Split-Phase Control
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\[ \bar{a}^2 = \left[ \begin{array}{cccc} \frac{1}{4} & -\frac{1}{8} & -\frac{1}{8} & -\frac{1}{8} \\ \frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} & \frac{1}{2} \end{array} \right] / g_{out} \]

\[ \bar{a}^{ab} = \left[ \begin{array}{cccc} 0 & -\frac{1}{8} & -\frac{1}{8} & -\frac{1}{8} \\ \frac{1}{4} & 0 & -\frac{1}{4} & -\frac{1}{4} \end{array} \right] / g_{out} \]

\[ D_a + D_{ab} = 50\% \quad D_z + D_{zab} = 50\% \]

\[ \begin{bmatrix} D_a & D_{ab} & D_z & D_{zab} \end{bmatrix} = \begin{bmatrix} \bar{a}^2 \\ \bar{a}^{ab} \\ \bar{a}^2 \\ \bar{a}^{ab} \end{bmatrix} = \begin{bmatrix} -\frac{1}{6} & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \]

\[ D_a = D_z = \frac{1}{6} \quad D_{ab} = D_{zab} = \frac{1}{6} \]

LTSpice Simulation

![Graph showing voltage (Vout) vs. current (Iout) for different LTSpice simulations with various flyback capacitance (Cfly) and on resistance (Ron). The graph illustrates split-phase and current-loaded modes.]
Complete Soft Charging

FCML and SC Buck