

Implementing Automotive Features Using CAN through Vector CANoe



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Abstract- *As the increasing amount of electronic controllers and instruments in the modern automotive, it is observed that the vehicle reliability is largely influenced by the complexity of circuit deployed in the control system. In addition, the maintenance is hard to carry out. From the layout point of view, the traditional electric systems use a single point-topoint communication approach, which will inevitably result in large pet cabling problem. Therefore, the high quality vehicles use CAN (Controller Area network) bus system to link all the controllers in a system to achieve unified management. That leads to easy data sharing and interoperability between different control systems. The main aim of the paper is to create a working network system with two nodes and alsoa panel with functional windows and buttons. Also, to generate test files in CAPL, to test the network functionality using CANoe tool. The paper also presents the designing, verification and Validation functions of Starting or stopping vehicle ignition, Locking or unlocking the doors and Adjusting window position using the CANoe tool.*

Keywords: Control Area Network, vector CANoe tool

I. INTRODUCTION:

Most network applications follow a layered approach to system implementation. This systematic approach enables interoperability between products from different manufacturers. A standard was created by the International Standards Organization (ISO) as a template to follow for this layered approach. It is called the ISO Open Systems Interconnection (OSI) Network Layering Reference Model. The CAN

protocol itself implements most of the lower two layers of the model and the communication medium portion of the protocol on multiple media for maximum flexibility (twisted pair, single wire, optically isolated, RF, IR, etc.). To ease some of these concerns, the International Standards Organization and Society of Automotive Engineers (SAE) have defined some protocols based on CAN that include the Media Dependant Interface definition such that all of the lower two layers are specified. The CAN protocol is an international standard defined in the ISO 11898. Beside the CAN protocol itself the conformance test for the CAN protocol is defined in the ISO 16845, which guarantees the interchange ability of the CAN chips. A principle of data exchange CAN is based on the "broadcast communication mechanism", which is based on a message- oriented transmission protocol. It defines message contents rather than stations and station addresses. Every message has a message identifier, which is unique within the whole network since it defines content and also the priority of the message. This is important when several stations compete for bus access (bus arbitration).

Controller Area Network (CAN) is a serial network that was originally designed for the automotive industry, but has also become a popular bus in industrial automation as well as other applications. The CAN bus is primarily used in embedded systems, and as its name implies, is the network established among microcontrollers. It is a two wire, half duplex, high speed network system and is well suited for high speed applications using short messages. Its robustness, reliability and the large following from the semiconductor industry are some of the benefits with

CAN. CAN theoretically link up to 2032 devices (assuming one node with one identifier) on a single network due to the practical limitation of the hardware (transceivers), it can only link up to 110 nodes (with 82C250, Philips) on a single network. It offers high speed communication rate up to 1 Mbps thus Local Interconnect Network (LIN). These technologies coexist in a heterogeneous network making debugging and testing more challenging and time consuming. An in-vehicle network integrates many modules that interact with the environment, and process high and low speed information. As a result, testing this network has become very challenging. This is mainly because parts of the network (like the nodes) have to process high speed data to satisfy safety and emission requirements. Other parts of the network are low speed that they are locally connected to lights and switches.

A vehicle contains a network of electronic devices to share information/data with each other. For example a spark ignition engine requires a spark to initiate the combustion chamber at the correct time so it communicates with engine control unit that adjusts the exact timing for ignition to provide better power and fuel efficiency. Another example is of a transmission control unit that changes the ratio of gear automatically with the changing speed. It uses information from engine control unit and various sensors in the system.

II. RELATED WORK:

Today's vehicles include a complex symbiosis of intelligent electronic systems and integrated mechanical structures. Newly, electronic components and systems accounted for over 20% of the cost of high-end passenger cars and this percentage figure is increasing awfully. An electronic system now provides the technology to enable the manufacturer to deliver new features and to meet the mandatory regulation requirements in a cost active manner. Automobile electronic systems are now customary and are growing in terms of both quantity and complication. Were it has-been demanding Local or Wide Area Network has more PCs, servers, printers etc. communicating with each other, a conventional vehicle network has more control modules communicating with each other. Control modules have been cases like Engine Control, Transmission Control etc.

Where as a typical Local or Wide Area Network has more PCs, servers, etc. communicating with both, a

allows real time control. In addition, the error confinement and the error detection feature make it more reliable in noise critical environment.

The automotive industry uses two main network technologies: Controller Area Network (CAN) and typically vehicle network has more control modules communicating with both. Cases of control modules are Body Controls, Transmission Controls and Engine Controls etc. These modules will usually communicate with each other in a vehicle, in real time, utilizing in the callusing of the auto-mobile. With sure limitations are placed on the emission gases for the automobiles, it has become an impossible to earn this level of control without the help of devices. On-board devices are also had contributed substantially to mechanical engines completed, denizen comfort, calm of manufacture and cost influences. Once upon a time a radio probably There was the only electronic device in an automobile; nowadays practically everything in the automobile has some electronic characteristic in it. Few devices are used in the auto-mobiles today are:

- Engine Control
- Transmission Control
- ABS Control
- Body Feature Control (Power locks, Power Windows etc.)
- Entertainment (Radio, CD player, DVD etc.)

An electronic module usually gets its input from sensors (speed, temperature, pressure etc.) that it uses in its computation. Various actuators are used to enforce the actions determined by the module (turn the cooling fan on, change gear etc.). The modules need to exchange data among themselves during the normal operation of the vehicle.. That is how auto-mobile networks came about. The auto-mobile network is the medium of data exchange.

Every electronic device has an ECU/MCU (electronic/microcontroller control unit) with its own set of rules to share/transfer information. For two or more devices to interact they should have the necessary hardware and software which allows them to communicate with each other. Before CAN was introduced in the automobiles, each electronic device was connected to other device using the wires (point to point wiring) which worked fine, when the functions in the system were limited. The figure below is the graphic view of the point to point wiring connection.

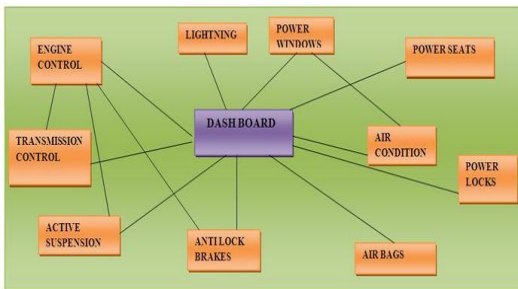


Figure-1: The pictorial view of the point to point wiring connection.

One of the major problems for automobile engineers was linking the ECUs of the dissimilar devices so that real time information can be exchanged. CAN protocol was designed to address this problem. It laid down the rules through which the various electronic devices can exchange information with each other over a common serial bus. This in turn reduced the wiring connections to a great extent there by reducing the bulkiness and complexity of the system. The image below shows how the different devices are connected using the CAN protocol.

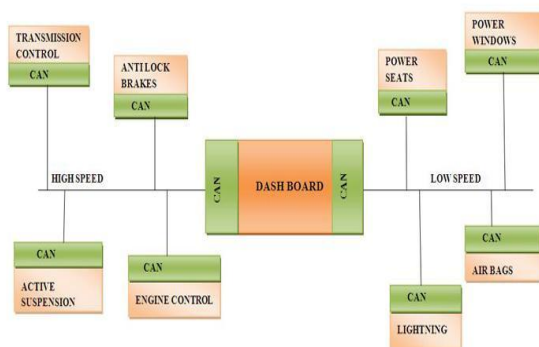


Figure -2: The Different devices connected using the CAN protocol.

Also the standard technology of time, asynchronous transmitter/receiver did not support multi domain communications. Domain is a group of electronic devices that have almost similar requirements to work in the system. For example CD/DVD PLAYER, GPS system, monitors and displays etc. form a single domain. Similarly air conditioning and climate control, dashboards, wipers, lights doors etc. form another domain. Hence the electronic devices implanted in a vehicle can be classified under different domain. CAN Facilitates multi-domain communication for the engineers.

III. MODEL AND DESIGN WORK:

In this proposed model, the main aim is to provide the communication between the Nodes (ECU'S) present inside the automobiles.

- Engine control
- Air bags
- Anti-breaking system
- Wipers
- Power seats
- Lightning and etc.

The presented paper focuses on three of the main functions as follows: Starting/ stopping vehicle ignition, Locking/ unlocking the doors and Adjusting, window position. All the above functions can be designed by using a CANoe tool. CANoe can be used to model all the network data and functions in these bus systems. When network data and functions need to be evaluated and validated at the design, implementation, or production stage, CANoe can become a test tool as well as a network simulation tool to test these network functions. There are many tools where CAN protocol can be implemented, some of them are:

- 1.CANoe /CAN alyzer
- 2.CANape
- 3.Dspace
- 4.CANdela
- 5.CANAero

1.1 CANoe /CAN-alyzer:

CAN-alyzer is the comprehensive software tool with intuitive operation for analysis and stimulation of bus communication. Use CAN-alyzer to check whether and what type of communication is occurring on the bus. It can also be used to send or log data. For every application it offers powerful basic functions for beginners as well as extensive detailed functions for experienced users.

1.2 CANape:

The primary application area of CAN-ape is in optimizing parameterization (calibration) of electronic control units. Calibrate parameter values and simultaneously acquire measurement signals during system runtime. The physical interface between CAN-ape and the ECU might be made via the CAN bus with CCP or XCP, for example. Additionally CAN-ape offers symbolic access to diagnostic data and services.

As a result it has all relevant integrated functions for measurement, calibration, flashing and diagnostics.

1.3 D-space:

D space systems are being used successfully at international automotive customers for developing and testing embedded electronics in fields such as engine control, power train control (including hybrid drive technologies and electric drives), vehicle dynamics (e.g., ESP, damping control), driver assistance systems (e.g., adaptive cruise control, parking assistance), comfort electronics, interior systems, infotainment, noise cancellation, diagnosis, etc. Our customers use controllers developed with Dspace tools in vehicles such as passenger cars, motorbikes, racing cars, and commercial vehicles like trucks, buses, and off-highway vehicles.

1.4 CAN dela:

The specification tool CANdela is a central component of the CANdela solution and supports users in creating and editing a formal ECU diagnostic specification. .

1.5 CANaero:

Over the years, a number of bus systems have become established in aerospace engineering. CAN is playing an increasingly important role here. CANoe.CANaero is a versatile tool for developing, testing and analyzing entire avionics networks as well as individual electronic units. Network designers, development and test engineers at aircraft manufacturers, system

IV. PROPOSED METHODOLOGY

Simulating a CAN Network (Vector CANoe)

The proposed model begins by developing a CAN database to symbolically represent the data on a CAN network with a simulated, virtual CAN network. The network will have two simulated network nodes and a panel as a user interface. The panel will give the user the ability to set the ignition to on/off, the doors to lock/unlock, and the window to up/down. Once the simulated network is implemented, we can use TFS to define a few test cases in both XML and CAPL to test the functional behavior of the network.

A. Create a New Directory:

- 1) Before loading CANoe, create a new directory called "test TFS" to contain the new configuration.
- 2) Load CANoe and use the main menu to go to **File**→**New Configuration**. A prompt will appear to select the default template and then click **[OK]**

suppliers and component producers will all benefit from its many different functions and configuration options.

Advantages:

- Reliable testing of the bus communications between electronic units – from simple interactive testing in design or implementation to systematic automated testing
- Automatically generated test reports
- Easy observation of data traffic and comprehensive network analysis
- Time-synchronous analysis of multiple buses and optional support of Ethernet enable gateway developments and tests
- Support of the protocols ARINC 825 and CANaerospace
- Open interfaces and database concept offer optimal support for proprietary protocols as well

Application Areas: CANoe, CANaero covers all use areas from simple network analysis to systematic testing of electronic units. The multi bus approach lets you simultaneously operate multiple channels, different bus systems such as CAN, Ethernet and FlexRay as well as different protocols. There are many ways to associate a panel to CANoe. The easiest method is by clicking once on the blue icon that looks like a meter with a plus sign on the toolbar of Panel Designer. Afterward, CANoe should be associated with a "Test" panel.

- 3) Go to **File** → **Save Configuration As**. Name the file "test TFS. cfg" and save it into the new directory. Then, click **[OK]**.

B. Creating a signal and Message to central locking system in data base

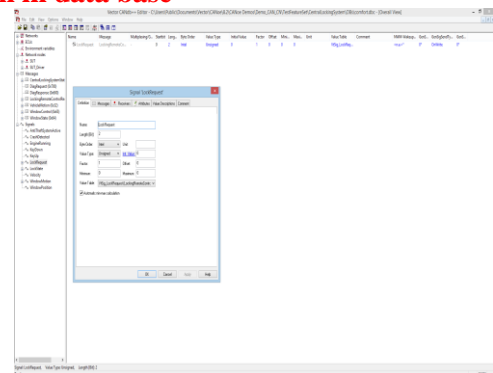


Figure -3: Image of Lock request signal and Data base.

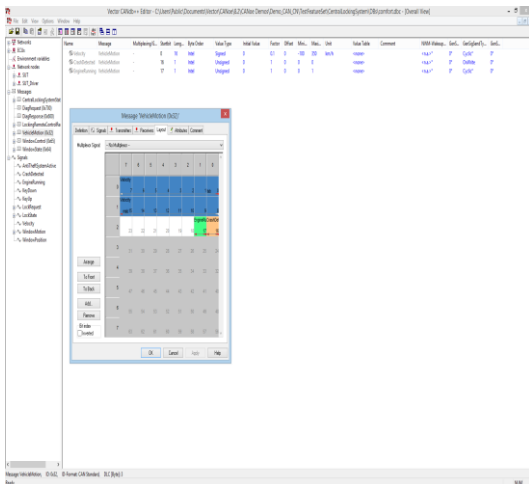


Figure -4: Image of Vehicle motion message in Data base.

C. Simulation processing using CANoe tool:

- 1) Go back to CANoe and open the Simulation Setup window.
- 2) In the left half of the window, right-click on the black/red parallel lines and select Insert network node. A new node will appear on the network with the default name "ECU 1".
- 3) Right-click on this new node and select Configuration....
- 4) Expand the *CANdb Name* drop down list and select the node name "SUT". Click [OK]. The node name should change from "ECU 1" to "SUT_DRIVER". The new node will appear in the tree list to the right.

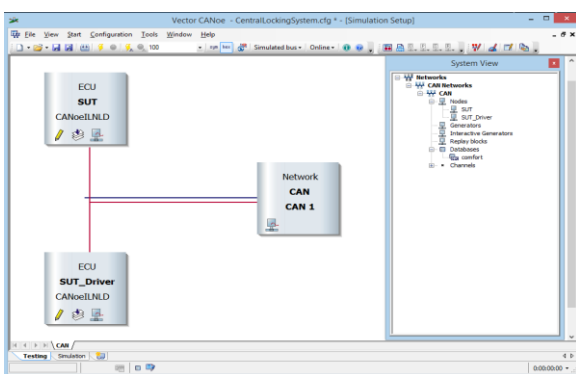


Figure -5: Design model of vector CANoe

D. Create Node Behavior:

Next, we need to use the CAPL programming language feature of CANoe to define the behavior of our two virtual nodes. A CAPL program is usually developed using the CAPL Browser. The CAPL Browser utility is subdivided into three distinct areas, or panes. The left pane contains a tree view of

available event types which can be defined by right-clicking and selecting **New**. The area on the upper right is where global variables will be placed for the CAPL program. The area below it is where the actual source code for each event procedure is written.

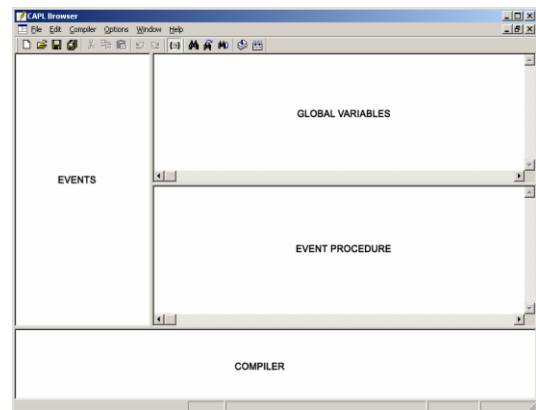


Figure -6: Window of CAPL Browser

E. Associate the Panel to Vector CANoe

There are two tools available to create graphic control panels, Panel Designer and Panel Editor. Each tool may be used as a separate application program; however, it is recommended to open them from CANoe so the associated database is reference. We will use Panel Designer in this example to create the panel. A circumstance of the device being tested that must be fulfilled during the test case if a condition is not met, then the test case will fail. Conditions can be used to check the system under test (SUT) behavior during the test execution. These can be defined easily with the functions or checks of the Test Service Library.

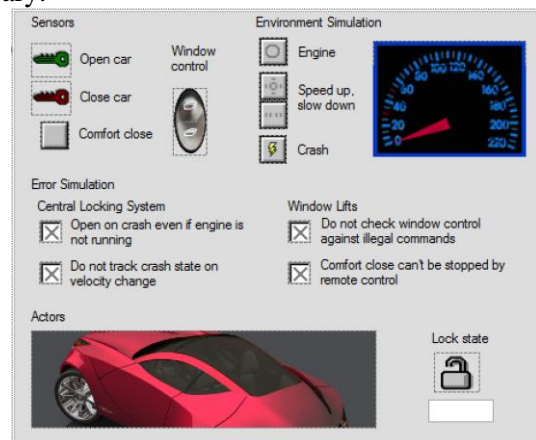


Figure -7: Simulation model of Test Panel

System under test (SUT): The system or device that is being tested by a test module.

- a. Test case: A specific property of a system/device under test (SUT) is tested in a test case. A test case has a clearly stated test task. After execution, a test result or verdict will state whether the test case has failed or passed.
- b. Test group: A test group is typically used to categorize a set of test cases in a test module to provide a better organizational structure and report generation. Test groups may be nested.
- c. Test module: A test sequence consisting test cases that are executed by CANoe.
- d. Test pattern: A test pattern is a pre-defined test procedure that is parameterized with concrete parameter values for execution. The execution of the test pattern and its result can change the verdict of the surrounding test case. Pre-defined test patterns are only used when a test module is implemented in XML.
- e. Test Service Library (TSL): A collection of prepared test functions (or checks) and value generation functions (stimuli) which make it easier for a user to assemble tests. These checks assist in solving specific test problems more effectively and efficiently. The usage of TSL functions is not restricted to test modules but, it is recommended that they only be used in XML and CAPL test modules.
- f. Test step: A test case consists of test steps or routines that are used to justify the test result or verdict. Test steps provide a finely structured and comprehensible manner when it comes to report generation.

F. Viewing the Test Report of Vector CANoe

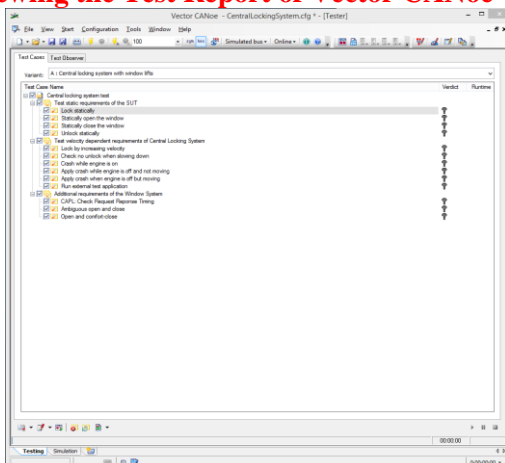


Figure -8: Image of the Test Cases or test module

After all test cases have been executed, a test report may be generated in XML and in HTML. For HTML test reports, there are two types of report formats: one

page and extended test reports. To view the test report of a test module, click on the icon in the test module window.

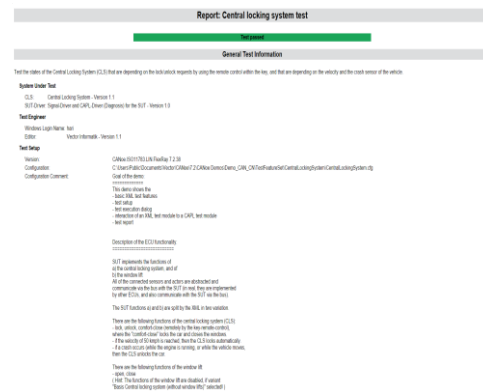


Figure -9: Report Generated from the Test cases.

IV CONCLUSION:

The existed paper presents “Implementing Automotive Features Using CAN through Vector CANoe” has been successfully designed and tested The Designing, verification and Validation of functions like Starting/ stopping vehicle ignition, Locking/ unlocking the doors and adjusting window position has been done using the CANoe tool. The paper also presents on how successfully created a working network system with two nodes and a panel with functional windows and buttons. Secondly, the system created test files in CAPL, to test the network functionality. The Presence of each and every module has been reasoned out and placed very carefully. Hence the contributing to the best working unit for automotive features implementation using Vector CANoe has been designed perfectly. This proposed model finds its major applications while we are monitoring larger areas like Transportation, Manufacturing, Agriculture, Healthcare, Communication, Science, Entertainment Retail and finance etc. This model assures us with more reliable and highly secured system. CAN is used in a variety of application domains related to any part of our human life.

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