PERICOM Enabling Serial Connectivity

Application Note ANxxx

PI3EQX8908A PCIE Gen3 Application Information

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1 Introduction:

Pericom Semiconductor's PI3EQX8908A is a PCIe, 8 differential channels ReDriver™. The device provides programmable linear equalization, output swing and gain, by either pin strapping option or I2C Control, to optimize performance over a variety of physical mediums by reducing Inter-symbol interference.

The PI3EQX8908A supports eight 100-Ohm Differential CML data I/O's and extends the signals across other distant data pathways on the user's platform.

The programmable settings can be applied easily via pins, software (I2C) or loaded via an external EEPROM. When operating in the EEPROM mode, the configuration information is automatically loaded on power up, which eliminates the need for an external microprocessor or software driver.

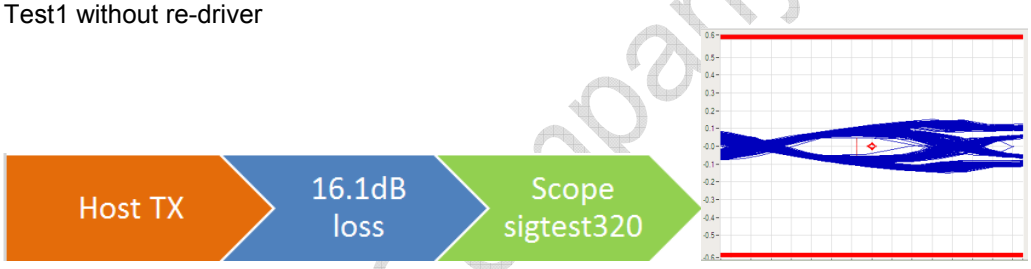
The PI3EQX8908A offers fully Linear Transfer function to fully comply with all PCIe 3 Link Training signals

2 Extent length after add ReDriver

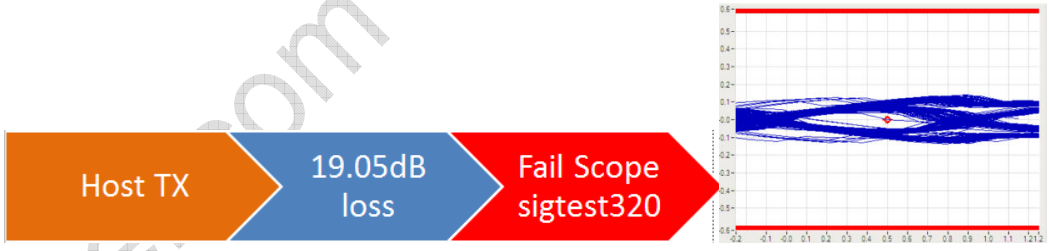
PCI-SIG provides PCI Express compliance tests that are utilized for testing PCI Express systems . The below PCI Express 3.0 TX Compliance Test use PCI Sigtest320 to check the test result (Figure 1)

Check sigtest P4 eye result

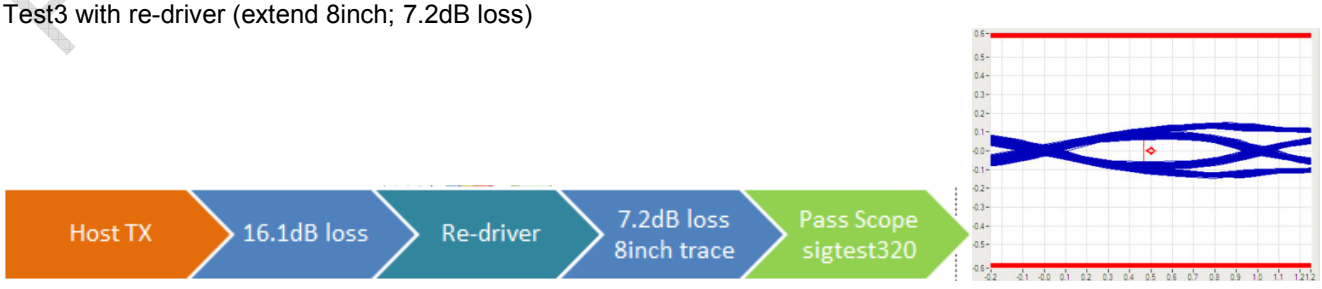
Test1 without re-driver



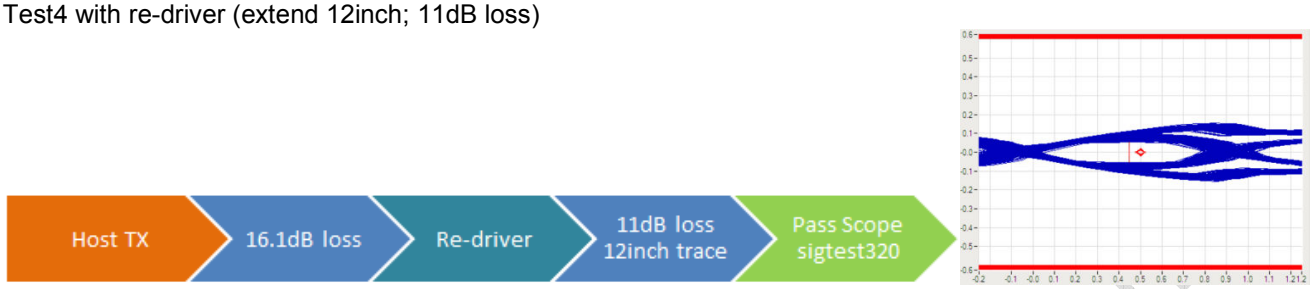
Test2 without re-driver



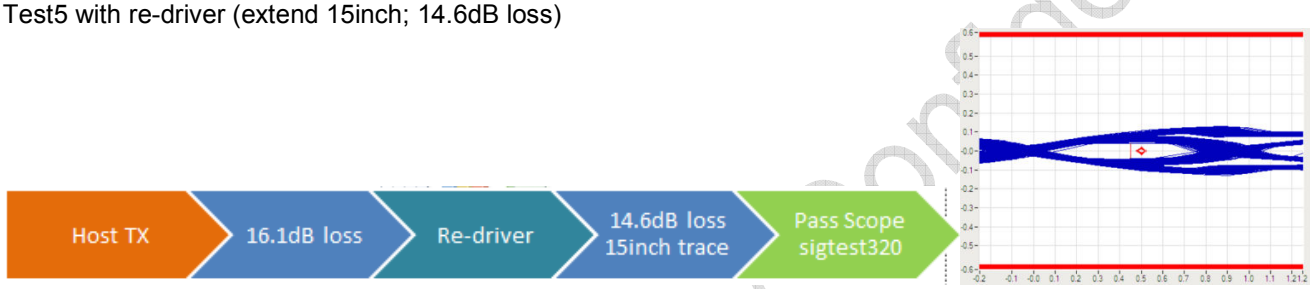
Test3 with re-driver (extend 8inch; 7.2dB loss)



Test4 with re-driver (extend 12inch; 11dB loss)



Test5 with re-driver (extend 15inch; 14.6dB loss)



Test6 with re-driver (extend 18inch; 17.56dB loss)

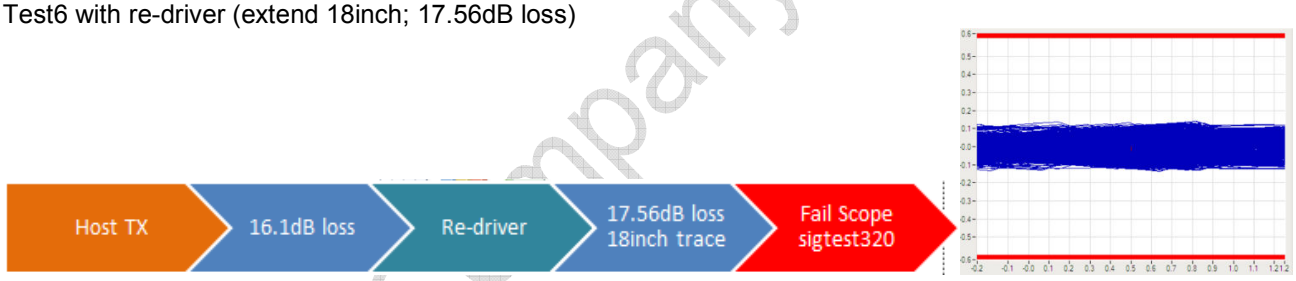
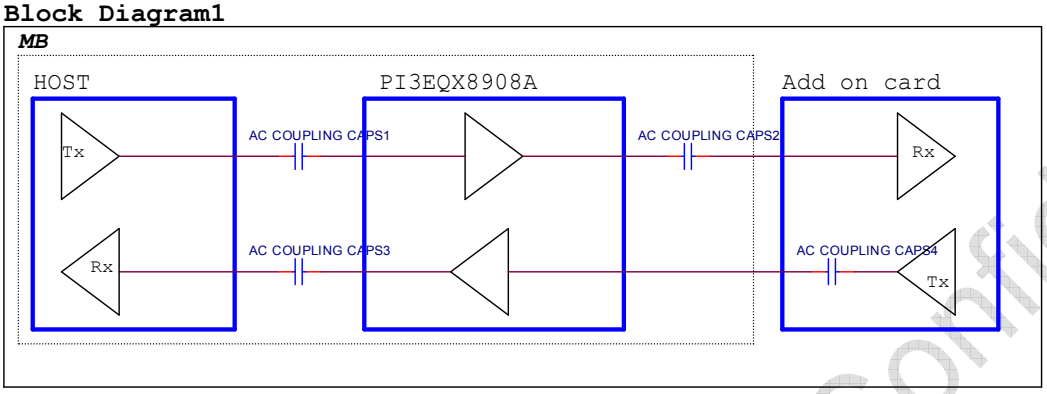


Figure 1. Extent length after add ReDriver

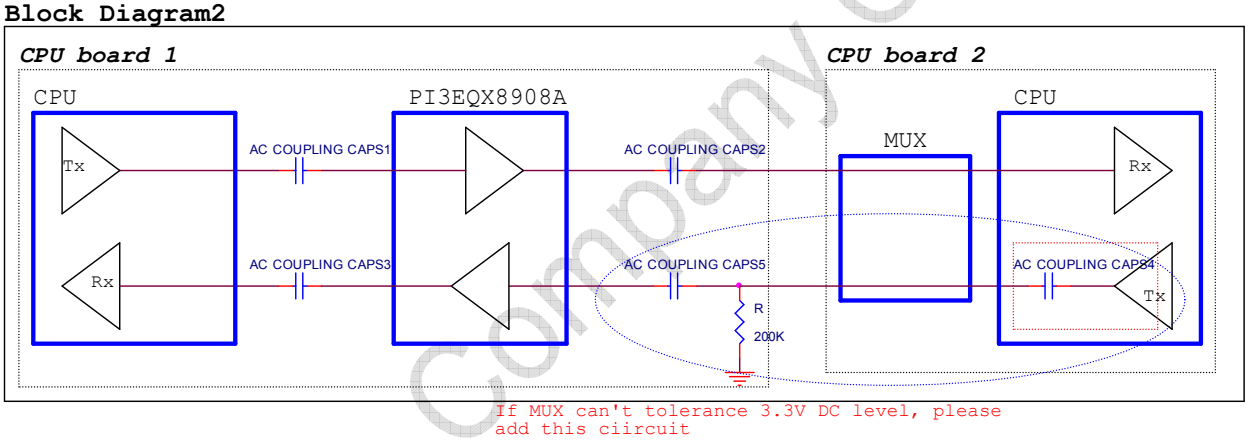
3 External Components Requirement when work with PCIE switch

If the PCIE MUX implement in the system which can't tolerance DC level 3.3V, please add AC coupling cap with 200Kohm to GND as below diagram

Block Diagram1



Block Diagram2



Block Diagram3

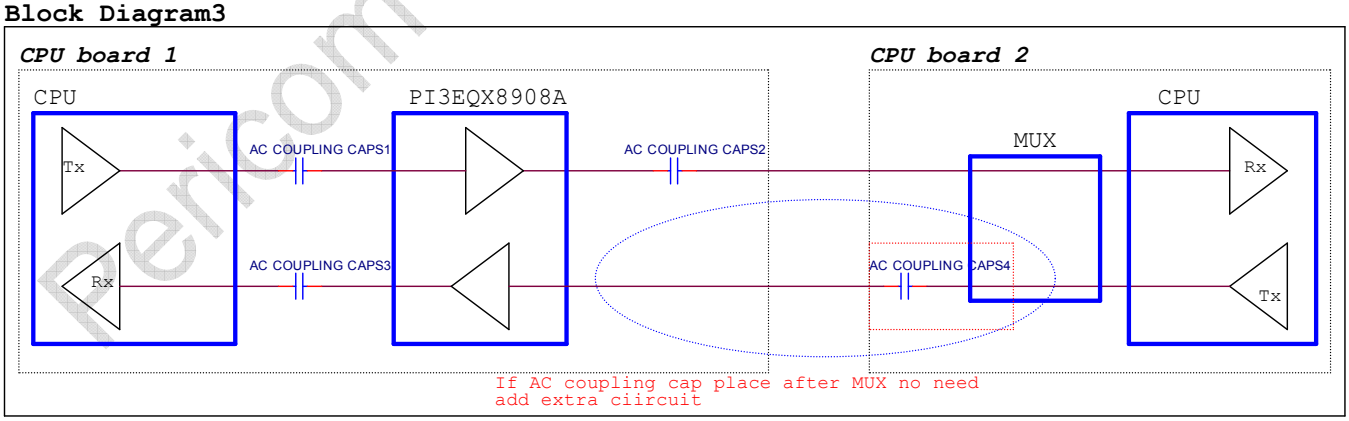


Figure 2. Add external component if work with Mux

4 How to use PI3EQX8908A (EQ/FG/SW setting)

Below Figure3 is standard PCIE TX compliance test, from Tektronix 25GHz scope sigtest result , we can get the eye height and eye width result then change EQ or FG to get better result. If re-driver input loss is bigger→ increase more EQ value, if output eye height is not good enough→increase FG value.

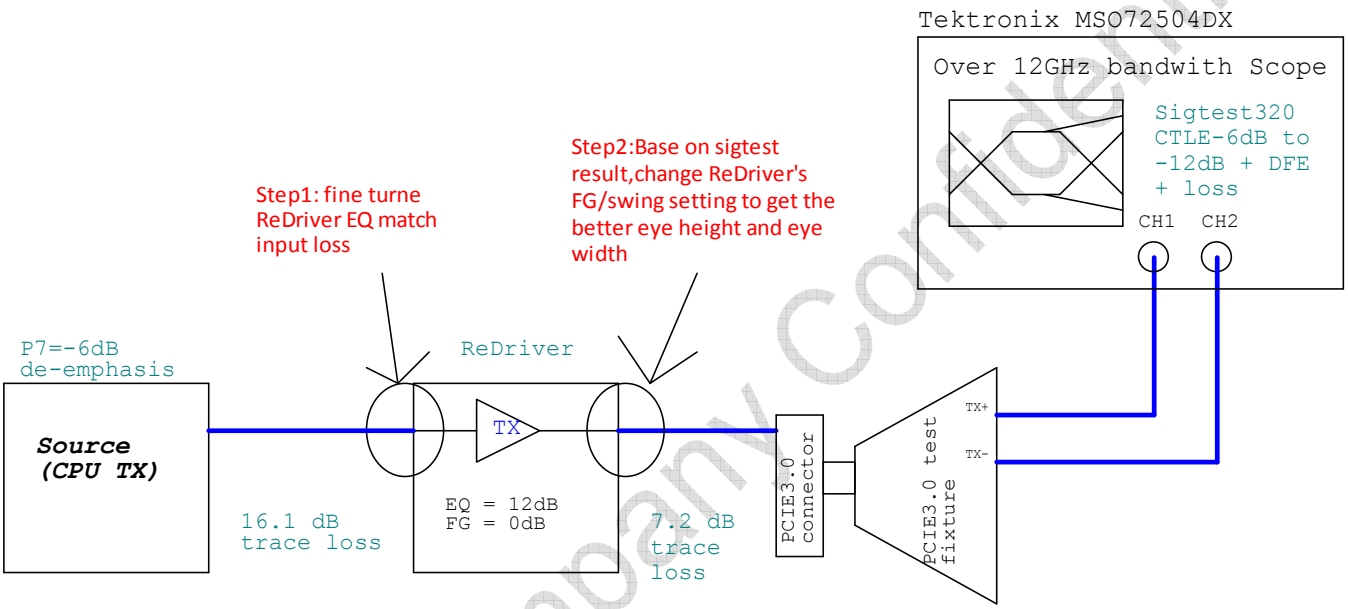


Figure 3 PCIE3.0 test setup example

1. **EQ:** Design transition to PI3EQX8908A from PI3EQX8908 the first step is to understand the changes in the EQ setting values noted in the table below. Note that the 8908A has the same 4dB EQ value steps, but different pin or I2C control values. The change can be from pins (EQA[0..2], EQB[0..2]), or from I2C register (Bytes[3..10]). Reset the EQ value on the 8908A as needed from the EQ/FG tuning procedure below in step 4.

2. **DE:** There is no De-Emphasis function on the 8908A. The 8908A will automatically reproduce whatever De-Emphasis value is on the input source. In place of DE, the same pins (FGA[0..1], FGB[0..1]) or I2C registers (Bytes[3..10]) set the FG (Flat Gain) value. (Please see below table for detail). You will tune the FG as needed from the EQ/FG tuning procedure in step 4.

3. **SW: Output Swing –** since the 8908A and 8908 OS setting values are very similar, in real application no change is typically needed. Use same pin or I2C register setting as 8908 for the 8908A as the starting point to tune the EQ and FG settings.

4. **FG and EQ Tuning:** Below Figure 4 and 5, the PCIE3.0 test setup shows “How to do the EQ/FG tuning”. The EQ mainly relates to the Re-driver input loss, and Figures 6 to 8 shows the typical EQ/FG settings vs. eye height and eye width. The 8908A is tuned from the procedure below.

5. **Re-driver input Threshold voltage:** When using a Re-driver also needs consider Re-driver input threshold voltage (Vpp)

Signal Detect Threshold Level:

Table 4. Signal Detect Threshold Level Setting via I²C Bus Mode

SD_TH1 <I²C bit>	SD_TH0	Threshold ON (mVppd)	Threshold OFF (mVppd)
0	0	130	30
0	1	150	50
1	0	170	70
1	1	210	110

Figure 4 is a measure example to count swing mVpp for 1010 Preset_4 PCIE compliance pattern

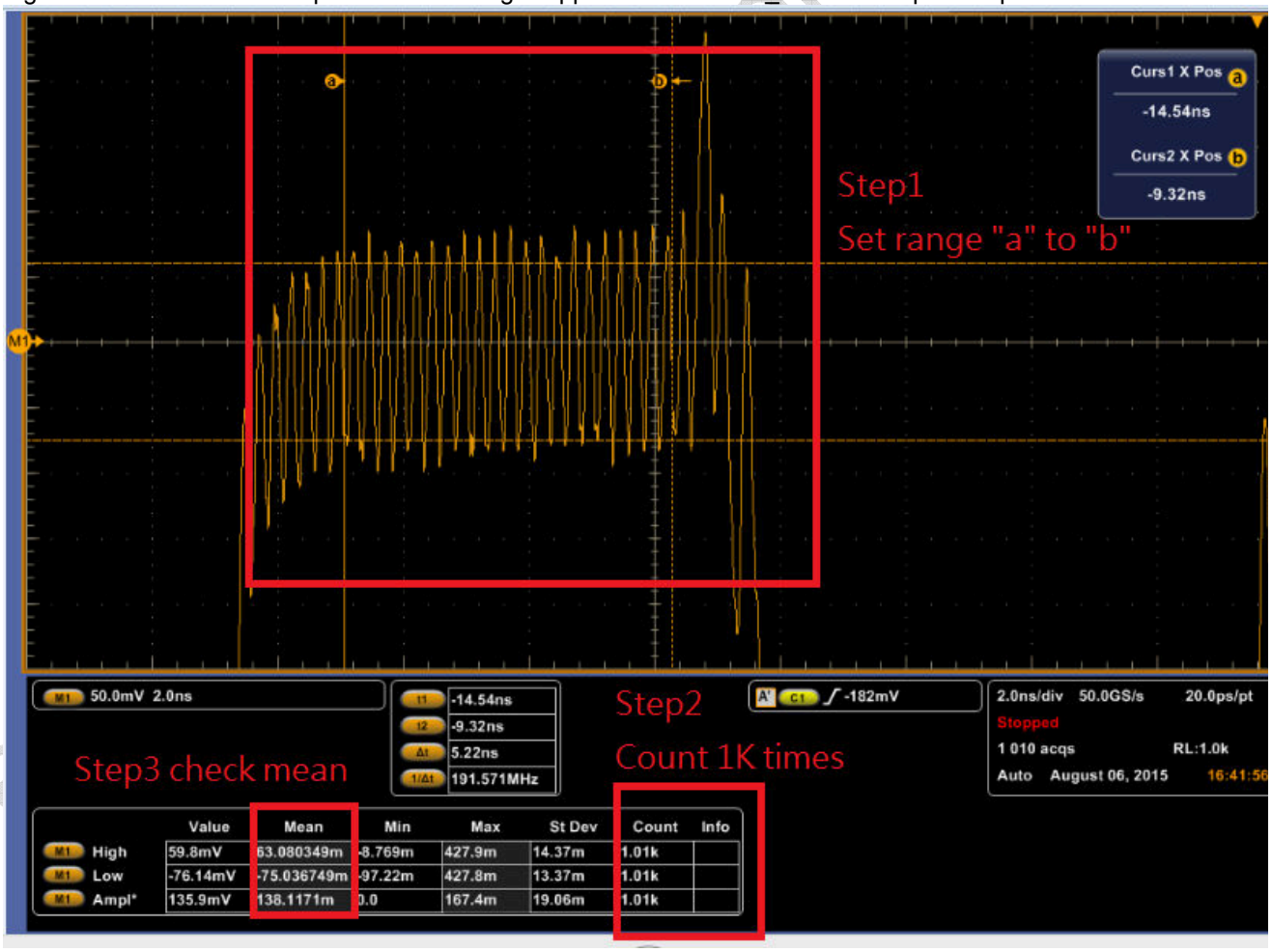


Figure 4

Figure 5 - Different EQ vs eye height. Note that higher EQ = higher eye height

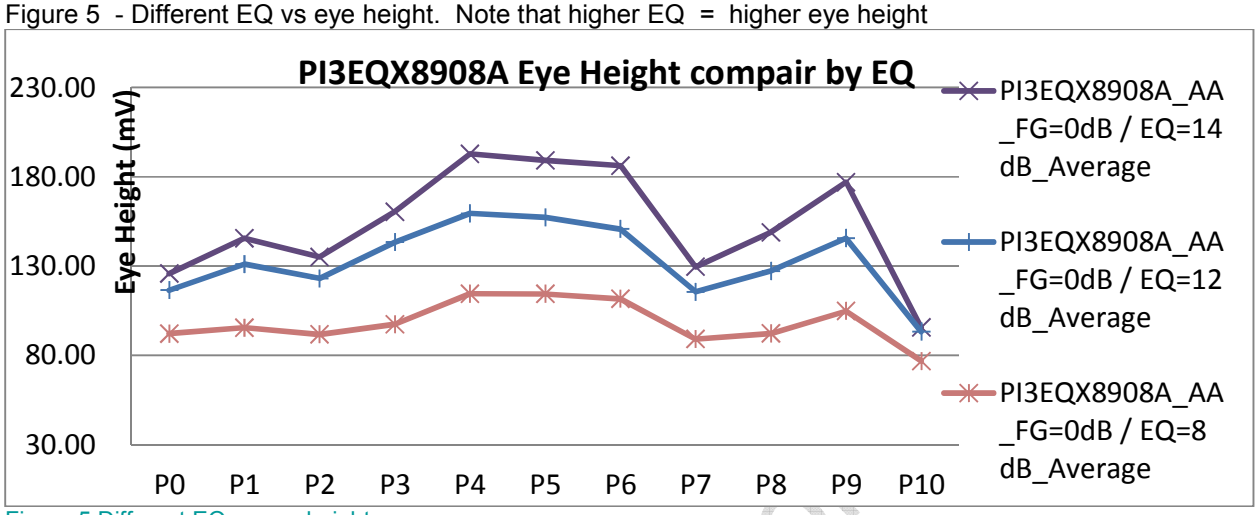


Figure 5 Different EQ vs eye height

Figure 6 - Different FG vs eye height. Note that higher FG = higher eye height.

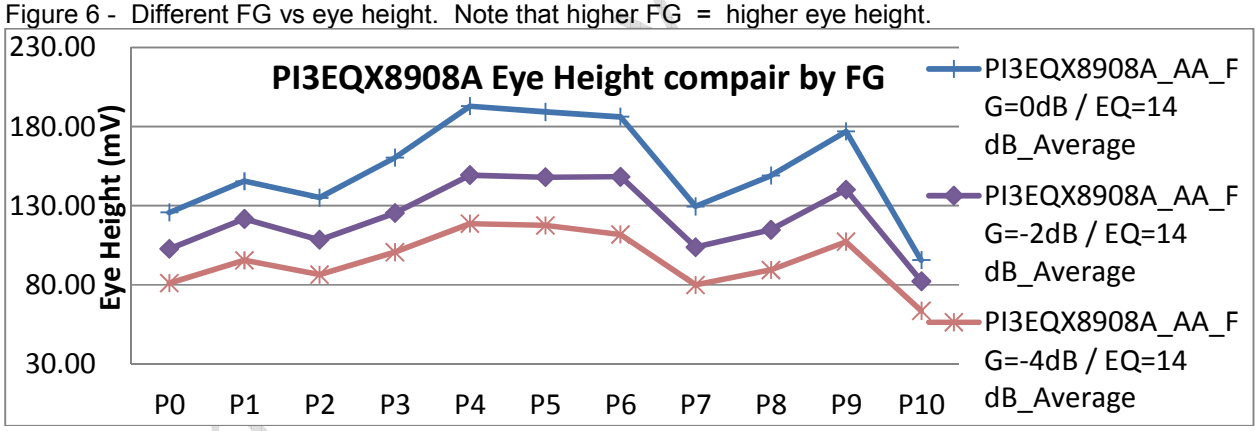


Figure 6 Different FG vs eye height

Figure 7 - Different FG vs eye width – Note that lower FG = better eye width

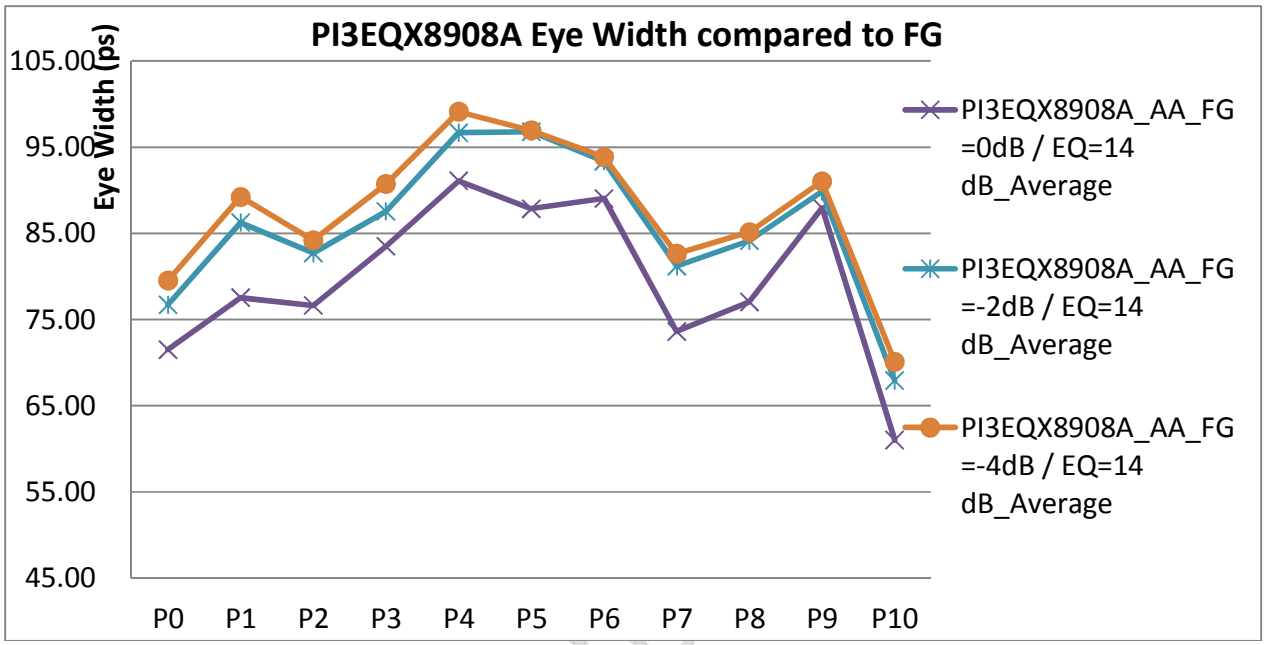


Figure 7 Different FG vs eye width

5 PCIE3.0 preset test

From below TX eye test, we can see that the PI3EQX8908A can reproduce the input eye almost identical for both eye width and eye height. Reproducing the input signal eye is needed for link training compliance.

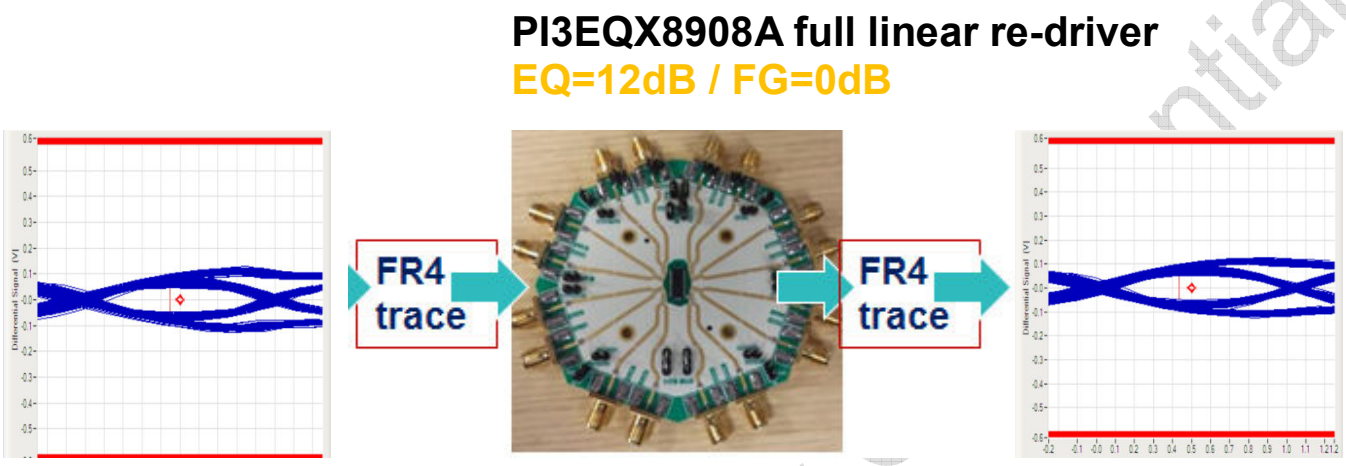


Figure 8

- From preset test result PI3EQX8908A can pass all P10 preset test but PI3EQX8908 can't identify different De-emphasis and pre-shoot. This means PI3EQX8908A can both boost the signal and keep the same De-emphasis and Pre-shoot as the input eye, thus PI3EQX8908A will pass through the PCIE3.0 link training signals.

PI3EQX8908A linear re-driver
EQ=12dB / FG=0dB

PRESET RESULTS					
Preset Name	Lane Name	PreShoot	De-Emphasis	Vb	Result
P0	Lane0	0.000 dB	-5.307 dB	398.267 mV	Pass
P01	Lane0	0.000 dB	-3.248 dB	504.779 mV	Pass
P10	Lane0	0.000 dB	-8.476 dB	276.516 mV	Pass
P02	Lane0	0.000 dB	-4.459 dB	439.109 mV	Pass
P03	Lane0	0.000 dB	-2.523 dB	548.730 mV	Pass
P04	Lane0	0.000 dB	0.000 dB	733.690 mV	Pass
P05	Lane0	1.753 dB	0.000 dB	599.571 mV	Pass
P06	Lane0	2.421 dB	0.000 dB	555.239 mV	Pass
P07	Lane0	3.116 dB	-5.821 dB	306.757 mV	Pass
P08	Lane0	3.289 dB	-3.392 dB	375.752 mV	Pass
P09	Lane0	3.089 dB	0.000 dB	514.145 mV	Pass

Preset	Preshoot	Deemphasis
P0	0.0 dB	-6.0 dB
P01	0.0 dB	-3.5 dB
P02	0.0 dB	-4.4 dB
P03	0.0 dB	-2.5 dB
P04	0.0 dB	0.0 dB
P05	1.9 dB	0.0 dB
P06	2.5 dB	0.0 dB
P07	3.5 dB	-6.0 dB
P08	3.5 dB	-3.5 dB
P09	3.5 dB	0.0 dB
P10	0.0 dB	-9.5 dB

PCIE3.0 Preset P0~P10 specification

6 Setting vs eye, Over EQ and Less EQ

Output Eye Diagram vs. Input FR4 trace and EQ setting at 8Gbps for PI3EQX8908A

Figure 6c: Output Eye Opening with Input Equalization, 8.0 Gbps, Vdd=3.0V, 25C
Using **PRBS 2^23-1 pattern**, **Input Swing=800mVd, Output Swing= 1000mV**
FG=10 (0dB)
Trace=12-in(5.16dB loss)

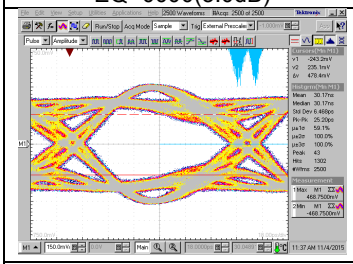
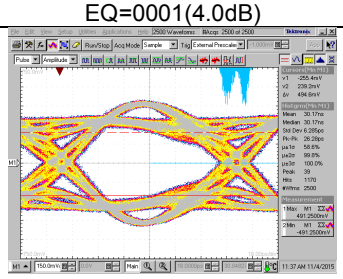
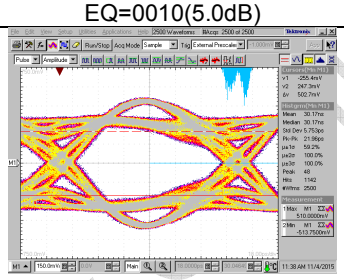
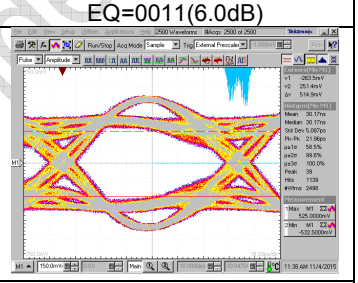
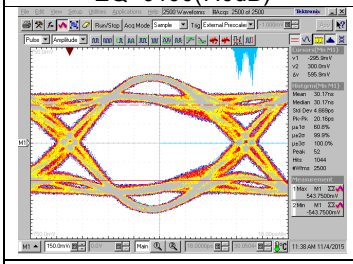
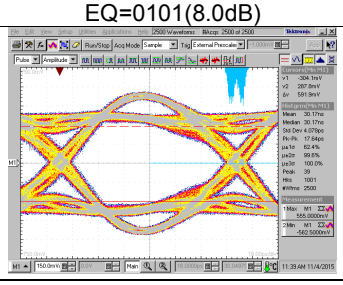
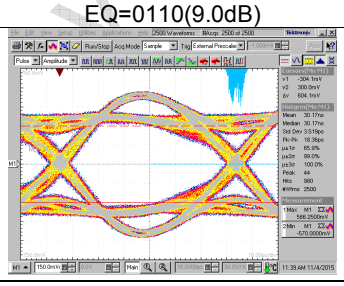
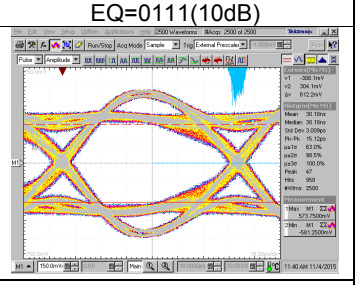
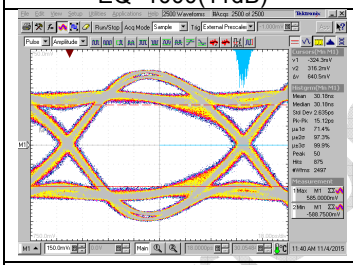
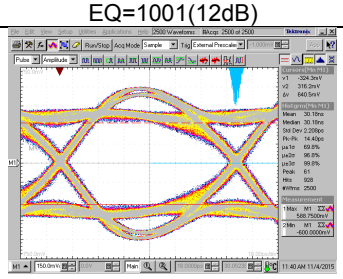
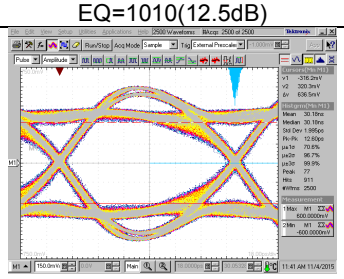
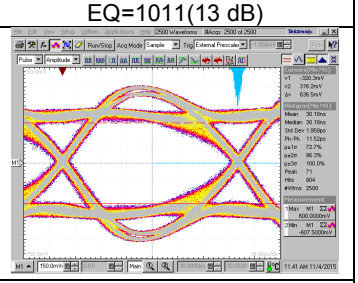
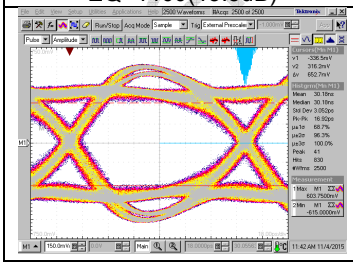
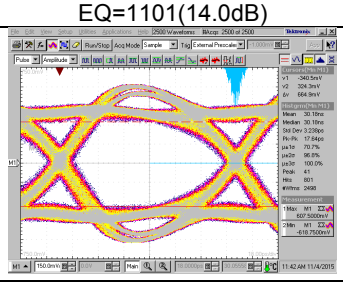
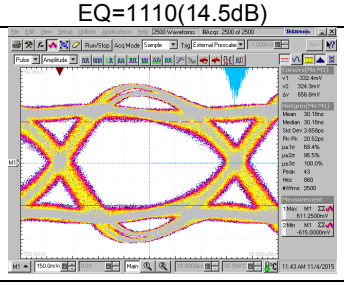
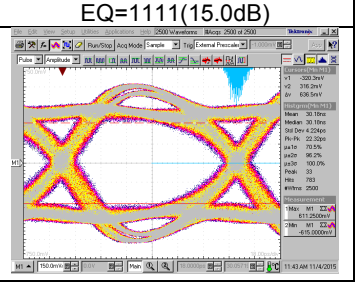
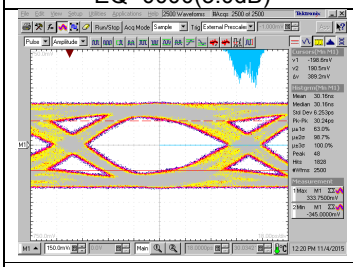
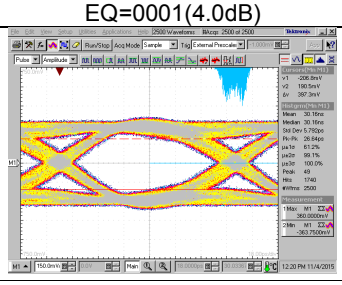
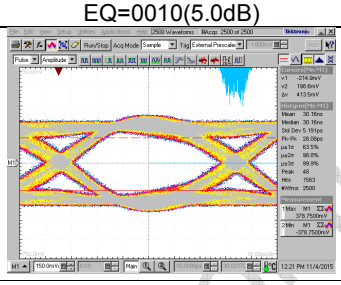
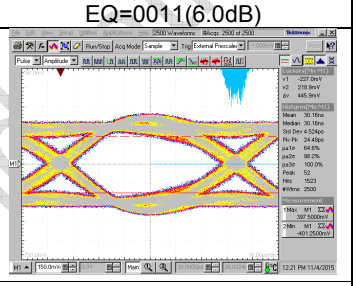
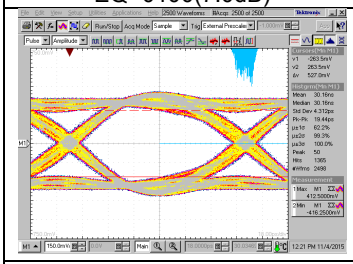
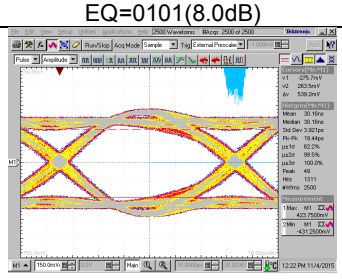
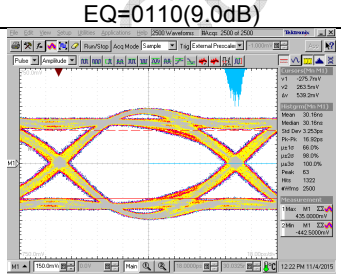
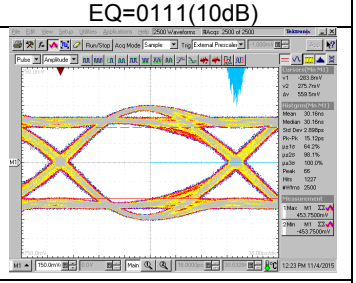
EQ=0000(3.0dB)	EQ=0001(4.0dB)	EQ=0010(5.0dB)	EQ=0011(6.0dB)
			
EQ=0100(7.0dB)	**EQ=0101(8.0dB)**	**EQ=0110(9.0dB)**	**EQ=0111(10dB)**
			
EQ=1000(11dB)	**EQ=1001(12dB)**	**EQ=1010(12.5dB)**	**EQ=1011(13 dB)**
			
EQ=1100(13.5dB)	**EQ=1101(14.0dB)**	**EQ=1110(14.5dB)**	**EQ=1111(15.0dB)**
			

Figure 6e: Output Eye Opening with Input Equalization, 8.0 Gbps, Vdd=3.0V, 25C
Using PRBS 2^23-1 pattern, Input Swing=800mVd, Output Swing= 1000mV
FG=10 (0dB)
Trace=24-in(10.32dB loss)

EQ=0000(3.0dB)	EQ=0001(4.0dB)	EQ=0010(5.0dB)	EQ=0011(6.0dB)
			
EQ=0100(7.0dB)	**EQ=0101(8.0dB)**	**EQ=0110(9.0dB)**	**EQ=0111(10dB)**
			
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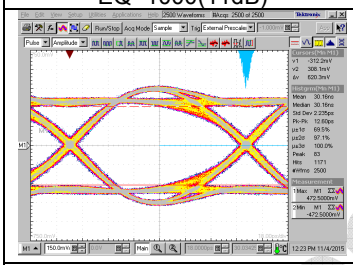
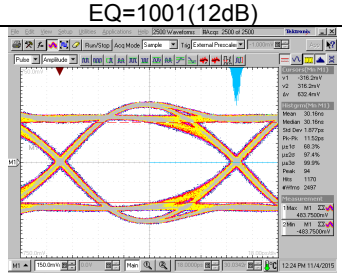
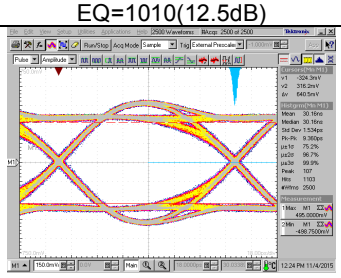
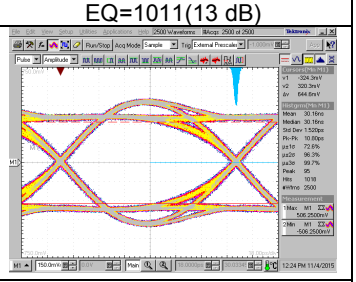
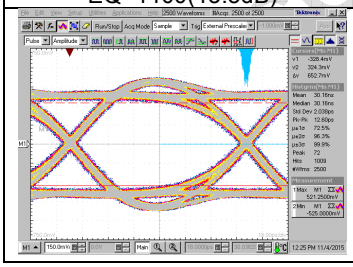
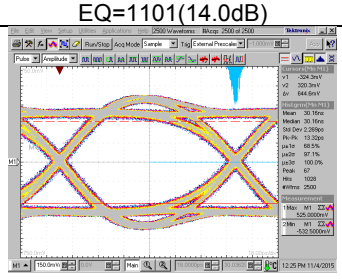
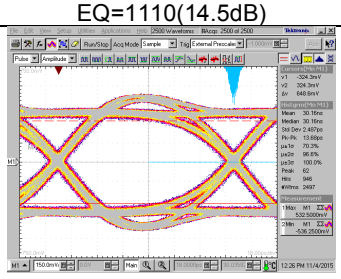
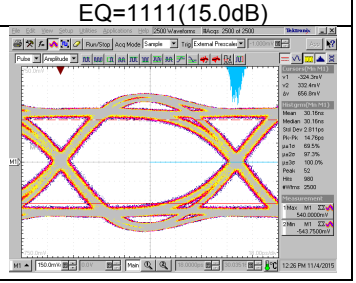
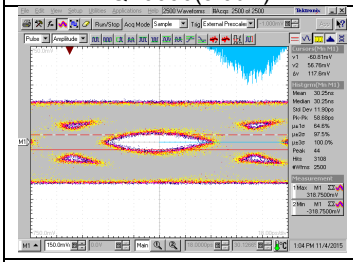
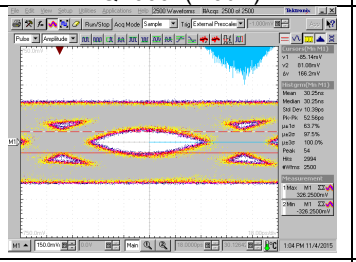
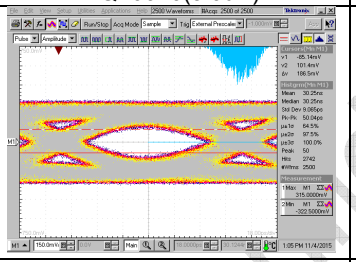
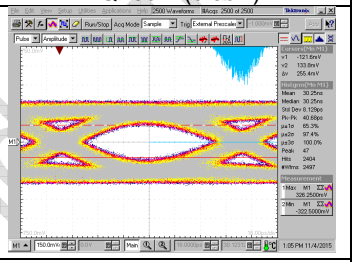
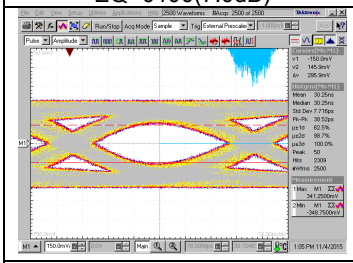
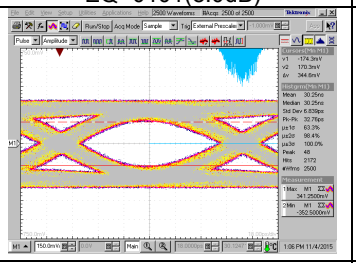
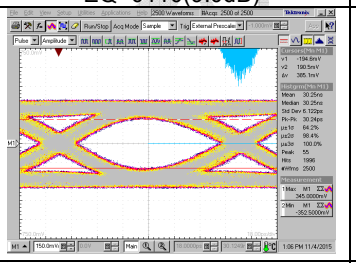
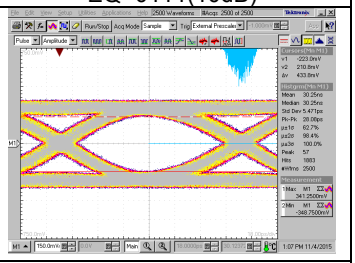
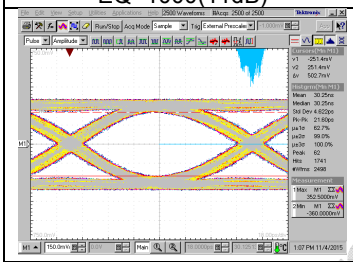
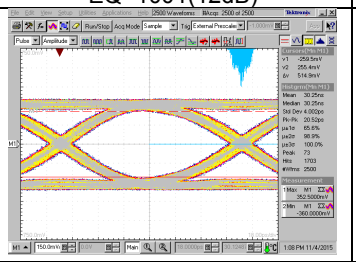
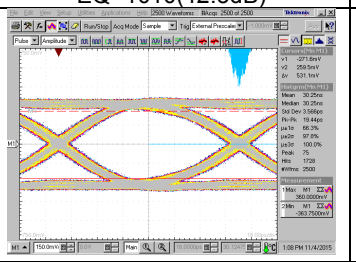
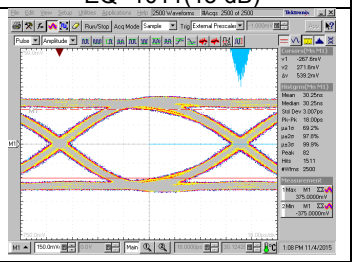
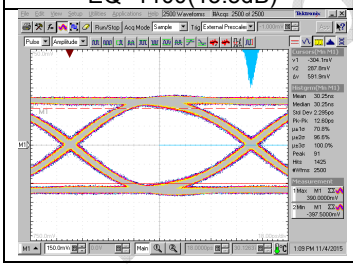
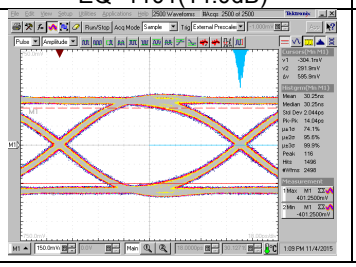
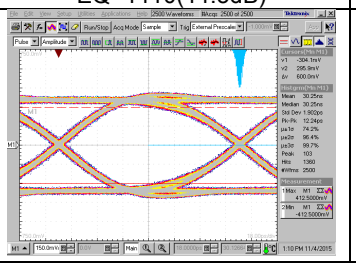
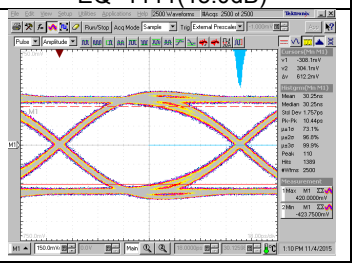
			
EQ=1100(13.5dB)	**EQ=1101(14.0dB)**	**EQ=1110(14.5dB)**	**EQ=1111(15.0dB)**
			

Figure 6g: Output Eye Opening with Input Equalization, 8.0 Gbps, Vdd=3.0V, 25C

Using PRBS 2^23-1 pattern, Input Swing=800mVd, Output Swing= 1000mV

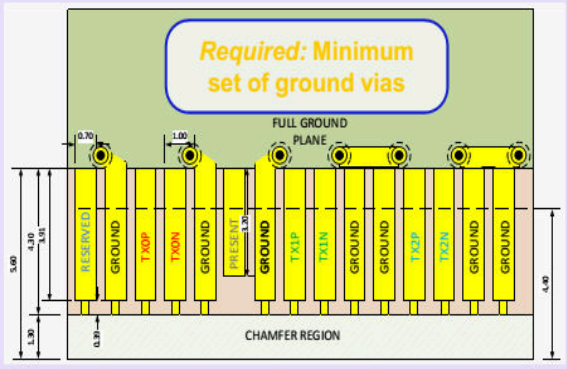
FG=10 (0dB)

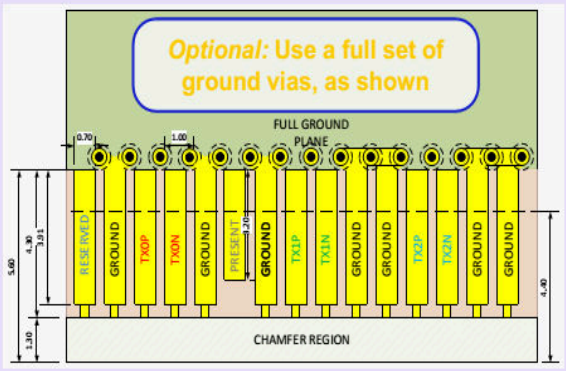
Trace=36-in (15.4dB loss)

EQ=0000(3.0dB)	EQ=0001(4.0dB)	EQ=0010(5.0dB)	EQ=0011(6.0dB)
			
EQ=0100(7.0dB)	EQ=0101(8.0dB)	EQ=0110(9.0dB)	EQ=0111(10dB)
			
EQ=1000(11dB)	EQ=1001(12dB)	EQ=1010(12.5dB)	EQ=1011(13 dB)
			
EQ=1100(13.5dB)	EQ=1101(14.0dB)	EQ=1110(14.5dB)	EQ=1111(15.0dB)
			

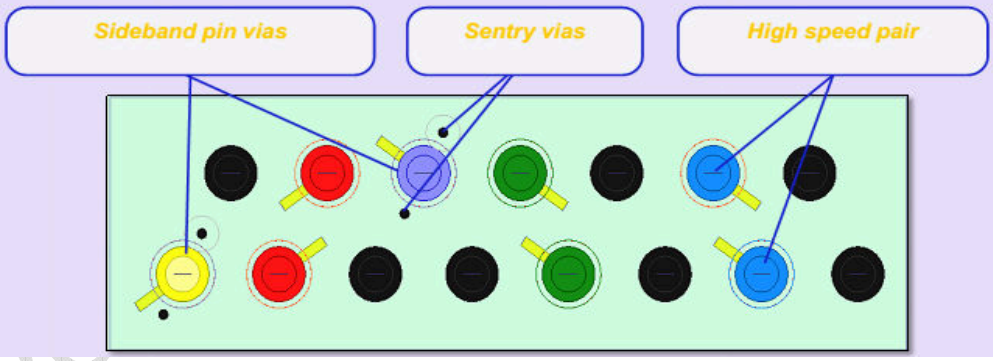
7 Layout suggestion for crosstalk improves

- Place add-in card (AIC) ground finger vias adjacent to the ground fingers
  - ✓ Join adjacent vias, for "double grounds"
- Benefit: Reduces crosstalk and improves insertion loss in the add in card (AIC) & connector body around 7-8 GHz

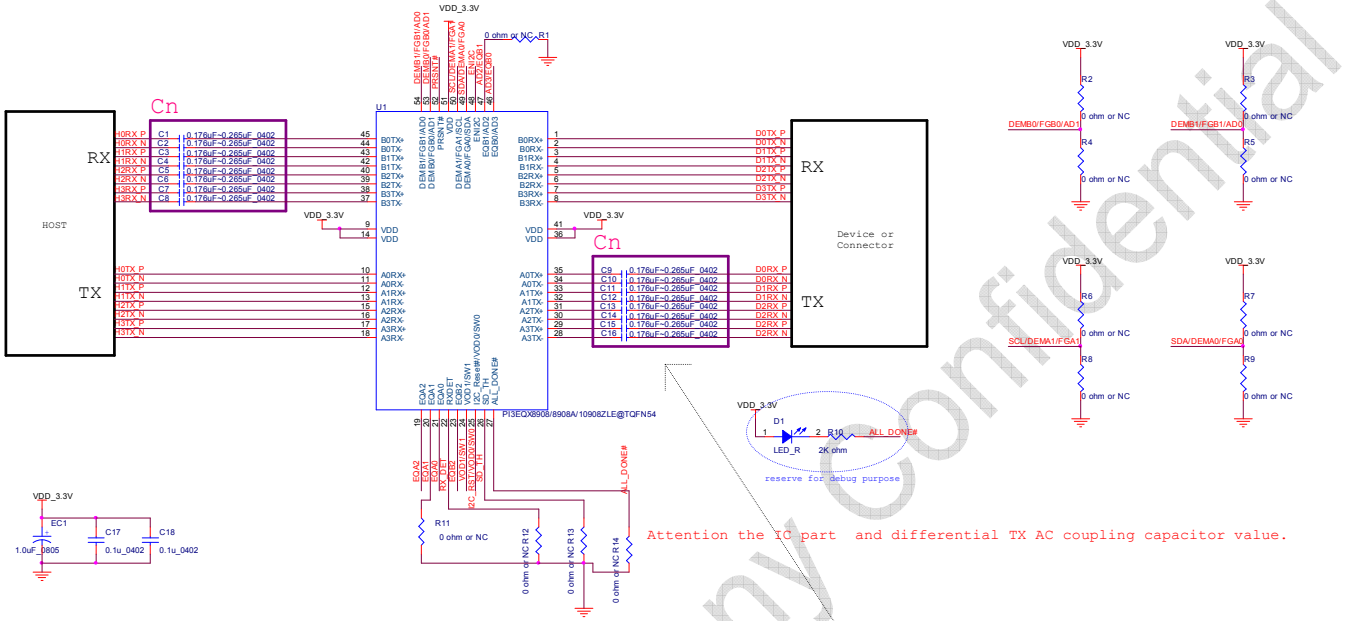




- Add two to four small "sentry" ground vias adjacent to sideband pin vias on the baseboard
- Benefit: Provides marked broadband crosstalk reduction
  - ✓ Also provides significant benefit for insertion loss at high frequencies



8 PI3EQX8908A typical reference circuit



Speed / Location	8Gbps	10Gbps
IC Part	PI3EQX8908/ PI3EQX8908A	PI3EQX10908
Cn	0.176uF~0.265uF	10GBASE-KR: 0.1uF 10GBASE-KX4:4.7nF

ENI2C=NC(Master mode) R11=NC, R19=NC	
SDA/DEMA0/FGA0	R32=0ohm
SCL/DEMA1/FGA1	R31=0ohm
I2C SDA / EEPROM SDA	Connect to EEPROM SDA
I2C SCL / EEPROM SCL	Connect to EEPROM SCL

ENI2C=High (I2C control) R11=on, R19=NC	
SDA/DEMA0/FGA0	R32=0ohm
SCL/DEMA1/FGA1	R31=0ohm
I2C SDA / EEPROM SDA	Connect to I2C SDA
I2C SCL / EEPROM SCL	Connect to I2C SCL

ENI2C=Low (Pin strap control) R11=NC , R19=on	
SDA/DEMA0/FGA0	R32=NC
SCL/DEMA1/FGA1	R31=NC
I2C SDA / EEPROM SDA	NC
I2C SCL / EEPROM SCL	NC

Pericom Semiconductor Corporation		
Size: Custom	Document Name: PI3EQX8908/8908A/10908ZLE APPLICATION SCHEMATIC	Rev: A02
Date: Monday, October 19, 2015	Sheet 2 of 4	

9 Power consumption test

PI3EQX8908A Power Consumption Measurement

1, Channel Current when enabled separately by register bits at constant temp.

Signal Detector=Enabled

	A3	A2	A1	A0	B3	B2	B1	B0	Idd	Unit: mA
SW=11(1200mV) FG=10/11 EQ=0000/1111	Disabled								2.3	
	Enabled								33.9	
		Enabled							34.0	
			Enabled						33.7	
				Enabled					33.8	
					Enabled				34.2	
						Enabled			34.1	
							Enabled		33.9	
								Enabled	34.3	
	Enabled								254.6	

Signal Detector=Enabled

	A3	A2	A1	A0	B3	B2	B1	B0	Idd	Unit: mA
SW=00(900mV) FG=10/11 EQ=0000/1111	Disabled								2.3	
	Enabled								32.7	
		Enabled							32.7	
			Enabled						32.4	
				Enabled					32.5	
					Enabled				32.9	
						Enabled			32.8	
							Enabled		32.7	
								Enabled	33.0	
	Enabled								244.8	

Signal Detector=Disabled

	A3	A2	A1	A0	B3	B2	B1	B0	Idd	Unit: mA
SW=11(1200mV) FG=10/11 EQ=0000/1111	Disabled								2.3	
	Enabled								29.1	
		Enabled							29.3	
			Enabled						28.9	
				Enabled					29.0	
					Enabled				29.4	
						Enabled			29.3	
							Enabled		29.1	
								Enabled	29.5	
	Enabled								216.2	

10 Errata

NA