SuperSpeed USB Reference Guide

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What is SuperSpeed USB?

SuperSpeed USB is the brand name that the USB Implementers Forum (USB-IF) has associated with the USB 3.0 Specification. The USB 3.0 Promoters Group aimed to deliver four key values to the consumer with SuperSpeed USB:

1. 10x speed increase to 5-Gbps raw bit transfer rate

2. Improving the power efficiency of the bus

3. Maintaining backwards compatibility

4. Improving the data transfer efficiency itself.

The most obvious difference in SuperSpeed USB is the 10x speed increase from 480 Mbps to 5 Gbps. Although USB 2.0 high speed (and even USB full speed [12 Mbps] and low speed [1.5 Mbps]) are more than adequate for many applications, for others, the USB connection can become a bottleneck. **The 5-Gbps data rate of SuperSpeed USB should provide headroom for the next five years.**

Improving power efficiency is ideal for extending the battery life for portable devices, whether hosts or peripherals. There are multiple aspects of the new specification that were developed to address reducing the overall power footprint of new USB devices including:

- Elimination of device polling

- Elimination of broadcasting packets

- Intermediate low–power IDLE states

- 10x data transfer speed increase
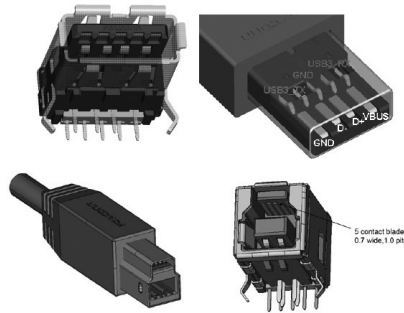
When you combine the bus usage efficiency (no broadcast packets and elimination of polling), the improved IDLE power states, and the lower average transmit power, **SuperSpeed USB will consume approximately one-third the power of USB 2.0.**

What does backwards compatibility really mean? When approached from the end–user perspective, it means that ALL existing products that are compliant with the specification will seamlessly connect to and work with all new products supporting the new specification. This means that the existing cables (i.e. plugs) must be able to be inserted into the appropriate new receptacle. The reverse is also true, that the new cables must be able to be inserted into the old receptacles – again where appropriate. Along with mechanical backward compatibility, the goal was to maintain the extensive device driver infrastructure. The same data transfer types – interrupt, bulk and isochoronous – were maintained. **Finally, this standard preserves existing USB ease-of-use expectations.**

There are two aspects to improve overall bus usage efficiency. The first aspect of this being the elimination of polling. Do not use the bus unless data is ready to be transferred. In addition, the full duplex architecture of SuperSpeed USB allows for concurrent bi–directional data flow as opposed to the half-duplex USB 2.0 architecture, eliminating the need to "turn around the bus," which significantly cuts into bus efficiency.

Applications and benefits

Where will SuperSpeed USB be used? Any place where high-capacity storage is needed to perform fast data sync-and-go to the computer.

The goal for sync-and-go operations is to take less than 90 seconds, the "threshold of pain" for many end users. Many portable devices use Flash memory for storage. Capacity will continue to increase, both because of customer demand and the dramatic increase in Flash capacity, as well as reduced cost. Therefore, Flash-based peripherals will benefit (and ultimately require) the much higher SuperSpeed USB data rates. This includes the most commonly used USB peripheral – the ubiquitous flash drive. Table 1 summarizes the user experience enhancement in moving from USB full speed to high speed, then to SuperSpeed USB. SuperSpeed USB enables well under 90 seconds for most sync-and-go applications.

Typical File Size	1 GB	6 GB	16 GB	27 GB
USB Full-speed	22 min	2.2 hr	5.9 hr	9.3 hr
USB High-speed	33 sec	3.3 min	8.9 min	13.9 min
SuperSpeed USB	3 sec	20 sec	53 sec	70 sec

Table 1: Sync-n-go rate comparison

In addition to these portable, consumer, content-rich applications, SuperSpeed USB will enable many additional applications where having a very fast transfer pipe from a peripheral to a PC is critical - such as image analysis, data acquistion, ultra-high-resolution imaging, and native USB displays.

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SN65LVPE502 SuperSpeed USB Redriver
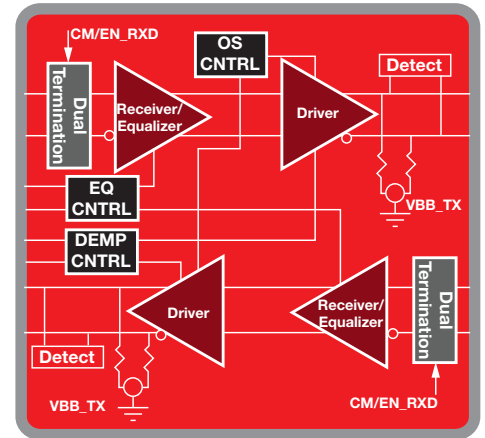
Description

The SN65LVPE502 is a dual channel, single lane USB 3.0 redriver and signal conditioner supporting data rates of 5.0 Gbps. The device complies with USB 3.0 spec revision 1.0, supporting electrical idle condition and low-frequency periodic signals (LFPS) for USB 3.0 power management modes. It features programmable equalization, de-emphasis and amplitude swing in order to minimize signal degradation effects such as crosstalk and inter-symbol interference (ISI) that limits the interconnect distance between two devices. Finally it supports three low power modes:

1. Sleep Mode
2. RX Detect Mode
3. U2/U3 Mode

Features and benefits

- Low power helps extend battery life in mobile applications with auto low-power modes
  - 6 mW when no cable detected
  - 70 mW in USB low-power modes
- Two–level equalization control and nine–level de-emphasis control enable excellent jitter and loss compensation to drive up to 24 inches of 6 mil on FR4
- Small 4mm x 4mm, 24–QFN package saves board space
- High protection against ESD transient
  - 8KV HBM
  - 1.5KV CDM

TUSB1310A SuperSpeed USB PIPE3/ULPI Transceiver

Description

The TUSB1310A is TI's second generation SuperSpeed USB transceiver that integrates both a USB 3.0 physical layer and a USB 2.0 physical layer. It implements industry-standard digital interfaces for connecting to the USB core-enabled processor, controller, or FPGA. PIPE3 is used for the SuperSpeed signal path, while ULPI is the path for high-speed, full-speed, and low-speed signals.

Features and benefits

- Receiver sensitivity of less than 50 mV differential peak-to-peak is twice as good as required by the specification. This allows for simpler board layout and longer cable usage to ensure broader compatibility.
- USB interface supports all USB application spaces.
- Industry standard digital interface enables easy system integration with attached core.
- Internal spread-spectrum generation enables use of a single, low-cost crystal.
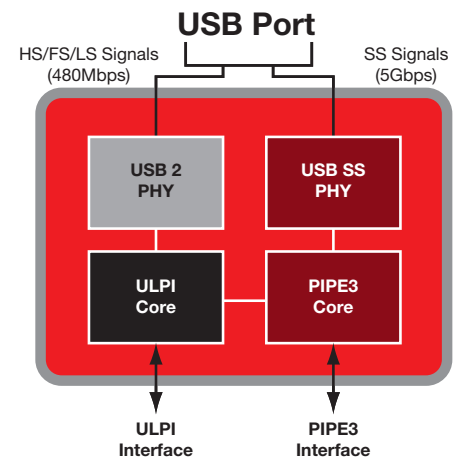

TUSB8040 SuperSpeed USB 4–port Hub

Description

The TUSB8040 is a SuperSpeed hub device that provides one upstream port and four downstream ports in compliance with USB specification version 3.0. Fully-compliant USB transceivers are integrated for all upstream and downstream ports. The downstream ports support both SuperSpeed USB and USB 2.0 connections, automatically routing through the hub logic to the appropriate upstream connection according to the speed of the device attached to the ports.

Features and benefits

- USB interface enables:
  - Increased number of available SuperSpeed ports.
  - Interoperability with latest high-performance USB peripherals.
  - Full backward- and forward-compatibility of all ports in a system.
- Internal spread-spectrum generation enables use of a single low-cost crystal.
- Best-in-class adaptive receiver equalizer design allows for simpler board layout and longer cable usage.

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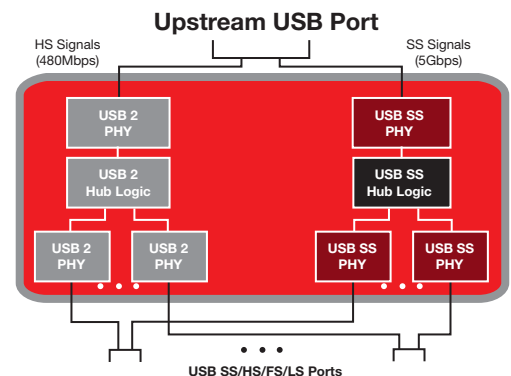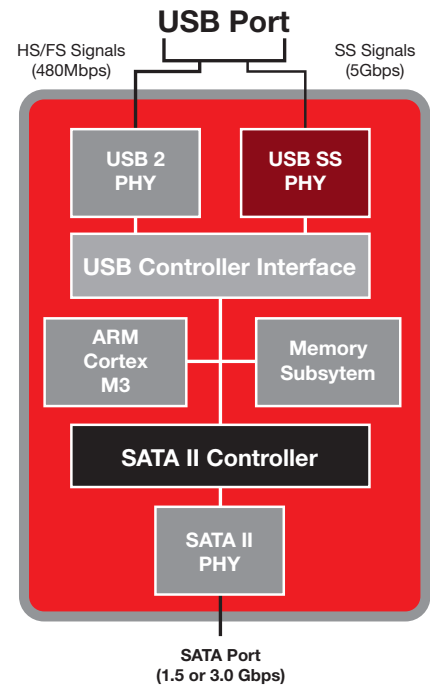
TUSB9261 SuperSpeed USB to Serial ATA 3–Gig Bridge

Description

The TUSB9261 is TI's second generation SuperSpeed USB function controller with integrated USB-compliant transceivers. It is intended as a USB-to-SATA bridge for storage devices using the SATA interface.

The TUSB9261 is designed to use both the fast performance of the state machine and the programmability and flexibility of the embedded microcontroller (MCU) and firmware. With the elaborate balance between the MCU and the state machine, it provides a bridge solution to meet both performance and flexibility requirements of next-generation external storage devices.

Features and benefits

- Performance enabled by TI's leading SuperSpeed USB analog PHY technology with Rx sensitivity of less than 50 mV differential peak–to–peak, which is twice as good as required by the USB 3.0 specification, enables longer etch runs or cable lengths to be used
- USB interface designed to maximize fast sync-and-go user experience
- SATA II interface insures cross platform compatibility and interoperability with latest high-performance storage drives
- Up to 12 GPIOs with PWM functionality for LED control on two GPIOs enables customer defined end-user configuration
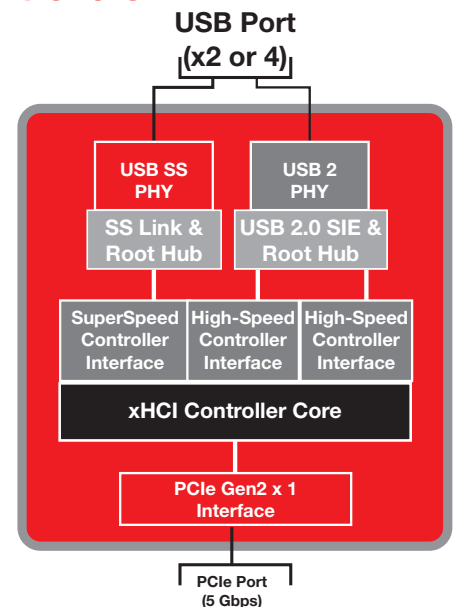
USB Port

HS/FS Signals (480Mbps)   SS Signals (5Gbps)

USB 2 PHY   USB SS PHY

USB Controller Interface

ARM Cortex M3   Memory Subsytem

SATA II Controller

SATA II PHY

SATA Port
(1.5 or 3.0 Gbps)

TUSB7320 & TUSB7340 SuperSpeed USB xHCI Host Controllers

Description

The TUSB73x0 family of SuperSpeed USB Host Controllers interface to the host system via a PCIe x1 Gen 2 interface. The downstream ports provide USB Interfaces that work up to 5 Gbps for data transfer when connecting to USB 3.0 compliant peripherals, while maintaining compatibility with existing USB high-speed, full-speed, or low-speed peripheral devices on the downstream USB ports. They comply with the USB 3.0 specification, and Intel's eXtensible Host Controller Interface (xHCI). The TUSB7340 supports up to four down-stream ports. The TUSB7320 supports up to two downstream ports. Both parts are available in a pin-compatible 100-pin RKM package.

Features and benefits

- Performance enabled by TI's leading SuperSpeed USB analog PHY technology with Rx sensitivity of less than 50 mV differential peak–to–peak, which is twice as good as required by the USB 3.0 specification, enables longer etch runs or cable lengths to be used
- USB interface designed to maximize compatibility across all USB peripheral spaces
- Full hardware solution requires no external Flash, saving up to $1.00 (USD) in BOM cost
- USB legacy support allows for BIOS support of keyboards and mice and booting from USB drive

**USB Port
(x2 or 4)**

USB SS PHY   USB 2 PHY

SS Link & Root Hub   USB 2.0 SIE & Root Hub

SuperSpeed Controller Interface   High-Speed Controller Interface   High-Speed Controller Interface

xHCI Controller Core

PCIe Gen2 x 1 Interface

PCIe Port
(5 Gbps)

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Devices	Description	Features
TUSB1310A	SuperSpeed USB transceiver with PIPE3/ULPI link interface	• ULPI & PIPE3 industry–standard digital interfaces • Receiver sensitivity 2X better than specification
SN65LVPE502	SuperSpeed USB redriver with adjustable equalization and de-emphasis	• 2–level equalization and 9–level de-emphasis • U2/U3 mode detection saves ~ 75% vs active power.
TUSB9261	SuperSpeed USB to SATA 3-GIG bridge	• SATA 2.6 compliant:: Gen1i, Gen1m, Gen2i, Gen2m • 12 GPIOs enable flexible end-product personalization
TPD2EUSB30	2-channel ESD for SuperSpeed USB differential signals	• Supports data rates in excess of 6 Gbps • Protection meets or exceeds IEC 61000-4-2 (Level 4)
TUSB7320	x1 PCIe GenII based 2-port SuperSpeed USB xHCI controller	• Supports USB charging port per battery charging 1.1 • USB legacy support
TUSB7340	x1 PCIe GenII based 4-port SuperSpeed USB xHCI controller	• Supports USB charging port per battery charging 1.1 • USB legacy support
TUSB8040	SuperSpeed USB 4-port hub	• SS/HS hub status outputs and USB 2.0 port indicators • Per port or ganged power management and over-current inputs option

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