

Source Termination Resistor Location And Its Impact On The Signal Integrity Of High Impedance Loads

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Abstract— It is of interest to understand the impact of the location of source termination resistors on the signal integrity of the received signal when the terminating resistor is placed away from the source, and the load is a high impedance load. This situation is commonly encountered when there is not enough printed circuit board area to place the terminating resistor close to the source, for example. Field programmable gate arrays are such an example in which the pin field is too dense to allow the placement of load termination resistors close to the sources.

I. INTRODUCTION

This paper discusses the signal integrity performance of series terminating resistors when the resistor is away from the source. In this case, if the risetime of the source's signal is small compared to the propagation delay to the terminating resistor, then reflections will occur between the terminating resistor and the source's output resistance. On the other hand, if this risetime is large compared to the propagation delay, then no reflections will occur between the source and the termination resistor. Figure 1 highlights this situation.

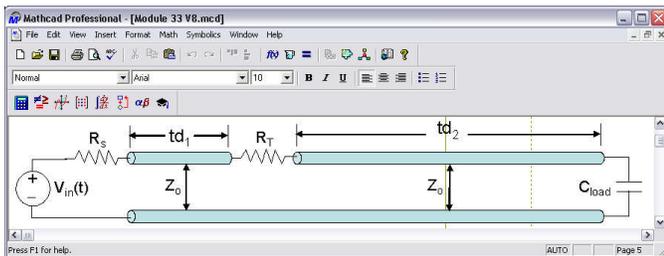


Fig. 1. Terminating the source with a series terminating resistor, R_T . The termination resistor can be placed either close to or away from the source.

II. SIMULATION RESULTS

In this situation, it is of interest to understand the quality of the received load waveforms when either the risetime of the source's signal (t_r) is much less than the propagation delay to the termination resistor (td_1), or when t_r is much larger than td_1 . Figure 2 shows the received load waveforms when a

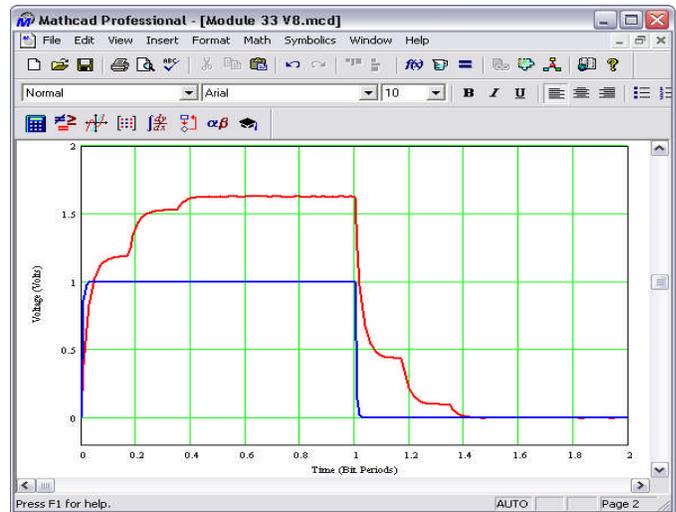


Fig. 2. Source (blue) and load (red) pulse waveforms when the risetime of the source signal is equal to the propagation delay between the source and its termination resistor, and $R_S = 10\Omega$ and $R_T = 40\Omega$.

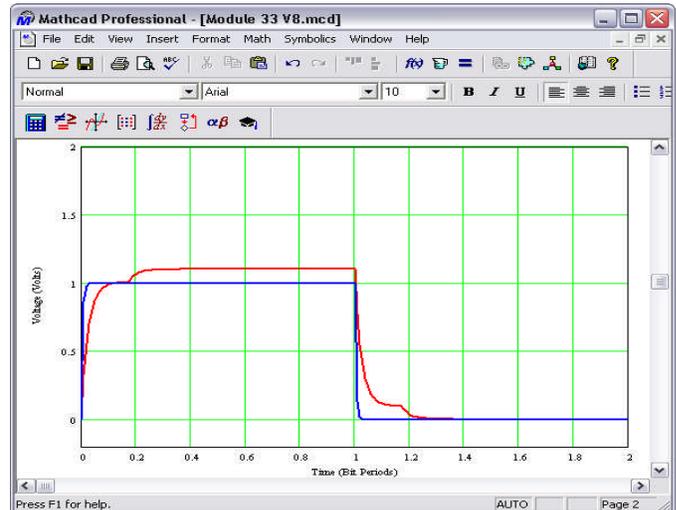


Fig. 3. Source (blue) and load (red) pulse waveforms when the risetime of the source signal is equal to the propagation delay between the source and its termination resistor, and $R_S = 40\Omega$ and $R_T = 10\Omega$.

20Mbps signal with a 200ps risetime, and with $td_1=200ps$ and $td_2=1.75ns$, propagates along a 50Ω transmission line. In this case, $t_r = td_1$, and reflections exist between the terminating

resistor and the high impedance load. In this case, the value of the termination resistance is about 80% of the transmission line's characteristic impedance.

Alternatively, Figure 3 shows the case in which the value of the termination resistance is small, and is about 20% of the transmission line's characteristic impedance. Figure 4, on the other hand, shows the results when t_{d1} is much less than t_r . Therefore, as long as the propagation delay between the source and the terminating resistor is small compared to the risetime, then the received load waveform exhibits good signal integrity characteristics. In addition, if the value of the termination resistance is small compared to the transmission line's characteristic impedance, then the reflections from the load to the source are smaller and may be acceptable. The propagation delay for signals on a printed circuit board is about 160ps/inch up to about 180ps/inch. For a 1-inch distance between the source and the termination resistor, the propagation delay is equal to about 160ps – 180ps. For no reflections to occur at the high impedance load, the risetime of the signals from the source should be much larger than these delays, for example.

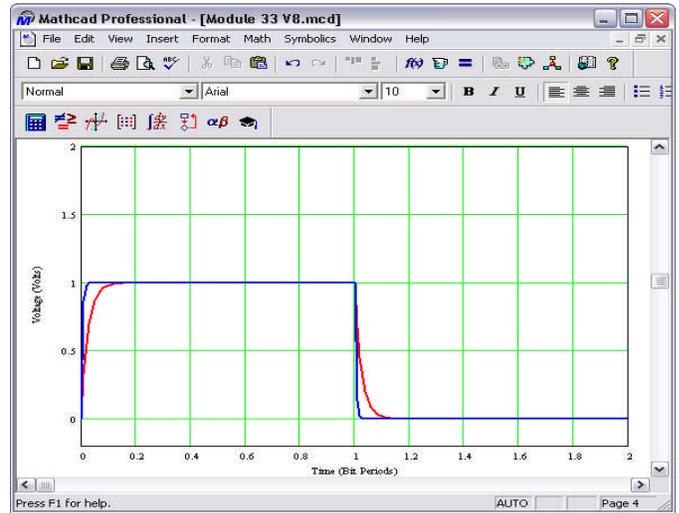


Fig. 4. Source (blue) and load (red) pulse waveforms when the risetime of the source signal is large compared to the propagation delay between the source and its termination resistor.

III. CONCLUSIONS

Based upon the previous research, it was disclosed that the source termination resistor can be placed away from the source as long as the propagation delay between the source and the termination resistor is small compared to the risetime of the source's signal. When this condition is violated, significant signal degradations can occur at the load. On the other hand, if the value of the termination resistance is small compared to the transmission line's characteristic impedance, then the reflections from the load to the source are smaller and may be acceptable.