

Module 5 - Remote Power, PoE

≡ Internet of Things (IoT)

≡ PoE - How It Works

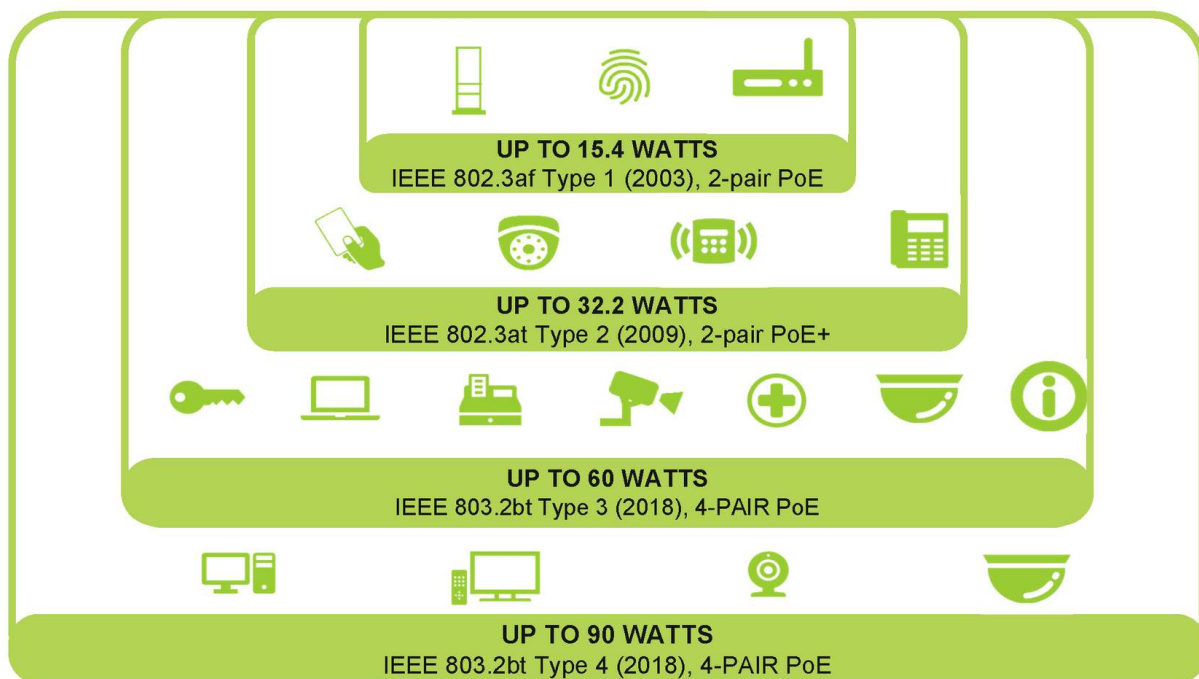
≡ Impact of PoE

≡ Mitigation of Thermal Impact

≡ Single Pair Ethernet

Internet of Things (IoT)

To get started, take a look at the below diagram, which provides a quick view of some of the devices we have become accustomed to seeing as remotely powered, along with a number of devices we expect to see in the future:



With the publication of IEEE 802.3bt in 2018, we now have 4 Pair PoE (4PPoE) with the potential of up to 90 watts powering, potentially bringing a rapid increase in the devices connected to the structured cabling. It will also bring certain challenges that have to be dealt with by the cabling installer.

One key factor will be the thermal impact of 90 watts 4PPoE. Ways of mitigating this factor will be covered later in this module.

Type 1

- IEEE 802.11b/g/n Wireless
- Biometric Readers
- Simple Thin Client Devices
- IP Cameras
- IP Phones

Type 2

- Internal PTZ IP Cameras
- Alarm systems
- Video IP Phones
- Card Readers

We have been connecting these devices to structured cabling and powering them with PoE since early in the 21st century. Some installs are purely dedicated to non-Voice and Data applications.

Type 3

- Access Control
- Tablets
- Point of Sales Readers
- Nurse Call
- External PTZ IP Cameras
- IEEE 802.11ac Wireless Access Points
- Information Kiosk

Type 4

- OLED Displays
- Laptop Charging
- Desktop computing (low power devices)
- IEEE 802.11ax Wireless Access Points
- IP Televisions
- Intelligent Lighting

The scope for the future with the new higher power provided by Type 3 and Type 4, 4PPoE will bring in devices that we never thought possible, including large displays and digital signage, even laptop powering and charging without the need for a local power socket and power supply.

This has led to forecasts of growth in PoE-enabled devices of 20% CAGR (compound annual growth rate) over the years 2020 to 2025.

Excel Encyclopaedia

At this point in the course, we recommend that you read through the Smart Building Integration chapter of the Excel Encyclopaedia. Just click this button to access the document.

[VIEW NOW](#)

Dielectric Path

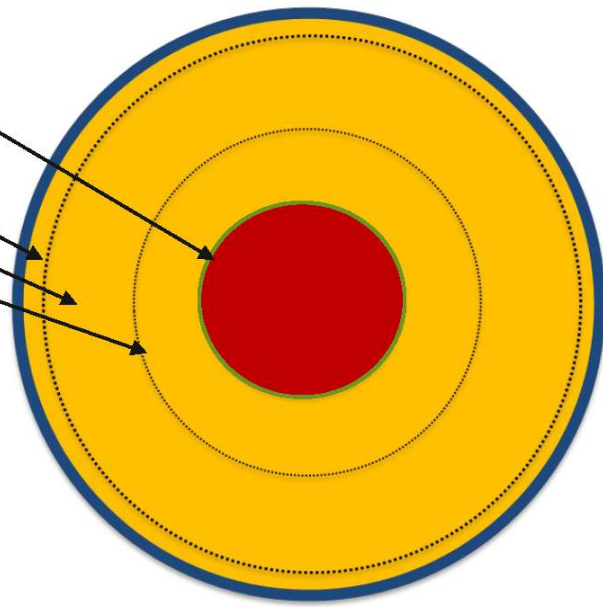
As a reminder, the power is delivered using the centre core of the conductors. The amount used for 802.3bt is no different to previous versions but we are now using four pairs instead of two.

IEEE 802.3bt 4PPoE

100 MHz Class D

250 MHz Class E

500 MHz Class Ea



PoE - How It Works

Power over Ethernet is an application in the same way as 10Base-T, designed to operate over standards-compliant Structured Cabling.

Power Sourcing Equipment
(**PSE**)

- Switches
- Source of the power
- 'Slave' in regards to PoE

Powered Device
(**PD**)

- End device
- IP Phone
- IP Camera

- 'Master' in regards to PoE

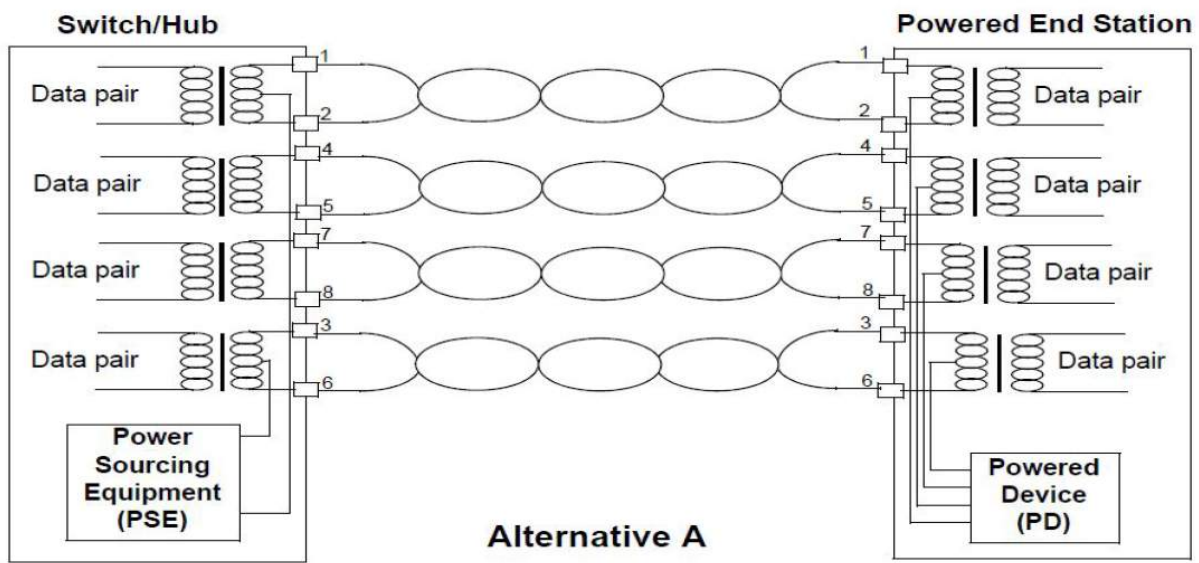
The Powered Device (PD) is effectively in control of the relationship, after a handshake it instructs the Power Sourcing Equipment (PSE) over what two pairs it requires the power in the case of Type1 & 2. As it is based on 57V d.c. it is outside of the ELV (Extra Low Voltage) directive which is based on 75V a.c. 100V d.c..

Type	Standards	Max. Current	No. of Energized Pairs	Power at Source	Power at Device	Max. Data Rate	Standard Ratified
PoE	IEEE 802.3af (802.3at Type 1)	350 mA	2	15.4 W	13 W	1000BASE-T	2003
PoE+	802.3at Type 2	600 mA	2	30 W	25.5 W	1000BASE-T	2009

Type	Standards	Max. Current	No. of Energized Pairs	Power at Source	Power at Device	Max. Data Rate	Standard Ratified
PoE++ (4PPoE)	IEEE 802.3bt Type 3 IEEE 802.3bt Type 4	600 mA 960 mA	4	60 W 90 W	51 W 71.3 W	10GBASE-T	Published 09/2018
No IEEE Standard	Cisco UPOE HDBaseT	600 mA >1000 mA	4	60 W >100 W	51 W >100 W	Varies	No official ratification

 The difference between the Power at Source and that at the Device is based on the resistance of the copper conductors in the cable, and has been calculated based upon the resistance of a 100 metre channel as outlined in the standards.

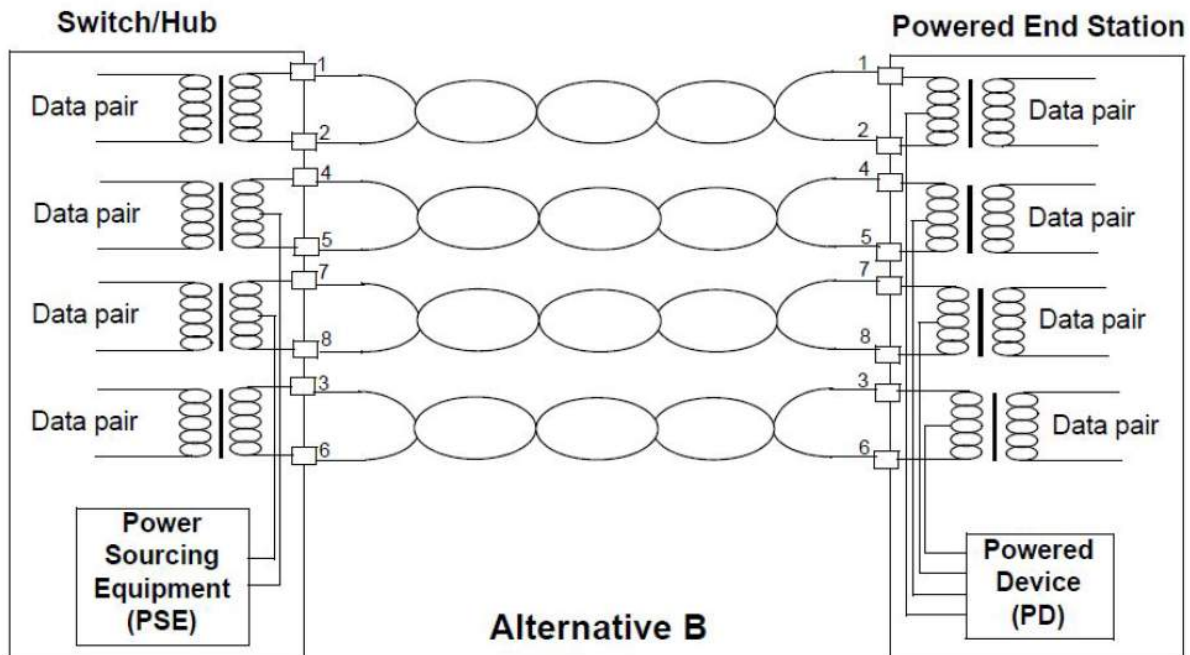
How PoE works: Type 1 and 2



Alternative A

Alternative A

- Alternative A delivers power over 1, 2 & 3, 6
- It is the PD that decides



Alternative B

Alternative B

- Alternative B delivers power over 4, 5 & 7, 8
- It is the PD that decides

i The majority of devices can transmit/receive power on all four pairs however, the original standard only required two pairs given the both the level of power.

How PoE works: Type 3 and 4

- Delivers power over all 4 pairs simultaneously

- There are 9 classes based upon the level of current mA

Class	Usage	Classification Current (mA)	Power Range at PD (W)	Max. Power from PSE (W)
0	Default	0-5	0.44 - 12.94	15.4
1	Optional	8-13	0.44 - 3.84	4
2	Optional	16-21	3.84 - 6.49	7
3	Optional	25-31	6.49 - 12.95	15.4
4	Valid for Type 2 (802.3at) devices, not allowed for 802.3af devices	35-45	12.95 - 25.50	30
5	Valid for Type 3 (802.3bt) devices	36-44 and 1-4	40 (4-pair)	45
6	Valid for Type 3 (802.3bt) devices	36-44 and 9-12	51 (4-pair)	60
7	Valid for Type 4 (802.3bt) devices	36-44 and 17-20	62 (4-pair)	75

Class	Usage	Classification Current (mA)	Power Range at PD (W)	Max. Power from PSE (W)
8	Valid for Type 4 (802.3bt) devices	36-44 and 26-30	71.3 (4-pair)	90

 Some PDs also require a specific Class of Power defined in milliamps (mA), however most switches accommodate for this during the initial 'handshake'.

Impact of PoE

Both ISO and Cenelec have spent time developing testing methods to understand the true impact of PoE:



International
Organization for
Standardization

ISO developed ISO/IEC TR
29125:2010



Cenelec produced TR EN
50174-99-1



Excel invested in formal research at De Montfort University in Leicester to understand the true impact of PoE. The research was carried over a number of months and included 7 different categories and constructions of cables. This was done to fully understand the impact and dispel a couple of assumptions that had been put forward in the earlier Technical Report (TR) ISO/IEC 29125.

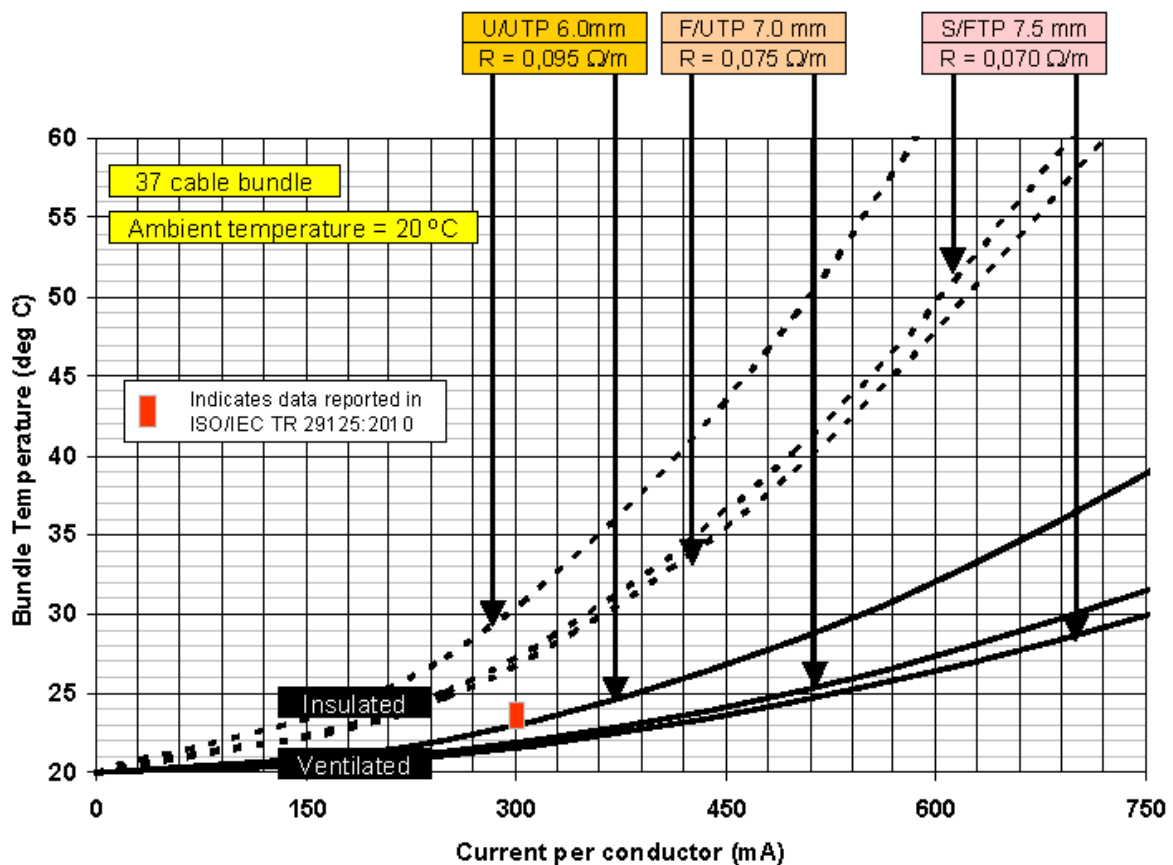
- Testing Methodology, 37 cable bundle ideal in a special rig
- Second set of Test Data for validation, Commscope in Sweden
- The results were almost identical
- They were shared with standards bodies producing the full Technical Report on Mitigation

 TRs are not standards they are technical reports to provide guidance.

The test included both free-space where the test rig was set up in the middle of an air-conditioned room where the temperature was at constant level. The cables were then encased in pipe cladding to simulate the other extreme of being enclosed in unventilated containment. The approach taken in TR EN50174-99-1 found that the variations in performance/temperature increase were even greater than that forecast in ISO/IEC TR29125:2010. The key factors were not the category of cable but **the size of the conductor** and the **outer diameter of the cable** itself. With a minor improvement whether it is screened or not, (the latter always increases the outer diameter anyway). Therefore a 23AWG F/UTP Category 6 cable performs better than a 26AWG U/UTP Category 6A cable.



Credit: TR EN 50174-99-1



Credit: TR EN 50174-99-1

The main impact that was being researched was that PoE creates heat. 4PPoE could double the potential level of heat produced, and heat is a major factor in an increase in attenuation (reduction in signal strength).

The performance criteria for the 100m Channel as outlined in EN 50173-2 is based upon it operating at an ambient temperature of 20 C and for every degree over this level this distance should be reduced.





$$L_{20-40C} = L / (1 + (T - 20) \times 0,004 + (T - 40) \times 0,006)$$

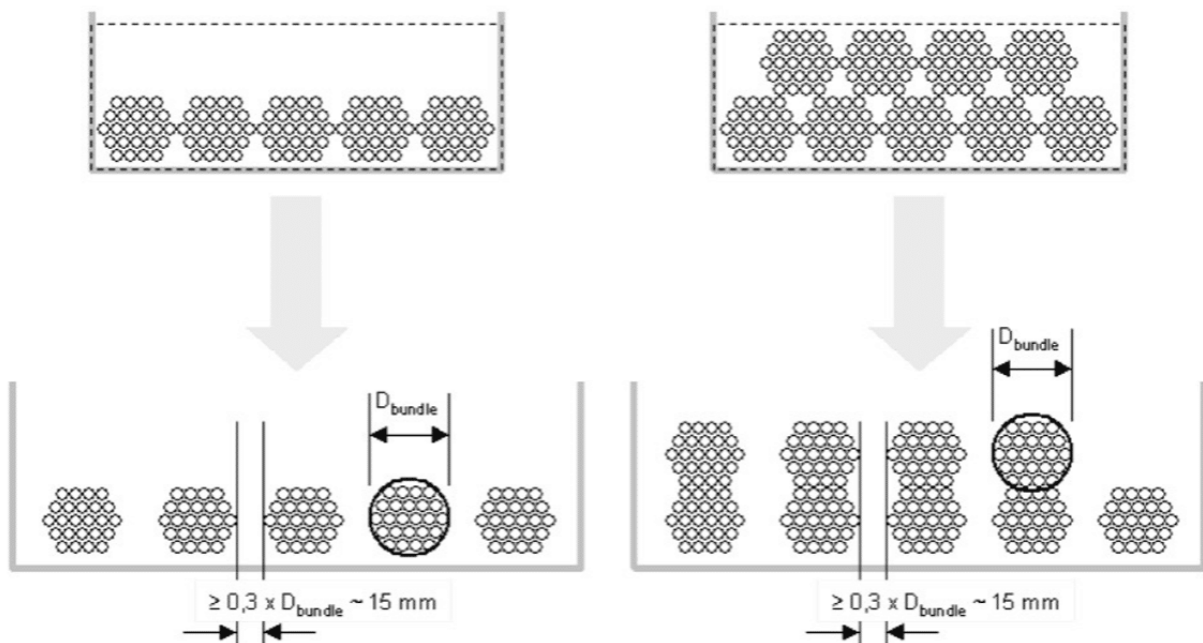
	Total Length of Cords (m)		
	10	15	20
Temperature (°C)	Channel Length (m)		
20	100	98	95
25	98	96	93
30	97	94	91
35	95	92	89
40	93	90	87
45	90	87	85
50	86	84	82
55	83	81	79
60	80	78	76

 The above table shows the results of running the calculation for unscreened cables. Therefore a 100m channel is designed and installed, yet when the temperature reaches 60°C it will not be able to support the applications it is intended for.

Mitigation of Thermal Impact

To reduce the thermal impact BS EN 50174 series has suggested a number of guidelines:

- 1 24 cables, maximum bundle size
- 2 15mm separation of bundles
- 3 Creation of 'chimneys' between bundle stacks
- 4 Potential loose lay of cables



One suggestion was to mix PoE and non-PoE cables within bundles, however this is not always practical as a cabling installation will last 2-3 changes in equipment, meaning that whilst the initial use may not include the requirement for PoE, subsequent changes in use may introduce the requirement.

Single Pair Ethernet

Single Pair Ethernet will bring similar issues however, the likelihood is all cables will be energised also dependent on the size of the conductor they could be carrying up to 52W over a single pair, which effectively twice the amount of 802.3bt, 4PPoE. Therefore the potential for temperature increase could be higher.

- Power delivery is similar, called 'Power over Data Line' PoDL (pronounced poodle)
- Up to 52W over a single pair
- Higher than PoE
- Dependent upon conductor size (18-24AWG)
- Amount of cables could be higher
- Suggested that the same mitigation techniques should be followed