綠能積體電路期末報告

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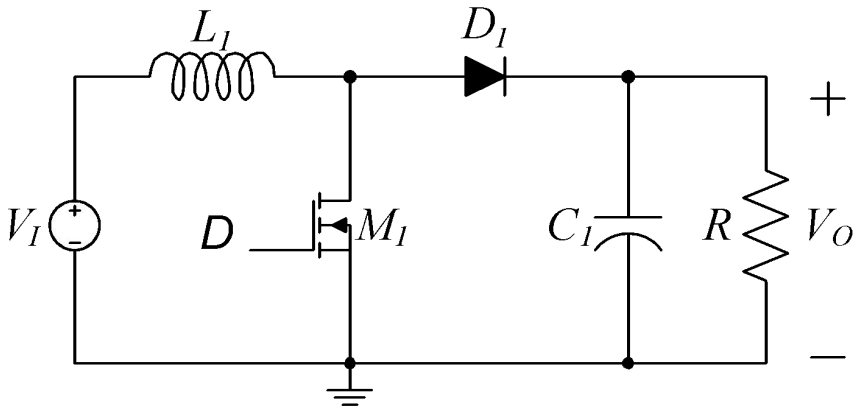
一、綠能積體電路設計－ Buck頻率補償

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

Vin	Vout	Io	fs	L	C	R
10V	5V	1A	200k	3.125×10^{-6}	12.5×10^{-6}	5 ohm



Converter	G_{g0}	G_{d0}	ω_0	Q	ω_z
buck	D	$\frac{V}{D}$	$\frac{1}{\sqrt{LC}}$	$R\sqrt{\frac{C}{L}}$	∞

AV(gain) T(s)

$$G_{vg}(s)\frac{\hat{v}_o(s)}{\hat{v}_{in}(s)} = V_g\frac{\left(R \parallel \frac{1}{sC}\right)}{sL + \left(R \parallel \frac{1}{sC}\right)}$$

$$= V_g\frac{1}{s^2LC + \frac{sL}{R} + 1}$$

$$= \frac{0.5}{3.90625\times10^{-11}S^2 + 6.25\times10^{-7}S + 1}$$

Duty Ratio T(s)

$$G_{vd}(s) = \frac{\hat{v}_{o(S)}}{\hat{d}_{(S)}} = D\frac{\left(R \parallel \frac{1}{sC}\right)}{sL + \left(R \parallel \frac{1}{sC}\right)}$$

$$= D\frac{\frac{R}{1+sCR}}{sL + \frac{R}{1+sCR}}$$

$$= D\frac{1}{s^2LC + \frac{sL}{R} + 1}$$

$$= \frac{10}{3.90625\times10^{-11}S^2 + 6.25\times10^{-7}S + 1}$$

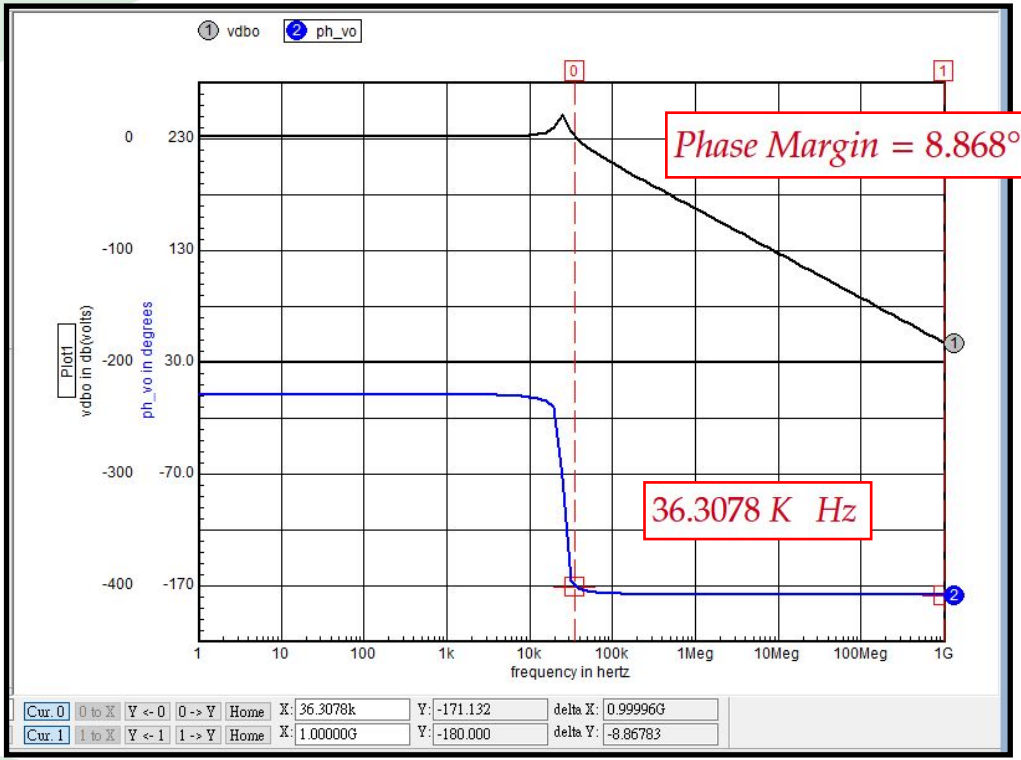
Zout

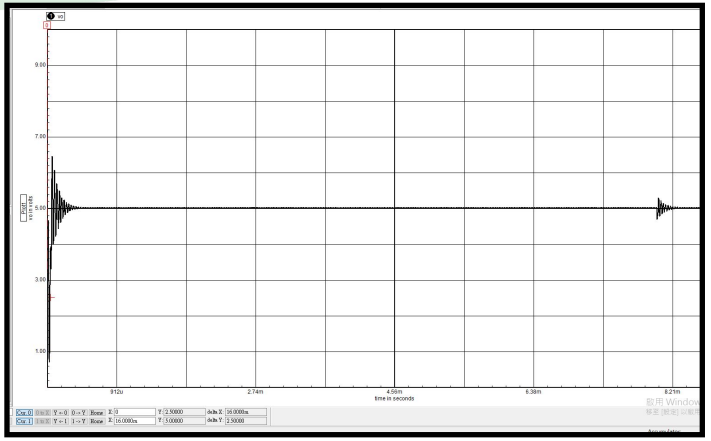
$$Z_{out}(s) = \frac{\hat{v}_{o(S)}}{\hat{i}_{o(S)}} = R \parallel \frac{1}{sC} \parallel sL$$

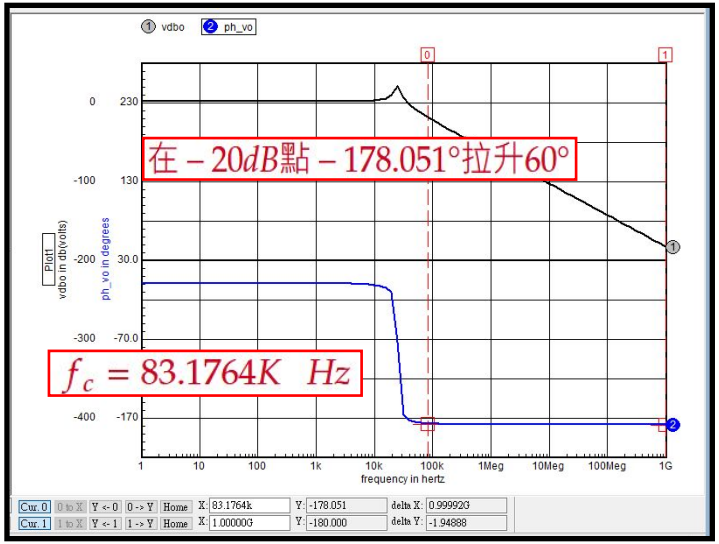
$$= \frac{sL}{s^2LC + \frac{sL}{R} + 1}$$

$$= \frac{3.125\times10^{-6}S}{3.90625\times10^{-11}S^2 + 6.25\times10^{-7}S + 1}$$

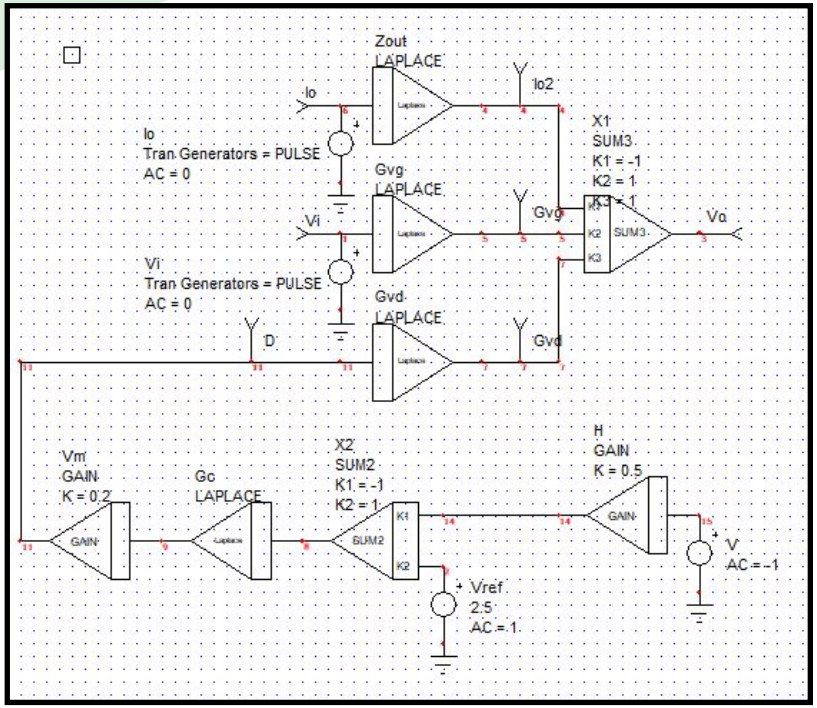
波德圖(未補償)

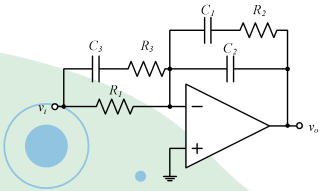

vdbo
ph_vo
Phase Margin = 8.868°
36.3078 K Hz
Plot1
vdbo in db(volts)
ph_vo in degrees
frequency in hertz
Cur. 0 X: 36.3078k Y: -171.132 delta X: 0.99996G
Cur. 1 X: 1.00000G Y: -180.000 delta Y: -8.86783

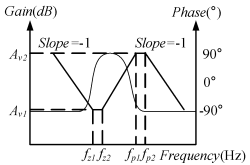



vdbo
ph_vo
在－20dB點－178.051°拉升60°
f_c = 83.1764K Hz
Plot1
vdbo in db(volts)
ph_vo in degrees
frequency in hertz
Cur. 0 X: 83.1764k Y: -178.051 delta X: 0.999920
Cur. 1 X: 1.00000G Y: -180.000 delta Y: -1.94888

Type III補償器改善







設計Type III補償器

使T(s)的Phase Margin提高至60°

fc=83.1764k Hz ， G≒20dB=10

P＝60°-(-178.051)-90° =148.051°

$$\frac{v_o(s)}{v_i(s)} \approx \frac{(1+sR_2C_1)(1+sR_1C_3)}{SR_1C_1(1+sR_2C_2)(1+sR_3C_3)}$$

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

$$C_1 = C_2(K-1) \qquad R_1 = 1000\Omega$$

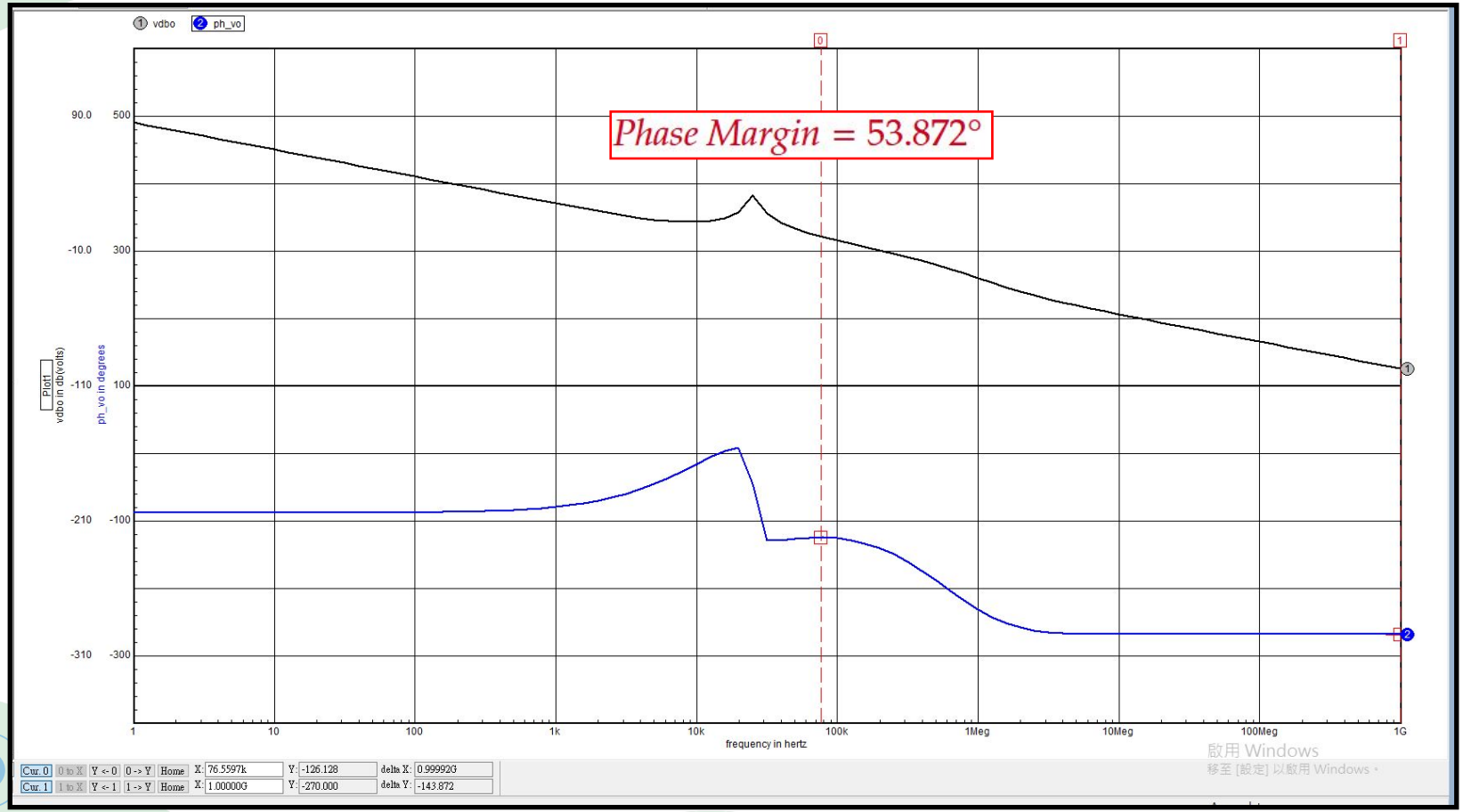
$$C_2 = \frac{1}{\omega_c R_1 G} \qquad R_2 = \frac{\sqrt{K}}{\omega_c C_1}$$

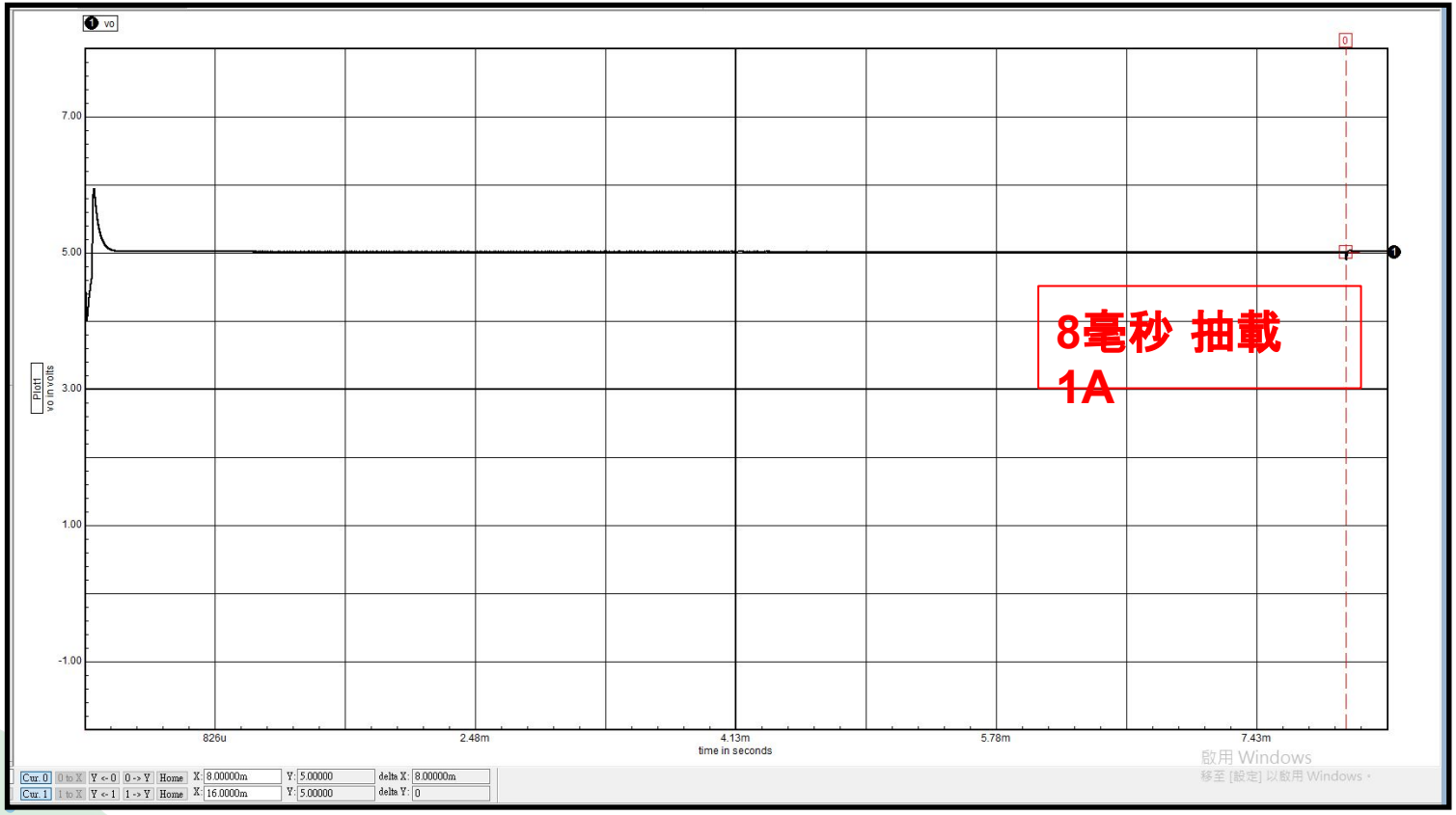
$$C_3 = \frac{1}{\omega_c R_3 \sqrt{K}} \qquad R_3 = \frac{R_1}{K-1}$$

$$w_0 = 2\times\pi\times f = 522612.73$$
$$K = 50.792$$
$$R_1 = 1000 \quad \Omega$$
$$R_2 = 1431.32 \quad \Omega$$
$$R_3 = 20.083 \quad \Omega$$
$$C_1 = 9.53\times10^{-9} \quad F$$
$$C_2 = 1.91\times10^{-10} \quad F$$
$$C_3 = 1.34\times10^{-8} \quad F$$

$$\frac{V_o(s)}{V_i(s)} \cong \frac{1.82\times10^{-10}S^2 + 2.7\times10^{-5}S + 1}{7.01\times10^{-19}S^3 + 5.17\times10^{-12}S^2 + 5.17\times10^{-6}S}$$

波德圖(補償後)


vdbo
ph_vo
Phase Margin = 53.872°
90.0
-10.0
-110
-210
-310
500
300
100
-100
-300
Plot1
vdbo in db(volts)
ph_vo in degrees
1
10
100
1k
10k
100k
1Meg
10Meg
100Meg
1G
frequency in hertz
Cur. 0
Cur. 1
X: 76.5597k
Y: -126.128
delta X: 0.99992G
X: 1.00000G
Y: -270.000
delta Y: -143.872



Thank you for your attention!