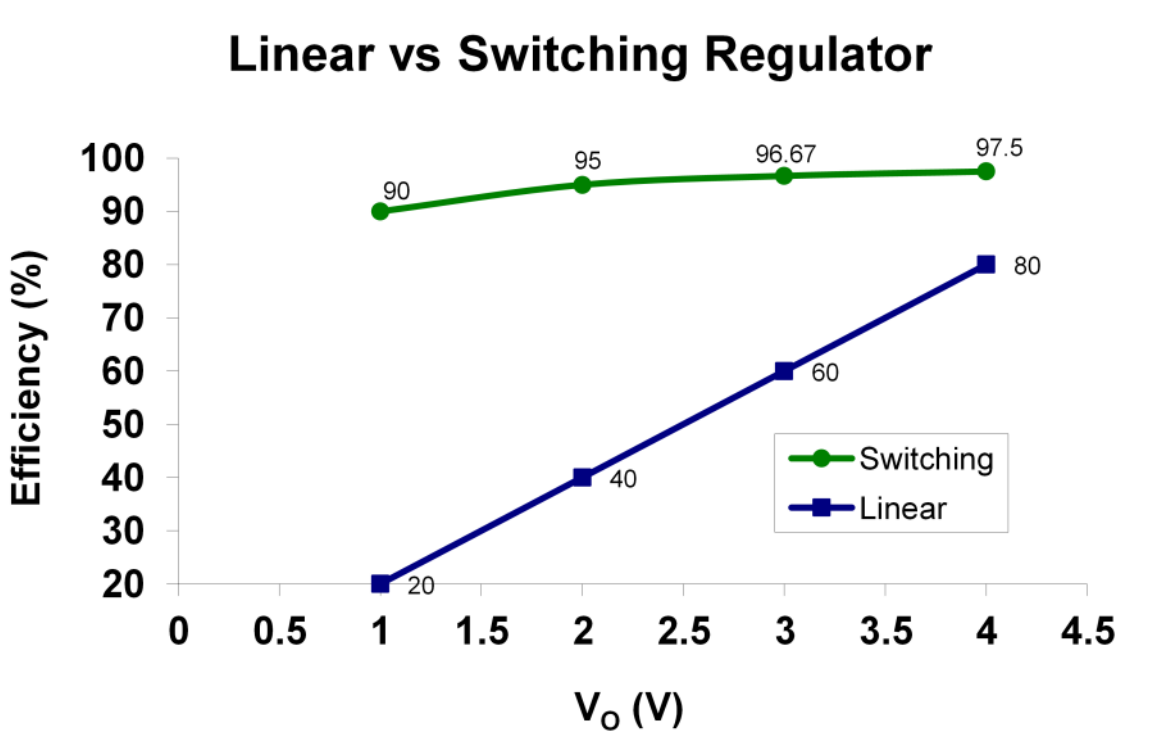
Switching Vs Linear Regulator



Switching

1. expensive
2. higher efficiency
3. Noisy

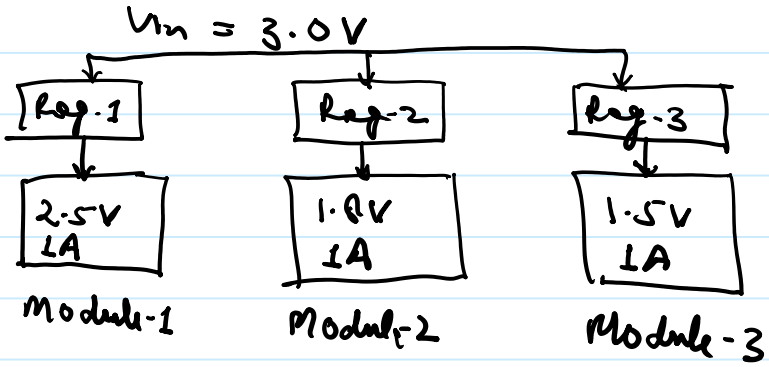
Linear

low cost
Lower efficiency
Quiet

How To Choose Between Linear and Switching Regulator

Parameter	Preference
1. Cost	→ Linear Regulator
2. Efficiency	→ Switching
3. High Power Delivery	→ Switching
4. Noise	→ Linear Reg.

Example-1



Assume Reg-1, Reg-2 & Reg-3 are switching with 90% eff. ($\eta = 0.9$)

$$\eta = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{P_{out} + P_{loss}}$$

$$\frac{1}{\eta} = 1 + \frac{P_{loss}}{P_{out}} \Rightarrow P_{loss} = \left(\frac{1}{\eta} - 1\right) P_{out}$$

$P_1 = 2.5 \times 1 = 2.5W \Rightarrow P_{loss1} = 0.11 \times 2.5 = 0.275W$

$P_2 = 1.8W \Rightarrow P_{loss2} = 0.11 \times 1.8 = 0.198W$

$P_3 = 1.5W \Rightarrow P_{loss3} = 0.11 \times 1.5 = 0.165W$

$$P_{loss} = P_{loss1} + P_{loss2} + P_{loss3} = 0.638 \simeq 0.64W$$

$$\eta = \frac{P_1 + P_2 + P_3}{P_1 + P_2 + P_3 + P_{loss}} = \frac{2.5 + 1.8 + 1.5}{2.5 + 1.8 + 1.5 + 0.64} = 90\%$$

Example-2

Reg-1, Reg-2 & Reg-3 → Linear

$P_{loss1} = (3 - 2.5)1A = 0.5\,W$

$P_{loss2} = (3 - 1.8)1A = 1.2\,W$

$P_{loss3} = (3 - 1.5)1A = 1.5\,W$

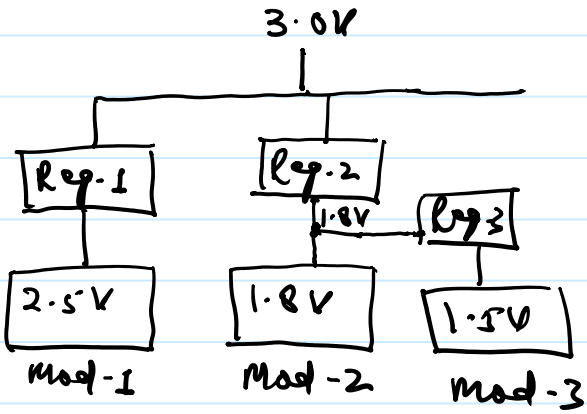
$$\eta = \frac{5.8}{5.8 + 3.2} = \frac{5.8}{9} = 64.45\%$$

Example-3

Reg.1 → linear

Reg.2 → switching

Reg 3 → linear



$P_{loss-1} = 0.5\,W$

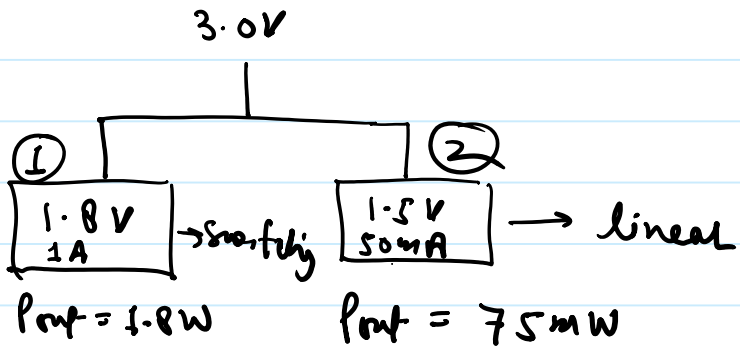
$P_{loss-2} = 0.4\,W$

$P_{loss-3} = 0.3\,W$

$P_{loss} = 1.2\,W$

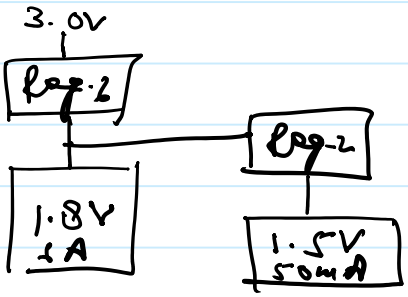
$$\eta = \frac{P_{out}}{P_{out} + P_{loss}} = \frac{5.8}{7} = 82.8\%$$

Example-4



$P_{loss-2} = 1.5 \times 50mA = 75mW$

$$\eta = \frac{1.8 + 0.075}{1.8 + 0.075 + 0.2 + 0.075} = 87.2\%$$

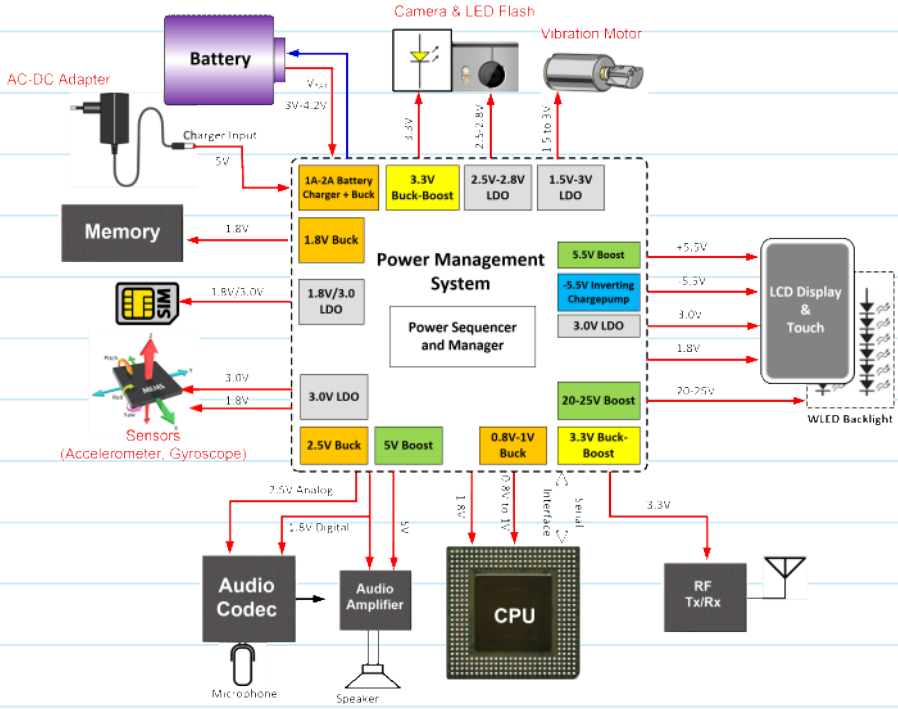


$P_{loss1} = 0.2W$

$P_{loss2} = 15mW$

$$\eta = \frac{1.8 + 0.075}{1.8 + 0.2 + 0.015 + 0.075} = 89.71\%$$

Power Management in a Smartphone



20 → 25 LDOs → ≈10% Power

5 – 6 → Bucks

2 – 3 → boost

1 – 2 → buck/boost

→ 90% Power