

ECN for USB Power Delivery Specification Revision 3.2

Version 1.1, 2024-10

Title: FRS update to discharge and detect disconnect

Brief description of the functional changes proposed:

FRS as previously defined almost always would guarantee failure to complete. After reviewing known designs, these succeed because the FRS capable charge-through devices are not following the spec as it is written. This was because the required behavior in the spec (specifically PSSourceOffTimer requirement) was orphaned (not with the FRS description) and not implemented nor was it in compliance testing.

There are several issues:

1. Requirement to not actively discharge when higher than vSafe5V (spec tried to hold this up as long as possible)
 - a. Conflicts with PSSourceOffTimer requirement
 - b. Not consistent with getting to a safe voltage quickly for a reattach.
2. Disconnect detect is not allowed after FRS signaling for the initial source and this can leave VBUS at a high voltage since not discharging if an actual disconnect occurs.
3. No requirement on the sender of the FRS signal to timeout receiving the FR_Swap message.

These were likely there to allow as much time as possible for the event to occur and the connection survive but in fact create safety/reliability issues as well as create worse situations that together would almost always cause FRS to fail.

Changes

1. Add FRSResponseTimer (FRSResponseTime) that exactly matches tSenderResponseTime for responding with the FR_Swap message.
2. Correctly call out that when normal type-c disconnect detection is allowed
3. Add that the initial source should discharge VBUS just as in any power role swap or disconnect.

Benefits as a result of the proposed changes:

Better for FRS success
Safer and more reliable

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

No impact to current solutions as they will still work as best they can

An analysis of the hardware implications:

Added FRSResponseTimer (can use SenderResponseTimer for this)
Enable discharge circuitry during FRS (hardware has to already be functional for other times)

An analysis of the software implications:

An analysis of the compliance testing implications:

FRSResponseTimer should be added
PSSourceOffTimer should be correctly implemented

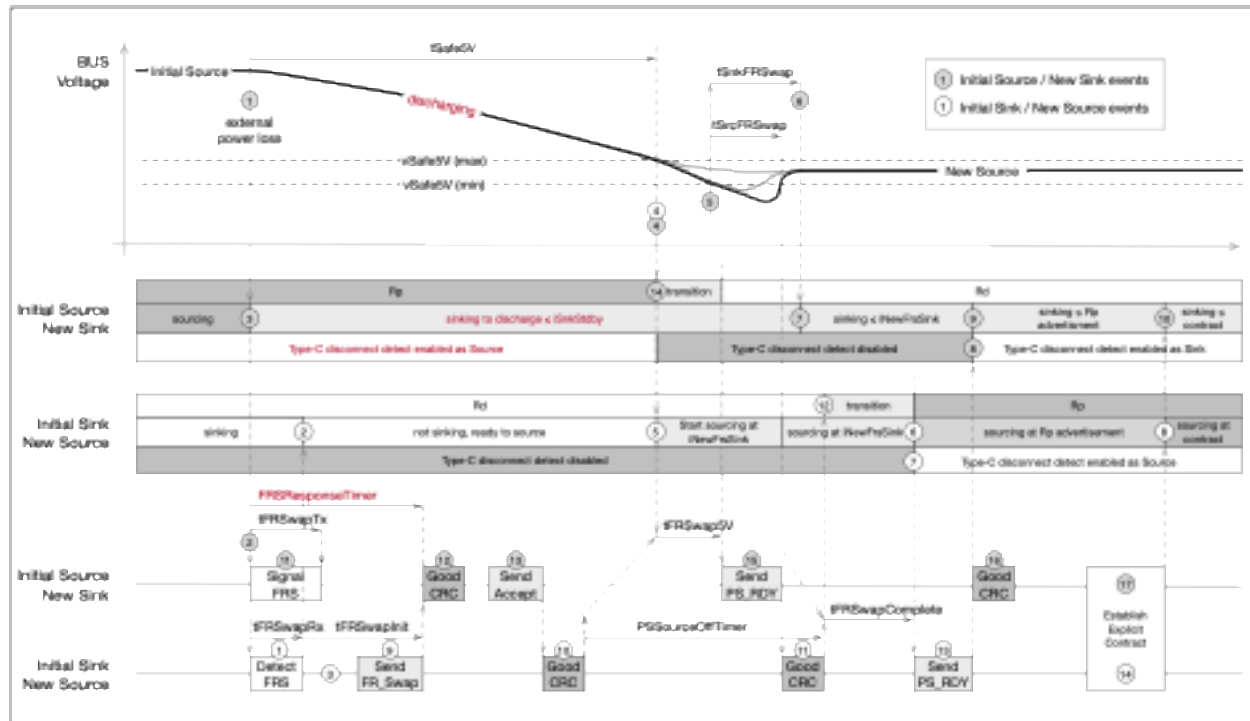
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Actual Change Requested

To Text:

(a). Figure 10.3



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10.4. Initial Source/New Sink

An FRS request is signaled by the Initial Source when it has lost external power and needs the Initial Sink to provide power to VBUS. The Initial Source Should signal the FRS as soon as it is aware that it has lost power. The following steps describe the behavior shown in the 'Signal FRS' activity diagram in Figure 10.2 and the timing diagram shown in Figure 10.3 and Figure 10.4 and match the numbers indicated in the figures.

Power and Control

1. The Initial Source detects external power loss.
2. The Initial Source Shall discard any pending messages and start sending the FRS Signal. The FRS Signal is transmitted by pulling the CC line below $v_{FRSwapCableTx}$ for at least $t_{FRSwapTx}$.
3. At the same time as starting the FRS Signal, the Initial Source Shall stop Sourcing VBUS and Shall start sinking current $\leq i_{SnkStby}$ from VBUS. While $VBUS \geq v_{Safe5V} (max)$, the New Sink Shall sink enough current to discharge to $v_{Safe5V} (max)$ within t_{Safe5V} .
4. When $VBUS \leq v_{Safe5V} (max)$, the New Sink Shall continue to pull current to discharge VBUS to $v_{Safe5V} (min)$. This prevents the process from stalling where the New Source's threshold for $v_{Safe5V} (max)$ might be lower than the New Sink's threshold. The New Source might begin to source VBUS before reaching $v_{Safe5V} (min)$ resulting in VBUS staying above $v_{Safe5V} (min)$.
5. If VBUS falls below $v_{Safe5V} (min)$, the New Sink Shall sink current $\leq i_{SnkStby}$, however is no longer required to discharge VBUS.
6. $i_{SnkStby}$ is the (max) current that can be drawn until $t_{SnkFRSwap}$ after both the FRS Signal was started and $VBUS < v_{Safe5V} (min)$.
7. After $t_{SnkFRSwap}$, the New Sink Shall sink current $\leq i_{NewFrsSnk}$. $i_{NewFrsSnk}$ is the current set by the FRS bits in the New Sink's Sink Capabilities initially provided to the Initial Sink. The New Sink Shall $\leq i_{NewFrsSnk}$ until it has detected the New Source's Rp termination.
8. When the PS_RDY message from the New Source is received, the New Sink is now in an implicit contract and Shall enable Type-C disconnect detection.
9. The New Sink Shall limit the sink current based on the Implicit Contract until an explicit contract is established.
10. Once an Explicit Contract is established, the New Sink Shall sink current up to the contract.

CC Signaling

11. The FRS Shall be signaled by pulling low on CC for a length $t_{FRSwapTx}$.
12. After sending the FRS Signal, the Initial Source waits to receive an FR_Swap message. If the FR_Swap message is not received and responded to within $t_{FRSResponse}$, the New Sink Shall go to errorRecovery.

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10.5. FRS Parameters

Table 10.1. FRS Timers

Timer Name	Timer Parameter	Description
FRSResponseTime	FRSResponse	Timer to enforce tFRSResponse time.
SnkFRSwapTime	SnkFRSwap	Timer to enforce tSnkFRSwap time.

Table 10.2. FRS Parameters

Parameter Name	Min Value	Nom Value	Max Value	Unit	Description
iNewFrsSink			Default USB	A	Maximum current the New Sink can draw during a Fast Role Swap until the New Source applies Rp.
			1.5	A	Matches the required Fast Role Swap required USB Type-C Current field of the Fixed Supply PDO of the Initial Source's Sink_Capabilities Message.
			3.0	A	
tFRSResponse			50	ms	Interval for the Initial Source to receive an FR_Swap Message from the Initial Sink after sending an FRS Signal. Start: the leading edge of the FRS Signal. End: the last bit of the FR_Swap Message EOP has been transmitted
tEDSwapSV			15	ms	Interval for the New Sink to assert Pd and send a PS_PDV