

Stability Assessment of Multi-rate Electromagnetic Transient Simulations

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Multi-rate Electromagnetic Transient (EMT) simulations use smaller time-steps for parts of the network requiring greater accuracy, and larger time-steps for the rest of the network. This paper presents an analytical approach for evaluating the stability of multi-rate EMT simulations of linear time-invariant (LTI) networks. It is shown that their resulting discrete time system is inherently time-periodic. Leveraging this characteristic, a sampled-data time-invariant representation of the simulated network is derived. The overall simulation's numerical stability can then be assessed through eigenvalue analysis. The paper shows that contrary to popular belief, a multi-rate EMT simulation may become unstable even if the well-known A-stable trapezoidal rule is used. The proposed approach is validated with example simulations.