New CAN Calibration Method by using Diagnostic Message in AUTOSAR Platform

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Abstract. AUTOSAR was jointly developed by automotive manufacturers, suppliers, and semiconductor chip vendors in order to overcome the complexity of contemporary automotive Electrics/Electronics architecture. AUTOSAR uses a component based software design model for a development of automotive system. There is a BSW module XCP for calibration in AUTOSAR R4.x specification. But there is no calibration module such as XCP in AUTOSAR R2.x and R3.x specification. So it is impossible to calibrate an ECU without calibration module. In this paper, we propose a new calibration method without special BSW modules for calibration. The proposed method use conventional Memory Stack and Communication Stack of AUTOSAR. The new scheme can access to non-volatile memory by using diagnostic messages. And it can control an ECU with updated data in the memory.

**Keywords:** AUTOSAR, Calibration, CanTp, Diagnostic

1   Introduction

The number of ECUs has been increasing for body, transmission, chassis, and infotainment domains because many drivers want to have safe assistance and convenience system. And software development for automotive applications has become increasingly important. Currently, software controls a large number of functions that make use of linked networks. AUTOSAR is a standard about system architecture for automotive ECU (electronic control unit) [1, 2].

CCP (CAN Calibration Protocol) is an ASAM (Association for Standardization of Automation and Measuring Systems) standard for calibration purpose of an ECU [3]. This protocol provides the following basic features: synchronous data acquisition, synchronous data stimulation, and online memory calibration (read / write access). It is a software interface used to interconnect a development tool with an ECU. There is a BSW module XCP (Universal Calibration Protocol) in AUTOSAR R4.x specification. It can support various transportation layers for calibration. But there is no BSW module in AUTOSAR R2.x and R3.x specification. So it is impossible to calibrate an ECU without XCP module.

In this paper, we propose a new CAN calibration method without special BSW module. This calibration method uses AUTOSAR communication stack modules and memory stack modules. And it can access to internal/external memories by using diagnostic messages. In section II, we reviews the conventional method for calibration with XCP module in AUTOSAR platform, while section III describes the detailed structure and design scheme of the new proposed method for calibration without special calibration modules in AUTOSAR platform. In section IV, we show the test bed for calibration test and describe the test results of the hardware implementation. Finally, section V provides some concluding remarks

2   Conventional Scheme for Calibration (with XCP module)
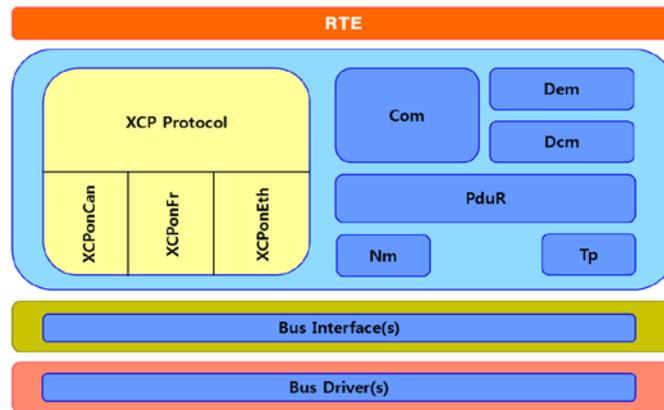
Fig. 1. Conventional scheme with XCP module.

Figure 1 shows a XCP module in AUTOSAR R4.0 specification [4]. This XCP module can support various transportation layers (CAN, FlexRay, and Ethernet). The XCP module is integrated in the ECU with AUTOSAR communication stack. The module is connected to CanIf, FrIf, and SoAd. The CAN Interface (CanIf) is used to transmit and receive XCP PDUs via CAN. The FlexRay Interface (FrIf) is used to transmit and receive XCP PDUs via FlexRay. The Socket Adaptor (SoAd) is used to transmit and receive XCP PDUs via Ethernet. Communication is conducted by Master-Slave principle. A tester is used as a XCP master. And XCP module in the ECU is used as a XCP slave.

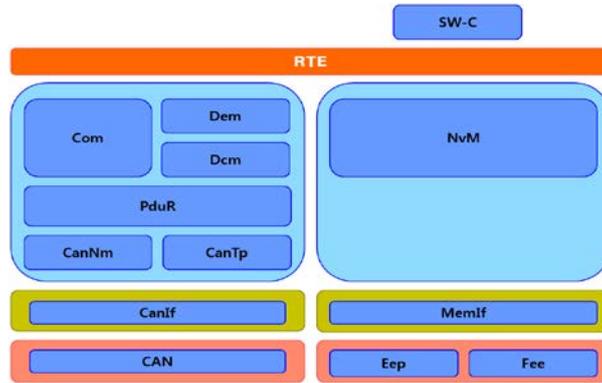## 3   Proposed Scheme for Calibration (without XCP module)

Fig. 2. Communication and Memory stack in AUTOSAR.

Figure 2 shows Communication and Memory stack in AUTOSAR R3.0 specification
[5, 6]. We propose a new scheme for calibration without XCP module in AUTOSAR
R4.0 specification. The proposed scheme uses AUTOSAR memory stack modules
instead of XCP module. In AUTOSAR layered software architecture memory stack
modules consist of NvM (Non-volatile Memory Manager) [5], MemIf (Memory
Abstraction Interface), Ea (EEPROM Abstraction), Fee (Flash EEPROM Emulation),
Fls (Flash Device Driver), and Eep (EEPROM Device Driver). These modules can be
used to abstract from memory hardware components and provide standardized access
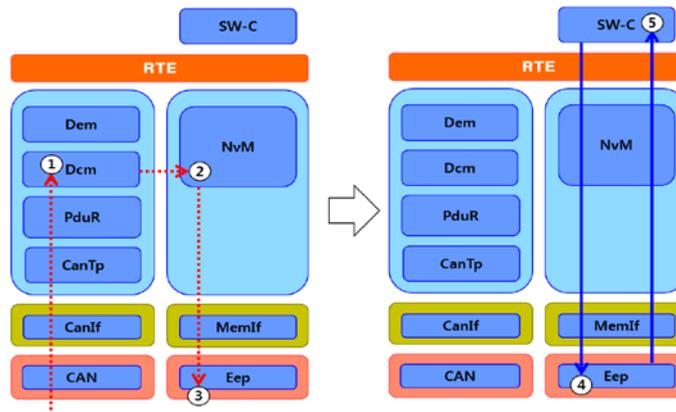to internal/external non-volatile memory.

Fig. 3. Proposed scheme without XCP module.

Figure 3 shows a proposed calibration scheme without XCP module. External tester sends diagnostic request messages to Dcm (Diagnostic Communication Manager) module. The Dcm module can parse and classify diagnostic request messages①. If the diagnostic request message is for CAN calibration, Dcm module sends the message to NvM module as shown in Figure 3②. NvM module calls APIs of Eep module to save data into non-volatile EEPROM③. SW-C (Software Component) calls APIs of NvM module to read the data in the EEPROM④. NvM module returns the data to SW-C⑤. SW-C uses the updated data in order to calibrated ECU.

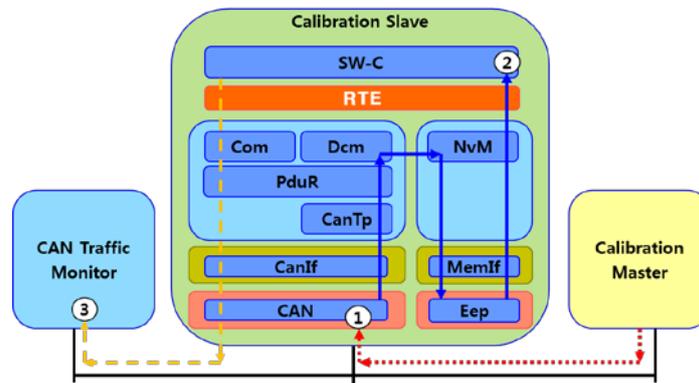## 4　　Calibration test and results

4.1　　Test Design

Fig. 4. ECU Calibration test concept.

Figure 4 shows a concept for ECU calibration test. A Calibration Master transmits diagnostic messages to a Calibration Slave①. The diagnostic messages that the Calibration Master sent have updated information to control a Calibration Slave. The Calibration Slave receives diagnostic messages and saves the data in non-volatile memory. SW-Cs in the Calibration Slave get the data from in the memory②. The SW-Cs check whether the data in the memory is changed or not. A CAN Traffic Monitor monitors all CAN protocol signals through CAN bus③.

4.2 Test Environment

Fig. 5. Test bed for ECU Calibration.

Figure 5 shows a test bed for ECU calibration. For this test, we implemented AUTOSAR R3.1 compliant communication stack modules and memory stack modules. We made an ECU target board with 16-bit Infineon X2364A MCU. The ECU target board was used as a Calibration Slave for calibration. The Dcm module in the ECU target board uses ISO15765-3 compliant UDS (Unified diagnostic services) service. And we used a VECTOR CANoe as a Calibration Master for calibration as well as CAN Traffic Monitor. The CANoe sends diagnostic messages to ECU target board and monitors the data traffic that ECU target board transmitted. The CANoe sends UDS service WriteMemoryByAddress (Service Id, 0x3d) message to write data into the memory and UDS service ReadMemoryByAddress (Service Id, 0x23) message to read data from the memory.
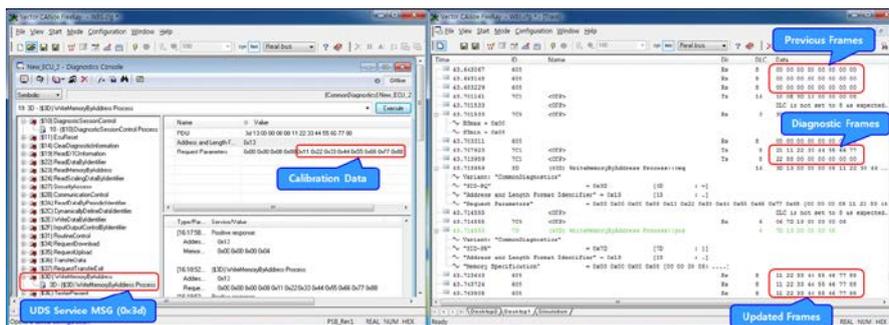
4.3 Test Results

Fig. 6. Test Result of ECU Calibration.

Figure 6 shows a test result. An ECU sends a CAN message periodically. A SW-C of the ECU makes a CAN message with the 8-byte data in the EEPROM. The initial EEPROM data is all zeros. A CANoe as a calibration master sends a UDS service diagnostic message. The service of the diagnostic message is a WriteMemoryByAddress (0x3d). The diagnostic message data is 0x11, 0x22, 0x33, 0x44, 0x55, 0x66, 0x77, and 0x88. The Dcm module sends the new data of the diagnostic message to the NvM module. The NvM module writes the new data to EEPROM. The SW-C reads the new data from EEPROM. The SW-C makes a CAN message with the 8-byte updated data in the EEPROM.

5   Conclusions

In this paper, we proposed new CAN calibration method without special BSW module like XCP for calibration in AUTOSAR platform. The proposed scheme used conventional Memory Stack modules and Communication Stack modules of AUTOSAR. With the proposed scheme, we can solve the restriction of AUTOSAR specifications which is related to a CAN calibration.

Acknowledgments

References

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