# PI3EQX16904GL\_TTT\_FG\_EQ\_RevA S-parameter Simulation

## Introduction:

To verify the 4 ports S-parameter model of linear redriver PI3EQX16904GL which we provided to customer, we did AC simulation, transient and step response simulation with 24inch input trace。

put 24inch input trace:

PI3EQX16904GL

24inch trace

Trace\_in

Output

We put 24 inch trace on the receiver side of PI3EQX16904GL, choose different 4port EQ s parameters to compensate the trace loss and get the eye-diagram at output.

## Conclusion:

The S-parameter is extracted from the linear redriver, it is not bi-directional, only s(4,1) s(4,2) and s(3,1) s(3,2) should be the insertion loss

Port definition:

Port1 = input +

Port2 = input –

Port3 = output+

Port4 = output-

Customer can use below syntax to call the 4port s parameter:

**.model smodeleq s n=4 tstonefile='./FGL\_EQL.s4p'**

**spa inp inn outp outn mname=smodeleq**

## AC Characteristics by different EQ settings

1. **FG = 0**

|  |  |
| --- | --- |
| **FG=0** | **Differential Insertion Loss** |
| **EQ=0~7**  **SW=1000mV** |  |

* **EQ value table:**

4 ports S-parameter differential insertion loss @ 100meg, 2GHz, 4GHz, 6GHz, 8GHz and 10GHz (unit: dB)

Model result:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EQ | 100MEG | 2G | 4G | 6G | 8G | 10G |
| 0 | -3.22 | -2.48 | -0.80 | 0.83 | 1.96 | 2.49 |
| 1 | -3.22 | -2.28 | -0.29 | 1.55 | 2.81 | 3.38 |
| 2 | -3.12 | -0.66 | 0.95 | 2.50 | 3.59 | 4.05 |
| 3 | -3.11 | -0.33 | 1.77 | 3.66 | 4.93 | 5.44 |
| 4 | -3.03 | 0.73 | 2.87 | 4.78 | 6.03 | 6.50 |
| 5 | -3.03 | 1.06 | 3.57 | 5.69 | 7.03 | 7.47 |
| 6 | -2.93 | 2.10 | 4.74 | 6.93 | 8.24 | 8.58 |
| 7 | -2.92 | 2.71 | 5.90 | 8.31 | 9.64 | 9.84 |

Measurement result :

**COMMENTS:** Only measurement GAIN curves are provided which has good match with the simulation results .(mismatch is less than -0.5 dB in comparison between curve values )

1. **FG = 1**

|  |  |
| --- | --- |
| **FG=1** | **Differential Insertion Loss** |
| **EQ=0~7**  **SW=1000mV** |  |

* **EQ value table:**

4 ports S-parameter differential insertion loss @ 100meg, 2GHz, 4GHz, 6GHz, 8GHz and 10GHz (unit: dB)

Model result:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EQ | 100MEG | 2G | 4G | 6G | 8G | 10G |
| 0 | -1.95 | -1.28 | 0.28 | 1.87 | 3.05 | 3.68 |
| 1 | -1.95 | -1.08 | 0.79 | 2.59 | 3.90 | 4.57 |
| 2 | -1.85 | 0.54 | 2.03 | 3.54 | 4.68 | 5.24 |
| 3 | -1.84 | 0.87 | 2.85 | 4.70 | 6.02 | 6.63 |
| 4 | -1.76 | 1.93 | 3.95 | 5.82 | 7.13 | 7.69 |
| 5 | -1.76 | 2.25 | 4.65 | 6.73 | 8.12 | 8.67 |
| 6 | -1.66 | 3.30 | 5.82 | 7.97 | 9.33 | 9.77 |
| 7 | -1.65 | 3.91 | 6.98 | 9.35 | 10.73 | 11.03 |

Measurement result :

**COMMENTS:** Only measurement GAIN curves are provided which has good match with the simulation results .(mismatch is less than -0.5 dB in comparison between curve values )

1. **FG = 2**

|  |  |
| --- | --- |
| **FG=2** | **Differential Insertion Loss** |
| **EQ=0~7**  **SW=1000mV** |  |

* **EQ value table:**

4 ports S-parameter differential insertion loss @ 100meg, 2GHz, 4GHz, 6GHz, 8GHz and 10GHz (unit: dB)

Model result:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EQ | 100MEG | 2G | 4G | 6G | 8G | 10G |
| 0 | -0.46 | 0.17 | 1.72 | 3.40 | 4.71 | 5.45 |
| 1 | -0.46 | 0.36 | 2.22 | 4.12 | 5.56 | 6.35 |
| 2 | -0.36 | 1.98 | 3.47 | 5.07 | 6.34 | 7.02 |
| 3 | -0.35 | 2.32 | 4.29 | 6.23 | 7.68 | 8.41 |
| 4 | -0.27 | 3.38 | 5.39 | 7.35 | 8.79 | 9.46 |
| 5 | -0.27 | 3.70 | 6.09 | 8.26 | 9.78 | 10.43 |
| 6 | -0.17 | 4.74 | 7.26 | 9.49 | 10.99 | 11.54 |
| 7 | -0.16 | 5.35 | 8.42 | 10.88 | 12.39 | 12.79 |

Measurement result :

**COMMENTS:** Only measurement GAIN curves are provided which has good match with the simulation results .(mismatch is less than -0.5 dB in comparison between curve values )

1. **FG = 3**

|  |  |
| --- | --- |
| **FG=3** | **Differential Insertion Loss** |
| **EQ=0~7**  **SW=1000mV** |  |

* **EQ value table:**

4 ports S-parameter differential insertion loss @ 100meg, 2GHz, 4GHz, 6GHz, 8GHz and 10GHz (unit: dB)

Model result:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| EQ | 100MEG | 2G | 4G | 6G | 8G | 10G |
| 0 | 1.34 | 1.90 | 3.47 | 5.23 | 6.63 | 7.39 |
| 1 | 1.34 | 2.10 | 3.97 | 5.95 | 7.47 | 8.28 |
| 2 | 1.44 | 3.72 | 5.21 | 6.90 | 8.25 | 8.95 |
| 3 | 1.44 | 4.05 | 6.03 | 8.06 | 9.59 | 10.34 |
| 4 | 1.53 | 5.11 | 7.13 | 9.18 | 10.70 | 11.39 |
| 5 | 1.53 | 5.43 | 7.83 | 10.09 | 11.69 | 12.36 |
| 6 | 1.63 | 6.48 | 9.01 | 11.33 | 12.90 | 13.47 |
| 7 | 1.64 | 7.09 | 10.17 | 12.71 | 14.30 | 14.71 |

Measurement result :

**COMMENTS:** Only measurement GAIN curves are provided which has good match with the simulation results .(mismatch is less than -0.5 dB in comparison between curve values )

## Transient Characteristics

PI3EQX16904GL

24inch trace

Trace\_in

Output

|  |  |  |
| --- | --- | --- |
| **Transient**  **Simulation** | **OUTPUT of transient waveform** | **OUTPUT of eye diagram** |
| **FG=0**  **EQ=0** |  |  |
| **FG=3**  **EQ=7** |  |  |

## Step Response of the S-parameter model (input Tr=50ps)

PI3EQX16904GL

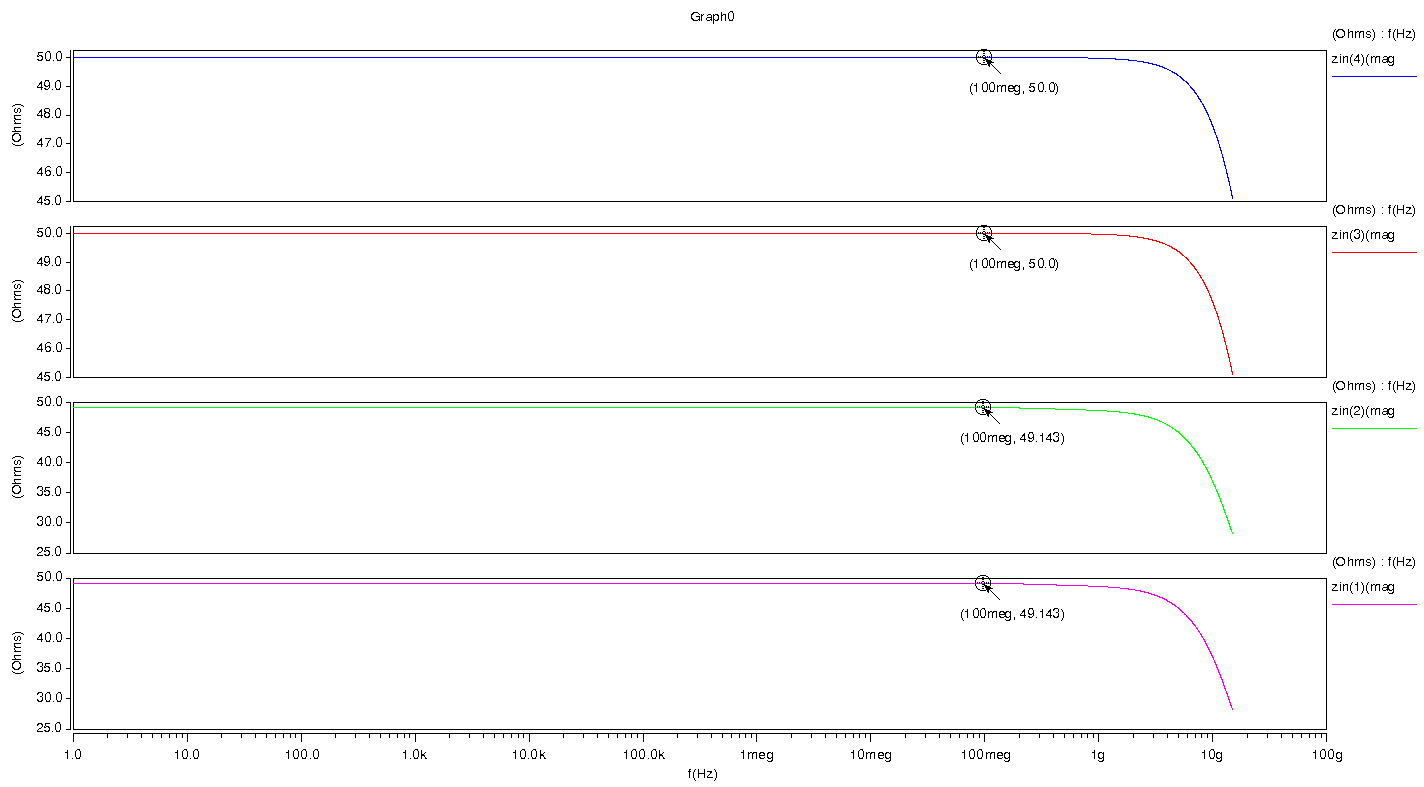
24inch trace

Trace\_in

Output

|  |  |
| --- | --- |
| **Step**  **Response** | **Waveform** |
| **FG=0**  **EQ=0** |  |
| **FG=3**  **EQ=7** |  |

## Characteristic Impedance of the S-parameter model



* The characteristic impedance of the Port1 is 49.143 ohm at 100meg;
* The characteristic impedance of the Port2 is 49.143 ohm at 100meg;
* The characteristic impedance of the Port3 is 50.0 ohm at 100meg;
* The characteristic impedance of the Port4 is 50.0 ohm at 100meg.