

Sanyo Denki America

Cooling Systems Division

Designing for Optimized Fan Acoustics

Agenda

- 1. What is fan noise
- 2. Where does fan noise comes from
- 3. Fan form factor versus acoustics
- 4. Optimizing your chassis design for fan acoustics

1. What is fan noise?

Fan noise is a term used to describe the sound pressure and sound quality emitted from an air mover.

Sound pressure measure how loud something sounds

Wave of pressure fluctuation to be transmitted through the air (Longitudinal wave)



Sound is a wave

Loudness of sound : Amplitude of a wave



1. What is fan noise?

Sound quality is related to how soothing or annoying something sounds.

Sound quality is comprised of the Pitch, Tone, and Modulation.



It is measured with the fan in an ISO 10302 plenum and a Binaural Head.

Fan noise originates from 3 areas of a fan in operation:



Wind Noise – Generated from the impeller hitting the air

The number of blades on a fan impeller affects the frequency of the sound emitted.

For every revolution, a 9 blade impeller strikes the air 9 times.

Noise from a 9 blade impeller→9th order (red solid line)





Example 1:

Model: 9G0612P4S001 Speed: 11,000rpm Impeller: 9 Blades



Frequency of impeller spinning at max speed:

11,000 (rpm) /60 (sec) = 183 (Hz) •••1st order (Basic freq.)

Frequency of 9 blades spinning at max speed:





Example 2: 9LG1212P1G001

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A Fast Fourier Transform(FFT) analysis is done at 2,400rpm

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Example 2: 9LG1212P1G001

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FFT Analysis results at 2,400 rpm

2,400 (rpm) /60 (sec) = 40 (Hz) •••1st order



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Example 2: 9LG1212P1G001



Example 2: 9LG1212P1G001





When more than one fan is used, the total noise from multiple fans is not derived from adding up the sound pressure dB level of each fan.

For Multiple Fans:

$$L_n = L_1 + 10\log(n)$$

Example for 2 pcs; n = 2+10log2 = +3 dB L_n: Composite SPL of "n" pcs Fan running

Therefore, each addition of a similar fan in operation adds 3 dB. Conversely, a 3 dB reduction in sound pressure equates to halving the perceptible sound level.

3. Form factor versus fan acoustics



Axial	Centrifugal	Blower
High frequency	Low frequency	Lower frequency
High sound level	Moderate sound level	High sound level

Factors affecting fan acoustics in a chassis:

- i) Proper selection of fan type
- ii) Number of fans used
- iii) Inlet obstructions
- iv) Outlet obstructions

Proper selection of fan type:

Axial Fan – Airflow direction at inlet same as outlet. Fans

with fixed outlet vanes have added noise.

Centrifugal Fan – Inlet airflow makes 90° turn and exhausts radially

Blower – Inlet airflow makes 90° turn and exhausts through a fixed outlet cross-section

The most suitable fan type will have the best efficiency to draw and exhaust air from the chassis





Number of fans used:



Using more fans increases noise levels.

If no space constraints exist, using larger fans reduces the number required for the same amount of airflow.

Inlet obstructions:

Examples of inlet obstruction are fingerguards, face plates, and components.

*Comparison with a finger guard attached on the inlet side Fan: 9S0812M401



*Unlike the outlet side, an obstruction on the fan inlet side causes the noise levels to greatly increase.

Outlet obstructions:

Examples of outlet obstructions are fingerguards, fixed vanes, sheet metal perforations, components

*Comparison with a finger guard attached on the outlet side Fan: 9S0812M401



Noise levels differ depending on the grill shape. The larger the grill opening, the less noise will be generated.



Relation Between Noise and the Distance to Obstructions



Relation Between Noise and the Distance to Obstructions

Proposal for reducing noise

Distance the fan from an obstruction as much as possible.



*At the minimum, leave a space greater than the width of the fan ventilation area (doughnut-shaped portion) to prevent turbulence and enhance the noise reducing effect.



With an obstruction on the fan inlet side, it is important to leave as much space as possible.

4. Optimizing chassis design for fan acoustics Other Methods of Reducing Noise

Proposal for reducing noise

Use a mounting surface with a larger area than the fan opening.





Removing obstructions on the fan inlet side is an effective way to reduce noise.

Conclusion

As was shown in the preceding slides, there are a multitude of factors that affect the noise level of a fan in a chassis.

Educated selection and placement of a fan and its surrounding components is the best way to minimize the sound levels.

These considerations need to be taken as early in the chassis design and layout as possible, since it is difficult to implement a change once the fan and chassis designs are finalized.

Thank You!