WHITE PAPER

Keysight PXIe Chassis Cooling Guidelines

M9010A PXIe Chassis
M9018B PXIe Chassis
M9019A PXIe Chassis

Introduction

The Keysight Technologies, Inc. PXIe chassis deliver the flexibility, compatibility, and performance required for demanding applications. With multiple PXIe hybrid slots, they give the system designer more flexibility to mix and match the number and location of PXIe and hybrid-compatible modules. However, the combination of modules and location in the chassis can impact the airflow and temperature within the chassis. Maintaining an appropriate temperature within the chassis and modules while not being affected by the fan noise for your environment is important in achieving the highest efficiency in cooling the PXIe chassis. This paper helps you understand the specifications, shows examples of efficiency, and gives guidelines on how to efficiently cool the chassis.

Module temperatures in a PXI system can impact operating conditions such as chassis fan noise, module performance, and long-term system reliability. Therefore, it's important to actively manage the environment inside your chassis.

Understand the chassis cooling specifications

The below list shows the factors that contribute to the performance of the chassis cooling capability. It is important to know the limitations and how to use them within their specifications.

- Ambient temperature range
- Per slot cooling specifications
- Total cooling capacity of a chassis versus maximum DC power available
- Audio noise versus fan speed

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Ambient temperature range

Keysight chassis are rated to perform from a 0 to 55 °C ambient temperature range. If the power limits are adhered to, an over-temperature condition is unlikely to occur. Each PXI module used will contribute to the temperature rise within the chassis. The Primary Power Module (PPM) shuts down if its internal temperature exceeds 110 °C. Be cautious of applications with a combination of high power modules which can cause chassis temperature to increase exceeding limits. This document will give you more guidelines on how to reduce the risk of over-temperature conditions.

Per slot cooling specifications

With the chassis ambient temperature limitation of 55 °C, each slot in the chassis can support up to an additional 15 °C temperature rise. Therefore, you should limit the module and internal chassis temperatures to 70 °C to avoid damaging chassis and module components. However, there are applications with high-power modules, such as the M9195B PXIe Digital Stimulus/Response with PPMU, which dissipate higher power and can result in a higher temperature rise. For such applications, it is recommended to set the fan speed on high when using a non-Keysight chassis (Keysight chassis can remain in Auto mode as we will describe later in this paper). It is also best to limit the ambient temperature environment if possible to ensure the chassis and module operate within safe limits.

Total cooling capacity of a chassis versus maximum DC power available

Some applications require you to fill all the slots causing the total power dissipation of the modules to exceed the available DC power of the chassis. For example, the M9010A can dissipate up to 518W (42W x 9 slots + 140W from the system slot) when completely full of modules. However, the chassis power supply can only supply 470W with 120V input but can supply more DC power when using a 220V input. In this case, it is recommended to use the chassis with 220 - 240V input voltage or step up to a larger chassis with greater power/cooling capability. Table 1 shows the total power available for peripheral module slots with limitation on how much power each slot can dissipate for Keysight chassis.

	M9010A	M9018B	M9019A
Total DC Power 220-240V Input	830W	858W	800W
Total DC Power 100-120V Input	470W	708W	650W
Power Dissipation, System Slot	140W	140W	140W
Power Dissipation, User Slot	42W	42W	42W
Power Dissipation, Timing Slot	42W	42W	42W

Table 1: DC Output Power (for peripheral module slots) and Power Dissipation Characteristics

In the opposite case, the chassis you selected may be able to provide more DC power than the chassis can dissipate. For example, the M9010A can provide up to 830W but can only dissipate up to 518W when used over the full temperature range. This extra power can still be used if it is dissipated outside the chassis or if the chassis is used at a lower ambient temperature. For example, using a module that supplies power to the application outside the chassis will not contribute to the interior temperature rise of the chassis. Also, ensuring the ambient temperature stays below 45°C can give you an additional 10°C of margin.

Audio noise versus fan speed

Each chassis contains a different number of fans to cool the chassis based on the chassis backplane temperature condition. Keysight chassis allows you to monitor the speed of each fan in revolutions per minute (RPM). You can also set a minimum fan speed threshold such that, if any fan speed falls below this threshold, a fan speed alarm is generated. To help you control the noise level that is generated by the fans, you can set the Fan Speed Selector Switch to AUTO and use the Soft Front Panel or IVI drivers to set the desired temperature at which maximum fan speed is achieved.

Examples of efficiency in cooling the chassis

Maintain the airflow

Typically, high pressure intake airflow requires filters and must be maintained. The M9018B and M9019A Keysight PXIe chassis are designed to reduce maintenance costs because they use a low-pressure air intake that doesn't require air filters. Instead, the fans are used to pull, rather than push, cool air through the chassis. And with the M9018B and M9019A, optional air inlet modules can be used to supply even more cool air from the front of the chassis directing it to module slots. Given the air outside the rack is generally cooler than the air inside the rack, this results in more efficient cooling of the PXIe modules. This option enables the system designer to decide how to best cool the chassis, providing more design flexibility than other PXIe chassis.

Fan speed control

Unlike many PXIe chassis, the fan speed of the Keysight PXIe chassis is controlled by using temperature sensors located on the top of the backplane, in the path of the module exhaust. This enables the fans in the chassis to react to actual changes in module temperatures, instead of ambient air temperature readings used by the typical PXIe chassis. This results in lower module operating temperatures and acoustical emissions when the AUTO fan setting is used.

Locations of air intakes and fan exhausts

The cooling airflow can vary from one chassis to another. For example, figures 1 and 2 show the air intake and exhaust for the Keysight M9010A, M9018B and M9019A chassis. It is important to take note of the locations of the air intakes and fan exhausts to make sure you do not block the airflow by placement of other instruments or instrument cabling. Position the chassis to provide ample space around the fan intake and exhaust vents. Blockage by walls or obstructions affects the airflow needed for cooling.

Figure 1: M9018B and M9019A Chassis Airflow

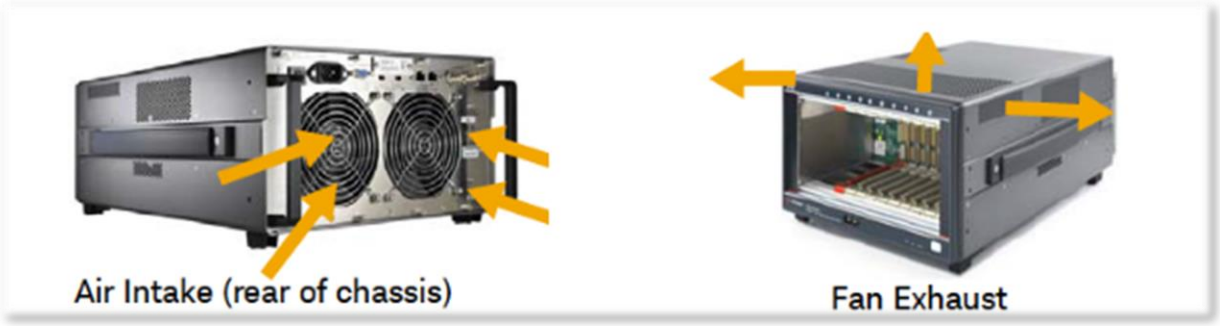


Figure 2: M9010A Chassis Airflow

The M9018B and M9019A are optimized for rack applications. Since the chassis cooling exhaust are located at the rear of the chassis, mounting instruments on top of the chassis will not affect the airflow in the chassis. Table 2 summarizes the chassis cooling characteristics of Keysight chassis.

	M9010A	M9018B	M9019A
Slot Airflow Direction	Bottom of module to top of module	Bottom of module to top of module	Bottom of module to top of module
Chassis Cooling Intake	Rear of chassis	Bottom of front bezel, side panels, and bottom panel of chassis	Bottom of front bezel, side panels, and bottom panel of chassis
Chassis Cooling Exhaust	Front top of chassis	Rear of chassis	Rear of chassis
Chassis Cooling Fans	Two 120 cfm fans on rear panel with HIGH/AUTO speed selector	Three 186 cfm fans on rear panel with HIGH/AUTO speed selector	Three 186 cfm fans on rear panel with HIGH/AUTO speed selector

Table 2: Chassis Cooling Characteristics

Fan settings and impact on noise

The typical PXIe chassis is only optimized for low fan noise below a certain ambient temperature, for example 30°C. If used above this temperature, the chassis should manually be set to high speed. This often results in a higher noise level when operating the chassis in racks or other environments where the ambient temperature is above 30°C. The Keysight PXIe chassis support using the auto fan-speed setting across the full operating range. As you can see from the test results shown below in tables 3 and 4, the M9019A and M9010A operate at a much lower noise level at operating temperature.

Ambient temp of 24°C and noise of 41.1 dBA		M9019A	Comparable 3rd Party Chassis
1 meter away from chassis	Front	42.3 dBA	48.4 dBA
	Rear	52.9 dBA	54.7 dBA
	Left	45.1 dBA	50.1 dBA
	Right	44.8 dBA	50.5 dBA

Table 3: M9019A Noise Level Comparison Between Empty Chassis with Auto Fan Setting

Ambient temp of 24°C and noise of 41.1 dBA		M9010A	Comparable 3rd Party Chassis
1 meter away from chassis	Front	41.1 dBA	41.6 dBA
	Rear	41.7 dBA	46.4 dBA
	Left	41.2 dBA	42.8 dBA
	Right	41.8 dBA	43.5 dBA

Table 4: M9010A Noise Level Comparison Between Empty Chassis with Auto Fan Setting

Using high-power PXI modules

As previously mentioned, certain modules such as the M9336A PXIe I/Q Arbitrary Waveform Generator dissipate an above average amount of power when compared to other single-slot PXIe modules. Even though it can dissipate up to 54W, it can still be used in PXIe chassis with a per-slot cooling specification below this. As stated above, many chassis require the use of the maximum fan setting for higher power modules such as the M9336A. However, a Keysight chassis can generally be operated in auto mode if the ambient temperature is appropriately limited. This can result in lower ambient noise. Tables 5 and 6 below show the fan noise level in the M9019A and M9010A PXIe chassis versus their comparable 3rd party PXIe chassis when this module is used. With the M9019A and M9010A innovative cooling design, the noise level is much lower than using a typical PXIe chassis. Also note that after 15 minutes of operating with the M9336A, the module temperature is higher when used in the 3rd party chassis.

Ambient temp of 24°C and noise of 41.1 dBA		M9019A (M9336A is 52°C after 15 mins of use)	Comparable 3rd Party Chassis (M9336A is 55°C after 15 mins of use)
1 meter away from chassis	Front	42.5 dBA	48.3 dBA
	Rear	51.0 dBA	54.2 dBA
	Left	45.2 dBA	49.7 dBA
	Right	44.4 dBA	49.3 dBA

Table 5: M9019A Noise Level Comparison Between Chassis with M9336A in Slot 17 and Auto Fan Setting

Ambient temp of 24°C and noise of 41.1 dBA		M9010A (M9336A is 52°C after 15 mins of use)	Comparable 3rd Party Chassis (M9336A is 60°C after 15 mins of use)
1 meter away from chassis	Front	41.7 dBA	41.5 dBA
	Rear	46.6 dBA	46.4 dBA
	Left	42.5 dBA	43.5 dBA
	Right	41.8 dBA	43.7 dBA

Table 6: M9010A Noise Level Comparison Between Chassis with M9336A in Slot 8 and Auto Fan Setting

Guidelines and tips on how to cool the chassis

Make sure there is enough power

It is important to choose the right PXIe chassis with enough power that would be able to support your application. Review the datasheet for the power specifications required to power the chassis and its modules. With the Keysight PXIe chassis, you can determine if your application will work in a given chassis by utilizing the **M901x PXIe Chassis Power Calculator** tool. This tool helps you calculate the total power available to the chassis modules.

Separate high-power modules or leave space around them

When working with high-power modules, separate them from other high-power modules in the chassis. Or if you have room, leave space around these high-power modules to allow them to distribute the heat evenly in the chassis and cool faster.

Always use slot blockers and cover empty slots

Missing filler panels or slot blockers will disrupt air circulation in the chassis. Use slot blockers and EMC filler panels in empty module slots to ensure proper operating temperatures. These accessories optimize module temperature performance and reliability of the test system. When using the M9021A, M9022A, or M9023A system module, install the 3-wide slot blocker and filler panel to the left of the module. This can be found in the Y1214B Air inlet module kit. More detail on available accessories to help with the airflow is provided in the chassis datasheet.

Monitor Module Temperatures

If possible, monitor the temperature of high-power modules until you are sure that they are operating within safe limits. Many Keysight modules provide a temperature monitoring feature in the Soft Front Panel and API.

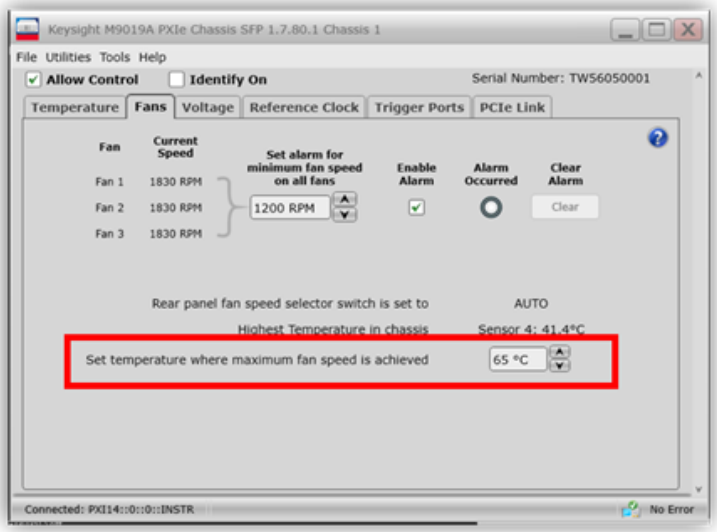
Make sure that the chassis feet are installed and extended when use on bench

The M9018B and M9019A have built in bottom vents to help with the airflow. The fans will have to work harder to pull air through the side vents if these vents are blocked. Installing and extending the chassis feet for benchtop application will help the fans run slower since they do not have to work as hard to pull air through the chassis.

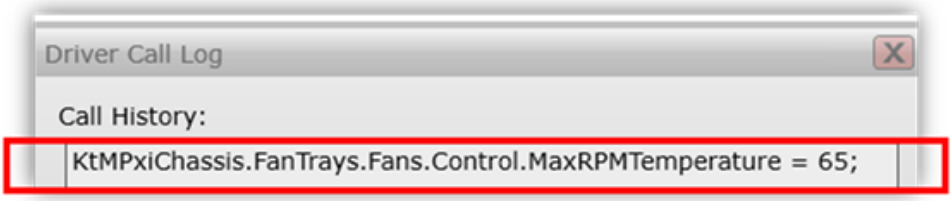
Adjust appropriate temperature setting where maximum fan speed is achieved

Your modules may run hot and require that the fans run on high. However, you do not need to be in high setting if your modules do not run hot. Check the temperature that would work for your application and apply it to the maximum fan speed setting. Below are different ways you can adjust this setting.

1. Using the Soft Front Panel, navigate to the Fans tab, and set the appropriate temperature under “Set temperature where maximum fan speed is achieved”.



2. Using IVI call.



3. Go to the chassis product website (i.e. for M9019A, it is www.keysight.com/find/M9019A), navigate to the Document Library, and download the FanControl.zip file from the PXIe Chassis Fan Control Tool link.

Summary

As you can see, many different factors affect the cooling of a PXIe chassis. After understanding the specifications, seeing the examples and guidelines above will help you achieve the highest efficiency for cooling your chassis. Remember to take these into account when you decide which PXIe chassis to use for your application.

Learn more at: www.keysight.com

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