ICS 33.120.20, 33.120.30, 35.200

SLOVENSKÁ TECHNICKÁ NORMA

Júl 2026

STN	**Rozhrania univerzálnej sériovej zbernice pre dáta a napájanie Časť 1-3: Spoločné súčasti Špecifikácia USB kábla a konektora typu C®**	**STN EN IEC 62680-1-3** 36 8365

Universal Serial Bus interfaces for data and power - Part 1-3: Common components - USB Type-C® cable and connector specification

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 06/26

Obsahuje: EN IEC 62680-1-3:2026, IEC 62680-1-3:2026

Oznámením tejto normy sa od 31.03.2029 ruší
STN EN IEC 62680-1-3 (36 8365) z mája 2025

obsahuje farebné strany

142611

Úrad pre normalizáciu, metrológiu a skúšobníctvo Slovenskej republiky, 2026
Slovenská technická norma a technická normalizačná informácia je chránená zákonom č. 60/2018 Z. z. o technickej normalizácii v znení neskorších predpisov.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62680-1-3

March 2026

ICS 33.120.20; 33.120.30; 35.200

Supersedes EN IEC 62680-1-3:2025

English Version

Universal Serial Bus interfaces for data and power - Part 1-3: Common components - USB Type-C(r) cable and connector specification (IEC 62680-1-3:2026)

Interfaces de bus universel en série pour les données et l'alimentation électrique - Partie 1-3: Composants communs - Spécification des câbles et des connecteurs USB Type-C(r) (IEC 62680-1-3:2026)

Universelle Bus-Schnittstellen für Daten und Energie - Teil 1-3: Gemeinsame Komponenten - Festlegung für USB Type-C Kabel und Steckverbindung (IEC 62680-1-3:2026)

This European Standard was approved by CENELEC on 2026-03-18. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2026 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

Ref. No. EN IEC 62680-1-3:2026 E

European foreword

The text of document 100/4332/CDV, future edition 7 of IEC 62680-1-3, prepared by TC 100/Technical Area 18 "(Disbanded) - Multimedia home systems and applications for end-user networks" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62680-1-3:2026.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2027-03-31
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2029-03-31

This document supersedes EN IEC 62680-1-3:2025 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 62680-1-3:2026 was approved by CENELEC as a European Standard without any modification.

IEC 62680-1-3

Edition 7.0 2026-02

INTERNATIONAL STANDARD

Universal Serial Bus interfaces for data and power -
Part 1-3: Common components - USB Type-C® cable and connector specification

ICS 33.120.20; 33.120.30; 35.200 ISBN 978-2-8327-0989-4

IEC 62680-1-3:2026-02(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

Universal Serial Bus interfaces for data and power - Part 1-3: Common components - USB Type-C® cable and connector specification

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62680-1-3 has been prepared by technical area 18: Multimedia home systems and applications for end-user networks, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

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.

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/4332/CDV	100/4381/RVC

Full information on the voting for its approval 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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Universal Serial Bus Type-C Cable and Connector Specification

Release 2.4
October 2024

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Copyright © 2014-2024, USB 3.0 Promoter Group:

Apple Inc., HP Inc., Intel Corporation, Microsoft Corporation, Renesas, STMicroelectronics, and Texas Instruments

All rights reserved.

NOTE: Adopters may only use the USB Type-C® cable and connector to implement USB or third-party functionality as expressly described in this Specification; all other uses are prohibited.

LIMITED COPYRIGHT LICENSE: The USB 3.0 Promoters grant a conditional copyright license under the copyrights embodied in the USB Type-C Cable and Connector Specification to use and reproduce the Specification for the sole purpose of, and solely to the extent necessary for, evaluating whether to implement the Specification in products that would comply with the specification. Without limiting the foregoing, use of the Specification for the purpose of filing or modifying any patent application to target the Specification or USB compliant products is not authorized. Except for this express copyright license, no other rights or licenses are granted, including without limitation any patent licenses. In order to obtain any additional intellectual property licenses or licensing commitments associated with the Specification a party must execute the USB 3.0 Adopters Agreement. NOTE: By using the Specification, you accept these license terms on your own behalf and, in the case where you are doing this as an employee, on behalf of your employer.

INTELLECTUAL PROPERTY DISCLAIMER

THIS SPECIFICATION IS PROVIDED TO YOU "AS IS" WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NON-INFRINGEMENT, OR FITNESS FOR ANY PARTICULAR PURPOSE. THE AUTHORS OF THIS SPECIFICATION DISCLAIM ALL LIABILITY, INCLUDING LIABILITY FOR INFRINGEMENT OF ANY PROPRIETARY RIGHTS, RELATING TO USE OR IMPLEMENTATION OF INFORMATION IN THIS SPECIFICATION. THE PROVISION OF THIS SPECIFICATION TO YOU DOES NOT PROVIDE YOU WITH ANY LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS.

All implementation examples and reference designs contained within this Specification are included as part of the limited patent license for those companies that execute the USB 3.0 Adopters Agreement.

USB Type-C®, USB-C® and USB4® are trademarks of the Universal Serial Bus Implementers Forum (USB-IF). DisplayPort™ is a trademark of VESA. All product names are trademarks, registered trademarks, or service marks of their respective owners.

Thunderbolt™ is a trademark of Intel Corporation. You may only use the Thunderbolt™ trademark or logo in conjunction with products designed to this specification that complete proper certification and executing a Thunderbolt™ trademark license – see https://www.usb.org/compliance for further information.

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Contents

Specification Editor 20
Specification Work Group Contributors 20
Pre-Release Draft Industry Reviewing Companies That Provided Feedback 28
Revision History 29
1 Introduction 30
1.1 Purpose 30
1.2 Scope 30
1.3 Related Documents 30
1.4 Conventions 31
1.4.1 Precedence 31
1.4.2 Keywords 31
1.4.3 Numbering 32
1.5 Terms and Abbreviations 32
2 Overview 38
2.1 Introduction 38
2.2 USB Type-C Receptacles, Plugs and Cables 39
2.3 Configuration Process 40
2.3.1 Source-to-Sink Attach/Detach Detection 41
2.3.2 Plug Orientation/Cable Twist Detection 41
2.3.3 Initial Power (Source-to-Sink) Detection and Establishing the Data (Host-to-Device) Relationship 41
2.3.4 USB Type-C VBUS Current Detection and Usage 42
2.3.5 *USB PD* Communications 42
2.3.6 Functional Extensions 43
2.4 VBUS 43
2.5 VCONN 43
2.6 Hubs 44
3 Mechanical 45
3.1 Overview 45
3.1.1 Compliant Connectors 45
3.1.2 Compliant Cable Assemblies 45
3.1.3 Compliant USB Type-C to Legacy Cable Assemblies 46
3.1.4 Compliant USB Type-C to Legacy Adapter Assemblies 47
3.2 USB Type-C Connector Mating Interfaces 47
3.2.1 Interface Definition 47
3.2.2 Reference Designs 71

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

3.2.3 Pin Assignments and Descriptions 78
3.3 Cable Construction and Wire Assignments 79
3.3.1 Cable Construction (*Informative*) 79
3.3.2 Wire Assignments 81
3.3.3 Wire Gauges and Cable Diameters (*Informative*) 82
3.4 Standard USB Type-C Cable Assemblies 84
3.4.1 USB Full-Featured Type-C Cable Assembly 84
3.4.2 *USB 2.0* Type-C Cable Assembly 86
3.4.3 USB Type-C Captive Cable Assembly 86
3.4.4 USB Type-C Thumb Drive Assembly 87
3.5 Legacy Cable Assemblies 87
3.5.1 USB Type-C to *USB 3.1* Standard-A Cable Assembly 88
3.5.2 USB Type-C to *USB 2.0* Standard-A Cable Assembly 89
3.5.3 USB Type-C to *USB 3.1* Standard-B Cable Assembly 90
3.5.4 USB Type-C to *USB 2.0* Standard-B Cable Assembly 91
3.5.5 USB Type-C to *USB 2.0* Mini-B Cable Assembly 92
3.5.6 USB Type-C to *USB 3.1* Micro-B Cable Assembly 93
3.5.7 USB Type-C to *USB 2.0* Micro-B Cable Assembly 94
3.6 Legacy Adapter Assemblies 94
3.6.1 USB Type-C to *USB 3.1* Standard-A Receptacle Adapter Assembly 94
3.6.2 USB Type-C to *USB 2.0* Micro-B Receptacle Adapter Assembly 96
3.7 Electrical Characteristics 96
3.7.1 Raw Cable (*Informative*) 97
3.7.2 USB Type-C to USB Type-C Passive Cable Assemblies 98
3.7.3 Mated Connector (*Informative – USB 3.2* Gen2 and *USB4* Gen2) 120
3.7.4 Receptacle Connector SI Requirements and Testing (*Normative – USB4* Gen3/Gen4) 124
3.7.5 USB Type-C to USB Legacy Cable Assemblies (*Normative*) 126
3.7.6 USB Type-C to USB Legacy Adapter Assemblies (*Normative*) 130
3.7.7 Shielding Effectiveness Requirements (*Normative*) 133
3.7.8 DC Electrical Requirements (*Normative*) 135
3.8 Mechanical and Environmental Requirements (*Normative*) 138
3.8.1 Mechanical Requirements 138
3.8.2 Environmental Requirements 143
3.9 Docking Applications (*Informative*) 144
3.10 Implementation Notes and Design Guides 145
3.10.1 EMC Management (*Informative*) 145

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

3.10.2 Stacked and Side-by-Side Connector Physical Spacing (*Informative*) 148
3.10.3 Cable Mating Considerations (*Informative*) 148
3.11 Extended Power Range (EPR) Cables 150
3.11.1 Electrical Requirements 150
3.11.2 EPR Cable Identification Requirements 150
4 Functional 151
4.1 Signal Summary 151
4.2 Signal Pin Descriptions 151
4.2.1 *USB 3.2*/*USB4* Pins 151
4.2.2 *USB 2.0* Pins 152
4.2.3 Auxiliary Signal Pins 152
4.2.4 Power and Ground Pins 152
4.2.5 Configuration Pins 152
4.3 Sideband Use (SBU) 152
4.4 Power and Ground 153
4.4.1 IR Drop 153
4.4.2 VBUS 154
4.4.3 VCONN 155
4.5 Configuration Channel (CC) 160
4.5.1 Architectural Overview 160
4.5.2 CC Functional and Behavioral Requirements 172
4.5.3 USB Port Interoperability Behavior 208
4.6 Power 226
4.6.1 Power Requirements during USB Suspend 227
4.6.2 VBUS Power Provided Over a USB Type-C Cable 228
4.7 USB Hubs 233
4.8 Power Sourcing and Charging 234
4.8.1 DFP as a Power Source 234
4.8.2 Non-USB Charging Methods 236
4.8.3 Sinking Host 237
4.8.4 Sourcing Device 237
4.8.5 Charging a System with a Dead Battery 237
4.8.6 USB Type-C Multi-Port Chargers 237
4.9 Electronically Marked Cables 241
4.9.1 Parameter Values 242
4.9.2 Active Cables 242

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

4.10 VCONN-Powered Accessories (VPAs) and VCONN-Powered USB Devices (VPDs) 243
4.10.1 VCONN-Powered Accessories (VPAs) 243
4.10.2 VCONN-Powered Devices (VPDs) 243
4.11 Parameter Values 245
4.11.1 Termination Parameters 245
4.11.2 Timing Parameters 247
4.11.3 Voltage Parameters 251
5 *USB4* Discovery and Entry 258
5.1 Overview of the Discovery and Entry Process 258
5.2 *USB4* Functional Requirements 259
5.2.1 *USB4* Host Functional Requirements 259
5.2.2 USB Device Functional Requirements 259
5.2.3 *USB4* Alternate Mode Support 259
5.3 *USB4* Power Requirements 260
5.3.1 Source Power Requirements 260
5.3.2 Sink Power Requirements 260
5.3.3 Device Power Management Requirements 260
5.4 *USB4* Discovery and Entry Flow Requirements 261
5.4.1 USB Type-C Initial Connection 261
5.4.2 USB Power Delivery Contract 261
5.4.3 *USB4* Discovery and Entry Flow 261
5.4.4 *USB4* Post-Entry Operation 267
5.5 *USB4* Hub Connection Requirements 267
5.5.1 *USB4* Hub Port Initial Connection Requirements 267
5.5.2 *USB4* Hub UFP and Host Capabilities Discovery 267
5.5.3 Hub DFP Connection Requirements 268
5.5.4 Hub Ports Connection Behavior Flow Examples 269
5.5.5 Connecting to Downstream *USB4* Hubs 275
5.5.6 Fallback Functional Requirements for *USB4* Hubs 275
5.6 *USB4* Device Connection Requirements 276
5.6.1 Fallback Mapping of *USB4* Peripheral Functions of USB Device Class Types 276
5.7 Parameter Values 277
5.7.1 Timing Parameters 277
6 Active Cables 278
6.1 General Specifications for All Active Cables 278
6.1.1 Discovering Active Cable Characteristics 278

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

6.1.2 Electrical Requirements 280
6.1.3 Mechanical Requirements 312
6.2 Additional Specifications for Copper and Hybrid-Optical Active Cables 313
6.2.1 Active Cable Block Diagram 314
6.2.2 *USB4* Asymmetric Mode Support 314
6.2.3 Active Cable *USB PD* Requirements 314
6.2.4 Active Cable Behaviors in Response to *USB PD* Events 314
6.2.5 Active Cable Power Requirements 315
6.3 Additional Specifications for Optically Isolated Active Cables 315
6.3.1 OIAC Block Diagrams 316
6.3.2 OIAC Limitations and General Requirements 318
6.3.3 OIAC Cable Power Requirements 319
6.3.4 OIAC *USB PD* Requirements 319
6.3.5 OIAC Connection Flow and State Diagrams 329
6.3.6 Additional Electrical Requirements for OIAC 348
6.3.7 Additional Mechanical Requirements for OIAC 351
A Liquid Corrosion Mitigation Mode 352
A.1 Overview 352
A.2 Detail 352
A.3 Liquid Detection Methods 354
A.3.1 Liquid Measurement Method 354
A.3.2 Pulsed Measurement Method 354
A.3.3 Impedance Measurement Method 355
A.4 Liquid Detection Pins in the Connector 358
B Debug Accessory Mode 361
B.1 Overview 361
B.2 Functional 361
B.2.1 Signal Summary 361
B.2.2 Port Interoperability 362
B.2.3 Debug Accessory Mode Entry 362
B.2.4 Connection State Diagrams 362
B.2.5 DTS Port Interoperability Behaviors 371
B.2.6 Orientation Detection 380
B.3 Security/Privacy Requirements 380
C USB Type-C Digital Audio 381
C.1 Overview 381

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

C.2 USB Type-C Digital Audio Specifications 381
D Thermal Design Considerations for Active Cables 382
D.1 Introduction 382
D.2 Model 382
D.2.1 Assumptions 382
D.2.2 Model Architecture 383
D.2.3 Heat Sources 383
D.2.4 Heat Flow 384
D.3 *USB 3.2* Single-Lane Active Cable 385
D.3.1 *USB 3.2* Single-Lane Active Cable Design Considerations 385
D.4 Dual-Lane Active Cables 388
D.4.1 *USB 3.2* Dual-Lane Active Cable Design Considerations 388
D.4.2 *USB 3.2* Dual-Lane Active Cable in a Multiple Port Configuration 390
D.5 *USB 3.2* Host and Device Design Considerations 391
D.5.1 Heat Spreading or Heat Sinking from Host or Device 391
D.5.2 Motherboard Temperature Control 392
D.5.3 Wider Port Spacing for Multi-Port Applications 392
D.5.4 Power Policies 392
E Alternate Modes 393
E.1 Alternate Mode Architecture 393
E.2 Alternate Mode Requirements 393
E.2.1 Alternate Mode Pin Reassignment 394
E.2.2 Alternate Mode Electrical Requirements 394
E.3 Parameter Values 397
E.4 Example Alternate Mode – USB DisplayPort™ Dock 398
E.4.1 USB DisplayPort™ Dock Example 398
E.4.2 Functional Overview 398
E.4.3 Operational Summary 399
E.5 Example Alternate Mode Entry Flow with Cable Warnings 400
E.5.1 Operational Summary 401
F Thunderbolt™ 3 Compatibility Discovery and Entry 402
F.1 *TBT3* Compatibility Mode Functional Requirements 402
F.1.1 *TBT3*-Compatible Power Requirements 402
F.1.2 *TBT3*-Compatible Host Requirements 402
F.1.3 *TBT3*-Compatible Device Upstream Requirements 402
F.1.4 *TBT3*-Compatible Device Downstream Requirements 402

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

F.1.5 *TBT3*-Compatible Self-Powered Device Without Predefined Upstream Port Rules 403
F.1.6 *TBT3*-Compatible Devices with a Captive Cable 403
F.2 *TBT3* Discovery and Entry Flow 403
F.2.1 *TBT3* Passive Cable Discover Identity Responses 404
F.2.2 *TBT3* Active Cable Discover Identity Responses 407
F.2.3 *TBT3* Device Discover Identity Responses 410
F.2.4 *TBT3* Discover SVID Responses 411
F.2.5 *TBT3* Device Discover Mode Responses 412
F.2.6 *TBT3* Cable Discover Mode Responses 413
F.2.7 *TBT3* Cable Enter Mode Command 414
F.2.8 *TBT3* Device Enter Mode Command 415
F.2.9 *TBT3* Cable Functional Difference Summary 417
G Extracting Pulse Response from Sampled Data and Calculating Non-Linearity Noise 418
H *USB PD* High-Voltage Design Considerations 420
H.1 Potential for Arcing Damage During Cable Withdrawal 420
H.2 Arcing During USB Type-C Cable Withdrawal 420
H.3 Mitigating Arcing Damage During Cable Withdrawal Due to Sink Discharge 422
H.3.1 Limiting Sink Discharge Rate 423
H.3.2 Load Removal 424
H.3.3 Limiting Source Current Capability 427
I *USB PD* Encoding Guidelines for USB Type-C Product Types 428
I.1 USB Type-C Product Type Definitions and *USB PD* Encodings 428
I.2 *USB PD* Encoding Guidelines Tables 429
I.3 Detailed Examples 436
I.3.1 *USB 3.2* Host – no DC – Power Consumer : DRP (Source or Sink) / Not DRD (DFP) 436
I.3.2 *USB 3.2* Peripheral – Power Provider : DRP (Source or Sink) / Not DRD (UFP) 436
I.3.3 *USB4* Host – Power Consumer : DRP (Source or Sink) / Not DRD (DFP) 437
I.3.4 *USB4* Host – *USB4* DC – Partial or no USB Equivalent : DRP (Source or Sink) / DRD 437
I.3.5 *USB4* Peripheral : UFP (Sink) 438
I.3.6 *USB4* Dock (Upstream) – Power Provider : DRP (Source or Sink) / Not DRD (UFP) 439
I.3.7 *USB4* Hub (Downstream) – DFP (Source) 439
J Design Assumptions for the *USB4* Gen4 LRD Cable Specification 441

Figures

Figure 2-1 USB Type-C Receptacle Interface (Front View) 38
Figure 2-2 USB Full-Featured Type-C Plug Interface (Front View) 39
Figure 3-1 USB Type-C Receptacle Interface Dimensions 50
Figure 3-2 Reference Design USB Type-C Plug External EMC Spring Contact Zones 54

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Figure 3-3 USB Full-Featured Type-C Plug Interface Dimensions 55
Figure 3-4 Right-Angle USB Type-C Plug Dimensional Requirements 58
Figure 3-5 Reference Footprint for a USB Type-C Vertical Mount Receptacle (*Informative*) 59
Figure 3-6 Reference Footprint for a USB Type-C Dual-Row SMT Right-Angle Receptacle (*Informative*) 60
Figure 3-7 Reference Footprint for a USB Type-C Hybrid Right-Angle Receptacle (*Informative*) 61
Figure 3-8 Reference Footprint for a USB Type-C Mid-Mount Dual-Row SMT Receptacle (*Informative*) 62
Figure 3-9 Reference Footprint for a USB Type-C Mid-Mount Hybrid Receptacle (*Informative*) 63
Figure 3-10 Reference Footprint for a *USB 2.0* Type-C Through Hole Right Angle Receptacle (*Informative*) 64
Figure 3-11 Reference Footprint for a *USB 2.0* Type-C Single Row Right Angle Receptacle (*Informative*) 65
Figure 3-12 *USB 2.0* Type-C Plug Interface Dimensions 67
Figure 3-13 USB Type-C Plug EMC Shielding Spring Tip Requirements 70
Figure 3-14 Reference Design of Receptacle Mid-Plate 71
Figure 3-15 Reference Design of Retention Latch 72
Figure 3-16 Illustration of the Latch Soldered to the Paddle Card Ground 72
Figure 3-17 Reference Design of the USB Full-Featured Type-C Plug Internal EMC Spring 73
Figure 3-18 Reference Design of the *USB 2.0* Type-C Plug Internal EMC Spring 74
Figure 3-19 Reference Design of Internal EMC Pad 75
Figure 3-20 Reference Design of a USB Type-C Receptacle with External EMC Springs 76
Figure 3-21 Reference Design of a USB Full-Featured Type-C Plug Paddle Card 77
Figure 3-22 Illustration of a USB Full-Featured Type-C Cable Cross Section, a Coaxial Wire Example with VCONN 80
Figure 3-23 Illustration of a USB Full-Featured Type-C Cable Cross Section, a Coaxial Wire Example without VCONN 80
Figure 3-24 USB Full-Featured Type-C Standard Cable Assembly 84
Figure 3-25 USB Type-C to *USB 3.1* Standard-A Cable Assembly 88
Figure 3-26 USB Type-C to *USB 2.0* Standard-A Cable Assembly 89
Figure 3-27 USB Type-C to *USB 3.1* Standard-B Cable Assembly 90
Figure 3-28 USB Type-C to *USB 2.0* Standard-B Cable Assembly 91
Figure 3-29 USB Type-C to *USB 2.0* Mini-B Cable Assembly 92
Figure 3-30 USB Type-C to *USB 3.1* Micro-B Cable Assembly 93
Figure 3-31 USB Type-C to *USB 2.0* Micro-B Cable Assembly 94
Figure 3-32 USB Type-C to *USB 3.1* Standard-A Receptacle Adapter Assembly 95
Figure 3-33 USB Type-C to *USB 2.0* Micro-B Receptacle Adapter Assembly 96
Figure 3-34 Illustration of Test Points for a Mated Cable Assembly 98
Figure 3-35 Recommended Differential Insertion Loss Requirement (*USB 3.2* Gen2 and *USB4* Gen2) 99
Figure 3-36 Recommended Differential Return Loss Requirement 99
Figure 3-37 Recommended Differential Crosstalk Requirement 100
Figure 3-38 Recommended Differential Near-End and Far-End Crosstalk Requirement between USB D+/D– Pair and TX/RX Pair 101
Figure 3-39 Recommended Differential Insertion Loss Requirement (*USB4* Gen3/Gen4) 101
Figure 3-40 Illustration of Insertion Loss Fit at Nyquist Frequency 102
Figure 3-41 Input Pulse Spectrum 103
Figure 3-42 IMR Limit as Function of ILfitatNq 104
Figure 3-43 IRL Limit as Function of ILfitatNq 106
Figure 3-44 Differential-to-Common Mode Conversion Requirement 106
Figure 3-45 IMR Limit as Function of ILfit at 10 GHz (*USB4* Gen3/Gen4) 110
Figure 3-46 Definition of Port, Victim, and Aggressor 111
Figure 3-47 IXT_DP and IXT_USB Limit as Function of ILfit at 10 GHz (*USB4* Gen3/Gen4) 111
Figure 3-48 IRL Limit as Function of ILfit at 10 GHz (*USB4* Gen3/Gen4) 112
Figure 3-49 Differential-to-Common Mode Conversion Requirement (*USB4* Gen3/Gen4) 112
Figure 3-50 Cable Assembly in System 113

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Figure 3-51 Requirement for Differential Coupling between CC and D+/D− 116
Figure 3-52 Requirement for Single-Ended Coupling between CC and D− in *USB 2.0* Type-C Cables 116
Figure 3-53 Requirement for Single-Ended Coupling between CC and D− in USB Full-Featured Type-C Cables 117
Figure 3-54 Requirement for Differential Coupling between VBUS and D+/D− 117
Figure 3-55 Requirement for Single-Ended Coupling between SBU_A and SBU_B 118
Figure 3-56 Requirement for Single-Ended Coupling between SBU_A/SBU_B and CC 119
Figure 3-57 Requirement for Coupling between SBU_A and differential D+/D−, and SBU_B and differential D+/D− 119
Figure 3-58 Illustration of USB Type-C Mated Connector 120
Figure 3-59 Recommended Impedance Limits of a USB Type-C Mated Connector 121
Figure 3-60 Recommended Ground Void Dimensions for USB Type-C Receptacle 121
Figure 3-61 Recommended Differential Near-End and Far-End Crosstalk Limits between D+/D− Pair and TX/RX Pairs 123
Figure 3-62 Recommended Limits for Differential-to-Common-Mode Conversion 124
Figure 3-63 IMR Limit as Function of ILfitatNq for USB Type-C to Legacy Cable Assembly 129
Figure 3-64 IRL Limit as Function of ILfitatNq for USB Type-C to Legacy Cable Assembly 129
Figure 3-65 Cable Assembly Shielding Effectiveness Testing 133
Figure 3-66 Shielding Effectiveness Pass/Fail Criteria 134
Figure 3-67 LLCR Measurement Diagram 135
Figure 3-68 Temperature Measurement Point 136
Figure 3-69 Example Current Rating Test Fixture Trace Configuration 137
Figure 3-70 Example of 4-Axis Continuity Test Fixture 139
Figure 3-71 Torque Force Application Distance for Right-Angle Plugs 141
Figure 3-71 Example Wrenching Strength Test Fixture for Plugs without Overmold 142
Figure 3-72 Reference Wrenching Strength Continuity Test Fixture 142
Figure 3-73 Example of Wrenching Strength Test Mechanical Failure Point 143
Figure 3-74 Wrenching Strength Test with Cable in Fixture 143
Figure 3-75 USB Type-C Cable Receptacle Flange Example 145
Figure 3-76 EMC Guidelines for Side Latch and Mid-Plate 146
Figure 3-77 EMC Finger Connections to Plug Shell 147
Figure 3-78 EMC Pad Connections to Receptacle Shell 147
Figure 3-79 Examples of Connector Apertures 148
Figure 3-80 Recommended Minimum Spacing between Connectors 148
Figure 3-81 Recommended Minimum Plug Overmold Clearance 149
Figure 3-82 Cable Plug Overmold and an Angled Surface 149
Figure 4-1 Cable IR Drop 153
Figure 4-2 Cable IR Drop for powered cables 153
Figure 4-3 Logical Model for Single-Lane Data Bus Routing across USB Type-C-based Ports 161
Figure 4-4 Logical Model for USB Type-C-based Ports for a Single-Lane Direct Connect Device 161
Figure 4-5 Pull-Up/Pull-Down CC Model 163
Figure 4-6 Current Source/Pull-Down CC Model 163
Figure 4-7 Source Functional Model for CC1 and CC2 166
Figure 4-8 Source Functional Model Supporting *USB PD* PR_Swap 167
Figure 4-9 Sink Functional Model for CC1 and CC2 167
Figure 4-10 Sink Functional Model Supporting *USB PD* PR_Swap and VCONN_Swap 168
Figure 4-11 DRP Functional Model for CC1 and CC2 169
Figure 4-12 Connection State Diagram: Source 174
Figure 4-13 Connection State Diagram: Sink 175
Figure 4-14 Connection State Diagram: Sink with Accessory Support 176
Figure 4-15 Connection State Diagram: DRP 177

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Figure 4-16 Connection State Diagram: DRP with Accessory and Try.SRC Support 178
Figure 4-17 Connection State Diagram: DRP with Accessory and Try.SNK Support 179
Figure 4-18 Connection State Diagram: Charge-Through VPD 180
Figure 4-19 Sink Power Sub-States 203
Figure 4-20 Passive Cable eMarker State Diagram 205
Figure 4-21 Active Cable eMarker State Diagram 205
Figure 4-22 Cable Ra Management State Diagram 206
Figure 4-23 Source to Sink Functional Model 209
Figure 4-24 Source to DRP Functional Model 210
Figure 4-25 DRP to Sink Functional Model 211
Figure 4-26 DRP to DRP Functional Model – CASE 1 212
Figure 4-27 DRP to DRP Functional Model – CASES 2 & 3 213
Figure 4-28 Source to Source Functional Model 215
Figure 4-29 Sink to Sink Functional Model 215
Figure 4-30 DRP to VPD Model 216
Figure 4-31 Example DRP to Charge-Through VPD Model 217
Figure 4-32 Source to Legacy Device Port Functional Model 224
Figure 4-33 Legacy Host Port to Sink Functional Model 224
Figure 4-34 DRP to Legacy Device Port Functional Model 225
Figure 4-35 Legacy Host Port to DRP Functional Model 226
Figure 4-36 Sink Monitoring for Current in Pull-Up/Pull-Down CC Model 229
Figure 4-37 Sink Monitoring for Current in Current Source/Pull-Down CC Model 230
Figure 4-38 *USB PD* over CC Pins 231
Figure 4-39 *USB PD* BMC Signaling over CC 231
Figure 4-40 USB Type-C Cable's Output as a Function of Load for Non-PD-based USB Type-C Charging 235
Figure 4-41 0 – 3 A *USB PD*-based Charger USB Type-C Cable's Output as a Function of Load 236
Figure 4-42 3 – 5 A *USB PD*-based Charger USB Type-C Cable's Output as a Function of Load 236
Figure 4-43 Electronically Marked Cable with VCONN connected through the cable 242
Figure 4-44 Electronically Marked Cable with SOP' at both ends 242
Figure 4-45 Example Charge-Through VCONN-Power USB Device Use Case 245
Figure 4-46 Example Source Implementation 247
Figure 4-47 Exiting from *Attached.SRC* with slow discharging VBULK 248
Figure 4-48 Exiting from *Attached.SRC* with fast discharging VBULK 248
Figure 4-49 DRP Timing 249
Figure 4-50 Pull-Up/Pull-Down Voltage Detection Model 251
Figure 4-51 Current Source Voltage Detection Model 251
Figure 5-1 *USB4* Discovery and Entry Flow Model 262
Figure 5-2 *USB4* Hub with *USB4* Host and Device Connection Flow Alignment 270
Figure 5-3 *USB4* Hub with *USB 3.2* Host and *USB4* Device Connection Flow Alignment 271
Figure 5-4 *USB4* Hub with *USB4* Host and *USB 3.2* Device Connection Flow Alignment 272
Figure 5-5 *USB4* Hub with *USB 3.2* Host and Device Connection Flow Alignment 273
Figure 5-6 *USB4* Hub with *USB4* Host and DP Alt Mode Device Connection Flow Alignment 274
Figure 5-7 *USB4* Hub with *USB 3.2* Host and DP Alt Mode Device Connection Flow Alignment 275
Figure 6-1 Active Cable Topologies 281
Figure 6-2 SuperSpeed USB Electrical Test Points 284
Figure 6-3 SuperSpeed USB Compliance Test Setup 284
Figure 6-4 Compliance Points Definition 287
Figure 6-5 RX Differential Return-Loss Mask 288
Figure 6-6 Re-timer-based Active Cable Compliance Test Setup 289
Figure 6-7 Example of Transmitter Frequency Variation During Clock Switching 291
Figure 6-8 Active Cable Functional Test Setup 292

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Figure 6-9 Linear Re-driver-based Active Cable Compliance Setup 293
Figure 6-10 Gain Parameters Specified for the Linear Re-driver Active Cable 296
Figure 6-11 OUTPUT_NOISE Limit Versus *ILfitatNq* 297
Figure 6-12 Gain Parameters for *USB4* Gen4 LRD Active Cables 300
Figure 6-13 *USB4* LRD Active Cable Snooping of TxFFE Negotiation 305
Figure 6-14 *USB4* State Machine per Channel (*Informative*) 306
Figure 6-15 *USB4* Gen4 CL1/CL2 Exit Flow with LRD Active Cable 308
Figure 6-16 *USB4* Symmetric to Asymmetric Transition 309
Figure 6-17 *USB4* Asymmetric to Symmetric Transition 311
Figure 6-18 OIAC *USB PD* Message Forwarding 324
Figure 6-19 OIAC Successful Data Role Swap 327
Figure 6-20 OIAC Rejected Data Role Swap 327
Figure 6-21 OIAC Wait Data Role Swap 328
Figure 6-22 OIAC Initiator Reject Data Role Swap 328
Figure 6-23 OIAC Initiator Wait Data Role Swap 329
Figure 6-24 OIAC Discovery – Phase 1 331
Figure 6-25 OIAC Reboot – Phase 2 332
Figure 6-26 OIAC Plug-A Configured as DFP – Phase 3 333
Figure 6-27 OIAC Plug-A Configured as UFP – Phase 3 334
Figure 6-28 OIAC Plug-A No Connection Possible Billboard – Phase 3 335
Figure 6-29 OIAC Plug-A State Diagram Part 1 (Phase 1 and 2) 336
Figure 6-30 OIAC Plug-A State Diagram Part 2 (Phase 3) 337
Figure 6-31 OIAC Plug-B State Diagram 343
Figure 6-32 Illustration of Usages for OIAC that Require an Adapter or Hub 350
Figure A-1 Electrolytic Liquid Corrosion Example 352
Figure A-2 Corrosion Mitigation in Pull-Up/Pull-Down CC Model 353
Figure A-3 Corrosion Mitigation in Current Source/Pull-Down CC Model 353
Figure A-4 Corrosion Mitigation in Current Source/Pull-Down CC Model with Alternate Mitigation 353
Figure A-5 Liquid Detection by Leakage Measurement 354
Figure A-6 Liquid Detection by Pulsed Measurement 355
Figure A-7 Example Measurement of a Dry Port 356
Figure A-8 Example Measurement of a Port with Reverse Osmosis Water 356
Figure A-9 Example Measurement of a Port with Tap Water 357
Figure A-10 Example Measurement of a Port with Artificial Sweat 357
Figure A-11 Example Measurement of a Port with Ocean Water 358
Figure A-12 Example Liquid Detect Pin(s)/Pad(s) Location Area 359
Figure A-13 Example Liquid Detect Pad Along All Connector Pins 359
Figure A-14 Example Liquid Detect Pins Adjacent to VBUS/SBU/CC 360
Figure A-15 Example Liquid Detect Connector Surface Mount View 360
Figure B-1 USB Type-C Debug Accessory Layered Behavior 361
Figure B-2 DTS Plug Interface 361
Figure B-3 Connection State Diagram: DTS Source 363
Figure B-4 Connection State Diagram: DTS Sink 364
Figure B-5 Connection State Diagram: DTS DRP 365
Figure B-6 TS Sink Power Sub-States 369
Figure D-1 Active Cable Model (Single Port, Top Mount Receptacle) 383
Figure D-2 Model Architecture 383
Figure D-3 Heat Sources and Heat Flow Paths 384
Figure D-4 Vertically Stacked Horizontal Connectors 3x1 Configuration (VERT) 385
Figure D-5 Horizontally Stacked Vertical Connectors 1x3 Configuration (HZ90) 386
Figure D-6 Horizontally Stacked Horizontal Connectors 1x3 Configuration (HORZ) 386

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Figure D-7 *USB 3.2* Single-Lane 3A Active Cable in a 3-Port Configuration....387
Figure D-8 *USB 3.2* Single-Lane 5A Active Cable in a 3-Port Configuration....387
Figure D-9 Impact of Overmold Power P_O and Thermal Boundary Temperature T_{MB} at 3 A V_{BUS} in a Single Port Configuration....389
Figure D-10 Impact of Overmold Power P_O and Thermal Boundary Temperature T_{MB} at 5 A V_{BUS} in a Single Port Configuration....389
Figure D-11 *USB 3.2* Active Cable Dongle Design (One End Shown)....390
Figure D-12 *USB 3.2* Dual-Lane 3A Active Cable in a 3-Port Configuration....390
Figure D-13 *USB 3.2* Dual-Lane 5A Active Cable in a 3-Port Configuration....391
Figure D-14 Example: Additional Heat Spreader on Receptacle in Host or Device....392
Figure D-15 Example: Heat Sinking on Chassis of Host or Device....392
Figure E-1 Pins Available for Reconfiguration over the Full-Featured Cable....394
Figure E-2 Pins Available for Reconfiguration for Direct Connect Applications....394
Figure E-3 Alternate Mode Implementation using a USB Type-C to USB Type-C Cable....396
Figure E-4 Alternate Mode Implementation using a USB Type-C to Alternate Mode Cable or Device....396
Figure E-5 USB DisplayPort Dock Example....398
Figure E-6 *USB4* DFP Mode Entry Flow Example....400
Figure F-1 *TBT3* Discovery Flow....404
Figure H-1 Arcing Damage to USB Type-C V_{BUS} Contacts....420
Figure H-2 Arcing Due to Discharge....421
Figure H-3 Arcing Prevention During Sink Discharge by Limiting Slew Rate....423
Figure H-4 Arcing Prevention During Sink Discharge by Load Removal....425

Tables

Table 2-1 Summary of power supply options....43
Table 3-1 USB Type-C Standard Cable Assemblies....46
Table 3-2 USB Type-C Legacy Cable Assemblies....47
Table 3-3 USB Type-C Legacy Adapter Assemblies....47
Table 3-4 USB Type-C Receptacle Interface Pin Assignments....78
Table 3-5 USB Type-C Receptacle Interface Pin Assignments for *USB 2.0*-only Support....79
Table 3-6 USB Type-C Standard Cable Wire Assignments....81
Table 3-7 USB Type-C Cable Wire Assignments for Legacy Cables/Adapters....82
Table 3-8 Reference Wire Gauges for standard USB Type-C Cable Assemblies....83
Table 3-9 Reference Wire Gauges for standard USB Type-C to Legacy Cable Assemblies....83
Table 3-10 USB Full-Featured Type-C Standard Cable Assembly Wiring....85
Table 3-11 *USB 2.0* Type-C Standard Cable Assembly Wiring....86
Table 3-12 USB Type-C to *USB 3.1* Standard-A Cable Assembly Wiring....88
Table 3-13 USB Type-C to *USB 2.0* Standard-A Cable Assembly Wiring....89
Table 3-14 USB Type-C to *USB 3.1* Standard-B Cable Assembly Wiring....90
Table 3-15 USB Type-C to *USB 2.0* Standard-B Cable Assembly Wiring....91
Table 3-16 USB Type-C to *USB 2.0* Mini-B Cable Assembly Wiring....92
Table 3-17 USB Type-C to *USB 3.1* Micro-B Cable Assembly Wiring....93
Table 3-18 USB Type-C to *USB 2.0* Micro-B Cable Assembly Wiring....94
Table 3-19 USB Type-C to *USB 3.1* Standard-A Adapter Assembly Wiring....95
Table 3-20 USB Type-C to *USB 2.0* Micro-B Receptacle Adapter Assembly Wiring....96
Table 3-21 Differential Insertion Loss Examples for USB TX/RX with Twisted Pair Construction....97
Table 3-22 Differential Insertion Loss Examples for USB TX/RX with Coaxial Construction....98
Table 3-23 Key Parameters in COM Configuration File....114
Table 3-24 Electrical Requirements for CC and SBU Wires....115

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Table 3-25 Coupling Matrix for Low Speed Signals....115
Table 3-26 Maximum Mutual Inductance (M) between VBUS and Low Speed Signal Lines....118
Table 3-27 USB D+/D– Signal Integrity Requirements for USB Type-C to USB Type-C Passive Cable Assemblies....120
Table 3-28 USB Type-C Mated Connector Recommended Signal Integrity Characteristics (*Informative*)....122
Table 3-29 USB Type-C Receptacle Connector Signal Integrity Characteristics for *USB4* Gen3 (*Normative*)....125
Table 3-30 USB D+/D– Signal Integrity Requirements for USB Type-C to Legacy USB Cable Assemblies (*Normative*)....126
Table 3-31 Design Targets for USB Type-C to *USB 3.1* Gen2 Legacy Cable Assemblies (*Informative*)....127
Table 3-32 USB Type-C to *USB 3.1* Gen2 Legacy Cable Assembly Signal Integrity Requirements (*Normative*)....128
Table 3-33 USB D+/D– Signal Integrity Requirements for USB Type-C to Legacy USB Adapter Assemblies (*Normative*)....130
Table 3-34 Design Targets for USB Type-C to *USB 3.1* Standard-A Adapter Assemblies (*Informative*)....131
Table 3-35 USB Type-C to *USB 3.1* Standard-A Receptacle Adapter Assembly Signal Integrity Requirements (*Normative*)....132
Table 3-36 Current Rating Test PCB....137
Table 3-37 Maximum DC Resistance Requirement (*Normative*)....137
Table 3-38 Force and Moment Requirements....140
Table 3-39 Environmental Test Conditions....143
Table 3-40 Reference Materials....144
Table 4-1 USB Type-C List of Signals....151
Table 4-2 VBUS Source Characteristics....154
Table 4-3 VBUS Sink Characteristics....155
Table 4-4 USB Type-C Source Port's VCONN Requirements Summary....156
Table 4-5 VCONN Source Characteristics....156
Table 4-6 Cable VCONN Sink Characteristics....157
Table 4-7 VCONN-Powered Accessory (VPA) Sink Characteristics....158
Table 4-8 VCONN-Powered Device (VPD) Sink Characteristics....159
Table 4-9 USB Type-C Port Interoperability....162
Table 4-10 Source Perspective....164
Table 4-11 Source (Host) and Sink (Device) Behaviors by State....164
Table 4-12 Recommended Implementation of Try.SRC and Try.SNK for Dual-Role Ports with Preferred Roles....171
Table 4-13 *USB PD* Swapping Port Behavior Summary....171
Table 4-14 Use of Power and Data Role Swaps for Dual-Role Ports with Preferred Roles....172
Table 4-15 Power Role Behavioral Model Summary....172
Table 4-16 Source Port CC Pin State....181
Table 4-17 Sink Port CC Pin State....181
Table 4-18 Mandatory and Optional States....207
Table 4-19 Precedence of Power Source Usage....227
Table 4-20 USB Type-C Current Advertisement and PDP Equivalent....229
Table 4-21 Sink Maximum Current Limit When Attached to CTVPD....232
Table 4-22 Example Charge-Through VPD Sink Maximum Currents based on VBUS Impedance and GND Impedance....233
Table 4-23 Examples of 4-port Shared Capacity Group and Power Sharing Policies....239
Table 4-24 SOP' and SOP" Timing....242
Table 4-25 Charge-Through VPD CC Impedance (RccCON) Requirements....244
Table 4-26 CTVPD Charge-Through Port VBUS Bypass Requirements....244
Table 4-27 Source CC Termination (Rp) Requirements....245
Table 4-28 Sink CC Termination (Rd) Requirements....246

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Table 4-29 Powered Cable Termination Requirements 246
Table 4-30 CC Termination Requirements for Disabled state, ErrorRecovery state, and Unpowered Source 246
Table 4-31 SBU Termination Requirements 246
Table 4-32 VBUS and VCONN Timing Parameters 247
Table 4-33 DRP Timing Parameters 249
Table 4-34 CC Timing Parameters 250
Table 4-35 Sink CC Pin Voltages for Connect Detection for Rd and Clamp Voltage ± 20% 254
Table 4-36 Sink CC Pin Voltages for Connect and Current Advertisement Detection for Rd ± 10% 254
Table 4-37 Source CC Pin Voltages for All Current Advertisements using a Pull-Up current 255
Table 4-38 Source CC Pin Voltages for Pull-Up Resistance to 5 V 256
Table 4-39 Source CC Pin Voltages for Pull-Up Resistance to 3.3 V 257
Table 4-40 CC Pin Clamping Voltage 257
Table 5-1 Certified Cables Where *USB4*-compatible Operation is Expected 264
Table 5-2 Fallback Mapping *USB4* Functions to USB Device Class Types 276
Table 5-3 USB Billboard Device Class Availability Following *USB4* Device Entry Failure 277
Table 6-1 *USB4* Cable Identity Summary 279
Table 6-2 Active Cable Features 280
Table 6-3 Active Cable SBU Requirements 281
Table 6-4 Active Cable Power-on Requirements 282
Table 6-5 Maximum *USB 3.2* U0 Delay 283
Table 6-6 *USB 3.2* U-State Requirements 283
Table 6-7 Active Cable *USB 3.2* Stressed Source Swing, TP1 285
Table 6-8 Active Cable *USB 3.2* Stressed Source Jitter, TP1 285
Table 6-9 Active Cable *USB 3.2* Input Swing at TP2 (*Informative*) 286
Table 6-10 Active Cable *USB 3.2* Output Swing at TP3 (*Informative*) 286
Table 6-11 Compliance Points Definition 287
Table 6-12 *USB4* CL-State Requirements for Active Cables 289
Table 6-13 Re-timer-based *USB4* Active Cable Output Specifications Applied for All Speeds (at TP3') 290
Table 6-14 Stressed Receiver Conditions for *USB4* Gen2 and Gen3 Cable Compliance Testing (at TP2) 292
Table 6-15 Linear Re-driver-based Active Cable Output Parameters 294
Table 6-16 Input Signal at TP2 for Compliance Testing 295
Table 6-17 *USB4* Gen4 LRD-based Active Cable ILfitMask Limits 299
Table 6-18 *USB4* Gen4 LRD-based Active Cable Wiring Diagram for Compliance 301
Table 6-19 *USB4* Gen4 Active Cable SBx Transaction Snooping 302
Table 6-20 *USB4* LRD Active Cable Logical Timing Parameters 303
Table 6-21 *USB4* LRD Tuning Register Snooping 312
Table 6-22 Cable Temperature Requirements 313
Table 6-23 OIAC *USB PD* Message Handling 320
Table 6-24 Recommended OIAC Sink_Capabilities PDO (SOP) on Initial Connection 321
Table 6-25 Recommended OIAC Sink_Capabilities PDO (SOP) on Active Connection 321
Table 6-26 Recommended OIAC Active Sink RDO (SOP) 322
Table 6-27 OIAC *USB PD* Message Timing 325
Table 6-28 Port and Plug Capabilities 330
Table 6-29 *USB 3.2* U-State Requirements 350
Table 6-30 *USB4* CL-State Requirements for OIAC 351
Table A-1 Example Measurement Test Conditions 355
Table B-1 DTS to TS Port Interoperability 362
Table B-2 Rp/Rp Charging Current Values for a DTS Source 369
Table B-3 Mandatory and Optional States 371
Table D-1 Heat Sources and Heat Dissipation Example (1.5 W cable and 5 A) 384

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Table D-2 *USB 3.2* Active Cable Design Single Port Case Study at 35 °C Ambient and 60 °C Thermal Boundary (Single Lane) 385
Table D-3 *USB 3.2* Active Cable Design Single Port Case Study at 35 °C Ambient and 60 °C Thermal Boundary (Dual Lane) 388
Table E-1 USB Safe State Electrical Requirements 397
Table E-2 USB Billboard Device Class Availability Following Alternate Mode Entry Failure 397
Table E-3 Alternate Mode Signal Noise Ingression Requirements 397
Table F-1 *TBT3* Passive Cable Discovery Identity VDO Responses 405
Table F-2 *TBT3* Passive Cable VDO for *USB PD* Revision 2.0, Version 1.3 406
Table F-3 *TBT3* Passive Cable VDO for *USB PD* Revision 3.0, Version 1.2 406
Table F-4 *TBT3* Active Cable Discovery Identity VDO Responses 407
Table F-5 *TBT3* Active Cable VDO for *USB PD* Revision 2.0, Version 1.3 408
Table F-6 *TBT3* Active Cable VDO 1 for *USB PD* Revision 3.0, Version 1.2 408
Table F-7 *TBT3* Active Cable VDO 2 for *USB PD* Revision 3.0, Version 1.2 409
Table F-8 *TBT3* Device Discovery Identity VDO Responses 410
Table F-9 *TBT3* Discover SVID VDO Responses 411
Table F-10 *TBT3* Device Discover Mode VDO Responses 412
Table F-11 *TBT3* Cable Discover Mode VDO Responses 413
Table F-12 *TBT3* Cable Enter Mode Command 414
Table F-13 *TBT3* Device Enter Mode Command 415
Table F-14 *TBT3* Cable Functional Difference Summary 417
Table G-1 Linear Fit Pulse Extraction Parameters 419
Table I-1 USB Type-C Product Example Clarifying Notes 430
Table I-2 *USB PD* Encoding Guidelines for Example Products 433

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Specification Editor

SpecWerkz Brad Saunders

Specification Work Group Contributors

The following is a list of contributor companies and the individuals that were members of the work group roster at the time of this release (October 2024). Note: For historical reasons, the following list also includes individuals that were members of the work group and associated with their company affiliations at the time of each release going back to Release 1.0.

Acroname Inc.	Grant Fritz	Connor Goss	Matt Krugman
Advanced-Connectek, Inc. (ACON)	Glen Chandler	Conrad Choy	Alan Tsai
	Victory Chen	Vicky Chuang	Wayne Wang
	Bobo Chen	Same Dai	Stephen Yang
	Dennis Cheung	Jessica Feng	Sunney Yang
	Jeff Chien	Aven Kao	Kevin Yao
	Lee (Dick Lee) Ching	Danny Liao	
Advanced Micro Devices	Steve Capezza	Jason Hawken	Joseph Scanlon
	Michael Comai	Juan Martinez	Peter Teng
	Walter Fry	Gerald Merits	Sujan Thomas
	Will Harris	Tim Perley	
Allion Labs, Inc.	Howard Chang	Yan Ken	Brian Shih
	Alex Chuang	Lexus Lee	Chester Tsai
	Maroco Fan	Stan Lin	Chou Tsungbo
	Jesse Jiang	Denver Mishima	Liam Wu
	Terry Kao	Minoru Ohara	
Amphenol Corporation	Louis Chan	Terry Ke	Shawn Wei
	Zhinenng Fan	Martin Li	Alan Yang
	Jesse Jaramillo	Lino Liu	
Agilent Technologies, Inc.	James Choate		
Analogix Semiconductor, Inc.	Mehran Badii	Haijian Sui	Yueke Tang
	Greg Stewart		
Apple Inc. (USB Promoter company)	Colin Abraham	Brian Follis	Nathan Ng
	Mahmoud Amini	Zheng Gao	James Orr
	Sree Anantharaman	Derek Iwamoto	Keith Porthouse
	Brian Baek	Scott Jackson	Breton Saunders
	Paul Baker	Girault Jones	Reese Schreiber
	Michael Bonham	Keong Kam	Jay Sha
	Jonathan Brown	Kevin Keeler	Sascha Tietz
	Carlos Calderon	Min Kim	Jennifer Tsai
	Jason Chung	Woopoung Kim	Colin Whitby-Strevens
	David Conroy	Alan Kobayashi	Jeff Wilcox
	Bill Cornelius	Alexei Kosut	Eric Wiles
	Christophe Daniel	Christine Krause	Dan Wilson
	Raju Desai	Chris Ligtenberg	Dennis Yarak
	William Ferry	Matthew Mora	
Aptiv Consumer Connectivity	Andrew Burchett	Moe Elghrawi	
ASMedia Technology Inc.	Kuo Lung Li		
Bizlink Technology, Inc.	Alex Chou	CY Tsai	Giovanni Wang
	Morphy Hsieh	Kevin Tsai	

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Cadence Design Systems, Inc.	Marcin Behrendt	Dariusz Kaczmarczyk	Neelabh Singh
	Huzaifa Dalal	Tomasz Klimek	Michal Staworko
	Pawel Eichler	Sanjeet Kumar	Fred Stivers
	Sanjai Gandhi	Jie Min	Mark Summers
	Sathish Kumar Ganesan	Asila Nahas	Claire Ying
		Uyen Nguyen	
Canova Tech	Piergiorgio Beruto	Michael Marioli	Paola Pilla
	Andrea Maniero	Antonio Orzelli	Nicola Scantamburlo
China Telecommunications Technology Labs	Ming Wei		
Cirrus Logic Inc.	Sean Davis	Darren Holding	Brad Lambert
Corning Optical Communication LLC	Wojciech Giziewicz	Ian McKay	Jamie Silva
Cosemi Technologies Inc.	Samir Desai	Devang Parekh	
Credo Semiconductor, Inc.	Jim Bartenslager	Yasuo Hidaka	Ping Xiong
	Yifei Dai	Justin Lee	
	Kevin Gao	Phil Sun	
Cypress Semiconductor	Chia Hua Chang	Rushil Kadakia	Jagadeesan Raj
	Mark Fu	Benjamin Kropf	Sanjay Sancheti
	Naman Jain	Venkat Mandagulathur	Subu Sankaran
	Savan Javia	Anup Nayak	Anita Thimma Govarthanarajan
Dell	Mohammed Hijazi	Ken Nicholas	Siddhartha Reddy
	Rose Hou	Marcin Nowak	Thomas Voor
	David Meyers	Ernesto Ramirez	Merle Wood
	Sean O'Neal		
Dialog Semiconductor (UK) Ltd.	Yimin Chen		
Diodes Incorporated	Kay Annamalai	Bob Lo	Jin-sheng Wang
	Justin Lee	Jaya Shukla	Ada Yip
	Paul Li	Qun Song	
DisplayLink (UK) Ltd.	Pete Burgers		
DJI Technology Co., Ltd.	Steve Huang		
eEver Technology, Inc.	Chien-Cheng Kuo		
Electronics Testing Center, Taiwan	Sophia Liu		
Elka International Ltd.	Roy Ting		
Ellisys	Abel Astley	Wenhui Luo	Chuck Trefts
	Rick Bogart	Mario Pasquali	Tim Wei
Etron Technology, Inc.	Chien-Cheng Kuo		
EverPro Technologies Company, Ltd.	Eva Chen	Hui Jiang	Silane Zhou
Feature Integration Technologies Inc.	Jacky Chan	KungAn Lin	Paul Yang
	Chen Kris	Yuchi Tsao	Amanda Ying
	Yulin Lan		

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Foxconn / Hon Hai	Patrick Casher	Fred Fons	Christine Tran
	Asroc Chen	Chris Goralka	Pei Tsao
	Brandon Chen	Bob Hall	AJ Yang
	Joe Chen	Chien-Ping Kao	Yuan Zhang
	Allen Cheng	Ji Li	Jessica Zheng
	Jason Chou	Ann Liu	Jie Zheng
	Edmond Choy	Terry Little	Andy Yao
	Shruti Deore	Steve Sedio	
Foxlink/Cheng Uei Precision Industry Co., Ltd.	Robert Chen	Armando Lee	Steve Tsai
	Sunny Chou	Dennis Lee	Wen Yang
	Carrie Chuang	Justin Lin	Wiley Yang
	Wen-Chuan Hsu	Robert Lu	Patrick Yeh
	Alex Hsue	Tse Wu Ting	Junjie Yu
Fresco Logic Inc.	Brian Collins	Bob McVay	Christopher Meyers
Google	Mehdi Abrishamchian	Mark Hayter	Vincent Palatin
	Naga Viswanadha Udaya Kiran Ammu	Eric Herrmann	Dylan Reid
	Lucasz Bartosik	Nithya Jagannathan	Adam Rodriguez
	Alec Berg	Nathan Kolluru	David Schneider
	Joshua Boilard	Lawrence Lam	Stephan Schooley
	Alec Berg	Adam Langley	Ketan Shringarpure
	Todd Broch	Benson Leung	Toshak Singhal
	Charlie Costakis	Abraham Levkoy	Bartosz Szpila
	Nehemiah Dureus	Ingrid Lin	Jameson Thies
	Chao Fei	Prashant Malani	Radu Vele
	Jim Guerin	George-Daniel Matei	Ken Wu
	Jeffrey Hayashida	Richard Palatin	Songping Wu
			Diana Zigterman
Granite River Labs	Yung Han Ang	Mike Engbretson	Kristof Mommen
	Velmurugan Ayyakkannu	Mark Jiang	Krishna Murthy
	Rajesh B	Vishal Kakade	Amy Peng
	Pascal Berten	Jesson Li	Johnson Tan
	Hariprasad Bhat	Caspar Lin	Annie Tao
	Sandy Chang	Olivia Lu	Vasudev Uttharahalli
	Allen Chen	Bala M	Chin Hun Yaep
	Swee Guan Chua	Prasannakumar Marikunte Nagaraju	Mike Yang
	Alan Chuang	Winson Mok	Yun Yang
GuangDong OPPO Mobile Telecommunications Corp, Ltd.	Jerry Qin		
Honor Device Co., Ltd.	Wang Feng		
Hirose Electric Co., Ltd.	Jeremy Buan	Hyejun Lee	Gourgen Oganessyan
	Kohei Hida	Zhili Liang	Youngbon Park
	Kazunori Ichikawa	Sang-Muk Lim	Eungsoo Shin
	Sukkyu Jang	William MacKillop	Sid Tono
	William Kysiak		
Hosiden Corporation	Takahisa Otsuji	Fumitake Tamaki	

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

HP Inc. (USB Promoter company)	Lee Atkinson Srinath Balaraman Rami Bathaniah Roger Benson Alan Berkema	Robin Castell Steve Chen Michael Krause Rahul Lakdawala	Jim Mann Linden McClure Mike Pescetto Asjad Shamim
Huawei Technology Co., Ltd.	Jianhong He Zhengbing Li	Gang Liang Lauri Soderbacka	Ruinan Sun Liansheng Zheng
Hynetek Semiconductor Co., Ltd.	Yingyang Ou	James Xie	
I-PEX (Dai-ichi Seiko)	Alan Kinningham	Jack Ozeki	Ro Richard
Indie Semiconductor	Ian Board	Jim Wilshire	
Infineon Technologies	Godwin Gerald Arulappan Pradeep Baipai Dominic Gutierrez Anton Gutsul Naman Jain	Behzad Jamasbi Benjamin Kropf Venkat Mandagulathur Aniket Shashikant Mathad	Geona Mary Pullankannappally Devasia Shopitham Ram Gayathri Vasudevan Tue Fatt David Wee
Insight Test Labs	Caspar Lin		
Intel Corporation (USB Promoter company)	Dave Ackelson Nirmala Bailur Mike Bell Dmitriy Berchanskiy Brad Berlin Pierre Bossart Huimin Chen Kuan-Yu Chen Hengju Cheng Oded David Sourabh Das Jhuda Dayan Hem Doshi Paul Durley Saranya Gopal Venkataramani Gopalakrishnan Yaniv Hayat Howard Heck Hao-Han Hsu Seppo Ingalsuo Abdul (Rahman) Ismail James Jaussi	Luke Johnson Ziv Kabiry Vijaykumar Kadgi Jerzy Kolinski Venkataramana Kotakonda Rolf Kuhnis Henrik Leegaard Edmond Lau Xiang Li Yun Ling Guobin Liu Steve McGowan Sankaran Menon Udaya Natarajan Aruni Nelson Chee Lim Nge Asutosh Pathak Sagar Pawar Duane Quiet Amardeep Rai Kannappan Rajaraman Sridharan Ranganathan	Rajaram Regupathy Oren Salomon Brad Saunders Tomer Savariego Ehud Shoor Amit Srivastava Einat Surijan Eliahu Suued Ron Swartz Chuen Ming Tan David Thompson Pranav Tipnis Karthi Vadivelu Venkataramani Gopalakrishnan Tsion Vidal Stephanie Wallick Rafal Wielicki Devon Worrell Gal Yedidia Li Yuan Reza M. Zamani Vitaly Zhivov

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Japan Aviation Electronics Industry Ltd. (JAE)	Kenji Hagiwara	Tadashi Okubo	Jussi Takaneva
	Hiroaki Ikeda	Kazuhiro Saito	Junichi Takeuchi
	Masaki Kimura	Kimiaki Saito	Tomohiko Tamada
	Toshio Masumoto	Yuichi Saito	Kentaro Toda
	Kenta Minejima	Mark Saubert	Kouhei Ueda
	Toshiyuki Moritake	Toshio Shimoyama	Takakazu Usami
	Joe Motojima	Tatsuya Shioda	Masahide Watanabe
	Ron Muir	Atsuo Tago	Youhei Yokoyama
	Norihiko Nakamura	Masaaki Takaku	
JPC/Main Super Inc.	Sam Tseng	Ray Yang	
Kandou Bus SA	Amanda Dong	Hitaish Sharma	Paul Wilson
	Majid Foodeei	David Stauffer	
Keysight Technologies Inc.	Soon Tatt Beh	Jit Lim	Abhijeet Shinde
	Fang Huey Lim	Pedro Merlo	Xiao Zhang
Kinetic Technologies, Inc.	Ramesh Dandapani	Jay Slivkoff	Kei Yasuno
	Akihiro Moto	Sireesha Vemulapalli	
Leadtrend	Yao-Wei Hsieh		
LeCroy Corporation	Mike Engbretson	Tyler Joe	Giuseppe Leccia
	Daniel H. Jacobs	Chetan Kopalle	
Lenovo	Rob Bowser	Jianye Li	Howard Locker
	Tomoki Harada	Wei Liu	Munefumi Nakata
LG Electronics Inc.	Won-Jong Choi	Jeeyoung Kim	Seung Hyun Yoo
	Do Kyun Kim	Minji Kim	
Lintes Technology Co., Ltd.	Tammy Huang	Guobin Liu	JinYi Tu
	Charles Kaun	Max Lo	Jason Yang
	RD Lintes	CT Pien	
Logitech Inc.	Niclas Granqvist		
Lotes Co., Ltd.	Ariel Delos Reyes	Charles Kaun	John Lynch
	Ernest Han	Chi-Chang Lin	Scott Shuey
	Mark Ho	James Lin	JinYi Tu
	Regina Liu-Hwang	Max Lo	Jason Yang
LSI Corporation	Dave Thompson		
Luxshare-ICT	Josue Castillo	Peter Jhou	Scott Shuey
	Daniel Chen	Antony Lin	James Stevens
	Kenny Chen	Gorden Lin	Carr Wang
	Lisen Chen	John Lin	Yangli Wang
	Sally Chiu	Stone Lin	Eric Wen
	Blue Ho	Alan Liu	Wayne Yeh
	CY Hsu	Sean O'Neal	Pat Young
	Alan Kinningham		
Maxim Integrated Products	Forrest Christo	Sang Kim	Michael Miskho
	Ken Helfrich	Jeff Lo	Jacob Scott
MCCI Corporation	Terry Moore		
MediaTek Inc.	Henry Chen	Liang-Yu Hsu	Alex YC Lin
	Yu-Yi Chu	Jing-Hao Huang	Tung-Sheng Lin
	Yishu Hsieh	Shih Jyun-Yang	Colin Tsai
	Jason Hsu	Akan Lin	Chasel Wang

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

MegaChips Corporation	Alan Kobayashi	Satoru Kumashiro	
Mercedes-Benz Research & Development, North America, Inc.	Hans Wickler		
Microchip (SMSC)	Josh Averyt Mark Bohm Shannon Cash Thomas Farkas Fernando Gonzalez	Matthew Kalibat Donald Perkins Richard Petrie Mohammed Rahman Andrew Rogers	John Sisto Anthony Tarascio Kiet Tran Christopher Twigg Prasanna Vengateshan
Microsoft Corporation (USB Promoter company)	Randy Aull Jim Belesiu Michelle Bergeron Fred Bhesania Anthony Chen Philip Froese Vivek Gupta David Hargrove Robbie Harris Teemu Helenius Robert Hollyer Lily Huang Dan Iatco	Kai Inha Jayson Kastens Andrea Keating Shoaib Khan Patrick Law Eric Lee Ivan McCracken Arvind Murching Gene Obie Toby Nixon Arjun Padmanabhan Praveen Kumar Palacharla	Rahul Ramadas Srivatsan Ravindran Kiran Shastry Nathan Sherman Ugan Sivagnanenthirarajah Bala Sivakumar Timo Toivola Vahid Vassey David Voth Andrew Yang Panu Ylihaavisto
Molex LLC	Adib Al Abaji	Alan MacDougall	
Monolithic Power Systems	Junyong Gong Di Han Yuncong Jiang	Istvan Nagy Chris Sporck Ao Sun	Greg Virnig Vincent Wu
MQP Electronics Ltd.	Sten Carlsen	Pat Crowe	
Multilane Inc.	Fadi Daou	Rita Khawaja	Elias Khoury
NEC Corporation	Kenji Oguma		
Newnex Technology Corp.	Sam Liu	Nimrod Peled	
Nokia Corporation	Daniel Gratiot Pekka Leinonen	Samuli Makinen Pekka Talmola	Timo Toivola Panu Ylihaavisto
Nuvoton Technology Corp.	Nimrod Peled		
NVIDIA	Jamie Aitken	Jason Tsai	
NXP Semiconductors	Mahmoud EL Sabbagh Dennis Ha Jia Guo Ken Jaramillo	Nate Johnson Vijendra Kuroodi Roger Lo	Guru Prasad Wouter Sijm Krishnan TN
Oculus VR LLC	Amish Babu	Marty Evans	Joaquin Fierro
ON Semiconductor	Edward Berrios Rod Comer Alex Cornwall Eduardo De Reza	Alan Finkel Oscar Freitas Christian Klein Amir Lahooti	Eric Maier Rick Pierce Michael Smith
Parade Technologies, Inc.	Tom Burton Jian Chen Brian Collins	Reginald Conley Robert McVay Craig Wiley	Paul Xu Alan Yuen Jingfan Zhang
Phison Electronics Corp.	Wilson Wen		

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Power Integrations	Shruti Anand Daryll Bonavente Rahul Joshi	Aditya Kulkarni Akshay Nayaknur	Amruta Patra Kaushik Raam
Qualcomm, Inc.	Lior Amarilio Vara Prasad Arikatla Aris Balatsos Nicholas Cadieux David Chang Tomer Ben Chen Richard Burrows Amit Gil	James Goel Amit Gupta Philip Hardy Will Kun Jonathan Luty Adi Menachem Lalan Mishra George Paparrizos	Vatsal Patel Jack Pham Vamsi Samavedam Matthew Sienko Dmitrii Vasilchenko Joshua Warner Chris Wiesner
Realtek Semiconductor Corp.	Marco Chiu Tsung-Peng Chuang Charlie Hsu Fan-Hau Hsu Ty Kingsmore	Ray Lee Jay Lin Ryan Lin Terry Lin	Chuting Su Kyle Tsai Jason Wang Changhung Wu
Renesas Electronics Corp. (USB Promoter company)	Kai Bao Yen-Mo Chen Yimin Chen Nobuo Furuya Tony Lai	Philip Leung Mengfei Liu Kiichi Muto Ziba Nami Hajime Nozaki	Yosuke Sasaki Toshifumi Yamaoka Fengshuan Zhou Yuhuan Zhou
Resillion (Belgium NV)	Bart Grispen		
Richtek Technology Corp.	Ben Chiang Tzuhsien Chuang Bryan Huang	Max Huang Leo Kang Roger Lo	Ken Shih Alex Yang
Rohde & Schwarz GmbH & Co. KG	Curtis Donahue Patrick McKenzie	Kai Uwe Schmidt Martin Stumpf	Randy White
Rohm Co., Ltd.	Mark Aaldering Kris Bahar Ruben Balbuena Nobutaka Itakura	Yusuke Kondo Arun Kumar Chris Lin Kazuomi Nagai	Yoshinori Ohwaki Takashi Sato Hiroshi Yoshimura
Samsung Electronics Co., Ltd.	Jaedeok Cha KangSeok Cho Junhwa Choi Wooin Choi Yeongbok Choi Cheolyoon Chung Ilhyung Chung JaeRyong Han Jaehyeok Jang Sung Geun Joo	Sangwoo Kang Wonseok Kang Koyoungwon Kim Sangju Kim Soondo Kim Woonki Kim Jagoun Koo Termi Kwon Cheolho Lee Edward Lee	Jun Bum Lee Kyunghwan Lee Kyungwoo Lee Jinyoung Oh Chahoon Park Chulwoo Park Youngjin Park Jung Waneui Sunggeun Yoon
SB C&S Corp.	Toshinari Nakamura Morito Ogikubo	Eiji Sakai	Kenji Watanabe
Scosche Industries	Josh Aguilera	Perry DeGuzman	Kevin Trejo
Seagate	Alvin Cox Emmanuel Lemay	Tony Priborsky Tom Skaar	Dan Smith Curtis Stevens
Shenzhen Deren Electronic Co., Ltd.	Smark (Zhudong) Huo Wen Fa Lei	Yang Lirong Valerie Yang	Lucy Zhang

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Silicon Line Gmbh	Ian Jackson	Boleslaw Wojtowicz	Zhiying Zhang
SiliConch Systems Private Limited	Jaswanth Ammineni Pavitra Balasubramanian Kaustubh Kumar Aniket Mathad	Shubham Paliwal Jinisha Patel Vinay Patel Rakesh Polasa	Vishnu Pusuluri Ranjith S Abhishek Sardeshpande Satish Anand Verkila
Simula Technology Inc.	John Chang Voss Cheng Thomas Li	Jung Lin Jyunming Lin Doris Liu	Richard Liu CK Wang Alice Yu
Softnautics LLP	Bhavesh Desai Hetal Jariwala	Dipakkumar Modi Ishita Shah	Ujjwal Talati
Sony Corporation	Shinichi Hirata	Shigenori Tagami	
Spectra7 Microsystems Corp.	Andrew Kim	James McGrath	John Mitchell
SpecWerkz	Robert Dunstan Amanda Hosler	Diane Lenox Steve McGowan	Brad Saunders
STMicroelectronics (USB Promoter company)	Jerome Bach Nathalie Ballot Filippo Bonaccorso Guenael Cadier Dominique Chaillot Christophe Cochard Nicolas Florenchie	Cedric Force Gregory Gosciniak Chekib Hammami Joel Huloux Christophe Lorin Yohann Martiniault Patrizia Milazzo	Federico Musarra Pascal Legrand Richard O'Connor Massimo Panzica Nicolas Perrin Mathieu Rouviere
Sumitomo Electric Ind., Ltd.	Takeshi Inoue Yasuhiro Maeda	Wataru Sakurai Sainer Siagian	Masaki Suzuki Mitsuaki Tamura
Synaptics Inc.	Daniel Bogard Dan Ellis	Jeff Lukanc	Prashant Shamarao
Synopsys, Inc.	Prishkrit Abrol Subramaniam Aravindhan	Morten Christiansen Jaspreet Gambhir Nivin George	Satya Patnala John Stonick
Taiwan Testing and Certification Center	Dennis Chang	Sophia Liu	
Tektronix, Inc.	Sourabh Das Mark Guenther	Nitin Jhanwar Abhijeet Shinde	Randy White
Texas Instruments (USB Promoter company)	Jawaid Ahmad Kasthuri Annamalai Mike Campbell Prajith Cheerakkoda Greg Collins Gary Cooper Biju Erayamkot Panayamthatta Anant Gole GP Gopalakrishnan Craig Greenberg Richard Hubbard Katherine Huckabay Nate Johnson	Michael Koltun IV Kevin Kosta Yoon Lee Grant Ley Win Maung Shafiuddin Mohammed Lauren Moore Jacob Ontiveros Brian Parten Martin Patoka Jason Peck John Perry	Louis Peryea Brian Quach Sai Karthik Rajaraman Wes Ray Dafydd Roche Anwar Sadat Cory Stewart Neeta Thawani Sue Vining Bill Waters Deric Waters Gregory Watkins Roy Wojciechowski
The Silanna Group Pty. Ltd.	Tod Wolf		
Thine Electronica, Inc.	Yuseke Fujita	Shuhei Yamamoto	

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Total Phase	Chris Yokum		
Trinity Co., Ltd.	Tetsushi Hoshikawa	Kinya Kishita	
Tyco Electronics Corp. (TE Connectivity Ltd.)	Max Chao	Mike Lockyer	Hiroshi Shirai
	Robert E. Cid	Jeff Mason	Hidenori Taguchi
	Calvin Feng	Takeshi Nakashima	Nathan Tracy
	Kengo Ijiro	Luis A. Navarro	Bernard Vetten
	Eiji Ikematsu	Masako Saito	Ryan Yu
	Joan Leu	Yoshiaki Sakuma	Noah Zhang
	Clark Li	Gavin Shih	Sjoerd Zwartkruis
UL LLC	Leo Chung	Dylan Su	Eric Wall
	Michael Hu	Henry Tsou	Lance Yang
	Terry Kao	Paul Vanderlaan	Chien-Wei Yeh
Unigraf OY	Steven Chen	Alexander Gushchin	Topi Lampiranta
	Sergey Grushin		
Varjo Technologies	Kai Inha		
Ventev Mobile	Brad Cox	Colin Vose	
VIA Technologies Inc.	Rex Hsu	Terrance Shih	Fong-Jim Wang
	Einsent Huang	Jay Tseng	
Vivo Mobile Communications Co. Ltd.	Benny Dong	Junchen Wei	Ziji Zhou
	Fangding Luo		
Weltrend Semiconductor	Hung Chiang	Wayne Lo	Eric Wu
	Jeng Cheng Liu	Ho Wen Tsai	
Western Digital	Dave Landsman	Rotem Sela	Prithviraj Sengupta
	Larry McMillan		
Xiaomi Communications Co., Ltd.	Canfeng Chen	Xiaoxing Yang	Qi Zhu
	Zhe Wang	Juejia Zhou	
Zhuhai iSmartWare Technology Co., Ltd.	Yuanchao Liang	Liu Qiong	Long Zhang

Pre-Release Draft Industry Reviewing Companies That Provided Feedback

Aces	JST Mfg. Co., Ltd.	Pericom
Fairchild Semiconductor	Korea Electric Terminal	Semtech Corporation
Fujitsu Ltd.	Marvell Semiconductor	Silicon Image
Industrial Technology Research Institute (ITRI)	Motorola Mobility LLC	SMK Corporation
Joinsoon Electronics Mfg. Co. Ltd.	PalCONN/PalNova (Palpilot International Corp.)	Toshiba Corporation

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

Revision History

Release	Date	Description
1.0	August 11, 2014	Initial Release
1.1	April 3, 2015	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
1.2	March 25, 2016	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
1.3	July 14, 2017	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
1.4	March 29, 2019	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
2.0	August 2019	New release primarily for enabling ***USB4*** over USB Type-C connectors and cables. Also includes incorporation of all approved ECNs as of the revision date plus editorial clean-up.
2.1	May 2021	New release primarily for enabling Extended Power Range (EPR) and defining EPR cables aligning with ***USB Power Delivery*** Specification R3.1 V1.0. Also includes incorporation of all approved ECNs as the revision date plus editorial clean-up.
2.2	October 2022	New release primarily for enabling ***USB4*** Version 2.0 (80 Gbps) over USB Type-C connectors and cables. Also includes incorporation of all approved ECNs as of the revision date plus editorial clean-up.
2.3	October 2023	New release primarily for *deprecating* the ***Audio Adapter Accessory Mode*** and *replacing it with* the ***Liquid Corrosion Mitigation Mode***, and for updating the ***Multi-port Charger Shared Capacity*** definition and behaviors. Also includes incorporation of all other approved ECNs as of the revision date. Note: this release was created using a newly developed document template that includes some style adjustments and editorial clean-up.
2.4	October 2024	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

1 Introduction

With the continued success of the USB interface, there exists a need to adapt USB technology to serve newer computing platforms and devices as they trend toward smaller, thinner, and lighter form-factors. Many of these newer platforms and devices are reaching a point where existing USB receptacles and plugs are inhibiting innovation, especially given the relatively large size and internal volume constraints of the Standard-A and Standard-B versions of USB connectors. Additionally, as platform usage models have evolved, usability and robustness requirements have advanced, and the existing set of USB connectors were not originally designed for some of these newer requirements. This specification establishes a new USB connector ecosystem that addresses the evolving needs of platforms and devices while retaining all the functional benefits of USB that form the basis for this most popular computing device interconnect.

1.1 Purpose

This specification defines the USB Type-C® receptacles, plug and cables.

The USB Type-C Cable and Connector Specification is guided by the following principles:

- Enable new and exciting host and device form-factors where size, industrial design and style are important parameters
- Work seamlessly with existing USB host and device silicon solutions
- Enhance ease of use for connecting USB devices with a focus on minimizing user confusion for plug and cable orientation

The USB Type-C Cable and Connector Specification defines a receptacle, plug, cable, and detection mechanisms that are compatible with existing USB interface electrical and functional specifications. This specification covers the following aspects that are needed to produce and use this new USB cable/connector solution in newer platforms and devices, and that interoperate with existing platforms and devices:

- USB Type-C receptacles, including electro-mechanical definition and performance requirements
- USB Type-C plugs and cable assemblies, including electro-mechanical definition and performance requirements
- USB Type-C to legacy cable assemblies and adapters
- USB Type-C-based device detection and interface configuration, including support for legacy connections
- ***USB Power Delivery*** optimized for the USB Type-C connector

The USB Type-C Cable and Connector Specification defines a standardized mechanism that supports ***Alternate Modes***, such as repurposing the connector for docking-specific applications.

1.2 Scope

This specification is intended as a supplement to the existing ***USB 2.0***, ***USB 3.2***, ***USB4®*** and ***USB Power Delivery*** specifications. It addresses only the elements required to implement and support the USB Type-C receptacles, plugs and cables.

Normative information is provided to allow interoperability of components designed to this specification. ***Informative*** information, when provided, may illustrate possible design implementations.

1.3 Related Documents

USB 2.0 ***Universal Serial Bus Revision 2.0 Specification***
This includes the entire document release package.

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

USB 3.2 ***Universal Serial Bus Revision 3.2 Specification***
This includes the entire document release package.
USB 3.1 Legacy Cable and Connector Specification, Revision 1.0

USB4 ***USB4 Specification, Version 2.0, June 2023***
(including posted errata and ECNs)

TBT3 *Chapter 13 of* ***USB4 Specification, Version 2.0, June 2023***

USB PD ***USB Power Delivery Specification, Revision 2.0, Version 1.3, January 12, 2017***
USB Power Delivery Specification, Revision 3.2, Version 1.1, October 2024
(including posted errata and ECNs)

USB BB ***USB Billboard Device Class Specification, Revision 1.2.2, January 29, 2021***

USB BC ***Battery Charging Specification, Revision 1.2, March 15, 2012***
(including posted errata and ECNs)

DP AM ***DisplayPort™ Alt Mode on USB Type-C Standard, Version 2.1a, August 2024***

All USB-specific documents are available for download at http://www.usb.org/documents.
The ***DisplayPort Alt Mode*** specification is available from VESA (http://www.vesa.org).

1.4 Conventions

1.4.1 Precedence

If there is a conflict between text, figures, and tables, the precedence ***shall*** be tables, figures, and then text.

1.4.2 Keywords

The following keywords differentiate between the levels of requirements and options.

1.4.2.1 Informative

Informative is a keyword that describes information with this specification that intends to discuss and clarify requirements and features as opposed to mandating them.

1.4.2.2 May

May is a keyword that indicates a choice with no implied preference.

1.4.2.3 May Not

May not is a keyword that is the inverse of ***May***. Indicates a choice to not implement a given feature with no implied preference.

1.4.2.4 N/A

N/A is a keyword that indicates that a field or value is not applicable and has no defined value and ***shall not*** be checked or used by the recipient.

1.4.2.5 Normative

Normative is a keyword that describes features that are mandated by this specification.

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.

1.4.2.6 Optional and Optionally

Optional and ***Optionally*** are equivalent keywords that describe features not mandated by this specification. However, if an ***optional*** feature is implemented, the feature ***shall*** be implemented as defined by this specification (***optional normative***).

1.4.2.7 Reserved

Reserved is a keyword indicating reserved bits, bytes, words, fields, and code values that are set-aside for future standardization. Their use and interpretation may be specified by future extensions to this specification and, unless otherwise stated, ***shall not*** be utilized, or adapted by vendor implementation. A reserved bit, byte, word, or field ***shall*** be set to zero by the sender and ***shall*** be ignored by the receiver. ***Reserved*** field values ***shall not*** be sent by the sender and, if received, ***shall*** be ignored by the receiver.

1.4.2.8 Shall

Shall is a keyword indicating a mandatory (***normative***) requirement. Designers are mandated to implement all such requirements to ensure interoperability with other compliant Devices.

1.4.2.9 Shall Not

Shall not is a keyword that is the inverse of ***Shall*** indicating non-compliant operation.

1.4.2.10 Should

Should is a keyword indicating flexibility of choice with a preferred alternative. Equivalent to the phrase "it is recommended that …".

1.4.2.11 Should Not

Should not is a keyword that is the inverse of ***Should***. Equivalent to the phrase "it is recommended that implementations do not ...".

1.4.3 Numbering

Numbers that are immediately followed by a lowercase "b" (e.g., 01b) are binary values. Numbers that are immediately followed by an uppercase "B" are byte values. Numbers that are immediately followed by a lowercase "h" (e.g., 3Ah) are hexadecimal values. Numbers not immediately followed by either a "b", "B", or "h" are decimal values.

koniec náhľadu – text ďalej pokračuje v platenej verzii STN

Copyright © 2024 USB 3.0 Promoter Group. All rights reserved.