Software Development for Vehicle Diagnostics and Communication for Airbag Control Unit

Kamakshi
R V College of Engineering, Bengaluru, India.

Dr. K. Sreelakshmi
R V College of Engineering, Bengaluru, India.

Abstract— Electronic control unit (ECU) is used in many modern vehicle as electronic device. Communication protocol called CAN is supported by ECU. Because of fault confinement quality CAN is used as communication protocol in vehicle. As the number of ECUs increases in car diagnosis of the vehicle is very important. To detect the fault in Airbag Control Unit (ACU), Unified Diagnostic Services are used. This paper explains about how to find out the fault in ACU through diagnostic service. To indicate the fault in ACU warning lamp is placed in the dash board of the car. After the warning lamp is on one can test the ACU with diagnostic services to read the faults. The simulated results are shown in this paper not only idetecting the problem but also can be found out where ectly the problem has occurred.

Index Terms – ECU, CAN, diagnosis, Warning lamp, DID.

1. INTRODUCTION

Automotive industry are growing in faster rate in recent years, because of the safety system such as seat belts and airbags. Since their introduction seat belts and air bags have made driving safer. Airbags are passive safety systems which deploys airbag during accidents and reduces body damage to the driver. Manufacturing airbags and its working is very complex technology. There is continuous evolution of airbag technology in terms of design material and performance.

Airbags works as supportive safety device and the occupant should be restrained with seat belt properly. So that when there is a collision seat belts holds occupant in same position without moving aside. Airbag is like cushion which is filled with gas inside and gives feel like pillow. Airbag is also called as air cushion restraint system (ACRS) or airbag supplemental restraint system. Now days, vehicles comprise of wide variety of airbags which may be in the form of driver, front passenger, rollover airbags.

Modern automobiles consist of more than 70 Electronic Control Unit (ECUs) for various tasks each ECU or a group of ECU will perform specific tasks. The input for such computing devices comes from multiple sensors or actuators placed inside the vehicle. For communication to happen between the ECUs, Vehicle bus provides specialized communication network for information exchange between components inside the vehicle. These vehicle buses are cost effective and there is no conflict between messages. Some of the popular Vehicle bus standards are CAN (Controller Area Network), LIN (Local Inter-connect Network), FlexRay etc. Whenever there is an abnormal functioning of the ECU, an error code indicating the problem which is named Diagnostics Trouble Code (DTC) is stored in EEPROM of an ECU for later retrieval.

Professional automobile diagnostic centers can diagnose a vehicle and fix the problem. To analyze the failures diagnostic tools read diagnostic trouble code (DTCs) from the EEPROM. Diagnostic data are located in the memory of an ECU are inspected or modified by the tester. The word Diagnostics means identifying the cause of a prob-lem or a situation which leads to the creation of a problem. Automotive diagnostics is a way to identify flaws in overall functionalities of a given vehicle.

Airbags will guarantee the physical well beingness of the driver and co-passengers, hence its essential safety device. There is a communication between Airbag Control Unit (ACU) and other ECUs in car. Protocol is a set of rules of communication that has to be followed by the end points. Diagnostic protocol is used for diagnostic purpose as well as the communication between two ECUs.

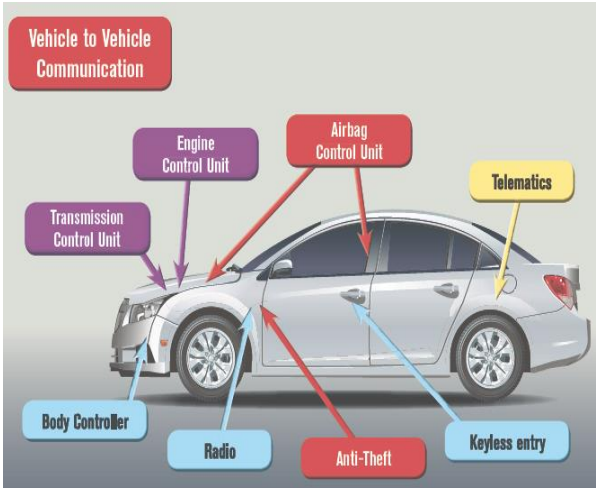

Figure 1. ECUs in car

Diagnostic protocol like K-line, UDS (Unified Diagnostics Services), and KWP (Keyword Protocol) has come up in automotive industry. In diagnostic there are different session available. Diagnostic session acts as basis for communication between ECU and diagnostic tool. ECU will be analyzed in particular session of diagnostic. A default session is the initial session that runs in a vehicle when an ECU is powered up. One's request is received from the diagnostic tool.

The communication between tester and ECU passes through many OSI layer as shown below. When the tester request message CAN receives it and sends to the targeted ECU. If the diagnostic message requested is more than 8 byte CAN TP comes into picture. Transport protocol can send and receive more than 8 bytes of data. CAN can also send more than 8 byte but not in single frame, it should be passed through multiple frames. In that first frame consist of 8 byte of data and remaining bytes are sent through flow control request to the ECU. If the ECU acknowledges continuous frames are sent.

2. LITERATURE REVIEW

Airbag malfunctioning is overcome by using the prior crash information, which is based on crash algorithm. The system is designed based on taking the inputs from the many sensors like acceleration sensor, steering angle sensor, speed sensor and ultrasonic sensors. Precrash information in addition with estimated information about frontal object makes more reliable to track the information about the host vehicle [1]. **S**ingle point sensing airbag units are improved by using upfront sensors in the form of capabilities to sense possible crashes. With the help of upfront sensors much better crash severity detection system is developed. However location where these sensors are placed is also important so that no additional sensors are not necessary to add. By considering mechanical concepts one can find best mounting place of the sensor. Perfect mounting location used by many number of vehicles is upper radiator cross bar. Proper occupant protection and crash sensing systems will also need structural changes of the car which is advantageous [2]. Occupant detection and classification makes use of intelligent crash sensing system for the deployment of airbag. Many algorithms are analysed based on safe distance decision, deployment decision and crash severity.

Software tools also been used to implement algorithm using Simulink, Stateflow, Sim-Mechanics and Matlab tools [3]. Interactive effects of failed components makes it difficult to find out the fault detections, isolation of multiple sensors, actuator failures and engine failures. Many residual generators provide provide separate residual signals based on which fault whether it is sensor fault or actuator fault. Mutual failure of sensors and actuators makes very difficult for fault. Decision logic is required for further circumstances. Residual code requires hexadecimal decimal decision table to find the failure patterns. By simple threshold testing of the residuals, residual code can be obtained which is output of general scheme residual generator [4]. A methodology is proposed for automotive software functions even though there is information exchange each partners IP is protected with the help of safe integration. Performance requirements such as timing and memory consumption of the ECU can be validated. For this formal analysis of ECU is required for legal certification [5].

3. METHODOLOGY

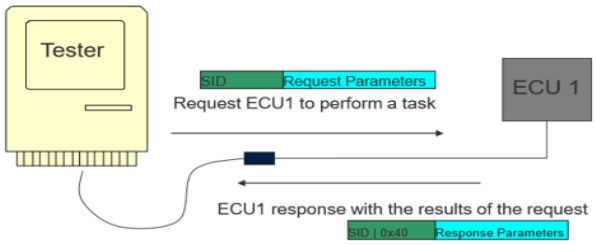

Figure 2 Block diagram of methodology

- The Tester controls the diagnostics and the ECU only responds to the tester request.
- The diagnostic service is information exchange initiated by the tester in order to obtain diagnostic information from the ECU or to modify ECU behavior for diagnostic purposes.
- The diagnostic services are denoted by unique Service ID.

3.1. Indicator Lamps

Indicator lamps are located in several areas of the cluster. All lamps within the cluster are served by the cluster printed circuit and cluster connector.

3.1.1. Airbag Indicator Lamp

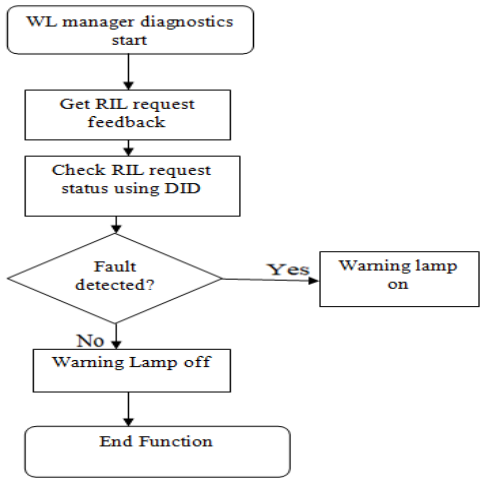

Figure 3 : Flow Chart of Airbag indicator Lamp

The airbag indicator lamp is switched to ground by the Airbag Control Module (ACM). The lamp lights for 2 seconds each

time the ignition switch is turned to the ON position as a bulb test and to indicate system self-test is in process. If the lamp remains on after the self-test or comes on while driving, it may indicate that the ACM has detected a system malfunction. Developing the software for diagnosing the ACU by sing the UDS services.

SRS Warning Lamp Operation

During the normal operation mode, the ACU shall turn on the SRS warning lamp right after certain fault is qualified by diagnosis function of the ACU.

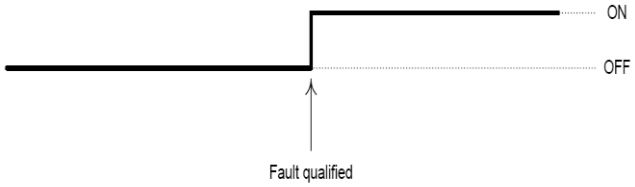

Figure 4 SRS warning lamp operation – fault qualification

If the qualified fault is no longer existed and finally de-qualified by diagnosis function of the ACU, the ACU shall turn off the SRS warning lamp right after the de-qualification process is completed unless specified fault condition is met."

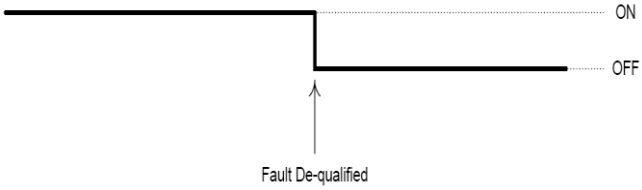

Figure 5: SRS warning lamp operation – fault de-qualification

For CAN communication connection type, it is allowed for cluster to turn the SRS warning lamp "On or Off" with ACU valid data command (i.e. ACU14 message) through CAN network according to criteria that is defined this section.

4. RESULTS

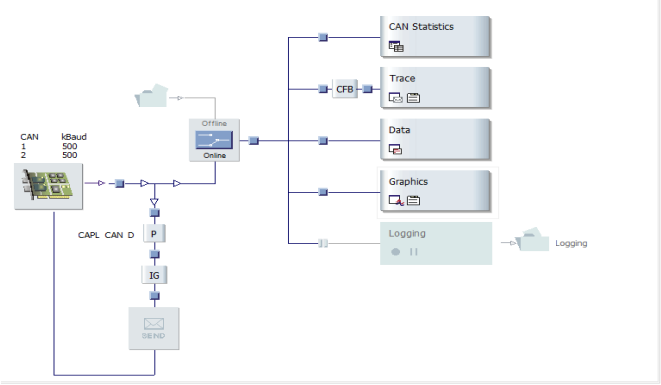

Figure 6: Simulation Setup of the ACU

Case 1: when the car ignition is on the status of the warning lamp will be off if there is no fault in the ACU.

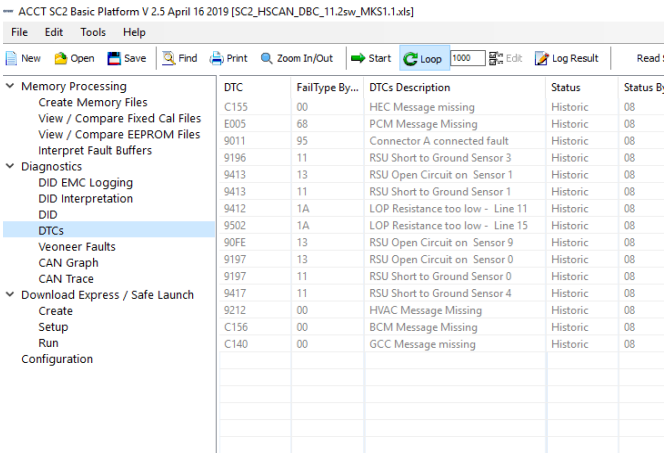

Figure 7: Trace window showing fault free

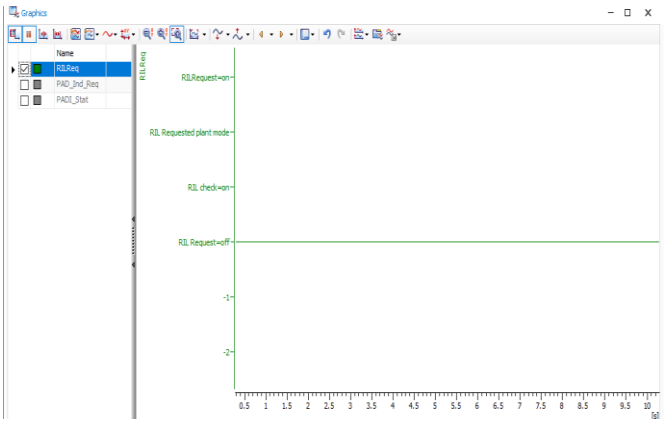

Figure 8 Trace window showing warning lamp off

Case 3: when there more than one sensor fault occurred the status of the warning lamp will be on.

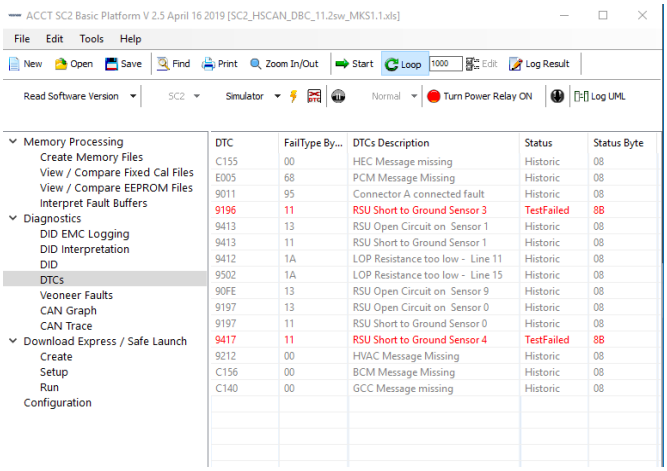

Figure 9 Trace window showing RSU short to ground 3&4.

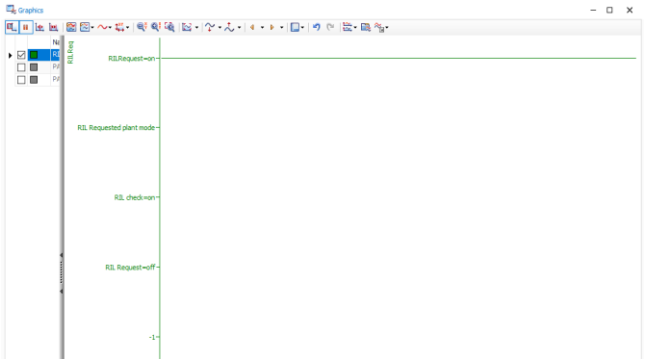

Figure 10: Trace window showing warning lamp on.

5. CONCLUSION

Air bags in car are much importance to save lives during accidents. So it is much needed that whether airbag control unit is in normal function. To indicate ACU is in proper functioning is determined by warning lamp. One can able to understand once the ignition on. If there is any problem ACU airbag will not deploy. By functional testing of ACU through UDS applications diagnose the ACU for proper functioning. So its used in all upcoming cars to save the lives of the people. In olden days only costly cars like BMW, Benz etc., embedded with airbag. But now a days it can be adopted in all types of cars. Detecting failures in such a complex machine is a big problem, UDS services helps in troubleshooting the failures which makes relatively easier.

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Authors

Kamakshi was born in Gulbarga 16-08-1994. She received B.E (ECE) degree from GSSS institute of technology for women's Mysore and pursuing MTech in R.V. College. She published paper in International journal of emerging technology in engineering research on topic software development for vehicle diagnostic and communication for airbag control unit. Her area of interest includes Digital communication, networking.

Dr. k. Sreelakshmi received B.E (ECE) degree from Siddaganga institute of technology Tumkur in 1990. MTech (ECE) degree from BMS College of engineering Bengaluru in 1999 and PhD in 2011 from Avinashi lingam university, Coimbatore, Tamilnadu India. Sreelakshmi joined R V college of engineering Bengaluru India in 1999. She served as assistant professor, associate professor till 2014 and as a professor from 2014. Presently working as Professor and HoD in the department of Telecommunication engineering. She has 17 years of teaching at diploma, degree and postgraduate levels, 3 years research experience as Junior research fellow (JRF), Life member of IETE and Life member of ISTE, she guided nearly 60 projects of UG and PG level related to different areas of telecommunication engineering, guiding three PhD scholars. She published papers in national, international conferences and journals. Her area of interests is RF communication system design, Advanced materials for devices.