White Paper

Deploying 10GBASE-T with Cisco Switches: Choose the Right Cabling

What You Will Learn

The 10GBASE-T IEEE 802.3an standard supports the creation of technology that is capable of transmitting 10 Gigabit Ethernet up to 100 meters over a twisted-pair copper cabling system. It is an exciting technology that provides end users with cost-effective media to achieve 10-Gbps data rates. The Cisco Catalyst® 4900 and 6500 Series Switches and Nexus 2200 Fabric Extenders that work in conjunction with Nexus 5500 Series Switches support the 10GBASE-T infrastructure that exists today.

To achieve 10-Gbps transmission over copper twisted-pair cabling, modulation in the host ports uses frequencies of up to 500 MHz - quite a bit higher than Gigabit Ethernet technology, which uses frequencies of up to 100 MHz. Demands on the copper cabling systems thus require suppression of both internal and external noise up to 500 MHz. Therefore, you must make sure that you are using an appropriate cabling system to help ensure 10GBASE-T operation in the network.

10GBASE-T Cabling Types

As in any network, the cabling infrastructure is crucial to successful deployment. Currently, a variety of cabling systems are designed to enable 10GBASE-T operation. For the infrastructure and facilities teams of an organization, the challenge is to determine what type of cabling system to use for 10GBASE-T deployments. To determine which cable system to use, you should understand the characteristics of the various cabling systems that can support 10GBASE-T.

Table 1 summarizes the supported cabling types listed in the IEEE 802.3an specification.

Table 1. Supported Cabling Types for 10GBASE-T

Cabling Type	Maximum Distance According to IEEE 802.3an-2006	Standard Specification and Comments
Class F, Category 7: shielded	100m (328 ft)	• ISO/IEC 11801 • These cabling systems exceed the minimum requirements for IEEE 10GBASE-T performance
Class Ea, Augmented Category 6 (Category 6A): both shielded and unshielded	100m (328 ft)	• ISO/IEC 11801 Ed 2.1/TIA -568-C.2 • These cabling systems exceed the minimum requirements for IEEE 10GBASE-T performance
Class E, Category 6: screened (shielded)	100m (328 ft)	• ISO/IEC TR-24750 TSB-155 • Category 6 is specified only to 250 MHz. The cabling system must be certified to 500 MHz according to TSB-155 to help ensure 10GBASE-T compliance
Class E, Category 6: unscreened (unshielded)	55m* (180 ft)	• ISO/IEC TR-24750 TSB-155 • Category 6 is specified only to 250 MHz. The cabling system must be certified to 500 MHz according to TSB-155 to help ensure 10GBASE-T compliance

* Further, Category 6 unshielded systems may be limited by alien crosstalk beyond 37-meter channels.

Cisco recommends a Category 6A cable system or better for new installations (Figure 1).

Figure 1. Cabling Systems

Category 6A Unshielded Twisted Pair (UTP) Cable

Category 6A Shielded Cable

Category 7 is high-frequency shielded cable (600 MHz) that provides higher performance and enhanced electromagnetic shielding. This cable is primarily used in Europe and is rarely installed in North America. It is generally used with Category 6A connectors to interface with 10GBASE-T equipment. In some rare cases, Category 7 has been used with Category 5 or 6 connectors. While Category 7 infrastructure provides better performance, if it is used with lower grades of connectors, the connectors should be replaced with Category 6A to help ensure 10GBASE-T compliance.

Category 6A is a newer cabling category that was developed especially for 10GBASE-T operation. It has improved specifications compared to Category 6 for internal crosstalk, alien crosstalk, and insertion loss, and it is defined at frequencies of up to 500 MHz for cable lengths of up to 100 meters. The Category 6A standard covers both shielded and unshielded cabling and connectivity. The Category 6A or Class Ea cabling system specifications developed by TIA and ISO exceed the minimum requirements defined by IEEE 802.3an. Since the structured cabling system is often installed well ahead of deployment of the active equipment, a user who has a certified Category 6A installation should be confident of 10 Gigabit Ethernet operation when the need arises.

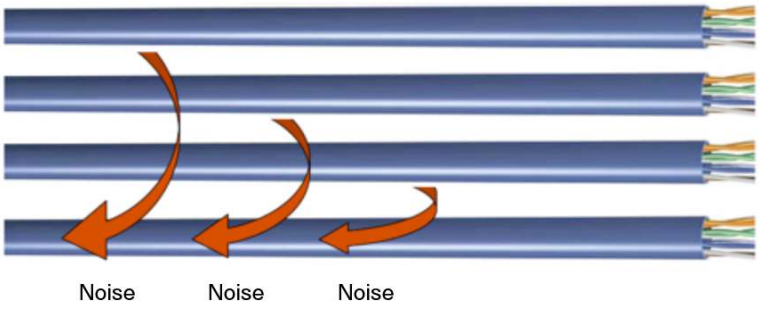
Category 6 is defined only for frequencies of up to 250 MHz. Category 6 is currently popular for installations that predate 10GBASE-T technology. Category 6 cabling has been included in the IEEE 802.3an standard and can support 10GBASE-T according to the guidelines in TIA TSB-155. The IEEE standard lists 55 meters as the typical expected 10GBASE-T reach depending on the alien-crosstalk environment, although TIA TSB-155 states that under worst-case bundling conditions, the reach may be limited to 37 meters. The guidelines in TIA TSB-155 include methods to mitigate the effects of alien crosstalk to increase the performance over existing cabling.

Most cabling vendors recommend installing a Category 6A cabling system if a 10GBASE-T network is to be deployed or is expected in the future. For existing infrastructure with Category 6 shielded or unshielded cabling, cabling vendors recommend following the guidelines of TSB-155 to help ensure that 10GBASE-T can be supported on the existing cabling. Note that shielded cabling can offer improved immunity to external noise sources and can eliminate the alien crosstalk within the bundle. However, if the shielded cabling has not been terminated or installed properly, it may cause problems for 10GBASE-T that are not detected for Gigabit Ethernet.

Alien Crosstalk

Alien crosstalk (AXT) is defined as a measure of the unwanted signal coupling between adjacent cabling or components. In high-speed transmission, such as 10GBASE-T, digital signal processing (DSP) techniques can be used to improve the performance within the channel. However, the receivers are not aware of the signaling of the neighboring cables and thus cannot improve performance against an alien-crosstalk noise source (Figure 2).

Figure 2. Cable-to-Cable Coupling, or Alien Crosstalk



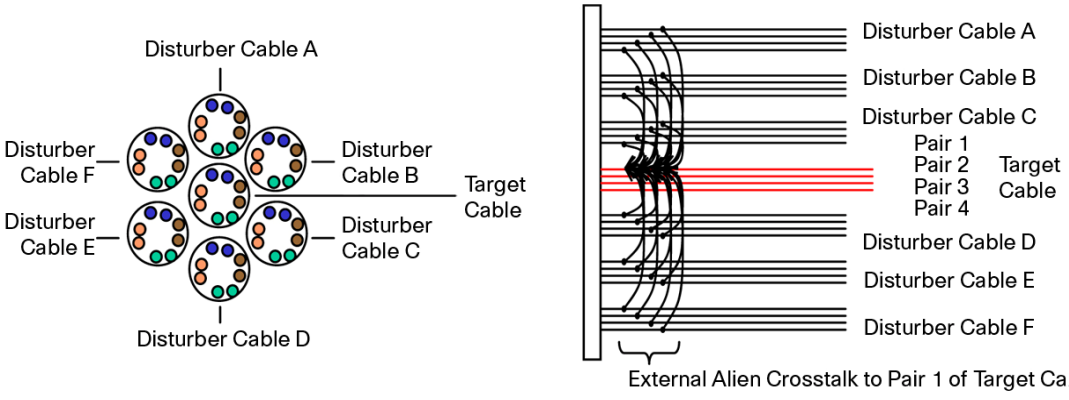
Although the definition of alien crosstalk is straightforward, the testing of it is not. The following sections present some guidelines. (TIA/EIA TSB-155 provides additional details.)

Laboratory Testing

In the laboratory, both TIA- 568-C.2 and TSB-155 require that alien crosstalk be measured as follows:

- Use a six-around-one cabling configuration. The six-around-one configuration provides the worst-case scenario on the center target cable with six disturber cables tightly bundled around it (Figure 3).

Figure 3. Six-Around-One Cabling Configuration



- Test with a frequency range of 1 to 500 MHz with a tester certified for Category 6a.
- Bundle cable with cable ties placed every 8 inches except for the last 3.3 feet (1 meter) from each end.
- Model four-connector channel configurations according to TIA-568-C.2 using the worst-case maximum and minimum channel lengths to determine the worst-case scenario for different crosstalk parameters:
  - 100m long channels (90m permanent link, including 5m zone cable and 10m patch cords)
  - 24m short channels (15m permanent link, including 5m zone cable and 4m patch cords)

- Measure alien crosstalk between all pairs for the center targeted cable and each pair of disturber cables.
- Measure overall alien-crosstalk noise as the calculated power sums of all external cabling pairs on the target pair at swept frequencies of up to 500 MHz.

Cabling system vendors often refer to their worse-case scenario six-around-one testing as validation that the cabling system will be compliant for alien crosstalk under any field installation conditions.

Field Testing

If a user wants to be completely sure of an installation's compliance or wants to certify a Category 6 installation, field testing of alien crosstalk is warranted. Field testing of alien crosstalk for 10 Gbps over copper cables presents more challenges when compared to lab testing because the position of the cable bundles can change and vary from one installation to another. Following are some guidelines:

- **Two testing setups can be used:** Permanent-link and channel-test configurations.
  - **Permanent-link testing:** Alien crosstalk (near end and far end) is measured by terminating test cords with plugs that exhibit 100-ohm differential and 50-ohm common mode terminations.
  - **Channel testing:** Alien crosstalk (near end and far end) is measured in the same manner as in permanent-link testing except that the remote ends of the disturbed and disturber pairs are terminated with factory-constructed jacks that also include a 100-ohm differential and 50-ohm common mode terminations (Figures 4 and 5).

Figure 4. TIA Recommended Configuration for Field Testing Alien Near-End Crosstalk (ANEXT)

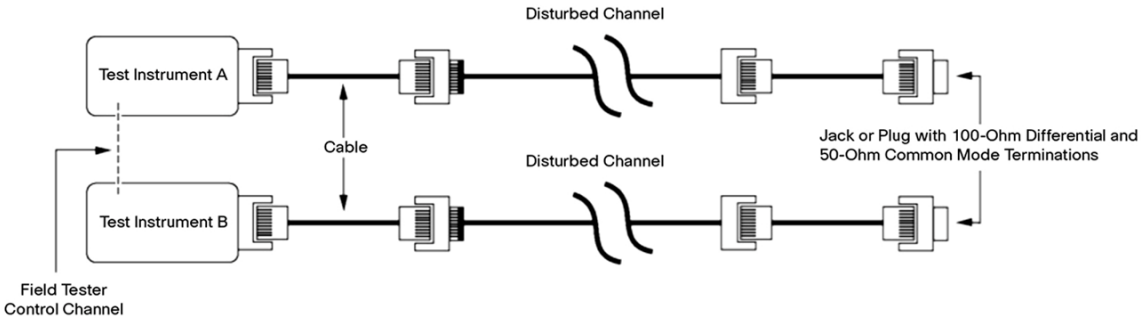
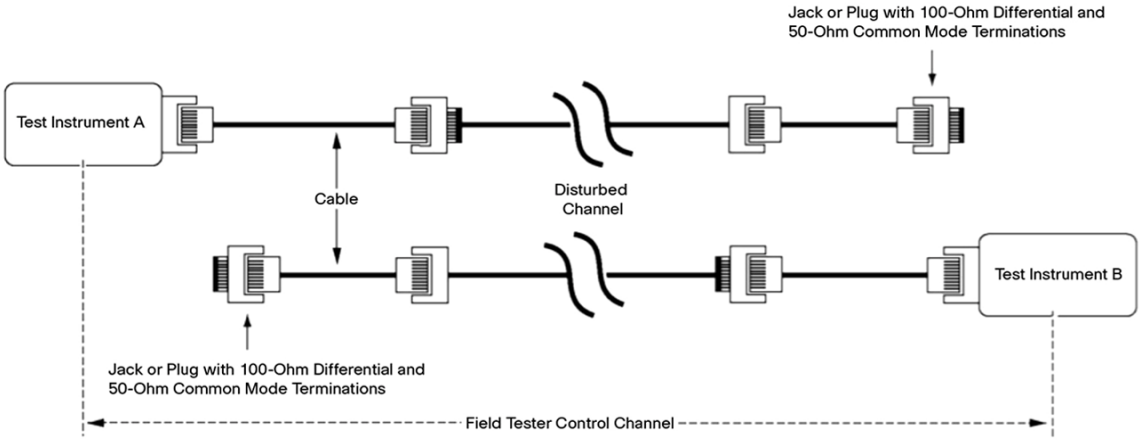


Figure 5. TIA Recommended Configuration for Field Testing Alien Attenuation Crosstalk Ratio Far-End (AACR-F)



- The test system consists of two jacks, with one jack connected to a main test unit, and the other connected to a remote test unit.
- Test with a frequency range of 1 to 500 MHz.
- Test only the link in the same cable bundle that is expected to contribute a significant amount of alien crosstalk.
- Select the longest links in the installation as well as the links with the shortest distance between connectors. These are considered the links most likely to have the highest alien-crosstalk levels.

For an effective use of time (and lower installation costs), you generally should follow a sampling strategy when testing an installation for alien crosstalk. The general industry recommendation to certify an installation for alien crosstalk is to test at least 1 percent of the links or at least five links, whichever is greater.

Alien-Crosstalk Mitigation Techniques

If on the basis of field-testing measurements, a Category 6 cabling system does not meet the electrical performance requirements to support 10GBASE-T operation, you can use the following procedures and cabling guidelines to mitigate the alien crosstalk between the disturbed and disturbing pairs of Category 6 channels and permanent links. You should try each procedure in order and retest until the channel passes the TSB-155 performance limits.

- At the patch panels, separate the equipment cords and the horizontal cables as much as possible. Greater spacing of the cables at the near end of the channel reduces the amount of crosstalk coupling at the area that can be most susceptible to noise.
- Employ nonadjacent patch panel positions where possible.
- Unbundle cables in the first 5 to 20 meters.
- Separate cords in the first 5 to 20 meters.
- Replace equipment cords with Category 6A cords or shielded Category 6 cords.
- Replace currently installed connectors with Category 6A connectors.

Conclusion

Since 10GBASE-T operates at a higher frequency and with more complex modulation than previous generations of Ethernet, you should pay close attention to the cabling plant to make sure that it will support the new technology. Category 6A cabling systems have been developed specifically to support 10GBASE-T operation. Installed Category 6 cabling may also support 10GBASE-T, though you should evaluate your Category 6 cabling installation to verify that it will support the application.

For More Information

- **Ethernet Alliance white paper:** http://ethernetalliance.org/files/static_page_files/127_10GBASE_T2.pdf
- **May 2005 TIA tutorial:** http://grouper.ieee.org/groups/802/3/an/public/may05/May%202005%20TIA%20Tutorial.pdf
- **TSB-155 Draft 1.3:** http://www.ieee802.org/3/an/public/feb05/tsb155_d1.3-Feb1.pdf
- **Panduit:** Testing 10-Gbps performance of Category 6 and 6A structured copper cabling systems within the unified physical infrastructure (UPI): http://www.panduit.com/groups/MPM-OP/documents/WhitePaper/107637.pdf
- **Panduit TX6A 10GIG copper cabling system testing procedures:** http://www.panduit.com/groups/MPM-OP/documents/InstallationInstruction/CMSCONT_035246.pdf

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