"Materials Issues for Low Skew Close Phase Matching in 25Gbps Differential System Designs"

by

Dr. Edward P. Sayre, P. E.
CTO, North East Systems Associates, Inc.
Mr. Sunichi Maeda, President KEI Systems, Inc.
Mr. Shinji Yoshikawa, Assistant Manager
Asahi-Kasei E Materials

North East Systems Associates, Inc.
9 Maple Lane, PO Box 807
Marshfield, Massachusetts 02050 U.S.A.
Tel: +1.781.837.9088 ❖ Fax: +1.781.837.9083
www.nesa.com

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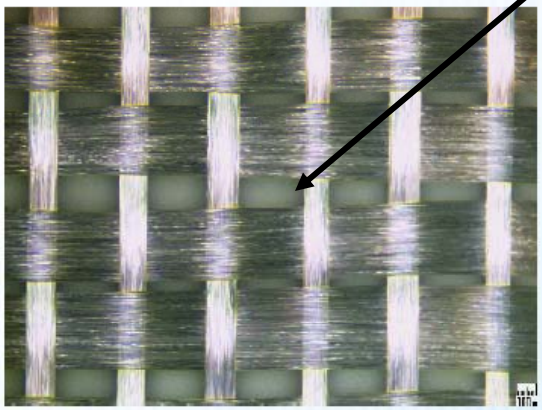
- The issue of material choice for PCB transmission media has vastly complicated by the problem of intra-pair skew in addition to loss mitigation.
- Understanding how these issues impact the economic and technical viability of 25Gbps differential system PCB design choices is the object of this investigation.
- Intra-pair skew affects signal detection, receiver design and EMI emission performance.

Glass Fiber Sample Material Exhibits

- Sample 1: FR-4[1] Resin with open weave 106 Fiber Glass Reinforcement
- Sample 2: PPE[2] Resin with open weave 106 Fiber Glass Reinforcement
- Sample 3: PPE[2] Resin with 1067 Glass Fiber woven, flattened and spread
- Sample 4: PPE[2] Resin with 6048 Glass fiber double knit weave
- Sample 5: PPE[2] Resin with 1037 Glass weave flattened and spread
- Sample 6: PPE[2] Resin with E-Glass filler with 1037 Glass weave flattened and spread

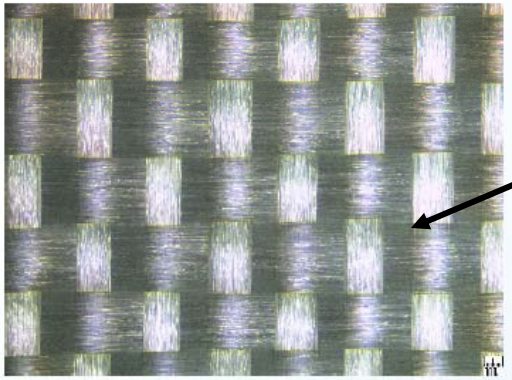
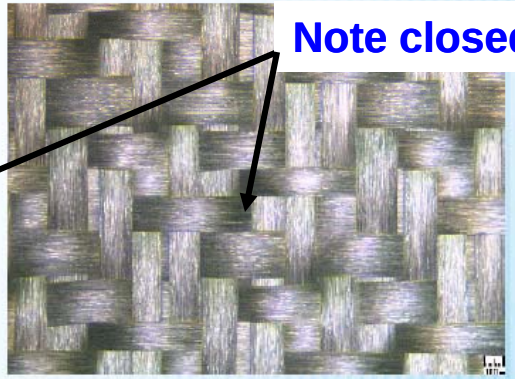
1. **FR-4: Flame Retardant 4, UV stabilized bromated tetrafunctional epoxy resin**
2. **PPE: polyphenylene ether resin**

Conventional Glass Fiber Reinforcement

	Sample 1	Sample 2
Style	#106	
Tickness of G.F.	0.038 mm	
Surface Image		
Resin	FR-4	PPE backbone epoxy

Note open "basket weave spaces

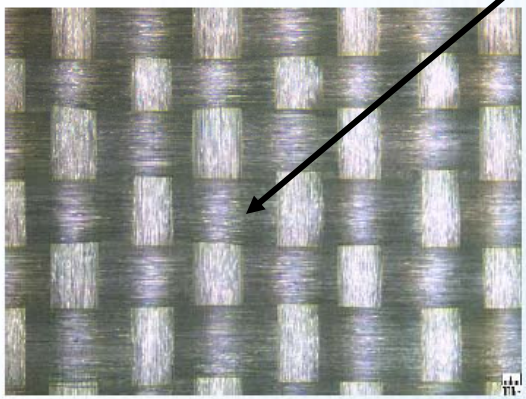
Glass Fiber Woven, Flattened and Spread Glass Fiber Double Knit Weave

	Sample 3	Sample 4
IPC Style	#1067	(6048)*
Tickness of G.F.	0.032 mm	0.030 mm
Surface Image		
Resin	PPE backbone epoxy	

Note closed spaces

*Developmental style

Test Samples 5 & 6 Glass Cloth Reinforcement with and without E-Glass filler

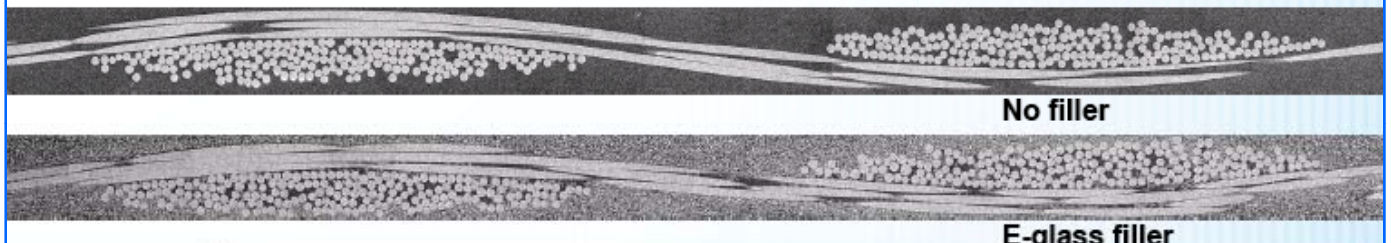
	Sample 5	Sample 6
IPC Style	#1037	#1037 + E-Glass Filler*
Tickness of G.F.	0.027 mm	
Surface Image		
Resin	PPE backbone epoxy	

Note spread fibers and flattened weave

*Developmental material

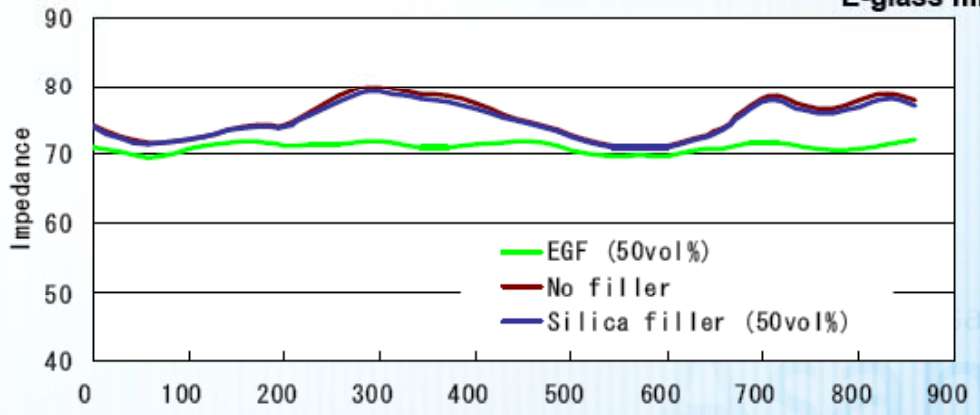
E-Glass Filled Material: Uniform Dielectric Density in X-Y-Z Directions

Excellent mechanical properties, CTE, and drilling ability
Uniform dielectric constant and via hole by laser drilling
Excellent insulation reliability by special finishing



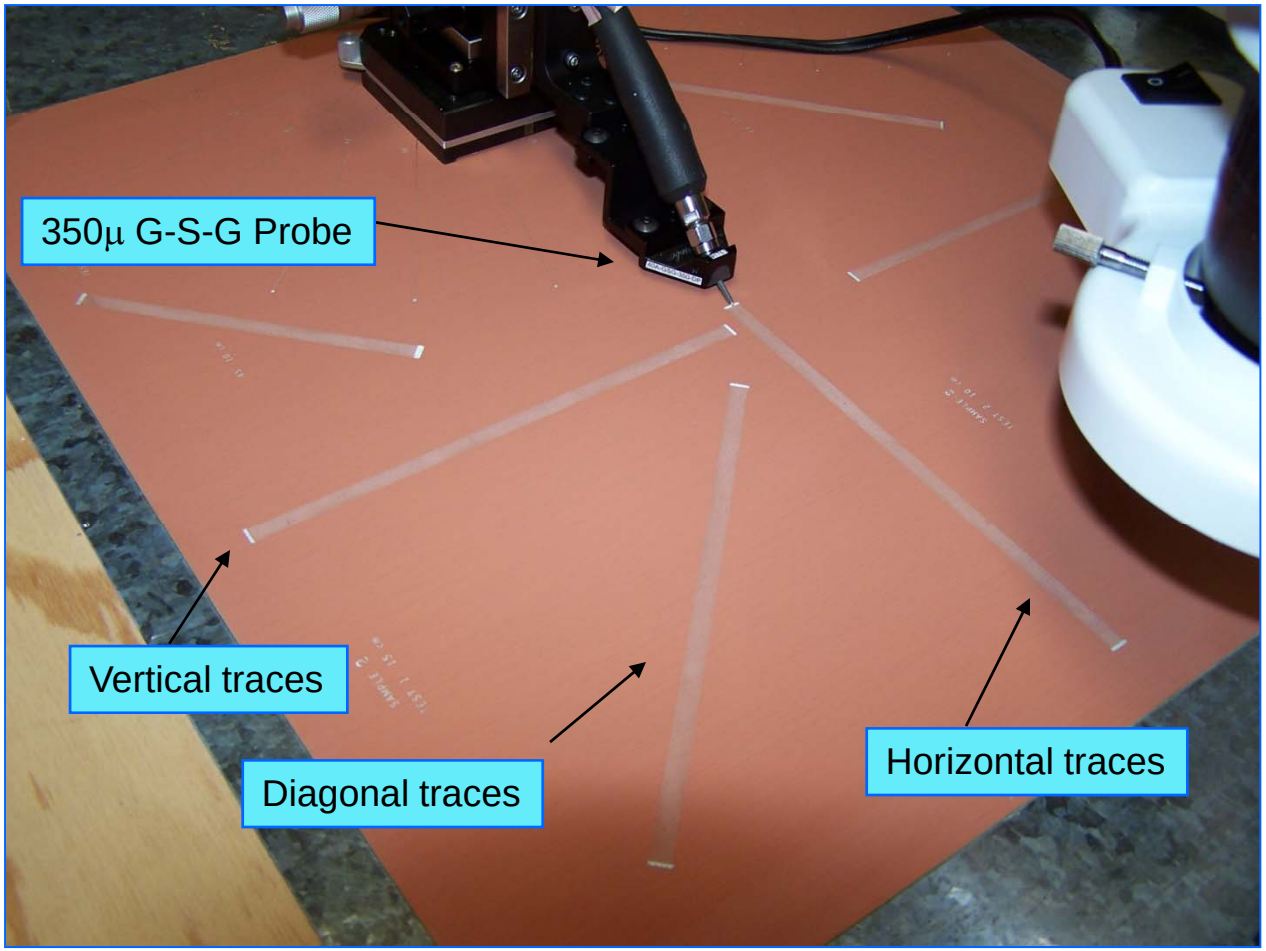
No filler

E-glass filler



Impedance distribution (simulation)

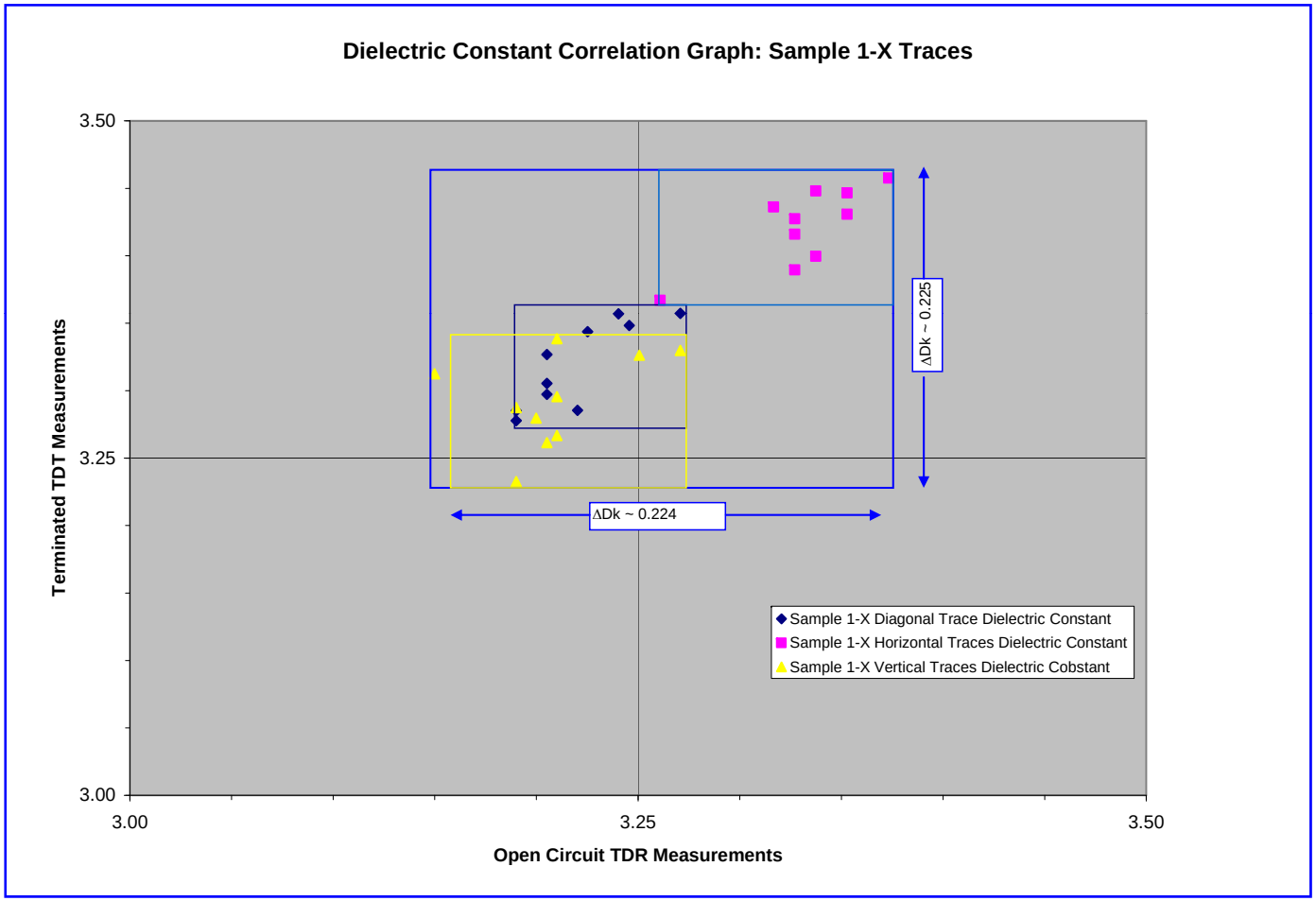
TDR Probe Set-up for 15 cm Trace Measurements



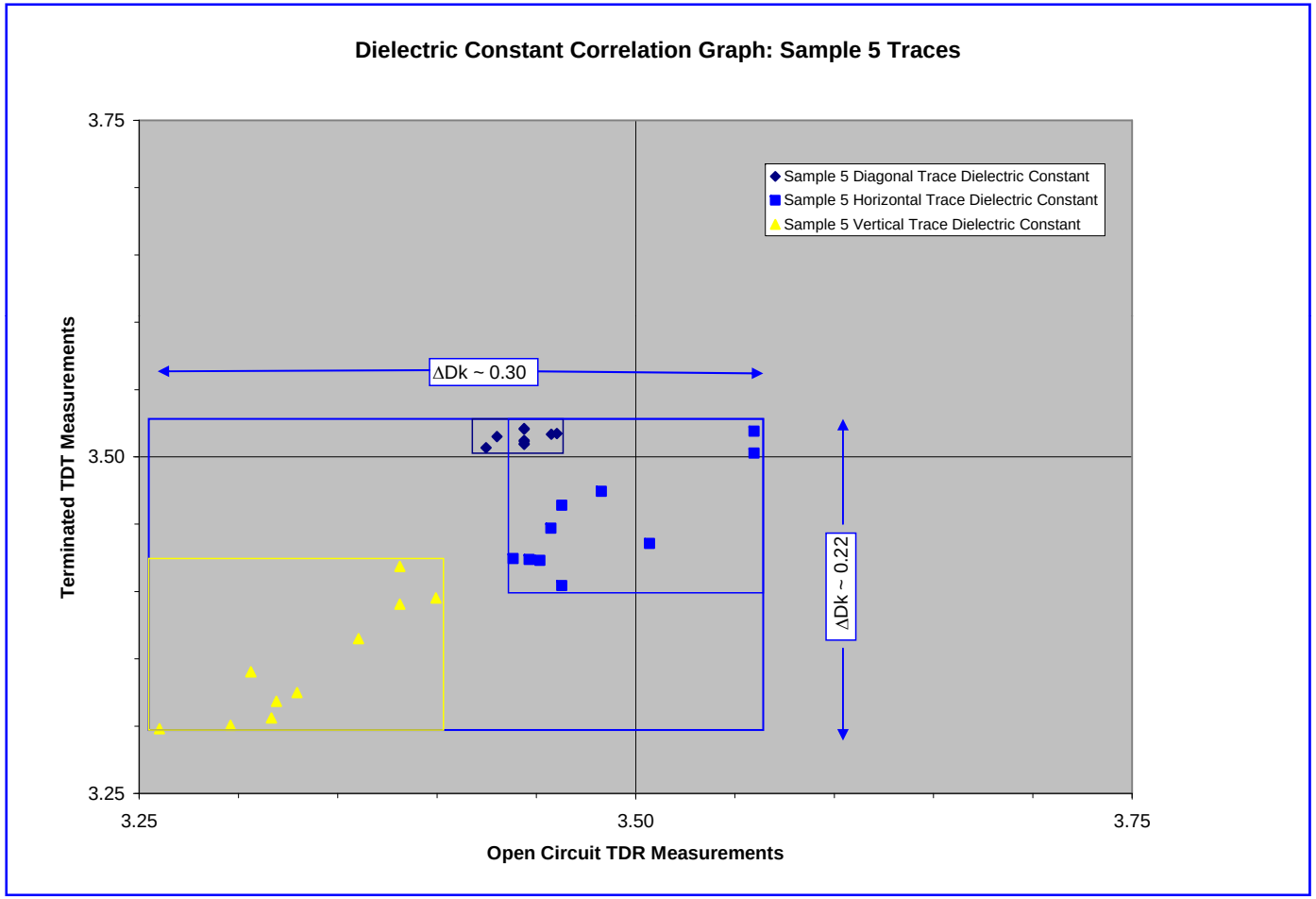
Data Analysis

- Data for a specific sample and sets of traces on the sample are measured and entered into a spreadsheet.
- The data is analyzed to determine the relative dielectric constant Dk. Statistical correlation is determined by usual and customary means.
- Dk data is plotted visualized on correlation charts to assess the data relationships between the horizontal, vertical and diagonal trace results.

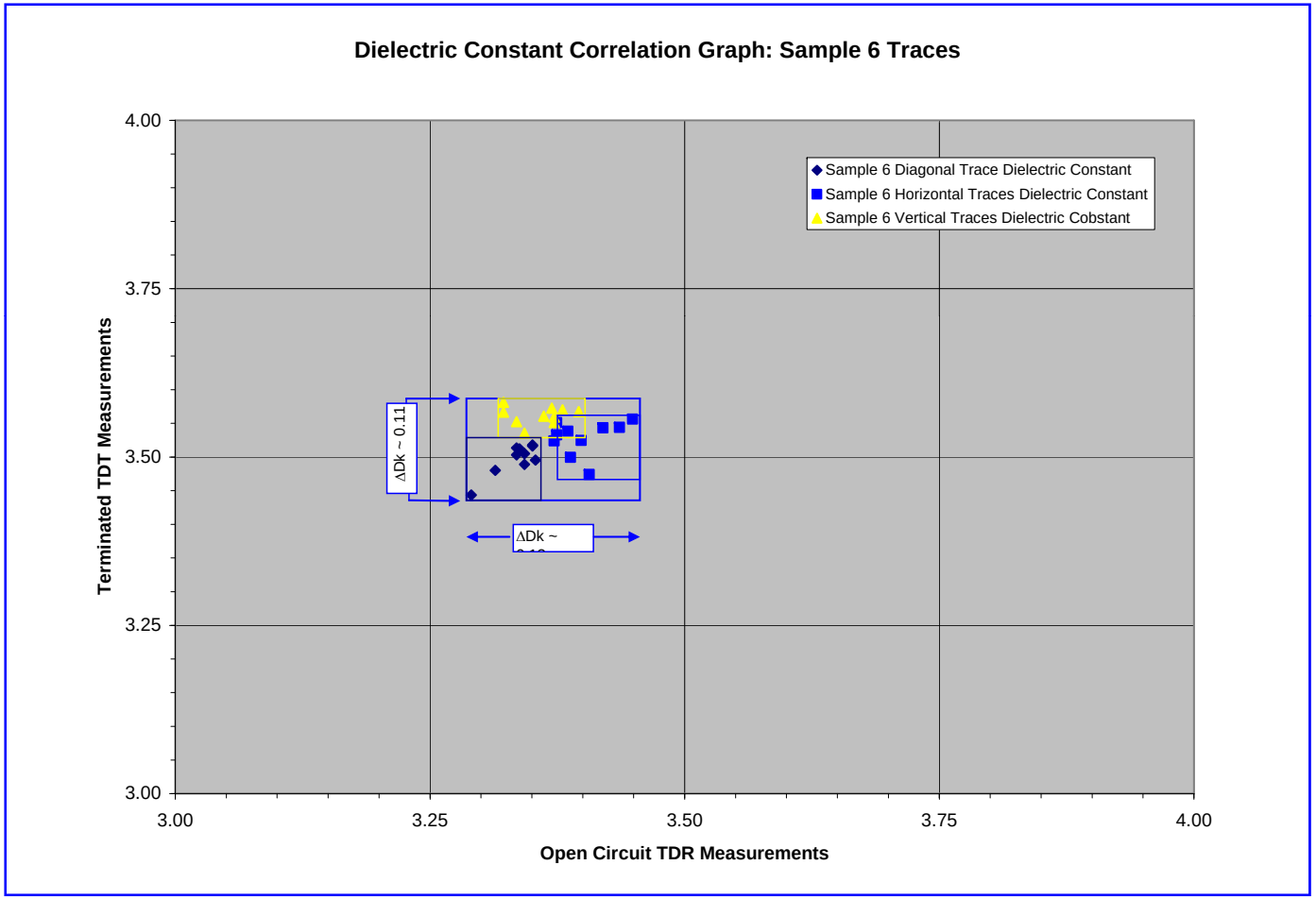
Dk Correlation: FR-4 E-Glass + Conventional Resin



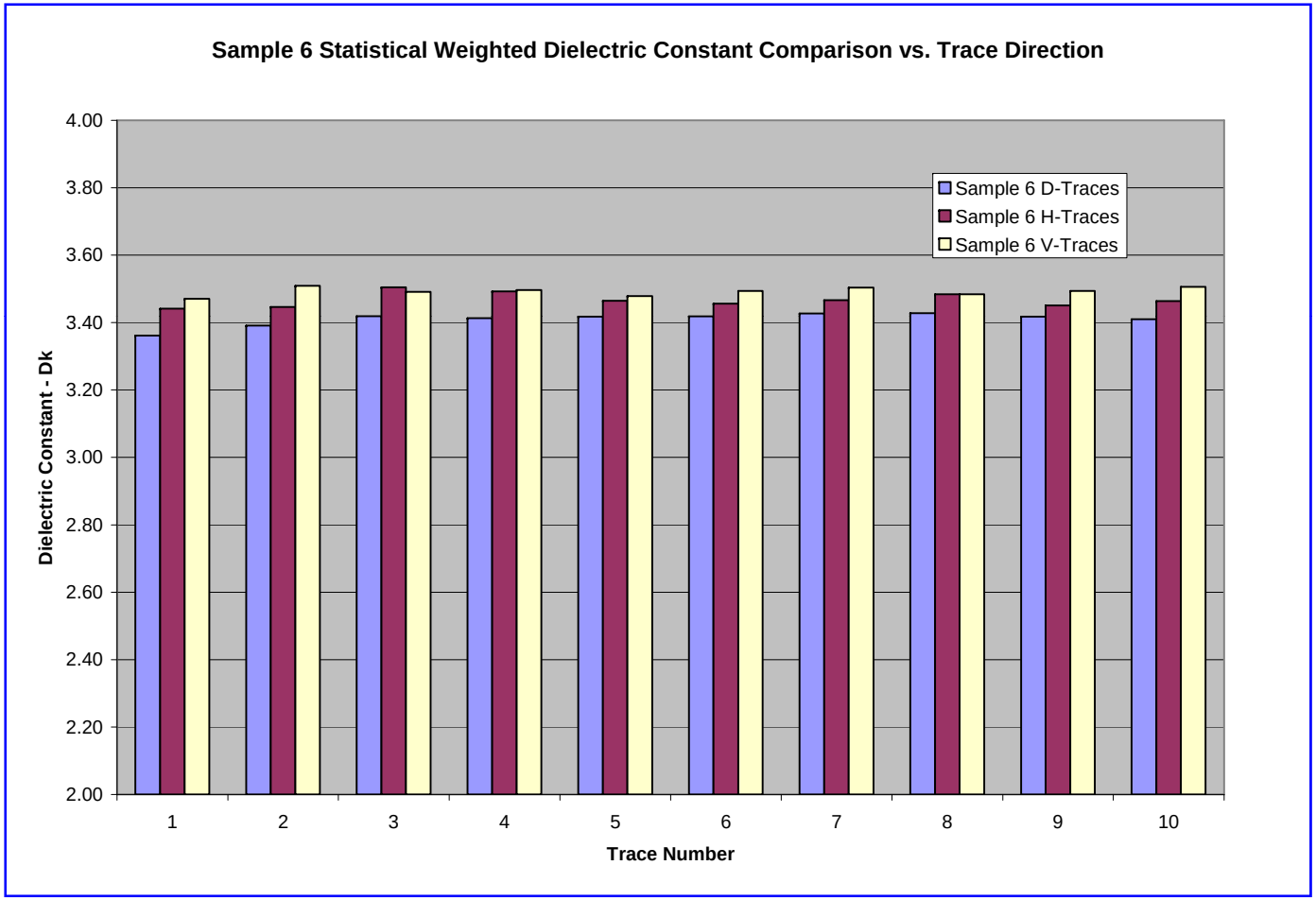
Dk Correlation: Flattened Fibers, No Glass in Resin



Dk Correlation: Same Glass Fibers with Glass Filled Resin



Composite Dielectric Constants: Sample 6



Summary

- Six PCB dielectric samples fabricated using different materials and more important different glass fiber weave styles and processing techniques.
- The methodology used two reliable time domain methodologies to determine the dielectric constant Dk and propagation performance.
- Samples 3, 4 and 6 are clearly the best materials with respect to dielectric constant Dk vs. direction.
- Samples fabricated using open basket weave 106 glass cloth show the greatest variation of Dk with direction.
- Overall, Samples 3 and 4 have the best propagation delay performance and offer the best low skew close phase matched performance.