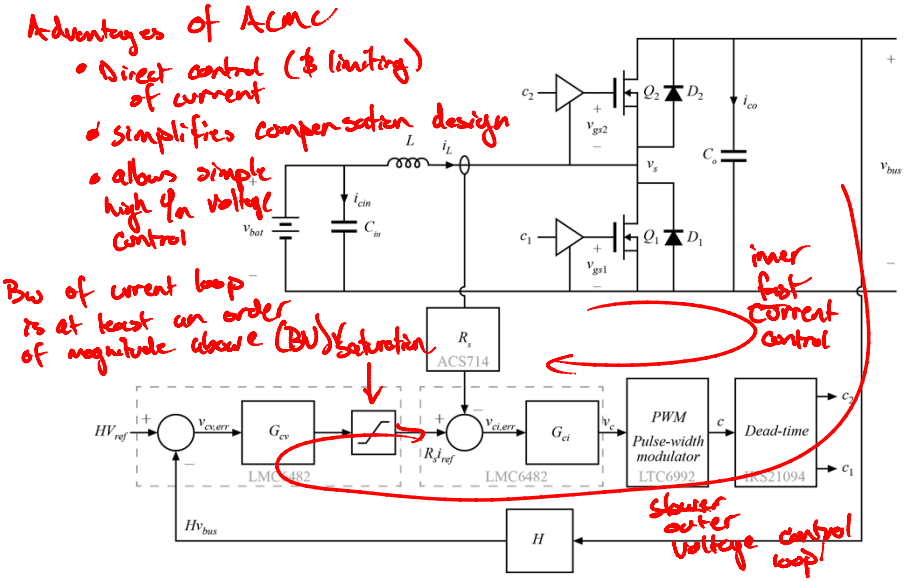
Boost Controller Design (cont.)

ECE 482 Lecture 8
February 7, 2014

Controller Implementation



Open-Loop Control-to-Current TF

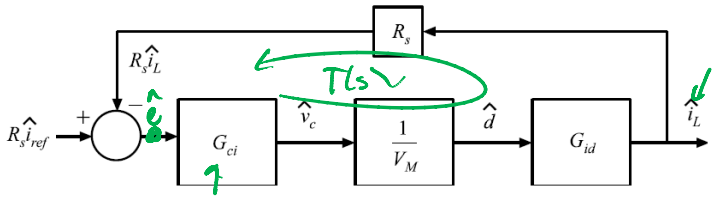
$$G_{id}(s) = \left.\frac{\hat{i}_L}{\hat{d}}\right|_{\hat{v}_{bat}=0,\,\hat{i}_{bus}=0} = G_{ido}\,\frac{1+\dfrac{s}{\omega_{zi}}}{1+\dfrac{s^2}{\omega_o^2}}$$

$$G_{ido} = \frac{I_L}{D'} = \frac{I_{bus}}{(D')^2}$$

$$f_{zi} = \frac{1}{2\pi}\frac{1}{C}\frac{I_{bus}}{V_{bus}}$$

$$f_o = \frac{1}{2\pi}\frac{D'}{\sqrt{LC}}$$

Current Loop Gain



$T(s) = G_{ci}\frac{1}{V_m}G_{id}R_s$

$\hat{e} = R_s\hat{i}_{ref} - R_s\hat{i}_L = R_s\hat{i}_{ref} - R_sG_{id}\frac{1}{V_m}G_{ci}\hat{e}$

$T(s)$

$\hat{e} = R_s\hat{i}_{ref} - T(s)\hat{e}$

$\hat{e} = \frac{R_s\hat{i}_{ref}}{1+T(s)}$

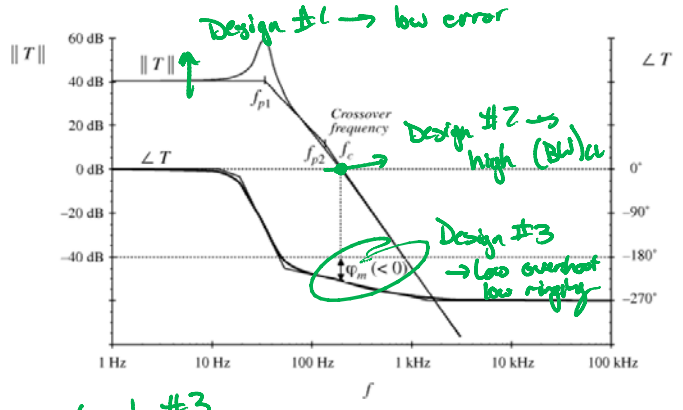
→ Design goal #1: Large $T(s)$ over wide range of freqs. $T(s\to 0) \to \infty$

$\hat{i}_L = \hat{e}\,G_{ci}\frac{1}{V_m}G_{id}$

$\hat{i}_L = \hat{i}_{ref}\frac{T}{1+T}$

→ Design Goal #2: Extend range of freq w/ $|T(s)| > 1$

Loop Gain & Stability



Design Goal #3

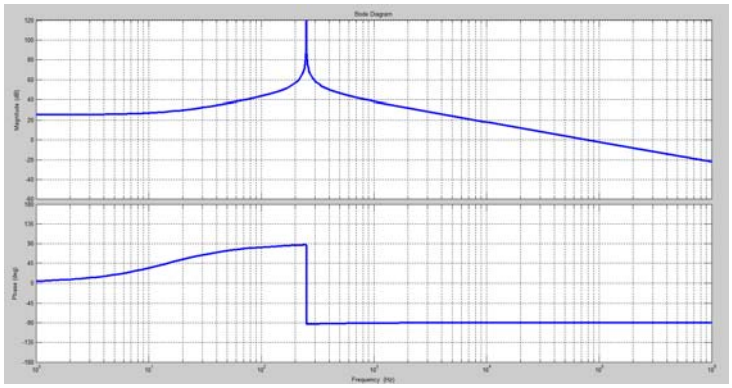
system well stabilized
→ large φ_m

ACMC Limits and Saturation

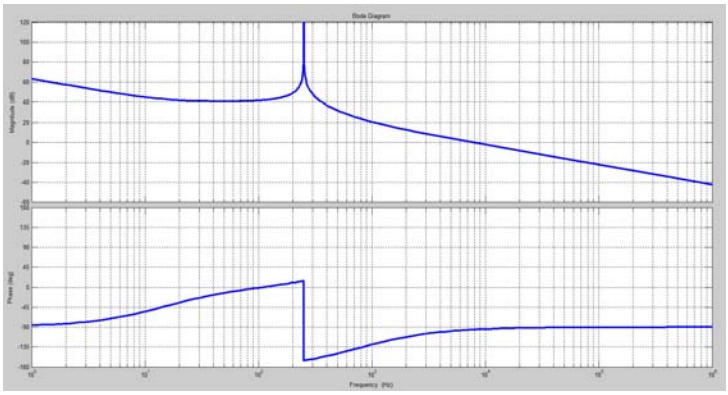
Loop Gain T_i

$I_{bus} = 5\text{A}$
$V_{bus} = 50\text{V}$
$V_{bat} = 26\text{V}$
$L = 100\mu\text{H}$
$C = 4 \times 270\mu\text{F}$

$G_{id0} = 25.4\text{dB}$
$\omega_{zi} = 92 \frac{\text{rad}}{\text{sec}}$
$\omega_0 = 1.6\text{k} \frac{\text{rad}}{\text{sec}}$



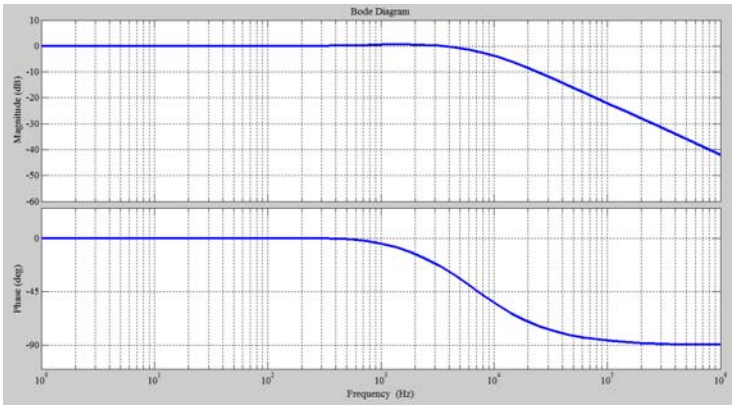
Compensated Loop Gain



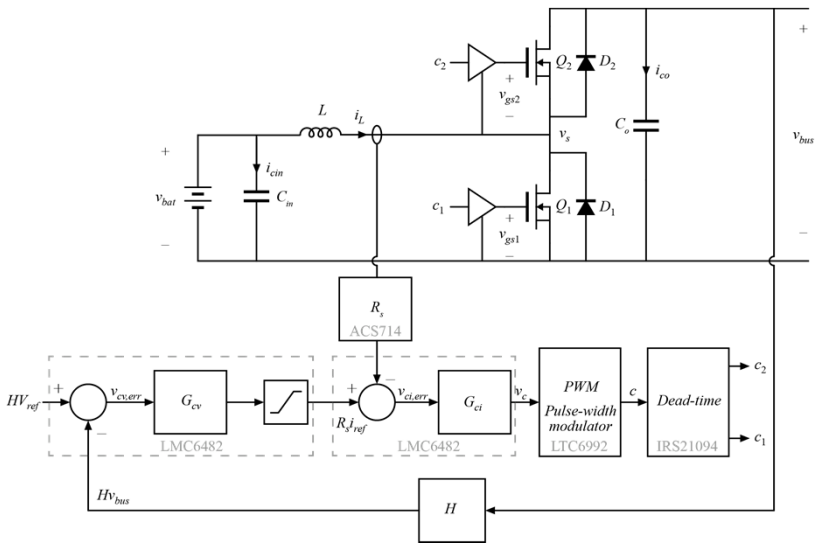
$$G_{ci} = \frac{1}{10}\left(1 + \frac{\omega_{zi}}{s}\right)$$

$\omega_{zi} = 5 \frac{\text{krad}}{\text{sec}}, \varphi_m = 84^\circ$

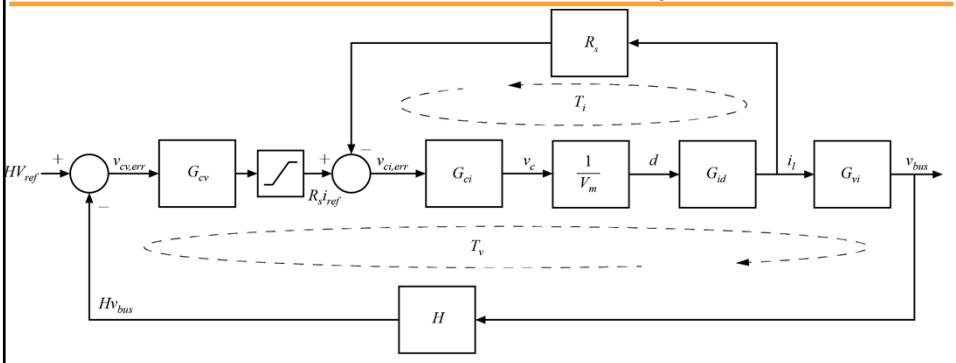
Closed Loop G_i



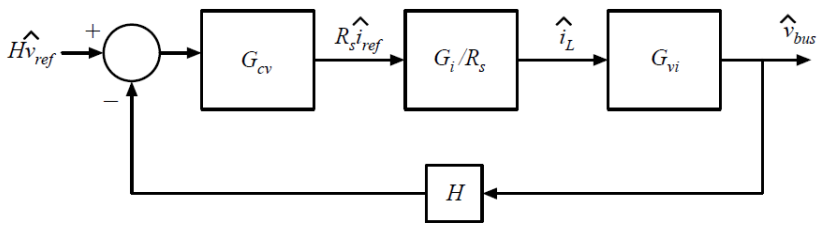
Voltage Loop



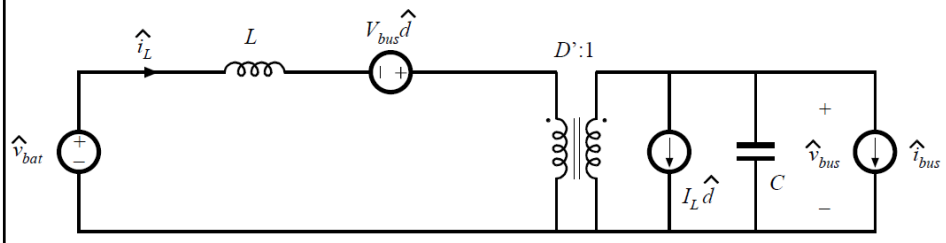
Full Control Loop



Voltage Loop Gain



Solving G_{vi}



$$G_{vi} = \left.\frac{\hat{v}_{bus}}{\hat{i}_L}\right|_{\hat{v}_{bat}=0,\,\hat{i}_{bus}=0}$$

Solving G_{vi}

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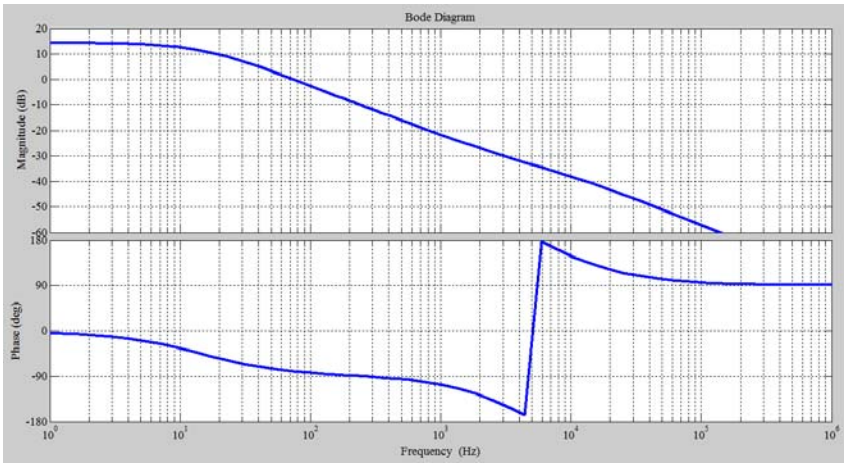
$$G_{vi} = \left.\frac{\hat{v}_{bus}}{\hat{i}_L}\right|_{\hat{v}_{bat}=0,\,\hat{i}_{bus}=0} = G_{vio}\frac{1-\dfrac{s}{\omega_z}}{1+\dfrac{s}{\omega_{zi}}}$$

$$G_{vio} = D'\frac{V_{bus}}{I_{bus}}$$

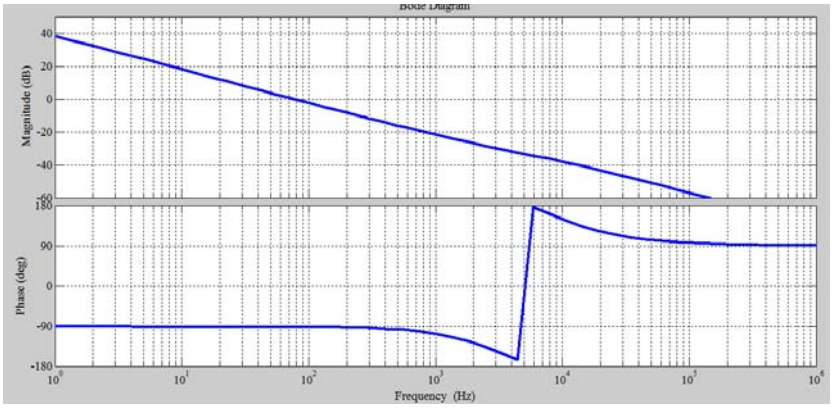
$$f_z = \frac{1}{2\pi}\frac{D'^2}{L}\frac{V_{bus}}{I_{bus}}$$

$$f_{zi} = \frac{1}{2\pi}\frac{1}{C}\frac{I_{bus}}{V_{bus}}$$

Uncompensated Voltage Loop Gain



Compensated Loop Gain



$$G_{ci} = 1\left(1 + \frac{\omega_{zv}}{s}\right)$$

$$\omega_{zv} = 100\,\frac{\text{rad}}{\text{sec}}, \varphi_m = 88^\circ$$

Closed Loop G_v