Is Superior Essex Outside Plant Copper Cable Rated Category 3?

The applicability of the Category 3 specification to outside plant cables is sometimes misunderstood. This white paper examines that issue, as well as the differences between typical OSP and Premises data protocols and their applicability to OSP cables.

Superior Essex Copper OSP (Outside Plant) cables are designed and guaranteed to meet all applicable industry standards for OSP installations (i.e., Rural Utility Service or RUS, Bellcore, American National Standards Institute or ANSI, Insulated Cable Engineers Association or ICEA). These OSP standards are designed to handle the applications used predominantly in OSP environments for distances up to and exceeding 20,000 feet; including T1, DSL, and ISDN. The standards used for OSP cables include requirements for pair-to-pair capacitance unbalance and far-end crosstalk, which are not specified parameters within the Category (CAT) 3 cable standards. In contrast, the TIA/EIA CAT 3 cable standard was designed primarily for premises installations, and specifically for local area network (LAN) applications with distance limitations. The typical data protocol used over CAT 3 cables, 10BASE-T Ethernet, has a maximum distance limit of 328 feet between electronics. This distance limitation is a function of the 50 microsecond "round trip delay" requirements of 10BASE-T Ethernet. Extend any CAT 3 cable run more than 328 feet and the cable has lost its CAT 3 designation and should not be used for 10BASE-T Ethernet transmissions.

In an OSP environment, where distances typically exceed 328 feet, CAT 3 has very limited applicability to OSP cables. While Superior Essex copper OSP cables are not designed around the TIA 568A CAT 3 standard, they typically do meet the electrical requirements of CAT 3 and they are fully capable of carrying 10BASE-T Ethernet signals the maximum distance allowed by the standard – 328 feet. However, aside from specific situations that require an outside plant 10BASE-T Ethernet network drop, CAT 3 has no relevance to the copper OSP cable used for POTS (Plain Old Telephone Service) or T1 applications.

OSP Cable and Wire Applications

Outside plant copper cable and wire products currently used throughout the United States are manufactured to specifications that have evolved through years of iterations of either Bellcore or RUS standardization activities.

A typical loaded voice grade customer loop can be extended from the central office to the customer premises, potentially a distance of 100,000 feet or more. The cable has been designed for both short and long distance transmissions. Active transmission products placed on outside plant cable systems in use today have been designed to take full advantage of non-loaded outside plant cable products under the Bellcore or RUS standardization specifications. Higher frequency systems such as T1, T1-C, ISDN, HDSL, ADSL and VDSL are examples of transmission systems specifically intended for use on non-loaded standard outside plant cable products. Figure 1 shows the distance and data rate relationship for these protocols over copper and fiber. The improvement in both distance and data rate capacity per protocol is the result of electronics with improved noise/error correcting techniques.

The protocols used over OSP cables are designed for point-to-point communications over long distances, as opposed to network protocols, (like Ethernet) which are designed to accommodate multiple users over short distances. This difference between protocols has resulted in key differences in electrical characteristics between OSP cables and LAN cables.
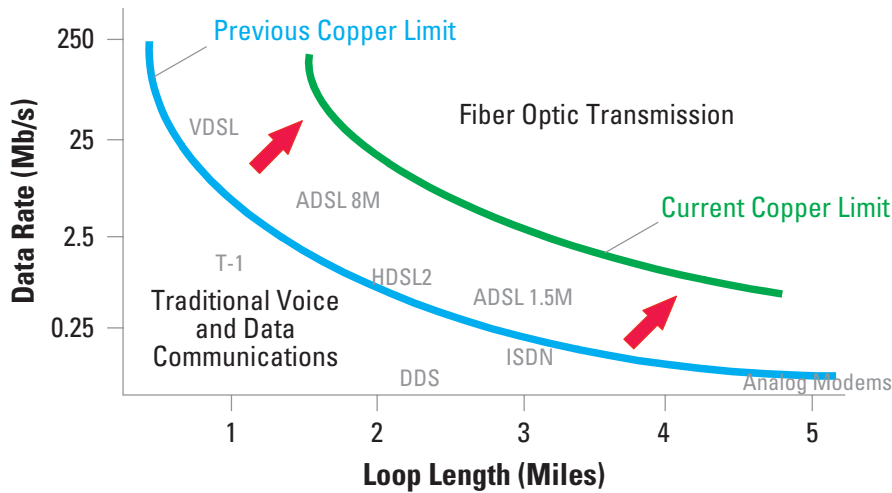
Figure 1: OSP Protocol Data Rates and Distances

LAN Cable and Wire Applications

Premises category-rated cables (CAT 3, 5, 5e and 6) are designed for high frequency transmission systems in indoor premises environment. Premises category-rated cables are capable of carrying several different protocols, the most common of which is Ethernet. CAT 3 cables can at most meet the requirements of 10BASE-T Ethernet (10 Mbps data rate) and have a maximum cable distance of 328 feet (including patch panel connections). CAT 5 cables are capable of carrying 100BASE-TX Ethernet (100 Mbps data rate) and CAT 5e cables are capable of carrying 1000BASE-T (Gigabit Ethernet). CAT 5 and 5e cables also are used for many other network protocols including 155 Mbps ATM and 622 Mbps ATM. The application versatility of CAT 5 and 5e cables has allowed them to virtually replace CAT 3 cables for network environments. This advantage for CAT 5/5e cables also applies to OSP LAN installations. CAT 5 and 5e cables designed for OSP installations are available from Superior Essex and are strongly recommended over cables with CAT 3 designation when a LAN protocol is planned to run over the installed cable. The data rate limitations of CAT 3 cables can restrict the network capacity unnecessarily, or worse, force an upgrade of the installed cable at considerable cost so that 100 Mbps Ethernet or Gigabit Ethernet may be employed.

In contrast to most OSP protocols, LAN protocols (over copper twisted pairs) are typically distance restricted. This is mainly a consequence of the design of the Ethernet protocol. The Ethernet protocol is also called Carrier Sense Multiple Access with Collision Detection (CSMA/CD). Every set of rules is best understood by characterizing its worst case. The worst case for Ethernet starts when a Personal Computer (PC) at the extreme end of one wire begins sending data. The electric signal passes down the wire through repeaters, and just before it gets to the last station at the other end of the LAN, that station (hearing nothing and thinking that the LAN is idle) begins to transmit its own data. A collision occurs. The second station recognizes this immediately, but the first station will not detect it until the collision signal retraces the path all the way back through the LAN to its starting point. The time it takes for this to occur is called "round trip delay" (see Figure 2).
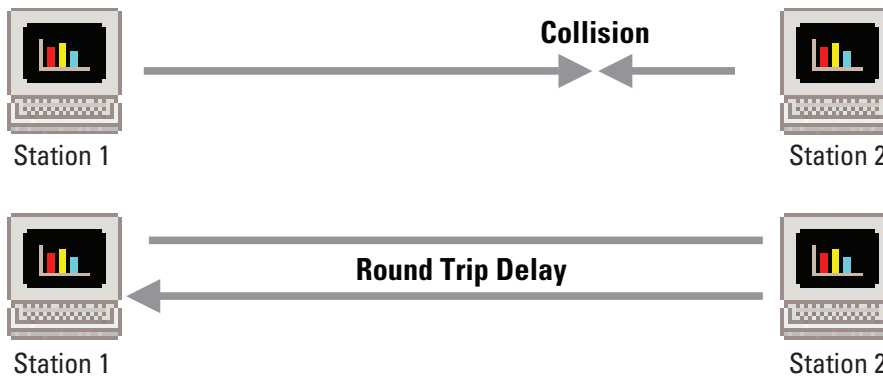
Figure 2

Any system based on collision detection must control the time required for the worst-case round trip delay through the LAN. As the term "Ethernet" is commonly defined, this round trip is limited to 50 microseconds (millionths of a second). At a signaling speed of 10 million bits per second, this is enough time to transmit approximately 500 bits. At 8 bits per byte, this is about 64 bytes. To make sure that the collision is recognized, the Ethernet protocol requires that a station must continue transmitting until the 50 microsecond period has ended. If the station has less than 64 bytes of data to send, then it must pad the data by adding zeros at the end. In this way, it is possible to translate the 50 microsecond limit and other electrical restrictions into rules about cable length, number of stations, and number of repeaters. The maximum length of wire for an Ethernet LAN is 328 feet of copper wire including patch panel connections. However as the limit is worked out, it is ultimately a reflection of the constraint on the worst-case round trip delay due to the protocol employed.

Category cables are highly specialized to ensure that any data transmissions are kept near the theoretical maximum speed of copper wire and that interference between copper pairs is minimized. The selection of improper insulation materials can slow down signals and could cause collisions because the round trip delay would have been exceeded at the maximum cable distances.
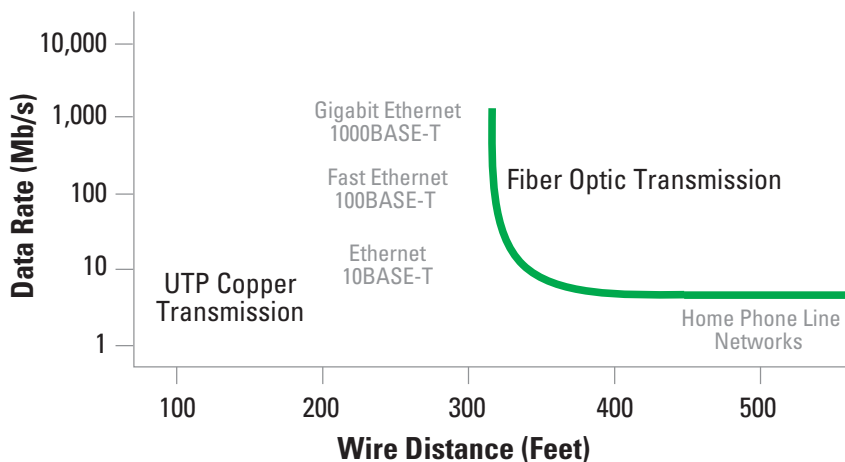

Figure 3

Differences

The basic difference between LAN cable and OSP cable product design is the intended installation length. LAN cables are optimized for a maximum 100 meters (328 feet) installation distance. OSP cables are optimized for longer distances with load coil treatment as far as 100 thousand feet in length. Figures 1 and 3 are graphical representations of the difference between OSP cable and LAN cable capabilities for data rates and distances. Note the difference in scale between the two and the fact that OSP distances are nearly a magnitude of order longer than those for LAN's. The copper limits for data rates continue to increase as new technology in microprocessors allows more complex line code encryption, but distance constraints have remained constant for Ethernet protocols during this progression (see Figure 4).
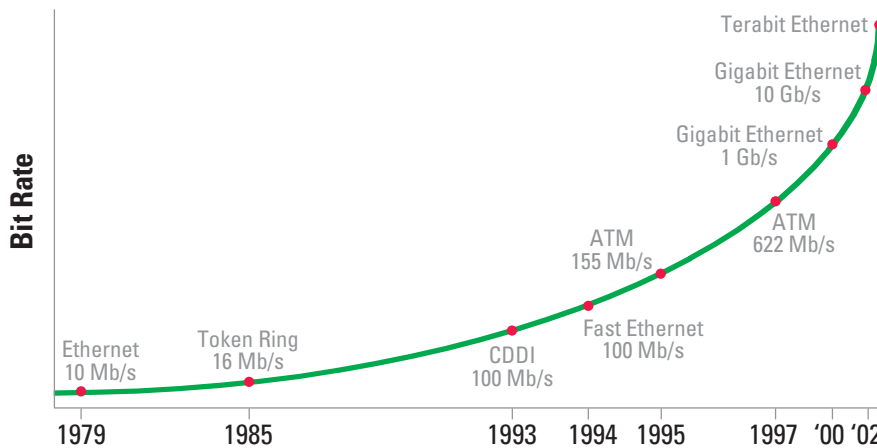

Figure 4: Local Area Network Data Rate Trends

Parameters such as Structural Return Loss (SRL), Propagation Delay, Velocity of Propagation and Propagation Delay Skew are extremely important when transmitting high frequency signals over very short distances found in the premises LAN applications. As installation lengths increase, such as are found in the outside plant, these parameters offer little meaning.

It must be noted that in all other electrical requirements, those for OSP are actually a bit tighter, mostly because OSP cables cover a much greater range of pair and gauge sizes as well as the longer installation lengths involved and temperature extremes. For example, OSP is tested for Far End Cross talk and Pair-to-Pair Capacitance Unbalance. Premises LAN product specifications do not include these requirements.

As described above, there are logical differences in the end point transmission requirements of Premises and OSP systems based on the intended application environment. The below application chart shows the applicability of select Superior Essex cable types to each transmission application. Note that the LAN protocols are limited in all cases to less than 328 feet in distance.

Superior Essex Products by Application						
Transmission Application at 24 AWG Copper	OSP Bellcore/ RUS	OSP Broadband CAT 5	OSP Broadband CAT 5e	Premises CAT 3**	Premises CAT 5e**	Premises CAT 6**
T-1	Yes	Yes	Yes	Yes	Yes	Yes
T1-C	Yes	Yes	Yes	Yes	Yes	Yes
ISDN 192 Kb/s	Yes	Yes	Yes	Yes	Yes	Yes
IDSL	Yes	Yes	Yes	Yes	Yes	Yes
HDSL	Yes	Yes	Yes	Yes	Yes	Yes
ADSL 1.5 Mb/s	Yes	Yes	Yes	Yes	Yes	Yes
ADSL G.Lite	Yes	Yes	Yes	Yes	Yes	Yes
SDSL 192 Kb/s	Yes	Yes	Yes	Yes	Yes	Yes
VDSL 13 Mb/s	Yes	Yes	Yes	Yes	Yes	Yes
RADSL	Yes	Yes	Yes	Yes	Yes	Yes
HDS 1.5 Mb/s	Yes	Yes	Yes	Yes	Yes	Yes
SHDSL	Yes	Yes	Yes	Yes	Yes	Yes
HDSL2 1.5 Mb/s	Yes	Yes	Yes	Yes	Yes	Yes
10BASE-T* Ethernet	Yes	Yes	Yes	Yes	Yes	Yes
100BASE-T* Ethernet	No	Yes	Yes	No	Yes	Yes
1000BASE-T* Ethernet	No	No	Yes	No	Yes	Yes

"Yes" = Product appropriate for application and distance
"No" = Product not guaranteed for application and distance

Consult transmission vendor during design phase for product details.

*Distance transmission is limited to less than 328 feet.
**Premises cables are not guaranteed for long distance transmission of OSP applications.

Summary

Aside from the specially designed CAT 5 and 5e OSP cables from Superior Essex, OSP copper cables have been designed around the applications used for long distance (over 20,000 feet) communications and not premises LAN applications. However, these OSP cables, while not guaranteed to meet all electrical specifications of CAT 3, are typically adequate for 10 Mbps Ethernet installations up to the maximum distance of 328 feet. Outside of this situation, the CAT 3 specification does not apply to the transmission requirements of protocols used in OSP applications and is not the proper standard to measure OSP cable capabilities.