

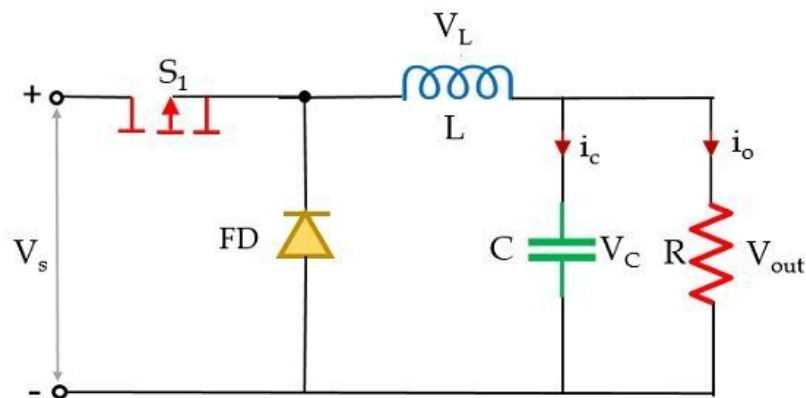
# 綠能積體電路期末報告

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## 一、綠能積體電路設計－ Buck頻率補償

描述：設計一個 Buck－Converter 電路，並做頻率補償，且在 8 毫秒時抽載 1A

$V_{in}$	$V_{out}$	$I_o$	$f_s$	$L$	$C$	$R$
10V	5V	1A	200k	$3.125 \times 10^{-6}$	$12.5 \times 10^{-6}$	5 ohm



Buck Converter

Converter	$G_{g0}$	$G_{d0}$	$\omega_0$	$Q$	$\omega_z$
buck	$D$	$\frac{V}{D}$	$\frac{1}{\sqrt{LC}}$	$R\sqrt{\frac{C}{L}}$	$\infty$

**AV(gain) T(s)**

$$\begin{aligned}
 G_{vg}(s) \frac{\hat{v}_o(s)}{\hat{v}_{in}(s)} &= V_g \frac{\left(R \parallel \frac{1}{sC}\right)}{sL + \left(R \parallel \frac{1}{sC}\right)} \\
 &= V_g \frac{1}{s^2LC + \frac{sL}{R} + 1} \\
 &= \frac{0.5}{3.90625 \times 10^{-11} s^2 + 6.25 \times 10^{-7} s + 1}
 \end{aligned}$$

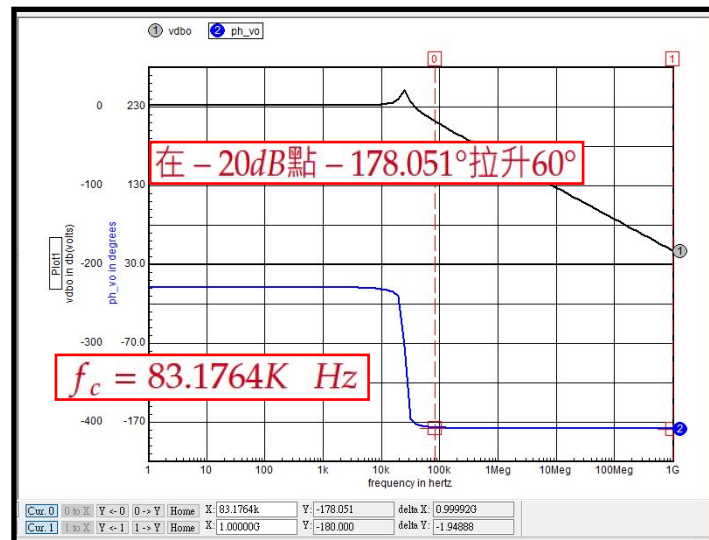
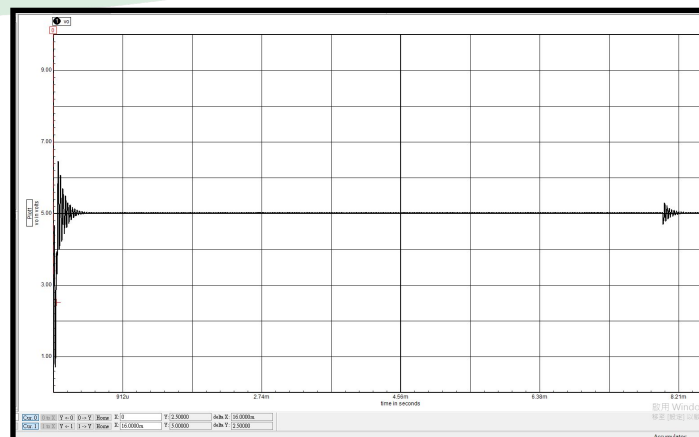
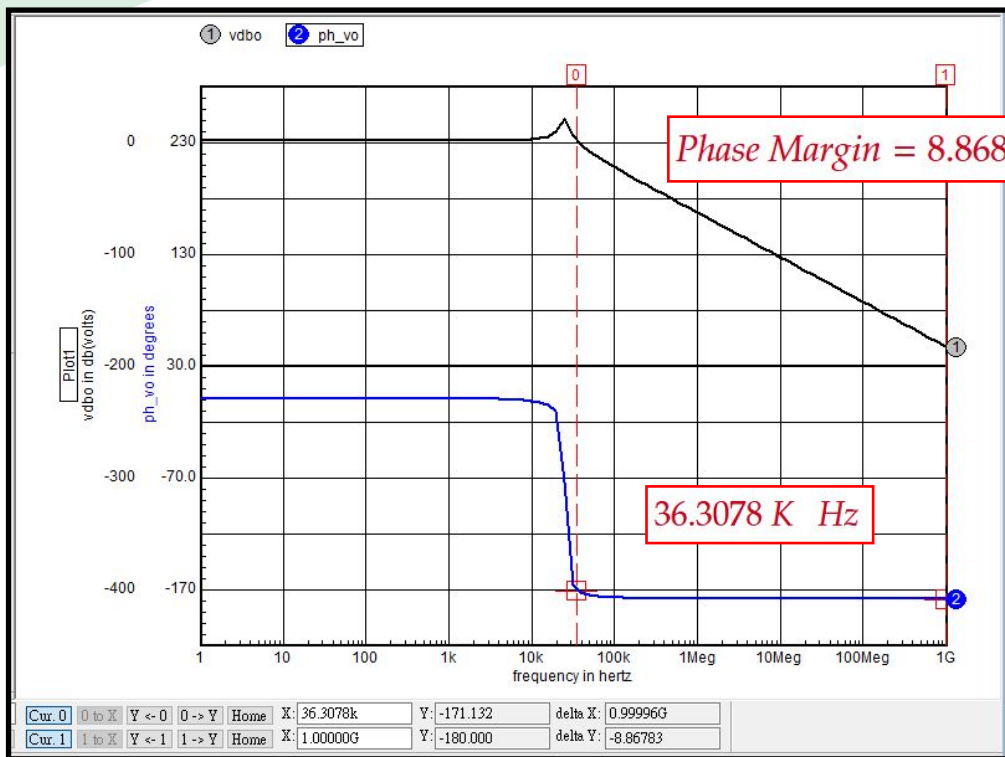
**Duty Ratio T(s)**

$$\begin{aligned}
 G_{vd}(s) = \frac{\hat{v}_o(s)}{\hat{d}(s)} &= D \frac{\left(R \parallel \frac{1}{sC}\right)}{sL + \left(R \parallel \frac{1}{sC}\right)} \\
 &= D \frac{\frac{R}{1 + sCR}}{sL + \frac{R}{1 + sCR}} \\
 &= D \frac{1}{s^2LC + \frac{sL}{R} + 1} \\
 &= \frac{10}{3.90625 \times 10^{-11} s^2 + 6.25 \times 10^{-7} s + 1}
 \end{aligned}$$

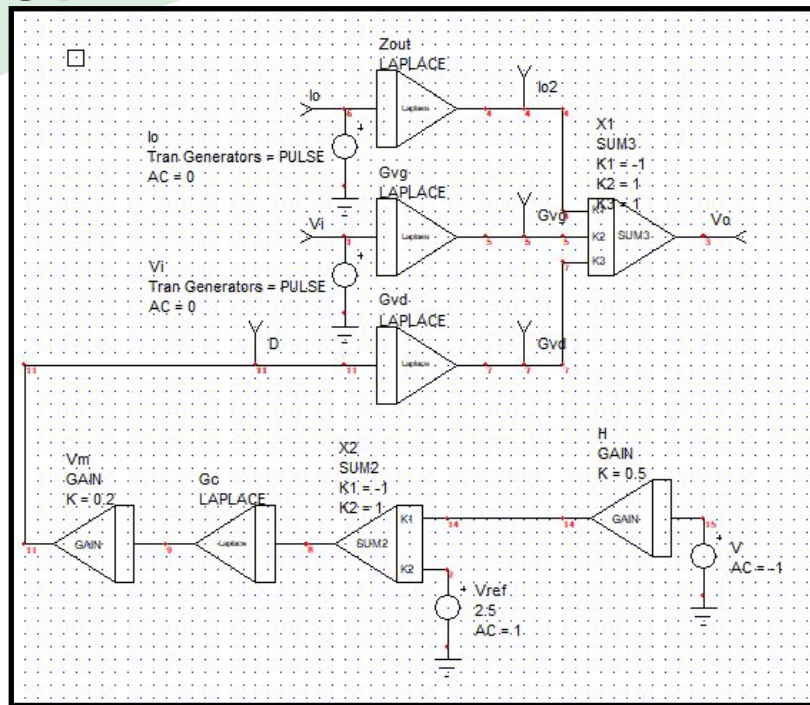
**Zout**

$$\begin{aligned}
 Z_{out}(s) &= \frac{\hat{v}_o(s)}{\hat{i}_o(s)} = R \parallel \frac{1}{sC} \parallel sL \\
 &= \frac{sL}{s^2LC + \frac{sL}{R} + 1} \\
 &= \frac{3.125 \times 10^{-6} s}{3.90625 \times 10^{-11} s^2 + 6.25 \times 10^{-7} s + 1}
 \end{aligned}$$

# 波德圖(未補償)



# Type III補償器改善



## 設計Type III補償器

使T(s)的Phase Margin提高至60°

$$f_c = 83.1764 \text{ k Hz}, \quad G \div 20 \text{ dB} = 10$$

$$P = 60^\circ - (-178.051^\circ) - 90^\circ = 148.051^\circ$$

$$\frac{v_o(s)}{v_i(s)} \approx \frac{(1 + sR_2C_1)(1 + sR_1C_3)}{sR_1C_1(1 + sR_2C_2)(1 + sR_3C_3)}$$

$$K = \left( \tan \left[ \left( \frac{P}{4} \right) + 45^\circ \right] \right)^2$$

$$\omega_0 = 2 \times \pi \times f = 522612.73$$

$$K = 50.792$$

$$R_1 = 1000 \quad \Omega$$

$$R_2 = 1431.32 \quad \Omega$$

$$R_3 = 20.083 \quad \Omega$$

$$C_1 = 9.53 \times 10^{-9} \quad F$$

$$C_2 = 1.91 \times 10^{-10} \quad F$$

$$C_3 = 1.34 \times 10^{-8} \quad F$$

$$C_1 = C_2(K - 1)$$

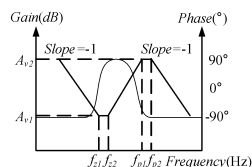
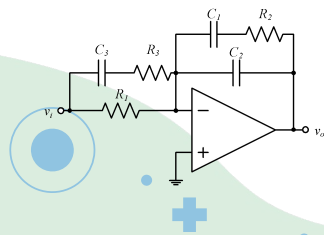
$$R_1 = 1000 \Omega$$

$$C_2 = \frac{1}{\omega_c R_1 G}$$

$$R_2 = \frac{\sqrt{K}}{\omega_c C_1}$$

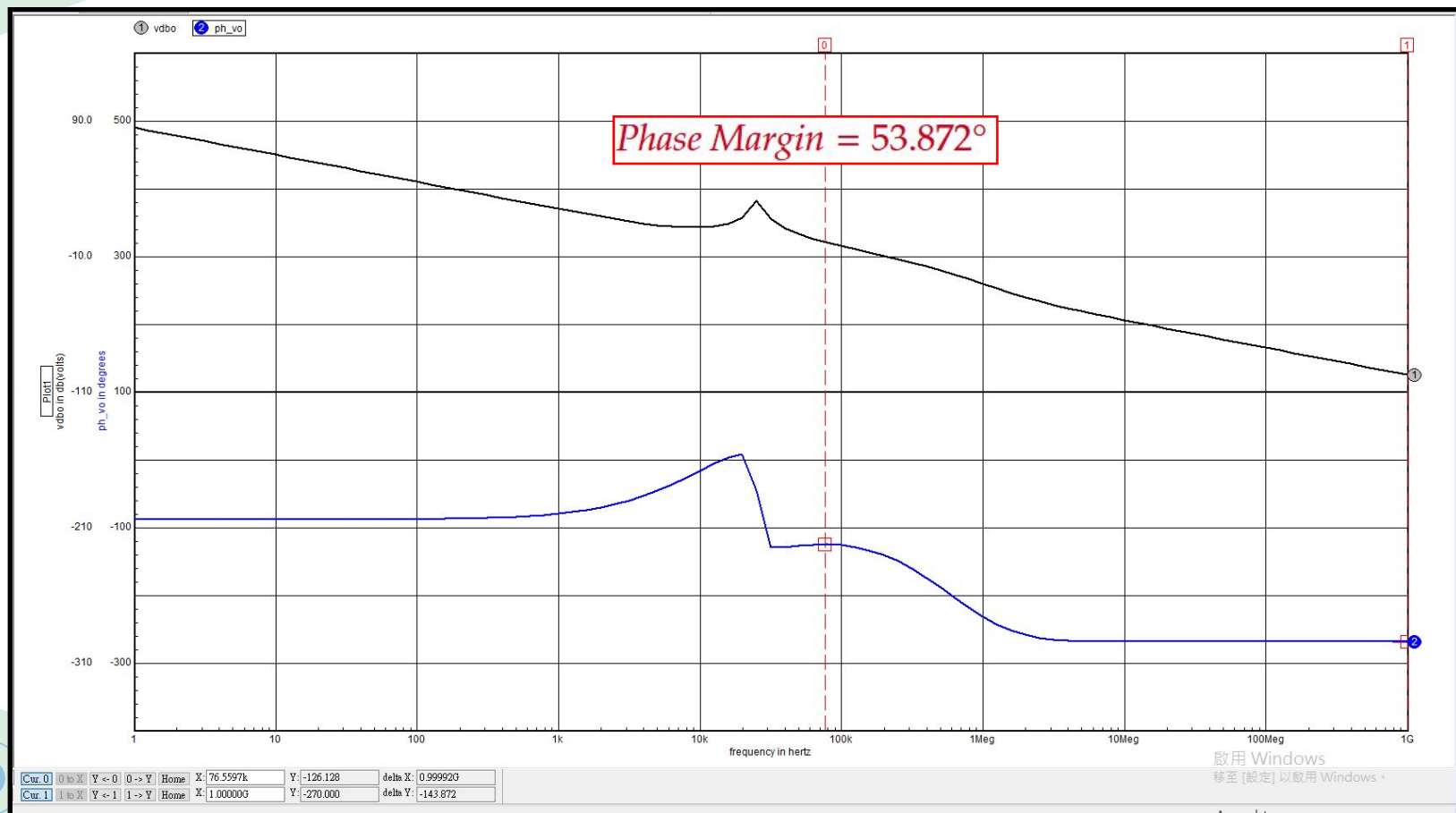
$$C_3 = \frac{1}{\omega_c R_3 \sqrt{K}}$$

$$R_3 = \frac{R_1}{K - 1}$$

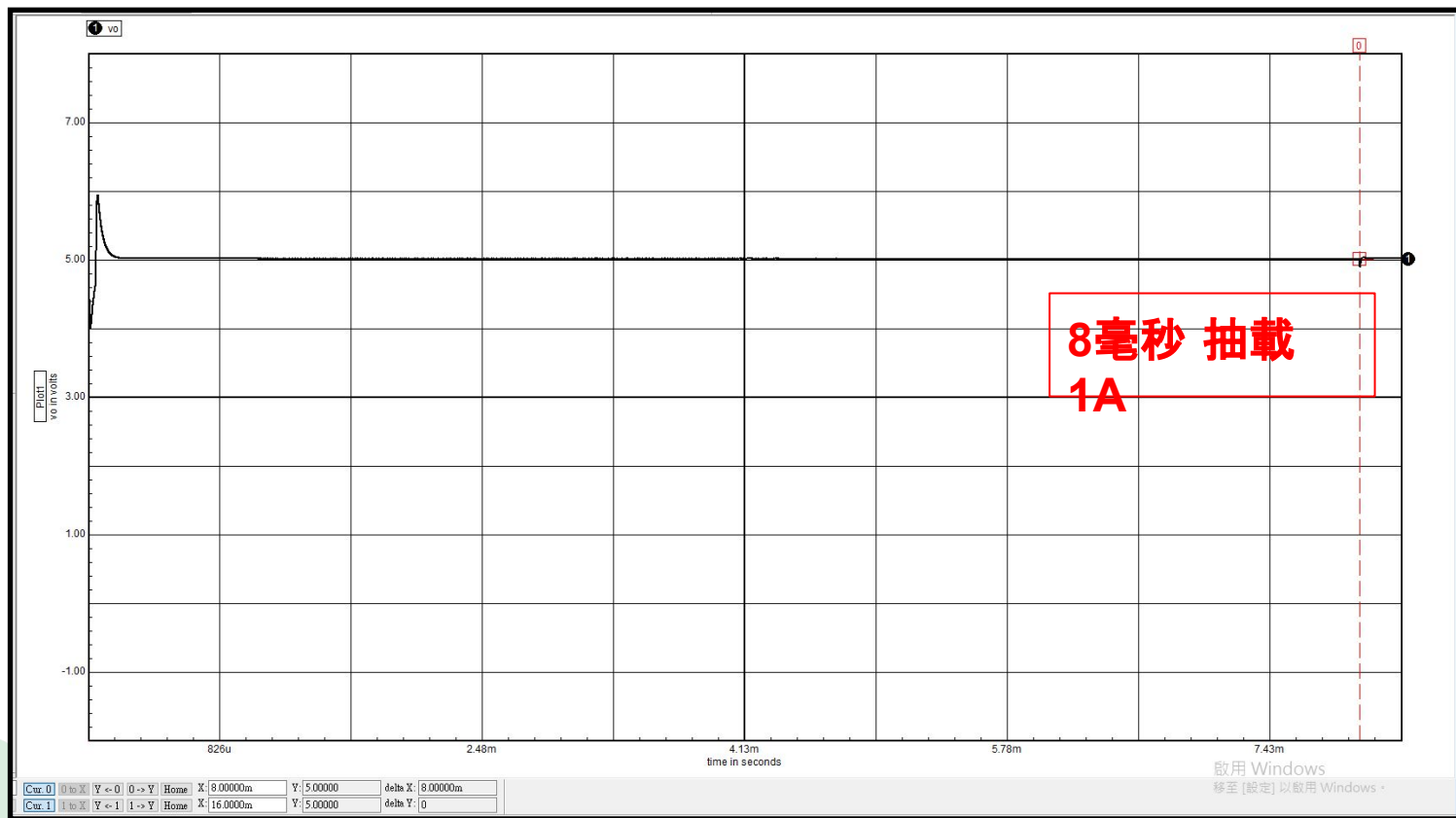


$$\frac{V_o(s)}{V_i(s)} \cong \frac{1.82 \times 10^{-10} S^2 + 2.7 \times 10^{-5} S + 1}{7.01 \times 10^{-19} S^3 + 5.17 \times 10^{-12} S^2 + 5.17 \times 10^{-6} S}$$

# 波德圖(補償後)



啟用 Windows  
移至 [設定] 以啟用 Windows。



**Thank you for your attention!**