Using PI7AT04 Active Terminator Over Classical Methods of Termination

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Introduction

Today's high-speed requirements are challenging hardware designers to a new level. With current speeds, the PCB traces that allow the communication between devices can not be treated as simple wires or PCB traces, but as transmission line media. A common affect that is associated with transmission line media is the matching of the trace impedance. When proper termination is not met, the results are overshoot and undershoot at the receiver's end. Heavy overshoots and undershoots voltages may result in lost of data and unreliable system behaviors. There are several methods of achieving good termination such as series termination, parallel termination, AC termination, or diode termination to reduce the level of undershoot and overshoot. Although some of these classical methods can provide good termination, it can be difficult to accomplish and can have drawbacks on the application. A different approach is using an active terminator such as the PI7AT04 from Pericom Semiconductor to provide optimal performance.

PI7AT04 Advantages

- Works with 3.3V and 5V devices
- Provide proper termination regardless of the transmission line impedance
- Minimal power dissipation: only active when overshoot and undershoot occur
  (Quiescent current is 10μA maximum)
- Low power dissipation when active
- Suitable for Bus structure applications
- SOTiny package: requires less space

PI7AT04 Termination vs. Classical Methods of Termination

Series Termination

Series, parallel, and AC termination all share a common drawback, which is, finding a precisely matched resistor that can terminate the line with optimal results. This can prove to be a difficult task for designers, since designers will need to match the transmission line impedance with other requirements depending on which termination approach is taken. In series termination, the transmission line impedance must be matched in such a way that the sum of the driver's output impedance and the termination resistor must be equal to the transmission line impedance. This method can be difficult since most driver's output impedance can vary from device to device and from one logic state to another. Figure 1. shows a series termination setup.

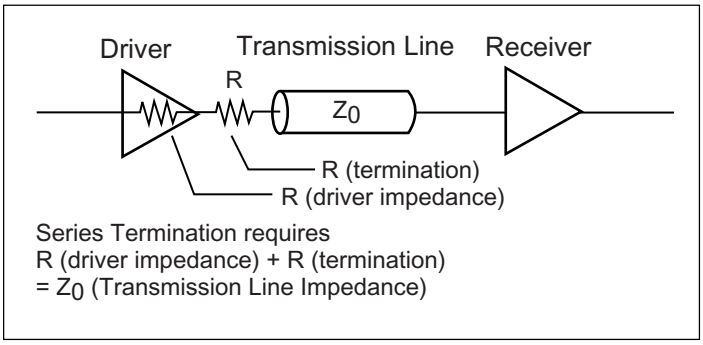

Figure 1. Series Termination

Parallel Termination

In parallel termination scheme, designers will need to worry about the amount of DC power dissipated from the termination resistor. This approach will require a constant DC current from the driver, which results in extra DC load on the driver itself. Figure 2. illustrates a parallel termination approach.

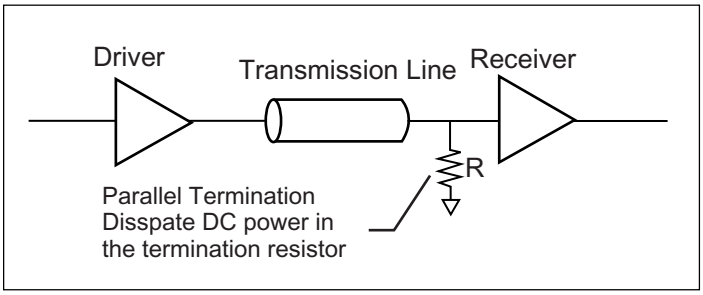

Figure 2. Parallel Termination

AC Termination

With AC termination, the task of finding a precise termination resistor is minimized and the constant flow of DC current is eliminated by a capacitor, which under DC conditions acts like an open circuit. Although the task of finding a precise resistor is minimized, the task does not completely go away, but is shifted to the capacitor. A capacitor's value for AC termination becomes very critical since

it will contribute to the RC time constant and can affect the slew rate. AC termination's performance will also depend greatly on the length of the transmission line; again, adding more barriers for designers to overcome. Figure 3. shows an AC termination configuration.

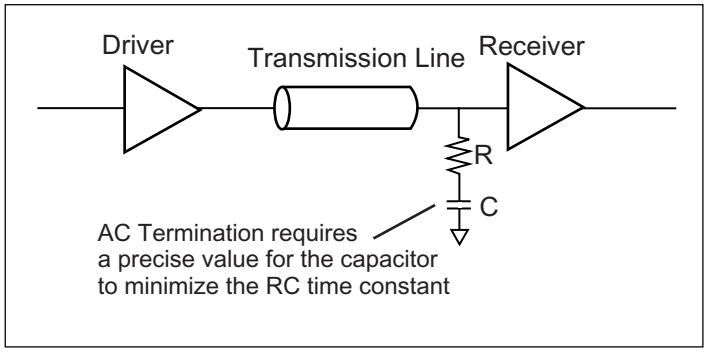

Figure 3. AC Termination

Diode Termination

Another approach, which completely voids out impedance matching and takes the termination resistor out of the equation is the diode termination approach. Diode termination can be an effective method compared to series, parallel and AC termination. It does not involve load impedance nor does it consume DC power when the signal voltage is operating within normal range. Although diode termination can be effective, one main drawback is the diode's forward-voltage-drop of 0.6V to 1V, which prevents the signal from being clamped rail-to-rail. Because of the forward-voltage-drop of the diode, it will only be able to clamp the overshoot to one forward-voltage-drop higher than Vcc. Similarly with undershoot clamping, the diode will only be able to clamp the undershoot level to one forward-voltage-drop lower than GND. For example, if an overshoot of 2V occurs on a 5V signal, a diode with a forward-voltage-drop of 0.8V will only be able to clamp the signal to 5.8V. Likewise, if an undershoot of –2V occurs, the diode will only be able to clamp the signal to –0.8V. Because of the forward-voltage-drop that is required of the diode, diode termination becomes less effective as the logic voltage level moves to a lower voltage such as 2.5V and 1.8V. Figure 4. shows a diode termination.

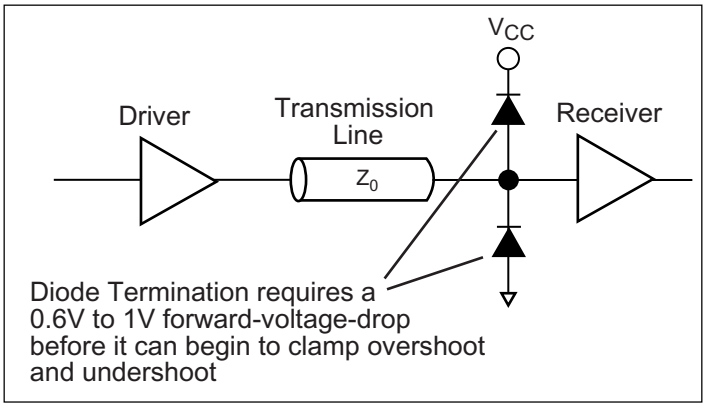

Figure 4. Diode Termination

Active Termination

Compared to classical methodologies , active termination is the best approach. Pericom Semiconductor offers the PI7AT04 as an active terminator product.

The PI7AT04 is an active terminator that has many advantages over classical termination methodologies. The main advantage the PI7AT04 has over some classical terminations is that it provides a universal solution for proper termination. Unlike series, parallel, and AC termination, the PI7AT04 does not require termination resistor matching, thereby, allowing it to clamp overshoots and undershoots with optimal results regardless of the value of the transmission line impedance. The universal solution advantage can be very crucial in applications where characteristic impedance of the transmission line may change over time such as in hotswap applications.

The PI7AT04 power dissipation is also minimal when compared to some classical terminations. When no overshoots or undershoots are detected, the PI7AT04 is inactive and the quiescent current is no more than 10μA. Therefore, the PI7AT04 is a more apparent choice in applications where power consumption is crucial such as battery operated applications.

Many of the advantagagious characteristics such as no termination resistor and low power consumption described above are also exhibited in diode termination. The main advantage an active terminator has over diode termination is that it presents a lower forward voltage drop than a termination diode. It will be able to clamp overshoots and undershoots closer to a rail voltage.

An application example is shown below in Figure 5. Figure 6. shows a signal after driving through a 5-inch transmission line without using the PI7AT04. Figure 7. shows how the signal quality has improved dramatically under the same condition when using the PI7AT04.

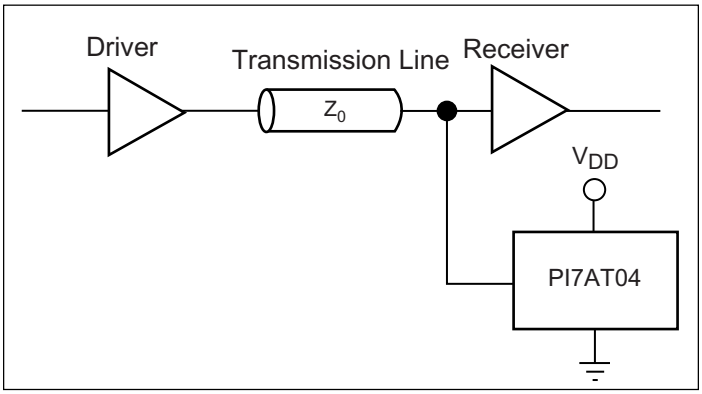

Figure 5. PI7AAT04 Circuit Configuration

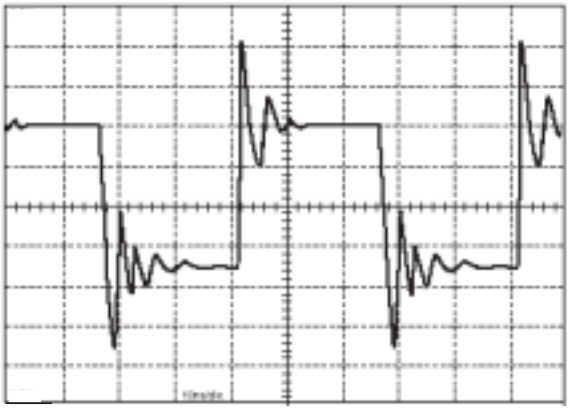

Figure 6. Signal with overshoot and undershoot when not using the PI7AT04.

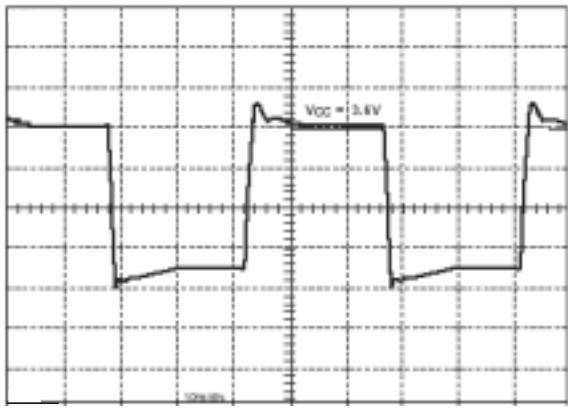

Figure 7. Overshoot and undershoot are reduced when using the PI7AT04

BUS Application for Pericom's PI7AT04

An application where the PI7AT04 can be applied is in bus structure such as a back plane application. In bus structure applications such as hot swaps, the bus is designed with long PCB traces and has high capacitive load when the slots are fully loaded with all the cards. Therefore, the requirement of strong driver strength is needed to drive the heavy capacitive load. But when the slots are loaded with fewer cards, the capacitive load is reduced and the driver strength designed for the heavy capacitance is much too strong and as a result, heavy overshoots and undershoots are generated.
Figure 8 and 9 show an example of the PI7AT04 for bus structure applications.

Figure 8 and 9 only show a generic application on how the PI7AT04 can be applied. The actual number of PI7AT04 required will vary from one application to another since in a bus application, the bus has no starting point and no ending point. A new card inserted will be a new beginning point or ending point depending on how we look at it. Therefore, it is recommended that at least one PI7AT04 is placed at the beginning, mid-section, and ending of the bus to cover all points. If the receiver is approximately one to two inches away from the driver, the PI7AT04 may not be required. But if the receiver is approximately three inches or more, it is suggested that the PI7AT04 should be used. But regardless of how many PI7AT04 are used, each PI7AT04 should be placed as close as possible to the receiver. Configurations for the PI7AT04 will vary from one application to another.

Conclusion

From the comparisons provided above, it showed that when good termination and low power consumption is needed, Pericom's PI7AT04 is the solution. The PI7AT04 is a universal solution for overshoots and undershoots protection that can be applied to many of today's applications. System behavior will be more reliable and false triggering can be a thing of the past.

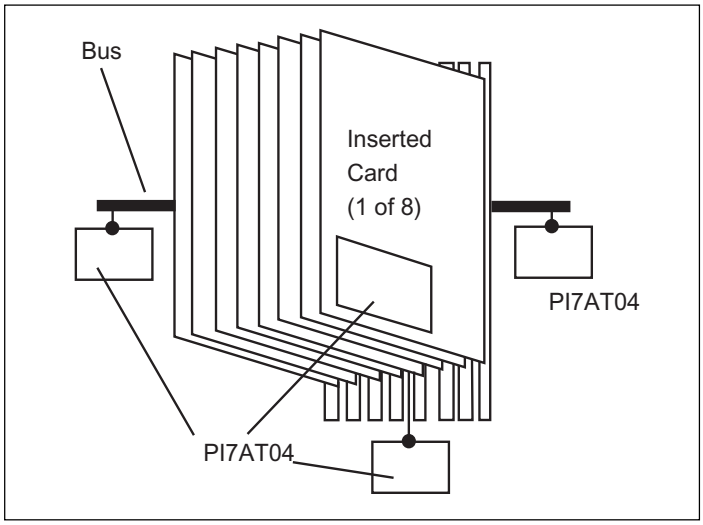

Figure 8. Backplane application where all cards are inserted.
Note: Actual numbers of PI7AT04 required are applications specific

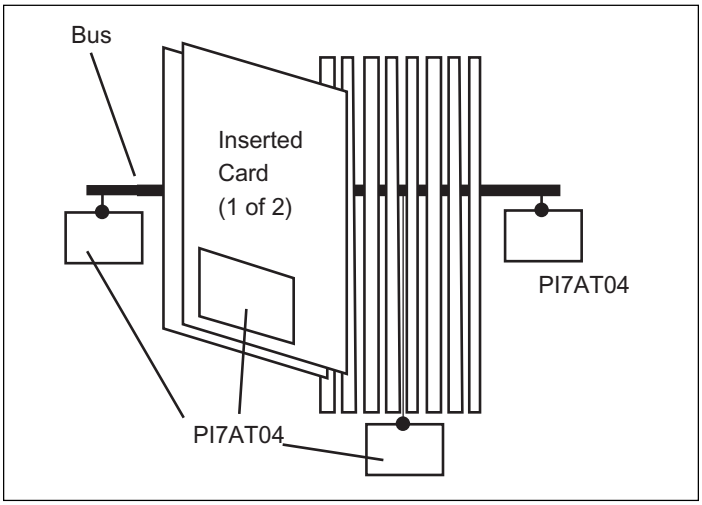

Figure 9. Backplane application with fewer cards inserted.
Note: Actual numbersof PI7AT04 required are application specific

References:

1. Karthik Ethirajan and John Nemec **" Termination Techniques for High Speed Busses"**, EDN Feb. 16, 1998

2. C. Pace, **"Termination Bus Lines to Avoid Overshoot and Ringing"** , EDN Sept. 1987
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