Task 6

16-681 MRSD Project Course

Daniel Arnett
Karthik (Venkata Rama) Paga
Dicong (David) Qiu
Matthew Swenson
Abdul Zafar

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1 Regulator Efficiency

Linear voltage regulator efficiency is given by $1 - \frac{V_{in} - V_{out}}{V_{in}}$. So:

$$\eta_{3.3V} = 1 - \frac{24V - 3.3V}{24V} = .1375$$

$$\eta_{5V} = 1 - \frac{24V - 5V}{24V} = .20833$$

$$\eta_{12V} = 1 - \frac{24V - 12V}{24V} = .5$$

2 Input Power

The input power for the motor at maximum rated output is

$$P_{IN,motor} = \frac{motor \times I_{motor,max}}{\eta_{motor}} = \frac{24V \times 10A}{1.0} = 240W$$

The input power for the CPU board at maximum rated output is

$$P_{IN,3.3V} = \frac{3.3V \times I_{3.3V}}{\eta_{3.3V}} = \frac{3.3V \times 1A}{0.1375} = 24W$$

The input power for the Wifi and Encoder subsystem at maximum rated output is

$$P_{IN,5V} = \frac{5V \times I_{5V}}{\eta_{5V}} = \frac{5V \times 1A}{0.20833} = 24W$$

The input power for the LIDAR at maximum rated output is

$$P_{IN,12V} = \frac{12V \times I_{12V}}{\eta_{12V}} = \frac{12V \times 2A}{0.5} = 48W$$

3 Total System Efficiency

The total system efficiency at maximum rated output is

$$
\begin{aligned}
\eta &= \frac{P_{motor} + P_{3.3V} + P_{5V} + P_{12V}}{P_{IN,motor} + P_{IN,3.3V} + P_{IN,5V} + P_{IN,12V}} \\
&= \frac{24V10A + 3.3V \times 1A + 5V \times 1A + 12V \times 2A}{240W + 24W + 24W + 48W} \\
&= 0.8104
\end{aligned}
$$