24W Flyback DCM Feedback Loop Design

1. Basic Coefficient :

$A := 1$ $V := 1$ $ohm := 1$ $W := 1$ $Hz := 1$

$meg := 10^{6}$ $k := 10^{3}$ $m := 10^{-3}$ $u := 10^{-6}$ $n := 10^{-9}$ $p := 10^{-12}$

2. Pervious parameter :

Line Frequency(Hz) : $f_{Line} := 50\ Hz$

Normal Line Voltage(V)120V<x<290V]: $Vin_Line := 120$

Bulk voltage at Vin_Line =120V : $V_{bulk} := 150$

Output voltage: $V_o := 48$

Output load: $R_{load} := 96$

Switching frequence: $f_s := 65\ k$

Primary inductance: $L_p := 750\ u$

Primary inductance turns: $N_p := 60$

Secondary inductance turns: $N_s := 38$

Transformer turns ratio: $N := \frac{N_s}{N_p} = 0.633$

Primary sense resistor: $R_{sense} := 0.6$

Output capacitor(Co)ESR at 25°ℂ: $R_{esr_min} := 0.04$

Output capacitor(Co)ESR at -10°ℂ: $R_{esr_max} := 0.12$

Output capacitor(uF): $C_o := 440\ u$

3. Design Process :

3.1 Control to Output :

First-order pole: $f_{p1} := \frac{1}{\pi \cdot R_{load} \cdot C_o} = 7.536$

Left half-plane zero(min): $f_{z0_min} := \frac{1}{2 \cdot \pi \cdot R_{esr_max} \cdot C_o} = 3.014 \cdot 10^{3}$

Left half-plane zero(max): $f_{z0_max} := \frac{1}{2 \cdot \pi \cdot R_{esr_min} \cdot C_o} = 9.043 \cdot 10^{3}$

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$$G_{DC} := V_{bulk} \cdot \sqrt{\frac{R_{load} \cdot f_s}{2 \cdot L_p}} \cdot \frac{L_p}{V_{bulk} \cdot R_{sense}} = 80.623$$

$$G_o := 20 \cdot \log\left(G_{DC}\right) = 38.129$$

$$G_{div} := 20 \cdot \log\left(\frac{1}{3}\right) = -9.542$$

$$G_{FbToVout} := G_o + G_{div} = 28.587$$

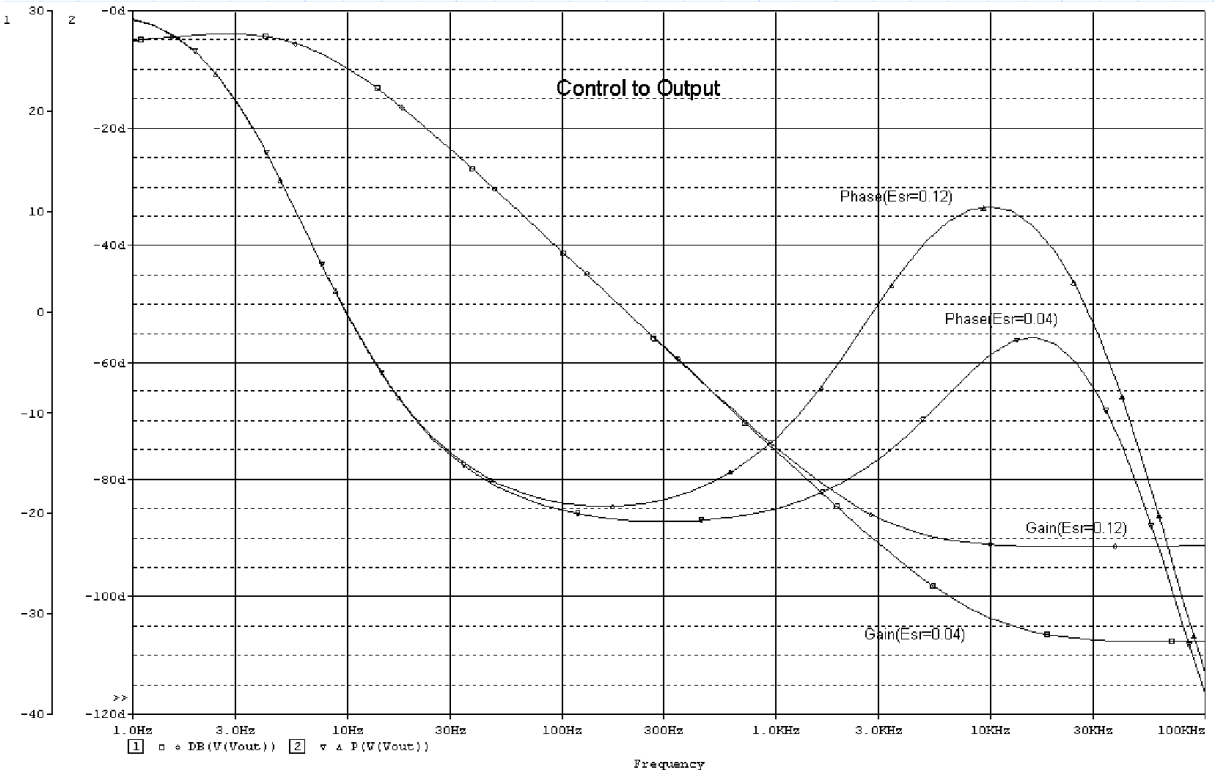
$$\Delta I := 0.45 \qquad \Delta V := 0.48$$

$$f_c := \frac{\Delta I}{2 \cdot \pi \cdot \Delta V \cdot C_o} = 339.109 \qquad f_c := 600$$

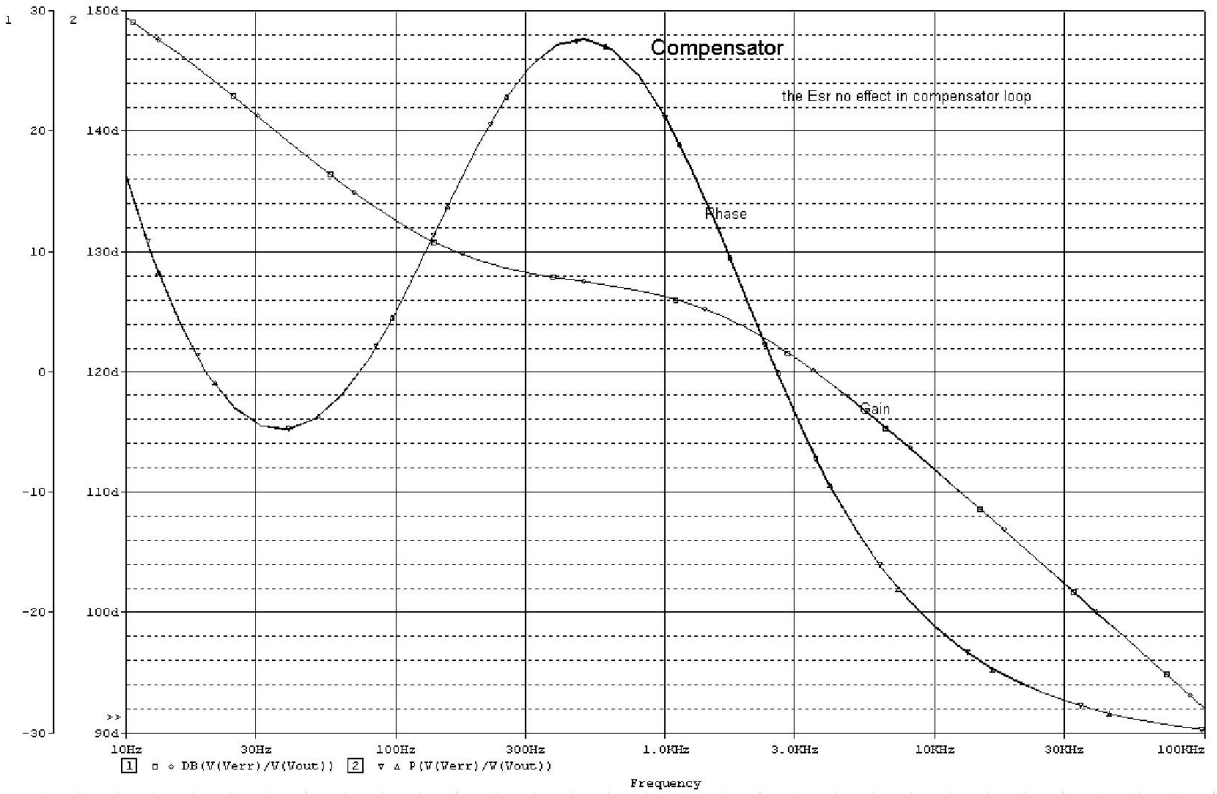
估值 $R_{led} := 4\ k$

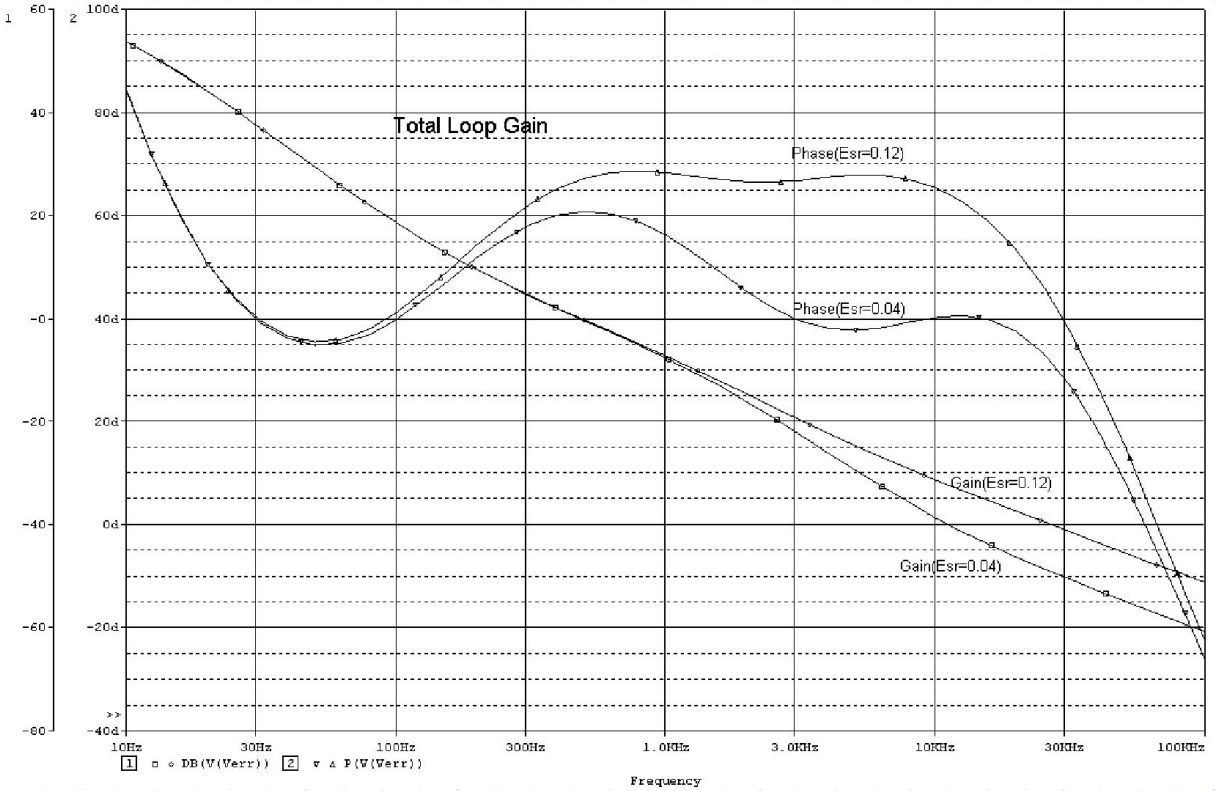
约束 $20 \cdot \log\left(\frac{40\ k}{R_{led}}\right) = 7.9$

求解器 $\text{find}\left(R_{led}\right) = 1.611 \cdot 10^4$



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计算结果与仿真结果基本一致，在穿越频率500Hz处有60度的相位裕量，没有条件稳定点。

$C_{pole} := 1.8\ n$ 考虑光耦等效结电容大概1.6n

$C_{zero} := 22\ n$ $R_{led} := 16\ k$ $R_{upper} := 51\ k$ $R_{lower} := 2.8\ k$

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