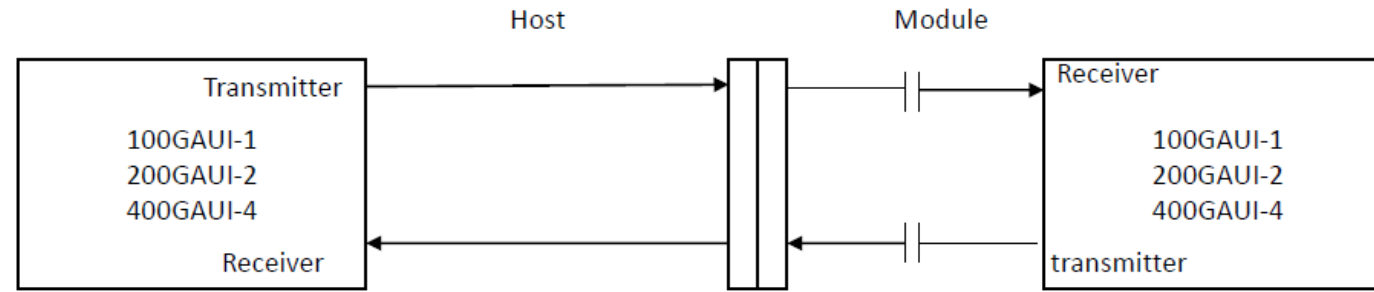# IEEE 802.3ck C2M Baseline Proposal

Phil Sun, Credo

Mike Li, Intel

C2M Link

❖ A typical C2M link includes host PCB trace, module PCB trace, AC-coupling capacitor and one connector.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Technical Choices

❖ Like 50GAUI-1/100GAUI-2/200GAUI-4/400GAUI-8 C2M (Annexes 120E and 135G), with enhancements.

❖ Signaling Rate: 53.125GBd.

❖ Modulation: PAM4.

❖ Gray code as defined in Clause 120.5.7.

❖ Precoding TBD.

❖ Channel insertion loss ≤ 16dB @ 26.5625GHz.

❖ Raw BER ≤ 1e-5 with the intent that with FEC the complete end-to-end link frame loss ratio is less than or equal to 6.2e-10 (BER 1e-12 equivalent) for 100GAUI-1, and 6.2e-11 (BER 1e-13 equivalent) for 200GAUI-2 and 400GAUI-4.

❖ Reference receiver equalizer is TBD.

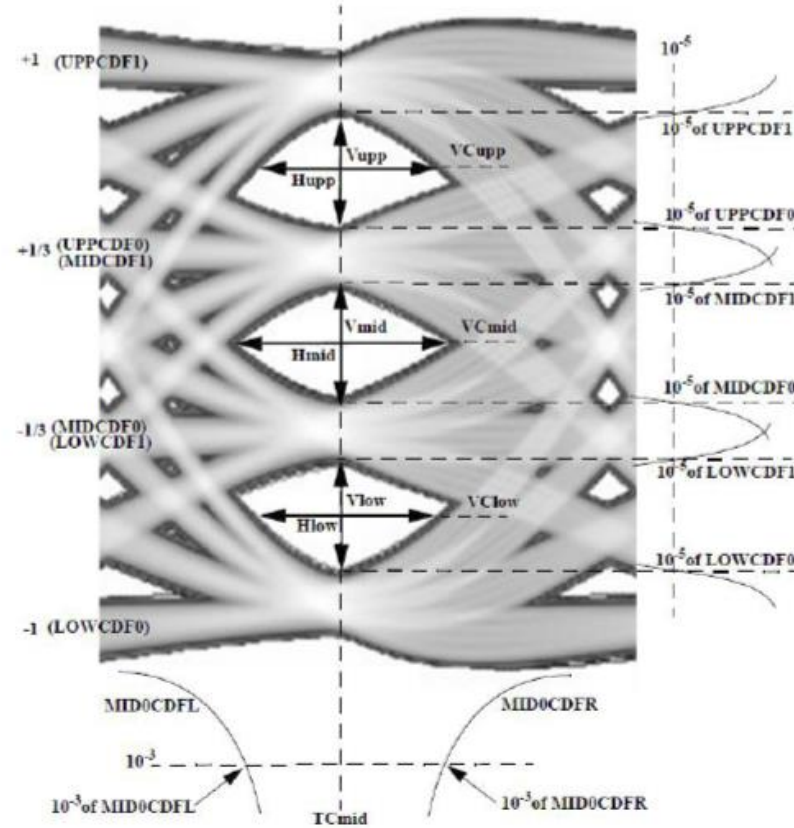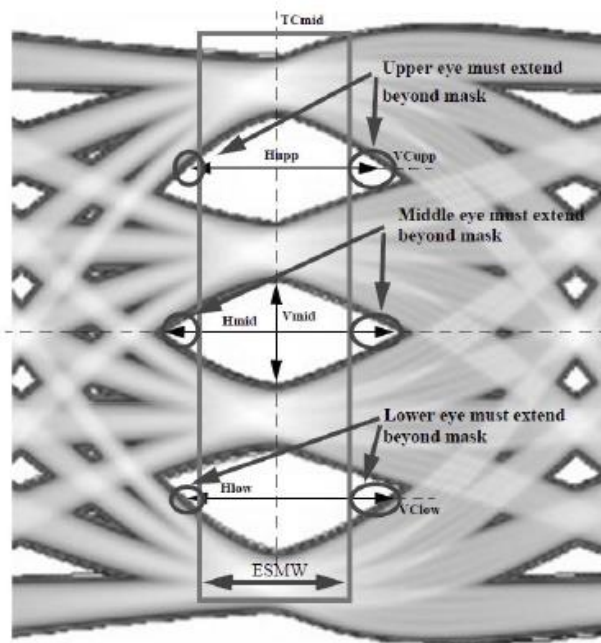Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

3

Specification Methodology

❖ Reuse 200GAUI-4 and 400GAUI-8 methodologies for electrical characteristics and corresponding tests.

 ❖ HCB/MCB method for host/module input/output compliance
 ❖ Test patterns
 ❖ Common to/from differential mode-conversion return loss and compliance point definitions
 ❖ Reuse clause 136 methodologies with ERL to replace differential return loss

❖ Leverage Annex 120E and OIF CEI-112G-VSR-PAM4 spec.

❖ Host output is specified at TP1a. Module output TP4 has near-end and far-end specs.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Eye width, eye height and VEC parameters

As in Annex 120E

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Parameter	400GAUI-8	100GAUI-1, 200GAUI-2, 400GAUI-4
Signaling Rate per lane	26.5625 GBd ± 100 ppm	53.125 GBd ± 100 ppm
DC common-mode output voltage (max)	2.8 V	2.8V
DC common-mode output voltage (min)	-0.3 V	-0.3 V
Single-ended output voltage (max)	3.3 V	3.3 V
Single-ended output voltage (min)	-0.4 V	-0.4 V
AC common-mode output voltage (max, RMS)	17.5 mV	17.5 mV

Differential peak-to-peak output voltage (max)
    Transmitter disabled
    Transmitter enabled
	35 mV
	880 mV
		35 mV
		870 mV

ESMW (Eye symmetry mask width)	0.22 UI	TBD
Eye height, differential (min)	32 mV	TBD
Vertical Eye Closure (max)	12 dB	TBD
Differential termination mismatch (max)	10%	10%
Transition time (min, 20% to 80%)	10 ps	TBD

❖ Parameters in magenta throughout this presentation need to be confirmed.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Parameter	400GAUI-8	100GAUI-1, 200GAUI-2, 400GAUI-4
Signaling Rate per lane	26.5625 GBd ± 100 ppm	53.125 GBd ± 100 ppm
AC common-mode output voltage (max, RMS)	17.5 mV	17.5 mV
Differential peak-to-peak output voltage (max)	900 mV	900 mV
Near-end ESMW (Eye symmetry mask width)	0.265 UI	TBD
Near-end Eye height, differential (min)	70 mV	TBD
Far-end ESMW (Eye symmetry mask width)	0.2 UI	TBD
Far-end Eye height, differential (min)	30 mV	TBD
Far-end pre-cursor ISI Ratio	-4.5% to +2.5%	TBD
Differential termination mismatch (max)	10%	10%
Transition time (min, 20% to 80%)	9.5 ps	TBD
DC common mode voltage (min)	-350 mV	-350 mV
DC common mode voltage (max)	2850 mV	2850 mV

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Host Input Characteristics

Parameter	400GAUI-8	100GAUI-1, 200GAUI-2, 400GAUI-4
Signaling Rate per lane	26.5625 GBd ± 100 ppm	53.125 GBd ± 100 ppm
Differential peak-to-peak input voltage tolerance (min)	900 mV at TP4	900 mV at TP4
Host stressed input test	120E.3.3.2	Reuse 120E.3.3.2 with updated parameters
Differential termination mismatch (max)	10% at TP4a	10% at TP4a
DC common mode voltage (min)	-0.3 V at TP4a	-0.3 V at TP4a
DC common mode voltage (max)	2.8 V at TP4a	2.8 V at TP4a

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Module Input Characteristics

Parameter	400GAUI-8	100GAUI-1, 200GAUI-2, 400GAUI-4
Signaling Rate per lane	26.5625 GBd ± 100 ppm	53.125 GBd ± 100 ppm
Differential peak-to-peak input voltage tolerance (min)	900 mV at TP1a	900 mV at TP1a
Module stressed input test	120E.3.4.1	Reuse 120E.3.4.1 with updated parameters
Differential termination mismatch (max)	10% at TP1	10% at TP1
Single-ended voltage tolerance range (min)	-0.4 to 3.3 V at TP1a	-0.4 to 3.3 V at TP1a
DC common mode voltage (min)	-0.35 V at TP1	-0.35 V at TP1
DC common mode voltage (max)	2.85 V at TP1	2.85 V at TP1

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Host/Module Input Differential to Common-mode Conversion Input Return Loss

❖ 400GAUI-8 (Equation (83E-6))

$$RLcd(f) \geq \begin{cases} 22 - 20\left(\dfrac{f}{25.78}\right) & 0.01 \leq f < 12.89 \\ 15 - 6\left(\dfrac{f}{25.78}\right) & 12.89 \leq f < 19 \end{cases} \quad (dB)$$

❖ 100GAUI-1, 200GAUI-2, 400GAUI-4

$$RLdc(f) \geq \begin{cases} 22 - 20\left(\dfrac{f}{53.125}\right) & 0.01 \leq f \leq 26.56 \\ 15 - 6\left(\dfrac{f}{53.125}\right) & 26.56 < f \leq 53.125 \end{cases} \quad (dB)$$
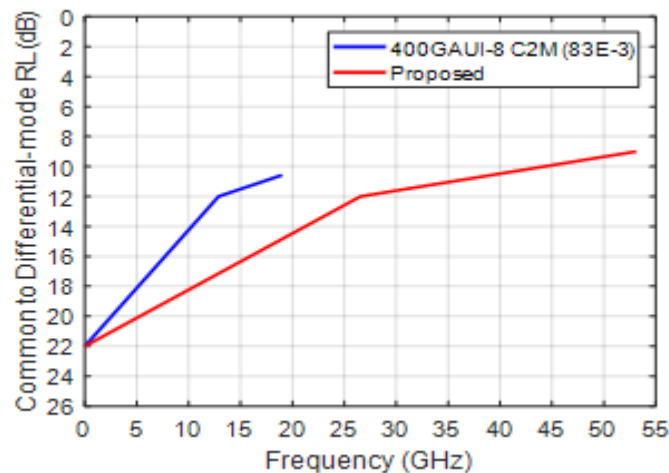
Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf
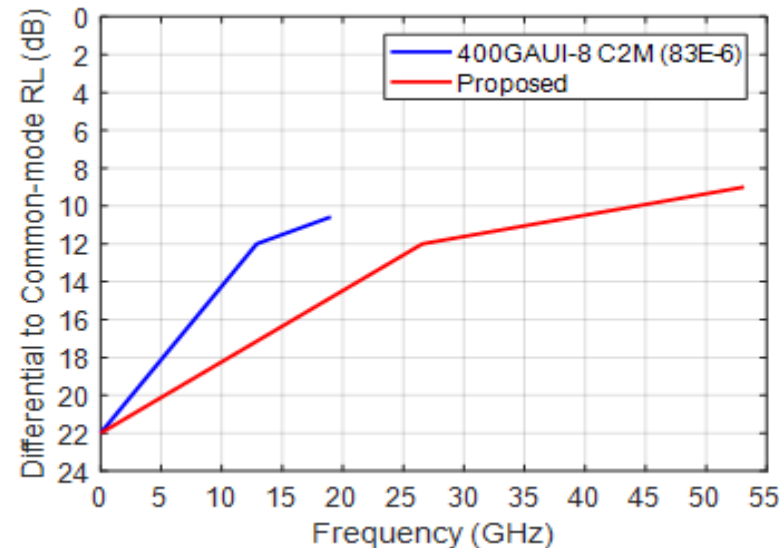
Host/Module Output Common to Differential-mode Conversion Return Loss

- ❖ 400GAUI-8 (Equation (83E-3))

  - ❖ $$RLdc(f) \geq \begin{cases} 22 - 20\left(\dfrac{f}{25.78}\right) & 0.01 \leq f < 12.89 \\ 15 - 6\left(\dfrac{f}{25.78}\right) & 12.89 \leq f < 19 \end{cases} \quad (dB)$$

- ❖ 100GAUI-1, 200GAUI-2, 400GAUI-4

  - ❖ $$RLdc(f) \geq \begin{cases} 22 - 20\left(\dfrac{f}{53.125}\right) & 0.01 \leq f \leq 26.56 \\ 15 - 6\left(\dfrac{f}{53.125}\right) & 26.56 < f \leq 53.125 \end{cases} \quad (dB)$$

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Host/Module Input / Output Effective Return Loss

Parameter	50GBASE-CR, 100GBASE-CR2, 200GBASE-CR4	100GAUI-1, 200GAUI-2, 400GAUI-4	
Transition time associated with a pulse	0.0189 ns	0.010 ns	
Incremental available signal loss factor	1.7 GHz	1.7 GHz	
Permitted reflection from a transmission line external to the device under test	0.3	0.3	
Length of the reflection signal	300 UI	600 UI	
Transmitter steady-state voltage, vf (min.) Transmitter steady-state voltage, vf (max.)	0.354 V 0.6 V	0.35 V 0.7 V	
Linear fit pulse peak (min.)	0.49 x vf V	~~0.4 x vf V~~ TBD	
Transmitter (Host/Module output) ERL	EQ 136-6 at TP2	EQ below at TP1a and TP4	
Receiver (Host/Module input) ERL	≥ 10 dB at TP3	≥ ~~9 dB~~ at TP1 and TP4a	TBD

- ❖ See 93A.5 for definition of parameters

- ❖ 50GBASE-CR, 100GBASE-CR2, 200GBASE-CR4 Transmitter ERL (Equation (136-6))
  - ❖ $$ERL \geq 40 \log_{10}\left(\frac{v_f}{\max_k(p(k))}\right) \quad (dB)$$

- ❖ 100GAUI-1, 200GAUI-2, 400GAUI-4 Host/Module output ERL
  - ❖ $$ERL \geq \cancel{40 \log_{10}\left(\frac{v_f}{\max_k(p(k))}\right)} \quad (dB) \quad \text{TBD}$$

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

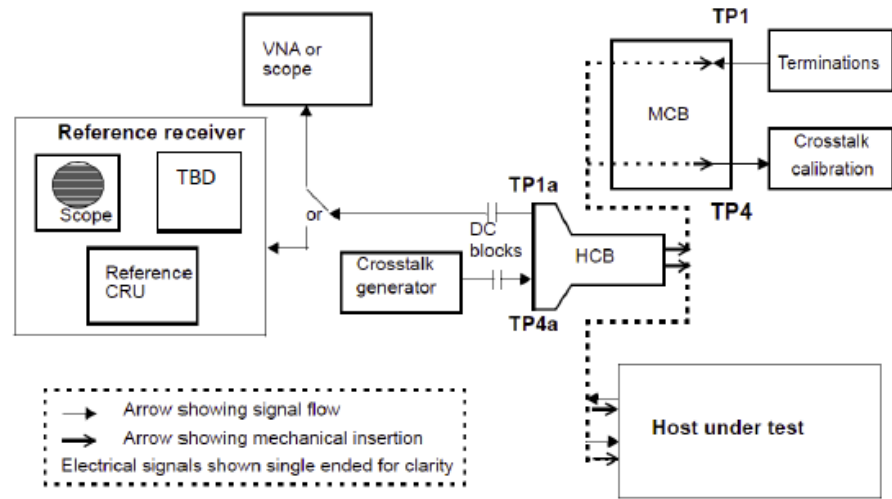# Host/Module Output Waveform Test

Figure 120E–8—Example host output test configuration

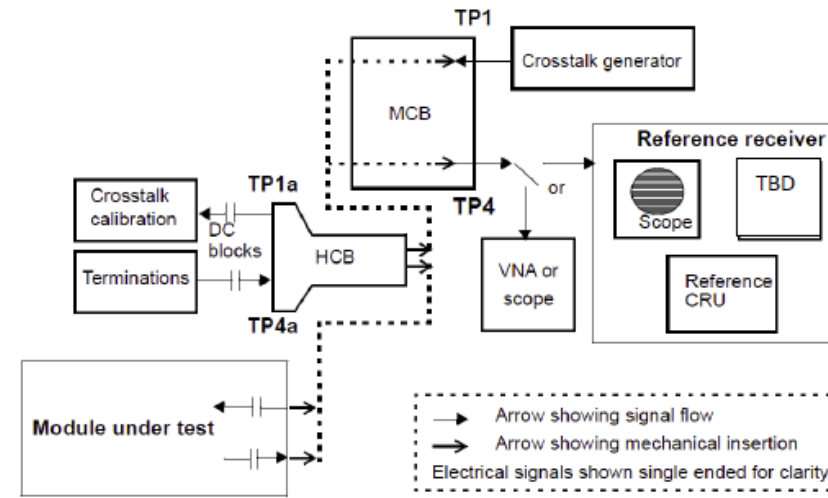Figure 120E–10—Example module output test configuration

- ❖ Test configuration is same as Annex 120E.
- ❖ Reference receiver TBD.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf
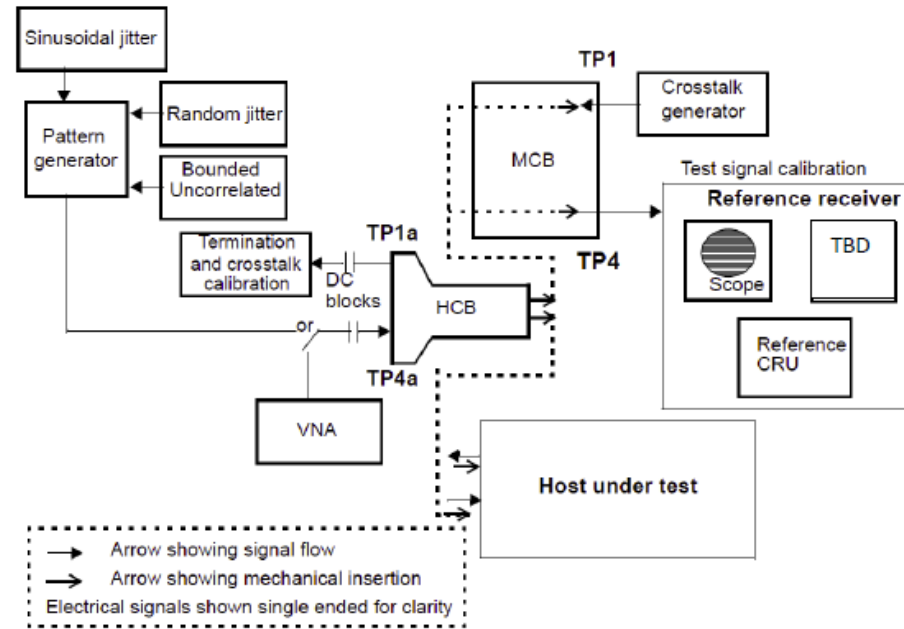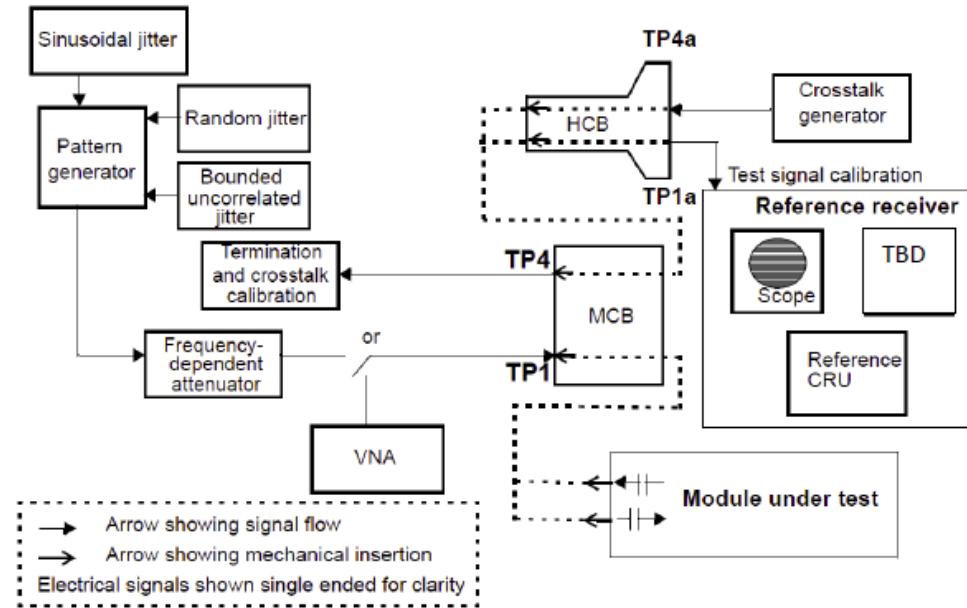
Host Stressed Receiver Test

Figure 120E–11—Example host stressed input test

- ❖ Test configuration is same as Annex 120E.
- ❖ Reference receiver TBD.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf
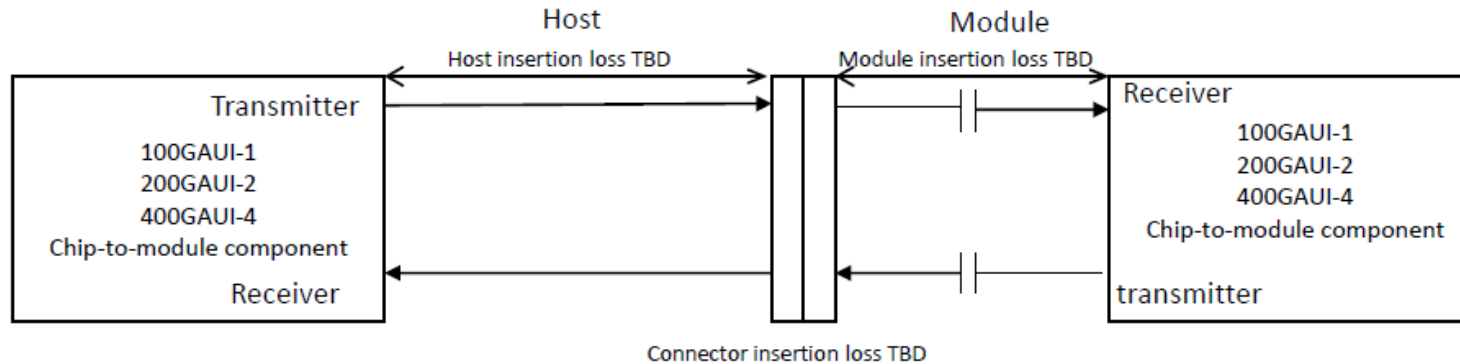
Module Stressed Receiver Test

Figure 120E–12—Example module stressed input test

- ❖ Test configuration is same as Annex 120E.
- ❖ Reference receiver TBD.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Insertion Loss Allocation

❖ Insertion loss allocation values are TBD.

❖ End-to-end insertion loss target is 16dB

- ❖ Reuse recommended insertion loss mask similar as in Annex 120E.
  - ❖ Alternatively use insertion loss target and replace insertion loss mask by COM.
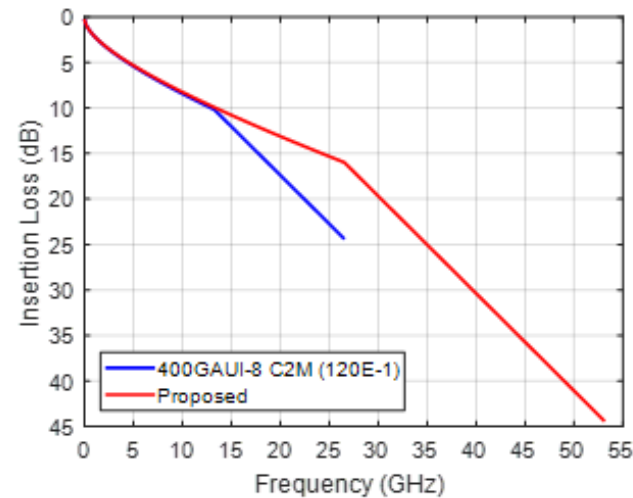
- ❖ 400GAUI-8 (Equation (120E-1))
  - ❖ 10.2dB
  - ❖
  $$Insertionloss(f) \leq \begin{cases} 0.05 + 1.8\sqrt{f} + 0.2705f & 0.01 \leq f \leq 13.28 \\ -4.0096 + 1.07f & 13.28 < f \leq 26.5625 \end{cases}$$

- ❖ 100GAUI-1, 200GAUI-2, 400GAUI-4
  - ❖ 16dB
  - ❖
  $$Insertionloss(f) \leq \begin{cases} 0.05 + 1.8\sqrt{f} + 0.2513f & 0.01 \leq f \leq 26.56 \\ -12.4181 + 1.07f & 26.56 < f \leq \cancel{40} \end{cases} \quad 53.125$$

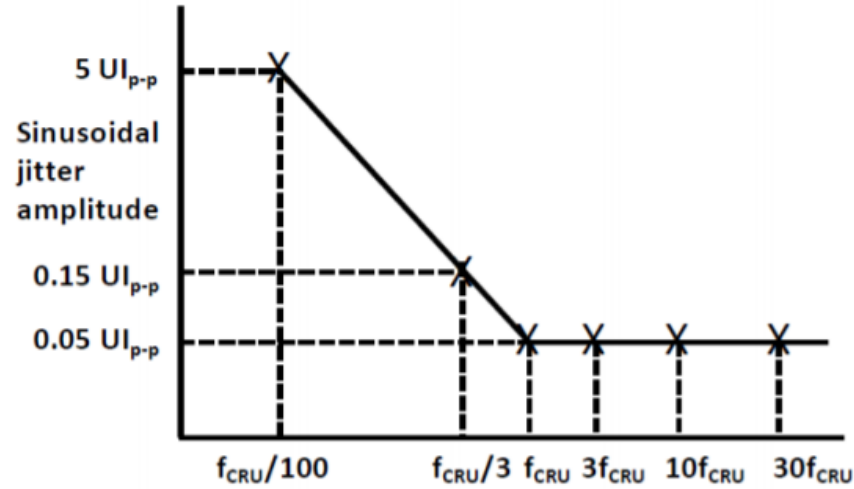Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

Compliance Boards

❖ 400GAUI-8
  ❖ HCB like 92.11.1 where the HCB performs equivalent function as the TP2 or TP3 test fixture.
  ❖ MCB like 92.11.2 where the MCB performs equivalent function as the cable assembly test fixture.
  ❖ The mated compliance board like 92.11.3 where the MCB and HCB performs the equivalent function as the cable assembly test fixtures.
  ❖ There are specs for HCB and MCB reference trace insertion losses, mated HCB-MCB max, min and reference trace insertion losses, differential and common return losses, through and return mixed-mode losses, ICN, MDNEXT, MDFEXT.

❖ 100GAUI-1, 200GAUI-2, 400GAUI-4
  ❖ HCB characteristics are same as the TP2 or TP3 test fixture of 100GBASE-CR1, 200GBASE-CR2, 400GBASE-CR4 PMD.
  ❖ MCB characteristics are same as the cable assembly test fixture of 100GBASE-CR1, 200GBASE-CR2, 400GBASE-CR4 PMD.
  ❖ The mated compliance board characteristics are same as the cable assembly test fixtures of 100GBASE-CR1, 200GBASE-CR2, 400GBASE-CR4 PMD.

Source: http://www.ieee802.org/3/ck/public/19_03/sun_3ck_03_0319.pdf

100GAUI-1,200GAUI-2, and 400GAUI-4 C2M Host and Module Stress Input Jitter Tolerance Mask

- fCRU = fb/13280
- fb=53.125GBd

Table 23-7. Sinusoidal jitter frequency for TP4 and TP1a testing

Frequency	Sinusoidal jitter, peak-to-peak (UI)
f_{CRU}/100	5
f_{CRU}/3	0.15
f_{CRU}	0.05
3f_{CRU}	0.05
10f_{CRU}	0.05
30f_{CRU}	0.05

Source: http://www.ieee802.org/3/ck/public/19_03/li_3ck_02b_0319.pdf

100GAUI-1,200GAUI-2, and 400GAUI-4 C2M Test Patterns

- 100GAUI-1, 200GAUI-2, and 400GAUI-4 PMA will reuse test pattern defined in clause 120.5.11.2
  - PRBS13Q for output
  - PRBS31Q for input

Source: http://www.ieee802.org/3/ck/public/19_03/li_3ck_02b_0319.pdf