Power Matters

IEEE802.3bt 4-Pair Power over Ethernet Task Force

New and old E2ECP2PRUNB information

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Topics

- Current E2ECP2PRUNB adhoc data base (Table G1, G2)
  - Agreed parameters
  - Parameters that was marked TBD (Diodes).
  - Parameters suggested to be considered and updated (Mosfets).
- PSE and PD P2P_Runb per table G1 at ~30W and 60W loads.
- PSE and PD P2P_Runb per table G1 at low current

Annex G1:Worst Case Data Base. See Ref 1.

#	Parameter	Data set 1	Data set 2
1	Cordage resistivity[1]	0.14Ω/m	
		0.09262Ω/m for AWG#24 for worst case analysis	
2	Horizontal cable resistivity option 1[2]	11.7Ω/100m=(12.5Ω - 4*0.2Ω) / 100m which is the maximum resistance resulting with maximum Iport.	7.4Ω/100m to 7.92Ω/100m (CAT6A, AWG23) This is to give us maximum P2PRunb
3	option 2[3]	0.098Ω/m.	
4	Unbalance parameters	• Cable Pair resistance unbalance: 2%. Channel pair resistance unbalance: 3% • Cable P2P Resistance Unbalance: 5%. Channel P2P Resistance Unbalance: 0.2Ω/6% max TBD.	
5	Channel use cases to check. See figure 1 for what is a channel.	A. 6 inch (0.15 m) of cordage, no connectors. B. 4 m channel with 1 m of cordage, 3 m of cable, 2 connectors C. 23 m channel with 8 m of cordage, 15 m of cable, 4 connectors D. 100m channel with 10 m of cordage, 90 m of cable, 4 connectors	
6	End to End Channel[6]	The Channel per figure 1 + the PSE and PD PIs.	
7	Transformer winding resistance	120mOhm min, 130mOhm max	
8	Connector resistance[8]	40mOhm min, 60mOhm max	30mOhm min, 50mOhm max
9	**Diode bridge[9]**	**Discreet Diodes: 0.39V+0.25Ω*Id min; 0.53V+0.25Ω*id max. (TBD)**	
10	**PSE output resistance [10]**	**0.25+0.1 Ohm min, 0.25+0.2 Ohm max**	**0.1+0.05 Ohm min, 0.1+0.1 Ohm max**

Ad-hoc response, June 24, 2014. Adhoc accept this table

Source: Yair Darshan, Christian Beia, Wayne Larsen

MOSFET RDSON Differences -1

- In adhoc Table G1 we took 100% difference between two MOSFETs of the same P/N.
- 0.1Ω and 0.2Ω, 0.05Ω and 0.1Ω etc.

- Now we will check the above worst case assumption with
  - Lab tests
  - Specification /Characterization analysis

MOSFET RDSON Differences -2

Test conditions:

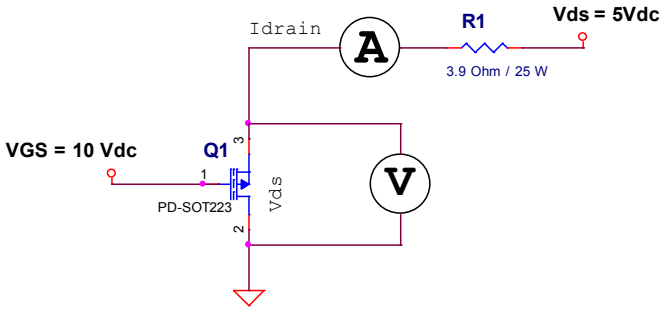
VGS= 10Vdc, VDS=5Vdc, Ambient Temp= 23° C

MosFET	Vds [mV]	Idrain [A]	$R_{DS(ON)}$ [mΩ]
1	265	1.125	235.556
2	235	1.142	205.779
3	245	1.131	216.622
4	239	1.136	210.387
5	242	1.128	214.539
6	234	1.138	205.624
7	232	1.132	204.947
8	242	1.131	213.970
9	246	1.133	217.123
10	242	1.134	213.404
11	245	1.131	216.622
12	261	1.128	231.383
13	251	1.12	224.107
14	246	1.132	217.314
15	250	1.128	221.631
16	246	1.132	217.314
17	253	1.132	223.498
18	263	1.128	233.156
19	254	1.131	224.580
20	242	1.132	213.781

Lab tests:

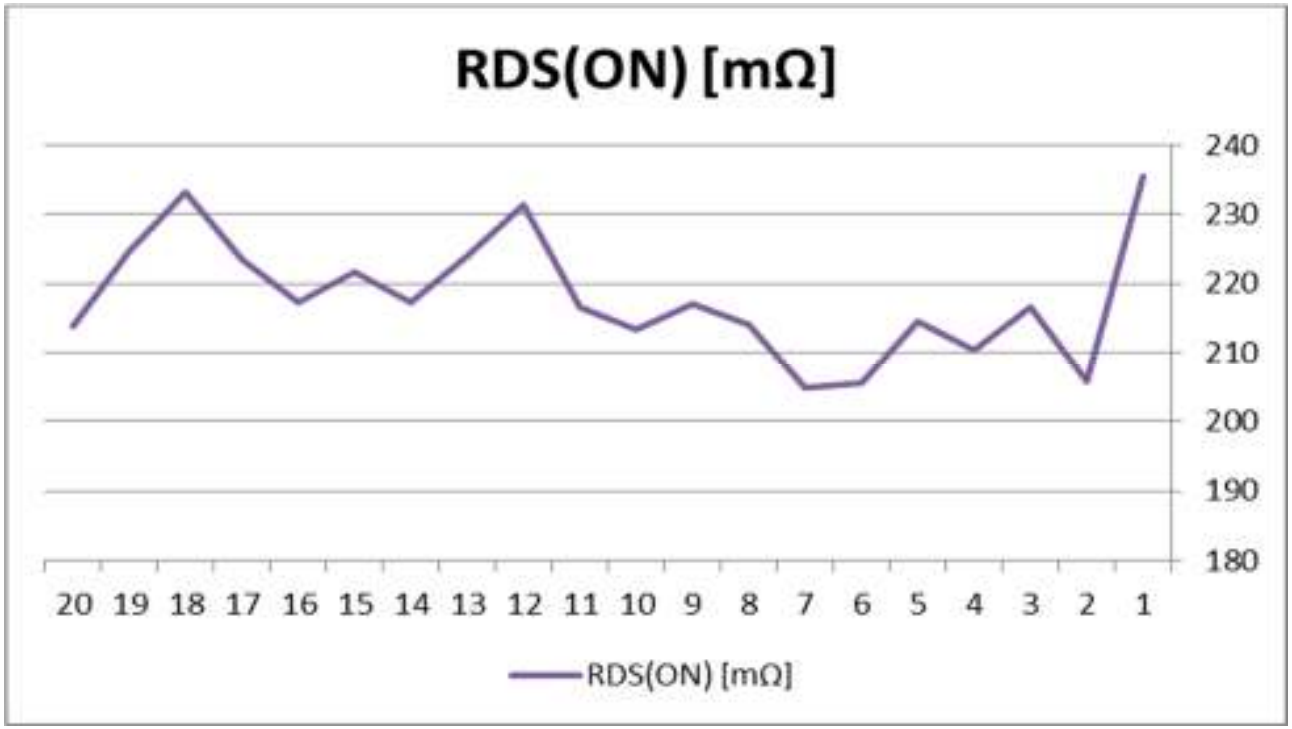
FQT7N10L

100V LOGIC N-Channel MOSFET



RDSON min [ohm]	205
RDSON max [ohm]	235.6
RDSON unb (Rmax-Rmin)/(Rmax+Rmin)	**6.95%**
RDSON DIFF [ohm] (Rmax-Rmin)	30.6
RDSON_DIFF[%] MAX (Rdiff/Rmin)	**14.9%**

MOSFET RDSON Differences -3



- **FQT7N10LTF**
- **RDSon variations at 23degC of 20 units sample.**

MOSFET RDSON Differences -4

- Specification /Characterization analysis
  - Checking 3 different MOSFETs datasheet used in PoE

P/N	Calculation	Specifications		Rdiff [ohm]	Unb
	Min	Typ	Max		
A	0.12	0.14	0.16	0.02	14.3%
B	0.2	0.275	0.35	0.075	27.3%
C	0.22	0.3	0.38	0.08	26.7%

  - It looks that the behavior of RDSON_min and RDSON_max differences is similar in MOSFETs used for PoE applications and is lower than 100% difference per our initial assumption.

MOSFET RDSON Differences -5

- Conclusions.
  - 15% maximum measured Rmax-Rmin from single P/N with 20 samples (Not enough to draw conclusions however with the addition of reviewing datasheets we may draw conclusion)
  - 27.3% maximum differences between 3 part numbers per their data sheets.
- Summary
  - It looks that the 100% Rmax-Rmin that we took as initial assumption was too aggressive.
  - 30% maximum difference of Rmax-Rmin is probably more realistic worst case range.
- Propose to update Table G1 accordingly.
  - RDSON_min=0.7*RDSON_max for Table G1
    - E.g. Rdson max=0.1 ohm. TDSon_min=0.07 ohm etc.

Diodes Vdiff at high Currents

- Currently data diode model data in Table G1 is:
  - 0.39V+0.25Ω*Id min; 0.53V+0.25Ω*id max.
  - It is 100%*(0.53V-0.39V)/0.39V=36%
- Per experiments done by Philips:
- See: http://www.ieee802.org/3/bt/public/nov14/yseboodt_1_1114.pdf
- The Forward voltage differences measured in percentage showed lower than 36%.
- We saw <6% at 350mA and lower at 600mA.
- It is proposed to change Table G1 for Vf difference in percentage at currents >350mA to be ≤ 10% instead of 36%.
- For lower currents, <<350mA, we will need different definition and more work to get to it.

Annex G1:Proposed Updated Table G1

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8	Connector resistance[8]	40mOhm min, 60mOhm max	30mOhm min, 50mOhm max
9	Diode bridge[9]	For I>0.35A, Vdiff is 10% max. For I<350mA(tbd). Definition is TBD.	
10	PSE output resistance [10]	Rsense=0.25+/-1% Proposing RDSON_MIN=0.7*RDSON_MAX	Rsense=0.25+/-1% Proposing RDSON_MIN=0.7*RDSON_MAX

Response:

Source: Yair Darshan, Christian Beia, Wayne Larsen

E2ECP2P_RUNB/CUNB simulation results

- See darashan_09_1114 for complete report.
- Worst case analysis.(with real field results: values are much lower)
  - Results per Vdiff, Channel Length, RDSON_diff, No Mosfet, for 51W load.
- Main conclusions:
- Vdiff=Vdiff_PSE+Vdiff_PD=0.1V
  - 100m, 12.5Ω: Imax<650mA. E2ECP2PRUNB=9%
  - 100m, CAT6A: Imax<615mA. E2ECP2PRUNB=9.6%
  - 5m, CAT6A: Imax<606mA. E2ECP2PRUNB=~17%
  - 0.15m, CAT6A: Imax<603mA. E2ECP2PRUNB=~19%
- Vdiff=0.2V
  - 0.15m, CAT6A: Imax<690mA. E2ECP2PRUNB=~36%

E2E_C_P2PRUNB Lab Results for Type 3 systems- 1

- Load: High current load: 0.5A range and 1A range
- Results: 5m: 5% max, 100m: 1.1% max
- 0.5m: Still around 5% range. Full report next meeting.
  - Cables: CAT5e
  - System: Type 3 (Power level wise)
  - Components:
    - Within the range of Table G1. Some of the components are with higher Rmin than shown in the table which will result with lower unbalance at 5m.
    - Some of the components has lower Rmax-Rmin than in G1 table which will result with lower unbalance at 5m.
  - Results are much better than worst case analysis however are not representing the behavior of CAT6A/CAT8 lower resistance and one PSE vendor and One PD.
- See report in darshan_08_1114. (November 2014 presentations)

E2E_C_P2PRUNB Lab Results for Type 3 systems- 2

- Load: Low current: 12mA. **Cables CAT5e.**
  - 0.5m: Ia=2mA, Ib=10mA. Runb=66%.
  - 5-7m: Ia=5mA, Ib=7mA. Runb=18%
- Components:
  - Within the range of Table G1. Cable is CAT5e only. Some of the components are with higher Rmin than shown in the table which will result with lower unbalance at 5m.
  - Some of the components has lower **Rmax-Rmin than in G1 table which will result with lower unbalance at 5m.**
  - **Results are a bit better and not much better than worst case analysis due to the fact that at low current for the same Vdiff we used for high currents, Rd which Is not effective** at low currents so has less compensation effect.
- Full Report will be submitted next meeting.

Thank You