

Type-C Cable Orientation

APPLICATION NOTE

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9/11/15

Summary

For the first time in USB, the new Type-C specification defines a connector that can operate in either of the two logical orientations. This application note explains the technical considerations in effect when operating the Voyager M310C with USB Type-C cables. With an understanding of how a Type-C cable operates, users will find that the M310C design allows the ability to test all logical cable orientations in their system.

The Mercury T2C also follows these plug orientation conventions.

The Voyager M310C was designed with optimized probe circuitry so that it can passively capture and pass through a very clean 10 Gbps signal. To achieve this goal, the system was designed with fixed pin-assignments for the primary SuperSpeed TX and RX pair. This prevents users from reversing the plug orientation on the analyzer side of the link. Some have raised concerns that there might be issues they are unable to capture in this manner. These concerns are unfounded, and it should be made clear that the plug orientation can be freely reversed on the DUT side of the link. **There is no scenario that cannot be fully debugged in this manner.**

Due to this design architecture, the M310C requires a bit more awareness from its users. Next to both ports is a status LED that indicates one of three states. GREEN indicates that the CC termination is detected in the proper orientation, while RED indicates that that CC termination is detected, but in the incorrect orientation. The LED will remain off if no CC connection is detected.



Diagram 1: The right cable here is plugged in incorrectly. It should be flipped, so that the LED turns green.

Despite necessitating an extra moment's work from the user, this implementation does not limit the test cases that they can debug. In a standard host-device environment, there are four different orientations in which one could connect a cable. This adds complexity for developers, who must multiplex the signals from these pins. It follows that they will be interested in verifying that they can correctly transmit and receive traffic in both orientations.

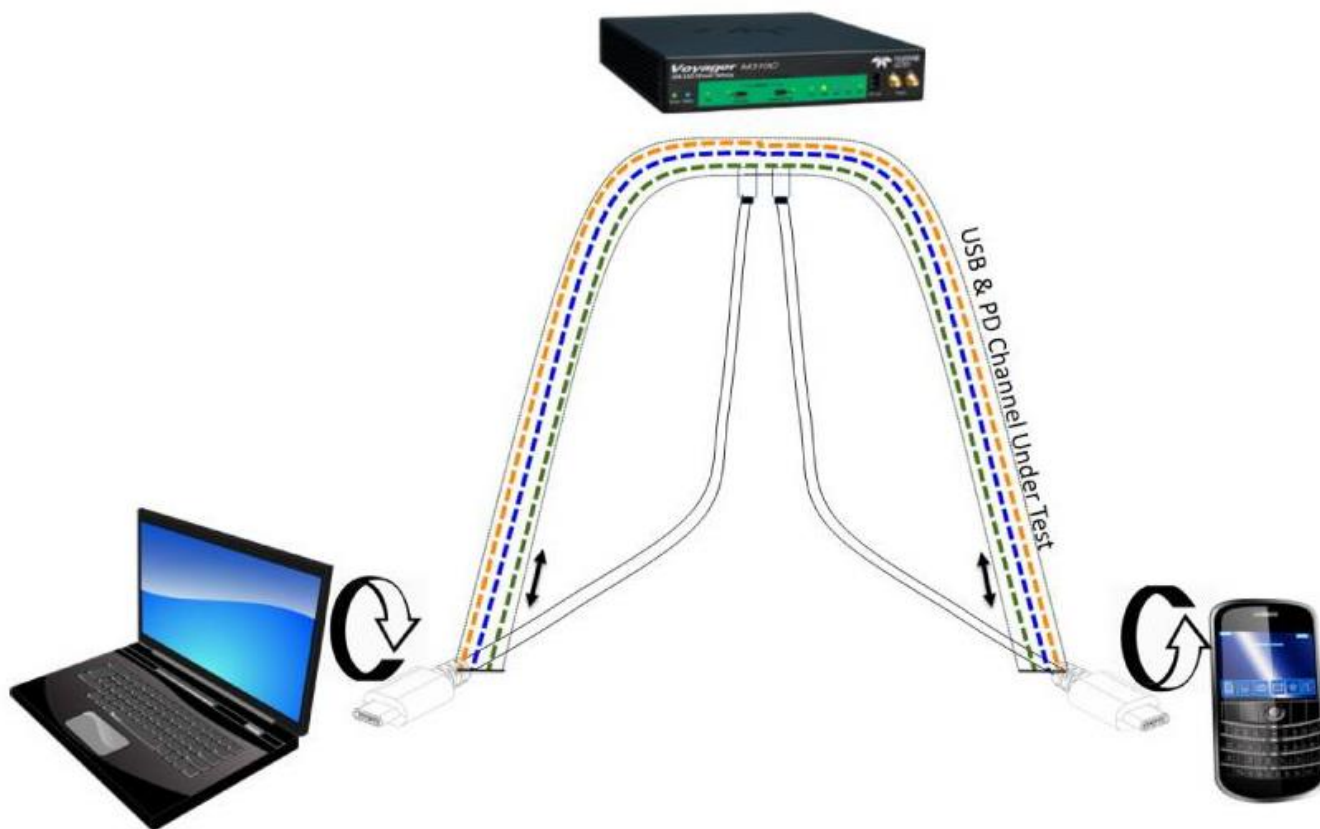


Diagram 2: A valid connection through the analyzer exists when both LEDs are green. At this point, users should view both cables as part of one logical channel through the analyzer. The four cable orientation scenarios can thus be tested by rotating the plugs device-side.

As seen in Figure 2-2, both ends of a cable have a CC pin (A5), from which each partner can determine the orientation. If the CC termination is detected on a receptacle's CC1 pin (A5, in Figure 2-1), the partner knows that it will receive PD traffic over that line, and SS traffic on the TX1/RX1 pins (A2-3, B10-11). If the CC termination is instead detected on the CC2 pin (B5), the partner will receive PD traffic over that line, and SS traffic on the TX2/RX2 (A10-11, B2-3) pins.

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

USB traffic will always travel across a cable over a predetermined set of wires. PD traffic will traverse the CC line (A5), while SS traffic is sent across the TX1/RX1 pins (A2-3, B10-11). USB 2.0 traffic runs across the single pair of D+/D- lines (A6-7). It is the receptacle side that must determine the orientation and multiplex the signaling. Unless a user is trying test whether the analyzer does this (it doesn't), there is no benefit to changing the orientation on the analyzer side. Remember that neither partner should be aware of an analyzer in the path, so the four cable orientations continue to be available. Users can orient the plug connecting to either partner with no consequences and, in that way, test all orientation scenarios.

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

Devices with captive cables are no different. As in the M310C, the lines of a captive device are hardwired internally, so the multiplexer circuitry is not necessary. Flipping the plug on the analyzer side does not change this, it simply necessitates that the analyzer be able to multiplex the signals.

Note: The above is inclusive of all USB and USB Power Delivery signaling. Devices may repurpose the SuperSpeed lines when operating in an Alternate Mode.

Diagrams by Peter Fletcher and Mike Micheletti.

Figures from the USB Type-C Specification, Revision 1.1, Copyright © 2015 USB 3.0 Promoter Group.