IEEE802.3at Task Force

Technical and market considerations regarding PoEp output voltage range

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Part A

Technical Considerations regarding PoEp output voltage range

Objectives

- To discuss optimum voltage range for PoEp
- To show advantages of having PoEp minimum voltage of 51V

HP POE voltage range

- Maximum voltage: 57V (safety consideration)
- What is most optimum value for minimum voltage?
- PoEp group objective; maximum power within practical limit (Power Dissipation, Safety consideration)
- Power dissipation is function of the current
- Increasing minimum voltage reduces current level for the same load power or
- Increasing Power delivery to the load for a given current value.
- Hence same infrastructure delivers more power to PDs for given PSE PS size and cost
- Bottom line: more applications may supported
  - Larger POEp market

PoEp minimum voltage

- Lets assume current is 0.35A and calculate power delivered to the load by four pairs

	44V	51V
Power dissipation on 4 pair	**3.06W**	**3.06W**
Maximum power delivered to the PD	**27.74W**	**32.64W**

- It means, that at 51V, for the same power dissipation on the cable, power delivered to the load will be 4.9W more then at 44V.
- The advantage of higher voltage is further increased for higher currents than 0.35A

PoEp minimum voltage

- Let us look on this issue under another angle assume minimum load need to be delivered to PD by four pair is 40W
- Power dissipation on a cables for 51V PSE will be 2.45W less then for 44V
- Advantages of higher voltage is increase with increasing power level

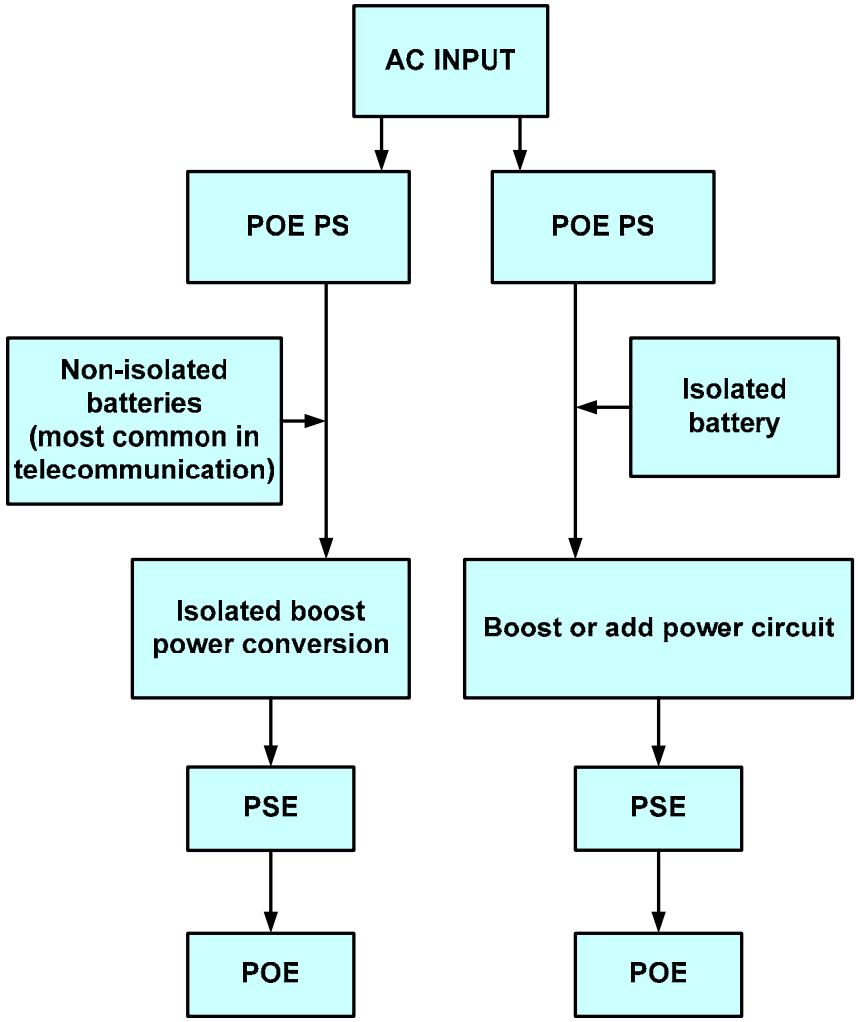
	44V	**51V**
Pd power	40W	40W
Current per pair	0.54A	0.44A
Power dissipation on a cables (4P)	7.3W	4.85W
PSE power	47.52W	44.88W
System efficiency for ~500W PSE PS	0.84	0.89

PoEp minimum voltage

- 51V required smaller PSE power supply then at 44V, for the same load.
- The technical advantage is clear for using higher voltage minimum voltage level for POEp PSE.
- Let consider different options in PoEp Power architectures :

- AC input and battery back up
- AC UPS input

PoEp Power Architecture-AC Input



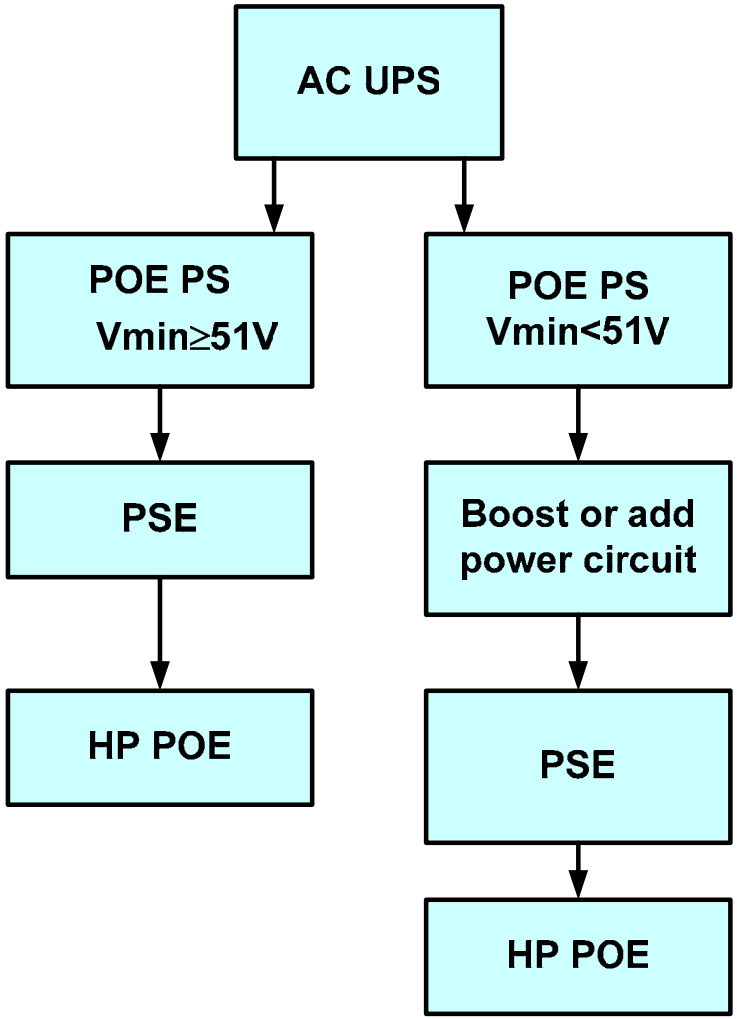
PoEp Power Architecture-AC Input

- One of the arguments for not using 51V power supply is that back up battery operates up to ~ 43 - 44V.
- However most batteries used in telecommunication have one of the terminal grounded (mostly positive)
- This would prevent direct use of this batteries in POE and would require to have isolated converter between batteries and PSE regardless of output voltage considerations
- Therefore increasing output voltage to ~51V would not add any system cost
- But boost converter would be useful even in case of isolated batteries (DC UPS), which really is not very popular power architecture.

HP POE Power Architecture-AC Input

- Taken at account the voltage drop on a high current battery cable and PSE voltage drop (Mosfet and CS resistor), it would require Low Voltage Disconnect to shutdown battery at ~46V in order to have 44V on the PSE output
- It means battery life would not be fully utilize
- Adding boost converter, which would keep output voltage of the system constant, in our case 51V,would extend batteries capabilities on ~15% in POE systems

PoEp Power Architecture-AC UPS

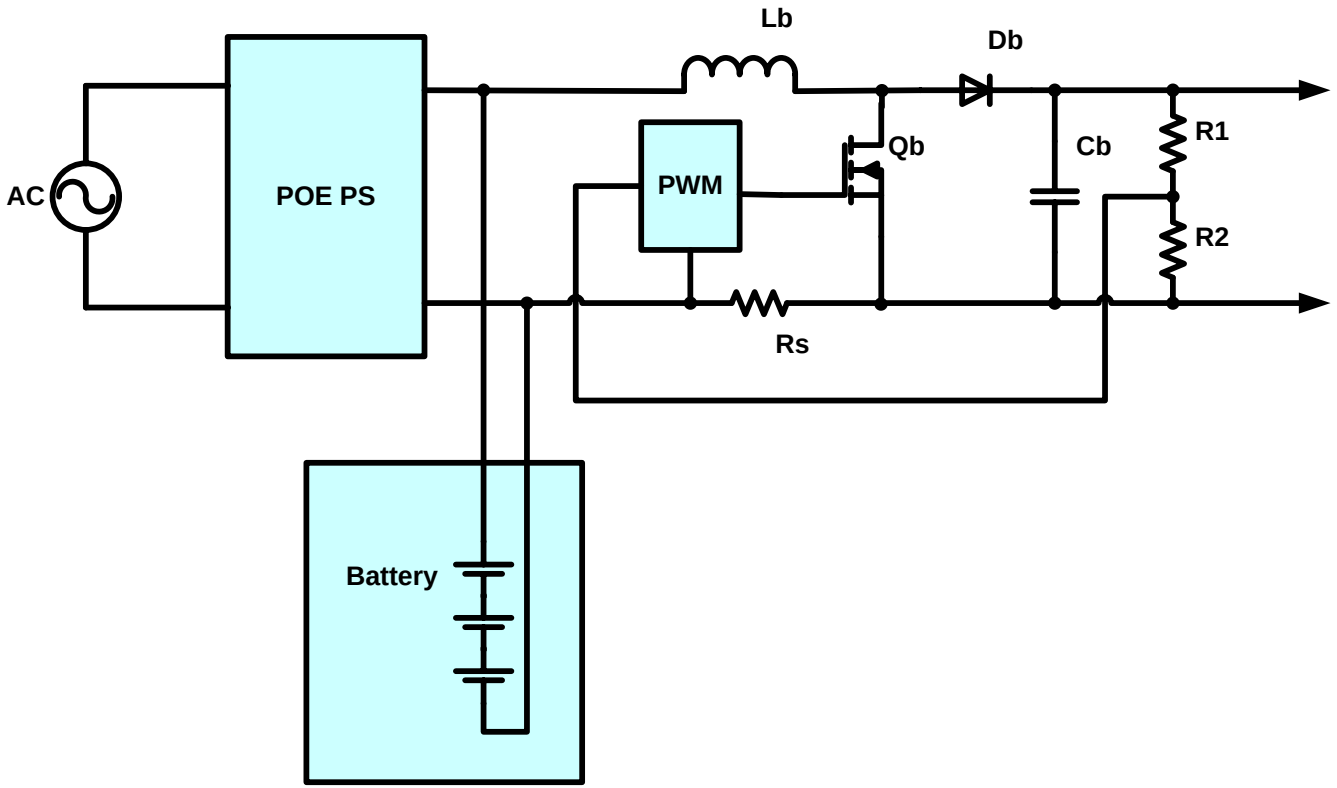


PoEp Power Architecture-AC UPS

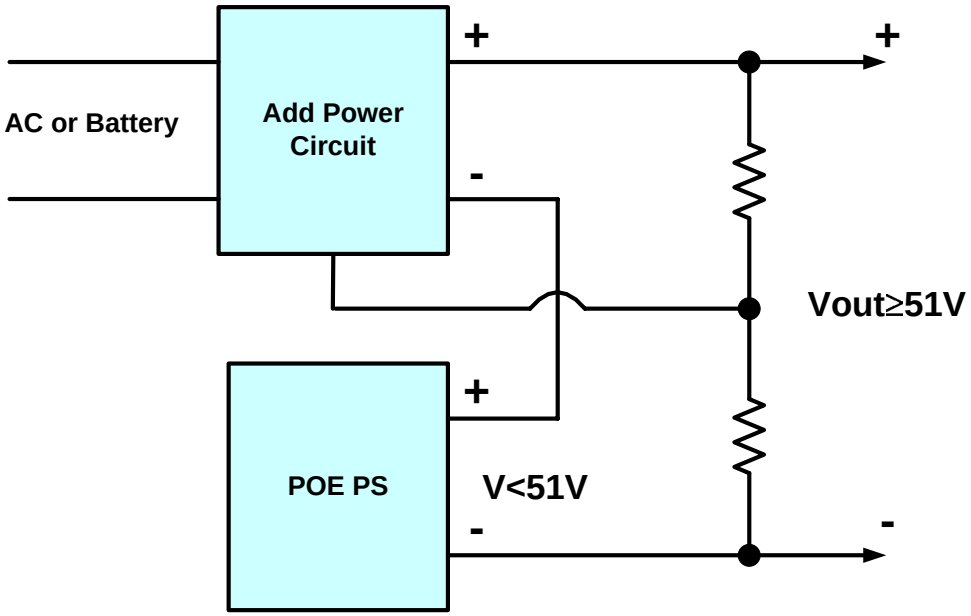
- Cost of power supply with 44V or 51V outputs is approximately the same. But under the same conditions, 51V output power supply will have higher efficiency then 44V PS

- Estimated cost of additional boost circuitry for supporting the change from 45V to 52V for 500W power supply is about 10% cost of power supply.

PoEp with Boost circuit



PoEp with Add Power



•For 48V 250W power supply, maximum power for add power converter would be (52V-48V)*(500/48)=42W or about 9% of 500W PS cost

•However taken in account improved system efficiency, total cost of ownership would remain about the same

Conclusions

- Increasing minimum PoEp voltage from 44V to 51V would increase overall system efficiency
- Costs of 51V PS and 48V PS are approximately the same and from technical point of view would be beneficial to have minimum 51V in PoEp PSE
- Regardless of output voltage consideration, adding boost circuit for system with batteries back up, would increase battery useful life in POE systems

Part B

Market considerations regarding 802.3at output voltage range

802.3af modular installed base considerations

- 802.3af minimum PSE voltage: 44V

- Modular switches
  - 44V power supply is deployed with chassis
  - Customer expectation: 802.3at-blades added to 802.3af-chassis
  - 51V minimum at PSE → Boost converter MUST be placed on blade
    - More power dissipation at blade
    - More components added to crowded blade

How to solve the conflict

- The Conflict is:
  - 51V is the Technically preferred solution
    - More power at low cost
    - Bigger addressable market
  - 44V addresses the existing modular installed base
    - Impossible to replaced 44V power supplies on the field

How to solve the conflict – PD side

- Proposed Solution

- Effects on PD specifications
  - PD operating voltage range: No effect. Remains 37-57V.
  - PD classification in 802.3at (including Class 4) should be mandatory and not optional
  - The enhanced classification table will be divided to two parts:

    (See details in “An Extended Classification Proposal- Proposal #1, Vancouver BC, Nov. 2005)
    - Part a: power classes that can work with either 44V or 51V.
    - Part b: power classes that can work only with 51V minimum at the PSE.
  - This may be documented in the Informative section of the standard.

How to solve the conflict – PSE side

- Effects on PSE specifications
  - PoEp PSE minimum voltage is 51V.
  - However PSE's that have a 44V minimum output and are 802.3at-complaint in any other aspect, are anyway able to power 802.3at-complaint PD's with classes of Part (a). (Hence all OK so far..)
  - Supplies power only if capable of (Like we do today in IEEE802.3af)
  - 802.3af PSE classification including class 4 should be mandatory (In order to PSE to know if to power or not)
    - To differentiate between 802.3af PD and PoEp PD.
  - 802.3at PSE extended classification is optional.
    - Like classification is currently optional in 802.3af

Summary

- The conflict level is pretty much reduce by the previous recommendations
- Compliant 802.3at PSE is the one with 51V minimum
- Physics allow to support most of the higher power classed even with 44V ((enhanced classification part A group). which is built in benefit however it doesn't concerns the other standard requirements nor affect it.
- It is perfectly OK that Switch/PSE is 802.3at compliant as long as its Power Supply supports 51V.
- If PSE PS Power Supply is 44V, then 802.3at PSE is not compliant but working and covered most of high power classes

Discussion

References

- An Extended Classification Proposal-Proposal #1. Yair Darshan, Vancouver BC, November 2005

Annex A: Enhanced Classification table

- Example for group A and group B
- With Pmax=40W

Tclass	t1	t2	t3	t4	t5	t6	t7	t8	t9	t > t9
I_class (802.3af)	Power Allocated [Watts]									
10mA	0.44	0.6	0.7	0.9	1.1	1.5	1.9	2.4	3.0	3.8
18.5mA	4.8	5.0	5.2	5.3	5.5	5.7	5.9	6.1	6.3	6.49
28mA	6.7	7.2	7.8	8.4	9.0	9.7	10.4	11.2	12.0	12.95
40mA	13.9	15.7	17.6	19.8	22.3	25.0	28.1	31.6	35.6	40.0
Ipse max [A]	Vpse_min									
0.35	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
0.35	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
0.35	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
0.44	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	51.0	51.0

Group B