Proposed Worst-case IC Power Dissipation Calculation

$$IC\_Pd = P_{COND\_Mos} + P_{SW} + P_{GD} + P_{IQ}$$

Take the value in Webench simulation result

$P_{HIGH\_COND} + P_{LOW\_COND}$

can be considered as constant in the entire temperature range

$V_{IN} * I_Q$

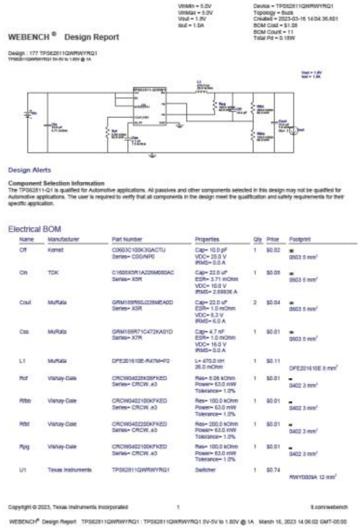
IC_{PD} (IC Power dissipation)

- Input all the application conditions (Vin, Vout, Iout) in Webench. Set the temperature to 30°C
- Click the "Customize" button to modify the passive component parameters (Cin, Cout, Lout, R_{FB}) if necessary.
- Use the "SIMULATE" function to calculate for the IC power dissipation
- Go to "Export" to generate the design report. Get the IC power dissipation data

Example:

click to open the Webench design report

16.	IC Pd	140.09 mW	Power	IC power dissipation



Webench link: https://webench.ti.com/power-designer/switching-regulator

Mosfet Conduction losses

- High-side FET conduction loss

$$\boldsymbol{P_{HS_{cond}}} = RDS_{onHS} * (I_o{}^2) * D \; * \left(1 + \frac{1}{12}\left(\frac{L\_Ipp}{I_o}\right)^2\right)$$

- Low-side FET conduction loss

$$\boldsymbol{P_{LS_{cond}}} = RDS_{onLS} * (I_o{}^2) * (1 - D) \; * \left(1 + \frac{1}{12}\left(\frac{L\_Ipp}{I_o}\right)^2\right)$$

P_{HScond}: high-side FET conduction loss

P_{LScond}: low-side FET conduction loss

***$R_{DSon_{HS}}$:** high-side FET on-state resistance

***$R_{DSon_{LS}}$:** high-side FET on-state resistance

I_O: output current

D: duty cycle (Vout / Vin)

L_Ipp : inductor peak-peak ripple current

- *for worst case analysis, use the max on-state resistance indicated in the datasheet*
- *take the calculated duty cycle and inductor peak-peak current ripple in Webench simulation result*

reference: https://www.ti.com/lit/an/slvaeq9/slvaeq9.pdf?ts=1665007621996

Calculate P_{SW} + P_{GD}

- Application condition
  - Vin = 3.3V
  - Vout = 1.8V
  - Iout = 1.0A

$$P_{HS_{cond}} = RDS_{onHS} * (I_o{}^2) * D * \left(1 + \frac{1}{12}\left(\frac{L\_Ipp}{I_o}\right)^2\right)$$

$$P_{LS_{cond}} = RDS_{onLS} * (I_o{}^2) * (1 - D) * \left(1 + \frac{1}{12}\left(\frac{L\_Ipp}{I_o}\right)^2\right)$$

- Calculate for P_{SW} + P_{GD} at Tamb = 30 °C
  - IC_Pd = 148.39 mW (from Webench)
  - P_{HS_cond} = 37mΩ * $(1A)^2$ * (0.37) * (1 + 1/12 $(1.103A)^2$) = 15.08mW
  - P_{LS_cond} = 15mΩ * $(1A)^2$ * (1 – 0.37) * (1 + 1/12 $(1.103A)^2$) = 10.41mW
  - P_{IQ} = 5.0V * 15µA = 75µW

  - P_{SW} + P_{GD} = IC_Pd + (P_{HScond} + P_{LScond}) + P_{IQ} = 148.39mW – 10.41mW – 15.08mW - 75µW
  - P_{SW} + P_{GD} = 122.675mW

Worst-case calculation sample

- $P_{SW} + P_{GD}$ = 122.675mW
- P_{HS_cond} = 60mΩ * $(1A)^2$ * (0.37) * (1 + 1/12 $(1.103A)^2$)
  = 24.45mW (wc on-state resistance)
- P_{LS_cond} = 35mΩ * $(1A)^2$ * (1 – 0.37) * (1 + 1/12 $(1.103A)^2$)
  = 24.28mW (wc on-state resistance)
- P_{IQ} = 5.0V * 30mA = 150µW

- IC_Pd = $P_{COND\_Mos} + P_{SW} + P_{GD} + P_{IQ}$
- IC_Pd = (24.45mW + 24.28mW) + (122.675mW) + 150µW
- IC_Pd = 171.55mW

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