AUTOMOTIVE COMMUNICATION AND DIAGNOSTICS

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Abstract: *This paper presents automotive communication between ECU (Engine Control Unit) and PC (Personal Computer). This paper we review the different communication protocols required for the above purposes. It also gives an overview of some diagnostic errors and way of their solution. Also, presents a virtual instrument panel of a car that can be used for educational purposes in order to clarify that the computer (ECU) sends signals to the vehicle.*

Key words: ECU, PC, Diagnostics, Simulations

1. Introduction

Electronic control unit (ECU) in automotive industry is a generic term for any embedded system that controls one or more of the electrical systems or subsystems in a motor vehicle.

Types of ECU include Electronic/Engine Control Module (ECM), Powertrain Control Module (PCM), Transmission Control Module (TCM), Brake Control Module (BCM or EBCM), Central Control Module (CCM), Central Timing Module (CTM), General Electronic Module (GEM), Body Control Module (BCM), Suspension Control Module (SCM), control unit, or control module. Taken together, these systems are sometimes referred to as the car's computer. (Technically there is no single computer but multiple ones.) Sometimes one assembly incorporates several of the individual control modules (PCM is often both engine and transmission)

Standard J2534 does not limit hardware possibilities for the connection between the PC used for the software application and the tool. The goal of this paper, according with standard J25334, is to ensure that reprogramming software from any vehicle manufacturer is compatible with hardware by any tool manufacturer.

2. Connection to Vehicle

The interface between the pass-thru device and the vehicle shall be an SAE J1962 connector for serial data communications (OBD II standard diagnostics connector).

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The maximum cable length between the pass-thru device and the vehicle is five (5) meters. Vehicle manufacturers will need to supply information about necessary connections to any connector other than the SAE J1962 connector.

3. Diagnostics

On-board diagnostics are into existence from the early 1980's. But in the recent years they have become highly sophisticated. Thus there are highly reliable protocols just used for on-board diagnostics. Some of the most frequently used once are:

ODBII protocol – This is a one of the most popularly used standard introduced in the mid 90's and takes care of the complete engine control and monitoring of the chassis and the accessories. It is used by almost all the automakers.
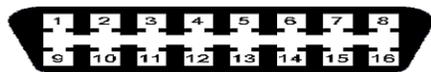

Fig.1. *Pins*

CAN ISO 11898 – Another very popular protocol used by almost all the automaker for on-board diagnostics. The pin details are as below.
Pin 2 - J1850 Bus+
Pin 4 - Chassis Ground
Pin 5 - Signal Ground
Pin 6 - CAN High (J-2284)
Pin 7 - ISO 9141-2 K Line
Pin 10 - J1850 Bus
Pin 14 - CAN Low (J-2284)
Pin 15 - ISO 9141-2 L Line
Pin 16 - Battery Power

Keyword 2000 and J1850 – These protocols are basically used by GM, Chrysler for on-board diagnostics. J1850 is a very old protocol and is being phased out.

The project "Design and development of hardware and software for connecting personal computers and electronic units in vehicles" basis for the implementation of standard SAE J2534, which provides the hardware of the device and software, which should meet the needs service, regardless of the manufacturer and vehicle models.

J2534-1 is a system devised of two independent parts: subscription software and a J2534-1 compliant Pass-Thru vehicle interface. The subscription software comes directly from the automaker, runs on your shop PC or laptop, and can either be web-based or CD-based. The subscription fees are charged differently for each automaker. Some automakers such as GM charge an annual fee for full access, while others have options for paying: per-vehicle, daily, weekly, monthly, or annually. Many of these services also include bonus features beyond flash reprogramming. FMP from Ford lets repair shops reprogram transponder keys, and other automakers are beginning to support diagnostic functionality.

4. Adapters for J2534

Fig. 2 present Pass-Thru adapters. It must provide for various physical protocols such as CAN and several UART specifications as well as specific programming voltages. The vehicle manufacturer provides the laptop software to send the encrypted data through the pass-through device to the addressed ECM. The ECM decrypts the data and programs it into its own FLASH memory. J2534 supports vehicle protocols ISO 9141, KWP2000, J1850 PWM & VPW, CAN, and Chrysler SCI. These are the network protocols that the Pass-Thru Adapter must use to communicate with various vehicles. Most vehicle makers are switching to the CAN bus, [4].

Fig. 2. *Pass thru Adapters*

If a reprogramming event fails, immediately retry the operation without disconnecting the J2534 tool. If a battery charger or jump pack was not used the first time, connect one and turn it on before you retry. Usually a failed attempt will complete successfully the second time. If you cannot get the reprogramming operation to succeed after repeated attempts, call the automaker's support number to find out if there is any other way to recover the module. If all else fails, the module might be reprogrammable offboard.

In project [1] is done simulation of work vehicle dashboard, which simulated the basics input data and errors. The appearance of the developed virtual simulator is shown in Fig. 3.

Considering the large number of car manufacturers, and model number for the project of technological development will primarily be made Virtual Engine Control Unit (VECU) which must meet all standards ISO and SAE. The need for

modeling VECU is clear for laboratory testing and reprogramming of the concrete vehicle.

Fig. 3. *Virtual Dashboard*

5. Conclusions

Application of standards J2534 and development of virtual and real simulations of the project will enable diagnosis of all defects and faults on vehicles using a universal interface. Bearing in mind the world trends of fathered development of the automotive industry in the development of this simulators and actual devices are taken into account that cars can be classic, hybrid and combined operations. This paper shown, that the current electronic systems on vehicles are complex and its sophistication is very useful to provide diagnostic and prognostic information to the operator.

Using external reprogramming tools for updating ECU firmware and calibration settings is a growing trend. Before the J2534 specification multiple hardware and software tools were necessary to reprogram vehicles from different manufacturers. The "multiple tools" situation proved confusing and expensive for any aftermarket business that repaired or customized vehicles from a wide array of manufacturers. In addition the U.S. Environmental Protection Agency (EPA) has developed vehicle network requirements that all vehicle manufacturers must meet for the 2004 model year and beyond. The EPA mandated compliance test suite (J1699) requires communicating with the vehicle network through a scan tool device. Both private business demands and new governmental regulations have provided the impetus for developing a hardware platform that is compatible with all vehicles. The J2534 specification defines a hardware device that interfaces to the vehicle network and a PC based software Application API that controls the hardware device. The PC based Application manages all aspects of the ECU reprogramming process through the J2534 API. The hardware device is concerned with providing physical and data link layer support for the specified J2534 protocols. This arrangement allows the vehicle manufactures to restrict access to proprietary reprogramming algorithms and support files and allows one hardware device to be used for programming all vehicles.

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