

Motor Overload Control based on GSM System

Enku Yosef Kefyalew, Prof. Jiang Dening
Tianjin University of Technology and Education (TUTE),
School of Electronics Engineering

Abstract -The purpose of this research is to develop a motor overload control and tracing system design using GSM for use in factory and plant. The system will alert maintenance to take action when there is problem with the motors. It is also increase productivity of workers and reduced cost for repairing the motor when damage. The main objective of developing this system is to alert operator whenever the motor is failed or not performing. When this happened, this system will trigger Short Message Service (SMS) to the operator, and at the same time data will be stored in the database for further analysis and tracking purposes. If it is necessary in the case of emergency the operator or the supervisor who receive the SMS will be able to shutdown the motor by sending SMS from his or her mobile to the system.

In this report, two main areas will be focused; Hardware Design and Software Development

To sum up, this project will explain in details the research and decisions made in selecting the suitable microcontroller, sensors, contactors, GSM modem, and it has uses software like Visual Basic.NET and database. This project will also touch on the Graphical User Interface (GUI) used to connect and display information. Hardware and Software integration are also covered to explain how different modules are integrated together to function motor overload control and tracing system design using GSM.

Keywords – GSM (Global System for Mobile Communication), Motor overload controlling,

1. INTRODUCTION

In our daily activities, GSM technology has become an important and essential part of everyone's life in terms of communication and obtaining information. As GSM is widely used and easily available, developers are making use of this technology to develop useful tools and applications.

Industrial motor control system reliability estimation has found to be one of the best methods to ensure that detect motor break down at workplace and automatically sent information to person responsibility and alert the workers about this failure. The main components in this system are GSM (Global System for Mobile Communication) electromechanical relays (contactor), sensors and microcontroller. The electromechanical relays and sensors are devices that measure a physical quantity or electrical parameters like voltage, flowing current and speed of the motor.

When the motor overload it will trigger the contactor to energize and the sensors will switch, then the signal sent to the microcontroller. The microcontroller is a small

computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Function microcontroller in this system is to get signal from the electromechanical. It convert signal from analog to digital data. This method use to ensure the system will perform satisfactorily when it used.

For further analysis and tracing system using the GUI (graphical user interface) the information sent by the GSM will be retrieved and stored in the database. Therefore anyone can check or trace the information stored in the data base at anytime and it's also use for periodical maintenance of the motor and the field devices.

2. OBJECTIVES OF THE PROJECT

There are several objectives for this project which are:

- Design, analyze and implement a Development Motor Overload Alert Using GSM.
- To know the microcontroller its features and its operation can analyze the data and operate properly.
- To understand GSM and its operation dials out stored telephone number and gives the message to the maintenance.
- To develop the device will trigger an alarm at the maintenance room.
- Implementing database system to store information in the data base for further tracking purpose.

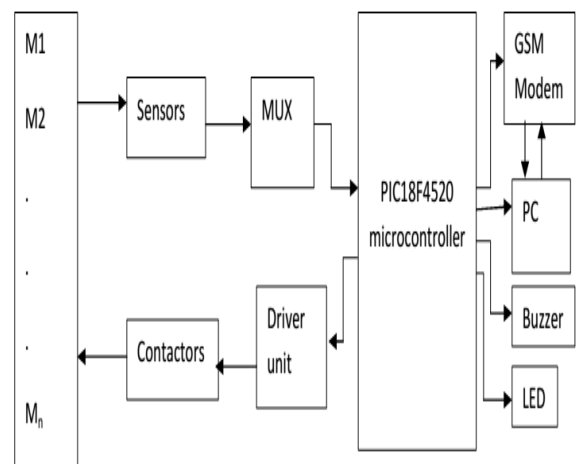


Figure 2.1 Block Diagram of the System

3. SOFTWARE DEVELOPMENT

3.1 Software Structure Flowchart

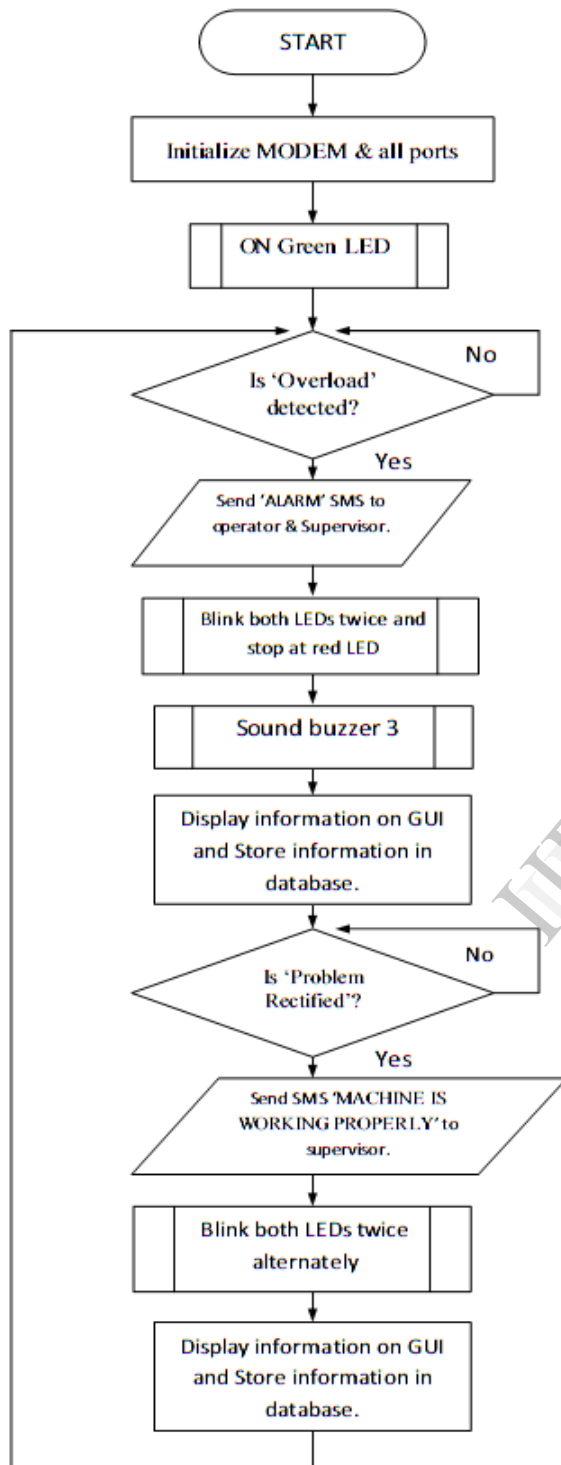


Figure 3.1 Software Structure Flowcharts

When the system is set up, initialization of modem and all ports are done. After which, the system will turn on the Green LED to indicate the motor is free from any overload problem. Next, the system will check the status of the machine. If an overload is detected by the field devices like

the contactors and sensors an “ALARM “ SMS will be sent to the operator together with blinking of both LEDs twice to indicate the SMS is being sent out follow by 3 buzz from the buzzer. When SMS is sent out, VB.NET will check for any data from RS232 and display the information on the GUI and data will be logged into the database when log data button is pressed.

After the problem has been notified, the operator will work on the problem. The system will monitor whether if the problem is “Rectified”. If this happened, the system will send another SMS. This time round it will send “MACHINE IS WORKING PROPERLY” SMS to the supervisor only instead of the operator so as to inform of the problem being solved. Blinking of both LEDs twice alternately, so as to differentiate between sending of “MACHINE IS WORKING PROPERLY” SMS as compared to “ALARM” ones. New statuses of information will also be displayed on GUI and stored into the database. The supervisor can also shutdown the system by sending an SMS “SHUTDOWN” from his mobile to the GSM of the system.

3.3 Database Implementation

A GUI using VB.NET or Java can be used to implement for data logging in this database implementation. The application will serve as an interface to communicate with the PC to the database. It allows user to connect to available COM ports, retrieve data, clearing data and data logging as shown in the figure 3.2. The database can be created by using Microsoft Access or SQL server. The database will store all SMSs that the GSM modem sent out.

From the research, I decided to use VB.NET for the GUI as it runs in Window Operating System. It is easy and simple to deploy as compare to Java.

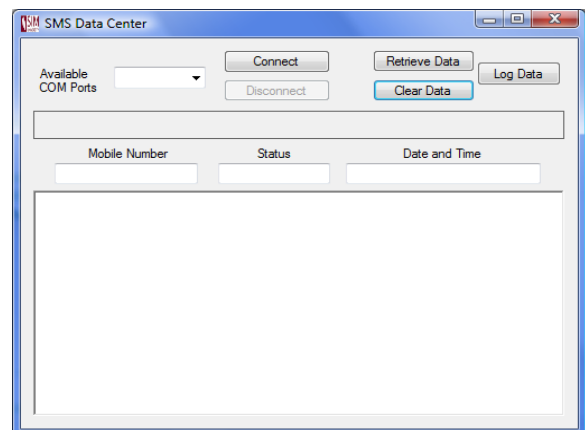


Figure 3.2 GUI of SMS Data Centre

As for the database, Figure 3.3 below show the history of all the SMSs that the modem sent out. The HP table shows the mobile, Status and Occurrence fields. This data log sheet provides information for supervisor to track the status of the motors and the downtimes spend before problem is rectified.

Msg_ID	Mobile	Status	Occurrence
1	15510965654	ALARM	3/10/2014 4:10:00 PM
2	15510965654	MOTOR WORKING	3/12/2014 9:15:00 AM
3	13207683576	ALARM	4/15/2014 7:13:00 PM
4	15620146047	MOTOR WORKING	4/15/2014 2:20:00 AM
5	15510965654	ALARM	4/16/2014 3:10:00 PM
6	15510965654	ALARM	4/17/2014 9:10:00 AM

Figure 3.3 SMSs stored in Microsoft Office Access 2007

4. HARDWARE DESIGN

4.1.1 Power Management Circuit

PIC18F4520's operating voltage range is in 2.0V to 5.5V. In order to power up the microcontroller, a 5V voltage regulator, L7805CV (able to take in voltage from 7.0V-35V [12]) is used to step down a 9V DC battery to 5V.

An ON-OFF switch (SW1) is catered in the design for user to power up and power down the prototype board in an efficient manner. A power indication LED (D1) is also included which serves as an indication that power is being supplied to the board when lighted up. The power management schematic is shown in Figure 4.1.

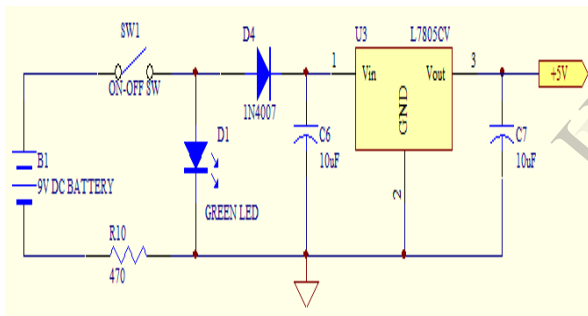


Figure 4.1. management schematic showing L7805CV voltage regulator

4.1.2 Indication LEDs Circuit and Piezo Buzzer Circuit

The designing of the Indication LED circuit is considered straight forward as we only need to select the resistor that limits the current flow passing through the LED. Figure 4.2 below shows the schematic of Indication LED. RB1 and RB2 are tied to MCU pins 34 & 35 respectively which are used to control the on/off state of the LEDs.

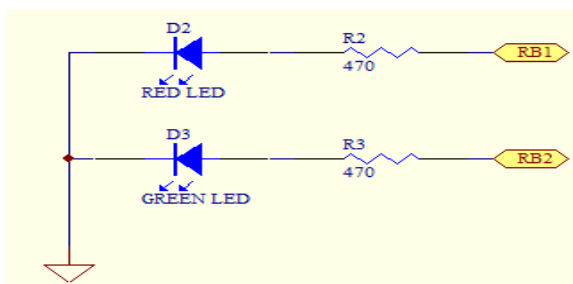


Figure 4.2 Indication LEDs Schematic

The connection for the piezo buzzer is also straight forward, a direct connection of the positive polarity to RC2 (pin17) and negative polarity to GND. Figure 4.3 below shows the connection of Piezo Buzzer schematic.

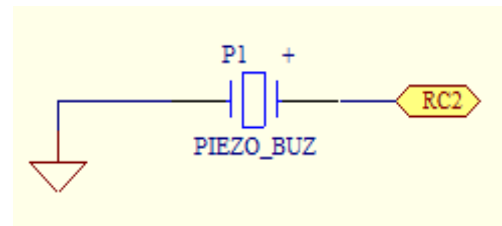


Figure 4.3 Piezo Buzzer Schematic

4.1.3 RS232 Interface Circuit

When communicating with various microprocessors one needs to convert the RS232 levels down to lower levels, typically 3.3 or 5.0 volts. The RS232 interface circuit here make use of the MAX232N, which is the first IC that contains the necessary drivers and receivers to adapt the RS232 signal voltage levels to Transistor-Transistor Logic (TTL) logic in one package. It is simple to use as it just need one voltage (+5v) and generates the necessary RS232 voltage levels.

Where pin 2 Receive Data (RXD) & 3 Transmit Data (TXD) of DB9 Female (J2) shown in Figure 4.4 is connected to pin 14 & 13 of MAX232N which is connected internally to pin 11 (TXD) & 12 (RXD) and subsequently to pin 25 (TXD) & 26 (RXD) of PIC18F4520 respectively. Not to forget, pin 5 is to be connected to the Ground (GND). All these 3 pins are required to complete the connection. DB9 Male (J1) is used to connect to the GSM modem whose pin assignments are the same as PIC's. Therefore, pin 2 & 3 have to swap position. Where pin 2 & 3 goes to pin 13 & 14 respectively, followed by pin 5 to GND.

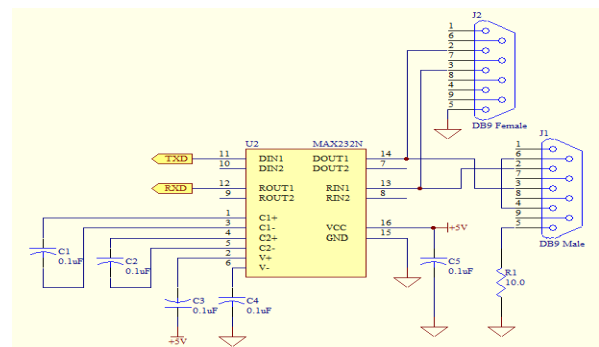


Figure 4.4 RS232 Interface Schematic showing MAX232

4.1.4 ICD Connector Circuit

For the building of ICD connector circuit, first to take note is that MPLAB ICD2 RJ11 Jack pin out and the modular connection pin are not in sequence It is of opposite direction. After knowing the sequence of the pin out;

connect the wire to the correct pins and by using a crimping tool to crimp the RJ11 onto the network cable and the other end to a 6 pin connector. Figure 4.5 shows the ICD Connector Schematic for the physical connection on the prototype board. Pin 1 is connected to NMCLR, pin 2 to +5V, pin 3 to GND, pin 4 to RB7 (pin 40) and pin 5 to RB6 (pin 39) of PIC18F4520 respectively.

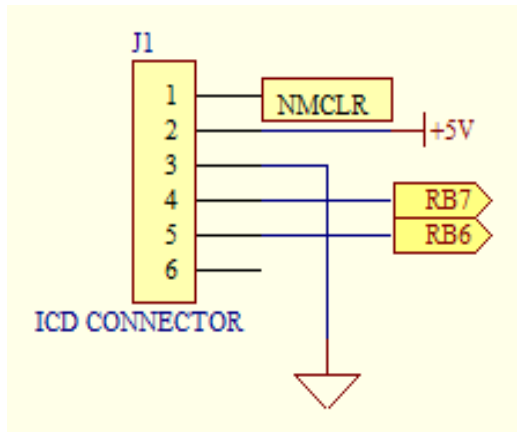


Figure 4.5 ICD Connector Schematic

4.1.5 Microcontroller Circuit (PIC18f4520)

The advantages of all PIC18 microcontrollers – namely, high computational performance at an economical price – with the addition of high endurance, Enhanced Flash program memory. On top of these features, the PIC18F2420/2520/4420/4520 family introduces design enhancements that make these microcontrollers a logical choice for much high performance, power sensitive applications.

All of the devices in the PIC18F2420/2520/4420/4520 family incorporate a range of features that can significantly reduce power consumption during operation.

The first design criterion is to decide at which frequency the system should operate at. PIC18F4520 can be operated in ten different oscillator modes. E.g. Low-Power Crystal (LP), Crystal/Resonator (XT), High-Speed Crystal/Resonator (HS), High-Speed Crystal/Resonator with PLL enabled (HSPLL) and so on. (From PIC18F4520 datasheet) In XT, LP, HS or HSPLL Oscillator modes, a crystal or ceramic resonator is connected to OSC1 and OSC2 pins to establish oscillations. Figure 4.6 below shows the Pin Connections.

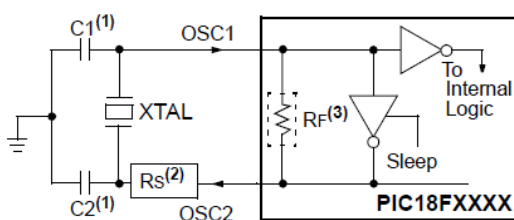


Figure 4.6 XT, LP, HS, and HSPLL Pin Connections (Source: PIC18F4520.pdf)

A crystal oscillator is an electronic component which uses the mechanical resonance of a vibrating piezoelectric crystal to create an electrical signal with precise frequency. Resonance refers to the condition whereby a system is oscillating at maximum amplitude at certain frequencies. Figure 4.7 below shows the crystal oscillator configuration schematic where a 4MHz crystal with two parallel load capacitor of 22pF is used.

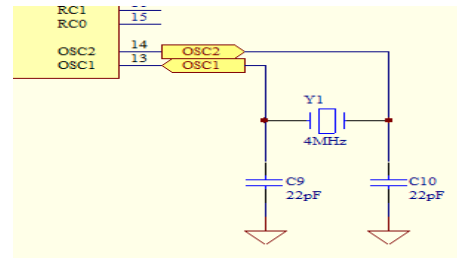


Figure 4.7 4MHz Crystal Oscillator Configuration Schematic

4.1.2 TC35 GSM Modem

One of the core components of the project is the modem. This serves as to send out instantaneous message to the carer once it is activated by the user. GSM modem has become popular in embedded system as it provides long distance and remote control and monitor solution. Though it is not designed for real time application, but much system does not require real time update. GSM solution is widely being used in home security, automotive anti-theft system, motor controlling, laboratory access and monitor, etc. it has the following features:-

- 7 - 12VDC single supply input, standard DC jack.
- Supporting both English and Chinese SMS data communication.
- Supporting 900/1800/1900 MHz Tri band.
- Status lights indication.
- On board buzzer and LED for "Incoming call" indicator.
- Supporting AT Command Set.
- RS232 (DB9) and UART TTL (2.65V) ready serial port interface.
- SIM Card holder available.

4.2 MCU Ports Initialization Routine

The function of this routine is to initialize and configure the ports in accordance to the hardware specifications.

//Configuration of Modem

```
ADCON1 = 0x0F; // default all pins to digital
TRISC = 0b10111111; // RC7 (RX) as input , RC6(TX) as output
SPBRG = 25; // baud rate of 9600
TXSTA = 0b00100100; // asynchronous mode, 8-bit data
// transmit enable, high baud rate select bit
RCSTA = 0b10010000; // serial port enable, 8-bit data
// continuous reception
TRISA = 0XF0; // bit 4 of PORTA as input
TRISB = 0b11110001; // bit 1-2 of PORTB as outputs, RB0 as input
```

5. CONCLUSIONS

This project has achieved the main objectives. Moreover, this project involved designing and development of remote data monitoring using GSM technology system had exposed to the better way of software and hardware architecture that blends together for the interfacing purposes. In order to make this project reality, it's requiring the application of PIC Compiler to program the PIC18f4520 microcontroller before the design can be interface with other components. From this interface users are allowed to send and received a data that retrieve from GSM module. The system is used to control motor overload by sending a message to the operators and as the same time the information which sent by the GSM will be recorded for further tracing and analysis purpose.

6. REFERENCES

- [1] <http://globaledge.msu.edu/>, February 20
- [2] <http://www.hongdian.com/en/products/h5910.htm>, Sept 2008
- [3] <http://www.ogpe.com>, Feb 2009
- [4] http://www.aarkei.com/sms_alarm_system_gsm_gprs_indian.pdf, Aar Kei Enterprises
- [5] Embedded Systems. Architecture, Programming and Design Second Edition, Raj Kamal, June 2008 (Reference Book)
- [6] <http://www.zilog.com>, Zilog Inc, Feb 2009
- [7] <http://www.rabbit.com/products/rab2000/>, A Digi International Brand, Feb 2009
- [8] <http://www.microchip.com>, Microchip Technology Inc, Feb 2009
- [9] <http://www.advoco.ie>, Advoco Technologies 2009, Feb 2009
- [10] <http://gprs-dtu.en.alibaba.com>, ShenZhen HuTong Technology Co, Ltd, Sep 2009
- [11] <http://buminetsys.com/PDF/GSM/TNC-G110-DS.pdf>, Taiko Network Communication Pte Ltd, April 2008
- [12] <http://www.kitronik.co.uk/pdf/7805reg.pdf>, Kirtronik Ltd, Sep 2008
- [13] <http://www.developershome.com/sms/atCommandsIntro.asp>, DevelopersHome, Feb 2009
- [14] Apress Practical.Net 2.0 Networking Projects, Wei-Meng Lee, 2007 (EBook)