

# Where Cat. 6<sub>A</sub> meets 600 MHz AMP NETCONNECT XG<sub>A</sub> System

By Allan Nielsen

<b>1</b>	<b>INTRODUCTION</b>	<b>3</b>
<b>2</b>	<b>STANDARDS</b>	<b>3</b>
2.1	Compliance with standards .....	3
2.2	Which standards are relevant to Category 6 <sub>A</sub> components .....	3
2.3	Naming of new standard channels .....	4
2.4	Mix and Match.....	6
2.5	Standards and Alien Crosstalk .....	7
<b>3</b>	<b>TECHNOLOGY</b>	<b>8</b>
3.1	Re-embedding .....	8
3.2	Field testing .....	8
3.3	Augmented to 500 MHz .....	9
3.4	Alien Crosstalk.....	9
3.5	2 connectors or 4 connectors .....	9
<b>4</b>	<b>PERFORMANCE</b>	<b>10</b>
4.1	NEXT .....	10
4.2	Return Loss.....	11
4.3	Alien Crosstalk.....	11
4.4	Transfer impedance .....	12
4.5	Permanent Link performance.....	12
4.5.1	Shannon Capacity.....	12
4.5.2	NEXT performance to 800 MHz.....	13
4.5.3	RL performance to 800 MHz .....	13
<b>5</b>	<b>IMPLEMENTATION</b>	<b>14</b>
5.1	Short length support.....	14
5.2	Patch cord management.....	14
5.3	Installation time.....	15
<b>6</b>	<b>SUPPORTED APPLICATIONS</b>	<b>15</b>

---

---

## 1 Introduction

This Guide explains why Tyco Electronics recommend the use of standard component compliant products. This paper should be read together with the introduction to the new AMP NETCONNECT XG<sub>A</sub> Cabling System and the new AMP TWIST 6<sub>A</sub>S SL modular jack.

Performance graphs and details listed in this paper can be considered as general guidelines. It is always advisable to consult Tyco Electronics AMP NETCONNECT Solutions Division for details and actual performance of the cabling system and components.

## 2 Standards

### 2.1 Compliance with standards

In the early 1990s the telecommunications industry recognized the need to establish guidelines for the cabling of buildings for both voice and data. These guidelines, or standards, provide direction for the proper installation of new telecommunications products as well as addressing the many moves, adds, and changes to an existing installation.

Standards are written and approved by committees made up of professionals from the industry that the standards affect, and these committees generally have representation from manufacturers, government, universities, and independent consultants who have a key interest in the manner that products and services are delivered.

Within customer premises, the importance of the cabling infrastructure is similar to that of other fundamental building utilities such as heating, lighting and mains power. As with other utilities, interruptions to service can have a serious impact. Poor quality of service due to lack of design foresight, use of inappropriate components, incorrect installation, poor administration or inadequate support can threaten an organization's effectiveness.

Standards are not mandatory and have no inherent jurisdiction over the products or systems that they cover, and may be voluntarily adopted by manufacturing and service organisations to make their product or service more attractive to the end user.

Alternatively the standards may be invoked by reference in a purchasing document such as a Request for Quotation (RFQ) or a Request for Tender (RFT). The use of standards with reference to these procurement documents enables the end user to provide detailed specifications for the product they want without going into great detail.

### 2.2 Which standards are relevant to Category 6<sub>A</sub> components

In EMEA the Standards that the structured cabling systems industry commonly refers to are the ISO/IEC series of standards, the CENELEC series of standards and the ANSI/TIA/EIA series of standards. Below is an overview of the current progress of these standards:

Standard body	Configuration	Standard for Cat. 6 (250 MHz)	Standard for Cat. 6 <sub>A</sub> (500 MHz)	Standard for Cat. 7 (600 MHz)	Standard for Cat. 7 <sub>A</sub> (1000 MHz)
	Channel	11801 2nd Ed.	11801 2nd Ed. Am. 1	11801 2nd Ed.	11801 2nd Ed. Am. 1
ISO/IEC	Permanent Link	11801 2nd Ed.	<b>11801 2nd Ed. Am. 2</b>	11801 2nd Ed.	<b>11801 2nd Ed. Am. 2</b>
	Component	11801 2nd Ed.	<b>11801 2nd Ed. Am. 2</b>	11801 2nd Ed.	<b>11801 2nd Ed. Am. 2</b>
	Channel	EN 50173-1:2002	EN 50173-1:2002 Am. 1	EN 50173-1:2002	EN 50173-1:2002 Am. 1
CENELEC	Permanent Link	EN 50173-1:2002	<b>EN 50173-1:2002 Am. 2</b>	EN 50173-1:2002	<b>EN 50173-1:2002 Am. 2</b>
	Component	EN 50173-1:2002	<b>EN 50173-1:2002 Am. 2</b>	EN 50173-1:2002	<b>EN 50173-1:2002 Am. 2</b>
			#		
	Channel	TIA/EIA-568-B.2	TIA/EIA-568-B.2 Add 10	N/A	N/A
TIA/EIA	Permanent Link	TIA/EIA-568-B.2	TIA/EIA-568-B.2 Add 10	N/A	N/A
	Component	TIA/EIA-568-B.2	TIA/EIA-568-B.2 Add 10	N/A	N/A

## 2.3 Naming of new standard channels

Although all standards have chosen to concentrate on the word “Augmented”, which is attached to Category 6 as an A, either as a capital A for TIA/EIA or as a subscript <sub>A</sub> for ISO/IEC and CENELEC, it has different meanings, which have proven to be confusing to many customers, as many are very weak in describing exactly what they deliver, or in other cases what they specify in their tenders.

Let’s first see what the different names of components, permanent links and channels mean to each standard.

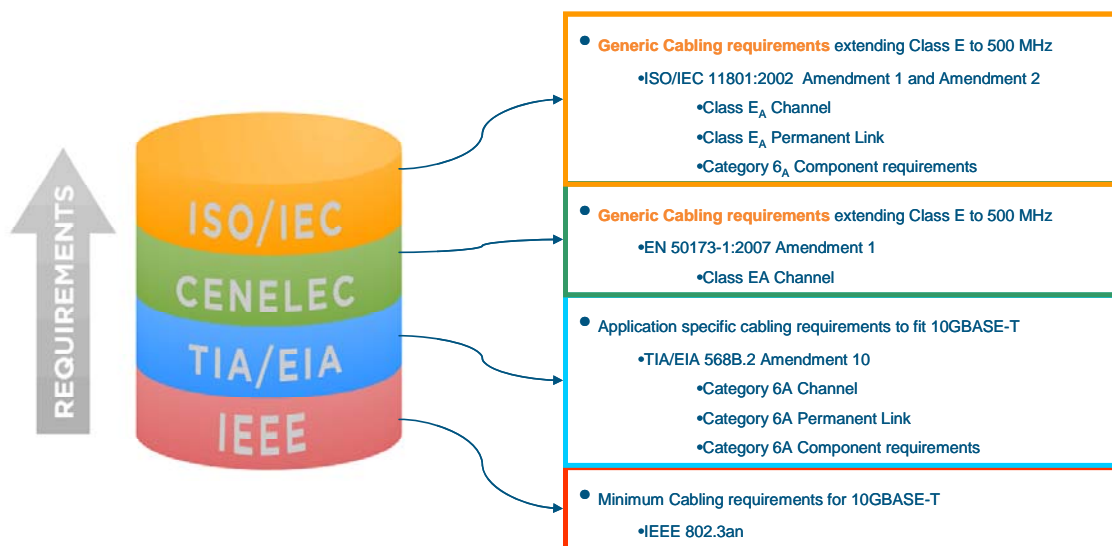
Standard-body	Configuration	Cat. 6 or ClassE	Cat. 6 <sub>A</sub> or ClassE <sub>A</sub> (500 MHz)
ISO/IEC	Channel	ClassE	<b>ClassE<sub>A</sub></b>
	Permanent Link	ClassE	<b>ClassE<sub>A</sub></b>
	Component	Cat. 6	<b>Cat. 6<sub>A</sub></b>
	Channel	ClassE	<b>ClassE<sub>A</sub></b>
CENELEC	Permanent Link	ClassE	<b>ClassE<sub>A</sub></b>
	Component	Cat. 6	<b>Cat. 6<sub>A</sub></b>
			#
TIA/EIA	Channel	Cat. 6	<b>Cat. 6A</b>
	Permanent Link	Cat. 6	<b>Cat. 6A</b>
	Component	Cat. 6	<b>Cat. 6A</b>

As it can be seen ISO/IEC and CENELEC name their permanent links and channels as Classes of performance, and their components as Categories of performance, whilst TIA/EIA use Category for permanent links, channels and components. This may confuse some, as when a system is described as meeting Category 6A, does

that then mean that it meets the channel, permanent link or also the components requirements, as it is well known that you can build a channel out of non-compliant components and still make it pass the channel requirements? Please note that such channels are no longer valid when a different length or performance of patch cords is attached, and therefore not advisable for future installations.

When specifying a good cabling system, one must specify that it has to meet the class of performance for the channel or permanent link, and that the components have to meet a specific category. The benefits of using standardized components are discussed later in this document.

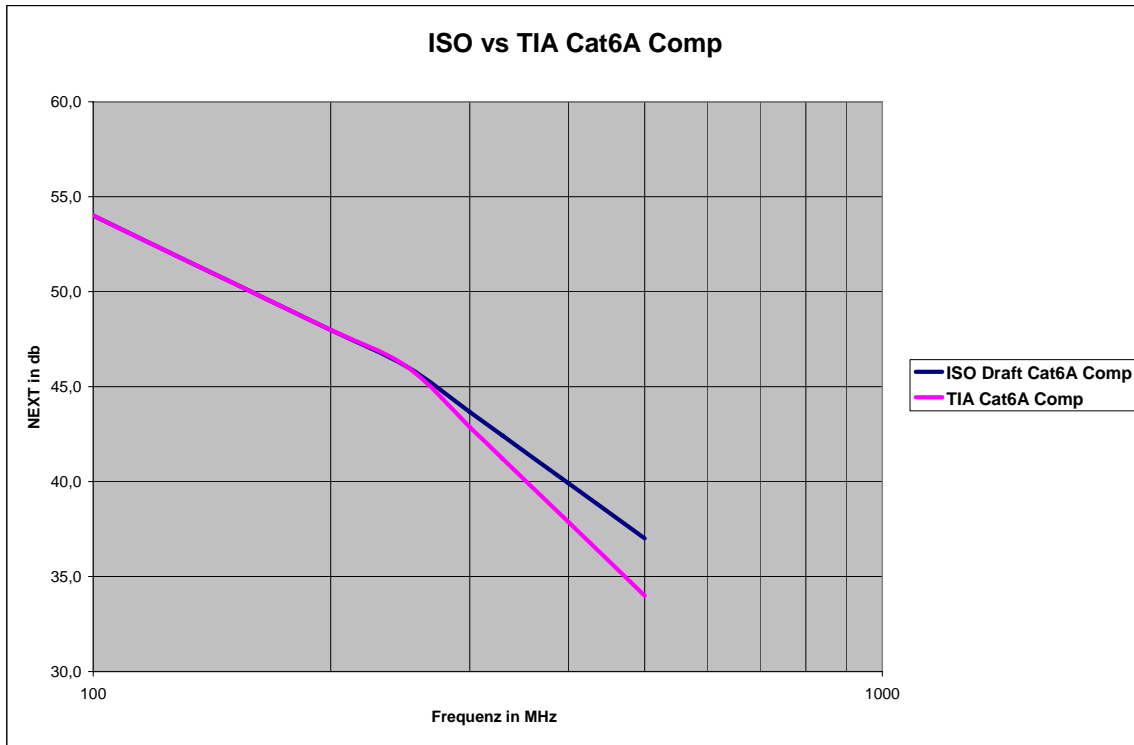
While the naming seems to confuse most people, it becomes even more confusing when the discussion is about the actual performance of the different standards, as ISO/IEC and CENELEC have chosen to follow the path of generic cabling systems, which supports a range of applications and TIA/EIA have chosen to follow the path of application specific cabling, which only delivers marginally more than the absolute minimum as specified in the application document from IEEE.



Although the differences seems to be minor, as it is only a matter of a few dB for NEXT in connecting hardware, and only at higher frequencies, it gives a rather interesting problem for the cabling industry, as these components cannot be mixed between different regions of the world.

If a component meets ISO/IEC or CENELEC, then it automatically meets the minimum requirements for TIA/EIA and IEEE, whilst a component that meets TIA/EIA will not conform with the minimum requirements for ISO/IEC or CENELEC, but meets the minimum requirements set in IEEE.

The difference between an ISO/IEC Category 6<sub>A</sub> component and a TIA/EIA Category 6A component is only with regard to NEXT and PS NEXT, which are described in the following graph:



As it can be seen there is approximately 3 dB difference in performance between the components, but the 3 dB gives some limitations as to where a component can be used.

In EMEA we either refer to CENELEC standards, or in the absence of a relevant CENELEC standard, ISO/IEC or IEC standard, which means that we normally need to conform with the international standards, unless specifically specified by the customer, for whatever reason. So if I install a TIA/EIA compliant modular jack with a Category 6<sub>A</sub> cable and measure the permanent link, then it may fail. The following table shows the compliance possibilities for different components.

	TIA Cat. 6A	TIA Cat. 6A	TIA Cat. 6A	ISO ClassE <sub>A</sub>	ISO ClassE <sub>A</sub>	ISO Cat. 6 <sub>A</sub>
	Channel	PL	Comp	Channel	PL	Comp
TIA/EIA Cat 6A	yes	yes	yes	no	no	no
ISO/IEC Cat 6 <sub>A</sub>	yes	yes	yes	yes	yes	yes

The only global product is the ISO/IEC compliant component, as this meets all applicable standards and requirements.

## 2.4 Mix and Match

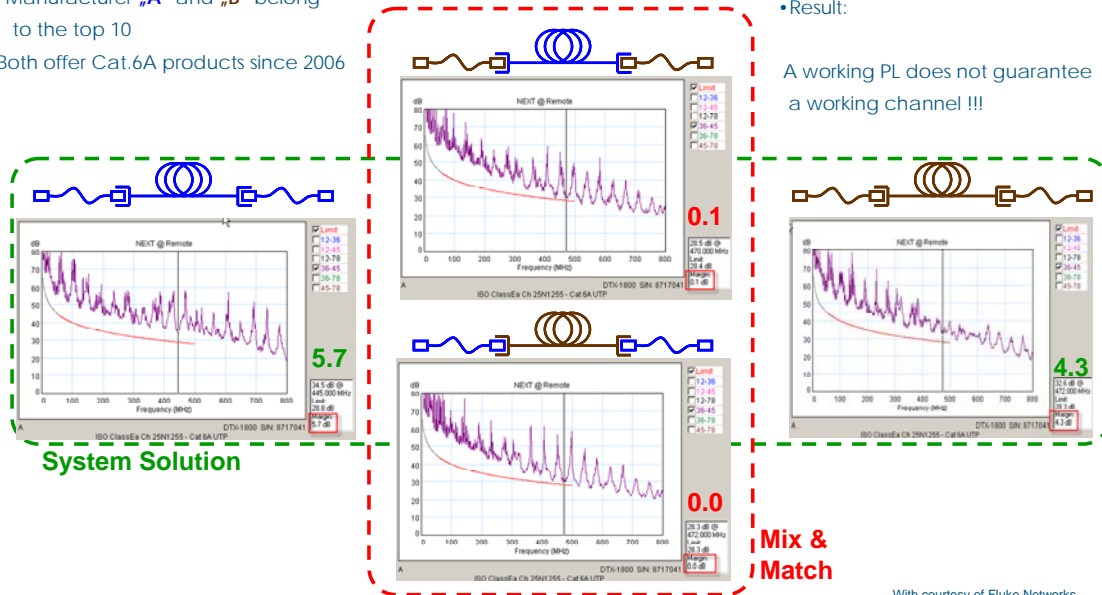
All standards are based on the fact that a customer must have the option to “Mix and Match” within his installation, which means that it must be possible to take a modular jack from one vendor and match it with a patch cord from another vendor. Provided that both meet their component specifications, then the jointed connection will meet the minimum performance specifications for a Category connection, as this is always described as a modular jack and a modular plug in a mated state.

When using systems which are only compliant with the channel or permanent link but not component requirements, then this standard feature cannot be applied, because each

connection is based on a manufacturer specific performance. This has the consequence that the user always needs to use patch cords from the specific manufacturer, in order to meet the minimum channel performance.

Fluke Networks have made a study with regard to this subject, and their measurements show that mixing different manufacturers' products, when only complying with the TIA/EIA channel performance, will result in failure.

- Manufacturer „A“ and „B“ belong to the top 10
- Both offer Cat.6A products since 2006



With courtesy of Fluke Networks

With a component compliant jack, the user is always sure that the connections will pass the channel requirements, as it is a part of the mix and match standard.

## 2.5 Standards and Alien Crosstalk

When a new requirement was introduced into the cabling standards, the first thing that happened was an attempt to find a suitable field measurement method for the new parameter. This has now been demonstrated and manufactured by several field measurement equipment manufacturers, so it can be measured.

Some manufacturers of cabling still do not believe that this is available, and therefore they are recommending their customers that they should not measure alien crosstalk.

Industry experts creating the cabling standards have only defined one situation where Alien crosstalk does not need to be measured, which is stated in ISO/IEC 11801:

*“If the coupling attenuation of Class E<sub>A</sub> or F permanent links or CP links is at least 10 dB better than the corresponding channel coupling attenuation requirements, and Class F<sub>A</sub> permanent links or CP links are at least 25 dB better than the corresponding channel coupling attenuation requirements, then the requirements of A.2.11 are met by design.”*

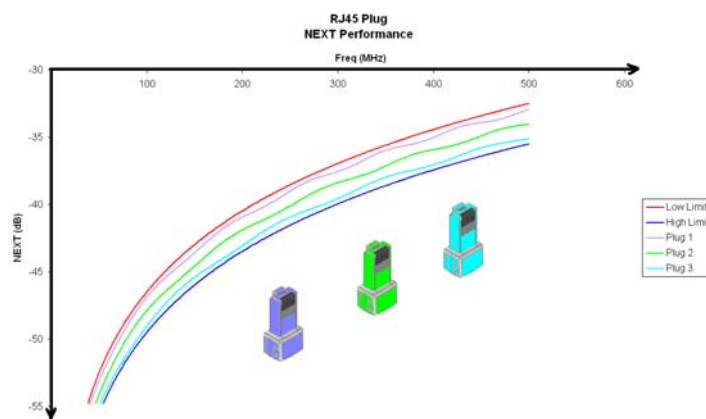
A.2.11 is Alien Crosstalk, which is separated between PS ANEXT and PS AACR-F, alien crosstalk in the near end and equal level alien crosstalk in the far end.

Unless you meet this requirement by design, then it is recommended that you measure alien crosstalk for installed permanent links or channels.

### 3 Technology

#### 3.1 Re-embedding

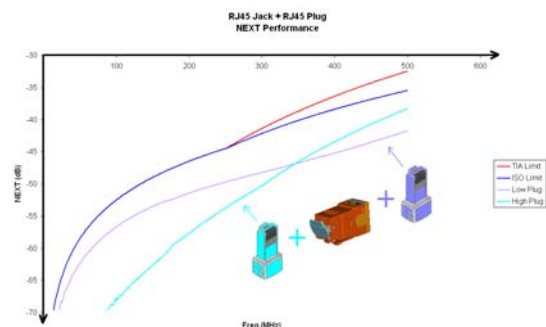
When qualifying a Category 6<sub>A</sub> component in accordance with ISO/IEC 11801 Amendment 2, then it needs to go through a verification procedure, where the modular jack is verified together with several types of modular plug. This can either be done by measuring the jack with all different types of plugs, or by measuring with a specialized plug, the performance of which is the average of all plugs, and then calculating the results of the remaining combinations. This new method is called the Re-Embedding method, and is a refinement of the existing De-Embedding method for measuring modular jacks.



In order to conform with the relevant component standards for ISO/IEC 11801, a manufacturer needs to verify their product by this Re-Embedded method, ensuring that it will be able to meet the minimum jointed performance requirements when mated with a range of plugs. This is to ensure that the mix and match requirement is met for the components. The picture above shows the range that has to be met

and as it can be seen there is a difference of around 4 dB between the high performing and the low performing plugs.

The verification process then involves a matrix where the manufacturer needs to show that they meet all requirements for a Modular Jack, when mated with both high end and low end performing plugs, while still meeting the minimum requirements set forth in the standard. Only a true Category 6<sub>A</sub> Modular Jack is able to meet this requirement.



The advantage for the user is that they can use any Category 6<sub>A</sub> patch cord, and still be confident that the final connection will meet the minimum requirements.

#### 3.2 Field testing

The special center plug used for the Re-Embedded measurement method is also the plug that is used for field testers when measuring permanent links, which means that the correlation between field measurements and laboratory measurements is reduced

---

drastically. The only difference that exists when migrating to the new method is the difference between the measurement accuracy of field testers and laboratory equipment. Tyco Electronics have evaluated field testers and their accuracy and provides a list of approved field testers in conjunction with their warranty program.

### **3.3 Augmented to 500 MHz**

When creating designs for Category 6 connecting hardware, many manufacturers had problems in controlling the noise signals up to 250 MHz, and in many cases it was seen that Near End Crosstalk Losses became very low after this frequency. So when designing a Modular Jack which did not perform better than the Category 6 connector, but with extended frequency up to 500 MHz, every engineering department had its challenges. The main challenge was to create a perfect noise compensation scheme, with a tolerance that had not yet been used in the connecting hardware industry, and what is seen now is that it is possible to control an RJ45 Modular Jack and Modular Plug beyond the 500 MHz, bearing in mind that this connector style was originally designed to carry a 3 MHz signal.

### **3.4 Alien Crosstalk**

When qualifying either cable or modular jacks for alien crosstalk, one needs to observe the qualification method that the manufacturer has used, as this is not yet fully standardized. This means that one manufacturer can qualify their cable with a distance between jacks, meeting the alien crosstalk requirements, but when installed in a real installation and in a high density patch panel, it can fail to meet the requirements. This is because the minimum distance needed between connectors for meeting the alien crosstalk requirement is not met when installed in real life. This fact is not only valid for UTP connectors but also shielded connectors which have holes in the outer body, creating passages for the crosstalk to pass from one connector to the other. If holes in the connector sit adjacent to each other when mounted in a patch panel, then some noise will be inducted from one connector to another.

Also cable can be qualified as a Category 6<sub>A</sub> component using spacing between the measurement cables, which are removed later. This has been seen on some UTP cables where the bundling of the cables will create a situation where it fails, unless it is separated in the installation as it was when the component was qualified as a Category 6<sub>A</sub> cable.

Serious manufacturers of components specify the minimum distance between components which has to be met in order to meet the alien crosstalk requirements.

### **3.5 2 connectors or 4 connectors**

The connector itself is nothing without a cable to create a channel, so when looking at the market place for Category 6<sub>A</sub> performance, and bearing in mind the nomenclature confusion caused by the standards, it is obvious that even components failing the minimum requirements for connecting hardware can be used for creating a Category 6<sub>A</sub> channel.

Some manufacturers use the tactics of measuring the channel using only 2 connectors, and this limits the use of the system, because if a user wants to use a consolidation point, then it may fail, or if service presentation for switching gear is needed, then it will also fail.

All standards apply a minimum of 4 connectors for a channel when calculating the necessary performance for components. This is in order to give the user the option of using both a

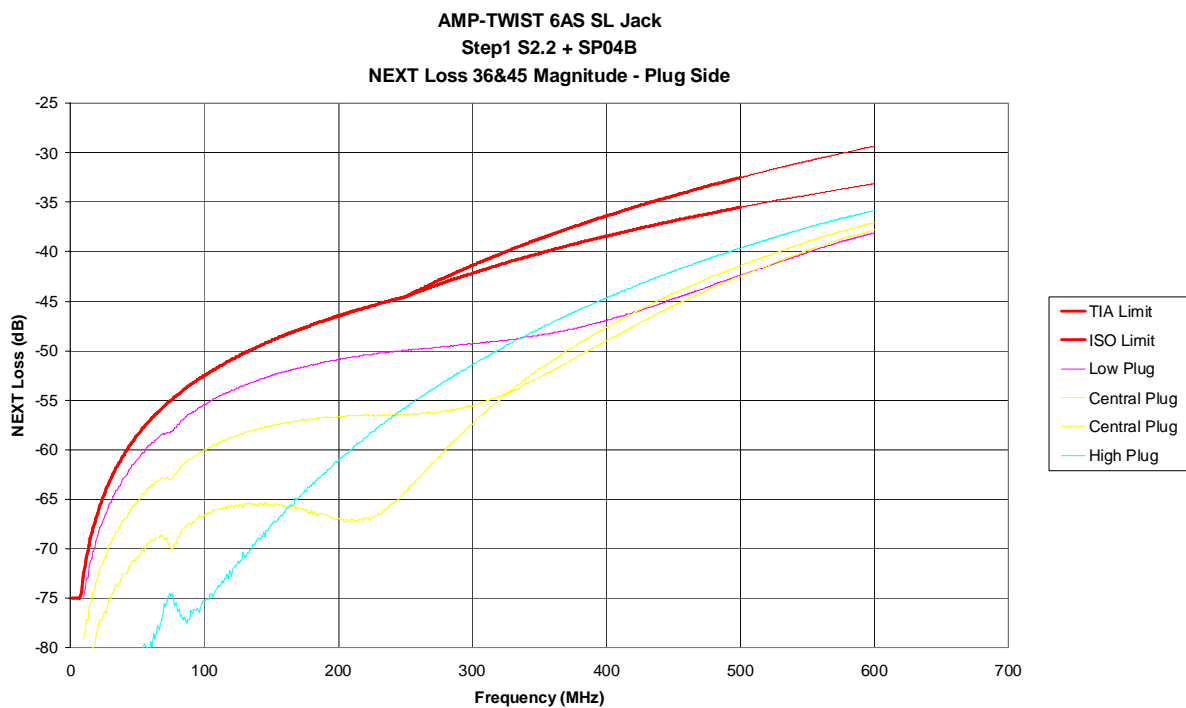


consolidation point and a cross connect. So standard compliant components need to have margins in order to be able to support these implementation methods.

## 4 Performance

The new Tyco Electronics AMP TWIST 6<sub>A</sub>S SL jack exceeds all expectations of the minimum performance of connecting hardware. Our engineering department even created a design that gives stable performance up to and beyond 600 MHz, which is the same frequency used for Class F cabling systems. This was considered to be impossible only a few years ago, but by using complex CAD designing tools, and of course decades of experience, they exceeded the minimum requirements by far.

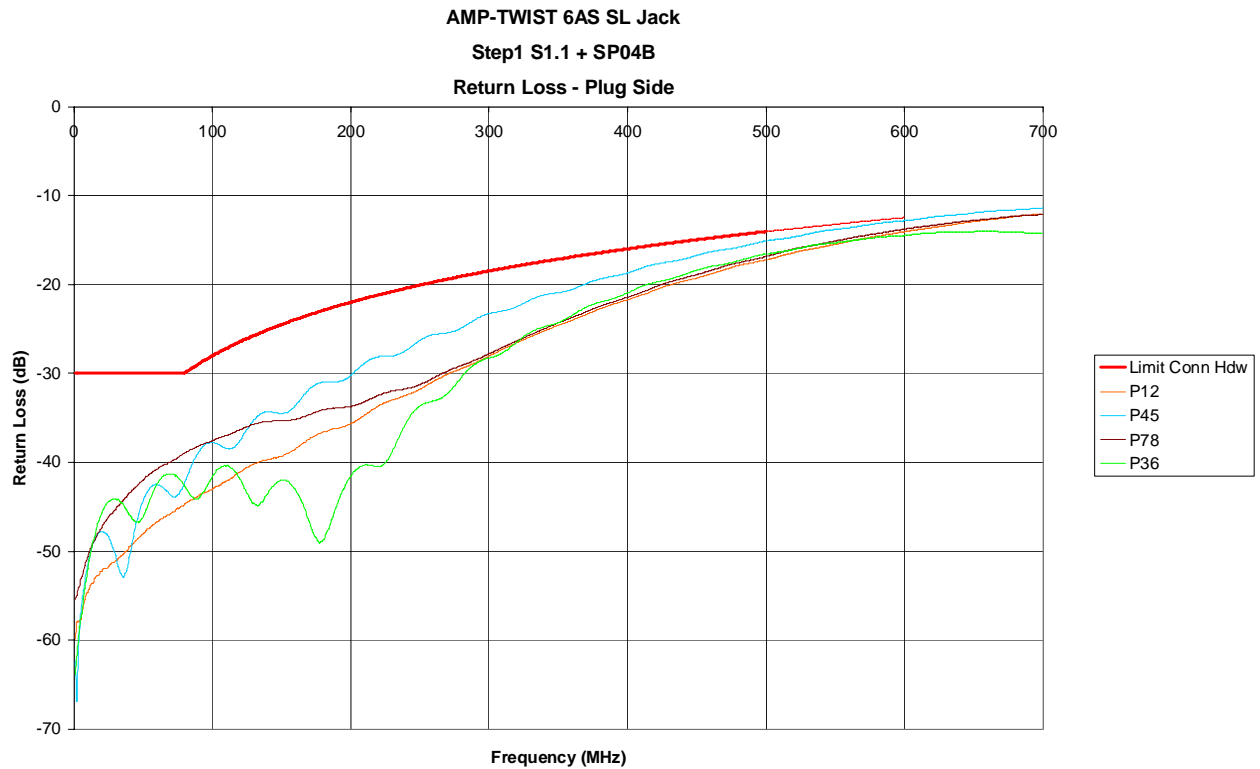
### 4.1 NEXT



With a minimum margin of 5 dB at 500 MHz, taking into account all the different combinations of plugs, the new AMP TWIST 6<sub>A</sub>S SL jack enables cabling systems to be used up to 800 MHz; this creates new possibilities for the performance class, as the support of higher data speeds than 10Gb/s is now within reach.

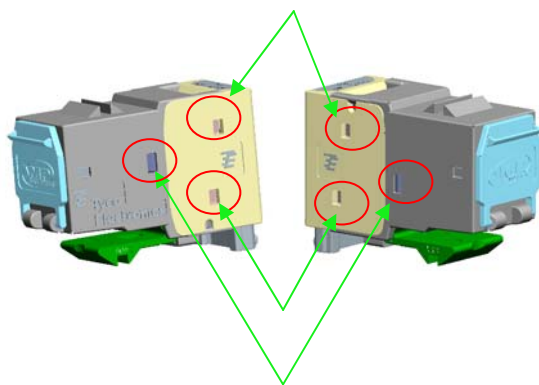
---

## 4.2 Return Loss

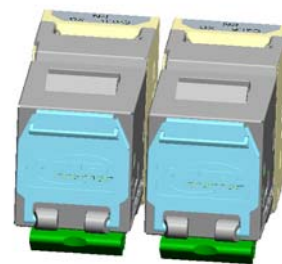


Return loss is an indication of how stable a modular jack connection is. As can be seen here the new AMP TWIST 6<sub>A</sub>S SL jack provides margins, even enough to support 600 MHz on connecting hardware and up to 800 MHz on the permanent link or channel.

## 4.3 Alien Crosstalk



Non symmetrical openings



The openings of the two sides are not placed face to face >>  
Reducing Alien Crosstalk

Mechanical latching holes are placed in such a way that they will not be next to each other when mounted in a patch panel or wall outlet, which greatly reduces the Alien Crosstalk to a level where it cannot be measured. As the connector also meets coupling attenuation with huge margins, Alien Crosstalk is met by design, and therefore need not be tested. Tyco Electronics have chosen to design around this in order to provide even better performance than needed by the standards.

## 4.4 Transfer impedance

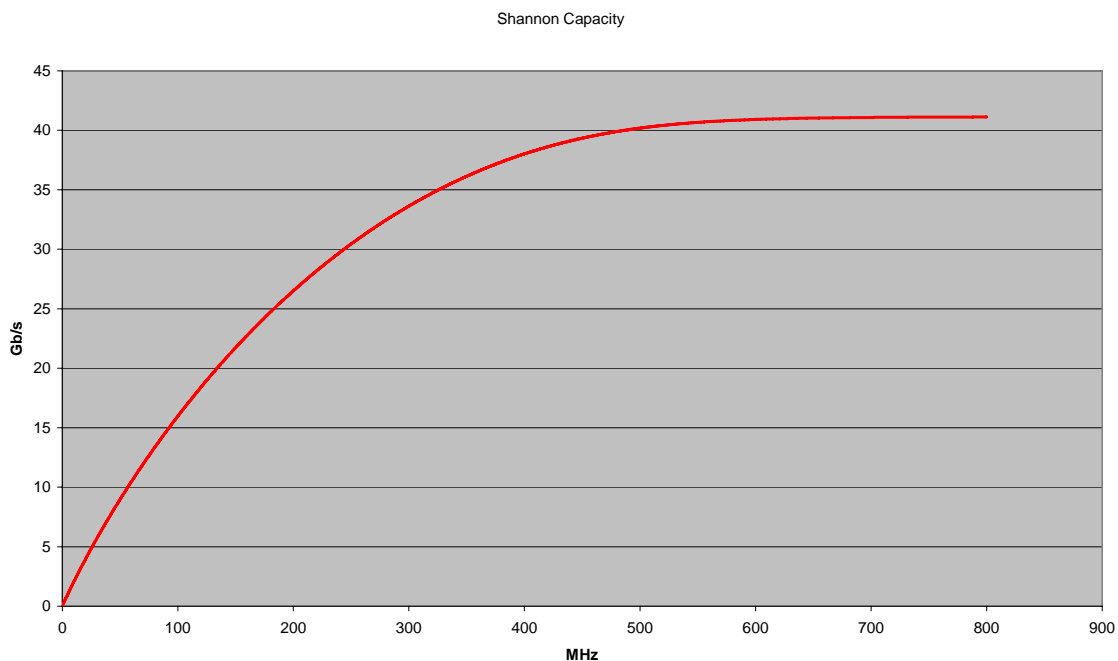


The 360° shield connection between connector and cable has been designed with a spring load, which ensures that the screening performance of the connector is met, independent of the movement of cables. This patented feature is unique in the industry.

## 4.5 Permanent Link performance

The new XG<sub>A</sub> Cabling system provides excellent margins for transmission performance of permanent links and channels up to 800 MHz, which enables the system to support both short and long length support.

### 4.5.1 Shannon Capacity

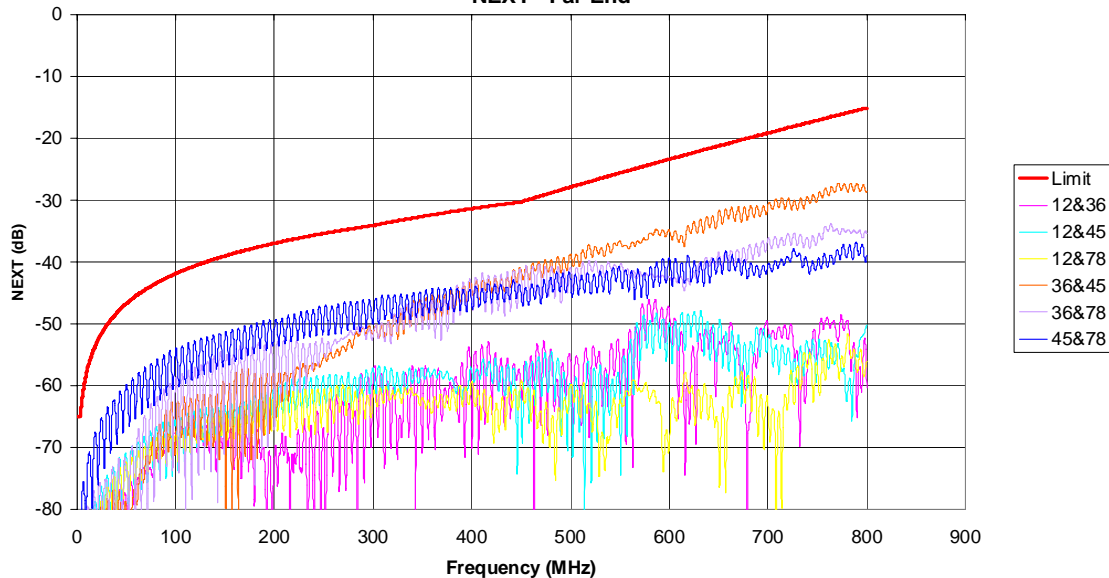


The new XG<sub>A</sub> Cabling system, which features the new AMP TWIST 6<sub>A</sub>S SL jack, is able to support up to 41 Gb/s of Shannon Capacity, making it the ideal choice for a future cabling system.

## 4.5.2 NEXT performance to 800 MHz

Worst Headroom = 10.19 dB

AMP-TWIST 6AS SL Jack  
PL 15m - Step 1  
NEXT - Far End

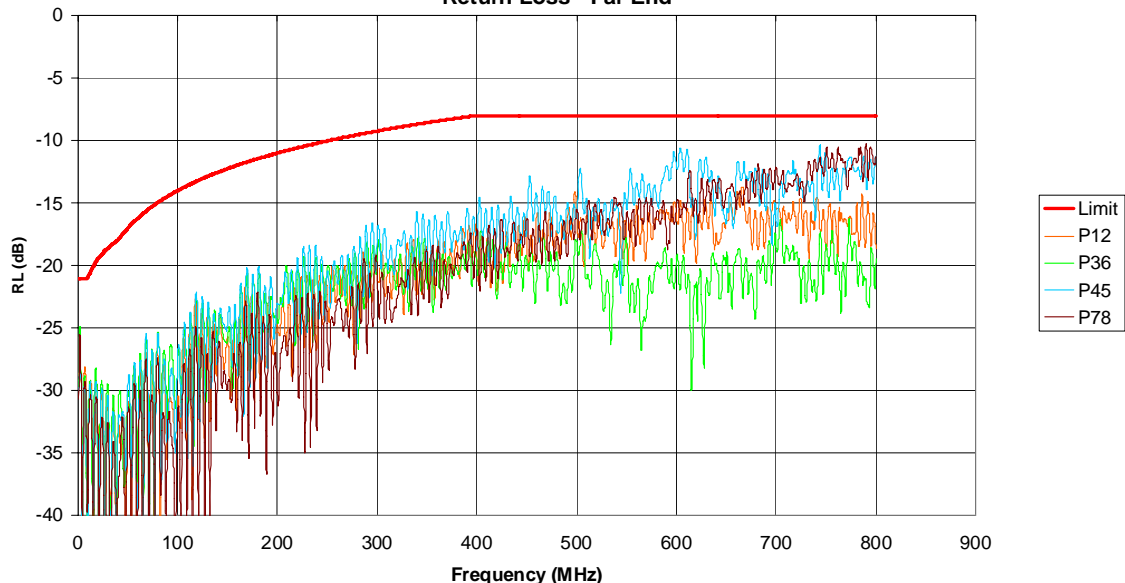


Near End CrossTalk is one of the key parameters for a cabling system, as can be seen in the graph above, the XG<sub>A</sub> Cabling system providing at least 10 dB margin over the full frequency range.

## 4.5.3 RL performance to 800 MHz

Worst Headroom = 2.20 dB

AMP-TWIST 6AS SL Jack  
PL 15m - Step 1  
Return Loss - Far End



Return Loss is the sum of imperfections for the complete cabling system, which creates reflections, as can be seen in the graph above, the XG<sub>A</sub> Cabling System providing on average 5 dB margin, and 2.2 dB margin at 800 MHz.

## 5 Implementation

When creating the new edition of ISO/IEC 11801, the group of experts used some minimum and maximum lengths to calculate the minimum component performance. The new XG<sub>A</sub> Cabling system is able to support both the minimum and maximum length, but can also exceed these lengths.

### 5.1 Short length support

Min. Length	Permanent Link	CP Cord	Cross Connect	Patch Cord	TEST
Standard	15m	5m	2m	2m	
4 connector channel	2m	2m	1m	1.5m	PASS
3 connector PL	2m	2m	NA	NA	PASS
2 connector PL	2m	NA	NA	NA	PASS

These short links are based on the minimum supported configurations allowed with the XG<sub>A</sub> Cabling System, using XG<sub>A</sub> copper cable and XG<sub>A</sub> copper patch cords.

### 5.2 Patch cord management

As the installation cables have become larger in diameter, the patch cords have also become much larger. This creates some difficulties in managing patch cords in a rack or cabinet. The new XG<sub>A</sub> patch cords have reduced diameter in order to support up to 640 connections in a rack or cabinet.

Typical UTP

XG<sub>A</sub> System



## 5.3 Installation time

Installation time has been greatly reduced by using the AMP NETCONNECT SL Tool and AMP NETCONNECT AWC technology, now supporting a jack termination time of less than one minute.



## 6 Supported applications

The new AMP NETCONNECT XG<sub>A</sub> Cabling system supports the following applications:

### System Application Performance

Application	Source	XG <sub>A</sub>
10BASE-T	IEEE 802.3i - 1990, ISO/IEC 8802-3	X
100BASE-TX, T4	IEEE 802.3u - 1995	X
1000BASE-T	IEEE 802.3ab - 1999	X
1000BASE-TX	TIA/EIA-854-2001	X
10GBASE-T	IEEE 802.3an - 2006	X
Power Over Ethernet	IEEE 802.3af - 2003, IEEE 802.3at - 2009	X
Token Ring 4/16 Mbps	IEEE 802.5, ISO/IEC 8802-5	X
Token Ring 100 Mbps	IEEE 802.5, ISO/IEC 8802-5	X
ATM LAN 25.6 Mbps over TP	ATM Forum, af-phy-0040.000	X
ATM LAN 51.84 Mbps over TP	ATM Forum, af-phy-0018.000	X
ATM LAN 155 Mbps over TP	ATM Forum, af-phy-0015.000	X
ATM LAN 1.2 Gbps over TP	ATM Forum, af-phy-0162.000	X
FDDI TP-PMD	ISO/IEC 9314-1, ANSI X3.263-1995	X
Fibre Channel 1 Gbps	INCITS 435	X
Fibre Channel 2 Gbps	INCITS 435	X
Fibre Channel 4 Gbps	INCITS 435	X
X.21	ITU-T Rec. X.21- 1992	X
V.11	ITU-T Rec. X.21 - 1996	X
ISDN S0-Bus (Extended)	ITU-T Rec. I.430 -1993	X
ISDN S0 Point-to-Point	ITU-T Rec. I.430 -1993	X
ISDN S1/S2	ITU-T Rec. I.430 -1993	X
Firewire 100 Mbps	IEEE 1394b - 1999	X

## AMP NETCONNECT Regional Headquarters:

### North America

Greensboro, NC, USA  
Ph: +1-800-553-0938  
Fx: +1-717-986-7406

### Latin America

Buenos Aires, Argentina  
Ph: +54-11-4733-2200  
Fx: +54-11-4733-2282

### Europe

Kessel-Lo, Belgium  
Ph: +32-16-35-2190  
Fx: +32-16-35-2188

### Mid East & Africa

Cergy-Pontoise, France  
Ph: +33-1-3420-2122  
Fx: +33-1-3420-2268

### Asia

Hong Kong, China  
Ph: +852-2735-1628  
Fx: +852-2735-1625

### Pacific

Sydney, Australia  
Ph: +61-2-9407-2600  
Fx: +61-2-9407-2519

## AMP NETCONNECT in Europe, Middle East, Africa and India:

**Austria** – Vienna  
Ph: +43-1-90560-1204  
Fx: +43-1-90560-1270

**Belgium** – Kessel-Lo  
Ph: +32-16-35-2190  
Fx: +32-16-35-2188

**Bulgaria** – Sofia  
Ph: +359-2-971-2152  
Fx: +359-2-971-2153

**Czech&Slovak Rep.** – Kurim  
Ph: +420-541-162-112  
Fx: +420-541-162-223

**Denmark** – Glostrup  
Ph: +45-70-15-52-00  
Fx: +45-43-44-14-14

**Egypt** – Cairo  
Ph: +20-2-2419-2334  
Fx: +20-2-2417-7647

**Finland** – Helsinki  
Ph: +358-95-12-34-20  
Fx: +358-95-12-34-250

**France** – Cergy-Pontoise  
Ph: +33-1-3420-2122  
Fx: +33-1-3420-2268

**Germany** – Langen  
Ph: +49-6103-709-1547  
Fx: +49-6103-709-1219

**Greece/Cyprus** – Athens  
Ph: +30-210-9370-396  
Fx: +30-210-9370-655

**Hungary** – Budapest  
Ph: +36-1-289-1007  
Fx: +36-1-289-1010

**India** – Bangalore  
Ph: +91-80-4011-5000  
Fx: +91-80-4011-5030

**Italy** – Collegno (Torino)  
Ph: +39-011-4012-111  
Fx: +39-011-4012-268

**Kazakhstan** – Almaty  
Ph: +7-327-244-5875  
Fx: +7-327-244-5877

**Lithuania** – Vilnius  
Ph: +370-5-213-1402  
Fx: +370-5-213-1403

**Netherlands** – Den Bosch  
Ph: +31-73-6246-246  
Fx: +31-73-6246-958

**Norway** – Nesbru  
Ph: +47-66-77-88-99  
Fx: +47-66-77-88-55

**Poland** – Warsaw  
Ph: +48-22-4576-700  
Fx: +48-22-4576-720

**Portugal** – Evora  
Ph: +351-961-377-331  
Fx: +351-211-454-506

**Romania** – Bucharest  
Ph: +40-21-311-3479  
Fx: +40-21-312-0574

**Russia** – Moscow  
Ph: +7-495-790-7902  
Fx: +7-495-721-1894

**Spain** – Barcelona  
Ph: +34-93-291-0330  
Fx: +34-93-291-0608

**Sweden** – UpplandsVäsby  
Ph: +46-8-5072-5000  
Fx: +46-8-5072-5001

**Switzerland** – Steinach  
Ph: +41-71-447-0-447  
Fx: +41-71-447-0-423

**Turkey** – Istanbul  
Ph: +90-212-281-8181  
Fx: +90-212-281-8184

**UK** – Stanmore, Middx  
Ph: +44-208-420-8140  
Fx: +44-208-954-7467

**Ukraine** – Kiev  
Ph: +380-44-206-2265  
Fx: +380-44-206-2264

**U.A.E.** – Dubai  
Ph: +971-4-321-0201  
Fx: +971-4-321-6300