IEEE802.3at Task Force

IEEE802.3at Short Circuit Protection

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Objectives

- To defined the requirements of the “short circuit” function parameters ILIM, TLIM when detected during port normal operation.
- To find a solution that will answer maintenance requests 1162, 1167 and 1168 as well
- To integrate Vport ad hoc findings to the proposed solution

General

- In power supply world, there are 3 main operating conditions:
- Startup: Iinrush, Tinrush until steady state. (IEEE802.3af: Iinrush=0.4-0.45A, Tinrush=50-75ms)
- Normal operation: Vport, Iport. (IEEE802.3af: Iport<=0.35A, Vport=44-57V)
- Overload: Icut, Tcut. Vport is still in normal operating range.

(IEEE802.3af: Icut=0.35-0.4A, Tcut=50-75ms, 5% duty cycle Vport=44-57V)

- Short Circuit: Any load that cause Vport to be below minimum operating voltage (44V in 802.3af). (IEEE802.3af: ILIM=0.4-0.45A,TLIM=50-75ms while Vpse >30V.)
- This presentation will be focusing on Short Circuit condition.

Rational for “Short Circuit” protection by limiting the current to a maximum value

- Protect the cabling infrastructure
- Protect PSE port controller
- Limit peak transient currents to control EMI and its effect on data integrity
- Protect PCB traces of legacy equipment at the infrastructure
- Protect PSE Power Supply operation in a multi-port system
- Allow reasonable and cost effective support for “port to port cross regulation” effects.

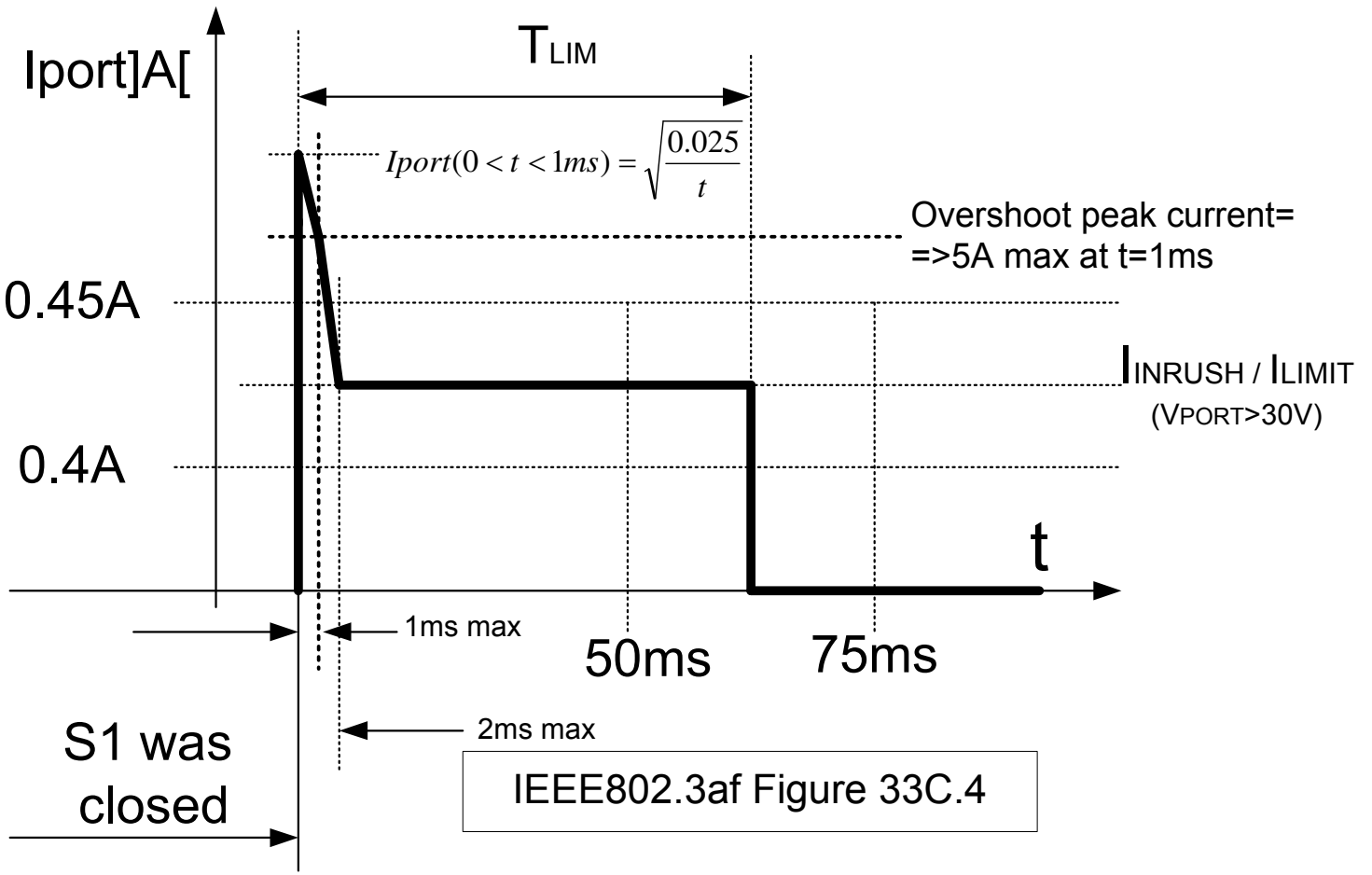
See:

http://www.ieee802.org/3/af/public/jul01/darshan_2_0701.pdf

http://www.ieee802.org/3/af/public/documents/proposal_for_Startup_line_load_cross.pdf

http://www.ieee802.org/3/af/public/documents/Port_to_Port_Cross_Reg.pdf

Rational behind IEEE802.3af ILIM, TLIM numbers



IEEE802.3af Figure 33C.4

Why TLIM value is as above?

Why ILIM value is as above?

Why all the above is relevant for Vport>30V (or other value? To be discussed)

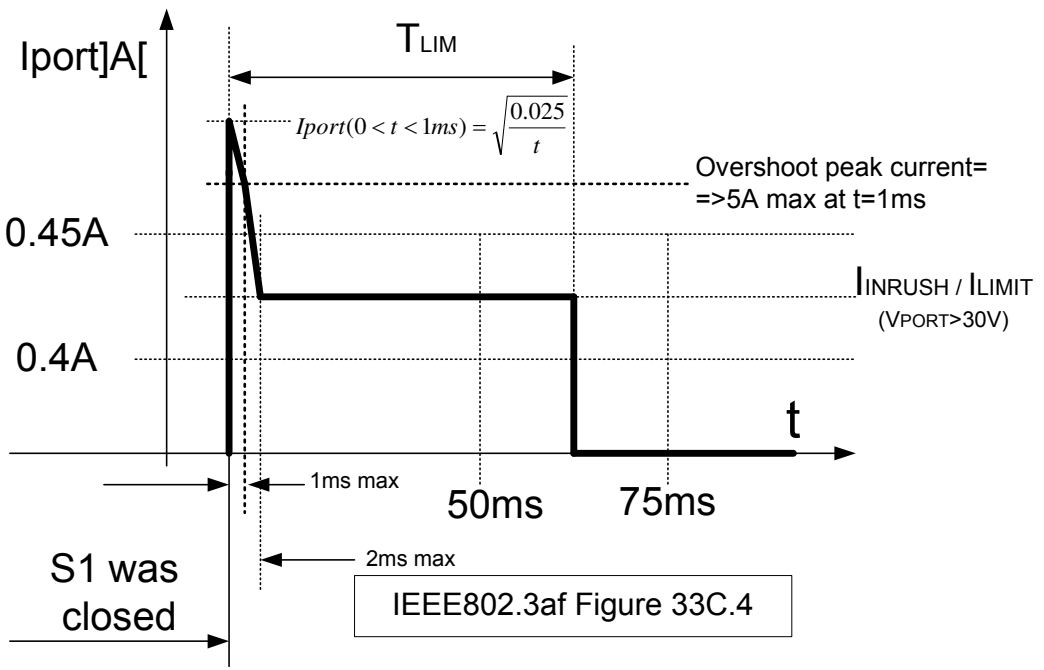
Rational behind IEEE802.3af ILIM, TLIM numbers

- TLIM in 802.3af:
- TLIM_min should be > any current transient duration
- TLIM should be short enough not to increase power supply cost
- Since we have already Tcut=50-75ms lets use the same values for TLIM to simplify the standard.
- Tlim_min=50ms is >> any current transients
- So every thing is OK…

- IEEE802.3at Vport ad hoc suggest shorter Tlim_min due to the fact that there is no technical justification for 50ms minimum. Margin is too big.
- See Vport ad hoc report that suggest around 5ms as Tlim_min.
- Work done in 802.3af shows that current transients duration due too load transients or power supply change from 44V to 57V takes much less then 50ms. See http://www.ieee802.org/3/af/public/jul01/darshan_2_0701.pdf
- So shortening Tlim is technically possible and justified.

Rational behind IEEE802.3af ILIM, TLIM numbers

- ILIM in 802.3af
- Should be ~15% above Icut to allow low cost current detection resolution
- Peak current at the 1st few ms should be higher then afterwards to allow low cost limited bandwidth current source/limiter.
- Peak current at the 1st few ms should be limited by fusing equation not to damage PCB traces, to control EMI transients, to protect RJ45 contacts etc.



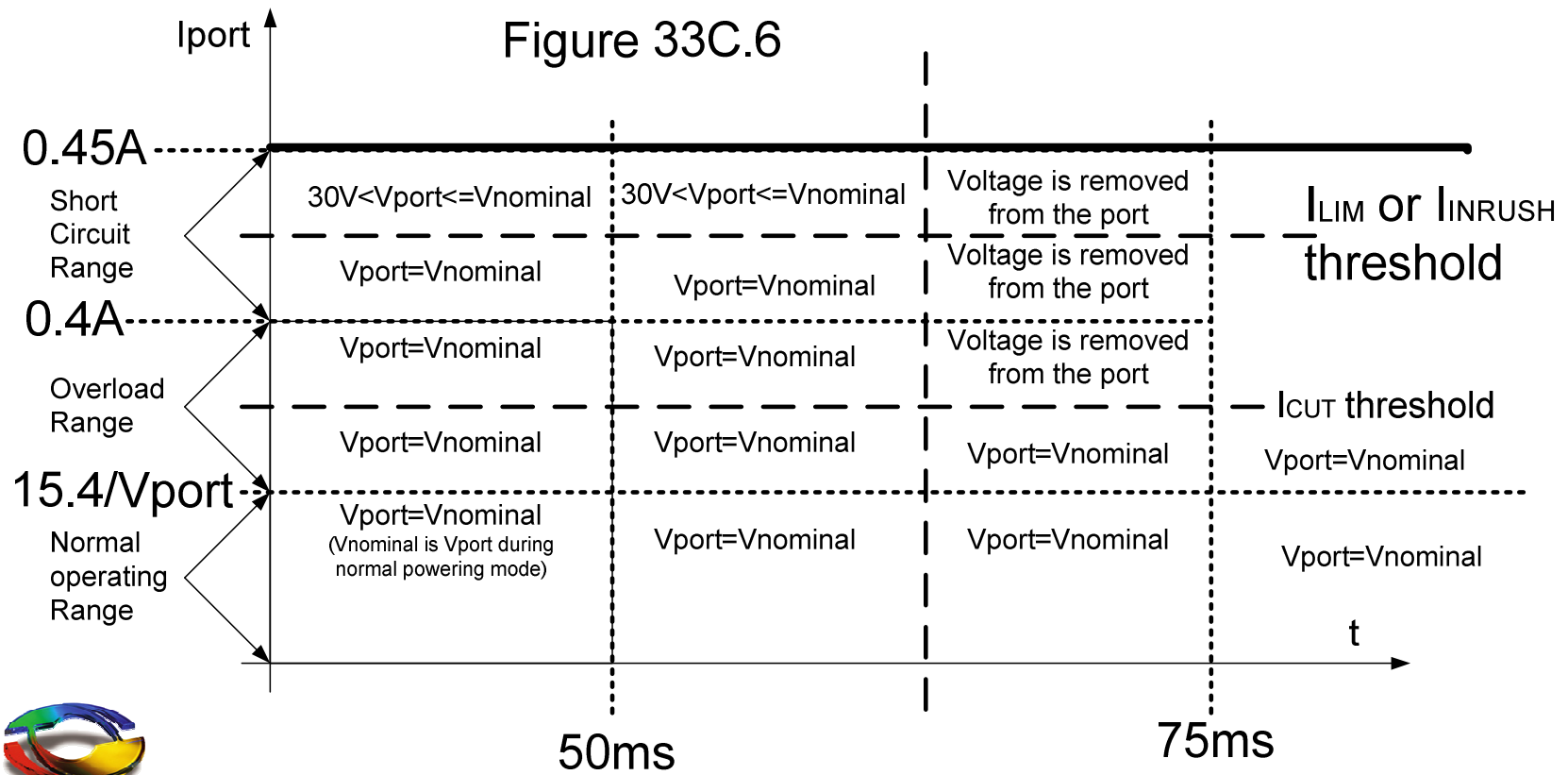
IEEE802.3af Figure 33C.4

Rational behind IEEE802.3af ILIM, TLIM numbers

- Why ILIM, TLIM is only relevant for Vport>30V?
- IEEE802.3af intention was to allow foldback current limit implementations
  - If Vport>30V then ILIM=0.4-0.45A
  - If Vport<30V then Ilim=60mA to 0.45A
- What happen at 30V?
- At 30V and below PD is dead. No reason to keep high ILIM.
- Actually, we should look at PSE side and not PD side!
  - When PD is at 30V, PSE is below 38V. (30V+0.4A*20ohm=38V, 802.3af)
  - PD must work down to 36V. So PSE voltage is 44V. (36+0.4A*20ohm=44V)
- Hence PD is definitely not working below Vpse=38V and may work between 38V to 44V.
- In 802.3af it is 30V at PSE which is well below extreme operating conditions

Problems with IEEE802.3af short circuits definitions

- Problem #1:
- Technically it is understood that if Port current is limited, Vport may be lower then Vport_min however it is not clearly specified in the normative text but it is clearly specified in the informative section in figure 33C.6.
- MR # 1168 should fix it.



Problems with IEEE802.3af short circuits definitions

- Problem #2
- To clarify the requirements for foldback current limit as clearly defined during startup phase.
- If Vport>30V then ILIM=0.4-0.45A
- If Vport<30V then ILIM=60mA to 0.45A.
- It is supported by the normative text by saying “see figures 33C.4 and figures 33C.6” and 33.2.8.5 but text is missing in 33.2.88 and drawings are in the informative section.

- MR #1162 should fix it

Problems with IEEE802.3af short circuits definitions

- Problem #3:
- IEEE802.3af state diagram requires supporting “recovery” function.
- Example for Recovery:
  - If I>=ILIM for 3ms, Vport goes down,Tlim counts to 3ms.
  - Iport < ILIM, Vport goes up, TLIM stopped.
  - This scenario may be repeated until Tlim gets 50ms.
- So what is he problem?
- If Vport goes to a value that PD is dead=disconnected (UVLO=30V) then each time Vport goes up, we will be in inrush situation.
- Problems:
- Violates IEEE802.3af table 33-5 item 21, Ted=750ms minimum between start up’s.
- Creating system interruption, motor boating, potential PSE-PD oscillations, excessive heat.
- The solution obviously is when PSE voltage gets to a value that PD is dead then PORT can be disconnected immediately even if t<TLIM_MIN. It is optional and not affecting legacy IEEE802.3af.
- MR # 1167 should fix it

How to fix all maintenance problems for 802.3af and 802.3at

- Key points:
  - Backwards compatible to legacy IEEE802.3af (802.at PD with power <12.95W connected to 802.3af PSE)
  - All changes for 802.3af are optional.
  - Minimal changes in the state diagram.
  - Ilim and Iinrush are separate variables for 802.3at.
  - Tlim and Tinrush should be separate variables for 802.3af and 802.3at.
  - “Short Circuit” conditions is a condition when I>=ILIM and optionally and/or Vport decreased during normal operation.
  - Maximum design flexibility
  - Implementation is not limited to linear protection

How to fix all maintenance problems for 802.3af and 802.3at

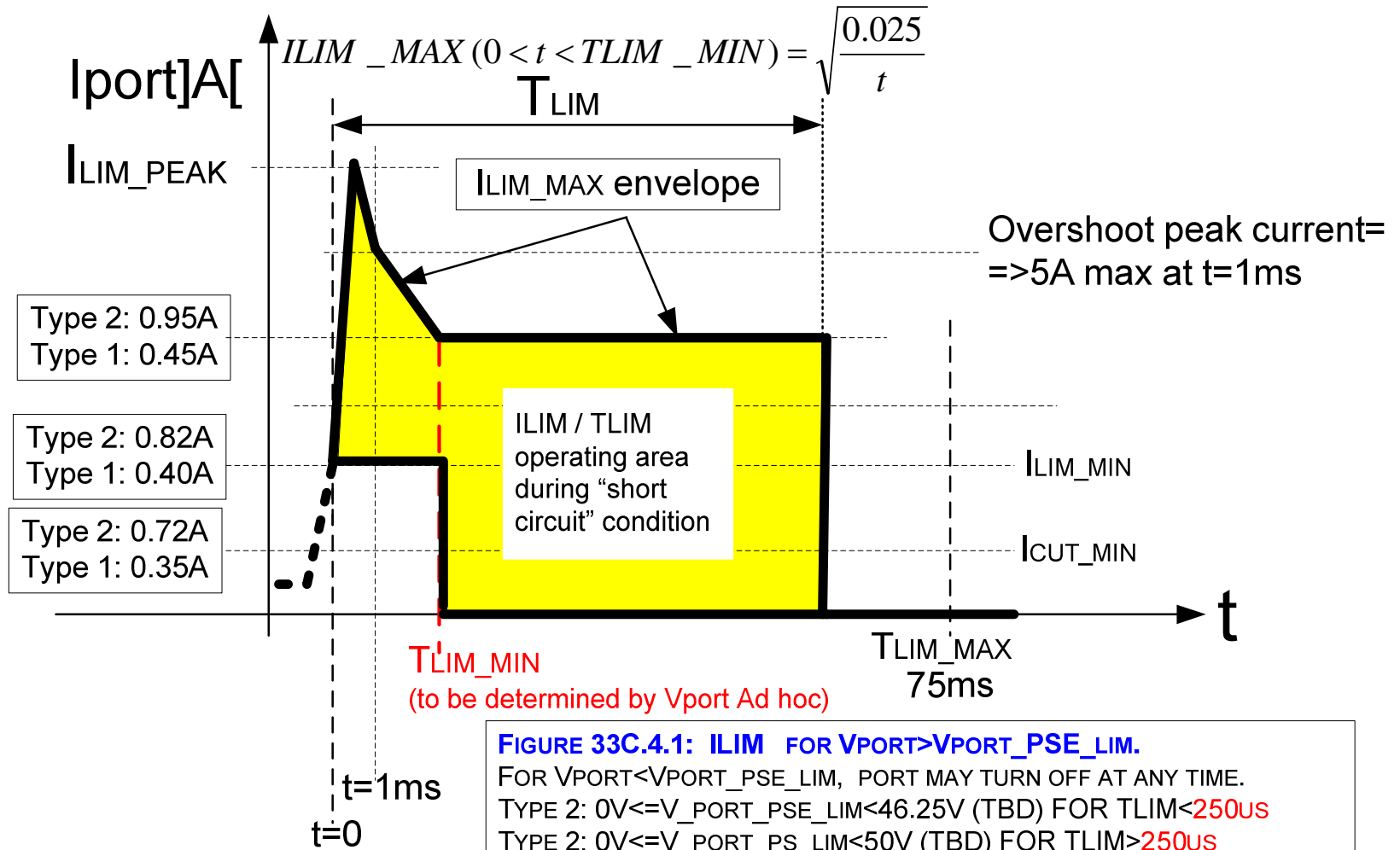
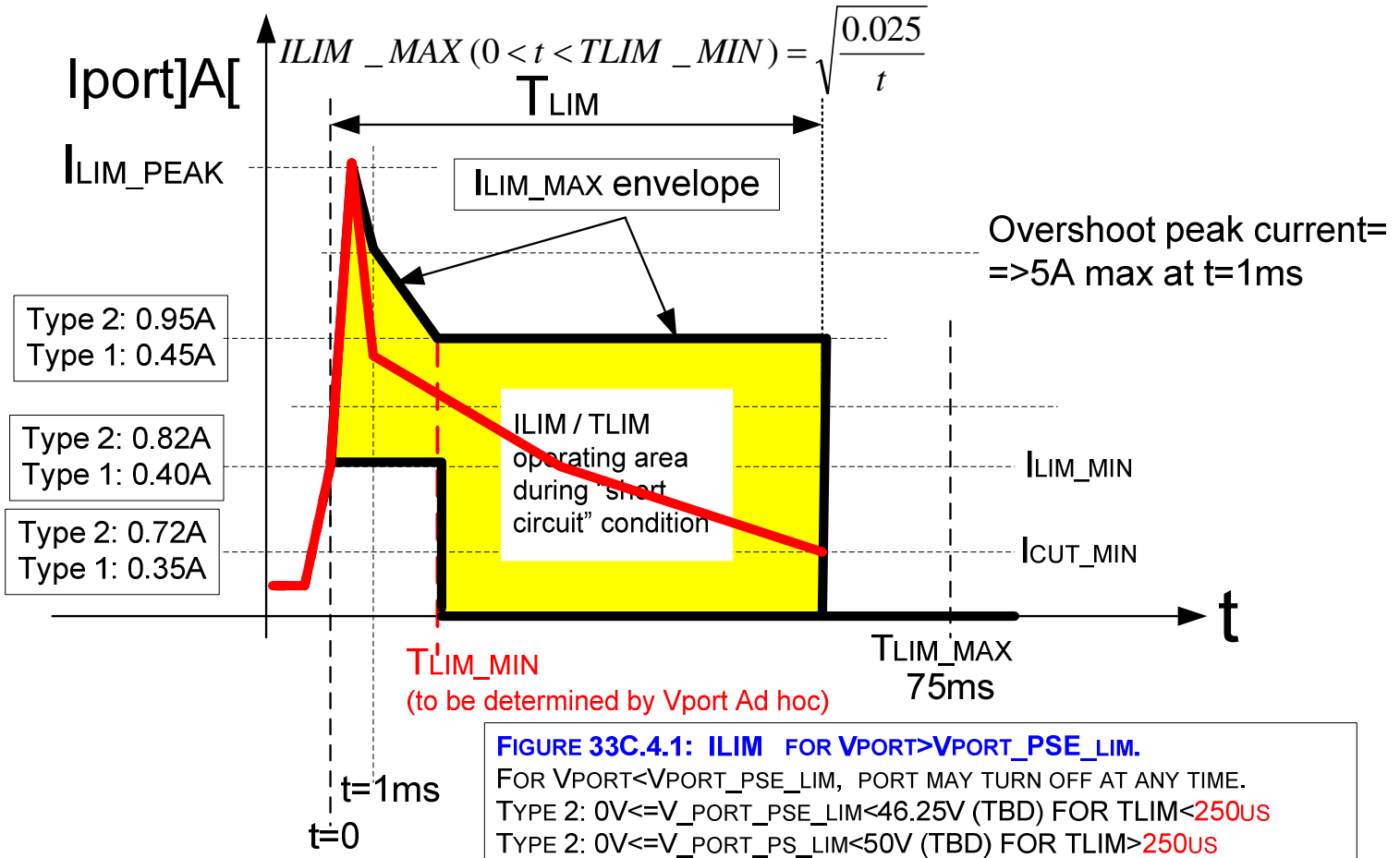


FIGURE 33C.4.1: ILIM FOR VPORT>VPORT_PSE_LIM.
FOR VPORT<VPORT_PSE_LIM, PORT MAY TURN OFF AT ANY TIME.
TYPE 2: 0V<=V_PORT_PSE_LIM<46.25V (TBD) FOR TLIM<250US
TYPE 2: 0V<=V_PORT_PS_LIM<50V (TBD) FOR TLIM>250US
TYPE 1: 0V<=VPORT_PSE_LIM<44V (TBD)
SEE SEPARATE DRAWING FOR IINRUSH

Possible Ilim Curve - example



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Questions/Discussion