BS EN IEC 62680-1-3:2018



BSI Standards Publication

Universal serial bus interfaces for data and power

Part 1-3: Common components – USB Type-C™ Cable and Connector Specification (IEC 62680-1-3:2018)

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/100, Audio, video and multimedia systems and equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

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The text of document 100/3011/CDV, future edition 3 of IEC 62680-1-3, prepared by Technical Area 14 "Interfaces and methods of measurement for personal computing equipment" of IEC/TC 100 "Audio, video and multimedia systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62680-1-3:2018.

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)	2019-03-28
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2021-06-28

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UNIVERSAL SERIAL BUS INTERFACES FOR DATA AND POWER –

Part 1-3: Common components – USB Type-C™ Cable and Connector Specification

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This third edition cancels and replaces the second edition published in 2017 and constitutes a technical revision.

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.

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

CDV	Report on voting
100/3011/CDV	100/3099/RVC

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

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This standard is the USB-IF publication USB Type-C™ Cable and Connector Specification Revision 1.3 as of July 14, 2017.

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Release 1.3
July 14, 2017

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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.

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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 is to establish a new USB connector ecosystem that addresses the evolving needs of platforms and devices while retaining all of the functional benefits of USB that form the basis for this most popular of computing device interconnects.

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 new 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 3.1* and *USB Power Delivery* specifications. It addresses only the elements required to implement and support the USB Type-C receptacles, plugs and cables.

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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.
http://www.usb.org/developers/docs

USB 3.1 *Universal Serial Bus Revision 3.1 Specification*
This includes the entire document release package.
http://www.usb.org/developers/docs

USB PD *USB Power Delivery Specification, Revision 2.0, Version 1.3, January 12, 2017*
USB Power Delivery Specification, Revision 3.0, Version 1.1, January 12, 2017 (including errata and ECNs through June 12, 2017)
http://www.usb.org/developers/docs

USB BB *USB Billboard Device Class Specification, Revision 1.21, September 8, 2016*
http://www.usb.org/developers/docs

USB BC *Battery Charging Specification, Revision 1.2 (including errata and ECNs through March 15, 2012), March 15, 2012*
http://www.usb.org/developers/docs

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 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.

1.4.2.4 Normative

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

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1.4.2.5 Optional

Optional is a keyword that describes 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).

1.4.2.6 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.

1.4.2.7 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.

1.4.2.8 Should

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

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.

1.5 Terms and Abbreviations

Term	Description
Accessory Mode	A reconfiguration of the connector based on the presence of Rd/Rd or Ra/Ra on CC1/CC2, respectively.
Active cable	An Electronically Marked Cable with additional electronics to condition the data path signals.
Alternate Mode	Operation defined by a vendor or standards organization that is associated with a SVID assigned by the USB-IF. Entry and exit into and from an Alternate Mode is controlled by the *USB PD* Structured VDM Enter Mode and Exit Mode commands.
Alternate Mode Adapter (AMA)	A *USB PD* Device which supports Alternate Modes and acts as a UFP.
Audio Adapter Accessory Mode	The Accessory Mode defined by the presence of Ra/Ra on CC1/CC2, respectively. See Appendix A.
BFSK	Binary Frequency Shift Keying used for *USB PD* communication over VBUS.
BMC	Biphase Mark Coding used for *USB PD* communication over the CC wire.

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Term	Description
Captive cable	A cable that is terminated on one end with a USB Type-C plug and has a vendor-specific connect means (hardwired or custom detachable) on the opposite end.
CC	Configuration Channel (CC) used in the discovery, configuration and management of connections across a USB Type-C cable.
Debug Accessory Mode (DAM)	The Accessory Mode defined by the presence of Rd/Rd or Rp/Rp on CC1/CC2, respectively. See Appendix B.
Debug and Test System (DTS)	The combined hardware and software system that provides a system developer debug visibility and control when connected to a Target System in Debug Accessory Mode.
Default VBUS	VBUS voltage as defined by the *USB 2.0* and *USB 3.1* specifications. Note: where used, 5 V connotes the same meaning.
DFP	Downstream Facing Port, specifically associated with the flow of data in a USB connection. Typically the ports on a host or the ports on a hub to which devices are connected. In its initial state, the DFP sources VBUS and VCONN, and supports data. A charge-only DFP port only sources VBUS.
Direct connect device	A device with either a captive cable or just a USB Type-C plug (e.g., thumb drive).
DRD (Dual-Role-Data)	The acronym used in this specification to refer to a USB port that can operate as either a DFP (Host) or UFP (Device). The role that the port initially takes is determined by the port's power role at attach. A Source port takes on the data role of a DFP and a Sink port takes on the data role of a UFP. The port's data role may be changed dynamically using *USB PD* Data Role Swap.
DRP (Dual-Role-Power)	The acronym used in this specification to refer to a USB port that can operate as either a Source or a Sink. The role that the port offers may be fixed to either a Source or Sink or may alternate between the two port states. Initially when operating as a Source, the port will also take on the data role of a DFP and when operating as a Sink, the port will also take on the data role of a UFP. The port's power role may be changed dynamically using *USB PD* Power Role Swap.
DR_Swap	*USB PD* Data Role Swap.
Electronically Marked Cable	A USB Type-C cable that uses *USB PD* to provide the cable's characteristics.
eMarker	The element in an Electronically Marked Cable that returns information about the cable in response to a *USB PD* Discover Identity command.
Initiator	The port initiating a Vendor Defined Message. It is independent of the port's PD role (e.g., Provider, Consumer, Provider/Consumer, or Consumer/Provider). In most cases, the Initiator will be a host.
Passive cable	A cable that does not incorporate any electronics to condition the data path signals. A passive cable may or may not be electronically marked.

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Term	Description
Port Partner	Refers to the port (device or host) a port is attached to.
Power Bank	A device with a battery whose primary function is to charge or otherwise extend the runtime of other USB Type-C devices.
Powered cable	A cable with electronics in the plug that requires VCONN indicated by the presence of Ra between the VCONN pin and ground.
PR_Swap	*USB PD* Power Role Swap.
Responder	The port responding to the Initiator of a Vendor Defined Message (VDM). It is independent of the port's PD role (e.g., Provider, Consumer, Provider/Consumer, or Consumer/Provider). In most cases, the Responder will be a device.
SBU	Sideband Use.
SID	A Standard ID (SID) is a unique 16-bit value assigned by the USB-IF to identify an industry standard.
Sink	Port asserting Rd on CC and when attached is consuming power from VBUS; most commonly a Device.
Source	Port asserting Rp on CC and when attached is providing power over VBUS; most commonly a Host or Hub DFP.
SVID	General reference to either a SID or a VID. Used by *USB PD* Structured VDMs when requesting SIDs and VIDs from a device.
Target System (TS)	The system being debugged in Debug Accessory Mode.
Type-A	A general reference to all versions of USB "A" plugs and receptacles.
Type-B	A general reference to all versions of USB "B" plugs and receptacles.
Type-C Plug	A USB plug conforming to the mechanical and electrical requirements in this specification.
Type-C Port	The USB port associated to a USB Type-C receptacle. This includes the USB signaling, CC logic, multiplexers and other associated logic.
Type-C Receptacle	A USB receptacle conforming to the mechanical and electrical requirements of this specification.
UFP	Upstream Facing Port, specifically associated with the flow of data in a USB connection. The port on a device or a hub that connects to a host or the DFP of a hub. In its initial state, the UFP sinks VBUS and supports data.
USB 2.0 Type-C Cable	A USB Type-C to Type-C cable that only supports USB 2.0 data operation. This cable does not include USB 3.1 or SBU wires.
USB 2.0 Type-C Plug	A USB Type-C plug specifically designed to implement the USB 2.0 Type-C cable.
USB Full-Featured Type-C Cable	A USB Type-C to Type-C cable that supports USB 2.0 and USB 3.1 data operation. This cable includes SBU wires.

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Term	Description
USB Full-Featured Type-C Plug	A USB Type-C plug specifically designed to implement the USB Full-Featured Type-C cable.
USB Safe State	The USB Safe State as defined by the *USB PD* specification.
VPD charge-through	A mechanism for a VCONN-Powered USB Device to pass power and CC communication from one port to the other without any reregulation. This will be defined in a future specification.
VCONN-Powered Accessory (VPA)	An accessory that is powered from VCONN to operate in an Alternate Mode. VPAs cannot implement the charge-through mechanism described for VPDs, and instead must intermediate by negotiating USB Power Delivery with both the connected host and source in order to enable similar functionality.
VCONN-Powered USB Device (VPD)	A USB direct-connect or captive-cable device that can be powered solely from either VCONN or VBUS. VPDs may optionally support the VPD charge-through capability.
VCONN_Swap	*USB PD* VCONN Swap.
VDM	Vendor Defined Message as defined by the *USB PD* specification.
VID	A Vendor ID (VID) is a unique 16-bit value assigned by the USB-IF to identify a vendor.
vSafe0V	VBUS “0 volts” as defined by the *USB PD* specification.
vSafe5V	VBUS “5 volts” as defined by the *USB PD* specification.

2 Overview

2.1 Introduction

The USB Type-C™ receptacle, plug and cable provide a smaller, thinner and more robust alternative to existing *USB 3.1* interconnect (Standard and Micro USB cables and connectors). This new solution targets use in very thin platforms, ranging from ultra-thin notebook PCs down to smart phones where existing Standard-A and Micro-AB receptacles are deemed too large, difficult to use, or inadequately robust. Some key specific enhancements include:

- The USB Type-C receptacle may be used in very thin platforms as its total system height for the mounted receptacle is under 3 mm
- The USB Type-C plug enhances ease of use by being plug-able in either upside-up or upside-down directions
- The USB Type-C cable enhances ease of use by being plug-able in either direction between host and devices

While the USB Type-C interconnect no longer physically differentiates plugs on a cable by being an A-type or B-type, the USB interface still maintains such a host-to-device logical relationship. Determination of this host-to-device relationship is accomplished through a Configuration Channel (CC) that is connected through the cable. In addition, the Configuration Channel is used to set up and manage power and Alternate/Accessory Modes.

Using the Configuration Channel, the USB Type-C interconnect defines a simplified 5 volt VBUS-based power delivery and charging solution that supplements what is already defined in the *USB 3.1 Specification*. More advanced power delivery and battery charging features over the USB Type-C interconnect are based on the *USB Power Delivery Specification*. As a product

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implementation improvement, the USB Type-C interconnect shifts the *USB PD* communication protocol from being communicated over VBUS to being delivered across the USB Type-C Configuration Channel.

The USB Type-C receptacle, plug and cable designs are intended to support future USB functional extensions. As such, consideration was given to frequency scaling performance, pin-out arrangement and the configuration mechanisms when developing this solution. The definition of future USB functional extensions is not in the scope of this specification but rather will be provided in future releases of the base USB Specification, i.e., beyond the existing *USB 3.1 Specification*.

Figure 2-1 illustrates the comprehensive functional signal plan for the USB Full-Featured Type-C receptacle, not all signals shown are required in all platforms or devices. As shown, the receptacle signal list functionally delivers both *USB 2.0* (D+ and D−) and *USB 3.1* (TX and RX pairs) data buses, USB power (VBUS) and ground (GND), Configuration Channel signals (CC1 and CC2), and two Sideband Use (SBU) signal pins. Multiple sets of USB data bus signal locations in this layout facilitate being able to functionally map the USB signals independent of plug orientation in the receptacle. For reference, the signal pins are labeled. For the *USB 2.0* Type-C receptacle, the *USB 3.1* signals are not implemented.

Figure 2-1 USB Type-C Receptacle Interface (Front View)

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1−	VBUS	CC1	D+	D−	SBU1	VBUS	RX2−	RX2+	GND
GND	RX1+	RX1−	VBUS	SBU2	D−	D+	CC2	VBUS	TX2−	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Figure 2-2 illustrates the comprehensive functional signal plan for the USB Type-C plug. Only one CC pin is connected through the cable to establish signal orientation and the other CC pin is repurposed as VCONN for powering electronics in the USB Type-C plug. Also, only one set of *USB 2.0* D+/D− wires are implemented in a USB Type-C cable. For USB Type-C cables that only intend to support *USB 2.0* functionality, the *USB 3.1* and SBU signals are not implemented. For the USB Type-C Power-Only plug (intended only for USB Type-C Sink applications), only nine contacts are implemented to support CC, VBUS, and GND.

Figure 2-2 USB Full-Featured Type-C Plug Interface (Front View)

A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2−	VBUS	SBU1	D−	D+	CC	VBUS	TX1−	TX1+	GND
GND	TX2+	TX2−	VBUS	VCONN			SBU2	VBUS	RX1−	RX1+	GND
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12

2.2 USB Type-C Receptacles, Plugs and Cables

Cables and connectors, including USB Type-C to USB legacy cables and adapters, are explicitly defined within this specification. These are the only connectors and cables that are authorized by the licensing terms of this specification. All licensed cables and connectors are required to

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comply with the compliance and certification requirements that are developed and maintained by the USB-IF.

The following USB Type-C receptacles and plugs are defined.

- USB Full-Featured Type-C receptacle for *USB 2.0*, *USB 3.1* and full-featured platforms and devices
- *USB 2.0* Type-C receptacle for *USB 2.0* platforms and devices
- USB Full-Featured Type-C plug
- *USB 2.0* Type-C plug
- USB Type-C Power-Only plug

The following USB Type-C cables are defined.

- USB Full-Featured Type-C cable with a USB Full-Featured Type-C plug at both ends for *USB 3.1* and full-featured applications
- *USB 2.0* Type-C cable with a *USB 2.0* Type-C plug at both ends for *USB 2.0* applications
- Captive cable with either a USB Full-Featured Type-C plug or *USB 2.0* Type-C plug at one end

All of the defined USB Type-C receptacles, plugs and cables support USB charging applications, including support for the optional USB Type-C-specific implementation of the *USB Power Delivery Specification* (See Section 4.6.2.4).

All USB Full-Featured Type-C cables are electronically marked. *USB 2.0* Type-C cables may be electronically marked. See Section 4.9 for the requirements of Electronically Marked Cables.

The following USB Type-C to USB legacy cables and adapters are defined.

- *USB 3.1* Type-C to Legacy Host cable with a USB Full-Featured Type-C plug at one end and a *USB 3.1* Standard-A plug at the other end – *this cable supports use of a USB Type-C-based device with a legacy USB host*
- *USB 2.0* Type-C to Legacy Host cable with a *USB 2.0* Type-C plug at one end and a *USB 2.0* Standard-A plug at the other end – *this cable supports use of a USB Type-C-based device with a legacy USB 2.0 host (primarily for mobile charging and sync applications)*
- *USB 3.1* Type-C to Legacy Device cable with a USB Full-Featured Type-C plug at one end and a *USB 3.1* Standard-B plug at the other end – *this cable supports use of legacy USB 3.1 hubs and devices with a USB Type-C-based host*
- *USB 2.0* Type-C to Legacy Device cable with a *USB 2.0* Type-C plug at one end and a *USB 2.0* Standard-B plug at the other end – *this cable supports use of legacy USB 2.0 hubs and devices with a USB Type-C-based host*
- *USB 2.0* Type-C to Legacy Mini Device cable with a *USB 2.0* Type-C plug at one end and a *USB 2.0* Mini-B plug at the other end – *this cable supports use of legacy devices with a USB 2.0 Type-C-based host*
- *USB 3.1* Type-C to Legacy Micro Device cable with a USB Full-Featured Type-C plug at one end and a *USB 3.1* Micro-B plug at the other end – *this cable supports use of legacy USB 3.1 hubs and devices with a USB Type-C-based host*
- *USB 2.0* Type-C to Legacy Micro Device cable with a *USB 2.0* Type-C plug at one end and a *USB 2.0* Micro-B plug at the other end – *this cable supports use of legacy USB 2.0 hubs and devices with a USB Type-C-based host*

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- *USB 3.1* Type-C to Legacy Standard-A adapter with a USB Full-Featured Type-C plug at one end and a *USB 3.1* Standard-A receptacle at the other end – *this adapter supports use of a legacy USB "thumb drive" style device or a legacy USB ThinCard device with a USB 3.1 Type-C-based host*
- *USB 2.0* Type-C to Legacy Micro-B adapter with a *USB 2.0* Type-C plug at one end and a *USB 2.0* Micro-B receptacle at the other end – *this adapter supports charging a USB Type-C-based mobile device using a legacy USB Micro-B-based chargers, either captive cable-based or used in conjunction with a legacy USB 2.0 Standard-A to Micro-B cable*

USB Type-C receptacle to USB legacy adapters are explicitly not defined or allowed. Such adapters would allow many invalid and potentially unsafe cable connections to be constructed by users.

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 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
- 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.

2.3.1 Source-to-Sink Attach/Detach Detection

Initially, Source-to-Sink attach is detected by a host or hub port (Source) when one of the CC pins at its USB Type-C receptacle senses a specified resistance to GND. Subsequently, Source-to-Sink detach is detected when the CC pin that was terminated at its USB Type-C receptacle is no longer terminated to GND.

Power is not applied to the USB Type-C host or hub receptacle (VBUS or VCONN) until the Source detects the presence of an attached device (Sink) port. When a Source-to-Sink attach is detected, the Source is expected to enable power to the receptacle and proceed to normal USB operation with the attached device. When a Source-to-Sink detach is detected, the port sourcing VBUS removes power.

2.3.2 Plug Orientation/Cable Twist Detection

The USB Type-C plug can be inserted into a receptacle in either one of two orientations, therefore the CC pins enable a method for detecting plug orientation in order to determine which

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SuperSpeed USB data signal pairs are functionally connected through the cable. This allows for signal routing, if needed, within a host or device to be established for a successful connection.

2.3.3 Initial Power (Source-to-Sink) Detection and Establishing the Data (Host-to-Device) Relationship

Unlike existing USB Type-A and USB Type-B receptacles and plugs, the mechanical characteristics of the USB Type-C receptacle and plug do not inherently establish the relationship of USB host and device ports. The CC pins on the receptacle also serve to establish an initial power (Source-to-Sink) and data (Host-to-Device) relationships prior to the normal USB enumeration process.

For the purpose of defining how the CC pins are used to establish the initial power relationship, the following port power behavior modes are defined.

1. Source-only – for this mode, the port exclusively behaves as a Source
2. Sink-only – for this mode, the port exclusively behaves as a Sink
3. Dual-Role-Power (DRP) – for this mode, the port can behave either as a Source or Sink

Additionally, when a port supports USB data operation, a port's data behavior modes are defined.

1. DFP-only – for this mode, the port exclusively behaves as a DFP
2. UFP-only – for this mode, the port exclusively behaves as a UFP
3. Dual-Role-Data (DRD) – for this mode, the port can behave either as a DFP or UFP

The DFP-only and UFP-only ports behaviorally map to traditional USB host ports and USB device ports, respectively but may not necessarily do USB data communication. When a host-only port is attached to a device-only port, the behavior from the user's perspective follows the traditional USB host-to-device port model. However, the USB Type-C connector solution does not physically prevent host-to-host or device-to-device connections. In this case, the resulting host-to-host or device-to-device connection results in a safe but non-functional situation.

Once initially established, the Source supplies VBUS and behaves as a DFP, and the Sink consumes VBUS and behaves as a UFP. *USB PD*, when supported by both ports, may then be used to independently swap both the power and data roles of the ports.

A port that supports dual-role operation by being able to shift to the appropriate connected mode when attached to either a Source-only or Sink-only port is a DRP. In the special case of a DRP being attached to another DRP, an initialization protocol across the CC pins is used to establish the initial host-to-device relationship. Given no role-swapping intervention, the determination of which is DFP or UFP is random from the user's perspective.

Two independent set of mechanisms are defined to allow a USB Type-C DRP to functionally swap power and data roles. When *USB PD* is supported, power and data role swapping is performed as a subsequent step following the initial connection process. For non-PD implementations, power/data role swapping can optionally be dealt with as part of the initial connection process. To improve the user's experience when connecting devices that are of categorically different types, products may be implemented to strongly prefer being a DFP or a UFP, such that the DFP/UFP determination becomes predictable when connecting two DRPs of differing categories. See Section 4.5.1.4 for more on available swapping mechanisms.

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As an alternative to role swapping, a USB Type-C DRP may provide useful functionality by when operating as a host, exposing a CDC/network (preferably TCP/IP) stack or when operating as a device, exposing a CDC/network interface.

USB hubs have two types of ports, a UFP that is connected up to a DFP (host or another hub) that initially functions as a Sink, and one or more DFPs for connecting other devices that initially function as Sources.

2.3.4 USB Type-C VBUS Current Detection and Usage

With the USB Type-C connector solution, a Source (host or downstream hub port) may implement higher source current over VBUS to enable faster charging of mobile devices or powering devices that require more current than is specified in the *USB 3.1 Specification*. All USB host and hub ports advertise via the CC pins the level of current that is presently available. The USB device port is required to manage its load to stay within the current level offered by the host or hub, including dynamically scaling back the load if the host or hub port changes its advertisement to a lower level as indicated over the CC pins.

Three current levels at default VBUS are defined by USB Type-C Current:

- Default values when configured for high-power operation as defined by a USB Specification (500 mA for USB 2.0 ports, 900 mA for USB 3.1 ports)
- 1.5 A
- 3.0 A

The higher USB Type-C Current levels that can be advertised allows hosts and devices that do not implement *USB PD* to take advantage of higher charging current.

2.3.5 USB PD Communication

USB Power Delivery is a feature on products (hosts, hubs and devices). *USB PD* communications is used to:

- Establish power contracts that allow voltage and current outside that defined by the *USB 2.0* and *USB 3.1* specifications.
- Change the port sourcing VBUS.
- Change the port sourcing VCONN.
- Swap DFP and UFP roles.
- Communicate with cables.

The *USB PD* Bi-phase Mark Coded (BMC) communications are carried on the CC wire of the USB Type-C cable.

2.3.6 Functional Extensions

Functional extensions (see Chapter 5) are enabled via a communications channel across CC using methods defined by the *USB Power Delivery Specification*.

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2.4 VBUS

VBUS provides a path to deliver power between a host and a device, and between a USB power charger and a host/device. A simplified high-current supply capability is defined for hosts and chargers that optionally support current levels beyond the *USB 2.0* and *USB 3.1* specifications. The *USB Power Delivery Specification* is supported.

Table 2-1 summarizes the power supply options available from the perspective of a device with the USB Type-C connector. Not all options will be available to the device from all host or hub ports – only the first two listed options are mandated by the base USB specifications and form the basis of USB Type-C Current at the Default USB Power level.

Table 2-1 Summary of power supply options

Mode of Operation	Nominal Voltage	Maximum Current	Notes
USB 2.0	5 V	See *USB 2.0*	
USB 3.1	5 V	See *USB 3.1*	
USB BC 1.2	5 V	Up to 1.5 A[1]	Legacy charging
USB Type-C Current @ 1.5 A	5 V	1.5 A	Supports higher power devices
USB Type-C Current @ 3.0 A	5 V	3 A	Supports higher power devices
USB PD	Configurable up to 20 V	Configurable up to 5 A	Directional control and power level management

Notes:

1. *USB BC 1.2* permits a power provider to be designed to support a level of power between 0.5 A and 1.5 A. If the *USB BC 1.2* power provider does not support 1.5 A, then it is required to follow power droop requirements. A *USB BC 1.2* power consumer may consume up to 1.5 A provided that the voltage does not drop below 2 V, which may occur at any level of power above 0.5 A.

The USB Type-C receptacle is specified for current capability of 5 A whereas standard USB Type-C cable assemblies are rated for 3 A. The higher rating of the receptacle enables systems to deliver more power over directly attached docking solutions or using appropriately designed chargers with captive cables when implementing *USB PD*. Also, USB Type-C cable assemblies designed for *USB PD* and appropriately identified via electronic marking are allowed to support up to 5 A.

2.5 VCONN

Once the connection between host and device is established, the CC pin (CC1 or CC2) in the receptacle that is not connected via the CC wire through the standard cable is repurposed to source VCONN to power circuits in the plug needed to implement Electronically Marked Cables (see Section 4.9). Initially, the source supplies VCONN and the source of VCONN may be swapped using *USB PD* VCONN_Swap.

Electronically marked cables may use VBUS instead of VCONN as VBUS is available across the cable. VCONN functionally differs from VBUS in that it is isolated from the other end of the cable. VCONN is independent of VBUS and, unlike VBUS which can use *USB PD* to support higher voltages, VCONN voltage stays within the range of 3.0 to 5.5 V (see Section 4.4.3).

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2.6 Hubs

USB hubs implemented with USB Type-C receptacles are required to clearly identify the upstream facing port. This requirement is needed because a user can no longer know which port on a hub is the upstream facing port and which ports are the downstream facing ports by the type of receptacles that are exposed, i.e., USB Type-B is the upstream facing port and USB Type-A is a downstream facing port.

3 Mechanical

3.1 Overview

3.1.1 Compliant Connectors

The USB Type-C™ specification defines the following standard connectors:

- USB Full-Featured Type-C receptacle
- *USB 2.0* Type-C receptacle
- USB Full-Featured Type-C plug
- *USB 2.0* Type-C plug
- USB Type-C Power-Only plug

3.1.2 Compliant Cable Assemblies

Table 3-1 summarizes the USB Type-C standard cable assemblies along with the primary differentiating characteristics. All USB Full-Featured Type-C cables shall support simultaneous, independent signal transmission on both *USB 3.1* (TX and RX pairs) data buses. The cable lengths listed in the table are informative and represents the practical length based on cable performance requirements. All cables that are either full-featured and/or are rated at more than 3 A current are Electronically Marked Cables.

Table 3-1 USB Type-C Standard Cable Assemblies

Cable Ref	Plug 1	Plug 2	USB Version	Cable Length	Current Rating	USB Power Delivery (BMC)	USB Type-C Electronically Marked
CC2-3	C	C	USB 2.0	≤ 4 m	3 A	Supported	Optional
CC2-5					5 A		Required
CC3G1-3	C	C	USB 3.1 Gen1	≤ 2 m	3 A	Supported	Required
CC3G1-5					5 A		
CC3G2-3	C	C	USB 3.1 Gen2	≤ 1 m	3 A	Supported	Required
CC3G2-5					5 A		

USB Type-C products are also allowed to have a captive cable. See Section 3.4.3.

3.1.3 Compliant USB Type-C to Legacy Cable Assemblies

Table 3-2 summarizes the USB Type-C legacy cable assemblies along with the primary differentiating characteristics. The cable lengths listed in the table are informative and represents the practical length based on cable performance requirements. *USB 3.1* Type-C

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legacy cables assemblies that only offer performance up to *USB 3.1* Gen1 are not allowed by this specification.

For USB Type-C legacy cable assemblies that incorporate Rp termination, the value of this termination is required to be specified to the Default setting of USB Type-C Current even though the cable assemblies are rated for 3 A. The Rp termination in these cables is intended to represent the maximum current of a compliant legacy USB host port, not the current rating of the cable itself. The cable current rating is intentionally set to a higher level given that there are numerous non-standard power chargers that offer more than the Default levels established by the *USB 2.0* and *USB 3.1* specifications.

Table 3-2 USB Type-C Legacy Cable Assemblies

Cable Ref	Plug 1[3]	Plug 2[3]	USB Version	Cable Length	Current Rating
AC2-3	USB 2.0 Standard-A	USB 2.0 Type-C[1]	USB 2.0	≤ 4 m	3 A
AC3G2-3	USB 3.1 Standard-A	USB Full-Featured Type-C[1]	USB 3.1 Gen2	≤ 1 m	3 A
CB2-3	USB 2.0 Type-C[2]	USB 2.0 Standard-B	USB 2.0	≤ 4 m	3 A
CB3G2-3	USB Full-Featured Type-C[2]	USB 3.1 Standard-B	USB 3.1 Gen2	≤ 1 m	3 A
CmB2	USB 2.0 Type-C[2]	USB 2.0 Mini-B	USB 2.0	≤ 4 m	500 mA
CμB2-3	USB 2.0 Type-C[2]	USB 2.0 Micro-B	USB 2.0	≤ 2 m	3 A
CμB3G2-3	USB Full-Featured Type-C[2]	USB 3.1 Micro-B	USB 3.1 Gen2	≤ 1 m	3 A

Notes:

1. USB Type-C plugs associated with the "B" end of a legacy adapter cable are required to have Rp (56 kΩ ± 5%) termination incorporated into the plug assembly – see Section 4.5.3.2.2.
2. USB Type-C plugs associated with the "A" end of a legacy adapter cable are required to have Rd (5.1 kΩ ± 20%) termination incorporated into the plug assembly – see Section 4.5.3.2.1.
3. Refer to Section 3.7.4.3 for the mated resistance and temperature rise required for the legacy plugs.

3.1.4 Compliant USB Type-C to Legacy Adapter Assemblies

Table 3-3 summarizes the USB Type-C legacy adapter assemblies along with the primary differentiating characteristics. The cable lengths listed in the table are informative and represents the practical length based on cable performance requirements.

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Table 3-3 USB Type-C Legacy Adapter Assemblies

Adapter Ref	Plug	Receptacle[3]	USB Version	Cable Length	Current Rating
CμBR2-3	USB 2.0 Type-C[1]	USB 2.0 Micro-B	USB 2.0	≤ 0.15 m	3 A
CAR3G1-3	USB Full-Featured Type-C[2]	USB 3.1 Standard-A	USB 3.1 Gen1	≤ 0.15 m	3 A

Notes:

1. USB Type-C plugs associated with the "B" end of a legacy adapter are required to have Rp (56 kΩ ± 5%) termination incorporated into the plug assembly – see Section 4.5.3.2.2.
2. USB Type-C plugs associated with the "A" end of a legacy adapter are required to have Rd (5.1 kΩ ± 20%) termination incorporated into the plug assembly – see Section 4.5.3.2.1.
3. Refer to Section 3.7.5.3 for the mated resistance and temperature rise required for the legacy receptacles.

3.2 USB Type-C Connector Mating Interfaces

This section defines the connector mating interfaces, including the connector interface drawings, pin assignments, and descriptions. All dimensions in figures are in millimeters

3.2.1 Interface Definition

Figure 3-1 and Figure 3-3 show, respectively, the USB Type-C receptacle and USB Full-Featured Type-C plug interface dimensions.

Figure 3-11 shows the *USB 2.0* Type-C plug interface dimensions. The dimensions that govern the mating interoperability are specified. All the REF dimensions are provided for reference only, not hard requirements.

Key features, configuration options, and design areas that need attention:

1. Figure 3-1 shows a vertical-mount receptacle. Other PCB mounting types such as right-angle mount and mid-mount are allowed.

2. A mid-plate is required between the top and bottom signals inside the receptacle tongue to manage crosstalk in full-featured applications. The mid-plate shall be connected to the PCB ground with at least two grounding points. A reference design of the mid-plate is provided in Section 3.2.2.1.

3. Retention of the cable assembly in the receptacle is achieved by the side-latches in the plug and features on the sides of the receptacle tongue. Side latches are required for all plugs except plugs used for docking with no cable attached. Side latches shall be connected to ground inside the plug. A reference design of the side latches is provided in Section 3.2.2.2 along with its grounding scheme. Docking applications may not have side latches, requiring special consideration regarding EMC (Electromagnetic Compatibility).

4. The EMC shielding springs are required inside the cable plug. The shielding spring shall be connected to the plug shell. No EMC shielding spring finger tip of the USB Full-Featured Type-C plug or USB 2.0 Type-C plug shall be exposed in the plug housing opening of the unmated USB Type-C plug (see Figure 3-12). Section 3.2.2.3 shows reference designs of the EMC spring.

5. Shorting of any signal or power contact spring to the plug metal shell is not allowed. The spring in the deflected state should not touch the plug shell. An isolation layer (e.g., Kapton tape placed on the plug shell) is recommended to prevent accidental shorting due to plug shell deformation.

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6. The USB Type-C receptacle shall provide an EMC ground return path through one of the following options:

    - a system of specific points of contact on the receptacle outer shell (e.g., spring fingers or spring fingers and formed solid bumps),
    - internal EMC pads, or
    - a combination of both points of contact on the receptacle outer shell and internal EMC pads.

    If points of contacts are used on the receptacle, then the receptacle points of contact shall make connection with the mated plug within the contact zones defined in Figure 3-2. A minimum of four separate points of contact are required. Additional points of contact are allowed. See Section 3.2.2.4 for a reference design of receptacle outer shell. The reference design includes four spring fingers as points of contact. Alternate configurations may include spring fingers on the A contact side or B contact side and formed solid bumps (e.g., dimples) on the B contact side or A contact side, respectively. Spring fingers are required on a minimum of one side to provide a pressure fit on opposing sides of the plug shell. Additional bumps may be used, but if bumps are on opposing sides of the receptacle shell, the minimum distance between the bumps shall be greater than the maximum plug shell defined dimension.

    If internal EMC pads are present in the receptacle, then they shall comply with the requirements defined in Figure 3-1. The shielding pads shall be connected to the receptacle shell. If no receptacle shell is present, then the receptacle shall provide a means to connect the shielding pad to ground. See Section 3.2.2.3 for a reference design of the shielding pad and ground connection.

7. This specification defines the USB Type-C receptacle shell length of 6.20 mm as a reference dimension. The USB Type-C receptacle is designed to have shell length of 6.20 ± 0.20 mm to provide proper mechanical and electrical mating of the plug to the receptacle (e.g., full seating of the plug in the receptacle and protection of the receptacle tongue during insertion/withdrawal). The USB Type-C receptacle at the system level should be implemented such that the USB Type-C receptacle connector mounted in the associated system hardware has an effective shell length equal to 6.20 ± 0.20 mm.

8. The USB Type-C connector mating interface is defined so that the electrical connection may be established without the receptacle shell. To prevent excessive misalignment of the plug when it enters or exits the receptacle, the enclosure should have features to guide the plug for insertion and withdrawal when a modified receptacle shell is present. If the USB Type-C receptacle shell is modified from the specified dimension, then the recommended lead in from the receptacle tongue to the plug point of entry is 1.5 mm minimum when mounted in the system.

    This specification allows receptacle configurations with a conductive shell, a non-conductive shell, or no shell. The following requirements apply to the receptacle contact dimensions shown in SECTION A-A and ALTERNATE SECTION A-A shown in Figure 3-1:

    - If the receptacle shell is conductive, then the receptacle contact dimensions of SECTION A-A shown in Figure 3-1 shall be used. The contact dimensions of ALTERNATE SECTION A-A are not allowed.
    - If the receptacle shell is non-conductive, then the receptacle contact dimensions of ALTERNATE SECTION A-A shown in Figure 3-1 shall be used. The contact dimensions of SECTION A-A are not allowed.
    - If there is no receptacle shell, then the receptacle contact dimensions of either SECTION A-A or ALTERNATE SECTION A-A shown in Figure 3-1 may be used. If

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there is no receptacle shell and the receptacle is used in an implementation that does not effectively provide a conductive shell, then a receptacle with the contact dimensions of ALTERNATE SECTION A-A shown in Figure 3-1 should be used.

9. A paddle card (e.g., PCB) may be used in the USB Type-C plug to manage wire termination and electrical performance. Section 3.2.2.5 includes the guidelines and a design example for a paddle card.

10. This specification does not define standard footprints. Figure 3-4 shows an example SMT (surface mount) footprint for the vertical receptacle shown in Figure 3-1. Additional reference footprints and mounting configurations are shown in Figure 3-5, Figure 3-6, Figure 3-7, Figure 3-8, Figure 3-9 and Figure 3-10.

11. The receptacle shell shall be connected to the PCB ground plane.

12. All VBUS pins shall be connected together in the USB Type-C plug.

13. All Ground return pins shall be connected together in the USB Type-C plug.

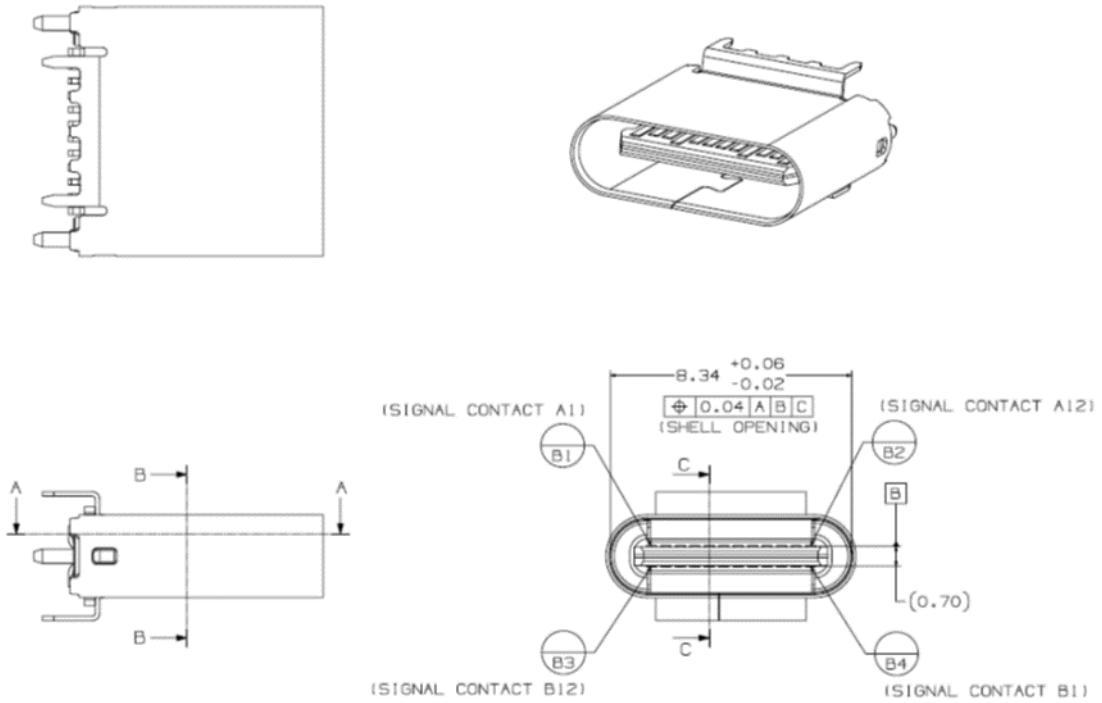
14. All VBUS pins shall be connected together at the USB Type-C receptacle when it is in its mounted condition (e.g., all VBUS pins bussed together in the PCB).

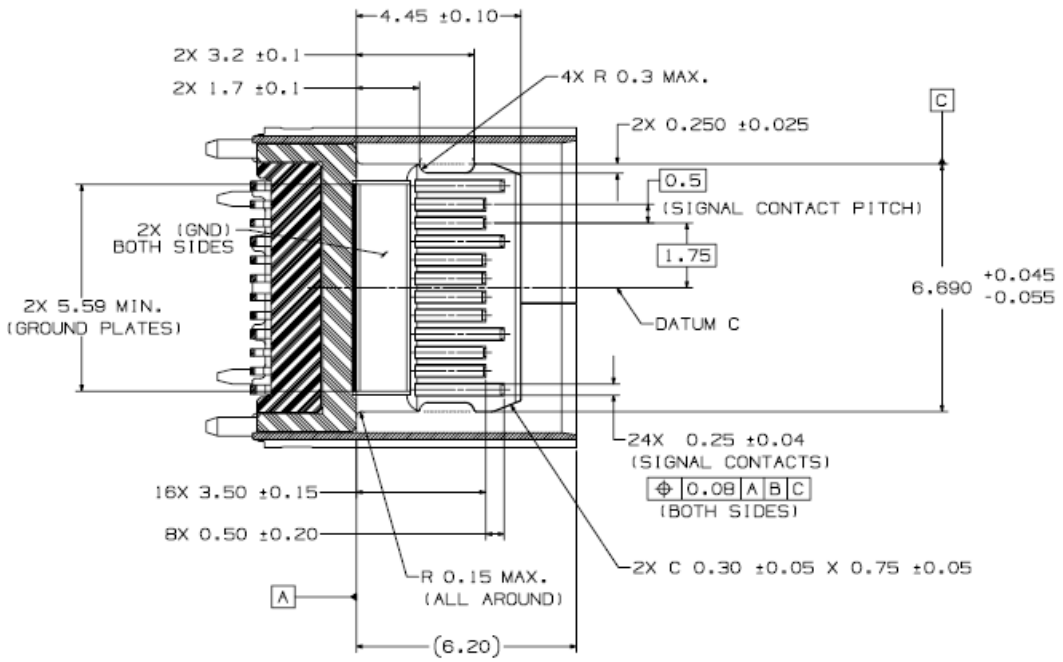
15. All Ground return pins shall be connected together at the USB Type-C receptacle when it is in its mounted condition (e.g., all Ground return pins bussed together in the PCB).

16. The USB Type-C Power-Only plug is a depopulated version of the USB Full-Featured Type-C plug or the USB 2.0 Type-C plug. The interface dimensions shall conform to Figure 3-3 or Figure 3-11. Contacts for CC, VBUS, and GND (i.e., A1, A4, A5, A9, A12, B1, B4, B9, and B12) shall be present. Physical presence of contacts in the other 15 contact locations is optional. The USB Type-C Power-Only plug shall only be used on a non-charger captive cable application. Implementation of Rp, Rd, or CC communication on pin A5 is required in the application.

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Figure 3-1 USB Type-C Receptacle Interface Dimensions





REFERENCE LENGTH – SEE NOTE 7.

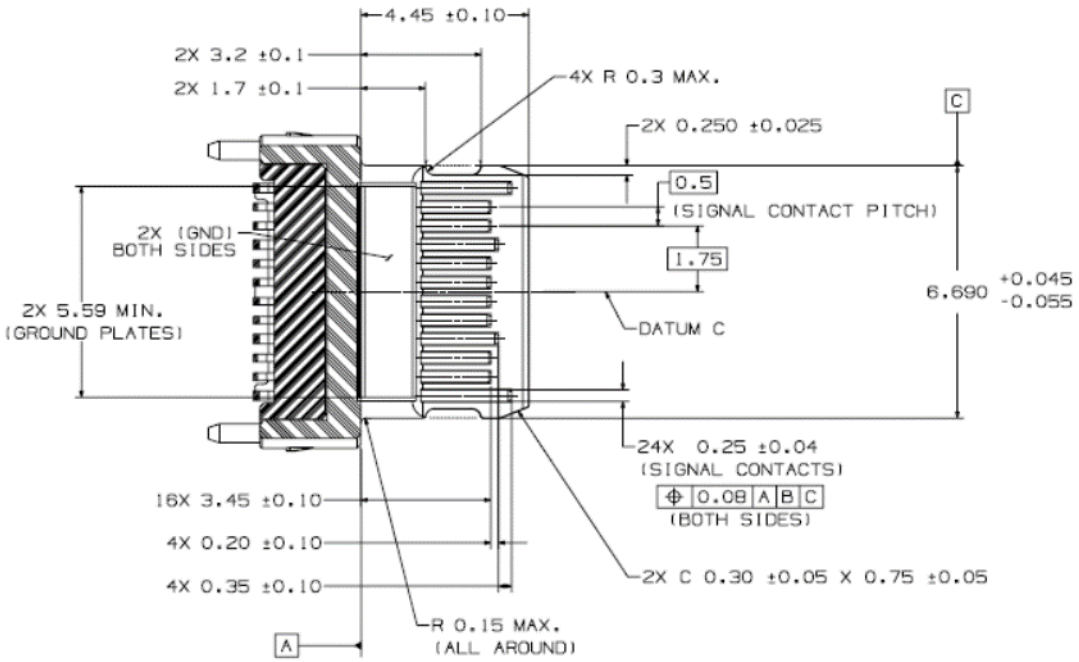
SECTION A-A

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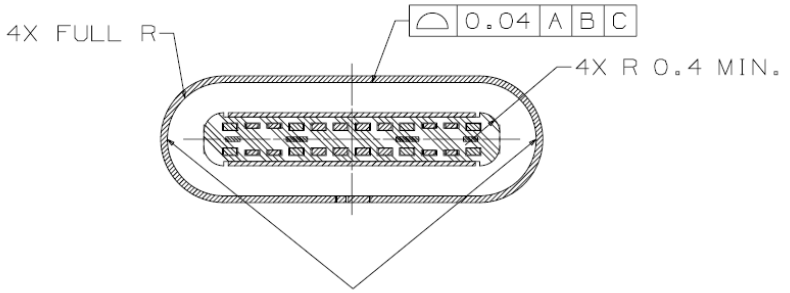
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Figure 3-1 USB Type-C Receptacle Interface Dimensions, cont.



ALTERNATE SECTION A-A dimensions for use if the receptacle shell is non-conductive or there is no receptacle shell. This configuration is not allowed for receptacles with a conductive shell. See text for full requirements.

ALTERNATE SECTION A-A



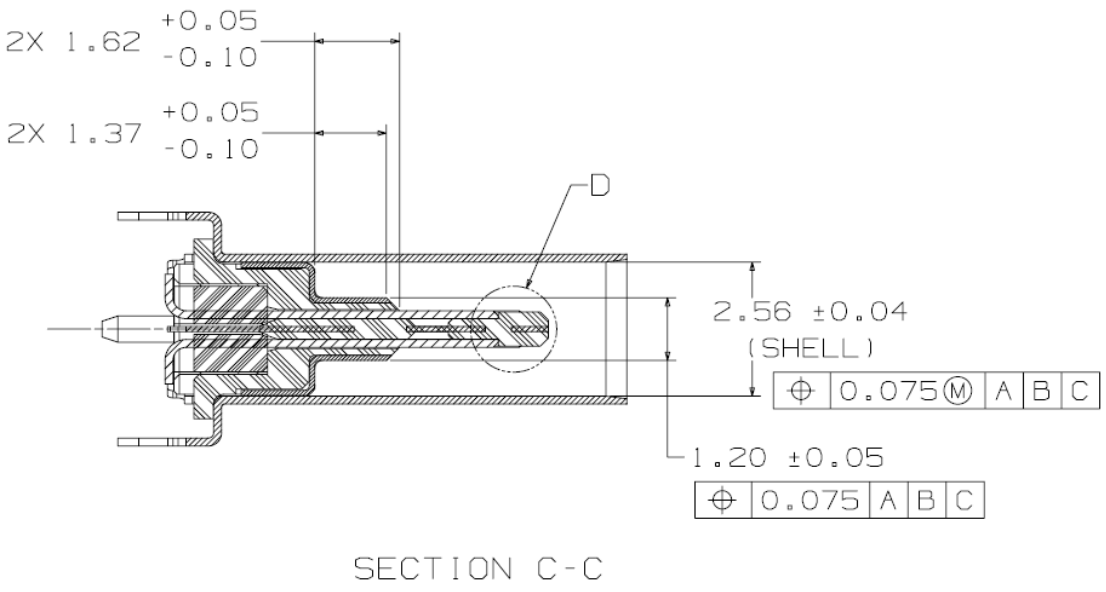
SECTION B-B

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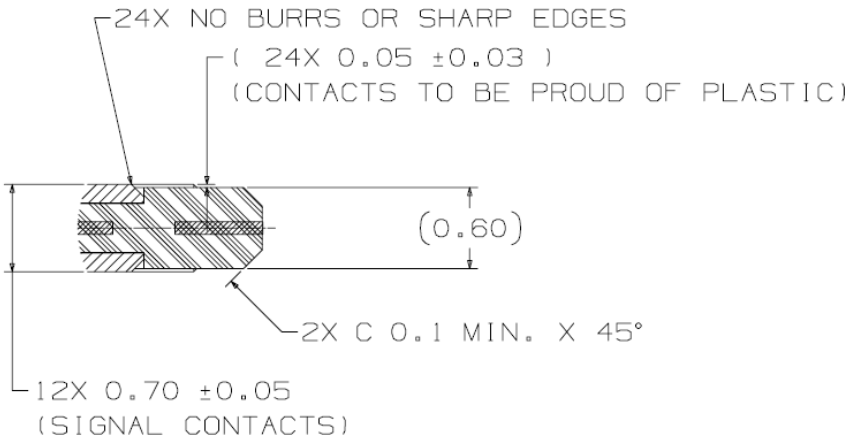
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Figure 3-1 USB Type-C Receptacle Interface Dimensions, cont.



SECTION C-C



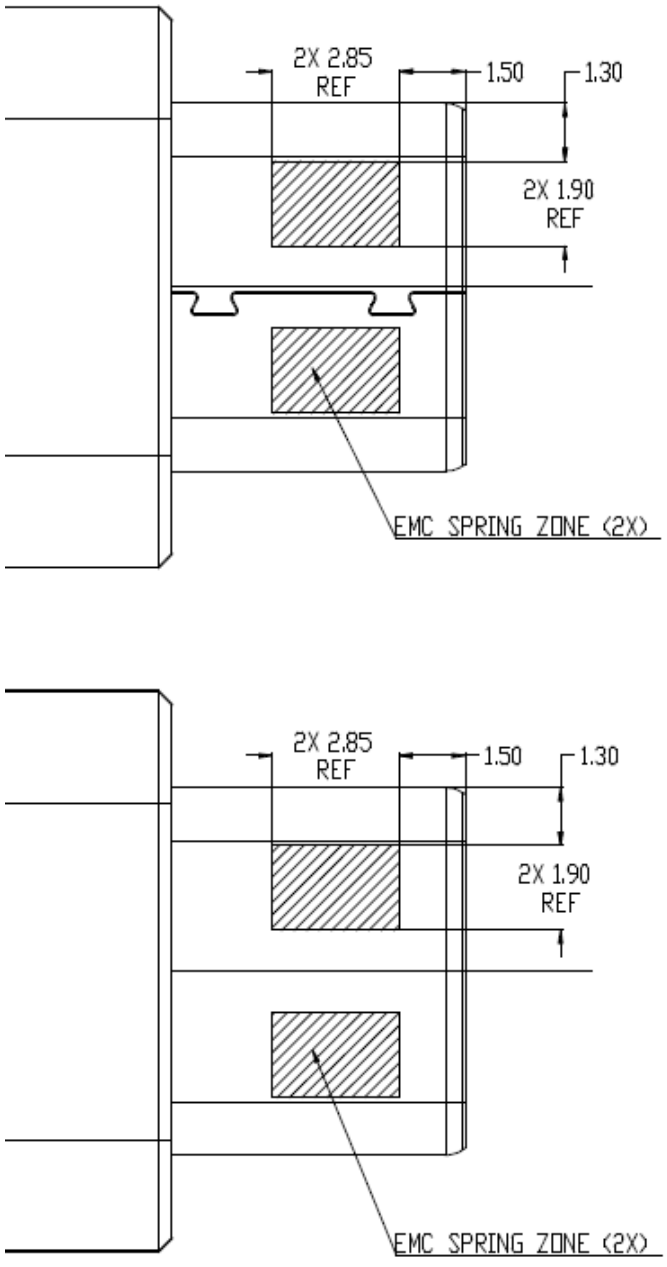
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Figure 3-2 Reference Design USB Type-C Plug External EMC Spring Contact Zones

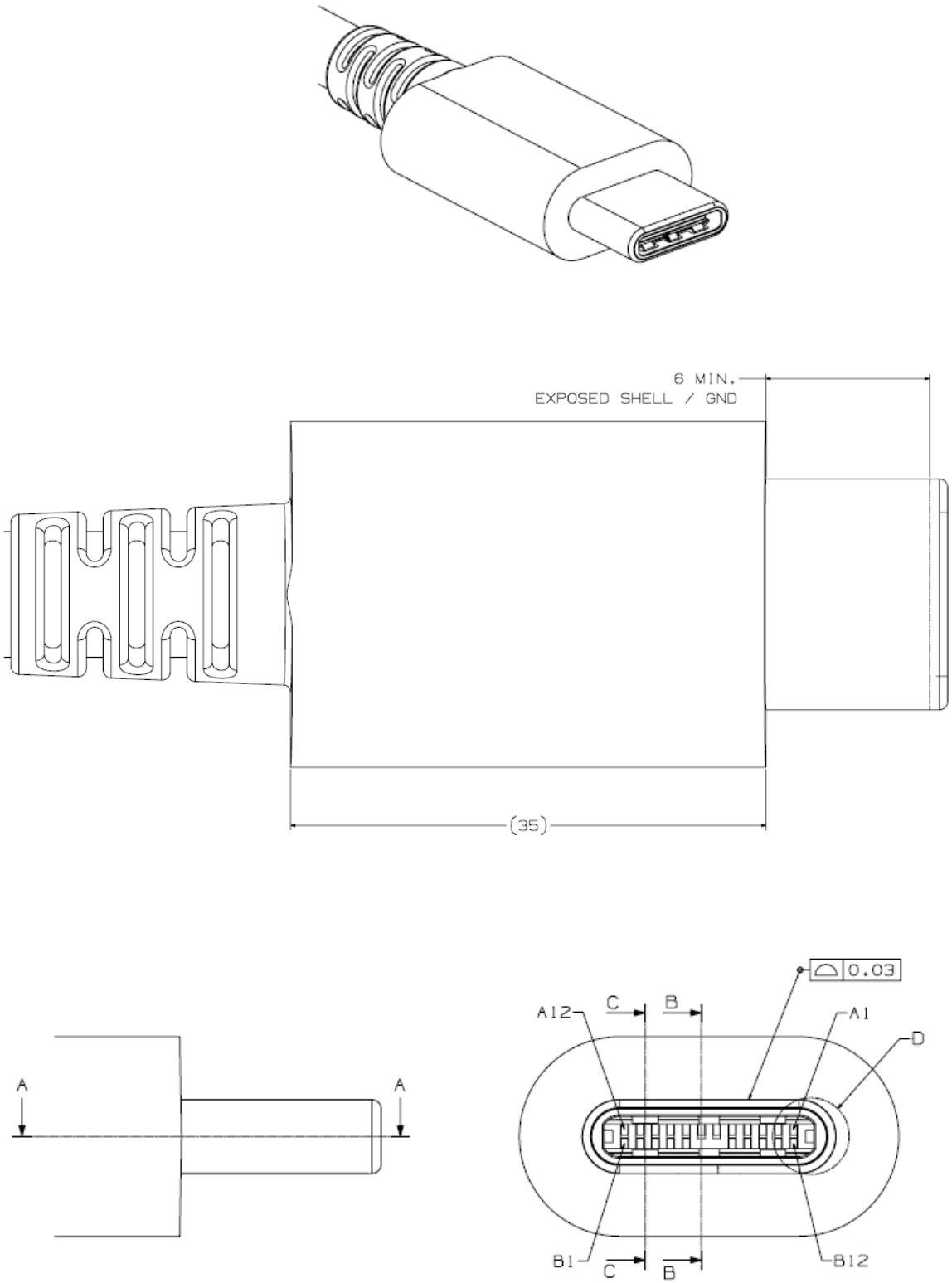


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Figure 3-3 USB Full-Featured Type-C Plug Interface Dimensions

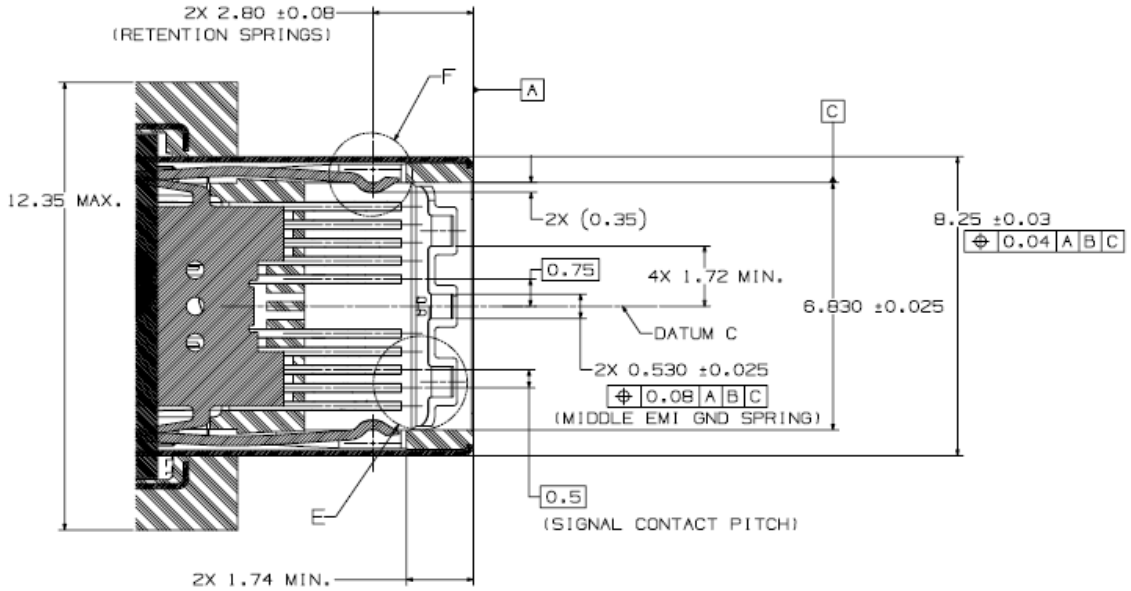


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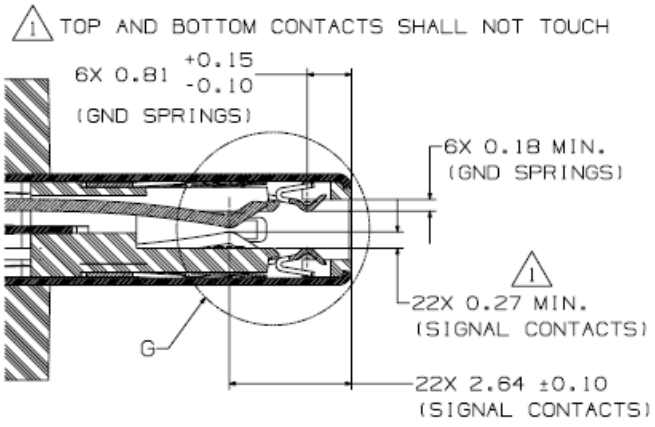
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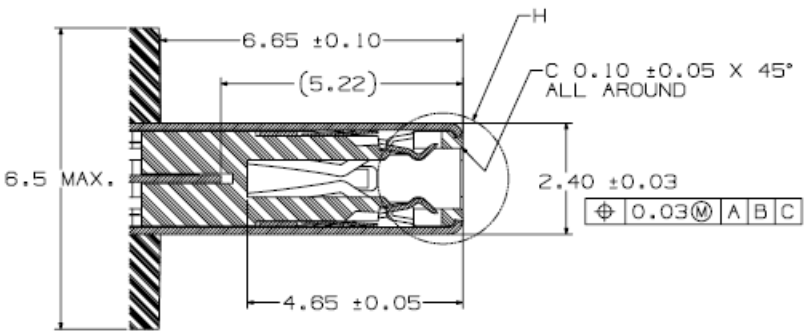
Figure 3-3 USB Full-Featured Type-C Plug Interface Dimensions, cont.



SECTION A-A



SECTION B-B

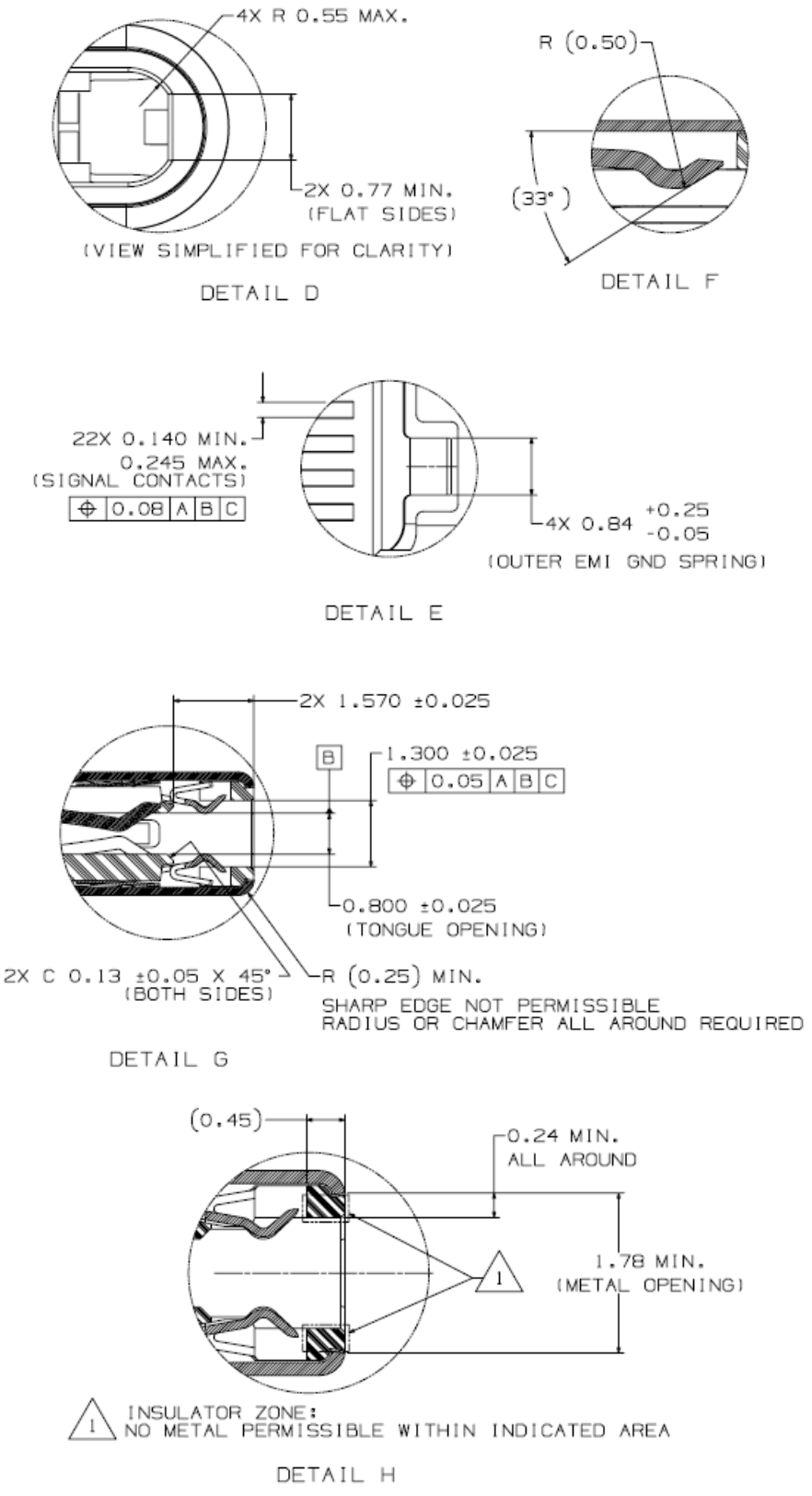


SECTION C-C

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Figure 3-3 USB Full-Featured Type-C Plug Interface Dimensions, cont.

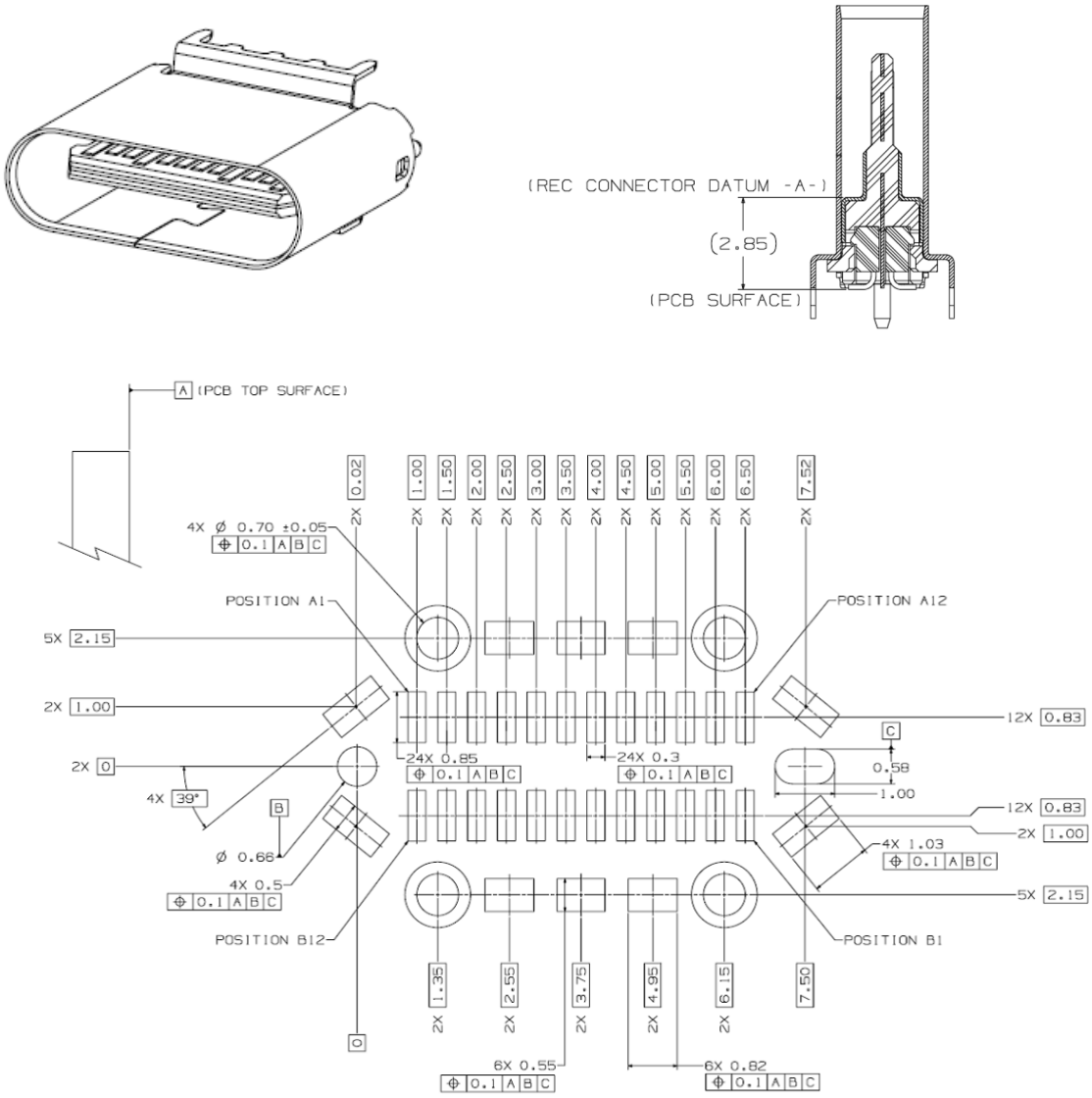


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Figure 3-4 Reference Footprint for a USB Type-C Vertical Mount Receptacle (Informative)

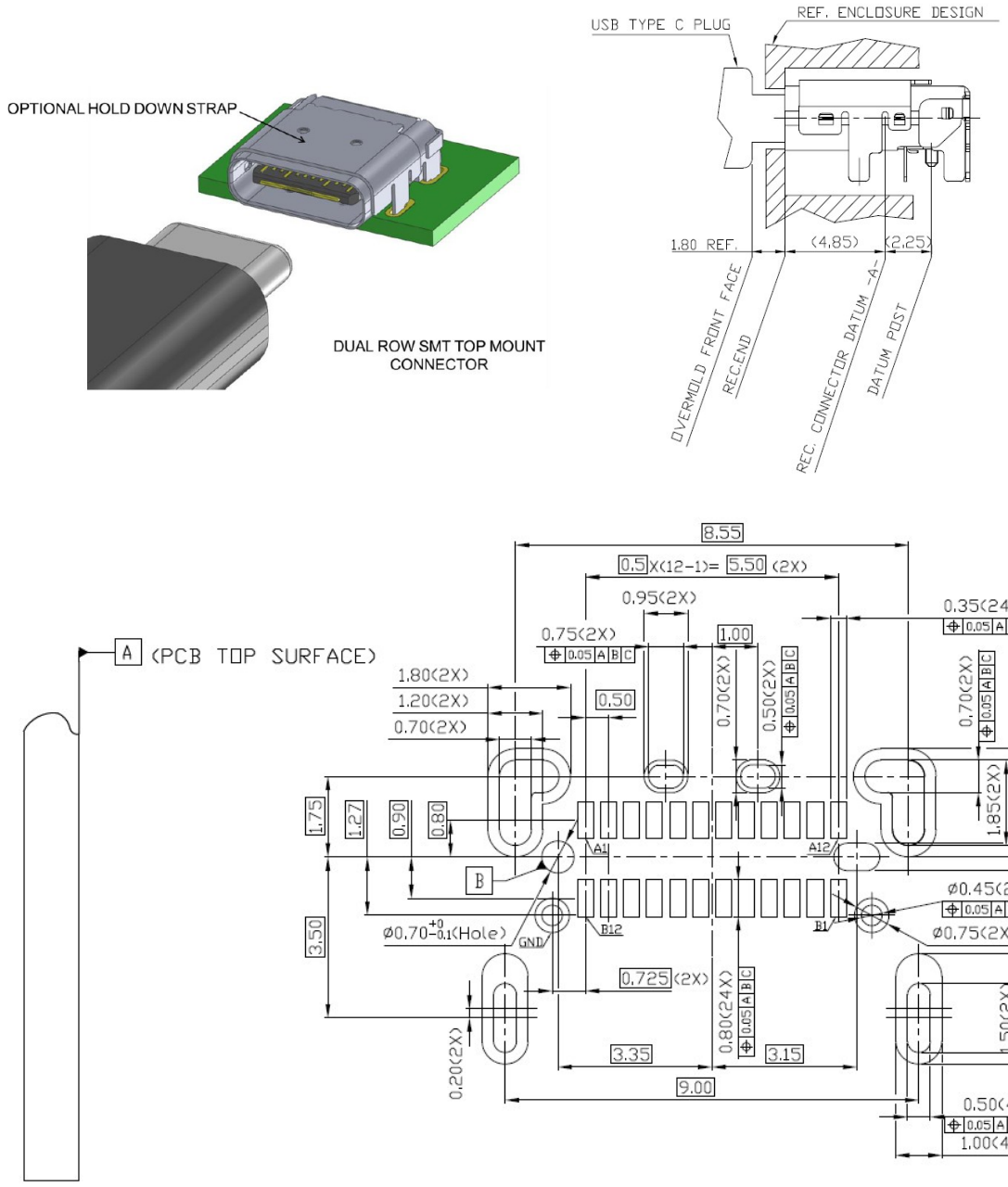


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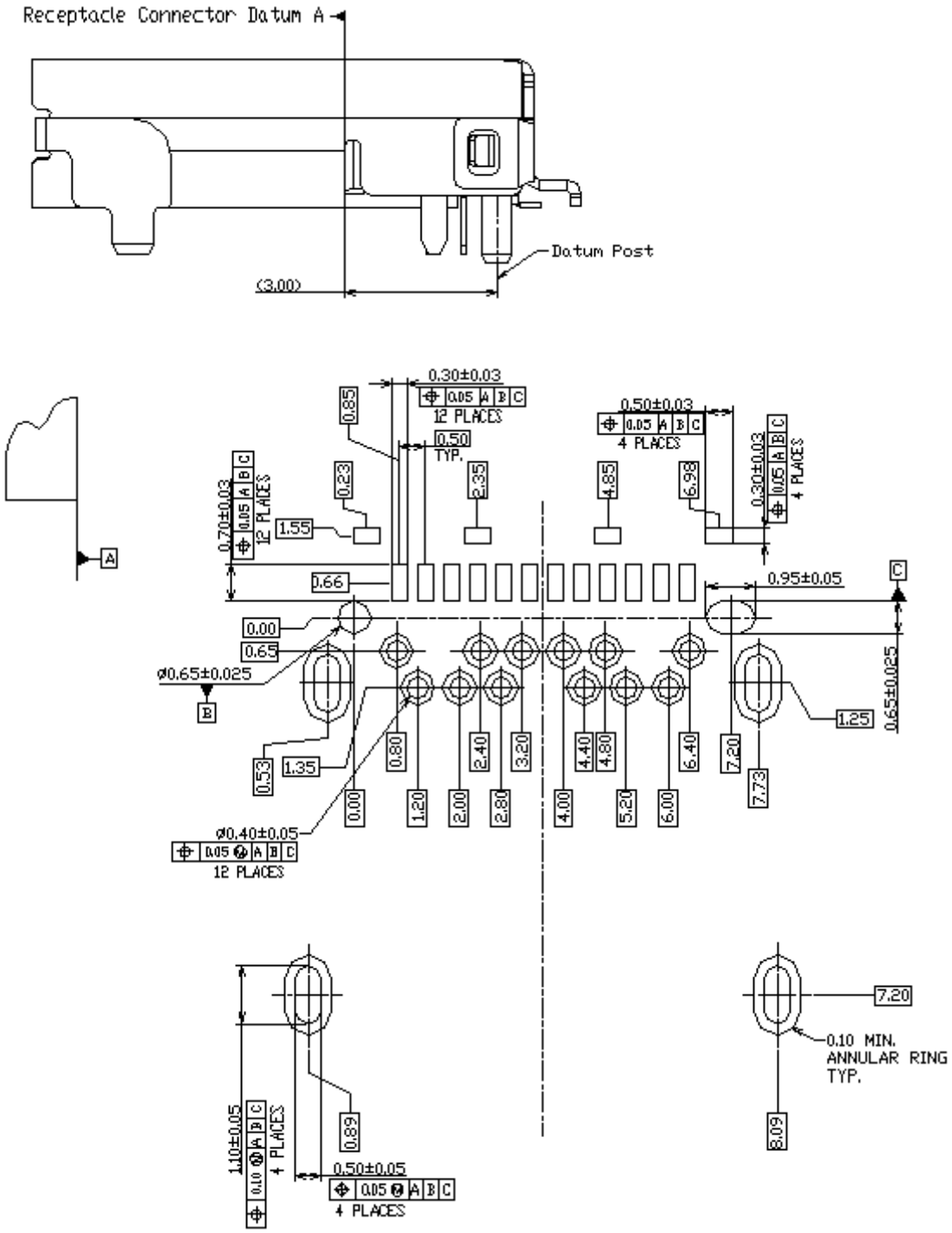
Figure 3-5 Reference Footprint for a USB Type-C Dual-Row SMT Right Angle Receptacle (Informative)



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Figure 3-6 Reference Footprint for a USB Type-C Hybrid Right-Angle Receptacle (Informative)

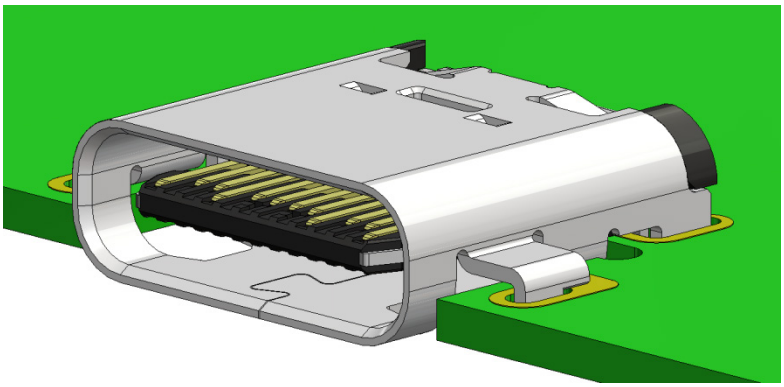


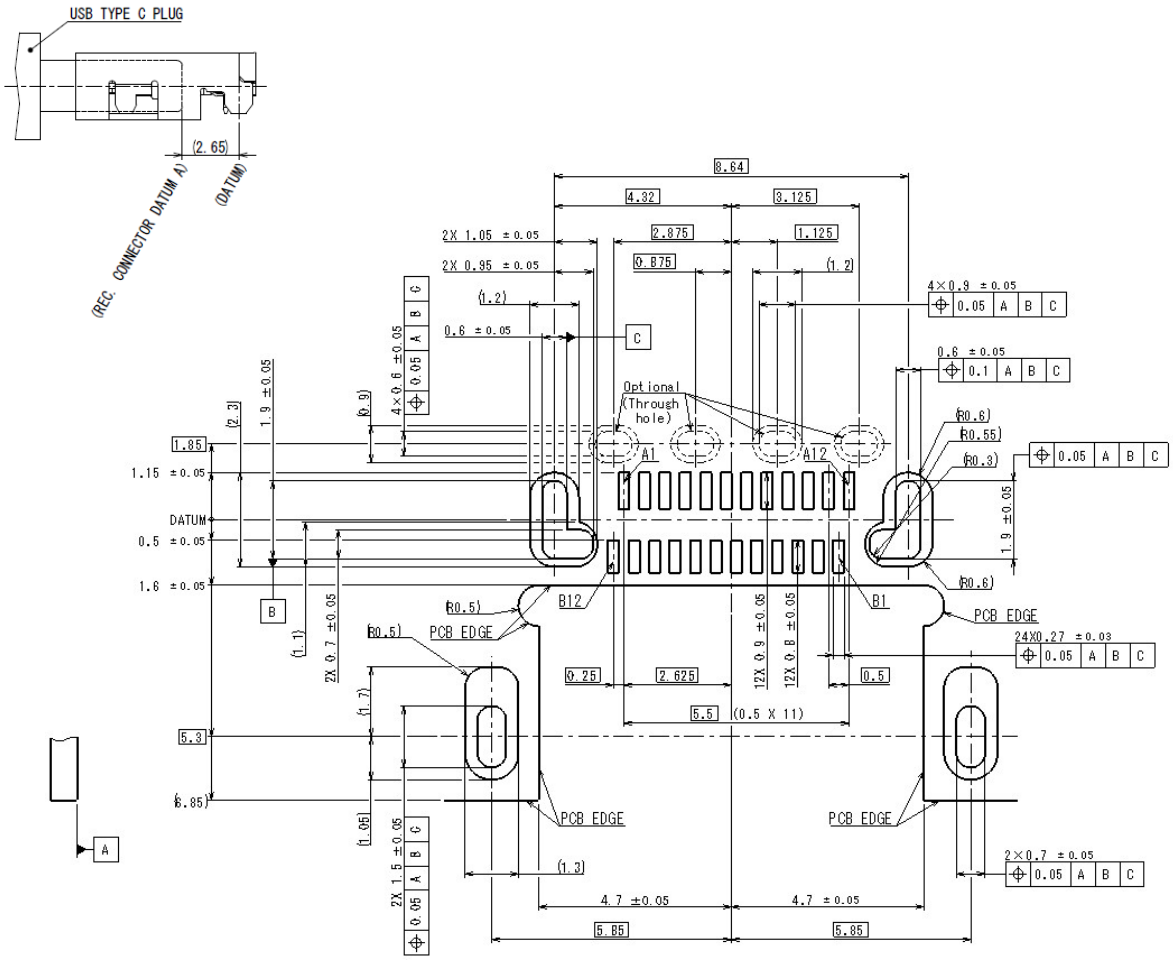
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Figure 3-7 Reference Footprint for a USB Type-C Mid-Mount Dual-Row SMT Receptacle (Informative)





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