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Intelligent Nodes Design of Hydraulic Auxiliary Drive Unit Based on CAN Bus

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Abstract: Parallel hydraulic hybrid vehicle has two sources of power, one of the power sources, the hydraulic auxiliary drive unit has the role of brake energy recovery, auxiliary vehicle drive and balance of engine power. This study designed the node of unit based on the bus technology, the design of intelligent node based on DSP TMS320LF2407 chip as the core, has the characteristics of simple hardware, low power consumption, strong software modular. Test shows that, the intelligent node can well meet the system detection and driving job requirements.

Key words: CAN bus, hydraulic hybrid, intelligent nodes, DSP

INTRODUCTION

Parallel hybrid hydraulic drive system including an engine, the original vehicle drive system, the basic structure of auxiliary hydraulic drive unit is shown in Fig. 1. While the auxiliary hydraulic power source as one of the drive unit, the control unit related to the precision with which the engine ability to achieve safe and efficient power coupling drive vehicle driving. CAN (controller area network, abbreviated CAN) bus, has a unique design, excellent features, high reliability and strong anti-jamming capability on site (Rao *et al*., 2003), widely used in vehicles, CAN bus technology is suitable for complex dynamic matching and network security requirement of hydraulic hybrid vehicle (Han and Jiang, 2005). This study designed the control subsystem of hydraulic auxiliary drive unit based on CAN bus technology, using shielded twisted pair to each network node is connected smart devices into the network system, the distributed intelligent control system: unit, intelligent node by the subsystem (hydraulic auxiliary drive unit) control with a gross vehicle control system (on the PC) composed three structures. Intelligent node belonging to subsystem control unit, is responsible for the completion of the sensor signal acquisition and control system communicates with the upper data exchange both tasks.

LAYOUT OF HYDRAULIC AUXILIARY DRIVE UNIT INTELLIGENT NODE

The hydraulic circuit of auxiliary hydraulic drive unit is shown in Fig. 2. Its main valve control is servo proportional valves 5. It is characterized by fast response, high control accuracy. The switch is controlled by Solenoid valve2. It works at the release and recovery of braking energy. The intelligent nodes of hydraulic auxiliary drive unit based on CAN Bus is shown in Fig. 3. Control system consists of intelligent node 1, intelligent node 2, the subsystems ECU of auxiliary hydraulic drive unit (Xie and Mao, 2006). The intelligent node one is responsible for detecting a pressure in the accumulator circuit, the variable pump/motor speed, the variable position of the cylinder. It can achieve precise control of the variable displacement pump/motor speed. It can control the coupling of two power source precisely and balance the engine's power efficiently. The intelligent node 2 is responsible for receiving the instruction and the output signal to drive a 2 solenoid valve and proportional servo valve 5 to action. Hydraulic drive unit ECU is responsible for system management,

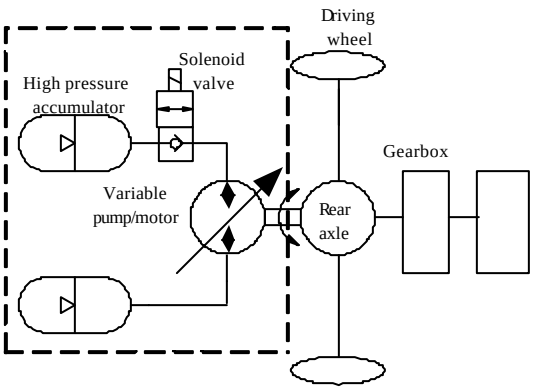

Fig. 1: Construction of drives system in hydraulic hybrid vehicle

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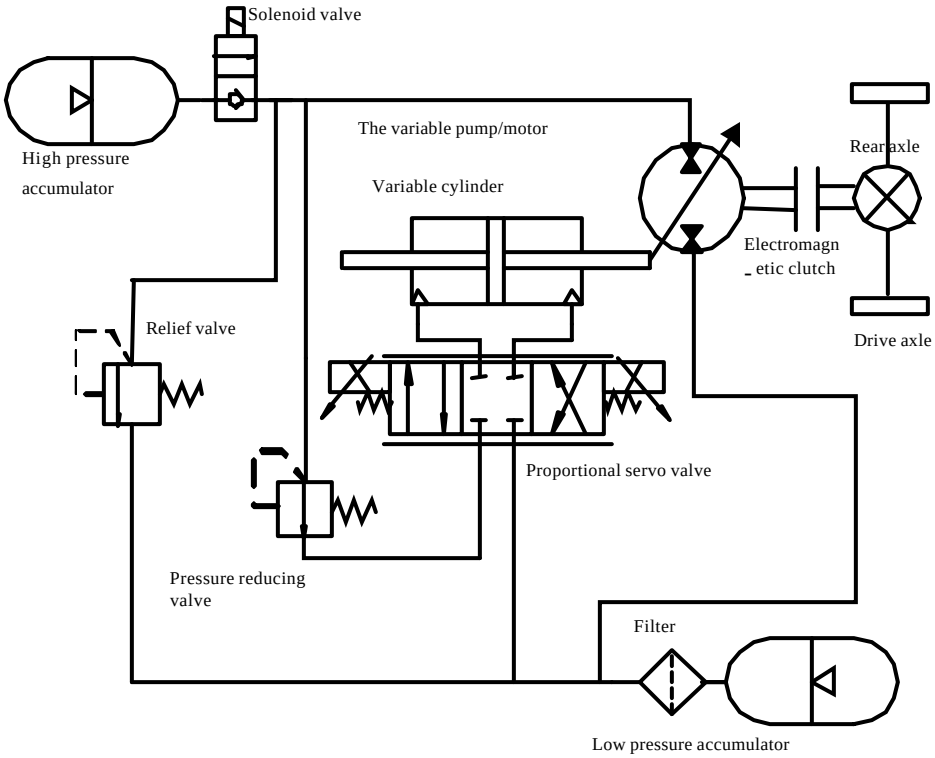

Fig. 2: Auxiliary hydraulic circuit diagram of a hydraulic drive unit

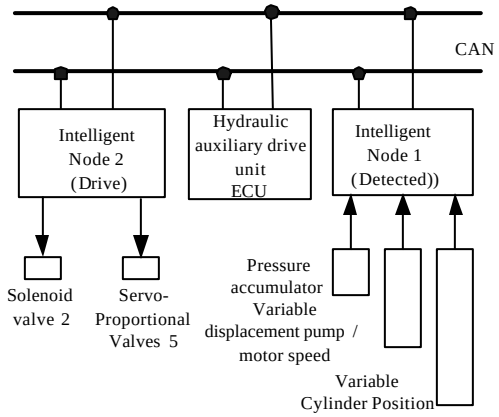

Fig. 3: Schematic diagram of intelligent node in hydraulic auxiliary drive unit based on CAN Bus

real time and the PC of vehicle driving system to communicate, to accept the instruction, to ensure the reliability of system control and operation (Xie *et al*., 2007).

SOFTWARE AND HARDWARE DESIGN OF INTELLIGENT NODES

Hardware design of intelligent nodes: The core of control chip intelligent node using TMS320LF2407A is a fixed-point DSP chip produced by TI company, its characteristic is the structure of C2xx kernel the enhanced DSP technology, uses the high performance static CMOS technology, make the power supply voltage is 3.3V, power consumption of the controller is reduced; the 30MIPS execution speed has shortened to 33 ns instruction cycle (30 MHz), thus improving the real-time control controller; CPU clock frequency can reach 40 MHz. On chip with 32 K FLASH, 544 words of DRAM and 2K SARAM and provides the signal and the external memory interface, individually addressable program memory, data memory and the 64 K space I/O. The two event management module is EVA and EVB, each with two 16 bits general purpose timer; with eight 16 bit PWM channel; three acquisition unit; 10 bits analog to digital converter 16 analog input channels; the watchdog circuit; three communication interface module, serial communication,

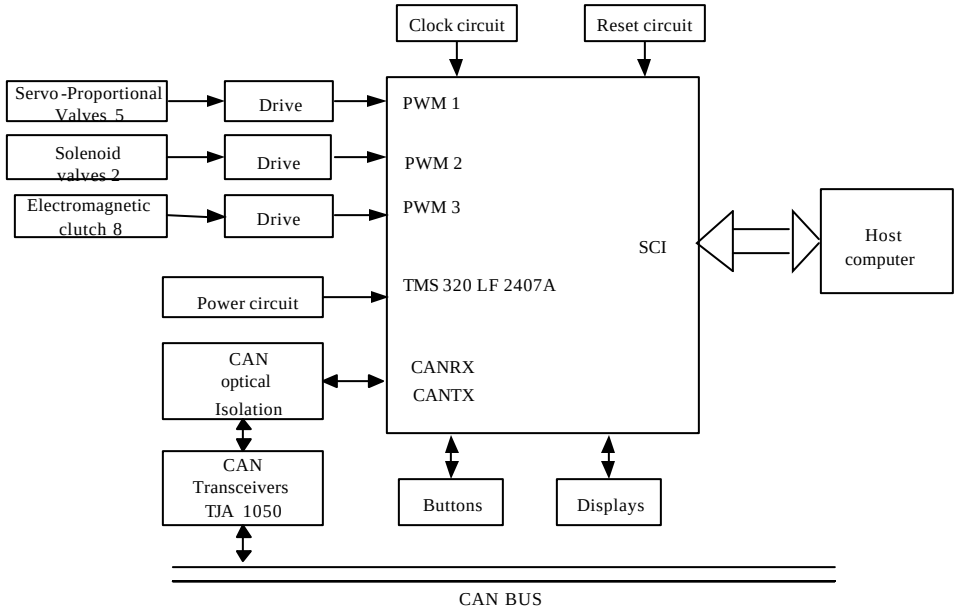

Fig. 4: Circuit schematics based on CAN intelligent node 1 (driver)

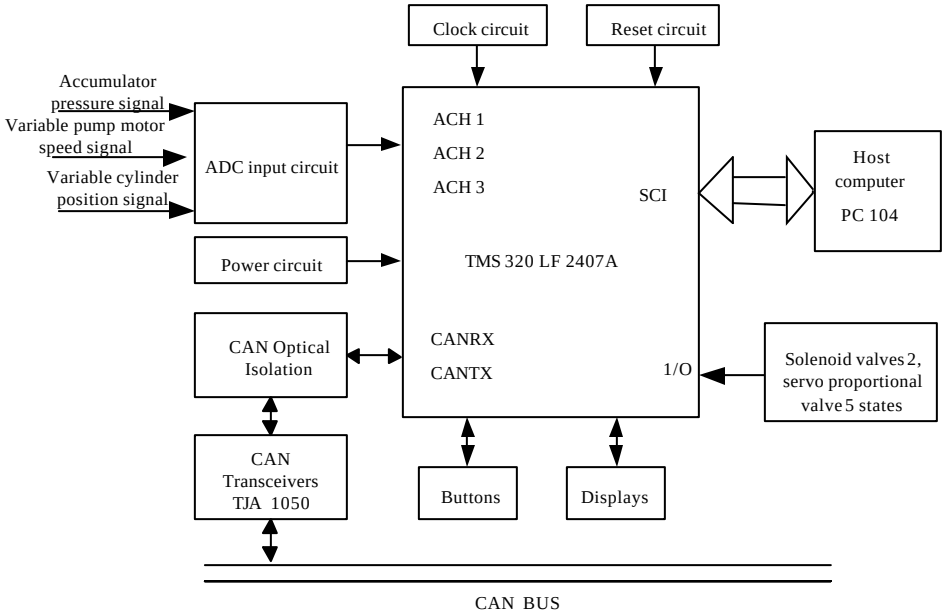

Fig. 5: Circuit schematics based on CAN intelligent node 2 (detection)

serial peripheral interface (SCI) interface (SPI) and Controller Area Network (CAN) module; JTAG interface (Liu *et al*., 2003). Because of these characteristics make it very suitable for application in vehicle control.The circuit schematics based on CAN intelligent nodes is shown in Fig. 4 and 5.

CAN bus interface circuit (Wu, 2002): The CAN module comes from TMS320LF2407A, connected by bus transceiver TJA1050 CAN bus physical. In the vehicle environment, TJA1050 chip can provide transient protection on the bus pins, the input voltage is compatible with 3.3 and 5 V electrical parts; comply with

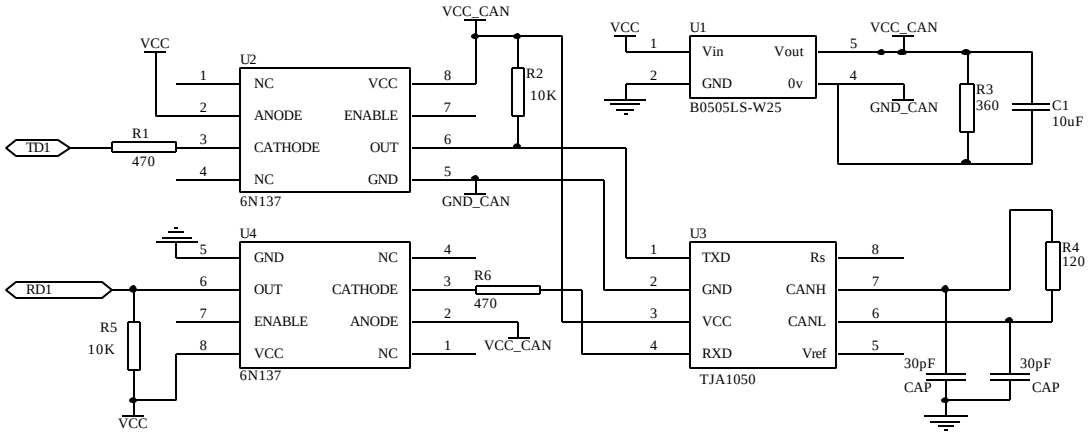

Fig. 6: Interface processing circuit in CAN Bus of TMS320LF2407A

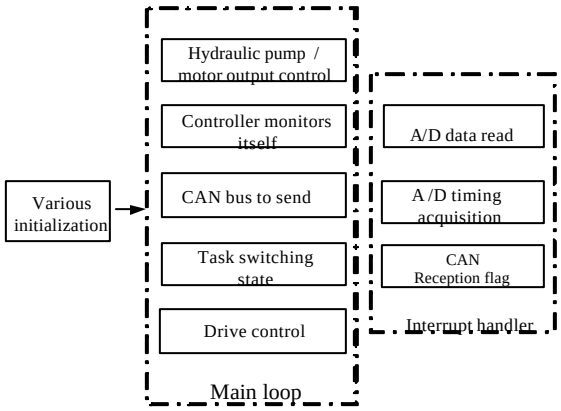

Fig. 7: Subsystem block diagram in main program of hydraulic auxiliary drive unit

ISO11898 standards. In order to enhance the anti-jamming capability of CAN bus communication interface, between the DSP controller and transceiver chips eCAN join 6N137 High Speed Opto-coupler isolation, each CAN node of the CAN bus ensure electrical isolation, to improve the reliability of the node (Bei, 2004). The interface processing circuit in CAN Bus of TMS320LF2407A is shown in Fig. 6.

Software design of intelligent nodes: The main program design of hydraulic auxiliary drive subsystem unit: The software mainly consists of three parts: The main loop foreground program, interrupt handling daemon and function modules daemon, each functional module will be relatively independent by this method, commissioning this program is very beneficial. The main loop foreground system includes software implementation and control strategies for each sub-module software control. The main loop the background system includes the interrupt handler and control based on the physical layer.

Each other to provide a good interface, will make the software easy to modify. The subsystem block diagram in main program of hydraulic auxiliary drive unit is shown in Fig. 7.

Program design of CAN controller in TMS320LF2407A chip: Intelligent node function of Hydraulic drive unit is collecting and detecting signal and driving, according to the unit subsystem of ECU command. The chip of DSP in TMS320LF2407 has a eCAN controller, it has six mailbox, Each mailbox by register control. The eCAN module is divided into the control / status register access as well as to the mailbox RAM read and write three parts. Before using the CAN controller must set to its initializations of register, set including I/O port, a timer and a mailbox (Du *et al*., 2007). The initialization flow chart is shown in Fig. 8.

After completion of the initialization step, the sending and receiving data request will be processed. When the data reception, message identifier received must receive email with the corresponding identifier, the information can be received, otherwise it is filtered out. Sending and receiving of data flow diagrams and flowcharts of the interrupt service is shownin Fig. 9.

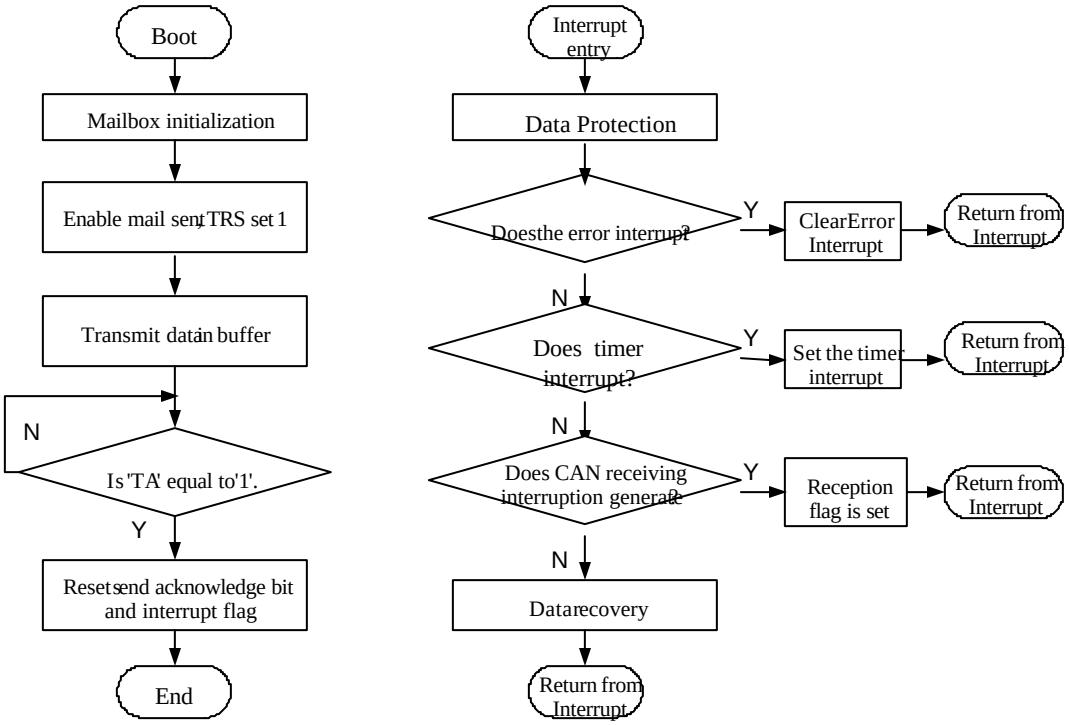

Fig. 8: Initialization flow chart of CAN module

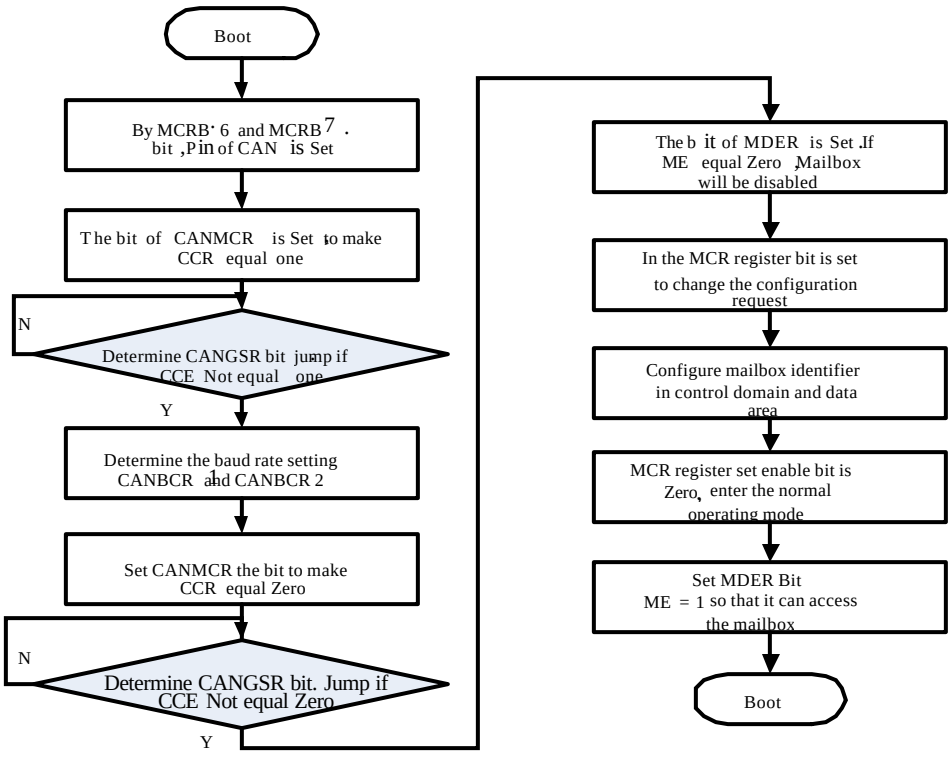

Fig. 9: Transmission and interrupts services of CAN data

CONCLUSION

The communication test of control system is based on these conditions: CAN bus communication baud rate is set to 80 K; communication distance is 20 m, data update cycle is 0.05 s, there are at least four nodes at work, the multi-node communication in lab, the controller works continuously for 48 h, without error. As the hydraulic auxiliary drive unit uses a DSP chip intelligent nodes, the nodes can be real-time troubleshooting and treatment, tests showed that the development of intelligent nodes, from reliability, drive control, signal acquisition, communication aspects fully meet the work requirements of hydraulic auxiliary drive unit.

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