Cat.8 Field Testing

"The certification of new Cat.8 installations in the field is a reality"

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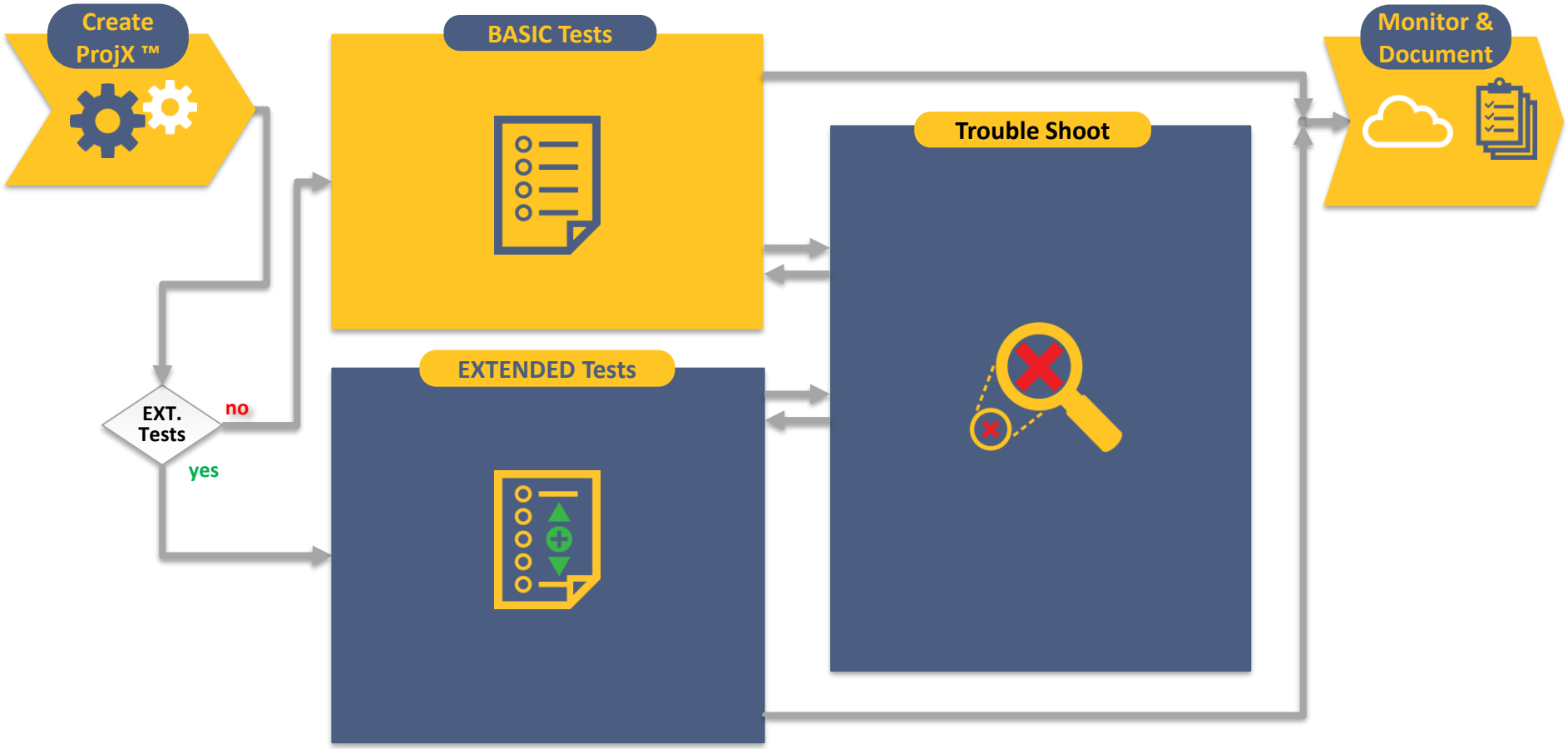
Agenda

- Cat.8 / Class I and II overview
- *Basic* Test Regime & Test Interfaces
- What makes RJ work at high frequencies
- Component testing in the lab
- Field Testing Requirements
- *Extended* Test Regimes
- Performance of Cat.8 samples

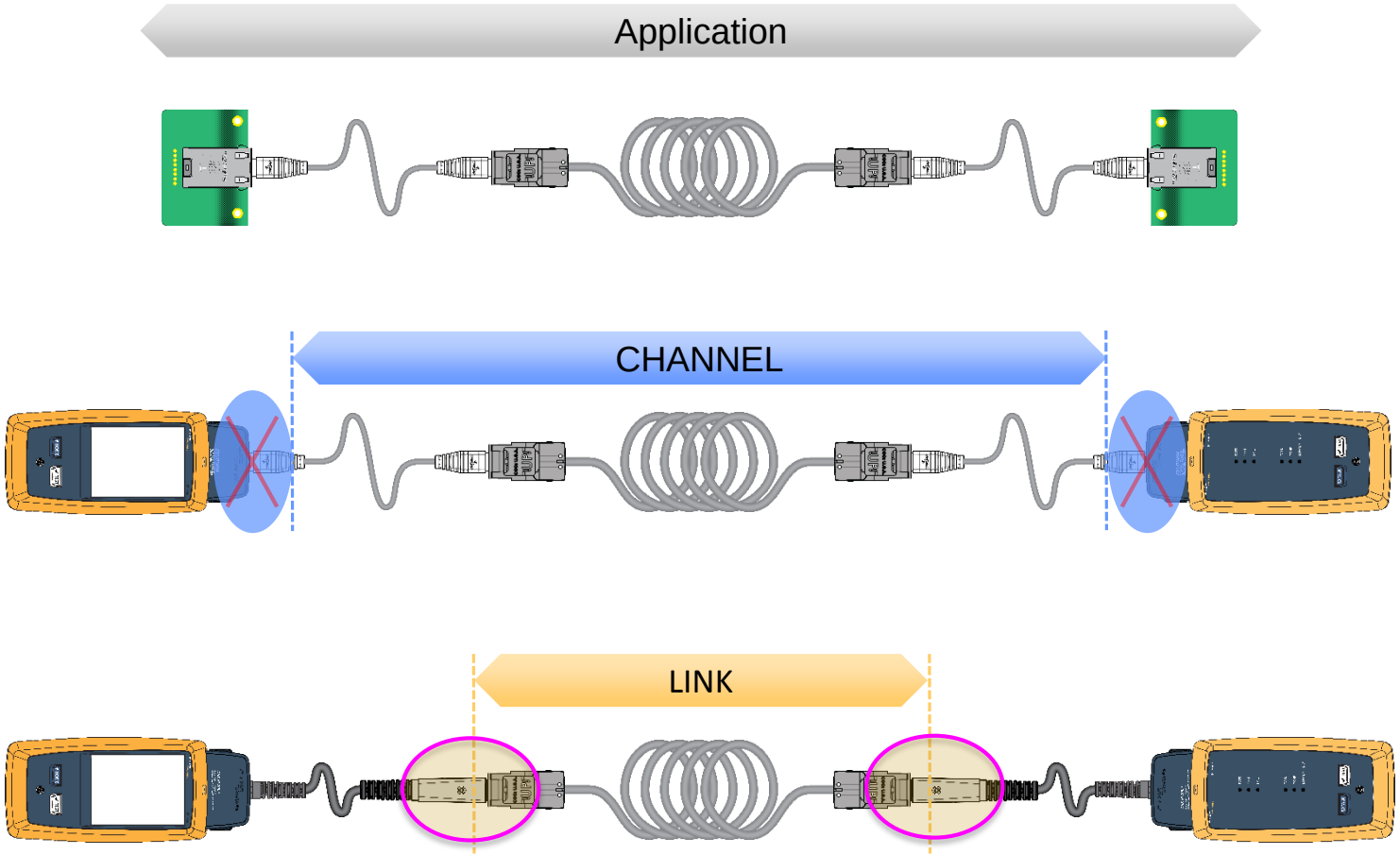
Which Cat.8 ?

	TIA	ISO 11801	
Channel / Perm. Link	Cat.8	Class I (DRAFT)	Class II (DRAFT)
Max. Frequency	2000 MHz		
Components	Cat.8	Cat.8.1	Cat.8.2
Extrapolated from	Cat.6A ← (equivalent) →	Class E_A	Class F_A
Style	RJ45		**Non**-RJ45 (TERA, GG45, ARJ45,….)
Field Test Standard	TIA 1152a	IEC 61935-1 Ed.5 (DRAFT)	
… Accuracy Level	2G	Level VI for Cl.I	Level VI for Cl.II

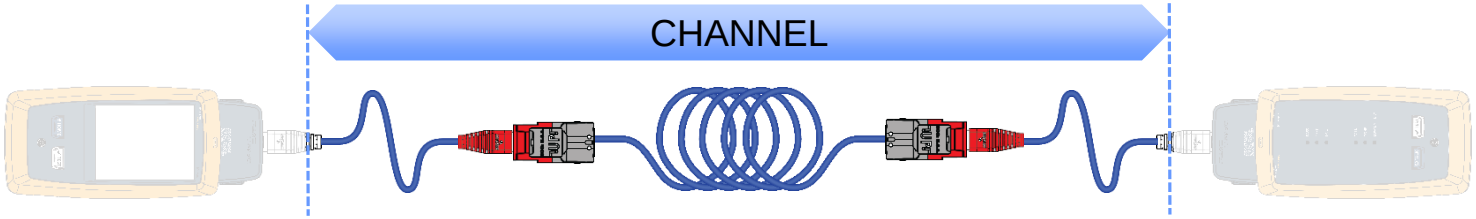
Step 1A: Basic (Minimum) Test Regime



Test Interfaces & Reference Planes

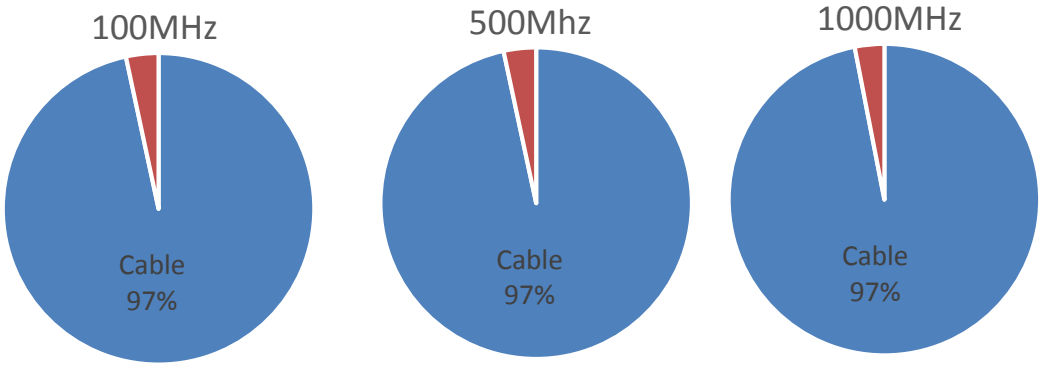


What Limits The Bandwidth more … Connectors or Cable ?

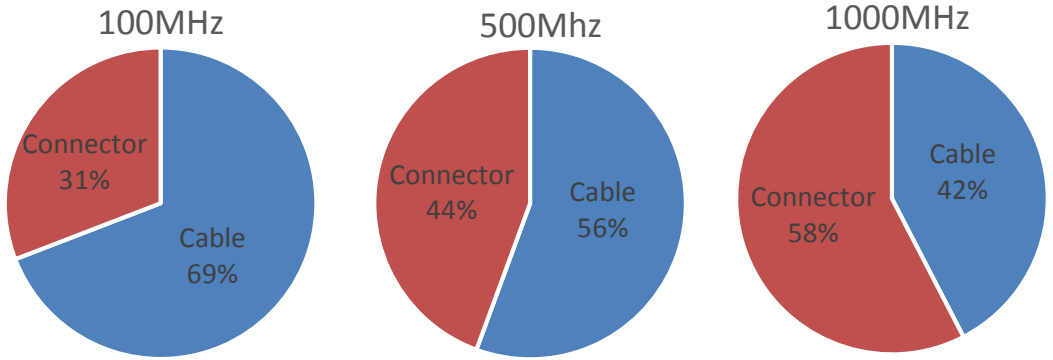


Example: 30m Link

- IL (Insertion Loss)



- **NEXT** (Near End Crosstalk)



What makes a Cat.5e, -.6, -.6A, .-8.1 Connector work ?

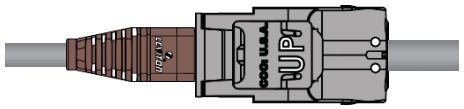
NEXT: 37dB …14mV

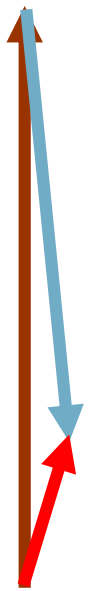
Cat.6, Cat.6A, Cat.8.1 …"Mated NEXT"
> 54dB … < 1.9mV

Note: Above is shown for the most critical pair 3,6/4,5 at 100MHz

Let‘s assume the plug is …

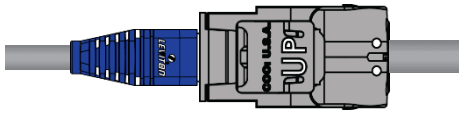
… “worse”

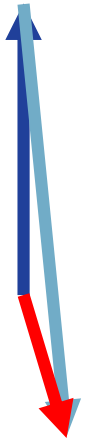




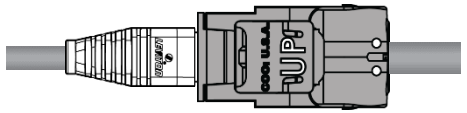
The jack
„under compensates“ because
the plug is to “LOW”

… “better”





The jack
„over compensates“ because
the plug is to “HIGH”

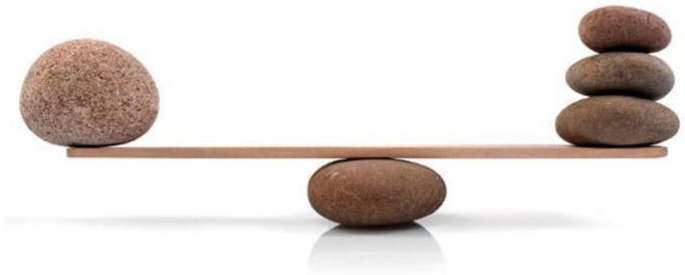


Cat.6, Cat.6A, Cat.8.1
…“Mated NEXT”
> 54 dB … < 1.9mV

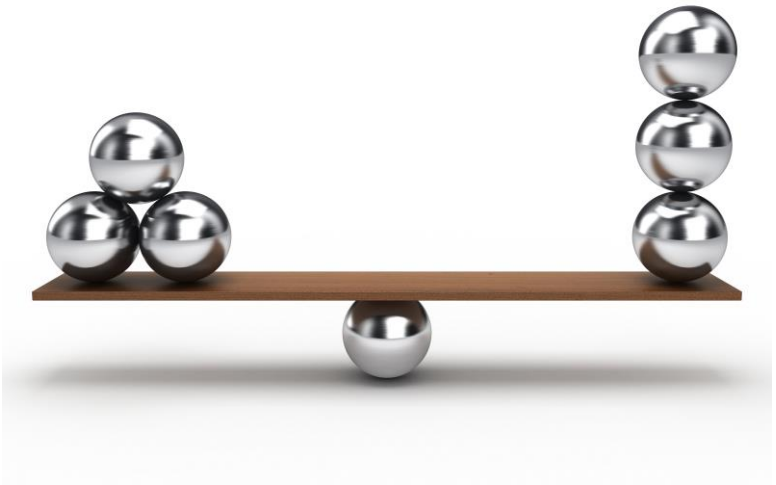
Plug / Jack NEXT Compensation at 2GHz is not trivial

Good performance rquires that the plug and jack NEXT are in perfect balance.

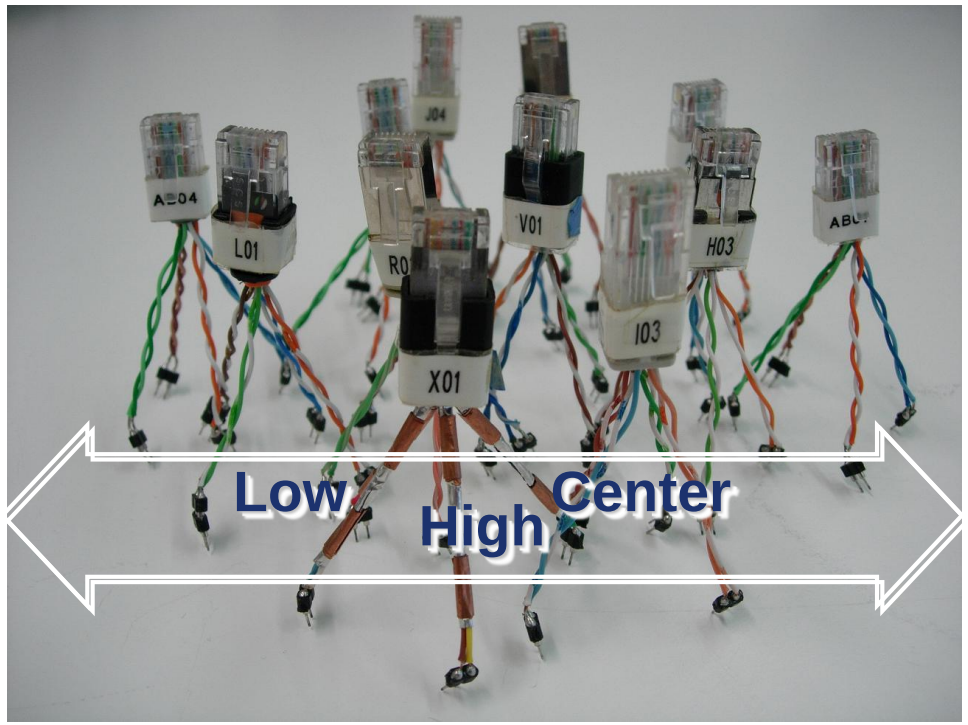
Cat.6/6A



Cat.8.1



Back in 2002: Many Plugs, Many Pyramids ….



- Multiple plugs used to test jacks for Cat.6 compliance
  - Included High, Low and Centered Plugs
  - Up to 12 plugs used
  - Finding 3 meeting all requirements would be like getting all right in a lottery
- The jack had to demonstrate compliant “Mated Next” in all 12 cases

"New" in 2006: One Centered Plug & Mathematics

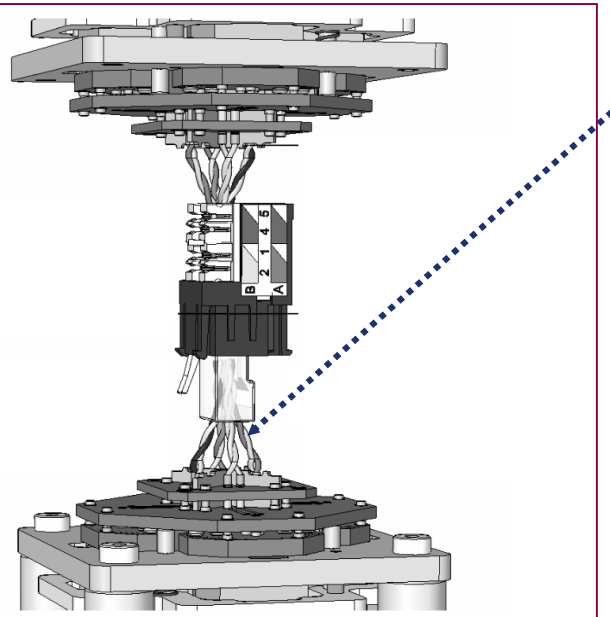


Figure E.9 - An example of a connecting hardware measurement configuration

- A single plug can be used to test for compliance in 14 cases
  - Instead of 12 actual plug
- **"Leaded"** or PCB based test plugs may be used
- Most of the time a **PCB based** plug is preferred
  - … off the shelf
  - …stable
  - …convenient
  - …proven in "round robins"

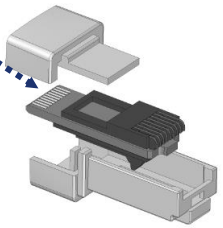


Figure E.7 - PCB based plug

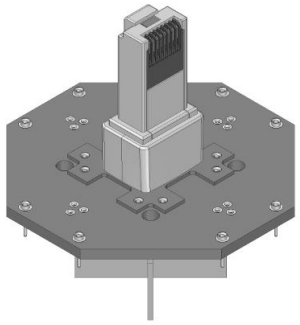
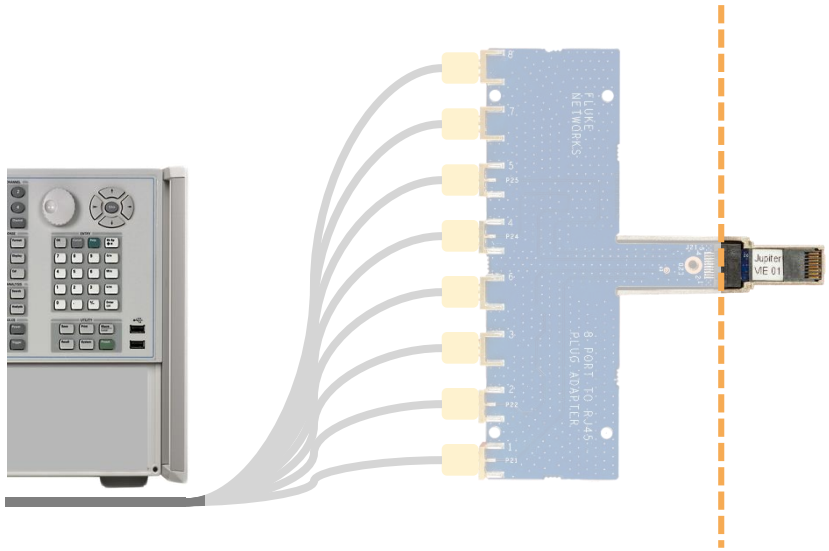


Figure E.8 - TP6A PCB based plug assembly with adapter

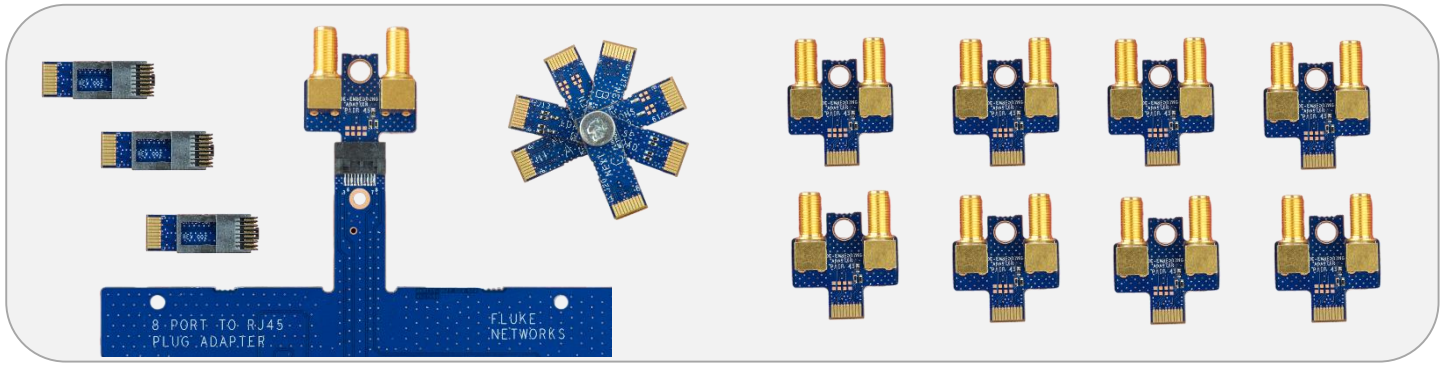
Cat.8.1: Combined Laboratory & Field Test Concept

… Auxiliary Tools

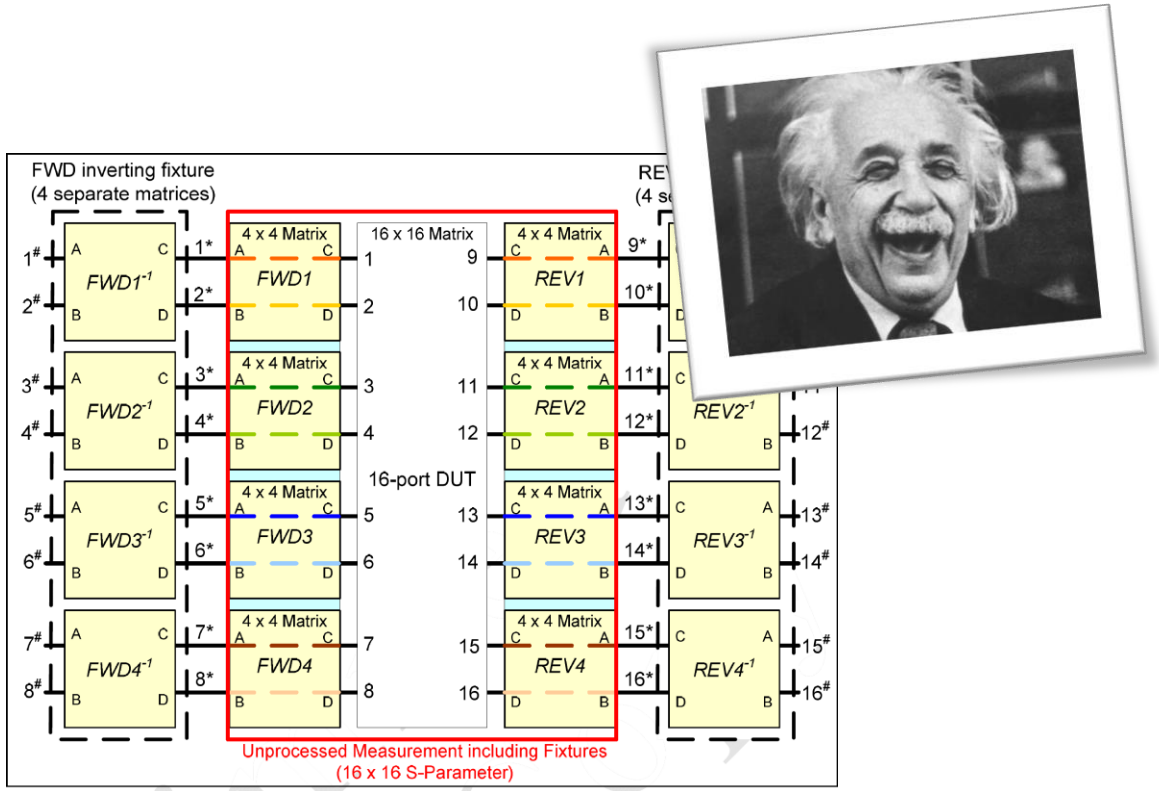


Requires adapters and artifacts for the proprietary test plug interface in order

1. … Neutralize the effect of the test plug interface
2. … Verify the compliance of the test plug

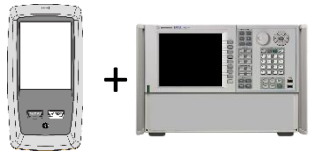


How simple was Cat.6A in comparison!
Cat.8.1 Action photos from the lab



Requirements for Feld Testers

ISO/IEC 61935-1 Ed.5 (CD): Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards

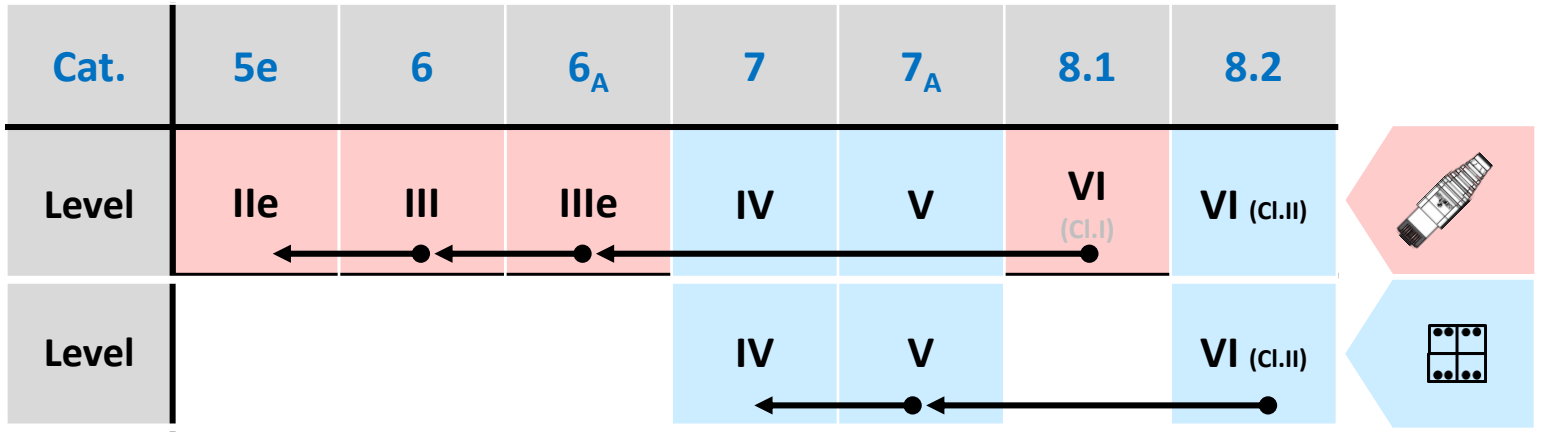


ANSI/TIA-1152A: Requirements for Field Test Instruments and Measurements for Balanced Twisted- Pair Cabling

	Class	D	E	E_A	F	F_A	I	II
	Level	IIe	III	IIIe	IV	V	VI (Cl.I)	VI (Cl.II)
	Cat.	5e	6	6_A			8	
	Level	IIe	III	IIIe			2G	

Question #1:

"In a Cat.6A project should I demand Level-IIIe or prefer Level-IV or better?"



- **Answer:** Abolutely NO !
  Level IV/V is in this case without Relevance Afuture Level VI (für Class I) would be relevant.

Comparing PERMANENT LINK Results

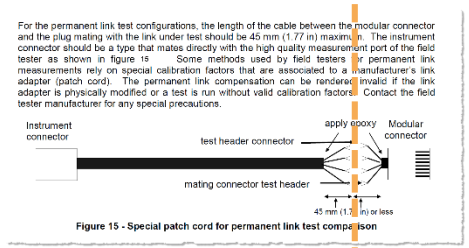
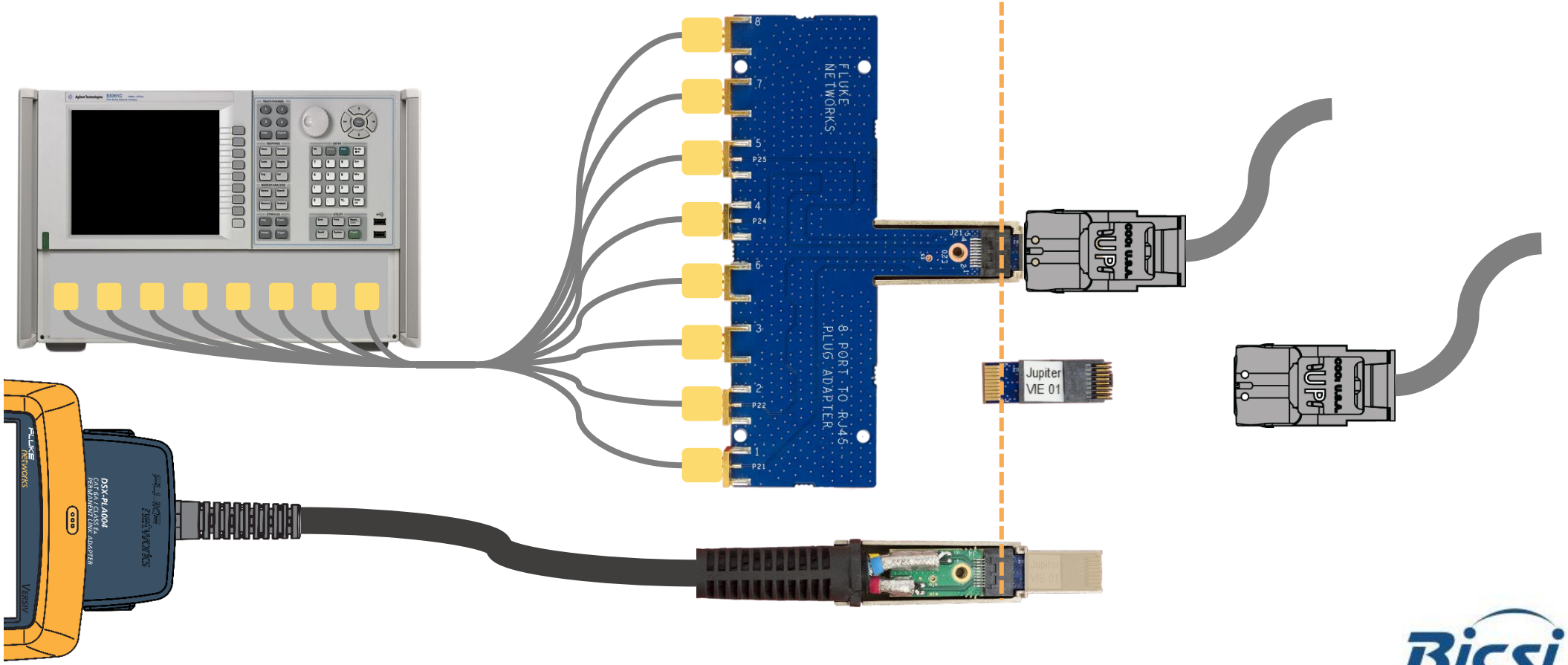
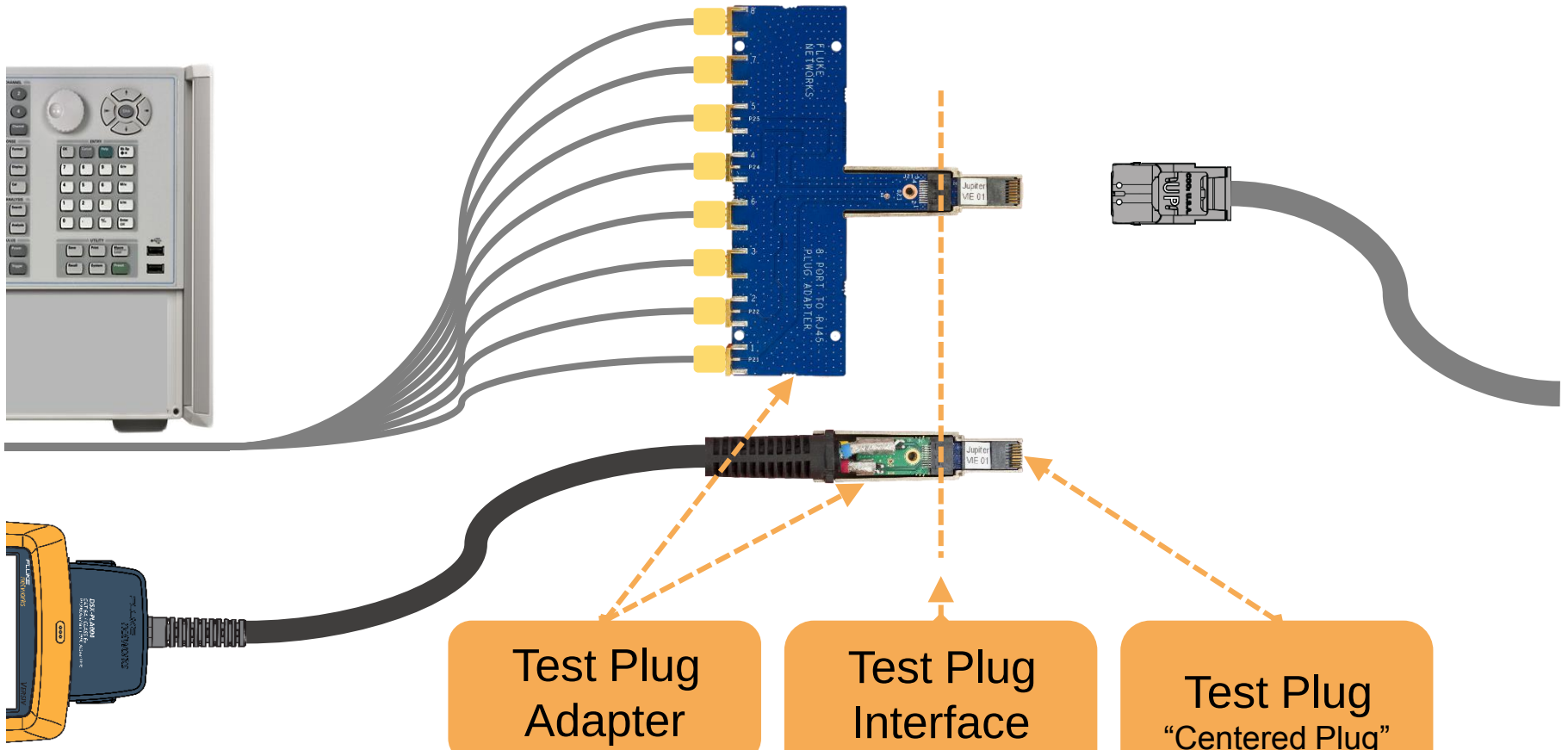


Figure 15 - Special patch cord for permanent link test comparison

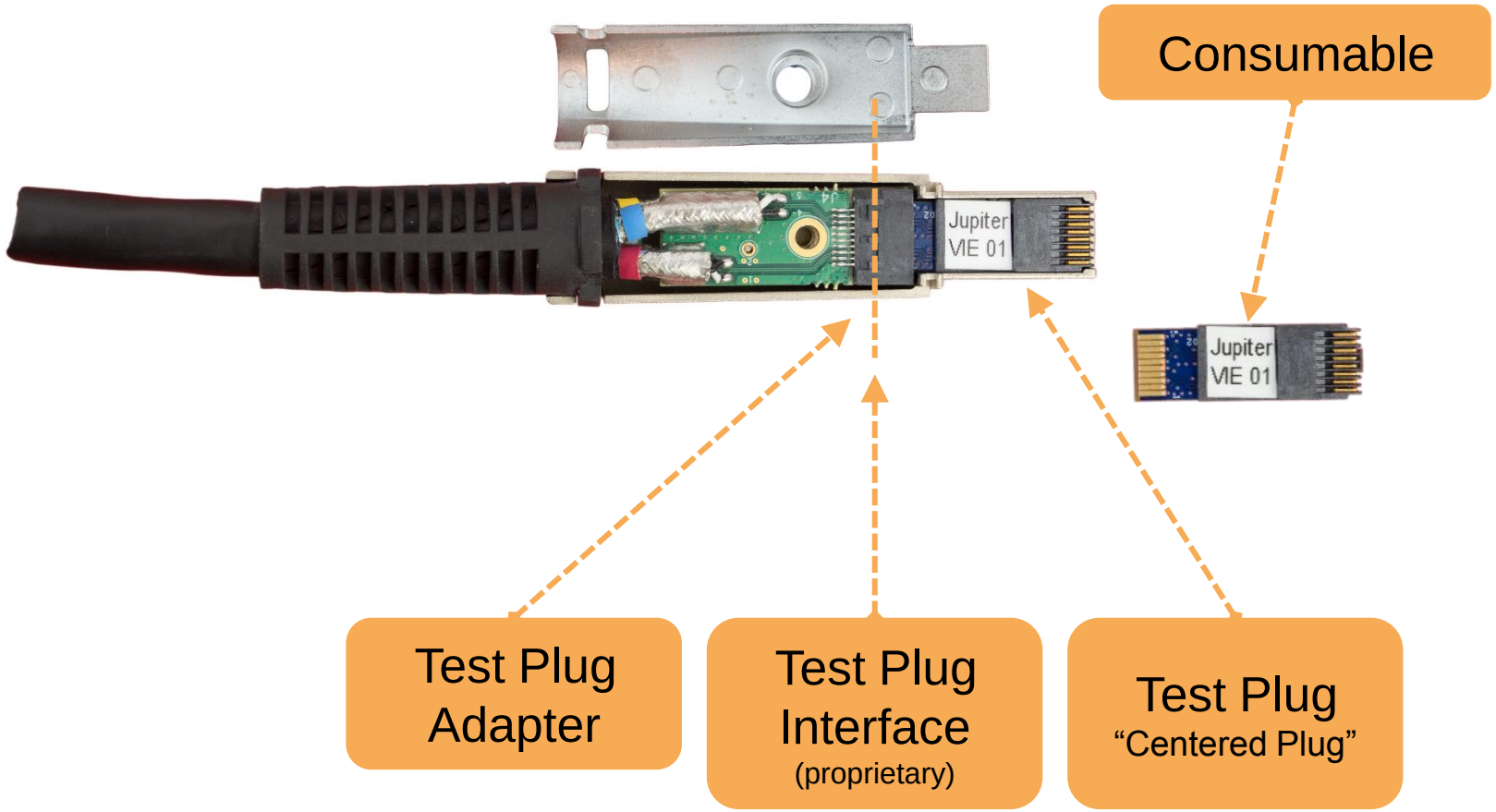


A combined Field & Lab Tester Concept for Cat.8.1….

Definition of the key elements



Permanent Link Adapter with a "CENTERED" Test Plug for the „Heavy Duty Field Use"



Question #2:
Does ANSI/TIA define a more accurate tester than ISO/IEC ?

TIA

Table 5 - Level IIIe nominal measurement accuracies at category 6A pass/fail limits

Test parameter	Freq (MHz)	Baseline accuracy at perm. link limits (± dB)	Permanent link accuracy at perm. link limits (± dB)	Channel accuracy at channel limits (± dB)
Insertion loss	100	0.6	0.7	0.7
	250	1.0	1.1	1.3
	500	1.3	1.4	1.6
NEXT loss	100	0.9	1.2	1.5
	250	1.4	1.8	2.1
	500	1.9	2.3	2.5
	100	1.0	1.3	1.6

2.3

ISO IEC

Table 10 – Worst case insertion loss, NEXT, ACR-N, ELFEXT/ACR-F and return loss measurement accuracy for level IIIE test instruments

Test parameter Level IIIe	Baseline accuracy at permanent link limit			Link accuracy at permanent link limit			Channel accuracy at channel limit		
Frequency	100 MHz	250 MHz	500 MHz	100 MHz	250 MHz	500 MHz	100 MHz	250 MHz	500 MHz
	dB	dB	dB	dB	dB	dB	dB	dB	dB
Insertion loss	1,2	1,9	2,7	1,3	2,3	2,8	1,4	2,5	3,1
NEXT	1,8	2,8	3,9	2,3	3,6	4,6	2,9	4,2	5,2
Power sum NEXT	1,9	2,9	4,0	2,6	3,8	4,7	3,2	4,5	5,4

4.6

Looking closely we see the requirements are the same!

4.4.2

configuration. Level III accuracies are computed at the category 6 permanent link pass/fail limit for the baseline and permanent link test configurations, and at the category 6 channel pass/fail

Status Cat.8 : Field Tester Requirements

ANSI/TIA-1152: Requirements for Field Test Instruments and Measurements for Balanced Twisted- Pair Cabling

PUBLISHED

Table 7 - Level 2G nominal measurement accuracies at category 8 pass/fail limits

Test parameter	Freq (MHz)	Baseline accuracy at perm. link limits (± dB)	Permanent link accuracy at perm. link limits (± dB)	Channel accuracy at channel limits (± dB)
Insertion loss	100	0.5	0.5	0.6
	250	0.7	0.8	0.8
	500	1.1	1.3	1.2
	1000	1.6	2.0	2.0
	2000	1.6	2.0	2.0
NEXT loss	100	0.7	0.8	0.9
	250	1.0	1.3	1.3
	500	1.6	2.0	2.0
	1000	2.1	2.6	2.7
	2000	2.1	2.6	2.8
PSNEXT loss	100	0.7	0.8	1.1
	250	1.0	1.3	1.5
	500	1.6	2.0	2.1
	1000	2.1	2.6	2.8
	2000	2.1	2.6	3.0
ACRF	100	0.9	1.0	2.6
	250	1.3	1.6	2.8
	500	2.0	2.4	3.1
	1000	2.5	3.1	3.8
	2000	2.5	3.1	3.8
PSACRF	100	0.9	1.0	3.6
	250	1.3	1.6	3.7
	500	2.0	2.4	4.0
	1000	2.5	3.1	4.5
	2000	2.5	3.1	4.5
Return loss	100	2.0	2.3	1.9
	250	1.5	1.7	1.7
	500	1.2	1.4	1.6
	1000	1.3	1.5	1.5
	2000	1.6	1.8	1.8

ISO/IEC 61935-1 : Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards

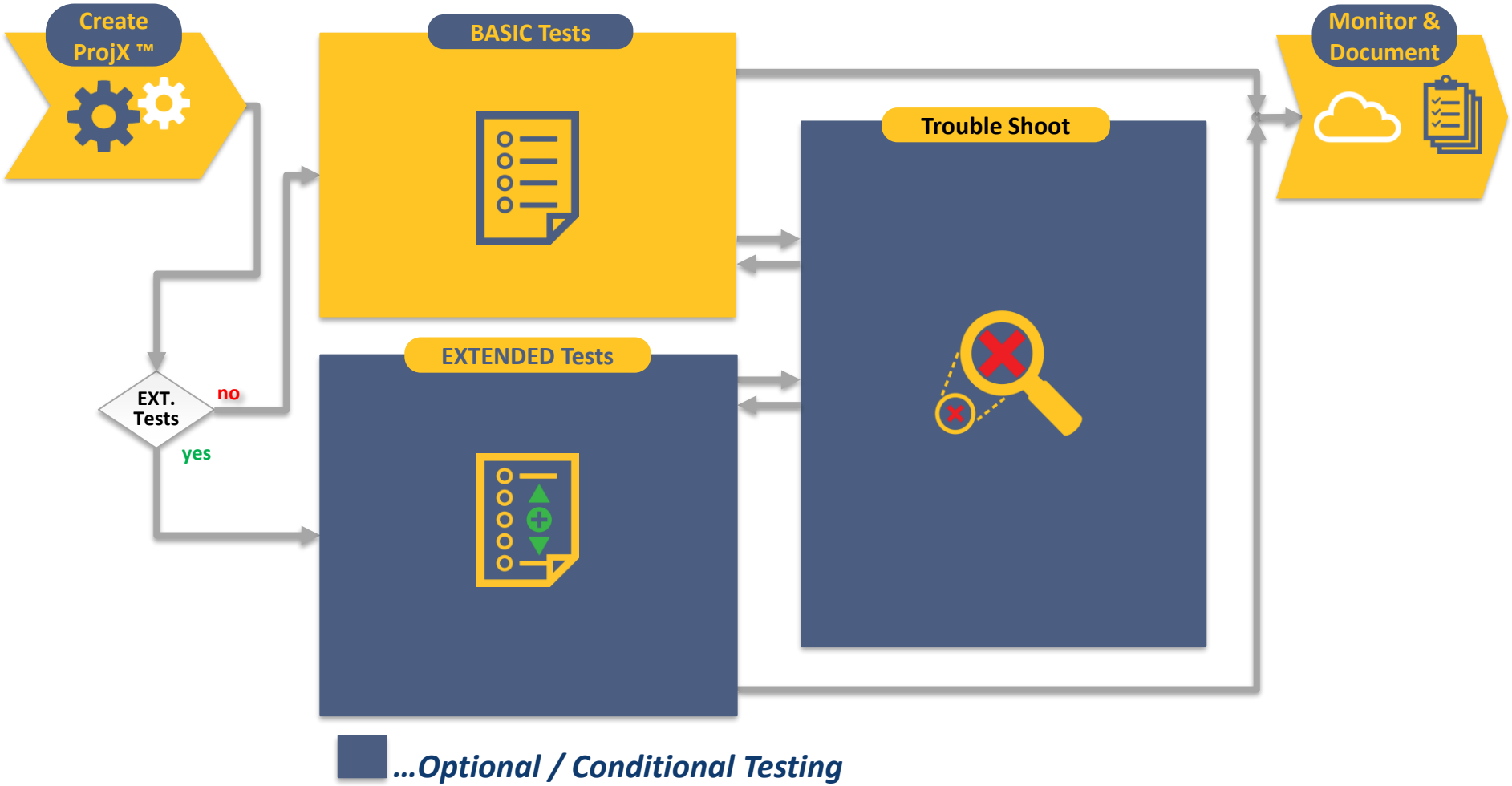
Committe Draft

2008
2009

Table 13 – Worst case insertion loss, NEXT, ACR-N, ACR-F and return loss measurement accuracy for level VI (Using Class I)

Test parameter Level V	Baseline accuracy at permanent link limit					Link accuracy at permanent link limit					Channel accuracy at channel limit				
Frequency	100 MHz	250 MHz	600 MHz	1000 MHz	2000 MHz	100 MHz	250 MHz	600 MHz	1000 MHZ	2000 MHz	100 MHz	250 MHz	600 MHz	1000 MHz	2000 MHz
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
Insertion loss	1.0	1.4	2.3	3.3	3.9	1.1	1.7	2.8	4.3	5.1	1.2	1.7	3.0	4.4	5.1
NEXT	1.3	2.0	3.5	4.1	4.4	1.5	2.5	4.4	5.1	5.4	1.8	2.6	4.5	5.3	5.7
Power sum NEXT	1.3	2.0	3.5	4.1	4.4	1.5	2.5	4.4	5.1	5.4	2.1	2.9	4.6	5.5	6.3
ACR-N	1.4	2.3	3.9	4.7	5.1	1.6	2.8	4.9	5.8	6.2	1.9	2.9	5.0	6.0	6.5
Power sum ACR-N	1.4	2.3	3.9	4.7	5.1	1.6	2.8	4.9	5.8	6.2	2.2	3.2	5.1	6.2	7.0
ACR-F	1.7	2.5	4.2	5.0	5.3	2.0	3.1	5.2	6.1	6.5	5.2	5.6	6.7	7.5	7.9
Power sum ACR-F	1.7	2.6	4.2	5.0	5.3	2.2	3.2	5.2	6.1	6.5	7.1	7.4	8.3	8.9	9.2
Return loss	3.9	2.9	2.6	2.5	2.8	4.5	3.4	3.0	2.9	3.2	3.8	3.4	3.0	2.9	3.2

Step 1B: Extended Test Regime



Why EXTENDED Testing ?

	Copper Certification to ISO/IEC 11801	
	Reference Conformance Testing	Installation Conformance Testing
Wire Map	✓	✓
Length	✓	
Propagation Delay	✓	✓
Delay Skew	✓	✓
DC Loop Resistance	✓	✓
DC Resistance Unbalance	✓	
Insertion Loss	✓	✓
NEXT, PS NEXT	✓	✓
Return Loss	✓	✓
ACR-N, PS ACR-N	✓	✓
ACR-F, PS ACR-F	✓	✓
TCL, ELTCTL	✓	
PS ANEXT, PS AACR-F [1)]	✓	✓

1) Class E_A only

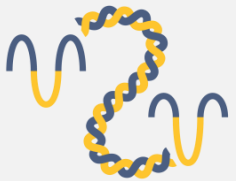
Why EXTENDED Testing ?

	Copper Certification	
	ANSI/TIA-568-C.2 (Cabling System)	ANSI/TIA-1152 (Minimum Field Test)
Wire Map	✓	✓
Length	✓	✓
Propagation Delay	✓	✓
Delay Skew	✓	✓
DC Loop Resistance	✓	
DC Resistance Unbalance	✓	
Insertion Loss	✓	✓
NEXT, PS NEXT	✓	✓
Return Loss	✓	✓
ACR-F, PS ACR-F	✓	✓
TCL, ELTCTL	✓	
PS ANEXT, PS AACR-F [1)]	✓	✓

1) Category 6A only

WHAT IF …

TCL / ELTCTL is not compliant

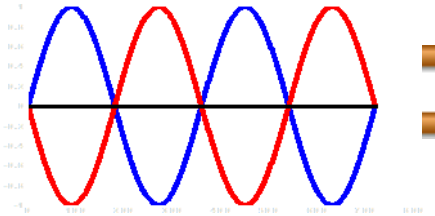


?

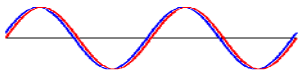
TCL (Transverse Conversion Loss)

- **T**ransverse **C**onversion **L**oss is the ratio (in dB) of a common-mode voltage measured on a wire pair relative to a differential-mode voltage applied to the same end of the pair. The TCL value shows you how well the impedances of the pair's conductors are balanced.

Differential Signal Applied



Common Mode Voltage Measured

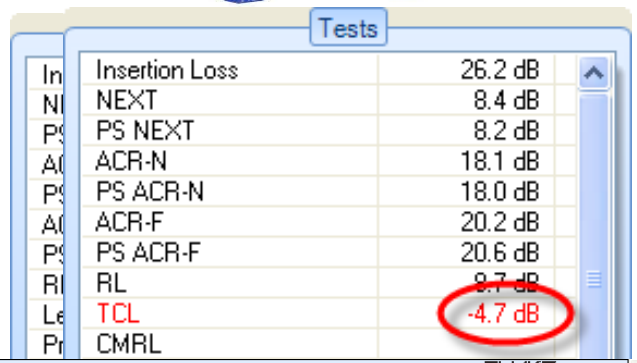


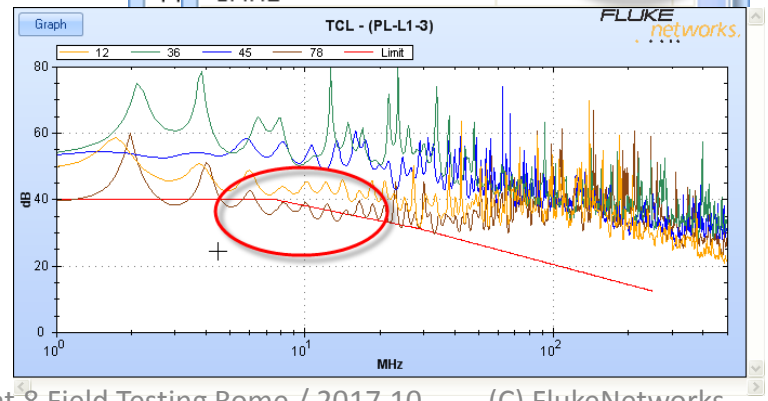
Mode Conversion – Real World Example

GOOD vs. BAD Drum of Cable

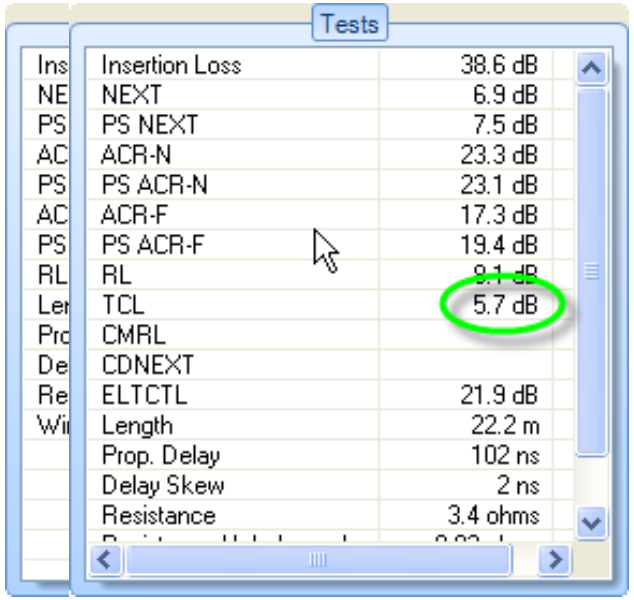
- 18km cable of identical type was installed
- 30% of the links don't carry 1000BASE-T

Drum #1





Drum #2

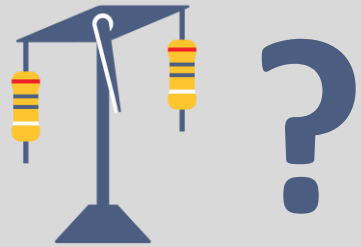


WHAT IF …

TCL / ELTCTL is not compliant

Even a legacy application like 1000Base-T may not work on an otherwise compliant Cat.6/6A system !

Resistive Unbalance is not compliant

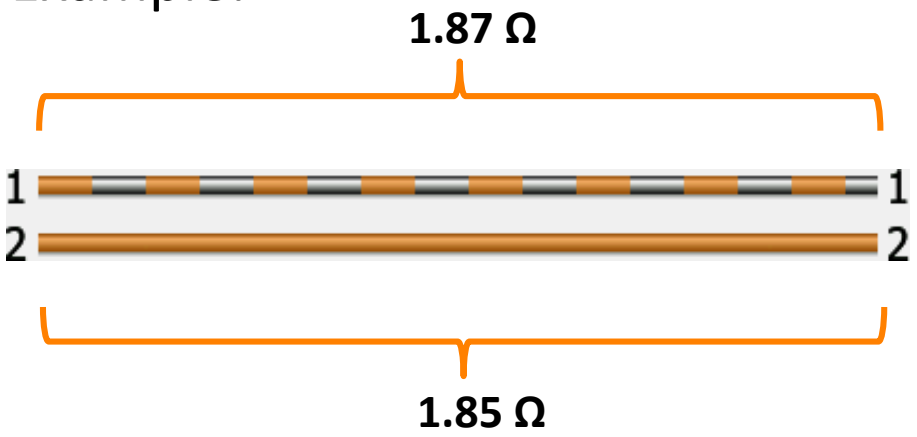


Shield Integrity is not given

Resistance Unbalance

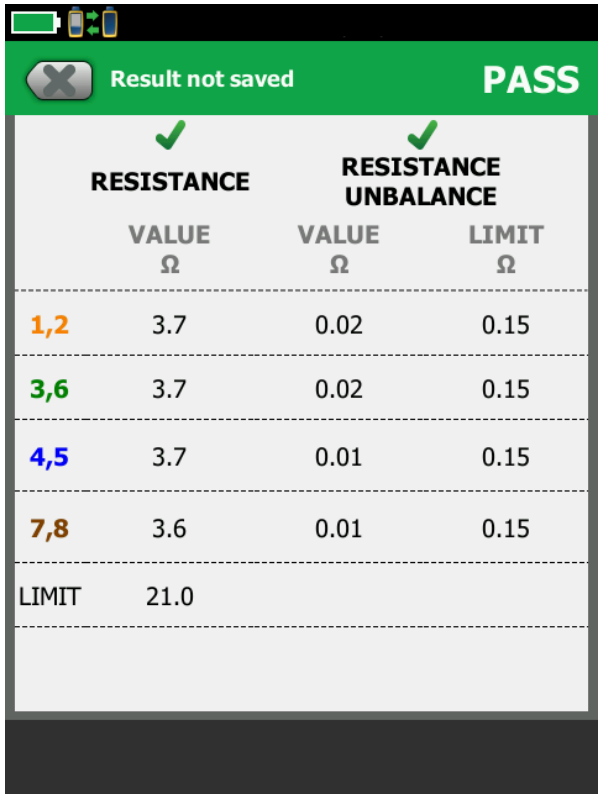
- Difference in Resistance between wires in the pair

- Example:

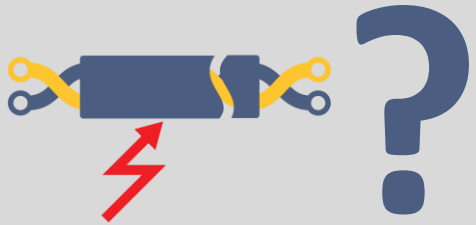


Resistance= 3.7 Ω

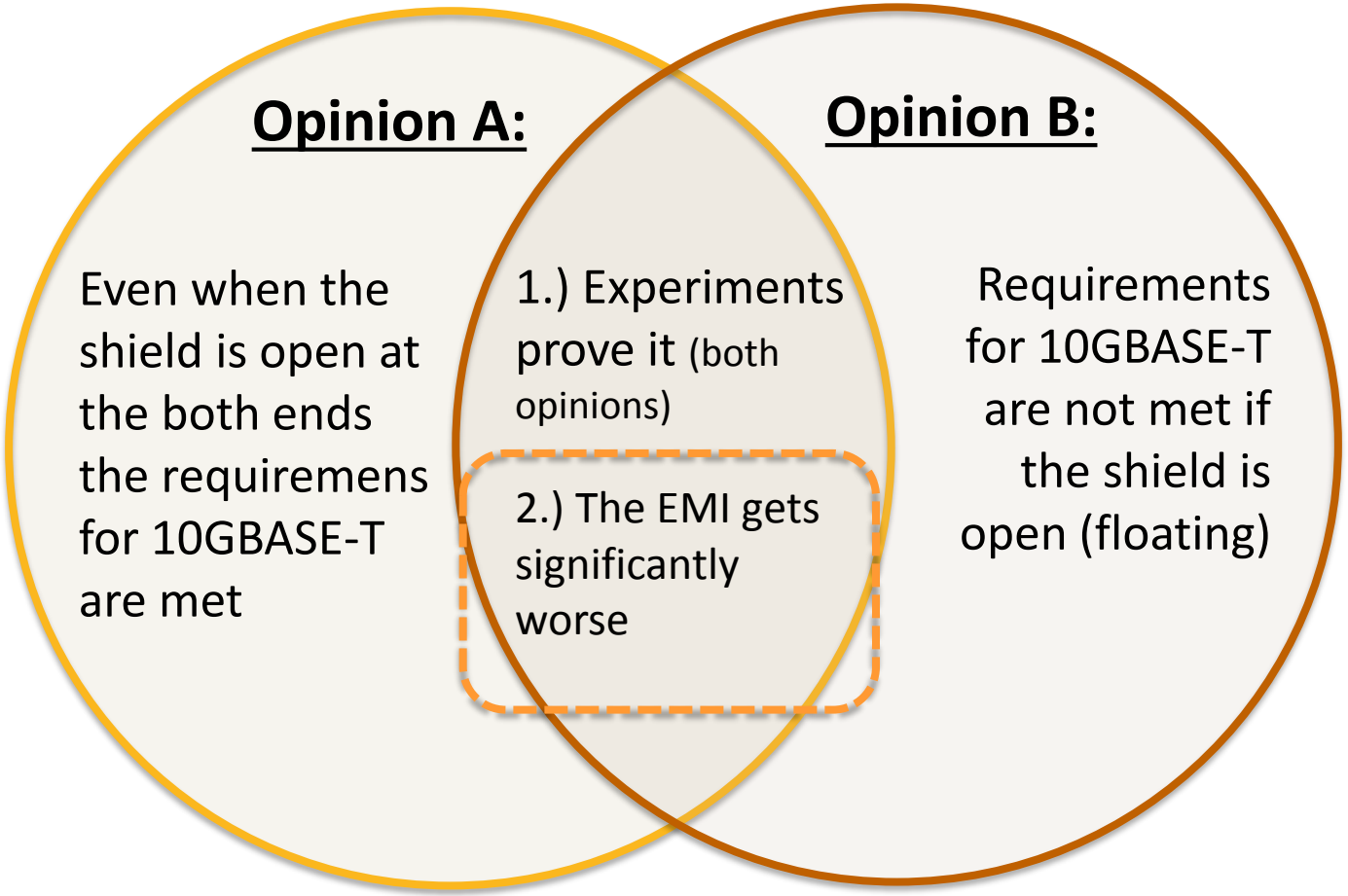
Resistance Unbalance = 0.02 Ω



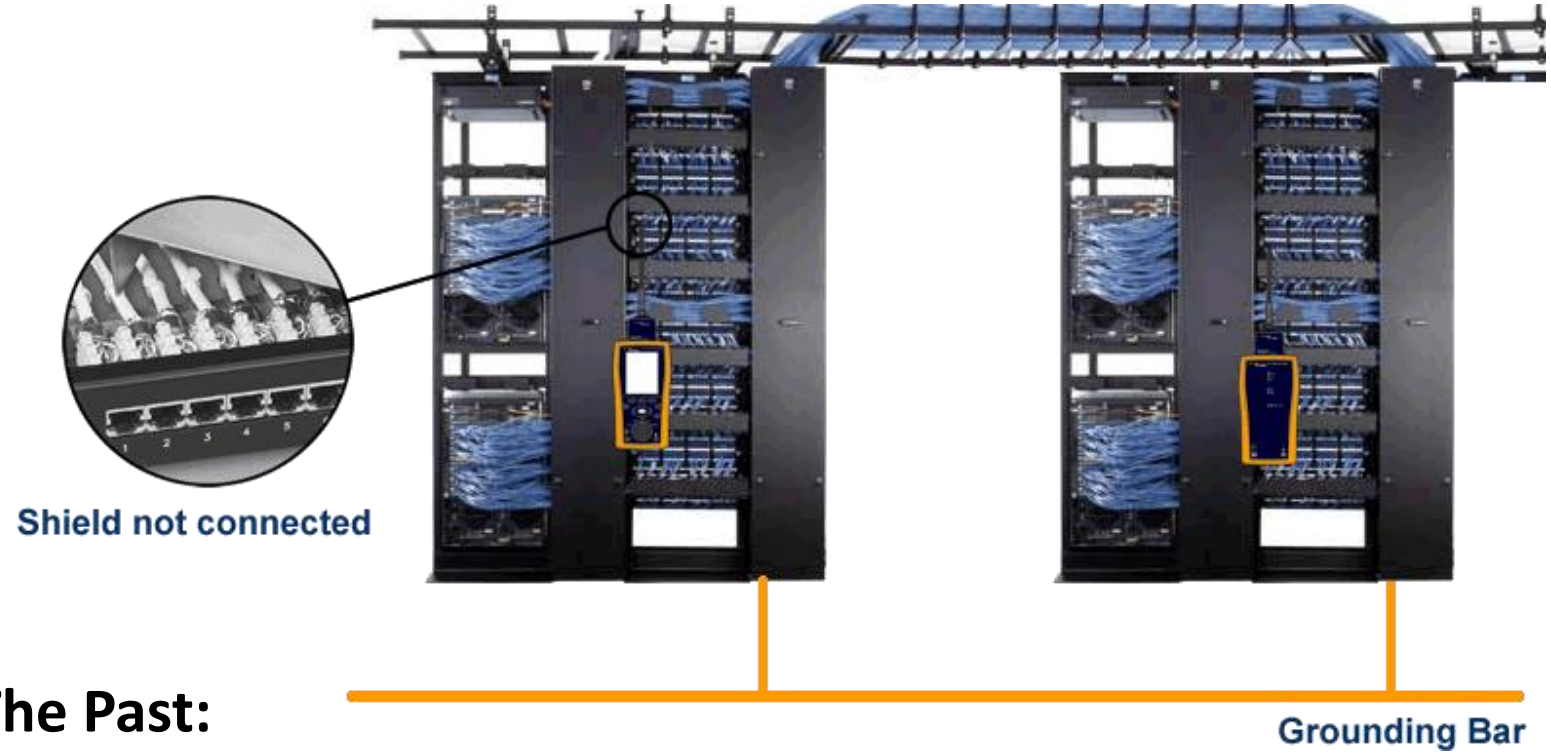
WHAT IF …

TCL / ELTCTL is not compliant	**Even a legacy application like 1000Base-T may not work on an otherwise compliant Cat.6/6A system !**
Resistive Unbalance is not compliant	**POE operation is at risk during maximum load** **Poor contacts may further degrade over time**
Shield Integrity is not given	

Shield Integrity … Opinions



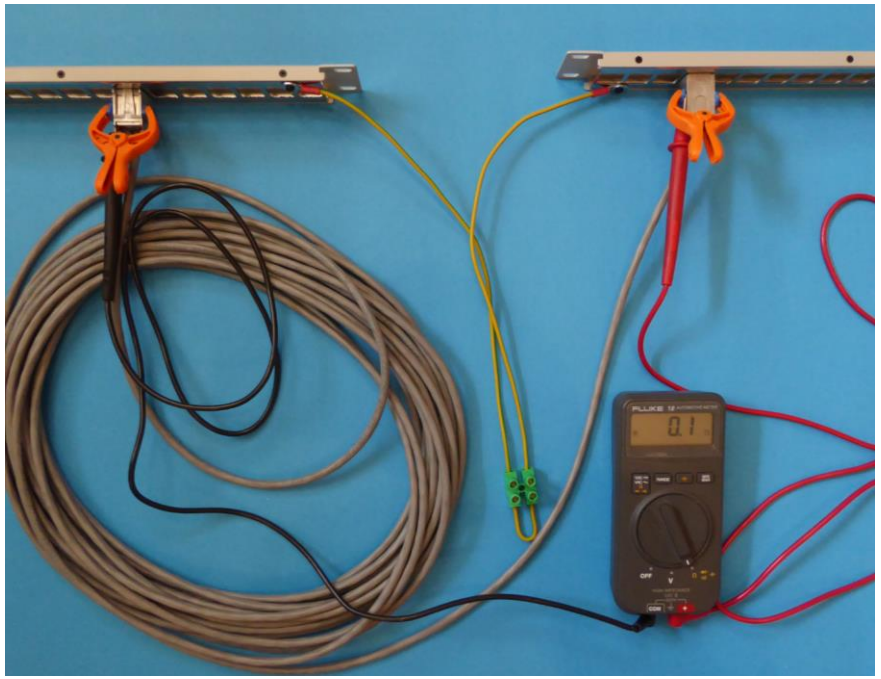
Shield Integrity

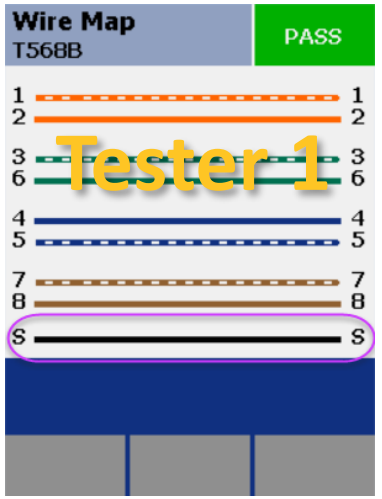


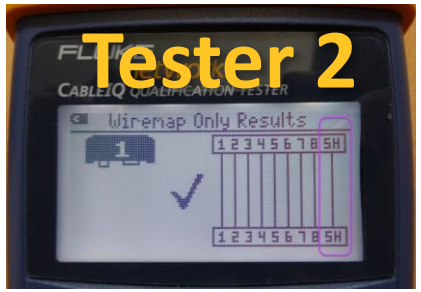
In The Past:

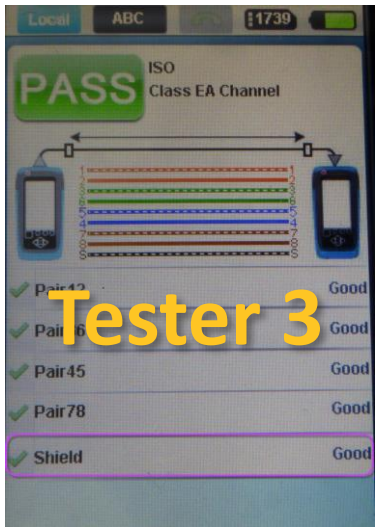
- Field testers could only verify that there is DC Continuity
- DC Continuity is given by grounding and earth
- Any open shields/ends could not be detected

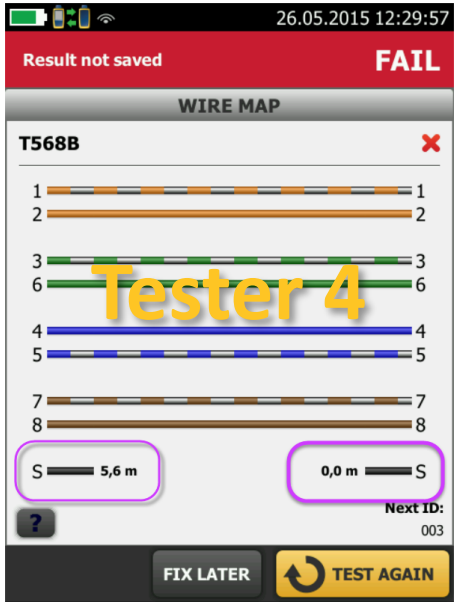
Does your field tester verify the shield ?
Use a UTP Cable and shielded jacks to find out







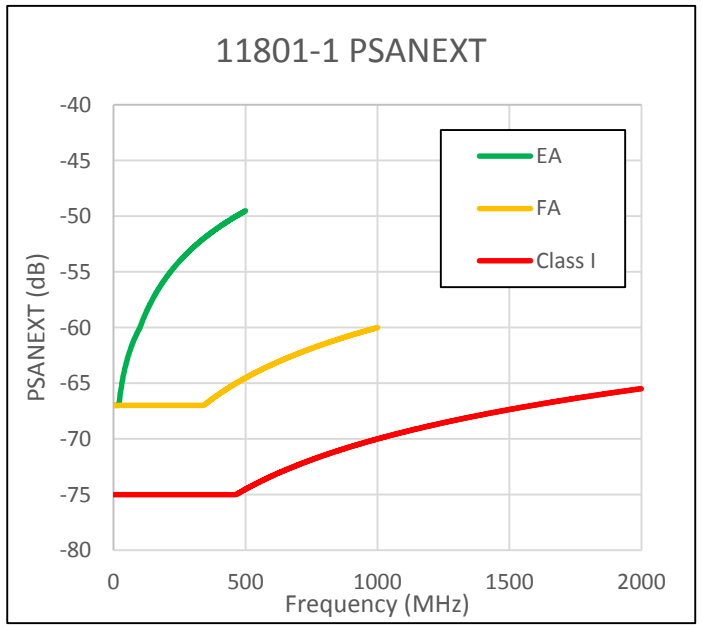




- Only 1 tester will detect the lack of a shield
- NOTE: In special applications it may be essential to verify that the shield is open on a defined end

Field tester – Shield Test Requirements

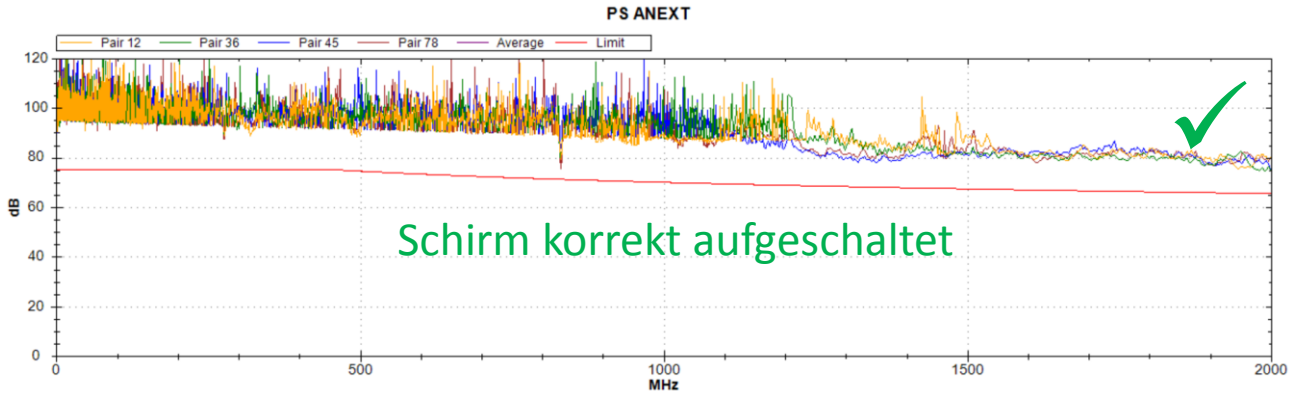
- Published TIA 1152A states:
  …for level 2G testers, it is understood that the screen continuity is tested along the path of the cabling.

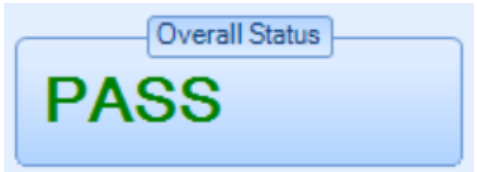


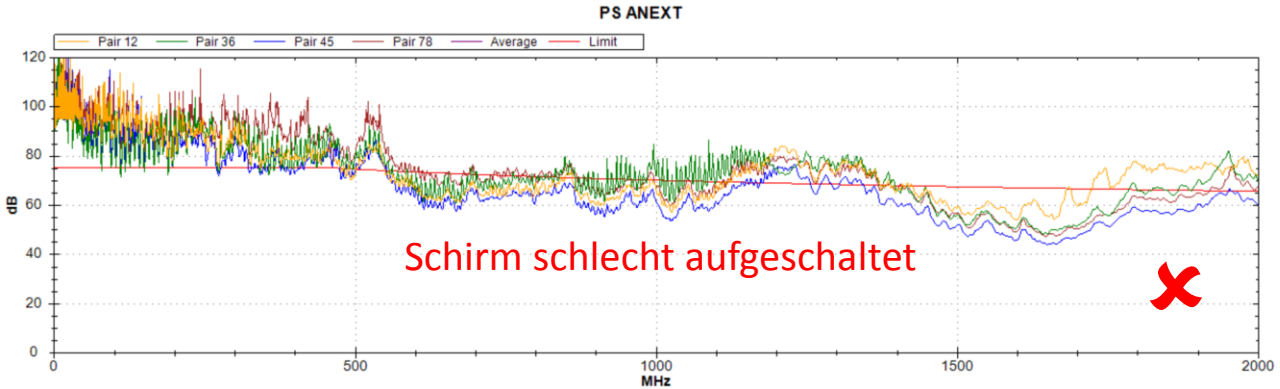
For Class E_A, where the alien crosstalk requirements are based on UTP cabling, this may not be of concern, however Class I/II alien crosstalk requirements are 10dB tighter than F_A and need the screen to be well terminated to ensure compliance.

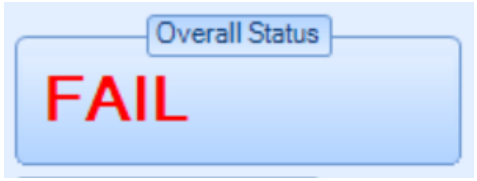
Results of poor shield termination

- It is important to check that the shield has continuity along the path of the cable – here the Disturbed cable has its shield open on one end







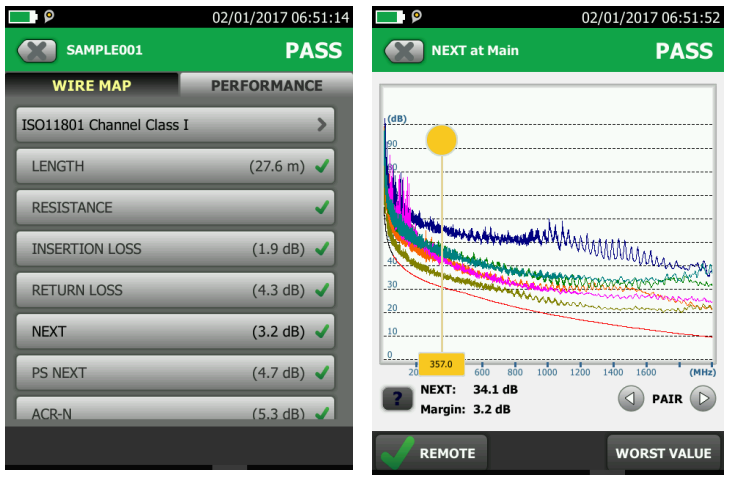


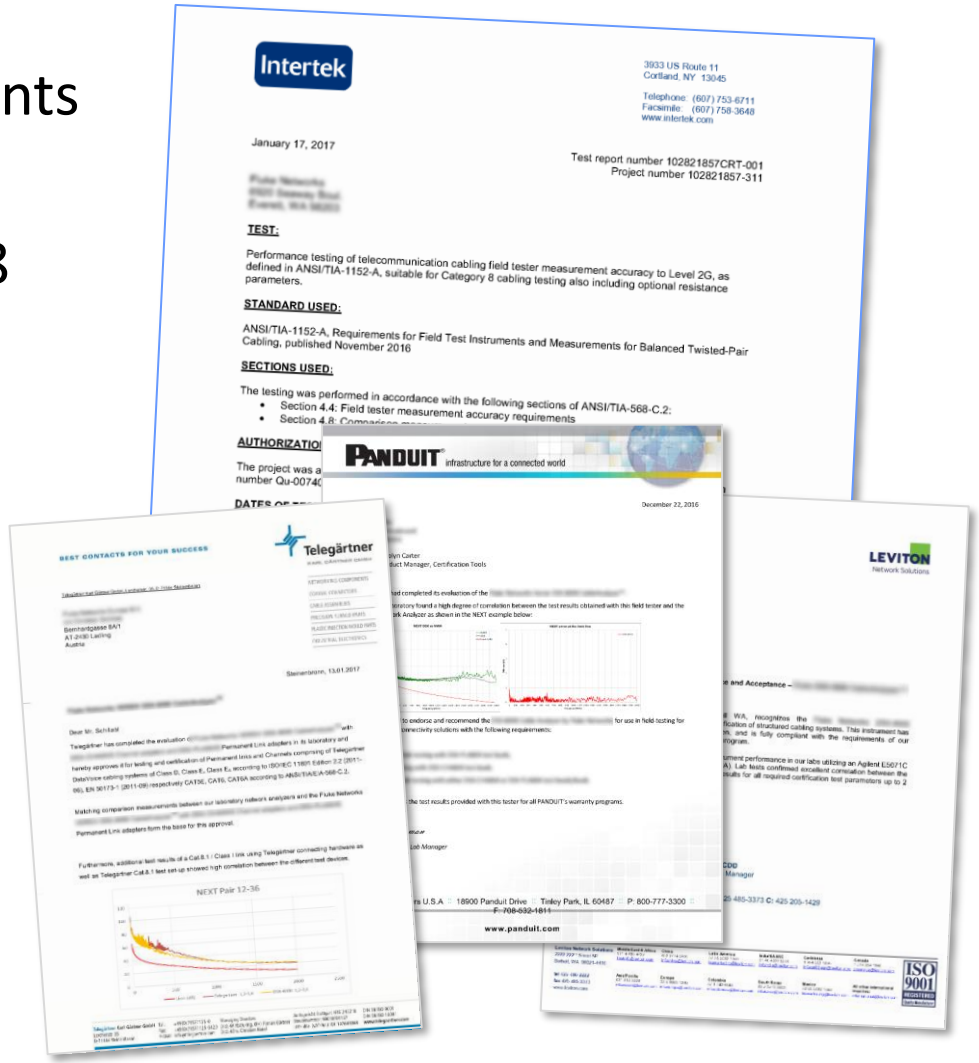
WHAT IF …

TCL / ELTCTL is not compliant	**Even a legacy application like 1000Base-T may not work on an otherwise compliant Cat.6/6A system !**
Resistive Unbalance is not compliant	**POE operation is at risk during maximum load** **Poor contacts may further degrade over time**
Shield Integrity is not given	**10 or 20 dB of electromagnetic immunity (EMI) is lost.** **Alien Crosstalk may become non-compliant**

Standards Compliant Cat.8 Field Testing…

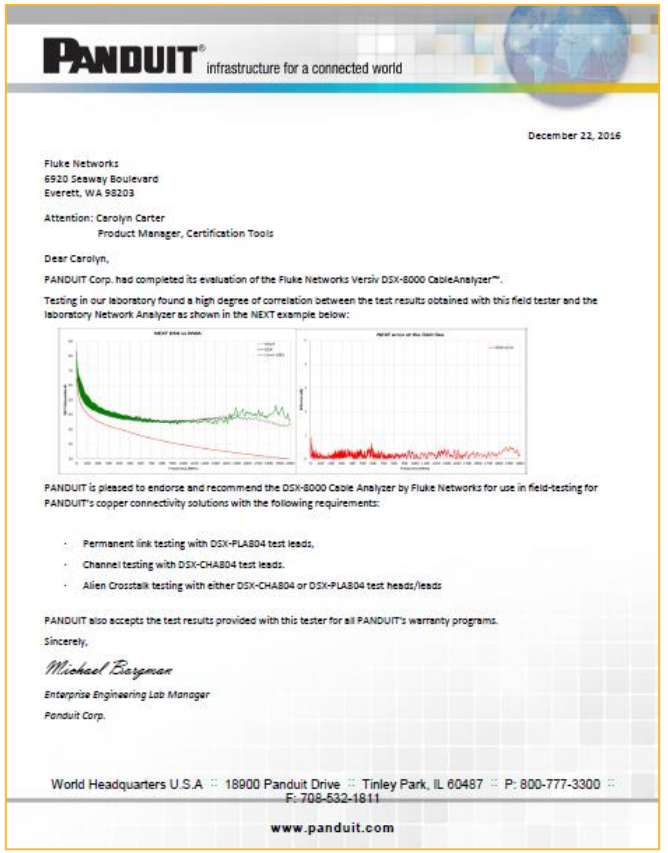
- Standards defined requirements for field testers
- Manufacturer endorsed Cat.8 Field Testers
- Testing Cat.8 links is no more complex the Cat.6_A





Manufacturer Endorsements

- Panduit
  - "…pleased to endorse and recommend the DSX-8000 Cable Analyzer by Fluke Networks for use in field-testing for PANDUIT's copper connectivity solutions…"
- Visit the DSX-8000 website for a current list of endorsements



PANDUIT infrastructure for a connected world

December 22, 2016

Fluke Networks
6920 Seaway Boulevard
Everett, WA 98203

Attention: Carolyn Carter
Product Manager, Certification Tools

Dear Carolyn,

PANDUIT Corp. had completed its evaluation of the Fluke Networks Versiv DSX-8000 CableAnalyzer™.

Testing in our laboratory found a high degree of correlation between the test results obtained with this field tester and the laboratory Network Analyzer as shown in the NEXT example below:

PANDUIT is pleased to endorse and recommend the DSX-8000 Cable Analyzer by Fluke Networks for use in field-testing for PANDUIT's copper connectivity solutions with the following requirements:

- Permanent link testing with DSX-PLA804 test leads,
- Channel testing with DSX-CHA804 test leads.
- Alien Crosstalk testing with either DSX-CHA804 or DSX-PLA804 test heads/leads

PANDUIT also accepts the test results provided with this tester for all PANDUIT's warranty programs.

Sincerely,

Michael Bazman

Enterprise Engineering Lab Manager

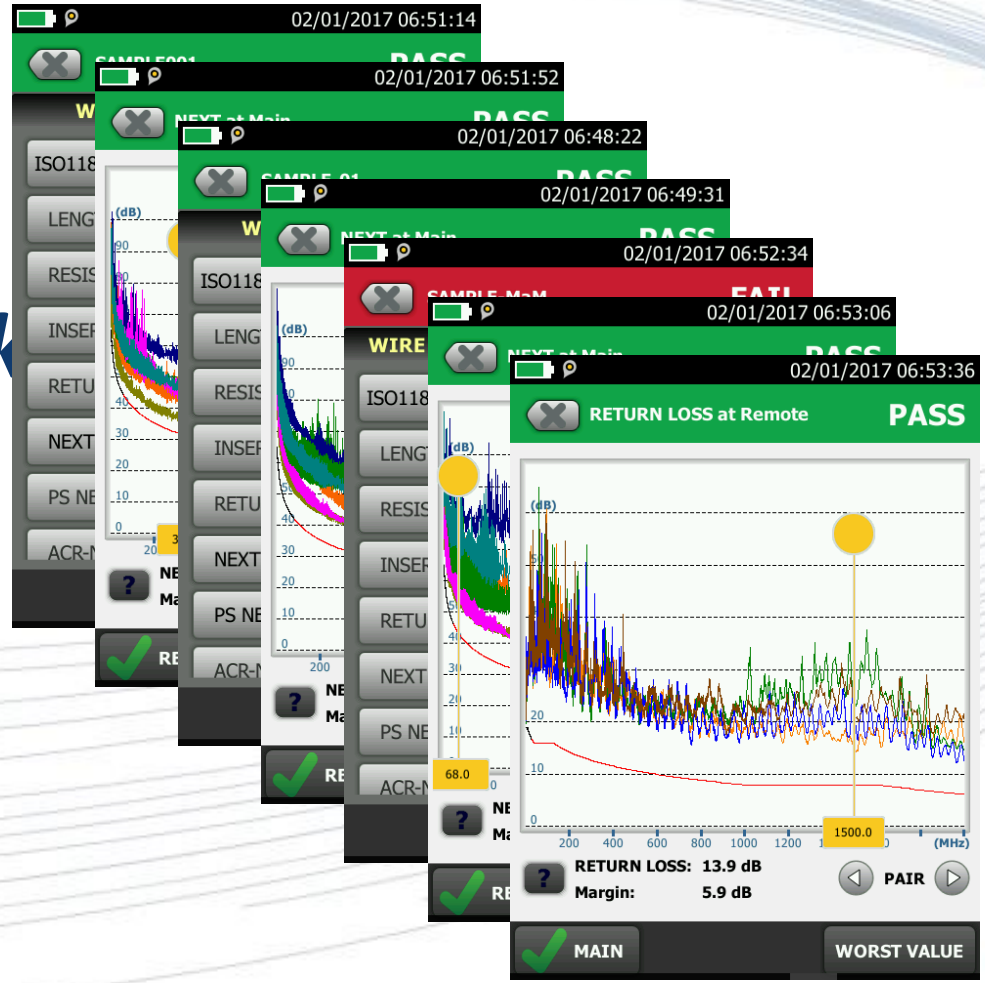
Panduit Corp.

World Headquarters U.S.A :: 18900 Panduit Drive :: Tinley Park, IL 60487 :: P: 800-777-3300 :: F: 708-532-1811

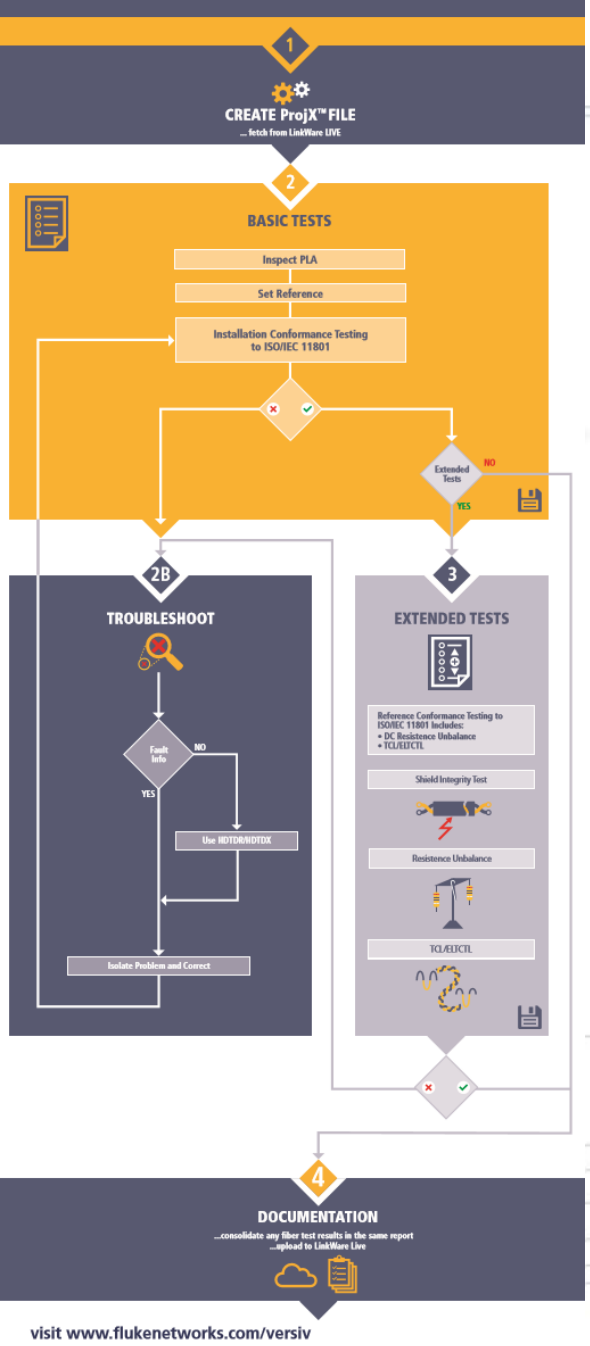
www.panduit.com

1. Channel:
   Manufacturer A
   NEXT 3.2 RL 4.3
2. Perm. Link:
   Manufacturer B
   NEXT 5.6 RL 3.8
3. Mix & Match
   Channel
   NEXT 8.3 RL 5.9

Cat.8 … „It's not walk



Conclusio



Qualified instruments and personnel paired with an efficient work flow ensures …

- … “Next Generation Readiness” by extending the certification to all parameters specified for a cabling system
- … a profitable certification of twister pair cabling systems

THANK YOU
FOR YOUR ATTENTION !

Questions?

For an animated PPT … http://tiny.cc/kkm2017

Christian.Schillab@FlukeNetworks.com