

Universal Serial Bus Type-C Shared Capacity Charger Interoperability Compliance Test Specification

Version 0.8

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Version History

Version	Issue Date	Comments
0.5	4/9/2023	First Draft
0.7	5/9/2023	Tests implemented manually
0.8	1/30/2024	Device update from Google Pixel 4 to Google Pixel 7a. Verification V5 added to doc Example results updated to show V5

Contributors

Amanda Hosler
Sydney Fernandes
Kyle O’Connell

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Introduction

Shared Capacity Charger products implement a power policy to manage power contracts across all ports on a power gang. The power contract on one port may change when a device is plugged into another port, and the change may be dependent on how much power the new device requires and how the new device requests power. In one device, possibilities for device policy management are many, which lends to varied policy interactions between a shared capacity charger and the breadth of devices it connects with.

The USB Type-C Interoperability procedure checks a charger's basic function and observes power contract status when the charger is connected to each of several popular sink devices in the USB ecosystem. The CTS is geared toward testing one port at a time. This document uses the same devices and is geared to test multiple ports in a power gang at the same time.

The goal of this test is to confirm the USB-C Specification Shared Capacity Charger power management requirements for USB Type-C ports from Section 4.8.6 are observed when the charger interacts with a range of devices at the same time.

Applicability

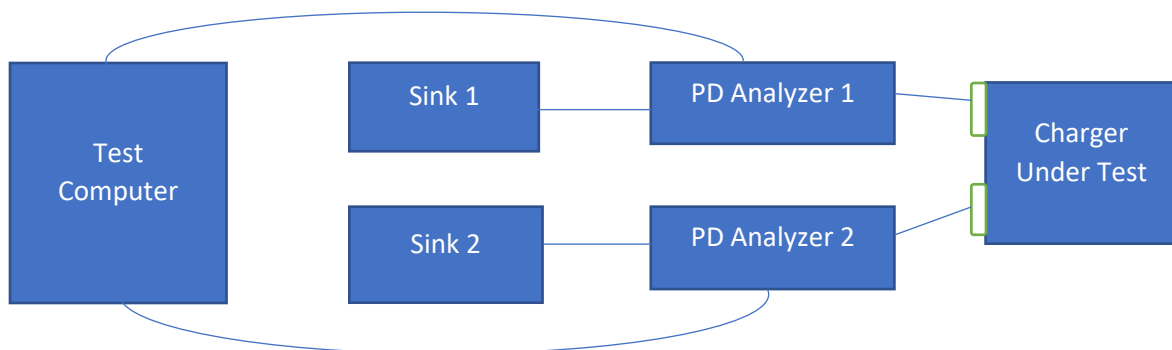
This test is applicable for USB-C Shared Capacity source products with a shared power gang on USB Type-C ports. This test is applicable and must be run separately for each such power gang on the product.

This test is not applicable for power sharing on Type-A port gangs.

If this test is applicable, it is in addition to all other tests that are applicable for the product.

Setup

The test setup will need to include the number of PD Analyzers equal to the number of ports in the shared power gang under test, or 4, whichever number is smaller. The figure below shows the test setup used for a two-port power gang. For gangs with more than 2 ports, this figure illustrates the test conditions where only two sinks are connected to the gang.



Some PD Analyzers, such as the GRL A1, can have multiple recording instances on one test machine as assumed in the setup shown above and the test procedure described below. Note that if the PD Analyzer used for testing needs one host machine for each PD Analyzer capture, such as for the Total Phase PD Analyzer, the test setup and procedure must be modified to include one Test Computer for each PD Analyzer.

Test

The following conditions are required for Shared Capacity Chargers with at least 2 ports on the shared power gang. For each condition, the first device is Sink1 and the second device is Sink2. For each condition, randomly choose which port will connect with Sink1 and which port will connect with Sink2.

Conditions:

1. Apple Macbook M1 and Google Pixelbook Go
2. Apple Macbook M1 and Samsung S21 Phone
3. Apple Macbook M1 and Google Pixel 7a Phone
4. Google Pixelbook Go and Samsung S21 Phone
5. Google Pixelbook Go and Google Pixel 7a Phone
6. Samsung S21 Phone and Google Pixel 7a Phone

Procedure:

1. Open two instances of PD Analyzer software.
2. Setup the test with the sinks indicated in the next Condition listed above and verify setup.
3. Set the charger under test to unpowered with a hard switch or unplug.
4. Check that each PD Analyzer HW is connected to an instance of its software.
5. Press the record button on each PD Analyzer software in quick succession, within 1 second of each other.
6. Power On the charger.
7. Wait 30 seconds.
8. Unplug Sink1 from the charger.
9. Wait 30 seconds.
10. Plug Sink1 back into the charger.
11. Wait 30 seconds.
12. Unplug Sink2 from the charger.
13. Wait 30 seconds.
14. Plug Sink2 back into the charger.
15. Wait 30 seconds.
16. Stop the PD Analyzer recording.
17. Unplug the charger from power.
18. Save the PD Analyzer recordings with apt names for later review.
19. Open new clean files on the PD Analyzer SW instances
20. Continue to step 2 with Sink1 and Sink2 set according to the next Condition above.

Results

To obtain a test result, review the PD Analyzer captures for each test condition.

Verify the following requirements:

1. The gang does not advertise more than total gang power.
2. Each port advertises at least 7.5W while the charger is powered.
3. The charger notifies all ports when the power reserve changes.
4. The port power contracts settle within 3s after a power reserve change.
5. The port power rebalancing is completed without using Hard Reset, Error Recovery, or Disabled.

For compliance testing, a test engineer will manually review the PD Analyzer files and fill out a result report.

A result set will show a pass/fail mark for Verifications 1 through 5 (V.1 – V.5) for each test condition (C.1 – C.6). Failure comments will include the file, time, and message index of the failure.

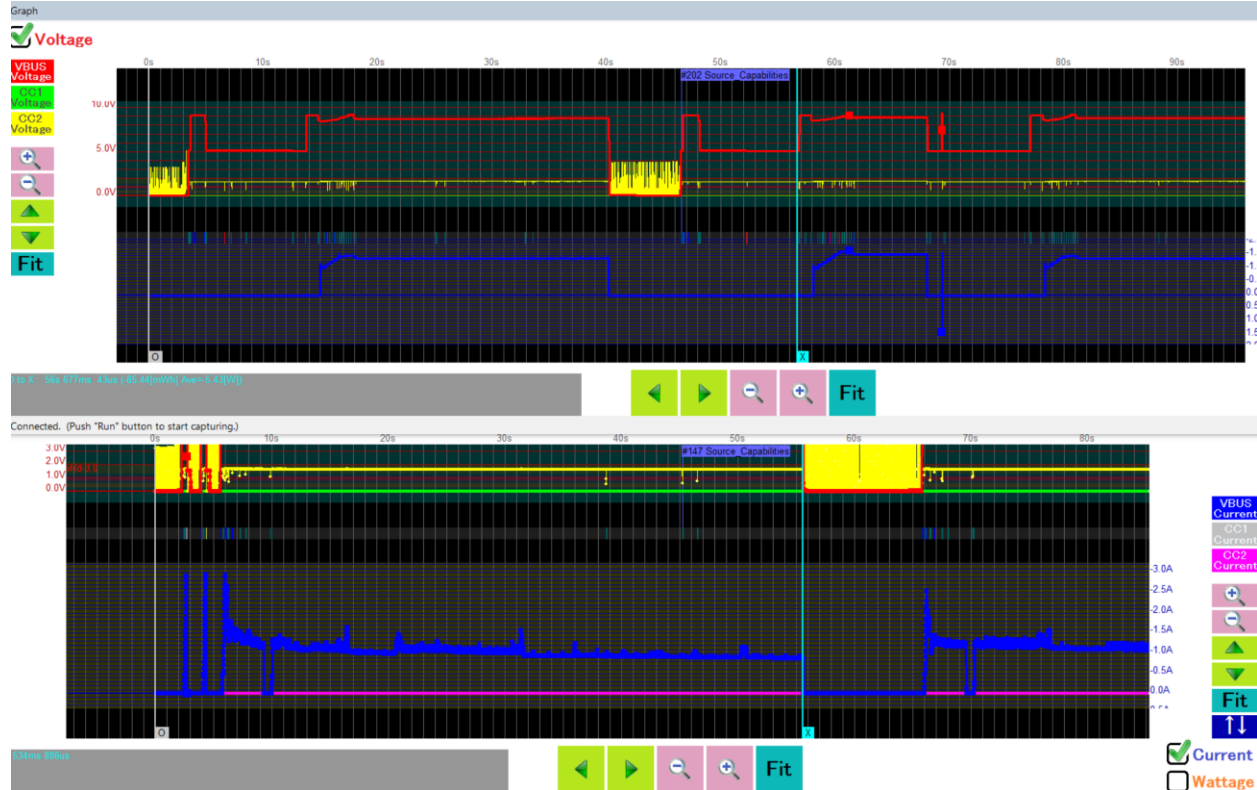
Note that the time component of this test is error prone due to the manual start/stop of the PD Analyzer SW. That being said, based on the messages and power changes across the ports, we can guess the time sync offset within milliseconds. Even so, this means there may be some false pass situations with this test methodology surrounding Verification 1 above.

Example result:

USB-C Shared Capacity Interop Test Result

Verification Definitions:			
V1	The gang does not advertise more than total gang power		
V2	Each port advertises at least 7.5W while the charger is powered		
V3	The charger notifies all ports when the power reserve changes		
V4	The port power contracts settle within 3s after a power reserve change		
V5	The port power rebalancing does not use Hard Reset, Error Recovery, or Disabled		
Condition	Verification	Result	Comment
C1	V1	pass	
	V2	pass	
	V3	pass	
	V4	fail	Contract did not settle for 5 seconds after initial contract (C1_port1_pbgo.wmc, index 54)
	V5	pass	
C2	V1	pass	
	V2	pass	
	V3	pass	
	V4	pass	
	V5	pass	
C3	V1	pass	
	V2	fail	Port 0 advertised 5V 1A, min allowed is 5V 1.5A (C3_port0_M1.wmc, index 200)
	V3	pass	
	V4	pass	
	V5	fail	Port 1 used Error Recovery or Disabled (removed terms) to rebalance power (C3_port1_M1.wmc, index 254)
C4	V1	pass	
	V2	pass	
	V3	fail	Sink 1 removed, port 1 did not send new Source Capabilities (C4_port1_S21.wmc, index 123)
	V4	pass	
	V5	pass	
C5	V1	fail	Sink 1 plugged in, port advertised more wattage than power reserve (C5_port1_p4.wmc, index 147)
	V2	pass	
	V3	pass	
	V4	pass	
	V5	pass	
C6	V1	fail	Sink 1 plugged in, port advertised more wattage than power reserve (C6_port0_p4.wmc, index 156)
	V2	pass	
	V3	pass	
	V4	pass	
	V5	pass	

For Verification 1, use the disconnect and reconnect Sink1 and Sink2 steps to sync the two PD capture files and find their start time offset to within 1s if possible. Use context cues between the two files. For instance, after Sink1 is unplugged in step 8, note the time on the file when the connection is lost, and look at the same time frame +/-1s on the other file for an unprompted Source Capabilities sent from the charger with a new max wattage advertised. Assume that message was sent in response to the power reserve power changing after Sink1 was removed on the other port. In this way the time offset is constrained to after Sink1 was removed. Similarly, after Sink2 is unplugged in step 12, note the time on the file when the connection is lost, and look at the same time frame on the other file for an unprompted Source Capabilities sent from the charger to Sink1. The found Source Caps is constrained to after the Sink1 disconnect time. In this way both files can be time constrained to each other in time.



Save the noted time offset between files as it will be used in Verification checks 1, 3 and 4. Check that each Source Capabilities, contracted PDO, and Type-C Current advertised or maintained at the same time across files sums to at or below the max wattage rating for the power gang as indicated in the VIF field Port_Source_Power_Gang_Max_Power.

For Verification 3, make sure that as Sink1 and Sink2 are plugged and unplugged, there is a related Source Capability or Type-C Current advertisement change on the other port as applicable. Plus, after a device initiates a request that resolves with a contracted PDO change, verify the other port reflects the change in power reserve with a new Source Capability or Type-C Current advertisement as applicable.

For Verification 4, make sure that after power on and starting time at the first explicit contract, when Sink1 and Sink2 are plugged and unplugged, and when Sink1 or Sink2 initiates a request that resolves with a contracted PDO change, power contracts settle on all ports within 3 seconds.

For Verification 5, make sure that after power on and when Sink1 and Sink2 are plugged and unplugged, and when Sink1 or Sink2 initiates a request that resolves with a contracted PDO change, power contracts on all ports are rebalanced without using Hard Reset, Error Recovery or Disabled. This generally means rebalancing power without the source removing Vbus or the source termination for any period of time.

For Verification 2, each Source Capabilities message (there might be a lot of them) must advertise at least 7.5W. If the port connection is over Type-C Current, then CC voltage must remain within $v_{Rd-1.5}$ min voltage and $v_{Rd-3.0}$ max voltage. The picture below indicates how to check each Source Capabilities message. It also highlights how to review the CC voltage in a Type-C Current case.

