USB Type-C ENGINEERING CHANGE NOTIFICATION

Title: USB4® V2 Updates
Applied to: USB Type-C Specification Release 2.1, May 2021

Brief description of the functional changes proposed:
Aligns USB Type-C with the forthcoming USB4 V2 spec. Primary focus is updates needed to discover and operate with USB4 80 Gbps cables, both passive and active. Updates to the electrical requirements portion of Chapter 6 which will come later in separate ECRs.

Benefits as a result of the proposed changes:
Alignment with the forthcoming new version of USB4 specification.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
Existing USB Type-C solution will be compatible to the new USB4 spec and most notably, the existing USB Type-C Gen3 passive cable will support operation at the new Gen4 speed without need for change. That said, existing active cables will remain applicable to the speeds for which they were originally designed and will not operate in Gen4.

An analysis of the hardware implications:
New Gen4 active cables are needed.

An analysis of the software implications:
New USB4 Gen4 systems will implement updated discovery protocols. No change to existing software that remains compatible at Gen3 and slower speeds.

An analysis of the compliance testing implications:
Updates will be needed to address the changes to discovery and cable requirements specific to USB4 Gen4.

Actual Change Requested

Changes highlighted in modified text and figures

Revision History

Revision	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	Month 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.

1 Introduction

1.3 Related Documents

USB4 *USB4™ Specification, Version ~~1~~2.0, ~~August~~ Month ~~2019~~2022 (including posted errata and ECNs)*

USB PD *USB Power Delivery Specification, Revision 2.0, Version 1.3, January 12, 2017*
USB Power Delivery Specification, Revision 3.~~1~~2, Version 1.0, ~~May~~ Month ~~2021~~ 2022 (including posted errata and ECNs)

DP AM *DisplayPort™ Alt Mode on USB Type-C Standard, Version 2.0, 12 March 2020*

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).

1.5 Terms and Abbreviations

Term	Description
Active cable	Active cables are USB Full-Featured Type-C Cables that incorporate repeaters in the *USB 3.2* data path. All active cables, regardless of length, are expected to comply with this specification, the *USB 3.2* Appendix E, and the *USB 3.2* active cable CTS. Active cables may incorporate repeaters in both ends of the cable, one end, or anywhere in the cable.

2 Overview

2.3 Configuration Process

The USB Type-C receptacle, plug and cable solution incorporates a configuration process to detect a downstream facing port to upstream facing port (Source-to-Sink) connection for VBUS management and host-to-device connected relationship determination.

The USB Type-C port configuration process is used for the following:

- Source-to-Sink attach/detach detection
- Plug orientation/cable twist detection
- Initial power (Source-to-Sink) detection and establishing the data (Host-to-Device) relationship
- Detect if cable requires VCONN
- USB Type-C VBUS current detection and usage
- *USB PD* communication
- Discovery and configuration of functional extensions

Two pins on the USB Type-C receptacle, CC1 and CC2, are used for this purpose. Within a standard USB Type-C cable, only a single CC pin position within each plug of the cable is connected through the cable.

2.3.6 Functional Extensions

Functional extensions, including *USB4* and Alternate Modes (see Chapter E). are enabled via a communications channel across CC using methods defined by the *USB Power Delivery Specification*.

3 Mechanical

3.3 Overview

3.1.2 Compliant Cable Assemblies

Table 3-1 USB Type-C Standard Cable Assemblies

Cable Ref	Plug 1	Plug 2	USB Version	Nominal Cable Length[2]	Current Rating	USB Power Delivery	USB Type-C Electronically Marked
CC2-3	C	C	USB 2.0	≤ 4 m	3 A	Supported (SPR only)	Optional
CC2-5[1]					5 A		Required
CC2-5E					5 A	Supported (SPR & EPR)	Required
CC3G1-3	C	C	USB 3.2 Gen1 and USB4 Gen2	≤ 2 m	3 A	Supported (SPR only)	Required
CC3G1-5[1]					5 A		
CC3G1-5E					5 A	Supported (SPR & EPR)	Required
CC3G2-3	C	C	USB 3.2 Gen2 and USB4 Gen2	≤ 1 m	3 A	Supported (SPR only)	Required
CC3G2-5[1]					5 A		
CC3G2-5E					5 A	Supported (SPR & EPR)	Required
CC4G3-3	C	C	USB4 Gen3 and USB4 Gen4[3]	≤ 0.8 m	3 A	Supported (SPR only)	Required
CC4G3-5[1]					5 A		
CC4G3-5E					5 A	Supported (SPR & EPR)	Required

Note 1: These cables are deprecated in favor of having all 5 A cables be EPR-capable versions.

Note 2: The cable lengths listed in the table are informative and represent the practical lengths based on cable performance requirements.

Note 3: *USB4* Gen4 passive cables are electrically equivalent to *USB4* Gen3 passive cables. For *USB4* Gen4 active cables, refer to Chapter 6 for the *USB4* Gen3 and Gen4 electrical requirements.

3.7 Electrical Characteristics

3.7.2 USB Type-C to Type-C Passive Cable Assemblies (Normative)

3.7.2.2 Recommended TX/RX Passive Cable Assembly Characteristics (USB4 Gen3/Gen4)

Note: While the recommended characteristics in this section are defined in terms of *USB4* Gen3, these characteristics apply also to *USB4* Gen4 passive cable assemblies as these are electrically equivalent to *USB4* Gen3 passive cable assemblies.

3.7.2.2.1 Differential Insertion Loss (Informative – USB4 Gen3/Gen4)

3.7.2.2.2 Differential Return Loss (Informative – USB4 Gen3/Gen4)

3.7.2.2.3 Differential Near-End and Far-End Crosstalk between TX/RX Pairs (Informative – USB4 Gen3/Gen4)

3.7.2.2.4 Differential Crosstalk between USB D+/D– and TX/RX Pairs (Informative – USB4 Gen3/Gen4)

3.7.2.5 Normative TX/RX Passive Cable Assembly Requirements (USB4 Gen3/Gen4)

Note: While the normative requirements in this section are defined in terms of *USB4* Gen3, these requirements apply also to *USB4* Gen4 passive cable assemblies as these are electrically equivalent to *USB4* Gen3 passive cable assemblies.

3.7.2.5.1 Insertion Loss Fit at Nyquist Frequencies (Normative – USB4 Gen3/Gen4)

3.7.2.5.2 Integrated Multi-Reflection (Informative – USB4 Gen3/Gen4)

3.7.2.5.3 Integrated Crosstalk between TX/RX Pairs (Normative – USB4 Gen3/Gen4)

3.7.2.5.4 Integrated Crosstalk from TX/RX Pairs to USB 2.0 D+/D– (Normative – USB4 Gen3/Gen4)

3.7.2.5.5 Integrated Return Loss (Normative – USB4 Gen3/Gen4)

3.7.2.5.6 Differential-to-Common-Mode Conversion (Normative – USB4 Gen3/Gen4)

3.7.2.5.7 COM Requirement (Normative – USB4 Gen3/Gen4)

3.7.4 Receptacle Connector SI Requirements and Testing (Normative – USB4 Gen3/Gen4)

Note: While the normative requirements in this section are defined in terms of *USB4* Gen3, these requirements apply also to *USB4* Gen4 passive cable assemblies as these are electrically equivalent to *USB4* Gen3 passive cable assemblies.

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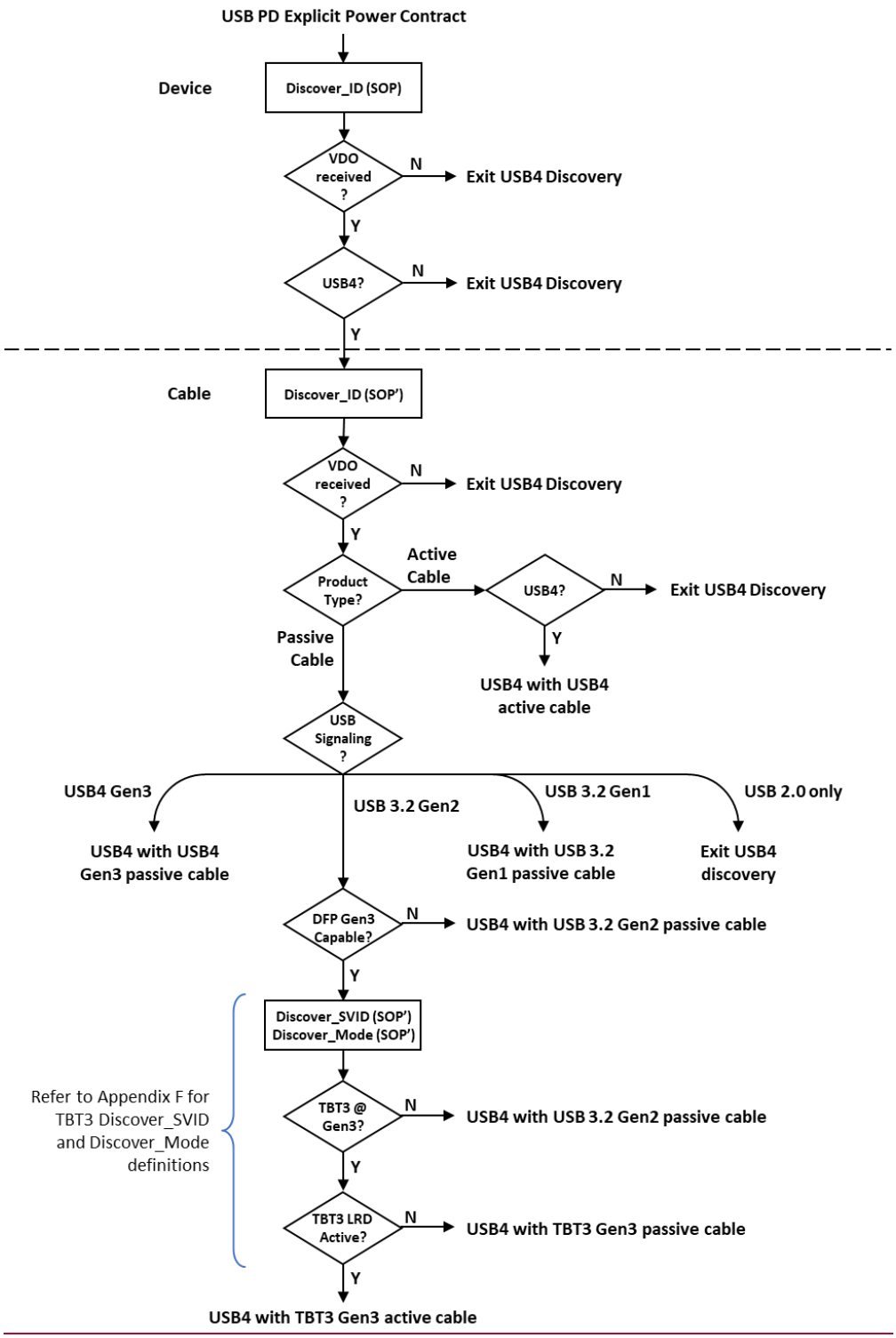
5 USB4 Discovery and Entry

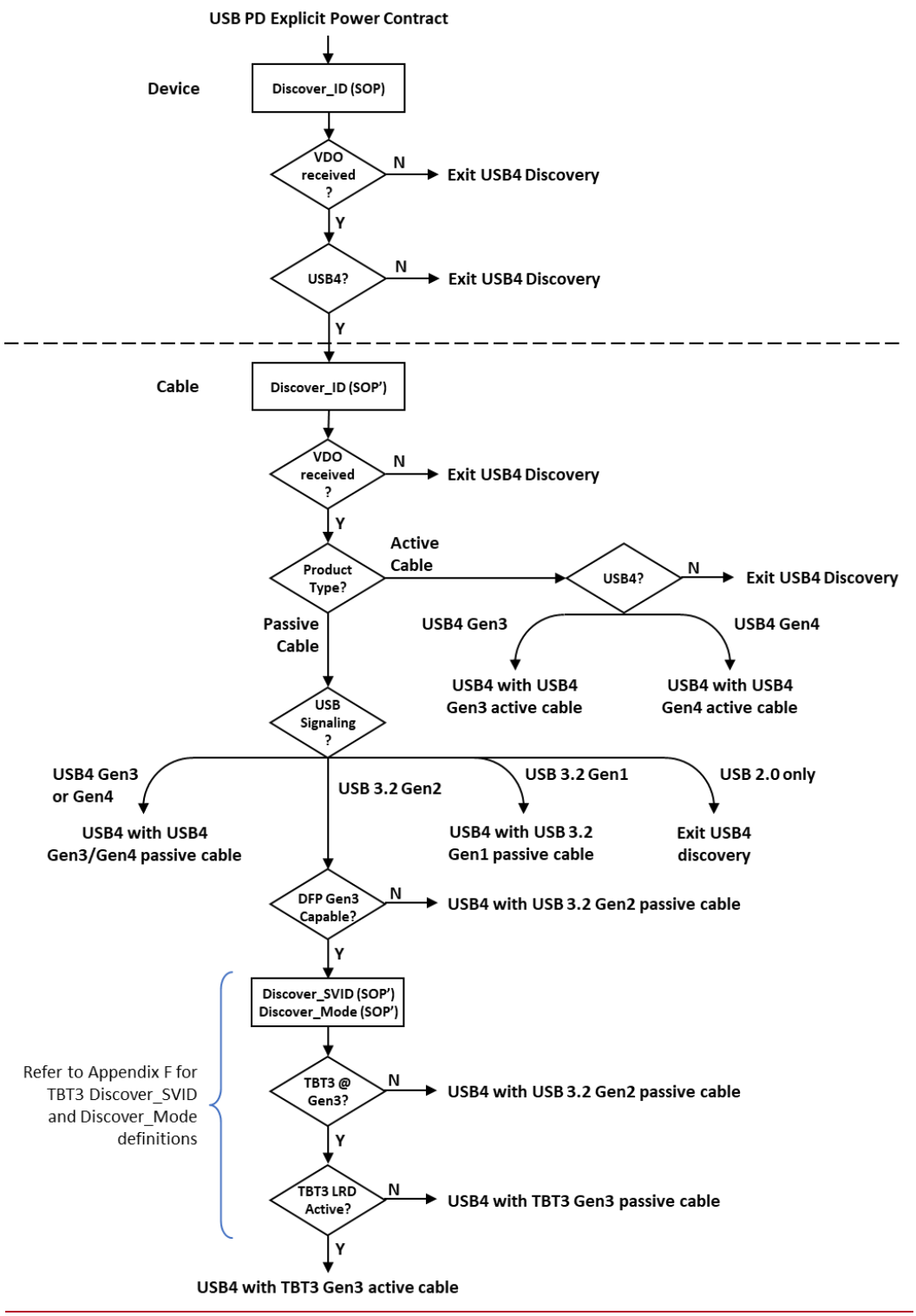
5.4 USB4 Discovery and Entry Flow Requirements

5.4.3 USB4 Discovery and Entry Flow

Figure 5-1 illustrates the basic flow model for *USB4* discovery and entry.

Figure 5-1 USB4 Discovery and Entry Flow Model




USB PD Explicit Power Contract
Device
Discover_ID (SOP)
VDO received ?
N
Exit USB4 Discovery
Y
USB4?
N
Exit USB4 Discovery
Y
Cable
Discover_ID (SOP')
VDO received ?
N
Exit USB4 Discovery
Y
Product Type?
Active Cable
USB4?
N
Exit USB4 Discovery
USB4 Gen3
USB4 Gen4
USB4 with USB4 Gen3 active cable
USB4 with USB4 Gen4 active cable
Passive Cable
USB Signaling ?
USB4 Gen3 or Gen4
USB 3.2 Gen2
USB 3.2 Gen1
USB 2.0 only
USB4 with USB4 Gen3/Gen4 passive cable
USB4 with USB 3.2 Gen1 passive cable
Exit USB4 discovery
DFP Gen3 Capable?
N
USB4 with USB 3.2 Gen2 passive cable
Y
Discover_SVID (SOP') Discover_Mode (SOP')
Refer to Appendix F for TBT3 Discover_SVID and Discover_Mode definitions
TBT3 @ Gen3?
N
USB4 with USB 3.2 Gen2 passive cable
Y
TBT3 LRD Active?
N
USB4 with TBT3 Gen3 passive cable
Y
USB4 with TBT3 Gen3 active cable

5.4.3.2 USB4 Cable Discovery (SOP')

Table 5-1 Certified Cables Where USB4-compatible Operation is Expected

	Cable Signaling	USB4 Operation	Notes
USB Type-C Full-Featured Cables (Passive)	*USB 3.2* Gen1	20 Gbps	This cable will indicate support for *USB 3.2* Gen1 (001b) in the USB Signaling field of its Passive Cable VDO response. Note: even though this cable isn't explicitly tested, certified or logo'ed for *USB 3.2* Gen2 operation, *USB4* Gen2 operation will generally work.
	USB 3.2 Gen2 (*USB4* Gen2)	20 Gbps	This cable will indicate support for *USB 3.2* Gen2 (010b) in the USB Signaling field of its Passive Cable VDO response.
	USB4 Gen4 (*USB4* Gen3)	80 Gbps ~~40 Gbps~~	This cable will indicate support for *USB4* Gen3 (011b) or *USB4* Gen4 (100b) in the USB Signaling field of its Passive Cable VDO response.
Thunderbolt™ 3 Cables (Passive)	TBT3 Gen2	20 Gbps	This cable will indicate support for *USB 3.2* Gen1 (001b) or *USB 3.2* Gen2 (010b) in the USB Signaling field of its Passive Cable VDO response.
	TBT3 Gen3	40 Gbps	In addition to indicating support for *USB 3.2* Gen2 (010b) in the USB Signaling field of its Passive Cable VDO response, this cable will indicate that it supports TBT3 Gen3 in the Discover Mode VDO response.
USB Type-C Full-Featured Cables (Active)[1]	*USB4* Gen2	20 Gbps	This cable will indicate support for *USB4* Gen2 (010b) in the USB Signaling field of its Active Cable VDO response.
	USB4 Gen3	40 Gbps	This cable will indicate support for *USB4* Gen3 (011b) in the USB Signaling field of its Active Cable VDO response.
	USB4 Gen4	80 Gbps	This cable will indicate support for *USB4* Gen4 (100b) in the USB Signaling field of its Active Cable VDO response.

Note:

1. SuperSpeed USB active cables do not support *USB4*–compatible operation.

5.4.3.2.1 Discovering Passive Cables

If the USB Signaling field [B2…0] in the Passive Cable VDO response is 011b (*USB4* Gen3) or 100b (*USB4* Gen4), the *USB4* discovery process is complete and *USB4* operation up to as high as ~~40~~ 80 Gbps is supported. In Chapter 3 of this specification, these cable assemblies are those with the following cable references: CC4G3-3, ~~and~~ CC4G3-5 and CC4G3-5E indicated in Table 3-1.

5.4.3.2.2 Discovering Active Cables

If the USB Signaling Support field [B2…0] in the Active Cable VDO 1 response is 011b (*USB4* Gen3), the *USB4* discovery process is complete and *USB4* operation up to as high as Gen3 is supported. If the USB Signaling Support field [B2…0] in the Active Cable VDO 1 response is 100b (*USB4* Gen4), the *USB4* discovery process is complete and *USB4* operation up to as high as Gen4 is supported.

6 Active Cables

Table 6-2 Summary of Active Cable Features

Cable Type	Length	USB PD	VBUS	VCONN Wiring	CC	*USB 2.0*	*USB 3.2* (All required)	*USB4*	Alternate Modes	SBU
USB 3.2 Short	< 5 m	SOP' Required (SOP" Optional)	3 A or 5 A	Same as passive cable	Same as passive cable	Same as passive cable	Gen 1x1 Gen 2x1 Gen 1x2 Gen 2x2	N/A	Optional	Note 3 Note 4
USB4 Short	< 5 m	SOP' Required (SOP" Optional)	3 A or 5 A	Same as passive cable	Same as passive cable	Same as passive cable	Gen 1x1 Gen 2x1 Gen 1x2 Gen 2x2	Gen2 Gen3 Gen4	TBT3 Note 2	Note 3 Note 5
USB 3.2 Optically Isolated	*USB 3.2* Latency[1]	SOP' and SOP" Required	0 A	Local cable plug only	Optical	Not Allowed	Gen 1x1 Gen 2x1 Gen 1x2 Gen 2x2		Optional	Note 6

Note 1: Length is set by the latency requirement in *USB 3.2*.

Note 2: Thunderbolt™ 3 Alternate Mode support required as defined in Appendix F.

Note 3: A passive connection in *USB 3.2* mode is required.

Note 4: Support for SBU is optional normative in Alternate Modes.

Note 5: SBU support for *USB4* can be either passive or active in the case of a linear re-driver-based active cable or active in the case of a re-timer-based active cable.

Note 6: SBU support for *USB 3.2* OIAC is optional normative in Alternate Modes only.

6.2.1.2 Discovering Cable Characteristics

Table 6-3 USB4 Cable Identity Summary

USB4™ Cable	Function				SOP' Configuration (USB PD Revision 3)					
					ID Header VDO	Passive Cable VDO	Active Cable VDO 1	Active Cable VDO 2		
	USB2	USB3	TBT3	DP	Cable Plug Passive/ Active B29…27	Cable Termination Type B12…11	Cable Termination Type B12…11	Physical connection B10	Active element B9	Optical Isolated Active Cable B2
Passive[1]	Yes	Yes	Yes	Yes	011b	00b/01b	n/a	n/a	n/a	n/a
TBT3 Linear Re-driver[1]	Yes	Yes	Yes	Opt.	011b	01b[2]	n/a	n/a	n/a	n/a
Linear Re-driver (Gen4)[1]	Yes	Yes	Yes	Opt.	100b[4]	n/a	10b/11b	0b	0b	0b
					011b[4]	01b[2]	n/a	n/a	n/a	n/a
Re-timer[1]	Yes	Yes	Yes	Opt.	100b	n/a	10b/11b	0b	1b	0b
Hybrid Optical[1, 3]	Yes	Yes	Yes	Opt.	100b	n/a	11b	1b	0b/1b	0b
Optically Isolated	No	Yes	Opt.	No	100b	n/a	11b	1b	0b/1b	1b

Notes:

1. USB4 cables, with the exception of Optically Isolated cables, are required to support Thunderbolt™ 3 compatibility ~~at this time~~. The TBT3-specific identity requirements are defined in Appendix F.
2. The TBT3 Linear Re-driver active cable represents as only a Passive Cable that is discovered per Figure 5-1.
3. A Hybrid Optical cable is defined as using an intermediate optical transmission line for the high-speed signaling path (TX/RX) while retaining a copper-based solution for the rest of the defined interfaces.
4. ~~3.~~ The Gen4 Linear Re-driver active cable identifies as either an Active Cable or Passive Cable (for backward compatibility) depending on the version number (B14…11) given in the Structured VDM Discover Identity message as follows: for B14…11 = 0101b, the cable identifies as Active, and for B14…11 = 0100b, the cable identifies as Passive.