NLX Thermal Design Suggestions

Thermal and Mechanical Design Guide

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Contents

Figures

Revision History

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600574	1.1	• No change in the Content. Applied the latest Intel Template and formatted the document.	July 2018

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1 Introduction

This document offers thermal design suggestions for low profile NLX form factor systems. Because of the complexity of varying chassis designs, it might be necessary to modify some of the suggestions given here to achieve an effective cooling scheme. The system's cooling scheme must ensure that all components and peripherals remain within their specified operating temperature ranges. Without sufficient air flow, performance within the system could be adversely affected.

Because system fans are in many cases speed controlled, a good thermal design should account for various load/temperature ("four-corners" as defined below) configurations. Acoustics are also an important consideration, because a cool running system may not always operate quietly. Thermal and acoustic testing are necessary to demonstrate design performance.

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2 Definitions

Light load / Heavy load—Power supply output. The light load and heavy load configurations differ in that the light load does not include add-in cards or secondary hard drives.

Four corner test—Testing with the following system configurations:

1. low temp/light load;
2. low temp/heavy load;
3. high temp/light load;
4. high temp/heavy load, where low temp and high temp refer to 22°C (room ambient) and 35°C, respectively.

Power supply side—When facing front of system, side of chassis to the right of the riser card.

Motherboard side—When facing front of system, side of chassis to the left of the riser card.

Single chamber—The internal chassis space is considered a single compartment with respect to airflow. This is in contrast to a dual chamber where no significant airflow exchange occurs between the motherboard side and the power supply side of the chassis. Thus in the dual chambered system, cooling in either side of the chassis can be treated separately.

Active heat sink—Fan and heat sink integrated as a single unit and used to cool the processor.

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3 Design Suggestions

The design suggestions described below were derived through testing NLX chassis assemblies that incorporate a one-fan single chamber approach with an active processor heat-sink solution (refer Figure 4-1).

3.1 Fans

Fans implement the forced convection approach to cooling. Stated simply, the greater the air velocity over the surface of a component, the greater the heat transfer from that component. As shown in Figure 1, airflow is drawn into the chassis by action of the power supply fan. The power supply fan induces a negative pressure (relative to room ambient) inside the chassis, which draws in through the vents. This inflow of air from the vents is pulled through the chassis andexhausted out the power supply. The advantage of using a fan to depressurize the chassis is that cool room ambient air can be delivered (via vents) to any location where it is needed to enhance heat transfer. It has been demonstrated that, with proper implementation, using a fan to depressurize the chassis produces significantly greater cooling than does using the same fan (or two fans in series) to pressurize the chassis. Fans may differ in their characteristics, and therefore a prudent choice of fans can optimize both airflow and acoustics.

Key considerations

- Fan size—One 80mm, 30CFM, .14amp, fan should be adequate. For lower acoustic levels try a fan with a lower current/speed rating. For greater thermal margin try a fan with a greater cfm/speed rating.
- Fan type—Tube Axial. Airflow and acoustic characteristics of some equivalently-sized fans may differ significantly between manufacturers.
- Fan location—Using an adequate fan to exhaust air out the power supply, along with proper venting, should yield sufficient cooling throughout the chassis. It should be noted that specifics of fan mounting and features of components near the fan can have a significant impact on sound generation.

3.2 Fan Speed Control

Fan speed control allows a system to vary its airflow as changes in load and/or temperature occur. Fan noise increases with fan speed and is a major contributor to total system noise. For systems that incorporate fan speed control, proper speed regulation is important because it is desirable to achieve low acoustic levels without overheating components. The fan speed control circuit should be designed such that it monitors temperature at a component (or several components) and adjusts fan speed as necessary to maintain the required thermal margin. For fans used in most systems, speed control can usually be accomplished by varying the voltage level at the fan's power terminals (many power supplies/fans are equipped with this feature). An operating voltage range example for an 80mm, 30CFM, .14amp fan might be 8V to 12V DC, corresponding to 1650rpm and 2500rpm, respectively. It should be noted that some fans need a minimum starting voltage (refer fan specification).

Key Considerations

- Is fan speed controlled? If so, how? Locations where temperature is monitored are important (sensing critical component case temperatures is recommended). It is suggested that the designer try an 8V to 12V DC operating voltage range (1650rpm to 2500rpm operating speed range).

  Fan noise increases with fan operating voltage/speed. Minimum fan noise occurs at maximum fan power efficiency (refer fan specification).

- If the fan is not speed controlled, at what voltage/speed level is it operating? Because it is not possible to vary fan speed, choose the lowest rated fan speed that will cool the system under worst-case loading/temperature conditions.

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4 Venting

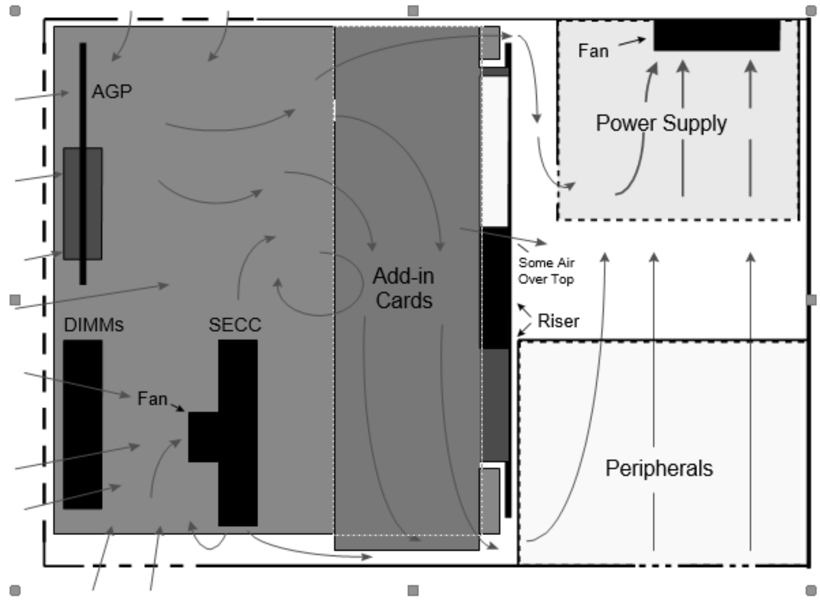
Proper venting is a key element in any good thermal design. As described earlier, the chassis can be depressurized by fan action, which permits an inflow of cooler air through the vents. This air can be made to flow in where needed to cool certain critical locations (ducting may be helpful here). The vent locations in Figure 4-1 have demonstrated adequate cooling during thermal testing.

It must be emphasized that a balanced vent configuration is a critical factor; therefore, implementing too little or too much venting could produce adverse cooling affects. To increase airflow through the system, all components should present the lowest possible air impedance. Thus, generous venting into the power supply is a necessity because practically all air that enters the system must exit via the power supply. Venting at the fan exhaust should also be as liberal as possible (round Chrome* wire grills should prove to be a good choice). Power supply cables and drive signal cables should be kept short and properly folded. Components within the power supply can be made low profile and streamlined. Venting at the riser card is crucial because air must pass from the left to right side of the chassis in a single chamber system. With proper venting both at the front and back of the riser card, air can flow over the surface of each add-in-card as it passes from the left to right side of the chassis, cooling as it goes. To eliminate possible electromagnetic compliance issues at chassis vents, neither the maximum vertical nor maximum horizontal vent dimension should exceed 1.27cm (1/2-inch).

Key considerations (refer Figure 4-1)

- Front bezel venting—Affects cooling of motherboard side and helps deliver airflow to processor. Make the bezel vent area as large as possible. Tests show high degree of cooling for an area of 23.0cm2.
- Riser card—Maximize front and back riser vent areas because this is critical to overall chassis cooling. Allows for depressurization of the chassis and draws air over add-in cards. Tests show high degree of cooling for an area of 6.6cm2 at riser back and 11.0cm2 at riser front.
- Side chassis venting motherboard side—Critical to motherboard side cooling (cools A.G.P. card). Keep vent dimensions less than 1.27cm (EMI). Tests show a high degree of cooling for an area of 19.0cm 2 spread evenly across the lower 1/3 of chassis side.
- Rear chassis venting—Adds air inflow to back of chassis (cools A.G.P. card). Tests show a high degree of cooling for an area of 5.2cm2.
- Riser card/power supply separation—Provides passage for airflow from back riser vent to power supply. Tests show a high degree of cooling for separation length of 1.5cm.
- Chassis venting peripheral bay—Cools peripherals. Minimal venting here (<5cm2) should produce adequate results. In fact, implementing too much venting here may cause lower airflow in other areas of the chassis.
- Power supply—Full venting across the front of the power supply with some venting on the left side. Tests show a high degree of cooling for an area of 48.4cm2 at front and 4.8cm2 at side. Chrome* wire grill for fan. Low profile and streamlined components in power supply offer decreased airflow impedance. Keep cables short and folded appropriately.

Figure 4-1. Typical Airflow Patterns in an NLX Chassis



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