ochin_CM4v2 Hardware test number 5

Power Supply circuits:

Stress test and overheat

Devices used for tests

1. ochin CM4v2 carrier board
2. Raspberry Pi CM4 module with eMMC
3. Power Supply 0-30Vdc
4. JST GHR-06V-S with AWG28 cables
5. DL24 electronic load

Test voltage : 2~200V

Working current: 0.2~20A

DL24 Discharge power: voltage*current < 180 W

Pico Scope 3000

4 analog channels
MSO models with 16 digital channels
200 MHz analog bandwidth
Up to 512 MS capture memory
1 GS/s real-time sampling
100 000 waveforms per second
Built-in arbitrary waveform generator
USB 3.0 connected and powered

6. Thermal camera Fluke Ti9

Sensor: 160x120

Temperature range: -20..250°C

Three-dimensional resolution: 2.5mrad

Thermal sensitivity (NETD): <=2@30°C

Test description

This test has the purpose of measuring the temperature of the ochin_CM4 board and of the CM4 module, of the components subjected to electrical stress. The temperature is measured by means of a Fluke Ti9 thermal imager and its dedicated software, which allows you to perform measurements in specific areas of the acquired thermal images.

The components whose temperature was measured are the following:

- Ochin_CM4 board
  - U1 SIA471DJ - IC1 MAX20008
  - L1 1uH
  - IC4 AP22615AWU-7
  - the PCB itself in the areas where the + 5V passes
- CM4 module
  - CPU
  - Power supply
  - eMMC

- RAM
- BCM54210

The test lasts 4 hours during which the load increases every 20 minutes until the current reaches the value of 3700mA. In addition to the current absorbed by the load, there is also the current absorbed by the CM4 module in normal operating conditions (but not under stress) which was not measured.

To increase the load over time, the test involves the insertion of an electronic load (DL24) connected to the VBUS.

Test execution

To carry out this test, an electronic load was applied to the output of the switching regulator mounted on the ochin board, at the edges of the capacitor C2. The electronic load DL24 was used for this purpose.

To measure the temperature of the components subjected to electrical stress, a Fluke Ti9 thermal imaging camera was used. The images were sampled every 20 minutes, both on the top side of the ochin_CM4 board and on the top side of the Raspberry Pi CM4 module.

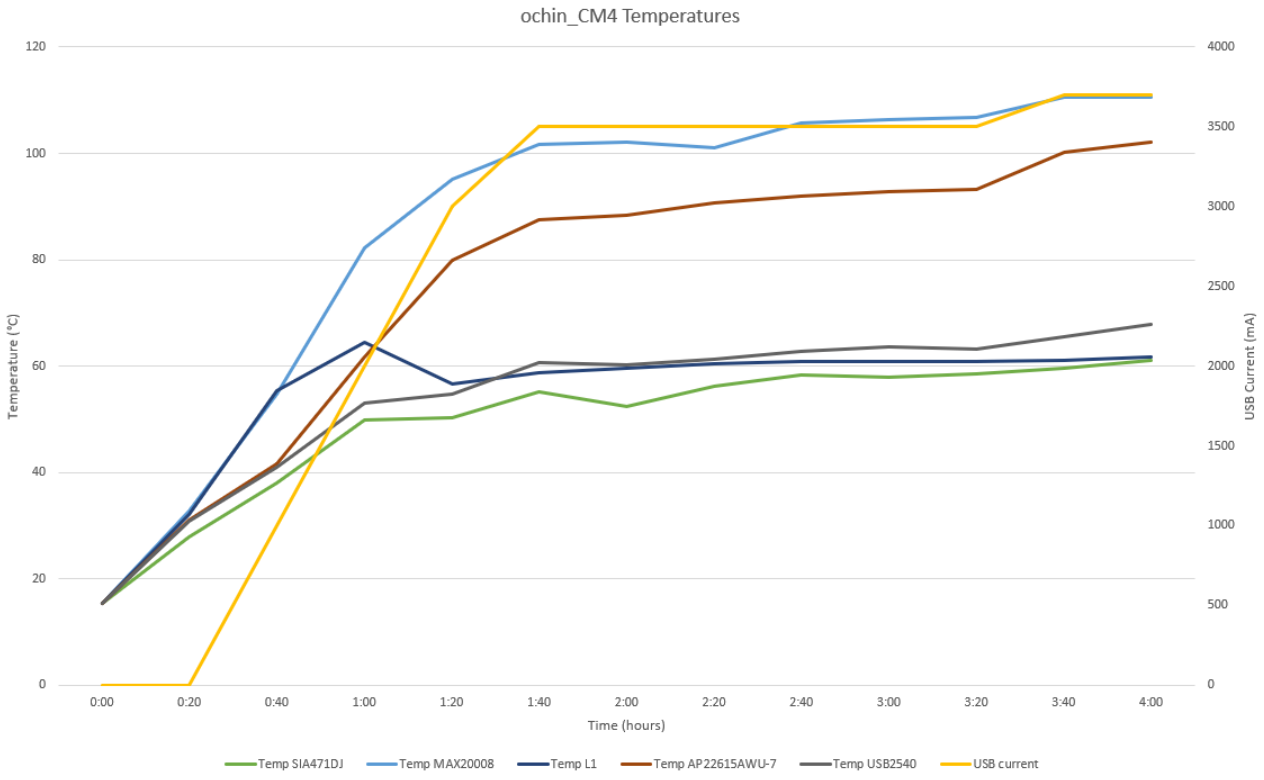
The images taken by the thermal camera were elaborated by the Fluke software called “Smart View”. By the means of this software was passible to measure the temperature of every component subjected to heat. The “component temperature” calculated by the software is the average of the temperatures measured by the camera sensor in the selected area.

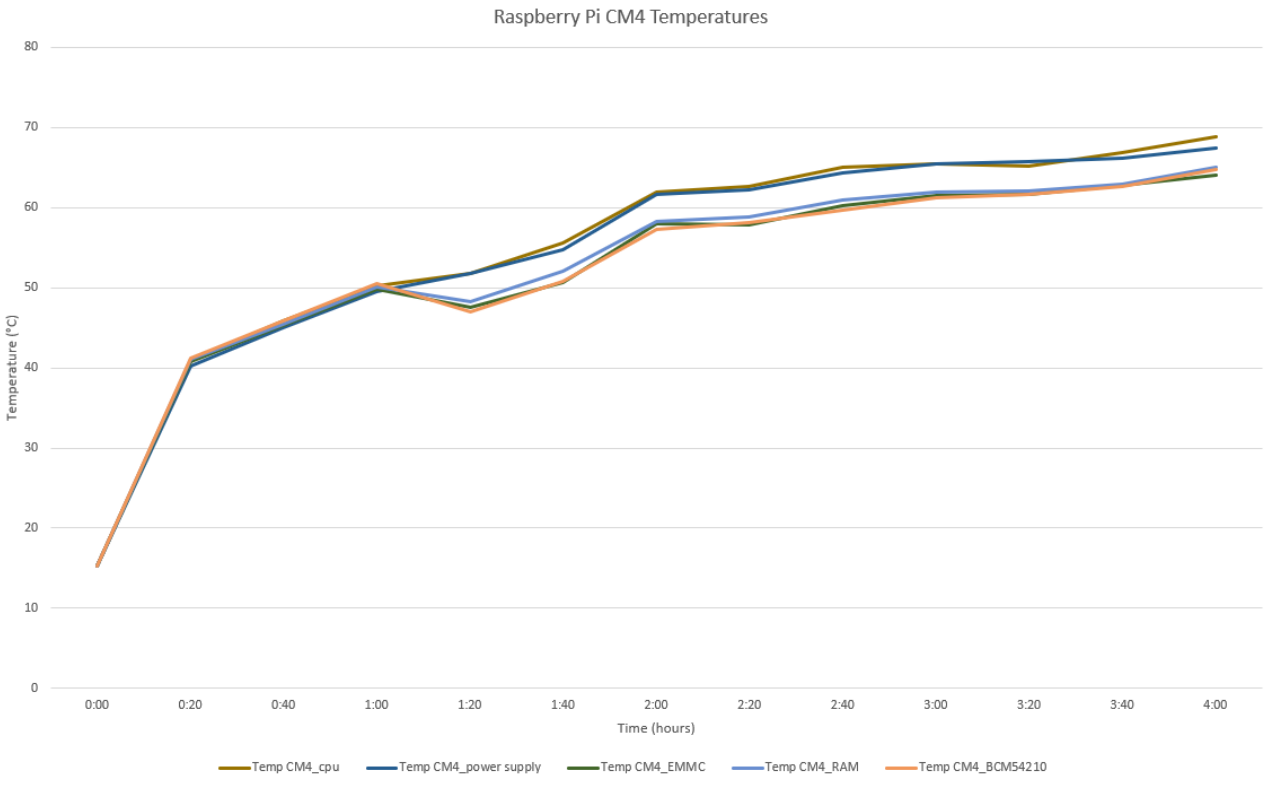
Test result

In the following plot is possible to see the temperature of the components over time where the yellow trace is the current being drawn by the electronic load connected to the .

To notice are the temperature of the switching regulator (MAX20008) and the current limiter (AP22615) which reach the highest values, over 100 °C.

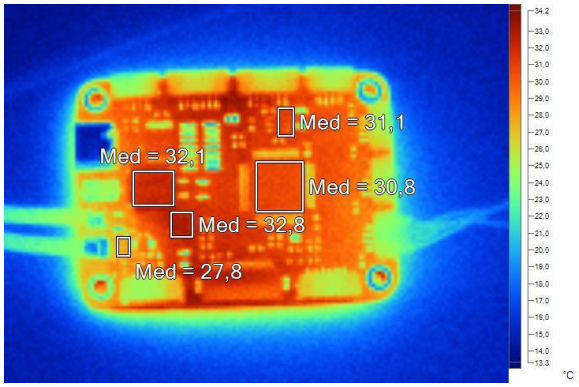
In the second plot is possible to see the temperature of some components mounted on the CM4 module.

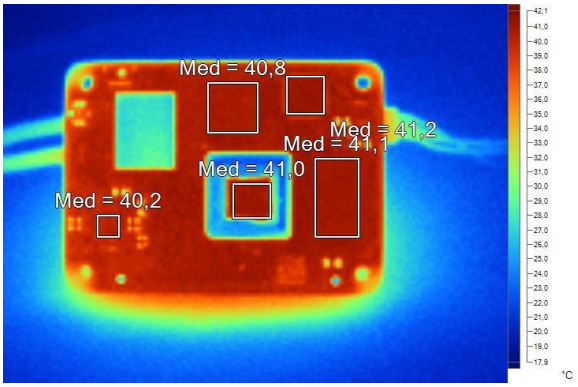

ochin_CM4 Temperatures
Temperature (°C)
USB Current (mA)
Time (hours)
Temp SIA471DJ
Temp MAX20008
Temp L1
Temp AP22615AWU-7
Temp USB2540
USB current


Raspberry Pi CM4 Temperatures
Temperature (°C)
Time (hours)
Temp CM4_cpu
Temp CM4_power supply
Temp CM4_EMMC
Temp CM4_RAM
Temp CM4_BCM54210

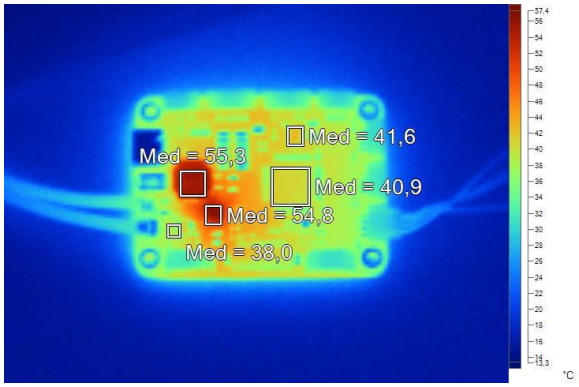
The next pictures are taken by Fluke Ti9 thermal camera, used to take the measurements for the plots. On the left there is the ochin_CM4 board and on the right the CM4 module.

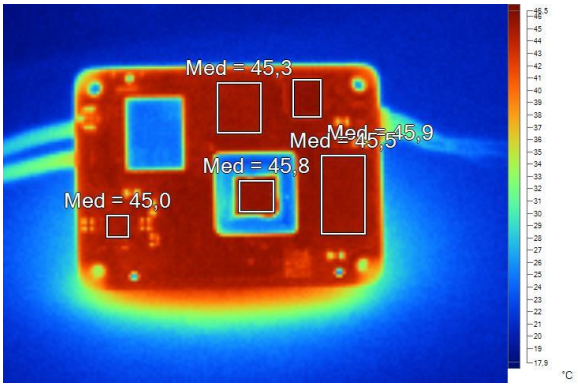
After 20min – USBcurr 0mA



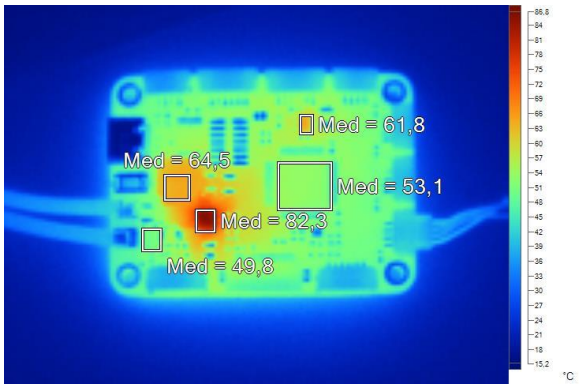


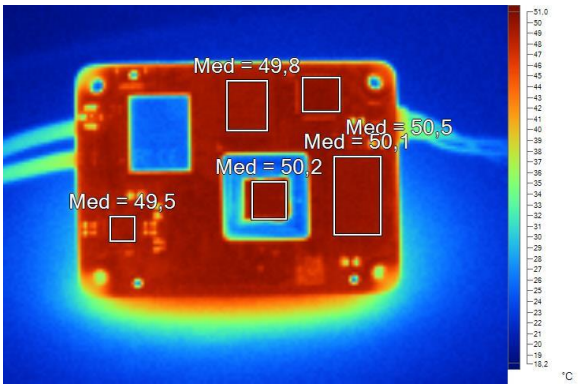
After 40min – USBcurr 1000mA



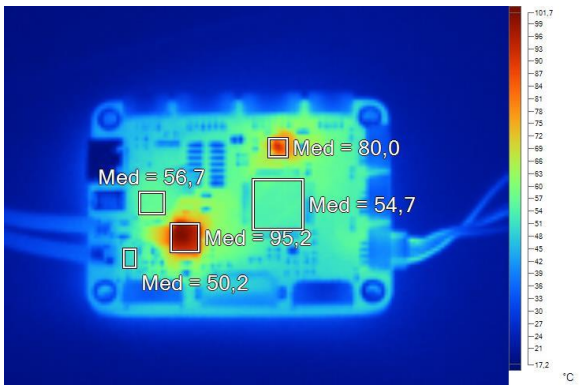


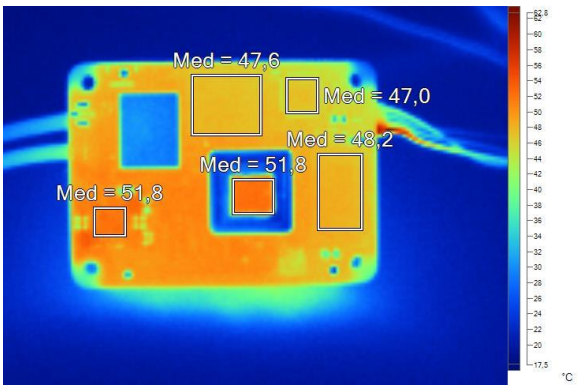
After 60min – USBcurr 2000mA



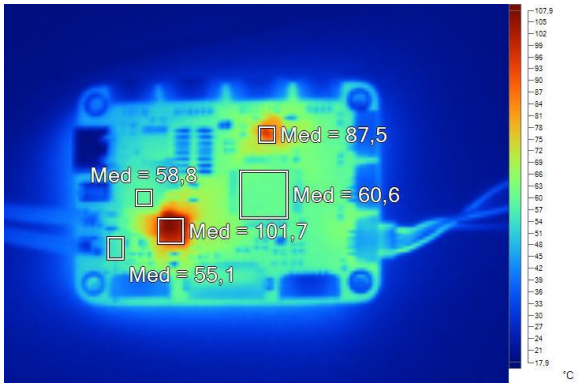


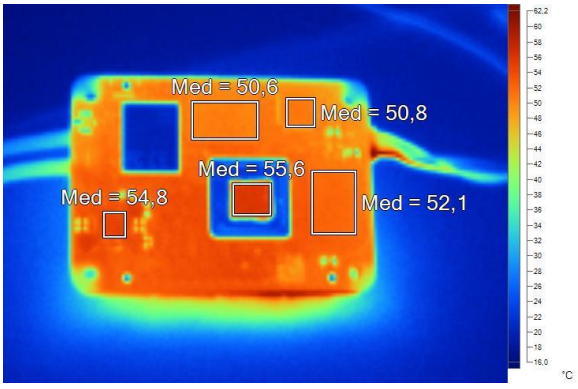
After 80min – USBcurr 3000mA



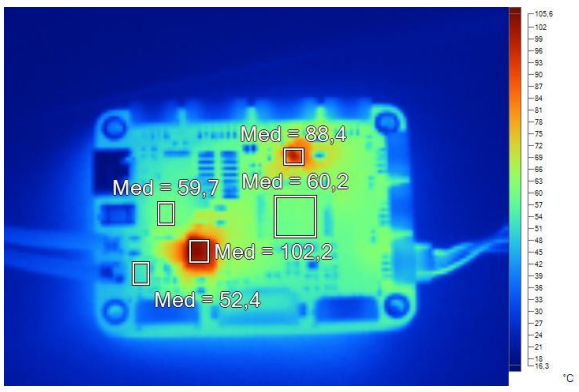


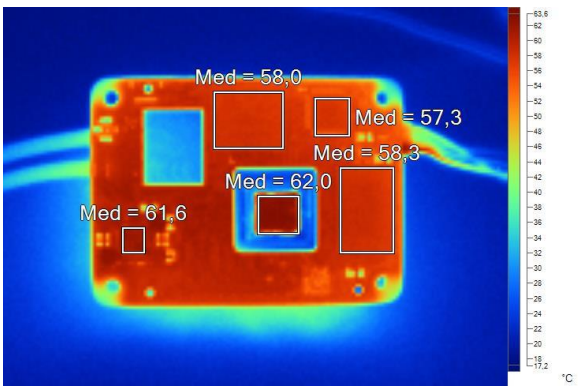
After 100min – USBcurr 3500mA



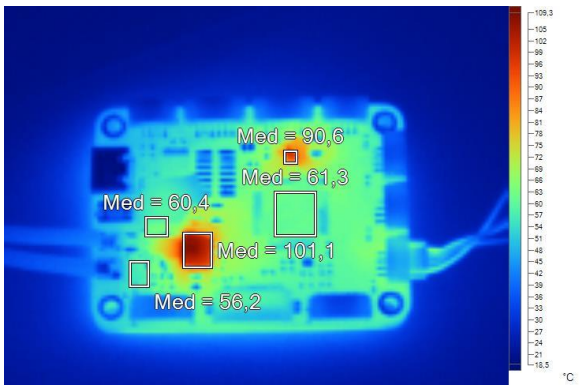


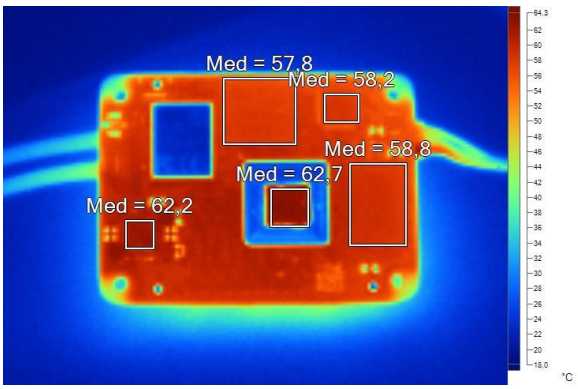
After 120min – USBcurr 3500mA



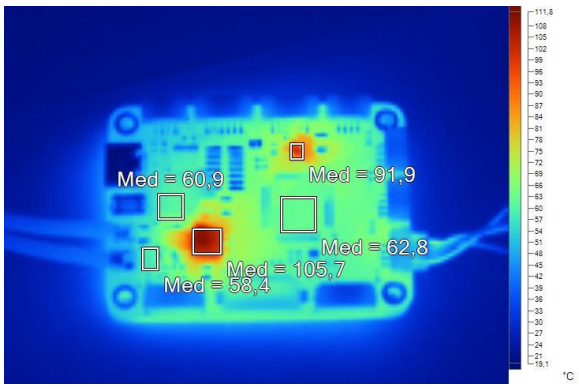


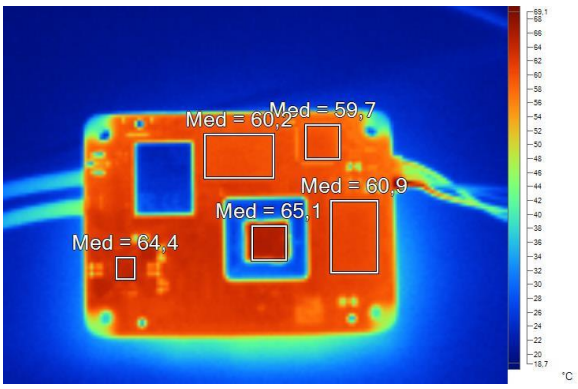
After 140min – USBcurr 3500mA



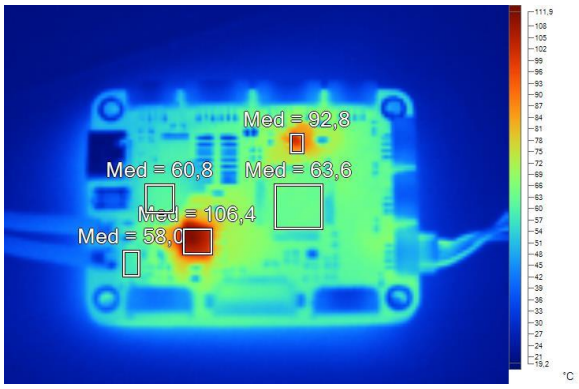


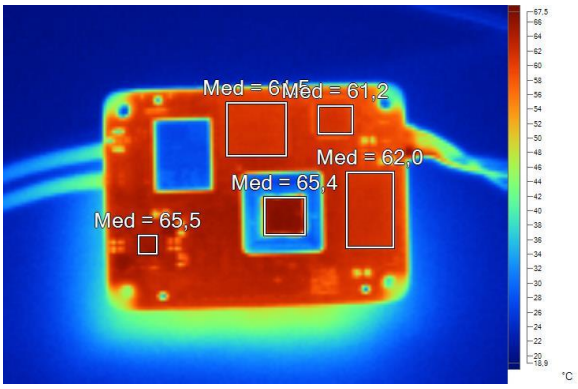
After 160min – USBcurr 3500mA



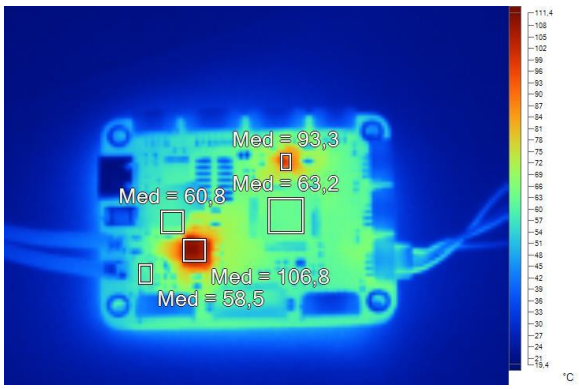


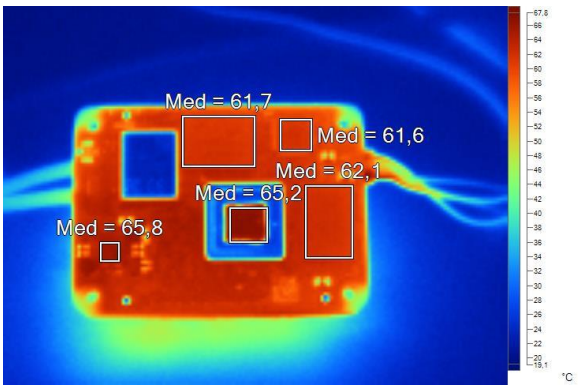
After 180min – USBcurr 3500mA



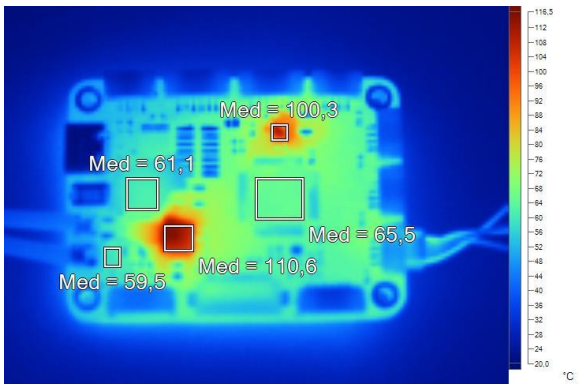


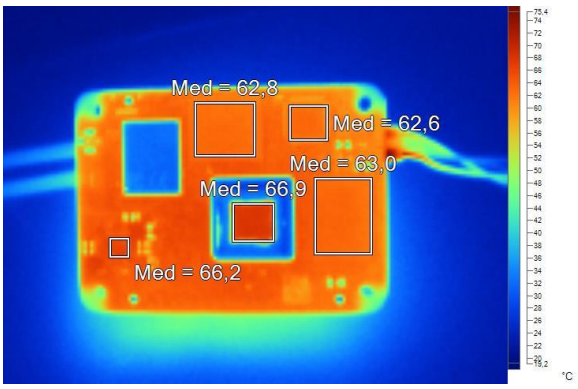
After 200min – USBcurr 3500mA



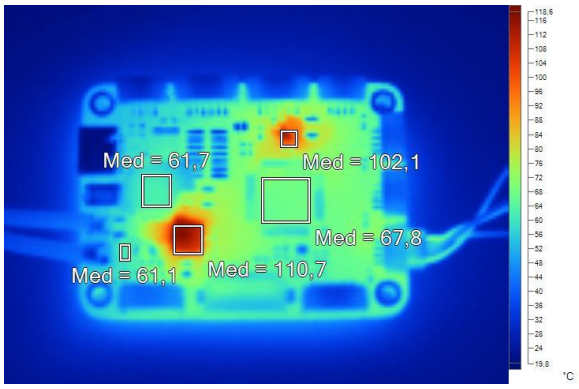


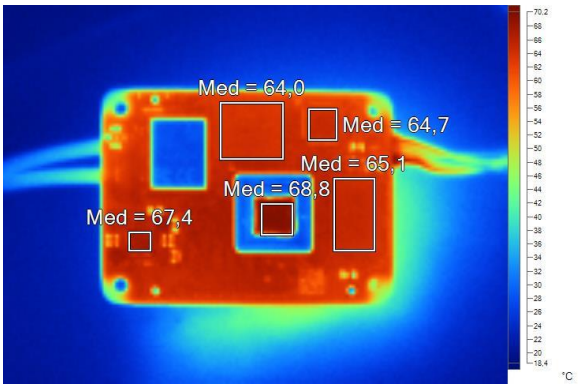
After 220min – USBcurr 3700mA





After 240min – USBcurr 3700mA





Both boards reached quite high temperatures. However, the long duration of the test and the non-negligible currents involved must be kept in mind. Furthermore, the test was carried out indoors, without air circulation and without the use of a heat sink.

In normal use it is certainly advisable to use at least one passive heat sink for the Raspberry Pi CM4 module.

If it's planned to drawn a lot of current from the ochin_CM4 board via the USB ports or side connectors, it is advisable to cool the MAX20008 and AP22615 as well.

Test Passed