

# Clock Termination Techniques

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## Introduction

Clock generation and distribution have become more difficult as the speed and performance of microprocessors increase to higher limits. Controlled and precise clocking distribution techniques are needed to maintain a synchronous system. Clock signal quality and skew are the two major problems with distributing clock signals. With higher frequencies with the associated fast edge rates, long traces behave like transmission lines. Ring back, overshoot, and undershoot occur as a result of poor termination of transmission lines. They contribute to bad signal quality, false switching, and they can cause damage in extreme cases.

## Termination Techniques

There are four techniques to terminate a transmission line: Series, Parallel, Thevenin, and AC. For most TTL devices, the driver output impedance is less than the transmission line characteristic's impedance. When such a TTL driver is driving a small number of devices, series termination is recommended. The advantage of series termination is that it is simple, consumes low power, and uses only one resistor. The disadvantage of series termination is that it increases the rise and fall times of the signal. By eliminating secondary reflection off the driver end, series termination helps with signal quality. The next three termination methods eliminate reflection at load end. Figure 1 below illustrates the series termination method. In most designs, a value of  $R = 25\Omega$  to  $30\Omega$  is recommended.

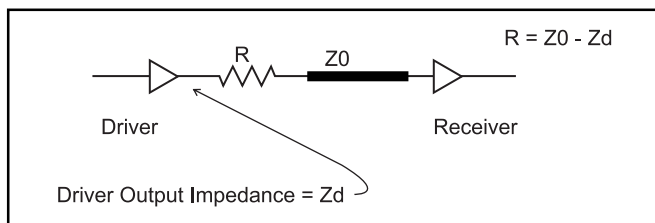


Figure 1. Series Termination

The other three termination techniques provide clean clock signals at the load. Figure 2 below depicts Parallel termination. Parallel termination consumes the largest amount of power.

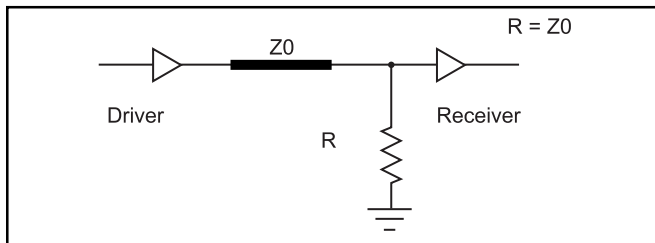


Figure 2. Parallel Termination

Thevenin termination consumes less power than parallel termination, however, it requires two resistors. Figure 3 depicts the Thevenin termination.

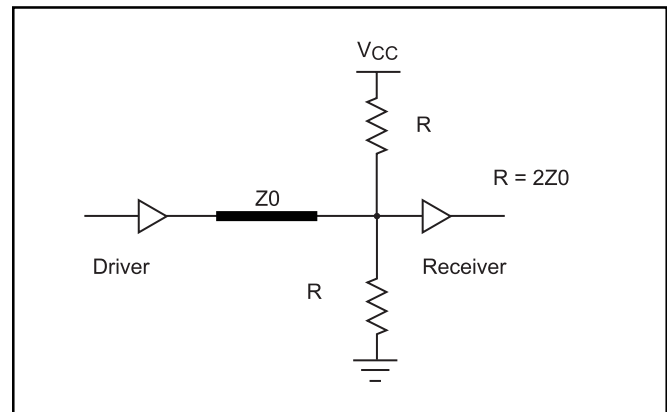


Figure 3. Thevenin Termination

AC termination is shown in the figure 4 below. AC termination adds a capacitive load to the driver and delay due to RC time constant, however, it consumes low power.

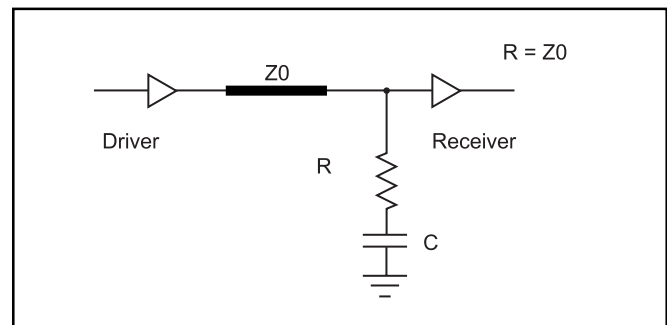


Figure 4. AC Termination

AC termination is recommended most for clock applications. An example of AC termination is when a  $75\Omega$  impedance is coupled with a  $100\text{pF}$  capacitor. To allow for leakage in input impedance of the receiver, the resistor is selected to be larger than the trace impedance. To allow for rapid transition of the clock edge, the capacitor value is selected at  $120\text{pF}$ . A higher capacitor value allows for heavier current levels to pass. However, higher capacitive values increases power dissipation. Capacitor values less than  $50\text{pF}$  diminish the effectiveness of termination.

