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Temperature Controlled DC Motor Using Can Protocol

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Abstract- In today's world, every enterprise needs automation. Industrial automation system have become popular in many industries and play crucial role in controlling several process related operations. Industrial automation and process control greatly reduces the need of human sensory & mental requirements. The main aim of this project is to provide more safety to machines from overheating. This can be implemented by using CAN protocol which will be cost effective process with easy implementation and it can be used in peer to peer network with accurate error checking capability and the data transfer rate is 1MBps. DC motor is controlled using CAN protocol and ARM7 based LPC2148 micro controller. LM35 sensors are used in integrated circuit as temperature sensors. Communication bus is the major component in industrial automation for reliable transfer of data among the controller's computers and also from the field device. CAN protocol is a multi-master serial communication bus and it is a network of independent controllers. For an effective transmission, it follows reliable error-detection, it uses carrier sense multiple access protocol. Due to these reliable data transfer characteristics, this protocol has been in use in buses, cars and other automobile systems, factor and industrial automation, mining applications etc.

Indexed Terms- CAN protocol, serial communication, temperature control, transmission.

I. INTRODUCTION

The CAN bus is a platform for the interconnection of modules and allows each module to communicate with any other module. CAN is a message based protocol designed for application like automotive applications. This paper describes the design of a system that shows the operation of CAN module in order to control the temperature of the DC motor by decreasing the speed. Controller - area network is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other without a host computer. A network system which requires fast and robust communication and also to where data should maintain high integrity, CAN can be used. The CAN protocol is robust and uses sophisticated error checking and handling. The CAN protocol allows error and failures to occur without shutting the entire system down which is useful in the motor control node. Here we are using two nodes each contains ARM7 based LPC2148 microcontroller, MCP2515 CAN controller, MCP2551 CAN transceiver. In the first node we are interfacing temperature sensor and second node contains loads and lights. Node one will measure the temperature and the values will sent to node two through CAN bus. The temperature sensor LM35 measures the temperature and sends the values to the microcontroller. The LM35 series are precisions integrated circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The node two will take the control actions based on the data received. The CAN protocol is implemented using SPI lines of ARM7. LPC2148 is an ARM7TDMI-S based high performance 32-bit RISC microcontroller, 512KB on-chip flash ROM, 32KB RAM, two 10bit ADCs with 14 channels, two SPI interfaces two 32-bit timers, watchdog timers, PWM unit, real time clock with optional battery backup, general purpose I/O pins. Here the programming is done using embedded C.

II. CAN PROTOCOL

A. History of CAN protocol

Development of CAN bus started in 1983 at Robert Bosch GmbH. CAN protocol was officially released in 1986 at the society of automotive engineer's conference in Detroit. The first CAN controller chip were introduced by Intel in 1987, and shortly thereafter by Philips. Released in 1991, the Mercedes-Benz W140 was the first production vehicle to feature a CAN-based multiplex wiring system. Bosch published several versions of the CAN specification and the latest is CAN 2.0 published in 1991. This specification has two parts; part A is for the standard format with an 11-bit identifier, and part B is for the extended format with a 29-bit identifier. A CAN device that uses 11-bit identifiers is commonly called CAN 2.0A and a CAN device that uses 29-bit identifiers is commonly called CAN 2.0B. These standards are freely available from Bosch along with other specifications and white papers.

In 1993, the International Organization for Standardization (ISO) released the CAN standard ISO 11898 which was later restructured into two parts; ISO 11898-1 which covers the data link layer, and ISO 11898-2 which covers the CAN physical layer for high-speed CAN. ISO 11898-3 was released later and covers the CAN physical layer for low-speed, fault-tolerant CAN. The physical layer standards ISO 11898-2 and ISO 11898-3 are not part of the Bosch CAN 2.0 specification. These standards may be purchased from the ISO.

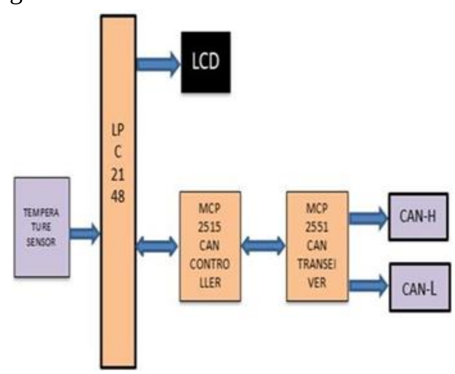
Bosch is still active in extending the CAN standards. In 2012, Bosch released CAN FD 1.0 or CAN with Flexible Data-Rate. This specification uses a different frame format that allows a different data length as well as optionally switching to a faster bit rate after the arbitration is decided. CAN FD is compatible with existing CAN 2.0 networks so new CAN FD devices can coexist on the same network with existing CAN devices.

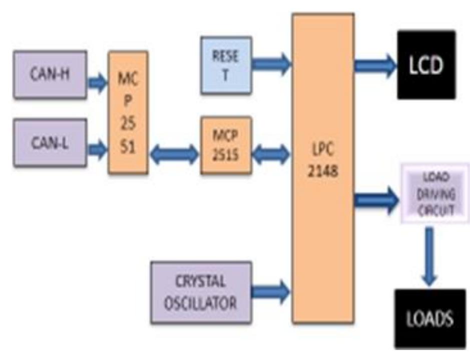
CAN bus is one of five protocols used in the on-board diagnostics (OBD)-II vehicle diagnostics standard. The OBD-II standard has been mandatory for all cars and light trucks sold in the United States since 1996. The EOBD standard has been mandatory for all petrol vehicles sold in the European Union since 2001 and all diesel vehicles since 2004.

B. construction

The proposed system consists of lpc2148 microcontroller, MCP2515 (CAN controller) and MCP2551 (CAN transceiver). In transmission part, Temperature sensor LM35 is Connected to pin 13 in LPC2148. MCP2515 pins from 12 to 17 are connected to pin 37 to 41 in LPC2148. LCD pins are connected to the I2C adapter pins. In MCP2551 TXD, RXD is connected to 2 LED's. CAN H and CAN L are connected to port 0 of LPC2148. Vcc and ground of I2C are connected to LPC2148. In receiving part, MCP 2551 TXCAN, RXCAN is connected to 2 LED's which is connected to the MCP 2515 of TXD and RXD. Pin 12 to 17 are connected to port 0 in LPC2148. CAN H and CAN L are connected to header female 2.54_1x2. Pin 8 is grounded. In L293D motor driver, enable pin, input1 pin and output1 pin is connected to the one side of motor. Another side of the motor is connected to output 2. Pin 8 Vs is given +12V and pin 16 is given +5V. Pin 4, 5, 12, 13 are grounded. Pin 1, 2, 7 in L293D are connected to pin 21, 27 and 29. Pin 4, 5, 6 and 11 to 14 from LCD are connected to port 0 pins in LPC2148

C. Figures





III. COMPONENT DESCRIPTION

A. Arm processor:

The ARM7TDMI-S is a general purpose 32-bit microprocessor. Offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC). The decode mechanism are much simpler than those of micro programmed Complex Instruction Set

Computers (CISC). Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously.

B. LPC2148:

The LPC2148 is a 16 bit or 32 bit ARM7 family based microcontroller and available in a small LQFP64 package. ISP (in system programming) or IAP (in application programming) using on-chip boot loader software. On-chip static RAM is 8 kB-40 kB, on-chip flash memory is 32 kB-512 kB, the wide interface is 128 bit, or accelerator allows 60 MHz high-speed operation. It takes 400 milliseconds time for erasing the data in full chip and 1 millisecond time for 256 bytes of programming. Embedded Trace interfaces and Embedded ICE RT offers real-time debugging with high-speed tracing of instruction execution and on-chip Real Monitor software. It has 2 kB of endpoint RAM and USB 2.0 full speed device controller. Furthermore, this microcontroller offers 8kB on-chip RAM nearby to USB with DMA.

One or two 10-bit ADCs offer 6 or 14 analogs i/ps with low conversion time as 2.44 μs/ channel. Only 10 bit DAC offers changeable analog o/p.External event counter/32 bit timers-2, PWM unit, & watchdog. Low power RTC (real time clock) & 32 kHz clock input. Several serial interfaces like two 16C550 UARTs, two I2C-buses with 400 kbit/s speed.5 volts tolerant quick general purpose Input/output pins in a small LQFP64 package. Outside interrupt pins-21.60 MHz of utmost CPU CLK-clock obtainable from the programmable-on-chip phase locked loop by resolving time is 100 μs. The incorporated oscillator on the chip will work by an exterior crystal that ranges from 1 MHz-25 MHz The modes for power-conserving mainly comprise idle & power down. For extra power optimization, there are individual enable or disable of peripheral functions and peripheral CLK scaling.

C. CAN transceiver:

The MCP2551 is the interface between the Controller Area Network (CAN) protocol controller and the physical bus. It is primarily intended for high speed applications. The Board includes MCP2515 CAN controller and MCP2551 transceiver. It is capable of transmitting and receiving both standard and extended data and remote frames. The CAN controller also has two acceptance masks and six acceptance filters that are used to filter out unwanted messages, thus reducing the host MCUs overhead.

D. CAN receiver:

MCP2515 IC is the main controller that internally consists of three main subcomponents: The CAN Module, the Control Logic and the SPI Block. CAN Module is responsible for transmitting and receiving messages on the CAN Bus. Control Logic handles the setup and operation of the MCP2515 by interfacing all the blocks. The SPI Block is responsible for the SPI Communication interface.

E. LM35:

LM35 series sensors are precision integrated circuit temperature sensors whose output voltage is linearly proportional to the celsius temperature. The LM35 requires no external calibration since it is internally calibrated. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to read-out or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1 degree celsius in air.

F. liquid crystal display:

Liquid crystal displays (LCDs) are a commonly used to display data in devices such as calculators, microwave ovens, and many other electronic devices with 16 pins. Eight of the pins are data lines (pins 7-14), two are for power and ground (pins 1 and 16), three are used to control the operation of LCD (pins 4-6), and one is used to adjust the LCD screen brightness (pin 3). The remaining two pins (15 and 16) power the backlight.

G. I2C adapter:

Serial I2C LCD display adapter converts parallel based 16 x 2 character LCD display into a serial I2C LCD that can be controlled through just 2 wires. Adapter uses PCF8574 chip that serves as I/O expander that communicates with Arduino or any other microcontroller by using I2C protocol. A total of 8 LCD displays can be connected to the same two wire I2C bus with each board having a different address. The default I2C address is 0X27 and may be changed to any of the following 0X20~0X27 via soldering A0 A1 A2 pins.

H. Battery:

The batteries are constructed of six individual 1.5 volt LR61cells enclosed in a wrapper. The rated capacity is 570 mAh. The cut-off voltage is 4.8 volts and rated load is 620 Ω. The discharge - C rate is 0.

IV. WORKING

CAN is a two wired half duplex high speed serial network technology. CAN ensures each node to wait for a given period before sending any message. Collision detection ensures that the collision is avoided by selecting the messages based on their prescribed priority. It provides a signalling rate from 125kbps to 1mbps. CAN consists of two nodes: CAN H and CAN L and their voltage levels to each other determine whether 1 or 0 is transmitted. Each node in CAN bus requires Transceiver – It converts the data from CAN controller to CAN bus levels and vice versa. CAN controller - This is an integral part of the microcontroller that handles framing. Microcontroller – It decides what the received messages mean and what messages it wants to transmit. Node 1 will measure the temperature and send the obtained values to node 2 through CAN bus. Then node 2 checks with the actual preset value and helps to control the motor. CAN protocol is implemented using SPI lines of ARM7. This protocol uses CAN transceiver and CAN receiver for communication. Instantaneous values of process parameter are showed in LCD. Control elements are activated and deactivated as per the program logic. Programming is done using embedded C. Microcontroller interfaces with LCD, motor driver, CAN transceiver and CAN transceiver.

V. APPLICATIONS

Electronic Gear Shift System, Main Interface in Automation (like industrial), Medical Equipment, Passenger vehicles, trucks, buses (gasoline vehicles and electric vehicles), Agricultural equipment, Electronic equipment for aviation and navigation, Industrial automation and mechanical control, Elevators, escalators, Building automation, Medical instruments and equipment, Pedelecs, Model Railways/Railroads.

CONCLUSION

Thus, this project proposed the automatic temperature control using CAN protocol. An efficient, simple cabling, automotive CAN protocol based device can give the public confidence by giving the improvement in security problems. It can also be operated in the restricted area because there is no need of external monitoring. Industrial automation has recently found more acceptance from various industries because of its huge benefits such as safety in low cost. The entire project is to reduce the need of human sensory & mental requirement and provides more safety to machines from overheating. CAN protocol follows reliable error detection hence that is used in buses, cars, and other automobile systems, factor and industrial automation and mining applications etc. automation industry will be blooming in future. CAN protocol serves the purpose in automation also. Hence the devices will be controlled with utmost accuracy.

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