ISSN 2395-1621

CAN Applications in Automotive Network Controls Using PIC Controller

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ABSTRACT

In an automotive system the information is shared between two controllers. This sharing of Information is done by using Controller Area Network (CAN), which acts as an information carrier. The electronic control unit of engine and Electronic Coordination Units for chassis and vehicle body should have the function of data acquisition, data management and data transmission. In the engine, Controller1 will measure the fluid level and temperature of engine and controller2 will measure the crank position and cylinder pressure. The information between these two controllers shall be shared via CAN BUS. In modern vehicles, based on requirements of CAN architecture shall be implemented so as to reduce point to point wiring harness in vehicle. The benefits of CAN network over traditional point to point schemes will offer increased flexibility, safety, comfort, emission and expandability for future technology insertions. The system shall be upgraded easily and the cost effective solutions are obtained. In this CAN BUS play an important role for communication technology. The exchange and sharing of data shall be achieved between control unit and one coordination unit.

Keywords— **CAN bus, Controllers, IC Engine, ECU**

ARTICLE INFO

Article History

Received :18th November 2015

Received in revised form :

19th November 2015

Accepted : 21st November , 2015

Published online :

22nd November 2015

I. INTRODUCTION

In this generation Automobiles are being developed by more of electrical parts for efficient operation where generally a vehicle was built with an analog driver-vehicle interface for indicating various vehicle statuses like speed, fuel level, Engine temperature etc., based on requirements of modern vehicle, in-vehicle Controller Area Network (CAN) architecture has been implemented. In order to reduce point to point wiring harness in vehicle automation, CAN is suggested as a means for data communication within the vehicle environment. The software part of the automobile control system is designed and sharing of data is fully realized among the node, Also CAN is a serial data transfer bus, due to its ease in use, low cost and provided reduction in wiring complexity it is mostly used in automotive and automation industries. By networking the electronics in vehicles with CAN, however, they could be controlled from a central point, the Engine Control Unit (ECU), thus increasing functionality and adding modularity, and making the diagnostic processes more efficient. CAN offer an efficient communication medium between sensors, actuators, controllers, and other nodes in real-time applications, and the CAN bus is known for its simplicity, reliability, and high performance.

II. LITERATURE REVIEW

The distributed system concept was adopted to provide the communication path among the electronic subsystems [1]. An example provided in declares 32 ECUs and 12 CAN networks in one truck [7]. As the electronics plays an important role also from the safety point of view, its correct behavior is required in all possible working conditions and must be appropriately tested and evaluated. There are two states – dominant and recessive – that represent logical 0 and logical 1. If any node on the bus transmits logical 0, there is the dominant state on the bus, regardless of the levels transmitted by the other nodes [6]. The recessive level is found on the bus only if all the nodes transmit logical 1. Another important feature of the CAN protocol is a detection of errors in the received data. In order to realize the objectives mentioned above, the ECU automatic measurement and control system (AMCS) is developed, for the purpose of various ECU internal MAP and dynamic real time data measurement. The development of ECU must be simulated with Hardware in Loop (HIL) and practical vehicle demarcation, which is the most important and time-consumed process during the research job.

III. CAN COMMUNICATION

Complexity in the automotive system demands the simplest communication for controllers of system, which will reduced by reducing wiring harness and using simple communication systems. Here CAN network protocol is specially developed for connecting the sensors, actuators and ECUs of a vehicle, which allows the CAN network to be used to share status information and real time control which is represented by T. P. Presi [1]. Two main methods to analyze the system real time performance are suggested by Fang Li et al i.e. one is based on mathematical model and another method to evaluate the real-time performance of CAN bus system is testing or experiment [2]. It transfers upto 8 data bytes within a single message. And at the Dashboard Side CAN controller checks if any data is available at the receive buffers. If any data is available, then that value is displayed through LCD and the CAN bus system performance analysis is based on message model, system performance analysis is mainly concerned to calculate message response time and bus load. For transparent flows of information originating in both sensors and actuators in heavy industrial applications which encompassing different requirements regarding data rate and power source, especially in some specific cases where power supply cabling is mandatory.

In the embedded system development has a wide application. But in fact, most embedded processors do not take CAN bus controller Therefore, the embedded processor expanded CAN bus interface chip in the external bus is the most common solution [8].. Behind the server computer, provides multiple experimental sets running simultaneously. In remote library System is categorized into two groups: Software packages such as MPLAB, LABVIEW and hpvee and software programs such as C# and Java to program the IC's. This architecture allows controlling multiple modules over a network using only one server computer.

IV. SYSTEM ARCHITECTURE

This system is divided into two parts Hardware architecture and Software Architecture, and they are explained below.

A. Hardware Architecture

The architecture of akif kutlu *et al* [1] design is the remote laboratory consists of a server computer with an industrial network card. Since the network card is plugged in a pci slot, it is called pci can card. The second experimental set measure diode and transistor characteristics, respectively. Each experimental set has one microcontroller and experimental circuit, which measures the output of circuit using analog to digital converter (ADC) component and sends obtained values to the user through can and internet.

Hardware of PIC is used because of its instruction execution time is less and can transceiver is a high-speed can and fault-tolerant device that serves as the interface between a can protocol controller and the physical bus monitoring system: temperature sensor LM35, light dependent resistor, gas sensor, liquid crystal display and universal synchronous asynchronous receiver transmitter.

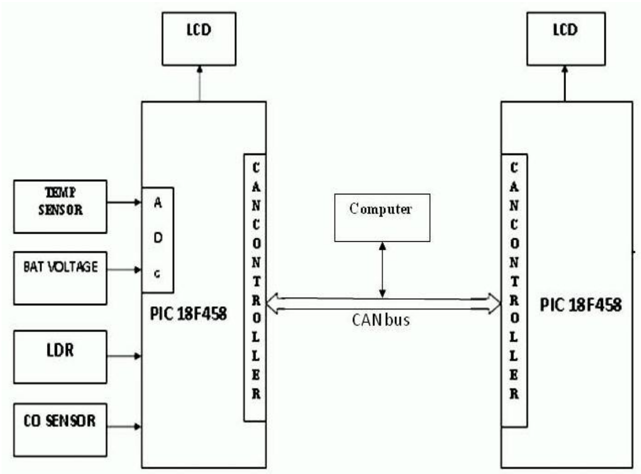

Fig.1 Block Diagram of Microcontroller Based Vehicle Monitoring System Using CAN

The PIC18F4580 Development Board can be used to evaluate and demonstrate the capabilities of Microchip PIC18F4580 microcontroller. The MCU on board provides support for 40 pin DIP package of PIC18F4580 controller. The board is designed for many applications and includes a variety of hardware to exercise microcontroller peripherals. It is a tool for code debugging, development and prototyping. The all new application designs have made it much more user-friendly than its predecessors. The components used in this board are of high quality and the PCB is high quality two layer PTH PCB, which makes this board durable.

B. Hardware Selection Criteria

PIC18F4580 is preferred for the CAN communication because of its compact and Included PIC18F4580 Microcontroller with built-in CAN Peripheral design. RS-232 Interface (For direct connection to PC's serial port) is available which is required for this project to display the results in digital form, the data from PC to board. Here to show the results of transmit and receive the data, Four multiplexed 7-Segment LED Display is connected which can be programmed by giving instructions using Built in Matrix keyboard (12 keys) and Built in Pull-Up (4 Keys) Keyboard. LM35 is mounted for temperature sensor. LED indicators are needed for the indication of data in/out, blinking of LED will shows that. Basically all these hardware is selected for the efficient data transfer and accuracy of the communication, which helps to reduce the error or loss of data. Generally CAN ports are not mounted, here CAN ports are mounted and it is compatible and works very well. List of Used components is:

Fig 2 : PIC18f4580 CAN board

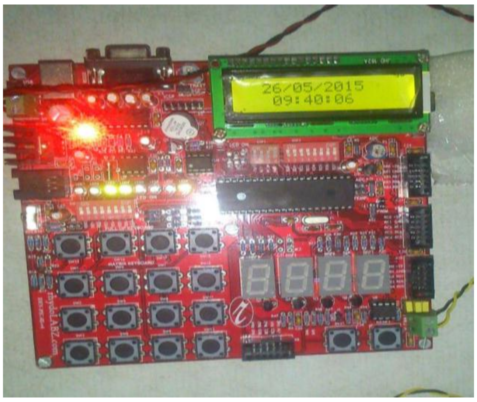

Fig 2 showing the board of Microchip PIC 18F4580 with 20 MHz Crystal Oscillator (With Boot loader Software) is used with Built-in CAN Peripheral. High Performance RISC CPU will help to improve the performance of system.32 KB Programmable Flash Memory and 1536 bytes Data Memory (SRAM) with 256 bytes EEPROM, which Supports Up to 40 MHz Operation. 36 I/O pins are available for input output operations. 11-Channel 10-bit Analog to Digital Converter (ADC) is inbuilt in board. One 8-Bit Timer/Counter and Three 16-Bit Timer/Counters are available here. With the help of all these features we are measuring and transmitting some analogue signals, digital data by using controller 1. Acknowledgement signal is generated by controller 2 using switch on/off mechanism. By the help of this switch mechanism delay can be generated.

PIC18F4580 specifications

PIC18F4580 is 40-pin Low Power Microcontroller with Flash Program Memory: 32 kb and EEPROM Data Memory: 256 bytes. It is having 36 I/O pins, with one 8 bit and three 16 bit timers. CAN port is connected to the board with CAN 2.0B Transmit and Receive Buffers.

The MCP2551 is a high-speed CAN and fault-tolerant device which serves the interface between a CAN protocol controller and the bus. The MCP2551 provides differential transmit and receive capability for the CAN bus controller and it is fully compatible with the ISO-11898 standard, including 24V requirements. It will operate at speeds of 1 Mb/s or less. typically; each node in a CAN system must have a device to convert the digital signals generated by a CAN controller to signals suitable for transmission over the bus cabling (differential output). It provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources (EMI, ESD, electrical transients, etc.).

Temperature ranges:
- Industrial (I): -40°C to +85°C
- Extended (E): -40°C to +125°C

C. Can Bus Network Algorithm

The software of main program unit is divided into: System initialization unit and CAN initialization unit, message sending unit and message receiving, interrupt service unit.

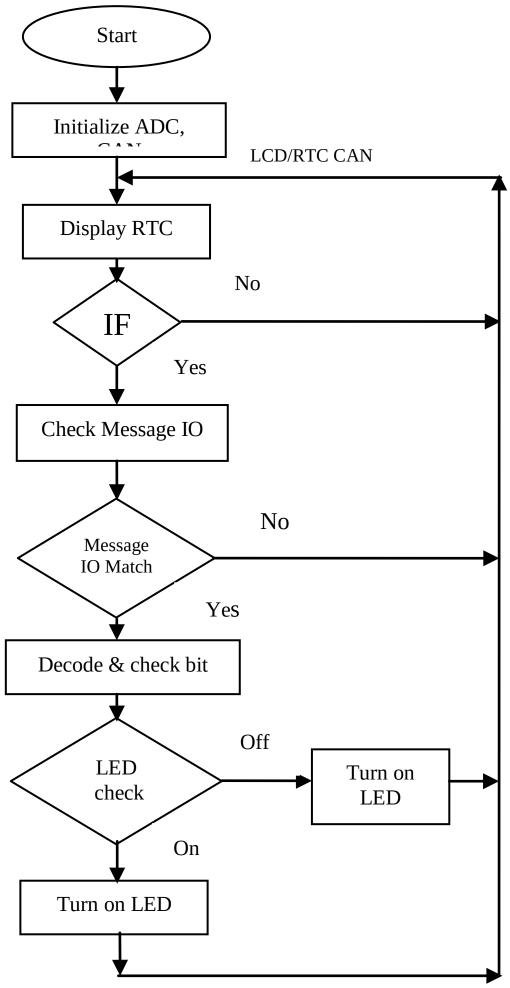

Fig.3 : Message Sending Algorithm

CAN Controller Initialization

CAN controller initialization process include initialization of internal register of CAN controller MCP2515, such as initialization of transmit and receive buffer. When initializing the CAN registers in the MCP2515, the system immediately clear the read and write buffer, Configures the operating mode, bit timing register, filter and mask register, and interrupt enable register.

CAN Message Sending

After initialization, the MCP2515 is in normal communication status and is ready to work. The message sending via CAN, adopts inquiry mode or it sends message when remote request is received. In inquiry mode, after specific time interval the LPC2148 IC creates packet and sends data to CAN Controller transmit buffer for further transmission.

CAN Message Receiving

There are two ways for messages receiving: inquiry mode and interrupt mode. In system design, interrupt mode is implemented. In interrupt mode, if MCP2515 CAN controller receives valid message in receive buffer, it generates interrupt signal on INT pin. Message is read by LPC2148 by using SPI commands of MCP2515.

Accuracy of the CAN Communication

In the CAN communication the data frame is the most common message type, and comprises the Arbitration Field, the Data Field, the CRC Field, and the Acknowledgment Field. The Arbitration Field contains an 11-bit identifier in and the RTR bit, which is dominant for data frames, it contains the 29-bit identifier and the RTR bit. Next is the Data Field which contains zero to eight bytes of data, and the CRC Field which contains the 16-bit checksum used for error detection. Last is the Acknowledgment Field. Error frame is transmitted when a node detects an error in a message, and causes all other nodes in the network to send an error frame as well. The original transmitter then automatically retransmits the message. An elaborate system of error counters in the CAN controller ensures that a node cannot tie up a bus by repeatedly transmitting error frames. A message is considered to be error free when the last bit of the ending EOF field of a message is received in the error-free recessive state. A dominant bit in the EOF field causes the transmitter to repeat a transmission. Another method of error detection is with the bit-stuffing rule where after five consecutive bits of the same logic level, if the next bit is not a complement, an error is generated. Stuffing ensures that rising edges are available for on-going synchronization of the network. Stuffing also ensures that a stream of bits is not mistaken for an error frame, or the seven-bit interframe space that signifies the end of a message. Stuffed bits are removed by a receiving node's controller before the data is forwarded to the application.

V. RESULTS AND CONCLUSION

CAN In automotive electronics, engine control units, sensors, anti-skid-systems, etc. are connected using CAN with bitrates up to 1 Mbit/s. this is a serial communications protocol which efficiently supports distributed realtime control with less error and good accuracy and very high level of security in automotive systems. Because of this advantage of CAN protocol, this is used in this project.

Here boudrate of CAN is up to 125k, which is sufficient for PIC18f4580 to transmit or receive the data and maintain the accuracy of the system.

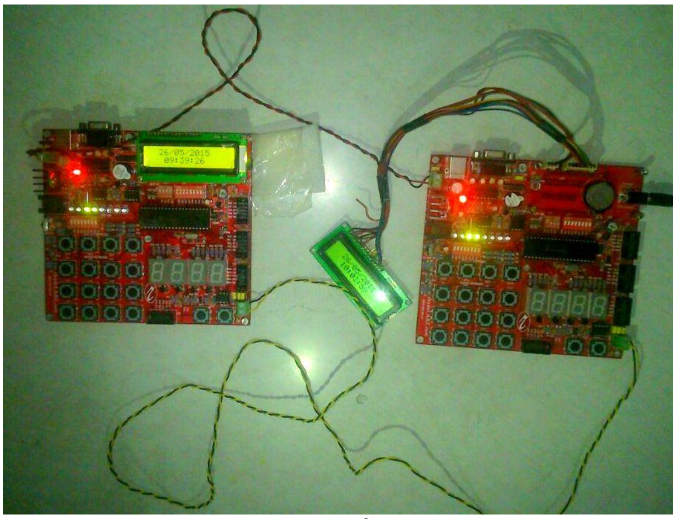

Fig. 4 : Prototype of PIC 18F4580

Reliability, flexibility and medium speed of communication, all these characteristics make CAN BUS an indispensable network communication technology, and most applicable system in automobile network communication field. In this paper, the CAN-bus based communication system for vehicle automation is designed. Software system and hardware system are easily to be expanded and upgraded. The snapshot of the prototype is shown in Fig 4, with its various components. For now only rpm is measured using PIC 18f4580 CAN board, and LCD is displaying the results.

ACKNOWLEDGMENT

The authors are thankful to the Mechatronics department of Sinhagad College of Engineering, for providing the necessary facilities and guidance for executing the model and the preparation of the paper.

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