Design of Automotive instrument cluster Based on OSEK Standard

Li Yanwen[1, a], Gong Jinfeng[2], Zheng   Wei[3]

[1]China Automotive Technology & Research Center, China, Tian Jin 300162

[2] China Automotive Technology & Research Center, China, Tian Jin 300162

[3] China Automotive Technology & Research Center, China, Tian Jin 300162

[a]liyanwenforever@126.com

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Abstract. An automotive instrument cluster was designed based on OSEK standard. The system includes hardware and software. The instrument module connects high and low speed can network, and the software is developed on OSEK standard, which makes the system designed has the following characteristics: universal, modular, standardized, and serialized.

Introduction

With the rapid development of electronic technology and extensive application in the car, automotive electronics increases more, the sensor signals of automotive ECU module that need to collect become more and more, and vehicle ECU has also been widely used. These applications make the production of more advanced vehicles, but also brought a series of problems. Complexity of automobile parts control, communications and network technology has greatly increased, automotive electronics software portability is poor, software development costs has rise, system stability and reliability is decreasing largely. In response to these problems, OSEK standard technology suitable for automotive environment emerged on the basis of computer network technologies and field bus control technologies [1].

Combined with digital automobile meter and body bus system, a automotive instrument cluster that includes information collecting and control in the complete integration is formed, which has become inevitable. Fusing with instrument and microprocessors, network technology, applying digital electronic devices based on CAN bus network to replace the original mechanical movement tables, electrical meter, and analog circuit electronic instruments, digital measurement of each parameter realizes[2]. The automotive instrument cluster exchange data with the other electronic centralized control system, which benefits development and implementation of automotive centralized control system and great improvement of power, safety, reliability, comfort of automotive.

In this paper, an automotive instrument cluster design is provided, OSEK and CAN bus were used both. The system designed has such advantages as data more accurate, more reliable, wiring the most simple, more versatile, etc.

System Design Plan

Figure 1 demonstrates the system design framework. The system connected with low speed body CAN bus and high speed power bus network not only can get most of the information related to body condition from low speed body CAN bus, but also can get information related to the power system operating parameters and status from power bus. The information includes speed, engine speed, coolant temperature, fuel level, oil pressure data; various body control signals; operating status information of EPS, ABS, SRS, AMT/CVT, etc. The CAN bus can guarantee their own advantages of digital, accuracy and real-time of parameters transmission. The CAN bus digital instrument has the advantage of intelligent, not only can processes, calculates, analyzes and

determines the information and data obtained, but also can implement various real-time control and data information display.

There are two ways in display includes pointer driven by stepper motor and LCD, and various status information shows warning instructions by LCD. All kinds of fault information and the average speed, average fuel consumption, instantaneous fuel consumption and other intelligence information can be displayed on the integrated information. In the fault condition, the bus digital instrument store current state automatically, and store data in FLASH, which can be stored in power-down status and queried on the integrated information display.

TPMS receiver module is designed, which can receive, display and monitor the tire pressure information; rear view camera system is integrated, which can wider the driver field of vision; Interface with OBD, air conditioning and entertainment systems is designed; diagnostic interface including K wire and CAN wire is designed, which can diagnose vehicle fault.
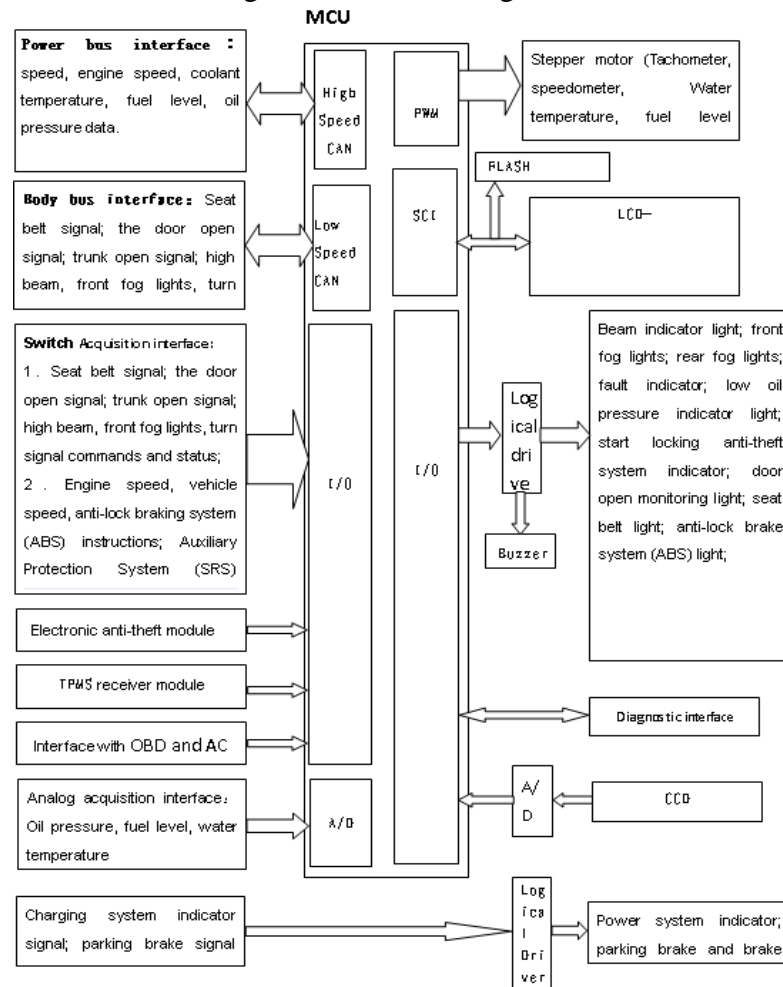
Figure1 system solution architecture

System Key Technologies

Hardware Platform Key technology

Implementing the solution architecture shown in Figure 1, the key technologies involved in the hardware platform are:

1) MCU module: The module uses chip H8SX1544 produced by Renesas Technology Corp. Automotive instrument cluster as a gateway or bridge, there will be a lot of unnecessary data movement. In order to clarify many of these data streams and select the necessary data, the module needs high-speed data processor. H8SX1544 is a chip with low-power and high-performance 32-bit. In addition, the central information displays a large amount of data, therefore to use large-capacity flash memory MCU. H8SX1544 built-in 512Kb flash memory and 24Kb SRAM. Standard peripherals include 2-way chip CAN controller, 6-channel PWM controller, stepper motor, 16-bit timers, UART / Clock Synchronous Serial Interface, sound generator. The MCU also includes SPI,

IIC bus interface, 10-bit A / D converter, 8-bit D / A converter and maximum operating frequency of 40 MHz[3].

2) Dual CAN communication module: MCU used by automotive instrument cluster has been integrated CAN controller, we just provides with the corresponding CAN transceiver for design of CAN module circuit. Because power bus interface need high-speed CAN transceiver, we used NXP PCA82C50, which can achieve 1MB maximum communication speed with very good EMI characteristics. Body bus interface need low-speed CAN transceiver, so we used NXP TJA1054, which can achieve 125k maximum communication speed with very good EMI characteristics.

3) Stepper motor module: MCU used by automotive instrument cluster has been integrated 6-channel stepper motor controller, 4 of which can be done directly through the register set of 24 micro-step function. The module controls the speed of the table, respectively, tachometer, water temperature and fuel gauge, and selected VID-23-type stepper motor.

4) Central Information Display Module: Central information display driver module selected VMC256, which has two display channels include analog video signals (CVBS) and MCU-channel digital display channel. Through MCU set register, it can achieve its appropriate channel to switch a display. Video channel accepts composite video signals, which can be displayed on the LCD with true color. MCU channels interface MCU with 8-bit data bus, and can display 256 kinds of colors. The module can receive the ranks of coordinate values, need not calculate the memory address. The controller uses the 512K SRAM high speed cache, has large display capacity. For the TFT 320 × 234 simulation screen, we could display 4 pages contents. It also has a function of address automatically added, and it has a very high speed for image display.

B. Software Platform Key technology

1) Software design based on OSEK specification: OSEK specification is one for automotive electronics, with an open system interface [4]. It gives an automotive electronics software programming ideas, has been widely used by foreign carmakers. OSEK software model is shown in Figure 2.

System software follows the OSEK standard design, the software is divided into the application layer, interaction layer, data link layer, network layer, diagnostics layer and network management layer. There is software between each layer, which can improve the portability of the software, and also provides a software upgrade later convenience.
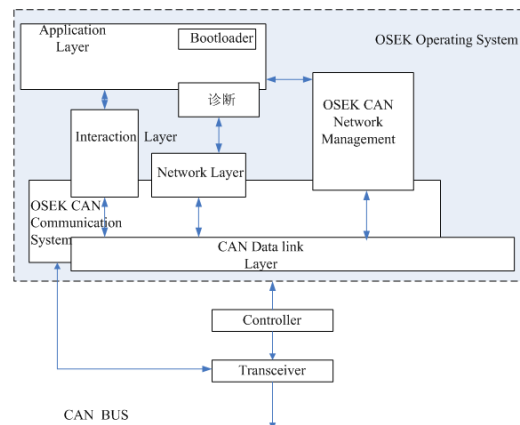

Figure2 OSEK automotive Electronics software model

Software flow chart: To achieve system function, which is corresponding to Figure 2, part of the application layer, the design system software flow is demonstrated as below.

First, determine whether the ignition switch is in the ON state or not. If it is true, software will execute related initialization, power-on self-test instrumentation, stepper motor driven pointer back to the place, and receiving buffer CAN message data. Determine whether there are changes between received CAN data and the before data, if it is true, software will execute the appropriate subroutine which CAN data frame is corresponding to. These subroutines include: LCD display module, compass module, LED display module, the mileage calculation and storage module, the pointer driven module, automatic backlight module, manual backlight model, clock set and display module.

It is a loop between judging ON state and performing the corresponding function subroutine. In the loop, determine whether the instrument need go to sleep, if it is true, determine whether there is a wake up caused by CAN line, if it is negative, the software will go to sleep; if there is a wake up, the software will go to main loop again.

Test of Digital CAN bus instrument

In order to test the performance of designed digital CAN bus instrument, we commissioned Tianjin Automotive Testing Center and National Passenger Car Quality Supervision and Inspection Center for the module to do the transient immunity test, which can test the power harassment induced by electrical conduction and coupling.

Test method is according to ISO7637-2: 2004 Road Vehicles-Electrical Disturbances From Conduction And Coupling-Part 2: Electrical Transient Conduction Along Supply Lines Only the provisions of Article 4.4 [5].

Judgment is according to ISO7637-2:2004 Road Vehicles-Electrical Disturbances From Conduction And Coupling-Part 2：Electrical Transient Conduction Along Supply Lines Only the requirements of Appendix A.

Test results are as follows.

TABLE I DIGTIAL CANBUS INSTRUMENT TESTING RESULTS

Test items	standards	Test results	Determination of functional status
DUT Anti-jamming performance under test pulse 1	Class A：During and after subjected to harassment, device or system could executive all pre-designed function. Class B：During and after subjected to harassment, device or system could executive all pre-designed function. However, system or device can have one or more indicators deviation outside the specified. While stopping harassment, all functions will automatic return to normal range. A class of storage level should be maintained. Class C：During and after subjected to harassment, device or system could not executive one or more pre-designed function. While stopping harassment, devices or system could automatically restored to normal operation status. Class D：During and after subjected to harassment, devices or system could not executive one or more pre-designed function. While stopping harassment, devices or system could automatically restored to normal operation status only through simple "operation or use" reset action.	Instrument tested can executive all pre-designed functions during subjected to harassment.; However, comprehensive information display flashed, stopping harassment, devices or system can automatic return to normal range.	Class B
DUT Anti-jamming performance under test pulse 2a		All functions and design of DUTtested are normal during and after subjected to harassment.	Class A
DUT Anti-jamming performance under test pulse 2b		Instrument tested can executive all pre-designed functions during subjected to harassment.; However, comprehensive information display flashed, stopping harassment, devices or system can automatic return to normal range.	Class B
DUT Anti-jamming performance under test pulse 3a		All functions and design of DUTtested are normal during and after subjected to harassment.	Class A
DUT Anti-jamming performance under test pulse 3b		All functions and design of DUTtested are normal during and after subjected to harassment.	Class A
DUT Anti-jamming performance under test pulse 4		All functions and design of DUTtested are normal during and after subjected to harassment.	Class A
DUT Anti-jamming performance under test pulse 5		All functions and design of DUTtested are normal during and after subjected to harassment.	Class A

The above test results show that the designed module could work normally under specified conditions and specified test conditions, and could meet demands. Module could operate normally in a variety of conditions, and has a good stability.

Summary

The automotive instrument cluster is designed on OSEK standard, and takes digital instrument as its core, and connects high and low speed network. The system achieves purpose of dada and information sharing, and realizes function of Auto information integration.

The designed system has some characteristics such as universal, modular, standardized, serialized. Hardware modules are detected by testing organizations, the results can meet testing standards and inspection requirements.

Acknowledgment

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