## Baseline for Figure 33-14 update to Type 3 and Type 4, v233

Some formatting is for reviewing clarity and will be removed prior to baseline submission.

**Info (not part of baseline!)**

This baseline attempts to create a complete solution for all the different cases of powering this standard will support. The scope is mostly around $P_{Class}$, $I_{Con}$, $I_{Con\text{-}2P}$ and the like. There seem to be three substantially different modes of operation:

1. **2-pair powering**
   This case includes all legacy (Type 1/Type 2) behavior.

2. **4-pair powering of:**

   – Single-signature PDs

   – Dual-signature PDs advertising the same class signature on each pairset

   With regards to behavior related to power, these two different PDs will behave the same. Both experience current unbalance in the same way. A Dual-signature PD with independent loads will behave like a perfectly balanced PD.

3. **4-pair powering of Dual-signature PDs that advertise a different class signature on each pairset** PDs that advertise a different class signature on each pairset are assumed to be constructed with independent loads. We can't use the 'rules' from case 2 here because by definition the pairsets can be significantly unbalanced (eg. 45W + 4W). For this special case the $P_{Class\text{-}2P}$ variable is introduced.

### 33.2.4.4 Variables

$I_{Port}$
: Total output current (see 33.2.7.6)

$I_{Port\text{-}2P}$
: Output current on a pairset (see 33.2.7.6)

$I_{Port\text{-}2P\text{-}other}$
: Output current on the other pairset, defined as $I_{Port\text{-}2P\text{-}other} = I_{Port} - I_{Port\text{-}2P}$

### 33.2.6 PSE classification of PDs and mutual identification

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Based on the response of the PD, the minimum power level at the output of the PSE is $P_{Class}$ as shown in Equation (33-3). ~~For Single-signature PDs,~~ $P_{Class}$ applies to the total PD power. ~~For Type 3/DS and Type 4/DS PDs, $P_{Class}$ applies to each pairset independently.~~

**Info (not part of baseline!)**

$P_{Class}$ *always* refers to the TOTAL power at the PSE PI, for all cases.

. . .

The minimum power output by the PSE for a particular PD class is defined by Equation (33-3). This equation applies to: 2-pair operation, and 4-pair operation when connected to a Single-signature PD, or connected to a Dual-signature PD that advertised the same class signature on both pairsets. Alternatively, PSE implementations may use $V_{PSE} = V_{Port\_PSE\text{-}2P}$ min and $R_{Chan} = R_{Ch}$ when powering using a single pairset, or $R_{Chan} = R_{Ch}/2$ when powering using two pairsets to arrive at over-margined values as shown in Table 33-7.

$$P_{Class} = \left\{ V_{PSE} \times \left( \frac{V_{PSE} - \sqrt{V_{PSE}^2 - 4 \times R_{Chan} \times n \times P_{Class\_PD}}}{2 \times R_{Chan}} \right) \right\}_W \qquad (33\text{-}3)$$

where

| | |
|---|---|
| $V_{PSE}$ | is the voltage at the PSE PI as defined in 1.4.423 |
| $R_{Chan}$ | is the channel DC loop resistance |
| $P_{Class\_PD}$ | is the PD's power classification (see Table 33-16a) |
| $n$ | is a dimensionless factor. $n = 1$ when connected to a Single-signature PD or for Type 1 and Type 2 PSEs, $n = 2$ when connected to a Dual-signature PD. |

**Info (not part of baseline!)**

The addition of $n$ allows Equation 33-3 to cover case 1 and 2 (2 pair + 4 pair/SS + 4 pair/DS(equal))
$n = 1$ is for PDs where $P_{Class\_PD}$ refers to the PI power (such as, Type 1+2 and Single-signature PDs
$n = 2$ is for Dual-signature PDs, where $P_{Class\_PD}$ refers to the pairset power

The minimum output power on a pairset for Type 3 and Type 4 PSEs that apply 4-pair power to a Dual-signature PD which requests a different class signature on each pairset is defined by Equation 33-3a.

$$P_{\text{Class-2P}} = \left\{ V_{\text{PSE}} \times \left( \frac{V_{\text{PSE}} - \sqrt{V_{\text{PSE}}^2 - 4 \times R_{\text{Chan}} \times P_{\text{Class\_PD}}}}{2 \times R_{\text{Chan}}} \right) \right\}_W \qquad (33\text{-}3a)$$

**Info (not part of baseline!)**

$P_{\text{Class-2P}}$ is used exclusively for the case of a DS PD that advertises a different class signature on each pairset. Such a PD will be treated (with regards to power management) as two completely independent entities.

### 33.2.7.4 Continuous output current capability in the POWER_ON state

**Info (not part of baseline!)**

The approach taken here is to have a number of parameters which are defined in the same way for the 3 cases:

$P_{\text{Class}}$ is the total PSE PI output power.

$I_{\text{Con}}$ is the total PSE PI output current.

$$I_{\text{Con}} = P_{\text{Class}}/V_{\text{PSE}} \qquad (1)$$

We handle the different cases (1, 2 and 3) by defining a different $I_{\text{Con-2P}}$ for each of them. See baseline below.

~~PSEs connected to a Single-signature PD shall meet $I_{\text{Con}}$ and $I_{\text{Con-2P\_unb}}$ as specified in Table 33-11. PSEs connected to a Dual-signature PD shall meet $I_{\text{con-TBD}}$ on each pairset as specified in Table 33-11.~~

PSEs that operate in 2-pair mode shall be able to source $I_{\text{Con-2P}}$ as specified in Equation TBD1. $I_{\text{Con-2P}}$ is the current the PSE supports on the powered pairset.

$$I_{\text{Con-2P}} = \frac{P_{\text{Class}}}{V_{\text{PSE}}} \qquad (\text{TBD1})$$

Type 3 and Type 4 PSEs operating in 4-pair mode, connected to a Single-signature PD, or connected to a Dual-signature PD that advertised the same class signature on each pairset shall be able to source $I_{\text{Con}}$, $I_{\text{Con-2P}}$, and $I_{\text{Con-2P\_unb}}$ as specified in Table 33-11 and Equation TBD2. $I_{\text{Con-2P}}$ is the current the PSE supports on each pairset and is defined by Equation TBD2. A PSE is not required to support $I_{\text{Con-2P}}$ values greater than $I_{\text{Con-2P\_unb}}$. $I_{\text{Con}}$ is the total current of both pairs with the same polarity that a PSE supports. $I_{\text{Con-2P\_unb}}$ is the maximum current the PSE supports over one of the pairs of same polarity under maximum unbalance condition (see 33.2.7.4.1) in the POWER_ON state.

$$I_{\text{Con-2P}} = \min\left(I_{\text{Con}} - I_{\text{Port-2P-other}},\ I_{\text{Con-2P\_unb}}\right) \qquad (\text{TBD2})$$

Type 3 and Type 4 PSEs operating in 4-pair mode, connected to a Dual-signature PD that advertised a different class signature on each pairset, shall be able to source $I_{\text{Con-2P}}$ on each pairset as specified in Equation TBD1. Note that for these PDs $I_{\text{Con-2P}}$ is calculated using Equation TBD3 for each pairset independently.

$$I_{\text{Con-2P}} = \frac{P_{\text{Class-2P}}}{V_{\text{PSE}}} \qquad (\text{TBD3})$$

~~When connected to Single-signature PDs, $I_{\text{Con}}$ is the total current of both pairs with the same polarity that a PSE must be able to source. $I_{\text{Con-2P\_unb}}$ is the maximum current the PSE must be able to source over one of the pairs of same polarity at maximum current unbalance condition in the POWER_ON state.~~

~~When connected to a Dual-signature PD, $I_{\text{con-TBD}}$ is the minimum current of a pairset that a PSE has to support.~~

In addition to $I_{\text{Con}}$, $I_{\text{Con-2P}}$ and $I_{\text{Con-2P\_unb}}$ as specified in Table 33-11, the PSE shall support the following AC current waveform parameters, while within the operating voltage range of $V_{\text{Port\_PSE-2P}}$:
...

### 33.2.7.7 Output current at short circuit condition

***Replace Figure 33-14, Equation 33-6 and Equation 33-7 by:***

- Equation 33-6, Equation 33-7 and Figure 33-14 apply to Type 1 and Type 2 PSEs.
- Equation 33-6a, Equation 33-7a and Figure 33-14a apply to Type 3 and Type 4 PSEs that operate in 2-pair mode, as well as to Type 3 and Type 4 PSEs operating in 4-pair mode, connected to a Dual-signature PD that advertised a different class signature on each pairset.

– Equation 33-6b, Equation 33-7b and Figure 33-14b apply to Type 3 PSEs operating in 4-pair mode, connected to a Single-signature PD, or connected to a Dual-signature PD that advertised the same class signature on each pairset.

– Equation 33-6c, Equation 33-7c and Figure 33-14c apply to Type 4 PSEs operating in 4-pair mode, connected to a Single-signature PD, or connected to a Dual-signature PD that advertised the same class signature on each pairset.

Figure 33-14—Type 1 or Type 2 PSE POWER_ON state PI operating current templates

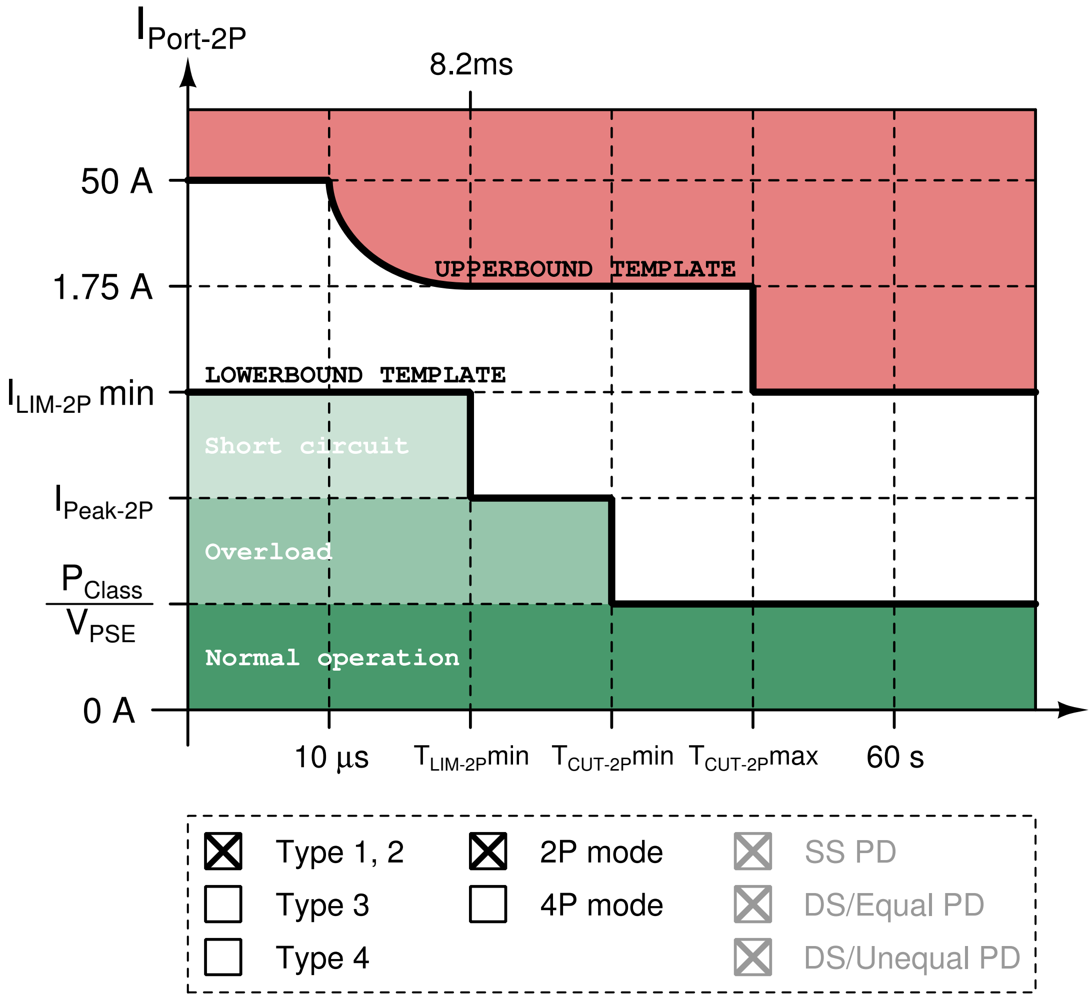
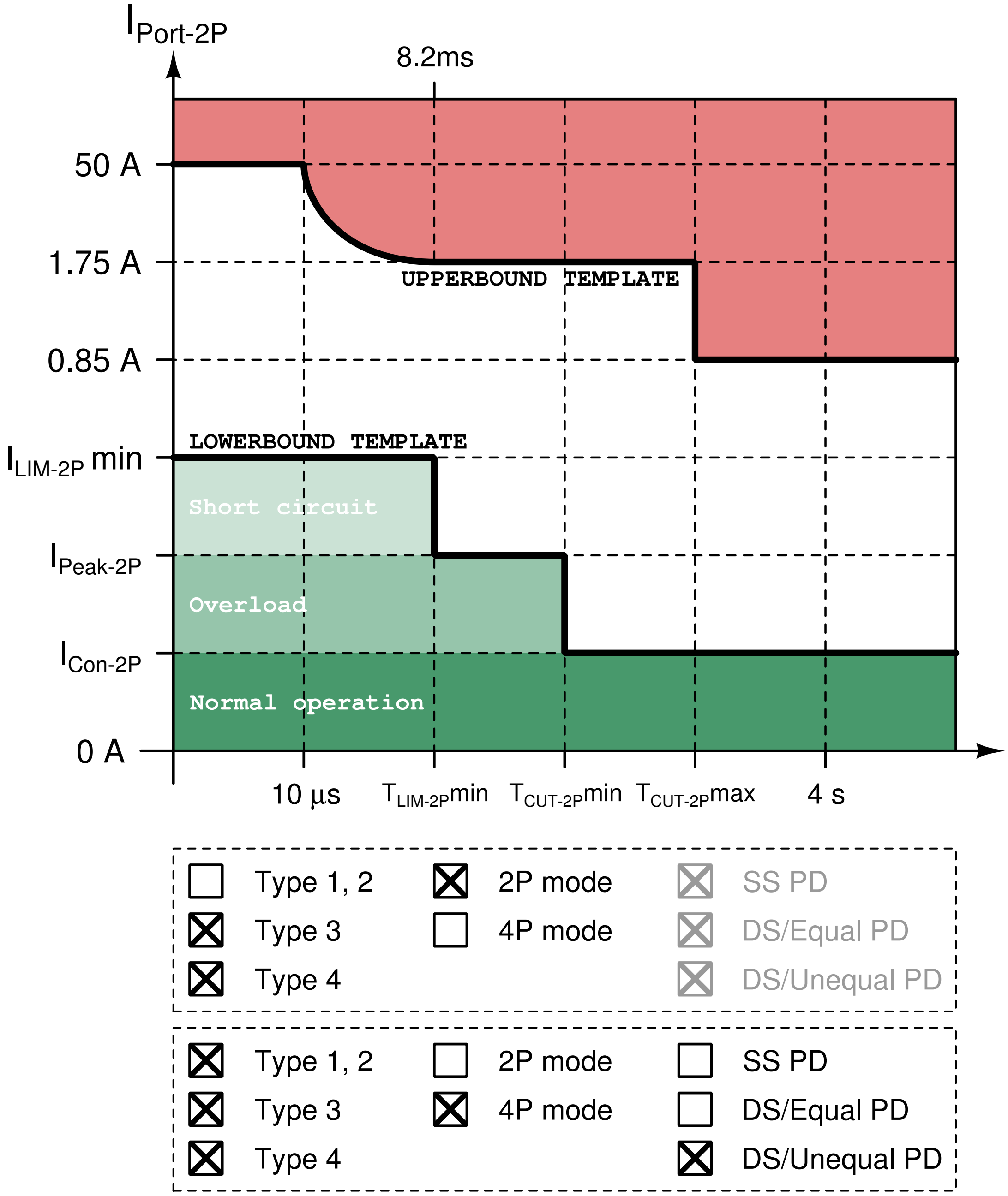


Figure 33-14a—Type 3 or Type 4 PSE POWER_ON state PI operating current templates when connected to a Dual-signature PD with different class code on each pairset




**Info (not part of baseline!)**

The fixed current limit of 0.85A in the upperbound template is introduced to allow a PSE to set an $I_{CUT}$ limit that is Type-fixed and does not need to change with Class. We are limited by LPS (Limited Power Source, IEC60950) requirements (source $\leq$ 100W) therefore the maximum continuous current per pairset allowed is:

$$\frac{100W}{57V}/2 = 877mA$$

By choosing 0.85A the maximum allowed sustained power for Type 3 is $0.85A \times 2 \times 57V = 96.9W$.

Figure 33-14b—Type 3 PSE POWER_ON state PI operating current templates

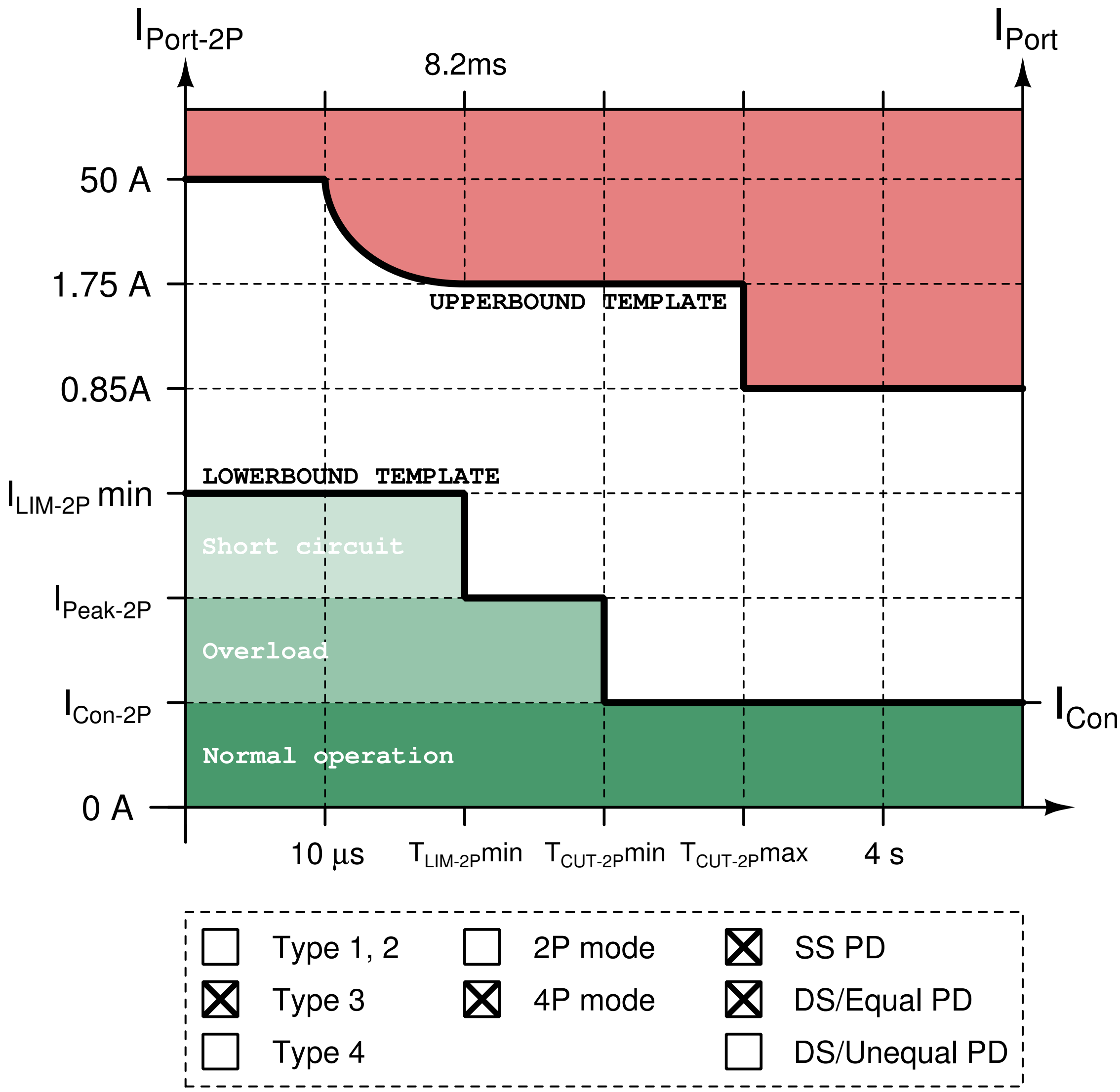
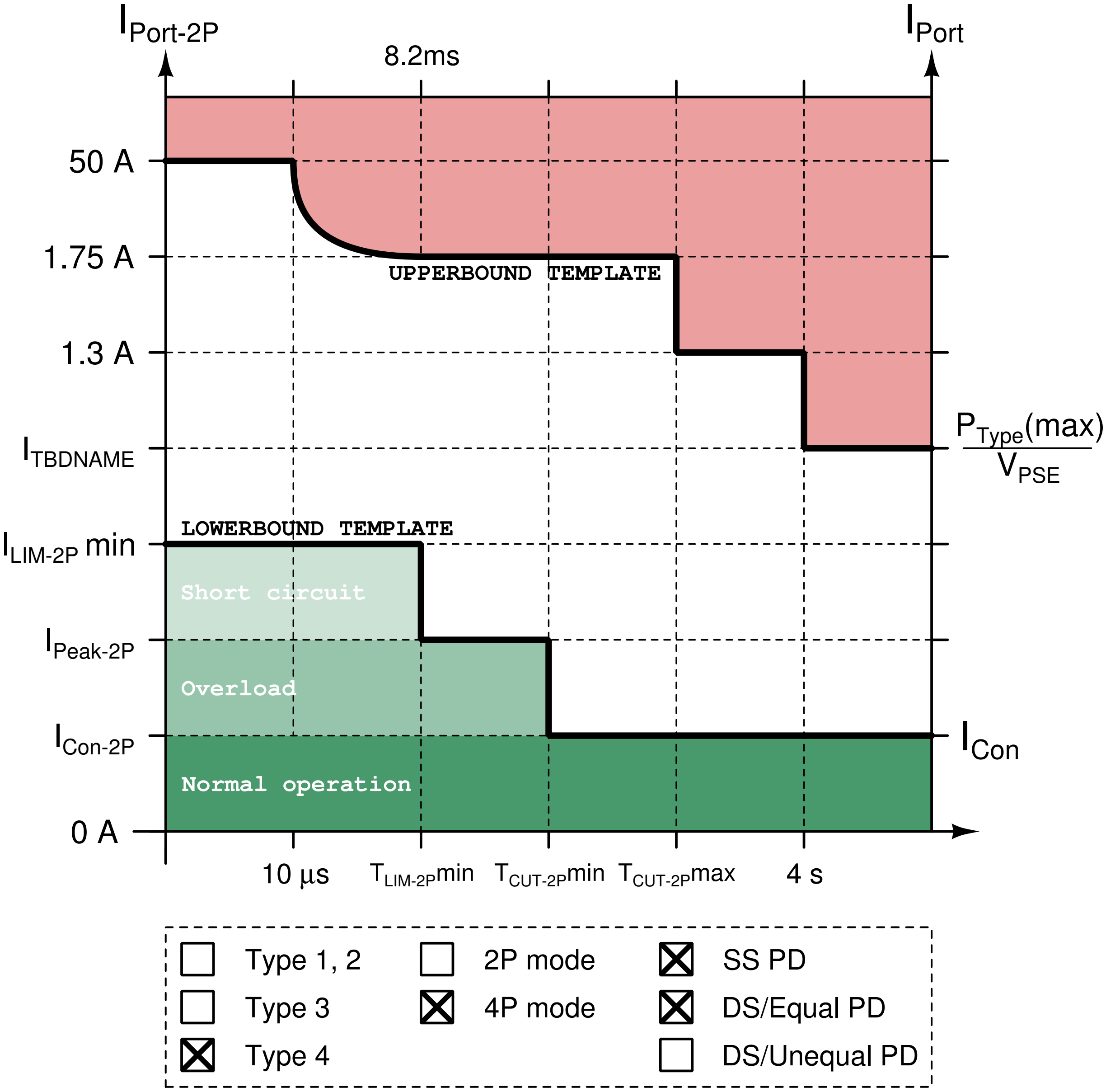


Figure 33-14c—Type 4 PSE POWER_ON state PI operating current templates



$$I_{\text{PSEUT-2P}}(t) = \left\{ \begin{array}{ll} 50 & \text{for } (0 \le t < 10.0 \times 10^{-6}) \\ \sqrt{\frac{K}{t}} & \text{for } (10.0 \times 10^{-6} \le t < 8.20 \times 10^{-3}) \\ 1.75 & \text{for } (8.20 \times 10^{-3} \le t < T_{\text{CUT-2P}} \max) \\ I_{\text{LIM-2P}} \min & \text{for } (T_{\text{CUT-2P}} \max \le t) \end{array} \right\}_A \quad (33\text{-}6)$$

$$I_{\text{PSEUT-2P}}(t) = \left\{ \begin{array}{ll} 50 & \text{for } (0 \le t < 10.0 \times 10^{-6}) \\ \sqrt{\frac{K}{t}} & \text{for } (10.0 \times 10^{-6} \le t < 8.20 \times 10^{-3}) \\ 1.75 & \text{for } (8.20 \times 10^{-3} \le t < T_{\text{CUT-2P}} \max) \\ 0.85 & \text{for } (T_{\text{CUT-2P}} \max \le t) \end{array} \right\}_A \quad (33\text{-}6a)$$

$$I_{\text{PSEUT-2P}}(t) = \left\{ \begin{array}{ll} 50 & \text{for } (0 \le t < 10.0 \times 10^{-6}) \\ \sqrt{\frac{K}{t}} & \text{for } (10.0 \times 10^{-6} \le t < 8.20 \times 10^{-3}) \\ 1.75 & \text{for } (8.20 \times 10^{-3} \le t < T_{\text{CUT-2P}} \max) \\ 0.85 & \text{for } (T_{\text{CUT-2P}} \max \le t) \end{array} \right\}_A \quad (33\text{-}6b)$$

$$I_{\text{PSEUT-2P}}(t) = \left\{ \begin{array}{ll} 50 & \text{for } (0 \le t < 10.0 \times 10^{-6}) \\ \sqrt{\frac{K}{t}} & \text{for } (10.0 \times 10^{-6} \le t < 8.20 \times 10^{-3}) \\ 1.75 & \text{for } (8.20 \times 10^{-3} \le t < T_{\text{CUT-2P}} \max) \\ I_{\text{TBDNAME}} & \text{for } (T_{\text{CUT-2P}} \max \le t) \end{array} \right\}_A \quad (33\text{-}6c)$$

where

| | |
|---|---|
| $t$ | is the duration in seconds that the PSE sources $I_{\text{Port-2P}}$ |
| K | is 0.025 $A^2$s, an energy limitation constant for the pairset current when it is not in steady state normal operation |
| $T_{\text{CUT-2P}}$ max | is $T_{\text{CUT-2P}}$ max per pairset, as defined in Table 33-11 |
| $I_{\text{LIM-2P}}$ min | is $I_{\text{LIM-2P}}$ min per pairset, as defined in Table 33-11 |
| $P_{\text{Type}}$ max | is the maximum power output for a given Type, as defined in Table 33-11 |
| $V_{\text{PSE}}$ | is the voltage at the PI of the PSE |
| $I_{\text{TBDNAME}}$ | is the maximum current at the PI of the PSE as defined in section 33.2.7.11a |

$$I_{\text{PSELT-2P}}(t) = \left\{ \begin{array}{ll} I_{\text{LIM-2P}} \min & \text{for } (0 \le t < T_{\text{LIM-2P}} \min) \\ I_{\text{Peak-2P}} & \text{for } (T_{\text{LIM-2P}} \min \le t < T_{\text{CUT-2P}} \min) \\ \frac{P_{\text{Class}}}{V_{\text{PSE}}} & \text{for } (T_{\text{CUT-2P}} \min \le t) \end{array} \right\}_A \quad (33\text{-}7)$$

$$I_{\text{PSELT-2P}}(t) = \left\{ \begin{array}{ll} I_{\text{LIM-2P}} \min & \text{for } (0 \le t < T_{\text{LIM-2P}} \min) \\ I_{\text{Peak-2P}} & \text{for } (T_{\text{LIM-2P}} \min \le t < T_{\text{CUT-2P}} \min) \\ I_{\text{Con-2P}} & \text{for } (T_{\text{CUT-2P}} \min \le t) \end{array} \right\}_A \quad (33\text{-}7a)$$

$$I_{\text{PSELT-2P}}(t) = \left\{ \begin{array}{ll} I_{\text{LIM-2P}} \min & \text{for } (0 \le t < T_{\text{LIM-2P}} \min) \\ I_{\text{Peak-2P}} & \text{for } (T_{\text{LIM-2P}} \min \le t < T_{\text{CUT-2P}} \min) \\ I_{\text{Con-2P}} & \text{for } (T_{\text{CUT-2P}} \min \le t) \end{array} \right\}_A \quad (33\text{-}7b)$$

$$I_{\text{PSELT-2P}}(t) = \left\{ \begin{array}{ll} I_{\text{LIM-2P}} \min & \text{for } (0 \le t < T_{\text{LIM-2P}} \min) \\ I_{\text{Peak-2P}} & \text{for } (T_{\text{LIM-2P}} \min \le t < T_{\text{CUT-2P}} \min) \\ I_{\text{Con-2P}} & \text{for } (T_{\text{CUT-2P}} \min \le t) \end{array} \right\}_A \quad (33\text{-}7c)$$

where

| | |
|---|---|
| $t$ | is the duration in seconds that the PSE sources $I_{\text{Port-2P}}$ |
| $I_{\text{LIM-2P}}$ min | is $I_{\text{LIM-2P}}$ min per pairset, as defined in Table 33-11 |
| $T_{\text{CUT-2P}}$ min | is $T_{\text{CUT-2P}}$ min per pairset, as defined in Table 33-11 |
| $I_{\text{Peak-2P}}$ | is $I_{\text{Peak-2P}}$ per pairset, as defined in Table 33-11 |
| $P_{\text{Class}}$ | is $P_{\text{Class}}$, as defined in Table 33-7 |
| $V_{\text{PSE}}$ | is the voltage at the PSE PI |
| $I_{\text{Con-2P}}$ | is the minimum supported continuous current on a pairset as defined in 33.2.7.4 |

## 33.2.7.10 Continuous output power capability in POWER_ON state

$P_{\text{Class}}$ is the class power defined in 33.2.6 and Equation (33-3), or PSE allocated power (as defined in 79.3.2.6) added to the channel power loss for both pairsets combined.

$P_{\text{Class-2P}}$ is the class power defined in 33.2.6 and Equation (33-3), or PSE allocated power (as defined in 79.3.2.6) added to the channel power loss for a pairset. This parameter only applies to Type 3 and Type 4 PSEs operating both pairsets and connected to a Dual-signature PD that advertised a different class signature on each pairset.

## 33.2.7.11a Type power

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Type 4 PSEs shall not source more power than $P_{\text{Type}}$ max as specified in Table 33-11 calculated with any sliding window with a width up to 4 seconds.

This equates to a maximum $I_{\text{Port-2P}}$ current defined in Equation 33-7c

$$I_{\text{TBDNAME}} = \min\left(\frac{P_{\text{Type}}\ \text{max}}{V_{\text{PSE}}} - I_{\text{Port-2P-other}},\ 1.3\right) \tag{33-7c}$$