ANALYSIS OF OPERATING PARAMETERS OF THE VEHICLE VIA CAN-BUS

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ABSTRACT

Intensive electronification and higher complexity of vehicles necessitates the use of data buses in vehicles. These buses are used for information exchange between control units. Information on the bus is in the form of data messages whose structure is defined by the relevant standards. In the data contained on the communication line there is commonly information about a vehicle operating parameters such as vehicle speed, engine speed, fuel consumption etc. The aim of this paper is to analyze the data communication on the CAN-Bus of a truck.

Key words: CAN-Bus, data exchange, bus monitor, fuel consumption, vehicle speed

Acknowledgments: This study was supported by the project no. IP 8/2013 “Implementation of a diagnostic protocol based on OBD-2 in the agricultural tractor” and financed by Internal Grant Agency Mendel University in Brno, Faculty of Agronomy. This study was supported by the project no. TP 5/2013 "Application of nondestructive methods of technical diagnostics in Agricultural technology" and financed by Internal Grant Agency Mendel University in Brno; Faculty of Agronomy.

INTRODUCTION

Higher demands on emission reductions and efficiency of transport caused great development control nodes in the form of electronic control units (ECU). This trend can be seen not only in cars and trucks, but also in agricultural machinery, especially in tractors. (Bauer et al., 2013) The ECU is essentially a computer that gives incentives for actuator of a predefined program. The ECU receives information (necessary for effective management) from internal sensors, which monitor the engine, transmission and other parts of the vehicle. On the basis of this information, the control unit determines the resulting need of action.

Before application communication lines, it was common electronic control units to operate independently. If necessary, the information exchange was transmitted over separate line. In practice, this meant that each parameter transmission from one controller to another required the installation of single communication line, that increasing production costs and management complexity. (Vlk, 2006) Complexity of conventional networking is shown in Fig. 1.

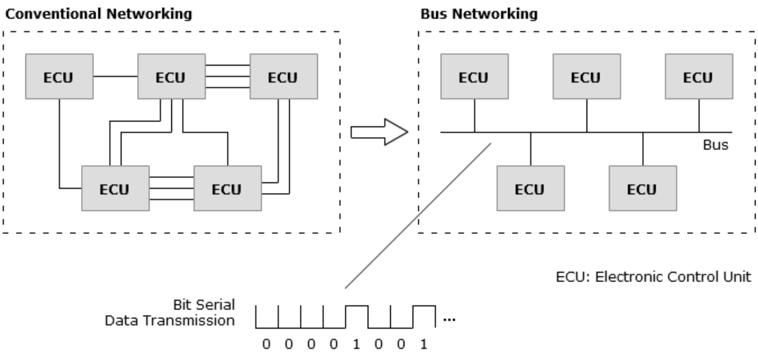

Fig. 1: Comparison of conventional and bus networking (Vector Informatik GmbH)

Electronic systems and those functions required more intensive exchange of information. For these reasons it was decided to communicate via the communication channel (bus). Architecture of such communication channel is in Figure 1 above. Using a digital network controller can efficiently and the desired speed of data exchange. The most widely used internal digital network vehicle CAN bus (Controller Area Network). Serial data bus CAN-Bus, which is used for internal communication network of sensors and control units of vehicle, was developed by Bosch company in the 80's. The transmission parameters are specified by ISO 11898, ISO 11783-2, SAE J2411 and SAE J1939. (Štěrba et al., 2011)

The aim of this paper is to analyze the data communication on the truck CAN-Bus and the data use to monitor the current operating parameters of combustion engine.

MATERIAL AND METHODS

For the analysis of the data communications bus CAN-Bus was used truck DAF XF 105.460 EEV (Figure 2). Selected technical parameters of the vehicle are shown in Tab. 1: DAF XF 105.460 engine parameters. The car has several mutually independent communication networks CAN-Bus, namely the V-CAN 1 (Vehicle) and V-CAN 2, the I-CAN (Instrument), the D-CAN (Diagnosis) and BB-CAN (Body Builder). All these CAN data buses are connected in central processing unit

VIC-3 (Vehicle Intelligence Centre), where all information are coordinated. Data bus systems in this truck meet worldwide standard for communication (SAE J1939/21 – cabling + network, and SAE J1939/71 –messages + protocol handling).

Fig. 2: DAF XF 105

DAF XF 105.460 EEV - Engine Parameters	
Number of cylinders	6
Displacement	12900 cm^3
Max. power	340 kW (1500 min^{-1})
Max. torque	2300 N.m (1000÷1410 min^{-1})
Emission limit	EEV

Tab. 1: DAF XF 105.460 engine parameters (DAF TRUCKS CZ)

Reading of data messages has been implemented using LabVIEW software and measurement software NI MAX (Measurement and Automation Explorer) from National Instruments (NI). As a hardware was used CAN-Bus interface NI USB-8473. This interface was connected via auxiliary cable directly to the OBD connector. After connecting the hardware to the OBD diagnostic connector was set up the software. In the next step, after preparation of measuring device has been switched on the ignition of the truck. At this moment has been triggered messages recording from CAN-Bus in the program NI MAX. It was also possible to observe messages directly in the list of messages (see Figure 4). Here you can find basic information about the messages on the bus. In the first column of the overall view of messages are message identifiers (Arb.ID) in the hexagonal form. After conversion to decimal form it could be found appropriate message and information contained therein in datasheet for SAE J1939 standard. File with messages was saved to HDD in „csv“ format. After starting the engine of the vehicle subsequently was higher number of messages which was available on the bus.

Arb.ID	Length	Data	Time Stamp	Rate	dt Min	dt Max	# (total)
0x18FEF1...	8	F7 00 00 04 01 00 E0 FF	73,0928	10,00	9,937e-002	0,101	731
0xCFDCC27*	8	0F FF FF FF FF FF FF FF	72,5728	1,00	1,000	1,001	52
0x18FDCD...	8	0F FF FF FF FF FF FF FF	72,9727	5,00	0,199	0,201	258
0x1CFDD1...	8	F0 30 32 30 30 FF FF FF	71,5739	1,00e...	10,001	10,001	6
0x18FEC0...	8	FF 7A 7D FF 00 FF FF FF	72,5740	1,00	0,999	1,001	52
0x18FEE7...	8	D1 00 00 00 FF FF FF FF	72,5746	1,00	0,999	1,001	52
0x18FEE9...	8	18 00 00 00 17 00 00 00	72,5752	1,00	0,999	1,001	52
0x18FEFC...	8	FF 09 FF FF FF FF FF FF	72,5758	1,00	0,999	1,001	52
0x18FD09...	8	FF FF FF FF FF FF FF FF	72,5764	1,00	0,999	1,001	52
0x18FDA4...	8	FF FF FF FF FF FF FC FF	73,0727	10,06	9,506e-002	0,105	516
0x18FEF2...	8	00 00 00 00 FF FF FF FF	73,0734	10,06	9,506e-002	0,105	516
0xCFE4127*	8	FF 0F FF FF FF FF FF FF	72,5783	1,00	0,999	1,001	52
0x18D0FF...	8	FA FF FF FF FF FF FF FF	71,5794	0,20	0,112	5,001	13
0x18F0050...	8	FF FF FF 7D FF FF FF FF	73,0740	10,06	9,384e-002	0,106	516
0xCFE6CEE*	8	00 00 C0 C0 00 00 00 00	73,1278	20,00	4,167e-002	5,734e-002	1032
0x18F0010...	8	00 00 C0 FF FF 01 FF F3	73,0751	10,01	9,366e-002	0,106	516
0x18FEC1...	8	93 13 00 00 93 13 00 00	73,0478	1,00	1,000	1,001	52
0x18FEE6...	8	70 09 09 02 16 1C 7D 7F	73,0784	1,00	1,000	1,002	52
0x18FF822...	8	00 00 00 FC FF FF FF FF	73,1388	3,99	0,246	0,253	205
0x18F0002...	8	C0 7D 7D FF 29 7D 00 57	73,1568	10,04	9,761e-002	0,100	510
0xCF00400*	8	FE 7D 7D 00 00 00 F0 FF	73,1576	99,95	3,984e-003	1,643e-002	5091

Fig. 4: NI MAX - Bus monitor (list of messages)

RESULT AND DISCUSSION

Investigated parameters were engine speed and instantaneous fuel consumption. In the list of messages were traced messages (on the SAE J1939 basis) containing information about speed and fuel efficiency. After decrypting the identifiers of messages has been possible to see which data messages indicate the engine speed and fuel consumption. In our case, the message identifier of engine speed was in the form of "0xCF00400". The last two numbers in the message identifier describe the message transmitter. In this case it is 00, which is a engine ECU. The second message, which is relevant for the vehicle testing or its diagnostic, is the instantaneous fuel consumption. The message identifier, where is instantaneous fuel consumption contained, was "0x18FEF200".
According to second column (messages data expressed in bytes) in Figure 4 we still cannot find out exact values of fuel consumption and engine speed without any further processing. Values are given, as in the case of messages identifiers, in hexagonal form. To convert to decimal form in other words to determine the exact values of the parameters was used proprietary software created in NI LabVIEW for this measurement. Block diagram for processing data messages and mask of proprietary software displaying the calculated values is shown in Figure 5.

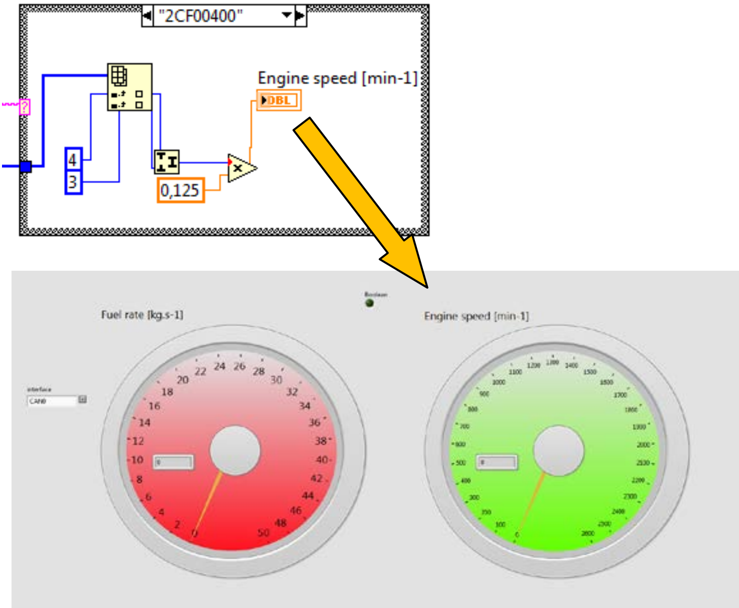

Fig. 5: Block diagram for processing data messages and mask displaying the calculated values (LabVIEW)

According to information contained in the data messages our proprietary software in LabVIEW already displayed the engine speed and instantaneous fuel consumption in the required form and in the appropriate units (after starting the engine).

As noted in a study by the authors Vykydal et al. (2012) is possible using data from the CAN-Bus evaluate a large variety of parameters for example during the field tests of agriculture tractor. Application of CAN-Bus during tractor pulling tests under field conditions described also Čupera et al. (2012) A possible problem that can occur by using data from the CAN-Bus is the scanned data accuracy. With the evaluation of accuracy of fuel consumption and data acquired from CAN-Bus of agriculture tractor dealt study by the authors Polcar et al. (2013) or Sedlák et al. (2011). Results of the study show that in certain engine modes engine ECU can determine inaccurate value of instantaneous fuel consumption.

CONCLUSIONS

Data analysis showed that there is information on tested car's CAN-Bus that are relevant to the testing and diagnostic of vehicles. Trucks are now commonly equipped with standard FMS (Fleet Management Systems). This system uses just CAN-Bus as a mean to transmit the requested information. If the vehicle meets the standard FMS, relevant messages on CAN-Bus meet the standard SAE J1939 (e.g. information from the tachograph, fuel consumption, temperature of coolant, using of retarder, warning lamp MIL illumination, etc.). With the scanning of these parameters can be quickly and efficiently determine the operating parameters of the engine and eventually can be reveal failure of the vehicle.

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