Battery Dimensioning Homework

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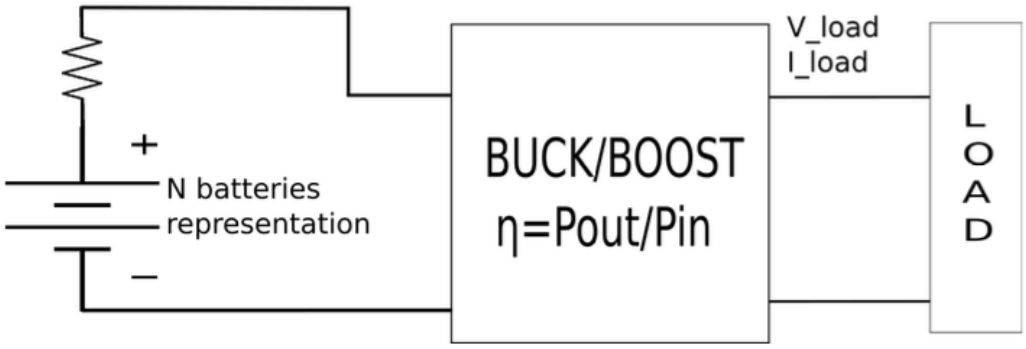
Arduino Course – P2

Statement data:

$$\begin{cases} P_{load} = 1W = cte \\ R_i = 0.12\Omega \\ \eta = 0.4 = cte \\ n = 4 \\ Q = 2000mAh \\ AA\,in\,series(\epsilon = 1.5V) \end{cases}$$

The problem we need to solve is the following one:



Having n batteries connected in series, we can state:

$$Q_{total} = 2000\,mAh$$
$$\epsilon_{total} = n{\cdot}\epsilon = 6\,V$$

From the buck/boost performance:

$$\eta = \frac{P_{load}}{P_\epsilon} \rightarrow P_\epsilon = 2.5\,W$$

$$P_\epsilon = V_\epsilon I_\epsilon$$

Having an internal resistance, the voltage of the battery will be lower:

$$V_\epsilon = 6\,V - I_\epsilon R_i$$

$$2.5\,W = (6\,V - I_\epsilon R_i)I_\epsilon \rightarrow \begin{cases} I_{\epsilon 1} = 49.58\,A \\ I_{\epsilon 2} = 0.42\,A \end{cases}$$

The same problem without internal resistance yields an input current of roughly $0.41\,A$ so we will take as valid $I_{\epsilon 2}$

$$Q_{total} = I_{\epsilon 2}{\cdot}t \rightarrow t = 4.76\,h$$