Standards: Reading the Fine Print

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Legrand
1- Current standards and their structures
2- Standard Differences
3- Missing standards
4- Standards in Constant Evolution
5- Conclusion
Structured cabling is the infrastructure for the network in LAN environment.

Data applications used in this environment are almost exclusively ETHERNET.
Current Standards and their Structure

The applicable Standards are:

**Ethernet applications:**
IEEE is the International Organization for Ethernet.
Example: IEEE 802.3

**Cabling Performance and Structure:**
ISO is the International organization for structured cabling
Example: ISO 11801
Cenelec is the European organization for structured cabling
Example: EN 50173
TIA is the North American organization for structured cabling
Example: ANSI/TIA 568C
Current Standards and their Structure

802: LAN/MAN

802.1: Higher Layer LAN Protocols v
- 802.3j (1990): 10base-T, 10base-F
- 802.3u (1995): 100base-Tx, 100baseT4, 100base-FX
- 802.3z (1998): 1000base-X (fiber optic)
- 802.3ab (1999): 1000base-T
- 802.3ae (2003): 10G on fiber
- 802.3af (2003): Power over Ethernet (PoE)
- 802.3an (2006): 10Gbase-T
- 802.3at (2009): “Poe+”
- 802.3ba (2010): 40G on fibre
- 802.3bq (????): 40Gbase-T

802.3: Ethernet (CSMA/CD)
- 802.3z (1998): 1000base-X (fiber optic)
- 802.3j (1990): 10base-T, 10base-F
- 802.3u (1995): 100base-Tx, 100baseT4, 100base-FX
- 802.3ab (1999): 1000base-T
- 802.3ae (2003): 10G on fiber
- 802.3af (2003): Power over Ethernet (PoE)
- 802.3an (2006): 10Gbase-T
- 802.3at (2009): “Poe+”
- 802.3ba (2010): 40G on fibre

802.11: Wireless (CSMA/CA)
- 802.11a (1999): 54Mbps @ 5GHz
- 802.11b (1999): 11Mbps @ 2.4GHz
- 802.11g (2003): 54Mbps @ 2.4GHz
- 802.11n (2009): 150Mbps @ 2.4 and 5GHz w/ MIMO 4
- 802.11ac (2012): 867Mbps @ 5GHz w/ MIMO 8
- 802.11ad (2014?): 6.75Gbps @ 2.4, 5, and 60GHz

802.15: Wireless PAM (Bluetooth, Zigbee..)
- 802.15.4 (2003)
- 802.15.4z (2005)
- 802.15.4w (2009)
- 802.15.4q (2010)
- 802.15.4v (2011)
- 802.15.4u (2014)
- 802.15.4x (2015)

...
# Current Standards and their Structure

<table>
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<tr>
<th>Component, Performance, Design</th>
<th>Implementation</th>
<th>Validation</th>
</tr>
</thead>
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<td><strong>TIA - 568-C.2</strong>&lt;br&gt;Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components</td>
<td><strong>TIA - 607-B</strong>&lt;br&gt;Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications</td>
<td><strong>TIA-536-14</strong>&lt;br&gt;Optical Power Loss Measurements of Installed Multi-Mode Fibre Cable Plant OFSTP-14</td>
</tr>
<tr>
<td><strong>TIA - 568-C.3</strong>&lt;br&gt;Optical Fibre Cabling Components Standard</td>
<td><strong>TIA - 606-B</strong>&lt;br&gt;Administration Standard for Telecommunications infrastructure</td>
<td><strong>TIA-TSB-155</strong>&lt;br&gt;Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10Gbase-T</td>
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<tr>
<td><strong>TIA - 758-B</strong>&lt;br&gt;Customer-Owned Outside Plant Telecommunications Cabling Standard</td>
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<td></td>
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<tr>
<td><strong>TIA - 862-A</strong>&lt;br&gt;Building Automation Systems Cabling Standard</td>
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<tr>
<td><strong>TIA - 942</strong>&lt;br&gt;Telecommunications Infrastructure Standard for data centres</td>
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<td></td>
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<tr>
<td><strong>TIA - 1005</strong>&lt;br&gt;Telecommunications Infrastructure Standard for Industrial Premises</td>
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<tr>
<td><strong>TIA - 1179</strong>&lt;br&gt;Telecommunications Infrastructure Standard for Healthcare Facilities</td>
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Current Standards and their Structure

<table>
<thead>
<tr>
<th>Components</th>
<th>Implementation</th>
<th>Validation</th>
</tr>
</thead>
</table>
| ISO/IEC 11801  
Information Technology  
Generic cabling for customer premises | ISO/IEC 14763-2  
Implementation and Operation of Customer Premises  
Part 2: Planning and Installation Implementation | ISO/IEC 61935-1  
Testing of balanced communication cabling in accordance with ISO/IEC  
Part 1: Installed Cabling |
| ISO/IEC 24764  
Information Technology  
Generic cabling for data centres |  | ISO/IEC 41763-3  
Implementation and Operation of Customer premises Cabling  
Part 3: Optical fibre cabling |
| ISO/IEC 24702  
Information Technology  
Generic cabling for industrial premises |  |  |
| ISO/IEC 24704  
Information Technology  
Customer premises cabling for wireless access points |  |  |
## Current Standards and their Structure

<table>
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<tr>
<th>Performance, Design</th>
<th>Implementation</th>
<th>Validation</th>
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<tbody>
<tr>
<td>CENELEC EN50173-1</td>
<td>CENELEC EN50174-1</td>
<td>CENELEC EN50346</td>
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<tr>
<td>Information Technology</td>
<td>Information technology</td>
<td>Information technology</td>
</tr>
<tr>
<td>Generic cabling systems</td>
<td>Cabling installation</td>
<td>Cabling installation</td>
</tr>
<tr>
<td>CENELEC EN50173-2</td>
<td>CENELEC EN50174-2</td>
<td></td>
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<tr>
<td>Information Technology</td>
<td>Information technology</td>
<td></td>
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<tr>
<td>Generic cabling systems</td>
<td>Cabling installation</td>
<td></td>
</tr>
<tr>
<td>Part 2: Office premises</td>
<td>Part 2: Installation planning and practices inside buildings</td>
<td></td>
</tr>
<tr>
<td>CENELEC EN50173-3</td>
<td>CENELEC EN50174-3</td>
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</tr>
<tr>
<td>Information Technology</td>
<td>Implementation and Operation of Customer premises</td>
<td></td>
</tr>
<tr>
<td>Generic cabling systems</td>
<td>Part 2: Planning and Installation</td>
<td></td>
</tr>
<tr>
<td>Part 3: Industrial premises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CENELEC EN50173-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generic cabling systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 4: Homes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CENELEC EN50173-5</td>
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<td></td>
</tr>
<tr>
<td>Information Technology</td>
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<td></td>
</tr>
<tr>
<td>Generic cabling systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 5: Data centers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1- Current standards and their structures
2- Standard Differences
3- Missing standards
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Let’s start simple with the terminology for design in commercial environment.
Standard Differences

But what’s an outlet?

...is this 1 or 2 outlets?
Standard Differences

- **ANSI/TIA 568-C.1**

  telecommunications outlet: An assembly of components consisting of one or more connectors mounted on a faceplate, housing or supporting bracket...

  - 1 outlet with 2 connectors

- **ISO 11801**

  telecommunications outlet
  fixed connecting device where the horizontal cable terminates

  - 2 outlets in one assembly
Standard Differences

There are 2 wiring schemes for the connector:

- **T568A**:
  - 1: White - Green
  - 2: Green - White
  - 3: White - Orange
  - 4: Blue - White
  - 5: White - Blue
  - 6: Orange - White
  - 7: White - Brown
  - 8: Brown - White

- **T568B**:
  - 1: White - Orange
  - 2: Orange - White
  - 3: White - Green
  - 4: Blue - White
  - 5: White - Blue
  - 6: Green - White
  - 7: White - Brown
  - 8: Brown - White

Which standard is this from?
Standard Differences

- ANSI/TIA 568-C.0

5.3.3.2 Eight-position modular jack pin-pair assignments
Pin/pair assignments shall be as shown in figure 4 or, optionally, per figure 5 if necessary to accommodate certain 8-pin cabling systems. The colors shown are associated with 4-pair cable.

```
Pair 2
Pair 3
Pair 1
Pair 4
1  2  3  4  5  6  7  8
W.G W.O W.O BL W.BL 6 W.BR BR
```

Figure 4 – Front view of eight position jack pin/pair assignments (T568A)

```
Pair 2
Pair 3
Pair 1
Pair 4
1  2  3  4  5  6  7  8
W.O W.G W.O W.BL W.BL G W.BR BR
```

Figure 5 – Front view of optional eight-position jack pin/pair assignment (T568B)
Standard Differences

- What about ISO 11801?

10.2.5 TO requirements

For all cabling classes, each horizontal balanced cable shall be terminated at the telecommunications outlet with an unkeyed fixed connector (jack) that meets the specifications of 10.2.3 and 10.2.4. Pin and pair grouping assignments shall be as shown in Figure 15, Figure 16 or Figure 17.

No color – coding!
How about some distances for horizontal cabling:

- Maximum PL length: 90m
- Maximum CHA length: 100m
- Maximum WA cord length: 5m
- Equipment cord and patch cord combined: 5m

ISO 11801, figure 10
Standard Differences

What about the minimum distances?

ISO 11801, figure 10

TIA 568-C.1:
For balanced twisted-pair cabling, in order to reduce the effect of multiple connections in close proximity on NEXT loss and return loss, the CP should be located at least 15 m (49 ft) from the TR or TE.

The 3dB rule:
If the measured Insertion Loss is less than 3dB, then the Return Loss measurement is ignored.

The 4dB rule: (Only for ISO.)
If the measured Insertion Loss is less than 4dB, then the NEXT measurement is ignored.

TIA 568-C.2: Figure J.1: Channel modeling configurations used for worst case analysis

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Channel configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Work area cord</td>
<td>5 m 2 m 1 m 1 m 1 m</td>
</tr>
<tr>
<td>T0</td>
<td>Telecommunications outlet / connector</td>
<td>p p p p p</td>
</tr>
<tr>
<td>B</td>
<td>Consolidation point cabling</td>
<td>5 m 5 m 5 m NP NP</td>
</tr>
<tr>
<td>CP</td>
<td>Consolidation point connector</td>
<td>p p p p NP NP</td>
</tr>
<tr>
<td>C</td>
<td>Horizontal cabling</td>
<td>85 m 15 m 15 m 15 m 10 m</td>
</tr>
<tr>
<td>C1</td>
<td>Horizontal cross-connect or interconnect</td>
<td>p p p p p</td>
</tr>
<tr>
<td>D</td>
<td>Patch cord or jumper cable</td>
<td>5 m 1 m 1 m 1 m 1 m</td>
</tr>
<tr>
<td>C2</td>
<td>Horizontal cross-connect or interconnect</td>
<td>p p p NP</td>
</tr>
<tr>
<td>E</td>
<td>Telecommunications room equipment cord</td>
<td>3 m 2 m 2 m 2 m NP</td>
</tr>
</tbody>
</table>

NP = Not present in this channel model
P = Present in this channel model

ISO 11801, table 32: Length assumptions used in the mathematical modeling of balanced horizontal cabling

<table>
<thead>
<tr>
<th>Segment</th>
<th>Minimum m</th>
<th>Maximum m</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD-CP</td>
<td>--</td>
<td>85</td>
</tr>
<tr>
<td>CP-TO</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>FD-TO (no CP)</td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>Work area cord</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Patch cord</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Equipment cord</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>All cords</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>
Let’s summarize this minimum length stuff…

- If your CP is closer than 15m to the patch panel, your test will probably always pass because of the 3dB rule...
  
  ... but this doesn’t mean that the complete permanent link will pass when you add the cabling to the outlet.

- Don’t do it. (unless specific single manufacturer warranty)

- Cords shorter than 1m are not standard compliant in the “inter-operable” sense.
  (Therefore can only be used in specific single manufacturer warranty)
The test of a permanent link of 95m would pass or fail?

1. Which standard are we using?
   - **TIA**: the 90m limit applies. The link would fail.
   - **ISO**: the length is informative only. The link would pass irrelevant on length.

2. How does the instrument know the length?
   - Length = NVP x C x Propagation Delay
   - NVP is a user input...anyone can make mistakes...
   - NVP is not precise. 10% uncertainty is “normal”.

American test limits for equipment are in ANSI/TIA-1152. Although the limit is 90m, it takes into account the variation and will allow up to 99m.

The shortest pair is used as reference.
And is the 90m PL rule always valid?

Condition 1: Not if we use a MUTOA

TIA-568-C.1, figure 6

TIA-568-C.1, Table 1

ISO 11801, Table 33
And what’s the maximum length of the W.A. cord in this case?

- **TIA:**

<table>
<thead>
<tr>
<th>Length of horizontal cable H (m ft)</th>
<th>24 AWG cords</th>
<th>26 AWG cords</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum length of work area cord W (m ft)</td>
<td>Maximum combined length of work area cord, patch cords, and equipment cord C (m ft)</td>
</tr>
<tr>
<td>90 (290)</td>
<td>5 (16)</td>
<td>10 (33)</td>
</tr>
<tr>
<td>85 (279)</td>
<td>9 (30)</td>
<td>14 (46)</td>
</tr>
<tr>
<td>60 (262)</td>
<td>13 (44)</td>
<td>18 (59)</td>
</tr>
<tr>
<td>75 (246)</td>
<td>17 (57)</td>
<td>22 (72)</td>
</tr>
<tr>
<td>70 (230)</td>
<td>22 (72)</td>
<td>27 (89)</td>
</tr>
</tbody>
</table>

- **ISO:**

where a multi-user TO assembly is used, the length of the work area cord should not exceed 20 m
And is the 90m PL rule always valid?

Condition 2: All values in the standards assume an ambient temperature of 20°C (68°F)

<table>
<thead>
<tr>
<th>Model</th>
<th>Figure</th>
<th>Class D channels using Category 5 components</th>
<th>Class E channels using Category 6 components</th>
<th>Class F channels using Category 7 components</th>
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</thead>
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<tr>
<td>Interconnect - TO</td>
<td>12a</td>
<td>$H = 109 - FX$</td>
<td>$H = 107 - 3^* - FX$</td>
<td>$H = 107 - 2^* - FX$</td>
</tr>
<tr>
<td>Cross-connect - TO</td>
<td>12b</td>
<td>$H = 107 - FX$</td>
<td>$H = 106 - 3^* - FX$</td>
<td>$H = 106 - 3^* - FX$</td>
</tr>
<tr>
<td>Interconnect - CP - TO</td>
<td>12c</td>
<td>$H = 107 - FX - CY$</td>
<td>$H = 106 - 3^* - FX - CY$</td>
<td>$H = 106 - 3^* - FX - CY$</td>
</tr>
<tr>
<td>Cross-connect - CP - TO</td>
<td>12d</td>
<td>$H = 105 - FX - CY$</td>
<td>$H = 105 - 3^* - FX - CY$</td>
<td>$H = 105 - 3^* - FX - CY$</td>
</tr>
</tbody>
</table>

$H$ the maximum length of the fixed horizontal cable (m)
$F$ combined length of patch cords/patch panels, equipment and work area cords (m)
$C$ the length of the CP cable (m)
$X$ the ratio of cord cable insertion loss (dB/m) to fixed horizontal cable insertion loss (dB/m) – see Clause 9
$Y$ the ratio of CP cable insertion loss (dB/m) to fixed horizontal cable insertion loss (dB/m) – see Clause 9

NOTE For operating temperatures above 20 °C, H should be reduced by 0.2% per °C for screened cables; 0.4% per °C (20 °C to 40 °C) and 0.6% per °C (>40 °C to 60 °C) for unscreened cables.

* This length reduction is to provide an allocated margin to accommodate insertion loss deviation.

ISO 11801, Table 33
Is this temperature issue important?

- Where are the cables installed?
  - Commercial installations: Plenum space.
  - Datacenter: Hot area.
- How about PoE?
  - P is the power converted from electrical to thermal energy.
  - I = current, R = Resistance
So what temperature increase can we expect?

- IEEE 802.3af, 2003: PoE
- IEEE 802.3at, 2009: “PoE+”
- Future IEEE 802.3bt: “4pair PoE+”
- HDBase-T (A/V Alliance):
- Modified Future IEEE 802.3bt: “4pair PoE+ 100W...”

* ΔT ≤ 15°C

Current: 600mA
Voltage: 44V
Power: 30W
Pairs: 2 (≥ Cat5e)

ΔT ≤ 5°C depending on test conditions*

Current: 1.2A
Pairs: 4 (≥ Cat5e)
Power: 49W

ΔT ≤ 10°C

Current: 500mA per pair
(≥ total 2A)

Power: 13.95W

Current: 1-2A?
(P=UI)

Power: 12.95W

* See ISO/IEC 25129 ed.2.0 Draft
So let’s calculate the cable temperature:

- **Datacenter, installed over the cabinets in the hot area:**
  - Hot Aisle temperature 35°C (95°F) to 40°C (104°F)
  - De-Rating of 6m.

- **Factory, installed under the (high) ceiling**
  - The air below the ceiling is very hot, and PoE makes it hotter: 60°C (140°F)
  - De-Rating of 15m.

<table>
<thead>
<tr>
<th>Temperature (°C (°F))</th>
<th>Maximum horizontal unscreened cable length (m)</th>
<th>Maximum horizontal screened cable length (m)</th>
<th>Length de-rating (m) (unscreened)</th>
<th>Length de-rating (m) (screened)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 (68)</td>
<td>90.0</td>
<td>90.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25 (77)</td>
<td>89.0</td>
<td>89.5</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>30 (86)</td>
<td>87.0</td>
<td>88.5</td>
<td>3.0</td>
<td>1.5</td>
</tr>
<tr>
<td>35 (95)</td>
<td>85.5</td>
<td>87.7</td>
<td>4.5</td>
<td>2.3</td>
</tr>
<tr>
<td>40 (104)</td>
<td>84.0</td>
<td>87.0</td>
<td>6.0</td>
<td>3.0</td>
</tr>
<tr>
<td>45 (113)</td>
<td>81.7</td>
<td>86.5</td>
<td>8.3</td>
<td>3.5</td>
</tr>
<tr>
<td>50 (122)</td>
<td>79.5</td>
<td>85.5</td>
<td>10.5</td>
<td>4.5</td>
</tr>
<tr>
<td>55 (131)</td>
<td>77.2</td>
<td>84.7</td>
<td>12.8</td>
<td>5.3</td>
</tr>
<tr>
<td>60 (140)</td>
<td>75.0</td>
<td>83.0</td>
<td>15.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

*Caution on those engineered “short length links”*

*Reduce even more if there’s a MUTOA in the link*

*TIA 568-C.2, Table G.2*
Don’t assume that you are always allowed up to 90m permanent link
Let’s take a look at some fiber

- The fiber standards are evolving extremely fast, and often the standard just cannot keep up fast enough. Examples when OM1, OM2, OM3, OM4 terminologies appeared.
  - OM1 is 160MHz.km or 200MHz.km @ 850nm?
  - Remember laser-optimized fiber?
  - And what is the maximum distance for 10Gbase-SR on OM2?
- But a significant difference today is the test method.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Fiber</th>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIA/TIA-526-14B</td>
<td>Multimode</td>
<td>Method A</td>
<td>Method B</td>
<td>Method C</td>
</tr>
<tr>
<td>EIA/TIA-526-7</td>
<td>Singlemode</td>
<td>Method B.1</td>
<td>Method A.1</td>
<td>Method C.1</td>
</tr>
<tr>
<td>IEC 61280-4-1</td>
<td>Multimode</td>
<td>Method 1: 2-Jumper</td>
<td>Method 2: 1-Jumper</td>
<td>Method 3: 3-Jumper</td>
</tr>
<tr>
<td>IEC 61280-4-2</td>
<td>Singlemode</td>
<td>Method 1b: 2-Jumper</td>
<td>Method 1a: 1-Jumper</td>
<td>Method 1c: 3-Jumper</td>
</tr>
</tbody>
</table>
Apply the test method

- To test a multimode link, use the 1- Jumper method:
  - Use an encircled flux compliant light source
  - Set reference
  - Verify the patch cord performance
  - Test
Standard Differences

What’s the result?

- If we measure at 850nm:
  - 100m of OM3 cable
  - Two connector pairs
  - The result is:

\[
0.1\text{km} \times 3.5\text{dB/km} = 0.35 \\
2 \times 0.75\text{dB/km} = 1.5 \\
1.85 \text{ dB}
\]

<table>
<thead>
<tr>
<th>Attenuation with reference cords</th>
<th>Multimode</th>
<th>Singlemode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Cord to Reference Cord</td>
<td>0.10 dB</td>
<td>0.20 dB</td>
</tr>
<tr>
<td>Reference Cord to non-Reference Cord</td>
<td>0.30 dB</td>
<td>0.50 dB</td>
</tr>
<tr>
<td>Non-Reference Cord to non-Reference Cord</td>
<td>0.75 dB</td>
<td>0.75 dB</td>
</tr>
</tbody>
</table>

ISO requires the use of reference cords for testing
Caution when measuring your maximum attenuation for specific applications!
1- Current standards and their structures
2- Standard Differences
3- Missing standards
4- Standards in Constant Evolution
5- Conclusion
Missing Standards

Some standards have no equivalent

- Everyone know the forgotten standard?
  - ANSI/TIA-606-B
- What’s the equivalent in ISO?
  - There is none!
- How about Grounding and bonding?
  - ANSI/TIA-607-B
- And in ISO?
  - Nothing..yet. Future ISO/IEC 30129
- The TIA 942 was first published in 2005
  - ISO 24764 was not published until 2010
- Residential, Industrial, Healthcare, building automation, most of these were published in TIA years before ISO.
Missing Standards

But let’s look at one standard missing in TIA…

- The future PoE will be around 500mA per conductor.
- We’ve seen the possible issues with heat in the cable.
- What about the connector?
  - Unplugging a connector under power creates an electrical arc
Missing Standards

The 8P8C is not designed for this !!!
Missing Standards

So what’s the American standard for connector resistance to PoE?

- There is none!
  - TIA standards cover performance, not durability
  - Durability is the FCC part 68 subpart F. But it doesn’t cover PoE.

- But there is an international standard for this: IEC 60512-99-001, 2012

Connectors for electronic equipment – Tests and measurements – Part 99-001: Test schedule for engaging and separating connectors under electrical load – Test 99a: Connectors used in twisted pair communication cabling with remote power
The IEC 60512-99-001

- It ensure minimal compliance to PoE
- “...used for the assessment of connectors....in support of IEEE std 802.3at-2009...”

- Connection / disconnection under 55V DC with a current of 600mA, which corresponds to a power of 33W in each conductor.
- 100 connections / disconnections under load, alternated with polarity change and ageing.

1. Cables in accordance with 4.1
2. Connector under test
3. Inductor 100 µH
4. Variable resistor
5. Capacitor 5 µF
6. Power source
But now the TIA references the IEC for component reliability

- ANSI/TIA-568-C.2, Annex A: Reliability testing of connecting equipment
- So the IEC 60512-99-001 could be also applicable for TIA

A.3 Modular plugs and jacks
Modular plugs and jacks shall comply with the reliability requirements of the applicable standard specified in Table A.2.

<table>
<thead>
<tr>
<th>Category and type</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 3, unscreened</td>
<td>IEC 60603-7</td>
</tr>
<tr>
<td>Category 3, screened</td>
<td>IEC 60603-7-1</td>
</tr>
<tr>
<td>Category 5e, unscreened</td>
<td>IEC 60603-7-2</td>
</tr>
<tr>
<td>Category 5e, screened</td>
<td>IEC 60603-7-3</td>
</tr>
<tr>
<td>Category 6, unscreened</td>
<td>IEC 60603-7-4</td>
</tr>
<tr>
<td>Category 6, screened</td>
<td>IEC 60603-7-5</td>
</tr>
<tr>
<td>Category 6A, unscreened</td>
<td>IEC 60603-7-41</td>
</tr>
<tr>
<td>Category 6A, screened</td>
<td>IEC 60603-7-51</td>
</tr>
</tbody>
</table>

A.5.1 General
As an example, the reliability of a modular jack with accessible insulation displacement connections is demonstrated by complying with the applicable requirements of both IEC 60352-3 and IEC 60603-7-4. The test schedules described in IEC 60352-3 and IEC 60603-7-4 at the time of this Standard’s publication are outlined in clause A.5.2, as depicted in figure A.1, and clause A.5.3, as depicted in figure A.2. It is advisable to refer to the IEC Standards for updates and revisions.
1- Current standards and their structures
2- Standard Differences
3- Missing standards
4- Standards in Constant Evolution
5- Conclusion
Standards in Constant Evolution

The standards are never perfect.

- There is always a first version to cover a need
- Then amendments to improve
- Then a revision
Standards in Constant Evolution

The first structured cabling standard was the TIA/EIA 568:1991.

- What categories were specified?
  - None.

  - Cat.3, Cat4, Cat.5
Standards in Constant Evolution

When did testing first appear?

- 1995, in TSB67 (of TIA 568-B)
- So for 4 years, you could install Cat.5 without testing!
Standards in Constant Evolution

What was the international standard at the time?

- There was none.
  - ISO 11801 1st edition was ratified only in 1995
- What impedance were the components in ISO 11801?
  - 100, 120 or 150 Ohm
  - How do you connect together? No One knows....
Standards in Constant Evolution

Gigabit Ethernet IEEE 802.3ab was ratified in 1999. What Category was it specified for?

- Category 5.
  - The objective was to use the 100MHz bandwidth and the 4 pairs
- Did it work on Cat.5?
  - Not really. That’s why additional testing was specified in TIA TSB 95: 1999
  - Then Cat.5e also appeared in addenda 5

IEEE STANDARD
802.3ab-1999 - IEEE Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T
Standards in Constant Evolution

So now Cat5 is replaced by Cat5e. What Categories are still valid today?

<table>
<thead>
<tr>
<th>TIA Category</th>
<th>ISO Category</th>
<th>Frequency</th>
<th>Testing Level and Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>16 MHz</td>
<td></td>
</tr>
<tr>
<td>5e</td>
<td>5</td>
<td>100 MHz</td>
<td>IIe 100 MHz</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>250 MHz</td>
<td>III 250 MHz</td>
</tr>
<tr>
<td>6A</td>
<td>6_A</td>
<td>500 MHz</td>
<td>IIIe 500 MHz</td>
</tr>
<tr>
<td>7 (1)</td>
<td>6_A</td>
<td>600 MHz</td>
<td>IV 600 MHz</td>
</tr>
<tr>
<td>7_A</td>
<td></td>
<td>1 GHz</td>
<td>IV (2) 600 MHz</td>
</tr>
</tbody>
</table>

(1) Category 7 is actually 6 years older than Category 6A
(2) There will be a level V 1GHz in the future
1- Current standards and their structures
2- Standard Differences
3- Missing standards
4- Standards in Constant Evolution
5- Conclusion
Conclusion

Standards are always improving

- By definition, since our knowledge increases and the technologies improve, a standard can never be perfect, but only the “best effort”.

- To fully comprehend them, we need to understand the differences and their limits.
Thank You

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