Paper Session 8 - WA1
Wednesday, February 2nd, 2011
Time: 8:30 AM - 9:10 AM

Novel Transmission Line for 40 GHz PCB Applications

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Outline

- **PMTL™ - Periodic Micro Transmission Lines** (Patents Pending)
- **Electromagnetic Engineered High Speed Transmission Lines**
- **Heaviside Optimal Condition**
- **Development of Advanced Transmission Lines**
- **Measured Data and Validation of PMTL Technology**
  - Rigid Board Stripline to PMTL Comparison
  - Flex PMTL
- **Manufacturing Considerations of the PMTL Design**
- **Summary/Conclusions**

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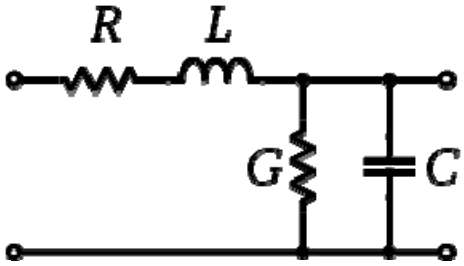
Basis of Design of PMTL™ Using Periodicity

$$\frac{\partial}{\partial x}I(x,t) = -C\frac{\partial}{\partial t}V(x,t)$$
$$\frac{\partial}{\partial x}V(x,t) = -L\frac{\partial}{\partial t}I(x,t)$$

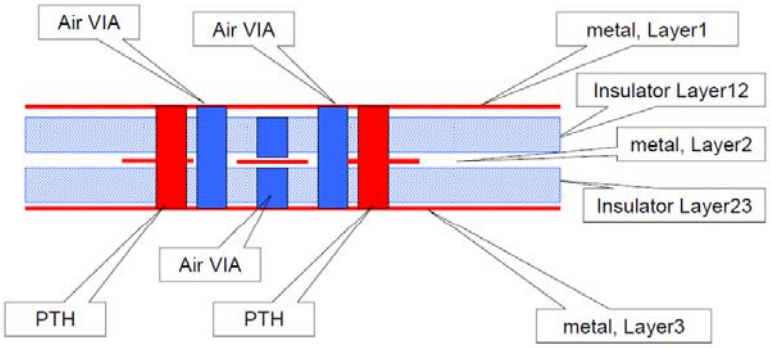
$$\frac{G}{C} = \frac{R}{L}.$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$
$$\nabla \times \mathbf{B} = \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}.$$



One Possible Stack of PMTL™

Stack Information Profile for PMTL SL



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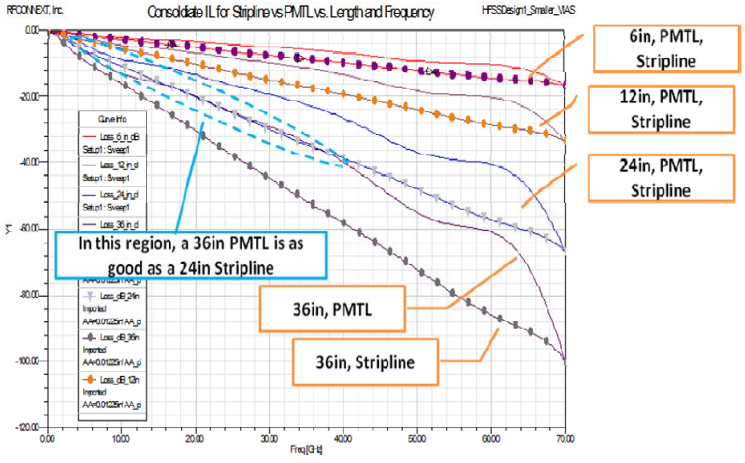
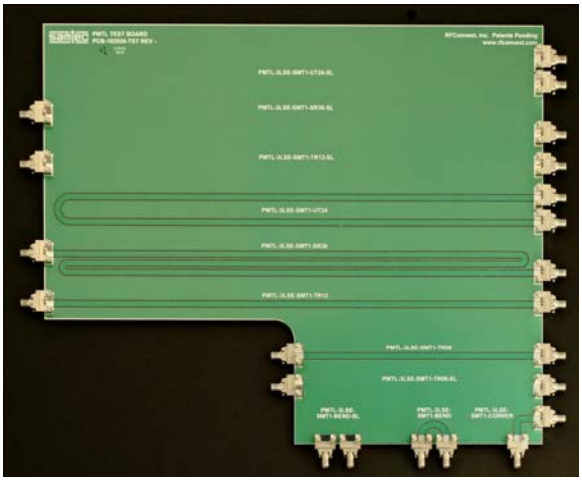
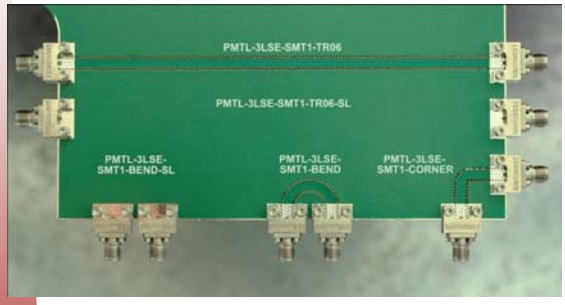
Comparing Loss of Various Lengths of PMTL™ with Stripline - 6”,12”, 24”, and 36”

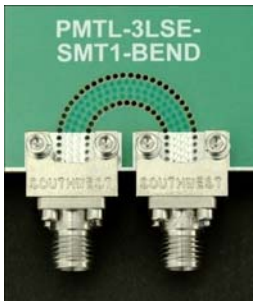


Test Board With 6”,12”, 24”, and 36” PMTL™ and Striplines

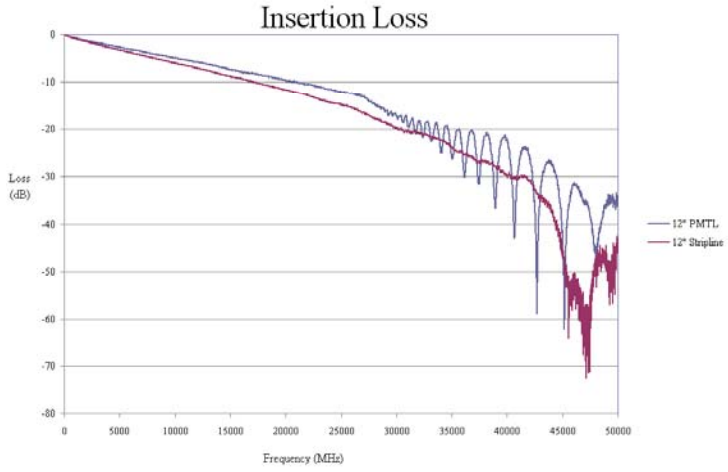


Test Board Containing 6” PMTL and Stripline and Turn Coupon





Measured Insertion Loss of 12” PMTL™ Compared to Equivalent Stripline



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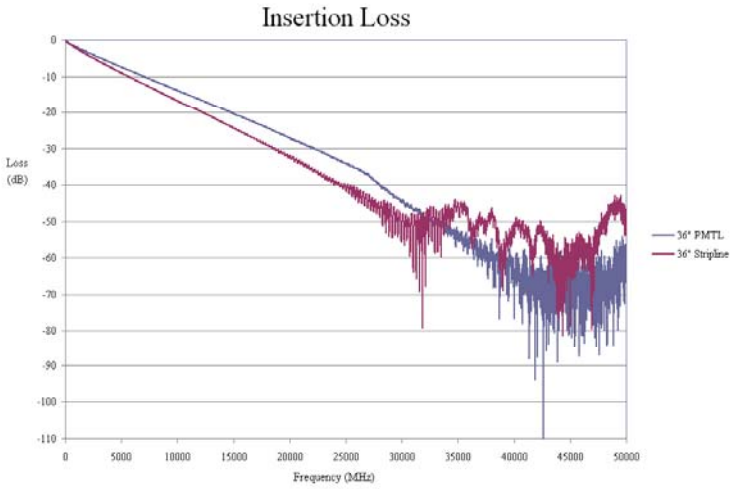
Measured Insertion Loss of 36” PMTL™ Compared to Equivalent Stripline

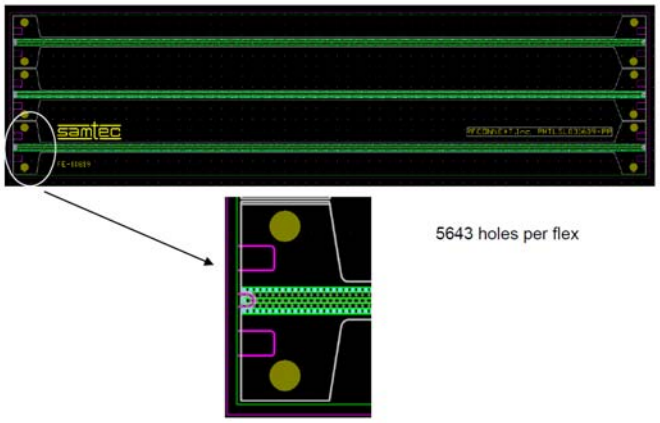


Observations

- **PMTL™ provides lower loss across the bandwidth compared to Stripline.**
- **This advantage is more prevalent at longer lengths and wider bandwidth.**
- **Discrepancies between Measured and Predicted Data are due to ideal assumptions.**
- **A 24” Stripline could be as lossy as a 36” PMTL for DC to 40 GHz.**
- **Lower cost materials can provide better SI/PI performance with PMTL™ technologies.**

CAM Drawing of a PMTL™ High Speed Flex (Patents Pending)

PMTL Design



5643 holes per flex

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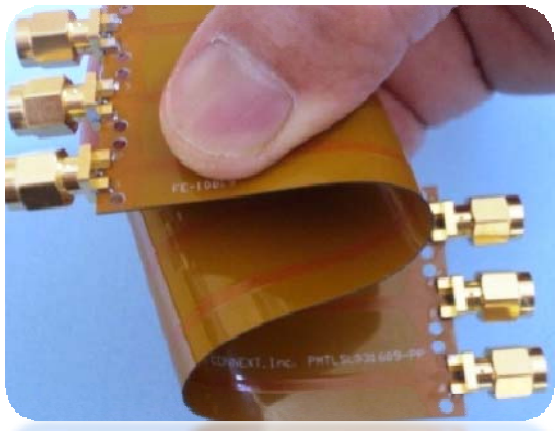
CAM Drawing of a PMTL™ High Speed Flex (Patents Pending)



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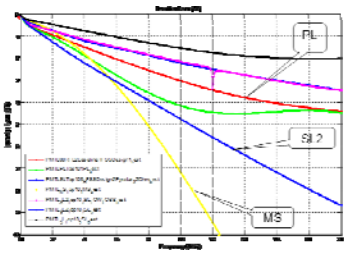
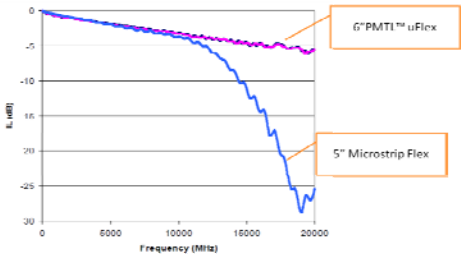
Comparison of PMTL™ Design Prediction and Measured Data





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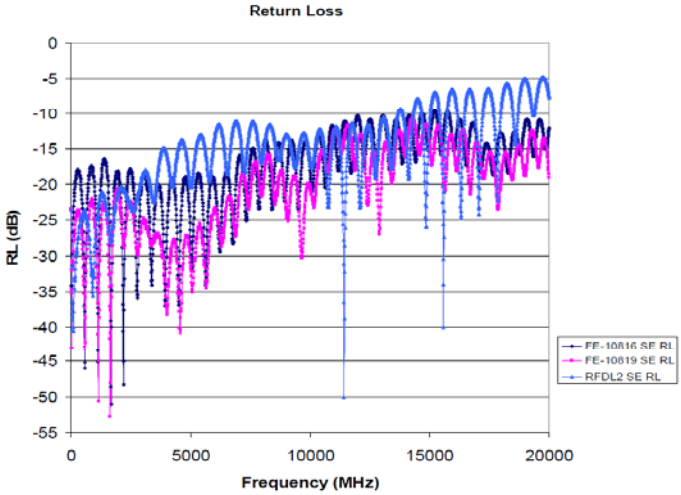
Measured Return Loss of PMTL™ High Speed Flex



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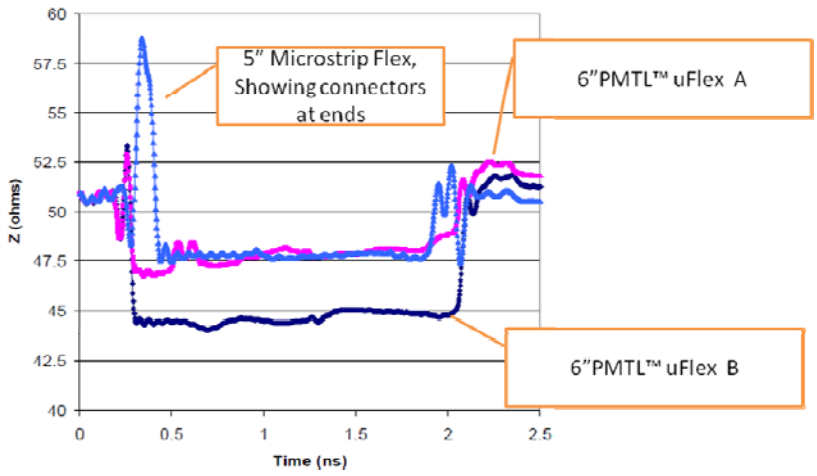
Measured Impedance of PMTL™ High Speed Flex



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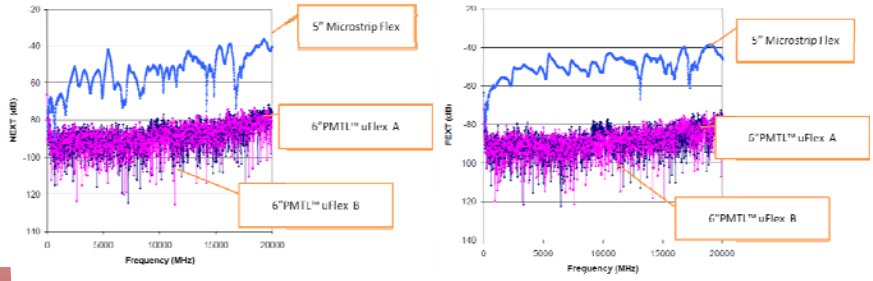
Measured FEXT and NEXT of PMTL™ High Speed Flex



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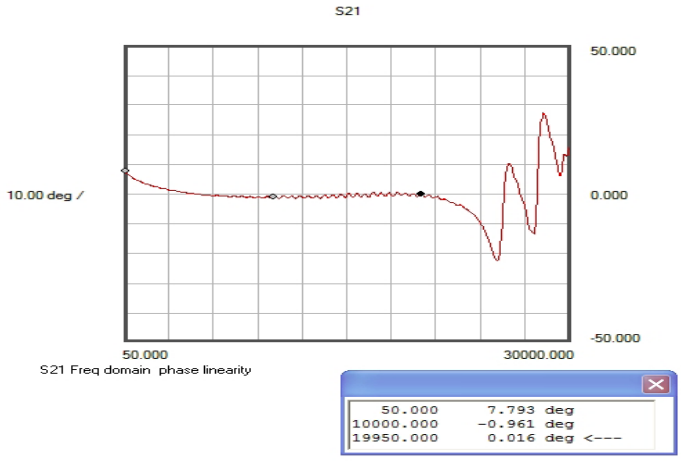
Measure of the Phase Linearity of PMTL™ High Speed Flex



Summary

- **Loss linearity to higher frequencies (no dispersion) due to TEM mode of propagation.**
- **Phase linearity to higher frequencies, thus predictable well defined delay and skew.**
- **Faster propagation.**
- **Lower DK and DF, thus providing lower signal loss.**
- **Less external interference and lower crosstalk.**
- **More consistent impedance.**
- **Improved overall SI/PI.**

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Conclusions

- **100% traditional PCB manufacturing processes.**
- **100% traditional PCB design and layout processes.**
- **DC to 20 GHz, 40 GHz, 60 GHz, and 100 GHz bandwidth.**
- **No need for electrical to optical transceivers, frequency up-converters, or expensive wideband RF amplifiers (DC-50 GHz)**
- **Highly scalable and embeddable into various elements of a high speed interconnect system.**

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