

Universal Serial Bus Specification

Compaq

Digital Equipment Corporation

IBM PC Company

Intel

Microsoft

NEC

Northern Telecom

Revision 1.0

January 15, 1996

EXHIBIT 1012

Universal Serial Bus Specification Revision 1.0

Scope of this Revision

The 1.0 revision of the specification is intended for product design. Every attempt has been made to ensure a consistent and implementable specification. Implementations should ensure compliance with this revision.

Revision History

Revision	Issue Date	Comments
0.7	November 11, 1994	Supersedes 0.6e.
0.8	December 30, 1994	Revisions to Chapters 3-8, 10, and 11. Added appendixes.
0.9	April 13, 1995	Revisions to all the chapters.
0.99	August 25, 1995	Revisions to all the chapters.
1.0 FDR	November 13, 1995	Revisions to Chapters 1, 2, 5-11.
1.0	January 15, 1996	Edits to Chapters 5, 6, 7, 8, 9, 10, and 11 for consistency.

Proposal for Universal Serial Bus Specification
Copyright © 1996, Compaq Computer Corporation, Digital Equipment Corporation,
IBM PC Company, Intel Corporation, Microsoft Corporation, NEC, Northern Telecom.
All rights reserved.

INTELLECTUAL PROPERTY DISCLAIMER

THIS SPECIFICATION IS PROVIDED "AS IS" WITH NO WARRANTIES WHATSOEVER INCLUDING ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE. A LICENSE IS HEREBY GRANTED TO REPRODUCE AND DISTRIBUTE THIS SPECIFICATION FOR INTERNAL USE ONLY. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY OTHER INTELLECTUAL PROPERTY RIGHTS IS GRANTED OR INTENDED HEREBY. AUTHORS OF THIS SPECIFICATION DISCLAIM ALL LIABILITY, INCLUDING LIABILITY FOR INFRINGEMENT OF PROPRIETARY RIGHTS, RELATING TO IMPLEMENTATION OF INFORMATION IN THIS SPECIFICATION. AUTHORS OF THIS SPECIFICATION ALSO DO NOT WARRANT OR REPRESENT THAT SUCH IMPLEMENTATION(S) WILL NOT INFRINGE SUCH RIGHTS.

GeoPort and Apple Desktop Bus are trademarks of Apple Computer, Inc.

Windows and Windows NT are trademarks and Microsoft and Win32 are registered trademarks of Microsoft Corporation.

IBM, PS/2, and Micro Channel are registered trademarks of International Business Machines Corporation.

AT&T is a registered trademark of American Telephone and Telegraph Company.

Compaq is a registered trademark of Compaq Computer Corporation.

UNIX is a registered trademark of UNIX System Laboratories.

I²C is a trademark of Phillips Semiconductors.

DEC is a trademark of Digital Equipment Corporation.

All other product names are trademarks, registered trademarks, or servicemarks of their respective owners.

Please send comments via electronic mail to USB@fes.fm.intel.com

For industry information, refer to the USB Implementers Forum web page at <http://www.teleport.com/~USB>

Contents

CHAPTER 1 INTRODUCTION

1.1 Motivation	11
1.2 Objective of the Specification	11
1.3 Scope of the Document.....	12
1.4 Document Organization.....	12

CHAPTER 2 TERMS AND ABBREVIATIONS

CHAPTER 3 BACKGROUND

3.1 Goals for the Universal Serial Bus	23
3.2 Taxonomy of Application Space	23
3.3 Feature List	24
3.4 Some Existing Technologies.....	26

CHAPTER 4 ARCHITECTURAL OVERVIEW

4.1 USB System Description	27
4.1.1 Bus Topology.....	28
4.2 Physical Interface.....	29
4.2.1 Electrical.....	29
4.2.2 Mechanical	30
4.3 Power.....	30
4.3.1 Power Distribution	30
4.3.2 Power Management.....	30
4.4 Bus Protocol.....	30
4.5 Robustness.....	31
4.5.1 Error Detection	31
4.5.2 Error Handling	31

4.6 System Configuration.....31
4.6.1 Attachment of USB Device 31
4.6.2 Removal of USB Device 32
4.6.3 Bus Enumeration..... 32
4.6.4 Inter-Layer Relationship..... 32

4.7 Data Flow Types.....32
4.7.1 Control Transfers 33
4.7.2 Bulk Transfers..... 33
4.7.3 Interrupt Transfers..... 33
4.7.4 Isochronous Transfers..... 33
4.7.5 Allocating USB Bandwidth 34

4.8 USB Devices.....34
4.8.1 Device Characterizations..... 34
4.8.2 Device Descriptions 35

4.9 USB Host: Hardware and Software37

4.10 Architectural Extensions.....37

CHAPTER 5 USB DATA FLOW MODEL

5.1 Implementer Viewpoints.....39

5.2 Bus Topology41
5.2.1 USB Host 41
5.2.2 USB Devices 42
5.2.3 Physical Bus Topology..... 42
5.2.4 Logical Bus Topology 43
5.2.5 Client Software to Function Relationship 44

5.3 USB Communication Flow.....44
5.3.1 Device Endpoints 46
5.3.2 Pipes 47

5.4 Transfer Types49

5.5 Control Transfers.....50
5.5.1 Data Format 50
5.5.2 Direction 51
5.5.3 Packet Size Constraints 51
5.5.4 Bus Access Constraints 52
5.5.5 Data Sequences 53

5.6 Isochronous Transfers.....54
5.6.1 Data Format 54
5.6.2 Direction 54
5.6.3 Packet Size Constraints 54
5.6.4 Bus Access Constraints 55
5.6.5 Data Sequences 56

Universal Serial Bus Specification Revision 1.0

5.7 Interrupt Transfers	56
5.7.1 Data Format	56
5.7.2 Direction	56
5.7.3 Packet Size Constraints	56
5.7.4 Bus Access Constraints	57
5.7.5 Data Sequences	58
5.8 Bulk Transfers	58
5.8.1 Data Format	59
5.8.2 Direction	59
5.8.3 Packet Size Constraints	59
5.8.4 Bus Access Constraints	59
5.8.5 Data Sequences	60
5.9 Bus Access for Transfers	61
5.9.1 Transfer Management	61
5.9.2 Transaction Tracking	64
5.9.3 Calculating Bus Transaction Times	65
5.9.4 Calculating Buffer Sizes in Functions/Software.....	67
5.9.5 Bus Bandwidth Reclamation	67
5.10 Special Considerations for Isochronous Transfers	67
5.10.1 Example Non-USB Isochronous Application.....	68
5.10.2 USB Clock Model	71
5.10.3 Clock Synchronization	73
5.10.4 Isochronous Devices.....	73
5.10.5 Data Prebuffering	81
5.10.6 SOF Tracking.....	82
5.10.7 Error Handling	82
5.10.8 Buffering for Rate Matching	83
 CHAPTER 6 MECHANICAL	
6.1 Architectural Overview	85
6.2 Dimensioning Requirements	85
6.3 Cable	86
6.3.1 Cable Specification	86
6.3.2 Connector (Series A).....	90
6.3.3 Connector (Series B).....	96
6.3.4 Serial Bus Icon.....	101
6.3.5 Plug/Receptacle Mechanical and Electrical Requirements.....	102
6.4 Cable Voltage Drop Requirements	107
6.5 Propagation Delay	108
6.6 Grounding	108
6.7 Regulatory Information	109

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.