LED Array System
Instruction Manual

LAD-1
LED ARRAY DRIVER

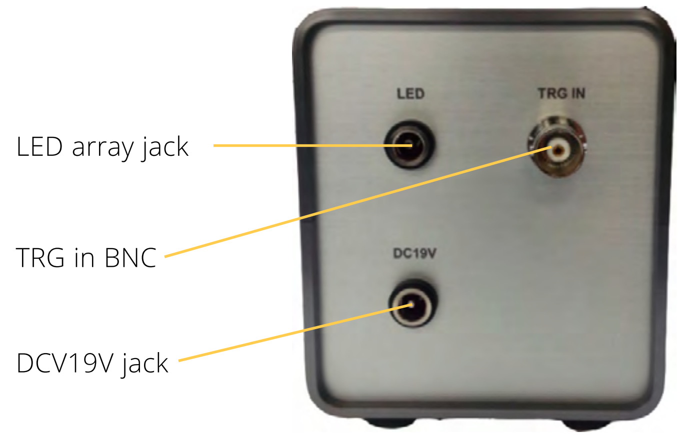
Teleopt

1. Name of Components

■ LAD-1 LED Array Driver

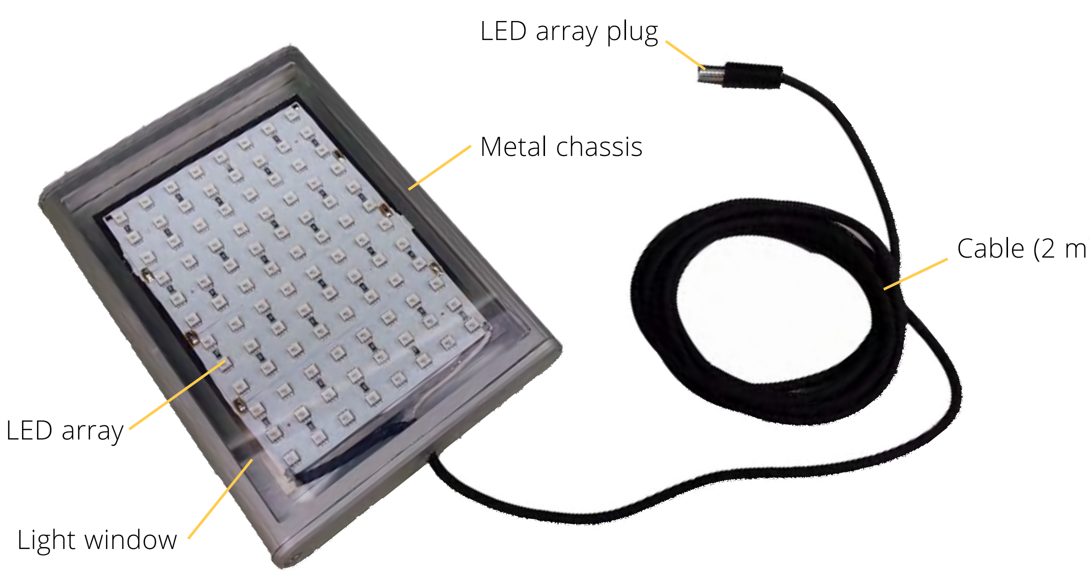
Front

Back



*DC19V Power source is included.

■ LEDA-x LED Array



2. How to use LAD-1

1. Connect DC19V power source to DC19V jack on LAD-1.
   Note: The center pin of DC19V jack is φ2.1 mm, whereas the center pin of LED array jack is φ2.5 mm. This is a fail-safe design so that you cannot connect DC19V power source to LED array jack.

2. Connect LED array plug to LED array jack on LAD-1.
   Note: LED array plug can go into DC19V jack, however, this is wrong connection. This will not immediately break the device, but please always make sure to use the correct connection.

3. Turn the Volume knob counter-clockwise until the end. Set the Mode switch at CONST position. Turn on the Power switch. Power switch and Voltage meter will be lit up.

4. Slowly turn the Volume knob clockwise. The voltage meter will go up, and LED array will be lit up gradually.
   Note: If you turn the Voltage knob quickly, the internal circuit of LAD-1 may be damaged.

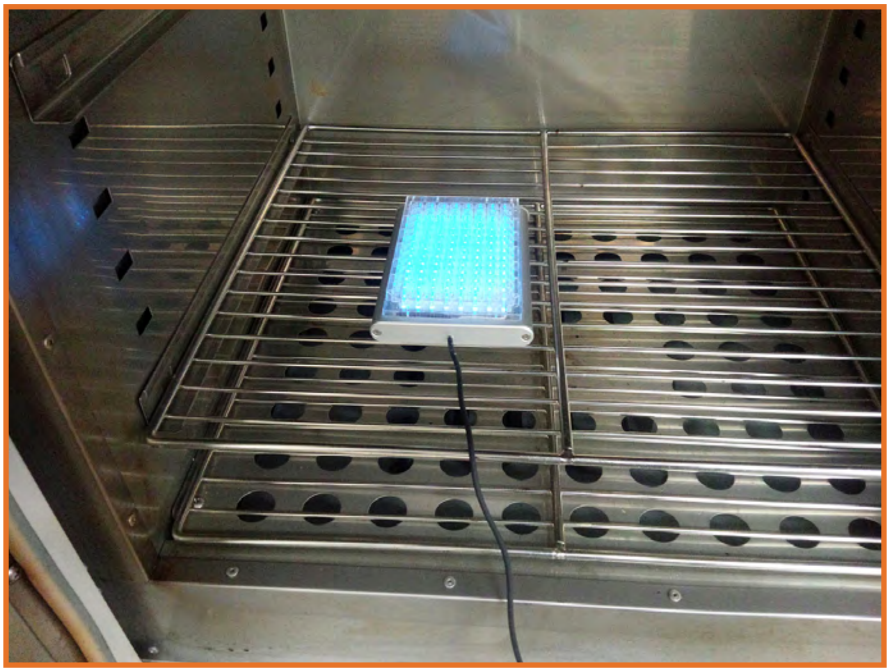
5. If you want to control the LED array by trigger pulses, set the Mode switch at TRG position. This will turn off the LED array. Connect a stimulator output to TRG IN BNC on the back panel of LAD-1. If you want the maximum output at the voltage, the trigger pulse should be 5V. By sending 5V pulses from the stimulator to LAD-1, the LED array flashes at 5V timing. Please see “6. Trigger Input” for more detail.
   Note: The light power in TRG mode and CONST mode is different even at the same voltage value. For safety reason, the light power of CONST mode is approx. 45% less than TRG mode at the same voltage. Please see “4. Voltage - Light power relationship” for more detail.

3. How to use LED array

There are two methods for illuminating sample by LED array.

1. Direct Method - directly put the sample plate on LED array.
2. Remote Method - remotely illuminate the sample plate.

1. Direct Method - directly put the sample plate on LED array



Direct method (inside incubator)

The advantage of Direct method is very high light power because you can make the distance between the sample plate and LED array as close as possible. The groove on the top of the LED array just fits standard multiwall array.

LED array with 96 well plate

3. How to use LED array

Top view - Each LED element comes just under each well.

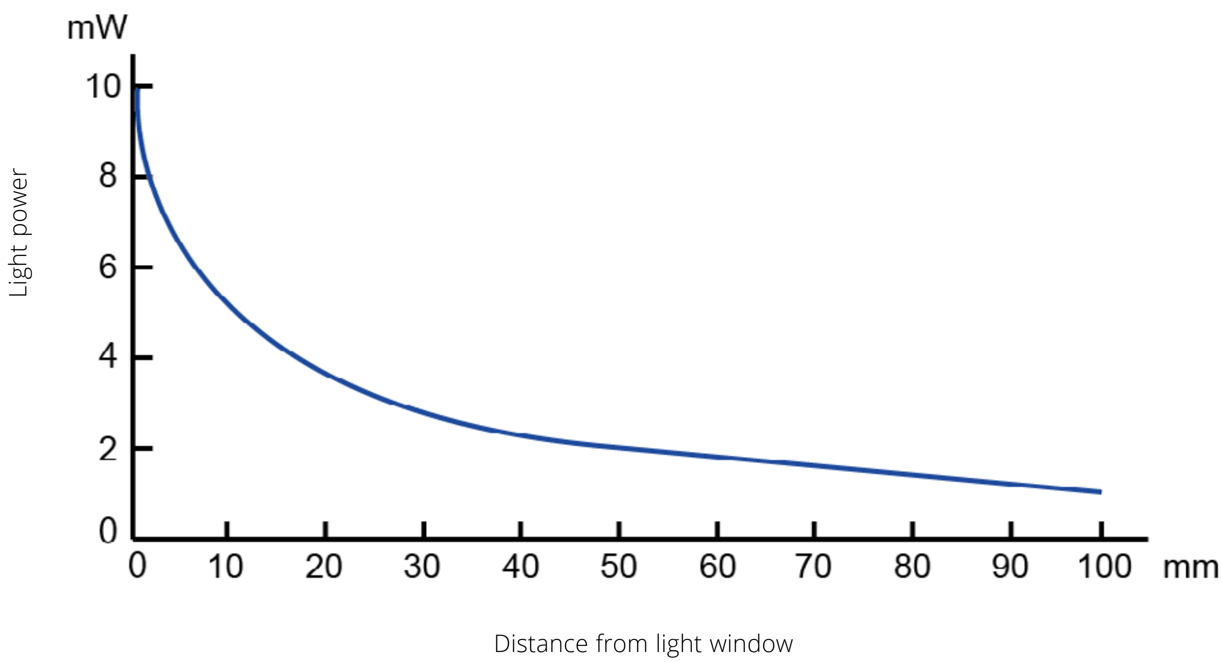
In Direct method, you have to be careful about heat because heat generated on the surface of the light window is likely to reach sample plate. The heat on the surface of the light window is roughly proportional to the light power but especially higher in constant illumination. In CONST mode, or TRG mode using longer pulse in minute-order, we recommend you to set the light power on the window surface less than 5 mW (@ LEDA-B/470 nm). If you use pulse train with pulse width in millisecond-order, the heat generation will be dramatically reduced. For example, the heat generation is about the same between 2.5 mW constant light and 40 mW pulse train in duty cycle 1/20 (5 ms pulse width/100 ms period). Please see "5. Heat – light power / duty cycle relationship" for more detail.

2. . Remote method – remotely illuminate the sample plate

Remote method (inside incubator)

3. How to use LED array

The advantage of Remote method would be, more uniform light can be achieved. If you want to illuminate sample plate with large bottom area, like petri-dish or 6 well plate, the light power can be uneven over the culture area in Direct method because the light power just above LED elements are much higher in near condition. In this case, the Remote method would be more suitable. In addition, you can be less careful about heat in Remote method because LED array does not touch the sample plate directly, so it would be more suitable if you want to use constant light or high duty pulses. The light power will be roughly even at more than 20 mm distance from the surface of light window. Below is a graph showing the relationship between the distance and light power (measured using LEDA-B/470 nm LED array and LPM-100 light power meter, @ 10 mW at the surface of light window, right above an LED element):

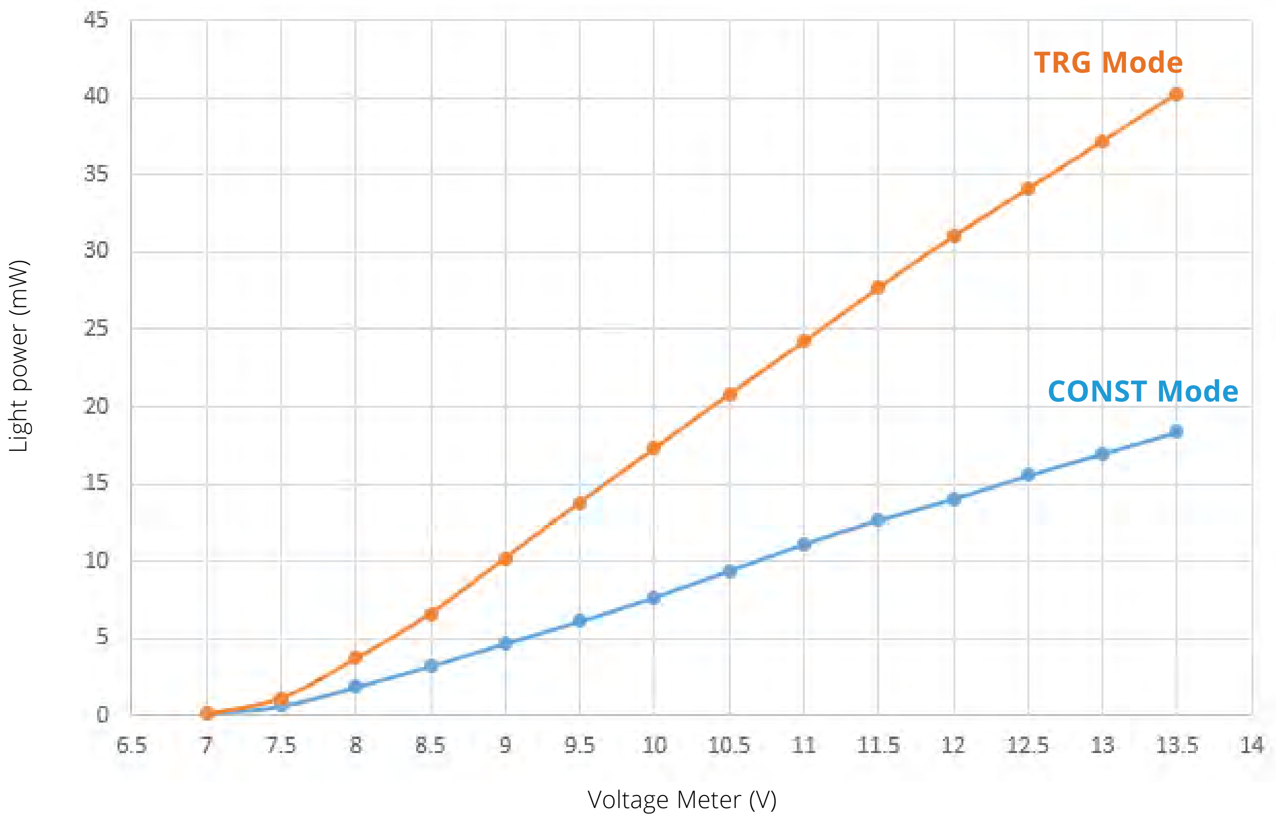


As you can see in the bottom image of previous page, a sample plate is placed on the upper shelf (grid or transparent is desirable), then the LED array is placed on the lower shelf right under the sample plate for illuminating upward. You can adjust the distance by putting the LED array on a platform with appropriate height. It is desirable to use a metal platform with large surface area for better heat dissipation.

Note: The LED array can survive in high humidity incubator. However, it cannot be soaked in water.

4. Voltage - Light Power Relationship

Below is the typical relationship between the voltage meter value on the front panel and Light power on the surface of the LED array. TRG mode is shown in orange line, and CONST mode is shown in blue line. As you can see, the light power in CONST mode is approx. 45% of the TRG mode at the same voltage. This specification is for safety reason because the heat significantly goes up in constant light and may quickly degrade/break LED array.



Condition of measurement

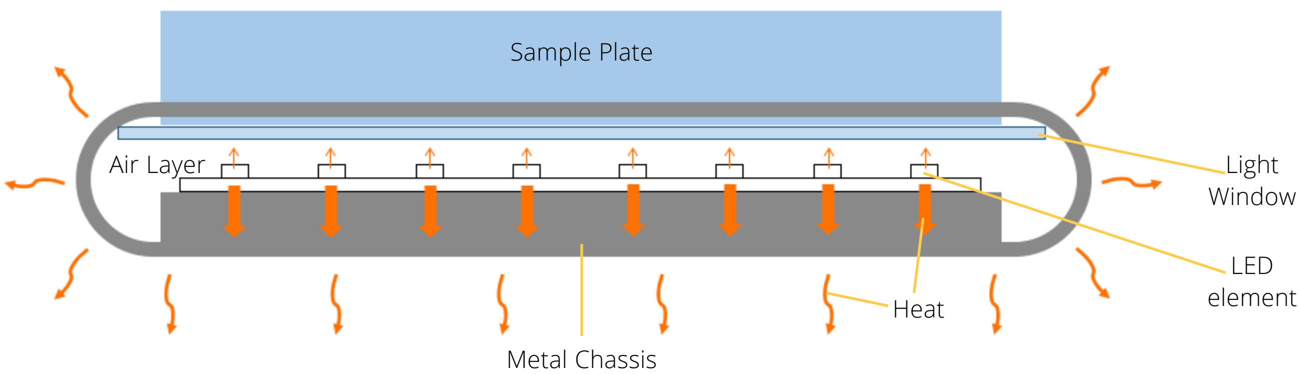
- LED array: LEDA-B (470 nm)
- Light power meter: LPM-100 (sensor area: 5.5 mm x 4.8 mm)
- The sensor of the power meter was put on the surface of light window, right above an LED element.

Note: The voltage drops 0.01 ~ 0.3 V while LED array is lit up.
The data in the above graph measured by referring the voltage while LED array is lit up.

Note: As you can see in the above graph, the light power can be extremely strong in TRG mode. If you use the light in light power over 17 mW (over 10 volts), we recommend you to use pulses with width less than 1 second, duty cycle less than 1/5. Please see “ Heat – light power/duty cycle relationship”.

5. Heat - light power/duty cycle relationship

LEDA-x LED array is designed by maximally considering heat dissipation characteristics. As shown in the image below, LED elements and light window is thermally isolated by an air layer. Most of the heat goes downward and be dissipated via the surface of metal chassis, without reaching light window. However, in strong load, especially in constant light, part of the heat reaches light window.

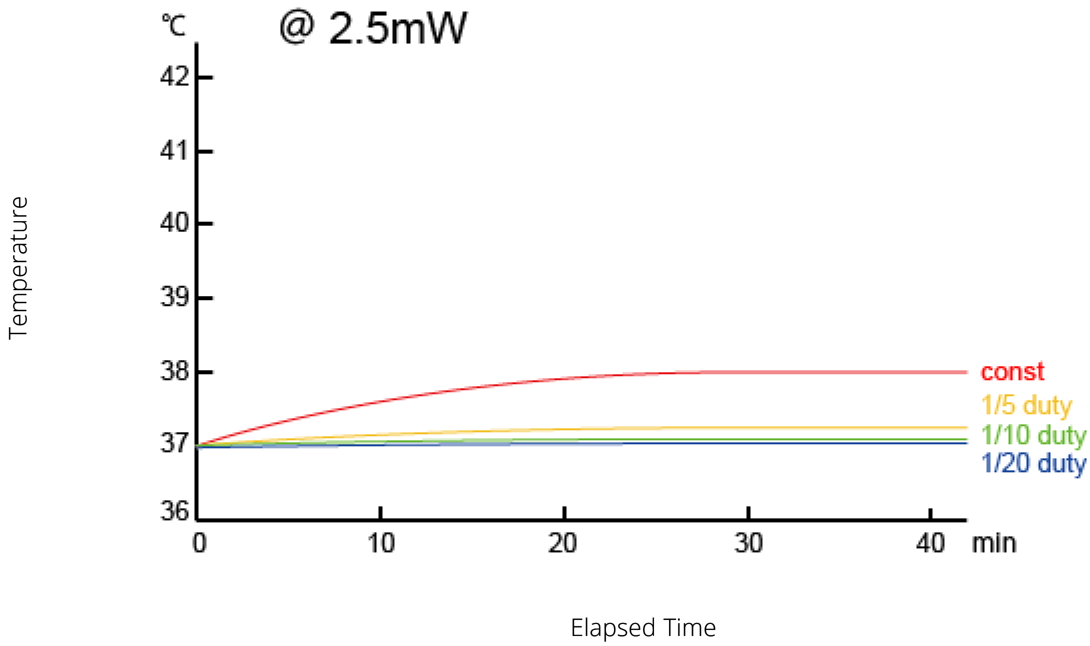


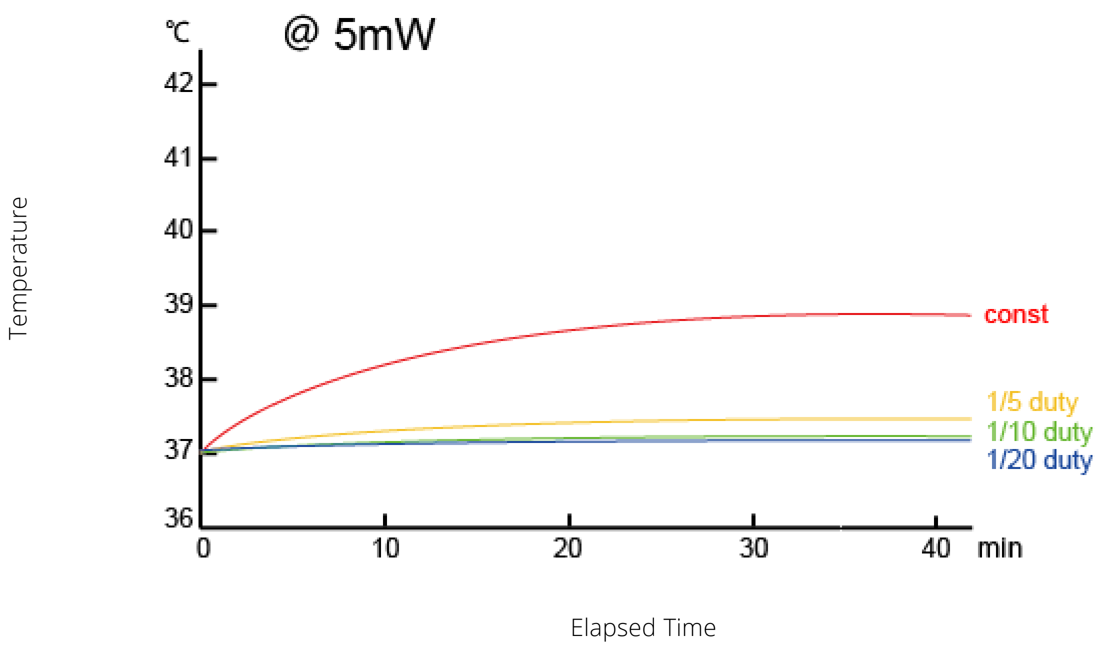
The surface temperature of the light window will be equilibrated at a certain temperature in 20 ~ 40 minutes. The below graphs are relationships between surface temperature and time at each light power:

Condition of measurement

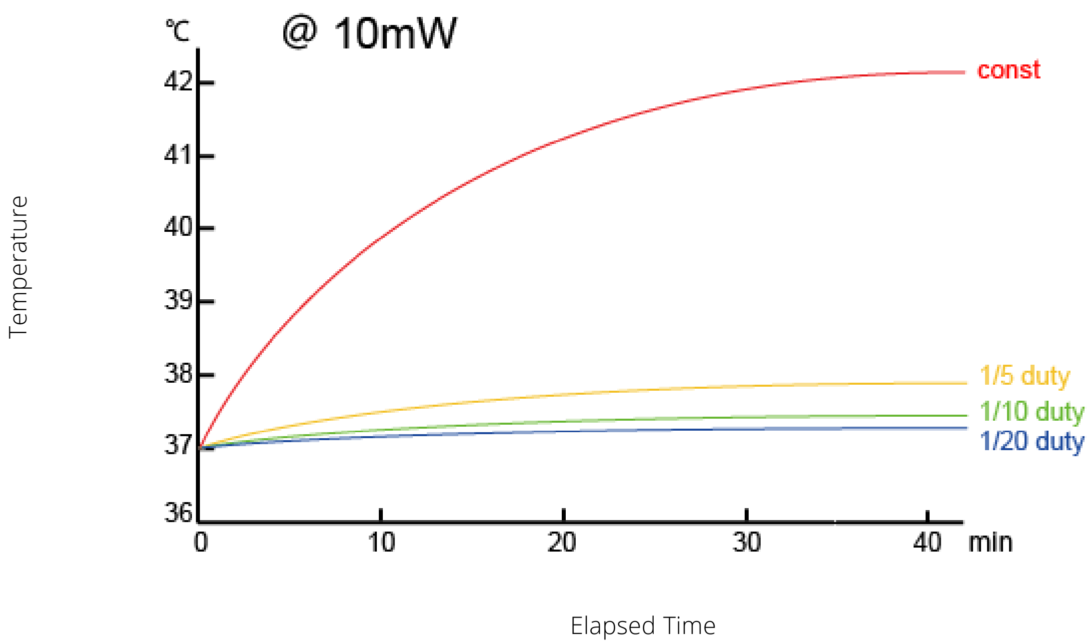
- LED array: LEDA-B (470 nm)
- Light power meter: LPM-100 (sensor area: 5.5 mm x 4.8 mm)
- Light sensor was put on window surface/right above an LED element.
- Tested in 37 degree incubator
- Temperature sensor was put on window surface/right above and LED
- **const**: Constant light
- **1/5 duty**: 20 ms width/100 ms period
- **1/10 duty**: 10 ms width/100 ms period
- **1/20 duty**: 5 ms width/100 ms period

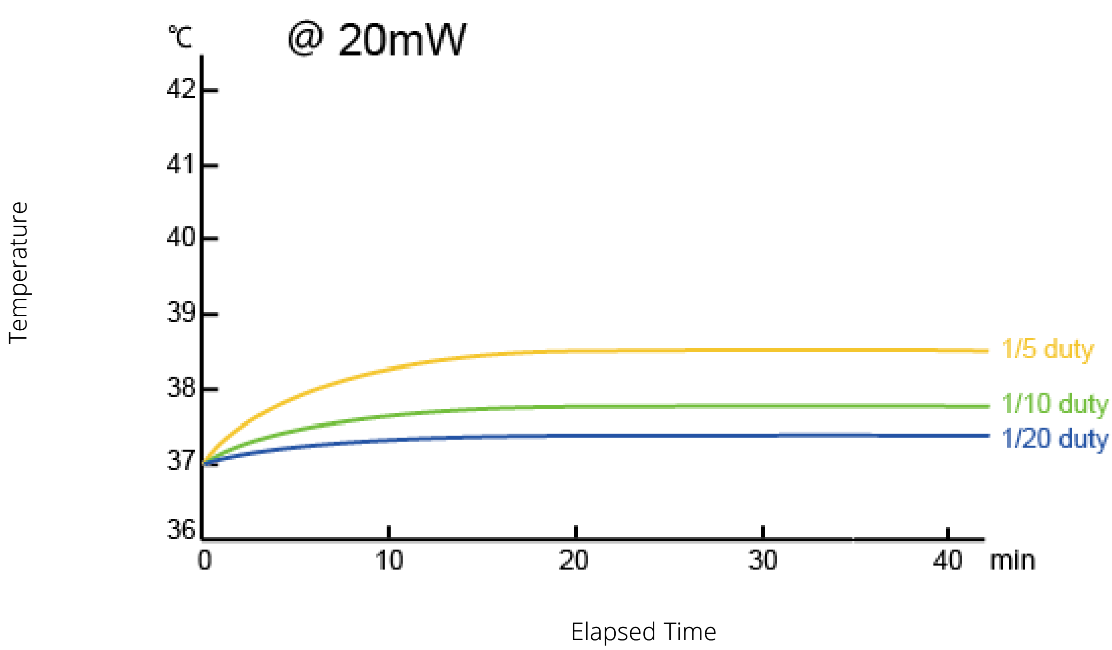
5. Heat - light power/duty cycle relationship



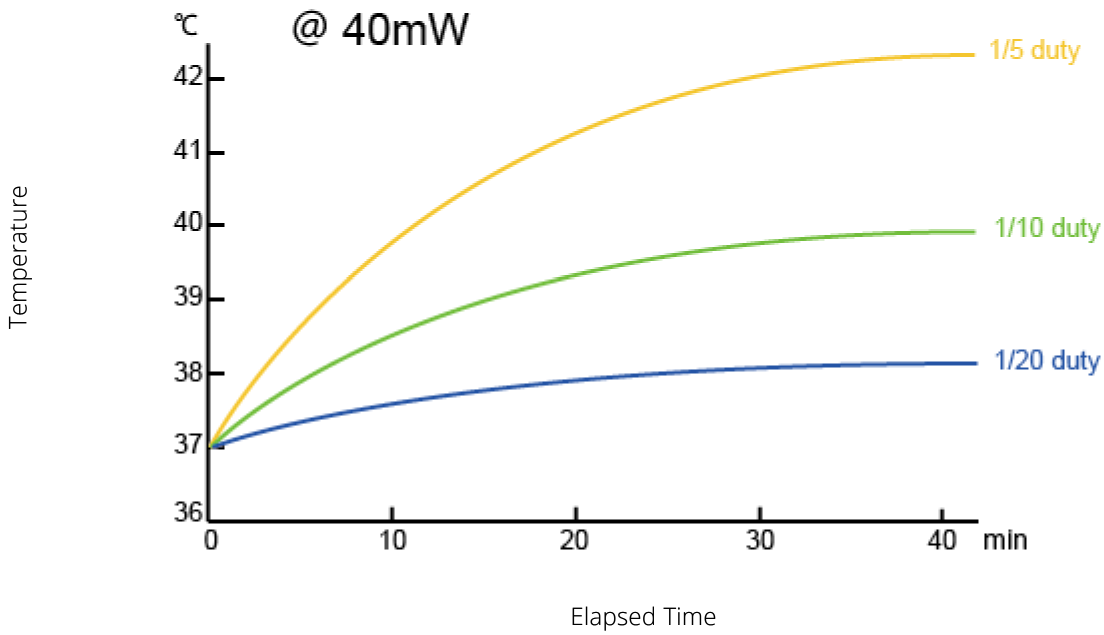


5. Heat - light power/duty cycle relationship





5. Heat - light power/duty cycle relationship

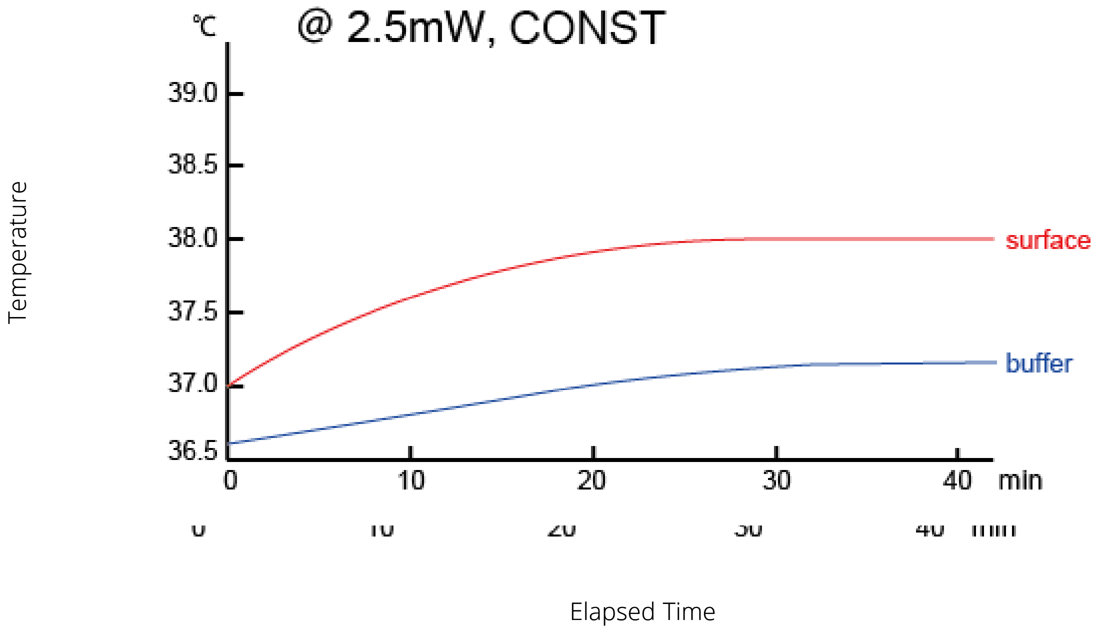


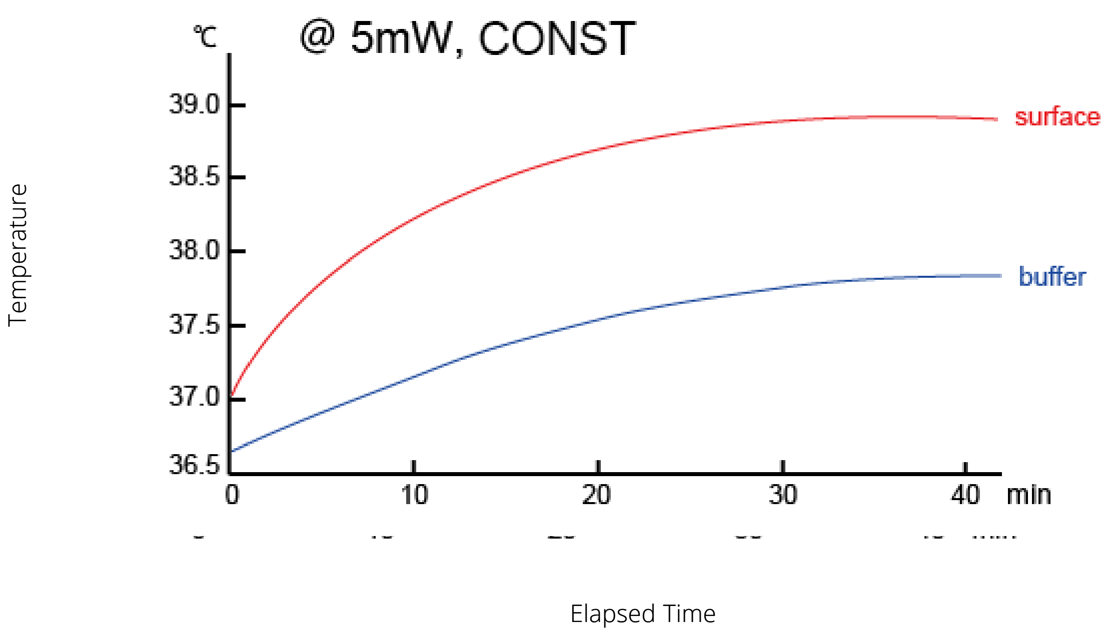
All the heat on the window surface will not reach the buffer inside the sample plate. The below graphs are simultaneous recordings of surface temperature and buffer temperature. Typically, after 30 ~ 40 minutes the buffer temperature will be equilibrated at 50 ~ 65% of surface temperature increase.

Condition of measurement

- LED array: LEDA-B (470 nm)
- Light power meter: LPM-100 (sensor area: 5.5 mm x 4.8 mm)
- Light sensor was put on window surface/right above an LED element.
- Tested in 37 degree incubator
- Temperature sensor was put on window surface/right above and LED (**surface**)
- 96 well plate, 250 μL saline in each well
- Another temperature sensor was put in buffer in a well (**buffer**)

5. Heat - light power/duty cycle relationship

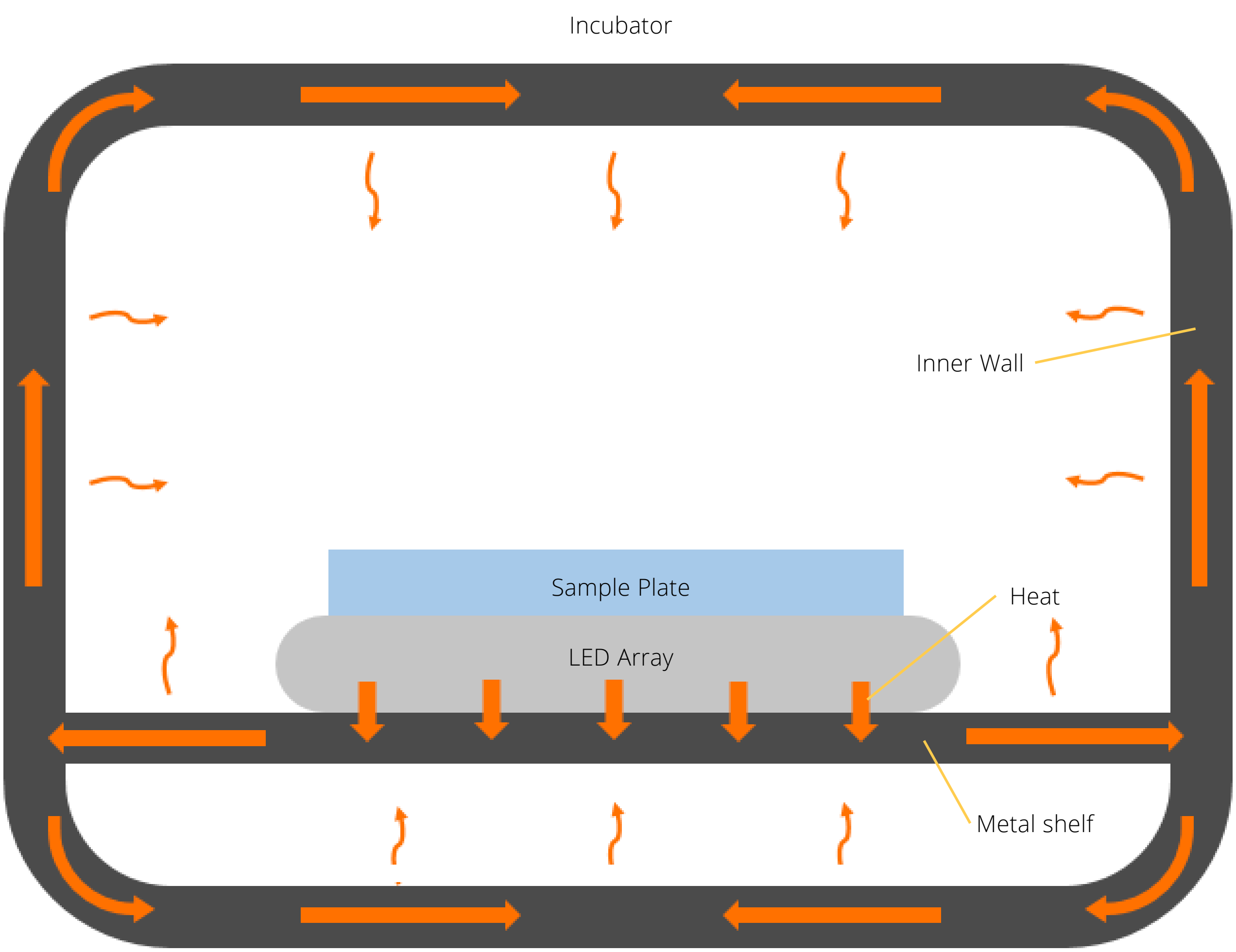




5. Heat - light power/duty cycle relationship

When you put the LED array in an incubator, it is desirable to put it on metal, large surface shelf for improved heat dissipation performance. A flat shelf which can touch the metal chassis of the LED array in large area would be better than a grid shelf. If you use a platform under the LED array, metal block would be desirable (e.g. aluminum).

As you can see in the image below, the heat generated from the LED array will be transferred to the metal shelf and inner wall of the incubator (if the inner wall is metal, too), then will be dissipated there. Normally incubator monitors the inside temperature all the time and tries to keep it at the set temperature, thus the heat from the LED array will not cause an increase of inner temperature in principle. However, if you see an increase of inner temperature maybe in high load or multiple LED array condition, you may need to adjust the set temperature of the incubator a bit lower.



6. Trigger Input

You can use analog voltage for controlling light power of the LEDA-x LED array, by sending 0-5 V to TRG IN port on the back panel of LAD-1. Below is the relationship between analog voltage and light power at 12.0 V power voltage. Please note that this is not completely linear. You should use 5V if you want the maximum output at the power voltage. Also please note that the achievable maximum voltage varies depending on the power voltage (the voltage meter value on the front panel of LAD-1).

Condition of measurement

- LED array: LEDA-B (470 nm)
- STOmk-2 for sending analog voltage
- Light power meter: LPM-100 (sensor area: 5.5 mm x 4.8 mm)
- Light sensor was put on window surface/right above an LED element.

Relationship between analog voltage and light power at 12.0 V