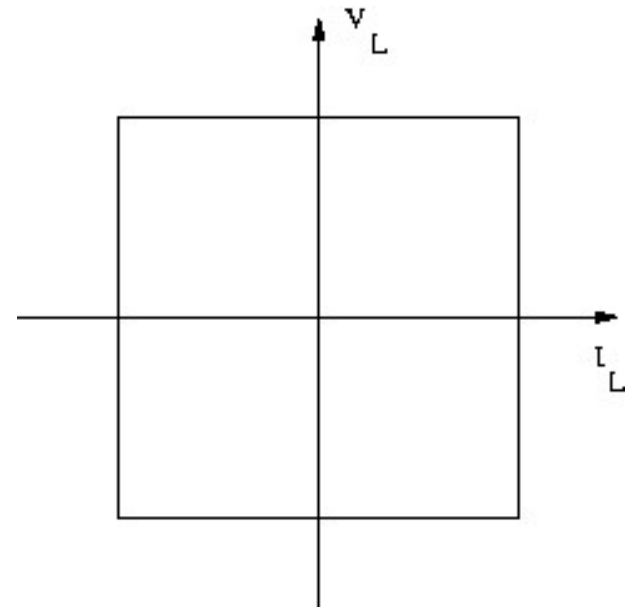
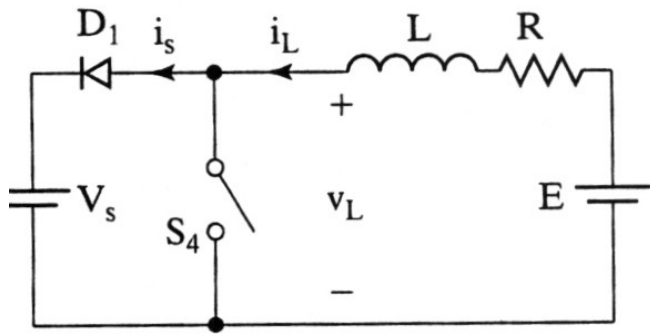


DC-DC Converter classification

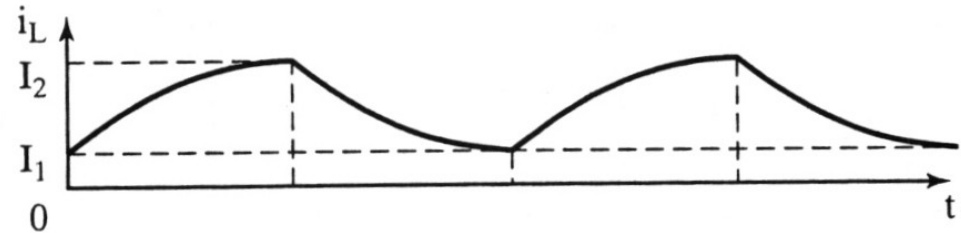
- First quadrant converter
- Second quadrant converter
- 1st and 2nd quadrant converter
- 3rd and 4th quadrant converter
- Four quadrant converter



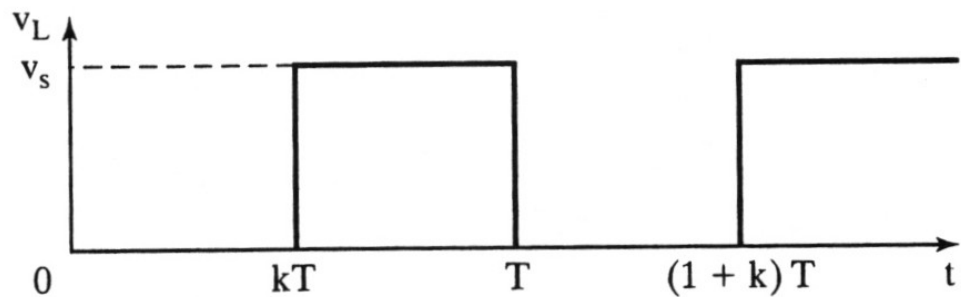
Second Quadrant Converter



(a) Circuit



(b) Load current

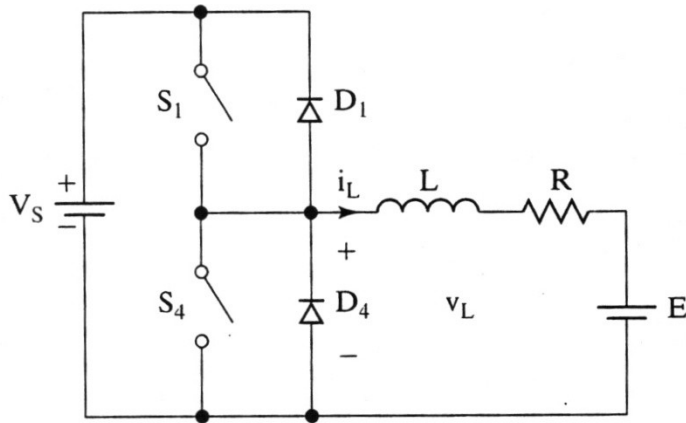


(c) Load voltage

$$I_1 = \frac{V_s}{R} \left(\frac{1 - e^{(k-1)z}}{1 - e^{-z}} \right) - \frac{E}{R}$$

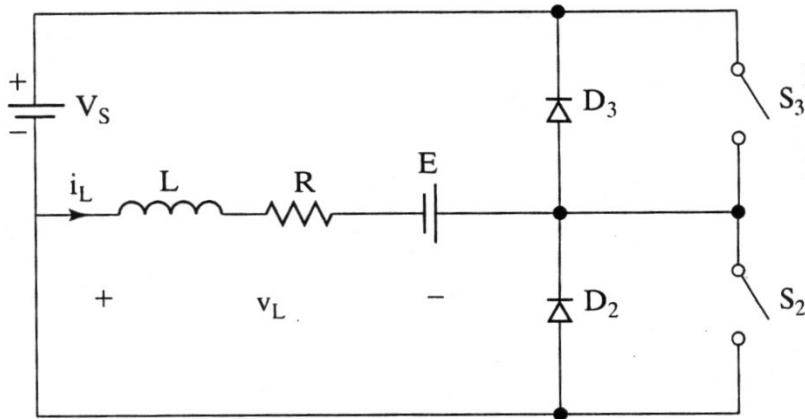
$$I_2 = \frac{V_s}{R} \left(\frac{e^{-kz} - e^{-z}}{1 - e^{-z}} \right) - \frac{E}{R}, \quad z = T \frac{R}{L}$$

1-2 and 3-4 quadrant converters



1st quad: S_1, D_4

2nd quad: S_4, D_1

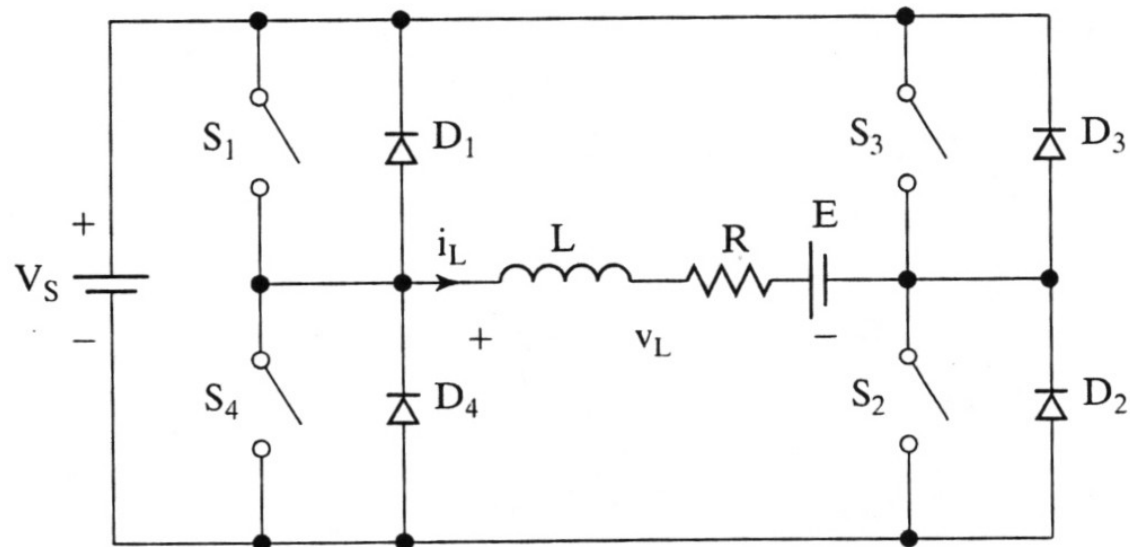


3rd quad: S_3, D_2

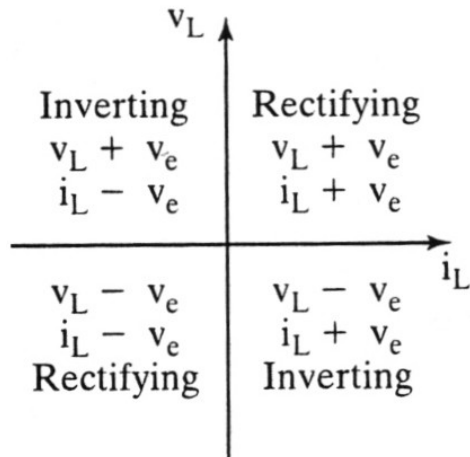
4th quad: S_2, D_3

Polarity of the load EMF is reversed.

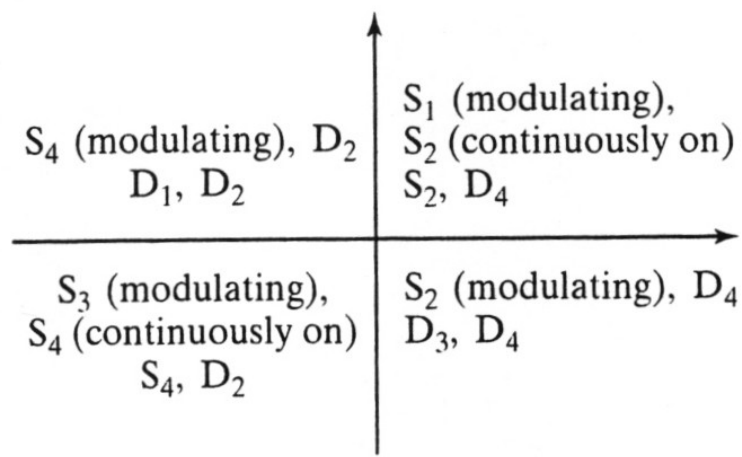
Four quadrant converter



(a) Circuit



(b) Polarities



(c) Conducting devices