iNEMI®

International Electronics Manufacturing Initiative

HFR-Free Signal Integrity Initiative

Advancing manufacturing technology

Overview 概况

Mission: Define and gain industry consensus on the electrical requirements of HF dielectrics ensuring suitability for high-speed digital designs 使业界对无卤电介质的电性能要求达成一致，保证高速数字信号的设计。

Scope:

- ✓ Develop and communicate the HF dielectric requirements to the PCB material suppliers **to drive volume up and cost down**和PCB材料供应商沟通并制定无卤电介质的需求，追求大批量低成本
- ✓ Gain critical mass by gaining participation from the enough of the market to ensure the message is strong enough to influence the material suppliers 得到业界充分的参与，有足够的市场份额，以保证对材料供应商的影响足够大。

Mechanism: iNEMI SIWG kicked off Feb. 18 2009, with bi-weekly meetings

Problem 问题

The critical electrical properties of available halide free dielectrics make high-speed bus design problematic without increasing the cost of the system

现有的无卤电介质的电性能，在不增加系统成本的情况下对高速总线设计造成很大问题。

Critical Electrical Parameters: Permittivity介电常数

Influences: Permittivity (also known as D_k, ε_r, or dielectric constant) dictates …

- Impedance 阻抗
- Crosstalk 串音干扰
- Propagation velocity 传播速度

Problem: D_k of widely available halogen-free dielectrics is too high

- Typical FR4 w/ 1080 glass: ~3.6<D_k<3.9
- HF FR4 w/ 1080 glass: ~4.2<D_k<5.2 (iNEMI data)

Impact on bus design:

- Increased crosstalk 串音干扰的增加；
- Reduced bus performance降低总线性能；
- More expensive designs (more layers to compensate for crosstalk) 更贵的设计方案（为弥补串音使用更多层数）

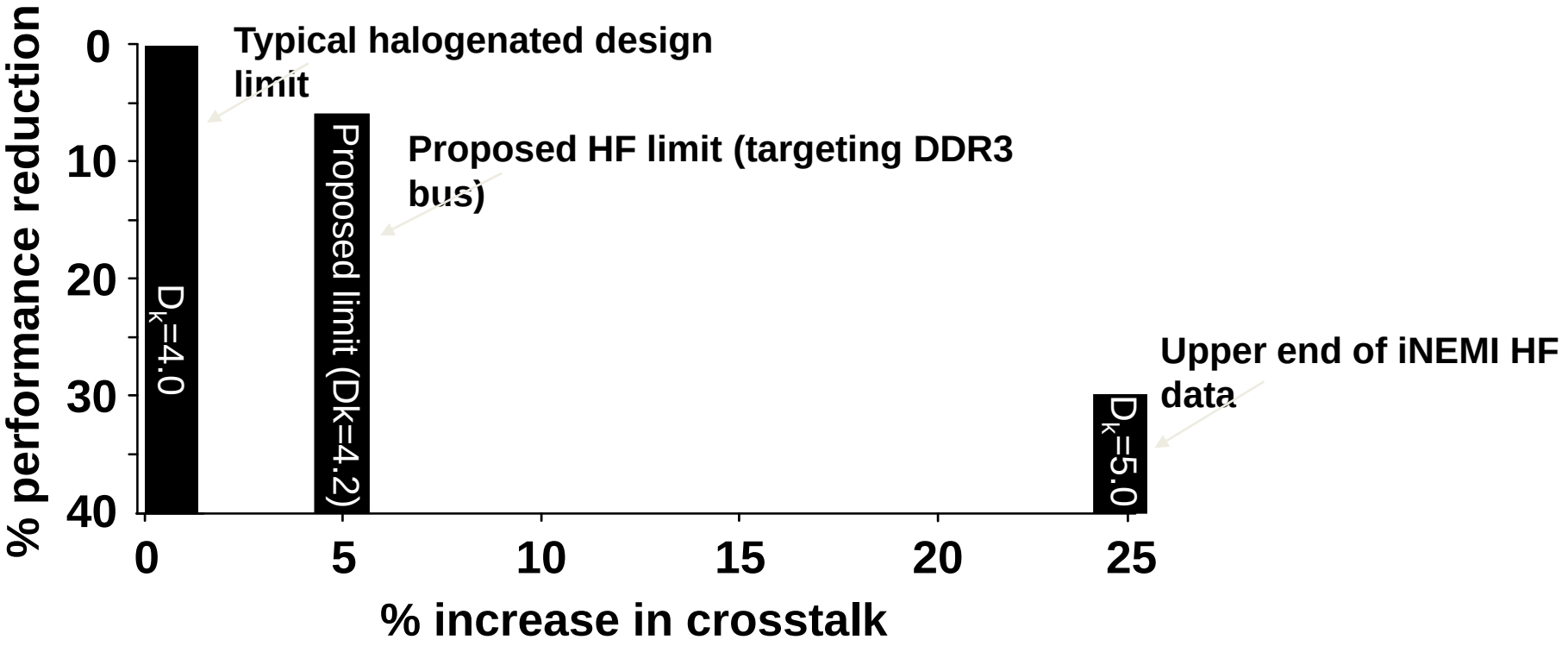
Critical Electrical Parameters: Permittivity介电常数

Goal: Limit the halogen-free D_k to ensure suitability for high-speed bus design限制无卤材料的Dk以适应高速总线设计

- ✓ **Achieving the same impedance with higher permittivity dielectric requires …**
  - **Thicker dielectric layers**
    - Leads to more crosstalk
  - **Narrowed trace widths**
    - Impractical: Many PC bus designs already designed with (or close to) minimum trace widths
- ✓ **Margin recaptured by spreading signals apart**
  - **Often requires more layers (PC designs tend to be maximally real-estate constrained)**

Critical Electrical Parameters: Permittivity介电常数

Margin reduction due to crosstalk @ 2 Gbits/s



Avoiding cost dictates reducing D_k

避免成本对降低介电常数Dk的支配

Critical electrical parameters: Loss Tangent 介电损耗

Influences: Loss Tangent (also known as (D_f or tanδ) dictates Signal attenuation 介电损耗决定着信号的衰减

- Dissipates energy as heat 能量变成热量而消散；
- Water absorption increases D_f 吸水性增加了介电损耗Df
  - As much as 50% for 1080 FR4（**1080 FR4 材料约50%**）

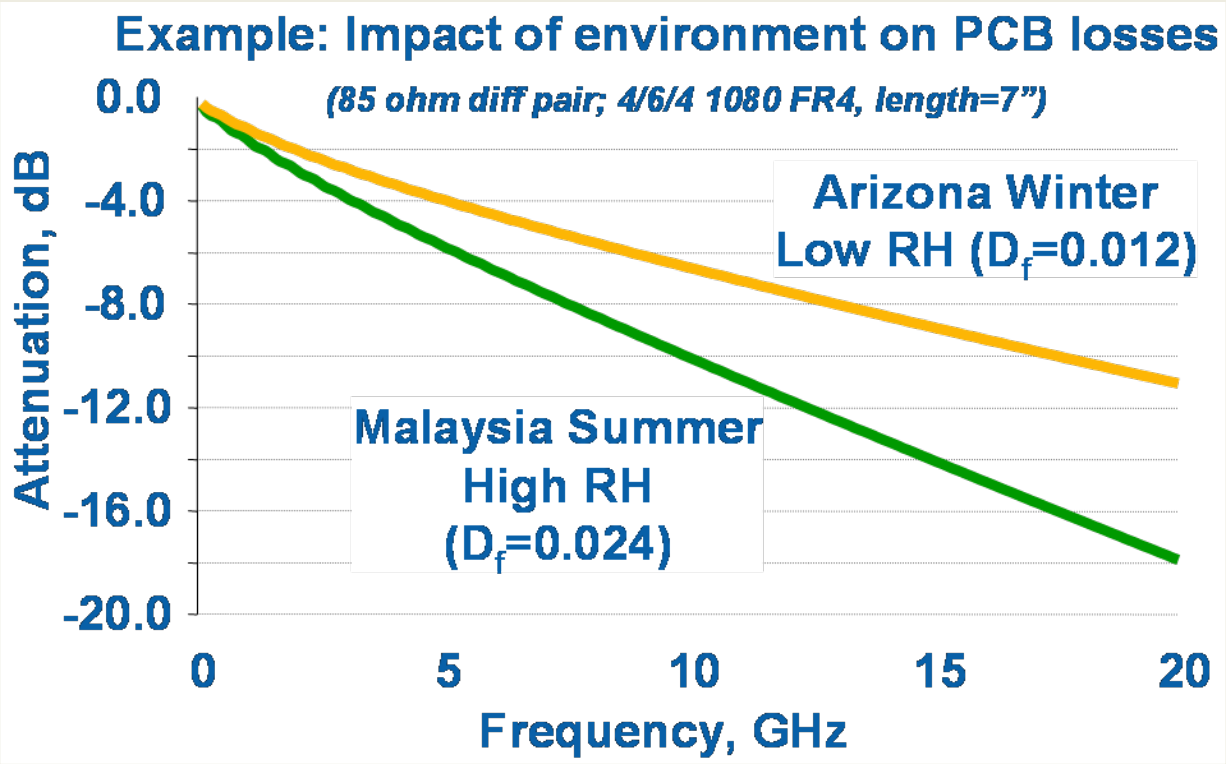
Problem: None so far …

- FR4 with 1080 glass shows a ~50% increase in D_f from nominal to humid environments
- Initial testing indicates halogen-free D_f is smaller than typical halogenated materials
- Some Halogen-free materials may absorb more water which degrades D_f

Impact on bus design:

- Lower D_f = higher margin (generally) 低Df介电损耗 = 高边界空间（通常来说）
- In some cases, lower D_f can hurt signal integrity because reflections are not critically damped 某些情况下，低Df可能对信号完整性造成损害，因为反射信号不能大幅度被衰减；

Critical electrical parameters: Loss Tangent



The loss tangent needs to be assessed at dry and humid environmental conditions to account for moisture

评价介电损耗要考虑到湿度影响，在干燥和潮湿的环境条件下进行

Goals:

- ✓ **Assess D_f limits to ensure suitability for high-speed bus design**
- ✓ **Ensure water absorption does not increase D_f more than typical halogenated materials**

Critical electrical parameters:

High Volume Manufacturing (HVM) Variation

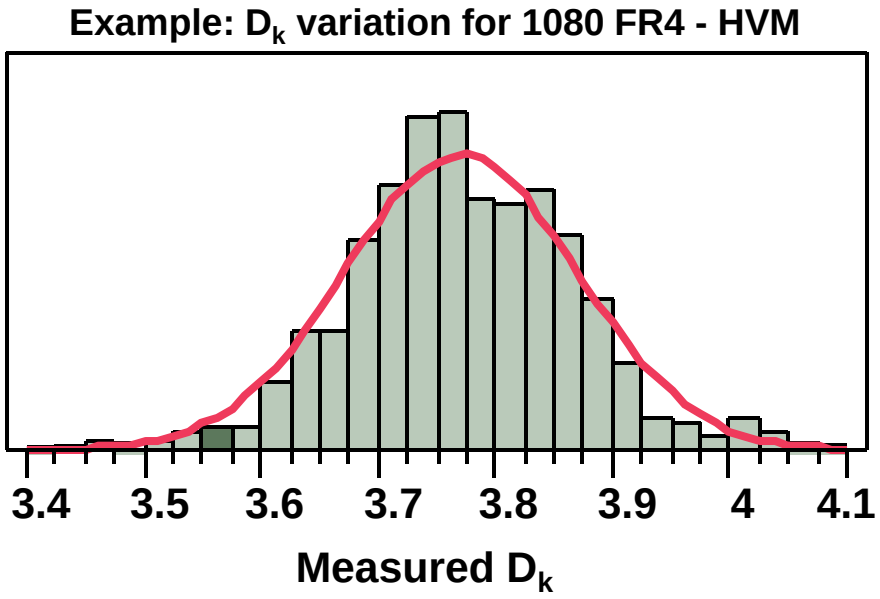
Goal: Make sure High Volume Manufacturing variations are equal to or better than typical halogenated materials (D_k, D_f)

Influences:

- Impedance variations
- Crosstalk variations

Impact on bus design:

- Higher D_k variations translates into looser impedance tolerances & lower bus performance



Parameter Limits参数的限定范围

	Handheld	Mobile	Desktop	Server	Telecomm
Dk					
Df					
Moisture (in terms of Dk & Df limits w/ temp & RH)					
HVM Variation (Dk,Df)					

Parameter input should be sent to Jim Arnold of iNEMI

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Summary 总结

- The key parameters have been identified已识别了关键的参数；
- The test method and structures will be tackled next接下来将研究定义测试方法和结构
- Member expectations include对项目成员的期望包括
  - Complete in-house design work to identify what parameter limits you need 完成自己的设计工作判断你需要怎样的参数限定范围
  - Compare your limits against material characterization data比较你的限定范围和材料性能数据间的差异
  - Identify where design changes can't compensate for material properties so that material changes can be driven找出哪些地方不能通过改变设计来达到对材料属性的弥补，以便促使改变材料