IEEE802.3bt PoE modules will make the transition into the new standard easier than ever. With our IEEE compliant modules, implementation of 4 Pair PoE technology into your device will be seamless, simple and cost effective, providing a complete solution that requires only minimal external components.