10GBASE-T

Physical Layer Specifications

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1000BASE-T Link Segment

• 1000BASE-T- The cabling system components (cables, cords, and connectors) used to provide the link segment shall consist of Category 5 components as specified in ANSI/TIA/EIA-568-A:1995 and ISO/IEC 11801:1995. Additionally:

b) 1000BASE-T is an ISO/IEC 11801 Class D application, with additional installation requirements and transmission parameters specified in Annex 40A.

• The term ‘link segment’ refers to four duplex channels and the term ‘duplex channel’ refers to a single channel with full duplex capability.

• Specifications for a link segment apply equally to each of the four duplex channels.
Figure 40A-1—Maximum horizontal subsystem configuration
Figure 40A-2—Minimum horizontal subsystem configuration
1000BASE-T Channel Models

- **Worst Case NEXT - 3 disturbers - Cat 5**
  - $27.1 - 16.8 \log_{10}(f/100)$ dB

- **FEXT - 3 disturbers**
  - $17 - 20\log_{10}(f/100)$ dB
  - $19.5 - 20\log_{10}(f/100)$ dB
  - $23 - 20\log_{10}(f/100)$ dB

- **PSELFEXT loss > 14.4 - 20\log_{10}(f/100)$$ dB

- **Return loss (2 models)**
  - $-15$ dB (1-20 MHz)
  - $-15 - 10\log_{10}(f/20)$ (20-100 MHz)

- **Insertion Loss (cat 5)**
  - $\text{Insertion\_Loss}(f) < 2.1 f^{0.529} + 0.4/f$ (dB)
1000BASE-T Matlab Code

- 3dB Design Point
- 10dB Design Point
3 dB Design Point -Summary Assumptions

D/ A: 17 levels at 125MHz
Launch Level: 2V ptp
Analog Transmit Filter: Single pole RC
Analog Receive Filter: BW2@ 100MHz
A/ D: 5.5bits ideal at 125MHz
Baseline Wander Correction: Digital
FFE - #taps: 12 taps at 125MHz
DFE - #taps: 10 taps at 125MHz
NEXT Cancellers - #taps: 12 taps at 125MHz
Echo Canceller - #taps: 50 taps at 125MHz
Viterbi Decoder: 12- stage
Total worst- case latency: 31BT < 40BT
Uniform Jitter Tolerance for 0dB margin: 1.3ns ptp [> 10ns ptp Gaussian]
Worst- Case Total Noise Budget: 140mV ptp
Est. Gate Count/ Power Consumption: 130K/ 2.2W
Margin without FEXT: 3.6dB (relative external noise margin)
Margin with Worst- Case FEXT: 2.6dB (relative external noise margin)
10 dB Design Point - Summary Assumptions

D/A: 17 levels at 125MHZ
Launch Level: 2V ptp
Analog Transmit Filter: Single pole RC
Analog Receive Filter: BW2@ 100MHz
A/ D: 6.5bits ideal at 125MHz
Baseline Wander Correction: Digital
FFE - #taps: 16 taps at 125MHz
DFE - #taps: 12 taps at 125MHz
NEXT Cancellers - #taps: 72 taps at 125MHz
Echo Canceller - #taps: 120 taps at 125MHz
Viterbi Decoder: 12- stage
Total worst-case latency: 31BT < 40BT
Uniform Jitter Tolerance for 0dB margin: 1.5ns ptp [> 10ns ptp Gaussian]
Worst- Case Total Noise Budget: 140mV ptp
Est. Gate Count/ Power Consumption: 330K/ 4W
Margin without FEXT: 10.5dB (relative external noise margin residual noise)
Margin with Worst- Case FEXT: 7.0dB (relative external noise margin residual noise)
1000BASE-T Link Specifications - Minimum Requirements

Cabling Installed to TIA/EIA-568-A with additional parameters as specified in Addendum and proposed TIA/EIA-Technical System Bulletin

IEEE 1000BASE-T- 802.3/ab
Installed Cabling Specification
- NEXT
- Attenuation
- ELFEXT
- Return Loss
- Delay, Delay Skew

TIA/EIA-568-A
- NEXT
- Attenuation

TIA/EIA-568-A-1
- Delay
- Delay Skew

TIA/EIA-TSB-95
- ELFEXT
- Return Loss
- Field Testing

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1000BASE-T Link Specifications

When Installing 1000BASE-T Links

- TIA/EIA-568-A
  - Attenuation
  - NEXT
- IEEE
  1000BASE-T- 802.3/ab
  Installed Cabling Specification
  - NEXT (worst pair)
  - Attenuation
  - ELFEXT (power sum)
  - Return Loss
  - Delay, Delay Skew

Category 5e

  - NEXT (worst pair, power sum)
  - ELFEXT (worst pair, power sum)
  - Return Loss
  - Field Testing

- TIA/EIA-568-A-1
  - Delay
  - Delay Skew
1000BASE-T Link Specifications

When Installing 1000BASE-T Links

IEEE
1000BASE-T- 802.3/ab
Installed Cabling Specification

ISO/IEC 11801 2nd edition -Class D
ISO/IEC 11801 2nd edition -Class E

ANSI/TIA/EIA
568-A-1995

568-B.1
Main Document
568-B2-1
Category 6

568-B.2
Copper

568-B.3
Fiber

Category 5e

ANSI/TIA/EIA
568-B-2000
10GBASE-T Link Specifications

IEEE 10GBASE-T- 802.3
Installed Cabling Specification

ISO/IEC 11801 2nd edition -Class D
ISO/IEC 11801 2nd edition -Class E

ANSI/TIA/EIA 568-B-2000
Main Document

ANSI/TIA/EIA 568-B-1995
Cabling Characterization
>250 MHz

ANSI/TIA/EIA 568-B-2000
Category 5e

ANSI/TIA/EIA 568-B2-1
Category 6

568-B.1
Copper

568-B.2
Fiber

568-B.3

ISO/IEC 11801 2nd edition -Class D
ISO/IEC 11801 2nd edition -Class E

ANSI/TIA/EIA 568-B-2000
Category 5e

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# Cabling - Specifications

*Category 5e Channel Transmission Performance*

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<th>Frequency MHz</th>
<th>Ins. Loss Max (dB)</th>
<th>NEXT Min (dB)</th>
<th>ACR Min (dB)</th>
<th>PSNEXT Min (dB)</th>
<th>PSACR Min (dB)</th>
<th>ELFEXT Min (dB)</th>
<th>PSELFEXT Min (dB)</th>
<th>Return Loss Min (dB)</th>
<th>Prop. Delay Max (ns/100m)</th>
<th>Delay Skew Max (ns/100m)</th>
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| 100           | 24                | 30.1          | 6.1          | 27.1            | 3.1           | 17.4            | 14.4              | 10                   | 548                      | 50                       |

(*ISO/IEC 11801 2nd edition -Class D*)

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[Diagram showing connecting hardware, consolidation point, equipment, cross-connect, building Cable, work area cable, and Channel]

10GBASE-T
## Cabling - Specifications

### Category 6 Channel Transmission Performance

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<th>Frequency MHz</th>
<th>Ins. Loss Max (dB)</th>
<th>NEXT Min (dB)</th>
<th>ACR Min (dB)</th>
<th>PSNEXT Min (dB)</th>
<th>PSACR Min (dB)</th>
<th>ELFEXT Min (dB)</th>
<th>PSELFEXT Min (dB)</th>
<th>Return Loss Min (dB)</th>
<th>Prop. Delay Max (ns/100m)</th>
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(*~ISO/IEC 11801 2nd edition -Class E*)

### Difference in Channel Transmission Performance (Cat 6 vs. Cat 5e)

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<th>Frequency MHz</th>
<th>Ins. Loss Max (dB)</th>
<th>NEXT Min (dB)</th>
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