Analysis of Cabling Requirements for IEEE 802.3bt Type 4 Devices

The National Electrical Code (NEC) in its 2017 edition describes the restrictions on Power over Ethernet (PoE) systems. The restrictions are based on the per-conductor current and are targeted to minimize the thermal rise that may occur in large bundles of cable delivering Power over Ethernet.

**Note**
The NEC defines a cable bundle as a group of cables that are tied together or in contact with one another in a closely packed configuration for at least 1.0m (40 in).

A standard Category cable used in Ethernet systems consists of eight conductors. IEEE 802.3af and 802.3at systems use only four of these conductors to carry current. Cisco UPOE and IEEE 802.3bt systems use all eight conductors to carry current. The following table lists the maximum current allowed under each standard and the associated per-cable and per-conductor current.

**Table 1: Maximum Current prescribed for various Standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Cable Current</th>
<th>Conductor Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.3af</td>
<td>350mA</td>
<td>175mA</td>
</tr>
<tr>
<td>802.3at</td>
<td>600mA</td>
<td>300mA</td>
</tr>
<tr>
<td>Cisco UPOE</td>
<td>1200mA</td>
<td>300mA</td>
</tr>
<tr>
<td>802.3bt</td>
<td>1732mA</td>
<td>433mA</td>
</tr>
</tbody>
</table>

Analysis of a cabling system for compliance to the NEC starts with section 840.160:

Installation of the listed 4-pair communication cables for a communication circuit or installation where 4-pair communication cables are substituted for Class 2 and Class 3 cables in accordance with 725.154(A) shall comply with 725.144.

*Exception: Installing communications cables in compliance with 725.144 shall not be required for listed 4-pair communications cables where the rated current of the power source does not exceed 0.3 amperes in any conductor 24 AWG or larger.*

This, in effect states that 802.3af, 802.3at, and Cisco UPOE systems do not require any further consideration when the conductors are 24AWG or larger. Also, TIA-568 compliant horizontal cables require a minimum
of 24AWG conductors. Hence any IEEE standard compliant PoE system that supplies 60W or less does not need additional cable consideration.

IEEE 802.3bt Type 4 systems (Class 7 and Class 8, 75W and 90W) do not qualify for the 0.3A exemption. Therefore, the analysis for compliance to NEC moves to section 725.144:

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors of 310.15(B) shall apply.

Exception: Compliance with 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current of the power source does not exceed 0.3 amperes.

Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked ampere limit located immediately following the suffix “-LP” and shall be permitted to transmit data to the equipment.

The following table is derived from Table 725.144, adjusted for 45°C ambient temperature using 310.15(B).

The values in green cells are accepted values for IEEE Type 4 PoE systems.

Analysis of the NEC 2020 Table 725.144, adjusted for 45°C, and the requirements of section 725.144 results in Cisco’s recommendation to use Category 6a cables rated at 75°C, with 23AWG conductors, in bundles sizes of 192 or less.