LMS Engineering services
HVAC thermal energy optimization
Using virtual testing to enhance vehicle comfort and energy efficiency

Benefits

- Develop the HVAC system to achieve optimal thermal comfort and low energy consumption
- Simulate vehicle components, the integration of systems and the combined system to make the best conceptual choice
- Assess coupling between the cooling system and AC loop
- Balance thermal comfort with other functional performance aspects
- Design and validate the system's control strategy

Summary

LMS™ Engineering services optimize the heating, ventilation and air conditioning (HVAC) system. By using 1D system simulation software with libraries for thermal analysis, air conditioning and two-phase flow, LMS Engineering experts increase thermal comfort and energy efficiency.

High-functioning HVAC systems are crucial for providing overall comfort in the cabin. But achieving thermal comfort with the ever increasing pressure for better fuel economy is a challenging task. This is particularly the case when building next-generation hybrid and electrical vehicles, in which inefficient HVAC systems can impact overall performance. The more power that is taken from the battery, the lower the vehicle's autonomy becomes. By simulating the system and its components as well as system integration in the vehicle, engineers can deliver optimal thermal comfort at low energy cost.

As HVAC systems interfere with major functional performance aspects, such as comfort and fuel economy, it is crucial to include validation and testing in the early design stages. Only then can comfort and fuel efficiency be properly optimized within the given boundary conditions. The 1D system simulation helps engineers virtually test the entire system and its components as well as the integrated systems in the vehicle. Depending on the availability of the data, this can be applied in a scalable manner throughout the design cycle. It is used to evaluate various concepts and select the best architecture. During the next phase, the objective is to further refine the system, taking into account the entire energy management inside the vehicle. And finally the system is optimized by using virtual models that include real vehicle data.

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A typical HVAC thermal energy optimization project is comprised of the following phases:

**Component and system validation**
LMS Engineering experts use LMS Imagine. Lab Amesim™ software and its libraries for refrigerant loop simulation to dimension HVAC components and validate the entire system. This helps LMS experts to understand transient system behavior by enabling them to model air conditioning loops. Additional libraries for passenger thermal comfort simulation allow combining the HVAC with a vehicle interior. By using these coupled models, components can be further refined and control strategies initiated.

**Assessing vehicle integration and energy management**
In a second phase, LMS Engineering can further detail the cabin models by using libraries from the LMS Amesim solution for vehicle energy management. These refined models allow balancing passenger comfort with fuel economy and studying the effect of architecture and material changes. In this way, optimal system integration can be assured, taking into account the boundaries set by other functional performance aspects.

**Optimizing control strategy**
Finally, LMS Engineering optimizes and validates the control strategy using model-in-the-loop (MiL) to offer the best possible thermal comfort.