Overview of OIF CEI T10/05-200r0

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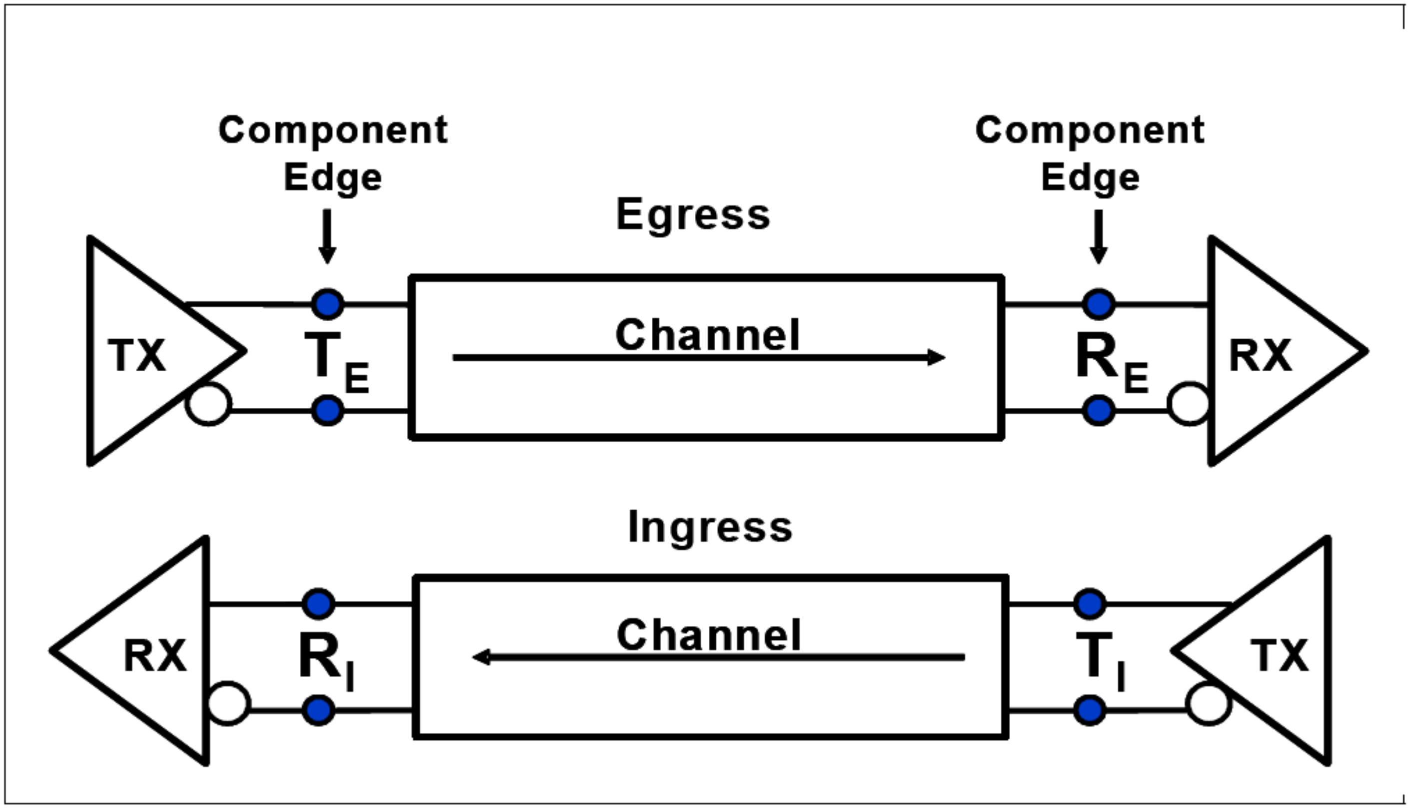
CEI Reference Model

- Two CEI Links (Ingress and Egress)

Figure 1-6.Reference Model



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CEI-6G Specifications

- Baud Rate 4.976 to 6.375 Gigabaud/second
- NRZ Differential Signaling
- Nominal Impedance 100 Ohm
- Supports Hot Plug
- AC coupling Required
  - assumed part of receiver
- DC Coupling Optional
- BER 10^{-15}

CEI-6G Specifications

- **CEI-6G-SR Short Reach**
  - 0 to 200mm PCB and up to 1 connector
  - Transmitter
    - 1 Tap Transmit Emphasis
    - T_Vdiff 400 mVppd minimum 750 mVppd maximum
  - Receiver
    - No equalization
    - R_Vdiff 125 mVppd minimum 750 mVppd maximum
- **CEI-6G-LR Long Reach**
  - 0 to 1,000mm PCB and up to 2 connectors
  - Transmitter
    - 1 Tap Transmit Emphasis
    - T_Vdiff 800 mVppd minimum 1200 mVppd maximum
  - Receiver
    - 5 Tap Decision Feedback Equalization or better
    - R_Vdiff 1200 mVppd maximum

CEI-11G Specifications

- Baud Rate 9.95 to 11.1 Gigabaud/second
- NRZ Differential Signaling
- Nominal Impedance 100 Ohm
- Supports Hot Plug
- AC coupling Required
  - assumed part of receiver
- DC Coupling Optional
- BER 10^{-15}

CEI-11G Specifications

- **CEI-11G-SR Short Reach**
  - 0 to 200mm PCB and up to 1 connector
  - Transmitter
    - No Transmit Emphasis
    - T_Vdiff 360 mVppd minimum and 770 mVppd maximum
  - Receiver
    - No equalization
    - R_Vdiff 110 mVppd minimum 1050 mVppd maximum

- **CEI-11G-MR Medium Reach**
  - Transmitter
    - 2 Tap Transmit Emphasis
    - T_Vdiff 800 mVppd minimum 1200 mVppd maximum
  - Receiver
    - No equalization
    - R_Vdiff 110 mVppd minimum 1200 mVppd maximum

- **CEI-11G-LR Long Reach**
  - 0 to 1,000mm PCB and up to 2 connectors
  - Transmitter
    - 2 Tap Transmit Emphasis
    - T_Vdiff 800 mVppd minimum 1200 mVppd maximum
  - Receiver
    - 5 Tap Decision Feedback Equalization or better
    - R_Vdiff 1200 mVppd maximum

Compliance

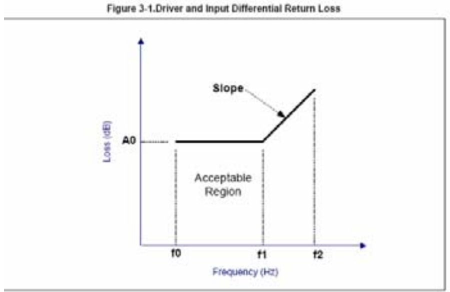
- Transmitter
  - Must meet Tx Mask Sets.
- Channel
  - S parameters of Channel must demonstrate performance with a simulated worst case Transmitter and Receiver.
- Receiver
  - Must operate with any compliant Transmitter and Channel.

6G SR Channel Compliance

Reference Transmitter:

1. A single post tap transmitter, with ≤ 3dB of emphasis and infinite precision accuracy.
2. A transmit amplitude of 400mVppd
3. Additional Uncorrelated Bounded High Probability Jitter of 0.15UIpp (emulating part of the Tx jitter)
4. Additional Uncorrelated Unbounded Gaussian Jitter of 0.15UIpp (emulating part of the Tx jitter)
5. A Tx edge rate filter: simple 20dB/dec low pass at 75% of baud rate, this is to emulate a Tx -3dB bandwidth at 3/4 baud rate at the maximum baud rate that the channel is to operate at or 6.375Gsym/s which ever is the lowest.
6. Worst case transmitter return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = T_Baud x ¾, F2 = T_Baud, Slope = 16.6 dB/decade

Figure 3-1.Driver and Input Differential Return Loss



Reference Receiver:

1. No Rx equalization and the Rx bandwidth is assumed to be infinite.
2. Worst case receiver return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = R_Baud x ¾, F2 = R_Baud, Slope = 16.6 dB/decade
3. A BER of 10^{-15}
4. A sampling point defined at the midpoint between the average zero crossings of the differential signal

6G LR Channel Compliance

Reference Transmitter:

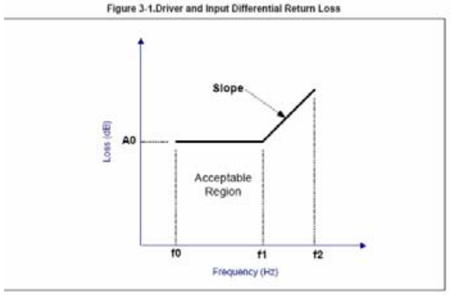
1. A single post tap transmitter, with **≤ 6dB** of emphasis and infinite precision accuracy.
2. A transmit amplitude of **800mVppd**
3. Additional Uncorrelated Bounded High Probability Jitter of 0.15UIpp (emulating part of the Tx jitter)
4. Additional Uncorrelated Unbounded Gaussian Jitter of 0.15UIpp (emulating part of the Tx jitter)
5. A Tx edge rate filter: simple **40dB/dec** low pass at 75% of baud rate, this is to emulate both Tx and Rx -3dB bandwidth at 3/4 baud rate at the maximum baud rate that the channel is to operate at or 6.375Gsym/s which ever is the lowest.
6. Worst case transmitter return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = T_Baud x ¾, F2 = T_Baud, Slope = 16.6 dB/decade

Reference Receiver:

1. Rx equalization: 5 tap DFE, with infinite precision accuracy and having the following restriction on the coefficient values:
   Let W[N] be sum of DFE tap coefficient weights from taps N through M where
   N = 1 is previous decision (i.e. first tap)   M = oldest decision (i.e. last tap)
   R_Y2 = T_Y2 = 400mV
   Y = min(R_X1, (R_Y2 - R_Y1) / R_Y2) = 0.30
   Z = 2/3 = 0.66667
   Then W[N] ≤ Y * Z(N - 1)

   For the channel compliance model the number of DFE taps (M) = 5. This gives the following maximum coefficient weights for the taps:
   W[1] ≤ 0.2625 (sum of taps 1 to 5)
   W[2] ≤ 0.1750 (sum of taps 2 to 5)
   W[3] ≤ 0.1167 (sum of taps 3 to 5)
   W[4] ≤ 0.0778 (sum of taps 4 and 5)
   W[5] ≤ 0.0519 (tap 5)
   Notes:
   - These coefficient weights are absolute assuming a T_Vdiff of 1Vppd
   - For a real receiver the restrictions on tap coefficients would apply for the actual number of DFE taps implemented (M)
2. Worst case receiver return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = R_Baud x ¾, F2 = R_Baud, Slope = 16.6 dB/decade
3. A BER of 10^{-15}

Figure 3-1.Driver and Input Differential Return Loss

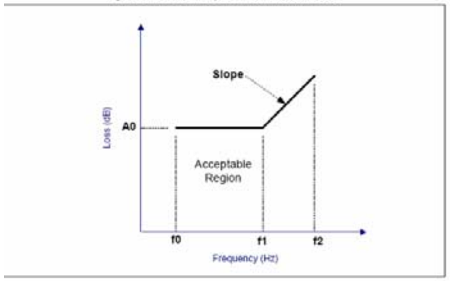


11G SR Channel Compliance

Reference Transmitter:

1. A transmitter with no emphasis
2. A transmit amplitude of both 360 mVppd and 770 mVppd
3. Additional Uncorrelated Bounded High Probability Jitter of 0.15 UIpp (emulating part of the Tx jitter)
4. Additional Uncorrelated Unbounded Gaussian Jitter of 0.15UIpp (emulating part of the Tx jitter)
5. At the maximum baud rate that the channel is to operate at or 11.1Gsym/s which ever is the lowest.
6. A Tx edge rate filter: simple 20dB/dec low pass at 75% of baud rate, this is to emulate a Tx -3dB bandwidth at 3/4 baud rate.
7. Worst case transmitter return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = T_Baud x ¾, F2 = T_Baud x 3/2,
   Slope = 16.6 dB/decade

Figure 3-1.Driver and Input Differential Return Loss



Reference Receiver A:

1. No Rx equalization and the Rx bandwidth is assumed to be infinite.
2. Worst case receiver return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = R_Baud x ¾, F2 = R_Baud x 3/2, Slope = 16.6 dB/decade
3. A BER of 10^{-15}
4. A wander divider equal to 10
5. A sampling point defined at the midpoint between the average zero crossings of the differential signal

Reference Receiver B (Jitter Transparent XFP/XFI):

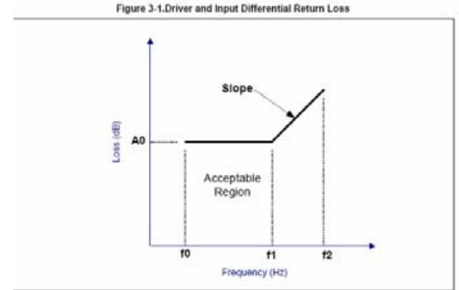
1. A receiver with a single zero single pole filter (as per Annex 2.B.8) and the Rx bandwidth is assumed to be infinite.
2. Worst case receiver return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = R_Baud x ¾, F2 = R_Baud x 3/2, Slope = 16.6 dB/decade
3. A BER constained by the optical specification
4. A wander divider equal to 10
5. A sampling point defined at the midpoint between the average zero crossings of the differential signal

11G LR Channel Compliance

Reference Transmitter:

1. Maximum Transmit Pulse, as per 2.D.7, of T_Vdiff min. of Table 9-1
2. A TX edge rate filter simple 40dB/dec low pass at 75% of Baud Rate
3. Effective Driver UUGJ, UHBHPJ and DCD as in Table 9-3
4. Equalizing Filter with 2 tap baud spaced emphasis no greater than a total of 6dB with finite resolution no better than 1.5dB.
5. Worst case Transmitter return loss described as a parallel RC element,
   - A0 = -8 dB, F0 = 100 Mhz, F1 = T_Baud x ¾, F2 = T_Baud, Slope = 16.6 dB/decade
6. Maximum baud rate that the channel is to operate at or 11.1 Gsym/sec whichever is the lowest,

Figure 3-1.Driver and Input Differential Return Loss



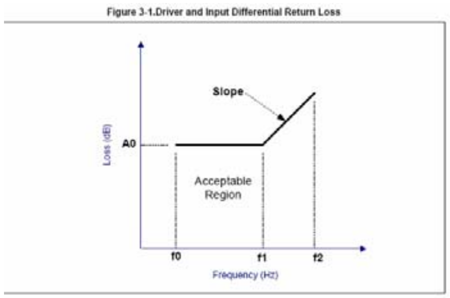
11G LR Channel Compliance

Reference Receiver A:

1. 4-tap baud spaced Non-Linear Discrete Inverse Channel Filter (DFE), with infinite precision accuracy and having the following restrictions:

   Let W[N] be sum of DFE tap coefficient weights from taps N through M where
   N = 1 is previous decision (i.e. first tap)
   M = 4
   R_Y2 = T_Y2 = 400mV
   Y = min(R_X1, (R_Y2 - R_Y1) / R_Y2) = 0.2625
   Z = 2/3 = 0.66667
   Then W[N] ≤ Y * Z(N - 1)
   For the channel compliance model the number of DFE taps (M) = 4. This gives the following maximum coefficient weights for the taps:
   W[1] ≤ 0.2625 (sum of absolute value of taps 1 and2)
   W[2] ≤ 0.1750 (sum of absolute value of taps 2, 3 and 4)
   W[3] ≤ 0.1167 (sum of absolute value of taps 3 and 4)
   W[4] ≤ 0.0778 (sum of absolute value of tap 4)
   Notes:

   - These coefficient weights are absolute assuming a T_Vdiff of 1Vppd
   - For a real receiver the restrictions on tap coefficients would apply for the actual number of DFE taps implemented (M)



2. Worst case receiver return loss described as a parallel RC elements,
   A0 = -8 dB, F0 = 100 Mhz, F1 = R_Baud x ¾, F2 = R_Baud, Slope = 16.6 dB/decade
3. A BER of 10^{-15}

Reference Receiver B:

1. A continuous-time equalizer with 3 zeros and 3 poles in the region of baudrate/100 to baudrate. Additional parasitic zeros or poles must be considered part of the receiver vendor's device and be dealt with as they are for reference receiver A. Pole and Zero values have infinite precision accuracy. Maximum required gain/ attenuation shall be less than or equal to 20dB.
2. The pole-zero algorithm takes the SDD21 magnitude response for the through channel and inverts it to produce a desired CTE filter response curve.
3. The input to pole-zero determination shall be the SDD21 magnitude at the following frequencies or nearest calculated frequencies: baudrate/100, baudrate/50, baudrate/20, baudrate/10, baudrate/5, baudrate/3, baudrate/2.
4. The algorithm is a least square fit of poles and zeros to the inverse of the magnitude of SDD21 at the 7 frequencies see 2.B.7.1.
5. The pole-zero determination shall be used to calculate the equalized SDD21.
6. Worst case Receiver return loss described as a parallel RC,
   A0 = -8 dB, F0 = 100 Mhz, F1 = R_Baud x ¾, F2 = R_Baud, Slope = 16.6 dB/decade

Interop Results at 6G

- Altera
- Flextronics
- Molex
- Northrop Grumman
- Tyco Electronics
- Vitesse
- Xilinx

6 G Interop Results		Silicon Source A	Silicon Source B	Silicon Source C
Backplane F Nelco N4000-13SI	Silicon Target A		21" (0.53 m)	31" (0.79 m)
	Silicon Target B	21" (0.53 m)	21" (0.53 m)	21" (0.53 m)
	Silicon Target C	31" (0.79 m)	21" (0.53 m)	
Backplane G Nelco N4000-13SI	Silicon Target A	49" (1.25 m)	25" (0.63 m)	30"-49" (0.76 m-1.25 m)
	Silicon Target B	25" (0.63 m)		30"-49" (0.76 m-1.25 m)
	Silicon Target C	30"-49"(0.76 m-1.25 m)	30"-49" (0.76 m-1.25 m)	
Backplane H Isola FR408	Silicon Target A	39" (1 m)		39" (1 m)
	Silicon Target B			39" (1 m)
	Silicon Target C	39" (1 m)	39" (1 m)	
Backplane I Nelco N4000-13	Silicon Target A		36" (0.91 m)	
	Silicon Target B	36" (0.91 m)		36" (0.91 m)
	Silicon Target C		36" (0.91 m)	
Backplane J Nelco N4000-6	Silicon Target A		35" (0.89 m)	
	Silicon Target B	35" (0.89 m)		35" (0.89 m)
	Silicon Target C		35" (0.89 m)	
Backplane K Rogers Laminate	Silicon Target A	37"-53" (0.94m-1.35 m)		
Backplane L Rogers Laminate SMT connector	Silicon Target A	53"(1.35 m)		45"-53" (1.14m-1.35 m)
	Silicon Target C	45"-53"(1.14 m - 1.35 m)		

Interop Results at 11G

- AMCC
- Flextronics
- Molex
- Northrop Grumman
- Tyco Electronics
- Xilinx.

11G Interop Results		Silicon Source D	Silicon Source E
Backplane M Nelco 4000-13SI	Silicon Target D	22"(0.56 m)	22"-31"(0.56 m - 0.79 m)
	Silicon Target E	22"-31"(0.56 m - 0.79 m)	
Backplane N Nelco 4000-13SI	Silicon Target D	25" (0.63 m)	30" (0.76 m))
	Silicon Target E	30" (0.76 m)	
Backplane O Isola FR408	Silicon Target D	25" (0.63 m)	30"(0.76 m)
	Silicon Target E	30"-40"(0.76 m-1.00 m)	
Backplane P Nelco 4000-13SI	Silicon Target D		22" -31"(0.56 m - 0.79 m)
	Silicon Target E	22" -31"(0.56 m - 0.79 m)	
Backplane Q Rogers Laminate Surface Mount Connector	Silicon Target D	33" (0.84 m)	33" - 45" (0.84 m - 1.14 m)
	Silicon Target E	33" - 45" (0.84 m - 1.14 m)	

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