10 GIGABIT ETHERNET STRUCTURED CABLING

The next generation of high performance copper connectivity is 10Gbit/s Ethernet. With an increasing number of shielded and un-shielded solutions being introduced into the structured cabling market, OCC is offering new high performance products for 10Gbit/s throughput, as well as compliant to the latest standards by IEEE, TIA, and ISO.

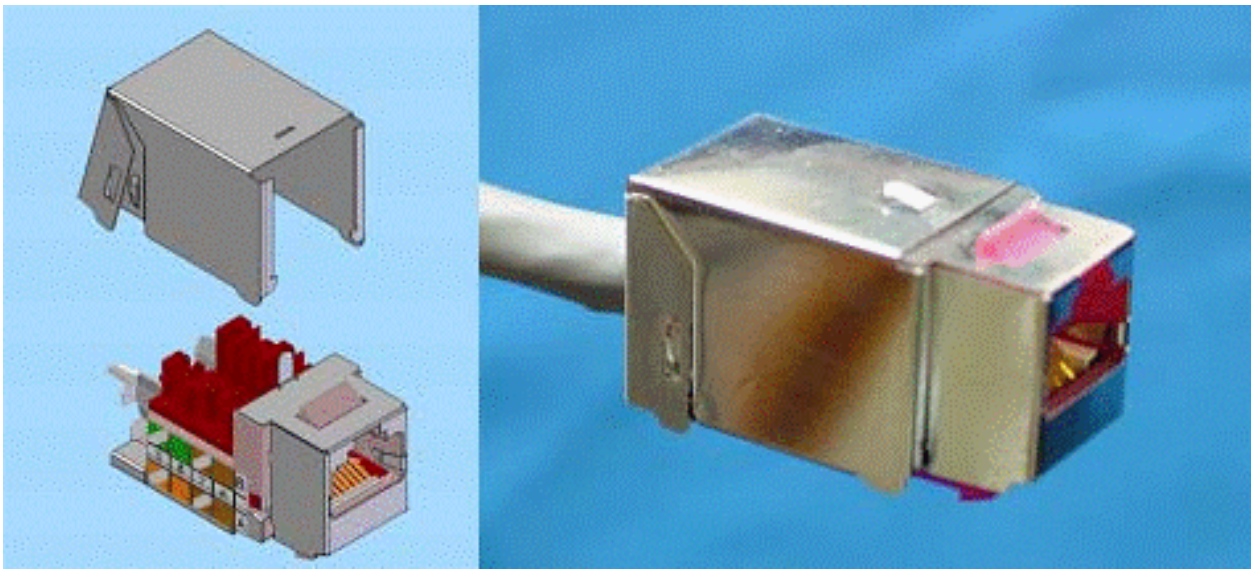

Figure 1: Slimline Shielded KMJ Cat 6A jack. (a) Design model (b) Prototype during testing

The new OCC Slimline product line utilizes a common small sized form factor for widespread applications. The Slimline product set includes:

- The UTP KMJA6 Cat 6 Jack
- The Shielded KMJA6 Cat 6 Jack
- The UTP KMJA6 Cat 6a Jack
- The Shielded KMJA6 Cat 6a Jack

The above parts use common and interchangeable internals to achieve production economy and flexibility. Performance enhancements to comply and exceed Cat6a requirements are achieved through contact and PCB design improvements. All KMJA6 products (shielded and UTP) achieve 24 ports in one rack space (1U). For UTP connectors, the 1U density is reduced to 16 ports to comply with Augmented Cat6 Alien crosstalk requirements.

We recommend and supply Augmented Cat6 compliant shielded patch cords utilizing Cat7 compliant stranded patch cord and patented Shielded Cat6/6a plugs. These cords are the perfect compliment to the shielded KMJA6 connectors and are also compatible with Cat6a UTP systems. We recommend that Cat6a patch cables be used with shielded connectivity at least on one end of the cord, either as an equipment cord, or with shielded connectivity in the cross-connect.

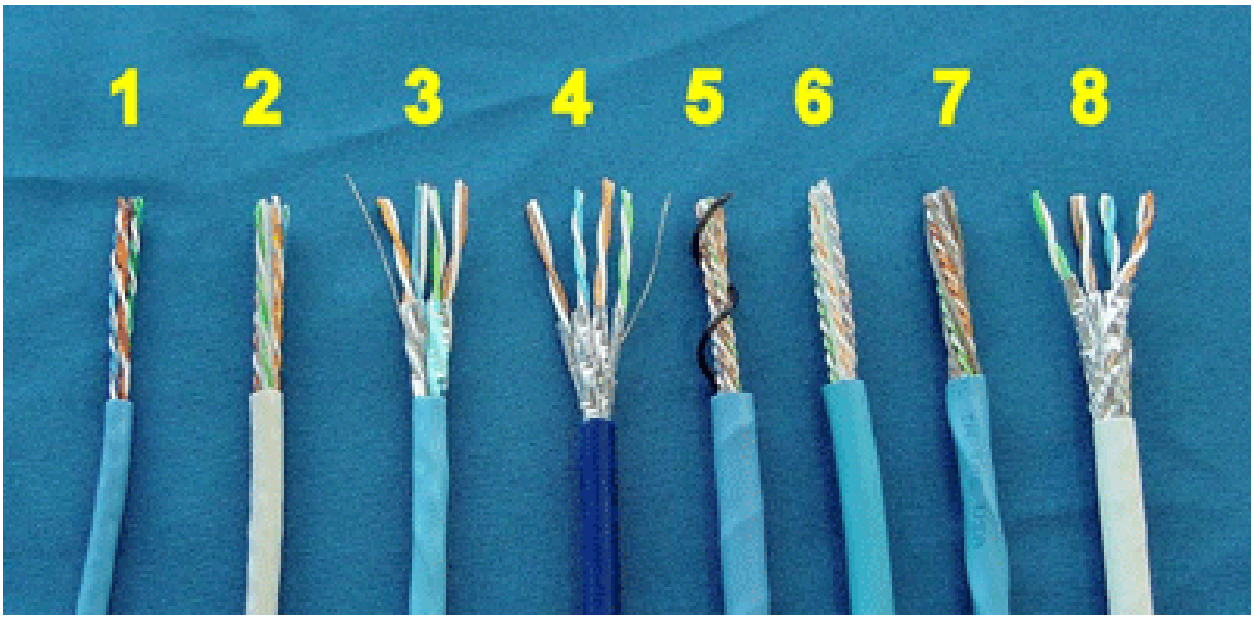

Figure 2. Cable Types

Figure 2, available cable types are:

1. Category 5e, 5.6mm (.220") dia. (For reference, not specified for 10GBASE-T)
2. Category 6 UTP, 6.5mm (.256") dia.
3. Category 6 500 MHz U/FTP, 6.8mm (.268") dia.
4. Category 6a U/FTP, 7.4mm (.292") dia.
5. Category 6a UTP, 8.89mm (.350") dia.
6. Category 6a UTP, 8.89mm (.350") dia.
7. Category 6a UTP, 8.89mm (.350") dia.
8. Category 7 S/FTP, 8.3mm (.327") dia.

Performance of cabling systems for 10GBASE-T

The primary performance metric for 10GBASE-T cabling is Alien crosstalk coupling. The so-called "primary parameters" of the cabling channel, NEXT, FEXT Return Loss, and to a small extent Insertion Loss, are equalized through high resolution DSP techniques at both transmitter and receiver. NEXT couplings are reduced by up to 50 dB across the frequency range from 10 MHz to 400 MHz, FEXT couplings are similarly reduced and RL reflections are cancelled up to 40 dB. Thus, the primary parameters, however important as they have been for cable qualification, are not limiting factors for 10GBASE-T transmission. For example, the sensitivity of the signal to noise ration (SNR) to changes in NEXT coupling is 1 in 12 dB. To put it another way, to reduce the SNR by 1 dB, you would need to reduce the Power sum NEXT by 12 dB, across the entire frequency band (10–400 MHz) of the 10GBASE-T application.

On the other hand, there may be little or no DSP applied to alien crosstalk couplings. Thus changes of PSANEXT levels (integrated across the frequency band) will have a direct 1-1 effect on 10GBASE-T SNR.

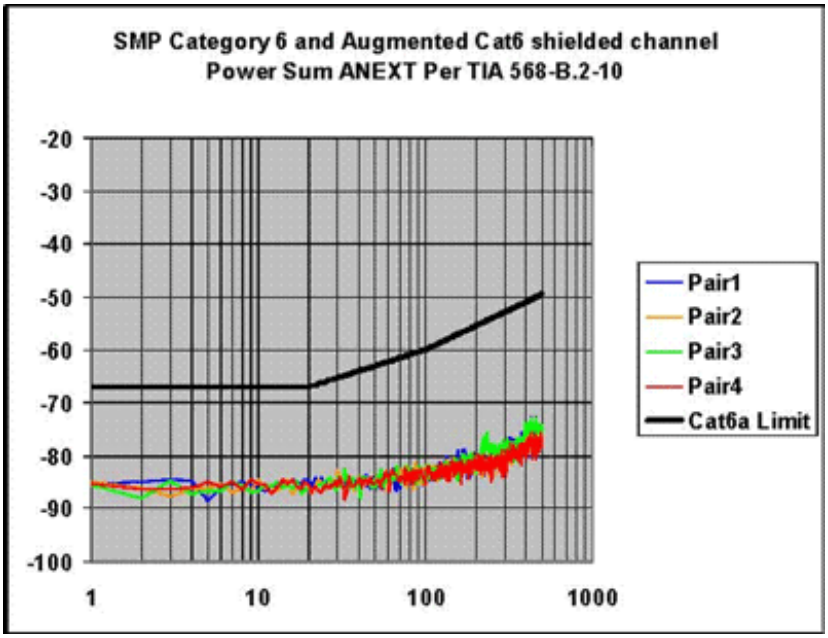

Figure 3.
Shielded 4 connector 100 meter channel PSANEXT

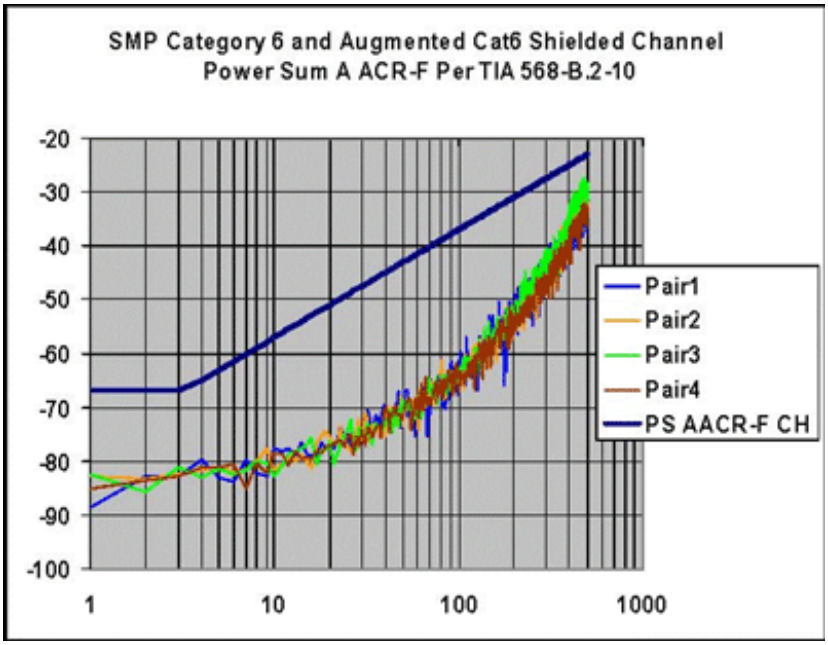

Figure 4.
Shielded 4 connector 100 meter PSAACR-F (Power Sum Alien Attentuation to Crosstalk Ratio, Far End)

The above graphs show how OCC Cat6 shielded connectivity (and Cat6a when it is available) will support 10GBASE-T with margin for full 100 meter and shorter channel configurations. With perforamnce margin as shown above, the channel alien crosstalk performance is assured by design, completely obviating the need for field test verification of alien crosstalk performance.

OCC UTP channel alien crosstalk performance

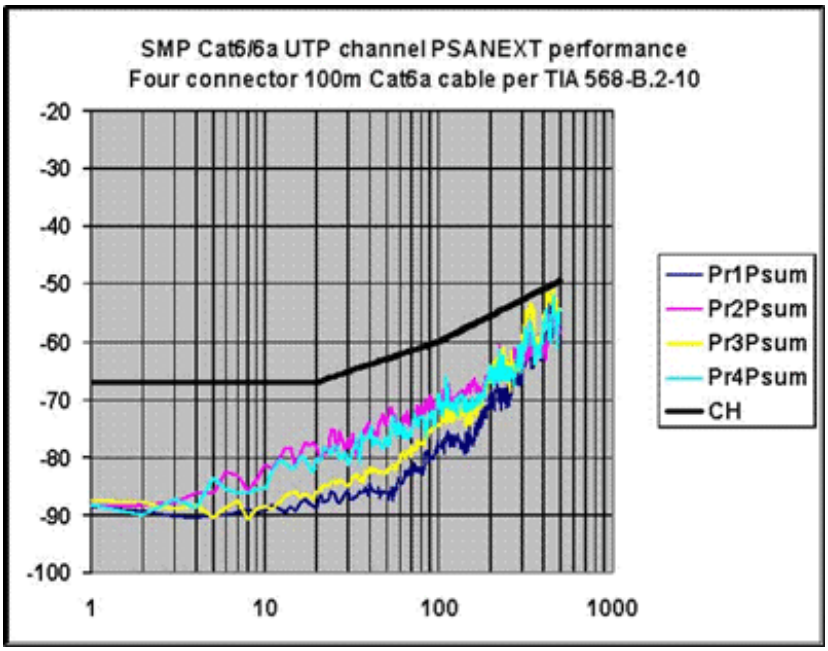

Figure 5.
Augmented Cat 6 UTP
4-connector channel 100 meter
PSANEXT

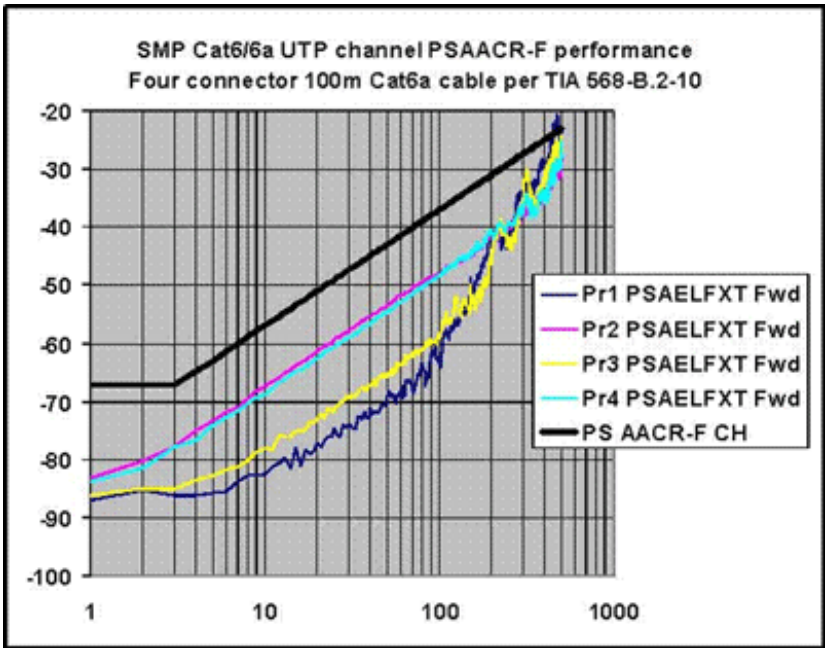

Figure 6.
Augmented Cat6 UTP
4-connector channel 100 meter
PSAACR-F

The alien crosstalk of UTP systems is assured given a suitable Augmented Cat6 cable is chosen. The charts show performance for 4-connector 100 meter channels with the highest quality (5 figure 2) Augmented Cat6 cable available. This channel performance yields and Alien crosstalk SNR (IEEE 802.3an clause 55.7.3.3) of greater than 22 dB (where 0 dB is the pass/fail limit). This is despite the peaks crossing the limit lines at high frequencies. (No measurement data was excluded from the Power sum calculation).

Connector performance

Augmented "Cat6a" connector performance for NEXT and return loss is a challenge to the design engineer. In addition, ISO channel requirements seem to require even better performance than the Augmented Cat6 channel requirements. To comply with TIA Cat6a NEXT requirements requires performance better than the limit line shown in Figure 7. The connector requirements to meet the proposed ISO 11801 requirements have not as yet been determined, but approach an extrapolated 20 dB slope to 500 MHz.

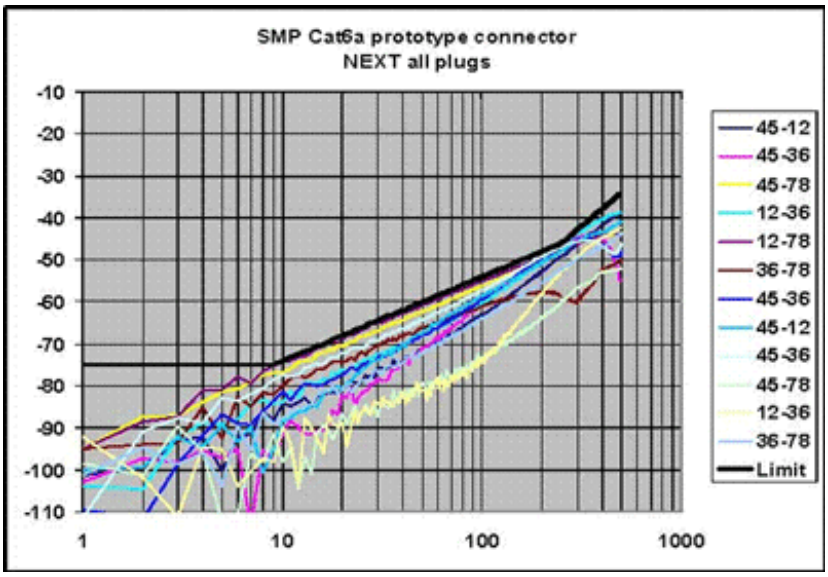

Figure 7.
Slimline Cat 6a NEXT performance

Figure 7 shows performance of a prototype OCC Cat6a outlet jack for NEXT with required TIA test plugs. Note that the performance at high frequencies is very good due to the use of state-of-the-art design methods.

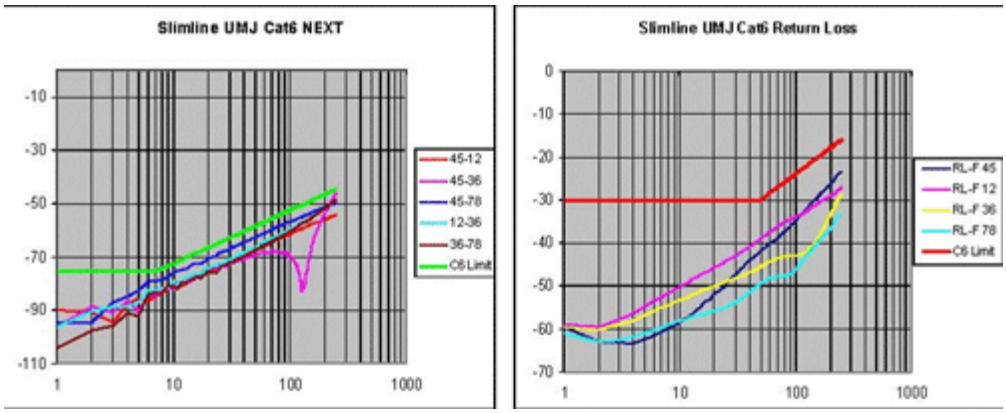

Figure 8.
(a) Slimline Cat6 NEXT
(b) Return Loss Measurements

Figure 8 shows representative performance for OCC Cat6 connectivity for NEXT and Return Loss.

The availability of OCC Slimline components are as follows:

- Shielded slimline KMJA6 Cat6 Jack
- Shielded slimline KMJA6 Cat 6a Jack
- UTP KMJA6 Cat6a Jack

Relevant Standards for 10GBASE-T applications:
Currently, the relevant 10Gbit/s Ethernet performance standards are under development by three independent committee groups. These three bodies and their respective documents include:

1. IEEE - 10GBASE-T 802.3an clause 55.7
2. TIA - TSB-155
3. ISO - TR-24750

The 10GBASE-T Ethernet standard is currently under development in IEEE 802.3an Task Force. This standard is due to publish in July 2006. This standard includes the "link segment" definition, clause 55.7 which specifies all of the relevant performance requirements for the cabling channel. The relevant cabling types and distances are specified in Table 55 - 12 of clause 55.7.2. Note that Class E/Cat 6 is specified up to 100 meters depending on the level of alien crosstalk, and that Cat6 screened is specified to 100 meters.

55.7.2 Link segment transmission parameters

A link segment consisting of up to 100 meters of Class E or up to 100 meters of Class F which meets the transmission parameters of this subclause provides a reliable medium. The transmission parameters of the link segment include insertion loss, delay parameters, nominal impedance, NEXT loss, ELFEXT, and return loss. In addition, the requirements for the alien crosstalk coupled "between" link segments is specified. Table55–12 lists the supported cabling types and distances.

Table 55–12— Cabling types and distances

Cabling	Supported link segment distances	Cabling references
Class E / Category 6	55 to 100 m[a]	ISO/IEC TR-24750 / TIA/EIA TSB-155
Class E / Category 6: unscreened	55 m	ISO/IEC TR-24750 / TIA/EIA TSB-155
Class E / Category 6: screened	100 m	ISO/IEC TR-24750 / TIA/EIA TSB-155
Class F	100 m	ISO/IEC TR-24750
Class E_A / Augmented Category 6	100 m	ISO/IEC 11801 Ed 2.1 /TIA/EIA-568-B.2-10

[a]Supported link segments up to 100 m shall meet the alien crosstalk to insertion loss requirements specified in 55.7.3.1.2 and 55.7.3.2.2.

Figure 9.
Table 55-12 IEEE 802.3an clause 55.7.2

The TIA TSB-155 document is essentially identical to clause 55.7 with the addition of testing and suggested mitigation techniques to improve the performance of existing category 6 installations if necessary. The TIA 42.7, formulating committee is also developing the addendum 568-B.2-10 "Augmented Category 6" which specifies channel, permanent link, and component (cable, connector and patch cord) requirements to support 10GBASE-T and "other" applications. The Augmented Cat6 requirements are an improvement over the requirements of 10GBASE-T in the areas of connector near end crosstalk from 250 MHz to 500 MHz and cable insertion loss. The Augmented Cat6 cable insertion loss is equal to the existing ISO Category 7 cable insertion loss. There are two levels of insertion loss in 10GBASE-T, one for exisiting Cat6, and the second for Augmented Cat6 cabling. The improved insertion loss of Augmented Cat6 allows for a 2 dB (100m) relaxation of the power sum alien near end crosstalk requirements, (fromn 62 dB to 60 dB at 100 MHz). Thus, for 100 meter channels, Category 6 alien crosstalk requirements are tighter than for Augmented Category 6, an apparent contradiction. The reason is apparent when we consider the overall signal to noise ratio (SNR) of the application (10G) and realize that we are trading insertion loss for crosstalk to end up with the same SNR for both cabling channel specifications.

ISO WG3-SC25 is developing the cable channel requirements to support 10GBASE-T for the international standards. These standards are similar to TIA and IEEE requirements except for the parameter of channel NEXT, where ISO has adopted an "extrapolated" limit which has the only effect of requiring tighter limits for connector NEXT at frequencies above 250 MHz. Since some connector manufacturers have drawn a line in the sand regarding Cat6a connector performance, this has caused a delay in implementation of connector performance requirements that will assure ISO Class Ea channel performance. The ISO standards also specify coupling attenuation as a metric for channel and cable EMI performance. In addition, the Class F channel and Cat7 cable insertion loss have been improved over the existing Cat7/Class F to stay ahead of the Augmented Cat6 insertion loss requirements. These standards specify both shielded and unshielded cabling systems as options to meet the IEEE requirements.

As an overview, the relevant documents and their titles are listed below:

1. IEEE 802.3an draft "Draft Amendment of: IEEE Standard for Information Technology - Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment: Physical Layer and Management Parameters for 10Gbit/s Operation, Type 10GBASE-T"
2. TIA TSB-155 "Guidelines for the assessment and mitigation of installed category 6 cabling to support 10GBASE-T"
3. ISO-TR 24750 "Assessment and mitigation of installed balanced cabling channels in order to support 10GBASE-T"
4. TIA 568-B.2-10 "Transmission Performance Specifications for 4-pair 100 ohm Augmented Category 6 Cabling"
5. ISO/IEC AM1.1 to ISO/IEC 11801:2002 "FPDAM 1.1 to ISO/IEC 11801:2002, Generic cabling for customer premises"

TIA and Augmented Category 6 (Cat6a) Performance:
As the standards have evolved, the TIA Augmented Category 6 (Cat6a) specification has designated key areas of performance improvement in the following component and channel attributes when compared to previous generations of products:

1. Return Loss (RL) for connecting hardware is improved, meaning less data signal reflection in the channel resulting from the connectors.
2. The overall channel return loss is also improved
3. Insertion loss (Attenuation) of the data signal is improved in Cat6a over the Cat6 channel, producing a better SNR (Signal to Noise Ratio) for the channel

However, the most obvious difference in the Cat6a specification compared to Cat6 for the installer and field tester is the extension of the frequency band from 250 MHz to 500 MHz.

Specification, Standards, and Confusion with ISO to achieve 10GBit/s Performance:
Confusion and specific problems have resulted within the industry in regards to differences between the three relevant committees and their respective proposed standards. ISO, for example, first completed a required channel specification based on an extrapolated Cat6 limit to 500 MHz. From this channel requirement component level performance specifications are to be extracted. The problem resulting from this approach is that firstly, the ISO component level performance specifications exceed the already established TIA Cat6a standards and secondly, some speculate whether or not component performance as specified by the ISO standard is necessary or even physically possible.

Participating heavily in the TIA committee process, OCC has already developed high performance products that can be sold in various channel configurations to meet 10GBit/s standards.

OCC 10GBASE-T specification IEEE 802.3an clause 55.7 and TIA TSB-155 compliant channel configurations include all OCC Cat6 connecting hardware combined with:

1. UTP Category 6 cabling up to lengths of 37m.
2. STP Category 6 cabling up to lenghts of 100m.
3. Augmentedc Category 6 cabling of lengths up to 100m.

Patch Cord Shielding and Radiated Emissions:
10GBit/s channel performance has resulted in the debate of the effects of utilizing a shielded product in structured cabling, and what effects these shields have upon the installed system.

Figure 10.
Category 6 shielded patch cord

OCC patch cords have terminated shields on both ends. This provides electromagnetic interference (EMI) protection for the end user, by providing screen connectivity through the structured cabling system.

Screen connectivity through the structured cabling system is the ideal configuration. Tabs on the inside of the shielded RJ45 jacks provide connectivity between the patch cord shield and the patch panel and active network components. Using a shield patch cord is not detrimental to system performance when combined with UTP horizontal cabling system, as the termination on one end of the patch cord is still connected to the active component on the network, such as a switch, workstation or server. The active component provides a termination of the system to ground, and thus does not induce a floating ground shield, or the “antenna effect.”

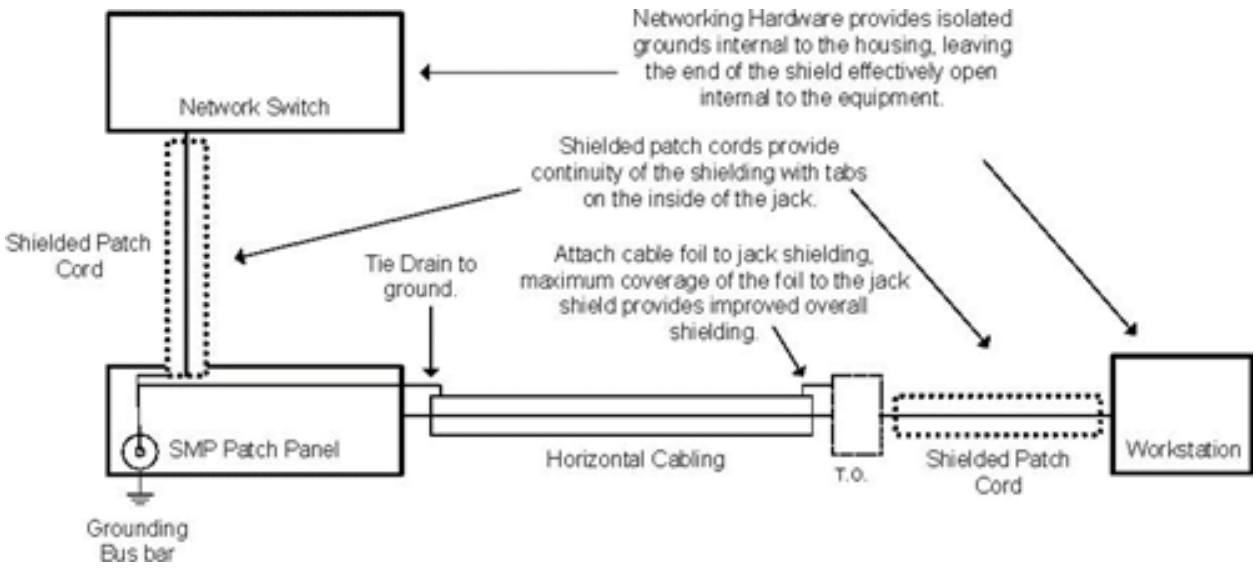

Figure 11: Ideal method of terminating shields for a structured cabling system

Simple Rules of Thumb

Installing Shielded Cabling Systems:

- Terminate the shield at both ends of the cable
- Use plastic backboxes to avoid contact with aluminum studs and other metal infrastructure
- The patch panel itself is tied to the grounding bus bar
- Simple rule of thumb - provide shielding connectivity out from the panel through all cable to the active network hardware