Revised Standards For Installed Cabling
and
Their Impact On Testing

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REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

BICSI Europe Conference
25th November 1998

Agenda

Testing Class D (1999)
Category 5E
Category 5 and Class D (1999)
Category 5 (1995)

Amendments to Design Standards

Testing the Revision
Optical Fibre
Category 7 and Class F
Category 6 and Class E
Horizontal Channel

Revision of Design Standards

Standards Development

REVISED STANDARDS FOR INSTALLED CABLING and THEIR IMPLICATIONS FOR TESTING
REVISED STANDARDS FOR INSTALLED CABLELING AND THEIR IMPACT ON TESTING

**International**
ISO/IEC JTC1 SC25 WG3
- Design
  - TR 14763-2 (1999)
  - IEC 61935 (1999?)
  - TR 14763-3 (1999)
- Applications
  - ISO
  - IEEE
  - ATM Forum

**USA**
ANSI/TIA/EIA TR41.8
- Design
  - None relevant
  - TIA/EIA TSB67 (1996)
- Testing
  - IEC 61935 (1999?)
  - TR 14763-3 (1999)

**European**
CENELEC TC215 WG1
- Design
  - EN 50173 (1995)
  - prEN50174 (1999)
  - Testing
  - prEN 50xxx (2000)
Amendments to Design Standards

REVISED STANDARDS FOR INSTALLED CABLELING AND THEIR IMPACT ON TESTING

International
- Amendment 1: Minor technical errata
- Amendment 2: Optical fibre bandwidth
- Amendment 3: Support for 1000BASE-T
  - Class D (1999)

USA
ANSI/TIA/EIA 568A
- Amendments 1, 2, 3 and 4:
  - Increasing parametric control
  - Components
  - Installed cabling
- Amendment 5: Category 5E
- TSB 95: 1000BASE-T Support

European
EN 50173 (1995)
- Amendment No. 1:
  - Minor technical errata
  - Support for 1000BASE-T
  - Class D (1999)
Simple Transmission Model

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

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Cat. 5 Channel (1995 - 1998)

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

HISTORY OF STANDARDISATION

Cat. 5 cables/connecting hardware
- ISO/IEC 11801
- EN 50173
- ANSI/TIA/EIA 568A

Cat. 5 links and channels
- ANSI/TIA/EIA 568A
- TIA/EIA TSB67

Cat. 5 links/channels specified for simple applications
- attenuation
- NEXT
- ACR
- delay
Complex Transmission Model

Complex
Simplex Bi-directional transmission

Complex
Duplex Bi-directional transmission

3 CONNECTOR MODEL

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ISO/IEC 11801 and EN 50173
• defined classes of links and channels
  • to support applications
  • rarely used for installed cabling
    • (568A/TSB67 preferred)
Amendments (1999)
• to support complex applications
• including 1000BASE-T
• re-defines classes of links and channels
  • installed link performance
  • installed channel performance
Class D (1999) Requirements

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

 CHANNEL

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Attenuation</th>
<th>Return Loss</th>
<th>Delay = 570ns. max.</th>
<th>Skew = 50ns. max.</th>
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 PERMANENT LINK

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<th>Attenuation</th>
<th>Return Loss</th>
<th>Delay = 522ns. max.</th>
<th>Skew = 43ns. max.</th>
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</tr>
<tr>
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<td>0</td>
<td>0</td>
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</table>
REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

Category 5 and Category 5E

Category 5 Components (1999)

Category 5E Components

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Class D (1999) Channel using Category 5E components

Maximum channel length = 100 metres
H = 90 metres maximum
X = A+E
X = 10 metres maximum

Maximum channel length = 100 metres
H = 90 metres maximum
X = A+B+E
X = 10 metres for unscreened (20%)
X = 9 metres for screened (50%)
Testing Class D (1999)

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

Current approach
- TIA/EIA TSB67
  - include test leads in measured values
  - specify equipment accuracy
- test schedule
  - wire map
  - attenuation
  - NEXT (local and remote)

Proposed approach
- ISO/CENELEC revisions
  - exclude test leads from measured values
  - specify measurement accuracy
- increase test schedule to include:
  - PSNEXT (local and remote)
  - ELFEXT (local and remote)
  - PSELFEXT (local and remote)
  - Return Loss (local and remote)
  - skew
- no change in frequency specification
- software upgrade for most test equipment
Revisions to Design Standards

REVISED STANDARDS FOR INSTALLED CABLE AND THEIR IMPACT ON TESTING

International
Revision 2000-2001
• Channel models
• Class E and Class F
• Category 6 and Category 7
• Optical fibre planning

USA
ANSI/TIA/EIA 568A
Continual amendment process
Revision ANSI/TIA/EIA 568B

European
EN 50173 (1995)
Revision 2000-2001
• Channel models
• Class E and Class F
• Category 6 and Category 7
• Optical fibre planning
REVISED STANDARDS FOR INSTALLED CABLELING AND THEIR IMPACT ON TESTING

**Horizontal Channel**

- Transition Point
  - electrically invisible
  - NOT a cabling interface
  - NOT a testing interface

- Consolidation Point
  - electrically visible
  - may be a cabling interface
  - may be a testing interface

- Permanent Link?? (electrical)
- Channel (electrical)

4 CONNECTOR MODEL
Class E and F Channels

Class E - Category 6
- 4 pair solution
- 4 connection model (CP and CC)
- positive PSACR at 200MHz
- supported over
  - unscreened balanced pairs
  - foil screened balanced pairs
  - IEC 60603-7 connectivity

Class F - Category 7
- 4 pair solution
- 4 connection model (CP and CC)
- positive PSACR at 600MHz
- supported over
  - individually screened balanced pairs
  - new connector

Existing standards text from BS EN 50173 (1995)
"Links of a given class will support all applications of a lower link class. Link class A is regarded as the lowest class."

Existing standards text from BS EN 50173 (1995)
"Cables and connecting hardware of different categories may be mixed within a subsystem and/or the cabling link, but the transmission characteristics of the link will be determined by the category of the least performing component."
REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

Class E Channel (05/98)

-60 -50 -40 -30 -20 -10 0 10 100 1000

Frequency (MHz)

dB

1.911*sqrt(f)+0.01785*f+0.084/sqrt(f)

PS NEXT
Cable 72.3-15*log(f)
Connector 90-20*log(f)

NEXT

pr-pr NEXT
Cable 74.3-15*log(f)
Connector 94-20*log(f)

PSNEXT

4 CONNECTOR MODEL

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Class E Channel Options

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OUTSTANDING ISSUES
- connecting hardware
- multi-vendor interoperability
  - Cat. 6 mix
- backwards compatibility
  - Cat. 5 mix

IEEE recommend lowest attenuation profiles
-60
-50
-40
-30
-20
-10
0
1 10 100 1000
Frequency (MHz)

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Class F Channel (05/98)

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Class F Channel Options

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

OUTSTANDING ISSUES
- connecting hardware
- selection of a design

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Category 6 and 7 Components

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- NO products claiming conformance
  - can guarantee to meet final figures
    - may fail tests when available
  - can guarantee interoperability with other products
    - Category 6: technical issue
    - Category 7: physical issue
  - can guarantee backwards compatibility

- all such products represent proprietary solutions
  - procurement of network configuration components may be restrictive
REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

<table>
<thead>
<tr>
<th>Geometry (μm)</th>
<th>B (MHzkm) 850nm</th>
<th>B (MHzkm) 1300nm</th>
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<td>500</td>
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<tr>
<td>50/125</td>
<td>600</td>
<td>1000</td>
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</table>

**1000BASE-SX**
- 1st window (850nm)
- CD LASER/VCSEL

220 metres for 160MHzkm

**1000BASE-LX**
- 2nd window (1300nm)
- SM LASER

275 metres for 200MHzkm

A recent survey by IEC found a total of 73 (50/125) and 43 (62.5/125) dual window combinations.

These figures are taken from IEC 60793-2 and are for dual window optical fibres.
REVISED STANDARDS FOR INSTALLED CABLELING AND THEIR IMPACT ON TESTING

These applications are bandwidth limited at the channel lengths shown. The use of lower attenuation components to produce channels exceeding the values shown cannot be recommended.

Distances specified assume 1.5dB max. of connection loss.
SMF Channel Lengths

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

Distances specified assume 1.5dB max. of connection loss

10/125

2000m
FDDI (1300)
ATM-52 (1300)
ATM-155 (1300)
ATM-622 (1300)
FC-266 (1300)
FC-531 (1300)
FC-1062 (1300)
1000BASE-LX (1300)
REVISED STANDARDS FOR INSTALLED CABLES AND THEIR IMPACT ON TESTING

Testing the Copper Channel

Length/connector-independent parameters
- Wire map

Length-dependent parameters
- Delay
- Skew
- Attenuation

NVP used for length calculation

Length/connector-dependent parameters
- NEXT
- PSNEXT
- ELFEXT
- PSELFEXT
- Return Loss

Length allowance is complex to compute

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Configuration-based Testing

REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

Testing at a TO or CP
LINK LIMITS - 1 Connector Model
• local NEXT, PSNEXT
• local ELFEXT, PSELFEXT (local)
• local Return Loss

Testing at a TO (including at CP)
CHANNEL LIMITS - 2 Connector Model
• local NEXT, PSNEXT
• local ELFEXT, PSELFEXT (local)
• local Return Loss

Attenuation: correct for actual length
Delay and Delay Skew: correct for actual length

Testing at a TO or CP
TO
Test Equipment
Test Equipment
Test Equipment
CP
PP
Test Equipment
Test Equipment
Test Equipment

Testing at a TO (including at CP)
CHANNEL LIMITS - 2 Connector Model
• local NEXT, PSNEXT
• local ELFEXT, PSELFEXT (local)
• local Return Loss

Testing at PP in an INTER-CONNECT Design
CHANNEL LIMITS - 2 Connector Model
• local NEXT, PSNEXT
• local ELFEXT, PSELFEXT (local)
• local Return Loss

Testing at PP in a CROSS-CONNECT design
LINK LIMITS - 1 Connector Model
• local NEXT, PSNEXT
• local ELFEXT, PSELFEXT (local)
• local Return Loss
Testing the New Classes

REVISED STANDARDS FOR INSTALLED CABLELING AND THEIR IMPACT ON TESTING

Class D (1999)
- ISO/CENELEC test standard
  - exclude test leads from measured values
  - specify measurement accuracy
- test schedule:
  - wire map
  - attenuation
  - NEXT (local and remote)
  - PSNEXT (local and remote)
  - ELFEXT (local and remote)
  - PSELFEXT (local and remote)
  - Return Loss (local and remote)
  - skew
- measurement range 1MHz - 100MHz

Class E
- extended frequency
  - 1 - 250MHz

Class F
- extended frequency
  - 1 - 600MHz
- remote parameters represent major challenge
  - attenuation at high frequencies
  - may not be measurable
## Testing Optical Fibre

### REVISED STANDARDS FOR INSTALLED CABLING AND THEIR IMPACT ON TESTING

**Current Approach**
- Test schedule:
  - Optical power loss
  - Power meter
  - Optical time domain reflectometer

**Issues**
- High bit rate applications
  - Low loss limit
  - Measurement accuracy is important
- Modal bandwidth
  - Installed base unknown
  - No low-skill test method

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Summary

REVISED STANDARDS FOR INSTALLED CABLELING AND THEIR IMPACT ON TESTING

AMENDMENTS TO ISO/IEC AND CENELEC STANDARDS

COMPLETE 1999

Permanent links - channels
- testable elements
Class D (1999) - 1000BASE-T support
- additional parameters
- component mapping
  - certain configurations require >Cat. 5
New tests
- existing parameters
  - current limits
- new parameters
- software upgrade for most test equipment

REVISIONS TO ISO/IEC AND CENELEC STANDARDS

COMPLETE 2001

New channel model
including "consolidation point"
New Classes
- E specified to 250MHz
- F specified to 600MHz
New components
- Category 6
- Category 7
New test equipment
- higher frequencies
Optical fibre
- bandwidth under pressure
- new planning guides