

Electrical Characterization of Serial ATA Interconnection at Gigabit Speeds

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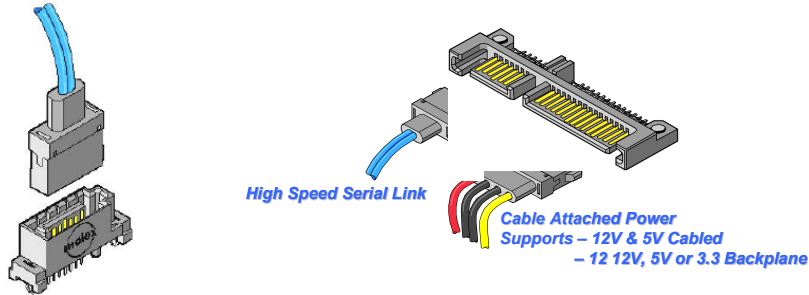
SCOPE

- **Serial ATA Technology Overview**
- **Characterization of Serial ATA Cable Interconnection**
- **Modeling, Simulation and Validation of Serial ATA Cable**
- **Conclusion**

What is Serial ATA (SATA) ?



- Next Generation Internal Storage Interconnect
- Point-to-Point, High Speed Serial Interface (150 Mbytes/sec)
- Thinner, longer cables for easier PCB routing
- Low signal Pin count requires less board space
- Low Voltage Differential Signaling with 8b/10b encoding
- Hot-Swap Capability
- 100% Software Compatible “Drop-in” replacement for current ATA
- Visit www.serialata.org for more information.

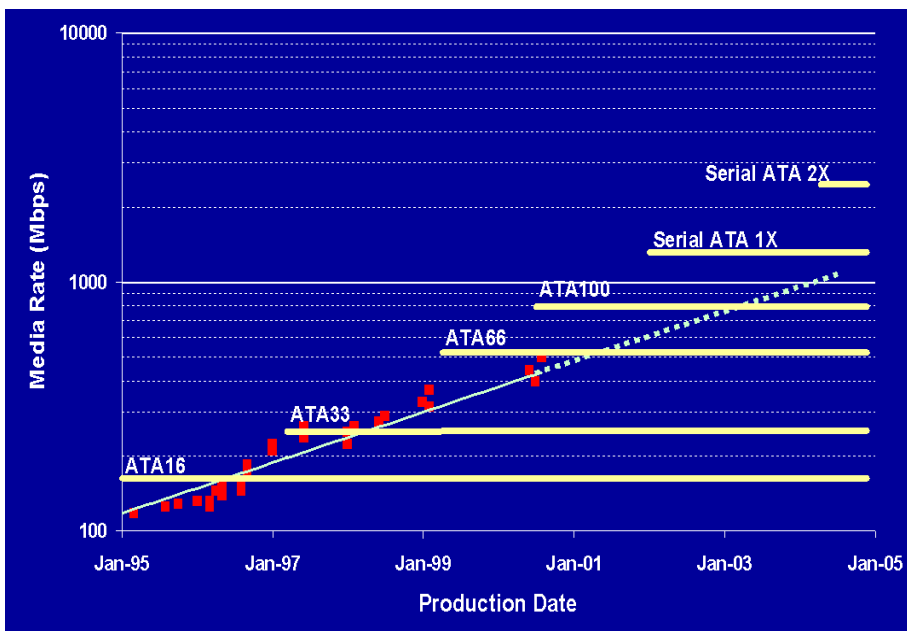


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Parallel Ultra ATA vs. Serial ATA

Key Technology	Ultra ATA	Serial ATA
Current Data Rate	100 – 133 Mbytes/sec	150 Mbytes/sec
Bus Architecture	Parallel	Serial
Bus Connection	Master/Slave Shared Bus	Point to Point Dedicated Bus
Clock Strategy	Non-interlocked	Embedded
Cabling	80-wire ribbon cable	4-wire cable with shield/drain wires
Connectors (Signal Pins)	80 signal pins	4 signal pins
PCB Routing	Parallel Data & Clock Routing	Differential Pair Routing
Signaling	Legacy 5V	LVDS
Hot-Plug	No	Yes
Bandwidth Scalability	No	6 Gb/s

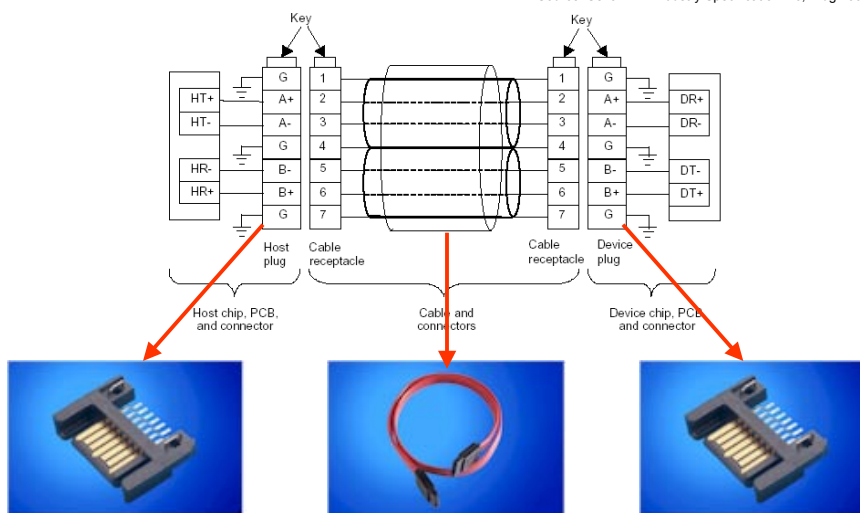
Data Storage Interface Speed Roadmap



Serial ATA Physical Interface – Cable Link

	Generation 1	Generation 2	Generation 3
Approximate Data Rates (10b Speed)	1.5 Gb/s	3.0 Gb/s	6.0 Gb/s

Source: Serial ATA Industry Specification 1.0, Aug 2002



Serial ATA High Speed Performance Targets

Source: Serial ATA Industry Specification 1.0, Aug 2002

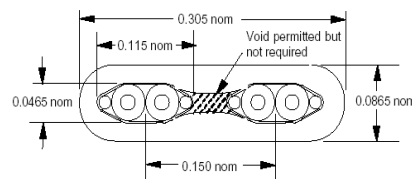
High Speed Parameter	Requirements
Mated Connector Impedance	100 Ohms +/- 15%
Cable Absolute Impedance	100 Ohms +/- 10%
Cable Pair Matching	+/- 5 Ohms
Common Mode Impedance	27 ~ 40 Ohms
Insertion Loss	6 dB max.
Near-End Crosstalk (NEXT)	-26 dB
Rise time	85ps max
Inter-Symbol Interference	50ps max.

Note: Requirements applicable to Generation 2 speed.

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Serial ATA Cable Assembly Design

- **Signal Cable**
 - Amphenol Spectra-Strip SkewClear 26 AWG Cable
 - 2 differential signal lines with grounds
 - Differential 100 Ohms
 - Point to point unidirectional construction
 - Generation 1 & 2 Performance levels
 - Can customize for any length under 1 meter
 - Small flexible cable for easy routing and no airflow restriction
- **Cable Receptacles**
 - Passive latching detent, vibration resistance
 - Low mating force
 - Positive polarization with visual indicator



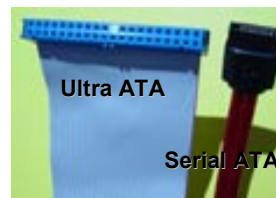
Cable Construction



Gen 2 High Speed Cable



Device Plug



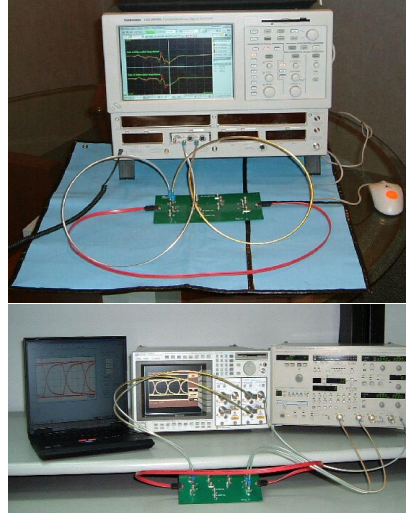
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Serial ATA Cable Assembly Characterization

High Speed Test Vehicle

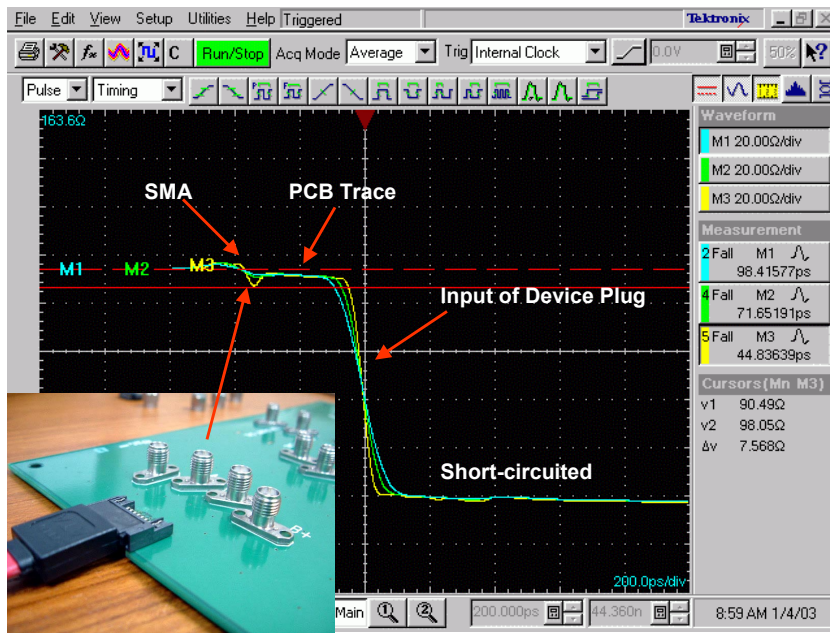
- Test Fixture Board
 - Controlled Impedance Signal Traces
 - Field Replaceable SMA interface
 - Calibration test structures
- Test Methods
 - EIA-364 Electronics Test Methods
 - Test conditions as specified in Serial ATA 1.0 Performance Specification
- Test Parameters
 - Differential/Common Mode TDR Impedance
 - Rise Time Degradation
 - Delay Skew
 - Insertion Loss
 - Near-End Crosstalk
 - Eye Pattern
- Test Equipment
 - High Speed Digital Sampling Oscilloscope with DTDR
 - High Speed Pulse Pattern Generator
- Modeling Software
 - TDA Systems IConnect Software

High Speed Measurement Setup

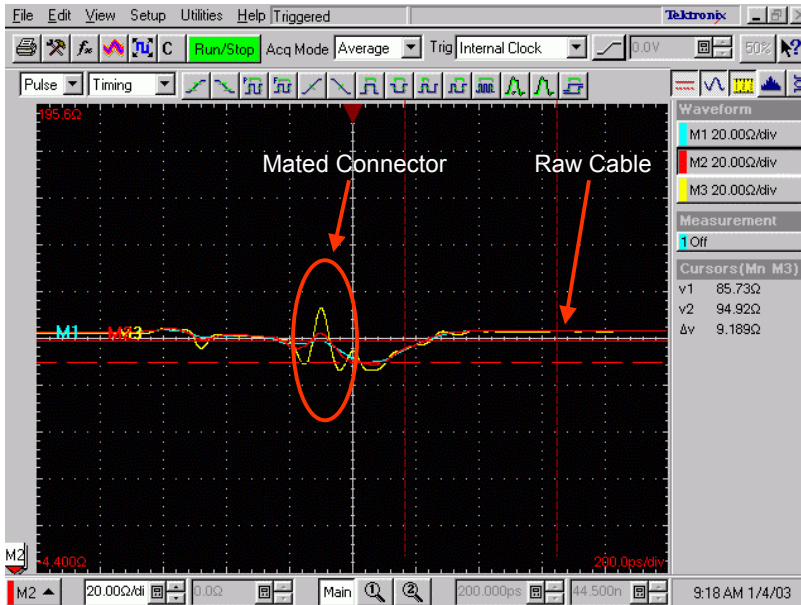


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Differential Impedance Measurement TDR Launch Rise Time

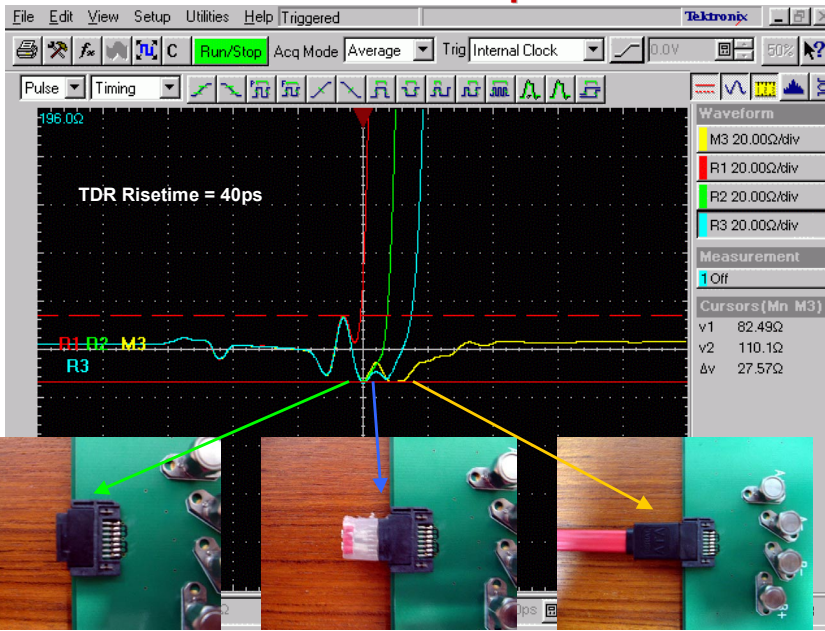


Differential Impedance Measurements Mated Connector & Cable Media Impedance



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Differential Impedance Measurements Mated Connector Impedance



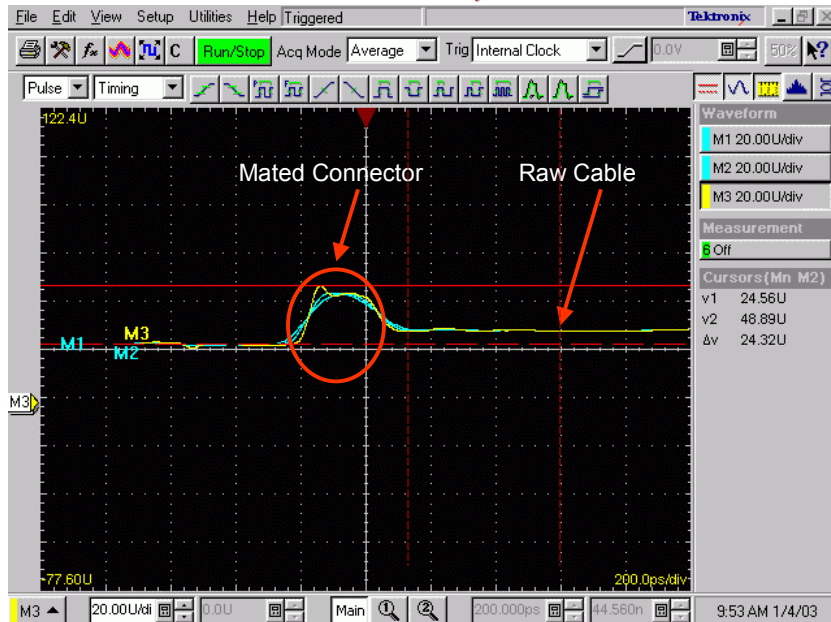
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Differential Impedance Measurements Cable Match Performance at Generation 2



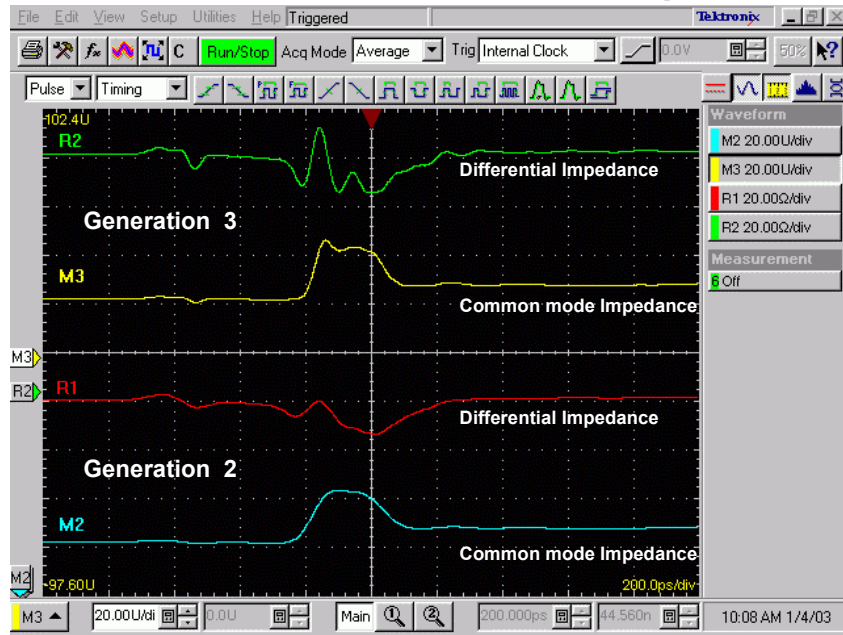
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Common Mode Impedance Measurements Generations 1, 2 and 3



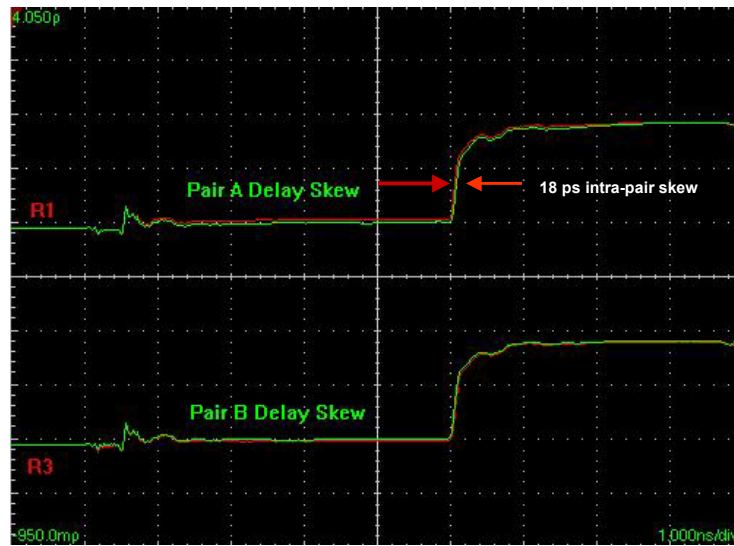
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Differential and Common Mode Impedance



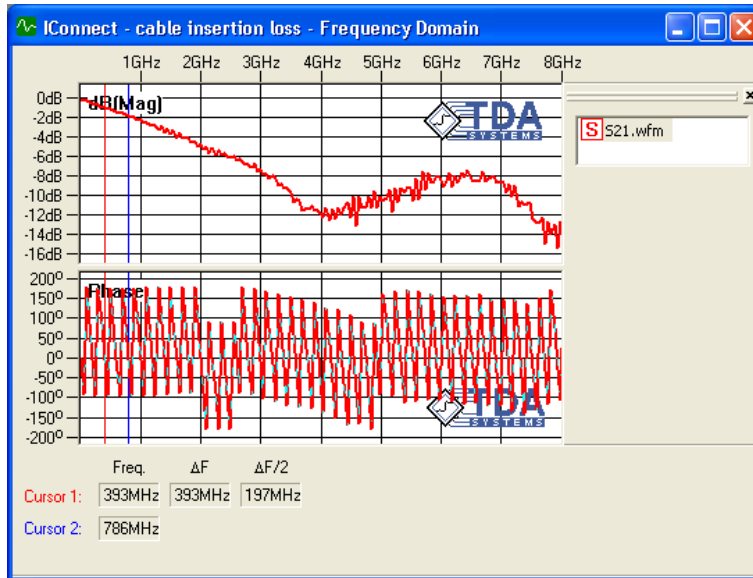
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Intra-Pair Skew Measurements



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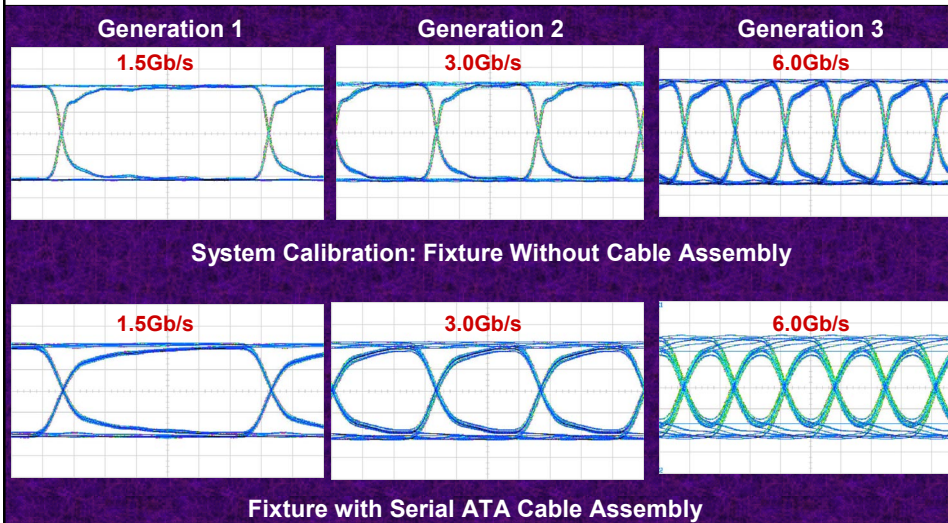
Differential Insertion Loss (S21)



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Eye Pattern Measurements

K28.5 Data Pattern, < 30ps, $V_{in}=800mV$



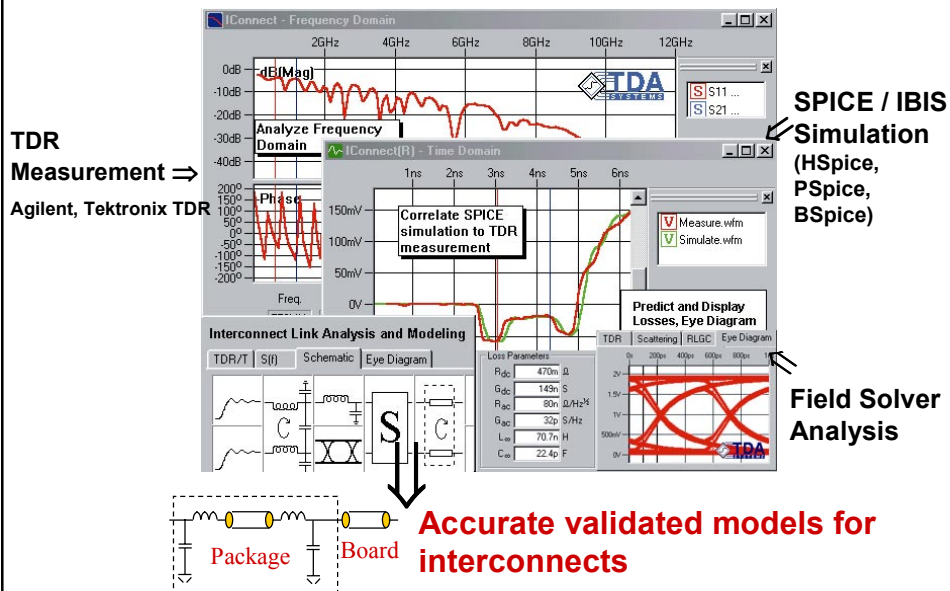
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TDA Systems, Inc. IConnect® Software

- Measure board **impedance** and **propagation delay**
 - Analyze failures, resolve smaller discontinuities
- Predict **eye diagram degradation** using lossy line model and eye-diagram display
- Model **crosstalk** and **jitter** in a differential coupled line
- Model reflections and ringing in a trace on a PCB, including connectors, cables, sockets, packages
- Validate models from field solver using IConnect integrated interface to SPICE simulators
- Analyze losses and resonances using **S-parameter computation**
- Obtain package or connector parasitic

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TDA Systems, Inc. IConnect® Software



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Serial ATA Cable Assembly Modeling Strategy using IConnect®

- **Mated Connector Modeling**
 - Full Coupled Line Model
 - Differential/Common Mode TDR Measurement
 - Odd/Even Mode Responses
 - Predict Connector/Cable Impedances

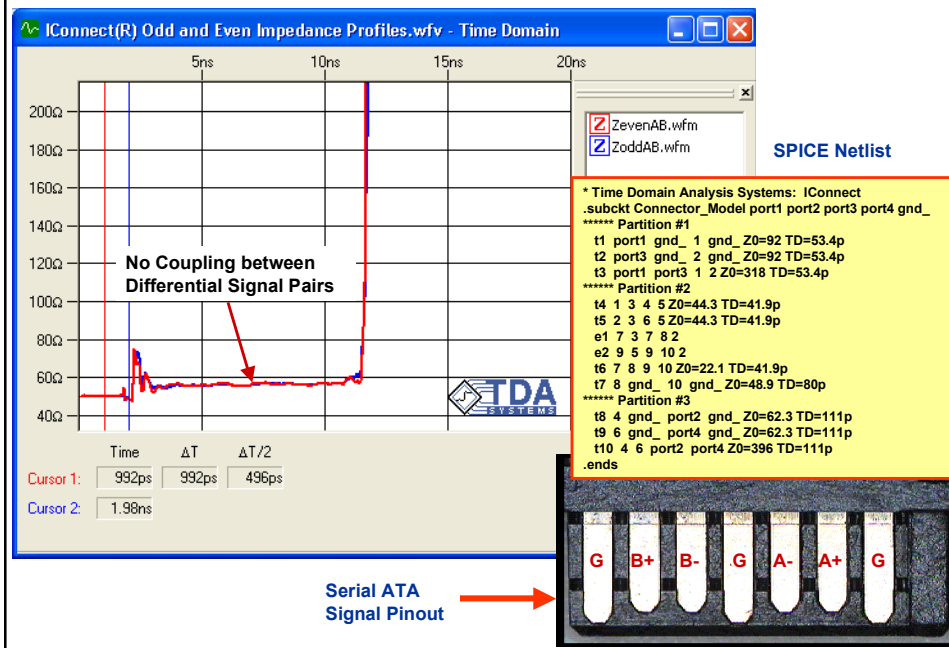
- **Cable Assembly Modeling**
 - Lossy Line Model
 - Differential TDR/TDT Measurement
 - Predict Eye Diagram and Insertion Loss (S21)

- **Composite Model Generation and Simulation**

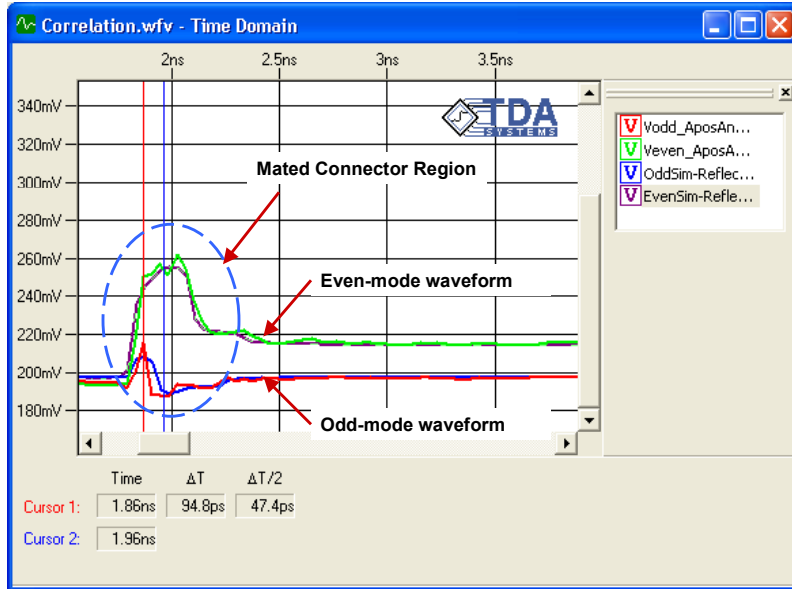
- **Model Verification and Validation**

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Full Coupled Line Connector Model Extraction

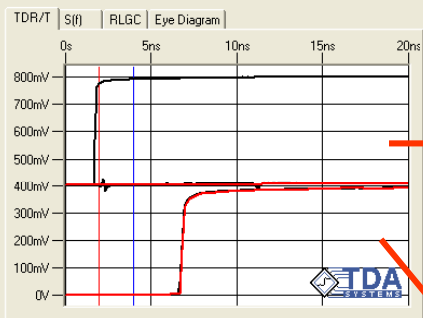


Simulate and Validate Models Odd and Even Mode Responses



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Cable Lossy Line Modeling

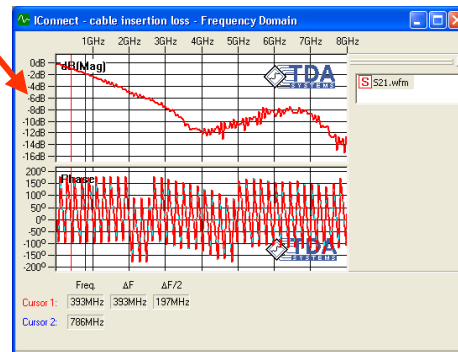


Odd-Mode Model Correlation

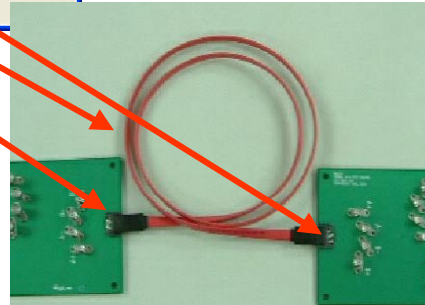
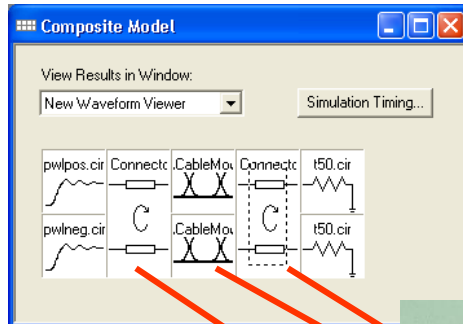
Lossy Line SPICE Netlist

```

.MODEL Lossy_Line_1_Model W MODELTYPE=RLGC N=1
+ Lo=2.5e-007
+ Co=9.97667e-011
+ Ro=1.48
+ Go=0.000224
+ Rs=0.00015
+ Gd=1.06667e-011
    
```

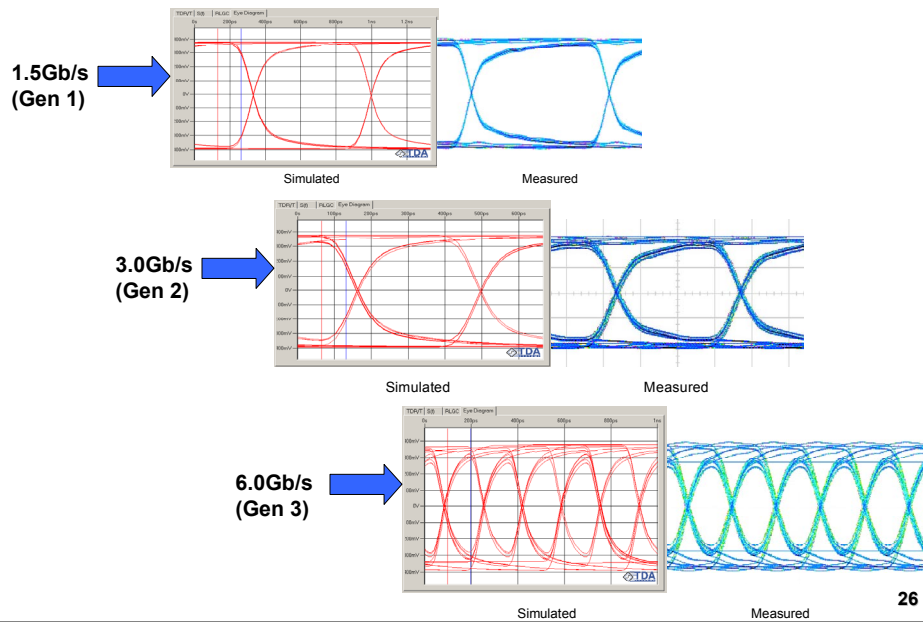


Composite Model Generation



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Model Validation Predicted and Measured Eye Diagrams



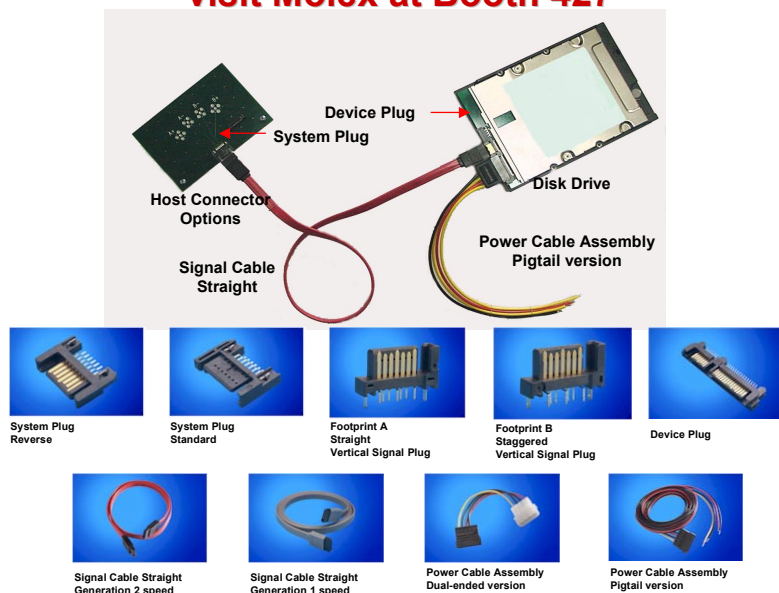
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Summary

- Characterization of Serial ATA Cable for Generations 1, 2 and 3 speeds.
- Conformance of Serial ATA Cable link capable up to Generation 2 speeds.
- Usage of TDA Iconnect Modeling software to extract, model and validate accurate SPICE models of the cable assembly

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**For more information on Serial ATA Solutions,
visit Molex at Booth 427**



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