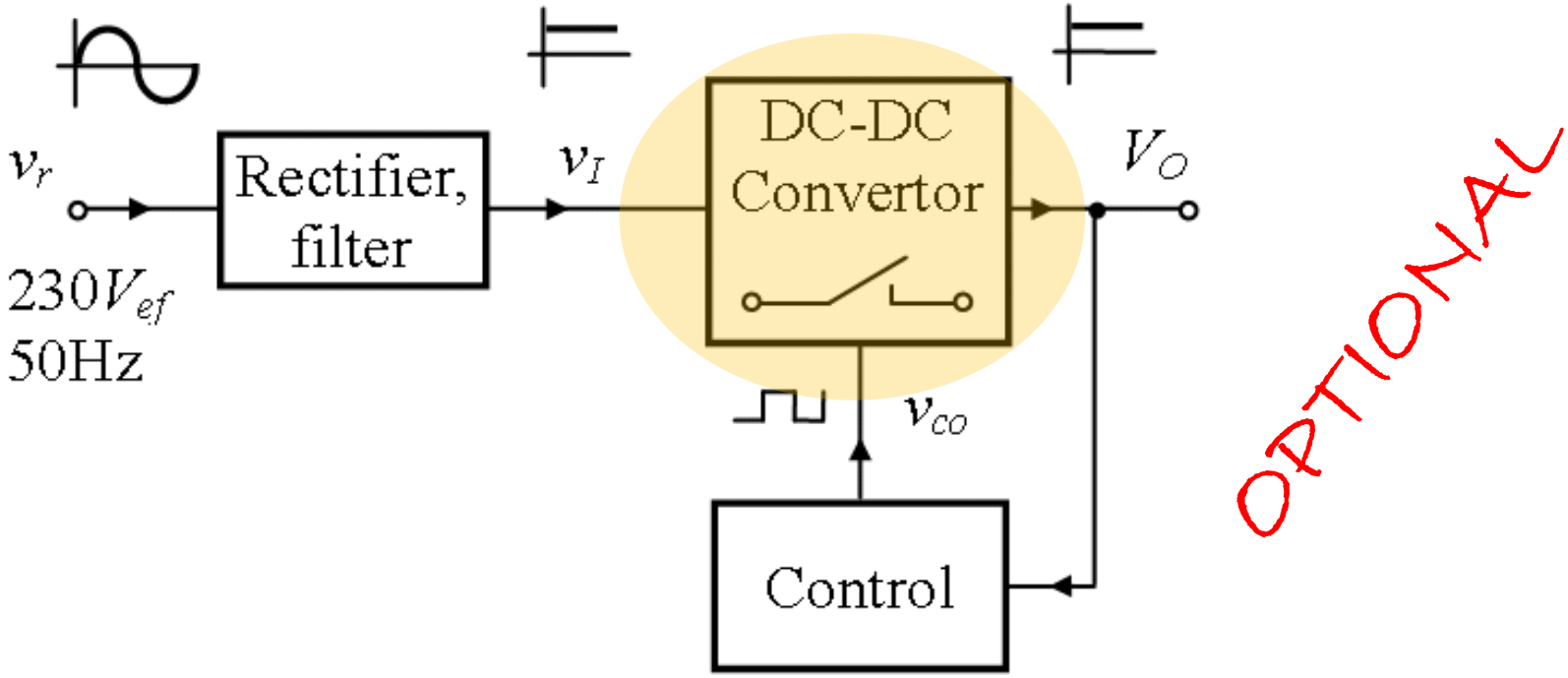
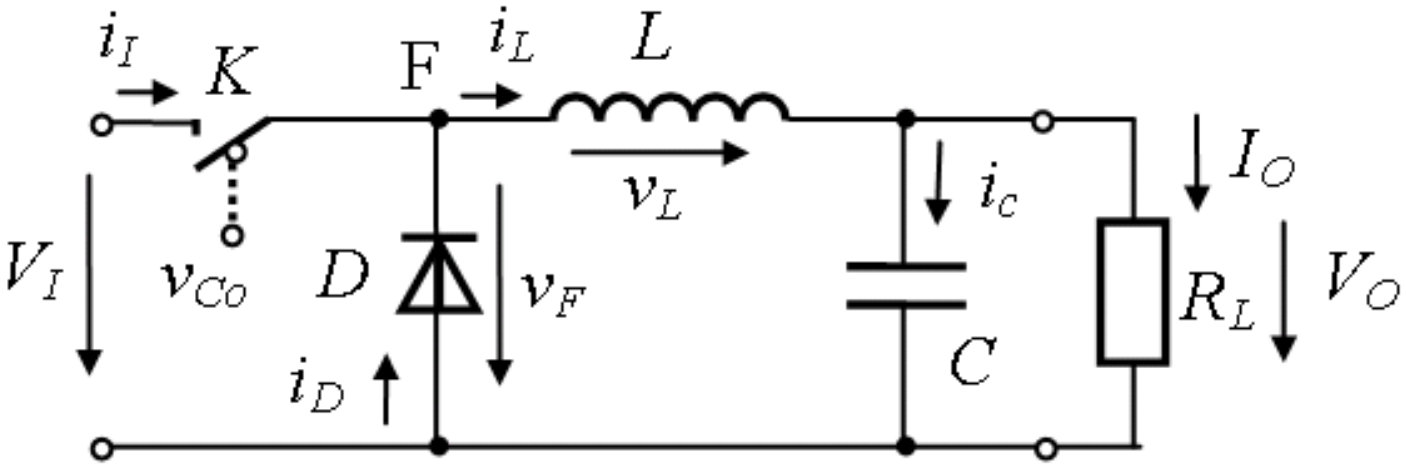
Switched Mode Power Supply



- v_I – periodically applied across an inductance for short time intervals
- energy is stored in the magnetic field $(1/2)Li_L^2$
- the energy is then transferred on a filtering capacitor, to the output
- the capacitor act like an energy reservoir and provides current into the load between the charging intervals
- the capacitor also smoothes the output voltage

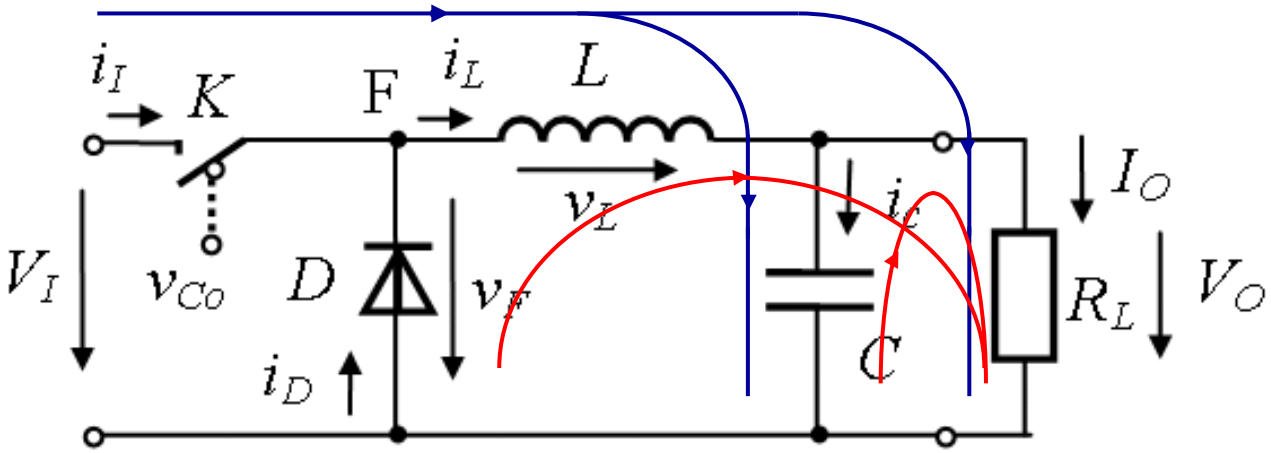
Step-down Converter or Buck Converter



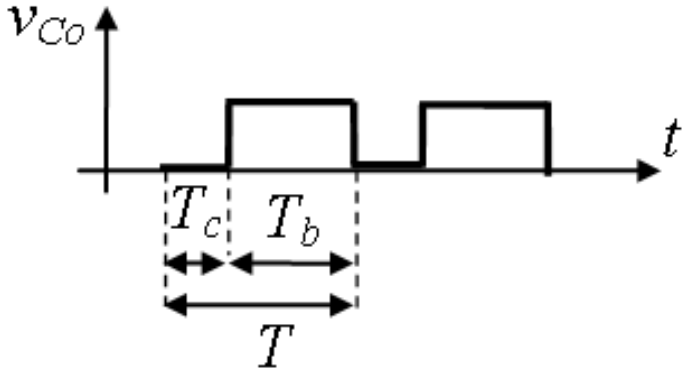
OPTIONAL

K is an ideal switch, *p* type (MOST *p* channel; BJT *pnp*) ;
All elements are lossless (except for load resistance);
The circuit operates in the steady state regime (all waveforms are periodic);
Output voltage is constant, (the ripple of the output voltage is neglected against the average value of V_O);
The input voltage is constant

Step-down Converter or Buck Converter – cont.



OPTIONAL

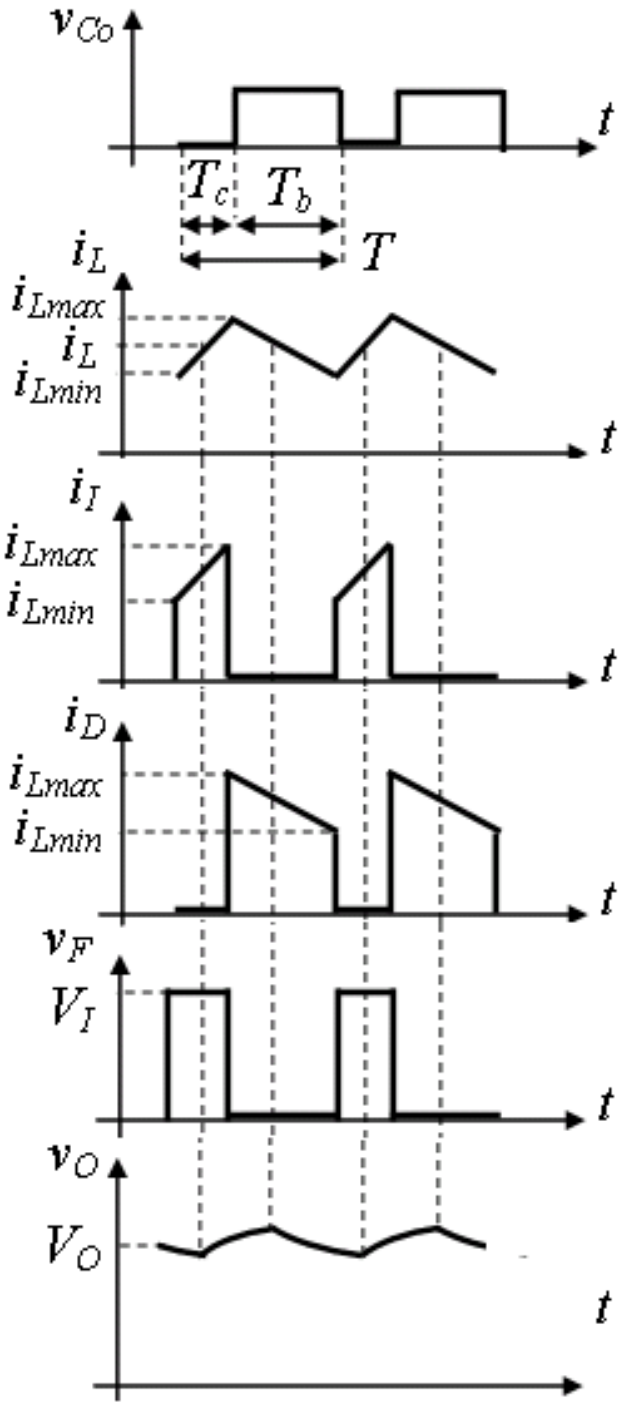


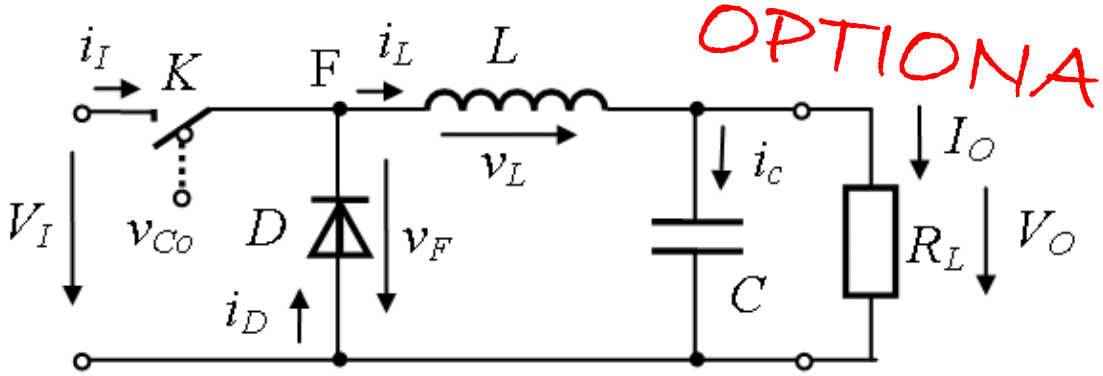
$$\frac{T_c}{T_c + T_b} = \frac{T_c}{T} = \delta$$

Duty factor

- ✓ T_c - conduction interval of K - energy is stored in the magnetic field of L
- ✓ T_b - blocking interval of K – energy is released to the output

OPTIONAL





For $v_L(t)=V_L$=cst

$$i_L(t)=\frac{1}{L}\int dv_L(t)dt$$

$$\Delta i_L=\frac{1}{L}V_L\Delta t$$

$\Delta t=T_c$ $\qquad \Delta i_L=I_{L\max}-I_{L\min}=\frac{1}{L}(V_I-V_O)T_c$

$\Delta t=T_b$

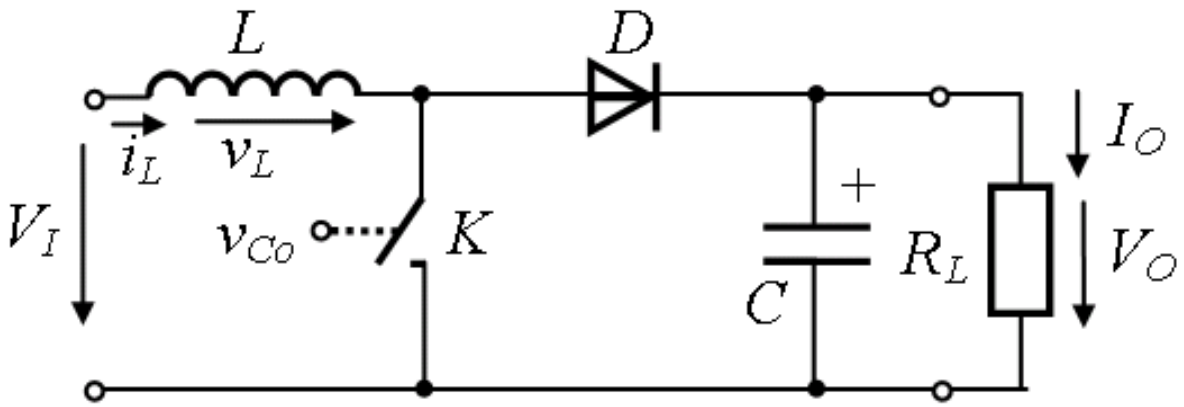
$$-\Delta i_L=I_{L\min}-I_{L\max}=\frac{1}{L}(-V_O)(T_b)=-\frac{1}{L}V_OT_b$$

$$\frac{1}{L}(V_I-V_O)T_c=\frac{1}{L}V_OT_b \qquad V_O=\frac{T_c}{T_c+T_b}V_I$$

$$\frac{T_c}{T_c+T_b}=\frac{T_c}{T}=\delta$$

$$\boxed{V_O=\delta V_I}$$

Step-up Convertor or Boost Convertor



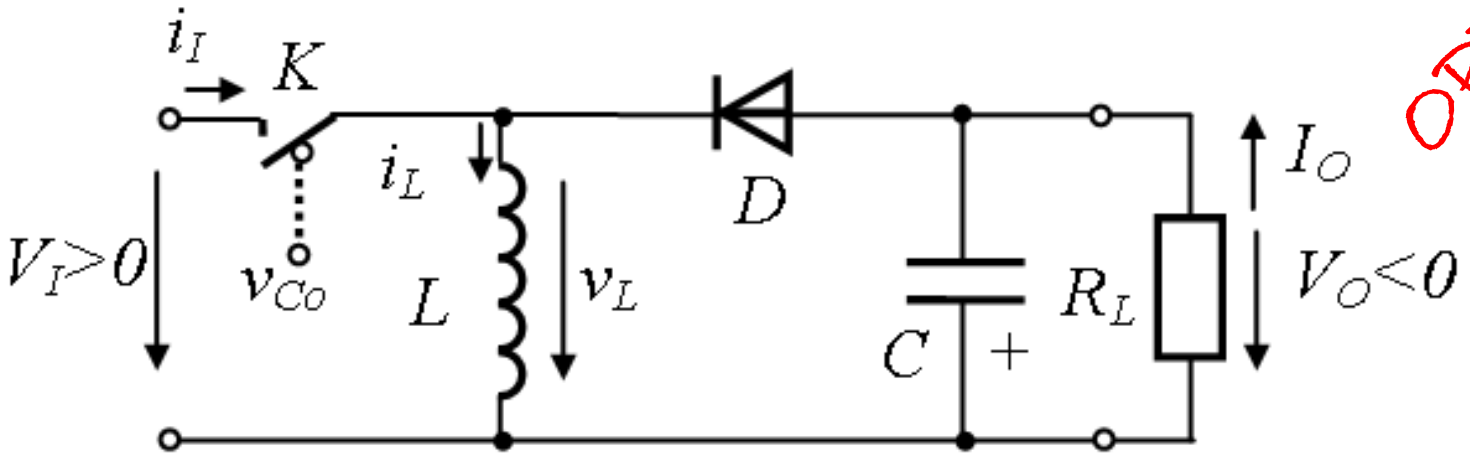
OPTIONAL

$$V_O = \frac{1}{1-\delta} V_I$$

$$\delta < 1 \qquad V_O > V_I$$

Step-down/Step-up Converter or Buck-Boost Converter

OPTIONAL



$$V_O = -\frac{\delta}{1-\delta} V_I$$

$\delta > 0.5$ The magnitude of the output voltage is greater than the input voltage

$\delta < 0.5$ The magnitude of the output voltage is less than the input voltage