

Ground Layout Design Considering Voltage Drop in Multiple Electronic Components

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KEY WORDS: Vehicle dynamics, Steering system, Driving stability, Body resistance [B1]

Modern vehicles contain numerous electrical components, and voltage drops resulting from load fluctuations may affect their operation. However, in the early stages of development, input conditions, including the selection of grounding points and the placement of electrical components, are not yet determined. In addition, the combinations of these input conditions are enormous, and the conditions influence one another, making individual evaluation of all conditions impractical. To address this issue, this paper proposes a grounding layout evaluation method based on the voltage drop (ΔV) for efficiently investigating grounding layouts under diverse input conditions.

The proposed method consists of three stages: single-point input evaluation, multi-point input evaluation, and input-condition trend analysis. First, in the single-point input evaluation, current is applied individually to each grounding point, and ΔV is evaluated. Based on the results, grounding points that tend to exhibit large voltage drops are identified, and measures such as relocating grounding points are considered to reduce the voltage drop.

Next, in the multi-point input evaluation, average voltage drop (ΔV_{ave}) and voltage drop range (ΔV_{range}), representing the variation among grounding points, are calculated from the ΔV values obtained at each grounding point under multiple input conditions. ΔV_{ave} represents the overall level of voltage drop, whereas ΔV_{range} represents the imbalance among grounding points; lower values of both indices are desirable. Furthermore, in the input-condition trend analysis, common characteristics of the extracted favorable conditions are identified to determine the features of input conditions that facilitate securing voltage margin, defined as the difference between the actual voltage supplied to each electrical component and its required voltage. The obtained results are then used as guidelines for determining grounding layouts in the later stages of vehicle development.

The proposed method was validated using a simplified plate model, and its application was demonstrated using a body-shell model of an actual vehicle. In the latter case, a single-point input evaluation was first conducted for seven candidate grounding points. After excluding candidate points with large voltage drops, a multi-point input evaluation was performed for 30 conditions using the selected five points. The results showed that both ΔV_{ave} and ΔV_{range} could be reduced by assigning electrical components with high current consumption to specific grounding points. These findings can be utilized as guidelines for determining grounding points for individual electrical components. Furthermore, analysis of the body-shell voltage drop distribution confirmed that differences in current allocation at the front part of the body affected the voltage drop distribution even in the rear part of the vehicle body.

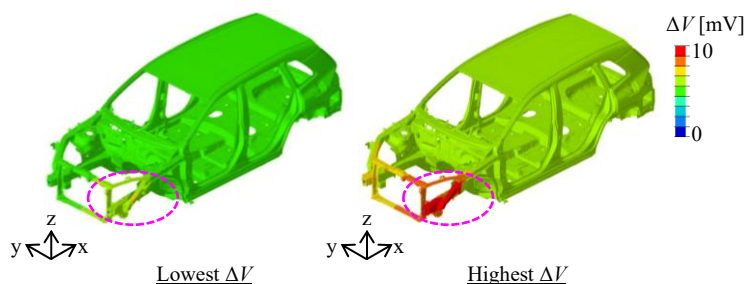


Fig.1 Comparison of voltage drop distributions

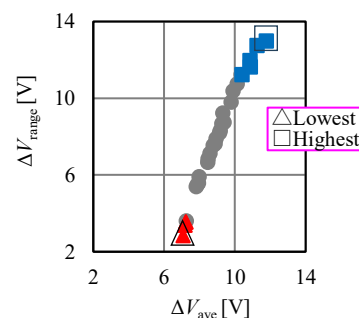


Fig.2 ΔV metrics for 30 cases under multiple input conditions