Type 3 and Type 4 short circuit protection

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Objectives

- To show that part-2 may be deleted because part 1 already covers this fault case (D1.6 page 110 line 2)
- OR in part 2, replace “should (TBD)” with “may”.

"Power shall be removed from a pairset PI of a PSE before the pairset PI current exceeds the "PSE upperbound template in Figure 33-14, Figure 33-14a, and Figure 33-14b.

Part 1

When connected to a single signature PD, a Type 3 or Type 4 PSE should (TBD) remove power from both pairsets before the current exceeds the "PSE upperbound template" on either pairset.“

Part 2

- To show removal of part-2 permits many applications.

Background - 1

- We already agreed in previous discussions:
  - Type 3 can work with 2-pair and 4-pairs.
  - Type 4 PSEs only provide 2-pair power after a fault

- The current specification (part-1) supports short-circuit protection (and other protection) done on a pairset basis:

"Power shall be removed from a pairset PI of a PSE before the pairset PI current exceeds the "PSE upperbound template in Figure 33-14, Figure 33-14a, and Figure 33-14b."

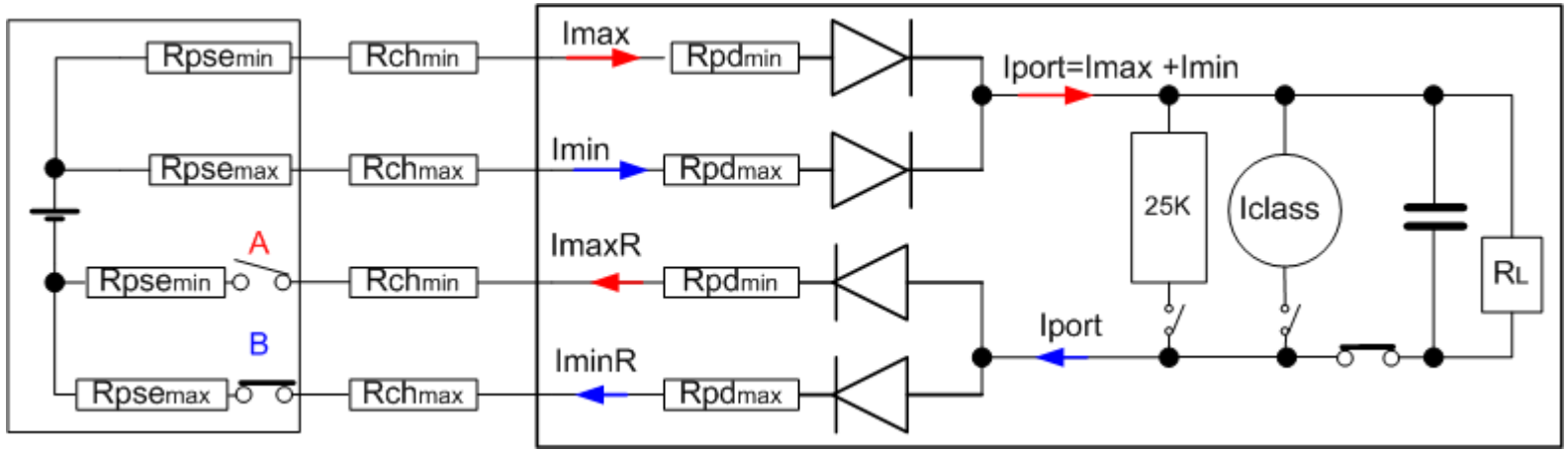
- If a singled-signature PD has a short circuit on a pairset, and power is removed from that pairset, the whole current flow will shift to the second pairset if the fault persists. This second fault condition requires the second pairset power to be removed.

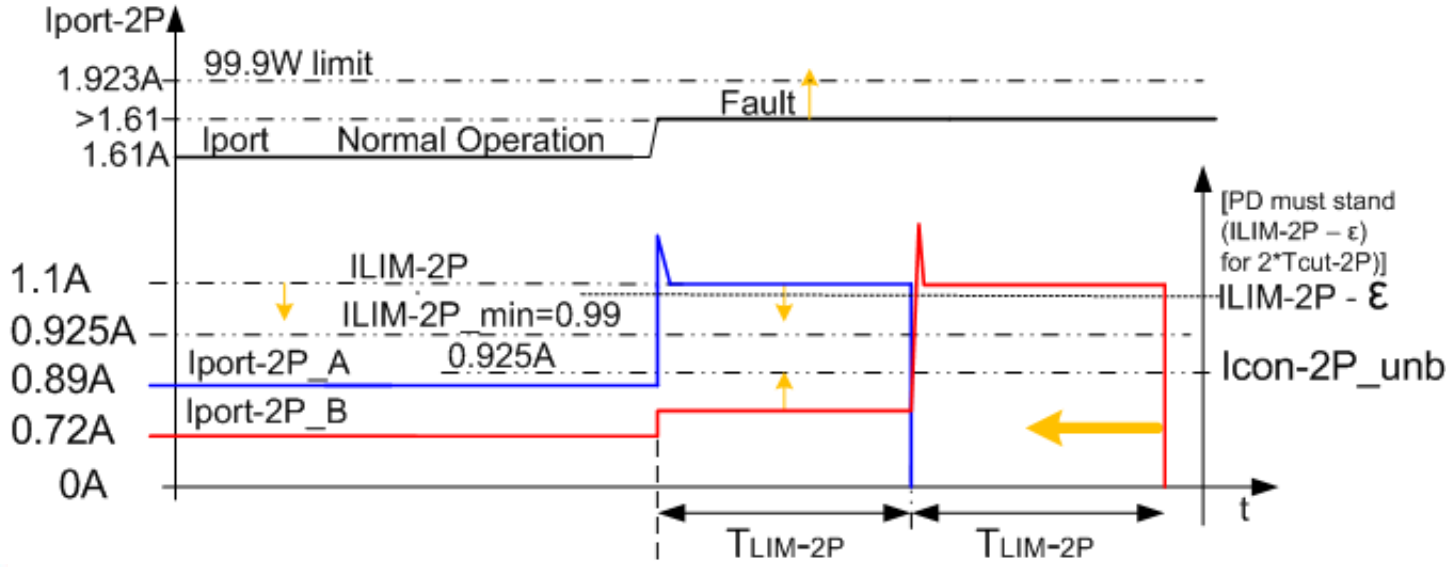
Background - 2

- There are applications for:
  - Dual-signature PDs and
  - Single-signature PDs.
- In both cases, forcing the PSE to shut off both pairs when there is a fault on one of the pairs kills the ability to support devices that can work and are designed to work over 2-pairs in case of fault.
- In addition, shutting off both pairs when there is fault on one of the pairs doesn't add extra protection to the PD.
- we do not want to make it illegal to power down both pairsets when there is a fault on one pairset. We believe this should be optional behavior.

Single-Signature PD Inherent 4-pairs protection

- We have short circuit on one of the pairs and power is removed from that pair. if short still persists, the whole current will flow through the 2nd pair and that per will shut off too.

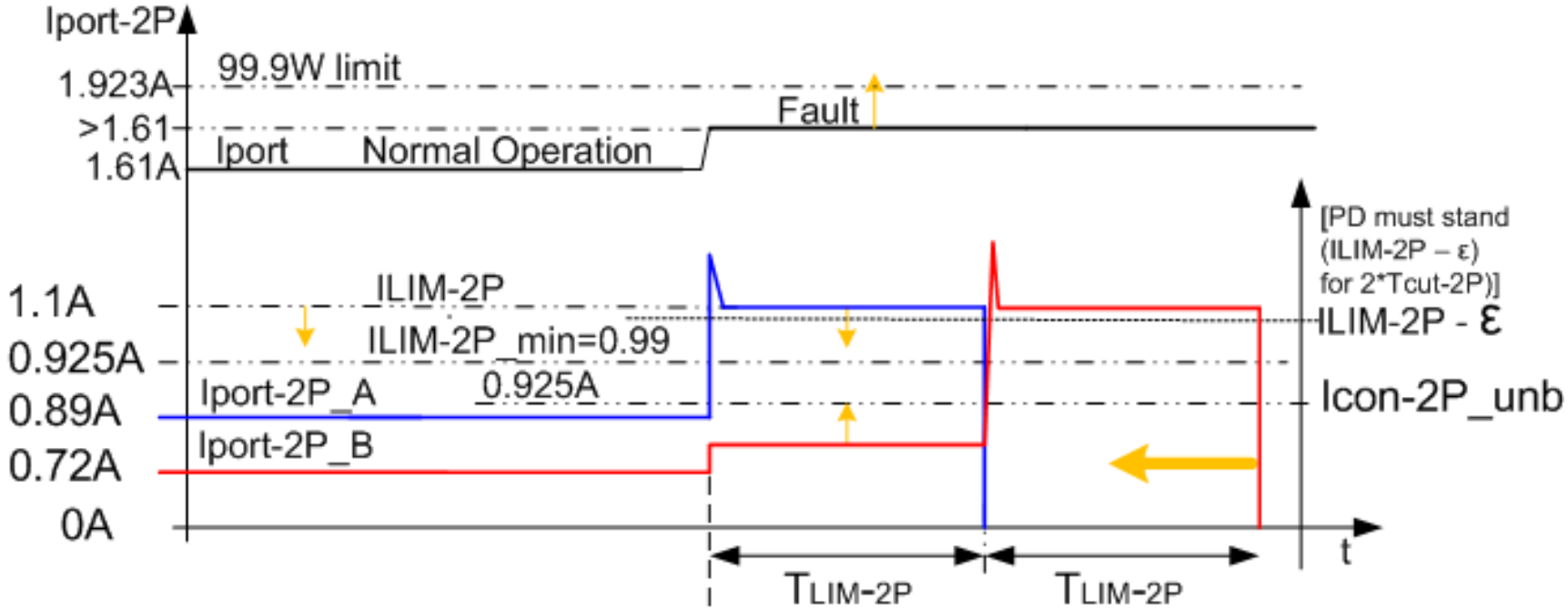




See details next slide.

Single-Signature PD Inherent 4-pairs protection

See simulation results in Annex A and B



- PD must be design to stand in both pairs (ILIM-2P-ε) for the maximum time allowed by the upperbound template in figure 33-28/29. See Annex C.
- Total T_{LIM-2P} will decrees (both pairsets will be in ILIM at the same time) when:
  - Unbalance is decreased
  - Short load current is increased so the pair with minimum current hits ILIM-2P.
  - ILIM-2P is set near to ILIM-2P_MIN and load current at short load is increased.

Protection summary

Shutting off both pairsets if only one pairset is faulty doesn't add extra protection to PDs.

- PSEs and PDs needs to be designed to meet Icon-2P_unb per pairset.
- PSEs and PDs needs to be designed to meet ($I_{LIM-2P} - \varepsilon$) per pairset.
- ($I_{LIM-2P} - \varepsilon$) per pairset can be anywhere between:

  - 1.3A to 1.75A for T_{CUT-2P_MAX}

  - ILPS to 1.3A for 4sec

  -ILIM-2P_MIN to (ILPS - ε) for ever
- As a result, PDs need to meet (1.75A - ε) for t>>T_{LIM-2P_MIN} per pairset any way. **(before current hits the current limiter threshold per pairset)**
- No need to force PSE to shut off both pairsets if there is a fault on one pairset.
  - it will happen automatically in single signature PD if fault is persists after the faulty pair is turned off.

Supporting PDs with reduce operating power mode during faults

- There are single-signature applications that under fault can work at lower power or with one of the pairsets used as backup power so they can work over 2-pairs under fault.
- A PD that is able to operate at reduces mode is still working compliant PD and are allowed in the current standard.
- The objective is to transition between 4-pairs to 2-pairs in case of fault without going through IDLE state, which saves time and keep the system up and running.
- Such a PD will consume the same current over a pairset (2P) as it did when operating over two pairsets (4P).
  - Otherwise the PSE will remove power from the remaining pairset.

Conclusions

- Remove the marked text **or** replace the "should(TBD) with "may":

"Power shall be removed from a pairset PI of a PSE before the pairset PI current exceeds the "PSE upperbound template in Figure 33-14, Figure 33-14a, and Figure 33-14b.

When connected to a single signature PD, a Type 3 or Type 4 PSE ~~should (TBD) remove power from both pairsets before the current exceeds the "PSE upperbound template" on either pairset.~~“

Due to the following reasons:

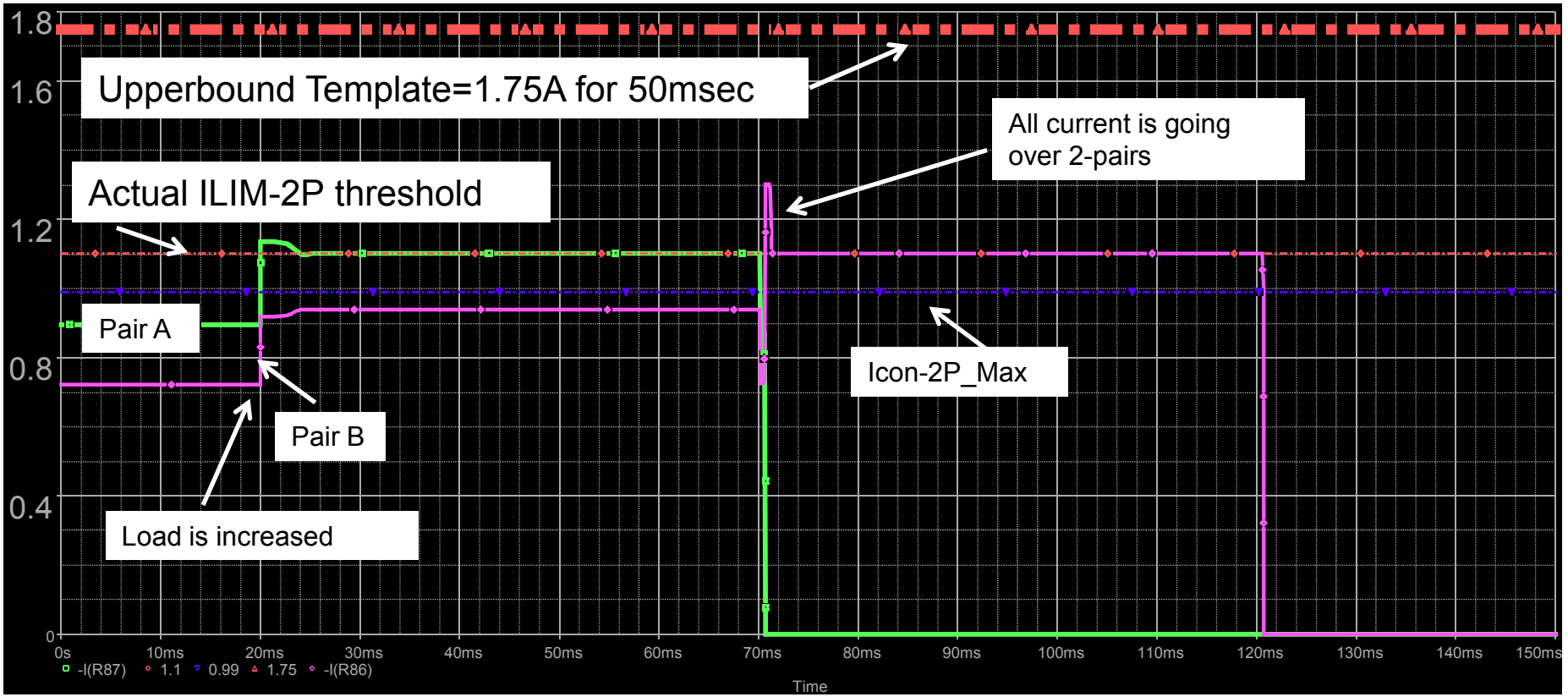
1. It is covered accurately per pairset in the previous paragraph above.
2. It does not provide additional protection for a PD. PD needs to meet worst case I_{LIM-2P} and timings anyway.
3. If we leave the text, It will preclude many PD applications for no technical reason.

We do not want to make it illegal to power down both pairsets when there is a fault on one pairset. We believe this should be optional behavior.

Thank You

Annex A- Simulation results for Type 4 system.

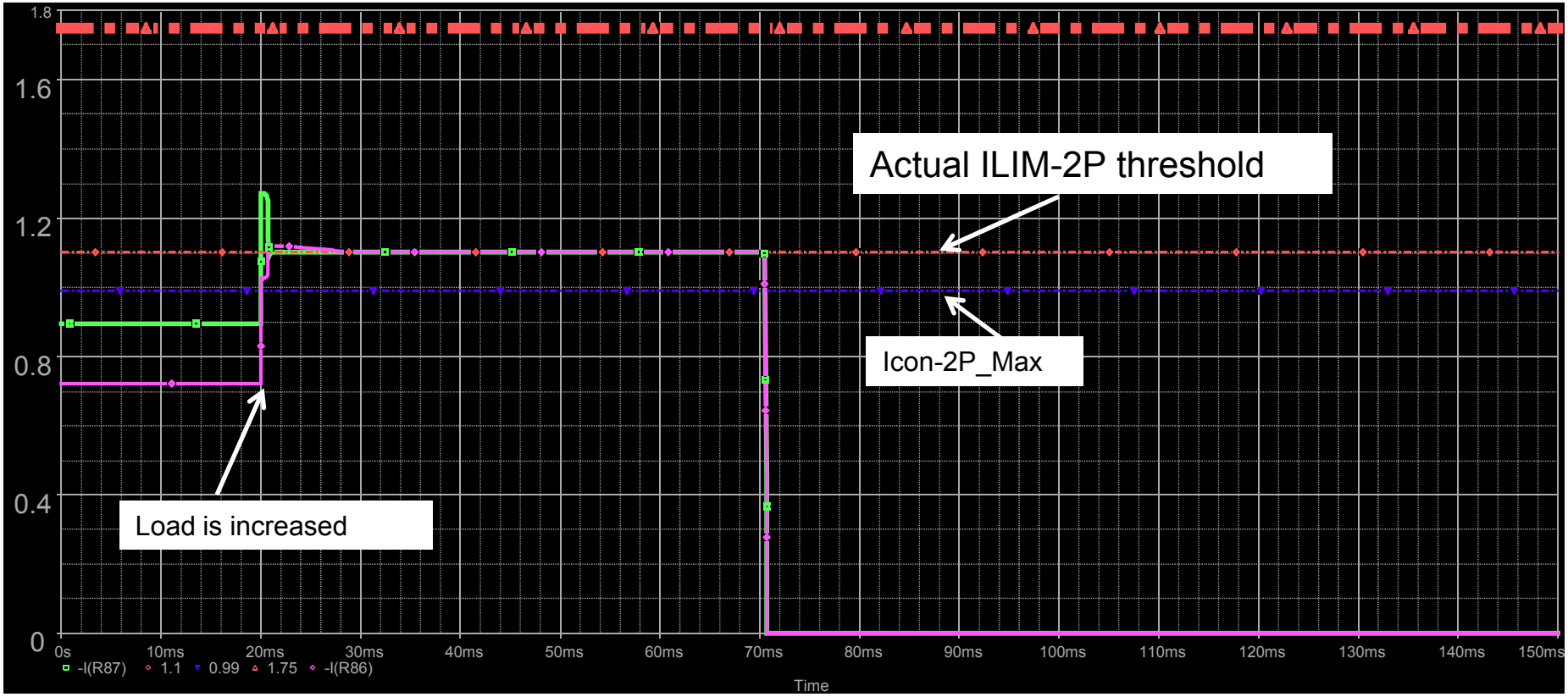
Short load condition: pair A is in current limit and Pair B is not yet...



- Per pairset current limit is set to 1.1A. **(ILIM_MIN=0.99A, ILIM_2P_MAX<1.75A for 50msec max.)**
- Icont-2P_A=0.89, Icont-2P_B=0.72. **(Icon-2P_unb_MAX=0.925A)**
- Under short load condition in which the pair with Icon-2P_max hits the current limit protection and the 2nd pair is not, we can see that after 50msec that pair is off and as a result all the current is going to the 2nd pair but its current limit is activated too and after 50msec this pair is power off too.

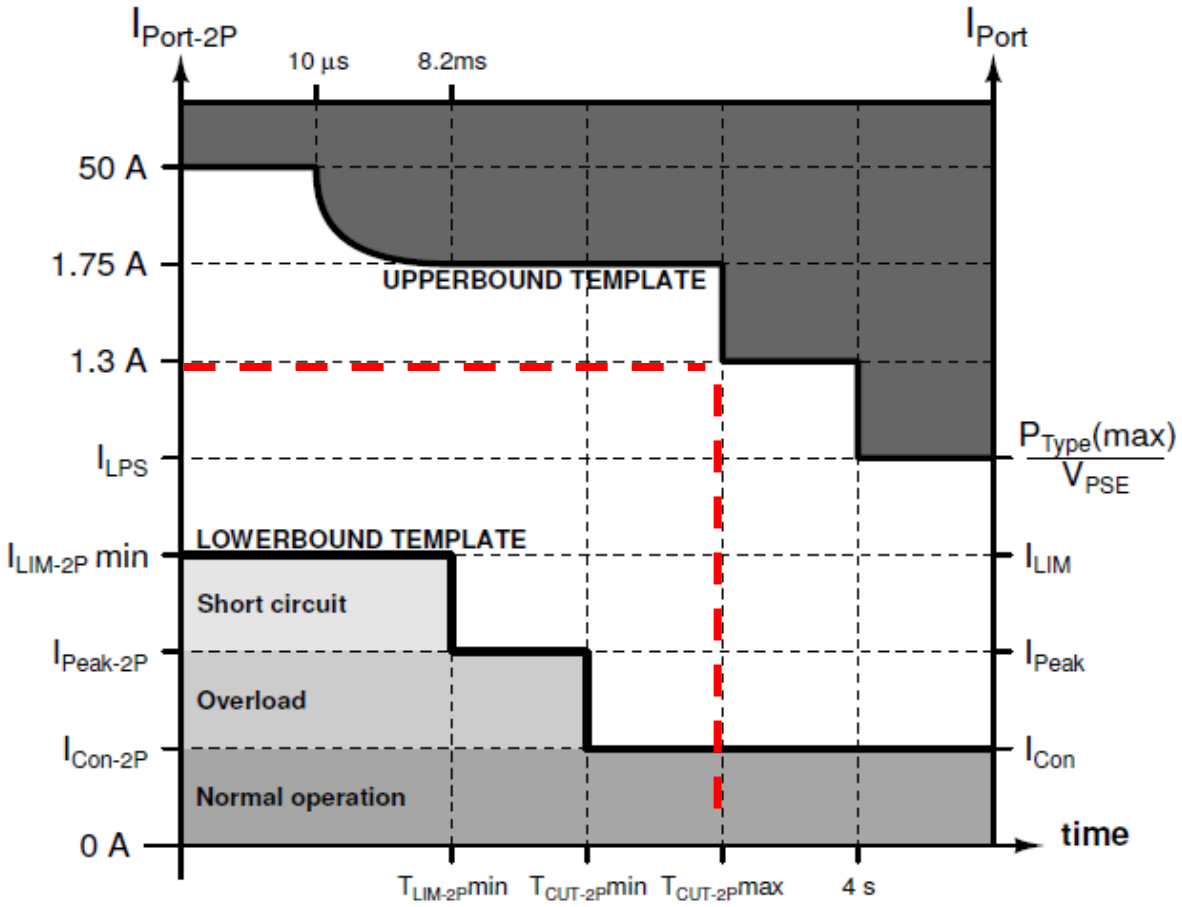
Annex B- Simulation results for Type 4 system.

Short load condition: both pair A and pair B are in current limit.



- Per pairset current limit is set to 1.1A. **(ILIM_MIN=0.99A, ILIM_2P_MAX<1.75A for 50msec max.)**
- Icont-2P_A=0.89, Icont-2P_B=0.72. **(Icon-2P_unb_MAX=0.925A)**
- Under short load condition in which BOTH pairs are in current limit, both of them automatically will power off after maximum 50msec.

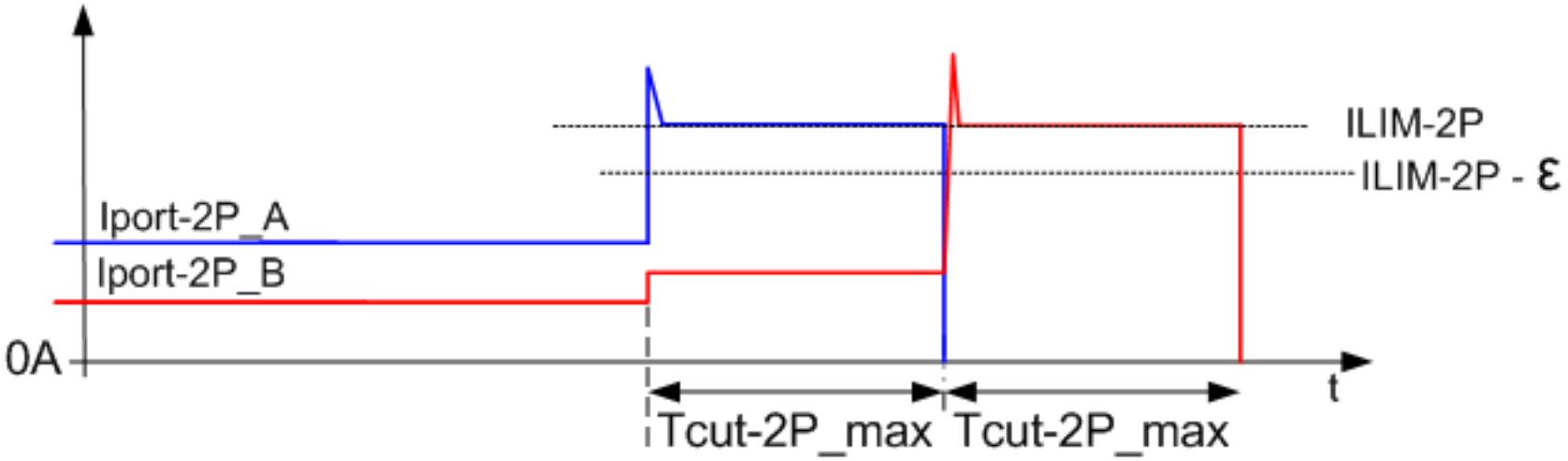
Figure 33-29- Figure 33–29—POWER_ON state, per pairset operating current template for Type 4PSEs



(ILIM-2P - ε) per pairset can be anywhere between:

- 1.3A to 1.75A for TCUT-2P_MAX
- ILPS to 1.3A for 4sec
- ILIM-2P_MIN to (ILPS - ε) for ever

What I*t must PD endure during normal operation?



PD must stand (ILIM-2P – ε) for t>>T_{LIM-2P_min}.

As a result, it must stand ~ILIM-2P for 2*TLIM-2P.

Defined behavior of PSE and PDs -1

- PSE that is connected to single-signature PD and has a short circuit on one of the pairs can do one of the following:
  - A) turn off the faulty pairset. If as a result the 2nd pairset is in short too, it will turn off the 2nd pairset.
  - B) turn of both pairsets even if there is a fault on only one pairset.
  - C) If PD equipped with the ability to work with reduced mode or power back etc. it can continue working on the good 2-pairs and the faulty one is OFF.
- All are defined behavior for the PSE and PD. It depends on PD construction if it can support reduced operating modes.

- Examples of precedencies of defined behavior or not, that we are OK with it. See next slide:

Defined behavior of PSE and PDs -2

- Examples of precedencies of defined behavior or not, that we are OK with it:
  - PD Type 2 connected to PSE Type 1:
    - May work or not, depends on PD reduced mode operation.
  - PD class N connected to PSE class N+1:
    - May work or not, depends on PD reduced mode operation.
    - Depends of PSE power available budgets
    - Depends of PSE power supply size..
    - Depend on power management algorithm – better use of available power
    - Depends if using LLDP, Autoclasis (which is optional) or just the typical mutual identification that has limited resolution in power management.
  - Extended power: The race who will use the power budget: PSE or PD?
  - Autoclass: Not all PSEs will support it. It is optional. Different behavior is expected for same PD with different PSE due to available power and power management efficiency.
  - Different PSE power management schemes. The same PD will not get the same service at each PSE.
  - And more…

What if after short circuit on one, at the same time that PD drawing less power so the 2nd pair will not go short also, and when it is operating on 2-pairs, the PD will suddenly increase power to maximum?

- The same protection mechanism will work again.
- When the 1st pairset had a short, it was disconnected.
- When the 2nd pairset got a short it was disconnected again after TBD time that it was working within the operating limits.
- All is good.

- But from fault isolation point of view how I will now at short time that I has a fault and will not have to wait until it happen?
  - When the first pairset goes off, we already know that you have a fault.
  - Regarding the whole PD: You can send command to e.g. to the lighting fixture to operate it at max power and then we will see the fault. It take couple of milliseconds.
  - There are many solutions for this question.

Does the PD after fault is still a PD?

- It depends if this PD can function after a fault with reduced operation modes or can't.

- PD after fault is still a PD if he can continue to function…ONLY a PD that after fault can't function anymore is not PD.
  - PD with reduces operating modes is still a PD
  - The fault could be in the cable over 2-pairs and not necessarily the PD