

# **IEC61076-3-110 Augmented RJ45**

## **Alternative MDI interface for 25 and 40GBASE-T**

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*IEEE P802.3bq 25/40GBASE-T Task force*  
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# **Alternative MDI interface for 25 and 40GBaseT IEC61076-3-110 Augmented RJ45**

## ***Abstract***

***The availability of robust copper connectivity is vital for implementation of 25 and 40GbE technology. The test data demonstrated that use of IEC/ISO 61076-3-110 Augmented RJ45 connectivity resulted in channels with improved transmission characteristics such as RL, NEXT, ACR, TCL. This technical contribution, put forward by leading manufactures of the integrated magnetics, proposes IEC61076-3-110 (Augmented RJ45) as an alternative interface connector for IEEE 802.3bq 25/40GbE MDI in addition to IEC 60603-7-81 (RJ45). The contribution reviews the comparative features of IEC 61076-3-110 (ARJ45) and IEC 60603-7 (RJ45) with and without integrated magnetics***

## Rationale:

The copper cabling channels of improved transmission parameters Return loss, NEXT , ACRF , TCL shall help to simplify and accelerate IEEE 802.3bq 25/40GbE PHY development, provide significant energy savings and accelerate 25 and 40GbE market adoption. The MDI interface is a major factor in the channel performance

## Objective

*In order to improve the transmission performance to propose IEC61076-3-110 (Augmented RJ45 ) as an alternative interface connector option for IEEE 802.3bq 25/40GbE MDI in addition to 60603-7-81 (RJ45 )*

ARJ45 is an abbreviation of Augmented Registered Jack 45  
RJ45 is an abbreviation of Registered Jack 45

## Resolution of the IEEE 802.3bq Meeting September 2014 , Kanata Minutes published

The secretary & Editor then noted that he understood the language of the motion not to preclude additional MDI's should they be offered in the future.

### **Motion #12 (Motion #7 reconsidered):**

**Move that 802.3bq include the RJ-45 as reflected in IEC 60603-7-51 (published) with the improved characteristics and frequency extensions specified in 60603-7-81 (currently CDV draft) as an MDI interface**

**M: Jerry Chiang      S: Peter Wu**

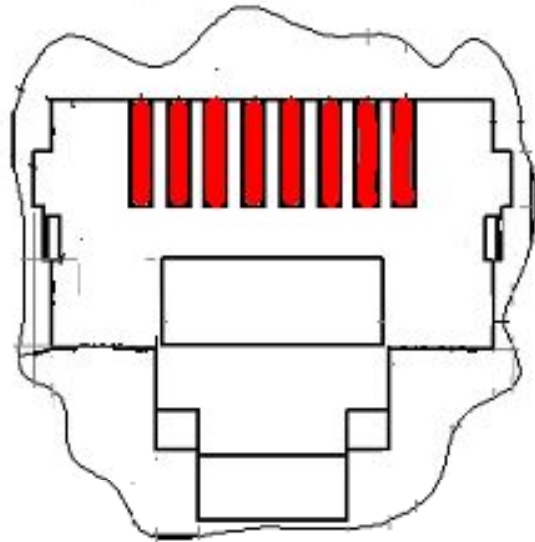
**Technical (> 75%)**

**Y: 16   N:5   A: 2**

**MOTION PASSES**

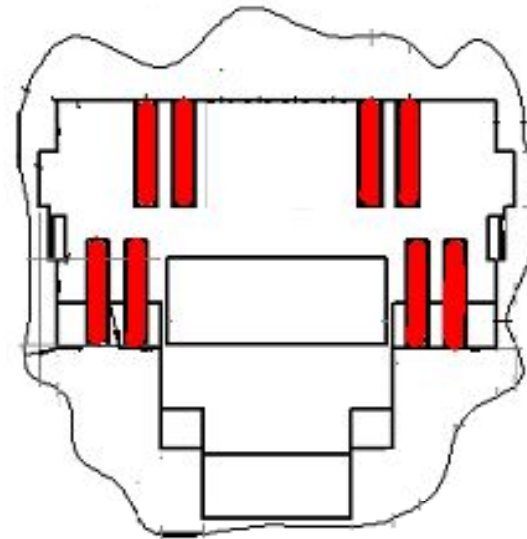
# STANDARD CONNECTOR INTERFACES

reviewed in this presentation



***IEC 60603-7***  
***RJ45 8-CONTACTS***

***Category 3 to 6<sub>A</sub>,***  
***Proposed category 8.1***



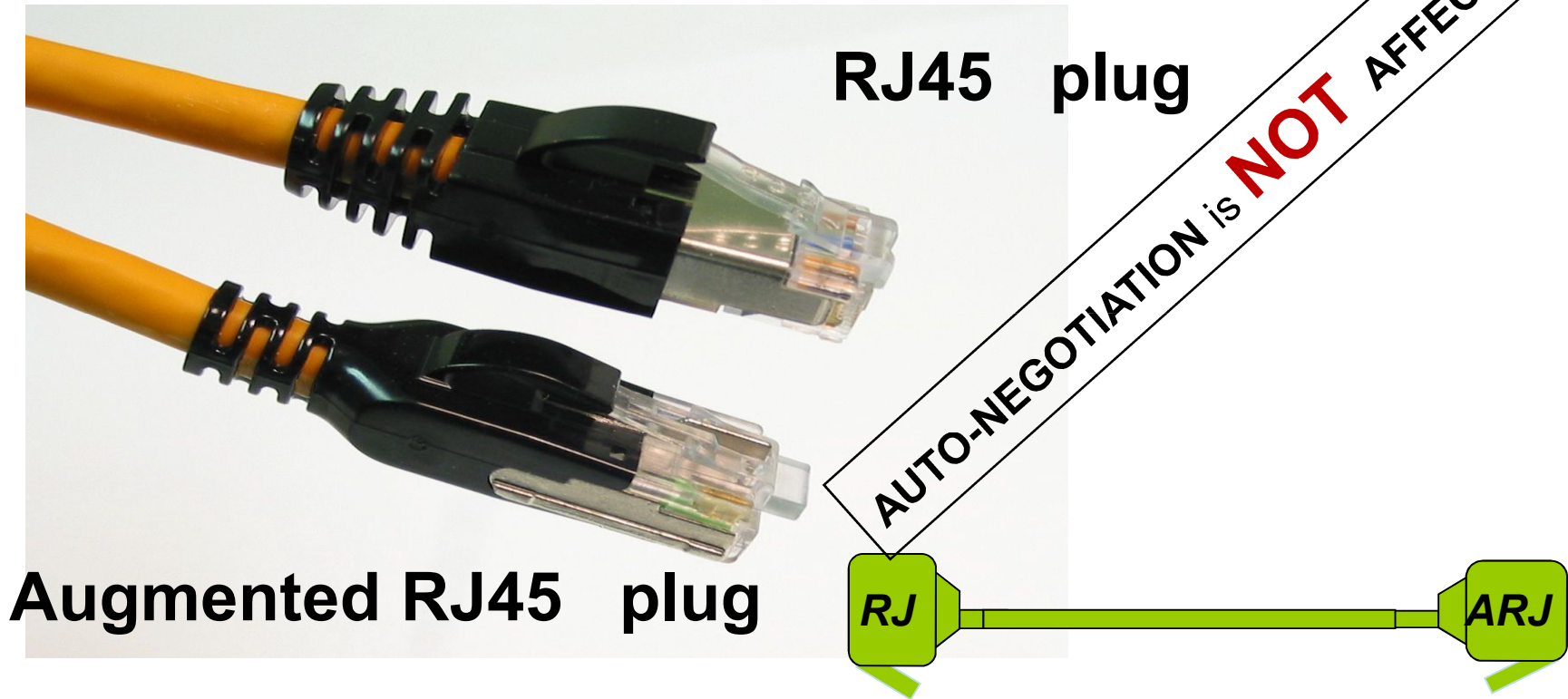
***IEC 61076-3-110***  
***Augmented RJ45 8-CONTACTS***

***Category 7<sub>A</sub>***  
***Proposed category 8.2***

# COMPATIBILITY of STANDARD CONNECTORS

## PLUGS and CORDS

*All Standard Connectors Utilize 8-wire Patch Cords*



Category 6 shielded RJ45 plug is shown combined with Augmented RJ45 Plug in same Patch Cord cable assembly

# RJ45 and Augmented RJ45

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**RJ45 and Augmented RJ45 are standard 4-pair connectors**

**Augmented RJ45 was derived from RJ45 (Registered Jack)**

**Augmented RJ45 is not a proprietary interface and is not subject to any known IP**

**Augmented RJ45 and RJ45 have the same form factor**

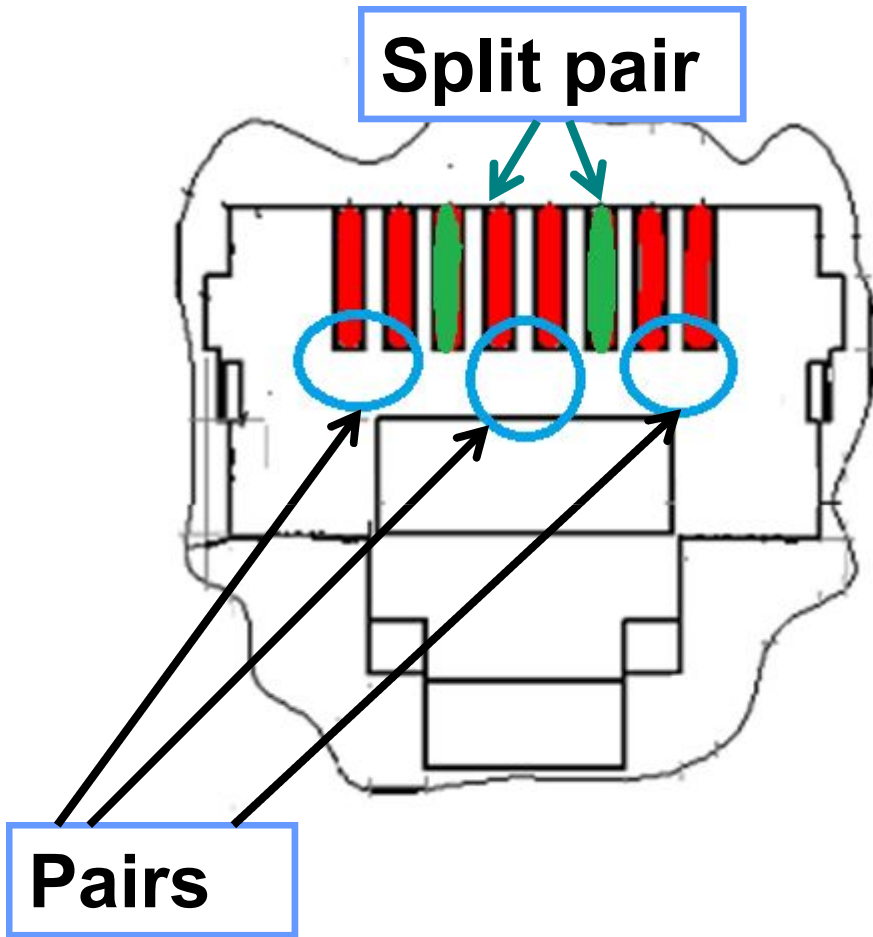
**Augmented RJ45 is an existing published IEC standard**

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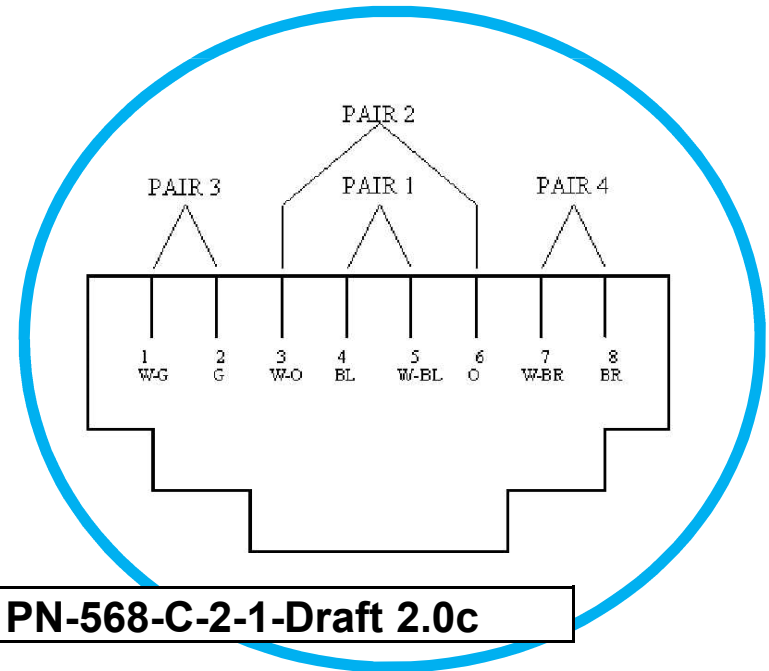
**RJ45 evolved from earlier connectors as a result has the “split” pair**

# RJ45

*Split pair legacy problem*



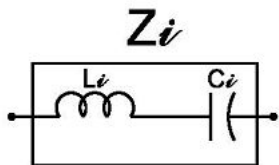
RJ45 Traditional pair assignment



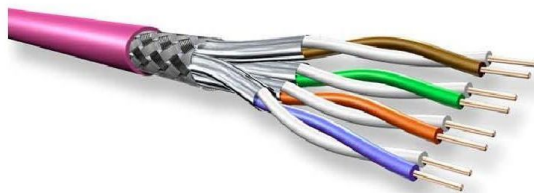
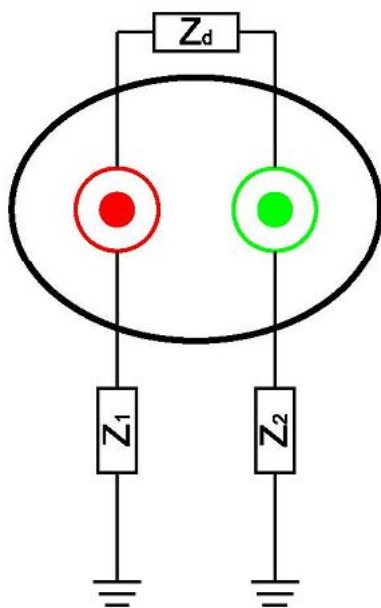
PN-568-C-2-1-Draft 2.0c



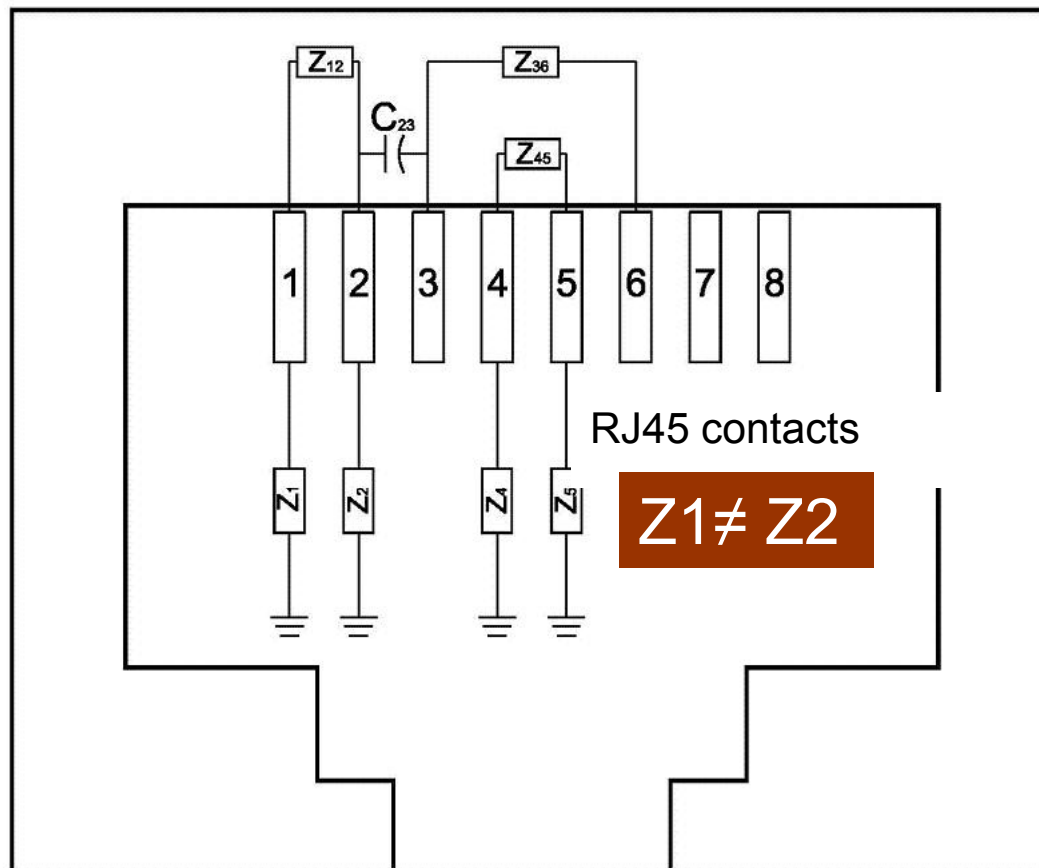
Differential Impedance  
of a balanced twisted pair



$$Z_1 = Z_2 \quad \text{and} \quad Z_d = Z_1 + Z_2$$



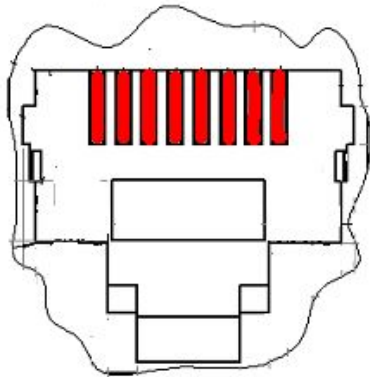
## RJ45 Split pair legacy problem



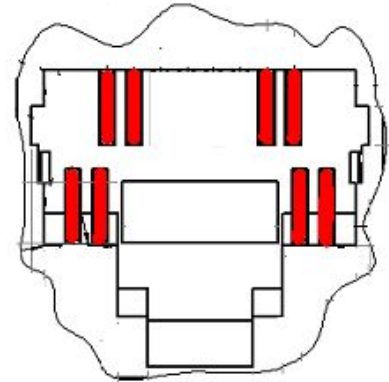
**Interface Geometry a major contributor to TCL**

# COMPENSATION vs. ISOLATION

Major difference between proposed 8.1 and 8.2



**CURE vs. PREVENTION**



**RJ45 8-CONTACTS**

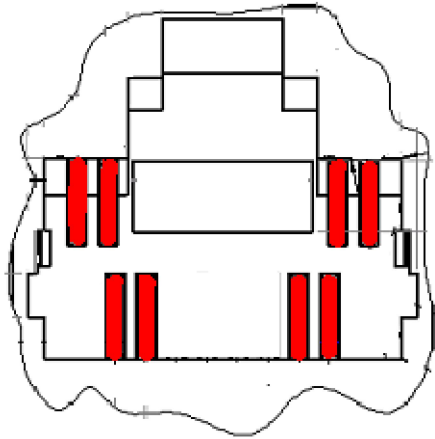
*Proposed category 8.1*

**Augmented RJ45 8-CONTACTS**

*Proposed category 8.2*

**RJ45** use **COMPENSATION** to reduce differential NEXT. Method of creating the crosstalk equal in amplitude but opposite in phase by adding capacitive and inductive elements

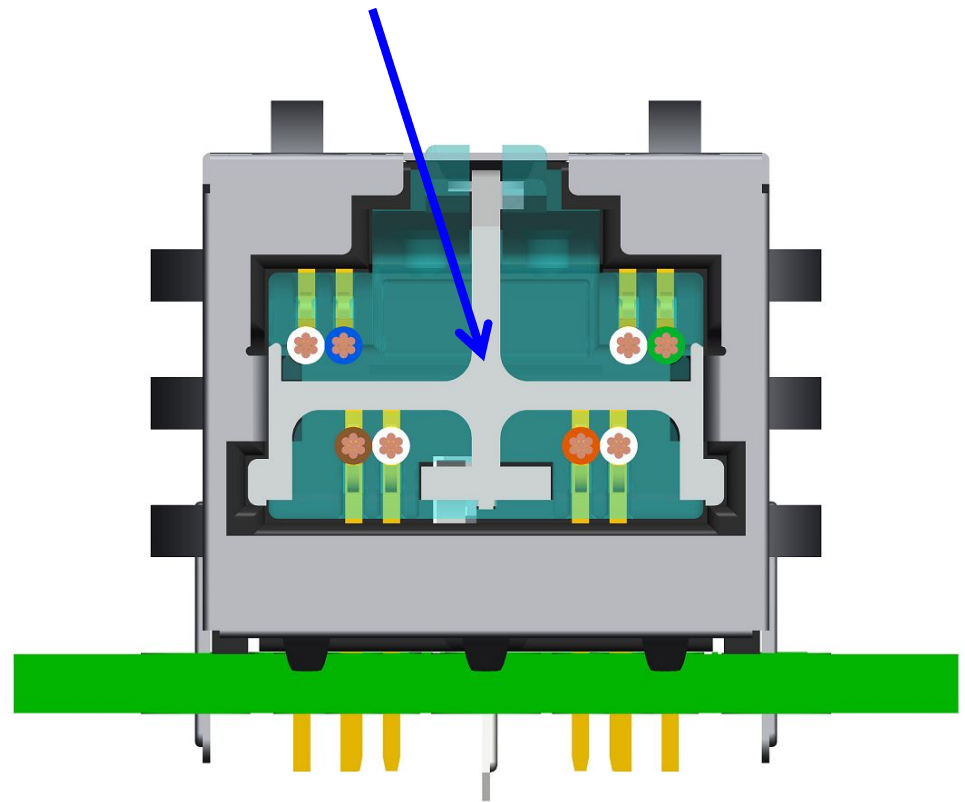
**Augmented RJ45** use **ISOLATION** to avoid differential NEXT. Faraday cage is built around each differential pair.



**Pairs are balanced within connector**

# Augmented RJ45

Conductive Faraday cage isolating differential pairs



# Transverse Conversion Loss TCL

$$\text{TCL (dB)} = 20 \text{ LOG } \frac{\text{Common Mode Voltage}}{\text{Differential Mode Voltage}} \quad (\text{measured on the same end})$$

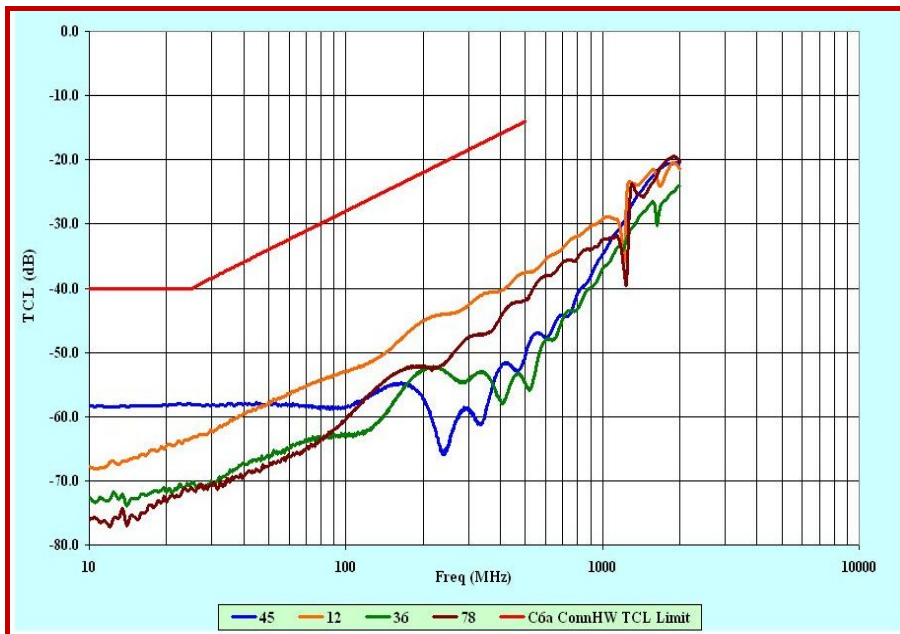
**TCL - measure of the quality of transmission line feature as a source of common mode**

**Measure of the balance and Dif. to Com. Mode conversion applicable to the interface .**

# Transverse Conversion Loss

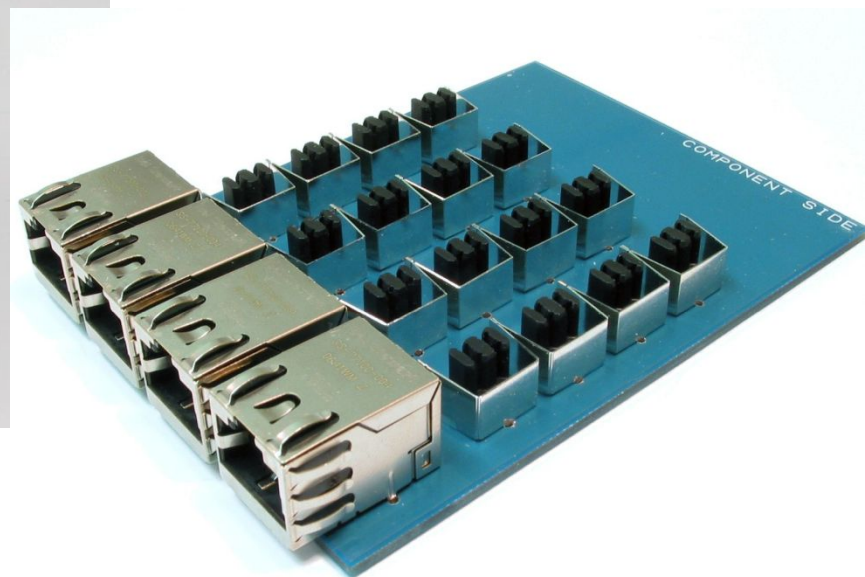
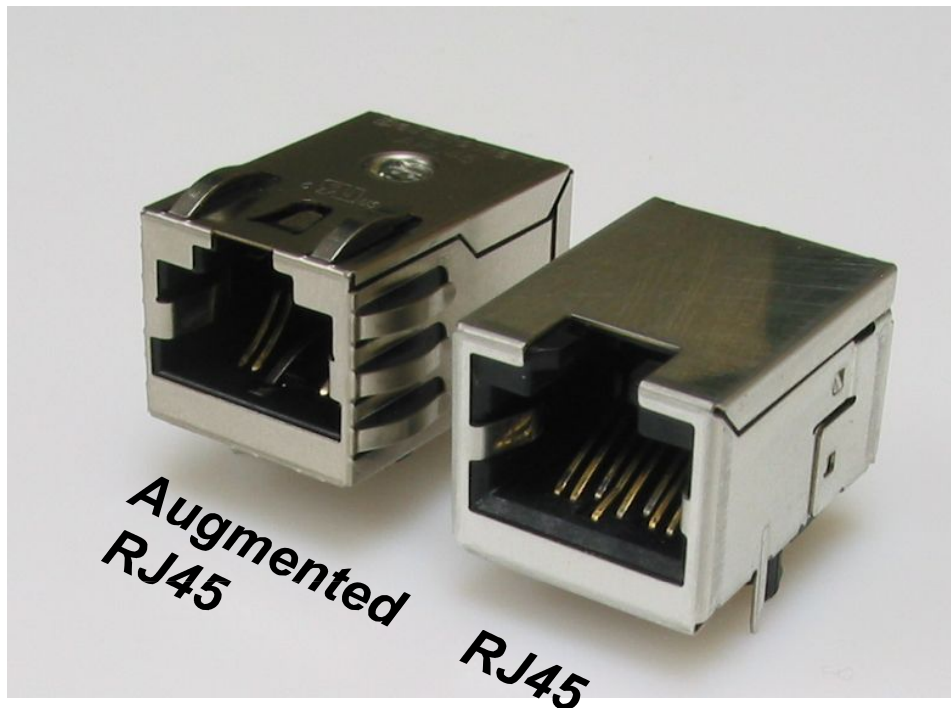
CONNECTING HARDWARE		
TCL TEST SUMMARY, dB		
Frequency, MHz	Limit* $34-20\text{LOG}(f/100)$	Augmented RJ45
100	34.0	53.0
250	26.0	56.1
500	20.0	42.2
1000	14.0	29.2
2000	8.0	19.1

\*\* test limit per PN-568-C-2-1-Draft 2.0c



**Measure of the balance and Dif. to Com. mode conversion applicable to the interface .**

## IEC 61076-3-110 connector examples

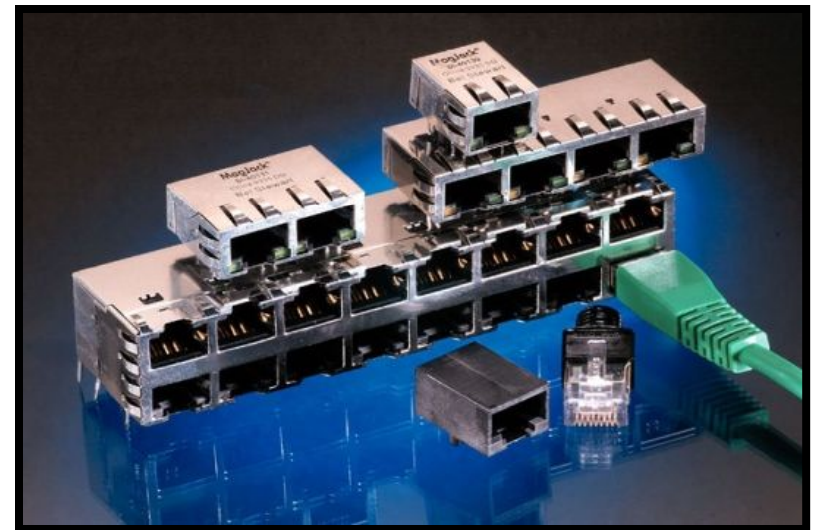
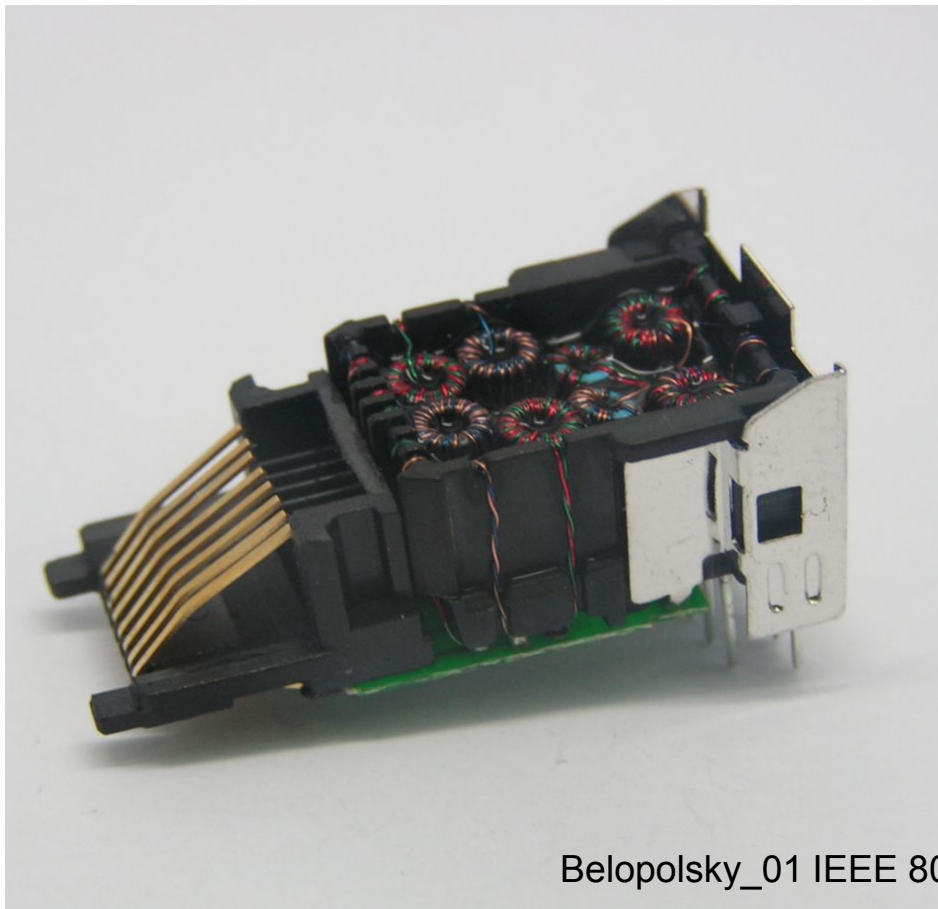


PCB JACKS

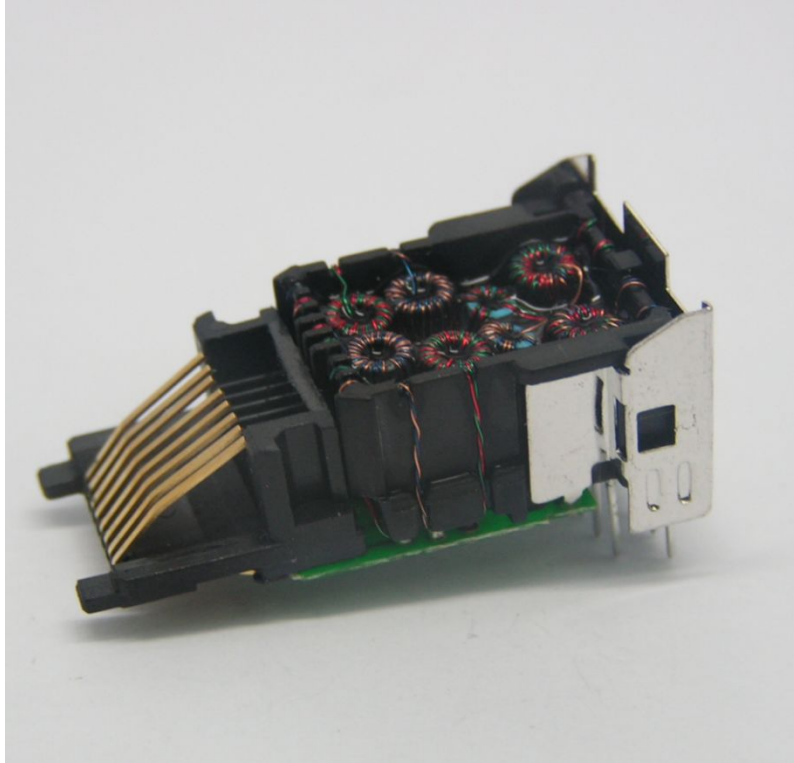
Traditional Patch panel

**The same form factor**

**MDI** Media Independent Interface :  
typically a shielded connector with integrated magnetics  
commonly a multiport design  
located within active equipment  
Also called **ICM** Integrated Magnetic Module



*Magnetic performance can be tuned to a particular PHY*



## ICM major fictions

Provides Voltage insulation - transformer

Filters and conditions the EMI performance

Carries the PoE circuitry

**ICM for 10, 25 and 40 GbE : 4 channels must be balanced and ideally to be symmetric**



# INTEGRATED MAGNETIC MODULES (MDI CONNECTORS)

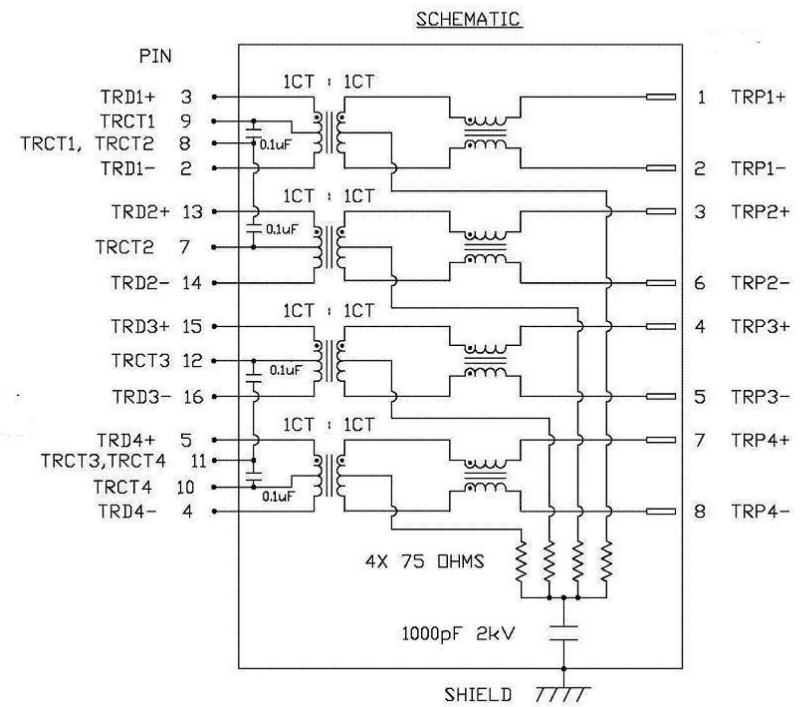


PRELIMINARY



RJ45

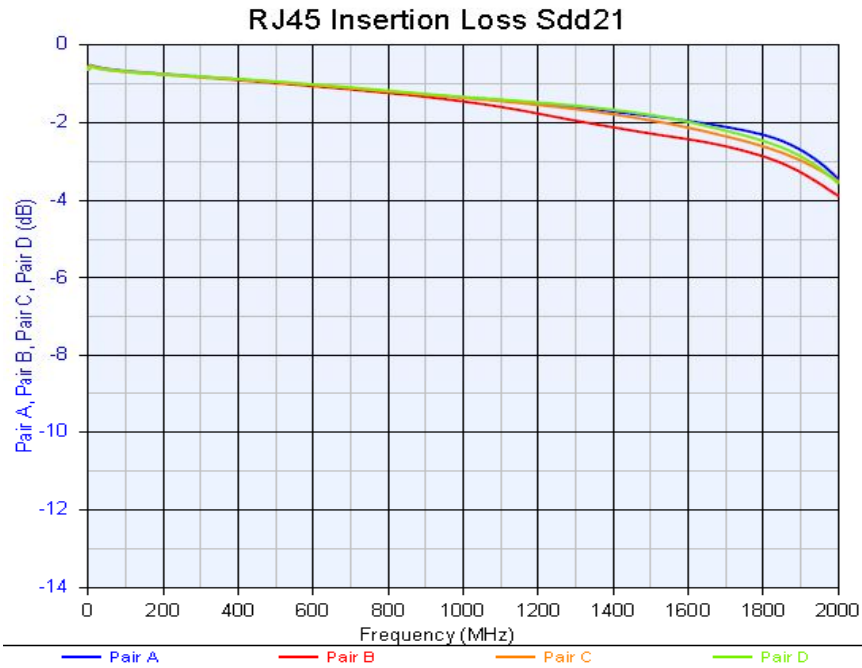
Augmented RJ45



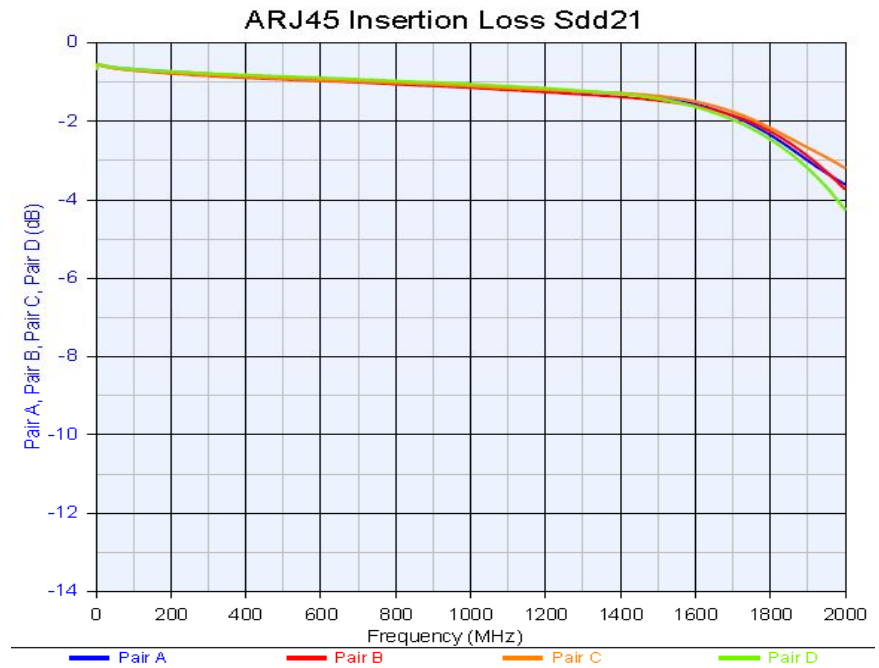
**The same form factor**

# Typical insertion loss

## RJ45 ICM



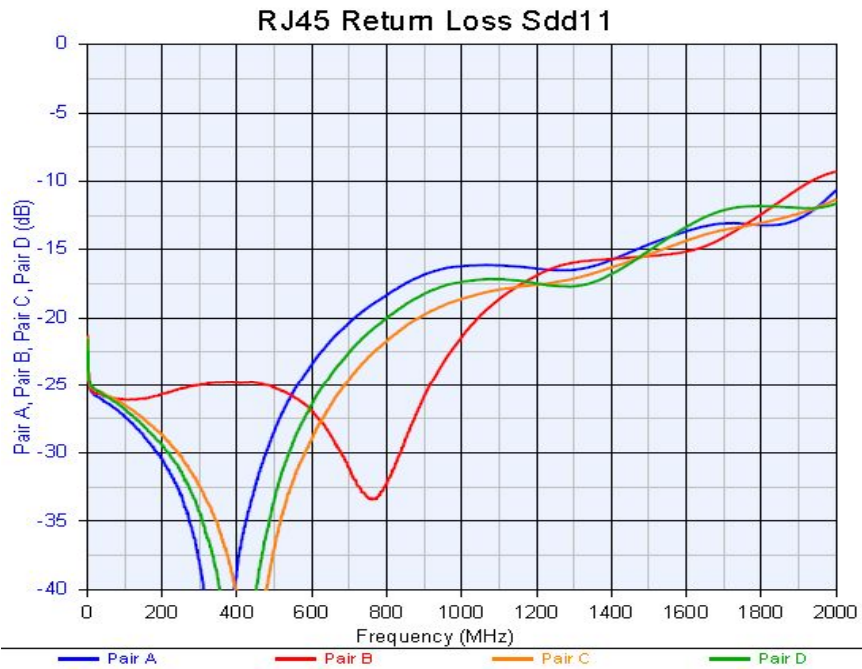
## Augmented RJ45 ICM



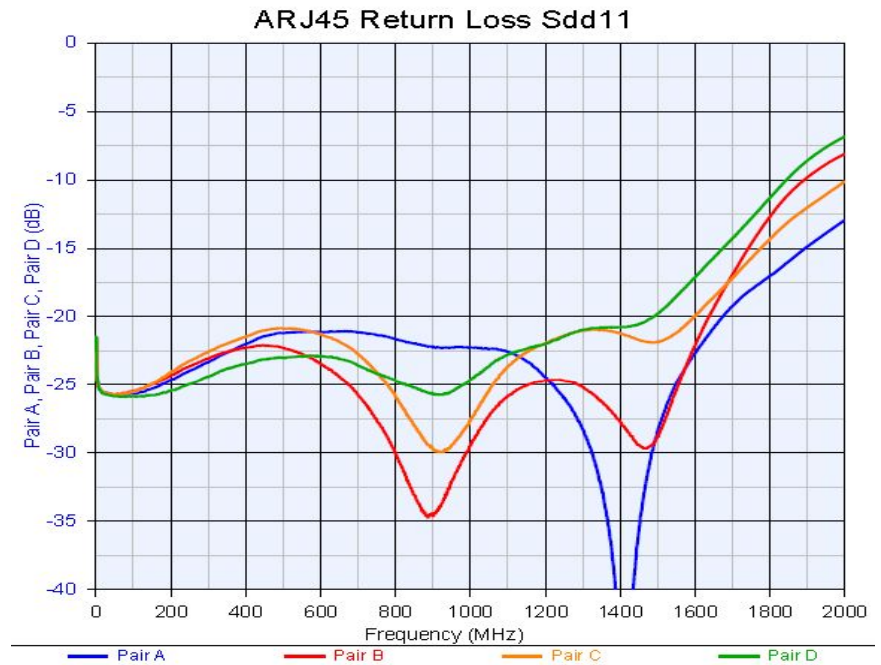
# 40GBASE-T ICM

# Typical return loss

## RJ45 ICM



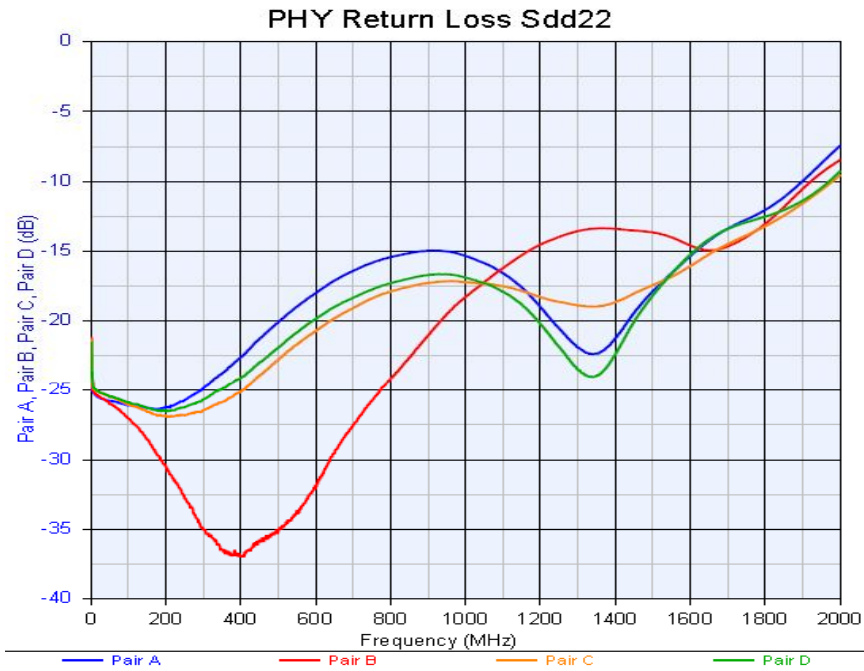
## Augmented RJ45 ICM



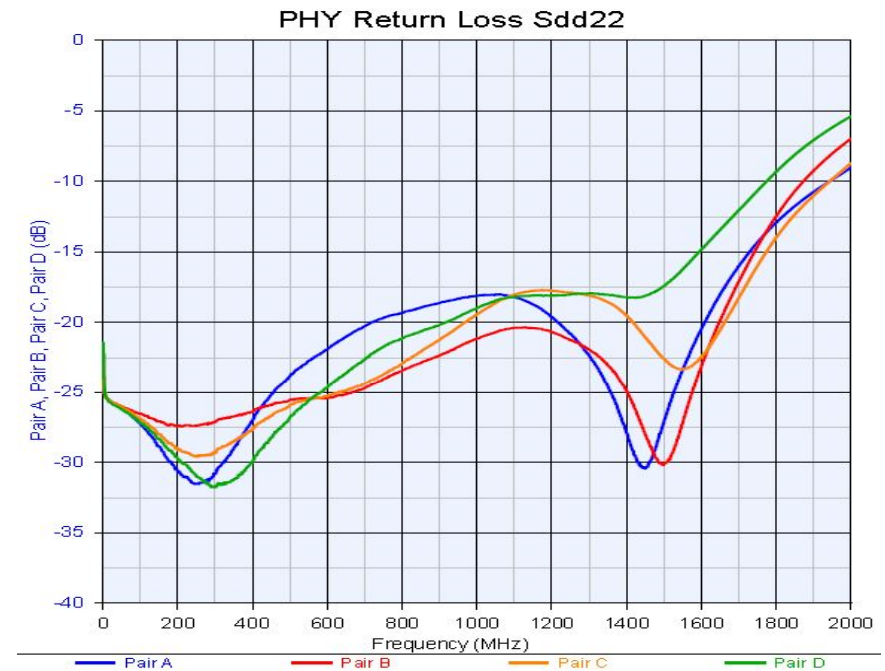
# 40GBASE-T ICM

# Typical return loss

## RJ45 ICM



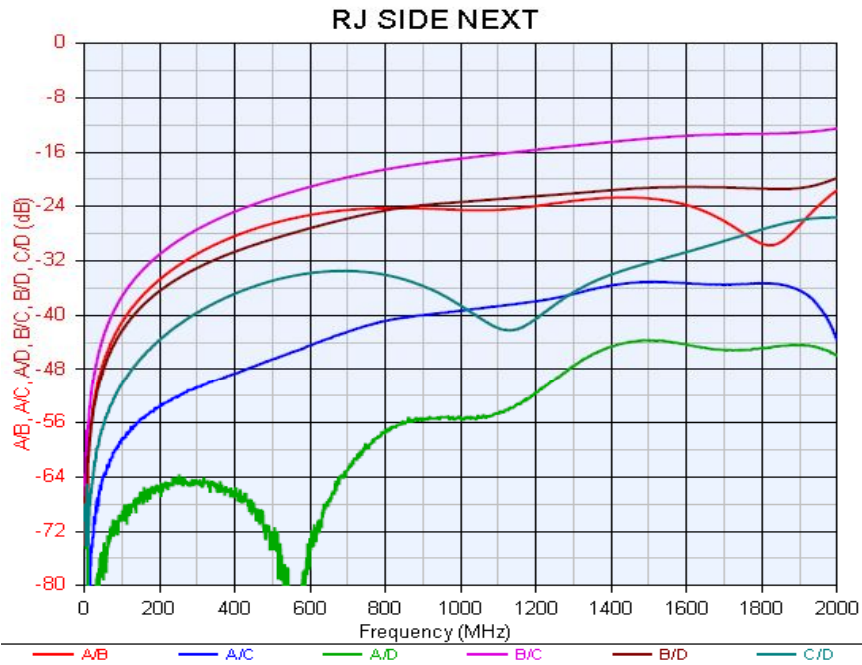
## Augmented RJ45 ICM



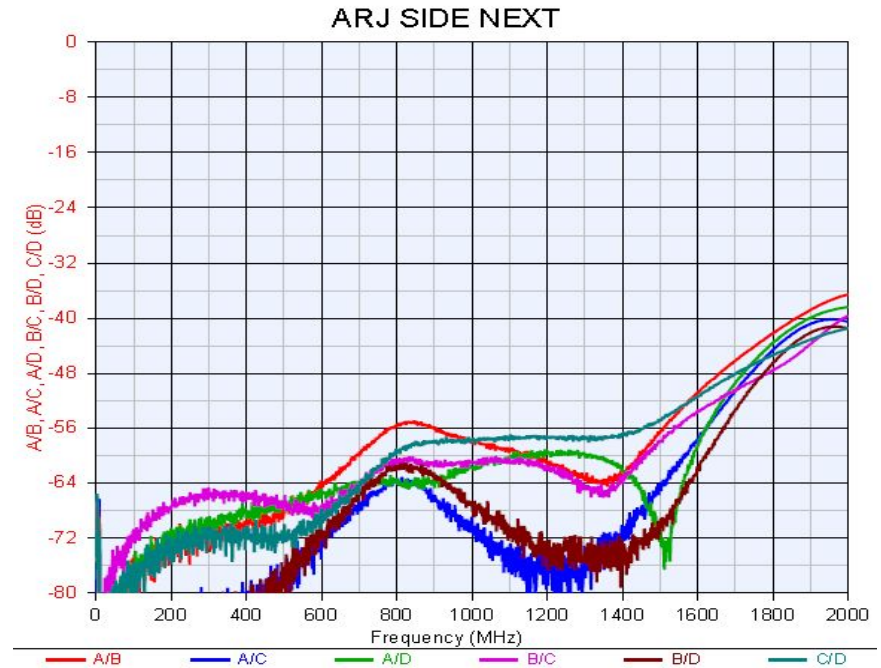
## 40GBASE-T ICM

# Typical NEXT

## RJ45 ICM



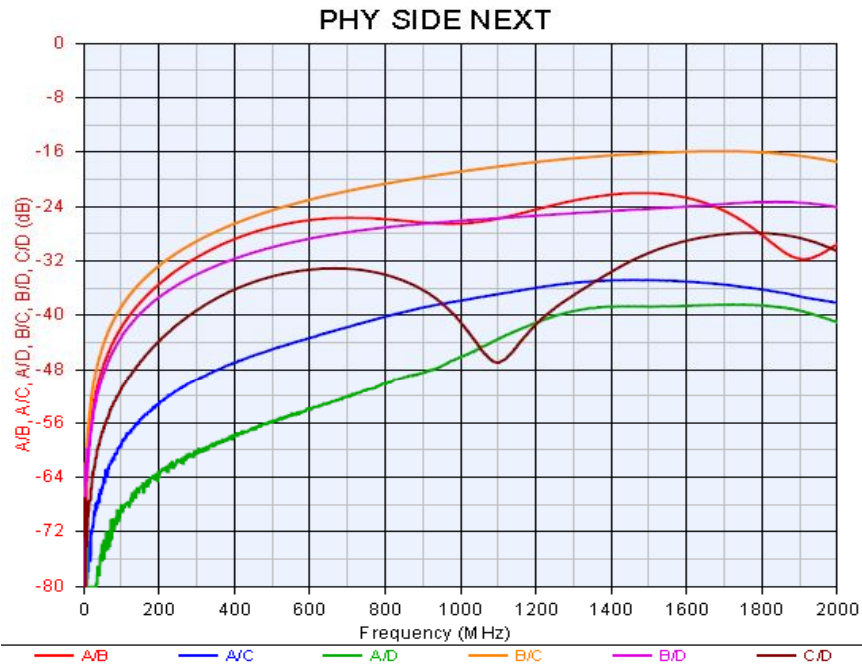
## Augmented RJ45 ICM



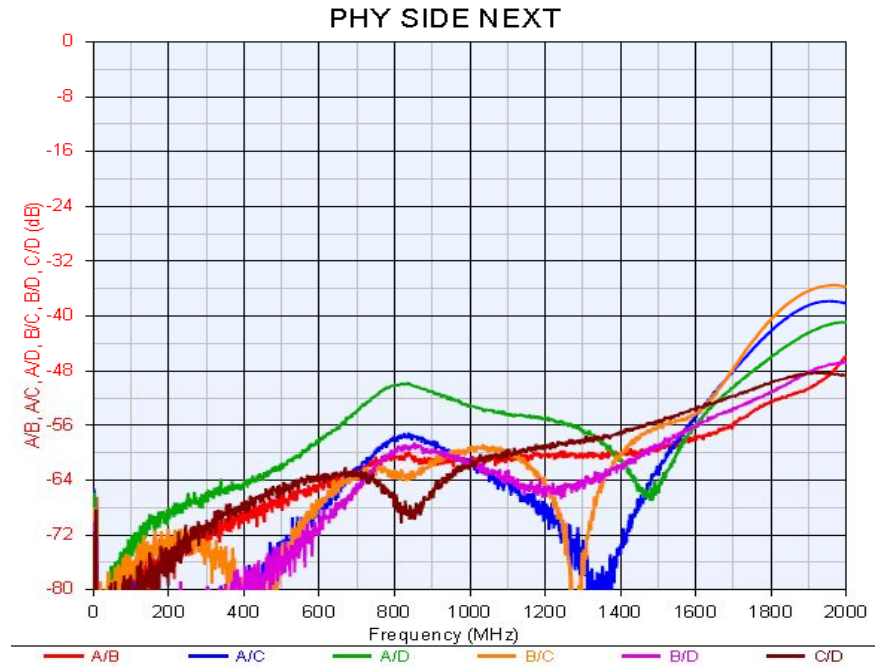
# 40GBASE-T ICM

# Typical NEXT

## RJ45 ICM



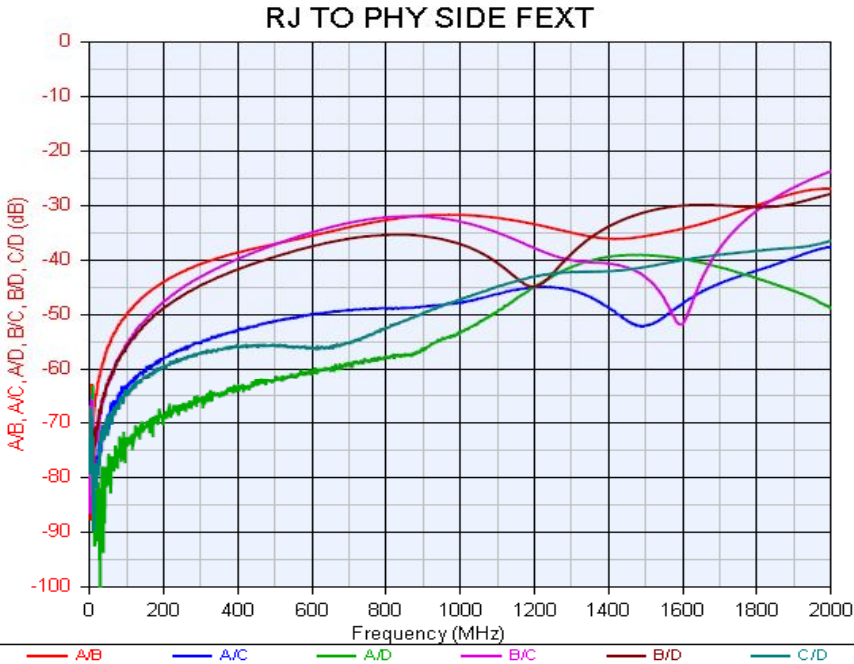
## Augmented RJ45 ICM



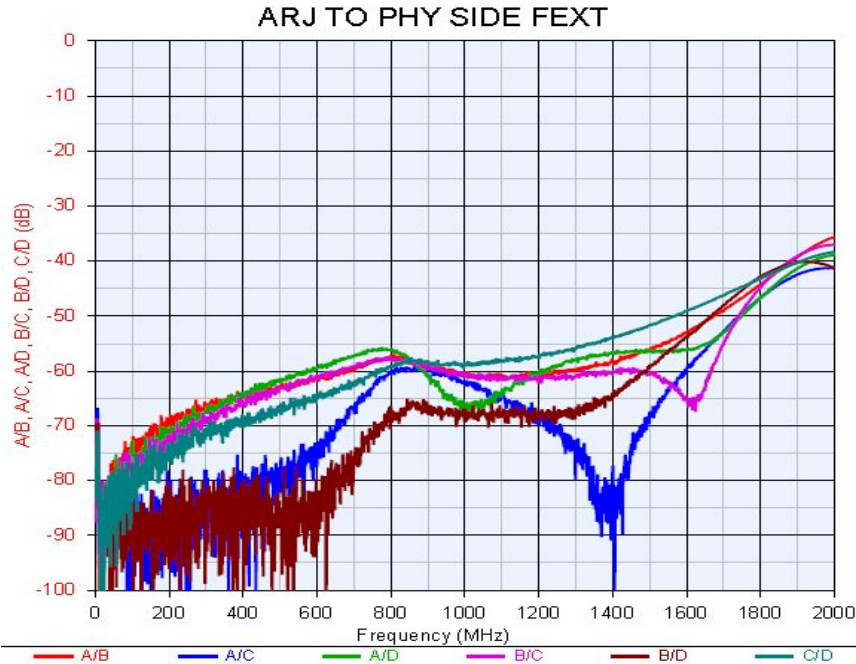
# 40GBASE-T ICM

# Typical FEXT

## RJ45 ICM



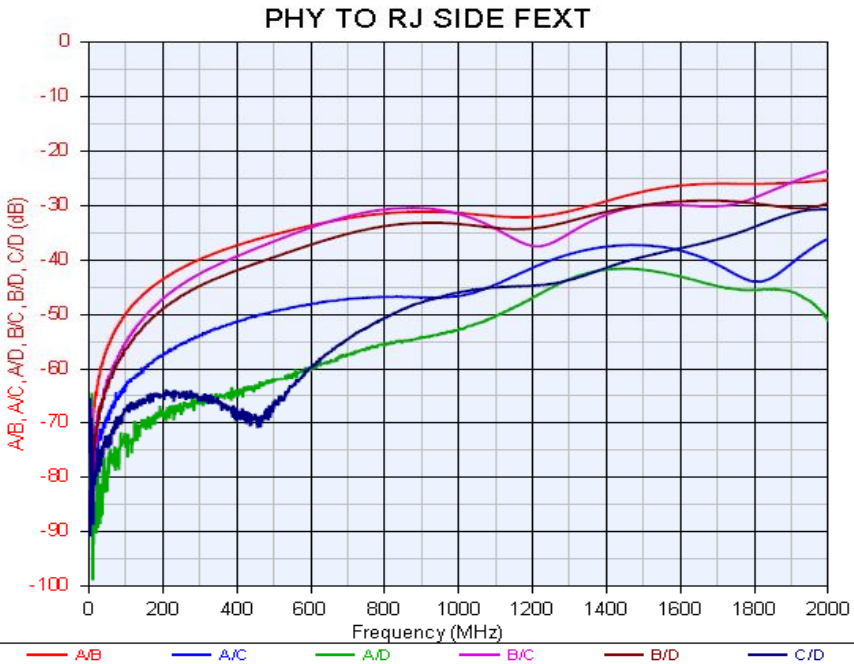
## Augmented RJ45 ICM



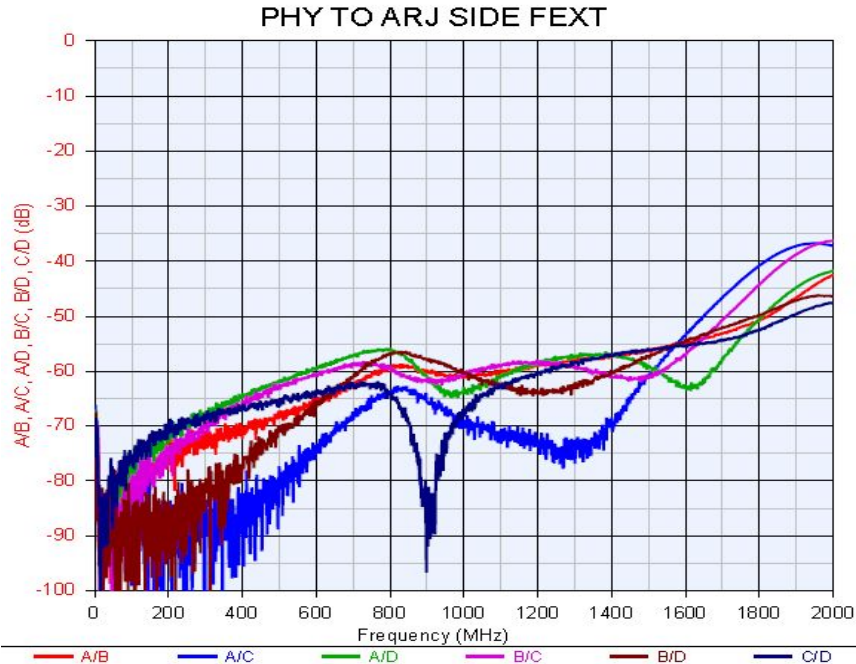
# 40GBASE-T ICM

# Typical FEXT

## RJ45 ICM



## Augmented RJ45 ICM



# 40GBASE-T ICM



# Summary and Conclusion

- ❖ *Use of IEC 61076-3-110 Connectivity in direct testing demonstrated improved Channel Transmission Performance NEXT, RL, ACR, TCL*
- ❖ *IEC 61076-3-110 (Augmented RJ45) connectors have the same form factor as 60603-7 (RJ45) connectors*
- ❖ *IEC 61076-3-110 (Augmented RJ45) connectors do not suffer from the split pair issues and allow better balance*
- ❖ *ICM data shows the improve performance of channels B & C without any need for compensation*

***We recommend to add the IEC 61076-3-110 connectors as an alternative MDI mechanical interface in addition to IEC60603-7 to IEEE 802.3bq***