Thermal testing of MaticBox 5 and Raspberry Pi 5

Following up on our testing done with MaticBox 4 and the Raspberry Pi4 we have made thermal tests with the new MaticBox 5 and Raspberry Pi5.

If you would like to read about the thermal testing of the Pi4 please read here:
https://leapmatic.com/which-is-the-most-efficient-fan-for-raspberry-pi-4/

When the Raspberry Pi5 was released, we naturally wanted to continue the line of MaticBoxes to include compatibility with it. Since the beginning, we understood that the Pi5 will be a powerhouse that has greater power and thermal requirements than the Pi4. Also at the time of release we saw that there will be an official Raspberry Pi5 Fan solution. It looked very adequate and well-designed so we decided to modify the design of the MaticBox 5 to include support for it.

This redesign meant that we will no longer have a fan mount for standard fans to be mounted above the CPU. On Figure 1, you can see the MaticBox 4 with the installed fan above the CPU, and on Figure 2, you can see the MaticBox 5 with the original fan mounted in the box.

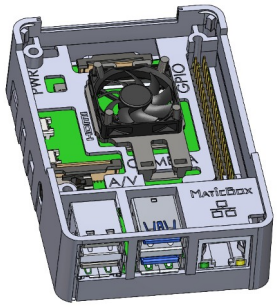


Fig.1 MaticBox 4 with mounted fan.

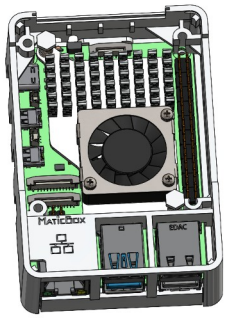
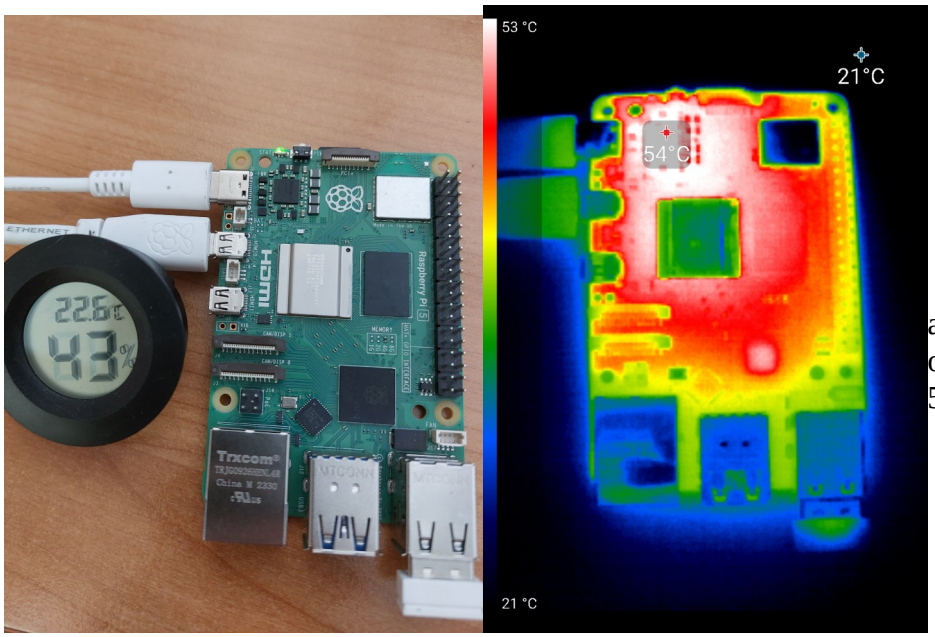


Fig. 2 MaticBox 5 with mounted original fan

In the following testing, we will evaluate the following scenarios and test conditions:
Ambient temperature: 22-23 degrees Celsius
Humidity: 42-43%
Power supply: Original Raspberry power supply

Tests:
1. Bare Raspberry Pi 5 without any additional fans or radiators.
2. Raspberry Pi 5 inside MaticBox5 without any additional fans or radiators.
3. Bare Raspberry Pi 5 with 2 passive radiators on CPU.
4. Raspberry Pi 5 inside MaticBox5 with 2 passive radiators on CPU.
5.Bare Raspberry Pi 5 with original fan solution.
6.Raspberry Pi 5 inside MaticBox5 with original fan solution.
7.Raspberry Pi 5 inside MaticBox5 with original fan solution and stacked between working Pi 4 and MB4 underneath and MB3 and Pi3 on top.

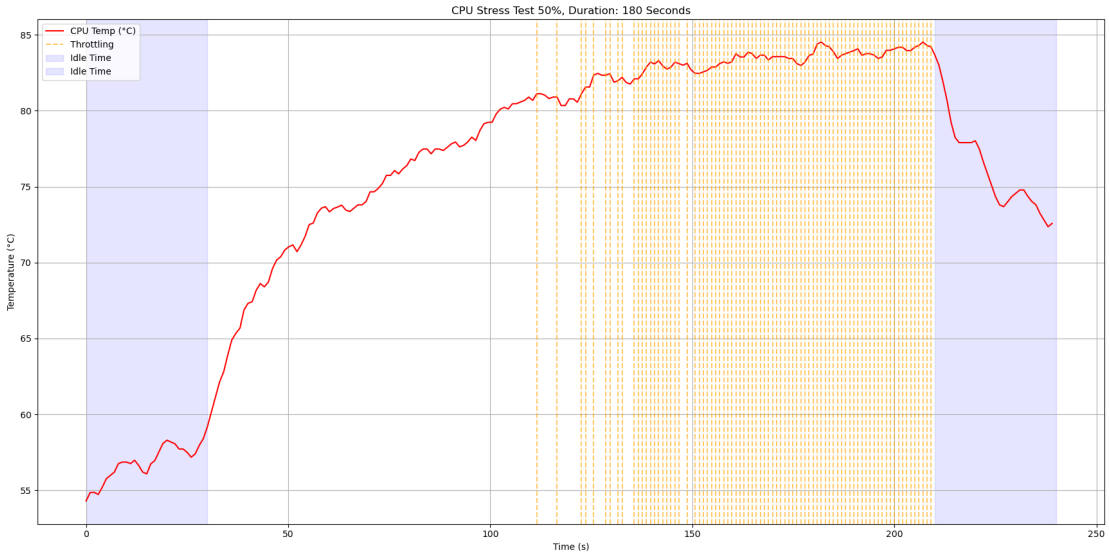
Test 1: Bare Raspberry Pi 5 without any additional fans or radiators.



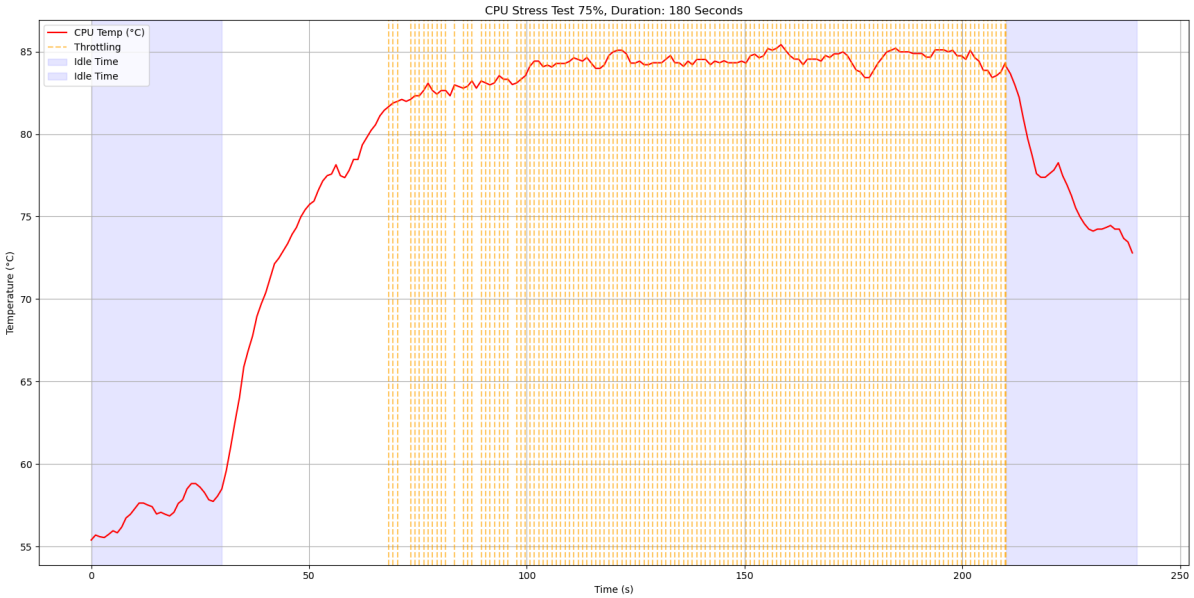
As you can see from the thermal imaging, the idle temperature of the CPU is around 50–55 degrees.

Hot-spots can be seen around the Power supply area of the PCB in the range of 50–55 degrees as well.

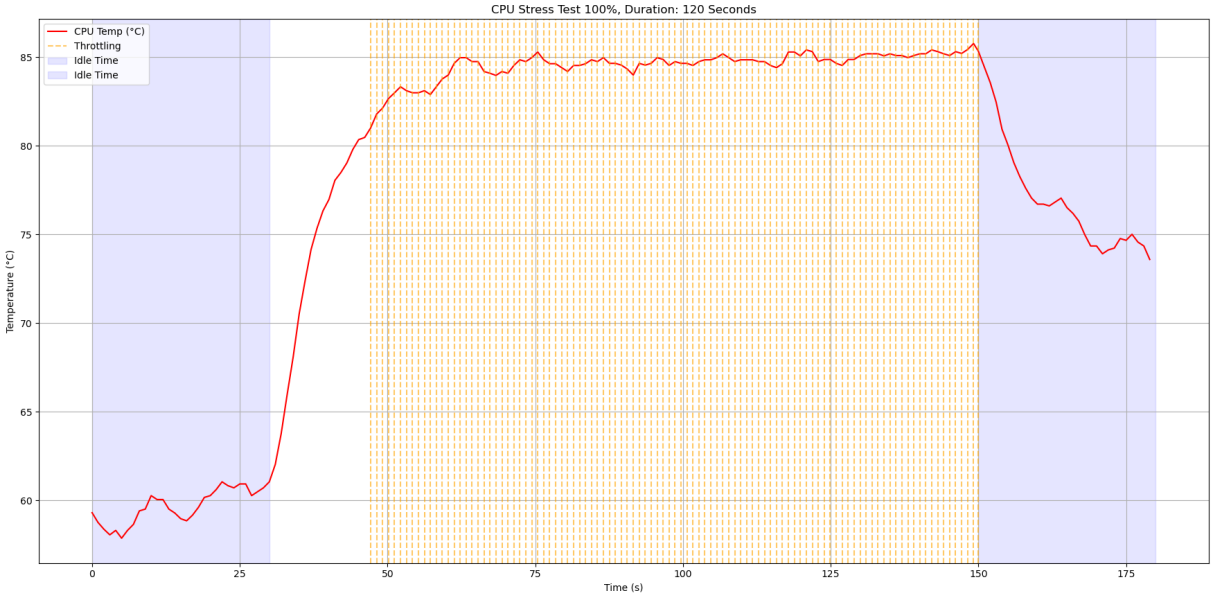
- Tests with 50% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 90 seconds of 50% load before the CPU starts to thermal throttle, as seen by the orange vertical lines.



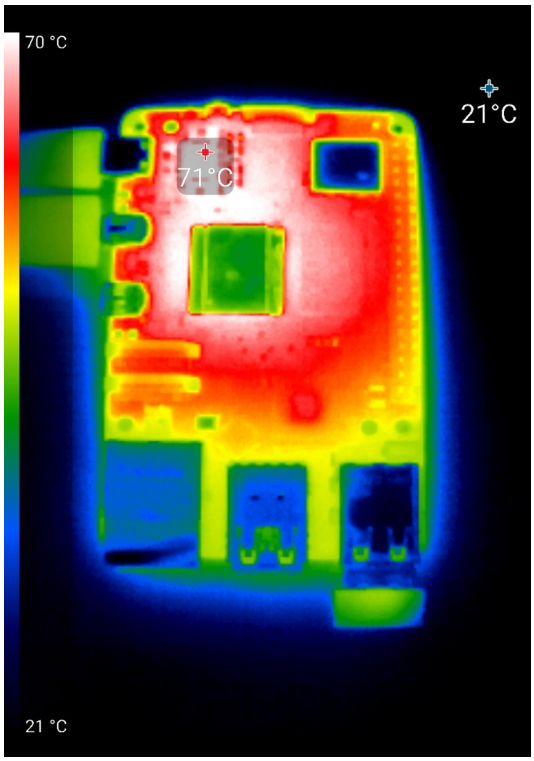
- Tests with 75% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 45 seconds of 75% load before the CPU starts to thermal throttle, as seen by the orange vertical lines.



- Tests with 100% CPU load for 120 seconds—30 seconds idle time before load and 30 seconds idle time after load.On the graph, you can see that it takes around 20 seconds of 100% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is the reason this test is shorter than the others, as there is no point in thermal stressing the CPU more.



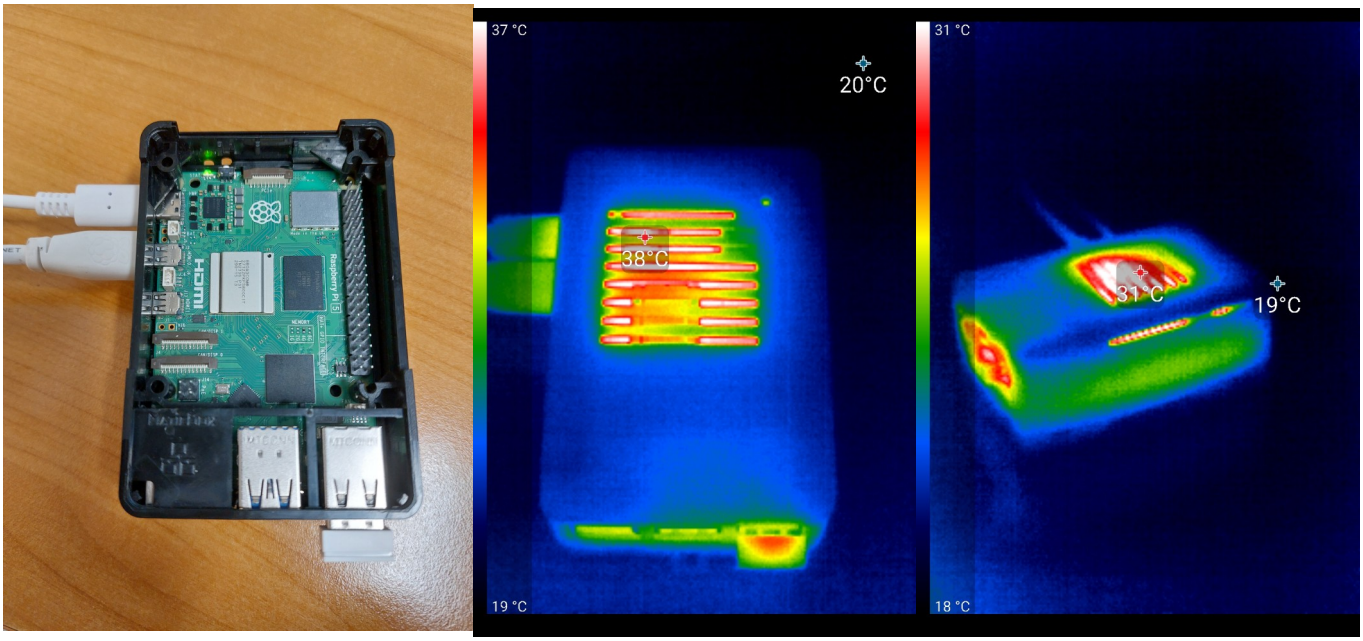
Conclusions from a bare Raspberry Pi 5 with no fan or radiator



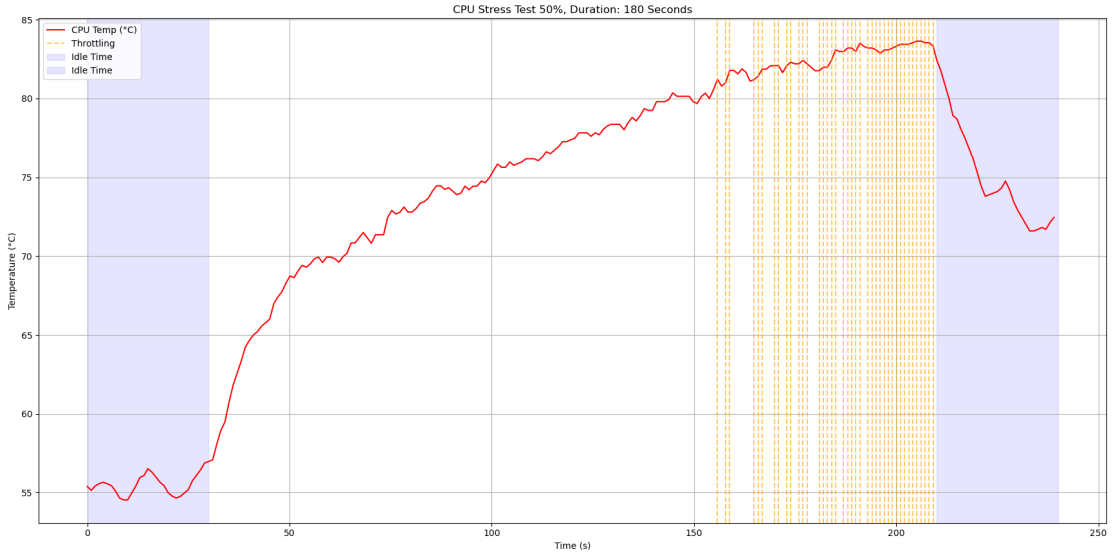
From the thermal imaging at the end of the tests, it is visible that the temperature of the PCB around the CPU and power supply area has drastically increased to around 70 degrees Celsius.

From the tests done with the bare Raspberry Pi 5 without any radiator or fan, we can conclude that it is not adequate to use it in such a use case as it puts unnecessary thermal stress on the power supply area of the PCB and CPU components.

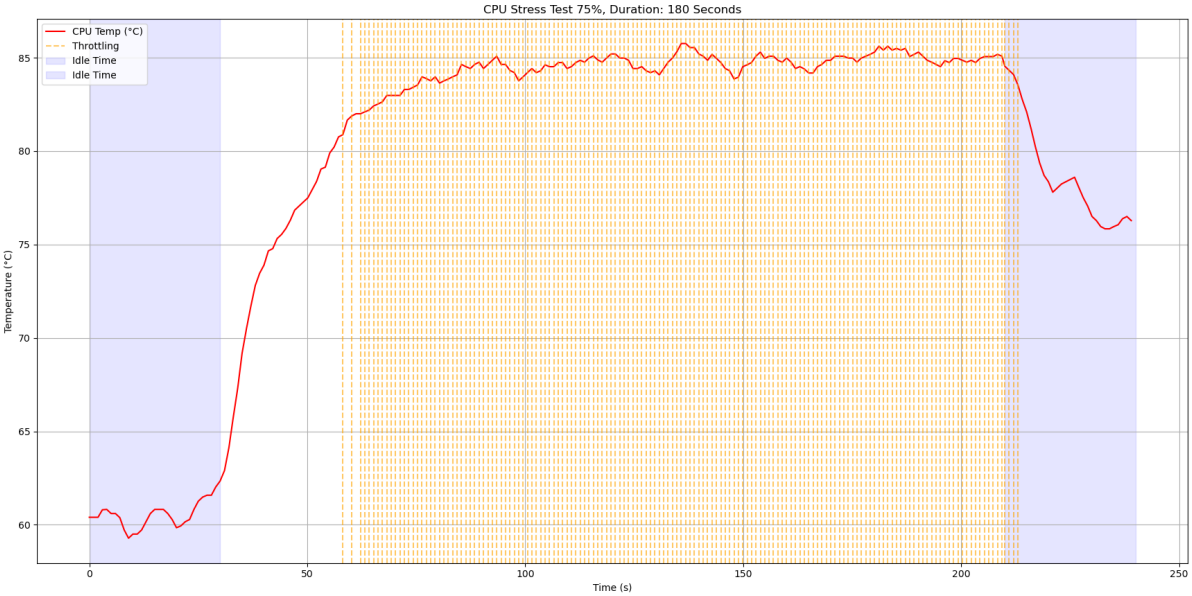
Test 2: Raspberry Pi 5 inside MaticBox5 without any additional fans or radiators.



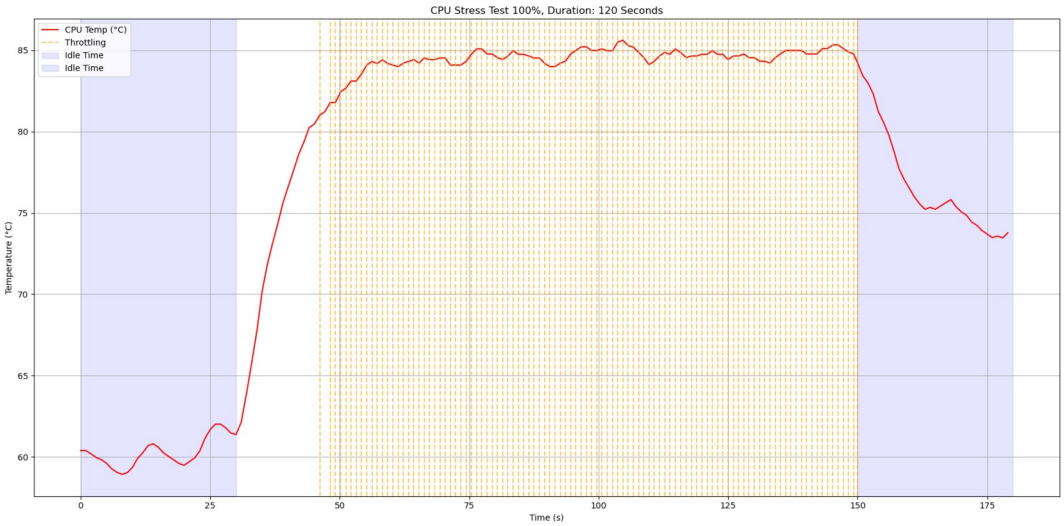
- Tests with 50% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load.On the graph, you can see that it takes around 120 seconds of 50% load before the CPU starts to thermal throttle, as seen by the orange vertical lines.



- Tests with 75% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 35 seconds of 75% load before the CPU starts to thermal throttle, as seen by the orange vertical lines.

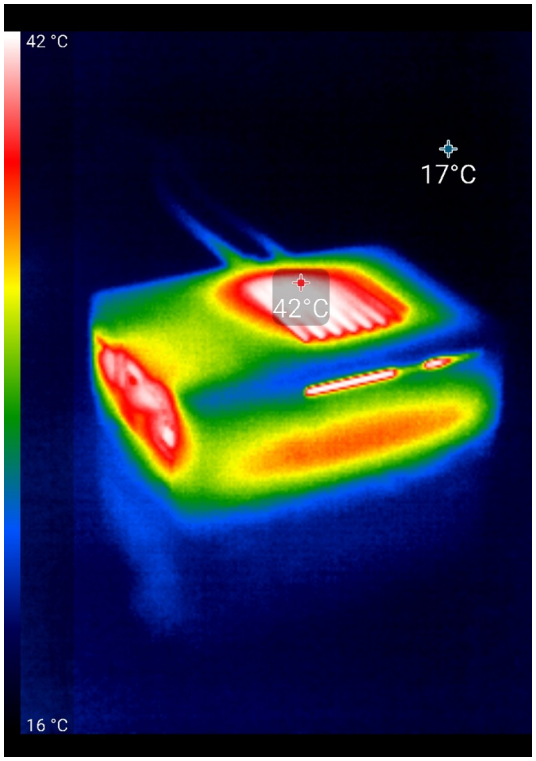


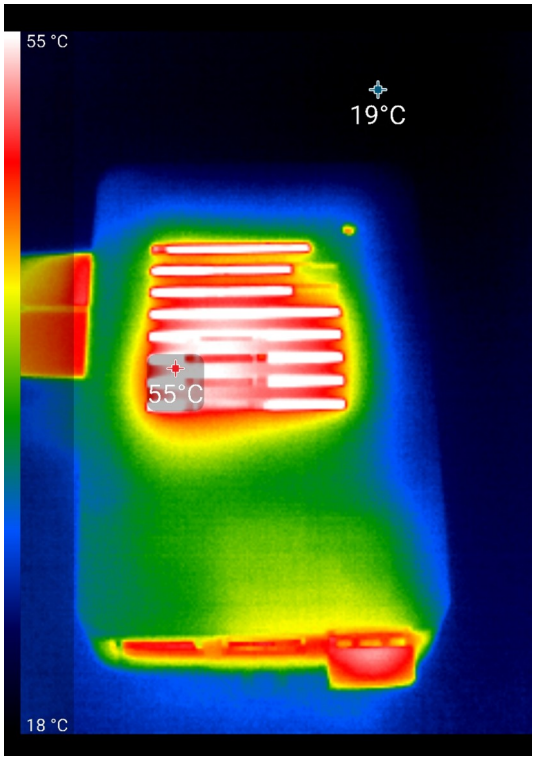
- Tests with 100% CPU load for 120 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 20 seconds of 100% load before the CPU starts to thermal throttle, as seen by the orange vertical lines.This is the reason this test is shorter than the others, as there is no point in thermal stressing the CPU more.



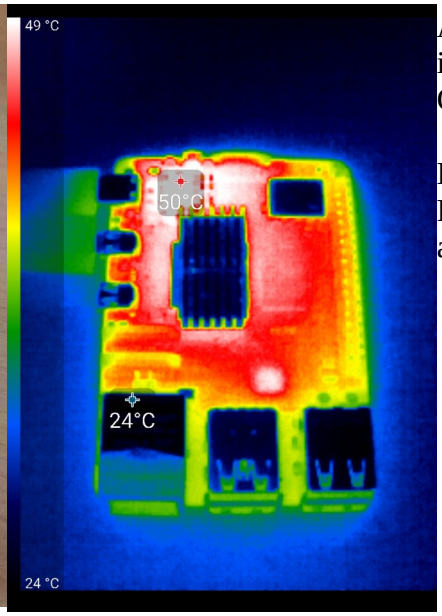
Conclusions from bare Raspberry Pi 5 with no fan or radiator inside MaticBox 5

From the thermal imaging at the end of the tests, it is visible that the temperature of the PCB around the CPU and power supply area has drastically increased to around 70 degrees Celsius. ***However, the use of MaticBox 5 does not negatively affect the cooling in this instance.***





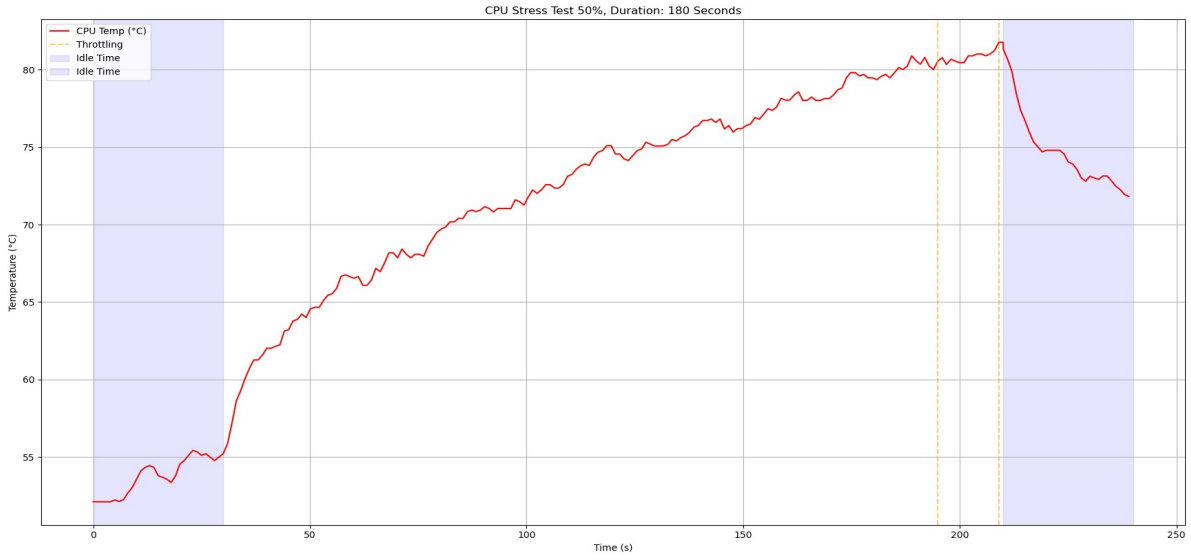
Test 3: Bare Raspberry Pi 5 with 2 passive radiators on CPU.



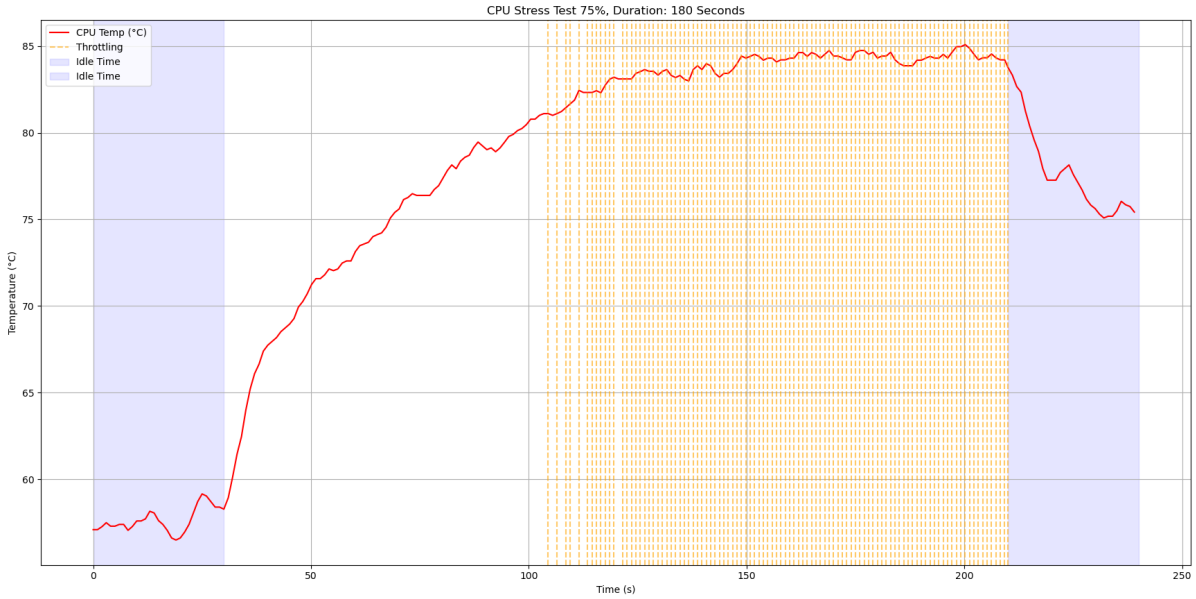
As you can see from the thermal imaging, the idle temperature of the CPU is around 45–50 degrees.

Hot spots can be seen around the Power supply area of the PCB at around 50 degrees as well.

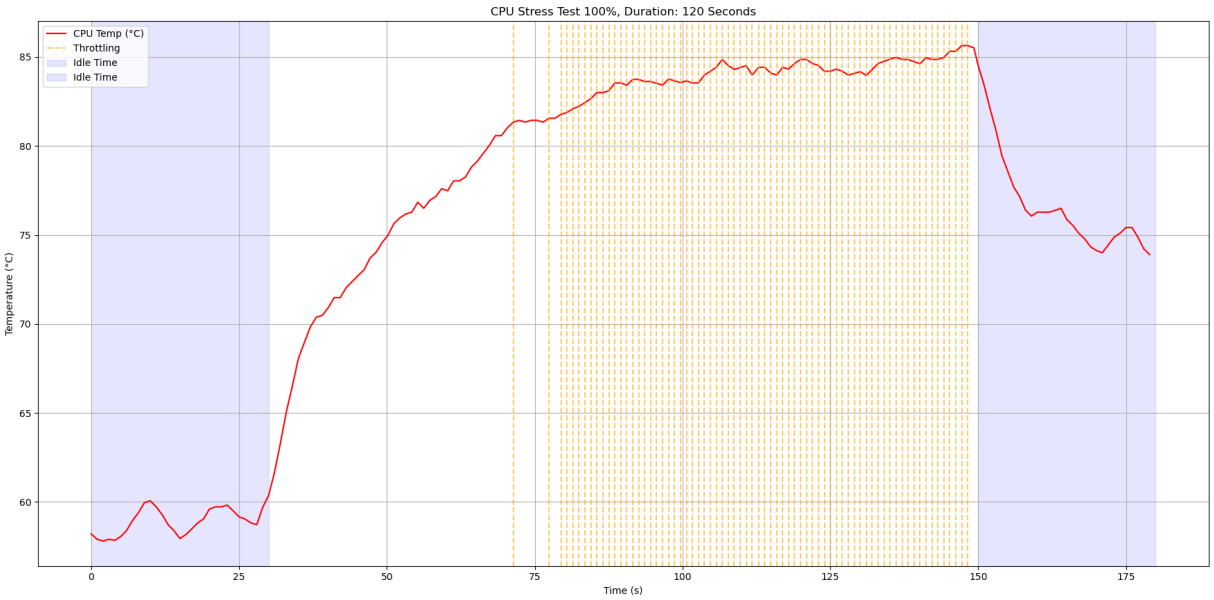
- Tests with 50% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 170 seconds of 50% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is much more time than the CPU with no cooling. This is due to the increased thermal mass of the CPU and radiators and the improved heat dissipation.

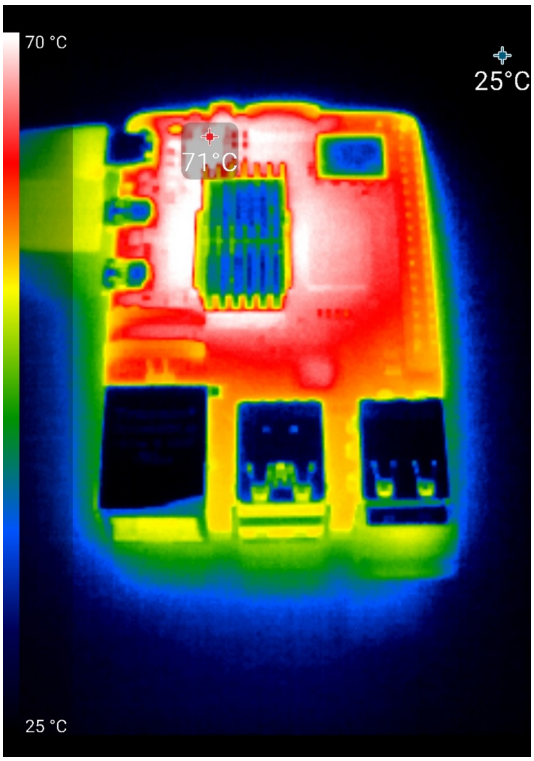


Tests with 75% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 70 seconds of 75% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is much more time than the CPU with no cooling. This is due to the increased thermal mass of the CPU and radiators and the improved heat dissipation.



- Tests with 100% CPU load for 120 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 45 seconds of 100% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is much more time than the CPU with no cooling. This is due to the increased thermal mass of the CPU and radiators and the improved heat dissipation.

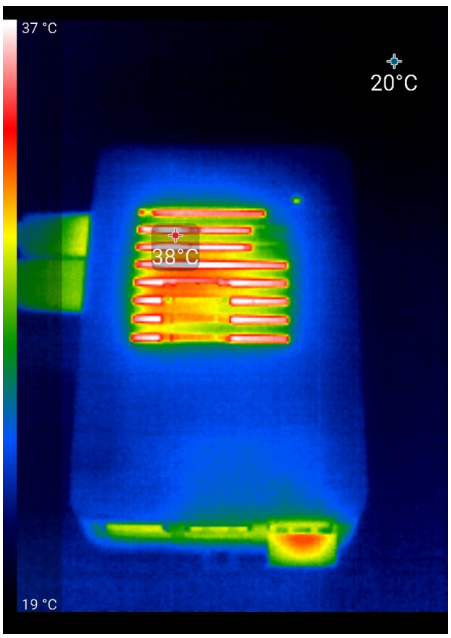




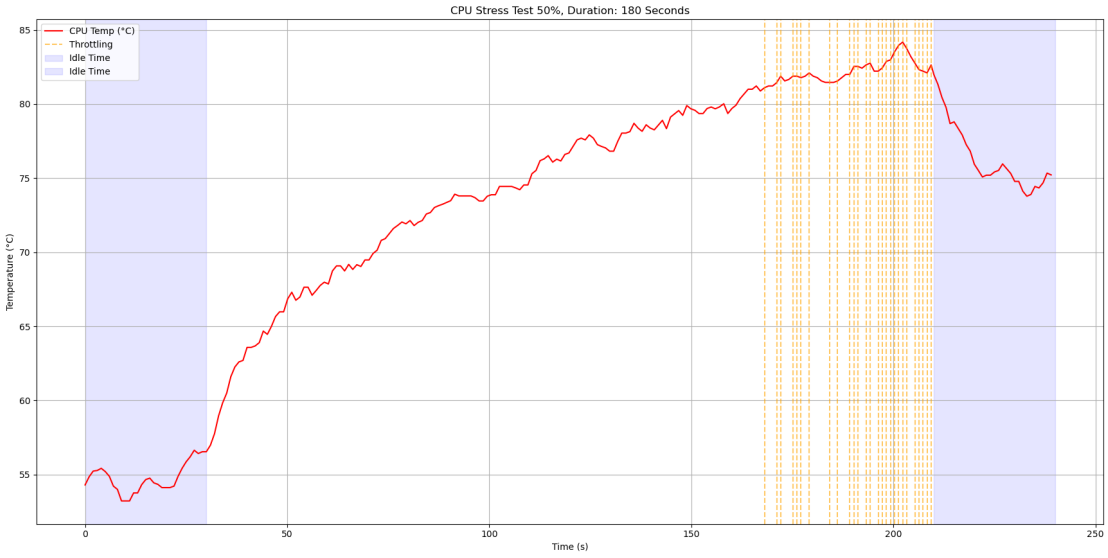
Conclusions from test with Raspberry Pi 5 with 2 passive radiators on CPU

From the thermal imaging at the end of the tests, it is visible that the temperature of the PCB around the CPU and power supply area has increased to around 70 degrees Celsius. The added Radiators provide an increased thermal mass of the CPU and better heat dissipation, but the area of the PCB where the power supply is still remains hot.

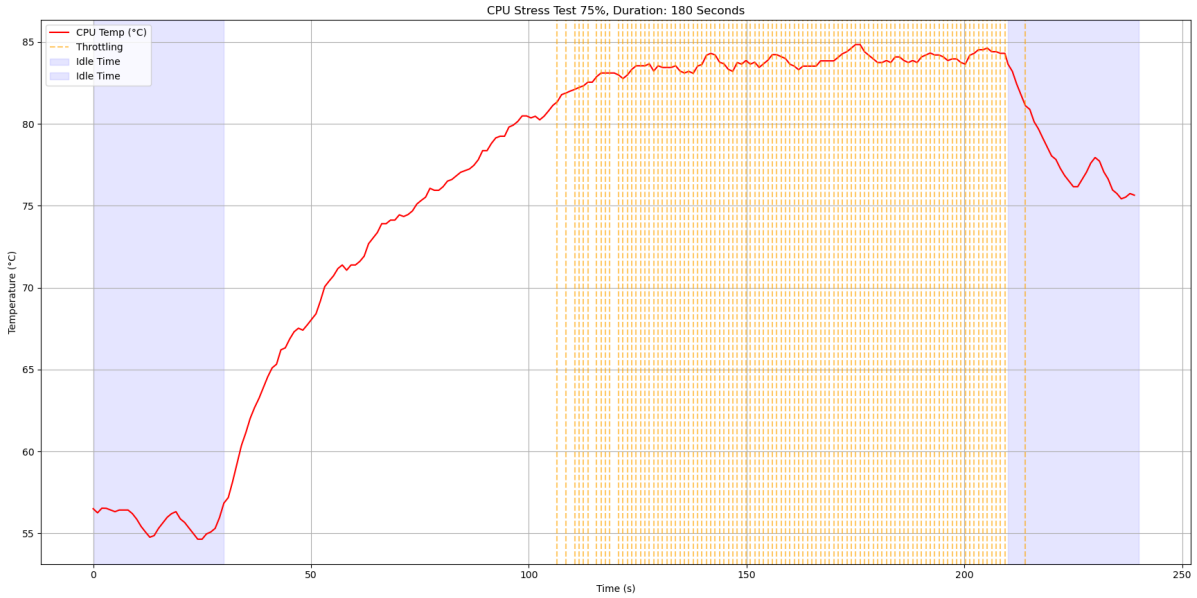
Test 4: Raspberry Pi 5 inside MaticBox5 with 2 passive radiators on CPU.



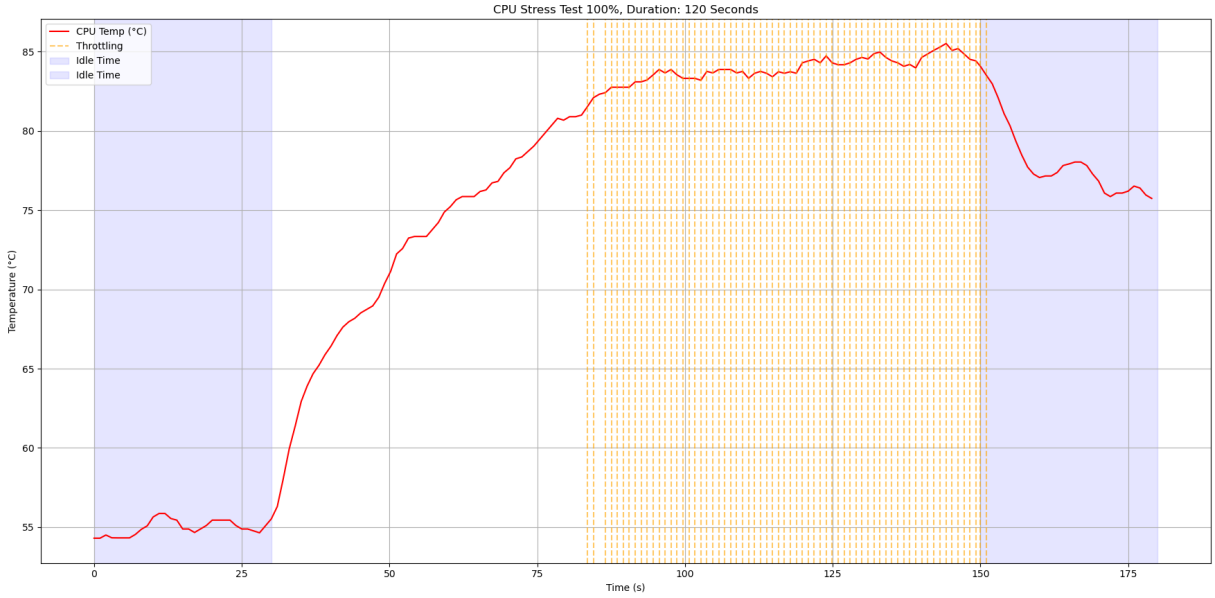
- Tests with 50% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 130 seconds of 50% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is much more time than the CPU with no cooling. This is due to the increased thermal mass of the CPU and radiators and the improved heat dissipation.



- Tests with 75% CPU load for 180 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that it takes around 70 seconds of 75% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is much more time than the CPU with no cooling. This is due to the increased thermal mass of the CPU and radiators and the improved heat dissipation.

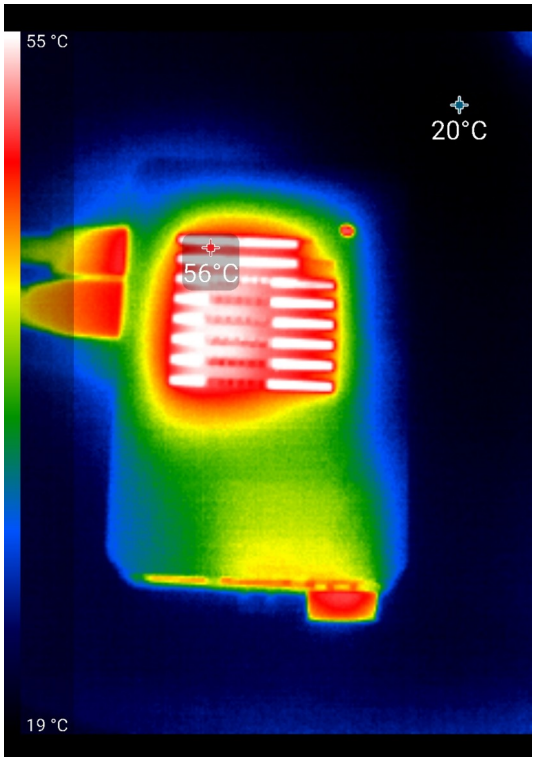


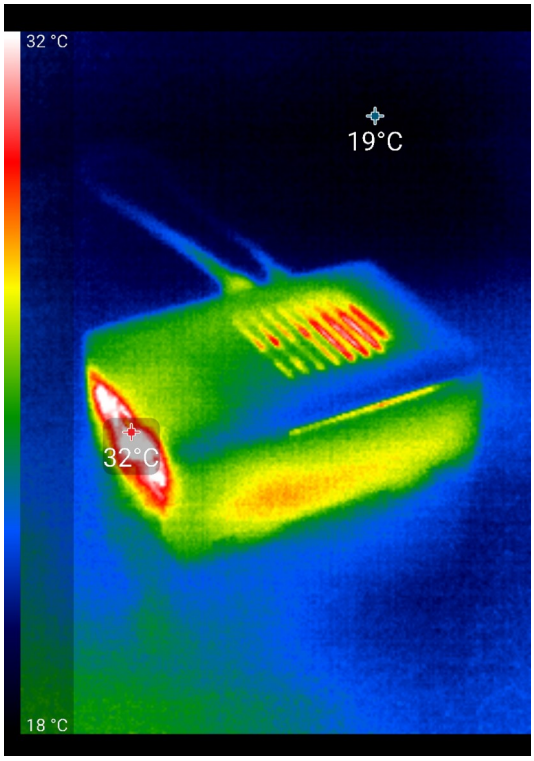
- Tests with 100% CPU load for 120 seconds – 30 seconds idle time before load and 30 seconds idle time after load.On the graph, you can see that it takes around 50 seconds of 100% load before the CPU starts to thermal throttle, as seen by the orange vertical lines. This is much more time than the CPU with no cooling. This is due to the increased thermal mass of the CPU and radiators and the improved heat dissipation.



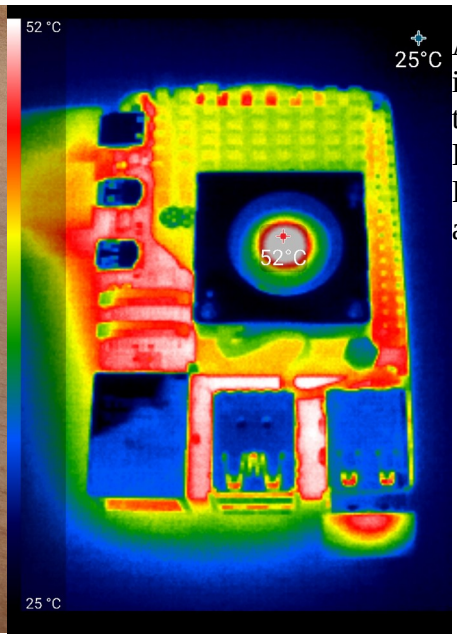
Conclusions from test with Raspberry Pi 5 inside MaticBox 5 with passive radiators on CPU

From the thermal imaging at the end of the tests, it is visible that the temperature of the PCB around theCPU and power supply area has increased to around 70 degrees Celsius. The added Radiators provide an increased thermal mass of the CPU and better heat dissipation, but the area of the PCB where the power supply is still remains hot. ***As seen from the graphs, MaticBox 5 does not negatively impact cooling performance.***From the tests done with the Raspberry Pi 5 with two passive radiators, we can conclude that it is a viable solution when the Pi 5 is used in not constantly CPU-intensive tasks such as automation. Still, there remains a thermal load on the PCB power supply area.



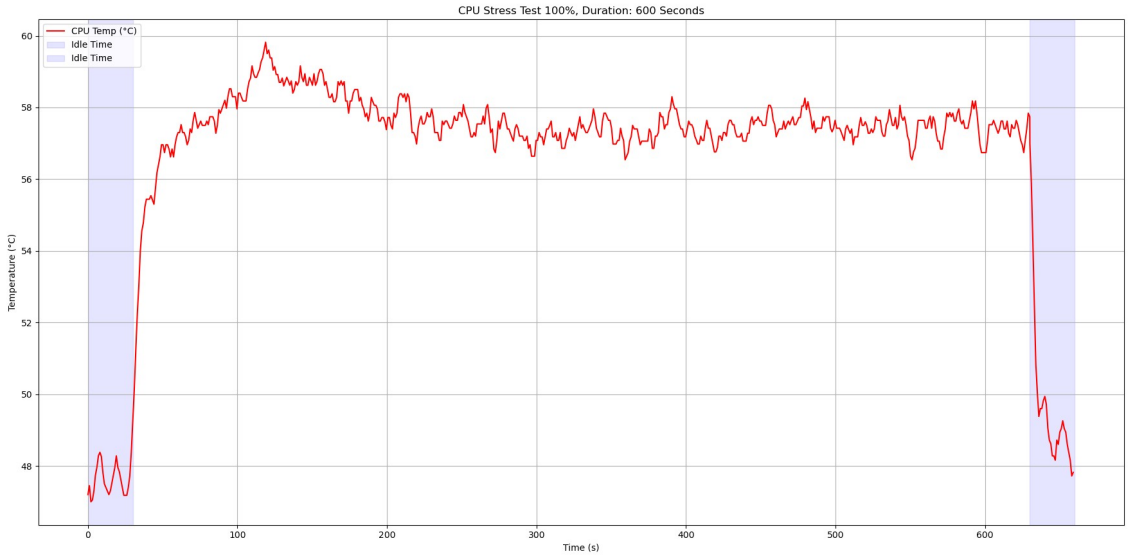


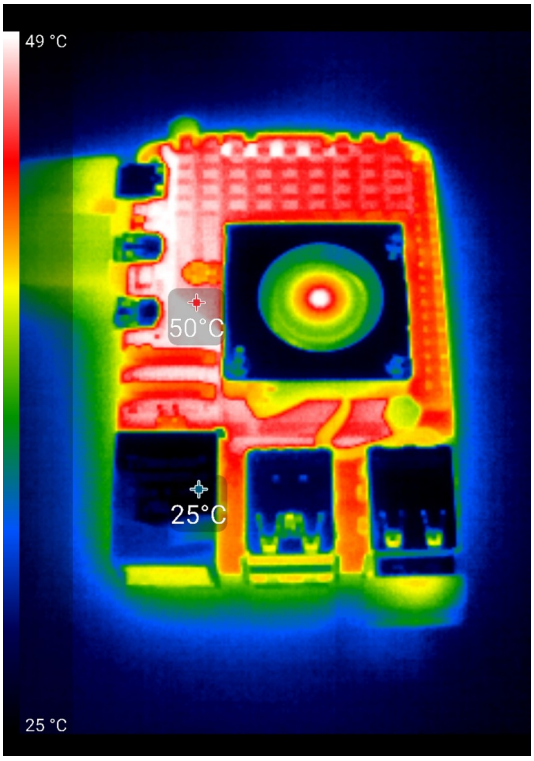
Test 5: Bare Raspberry Pi 5 with original fan solution.



As you can see from the thermal imaging, the idle temperature of the CPU is around 45 degrees. Hot spots can be seen around the Power supply area of the PCB at around 50 degrees as well.

- Tests with 100% CPU load for 600 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that the CPU never goes over 60 degrees Celsius, which is far from the thermal throttling temperature of 80–85 degrees. This is evidence that the Original solution for the Raspberry Pi5 cooler is very adequately sized and is a very nice and affordable solution to cool your Raspberry Pi 5



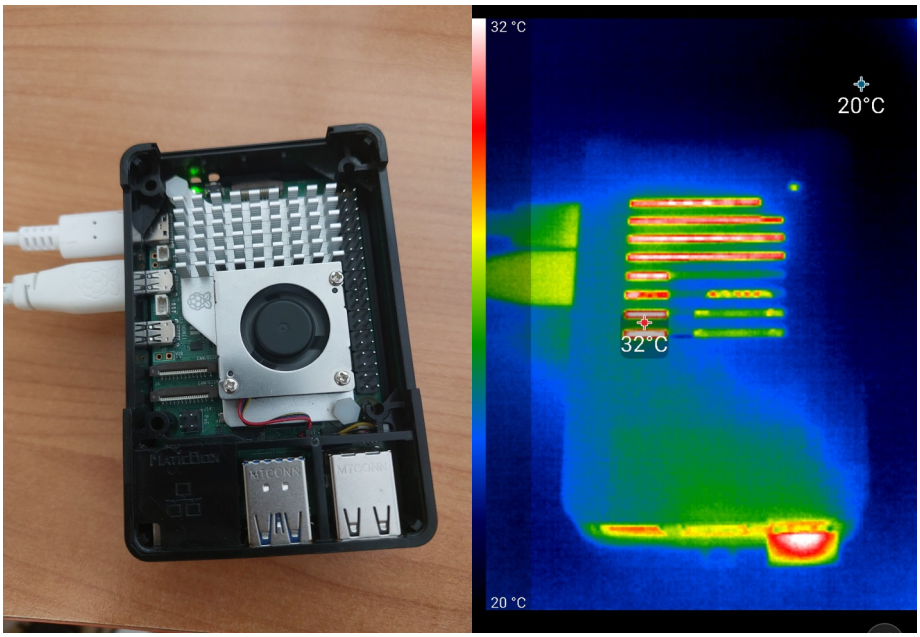


Conclusions from test with Raspberry Pi 5 with Original Pi5 Fan

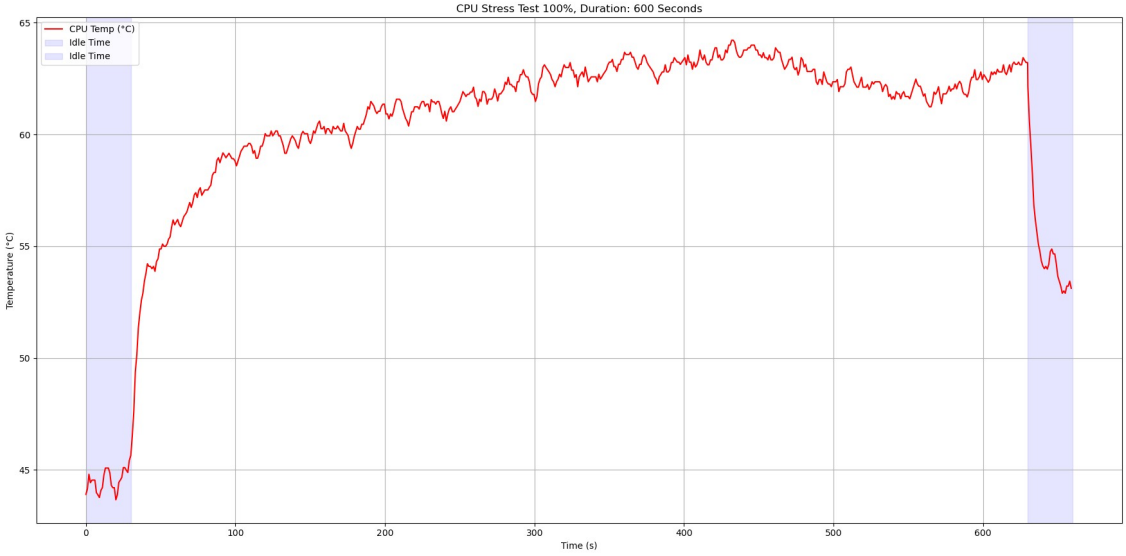
From the thermal imaging at the end of the tests, it is visible that the temperature of the PCB around the CPU and power supply area has increased to around 50 degrees Celsius. The added original fan provides very large cooling capacity. The area of the PCB where the power supply is located is also cooled by the installed fan and radiator combination, and therefore is much less thermally stressed than previously tested solutions.

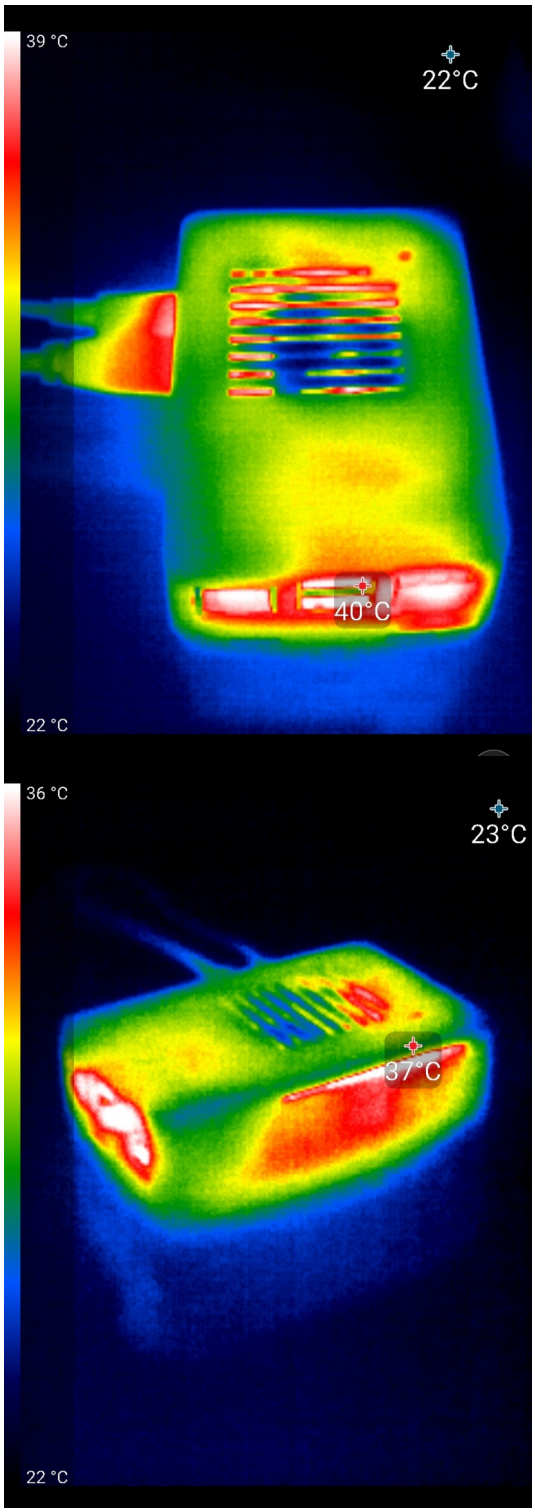
From the tests done with the Raspberry Pi 5 with the original fan, we can conclude that it is a very well-thought-out cooling solution that is adequately sized for the application. ***Also, the price point of it makes it a very affordable option and is also the reason why MaticBox 5 was designed to use this exact cooling solution out of the box.***

Test 6: Raspberry Pi 5 inside MaticBox5 with original fan solution.



- Tests with 100% CPU load for 600 seconds—30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that the CPU never goes over 65 degrees Celsius, which is far from the thermal throttling temperature of 80–85 degrees. This is evidence that the Original solution for the Raspberry Pi5 cooler is very adequately sized and is a very nice and affordable solution to cool your Raspberry Pi 5



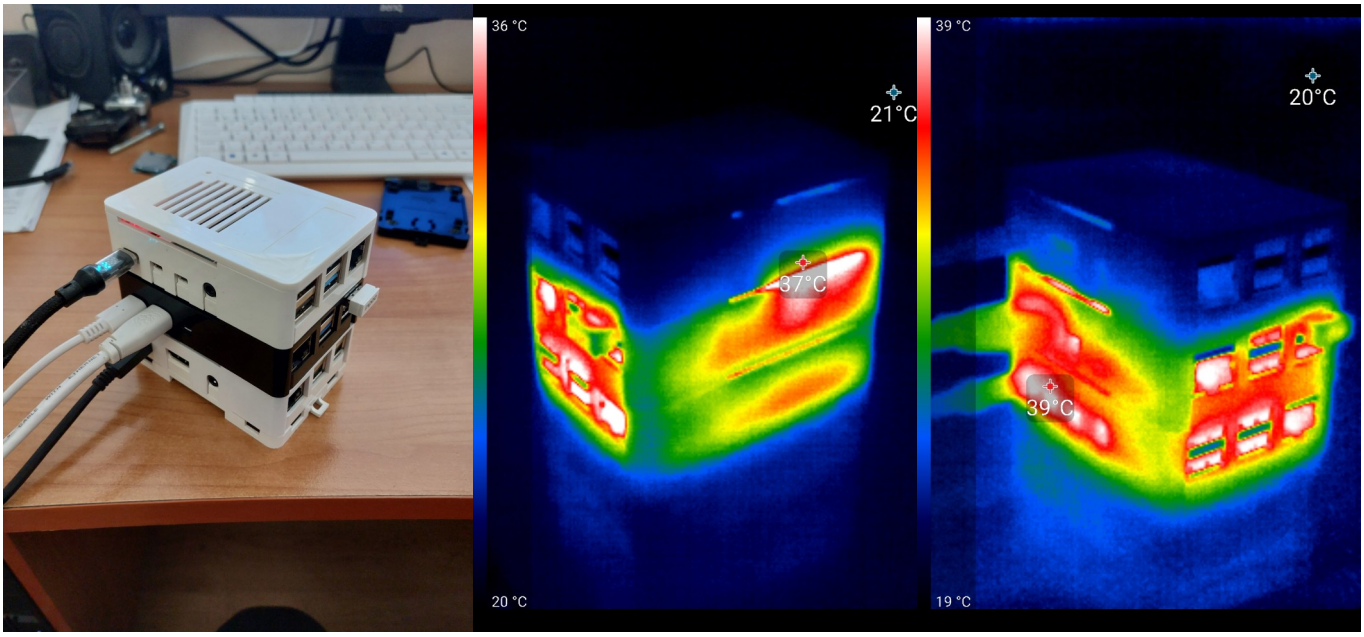


Conclusions from test with Raspberry Pi 5 inside MaticBox 5 with Original Pi5 Fan

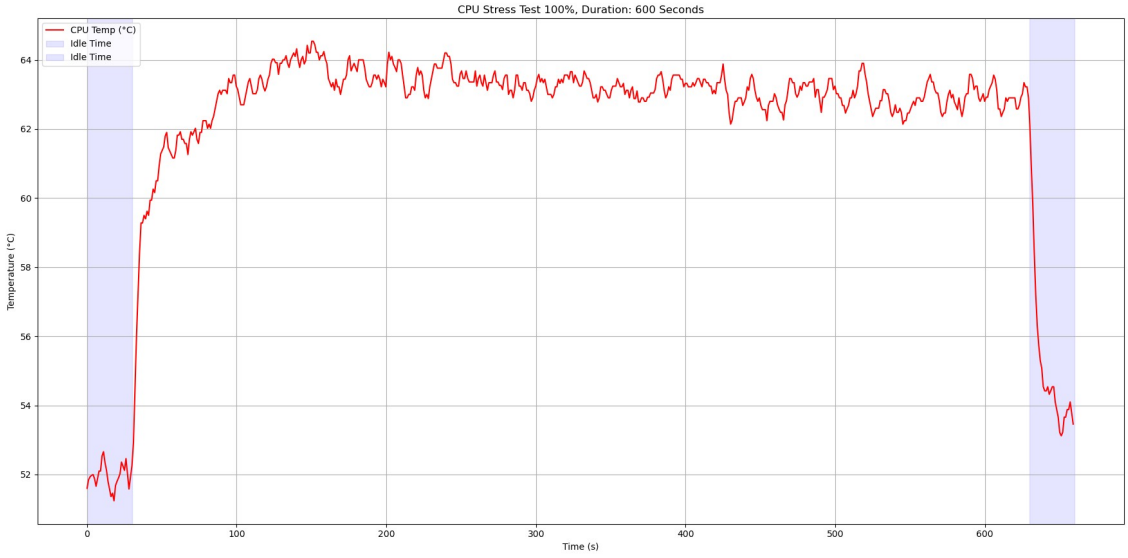
From the thermal imaging at the end of the tests it is visible that the temperature of the PCB around the CPU and power supply area has increased to around 50 degrees Celsius. The added original fan provides very large cooling capacity. The area of the PCB where the power supply is located is also cooled by the installed fan and radiator combination and therefore is much less thermally stressed than previously tested solutions. ***MaticBox 5 affects the CPU temperature by an increase of 5 degrees Celsius, which is far from the thermal throttling range of 80-85 degrees Celsius.***

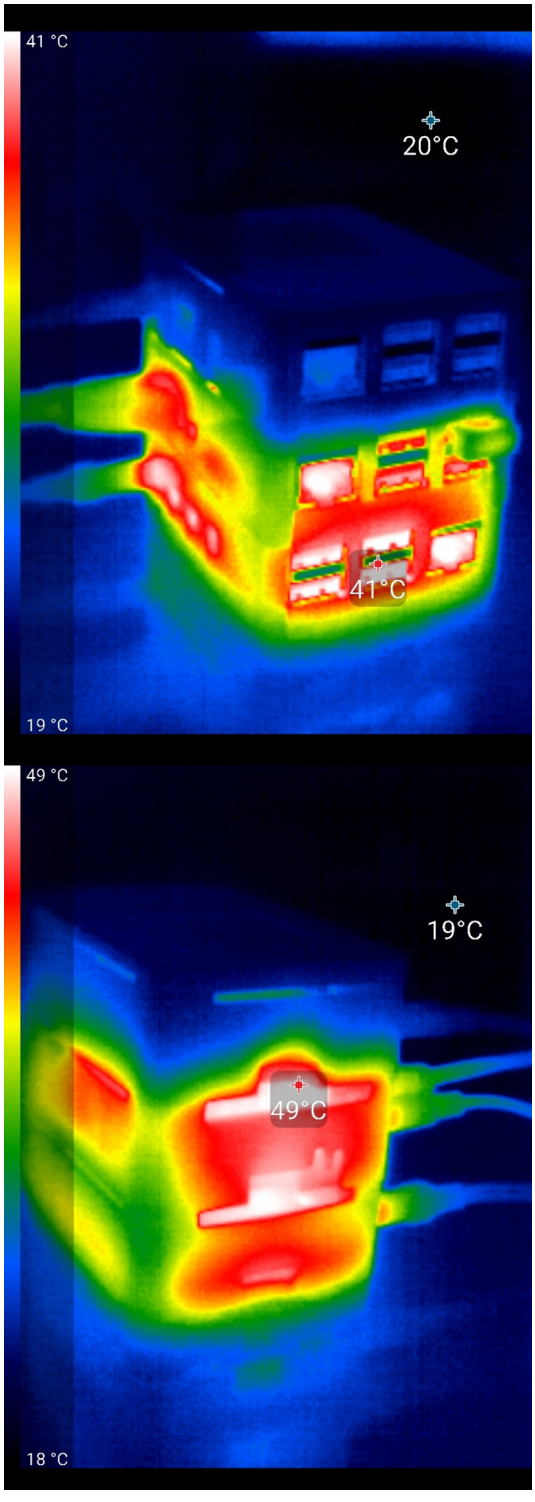
From the tests done with the Raspberry Pi 5 with the original fan, we can conclude that it is a very well-thought-out cooling solution that is adequately sized for the application. Also, the price point of it makes it a very affordable option and is also the reason why MaticBox 5 was designed to use this exact cooling solution out of the box.

Test 7: Raspberry Pi 5 inside MaticBox5 with original fan solution and stacked between working Pi 4 and MB4 underneath and MB3 and Pi3 on top.



- Tests with 100% CPU load for 600 seconds – 30 seconds idle time before load and 30 seconds idle time after load. On the graph, you can see that the CPU never goes over 65 degrees Celsius, which is far from the thermal throttling temperature of 80–85 degrees. This is evidence that the Original solution for the Raspberry Pi5 cooler is very adequately sized and is a very nice and affordable solution to cool your Raspberry Pi 5.





Conclusions from test with Raspberry Pi 5 inside MaticBox 5 with Original Pi5 Fan and stacked between working Pi 4 and MB4 underneath and MB3 and Pi3 on top.

From the thermal imaging at the end of the tests, it is visible that the temperature of the PCB around the CPU and power supply area has increased to around 50 degrees Celsius. Even when stacked, there are enough cooling holes to provide adequate air circulation and therefore adequate cooling of the Stack.

From the tests done with the Raspberry Pi 5 and this configuration, we can conclude that it is in fact a good solution for compute stacks, and users can confidently use MaticBox with the original Pi fan to provide enough cooling for their Pi even in the toughest conditions.