Design transition to PI3EQX8908A from PI3EQX8908 - Application Note

By YT Tso, Anne Wu, Jerry Chou

• Introduction:

This application note shows the difference between PI3EQX8908A / PI3EQX8908, the procedure to do the tuning change from PI3EQX8908 to PI3EQX8908A, and also include the reference circuit.

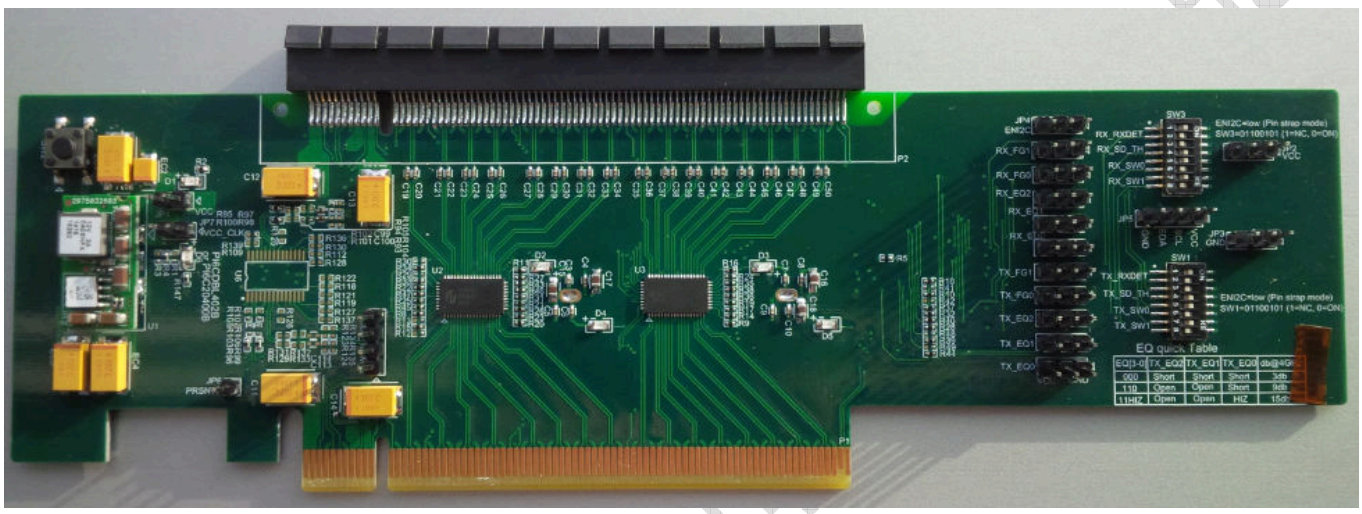


Figure 1 top view of PI3PCIE8908A EVB

Content

- The main difference between PI3EQX8908A and PI3EXQ8908
- Procedure to do the tuning change(EQ/FG setting)
- PI3EQX8908A and PI3EXQ8908 typical reference circuit

- **The main difference between PI3EQX8908A and PI3EXQ8908**

For PI3EQX8908A and PI3EQX8908, the package (54 pin TQFN), I2C registers, and 3.3V power are same. There are 3 differences between the 8908 and 8908A as shown below:

1. EQ register settings (Rx channel) are spaced differently for more accuracy.
2. DE register is replaced with FG register. Since 8908A is fully linear redriver, it cannot use DeEmphasis on the Tx channel. Instead, Tx 'gain' is provided by a Flat Gain setting.
3. Output Swing register settings are changed very slightly. For most applications, no change is needed.

1. EQ range

PI3EQX8908 EQ Table

Pin19,20,21 for EQA[2:0]
Pin23,47,46 for EQB[2:0]

Equalizer setting					
EQA2 EQB2 (Pin Control)	EQA1 EQB1 (Pin Control)	EQA0 EQB0 (Pin Control)	EQ 4 bits (I²C Control)	@2.5GHz	@4GHz
0	0	0	0000	2.4 dB	4.2 dB
0	0	1	0001	3.7 dB	5.9 dB
0	1	0	0010	5.1 dB	7.7 dB
0	1	1	0011	6.5 dB	9.3 dB
1	0	0	0100	8.3 dB	11.4 dB
1	0	1	0101	10 dB	13.2 dB
1	1	0	0110	11.8 dB	15.1 dB
1	1	1	0111	13.6 dB	16.9 dB
HIZ	0	0	1000	15.5 dB	18.9 dB
HIZ	0	1	1001	17.4 dB	20.8 dB
HIZ	1	0	1010	19.3 dB	22.8 dB
HIZ	1	1	1011	21.2 dB	24.7 dB
0	0	HIZ	1100	23 dB	26.5 dB
0	1	HIZ	1101	25 dB	28.5 dB
1	0	HIZ	1110	27 dB	30.5 dB
1	1	HIZ	1111	29.1 dB	32.6 dB

PI3EQX8908A EQ Table

Pin19,20,21 for EQA[2:0]
Pin23,47,46 for EQB[2:0]

Equalizer setting				
EQA2, EQB2 (Pin Control)	EQA1, EQB1 (Pin Control)	EQA0, EQB0 (Pin Control)	EQ 4 bits (I²C Control)	@4GHz
0	0	0	0000	3 dB
0	0	1	0001	4 dB
0	1	0	0010	5 dB
0	1	1	0011	6 dB
1	0	0	0100	7 dB
1	0	1	0101	8 dB
1	1	0	0110	9 dB
1	1	1	0111	10 dB
HIZ	0	0	1000	11 dB
HIZ	0	1	1001	12 dB
HIZ	1	0	1010	12.5 dB
HIZ	1	1	1011	13 dB
0	0	HIZ	1100	13.5 dB
0	1	HIZ	1101	14 dB
1	0	HIZ	1110	14.5 dB
1	1	HIZ	1111	15 dB

2. De-emphasis change to FG(Flat gain) function

PI3EQX8908 Demphasis Table

Pin 50,49 for DEMA[1:0]
Pin 54,53 for DEMB[1:0]

DEMA1 DEMB1	DEMA0 DEMB0	DEM (dB)
0	0	0
0	1	- 3.5
1	0	-6
1	1	-9

PI3EQX8908A Flat Gain Table

Pin 50,49 for FGA[1:0]
Pin 54,53 for FGB[1:0]

FGA1 FGB1	FGA0 FGB0	(dB)
0	0	-4
0	1	-2
1	0	0
1	1	2

3. Output swing table comparison

PI3EQX8908/ Output Swing Table
Pin 25,24 for VOD[1:0]

VOD1	VOD0	VOD Vp-p
0	0	0.8
0	1	0.95
1	0	1.15
1	1	1.2

PI3EOX8908A Output Swing Table
Pin 25,24 for SW[1:0]

SW1	SW0	mVp-p
0	0	900
0	1	1,000
1	0	1,100
1	1	1,200

- **PCIE3.0 TX compliance test comparison**

From 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. Note that the 8908 eye has 'artificial' bigger eye height, which is not desirable for linear operation.

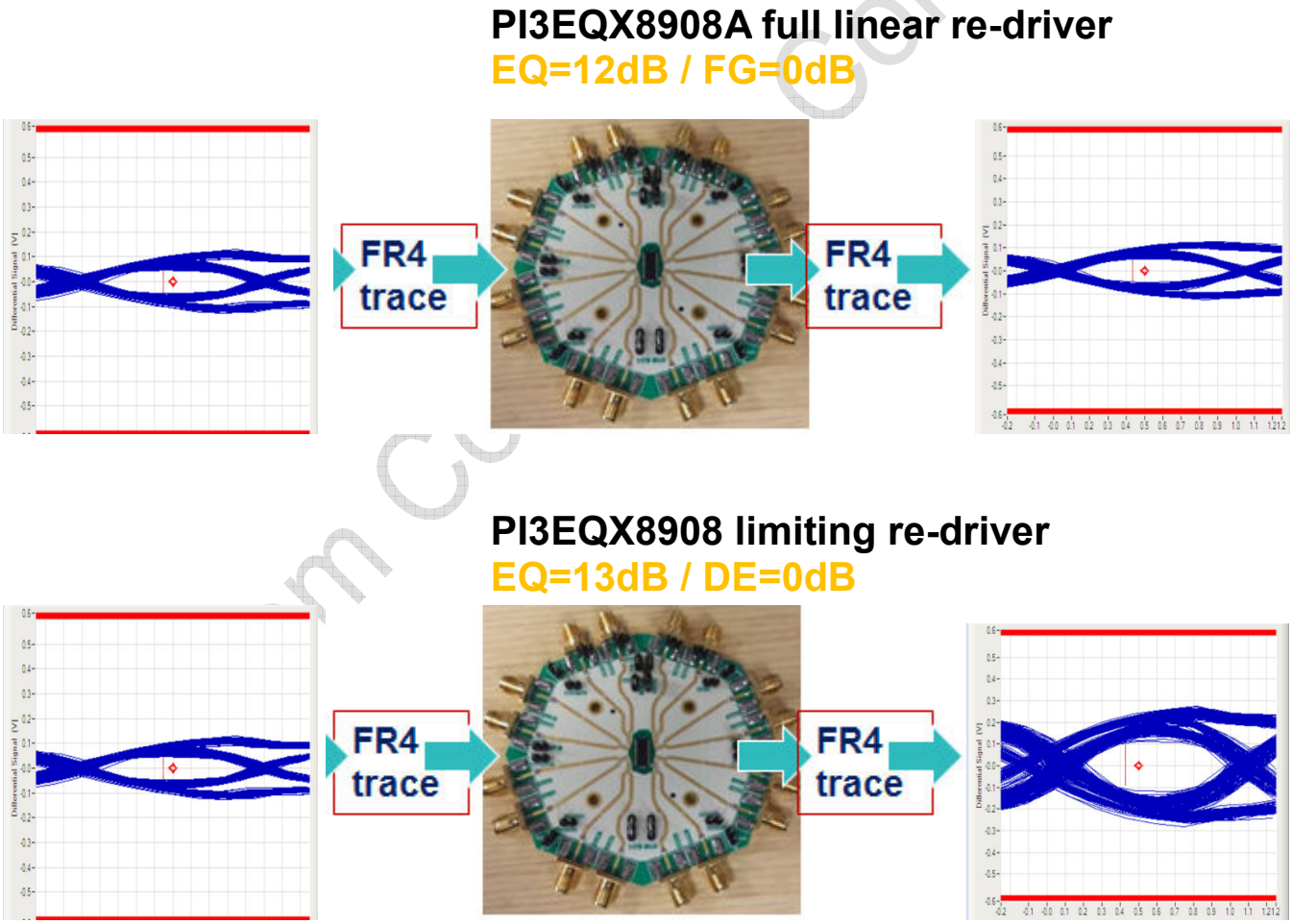


Figure 2 PCIE3.0 PI3EQX8908A and PI3EQX8908 TX eye compares

- 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

PRESET RESULTS			EQ=12dB / FG=0dB		
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

PI3EQX8908 limiting re-driver

PRESET RESULTS			EQ=13dB / DE=0dB		
Preset Name	Lane Name	PreShoot	De-Emphasis	Vb	Result
P0	Lane0	0.000 dB	-0.223 dB	981.462 mV	Fail
P01	Lane0	0.000 dB	-0.048 dB	1001.475 mV	Fail
P10	Lane0	0.000 dB	-1.378 dB	859.296 mV	Fail
P02	Lane0	0.000 dB	-0.088 dB	996.875 mV	Fail
P03	Lane0	0.000 dB	-0.002 dB	1006.826 mV	Fail
P04	Lane0	0.000 dB	0.000 dB	1007.039 mV	Pass
P05	Lane0	0.005 dB	0.000 dB	1006.413 mV	Fail
P06	Lane0	0.020 dB	0.000 dB	1004.756 mV	Fail
P07	Lane0	0.816 dB	-0.899 dB	907.446 mV	Fail
P08	Lane0	0.322 dB	-0.304 dB	970.186 mV	Fail
P09	Lane0	0.017 dB	0.000 dB	1005.065 mV	Fail

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

Figure 3 PCIE3.0 Preset P0~P10 specification

- **Procedure to do the tuning change(EQ/FG setting)**

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.

PI3EQX8908A	I2C control	PI3EQX8908	I2C control
4dB EQ	0001	4.2dB EQ	0000
8dB EQ	0101	7.7dB EQ	0010
12dB EQ	1001	11.4dB EQ	0100
14dB EQ	1101	13.3dB EQ	0101

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.

	PI3EQX8908A	PI3EQX8908
De-emphasis 1	follow from source's de-emphasis, no needs to set	(0 dB)
De-emphasis 2	follow from source's de-emphasis, no needs to set	(-3.5 dB)

De-emphasis 3	follow from source's de-emphasis, no needs to set	(-6 dB)
De-emphasis 4	follow from source's de-emphasis, no needs to set	(-9 dB)

3. **OS: 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.

Below Figure4 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.

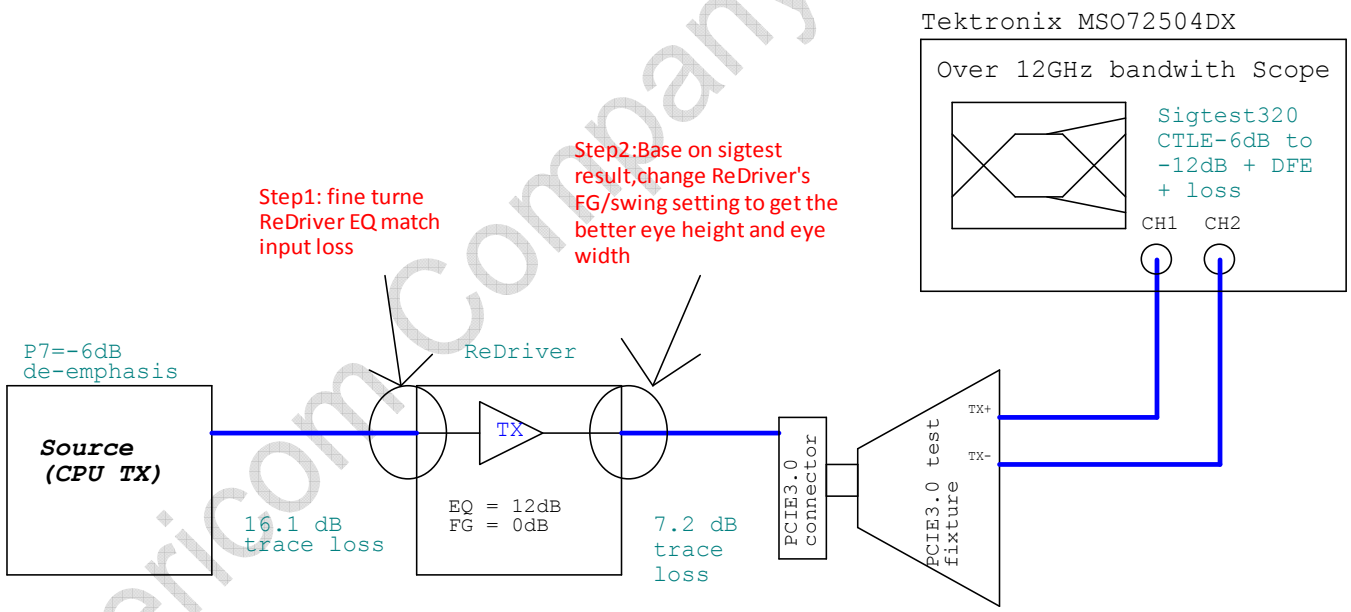


Figure 4 PCIE3.0 test setup example

Below Figure5 is a server application, different controller board go throw mid-plane for long trace and put both re-driver at two CPU RX side.

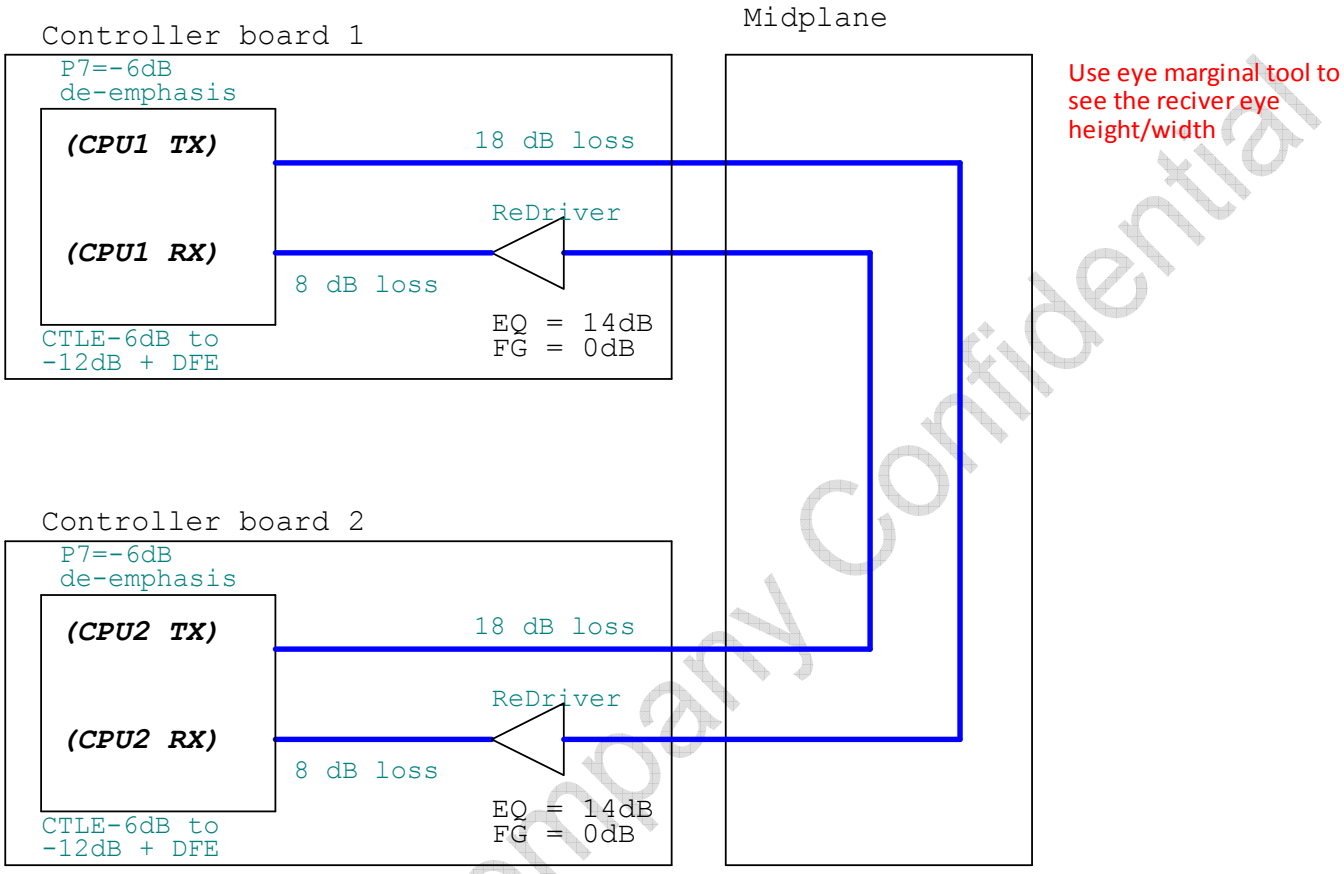


Figure 5 PCIE3.0 re-driver application example

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

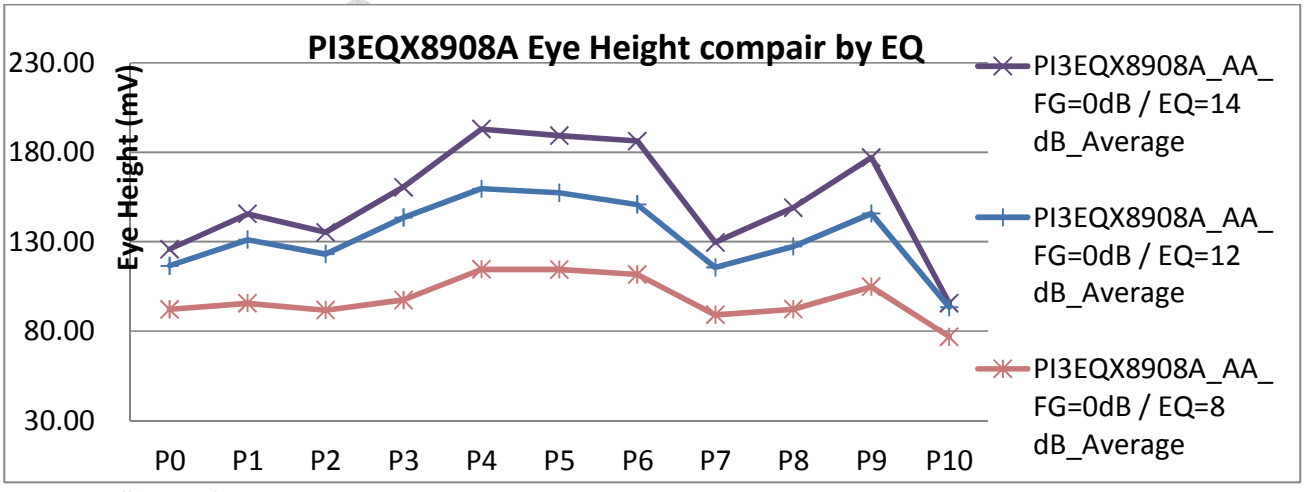


Figure 6 Different EQ vs eye height

Figure 7 - Different FG vs eye height. Note that higher FG = higher eye height.

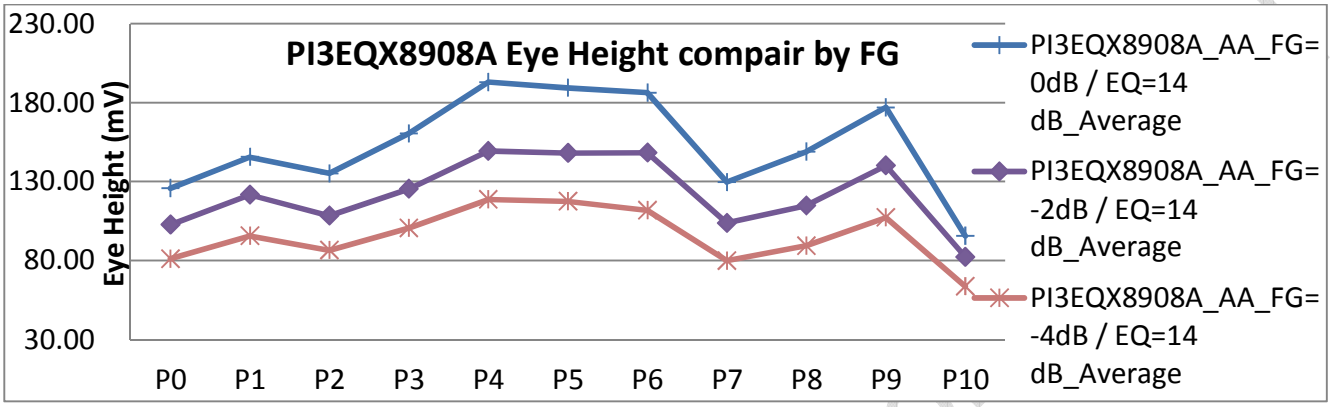


Figure 7 Different FG vs eye height

Figure 8 - Different FG vs eye width – Note that lower FG = better eye width

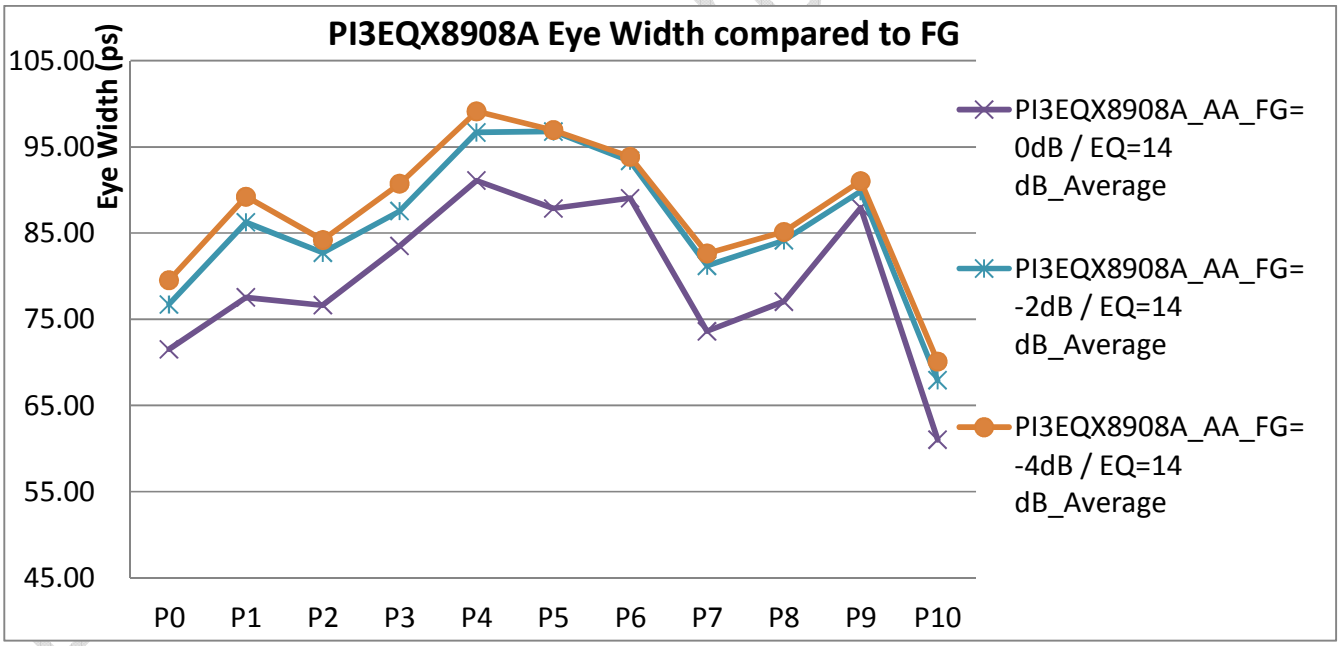
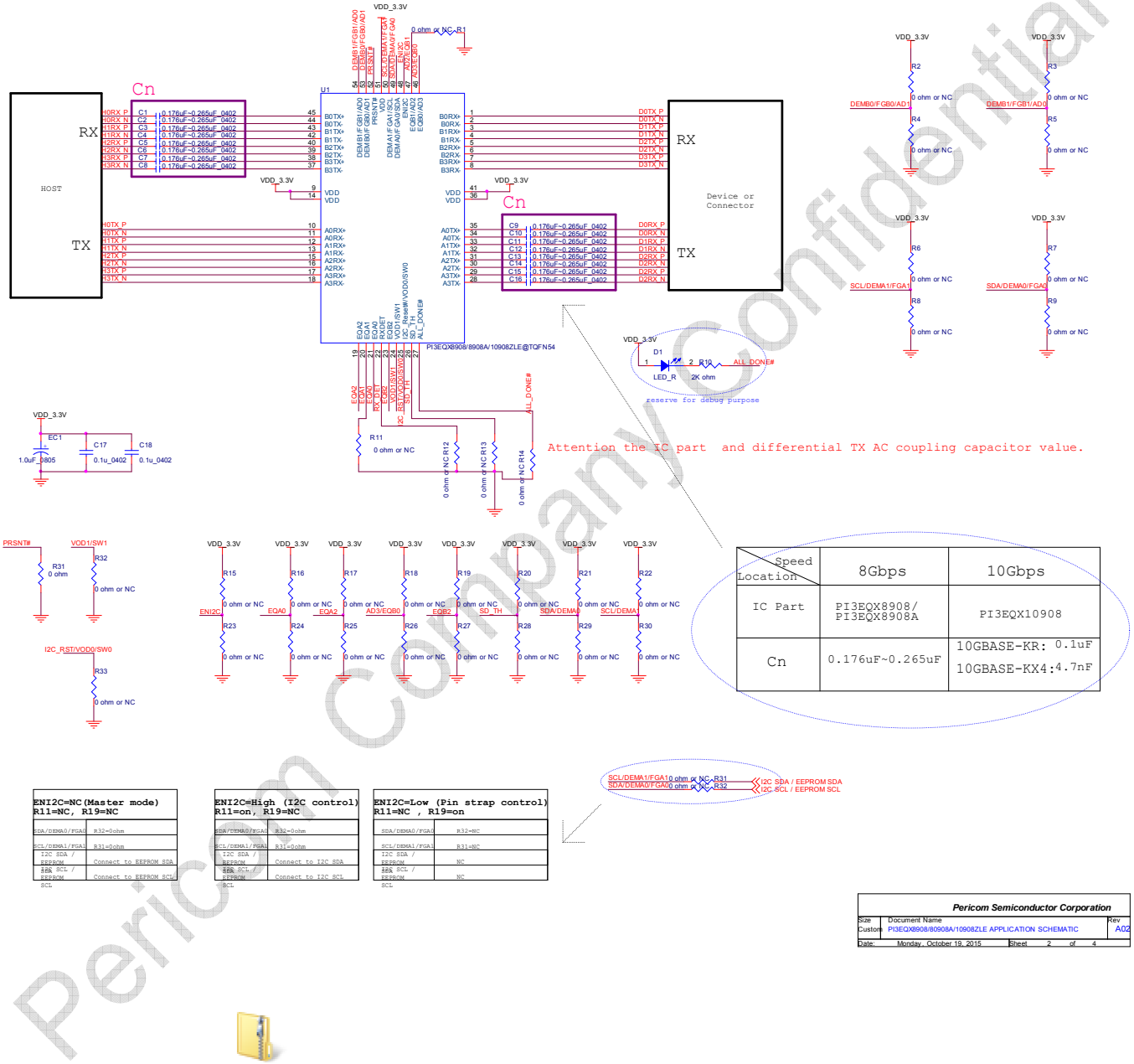


Figure 8 Different FG vs eye width

- **PI3EQX8908A and PI3EXQ8908 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

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