

A Low-pass Filter Method to Suppress the Voltage Variations Caused by Introducing Droop Control in DC Microgrids



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1. Microgrid Configurations

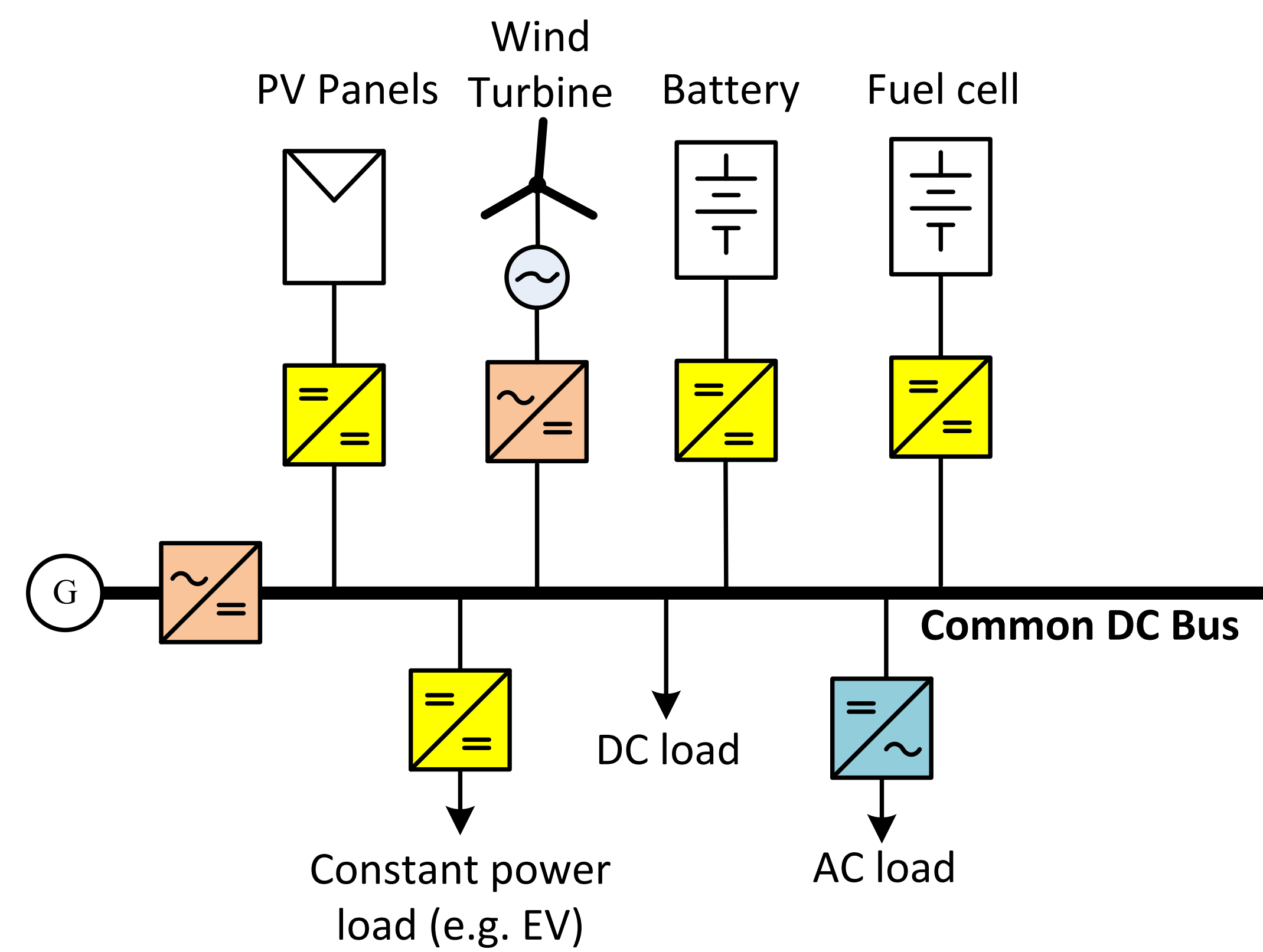


Fig.1: Single DC Bus microgrid configuration

Contains:

- ✓ Distributed sources
- ✓ Energy storage
- ✓ DC load/AC load

Control methods:

- ☐ Droop control
- ☐ DC bus signalling
- ☐ Master-slave control

Large droop coefficient \rightarrow bus oscillations

- Exceed the designed margin \rightarrow instability
- Variations in introduced output current

2. Control blocks of Two Nodes

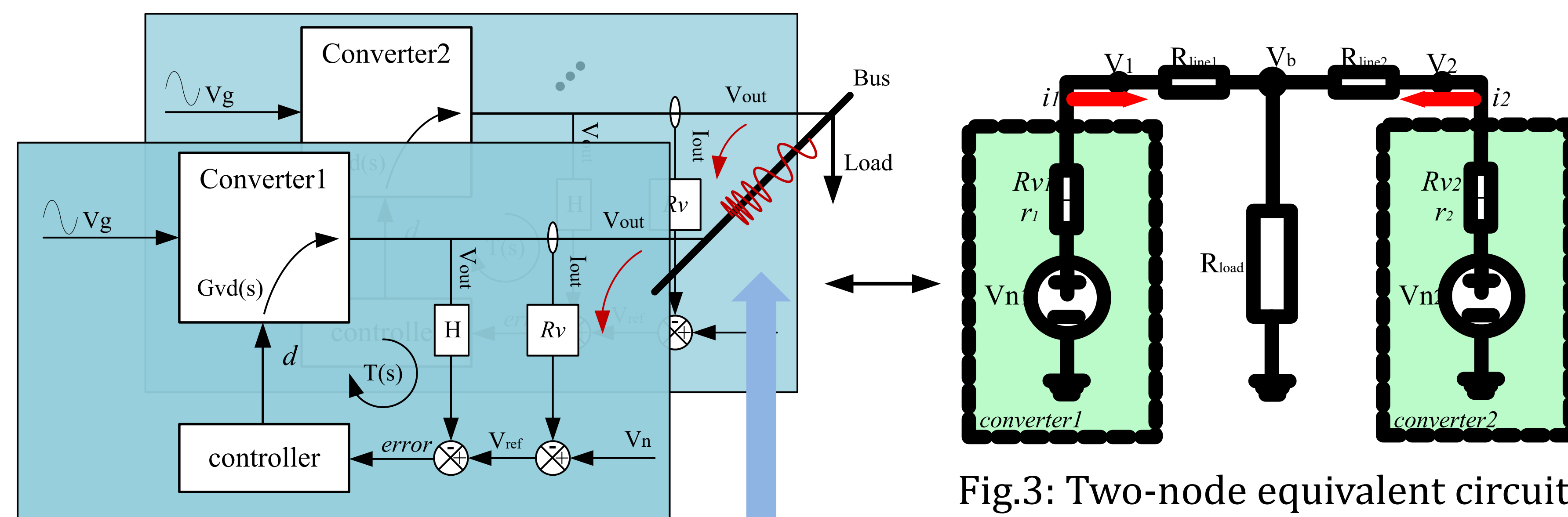


Fig.2: Control blocks of droop control

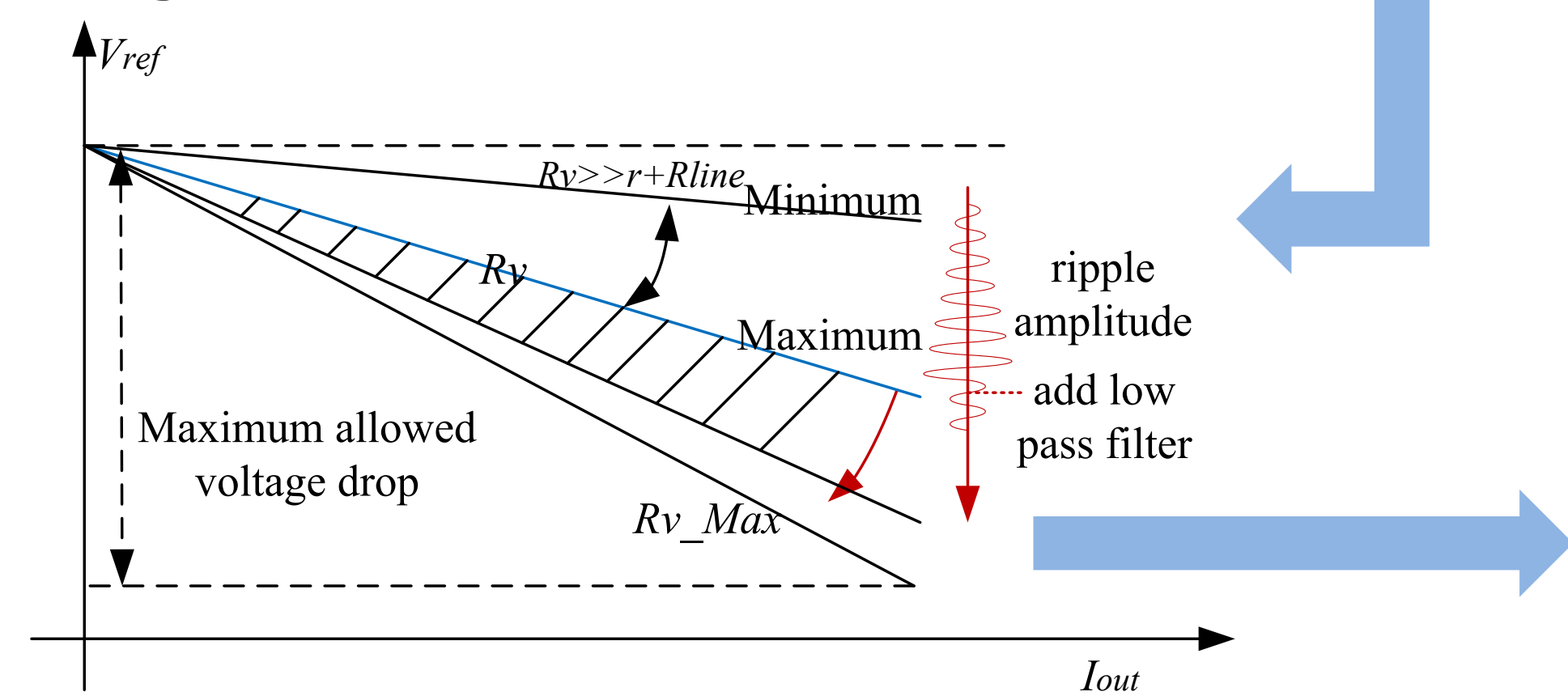


Fig.4: Droop curve and ripple variations

Fig.3: Two-node equivalent circuit model

$$V_b = V_{n1} - i_1(R_{v1} + R_{line1} + r_1)$$

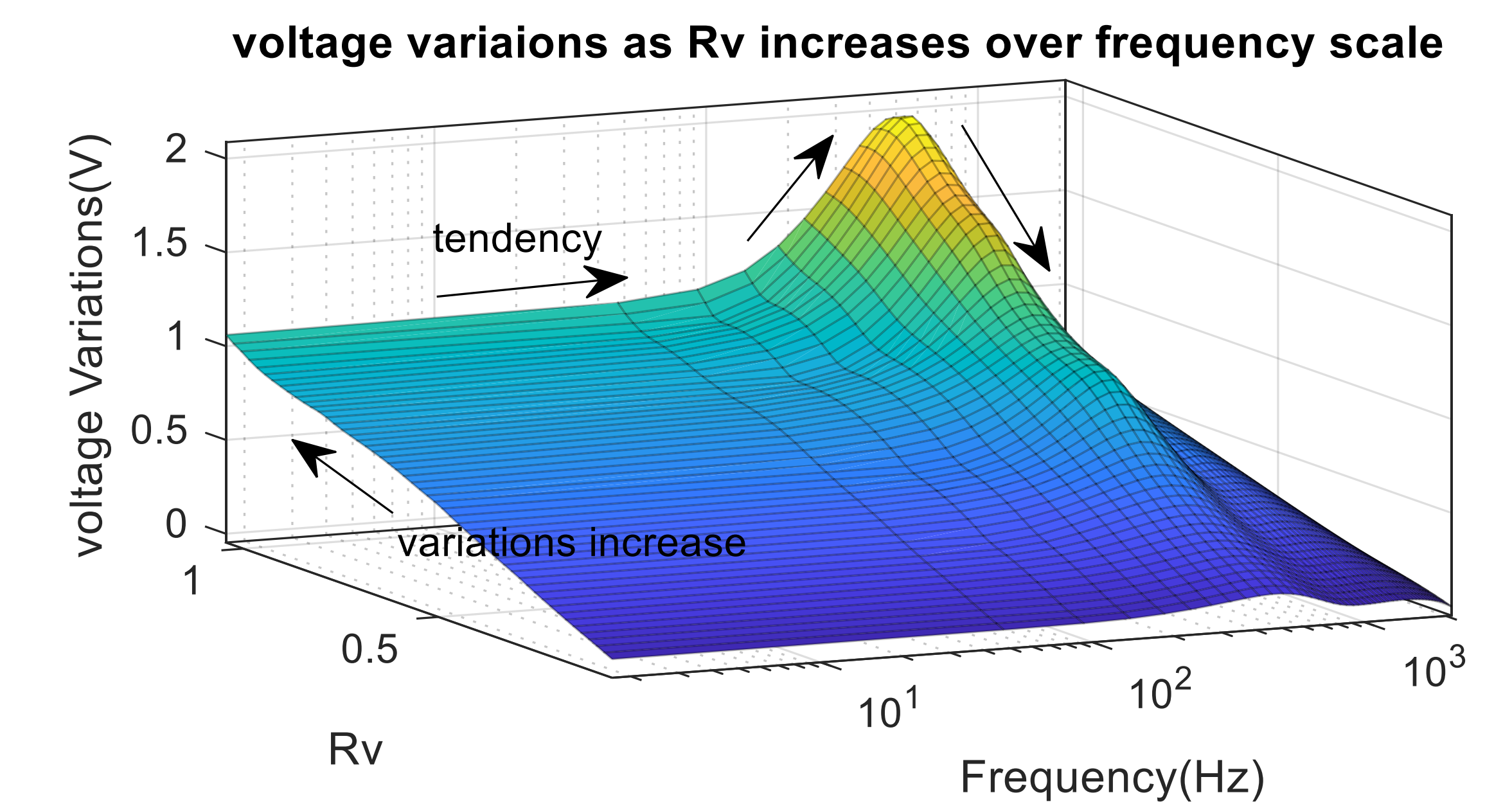
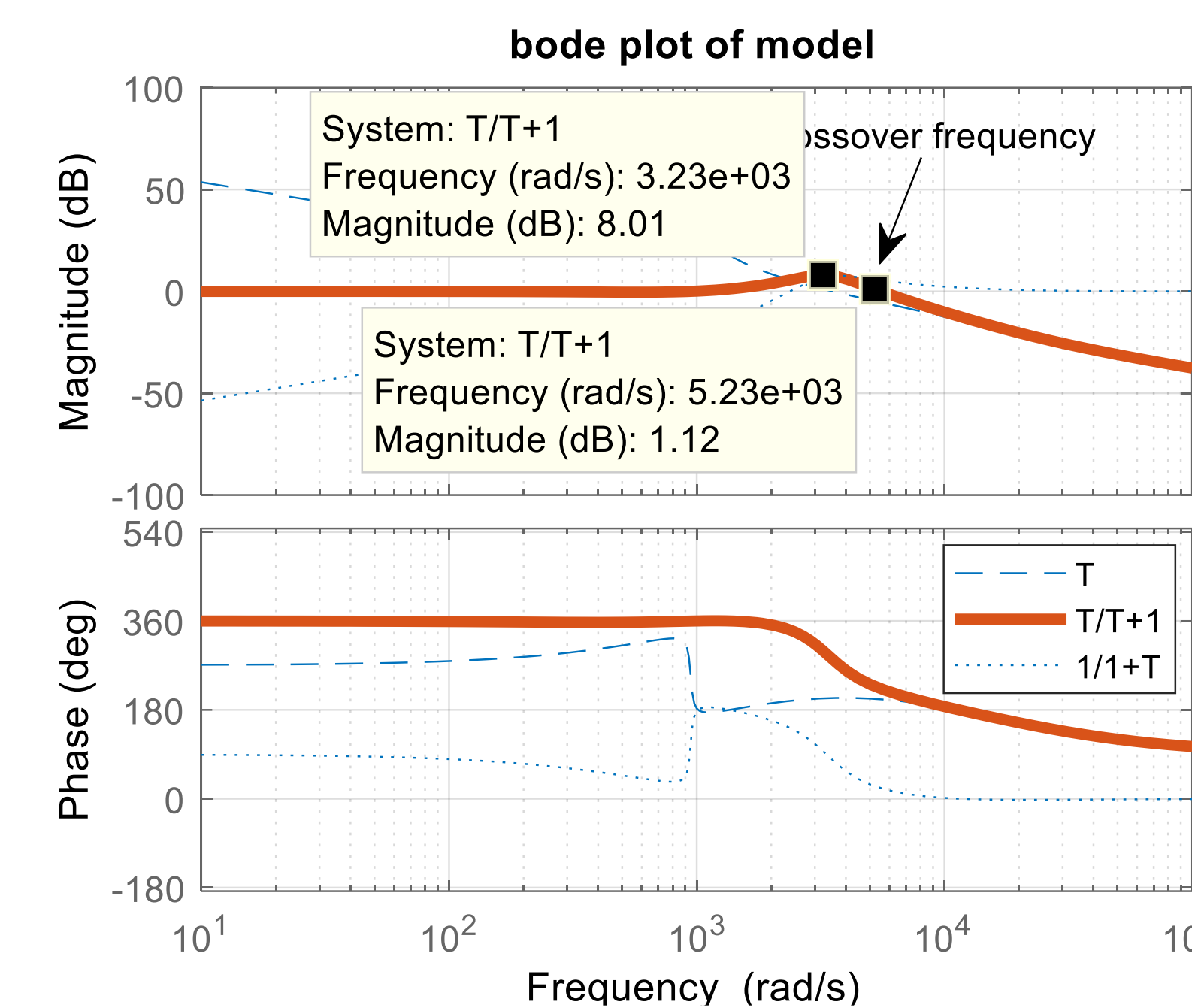
$$V_b = V_{n2} - i_2(R_{v2} + R_{line2} + r_2)$$

$$V_{out} = \underbrace{(V_n - I_{out}R_v)}_{V_{ref}} \frac{1}{H} \frac{T}{1+T} + V_g \frac{G_{vg}}{1+T} - I_{out} \frac{Z_{out}}{1+T}$$

Variation in output current $\Delta i \rightarrow *R_v \rightarrow \Delta V$

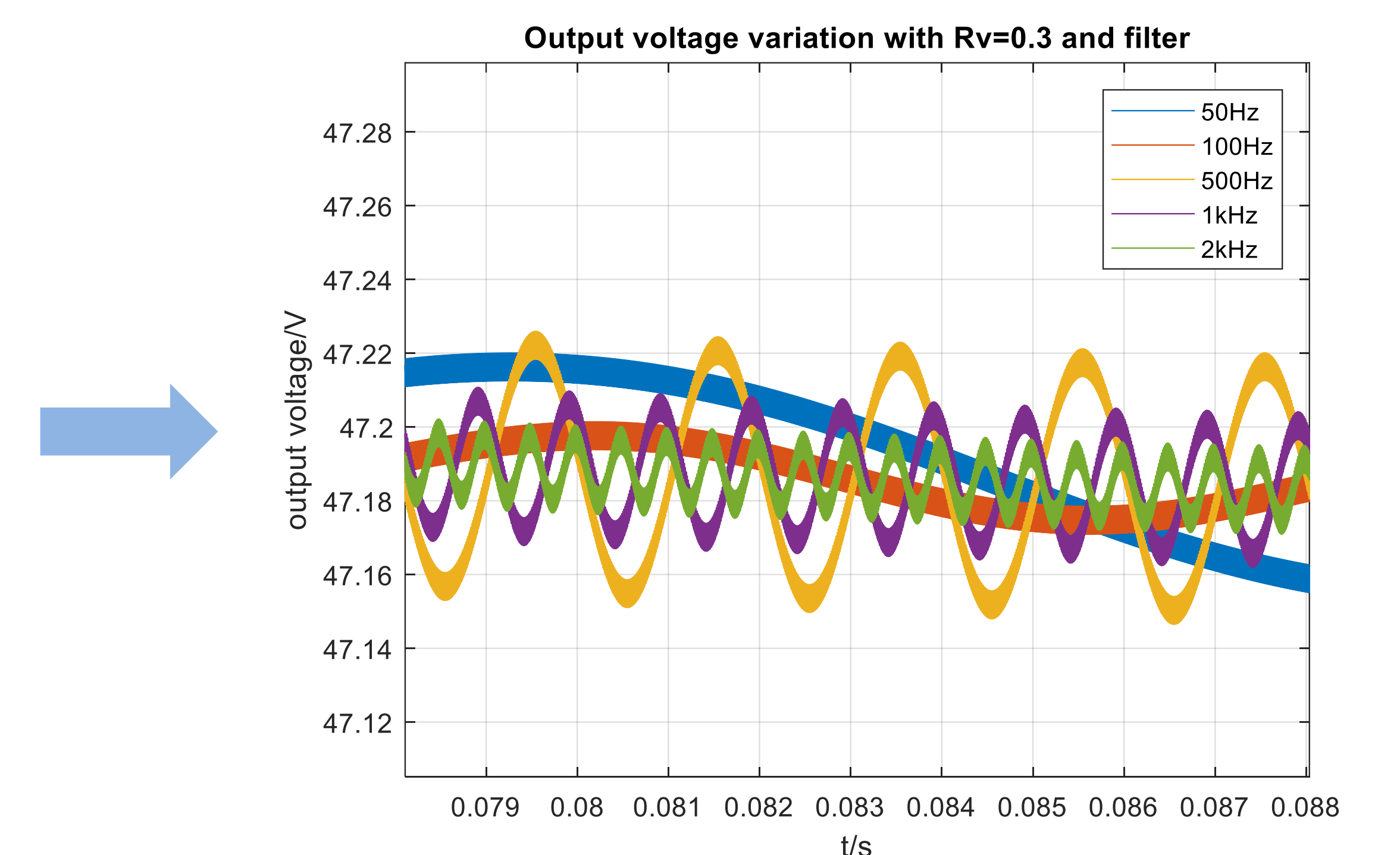
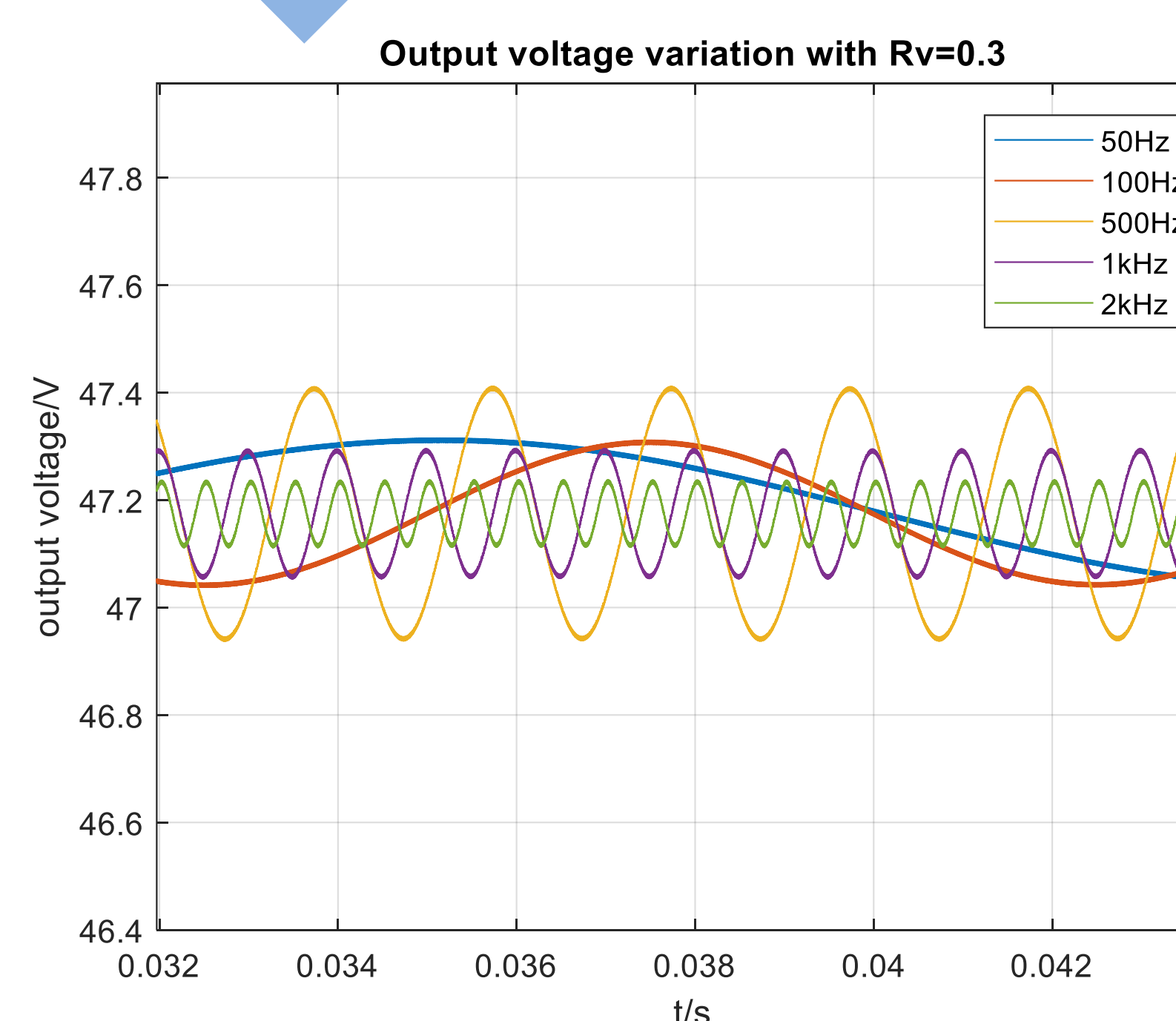
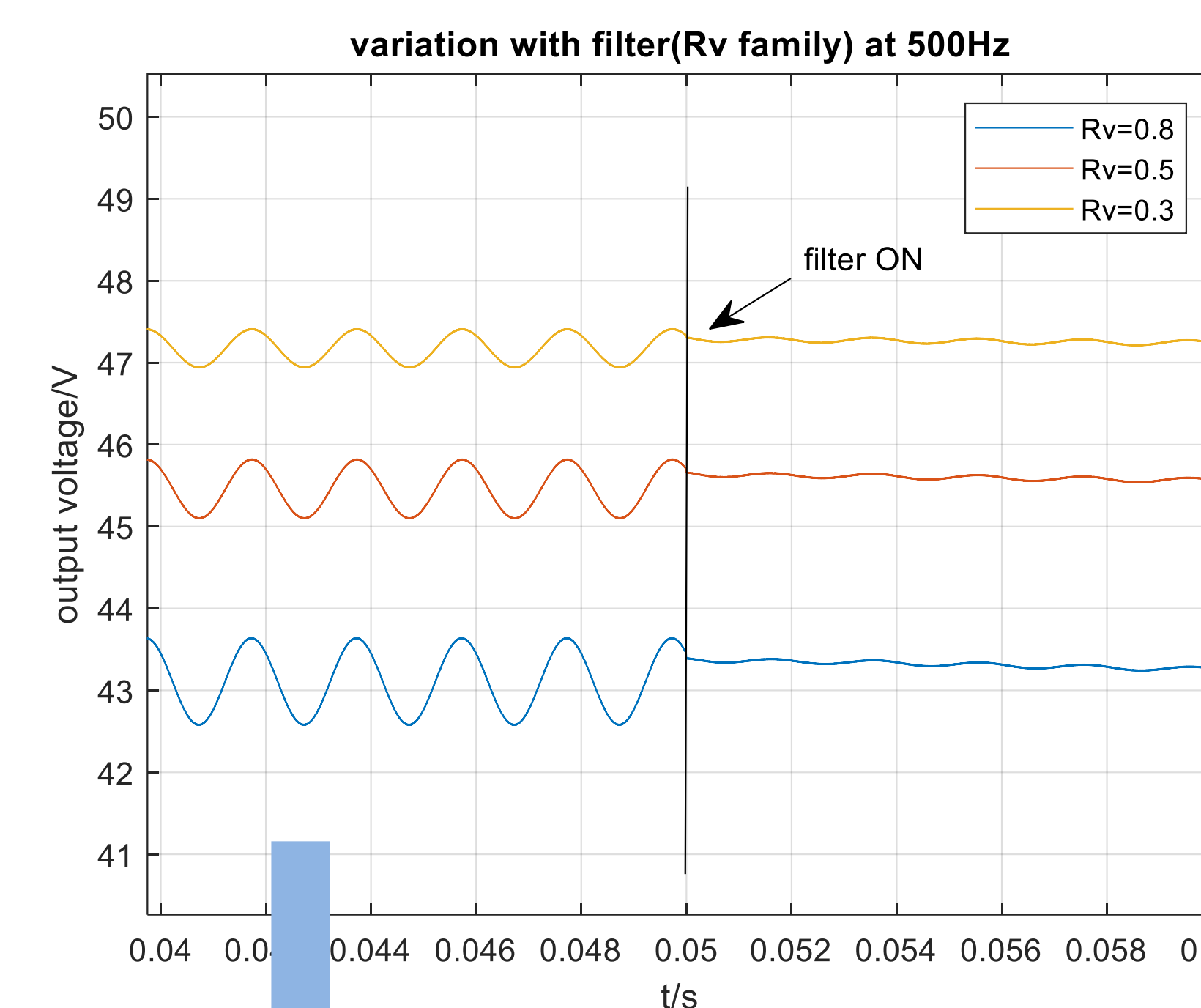
- ❖ Large droop coefficient will lead to large voltage variations

3. Analysis



- ❖ Lack the immunity on frequencies lower than crossover frequency
- ❖ Adding low-pass filter can compensate the unavailability over lower frequencies

4. Simulation Results



Conclusions:

1. Introducing droop control can cause voltage variations
2. Larger droop coefficient can cause larger variations
3. Low-pass filter on output current path can reduce variations