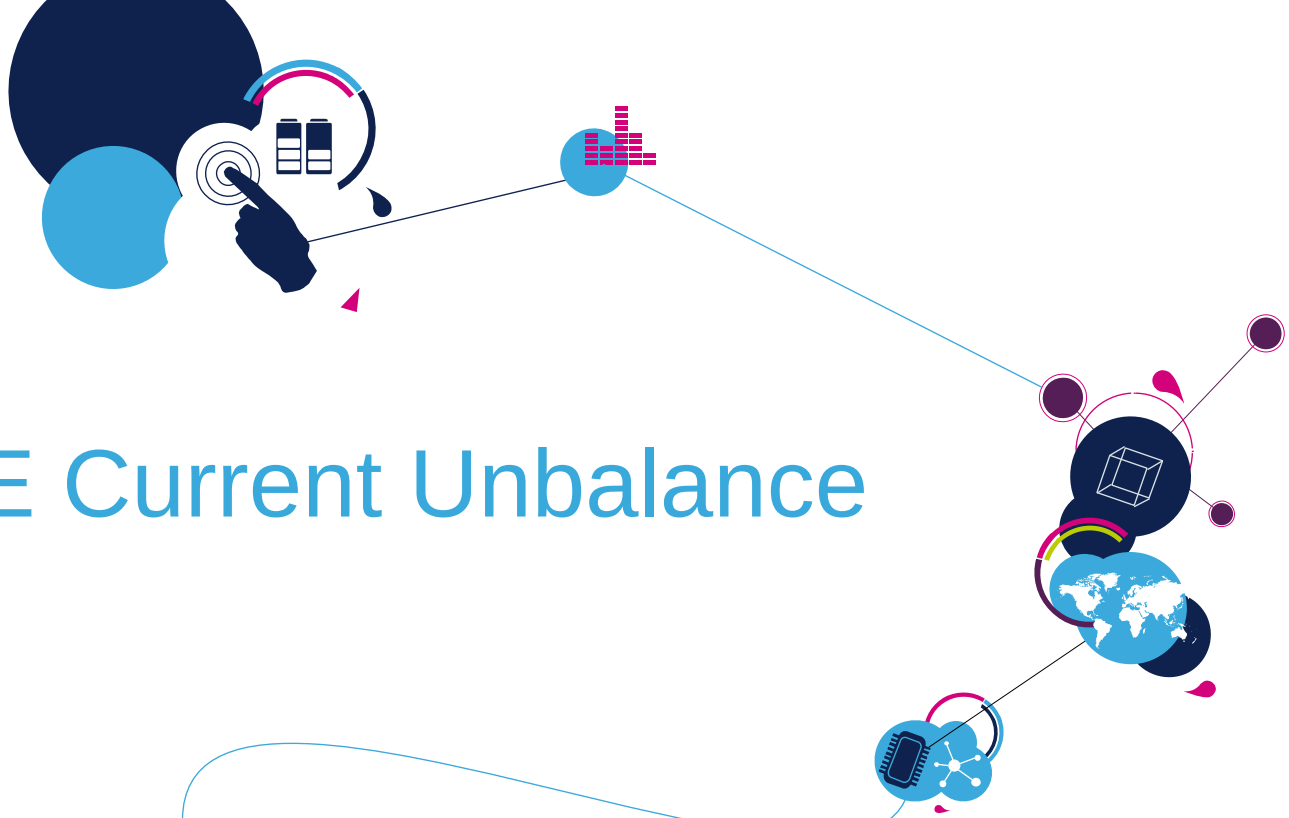

4-Pair PoE Current Unbalance Update

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IEEE802.3 bt Task Force - Norfolk, VA - May 2014

life.augmented

Supporters

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Introduction

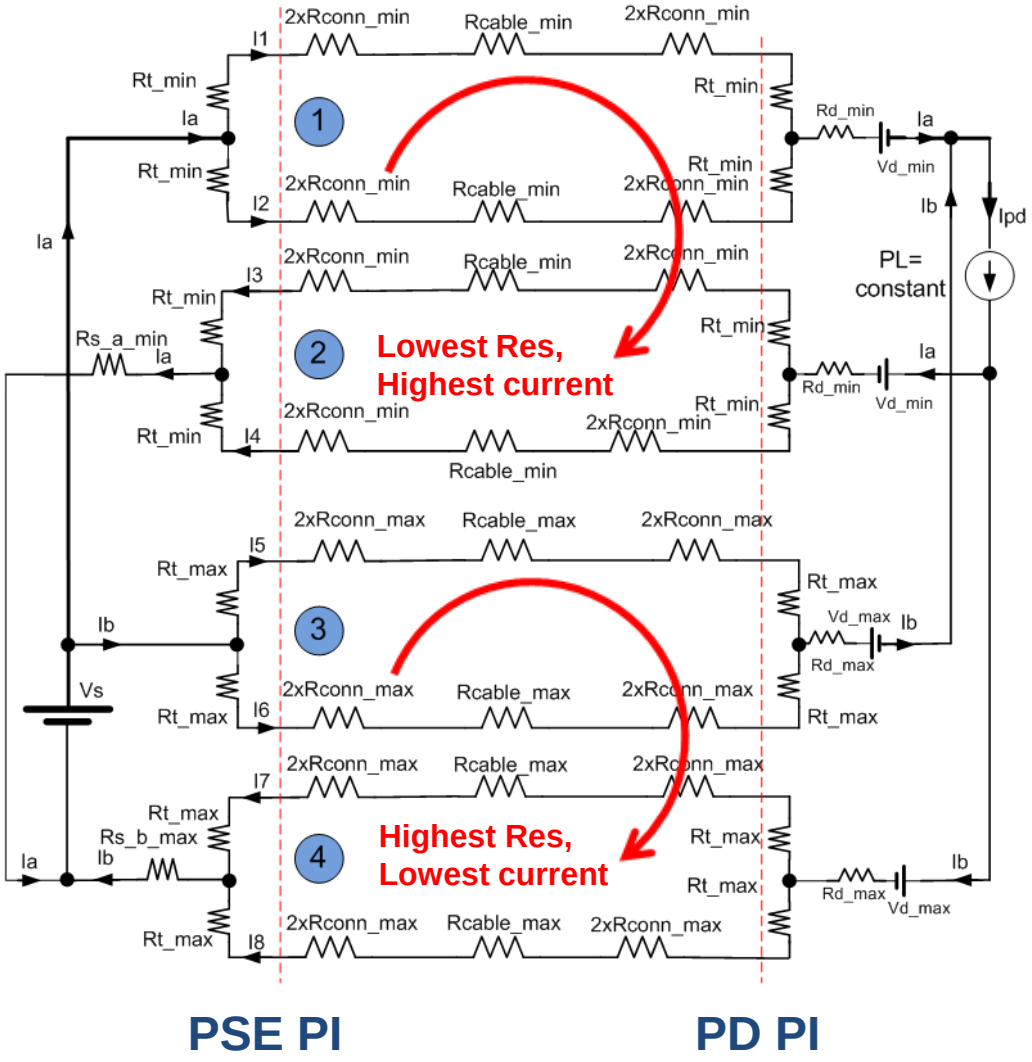
- This is un update of the pair to pair current unbalance analysis with the following new items:
  - New worst case model for diode bridge after receiving characterization data of a diode used in PoE applications
  - Extended range of PD power for Type 3 and Type4 analysis (51W or 75W at PD end)
  - Three channel models: 2, 4 and 6 connectors
  - Four Cable length: 0.15m, 1m, 10m, 100m
  - CAT5E and CAT6 cabling

- For any condition the End to End P2P Channel RUNB was calculated using the definition:

$$CP2PRunb = \frac{Imax - Imin}{Imax + Imin}$$

  - For further details on CP2PRunb refer to: http://www.ieee802.org/3/4PPOE/public/nov13/darshan_03_1113.pdf

Max unbalance 4Pairs PoE System model



- Vport_PSE min = 50V – as per Table 33-11
- The PD model is a constant power load that draws current from Alt-A and Alt-B through a diode bridge.
- The PSE model is a single voltage source with two outputs with their output resistance each. The upper resistor is set to zero as a worst case.
- The worst case for current unbalance happens when Alt-A loop resistance is minimum and Alt-B is maximum (or vice versa)

New diode linearized model

- New worst case data are now available for STPS2H100 (2A, 100V Schottky diode)
  - Those data come from production characterization at 25C. Min and max are set at 5sigma of a normal distribution.

- The linearized model intercepts the V-I characteristic at 0.5A, and it is accurate enough in the range of 0.3A to 0.7A:

Vd_MIN = 0.39+0.25*Id **Vd_MAX = 0.53+0.25*Id**

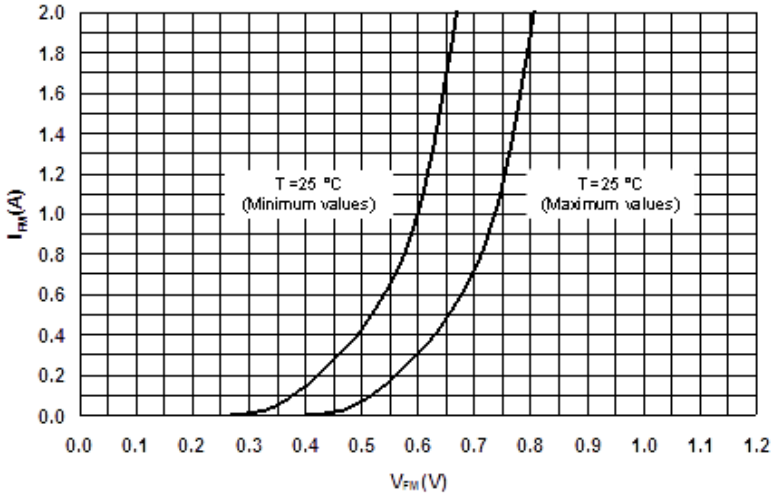
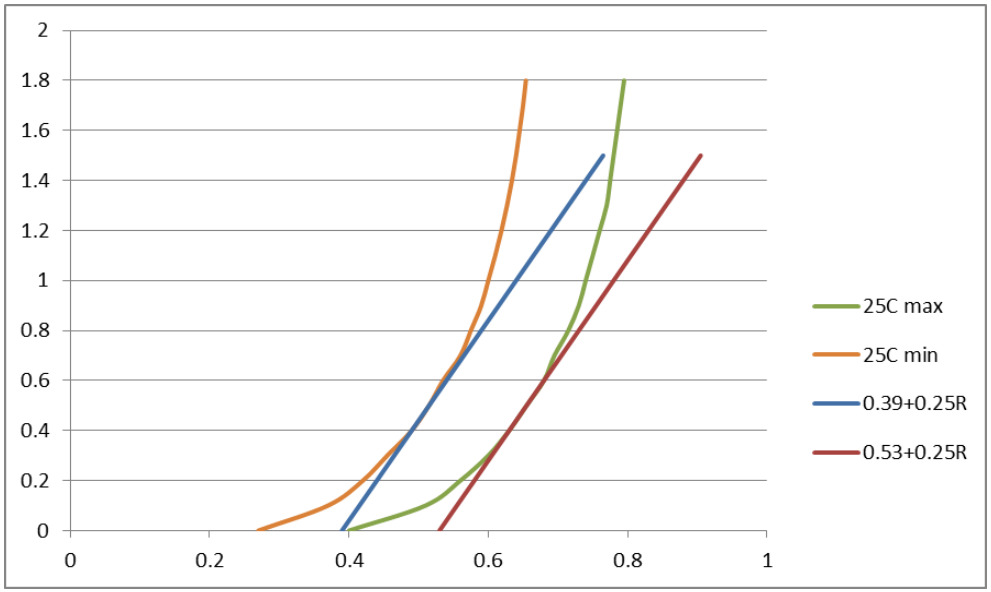


Fig 1: Forward voltage drop versus forward current (low level)



Worst case numbers set

- Two scenarios have been identified: CAT5E cables CAT6/A.

Table 1	CAT5E Cable resistivity	CAT6/A Cable resistivity
Cable resistivity	117mOhm/m	66mOhm/m
Transformer winding resistance	120mOhm min, 130mOhm max	120mOhm min, 130mOhm max
2-connector Contact resistance	15mOhm min, 30mOhm max	15mOhm min, 30mOhm max
4-connector Contact resistance	30mOhm min, 60mOhm max	30mOhm min, 60mOhm max
6-connector Contact resistance*	45mOhm min, 90mOhm max	45mOhm min, 90mOhm max
Diode bridge	0.39V+0.25Ohm*Id min; 0.53V+0.25Ohm*id max	0.39V+0.25Ohm*Id min; 0.53V+0.25Ohm*id max
PSE output resistance (e.g. Rs_a/b=Rsense+Rdson)	0.25+0.1 Ohm min 0.25+0.2 Ohm max	0.1+0.05 Ohm min 0.1+0.1 Ohm max

- All parameters are at room temperature and further study is required to address temperature variations

- *6-connector model is informative, since channel specification is 4-connector max

CAT6/A, 2-connector model

Length [m]	PD power [W]	Pair with min current [mA]	Pair with max current [mA]	Idiff [mA]	P2PCRunb [%]
0.15	51	713.09	333.59	379.51	**36.26%**
1	51	703.75	343.54	360.21	**34.39%**
10	51	647.97	405.83	242.14	**22.98%**
100	51	612.77	516.87	95.89	**8.49%**
0.15	75	975.35	571.98	403.37	**26.07%**
1	75	966.43	582.25	384.18	**24.81%**
10	75	915.09	648.09	267.00	**17.08%**
100	75	937.66	810.77	126.89	**7.26%**

CAT6/A, 6-connector model

Length [m]	PD power [W]	Pair with min current [mA]	Pair with max current [mA]	Idiff [mA]	P2PCRunb [%]
0.15	51	711.42	337.09	374.33	**35.70%**
1	51	703.83	345.29	358.54	**34.17%**
10	51	654.98	400.77	254.21	**24.08%**
100	51	617.65	514.68	102.96	**9.09%**
0.15	75	987.44	564.02	423.42	**27.29%**
1	75	979.68	573.15	406.53	**26.18%**
10	75	931.34	636.24	295.10	**18.83%**
100	75	947.13	808.59	138.54	**7.89%**

CAT5E, 2-connector model

Length [m]	PD power [W]	Pair with min current [mA]	Pair with max current [mA]	Idiff [mA]	P2PCRunb [%]
0.15	51	713.08	336.22	376.86	**35.91%**
1	51	697.53	352.86	344.67	**32.81%**
10	51	628.90	433.31	195.58	**18.41%**
100	51	653.74	568.96	84.78	**6.93%**
0.15	75	977.02	576.14	400.88	**25.81%**
1	75	962.23	593.34	368.89	**23.71%**
10	75	901.66	680.49	221.17	**13.98%**
100	75	1087.30	961.05	126.25	**6.16%**

*…

CAT5E, 6-connector model

Length [m]	PD power [W]	Pair with min current [mA]	Pair with max current [mA]	Idiff [mA]	P2PCRunb [%]
0.15	51	711.75	339.41	372.33	**35.42%**
1	51	698.99	353.28	345.72	**32.85%**
10	51	636.67	427.56	209.10	**19.65%**
100	51	658.14	568.37	89.77	**7.32%**
0.15	75	989.47	567.90	421.57	**27.07%**
1	75	976.47	583.37	393.10	**25.20%**
10	75	917.08	669.74	247.35	**15.59%**
100	75	1099.57	964.24	135.33	**6.56%**

*…

Conclusions

- Worst case condition for P2PCRunb is:
  - Single 0.15m CAT6A cable between PSE and PD (2-connector model)
- The max P2PCRunb is 36.26%, i.e. 380mA over 1.05A
- Increasing the number of connector has a ballasting effect, decreasing P2PCRunb.
  - 4-connector results are in the middle between 2 and 4 connector models
- With CAT6/A cabling it is possible to deliver 75W to the PD without exceeding 1A per pair (for any cable length and # of connectors)
- A 100m CAT5E cable in a 6-connectors environment would require up to 1.1A to deliver 75W to the PD

Thank You