Digital Controller Design

Goal: Find number of quantization bits and maximum frequency of the buck converter

Given:

- Controller frequency f_{clk} = 1MHz.
- As the designer, I choose a quantization resolution of 1%
- N_r is the number of discrete levels where $N_r \leq 2^{N_{pwm}} - 1$

Solve # of bits:

- $q = \frac{1}{N_r}$ and $q = 0.01$
- Then $N_r = \frac{1}{0.01} = 100$
- $100 \leq 2^{N_{pwm}} - 1$
- Thus $N_{pwm} = 7$ bits

Solve max switching frequency of converter (f_{sw}):

- $\frac{1}{N_r} = \frac{t_{clk}}{T_{sw}} = \frac{f_{sw}}{f_{clk}}$
- Then $f_{sw} = \frac{f_{clk}}{N_r}$
- This is true however we are constrained to use an exact number of bits so redefine f_{sw}
- $f_{sw} = \frac{f_{clk}}{2^{N_{pwm}}} = \frac{1MHz}{2^7} \approx 7.8$ kHz

Given $V_{in} = 24V$, what is the output voltage resolution?

- $V_0 = D \cdot V_{in}$
- $\Delta V_0 = \Delta D \cdot V_{in}$
- $\Delta V_0 = q \cdot V_{in}$
- $\Delta V_0 = 0.01 \cdot 24 = 0.24V$

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