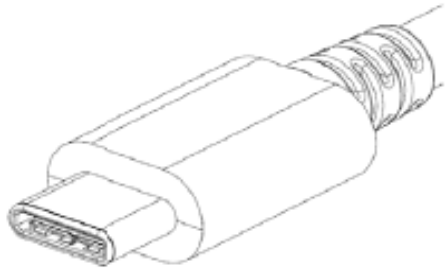
• Common USB Charging Modes

• Mode of Operation	• Nominal Voltage	• Maximum Current	• Notes
• USB 2.0	• 5V	• 500mA	• Default Current, based on definitions in the base specifications.
• USB 3.1	• 5V	• 900mA	
• USB BC 1.2	• 5V	• Up to 1.5A	• Legacy charging
• DCP 1.2V mode	• 5V	• Up to 2.0A	• Samsung's proprietary mode
• Divider 3 mode	• 5V	• Up to 2.4A	• Apple's proprietary mode
• USB Type-C Current @1.5A	• 5V	• 1.5A	• Supports higher power devices
• USB Type-C Current @3.0A	• 5V	• 3A	• Supports higher power devices
• USB PD 2.0	• 5, 12, 20 V	• Up to 5 A	• Supports higher voltage & higher amp.

USB Type-C Functional Pin-out

Looking into the product receptacle:

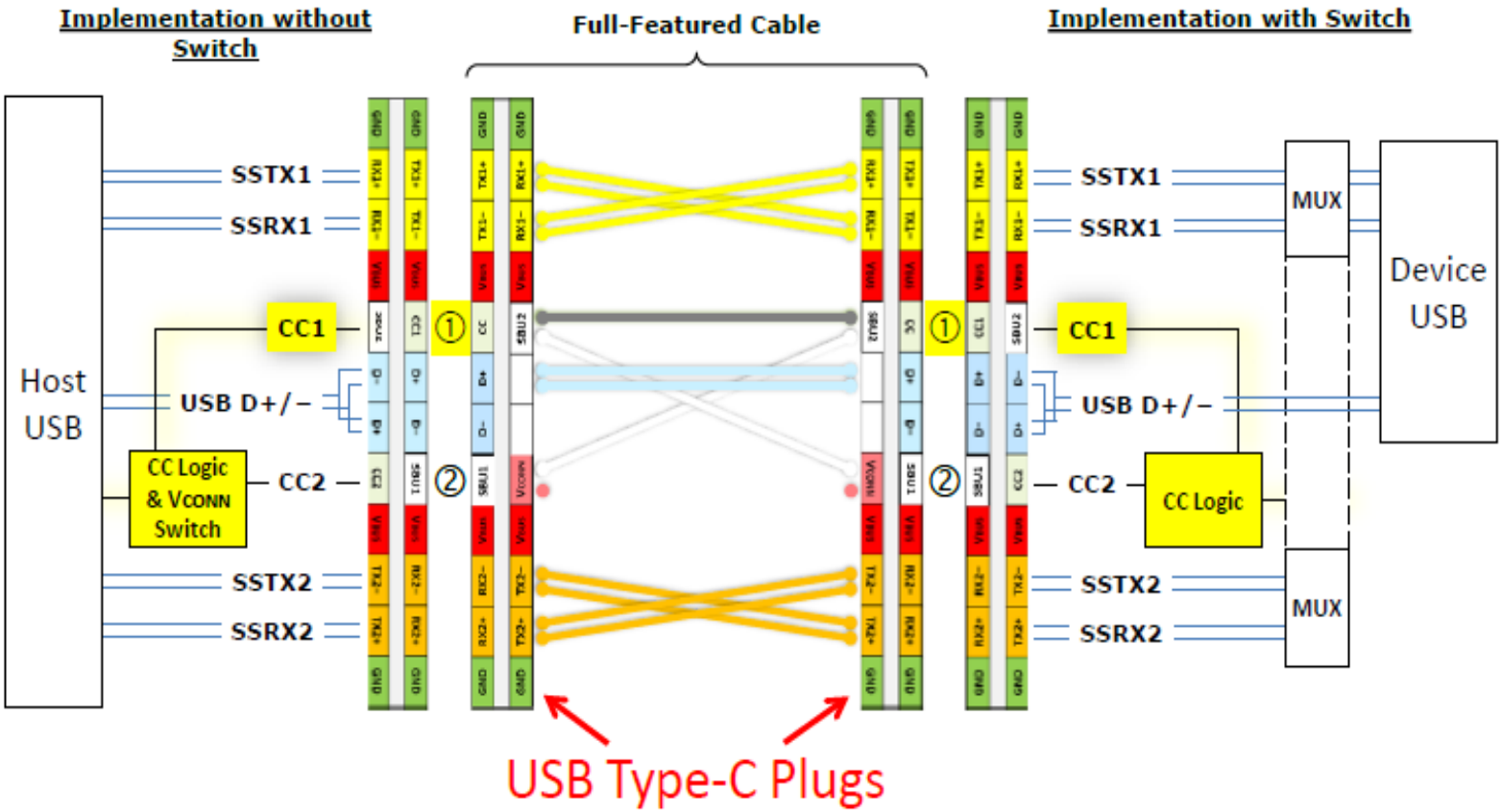
A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1−	VBUS	CC1	D+	D−	SBU1	VBUS	RX2−	RX2+	GND
GND	RX1+	RX1−	VBUS	SBU2	D−	D+	CC2	VBUS	TX2−	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1



Looking into the cable or product plug:

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

USB Type-C Functional Model



CC wire determines orientation through the cable

USB Type-C Configuration Channel (CC)

- ✓ Detect attach of USB ports
- ✓ Resolve cable orientation and twist connections to establish USB data bus routing
- ✓ Establish “host” and “device” roles between two attached ports
- ✓ Discover and configure V_{BUS}
- ✓ Configure V_{CONN}
- ✓ Discover and configure optional Alternate and Accessory modes

Understanding USB Type-C port behaviors

Data roles:

- Downstream Facing Port (DFP) – typical of Standard-A host or hub ports
- Upstream Facing Port (UFP) – typical of Standard-B or Micro-B device ports

Power roles:

- Source – typical of Standard-A host or hub ports
- Sink – typical of Standard-B or Micro-B device ports

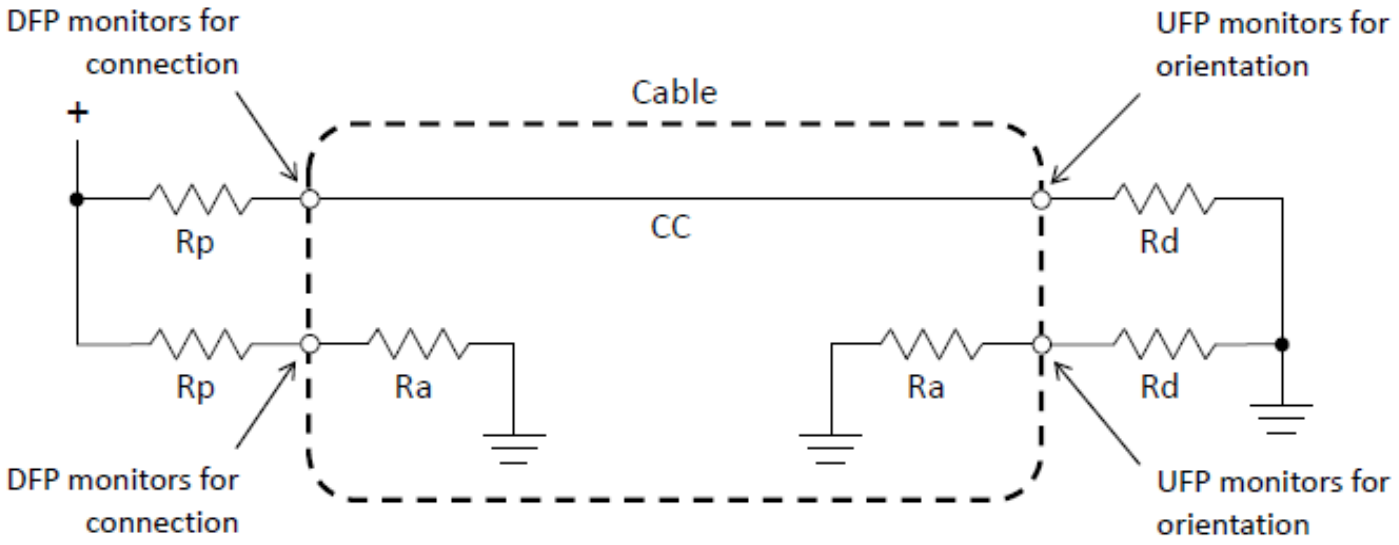
USB Type-C Ports can be:

- Host-mode only, Device-mode only or Dual-Role
- A Dual-Role Port (DRP) transitions between DFP and UFP port states until it resolves to the appropriate state based on what is attached

Roles can be dynamically swapped using USB PD

- Data role swap, power role swap

USB Type-C Pull-Up/Pull-Down CC Model



- ✓ Host side can substitute current sources for Rp
- ✓ Powered cables introduce Ra at the “unwired” CC pins which are used to indicate the need for V_{CONN} over one of those pins

USB Type-C – Host Detected Connection States

CC1	CC2	State	Position
Open	Open	Nothing connected	N/A
Rd	Open	UFP connected	①
Open	Rd	UFP connected	②
Open	Ra	Powered Cable/No UFP connected	①
Ra	Open	Powered Cable/No UFP connected	②
Rd	Ra	Powered Cable/UFP connected	①
Ra	Rd	Powered Cable/UFP connected	②
Rd	Rd	Debug Accessory Mode connected (Appendix B)	N/A
Ra	Ra	Audio Adapter Accessory Mode connected (Appendix A)	N/A

DFP & UFP Behaviors

State	DFP Behavior	UFP Behavior
Nothing attached	• Sense CC pins for attach • Do not apply VBUS or VCONN	• Sense VBUS for attach
UFP attached	• Sense CC for orientation • Sense CC for detach • Apply VBUS and VCONN	• Sense CC pins for orientation • Sense loss of VBUS for detach
Powered cable/No UFP attached	• Sense CC pins for attach • Do not apply VBUS or VCONN	• Sense VBUS for attach
Powered cable/UFP attached	• Sense CC for orientation • Sense CC for detach • Apply VBUS and VCONN	• Sense CC pins for orientation • Sense loss of VBUS for detach
Debug Accessory Mode attached	• Sense CC pins for detach • Reconfigure for debug	• N/A
Audio Adapter Accessory Mode attached	• Sense CC pins for detach • Reconfigure for analog audio	• N/A

Compliance USB Type-C

Two areas of testing

- Cable and connectors
- Platforms

Cable and Connector

- Mechanical
- Electrical

Platforms

- Electrical
- Functional