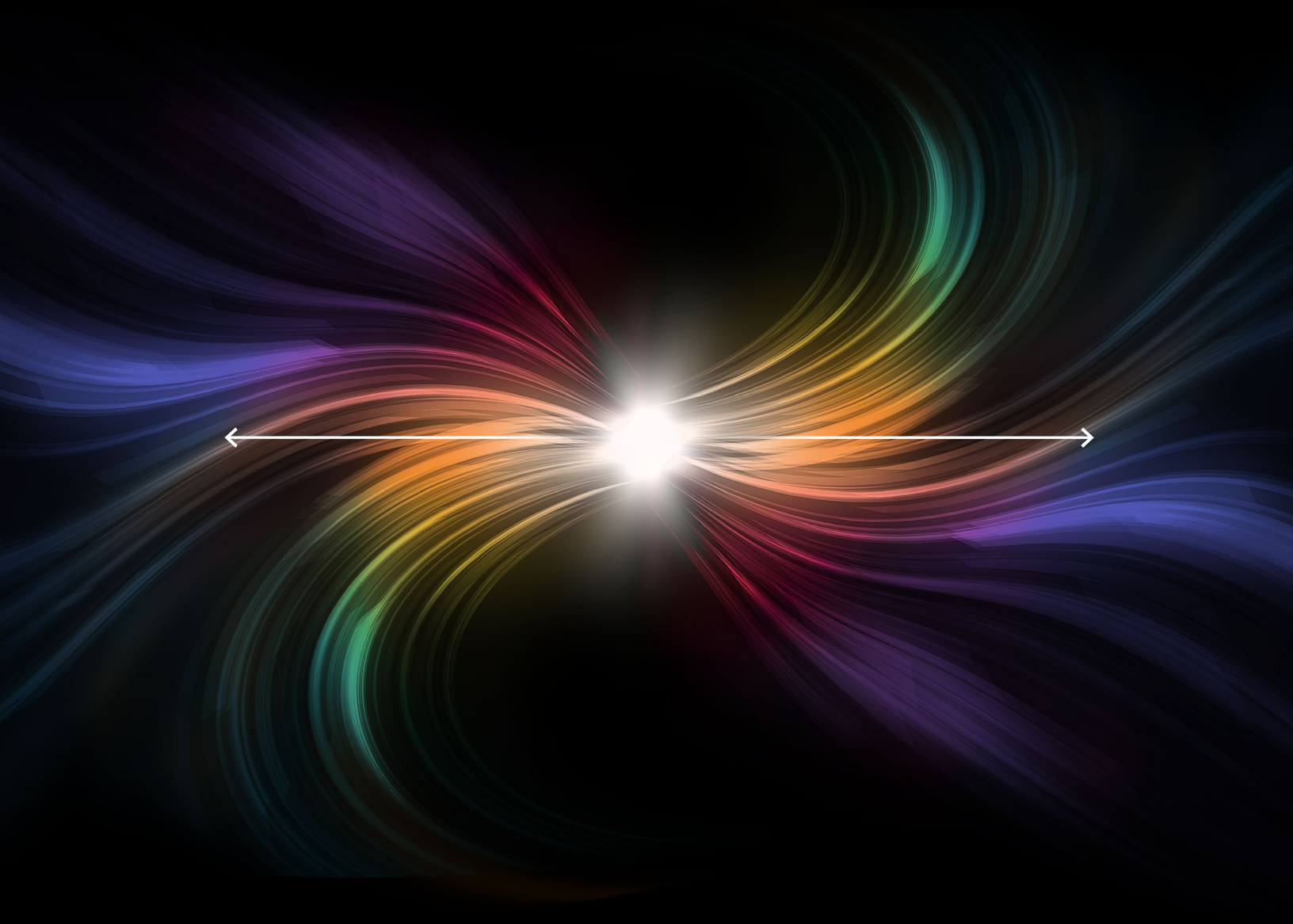
SYSTIMAX®
COMMSCOPE

Engineering Credible Extended-Distance Cabling Claims

A Margin-Based Framework for Application Performance, Remote Power, and Field Reliability



Executive Summary

Extended-distance cabling claims require more than a successful laboratory demonstration. A credible claim must preserve margin to applicable specifications and published reach while remaining compatible with standards-compliant endpoint equipment and real installation and environmental variation. This paper presents a practical framework for evaluating those claims, examines the effect of conductor size on IEEE 802.3bt Type 4 remote power, and uses an anonymized bundled-channel study to illustrate the field risk created when published reach is positioned too close to the demonstrated operating boundary.

The Basis for Credible Performance Claims

Enterprise network customers, designers and installers depend on clear and credible performance claims from cabling vendors to accurately compare extended-distance solutions.

To be considered credible, a cable's performance claim must:

- **Consistently fall within the product's demonstrated capability envelope.**
- **Exceed the application's performance requirements.**
- **Account, in part, for performance variations in the channel's other components.**

Therefore, a cable that occasionally meets its stated maximum distance, power level, temperature, bandwidth or loading performance is neither reliable nor can its claims be regarded as credible. Such limitations represent operating boundaries that create engineering uncertainty for installers and customers and can result in a compliant prototype becoming a marginal (and possibly non-compliant) component when installed.

For example, a link may pass a brief demonstration yet fail under sustained traffic, elevated temperature, bundle loading, different endpoint implementations, or normal installation tolerances. It may negotiate to a lower rate or become intermittent—hiding the problem during commissioning and making an ordinary production variation look like a field reliability issue.

Why Performance Margin Matters: Sources of Field Variation

Variable Equipment
- Different sending and receiving PHYs
- Different manufacturers
- PHY S/N sensitivity

Variable Installation
- Cord routing/bundling
- Workmanship
- Manufacturing tolerances (involving third party connectivity)

Varying Environment
- Temperature
- Noise sources
- Alien crosstalk

Varying Applications
- PoE loading
- Sustained traffic loads
- Migration to multi-gig speeds
- Mixed MGig environments

Why Extended-Distance Claims Require Greater Margin

Extended-distance claims involve more risk than those that comply with standards like IEEE 802.3. One reason is that there are multiple components in a channel, and each affects the channel's ability to support the extended-distance claim. Cable performance is just one of many variables that determine application support; others include endpoint design, installation quality, environment, and component variation. Supporting credible performance claims in this variable environment requires components designed with increased performance margins.

For example, to boost the operating margin and to offset performance variations across a 2.5GBASE-T extended-reach channel, the cabling may need to reduce insertion loss and preserve receiver signal-to-noise ratio while controlling alien crosstalk. Even then, the complete channel must still be validated with representative endpoints and realistic installation stress.

A Margin-Based Product Approach

The question then becomes: How does a cable manufacturer calculate the margin needed to ensure the end-to-end channel can support the application requirements? After all, no manufacturer can test every equipment pairing. CommScope faced this challenge in designing its GigaREACH® XL Category 6 UTP extended-reach cable.

First, CommScope engineers identified lower-performing, standards-compliant endpoints and verified the operating performance of each under elevated temperature and alien-crosstalk stress. The GigaREACH XL solution claims were then set in a way that supports these endpoints with added margin so that applications don't operate at their practical limit.

The GigaREACH XL solution claims are not designed to exceed those of competitors. Instead, CommScope has established claims that customers can rely on regardless of the equipment they chose to support.

Conductor Size and IEEE 802.3bt Type 4 Remote Power

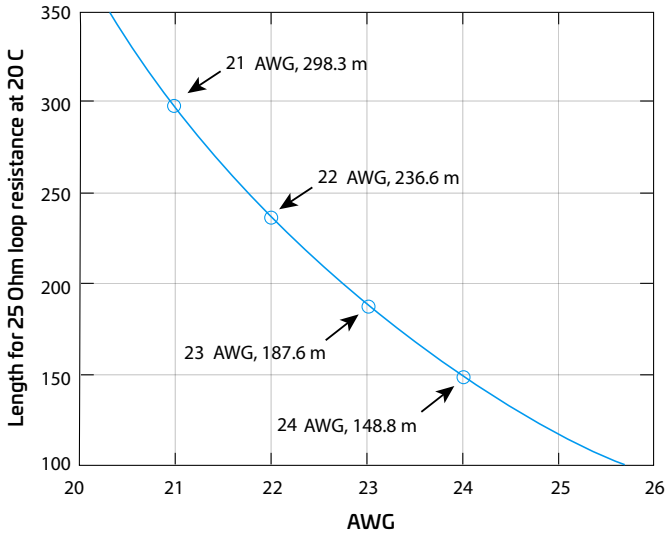
Conductor size is another critical consideration when designing cables to support extended-distance channels. In applications involving IEEE 802.3bt power, all four pairs are energized. This enables a Type 4 transmitter (power source equipment) to output up to 90 watts, deliver a minimum of 71.3 W at a Class 7/8 receiver (powered device), and maintain approximately 960 mA per pair set.

To understand how connector size affects extended distance support, consider two lengths of cable operating at 20 degrees C. One cable uses 22 AWG conductors and the other uses 21 AWG conductors.

The conductors in the 22 AWG cable will have an end-to-end resistance of 16.14 ohms or a loop resistance of 32.28 ohms. The IEEE 25 ohm loop resistance maximum means that the maximum cable length could not exceed 236 meters. The slightly larger 21 AWG cable, however, exhibits a lower end-to-end resistivity of 12.8 ohms or a loop resistance of 25.6 ohms, extending the supportable length to a maximum of 298 meters—26% longer than the 22 AWG cable and with higher thermal and electrical margins.

It is important to note that these calculations refer only to the cables' resistance and do not include other channel variables, such as connectors, cords, temperature, manufacturing tolerance, resistance unbalance, termination effects and design margin. Practical claims must therefore be shorter.

One important takeaway from this exercise is that any claims of 250 meters using 22 AWG conductors warrant careful scrutiny—if for no other reason than the calculated conductor resistance alone exceeds the limit before other channel factors are considered.

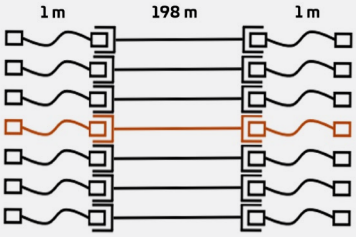


Case Study: When an Extended-Length Claim Lacks Dependable Field Margin

CommScope engineers evaluated a commercially available 22 AWG cable, which the manufacturer claimed supported Gigabit and multi-Gigabit applications over extended distances. The goal was to determine the extent to which those claims could serve as a dependable design rule under realistic bundle and endpoint conditions. To accomplish this, it was necessary to understand how the cable performed when using legacy 10/100/1000BASE-T PHYs, 100/1000/2.5G/5GBASE-T PHYs, or a combination of the two.

Test Configuration

Seven 200 m channels were constructed, each consisting of a 198 m length of 22 AWG cable and a 1 m cord at either end. The channels were arranged in a six-around-one bundle (six disturbers surrounding a central victim) to create alien-crosstalk stress that is present in multi-gigabit applications.



Testing was conducted using a 2.5 Gbps and a 1 Gbps data stream fed through legacy 1000BASE-T PHY-enabled non-multi-gig ports and more modern 2.5GBASE-T PHY-enabled multi-gig ports. Sustained error-free traffic was used to identify a successful link.

2.5GBASE-T Results

At the claimed length, only five of the seven 2.5GBASE-T channels linked, with one linked channel often performing well below the rated throughput. Successfully linking all channels required a 30 m reduction in length. Without sufficient alien-crosstalk margin, the cable design failed to provide the claimed performance.

1 Gbps Results

Test results showed that, when using 2.5GBASE-T PHY-enabled multi-gig ports operating at 1 Gbps, a 40 m reduction in claimed length was required to link all seven channels. When using the 1000BASE-T PHY-enabled non-multi-gig ports, all seven channels linked at the expected length. The results indicate that port type and physical-layer implementation can materially affect extended-distance performance—a fact that must be reflected in qualification and customer guidance.

Implications for Channel Performance and Risk

It is important to note that the tested solution failed to meet the stated distance claims in a controlled laboratory environment, where many field uncertainties were absent. Those uncertainties, are to be expected. Extended-distance products whose claims are based on a best-case scenario (instead of an increased and verified performance margin) should not be considered dependable for field use. To do otherwise invites additional cost, network risk, and places the burden of determining cabling capability on the customer.

Endpoints	Legacy 10/100/1000 BASE-T PHY-enabled non-multi-gig ports		Modern 100/1000/2.5G/5G BASE-T PHY-enabled multi-gig ports	
2.5GBASE-T	NA		Claimed length	Not all channels linked
			Length reduced by 30 m	All channels linked
1000BASE-T	Claimed length	All channels linked	Claimed length	Not all channels linked
			Length reduced by 40 m	All channels linked

Case Study: When an Extended-Length Claim Lacks Dependable Field Margin (continued)

Problems often surface after cable, endpoints and hardware are installed and the space and resources committed.

For example: Links may negotiate then fail to sustain throughput, or they may pass superficial commissioning then fail intermittently under load. Given the differences in endpoint design, protocols and performance, troubleshooting after installation can be expensive and inconsistent.

The evidence does not establish that every extended-distance channel will fail. It does, however, show that the published claim did not provide sufficient margin for demanding application and endpoint conditions and may therefore create a misleading expectation of dependable performance.



Port	Link	State	Dupl	Speed	Trunk	Tag
1/1/25	Up	Forward	Full	2.5G	None	No
1/1/26	Up	Forward	Full	2.5G	None	No
1/1/27	Up	Forward	Full	2.5G	None	No
1/1/28	Up	Forward	Full	2.5G	None	No
1/1/29	Down	None	None	None	None	No
1/1/30	Down	None	None	None	None	No
1/1/31	Up	Forward	Full	2.5G	None	No
1/1/32	Up	Forward	Full	2.5G	None	No

Principles for Defensible Extended-Reach Claims

A defensible extended-reach claim:

- Considers and defines the complete channel and verifies representative active equipment.
- Is based on realistic bundle configurations and sustained, high-stress traffic conditions.
- Creates and retains a calculated and adequate performance guard band below the demonstrated limit.
- Establishes margins based on the highest expected operating temperature above which conductor resistance and insertion loss increase—reducing remote-power capability and signal-performance reserve.

Finally, it is strongly recommended that special consideration be given before deploying a cable that has been validated for lower speeds in a multi-gig application. Higher signaling rates increase the cable's sensitivity to insertion loss, signal-to-noise ratio, alien crosstalk, endpoint compatibility and installation variation.

The SYSTIMAX GigaREACH XL solution was designed to take advantage of the performance benefits of 21 AWG conductors. When used with traditional CommScope connectivity components, the GigaREACH XL system has been independently verified to support 1 Gbps to 150 m, 100 Mbps to 200 m, and 10 Mbps to 250 m. These published values are conservative when compared to the demonstrated capability.

GigaREACH XL Channel/Link Application Support Matrix

	10 Mbps			100 Mbps			1 Gbps		
	Channel	PL	MPTL	Channel	PL	MPTL	Channel	PL	MPTL
Maximum number of connectors	4	3		4	3		4	3	
Maximum cord length (MCL)	10 m	8 m	9 m	10 m	8 m	9 m	10 m	8 m	9 m
Maximum xx73A length	250 m – MCL			200 m – MCL			150 m – MCL		
PoE support	IEEE 802 3bt 90 Watt								

Conclusion

Credible extended-distance claims are conservative engineering statements, not descriptions of the best-case observed results. They must account for specification headroom, endpoint variation, bundle interference, environmental stress, remote-power resistance, and production and installation variability. Claims placed comfortably within a demonstrated capability envelope support confident design, while boundary claims transfer uncertainty and life-cycle cost to the customer.

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