Impact of accurate PDN model on IBIS SI and PI simulations

European IBIS Summit - Sorrento (Italy)

May 16th, 2012

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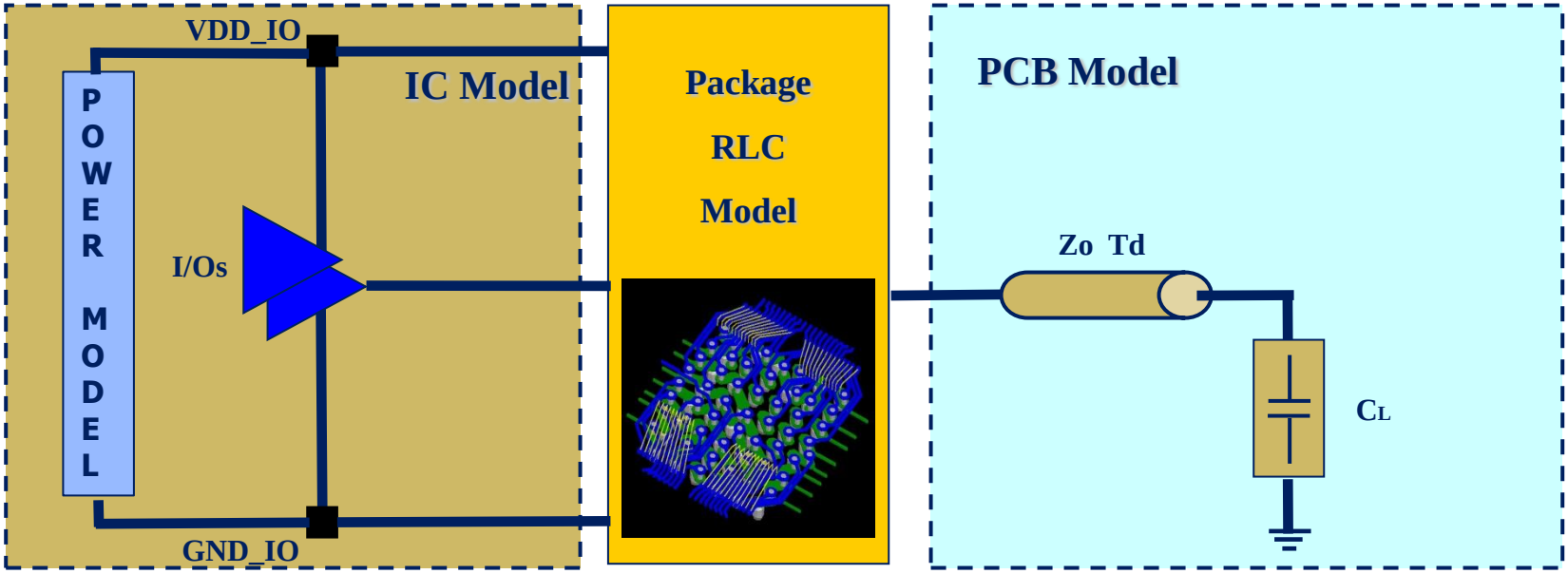
Simulation Testbench



- Ran SSO simulations and compared IBIS and Spice results
- DUT has a LPDDR2 interface and can reach a data rate of 800Mbps
- Used post-layout netlists for spice buffers
- IBIS model includes the power modeling features (BIRD95 and BIRD98)
- Package model is related to a MCP that contains the DUT
- PCB load: transmission line Z0=50; Td=300ps; CL=3.5pF
- Output driver strength: 60 Ohm

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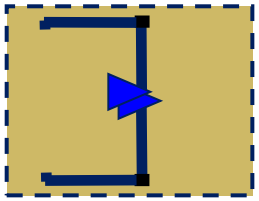
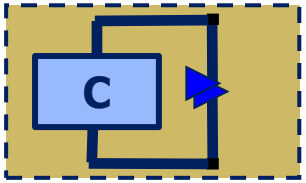
Summary of Analysis

Four different cases of PDN model were used for IBIS simulations and the obtained results were compared to SPICE ones:

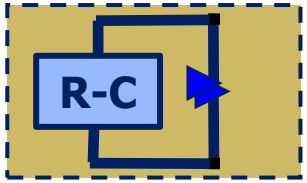
Case 1: no PDN model



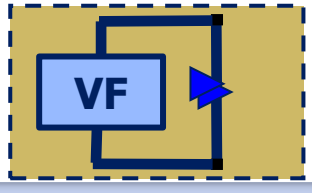
Case 2: a capacitance only (100pF) added on the power nodes of each buffer



Case 3: an equivalent impedance (R-C) extracted manually by fitting the AC waveforms



Case 4: an equivalent spice model extracted by an automatic tool based on vector fitting



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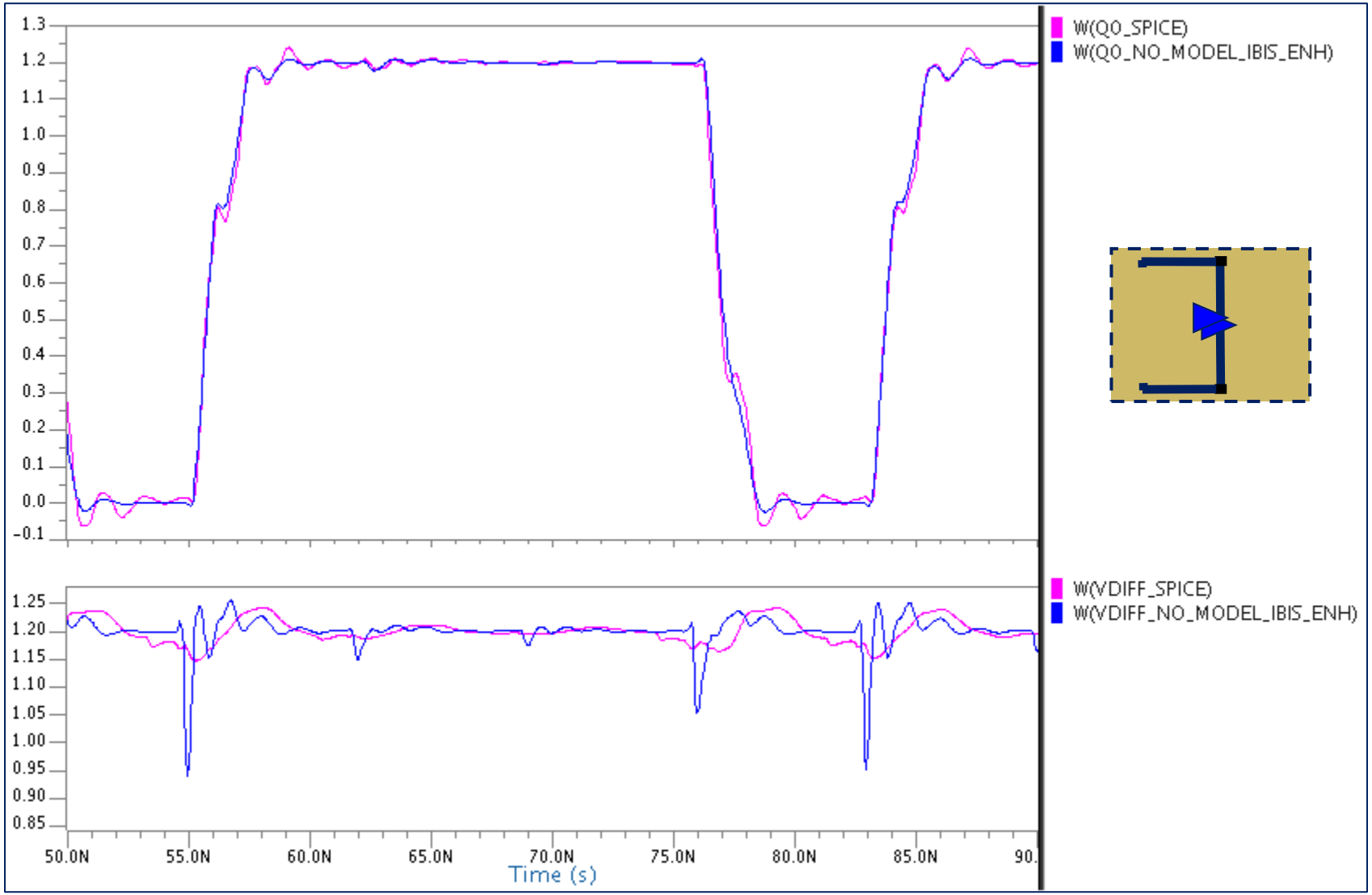
Case 1: No PDN Model



IBIS testbench generates a higher power drop than SPICE one

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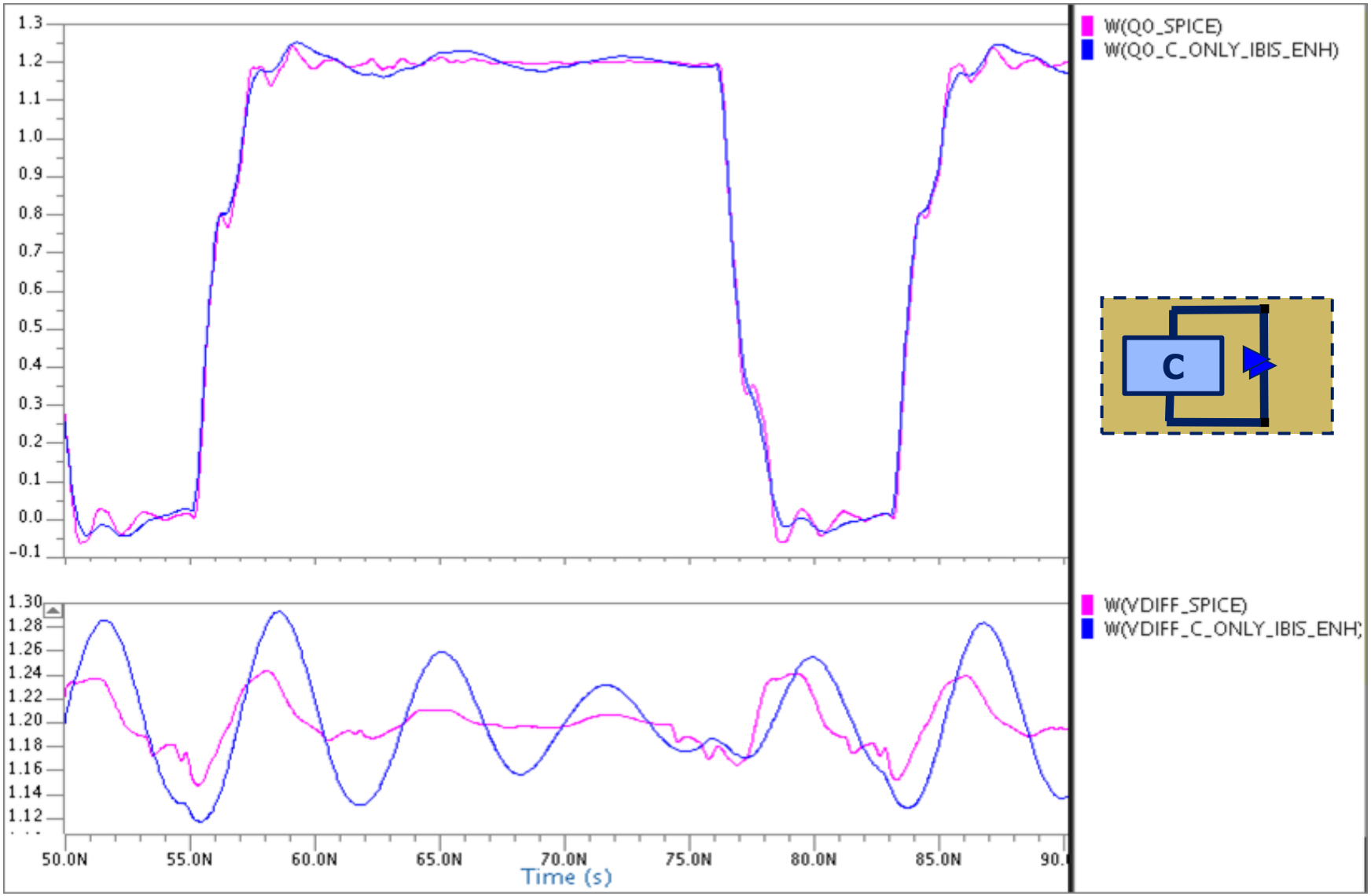
Case 2: Capacitance added to power nodes



Unexpected worse and strange (maybe unreal) power noise behaviour

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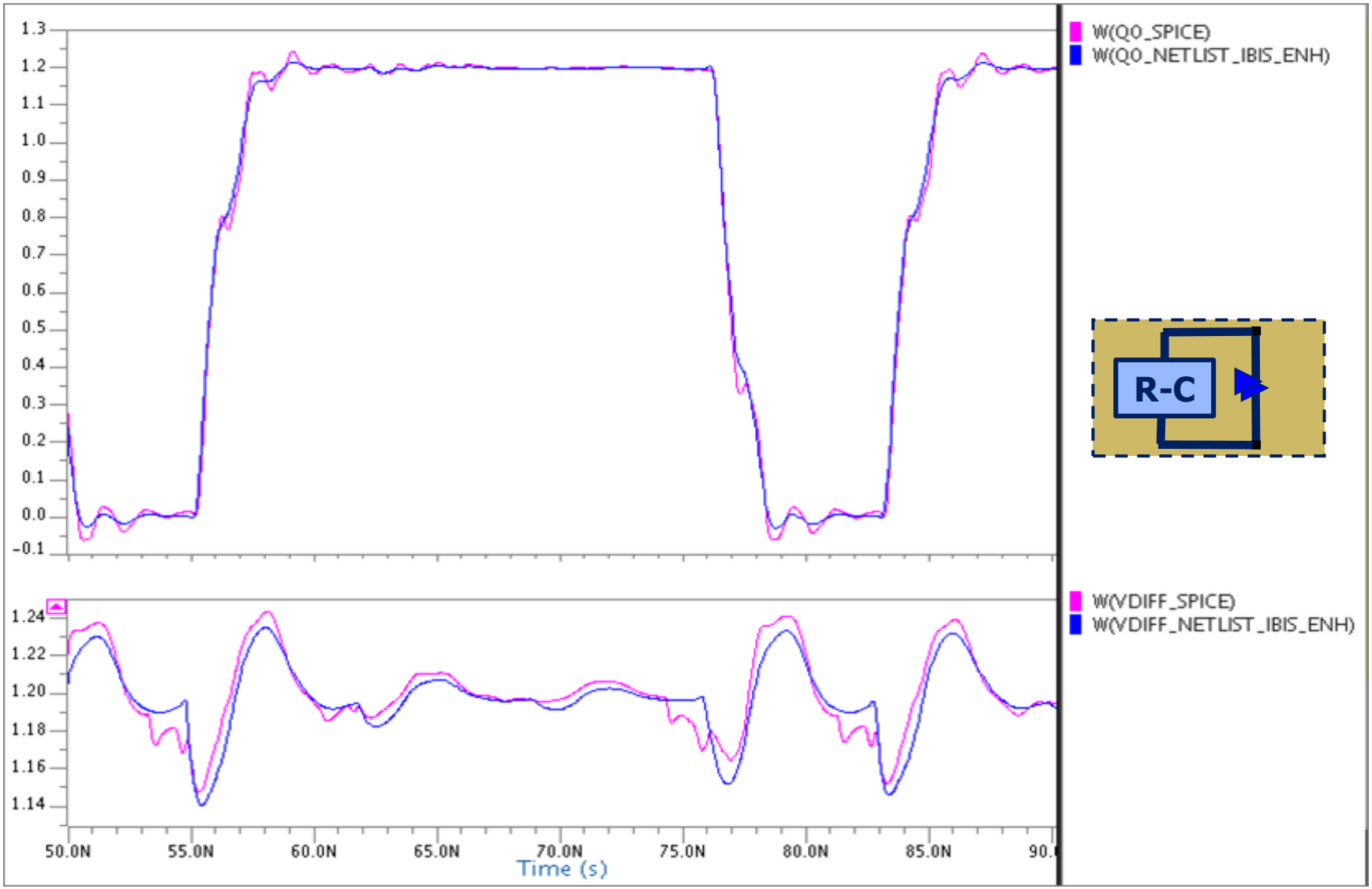
Case 3: Equivalent impedance (R-C) extracted manually



Better agreement between IBIS and SPICE results and the strange (maybe unreal) power noise has disappeared

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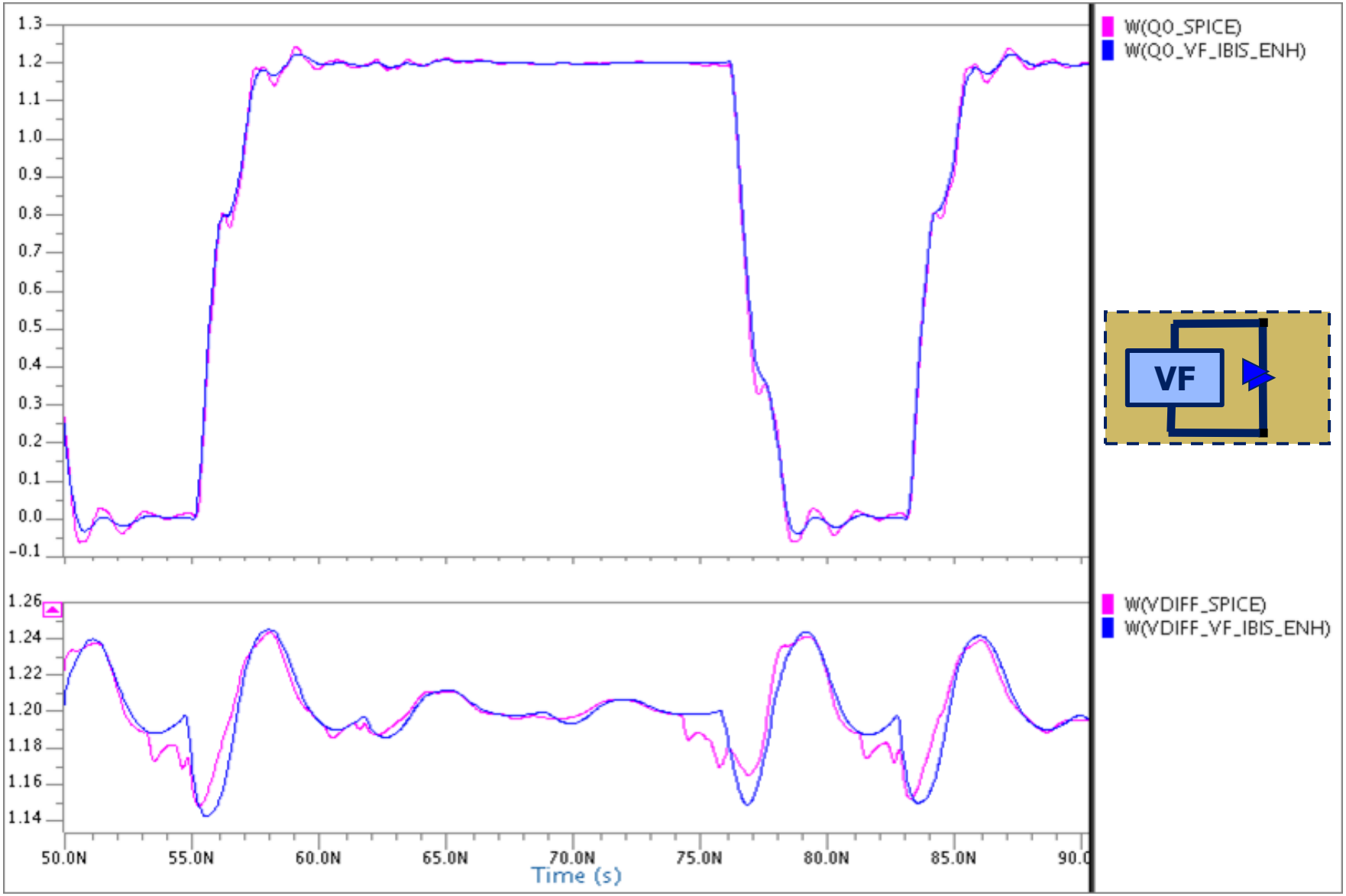
Case 4: Equivalent impedance by vector fitting



Further improvement of IBIS vs SPICE agreement

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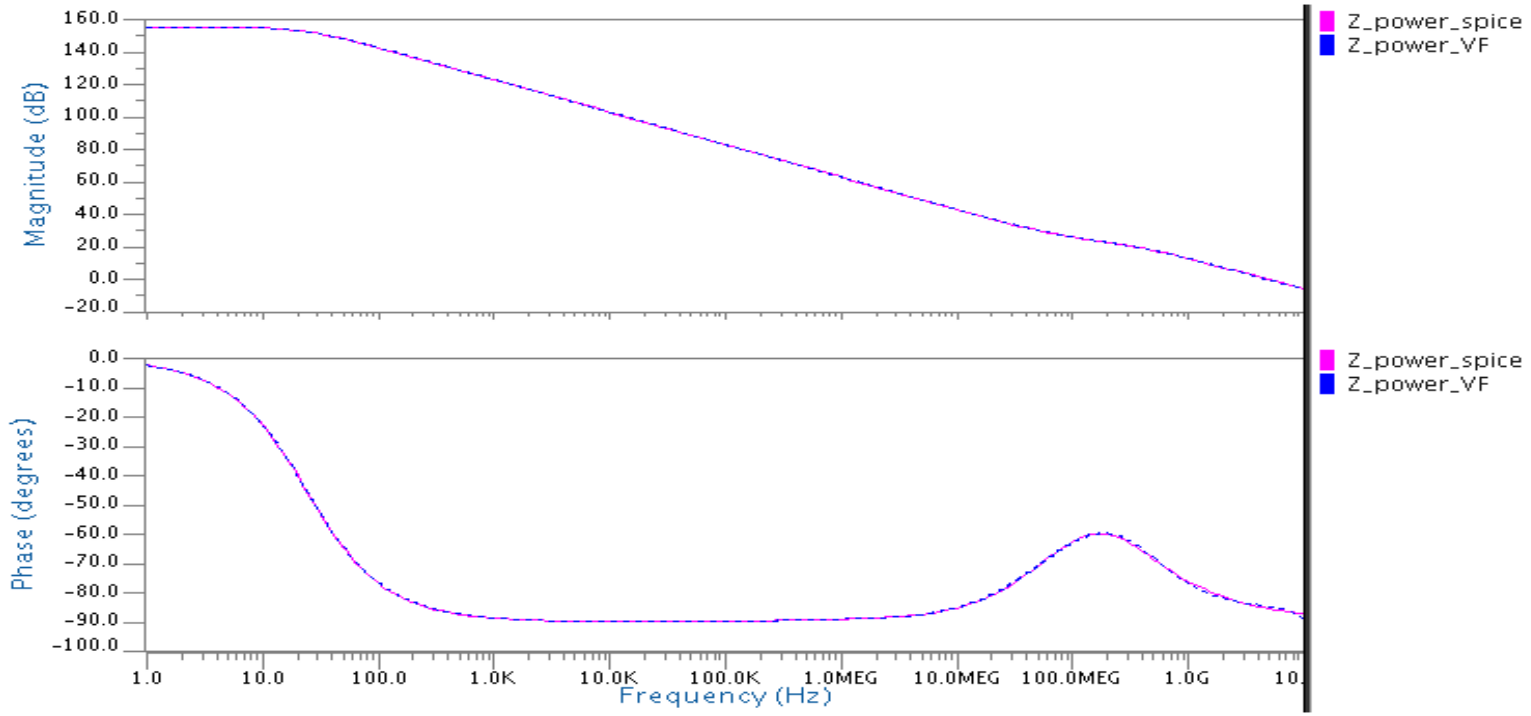
PDN Modeling

- The RC model was extracted by running an AC analysis between power nodes of SPICE netlist and then fitting manually the magnitude and phase waveforms.

- The macromodel extracted by a vector fitting tool is a spice subcircuit that mimics the frequency behavior of PDN. Its input was the S11 parameter.



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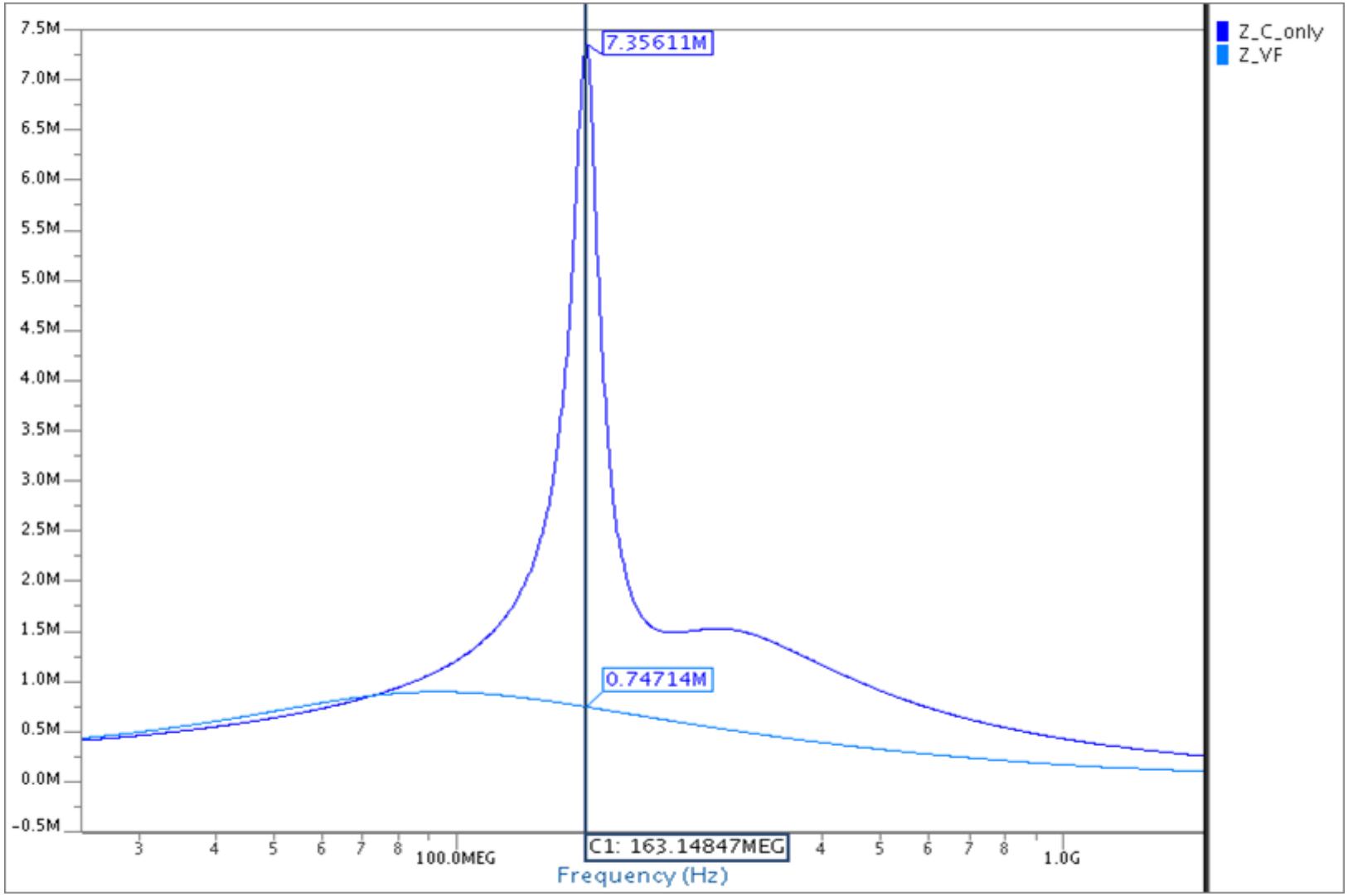
Power Network AC Analysis



In case of **"C only"** model, a resonance was introduced at mid-frequency, but it was unreal and not confirmed by more accurate models like R-C and VF.

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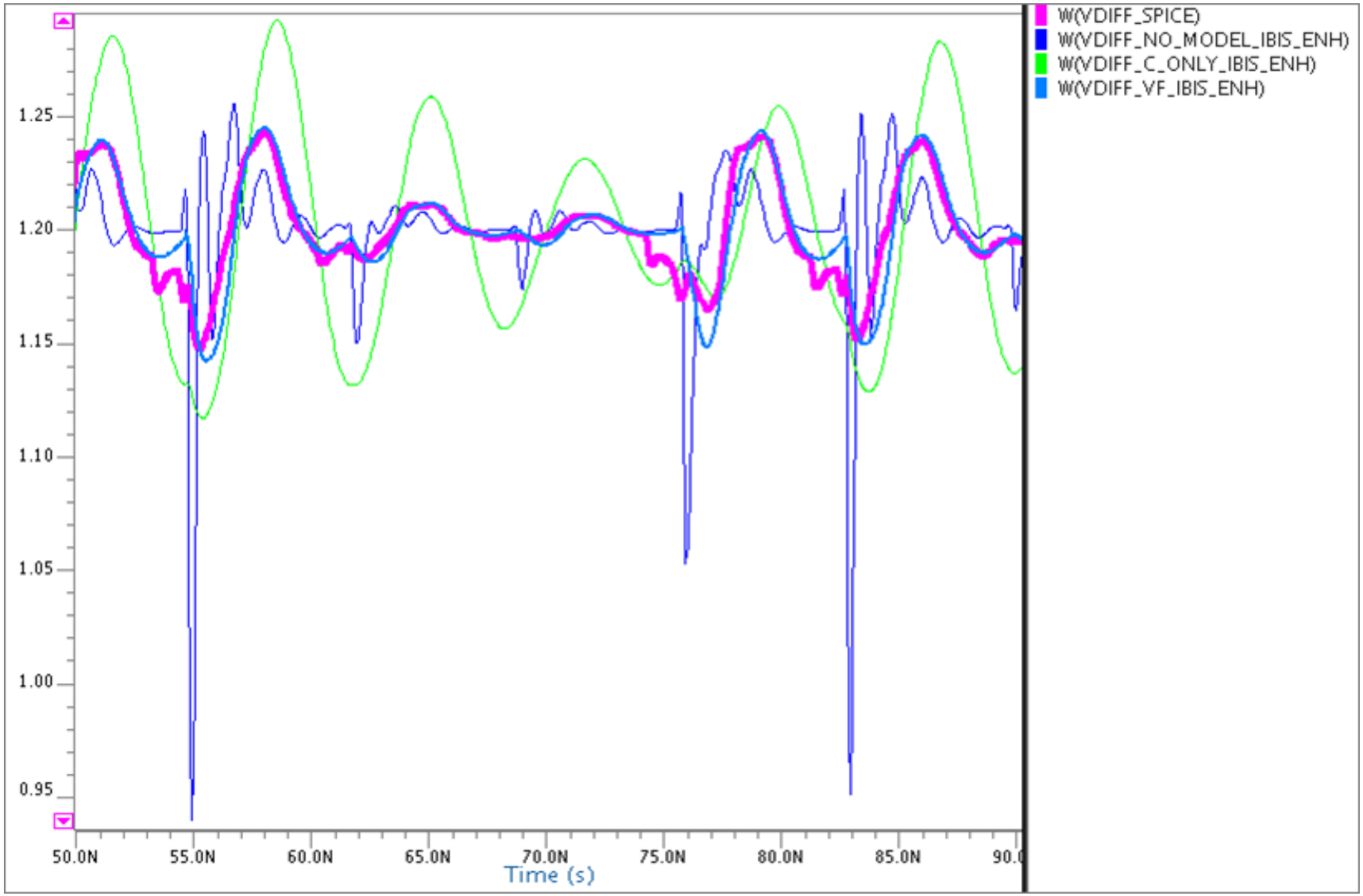
PDN models effectiveness comparison: Power Noise



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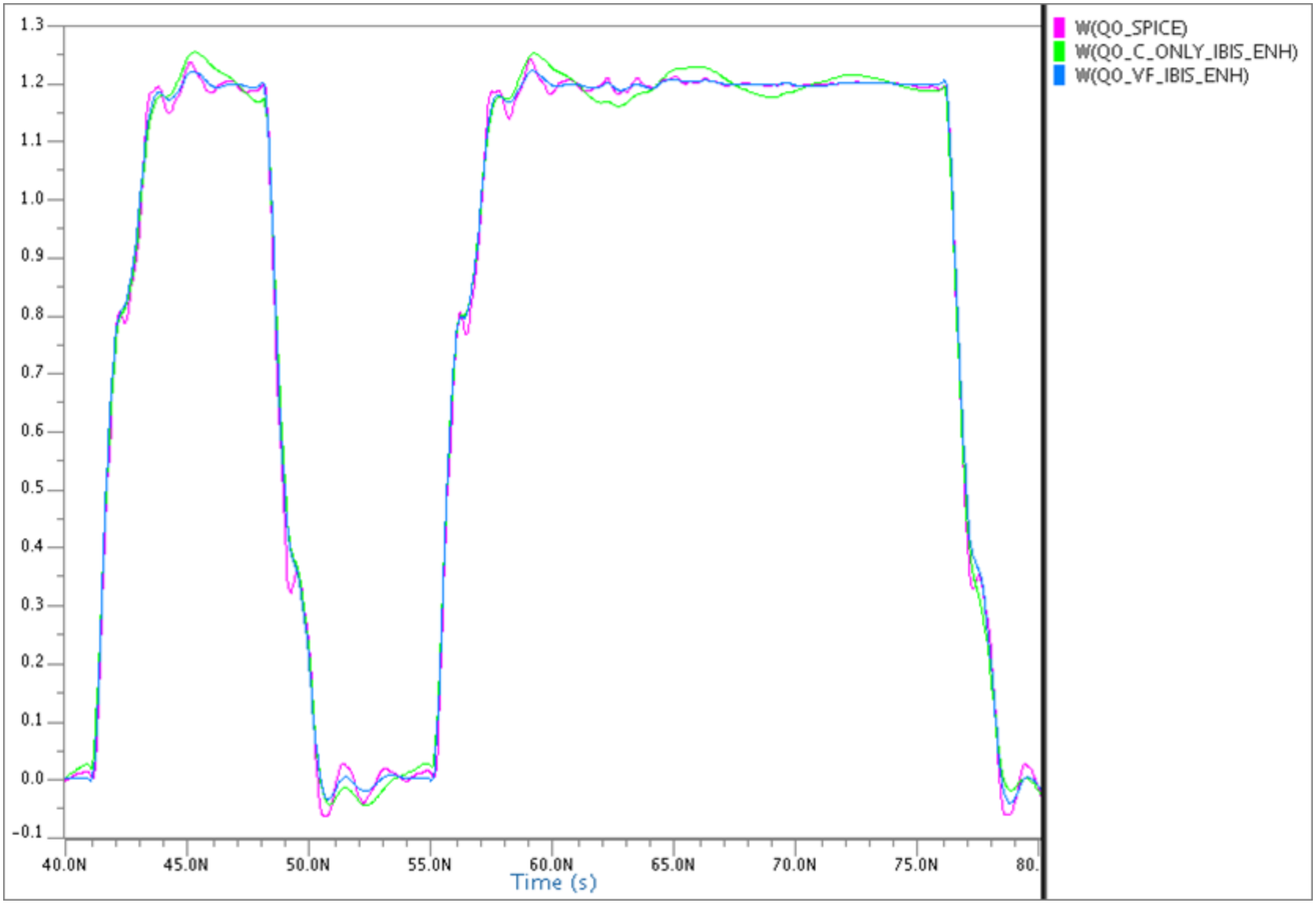
PDN models effectiveness comparison: Data signal



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Conclusions

- Sometimes a PDN model based on an equivalent capacitance only may be harmful to PI/SI IBIS simulation accuracy, generating unreal resonances.

- For this DUT the power noise was not too large because the IC and package PDN were well designed, but two main lessons have come up from this analysis:

  a) To allow an effective use of IBIS power integrity features (BIRD95/98), it is strongly recommended to reproduce as accurately as possible the actual power noise

  b) A frequency-dependent PDN model is advised, possibly extracted by a Vector Fitting tool

- Although in this case the two frequency-dependent PDN models (R-C and VF) seem equivalent, that's not always true. Sometimes the manual fitting may be very complex and difficult to cover the whole frequency range of interest.

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