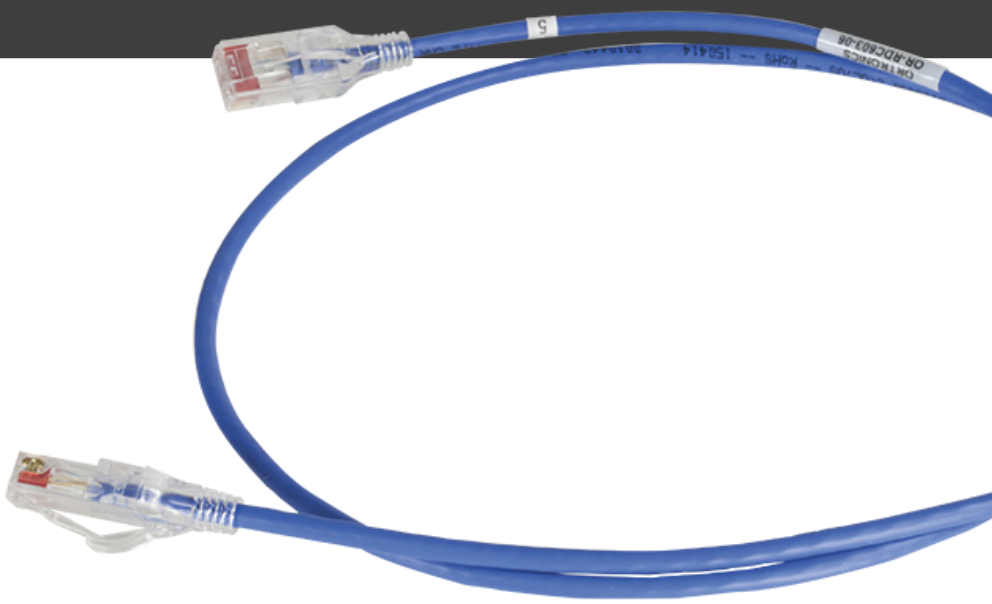
28 AWG CORDAGES FOR DATA & POWER CABLING SYSTEMS

Using 28 AWG patch cordages in today's cabling can provide an efficient option for transmission of Data & Power



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28 AWG Cordages for Data & Power Cabling Systems

Introduction

With the need to be as efficient with material as possible, using smaller gauge cordages, in particular 28 AWG cords, has shown to be a viable option in today's network cabling installations. To show the potential of using 28 AWG patch cordages in a cabling channel, we explore some of the challenges that occur when actual data signals are combined with Power over Ethernet (PoE) wattages for potential powered device applications in worst-case environments.

Background

"Past ingenuity is a predicate for future success"

Up until 2014 most patch cordages used for copper transmission of Ethernet signals were in the range of 24 AWG to 26 AWG. This provided the benefit of maximum signal performance, reduction of transmission loss, and transfer of PoE DC power, but at the price of increased size, weight, and cost. The benefits of using 28 AWG patch cordages has been well documented from various sources; this includes an increased cord capacity of cable management spaces, better air flow in data center patching situations, and ease of handling.

Despite these benefits, switching to 28 AWG cordages has some challenges, increased data signal loss and increased cable heat rise. Essentially, the higher the wire gauge (smaller wire cross-sectional area), the higher the DC resistance, meaning a 28 AWG patch cord is resisting the data signal and DC power transmissions more than a 24 AWG patch cord. Diagram A shows some of the cabling trade-offs and benefits of going from 24 AWG to 28 AWG patch cordages.

As shown in diagram A, the increase in resistance (Ohms/foot @ 60°C) is directly related to the wire gauges of the copper conductor by definition. Additionally, as the wire gauge increases, the supported maximum amperage decreases, however the maximum amperage for all three of the listed cord gauges is more than enough to support IEEE802.3bt current levels.

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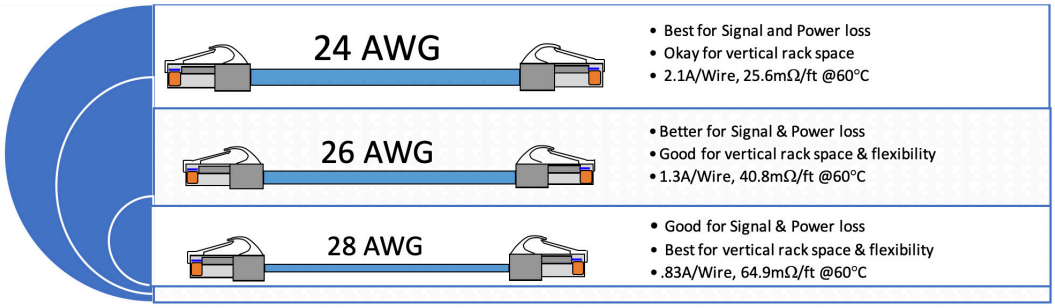

Diagram A (Wire gauge features and specifications)

The drawbacks of a higher resistance system is the higher data signal loss that is measured in the parameter Insertion Loss (IL), as well as higher thermal (heat) release of the patch cables. The concern with increased thermal release is amplified by the associated smaller outer jacket's diameter allowing the patch cords to be placed closer together. As shown in Chart A, there has been a constant increase in the power and current output requirements from the Power Source Equipment (PSE) to support increased power application usages.

Chart A (IEEE803.2af-bt table showing power increases)

IEEE	Type 1: 802.3af		Type 2: 802.3at					
IEEE	Type 3: 802.3bt						Type 4: 802.3bt	
Class	1	2	3	4	5	6	7	8
PSE (W)	4	7	15.4	30	45	60	75	90
PD (W)	3.84	6.48	13	25.5	40	51	62	71.3
Current/Pair (A)	0.35	0.35	0.35	0.6	0.6	0.6	0.6	0.866
Current/Wire (A)	0.175	0.175	0.175	0.3	0.3	0.3	0.3	0.433

Ensuring cabling systems meet these power and current output requirements is important because any cabling product that is heated past the manufacturers usage ratings, can cause issues; such as material damage, safety concerns, and reduction or potential loss of data signal.

Updated Standards

"Options are the basis for creativity"

To tackle the transmission issues of data & power running efficiently over 28 AWG cordages, the following Telecommunication Industry Association (TIA) standard documents were updated:

ANSI/TIA 568.2-D: Balanced Twisted-Pair Telecommunications Cabling and Components Standard, September 2018

TSB 184-A-1: Guidelines for Supporting Power Delivery over Balanced Twisted-Pair Cabling-Addendum 1- use of 28 AWG cords, February 2019

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These two standards address the issues of implementing 28 AWG cordages in a cabling channel system. The ANSI/TIA 568.2-D addresses data signal losses due to 28 AWG cordages by utilizing an additional cabling de-rating factor, which reduces the channel length to ensure a proper, usable signal performance level. The Technical Service Bulletin TSB-184-A-1 discusses mitigation methods to maintain an acceptable heat rise when transmitting power from sources such as;

- IEEE 802.3af-bt Power over Ethernet
- PoH (Power over HDBASE-T)
- CISCO Ultra Power over Ethernet (UPoE)

Using the tables and equations in TIA 568.2-D Annex G, Table 1 and Table 2 show maximum cabling length scenarios. Table 1 is based on an ambient temperature of 20°C (68°F) to represent room temperature. Table 2 is based on a temperature of 60°C (140°F) to represent the maximum recommended temperature for a cabling cordage bundle. This maximum recommended temperature accounts for an ambient temperature of 45°C (113°F) with a cabling bundling temperature rise of 15°C (27°F)

Table 1 uses the following paraphrased equations from TIA 568.2-D:

$102 \rightarrow = (D_p * P) + (D_h * H)$

Where:

H = Permanent Link length in meters
D_h = De-rating factor of Horizontal Cable (1 for 20°C, 1.2 for 60°C)
D_p = De-rating factor of Patch Cord (1.95 for 28 AWG Cords)
P = 28 AWG Patch Cord length in meters
C = Channel length in meters

Table 1: Using 28 AWG cordage at 20°C (68°C)

Maximum permanent link length m(ft)	Maximum length of 28 AWG cord cable m(ft)	Maximum channel length m(ft)
90 (295.3)	6.2 (20.2)	96.2 (315.5)
82.5 (270.7)	10.0 (32.8)	92.5 (303.5)
72.8 (238.7)	15.0 (49.2)	87.8 (287.9)

Table 2: Using 28 AWG cordage at 60°C (140°F)

Maximum permanent link length m(ft)	Maximum length of 28 AWG cord cable m(ft)	Maximum channel length m(ft)
75.0 (246.1)	6.2 (20.2)	81.2 (266.4)
68.8 (225.7)	10.0 (32.8)	78.8 (258.5)
60.7 (199.1)	15.0 (49.2	75.7 (248.4)

Note: Patch cords are assumed to be at 20°C

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Table 3: TSB-184-A-1 describes the maximum number of 28 AWG patch cords in a bundle for a maximum 15°C temperature rise at 20°C and 45°C ambient air temperature

Current per pair (mA)	Number of cables in bundle	
	20° C Ambient	45° C Ambient
600	88	77
720	53	47
866	32	28
1000	21	18

Table 3 shows that when using IEEE802.3bt Power Sourcing Equipment of 866mA per pair output (PSE Type 4), you should limit the number of 28 AWG patch cords in a single bundle to 32 at 20°C and 28 at 45°C.

Elevated Performance Evaluation

"Somethings are predicted from past ingenuity"

Past requirements of Unshielded Twisted pair (UTP) cabling channel being used strictly for transmission of data signals, have always been expected to operate within a range of room temperatures along the run. A typical 100m (328ft) cabling run can be exposed to multiple shifts in ambient temperatures. The various temperature zones can start in the controlled data center area of tightly bundled patch cordages and continue through the elevated ceiling trays near heat sources such as piping and HVAC.

Now, that we understand the restrictions and required mitigations for using 28 AWG cordages in your cabling system, what is the performance results of such usage? To evaluate the worst case conditions of an installed 28 AWG cordage environment, two simulated cabling channels were constructed that utilized 28 AWG patching. One test simulates a horizontal cabling breakout location and the other test simulates vertical patching at the data center equipment location.

To support the test and show the potentials of using 28 AWG patch cordages in a cabling channel, actual data signals are combined with Power over Ethernet (PoE) for intended powered device (PD) applications.

Note, the two test channels represent the longest cabling channels recognized by the TIA 568.2-D Annex G.

Cabling Diagram 1 represents the longest cabling channel of 96.2m (90m horizontal) + (6.2m cordages).

Cabling Diagram 2 represents the longest cordage cabling channel of 87.8m (72.8m horizontal) + (15m cordages).

The channel evaluated were Legrand C6A enhanced nCompass components and cabling with RDC (Reduce Diameter Cordage) 28 AWG cordages. These cabling structures were simultaneously injected with a data signal as well as DC power. To represent the data, the TIA568.2-D rated category signal frequencies were used, and to represent the power, the IEEE802.3bt max power was sourced.

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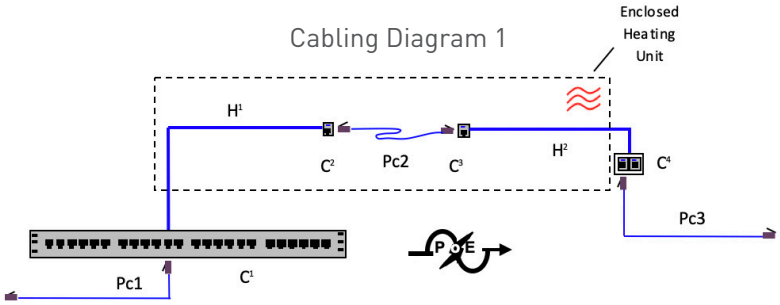
Example of a heated and uncontrolled environment.

The following cabling diagram could be a junction ceiling run at a manufacturer's southwest plant location. With high ceiling runs sometimes being unavoidable, the ambient temperatures can reach well over 40°C.

Cabling Diagram 1

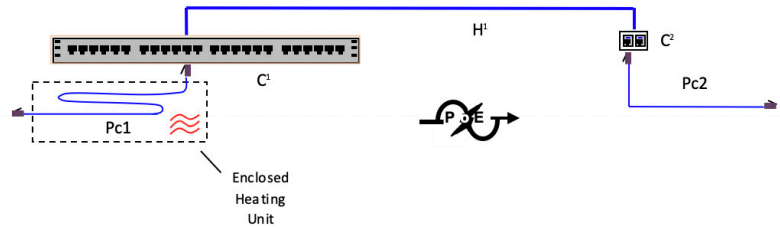


Tests the heat effect of an elevated temperature ceiling run that uses 28 AWG cordages at the cross-connection

Example of a heated bundle of 28 AWG Patch Cordages.

Even in a controlled air space, such as Data Centers or Equipment Rooms, bundling of cordages could increase the core bundle temperature by 15°C, when maximum Power over Ethernet DC power is being transmitted on all cables.

Cabling Diagram 2



Tests the heat effect of an enclosed cable management system at a worst case temperature using 28 AWG cordages

The 28 AWG patch cords are placed in the 60°C enclosed heating unit to simulate a 15°C cabling bundling rise at the maximum ambient temperature of 45°C. For cabling diagram 2, the englosed heating unit was maintained at 60°C, but in most cases would be at a temperature of 21°C or lower with a potential cable bundling rise of 15°C.

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Elevated Performance Evaluation

Table 4: (Evaluated at maximum cabling lengths at 60°C)

Cabling Evaluation 1

802.3bt PoE Class#	Power Out Source (W)	Power In Received (W)	Power Eff	IEEE Eff Spec[3]	NEXT (dB)	RL (dB)	IL (dB) at 500 MHz	ACR (dB)
3	15.4	13.1	85%	84%	8.0	3.74	4.82	8.38
6	60	51	85%	85%	7.9	3.53	3.3	8.24
8[2]	100	83	83%	79%	7.9	3.13	1.88	8.13

Cabling Evaluation 2

802.3bt PoE Class#	Power Out Source (W)	Power In Received (W)	Power Eff	IEEE Eff Spec[3]	NEXT (dB)	RL (dB)	IL (dB) at 500 MHz	ACR (dB)
3	15.4	13.1	85%	84%	14.3	2.67	5.98	11.13
6	60	51.1	85%	85%	14.2	2.64	5.96	11.10
8[2]	100	84.5	84.5%	79%	14.2	2.62	5.96	11.08

[2] Class rating is slightly higher than 803.2bt (90W) but is related to HDBase-T maximum power level.
[3] IEEE Eff Spec is the expected power efficiency required from the PSE rated class for proper Power Device (PD) operation.

Resultant data from cabling evaluation 1 and 2 showing the IEEE802.3 PoE power efficiency and the TIA 568.2-D signal margins over Category 6A channel limit lines with Insertion Loss margin shown at its maximum categorized frequency. Both cabling systems showed power losses, but were essentially able to meet and exceeded the requirements of IEEE 802.3bt PoE systems and also maintained its enhanced TIA category 6A cabling electrical signal margins, while subjected to an elevated environment of 60°C.

Summary & Cordages Temperature Rise

Legrand 28 AWG patch cordages are rated up to 75°C and utilize proprietary features and quality designed materials to reduce the cable bundling temperature rise to stay well below the TIA-184-A-1 recommended limits. During the test, the DC loop Resistance was maintained well under the specified limits of the TIA 568.2-D recommendation for proper PoE operations of 25 ohms for all channels.

As shown in chart B, higher bundle sizes than the TIA 184-A-1 recommended cordage bundle size were subjected to 600mA & 1A PoE inputs from IEEE802.3bt, while maintaining the recommended maximum cordage bundle rise of 15°C. The measured C6A 28 AWG cordage temperature rise was 10.6°C at 1A with the TIA bundle size limit of 21 cordages and was 5°C at 600mA with the TIA bundle size limit of 88 cordages. When interpolated, the RDC bundle sizes are able to go up to 34 cordages and 115 cordages for 1A and 600mA respectively to maintain the highest allowed cordage bundling temperature rise of 15°C.

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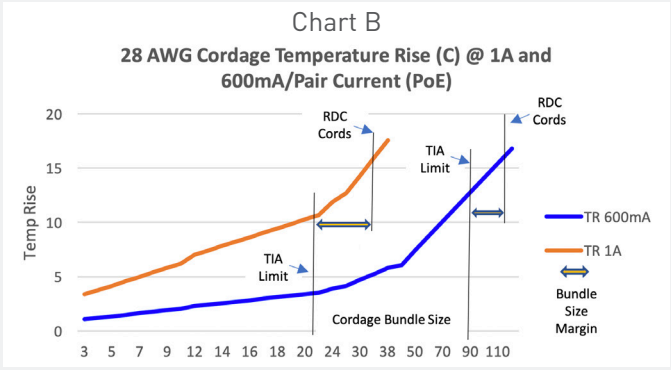
As seen in Chart B, the cordage measurements exceed the standards for safe bundle operation of data and power transmission on UTP cabling. The bundle size margin and results from the cabling evaluations 1 and 2 provides further confidence of running data and power in heated conditions on channels utilizing 28 AWG patch cordages.

Chart B



The reduced temperature rise compared to the TIA Limit aids in ensuring that data and power can be transmitted safely. As shown, the TIA safety recommendation bundle size can be increased with added cordage bundle size margin while maintaining a maximum cordage temperature rise of 15°C.

When properly used, 28 AWG cordages can provide an additional option for today's network cabling. As shown in the previous evaluations and graphs, 28 AWG patch cordages can meet the power delivery efficiency standards, while maintaining electrical signal performance margins, to ensure your combination of power and data transmission will function properly. The presented results are from Legrand nCompass solution cabling components, other cabling systems could provide different results.

About Legrand

Legrand is the global specialist in Data Power and Controls. In North America, Legrand's high-performance network infrastructure solutions feature well-known product lines, including Ortronics®, AFCO®, Raritan®, Servertech®, Quiktron® and Starline®. This comprehensive offering includes copper, fiber optic connectivity, physical infrastructure products, and overhead power distribution units.

References:

TIA 568.2-D: Balanced Twisted-Pair Telecommunications Cabling and Components Standard

TSB-184-A-1: Guidelines for Supporting Power Delivery over Balanced Twisted-Pair Cabling- Addendum 1- use of 28 AWG cords

IEEE802.3at-2009: Standard for Information technology, DTE Power via Media Dependent Interface Enhancements

IEEE802.3bt-2018: Standard for Ethernet Amendment: physical layer and management Interface Enhancements DTE Power via MDI over 4-Pair

1Brown & Sharpe wire gauge: American Wire Gauge Standard

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