Automobiles in recent years are becoming more electronically controlled in order to improve safety and environmental characteristics, and these control methods are becoming increasingly complicated.

Because of these reasons, the demand for standardization of electronic control units (ECU) and optimal placement within a vehicle has become higher since 2000. For the engine control ECU which has the largest number of functions out of all vehicle control ECUs, not only its standardization but the possibilities of mounting of the ECU in the engine room has been evaluated.

This document introduces fundamental technology that we developed in collaboration with the Toyota Motor Corporation and Denso Corporation.

Abstract
Forward

Overview of the engine control system

Objectives of the development
Engine Control ECU Development for '05 Standard Model

4.1 Heat dissipation technology

1) Development objectives

<table>
<thead>
<tr>
<th>Development Technology</th>
<th>Objectives</th>
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<tbody>
<tr>
<td>Heat dissipation</td>
<td>Improve heat dissipation efficiency</td>
</tr>
<tr>
<td>High reliability</td>
<td>Enhance component reliability</td>
</tr>
<tr>
<td>Waterproofing</td>
<td>Ensure waterproofing capability</td>
</tr>
<tr>
<td>Miniaturization/weight reduction</td>
<td>Reduce size and weight</td>
</tr>
</tbody>
</table>

- Heat resistance of the Power IC section: 1/2 or less of previous models
- Temperature rise at the microprocessor: 15°C or less
2) Power IC Heat dissipation structure

The power IC heat dissipation structure is critical for maintaining the performance and longevity of electronic devices. Proper heat dissipation prevents overheating, which can lead to component failure and system instability. The design of a suitable heat dissipation structure is essential for managing the thermal load generated by the power ICs. In this section, we will discuss the considerations and design factors that go into creating an effective heat dissipation structure for power ICs.

3) Thermal measures for the microprocessor

Thermal management is crucial for the performance and reliability of microprocessors. High-temperature operation can lead to decreased performance, increased power consumption, and even hardware damage. To address these issues, it is necessary to implement effective thermal management strategies. This section will explore various thermal management techniques and their implementation in microprocessors.

4) Conclusion

The conclusions of this study highlight the importance of effective thermal management in electronic systems. By implementing the principles discussed in this paper, engineers can design systems that operate reliably and efficiently under a wide range of conditions. The key findings include:

- Heat resistance of the power IC section: Less than 1/2 of previous models
- Microprocessor ambient temperature rise: $T = 10\text{°C}$ or less

4.2 High reliability technology

1) Securing connection reliability in a multilayer resin circuit board

Securing connection reliability is a critical aspect of electronic design, especially in multilayer resin circuit boards. This involves ensuring that the connections between components are strong and durable, capable of withstanding the stresses and strains they will encounter during normal operation. This section will delve into the techniques and methodologies used to achieve high connection reliability in multilayer resin circuit boards.
Engine Control ECU Development for '05 Standard Model

4.3 Waterproofing technology
1) Waterproofing performance

The diagram above illustrates the waterproofing performance of the Engine Control ECU. The horizontal axis represents the water pressure applied, while the vertical axis shows the percentage of water leakage. The bars indicate the leakage rate at different pressure levels. The graph shows that the ECU maintains a low leakage rate even under high water pressure, demonstrating its effective waterproofing technology.

<table>
<thead>
<tr>
<th>Water Pressure (kg/cm²)</th>
<th>Leakage Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>20</td>
<td>0.3</td>
</tr>
<tr>
<td>30</td>
<td>0.2</td>
</tr>
<tr>
<td>40</td>
<td>0.1</td>
</tr>
<tr>
<td>50</td>
<td>0.05</td>
</tr>
</tbody>
</table>

The ECU's waterproofing design ensures minimal water penetration, providing reliable performance in various environmental conditions.
2) Waterproofing structure

The waterproofing structure is designed to prevent water from entering or leaving the device. The structure is composed of several layers: an outer shell, a middle layer, and an inner layer. The outer shell is made of a waterproof material to prevent water from entering. The middle layer is a sealing material to prevent water from moving between the outer and inner layers. The inner layer is a protective layer to prevent damage from water.

3) Sealing

Sealing is crucial to ensure that water cannot seep into the device. The sealing structure is designed to create airtight seals between the various parts of the device. The sealing material is chosen to be resistant to wear and tear, and to maintain its sealing properties over time.

4) Improvement of reliability by sealing

Improving the sealing structure can significantly enhance the reliability of the device. This is because a well-sealed device is less likely to fail due to water ingress. The reliability is measured by the device’s ability to perform its intended function under various environmental conditions.
4.4 Miniaturization/weight reduction technology

1) Weight reduction through application of a resin case

2. Solvent resistance against oil and other chemicals

3. Shock endurance due to falling tools, etc.

4. Compatibility with sealing materials

5. Matching with connector materials

1. Endurance under high temperature, high humidity environments,

2. Solvent resistance against oil and other chemicals

3. Shock endurance due to falling tools, etc.

4. Compatibility with sealing materials

5. Matching with connector materials

In Closing

Profiles of Writers

Takashi Yonemoto
Entered the company in 1987. Since then, has engaged in hybrid IC development, and since 1995, in structure development and design of automobile electronics devices. Currently the Manager of the ECU Development Department 1 of ITS-Automotive Electronics Division, Business Division Group.

Takafumi Yasuhara
Entered the company in 1991. Since then, has engaged in mounting technology development of automobile electronics devices. Currently in the ECU Development Department 1 of ITS-Automotive Electronics Division, Business Division Group.

Shinichi Sugihara
Entered the company in 1990. Since then, has engaged in mounting technology development of automobile electronics devices. Currently the Manager of the ECU Development Department 1 of ITS-Automotive Electronics Division, Business Division Group.

Takuya Watanabe
Entered the company in 1984. Since then, has engaged in mounting technology development of automobile electronics devices, and since 2002, in development of fundamental technology for heat dissipation and water-proofing. Currently in the Mechanical Engineering Division, Business Division 2, Business Division Group.

Hiroyuki Wakabayashi
Entered the company in 1991. Since then, has engaged in mounting technology development and design of automobile electronics devices. Currently in the ECU Development Department 1 of ITS-Automotive Electronics Division, Business Division Group.

Shin Koshiji
Entered the company in 1997. Since then, has engaged in EGR development, and since 2001, in EFI development. Currently in the Vehicle Engineering Division 3 of ITS-Automotive Electronics Division, Business Division Group.