Detailed Design – Electrical Power Requirements

# Section 1: Objective

The objective of this calculation is to determine the electrical power requirements of the system being designed. Power calculations are based on the parts selected to implement full system functionality, per selected project objectives and constraints.

# Section 2: References

Mechanical has selected a motor from Adafruit, available at Digikey: <https://www.digikey.ca/en/products/detail/adafruit-industries-llc/324/5022791>

Controls has selected a Jetson Nano 2GB controller, available at NVIDIA: <https://developer.nvidia.com/embedded/jetson-nano-2gb-developer-kit>

All other selected parts are purely electrically selected. Links and datasheets for relevant information are available in the Datasheets folder of Electrical Detail Design on Microsoft Teams for MTE 380 Project Group 13.

# Section 3: Design Inputs

The design parameters used for power calculations are based on the supply voltages, supply currents, and/or supply power required of each of the parts selected for meeting project objectives and constraints.

These inputs are more clearly listed under Section 4: Assumptions since there is some assumption involved in the power consumed by each component.

# Section 4: Assumptions

Various ensuing power calculations use conservative calculations to ensure that the system will work in the worst-case scenario:

* The NMOS transistor used to drive the LED strip has a worst-case power consumption of 500 mW.
* The Jetson Nano draws a full 5 A at 5 V.
* 3 motors in use
* Each stepper motor draws a full 0.35 A at 12 V.
* The DC DC converter is operating at the lowest efficiency listed for 5 V output: 91%.
* 3 limit switches in use
* Each limit switch draws a full 0.01 A at 5 V.
* LED strip draws a full 660 mA at 12 V.

One assumption is not conservative: the stepper motor driver has no significant power consumption. This assumption is reasonable because the stepper driver uses digital logic, which consumes very little power, and power used to move the motor follows the reasonable approximation that the power is transferred directly through the driver to the motor (high efficiency).

# Section 5: Analytical Method and Computations

Power (*P*, in W) is a calculation that can be performed by superposition (i.e. power consumption of all components is additive),

(1)

Power consumption of individual components is either given in datasheets, or may be calculated if voltage (*V*, in V) and current (*I*, in A) are given in datasheets,

(2)

Notice that power and current are directly proportional if the voltage is unchanging.

Finally, power will flow from the supply through the 12VDC to 5VDC converter to individual components,

(3)

Where *PxV* represents the power consumed at *x* V.

The choice of DCDC converter can be confirmed as appropriate if it can supply sufficient power/current at its output voltage, and the choice of wall AC to 12 VDC adapter will be informed based on the total power/current requirement of the circuit.

# Section 6: Calculations

Components supplied at 5V include the Jetson Nano, the stepper motor drivers, and the limit switches. Recall that the stepper motor drivers are assumed to consume 0 W of power. Combining Equations 1 and 2 for all components supplied with 5 V,

The selected DCDC converter is rated for up to 50 W of output power and 10 A of output current. Clearly, the power requirement is under this threshold with room to spare in case the assumption that stepper drivers consume 0 W is not a good approximation. Checking the output current:

Which is clearly within the specification.

Components supplied at 12 V include the LED strip for lighting specimens and the transistor used to control it and the stepper motors,

Therefore, the total power consumption of the system is,

# Section 7: Results/Conclusions

The selected wall AC to 12VDC adapter must be able to supply a minimum of ~49 W of power.

The selected DC DC converter is appropriate for this application.