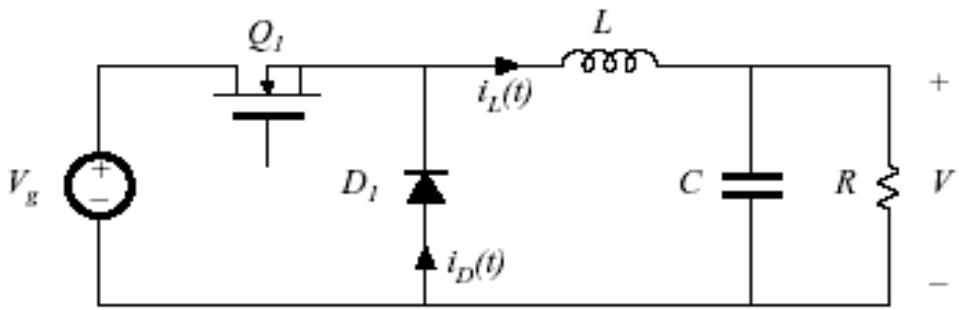
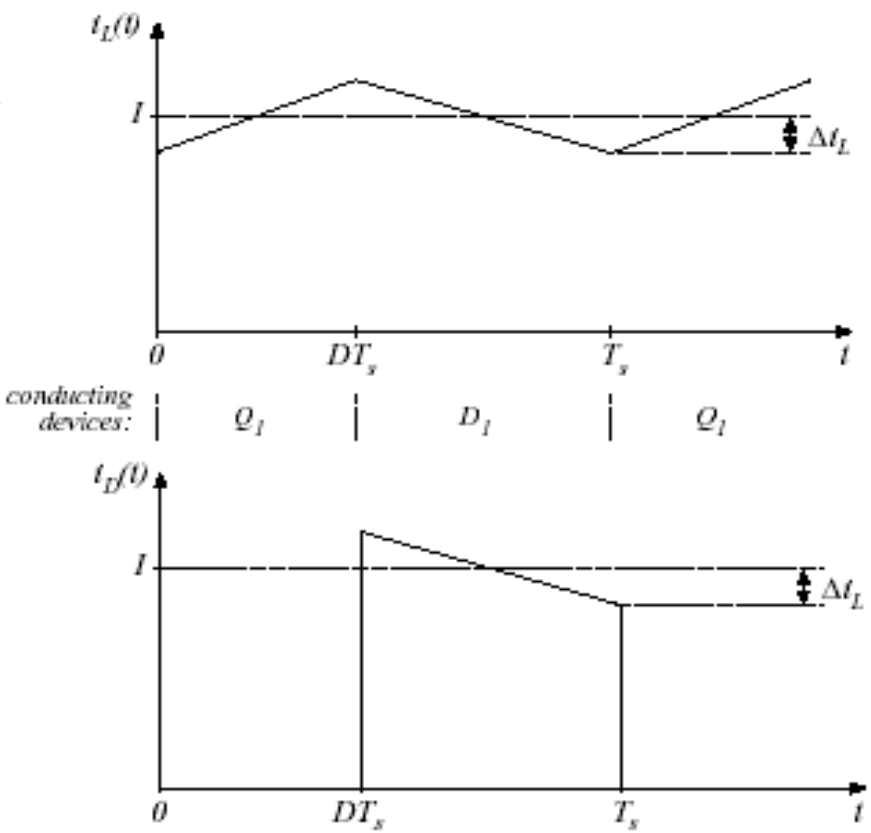
BUCK：CCM

Buck converter example, with single-quadrant switches



continuous conduction mode (CCM)



Minimum diode current is $(I - \Delta i_L)$

Dc component $I = V/R$

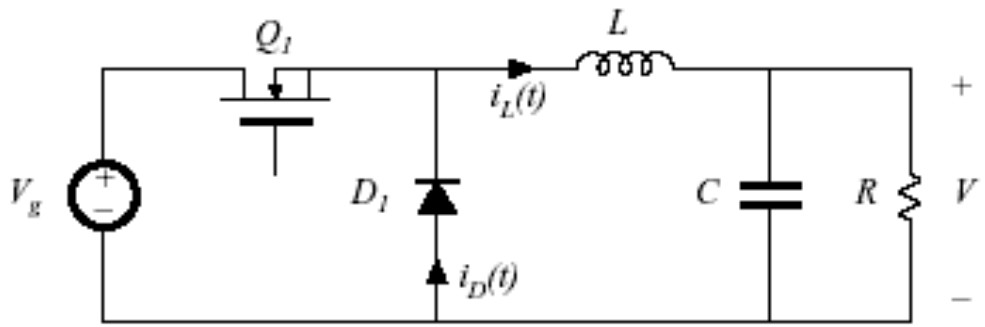
Current ripple is

$$\Delta i_L = \frac{(V_g - V)}{2L} DT_s = \frac{V_g DD'T_s}{2L}$$

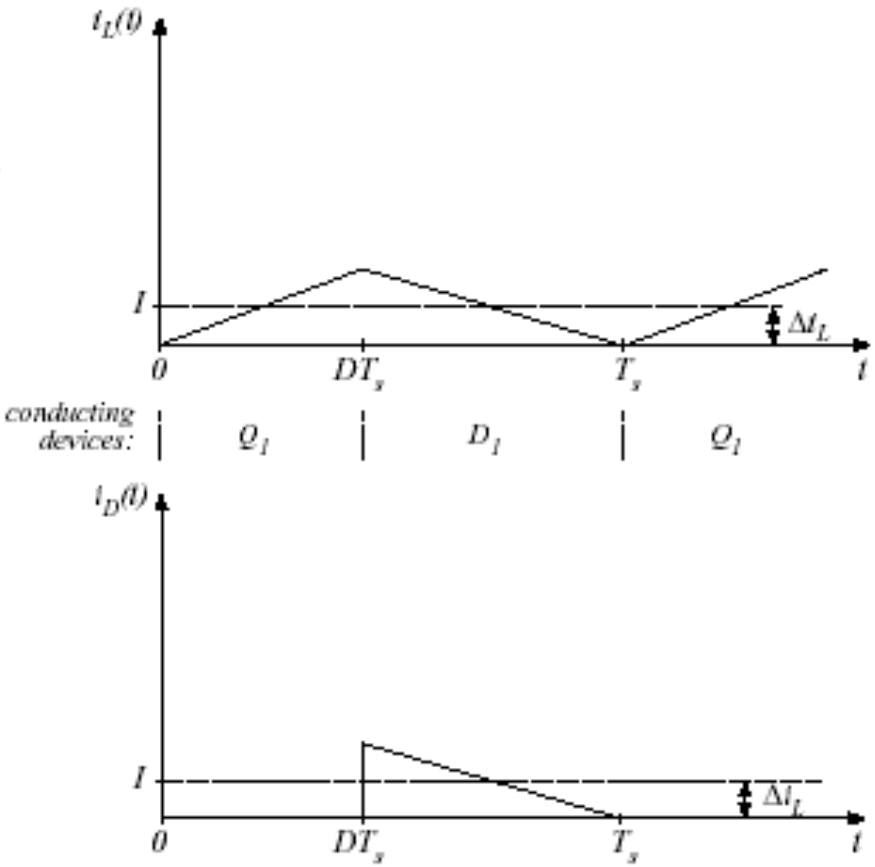
Note that I depends on load, but Δi_L does not.

BUCK：CCM－DCM－Boundary

Increase R, until $I = \Delta i_L$



CCM-DCM boundary



Minimum diode current is $(I - \Delta i_L)$

Dc component $I = V/R$

Current ripple is

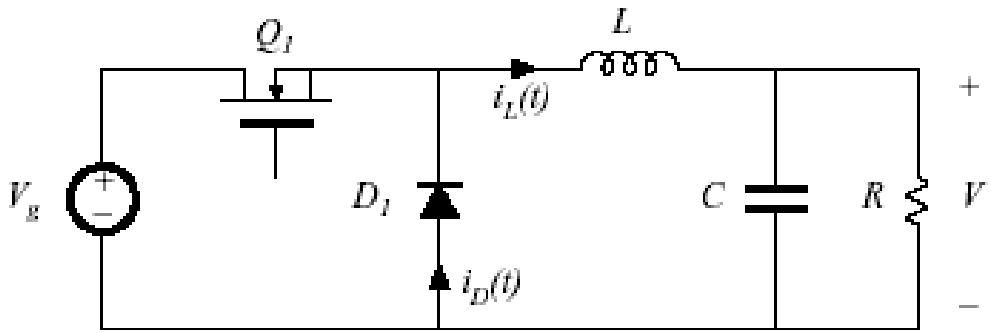
$$\Delta i_L = \frac{(V_g - V)}{2L} DT_s = \frac{V_g DD'T_s}{2L}$$

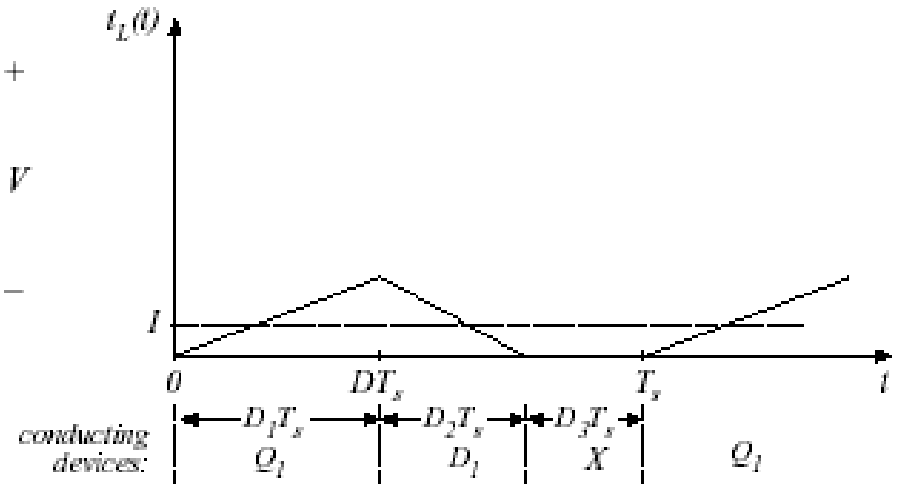
Note that I depends on load, but Δi_L does not.

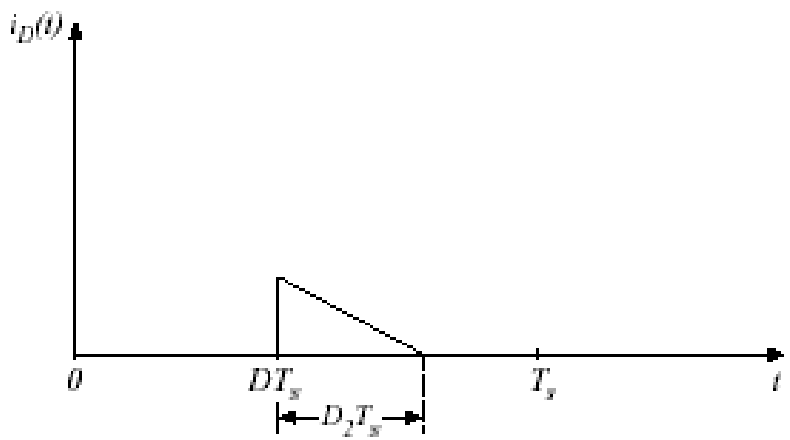
BUCK：DCM

Increase R some more, such that $I < \Delta i_L$

Discontinuous conduction mode







Minimum diode current is $(I - \Delta i_L)$

Dc component $I = V/R$

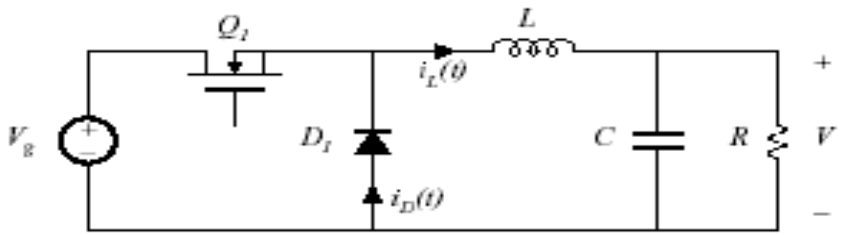
Current ripple is

$$\Delta i_L = \frac{(V_g - V)}{2L} DT_s = \frac{V_g DD'T_s}{2L}$$

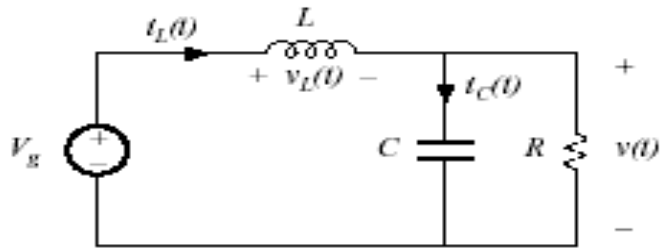
Note that I depends on load, but Δi_L does not.

The load current continues to be positive and non-zero.

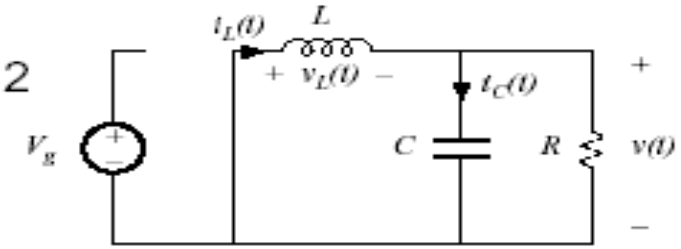
BUCK：DCM



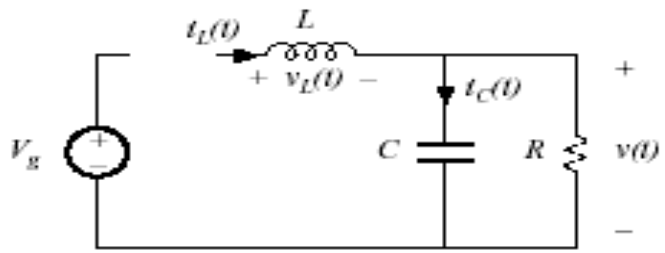
subinterval 1

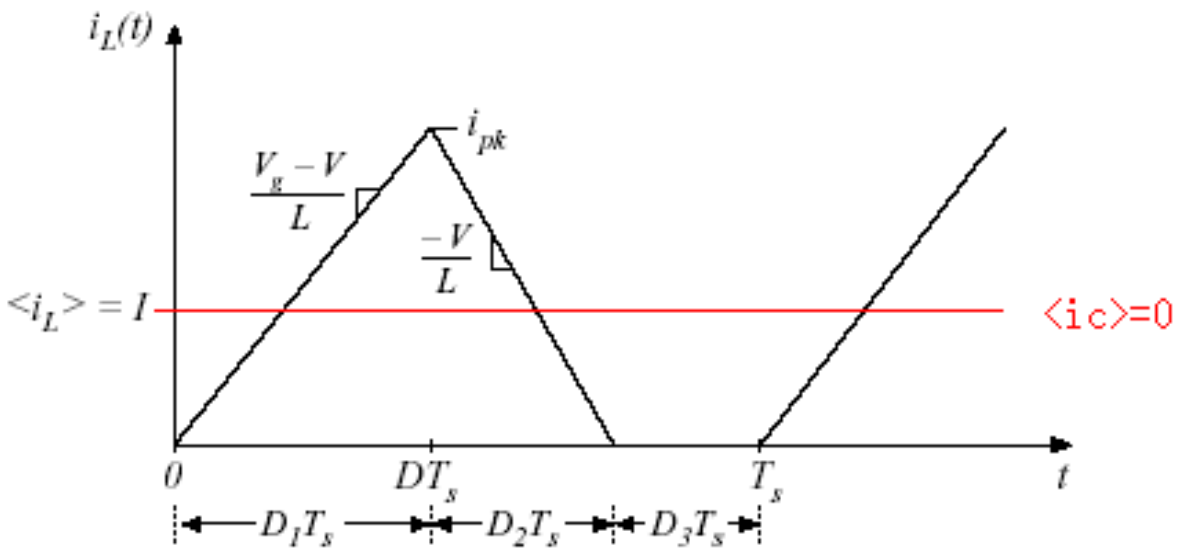


subinterval 2

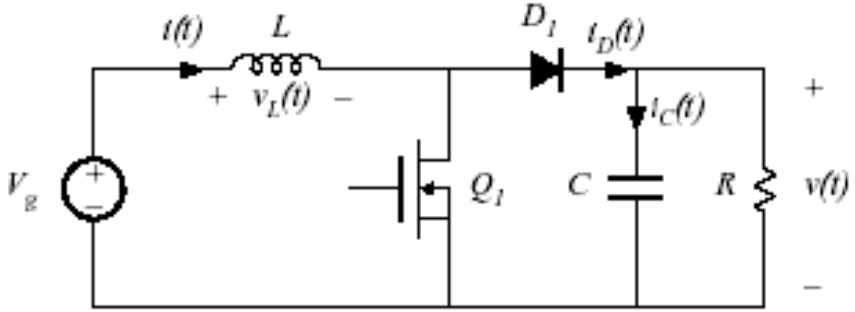


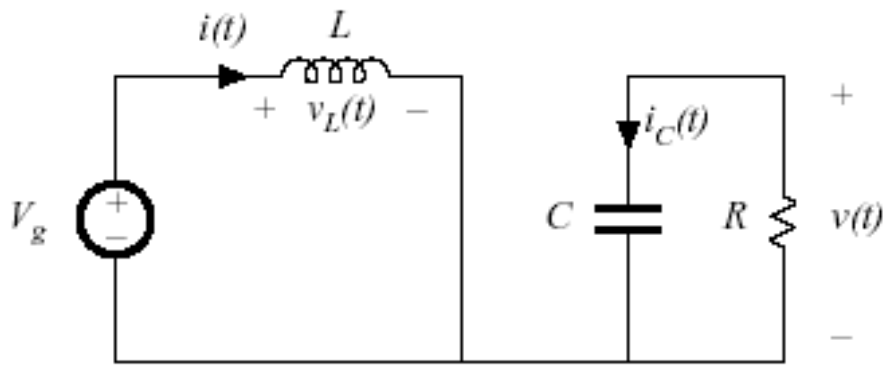
subinterval 3

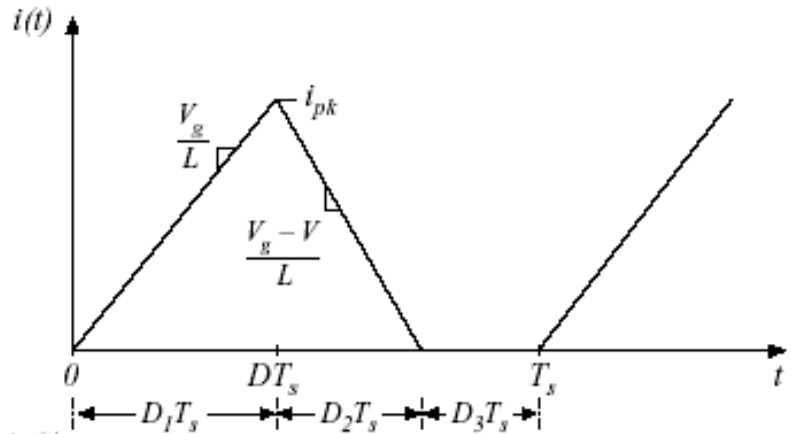


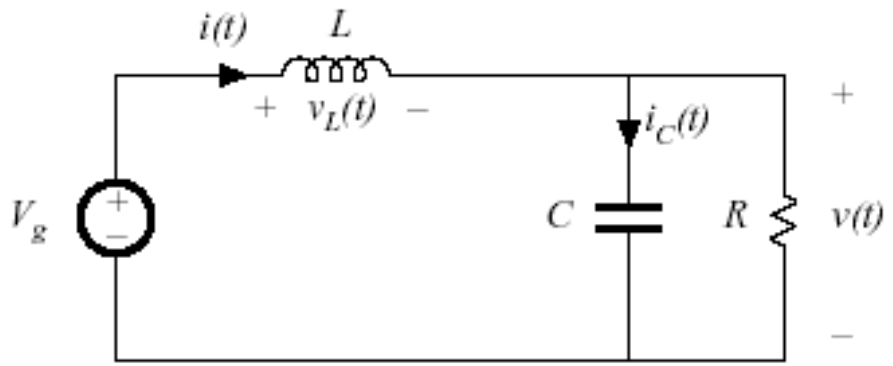


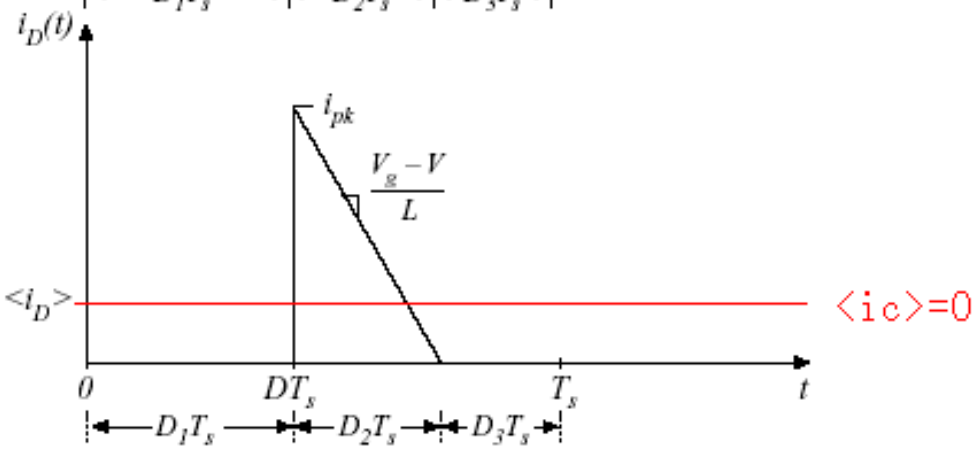
BOOST：DCM

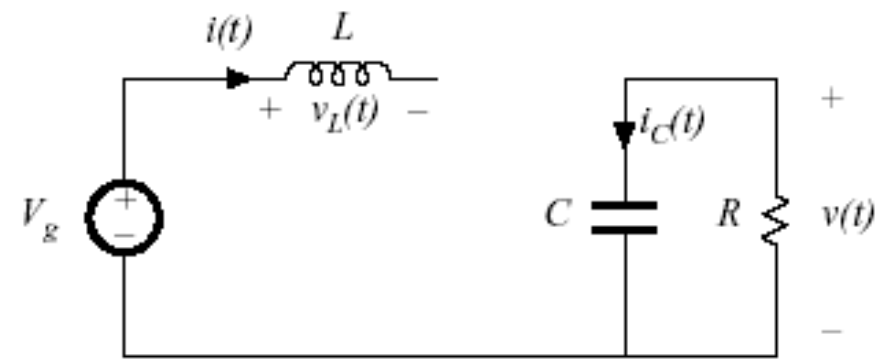

i(t)
L
D1
iD(t)
+ vL(t) –
iC(t)
Vg
Q1
C
R
v(t)
+
–


i(t)
L
+ vL(t) –
iC(t)
Vg
C
R
v(t)
+
–


i(t)
ipk
Vg/L
(Vg – V)/L
0
DTs
Ts
t
D1Ts
D2Ts
D3Ts


i(t)
L
+ vL(t) –
iC(t)
Vg
C
R
v(t)
+
–


iD(t)
ipk
(Vg – V)/L
<iD>
<ic>=0
0
DTs
Ts
t
D1Ts
D2Ts
D3Ts


i(t)
L
+ vL(t) –
iC(t)
Vg
C
R
v(t)
+
–