
USB3503 Low Power Configurations

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INTRODUCTION

The USB3503 is the industry's first HSIC-based USB 2.0 hub controller designed specifically for portable consumer electronics products such as smartphones, tablets and e-readers. The USB3503 features one HSIC upstream port, 3 downstream USB 2.0 ports, and is designed to deliver the low-power and ultra-small footprint that portable product designers demand.

Minimizing power consumption, thus extending portable device battery life, is crucial for maintaining a competitive edge in the portable device market. This document contains information for portable product designers looking to minimize suspended state power consumption in designs containing the USB3503.

This document includes the following topics:

- [Low Power Modes Overview](#)
- [Standard Suspend Mode](#)
- [Reset Suspend Mode](#)
- [Suspend Mode with Clock Power-Down](#)

Audience

This document is written for developers who are familiar with USB/HSIC protocol and the various features of the USB3503 hub. The goal of this application note is to familiarize the reader with low power options for the USB3503 and to assist the developer with choosing the most appropriate configuration for their design.

LOW POWER MODES OVERVIEW

The USB3503 is designed to handle USB communication within a personal device, such as a mobile phone or tablet device. The low power configurations detailed in this application note are presented as if the hub was designed into a personal device, where battery consumption is a primary concern. In a typical application, the HSIC upstream connection will interface with the personal device's microprocessor/controller. A downstream port may be connected to a device such as a modem which may be used to send and receive calls. To conserve power consumption while there is no modem activity, it is desirable to place the USB hub into low-power, suspended state. It may also be desirable that hub be able to rapidly exit the suspended state when data is ready to be sent to the hub from the downstream port. This document presents three different options for minimizing hub power consumption while the hub is not in use:

1. [Standard Suspend Mode](#)
2. [Reset Suspend Mode](#)
3. [Suspend Mode with Clock Power-Down](#)

[Table 1](#) describes the primary trade-offs associated with these configuration options.

TABLE 1: LOW POWER CONSUMPTION MODES QUICK COMPARISON

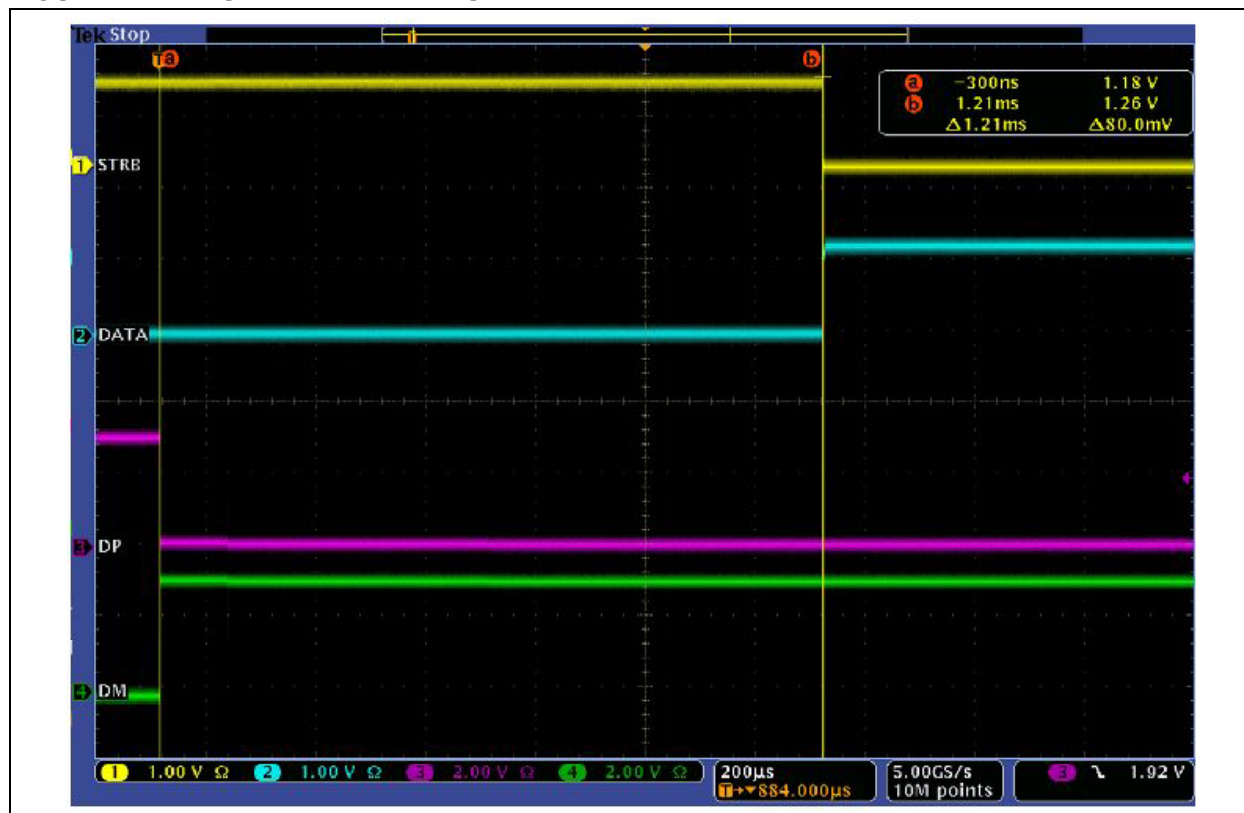
Mode	Pros	Cons
Standard Suspend Mode	• Fastest resume/wakeup • Simplest implementation	• Highest power consumption
Reset Suspend	• Lowest power consumption	• Slow resume/wakeup due to re-enumeration
Suspend Mode with Clock Power-Down	• Fast resume/wakeup • Reduced power consumption over standard suspend mode due to suspension of clock	• Non-default hub configuration and additional chip-to-chip signaling required

STANDARD SUSPEND MODE

For standard suspend configuration, the hub may be left in its default configuration. While the hub is in a suspended state, the downstream USB 2.0 D+ line is kept high and the D- line is kept low. When a downstream device attempts to wake up the hub from suspend to prepare upstream devices for data transmission, the downstream D+ line is switched low and D- line is switched high. This signaling is interpreted by the hub and passed upstream via the HSIC lines to signal the upstream device to prepare for data transmission. A screen capture of a standard wakeup event on the USB3503 is shown in [Figure 1](#).

While this method is fast, the hub must be kept in a low power suspended state while there is no USB activity. The clock signal is not interrupted when switching between states and thus continuously consumes power during the suspended state.

FIGURE 1: STANDARD WAKE-UP EVENT

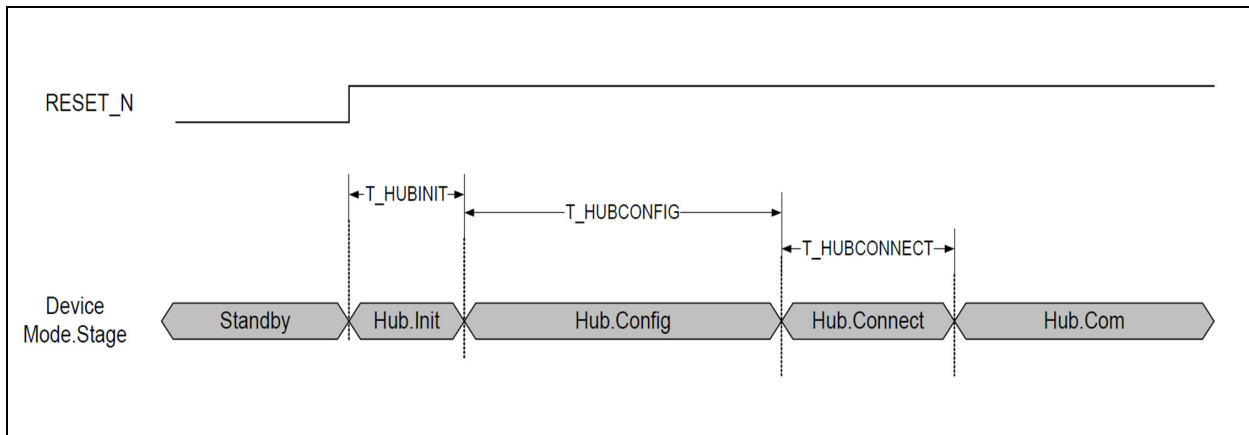


RESET SUSPEND MODE

The second option to minimize hub power consumption is to completely power down the hub when there is no activity by asserting the RESET_N pin. This configuration offers the lowest amount of power consumption, but is significantly slower to resume to active hub operation. Additionally, a microcontroller must be used in this case to determine when to de-assert RESET_N, as the hub will not automatically respond to communication from the downstream lines while in this state. The hub must then be fully configured (if needed) and enumerated every time the hub must switch to an active state.

The hub startup stages are shown in Figure 2. Typical values for $T_{HUBINIT}$, $T_{HUBCONFIG}$, and $T_{HUBCONNECT}$ are 3 ms, 95 ms, and 1 ms, respectively. After the hub startup sequence is complete, the hub must still be enumerated by the host before any data is transmitted, adding additional time delay until data may be transmitted upstream.

FIGURE 2: USB3503 STARTUP TIMING DIAGRAM



It is possible to cut down on the hub startup time by writing to register E7h, via SMBus address 8h, and forcing the hub to connect immediately instead of allowing the configuration timer to run out. Writing a "0" to bit [1] of this register will force the hub directly into the communication stage after asserted through a serial port write.

Figure 4 details the occurrence when the INT_N signal triggers the startup of a clock signal. It takes approximately 1.2 ms to pass the wake-up signal from the downstream USB 2.0 lines to the upstream HSIC lines in the USB3503 hub.

FIGURE 4: HUB WAKE-UP SEQUENCE WITH INT_N TRIGGERED CLOCK SIGNAL



The clock signal must be triggered and reach a steady state within 10 ms of the INT_N signal assertion. Figure 5 details that even with a relatively long clock signal startup delay of just under 10 ms, the hub is still able to pass the wake-up signals to the upstream HSIC lines and resume its normal active state.

FIGURE 5: HUB WAKE-UP SEQUENCE WITH 10 MS DELAYED INT_N TRIGGERED CLOCK SIGNAL



NOTES:

APPENDIX A: REFERENCES

The following document should be referenced when using this application note. Contact your Microchip representative for availability.

- USB3503 Data Sheet

APPENDIX B: REVISION HISTORY

Revision A (November 2013)

- Initial release of this document.

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ISBN: 978-1-62077-512-7

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