Kria K24 SOM Thermal

Design Guide

UG1094 (v1.0) October 20, 2023

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Introduction

The objective of this document is to provide thermal design guidelines for designers of AMD Kria™ K24 SOM based products. The goal is to ensure that the temperature of all components in a system are maintained within their functional temperature range. Within this temperature range, a component is expected to meet its specified performance and lifetime. Operation outside the functional temperature range can degrade system performance, cause logic errors, or cause component and/or system damage. Temperatures exceeding the maximum operating limit of a component can result in irreversible changes in the operating characteristics of the component.

In a system-level environment, the AMD Zynq™ UltraScale+™ MPSoC temperature is a function of both the system and the individual component thermal characteristics. The system-level thermal constraints consist of the local ambient air temperature and airflow over the Zynq UltraScale+ MPSoC as well as the physical constraints at and above the Zynq UltraScale+ MPSoC. The Zynq UltraScale+ MPSoC temperature depends upon the on-board component power dissipation, the Zynq UltraScale+ MPSoC package thermal characteristics, and the system cooling solution.

All these parameters are affected by the increase in Zynq UltraScale+ MPSoC performance levels and packaging density (more transistors). With an increase in operating frequencies and decrease in package sizes, the power density increases while the thermal solution space and airflow typically become more constrained or remain the same. The system design becomes more important to ensure that thermal design requirements are met for each component including the Zynq UltraScale+ MPSoC in the system.

Requirements for Designers

- It is very important that you read and understand this guide before designing your system.
- The thermal solution on your system must provide adequate cooling to maintain all PCB components (including the K24 SOM) at or below the maximum temperature specifications as described in the K24 SOM Temperature section, using maximum thermal load and worst-case system conditions.
- You are responsible for qualifying the K24 SOM in your specific system design and for any issues arising from a failure to qualify your system-level product where the K24 SOM is a component of the overall design.

K24 SOM

Table 1: **K24 SOM Thermal Specifications**

K24 SOM	Operating Temperature	
K24C SOM	0°C to 85°C	
Metal enclosure (HSP-00098-01)	C grade	0°C to 70°C maximum

TIP: *The K24 is a production qualified SOM. For evaluation, the Kria KD240 Drives Starter Kit is available but is not intended for deployment. See Kria K24 SOM Data Sheet (DS985).*

The K24 SOM has a metal enclosure. This metal enclosure makes full contact with all the high-power active components, including the Zynq UltraScale+ MPSoC, LPDDR4 memory, eMMC, power management integrated circuit (PMIC), and power regulators. The primary function of the metal enclosure is to transfer the non-uniform heat distribution of the module that is generated on the PCB assembly to the metal enclosure, making the heat flux more uniform and spread over a larger surface area. This allows for more efficient heat transfer out of the package to an attached thermal device. Any external thermal solutions added to user-defined systems should be directly attached to the top surface of the metal enclosure to properly maintain the operating temperature maximums.

Figure 1: **K24 SOM**

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The metal enclosure has four M3 mounting holes on the corners to attach the appropriate thermal solution for your system. Further details are available in the *Kria SOM Carrier Card Design Guide* (UG1091). Your system thermal solution must provide adequate cooling to maintain all the components on the PCB, including the K24 SOM, below the maximum temperature specifications as detailed in Table 3: K24 SOM Component Thermal Specifications.

K24 SOM Temperature

The K24 SOM Zynq UltraScale+ MPSoC junction temperature (T_j) represents the die temperature read from either the PS or PL System Monitor sensors. The on-die thermal sensors are used for T_j management and many other temperature-dependent functions.

The on-die temperature sensors (System Monitor) of the Zynq UltraScale+ MPSoC on the K24 SOM are placed for a high accuracy measurement of the maximum junction temperature. To maintain the performance and reliability of the K24 SOM module, your design must be in compliance with the specifications in the following table.

Table 2: **K24 SOM Thermal Specifications**

Parameter	SOM	Junction Temperature (T_j)
Maximum K24 SOM operating temperature[1]	K24C SOM	85°C
	K24I SOM	100°C
K24 SOM critical temperature[2]	K24C SOM	90°C
	K24I SOM	105°C

Notes:

1. The K24 SOM maximum operating temperature is the temperature below which the product operates at the specified clock speeds.
2. The K24 SOM is considered damaged if it reaches or exceeds critical temperature. Maintain or shutdown the SOM prior to reaching this temperature.

Chapter 2

Thermal Design Guidance

This chapter provides design guidance for your system to work with the AMD Kria™ K24 SOM thermal specifications.

Thermal Information

The K24 SOM is not designed with a system thermal solution to dissipate the total module power (TMP) thermal load into the ambient environment. This is because every system has unique environmental, operating, and mechanical constraints. Your system design is required to have an adequate thermal solution to maintain all the component temperatures below the de-rated limits as specified in the following Total Thermal Module Power section.

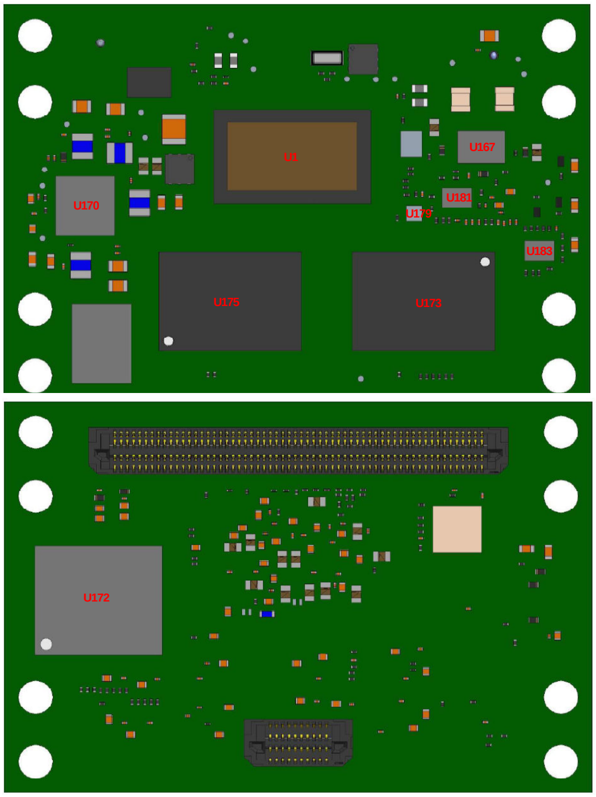
The K24 SOM thermal model enables you to simulate and design the appropriate thermo-mechanical system-level solution to ensure all the component temperatures are below their specified rated limits. The simulation models support both the Ansys Icepak and Siemens Flotherm thermal software packages.

The design goal for system thermal management is to keep the temperature of the Zynq UltraScale+ MPSoC in the K24 SOM below the limits specified in Table 1: K24 SOM Thermal Specifications.

Total Thermal Module Power

The total module power (TMP) represents the maximum board power dissipation while the system is running the target workload under worst-case conditions. System designs must be capable of providing enough cooling for the K24 SOM when operating at the TMP level. The TMP depends on how the SOM is configured and used. The TMP can be obtained via an accurate power estimation of the K24 SOM using the Power Design Manager (PDM) tool, detailed in the Power Estimation section. Prior to evaluating a thermal solution, the PDM tool provides the appropriate thermal loading based on your estimated inputs. The following figure maps the top-side view of the component placement on the K24 SOM PCB. The power dissipation values are listed in the following table.

Figure 2: **K24 SOM Component Placement Map**



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The power presented in the following table is only an example. The actual power dissipation should be obtained from the PDM tool. For the purpose of a thermal simulation, some of the smaller components are removed.

Table 3: **K24 SOM Component Thermal Specifications**

Type	Part Reference	Description	Maximum Thermal Specifications		Metal Enclosure T_C Monitor
			T_j (°C)	T_C (°C)	
MPSoC	U1	XCK24-UBVA530-2LV	85 (C) 100 (I)	N/A	Yes
Memory	U173, U175	LPDDR4 memory	N/A	85 (C) 105 (I)	Yes
IC and Clocks	U172	eMMC memory	N/A	85 (C) 105 (I)	Yes
	U179	PS supervisor	150	N/A	
	U181		150	N/A	
	U183	PL supervisor	150	N/A	
Power Supplies	U167	PMIC	125	N/A	Yes
	U170		125	N/A	Yes

These thermal specifications are for simulation evaluations. The designed SOM thermal solution is expected to be sufficient to maintain the on board components within their maximum temperature limits as detailed in the table. T_j of the K24 SOM can be accessed during qualification test via the SYSMON.

***Note*:** There are no active components included on the bottom side of the PCB that require thermal consideration.

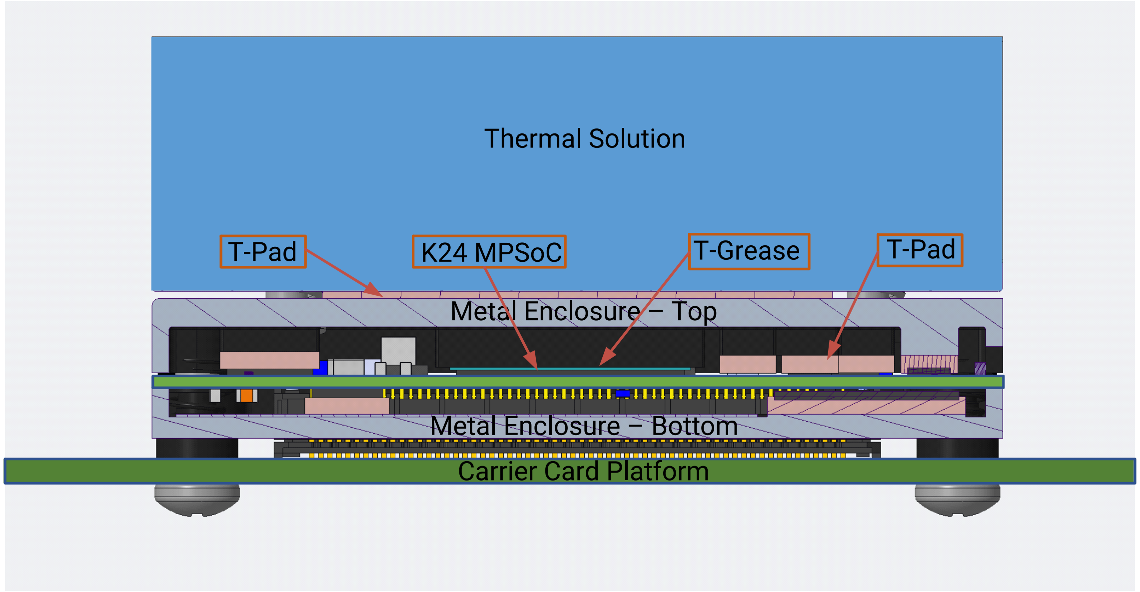
Thermal Solution Requirements

When designing your system to mate with the K24 SOM, the design must consider the following items:

- **Thermal Solution:** A system thermal solution capable of cooling the appropriate amount of TMP for the target workload.
- **Thermal Interface Material (TIM):** The thermally conductive compound between the heat sink and the device. This material fills the air gaps and voids and enhances the transfer of heat from the device to the heat sink. Your design must include the TIM between the K24 SOM metal enclosure and your system thermal solution. For the best thermal performance, the TIM should provide the lowest thermal impedance within the mechanical, reliability, and cost constraints of the end product.
- **Maximum Temperature:** The thermal solution design must ensure that the maximum Zynq UltraScale+ MPSoC based K24 SOM operating temperature is less than the value specified in Table 1: K24 SOM Thermal Specifications and that the maximum component temperatures on the PCB do not exceed the values specified in Table 3: K24 SOM Component Thermal Specifications.

The following illustration is of a thermal stack-up.

Figure 3: **K24 SOM Thermal Stack-up**



The overall system thermal solution is the mechanical element that interfaces to the K24 SOM and provides cooling. A variety of thermal solution configurations (passive cooling, air cooling, and liquid cooling) are possible, depending on the system design. In all cases, the following recommendations are applicable:

- Good contact between the thermal solution and the K24 SOM is critical for maximizing performance. In general, the K24 SOM consumes the majority of the TMP.
- You must ensure that the system thermal solution has the appropriate direct-contact surface mounting on the metal enclosure top to cover all selected heat sources.

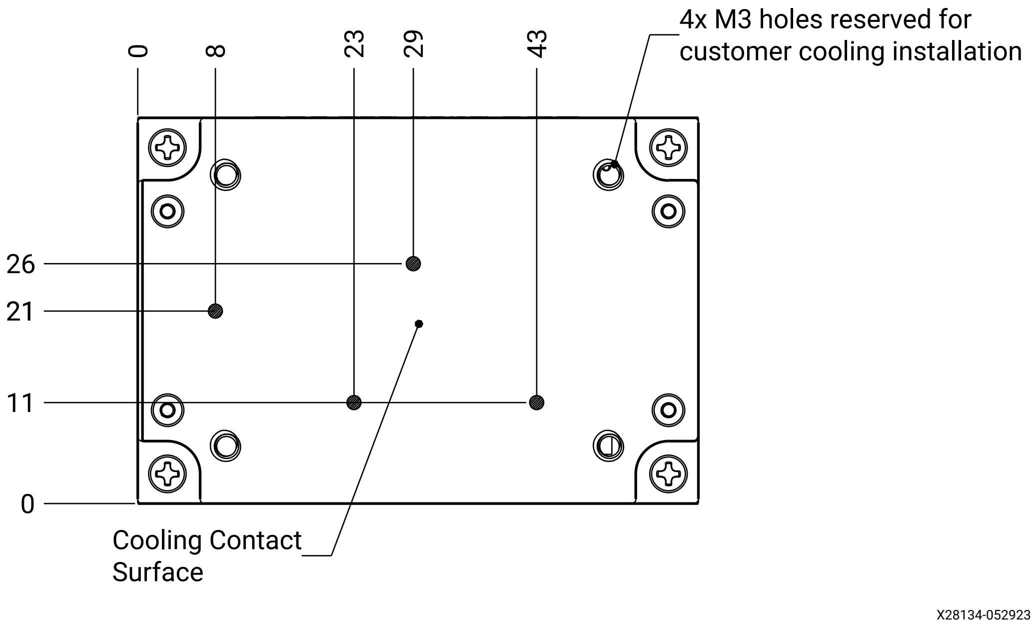
  ✓ **RECOMMENDED:** *The recommended contact pressure is between 20 and 30 PSI.*

- The cooling solution must be capable of maintaining the surface temperature on top of the metal enclosure at or less than the values specified in Table 1: K24 SOM Thermal Specifications.
- The four M3 mounting holes on the metal enclosure are provided to accommodate a variety of thermal solution assembly variances in your system design. Spring screws are recommended to maintain the contact pressure within a specific range with a preset torque driver.

  ✓ **RECOMMENDED:** *Ensure the bond-line thickness (BLT) is kept to a minimum to ensure an optimal thermal solution, where the recommendation is below 0.5 mm. A TIM with a thermal conductivity of ~5.0 W/mK is also recommended.*

The following figure shows the recommended thermocouple locations on the top metal enclosure to verify cooling performance (dimensions in mm). The four M3 holes are reserved for the cooling installation in your system design.

Figure 4: **Recommended Contact Area and 4X Thermocouple Locations on Top Metal Enclosure for Characterization and Debug**



Thermal Solution Installation Examples

A stand-alone (metal enclosure only) K24 SOM can be used in your application when the environment is able to maintain the temperature of the key components below the specifications listed in Table 3: K24 SOM Component Thermal Specifications.

Figure 5: **K24 SOM Stand-alone Solution**

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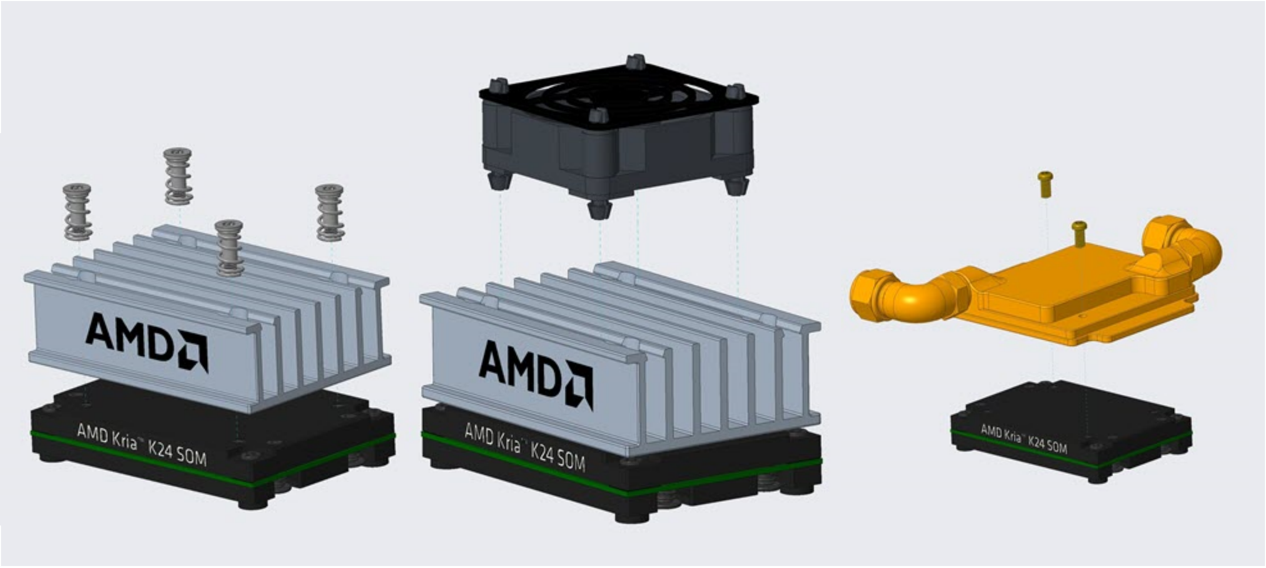
However, one of the following cooling solutions can be introduced:

- An off-the-shelf aluminum heat sink mounted to the metal enclosure to extend thermal performance (left).
- An off-the-shelf aluminum heat sink with a fan mounted to the metal enclosure to extend thermal performance (middle).
- A cold plate mounted to the enclosure to maximize the thermal performance (right).

Figure 6: **Examples of Cooling Solutions**



No matter the application, a thorough thermal model simulation must be conducted to ensure that the thermal solution is capable of maintaining the active components at temperatures below their rated temperatures. Also, if a thermal solution is added to the metal enclosure, the appropriate thermal interface material (TIM) must be used.

Thermal Simulation

Numerical simulation plays an important role in thermal design. The thermal requirements of the on-board components are the prime reason for cooling selection and mechanical design parameters. With this thermal design guide, AMD provides K24 SOM compact thermal models in both Icepak and Flotherm formats to enable system cooling design based upon your system thermal power and boundary conditions. The thermal models have the metal enclosure integrated as a thermal interface base to help you build a solution to install on it with a selected TIM (see the detailed thermal stack up in Figure 3: K24 SOM Thermal Stack-up).

Figure 7: **K24 SOM Icepak Compact Model**

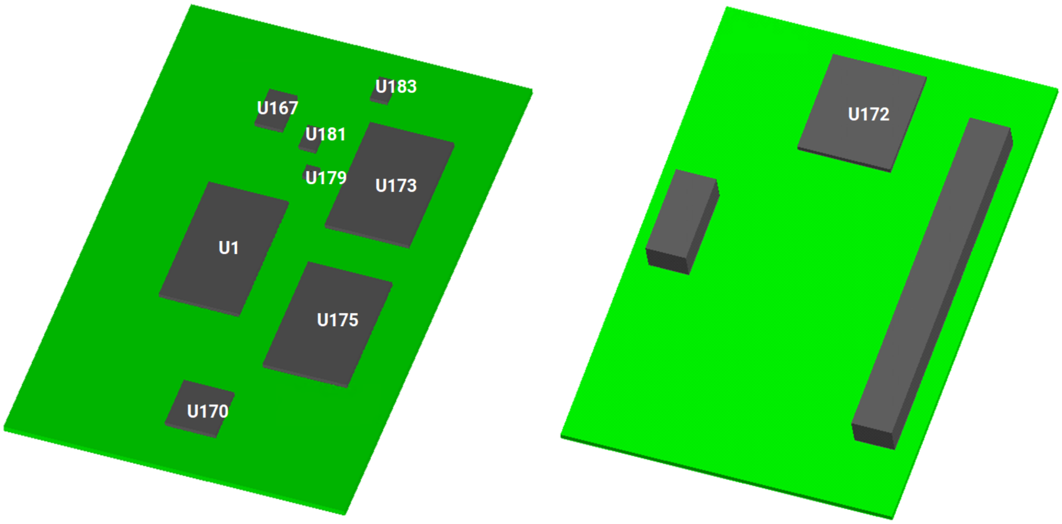


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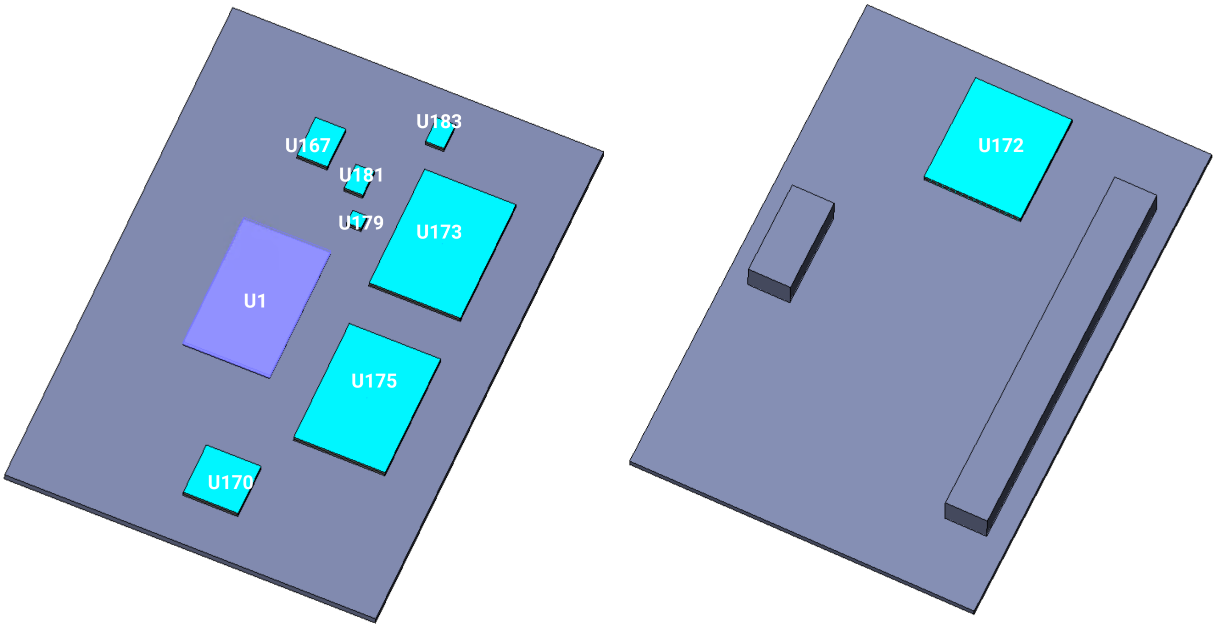
Figure 8: **K24 SOM Flotherm Compact Model**



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Modeling in Detail

To help reduce the computation time to solve and model the K24 SOM in your system, a technical treatment is implemented as follows.

- For the K24 MPSoC, a DELPHI thermal model is used in the K24 SOM thermal compact model.
- Two resistance models were used for the two LPDDRs and other components.
- These individual models have their own TIM, metal islands combined, and resistance re-characterized to the desired precision and accuracy.
- SOM Icepak and Flotherm users need to look up on-board component temperature, which cannot exceed its maximum specification according to I-grade or C-grade rating.
- Dissipation values should be applied according to their targeted system performances as reported by the PDM tool (see Power Estimation).
- Numerical model boundary conditions are system parameters such as the operating ambient temperature, airflow, and pressure drop. In some cases the system platform altitude affect also needs to be considered and simulated.
- Cooling simulation results should address design margins due to sensor accuracy, the character tolerances of the thermal interface material, mechanical manufacturing variations from fans, fins, heat pipe or vapor chamber soldering, and the heat sink base contact surface flatness.

Empirical Correlations to Determine the Thermal Solution Performance

Empirical Formula for the Metal Enclosure Temperature Rise

The following empirical formula is used to calculate the metal enclosure temperature rise:

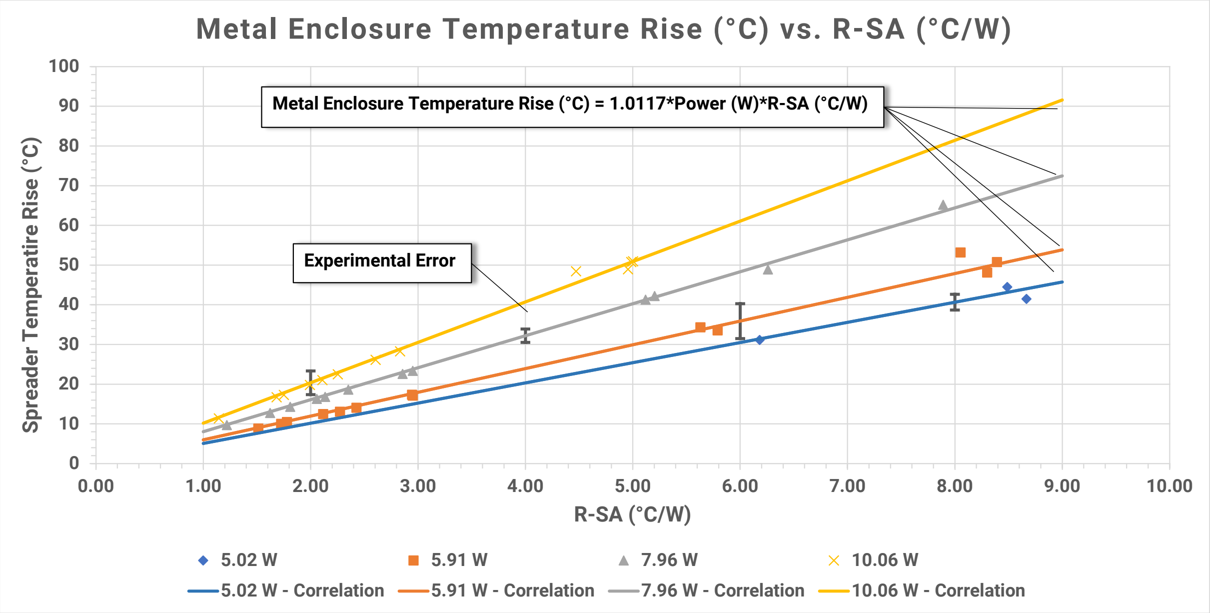
$$\text{Metal Enclosure Temperature Rise (°C)} = 1.0117 * \text{Power (W)} * \text{R-SA (°C/W)}$$

Where:

- Metal Enclosure Temperature = Ambient Temperature + Metal Enclosure Temperature Rise
- R-SA is the thermal resistance of the cooling solution designed for your system, with TIM to ambient in °C/W.
- Power is the total SOM input power (W).

The following plot shows the deviation of the metal enclosure temperature rise obtained from the above correlation for different input system powers associated to the experimental values. The points represent experimental data while the solid lines show the correlation trend which aligns very well with the test points.

Figure 9: **Metal Enclosure Temperature Rise vs. Thermal Resistance R-SA**



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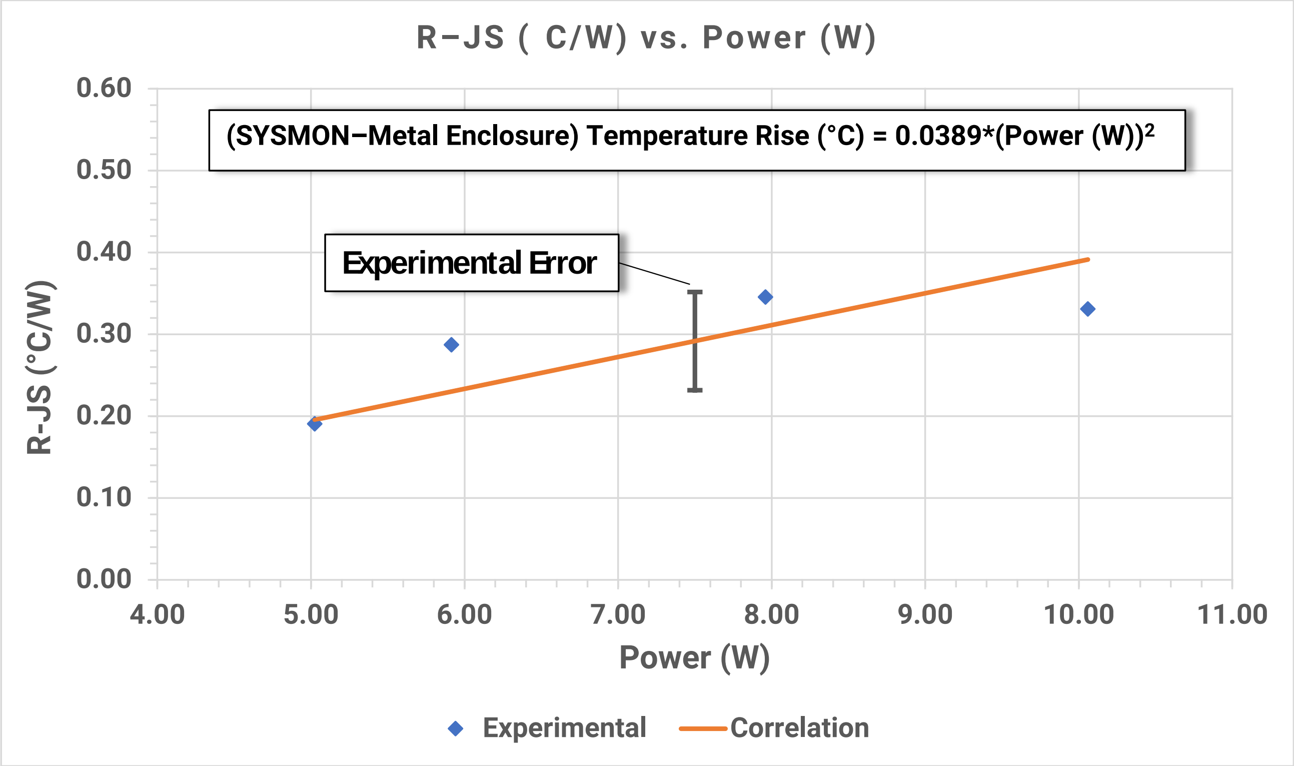
From this image you can use the correlation obtained from the estimated system power of your application and the target system thermal resistance of the solution installed on the K24 SOM metal enclosure to find the metal enclosure temperature rise.

Empirical Formula to Find the Temperature Rise between the SYSMON and Metal Enclosure

The following empirical formula is used to calculate the temperature rise between the K24 SYSMON and the metal enclosure:

$$(\text{SYSMON} - \text{Metal Enclosure})\ \text{Temperature Rise}\ (^\circ\text{C}) = 0.0389 * \text{Power}\ (\text{W})^2$$

Figure 10: **Junction to Metal Enclosure Temperature Rise vs. Total Power**



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Using the correlation with the target system power, the expected temperature rise between the K24 SOM SYSMON and metal enclosure can be calculated.

Note: The SYSMON temperature should always be less than the temperature specification given in Table 1: K24 SOM Thermal Specifications.

Illustrations of Applying the Empirical Correlations

In this first example, the system is operated at 35°C ambient, with a total estimated power of 10W and the thermal resistance of a cooling solution is 5°C/W. The SYSMON temperature is obtained by using the correlations outlined earlier in this section. Using the *Empirical Formula for the Metal Enclosure Temperature Rise*:

$$\text{Metal Enclosure Temperature Rise (°C)} = 1.0117 * \text{Power (W)} * \text{R-SA (°C/W)} = 1.0117 * 10 * 5 = 50.59\text{°C}$$

$$\text{Metal Enclosure Temperature (°C)} = 50.59\text{°C} + T_a$$

$$\text{Metal Enclosure Temperature (°C)} = 50.59\text{°C} + 35.00\text{°C} = 85.59\text{°C}$$

$$\text{SYSMON Temperature (°C)} = 0.0389 * \text{Power (W)}^2 + \text{Metal Enclosure Temperature (°C)} = 0.0389 * 10^2 + 85.59\text{°C} = 89.48\text{°C}$$

The result of this example is that with the estimated SYSMON temperature obtained from the empirical relations, you can verify whether your selected thermal solution meets the K24 SOM thermal specifications list in Table 1: K24 SOM Thermal Specifications.

The second example has an estimated system power of 10W when operating in 25°C ambient temperature, the maximum SYSMON temperature is specified as 85°C. Using the correlations outlined earlier in this section, an estimated thermal resistance from metal enclosure to ambient (R-SA) is calculated, defining an appropriate thermal solution as:

$$\text{Metal Enclosure Temperature } (^\circ\text{C}) = \text{SYSMON Temperature } (^\circ\text{C}) - (0.0389 * \text{Power (W)}^2) = 85 - (0.0389*10^2) = 81.11\ ^\circ\text{C}$$

$$\text{Metal Enclosure Temperature Rise } (^\circ\text{C}) = 81.11^\circ\text{C} - 25^\circ\text{C} = 56.11^\circ\text{C}$$

$$\text{R-SA } (^\circ\text{C/W}) = \text{Metal Enclosure Temperature Rise } (^\circ\text{C})/(1.0117 * \text{Power (W)}) = 56.11/(1.0117 * 10) = 5.5^\circ\text{C/W}$$

K24 SOM Stand-alone and Exposed to Air

In a K24 SOM system where the metal enclosure is exposed to air, the recommended clearance above the metal enclosure is approximately 30 mm. In this case, it is anticipated that the thermal resistance from the metal enclosure to the ambient would be in the range of ~9 to 10°C/W. This arrangement can produce limited performance where the dissipated power from K24 SOM is smaller. It is crucial that K24 SOM is operating in a system arrangement that keeps the SYSMON temperature below the specification outlined in Table 1: K24 SOM Thermal Specifications.

For example, a K24 SOM with a metal enclosure that has a thermal resistance from the metal enclosure to an ambient temperature of 9°C/W. The area surrounding the K24 SOM in 30 mm of free area is 35°C, and the maximum SYSMON temperature specified from the specification is 100°C. Under this condition, the maximum dissipated power from the K24 SOM is described in the following formulas:

$$\text{Metal Enclosure Temperature} - \text{Ambient temperature } (^\circ\text{C}) = 1.0117 * \text{Power (W)} * \text{R-SA } (^\circ\text{C/W}) = 1.0117 * \text{Power} * 9$$

$$\text{Metal Enclosure Temperature} - 35\ (^\circ\text{C}) = 9.11 * \text{Power}$$

$$\text{SYSMON Temperature } (^\circ\text{C}) - \text{Metal Enclosure Temperature } (^\circ\text{C}) = 0.0389 * \text{Power (W)}^2$$

$$100\ (^\circ\text{C}) - \text{Metal Enclosure Temperature } (^\circ\text{C}) = 0.0389 * \text{Power (W)}^2$$

Calculating the sum of the two equations:

$$65\ (^\circ\text{C}) = 9.11 * \text{Power} + 0.0389 * \text{Power (W)}^2$$

Solving this equation gives Power = 6.9W.

THERMAL TIP: *Following best engineering practices includes numerically modeling the parameters using the thermal models provided by AMD. The numerical model must be validated with experimental data to ensure that the K24 SOM system is operated under the rated specifications as per these guidelines and the data sheet. The empirical correlations provided in this document are only for an initial thermal assessment and cannot be used for production thermal design.*

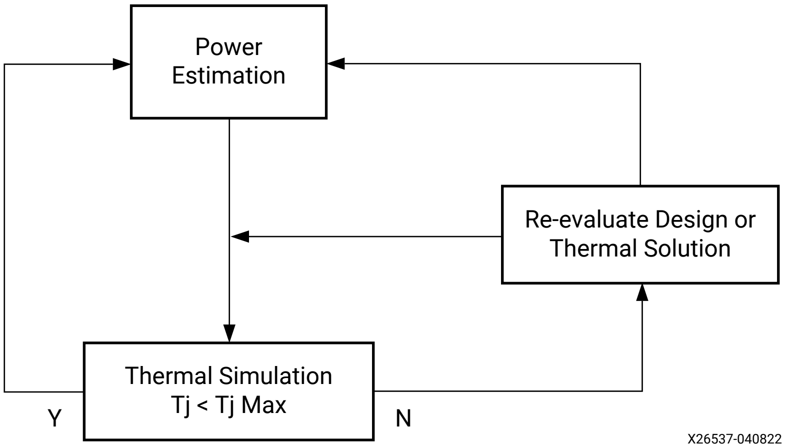
Power Estimation

The K24 SOM power estimation is done using two tools. The Power Design Manager (PDM) tool provides early power estimation. After implementation, the output from the Vivado Power Report (as described in *Vivado Design Suite User Guide: Power Analysis and Optimization* (UG907)) ensures the implemented design is within the SOM and carrier card constraints. The Vivado Power Report only provides the power estimation for the Zynq UltraScale+ MPSoC, you must estimate the power consumption of the other peripherals on the SOM using the values found in the Thermal Loading table.

POWER TIP: *When designing a SOM carrier card, the PDM tool lists the required 5V and V_{CCO} current requirements, which is critical for a thorough estimation. The same estimation also generates the thermal loading information needed for thermal simulation. Either your Vitis or Vivado design should be appropriately constrained for power based on the results of the estimation and thermal analysis.*

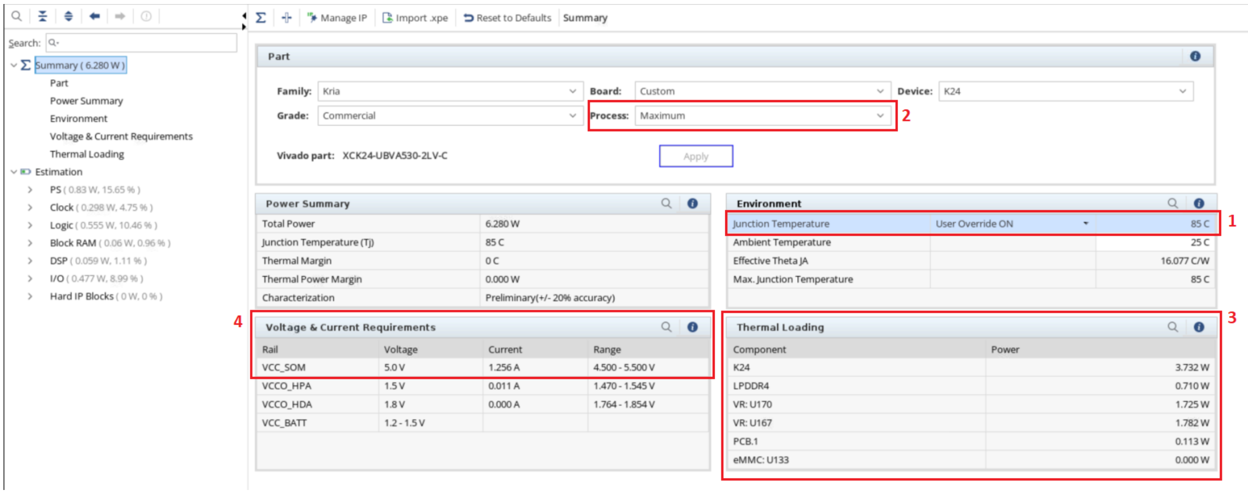
An accurate power estimation is critical to defining an effective thermal solution and keeping the K24 SOM components below their maximum junction temperature (T_j). When designing the K24 SOM thermal solution, the worst-case power is the starting point for simulation. Once a thermal solution is defined and the T_j is within the limits, the theta J_A (ΘJ_A) of the system can be input back into the PDM tool for a more accurate estimation of the power requirements for the K24 SOM.

Figure 11: **Recommended Thermal Validation Flow**



Based on the temperature grade of the commercial temperature grade K24C SOM or the industrial temperature grade K24I SOM, the junction temperature should be forced to the maximum desired operating temperature (often maximum device operating temperature) to get the worst-case power estimation for the K24 SOM. The following example shows the K24C SOM when the T_j is forced to 85°C. The power dissipation of each of the components on the SOM is shown in the Thermal Loading table.

Figure 12: **Example Showing Thermal Loading**



Part

Family: Kria

Board: Custom

Device: K24

Grade: Commercial

Process: Maximum

Vivado part: XCK24-UBVA530-2LV-C

Power Summary

Total Power	6.280 W
Junction Temperature (Tj)	85 C
Thermal Margin	0 C
Thermal Power Margin	0.000 W
Characterization	Preliminary(+/- 20% accuracy)

Environment

Junction Temperature	User Override ON	85 C
Ambient Temperature		25 C
Effective Theta JA		16.077 C/W
Max. Junction Temperature		85 C

Voltage & Current Requirements

Rail	Voltage	Current	Range
VCC_SOM	5.0 V	1.256 A	4.500 - 5.500 V
VCCO_HPA	1.5 V	0.011 A	1.470 - 1.545 V
VCCO_HDA	1.8 V	0.000 A	1.764 - 1.854 V
VCC_BATT	1.2 - 1.5 V		

Thermal Loading

Component	Power
K24	3.732 W
LPDDR4	0.710 W
VR: U170	1.725 W
VR: U167	1.782 W
PCB.1	0.113 W
eMMC: U133	0.000 W

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In this example:

1. T_j is forced to the maximum allowed for the K24C SOM (85°C)
2. Maximum process is selected to get the worst-case static power
3. The thermal power of the SOM components
4. Total electrical power required on the SOM 5V connector is based on the current estimation

The thermal loading in the PDM tool matches the components in the SOM thermal model, the thermal power for every component listed should be added. The PCB also has a small amount of power loss to account for an inductor or other ancillary components, this power should be applied to the PCB in the model.

THERMAL TIP: *The SOM thermal model supports both the Ansys Icepak and Siemens Flotherm EDA tools. For thermal modeling assistance, the following Thermal Partners are available.*

Once a capable thermal solution is designed and validated in thermal simulation, the power estimation can be refined using the simulation results.

1. Apply the calculated effective ΘJ_A of the system in the PDM tool along with the maximum supported T_a for the product. This is the recommended approach because the power estimation dynamically estimates the anticipated T_j and provides a more accurate estimated power.

THERMAL TIP: *ΘJ_A is a measure of how the junction temperature (T_j) will increase above the ambient temperature (T_A) for every watt of power dissipated (P_d) in the device, the units are °C/W. ΘJ_A is calculated using the following equation: $\Theta J_A = (T_j - T_A) / P_D$.*

The following example shows a T_A of 25°C with a ΘJ_A of 3.954°C/W and the estimate T_j based on the current estimation is 35.3°C, which is a more accurate total power estimation for the SOM. The total power at 35.3°C is 5.2W, compared to 6.5W at 85°C in the worst-case estimate.

Figure 13: **Power Estimation Example**

Power Summary	
Total Power	5.148 W
Junction Temperature (Tj)	35.32 C
Thermal Margin	50 C
Thermal Power Margin	12.565 W
Characterization	Preliminary(+/- 20% accuracy)

Environment		
Junction Temperature	User Override OFF	
Ambient Temperature		25 C
Effective Theta JA		3.954 C/W
Max. Junction Temperature		85 C

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2. Use the results of your initial estimation and thermal simulations to constrain a Vitis or Vivado design to keep the power of the deployed application within the required power limits. As a minimum, use the following constraints to report power for a correct analysis of the SOM power and to accurately assess static and dynamic power:

```
set_operating_conditions -design_power_budget <Power in Watts>
set_operating_conditions -process maximum
set_operating_conditions -ambient_temp <Max Supported by Application>
set_operating_conditions -thetaja <Increase in Tj for every W dissipated
C/W>
```

POWER TIP: *To get the complete SOM power estimation from a currently implemented design, load the `XPE` file from the report power into the PDM tool to estimate the power required for the other components on the SOM.*

***Note*:** For further power estimation design resources, consult the *Power Design Manager User Guide* (UG1556).

Appendix A

Additional Resources and Legal Notices

Finding Additional Documentation

Documentation Portal

The AMD Adaptive Computing Documentation Portal is an online tool that provides robust search and navigation for documentation using your web browser. To access the Documentation Portal, go to https://docs.xilinx.com.

Documentation Navigator

Documentation Navigator (DocNav) is an installed tool that provides access to AMD Adaptive Computing documents, videos, and support resources, which you can filter and search to find information. To open DocNav:

- From the AMD Vivado™ IDE, select **Help → Documentation and Tutorials**.
- On Windows, click the **Start** button and select **Xilinx Design Tools → DocNav**.
- At the Linux command prompt, enter `docnav`.

Note: For more information on DocNav, refer to the *Documentation Navigator User Guide* (UG968).

Design Hubs

AMD Design Hubs provide links to documentation organized by design tasks and other topics, which you can use to learn key concepts and address frequently asked questions. To access the Design Hubs:

- In DocNav, click the **Design Hubs View** tab.
- Go to the Design Hubs web page.

Support Resources

For support resources such as Answers, Documentation, Downloads, and Forums, see Support.

References

These documents provide supplemental material useful with this guide:

1. *Kria SOM Carrier Card Design Guide* (UG1091)
2. Power Design Manager tool.
3. *Power Design Manager User Guide* (UG1556)
4. *Kria K24 Thermal Models* (XTP784)
5. *Kria K24 SOM Data Sheet* (DS985)
6. *Kria KD240 Drives Starter Kit Data Sheet* (DS984)
7. *Kria KD240 Drives Starter Kit User Guide* (UG1093)
8. *Vivado Design Suite User Guide: Power Analysis and Optimization* (UG907)
9. *Kria K24 SOM 3D CAD Model* (XTP777)

Revision History

The following table shows the revision history for this document.

Section	Revision Summary
10/20/2023 Version 1.0	
Initial release.	N/A

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