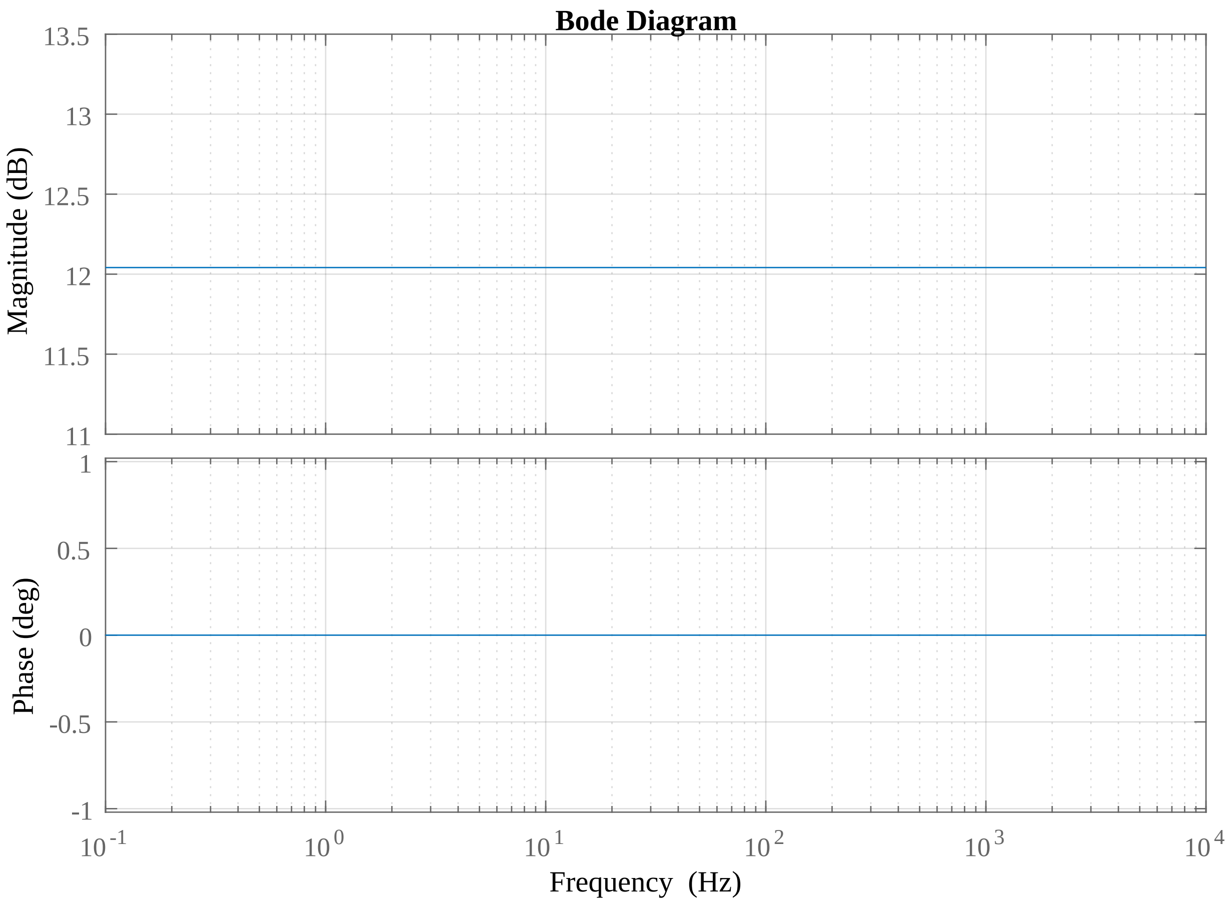
Digital Control of Power Electronics

Intro to Continuous Control Part 2

$$H(s) = 4 \tag{1}$$

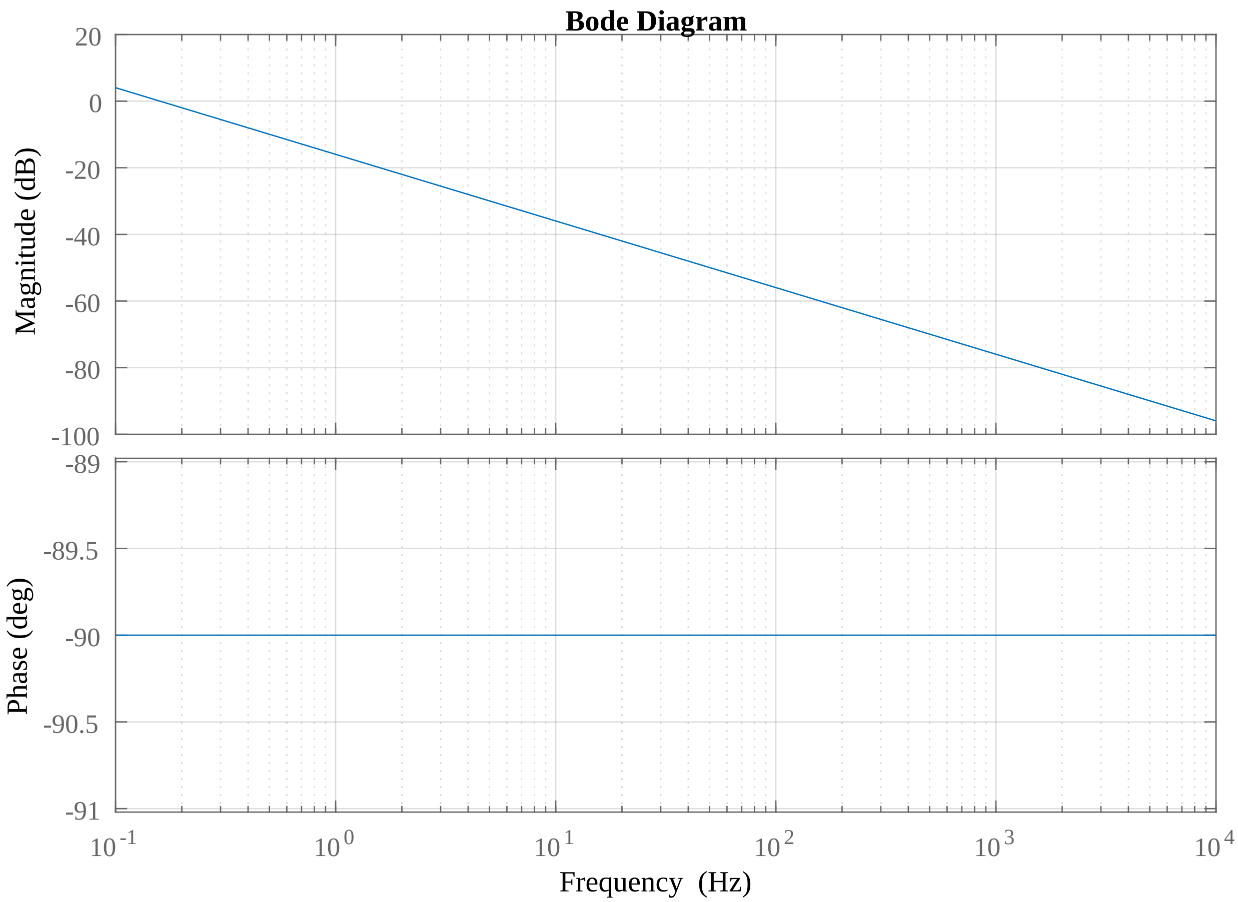


Below is a transfer function for an integrator.

$$H(s) = \frac{1}{s} \tag{2}$$

$$|H(s)| = |H(j\omega)| = \left|\frac{1}{j\omega}\right| = \frac{1}{\omega} \tag{3}$$

$$\angle H(s) = \angle H(j\omega) = \angle\left(\frac{1}{j\omega}\right) = \angle\left(\frac{-j}{\omega}\right) = -90^\circ \tag{4}$$



Shown below is a transfer function for a zero.

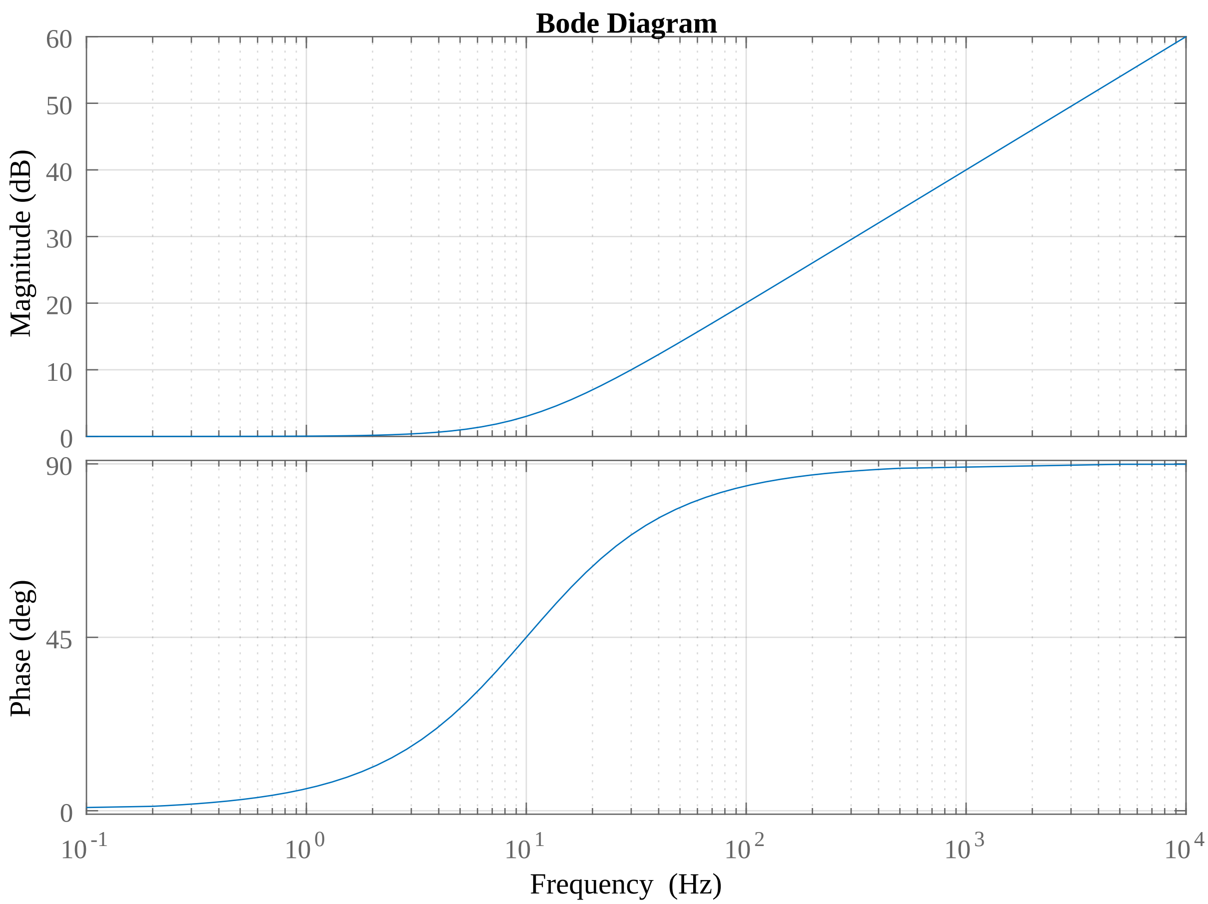
$$H(s) = \left(1 + \frac{s}{\omega_z}\right) = \left(1 + \frac{s}{62.8319}\right) \tag{5}$$

Calculate gain of transfer function

$$|H(s)| = |H(j\omega)| = \left|1 + \frac{j\omega}{\omega_z}\right| = \sqrt{1^2 + \left(\frac{\omega}{\omega_z}\right)^2} = \sqrt{1^2 + \left(\frac{\omega}{62.8319}\right)^2} \tag{6}$$

Calculate phase of transfer function

$$\angle H(s) = \angle H(j\omega) = \angle\left(1 + \frac{j\omega}{\omega_z}\right) = \tan^{-1}\left(\frac{\omega}{\omega_z}\right) = \tan^{-1}\left(\frac{\omega}{62.8319}\right) \tag{7}$$



Shown below is a transfer function for a pole.

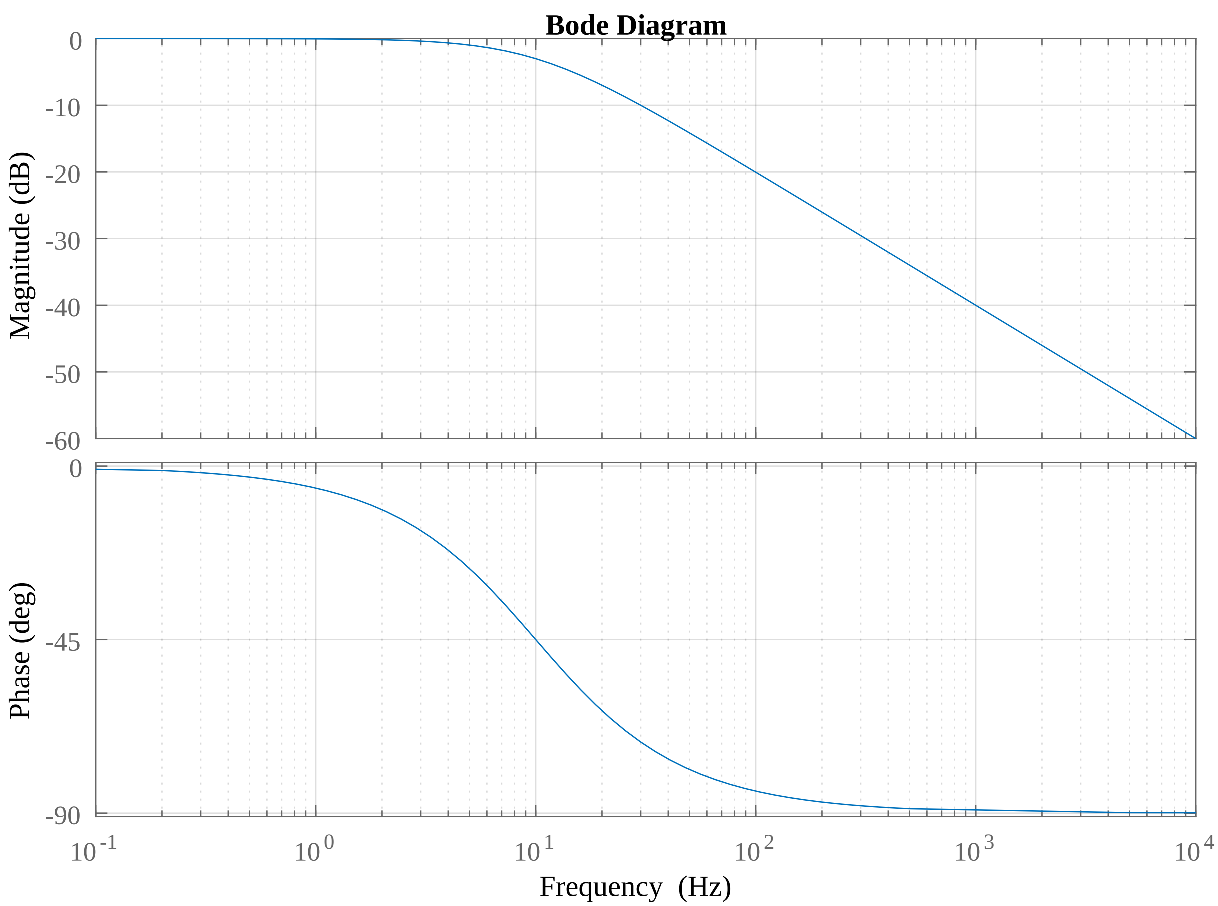
$$H(s) = \frac{1}{\left(1+\dfrac{s}{\omega_p}\right)} = \frac{1}{\left(1+\dfrac{s}{62.8319}\right)} \tag{8}$$

Calculate gain of transfer function

$$|H(s)| = |H(j\omega)| = \left|\frac{1}{1+\dfrac{j\omega}{\omega_p}}\right| = \frac{1}{\sqrt{1^2+\left(\dfrac{\omega}{\omega_p}\right)^2}} = \frac{1}{\sqrt{1^2+\left(\dfrac{\omega}{62.8319}\right)^2}} \tag{9}$$

Calculate phase of transfer function

$$\angle H(s) = \angle H(j\omega) = \angle\left(\frac{1}{1+\frac{j\omega}{\omega_p}}\right) = \angle\left(\frac{1-\frac{j\omega}{\omega_p}}{1+\frac{\omega^2}{\omega_p^2}}\right) = \tan^{-1}\left(-\frac{\omega}{\omega_p}\right) = \tan^{-1}\left(-\frac{\omega}{62.8319}\right) \tag{10}$$

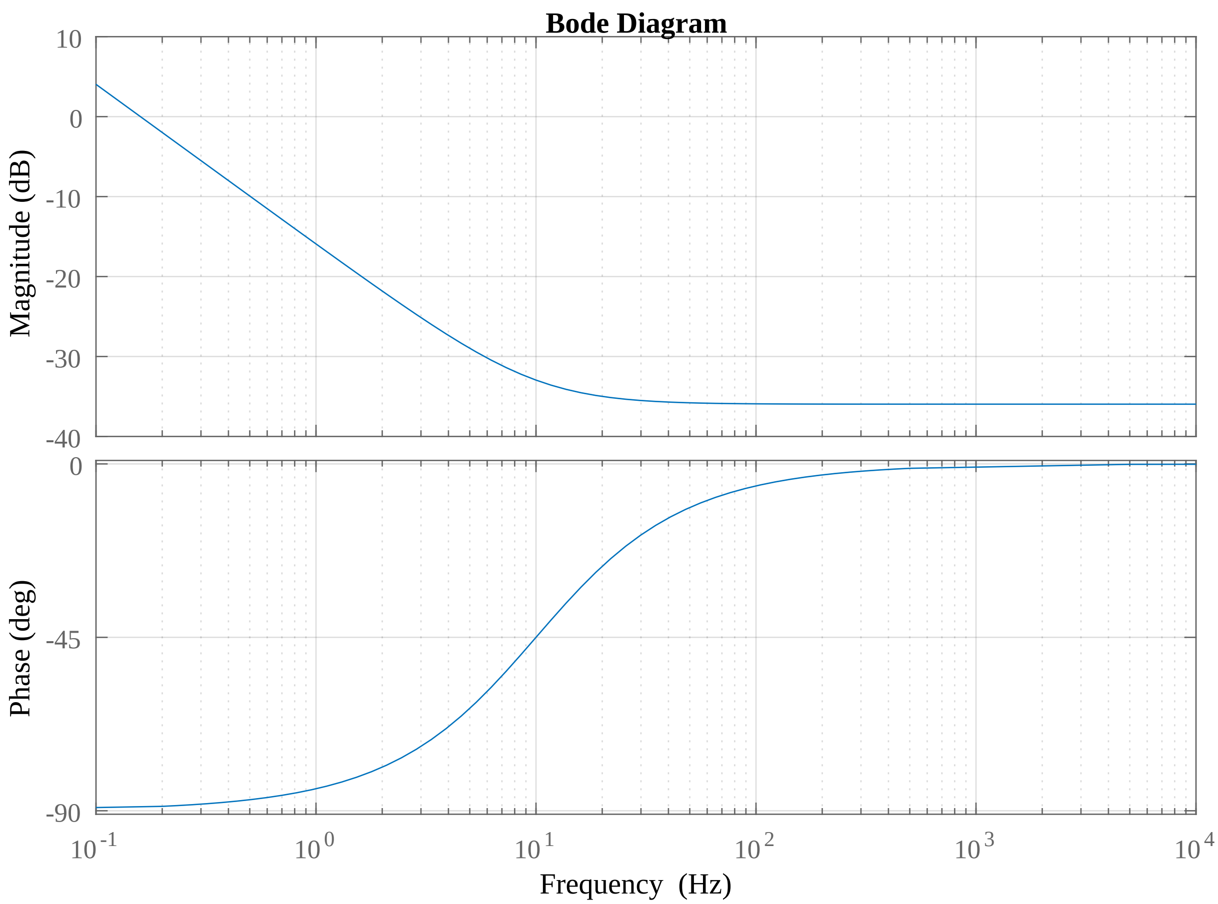


$$H(s) = \frac{s + 62.83}{62.83s} = \frac{\frac{s}{62.83} + 1}{s} \tag{11}$$

Note one zero and a pole at the origin.

$$|H(jw)| = \left| \frac{\frac{j\omega}{62.83} + 1}{j\omega} \right| = \frac{\left| \frac{j\omega}{62.83} + 1 \right|}{|j\omega|} = \frac{\sqrt{(\frac{\omega}{62.83})^2 + 1^2}}{\omega} = 20\log_{10}\left(\sqrt{(\frac{\omega}{62.83})^2 + 1^2}\right) - 20\log_{10}(\omega) \tag{12}$$

$$\angle H(jw) = \angle\left(\frac{\frac{j\omega}{62.83} + 1}{j\omega}\right) = \frac{\angle\left(\frac{j\omega}{62.83} + 1\right)}{\angle(j\omega)} = \tan^{-1}\left(\frac{\omega}{62.83}\right) - 90^\circ \tag{13}$$



$$H(s) = \frac{\frac{s}{6.283} + 1}{s\left(\frac{s}{6283} + 1\right)} \tag{14}$$

$$|H(j\omega)| = \frac{\left|\frac{j\omega}{6.283} + 1\right|}{|j\omega|\left|\frac{j\omega}{6283} + 1\right|} = \frac{\sqrt{\left(\frac{\omega}{6.283}\right)^2 + 1^2}}{\omega\sqrt{\left(\frac{\omega}{6283}\right)^2 + 1^2}} = 20\log_{10}\left(\sqrt{\left(\frac{\omega}{6.283}\right)^2 + 1^2}\right) - 20\log_{10}\left(\omega\sqrt{\left(\frac{\omega}{6.283}\right)^2 + 1^2}\right) \tag{15}$$

$$\angle H(j\omega) = \frac{\angle\left(\frac{j\omega}{6.283} + 1\right)}{\angle(j\omega)\angle\left(\frac{j\omega}{6283} + 1\right)} = \tan^{-1}\left(\frac{\omega}{6.283}\right) - 90^\circ - \tan^{-1}\left(\frac{\omega}{6283}\right) \tag{16}$$