Automotive Inter ECU Communication Application-Glow Control Unit

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Abstract— Nowadays a vehicle consists of many Electronic control units which controls electronic components, actuators etc. These electronic control units interact with each other engine related information such as engine speed, engine coolant temperature, engine torque, key status, environmental pressure, environmental temperature etc. these information will be needed by various components for their functioning. This paper describes about one of such application Glow Control Unit (GCU) which makes use of this information on vehicle bus and functions independent of assistance from electronic control unit, GCU is an embedded system which controls the glow plugs which are used to heat the air inside combustion chamber prior to ignition in cold environments. In this project GCU is made up of RL78 microcontroller which provides a cost effective and efficient solution as compared to existing systems.

Key words: RL78 Microcontroller, Glow Plug, ECU, GCU

I. INTRODUCTION

Nowadays Automotive environment comprise of many Electronic Control Units (ECUs), which are connected via different bus systems (CAN, LIN, FlexRay etc.). Electronic Control Unit (ECU) is a generic term for any embedded system that controls one or more of the electrical system or subsystems in a motor vehicle. An engine control unit (ECU) is a type of electronic control unit that controls a series of actuators on an internal combustion engine to ensure optimal engine performance. It does this by reading values from a multitude of sensors within the engine bay, interpreting the data using multidimensional performance maps (called lookup tables), and adjusting the engine actuators accordingly.

A vehicle bus is a specialized internal communications network that interconnects components inside a vehicle (e.g. automobile, bus, train, industrial or agricultural vehicle, ship, or aircraft). Special requirements for vehicle control such as assurance of message delivery, of non-conflicting messages, of minimum time of delivery, of low cost, and of EMF noise resilience, as well as redundant routing and other characteristics mandate the use of less common networking protocols. Protocols include Controller Area Network (CAN), Local Interconnect Network (LIN) and others. Conventional computer networking technologies (such as Ethernet and TCP/IP) are rarely used, except in aircraft, where implementations of the ARINC 664 such as the Avionics Full-Duplex Switched Ethernet are used. In luxury cars the number of ECUs may even reach 70. They are classified into several system domains like power train domain, chassis domain, body domain, safety, infotainment, etc. Inter domain communication is established through gateways. The functional behavior of an ECU is specified by the Original Equipment Manufacturer (OEM), and implemented by the hardware supplier. Each ECU implements certain application functions, which interact in some way with Other ECUs. It is a common approach, that ECU hardware manufacturers also supply application software with their ECU. With this approach the system integration medium is more or less the bus system the ECU is connected to. With such a large number of ECUs and interacting functions error detection within a system is a challenge for the system integrator.

Glow control unit is the device used for cold start of engine in the environments where temperature is low. In normal environments air is injected into combustion chamber, compressed and when fuel is injected then combustion will takes place without need of Glow plug but in cold environments even though air is compressed and when fuel is injected combustion does not takes place. In such cases glow plug is needed to heat the air so that combustion takes place when fuel is injected. Apart from heating the glow plug, GCU performs many other diagnosis functions such as over current switch off, short circuit to battery detection, short circuit to ground detection, Battery voltage correction, ground offset correction, inverse polarity protection etc.

Glow control unit make use of information that flows on vehicle network such as engine speed, engine torque, vehicle key status, environmental pressure, environmental temperature etc. based on these information, GCU works as a standalone system without assistance from Electronic control unit.

In proposed system, we focus on making the device highly efficient, low power consuming and highly cost effective by using RL78 microcontroller and Independent operation without much dependency on Electronic Control Unit(ECU). Driving mechanism used in the proposed system is completely different from the existing system. In this system glow plugs are driven by the pulse width modulated signals from Microcontroller. The voltage required for driving the glow plugs is calculated and it is mapped into duty cycle, duty cycle is loaded into duty cycle registers of RL78 microcontroller which in turn generates the pulse width modulated signals which drives the glow plugs.

Overall system is monitored with a single shunt wherein the current of the overall system is measured and entire system will be switched off if current exceeds some predetermined limit.

Supply voltage is also monitored for over voltage as well as under voltage. PCB board is monitored against over temperature shutoff to avoid any damage to the system when temperature exceeds acceptable limit.

II. BLOCK DIAGRAM

The basic block diagram of the Inter ECU Communication is shown in figure 1. The Basic Block Diagram of the system is shown in figure 2. Many ECUS' in the system communicates with each other via standard via different systems such as CAN Network. Every ECU in turn controls Actuators, sensors etc

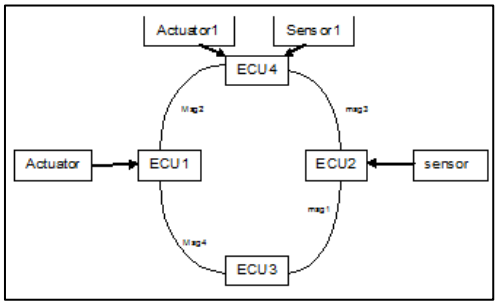

Fig. 1: Inter ECU Communication Overview

The microcontroller controls the glow plugs, it provides glowing command and timing information ie for what duration glow plug will be actuated and turned off in the given period of time. The microcontroller takes Signals on vehicle networks for calculating glow timings and calculates independently and drives the glow plugs independently without assistance from ECU.

Smart FETs are used to turn on the channel for glow plugs, Pulse width modulated signal is given as input to the MOSFET. Which turn it on for some specified duration Pulse width modulated signal is generated from the Timers of microcontroller RL78. Duty cycle is loaded into timer registers based on calculated glow voltage.

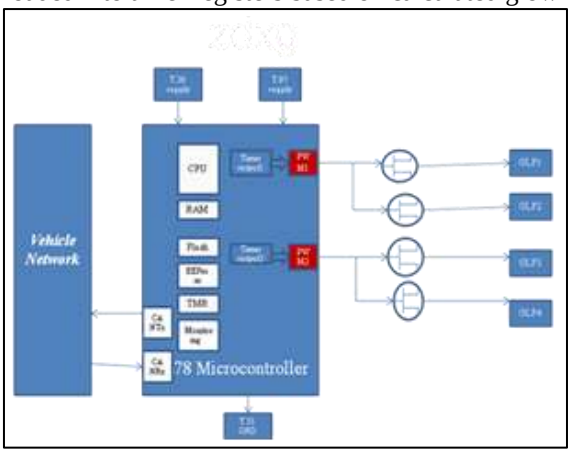

Fig. 2: Glow Control Unit Block Diagram

III. HARDWARE PLATFORM

The Hardware platform used is RL78 Microcontroller, The RL78 Family of microcontrollers (MCUs) combines advanced low power technology, outstanding performance, and the broadest line-up in its class for the most demanding 8- and 16-bit embedded applications. The RL78 MCUs' innovative "Snooze" mode achieves ultra-low power by allowing ADC operation and serial communication, all while the CPU is turned off. This makes the RL78 MCUs best in class for low power applications. RL78 is Renesas Electronics' new-generation microcontroller family combining advanced features from both the 78K and R8C families to deliver low power consumption and high performance. RL78 is based upon 16 bit CISC architecture with analogue rich functionality. The platform lineup will include general purpose, LCD and ASSPs including lighting and automotive microcontrollers. RL78 is designed specifically for ultra-low power applications enabling customers to build compact and energy-efficient systems at lower cost.

A. Software Description

IAR RL78: Integrated development environments are designed to maximize programmer productivity by providing tight-knit components with similar user interfaces. IDEs present a single program in which all development is done. This program typically provides many features for authoring, modifying, compiling, deploying and debugging software. This contrasts with software development using unrelated tools, such as vi, GCC or make.

One aim of the IDE is to reduce the configuration necessary to piece together multiple development utilities, instead providing the same set of capabilities as a cohesive unit. Reducing that setup time can increase developer productivity, in cases where learning to use the IDE is faster than manually integrating all of the individual tools. Tighter integration of all development tasks has the potential to improve overall productivity beyond just helping with setup tasks. For example, code

can be continuously parsed while it is being edited, providing instant feedback when syntax errors are introduced. That can speed learning a new programming language and its associated libraries.

Fig. 3: Placement of Glow control unit in Engine combustion chamber

B. CAN: The Communication Network

A controller area network (CAN bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications without a host computer. It is a message-based protocol, designed originally for automotive applications, but is also used in many other contexts.

CAN is a multi-master serial bus standard for connecting Electronic Control Units [ECUs] also known as nodes. Two or more nodes are required on the CAN network to communicate. The complexity of the node can range from a simple I/O device up to an embedded computer with a CAN interface and sophisticated software. The node may also be a gateway allowing a standard computer to communicate over a USB or Ethernet port to the devices on a CAN network.

IV. EXPERIMENTAL RESULTS

A. CAN Communication

The Proposed Glow control unit device communicates with the vehicle network to receive signals which contains engine related information such as engine speed, engine coolant temperature, engine torque, environmental pressure, environmental temperature, vehicle key status. Communication results are be viewed by simulating Engine control unit which sends this information. And Reception of these signals can also be viewed in the simulator.

B. The Glow Control Unit Test Results

The test is conducted for generating timing information for glowing the glow plugs. The timing signals follows the alternative switching concept where at the falling edge of one PWM signal, second PWM signal is generated. The main aim behind this technique is to reduce overall board net load on the battery system.

The generated PWM signals which are used to drive the glow plugs are given in the fig 4.

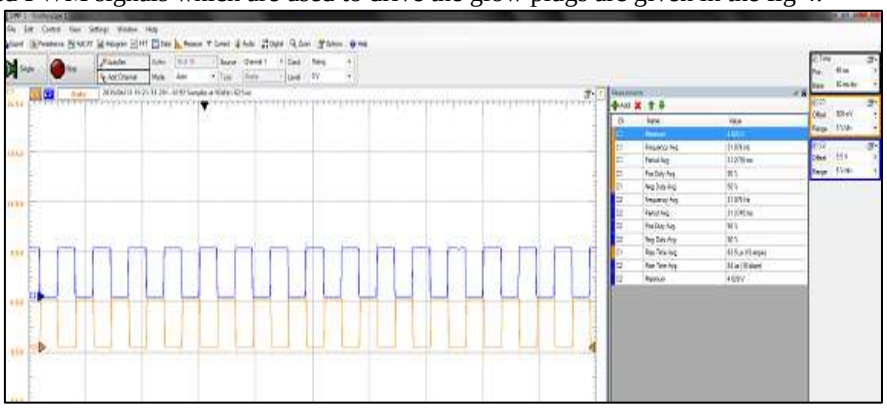

Fig. 4: Timing signal for driving glow plug

V. CONCLUSION

The entire system is tested and developed in Microcontrollers Lab. The proposed system finds vital application in Automotive industry, it is cost effective hence attractive in the competitive market and it is highly efficient and less power consuming hence saves energy. It reduces emissions into atmosphere so it is environmental friendly.

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