Fiber Glass-Weave Skew Analysis using the Finite-Difference Time-Domain Method

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As the interconnects on a high-speed printed circuit board (PCB) carry more bits per second, the receiver-side skew (between the two signals on a differential pair) because of the glass fiber weave inside the PCB composite becomes more crucial to predict and control. Accurate simulation models to estimate the glass-weave skew and thereby predict the bit error rate, and the differential-to-common signal conversion are very helpful in the robust design of high-speed boards.

The finite difference time domain (FDTD) technique with its inherent capability to produce transient (time-domain) and wide-band (frequency-domain) responses might better suit this skew study. The challenges in FDTD are to implement frequency-dependent conductor (skin effect) and dielectric losses (dispersive complex permittivity) with high degree of accuracy. Keeping in mind the complex permittivity profile as a function of frequency when inverse Fourier-transformed to time domain, one should expect a causal response.

This work demonstrates that FDTD, with the help of the techniques available in the literature, can successfully estimate the signal skew in high-speed PCBs. Skew can be extracted directly from the FDTD time-domain responses without the need for transfer functions and impulse responses constructed from S-parameters. Also, the FDTD simulation data in the form of S-parameters are benchmarked with the measurement data and the data from frequency-domain FEM solvers such as HFSS and/or Simbeor. The acceleration of FDTD using the GPU leads to faster FDTD simulations and results in a wide-band S-parameter data from a single simulation.

Other glass weave effects such as accentuated losses at certain frequencies because of the periodic discontinuities (the so-called Bloch wave effect) were also investigated.