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ADS 2016.01

# Ethernet 802.3-2014 Compliance Test Bench



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# Installing the Ethernet 802.3-2014 Compliance Test Bench

# Installing the Ethernet 802.3-2014 Compliance Test Bench

This section provides information on prerequisites and steps to install the Ethernet 802.3-2014 Compliance Test Bench (CTB).

## Prerequisites

Before using the Ethernet 802.3-2014 CTB, ensure that the following softwares are installed:

- Infiniium Offline (Version 05.50.0015)
- CR4 Compliance App (Version 2.01(2.1\*))
- KR4 Compliance App (Version 2.01(2.1\*))
- ADS 2016.01

\* This is the version that is shown in the splash screen when the app is opened, and also when using the **Help->About...** menu from the app.

After installing the Ethernet 802.3-2014 CTB, launch the Infiniium Offline software to ensure the Ethernet 802.3-2014 Test App is available under **Analyze > Automated Test Apps**.

F	ile Control Setup	Display	Trigger	Measure	Math	Analyze Utilities Demos He	elp	
	Offline	]~~	$\sim$	$\sim\sim$	$\sim\sim$	Histogram Mask Test		T 0.0 V
	1 100 mV/ 0	.0 V	2 1.00	) V/ 3.	58 V	Automated Test Apps	Þ	N8829A 100GBASE-KR4 Test App
a						Measurement Analysis (EZJI	IT)	N8830A 100GBASE-CR4 Test App
MEds						Jitter/Noise (EZJIT Complete	e)	U7243B USB3 Test App
						RTEye/Clock Recovery (SDA)	s) `	
VELU						Equalization		

## Install Instructions

To install the Ethernet 802.3-2014 CTB:

- 1. Download the Ethernet802p3.deb package.
- Select DesignGuide > Add DesignGuide from the ADS Main window. The Add DesignGuide dialog box is displayed.
- 3. Click Add Global DesignGuide.
- 4. Browse and select the *Ethernet802p3.deb* package.
- 5. Click Open.

The Ethernet 802.3-2014 Compliance Test Bench will be added.

#### 6. Restart ADS.

 7. Open a Schematic view and select DesignGuide.
 The Ethernet 802.3-2014 Compliance Test Bench will be listed under the DesignGuide menu with the name 'Ethernet 802.3-2014 Compliance Test Bench'.

# Ethernet 802.3-2014 100GBASE-CR4 Compliance Test Bench Simulation Setups

# Ethernet 802.3 -2014 100GBASE-CR4 Compliance Test Bench Simulation Setups

100GBASE-CR4 d efines a 4-lane 100 Gbit/s PHY for operation over links consistent with copper twinaxial cables with lengths up to at least 5m. Signalling used is NRZ.

The Ethernet 802.3-2014 Compliance Test Bench provides a variety of tests, which helps to understand the various aspects of the Ethernet 802.3-2014 digital standard (CR4, KR4 and KP4). It provides you the ability to create designs using the included models or your own models. You can refer to the included examples for developing your designs. This Compliance Test Bench provides the following Models and Examples for CR4:

Ethernet 802.3bj Compliance Test Bench:1
Ethernet 802.3bj
▲ CR4
A Channel Models
Cable Assembly
Host To Module Link
Tx Package
Rx Package
<ul> <li>Compliance Examples</li> </ul>
TP2 Transmitter Tests
Transmitter Characteristics
Cable Assembly Characteristics
Receiver Characteristics
▷ KR4
▷ KP4
About Ethernet802.3bj Compliance Test Bench
Ethernet802.3bj Compliance Test Bench Documentation

NOTE - The Models used in this design for the host-to-module link, have been downloaded from the IEEE website Public area - http://www.ieee802.org/3/100GCU/public/channel.html

NOTE - Package Models are for educational demonstration only and are not intended for design purposes. Please download the latest up to date models for your application directly from the vendor's website. Models in this example were downloaded from Xilinx Inc. : www.xilinx.com

Models

The following CR4 channel models are available :

- Cable Assembly
- Host To Module Link
- Tx Package
- Rx Package

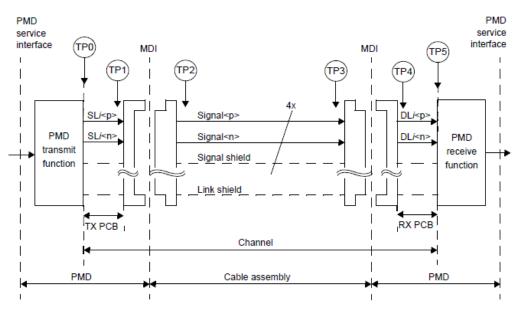
## Examples

The following examples are included in the Ethernet 802.3-2014 Compliance Test Bench for CR4:

- TP2 Transmitter Tests
- Transmitter Characteristics
- Cable Assembly Characteristics
- Receiver Characteristics

## **TP2 Transmitter Tests**

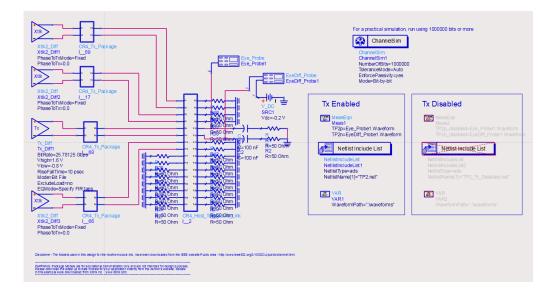
The following design displays an Ethernet 802.3-2014 CR4 connection from the Transmitter to the Cable Connector(TP2) where the Transmitter Compliance Testing has to be done:



In this design, a 100GBASE-CR4 link in one direction is displayed. The 100GBASE-CR4 channel is defined between the transmitter (TP0) and receiver (TP5) blocks to include the transmitter and receiver differential controlled impedance printed circuit board insertion loss and the cable assembly insertion loss. For 100GBASE-CR4, there are 4 differential paths in each direction for a total of 8 pairs, or 16 connections. The circuit below shows 1 transmitting pair. The other 3 pairs introduce crosstalk on to that transmitting pair.

The Transmitter transmits true PRBS9 data using a file 'prbs9\_950.txt', at a rate of 25.78125 Gbps. The signal from a Differential Transmitter flows through the package and host-to-module link. Eye Probes placed in the circuit capture the waveforms for compliance testing.

#### NOTE



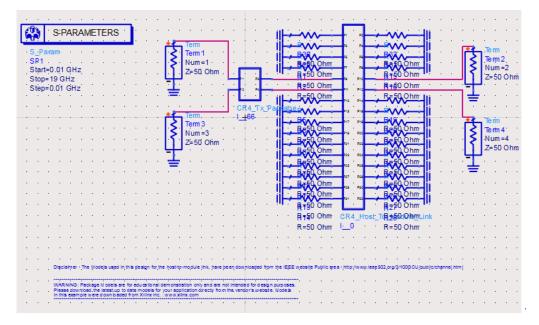
To run the Compliance Test, which requires the Tranmitter to be disabled, disconnect the Tx\_Diff component, short V\_DC, deactivate the 'Tx Enabled' block and activate the 'Tx Disabled' block.

The two lines of the differential pair should carry signals between the same voltage levels but having opposite state. The ADS Tx component creates a differential pair where the two lines carry signals from 0 to X volts and 0 to -X volts, instead of the required 0 to X volts for both lines. To overcome this, a dc voltage of -0.2V is applied to the differential eye probe to move the 'n' signal in the same voltage level as the 'p' signal.

The waveforms generated at TP2 are saved in the data/waveforms directory with the names TP2p.h5 and TP2n.h5.

## **Transmitter Characteristics**

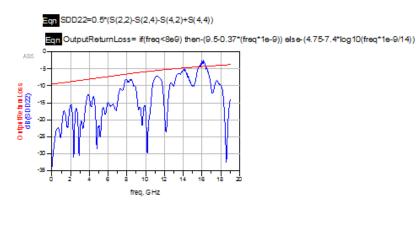
The following design shows the S-Parameter simulation required for the CR4 Transmitter Compliance. The results have been compared with the corresponding Masks.



The following parameters are plotted in the results, along with their masks:

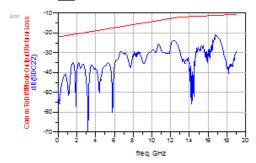
- Differential Output Return Loss
- Common-mode to differential mode output return loss

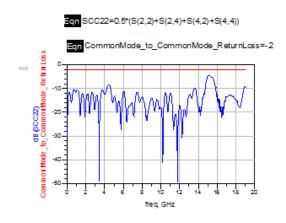
Common-mode to common-mode output return loss



Eqn SDC22=0.5\*(S(2,2)+S(2,4)-S(4,2)-S(4,4))

Eqn Comm To DiffModeOutputReturnLoss=if(freq<12.89e9) then-(22-(20/25.78)\*freq\*1e-9) else-(15-(6/25.78)\*freq\*1e-9)</p>





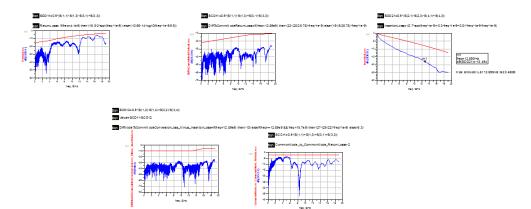
## Cable Assembly Characteristics

The following design shows the S-Parameter simulation of a CR4 Cable Assembly. The results have been compared with the corresponding Cable Assembly Masks:

Image: Second	=2 ·
Image: Second	=2 ·
Num=1     Image: Second s	=2 ·
	) Ohm
	· ·
	• •
Ref Ohm Bef Ohm	
Brash Ohm Brash Ohm	
S Param	4
Start=0.01 GHz	) Óhm
Stop=19.GHz	· ·
step=0.01 GHz	
Beith China and Annual a	
Beat Ohm Beat Ohm	
Brad Ohm Brad Ohm	
R+50 Ohm R+50 Ohm	
R+50 Ohm CR4 Cable R250 @hm32b	
R=50 Ohm L_0 R=50 Ohm	
	• •
Disclaimer- The Models used in this design for the cable, have been downloaded from the IEEE website Public area - http://www.leee302.org/3/100.GCJ/iguolo/channel.html	

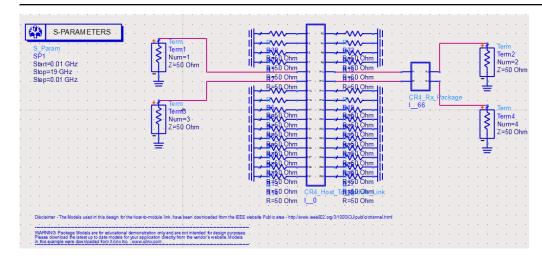
The following parameters are plotted in the results, along with their masks:

- Maximum insertion loss at 12.8906 GHz
- Minimum insertion loss at 12.8906 GHz
- Minimum return loss at 12.8906 GHz
- Differential to common-mode return loss
- Differential to common-mode conversion loss
- Common-mode to common-mode return loss



## **Receiver Characteristics**

The following design shows the S-Parameter simulation required for the CR4 Receiver Compliance. The results have been compared with the corresponding Masks.

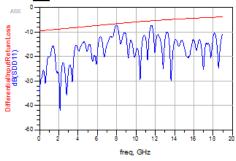


The following parameters are plotted in the results, along with their masks:

- Differential input return loss
- Differential to common-mode input return loss

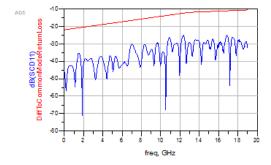
Eqn SDD11=0.5\*(S(1,1)-S(1,3)-S(3,1)+S(3,3))

Eqn DifferentialInputReturnLoss= if(freq<8e9) then-(9.5-(0.37\*freq\*1e-9)) else-(4.75-7.4\*log10((freq\*1e-9)/14))



Eqn SCD11=0.5\*(S(1,1)-S(1,3)+S(3,1)-S(3,3))

Eqn DiffToCommonModeReturnLoss=if(freq<12.89e9) then-(22-((20/25.78)\*freq\*1e-9)) else-(15-((6/25.78)\*freq\*1e-9))



#### References

• IEEE Std 802.3bj<sup>™</sup>-2014 - IEEE Standard for Ethernet, Amendment 2: Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables

# Running 100GBASE-CR4 Compliance Tests on Infiniium Offline

# Running 100GBASE-CR4 Compliance Tests on Infiniium Offline

Using the Keysight Infiniium Offline software you can run the compliance test on these waveforms. In the Ethernet 802.3-2014 100GBASE-CR4 Compliance Test Bench Simulation Setups section, the Channel Simulation example generated signal waveforms in .h5 format.

NOTE

For the test that requires the transmitter to be disabled, use the waveforms generated after making the necessary changes as described in the design.

The waveforms TP2p.h5 and TP2n.h5 are used in this tutorial.

NOTE

Ensure that the waveforms are generated with number of bits simulated in the Channel Simulation Controller equal to or more than 1000000.

To run the Compliance tests:

1. Click Analyze > Automated Test Apps > N8830A 100GBASE-CR4 Test App from the Infiniium Offline software to open the CR4 application.

File Control Setup Display Trigger Measure Math	Analyze Utilities Demos Help		
Offline	Histogram Mask Test	T 0.0 V	- <b></b>
<b>∃</b> (1.00 V 0.0 V + ₽	Automated Test Apps	N8829A 100GBASE-KR4 Test App	
	Measurement Analysis (EZJIT)	N8830A 100GBASE-CR4 Test App	4.00 V
leas	Jitter/Noise (EZJIT Complete)	U7243B USB3 Test App	
Ye	RTEye/Clock Recovery (SDA)		3.00 V
rtic	Equalization		
			2.00 V
			1.00 V
			0.0 V
M			
			-1.00 V
			-2.00 V
ne			-2.00 V
			-3.00 V
			-4.00 V
-500 ns -400 ns -300 ns -200 ns	-100 ns 0.0 s 100 ns	200 ns 300 ns 400 ns	500 ns 1
🛞 🛞 100 ns/ 0.0 s 😰 🌐 📮			

) 🚔 🖬   🖿	Set Up   Select Tests   Configure   Connect   Run Tests   Automation   Results   Html Report
Set Up Select Tests Configure Connect	Test Environment Setup         Device Under Test (DUT)         Measurement Option       Multi-Lane Option         © 100GBASE-CR4       © Switch Matrix         © 100GBASE-CR4       © Switch Matrix         © Channel Pair       © Switch Matrix         © Real Edge       © Channels 1 and 3         © Channels 1 and 3       © Channels 2 and 4         Select Lane Number         Test Report Comments (Optional)         Device Identifier:       User Description:         [SELECT OR TYPE]       [SELECT OR TYPE]         Comments:       [SELECT OR TYPE]
	InfiniiSim Setup     Set Channel skew     Saved Waveform Setup       No Device Connected     PNA     Connect PNA/ENA

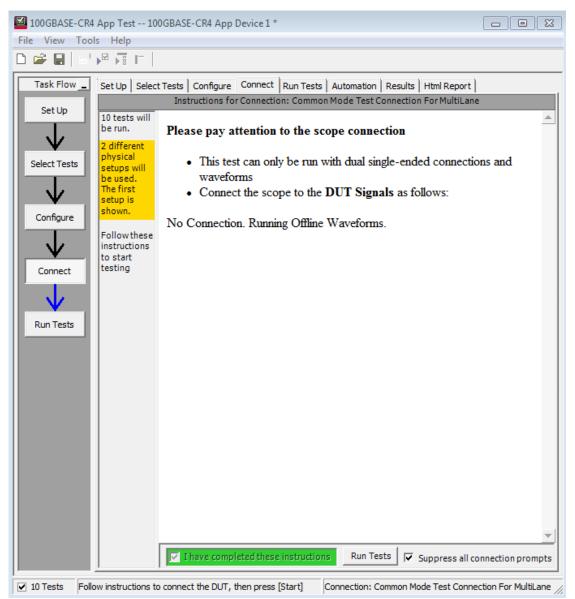
 $2. \ \ \mbox{In the Setup tab, click Saved Waveform Setup}.$ 

3. Click **Browse** and select the *TP2p.h5* and *TP2n.h5* waveform files for the DUT+ and DUT- fields respectively. Click **Done**.

🖳 frmOfflineSetup	
DUT+ waveform for General Measurements:	
van\default15_01\Ethernet_wrk\data\waveforms\TP2p.h5	Browse
DUT- waveform for General Measurements:	
van\default15_01\Ethernet_wrk\data\waveforms\TP2n.h5	Browse
Done	
Done	
	//

- ☑ 100GBASE-CR4 App Test -- 100GBASE-CR4 App Device 1 \* - • × File View Tools Help 🗅 🚅 🖶 🔄 🛩 🎵 🗖 🚳 🕤 🚺 Task Flow \_ Set Up Select Tests Configure Connect Run Tests Automation Results Html Report 100GBASE-CR4 Tests
   100GBASE-CR4 Tests
   Main Voltage Measurements (pattern: PRBS9) Set Up Main Voltage Measurements (pattern: PRBS9)
   Offerential Peak to Peak Output Voltage Test with TX disabled
   Of Common Mode Output Voltage Test
   Offerential Peak to Peak Output Voltage Test
   Output Vaveform Measurements (pattern: PRBS9)
   O  $\downarrow$ Select Tests  $\mathbf{v}$ Configure  $\mathbf{V}$ Connect  $\mathbf{v}$ Run Tests (Click a test's name to see description) . Limit Set: IEEE 802.3 100GBASE-CR4 Test Limit Ŧ
- 4. Click the Select Tests tab and select the tests, as shown in the following figure:

- 5. Click the **Connect** tab and select the following:
  - a. Check I have completed the instructions.
  - b. Click Run Tests.



6. Once the tests are completed, you can view the test results under the Results tab.

100GBASE-CR4 App	Test 100GBASE-C	R4 App Device 1 *			
File View Tools H	lelp				
🗅 🚅 🖬 🔤 🖂	🗖 F 🛛 🗙 🐘				
Task Flow _ Set	Up Select Tests Co	onfigure   Connect   Run Te	ests Automation Resu	ults Html	Report
Set Up Te	est Name		Actual Val	Margin	Pass Limits
	DC Common Mode Ou	utput Voltage Test	87.93 mV	4.6%	0.00000 V <= VALUE <= 1.90000 V
	AC Common Mode Ou	utput Voltage Test	3.70 mV	87.7%	VALUE <= 30.00 mV
· · · · · · · · · · · · · · · · · · ·	Differential Peak to P	eak Output Voltage Test	1.133 V	5.6%	VALUE <= 1.200 V
	Signaling Rate		25.781198918 Gbps	49.0%	25.778671875 Gbps <= VALUE <= 25.783828125 Gbps
	Even-Odd Jitter		22.6 mUI	35.4%	VALUE <= 35.0 mUI
	Bounded Uncorrelate	d Jitter	2.6 mUI	97.4%	VALUE <= 100.0 mUI
	Total Uncorrelated Ji	tter	25.5 mUI	85.8%	VALUE <= 180.0 mUI
Configure 🗸	Steady-State Voltage	e Vf	564 mV	13.8%	340 mV <= VALUE <= 600 mV
	Linear Fit Pulse Peak		380 mV	49.6%	VALUE >= LinearMin V
	Signal-to-noise-and-o	distortion ratio	34.341 dB	32.1%	VALUE >= 26.000 dB
Run Tests					
•			III		•
	tails: Signal-to-noi	se-and-distortion ratio			
F	Parameter	Value			
	Pass Limits	>= 26.000 dB			
	Parameter Tested	Signal-to-noise-and-distort	tion ratio		
	Actual Value Referenced Values:	34.341 dB			
N	Number UI Tested .ane Number	1e6 Lane0	_		
▼ 10 Tests 10 results	s shown. [Html Report]	tab shows details Con	nection: PRBS9 Connect	ion	

#### You can also view the HTML report under the $\ensuremath{\text{HTML Report}}$ tab.

100GBASE	-CR4 App Test 100GBASE-CR4	App Device 1 *		
File View	Tools Help			
🗅 🗳 日	a' 🖻 🏹 🖿 🛛 🗟 🎒			
Task Flov	Set Up   Select Tests   Config	gure Connect Run Tests Auto	mation Results Html Report	
Set Up				
Select Test	s	100GBASE-CR	4 App Test Repo	rt 📃
$  \downarrow$		Overall R	esult: PASS	
Configure		Test Conf	iguration Details	
			Description	
<b>V</b>		Switch Option	Single Lane	
Connect		ChanPair	Real Edge	
		Speed Grade	100GBASE-CR4	
$  \mathbf{V}$		Test Se	ession Details	
Run Tests		Infiniium SW Version	05.50.0015	
		Infiniium Model Number	N8900A	
		Infiniium Serial Number	No Serial	
		Application SW Version	2.01	
		Debug Mode Used	No	
		Compliance Limits (official)	IEEE 802.3 100GBASE-CR4 Test Limit	
		Last Test Date	2015-07-21 14:17:45 UTC +05:30	
	Summary of Resu	lts		
	Test StatisticsFailed0Passed10Total10			<u>_</u>
✓ 10 Tests	View/Save/Print detailed HTML resu	Its. Connection: PRBS9 Connec	tion	li.

#### NOTE

If you open the **Select Tests** tab before loading your waveforms, you will see tests which are not listed in the screenshot in Step 4 above. These tests are in the application but not supported currently. They will be supported in a future release of this Compliance Test Bench and 100GBASE-CR4 application.

## References

• IEEE Std 802.3bj<sup>™</sup>-2014 - IEEE Standard for Ethernet, Amendment 2: Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables

# Ethernet 802.3-2014 100GBASE-KR4 Compliance Test Bench Simulation Setups

# Ethernet 802.3 -2014 100GBASE-KR4 Compliance Test Bench Simulation Setups

100GBASE-KR4 d efines a 4-lane 100 Gbit/s backplane PHY for operation over links consistent with copper traces on "improved FR-4" with lengths up to at least 1m . Signalling used is NRZ.

The Ethernet 802.3-2014 Compliance Test Bench provides a variety of tests, which helps to understand the various aspects of the Ethernet 802.3-2014 digital standard (CR4, KR4 and KP4). It provides you the ability to create designs using the included models or your own models. You can refer to the included examples when developing the designs. This Compliance Test Bench provides the following Models and Examples for KR4:

🔛 Ethernet 802.3bj Compliance Test Bench:1
Ethernet 802.3bj
▷ CR4
▲ KR4
A Channel Models
Card Trace
Channel
Tx Package
Rx Package
Compliance Examples
TPOa Transmitter Tests
Transmitter Characteristics
Channel Characteristics
Receiver Characteristics
> KP4
About Ethernet802.3bj Compliance Test Bench
Ethernet802.3bj Compliance Test Bench Documentation

NOTE - The Models used in this design for the host-to-module link, have been downloaded from the IEEE website Public area - http://www.ieee802.org/3/100GCU/public/channel.html

NOTE - Package Models are for educational demonstration only and are not intended for design purposes. Please download the latest up to date models for your application directly from the vendor's website. Models in this example were downloaded from Xilinx Inc. : www.xilinx.com

## Models

The following KR4 channel models are supported:

• Card Trace

- Channel
- Tx Package
- Rx Package

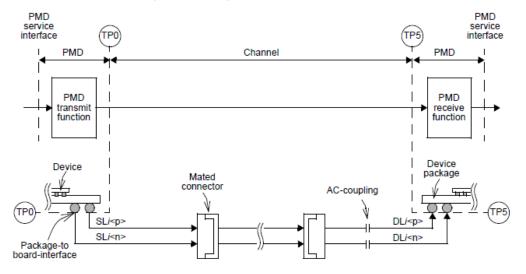
## Examples

The following examples are included in the Ethernet 802.3-2014 Compliance Test Bench for KR4:

- TP0a Transmitter Tests
- Transmitter Characteristics
- Channel Characteristics
- Receiver Characteristics

## **TPOa Transmitter Tests**

The following design displays an Ethernet 802.3-2014 KR4 connection from the Transmitter to the Card Traces(TP0a) where the Transmitter Compliance testing is done.

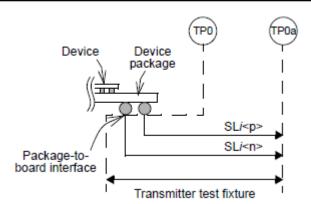


One direction for one lane of a 100GBASE-KR4 link is shown in Figure above. The 100GBASE-KR4 channel is defined between the transmitter (TP0) and receiver (TP5) blocks.

For 100GBASE-KR4, there are 4 differential lanes in each direction for a total of 8 pairs, or 16 connections. The circuit below shows 1 transmitting lane. The other 3 lanes are not shown as the crosstalk effects are negligible.

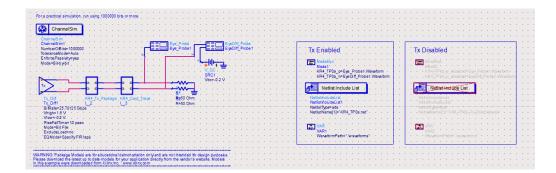
The Transmitter transmits true PRBS9 data using a file 'prbs9\_950.txt', at a rate of 25.78125 Gbps.

The signal from a Differential Transmitter flows through the package and card traces. Eye Probes placed in the circuit at TP0a capture the waveforms for compliance testing.



#### NOTE

To run the Compliance Test which requires the Tranmitter to be disabled, disconnect the  $Tx_Diff$  component, short V\_DC, deactivate the 'Tx Enabled' block and activate the 'Tx Disabled' block.



The two lines of the differential pair should carry signals between the same voltage levels but having opposite state. The ADS Tx component creates a differential pair where the two lines carry signals from 0 to X volts and 0 to -X volts, instead of the required 0 to X volts for both lines.

To overcome this, a dc voltage of -0.2V is applied to the differential eye probe to move the 'n' signal in the same voltage level as the 'p' signal.

The waveforms generated at TPOa are saved in the data/waveforms directory with the names *KR4\_TPOa\_p.h5* and *KR4\_TPOa\_n.h5*.

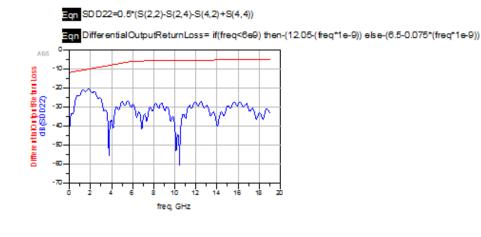
## **Transmitter Characteristics**

The following design shows the S-Parameter simulation required for the KR4 Transmitter Compliance. The results have been compared with the corresponding Masks.

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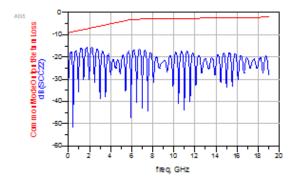
The following parameters are plotted in the results, along with their masks:

- Differential Output Return Loss
- Common-mode output return loss



SCC22=0.5\*(S(2,2)+S(2,4)+S(4,2)+S(4,4))

Eqn CommonModeOutputReturnLoss=if(freq<8e9) then-(9.05-(freq\*1e-9)) else-(3.5-0.075\*(freq\*1e-9))



## **Channel Characteristics**

The following design shows the S-Parameter simulation of a KR4 Channel. The results have been compared with the corresponding Channel Masks.

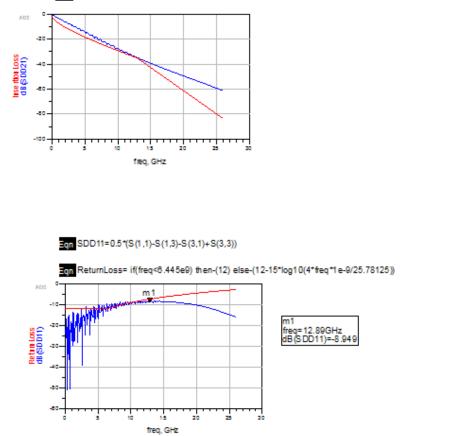
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	-	S_ SP		am	·	•	·	·	÷	·	÷	·	·	·	·	١ <u>٢</u>		1m= 50	:1 Ohn	n İ		Г		]		·	·	·	·	Ì		im= :50	=3 Ohi	m	•	
		Sta Sto	art= op=	26 (	1 GI GHz	:										Ŧ					Ē	•			1					Ī						
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						+										ť₹	<b>-</b>	rm rm2											ſ	Ł		rim rm4	4. 4			
:		•				:	•		•	:		•		•	•	١٤	Nı Z=		≘2. Ohn	n.		•	•							٤	Nı Z=		=4 Ohi	m		 
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The following parameters that are plotted in the results, along with their masks:

- Insertion Loss
- Return Loss

Eqn SDD21=0.5\*(S(2,1)-S(2,3)-S(4,1)+S(4,3))

Insertion Loss=if(freq<12.89e9) then-(1.5+(1.318\*freq\*1e-9)+(4.8\*sqrt(freq\*1e-9))) else-(-12.71+3.7\*freq\*1e-9)



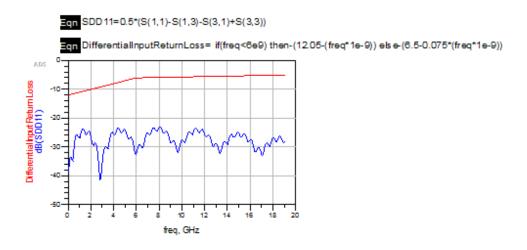
## **Receiver Characteristics**

The following design shows the S-Parameter simulation required for the KR4 Receiver Compliance. The results have been compared with the corresponding Masks.

S .S	Par P1 itart= itop=	0.0 19	GHz		ИЕТ	TEF		· · · ·		[		'N	erm erm lum =50	=1	im	· · ·			· · · ·	· · ·		· · ·						· · · ·	· · · ·			Ten Ten Nu Z={	m m2 m=2 50 O	)hm	
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WARNIN Please d In this ex	ownio	ed the	Inter	tupte	date	mipd	ie ie fe	нуры	a 100	licat	ion d	/ and inecti	l soe r ly fron	not in The	le a de vendi	d /or	dani webs	gn p ite. N	Ingras Acciel													•			

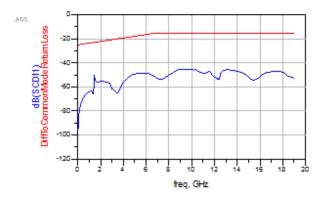
The following parameters that are plotted in the results, along with their masks:

- Differential input return loss
- Differential to common-mode input return loss





Eqn DiffToCommonModeReturnLoss=if(freq<8.95e9) then-(25-(1.44\*freq\*1e-9)) else-15



#### References

• IEEE Std 802.3bj<sup>™</sup>-2014 - IEEE Standard for Ethernet, Amendment 2: Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables

# Running 100GBASE-KR4 Compliance Tests on Infiniium Offline

### Running 100GBASE-KR4 Compliance Tests on Infiniium Offline

In the Ethernet 802.3-2014 100GBASE-KR4 Compliance Test Bench Simulation Setups section, the Channel Simulation example generates signal waveforms in .h5 format. Using the Keysight Infiniium Offline software you can run the compliance test on these waveforms.

The waveforms *KR4\_TP0a\_p.h5* and *KR4\_TP0a\_n.h5* are used in this tutorial. For the test that requires the transmitter to be disabled, use the waveforms generated after making the necessary changes as described in the design.

NOTE

Ensure that the waveforms are generated with number of bits simulated in the Channel Simulation Controller equal to or more than 1000000

To run the Compliance tests:

1. Click Analyze > Automated Test Apps > N8829A 100GBASE-KR4 Test App from the Infiniium Offline software to open the KR4 application.

File Control Setup Display Trigger Measure Math			
Offline	Histogram Mask Test	T 0.0 V	<b>₩</b>
	Automated Test Apps  Measurement Analysis (EZJIT)	Hooesin resemp	4.00 V
Mea	Jitter/Noise (EZJIT Complete)	N8830A 100GBASE-CR4 Test App U7243B USB3 Test App	
s Verti	RTEye/Clock Recovery (SDA) Equalization		3.00 V
(3) 1.00 V (0.0 V → □ 1.00 V (0.0 V → □ 1.00 V (0.0 V → □ 1.00 V (0.0 V → □)			2.00 V
			1.00 V
			0.0 V
Measu			-1.00 V
Ireme			-2.00 V
nts			-3.00 V
			-4.00 V
	-100 ns 0.0 s 100 ns	200 ns 300 ns 400 ns	500 ns 1
H 100 ns/ 0.0 s			

2. Click Saved Waveform Setup in the Set Up tab.

3. Click **Browse** and select the *KR4\_TP0a\_p.h5* and *KR4\_TP0a\_n.h5* waveform files for the DUT+ and DUT- fields respectively.

🖳 frmOfflineSetup	
DUT+ waveform for General Measurements:	
Jult 15_01\Ethemet_wrk\data\waveforms\KR4_TP0a_p.h5	Browse
DUT- waveform for General Measurements:	
Jult15_01\Ethernet_wrk\data\waveforms\KR4_TP0a_n.h5	Browse
Done	
	///

- 4. Click Done.
- 5. Click the **Select Tests** tab.

6. Select the tests, as shown in the following figure:

🖾 100GBASE-KR4	R4 App Test 100GBASE-KR4 App Device 1 *	8
File View Too	ols Help	
🗅 🚔 🖬 🛛 🖓		
Task Flow _	Set Up Select Tests Configure Connect Run Tests Automation Results Html Report	
Set Up Select Tests Configure Connect	<ul> <li>IOUGBASE-KR4 Tests</li> <li>Main Voltage Measurements (pattern: PRBS9)</li> <li>Differential Peak to Peak Output Voltage Test</li> <li>A C Common Mode Output Voltage Test</li> <li>A C Common Mode Output Voltage Test</li> <li>Jitter and Signaling Rate Measurements (pattern: PRBS9)</li> <li>Signaling Rate</li> <li>Even-Odd Jitter</li> <li>Bounded Uncorrelated Jitter</li> <li>Output Waveform Measurements (pattern: PRBS9)</li> <li>Steady-State Voltage Vf</li> <li>Linear Fit Pulse Peak</li> <li>Signal-to-noise-and-distortion ratio</li> </ul>	
	(Click a test's name to see description)	-
	Limit Set: IEEE 802.3 100GBASE-KR4 Test Limit	*

7. Click the **Connect** tab.

100GBASE-KR4 App Test -- 100GBASE-KR4 App Device 1 \* File View Tools Help 🗅 🚅 🖬 | Task Flow 🔔 Set Up | Select Tests | Configure Connect | Run Tests | Automation | Results | Html Report | Instructions for Connection: Common Mode Test Connection For MultiLa Set Up 10 tests will be run. Please pay attention to the scope connection  $\mathbf{V}$ 2 different physical setups will be used. The first setup is shown. · This test can only be run with dual single-ended connections and waveforms Select Tests · Connect the scope to the DUT Signals as follows:  $\mathbf{v}$ No Connection. Running Offline Waveforms. Configure Follow these  $\mathbf{v}$ instructions to start testing Connect  $\mathbf{v}$ Run Tests Run Tests Suppress all connection prompts 🔽 I hav ✓ 10 Tests Follow instructions to connect the DUT, then press [Start] Connection: Common Mode Test Connection For MultiLane

#### 8. Select I have completed the instructions.

- 9. Click Run Tests.
- 10. Click the **Results** tab. The test results are displayed, as shown in the following figure:

Tile View Tee				- O X
rile view loc	ols Help			
D 🚅 🖬 🖓				
Task Flow _	Set Up   Select Tests   Configure   Connect   Run T	ests Automation Res	ults Html Report	
Set Up	Test Name	Actual Val	Margin Pass Limits	
	✓ DC Common Mode Output Voltage Test	96.72 mV	5.1% 0.00000 V <= VALUE <	= 1.90000 V
	✓ AC Common Mode Output Voltage Test	1.24 mV	89.7% VALUE <= 12.00 mV	
<b>V</b>	✓ Differential Peak to Peak Output Voltage Test	1.131 V	5.8% VALUE <= 1.200 V	
Select Tests	√ Signaling Rate	25.781185743 Gbps	48.8% 25.778671875 Gbps <=	= VALUE <= 25.783828125
السوعا	✓ Even-Odd Jitter	19.2 mUI	45.1% VALUE <= 35.0 mUI	
	✓ Bounded Uncorrelated Jitter	3.8 mUI	96.2% VALUE <= 100.0 mUI	
<b></b>	✓ Total Uncorrelated Jitter	26.7 mUI	85.2% VALUE <= 180.0 mUI	
Configure	✓ Steady-State Voltage Vf	556 mV	22.0% 400 mV <= VALUE <=	500 mV
	✓ Linear Fit Pulse Peak	395 mV	0.0% VALUE >= LinearMin V	
$\nabla$	✓ Signal-to-noise-and-distortion ratio	32.809 dB	21.5% VALUE >= 27.000 dB	
Connect				
$\nabla$				
Run Tests				
	•	III		P.
	Details: Signal-to-noise-and-distortion ratio			
	✓ Trial 1			
	Parameter Value			
	Pass Limits >= 27,000 dB			
	Parameter Tested Signal-to-noise-and-distor	tion ratio		
	Actual Value 32.809 dB			
	Referenced Values: Number UI Tested 1e6			
	Number UI Tested 1e6 Lane Number Lane0			
	Lane Wander Lanev			
	J			
10 Tests 10	results shown. [Html Report] tab shows details Cor	nection: PRBS9 Connect	tion	

You can also view the HTML report under the HTML Report tab.

_	-KR4 App Test 100GBASE-KR4 App	p Device 1 *		
	Tools Help			
	=' 🖻 🖬 📭   🗟 🎒			
Task Flov	Set Up Select Tests Configure	e   Connect   Run Tests   Autor	mation Results Html Report	
Set Up				▲
Secop				
	TECHNOLOGIES			
Select Tes				
Select Tes	<u> </u>	00GBASE-KR4	4 App Test Repo	rt
		Overall R	esult: PASS	
Configure	•	Test Confi	iguration Details	
			Description	
¥		Switch Option	Single Lane	
Connect		ChanPair	Real Edge	
		Speed Grade	100GBASE-KR4	
₩.		Test Se	ssion Details	
Run Tests	5	Infiniium SW Version	05.50.0015	
		Infiniium Model Number	N8900A	
		Infiniium Serial Number	No Serial	
			2.01	
		Debug Mode Used	No	
			IEEE 802.3 100GBASE-KR4 Test Limit	
		Last Test Date	2015-07-21 15:16:52 UTC +05:30	
	Summary of Results			
	Summary of Results			
	Test Statistics			
	Failed 0			
	Passed 10			
	Total 10			-
10 Tests	View/Save/Print detailed HTML results.	Connection: PRBS9 Connect	tion	/

NOTE

If you open the **Select Tests** tab before loading your waveforms, you will see tests that are not listed in the screenshot in Step 4 above. These tests are in the application but not supported currently. They will be supported in a future release of this Compliance Test Bench and 100GBASE-KR4 application.

#### References

 ○ IEEE Std 802.3bj<sup>™</sup>-2014 - IEEE Standard for Ethernet, Amendment 2: Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables

# Ethernet 802.3-2014 100GBASE-KP4 Compliance Test Bench Simulation Setups

## Ethernet 802.3-2014 100GBASE-KP4 Compliance Test Bench Simulation Setups

100GBASE -KP4 d efines a 4-lane 100 Gbit/s backplane PHY for operation over links consistent with copper traces on "improved FR-4" with lengths up to at least 1m . Signalling used is PAM4.

The Ethernet 802.3-2014 Compliance Test Bench provides a variety of tests, which helps to understand the various aspects of the Ethernet 802.3-2014 digital standard (CR4, KR4 and KP4). It provides you the ability to create designs using the included models or your own models. You can refer to the included examples when developing the designs. This Compliance Test Bench provides the following Models and Examples for KR4:

🔛 Ethernet 802.3-2014 Compliance Test Bench:1
Ethernet 802.3-2014
100GBASE-CR4
100GBASE-KR4
100GBASE-KP4
Channel Models
Tx BGA Package
Blind_Via model_Common_Antipad
Blind_Via model_Separate_Antipad
Standard_Via model_Separate_Antipad
Transmission_Line_CoupledTrace
Transmission_Line_SingleTrace
Rx BGA Package
<ul> <li>Simulation Test Examples</li> </ul>
Channel Operating Margin (COM) Analysis
FEXT Analysis
NEXT Analysis
THRU_Channel Analysis
Channel Simulation
Channel Crosstalk Analysis
Ethernet802.3-2014 Compliance Test Bench Documentation
About Ethernet802.3-2014 Compliance Test Bench
۰ III ا
OK Cancel

NOTE -

- 1. Package Models are for educational demonstration only and are not intended for design purposes. Please download the latest up to date models for your application directly from the vendor's website. Models in this example were downloaded from Xilinx Inc. : www.xilinx.com
- 2. This design guide includes features which are supported after ADS 2016.01 version.

#### Models

The following KP4 channel models are supported:

- Tx Package
- Rx Package
- Connector
- Via models
- Transmission Line Models

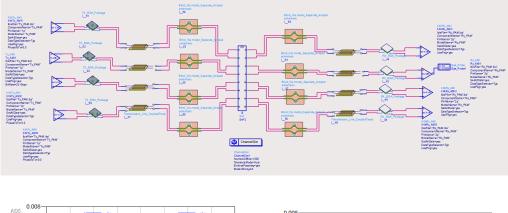
#### Examples

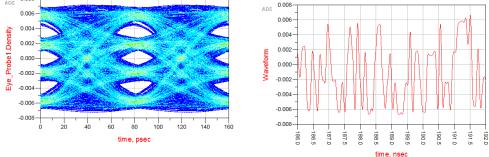
The following examples are included in the Ethernet 802.3-2014 Compliance Test Bench for KR4:

- Channel Crosstalk Analysis
- Channel Operating Margin (COM) Analysis
- Channel Simulation

#### C hannel Crosstalk Analysis

Enable or Disable Crosstalk components, "Xtalk TX AMI & Xtalk RX AMI", to see the interference of noise on Eye Diagram.





#### C hannel Operating Margin (COM) Analysis

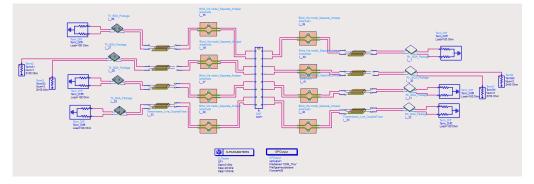
The following design shows the S-Parameter generating model required to run Channel Operating Margin (COM) Analysis for the KP4. In order to perform COM analysis, the user need to generate THRU channel, FEXT and NEXT models fro the channel. Goto respective designs to generate the required models.

### THRU Channel Analysis:

This design extracts the following files in data folder of workspace.

- 1. config\_com\_ieee8023\_93a=100GBASE-KP4.xls
- 2. config\_com\_ieee8023\_93a\_doc.pdf
- 3. com\_ieee8023\_93a.m

Run this design to generate "COM\_Thru" 4 port S-parameter model at data folder of workspace.

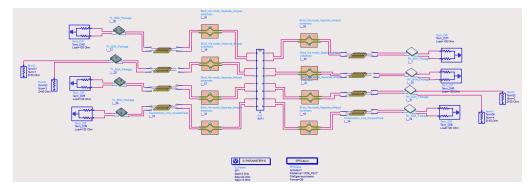


#### FEXT Analysis:

This design extracts the following files in data folder of workspace.

- 1. config\_com\_ieee8023\_93a=100GBASE-KP4.xls
- 2. config\_com\_ieee8023\_93a\_doc.pdf
- 3. com\_ieee8023\_93a.m

Run this design to generate "COM\_FEXT" 4 port S-parameter model at data folder of workspace.



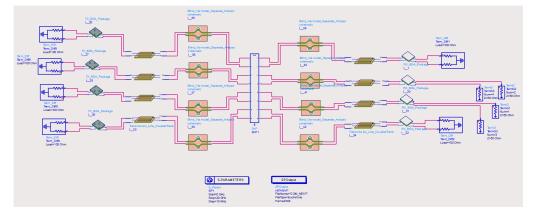
#### NEXT Analysis:

This design extracts the following files in data folder of workspace.

1. config\_com\_ieee8023\_93a=100GBASE-KP4.xls

- 2. config\_com\_ieee8023\_93a\_doc.pdf
- 3. com\_ieee8023\_93a.m

Run this design to generate "COM\_NEXT" 4 port S-parameter model at data folder of workspace.



Matlab for Channel Operating Margin (COM) Analysis:

• Open the Matlab software and load the code "com\_ieee8023\_93a.m"

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	Open V Cancel	
	26       % OrdSAC413         27       % 1 = 1> THEU index         28       1 = 2, num_fext+1> PEXT channel index         29       i = num_fext+2, num_next+num_fext+1         30       base: name of THEU file         31       À: amplitude         w	

• Now edit the contents in "config\_com\_ieee8023\_93a=100GBASE-KP4.xls" file and save them as per the design requirement.

XI	<mark>, ∥) • (</mark> ≌ ×   <del>,</del>							confi	a com ieee8	023 93a=10	DOGBASE-	KP4.xls [Compatibility Mode] -	Microsoft Excel		
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1		Table 93A-1 parameters					1/0	D control					93A-2 parameters		
2	Parameter	Setting	Units	Information		DIAGNO		1		logical		Parameter	Setting	Units	
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4	f_min Delta_f	0.05	GHz			Display freque		1		logical logical		package_tl_gamma0_a1_a2 package_Z_c	[0 1.734e-3 1.455e-4 78.2	Ohm	-
6	C_d	[2.5e-4 2.5e-4]	nF	[TX RX]		SAVE_FIGUR		0		logical		pockoge_c_c	70.2		
7	z_p select	[1 2]		[test cases to run]		RESULT	DIR	.\test_resu	lts_C94\	-		Table	92–12 parameters		
8	z_p (TX)	[12 30]	mm	[test cases]		SAVE_FIG		0		logical		Parameter	Setting		
9	z_p (NEXT)	[12 12]	mm	[test cases]		Port Or		[132	4]			board_tl_tau	6.191E-03	ns	_
10 11	z_p (FEXT) z_p (RX)	[12 30]	mm	[test cases] [test cases]		RX_CALIBR		iver testing 0		logical		board_tl_gamma0_a1_a2 board_Z_c	[0 4.114e-4 2.547e-4 109.8	Ohm	_
11	C_p	[1.8e-4 1.8e-4]	nF	[TX RX]		Sigma BB		5.00E		V		z_bp (TX)	109.8	mm	-
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14	R_d	[55 55]	Ohm	[TX RX]		T_r		8.00E	-03	ns		z_bp (FEXT)	72	mm	
15	tu .	0.75	*fb									z_bp (RX)	151	mm	
16	c(0)	0.62		min		INC_PAC		rd control opti 1	ons	descion d					
17 18	c(-1) c(1)	[-0.38:0.02:0]		[min:step:max] [min:step:max]		IDEAL RX		0		logical logical					
19	g_DC	[-12:1:0]	dB	[min:step:max]		INCLUDE		1		logical					
20	f_2	3.3984375	GHz			INCLUDE_TX_		1		logical					
21	f_p1	3.3984375	GHz												
22	f_p2	13.59375	GHz												
23	A_v A fe	0.4	v												
24	A_ne	0.4	v												
26	L	4													
27	м	32													
28	N_b	16	UI												
29 30	b_max(1) b_max(2N_b)	1													
30	sigma_RJ	0.005	UI												
32	A_DD	0.025	UI												
33	eta_0	5.20E-08	V^2/GHz												
34	SNR_TX	31	dB												
35	R_LM	0.92 3.00E-04													
36 37	DER_0	3.00E-04 Operational control	1	L											
38	COM Pass threshold	3	dB												
39	Include PCB	0	logical												
40															
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• Click Run in the Matlab software to Start simulation

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		can be published to a formatted document. For more information, see the publishing video or help.	
		function results=com_ieee8023_93a(config_file, num_fext, num_next, varargin)	
		* Implementation of Annex 93A of IEEE 802.3	_
	3	5 m	=
	4 5	% Usage: % result=com ieee8023 93a(config file, num fext, num next [, <s4p files="">])</s4p>	-
	6	<pre>% result=com_leeeou2s_Ssa(config_file, num_rext, num_hext [, <s+p_files>]) % - config_file: XLS file which contains configuration settings (samples in</s+p_files></pre>	
	2	http://www.ieee802.org/3/bj/public/tools/ran 3bj com d2p2 02 0813.zip)	
		<pre>% - num fext: number of FEXT sip files in the list</pre>	_
		Instruct number of NEXT stp files in the list	
	10	% - <sip files="">: (1+num fext+num next) file names. If not supplied, program</sip>	
	11	will ask for each of the files interactively.	
	12	8	
	13	% This program is intended for the development of channel specifications	
	1.4	% and reflects the work of IEEE P802.3bj, Annex 93A.	
	15	-% It is not an official IEEE document.	
	16		
	17		
	18	% Internal comments - do not remove the empty line above this line	_
	19	% \$Id: com_ieee8023_93a.m.rca 1.54 Tue Aug 26 00:04:42 2014 aran Experimental \$	
	20	e	
	21	% Original authors:	
	22	% Adee Ran (adee.ran@intel.com)	
	23	% Richard Mellitz (richard.mellitz@intel.com)	-
	24 25	<pre>% structures:</pre>	
	25	<pre>% structures: % chdata(i)</pre>	
	26	s chasta(1)	

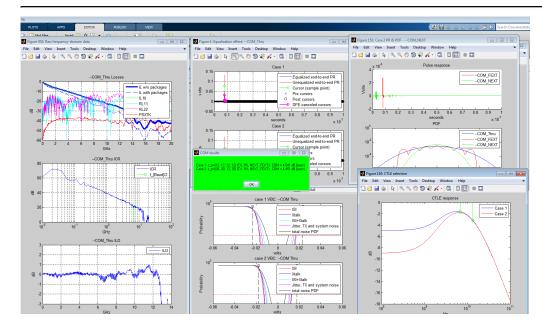
• Click Enter to load the configuration file " "config\_com\_ieee8023\_93a=100GBASE-KP4.xls"

	EDTOR PARLEM VEW	
Comment %     Comment %	See 23 Coll Ge To V Run Section	
	wrk + data + + fy Search data p	
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	Qpen         Cancel           24         * CMARKAII           27         * I=1> THRD index           28         * I=2, num_fext+1           29         * I= num_fext+1, num_next+num_fext+1	-
	30 % base: name of THRU file 31 % A: amplitude	
	€	•
	Command Window	•
	Your MATLAB license will expire 1s 47 days. Flease consist your system definitions and the system of the system o	is not normative.

• Enter the number of channel of created for FEXT and NEXT analysis. In this case, we have created for 1 channel for FEXT and 1 channel for NEXT channel.Click enter to load the touchstone models from data folder of workspace. This file will be generated from ADS channel simulation: COM\_Thru.s4p, COM\_FEXT.s4p and COM\_NEXT.s4p one by one a Matlab prompts.

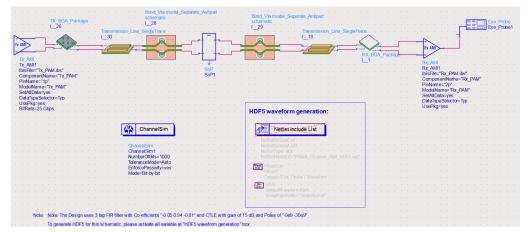
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• After loading the required files, the software initiates simulation and displays the following results for KP4 - COM analysis.

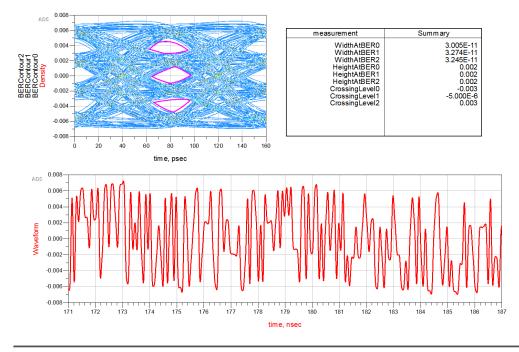


#### **Channel Simulation**

The following design shows the end to end simulation of KP4 channel and generates eye diagram.



The following parameters that are plotted in the results:



### References

• IEEE Std 802.3bj<sup>™</sup>-2014 - IEEE Standard for Ethernet, Amendment 2: Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables