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# AMI Model-to-Hardware Correlation

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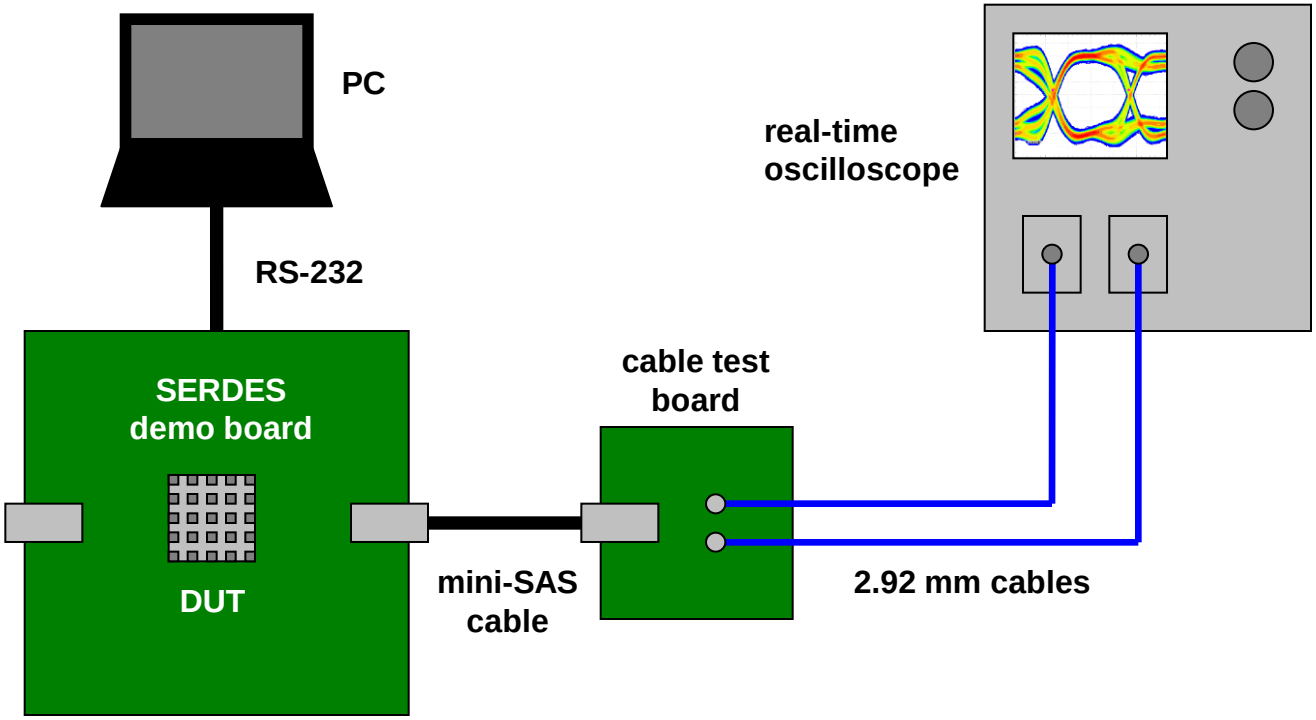
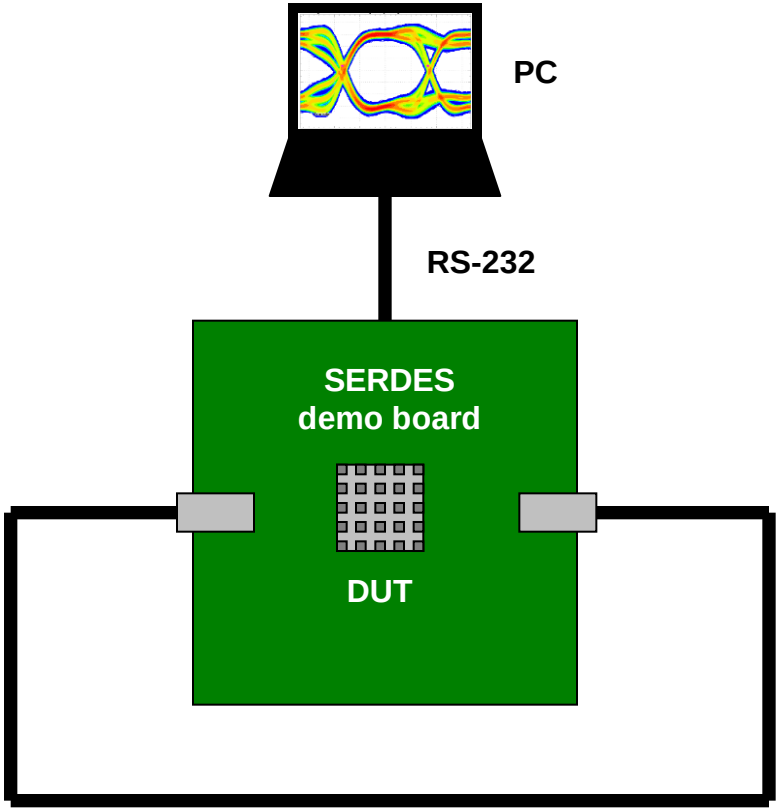
# TX Eye Measurement



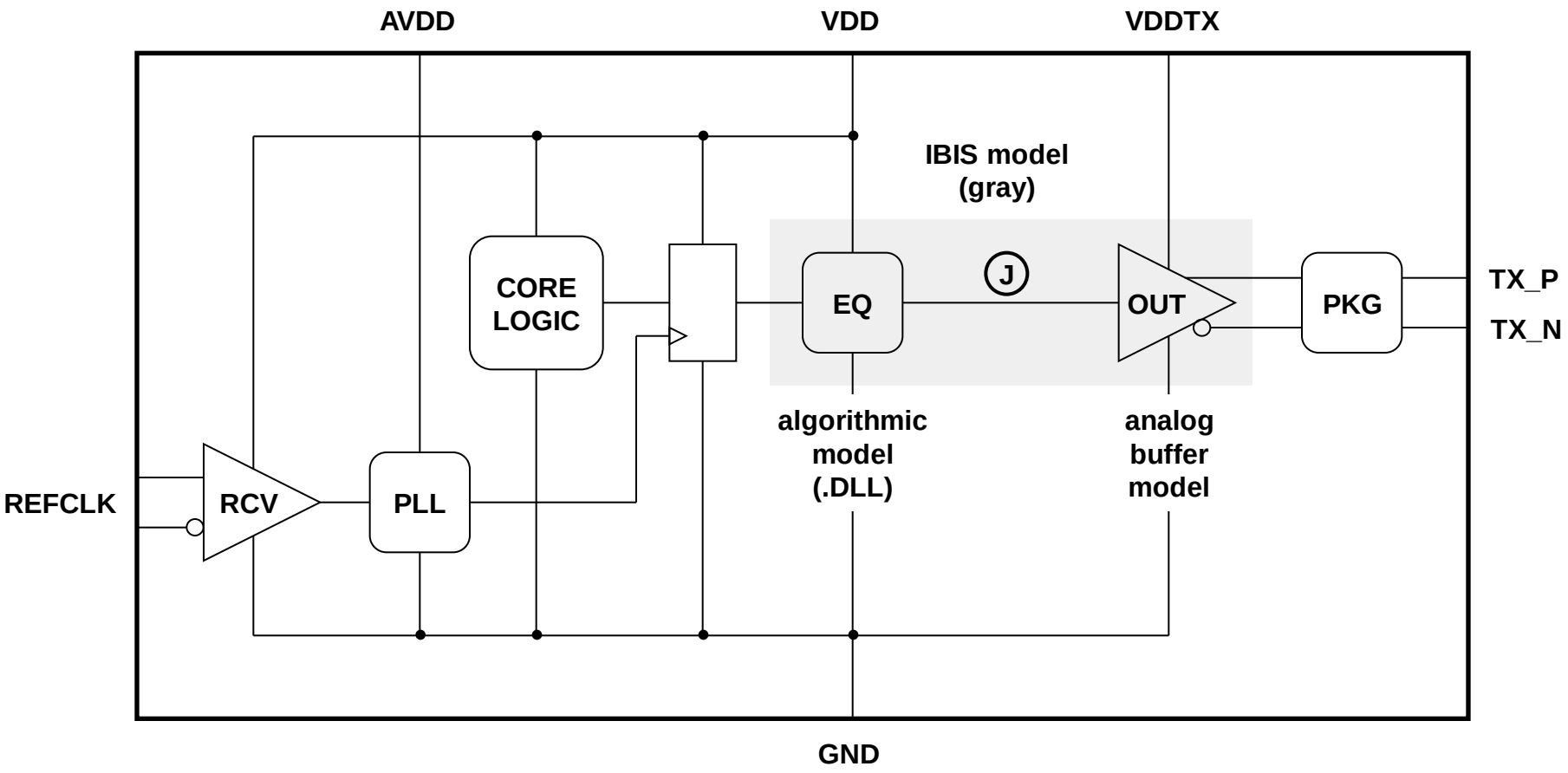
# RX Eye Measurement



# TX Model Parameters

| Function | Analog Buffer Model (.ibs) | Algorithmic Model (.ami) |
|---|---|---|
| Output stage supply voltage | [Voltage Range] | |
| Output stage impedance | [Pulldown], [Pullup] | |
| Rise time | [Ramp], [Rising Waveform] | |
| Fall Time | [Ramp], [Falling Waveform] | |
| Capacitance | C_comp | |
| Jitter | | Tx_Jitter (DjRj) |
| De-emphasis | | txtaps (0, 1) |

# TX Block Diagram



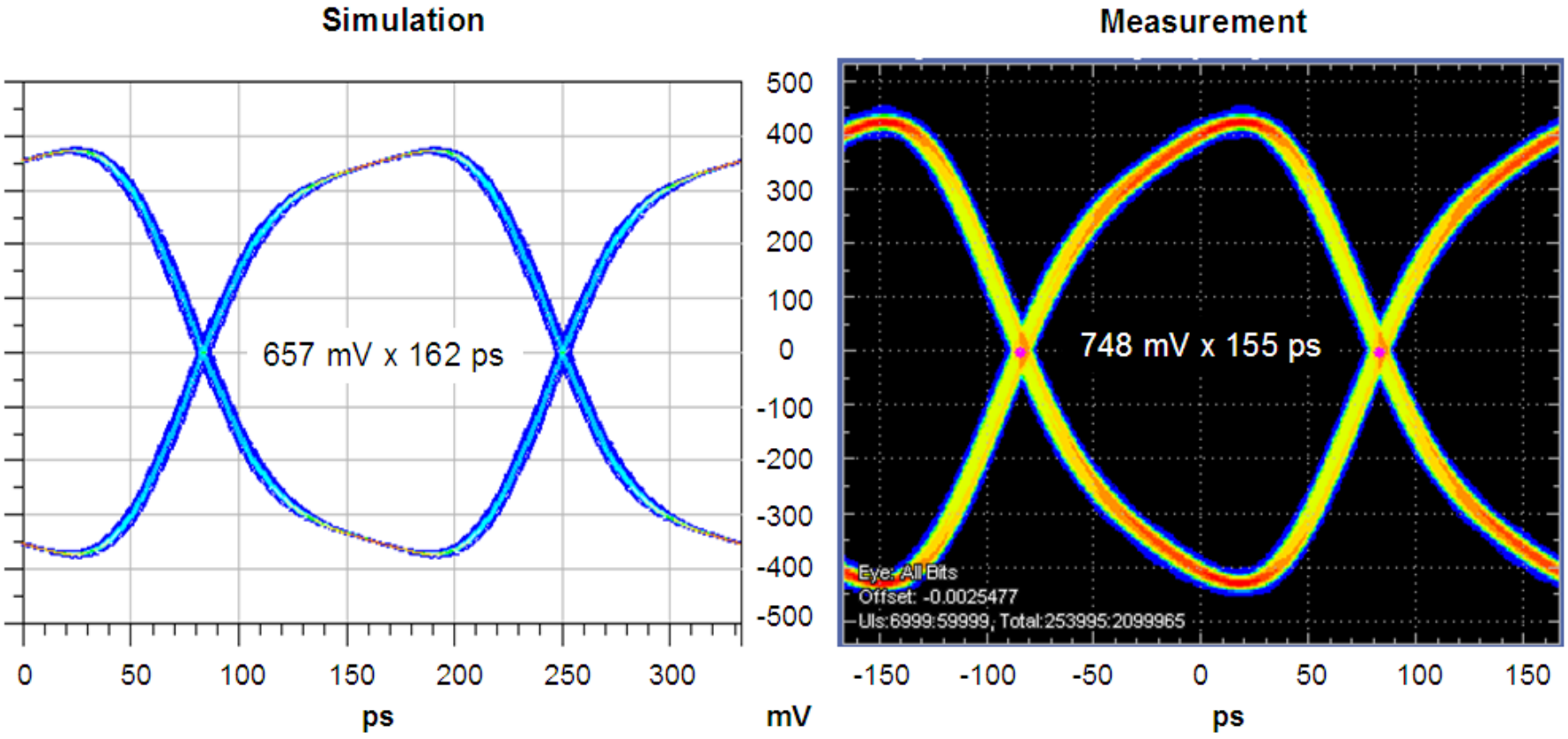
# TX Model-to-Hardware

## D10.2 Pattern 0.6 m Cable

| Parameter | Symbol | Sim | Meas | Std Dev | SAS-2 | Units |
|---|---|---|---|---|---|---|
| Height, p-p differential | H | 657 | 748 | 3 | n/a | mV |
| Width | W | 162 | 155 | 1 | n/a | ps |
| Rise Time, 20-80% | TR | 47 | 59.7 | 1.0 | 42 | ps |
| Fall Time, 20-80% | TF | 47 | 59.1 | 1.1 | 42 | ps |
| Total Jitter | TJ | 12.50 | 12.10 | 0.84 | 42 | ps |
| Random Jitter, rms | RJ | 0.88 | 0.53 | 0.02 | 25 | ps |
| Deterministic Jitter | DJ | 0.00 | 5.31 | 0.90 | n/a | ps |
| Data Dependent Jitter | DDJ | 0.04 | 0.00 | 0.00 | n/a | ps |
| Periodic Jitter | PJ | 0.02 | 5.31 | 0.90 | n/a | ps |

# TX Model-to-Hardware

## D10.2 Pattern 0.6 m Cable



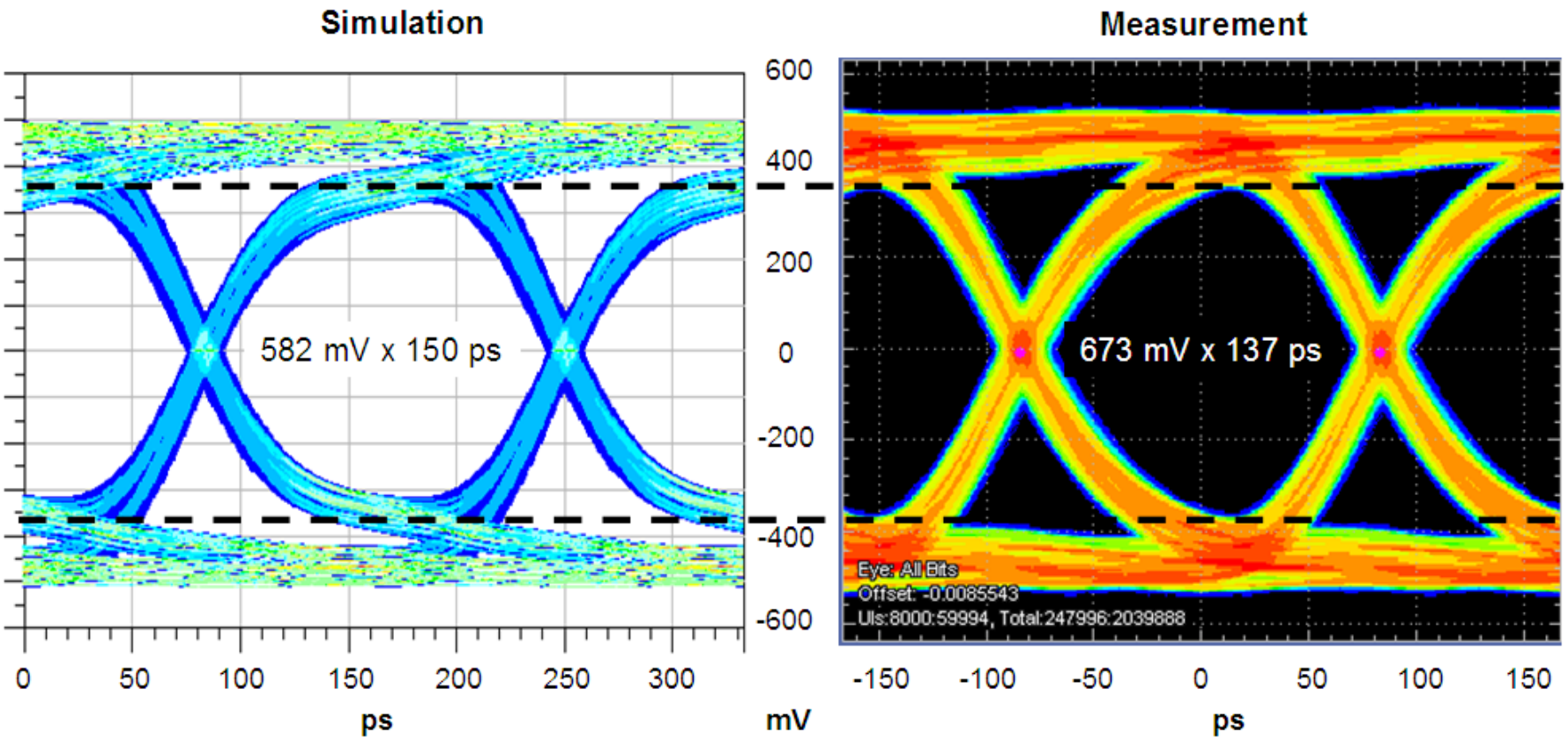
# TX Model-to-Hardware

## PRBS-7 Pattern 0.6 m Cable

| Parameter | Symbol | Sim | Meas | Std Dev | SAS-2 | Units |
|---|---|---|---|---|---|---|
| Height, p-p differential | H | 582 | 673 | 3 | n/a | mV |
| Width | W | 150 | 137 | 0.99 | n/a | ps |
| Total Jitter | TJ | 21.92 | 30.00 | 0.99 | 42 | ps |
| Random Jitter, rms | RJ | 0.87 | 0.57 | 0.03 | 25 | ps |
| Deterministic Jitter | DJ | 9.50 | 23.54 | 0.93 | n/a | ps |
| Data Dependent Jitter | DDJ | 12.05 | 15.98 | 0.01 | n/a | ps |
| Periodic Jitter | PJ | 0.08 | 5.30 | 0.93 | n/a | ps |

# TX Model-to-Hardware

## PRBS-7 Pattern 0.6 m Cable



# Changes

| Parameter | Old | New | Units |
|---|---|---|---|
| [Ramp] | 14 | 8 | V/ns |
| Tap 0 | 1.00 | 1.05 | |
| Eye height measurement point | 40-60 | 49-51 | % |
| Maximum impulse response frequency | n/a | 50 | GHz |
| Number of points per UI | 32 | 128 | |
| [Voltage Range] | 1.000 | 1.007 | V |

# TX Model-to-Hardware

## D10.2 Pattern 0.6 m Cable

| Parameter | Symbol | Sim | Meas | Std Dev | SAS-2 | Units |
|---|---|---|---|---|---|---|
| Height, p-p differential | H | 731 | 748 | 3 | n/a | mV |
| Width | W | 162 | 155 | 1 | n/a | ps |
| Rise Time, 20-80% | TR | 55 | 59.7 | 1.0 | 42 | ps |
| Fall Time, 20-80% | TF | 55 | 59.1 | 1.1 | 42 | ps |
| Total Jitter | TJ | 12.70 | 12.10 | 0.84 | 42 | ps |
| Random Jitter, rms | RJ | 0.89 | 0.53 | 0.02 | 25 | ps |
| Deterministic Jitter | DJ | 0.00 | 5.31 | 0.90 | n/a | ps |
| Data Dependent Jitter | DDJ | 0.02 | 0.00 | 0.00 | n/a | ps |
| Periodic Jitter | PJ | 0.03 | 5.31 | 0.90 | n/a | ps |

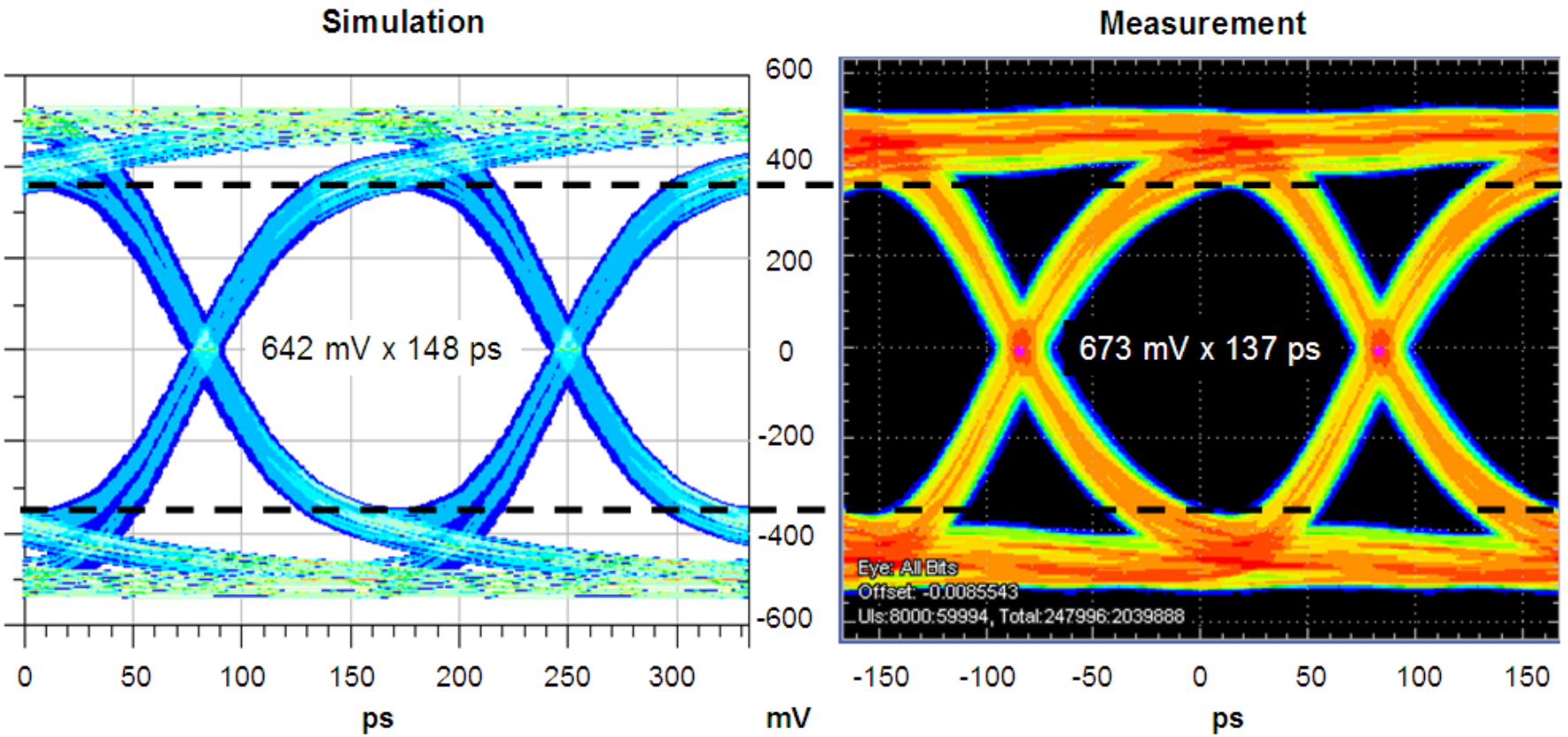
# TX Model-to-Hardware

## PRBS-7 Pattern 0.6 m Cable

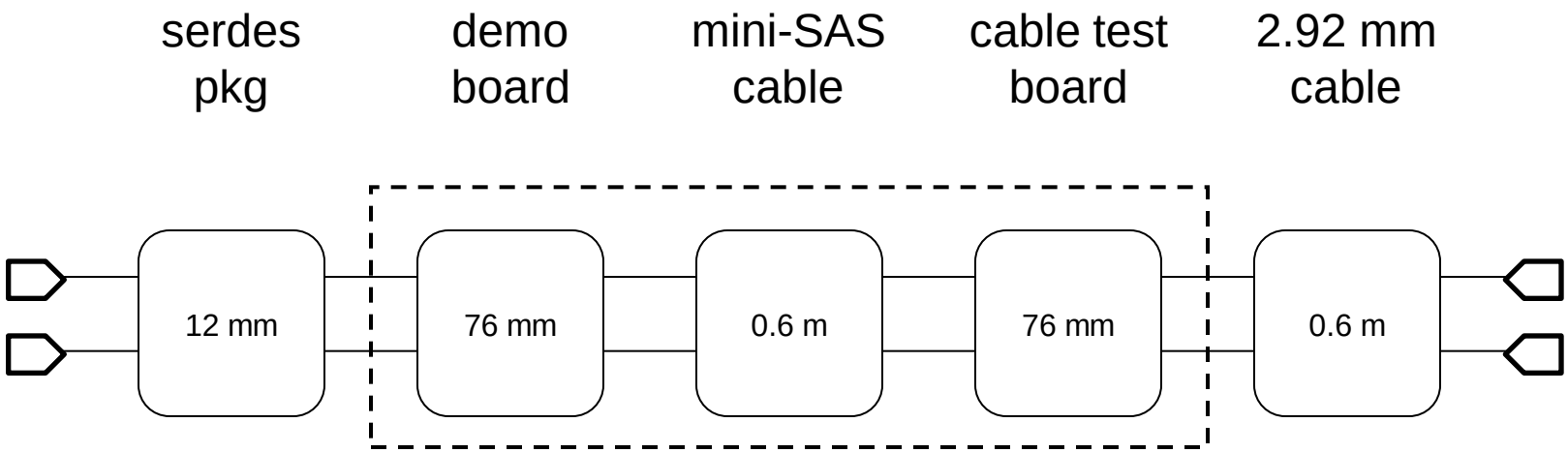
| Parameter | Symbol | Sim | Meas | Std Dev | SAS-2 | Units |
|---|---|---|---|---|---|---|
| Height, p-p differential | H | 642 | 673 | 3 | n/a | mV |
| Width | W | 148 | 137 | 0.99 | n/a | ps |
| Total Jitter | TJ | 23.77 | 30.00 | 0.99 | 42 | ps |
| Random Jitter, rms | RJ | 0.88 | 0.57 | 0.03 | 25 | ps |
| Deterministic Jitter | DJ | 11.25 | 23.54 | 0.93 | n/a | ps |
| Data Dependent Jitter | DDJ | 13.91 | 15.98 | 0.01 | n/a | ps |
| Periodic Jitter | PJ | 0.00 | 5.30 | 0.93 | n/a | ps |

# TX Model-to-Hardware

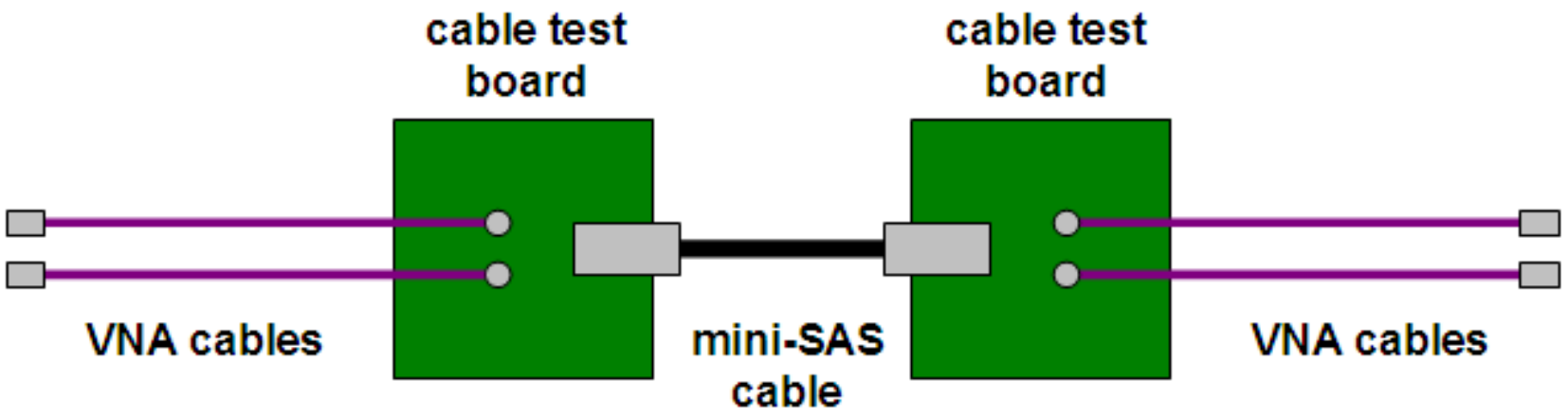
## PRBS-7 Pattern 0.6 m Cable



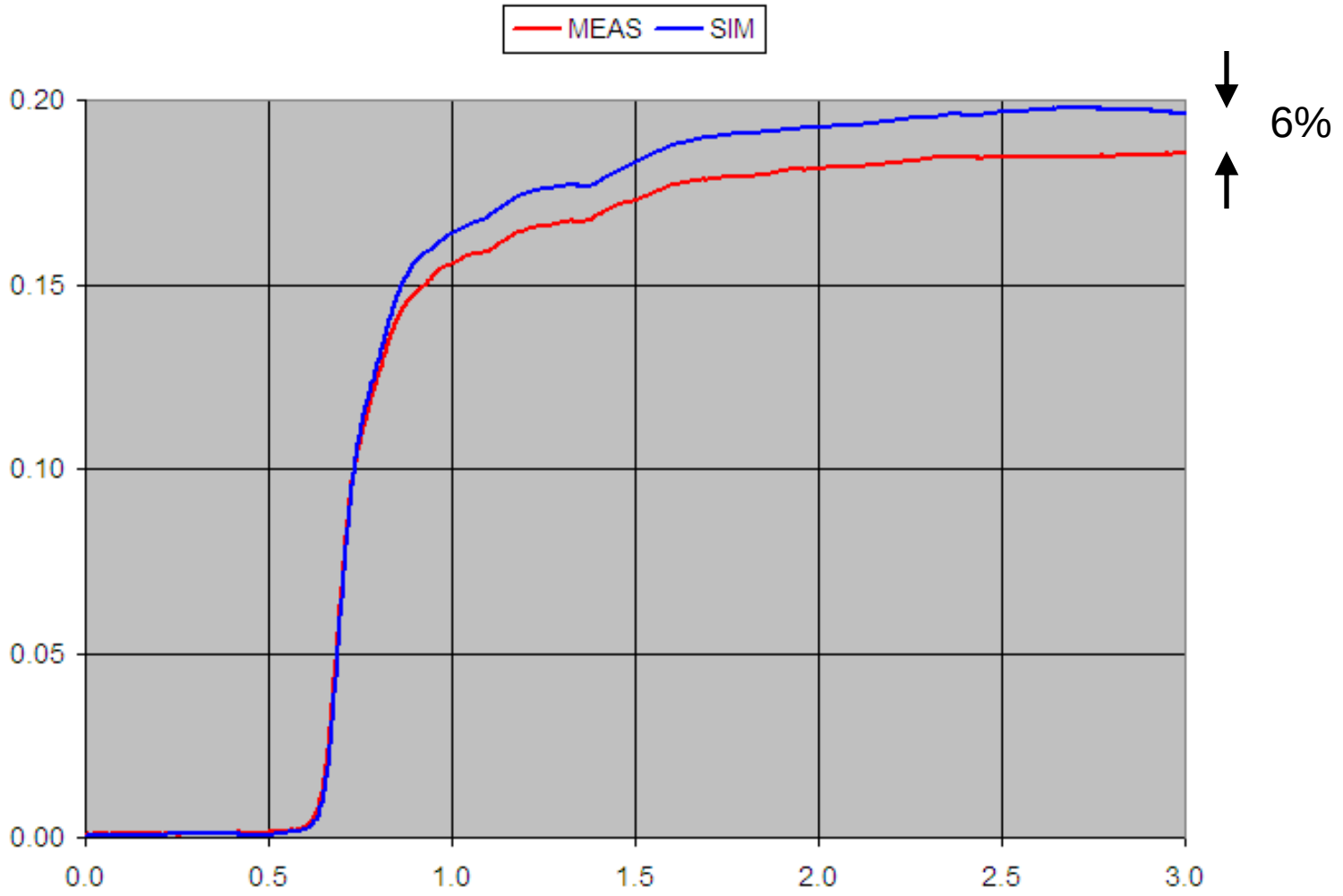
# Interconnect Models



# Cable Assy. S-Parameters



# 0.6 m Cable Step Response



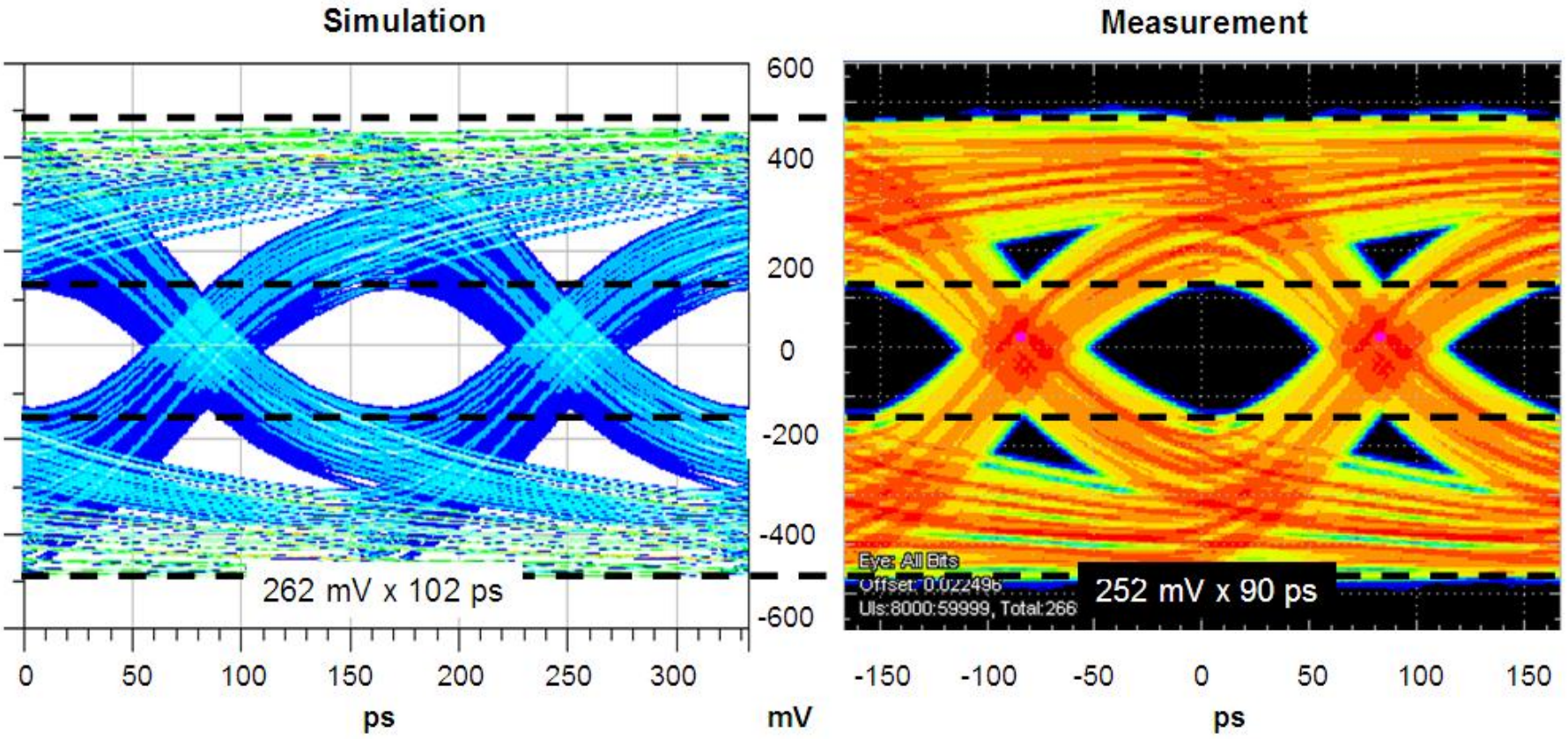
# TX Model-to-Hardware

## PRBS-7 Pattern 3.25 m Cable

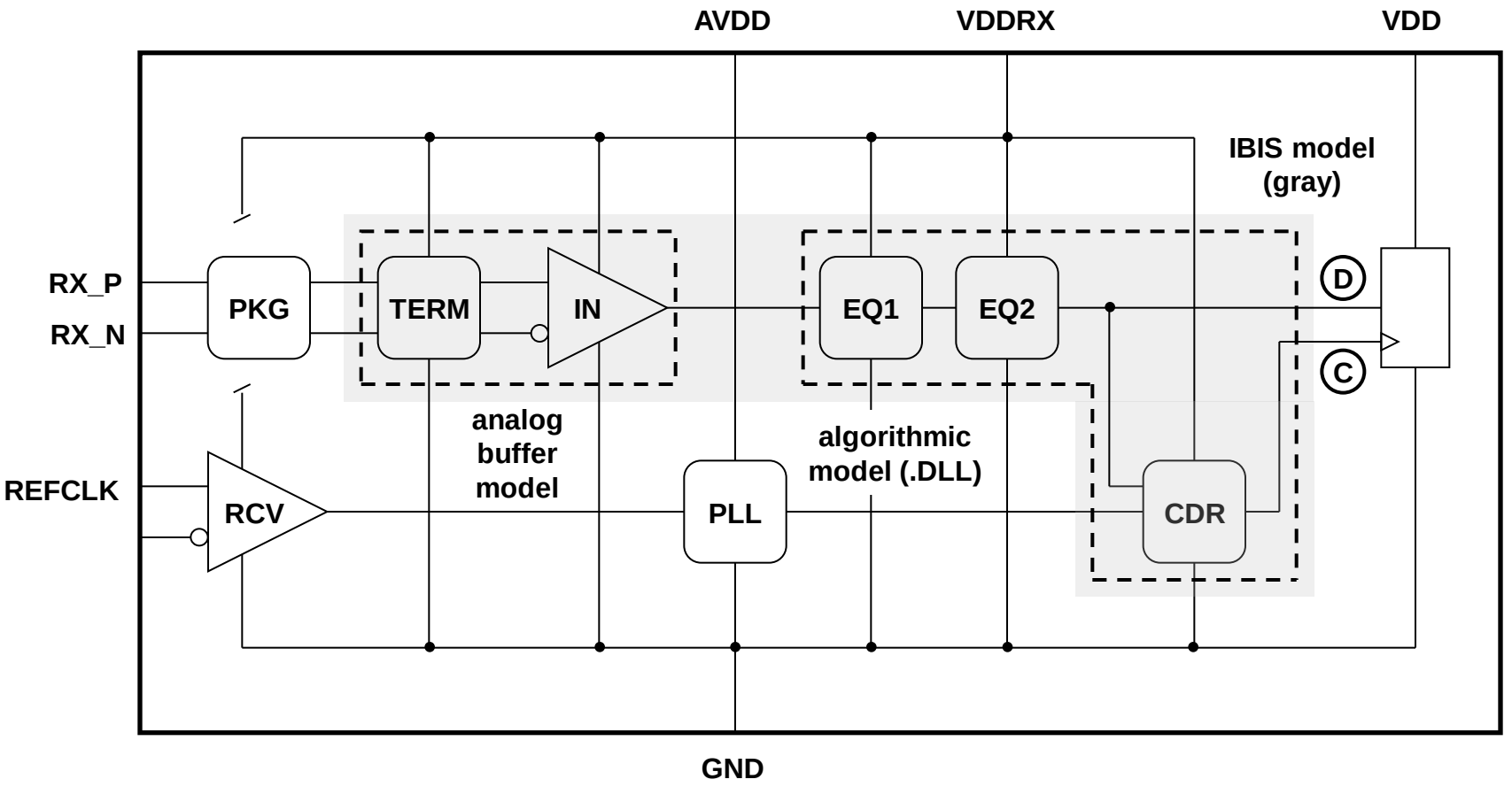
| Cable | Parameter | Symbol | Sim | Meas | Units |
|---|---|---|---|---|---|
| 1.2 m | Height, p-p differential | H | 575 | 582 | mV |
| | Width | W | 145 | 130 | ps |
| 2.5 m | Height, p-p differential | H | 344 | 344 | mV |
| | Width | W | 121 | 113 | ps |
| 3.25 m | Height, p-p differential | H | 262 | 252 | mV |
| | Width | W | 102 | 90 | ps |

# TX Model-to-Hardware

## PRBS-7 Pattern 3.25 m Cable



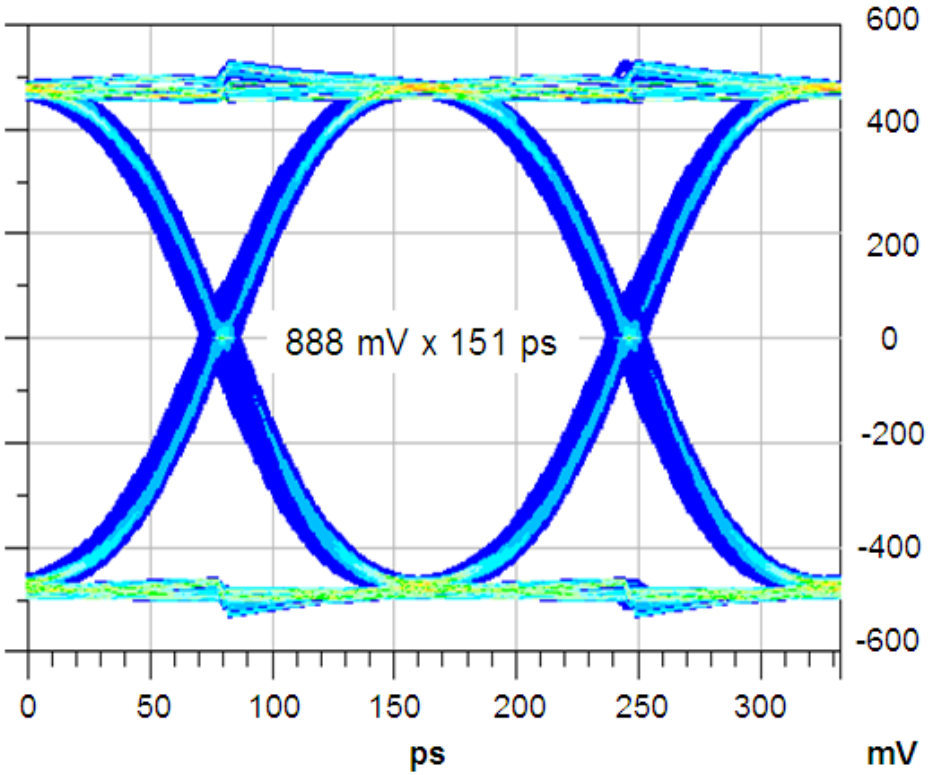
# RX Block Diagram



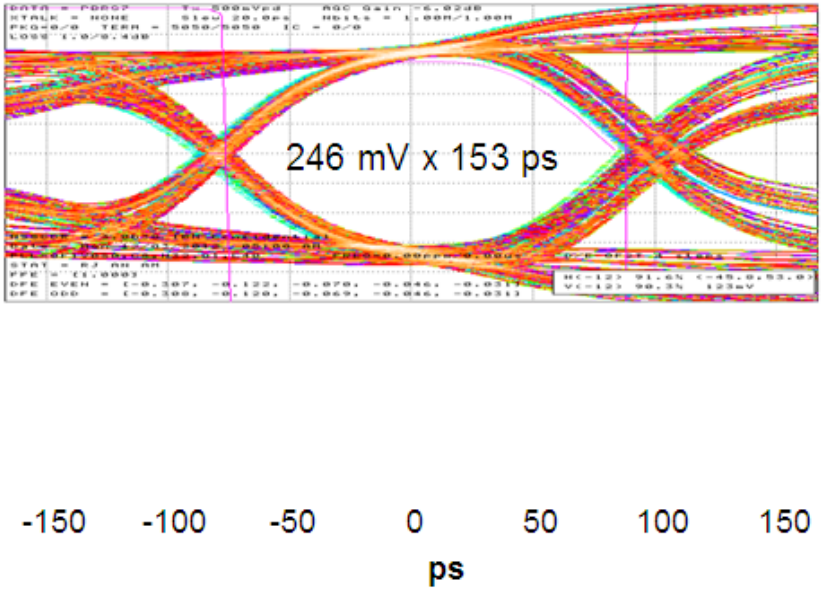
# RX Eye w/ & w/o AGC

## PRBS-7 Pattern 3.25 m Cable

**Simulation w/o AGC**




**Simulation w/ AGC**



# RX Eye at Latch

## PRBS-7 Pattern

| Cable | Parameter | Symbol | Sim | Meas | Units |
|---|---|---|---|---|---|
| 0.6 m | Height, p-p differential | H | 382 | 237 | mV |
| 1.2 m | | | 346 | 248 | mV |
| 2.5 m | | | 274 | 240 | mV |
| 3.25 m | | | 246 | 230 | mV |
| 10.0 m | | | 114 | 208 | mV |
| 15.0 m | | | n/a | 115 | mV |
| 0.6 m | Width | W | 134 | 153 | ps |
| 1.2 m | | | 145 | 147 | ps |
| 2.5 m | | | 124 | 151 | ps |
| 3.25 m | | | 139 | 151 | ps |
| 10.0 m | | | 135 | 119 | ps |
| 15.0 m | | | n/a | 58 | ps |

# AMI Acceptance Criteria

## ACCURACY

- Features that affect S11 not included in algorithmic model
- No double counting of package, e.g. s-parameters and .ibs file
- No double counting of C_Comp, e.g. s-parameters and .ibs file
- S-parameters for test channel distributed with model
- Expected jitter and eye dimensions for test channel
- PHY supports on-chip oscilloscope GUI running on PC
- PHY outputs D10.2 & PRBS-7 patterns with oscilloscope connected
- Demo board to include 2.92 mm connection to TX, max 2 in. wire

# AMI Acceptance Criteria

## ACCURACY

- Lab report to include:
  a. TX jitter decomposition measurements
  b. RX stressed eye testing
  c. Model-to-hardware correlation
  d. Proof of industry standard compliance

## COMPLETENESS

## DOCUMENTATION

## FUNCTIONALITY

# Conclusions

- IBIS-AMI model development requires IO circuit engineering and programming skills.
- IBIS-AMI model development is a LOT of work!
  - Supplier could spend 2 – 4 person months.
  - Customer could spend 1 – 2 person months.
- Estimate work load and capital equipment.
- Clarify expectations before buying.