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Universal Serial Bus interfaces for data and power – Part 3-1: Universal Serial Bus 3.1 Specification

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UNIVERSAL SERIAL BUS INTERFACES FOR DATA AND POWER –

Part 3-1: Universal Serial Bus 3.1 Specification

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The text of this standard was prepared by the USB Implementers Forum (USB-IF). The structure and editorial rules used in this publication reflect the practice of the organization which submitted it.

The text of this standard is based on the following documents:

CDV	Report on voting
100/2589/CDV	100/2684/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

A list of all parts in the IEC 62680 series, published under the general title *Universal serial bus interfaces for data and power*, can be found on the IEC website.

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- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The IEC 62680 series is based on a series of specifications that were originally developed by the USB Implementers Forum (USB-IF). These specifications were submitted to the IEC under the auspices of a special agreement between the IEC and the USB-IF.

The USB Implementers Forum, Inc. (USB-IF) is a non-profit corporation founded by the group of companies that developed the Universal Serial Bus specification. The USB-IF was formed to provide a support organization and forum for the advancement and adoption of Universal Serial Bus technology. The Forum facilitates the development of high-quality compatible USB peripherals (devices), and promotes the benefits of USB and the quality of products that have passed compliance testing.

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Universal Serial Bus 3.1 Specification

Hewlett-Packard Company

Intel Corporation

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Renesas Corporation

ST-Ericsson

Texas Instruments

Revision 1.0

July 26, 2013

Revision History

Revision	Comments	Issue Date
1.0	Initial release. USB 3.0	November 12, 2008
	Incorporated errata and ECNs	June 6, 2011
1.0	Initial release. USB 3.1	July 26, 2013

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Acknowledgement of Technical Contribution

Dedication

Dedicated to the memory of Brad Hosler, the impact of whose accomplishments made the Universal Serial Bus one of the most successful technology innovations of the Personal Computer era.

The authors of this specification would like to recognize the following people who participated in the USB 3.0 Bus Specification technical workgroups. We would also like to acknowledge the many others throughout the industry who provided feedback and contributed to the development of this specification.

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NOTE All Engineering Change Notices (ECN) and Errata documents as of May 01, 2015 that pertain to this core specification follow the last page of the specification, starting on page 567.

1 Introduction

1.1 Background

The original Universal Serial Bus (USB) was driven by the need to provide a user-friendly plug-and-play way to attach external peripherals to a Personal Computer (PC). USB has gone beyond just being a way to connect peripherals to PCs. Printers use USB to interface directly to cameras. Mobile devices use USB connected keyboards and mice. USB technology commonly finds itself in automobiles, televisions, and set-top boxes. USB, as a protocol, is also being picked up and used in many nontraditional applications, such as industrial automation. And USB as a source of power has become the mobile device charging solution endorsed by international communities across the globe.

Initially, USB provided two speeds (12 Mbps and 1,5 Mbps) that peripherals could use. As PCs became increasingly powerful and able to process larger amounts of data, users needed to get more and more data into and out of their PCs. This led to the definition of the USB 2.0 specification in 2000 to provide a third transfer rate of 480 Mbps while retaining backward compatibility. By 2006, two things in the environment happened: the transfer rates of HDDs exceeded 100 MB/s, far outstripping USB 2.0's ~32 MB/s bandwidth and the amount of digital content users were creating was an ever increasing pace. USB 3.0 was the USB community's response and provided users with the ability to move data at rates up to 450 MB/s while retaining backward compatibility with USB 2.0.

Now, with the continued trend for more bandwidth driven by larger and faster storage solutions, higher resolution video, and broader use of USB as an external expansion/docking solution, USB 3.1 extends the performance range of USB up to 1 GB/s by doubling the SuperSpeed USB clock rate to 10 Gbps and enhancing data encoding efficiency.

1.2 Objective of the Specification

This document defines the latest generation USB industry standard, USB 3.1. The specification describes the protocol definition, types of transactions, bus management, and the programming interface required to design and build systems and peripherals that are compliant with this specification. USB 3.1 is primarily a performance enhancement to SuperSpeed USB 3.0 resulting in providing more than double the bandwidth for devices such as Solid State Drives and High Definition displays.

This specification refers to Enhanced SuperSpeed as a collection of features or requirements that apply to both USB 3.0 and USB 3.1 bus operation. Additionally, where specific differences exist with regard to the USB 3.0 definition of SuperSpeed features or requirements, those differences will be uniquely identified as SuperSpeedPlus (or SSP) features or requirements – generally, "SuperSpeed" is in reference to 5 Gbps operation and "SuperSpeedPlus" is in reference to 10 Gbps operation.

USB 3.1's goal remains to enable devices from different vendors to interoperate in an open architecture, while maintaining and leveraging the existing USB infrastructure (device drivers, software interfaces, etc.). The specification is intended as an enhancement to the PC architecture, spanning portable, business desktop, and home environments, as well as simple device-to-device communications. It is intended that the specification allow system OEMs and peripheral developers adequate room for product versatility and market differentiation without the burden of carrying obsolete interfaces or losing compatibility.

1.3 Scope of the Document

The specification is primarily targeted at peripheral developers and platform/adapter developers, but provides valuable information for platform operating system/BIOS/device driver, adapter IHVs/ISVs, and system OEMs. This specification can be used for developing new products and associated software.

Product developers using this specification are expected to know and understand the USB 2.0 Specification. Specifically, USB 3.1 devices must implement device framework commands and descriptors as defined in the USB 2.0 Specification. Devices operating at the new 10 Gbps (Gen 2) speed must implement the SuperSpeedPlus enhancements defined in this version of the specification.

1.4 USB Product Compliance

Adopters of the USB 3.1 specification have signed the USB 3.0 Adopters Agreement, which provides them access to a reasonable and nondiscriminatory (RANDZ) license from the Promoters and other Adopters to certain intellectual property contained in products that are compliant with the USB 3.1 specification. Adopters can demonstrate compliance with the specification through the testing program as defined by the USB Implementers Forum (USB-IF). Products that demonstrate compliance with the specification will be granted certain rights to use the USB-IF logos as defined in the logo license.

Starting with USB 3.1, product compliance requirements are being tightened up to prohibit non-certified cables and connectors. Use of any registered icons or logos on products, documentation or packaging will require a license and license requirements will include passing specific product certification.

1.5 Document Organization

Chapters 1 through 4 provide an overview for all readers, while Chapters 5 through 11 contain detailed technical information defining USB 3.1.

Readers should contact operating system vendors for operating system bindings specific to USB 3.1.

1.6 Design Goals

USB 3.0 was a revolutionary step for USB. USB 3.1 is the next evolutionary step to increase the bandwidth. The goal remains the same; end users view it as the same as they viewed USB 2.0 and USB 3.0, just faster. Several key design areas to meet this goal are listed below:

Preserve the USB model of smart host and simple device.

- Leverage the existing USB infrastructure. There are a vast number of USB products in use today. A large part of their success can be traced to the existence of stable software interfaces, easily developed software device drivers, and a number of generic standard device class drivers (HID, mass storage, audio, etc.). Enhanced SuperSpeed USB devices are designed to keep this software infrastructure intact so that developers of peripherals can continue to use the same interfaces and leverage all of their existing development work.
- Significantly improve power management. Reduce the active power when sending data and reduce idle power by providing a richer set of power management mechanisms to allow devices to drive the bus into lower power states.
- Ease of use has always been and remains a key design goal for all varieties of USB.
- Preserve the investment. There are a large number of PCs in use that support only USB 2.0. There are a larger number of USB 2.0 peripherals in use. Retaining backward compatibility at the Type-A connector to allow Enhanced SuperSpeed devices to be used, albeit at a lower speed, with USB 2.0 PCs and allow high speed devices with their existing cables to be connected to the USB 3.1 SuperSpeed Type-A connectors.
- Features that allow the host controller to take advantage of the USB 3.1 speed without any change to the OS.

1.7 Related Documents

Universal Serial Bus Specification, Revision 2.0

USB On-the-Go Supplement to the USB 2.0 Specification, Revision 1.3

USB On-the-Go and Embedded Host Supplement to the USB 3.0 Specification, Revision 1.0

Universal Serial Bus Micro-USB Cables and Connectors Specification, Revision 1.01

EIA-364-1000.01: Environmental Test Methodology for Assessing the Performance of Electrical Connectors and Sockets Used in Business Office Applications

USB 3.0 Connectors and Cable Assemblies Compliance Document

USB SuperSpeed Electrical Test Methodology white paper

USB 3.0 Jitter Budgeting white paper

INCITS TR-35-2004, INCITS Technical Report for Information Technology – Fibre Channel – Methodologies for Jitter and Signal Quality Specification (FC-MJSQ)

Universal Serial Bus 3.0 Specification (including errata and ECNs through May 1, 2011)

Universal Serial Bus Power Delivery Specification, Revision 1.0 Including Errata through 31-October-2012