Improved Transmission Characteristics of Channels utilizing IEC Standard Connectors
Test Data and Information

Rich Marowsky, Bel Stewart
Yakov Belopolsky, Bel Stewart

IEEE P802.3bq 40GBASE-T Task force
Geneva, Switzerland, July 2013
Supporters

Alan Flatman
Albrecht Oehler
Arvind Patel
Bernie Hammond
Bob Wagner
Brad Booth
Harry Forbes
Joerg Wardin
Kris Nippani
Martin Rossbach
Michael Grimwood
Ron Nordin
Valerie Maguire
Yvan Engels

LAN Technologies
Reutlingen University.
Psiber Data
TE Connectivity
Panduit
Independent
Nexans
3M
TE Connectivity Madison Cable
Nexans
Broadcom
Panduit
Siemon Co
Leoni
Improved Transmission Characteristics of Channels utilizing IEC Standard Connectors. Test Data and Information

Abstract

This technical contribution in support of IEEE 802.3bq 40GbE standard development provides information and test data for copper cable channels utilizing the standard connectors per IEC 61076-3-110. The data cover short channels 1-5-1 m as well as longer 50 m channels 2-46-2. Testing was done in 2 GHz and 3 GHz spectra. Data demonstrated that significant improvement in RL (10 to 12 dB) and NEXT (up to 30 dB) can be achieved. It is believed that the Improved channel performance may reduce energy consumption, reduce the PHY complexity and accelerate implementation of 40 GbE technology. The channels were built using the materials and components provided by Bel, Berk Tek and TE Connectivity Madison Cable.
**Rationale:**
The copper cabling channels of improved transmission parameters Return loss, NEXT, ACRF, TcL would help to simplify and accelerate IEEE 802.3bq 40GbE PHY development, provide significant energy savings and accelerate 40GbE market adoption.

**Objectives**

1. **PROVIDE INFORMATION** on IEC Standard connector interfaces

2. Provide test data on short and longer cable channel performance in spectra to 2 and 3 GHz

3. Help to respond to concerns of 40GbE copper channel
To help to alleviate some concerns and make copper channel option more appealing to wider application environment

**Concerns**

Length of copper cabling (up to 30 m) may not address some applications

Copper channels can provide only marginal transmission performance

Complex PHY and DSP would be needed to compensate for marginal transmission abilities of copper

40GbE may have very high power consumption requirements

RJ45 connectivity may not provide enough safety margin for robust implementation

*Is the 40GBASE-T the last IEEE BASE-T Ethernet copper standard*
STANDARD CONNECTOR INTERFACES

IEC 60603-7
RJ45 8-CONTACTS

IEC 60603-7-71
contains a switch
GG45 or S-RJ45

IEC 61076-3-110
ARJ45 8-CONTACTS

IEC 61076-3-104
IEC 61076-3-110 connector examples

ARJ45  RJ45

PCB JACKS

Cable Jack
INTEGRATED MAGNETIC MODULES
(MDI CONNECTORS)
ICM INTEGRATED CONNECTOR MODULE

1st connector in the “transmission line” – located within active equipment

Magnetic performance can be tuned to a particular PHY

INSIDE MDI connector
Category 6 shielded RJ45 plug is shown combined with ARJ45 Plug in same Patch Cord cable assembly.
COMPATIBILITY of STANDARD CONNECTORS

FORWARD COMPATIBILITY

GG45 or S-RJ45 contains a switch

RJ cord RJ

ARJ cord ARJ

RJ45

ARJ45

No effect on the AUTONEGOTIATION
COMPATIBILITY of STANDARD CONNECTORS

All Standard Connectors Utilize 8-wire Patch Cords

No effect on the AUTONEGOTIATION

Belopolsky IEEE 802.3bq Geneva 2013
1-5-1 Channel Configuration

Channel Data Collected w/ 

✓ Psiber Data WireXpert
✓ E5071C Network Analyzer
1-5-1 Channel Configuration (cable A)

Channel Data Collected w/ **WireXpert** 2GHz Field Tester

- (1) Insertion Loss
- (2) Return Loss
- (3) NEXT
- (4) ACRF

Channel Data Collected w/ **E5071C** Network Analyzer

- (5) TcL

---

**TE InfiniTwist Cable**

**ARJ45 connector**

**Cable A - construction:** 4-pairs; individually shielded pairs with overall shield
1-5-1 m Channel Insertion Loss

CABLE A

ARJ45 connector
1-5-1 m Channel Return Loss - Meas WireXpert

CABLE A

ARJ45 connector

Belopolsky IEEE 802.3bq Geneva 2013
1-5-1 m Channel ACRF - Meas WireXpert

CABLE A

ARJ45 connector

Frequency (MHz)
1-5-1 Channel Configuration (cable B)

Channel Data Collected w/ **WireXpert** 2GHz Field Tester

- (1) Insertion Loss
- (2) Return Loss
- (3) NEXT
- (4) ACRF

Channel Data Collected w/ **E5071C** Network Analyzer

- (5) TcL

**Berk-Tek S/FTP Cable**

**ARJ45 connector**

**Cable B - construction:** 4-pairs; individually shielded pairs with overall shield
1-5-1 m Channel Insertion Loss

CABLE B

ARJ45 connector
1-5-1 m Channel Return Loss - Meas WireXpert

Frequency (MHz)

Return Loss (dB)

CABLE B
ARJ45 connector

Belopolsky IEEE 802.3bq Geneva 2013
1-5-1 m Channel NEXT - Meas WireXpert

CABLE B

ARJ45 connector

Frequency (MHz)

NEXT (dB)

Belopolsky IEEE 802.3bq Geneva 2013
1-5-1 m Channel TCL - Meas E5071C

Frequency (MHz) vs. TCL (dB) graph showing various cable types and limits. The graph includes lines for NA 45 TCL, NA 12 TCL, NA 36 TCL, NA 78 TCL, Cat 8 Chan TcL Limit, and a 12 dB Improved TcL Limit. The graph is labeled with 'CABLE B' in a designated box.
50 meter channel configuration
ARJ45 connectivity - 3GHz bandwidth

- Measurements Performed on 50 meter, 2-Connector Channel
- 2m Patch Cords, 46m Horizontal
- TIA 1183 Balun-Less Measurement Method w/Alternative Fixturing

Note: available 50m channel was used to obtain the test data; no intent to propose a longer channel objective
Category 6a RJ45
Test limit for comparison
Category 6a
RJ45 limit for comparison
2-46-2 ARJ45 CHANNEL RETURN LOSS

Return Loss (dB)

Freq (MHz)

14.1 dB @ 2GHz
9.0 dB @ 3GHz
2-46-2 ARJ45 CHANNEL FEXT
Use of IEC/ISO 61076-3-110 Standard Interface connectors in short channels resulted in significant improvement of transmission characteristics as compared to requirements of Working Draft 7.0 Balanced Twisted-Pair Telecommunications Cabling And Components Standard, Addendum 1: Specifications for 100Ω Category 8 Cabling

### 0-2000 MHz COMPARATIVE MARGIN

<table>
<thead>
<tr>
<th></th>
<th>Cable A</th>
<th>Cable B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Return loss</strong></td>
<td>+12 dB</td>
<td>+9 dB</td>
</tr>
<tr>
<td><strong>NEXT</strong></td>
<td>+30 dB</td>
<td>+30 dB</td>
</tr>
<tr>
<td><strong>ACRF</strong></td>
<td>+32 dB</td>
<td>+32 dB</td>
</tr>
<tr>
<td><strong>TCL</strong></td>
<td>+12 dB</td>
<td>+12 dB</td>
</tr>
</tbody>
</table>
Measurement Data Summary

50 meter CHANNEL 0 to 3GHz bandwidth

The comparative performance data was not available
The test results in absolute values for 50 m channel

<table>
<thead>
<tr>
<th></th>
<th>0 to 500 MHz</th>
<th>501 to 2000 MHz</th>
<th>2001 to 3000 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEXT</td>
<td>63 dB</td>
<td>57 dB</td>
<td>52 dB</td>
</tr>
<tr>
<td>Return loss</td>
<td>23 dB</td>
<td>14 dB</td>
<td>9 dB</td>
</tr>
<tr>
<td>TCL</td>
<td>33 dB</td>
<td>26 dB</td>
<td>23 dB</td>
</tr>
</tbody>
</table>
Conclusion and Future Work

- **Use of IEC 61076-3-110 Connectivity in direct testing demonstrated improved Channel Transmission Performance**

  Note: It is expected that utilization of IEC 61076-3-104 connectors in similar channels would result in similar performance

- **Future work**

  *Provide test data to the IEEE P802.3bq task force to quantify how improved channel NEXT and RL help to lower PHY Power*
  
  *Conduct additional testing in reference to Technical Report TR ISO/IEC 11801-99-1 channel class II*
  
  *Evaluate end-to-end channel including MDI connectors*
  
  *Measure Coupling Attenuation and Identify TCL effects on the transmission time delay*