Indian J.Sci.Res.3(2) : 17-20 , 2012

PC BASED TEMPERATURE MONITORING AND ALARM SYSTEM

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ABSTRACT

A PC based temperature monitoring and alarm system has been designed, constructed and tested. The system uses a linear and highly sensitive temperature transducer whose analog output is converted to digital format using an 8 bit analog to digital converter (ADC) before the digital signals are fed to the personal computer (PC) through the parallel port for display on the monitor. A program was written using Visual C++ which provides a user interface through which a predefined temperature limit can be set so that the threshold alarm is triggered when this limit is exceeded. A database to record the temperature readings for a certain period of time is also incorporated in the program. The device was tested within a temperature range of 25°C to 150°C while varying the threshold temperature. From the results obtained the alarm was triggered at ± 0.1°C of the selected threshold temperature. The system finds application in power plants, laboratories, workshops and domestic kitchens. The system can also be adopted for multiple zone temperature sensing such as the simultaneous temperature measurement of automobile radiators and engines and measurement of boiler temperatures in power plants.

KEYWORDS: Temperature, Alarm, PC, Monitoring,System

The last decade has seen a large-scale growth in the requirement of temperature detection for industries, residential and commercial complexes and educational institutions (Chenetal, 2005; Prajaetal, 2011 and Mahanandiaetal 2008). Proper control and monitoring of temperature in these locations is necessaryto reduce failure rates because adverse temperatures in some of the systems will affect their functionality and availability. The need to monitor and control the temperature of equipments (whose functionalities depend on temperature) on real-time basis is necessary to avoid complete or partial loss of performance, accidents and damage of valuable machines which would take a lot of money and resources to restore to a good working condition. In power generating plants, for example, the output voltage produced is relatively affected by the temperature of the generators hence precise temperature sensing and control is very important (Alrashidi et al., 2009, Averyanova et al., 2011)

In temperature monitoring systems, temperature is first converted to electrical signals using temperature transducers. The output of the transducers are conditioned and processed to give the output in the desired format. The output can be displayed on liquid crystal display (LCD) screens or on the PC monitor. The use of the PC has more advantages because, with the aid of a written program, it provides a user interface through which a predefined temperature limit can be set so that an alarm is triggered when this limit is exceeded. Temperature values can also be stored and easily retrieved and modifications can easily be made to suite the particular equipment or system whose temperature is being monitored. The system can be easily interfaced with other PC based control systems in a larger perspective such as combining two machines. The PC based temperature monitoring and alarm system does not control temperature but monitors the temperature of the equipment and gives a warning when the threshold temperature is exceeded.

MATERIALS AND METHODS

In order to achieve the aim set out, existing systems were studied and various design options were considered (Praja et al.,2011;Averyanova et al.,2011;Wara et al., 2009; Agarwal and Pal ,2011;Dadji et al., 2009; Jovanović and Jevtic, 2011). The system was broken down into four sections: The power supply unit, the temperature sensing unit, the data acquisition and control unit and the output unit. A program in C++ required by the PC to monitor and control the device was developed after which the hardware and software parts of the system were integrated. The integrated module was tested and the results obtained were analyzed. The output voltage of the temperature transducer at different temperatures was tested. The equipment used for this purpose were; thermometer, heat source, a voltmeter and light emitting diodes (LEDs). The voltmeter was connected across the transducer (LM35) to measure the output voltage.

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The LEDs were connected to the output of the ADC to determine their state. The thermometer was used to determine the temperature of the soldering iron used as heat source. At selected temperatures, the soldering iron was placed on the LM35 and the output voltage and the temperature were read from the voltmeter and the PC respectively and then recorded. The digital output of the ADC was read from the LEDs states, where ON represents HIGH and OFF represents LOW.

Principle of Operation of the System

The diagram of the system is shown in Fig.1. The system is powered by rectified and regulated 12V and 5V D.C. power sources. The temperature sensing unit comprises of the temperature transducer and the analogue to digital converter (ADC0804). Temperature is sensed by the transducer and converted to an analog voltage by a transducer. The voltage from the transducer is passed to the ADC which produces digital signals which are sent to the PC via the parallel port. The PC is the data acquisition and control unit. Signals from the ADC are transferred to the PC for processing via the data pins parallel ports. From the written program of Visual C++, the signal received, is executed pulse by pulse to convert the temperature sensed to a visual form where it can be monitored. The predefined limit of temperature that is to be monitored is achieved by the Visual C++ program. A data base to record all the temperature readings for a certain period of time is also incorporated in the program.

The PC reads the value of the analog to digital converter output then interprets it to graphic User Interface (GUI). The value of the temperature is read on the monitor of the PC. The program has the following features: a Centigrade Scale, Data logging on easily readable text file, sampling rate of 1, 5, 30 or 60 seconds: this feature enables the operator to determine at what rate the temperature should be monitored. Easily upgradeable source code for further capabilities: additional programming can be done on the existing one because of this important feature of the program.

Based on signals sent out by the PC which depends on the monitored temperature, a green LED is litfor temperatures below the threshold,a yellow LED is lit for temperatures equal to the threshold anda red LED is lit for temperatures above the threshold. When the threshold temperature has been exceeded, the last signal sent out from the PC is to the optocoupler energizing it thus causing it to trigger the buzzer.

RESULTS AND DISCUSSION

The recorded values of the results obtained from the tests are given in table 1. The thermometer and digital (ADC) temperatures versus output voltage is shown in Fig.2.

The temperature output of the PC compares well with that obtained from the thermometer (± 0.2^{o}C). The alarm was triggered at ± 0.1^{o}C of the threshold temperature. It was observed that the ADC output in decimal differed from the thermometer reading by 10^{o}C. This was due to the end error reading from the LM35 and the ADC. The end error reading was found to be 10%. Since it is the binary equivalent of this ADC output that is fed into the PC, the program was written to display the temperature taking into consideration this end error reading of the LM35 and the ADC. The program was adjusted to ensure that the 10^{o}C end error was subtracted from the measured temperature before it will be displayed on the PC screen, hence the temperature displayed on the PC screen compares well with that of the Thermometer despite the end error of the LM35 and the ADC.

The device is able to measure and monitor temperature, display the value on the PC monitor and keep a record of measured values. An alarm is triggered when the selected threshold temperature is reached. Due to the temperature transducer used, the device range is limited to −55° to +150°C. Another temperature transducer will have to be used for temperatures outside this range. The system finds application in power plants, laboratories, workshops and domestic kitchens. The system can also be adopted for multiple zone temperature sensing such as the simultaneous temperature measurement of the radiator and engines in automobiles and the measurement of boiler temperatures in power plants.

Table 1: Test Results

PC Temperature Reading						Thermometer Temperature (°C)	LM35 Output Voltage (V)	ADC Output (Digital Temperature)	
1st test (Selected threshold temp = 40°C)			2nd Test (Selected threshold temp = 80°C)					Binary	Decimal
Temp (°C)	Alarm	LED type ON	Temp (°C)	Alarm	LED type ON				
30.1	OFF	Green	30.1	OFF	Green	30	0.37	00101000	40
39.9	ON	Yellow	39.8	OFF	Green	40	0.47	00110010	50
50	ON	Red	50	OFF	Green	50	0.58	00111100	60
60.1	ON	Red	60	OFF	Green	60	0.67	01000110	70
69.8	ON	Red	70.1	OFF	Green	70	0.78	01010000	80
80	ON	Red	80.1	ON	Yellow	80	0.87	01011010	90
90.1	ON	Red	90	ON	Red	90	0.96	01100100	100

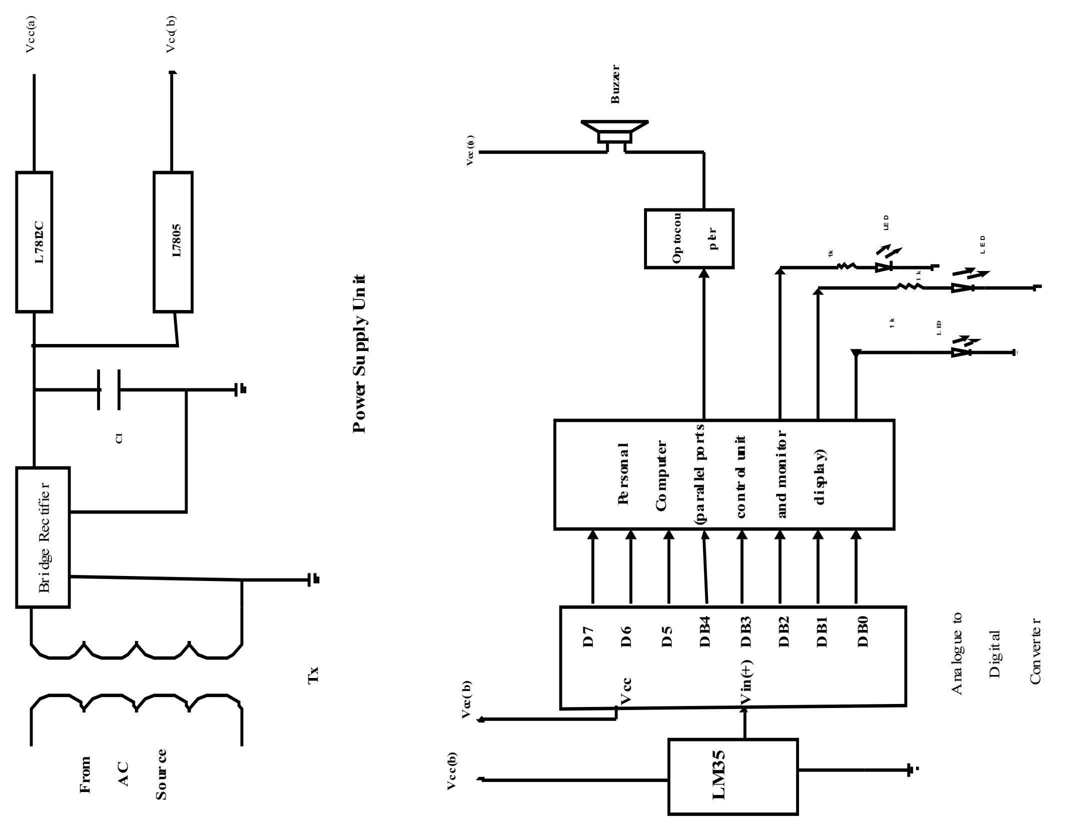

Fig. 1: PC Based Temperature Monitoring and Alarm System

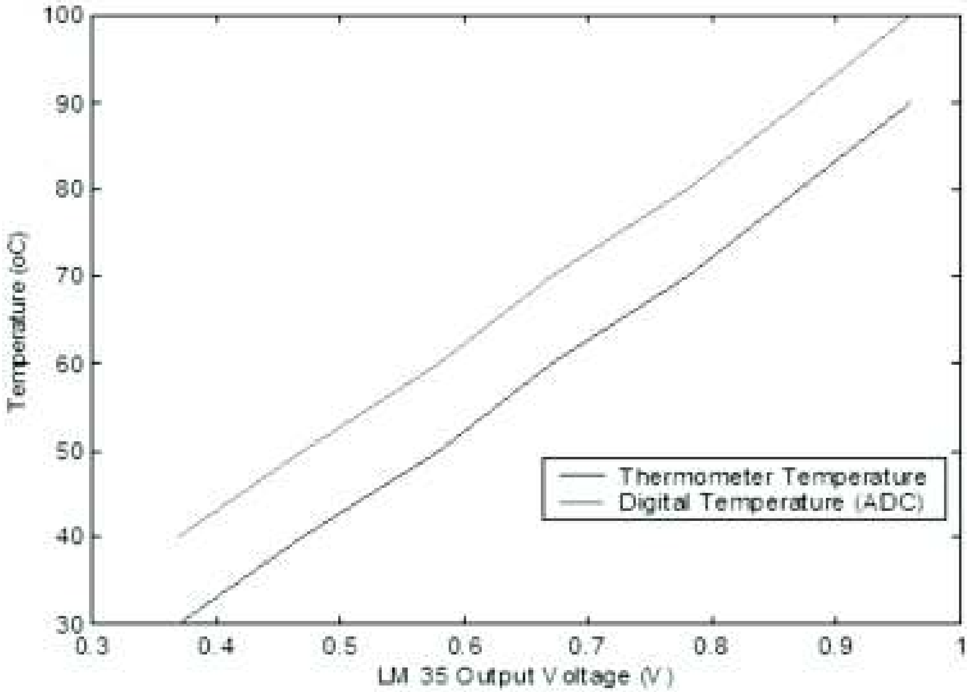

Fig.2: Thermometer and Digital (ADC) temperatures versus output voltage

ACKNOWLEDGEMENT

I acknowledge the contributions of EngrAbayomi-Alli Adebayo, Prof Wara S.T andEkpenyongU. in formatting, discussing, and in design and development of this work respectively.

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