Report – Thermal analysis of GDM with different heat sinks.

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Aim – The aim of this experiment is to find the best heat sink for the GDM monitors.

Method – The processor is subjected to a stress test which will heat up the CPU and readings of the temperature will be recorded at regular time intervals. Different types of passive heat sinks will be attached to the system for comparison.

The experiment is being done at room temperature which is about 20-25 degree Celsius. The readings of the temperature will have to be adjusted according to the temperature of the environment where the GDM is being used.

Apparatus used - GDM, 5 types of heat sinks, power supply, Tera Term, PuTTY, Polyimide Film Tape (to over any open gaps so that there is no escape of heat.)

Site of experiment – Personal Desk. room temperature 20-25 degree Celsius.

Types of heat sinks used –

1. A simple thin layer of copper sheet (Fig. 1)
   This is currently being used in the latest GDMs.

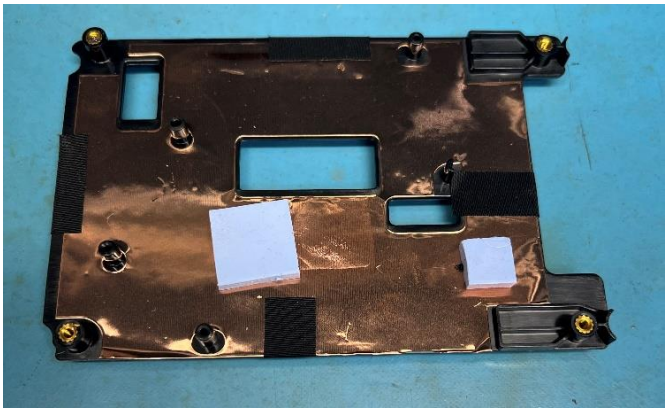


Figure 1: Copper Sheet

2. Aluminum plate (Fig. 2)

Figure 2: Aluminum Plate

3. Aluminum border along with the aluminum plate. (Fig. 3)
   The Border was added to method 2 to try and bring the heat out of the GDM.

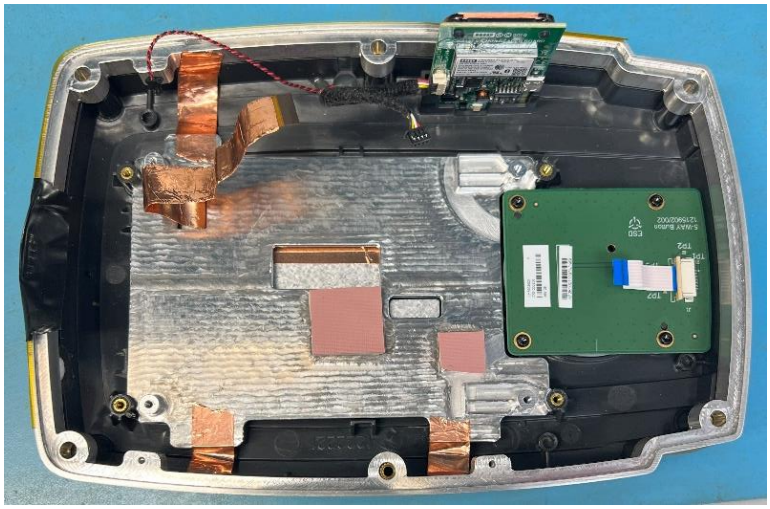


Figure 3: Aluminum border with Aluminum plate.

4. Thermal Pad (Fig. 4)
   As you can see in figure 4, the circuit board of GDM is kept in the open when used with the thermal pad, this is not an ideal setup since there is no enclosure around the board. Hence a 3d fixture was mounted on the top of the board in the next method.

Figure 4: Thermal Pad

5. Thermal Pad with 3d printed fixture (to replicate the GDM.) (Fig. 5)

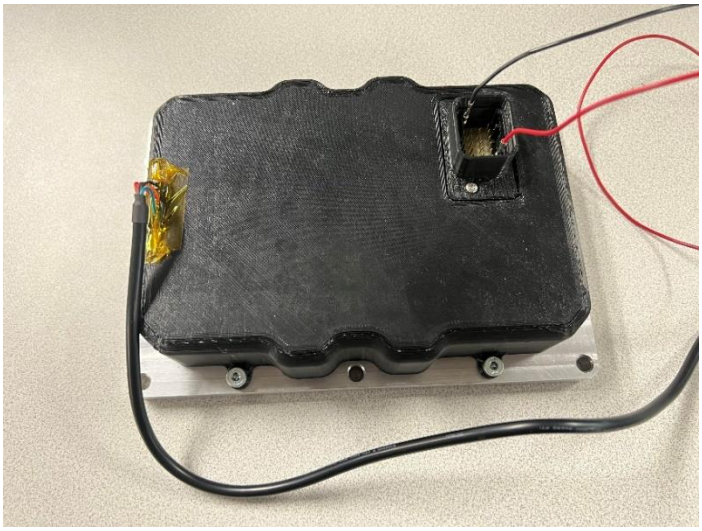


Figure 5: Thermal Pad with 3d fixture

Stress Test used - A simple for loop – " for i in 1 2 3 4; do while :; do : ; done & done "

This command will start 4 endless loops.

Results –

*Temperatures are in milli Celsius degrees

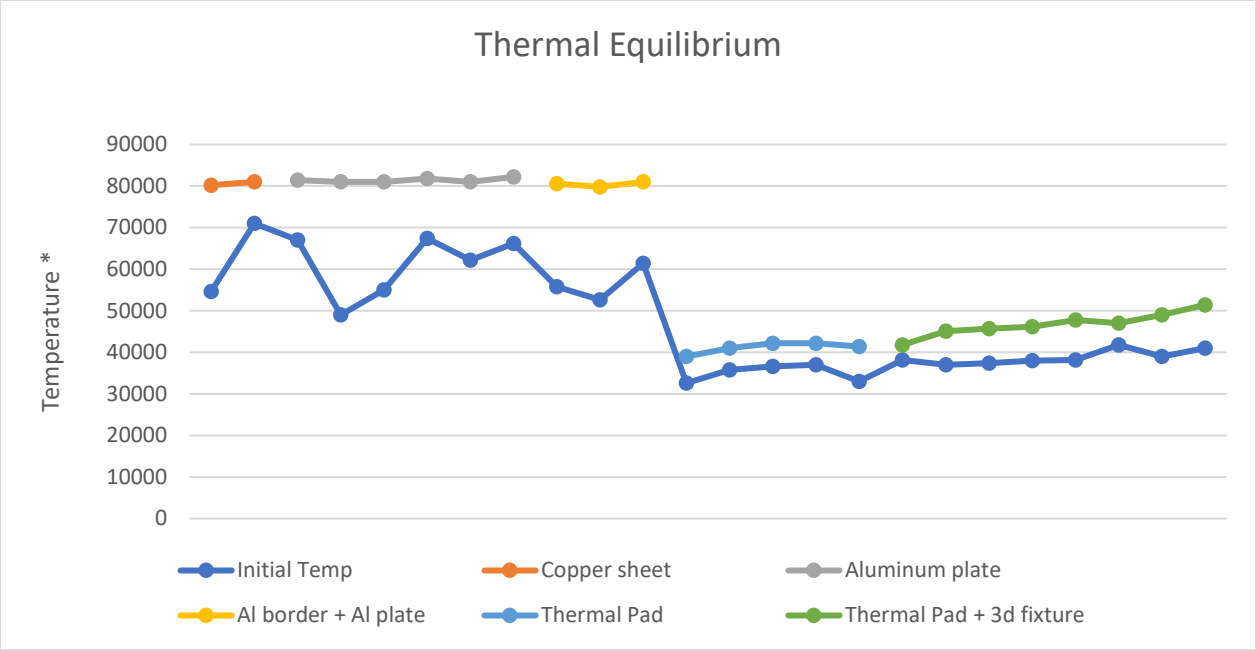


Figure 6: Thermal equilibrium for each heat sink.

Fig 6 describes the initial temperature and the highest temperature the system reaches with the heat sink.

Copper sheet, Al plate and Al plate with border reaches up to 80000 milli degree Celsius, whereas the thermal pad experiments give us temperature in the range of 40000 – 50000 milli degree Celsius.

With the thermal pad, there is also a significant decrease in the initial temperature of the GDM.

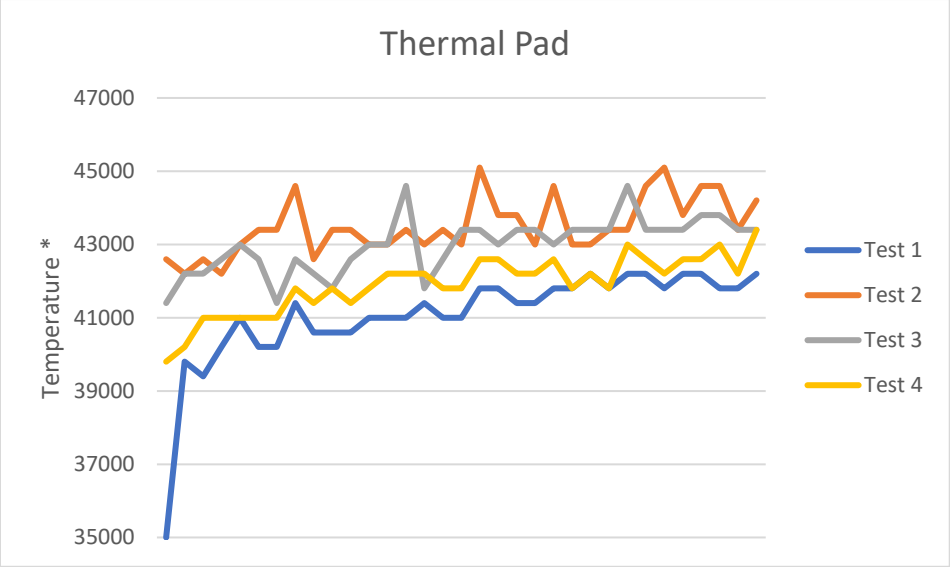
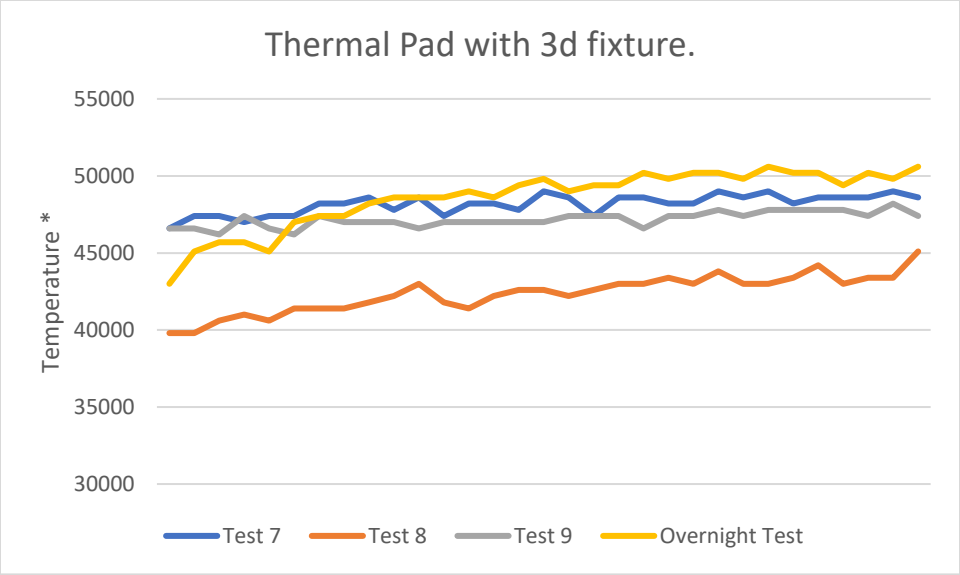


Figure 7: Trend of temperature over time for Thermal Pad heat sink.

Each test was a 15-minute test.



Tests 7, 8 and 9 were 20-minute tests

The overnight test was for about 17 hours.

Observations –

1. The default heat sink – Copper sheet is very ineffective as it raises up to 81 degrees Celsius and hence an alternate is required.
2. The first tests for each experiment show slightly lower initial and equilibrium temperature, that's because it was the first test of the day on the system, when the system is completely cooled down.
3. Figure 6 compares the thermal equilibrium of each of the heat sink setups we have used. Thermal pad gives almost half the temperature as others.

Other Observations –

1. The CPU will start throttling its speed after a point. It keeps jumping from maximum frequency of 1500khz to the minimum frequency of 1000khz. This happens as it will try to reduce the temperature or shut down as a means of protection.
2. During longer tests (30 mins), the GDM fails to boot up when the power supply is reset. Will have to wait a minute or two before I supply power again so that the GDM boots up.
3. The thermal pad with the 3d fixture does get much warmer as compared to just using the thermal pad.

Conclusions –

1. The thermal pad gives us a very effective model of heat sink to bring the temperature down from 80000 to 50000 as compared to previous models.