

USB Type-C ENGINEERING CHANGE NOTICE

Title: Total Shared Capacity Definition Update

Applied to: USB Type-C Specification Release 2.2, October 2022

Brief description of the functional changes proposed:
Clarifies the definition of total shared capacity. Also allows that charger can address meeting the 7.5W minimum port power available rule without having to withhold power as a reserve – this is different than what is now required based on the total power available equation in the shared port behavior rules.

Benefits as a result of the proposed changes:
Clears up definition which impacts power supply design requirement and enables minimizing power supply requirements by allowing port PDP and total available power to be equal.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
Does not impact existing products.

An analysis of the hardware implications:
Will impact HW design if a product is to take advantage of the ability to lower total available power in a shared group.

An analysis of the software implications:
No impact to SW.

An analysis of the compliance testing implications:
Compliance testing will have to be updated to align with the new rules, might simplify testing of power sharing between ports.

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Actual Change Requested

(a) Section 1.5

Redline changes:

1.5 Terms and Abbreviations

Term	Description
Remaining Shared Capacity	The remaining power available for a Shared Capacity group of ports after power has been allocated to one or more of its ports.
Shared Port Power Available	The power available, up to the port's PDP, to an unattached port in a Shared Capacity group of ports. This power represents what is available to each port in the group when a Sink is attached after considering power that is already allocated (contracted) to ports with connected Sinks. This power will be a minimum of 7.5 W, initially offered as USB Type-C Current @ 1.5 A.
Total Shared Capacity	The total power available for a Shared Capacity group of ports. This is the overall power available when none of the ports in the group are connected to Sinks.

(b) Sections 4.8.6.1, 4.8.6.2 and 4.8.6.3

Redline changes:

4.8.6.1 General Requirements

Individual source ports shall always comply with power negotiation and rules set forth by the USB Type-C and USB Power Delivery specifications, adjusted as needed when available resources change as other ports take more or less power.

The minimum capability of all individual USB Type-C ports of a USB Type-C Multi-Port Charger *shall* be 5V @ 1.5 A independent of how many of the other ports are in use.

For Shared Capacity Chargers, the following are defined:

- **Total Shared Capacity** is the total power available for a Shared Capacity group of ports. This is the overall power available when none of the ports in the group are connected to Sinks
- **Remaining Power Available** = Total Shared Capacity minus the sum of the power allocated to the attached ports. When doing this calculation, for ports in a USB PD power contract, the maximum power offered in the **USB PD** source capabilities is used, not the power requested in the RDO.
- **Shared Port Power Available** is either:
 - the port's PDP when less than or equal to the Remaining Power Available.
 - the Remaining Power Available when greater than 7.5 W and less than the port's PDP, or
 - 7.5 W.

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When a Shared Capacity Charger reclaims power from one or more already connected ports to meet the 7.5 W minimum requirement for a newly attached device, the charger **shall** use standard **USB Type-C Current** and/or **USB PD** renegotiation methods and **shall not** use Hard Resets, **Error Recovery**, or the **Disabled** state.

When a USB Type-C Charger includes charging ports that are based on USB Standard-A receptacles, the following requirements **shall** be met.

- The USB Standard-A ports **shall** be implemented as an independent group, i.e., USB Standard-A ports shall not be included in a group of USB Type-C ports behaving as a Shared Capacity Charger. Any load change on a USB Type-A port **shall not** result in a voltage change on any of the USB Type-C ports and vice-versa.
- The minimum capability of each USB Standard-A port **shall** be 5V @ 500 mA independent of how many of the other ports are in use.

Implementation Note: When designing a Shared Capacity Charger, user experience should be an important factor in deciding the Total Shared Capacity to support. There are tradeoffs to be made regarding port PDP, the number of ports, and the total power available to be shared that will notably impact what a user can expect when charging multiple devices.

Table 4.X gives some comparative examples of a 4-port Shared Capacity Charger to illustrate how the PDP and Total Shared Capacity impacts user experience as more devices are connected to the charger. Two simplistic power sharing policies are illustrated: a Highest-to-Lowest policy that emphasizes supplying the highest power to ports based on a first-come/first-serve priority, and a Balanced policy that always equally balances power across all connected ports. These example policies assume that the charger has no knowledge of the device's specific needs other than what the device requests when selecting from the charger's advertised capabilities, and that the order of connecting devices is from highest to lowest power consumer.

Table 4-X Examples of 4-port Shared Capacity Chargers and Power Sharing Policies

	Port PDP Rating	Total Shared Capacity	Highest-to-Lowest				Balanced				Notes
			1	2	3	4	1	2	3	4	
1	7.5 W	30 W	7.5	!	!	!	7.5	!	!	!	The minimal implementation is the functional equivalent to a group of Assured Ports where the Total Shared Capacity = PDP · n with n being the number of ports in the group.
			7.5	7.5	!	!	7.5	7.5	!	!	
			7.5	7.5	7.5	!	7.5	7.5	7.5	!	
			7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
2	30 W	30 W	30	!	!	!	30	!	!	!	These implementation examples illustrate that as Total Shared Capacity increases while port count and PDP remain constant, the user experience when charging multiple devices improves. Also, as the ratio of Total Shared Capacity to Port PDP Rating increases, the sharing policy of the charger relies less on reclaiming power from already connected ports.
			22.5	7.5	!	!	15	15	!	!	
			15	7.5	7.5	!	10	10	10	!	
			7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
3	30 W	60 W	30	!	!	!	30	!	!	!	
			30	30	!	!	30	30	!	!	
			30	22.5	7.5	!	20	20	20	!	
			30	15	7.5	7.5	15	15	15	15	
4	30 W	100 W	30	!	!	!	30	!	!	!	
			30	30	!	!	30	30	!	!	
			30	30	30	!	30	30	30	!	
			30	30	30	10	25	25	25	25	

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More sophisticated policies could be implemented for an even better user experience, these likely considering capabilities information retrieved from the device. For example, when multiple devices are attached, the needs of each device can be determined, and power allocated to give preference to devices that require higher power. As each new device is attached, power can be rebalanced after considering the additional needs of the new device.

4.8.6.2 Multi-Port Charger Behaviors

Each Source port of Assured Capacity Chargers shall, by design, behave independently and be unaffected by the status and loading of the other ports. An exception to this behavior is allowed if the charger has to take any action necessary to meet an overall product operational safety requirement due to unexpected behavior on any port.

For Shared Capacity Chargers, the following behavioral rules shall apply:

- Each of the exposed Source Ports **shall** have the same power capabilities. Each port of the charger **shall** be capable of the same maximum capability, minimum capability, and be able to draw from the shared power equally.
- ~~All exposed USB PD unattached Source Ports shall have the same power capabilities.~~
 - Ports **shall** have the ability to supply the available shared capacity power up to the port's maximum power **(PDP)**.
 - ~~PA shared capacity charger's ports may offer less than this value but shall increase the offer up to the required value when the Sink sets the Capabilities Mismatch bit in its response. This may be done in multiple steps, but all ports in the Shared Capacity Group shall reach the maximum power within three seconds.~~
 - Whenever a power contract is made or changed on any port, the **Remaining Power Available and the Shared Port Power** available ~~shared capacity~~ **shall** be re-computed, and the ~~source~~ **Source** **shall** send updated Source Capability messages as needed.
 - ~~As ports of a Shared Capacity Group are connected, each remaining unattached Source Port shall be capable of advertising the lower of the Maximum Capability of the port OR the Total Shared Capacity the contracted power for the attached ports (the number of unattached ports - 1) * the minimum port power.~~
 - ~~Ports shall offer at least 7.5 W.~~
 - ~~When calculating the available shared capacity for ports in a Fixed Supply power contract, the shared capacity charger shall use the Voltage times the Maximum Current in the PDO as the power the port is supplying regardless of the actual Operating Current requested in the RDO request.~~
 - ~~When calculating the available shared capacity for ports in a PPS power contract, the shared capacity charger shall use the Maximum Voltage times the Maximum Current in the APDO as the power the port is supplying regardless of the actual voltage and current in the RDO request.~~
 - Ports when not in a **USB** PD contract **shall** follow the rules for a shared USB Type-C Current source ~~unless there is sufficient remaining power for each port to advertise 15 W.~~
- All exposed USB Type-C Current ports **shall** have the ability to offer the same power capabilities.
 - All ports **shall** initially offer at least 1.5 A **- e.g., shall not offer Default.**
 - The total of offers across all the ports **shall** never exceed the capacity of the shared supply.

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- Ports that initially offer 1.5 A **shall** increase to 3 A after attach if they have sufficient available shared capacity within one second.

~~○ Ports shall never offer less than 1.5 A — e.g. shall not offer Default.~~

As Source ports are connected and begin providing power, the remaining Source ports will each have the same power capabilities. The maximum capability may be less than the previously connected ports due to less unused capacity of the total power delivery capacity of the charger. For example, if the total power delivery capacity of a USB Type-C two-port charger is 60 W with a port PDP of 35 W and the first connected Source port has established a 35 W power contract with its connected Sink, then the second Source port will only be able to offer a PDP of 25 W.

Each port **should** start by offering the minimum capability for the port and increase the offering to the Sink upon a connection. For example, if the maximum capability of a USB Type-C only Source port is 3 A, then all of the exposed Source ports will be able to offer 3 A. Each port should start by offering less than the max (such as 1.5 A) and then increase the offering to 3 A after an attach. This would happen for each port as it is connected until the unused shared capacity is exhausted, at which point no other ports would increase to 3 A offering. A sink, in this example, would see a starting advertisement of [USB Type-C Current](#) @ 1.5 A at attach and would then see the [USB Type-C Current](#) advertisement increase to 3 A. As another example, if the maximum capability of a USB Type-C Source port is to offer [USB PD](#) with a PDP of 35 W, then all of the exposed Source ports would also support [USB PD](#) 35 W. Each port would start by offering something less on initial connection, like 15 W, and then increase the offering with new Source Capabilities when it determines the Sink would like more power. If the Sink is not offered the power it requires, it will send a request with the Capability Mismatch bit set to indicate to the source it wants more power. This will happen for each port as it is connected until the unused shared capacity is exhausted, at which point no other ports would increase the power offering.

When establishing the remaining available capacity, a charger that supports policy-based power rebalancing **may** include the power that can be reclaimed from ports already in use:

1. by adjusting advertised source capabilities equivalent with a reduced PDP to one or more ports that are already in use; or
2. by issuing a [USB PD](#) GotoMin command to one or more ports already in use.

Policy-based power rebalancing **should** consider providing good user experience and preserving nominal USB functionality on impacted devices. Fixed rebalancing algorithms that do not factor in overall USB system policy **may not** be appropriate for power rebalancing implementations.

4.8.6.3 Multi-Port Charger Port Labeling

Multi-port chargers shall have OEM-designed port labeling consistent with the following rules.

- For Assured Capacity Chargers, each exposed Source port **shall** be labeled to indicate the PDP of the port. In this case, the user will be able to expect that each of the labeled ports will be able to meet power contracts consistent with the labeling independent of how many of the Source ports are in use.
- For Shared Capacity Chargers, each Source port **shall** be labeled to indicate the same PDP. Additionally, the charger **shall** have a label that, with a minimum of equal visual prominence, indicates the ~~total power delivery capacity~~ **Total Shared Capacity (see Section 4.8.6.1)** being shared across all of the ports identified as a group.

A Multi-Port Charger that offers in a single product separate groupings of charging ports, each grouping **shall** be clearly identified as a separate grouping and each grouping **shall** be individually labeled consistent with that group's behavior model, either as an Assured Capacity Charger or a Shared Capacity Charger.

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Refer to the USB Implementers Forum (USB-IF) for USB Type-C Chargers certification along with further labeling guidelines.