Bringing Forward the Dk & Df Algebraic Model (v1.01)

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IEEE - Nov. 2011

Overview

- Quick look at algebraic tool
- Tool to fill a gap
- Looking forward

Algebraic Tool – v1.01

- Action item from Sept. meeting:
  - available online
  - Information: http://www.ieee802.org/3/bj/public/nov11/goergen_01_1111.pdf
  - Tool: http://www.ieee802.org/3/bj/public/nov11/goergen_02_1111.xlsm
- Created in MS Excel '07
  - Haven't tried in earlier version
  - Need to enable/trust macros
    - Go to  , click Excel Options (at bottom of menu) >> Trust Center >> Trust Center Settings >> Macro Settings

Algebraic Tool – v1.01

- Conductor and dielectric loss ONLY in v1.01
  - NO SURFACE ROUGHNESS
  - No via, connector, reflection, or xtalk penalty… yet.
- Use graph comparison with grain of salt
  - Uses same design (trace width, diel. height, etc)
    - Z_0 will be different -> not fair comparison?
  - KR IL limit – Amax may be better comparison
- No secret sauce (see information document: goergen_01_1111)
- Not 2D/3D simulator… not trying to be

Filling a Gap

- Inconsistent losses seen
  - Improved FR4:
    - 38.2dB loss for 40in and 2 connectors (beukema_01_1111)
    - 1.04dB/in w/o surface roughness (kipp_01_1111, originally goergen_01_0911)
  - Megtron6:
    - 0.9dB/in (ghiasi_01_1111)
    - 0.65-0.68dB/in (kipp_01_1111)
    - 30.2dB for 1m and 2 connectors (meghelli_01_0911, originally patel_01_0911)
  - Even within algebraic tool (continued on next page)
  - Understandable, but difficult to work together
- The Algebraic Tool helps us talk the same language
  - If you take a loss number/plot from the tool,

    expect to show Dk, Df, w, b, t, and L

Algebraic Tool v1.01 – Improved FR4 with tolerances

Remember goergen_01_0511:

Definition: "Improved FR-4" as defined by IEEE P802.3ap

- Improved FR-4 (Mid Resolution Signal Integrity):
  - 100Mhz: Dk ≤ 3.60; Df ≤ .0092
  - 1Ghz: Dk ≤ 3.60; Df ≤ .0092
  - 2Ghz: Dk ≤ 3.50; Df ≤ .0115
  - 5Ghz: Dk ≤ 3.50; Df ≤ .0115
  - 10Ghz: Dk ≤ 3.40; Df ≤ .0125
  - 20Ghz: Dk ≤ 3.20; Df ≤ .0140
- Temperature and Humidity Tolerance (0-70degC, 10-90% non-condensing):
  - Dk:+/- .04
  - Df: +/- .001
- Resin Tolerance (standard +/-2%):
  - Dk:+/- .02
  - Df: +/- .0005

Imp. FR4 – low tolerances

Material/Design Characteristics	
Length (inch)	40
Trace Width (mil)	6
Cu Thickness (mil)	0.67
Diel. Thickness (mil)	13.6

Freq	Dk	Df
1.00E+08	3.54	0.0077
1.00E+09	3.54	0.0077
2.00E+09	3.44	0.01
5.00E+09	3.44	0.01
1.00E+10	3.34	0.011
2.00E+10	3.14	0.0125

Imp. FR4 – typical

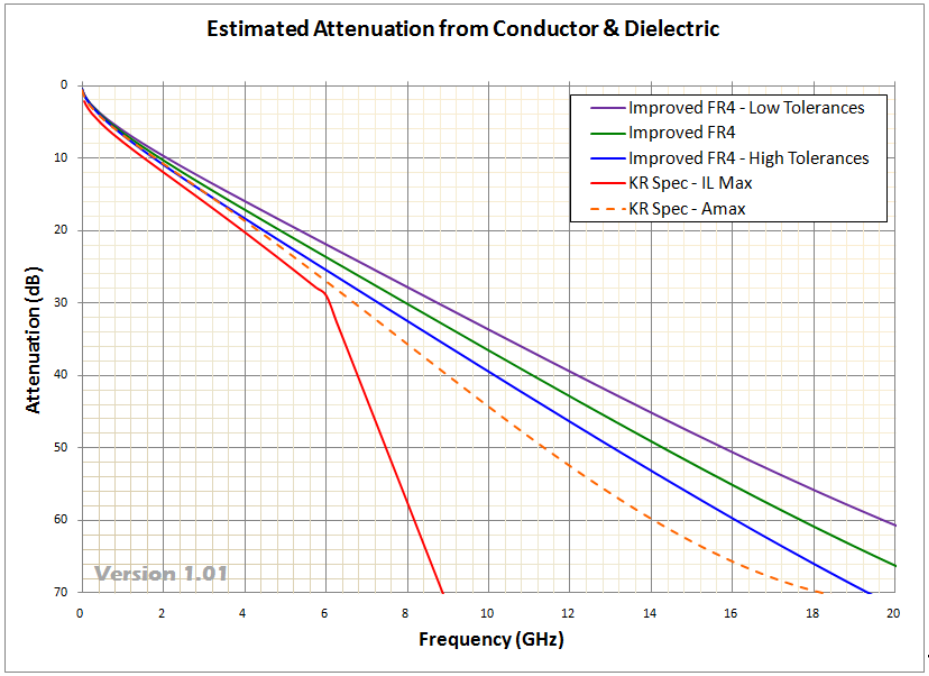
Material/Design Characteristics	
Length (inch)	40
Trace Width (mil)	6
Cu Thickness (mil)	0.67
Diel. Thickness (mil)	13.6

Freq	Dk	Df
1.00E+08	3.6	0.0092
1.00E+09	3.6	0.0092
2.00E+09	3.5	0.0115
5.00E+09	3.5	0.0115
1.00E+10	3.4	0.0125
2.00E+10	3.2	0.014

Imp. FR4 – high tolerances

Material/Design Characteristics	
Length (inch)	40
Trace Width (mil)	6
Cu Thickness (mil)	0.67
Diel. Thickness (mil)	13.6

Freq	Dk	Df
1.00E+08	3.66	0.0107
1.00E+09	3.66	0.0107
2.00E+09	3.56	0.013
5.00E+09	3.56	0.013
1.00E+10	3.46	0.014
2.00E+10	3.26	0.0155



- Imp FR-4 definition does ***not*** account for surface roughness or design
- It is premature to assume a loss/m

Looking Forward

- Understand variations in insertion loss
  - Manufacturing differences
  - Trace width variation, even if Z_0 is the same
    - Simple experiment shows ~0.2dB/in variation at 12.9G for 50ohms just by going 6mil width -> 10mil width
  - Foil roughness
- Spend time on the tool
  - E-mail with questions: edonnay@cisco.com
  - Next version includes surface roughness, multi-board abilities, and likely to include connector loss
    - To be presented on conf. call by early Dec.
- Build consensus on assumptions/loss
  - Do not forget cost implications – not included in tool