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

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

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Yvan Engels	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.

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

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

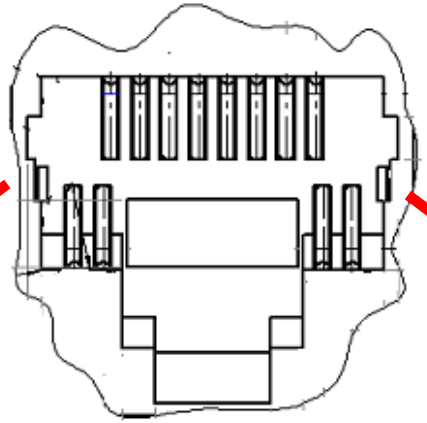
Complex PHY and DSP would be needed to compensate for marginal transmission abilities of copper

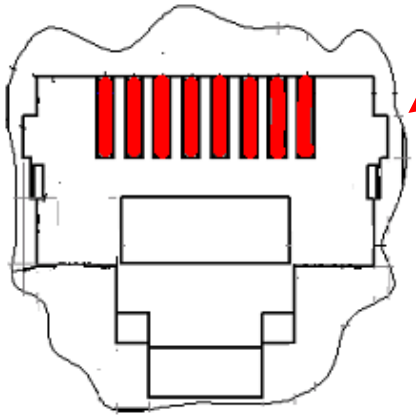
40GbE may have very high power consumption requirements

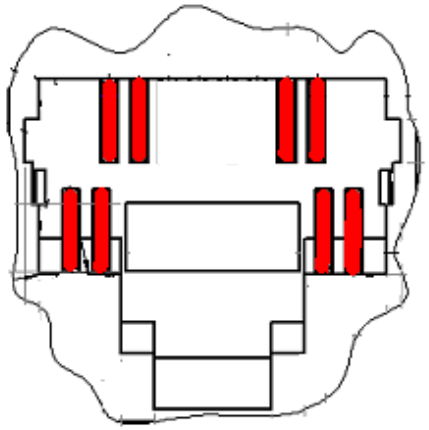
RJ45 connectivity may not provide enough safety margin for robust implementation

Is the 40GBASE-T the last IEEE BASE-T Ethernet copper standard

STANDARD CONNECTOR INTERFACES







IEC 60603-7-71

contains a switch

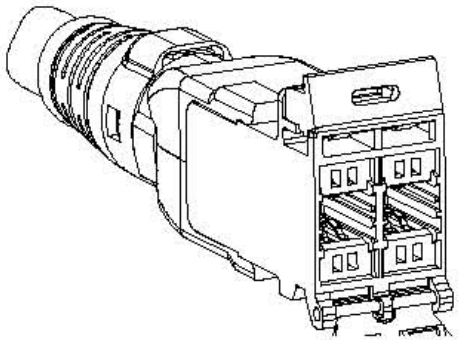
GG45 or S-RJ45

IEC 60603-7

RJ45 8-CONTACTS

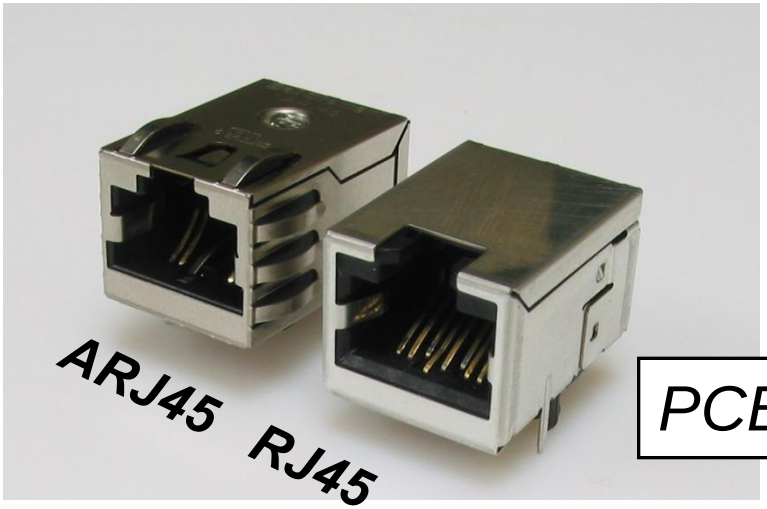
IEC 61076-3-110

ARJ45 8-CONTACTS

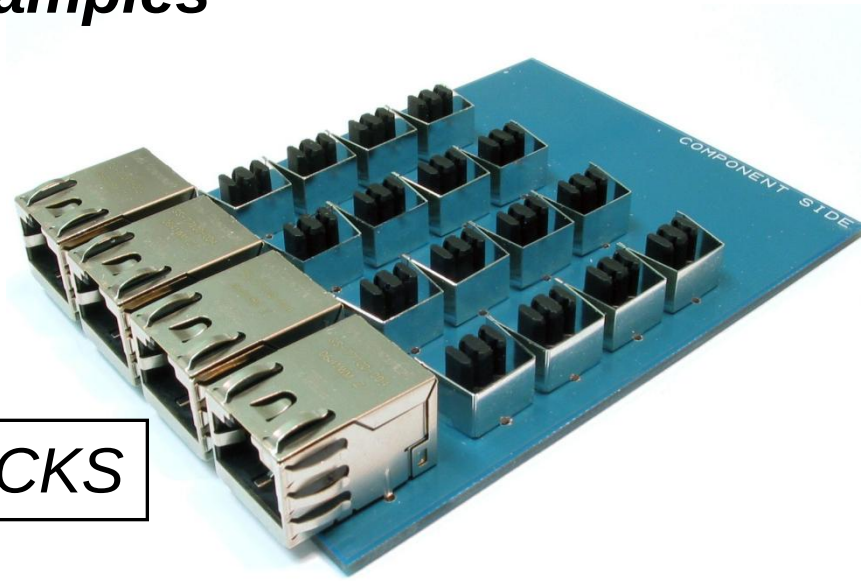


IEC 61076-3-104

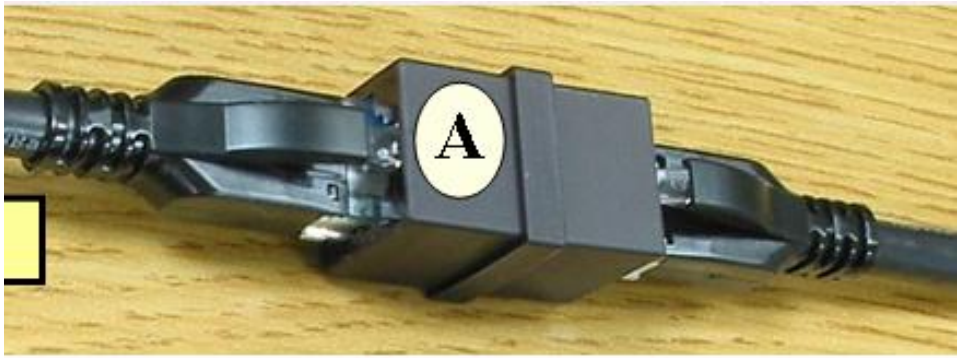
IEC 61076-3-110 connector examples



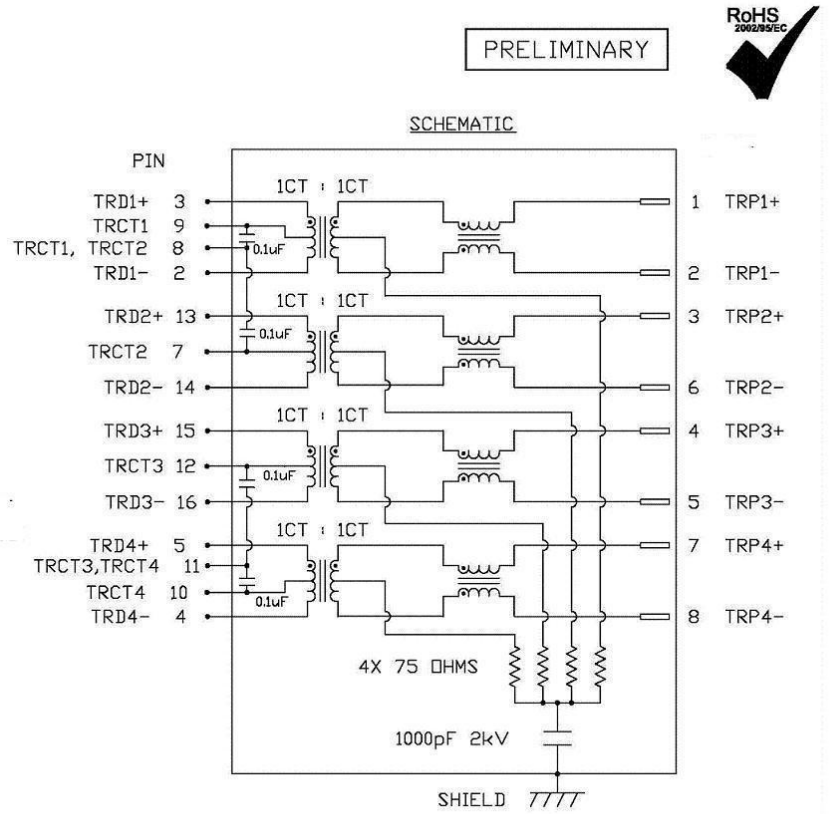
PCB JACKS



Cable Jack

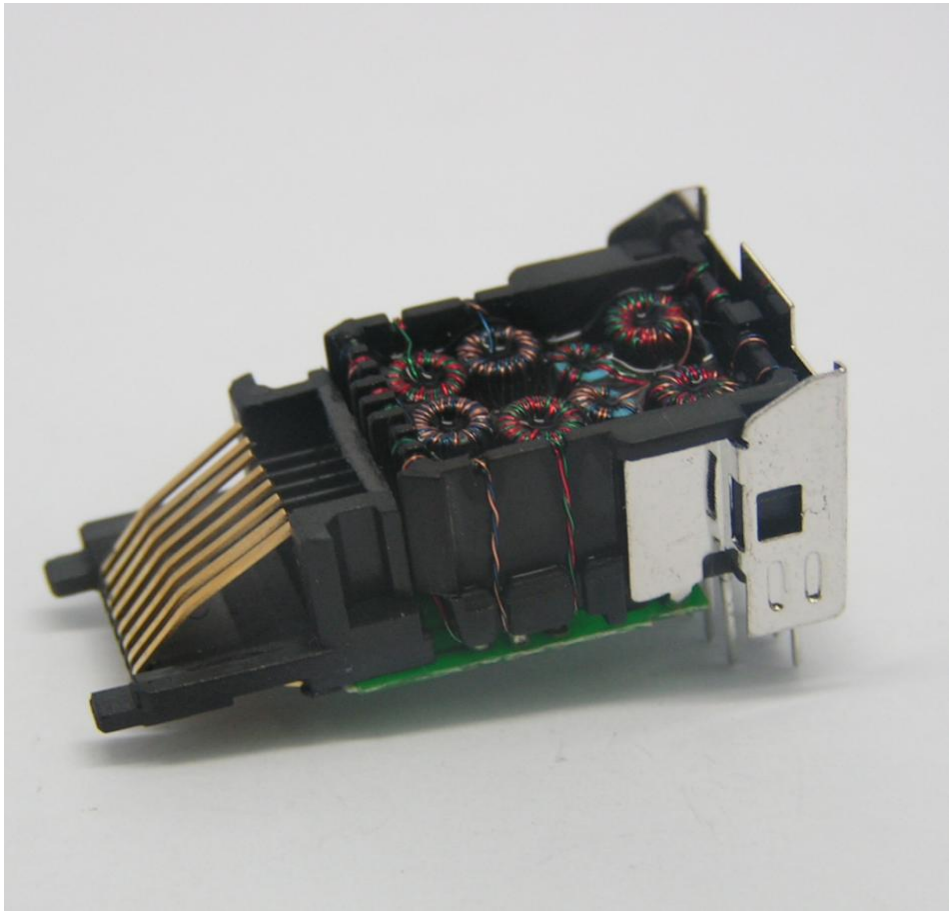


INTEGRATED MAGNETIC MODULES (MDI CONNECTORS)



ICM INTEGRATED CONNECTOR MODULE

1st connector *in the " transmission line"* – located within active equipment



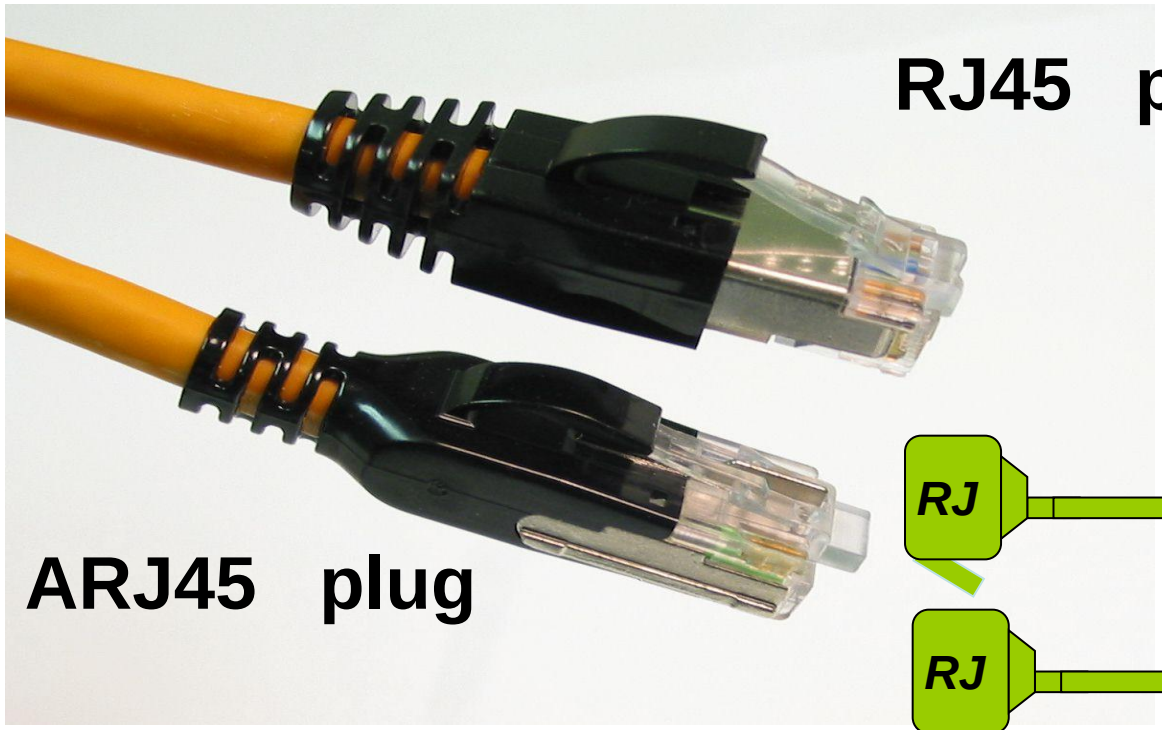
Magnetic performance can be tuned to a particular PHY

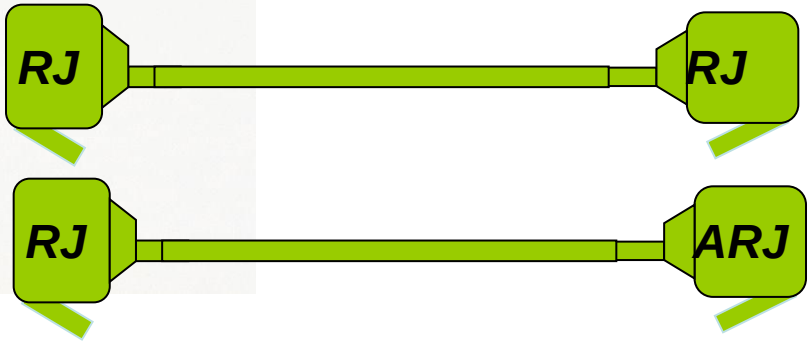
INSIDE MDI connector

COMPATIBILITY of STANDARD CONNECTORS

PLUGS and CORDS

All Standard Connectors Utilize 8-wire Patch Cords

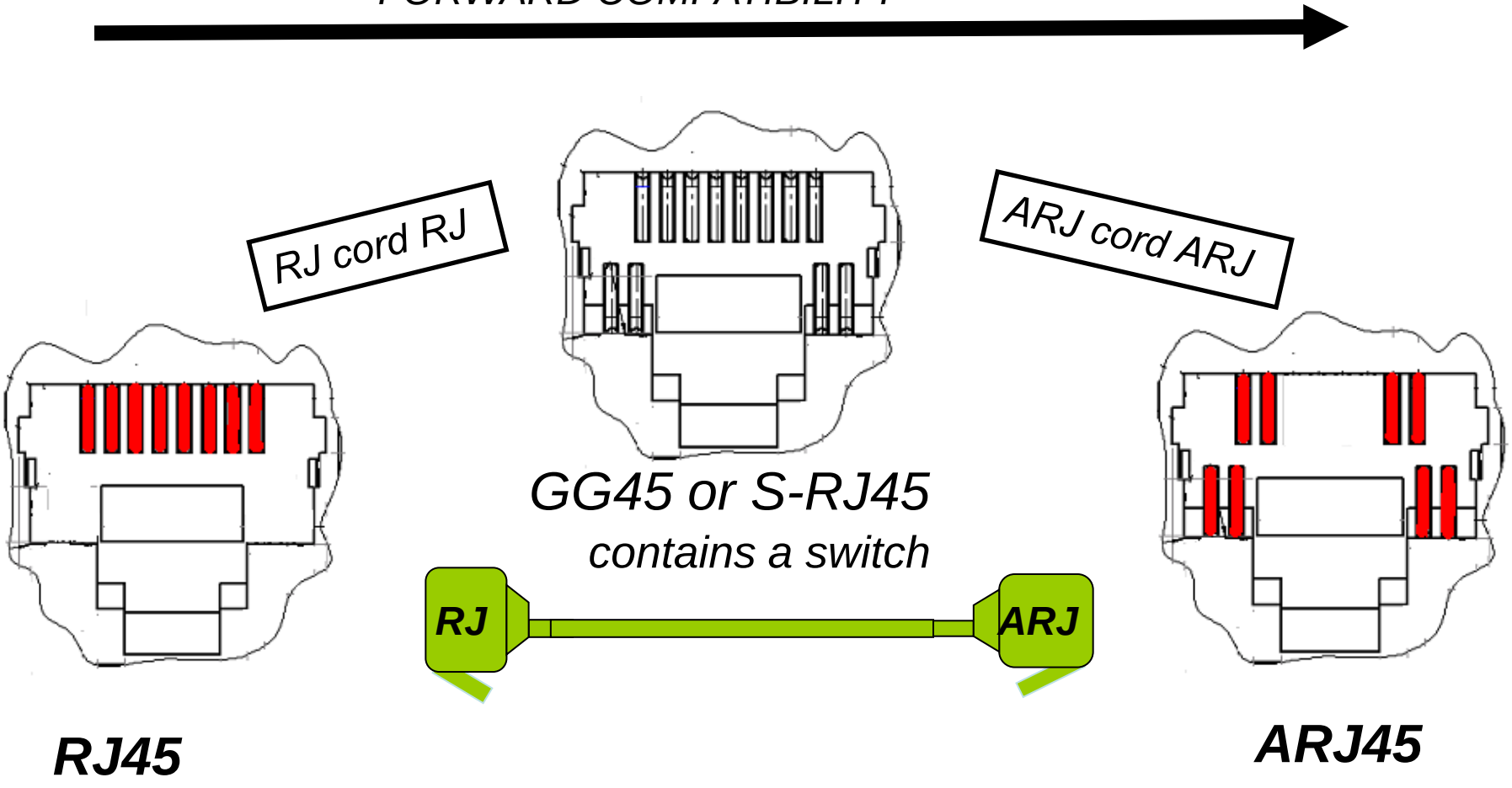




Category 6 shielded RJ45 plug is shown
combined with ARJ45 Plug in same Patch Cord cable assembly

COMPATIBILITY of STANDARD CONNECTORS

FORWARD COMPATIBILITY



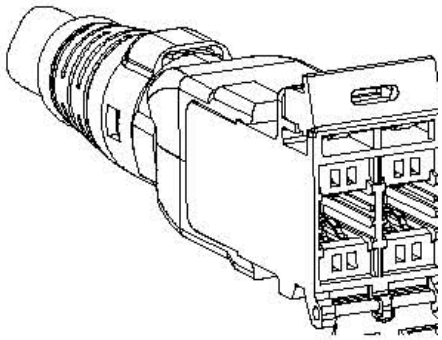
No effect on the AUTONEGOTIATON

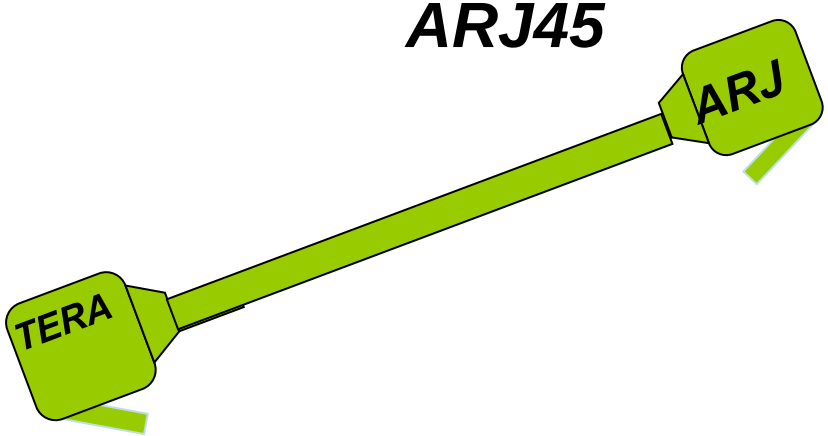
COMPATIBILITY of STANDARD CONNECTORS

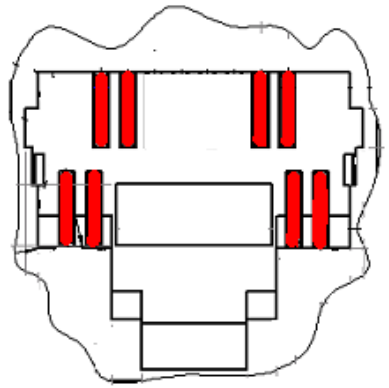
All Standard Connectors Utilize 8-wire Patch Cords

ARJ45

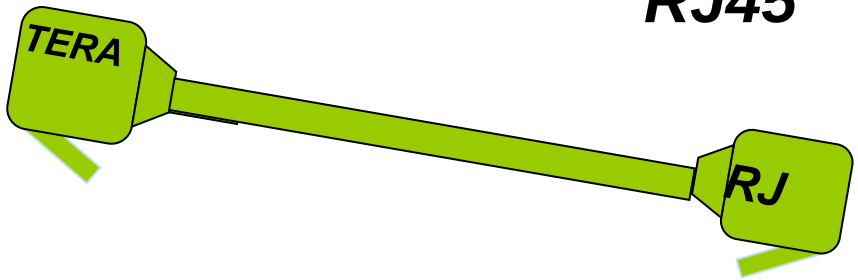
TERA

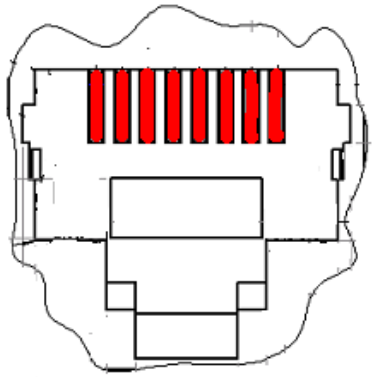






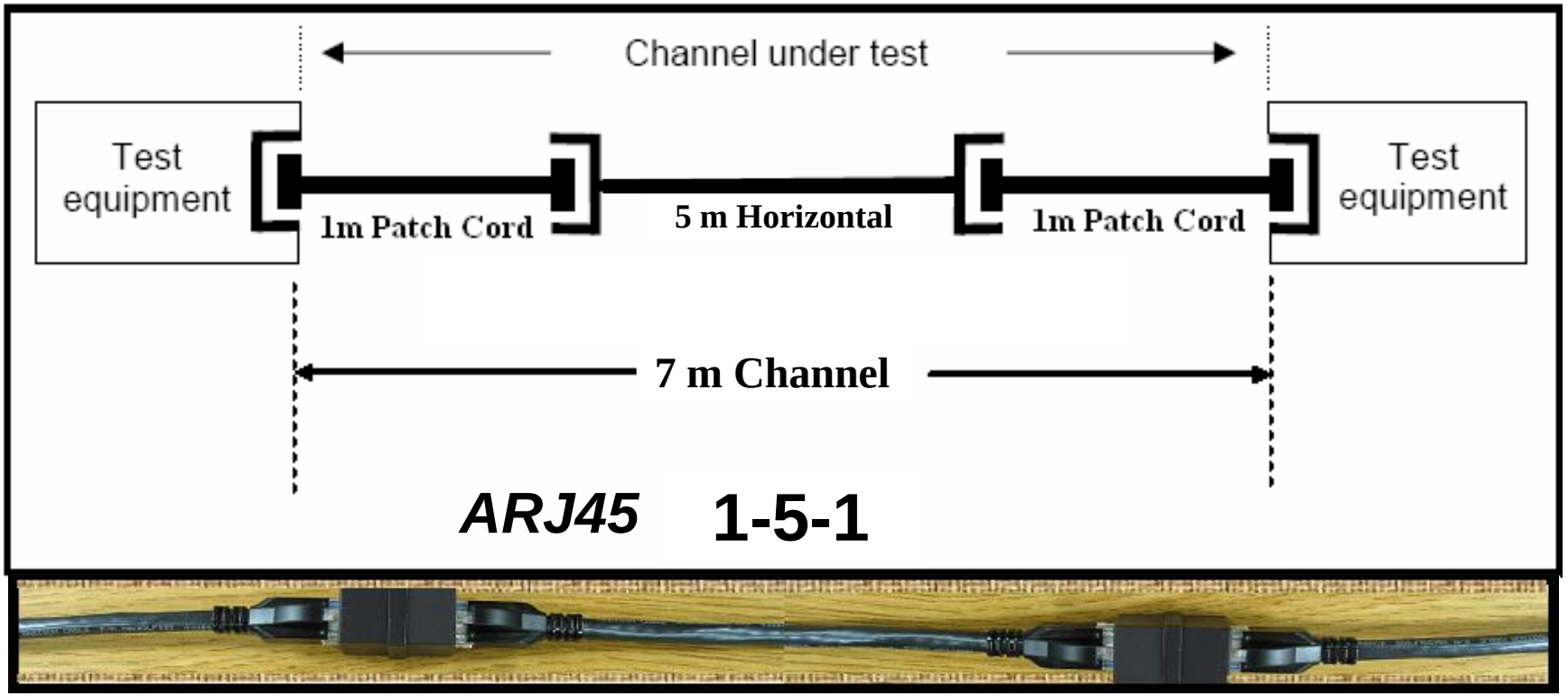
RJ45





No effect on the AUTONEGOTIATON

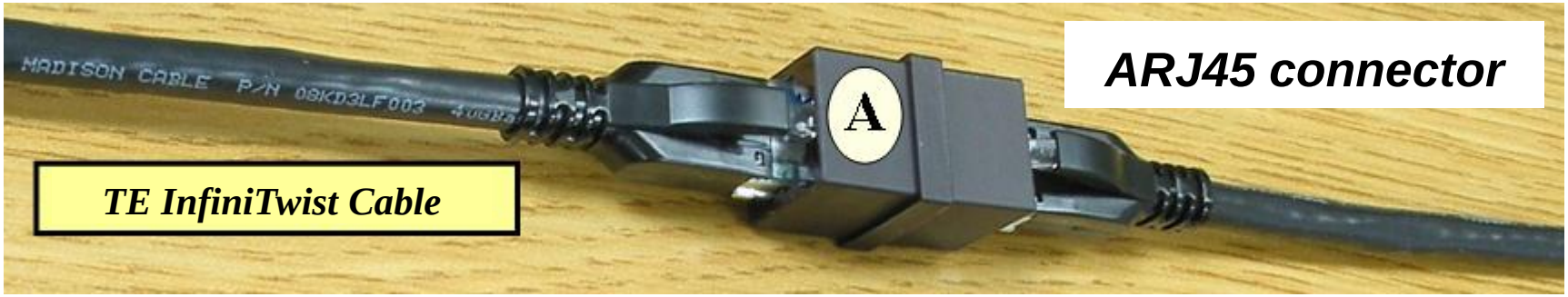
1-5-1 Channel Configuration



Channel Data Collected w/

- ✓ Psiber Data WireXpert
- ✓ E5071C Network Analyzer

1-5-1 Channel Configuration (cable A)



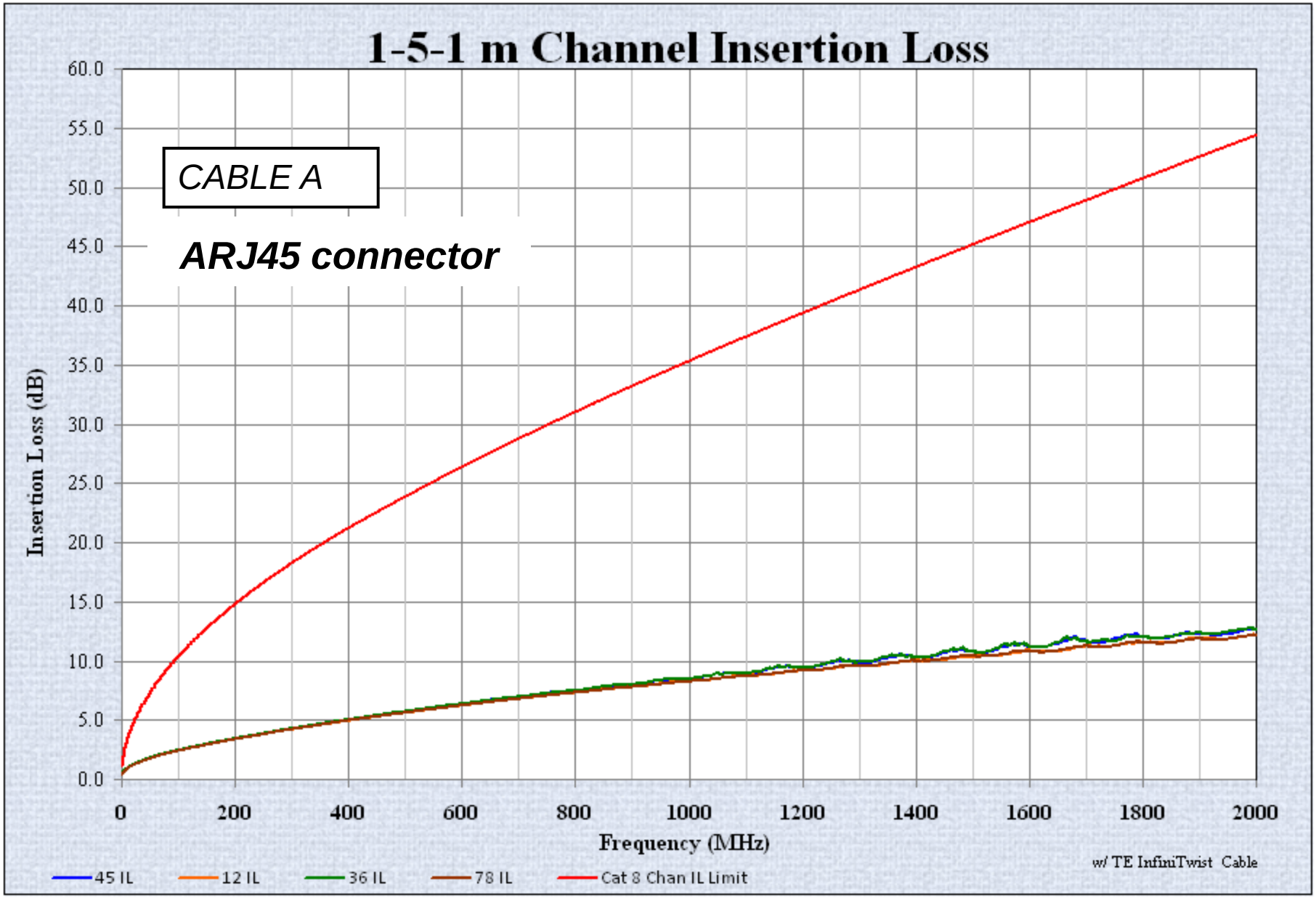
Channel Data Collected w/ **WireXpert** 2GHz Field Tester

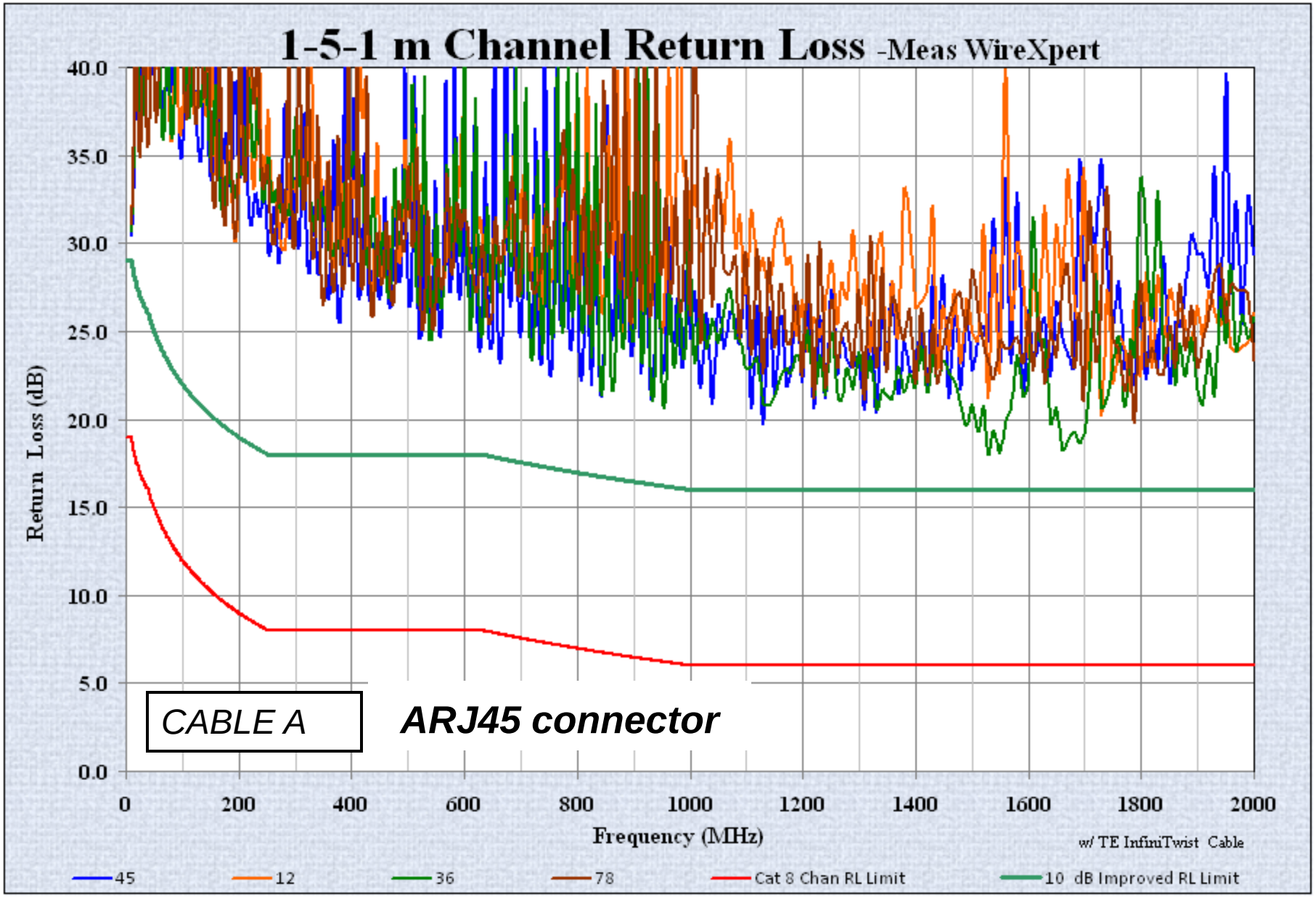
- ✓ (1) Insertion Loss
- ✓ (2) Return Loss
- ✓ (3) NEXT
- ✓ (4) ACRF

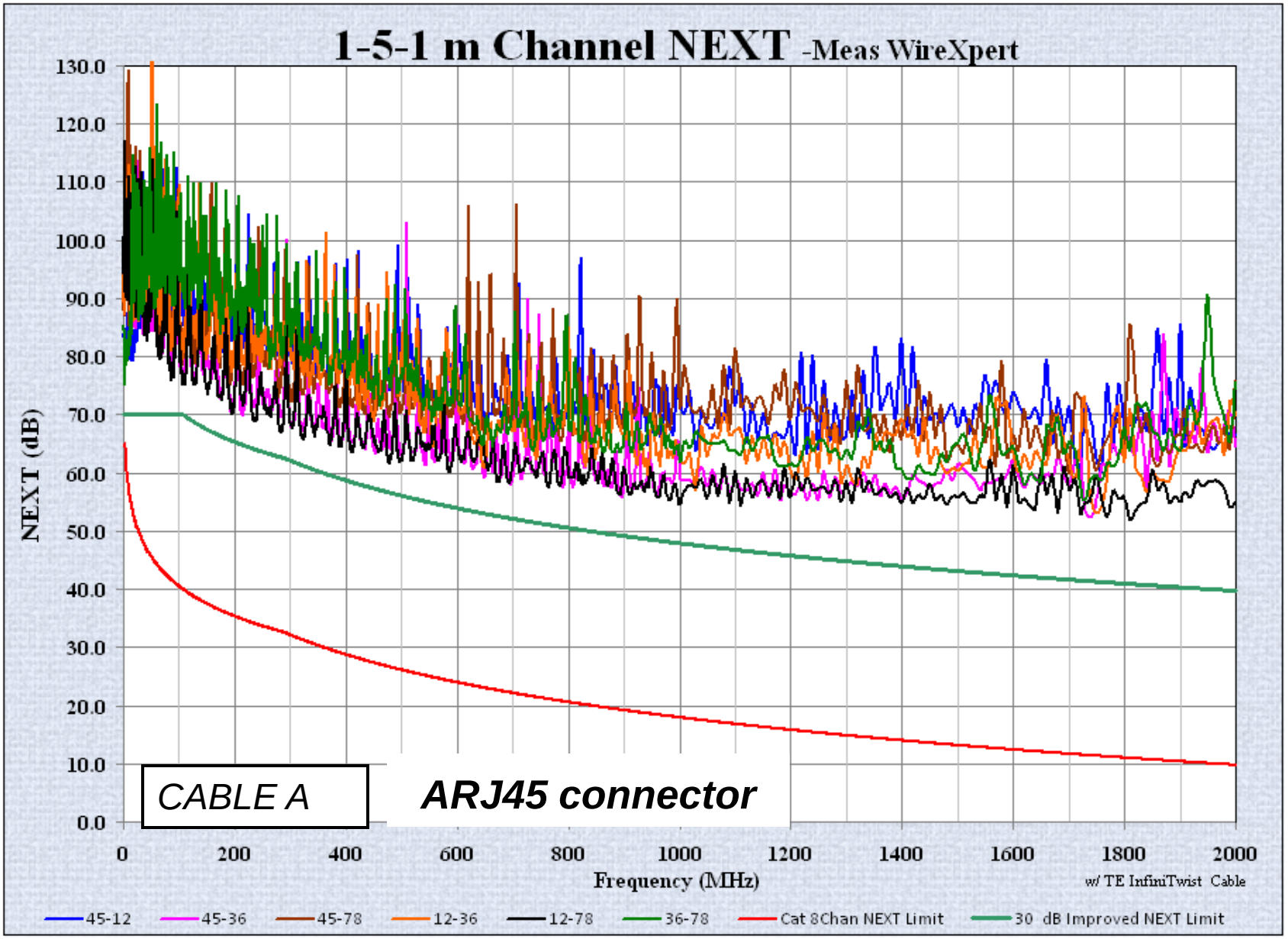
Cable A - construction: 4-pairs; individually shielded pairs with overall shield

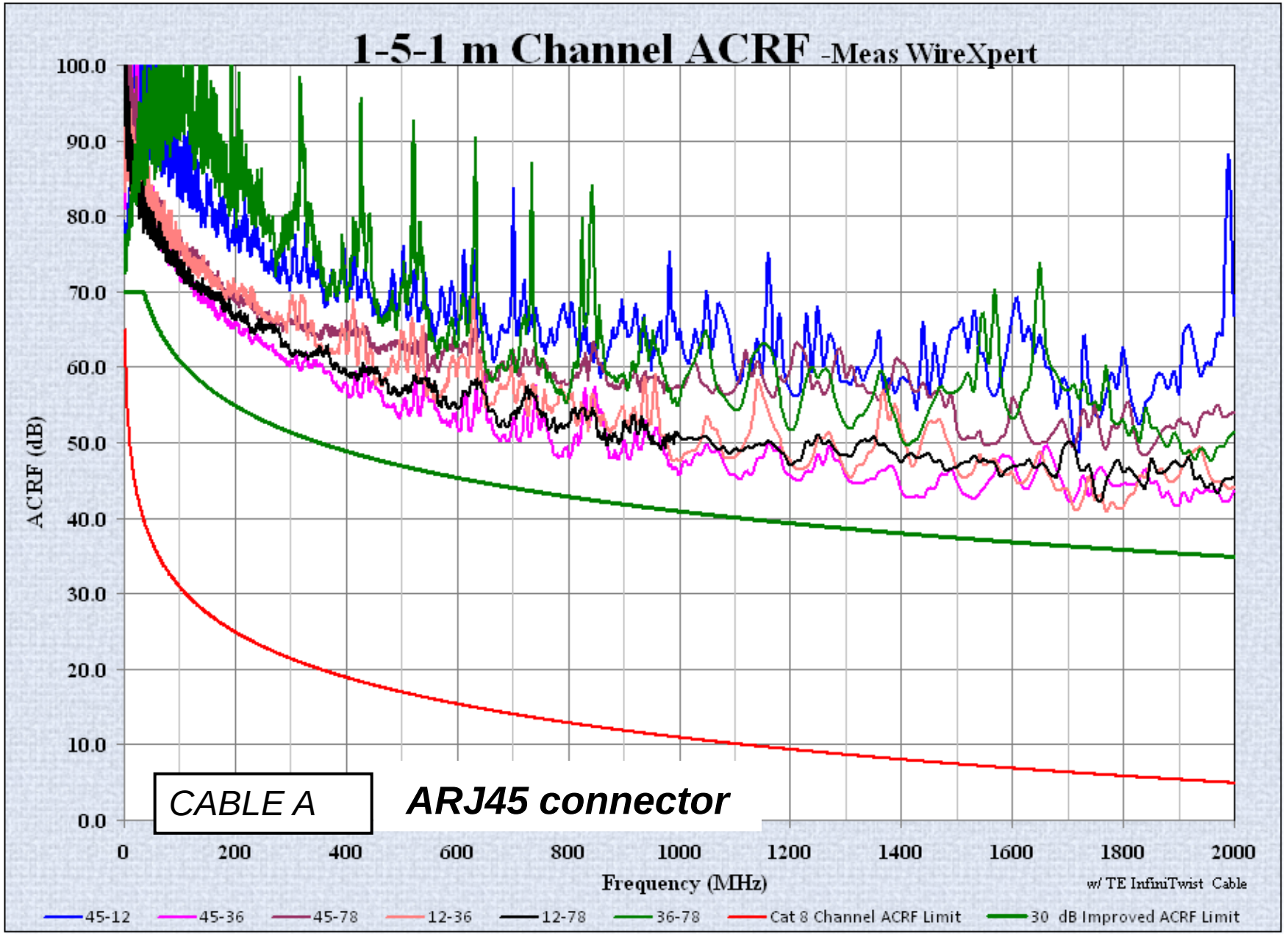
Channel Data Collected w/ **E5071C** Network Analyzer

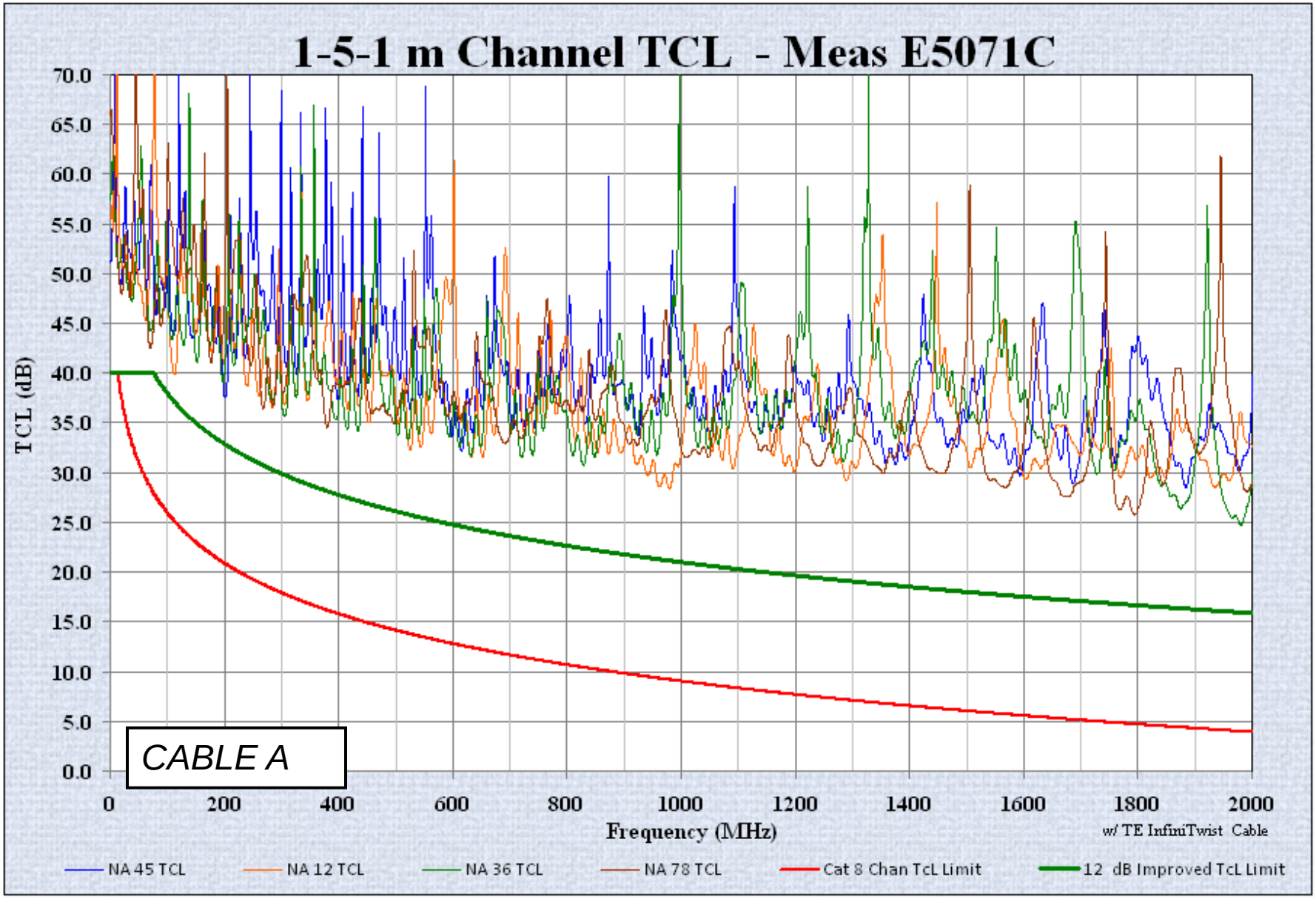
- ✓ (5) TcL


1-5-1 m Channel Insertion Loss
CABLE A
ARJ45 connector
Insertion Loss (dB)
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ TE InfiniTwist Cable
45 IL
12 IL
36 IL
78 IL
Cat 8 Chan IL Limit

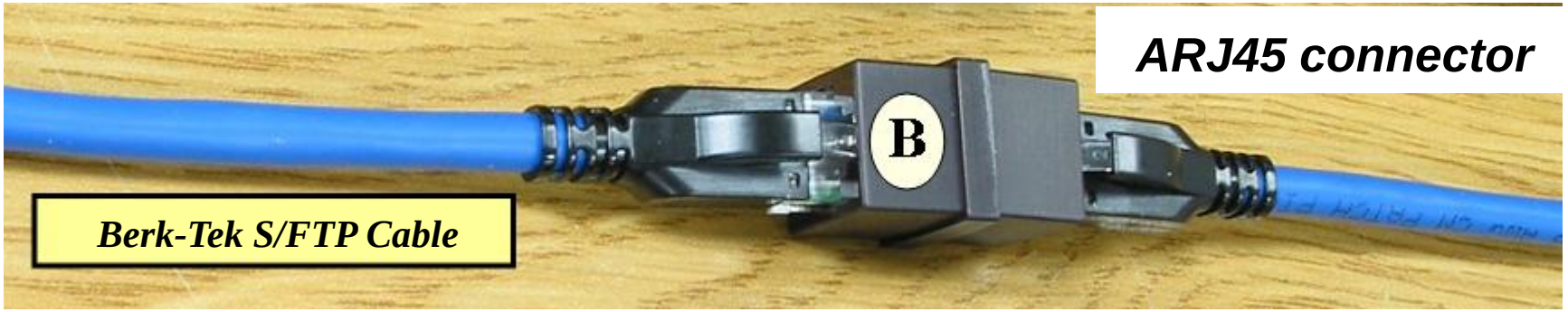

1-5-1 m Channel Return Loss -Meas WireXpert
Return Loss (dB)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ TE InfiniTwist Cable
CABLE A
ARJ45 connector
45
12
36
78
Cat 8 Chan RL Limit
10 dB Improved RL Limit


1-5-1 m Channel NEXT -Meas WireXpert
NEXT (dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ TE InfiniTwist Cable
CABLE A
ARJ45 connector
45-12
45-36
45-78
12-36
12-78
36-78
Cat 8Chan NEXT Limit
30 dB Improved NEXT Limit


1-5-1 m Channel ACRF -Meas WireXpert
ACRF (dB)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ TE InfiniTwist Cable
CABLE A
ARJ45 connector
45-12
45-36
45-78
12-36
12-78
36-78
Cat 8 Channel ACRF Limit
30 dB Improved ACRF Limit


1-5-1 m Channel TCL - Meas E5071C
TCL (dB)
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ TE InfiniTwist Cable
CABLE A
NA 45 TCL
NA 12 TCL
NA 36 TCL
NA 78 TCL
Cat 8 Chan TcL Limit
12 dB Improved TcL Limit

1-5-1 Channel Configuration (cable B)



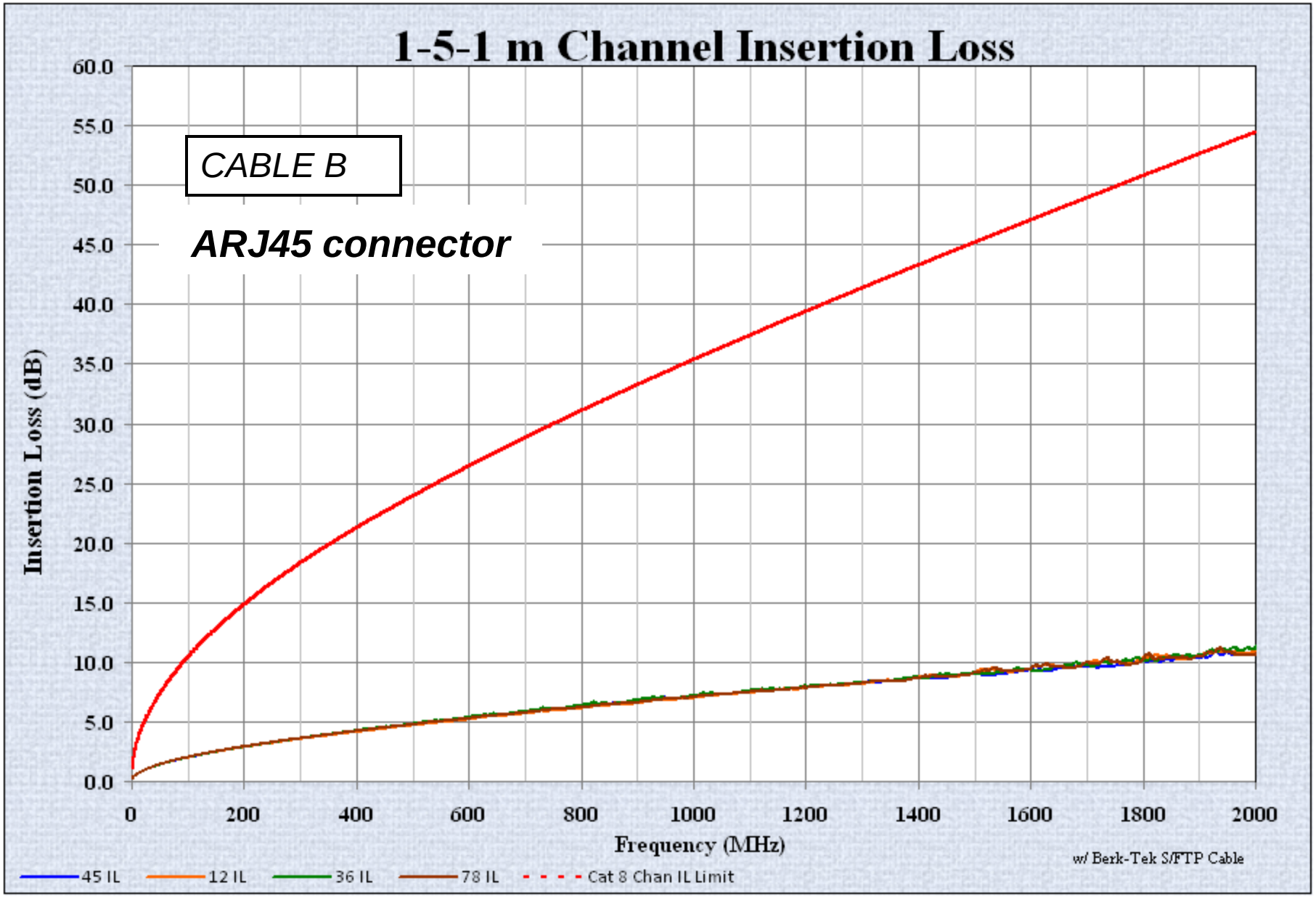
Channel Data Collected w/ **WireXpert** 2GHz Field Tester

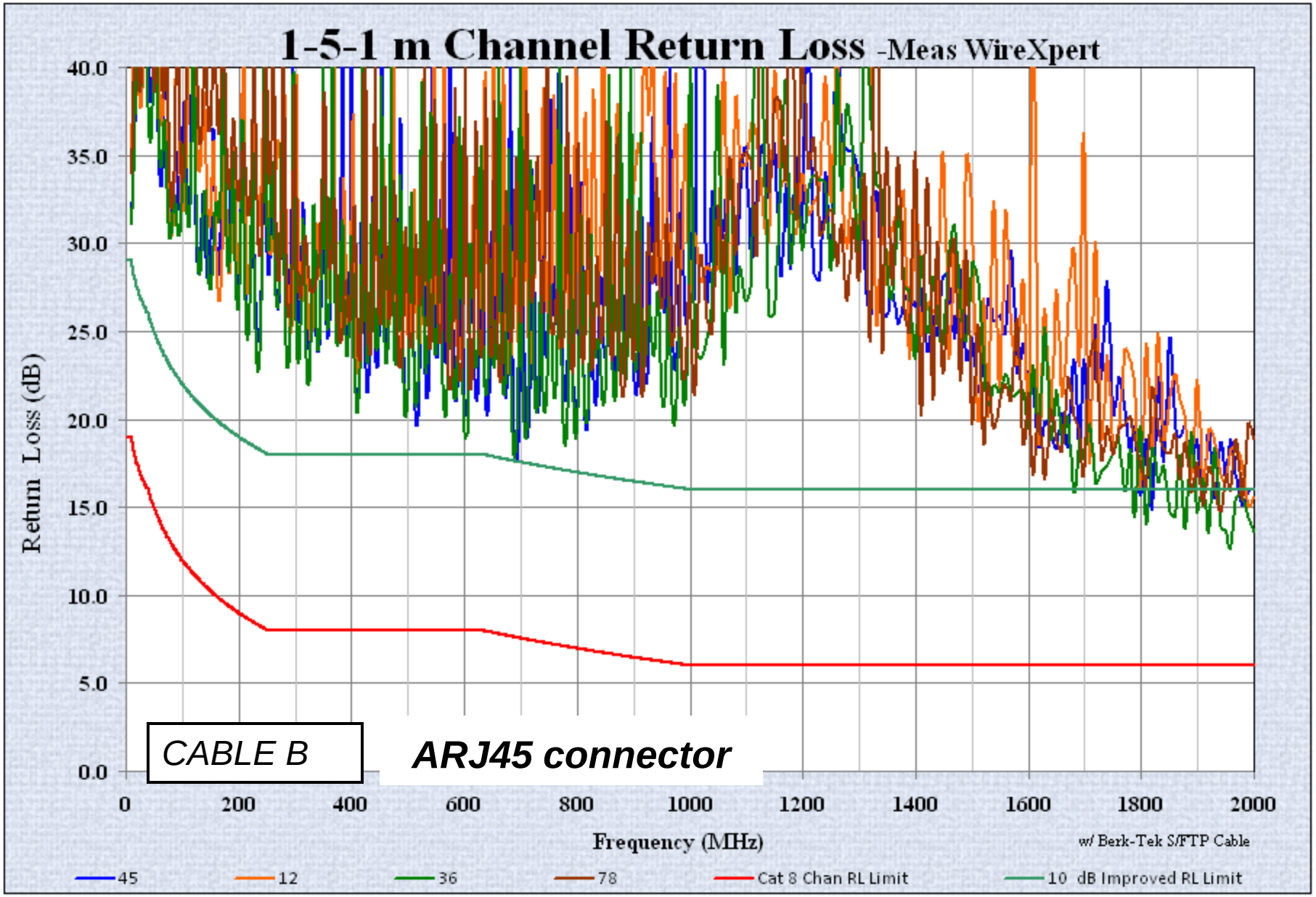
- ✓ (1) Insertion Loss
- ✓ (2) Return Loss
- ✓ (3) NEXT
- ✓ (4) ACRF

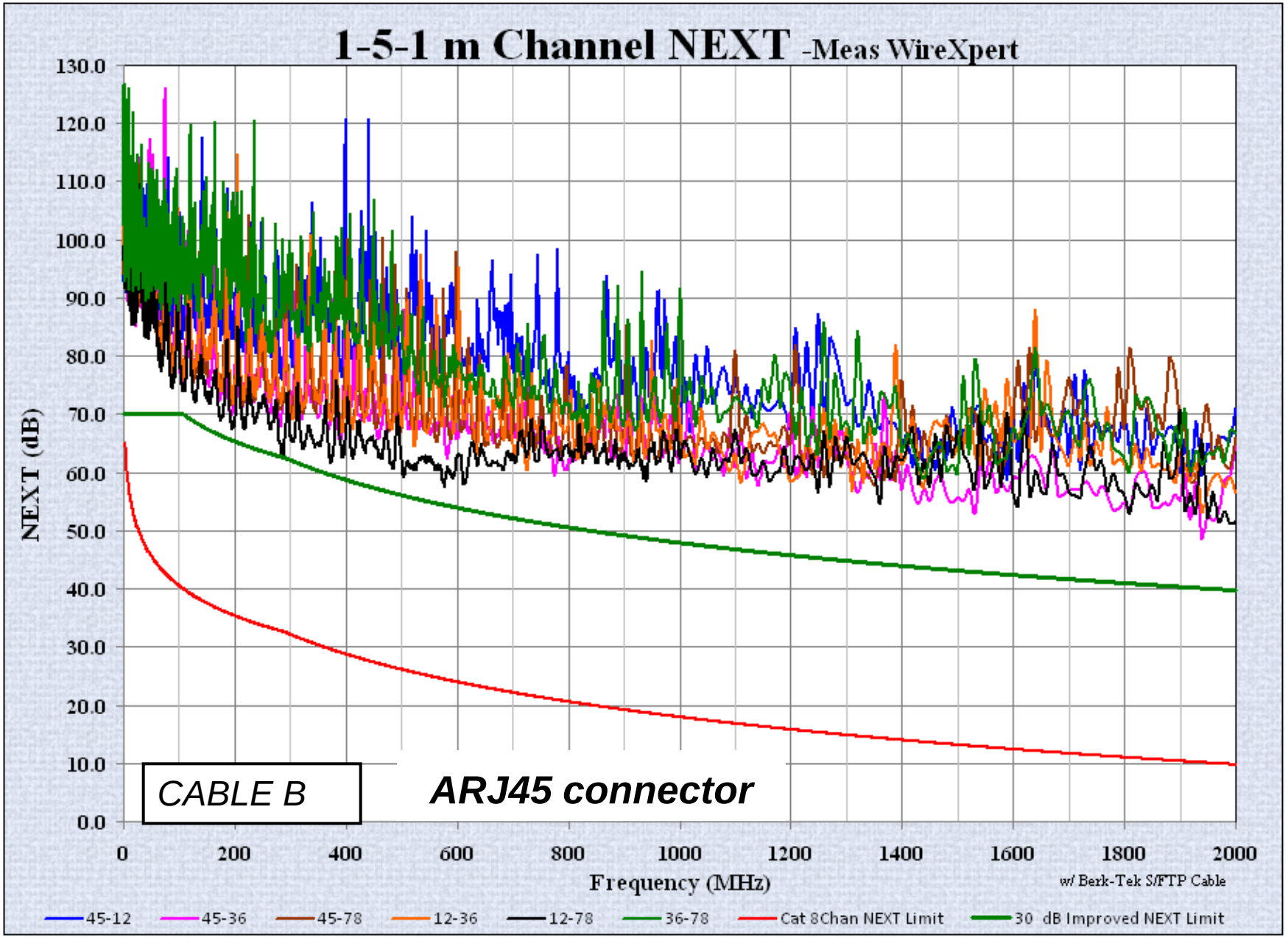
Cable B - construction: 4-pairs; individually shielded pairs with overall shield

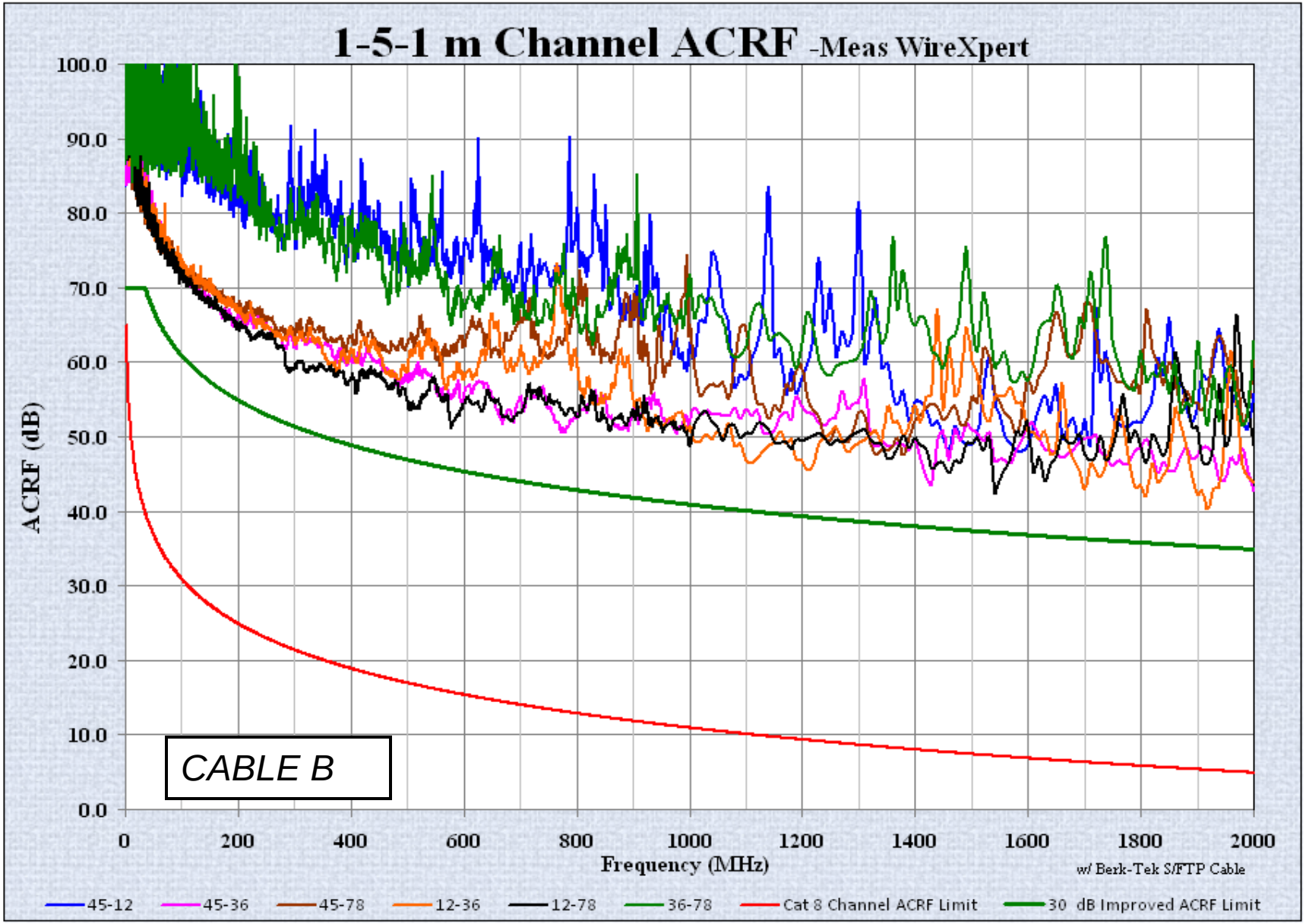
Channel Data Collected w/ **E5071C** Network Analyzer

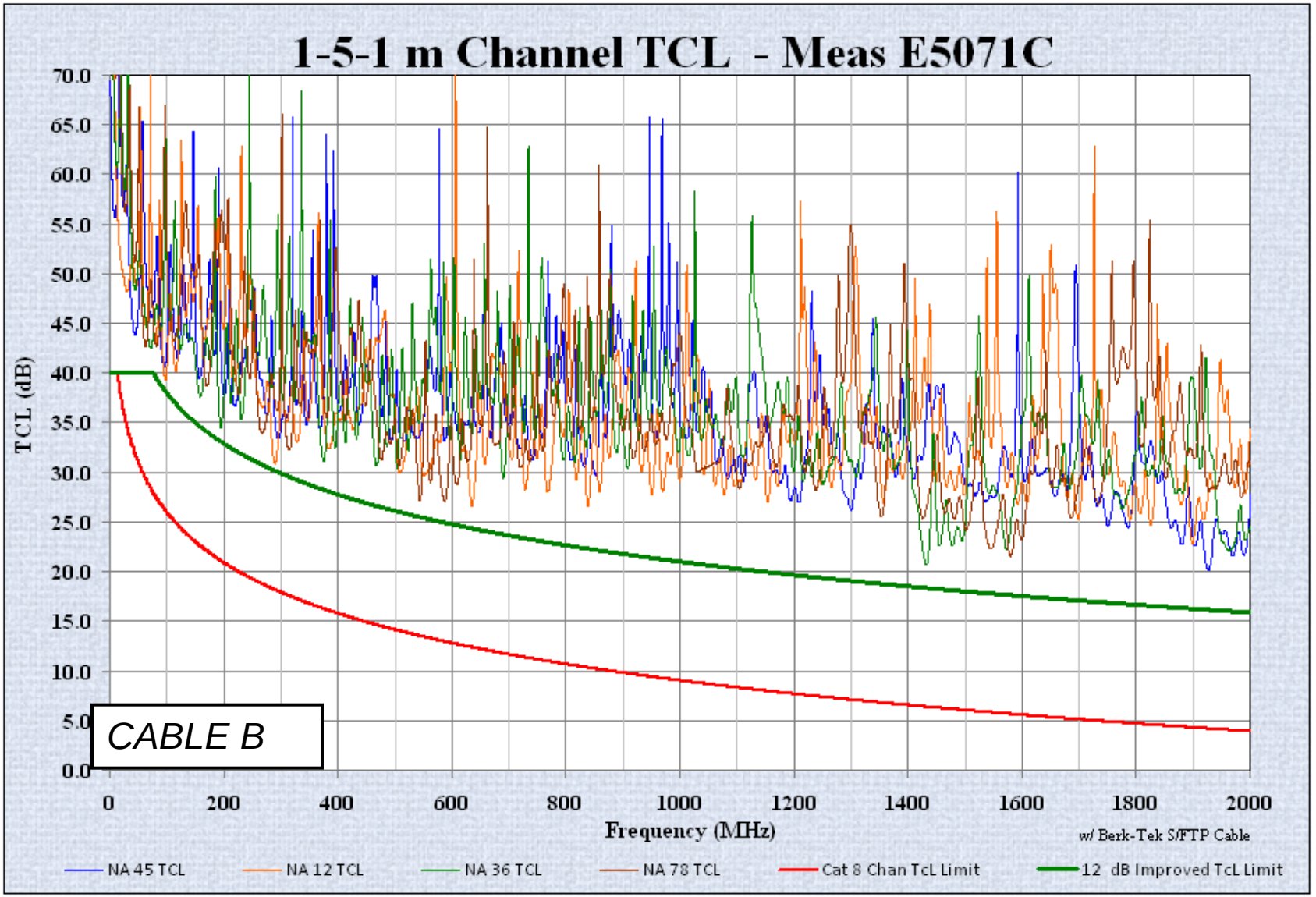
- ✓ (5) TcL


1-5-1 m Channel Insertion Loss
CABLE B
ARJ45 connector
Insertion Loss (dB)
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ Berk-Tek S/FTP Cable
45 IL
12 IL
36 IL
78 IL
Cat 8 Chan IL Limit


1-5-1 m Channel Return Loss -Meas WireXpert
Return Loss (dB)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ Berk-Tek S/FTP Cable
45
12
36
78
Cat 8 Chan RL Limit
10 dB Improved RL Limit
CABLE B
ARJ45 connector

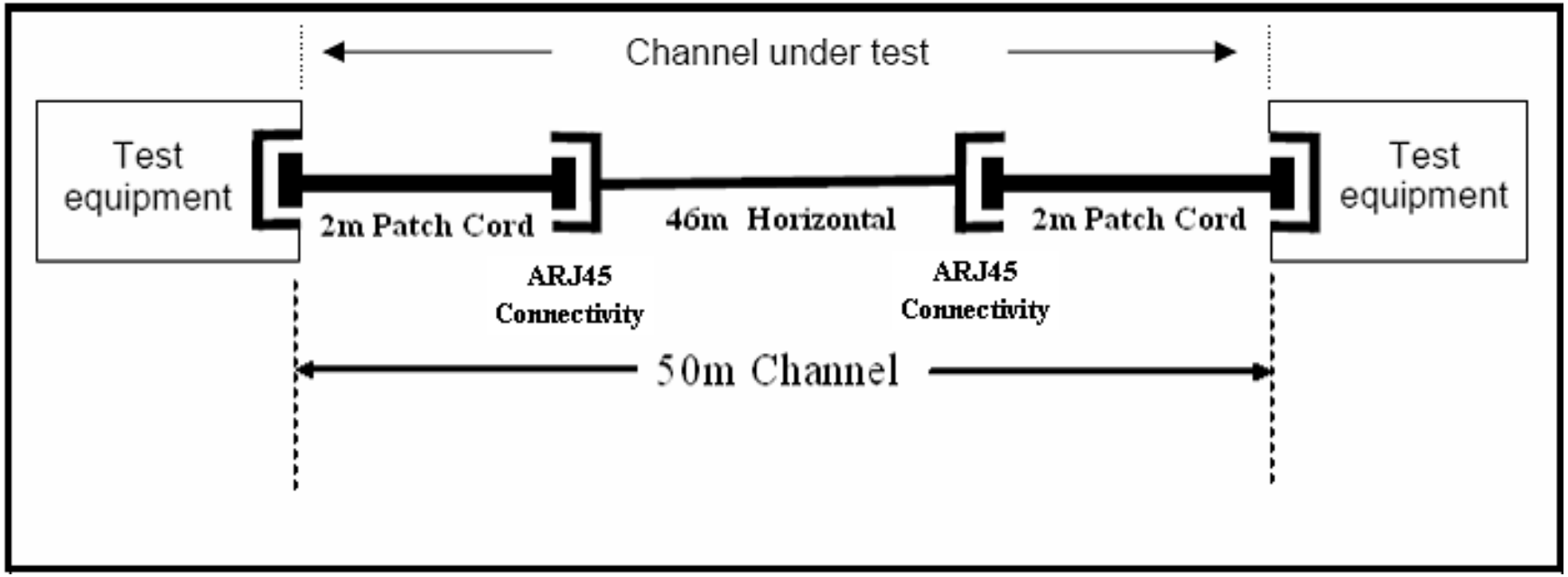

1-5-1 m Channel NEXT -Meas WireXpert
NEXT (dB)
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ Berk-Tek S/FTP Cable
CABLE B
ARJ45 connector
45-12
45-36
45-78
12-36
12-78
36-78
Cat 8Chan NEXT Limit
30 dB Improved NEXT Limit


1-5-1 m Channel ACRF -Meas WireXpert
ACRF (dB)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
w/ Berk-Tek S/FTP Cable
CABLE B
45-12
45-36
45-78
12-36
12-78
36-78
Cat 8 Channel ACRF Limit
30 dB Improved ACRF Limit

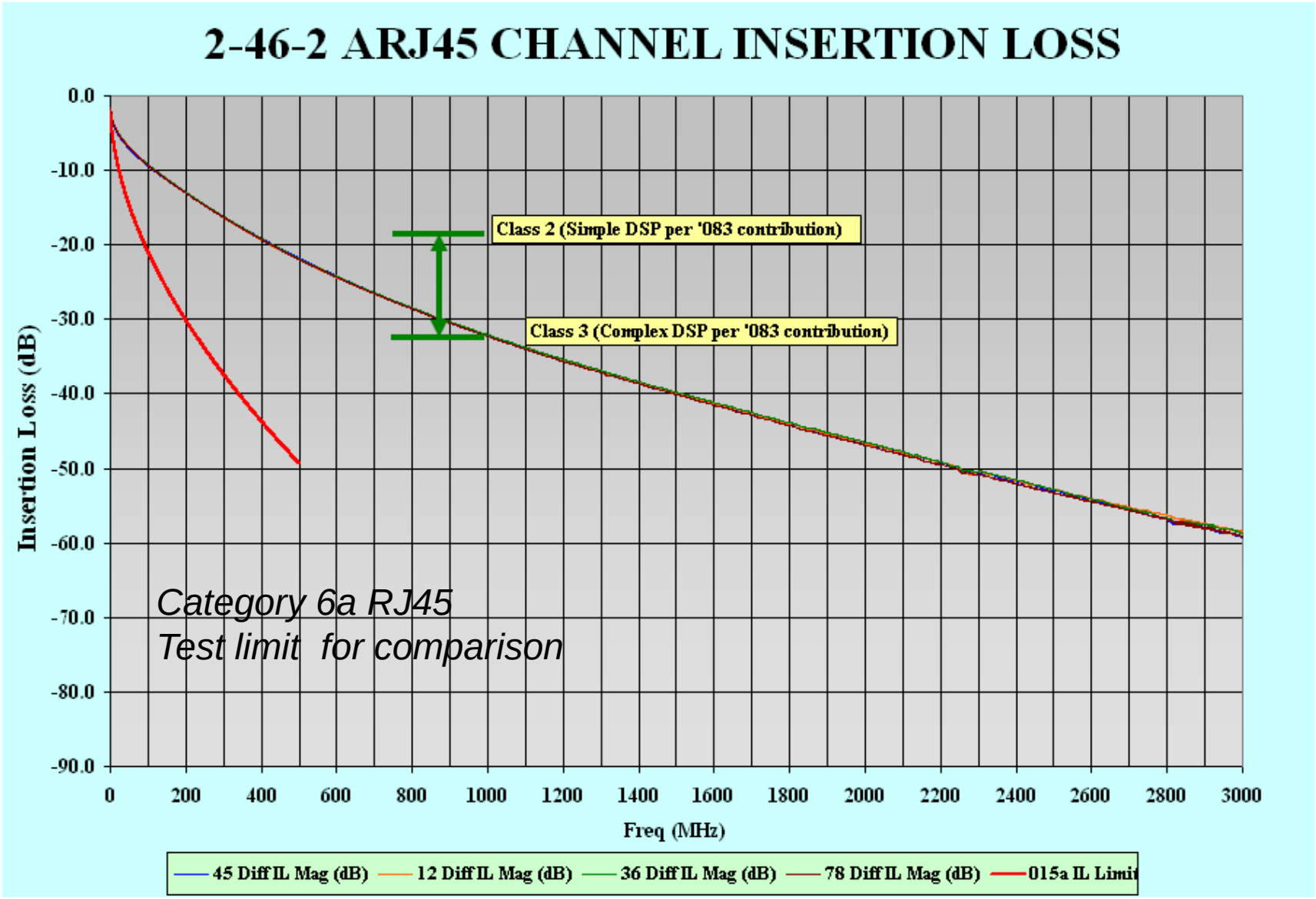

1-5-1 m Channel TCL - Meas E5071C
TCL (dB)
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Frequency (MHz)
CABLE B
w/ Berk-Tek S/FTP Cable
NA 45 TCL
NA 12 TCL
NA 36 TCL
NA 78 TCL
Cat 8 Chan TcL Limit
12 dB Improved TcL Limit

50 meter channel configuration
ARJ45 connectivity - 3GHz bandwidth

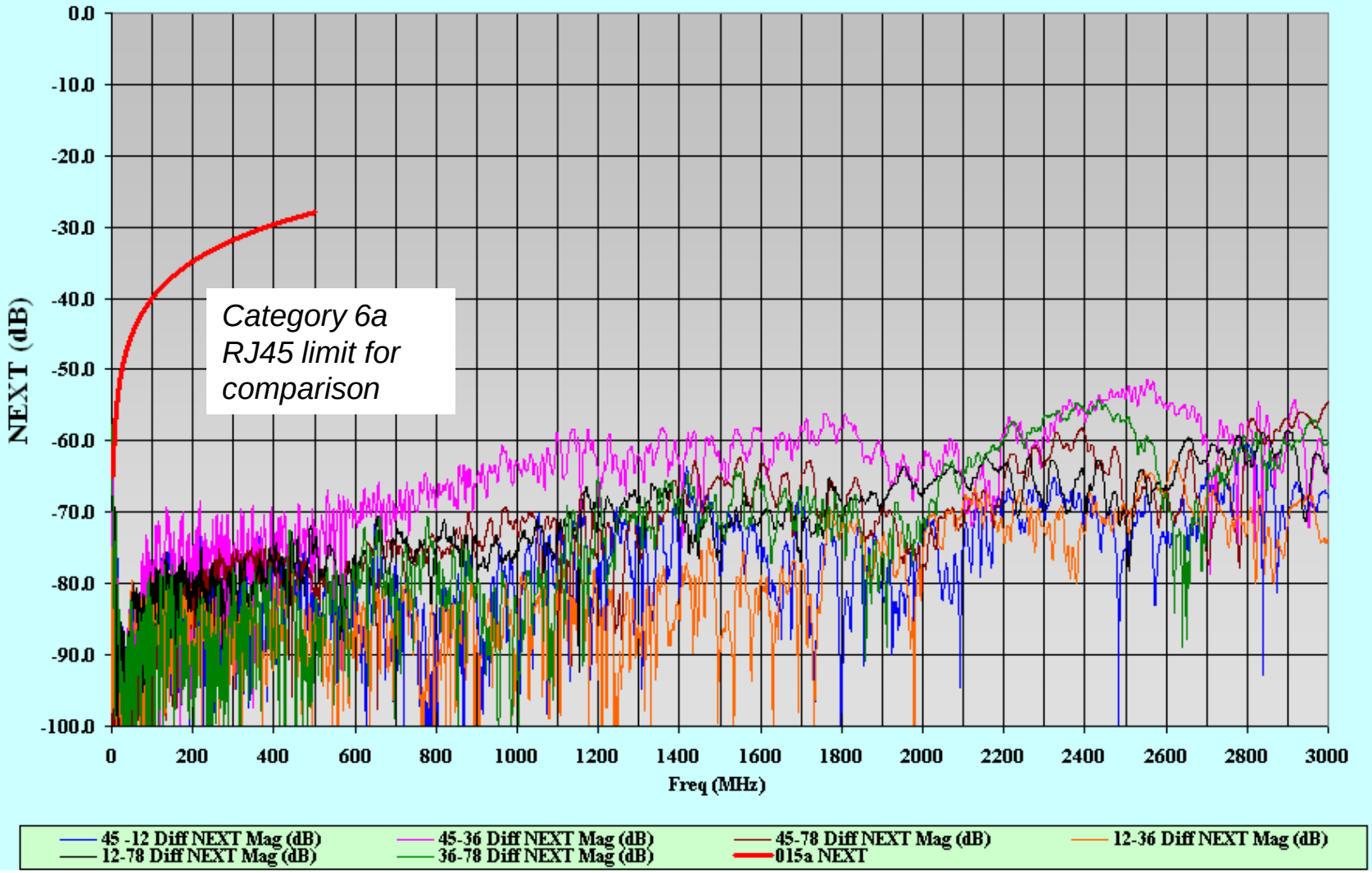
- Measurements Performed on 50 meter, 2-Connector Channel
- 2m Patch Cords, 46m Horizontal
- TIA 1183 Balun-Less Measurement Method w/Alternative Fixturing



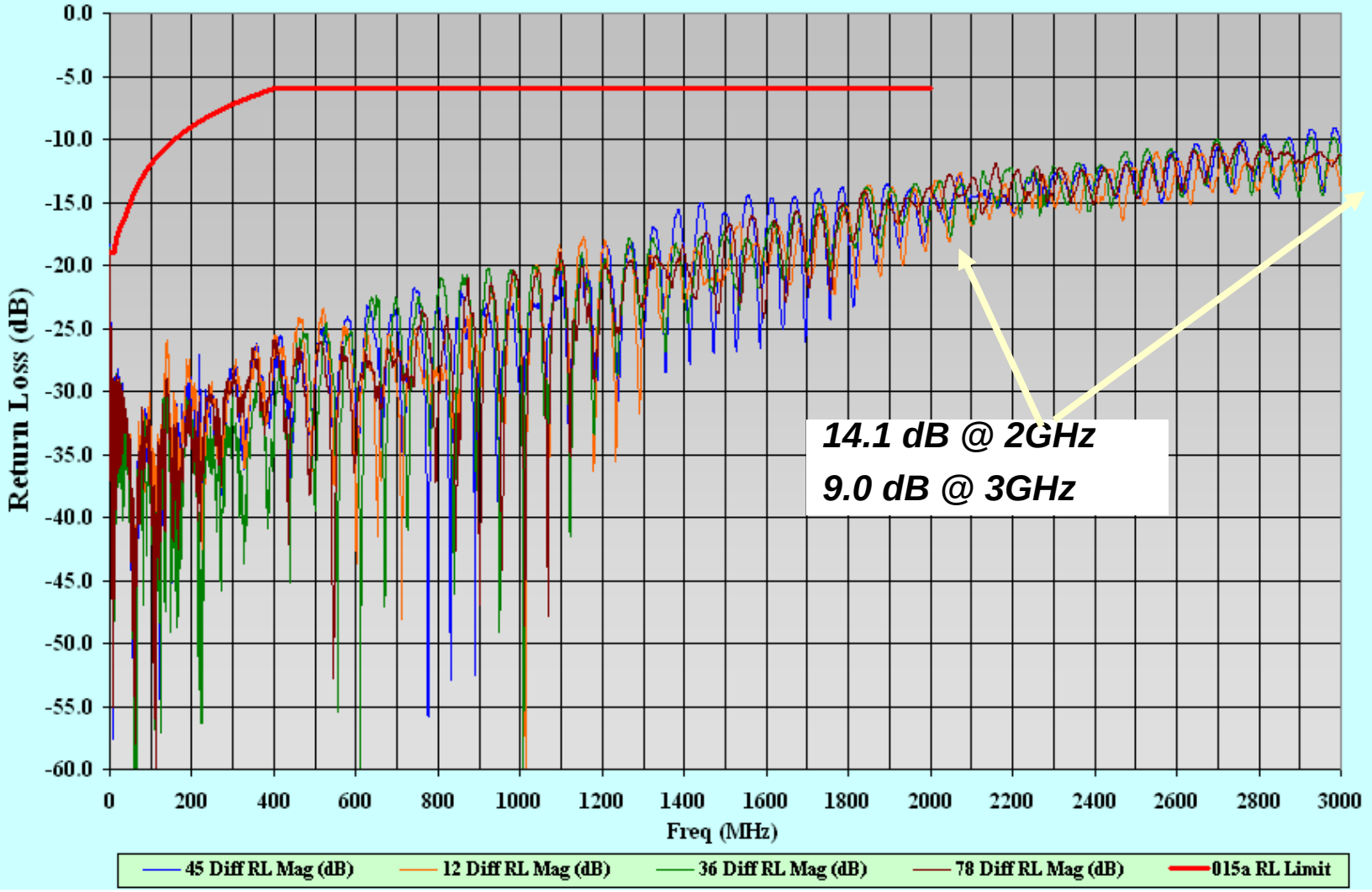
Note: available 50m channel was used to obtain the test data; no intent to propose a longer channel objective

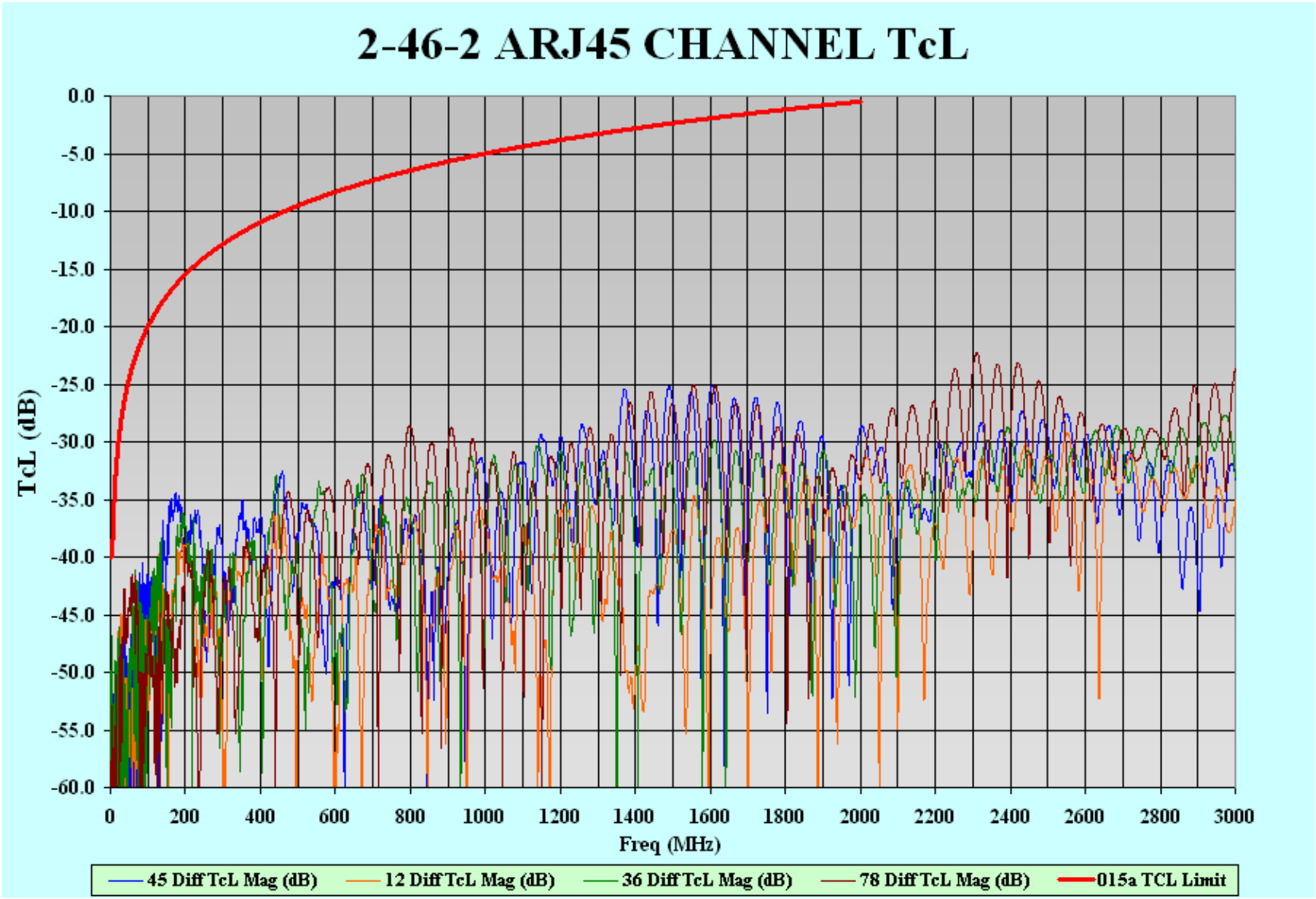

2-46-2 ARJ45 CHANNEL INSERTION LOSS
Insertion Loss (dB)
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Freq (MHz)
Class 2 (Simple DSP per '083 contribution)
Class 3 (Complex DSP per '083 contribution)
Category 6a RJ45
Test limit for comparison
45 Diff IL Mag (dB)
12 Diff IL Mag (dB)
36 Diff IL Mag (dB)
78 Diff IL Mag (dB)
015a IL Limit

2-46-2 ARJ45 CHANNEL NEXT

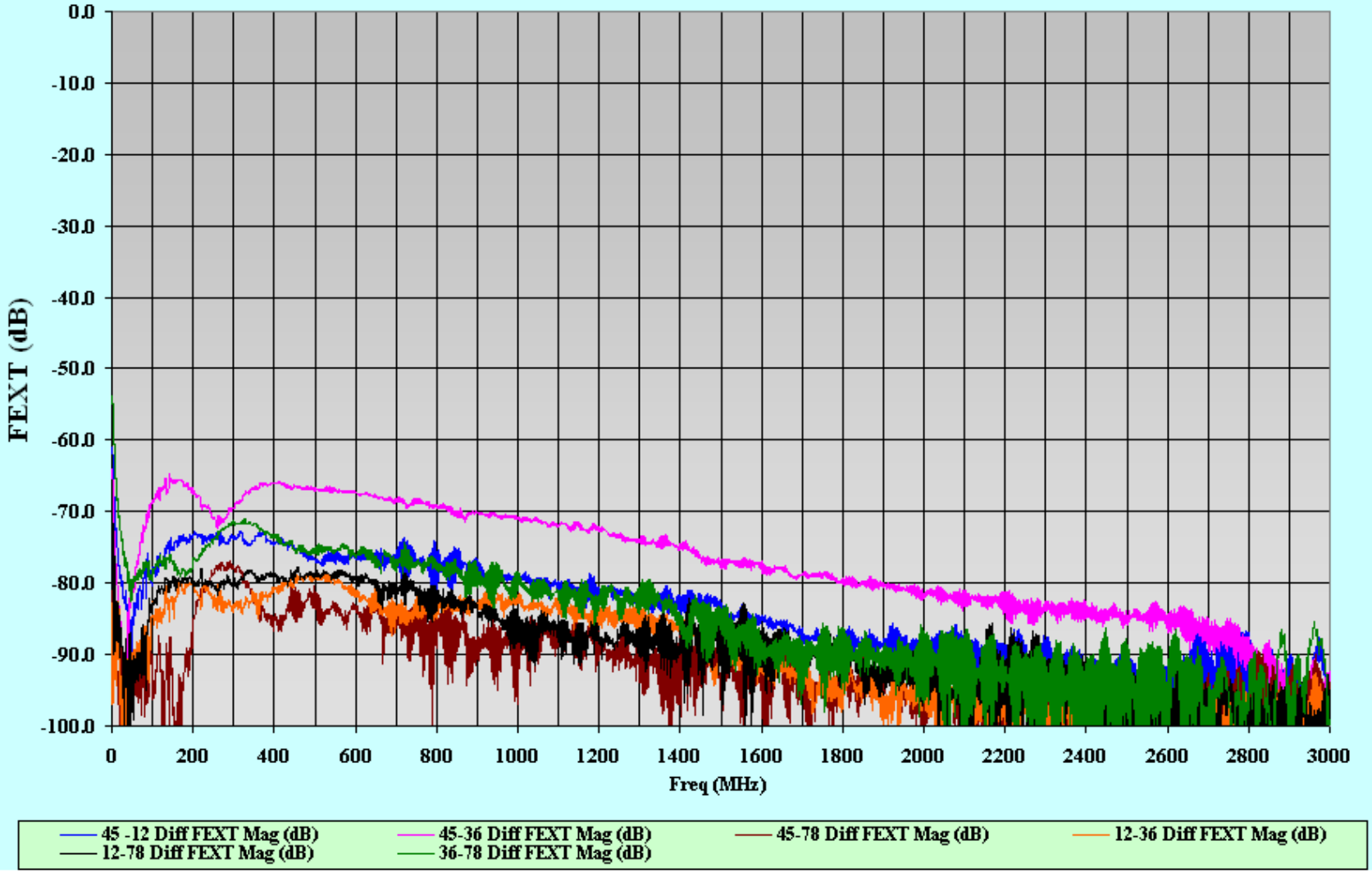


2-46-2 ARJ45 CHANNEL RETURN LOSS




2-46-2 ARJ45 CHANNEL TcL
TcL (dB)
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
-55.0
-60.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Freq (MHz)
45 Diff TcL Mag (dB)
12 Diff TcL Mag (dB)
36 Diff TcL Mag (dB)
78 Diff TcL Mag (dB)
015a TCL Limit

2-46-2 ARJ45 CHANNEL FEXT



Measurement Data Summary

I

SHORT CHANNEL (1-5-1)

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**

	Cable A	Cable B
Return loss	+12 dB	+ 9 dB
NEXT	+30 dB	+30 dB
ACRF	+32 dB	+32 dB
TCL	+12 dB	+12 dB

Measurement Data Summary

II

50 meter CHANNEL 0 to 3GHz bandwidth

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

ABSOLUTE VALUE , worst case

	0 to 500 MHz	*501 to 2000 MHz*	*2001 to 3000 MHz*
NEXT	**63 dB**	**57 db**	**52 db**
Return loss	**23 dB**	**14 dB**	**9 dB**
TCL	**33 dB**	**26 dB**	**23 dB**

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