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PASSENGER GROUND VEHICLE LIVE PARAMETER MONITORING AND GOVERNING USING AUTOMOTIVE IVN PROTOTYPE MODEL

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Abstract:-

Now a day the ground passenger vehicle safety becomes the most sensitive and major research area. There are many distributed sensors placed inside these vehicle for continually monitoring and actuating various moving and non-moving components of the vehicle. Thus in-vehicle based modern networking bus used to communicate data between various distributed sensor and actuator nodes, This paper describe the novel efficient implementation between Electronic control unit (ECU) and the distinguished CAN (controller area network) protocol utilized across most of the automotive industry, designed and maintained by Robert Boschs. The CAN based ECU system is implemented using three PIC microcontroller boards. The system is explain in simple way to understand the most difficult part of passenger vehicle. Real time system is prototypes and simulates within controlled environment, tested with all the possibilities and presumes conditions focusing towards all the real-world conditions. The system having multiple displays and indicators to indicate various parameters. The observations are analyzed and found satisfactory; the in vehicle network (IVN) is wider and sensitive subject which is studied extensively by most of the automotive abd allied industry. This research paper is the novel resemblance of the in vehicle CAN bus network in prototype presentation.

Keywords:-*Passenger Vehicle Data Monitoring, Controller area network (CAN bus), Vector Tool used for Real Time data logging and analysis of vehicle network(CANoe), In-Vehicle Networking (IVN). Open source Index (OSI), modern Electronic Control Unit (ECU),*

I. INTRODUCTION

Automobile sector mainly uses CAN bus as a communication channel for interconnection and data exchange between variety of in-vehicle embedded systems. This bus provides standard designed to allow controllers and devices to communicate with each other without computer. CAN bus is mainly broadcasting and message based communication protocol which is derived from Open source index (OSI) layer model. CAN bus is a three layer namely physical, communication and Network layer architecture instead of OSI seven layer architecture, which makes it more simple to understand. The CAN protocol simplifies most of coding complexity to great extent as well as the majority of modules effectively communicate with each other with most speed way and reliably, that is most important in automobile interfacing. Due to these benefits of CAN bus is widely used in many critical function realization of atomization in passenger vehicle such as ABS, Air Bag, Many Indicators and Controllers etc. with diagnostic capability for interpretation and healing the error also called as DTC i.e. diagnostic trouble code. The CAN protocol is widely used in vehicle networking as it provide most efficient communication among all types of actuators, in vehicle sensors in real-time with efficient self-diagnostic process.

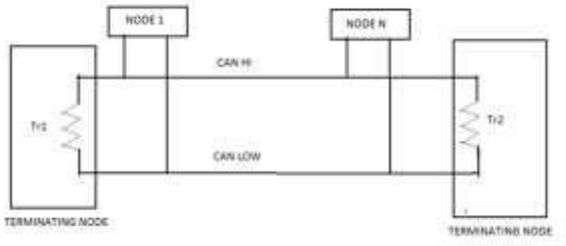


Fig.1 Basic Node structure of CAN network

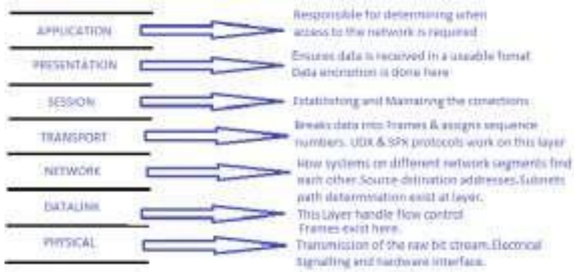


Fig. 2 OSI Layers

The above Fig 1 depict the necessity of communication where at least two nodes are required for message communication with only twisted pair wires of CAN HI & CAN LOW are sufficient. For better performance of the bus, the cabling capacity is calculated based on the number of different functions called and connected nodes over the bus. Thus depending upon the pay load, maximum number of active nodes and length of the wired network decides the bus baud rate. It is found from many literature that the network length of most of the passenger cars is around 20 meter with a data rate (baud rate) of 1kbps. Whereas commercial vehicles data rate is around 250kbps to 500 kbps. The CAN bus protocol is broadcasting type protocol where all ECU's trying to send their messages over the single bus as well as the nodes whoever required the specific information will fetch the desired encapsulated data from the different message floated over the bus.

CAN bus utilize the run time prepared CAN matrix, also called as data base collection (DBC) where each ECU allocated its particular messages and its own parameters such as periodicity, bit length etc? Depending upon the message ID and its periodicity will be defined.

II. LITERATURE REVIEW

In CAN bus protocol is introduces by Robert Bosh company in 1986. The first flavor of CAN protocol was published in 1987 at SAE conference. Thus to support the protocol and the supportive devices Intel and Philips developed first hardwired chip including all the functionality of CAN controller, these are available inbuilt and separate controller which handles the CAN bus protocol. Eventually after the incorporation of these buses inside the various systems Bosch published many dedicated versions for CAN so as to accommodate within various platform and applications having different specifications. Initially CAN specifications has been divided into two parts; part A is made of 11-bit identifier, and part B is specially utilize extended format almost with a 29-bit lengthy identifier. An 11-bit identifiers CAN devices are categorized as CAN 2.0A whereas 29-bit identifier CAN device where called as CAN 2.0B.

In **1993** CAN bus was adopted by many automobile industry due to its noise cancellation property, thus the ISO accept and released the CAN standard ISO-11898 which was further revised into two parts; ISO **11898-1** which incorporate the OSIISO data link layer, and ISO **11898-2** which almost covers the CAN physical layer for durable high-speed communication. Here after ISO again released **11898-3** and covers the CAN physical layer to accommodate low-speed, fault-tolerant CAN bus communication. The ISO 11898-2 physical layer standards and ISO 11898-3 standard are modified version and are not a part of the Bosch CAN 2.0 defined specification. Bosch is continually working and improving the CAN bus and still improving the extending CAN standards. Bosch also released CAN FD 1.0 used for Flexible Data-Rate having different data frame format that handle a different data length with optional switching to a faster baud rate after the arbitration. The bus arbitration is unequivocal and also CAN FD is compatible with existing CAN 2.0 networks specification so as new inbuilt CAN FD devices can coexist within system over the same network with existing in system CAN devices.

CAN bus is similar to one of five protocols used in the on-board system diagnostics (OBD-II) called as vehicle diagnostics standard. In some countries the OBD-II standard has become mandatory for all cars and light trucks, whereas EOBD standard has become mandatory for most of the petrol and diesel vehicles procure in the European Union countries.

CANoe is a powerful universal software tool made available by Vector Informatik GmbH. CANoe is a most versatile tool used for the vehicle embedded system development, testing and analysis of entire vehicle ECU networks and discrete ECUs which is made accessible to every project participants over the complete development process from initial planning to start-up of complete distributed systems or separate ECUs.

The software tools are utilize by most of the automotive manufacturers and electronic control unit (ECU) suppliers for development, analysis, simulation, testing, diagnostics and start-up of ECU networks and individual ECUs. Its widespread use and large number of supported vehicle bus systems makes it especially well-suited for ECU development in conventional vehicles, as well as hybrid vehicles and electric vehicles. The simulation and testing facilities in CANoe are performed with CAPL, a very interactive programming language.

III.COMPONENTS USED IN HARDWARE PROTO MODEL

The system prototype is designed using various components such as relay and display driver circuit based on transistor BC547, the relay driver current/ voltage booster ULN2003A, Power supply regulator IC LM7805, CAN transceiver - SN65HVD1040 module to interface PIC microcontroller 18F458, The visual system is built using LCD 16x2 to measure and monitor various parameter

IV.DESIGN OF IVN PROTO MODEL *CIRCUIT SCHEMATICS*

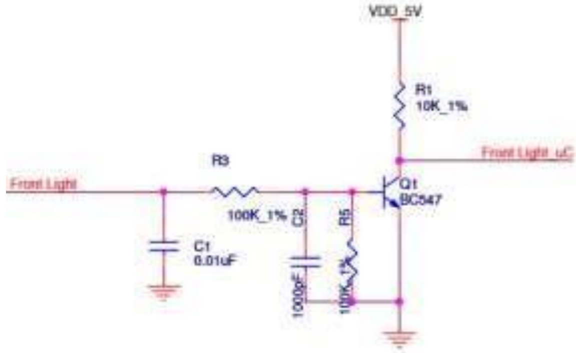


Fig. 3 Analog Inputs to PIC controller (Here we considered Front Light Input)

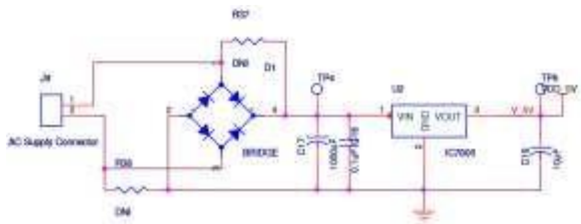


Fig. 4 Rectified Input to POWER-ON the Controller

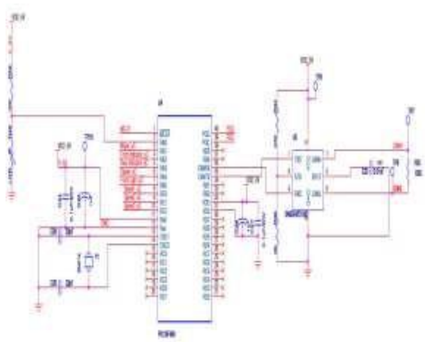


Fig. 5 Master (Input Board) sending the message on CAN bus

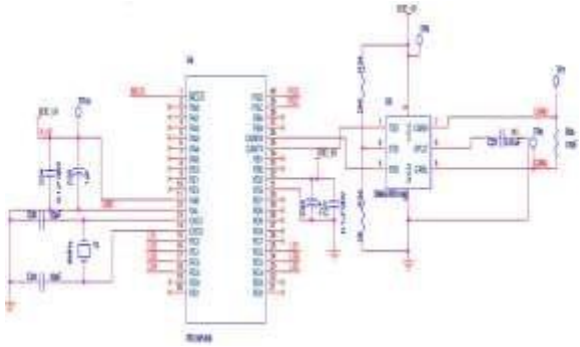


Fig.6 Slave (Output Board) receiving the input over CAN bus

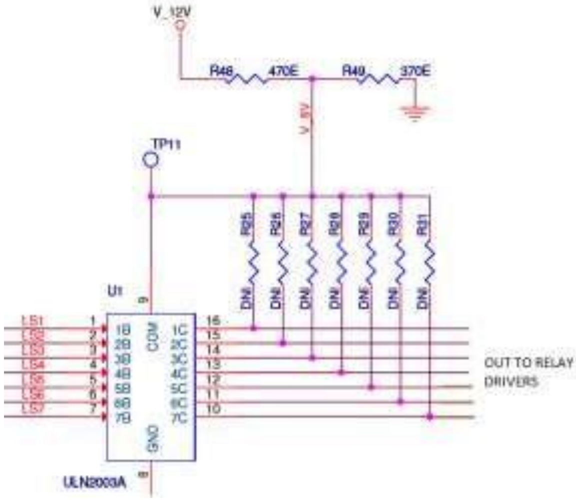


Fig.7 Relay Driver driving the Relays or Actuators

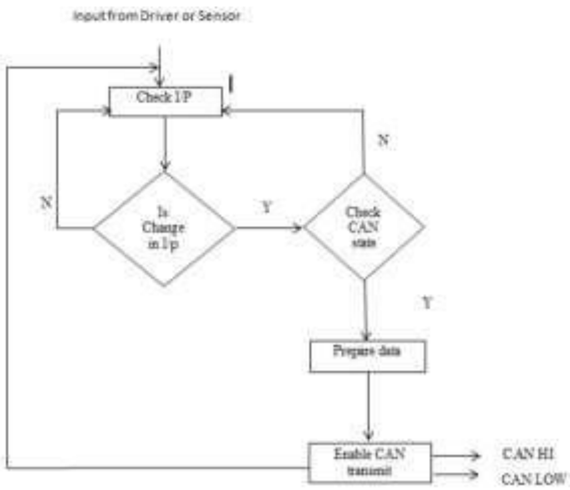


Fig. 8 Data Flow Diagram Input board

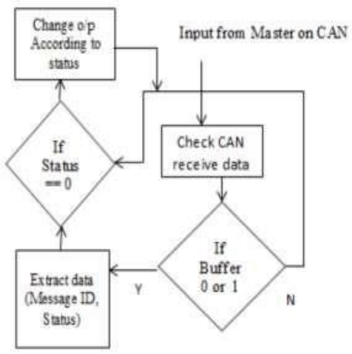


Fig. 9 Data Flow Diagram output board

The Fig.9 and Fig.10 describe the data flow model of Master Controller which takes the real time input from various sensors and switches, thus it process these input to send the appropriate message to input Master controller transmit the message (based on the code flashed in to it). Thus the signal on CAN bus is send as well as the same will be received by Salve controller so as to release the specific function through relay drives or indicators. Here in prototype the same Master slave communication is realized as mimic similar to actual vehicle level broadcasting, serial, message based communication in three layers format that is Physical layer, Communication Layer and Network layer.

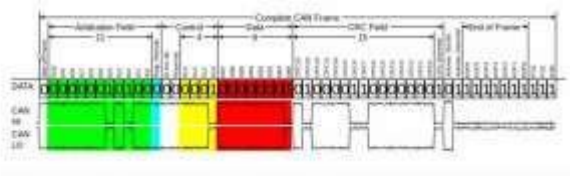


Fig. 10 CAN message format

Fig. 11 CAN signal working voltage

Fig. 11 explains the message format and the broadcast signal contains transmitted and received over the CAN bus physical line. Fig. 12 explains the voltage format for the same.

V.CASE STUDY

MIL (Malfunction Indicator Lamp) warning lamp

1.1 Purpose

In passenger vehicle, according to vehicle Engine functionality, EMS ECU unceasing observers the functionality of different sensors and insures the MIL lamp turned ON and OFF according to fault occurred by which emissions are out of bounds based on OBD Regulation. The MIL telltale directly driven by EMS ECU and instrument cluster has to operate the lam1p as per table below.

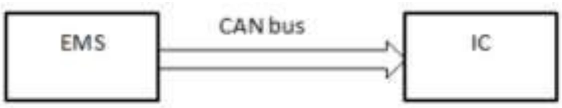


Fig.13 Connection Between ECU and IC through CAN Bus

1.2 Description

The following feature constantly monitors the vehicle Engine states and warns the driver in case of engine malfunction.

TABLE: I. SIGNAL DESCRIPTION

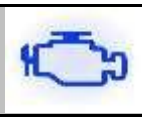
No.	Picture	Bulb check	Driven By	Remarks
1.		Yes	EMS	

TABLE: II. SIGNAL PARAMETER

Signal	Start- up	Periodicity (Ms)	Signal	Signal State	When This particular State will be set?
MIL Lamp State	00	100	00	MIL is off	No Fault in the system
			01	MIL is Flashing	Specific Errors
			10	MIL is ON	Fault in the system
			11	Reserved for future use	Not used

2.1 Behavior Modes

a) As per the standard initial positions ignition key must be in IGNITION position whenever MIL cautioning indication feature.
b) On system boots the initial bulb checking process is run and the initial test blink of MIL warning lamp is operated by EMS for ~3 sec for every ignition cycle.
c) IC must generate all the visual and text warnings for each of these feature (if required) as per below table. (Please refer applicable IVN message map for MIL lamp State signal detail)

2.2 Failure Modes

a) In case of MIL Lamp State message is time out, then the MIL warning tell-tale lamp shall be turn ON.
b) The MIL warning tell-tale lamp shall be turn ON, whenever IVN bus signal status is OFF.

2.3 Signal generation

The signal generation process is mainly based on the Engine working functionality; where EMS ECU is uninterruptedly monitors various sensors and insures the all the respective MIL lamp condition according to the occurrence of fault by which emissions might be out of threshold value according to OBD regulation. Thus the EMS ECU generate output signal state based on “ECU Diagnostic document” therefore MIL Lamp will Flashing depending upon EMS.

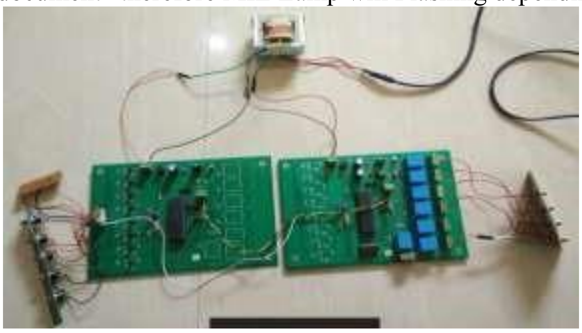


Fig. 14 Hardware pictorial view

Fig.15 Practical set up of ECU testing Connected over CAN bus, Laptop with CANoe application installed for graphical representation of signals, graphs, Vector CANoe tool for ECU signal simulation.

System Requirement   Hardware: Laptop/Toughbook
CANoe license USB cable Y-Cable to connect with
OBD connector
Software: CANoe setup Hardware tool drivers
Files: Database file (.dbc file)

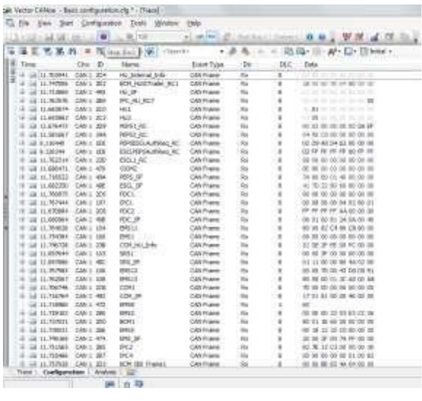


Fig. 16 CAN Message and Signal window on Laptop showing all ECU CAN bus real time message and signal status with all attributes (Time at which signal appearing on the bus in milliseconds, ID, Signal Name, Signal Direction whether Tx or Rx etc.)

V.RESULTS AND CONCLUSIONS

TABLE: III. PARAMETER PARAMETER

Boards	Board No 1	Board No 2	Board No 3
Communicati on	Transmitter / Receiver	Transmitter / Receiver	Transmitt er / Receiver
Parameter Sensing	Engine Temperature	Tire Pressure	Light Intensity and Obstacles
Range	50 - 230 D	0 - 50 Bar	Light Intensity : in Lux Obstacles : Present / Absent
Controlling	Lights : ON / OFF	Air Condition er Relay Brakes ON/ Release	Heater : ON / OFF

TABLE: IV. RESULT TABLE

Parameter	Lower Range	Action Taken	Higher Range	Action Taken
Temp	<50	Ignition Failure Alarm	>230	Ignition Failure Alarm
Tyre Pressure	<5 Psi	Pressure Alarm ON	>5 Psi	Pressure Alarm Off
Ligth intensity	<100 lux	Lights ON	>100 lux	Lights OFF
Temp	<50	AC OFF	>230	AC ON

This paper describe the proto implementation of realtime IVN system use in automobile with implementation of CAN protocol for parameter monitoring and control. Here Light dependent resistor LDR sensor is used for sensing the external light and communicated it over the CAN for actuator controlling signal or any other activation function to be operated based on the inputs sense from sensor. Simulation results are recorded using proteus professional software**.** Using a general PCB board interfacing of initial PIC controllers interfacing of CAN and display is verified. By using Or-CAD circuit schematics are drawn for various system components. To observe the outputs of various stage alphanumeric LCD Display are use, for other indications different colour LED's are used. Inputs are given through various switches to receive the input request from users or from many component or system, such as Engine-sensors sending signal of change in temperature level input to micro-controller unit to take appropriate set of action as programmed inside the main controller upon attainment that definite value.

VII.SCOPE FOR FUTURE WORK

In real time scenario like in passenger cars or high end smart cars like Audi, Mercedes Benz this 2 nodes will increase up to 15, 20, 25 & so on based on the function and feature criticality. Here we are not considering any Errors, Diagnostics which is by preparing CAN Matrix or DBC that is data base collection we can manage the Messages and signal attributes for healthy communication and we can prepare the same by using CAN DB+ editor tool. Bosch is still doing improvement in CAN Gateway for more and more nodes and heavy bus load. There is huge scope for improvement in ADAS (Advanced driver assistance system) and connected cars which is the future of the automotive world here after.

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