

## APPLICATION NOTE 023

### TOLERANCE IN SURFACE MOUNT VARACTOR DIODES

The ability to specify tolerance in the nominal capacitance has been added to selected models in the Modelithics Non-Linear Diode (NLD) Model Library in order to emulate the variation typically specified in manufacturer data sheets. The feature will be included in additional models in future library releases. This application note briefly reviews this new capability and provides suggestions on how it should be used.

A sample simulation schematic from Agilent's Advanced Design System is shown in Figure 1. Included in the schematic is the VAR\_TSH\_TG1A\_005 model for the Toshiba P/N 1SV280 varactor diode. The model parameter used to specify the capacitance tolerance is **Cap\_tolerance** – this parameter should have a nominal value of 1, with the tolerance specified as a percentage (in this case +/- 12%). The **Res\_tolerance** parameter can be used in a similar fashion to emulate variation in the series resistance of the device, another parameter that is often specified by diode manufacturers.

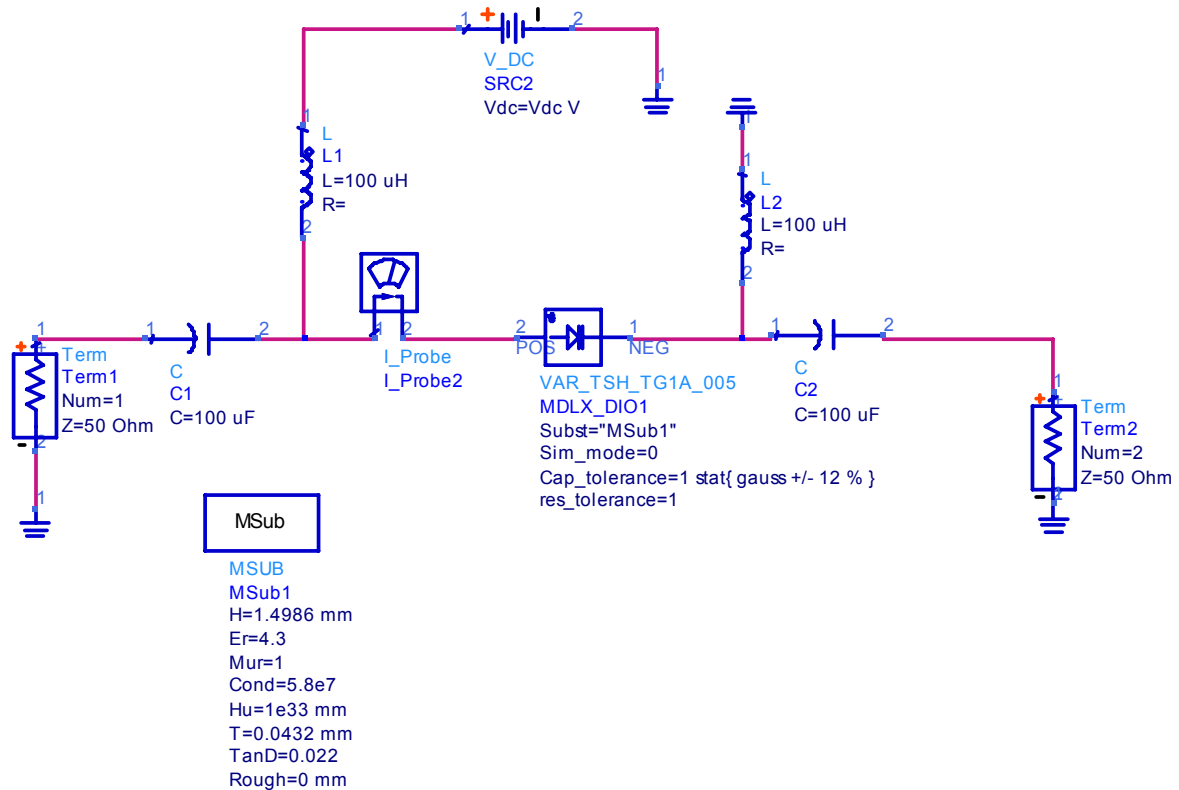
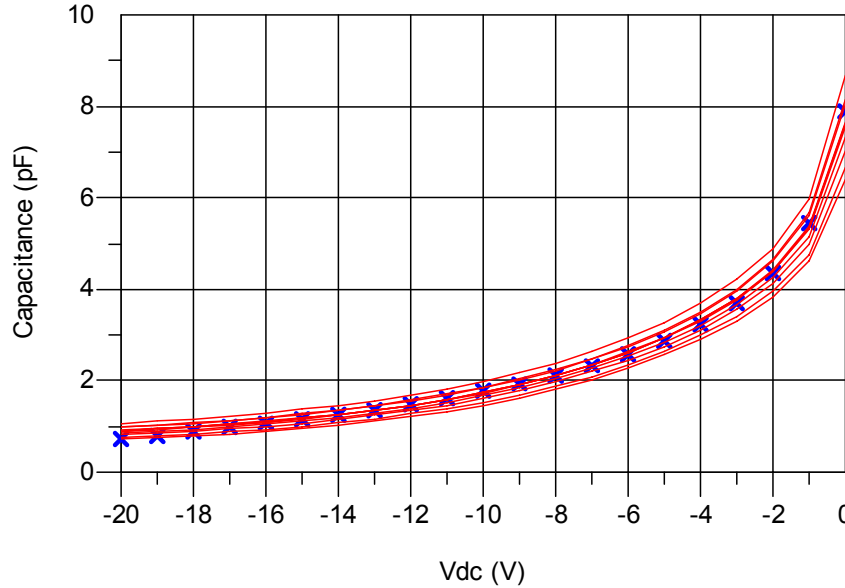


Figure 1 - ADS schematic for simulating tolerance in the varactor diode tolerance.

The simulation results for the schematic in Figure 1, at 1 MHz, are shown in Figure 2. Here the effective series capacitance has been calculated from the Y-parameter data as a function of reverse bias.



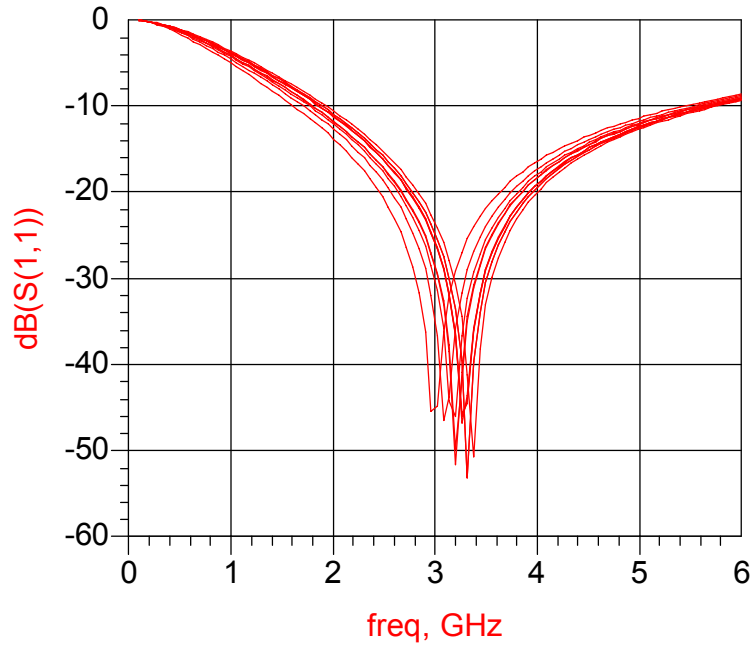
**Figure 2 – Effective capacitance extracted from the Y-parameters of the circuit in Figure 1, at 1 MHz.**

A comparison between the results in Figure 2 and the manufacturer specifications is given in Table 1. These results indicate that the +/-12% Gaussian distribution is an appropriate specification in order to accurately emulate the vendor-supplied data.

**Table 1 - Comparison between simulated and vendor-specified capacitance.**

	Minimum		Maximum	
	Simulated	Vendor specification	Simulated	Vendor specification
Capacitance (-2V) in pF @ 1MHz	3.85	3.8	4.9	4.7
Capacitance (-10V) in pF @ 1MHz	1.48	1.5	1.98	2.0

For completeness, a broadband S-parameter (Monte Carlo) simulation illustrating the effect of the capacitance tolerance on resonant frequency is shown in Figure 3. This simulation was run at -10V reverse bias.



**Figure 3 - Monte Carlo S-parameter simulation at -10V bias.**

The complete NLD Library features approximately 30 diode models, including Schottky, PIN and varactor types. Contact [sales@modelithics.com](mailto:sales@modelithics.com) to request a free trial.

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