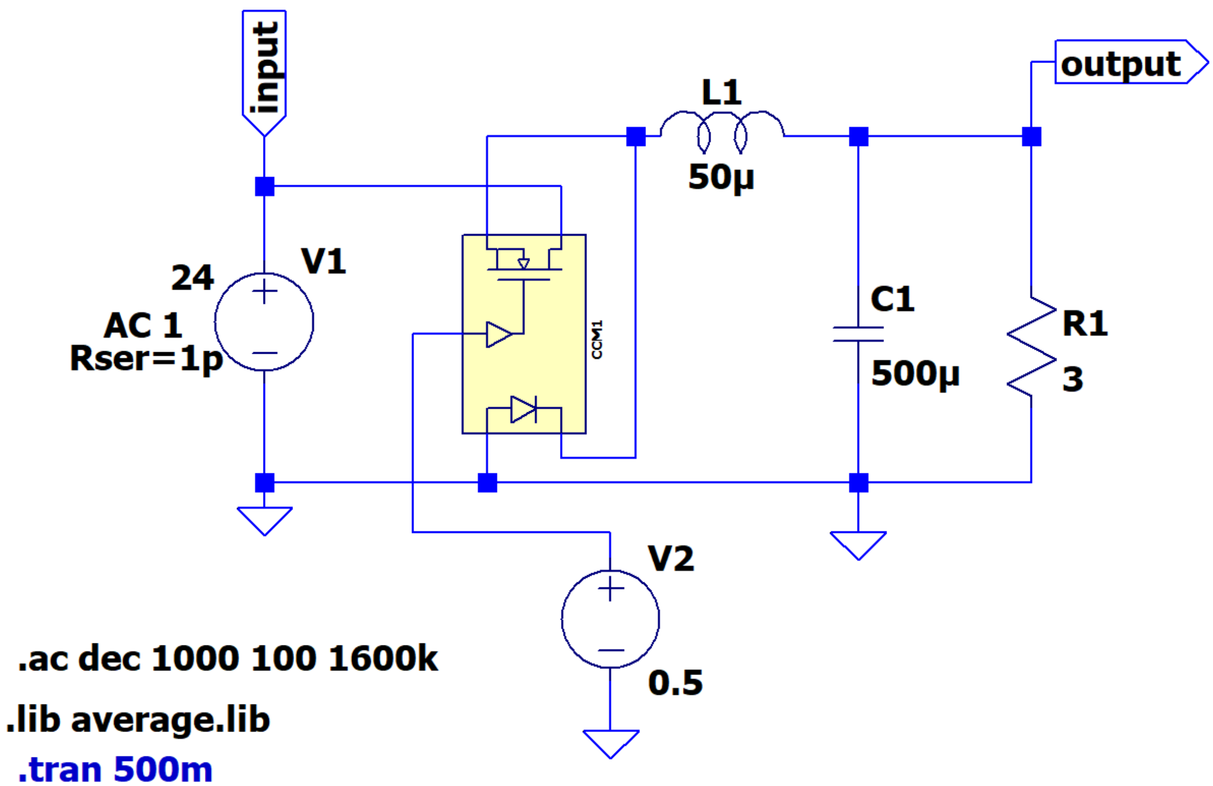
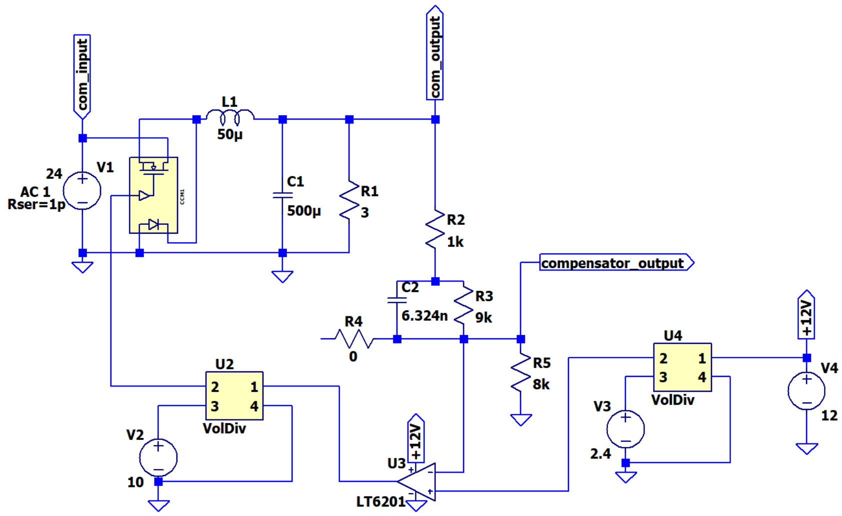
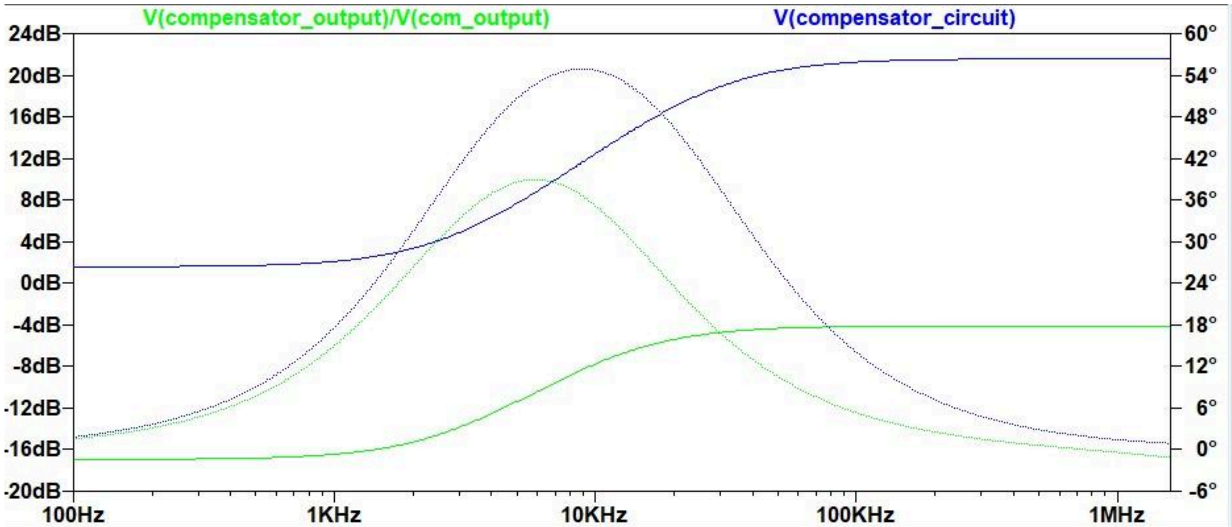
Buck Converter Compensator Design 20000043

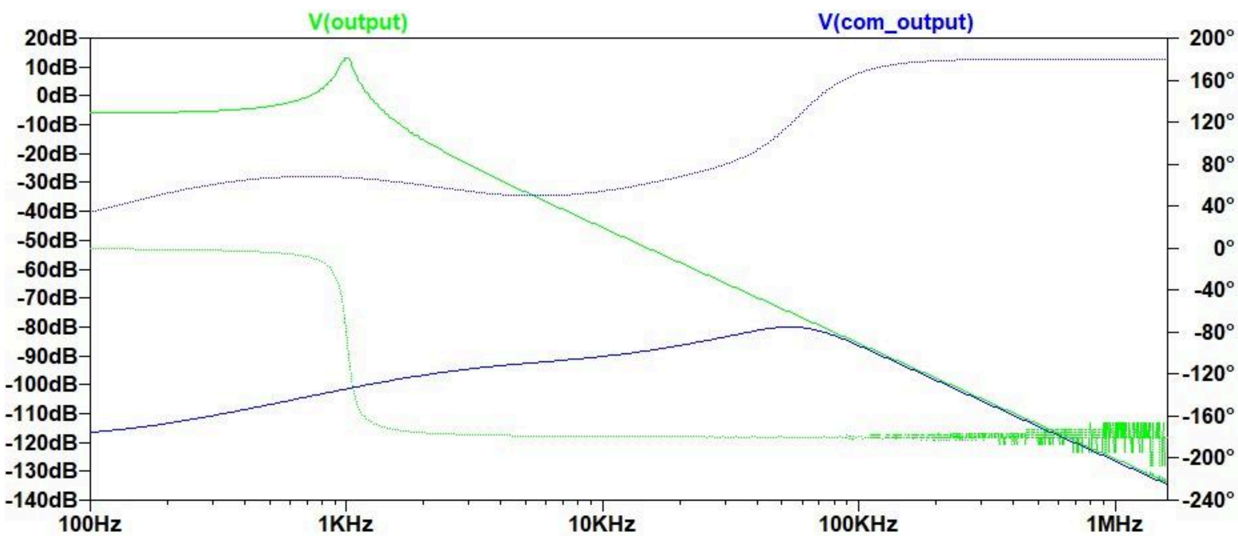
Buck Converter Without Copensator

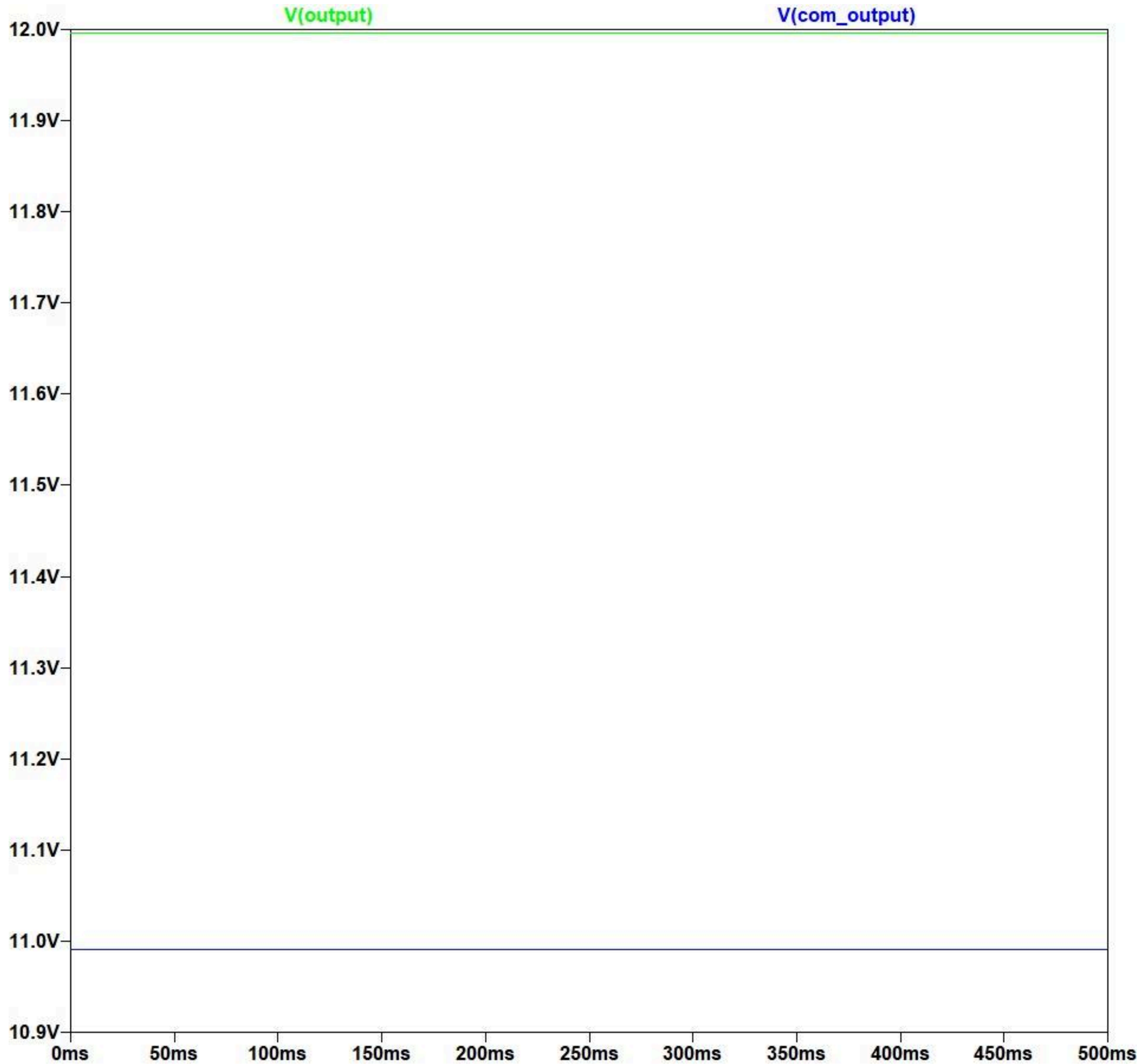


Buck Converter with Lead compensator

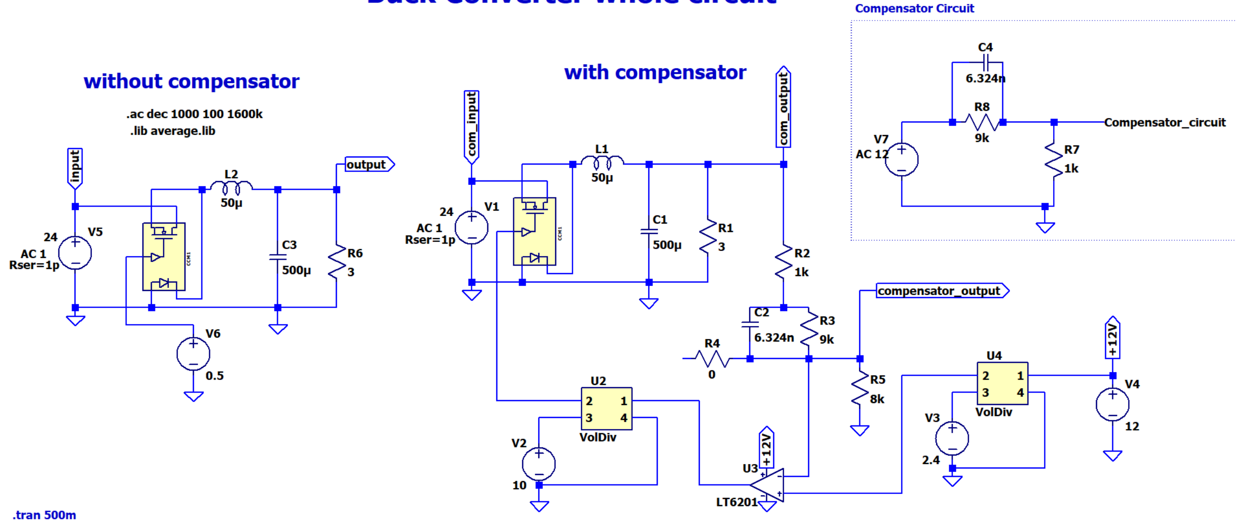



V(compensator_output)/V(com_output)
V(compensator_circuit)
24dB
20dB
16dB
12dB
8dB
4dB
0dB
-4dB
-8dB
-12dB
-16dB
-20dB
60°
54°
48°
42°
36°
30°
24°
18°
12°
6°
0°
-6°
100Hz
1KHz
10KHz
100KHz
1MHz


V(output)
V(com_output)
20dB
10dB
0dB
-10dB
-20dB
-30dB
-40dB
-50dB
-60dB
-70dB
-80dB
-90dB
-100dB
-110dB
-120dB
-130dB
-140dB
200°
160°
120°
80°
40°
0°
-40°
-80°
-120°
-160°
-200°
-240°
100Hz
1KHz
10KHz
100KHz
1MHz

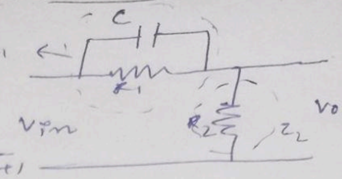

V(output)
V(com_output)
12.0V
11.9V
11.8V
11.7V
11.6V
11.5V
11.4V
11.3V
11.2V
11.1V
11.0V
10.9V
0ms
50ms
100ms
150ms
200ms
250ms
300ms
350ms
400ms
450ms
500ms

Buck Converter whole circuit



Lead compensator / Components calculation

For. Buck Converter:



the converter freq. is 100 kHz

$$\frac{V_o}{V_{in}} = \frac{Z_2}{Z_1+Z_2}, \quad Z_2 = R_2, \quad Z_1 = R_1 \parallel \frac{1}{sC} = \frac{R_1}{R_1 sC+1}$$

$$\frac{V_o}{V_{in}} = \frac{R_2}{R_2 + \frac{R_1}{R_1 sC+1}} = \frac{R_2(1+R_1 sC)}{R_1R_2 sC + R_2 + R_1} = \frac{R_2}{R_1+R_2}\left[\frac{1+\frac{s}{1/R_1C}}{1+\frac{s}{\left(\frac{R_1+R_2}{R_2}\right)\left(\frac{1}{R_1C}\right)}}\right]$$

putting it in lead compensator form

$$\frac{V_o}{V_{in}} = \alpha\frac{\left(1+\frac{s}{1/T}\right)}{\left(1+\frac{s}{\left(\frac{1}{\alpha T}\right)}\right)}, \quad T = R_1C, \quad \alpha = \frac{R_2}{R_1+R_2}$$

comparing with lead compensator standard form

$$G_c(s) = G_c(0)\frac{\left(1+\frac{s}{\omega_z}\right)}{\left(1+\frac{s}{\omega_p}\right)} \quad \text{where} \quad G_c(0) = \alpha \rightarrow \text{DC gain}$$

$$\omega_z = \frac{1}{T}, \quad \omega_p = \frac{1}{\alpha T}$$

let DC gain $\alpha = 0.1$, $\alpha = \frac{R_2}{R_1+R_2} = \frac{1}{10}$ & $R_1 = 9R_2$

let $R_2 = 1k$, $R_1 = 9k$

freq. at which phase margin is maximum

$$\omega_m = \sqrt{\omega_z \omega_p} = \frac{1}{T\sqrt{\alpha}} \quad \omega_m = 500\,kHz \Rightarrow 5\times10^5 = \frac{\sqrt{10}}{T}$$

& $T = 10\sqrt{\frac{2}{5}}\times10^{-6}$

$\therefore T = R_1C = 10\sqrt{\frac{2}{5}}\times10^{-6}$, $C = 6.324\,nF$

$\omega_z = 158\,kHz$, $\omega_p = 1.58\,MHz$