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ARM LPC2129 based Data Acquisition System using Controller Area Network (CAN) Protocol

Author: Karthik M[1]; Vinayak Tambralli[2]

Affiliation: M.Tech (Electronics), B.M.S. College of Engineering[1]; M.Tech (Digital Communication), B.M.S. College of Engineering[2]

E-mail: karthik.raj016@gmail.com[1]; vinaypk7t@gmail.com[2]

ABSTRACT

Controller Area Network (CAN) protocol is developed at Robert Bosch GmBh in 1983 and the protocol was officially released in 1986. CAN is a vehicle bus standard and an attractive alternative in the automobile industries to establish a communication between various devices inside an automobile. Because of its ease to use, it is widely used in automobile industries and it reduces wiring complexity. The main aim of the project is implementation of CAN protocol using ARM LPC 2129 for data acquisition in vehicle monitoring. The coding is done in Embedded C using Keil IDE.

Keywords: ARM controller, Carbon Monoxide (CO), Controller Area Network (CAN), Humidity, Pressure, Temperature.

1. INTRODUCTION

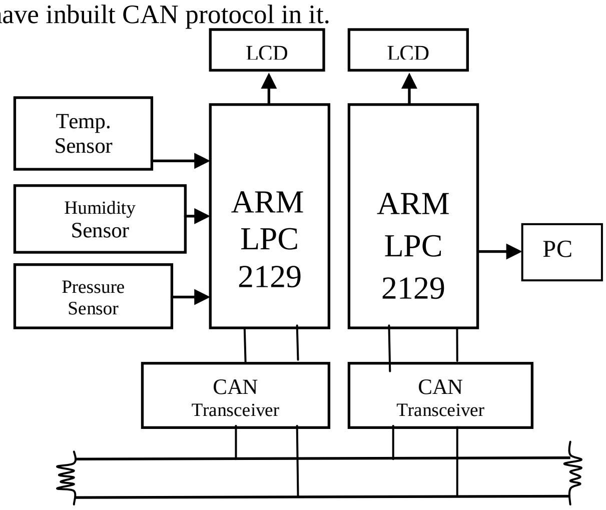
CAN is an alternative in the automotive industries and is an ISO defined serial communication bus that reduces complex wiring with a two wire-bus. The most important features of CAN are its high immunity to electrical interference, repair data errors and the ability to self-diagnose. This leads for CAN's popularity in manufacturing, automation and medical industries. The biggest advantage of using CAN is the priority based message scheduling, flexibility, simple implementation, efficient bandwidth utilization are some of the important advantages. CAN was developed by Bosch in the early 1980s [1]. Several versions of CAN has been published by Bosch and CAN 2.0 is the latest published in 1991. CAN 2.0 has part A and part B: part A is standard format with 11 bit identifier and part B is extended format with 29 bit identifier.

CAN is known for its simplicity, high performance and reliability [2]. In real-time applications, it is an efficient communication protocol between sensors, actuators and other nodes. CAN has bus topology [3]. Each device on the bus can send or receive data. Only one device can send data at a time while all others listen. The device with the highest priority is allowed to send data when two or more devices attempt to send data over the bus. A CAN network has two frame formats: base frame format (with 11 identifier bits) and the extended frame format (with 29 identifier bits) [4]. CAN distinguishes four frame types viz. data, remote, error and overload frames. The data frame is for actual data transmission. Data format begins with Start-of-frame bit followed by identifier (11 bit) and the Remote Transmission Request (RTR) bit. Data length code (4 bits) indicates the number of bytes of data (0-8 bytes). Data field varies from 0 to 8 bytes. Data field is followed by Cyclic Redundancy Check (CRC) and Acknowledgement (ACK) fields. Last field is 7-bit End-of-frame. Error detection is done in 5 different ways: bit monitoring, bit stuffing, frame check, ACK check and CRC.

The main aim of the project is developing a system which monitors vehicle parameters such as temperature, humidity and pressure using CAN protocol. The block diagram is shown in Fig.1.

2. BLOCK DIAGRAM

The block diagram is shown in Fig.1. Both controllers have inbuilt CAN protocol in it.



CAN Bus

Fig.1. Block diagram

3. SYSTEM HARDWARE

3.1 ARM LPC 2129

LPC 2129 is an ARM7 based 32-bit RISC Microcontroller with high performance [5]. It has 256KB on-chip flash ROM, Two UARTs, Two Timers, 4 channels 10-bit ADC and Two CAN channels. It is very cost effective. It has Watch Dog Timer which resets the controller when it deviates from its normal operation. It has 9 interrupt sources which can provide useful interrupting. Inbuilt ADC, CAN increases the versatility of the controller.

3.2 CAN Transceiver

The MCP2551 [6] shown in Fig.2 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller and is fully compatible with the ISO-11898 standard, including 24V requirements. It will operate at speeds of up to 1 Mb/s. 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) [7].

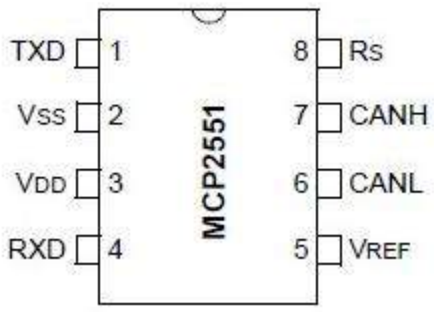


Fig.2.Transceiver PIN diagram

It also provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources. The main features are: it supports 1 Mb/s operation. It is suitable for 12V and 24V systems. It is a low current standby operation. There is protection against damage due to short circuit conditions (positive or negative battery voltage). Also there is protection against high-voltage transients. Up to 112 nodes can be connected.

ARM LPC2129 is connected to CAN Transceiver at the engine side. Temperature sensor, CO sensor and LDR are connected to ports. LCD is used to display the read data.

3.3 Temperature Sensor

The LM35 is an integrated circuit sensor [9] shown in Fig.3 that can be used to measure temperature with an electrical output proportional to the temperature. It measures temperature more accurately than using a thermistor. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. It has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/ degree C. The LM35 does not require any external calibration and maintains an accuracy of +/-0.4 degree C at room temperature. Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self heating capability.

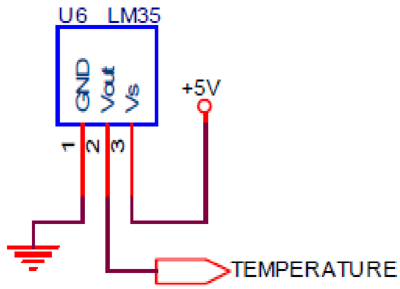


Fig.3. LM35 circuit

3.4 Humidity Sensor

The humidity sensor is used for measuring the moisture content. SY-HS230 is used in the project to measure the humidity [10]. The sensor utilizes a laser trimmed thermo set polymer capacitive sensing element with on-chip integrated signal conditioning. The sensor's construction provides excellent resistance to witting, dust, dirt, oils and common environmental chemicals. A CMOS signal conditioning circuit provides a linear voltage output over the full range of 0-100% RH. The accuracy is of ±5 RH. These sensors provide 0.70 to 3.30V when 5V is supplied. Current consumption is 3mA (maximum) at 5V. The sensor's linear voltage output makes direct input in to a controller or other device possible. SY-HS230 sensor has an operating temperature range of -30 to +85°C.

3.5 Pressure Sensor

The LPS25H is an ultra-compact absolute piezo resistive pressure sensor. It includes a monolithic sensing element and an IC interface able to take the information from the sensing element and to provide a digital signal to the external world. The LPS25H is available in a cavity holed LGA package (HCLGA). It is guaranteed to operate over a temperature range extending from -30 °C to +105 °C. The package is holed to allow external pressure to reach the sensing element.

4. MONITORING SYSTEM

CAN 2.0B is a network protocol that was specially developed for connecting the sensors, actuators and ECUs of a vehicle. CAN 2.0B supports data rates from 5kbps to 1Mbps, which allows the CAN network to be used to share status information and real time control. It can transfer up to 8 data bytes within a single message. In this project 2 nodes are used for monitoring parameters. The various sensors used are temperature and CO sensors. Values are transferred to microcontrollers in the dashboard from ADC and digital ports via CAN Protocol and is displayed in the LCD. Also the message can be seen through computer via UART.

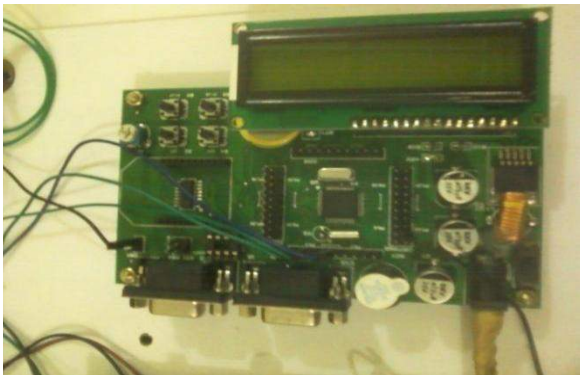


Fig.4. LPC 2129 interface with LCD

Temperature sensor, Pressure sensor, & relative humidity sensors are interfaced to ARM 7 (LPC 2129). The corresponding measuring different parameters are displayed on LCD as shown in Fig.5.

Fig.5. Output parameters

5. CONCLUSION

This project is concerned about implementation of CAN nodes for monitoring parameters. The monitoring parameters are temperature, pressure and humidity. For implementing this, the programming of LED, ADC and LCD interfacing with microcontroller is done using Embedded C. The programming of microcontroller interfacing using CAN Protocol is verified. The parameters can be transferred from engine to dashboard via CAN Protocol and these readings are displayed through LCD on the dashboard.

6. FUTURE WORK

This project is limited to a two node network. This can be extended to four nodes, eight nodes, 16 nodes etc. for vehicle monitoring applications.

7. REFERENCES

[1]. CAN specification version 2.0. Robert Bosch GmbH, Stuttgart, Germany, 1991.
[2]. Steve Corrigan, "Introduction to the Controller Area Network", Published by Texas Instruments Application Report, SLOA101A, August 2002–Revised July 2008
[3]. Renjun Li, Chu Liu and Feng Luo, "A Design for Automotive CAN Bus Monitoring System", IEEE Vehicle Power and Propulsion Conference (VPPC), September 3-5, 2008, Harbin, China
[4]. Controller Area Network, retrieved from http://en.wikipedia.org/wiki/CAN_bus
[5]. ARM LPC 2129 Datasheet.
[6]. Dogan Ibrahim, "Microcontroller based temperature monitoring and control", ISBN: 0750655569, Elsevier Science & Technology Books
[7]. MCP 2551 High speed CAN Transceiver Datasheet.
[8]. Dogan Ibrahim, "Microcontroller based temperature monitoring and control", ISBN: 0750655569, Elsevier Science & Technology Books
[9]. National Semiconductor, "LM35 Precision Centigrade Temperature Sensors Data sheet", National Semiconductor Corporation, November 2000.
[10]. Humidity sensor interface, Retrieved from "http://www.engineersgarage.com/microcontroller/8051projects/interface-humidity-sensor-circuit