

# IEC 63171-1 EMC performance with Pepperl+Fuchs 10BASE-T1L prototype transceivers

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# Acknowledgements

- Ron Nordin, Paul Wachtel, Chris Diminico affiliated with Panduit for hosting, use of test facilities, and guidance
- Steffen Graber affiliated with Pepperl+Fuchs for advice and use of their 10BASE-T1L prototype transceivers
- Wayne Hopkinson, Jeff Oberski, Paul Pepe affiliated with CommScope for preparing the CommScope IEC 63171-1 MDI connectors, cords, associated test setup devices and working with Paul Wachtel of Panduit, who conducted the test program

# Purpose and Objectives

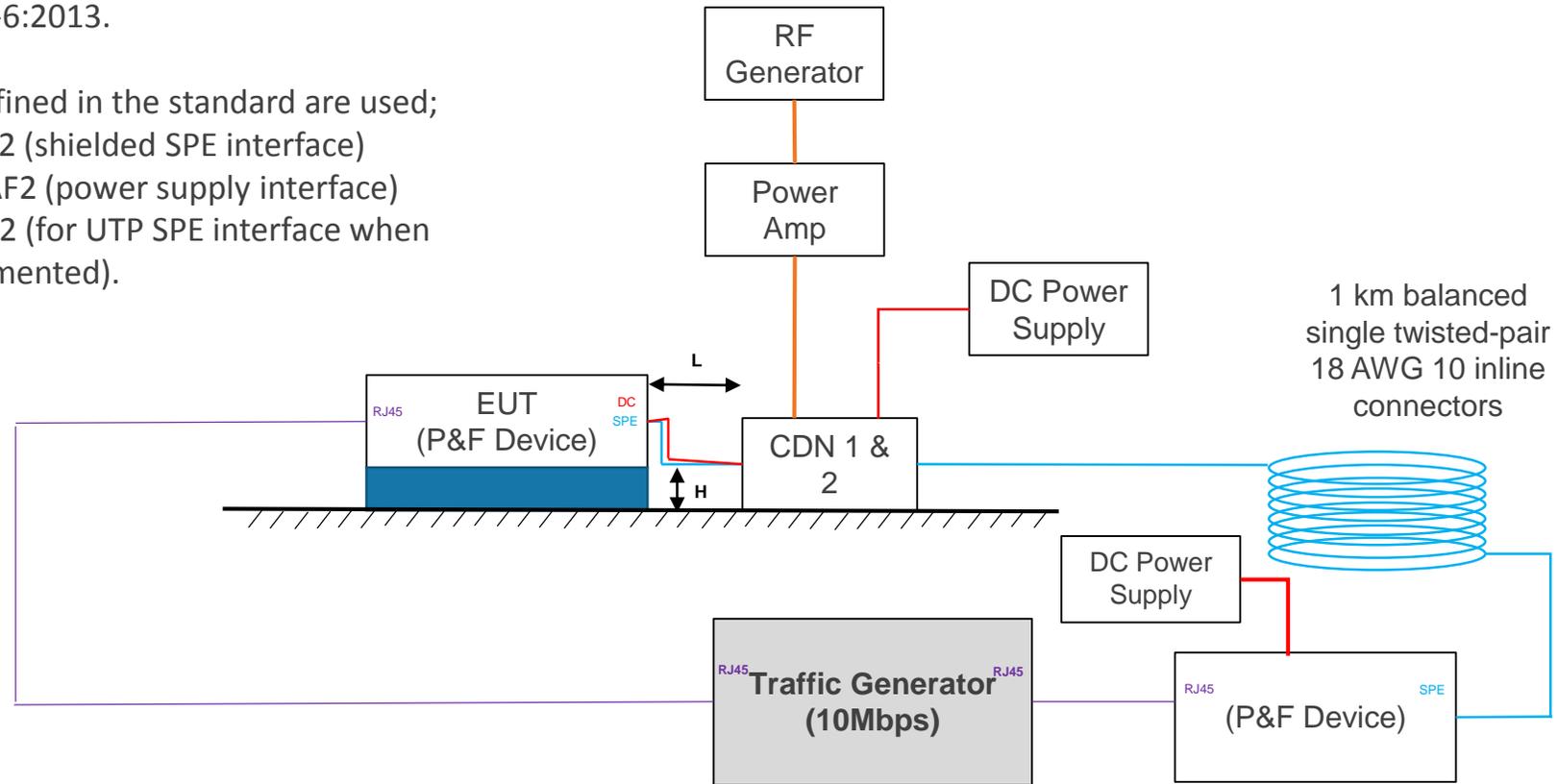
- Demonstrate PEPPERL+FUCHS 10BASE-T1L transceivers with IEC 63171-1 MDI connectors and a 1 km 18 AWG link segment with 10 inline connections passes IEC 61000-4-6 conducted immunity at 10 V rms
- Demonstrate that CommScope and Panduit IEC 63171-1 plug and jack components can be interchanged and pass IEC 61000-4-6 at 10 V rms

# EMC Test Setup

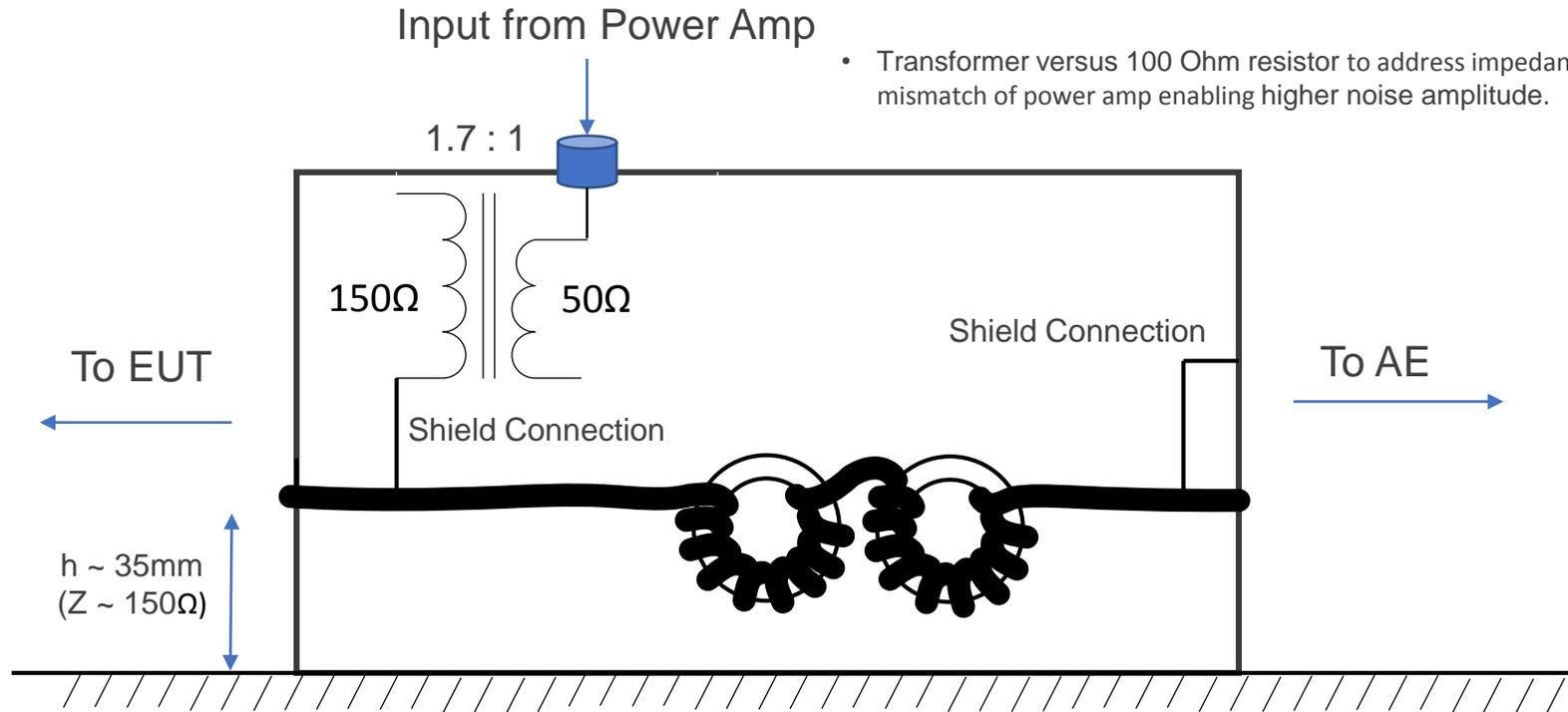
The conducted immunity measurements per IEC 61000-4-6:2013.

CDNs defined in the standard are used;

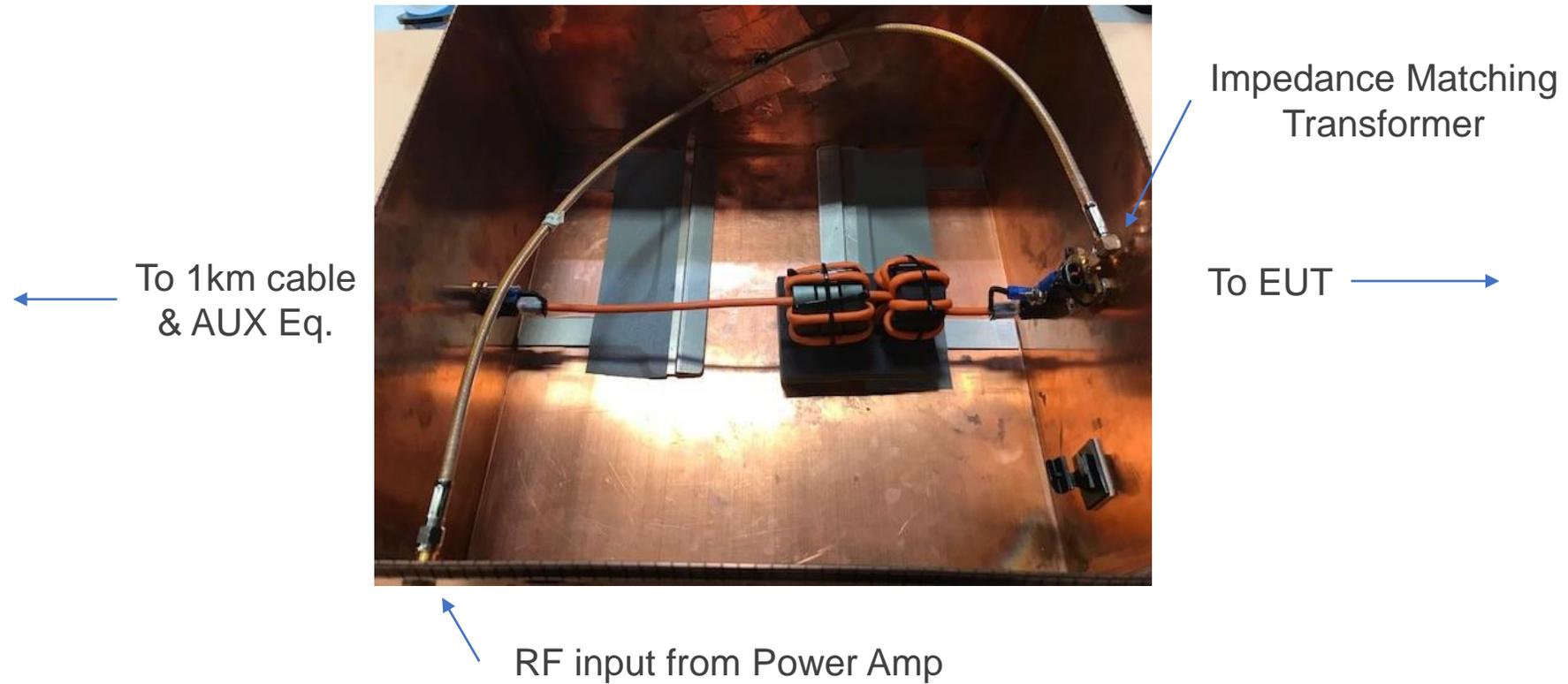
- CDN-S2 (shielded SPE interface)
- CDN-AF2 (power supply interface)
- CDN-T2 (for UTP SPE interface when implemented).



# CDN ( Coupling De-Coupling Network)



# CDN

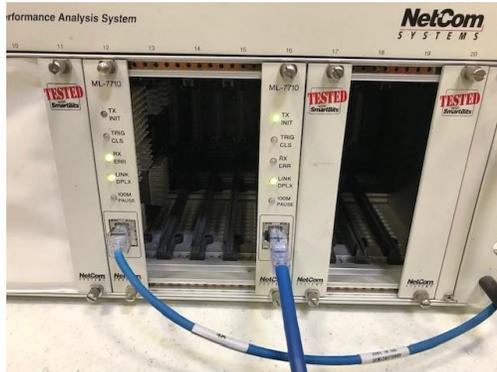


# Test Configuration

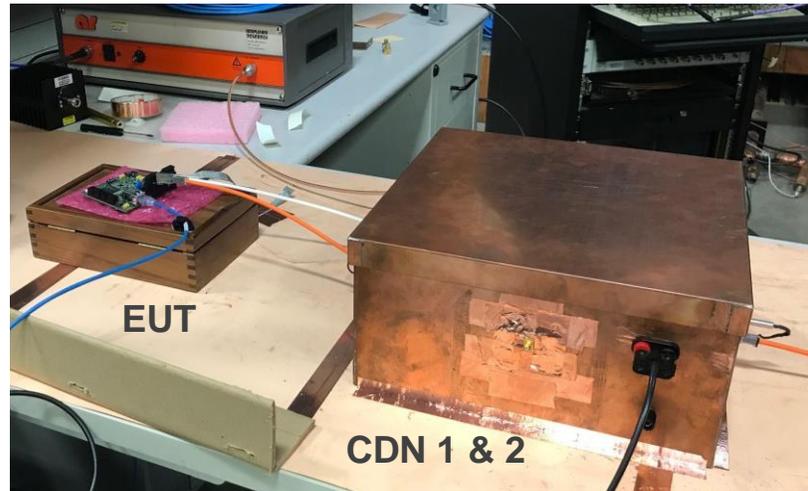
AUX Eq



Traffic Generator



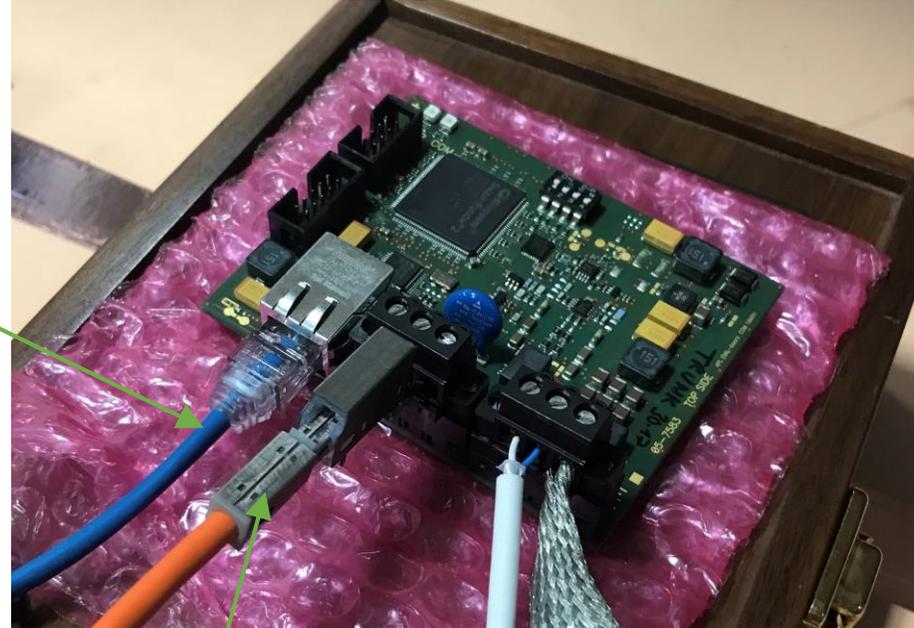
1 km balanced single  
twisted-pair 18 AWG  
10 inline connectors



Inline connector

# EUT with IEC 63171-1 MDI

MJ interface  
to traffic tester



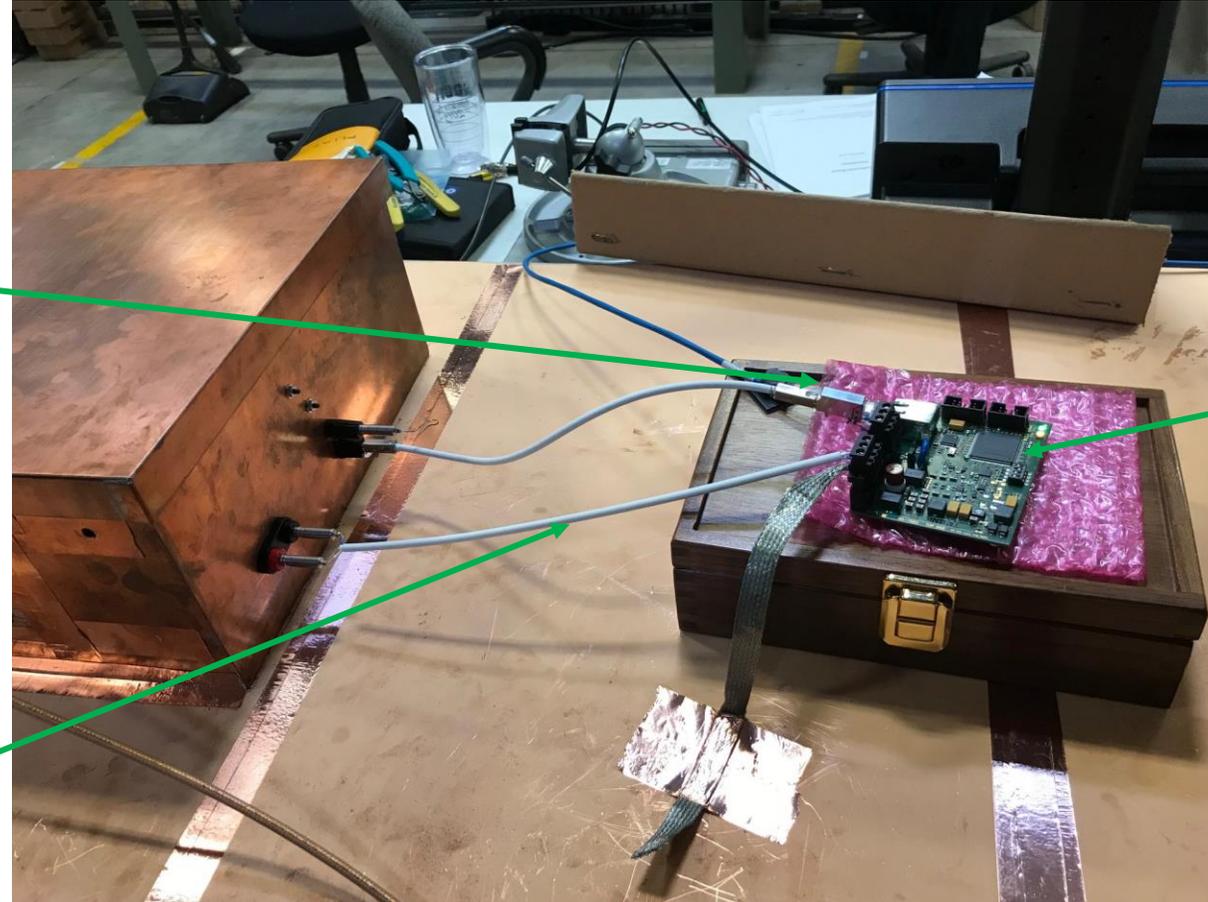
IEC 63171-1 MDI – Panduit shielded plug and connector

# IEC 61000-4-6 Measurement and DUT Setup



# Detail of cords connecting the CDN to the transceivers

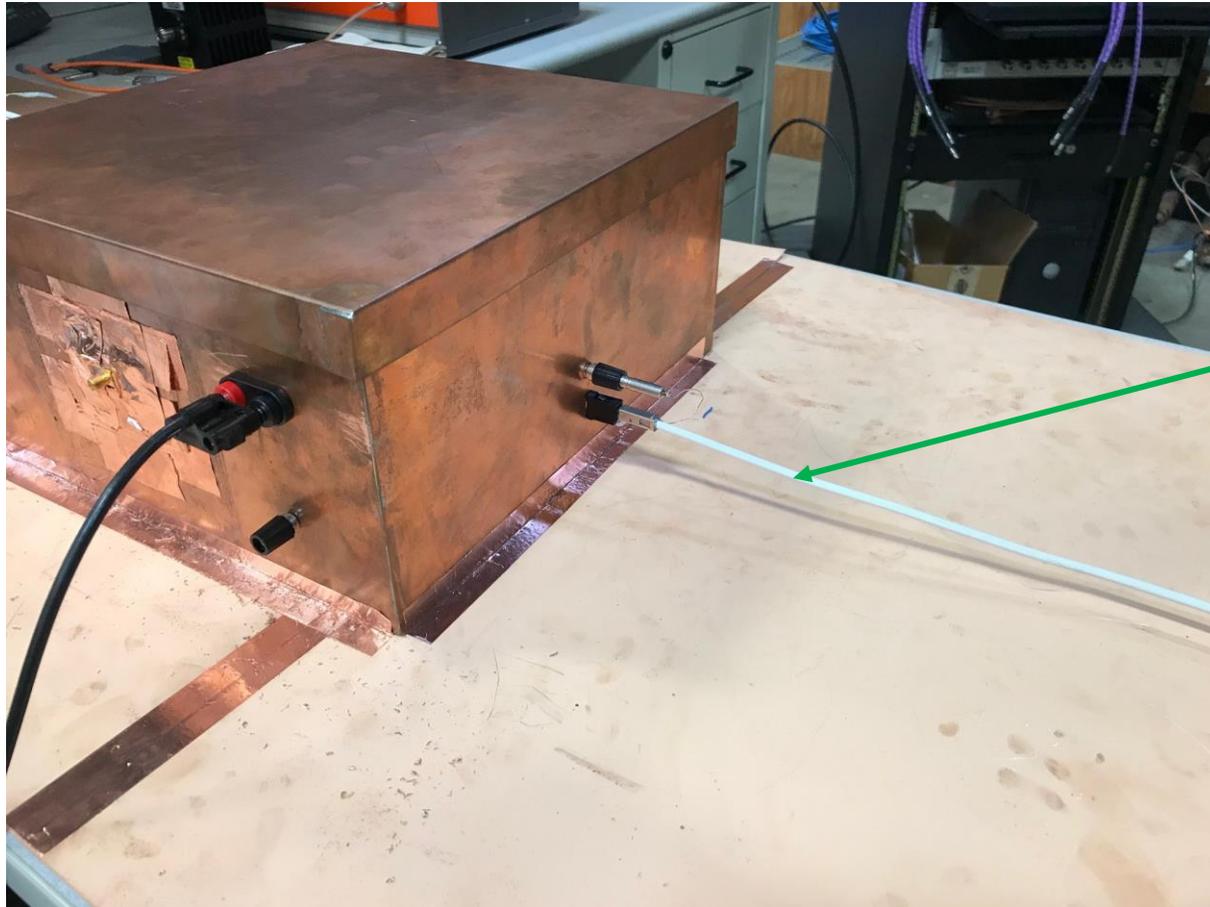
IEC 63171-1 MDI – CommScope shielded plug and connector



10-BASE-T1L  
transceiver

Power supply cord

# CDN 10BASE-T1L channel and input power connections



**IEC 63171-1 MDI – CommScope shielded cord**

# Pass Fail Criteria

## Criteria A:

The link operated normally at all levels up to and including the 802.3cg 10Vrms Vo requirement.

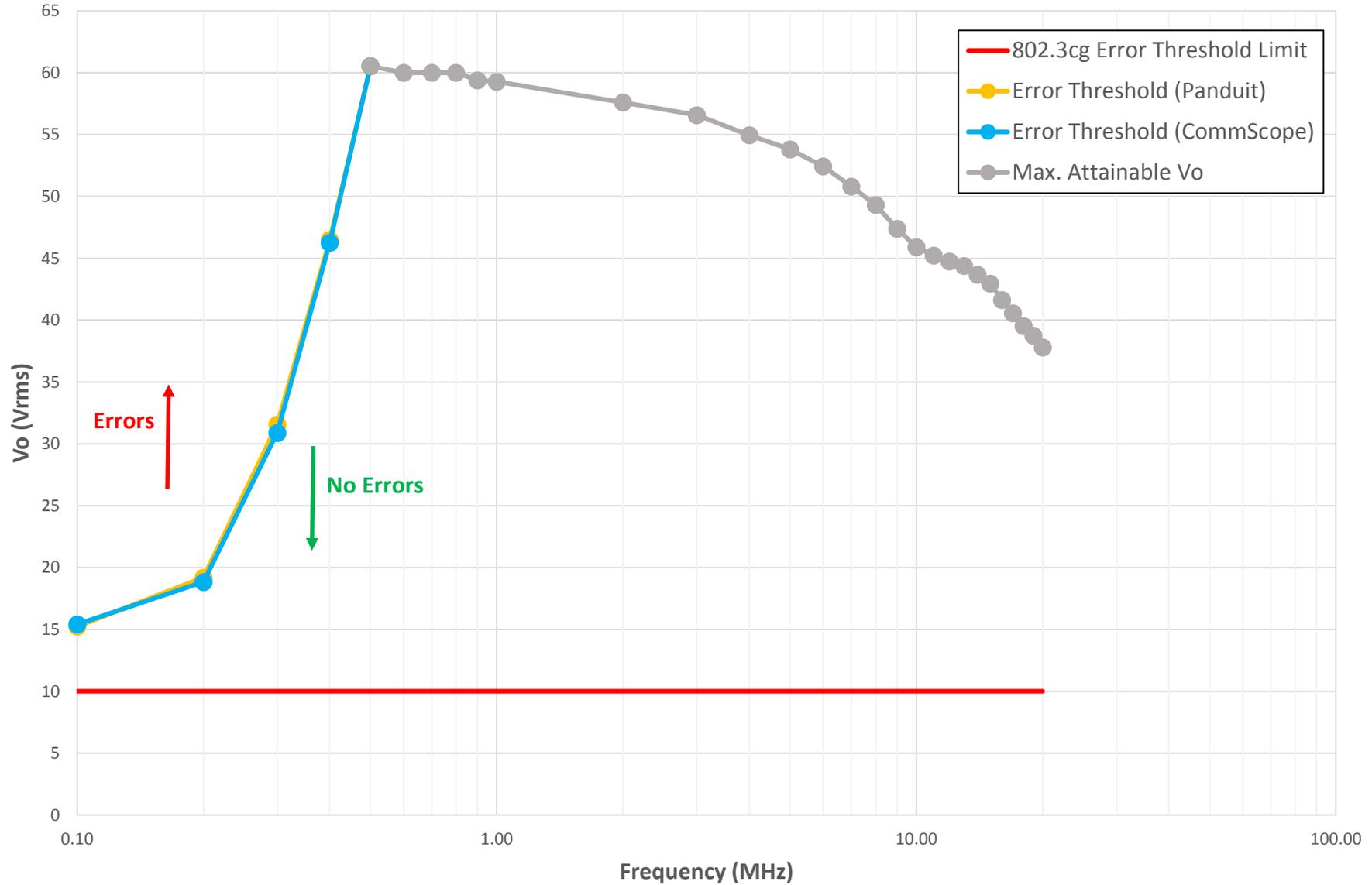
## Criteria B:

The link experienced temporary degradation at levels at and above the Vo Error-Threshold levels shown in the plot, which are all well above the 10Vrms requirement, but self-recovered once the Vo level was reduced below the Error Threshold level.

- Links tested passed Criteria A up to 10 V rms

**NOTE: Link/DUT also passed Criteria B above 10 V rms because the 10BASE-T1L link recovered back to normal operation without operator intervention once the noise level was reduced below the error threshold level of 10 V rms**

# Conducted Immunity



# Summary

- Pepperl+Fuchs 10Base-T1L development board easily met the conducted emissions requirement with IEC 63171-1 MDI connectors and patch cords from two independent vendors
- The plot also shows that the Error Threshold levels were not affected by changing out the CommScope plugs/cords, and MDI connectors with like Panduit components.
- The almost identical IEC 61000-4-6 EMC performance of Panduit and CommScope IEC 63171-1 connector/cords further demonstrates repeatable interoperability of SPE cords and MDI connectors

# Re-Cap & Recommendation

- The design, testing, and standards effort for IEC 63171-1 components has spanned over 2 years and involved many useful discussions/interactions with IEEE 802.3cg members as referenced below:
  - [http://www.ieee802.org/3/cg/public/July2017/keith\\_shariff\\_3cg\\_01\\_0717-rev2.pdf](http://www.ieee802.org/3/cg/public/July2017/keith_shariff_3cg_01_0717-rev2.pdf)
  - [http://www.ieee802.org/3/cg/public/Sept2018/pelletier\\_3cg\\_01a\\_0918.pdf](http://www.ieee802.org/3/cg/public/Sept2018/pelletier_3cg_01a_0918.pdf)
  - [http://www.ieee802.org/3/cg/public/Nov2018/shariff\\_3cg\\_01a\\_1118.pdf](http://www.ieee802.org/3/cg/public/Nov2018/shariff_3cg_01a_1118.pdf)
  - [http://www.ieee802.org/3/cg/public/Aug2019/diminico\\_3cg\\_01\\_0819.pdf](http://www.ieee802.org/3/cg/public/Aug2019/diminico_3cg_01_0819.pdf)
  - [http://www.ieee802.org/3/cg/public/Aug2019/shariff\\_3cg\\_08\\_0219.pdf](http://www.ieee802.org/3/cg/public/Aug2019/shariff_3cg_08_0219.pdf)
- IEEE 802.3cg should consider the long term strategic value of having a common connector to simplify testing while providing convenient mobility/interoperability of equipment and devices in the 10BASE-T1 ecosystem

Additional information related to comments  
r03-13 and r03-14

# IEEE 802.3 isolation requirements?

- Isolation requirements in IEEE 802.3cg now defer to the ongoing work in IEEE 802.3cr
- Current draft shows in annex J the following requirement

## **Annex J**

(normative)

### **Title of Clause**

*Insert Annex J at the end of the lettered Annexes.*

#### **J.1 Electrical Isolation**

This electrical isolation shall withstand at least one of the following electrical strength tests:

- a) 1500 V rms at 50 Hz to 60 Hz, applied as specified in Section 5.4.9.1 of IEC 62368-1:2018.
- b) 2250 V dc, applied as specified in Section 5.4.9.1 of IEC 62368-1:2018.
- c) A sequence of ten 2400 V impulses of alternating polarity, applied at intervals of not less than 1 s. The shape of the impulses is 1.2/50  $\mu$ s (1.2  $\mu$ s virtual front time, 50  $\mu$ s virtual time or half value), as defined in Annex D of IEC 62368-1:2018.

There shall be no insulation breakdown, as defined in Section 5.2.9.1 of IEC 62368-1:2018, during the test. The resistance after the test with the replacement of any components removed for AC or DC voltage testing shall be at least 2 M $\Omega$ , measured at 500 V dc as specified in Table 23 of IEC 62368-1:2018.

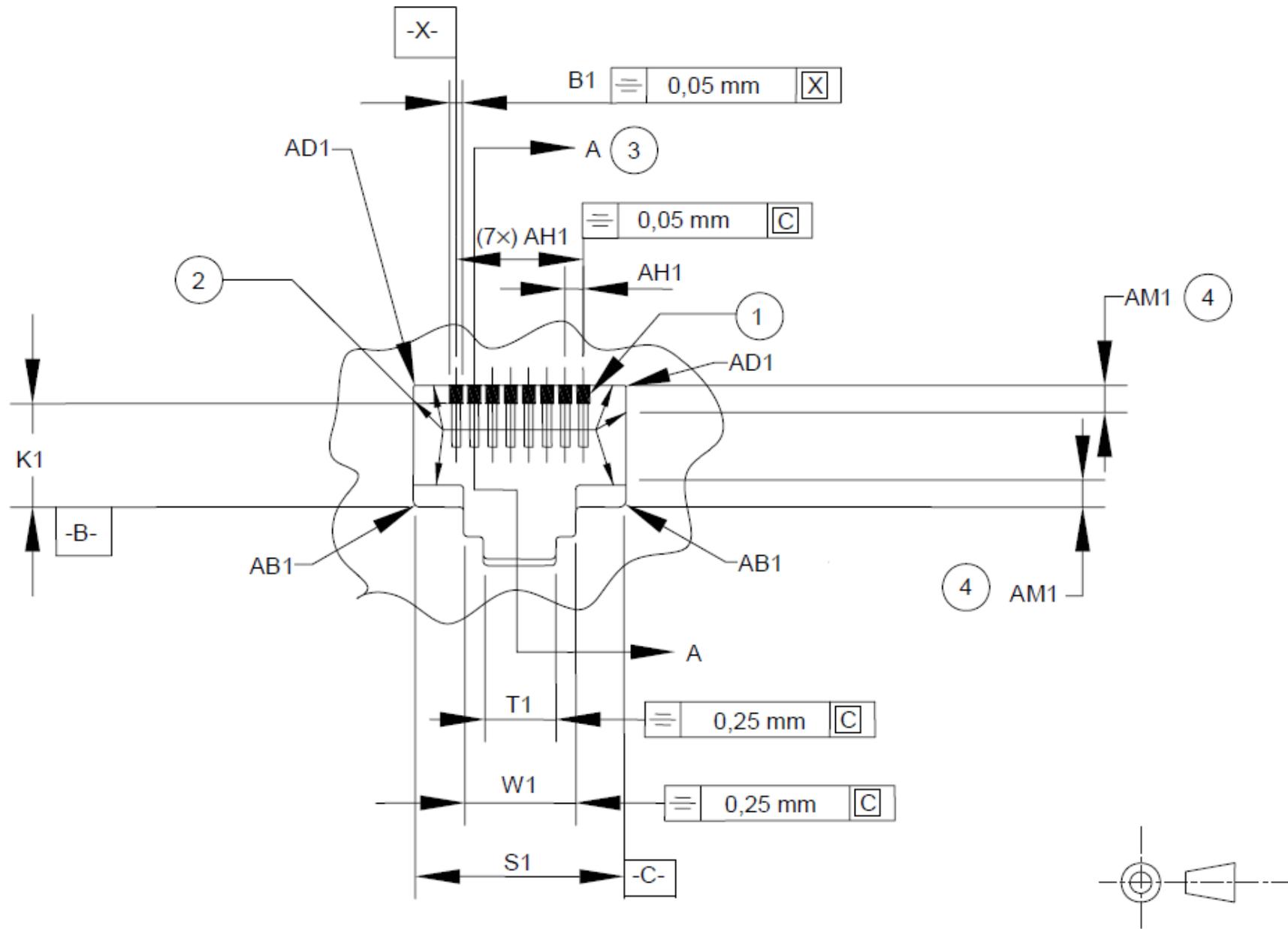
#### **J.2 General safety requirements**

All equipment meeting this standard shall conform to IEC 62368-1:2018.

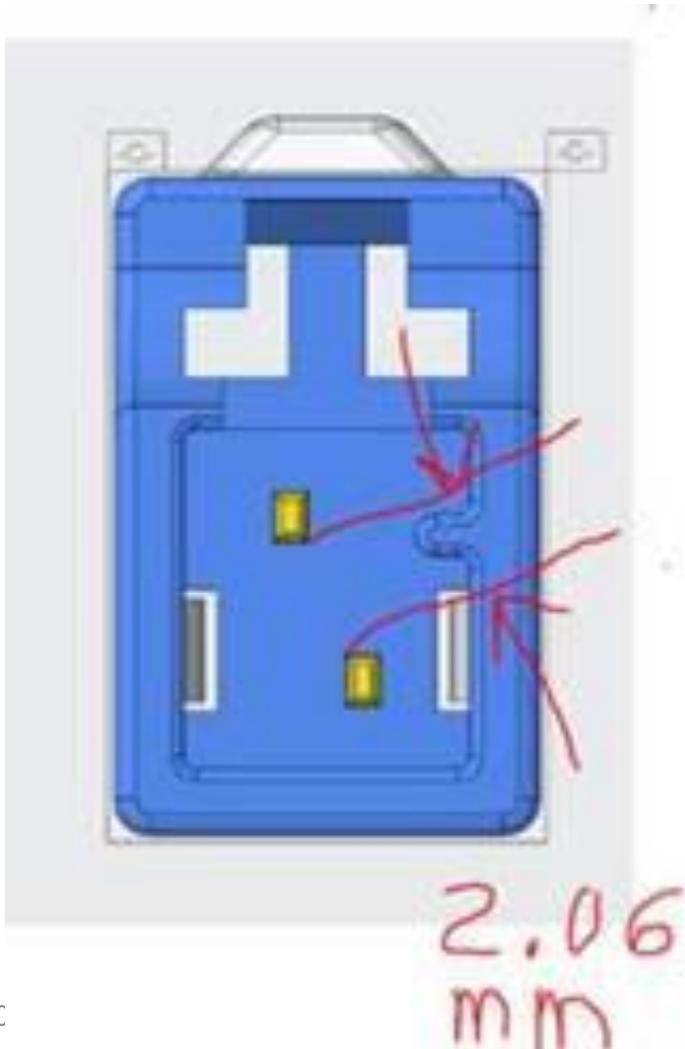
Baseline center  
to center  
physical spacing  
of contacts in IEC  
60603-7 (RJ45)  
specification  
Dimension AH1 is  
specified as:

AH1 1,02

### 3.2.3 Fixed connector



# Physical Isolation of the contacts specified in the IEC 63171-1 socket (MDI) connector



# Physical Isolation of the contacts specified in IEC 63171-1 plug connector

