

Measured vs. Simulated Correlation of Package Model

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MediaTek

For IEEE 802.3ck

Supporters

- Liav Ben-Artzi, Marvell
- Richard Mellitz, Samtec
- Ali Ghiasi, Ghiasi Quantum

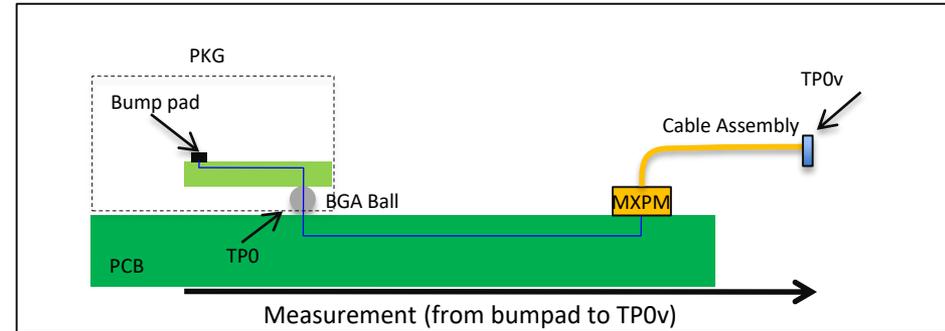
Outlines

- Background
- Model Decomposition
- Measured vs. Simulated Models Correlation
- Summary

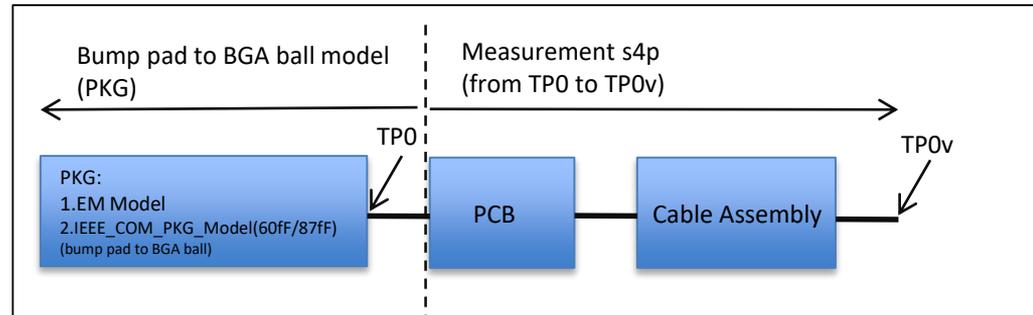
Background

- During D1p4 comment stage, [comments #115](#), [#116](#), and [#117](#) proposed the following change
 - $C_p = 87 \text{ fF} \rightarrow 60 \text{ fF}$
- One contribution, [bois 3ck adhoc 01 011321](#), shared related justifications
- Remind #1: there were some previous contributions on this topic & we set up the consensus of $C_p = 87 \text{ fF}$ based on them
 - [mellitz 3ck adhoc 03 081518](#), [benartsi 3ck 01 0119](#), [benartsi 3ck 01a 0319](#), and others
- Remind #2: COM is sensitive to C_p value, [wu 3ck 01 0119](#)
 - COM difference $\sim 0.3 \text{ dB}$ for $C_p = 87 \rightarrow 60 \text{ fF}$
- The correlation of measured and simulated package models was analyzed
 - $C_p = 87 \text{ fF}$ is more correlated to measured TDR than 60 fF

The Example TP0v Test Fixture – Model Decomposition

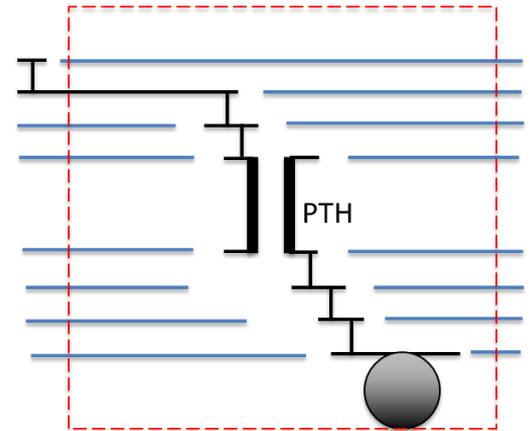
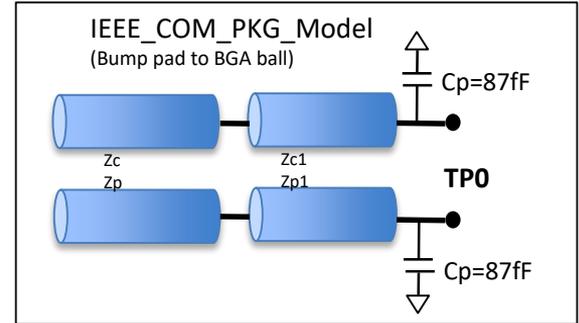


- 2 types of PKG models
 - EM_Model: created by EM solver
 - IEEE_PKG_Model



Information of IEEE COM PKG Model & BGA Ball

- IEEE PKG Model
 - Z_c, Z_p : set to align PKG substrate design
 - $Z_c = 92.5 \text{ Ohm}, Z_p = 6 \text{ mm}$
 - Z_{c1}, Z_{p1}, C_p : adopt IEEE values
 - For Via, PTH, & BGA ball
 - $Z_{c1} = 92.5 \text{ Ohm}, Z_{p1} = 1.8 \text{ mm}$
- Observations of IEEE_COM_PKG_Model
 - Two cascaded TL with C_p can approximate the EM simulation results well
 - C_p : model not only BGA ball, but also the interconnection between via and ball
 - Extracting BGA ball only with the EM simulator cannot represent the C_p and thus under-estimate capacitance value
- BGA geometry
 - BGA diameter = 600 μm
 - Ball pitch = 1000 μm



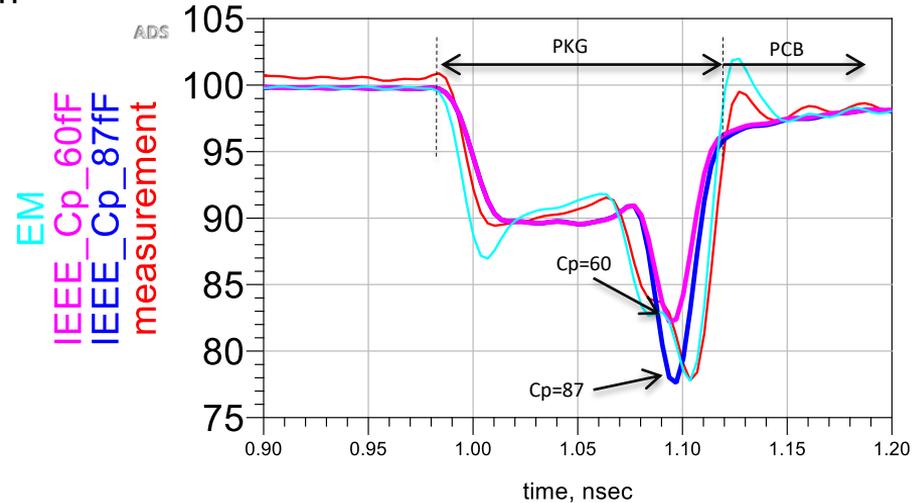
TDR Responses – Comparison

- TDR of the following 3 models are compared with Meas. TDR Data (from bump_pad to TP0v)
 - Take 'measurement' as golden

TDR Response	PKG Model	TP0 to TP0v Model
'EM'	Model extracted by EM simulator	Meas. Data
'IEEE_COM_Cp_60fF'	COM PKG w/i Cp = 60 fF	Meas. Data
'IEEE_COM_Cp_87fF'	COM PKG w/i Cp = 87 fF	Meas. Data

- EM model matches well with measured TDR data
- 'COM_Cp_87fF' model matches well at PKG part
 - $Z \approx 78 \text{ Ohm}$ @ BGA ball, close to measured data
 - $Z \approx 82 \text{ Ohm}$ for $C_p = 60 \text{ fF}$

TDR Response for measurement, EM model and IEEE_COM_model



- 'measurement' settings
 - Min. Freq. = 10 MHz, Step = 10 MHz, Max. Freq. = 50 GHz
- TDR rise time (20%~80%) = 7.5 ps

Summary

- Based on the previous analysis & this new correlation data, we suggest
 - Keep $C_p = 87$ fF in IEEE COM PKG model for considering big packages in the host side

Thank You