Development of New BCM

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Abstract

Number of electronic units in a vehicle has recently been increasing. This trend extended the lead time for assembly and increased standby current, which may cause flat battery during vehicle transportation. Thus zero standby current is required along with shortened assembly time. In addition, efficient evaluation procedure was needed as more and more complex functions are included. This time Calsonic Kansei developed new BCM design that addresses these issues. Also new evaluation method has been employed in the course of BCM development.

Key Words : Zero standby current/ Snap-fit/Auto full testing

1. Introduction

With an increase of the number of electronic units installed on recent vehicles, BCMs are required to meet the following three needs: first of all, zero standby current to avoid possible flat battery during vehicle transportation, simple structure for vehicle installation to reduce assembly lead time in the second, and function evaluation environment and test method corresponding to increase of BCM's function.

In the development of the new BCM shown in Fig. 1, we have satisfied theses needs by introducing the "Super Sleep Mode" for achieving zero standby current, adopting a snap-fit structure that can shorten installation time, and introducing completely automated function evaluation environment.

Fig. 1 New BCM

2. Super Sleep Mode

As shown in Fig. 2, the new BCM is connected to two power supply lines: the ignition (IG) line that supplies electric power via the ignition switch (IG SW), and the +battery (+B) line that supplies directly from the battery using a fuse. The +B line is further divided into +B1 and +B2 lines. In the +B1, the fuse is removed during vehicle transportation. On the other hand, in the +B2, constant power supply is available.

As shown in Fig. 2, zero standby current is realized by adding the power control circuits "a" and "d" in the +B2, which allow electric power supply into the BCM only when vehicle operation is necessary.

2.1. Basic function for BCM operation

The BCM comprises an input interface (IN I/F) for directly monitoring a vehicle state, a serial communication interface (S I/O IF) for obtaining information from other units and distributing BCM information, an output interface (OUT I/F) for controlling auxiliary parts such as driving a wiper, and a microcomputer (MPU) for controlling all these interfaces.

The BCM is connected to three power supply lines: +B1, +B2, and IG. During normal operation, the +B1 is selected from these three lines.

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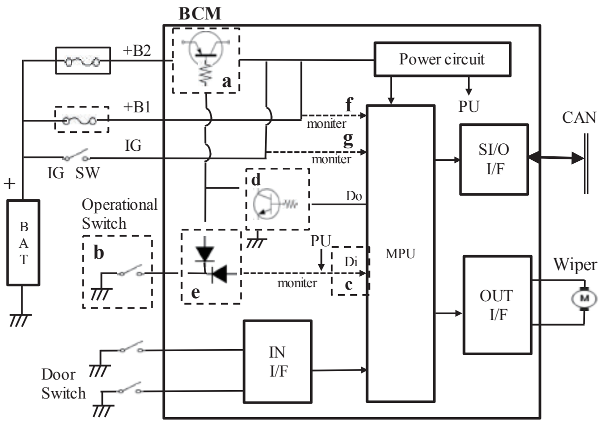


Fig. 2 Power control circuit of BCM

While the ignition is on, or while the vehicle is under operations such as door opening/closing or processing control such as room lamp lighting-on/-off, the BCM keeps an operation state. When the ignition is turned off and vehicle operations are not monitored for a certain period of time, the MPU stops communications and shifts the BCM to sleep mode (low current consumption mode). Fig. 3 illustrates an overview of BCM state transition between several modes.

2.2. Transition to Super Sleep Mode

The BCM goes into the Super Sleep Mode when the fuse is removed from the +B1 line. In this mode, the BCM is connected only to +B2, constantly-connected power supply line. However, as the circuits "a" and "d" shown in Fig. 2 are not operative, power supply to the internal circuits can be completely shut down and as a result the BCM can realize "zero" current consumption.

2.3. Transition to operation from Super Sleep Mode

Block (A) in Fig. 3 illustrates a state transition of BCM from the Super Sleep Mode to other Modes. When the operation switch "b" (shown in Fig. 2, such as a trunk switch) is pressed and held for a certain short period of time, the power supply control circuit for feeding electric power to the internal circuit is activated and the MPU is started up.

Then the MPU determines whether the fuse has been removed from the +B1 by monitoring the circuit "f." shown in Fig. 2. When the fuse has been removed, the MPU drives the circuit "d" for power source self-holding. Thus the power control circuits are set to an operation state and the BCM starts normal operation. When vehicle operations are not observed for a certain period of time, the MPU turns off the power control circuits and returns the BCM to the Super Sleep Mode.

2.4. Engine start-up from Super Sleep Mode

In the same way as 2.3, when the ignition is turned on to move the vehicle out of a motor pool during the Super Sleep Mode, the power control circuits are set to an operation state and BCM starts normal operation (Block (B) in Fig. 3).

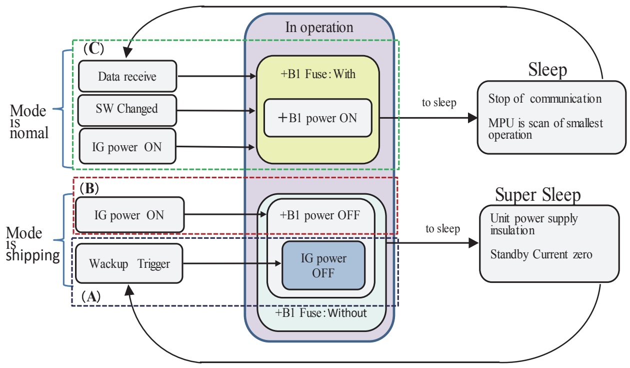


Fig. 3 State Transition Diagram

Thus, we have achieved zero standby current by shutting down power supply to the internal circuits when BCM operations are not necessary with the installation of the operation switch that can activate the power control circuits as required.

3. Simplified structure for vehicle installation

While a conventional BCM is fastened to a vehicle via a bracket by screwing, the new BCM adopts a snap-fit structure that enables vehicle installation without using the bracket or screws.

3.1. Installation structure and assembly procedure

Fig. 4 illustrates a new structure employing a snap-fit. The BCM can be assembled to the vehicle in following two steps

1) Clip the BCM lower hook "a" on the vehicle-side bracket.
2) Fasten the BCM upper hook "b" into the bracket.

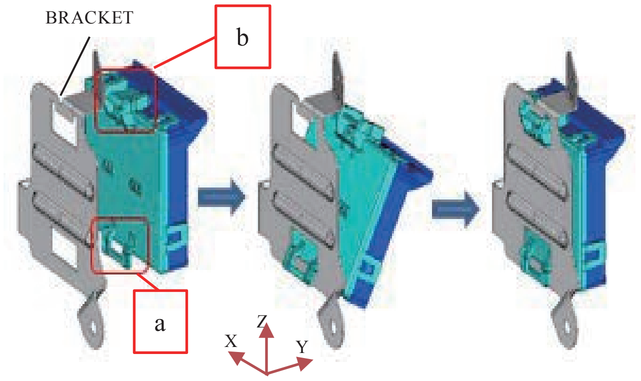


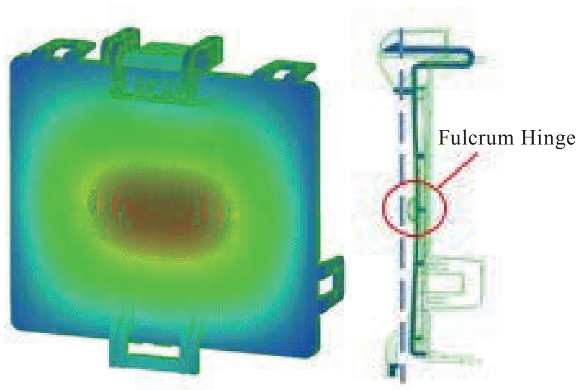
Fig. 4 Assembly Procedure to the Vehicle

Through the adoption of the snap-fit structure, the number of assembly steps has been reduced in comparison with a current structure. In addition the elimination of the bracket and screws could decrease the number of BCM components.

3.2. Issue with snap-fit structure

This snap-fit structure poses an issue of rattle that may occur during vehicle vibration. To address this issue, we added a contact rib named the fulcrum hinge at the lower case to fill a gap between the BCM hooked areas and the vehicle-side bracket. Raising the overlap amount between the rib and the bracket can increase the retaining force after installation; however, this requires a larger insertion load to be applied during vehicle installation and thereby worsen workability. We decided an optimal rib height and select an appropriate resin material by using CAE analysis as a verification tool.

Since a conventional PP material was not sufficient either in rigidity, creep resistance, or heat resistance, we employed PBT-GF30. From the CAE analysis results shown in Fig. 5, we confirmed that the requirements can be met when the contact rib has a 0.2 to 0.5 mm overlap.



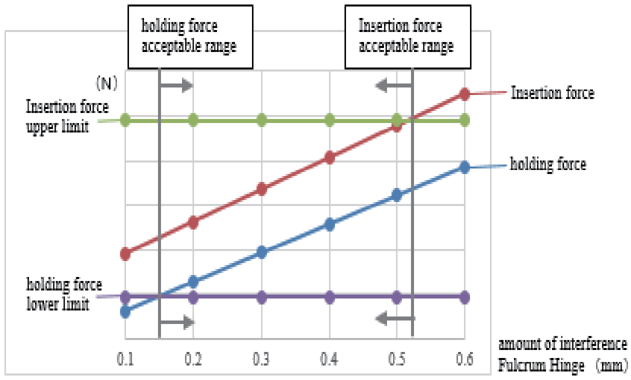


Fig. 5 Analysis results of insertion force and holding force

4. Function evaluation

In the development of the new BCM, we established and utilized an automated evaluation environment capable of reducing development cycle and improving evaluation accuracy. In addition, we applied a combinatorial testing method to evaluation item selection in order to efficiently ensure the coverage of test patterns.

4.1. Automated evaluation environment

For input control for BCM evaluation, a dedicated editor (Fig. 6) was used to create a series of control sequence (Fig. 7) called the test scenario. Since the test scenario automatically runs, we are able to continue testing 24hours a day.

With the environment, pass/fail of test results can also be automatically judged by entering expected output value of a BCM in the test scenario. Since the test scenario is stored in a reusable state, the environment is expected to be further effective especially when executing repetitive evaluations such as regression testing.

In addition, as the environment can easily control input timing as well as input values to a BCM, we carried out additional evaluation to confirm the effects of different input timing by every 1 ms.

Fig. 6 Auto Validation System

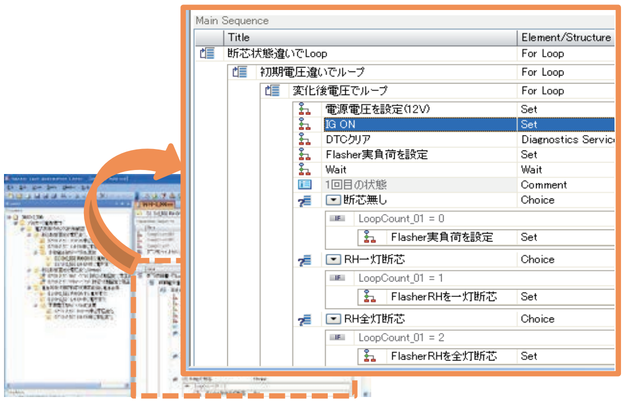


Fig. 7 Test scenario

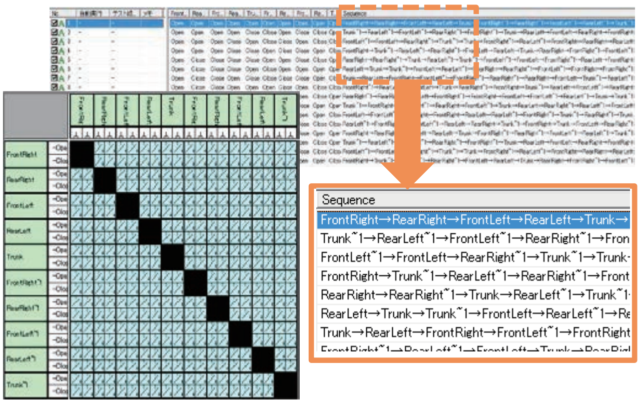


Fig. 8 HAYST Method

4.2. Improvement of coverage of test patterns

Evaluating products by simulating all possible combinations of relevant inputs causes an exponential increase in test patterns. Therefore even if evaluation can be expedited with the automated environment, it may not be feasible.

To address this issue, we introduced a new test pattern creation method called the HAYST® (Highly Accelerated and Yield Software Testing) to the evaluation. The HAYST is a test design method for ensuring a high level of error detection while reducing test patterns by extracting a factor and level of each testing input value and creating a combination between two factors as a test pattern.

The dedicated software allows automated execution of test pattern creation based on the HAYST. We applied this software to our preliminary study of test items and thereby could create test patterns efficiently. Fig. 8 illustrates an example of the test patterns created by the HAYST. In this example, we could reduce the necessary number of test patterns from 1024 to 16 regarding each vehicle door operation.

Remarks: The HAYST is the trademark of Fuji Xerox Co., Ltd.

5. Summary

The newly developed BCM has been produced for Mazda Motor Corporation's Demio and Roadster since October, 2014. We will expand the range of applications of its snap-fit structure, Super Sleep Mode, and automated evaluation. In particular, we will promote further efficiency improvement of the automated evaluation by sharing the test scenario among other vehicle models and vehicle manufacturers.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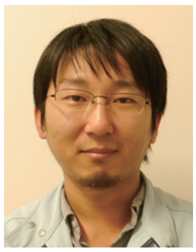
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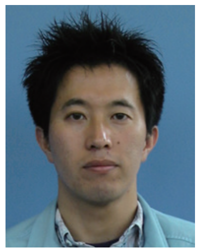
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