Category 8 Cable Testing

Dennis L. Molina
PECE, CCTT, CSCIS
Senior Technical Manager
AWS DISTRIBUTION PHILIPPINES CORP.
CATEGORY 8 CABLE TESTING

Dennis L. Molina, PECE, CCTT, CSCIS
Senior Technical Manager
AWS DISTRIBUTION PHILIPPINES CORP.
AGENDA

Copper Field Testing Standards Update
Emerging Ethernet Technologies

• Copper based Technologies
  – New speeds introduced for Copper Cables
    • IEEE802.3bz, sometimes referred to as NBASE-T
      – 2.5GBASE-T and 5GBASE-T on Cat 5e or Cat 6 cables
    • 25GBASE-T and 40GBASE-T on Cat 8 cabling
  – Longer Channels
    • 200m Channel at 2.5GBASE-T is possible, happening already.
  – More Power delivered
    • 802.3bt will be able to deliver in excess of 90 watts.
What are the relevant standards for Cat 8 cabling?

- IEEE 802.3bq 25G/40GBASE-T, published 8 September 2016 – This defines minimum transmission characteristics for the application on a twisted pair channel to support 25 Gbps and 40 Gbps over twisted pair cabling.
- ANSI/TIA-568-C.2-1 published 30 June 2016 - Defines Category 8 Channels and Permanent Links and includes limits for Resistance Unbalance, TCL, ELTCTL.
- ANSI/TIA-1152-A published, 10 November 2016 - Defines field tester measurement and accuracy requirements for Category 8, including the new “2G” accuracy requirements for Cat 8 testers.
- ISO/IEC Standards are expected in 2017, including ISO/IEC 11801-99-1 which defines the Class I/II Channels and Permanent Links and IEC 61935-1 Ed5.0 which defines tester measurement and accuracy requirements, including the same “2G” requirement from ANSI/TIA1152-A.
IEC 61935-1 Ed.5

- Defines field tester accuracy for ISO/IEC 11801:2010
  - Level IIe, supports Class D (100 MHz)
  - Level III, supports Class E (250 MHz)
  - Level IIIe, supports Class EA (500 MHz)
  - Level IV, supports Class F (600 MHz)
  - Level V, supports Class FA (1,000 MHz)
  - Level VI, supports Cat 8 (2 GHz)
ANSI/TIA-1152 -A

- Defines field tester accuracy for ANSI/TIA-568-C.2
  - Level IIe, supports Category 5e (100 MHz)
  - Level III, supports Category 6 (250 MHz)
  - Level IIIe, supports Category 6A (500 MHz)
  - Level 2G, supports Cat 8 (2GHz)
ETL Verified Certificate of Conformance Number: 102821857CRT-001

On the basis of the tests undertaken, the sample(s) of the below product have been found to comply with the essential requirements of the referenced specifications at the time the tests were carried out.

Rendered to:
Fluke Corporation
6920 Seaway Blvd.
Everett, WA 98203
www.flukenetworks.com
Contact: Mr. Theodore Billhart

Verification/Report Number: 102821857CRT-001
Product Tested: Field Tester
Model(s) and or Brand Name: DSX-8000 CableAnalyzer
Standard(s)/Specification: ANSI/TIA-1152-A Level 2G with the applicable measurement accuracy
Product package marking shall be ETL Verified to ANSI/TIA-1152-A Level 2G and the product model(s) and or brand name.

Continuing compliance to this specification is monitored through production testing, quarterly inspections by Intertek at the production facility and random sample testing.

Date Verified: June 22, 2017

Approved By: Antoine Pellater, Project Engineer

This verification supersedes all previous verifications with the noted Verification/Report number(s) dated before this verification notice.

NOTE: This verification is part of the full test report(s) and should be read in conjunction with it.

This Verification is for the exclusive use of Intertek’s Client and is provided pursuant to the agreement between Intertek and its Client. Intertek’s responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party other than the Client in accordance with the agreement. Any loss, expense or damage occasioned by the use of this Verification. Only the Client is authorized to copy or distribute this Verification. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results referenced from this Verification are relevant only to the sample tested. This Verification by itself does not imply that the material, product, or service is or has ever been under an Intertek verification program.
What other tests are performed by a CAT 8 tester?

• Resistance Unbalance: which is important for successful PoE operation
• TCL and ELTCL balance measurements
Field test requirements

• With the new ANSI/TIA-1152-A and Draft IEC 61935-1 Ed. 5 we also get some changes in field testing.
  – We carry out all the usual parametric tests but now out to 2GHz, to cover all types of Cat 8.
  – Wiremap has a requirement, when testing Cat 8 installations, to check the shield continuity along the path of the cabling.
    • Prevents the field tester being fooled by ground paths via racking and the earth connections.
  – Optional tests added to support the emerging IEEE 802.3bt PoE++ standard.
    • Channel dc loop resistance is to be below 25Ω.
    • Current imbalance between pairs is to be minimised. This is achieved with Resistance Unbalance measurements within the pair and between pairs.

<table>
<thead>
<tr>
<th>Copper Certification</th>
<th>ISO/IEC 11801 Edition 3 Conformance Requirements</th>
<th>IEC 61935-1 Edition 5 Field Test Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Map *</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Length</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Propagation Delay</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Delay Skew</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>dc Loop Resistance</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Resistance Unbalance **</td>
<td>✓</td>
<td>Optional</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>NEXT, PS NEXT</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Return Loss</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ACR-F, PS ACR-F</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TCL, ELTCTL</td>
<td>✓</td>
<td>Optional</td>
</tr>
<tr>
<td>Coupling Attenuation</td>
<td>✓</td>
<td>Optional</td>
</tr>
<tr>
<td>PS ANEXT, PS AACR-F</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

* For Level 2G testers screen continuity is tested along the path of the cabling.
** Proposed Measurement requirement to support IEEE 802.3bt DTE Power over MDI
Resistance Unbalance

• They are optional tests for field testing that allows an installed link to be evaluated for PoE transmission.
  – Adds a Loop Resistance check (Already an ISO 11801 requirement)
  – Adds a DC Resistance Unbalance check within the pairs

\[
\text{Loop Resistance} = 2.106 \Omega + 1.114 \Omega = 3.22 \text{ Ohms}
\]

\[
\text{DC Resistance Unbalance} = |2.106 - 1.114| = 0.992 \text{ Ohms}
\]
Resistance Unbalance

Resistance = 3.7 Ω
Resistance Unbalance = 0.02 Ω

<table>
<thead>
<tr>
<th>TEST LIMIT</th>
<th>TEST LIMIT</th>
<th>TEST LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIA</strong></td>
<td><strong>ISO</strong></td>
<td><strong>PASS</strong></td>
</tr>
<tr>
<td>TIA TSB155 Ch</td>
<td>ISO11801 Channel Class C</td>
<td>Result not saved</td>
</tr>
<tr>
<td>TIA Cat 6A Perm. Link (+PoE)</td>
<td>ISO11801 PL2 Class Fa (+PoE) (1 GHz)</td>
<td>PASS</td>
</tr>
<tr>
<td>TIA Cat 6 Perm. Link (+PoE)</td>
<td>ISO11801 PL2 Class Fa (+PoE) (600 MHz)</td>
<td></td>
</tr>
<tr>
<td>TIA Cat 5e Perm. Link (+PoE)</td>
<td>ISO11801 PL2 Class E (+PoE)</td>
<td></td>
</tr>
<tr>
<td>TIA TSB155 PL (+PoE)</td>
<td>ISO11801 PL Class F (+PoE)</td>
<td></td>
</tr>
<tr>
<td>TIA 1005 Cat 6A Perm. Link (+PoE)</td>
<td>ISO11801 PL Class E (+PoE)</td>
<td></td>
</tr>
<tr>
<td>TIA 1005 Cat 6 Perm. Link (+PoE)</td>
<td>ISO11801 PL Class D (+PoE)</td>
<td></td>
</tr>
<tr>
<td>TIA 1005 Cat 5e Perm. Link (+PoE)</td>
<td>ISO11801 Channel Class Fa (+PoE) (1 GHz)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>RESISTANCE</strong></th>
<th><strong>VALUE</strong></th>
<th><strong>VALUE</strong></th>
<th><strong>LIMIT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>3.5</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>3.6</td>
<td>3.5</td>
<td>0.03</td>
<td>0.26</td>
</tr>
<tr>
<td>4.5</td>
<td>3.6</td>
<td>0.06</td>
<td>0.20</td>
</tr>
<tr>
<td>7.8</td>
<td>3.5</td>
<td>0.02</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>LIMIT</strong></td>
<td>25.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bicsi
Resistance Unbalance

- They are optional tests for field testing that allows an installed link to be evaluated for PoE transmission.
  - Adds a Loop Resistance check (Already an ISO 11801 requirement)
  - Adds a DC Resistance Unbalance check within the pairs
  - Adds a DC Resistance Unbalance check between the pairs

\[
\text{Parallel Resistance} = \frac{2.106 \times 1.114}{2.106 + 1.114} = 0.729 \text{ Ohms}
\]

\[
\text{Parallel Resistance} = \frac{1.151 \times 1.149}{1.151 + 1.149} = 0.574 \text{ Ohms}
\]

\[
\text{Loop Resistance} = 2.106 + 0.729 - 3.22 = 0.155 \text{ Ohms}
\]

\[
\text{DC Resistance Unbalance} = |2.106 - 1.114| = 0.992 \text{ Ohms}
\]
- $R_t1 = 0.22 \, \Omega$, $R_t2 = 0.33 \, \Omega$
- $R_T = 0.33 - 0.22 = 0.11 \, \Omega$

<table>
<thead>
<tr>
<th>Loop</th>
<th>Pair UBL</th>
<th>P2P UBL</th>
<th>DC resistance unbalance between pairs calculation</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,6</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,5</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,8</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIMIT</td>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loop</th>
<th>Pair UBL</th>
<th>P2P UBL</th>
<th>DC resistance unbalance between pairs calculation</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2</td>
<td>0.03</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,6</td>
<td>0.87</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,5</td>
<td>0.01</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,8</td>
<td>0.03</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIMIT</td>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loop</th>
<th>Pair UBL</th>
<th>P2P UBL</th>
<th>DC resistance unbalance between pairs calculation</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2-3,6</td>
<td>0.11</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2-4,5</td>
<td>0.01</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2-7,8</td>
<td>0.01</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,6-4,5</td>
<td>0.13</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,6-7,8</td>
<td>0.13</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,5-7,8</td>
<td>0.00</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Balance is critical for successful transmission
• Reduces emissions
• Mitigates external noise sources
Why Balance Matters?

**Link with good balance**

+2.0 V

Differential mode signal injected at 2 V

+1 V 
-1 V

+0.5 V noise spike

+1.5 V 
-0.5 V

Differential mode signal remains at 2 V

**Link with poor balance**

+2.0 V

Differential mode signal injected at 2 V

+1 V 
-1 V

+0.5 V noise spike

+1.0 V noise spike

+2.0 V 
-0.5 V

0.5 V spike of differential noise added to the signal
Mode Conversion Testing

- TCL
- TCTL
- ELTCTL
- CDNEXT
- CMRL
Transverse Conversion Loss

Transverse Conversion Loss is the ratio of a common-mode voltage measured on a wire pair relative to a differential-mode voltage applied to the same end of the pair.
High TCL values correspond to better noise immunity and lower emissions.
Transverse Conversion Transfer Loss is the ratio of a common-mode voltage measured at the far end of a wire pair relative to a differential-mode voltage applied to the near end of the same pair.
High ELTCTL values correspond to better noise immunity and lower emissions.
There are no test limits in ANSI/TIA-568-C.2, ANSI/TIA-1005 or ISO/IEC 11801:2010. However, you will find it discussed in TIA-TSB-1197.
High CDNEXT values correspond to better noise immunity and lower emissions.
High CMRL values correspond to better noise immunity and lower emissions.
**Test Report**

**Cable ID:** 0019E2X

**Test Summary:** PASS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (ft)</td>
<td>120</td>
<td>120</td>
<td>PASS</td>
</tr>
<tr>
<td>Wire Gauge</td>
<td>22</td>
<td>22</td>
<td>PASS</td>
</tr>
<tr>
<td>ULT Tape</td>
<td>45</td>
<td>45</td>
<td>PASS</td>
</tr>
<tr>
<td>Test Type</td>
<td>Calibration</td>
<td>Calibration</td>
<td>PASS</td>
</tr>
</tbody>
</table>

**Calibration Date:** 06/19/2013

**Operator:** DF-0920

**Software Version:** V 4.3 Build 6

**Remote Adapter:** PON-0300

---

**Cable ID:** 0019E2X

**Test Summary:** PASS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (ft)</td>
<td>120</td>
<td>120</td>
<td>PASS</td>
</tr>
<tr>
<td>Wire Gauge</td>
<td>22</td>
<td>22</td>
<td>PASS</td>
</tr>
<tr>
<td>ULT Tape</td>
<td>45</td>
<td>45</td>
<td>PASS</td>
</tr>
<tr>
<td>Test Type</td>
<td>Calibration</td>
<td>Calibration</td>
<td>PASS</td>
</tr>
</tbody>
</table>

**Calibration Date:** 06/19/2013

**Operator:** DF-0920

**Software Version:** V 4.3 Build 6

**Remote Adapter:** PON-0300

---

**Bicsi**
The Real CAT 8 Tester?

• The Permanent Link and Channel adapters with a full 2 GHz range.
• The tester to be endorsed by a Cat 8 cabling manufacturer. One of the main reasons for certifying installed cabling is to obtain a manufacturer’s warranty.
• The tester independently verified to meet the ANSI/TIA-1152-A Level 2G requirements for measurement accuracy required for Cat 8 testers.
• The tester to test screen continuity along the path of the cabling as required for Level 2G testers
THANK YOU