Calcualtions for DLI #25

M Mateusz Kazimierczak
6 days ago in **Prototyping Help**

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Hello,

Me and my team have been stuck a few days on the calculations for the power our LEDs should have, in order to choose the resistors correctly. Here is the calculations we followed in order to obtain the power needed are as follows:

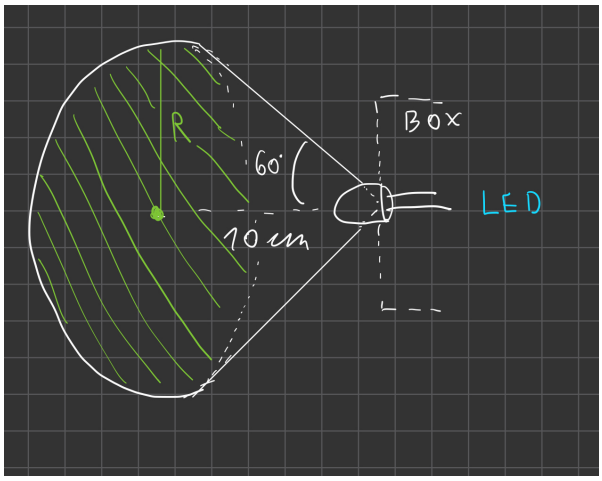
The design handout mentions that the DLI should be > 10.

According to the wikipedia page on DLI.

$$10\frac{mol}{m^2 \cdot day} = 3.6 \cdot 10^{-3} \cdot PPFD \cdot 24 \rightarrow PPFD = \SI115.74\frac{\micro\mol}{\meter^2\second}$$

PPFD is the number of photons within an acceptable range.

We can approximate the area upon which the LEDs act as 0.16 m^2. This corresponds to the LEDs being placed 3 cm from the plant surfacer, and a radial range of 120 degrees actually arriving at the plant surface like in the following figure:



Based on the calculated PPFD value, the number of photons per second is:

$$n_{photons} = \SI115.74\frac{\micro\mol}{\meter^2\second} \cdot 0.16m^2 \cdot \frac{6.022 \cdot 10^{17}}{\SI1\micro\mol} = 1.115 \cdot 10^{19} \cdot \frac{1}{s}$$

Assuming the wavelength of our light is 660nm (close to red specturm), our photons will have an energy of:

$$E = h \cdot f = 3.01 \cdot 10^{-19} J$$

Now, multiplying the number of photons per second times its energy, we obtain a power value of:

$$P = 3.4615\ W$$

Which, if we are allowed to use 3 LEDs, would correspond to around 1 W per LED. This is already a low estimate, because it assumes that all of the photons generated by the LEDs arrive at the plants.

A typicall red LED is usually rated at 2V and 20mA, which is 0.04 W. This is orders of magnitude smaller compared to what we should be getting.

I would really appreciate if you could let us know if you find any mistake or misinterpreation of the desing handout in this calcualtions process so we can move forward with the project.

thank you in advance,

Mateusz

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1 Answer

M

Morgan Hooper **CORE TEAM**
6 days ago

Hi! Thanks for reaching out!

It looks like you've put a lot of effort into understanding the DLI metric here, which is great! However, I would encourage you to think about whether or not it's reasonable for your prototype system to meet this requirement. The prototype you're building is a representation of a much larger system, one that includes full-sized greenhouse overhead lighting in a variety of colours, as well as a user interface.

As we mentioned in lecture today, we (the core team) have done the work to translate the Requirements (which in general describe the functions and performance necessary for Design Concepts) into a Specification for a basic prototype system, which helps to demonstrate some of the key functions of the Design Concept we're going with (greenhouse lighting which changes colour when users are present). Therefore, it's expected that your prototype meet the specification, but we wouldn't expect it to directly meet the engineering requirements. In fact, the Pico can only source 50mA total, at a theoretical upper voltage limit of 3.3V -- this is much, much less power than we would need to illuminate even the smallest practical greenhouse, as you've indicated.

Hope this helps!

-- Prof Hooper

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M 'ateusz Kazimierczak 5d

Thank you!

The lecture yesterday was also helpful to clear this out.

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