

How works a resonant converter?

Battery Voltage U_B

Unity Charge $Q = C \cdot U_B$

$$\omega^2 = 1/LC$$

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

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

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

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

$$\text{Work performed} = U_C \cdot Q_C = 4 Q U_B$$

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

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

$$I_{\text{RMS}} = I_{\text{peak}} / \sqrt{2} \text{ (when sinusoidal)}$$

Balance of Energy:

First half cycle = second half cycle

$$\frac{1}{2} L \cdot I_{\text{RMS}}^2 - Q U_B = 2 Q U_B + Q U_B$$

$2 \cdot Q U_B$ = 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.

$2 Q U_B$ = amount of energy stored by the current $\frac{1}{2} L \cdot I_{\text{RMS}}^2$ through L in the magnetic field of L during first half cycle that is then discharged during second half cycle and lifts the charges of C by $2 U_B$ on double battery voltage.

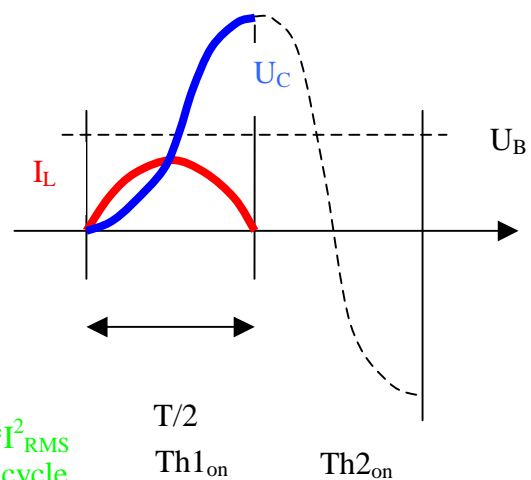
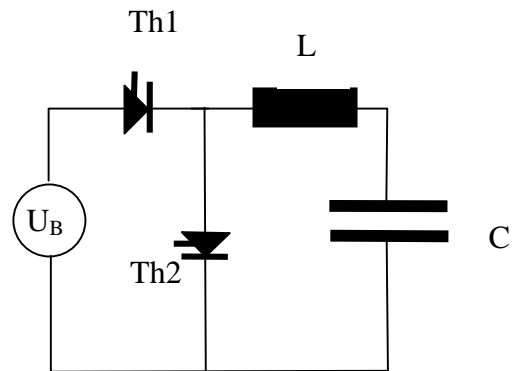
$$\frac{1}{2} L \cdot I_{\text{RMS}}^2 = 2 Q U_B + 2 Q U_B$$

$$I_{\text{peak}}^2 = 16/L \cdot Q U_B$$

$$= 4/L \cdot C U_B^2$$

$$I_{\text{peak}} = C \omega 2 U_C = C \omega 4 U_B$$

$$W_B = \int_0^{T/2} I_L \cdot U_B dt = C \int_0^{T/2} \omega 4 U_B \sin \omega t U_B dt = C 4 U_B^2 = 4 Q U_B = Q_C U_C = 2 W_C$$



➔ 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.

Can also be nicely seen on the ETH Zurich page:

http://www.ipes.ethz.ch/ipes/resonant/e_spgmul.html