Structured Electronic Design
Phantom Zero Compensation 2nd-order System

Phantom compensation 2nd order system

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$$L(s) = L_{DC} \frac{1 - s/z}{(1 - s/p_1)(1 - s/p_2)}$$

Phantom compensation 2nd order system

$$L(s) = L_{DC}\frac{1-s/z}{(1-s/p_1)(1-s/p_2)}$$

$$S(s) = \frac{-L_{DC}}{1-L_{DC}}\frac{1-s/z}{\frac{(1-s/p_1)(1-s/p_2)}{1-L_{DC}} - \frac{L_{DC}}{1-L_{DC}}(1-s/z)}$$

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$$A_f = A_i(s)\frac{-L_{DC}}{1-L_{DC}}\frac{1}{1+s\left(\frac{L_{DC}}{z(1-L_{DC})}-\frac{p_1+p_2}{p_1p_2(1-L_{DC})}\right)+\frac{s^2}{p_1p_2(1-L_{DC})}}$$

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Phantom zero canceled by pole in the ideal gain (= asymptotic gain)

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$$A_f \approx A_i(s)\frac{-L_{DC}}{1-L_{DC}}\frac{1}{1+s\left(-\frac{1}{z} - \frac{p_1+p_2}{p_1 p_2(1-L_{DC})}\right) + \frac{s^2}{p_1 p_2(1-L_{DC})}}$$

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← Low-pass cut-off frequency designed with LP product

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Low-pass cut-off frequency designed with LP product

A negative real zero increases the coefficient of s

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Absolute value of the sum of the poles can only be increased!

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Second-order MFM if:

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$$A_f = A_i(s) \frac{-L_{DC}}{1 - L_{DC}} \frac{1}{1 + s\left(\frac{L_{DC}}{z(1 - L_{DC})} - \frac{p_1 + p_2}{p_1 p_2 (1 - L_{DC})}\right) + \frac{s^2}{p_1 p_2 (1 - L_{DC})}}$$

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Second-order MFM if: $S'(s) = \frac{1}{1 + s\frac{\sqrt{2}}{\omega_h} + \frac{s^2}{\omega_h^2}}$

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Phantom compensation 2nd order system

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Example 12.2

Phantom compensation 2nd order system

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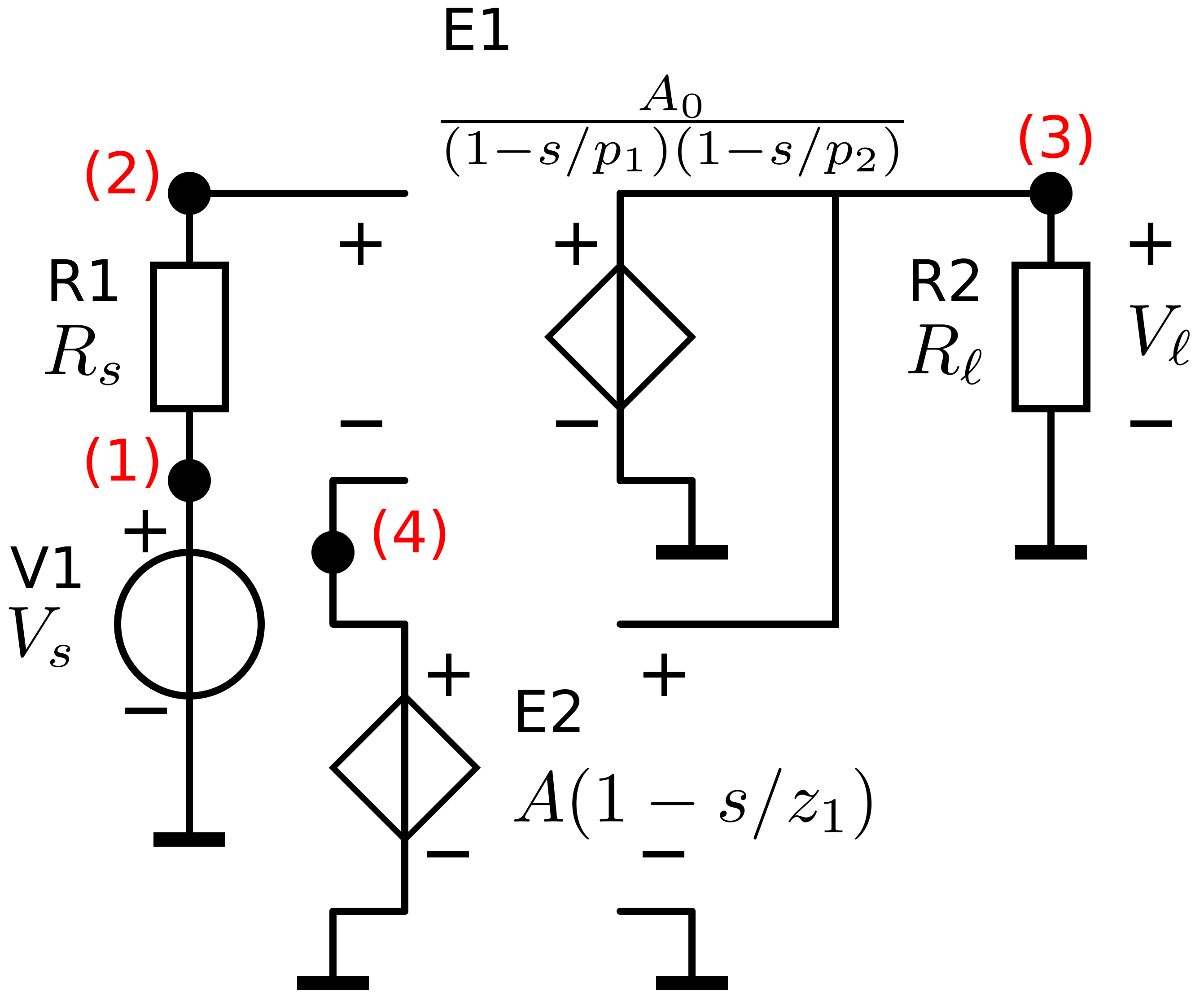
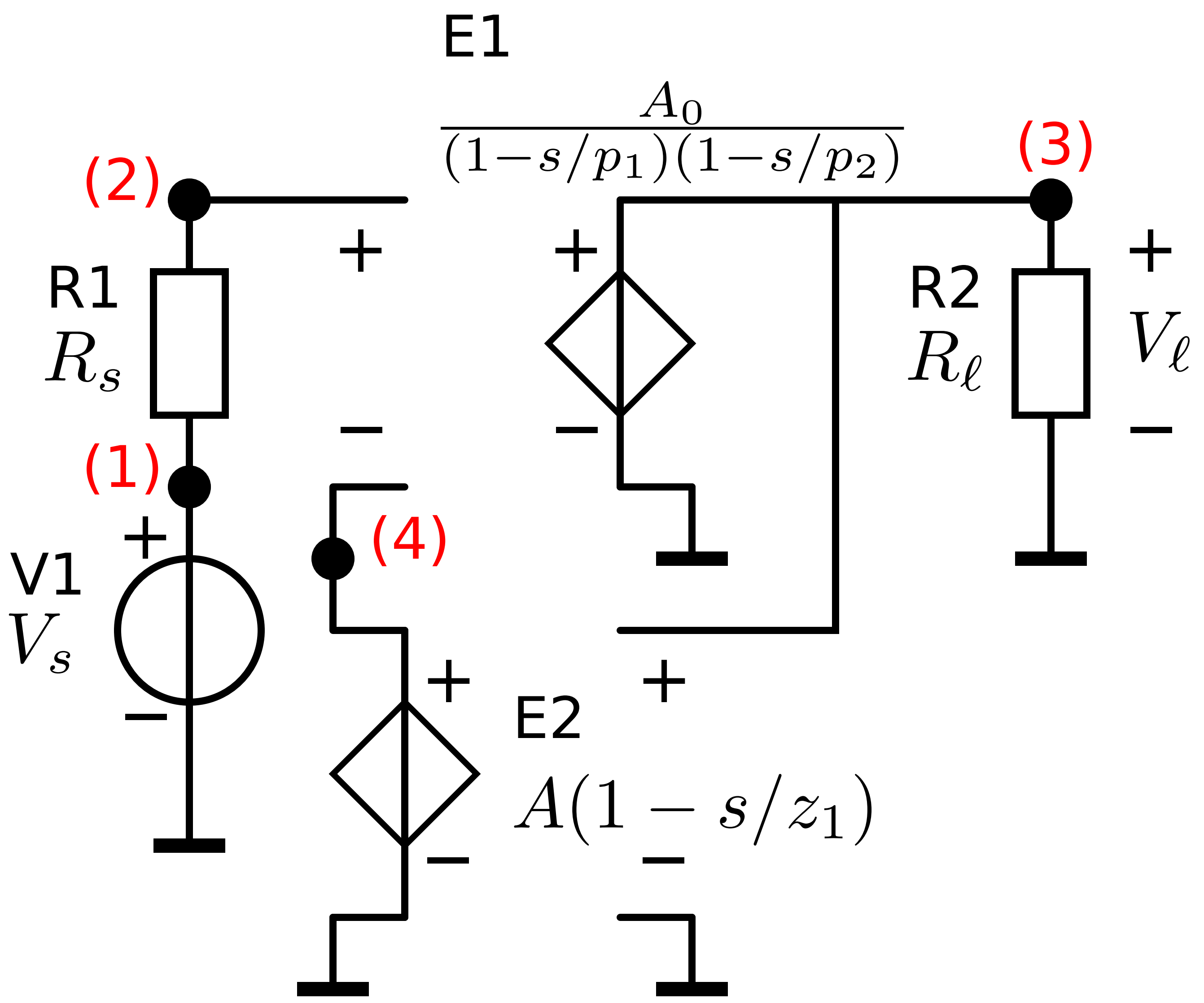


Phantom compensation 2nd order system

Example 12.2



$$p_1 = -1 \text{ Hz},$$

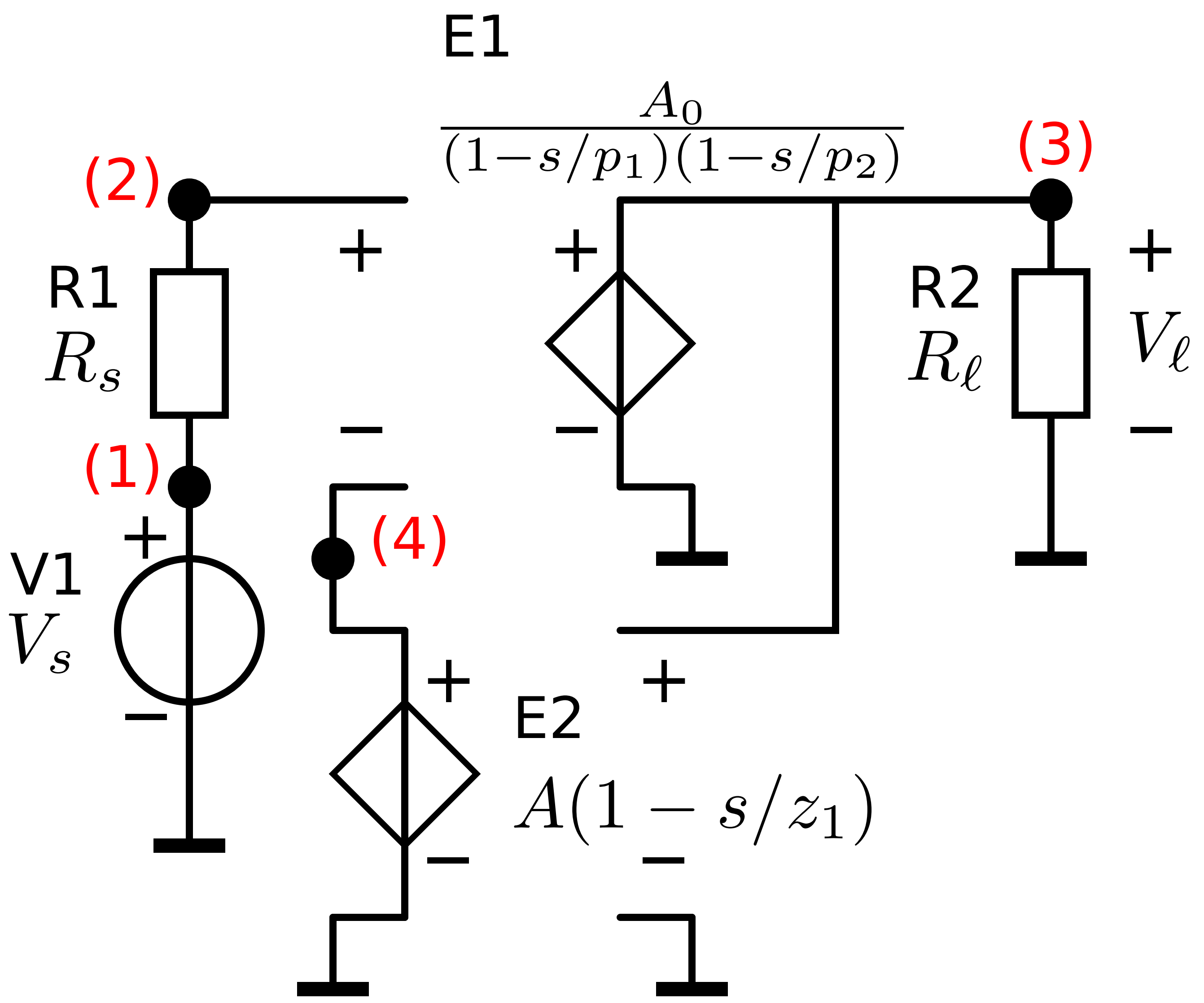
$$p_2 = -100 \text{ Hz},$$

$$A_0 = 10^6 \text{ [-]},$$

$$A = \frac{1}{100} \text{ [-]}.$$

Phantom compensation 2nd order system

Example 12.2



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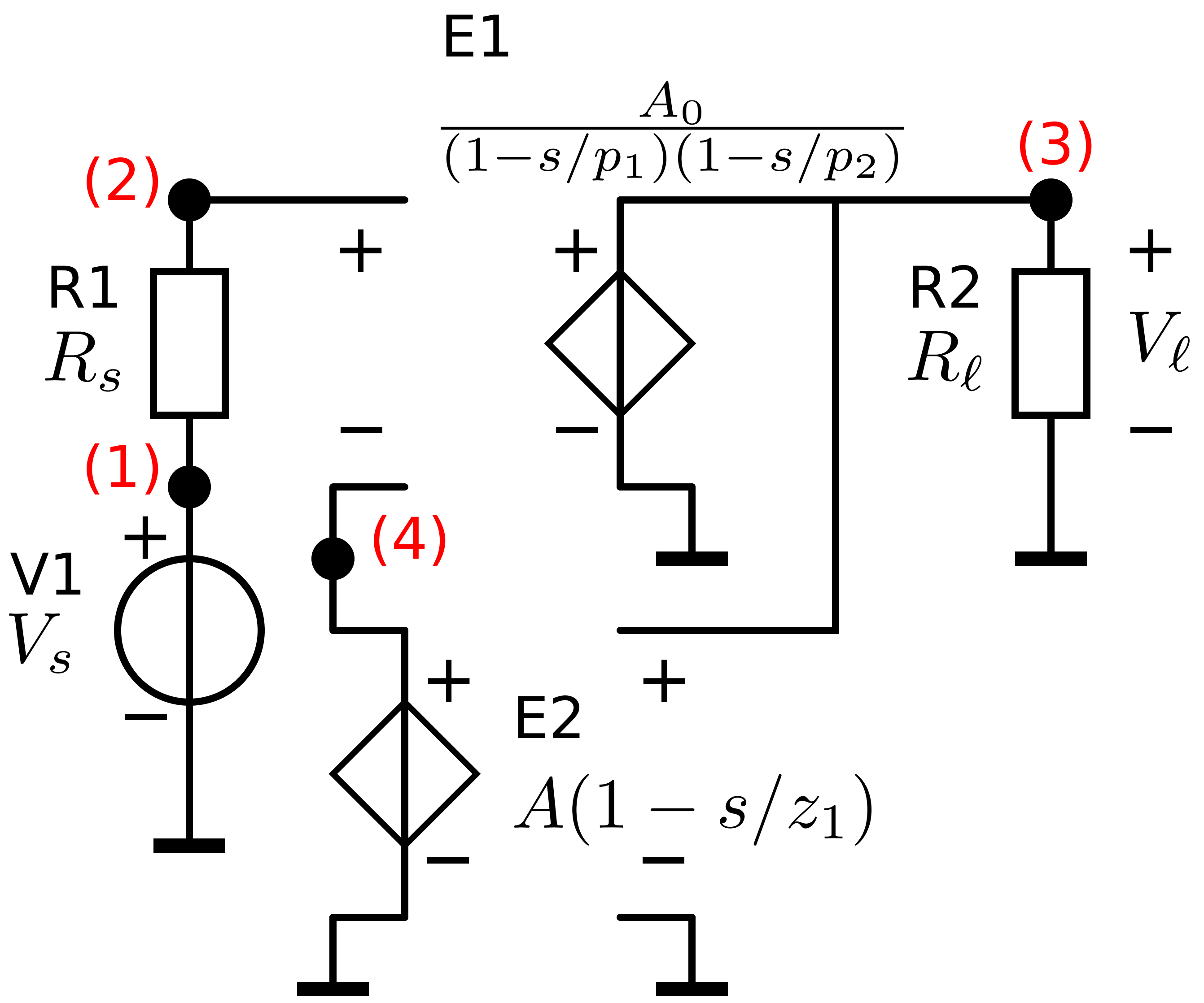
$$f_h = \sqrt{1 \cdot 100 \cdot \frac{1}{100} \cdot 10^6} = 1000 \text{ [Hz]}$$

Phantom compensation 2nd order system

Example 12.2



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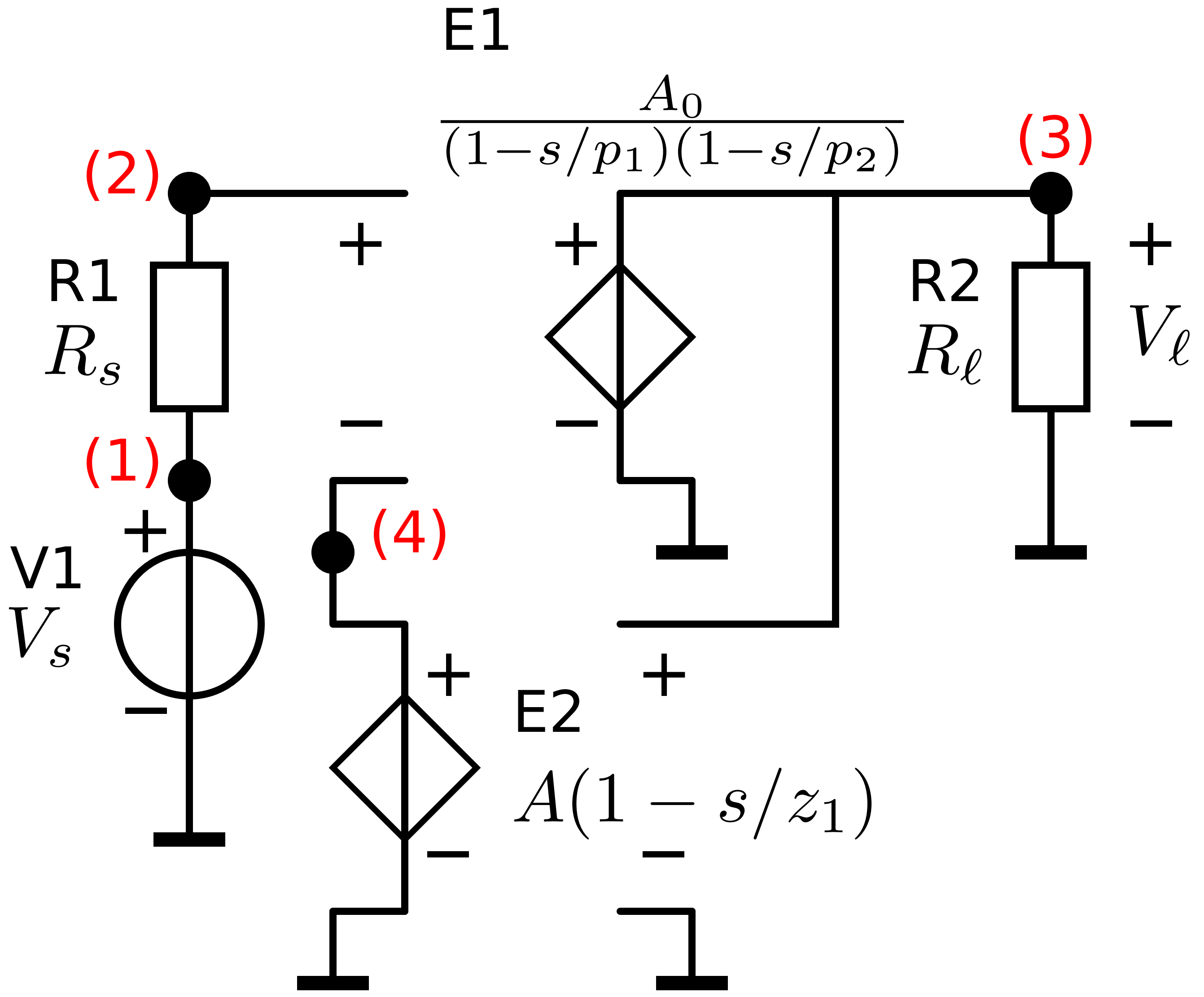
$$z = -\frac{10^6}{1000\sqrt{2}-101} = -761.49 \text{ [Hz]}$$

Phantom compensation 2nd order system

Example 12.2



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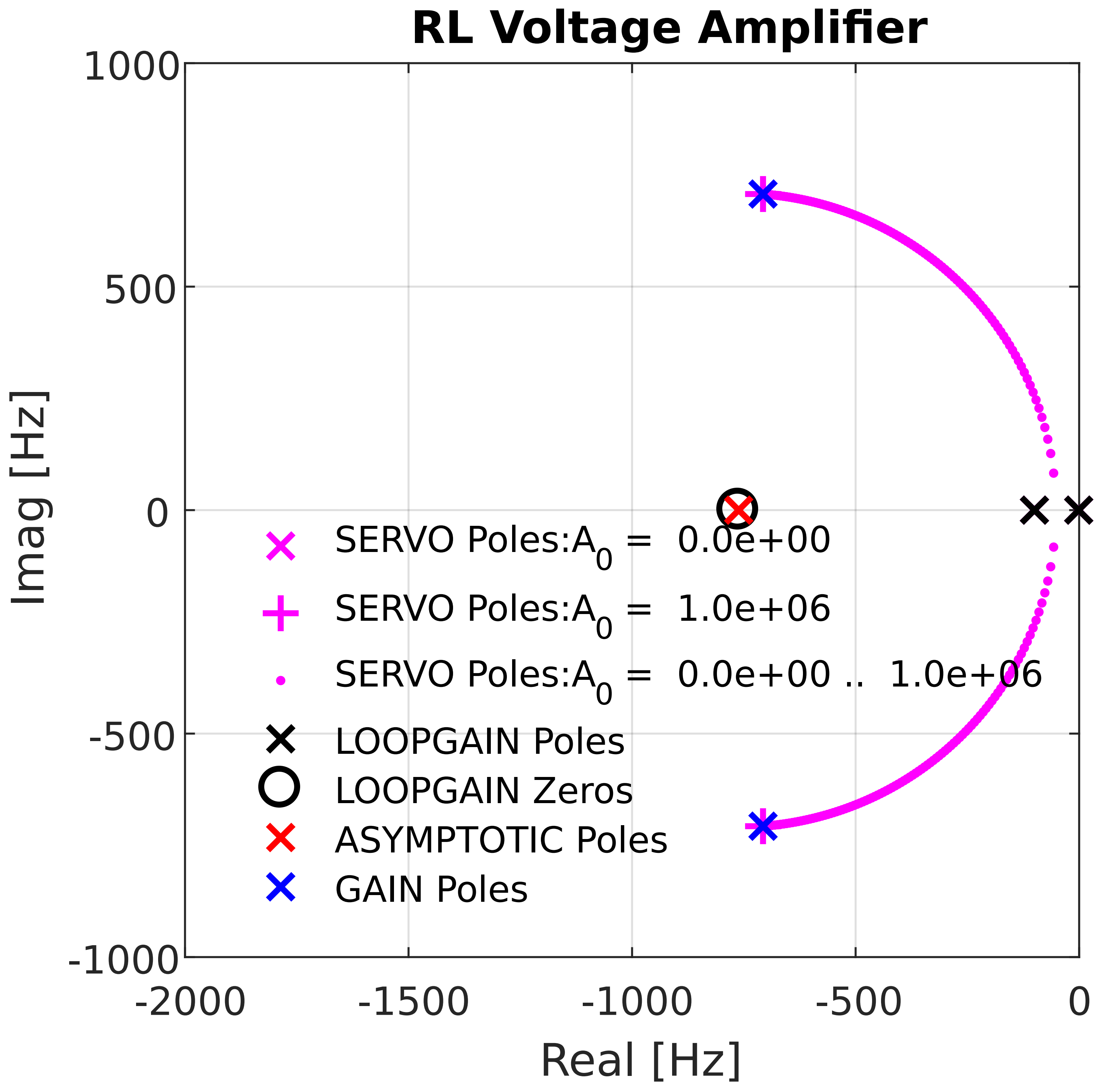

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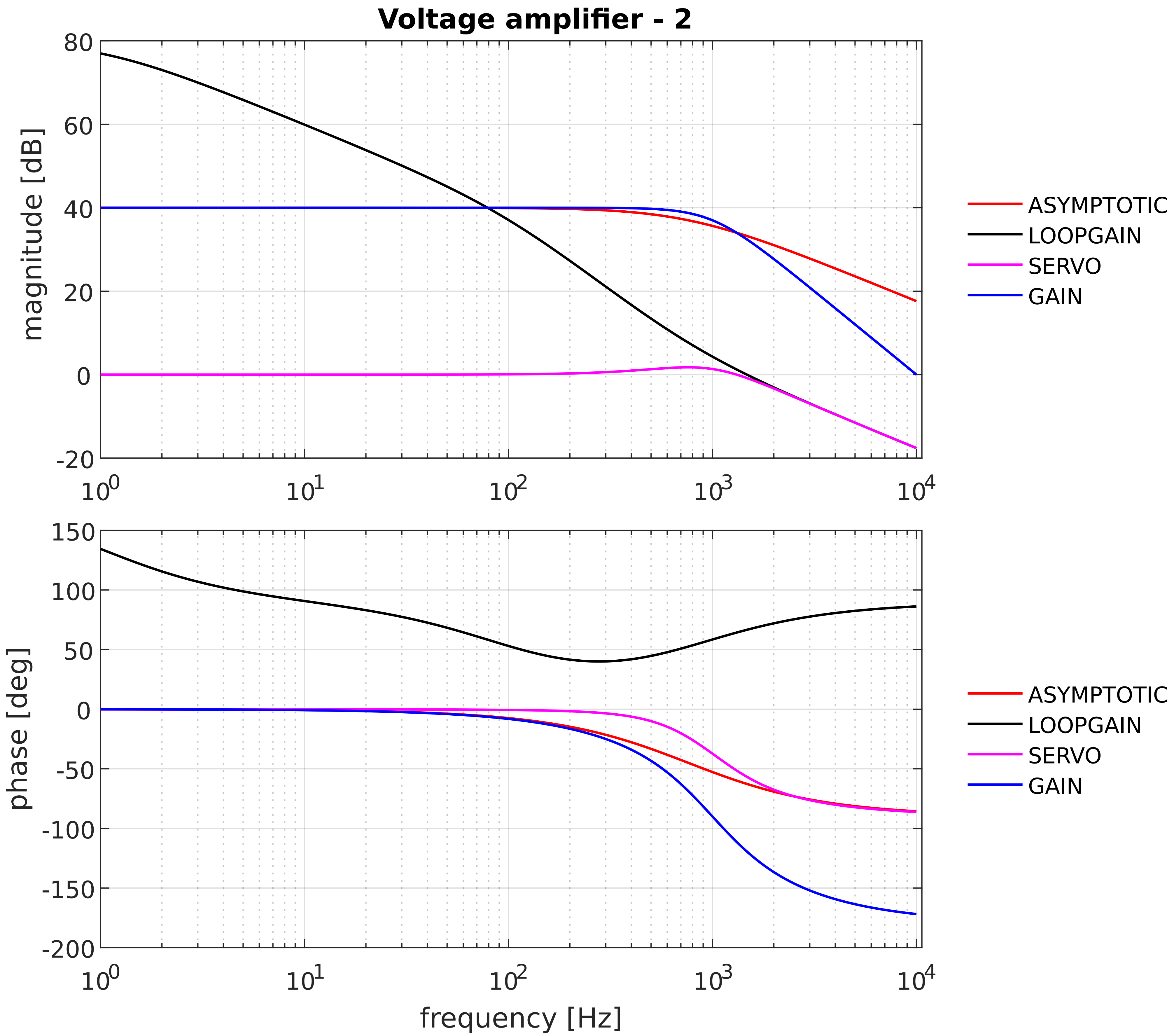
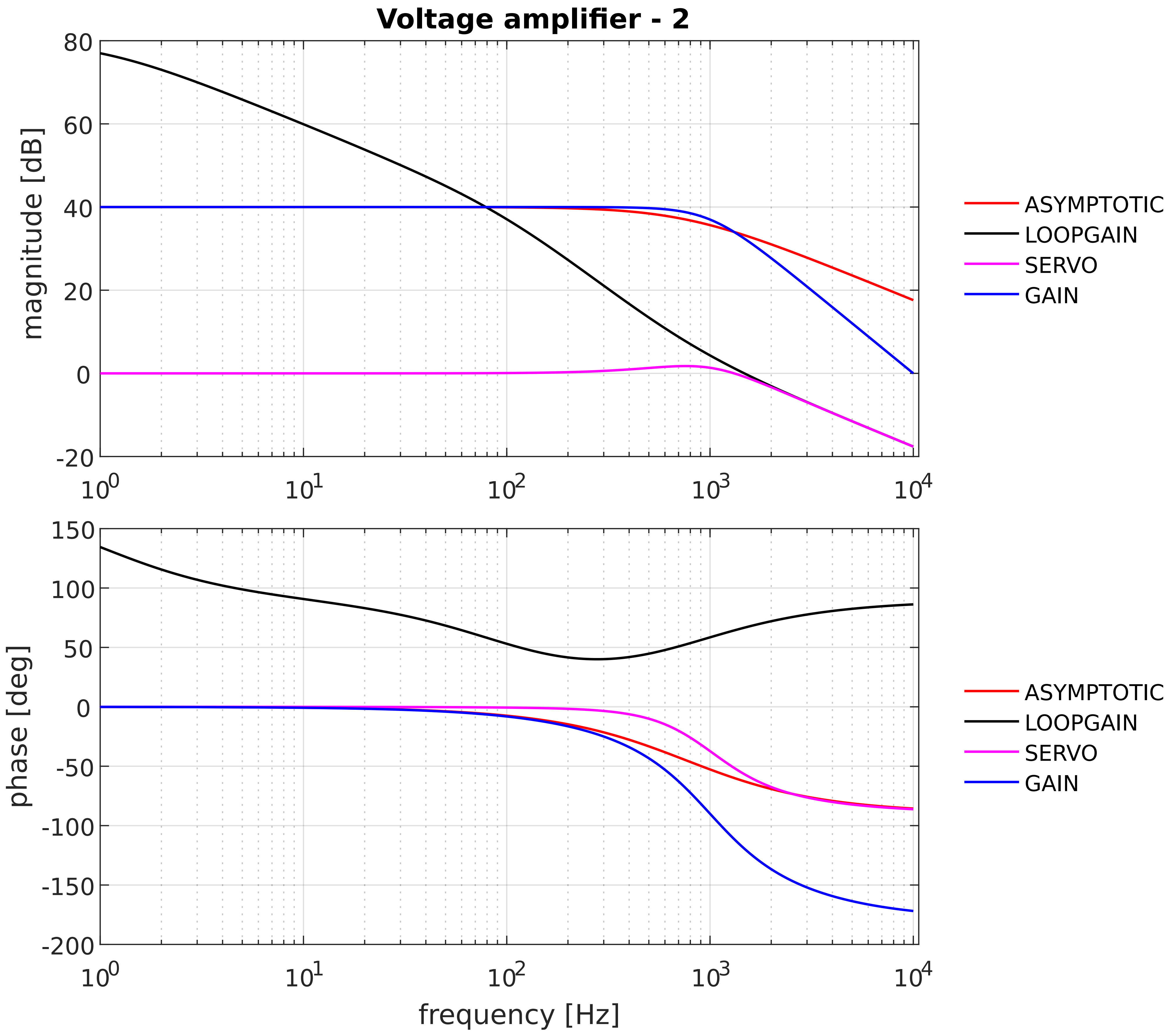


Phantom compensation 2nd order system

Example 12.2

Phase margin:
67 degrees
at 1.5kHz



Phantom compensation 2nd order system

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