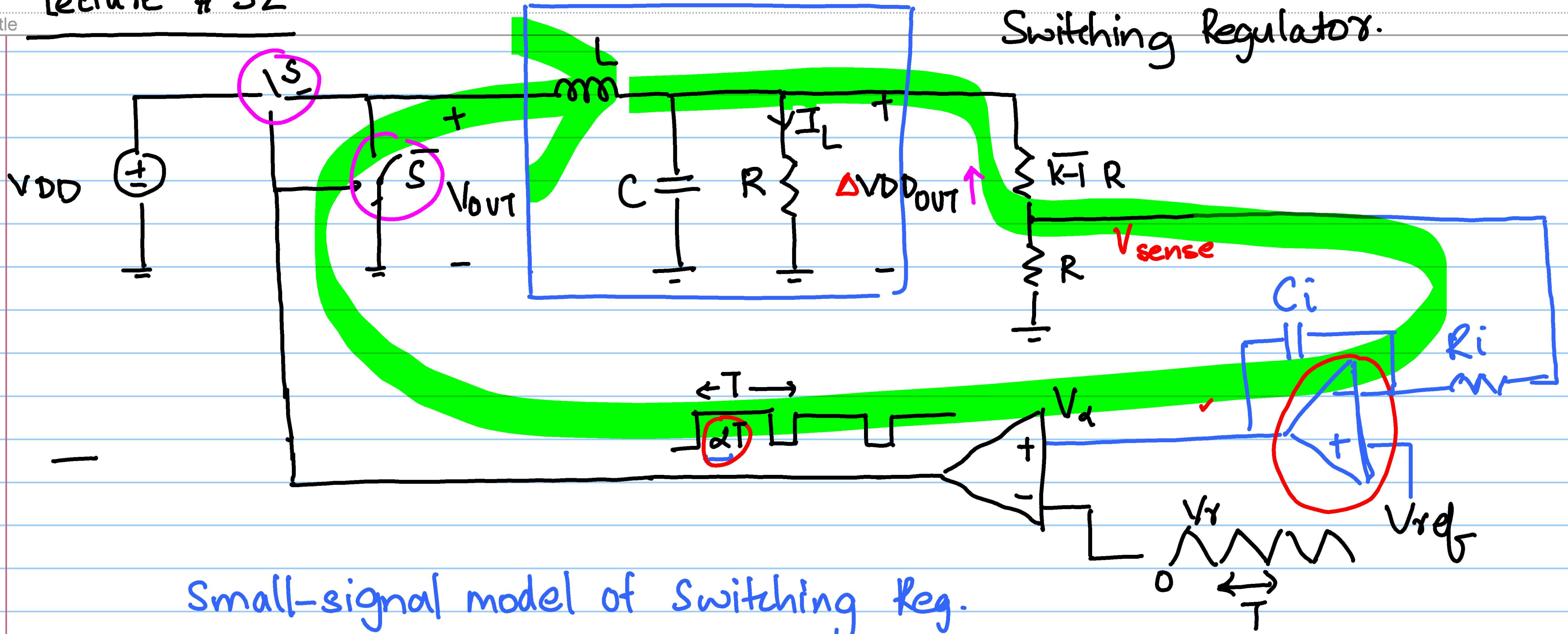
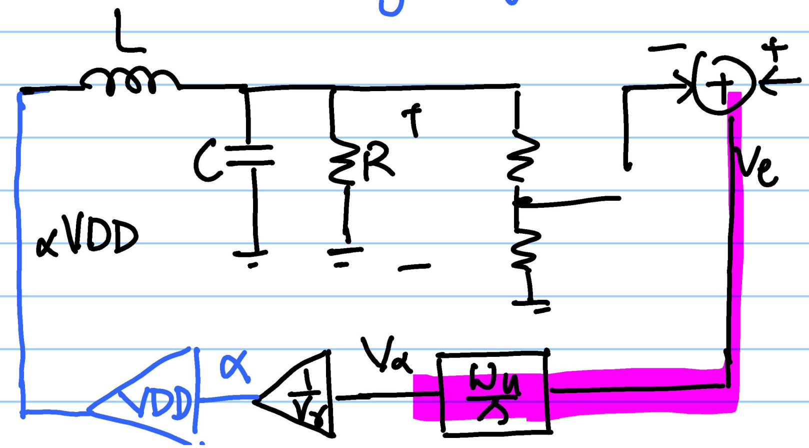
Note Title

lecture # 32

Switching Regulator.

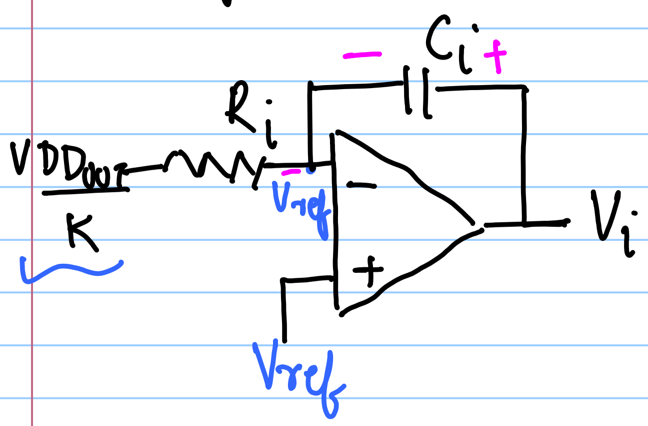


Small-signal model of Switching Reg.



$$LG = \frac{1}{K}\frac{\omega_u}{s}\frac{1}{V_{rf}} \cdot VDD \frac{1}{\underbrace{1+\frac{sL}{R}+s^2LC}_{Q}}$$

$$\text{Integrator Output} = \frac{\omega_u}{s}\left(V_{ref} - \frac{VDD_{OUT}}{K}\right) = V_{ref}\cdot\frac{\omega_u}{s} - \frac{VDD_{OUT}}{K}\cdot\frac{\omega_u}{s}$$



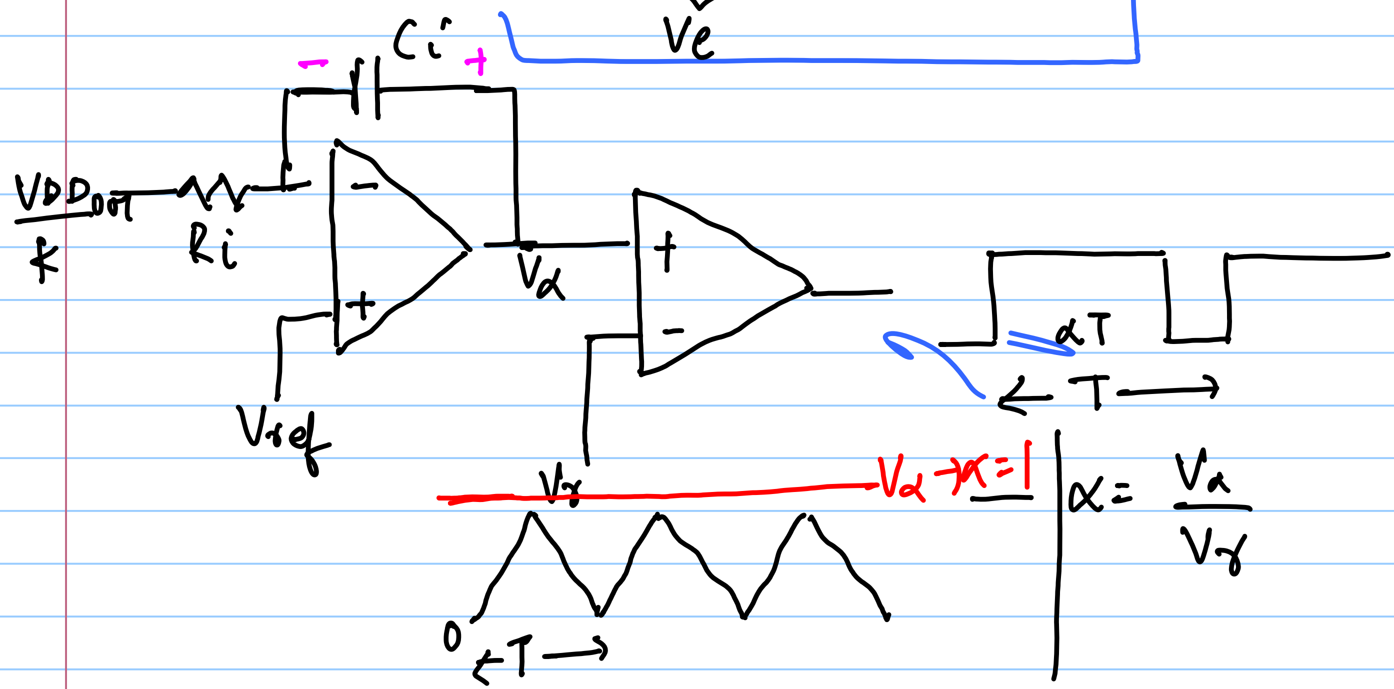
$$V_i = \frac{VDD_{OUT}}{K}\left(-\frac{1}{sR_iC_i}\right) \qquad \omega_u = \frac{1}{R_iC_i}$$

$$\frac{V_{ref}}{R_i} = \frac{V_i - V_{ref}}{1/sC_i}$$

$$V_{ref}\left(\frac{1}{R_i} + sC_i\right) = V_i\, sC_i$$

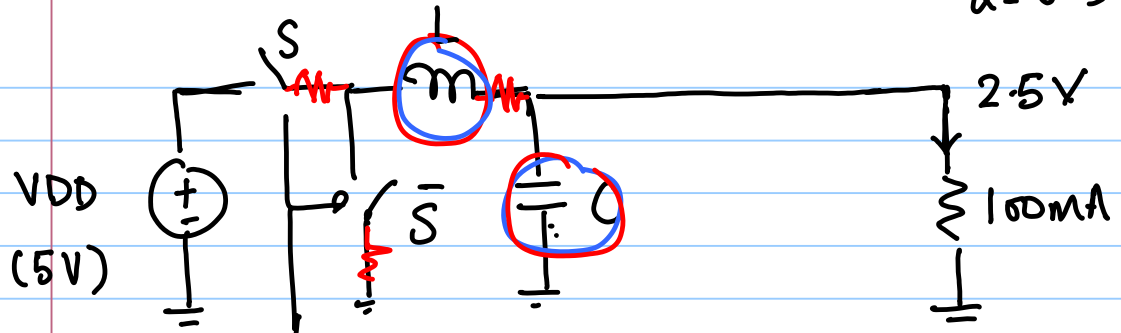
$$V_i = \frac{V_{ref}}{sR_iC_i} + V_{ref}$$

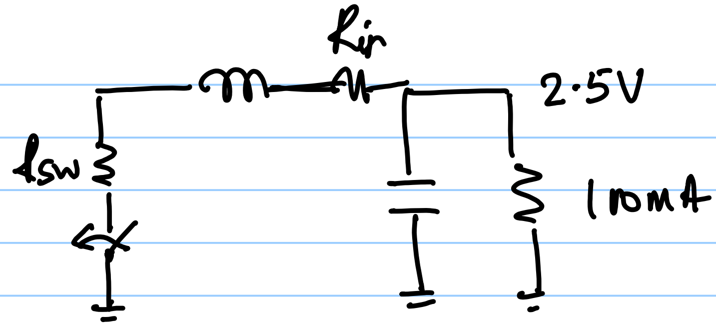
$$V_\alpha = V_i = \left(V_{ref} - \frac{VDD_{OUT}}{k}\right)\frac{1}{sR_iC_i} + V_{ref}$$

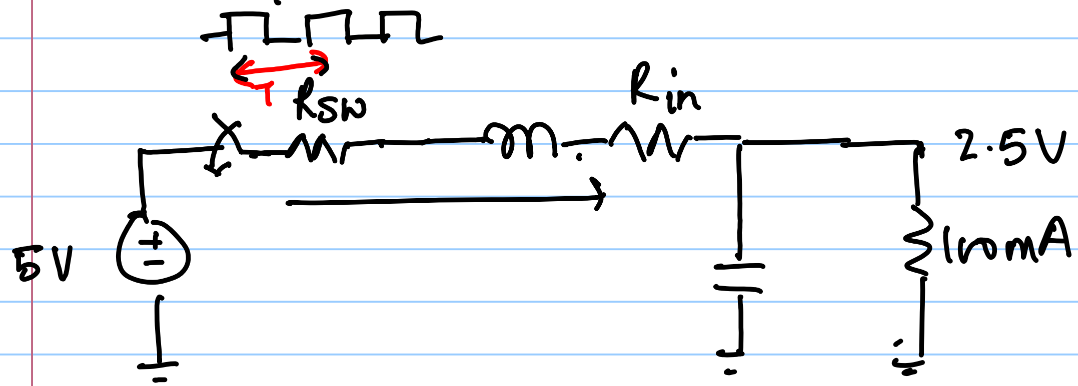


$$\alpha = \frac{V_\alpha}{V_\gamma}$$

$\alpha = 0.5$







Power delivered to load, $P_L = 2.5 \times 0.1 = 0.25\,W$

Power dissipated in switches, $P_{sw} = I_L^2 (R_{sw} + R_{in})$

$P_L = 2.5 \times 0.1$

Power dissipated $= I_L^2 (R_{sw} + R_{in})$

$R_{sw} = 0.25\,\Omega.$

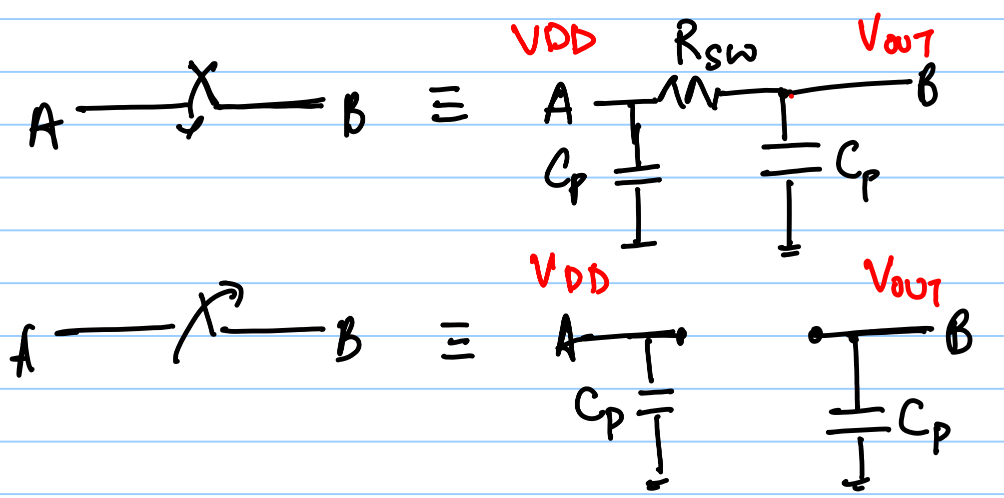
$R_{in} = 0.1\,\Omega$

$$\eta = \frac{\text{Power delivered to load}}{\text{Power drawn from supply}}$$

$$= \frac{P_L}{P_L + P_{sw} + P_{clk}} = \frac{0.25}{0.25 + 0.01\,(0.25 + 0.1)} = \frac{0.25}{0.25 + 0.0035} \approx 100\%$$

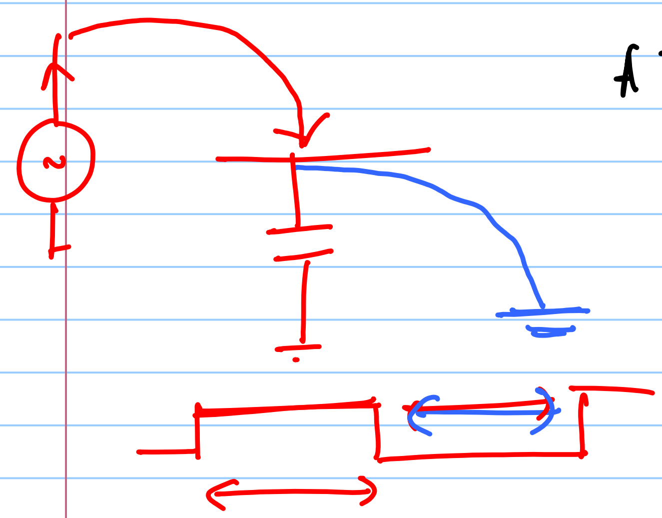
$\geq 90\%$

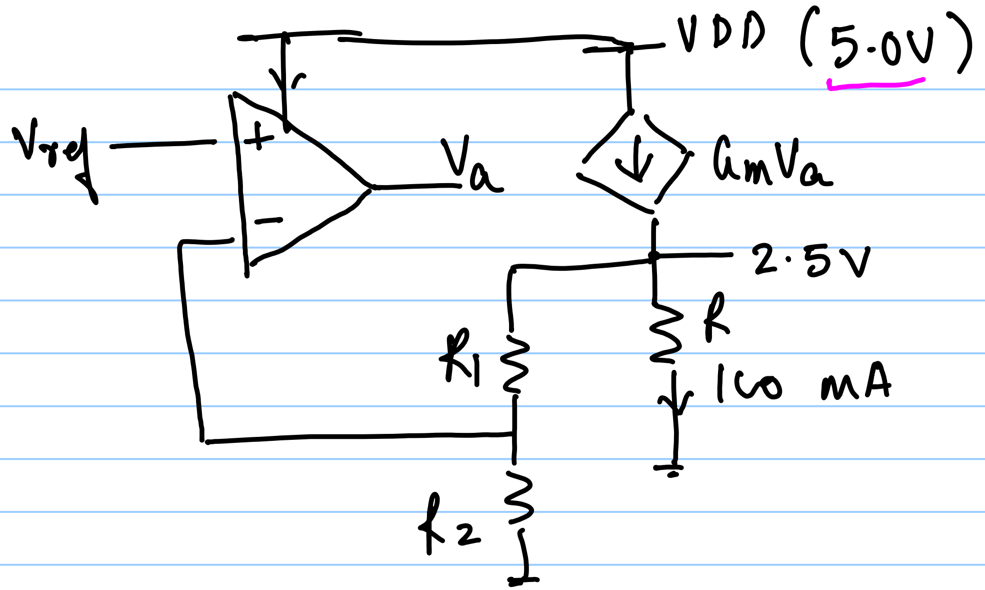
Clocking power:



⇒ C_p is charged to VDD

⇒ C_p is discharged to ground.





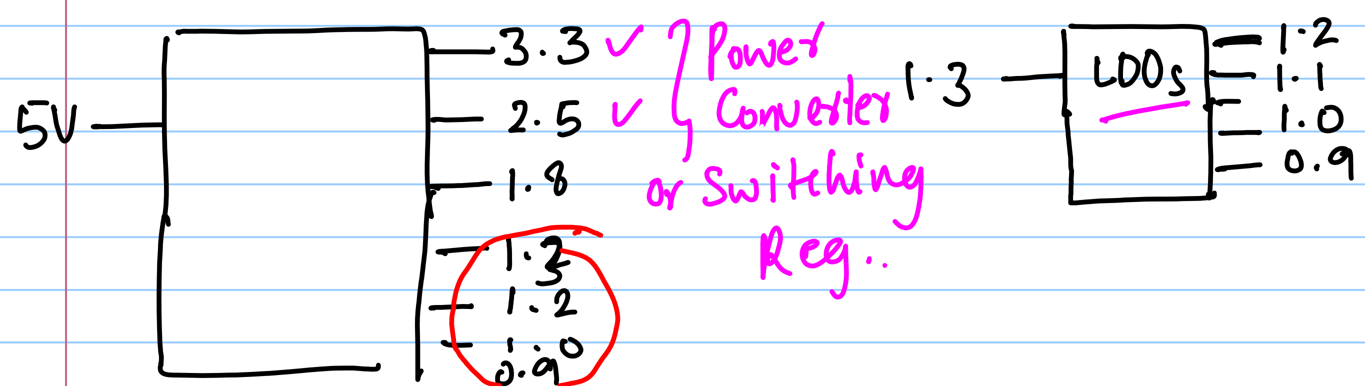
$P_L = 2.5 \times 0.1\,A = 0.25\,W$

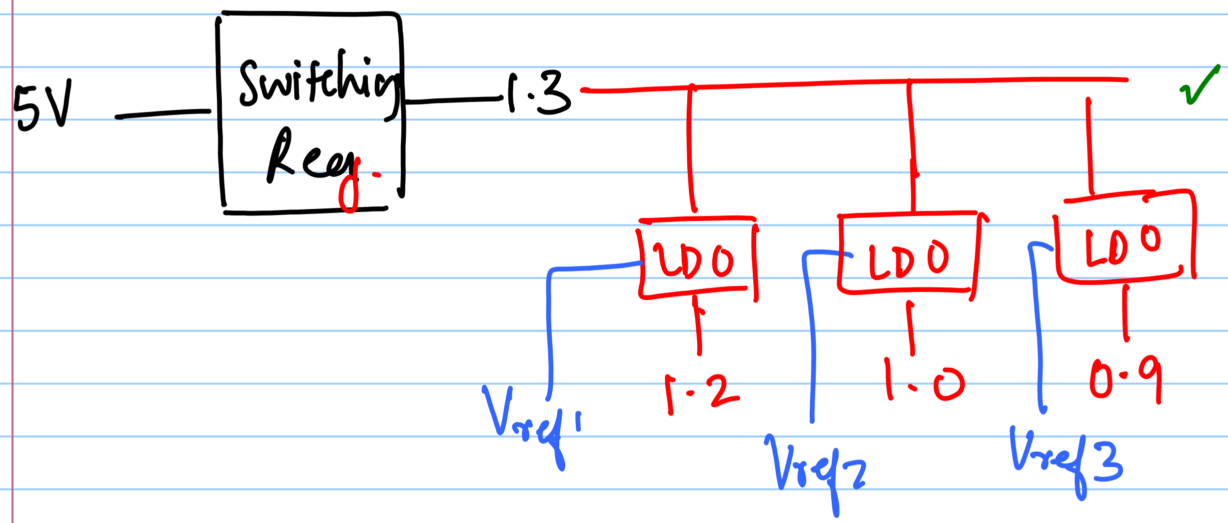
$P_S = 5.0\,V \times 0.1\,A + P_a$

$$\eta = \frac{0.25}{0.5 + P_a} \times 100\% < 50\%$$

Does it mean LDO is not useful at all?

LDO is quite useful when dropout voltage is lesser.





Dropout Vol. 0.1 0.3 0.4