

High Density Integrated Stack Capacitor (ISC) for Advanced Package Solutions

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March 5, 2020
Samsung Foundry

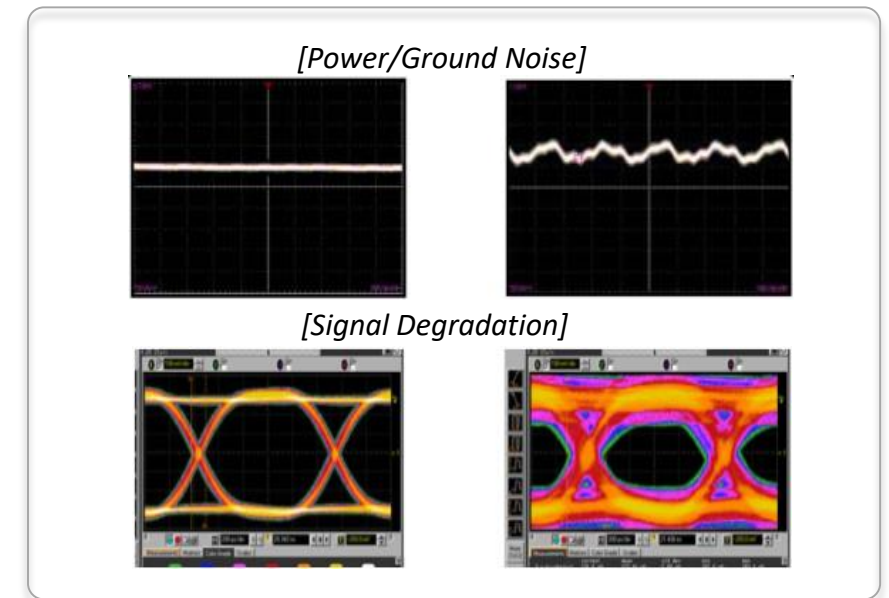
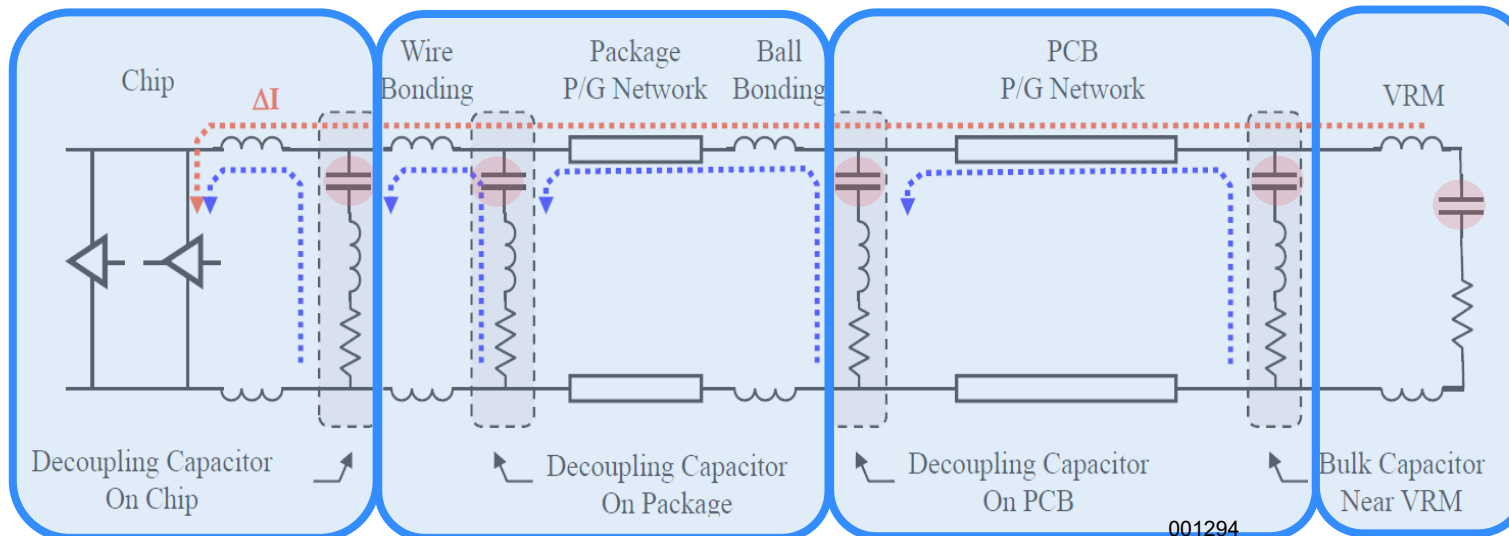
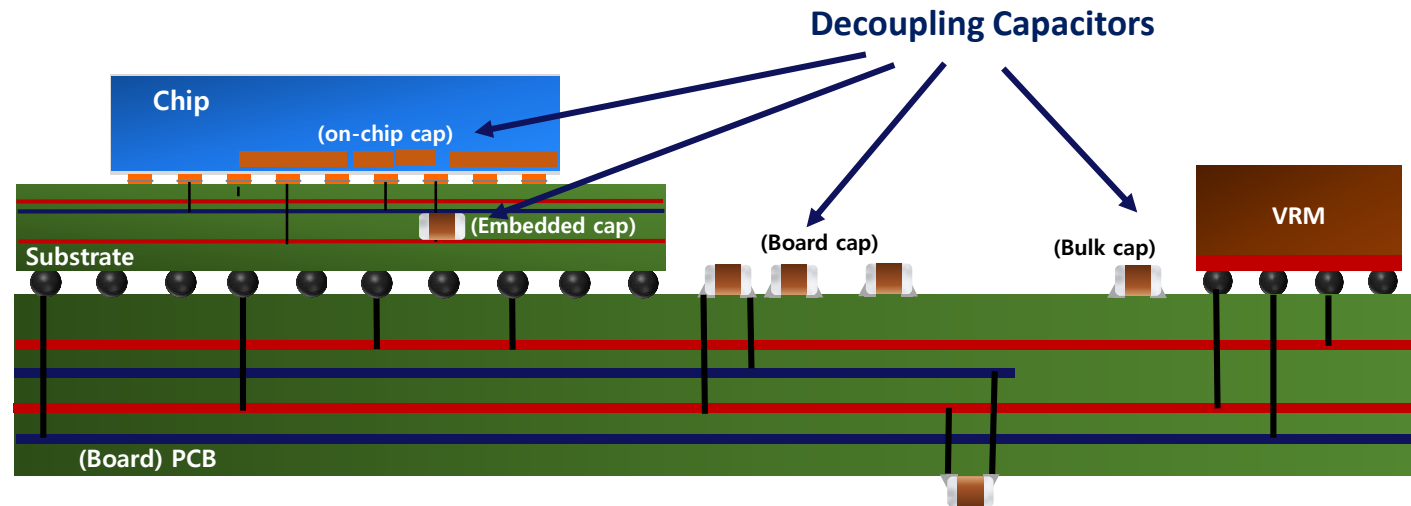


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- Introduction
- ISC design, implementation & results
 - Discrete ISC
 - Interposer ISC
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Power Integrity, PDN and Decoupling Capacitors

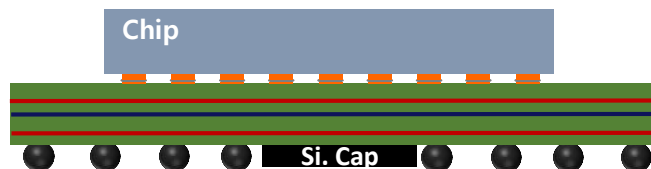


Why Silicon Cap?

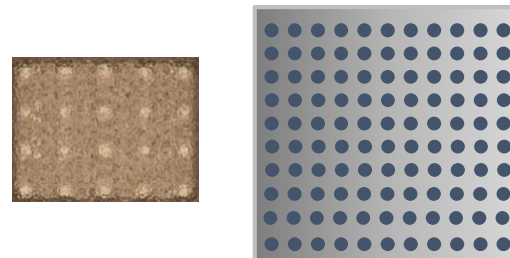
High performance

Parameter	Silicon Capacitor	Ceramic Capacitor
ESR	1	1
ESL	1	10
Capacitance tol. over Voltage	Low (<5%)	High (>10%)
Capacitance tol. over Temperature	Low (<5%)	High (>10%)
Capacitance/Volume	Mid	High

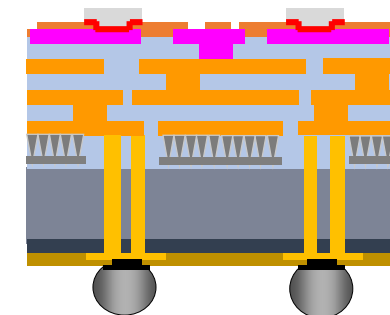
Thin & light



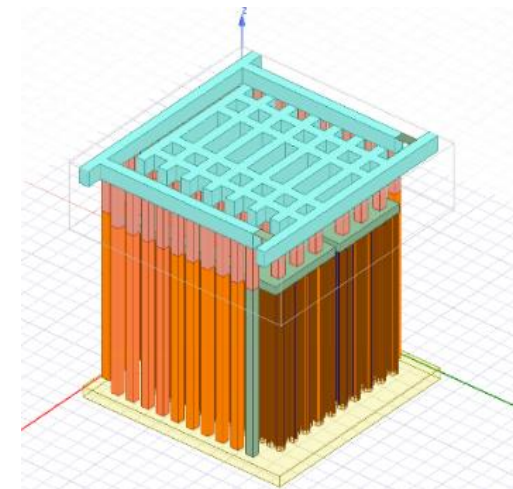
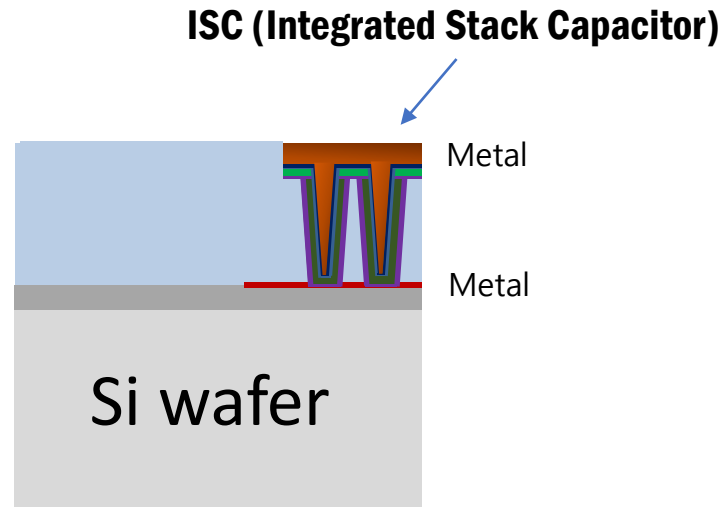
Multi-terminal



Higher integration



ISC (Integrated Stack Capacitor)



- Between metal stacks on wafer
- Ultra low profile

🌐 300mm Si wafer

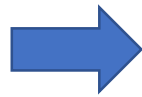
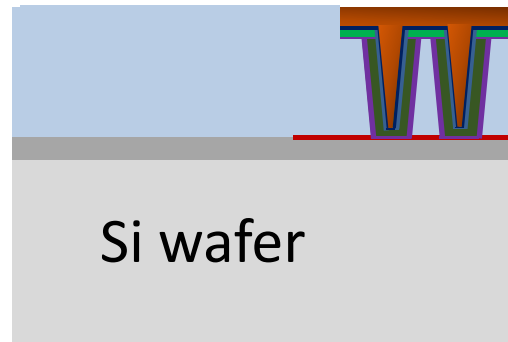
🌐 Proven process → simplified for cost reduction (> 70%)

Discrete ISC

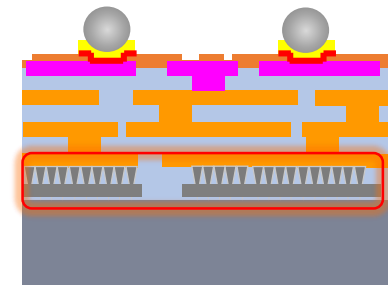
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Discrete ISC : Integration

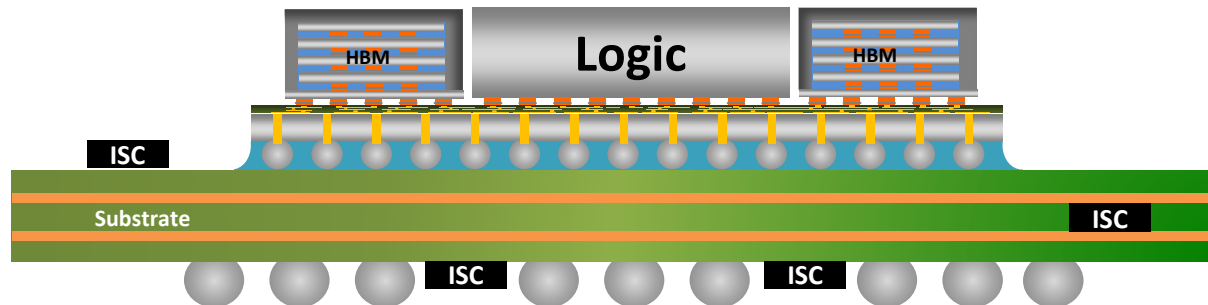


- BEOL
- Surface finish
- Wafer thinning
- Wafer sawing
- ...



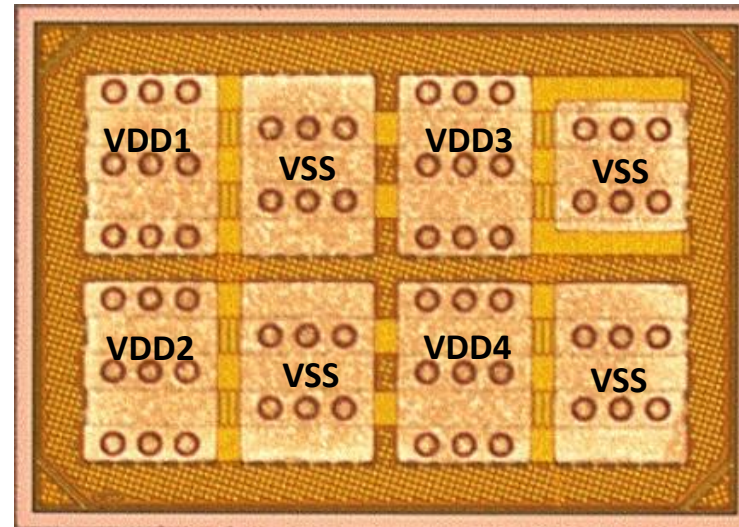
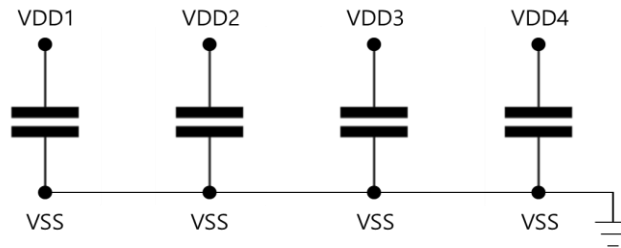
*Discrete chip
with multi terminal*

SMT-type Discrete ISC

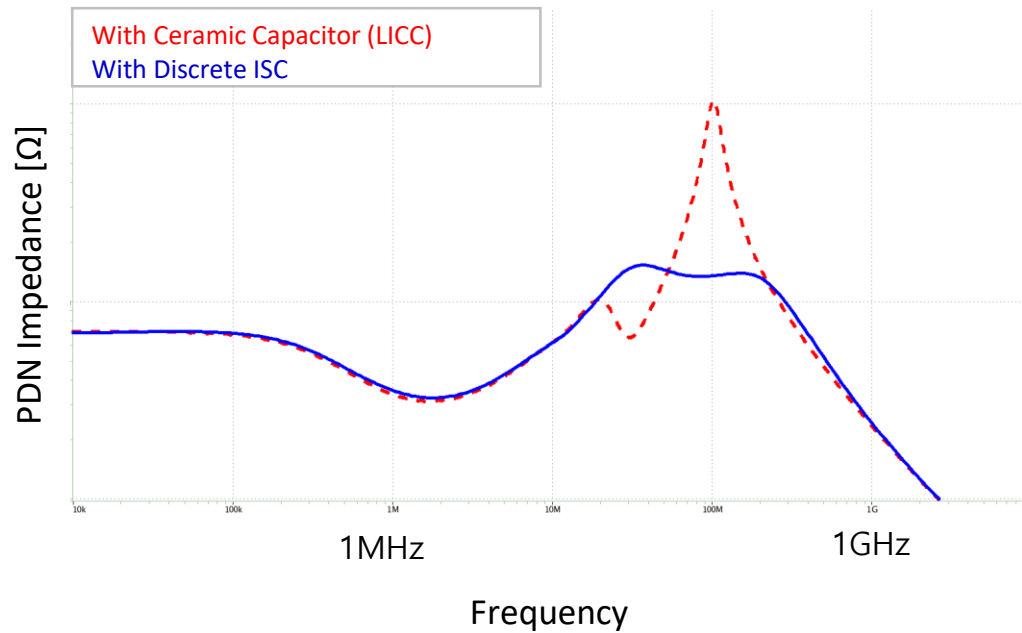


Discrete ISC : Design & Silicon Result

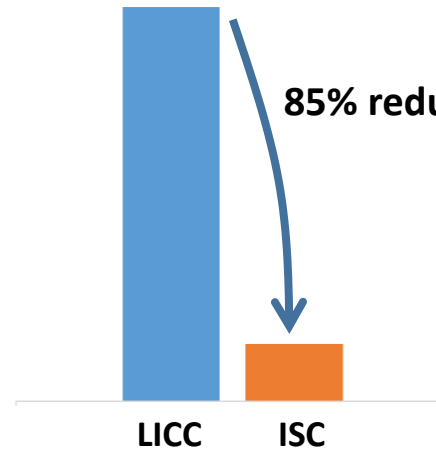
- ESL (2 pH), Specific Capacitance ($> 300\text{nF}/\text{mm}^2$), and Stable capacitance over Temperature & Voltage



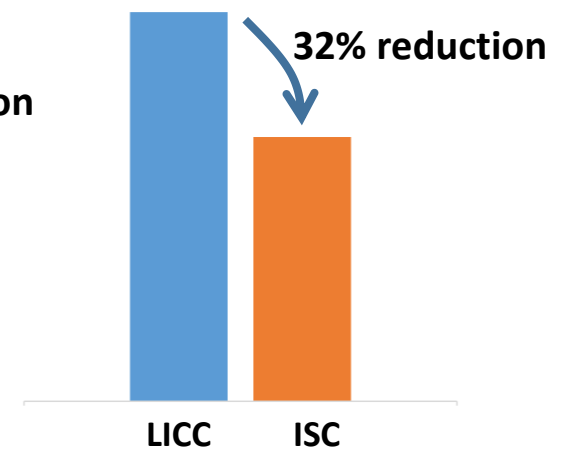
Discrete ISC : PI Performance



[PDN Peak Impedance]



[Voltage Drop]



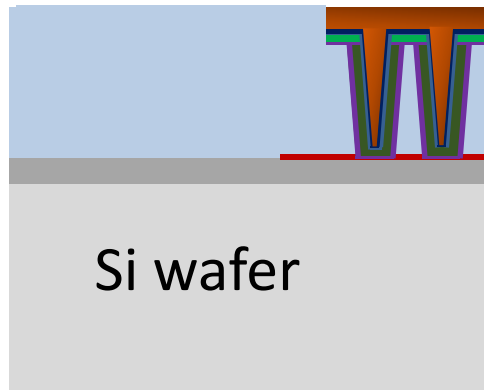


Interposer ISC

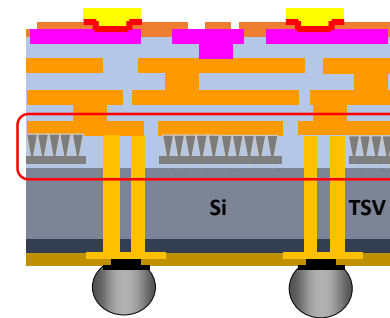
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Interposer ISC : Integration

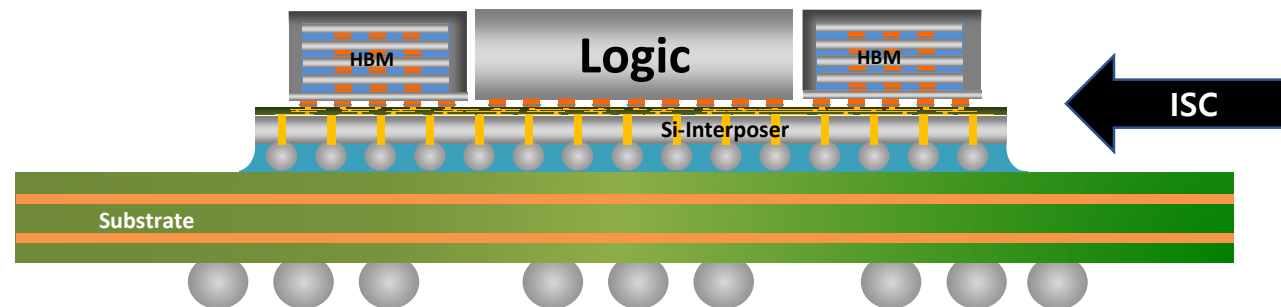


➔ + TSV formation + Others



Integrated with TSV
Big die: > 2 shot 1 die

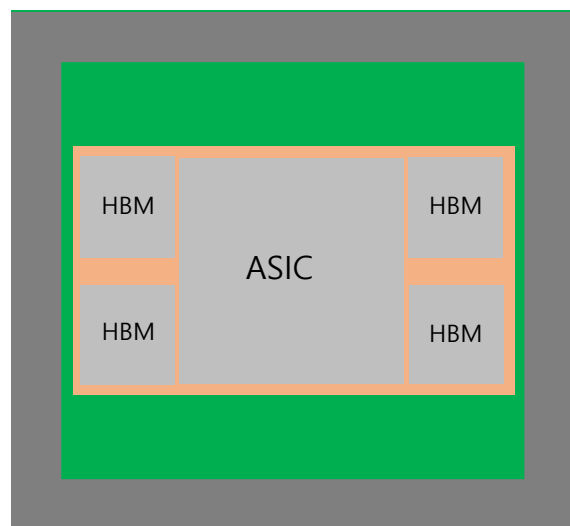
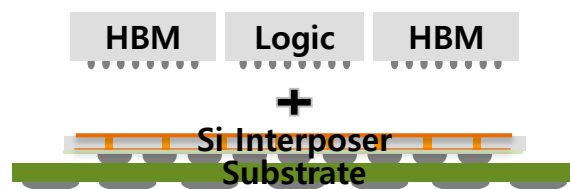
Interposer ISC



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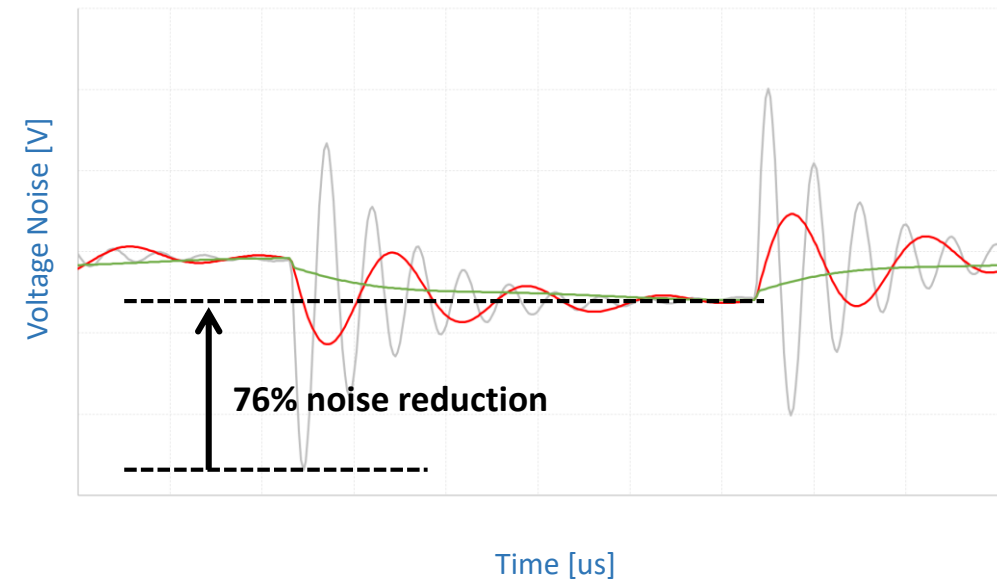
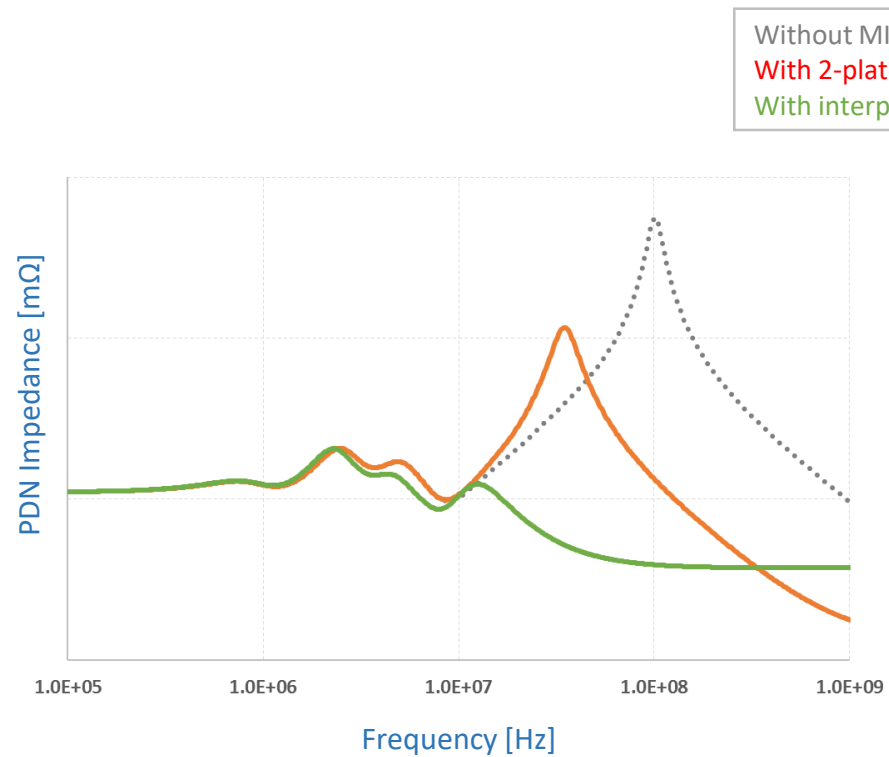
Interposer ISC : Test Vehicle Design

🌐 Test vehicles running for process qualification and PI/SI evaluation



- Package Size: 65X65mm²
- Si Interposer: ~1600 mm² (32x49), 2X Reticle Size
- 4*HBM2e (10x11mm): 1.6TB/s Bandwidth
- with interposer ISC

Interposer ISC: PI Performance



Wafer ISC

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Summary

- ⌘ **Designed, demonstrated and qualified 300nF/mm² Discrete ISC on package**
- ⌘ **Developing and designing the Interposer ISC on Si interposer**
- ⌘ **Developing Wafer ISC on Logic**
- ⌘ **Developing higher density Si Capacitor**

Acknowledgement

The authors would like to acknowledge Howoo Park, JeongHoon Ahn, Sungwook Moon, and their team for support of this work.



Thank You

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