

Inrush / Soft-Start Calculator

Quick worksheet for sizing load-switch / eFuse parameters (dV/dt, ILIM, RON) and estimating thermal stress during start-up.

Inputs (per rail)

Parameter	Symbol	Units	Value (enter)	Notes
Input voltage	V_IN	V		
Target output	V_OUT	V		Often equals V_IN for simple rails
Load capacitance	C_load	μF		Total downstream capacitance
Soft-start slope	dV/dt	V/ms		Program via capacitor/resistor pin where applicable
Switch on-resistance	R_ON	mΩ		From datasheet at operating temp
Current-limit	I_LIM	A		Programmable or fixed (eFuse)
Ambient rise allowed	ΔT_allow	°C		Thermal budget for package/board

Equations

$$I_{\text{inrush}} = C_{\text{load}} \cdot dV/dt$$

$$t_{\text{ramp}} = V_{\text{OUT}} / (dV/dt)$$

$$P_{\text{diss}} \approx I_{\text{inrush}}^2 \cdot R_{\text{ON}} \text{ (during initial ramp)}$$

$$\Delta T_{\text{est}} \approx (P_{\text{diss}} \cdot R_{\theta JA})$$

$$I_{\text{req}} \geq \max(I_{\text{load_peak}}, I_{\text{inrush}}) \cdot \text{safety_factor (use 1.3-1.6x)}$$

Worked Example

Assume V_IN=5.0 V, V_OUT=5.0 V, C_load=470 μF, dV/dt=1.25 V/ms, R_ON=28 mΩ.

$$I_{\text{inrush}} = 470e-6 \cdot 1.25e3 = 0.5875 \text{ A} \approx 0.59 \text{ A}$$

$$t_{\text{ramp}} = 5.0 / 1.25 = 4.0 \text{ ms}$$

$$P_{\text{diss}} \approx (0.59)^2 \cdot 0.028 \approx 9.7 \text{ mW (peak, ignoring foldback)}$$

Choose I_LIM ≥ 1.5 × max(I_load_peak, 0.59 A). For a 1.2 A peak load, target I_LIM ≈ 1.8 A.

Multi-Rail Planning (fill and copy as needed)

Rail Name	V_OUT [V]	C_load [μF]	dV/dt [V/ms]	I_inrush [A]	I_LIM [A]	R_ON [mΩ]	Notes

Notes & Tips

- Program dV/dt where available to keep I_{inrush} under I_{LIM} with margin.
- Watch reverse blocking/ideal diode behavior for back-powering risks.
- For automotive rails, consider ISO 7637-2/load-dump events and AEC-Q100 parts.
- Thermal estimates are first-order; verify on board with worst-case temperature.