PB product brief

Using USB 3.0 for Storage Media Applications

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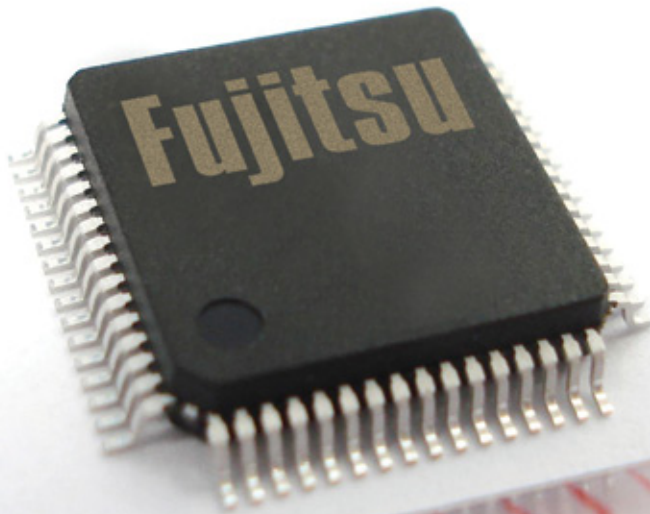
Introduction

Spurred by the increasing resolution and storage capabilities of consumer electronic devices, along with the wider availability of media via broadband Internet connections, users want a faster transfer capability to simplify downloading, storing and sharing large amounts of multimedia content. USB 3.0 will play a key role in providing the simple connectivity consumers want.

In fact, by closing the gap between internal and external storage performance, USB 3.0 is bringing a fundamental shift to the storage market. Because USB 3.0 enables external drives to achieve data transfer rates as fast as a PC's internal drives, users will be able to take advantage of external storage much more than they have in the past.

USB 3.0 delivers this new level of performance without changing the USB connector, offering full backward compatibility with existing PCs and devices. With its seamless interoperability, improved performance and features, USB 3.0 provides the ideal solution for a wide range of connectivity applications.

This product brief gives an overview of USB 3.0 benefits, as well as factors affecting the adoption of USB 3.0. The paper covers storage and other applications, since USB's universality is a major reason to use this interface for external disk drives.

USB has traditionally been the interface of choice for external storage while Serial ATA (SATA) has served as the interface for internal storage. But since USB 3.0 now supports the higher transfer rates of disk drives, commonly available SATA drives can be used as external USB 3.0 peripherals. Adding a USB 3.0 interface to a SATA drive is a straightforward process through the use of a device that bridges USB 3.0 to SATA.

To take advantage of this opportunity, Fujitsu has introduced a family of highly integrated USB 3.0-to-SATA and SATA-RAID bridge chips. With a form factor that fits easily into existing system configurations, the chip dramatically simplifies the implementation of external hard disks for both PC and Mac platforms and provides transparent data transfer between a USB 3.0 port and external disk drive. The new USB 3.0 device offers a compelling alternative to the use of external SATA (eSATA) for demanding external storage applications. Drive manufacturers can now design devices that take advantage of USB 3.0's promise of universal connectivity without sacrificing performance or features.

USB 3.0 Overview

USB 3.0—also known as SuperSpeed USB—provides a standard interface for almost everything that connects to a PC or audio/video equipment. From keyboards to high-throughput disk drives, devices can use this low-cost interface for plug-and-play connections that work so smoothly that users rarely give them much thought.

While maintaining full backward compatibility with USB 2.0, the new 3.0 standard offers several enhancements:

- Dramatically increased bandwidth—up to 5Gbps full duplex (compared to 480Mbps simplex for USB 2.0)
- Better power management
- Ability of the host to deliver more power to devices, enabling applications such as USB-rechargeable batteries, LED lighting, and mini fans
- Faster device identification by the host
- New protocols that make data handling more efficient

USB 3.0 can transfer large files (such as high-definition movies) at speeds limited only by the transfer rate of current storage devices. For example, a flash drive using USB 3.0 can move 1Gbyte of data to a host device in 3.3 seconds, compared to 33 seconds with USB 2.0.1.

For both system and ASIC developers, the wide availability of USB 3.0 chips and intellectual property ensures that every design requirement can be met in a timely way. This broad support is especially important for a standard such as USB 3.0 where high speeds, sophisticated protocols and variable cable length (from a few inches to several meters) make both design and standard compliance a challenge.

SATA vs. USB

Each of the interfaces competing for external storage applications in recent years—USB, eSATA and FireWire—has claimed a significant numbers of wins in the personal computer space. At this point, SATA, with its low processor overhead and fast transfer rates, has replaced all other interfaces for internal drive connectivity in consumer PCs. The older Parallel ATA (PATA) remains in use for industrial and embedded applications using CompactFlash as a storage medium, although the new CompactFlash version known as CFast will be based on SATA.

Since its introduction in 2004, eSATA has challenged USB 2.0 and FireWire for external storage applications. With transfer rates up to 3Gbps, eSATA transfers data to and from external devices at the same rate supported by SATA for internal drives. Even with actual transfer rates reduced by encoding overhead,
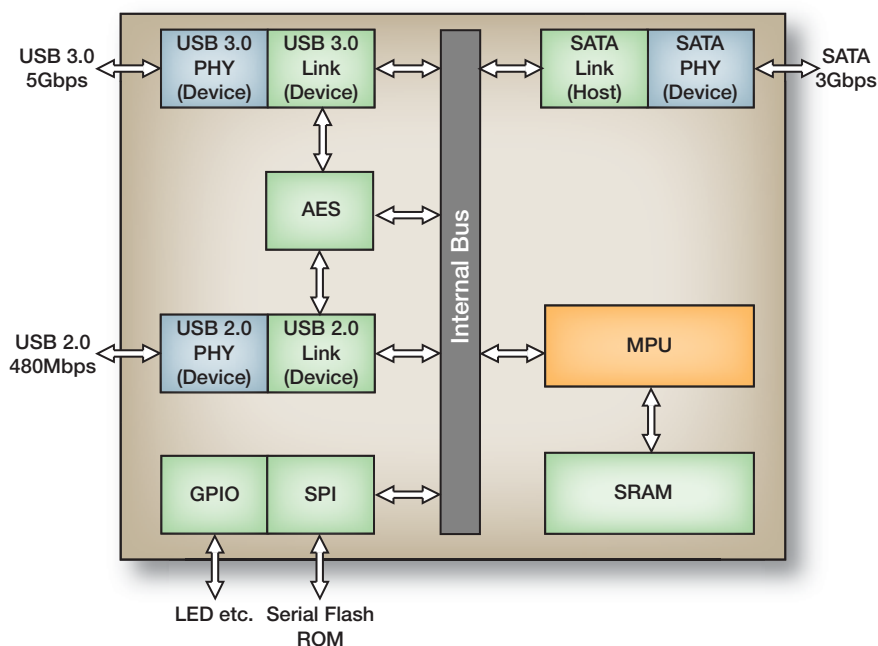

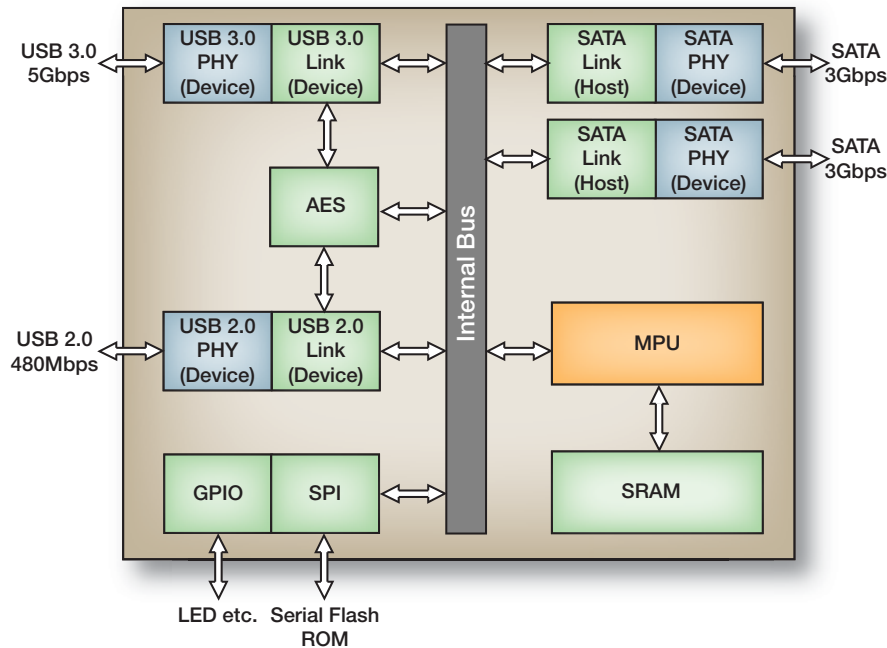Figure 1: Block diagrams of the MB86C311A chip with hardware AES

FIgure 2: Block diagrams of the MB86E501A (dual-port RAID) chip with hardware AES

eSATA's data rate is more than high enough for the fastest hard drives, which can transfer data at about 120MB/s (about 960Mbps).

This performance has enabled eSATA to take market share from both USB 2.0 and FireWire, even though eSATA is useful only for storage applications. But eSATA's advantageous position may be about to change.

USB 3.0 is considerably better than eSATA and FireWire 800. At 5Gbps full duplex, USB 3.0 is much faster than eSATA and FireWire 800 (which achieves almost 800Mbps full duplex). But the advantage is not just in speed. USB 3.0 provides a full-duplex transfer rate in contrast to eSATA's simplex 3Gbps transfer rate. Finally, while it is too complex to describe here in detail, USB 3.0 includes optional provisions for transferring out-of-order data optimized for disk drive seeks.

Fujitsu USB 3.0 - SATA Chip Solution

The Fujitsu MB86C31 and MB86E50 single-chip solutions enable a straightforward way to bridge between USB 3.0 and SATA/ATA/ATAPI-based mass storage devices. By translating USB 2.0 and USB 3.0 mass storage commands to SATA and ATA/ATAPI communication protocols, the bridge chip allows designers to adapt SATA hard drives for USB 3.0.

The Fujitsu MB86C31 and MB86E50 series chips, which are fabricated based on 65nm CMOS technology, offer low power consumption and greater flexibility in adopting higher-speed USB specifications in the near future.

The MB86C31 and MB86E50 series chips comply with USB 3.0 specification 1.0, which was released in November 2008, and with SATA specification revision 2.6. Both chips adhere to the USB Attached SCSI (UAS) and Mass Storage Class Bulk-Only Transport (BOT) specifications. The MB86E50 series adds RAID capability to the design, allowing for high-performance dual HDD/SSD applications.

The block diagrams in Figure 1 and FIgure 2 illustrate the main functions of both the MB86C31 and MB86E50 series chips.

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Features

High-speed encryption engine
For security-sensitive storage applications, the MB86C31 and MB86E50 series offer optional high-speed encryption technology. The security-enabled MB86C311A and MB86E501A are embedded with a command parser that supports the ATA command set with a high-speed encryption engine and DMA controller. Because encryption is handled in hardware rather than software, the MB86C311A and MB86E501A maximize the USB 3.0 potential transfer rate. The chips support 256-bit key length for XTS-AES. The encryption engine is based on the National Institute of Standards and Technology (NIST) standard AES code/decode hardware engine.

Power management
The MB86C31 and MB86E50 series supports many new power-management features that were introduced with USB 3.0. For example, USB 3.0 endpoints inform the host when they are ready to send data, saving power that would be wasted in polling endpoints. Other protocol changes save power in similar ways, and the USB 3.0 link layer automatically goes into low-power states based on bus activity.

PHY and link integration for USB 2.0/USB 3.0 and SATA
The MB86C31 and MB86E50 series integrates physical layer interface (PHYs), USB2.0, USB3.0 and SATA. The implementation requires a minimal number of external components and enables easy connection to the physical medium.

Embedded spread-spectrum clock generator (SSCG)
Because electromagnetic interference (EMI) becomes more problematic at higher frequencies, USB 3.0 requires the use of a spread-spectrum clock, which must be generated independently in the host and at each endpoint. The Fujitsu bridge chip operates at 75 MHz and integrates an SSCG. This integration simplifies the system design, and reduces the need for other noise-abatement components such as bypass capacitors, choke coil, and ferrite beads.

High-performance CPU and other resources
The MB86C31 and MB86E50 series integrates a high-performance, 32-bit ARM™ Cortex-M3™ processor, operating at 75 MHz with a dedicated program memory of 64 Kbytes. With custom firmware, developers can create highly differentiated external SATA drives. General-purpose I/Os (GPIOs) further extend the device's versatility.
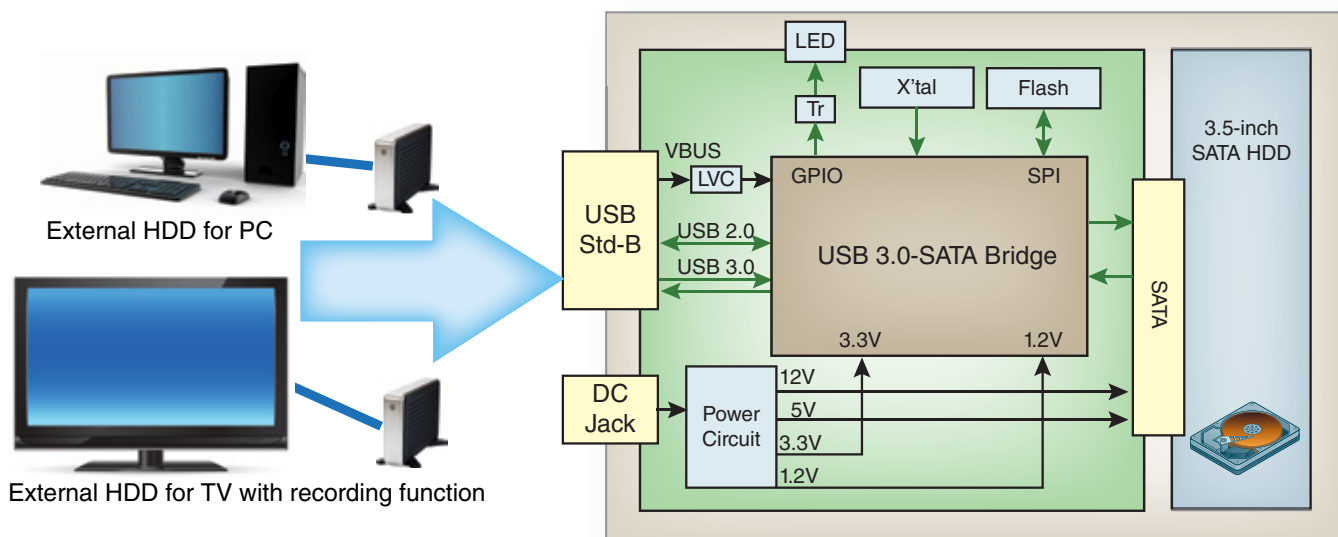
Figure 3: Hard disk drive applications using the Fujitsu MB86C311A bridge chip

SPI interface option

The MB86C31 and MB86E50 series features a Serial Peripheral Interface (SPI) to provide connectivity to serial flash ROM.

Customized functions (VID and PID)

Every USB product has a unique Vendor ID (VID) and Product ID (PID). Both the MB86C31 and MB86E50 series allow customers to customize the VID, PID and strings on the chips.

Easy migration

To address the costs and risks associated with migration to a new standard, Fujitsu offers the MB86C31 with two of the industry's most popular packages. The MB86C31 is available in either a 64-pin (7mm x 7mm) LQFP or a 48-pin (6mm x 6mm) QFN with a 0.4mm pitch, thereby providing design flexibility that will help keep PCB manufacturing costs to a minimum. The MB86E50 series is available in a compact 68-pin QFN (0.4mm pitch, 8mm x 8mm) package.

The MB86C31 and MB86E50 series complies with these standards:

- Universal Serial Bus Specification 3.0, Revision 1.0
- Universal Serial Bus Specification, Revision 2.0
- Mass Storage Class Bulk-Only Transport, Revision 1.0
- USB Attached SCSI (UAS), Revision 4
- Serial ATA Specification Revision 2.6

ATA and ATAPI device support

Presently the USB Class Driver functions as a Logical Device Driver (LDD) that provides for interoperability with HDD or Blu-Ray devices.

The block diagram in Figure 3 shows representative applications for external hard drives connected via USB 3.0 in conjunction with a PC or consumer electronics device.

Dual-port RAID support (MB86E50)

The Fujitsu MB86E50 series is specifically designed for external USB 3.0 dual-port RAID and non-RAID HDD/SSD applications. The series supports RAID 0 (striping) and RAID 1 (mirroring) as well as JBOD ("just a bunch of disks") and dual LUN configurations.

RAID configurations have traditionally been used for the enterprise and high-performance storage applications that require the greater reliability, redundancy and performance of multiple-disk-based storage. Currently, most RAID configurations are based on SATA (internal) or eSATA (external).

With the MB86E50, Fujitsu enables drive and system manufactures to offer RAID-enabled storage based on the USB 3.0 standard. The MB86E50 series combines the advantages of USB 3.0—including higher transfer rates, plug-and-play interoperability, and hot-swapping—with the greater reliability and performance of RAID. Available with a hardware-based high-speed encryption engine, the MB86E50 series offers a truly robust, secure and flexible external storage solution.

Summary

The need to transfer ever greater amounts of information between PCs, external hard drives, portable electronics devices, and flash-based SSD drives continues to drive the need for faster transfer methods. With an order of magnitude higher throughput than the previous USB version, USB 3.0 provides a transfer method that will satisfy a broad range of requirements for many years to come. Fujitsu's MB86C31 and MB86E50 series USB 3.0/SATA bridge devices offer an easy way for developers to adapt SATA drives for USB 3.0, enabling customers to complete data transfers in seconds that formerly would have taken many minutes.