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LSI® SAS 9206-16e HBA Temperature and Airflow

Application Note

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Revision History

Version and Date	Description of Changes
Preliminary, Version 1.0, November 2013	Initial release of this document.

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1 Overview

The LSI® SAS 9206-16e PCI Express® (PCIe®)-to-Serial Attached SCSI (SAS) host bus adapter (HBA), referred to as the LSI SAS 9206-16e HBA, provides external storage connectivity for high-performance servers. The LSI SAS 9206-16e HBA uses two LSI SAS 2308 controller chips to achieve greater than 1-M IOPS. These controller chips are powerful and generate heat that must be dissipated for successful server operation.

The LSI SAS 9206-16e HBA includes heat sinks to dissipate a portion of the heat; however, adequate airflow is also required to control critical chip temperatures for proper board functionality. LSI develops the minimum airflow requirements in a laboratory environment with ideal airflow. Your server design might require different limits, based on your specific installation and application situation. This document explains heat sink and airflow considerations, how you can test your current setup for adequate airflow, and how to make sure the environment maintains proper operating temperatures.

1.1 LSI SAS 9206-16e HBA Overview

The LSI SAS 9206-16e HBA is based on the LSI SAS 2308 controller that integrates the latest enhancements in PCIe 3.0 technology and 6Gb/s SAS technology. The LSI SAS 9206-16e HBA low-profile design lets you use the HBA in many diverse server form factors and configurations. This section lists the LSI SAS 9206-16e HBA features.

- Implements two LSI SAS 2308 eight-port 6Gb/s to PCIe 3.0 controllers
- Supports 8-lanes, full-duplex PCIe 3.0 performance
- Supports sixteen external 6Gb/s SATA+SAS ports
- Supports SAS/SATA link rates of 1.5Gb/s, 3.0Gb/s, and 6.0Gb/s
- Provides four x4 external mini-SAS HD connectors (SFF-8644)
- Supports active copper cable, passive copper cable, and optical cable
- Supports up to 1024 SATA or SAS end devices
- Offered with a full-height bracket and low-profile vented bracket

The operating temperature limits for the LSI SAS 9206-16e HBA are as follows:

- Temperature range: 0 °C to 55 °C (32 °F to 131 °F) (dry bulb)
- Minimum airflow:
  - 100 linear feet per minute at 35 °C (95 °F) bay inlet temperature
  - 150 linear feet per minute at 45 °C (113 °F) bay inlet temperature
  - 200 linear feet per minute at 55 °C (131 °F) bay inlet temperature

NOTE LSI specifies airflow limits in ideal conditions.

The following limits define the storage and transit environment for the LSI SAS 9206-16e HBA:

- Temperature range: –45 °C to +105 °C (–49 °F to +221 °F) (dry bulb)
- Relative humidity range: 5 percent to 90 percent noncondensing

2 Heat Sink and Airflow Overview

Adequate airflow for your HBA is a crucial factor for successful board performance. Failure to maintain correct operating conditions (for example, allowing the device to overheat) can cause errors, degrade performance, shorten device lifetime, or damage parts.

2.1 Heat Sink Physical Characteristics

The LSI SAS 9206-16e HBA heat sinks are designed to efficiently transfer heat from the devices on the board to the surrounding air. In all heat sink designs, the velocity and direction of moving air around the heat sink affect the amount of heat removed and the efficiency of the heat transfer. The LSI SAS 9206-16e HBA heat sinks have a heat plate that interfaces with the device and metal fins that provide the surface area necessary to transfer the heat drawn away from the device to the air moving past the fins so that the heat can be removed.

The most common materials to manufacture heat sinks are aluminum and copper. Both are good heat conductors. Aluminum is less expensive than copper, but copper is more effective. Several factors determine the effectiveness of a heat sink, including the material, height, length, width, fin density, and fin spacing. The LSI SAS 9206-16e HBA uses copper heat sinks with cross-cut skived fin technology for optimal thermal performance in highly constrained low-profile host systems.

2.2 Airflow

Airflow refers to the amount of air moving across the chip heat sink and how quickly that air moves. Airflow is measured in linear feet per minute (LFM) at the heat-sink surface. More available cooling air means more heat can be removed. The temperature of the exiting air relative to the incoming air indicates heat-sink efficiency and how much heat is removed from the board. When these various temperatures stabilize, the heat dispenses at the same rate as the rate of heat generation.

When that equivalent state is reached, the heat-sink temperature is the best indicator of the temperature inside the chip, mounted to the heat sink.

3 System Evaluation

You must measure the inlet air temperature and heat-sink temperature to verify that your board has sufficient airflow for successful operation within the LSI SAS 9206-16e HBA operating specifications.

3.1 Inlet Air Temperature

The inlet air temperature is the temperature of the air outside of where the LSI SAS 9206-16e HBA is enclosed. If the HBA is within a datacenter, the inlet air temperature is the rack (cold aisle) temperature. Measure this temperature with a thermometer, thermocouple, or temperature sensor of your choice. Meet the following conditions to make sure the inlet air temperature is accurately measured.

- Set up system components in the way you intend to use the system
- Run your system at the intended maximum workload for your applications
- Determine the maximum value that this temperature will reach during operation of the server with the HBA and the difference from the test condition

3.2 Heat Sink Temperature

Use an infrared sensor, IR thermometer, or a thermocouple instrument to measure the heat sink temperature. Adhere to the instructions that accompany the instrument of your choice. Meet the following conditions to make sure the heat-sink temperature is accurately measured.

- Mount the board in the intended final location within the host server.
- Set up additional system components in the way you intend to use the system.

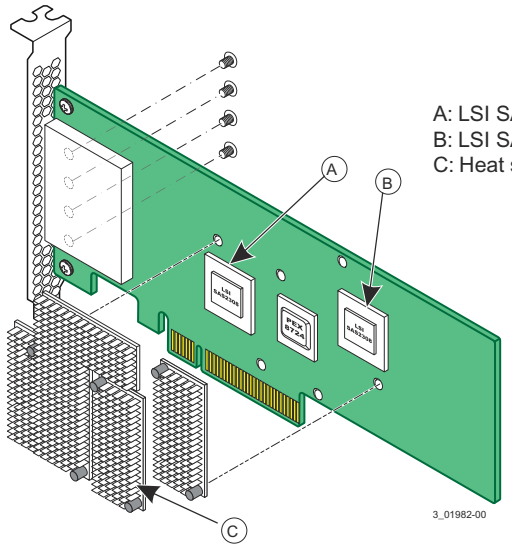
NOTE Most systems require the top cover be in place for proper airflow, and some have special internal baffles to direct internal airflow over critical components.

- Run your system at the intended maximum workload for your system.

4 Measure the Temperatures

After adhering to the conditions in Section 3.1 and Section 3.2, use the following steps to take measurements. The following figure represents the LSI SAS 9206-16e board.

Figure 1 LSI SAS 9206-16e HBA Chip Layout



A: LSI SAS controller chip nearest the connector
B: LSI SAS controller chip furthest from the connector
C: Heat sinks

1. Measure the inlet air temperature and record the value (see Section 3.1).
2. Prepare the heat sink and thermometer instrument according to the instructions accompanied with the instrument of your choice.
3. Measure the heat sink A temperature.
   a. If you use a thermocouple, measure the base of the heat sink (between the fins) and in the center of the heat sink. For an accurate reading, the measurement must be as close as possible to where the heat sink contacts the LSI controller chip.
   b. If you use an IR thermometer, use the IR thermometer to locate and measure the hottest point in the center of the heat sink. Ideally this location is directly above the chip die.
4. Record the value for heat sink A.
5. Compare the values from Step 1 and Step 2 in Figure 3 to determine appropriate airflow options.

6. Measure the heat sink B temperature.
   a. If you use a thermocouple, measure the base of the heat sink (between the fins) and in the center of the heat sink. For an accurate reading, the measurement must be as close as possible to where the heat sink contacts the LSI controller chip.
   b. If you use an IR thermometer, use the IR thermometer to locate and measure the hottest point in the center of the heat sink. Ideally this location is directly above the chip die.
7. Compare the values from Step 1 and Step 5 in Figure 2 to determine appropriate airflow options.
8. The limiting controller chip dictates your ideal airflow.

The measured heat sink temperature on either heat sink should not exceed 110 °C (230 °F). If the temperature is greater than 110 °C, try the board in a different slot, provide more airflow, or make both changes.

4.1 Measurements

LSI directly measured die temperature to develop the recommended operating environment. The following figures reflect the following operating conditions.

- PCIe 8Gb/s x8 lane host server
- SAS 6Gb/s on all 16 ports
- Performing at HBA performance limits

The number of attached drives or drive type is irrelevant for measuring thermal values.

Figure 2 LSI SAS 9206-16e Controller Chip B (Furthest from the Connector) Temperature Chart

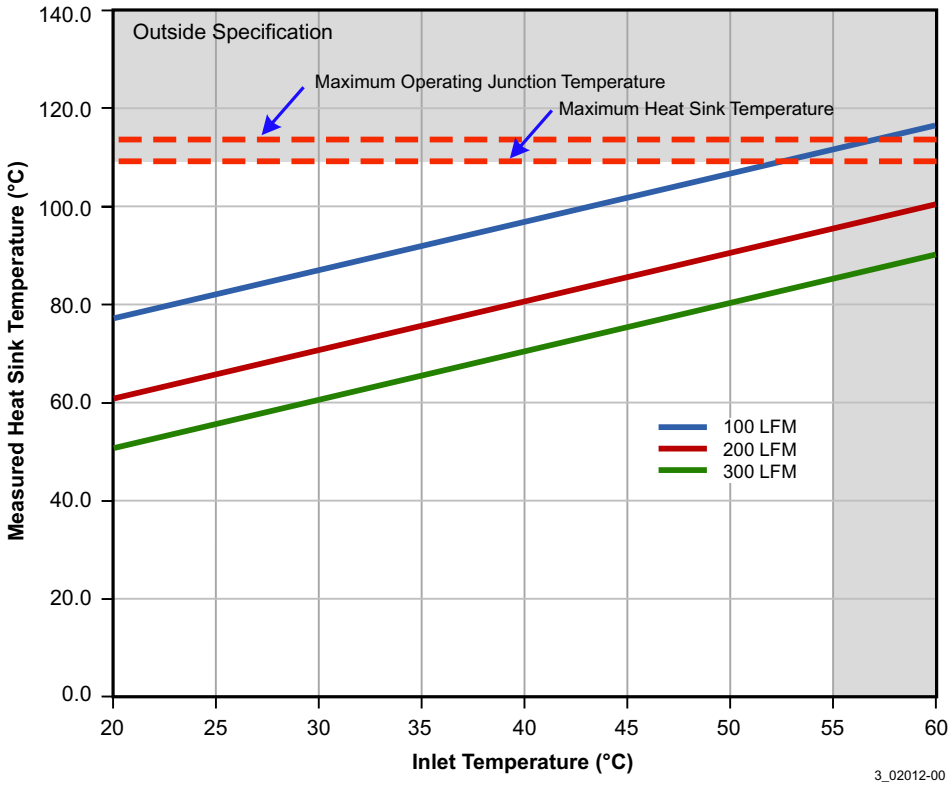
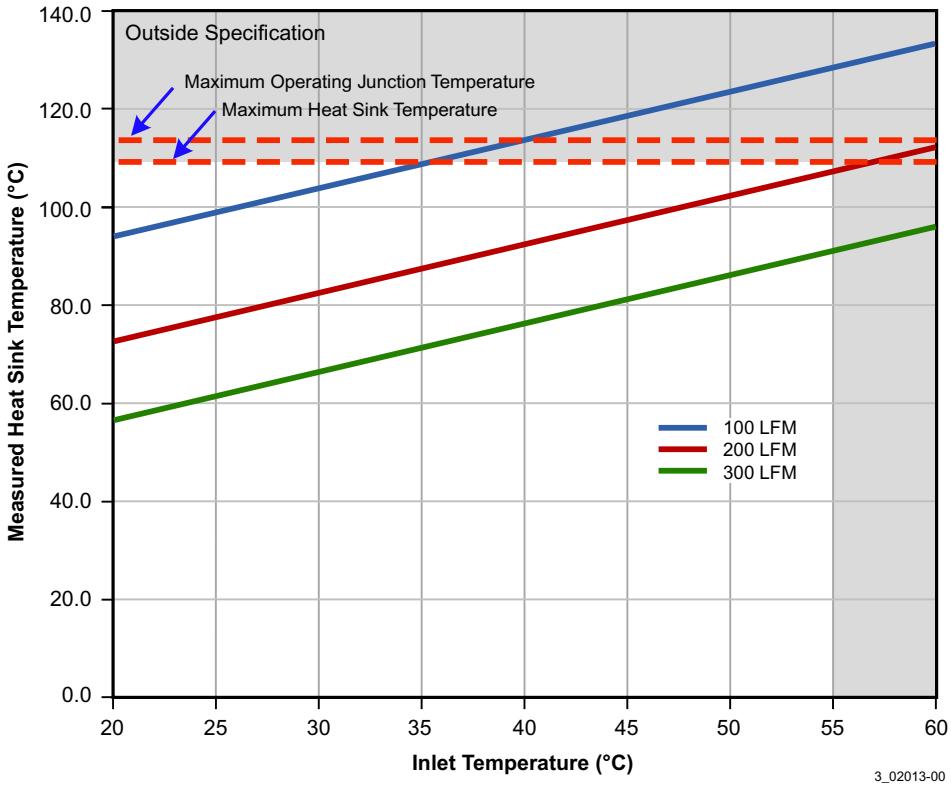


Figure 3 LSI SAS 9206-16e Controller Chip A (Nearest the Connector) Temperature Chart



5 Example

You must verify operation specific to your system. The following example demonstrates how to verify a possible system scenario.

This example uses the heat sink on the board, controller chip A, nearest the connector. The inlet temperature and the heat sink temperature that you measure are:

- Inlet temperature = 40 °C
- Heat sink A temperature = 103 °C

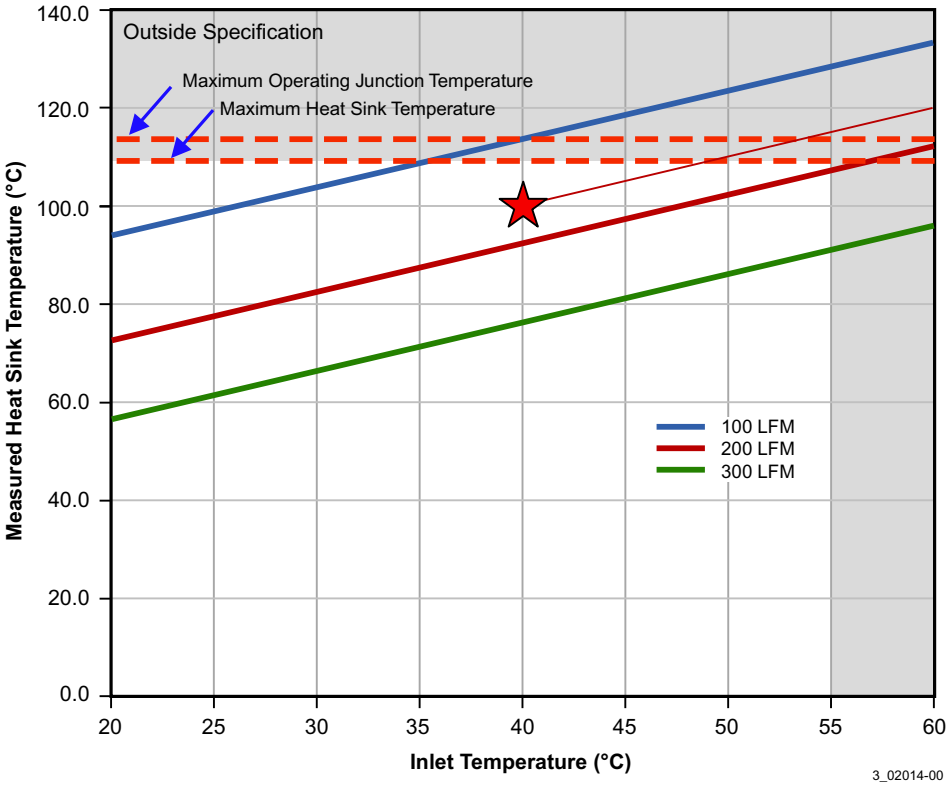
Complete the following steps using this information to verify the system operation.

1. Plot these values on the chart in Figure 3.
2. Extend this point parallel to the other airflow lines and intersects the Maximum Heat Sink Temperature line. See Figure 4 for the chart.
3. Interpolate between airflow lines to find the effective airflow rate. In this example, 165 LFM.
4. Locate the point where the effective airflow rate line intersects the Maximum Heat Sink Temperature line. This value is the maximum operating specification for the tested server.

In this example, the effective airflow rate is 165 LFM and the maximum operating specification is 48 °C. Prior to step 1 of this process, the inlet temperature is 40 °C, therefore, the temperature is less than the maximum, so the current setup is functional.

If the inlet temperature was greater than 48 °C, you must change the system setup. Change options include positioning the server for greater airflow or lower the operating environment expectations.

Figure 4 Example Scenario Temperature Chart



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