

TECHNICAL BULLETIN

Short is tough

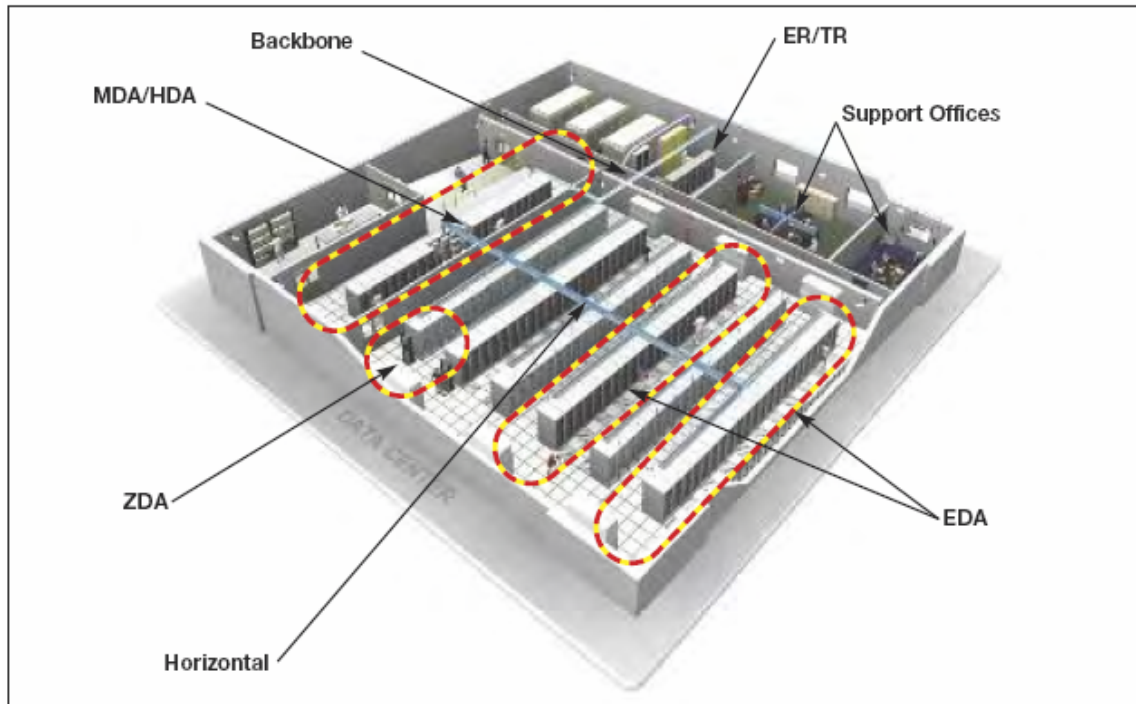


Figure 1 - Physical layout for a data center

The data center is the nerve center of a telecommunications network. Most data traffic originates in, is processed in, or passes through the data center on its way to other users or networking locations. There is an increasing volume of data traffic in data centers to support a growing number of users for bandwidth intensive video and imaging applications, e-commerce, financial transactions and parallel processing applications. In order to meet these increasing demands, there is a need for higher data rates and higher information capacity. Even for smaller data centers 1 Gb/s data rates has become too slow and is insufficient to meet networking demands, thus leading to a natural transition to 10 Gb/s Ethernet to alleviate networking bottlenecks. The most economical way to meet these needs is to provide 10GBASE-T switch ports and 10GBASE-T network interface cards (NICs) on network servers and data storage equipment.

The data center is a microcosm of a structured cabling system for a LAN except that the distances are much shorter and the density of cables is much higher. Figure 2 below illustrates the cable connections between switch ports and server cabinets for a centralized cross-connect topology. The horizontal cable distance as shown in blue can be as short as 3 meters (10 ft) between adjacent racks or cabinets and are usually no longer than 75 meters (250 ft).

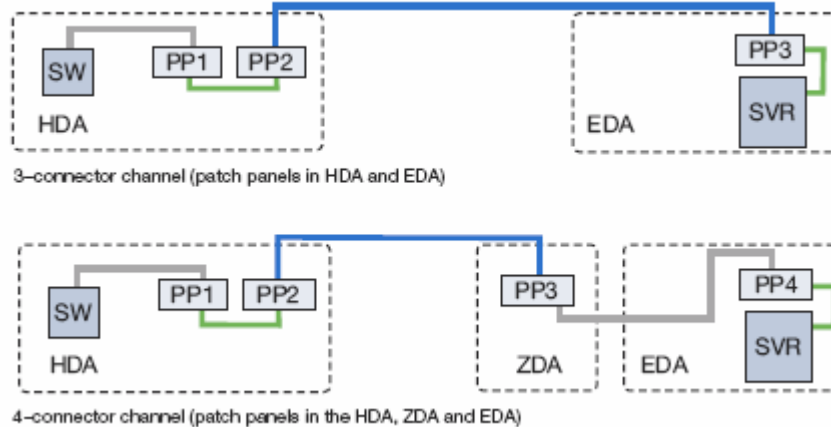


Figure 2 – Cabling topology between switch ports and servers in a data center

In April, 2008, the TIA 568-B.2-10, Category 6A cabling standard was published. Category 6A is the minimum performance level that is required to support all the operating modes for 10GBASE-T transmission for distances up to 100 meters, including “short reach mode”. Category 6A provides a significant improvement in performance compared to Category 6. The key improvements are summarized in Table 1.

<u>Category 6A vs. Category 6</u>	<u>Category 6A vs. Category 6</u>
<ul style="list-style-type: none"> – Lower Insertion Loss <ul style="list-style-type: none"> • 4dB @ 500 MHz – Lower NEXT Loss <ul style="list-style-type: none"> • ~ 4 dB @ 500 MHz (TIA) • ~ 6 dB @ 500 MHz (ISO) – Significantly lower alien crosstalk loss <ul style="list-style-type: none"> • ~13 dB PSANEXT @ 500 MHz • ~ 4 dB PSAACRF @ 500 MHz – Exceeds 10GBASE-T alien crosstalk requirements under worst case bundling conditions for channel up to 100 meters 	<ul style="list-style-type: none"> – 23 AWG vs. 24 AWG conductors – Larger cable diameter <ul style="list-style-type: none"> • Up to 0.354 inch is permitted in standard (Belden 10GX 2nd gen. cable is 0.295 inch) – Does not require mitigation – Supports 10GBASE-T Short Reach (Low Power) Mode

Table 1 - What is different about Category 6A?

Because Category 6A is such a demanding specification, it requires much better performing components. The most critical component is the connecting hardware and patch cords. In order to meet the Category 6A specification at frequencies extending to at least 500 MHz, a different design approach is required compared to Category 5e and Category 6 connector designs. Belden

has met the challenge with the introduction of the 10GX connectivity product line in 2005. See a companion paper on the Belden web site that describes the innovative technologies¹ that were developed for the Belden 10GX connectivity, namely the Flexpoint PCB, Matrix IDC and X-Bar technologies. Belden 10GX is by far the best performing Category 6A connectivity in the industry today.

Surprisingly, it is much more difficult to meet the Category 6A performance requirements for a short permanent link or channel compared to a long permanent link or channel. Why is this so? For example, you would think that there is more crosstalk coupling for long lengths of cable than for short lengths. Well, it just so happens that pair-to-pair “Near-end Crosstalk” (NEXT) Loss, Return Loss and “Power Sum Alien Near-end Crosstalk” (PSANEXT) Loss are more seriously impacted at high frequencies by connectors located in close proximity to the equipment. Furthermore, this impact is much worse for a short permanent link or a channel with more than 2 connectors.

Copper cable lengths are usually short in data centers (typically 5 to 30 m). With some connector designs, it may not be possible to meet the Category 6A specification when the horizontal cable distance is less than 15 meters in a 3-connector permanent link or a 4-connector channel. It is important to consult with the manufacturer of the connectivity components about any short length channel or permanent link restrictions. The 15m rule severely limits the design flexibility in a data center. Because of the high density of cables, it is impractical to store excess lengths of cable in overhead trays or under the floor. Belden 10GX connectivity does not have such short length design restrictions. The horizontal cable lengths can be as short as 3 meters for a 2-connector channel and as short as 5 meters for 3 or 4 connector channels. Annex A provides summary of the minimum patch cord lengths and horizontal cable lengths for different channel configurations using Belden 10GX connectivity. These channels are certified to meet and exceed Category 6A requirements.

To verify the performance of Belden 10GX connectivity compared with three other leading 10G connectivity solutions in the market, we performed a series of tests in our lab. The tests were performed under identical conditions (see note) for the following permanent link test configurations:

1. connector – 15 m cable – connector
2. connector – 15 m cable – connector – 2 m cable – connector
3. connector – 10 m cable – connector – 2 m cable – connector
4. connector – 5 m cable – connector – 2 m cable – connector

Note: The same “six-around-one” cable bundles were used for all the tests. Only the connecting hardware was interchanged for each test 1, 2, 3 & 4 using Belden 10GX, Vendor A, Vendor B and Vendor C.

The performance margins (in dB) were compared to the Category 6A permanent link requirements. The results in Table 2 indicate that Vendor A, B and C connectivity do not meet Category 6A requirements for NEXT, Return Loss and/or PSANEXT for the permanent link configurations with 3-connectors (test configuration 2, 3 and 4) The graphs for all these parameters are provided in Annex B

Parameter	Permanent Link - Margin in dB vs. TIA Category 6A Standard												
	2-connector x-15m-x				3-connector x-15m-x-2m-x				3-connector x-10m-x-2m-x				3-conn. x-5m-x-2m-x
	10GX	A	B	C	10GX	A	B	C	10GX	A	B	C	10GX
NEXT	8.9	2.4	5.6	2.7	7.2	(1.3)	2.5	(1.1)	6.4	(1.4)	3.9	(1.9)	6.0
RL	3.7	1.9	1.1	4.8	1.8	(0.5)	(1.1)	2.3	1.5	(0.6)	(1.1)	1.6	1.1
PSANEXT	6.3	6.2	(0.4)	3.7	4.7	0.9	(0.2)	(0.1)	5.0	(1.0)	(5.6)	(2.6)	2.7

* Green: Passing result; Orange: Failing result

Table 2 - Worst case margin of Belden 10GX vs. Vendor A, B, and C connectivity for different permanent link test configurations

Conclusions

Short is tough indeed. The Category 6A requirements for short channels and permanent links are difficult to meet. For a data center application, cable distances as short as 5 meters are commonly used for cable connections between racks or cabinets that are located side-by-side. It is not practical to coil and store excess lengths of cable to maintain a 15 meter or even 10 meter distance between connection points. Comparative tests performed in our lab have identified weakness in a number of Category 6A connector designs on the market, which shows up in inferior NEXT, Return Loss and PS ANEXT performance at high frequencies when multiple connection points are located in close proximity. To be able to meet the Category 6A specification requires a connector design that is up to the task. The innovative technologies built into the Belden 10GX connectivity enable cable distances as short as 3 meters (10 ft) for a 2-connector topology and 5 meters (15 ft) for a 3 or 4 connector topology. So in summary, don't get short changed when making an investment in your Category 6A cabling infrastructure. Ensure that the cabling can meet Category 6A requirements for the shortest distance and the worst case topology for your data center application.

References

- 1) "Belden IBDN System 10GX – Enabling Technologies", Revision 1, Nov 08

ANNEX A - Belden IBDN System 10GX vs. TIA Category 6A Minimum Channel Lengths

2-Connector Channel Interconnect	Min. Channel Length	Channel Configuration			
		Horizontal Distribution Area		Equipment Distribution Area	
		Horizontal Distribution Area Connector	Horizontal Cabling Min. Cable Length	Equipment Distribution Area Connector	Equipment Distribution Area Min. Modular Cord Length
TIA Category 6A	12 m	1 m	10 m	1 m	1 m
10GX System w/ RJ45 Jack	3.6 m	0.3 m	3 m	0.3 m	0.3 m
10GX System w/ RJ45 Coupler	1.6 m	0.3 m	1 m	0.3 m	0.3 m
10GX System w/ IDC Block	1.6 m	0.3 m	1 m	0.3 m	0.3 m

3-Connector Channel Cross-Connect	Min. Channel Length	Channel Configuration			
		Horizontal Distribution Area		Equipment Distribution Area	
		Horizontal Distribution Area Connector	Horizontal Cabling Min. Cable Length	Equipment Distribution Area Connector	Equipment Distribution Area Min. Modular Cord Length
TIA Category 6A	19 m	2 m	1 m	15 m	1 m
10GX System w/ RJ45 Jack	6.6 m	0.3 m	1 m	5 m	0.3 m
10GX System w/ RJ45 Coupler	2.6 m	0.3 m	1 m	1 m	0.3 m
10GX System w/ IDC Block	2.6 m	0.3 m	1 m	1 m	0.3 m

4-Connector Channel Cross-Connect & Zone Distribution Area	Min. Channel Length	Channel Configuration					
		Horizontal Distribution Area		Horizontal Cabling		Zone Distribution Area	
		Horizontal Distribution Area Connector	Horizontal Cabling Min. Cable Length	Connector	Horizontal Cabling Min. Cable Length	Zone Distribution Area Connector	Zone Distribution Area Min. Modular Cord Length
TIA Category 6A	24 m	2 m	1 m	1 m	15 m	5 m	1 m
10GX System w/ RJ45 Jack	16 m	2 m	1 m	1 m	10 m	2 m	1 m
10GX System w/ RJ45 Coupler	4.6 m	0.3 m	1 m	1 m	2 m	1 m	0.3 m
10GX System w/ IDC Block	3.6 m	0.3 m	1 m	1 m	1 m	1 m	0.3 m

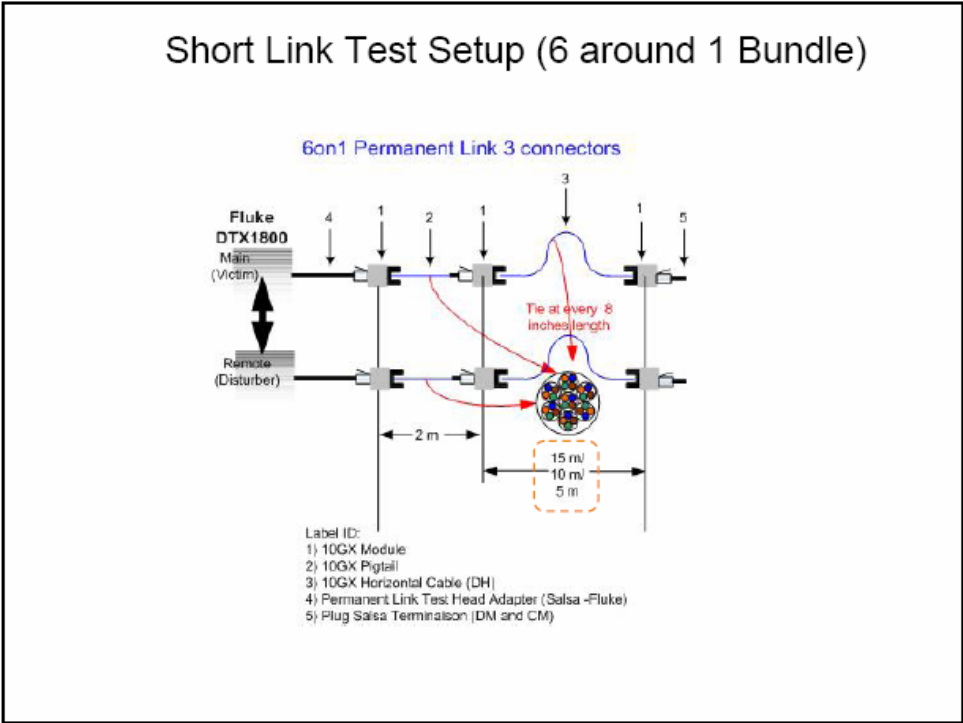
4-Connector Channel Zone Cross-Connect Area (2 Permanent Links)	Min. Channel Length	Channel Configuration					
		Horizontal Distribution Area		Zone Cross-Connect Area		Horizontal Cabling	
		Horizontal Distribution Area Connector	Horizontal Cabling Min. Cable Length	Connector	Zone Cross-Connect Area Min. Cross-Connect Length	Connector	Horizontal Cabling Min. Cable Length
TIA Category 6A	34 m	1 m	15 m	1 m	2 m	15 m	1 m
10GX System w/ RJ45 Jack	14 m	1 m	5 m	1 m	2 m	5 m	1 m
10GX System w/ RJ45 Coupler	5.6 m	0.3 m	2 m	1 m	1 m	2 m	0.3 m
10GX System w/ IDC Block	3.6 m	0.3 m	1 m	1 m	1 m	1 m	0.3 m

For Belden IBDN 10GX End-to-End Systems using 10GX Components.
 TIA/EIA-568-B.2-10-2008 Category 6A Standard.
 Contact Belden for custom channel configurations.

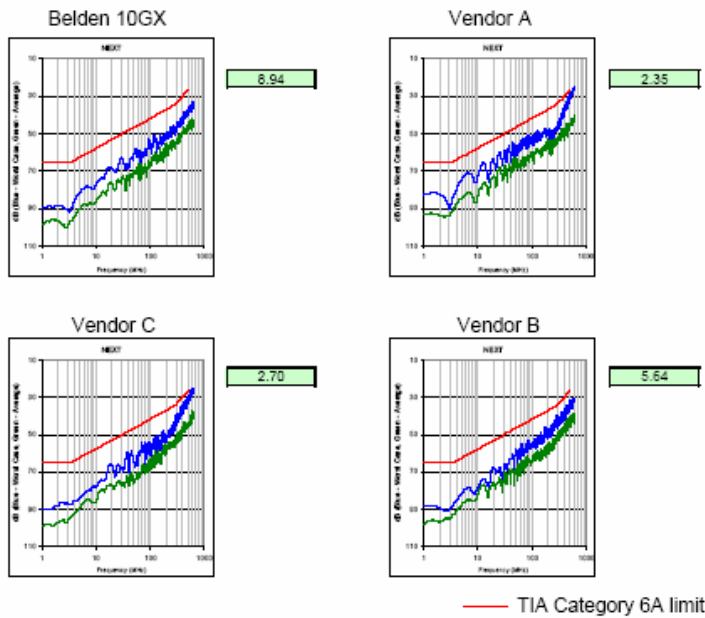
Annex B

Permanent Link Test Results

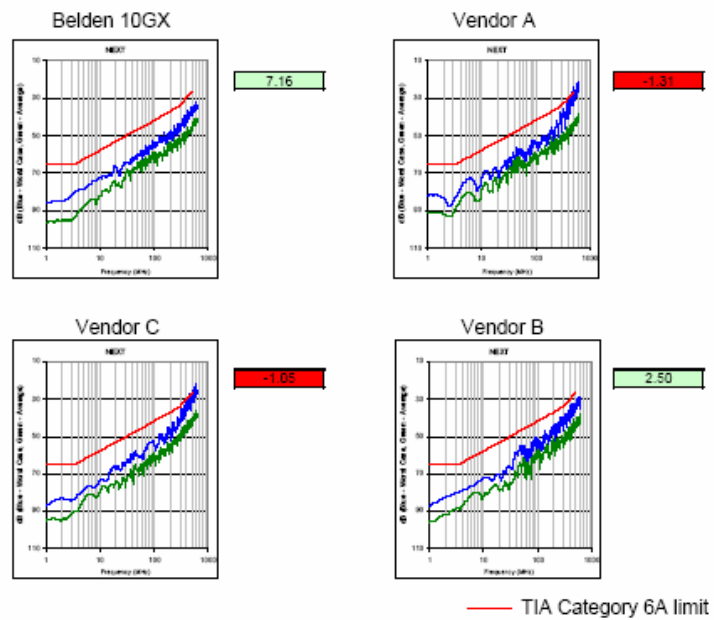
Category 6A
Short links
Internal parameters



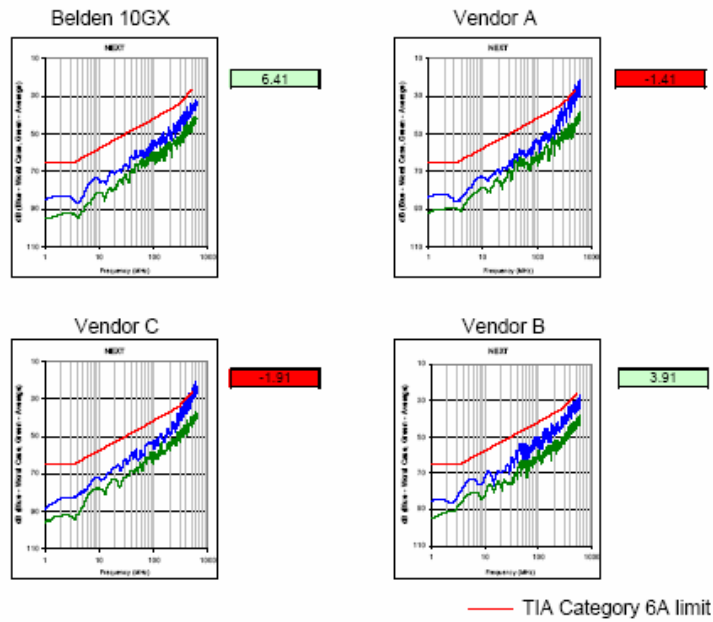
NEXT Permanent Link (x-15m-x)



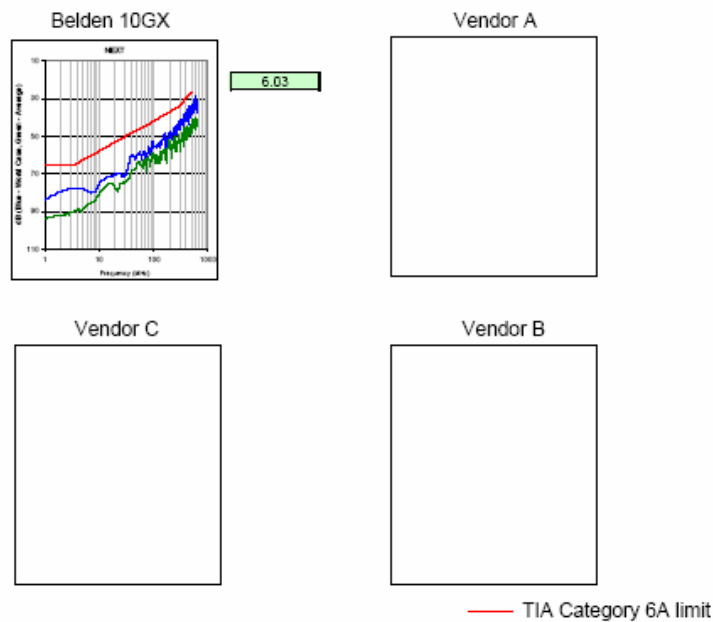
NEXT Permanent Link (x-15m-x-2m-x)



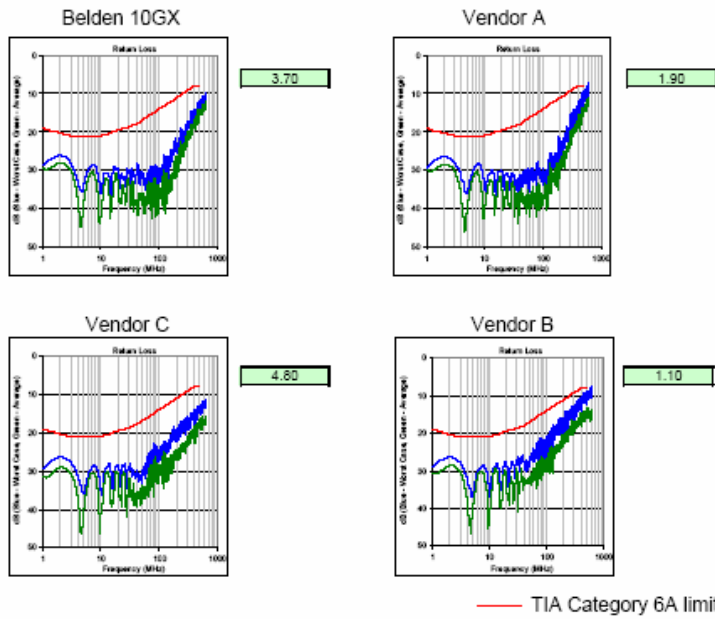
NEXT Permanent Link (x-10m-x-2m-x)



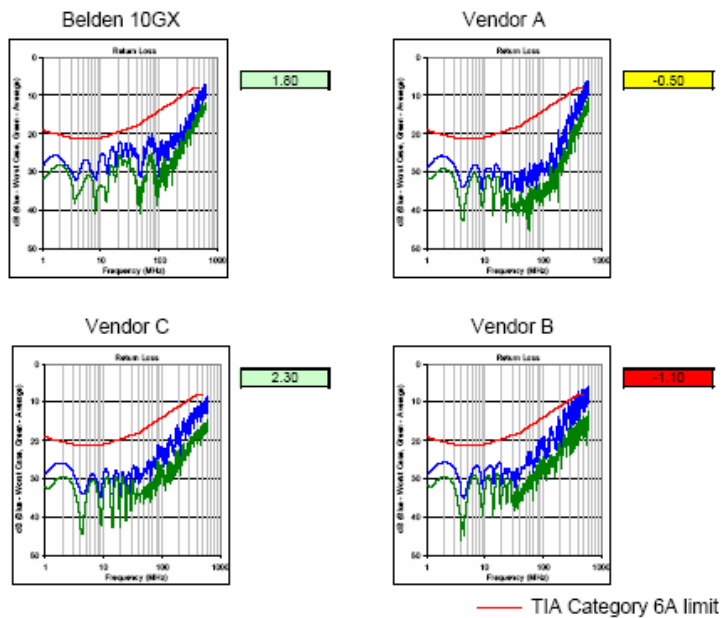
NEXT Permanent Link (x-5m-x-2m-x)



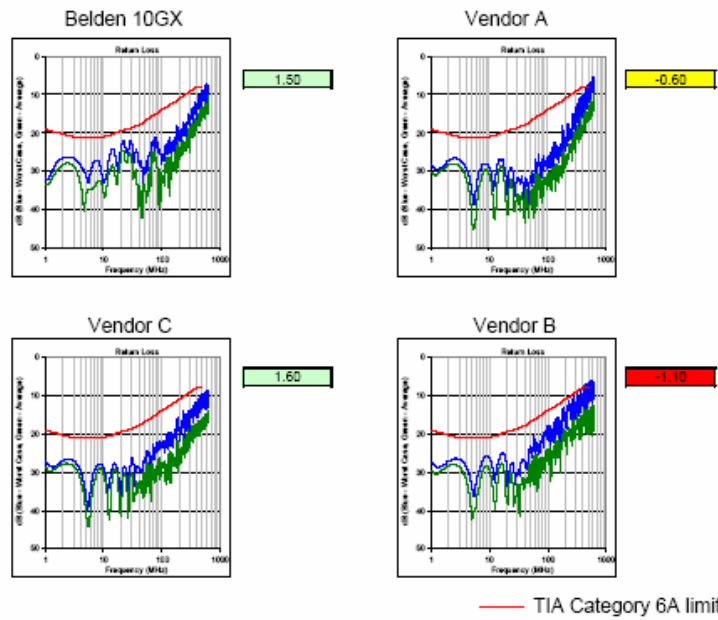
Return Loss Permanent Link (x-15m-x)



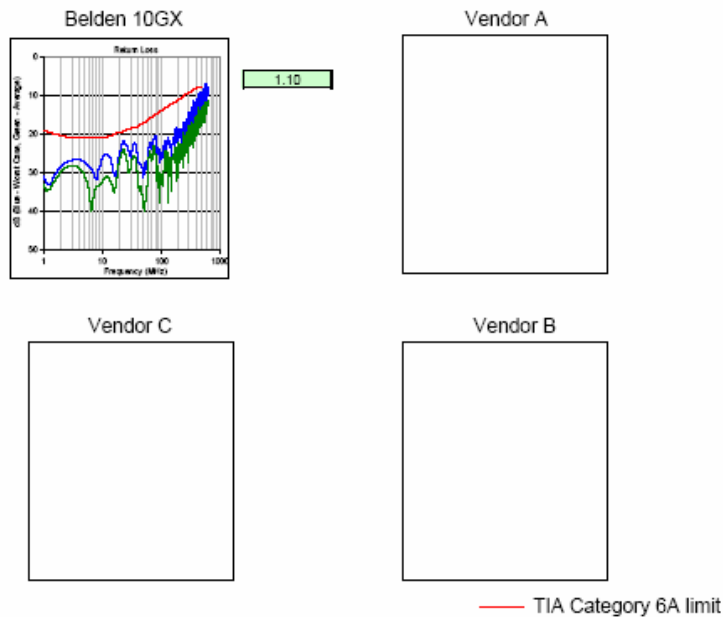
Return Loss Permanent Link (x-15m-x-2m-x)



Return Loss Permanent Link (x-10m-x-2m-x)



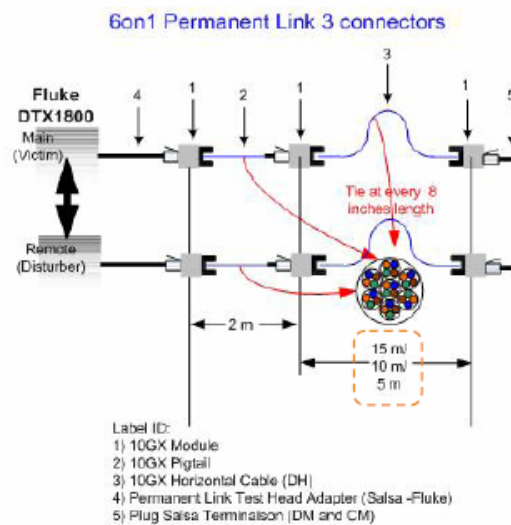
Return Loss Permanent Link (x-10m-x-2m-x)



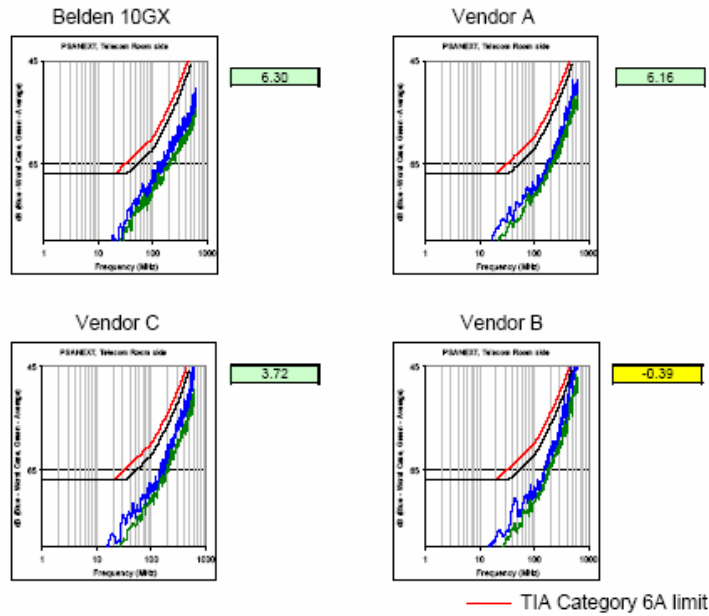
Category 6A Short links

External parameters

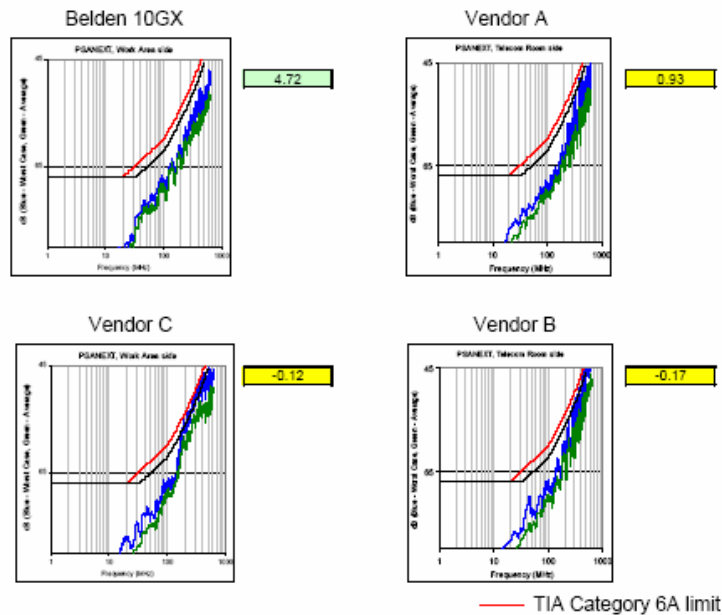
Short Link Test Setup (6 around 1 Bundle)



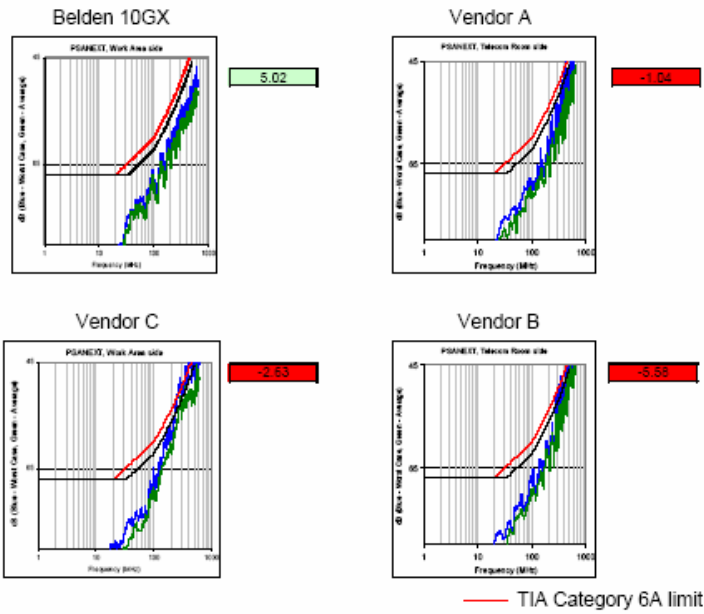
PSANEXT Permanent Link (x-15m-x)



PSANEXT Permanent Link (x-15m-x-2m-x)



PSANEXT Permanent Link (x-10m-x-2m-x)



PSANEXT Permanent Link (x-5m-x-2m-x)

