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DESIGN AND IMPLEMENTATION OF SCADA CONTROL FOR REMOTE INDUSTRIAL PLANT

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ABSTRACT

Automatic temperature control is first step in applications such as industries. The main aim of temperature sensor using SCADA is to sense the temperature and perform the required performance using temperature sensors. It continuously senses the environment temperature and according to it performs its function. It works on the sensation of temperature that when temperature is above 40 degree celsius then fan is on and when temperature is below 23 degree celsius then only a bulb is on which increases the temperature of environment. The project paper focuses on developing a combination of hardware and software to monitor and control various parameters in industry. Almost all the Industrial Data Acquisition and control systems today use connection oriented concepts for interfaces. However, the variety of physical shapes and functional commands that each cable or wire based system has also raises numerous problems: the difficulties in locating the particular area affected by the industrial parameter, the complexity in operation of the system, the maintenance issue and so on. The control of temperature by using SCADA-based wireless technology has gained significant industry attention. The control of the temperature of a room has provides effective and efficient role in industry. They have used cables and bulky equipment which require large amount of space, high degree of the maintenance and are easily destroyed by moisture and excessive heat. Additionally, the Data acquisition and control techniques used so far have imposed considerable computational burden and have not provided a consistent and accurate results expected by the employees and their industries.

INTRODUCTION

SCADA systems are common process automation systems that are used to gather information from instruments and sensors placed at remote sites and to transmit information at a central site for either monitoring or controlling purpose. The collected information from sensors and instruments is typically viewed on one or a lot of SCADA host computers that square measure placed at the central location. Based on the knowledge received from the remote stations, machine-controlled or operator-driven higher-up commands is pushed to terminal management devices, that square measure typically observed as field devices.
This is a control system that uses computers, networked data communications and graphical user interfaces for process supervisory management, it also uses other peripheral devices like programmable logic controllers and discrete PID controllers to interface to the process plant or machinery.
The operator interface that enable monitoring and therefor the supply of process commands, like controller set-point changes, are handled through the SCADA system. However, the real-time control logic or controller calculations are performed by networked modules that are interface with the field sensors and actuators.

The SCADA idea was developed as a universal way of remote access to a range of local control modules that may be from completely different makers permitting access through normal automation protocols. In practice, large SCADA systems have grown to be-come very similar to distributed control systems in function, by using multiple means of interfacing with the plant. They can control large-scale processes that may embody multiple sites, and beat massive distances likewise as little distance.

For achieving the SCADA control for remote industrial process, a temperature logging system for a remote plant operation is taken. Here temperature sensors are duly interfaced to the PIC microcontroller. Data collected from the temperature sensors are perpectually sent to the microcontroller that is sucessively connected to a computer.
At the front end, software is loaded on the pc that takes these values and displays them on its front panel, and as well logs them in the database. One can set parameters like set point, low limit and high limit on the computer screen.
When the temperature of a sensor goes above or below set point the microcontroller sends a command to the corresponding relay. The heaters connected through relay contacts (corresponding to their sensors) are turned OFF/ON. High limit and low limit features are available for generating an AV alarm on the computer in the event of system failure.

Significance of Study

The project scopes covers:

1. Supervisory control and data acquisition system (SCADA).
2. Industrial plant and Process parameters such as temperature etc.
3. PC Based Application Software.
4. Embedded systems i.e. microcontrollers and communication interfaces.

The Objectives of the Study

The following are the specific objectives of the study:

1. To be able to determine the temperature of a process using temperature sensor.
2. To be able to develop a combination of hardware and software to monitor and control temperature and other processes in industry.
3. To be able to connect the microcontroller and the PC so as to feed the acquired data to the PC based application.

Block Presentation of a SCADA Control for Remote Industrial Plant

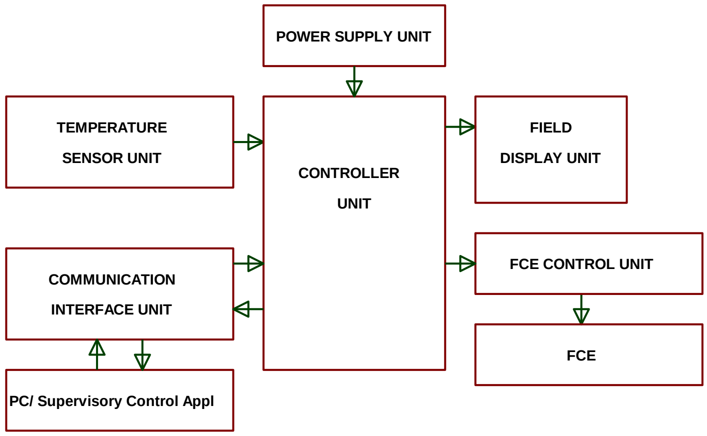


Fig. 1. Block diagram of a *SCADA Control for Remote Industrial Plant*

1. *Power Supply Unit*

This unit provides the required power (5V/12V DC) for the circuit. It is powered from the 220/230V AC Mains supply.

2. *The Temperature Sensor*

This unit converts the temperature of the process into electrical signal that is fed into the controller unit.

3. *The Field Display Unit*

This unit, installed with the process, gives a visual presentation of the process temperature. It enables field technicians to monitor the temperature of the process.

4. *Final Control Element*

The final control element (FCE) which serves as a heating element is used to increase the temperature of the process.

5. *FCE Control Unit*

This unit enables the controller unit to control (i.e. turn ON/OFF) the power of the FCE.

6. *Communication Interface Unit*

This unit enables the Controller to communicate with the computer/PC where the supervisory and control Application runs. The serial communication protocol was used to implement the interface. This unit was implemented with a TTL TO USE MODULE.

7. *The Controller Unit*

This unit performs the logic of the entire system. It reads the electrical signal from the temperature sensors, calibrate it, and sends it to the field display unit for field monitoring and also to the PC through the communication interface. The SET Points is set at the PC Level and saved in the internal EEPROM of the controller.

8. *The PC (Personal Computer)*

The PC runs the supervisory and control application. The application is in C# Programming language by Microsoft Corporation. The applications runs on windows 7, 8 and 10. The application presents a visual presentation of the entire process and also allows the operator to input set-points for the processes.

Design Methodology

Design Specification

This system has the following design specifications:
Input voltage: 220/220VAC @ 50HZ
Number of Process: Three (3)
Process Type: Two is AIR; one is Water
Temperature Sensor type: Two LM35 (Air Processes) and 10K Thermistor
Field Display: 16 x 4 liquid crystal display (LCD)
Communication Port: USB

1. The Temperature Sensor Unit

This unit converts the temperature of the process into electrical signal.
Below are the Requirements for the selection of the Temperature Sensor

- Reasonable Temperature Range
- Easy to Mount an d Use
- Easy to Bias
- Availability and Cost Effective

The Temperature Sensor LM35 and 10K NTC Thermistor was selected, below are some of the Features of the 10K Thermistor:

- Temperature Range: -80 to +150 degree Centigrade
- It Readily Available and Cost Effective than the Thermocouples and Platinum RTD Sensor
- It is easy to bias i.e. Using a Voltage divider resistor Network, its Resistance is inversely proportional to temperature

Below are some Features of the LM35 sensor

- Temperature Range: 0 to 120 degree Centigrade
- Easy to bias: i.e. it outputs 10milli volts per 1 degree temperature rise.
- it is Readily Available and Cost effective

The Two AIR Process uses the LM35 as the temperature sensor, while the WATER Process uses the 10K NTC Thermistor sensor. The outputs of the Temperature sensors is connected directly to the Analog Digital converter Pins of the Microcontroller. Below is the circuit of the Temperature Sensor unit interface with the microcontroller.

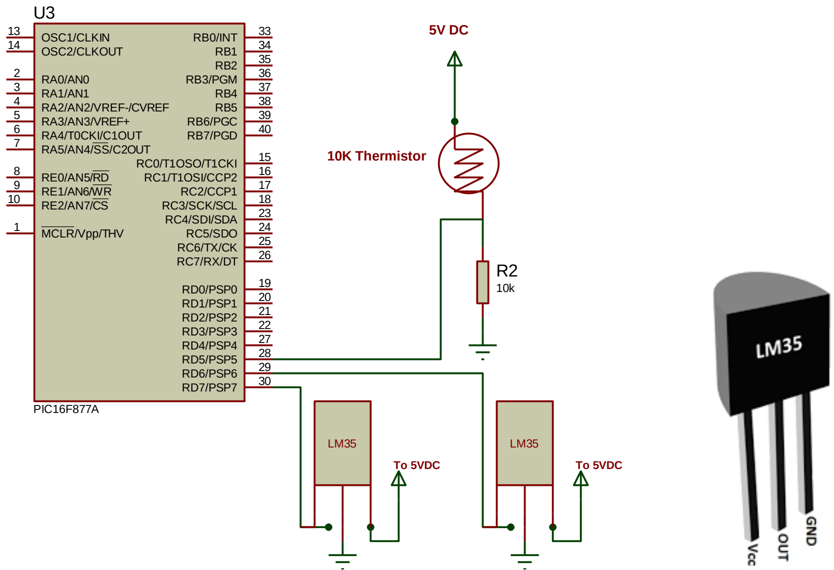


Fig. 2.0: Circuit Interface between the LM35 Temperature Sensor and the Microcontroller

2. The Field Display Unit

This unit, installed with the process, gives a visual presentation of the process temperature. It enables field technicians to monitor the temperature of the process.

Requirements of the Field Display unit:

- Be Large Enough to represent the temperature values of the three (3) process.
- Easy to interface, bias and use.
- Cost Effective and Available.

Selection of the Field Display Unit

The 16x4 LCD Standard Hitachi HD44780 was Used. Below are some of its features:

- It has four (4) Rows and 16 Characters per Row, Enough to represent the process temperatures.
- It is Cost Effective, available and Easy to Interface.

The 16x4 LCD connects directly to the microcontroller, below is the circuit interface of the 16x4 LCD and the microcontroller.

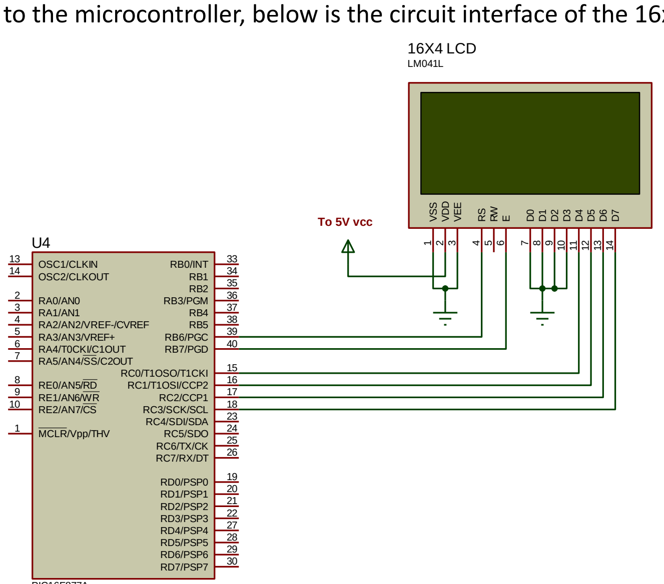


Fig. 3.0: The Circuit interface between the Field Display Unit and the Microcontroller

3. The Final Control Element and Control Unit

Heat sources was used as the Final control element (FCE) of the system. The two AIR Processes uses two 100watts 230V Bulbs as the Heat source while the WATER Process uses a 60watts 230V heating element as the Heat source.

The FCE control unit enables the controller to ON or OFF the FCE of each of the processes. The FCE control unit was implemented with the following components:

- Three Relay (12V 10A DC).
- Three 1K Resistor.
- Three NPN transistor (BC547).

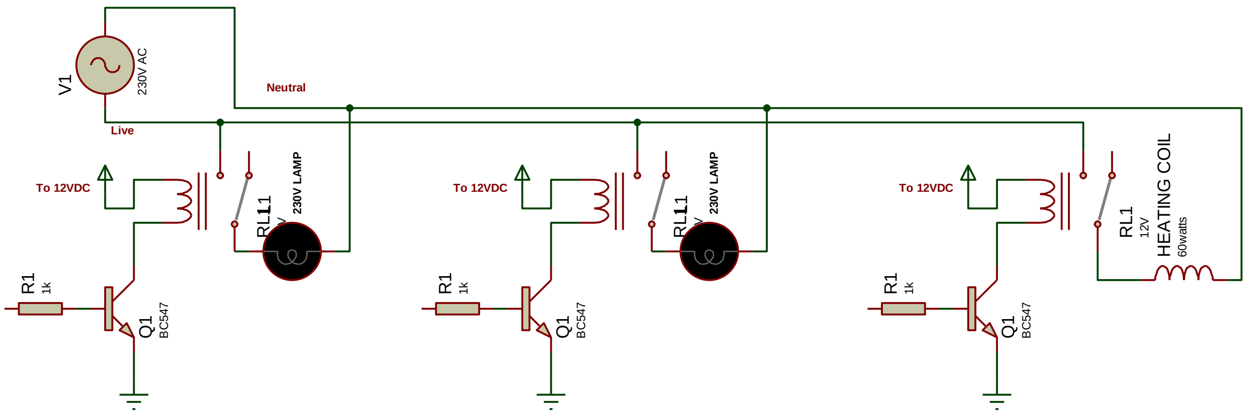


Fig 4.0: FCE Control Unit

4. The Overflow Prevention Unit

This unit was installed in the WATER Process reservoir. It prevents the overflow of water from the reservoir. It was implemented with:

- A 12V DC Solenoid valve
- A 12V DC Relay
- Electrical Probes as a Level Switch.
- A bc547 NPN Transistor and resistor

Below is the Circuit diagram of the Overflow prevention unit.

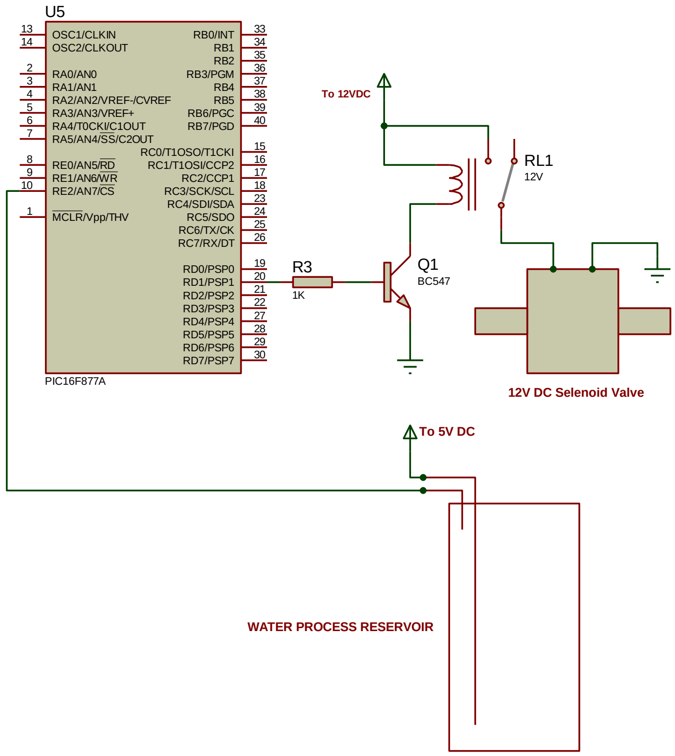


Fig. 5.0: The Overflow Prevention circuit diagram

5. The Level Switch

Two aluminum conductor was used to implement the level sensing probes. One was strategically fitted to the bottom of the reservoir is connected to 5V DC, while the other to the FULL level in the reservoir was connected directly to the microcontroller. Recall that water is a conductor of electricity, when the water level in the reservoir reaches the top, it makes the two probes contacts, then allowing current to flow to the microcontroller, on the microcontroller receiving this signal activates the solenoid valve through the transistor and relay to open, so as to let water discharge from the reservoir.

6. The Communication Interface Unit

This unit enables the controller to transmit the temperature values of the three processes to the SCADA Application in the PC.

Requirements of the communication Interface Unit

- It should be able to transmit DATA within a reasonable range.
- Easy principle of operation, easy to use and mount.
- Easy to interface to a microcontroller
- Easy to Bias i.e. it should involve less electronic components
- Power requirements should be reasonable.
- Availability and Cost Effective

Selection of the communication interface Unit

After research, this unit was implemented with a USB TO TLL Serial Communication Module. It communicates with RS232 serial communication protocol using the TX, RX and Common terminal. Below is the circuit interface of the USB TO TTL Module with the microcontroller.

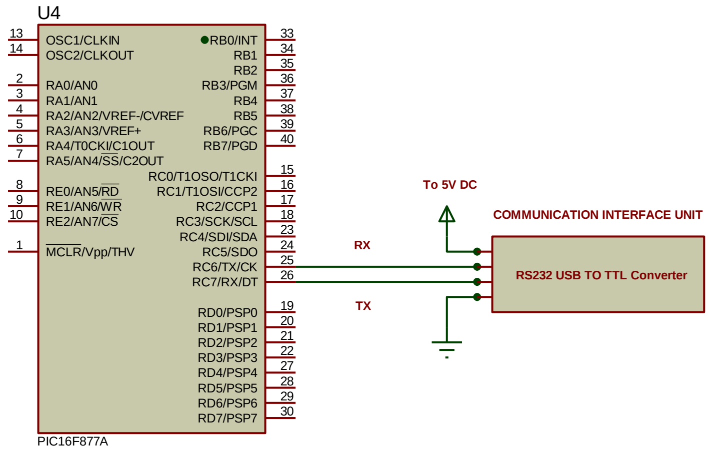


Fig. 6.0: Circuit Communication Interface unit

7. Communication Data format between the controller and the SCADA Application

The Controller transmit a 24bit (3 byte) DATA packet to the SCADA Application at every 1 seconds. Each byte in the packet represent the temperature value of a process i.e. the first byte represent the temperature in degrees of the first process.
The SCADA Application receives the 3 byte packet data, parse it and displays it on the Process image in the Application.
The SCADA Application transmit a 3 byte CONTROL Packet to the microcontroller, where each byte represent the control state of the FCE Of the process. Each byte can either be 00H or FFH i.e. OFF FCE or ON FCE respectively.
The communication baud rate between the controller and the SCADA Application is 9600bps.

8. SCADA Application

This is a graphical user interface unit of the system. it was designed with Microsoft visual studio 10 using C# Programming language. The Design carries three reservoirs images, where each reservoir image represent a process. The temperature of the process, transmitted in by the microcontroller is display in on the Reservoir image of the SCADA Application.
The SCADA Application also has a TEXTBOX AND BUTTON under each reservoir image that is used to input the Temperature SET POINT of the Process. Below is the Pictorial View of the SCADA Application. See Fig 3.11 for SCADA Application interface.

9. Coding

The coding is done in MPLAB C-Language language. The code contains the instruction of program that runs in the microcontrollers.

Flow Chart

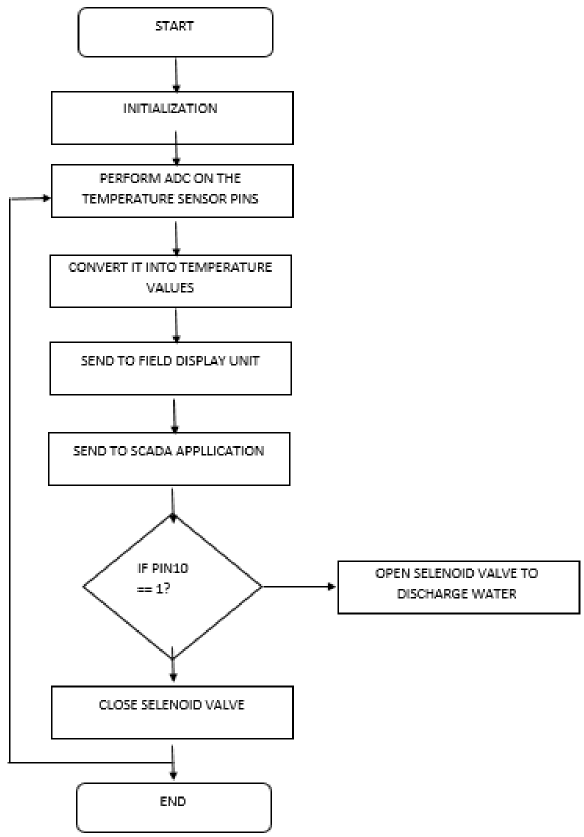


Fig. 3.9: flow chart

Testing and Result

The completed project as stated in the problem statement was tested to confirm if it could provide solution to the stated problems.

Power – up test

The unit was connected to the public power supply and switched on.

Expected result: LCD display should come on.

Back lights should come on LCD.

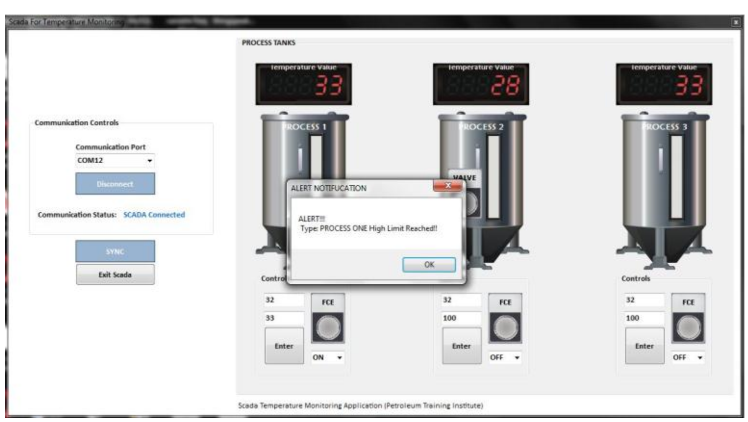
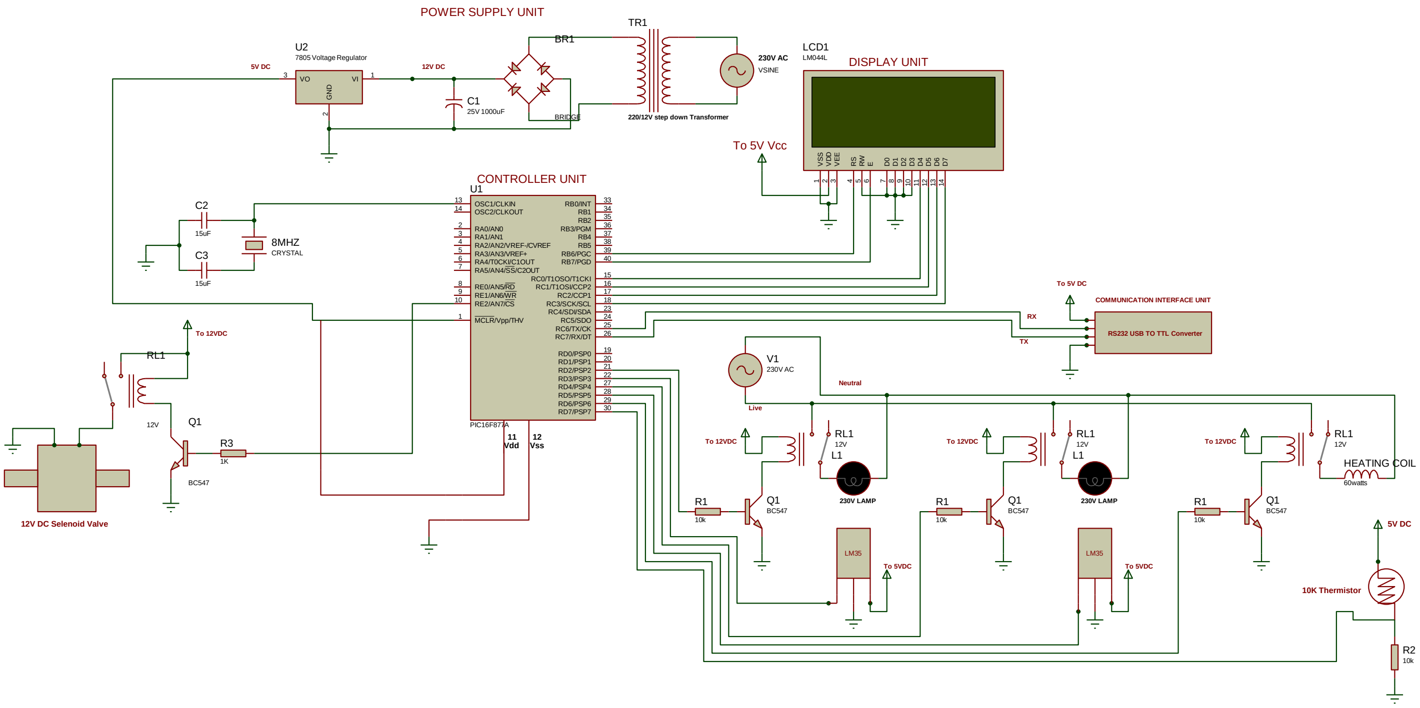


Fig4.2: Process one High Limit Reached Alert



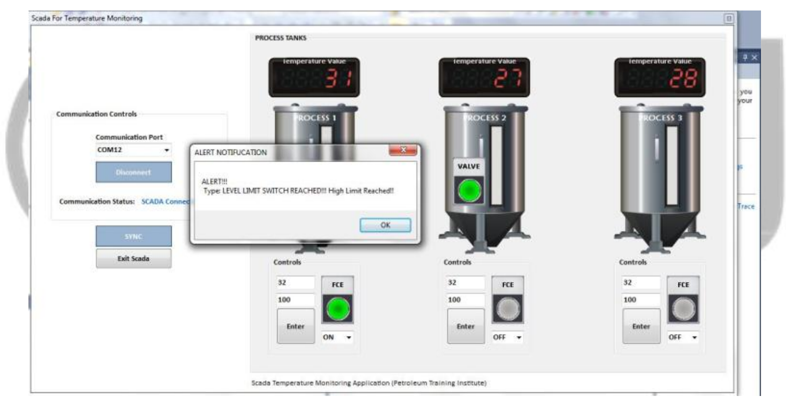


Fig 4.3: Process Two Level Limit Alert

Conclusion

A successful attempt has been made to design and construct a SCADA based temperature monitoring system for three process using locally available material. The system is capable of enhancing remote monitoring and control over SCADA Applications. The completed work had been tested and worked satisfactory.

A research approach was adopted in the implementation of this system, from whence a workable circuit was designed. The design was done using embedded system technology. This is to reduce component count, keep the system simple and cost effective.

Acknowledgment

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