

GSM Based Temperature Logger for CNC Machines Using CAN Bus

Pratik Patil¹ and Prof. Sheela K. Kore²

¹Student, M. Tech VLSI Design and Embedded Systems, KLES DR. M. S. Sheshgiri College of Engineering and Technology, Belgaum, Karnataka, India

¹mailpratikpatil@gmail.com

² Assoc.Prof, Department of Electronics and Communication, DR. M. S. Sheshgiri College of Engineering and Technology, Belgaum, Karnataka, India

² sheelakore@rediffmail.com

ABSTRACT

Accurate information of the temperature over time is required in medical, scientific and various industrial applications. The objective of this work is to design and develop a fully automated microcontroller-based data logging system to measure the temperature in multiple plants of Computer Numerical Control (CNC) machines which are interconnected through the Control Area Network (CAN) bus. The temperature is measured and collected periodically. The collected data is sent to the Control Room using the Global System for Mobile Communications (GSM). The collected temperature data is stored in a memory device, Electrically Erasable Programmable Read Only Memory (EEPROM), located in the Computer system in the Control Room. PIC18F458 microcontroller is used to control and system and LM35 temperature sensor is used to measure the temperature.

Keywords — Data logger, CNC machines, CAN bus, GSM, PIC18F458, LM35.

1. INTRODUCTION

A data logger is an electronic device that records data over time for a specific location either with a built in or external instrument or sensor. Data loggers vary between general purpose types for a range of measurement applications to very specific devices for measuring in one environment or application type only. It is common for general purpose types to be programmable; however, many remain as static machines with only a limited number or no changeable parameters. Electronic data loggers have replaced chart recorder in many applications. One of the primary benefits of using data loggers is the ability to automatically collect data on a 24-hour basis.

Upon activation, data loggers are typically deployed and left unattended to measure and record information for the duration of the monitoring period. This allows for a comprehensive, accurate picture of the environmental conditions being monitored, such as air temperature and relative humidity.

Wireless data logging is an extension of PC-based data acquisition to measurement applications where wiring is difficult or cost-prohibitive. Wireless Data Loggers allow you to acquire data in real time over any existing wireless network, and a hardwired Ethernet connection depending upon the model. Power is provided either through a long-lasting internal rechargeable battery or via an A.C. power adapter. This, coupled with on-board memory to store data, provides a true stand-alone operation that allows these data loggers to be deployed anywhere a wireless signals can be obtained. Data points are accurately measured and date stamped for future analysis and is easily exported to a spreadsheet program (like Microsoft Excel).

A temperature data logger, also called temperature monitor, is a measurement instrument that is capable of autonomously recording temperature over a defined period of time. The digital data can be retrieved, viewed and evaluated after it has been recorded. [1]

2. SURVEY PAPERS

2.1 Design And Development Of A Pc-Based Automated Data Logging System For Measuring Temperature[2]

This paper gives an overview of data logging for CNC machines which is used widely in industries for the process of drilling. The data of the process needs to be logged in a database for further analysis and supervisory control. A wireless data logger along with the help of Visual Basic 6 program simulates the process and the generated data are logged in to the database with proper indication about the status of the process. Two transmitters are used for getting the process count and the waste piece count which is rejected, which gives the actual production count and a receiver ZIGBEE module for taking signals whenever the process is initialized and interfacing with the help of receiver RF module using Visual Basic 6 software that generates an excel sheet of the data.

2.2 Temperature Monitoring And Logging System Suitable For Use In Hospitals, Incorporating Gsm Text Messaging[3]

In this paper, a microcontroller-based temperature monitoring and logging system suitable for use in hospitals was designed and constructed. The features include ability to monitor a patient's temperature on a continuous basis while displaying the instant result on a Liquid Crystal Display (LCD) device. The temperature monitored is logged in a memory device, Electrically Erasable Programmable Read Only Memory (EEPROM), located in the system at every 10 minutes interval and can be interfaced with a computer using USB or RS232 UART device. An ATmega16 AVR is used as the heart of the control and coordination of all the activities of the individual modules. It allowed a doctor at location from the patient to keep track of his patient's condition while attending to other issues.

3. PROPOSED SYSTEM

The ability to take sensor measurements and store the data for future use is, by definition, a characteristic of a data logger. However, a data-logging application rarely requires only data acquisition and storage. Inevitably, the ability to analyze and

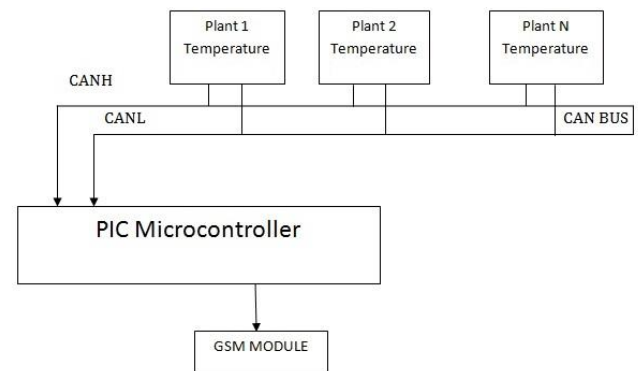


Fig-1 System Block Diagram

present the data to determine results and make decisions based on the logged data is needed. The temperature from the individual plants is sensed by the temperature sensors located in each of the CNC plants. Each of these temperature sensors is connected to the PIC microcontroller through the CAN bus. It transmits data through the bus in the form of packets. Each of the CNC plants are the CAN bus nodes which bear their individual address. Whenever there is variation in the room temperature from the desired temperature the Microcontroller can control the speed of the Fan or the AC temperature so as to bring the temperature of the room to the desired temperature. This real time data is transferred to the main control room through the GSM system. In the main control room all the acquired data is stored in the EEPROM. Whenever there is problem in the Air conditioning system or there is undesirable increase or decrease in the temperature in any plant, the PIC microcontroller collects the information of that plant. The specific location of that plant is then notified to the main control room through the GSM system.

This reduces the time for the error detection and also eases the work of the troubleshooting mechanic.

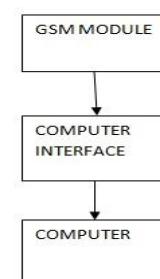


Fig-2: Receiver Block Diagram

The receiver circuitry consists of GSM module, MAX232 and RS232 serial port which act as the computer interface that converts the TTL logic to RS232 logic. In the receiver section the GSM module can be used as receiver. This module

receives the data send by the GSM transmitters that is placed at the CNC machine Plant. The received data is stored in the EEPROM so that it can be used for the future reference.

4. DATA LOGGERS

The data logger is a tool to collect and analyze experimental data, having the ability to present real time analysis with sensors and probes able to respond to parameters that are beyond the normal range available from the most traditional equipment. The differences between various data loggers are based on the way that data is recorded and stored.

Data logger is an electronic device that automatically records, scans and retrieves the data with high speed and greater efficiency during a test or measurement, at any part of the plant with time. The type of information recorded is determined by the user i.e. whether temperature, relative humidity, light intensity, voltage, pressure or shock is to be recorded, therefore it can automatically measures electrical output from any type of transducer and log the value. A data logger works with sensors to convert physical phenomena and stimuli into electronic signals such as voltage or current. These electronic signals are then converted into binary data. The binary data is then easily analyzed by software and stored on memory for post process analysis. [4]

5. CONTROL AREA NETWORK(CAN)

The Controller Area Network (CAN) is a serial communication protocol for real time applications. CAN bus is a differential bus terminated by 120Ω resistors at both the terminals. CAN defines only the physical and data-link layers. The CAN physical layer connects the CAN controller to the physical bus wires. A CAN network is made up of group of nodes. Each node can communicate with other nodes using predefined messages called CAN Objects (COB). In a CAN network, higher priority is given to the lower COB-ID. All the nodes that want to acquire the bus will be continuously monitoring the bus. When the bus becomes free all the nodes which were requesting the bus start transmitting their messages, starting with the COB-ID. Only the device with the lower COB ID will acquire the bus for the transmission. All other nodes withdraw transmission. As a result one of the messages will be transmitted without collision. This is in contrast to the situation on Ethernet where all the messages are

lost in the case of a collision. This improves the performance on a slow network.

CAN protocol has two types of data frames,

1. Standard data frame has 11-bit message identifier
2. Extended data frame has 29-bit message identifier

CAN data is transmitted in one of following four frame types:

1. Data frame: transmits the data from a transmitting node to any node or to all the nodes.



Fig.- 3:Data frame of CAN

Data frame consists of Arbitration field, Control field, Data field, CRC field, Acknowledgement. The data frame starts with Start of Frame and ends with End of Frame. Acknowledgement is transmitted by the receiving node during the frame time.

2. Remote frame is a request for data from other nodes
3. Error frame is transmitted by any node on the network on detecting a bus error.
4. Overload frame is used to provide an extra delay between the preceding and the succeeding data or remote frames.

The maximum data rate of a CAN bus largely depends on its length. The maximum data rate is 1Mbps for a CAN bus of length 40m and the minimum data rate is 10Kbps for a bus of length 1Km. Generally bus speeds are selected similar to the speeds specified for RS232 connection (9.6Kbaud, 115Kbaud etc) though it is not necessary to stick to these speeds.

CAN based systems often contain only one segment. So, there is no need to describe a logical link and transport layers. Similarly, login or security related issues are not specifically addressed. Hence, session and application layers are not described separately. Much functionality of these layers are clubbed into a single protocol and hence the name higher layer protocol. Several higher layer protocols are available for CAN.[5]

5.1 Advantages of CAN

- Good electromagnetic compatibility (EMC)
- The possible line length of up to several kilometers
- The availability of CAN interfaces on most industrial microcontrollers

- Very good network stability, flexibility in terms of intercommunication of the devices
- Low cost

6. PIC MICROCONTROLLER(PIC18f458)

- RISC Architecture
- 40 pins
- 5 ports
- 10-bit, up to 8-channel Analog-to-Digital Converter module (A/D)
- Priority levels for interrupts
- Four Timers-
- Timer0- 8/16 bit with 8 bit Programmable Presale
- Timer1, Timer3- 16 bit Timer/counter
- Timer2- 8-bit timer/counter with 8-bit period register
- Inbuilt CAN bus Module with Message bit rates up to 1 Mbps
- Wide operating voltage range (2.0V to 5.5V)
- Temperature Range (-40°C to 125 °C)[5]

7. LM35 TEMPERATURE SENSOR

- Calibrated directly in ° Celsius (Centigrade).
- Linear +10.0 mV/°C scale factor.
- 0.5°C accuracy (at +25°C).
- Rated for full -55° to +150°C range.
- Suitable for remote applications.
- Low cost due to wafer-level trimming.
- Operates from 4 to 30 volts.
- Less than 60 μ A current drain.
- Low self-heating, 0.08°C in still air.
- Nonlinearity only $\pm 1/4^\circ\text{C}$ typical.[6]

8. SOFTWARE TOOL(MPLAB X IDE v2.30)

MPLAB X IDE is a software program that is used to develop applications for Microchip microcontrollers and digital signal controllers.

This development tool is called an Integrated Development Environment, or IDE, because it provides a single integrated “environment” to develop code for embedded microcontrollers. [7]

9. ADVANTAGES

- Measurements are always taken at the right time. Thus avoiding the Human errors.
- The problem in the plant is detected in real time and the same is notified to the main Control Room.
- No human error in reading the temperature.
- Graphs and tables of results can be produced automatically by the data logging software.
- The use of CAN bus and GSM makes the system fairly low cost

10. SIMULATION AND RESULTS

The work started with the successful interfacing results of the LM35 Temperature Sensor with the PIC18F458.

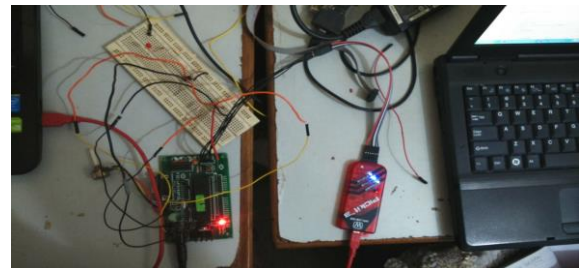


Fig.-4: LM35 Interfacing with PIC

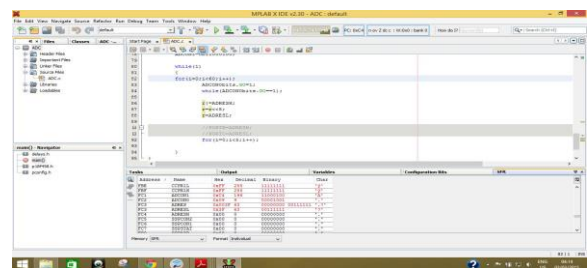


Fig.- 5: LM35 Sensor Output

The CAN bus Transmission and Reception Output was checked

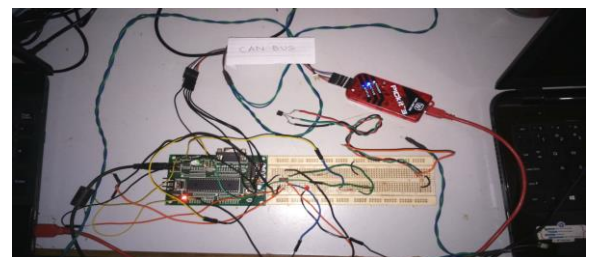


Fig.- 6: CAN Bus Connection

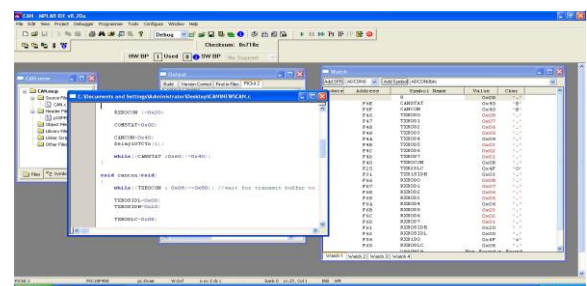


Fig.- 7: CAN Bus Tx and Rx

The UART and the GSM module was Simulated tested to send the SMS. The Simulation and the Actual results matched as shown in figure below.

The Simulation was tested using the Proteus 8 Professional Design Suite.

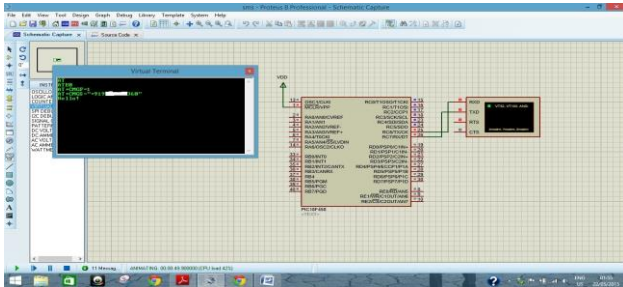


Fig- 8: UART AT Commands Simulation

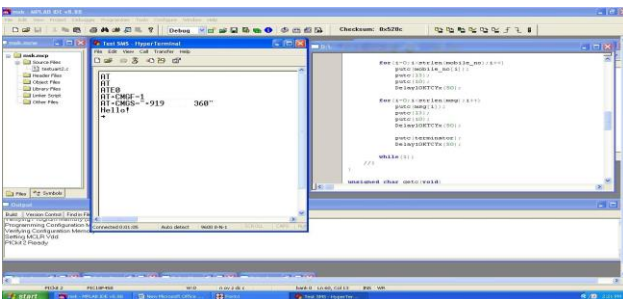


Fig.- 9: Testing UART AT on HyperTerminal

The code was then successfully tested with the VISIONTEK 81GC GSM modem to send the SMS.

11. CONCLUSIONS

The design of a Low cost, High Speed, Reliable Temperature Data logger was presented. The use of CAN bus makes the system spread across long distance and the use of GSM allows the user to access the logged data from any part of the World.

REFERENCES

- [1] EFFECTIVE PRODUCTION MONITORING SYSTEM FOR CNC MACHINE USING WIRELESS DATA LOGGER, International Journal of Industrial Engineering & Technology (IJIET), Oct 2013
AUTHORS: S. RAMKUMAR, UMAMAGESHWERA RAO, N. VIGNESH PRASANA and M. DHIVYA
- [2] DESIGN AND DEVELOPMENT OF A PC-BASED AUTOMATED DATA LOGGING SYSTEM FOR MEASURING TEMPERATURE, ARPN Journal of Engineering and Applied Sciences, Nov 2013

AUTHORS: Md. Abdullah A Mamun, Kenneth Sundaraj, N. Ahmed, Matiur Rahman, Mijanur Rahman and Nizam Uddin Ahamed

- [3] TEMPERATURE MONITORING AND LOGGING SYSTEM SUITABLE FOR USE IN HOSPITALS, INCORPORATING GSM TEXT MESSAGING, International Journal of Information Sciences and Techniques (IJIST) January 2013

AUTHORS: I. G. Saidu, and M. Momoh and A. S. Mindaudu

- [4] Temperature Data Logger Theory
http://en.wikipedia.org/wiki/Temperature_data_logger
- [5] PIC18F458 data sheet, <http://www.microchip.com>
- [6] National Semiconductor Corporation, LM35 datasheet, precision centigrade temperature sensors
- [7] MPLAB X IDE User Guide,
<http://ww1.microchip.com/downloads/en/DeviceDoc/50002027C.pdf>