

Digital Twin Emulation of a Hartley Oscillator Circuit for EMI and Thermal Mitigation of Semiconductor Device Packages

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Higher manufacturing yields for higher density and higher data speed heterogeneous electronics imply Electromagnetic Interference (EMI) challenges. As an example, the realization of simple Hartley oscillator circuits require the packaging of passive components with an active device. Oscillatory circuits, like the Hartley oscillator, are well behaved at room temperature with acceptable margins. However, as the components are more densely packaged, there is Electromagnetic Interference (EMI) on the oscillator circuit, leading to a phase lock loop instability that must be addressed.

The impact of EMI can be better understood through digital twin simulations [G. A. Duhni, et al, "Component-Level Shielding with Assembled Copper Trenches in Package Slots," *SoutheastCon 2023*, Orlando, FL, USA, 2023, pp. 38-42, doi: 10.1109/SoutheastCon51012.2023.10115102]. By developing a model-based design approach using a virtual digital twin an understanding of the vulnerabilities can be studied for design adjustments. The goal is to create an "in-situ tuning" of the Hartley oscillator to mitigate variabilities caused by external electrothermal and EMI variabilities. Notably, "in-situ tuning" of the circuit's oscillation frequency is traditionally accomplished by varying the value of the tuning capacitor or the position of a movable core within the inductor, avoiding a need to physically change components in the circuit. By contrast, in this paper, "in-situ tuning" is accomplished by adjusting "coupling effects" through increased transmission line lengths or passive component tuning during the fabrication process. Essentially, the tuning structures are strategically introduced into the devices feedback paths as in Figure 1. These tuning components become an essential part of the circuit to carry out the necessary adjustments during final fabrication and without requiring active intervention. Essentially, the tuning adjustments are accomplished passively, relying on inherent coupling mechanisms to manage the situations without direct intervention. At the meeting, specific oscillator circuit design will be presented along with mitigation approach using digital-twin models.

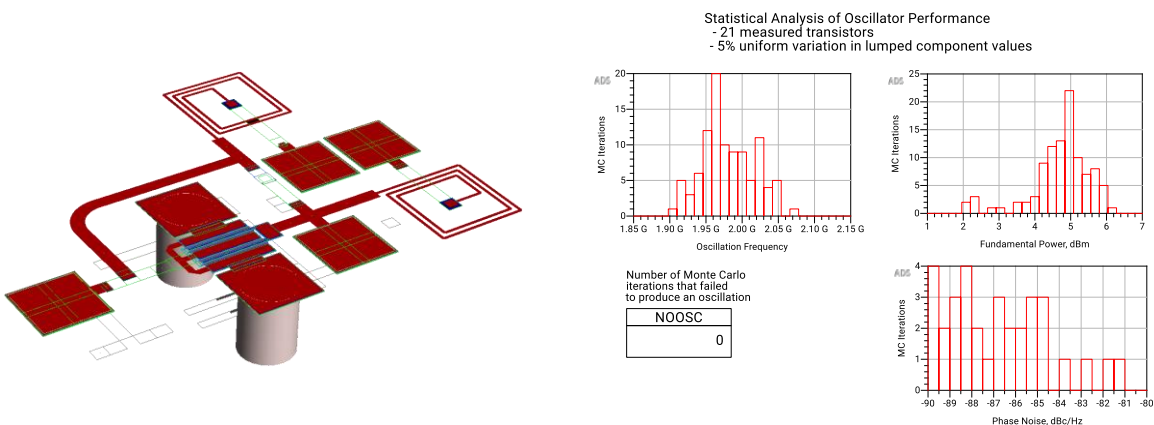


Figure 1. Hartley oscillator realization (left) and Monte Carlo Analysis (right).

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