

50Gb/s Modulation Proposal

Joel Goergen – Cisco Systems / Vasu Parthasarathy – Broadcom
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Overview

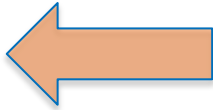
- What are the reaches and how should we cover those?
- Looks like C2EO is really the nPPI or eL'PPI in this case.
- Propose basic channel models for C2M and C2C.
- Proposal for 50Gb/s modulation.



Where is IEEE802.3bs 400GE in the Modulation Wars?

The following simplified process steps are used to build consensus:

- Defining / Discussing Reach
- System Architecture
- **Channel Loss**
- **Modulation**
- Equalization
- Error Correction
- Power



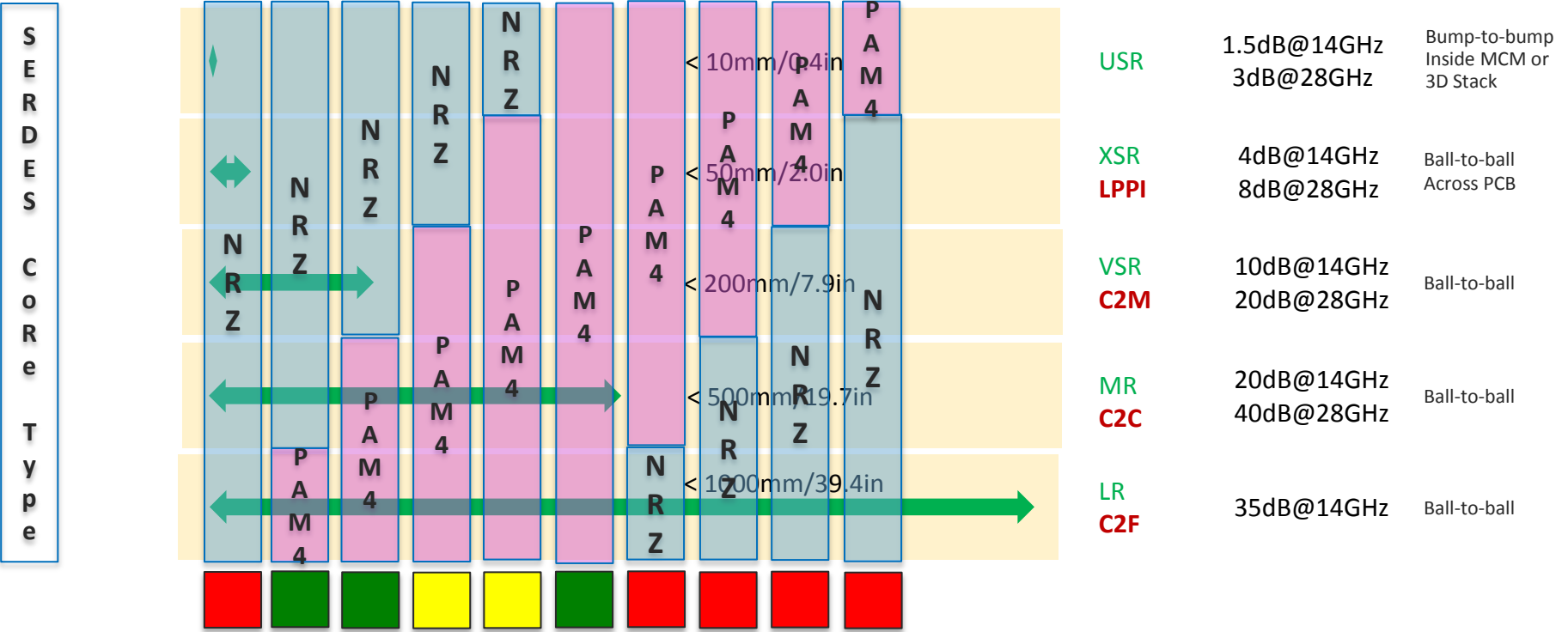
Focus Here

Review - Modulation is Tough Love !!

- If we focus on one reach, the conversation around modulation and power is easy.
- If we focus on our system design today, tomorrow, and out to 2017, the conversation turns to tough love!
- The next slide lays out some possible directions for picking modulation.

We think the discussion comes down to this – even though we are only focused on C2M and C2C (LPPI?)

IL



Not Really Practical

Compatibility Concerns

Feasible Technology – Min
Compatibility Concern

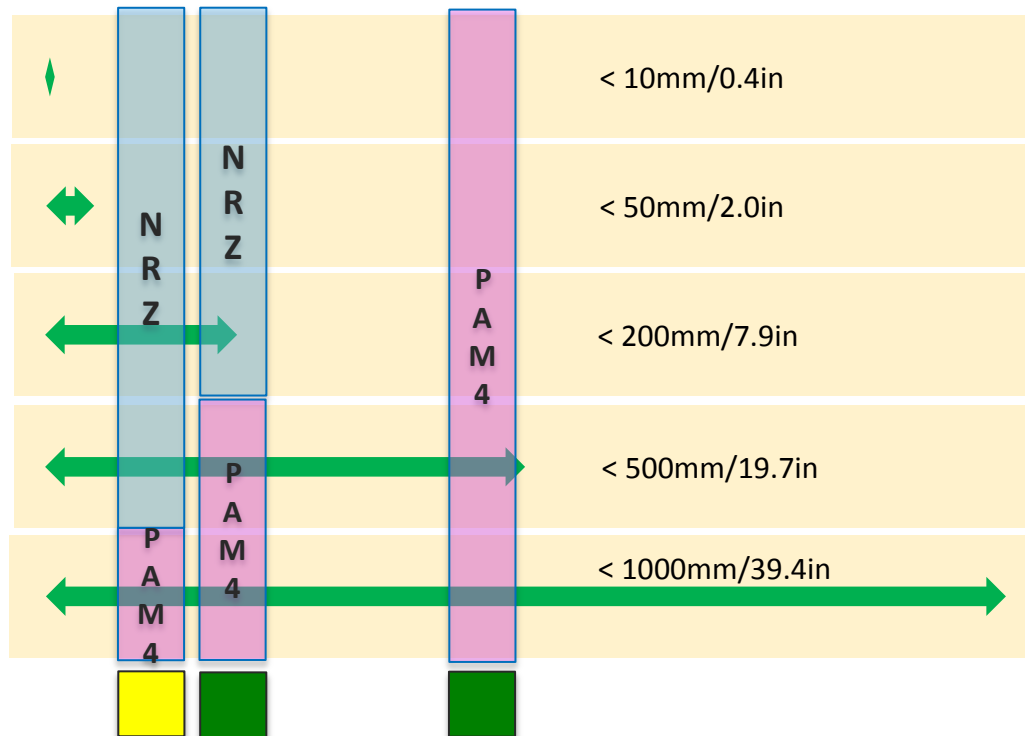
Tough Love – Choices for 50Gb/s Modulation Strategy

IL

S
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C
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T
Y
P
E



USR

1.5dB@14GHz
3dB@28GHz

Bump-to-bump
Inside MCM or
3D Stack

XSR

LPPI

4dB@14GHz
8dB@28GHz

Ball-to-ball
Across PCB

VSR

C2M

10dB@14GHz
20dB@28GHz

Ball-to-ball

MR

C2C

20dB@14GHz
40dB@28GHz

Ball-to-ball

LR

C2F

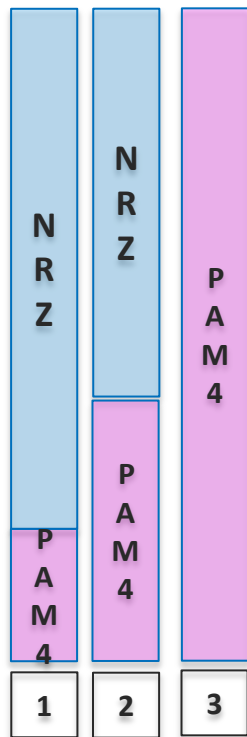
35dB@14GHz

Ball-to-ball

C2C Reach is a Worry

Safe Bet Across
Technologies

Choices for 50Gb/s Modulation Strategy



- *1 – NRZ for LPPI / C2M / C2C*
 - Long term covering C2F with PAM4 and covering USR with NRZ
 - Might be a challenge for C2M
 - Preserves SI test equipment and strategies in the lab
 - Optics can stay NRZ
- *2 – NRZ for LPPI / C2M and PAM4 for C2C*
 - Long term covering C2F with PAM4 and covering USR with NRZ
 - Compatibility between C2C and C2F
 - Complicates test equipment and SI strategy in some cases
 - Optics can stay NRZ
- *3 – PAM4 for LPPI / C2M / C2C*
 - Compatibility across all reaches
 - Changes test equipment and SI strategies, but not sure the extent
 - Optics has to move to PAM4 unless a conversion step is specified

A Closer Look at 50Gb/s

These Values are under discussion

Application	Length	Loss	Modulation	pJ/bit	DFE?	FEC?
LPPI(XSR)	< 2in	<4dB@14GHz	PAM-4	TBD	TBD	TBD
		<8dB@28GHz	NRZ	TBD	TBD	TBD
C2M (VSR)	2-8in	4-10dB@14GHz	PAM-4	TBD	TBD	TBD
		8-20dB@28GHz	NRZ	TBD	TBD	TBD
C2C (MR)	8-20in	10-20dB@14GHz	PAM-4	TBD	TBD	TBD
		20-40dB@28GHz	NRZ	TBD	TBD	TBD

50Gb/s Modulation

Proposal #1

NRZ for LPPI / C2M / C2C

50Gb/s NRZ(PAM2) for LPPI / C2M / C2C

- Follow both clause 93 parameters and dudek_01a_0312 baseline proposal as a guide.
- Providing basic values.
- Compliance test points, if any, should follow the incredible amount of work already done.

50Gb/s NRZ(PAM2) for LPPI / C2M / C2C

These Values are under discussion

Application	Length	Loss	Modulation	pJ/bit	DFE?	FEC?
LPPI(XSR)	< 2in					
		<8dB@28GHz	NRZ	TBD	TBD	TBD
C2M (VSR)	2-8in					
		8-20dB@28GHz	NRZ	TBD	TBD	TBD
C2C (MR)	8-20in					
		20-40dB@28GHz	NRZ	TBD	TBD	TBD

50Gb/s NRZ(PAM2) for LPPI / C2M / C2C

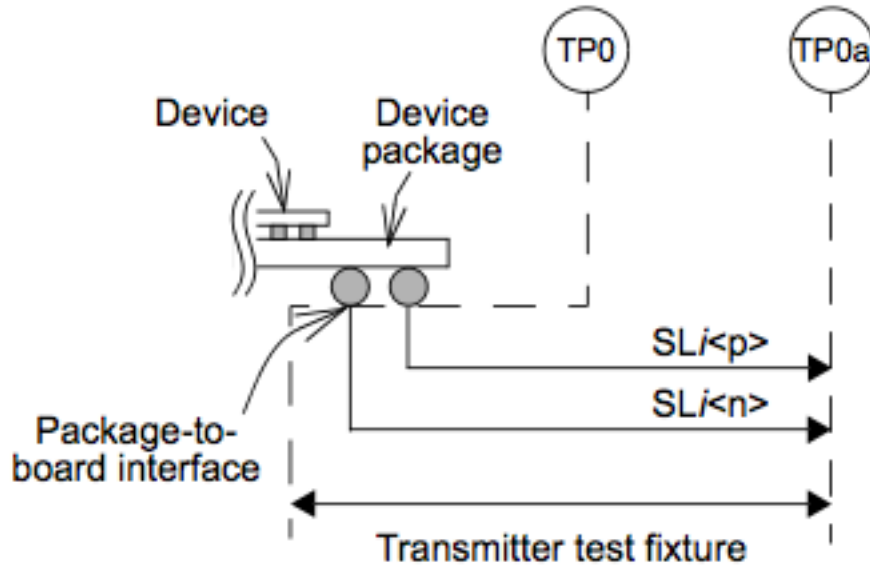


Figure 93–5—Transmitter test fixture and test points

Reference Clause 93 P802d3bj_D3p2

50Gb/s NRZ(PAM2) for LPPI / C2M / C2C

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
Nominal Signaling rate		50	GBd	
Differential peak to peak output voltage (max)		TBD	mV	
Differential peak to peak output voltage (max) with Tx disabled.		TBD	mV	
Common-mode voltage limits (max)		TBD	V	
Common-mode voltage limits (min)		TBD	V	
Differential output return loss (min)		TBD		
Common-mode output return loss (min)		TBD		
Common-mode AC output voltage (max, RMS)		TBD	mV	
Transition time (20-80%) (min) de-emphasis off		TBD	ps	
Steady state output (Vf) (max) de-emphasis off		TBD	V	
Steady state output (Vf) (min) de-emphasis off		TBD	V	
Linear fit pulse (min) de-emphasis off		TBD	V	

50Gb/s NRZ(PAM2) for LPPI / C2M / C2C

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
max normalized error (linear fit) "e"		TBD		
normalized coefficient step size (min)		TBD		
normalized coefficient step size (max)		TBD		
minimum precursor fullscale range		TBD		
minimum postcursor fullscale range		TBD		
Far-end transmit output noise (max)		TBD		
Low insertion loss channel		TBD	mV	
High insertion loss channel.		TBD	mV	
Max output jitter (peak-to-peak)		TBD		
Random jitter		TBD	UI	

Additional Thoughts to the Parameters

- FEC is TBD. It is assumed that if FEC is required for coding gain, then an appropriate FEC should be specified.
- The listed parameters implicitly assume there is only 1 pre-cursor and 1 post-cursor. This is probably a bit early to specify. Depending on de-emphasis taps in the final architecture, this may change appropriately.

50Gb/s Modulation

Proposal #2

NRZ for LPPI / C2M

PAM4 for C2C



50Gb/s NRZ(PAM2) for LPPI / C2M

- Follow both clause 93 parameters and dudek_01a_0312 baseline proposal as a guide.
- Providing basic values.
- Compliance test points, if any, should follow the incredible amount of work already done.

50Gb/s NRZ(PAM2) for LPPI / C2M

These Values are under discussion

Application	Length	Loss	Modulation	pJ/bit	DFE?	FEC?
LPPI(XSR)	< 2in					
		<8dB@28GHz	NRZ	TBD	TBD	TBD
C2M (VSR)	2-8in					
		8-20dB@28GHz	NRZ	TBD	TBD	TBD
C2C (MR)	8-20in					
		20-40dB@28GHz	NRZ	TBD	TBD	TBD

50Gb/s NRZ(PAM2) for LPPI / C2M

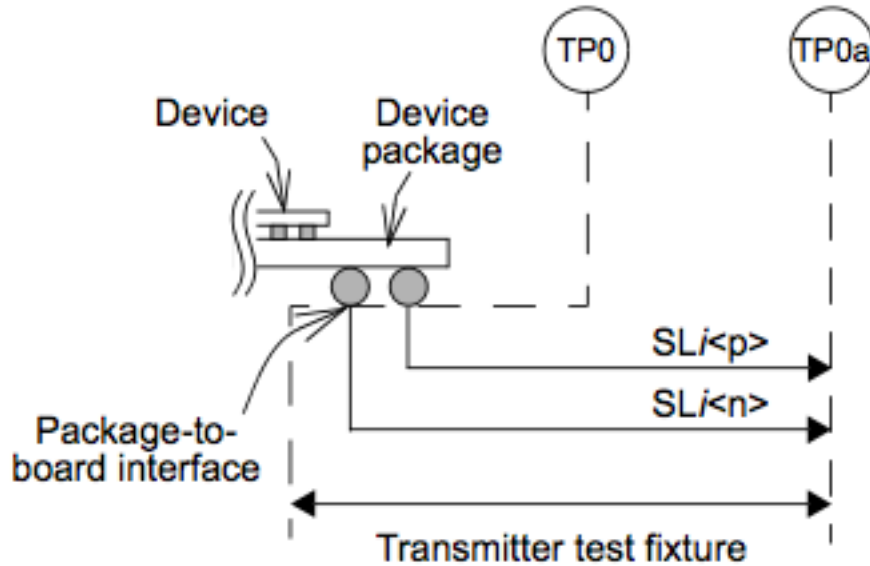


Figure 93–5—Transmitter test fixture and test points

Reference Clause 93 P802d3bj_D3p2

50Gb/s NRZ(PAM2) for LPPI / C2M

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
Nominal Signaling rate		50	GBd	
Differential peak to peak output voltage (max)		TBD	mV	
Differential peak to peak output voltage (max) with Tx disabled.		TBD	mV	
Common-mode voltage limits (max)		TBD	V	
Common-mode voltage limits (min)		TBD	V	
Differential output return loss (min)		TBD		
Common-mode output return loss (min)		TBD		
Common-mode AC output voltage (max, RMS)		TBD	mV	
Transition time (20-80%) (min) de-emphasis off		TBD	ps	
Steady state output (Vf) (max) de-emphasis off		TBD	V	
Steady state output (Vf) (min) de-emphasis off		TBD	V	
Linear fit pulse (min) de-emphasis off		TBD	V	

50Gb/s NRZ(PAM2) for LPPI / C2M

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
max normalized error (linear fit) "e"		TBD		
normalized coefficient step size (min)		TBD		
normalized coefficient step size (max)		TBD		
minimum precursor fullscale range		TBD		
minimum postcursor fullscale range		TBD		
Far-end transmit output noise (max)		TBD		
Low insertion loss channel		TBD	mV	
High insertion loss channel.		TBD	mV	
Max output jitter (peak-to-peak)		TBD		
Random jitter		TBD	UI	

Additional Thoughts to the Parameters

- FEC is TBD. It is assumed that if FEC is required for coding gain, then an appropriate FEC should be specified.
- The listed parameters implicitly assume there is only 1 pre-cursor and 1 post-cursor. This is probably a bit early to specify. Depending on de-emphasis taps in the final architecture, this may change appropriately.

50Gb/s PAM4 for C2C

- Follow both clause 94 parameters and dudek_01a_0312 baseline proposal as a guide.
- Providing basic values
- Compliance test points, if any, should follow the incredible amount of work already done.

50Gb/s PAM4 for C2C

These Values are under discussion

Application	Length	Loss	Modulation	pJ/bit	DFE?	FEC?
LPPI(XSR)	< 2in	<4dB@14GHz	PAM-4	TBD	TBD	TBD
C2M (VSR)	2-8in	4-10dB@14GHz	PAM-4	TBD	TBD	TBD
C2C (MR)	8-20in	10-20dB@14GHz	PAM-4	TBD	TBD	TBD

50Gb/s PAM4 for C2C

94.3.12.1 Test Fixture

The test fixture of Figure 94–10 or its equivalent, is required for measuring the transmitter specifications described in 94.3.12.

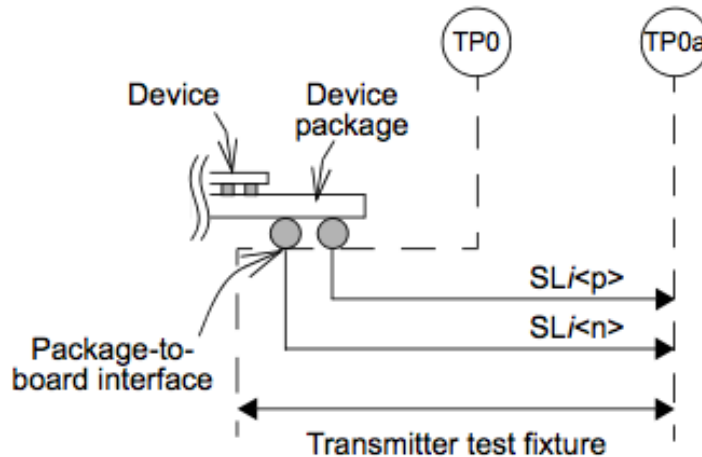


Figure 94–10—Transmitter test fixture and test points

Reference Clause 94 P802d3bj_D3p2

50Gb/s PAM4 for C2C

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
Nominal Signaling rate		25	GBd	
Differential peak to peak output voltage (max)		TBD	mV	
Differential peak to peak output voltage (max) with Tx disabled.		TBD	mV	
Common-mode voltage limits (max)		TBD	V	
Common-mode voltage limits (min)		TBD	V	
Differential output return loss (min)		TBD		
Common-mode output return loss (min)		TBD		
Common-mode AC output voltage (max, RMS)		TBD	mV	
Transition time (20-80%) (min) de-emphasis off		TBD	ps	
Steady state output (Vf) (max) de-emphasis off		TBD	V	
Steady state output (Vf) (min) de-emphasis off		TBD	V	
Linear fit pulse (min) de-emphasis off		TBD	V	

50Gb/s PAM4 for C2C

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
max normalized error (linear fit) "e"		TBD		
normalized coefficient step size (min)		TBD		
normalized coefficient step size (max)		TBD		
minimum precursor fullscale range		TBD		
minimum postcursor fullscale range		TBD		
Far-end transmit output noise (max)		TBD		
Low insertion loss channel		TBD	mV	
High insertion loss channel.		TBD	mV	
Max output jitter (peak-to-peak)		TBD		
Random jitter		TBD	UI	

Additional Thoughts to the Parameters

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50Gb/s Modulation

Proposal #3

PAM4 for LPPI / C2M / C2C



50Gb/s PAM4 for LPPI / C2M / C2C

- Follow both clause 94 parameters and dudek_01a_0312 baseline proposal as a guide.
- Providing basic values
- Compliance test points, if any, should follow the incredible amount of work already done.

50Gb/s PAM4 for LPPI / C2M / C2C

These Values are under discussion

Application	Length	Loss	Modulation	pJ/bit	DFE?	FEC?
LPPI(XSR)	< 2in	<4dB@14GHz	PAM-4	TBD	TBD	TBD
C2M (VSR)	2-8in	4-10dB@14GHz	PAM-4	TBD	TBD	TBD
C2C (MR)	8-20in	10-20dB@14GHz	PAM-4	TBD	TBD	TBD

50Gb/s PAM4 for LPPI / C2M / C2C

94.3.12.1 Test Fixture

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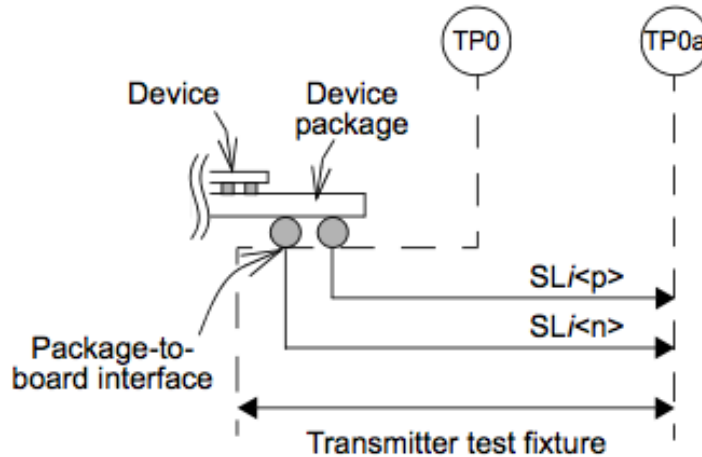


Figure 94–10—Transmitter test fixture and test points

Reference Clause 94 P802d3bj_D3p2

50Gb/s PAM4 for LPPI / C2M / C2C

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
Nominal Signaling rate		25	GBd	
Differential peak to peak output voltage (max)		TBD	mV	
Differential peak to peak output voltage (max) with Tx disabled.		TBD	mV	
Common-mode voltage limits (max)		TBD	V	
Common-mode voltage limits (min)		TBD	V	
Differential output return loss (min)		TBD		
Common-mode output return loss (min)		TBD		
Common-mode AC output voltage (max, RMS)		TBD	mV	
Transition time (20-80%) (min) de-emphasis off		TBD	ps	
Steady state output (Vf) (max) de-emphasis off		TBD	V	
Steady state output (Vf) (min) de-emphasis off		TBD	V	
Linear fit pulse (min) de-emphasis off		TBD	V	

50Gb/s PAM4 for LPPI / C2M / C2C

Transmitter Characteristics at TP0				
Parameter	IEEE subclause reference	Value	Units	Comment
max normalized error (linear fit) "e"		TBD		
normalized coefficient step size (min)		TBD		
normalized coefficient step size (max)		TBD		
minimum precursor fullscale range		TBD		
minimum postcursor fullscale range		TBD		
Far-end transmit output noise (max)		TBD		
Low insertion loss channel		TBD	mV	
High insertion loss channel.		TBD	mV	
Max output jitter (peak-to-peak)		TBD		
Random jitter		TBD	UI	

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Thank you!

From:

Vasu Parthasarathy - Broadcom
Beth Kochuparambil – Cisco Systems
Vivek Telang - Broadcom
Joel Goergen – Cisco Systems

