An Optimal Environmental Test Sequence Based on Severity for Electrical Units in Automobiles

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1. Introduction

Electrical units feature electrical and electronic components that use battery power, including the small printed circuit boards (PCBs) used in various devices. Electrical units of automobiles and railway vehicles must be very safe and reliable. Reliability issues triggering vehicle recalls are common. Test sequences are used to reduce reliability problems, particularly those associated with different environmental conditions. Using operations research techniques, we created an environmental reliability test sequence by reference to ISO16750. The ISO16750 test sequence was determined by operation research with severity.

2. National standard MIL-STD-810G sequence

Tests associated with environmental testing of electrical units include low pressure (altitude), high temperature, low temperature, temperature shock, solar radiation (sunshine), rain, humidity, fungus, salt fog, sand and dust, and immersion [1].

Prior to determine ISO16750 test sequence, MIL-STD-810G test sequences were checked as recommended. Following checked recommendation, MIL-STD-810G test sequences were schematized [2, 3].

3. Severity of ISO 16750 test items based on analytic hierarchy process

We used analytic hierarchy process (AHP) to offered severity of ISO 16750 test items [4-6]. In accordance with field conditions, electrical units of automobiles classified depending on three mounting position.

To carry out AHP, we determined five criteria. A pairwise comparison matrix was created to calculate weights between criteria within the same hierarchy. In order to verify that appropriate weights were calculated, we checked the consistency index and the consistency ratio.

Calculated scores have been severity of ISO16750 test items. Then, scores will be used at objective function.

4. Environmental test (ISO 16750) sequence optimization

We maximized the severity of test leg associated with determined severity of ISO16750 test items based on AHP. Then, a difference in severity among legs was limited as predetermined value.

In addition, we have assumed practical industrial environment. Thus, constraints have been total test time and cost. The final test sequences were optimized in the operations research context, using a generic algorithm.

5. Conclusions

Using the existing individual testing protocols, it is not possible to simulate and prevent field failures of electrical units because several environmental stressors are not evaluated; thus, a new reliability concept is needed. Hence, we examined the military national standard mentioned above when constructing reliability test sequences simulating the field failures not detected by existing reliability tests. We performed AHP based on the test items of ISO16750 and field failures of electronic components mounted in different places. To emphasize the importance of the environmental tests, ISO16750 test items were defined severity, objective functions and constraints were established, and modeling was performed using a generic algorithm. The modeled functions were applied to integer programming performed in Microsoft Excel. We derived environmental test sequences to maximize severity of leg by practical case.

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