TSB-155 Draft 1.0
Additional Guidelines
for 4-pair 100 Ω Category 6 Cabling
and Link Segment Specifications

July 2004
Portland, OR

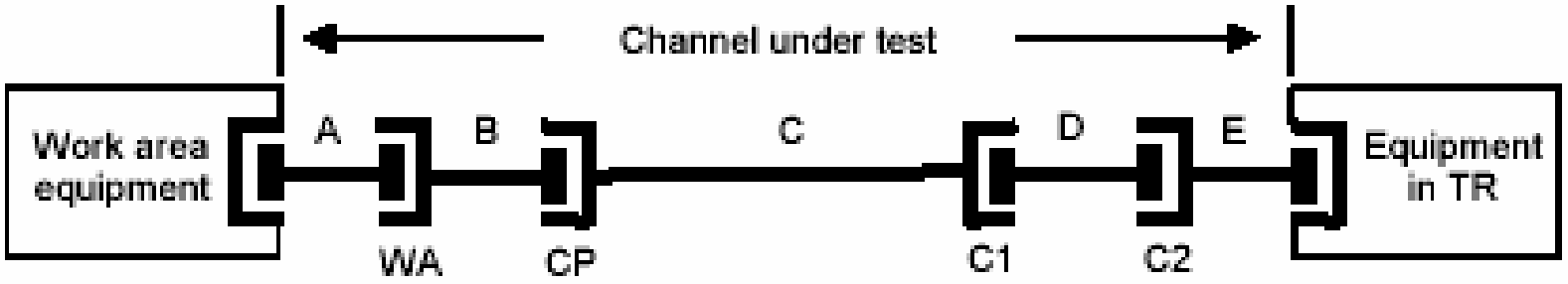
Chris DiMinico
MC Communications
cdiminico@ieee.org

PURPOSE AND SCOPE

- Additional guidelines for 100 Ω, 4-pair category 6 cabling
  - Extended frequency transmission guidelines for category 6 cabling from 250 MHz up to 625 MHz.
  - Alien Crosstalk
  - Field test equipment and field test methods
  - Alien crosstalk mitigation.

TSB-155: Table of Contents

Channel Test Configuration



Legend

Cables and cords

Work area cord ..... A
Optional transition cabling ..... B
Horizontal cabling C
Patch cord or jumper cable ..... D
Telecommunications room equipment cord ..... E

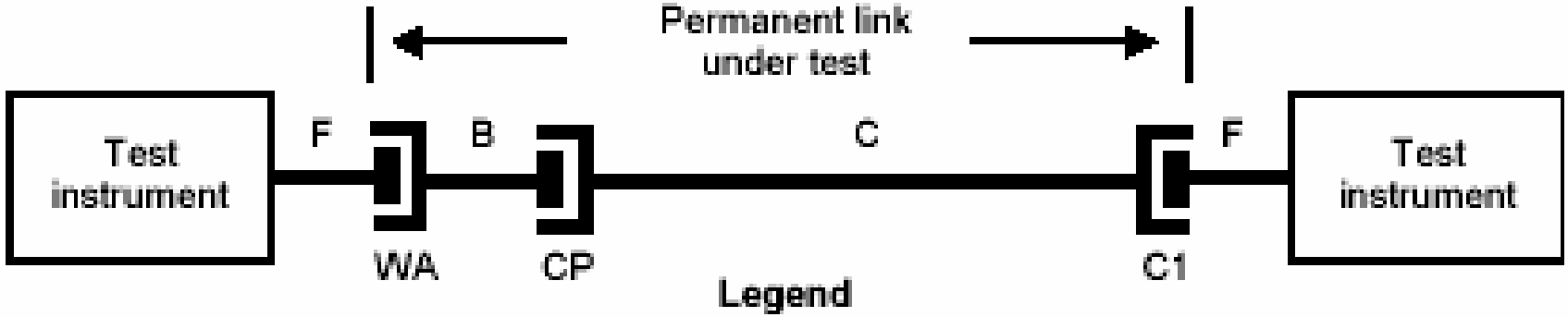
Connecting hardware

Telecommunications outlet/ connector ..... WA
Optional transition/consolidation point connector ..... CP
Horizontal cross-connect or interconnect C1, C2

Maximum length

B + C ..... 90 m (295 ft)
A + D + E ..... 10 m (32.8 ft)

Permanent Link Test Configuration



Legend

Cables and cords

Test equipment cord ..... F
Optional transition cabling ..... B
Horizontal cabling C

Connecting hardware

Telecommunications outlet/
connector ..... WA
Optional transition/consolidation
point connector ..... CP
Horizontal cross-connect or
interconnect C1

Maximum length

B + C ..... 90 m (295 ft)

TSB-155 Cabling Insertion loss

For all frequencies from 1 MHz to 250 MHz, category 6 channel insertion loss shall meet the values determined using equation (1) as specified in TIA/EIA-568-B.2.-1. Channel Insertion Loss:

Equation 1:

$$INSERTIONLOSSchannel \leq 1.924 \times \sqrt{f} + 0.0173 \times f + \frac{0.204}{\sqrt{f}} + 0.0003 \times f^{1.5} \qquad (1)$$

For all frequencies (250 < f ≤ 625) the insertion loss of the channel should meet the values determined using equation (2).

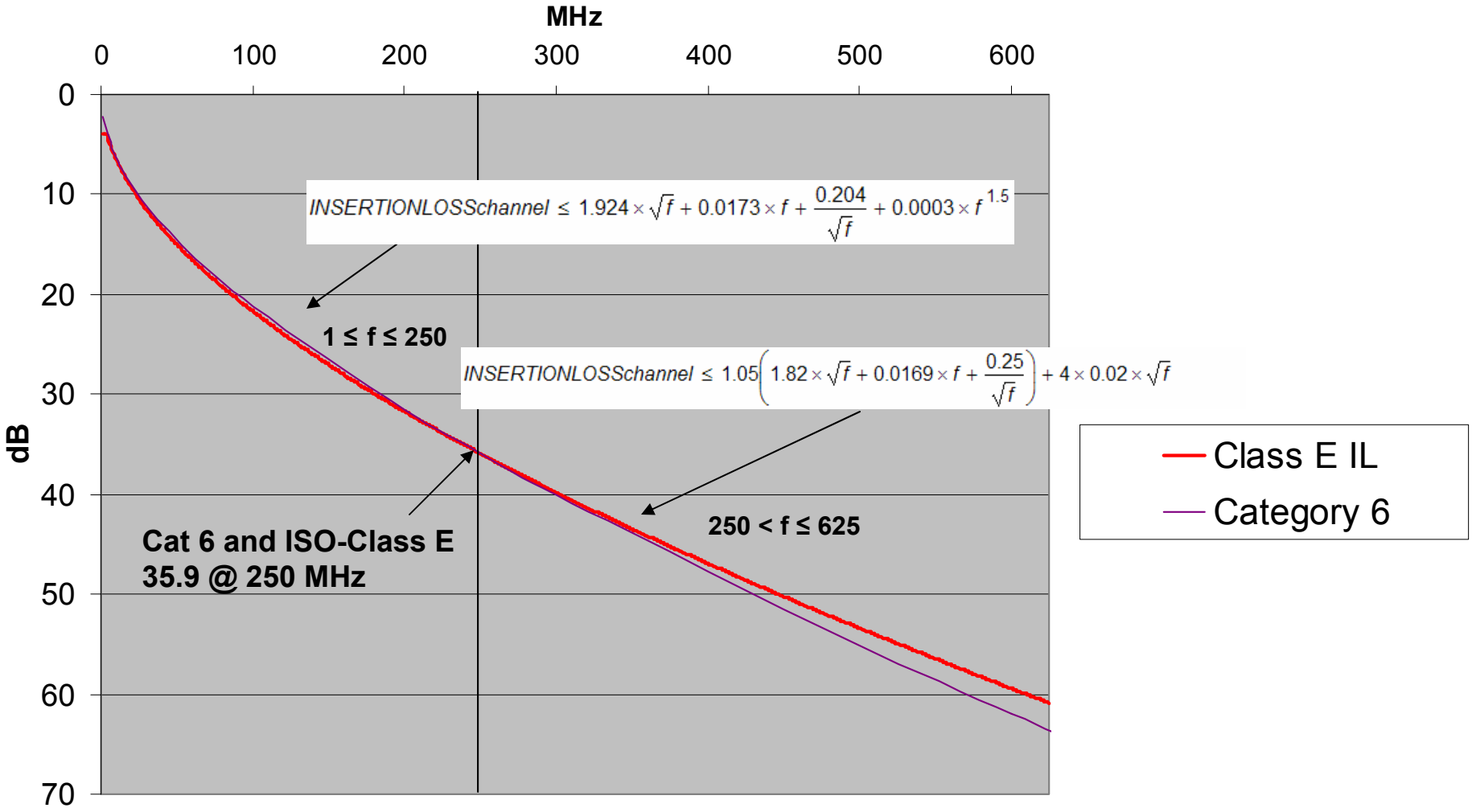
Equation 2:

$$INSERTIONLOSSchannel \leq 1.05\left(1.82 \times \sqrt{f} + 0.0169 \times f + \frac{0.25}{\sqrt{f}}\right) + 4 \times 0.02 \times \sqrt{f} \qquad (2)$$

Equation 3:

Permanent Link Insertion Loss (TBD):

TSB-155 Cabling Insertion loss



TSB-155 Insertion Loss Scaling

The scaled Category 6 insertion loss is defined by equation (4):

Scaled Channel Insertion Loss

Equation 4:

$$Scaled\_IL\_channel \le \frac{Length\_m}{100} \times 1.05 \left(1.82 \times \sqrt{f} + 0.0169 \times f + \frac{0.25}{\sqrt{f}} \right) + 4 \times 0.02 \times \sqrt{f} \qquad (4)$$

TSB-155 Insertion Loss of a Category 6 channel of 55 meters

For all frequencies from 1 MHz to 250 MHz, the category 6 insertion loss of a 55 meter channel shall meet the values determined using equation below.
For all frequencies (250 < f ≤ 625) MHz the category 6 insertion loss of a 55 meter channel should meet the values determined using equation below.

$$Scaled\_IL\_channel(55\ m) \le \frac{55}{100} \times 1.05 \left(1.82 \times \sqrt{f} + 0.0169 \times f + \frac{0.25}{\sqrt{f}} \right) + 4 \times 0.02 \times \sqrt{f}$$

Insertion Loss of a Category 6 permanent link of (TBD meters)

TSB-155 Cabling pair-to-pair NEXT loss

NEXT Channel

For all frequencies from 1 MHz to 250 MHz, category 6 channel pair-to-pair NEXT loss shall meet the values determined using equation (7) as specified in TIA/EIA-568-B.2.-1.

For all frequencies between (250 < f < 330) MHz the channel pair-to-pair NEXT loss should meet the values determined using equation (7).

Equation (7)

$$NEXTchannel \geq -20 \times log10\left(10^{\frac{44.3-15\ log10\left(\frac{f}{100}\right)}{-20}} + 2 \times 10^{\frac{54-20\ log10\left(\frac{f}{100}\right)}{-20}}\right)$$

For all frequencies (330 ≤ f ≤ 625) MHz the channel pair-to-pair NEXT loss of the cabling should meet the values determined using equation (8).

Equation (8)

$$NEXTchannel \geq 31 - 50 \times log10\left(\frac{f}{330}\right)$$

NEXT Permanent Link Equation (TBD)

TSB-155 Cabling power sum NEXT loss

PSNEXT Channel

For all frequencies (250 < f < 330) MHz the channel pair-to-pair PSNEXT loss should meet the values determined using equation (10).

For all frequencies (330 ≤ f ≤ 625) MHz the channel pair-to-pair PSNEXT loss of the cabling should meet the values determined using equation (10).

Equation (10)

$$PSNEXTchannel \geq -20 \times log10\left(10^{\frac{42.3-15\ log10\left(\frac{f}{100}\right)}{-20}} + 2 \times 10^{\frac{50-20\ log10\left(\frac{f}{100}\right)}{-20}}\right)$$

For all frequencies (330 ≤ f ≤ 625) MHz the channel pair-to-pair PSNEXT loss of the cabling should meet the values determined using equation (11).

Equation (11)

$$PSNEXTchannel \geq 28 - 42 \times log10\left(\frac{f}{330}\right)$$

PSNEXT Permanent Link equation (TBD)

TSB-155 Pair-to-pair cabling ELFEXT

For all frequencies from 1 MHz to 250 MHz, category 6 channel ELFEXT shall meet the values determined using equation (13) as specified in TIA/EIA-568-B.2.-1.

For all frequencies ($250 < f \leq 625$) the insertion loss of the channel should meet the values determined using equation (13).

Pair-to-pair cabling ELFEXT Channel

equation (13)

$$ELFEXTchannel \geq -20 \times log10\left(10^{\frac{27.8-20\ log10\left(\frac{f}{100}\right)}{-20}} + 4 \times 10^{\frac{43.1-20\ log10\left(\frac{f}{100}\right)}{-20}}\right)$$

For all frequencies from 1 MHz to 250 MHz, category 6 permanent link ELFEXT shall meet the values determined using equation (14) as specified in TIA/EIA-568-B.2.-1. For all frequencies ($250 < f \leq 625$) the insertion loss of the permanent link should meet the values determined using equation (14).

equation (14)

Pair-to-pair cabling ELFEXT Permanent Link (TBD)

TSB-155 Cabling power sum ELFEXT

For all frequencies from 1 MHz to 250 MHz, category 6 channel power sum ELFEXT shall meet the values determined using equation (16) as specified in TIA/EIA-568-B.2.-1. For all frequencies (250 < f ≤ 625) the insertion loss of the channel should meet the values determined using equation (16).

Cabling power sum ELFEXT Channel

equation (16)

$$PSELFEXTchannel \geq -20 \times log10\left(10^{\frac{24.8-20\ log10\left(\frac{f}{100}\right)}{-20}} + 4 \times 10^{\frac{40.1-20\ log10\left(\frac{f}{100}\right)}{-20}}\right)$$

For all frequencies from 1 MHz to 250 MHz, category 6 permanent link power sum ELFEXT shall meet the values determined using equation (17) as specified in TIA/EIA-568-B.2.-1. For all frequencies (250 < f ≤ 625) the permanent link power sum ELFEXT should meet the values determined using equation (17).

Cabling power sum ELFEXT Permanent Link (TBD)

Power sum Alien NEXT loss for a Category 6 channel of 100 meters

Power sum Alien NEXT loss

For a 10GBASE-T 100 meter Category 6 channel with the maximum insertion loss specified in 6.1 the PS ANEXT loss between the disturbed duplex channel and the disturbing duplex channels in adjacent cables shall meet the values determined using equation (21).

equation (21)

$$PS\ ANEXT \geq \begin{cases} 62 - 10*\log10(fMHz/100) & 1\ MHz \leq f \leq 100\ MHz \\ 62 - 15*\log10(fMHz/100) & 100\ MHz < f \leq 625\ MHz \end{cases}$$

Power sum ANEXT for a Category 6 channel of 55 meters

For a 10GBASE-T 55 meter Category 6 channel with the maximum insertion loss specified in 6.1.3 the PS ANEXT loss between the disturbed duplex channel and the disturbing duplex channels in adjacent cables shall meet the values determined using equation (23).

Equation (23):

$$\text{PS ANEXT} \geq \begin{cases} 47 - 10\log_{10}(f_{MHz}/100) & 1\ \text{MHz} \leq f \leq 100\ \text{MHz} \\ 47 - 15\log_{10}(f_{MHz}/100) & 100\ \text{MHz} < f \leq 625)\ \text{MHz} \end{cases}$$

Power sum Alien NEXT loss Adjustment

The adjusted PS ANEXT loss requirement is determined by first calculating the PS ANEXT_constant and utilizing the constant in the PS ANEXT limit line model. The PS ANEXT_constant is defined by the following equation:

$$PSANEXT\_Constant = 62 - (Cat6\_IL\_250MHz - SCat6\_IL\_250MHz) \times \frac{15}{15.6}$$

where
Cat6_IL_250MHz is the Category 6 insertion Loss at 250 MHz
SCat6_IL_250MHz is the scaled Category 6 insertion at 250 MHz

TSB-155 Cabling Return Loss

For all frequencies from 1 MHz to 250 MHz, category 6 channel return loss shall meet the values specified in table 1 as specified in TIA/EIA-568-B.2.-1. Category 6 channel return loss. For all frequencies ($250 < f \leq 625$) the category 6 channel return loss should meet the values in Table 1.

Table 1

Frequency (MHz)	Return Loss (dB)
$1 \leq f < 10$	19
$10 \leq f < 40$	24- 5log10(f)
$40 \leq f \leq 250$	32- 10log10(f)
$250 < f < 400$	32- 10log10(f)
$400 \leq f \leq 625$	6

Category 6 permanent link return loss (TBD)

Cabling propagation delay

The maximum propagation delay for a category 6 channel configuration shall be less than 555 ns measured at 10 MHz. The maximum propagation delay for a category 6 permanent link configuration shall be less than 498 ns measured at 10 MHz.

Cabling propagation delay skew

The maximum propagation delay skew for a category 6 channel configuration shall be less than 50 ns.

The maximum propagation delay skew for a category 6 permanent link configuration shall not exceed 44 ns.

Annex- A, B, and C

- Annex A Cabling (field) measurement procedures

- Annex B Field Test Instruments (informative)
  - Accuracy requirements for level IIIe field testers
  - Measurement performance requirements
    - † e.g., frequency range and resolution
    - † Dynamic range, etc..

- Annex C Alien Crosstalk Mitigation Procedures
  - Patch cord mitigation

O.3 Return loss modeling results

A reasonable worst case channel configuration used to develop the return loss limits is shown in figure O.1. All flexible cable segments are assumed to have a asymptotic fitted characteristic impedance value of 95 Ω. The solid core cable segments are assumed to have a 105 Ω asymptotic fitted characteristic impedance. All connecting hardware is assumed to have return loss performance at the return loss limit for connecting hardware.

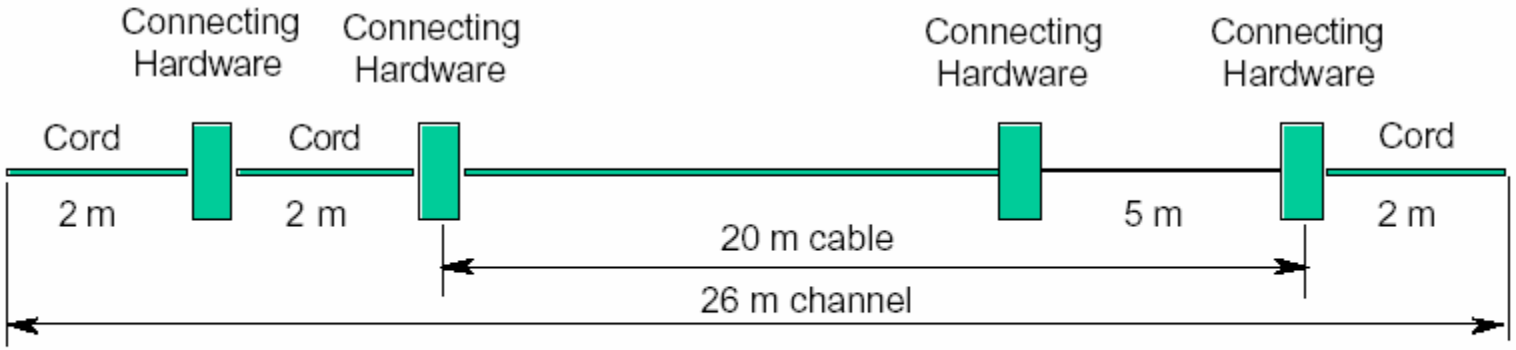


Figure O.1 - Modeling configuration