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APPLICATION OF CAN BUS WITH DSPACE SIMULATOR USAGE

APLIKACE CAN SBĚRNICE S VYUŽITÍM SIMULÁTORU DSPACE

### Abstract

In recent years we can see the increasing of electronic control systems in cars. The reason of this increasing is to ensure better safety, comfort, requirements of users and to bear up against the competitive pressure etc., last but not least the pressure of single governments on all the time reducing of consumption sources and the tendency to lower the emitting of emissions to the atmosphere too. These require to implement new systems to the car. The growing of control systems has the influence on quantity of interconnecting wires, which brings the problems (failure rate, unreliability of connection, disturbance, energy losses, etc.). The right coordination of individual control units have to be ensured e.g. the co-operation of engine, ABS/ASR and automatic gearbox. These systems come through different tests for the ensuring of correct functions.

For these purposes the serial communication protocol (Controller Area Network - CAN) by BOSCH company was created. The protocol is designed especially for using in the cars. CAN is used for connection of different device types (drivers, sensors, actuators etc.) through the serial data bus. This protocol is used in different industrial applications too. The reason is above all the lower price, easy access point, reliability, high data rate and easy extensibility.

### Abstrakt

V posledních několika letech jsme svědky nárůstu elektronických řídicích systémů v automobilech. Důvodem tohoto nárůstu je zajištění větší bezpečnosti, komfortu, vzrůstajících nároků uživatelů, konkurenčního tlaku, atd. V neposlední řadě je to také tlak jednotlivých vlád na neustálé snižování spotřeby zdrojů a požadavky vyplývající ze snahy snížit vypouštěné emise do ovzduší. To vyžaduje implementovat nové systémy do vozidla. Při nárůstu řídicích systémů a s nimi řídicích jednotek, musí jednoznačně docházet ke zvyšování propojovacích vodičů, což přináší problémy (poruchovost, nespolehlivost spojení, náchylnost k rušení, energetické ztráty, apod.). Navíc musíme zabezpečit správnou koordinaci samostatných řídicích jednotek, jako například součinnost motoru, ABS/ASR a automatické převodovky. Z tohoto důvodu tyto systémy procházejí různými testy pro zaručení správné funkčnosti.

Abychom se vyhnuli problémům a překonali omezení způsobené připojením na konvenční ovládací zařízení, byl vyvinut firmou BOSCH sériový komunikační protokol Controller Area Network (dále jen CAN) speciálně pro použití v automobilech. CAN se používá pro propojení různých druhů zařízení (ovladače, senzory, akční členy) přes sériovou datovou sběrnici, přičemž stále dochází k častějšímu využívání tohoto protokolu i v různých průmyslových aplikacích. Důvodem je

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především nízká cena, snadné nasazení, spolehlivost, vysoká přenosová rychlost a snadná rozšiřitelnost.

## 1 INTRODUCTION

The dSPACE system has extension for Real-Time Interface and can be used for combining dSPACE systems with CAN communication network. The RTI CAN Blockset is especially suited for developing and testing control functions that communicate via a CAN bus system.

## 2 DESCRIPTION OF CAN BUS AND THEIR APPLICATIONS

Signals are sent and received with minimal delay and without lost of data in CAN bus. Nowadays CAN protocol has the stable position in other Fieldbus. CAN bus is defined by ISO 11898. This ISO standard describes the physical layer of protocol and specification CAN 2.0A. CAN 2.0B was created later. This norm establishes two terms – standard and extended format of the message. The identifiers are different between these messages. These norms define only physical and link layer of protocol according to the reference model of ISO/OSI. Application layer of CAN protocol is defined by number of one another incompatible standards (CAL/CANopen, DeviceNet,...).

### 2.1 Requirement of serial communication in cars

The unique transmission line is reserved for each signal in convention systems. This solution is unbearable for too many transmit signals. This disadvantage goes out from financial aspect. Too many signals influence the quality of data transmission.

Sensors and control units, which obtain useful information, are connected with the help of CAN bus. The bus is used in the automotive industry for communication among control units in such a way to do not attend to the big load of the central processor [CAN - Controller Area Network, 2007-02-10].

### 2.2 Properties of CAN bus

CAN bus is serial communication protocol that supports distributed real-time control with a high level of the security. In a CAN network, each signal is transmitted and received with minimum delay and without data loss. The range of applications for CAN extends from high-speed networks to low-cost multiplexed wiring. Connected via CAN, each bus member can transmit and receive the data it requires only when needed.

Is concerned about multi-master protocol, where each node of bus can be master and allow to control the behavior of other nodes. It isn't necessary to control whole network from one higher node which brings the simplification of the control and increases the reliability. When one node has the failure, the rest of the network can work. The bus with random access is used for the control of access to the medium, which solves collisions on the basis of priority decision making. The communication proceeds between two nodes by the help of messages (data message and request for data). The management of network is ensured with the help of two special messages (error messages and messages about overload) [CAN - Controller Area Network, 2007-02-10].

Messages transmitted on the bus by CAN protocol does not contain any information about the end node for which are intended and are received by all nodes. Every message contains the identifier, which determines the meaning of transmitted message and its priority. In the case of collision two messages the CAN protocol provides that the message with high priority is delivered in preference. In addition according to the identifier it is possible to determine that node receives messages, which are targeted only for it.

CAN bus is divided to the tree different layers:

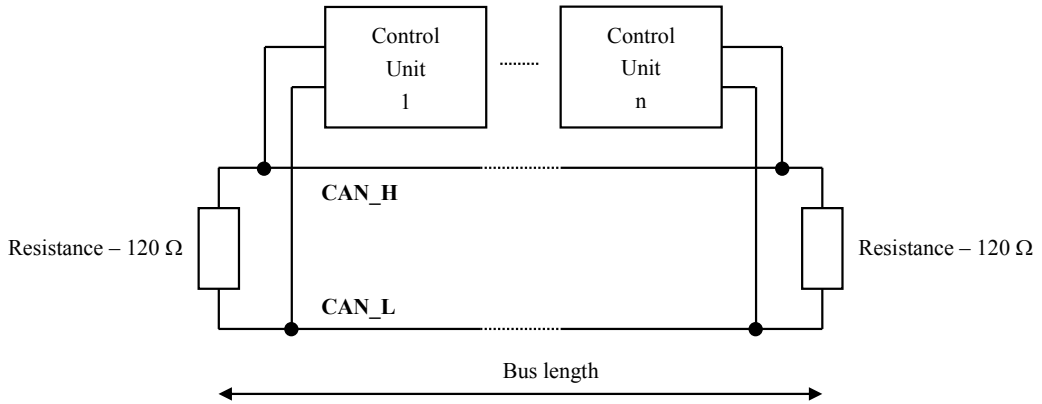
- CAN object layer

- CAN transport layer
- physical layer

Object layer and transport layer include all services and functions which are provided in terms of line layer. Object layer is responsible for:

- finding of message which has to be transmitted
- decision, which received messages from transport layer have to be used
- providing of the interface for application layer related with hardware

In the figure 1, we can see the physical layout of CAN network according to ISO 11898.



**Fig. 1** Physical layout of CAN network according to ISO 11898

### 3 CAN TYPES OF TRANSCEIVERS

To realize application was used the software MATLAB/Simulink and hardware dSPACE. To communicate with other bus members in a CAN bus, each bus member is equipped with a CAN transceiver. The table 1 shows the dSPACE boards with CAN interface, and the supported transceivers [dSPACE HelpDesk, 2007-04-03].

**Tab. 1** Transceivers on dSPACE boards

dSPACE Board	Supported Transceiver
DS1103	ISO 11898 transceiver
MicroAutoBox	ISO 11898 transceiver
DS2202	ISO 11898 transceiver
DS2210	ISO 11898 transceiver
DS2211	ISO 11898 transceiver
DS4302	<ul style="list-style-type: none"> <li>• ISO 11898 transceiver</li> <li>• RS485 transceiver</li> <li>• C252 fault-tolerant transceiver</li> <li>• Custom transceivers</li> </ul>

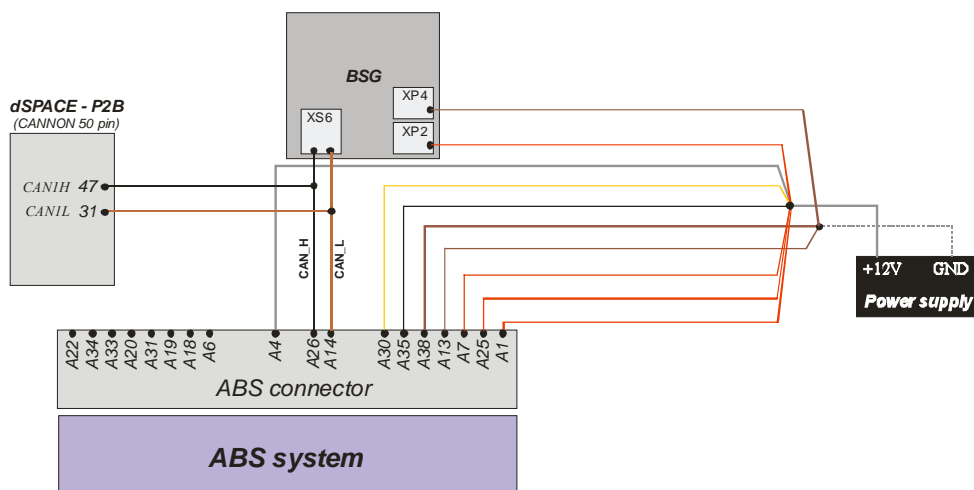
### 3.1 dSPACE software for CAN bus

The Real-Time Interface (RTI) board library for CAN boards contains the RTI blocks that implement the functionality and I/O capabilities of dSPACE CAN boards in Simulink models. The dSPACE CAN software allows to easily define CAN messages to be transmitted or received. The RTI CAN Blockset Library contains the blocks to define communication over the CAN bus. RTI CAN Blockset can define a message as a Transmit (TX), Receive (RX), Request (RQ), or Remote (RM) message. With RTI CAN Blockset, we have to implement one message block for each message.

The RTICAN CONTROLLER SETUP block is main part of RTI CAN Blockset. This block must always be present in each model to use any of the other RTI CAN blocks. The RTICAN CONTROLLER SETUP block allows to define the global settings that apply to the CAN hardware such as the board/module type (DS4302, DS2202, DS2210, DS2211), board/module number, controller and baud rate [dSPACE HelpDesk, 2007-04-03].

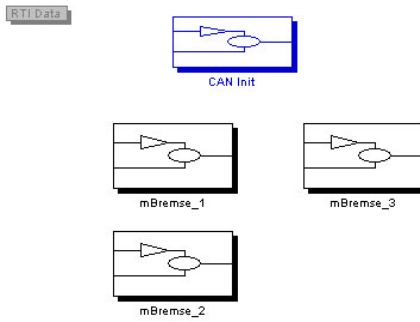
### 3 EXAMPLE 1 – RECEIVE CAN MESSAGES FROM ABS CONTROL UNIT

The figure 2 shows the schema of connection between anti-lock braking (ABS) systems and DS2211 HIL I/O board. The CAN channel number one is used to this example. The pins A26 (CAN-H) and A14 (CAN-L2) are used to bus access. The CAN connects except ABS and DS2211 HIL I/O board also Bordnetz SG unit. The pins A6 to A22 connects wheel speed sensors. These sensors aren't connected in this application. The example realizes displaying CAN data from control unit (standing vehicle). The next pins connect power supply and send information about turn ignition switch and also information about press brake pedal.



**Fig. 2** The layout of connection between ABS unit and DS2211 HIL I/O board

The simulation model was created for this example. The model has been designed in MATLAB/Simulink environment and next downloaded to dSPACE simulator. The figure 3 shows the schema of simulation model. The picture doesn't contain other details. These information are protected by Škoda Auto Company.



**Fig. 3** The model of simulation schema (CAN bus)

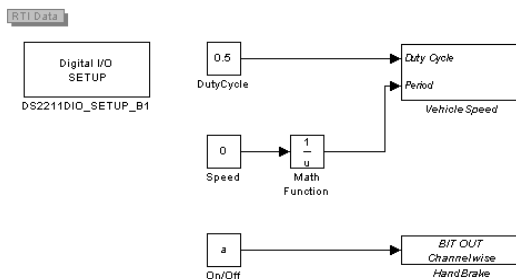
The figure 4 shows graphical user interface to displaying all information from CAN bus. The interface has been designed in ControlDesk environment.



**Fig. 4** The graphical user interface (CAN bus)

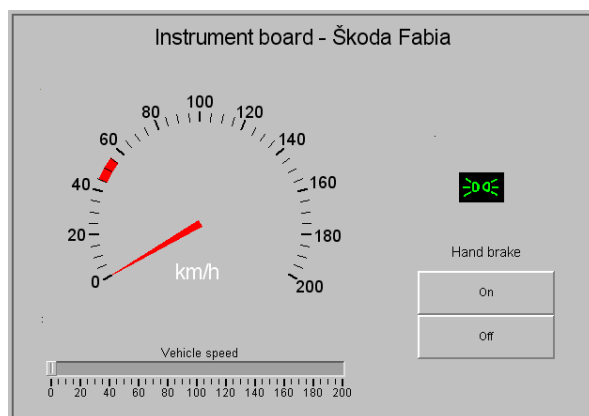
#### 4 EXAMPLE 2 – CONTROL OF COMPONENTS ON THE INSTRUMENTAL PANEL

The second application controls indicators of instrumental panel (Škoda Fabia). For check this possibility was selected indicator of vehicle speed and indicator of hand-brake. The vehicle speed is controlled by PWM signal and indicator of hand-brake is controlled by digital signal. Also for this example was created simple simulation model in MATLAB/Simulink environment. The figure 5 shows this simple simulation model.



**Fig. 5** The model of simulation schema (instrumental panel)

The graphical user interface displays only indicators, which are controlled. This interface allows to define vehicle speed value and indicator of hand-brake through slider and two buttons. The slider located on bottom of figure 6. The vehicle speed interval is from 0 to 200 km/h. The hand-brake indicator relate with tone beep. If hand-brake is activated and vehicle speed isn't zero, so tone beep is activated.



**Fig. 6** The graphical user interface (instrumental panel)

## 5 CONCLUSIONS

The CAN bus is very important communication protocol in automotive industry and also in other branches. This work is dealing with using of dSPACE simulator for diagnostic of vehicle electronic systems. This diagnostic method was applied to the anti-lock braking (ABS) system and the instrumental panel of Škoda Fabie. CAN serial communication protocol is used for communication among control units and dSPACE simulator for both practical examples. The first example describes interface between ABS control unit and simulator. The second example describes control of components on the instrumental panel. Both applications contains graphical user interface. First application displays CAN messages, which ABS unit sends for next possibilities of evaluation. Second graphical environment contains virtual components for direct control of instrumental panel.

## REFERENCES

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