SIGNAL INTEGRITY
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To tee or not to tee

You cannot satisfactorily terminate the net topology in **Figure 1**. What I mean is, you can't obtain a crisp first incident wave that is full-size without reflections and still meet the demands of good circuit-design practice. You can satisfy any combination of some, but not all, of the above requirements. (If you are interested, details about the waveforms and simulation parameters described in this article are available at www.sigcon.com/articles/edn/tee.htm.)

With a fast, 1-nsec driver, the basic problem with this topology is that the signal delay on each branch (1 nsec) is longer than the rise time. Such a net, if left unterminated, displays what you would expect: full transmission-line characteristics with lots of overshoot and ringing (Waveform 1).

A slower driver improves the ratio of line delay to rise time. For example, a 15-nsec driver is slow enough to damp out the ringing and reflections, but, unfortunately, such a slow driver gives you a long, sloppy, rise time. You lose the first criterion: a nice, crisp first incident wave (Waveform 2).

Attenuation can help. A combination of a 50Ω series termination at A and 50Ω end terminations at C and D damps all reflection modes. Unfortunately, this approach shrinks the received signal to only one-third of normal size—too small for practical use (Waveform 3).

Partial terminations can help calm, but not totally cure, the ringing behavior. With 100Ω terminations at C and D, the first incident wave looks perfect. But, after a while, the reflections trapped between the low-impedance driver at A and the mismatch at junction B cause the received signal to overshoot, crest, and rattle about (Waveform 4).

If you are willing to use a sneaky trick, you can have it all. The trick is to implement segment A-B as a 50Ω line while implementing segments B-C and B-D as 100Ω lines. (It takes really skinny microstrips to get this approach to work, but it's possible.) When the signal from A hits Junction B, it sees two 100Ω loads in parallel, which is a good match for the 50Ω segment A-B. No reflections

> **When you try something tricky—even if you sit with the layout person during design to make it work—the design will ultimately self-destruct when someone else revises the layout as part of a future product upgrade.**