

# **Channel, End to End & MPLS: Topologies, Testing Methods & Standards**

Presented by:

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Softing IT Networks



# Agenda

- About Softing
- Applications
  - Channel Test
  - MPTL
  - End to End (E2E)
- Wrap Up
- Questions



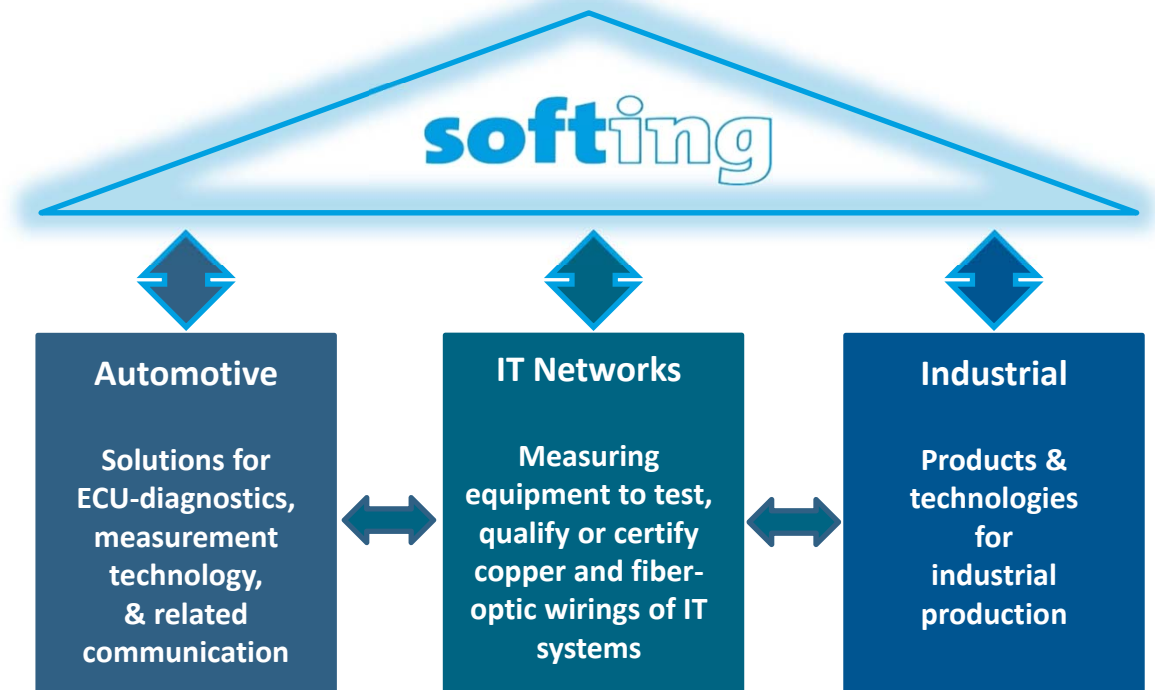
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# Who We Are

- Headquartered in Haar, Germany.
- Run in accordance with the principles and values of a German *medium-sized* enterprise.
- Founded in 1979.
- Publicly traded company on the German Stock exchange.
- ~400 employees (annual average).

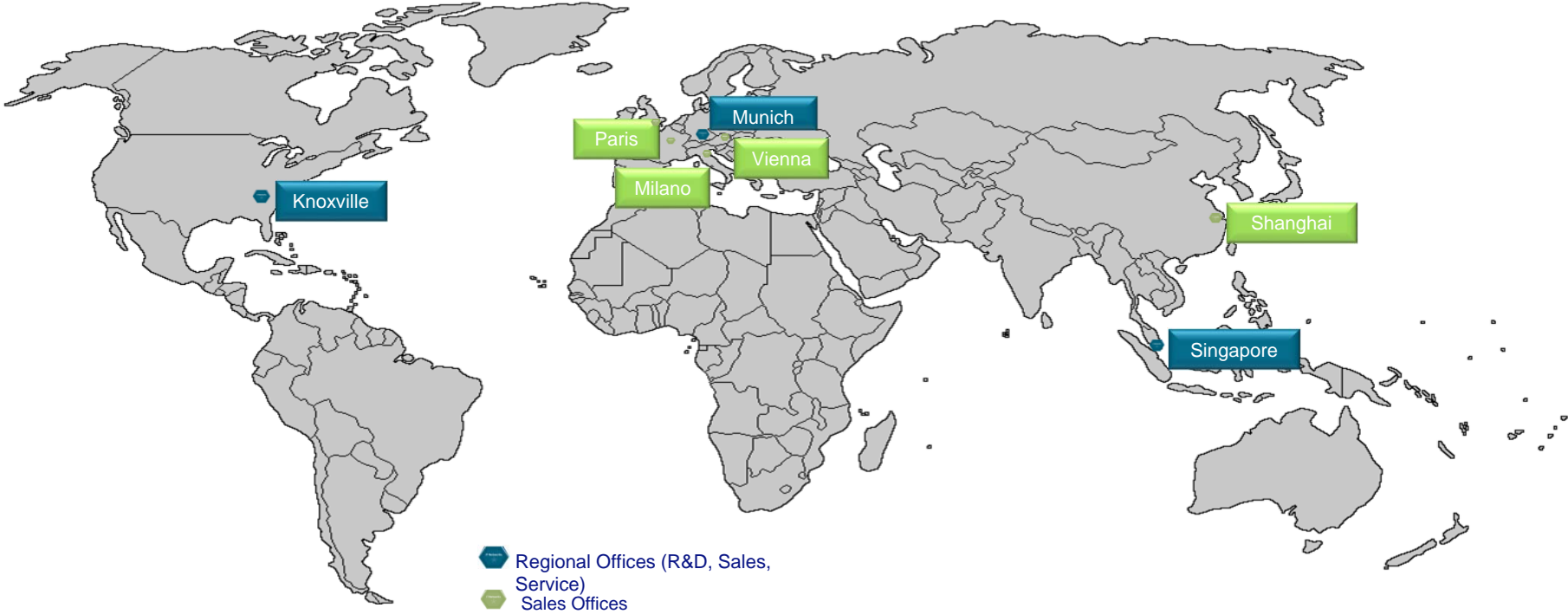


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# Where We Are



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# Disclaimer

- While the standards apply to all testers; adapters and test methods for todays presentation are specific to the Softing WX4500FA running firmware 7.4
- Check with your tester manufacturer for their proper test methods.
- A proper set reference is assumed before all testing.

# Disclaimer

- While the standards apply to all testers; adapters and test methods for today's presentation are specific to the Softing WX4500FA running firmware 7.4.
- Check with your tester manufacturer for their specific test methods.
- Ensure to set a proper reference before all testing.

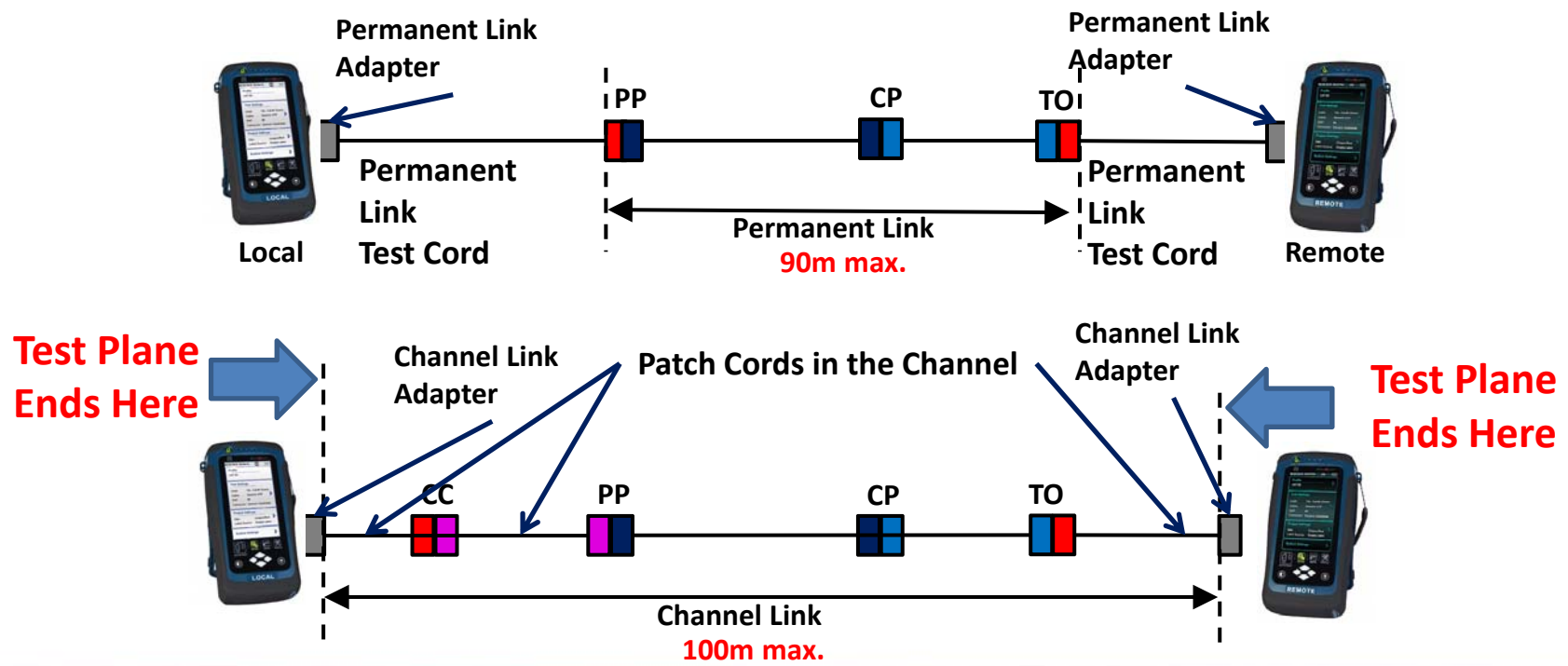


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# Permanent Link & Channel Link



# Topologies

- Permanent link and channel link have served us well.
- New topologies (MPTL) require higher bandwidth and field installable RJ45.
- E2E provides for multi-segment capability & flexibility.



# Higher Bandwidths

What's prompting the need for MPTL connectors?

- Design recommendation for WAP installations calls for two Cat 6A at each location.
- Additional IoT applications require the increased bandwidth provided by a Cat 6A link.
- Lower costs necessitate these bandwidths rather than traditional biscuit and patch cord.
- Difficulty in crimping a traditional RJ45 onto a Cat 6A cable.
- Component manufacturers have responded with a better mouse trap.



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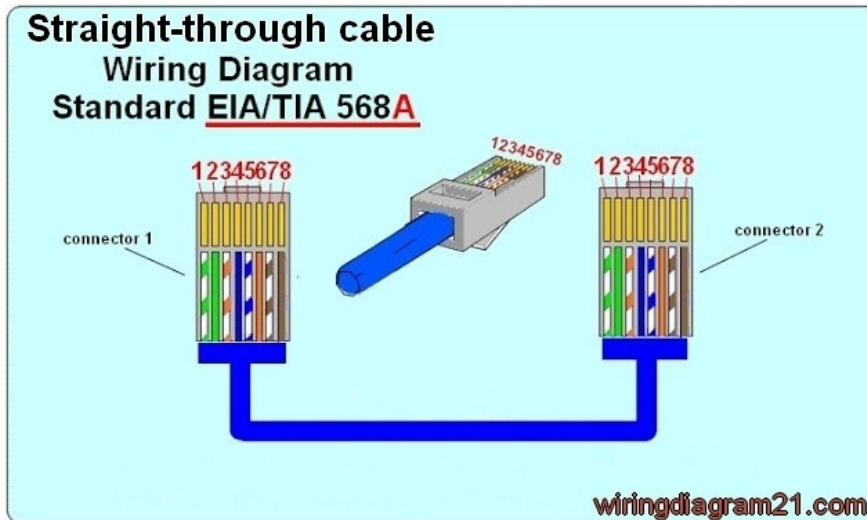
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Crimp on  
male RJ45



# Crimping History



- Cat 3: easiest, small O.D., few twists.
- Cat 5e: easier, smaller O.D., untwisting is still easy.
- Cat 6: harder, larger O.D, twist is tighter.
- Cat 6A: good luck.



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# The Better Mousetrap

The industry often innovates to meet a need in the marketplace.

## Sample MPTL Connectors



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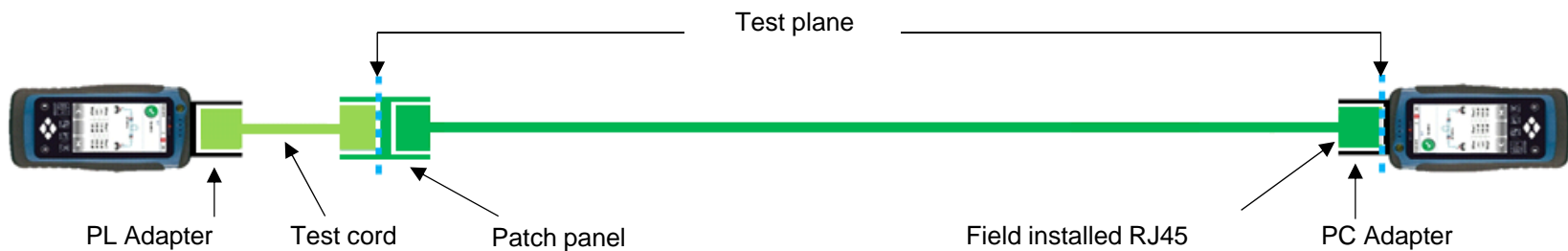
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# Testing Requirements - MPTL Assemblies

## Implications for field testers

- Classical channel test setup CANNOT be used.
- Channel tests do NOT include the first and last connector.




- **Failures** due to field termination (other than simple wiremap errors) may not be found using channel mode.

# Sample MPTL Report - Passing

Figure 1-A: WireXpert test on 45-foot Cat 6 assembly.

- One end connected to a patch panel.
- Remote end terminated with MPTL RJ-45 connector.
- MPTL test was performed.
- Cable link gets overall pass.

Cable Label: W CHANNEL				Overall Result:
Date & Time:	7/10/2018 1:21:53 PM	Building:	Unspecified-Building	
Limit Type:	TIA - Cat 6 MPTL	Floor:	Unspecified-Floor	
Cable Name:	CAT 6 UTP	Room:	Unspecified-Room	
Connector Name:	UTP Mod Jack 6	Rack:	Unspecified-Rack	
Site:	HOLE IN THE WALL TEST LAB	Panel:	Unspecified-Panel	
Operator Name:	BUTCH			
Local Ser. No.:	pw20300006	Remote Ser. No.:	sw20301164	
Local Adapter:	Cat 6A Channel	Remote Adapter:	Cat 6A Link	
Local Calibration Date:	Mar 1 2018	Remote Calibration Date:	Mar 1 2018	
Device Software:	7.4	Reporting Software:	Build_#972_7.4_2018-04-02_10-26-38	

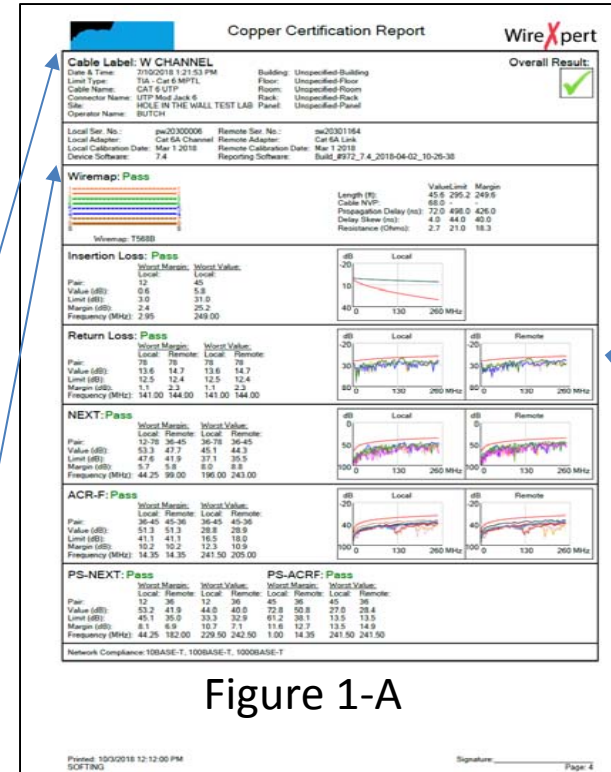



Figure 1-A

# Sample MPTL Report - Fail

Figure 1-B: Cable link immediately re-tested with Patch Cord Adapter & PL Adapter.

- Cable Fails Return Loss test.

Cable Label: W PC ADAP		Overall Result:	
Date & Time: 7/10/2018 1:23:50 PM	Building: Unspecified-Building		
Limit Type: TIA - Cat 6 MPTL	Floor: Unspecified-Floor		
Cable Name: CAT 6 UTP	Room: Unspecified-Room		
Connector Name: UTP Mod Jack 6	Rack: Unspecified-Rack		
Site: HOLE IN THE WALL TEST LAB	Panel: Unspecified-Panel		
Operator Name: BUTCH			
Local Ser. No.: pw20300006	Remote Ser. No.: sw20301164		
Local Adapter: Cat 6 Patch Cord	Remote Adapter: Cat 6A Link		
Local Calibration Date: Mar 1 2018	Remote Calibration Date: Mar 1 2018		
Device Software: 7.4	Reporting Software: Build_#972_7.4_2018-04-02_10-26-38		

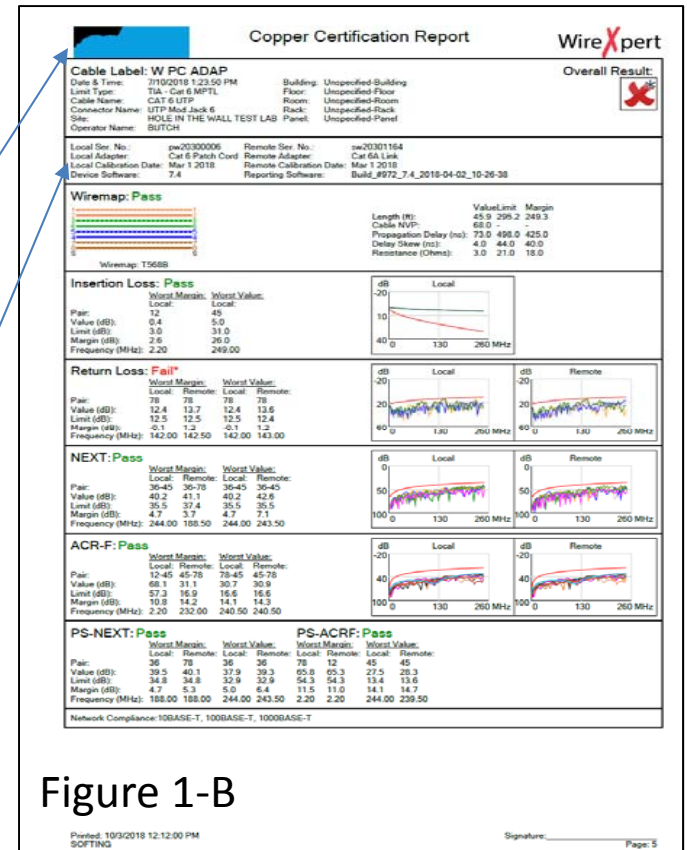


Figure 1-B

# How to Test MPTL

The TIA 568-2-D states:

- Tester shall use a PL (Permanent Link) adapter on the patch panel side.
- Tester shall use a patch cord adapter on the field RJ45 side.

Note: patch cord adapters are category specific, you will need to match the adapter to the type of assembly under test.



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# How to Set Up MPTL



- Permanent link adapter installed on the local side.
- Terra to RJ45 TRC (test reference cord) plugged into the patch panel.
- Proper category rated patch cord adapter installed on remote side.
- Field installed MPTL will plug directly into patch cord adapter.



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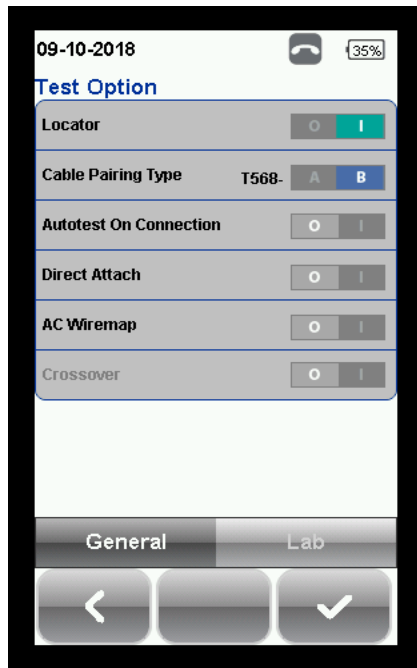
# WireXpert with MPTL Adapters



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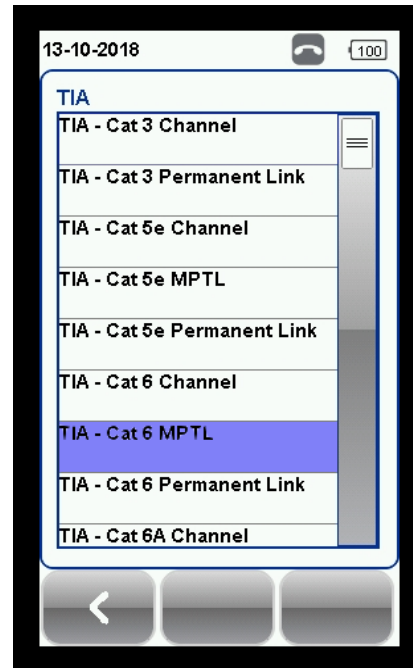
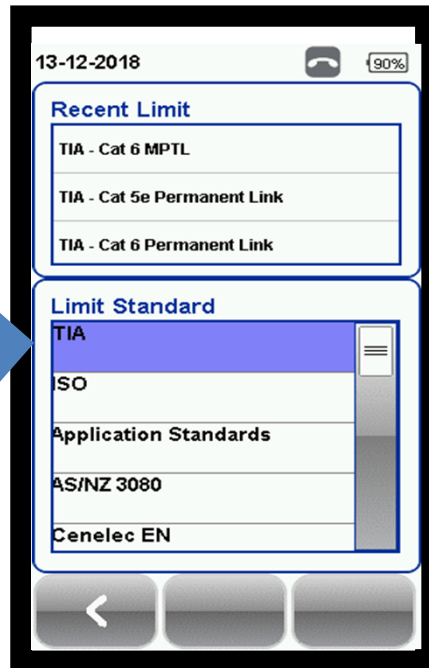
# Advanced Test Set Up



- Tester will give you an error message if you have dissimilar adapters installed.
- Process:  
Advanced Test Option Screen  
Direct Attach – turn on



# Select your Test Limits



(scroll down for Cat 6A MPTL)

- Patch cord adapters are category specific. Be sure to install proper adapter for assembly under test.
- Process:
  - Test limit drop down
  - TIA standards
  - Test limit for assembly testing
  - Autotest
  - Save the results
  - Send to Xport software
  - Produce certification reports



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# WireXpert MPTL Set Up



- Side plugs into the patch panel (simulated with green connector).
- Remote side male MPTL/RJ45 plugs directly into the female patch cord adapter.
- Process:  
Autotest



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# eXport Reporting Software

X eXport - New Project

File Import Export Settings Tools Help Languages

Cable Label

New Project

- GASTON
- TT
- SOFTING
- Rk
- CC
- Bldg 333
- TNC
- MASS ELEC TEST SITE
- MASS ELECCOPPER TESTS
- ARMORY
- TEST
- Netcom
- training
- Health Info Net
- HISCALL

	Test Type	Device Type	Cable Label	Overall Result	Limit Type	Overall Length (ft)	NEXT Margin (dB)	RL Margin (dB)	Time Stamp
1	Copper	WX4500	A-1	X	TIA - Cat 6 Permanent Link	26.2	0.00	0.00	26/09/2018 C
2	Copper	WX4500	BICSI-F1-ER01-R1-PP01-03	X	TIA - Cat 6 Permanent Link	26.2	0.00	0.00	26/09/2018 C
3	Copper	WX4500	BICSI-F1-ER01-R1-PP01-01	✓	TIA - Cat 6 Permanent Link	25.3	3.20	2.50	26/09/2018 C
4	Copper	WX4500	XYZ-F01-TR1-R01-PP1-01	✓	TIA - Cat 6 Permanent Link	24.9	5.00	1.80	27/09/2018 C
5	Copper	WX4500	BICSI-F1-ER01-R1-PP01-03	X	TIA - Cat 6 Permanent Link	26.2	0.00	0.00	15/10/2018 C
6	Copper	WX4500	BICSI-F1-ER01-R1-PP01-01	✓	TIA - Cat 6 Permanent Link	25.6	5.70	1.80	15/10/2018 C
7	Copper	WX4500	BICSI-F1-ER01-R1-PP01-02	✓	TIA - Cat 6 Permanent Link	25.3	3.20	2.50	26/09/2018 C
8	Copper	WX4500	BICSI-F1-ER01-R1-PP01-04	✓	TIA - Cat 6 Permanent Link	24.9	3.20	2.50	26/09/2018 C
9	Copper	WX4500	A-1	X	TIA - Cat 6 Permanent Link	32.8	0.00	0.00	27/09/2018 C
10	Copper	WX4500	XYZ-F01-TR1-R01-PP1-03	X	TIA - Cat 6 Permanent Link	25.9	0.00	0.00	27/09/2018 C

Summary

Local Ser. No. sw20301219

Remote Ser. No. sw20301220

Cable Manufacturer Generic UTP

Cable Name CAT 6 UTP

Cable Type Unshielded

Connector Manufacturer Generic Unshielded

Connector Name UTP Mod Jack 6

Connector Type Unshielded

Limit TIA - Cat 6 Permanent Link

A-1

Overall Result

Measurement	Value/Margin
Length (ft)	26.2
Delay (ns)	52.0
Cable NVP (%)	68.0
Resistance (Ohms)	0.0
Insertion Loss (dB)	-
Return Loss (dB)	-
NEXT (dB)	-
PS-NEXT (dB)	-
ACR-F (dB)	-
PS-ACR-F (dB)	-

Total Records: 309 Selected Record No.: 1

Type here to search

8:50 AM 12/21/2018

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# Sample MPTL Test Report

Limit Type is Cat 6A MPTL

Adapters are PL (Permeant Link) and Cat 6A Patch Cord

**Copper Certification Report** WireXpert

**Cable Label: W PATCH RED 6A** **Overall Result:**

Date & Time: 7/10/2018 1:50:07 PM	Building: Unspecified-Building
Limit Type: TIA - Cat 6A MPTL	Floor: Unspecified-Floor
Cable Name: CAT 6A UTP	Room: Unspecified-Room
Connector Name: UTP Mod Jack 6	Rack: Unspecified-Rack
Site: HOLE IN THE WALL TEST LAB	Panel: Unspecified-Panel
Operator Name: BUTCH	

Local Ser. No.: pw20300006	Remote Ser. No.: sw20301164
Local Adapter: Cat 6A Patch Cord	Remote Adapter: Cat 6A Link
Local Calibration Date: Mar 1 2018	Remote Calibration Date: Mar 1 2018
Device Software: 7.4	Reporting Software: Build_#972_7.4_2018-04-02_10-26-38

**Copper Certification Report** WireXpert

**Cable Label: W PATCH RED 6A** **Overall Result:**

Date & Time: 7/10/2018 1:50:07 PM

Building: Unspecified-Building  
Floor: Unspecified-Floor  
Room: Unspecified-Room  
Rack: Unspecified-Rack  
Panel: Unspecified-Panel

Operator Name: BUTCH

Local Ser. No.: pw20300006	Remote Ser. No.: sw20301164
Local Adapter: Cat 6A Patch Cord	Remote Adapter: Cat 6A Link
Local Calibration Date: Mar 1 2018	Remote Calibration Date: Mar 1 2018
Device Software: 7.4	Reporting Software: Build_#972_7.4_2018-04-02_10-26-38

**Wiremap: Pass**

Length (ft): 36.7 295.2 258.5	Value/Limit	Margin
Cable NVP: 68.0		
Propagation Delay (ns): 57.0 498.0 441.0		
Delay Skew (ns): 2.0 44.0 42.0		
Resistance (Ohms): 3.5 21.0 17.5		

Wiremap: T568B

**Insertion Loss: Pass**

Local: Local: Worst Margin: Worst Value:	
Pair: 12 36	
Value (dB): 0.3 5.8	
Limit (dB): 3.0 43.4	
Margin (dB): 2.7 37.6	
Frequency (MHz): 489.00 494.00	

**Return Loss: Pass**

Local: Remote: Local: Remote: Worst Margin: Worst Value:	
Pair: 12.8 25.4 12.8 15.9	
Value (dB): 8.0 19.2 8.0 8.0	
Limit (dB): 4.8 7.2 4.8 7.9	
Margin (dB): 489.00 23.20 489.00 489.00	

**NEXT: Pass**

Local: Remote: Local: Remote: Worst Margin: Worst Value:	
Pair: 36.78 36.78 35.45 35.45	
Value (dB): 61.0 54.7 37.3 37.1	
Limit (dB): 51.5 47.2 26.8 27.1	
Margin (dB): 9.5 7.5 10.5 10.0	
Frequency (MHz): 25.00 46.25 496.00 485.00	

**ACR-F: Pass**

Local: Remote: Local: Remote: Worst Margin: Worst Value:	
Pair: 45.78 45.78 78.45 45.78	
Value (dB): 69.0 63.9 26.4 26.4	
Limit (dB): 57.3 49.9 10.3 10.3	
Margin (dB): 11.7 14.0 16.1 16.1	
Frequency (MHz): 2.20 5.20 494.00 494.00	

**PS-NEXT: Pass**      **PS-ACRF: Pass**

Local: Remote: Local: Remote: Local: Remote: Local: Remote: Worst Margin: Worst Value:	
Pair: 36 36 36 36 78 45 45 45	
Value (dB): 59.5 39.5 34.5 33.8 65.5 66.3 25.0 25.3	
Limit (dB): 49.1 32.2 23.9 24.8 54.3 54.3 7.2 7.9	
Margin (dB): 10.4 7.3 10.6 9.0 11.2 12.0 17.8 17.4	
Frequency (MHz): 25.00 269.00 496.00 467.00 2.20 2.20 496.00 461.00	

Network Compliance: 10BASE-T, 100BASE-T, 1000BASE-T, 10GBASE-T, manufacturer should state AXT compliance

# End to End

- End-2-End (E2E) is well-known in industrial settings, particularly in Europe.
- US growth as industrial ethernet replaces proprietary networks.
- Industrial ethernet takes advantage of the reliability and efficiency of an End-to-End network topology, a number of point-to-point segments in a series.
- This topology is becoming more common in enterprise networks with Power over Ethernet devices as information points with unique IP addresses.
- End-to-End allows these additional points to be linked serially for signal efficiency and with patch cord (segments) for ease of installation.
- The segments can be linked by adapters, hubs, switches, and gateways. Increasingly, E2E links support widely varying requirements in bandwidth, PoE and reliability.



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# End to End Applications

- **LED Lighting:** Many new systems run on PoE and are segment-based topologies.
- **Healthcare:** Many nurse call and patient room applications are segment-based.
- **Data Center**
  - Direct connection between devices, i.e. servers in the same row.  
(Note: E2E not yet standardized for CAT6A / Class E<sub>A</sub>)
- **Professional Entertainment:** Cabling “on the fly” for stage equipment



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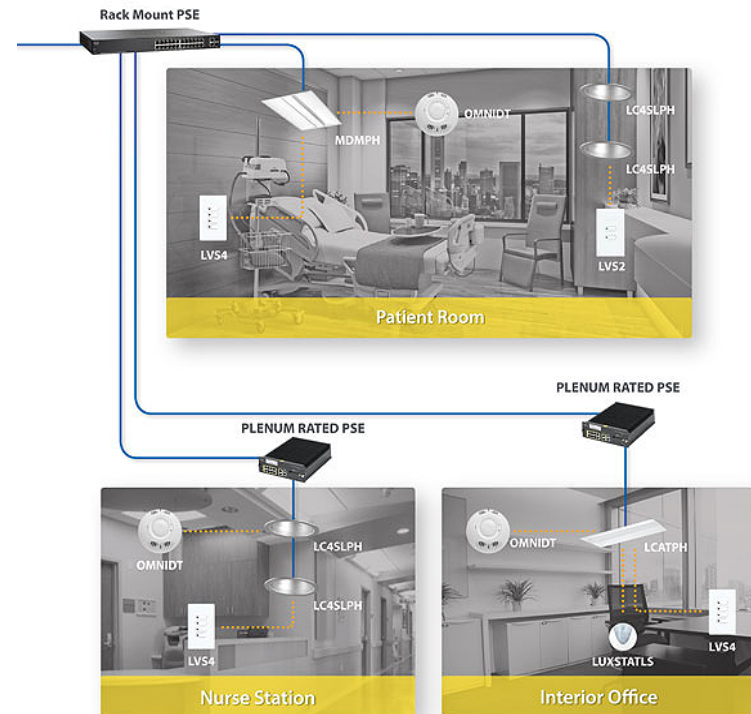




# End to End Installation

A Power over Ethernet installation reduces material and labor cost by using a single Cat5e/6 connection for power and communication. This plug-and-play, low-voltage cabling approach greatly simplifies the installation process, saving time, minimizing safety risk and helps to alleviate resourcing constraints for skilled labor.

From Hubbel's website



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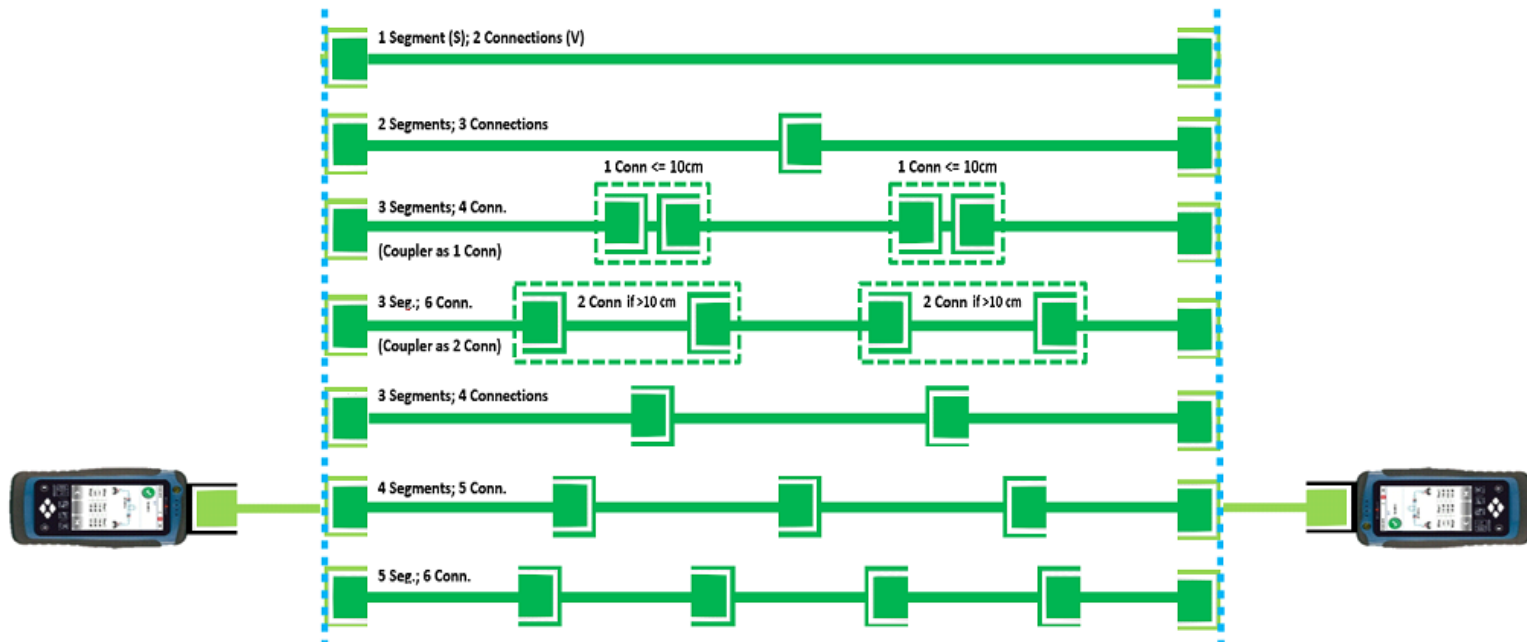
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# What's Different About End to End

- E2E is a segment-based topology.
- You can have multiple segments between the end point connecting devices.
- Quantity of RJ45 connectors will vary.
- Number of segments & connectors will determine the loss limit.
- WireXpert is already programmed with these loss limits.

# Segments



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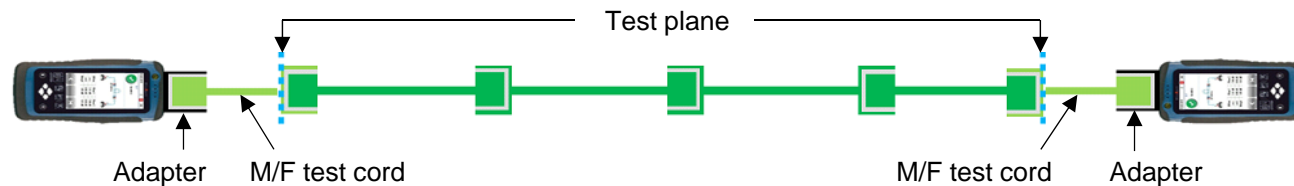
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# Testing Requirements – End to End Assemblies

## Implications for field testers

- Classical channel test setup CANNOT be used
- Channel tests does NOT include the first and last connector



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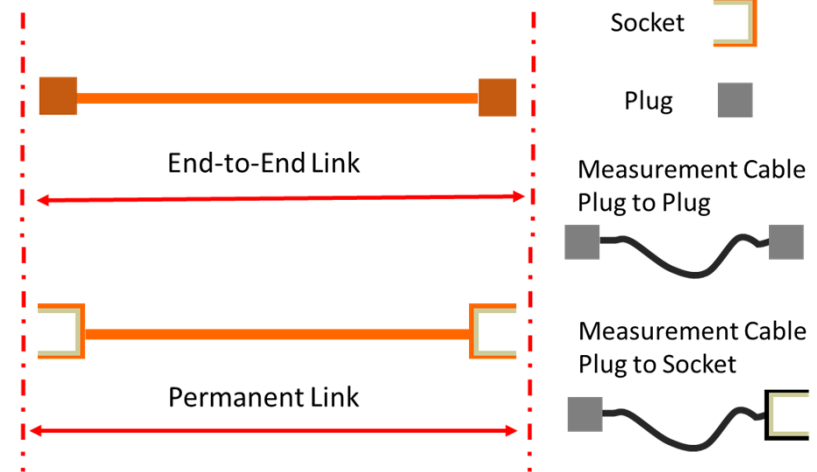
# End to End Practical Guidelines

- Make sure your tester supports E2E links.
- WireXpert software 7.3 or higher supports E2E link testing.
- Standards only define measurement up to CAT6 / Class E<sub>A</sub>.
- Max Ethernet supported speed is 1000MBit/s.
  - If 10GBit/s performance is required, Softing recommends using hybrid cables and CAT6A / Class E<sub>A</sub> permanent link limits.
- Hybrid cords can help to access tight or exposed locations.
  - Make sure the device can handle measurement using hybrid cords.

# Cabling Requirements for IoT

## E2E link configuration

- Up to 100m on solid wires, ~80m on stranded (depends on brand).
- Permanent link – E2E has plugs at the end.
- Direct connect equipment plugs into patch cables.
- Field installed plugs need to be included in test because they have been terminated.



# Testing End to End

Currently E2E is governed by the ISO 11801

- WireXpert should be fitted with M12 (Industrial Ethernet) or End to End adapters.
- When testing RJ45's on both ends, terra to female RJ45 TRC's (test reference cords) will be used.



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# Category vs. Class D & E

- Class A: link/channel up to 100 kHz using [Category 1](#) cable/connectors
  - Class B: link/channel up to 1 MHz using [Category 2](#) cable/connectors
  - Class C: link/channel up to 16 MHz using [Category 3](#) cable/connectors
  - Class D: link/channel up to 100 MHz using [Category 5e](#) cable/connectors
  - Class E: link/channel up to 250 MHz using [Category 6](#) cable/connectors
  - Class E<sub>A</sub>: link/channel up to 500 MHz using [Category 6<sub>A</sub>](#) cable/connectors
- (Amendment 1 and 2 to ISO/IEC 11801, 2nd Ed.)





# How to Set Up End to End



- Adapters are hot-swappable and interchangeable.
- With Terra connectors, the TRC (test reference cords) will be a Terra to female RJ45.
- Process:
  - Install M12 (Industrial Ethernet) adapters on local and remote units.

# WireXpert with End to End Adapters

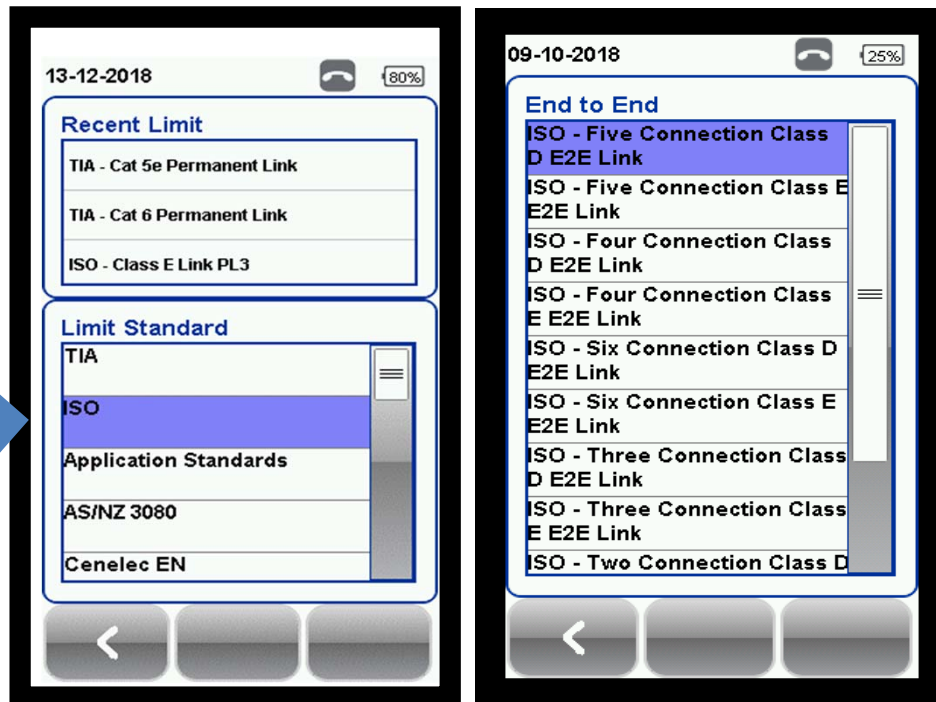


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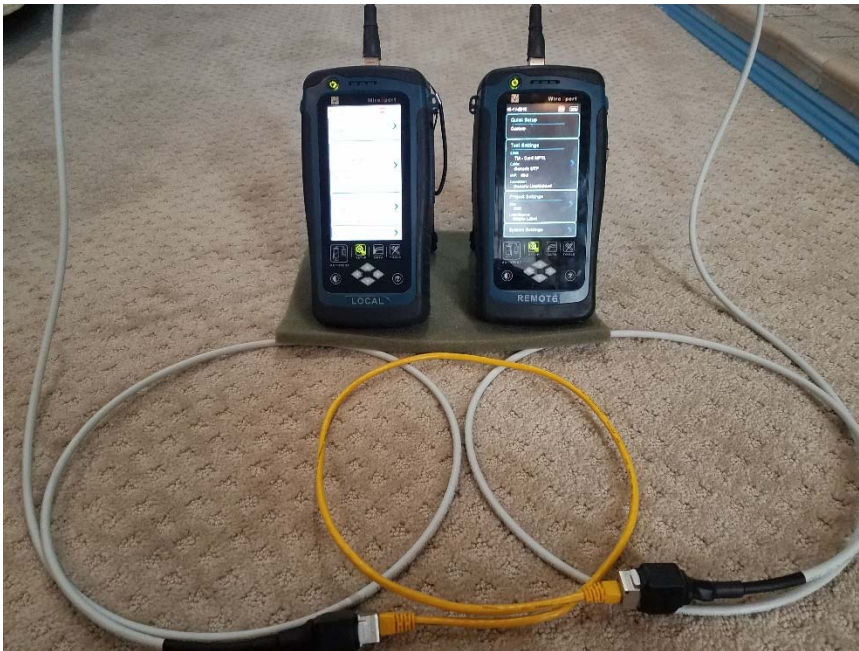
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# Select your Test Limits



- Process:
  - ISO standards from test limit.
  - Select test limit for number of segments and connectors.
  - Autotest
  - Save the result
  - Send to Xport software
  - Produce certification reports

# WireXpert End to End Set Up



- Process:
  - Terra to Female RJ45's on Local & Remote
  - Yellow Cable simulating a 2 connector,  
1 segment E2E link
  - Save the result
  - Send to Xport software



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# End to End Test Results

<b>Cable Label: E TO E 3 CON W/M12 CAT 6A</b>			<b>Overall Result:</b>
Date & Time:	7/11/2018 10:33:08 AM	Building:	Unspecified-Building
Limit Type:	ISO - Three Connection Class D E2E Link	Floor:	Unspecified-Floor
Cable Name:	CAT 6A UTP	Room:	Unspecified-Room
Connector Name:	UTP Mod Jack 6A	Rack:	Unspecified-Rack
Site:	HOLE IN THE WALL TEST LAB	Panel:	Unspecified-Panel
Operator Name:	BUTCH		
Local Ser. No.:	pw20300006	Remote Ser. No.:	sw20301164
Local Adapter:	M12	Remote Adapter:	M12
Local Calibration Date:	Mar 1 2018	Remote Calibration Date:	Mar 1 2018
Device Software:	7.4	Reporting Software:	Build_#972_7.4_2018-04-02_10-26-38

Copper Certification Report		WireXpert
<b>Cable Label: E TO E 3 CON W/M12 CAT 6A</b>		<b>Overall Result:</b>
Date & Time:	7/11/2018 10:33:08 AM	Building:
Limit Type:	ISO - Three Connection Class D E2E Link	Floor:
Cable Name:	CAT 6A UTP	Room:
Connector Name:	UTP Mod Jack 6A	Rack:
Site:	HOLE IN THE WALL TEST LAB	Panel:
Operator Name:	BUTCH	
Local Ser. No.:	pw20300006	Remote Ser. No.:
Local Adapter:	M12	Remote Adapter:
Local Calibration Date:	Mar 1 2018	Remote Calibration Date:
Device Software:	7.4	Reporting Software:
<b>Wiremap: Pass</b>		
Length (ft):	102.3	Value Limit
Cable NVP:	69.0	Margin
Propagation Delay (ns):	160.0553.0	393.0
Delay Skew (ns):	7.0	49.0
Resistance (Ohms):	5.0	23.0
Resistance (Ohms):		18.0
Wiremap: T568B		
<b>Insertion Loss: Pass</b>		
Pair:	Local: Remote: Worst Margin: Worst Value:	dB
Value (dB):	12 36	Local
Limit (dB):	0.9 6.5	Remote
Margin (dB):	4.0 20.4	
Frequency (MHz):	2.95 100.00	
<b>Return Loss: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	45 12 42 45	Local
Limit (dB):	29.0 22.7 25.1 22.2	Remote
Margin (dB):	17.4 13.0 19.0 12.4	
Frequency (MHz):	11.6 9.7 6.1 9.8	
Frequency (MHz):	28.50 60.25 1.00 91.75	
<b>NEXT: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	36-45 36-45 36-45 36-45	Local
Limit (dB):	43.4 45.1 38.8 42.7	Remote
Margin (dB):	37.7 36.3 32.8 32.8	
Frequency (MHz):	5.7 5.9 6.0 9.9	
Frequency (MHz):	46.75 57.00 93.25 93.50	
<b>ACR-F: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	12-36 36-12 36-45 45-36	Local
Limit (dB):	62.2 62.2 41.2 41.0	Remote
Margin (dB):	44.5 44.5 18.7 18.6	
Frequency (MHz):	17.7 17.7 22.5 22.4	
Frequency (MHz):	5.05 5.05 99.50 100.00	
<b>ACR-N: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	36-45 36-45 36-45 36-45	Local
Limit (dB):	39.4 42.7 32.5 36.6	Remote
Margin (dB):	24.2 24.1 12.2 13.1	
Frequency (MHz):	15.2 18.6 20.3 23.5	
Frequency (MHz):	46.75 47.00 98.25 93.50	
<b>PS-NEXT: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	36 36 36 36	Local
Limit (dB):	42.1 45.1 37.4 42.5	Remote
Margin (dB):	34.7 34.1 29.4 29.8	
Frequency (MHz):	46.75 51.00 98.00 93.50	
<b>PS-ACRF: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	36 36 36 36	Local
Limit (dB):	42.1 45.1 37.4 42.5	Remote
Margin (dB):	34.7 34.1 29.4 29.8	
Frequency (MHz):	46.75 51.00 98.00 93.50	
<b>PS-ACRN: Pass</b>		
Pair:	Local: Remote: Local: Remote:	dB
Value (dB):	36 36 36 36	Local
Limit (dB):	42.1 45.1 37.4 42.5	Remote
Margin (dB):	34.7 34.1 29.4 29.8	
Frequency (MHz):	46.75 51.00 98.00 93.50	
Network Compliance: 10BASE-T, 100BASE-T, 1000BASE-T		
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## Wrap Up

- Channel adapters as a one size fits all solution is not recommended.
- TIA 568-2-D allows you to certify MPTL assemblies with the proper WireXpert adapters and test reference cords.
- ISO 11801 allows you to certify E2E assemblies with the WireXpert M12 adapters and Terra to female RJ45 test reference cords.

# Questions?



# Thank You

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