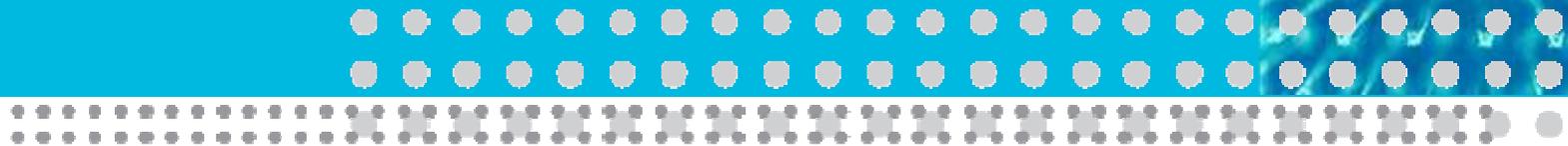
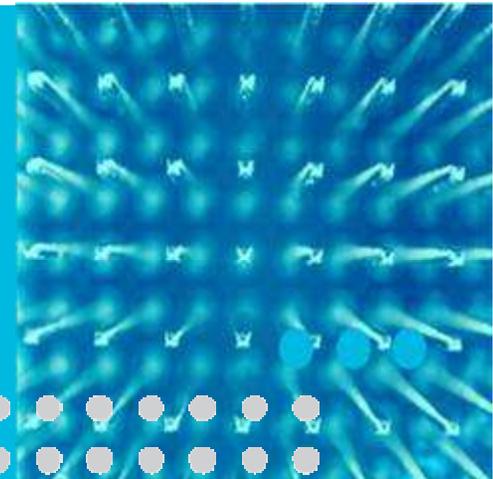




A System's Perspective: Connectivity Applications

December 18, 2014



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Agenda

- P802.3bs Objectives
- System Applications
- Reach vs IL
- Trade Offs
- Q&A

P802.3bs Objectives

Provide physical layer specifications which support link distances of:

- At least 100 m over MMF
- At least 500 m over SMF
- At least 2 km over SMF
- At least 10 km over SMF

	< 50mm/2.0in	XSR C2EO	4dB@14GHz 8dB@28GHz
	< 200mm/7.9in	VSR C2M	10dB@14GHz 20dB@28GHz
	< 500mm/19.7in	MR C2C	20dB@14GHz 40dB@28GHz

* From goergen_03_1024_elect.pdf

System's Applications

- Speed has quadrupled but connectivity reaches are the same
- ▶ **Product breadth**
 - ▶ Generally a system vendor has numerous product families across product portfolio
 - ▶ Switching – low-end access to high-end core
 - ▶ Routing – low end access to high-end core
 - ▶ Transport – low-end access to high-end core
 - ▶ Server – low-end server to high-end blade server
- ▶ **Applications / Products – lots of different types**
 - ▶ High-end, mid, low-end
 - ▶ Different capacities to support
 - ▶ Different cost targets

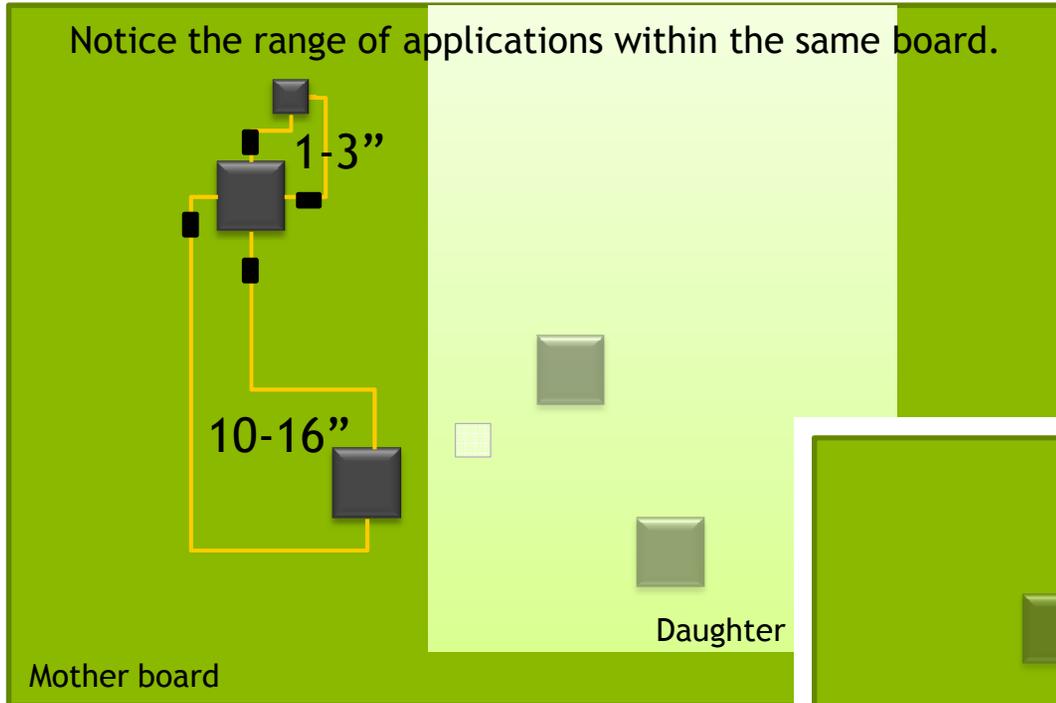
(from Nowell_01_0112)

*The success of a standard is measured on how comprehensive it is
and how many projects/designs will adopt it*

Example Applications (1)

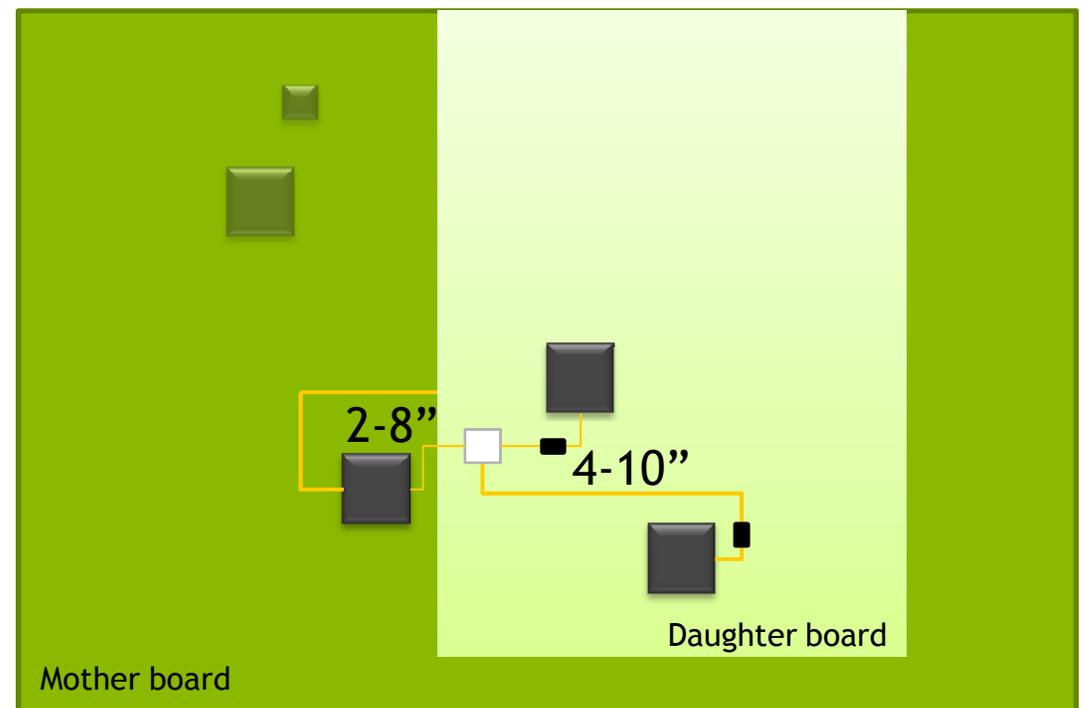
- Chip-to-Chip channel - single-board

Notice the range of applications within the same board.



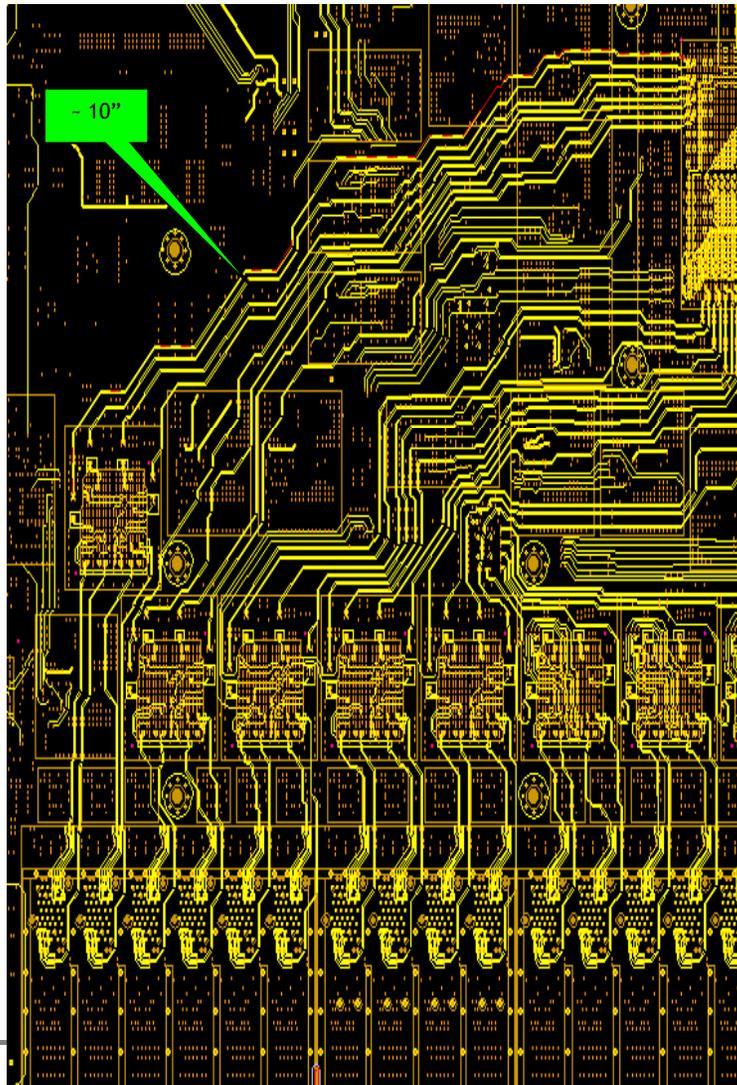
Cisco Example

- Chip-to-Chip channel - multi-board (1 connector)

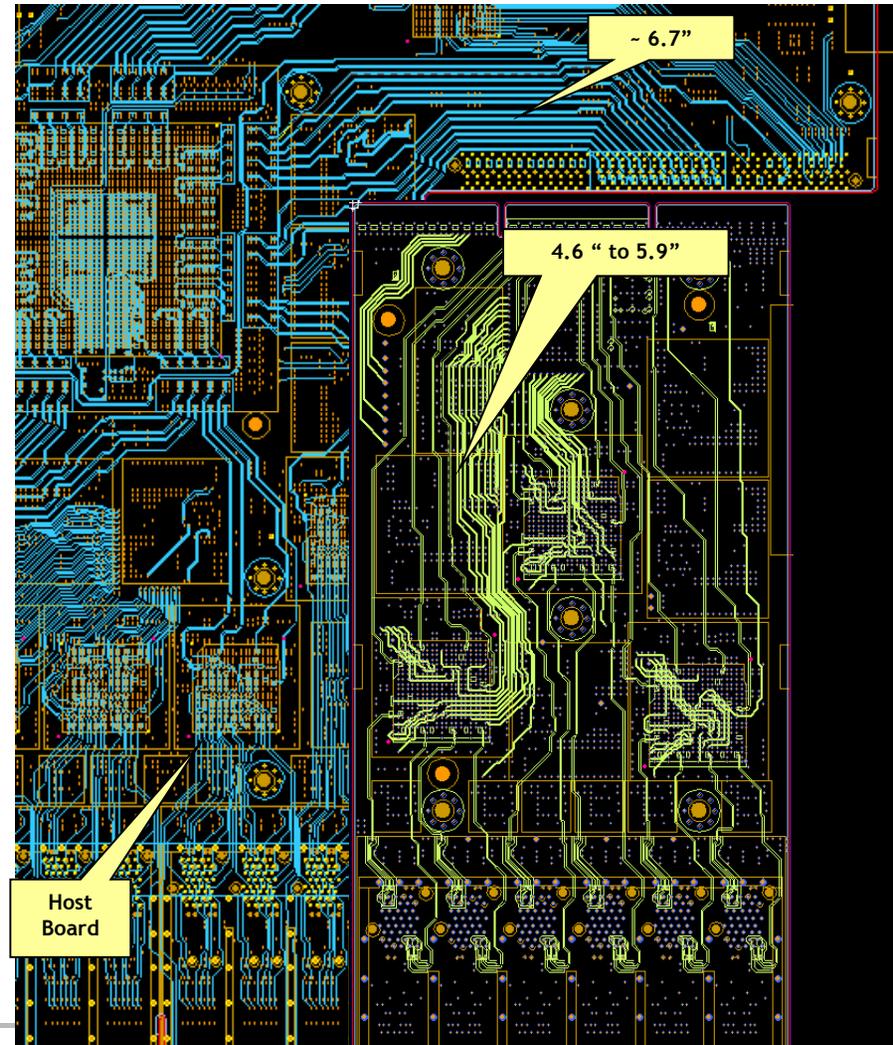


Example Applications (2)

Chip-to-Chip channel - single board

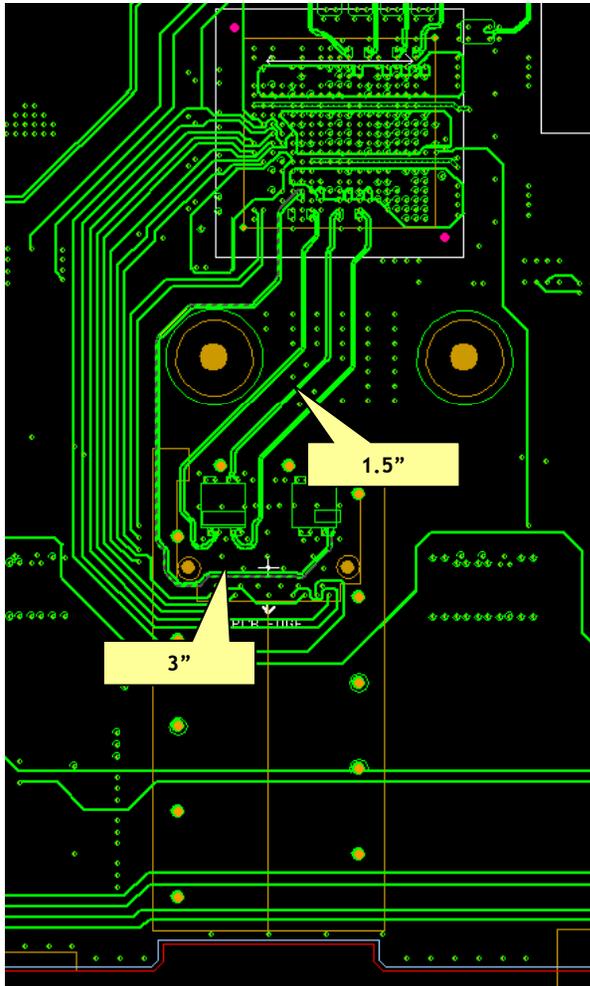


Alcatel-Lucent Enterprise Channels
Chip-to-Chip channel - multi-board (1 connector)



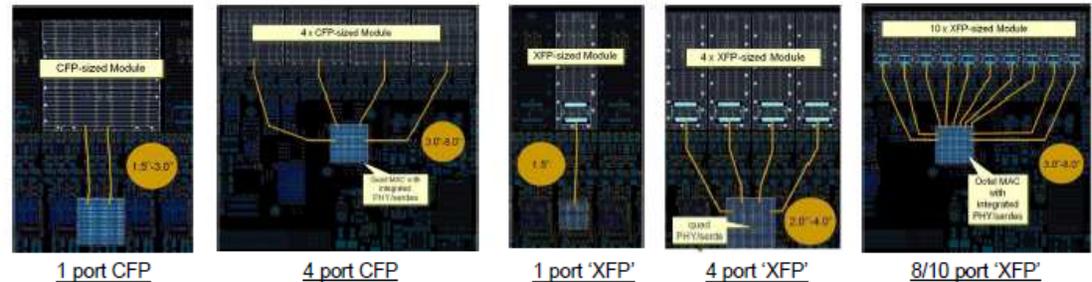
Example Applications (3)

Alcatel-Lucent Enterprise Channel Chip-to-QSFP28 Module (SMT)



802.3ba – nAUI/nPPI recap

- Distances for nAUI/nPPI were primarily driven out of [nicholl_01_0708](#)



CFP sized module (Retimed)

1 port: 1.5" - 3"
4 port: 3.0" - 8.0"

CXP/QSFP sized module (Unretimed)

1 port: 1.5"
4 port: 2.0" - 4.0"
8 port: 3.0" - 8.0"

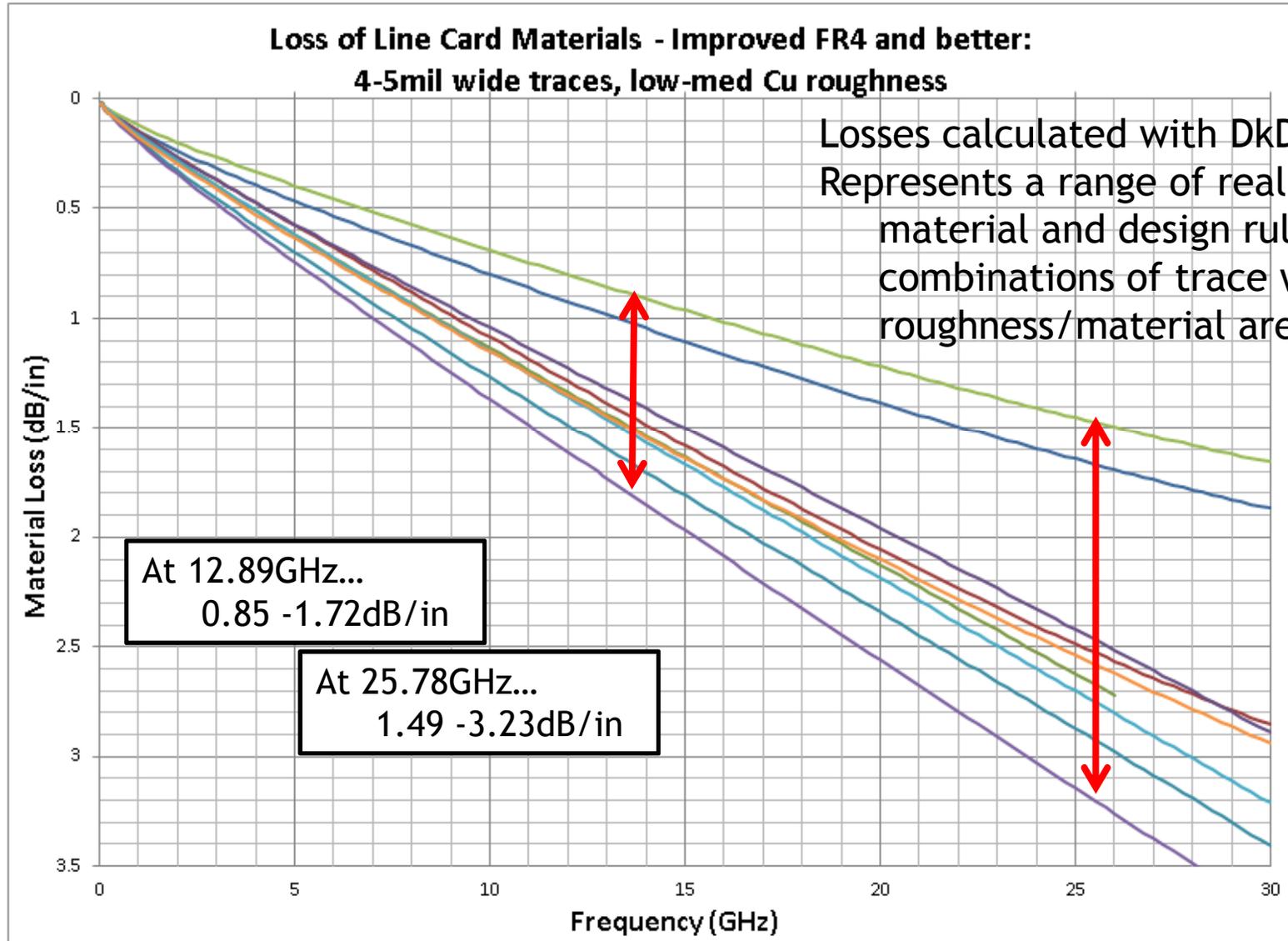
- In keeping with the 'Quad Phy' rule-of-thumb, 802.3ba targeted 8" for nAUI (retimed) and 4" for nPPI (unretimed)

As seen in [nicholl_01_1111...](#) and previously in [nicholl_01_0708](#) Chip-to-module can be 1.5-8" depending on the module/interface.

Design Choice Assumptions

- Materials
 - Greater materials exist (have you heard of Megtron 7?)...
 - Lower laminates Dk helps, now, copper roughness main IL contributor
 - But that doesn't mean the general industry can use them!
 - Same *consistent* pressure to use cost effective materials
 - Used various Improved FR4 and better
- Trace width
 - Design restrictions range
 - Used 4-5mil to balance optimism/pessimism
- Cu Roughness
 - Med roughness has become mainstream

Material and Cost Restrictions Still Exist



Losses calculated with DkDf model.
Represents a range of realistic Line Card material and design rules -- Not all combinations of trace width/Cu roughness/material are shown.

Where Do We Go From Here?

- To hold broad market potential, we need to be mindful of the wide range of applications that will use this spec.
- Insertion loss is not the only metric; Be cautious to limit the loss curves too much as rough Cu and dielectric loss is unavoidable.
- **Are there other areas we can find margin or restrict bad designs?**
 - Channel reflection/ILD
 - Silicon side - What equalizations could help open the eye? -- Is there untapped potential available here??

Thank you !

Material Properties Used in Material/Loss Slide

Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.47 dB			Loss at 12.89GHz: 0.98 dB			Loss at 25.78GHz: 1.68 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	4		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	8.56		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.67	0.0039	1.00E+08			1.00E+08		
1.00E+09	3.65	0.004	1.00E+09			1.00E+09		
2.00E+09	3.59	0.0043	2.00E+09			2.00E+09		
5.00E+09	3.576	0.0049	5.00E+09			5.00E+09		
1.00E+10	3.3494	0.0055	1.00E+10			1.00E+10		
3.00E+10	3	0.0065	3.00E+10			3.00E+10		
Low Roughness	20	6.0E-07						
ded			ded			ded		
Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.58 dB			Loss at 12.89GHz: 1.37 dB			Loss at 25.78GHz: 2.55 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	5		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	10.6		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.6	0.0092	1.00E+08			1.00E+08		
1.00E+09	3.6	0.0092	1.00E+09			1.00E+09		
2.00E+09	3.5	0.0115	2.00E+09			2.00E+09		
5.00E+09	3.5	0.0115	5.00E+09			5.00E+09		
1.00E+10	3.4	0.0125	1.00E+10			1.00E+10		
3.00E+10	3.2	0.014	3.00E+10			3.00E+10		
Medium Roughness	31	6.0E-07						
ded			ded			ded		
Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.62 dB			Loss at 12.89GHz: 1.42 dB			Loss at 25.78GHz: 2.7 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	5		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	12.3		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.98	0.01276	1.00E+08			1.00E+08		
1.00E+09	3.98	0.01288	1.00E+09			1.00E+09		
2.00E+09	3.965	0.01297	2.00E+09			2.00E+09		
5.00E+09	3.92	0.0132	5.00E+09			5.00E+09		
1.00E+10	3.898	0.0135	1.00E+10			1.00E+10		
3.00E+10	3.8	0.015	3.00E+10			3.00E+10		
Medium Roughness	31	6.0E-07						
ded			ded			ded		



Material Properties Used in Material/Loss Slide

Version 2.06 .OSS SNAPSHOT Loss at 5GHz: 0.57 dB			Loss at 12.89GHz: 1.31 dB			Loss at 25.78GHz: 2.49 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	5		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	12.3		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.98	0.01276	1.00E+08			1.00E+08		
1.00E+09	3.98	0.01288	1.00E+09			1.00E+09		
2.00E+09	3.965	0.01297	2.00E+09			2.00E+09		
5.00E+09	3.92	0.0132	5.00E+09			5.00E+09		
1.00E+10	3.898	0.0135	1.00E+10			1.00E+10		
3.00E+10	3.8	0.015	3.00E+10			3.00E+10		
Low Roughness	20	6.0E-07						
			ded					
Version 2.06 .OSS SNAPSHOT Loss at 5GHz: 0.7 dB			Loss at 12.89GHz: 1.58 dB			Loss at 25.78GHz: 2.95 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	4		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	10.14		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.98	0.01276	1.00E+08			1.00E+08		
1.00E+09	3.98	0.01288	1.00E+09			1.00E+09		
2.00E+09	3.965	0.01297	2.00E+09			2.00E+09		
5.00E+09	3.92	0.0132	5.00E+09			5.00E+09		
1.00E+10	3.898	0.0135	1.00E+10			1.00E+10		
3.00E+10	3.8	0.015	3.00E+10			3.00E+10		
Medium Roughness	31	6.0E-07						
			ded					
Version 2.06 .OSS SNAPSHOT Loss at 5GHz: 0.4 dB			Loss at 12.89GHz: 0.85 dB			Loss at 25.78GHz: 1.49 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	5		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	10.2		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.67	0.0039	1.00E+08			1.00E+08		
1.00E+09	3.65	0.004	1.00E+09			1.00E+09		
2.00E+09	3.59	0.0043	2.00E+09			2.00E+09		
5.00E+09	3.576	0.0049	5.00E+09			5.00E+09		
1.00E+10	3.3494	0.0055	1.00E+10			1.00E+10		
3.00E+10	3	0.0065	3.00E+10			3.00E+10		
Low Roughness	20	6.0E-07						
			ded					



Material Properties Used in Material/Loss Slide

Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.74 dB			Loss at 12.89GHz: 1.72 dB			Loss at 25.78GHz: 3.23 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	4		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	10.86		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	4.35	0.0138	1.00E+08			1.00E+08		
1.00E+09	4.3	0.0143	1.00E+09			1.00E+09		
2.00E+09	4.27	0.0144	2.00E+09			2.00E+09		
5.00E+09	4.22	0.01475	5.00E+09			5.00E+09		
1.00E+10	4.185	0.01524	1.00E+10			1.00E+10		
3.00E+10	4.13	0.01665	3.00E+10			3.00E+10		
Medium Roughness	31	6.0E-07						

Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.62 dB			Loss at 12.89GHz: 1.45 dB			Loss at 25.78GHz: 2.78 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	5		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	13		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	4.35	0.0138	1.00E+08			1.00E+08		
1.00E+09	4.3	0.0143	1.00E+09			1.00E+09		
2.00E+09	4.27	0.0144	2.00E+09			2.00E+09		
5.00E+09	4.22	0.01475	5.00E+09			5.00E+09		
1.00E+10	4.185	0.01524	1.00E+10			1.00E+10		
3.00E+10	4.13	0.01665	3.00E+10			3.00E+10		
Low Roughness	20	6.0E-07						

Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.63 dB			Loss at 12.89GHz: 1.44 dB			Loss at 25.78GHz: 2.6 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)	1		Length (inch)	0		Length (inch)	0	
Trace Width (mil)	4		Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)	0.67		Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)	9.14		Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.6	0.0092	1.00E+08			1.00E+08		
1.00E+09	3.52	0.0105	1.00E+09			1.00E+09		
2.00E+09	3.49	0.0108	2.00E+09			2.00E+09		
5.00E+09	3.46	0.011	5.00E+09			5.00E+09		
1.00E+10	3.44	0.0112	1.00E+10			1.00E+10		
3.00E+10	3.41	0.012	3.00E+10			3.00E+10		
Medium Roughness	31	6.0E-07						



Material Properties Used in Material/Loss Slide

Version 2.06 .LOSS SNAPSHOT Loss at 5GHz: 0.51 dB			Loss at 12.89GHz: 1.16 dB			Loss at 25.78GHz: 2.14 dB		
Backplane/Trace Material			Linecard A Material			Linecard B Material		
Length (inch)		1	Length (inch)		0	Length (inch)		0
Trace Width (mil)		5	Trace Width (mil)			Trace Width (mil)		
Cu Thickness (mil)		0.67	Cu Thickness (mil)			Cu Thickness (mil)		
Diel. Thickness (mil)		10.94	Diel. Thickness (mil)			Diel. Thickness (mil)		
Freq	Dk	Df	Freq	Dk	Df	Freq	Dk	Df
1.00E+08	3.6	0.0092	1.00E+08			1.00E+08		
1.00E+09	3.52	0.0105	1.00E+09			1.00E+09		
2.00E+09	3.49	0.0108	2.00E+09			2.00E+09		
5.00E+09	3.46	0.011	5.00E+09			5.00E+09		
1.00E+10	3.44	0.0112	1.00E+10			1.00E+10		
3.00E+10	3.41	0.012	3.00E+10			3.00E+10		
Low Roughness	20	6.0E-07						

www.alcatel-lucent.com

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