Implementation considerations for cabling supporting remote powering

COMMSCOPE®

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Background

Remote powering, such as Power over Ethernet (PoE), is a popular method of dc power delivery using communications cabling, with more than 100 million nodes installed around the globe. Power over Ethernet has evolved—from initially sourcing up to 15 watts at the power source equipment (PSE) as specified in IEEE Std. 802.3af-2003, increasing to up to 30 watts in IEEE Std 802.3at-2009, and now increasing further by IEEE P802.3bt project to source up to 90 watts at the PSE. It is important to note that all PoE powering levels and classifications comply with the SELV (Safety Extra Low Voltage) 60 volts and LPS (Limited Power Source) 100 VA (watts) requirements in IEC 60950-1, making PoE a low-risk, reliable, and cost-effective application for delivering power over the same balanced twisted-pair cabling used for data communications.

Cabling infrastructure standards development organizations such as TIA, ISO/IEC, CENELEC, and NEC have published and/or are developing specifications with design, installation and operational guidelines to facilitate reliable and robust deployment of remote powering networks, including PoE. The documents listed below are the source of many of the guidelines included in these implementation considerations.

The guidelines in the documents to the right include maximum current carrying capacity of category cables typically used in enterprise commercial buildings under various installation conditions and ambient temperatures. This allows the cabling to be designed, installed and operated to optimize thermal and electrical performance in various configurations. The guidelines support delivery of power using all four pairs with up to 1000 mA per pair (500 mA per conductor) for a maximum power of 100 VA (100 watts) at the power source over four-pair cabling, assuming a nominal 50 V power supply at the PSE.

Additionally, to improve the consistency and harmonization of installation practices, the proposed IEC 60364-7-716 (new part of the IEC Electrical installation standard used as a reference document in many international electrical codes) states that—if telecommunication cabling is used for power delivery—it shall be planned and installed in accordance with ISO/IEC 14763-2 or CENELEC EN 50174 series.

Implementation Considerations

A TIA TSB 184-A Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling

B ISO/IEC TS 29125 INFORMATION TECHNOLOGY—TELECOMMUNICATIONS CABLING REQUIREMENTS FOR REMOTE POWERING OF TERMINAL EQUIPMENT

C CENELEC CLC/TR 50174-99-1 Information technology—Cabling installation—Part 99-1: Remote powering

D NEC NFPA 70 Code

E TIA 569.D-2 Additional pathway and space considerations for supporting remote powering over balanced twisted-pair cabling

F ISO/IEC 14763-2 revision including remote power planning and installation is in development

Advantages of remote powering using communications cabling

Remote powering such as PoE facilitates the use of communications cabling for the support of remote power delivery without compromising the data communications functionality, thereby increasing the utility of communications cabling. This dual usage makes power delivery cost-effective while also enabling power delivery to a wider range of devices. These guidelines are intended to support all types of power and classifications being developed by IEEE P802.3bt, IEEE 802.3at and IEEE 802.3af for a variety of use cases, ranging from wireless access points (WAPs) to cameras, lighting, and intelligent building systems (IBS) devices. Other advantages of remote dc powering over communications cabling include:

- Smaller size of cables and connectors compared to ac line power, enabling higher density
- Enhanced communication between PSE and powered device (PD) for calibrated and reliable powering
- Continuous monitoring of the circuit for faults and other operating conditions
- Lower installation costs since low-voltage-cabling installers can install the cabling at the same time as part of communications cabling
- Improved control and operation of devices for better facility management
- Synergies created by power delivery simultaneous with communication, enabling a diverse and intelligent infrastructure (e.g., smart LED lighting)
- UPS backup, enabling robust and reliable operation

CommScope implementation considerations for remote powering

WHAT ARE THE VARIOUS FACTORS TO CONSIDER WHEN IMPLEMENTING REMOTE POWERING?

Factors that affect and influence the efficient operation of remote powering include:

1. Type of cables, cords, and connectors selected
2. Type of pathway infrastructure used to support the cables
3. Cable bundling configurations
4. Cable routing lengths

COMMSCOPE APPROACH TO DESIGN AND INSTALLATION

CommScope's recommendation for a robust and reliable installation to support remote powering is to use a holistic approach covering all aspects, including:

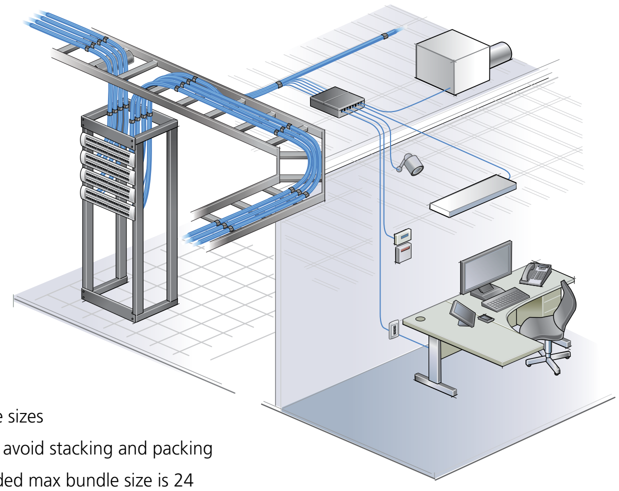
- Cable types and installation practices
- Pathway types and routing distances
- Accurate administration and optimal operations

CommScope implementation considerations for remote powering

TYPICAL DISTRIBUTION TOPOLOGY IN BUILDINGS

Figure 1 shows an illustration for the typical cabling topology used in buildings. For efficient PoE deployments, bundle sizes should be limited—and bundles should not be stacked or packed tightly. As a simple rule of thumb, we recommend that bundle sizes be limited to a maximum of 24 cables per bundle*, allowing gauge sizes from 24 AWG or larger to be within the cable temperature rating of 60°C when installed in worst-case conditions. A worst-case ambient temperature of 45°C is used for both air and conduit, with the conduit being the worst-case installation condition.

NOTE: 24-cable bundles match typical patch panel configurations, and is a practical configuration—for installation considerations—that also provides some extra margin.



NOTES:

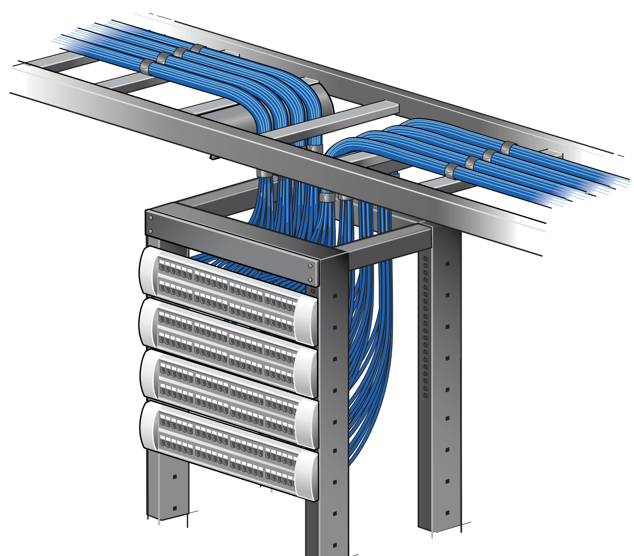
1. Limit bundle sizes
2. Organize to avoid stacking and packing
3. Recommended max bundle size is 24

Figure 1

Illustration of typical cabling topology

CABLE MANAGEMENT IN EQUIPMENT ROOMS AND TELECOMMUNICATIONS ROOMS

Cable bundles are commonly used in telecommunications rooms, equipment rooms and entrance facilities to manage and route cables in an aesthetic manner. Figure 2 illustrates a typical cabling topology used in equipment rooms and telecommunications rooms.



NOTES:

1.Cable bundles open to air flow throughout rack space

2. 24 cable bundles patch panel exiting on both sides of patch panel

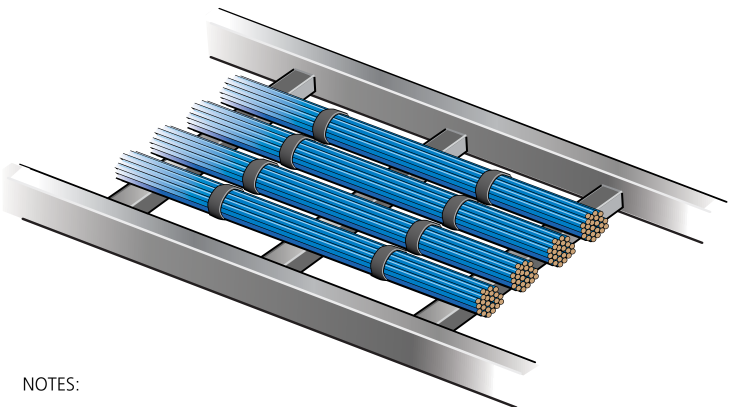
Figure 2

Illustration of 24-cable bundles in equipment and telecommunications rooms

CommScope implementation considerations for remote powering

CABLE MANAGEMENT IN HORIZONTAL DISTRIBUTION

The horizontal cabling design should configure cables to allow maximum ventilation by selecting pathway systems that spread the cables over the full width of a pathway. Figure 3 shows an illustration for typical cabling installation in a tray. Figure 4 shows an example of a typical installation of multiple bundles in ceiling trays.



NOTES:

1. Some amount of space should be maintained between bundles to allow for free air flow
2. Aligned strap positioning can be used to create gap

Figure 3

Illustration of cables in ceiling trays

Figure 4

Example installation of cables in ceiling trays

SERVICE CONCENTRATION POINT TERMINATION

Figure 5 shows an illustration for routing and termination at service concentration points (SCP) near the ceiling. A distributed ceiling grid cabling installation—according to ISO/IEC 11801-6 (in development), EN 50173-6 or TIA-862-B—allows future proofing and flexibility when installing several different remote-powered applications that are connected above the ceiling.

Figure 6 shows close-up detail of cable termination at a service concentration point (SCP).

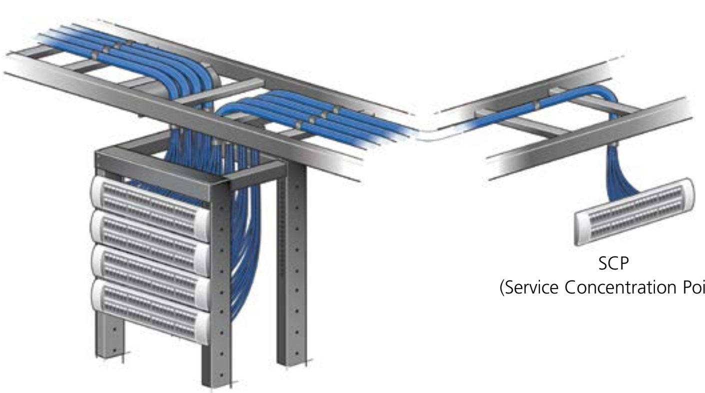


Figure 5

Illustration of routing and termination at an SCP

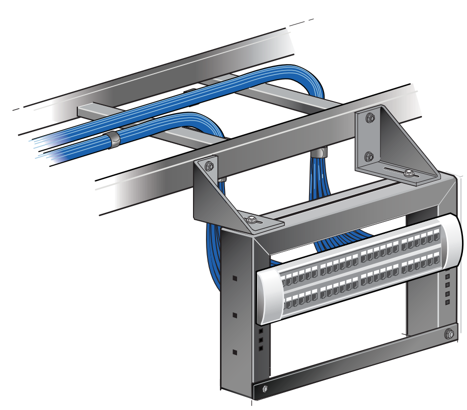


Figure 6

Illustration of mounting and cable termination at a SCP

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PATHWAY SYSTEMS

Pathway systems can affect heat dissipation and impact the temperature rise in a cable bundle. Figure 7 shows two pathways with identical cable bundles and size. Typically, the wire basket has a lower temperature rise than the solid bottom cable tray because of more air circulation.

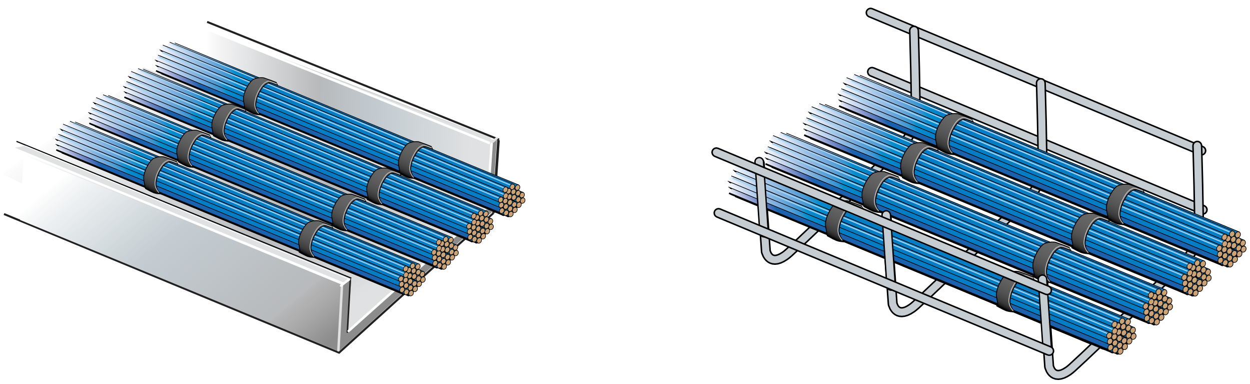


Figure 7

Illustration of cable bundles in solid-bottom and wire mesh cable tray

Figure 8 shows an illustration of cables installed in non-continuous cable supports—allowing air circulation around the cables and also serving to control the number of cables in the bundle.

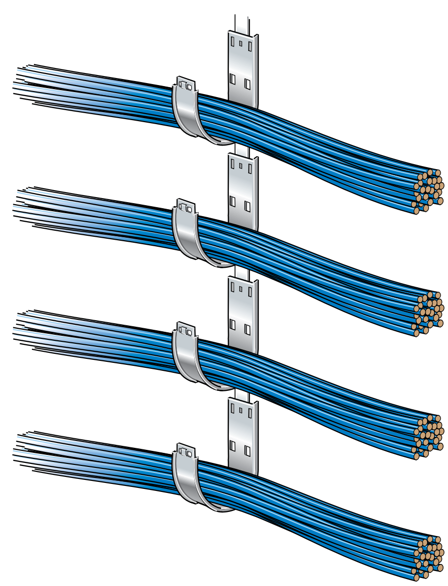


Figure 8

Example of cables in non-continuous support

CommScope implementation considerations for remote powering

INSTALLATION IN CONDUIT

Installation in conduit degrades thermal performance—with a higher temperature rise than open-air installation. Conduit installation should be minimized to only those areas mandated by the local authority having jurisdiction (AHJ), using a maximum fill percentage of 40 percent and maximum bundle sizes of 24 cables per bundle. Figure 9 shows an example of a 2-inch conduit installation with an approximate fill of 24 percent for typical Category 5e cables.

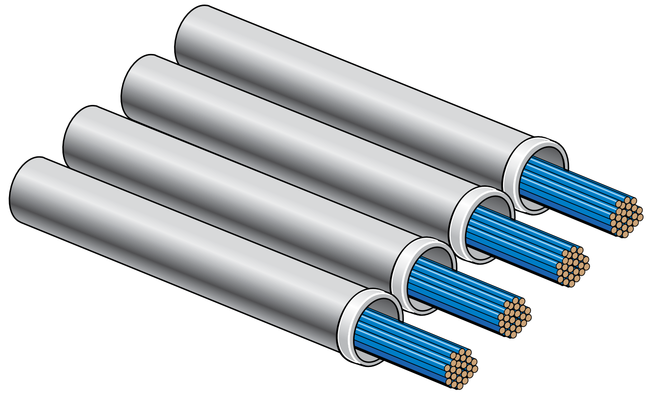
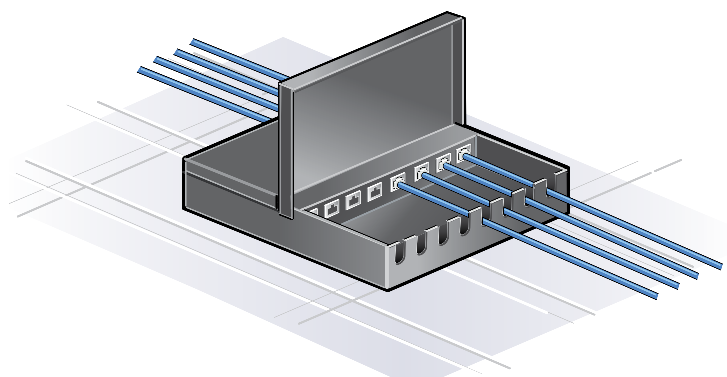


Figure 9
Example of cables in conduits

Remote powering equipment

Equipment for remote power delivery connected to cabling shall comply with IEC 62949 or EN 62368-3. The installer should check the nameplate on the remote powering equipment to determine if there is a maximum current per conductor at each port. If the current is less than 0.3 amps nominal, the port can, without further consideration, be connected to Category 5 or higher communications cabling as specified in TIA, ISO/IEC, and CENELEC standards. If the port has a maximum current above 0.3 amps nominal per conductor, the applicable standards or codes will need to be consulted for the maximum bundles size. If bundle size is limited to 24 cables, there is no need for any further consideration for current up to 0.5 amps per conductor in a four-pair cable with conductors 24 AWG or larger.



NOTES:

1. Check for maximum current on equipment nameplate
2. Current less than 300 mA nominal per conductor is safe for Category 5 and above
3. Standards and codes limit bundle sizes for higher current

Figure 10
Example of cables in equipment

CommScope administration support for remote powering

CommScope imVision® AIM System Manager software includes support for remote powering management features. The software has implemented the requirements of Annex C of TIA-568-C to create bundle identifiers, bundle records, and associated links. imVision System Manager software can list all the cables in a bundle, together with the maximum power on the power source equipment port where these cables are connected. This allows a network administrator to view the cables in a bundle, together with the power sourced by each cable. Alerts are issued when the number of cables in a bundle exceeds a given threshold (such as 24 cables) or the power levels exceed defined thresholds. This capability provides additional insight for ongoing administration operations of cables supporting remote powering.

Checking suitability of higher bundle sizes

The 24-cable bundle size is a recommendation, not a requirement—but should be followed as a general rule of thumb. Sometimes, larger bundle sizes may be needed; a qualified designer/installer can make the necessary evaluation to determine if a bundle size will cause any overheating. Tables in the appropriate TIA, ISO/IEC and CENELEC cabling standards on remote powering implementation provide a mechanism to check if a particular cable category bundle size is acceptable. For a given ambient temperature and installation condition—if the current per pair is greater than the maximum current on the PoE port—the cable bundle size is acceptable.

An example of this is shown with data taken from **Table 1: Current capacity per pair at 45˚ C ambient temperature for a category of cable versus number of cables in bundle for standard 60˚ C rated cables,** shown below:

TABLE 1

NO. OF CABLES	26 AWG		CATEGORY 5e		CATEGORY 6		CATEGORY 6A	
	Air	Conduit	Air	Conduit	Air	Conduit	Air	Conduit
1	2.664	2.091	3.492	2.844	4.099	3.243	4.380	3.541
7	1.545	1.223	1.971	1.628	2.287	1.857	2.460	2.039
19	1.140	0.909	1.424	1.188	1.638	1.356	1.770	1.496
24	1.059	0.846	1.314	1.100	1.509	1.255	1.632	1.386
37	0.919	0.737	1.128	0.949	1.290	1.084	1.399	1.200
48	0.842	0.677	1.026	0.866	1.170	0.989	1.271	1.097
52	0.819	0.660	0.997	0.842	1.135	0.962	1.234	1.067
61	0.775	0.625	0.939	0.795	1.068	0.908	1.162	1.008
64	0.763	0.615	0.922	0.781	1.049	0.893	1.141	0.991
74	0.725	0.586	0.873	0.741	0.991	0.847	1.079	0.941
91	0.673	0.545	0.806	0.686	0.914	0.784	0.996	0.873
97	0.658	0.533	0.787	0.670	0.891	0.766	0.971	0.852
100	0.651	0.528	0.777	0.662	0.880	0.757	0.960	0.843
127	0.596	0.485	0.708	0.605	0.799	0.691	0.872	0.771
169	0.536	0.437	0.631	0.541	0.711	0.619	0.777	0.691

Checking suitability of higher bundle sizes

To determine the maximum current that will not exceed the temperature rating of a 60°C rated cable, a designer/installer can do a table lookup for the particular ambient temperature. For example, for Category 6A, if a 61-cable bundle is installed in 45°C ambient, the maximum current from Table 1 is 1.162 amps in air and 1.008 amps in conduit, which is more than the 0.96 maximum current IEEE 802.3bt equipment will source—so the 61-cable Category 6A bundle can easily support all IEEE 802.3 PoE applications at 45°C ambient. Additionally, it should be pointed out that these current capacities in IEEE 802.3bt are for a worst-case 100-meter 24-AWG cabling with a loop resistance of 25 ohms. CommScope cabling will do much better, and informed installers can certainly increase the bundle sizes for shorter distances and better gauge sizes than 24 AWG (Category 6A is 23 AWG). Check with your CommScope representative for CommScope-specific product information for PoE that will be published in a later document.

NFPA NEC 2017 and LP cables

Some companies are touting LP rating as a requirement to support PoE above 60 watts per four-pair balanced twisted-pair cable. Article 840.160 of the NEC 2017 regulation exempts communications circuits delivering less than 60 watts (nominal 0.3 amps per conductor) to communications equipment. At higher power levels, the specifications require either adherence to a table (limiting the bundle size based on the current to be carried, the copper wire gauge used, and the temperature rating of the cabling) or they require providing the option of using cabling with a new rating, known as "LP" cabling. Table 725.144 as shown below is generic to all Class 2 and 3 cable types.

Table 725.144, Ampacities of Each Conductor (in Amperes) in a 4-Pair Class 2 or Class 3 Data Cables, Based on Copper Conductors at Ambient Temperature of 30˚C (86˚F) with all Conductors in All Cables Carrying Current, 60˚C (140˚F), 75˚C (140˚F) and 90˚C (194˚F) Rated Cables

NUMBER OF 4-PAIR CABLE IN A BUNDLE																					
AWG	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temperature rating			Temperature rating			Temperature rating			Temperature rating			Temperature rating			Temperature rating			Temperature rating		
	60˚ C	75˚ C	90˚ C	60˚ C	75˚ C	90˚ C	60˚ C	75˚ C	90˚ C	60˚ C	75˚ C	90˚ C	60˚ C	75˚ C	90˚ C	60˚ C	75˚ C	90˚ C	60˚ C	75˚ C	90˚ C
26	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	N/A	N/A	N/A
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3.0	3.0	3.0	1.4	1.8	2.1	1.0	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cable, or for conductor sizes smaller than 26AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.
Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.
Informational Note: The conductor sizes in data cables in wide-spread use are typically 22-26 AWG.

Article 725.144 specifies two options (shown below) for meeting the requirements for table 725.144:

Option A: Traditional CL3P, CL2P, CL3R, CL2R, CL3, or CL2 cables used to transmit power and data that comply with the requirements in Table 725.144 (e.g., 23-AWG 60°C-rated cable can support up to 0.4 amps per conductor in a 192-cable bundle). Article 840.160 additionally allows the substitution of communication cables (Class CM) for Class 2 and Class 3 (CL) cables.

Option B: Cables, as in Option A, with an "-LP" appended to the listing (e.g., CL2P-LP) that have been tested at UL up to a bundle configuration of 192 cables and have the corresponding ampacity rating marked on the jacket (e.g., CL2P-LP[0.5A], 23 AWG).

As described in these implementation considerations, CommScope uses a holistic approach for PoE that includes not only ampacity control but implementation of the practical guidelines for reducing temperature rise in ISO TR 29125, TIA TSB 184-A, and EN-50174 series. These documents recommend a maximum bundle size of 24 cables—significantly improving the thermal performance of Category cables to negate the need for LP cables.

Remote powering and CommScope Application Warranties

For registered CommScope Network Infrastructure System installations, IEEE 802.3 Power over Ethernet applications are covered per the SYSTIMAX® Applications Assurance Program, and the Uniprise® and NETCONNECT® Application Warranty Programs, based on complying with the applicable standards, guidelines, and codes. Consult your local CommScope representative for details.

Recommendations

To manage remote powering, CommScope recommends a holistic approach that includes not only controlling the maximum current in conductors, but implementation of the practical guidelines for reducing temperature rise in ISO/IEC TR 29125, CENELEC CLC/TR 50174-99-1, CENELEC EN 50174 series and TIA TSB 184-A. These documents recommend the use of Category 6A or Class EA or higher cabling for all new installations—based on its superior performance supporting remotely powered channels—and a maximum bundle size of 24 cables, which will significantly control cable thermal performance. Using these documents together with CommScope installation practices will lead to correct installations for all levels of remote powering, ranging from 15–90 watts delivered by the power source equipment (PSE).

It should also be pointed out that transmission parameters are specified up to 60˚C in TIA, CENELEC and ISO cabling standards—and communications equipment has been designed to operate under these conditions. Hence, going above 60˚C is nonstandard, not generic, and impractical since it poses considerable risk of applications not working at temperatures between the 60˚C and 90˚C currently allowed in Table 725.144 of NEC-2017.

It is also worth noting that compliance to safety regulations is facilitated by a similar comprehensive holistic approach taken by national and international cabling standards, including working closely with application committees such as IEEE 802.3. For example, star wiring (limiting one PSE port to power one PD) improves control and compatible power supply since LLDP is used to manage power to all devices connected to a PSE. The cabling committees reference national and international electrical codes to ensure compliance with local codes and regulations. It is this comprehensive coordinated and consistent approach that has led to a perfect record of no reported loss of life or property using communications networks for power delivery. CommScope is committed to maintaining this perfect record in the future for emerging standardized remote power applications by specifying and managing all aspects of the cabling infrastructure to improve thermal performance.

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ANSI/TIA-569.D-2 Additional pathway and space considerations for supporting remote powering over balanced twisted-pair cabling

CENELEC CLC/TR 50174-99-1 guidelines for remote powering

IEC 60950-1 INFORMATION TECHNOLOGY EQUIPMENT—SAFETY—PART 1: GENERAL REQUIREMENTS, 2013

IEEE Std 802.3af-2003, DTE Data Terminal Equipment (DTE) Power Via the Media Dependent Interface (MDI)

IEEE Std 802.3at-2009 Data Terminal Equipment (DTE) Power Via the Media Dependent Interface (MDI) Enhancements

IEEE P802.3bt Amendment: Physical Layer and Management Parameters for DTE Power via MDI over 4-Pair

ISO/IEC TS 29125 INFORMATION TECHNOLOGY—TELECOMMUNICATIONS CABLING REQUIREMENTS FOR REMOTE POWERING OF TERMINAL EQUIPMENT

NFPA 70® National Electrical Code® 2017 Edition

TIA TSB-184-A Guidelines for Supporting Power Delivery over Balanced Twisted-Pair Cabling

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