

Power Over Ethernet (PoE) and Similar Technologies:

Navigating Your Way Through The NEC

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What is PoE?

“Definition”

Power over Ethernet (PoE) describes any of several standardized or proprietary Ethernet systems which carry electrical power along with data on Cat 3 or higher type cable. This allows a single 8 conductor cable to provide both data connection and electrical power to devices such as IP Phones, IP Cameras, IP monitoring equipment, and wireless access points. PoE allows data communications up to 100M (≈ 330 feet). Power may be carried on the same conductors as the data, or it may be carried on dedicated conductors in the same cable. The system or network circuit consists of a PSE (Power Source Equipment) and a PD (Powered Equipment)

What is PoE?

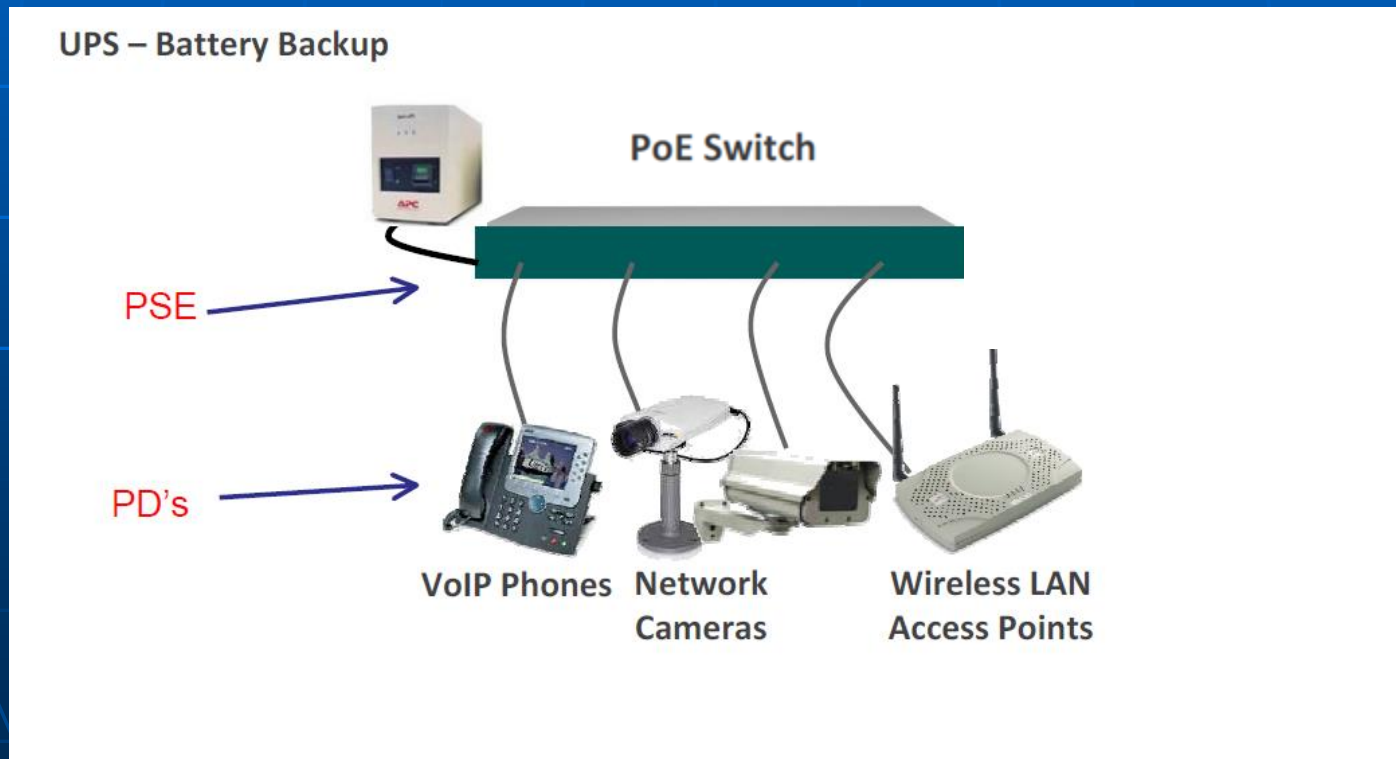
“Characteristics of PoE”

- Uses 2 Pairs for power (10/100 baseT, GigE)
- New “Proprietary System” might supply power on 4 pairs
- Voltage limits are always “supposed to be under 60 Vdc (SELV, ES1) in North America
- Current and Power are tightly controlled by standards (IEEE 802.3, NEC, ATIS, and Product Safety Standards)
- Standardized PSE output power levels 15, 30, 60 Watts
- PoE power using all 4 pairs up to 100 Watts (available soon)
- Currents up 1000 mA dc (500 mA per conductor)

What is PoE?

”How is PoE used”

Typical Configurations



What is PoE?

”How is PoE used”

Typical PD's



Voice and Video IP Phones

WiFi Access Points a/b/g/n

Network Security Cameras – Enclosures – Heaters – Pan and Tilt

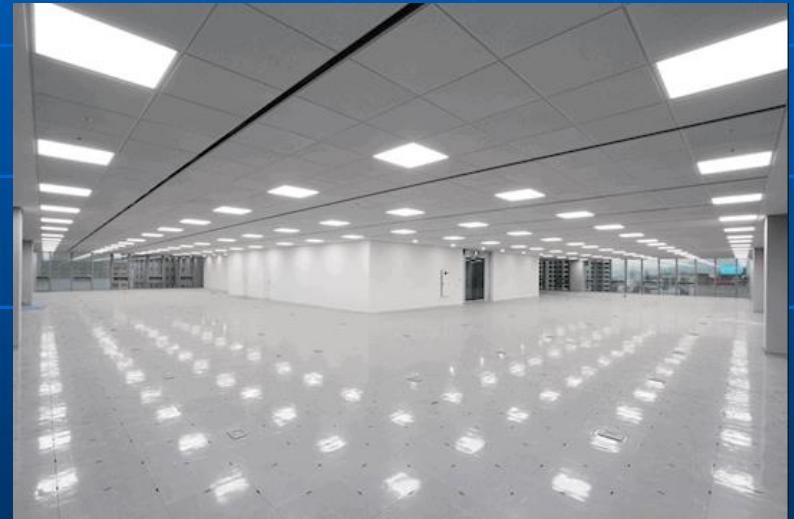
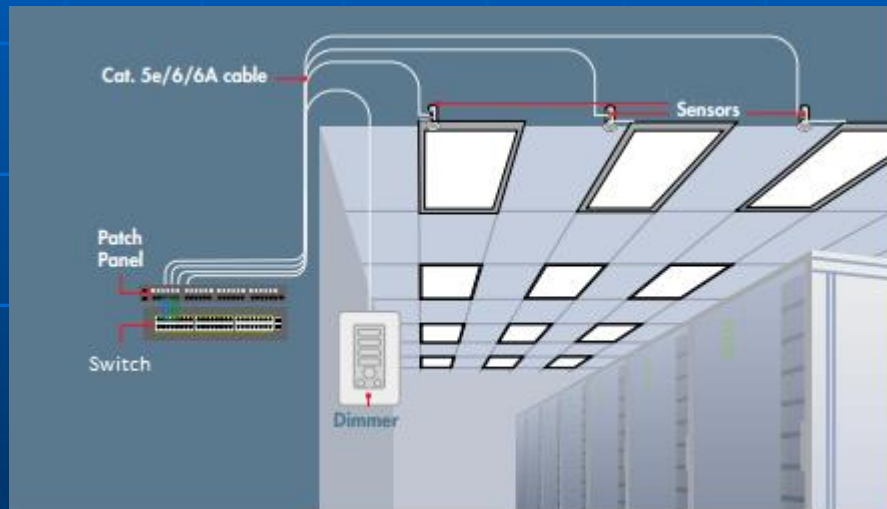
Building / Access Control – Gas and Fire Alarms – Digital Signs

Digital and School Clocks – SIP IP Paging – Door locks - Gateways

What is PoE?

"How is PoE used"

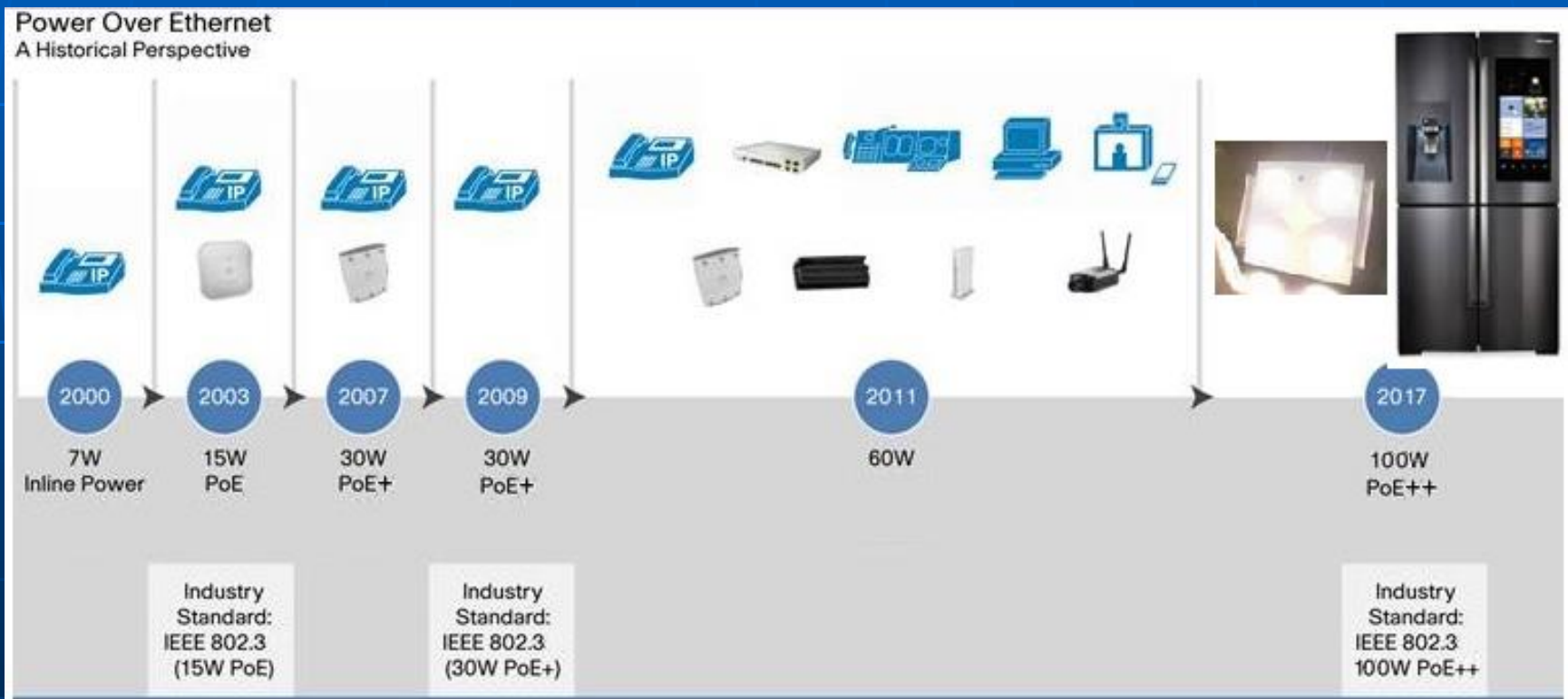
New Types of PD's!!!



What is PoE?

"How is PoE used"

PoE PD Timeline and where PoE / Similar technologies are going



What is PoE?

”How is PoE used”

PoE PD Specifications

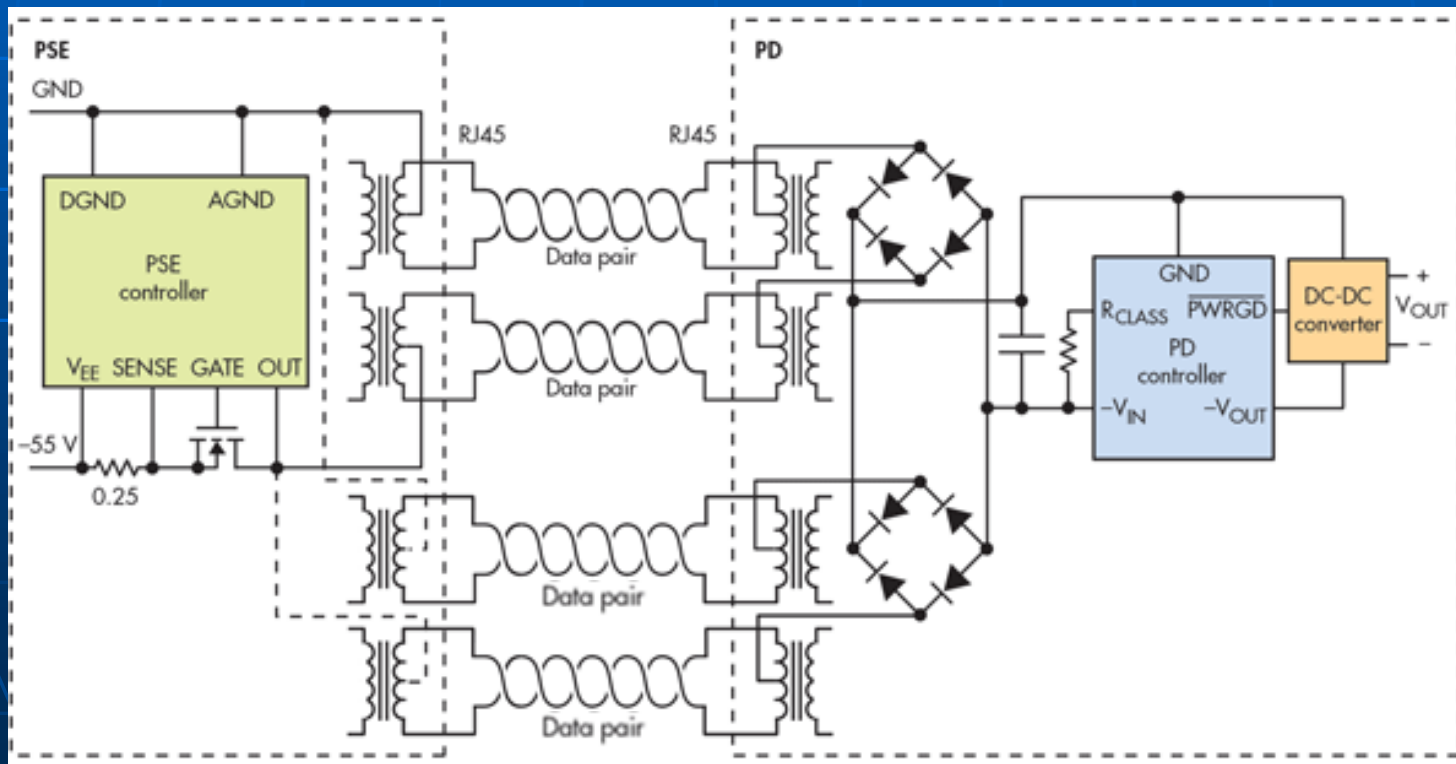
(note divide current in half for per conductor current)

Type	Standards	Max Current	Energized Pairs	Power at Device	Standard Ratified
PoE	IEEE 802.3af (802.3at Type 1)	350 mA	2	12.95W	2003
PoE+	IEEE 803.3at Type 2	600 mA	2	25.5W	2009
PoE++	Proposed IEEE 802.3bt Type 3	600 mA	4	49W	Expected 2016-2017
PoE++	Proposed IEEE 802.3bt Type 4	1000 mA	4	96W	Expected 2016-2017
Non-PoE standard-based	Cisco UPOE	600 mA	4	60W	No official ratification
Non-PoE standard-based	HDBase-T	1000 mA	4	96W	No official ratification

What is PoE?

“Schematics of PoE”

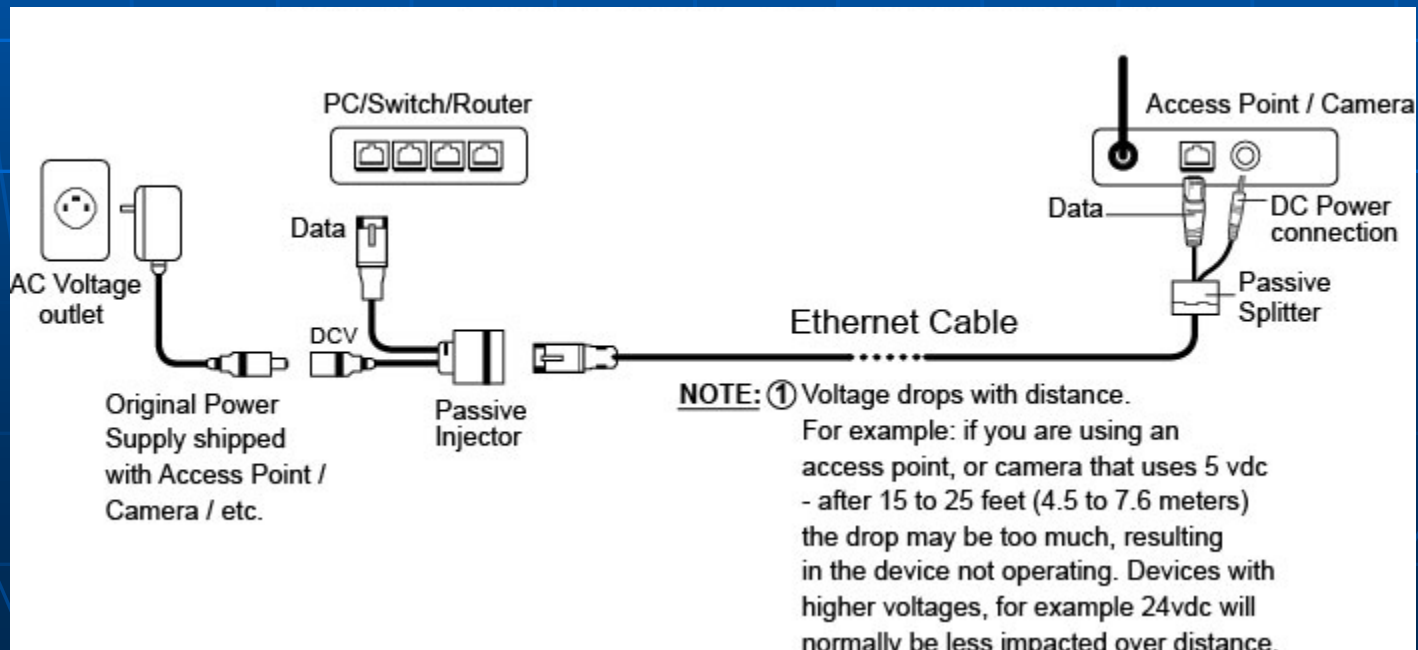
Powering for GigE



What is PoE?

“Alternative method of PoE Power injection”

In certain instances, the PC, switch or router only have regular Ethernet ports without PoE. In those cases a PoE midspan injector can be used.



What is PoE?

"How is PoE used"

PoE Injector



PoE Splitter



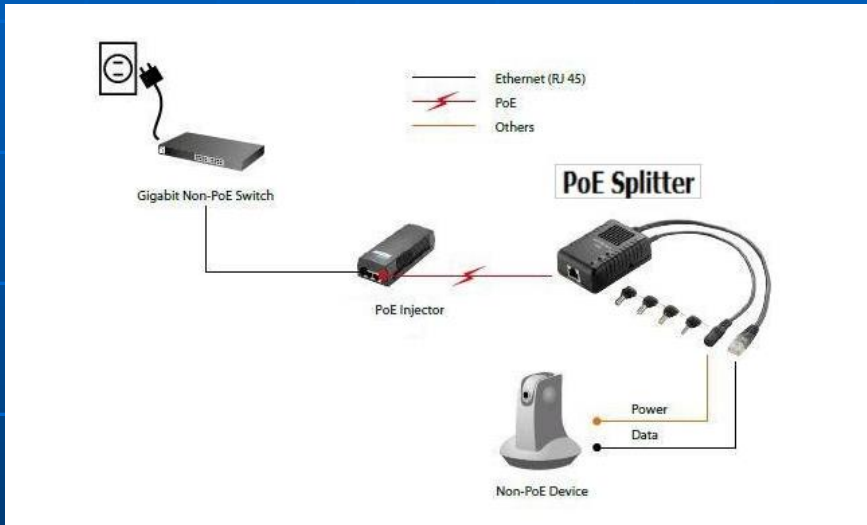
PoE Prot/Inj



What is PoE?

”How is PoE used”

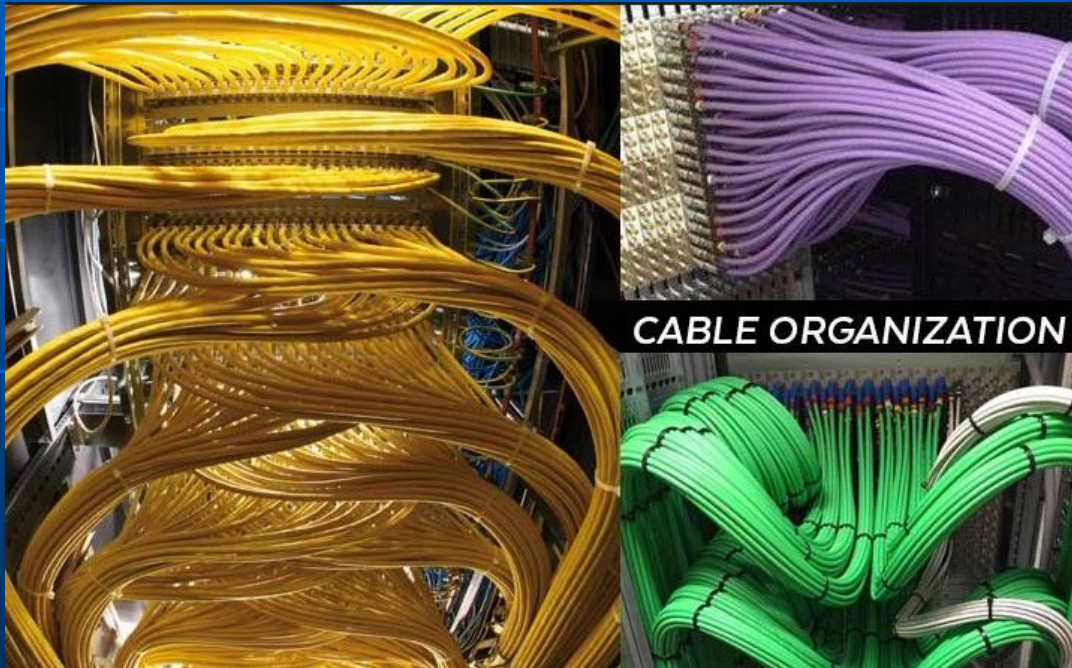
Typical PoE Injector usage



What is PoE?

”How is PoE wired”

WHY ALL THE UPROAR OVER NEC ARTICLES 840/725???



What is PoE?

This is pretty cool, Fireplace provided by PoE!



What is PoE?

This IS NOT pretty cool, Fire provided by PoE!



What is PoE?

This IS REALLY NOT pretty cool!!!



Navigating the NEC?

“Where do we start”

- NEC or NESC?
- Article 725 – Class 2/Class 3 ITE Circuits?
- Article 800 – Communications Systems?
- Article 830 – Network Powered Communications Systems?
- Article 840 – Premise Powered Communications Systems?

Navigating the NEC?

“Where do we start”

We should be able to dispense with Article 830, fairly easily?

Article 830 - Network Powered Broadband Communications Systems

It is widely believed this article is essentially obsolete as it was for a no longer deployed Hybrid Fiber low or medium powered Coax System. The required cabling (BM, BMX) is no longer available. The electrical parameters (Table 830.15) are for AC line powering from a AC pole to a house, and are inconsistent with what is in the safety standards. Plus the content in 830 simply does not match anything being deployed.

Navigating the NEC?

“Where do we start”

Table 830.15 Limitations for Network-Powered Broadband Communications Systems

Network Power Source	Low	Medium
Circuit voltage, V_{max} (volts) ¹	0-100	0-150
Power limitation, VA_{max} (volt-amperes) ¹	250	250
Current limitation, I_{max} (amperes) ¹	$1000/V_{max}$	$1000/V_{max}$
Maximum power rating (volt- amperes)	100	100
Maximum voltage rating (volts)	100	150
Maximum overcurrent protection (amperes) ²	$100/V_{max}$	NA

Navigating the NEC?

“Where do we start”

Part I. General

830.1 Scope. This article covers network-powered broadband communications systems that provide any combination of voice, audio, video, data, and interactive services through a network interface unit.

Informational Note No. 1: A typical basic system configuration includes a cable supplying power and broadband signal to a network interface unit that converts the broadband signal to the component signals. Typical cables are coaxial cable with both broadband signal and power on the center conductor, composite metallic cable with a coaxial member(s) or twisted pair members for the broadband signal and twisted pair members for power, and composite optical fiber cable with a pair of conductors for power. Larger systems may also include network components such as amplifiers that require network power.

Informational Note No. 2: See 90.2(B)(4) for installations of broadband communications systems that are not covered.

Navigating the NEC?

“Where do we start”

Article 800 might apply?

Article 800 - Communications Circuits

Might be apply depending upon location and usage of equipment

Part I. General

800.1 Scope. This article covers communications circuits and equipment.

Informational Note No. 1: See 90.2(B)(4) for installations of communications circuits and equipment that are not covered.

Communications Circuit. The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), outside wiring for fire alarm and burglar alarm from the communications utility to the customer's communications equipment up to and including terminal equipment such as a telephone, fax machine, or answering machine.

Navigating the NEC?

“Where do we start”

Article 840 might apply?

Article 800 – Premises-Powered Broadband Communications Circuits

Might be apply depending upon location and usage of equipment

Navigating the NEC?

“Where do we start”

Article 840 might apply?

Depends upon where the “network terminal” power is derived from (service provider vs premises/customer)

840.1 Scope. This article covers premises-powered broadband communications systems.

Informational Note No. 1: A typical basic system configuration consists of an optical fiber, twisted pair, or coaxial cable to the premises supplying a broadband signal to a network terminal that converts the broadband signal into component electrical signals, such as traditional telephone, video, high-speed Internet, and interactive services. Powering for the network terminal and network devices is typically accomplished through a premises power supply that might be built into the network terminal or provided as a separate unit. In order to provide communications in the event of a power interruption, a battery backup unit or an uninterruptible power supply (UPS) is typically part of the powering system.

Informational Note No. 2: See 90.2(B)(4) for installations of premises-powered broadband communications systems that are not covered in this article.

840.2 Definitions. The definitions in Part I of Article 100 and 645.2, 770.2, 800.2, and 820.2 shall apply. For purposes of this article, the following additional definitions apply.

Navigating the NEC?

“Where do we start”

BUT, only if a “communications utility service provider” is involved!

Network Terminal. A device that converts network-provided signals (optical, electrical, or wireless) into component signals, including voice, audio, video, data, wireless, optical, and interactive services, and is considered a network device on the premises that is connected to a communications service provider and is powered at the premises.

Premises Communications Circuit. The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), and outside wiring for fire alarm and burglar alarm from the service provider's network terminal to the customer's communications equipment up to and including terminal equipment, such as a telephone, a fax machine, or an answering machine.

Navigating the NEC?

“Where do we start”

If power per port is >60 watts, article 725.144 must also be met, But Why? The point where the PoE exits the switch is the Point of demarcation. Utility service providers would not be responsible for the customers side wiring installation and cables!

Part VI. Premises Powering of Communications Equipment over Communications Cables

840.160 Powering Circuits. Communications cables, in addition to carrying the communications circuit, shall also be permitted to carry circuits for powering communications equipment. Where the power supplied over a communications cable to communications equipment is greater than 60 watts, communication cables and the power circuit shall comply with 725.144 where communications cables are used in place of Class 2 and Class 3 cables.

Navigating the NEC?

“Where do we start”

Whoops

What if the service provider installs a PoE switch at the premises and runs a Cat 5 cable to a wireless access point power inside inside that facility. Maybe in a football stadium?? The service provider may have some limited number of premises located cables between the switch and the access points, so maybe in some instances the service provider might have to worry about cabling!

Navigating the NEC?

“Where do we start”

But most PoE equipment is not installed by communications utility service providers, and it is very unlikely they would be installing large cable bundles of LAN cables

So why are the NEC committees potentially messing with Article 840 and in particular with 840.160??

The law of unintended consequences!!!!

Don't mess with Chapter 8, other to provide some much needed clarifications

Navigating the NEC?

“Where do we start”

Therefore, if not service provider installed PoE switch or PSE, most PoE will be covered in the Class 2/Class 3 ITE sections of article 725, especially the ones with large cable bundles that could cause a fire hazard.

This works, but has lots of extra installation requirements service providers would want to avoid and is un-necessary, and therefore service provider equipment regardless of power per port should not be referred here. This is all adequately covered by 840, and the safety listing criteria, as well as GR-1089-CORE and ATIS/ANSI 0600337-2016.

Navigating the NEC?

“Where do we start”

But 725 needs help as well. Safety standards rely on the NEC and other standards.

Look at the Table from 725 for voltage, current and power that the NEC would allow from a PoE switch

Navigating the NEC?

“Where do we start”

Table 11(B) Class 2 and Class 3 Direct-Current Power Source Limitations

Power Source	Inherently Limited Power Source (Overcurrent Protection Not Required)					Not Inherently Limited Power Source (Overcurrent Protection Required)			
	Class 2				Class 3	Class 2		Class 3	
	0 through 20*	Over 20 and through 30*	Over 30 and through 60*	Over 60 and through 150	Over 60 and through 100	0 through 20*	Over 20 and through 60*	Over 60 and through 100	Over 100 and through 150
Source voltage V_{max} (volts) (see Note 1)	0 through 20*	Over 20 and through 30*	Over 30 and through 60*	Over 60 and through 150	Over 60 and through 100	0 through 20*	Over 20 and through 60*	Over 60 and through 100	Over 100 and through 150
Power limitations VA_{max} (volt-amperes) (see Note 1)	—	—	—	—	—	250 (see Note 3)	250	250	N.A.
Current limitations I_{max} (amperes) (see Note 1)	8.0	8.0	$150/V_{max}$	0.005	$150/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	1.0
Maximum overcurrent protection (amperes)	—	—	—	—	—	5.0	$100/V_{max}$	$100/V_{max}$	1.0
Power source maximum nameplate rating	VA (volt-amperes)	$5.0 \times V_{max}$	100	100	$0.005 \times V_{max}$	100	$5.0 \times V_{max}$	100	100
	Current (amperes)	5.0	$100/V_{max}$	$100/V_{max}$	0.005	$100/V_{max}$	5.0	$100/V_{max}$	$100/V_{max}$

*Voltage ranges shown are for continuous dc in indoor locations or where wet contact is not likely to occur.

For interrupted dc or wet contact conditions, see Note 4.

Notes for Table 11(A) and Table 11(B)

1. V_{max} , I_{max} , and VA_{max} are determined with the current-limiting impedance in the circuit (not bypassed) as follows:

V_{max} : Maximum output voltage regardless of load with rated input applied.

I_{max} : Maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed if used. Where a transformer limits the output current, I_{max} limits apply after 1 minute of operation. Where a current-limiting impedance, listed for the purpose, or as part of a listed product, is used in combination with a nonpower-limited transformer or a stored energy source, e.g., storage battery, to limit the output current, I_{max} limits apply after 5 seconds.

VA_{max} : Maximum volt-ampere output after 1 minute of operation regardless of load and overcurrent protection bypassed if used.

2. For nonsinusoidal ac, V_{max} shall not be greater than 42.4 volts peak. Where wet contact (immersion not included) is likely to occur, Class 3 wiring methods shall be used or V_{max} shall not be greater than 15 volts for sinusoidal ac and 21.2 volts peak for nonsinusoidal ac.

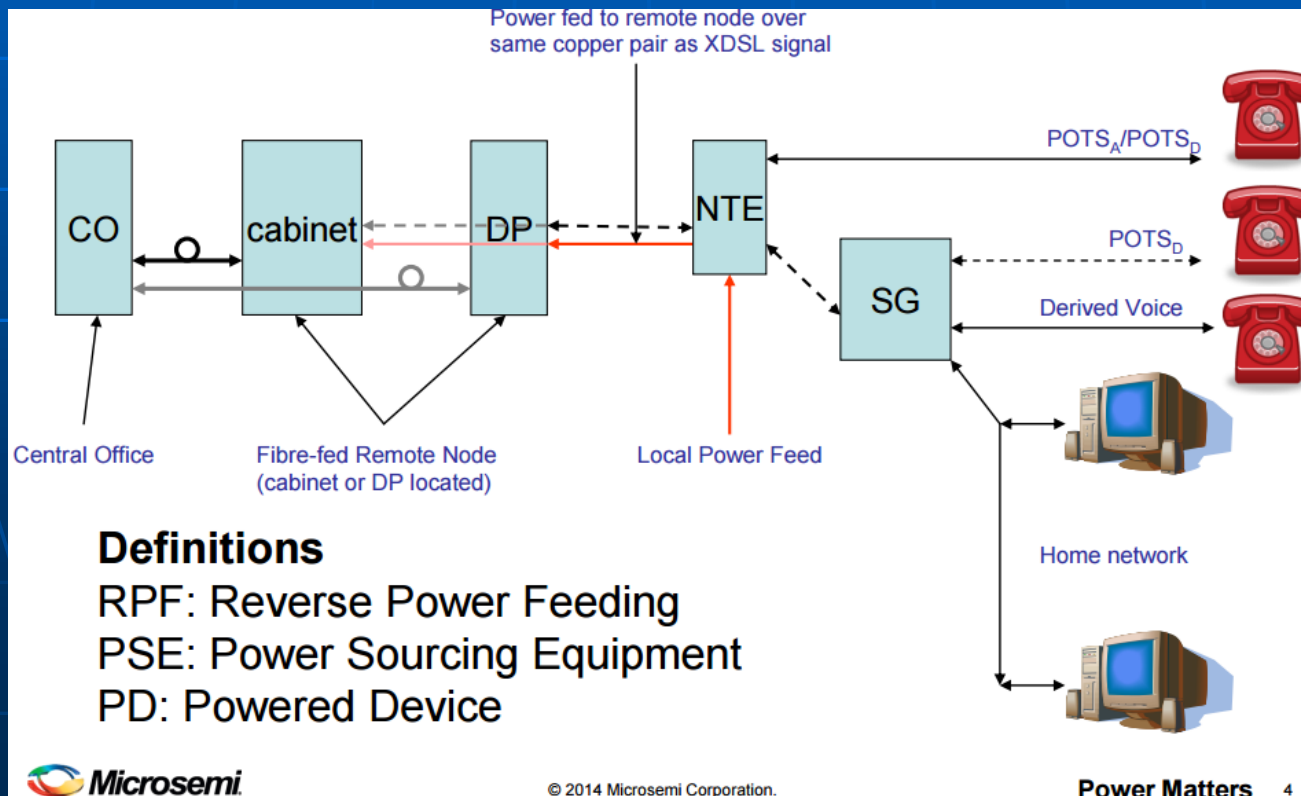
3. If the power source is a transformer, VA_{max} is 350 or less when V_{max} is 15 or less.

4. For dc interrupted at a rate of 10 to 200 Hz, V_{max} shall not be greater than 24.8 volts peak. Where wet contact (immersion not included) is likely to occur, Class 3 wiring methods shall be used, or V_{max} shall not be greater than 30 volts for continuous dc; 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz.

Navigating the NEC?

“What do we do with this?”

- What about G.fast/VDSL2 with Reverse Power Feeding???



Questions???