Abstract To engage in the practical design and construction of electronic components and systems, one must mitigate the presence of uncertainty in the design and manufacturing process which leads to material and structural variability in the realized system. To improve production yields of widely multi-scale structures under conditions of uncertainty in a high volume manufacturing (HVM) environment, the designer resorts to electrical design automation (EDA) tools in the search for a robust solution space. In this context, the accuracy and efficiency of the underlying models and methods of EDA are fundamentally critical to the characterization efforts of the components and system, and in providing indispensable intuition and guidance throughout the design process. To enable an efficient stochastic-based design optimization methodology for electrical components and systems, which exhibit randomness in their material and geometric characteristics, we infuse the stochastically collocated reduced-order state-space electromagnetic model, into one of the most extensively used methods for electromagnetic modeling and simulation, namely, the method of finite-difference time-domain (FDTD). To this end, we develop the stochastic electromagnetic macro-model in FDTD by formulating an abstraction layer that encapsulates the fine features of the multi-scale structure, where uncertainty is most often present.