# 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.