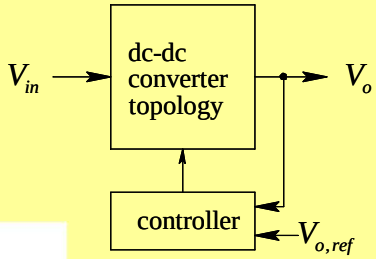
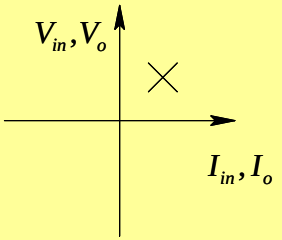
Discontinuous Conduction Mode (DCM) in DC-DC Converters

- CCM
- DCM
  - Border of CCM and DCM
  - Explanation for DCM
  - Average Representation in DCM

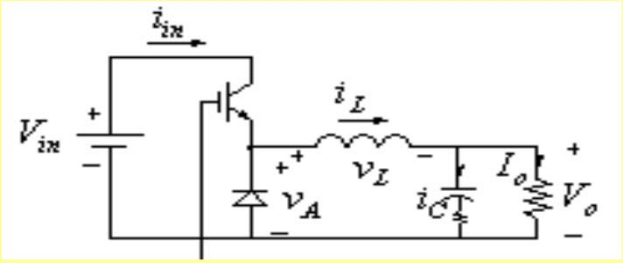
DC-DC Converters

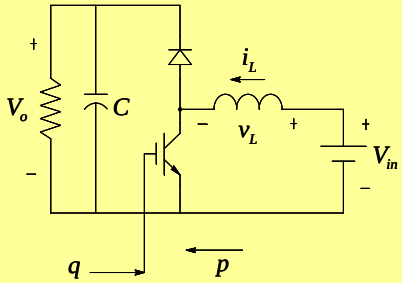


(a)

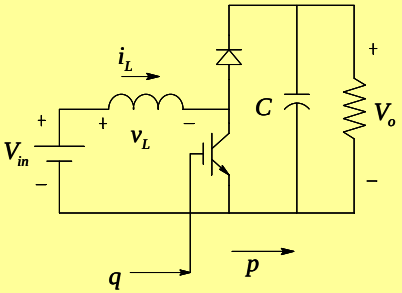


(b)

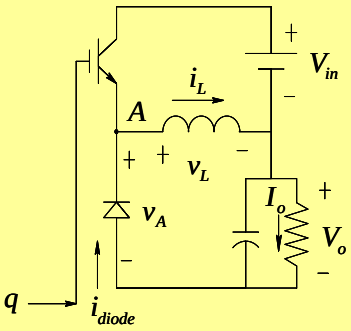




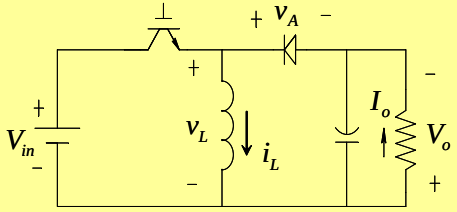
(a)



(b)

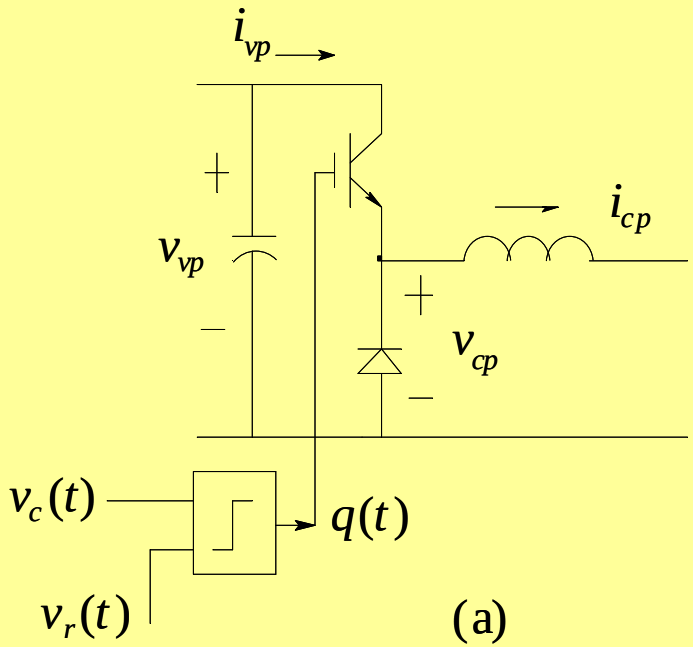


(a)

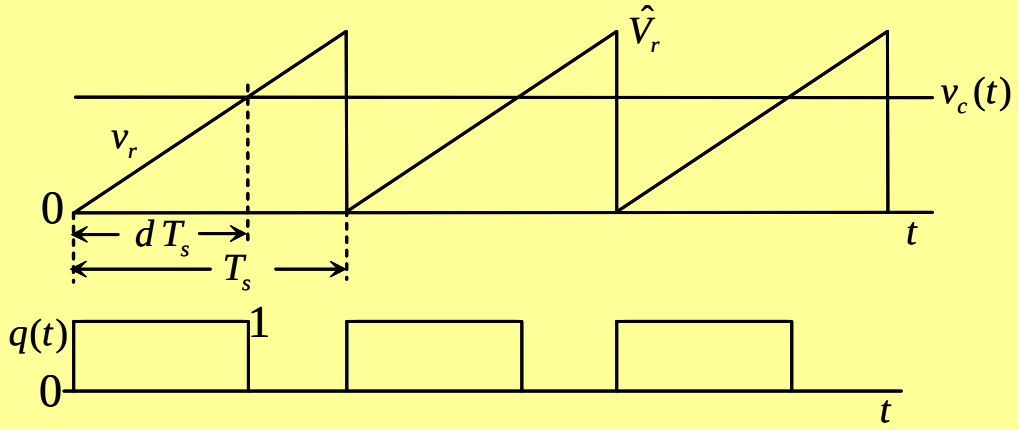


(b)

PWM in Switching Power-Poles:



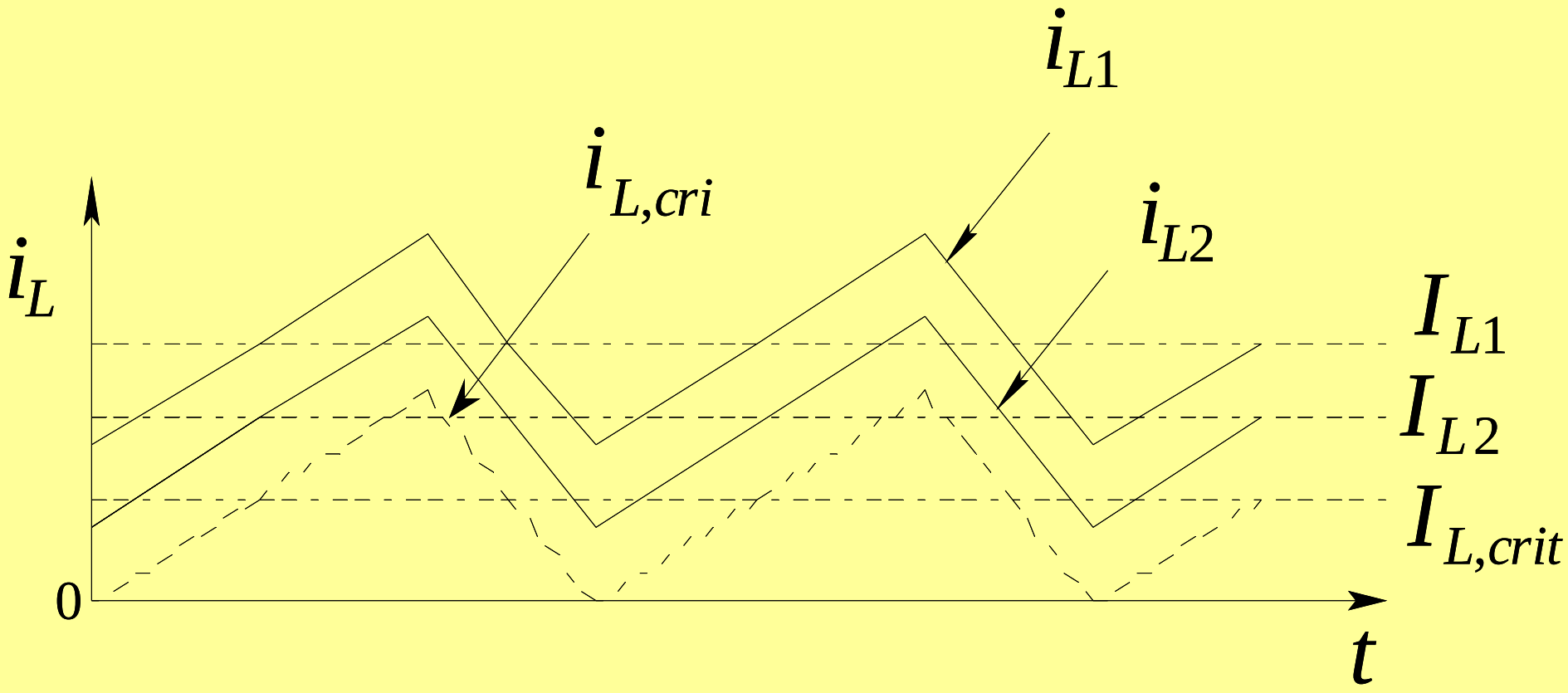
(a)



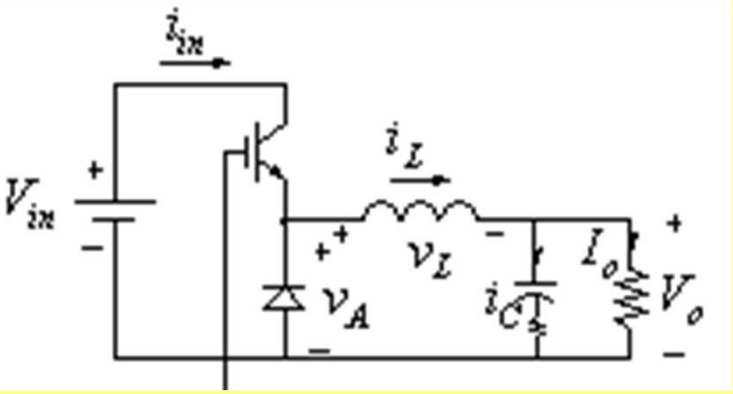
(b)

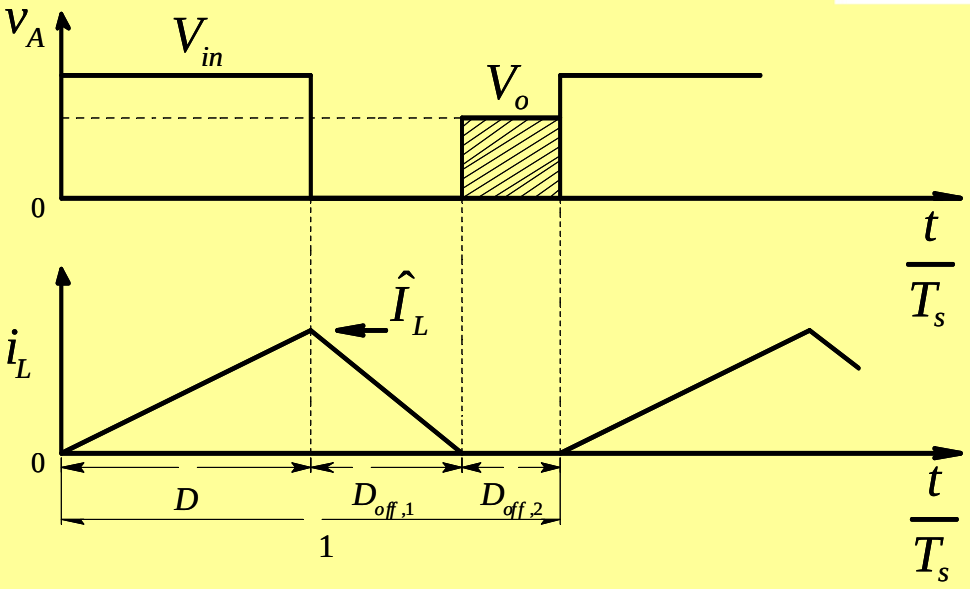
$$v_c(t) \longrightarrow \boxed{\frac{1}{\hat{V}_r}} \longrightarrow d(t) = \frac{v_c(t)}{\hat{V}_r}$$

Border of CCM and DCM:

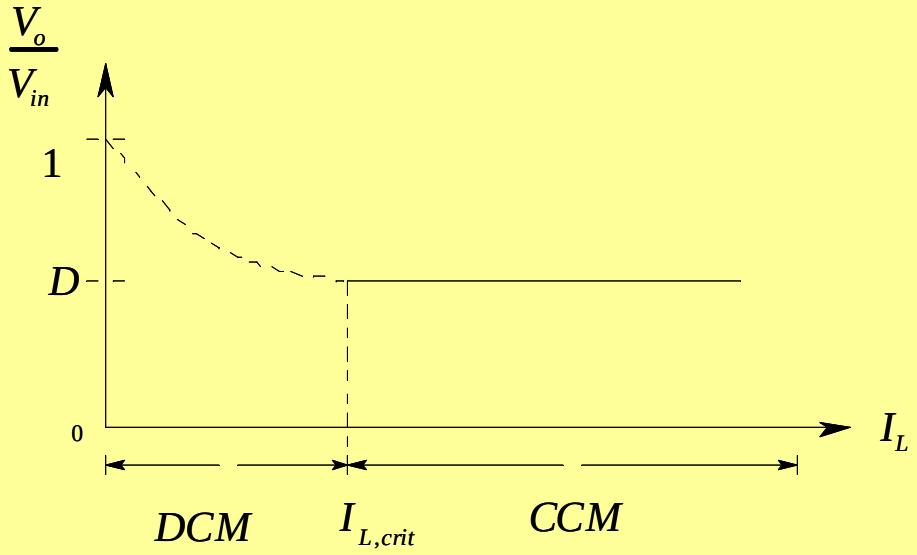


Buck converter in DCM





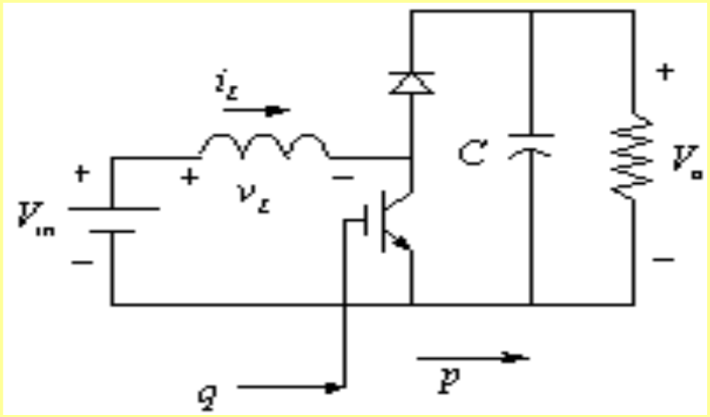
(a)

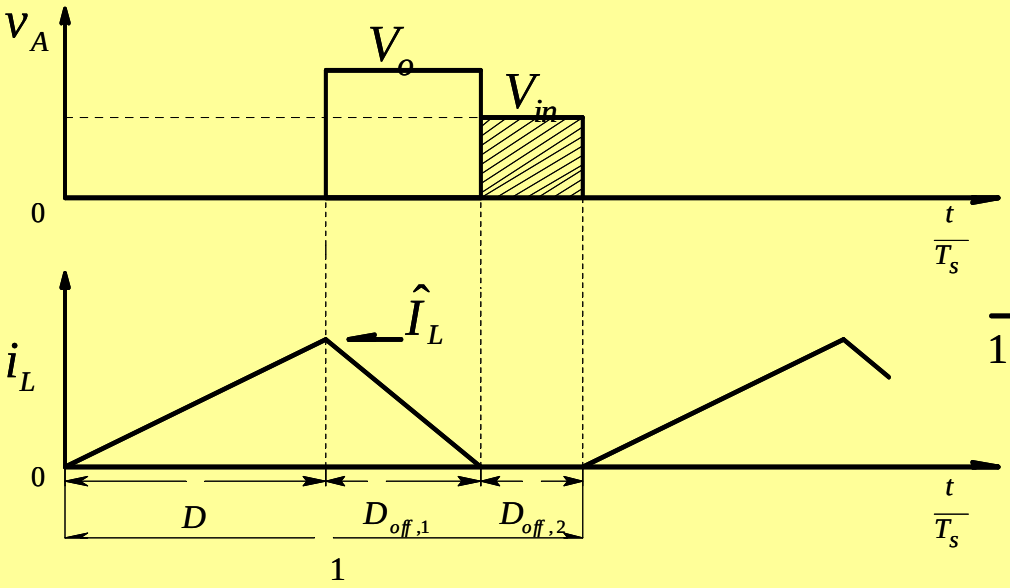


(b)

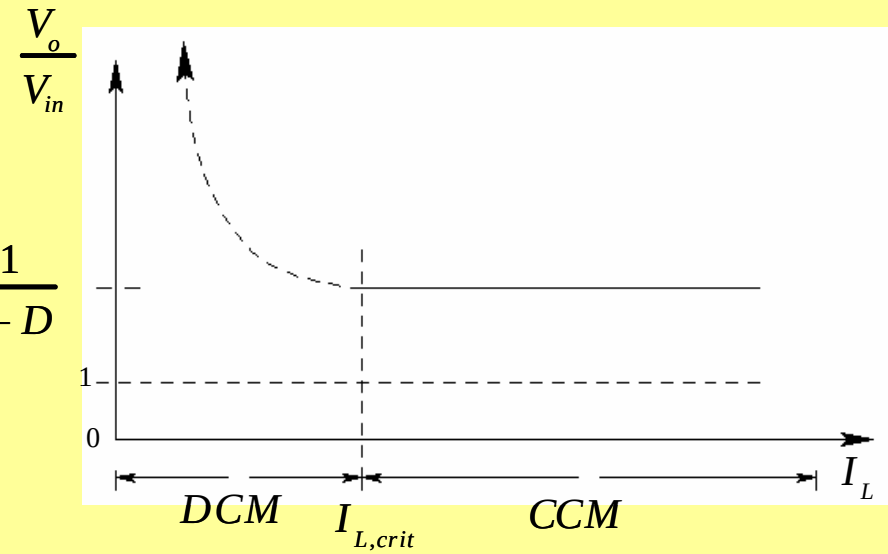
$$I_{L,crit,Buck} = \frac{V_{in}}{2Lf_s} D(1-D) \qquad R_{crit,Buck} = \frac{2Lf_s}{(1-D)}$$

Boost Converters in DCM





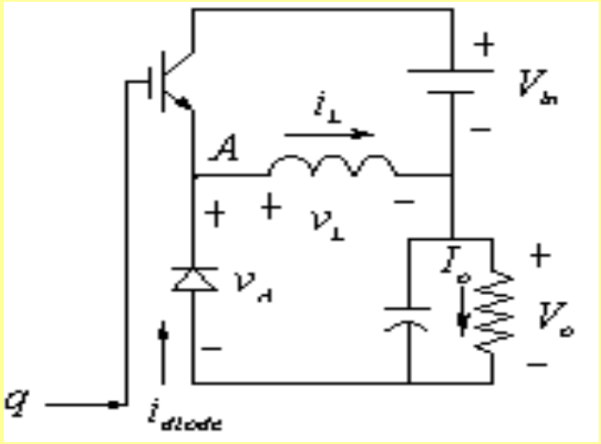
(a)

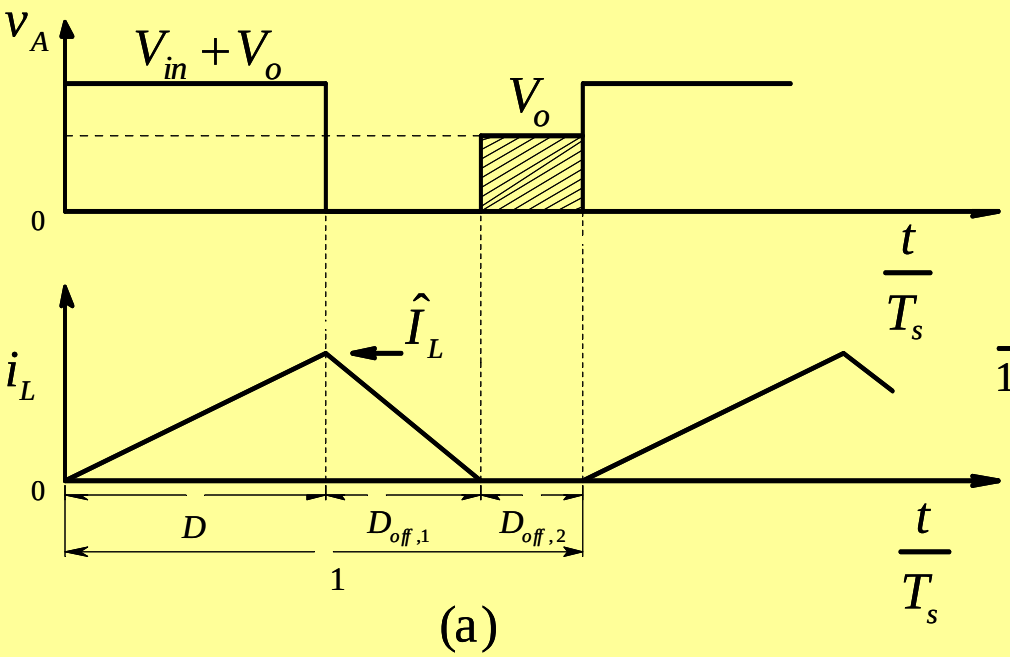


(b)

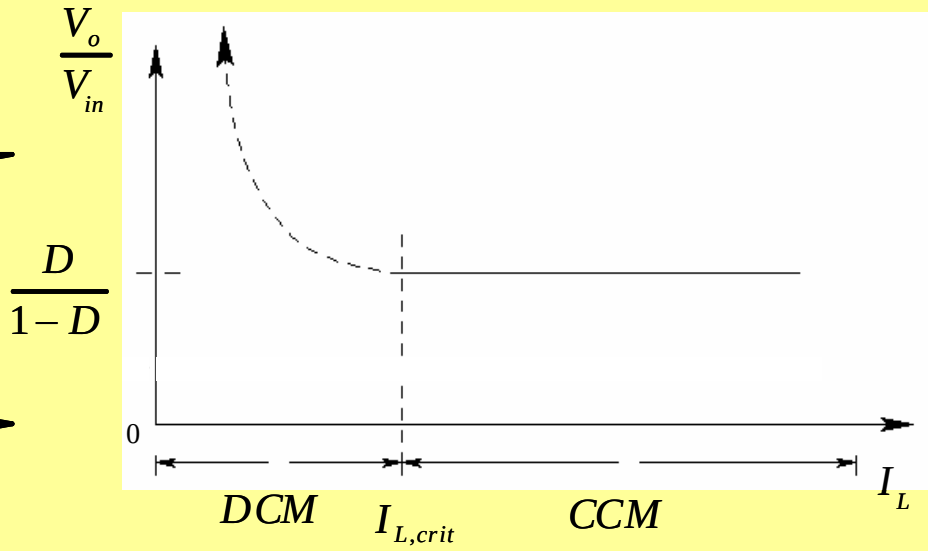
$$I_{L,crit,Boost} = \frac{V_{in}}{2Lf_s} D \qquad R_{crit,Boost} = \frac{2Lf_s}{D(1-D)^2}$$

Buck-Boost converter in DCM



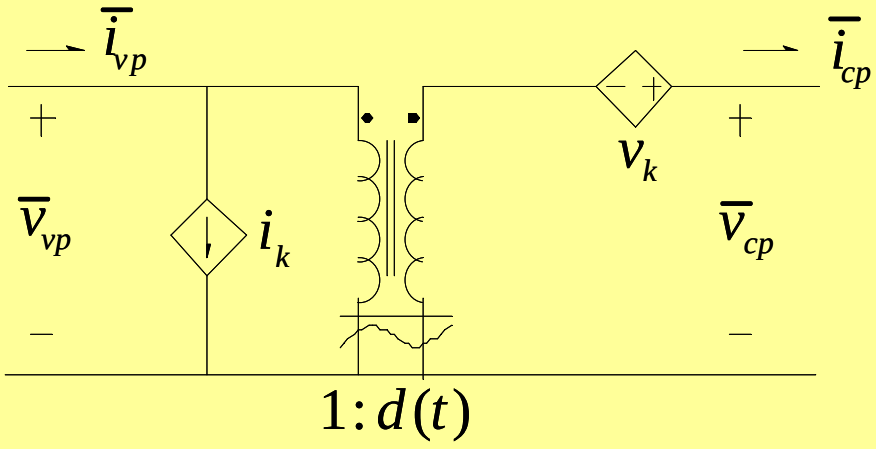


(a)

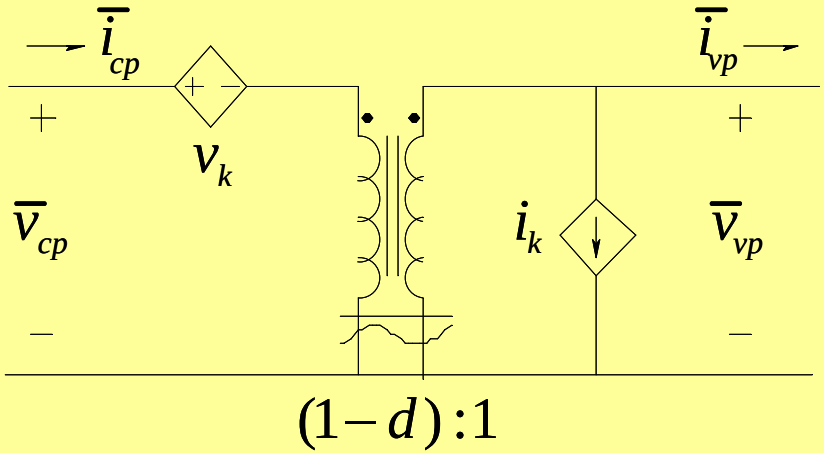


(b)

$$I_{L,crit,Buck\text{-}Boost} = \frac{V_{in}}{2Lf_s}D \qquad R_{crit,Buck-Boost} = \frac{2Lf_s}{(1-D)^2}$$



(a) Buck and Buck-Boost



(b) Boost

Converter	v_k	i_k
Buck	$\left(1-\frac{2Lf_s\bar{i}_L}{(V_{in}-\bar{v}_o)d}\right)\bar{v}_o$	$\frac{d^2}{2Lf_s}(V_{in}-\bar{v}_0)-d\bar{i}_L$
Boost	$\left(1-\frac{2Lf_s\bar{i}_L}{V_{in}d}\right)(V_{in}-\bar{v}_0)$	$\frac{d^2}{2Lf_s}V_{in}-d\bar{i}_L$
Buck-Boost	$\left(1-\frac{2Lf_s\bar{i}_L}{V_{in}d}\right)\bar{v}_o$	$\frac{d^2}{2Lf_s}V_{in}-d\bar{i}_L$

Summary

- Discontinuous Conduction Mode (DCM) in DC-DC Converters
  - Border of CCM and DCM
  - Explanation for DCM
  - Average Representation in DCM