# IEEE802.3at Task Force

# Vport ad hoc

## Suggested Remedy for comment #183, 184

October 2007

Yair Darshan
Microsemi Corporation

# Background for comments 183 and 184

- Based on Vport ad-hoc meeting on October 11,2007 the group agree on the following baseline concept to address those comments:
  - (1) PD Model is constant power model ➔ Iport=Ppd/Vport
  - (2) Iport_avg and Iport_peak are function of Vport at PD input/PSE output
  - (3) Ipeak/Iavg = $Ki_{CLASS}$ determined by the specifications (design constrains).
  - (4) Specification shall support legacy PD peak current numbers as presented in table 33-12 item 4.

- As a result of the above baseline, the following text corrections are proposed to meet (1) to (4) objectives.

# IEEE802.3 Draft D0.9 Status

Eq-2 is just Informative..

It is better to allow higher Idc for class 1,2 and to use the same 0.4/0.35 ratio for all classes

$$(Eq-2)\quad Kp_{class} = \frac{Ki_{class}\cdot(Vpse - Ki_{class}\cdot Iport\_avg\cdot Rc)}{(Vpse - Iport\_avg\cdot Rc)}$$

| Source | Table 33-10 | | Table 33-12 | Table 33-12 | Table 33-12 | Table 33-12 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Ppd_Class | Ppd_Class | Vpd | Vpd | Iport | Iport | Ppeak/Pavg | Ipeak/Iavg | Rc | Vpse |
| Units | W (DC/RMS) | W peak | avg | at Ipeak | peak | avg | Kp | Ki | OHMS | Vdc |
| Class1 | 3.84 | 4.992 | 42.179 | 41.600 | 0.12 | 0.091 | 1.300 | 1.318 | 20 | 44 |
| Class 2 | 6.49 | 8.358 | 40.820 | 39.800 | 0.21 | 0.159 | 1.288 | 1.321 | 20 | 44 |
| Class 0,3 | 12.95 | 14.400 | 37 | 36.000 | 0.4 | 0.350 | 1.112 | 1.143 | 20 | 44 |
| Class 4 | 29.52 | 32.683 | 41.000 | 39.713 | 0.823 | 0.720 | 1.107 | 1.143 | 12.5 | 50 |

$$(Eq-3)\quad Iport\_peak = Ki_{class}\cdot Iport\_avg$$

$$(Eq-1)\quad Iport\_avg = \frac{Vpse - (Vpse^2 - 4\cdot Ppd\_avg\cdot Rc)}{2\cdot Rc}$$

Shown in the specification or derived directly from it

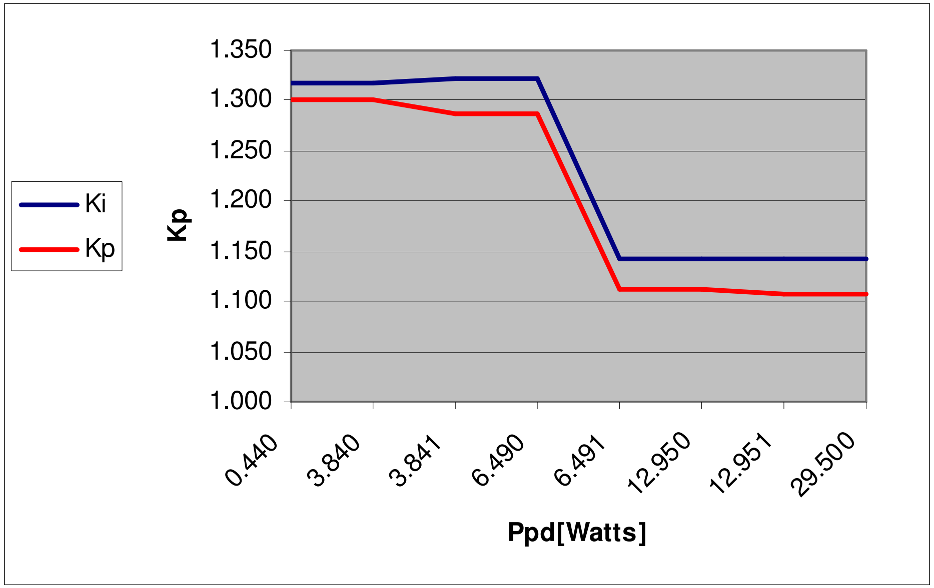
Calculated values based on PD constant power equations

# Key inputs

- **Ki_class=Ipeak/Iavg. ➔ Ki_class determines Ipeak, Ppeak.**
- Kp_class is a function of Ki_class, Vpse and Iport_avg. It is not a constant actually it is a complex variable.
  - Kp transforms current to power in the PD constant power equations.
- **Using only Ki as proposed in the Table below allows meeting all our objectives**

| Class | Ppd | Kp | Ki |
|---|---|---|---|
| 1 | 0.440 | 1.300 | 1.318 |
| 1 | 3.840 | 1.300 | 1.318 |
| 2 | 3.841 | 1.288 | 1.321 |
| 2 | 6.490 | 1.288 | 1.321 |
| 0,3 | 6.491 | 1.112 | 1.143 |
| 0,3 | 12.950 | 1.112 | 1.143 |
| 4 | 12.951 | 1.107 | 1.143 |
| 4 | 29.500 | 1.107 | 1.143 |

Table TBD-1



# Suggested Text changes – Comment #183,184

Suggested Remedy principles:

For maintaining consistency with Table 33-12 item 4 and 33.2.8.4:

1. Table 33-12 item 4: Change symbol from “Iport” to “Iport_peak”
2. Replace the equation “Pport_max/Vport” with “Iport_peak as defined by Table 33-12 item 4”.
2. Add the text “Iport_peak is approximated by Eq-3”
3. Add equation Eq-3, Eq-1 and Ki_class constants from Table TBD1 to table 33-10 in separate column.
4. Update accordingly 33.2.8.4 and 33.2.8.4a by removing “17.6W/Vport” and referring to Eq-1 and Eq-3.
5. Update 33.2.8.6 to reflect the above changes.
6. **See attached word document for detailed remedy**

# Suggested Remedy Text for comment #183, 184

- See attached word document for full description of text changes.

# Additional Information

# Issues to be solved with the original suggested remedy

- Ipeak used in Table 33-12 item 4 contains margins for class 1 and 2 i.e. Ki>0.4/0.35. Hence the equation as proposed to be used needs some modifications to present Ipeak as function of Ki_class.
  - The actual PD constant power model is not pure constant power model since efficiency is not 100%. This is the reason for the margin taken for Class 1,2 at Iport_eak per table 33-12 item 4.

- Ipeak numbers per table 33-12 item 4 can not be changed due to the above rational and to keep legacy PDs compliant.

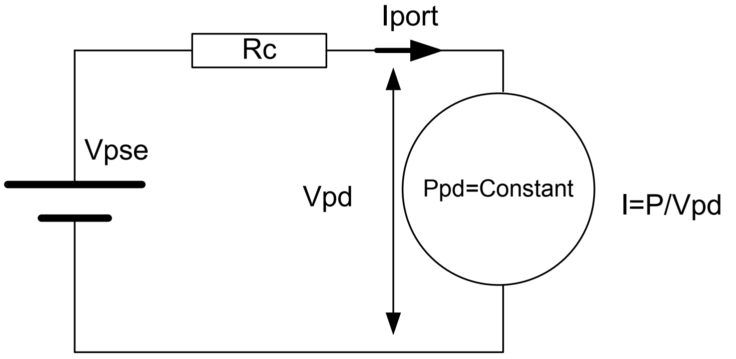
# Simplified PD constant Power Model[1]

$$Assuming\ efficiency\ of\ PD\ is\ 100\%$$

$$\frac{Vpse - Vpd}{Rc} = \frac{Ppd}{Vpd}$$

$$Vpd = \frac{Vpse + (Vpse^2 - 4 \cdot Ppd \cdot Rc)^{0.5}}{2}$$

$$Iport = \frac{Vpse - Vpd}{Rc} = \frac{Vpse - (Vpse^2 - 4 \cdot Ppd \cdot Rc)^{0.5}}{2 \cdot Rc}$$




$$Ki = \frac{Iport\_peak}{Iport\_avg}$$

$$Iport\_peak = Ki \cdot Iport\_avg$$

$$Vpd\_peak = (Vpse - Iport\_peak \cdot Rc)$$

$$Vpd\_avg = (Vpse - Iport\_avg \cdot Rc)$$

$$Kp = \frac{Ppd\_peak}{Ppd\_avg} = \frac{Vpd\_peak \cdot Iport\_peak}{Vpad\_avg \cdot Iport\_avg} =$$

$$Kp = \frac{Ki \cdot (Vpse - Ki \cdot Iport\_avg \cdot Rc)}{(Vpse - Iport\_avg \cdot Rc)}$$

$$Iport\_peak = \frac{Vpse - (Vpse^2 - 4 \cdot Ppd\_avg \cdot Kp_{class} \cdot Rc)^{0.5}}{2 \cdot Rc}$$

or

$$Iport\_peak = Ki_{class} \left[ \frac{Vpse - (Vpse^2 - 4 \cdot Ppd\_avg \cdot Rc)^{0.5}}{2 \cdot Rc} \right]$$

# Actual PD constant power model

$$Assuming\ efficiency\ of\ PD\ is\ a\ variable,\ eff:$$

$$eff = \frac{Pout}{Ppd} = \frac{Pout}{Pout + Ploss}$$

$$Ploss = \frac{Pout \cdot (1 - eff)}{eff}$$

$$Reff = \frac{Pout \cdot (1 - eff)}{eff \cdot Iport^2}$$

$$Vpse - Ipd \cdot Rc - Ipd \cdot Reff = V$$

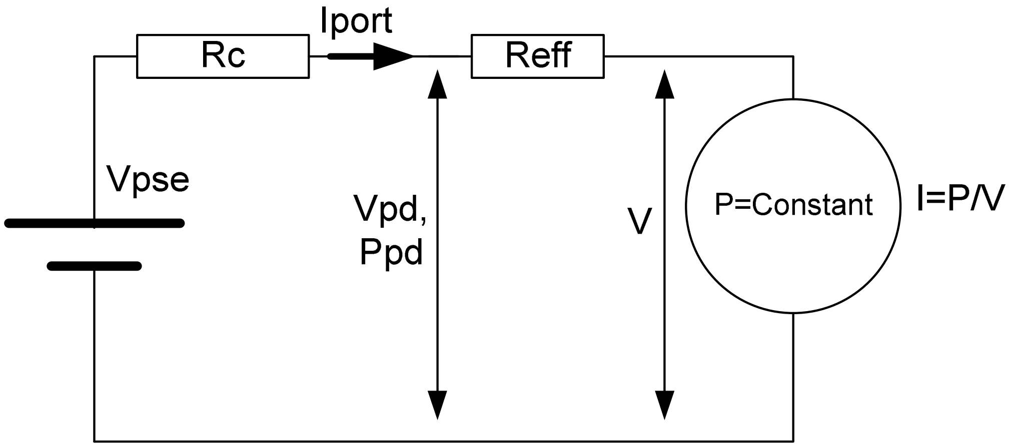
$$Ipd = \frac{P}{V}$$

$$V^2 - V \cdot Vpse + P(Rc + Reff) = 0$$

$$V = \frac{Vpse - (Vpse^2 - 4 \cdot P \cdot (Rc + Reff))^{0.5}}{2}$$

$$Ipd = \frac{Vpse - V}{Rc + Reff}$$

$$Vpd = V + Reff \cdot Ipd$$




$$Ipeak = \frac{Vpse - (Vpse^2 - 4 \cdot P \cdot Kp\_class \cdot (Rc + Reff))^{0.5}}{2 \cdot (Rc + Reff)}$$

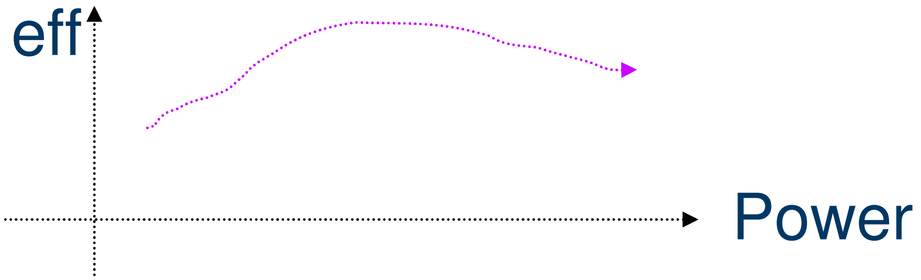
*or*

$$Ipeak = Ki_{class} \left[ \frac{Vpse - (Vpse^2 - 4 \cdot P \cdot (Rc + Reff))^{0.5}}{2 \cdot (Rc + Reff)} \right]$$

For each Ppd we need to find its Reff, P numbers on order to get Vpd and Ppd. Next we have to use Ki, Kp techniques as in the simplified model

# Efficiency v.s. Power

- In conventional DC/DC converters efficiency is optimized near max. power.
- If output power is decreased, efficiency is decreased due to the growing effect of constant losses that are not function of the load power (housekeeping etc.)
- As a result, the simplified model is good enough at max. power range. At lower power range additional design margin is required. Hence Table 33-12 item 4 is using higher peak current than Ki=0.4/0.35 for class 1 and 2.



# Discussions and comments