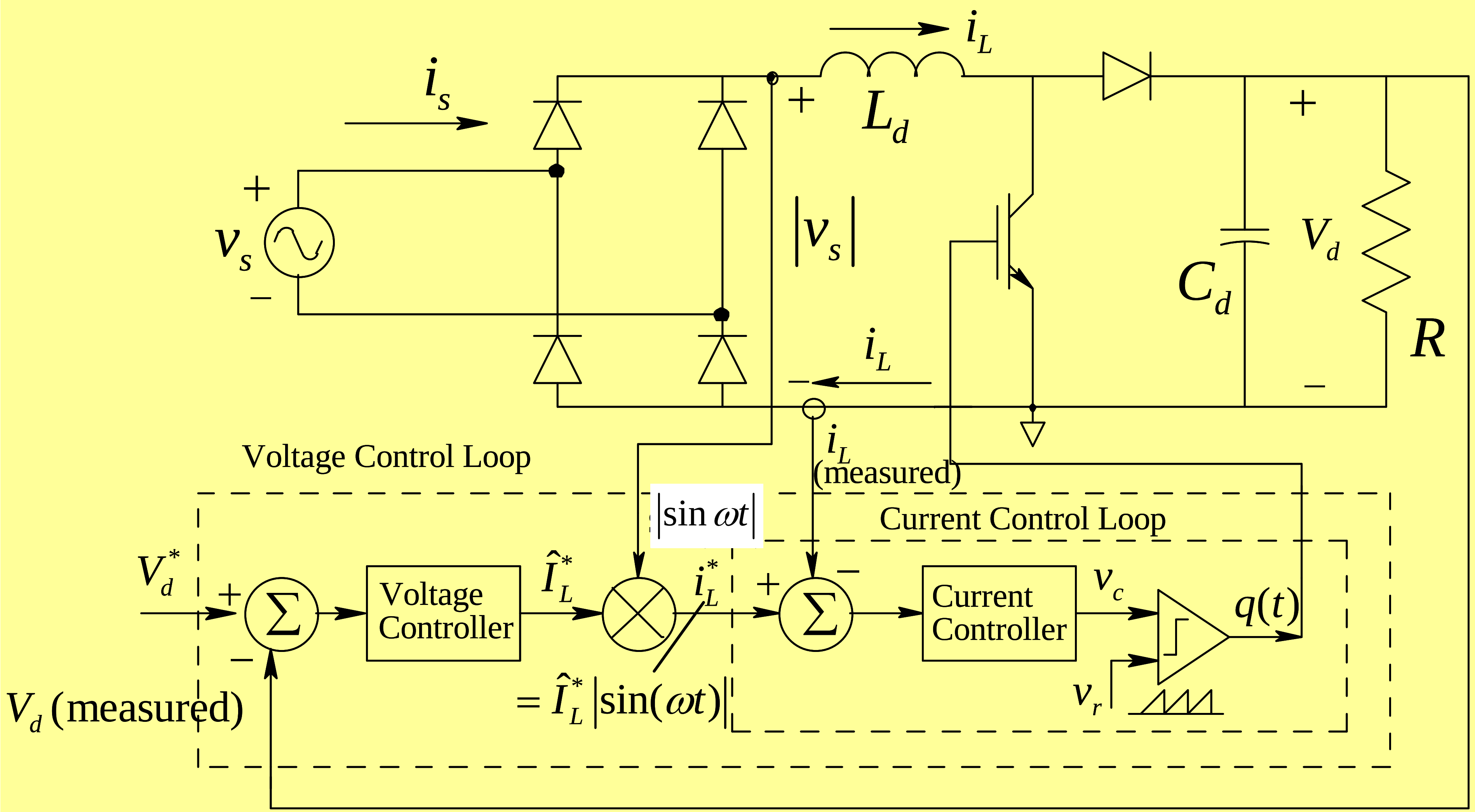
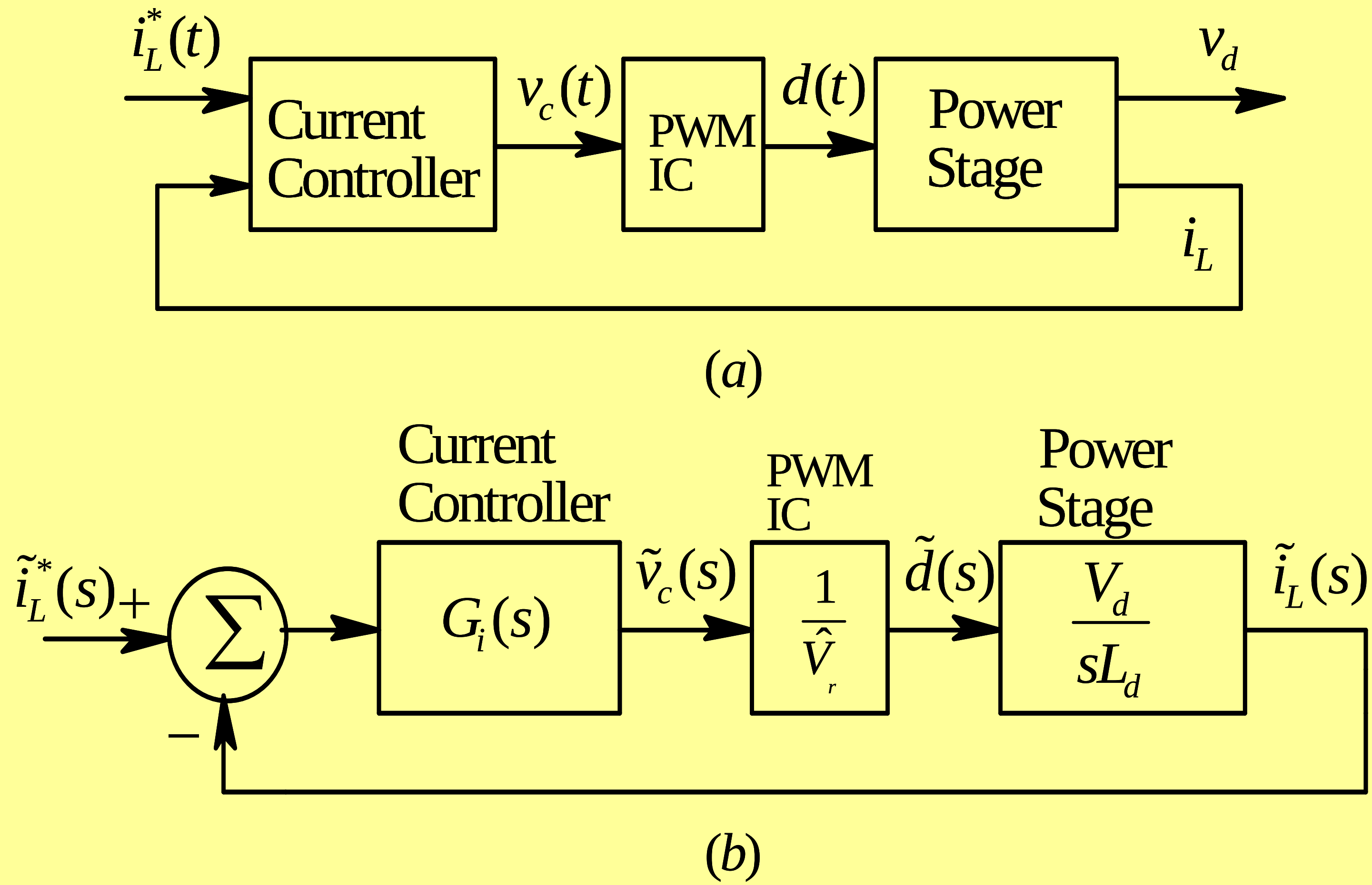
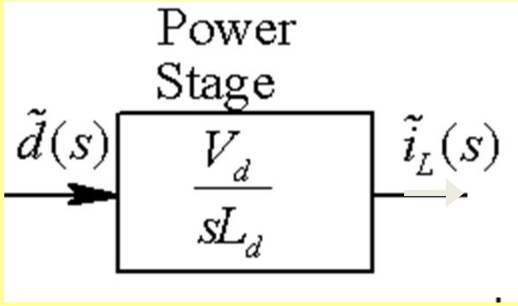
PFC Controller Design

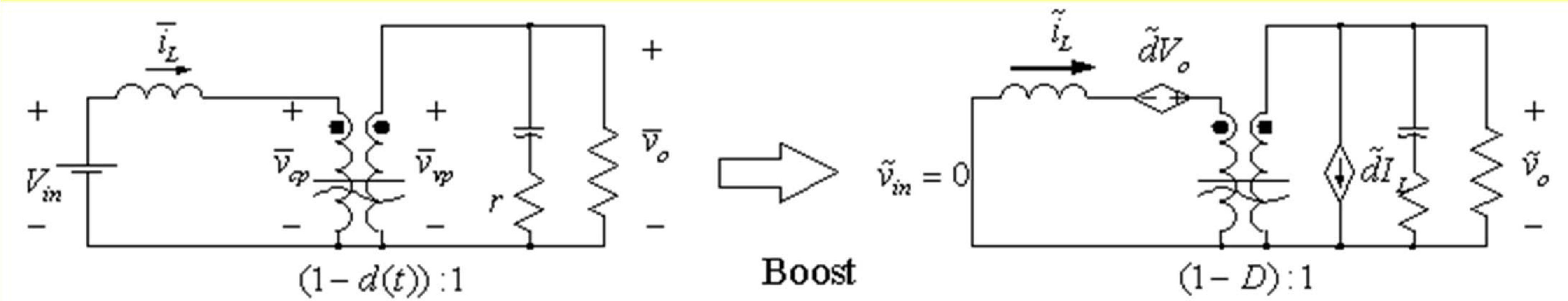


DESIGNING INNER AVERAGE-CURRENT-CONTROL LOOP

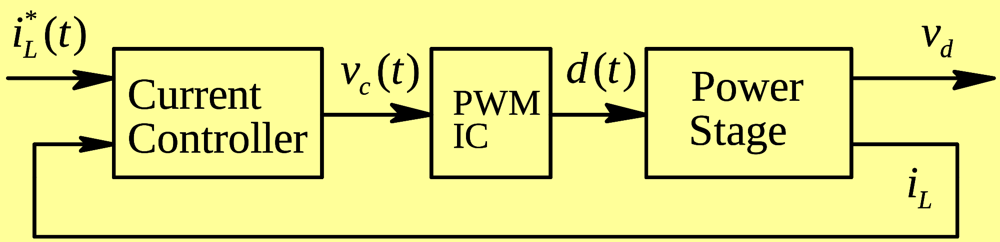



Power Stage
$\tilde{d}(s)$
$\frac{V_d}{sL_d}$
$\tilde{i}_L(s)$

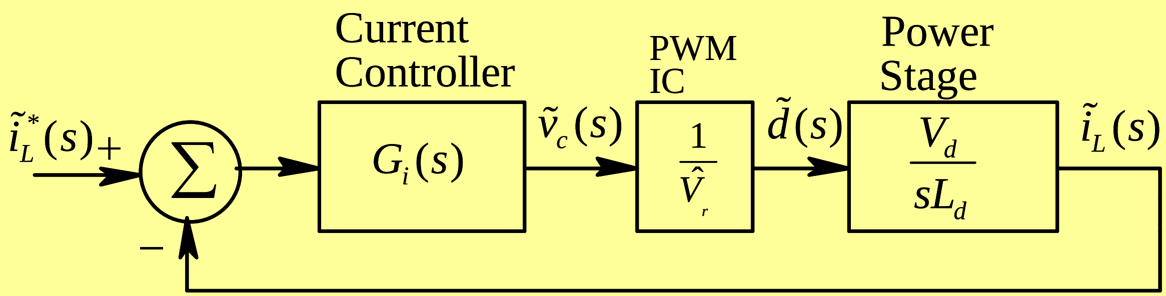
Why?


$\bar{i}_L$
V_{in}
$\bar{v}_{cp}$
$\bar{v}_{vp}$
r
$\bar{v}_o$
$(1-d(t)):1$
Boost
$\tilde{i}_L$
$\tilde{d}V_o$
$\tilde{v}_{in}=0$
$\tilde{d}I_L$
$\tilde{v}_o$
$(1-D):1$

DESIGNING INNER AVERAGE-CURRENT-CONTROL LOOP



(a)



(b)

PWM-IC: $$\frac{\tilde{d}(s)}{\tilde{v}_c(s)} = \frac{1}{\hat{V}_r}$$

Power-Stage: $$\frac{\tilde{i}_L(s)}{\tilde{d}(s)} = \frac{V_d}{sL_d}$$

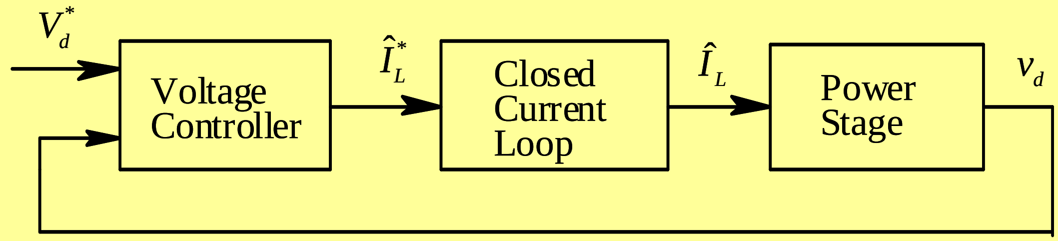
Controller: $$G_i(s) = \frac{k_c}{s}\underbrace{\frac{1+s/\omega_z}{1+s/\omega_p}}_{\text{phase boost}}$$

$$K_{boost} = \tan(45^o + \frac{\phi_{boost}}{2})$$

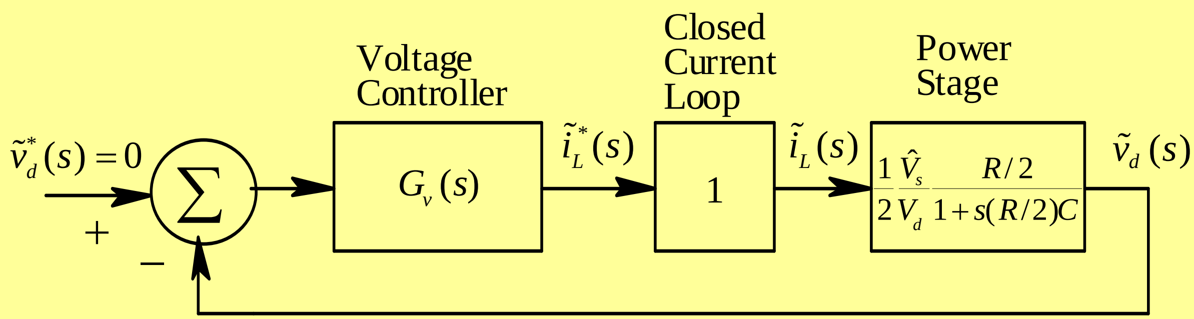
$$f_z = \frac{f_{ci}}{K_{boost}} \qquad f_p = K_{boost}\, f_{ci} \qquad k_c = \omega_z \left|G_C(s)\right|_{f_c}$$

DESIGNING THE OUTER VOLTAGE LOOP

(*a*)



(*b*)

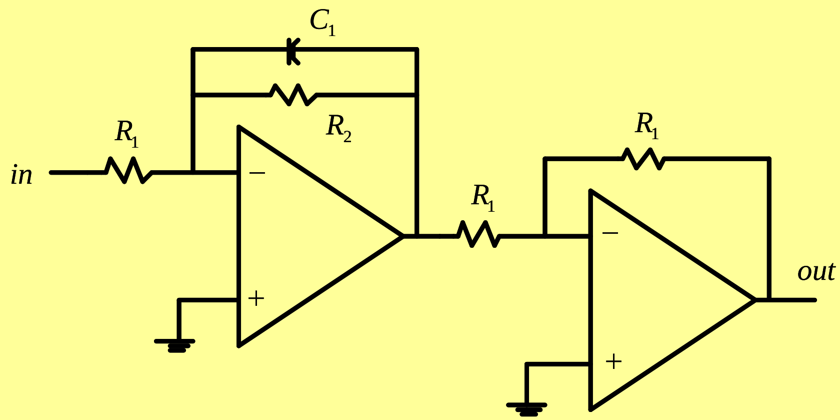


$$G_v(s) = \frac{k_v}{1+s/\omega_{cv}}$$

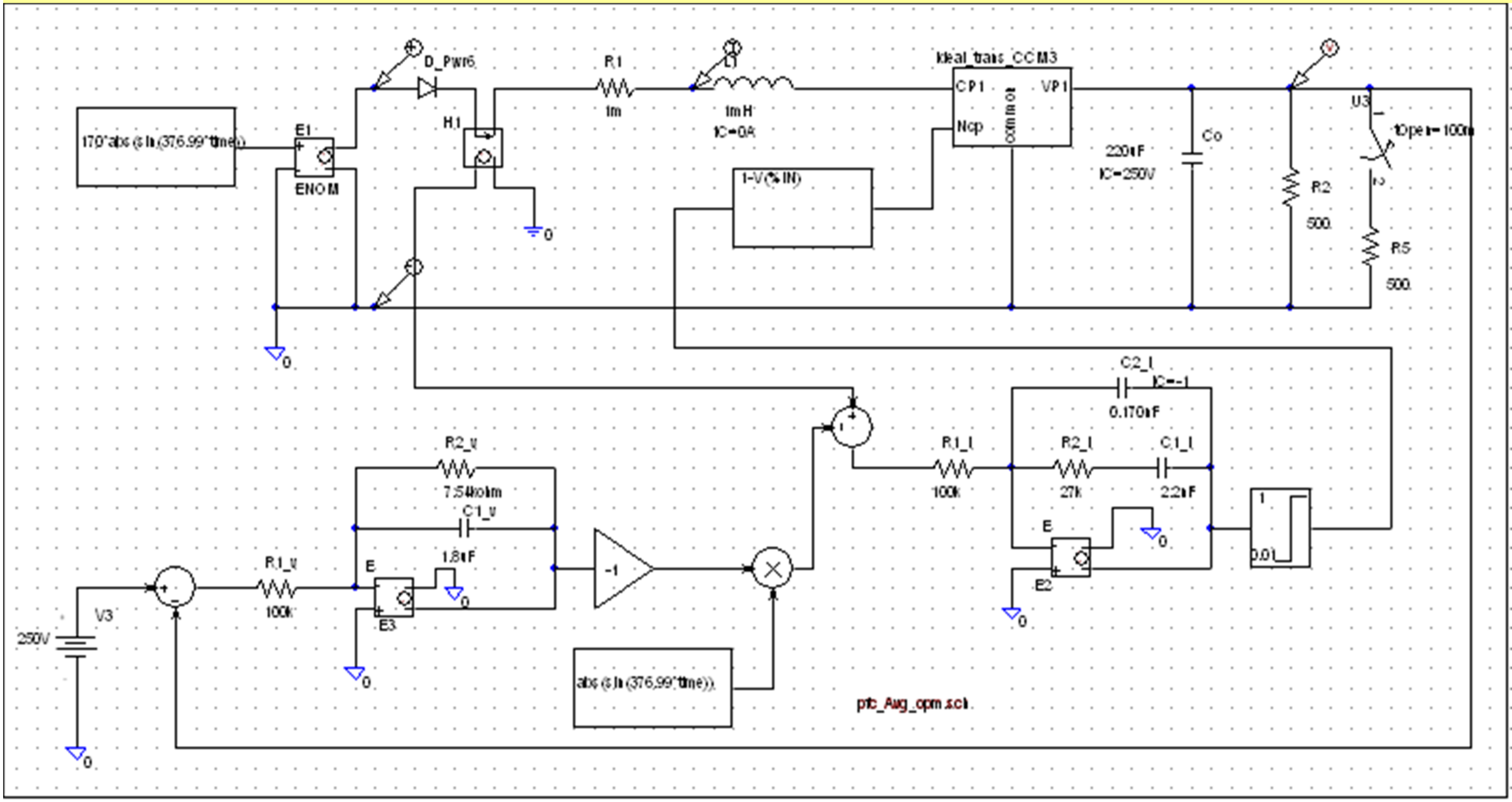
$$\left| \frac{k_v}{1+s/\omega_{cv}} \frac{1}{2} \frac{\hat{V}_s}{V_d} \frac{R/2}{1+s(R/2)C} \right|_{s=j(2\pi\times f_{cv})} = 1$$

$$\left| \frac{k_v}{1+s/\omega_{cv}} \right|_{s=j(2\pi\times 120)} = \frac{\hat{I}_{L2}}{\hat{V}_{d2}} \qquad \frac{\hat{I}_{L2}}{\hat{I}_L} = 1.5\%$$

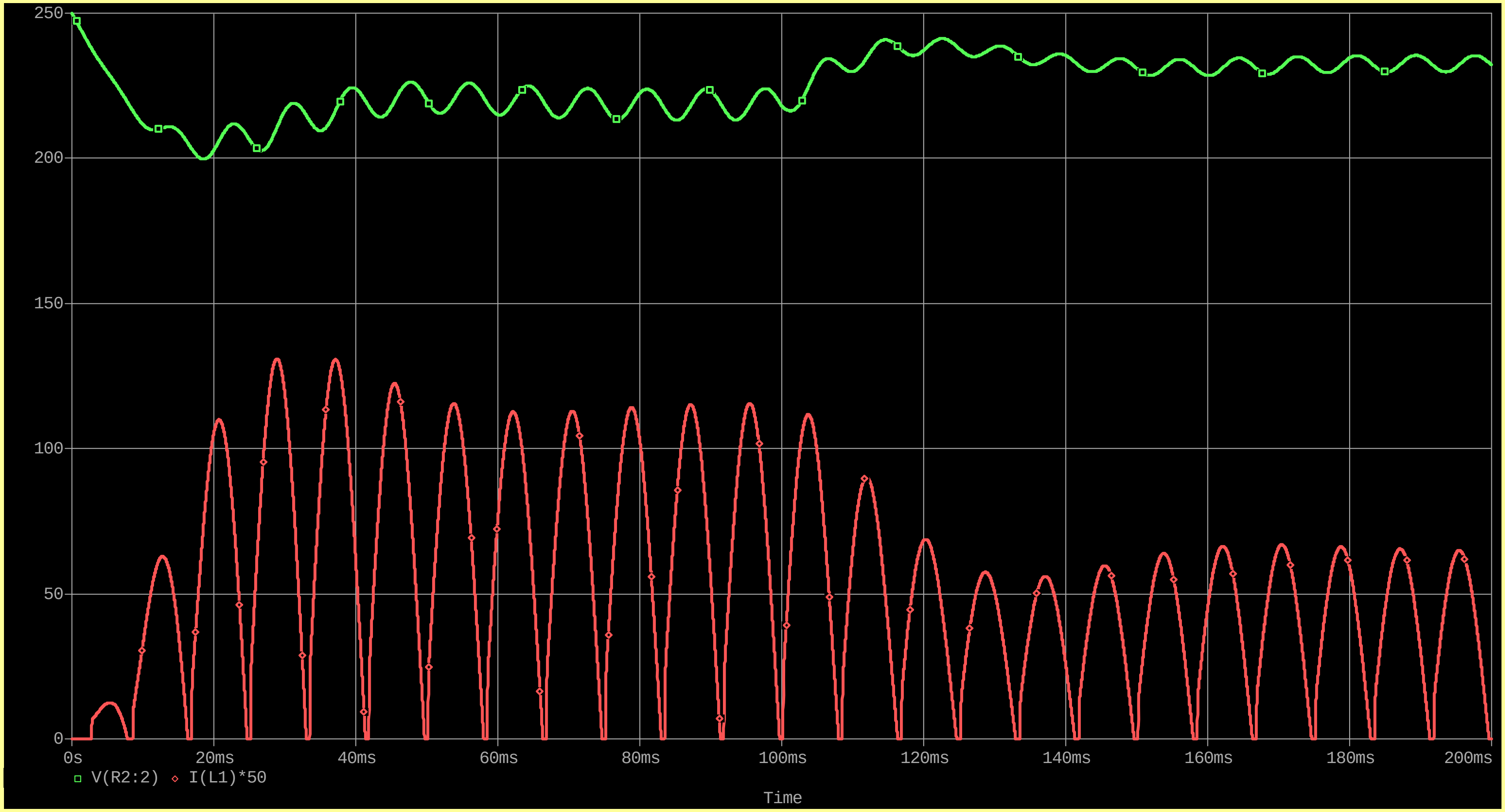
$$G_v(s) = \frac{k_v}{1 + s/\omega_{cv}}$$



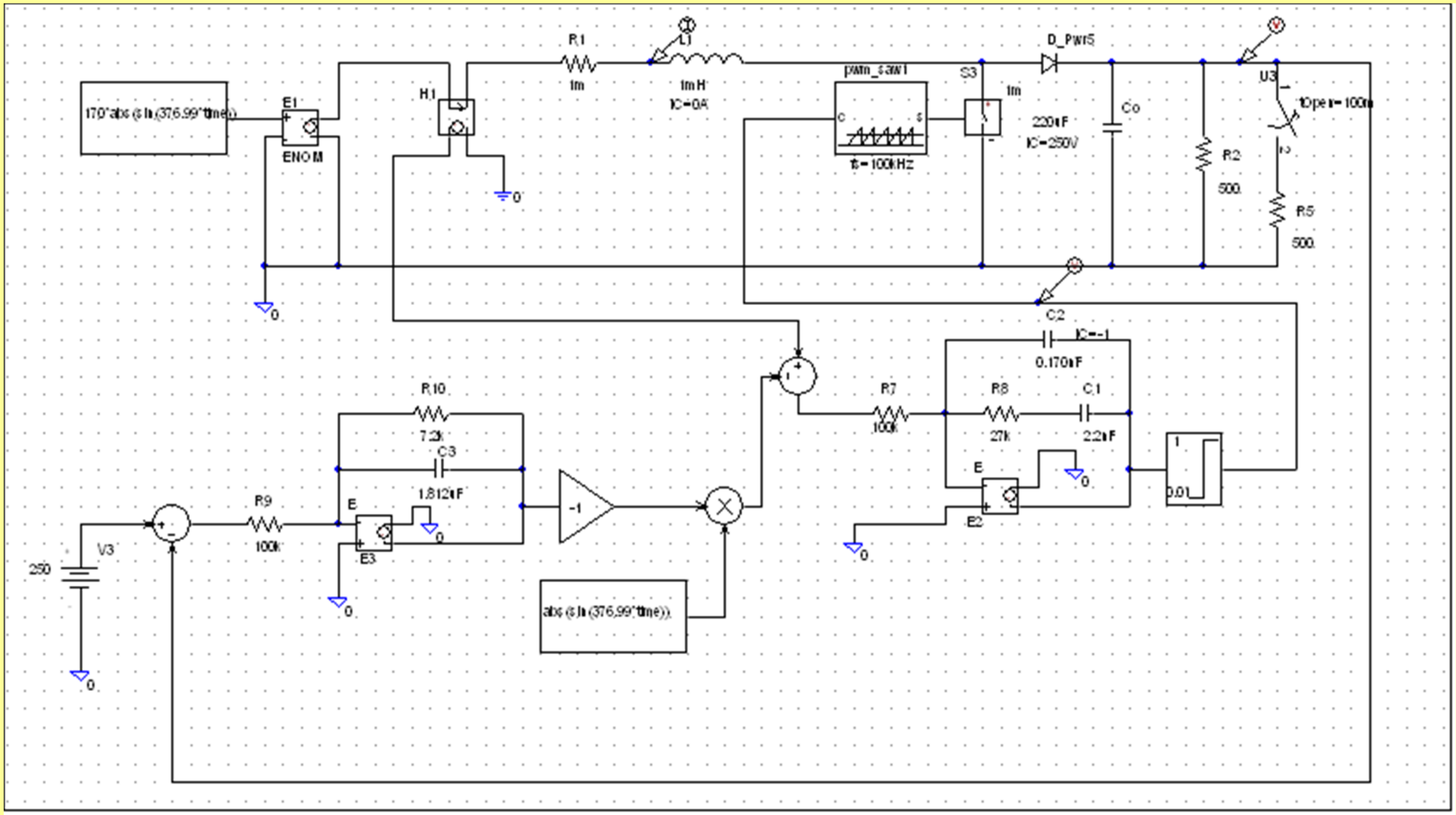
PSpice Modeling:



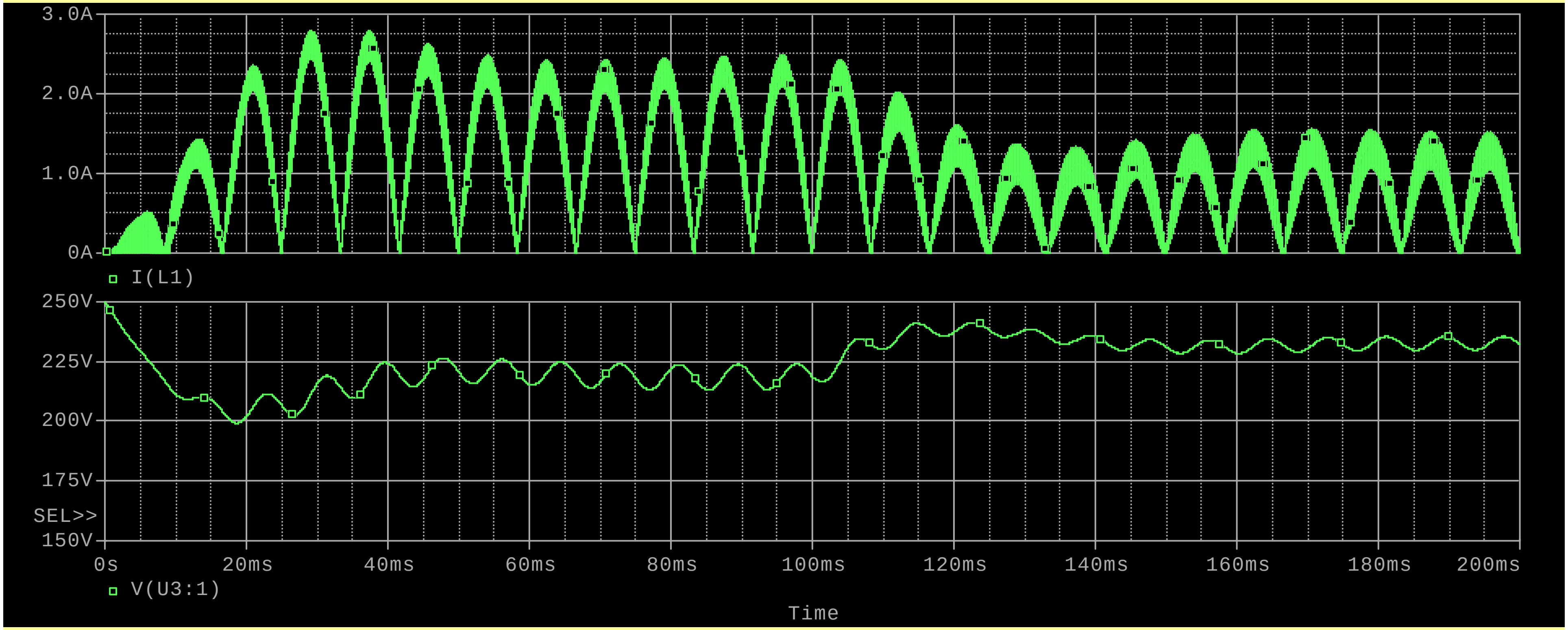
Simulation Results



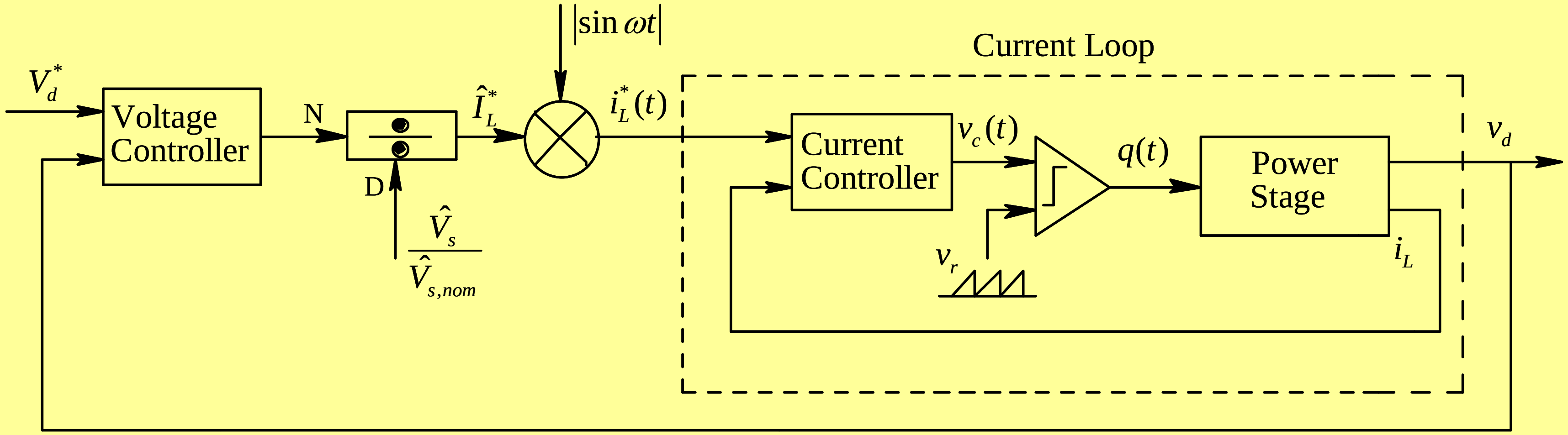
PSpice Switching Circuit Modeling:



Simulation Results



FEEDFORWARD OF THE INPUT VOLTAGE



Summary

- PFC Controller Design