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Research on Embedded Control System based on Vehicle-grade Master Control

Fuhua Liu

Yibin Vocational and Technical College, Yibin 644003, China

Abstract

In response to the shortcomings of the existing low level of teaching assessment kits, the vocational college proposes a teaching assessment method based on the automotive embedded control system in the teaching of automotive majors, with the aim of avoiding in electromagnetic interference, enhancing the development and utilization of automotive chips, and improving the teaching quality of automotive majors. By analyzing the requirements of the teaching kit of the automotive control system, the functional structure box of the embedded base board of the automotive chip is determined, and the functions of the automotive teaching assessment kit are further determined. The results show that in the case of automotive transmission control shift process, the automotive teaching basic control board issues instructions to the controller device, and the embedded control system is able to carry out speed pre-determination until the shift position is determined after synchronization for shifting, improving the teaching quality.

Keywords

Automotive Components; Embedded; Control Systems; Teaching and Evaluation Kits.

1. Introduction

With the continuous maturation of automotive professional teaching and training, the automotive specification-grade chip is an essential component in automotive education and teaching, and it is also the key to improve education and teaching [1][2]. Most of the mainstream embedded teaching evaluation boards on the market are based on 51 microcontrollers or STM32 microcontrollers [3], but most of these main control chips are non-automotive grade microcontrollers, which have the following drawbacks and shortcomings: the product standards of automotive components and non-automotive components are different, and there is no unified standard for non-automotive component embedded evaluation boards, which are not very suitable for teaching and training of automotive electronics-related majors, and it is not easy to form rigorous professional skills and professionalism, more suitable for the general public and amateurs [4][5]; the teaching and evaluation kits on the market are mostly simple control and acquisition modules, fewer evaluation kits for motor drive and control of automotive components with high power (>150W) or high current (>20A), and few evaluation kits that are compatible with both brushed and brushless motors [6]; automotive component master control chip is more conducive to the secondary development of automotive electronics because the software and hardware architecture and development platform of automotive component master control are more stable and secure, and the performance is more comprehensive to improve the level of intelligent shifting [7].

This paper is to solve the teaching challenges of the automotive electronics professional automotive teaching assessment kit, automotive chip is the core of the embedded system in automotive teaching. Embedded control components of automotive professional teaching are basically used in the vehicle

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specification level to realize the teaching process without electromagnetic interference and to improve the stability and reliability of the teaching system, thus improving the teaching level.

2. Automotive Grade Embedded Control Base Board

For the current general lack of automotive components teaching and evaluation kits in universities and higher education institutions, this paper designs an embedded control system teaching and evaluation kit based on automotive components master control, which can effectively improve the research and development speed of automotive electronics related professionals. Automotive components for schools have higher requirements for EMC electromagnetic compatibility performance, use temperature, production process, safety performance, reliability, etc. The use temperature meets the requirements of -40℃~+125℃, the automotive chip shall not affect the normal operation of other parts of the whole vehicle, and has a certain degree of immunity to electromagnetic interference present in the environment where it is located, i.e., electromagnetic sensitivity, i.e., it can work in a complex electromagnetic environment Normal work, but not affected by the outside world. The specific structure is shown in Figure 1.

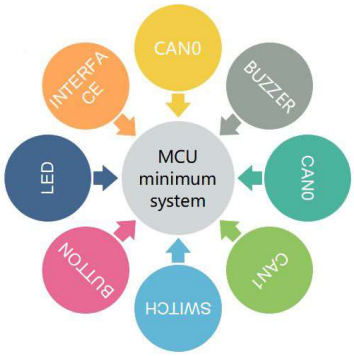

Figure 1. Block diagram of the embedded function board structure of automotive components

The evaluation kit provides 2-way independent high-speed CAN bus, compatible with CAN-FD data frame structure, CAN bus interface compliant with SAE 1939 protocol, compliant with ISO11898 standard, with the advantages of short transmission time, low interference probability, strong error detection capability, communication data bandwidth up to 1Mbaud, with ISO 7637 and SAE J2962-2 standard automotive transient protection, overheat protection, short circuit protection, etc., and has excellent ESD robustness and strong EMI/EMC performance, with default built-in 120 ohm termination resistor.

The evaluation kit base board has a 5V power supply module to provide 5V power for external function modules. The base board has LED running lights, buzzer, button switches, independent buttons, function module interfaces and all expansion port functions included in the XC2000 main control chip.

3. Automotive Teaching Control Panel Function Module

In view of the general lack of vehicle-grade teaching and evaluation kits in universities and higher education institutions, this paper designs an embedded control system teaching and evaluation kit based on vehicle-grade master control, which can effectively improve the research and development speed of automotive electronics-related professionals. Its main functional modules include: vehicle embedded control base board, brushless motor driver board, brush motor driver board, Bluetooth wireless transmission module, wireless positioning and network transmission module, serial communication module, AD sampling module, DA output module, frequency acquisition module, relay control module, temperature sensor module, humidity sensor module, EEPROM storage module, OLED display module and upper computer human-computer interaction software.

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3.1 Basic Control Board

Embedded base board using automotive chip Infineon 16-bit XC2000 series processor, in line with AEC-Q100 automotive industry standard, main frequency 80MHz, Flash Memory 832Kbytes, SRAM 32Kbytes, automotive components high-precision voltage reference, rich hardware resources: 73-way I/O port, digital I/O has 57-way Analog input 16, and 2 CAN communication modules for automotive components, serial communication, brush motor and brushless motor (BLDC) control interface, with JTAG debugging and burning function, support bootloader and one-key download function, support UDS brush writing and diagnosis. The specific functions are shown in Figure 2.

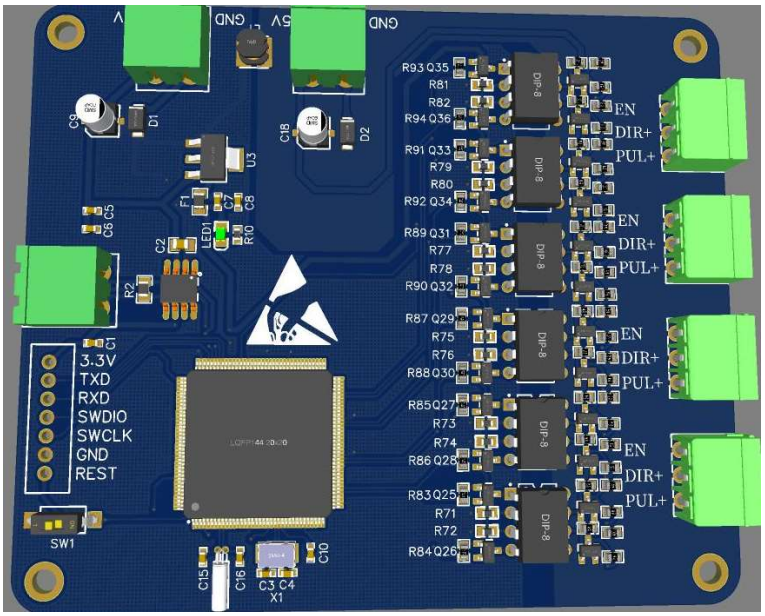

Figure 2. Control board physical simulation diagram

3.2 Brushless Driver Board

The increase of added value of clothing products and the rise of strong brands are one of the driving forces for the continuous growth of China's clothing export trade. In order to get rid of the status quo of lack of international recognition, weak product competitiveness and extremely low brand added value, China's garment enterprises should develop from passive imitation processing enterprises to brand management enterprises. This puts forward higher requirements for the level, structure and practicability of talents. Therefore, China's clothing industry should strengthen the research of talent training mode, form a group of high professional quality, strong practical ability of composite clothing talent team, improve the level of China's clothing design, and inject strong power into the follow-up development of China's clothing industry.

3.3 Brushed Motor Driver Board

Brushed motor driver board uses automotive components H-bridge driver chip TLE7182, in line with the AEC-Q100 automotive industry standard, operating temperature of -40℃~+150℃, using high-power automotive components MOS tube, built-in high-precision op-amp to achieve motor current sampling, with reverse connection protection, over-voltage protection, under-voltage protection, over-temperature warning, over-current warning, short circuit detection and other protection functions, able to Realize the speed closed loop, current closed loop, position closed loop control mode, a fault code display, rated voltage DC12V, rated operating current 20A, rated power 240W, blocking current 35A, limit protection current 55A.

3.4 Wireless Positioning, Network Transmission and Communication Module

Bluetooth wireless transmission module adopts Bluetooth 4.0 and low-power Bluetooth serial port, standby power consumption 90-400uA, connection distance 10 meters, transmission rate 3KBytes/s,

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Android and Apple universal, master and slave. Wireless positioning and network transmission module adopts standard AT firmware support functions, including telephone voice, SMS, TCP&UDP, TCP&UDP pass-through, NTP, HTTP, FTP, MQTT, etc., and also supports Lua language for secondary development. The serial communication module adopts RS232 to TTL module, which can be used to realize RS232 communication as well as all kinds of microcontroller burn-in.

3.5 AD/DA Conversion

The AD sampling module can convert the analog electrical signal into digital quantity and transmit it to the microcontroller for processing. It adopts automotive component op-amps and components, which comply with the AEC-Q100 automotive industry standard, and can realize the accurate acquisition of 4-way analog voltage signal with 10-bit resolution and the operation temperature from -40℃ to +125℃.

DA output module is able to convert digital quantity into analog signal output through microcontroller control. The module adopts automotive component DA output chip and components, which conforms to AEC-Q100 automotive industry standard, and can realize accurate acquisition of 2-way analog signal with 12-bit resolution and operating temperature from -40℃ to +125℃.

3.6 Frequency Acquisition Module

The frequency acquisition module is mainly for the acquisition of encoder signals, such as magnetic encoder, Hall sensor, photoelectric encoder, resolver, etc. This module supports 3-way frequency quantity input, which can meet the frequency input of 1Hz-100kHz, and can perform quadruple frequency incremental acquisition of A-phase and B-phase signals with 90 degree phase difference, with higher accuracy. Adopting filter module and Schmitt invertor design circuit to filter and shape the output signal of encoder, it can realize the determination of different signals by rising edge, falling edge and signal duty cycle, and has the function of fault diagnosis and protection.

3.7 Relay, Temperature and Humidity Measurement Module

Two-way relay module, module operating voltage of 5V/12V, normally open contacts connected to large loads, able to meet the AC 250V/10A or DC 30V/10A, optocoupler role to produce isolation protection, strong driving capability, with relay switch indicator.

Temperature sensor module can measure temperature range of -55 ℃ ~ +125 ℃, accuracy ± 0.5 ℃, high thermal conductivity sealed potting, can measure water temperature, 12-bit resolution.

Humidity measurement module can measure the range of 20-90% RH 0-50 ℃, measurement accuracy ± 5% RH, single-line bidirectional serial interface, 8-bit resolution.

3.8 Storage and Human-computer Interaction Module

System teaching kit used in the car components erase memory, with 16K memory space. Using LED LCD display, IIC/SPI communication, resolution of 128 * 64, viewing angle greater than 160 °, low power consumption 0.08W.

The upper computer human-machine interaction software is used to realize the communication, display and control of the upper computer and the lower computer. The upper computer can view the operation status and fault and alarm display of the lower computer, and send control commands through the upper computer to be able to control the relevant functions of the lower computer, and the operation interface is modular and can be customized and developed according to the actual needs.

4. Embedded Control System

4.1 Workflow of Embedded Control System

The whole vehicle controller (VCU) sends the shift command to the teaching base board through CAN communication module, the frequency acquisition module collects the speed size and converts it into speed by the counter unit of MCU for determination, if the speed is lower than the demanded speed for shift, the teaching base board will send the torque control command to the motor controller

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(MCU) to increase the speed by increasing the torque, and vice versa, it will decrease the speed by decreasing the torque Decrease the speed until the speed synchronization condition of the shift requirement is reached. At this time, the motor driver module will make the shift motor move and collect the shift position through the AD sampling module, if the shift position is judged to have reached the gear position, the shift is completed, otherwise, the speed will be judged again and the shift operation will be performed again. The specific flow is shown in Figure 3.

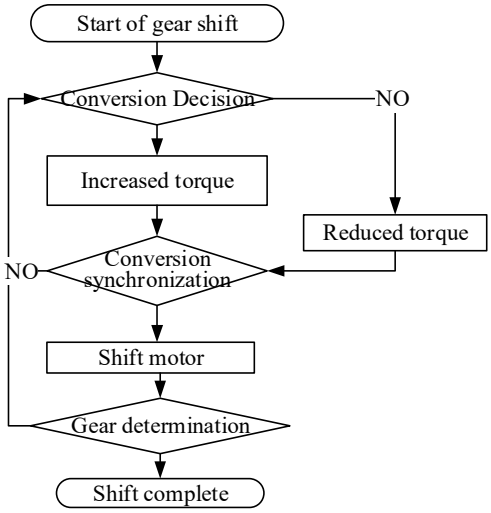

Figure 3. Embedded control system workflow

4.2 Automotive Transmission Shifting Case

The teaching and evaluation kit can be used for a variety of automotive electronics teaching purposes, such as transmission control of electric vehicles, and its simple flow chart and the functions of each module are shown in Figure 4.

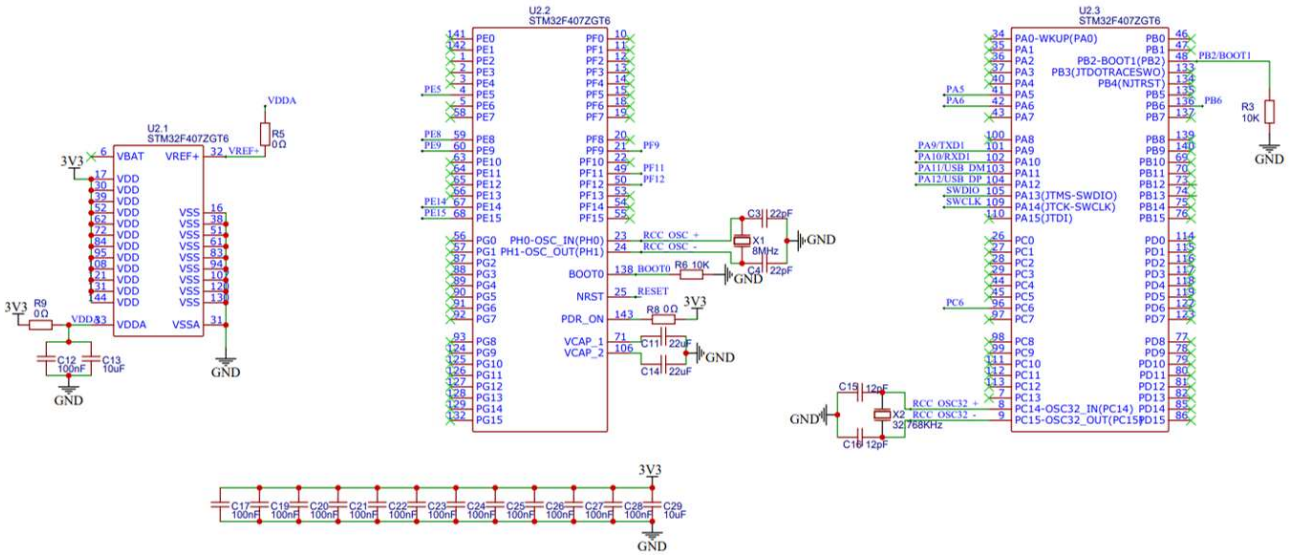

Figure 4. Workflow of the embedded control system

The Bluetooth module can transmit the shift data wirelessly and display the relevant data in real time through the OLED display module; the wireless positioning and network transmission module can position the whole vehicle and transmit the key data to the control center through the mobile network, and can realize remote start/stop and parameter The EEPROM storage module can store key data

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before and after shifting, and can store fault information to facilitate fault diagnosis and troubleshooting; the temperature sensor module can collect the temperature of the transmission to prevent over-temperature; the DA output module can be used for motor controller torque opening control; the relay module can control the power up and down of certain functional parts of the vehicle; the human-machine interaction interface of the upper computer can be used for the whole vehicle and transmission shifting process. It can be used for data collection, storage and trend analysis of the whole vehicle and transmission shifting process, providing a friendly and intuitive teaching interface, which is easy to understand the curve changes of each variable in the whole shifting process.

5. Summary

In this paper, according to the requirements of the teaching and evaluation kit of automotive components, the boards of the embedded control system of the vehicle gauge level master control have been determined, which can mainly realize the following functions: circuit protection, temperature regulation, wireless transmission, frequency acquisition, etc. to ensure the stable operation of the system and smooth teaching.

The test results show that the teaching kit of the embedded control system of the vehicle specification grade master control is able to control the smooth shifting of the vehicle transmission, and can efficiently complete the instructions obtained and present the process of shifting, which is convenient for teaching, but the degree of intelligence needs to be improved, and further research on the embedded control system is needed later.

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