Power Matters

Microsemi

Type 3/4 PSEs Inrush_max value with Type 1/2 PDs

IEEE802.3bt

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Objectives

- To show that Type 1 PD when connected to Type 3 or 4 PSE can handle and must handle Type 3 and 4 Iinrush max due to other systems requirements beyond Iinrush.
- Moreover: a PD that can't do the above, violates the following standards:
  - IEEE requirements
  - UL requirements
  - Practical considerations in system level.
- To show that if we keep 0.4A to 0.45A per pair set, we are good with all PSE-PD Types combinations.

Summary - The facts

- All PDs (that I know of..) has internal Iinrush control in the range of 150mA to 350mA that limits the current during startup regardless of the PSE Iinrush capability.
- Therefore PD can handle any PSE Iinrush beyond 0.45A.
- Those PDs that can not handle transient current up of 2.5A or higher per 33.3.7.6 are not compliant.
- PDs that can not handle current levels below the upperbound of figure 33-14 (<50A, 1.75A, Ppeak, Pclass as function of the different timings) are not compliant to the standard.
- PDs that are not protected when connected to any power source are violating UL requirements.
- Therefore PSE Iinrush of 0.9A is negligible issue compared to the above use cases needed to be addressed.
- System vendors do not want to be liable for poorly designed PD or non compliant PDs
- Therefore, Type 3 and 4 PSEs supplying 0.4A-0.45A to Type 1/2 PDs could be a feature but can not be mandatory. PD need to be designed to handle higher than 0.9A anyway.

Proposed Changes for D.12

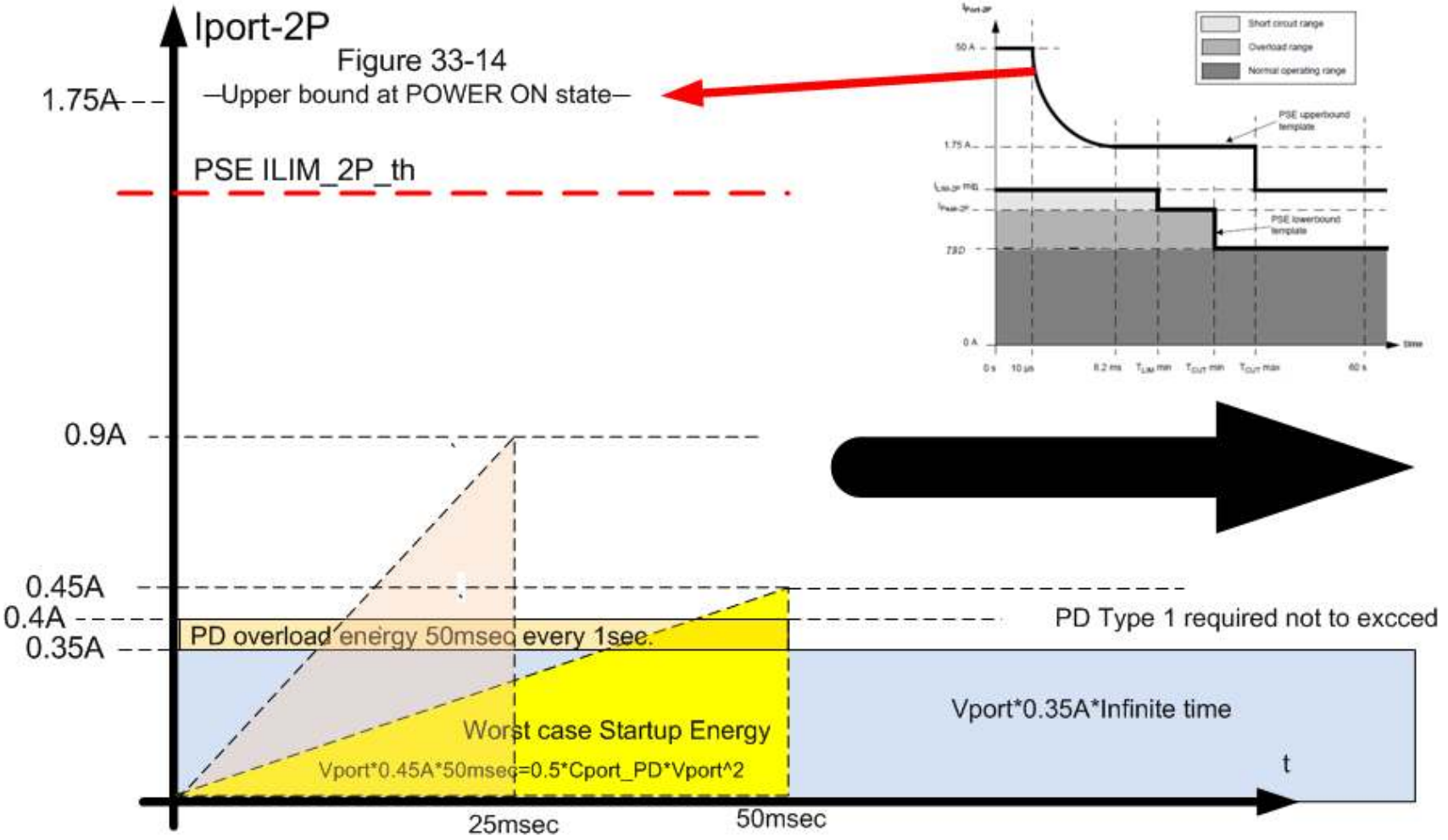
#	Parameter	Symbol	Units	Min	Max	PSE Type	Additional Information
5	Output current in POWER_UP state	Iinrush	A	0.4	See Info	1,2,3,4	~~For Type 1 and Type 2 PDs.~~ See 33.2.7.5. Max value defined by Figure 33-13.

Backup slides

- Originally presented in July 2015

Type 3/4 PSE connected to Type 1/2 PD

- If we keep Type 3 and 4 PSEs with 0.4A to 0.45A Iinrush per pair set, we have no issues when Type 1 / 2 PDs are connected to Type 3 and 4 PSEs.



Background

- PD Type 1 or 2 works with PSE Type 1/2 with Inrush=0.4A to 0.45A.
- When Type 3 or 4 PSE is connected to Type 1 and 2 PDs with Iinrush capability of 0.4 to 0.45A per pairset (Total 0.8A to 0.9A if both pair sets are ON together):
  - The stress on the components up to the diode bridges outputs stays the same.
  - The capacitor will see twice the charging current for half of the time which is the same energy.
  - Series resistance such EMI filters dumping elements and hot swap MOSFET needs to meet: t*R*Icont^2 >> 25ms*R*0.9^2)/3.
  - In addition all the components above need to meet much higher current transients etc. due to internal and external effects (UL, IEEE etc.).
- What if during operation a **pair set** is disconnected?
  - Nothing happen. It is similar to Type 1/2 system. Same currents.
- What if during operation only a pair is disconnected?
  - One diode bridge and one transformer will see 0.9A for maximum 25msec.
  - Same energy stress for shorter time. No issues.
    - Moreover : In POWER ON the currents are higher for longer time (until system shuts off) which is worsen than the previous case ➔ No issues.

What a PD need to do for its own protection?

- **IEEE (**Need to be guaranteed by PD at all times)**:**
- Type 1: Not to consume more than 0.4A for more than 50msec.
- Type 2: Not to consume more than ~0.6A*1.14 for more than 50msec
- All types: to meet PSE dv/dt that will generate Ipeak=2.5A and will be limited by PSE ILIM.

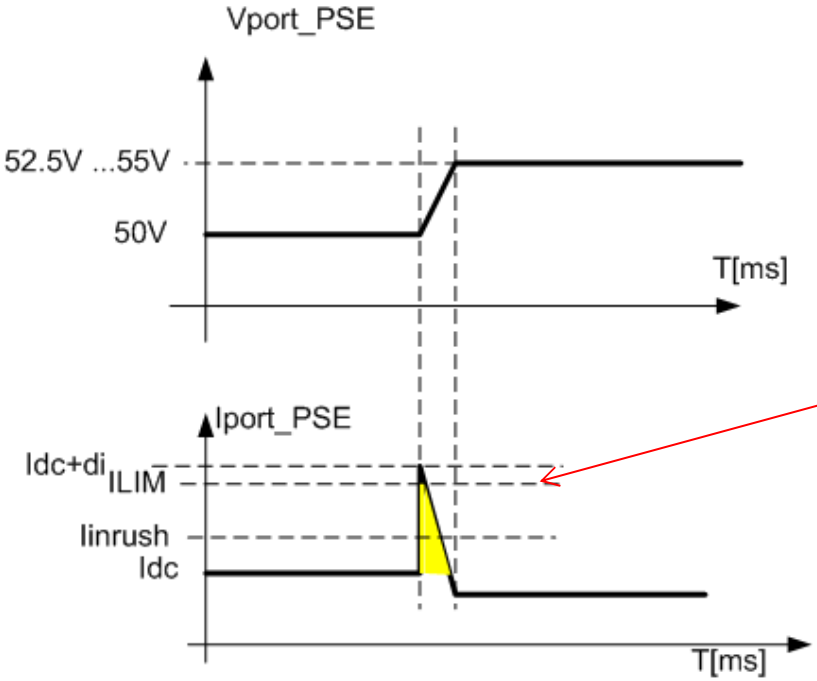
- **UL:** Not to to cause fire hazard or damage to infrastructure if it has internal short circuit when connected to any power source with any current capability.
  - Consider possible scenario:
  - PD is connected to a PSE multiport system with 1KW main power supply. One of the PSE port controller is permanently ON due to a fault in PSE. Now PD sees 1KW power source
  - PD is tested in the LAB with lab power supply that is not PoE current limited or LPS limited.
    - All of the above considered single fault condition in the tested device.

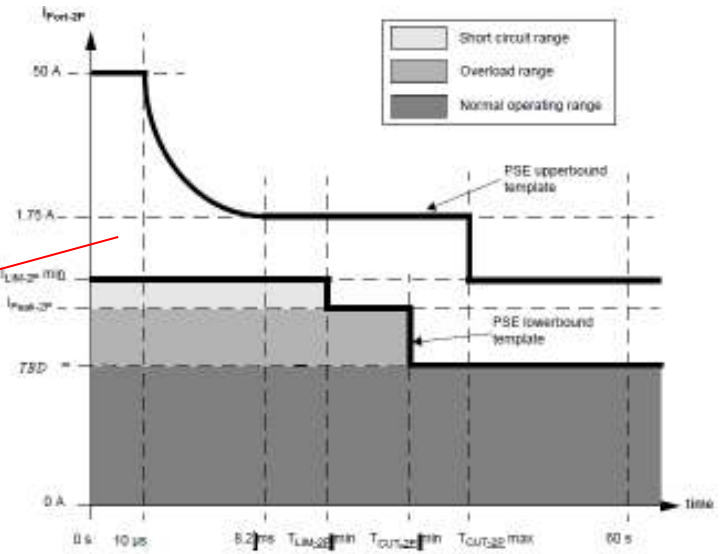
Typical use cases were Iport>Iinrush

- 33.2.7.7:
- The PSE shall limit the a pair set current to ILIM-2P for a duration of up to TLIM-2P in order to account for PSE dV/dt transients at the PI pair set

Ipeak=Idc+180uF*5V/0.5msec=(Idc+1.8A) > Iinrush=0.9A max

Actual Ipeak is limited by ILIM which can be anything up to upper bound template.





33.3.7.6 PD behavior during transients at the PSE PI

A Type 1 PD input current shall not exceed the PD upperbound template (see Figure 33–18) after TLIM min (see Table 33–11 for a Type 1 PSE) when the following input voltage is applied. A current limited voltage source is applied to the PI through a RCh resistance (see Table 33–1). The current limit meets Equation (33–14) and the voltage ramps from VPort_PSE min to VPort_PSE max at 2250 V/s.

A Type 2 PD shall meet both of the following: a) The PD input current spike shall not exceed 2.5 A and shall settle below the PD upperbound template (see Figure 33–18) within 4 ms. During this test, the PD PI voltage is driven from 50 V to 52.5 V at greater than 3.5 V/µs, a source impedance of 1.5Ω, and a source that supports a current greater than 2.5 A.

Conclusions

- PDs has to be internally designed to withstand any I>Iinrush when connected to PoE under normal and abnormal operating states.
- In particular, PD has to be designed to withstand PSE ILIM current levels unless PD activate protection earlier at lower current. ILIM>Iinrush.
  - ILIM can be higher than 1.75A > Iinrush
    - As a result if PD is exposed to higher level of Iinrush it shouldn't affect the PD reliability nor performance.
- It is required by UL not to cause damage and safety hazard when PD is connected to any power source.
- During PSE system voltage source exchange from 50V to 55V etc. PD may experience I>Iinrush limited only by ILIM.
- As a result, Type 3 and 4 PSEs with 0.8A to 0.9A per pair set can be connected to Type 1 and 2 PDs without additional requirements for PSE or PD.

Summary

- We have good IEEE standard.
- No need to impose NEW requirements on PSEs because PD may not meet the current IEEE specs and other standards.
- Type 3 and 4 PSEs can be connected to Type 1 and 2 PDs with Inrush 0.4A to 0.45A per pairset.
  - PD has to stand much higher currents anyway.
- In General, PSE with Type 4 is not required to set its Iinrush, ILIM per PD type.
- It can be a feature and not a requirement.

THANK YOU

Annex A: System model during POWERUP