

Construction of an Integrated MBD Environment for Vehicle Power Supply System Development and Its Application Benefits

- Feasibility Evaluation of Vehicle Power Supply Systems Using MILS/HILS -

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1. Preface

With the progress of CASE, the number of electrical components installed in automobiles is increasing, and auxiliary power supply systems are required to offer higher capacity, higher reliability, and higher functionality. Conventionally, the system was relatively simple, consisting of an alternator, a lead-acid battery, and various electrical loads, and was realized mainly by managing the battery terminal voltage.

In recent years, the application of Lithium-ion Batteries (LiB) to auxiliary power supplies has advanced, and in particular, LiBs require integrated control that takes into account the charge/discharge current, temperature, State of Charge (SOC), State of Health (SOH), and functional safety in addition to conventional voltage control. Therefore, a system design in which the Battery Management System (BMS), the DC-DC converter, and the vehicle control ECU work in coordination is required, and its complexity increases significantly. Feasibility evaluation at the level of individual components is extremely difficult, and specification changes in the later stages of development have a large impact on performance and cost, so the importance of system feasibility evaluation in the early stages of development is increasing.

In this report, the technical issues in auxiliary power supply system development are organized, an integrated Model In the Loop Simulation (MILS)/Hardware In the Loop Simulation (HILS) environment coupling a control model and an electrical circuit model is constructed, and the pre-vehicle-build methods for system feasibility and desk-based performance evaluation and their application results are reported.

2. Technical Issues in Auxiliary Power Supply System Development

The vehicle auxiliary power supply consists of two power sources connected in parallel, a generator and a battery. The generator is responsible for the functional requirements of charging the battery and supplying power to the vehicle's electrical components, while the battery is responsible for the functional requirements of supplying the vehicle system startup power and assisting transient high-power supply. Because these functional requirements are affected by the performance of each component, such as the vehicle installation layout, wiring resistance, DC-DC converter output performance, cell characteristics, CAN communication cycle, ADC resolution, SOC management specifications, and charge control specifications, it is difficult to judge the validity of the vehicle system requirements from stand-alone component performance alone, which has become a cause of specification reviews in the later stages of development after vehicle evaluation.

Furthermore, auxiliary LiBs are in a transitional period of adoption, making it difficult to define necessary and sufficient requirements in the early stages of development. As a result, cost increases due to excessive requirements and unnecessary performance negotiations with suppliers occur, becoming factors that reduce development speed and cost performance.

Defining necessary and sufficient requirements in the early stages of development is the challenge for improving cost performance and development speed.

3. Chapter Summary

In this study, a MILS/HILS environment integrating a control model and an electrical circuit model was constructed, making it possible to evaluate system feasibility, control feasibility, and reliability at an early stage of development and before vehicle fabrication. This enabled validation of each component specification and improved accuracy in requirement definition, and it was confirmed to be effective in reducing rework and improving development efficiency.

Going forward, we aim to achieve further improvements in accuracy and speed by accumulating data through actual vehicle evaluation and feeding it back into MILS/HILS.

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