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Assembling Cooled LED Illuminator [↗](#)

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In Development

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ABSTRACT

The cooled LED illuminator is a large heatsink with self-adhesive LED strips, four axial fans, and the LED controller attached to it.

This document is part of the Illuminated Orbital Shaker for Microalgae Culture project:

- Procuring Parts for Algal Shaker
- Assembling LED Controller Electronics
- 3D Printing Case for LED Controller
- Assembling Cooled LED Illuminator (*this document*)
- Cutting and Drilling Clear Acrylic Sheet
- Assembling Algal Shaker

EXTERNAL LINK

<https://app.labstep.com/sharelink/8f145ee3-eecc-4f9f-8e99-fc7b4f41d12e>

GUIDELINES

Introduction

The cooled LED illuminator is a large heatsink with self-adhesive LED strips, four axial fans, and the LED controller attached to it. The segments of LED strips are connected together in parallel by short wire sections. The LED strips and the fans are connected to the LED controller electronics. The assembly should take no more than 3 hours. The work takes place in the following steps:

- Fixing LED strip to the heatsink.
- Soldering the LED strips together
- Fixing axial fans to the heatsinks.
- Connecting the LED strip and axial fans to the LED regulator electronics circuit.

MATERIALS TEXT

Materials

- LED strip (2 m)
- Heatsink (1)
- Axial Fan (4)
- 30V/1A Power Supply
- General Purpose Solvent-Based Adhesive
- Red and black 0.5 mm² (AWG 20–22) cables
- Electricians tape
- Scissors, fine-tip permanent marker, ruler
- Wire strippers and soldering equipment

SAFETY WARNINGS

Consider the safety of the soldering process and observe local regulations. Soldering creates risks of fire, exposure to hazardous fumes, and skin exposure to the soldering flux. Take all necessary precautions. Keep the work area tidy, especially devoid of any combustible

materials. Never leave the soldering iron unattended when hot. Use fume extractor during soldering and laboratory gloves when handling the flux-stained PCB.

Solvent-based adhesive contain substances that are hazardous to humans. Make sure to read and understand the safety guidelines for the use of the glue. The minimum precautions include working in a well ventilated area and using disposable laboratory gloves to minimize exposure through breathing and skin.

1 Fixing LED Strip to Heatsink

Prepare two meters of the LED strip.



Self-adhesive LED strip to be fixed to the heatsink.

Cut the LED strip into ten 200 mm (8") long segments using scissors. Cut along the designated lines going through the solder pads.

Prepare the heatsink. The recommended heatsink features a 200 mm × 150 mm flat surface area, 40 mm height, and 0.5 °C/K thermal resistance. Other heatsink may be used, but it must be sufficiently large to accommodate the LEDs and the axial fans fixed to its side. Any heatsink of this size should have sufficiently low thermal resistance.

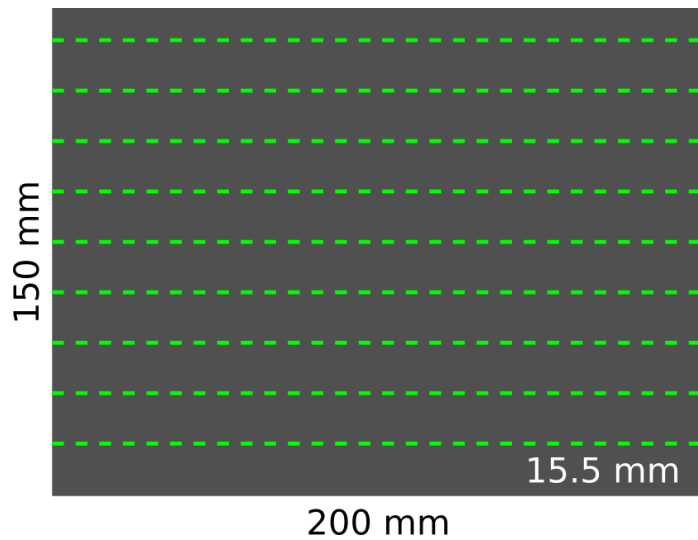


Heatsink to hold the LED strips and fans.

Use a permanent marker and ruler to draw lines, along which the LED strip will be glued to the adhesives. For ten ($N_S = 10$) parallel LED strips, each $w_S = 10$ mm wide, there are nine ($N_G = 9$) gaps of unknown width (w_G). The width of the heatsink is $w_H = 150$ mm. The spacing of the lines (w_L) can be calculated using the following equation:

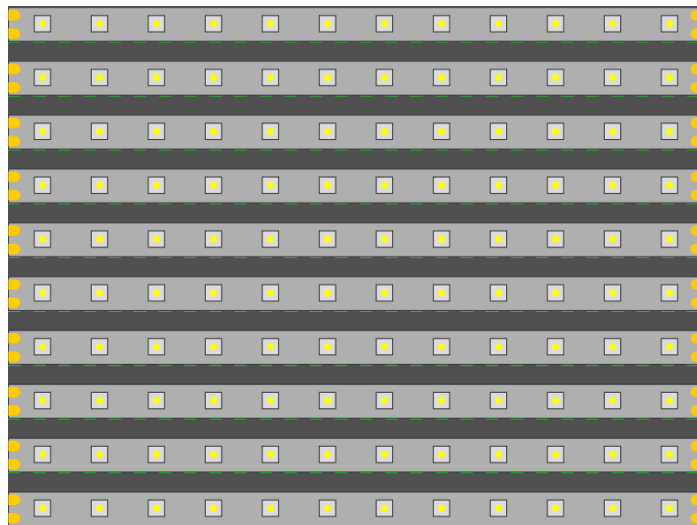
$$\begin{aligned} N_S \times w_S + N_G \times w_G &= w_H \\ w_G &= (w_H - N_S \times w_S) / N_G = (150 \text{ mm} - 10 \times 10 \text{ mm}) / 9 \cong 5.5 \text{ mm} \\ w_L &= w_G + w_S \cong 5.5 \text{ mm} + 10 \text{ mm} = \underline{\underline{15.5 \text{ mm}}} \end{aligned}$$

Lay the heatsink on a table with the flat surface facing the top. Draw nine lines with a permanent marker onto the heatsink surface. The lines are parallel to the longer edge of the heatsink. The first one starts 15.5 mm from the heatsink edge and they are spaced 15.5 mm apart, as in the image below:



Sketch of the heatsink surface with green lines spaced 15.5 mm, starting from the bottom. Draw these lines using a permanent marker onto the actual physical heatsink. They will be used as guides for attaching the self-adhesive LED strips.

Peel the backing foil from the LED strip one-by-one and stick it along the drawn lines onto the heatsink surface. Make sure that the orientation of all the strip segments is the same to avoid confusion later. Once all the LED strip segments are attached, the surface of the heatsink will be covered with the LED strip segments as in the image below:



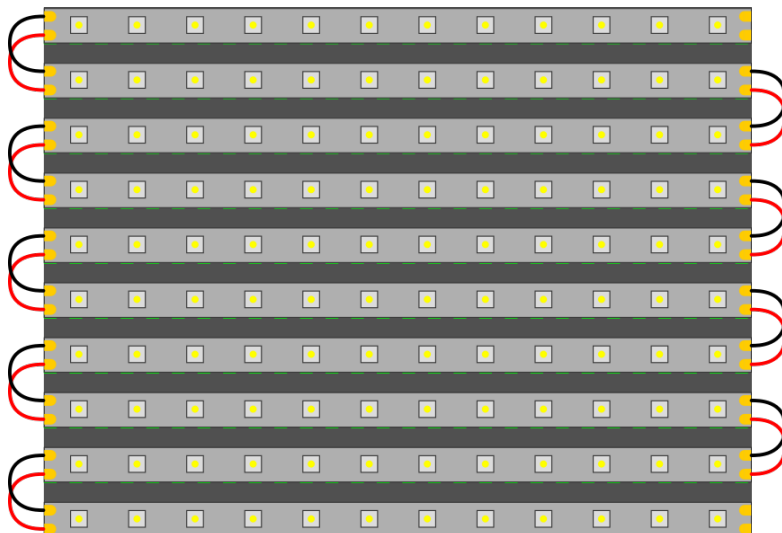
Sketch of LED strips stuck to the heatsink surface. The LED strips are attached along the green lines shown in the picture above to produce equal spacing across the entire surface of the heatsink.

2 Soldering LED Strips Together

Prepare the soldering equipment.

Cut the red and black 0.5 mm² wires into nine 30 mm (1") long segments of both colors. Strip the insulation from both ends of each segment.

Solder the neighboring LED strip segments together, with the red cable segments connecting the anodes (+) and the black cable segments connecting the cathodes (-), as in the image below:

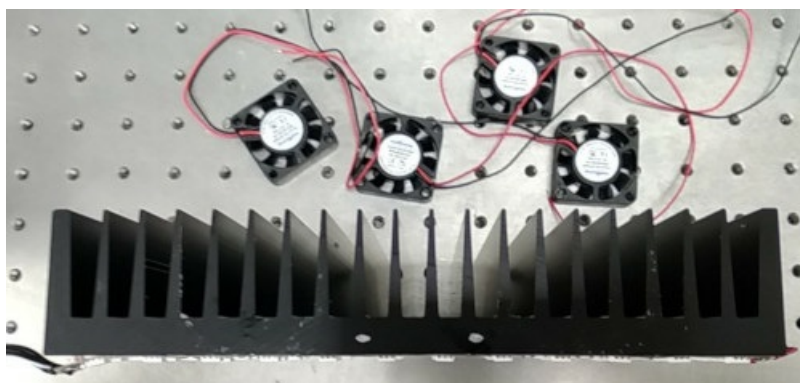


Sketch of LED strips on the heatsink with short cable segments connecting their electrodes. The red cables connect the anodes (+) and the black cables connect the cathodes (-).

Note: The soldering may be problematic if the soldering iron does not have sufficient power to heat up the solder pads of the LED strips attached to the heatsink. In that case, lift the ends of the LED strips by peeling them off the heatsink temporarily. Reseal the self-adhesive backing to the heatsink once finished soldering.

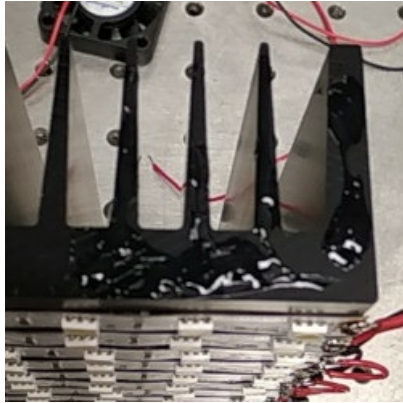
3 Fixing Axial Fans to Heatsink

The heatsinks are attached to the side of the heatsink using general purpose solvent based glue. Prepare the glue, the heatsink with the LED strips attached, scissors, electricians tape, and four axial fans:



Four axial fans prepared to be glued to the heatsink with the LEDs already attached.

Deposit the general purpose glue onto the side of the heatsink, where the fans will go:



Glue is liberally applied to the edge of the heatsink. The fans will be fixed to the heatsink with the glue. The fans are oriented such that the frame is touching the heatsink and the rotor with the blades is facing the outside.

Press the axial fan into the glue with the sticker facing the heatsink. Do not glue the rotor with the blades, but the frame of the fan.

Glue all four fans side-by-side with the supply cables facing the side, where LEDs are attached:



All four fans have been glued to the edge of the heatsinks. Notice the fans are oriented such that their power leads face up, the same way the LED strips face.

The glue dries quite quickly and if the fans are handled carefully, you can proceed immediately to the next steps. Dab a bit of glue onto the side of the fan near its power supply cables. Push the cables into the glue blob and fix them with electricians tape in place. Cover the glue patch with more glue, which will reliably fix the cables to the side of the fan:



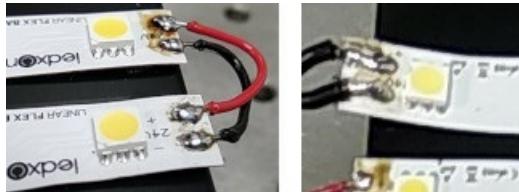
The heatsink leads are glued along the fan top using the multipurpose solvent-based adhesive. The leads are temporarily fixed using electricians tape to the fan - holding the leads in place while the glue dries and solidifies.

Do this for all fan leads and fans to tidy up the cables using more glue and more electricians tape:



Gradually fix using a multipurpose solvent-based adhesive all supply leads to the fans along the heatsink to the fan bodies. Use electricians tape to temporarily hold the leads in place while the glue sets.

The LED strips tend to peel off from the heatsink, especially near the edges. The peeling process is gradual, however pushing the strip back down does not fix the problem and the strip will peel off over time as seen in the pictures below:



The LED strips tend to peel off from the heatsink. The peeling is most obvious near the ends of the strips.

The self-adhesive backing can be reinforced with the general purpose glue. Push down the LED strip segments to stick flat to the heatsink. Dispense the all-purpose glue in between and along the edges of the LED strip segments. Push again on all the LED down with finger to make sure the strip is adhered to the heatsink before the glue dries. If any part of the LED strip does not hold adhered, weight it down with a suitable object while the glue is setting.

The image below shows glue between the top to segments of the strip (not clearly visible, due to its transparent look), the finger pushing down on the LED and a steel post weighting down end of a strip, which kept bulging up without the weight:



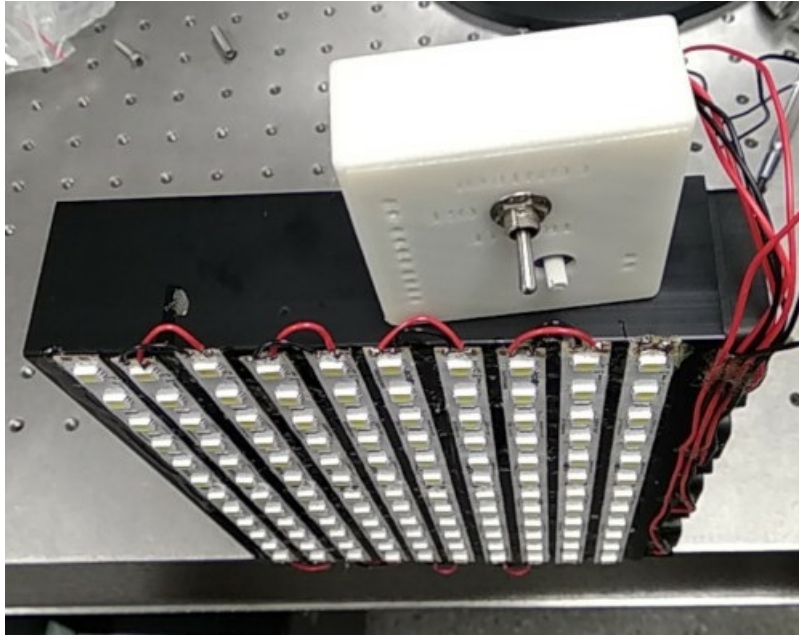
Deposit glue onto the heatsink surface, covering the edges of the LED strips. This way the glue will bond the LED strip thoroughly to the heatsink. Use a heavy weight (1" stainless steel post in the photo) to hold any lifting LED strips while the glue is drying. Use gloves and not a bare finger, unlike shown in the photo.

Leave the glue dry out. The drying time will depend on the type of the glue and the environmental conditions, but could take an hour or more. Glue all strips in one go, if in rush, or glue them in batches of a few strips at a time.

4 Fixing LED Controller to the Heatsink

The LED controller can be left lying next to the heatsink on the shaking incubator. The fixing does not need to be done at this point and could be postponed until everything is tested and working. The primary reason to fix the LED controller to the heatsink is to keep the wiring tidy and reliable in the long-term by minimizing risk of snapping of the cables.

Position the heatsink on the edge of a table to have it standing sideways. Make sure the LED controller can be mounted sideways, as in the image below:



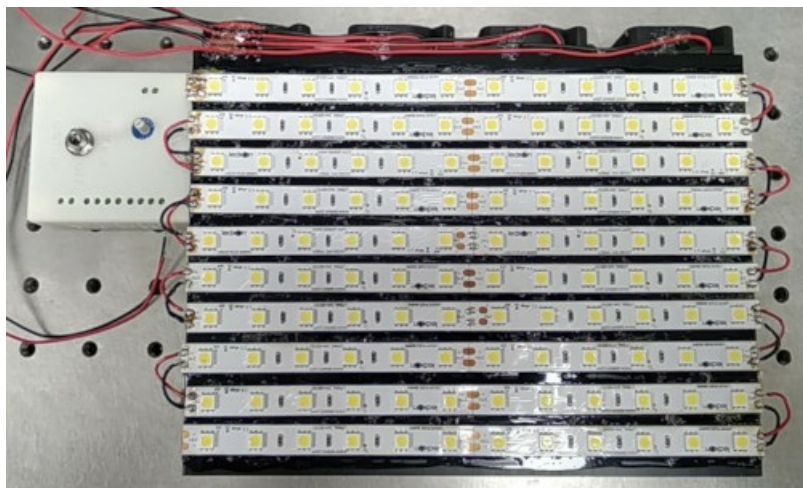
Heatsink placed on the edge of a table on its side. The LED controller is positioned standing on the other side of the heatsink.

Apply the general purpose glue to the side of the heatsink, where the LED controller is to be mounted. Press the LED controller into the glue and make sure that the bottom of the heatsink and the bottom of the LED controller are spaced at least 6 mm (1/4") apart. This is to ensure that the LED controller stays above the rim of the orbital shaker platform. The rim is about 6 mm high. If you have a different orbital shaker, make sure that either the heatsink with the LED controller fit entirely onto the platform, or check for minimum clearance required to accommodate the platform rim.



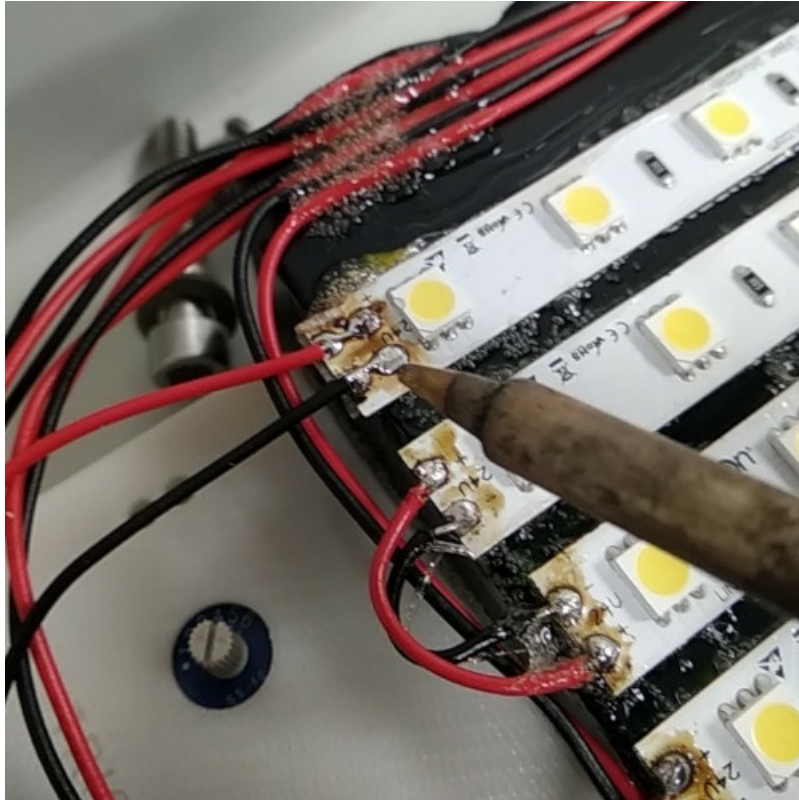
Fix the LED controller to the side of the heatsink with the general purpose solvent-based adhesive. Make sure there is enough space (6 mm) between the bottom of the heatsink and the bottom of the LED controller, so the rim of the orbital shaker platform is no in the way of the LED controller.

Let the glue dry for 10-30 minutes, depending on the type of the glue and environmental conditions. Even once the glue is partially set, handle the unit with care, as the glue will initially be quite weak. Once happy with the strength of the glue, lay the heatsink back on its back:



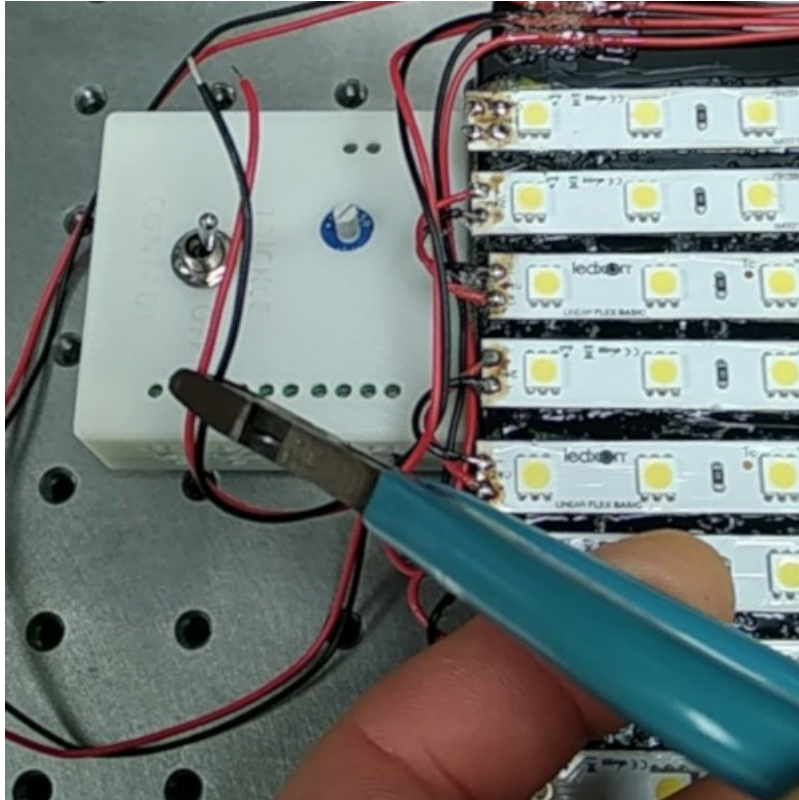
This photo shows the heatsink with the LED controller glued to its side.

Solder short lengths of red and black 0.5 mm² cables to an unconnected end of the LED strip. Connect the red cable with the (+) labeled solder pad and the black cable to the (-) labeled solder pad.



Solder the power supply leads to the first LED strip. Connect a black cable to the cathode (-) and the red cable to the anode (+).

Trim the fan cables to length suitable for connecting to the LED controller. Make sure to connect the pairs of red and black cables coming from each fan to the two neighboring terminals in the LED controller. Connect the red cable to the (+) labeled terminal and the black cable to the (-) labeled terminal. It does not matter which fan connects to which pair of terminals.



Trim the fan power supply leads to a length long enough to comfortably reach the screw terminals in the LED controller.

Strip the ends of each lead and connect them to the LED controlled terminals. As explained above, ensure the cables to one fan go into the neighboring pairs of terminals. The LED is connected to the terminal labelled LED. Observe the polarity signs printed on the side of the LED controller or follow the labeling in the image below:



The cables are connected to the LED controller. The two leftmost terminals connect the LED strips. The four pairs of terminals are for the four cooling fans.

5 Testing the LED controller

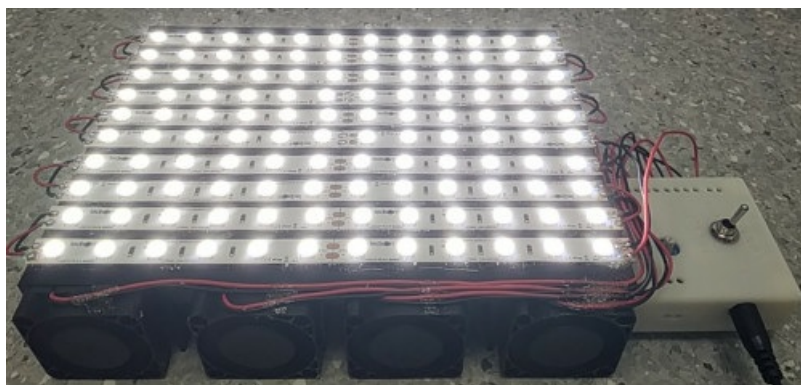
Connect the 30V/1A Power Supply to the LED controller and plug it into the socket. Flick the toggle switch between the 3 positions: TICKLE CURRENT - OFF - CONTROLLED CURRENT. In the OFF mode, the LEDs and fans should be off. In the TRICKLE mode, the LED should glow weakly and the fans should be stationary. In the CONTROL mode, the fans should be spinning and the LEDs should be glowing bright. Use a screwdriver to adjust the LED brightness by turning the rotary switch between the end positions (•), for maximum brightness, and (6), for minimum brightness.

LEDs are in the trickle mode and fans stationary:



LEDs glow is dim in the trickle current mode. The fans are stationary.

LEDs are in the controlled current mode and the fans are spinning:



In the controlled current mode the fans are spinning and the LEDs are considerably brighter.

6 Summary

This protocol explained the procedure of mounting LED strips to a heatsink, adding axial fans for cooling, and the LED controller. It described the electrical connection of these parts and finally shown how to verify the function of the cooled LED illuminator. The next document will describe how to cut a clear acrylic sheet for the illuminated orbital shaker.

7 This document is part of the Illuminated Orbital Shaker for Microalgae Culture project:

- Procuring Parts for Algal Shaker
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- 3D Printing Case for LED Controller
- Assembling Cooled LED Illuminator (*this document*)
- Cutting and Drilling Clear Acrylic Sheet
- Assembling Algal Shaker



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