# THE DEFINITIVE GUIDE TO PATCH CORD CABLE

From the Stranded Data Cable Experts

QUABBIN® WIRE & CABLE CO., INC.

## DataMax® Commercial Data Cable

Catalog and Reference Guide

www.quabbin.com/commercial-data-cable

# Superior Performance in Stranded Data Cable

**Superior performance — expect it from our cable and from our company.** At Quabbin, our focus is on being the industry leader and manufacturing the best and most reliable cable on the market. Our advanced design, manufacturing, and customer service bring you world-class stranded data cable. We believe we only succeed when our customers succeed.

PROUDLY MADE IN THE U.S.A.

Customers choose us for the value we provide through product and service quality. Our cable is manufactured in a single U.S. facility and constructed to industry standards with proprietary, high-speed equipment. Advanced, real-time process controls monitor quality and dimensional integrity throughout the manufacturing cycle. This establishes a foundation of quality at the beginning of the cable supply chain and contributes to assembly cost control by increasing yield and reducing rework and scrap.

Our ISO 9001 quality system ensures superior lot traceability, consistency, and customer focus. With inventory stocked throughout North America, ordering and delivery are quick and easy.

Cable design experts and sales support representatives are easily accessible and welcome feedback and suggestions. We aim to be a trusted partner to address your design, processing, and delivery needs.

Quabbin has been the trusted choice of assemblers, OEMs, and cable distributors for nearly five decades. Choose Quabbin — the stranded data cable experts.

**www.quabbin.com • (800) 368-3311**

**www.quabbin.com/commercial-data-cable**

## Cable Finder

*Search our products by:*

- Application
- Part Number
- Construction
- Ratings & Approvals
- Physical Properties
- Category

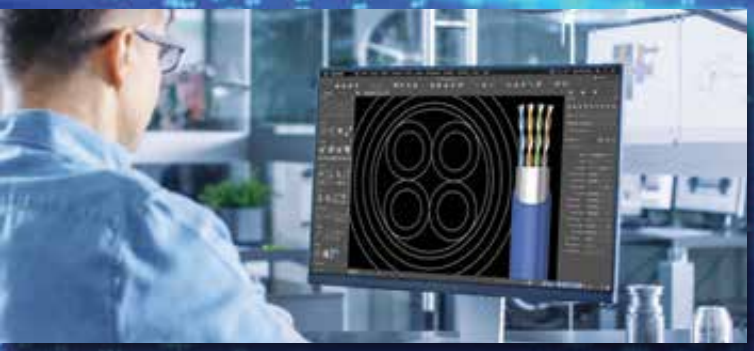
www.quabbin.com/cable-finder

## Inventory Finder

*Check our inventory:*

- Part Number
- Warehouse Location
- Quantity Available

www.quabbin.com/inventory

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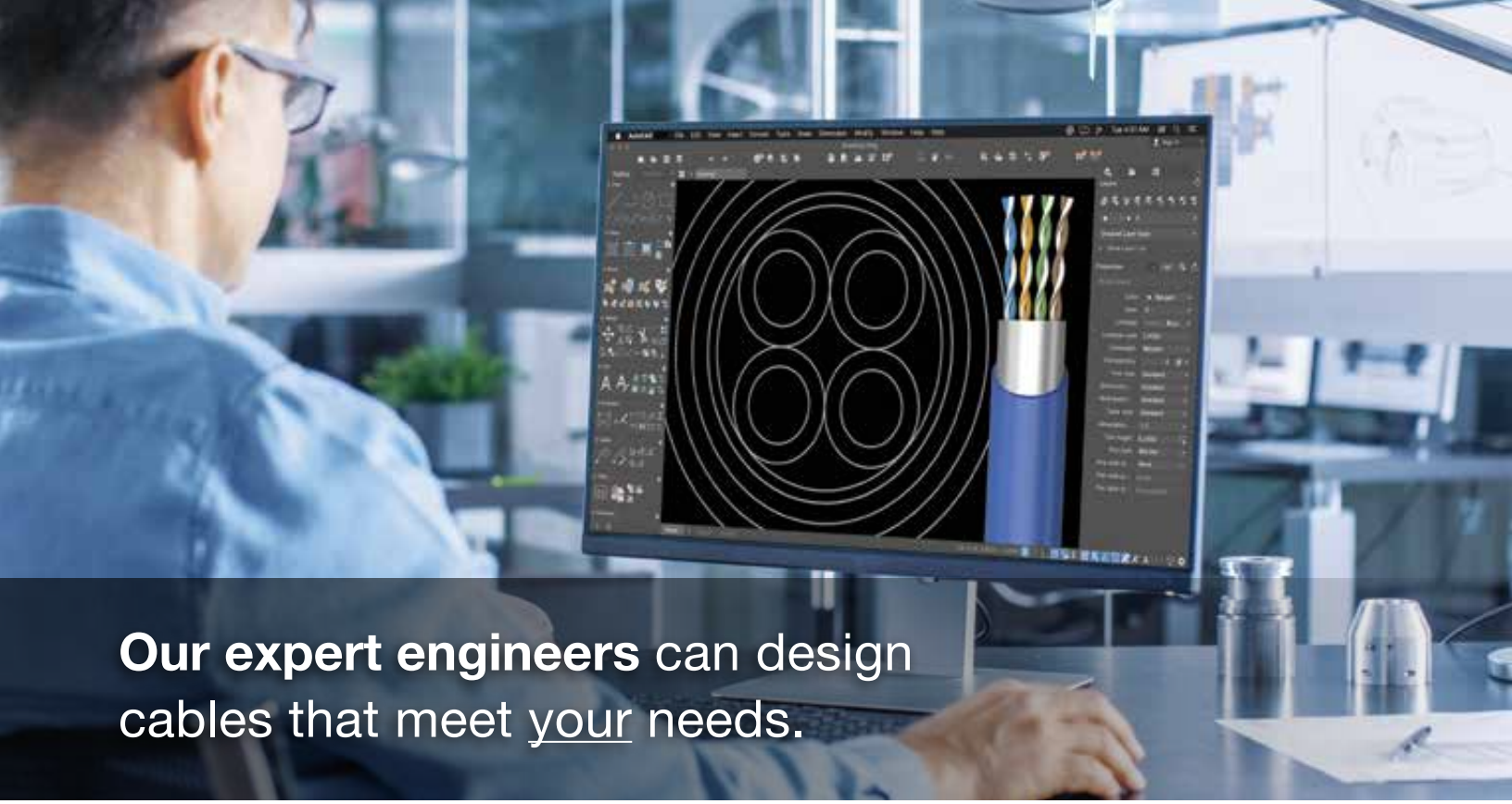


# **Our expert engineers** can design cables that meet your needs.

**Call 1-800-368-3311** to speak with a Cable Design Specialist.



## Cable Types

- Cat 5e, 6 and 6a
- Telco T-1, E-1 and xDSL

## Construction

- 1, 2 and 4 pair
- Hybrid mixture of components
- Shielded and unshielded
- Separator-free options

## Copper

- 22 AWG-28 AWG
- Tinned
- Bare
- Stranded
- Solid (single pair to 18 AWG)

## Insulation Materials

- PE (Polyethylene)
- PP (Polypropylene)
- FPP (Foam Polypropylene)
- Composite or dual layer
- Foam FEP (Flourinated Ethylene Propylene)

## Shielding and Tapes

- Aluminum polyester foil with a drain wire
- LSZH foil and binder tape
- LSZH tissue separator
- Clear polyester tape
- Vinyl or foam PPRO

## Jacket Materials

- RoHS compliant compounds
- Various types of PVC (Polyvinylchloride)
- LSZH (Low Smoke/Zero Halogen)
- LS PVC (Low Smoke PVC)

## Color Coding and Identification

- Private labeling
- Custom print legends
- Longitudinal colored stripes
- Footage or meter marking
- Date codes
- Custom concentrate (color matching)

## Packaging

- Wooden reels 12”-30”
- Plastic and cardboard 12”-30”

# Product Development

**Quabbin's product development team** continually collects data from customers, end users and market experts to inform and shape new generations of products. We're committed to the industry and to working together to meet future needs. Contact our cable design experts at **1-800-368-3311** for technical support for your application and project needs.

Quabbin's cable design team: Jim Rivernider, Samantha Herr, and Zach Smigelski

## Single Pair Ethernet (SPE) Patch Cord Cable

SPE cabling provides the necessary infrastructure for the Internet of Things (IoT).

| Preliminary Designs | Ratings | Applications |
|---|---|---|
| 26 - 18 AWG<br>Shielded<br>Foamed FEP and PE insulation<br>PVC and LSZH jackets | CM-LS<br>CMP<br>CMR<br>CMX | Smart buildings<br>Industrial automation<br>Smart transportation<br>Edge computing |

## Category 8 (Cat 8)

Developed under ANSI/TIA 568.2-D to support 25GBASE-T and 40GBASE-T applications. Cat 8 cables offer greater throughput capability, supporting data transmission up to 40Gbps over balanced twisted pair copper cabling.

| Preliminary Designs | Applications |
|---|---|
| 28 - 26 AWG<br>Shielded<br>Foamed FEP insulation<br>PVC and PUR jackets | High speed data centers<br>High speed networks<br>Top of rack<br>Test equipment |

# DataMax® Commercial Ethernet Patch Cord Cable

**Quabbin DataMax® Patch Cord Cables** offer outstanding electrical performance and reliability. Each cable is tested on everything from color to conductivity to ensure it meets the highest quality standards. In addition to the testing that takes place in-house, Quabbin also works closely with OEMs, assemblers, and connector manufacturers to effectively develop and deliver the best market solutions for all your commercial data needs.

- **#1 choice for data center and patching applications**
- **Meets TIA 568.2-D**
- **Quick termination and high yield**
- **Compatible with popular modular plugs**
- **High performance stranded tinned copper**
- **Manufactured with premium components and materials**
- **Ideal for component compliant assemblies**
- **Inline manufacturing monitoring**
- **Designed and manufactured in the same U.S. facility**
- **Available with PVC, LSZH and Plenum-rated jackets**

## DataMax® CMP Stranded Patch Cable Solutions

**At Quabbin**, our focus is on manufacturing the best cables in the market. That's why we are excited to introduce our DataMax® CMP Patch Cable Solutions — DataMax® Relaxed Plenum 26 AWG and Mini Plenum 28 AWG.

These cables are ideal for patching applications where CMP is required or simply preferred for fire protected and limited smoke emissions. The smaller, flexible design improves cable density, has a max temperature rating of 105°C, and promotes increased air flow to maximize rack ventilation.

### DataMax® Relaxed Plenum (CMP) 26 AWG

Product (right) offers increased flexibility over standard 26 AWG cable (left)

### DataMax® Mini Plenum (CMP) 28 AWG

Product (right) offers space savings over standard 26 AWG cable (left)

#### DESIGN FEATURES

» 105°C Temperature Rating
» 26 AWG or 28 AWG Stranded Tinned Copper
» Twisted Pair Construction
» Foamed FEP Insulation
» Patented Shield System
» Slim Design
» Increased Flexibility
» Tight Bend Radius
» Improved Cable Density

#### APPLICATIONS

» Plenum Spaces
» Top of Rack
» Patching Solutions
» High Density Installations
» Temperature Sensitive Spaces
» Secure Networks
» PoE

#### BENEFITS

» Multipurpose Patch Solution
» Fire Protection
» Possible Insurance Advantages
» Longer Flex Life vs. Horizontal
» USA Made

#### LISTINGS/RATINGS

» NEC (ETL) Type CMP
» CEC C(ETL) Type CMP

# Patch Cord Cable
# Cat 6a Mini / 28 AWG

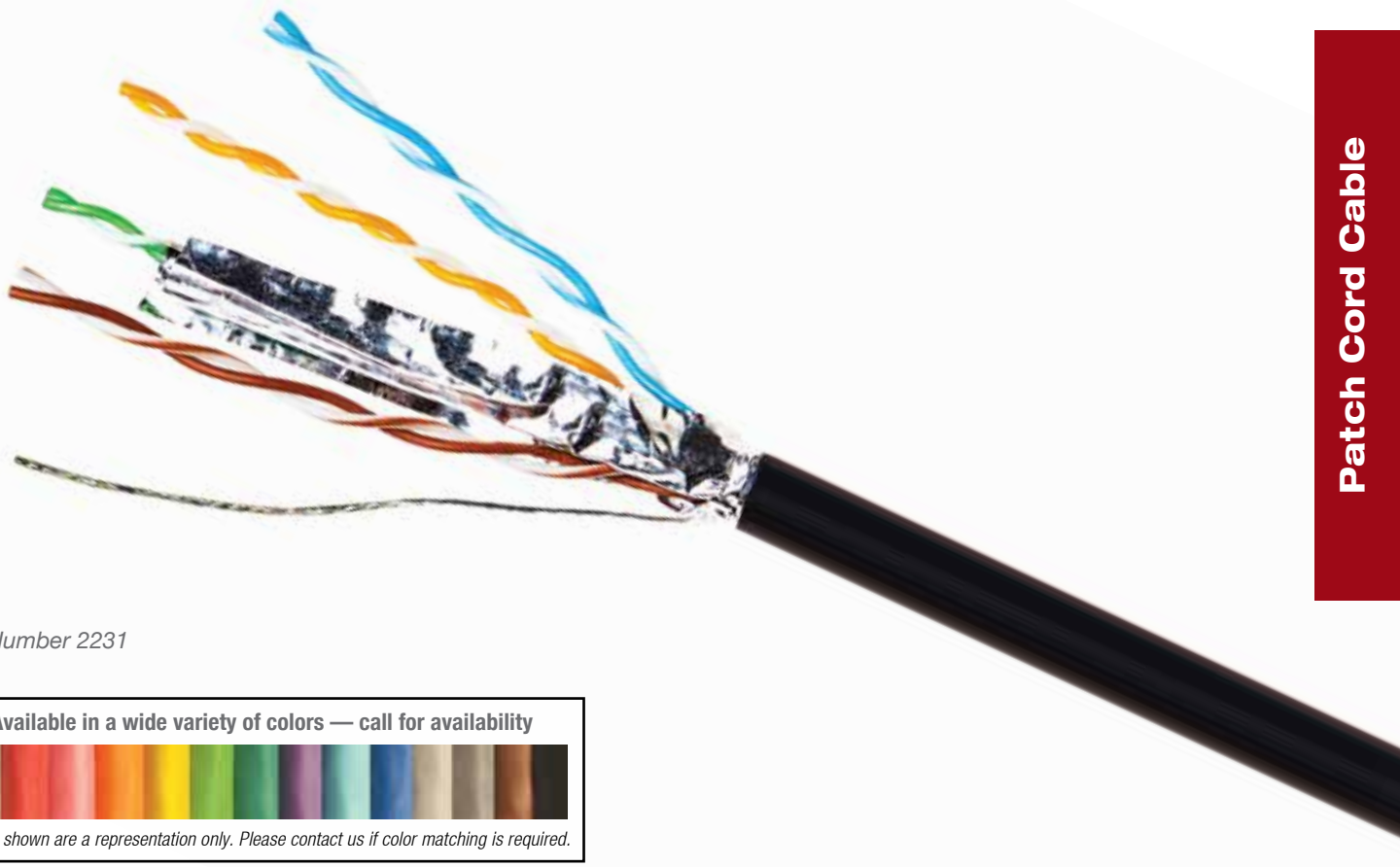
- All 28 AWG 7/36 Stranded Tinned Copper
- Reduced diameter profile, featuring a patented shield which eliminates the need for a spline
- Meets Category 6a plug-to-plug electrical and transmission parameters up to 56 meters
- RoHS Compliant
- PoE, PoE+, PoE++/4PPoE
- Popular colors stocked; check website for inventory
- Voltage Rating Max 300V
- Bend Radius 8x OD
- Weight = WT./M', Nom., Net

## Foil Shield

| Part Number | Category | AWG | Jacket | Pair Count | Rating | Temp Max | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 2231-2245 | 6a Mini | 28 | PVC | 4 | CMR | 75°C | -20°C | 15.2 lbs. | .186" | 500 MHz |
| 2270-2278 | 6a Mini | 28 | LSZH | 4 | CM-LS | 75°C | -20°C | 16.8 lbs. | .190" | 500 MHz |
| 2034-2044 | 6a Mini | 28 | PVC | 4 | CMP | 105°C | -20°C | 16.5 lbs. | .186" | 500 MHz |

### Compatible Connectors

| Part Number | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 2231-2245 | SS-39200-055 | 111S080800C7LA4 |
| 2270-2278 | SS-39200-055 | 111S080800C7LA4 |
| 2034-2044 | SS-39200-055 | 111S080800C7LA4 |



*Part Number 2231*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 6a / 26 AWG

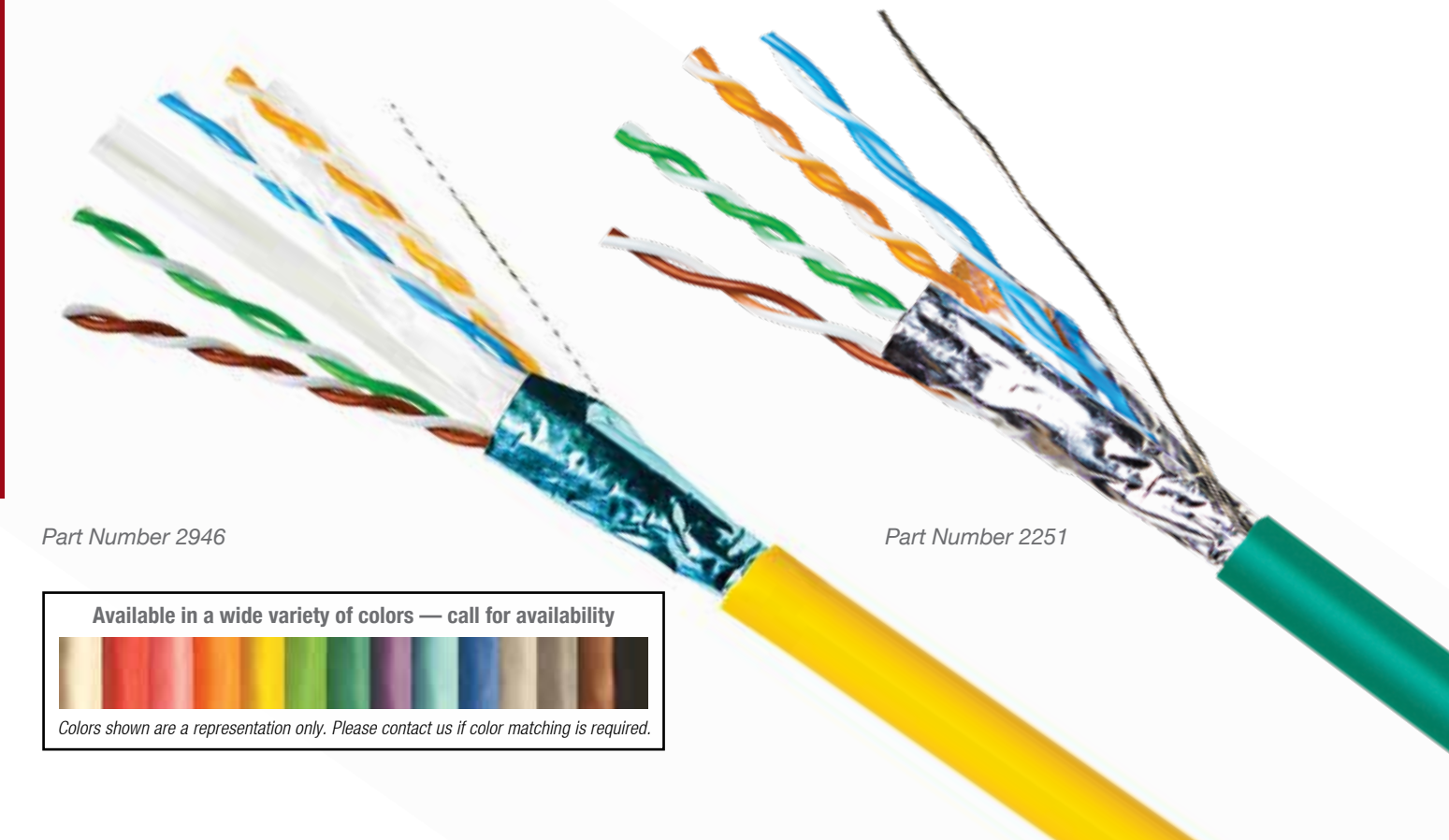
- 26 AWG 7/34 Stranded Tinned Copper
- RoHS Compliant
- Voltage Rating Max 300V
- Bend Radius 8x OD
- Popular colors stocked, check website for inventory
- PoE, PoE+, PoE++/4PPoE
- Weight = WT./M', Nom., Net
- Refer to quabbin.com/calculator for the plug-to-plug maximum length for your application

## Foil Shield

| Part Number | Category | AWG | Jacket | Pair Count | Rating | Temp Max | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 2942-2953 and 2991 | 6a | 26 | PVC | 4 | CMG, CMR | 75°C | -20°C | 24.5 lbs. | .235" | 500 MHz |
| 2978-2989 | 6a | 26 | LSZH | 4 | CMX | 75°C | -20°C | 30.1 lbs. | .265" | 500 MHz |
| 2056-2066 | 6a Relaxed | 26 | PVC | 4 | CMP | 105°C | -20°C | 22.2 lbs. | .223" | 500 MHz |
| 2246-2259 | 6a Relaxed | 26 | PVC | 4 | CMG, CMR | 75°C | -20°C | 23.6 lbs. | .233" | 500 MHz |
| 2279-2287 | 6a Relaxed | 26 | LSZH | 4 | CM-LS | 75°C | -20°C | 23.2 lbs. | .230" | 500 MHz |

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 2942-2953 and 2991 | SS-39200-035 | 111S08080095LA4 |
| 2978-2989 | SS-39200-053 | 111S08080095HA4 |
| 2056-2066 | SS-39200-055 | 111S080800C7LA4 |
| 2246-2259 | SS-39200-036 | 111S08080095LA4 |
| 2279-2287 | SS-39200-036 | 111S08080095LA4 |



*Part Number 2946*

*Part Number 2251*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 6 Mini / 28 AWG

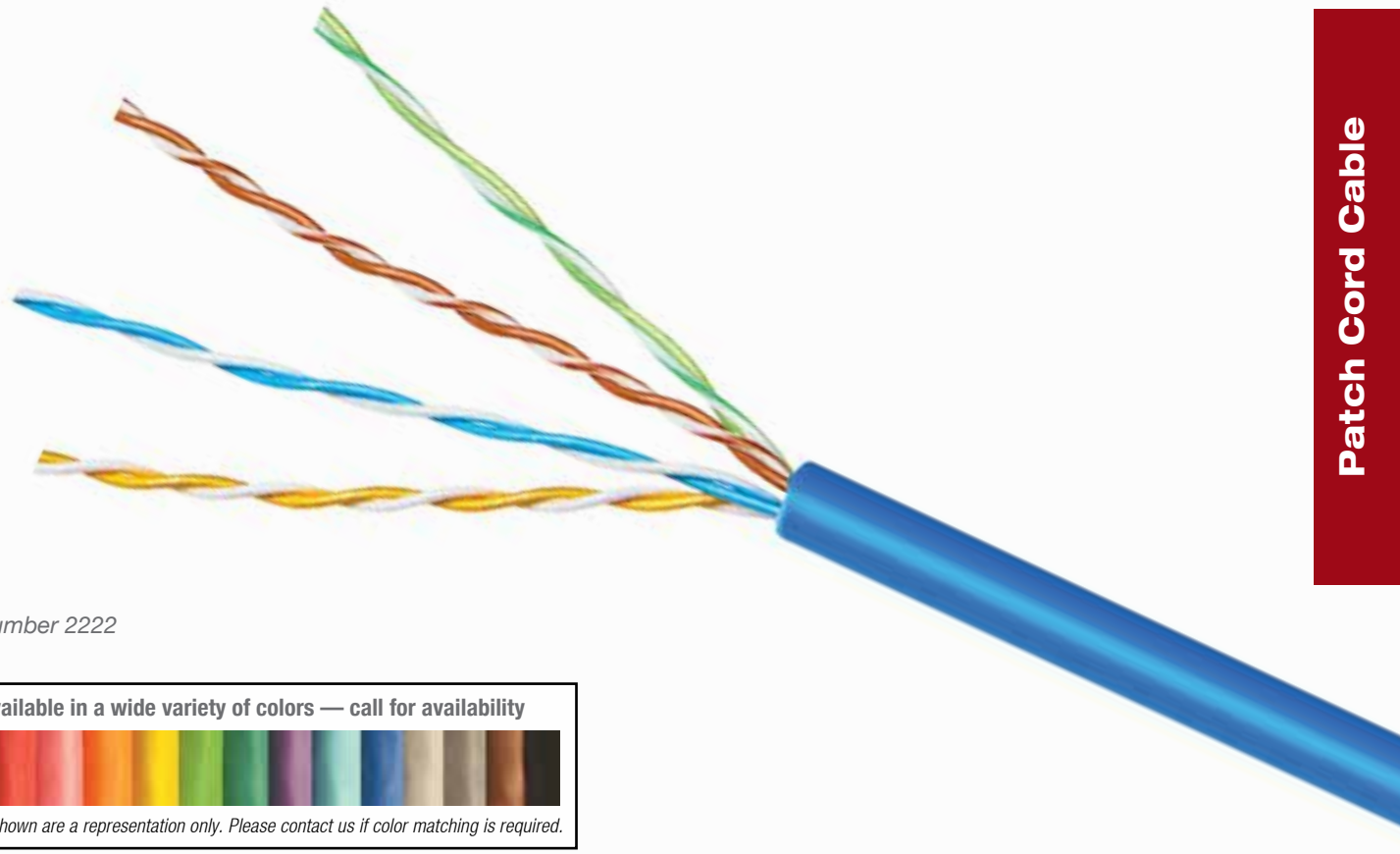
- 28 AWG 7/36 Stranded Tinned Copper
- Reduced diameter profile, meets Category 6 plug-to-plug electrical and transmission parameters up to 55 meters.
- RoHS Compliant
- Popular colors stocked; check website for inventory
- Voltage Rating Max 300V
- PoE, PoE+, PoE++/4PPoE
- Bend Radius 4x OD
- Weight = WT./M', Nom., Net

## Unshielded

| Part Number | Category | AWG | Jacket | Pair Count | Rating | Temp Max | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 2216-2230 | 6 Mini | 28 | PVC | 4 | CMR | 75°C | -20°C | 10.8 lbs. | .150" | 250 MHz |
| 2260-2269 | 6 Mini | 28 | LSZH | 4 | CM-LS | 75°C | -20°C | 10.8 lbs. | .150" | 250 MHz |
| 2045-2055 | 6 Mini | 28 | PVC | 4 | CMP | 105°C | -20°C | 16.5 lbs. | .186" | 250 MHz |

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 2216-2230 | SS-39100-039 | 111-080800B5LA4 and B00058L |
| 2260-2269 | SS-39100-039 | 111-080800B5LA4 and B00058L |
| 2045-2055 | SS-39200-055 | 111S080800C7LA4 |



*Part Number 2222*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 6 / 26 AWG

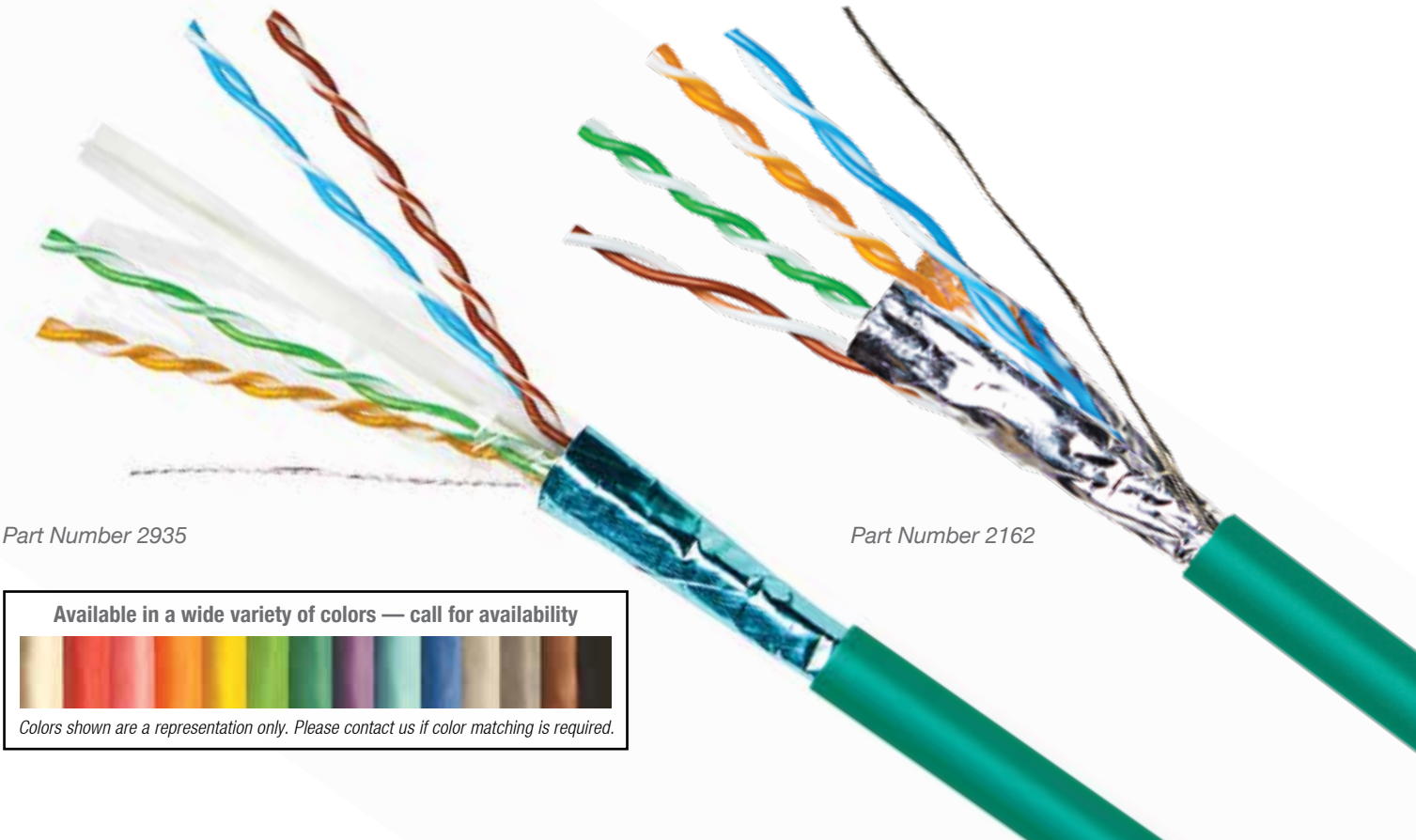
- 26 AWG 7/34 Stranded Tinned Copper
- RoHS Compliant
- Voltage Rating Max 300V
- Bend Radius 8x OD
- PoE, PoE+, PoE++/4PPoE
- Popular colors stocked; check website for inventory
- Weight = WT./M', Nom., Net
- Refer to quabbin.com/calculator for the plug-to-plug maximum length for your application

## Foil Shield

| Part Number | Category | AWG | Jacket | Pair Count | Rating | Temp Max | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 2930-2941 | 6 | 26 | PVC | 4 | CMG, CMR | 75°C | -20°C | 24.5 lbs. | .235" | 250 MHz |
| 2966-2977 | 6 | 26 | LSZH | 4 | CMX | 75°C | -40°C | 29.9 lbs. | .265" | 250 MHz |
| 2067-2077 | 6 Relaxed | 26 | PVC | 4 | CMP | 105°C | -20°C | 22.2 lbs. | .223" | 250 MHz |
| 2025-2033 | 6 Relaxed | 26 | LSZH | 4 | CM-LS | 75°C | -20°C | 23.2 lbs. | .230" | 250 MHz |
| 2157-2168 | 6 Relaxed | 26 | PVC | 4 | CMG, CMR | 75°C | -20°C | 23.6 lbs. | .233" | 250 MHz |

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 2930-2941 | SS-39200-035 | 111S08080095LA4 |
| 2966-2977 | SS-39200-053 | 111S08080095HA4 |
| 2067-2077 | SS-39200-036 | 111S08080095LA4 |
| 2025-2033 | SS-39200-036 | 111S08080095LA4 |
| 2157-2168 | SS-39200-036 | 111S08080095LA4 |



*Part Number 2935*

*Part Number 2162*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 6 / 24 AWG

- 24 AWG 7/32 Stranded Tinned Copper
- RoHS Compliant
- Voltage Rating Max 300V
- Bend Radius 4x OD
- Popular colors stocked; check website for inventory
- PoE, PoE+, PoE++/4PPoE
- Weight = WT./M', Nom., Net
- Refer to quabbin.com/calculator for the plug-to-plug maximum length for your application

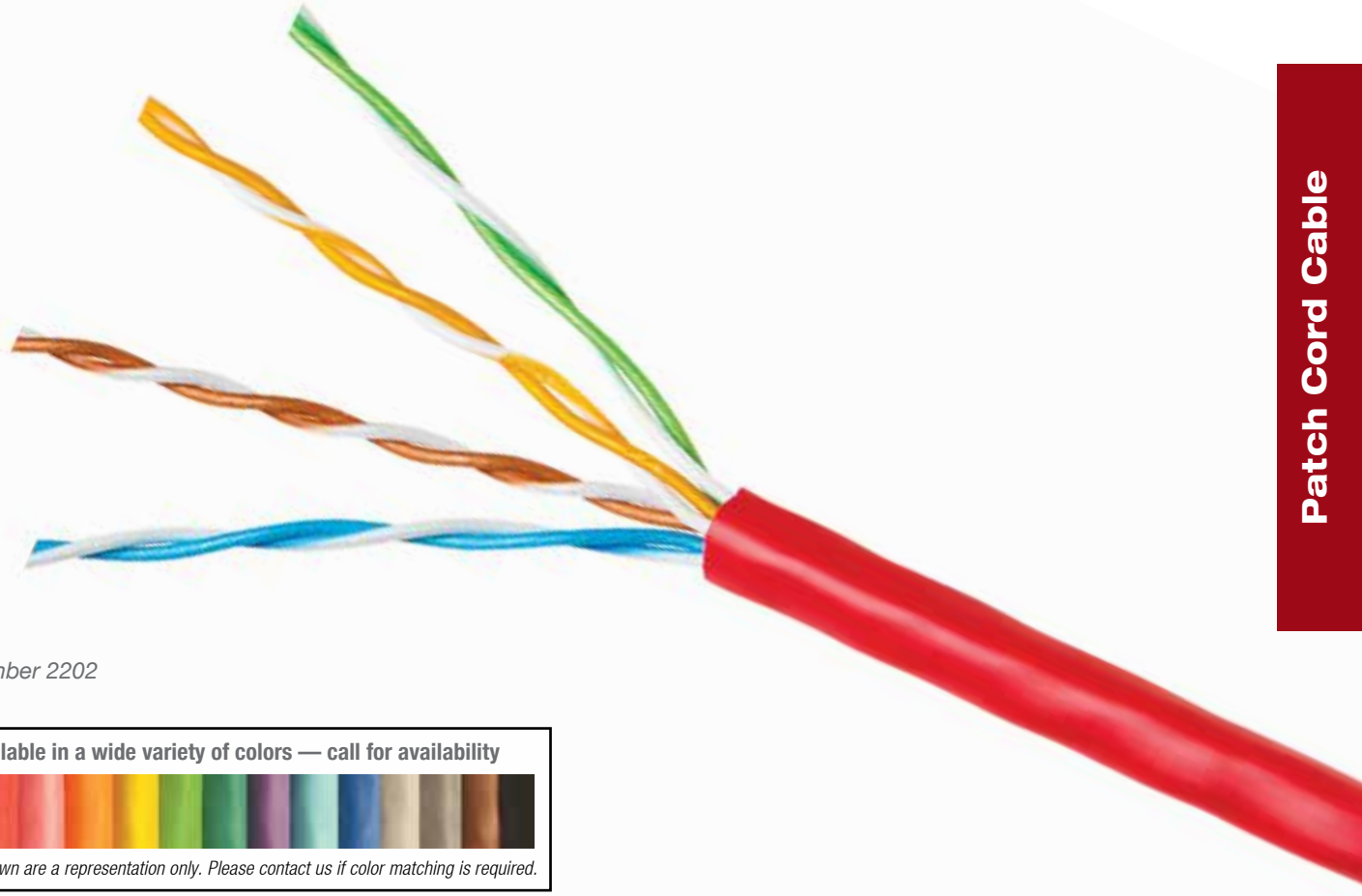
## Unshielded

| Part Number | Category | AWG | Jacket | Pair Count | Rating* | Temp Max* | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 1300-1312 | 6 | 24 | LSZH | 4 | CMX | 75°C | -20°C | 27.4 lbs. | .231" | 250 MHz |
| 2200-2215 | 6 | 24 | PVC | 4 | CMG/CMR | 60°C/75°C | -20°C | 23.7 lbs. | .220" | 500 MHz |
| 2200B-2215B | 6 | 24 | PVC | 4 | CMG/CMR | 60°C/75°C | -20°C | 24.0 lbs. | .220" | 500 MHz |

*Canada/US

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 1300-1312 | SS-39100-021 | 111-08080054L34 |
| 2200-2215 | SS-39100-021 | 111-08080054L34 |
| 2200B-2215B | SS-39100-021 | 111-08080054L34 |



*Part Number 2202*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 5e / 26 AWG

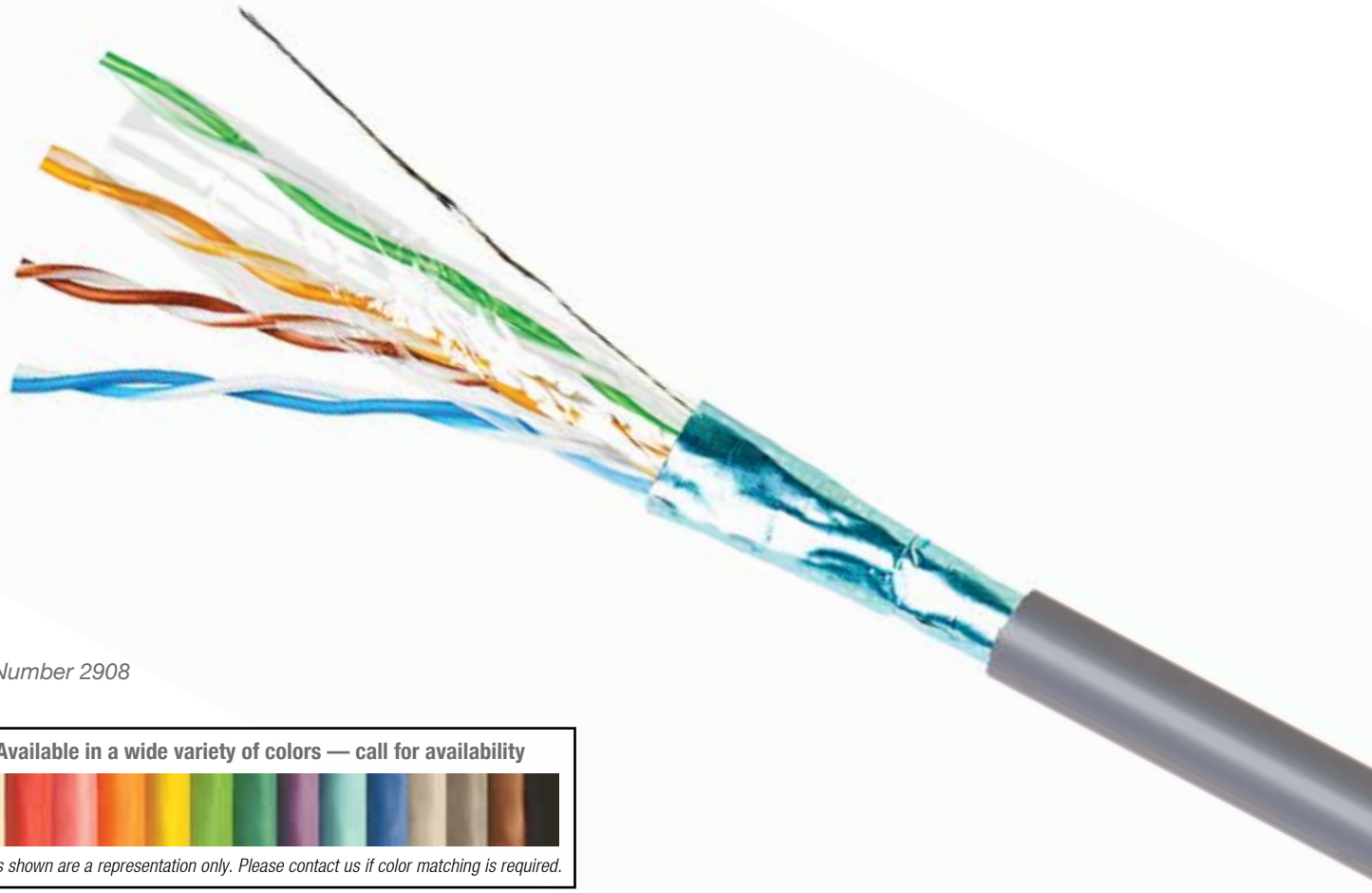
- 26 AWG 7/34 Stranded Tinned Copper
- RoHS Compliant
- Voltage Rating Max 300V
- Bend Radius 8x OD
- Popular colors stocked; check website for inventory
- PoE, PoE+, PoE++/4PPoE
- Weight = WT./M', Nom., Net
- Refer to quabbin.com/calculator for the plug-to-plug maximum length for your application

## Foil Shield

| Part Number | Category | AWG | Jacket | Pair Count | Rating | Temp Max | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 2510-2514 | 5e | 26 | PVC | 4 | CM | 75°C | -20°C | 32.2 lbs. | .226" | 100 MHz |
| 2800-2810 | 5e | 26 | LSZH | 4 | CMX | 75°C | -20°C | 26.8 lbs. | .241" | 100 MHz |
| 2900-2912 | 5e | 26 | PVC | 4 | CMR | 75°C | -20°C | 22.2 lbs. | .222" | 100 MHz |

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 2510-2514 | Contact Quabbin | Contact Quabbin |
| 2800-2810 | SS-39200-054 | 111S08080028L34 |
| 2900-2912 | SS-37200-028 | 110S080820-24 |



*Part Number 2908*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 5e / 24 AWG

- 24 AWG 7/32 Stranded Tinned Copper
- RoHS Compliant
- Voltage Rating Max 300V
- Bend Radius 4x OD
- Popular colors stocked; check website for inventory
- PoE, PoE+, PoE++/4PPoE
- Weight = WT./M', Nom., Net
- Refer to quabbin.com/calculator for the plug-to-plug maximum length for your application

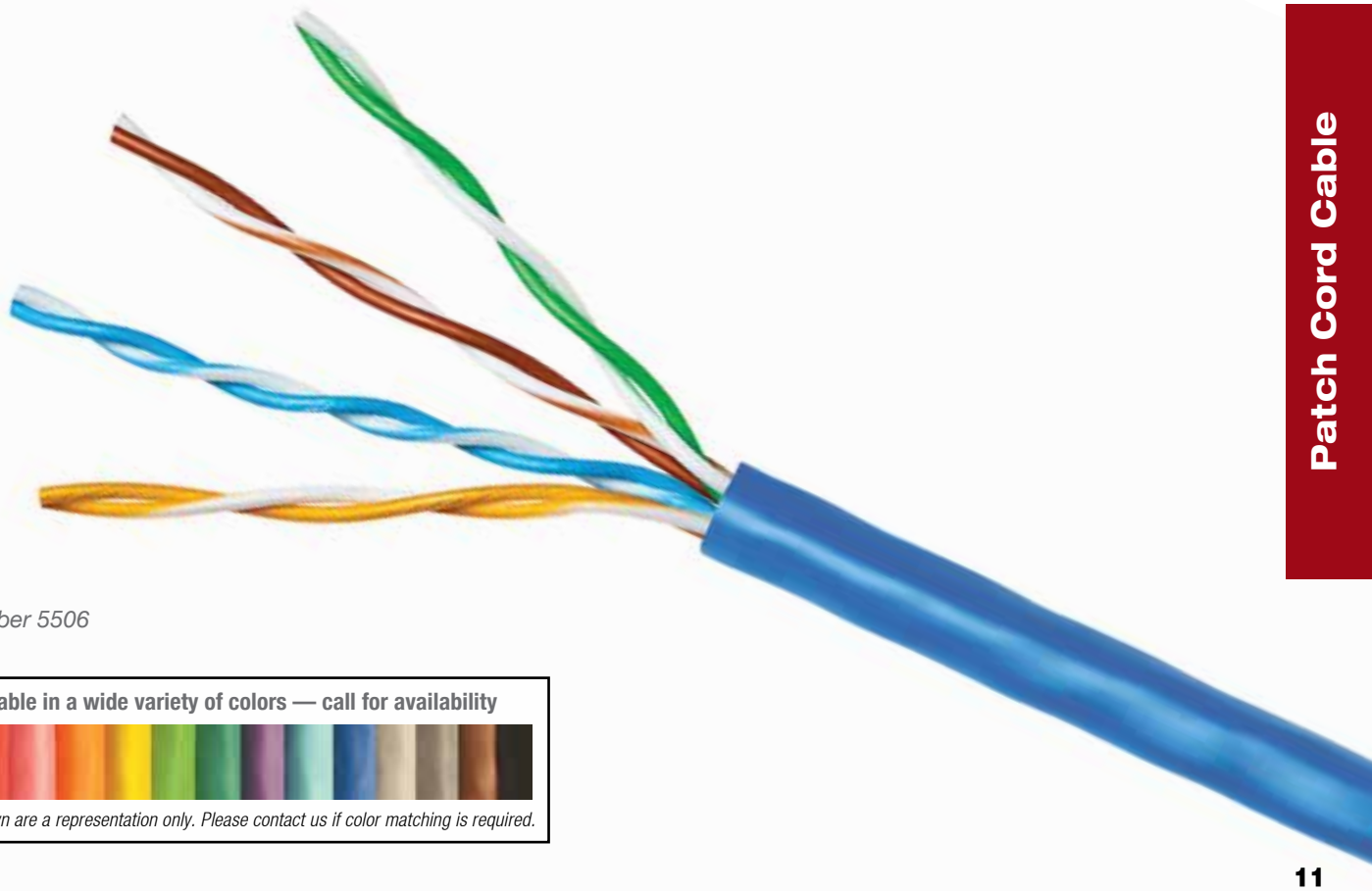
## Unshielded

| Part Number | Category | AWG | Jacket | Pair Count | Rating* | Temp Max* | Temp Min | Weight/M' | Nom. OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 1200-1215 | 5e | 24 | LSZH | 4 | CMX | 75°C | -20°C | 26.5 lbs. | .223" | 100 MHz |
| 5100-5112 | 5e | 24 | PVC | 1 | CM/CMG | 60°C/75°C | -20°C | 7.77 lbs. | .120" | 100 MHz |
| 5200-5212 | 5e | 24 | PVC | 2 | CM, CMG | 75°C | -20°C | 14.2 lbs. | .200" | 100 MHz |
| 5500-5515 | 5e | 24 | PVC | 4 | CMG/CMR | 60°C/75°C | -20°C | 22.2 lbs. | .215" | 100 MHz |

*Canada/US

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 1200-1215 | SS-39100-048 | 111-08080028L34 |
| 5100-5112 | Contact Quabbin | Contact Quabbin |
| 5200-5212 | Contact Quabbin | Contact Quabbin |
| 5500-5515 | SS-37000-007 | 106-080800-34 |



*Part Number 5506*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

# Patch Cord Cable
# Cat 5 / 26 AWG

- 26 AWG 7/34 Stranded Tinned Copper
- RoHS Compliant
- Voltage Rating Max 300V
- UL AWM Style 2552
- Bend Radius 8x OD
- PoE, PoE+, PoE++
- Weight = WT./M', Nom., Net
- Refer to quabbin.com/calculator for the plug-to-plug maximum length for your application

## Foil Shield

| Part Number | Category | AWG | Jacket | Pair Count | Rating | Temp Max | Temp Min | Weight/M' | Nom OD | Tested to |
|---|---|---|---|---|---|---|---|---|---|---|
| 9604 | 5 | 26 | PVC | 2 | CMR | 60°C | -20°C | 13.7 lbs. | .170" | 100 MHz |

### Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 9604 | SS-37200-028 | Contact Quabbin |

*Part Number 9604*

**Available in a wide variety of colors — call for availability**



*Colors shown are a representation only. Please contact us if color matching is required.*

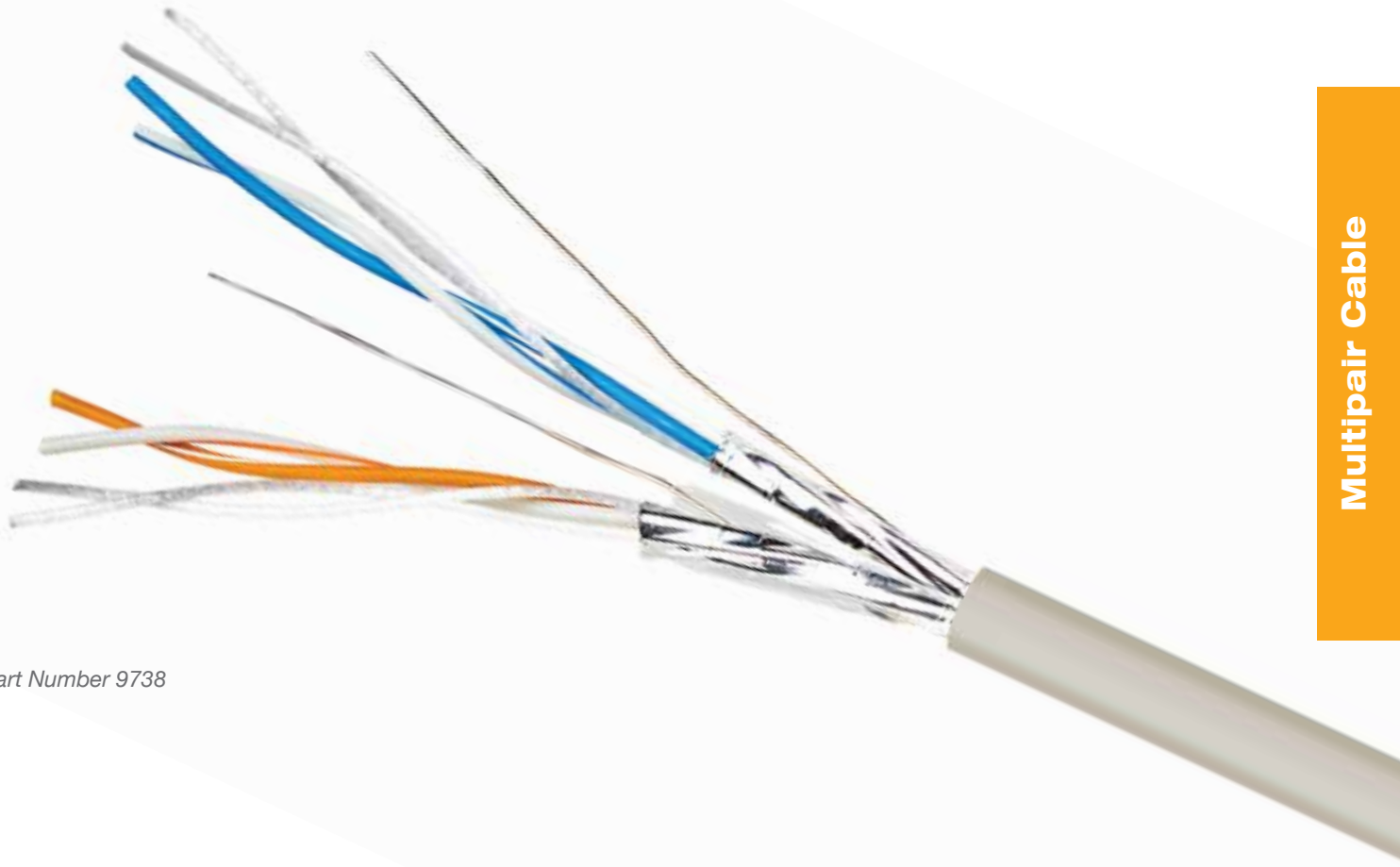
# Multipair Cable
# T1, E1, xDSL

- » 22 or 24 AWG solid, bare or tinned copper
- » All parts contain a drain wire
- » RoHS Compliant
- » Parts 9720 and 9738 fit modular plug and comply with ANSI T1.202-2004 to 200m (650 ft.), Part 9770 to 160m (525 ft.)
- » Weight = WT./M', Nom., Net
- » Voltage Rating Max 300V
- » Bend Radius 8x smallest dimension
- » Popular stocked parts listed below—see website for additional parts and spec information

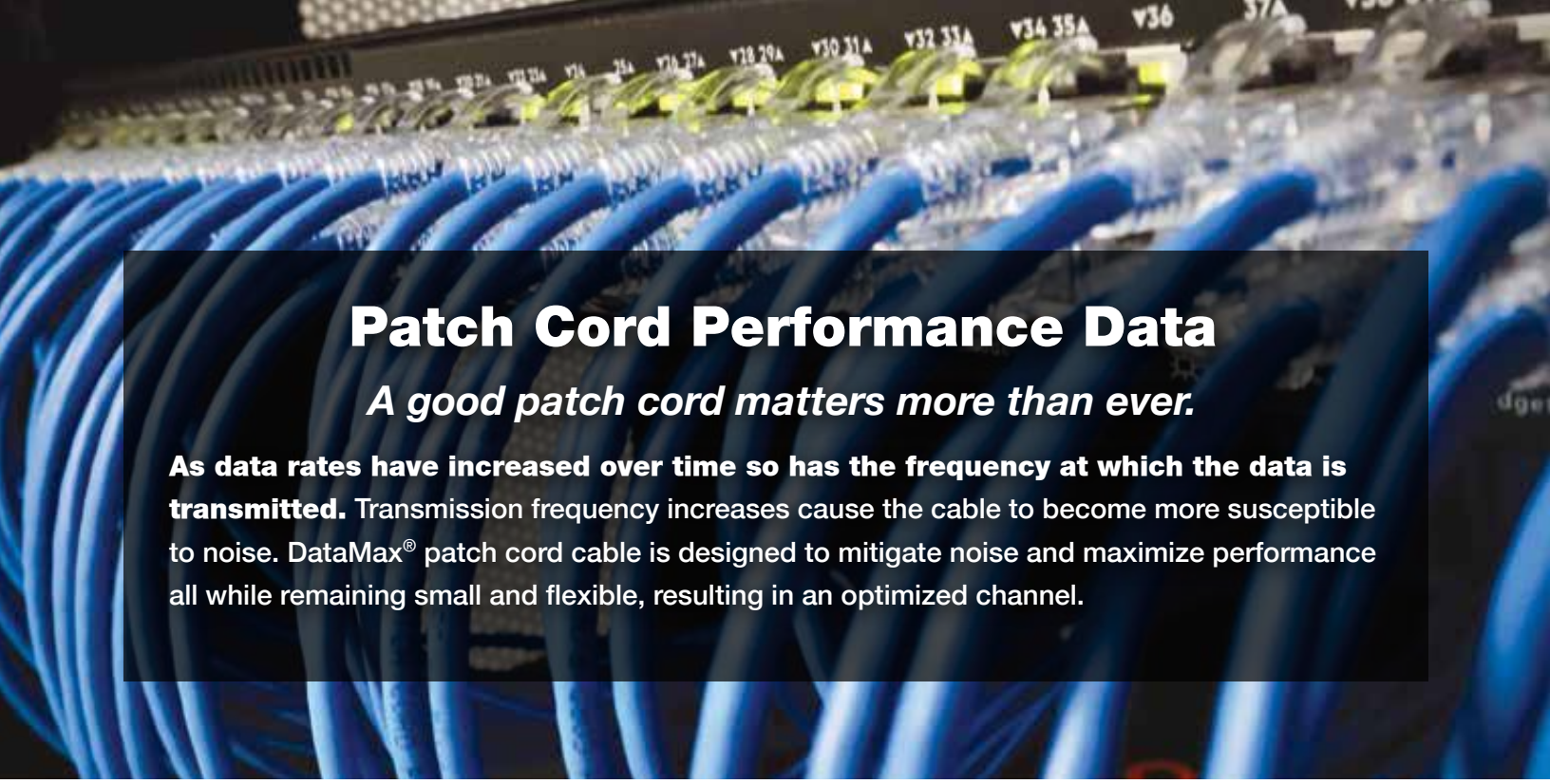
| Part Number | Pair Count | AWG | Copper | Shielded Pairs | Jacket | Rating | Color | Temp Max | Temp Min | Weight/M' | Nom Dimensions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9720 | 2 | 22 | Tinned, solid | X | PVC | CMR | Beige | 75°C | -20°C | 37.5 lbs. | .184" X .326" |
| 9738 | 2 | 22 | Bare, solid | X | ECTFE | CMP | Gray | 150°C | -40°C | 27.0 lbs. | .169" X .308" |
| 9770 | 2 | 24 | Tinned, solid | X | PVC | CMR | Beige | 60° C | -20°C | 27.5 lbs. | .170" X .300" |

## Compatible Connectors

| Quabbin P/N | Bel Stewart Connector | Sentinel Connector |
|---|---|---|
| 9720<br>9738<br>9770 | 940-SP-3088-0B | 110-080820-24<br>110S080820-24 |



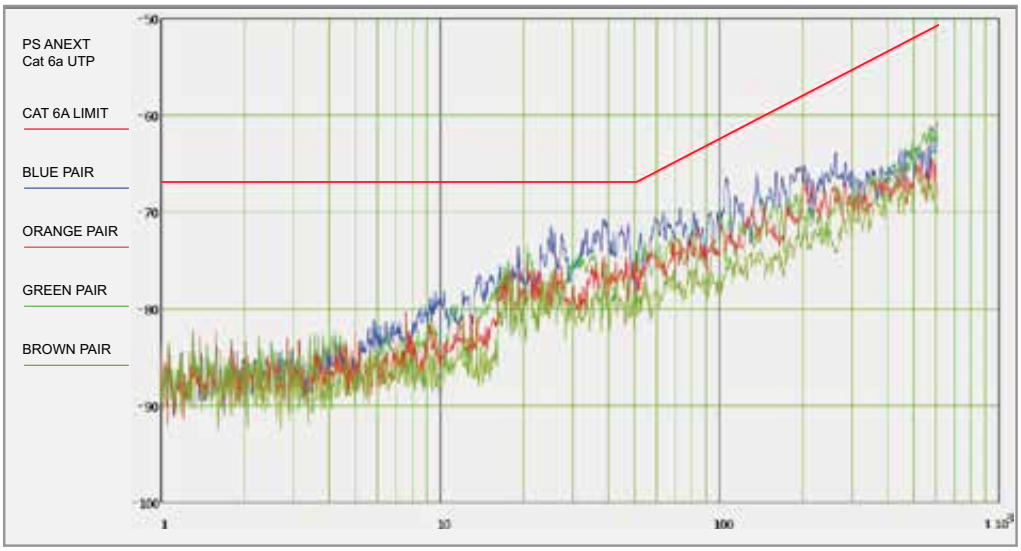
*Part Number 9738*



# Patch Cord Performance Data

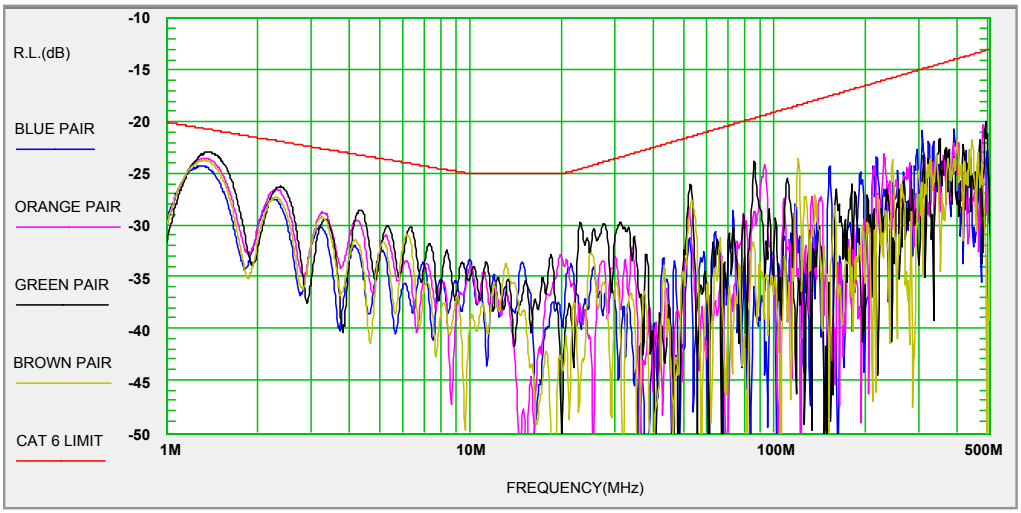
## *A good patch cord matters more than ever.*

**As data rates have increased over time so has the frequency at which the data is transmitted.** Transmission frequency increases cause the cable to become more susceptible to noise. DataMax® patch cord cable is designed to mitigate noise and maximize performance all while remaining small and flexible, resulting in an optimized channel.



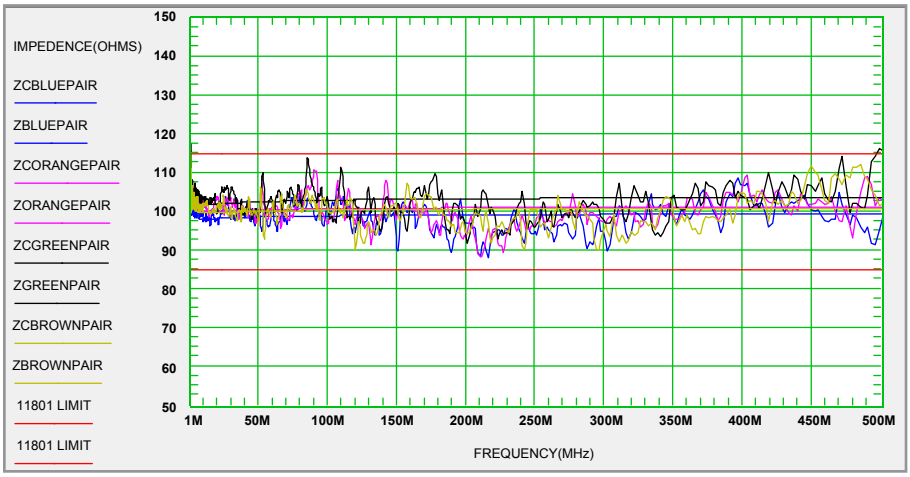

### ANEXT

The unique construction of DataMax® resists electrical noise trying to couple from one pair of wires to another within a multi-pair cable. Notice how the crosstalk levels of the various cable pairs do not touch the red limit line. This is optimum and demonstrates that any crosstalk present in the cable is too small to affect transmissions.



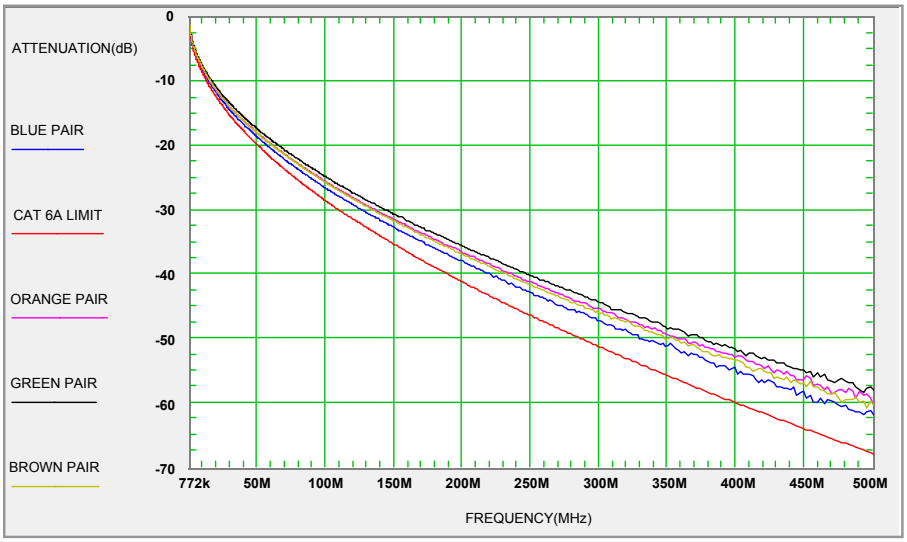

### RETURN LOSS

Test results show superior performance which means impedance variations that distort high speed transmissions are minimal, resulting in optimized signal strength and clarity.




## IMPEDANCE

The impedance chart to the left shows test results of Quabbin's DataMax® 10Gig product — and demonstrates our product development team's expertise in designing a cable with stable impedance.




## ATTENUATION

(Insertion Loss) in this case measures the change in signal strength over the length of the cable. The signal at the far end must be strong enough for the receiver to distinguish it. If not, retransmissions are required which gives the user the impression that the network is slow. As seen in the graph, the signals of the pairs are much stronger than the limit line requires for success on the first transmission.

## Impedance

The impedance chart above shows both an upper and lower limit line depicting high and low impedance. Quabbin's DataMax® products are expertly designed for stable impedance – a key performance factor for precision data cable.

## Round Design for Higher Yield Assembly

Patch cord assembly relies upon dimensional consistency for ease of processing. The best cables are manufactured with consistent dimensions that allow for maximum throughput, high yield and a short learning curve for assemblers. DataMax® patch cord cable is designed specifically to contribute to efficient, problem-free and profitable assembly operations.

## Installation

DataMax® patch cord cables are designed with the installer in mind. Durability and flexibility are paramount given the multiple moves, adds and changes that are typical in data centers. Cables that are both pliable and durable allow the installer to manipulate the cable more easily without compromising data integrity.

DataMax® cables undergo millions of cycles of bend/flex testing to verify that their performance will withstand the most challenging installations. Installation-friendly designs must be considered when specifying cables for today's high volume data environments.

# **White Paper:** Design factors for implementing commercial PoE on 28 AWG and 26 AWG stranded patch cord cable

By Jim Rivernider and Eric Olson

**Power over Ethernet (PoE) technology** simplifies enterprise and datacenter building infrastructure, enabling power delivery over network cables to provide data connectivity and power supply with a single cable.

The convenience of PoE, however, comes at a cost. When designing structured telecommunications cabling systems for PoE, engineers must consider an additional factor that is not a concern for simple, network-only cable installations. When delivering power in any cable, a small portion of the power is dissipated as heat due to the DC resistance of the conductors. This heat causes a temperature rise in the cabling that can diminish cable life, degrade data transmission performance, and even pose a fire risk. Heat dissipation increases as conductor diameter decreases, and temperature rise is amplified in installation scenarios that bundle multiple cables together. Consequently, designers must account for these factors during the design of PoE cabling systems to properly manage temperature rise and keep cables below their maximum operating temperature.

Thinner 28 AWG and 26 AWG stranded ethernet patch cord cables offer flexibility, easier cable management and improved air flow around server racks compared to thicker network cables; however, they also dissipate more power as heat, requiring a focus on installation configuration (e.g., bundle sizes) to maintain desired performance levels and safe operating conditions.

## PoE types

PoE dates back to 2003, when IEEE approved the 802.3af standard. Proprietary methods to deliver power over network cables existed before 802.3af, but the new standard defined a systematic way to supply power from power sourcing equipment (PSE) over an ethernet cable to a powered device (PD). 802.3af allowed power delivery over two of the four pairs of conductors in an ethernet cable, with a maximum power output from the PSE of 15.4 W, ensuring a minimum of 12.95 W delivered to the PD. This level of PoE is known as Type 1.

Power demands multiplied as PoE grew in popularity due to its convenience and as more varied devices with increasing capabilities were deployed. In 2009, IEEE ratified the 802.3at standard that defines Type 2 PoE and increases the amount of power supplied over two energized pairs to a maximum 30 W from the PSE, and a minimum power delivery to the PD of 25.5 W.

The latest PoE standard, IEEE 802.3bt, defines two additional PoE types, Type 3 and Type 4, each utilizing the full four pairs of the cable to deliver power alongside data. Type 3 PoE allows a maximum power output from the PSE of 60 W and a minimum power delivery to the PD of 51 W. Type 4 PoE permits up to 99.9 W for the PSE and PD power delivery of 71 W. Note Type 4 complies with the 100 W per port limit imposed by the limited power source and safety extra low voltage (SELV) requirements defined in ISO/IEC 60950.

| Standard | IEEE 802.3af | IEEE 802.3at | IEEE 802.3bt | |
|---|---|---|---|---|
| Common Terminology | PoE | PoE+ | PoE++/4PPoE | |
| PoE Type | 1 | 2 | 3 | 4 |
| Date of Standard Ratification | 2003 | 2009 | September 2018 | |
| Maximum Number of Energized Pairs | 2 | 2 | 4 | 4 |
| Maximum DC Current per Pair | 350 mA | 600 mA | 600 mA | 960 mA |
| Maximum Power Delivered by the Power Sourcing Equipment (PSE) | 15.4 W | 30 W | 60 W | 99.9 W |
| Minimum Required Power at the Powered Device (PD) | 12.95 W | 25.5 W | 51 W | 71 W |
| Maximum Data Rate | 1000BASE-T | 1000BASE-T | 10GBASE-T | |

*Figure 1: Maximum power delivery allowed for each of the four PoE types specified in IEEE 802.3 standards.*

## Stranded vs. solid conductors

Generally, ethernet cables are comprised of eight conductors arranged in four pairs, with each conductor in the pair twisted around its partner in a helical configuration. Each conductor is covered by an insulating material such as polyethylene or fluorinated ethylene propylene (FEP) to protect the metal wire from environmental exposure degradation and meet electrical performance. The four pairs are optionally wrapped in a shield such as aluminum polyester foil to minimize electromagnetic interference (EMI) and crosstalk. The assembled pairs are then enveloped in a protective outer jacket (e.g., polyvinylchloride) for protection from the environment.

Reference Guide

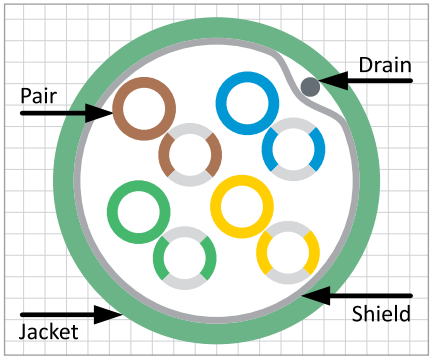



*Figure 2: Cross-section of a PoE cable showing external jacketing and internal construction including insulation, shielding and arrangement of conductor pairs.*

Ethernet cables are supplied with two different types of core conductor configurations: stranded and solid. The conductors in stranded ethernet cables are comprised of seven smaller wires twisted together. Solid ethernet cables, on the other hand, have a single wire for each conductor. Each of the various categories of ethernet cable defined by ANSI/TIA-568 and ISO/IEC 11801, including category 5e, 6 and 6a, is available.

Gauge size describes the thickness of each conductor and is commonly measured in American wire gauge (AWG). The number of strands per conductor is indicated by additional numbers after the conductor gauge size. For example, 28 AWG 7/36 indicates that the 28 AWG conductors in the cable are each comprised of seven wires with thicknesses of 36 AWG.

Stranded cables have several advantages compared to solid cables. They exhibit lower DC resistance, resulting in less heat generation for a given current passing through them. Their twisted, multi-wire construction also resists breakage when exposed to repetitive bending. Stranded cables' durable flexibility makes them well-suited for applications like patch cabling, where installations may require sharp bends or frequent relocation.

Solid cables are more susceptible to damage from bending. They are better suited to permanent installation in applications like horizontal cabling and backbone cabling between entrance facilities, equipment rooms and telecommunications closets.

## Design considerations for PoE 28 AWG and 26 AWG stranded patch cord cable

When selecting ethernet cable gauge size, engineers should take into account a number of design considerations. 28 AWG and 26 AWG stranded patch cord cables have several advantages compared to thicker cables. With smaller diameters, they weigh less and occupy less space. This is particularly beneficial in cramped locations near patch panels, where dozens of cables converge in a small space. Smaller, lighter patch cord cables enable easier cable management and allow more air flow to reach network equipment.

*Figure 3: Comparison of 26 AWG (left) and 28 AWG (right) DataMax® patch cord cable. DataMax® Mini 6a F/UTP 28 AWG patch cord cable is 23% smaller in size, 38% smaller in cross-sectional area and 33% lighter than standard 26 AWG cable.*

### Insertion loss

On the other hand, thin 28 AWG and 26 AWG ethernet cables have higher insertion losses than cables of thicker gauges. Insertion loss is also higher for stranded cables than solid cables. Insertion loss, or attenuation, is the ratio of received signal power at the end of the cable to the signal power inserted at the start of the cable, measured in decibels (dB). It represents the amount of signal power lost over the length of the cable.

Insertion loss rises with increasing cable length, signal frequency and cable temperature. As a result, it is important to design cable systems with appropriate margins for insertion loss based on cable size, environmental operating conditions and signal characteristics. This involves derating, or shortening, the length of channels to ensure sufficient signal-to-noise ratio and avoid data packet loss. For example, the total length of a channel incorporating 28 AWG patch cord should be shortened to counteract the higher insertion loss from thin, stranded conductors.

### DC resistance

28 AWG and 26 AWG patch cord cables also have higher DC resistances compared to thicker-gauge cables. As a result, they generate more heat per unit of current that flows through them, resulting in higher cable temperatures for the same current capacity. The consequence of this high resistive heating is that thin cables safely carry less current than thick cables. If cable temperature rises above the rating of the cable's insulation and jacketing, the cable could melt or ignite.

### Shielding

Shielding can help mitigate thermal risks. Cables with integral foil shielding wrapped around the conductors dissipate heat more efficiently than unshielded cables. The foil conducts heat away from the interior of the cable to its exterior surface, where radiation and convection convey heat away from the cable. Temperature rise is reduced for shielded cables, allowing them to safely carry high currents.

Quabbin Wire & Cable offers 28 AWG and 26 AWG patch cords with a patented design that maximizes shield effectiveness and improves heat dissipation. The design eliminates both the spline and polyester tape inside of the cable that typically separates the conductor pairs to reduce crosstalk. Instead, a special shield arrangement achieves this same purpose. The lack of a spline eases patch cord assembly since there is no need to carefully cut it out during fabrication. The cable is also light and effectively dissipates heat.

## PoE standards and installation guidelines

Engineers designing cable systems with 28 AWG and 26 AWG stranded patch cord cables can refer to requirements and guidance provided by several standards, guidelines, certifications and codes.

The Telecommunication Industry Association's (TIA) ANSI/TIA-568.2-D standard specifies mechanical and transmission requirements for balanced twisted-pair telecommunications cabling and components. In general, the standard requires 22 AWG to 28 AWG for cord cable. The requirements include limiting the maximum length of 28 AWG cords in a channel to 15m; derating the maximum channel length to make up for the higher insertion loss of 28 AWG cord according to Annex G of the standard; and following the guidelines enumerated in Technical Systems Bulletin TIA-TSB-184-A-1.

*Figure 4: DataMax® Relaxed Patch Plenum Cat 6a F/UTP 26 AWG Cable.*

TIA-TSB-184-A-1 provides conservative guidance for 28 AWG cord cables, specifying the temperature rise for various cable bundle sizes and different current levels. It also recommends the maximum number of cables allowed in a bundle to limit temperature rise to 15°C at ambient temperature conditions of both 20°C and 45°C. TIA-TSB-184-A-1 is an addendum to TIA-TSB-184-A, which provides similar guidance for 26 AWG stranded cord cables as well as thicker cable gauges.

The 2017 National Electric Code (NEC) 725.144 does not cover patch cord cable. For generic cables the standard sets limits on bundle size, length and temperature rise based on minimally compliant cable. Quabbin performs tests and offers supporting data on each of our category cables to support PoE recommendations that exceed the standard's limits.

## CMR vs. CMP

The 2017 NEC also specifies cable rating requirements based on the spaces inside a building where cables are installed in order to limit the spread of fire and smoke in the event of a fire emergency. Riser-rated (CMR) cables are approved for installation in vertical shafts between floors in a building through which wiring, conduit and pipes are routed to transfer power and utilities. CMR cables must resist spreading fire from floor to floor. Plenum-rated (CMP) cables are rated for installation in a building's plenum spaces, which are areas for air circulation for heating and air conditioning. CMP-rated cables have strict flame propagation as well as low-smoke requirements.

## Quabbin PoE Testing

Determining the proper cable and installation configurations for 28 AWG and 26 AWG stranded patch cord cable PoE applications can be a complicated and lengthy process. Quabbin Wire & Cable simplifies matters by providing customers with specific guidance relative to their unique application. This is enabled by Quabbin's capability to evaluate temperature rise for most bundle sizes and current levels.

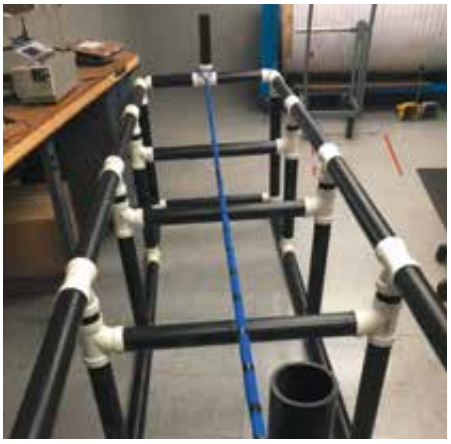


*Figure 5: Test fixture used to characterize temperature rise for various cable bundle sizes, cable constructions and current levels.*

Quabbin's test setup consists of a fixture holding a bundle of cables through which a constant DC current is delivered by a power supply. Ambient temperature is fixed at 20°C. Thermocouples connected to a data logger are placed inside slits in the center cable and outermost cable as well as on the fixture. Temperature rise at the center of the bundle is recorded for the duration of each test. Each test is run until the temperature has stabilized; a condition defined as a temperature variation of not more than 0.3°C in 15 minutes. The next test is started after the bundle has returned to ambient temperature. The average duration of a test is 1 hour and 30 minutes. Tests are run for a variety of different bundle sizes, cable constructions and DC current levels.

From the data generated by these tests, Quabbin derives trend lines for temperature rise versus number of cables in a bundle at various current levels. From these trend-line equations, the maximum bundle size for a desired maxi-

mum temperature rise can be calculated. This is accomplished by choosing the trend-line equation for the required current level, inputting the desired temperature rise as the y-value and solving for the x-value. The x-value is the number of cables in a bundle that will raise the bundle temperature by the amount specified at the given current level.

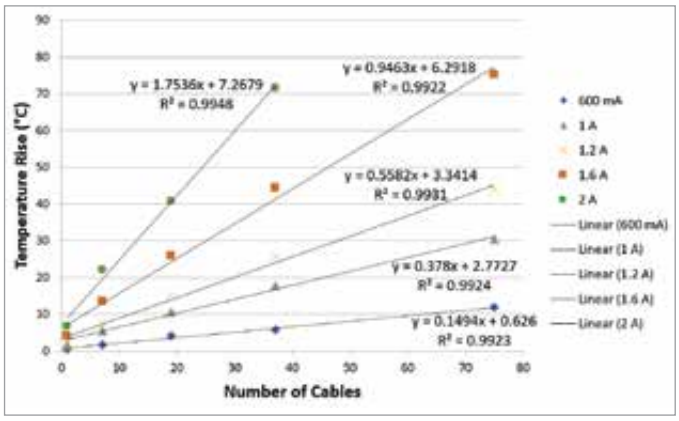



*Figure 6: Test data for temperature rise in Quabbin DataMax® Patch Plenum Mini 6a 2043 cable for various cable bundle sizes and current levels, with trend lines plotted for each current level.*

Based on these calculations, Quabbin can specify the maximum bundle size to ensure temperature rise does not exceed a cable's temperature rating, as well as the maximum bundle size to limit temperature rise below a desired maximum value.

| Current | PN 2222 UTP 28 AWG 75 C Rating | PN 2240 F/UTP 28 AWG 75 C rating | PN 2043 F/UTP 28 AWG 105 C rating | PN 2049 F/UTP 26 AWG 105 C rating |
|---|---|---|---|---|
| 600 mA | 264 Cables | 404 Cables | 564 Cables | 1191 Cables |
| 1A | 90 Cables | 130 Cables | 217 Cables | 406 Cables |
| 1.2A | 62 Cables | 90 Cables | 146 Cables | 271 Cables |
| 2A | 21 Cables | 26 Cables | 44 Cables | 90 Cables |

*Figure 7: Maximum bundle sizes to limit temperature rise below cable temperature ratings for four Quabbin patch cord cables. Numbers are calculated based on empirical temperature rise test data.*

| Current | PN 2222 UTP 28 AWG 75 C Rating | PN 2240 F/UTP 28 AWG 75 C rating | PN 2043 F/UTP 28 AWG 105 C rating | PN 2049 F/UTP 26 AWG 105 C rating |
|---|---|---|---|---|
| 600 mA | 71 Cables | 106 Cables | 96 Cables | 204 Cables |
| 1A | 22 Cables | 31 Cables | 32 Cables | 64 Cables |
| 1.2A | 15 Cables | 20 Cables | 20 Cables | 41 Cables |
| 2A | 2 Cables | 2 Cables | 4 Cables | 9 Cables |

*Figure 8: Maximum bundle sizes to limit temperature rise to 15°C for four Quabbin patch cord cables. Numbers are calculated based on empirical temperature rise test data.*

Quabbin has also performed testing on cable performance over temperature on several of their constructions. Terminated assemblies are placed inside bundles of cable and a thermocouple is used to monitor the temperature in a cable next to the assembly. Handheld testers are used to measure cable performance at different temperatures and this data is compared to room temperature cable performance. This measurement was performed for the Mini 6 unshielded and Mini 6a shielded cables. The results of this measurement are shown below:

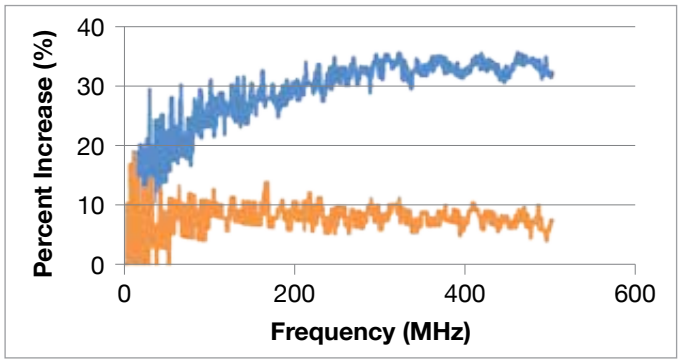



*Figure 9: Percent change in insertion loss vs. frequency for 85°C temp. increase. Test data shows the superiority of shielded cable (orange) over unshielded cable (blue).*

Quabbin's test results indicate a clear performance advantage to using a shielded cable versus an unshielded cable, especially when it comes to insertion loss. The shielded Mini 6a cable insertion is degraded by about 10%, whereas the unshielded Mini-6 cable insertion is degraded by upwards of 30%. The shielding offers some protection from the high loss jacketing materials used in these constructions.

## Conclusion

28 AWG and 26 AWG stranded patch cord cables offer several benefits over heavier, thicker gauge cables for PoE implementations. Thin patch cord cables are more flexible, lighter and take up less space. There are, however, important design factors that should be considered when using thin patch cord cables for PoE applications. Higher DC resistances generate more heat dissipation and steeper temperature rises in thin cables, necessitating careful consideration of safe amperage levels and bundle sizes that will not exceed cable temperature ratings. Several standards and guidelines offer guidance on these factors.

Quabbin Wire & Cable makes it easy to determine the proper cable configuration for specific applications based on empirical temperature rise test data. Contact Quabbin today to learn more about the optimal DataMax® commercial data cable for your application.

# Calculating Channel Length

## Cat 6a

**Equation for patch cord cable length**: C=(105-H)/(1+D)
**Maximum Length Limit**: T=H+C, T≤100 meters

| Patch Cord Cable Gauge | D | H | C | T |
|---|---|---|---|---|
| | Patch De-rating | Horizontal Length | Total Patch Length (stranded cable) | Total Channel Length (must be less than 100m) |
| 24 | 0.2 | 50 | 45.8 | 95.8 |
| 26 | 0.5 | 50 | 36.7 | 86.7 |
| 28 | 0.95 | 50 | 28.2 | 78.2 |
| 22 | 0 | 50 | 50.0 | 100.0 |

## Cat 5e/6

**Equation for patch cord cable length**: C=(102-H)/(1+D)
**Maximum Length Limit**: T=H+C, T≤100 meters

| Patch Cord Cable Gauge | D | H | C | T |
|---|---|---|---|---|
| | Patch De-rating | Horizontal Length | Total Patch Length (stranded cable) | Total Channel Length (must be less than 100m) |
| 24 | 0.2 | 50 | 43.3 | 93.3 |
| 26 | 0.5 | 50 | 34.7 | 84.7 |
| 28 | 0.95 | 50 | 26.7 | 76.7 |
| 22 | 0 | 50 | 50.0 | 100.0 |

Visit our Stranded Cable Calculator Tool at www.quabbin.com/calculators

### Mini 6a Standard TIA Channel Using 28 AWG

**TIA EXAMPLE**

*90 Meter Horizontal + 10 Meter Patch = 100 Meter Channel*


**28 AWG CAT 6a PATCH EXAMPLES**

*90 Meter Horizontal + 7.8 Meter Patch = 97.8 Meter Channel*


*86 Meter Horizontal + 2 Meter Patch = 88 Meter Channel*


*Plug to Plug 28 AWG DataMax® Mini-6a = 56 Meters*

### Mini 6 Standard TIA Channel Using 26 AWG

**TIA EXAMPLE**

*90 Meter Horizontal + 10 Meter Patch = 100 Meter Channel*


**28 AWG CAT 6 PATCH EXAMPLES**

*90 Meter Horizontal + 6 Meter Patch = 96 Meter Channel*


*83 Meter Horizontal + 10 Meter Patch = 93 Meter Channel*


*Plug to Plug 28 AWG DataMax® Mini-6 = 55 Meters*

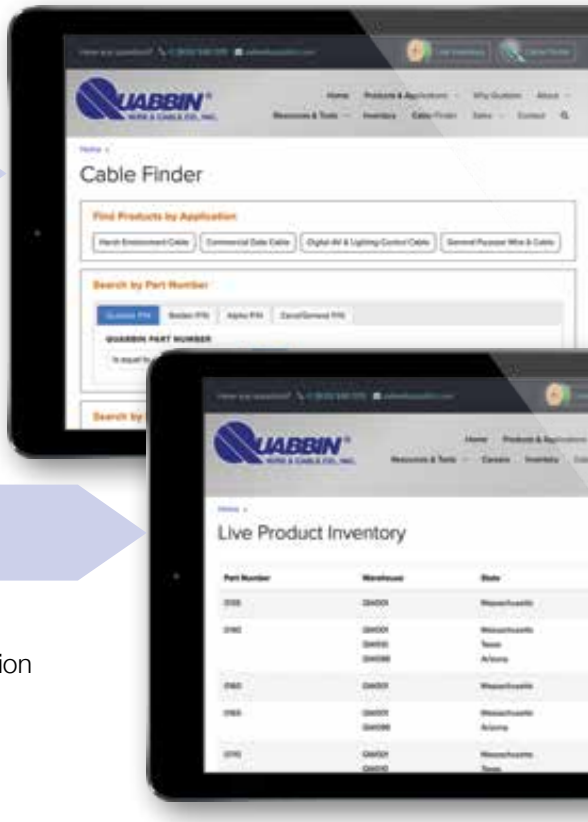
# Quabbin Website Tools

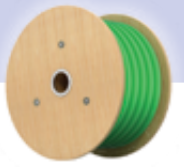
## Cable Finder

*Search our products by:*

- Application
- Construction
- Physical Properties
- Category
- Part Number
- Ratings & Approvals

www.quabbin.com/cable-finder



## Inventory Finder

*Check our inventory:*

- Part Number
- Quantity Available
- Warehouse Location

www.quabbin.com/inventory

Reference Guide

# Improving Subpar Channels

***Quabbin DataMax® patch cord cable is so good it can lend its headroom to a subpar channel.***

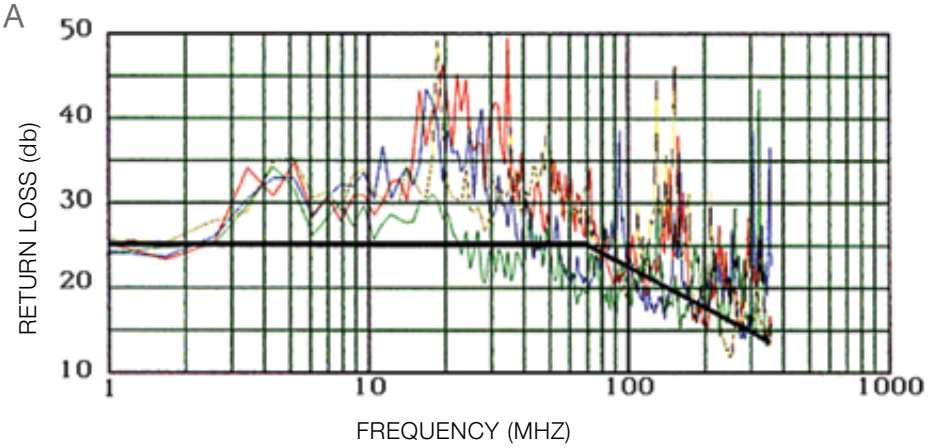
**The cable, one of the least expensive parts of the network, can and does have an enormous impact on system response time.** The key to success is measured with a cable cost-to-performance ratio that always makes the Quabbin user a winner. Not only is DataMax® patch cord cable proven to deliver fully compliant operational characteristics, it's so good it can enhance the overall performance of a subpar channel as shown below.

## AN INEXPENSIVE YET EFFECTIVE FIX

Chart A below illustrates the actual return loss noise in a "problem channel." Notice that it barely meets the required minimum performance for Category 5e. There is very little performance margin/headroom.

Chart B below illustrates the same channel after simply replacing the patch cord cables with high quality DataMax® products. The wall plates, patch panels, horizontal cabling and other components were unchanged. Since any enhancement or decline in channel component performance is cumulative, the improvement in patch cord cable performance translates into a 4-6 dB increase in return loss headroom for the entire channel. A borderline network has been converted to a healthy one with an inexpensive yet effective fix. This also applies to Category 6 and 6a channels.

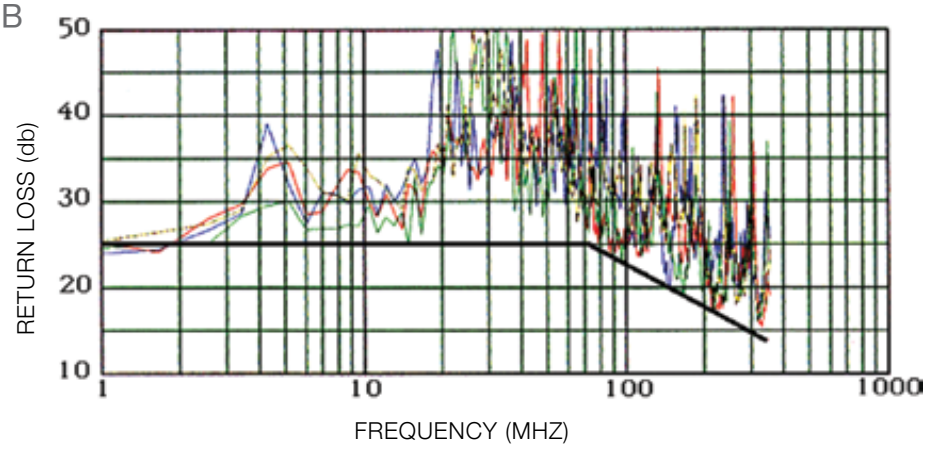
A




### Problem Channel

Return loss fails to meet the required minimum performance for Category 5e.

B




### Channel after patch cord cables replaced with DataMax®

The same channel after simply replacing the patch cord cables with high quality DataMax® cords — resulting in an increase in return loss headroom for the entire channel. A borderline network has been converted to a healthy one with an inexpensive yet effective fix. This also applies to Category 6 and 6a.

# DataMax® Patch Cord Cable Specifications

| DataMax® Commercial | Category | AWG | Pair Count | Stranded | Shield | Separator Free | Jacket | Rating* | Temp Max* | Temp Min | Weight/M' | Nom OD | Tested to | RoHS | Part Number | Page |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NON HALOGEN | 6a Mini | 28 | 4 | • | • | • | LSZH | CM-LS | 75°C | -20°C | 16.8 lbs. | .190" | 500 MHz | • | 2270-2278 | 5 |
| | 6a Relaxed | 26 | 4 | • | • | • | LSZH | CM-LS | 75°C | -20°C | 23.2 lbs. | .230" | 500 MHz | • | 2279-2287 | 6 |
| | 6a | 26 | 4 | • | • | | LSZH | CMX | 75°C | -20°C | 30.1 lbs. | .265" | 500 MHz | • | 2978-2989 | 6 |
| | 6 Mini | 28 | 4 | • | | | LSZH | CM-LS | 75°C | -20°C | 10.8 lbs. | .150" | 250 MHz | • | 2260-2269 | 7 |
| | 6 Relaxed | 26 | 4 | • | • | • | LSZH | CM-LS | 75°C | -20°C | 23.2 lbs. | .230" | 250 MHz | • | 2025-2033 | 8 |
| | 6 | 26 | 4 | • | • | | LSZH | CMX | 75°C | -40°C | 29.9 lbs. | .265" | 250 MHz | • | 2966-2977 | 8 |
| | 6 | 24 | 4 | • | | | LSZH | CMX | 75°C | -20°C | 27.4 lbs. | .231" | 250 MHz | • | 1300-1312 | 9 |
| | 5e | 26 | 4 | • | • | | LSZH | CMX | 75°C | -20°C | 26.8 lbs. | .241" | 100 MHz | • | 2800-2810 | 10 |
| | 5e | 24 | 4 | • | | | LSZH | CMX | 75°C | -20°C | 26.5 lbs. | .223" | 100 MHz | • | 1200-1215 | 11 |
| PLENUM | 6a Mini | 28 | 4 | • | • | • | PVC | CMP | 105°C | -20°C | 16.5 lbs. | .186" | 500 MHz | • | 2034-2044 | 5 |
| | 6a Relaxed | 26 | 4 | • | • | • | PVC | CMP | 105°C | -20°C | 22.2 lbs. | .223" | 500 MHz | • | 2056-2066 | 6 |
| | 6 Mini | 28 | 4 | • | • | • | PVC | CMP | 105°C | -20°C | 16.5 lbs. | .186" | 250 MHz | • | 2045-2055 | 7 |
| | 6 Relaxed | 26 | 4 | • | • | • | PVC | CMP | 105°C | -20°C | 22.2 lbs. | .223" | 250 MHz | • | 2067-2077 | 8 |
| PVC | 6a Mini | 28 | 4 | • | • | • | PVC | CMR | 75°C | -20°C | 15.2 lbs. | .186" | 500 MHz | • | 2231-2245 | 5 |
| | 6a Relaxed | 26 | 4 | • | • | • | PVC | CMG, CMR | 75°C | -20°C | 23.6 lbs. | .233" | 500 MHz | • | 2246-2259 | 6 |
| | 6a | 26 | 4 | • | • | | PVC | CMG, CMR | 75°C | -20°C | 24.5 lbs. | .235" | 500 MHz | • | 2942-2953, 2991 | 6 |
| | 6 Mini | 28 | 4 | • | | | PVC | CMR | 75°C | -20°C | 10.8 lbs. | .150" | 250 MHz | • | 2216-2230 | 7 |
| | 6 Relaxed | 26 | 4 | • | • | • | PVE | CMG, CMR | 75°C | -20°C | 23.6 lbs. | .233" | 250 MHz | • | 2157-2168 | 8 |
| | 6 | 26 | 4 | • | • | | PVC | CMG, CMR | 75°C | -20°C | 24.5 lbs. | .235" | 250 MHz | • | 2930-2941 | 8 |
| | 6 | 24 | 4 | • | | | PVC | CMG/CMR | 60°C/75°C | -20°C | 23.7 lbs. | .220" | 500 MHz | • | 2200-2215 | 9 |
| | 6 | 24 | 4 | | | | PVC | CMG/CMR | 60°C/75°C | -20°C | 24.0 lbs. | .220" | 500 MHz | • | 2200B-2215B | 9 |
| | 5e | 26 | 4 | • | • | | PVC | CM | 75°C | -20°C | 32.2 lbs. | .226" | 100 MHz | • | 2510-2514 | 10 |
| | 5e | 26 | 4 | • | • | | PVC | CMR | 75°C | -20°C | 22.2 lbs. | .222" | 100 MHz | • | 2900-2912 | 10 |
| | 5e | 24 | 1 | • | | | PVC | CM/CMG | 60°C/75°C | -20°C | 7.77 lbs. | .120" | 100 MHz | • | 5100-5112 | 11 |
| | 5e | 24 | 2 | • | | | PVC | CM, CMG | 75°C | -20°C | 14.2 lbs. | .200" | 100 MHz | • | 5200-5212 | 11 |
| | 5e | 24 | 4 | • | | | PVC | CMG/CMR | 60°C/75°C | -20°C | 22.2 lbs. | .215" | 100 MHz | • | 5500-5515 | 11 |
| | 5 | 26 | 2 | • | • | | PVC | CMR | 60°C | -20°C | 13.7 lbs. | .170" | 100 MHz | • | 9604 | 12 |

*Canada/US

| Jacket Color | Cat 6a | | | | | | | | Cat 6 | | | | | | | | | | Cat 5e | | | | Cat 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 AWG F/UTP 4 PAIR CMG, CMR | 26 AWG F/UTP 4 PAIR CMX | 28 AWG F/UTP* 4 PAIR CMR | 28 AWG F/UTP* 4 PAIR CM-LS | 28 AWG F/UTP* 4 PAIR CMP | 26 AWG F/UTP* 4 PAIR CMG, CMR | 26 AWG F/UTP* 4 PAIR CM-LS | 26 AWG F/UTP* 4 PAIR CMP | 24 AWG UTP 4 PAIR CMG/ CMR** | 24 AWG UTP 4 PAIR CMX | 26 AWG F/UTP 4 PAIR CMG, CMR | 26 AWG F/UTP 4 PAIR CMX | 28 AWG UTP 4 PAIR CM-LS | 28 AWG UTP 4 PAIR CMR | 28 AWG F/UTP* 4 PAIR CMP | 26 AWG F/UTP* 4 PAIR CMP | 26 AWG F/UTP* 4 PAIR CM-LS | 26 AWG F/UTP* 4 PAIR CMG, CMR | 24 AWG UTP 4 PAIR CMG/ CMR** | 24 AWG UTP 4 PAIR CMX | 26 AWG F/UTP 4 PAIR CMR | 26 AWG F/UTP 4 PAIR CMX | 26 AWG F/UTP 2 PAIR CMR |
| Black | 2942 | 2978 | 2231 | 2270 | 2034 | 2246 | 2279 | 2056 | 2200 | 1300 | 2930 | 2966 | 2260 | 2216 | 2045 | 2067 | 2025 | 2157 | 5500 | 1200 | 2900 | 2800 | |
| Brown | 2943 | 2979 | 2232 | | 2035 | 2247 | | 2057 | 2201 | 1301 | 2931 | 2967 | | 2217 | 2046 | 2068 | | 2158 | 5501 | 1201 | 2901 | 2801 | |
| Red | 2944 | 2980 | 2233 | 2271 | 2036 | 2248 | 2280 | 2058 | 2202 | 1302 | 2932 | 2968 | 2261 | 2218 | 2047 | 2069 | 2026 | 2159 | 5502 | 1202 | 2902 | 2802 | |
| Orange | 2945 | 2981 | 2234 | 2272 | 2037 | 2249 | 2281 | 2059 | 2203 | 1303 | 2933 | 2969 | 2262 | 2219 | 2048 | 2070 | 2027 | 2160 | 5503 | 1203 | 2903 | 2803 | |
| Yellow | 2946 | 2982 | 2235 | 2273 | 2038 | 2250 | 2282 | 2060 | 2204 | 1304 | 2934 | 2970 | 2263 | 2220 | 2049 | 2071 | 2028 | 2161 | 5504 | 1204 | 2904 | 2804 | |
| Green | 2947 | 2983 | 2236 | 2274 | 2039 | 2251 | 2283 | 2061 | 2205 | 1305 | 2935 | 2971 | 2264 | 2221 | 2050 | 2072 | 2029 | 2162 | 5505 | 1205 | 2905 | 2805 | |
| Blue | 2948 | 2984 | 2237 | 2275 | 2040 | 2252 | 2284 | 2062 | 2206 | 1306 | 2936 | 2972 | 2265 | 2222 | 2051 | 2073 | 2030 | 2163 | 5506 | 1206 | 2906 | 2806 | |
| Violet | 2949 | 2985 | 2238 | 2276 | 2041 | 2253 | 2285 | 2063 | 2207 | 1307 | 2937 | 2973 | 2266 | 2223 | 2052 | 2074 | 2031 | 2164 | 5507 | 1207 | 2907 | 2807 | |
| Gray | 2950 | 2986 | 2239 | 2277 | 2042 | 2254 | 2286 | 2064 | 2208 | 1308 | 2938 | 2974 | 2267 | 2224 | 2053 | 2075 | 2032 | 2165 | 5508 | 1208 | 2908 | 2808 | |
| White | 2951 | 2987 | 2240 | 2278 | 2043 | 2255 | 2287 | 2065 | 2209 | 1309 | 2939 | 2975 | 2268 | 2225 | 2054 | 2076 | 2033 | 2166 | 5509 | 1209 | 2909 | 2809 | |
| Beige | 2952 | 2988 | 2241 | | 2044 | 2256 | | 2066 | 2210 | 1310 | 2940 | 2976 | | 2226 | 2055 | 2077 | | 2167 | 5510 | 1210 | 2910 | 2810 | 9604 |
| Lt. Blue | | | 2242 | | | | | | 2211 | | | | | 2227 | | | | | 5511 | | | | |
| Pink | 2953 | 2989 | 2243 | | | 2257 | | | 2212 | 1312 | 2941 | 2977 | 2269 | 2228 | | | | 2168 | 5512 | 1212 | 2912 | | |
| Aqua | 2991 | | 2244 | | | 2258 | | | 2213 | | | | | 2229 | | | | | | | | | |
| Lime | | | 2245 | | | | | | 2215 | | | | | 2230 | | | | | 5515 | 1215 | | | |
| **Below are suggested Bel Stewart and Sentinel mating RJ45 plugs. PLEASE VERIFY P/Ns WITH MANUFACTURER!** | | | | | | | | | | | | | | | | | | | | | | | |
| Bel Stewart P/N Sentinel P/N | SS-39200-035 111S08080095LA4 | SS-39200-053 111S08080095HA4 | SS-39200-055 111S08080C7LA4 | SS-39200-055 111S08080C7LA4 | SS-39200-055 111S08080C7LA4 | SS-39200-036 111S08080095LA4 | SS-39200-036 111S08080095LA4 | SS-39200-036 111S08080095LA4 | SS-39100-021 111-08080054L34 | SS-39100-021 111-08080054L34 | SS-39200-035 111S08080095LA4 | SS-39200-053 111S08080095HA4 | SS-39100-039 111-08080B5LA4 & B00058L | SS-39100-039 111-08080B5LA4 & B00058L | SS-39200-055 111S08080C7LA4 | SS-39200-036 111S08080095LA4 | SS-39200-036 111S08080095LA4 | SS-39200-036 111S08080095LA4 | SS-37000-007 106-080800-34 | SS-39100-048 111-08080028L34 | SS-37200-028 110S080820-24 | SS-39200-054 111S08080028L34 | SS-37200-028 Contact Quabbin |

**Splineless design featuring the removal of separator using Quabbin's patented shield system. This makes the cable much more flexible.*

***Canada/US*

*Contact Quabbin for the most up-to-date information.*

# Data Cable Security

## Continuous Shield vs. Non-continuous Shield

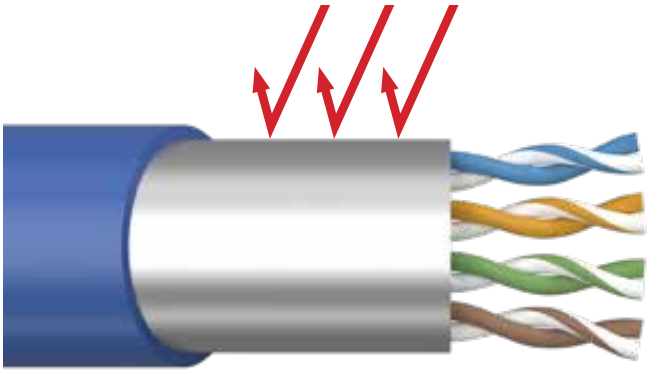


*Figure 1 — Quabbin DataMax® shielded cable design*

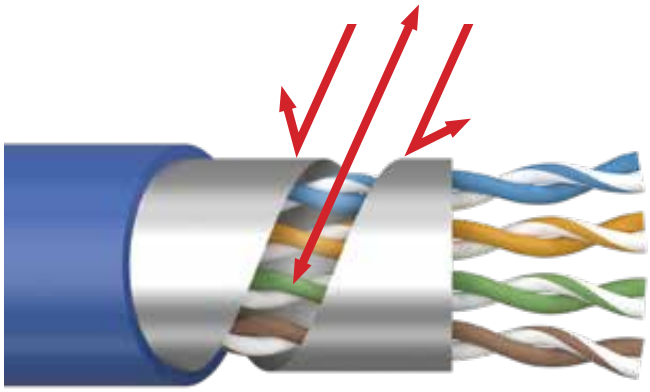
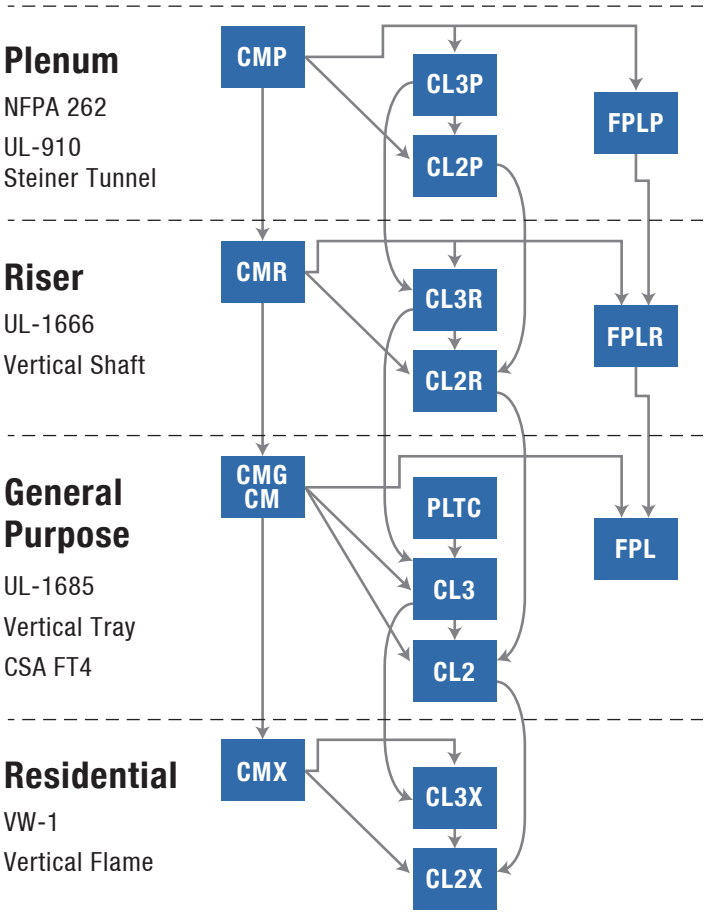


*Figure 2 — Competitors' discontinuous shield*

**Fully-shielded data cable** is available from Quabbin in all categories for higher data integrity and security. As shown above, the DataMax® cable core is protected from external noise and alien crosstalk. Our competitors' discontinuous shield is susceptible to external noise and signal emission that negatively affects data speed and security.

# Electric Code Substitution Chart




# Jacket Material Ratings

NFPA-70 National Electric Code® (NEC) is the guideline for safe electrical design, installation, and inspection to protect people and property from electrical hazards. As such, NEC established cable jacket ratings for the environment where each cable is best suited. These ratings are based on flammability testing to meet either required NFPA or UL specifications.

| NEC Rating | Multipurpose Residential | General Use | Riser | Plenum |
|---|---|---|---|---|
| CMX | X | | | |
| CM/CMG | X | X | | |
| CMR | X | X | X | |
| CMP | X | X | X | X* |
| CM-LS | X | X* | | |

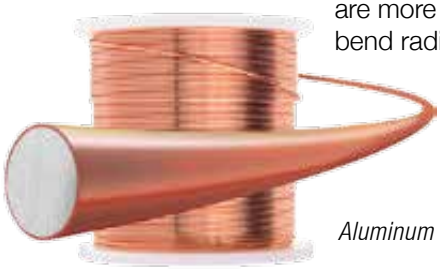
**Useful where low smoke generation is critical*

LSZH cables are tested to different criteria than CM/CMG, CMR and CMP cables and some, such as Quabbin's DataMax® Mini 28 AWG patch cord cables, are made with Low Smoke Zero Halogen materials.

# Copper Conductor Facts

## Copper Clad Aluminum

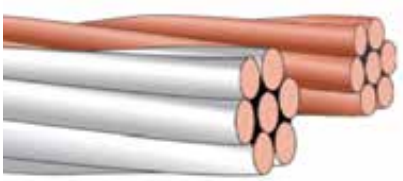
**One way to spot** a subpar patch cord cable is by scraping the conductor. If the copper flakes off to expose a metal core, this means you have likely purchased aluminum disguised as copper. These cables degrade performance, are more fragile and have a lower bend radius. Quabbin uses only the highest grade copper conductor — never copper clad aluminum.



*Aluminum disguised as copper*

## Tin vs. Bare Copper Conductors

**While you shouldn't trust** aluminum coated with copper, you should trust copper coated with tin — which is an essential step in protecting against oxidation and corrosion. Quabbin has long studied the benefits of plating copper conductors with tin vs. using bare copper alone, and we use this upgrade/enhancement extensively throughout our product line.



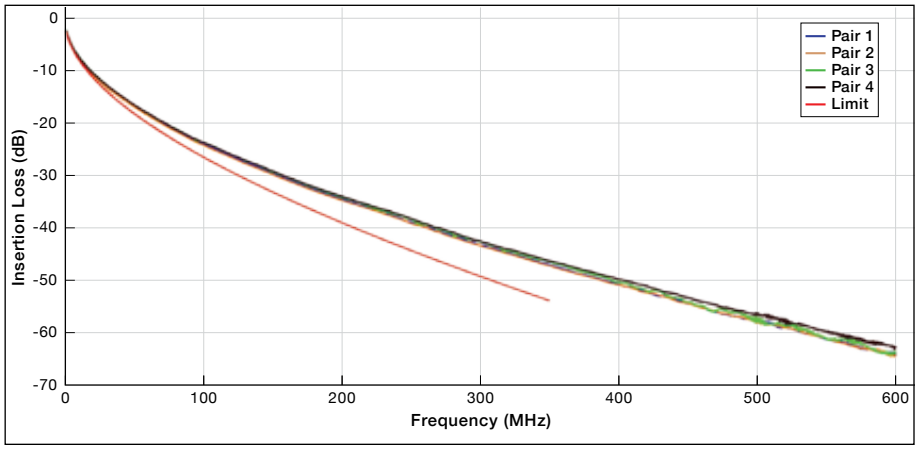
*Bare copper (top) and copper coated with tin (bottom)*

## Aged Copper: Stranded vs. Solid

**While other suppliers** may have difficulty with aging cables in the field, Quabbin has avoided this issue by using tinned copper and other premium materials, as well as design and manufacturing processes continually refined for decades.

In October 2020 a member of the user community submitted a presentation at the Telecommunications Industry Association's TR-42.7 Copper Cabling Systems meeting recommending against the use of stranded copper. The member measured a solid and stranded cable after an accelerated aging test (40oC, 90% RH, 2 Weeks). Data showed that a significant degradation in insertion loss due to aging can cause channels using stranded cable to fail.

Our engineering team located a Quabbin cable manufactured in May 1997, which was stored in temperatures ranging from 0°F to 90°F and unknown humidity levels. The 24 AWG 7/32 tinned copper 4-pair UTP cable was tested against the current TIA patch cord limits and passed. This cable was aged in a more realistic temperature environment and after 23 years still passed the TIA patch cord insertion loss limits. Test data is shown above.




*The measured insertion loss of 23-year-aged Quabbin stranded cable exceeds TIA standards.*

Quabbin presented data that proved when using quality materials and processes, stranded copper cable will meet all TIA requirements and stand the test of time. As a result, the TIA decided against the ban on stranded cables. Our expertise in designing and manufacturing stranded data cable distinguishes us from our competitors.

# Cable Category Designations and Features

| Category | Max. Data Rate | Bandwith | Max. Distance | Usage |
|---|---|---|---|---|
| Category 5e | 1 Gbps | 100 MHz | 100 m (328 ft.) | 100BaseT Ethernet, residential homes |
| Category 6 | 1 Gbps | 100 MHz | 100 m (328 ft.) | Gigabit Ethernet, commercial buildings |
| Category 6a | 10 Gbps | 500 MHz | 100 m (328 ft.) | Gigabit Ethernet in data centers and commercial buildings |
| Category 8 | 25 Gbps (Cat8.1)<br>40 Gbps (Cat8.2) | 2000 MHz | 30 m (98 ft.) | 25 Gbps/40 Gbps Core Infrastructure |

# Glossary

**ANSI**: The American National Standards Institute

**ASTM**: ASTM International, formerly known as American Society for Testing and Materials

**Attenuation**: Ratio of received signal power at the end of the cable to the signal power inserted at the start of the cable, measured in decibels (dB). It represents the amount of signal power lost over the length of the cable.

**AWG (American Wire Gauge)**: Used to measure the diameter of solid and round electrical conducted wire. This measurement helps determine a wire's current carrying capacity, voltage, and resistance level.

**Bend radius**: Radius of a measured arc that a cable can bend around during installation.

**Braid**: Shield constructed with interwoven copper strands that provides structural integrity.

**Capacitance**: Ability of two conductors separated by an insulating material to store a charge.

**Color code**: Color system used for wire identification

**Cord cable**: Cable used to make a patch cord

**Core**: The cable components; typically, a group of insulated wires that may include a shield, tape, drain wire, filler, and separator.

**Crosstalk**: Unwanted signal interference. For the purpose of the test, "Near" and "Far" ends are used are reference points to establish where the signal originates.

***Near End Crosstalk (NEXT)***: Interference between two pairs in a cable measured at the same end of the cable as the interfering transmitter. Interference will be the greatest at the end where the interfering signal is transmitted from, called the "Near" end.

***Power Sum Near End Crosstalk (PS-NEXT)***: Calculation of the sum of unwanted signals from all the other pairs (in every combination) in the cable that affect the "victim" pair.

***FEXT***: The same as NEXT (measuring the effect on one pair to another) but at the other end of the cable from the transmitting device.

***Power Sum Attention to Crosstalk Ratio Far End (PSACRF)***: The sum of the unwanted signals from pairs on the far end onto a pair on the near end.

***Near End Alien Crosstalk (ANEXT)***: Unwanted signal interference from adjacent cables.

***PSANEXT***: Calculation of the sum of unwanted signal interference from all the other pairs (in every combination) in the cable that affect the "victim" pair.

***PSAACRF***: Power sum attenuation to alien crosstalk ratio, far end.

**CSA (Canadian Standards Association)**: Global organization dedicated to safety, social good and sustainability.

**Data Cable**: Cable designed to meet specific electrical standards for use in data transmission systems. May be used in more rigorous or demanding applications.

**Derating**: Shortening the length of channels to ensure sufficient signal-to-noise ratio and avoid data packet loss.

**Drain wire**: The uninsulated wire in contact with the shield throughout the length of the cable. The drain disperses unwanted electrical energy from the cable to a safe grounding point.

**E1**: Digital communication link that enables the transmission of voice, data, and video signals. E1 is the European standard and is equivalent to the North American T1 standard.

**Electromagnetic interference (EMI)**: Unwanted noise or interference in an electrical path or circuit caused by an outside source.

**Elongation**: Measurement of how much an object will increase in length under a certain load. The results are expressed as a percentage of the original length.

**ETL (Electrical Testing Labs)**: Administered by Intertek, a global Total Quality Assurance provider. An ETL listing is proof of product compliance with official quality and safety standards.

**FEP**: Fluorinated Ethylene Propylene

**F/FTP**: Foiled with Foiled Twisted Pairs

**F/UTP**: Foiled with Unshielded Twisted Pairs

**IEC (International Electrotechnical Commission)**: The world's leading organization for the preparation and publication of international standards for all electrical, electronic, and related technologies.

**IEEE (Institute of Electrical and Electronics Engineers)**: The world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.

**Impedance**: Opposition of an electric current or the resistance to the flow of energy when voltage is applied to an electrical circuit or cable. Generally, the need for high or low impedance varies depending on the cable application.

**Insertion loss**: Ratio of received signal power at the end of the cable to the signal power inserted at the start of the cable, measured in decibels (dB). It represents the amount of signal power lost over the length of the cable.

**Jack**: Receptacle connector

**Jacket**: Extruded, external casing that surrounds and protects the cable core.

**LAN (Local Area Network)**: Collection of devices connected in one physical location, such as a building, office, or home.

**LSZH (Low Smoke Zero Halogen)**: LSZH cables are built with a jacket material free of halogen.

**Max OD**: Maximum allowable outer diameter or wire or cable

**MHz**: Megahertz (MHz) is one million hertz and is used to measure the transmission speed of electronic devices, including channels, buses, and the computer's internal clock.

**Min OD**: Minimum allowable outer diameter of wire or cable

**NEC (National Electric Code)**: NFPA 70®, National Electrical Code®, is the authoritative document addressing electrical installations in residential, commercial, and industrial settings.

**NFPA**: National Fire Protection Association (NFPA)

**Nom OD**: Desired outer diameter of wire or cable

**OD (Outside Diameter)**: The diameter of a cable. In general, as the wire gauge increases, so does the cable OD.

**Patch cord**: Stranded copper cable with modular plugs attached, for patch panel or work area connections

**PoE (Power over Ethernet)**: Technique for delivering DC power to devices over copper ethernet cabling, eliminating the need for separate power supplies and outlets.

**Plug**: The part of a cord that connects to a port.

**PE (Polyethylene)**: Common data cable insulation

**PVC (Polyvinyl Chloride)**: A thermoplastic material. PVC is a versatile and widely used compound resistant to UV, chemicals, and water.

**Return loss**: Portion of a signal that cannot be absorbed by the end of line termination or cannot cross an impedance change at some point in the transmission system.

**RoHS (Restriction of Hazardous Substances)**: Directive originated in the European Union (EU).

**Separator**: Also called web separator or spline, is used to improve crosstalk performance by separating pairs.

**S/FTP**: Screened with Foiled Twisted Pairs.

**Shield**: Metallic layer of braid, spiral serve or tape that is applied over a core of a single insulated conductor or a group of conductors to prevent electrostatic or electromagnetic interference between adjacent wires and external sources.

**Solid copper cable**: Cable made with solid copper conductors.

**Stranded copper cable**: Cable made with small gauge copper conductors twisted together to create a single large conductor.

**Structured cabling**: System of cables, wires, and other hardware that connects communication systems into one cohesive unit.

**T1**: High-speed digital network developed by AT&T in 1957. This network scheme was implemented in the 1960s to support long haul digitized (digital) voice signals to upgrade and replace the full analog telephone system of the time.

**TIA (Telecommunications Industry Association)**: Accredited by ANSI as a standards-developing organization (SDO).

**UL**: The largest and best known independent, not-for-profit testing laboratory in the world.

**UTP**: Unshielded Twisted Pairs

**xDSL**: Technology which enables ordinary voice-grade copper telephone wires.

# Frequently Asked Questions

## What is the minimum bend radius of the cable?

Bend radius is the inside radius of the cable when bent. It is a stationary bend not continuous motion. ANSI/TIA-568.2-D requires UTP cable to have a minimum bend radius of 4x the cable OD for UTP cable and 8x the cable OD for shielded cable at -20°C. For flat cables, Quabbin lists the bend radius for the smallest dimension.

## How long of a patch cord can I use?

The ANSI/TIA-568.2-D uses a total of 10 meters of patch cord cable to derive the channel requirements. This includes 90 meters of horizontal cable and 4 plug/jack connections. It is possible to use longer cords in a channel by allocating more insertion loss per meter to the patch cord. For 24 AWG patch cord each additional meter of patch cord would require that 1.2 meters of horizontal be removed. So if you want to use 20 meters of 24 AWG patch cord cable the maximum horizontal length is 78 meters and the maximum channel length is 98 meters instead of 100 meters. The same is true of 26 AWG patch except that the factor is 1.5 meters of horizontal removed for each additional meter of patch. For 28 AWG the factor is 1.9 meters. *See "Calculating Channel Length" on page 20 for more information.*

## I want to use only patch cord cable in the channel (no jacks, patch panels or horizontal cable). How long can the cord be?

This has become fairly common. This is listed as the plug-to-plug maximum length on each catalog page. It is determined by comparing the cable performance against the channel specification. When making an assembly for this purpose, it is preferred that the assembly be tested as a channel and as a cord since the channel test would not include the plug. This ensures that the plug is assembled properly.

## I want to make assemblies with shielded cable and unshielded plugs. Will it work?

This has become a common practice especially in Cat 6a applications because shielded cable is generally smaller than Cat 6a UTP cable. Based on testing Quabbin has done on cable with the shield floating, we believe the cable will work for a Cat 6a application and meet alien crosstalk requirements. The assembly will not be a shielded assembly, and if it is installed in a shielded channel, it will reduce the effectiveness of the channel shielding by breaking the shield connections.

## What does the “R” in the part number printed on the cable mean?

The “R” is to identify the cable as being RoHS compliant. All the cables in this catalog are RoHS compliant. Quabbin will supply RoHS compliance information on request.

## Does Quabbin sell assemblies?

No, Quabbin sells bulk cable. Please contact your Quabbin sales representative for an assembler or distributor in your area.

## Can I use your category cable for PoE applications?

Yes, Quabbin category cable supports all standards based PoE systems (PoE, PoE+ and PoE++). The cables are CMX, CM, CMG or CMR, and they support Class 2 applications per the NEC.

## How cold can cable be when I install it?

The minimum cable temperature for installation is 0°C.

## What should I consider when specifying Ethernet patch cord cables?

Patch cords are integral to any cable network yet are also considered the weakest links in the cabling system — this is often due to low-quality materials and/or poor assembly practices. You can minimize these issues by specifying Quabbin patch cord cable.

While it may be tempting to specify a cable or connector primarily based on cost, low-quality components can impede a system from meeting applicable TIA standards. For example, patch cord cable made with copper-coated aluminum is cheaper but is more fragile, has a lower bend radius, and is likely to degrade performance. In addition, to prevent costly network downtime, both cable and connectors should be sourced from companies that manufacture in accordance with industry standards.

When specifying patch cords, consider the environment the cables will be in. For example, bare copper and plated copper are both effective in electrical performance, but copper plated with silver, gold, or tin is protected from oxidization and corrosion. Silver and gold have some advantages but are expensive. Tin, the cheapest of the three, is highly conductive, stable, and proven to maintain cable performance longer. For these reasons, Quabbin uses tin-plated copper exclusively.

## What is return loss? Why is it important?

Return Loss (RL) is an important noise measurement for local area networks (LANs) and their components. With faster and bidirectional signaling being implemented, RL has become a more relevant measurement. RL is a summation of all the reflected signal energy returning to the end where it originated. In a LAN system that uses bidirectional signaling, RL is like an echo, and is not the same as crosstalk. But while RL is real data, it still interferes with the desired signal, and must be treated as noise.

Discontinuities, which can occur at connections where the cable meets a plug or jack, and within the plug or jack itself, are one of the causes of RL. A discontinuity can also occur if a cable is bent too much, kinked, or damaged. When a transmitted signal pulse hits a structural discontinuity, it creates an echo or Return Loss.

Mismatches are another cause of RL. Mismatches are usually component-to-component related. For example, if the horizontal cable in a network averages 100 ohm, and the patch cord cables used in the network are 106 ohms, each 6-ohm mismatch causes poor RL performance.

In order to accurately measure and predict RL, it's important to understand how data transmission behaves. Data streams are complex packages of many different frequencies and electronic vibrations. As a result, when predicting RL, simply adding up the responses of the individual system components will not accurately model how the larger structure will behave. Moreover, when testing networks for RL both ends of the network should be evaluated as they generally are asymmetrical.

## Why is cable capacitance important for electronic applications?

Modern networking standards are designed to ensure that compatible networks can communicate with one another. Organizations such as the Electronic Industries Alliance (EIA), Telecommunications Industry Association (TIA), American National Standards Institute (ANSI), and the Institute of Electrical and Electronics Engineers (IEEE) develop standards such as the EIA RS-232 and IEEE 802.3, which establish common terminology and interface requirements. If a system is built to meet these standards, it will be able to interface successfully with similar systems. The standards set by the aforementioned organizations specify cable constructions and electrical performance necessary to meet the system data speeds and transmission distances. Cables that fail to meet those specifications will degrade the system performance, not transmit at the specified maximum distance, and/or cause the system to be incompatible with others.

The standards often are based on the input versus the output of the cable. When data is transmitted through the cable in high-speed pulses, it will degrade or deteriorate. If it deteriorates too much, the device at the end will either be unable to recognize the data or record false data. By balancing conductor size, insulation material, and insulation wall thickness, the cable designer can produce electronic cables that are tailor-made to transmit high-frequency digital data pulses over a maximum distance.

## I can't afford network downtime. What do you recommend?

Quabbin evaluated the electrical performance of 56 different Cat 6 and 6a patch cords from various sources on the open market. Quabbin found that 60% failed to meet TIA's critical performance requirements. Our previous study of Cat 5e and Cat 6 patch cords, "Most Patch Cords Fail Testing," proved that 70% of the patch cords failed to meet return loss and/or crosstalk specifications. These two market surveys clearly demonstrate the importance of specifying high-quality components, such as the patch cords produced by Quabbin, in the assembly.

Patch cords that fail requirements can considerably weaken network performance or even cause the network to fail, resulting in costly downtime and repairs. Based on the results of our study, network engineers and IT professionals should specify the highest quality cable and connectors for their patch cords.

# Sales and Customer Service

## Inventory Stocked Throughout USA

- Eliminates overseas shipping times and costly delays
- Locations from coast to coast (MA, AZ, FL, CA, TX)

## Easy Ordering & Shipping

- Sales representatives located throughout North America
- Sales support specialists available to answer questions and process orders
- Orders for in-stock items placed by 1 p.m. Eastern Time qualify for same day shipping

## GLOBAL AND REGIONAL SALES MANAGERS

Ted Brunk

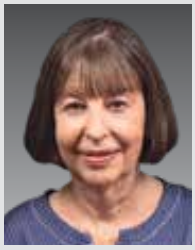
Dean Hart

Steve Spoonts

Jason Sterndale

## SALES SUPPORT

Ron Cooney



Martha Parker

Kerry Wells

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QUABBIN® WIRE & CABLE CO., INC.

**Quabbin Wire & Cable Co., Inc.**, 10 Maple Street, Ware, MA 01082

800.368.3311 • 413.967.6281 • fax 413.967.7564 • www.quabbin.com