Power Classes, Turn On/Off Voltages, and Sleep Mode Current Thresholds

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Items Addressed in this Presention

- The power class table (Table 104-1) needs updating to take the following into consideration:
  - System Stability
  - Hysteresis between turn on and turn off thesholds
  - Accuracy of these thresholds in the PD
- The PD power table (Table 104-6) needs updating to take the following into consideration:
  - The new turn on and turn off thresholds
  - New transition thresholds for sleep mode that are based on economic feasibility.

Power Class Table

- A little background on how PoE handles these issues (based on my own reverse engineering of the numbers):
  - The max current was backed off from the stability point by a factor of 0.6 (I assume due to temperature rise concerns).
  - The max turn on threshold of the PD is slightly below the minimum PD voltage (based on normal operation and channel loss).
  - The min turn off threshold is well below the stability point of the system and is meant to shut down the PD cleanly if something goes wrong.
  - Clause 33 allowed for 24% of VPSE min for hysteresis between turn on and turn off and required an accuracy of 15% from the PD to implement half of the maximum hysteresis allowed.
- We can copy this method and choose how much we want to back off the max current by.
  - Only the unregulated 12V class has issues with turn on/off accuracy due to the sleep/wake range setting a hard boundary.

Suggested Power Class Table

	12V Classes			24V Classes			48V Classes			
	Unreg	I	II	Unreg	I	II	Unreg	I	II	III
VPSE Max	18	18	18	28	28	28	56	56	56	56
VPSE min	5.3	14	14	10.6	21.6	21.6	21.2	43.2	43.2	43.2
RPSE max	4	4	1	4	4	1	4	4	4	1
Rloop max	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
IPI max	0.13	0.42	0.50	0.32	0.55	0.77	0.64	0.98	1.31	1.55
Suggested Ppd	0.50	4.50	5.00	2.50	9.50	12.50	10.50	25.00	45.00	51.00
Suggested PD Von max	4.80	12.00	12.00	9.00	18.00	18.00	18.00	36.00	36.00	36.00
Suggested PD Voff min	4.30	9.00	9.00	6.75	13.50	13.50	13.50	27.00	27.00	27.00

Sleep Mode Thresholds (I)

- The total system dynamic range is determined by the max current and the MPS current.
  - The proposed Power Class table has a max current of about 1.5A.
  - The current draft has an MPS current (Ihold) range of 5-15uA (10uA).
    - This gives a total dynamic range of 150,000.
- Again, let's compare these numbers to PoE.
  - 802.3at had an MPS range of 5mA and a max current of 600mA
    - This is a dynamic range of 120.
  - 802.3bt is proposing an MPS range of 10mA and a max current around 1.7A.
    - This is a dynamic range of 170 (an increase of ~42%).

Sleep Mode Threshold (II)

- The wake and sleep modes in PoDL can be split apart (by switching the sense resistor for example), leaving two separate dynamic ranges, where the threshold between them is Iwakeup – Isleep.
  - This would reduce the dynamic range required for each mode to sqrt(150K) = ~387.
- The upper threshold (Iwakeup) will limit the lower bound power dissipation of a PD in POWER_ON mode.
- Isleep must be below Iwakeup in order to maintain a stable system.
- If the PD goes from full power to disconnected, the transition from POWER_ON to sleep mode will affect the disconnect timings.
- The voltage drop across the sense element can not be overly large due to the small differences between 3.9V and Voff min.
  - My suggested Voff min for the 12V unregulated class is actually 3.75 in order to try to allow for some amount of hysteresis and accuracy tolerance.
  - Sleep mode doesn't seem possible for this class.
- Will the voltage transients of the unregulated classes cause problems?
- Will leakage be a problem when trying to sense a disconnect (particularly at 48V)?

Some Example Calculations

- These Calculations are based on the current draft numbers:
  - The PD sleep current max = 100uA
  - The PD wake current is between 3mA and 10mA.
  - Both PSE thresholds are TBD, but would need to be 100uA and 3mA if no margin was added.
  - This means a 48V system would not allow the PD to use less than 56V*10mA = 560mW of power in POWER_ON mode.
  - The dynamic range of the POWER_ON mode is 1.5A/3mA = 500.
  - The dynamic range of the Sleep mode is 3mA/10uA = 300.

Sleep Mode Conclusions

- We need to increase the MPS current (and wake currents) in order to decrease the dynamic range of the system.
  - Can we lower the duty cycle in order to achieve this?
  - Do the current numbers take into account the 33% duty cycle that is already in the spec? What is the number that the automotive industry actually needs.
- There is no other magic to make this work and we need to spend significant time making sure the issues outlined are not unsolvable.