Operation Manual

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March 30th, 2018

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Contents

Acknowledgements

Our team would like to thank Unison Industries for giving us an opportunity to design and experimentally validate a forced air cooled heat sink.

Team 19 would like to acknowledge a few people without whom this project would not be at the stage its at. These people are Dr. McConomy, Dr. Ordonzez, and Mr. Walker. Our biggest thanks go out to these people for there roles as mentors.

We would also like to thank Jeremy Parker at Parker Services LLC. for providing us with useful material and labor for free. Their technical knowledge and expertise is invaluable and we are grateful.

Abstract

Heat removal has long been an issue for engineers. In electronics, heat is dissipated as an electric current runs through. In the case of this project, Unison Industries has tasked us with designing a forced-air heat-sink to remove 300W of heat produced by 24 silicon semiconductors in an 85 C environment. These semiconductors will be used to convert AC to DC in order to power the planes electronics. If not removed the heat could build up, and cause the chip to rise above 150 C. That would cause the semiconductors to stop working. This heat sink must maintain a chip temperature below 135C for a factor of safety, and be as light weight as possible. A standard heat sink design was simulated on the computer that put the max temperature well below the previously stated goal of 135 C. To achieve an optimized light-weight heat sink design we will be performing simulations with our prototype. During simulation the semiconductors will be modeled cheaply using resisters of similar size that will dissipate the required heat. A heat camera was used in order see what parts of the heat sink are close to the environments temperature. These areas can be taken off as there is not heat transfer, and this will optimize the weight of our heat sink.

Equipment Needed

Our design and setup for Unison industries forced air cooled heat sink required both equipment and parts to be ordered or acquired. A list of equipment/parts can be seen below:

Table 1: A table of Equipment needed for the Assembly of the Heat Sink.

Equipment and quantities needed for each	
Equipment	Quantity
Machined Heat Sink	1
Semiconductors	24
M3 Screws	32
Size 3 Washers	32
M7 Machine Screws	4
Size 7 Washers	4
3.5 in Cooling Fans	2
In line on/off switch	1
Fan Duct	1
Thermal Sheets	2
2.5 mm Hex Screw Driver	1
6 mm Hex Screw Driver	1
Solder Iron	1
12 Volt DC Supply	1

For the application of the heat sink we wired 24 semiconductors in series of three and screwed each semiconductor into the base plate of the heat sink with M3 screws and size 3 washers. Between the semiconductors and the base plate of the heat sink the thermal sheets will be attached to improve

heat transfer. There will be two 3.5 inch diameter fans to provide the forced air cooling in the heat sink and the fans will be wired to a 12 volt DC supply. There will also be an in line on/off switch to eliminate the chance of someone wiring the fans with the power on. The fans will be mounted in a fan duct with M3 screws in pair with size 3 washers and the fan duct will be mounted to the base plate of the heat sink using M7 screws in pair with size 7 washers. Wire will be needed to wire the fans up with the 12 Volt supply. To wire the fans up a solder iron will be used to attach them together. Lastly, a 2.5 mm and 6 mm Hex screw driver will be used to screw the 3 screws and M7 screws into the base plate.

How To Setup

To setup the heat sink, the 24 semiconductors must first be connected with M3 machine screws to the bottom surface of the heat sink. A thermal pad, thermal sheet, or thermal contact paste must be placed at the interface between the semiconductors and heat sink. Semiconductors must be wired as necessary after being placed onto the bottom surface of the heat sink.

Following this, the fans must be be connected to the duct with M3 machine screws through the aligned holes. Following this step, the fan must be wired to a 12 Volt power supply with an in-line switch in the off position. This is necessary to prevent the operator from being harmed by the spinning fans during assembly and maintenance. It is also highly suggested that heat-shrink tubing or some other sort of insulating layer be placed to prevent unintended shorting of electrical wiring.

After the fans are attached to the duct and wired to a 12 Volt supply, the duct can be attached to the heat sink by aligning the holes in the duct with M7 machine screws. These are the same screws that the heat sink is designed to attach to aircraft with. It was specified that Team 19 is not in charge of connecting the semiconductors to the heat sink or attaching the heat sink to the aircraft, so these design parameters are simply suggestions.

Once the entire heat sink is assembled and attached to the aircraft, the operation of the semiconductors and fans should be tested to verify seamless operation. If there is failure within either component, the wiring should be rechecked.

How To Turn On/Setup Operation

Make sure that the assembly is rigidly attached to a secure location before operating. Since this device is set to operate within a small aerial vehicle, if it is not properly secured it could cause serious damage to other components of the innards of the vehicle. Once it is secured, turn on the vehicle. The power supply for the semi-conductors and the fans will be wired directly to the same line so that when there is current passing through the chips, the fans will automatically turn on in order to begin removing heat.

Once the heat sink reaches steady state, it will operate as it should, dissipating 300W of heat to the surroundings and maintaining a temperature below 135°C in order to ensure the chips do not fail.

How To Use

Once the heat sink has been assembled before the semiconductors are turned on there are a few things that must be checked to ensure that the heat can be dissipated safely.

First, one must do a visual inspection of the wires to make sure that they aren't damaged. There will be a spinning fan, so there is always a possibility that they could get cut if they are not tied down properly. An exposed wire can pose many threats. Most of all, this could be a spark hazard. This spark could land on something and start a fire. Plane fuel is highly explosive, so this is a risk no worth taking. This must be a meticulous inspection as there are many wires in this set up. A split wire should be replaces immediately. When working with electric parts always make sure that the power supply has been switched to the off position.

Next, depending on the type of thermal pad used there could be a need to ensure that there is a proper amount of the pad left. If there is a phase change within the range the heat sink operated in then some of the pad could have evaporated. These pads are essential to allowing the heat to travel smoothly between the heat sink and the semiconductor. If the pad cannot be seen from the edges of the semiconductor than it needs to be replaced. To do this simply remove the screw holding the semiconductor in place. After that then you must simply place a new pad where the semiconductor sits. Then screw the semiconductor back on to the base plate of heat sink.

After that, one can do can ensure that the fans are working. The fans will be attached to the main power supply on the plane, so they should turn on when the plane turns on. To test without turning on the plan there is a simple process. With a 12 V battery attach one lead to the positive side of the battery, and the other lead to the negative side. This should start the motion of the fan. Without the fans then the semiconductors will be cooled

by the heat sink via natural convection. Natural Convection is a way less effective mode of cooling, and this could mean that the semiconductors could reach there max operating temperature in lower ambient temperatures than this is rated for.

Then one must check to make sure that the fins have not been damaged. If it is noticed that fins our touching then the heat sink cannot be effective. The screws for the duct must be taken off to do further evaluation. If there is cracking in the fins then the heat sink must be replaced. If there is only bending then a fin comb can be used. Ensure that none of the fins are touching before resuming normal operation.

Finally, when using this heat sink it must be noted that the ambient temperature plays an important role in the effectiveness of the heat transfer. The heat sink designed by our team has a max recommended ambient temperature of 85 C. Anything above this, and the semiconductors may exceed the max operating junction temperature.

Once this has all been checked then the heat sink should be ready for the semiconductors to be turned on. When the plane is turned on the semiconductors will be rectifying the AC to DC, and the heat sink will be working.

How To Clean Up

The cleaning of the heat sink is essential in order to ensure the heat transfer is as efficient as possible. If the surface of the heat sinks becomes dirty, it could make it difficult for convection to carry away heat on the surface. It is also possible that the build-up of dust mixed with a sudden failure could lead to a fire aboard the plane mid-flight. This would prove disastrous. In order to properly clean this heat sink one should:

1. Remove heat sink from plane.
2. Blow away any dust using a dust removing spray for maximum results (ignore the semi-conducting chips for now).
3. Make sure to get between the fins where dust will tend to build up.
4. Clean the thermal contact area between the semi-conductors and heat sink with a soft brush so that to not damage the chips themselves.
5. Soak a rag with a vinegar based cleaner and shine only the heat sink in order to reduce emissivity to it's designed rating.
6. Clean the fan blades themselves with the dust-removal spray.
7. Let it dry before reattaching.
8. Place heat sink back in vehicle and secure it properly.
9. Reattach any loose wires and secure them to their original positioning.

If this heat sink is regularly maintaining it should operate until the shelf life of the motorized fans is over. Should one fail to regularly maintain the heat sink, it could cause cataclysmic failure to the devices it maintains which could prove detrimental to the overall vehicle and any passengers on board. We recommend checking it biannually to maximize longevity.

How To Store

In order to safely store the heat sink, the storage container must be larger than 321 mm in length, 150 mm in height, and 250 mm in width. The heat sink assembly should ideally not be stored in hard to reach places, as the fully assembled heat sink is approximately 4 kg and could be dangerous if dropped. No objects should be stored on top of the heat sink assembly. Special care must also be taken to not bend the fins, duct, or fans when transporting the heat sink to its storage location.

Parts List

All parts for the design can be found in figure **??** along with their appropriate part number which correlates to the provided exploded view. Use this to help with the setup and to make sure all parts are accounted for.

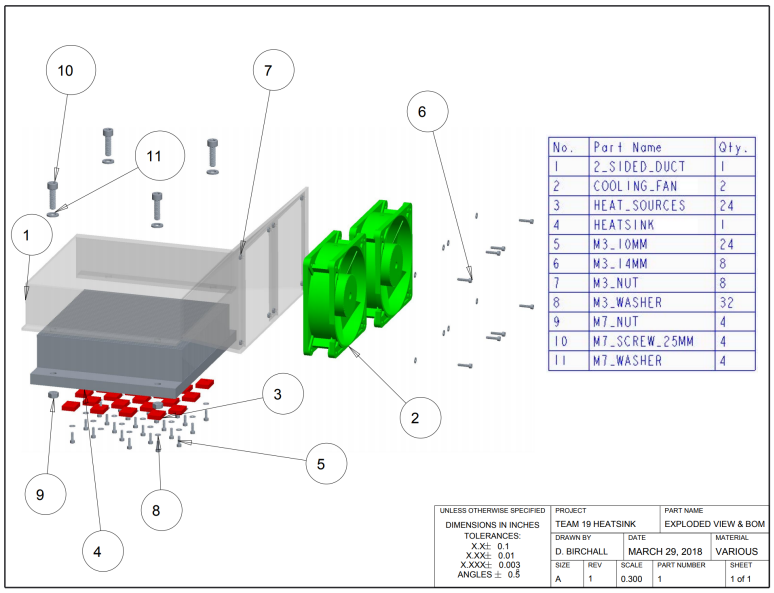

Figure 1: Exploded view of design & bill of materials