

How works a resonant converter? (Corrected Version)

Battery Voltage U_B

Unity Charge $Q = C \cdot U_B$

$$\omega^2 = 1/LC, Z = \sqrt{L/C}$$

$$\omega = 2\pi f = 2\pi/T$$

$$U_C = U_B - U_B \cdot \cos(\omega t)$$

$$U_C = 2 U_B \text{ after one swing } \omega t = \pi$$

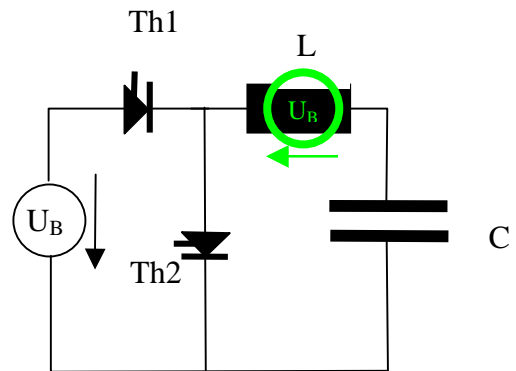
$$Q_C = C \cdot U_C = C \cdot 2 \cdot U_B = 2 Q$$

Work performed during second half cycle:

$$U_B \rightarrow 2U_B = C(2U_B)^2 - CU_B^2 = 3QU_B$$

$$W_C = \frac{1}{2} Q_C U_C = 2 Q U_B$$

$$I_L = I_{\text{peak}} \cdot \sin(\omega t)$$



Balance of Energy:

First half cycle = second half cycle

$$\frac{1}{2} L \cdot I^2 + QU_B = 2QU_B + QU_B$$

$2 \cdot QU_B$ = amount of energy loaded onto the C by the battery alone without the L help, being actually the charge $2Q$ that flows onto the C.

$2QU_B$ = max. amount of energy stored by the current

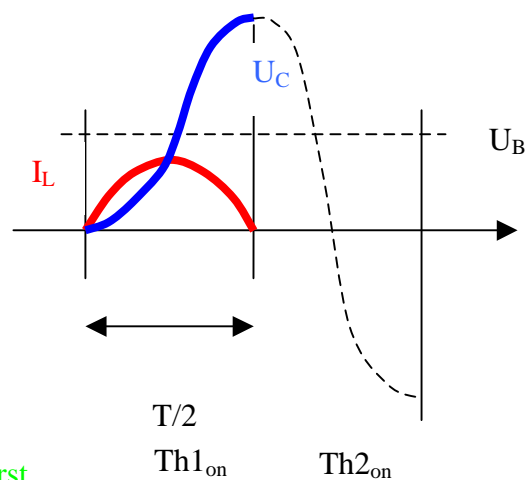
$\frac{1}{2} L \cdot I^2$ through L in the magnetic field of L during first half cycle that is then discharged (by reverse voltage like an additional serial voltage source) during second half cycle and lifts the charges of C by $2U_B$ on double battery voltage.

$$\frac{1}{2} L \cdot I^2 = 2QU_B$$

$$I^2 = \frac{4}{L} QU_B$$

$$= 4 \omega^2 C^2 U_B^2$$

$$I_{\text{peak}} = C \omega 2 U_B = 2U_B/Z \rightarrow \text{At end of second half cycle the battery voltage is double!}$$



$$W_B = \int_{T/2}^{T/2} I_L \cdot U_B dt = C \int_{T/2}^{T/2} \omega 2U_B \sin \omega t U_B dt = C 4U_B^2 = 4 QU_B = Q_C U_C = 2 W_C$$

→ Only 50 % of the energy supplied by the battery is eventually stored on the capacitor, the other 50 % energy gets lost as heat also when charging with a switched power supply!

→ The losses however in the circuit of the switched converter alone are extreme low, the lost energy dissipates inside the capacitor.