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RESEARCH ARTICLE OPEN ACCESS

Implementation of a Microcontroller Base Temperature calibrated Kettle with Temperature 0 – 100^0c

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Abstract:

The project is about design and construction of temperature calibrated electric kettle. This is an appliance that works by passing current through the heating element and the resistance to the flow of electricity generates heat which is then conducted into the water. The project is calibrated to accept set point range of 0^0C to 100^0C with the aid of Human Machine Interface (HMI). When a desired temperature is set, the heater turns ON automatically and is deactivated reaching the set point. A buzzer alarm turns on automatically thereby notifying the user that a set point has been reached. This technology is employed in order to prevent further boiling of water and it also saves us from electrical fire hazard. The project is achieved with the use of a thermistor (which is the heat sensor) soldered to the body of the kettle to sense the heat at a particular temperature and send a signal to the microcontroller circuit which process the signal and output result. Also, this project consist of four chapter in which the literature review of all the component used, principle of operation, costing, construction and testing of the project were discussed.

Keywords:- **Thermistor, Temperature, Kettle, Buzzer, microcontroller, buzzer.**

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I. INTRODUCTION

With respect to the rapid development of science and technology in the present world today, it has become expedient for people especially those of the developing countries to move along with the trend of technological advancement. The use of electrical heating element in the home and industries for different purpose is an aspect that cannot be overlooked.

It cannot be overlooked because it has caused a lot of fire disaster and hazard in various part of the world.

One of the main three effects of and electric current is that heat is produced whenever a current is passed through a wire. This heating effect is in many forms of electric heating appliances such as water-heater, electric kettle, cooker and ring boiler. A heating element consists of resistance wire supported on a ‘former’ which is capable of withstanding high temperature. An electric kettle is an example of an electric water heater. It uses an immersion type-heater coil insulated with calcium oxide, which is enclosed in a water tight metal oxide.

An electric kettle has various model and design. They are rated in different ranges like for instance 230V/50Hz 2000w 45L for medium, 220/240 50Hz for small and 2400W of large type. The power demand is about 1KW, 2KW, 2.2KW to 2.4KW respectively while rated current is 13Amps.The chosen element is rated 500W 220/240V 50Hz.

The temperature of the heating system "Electric kettle" can be indicated automatically with the help of electric thermistor to cut off the source of supply when the preset temperature of the heating system is reached. This is manufactured and put in place so that in case the user carelessly abandons or leaves the appliance without switching it off.

A. *Aims and Objectives*

The aims of this project is to construct an electric sensing device that can eliminate the possible risk of electric fire out-break from electric kettle. And also to ensure current is tripped off from the kettle when the water is warm or boils depending on preset temperature of the heat sensor.

B. *Applications of Automatic Change Over Switch*

An automatic change over switch finds its relevance in the following areas;

1. In HOSPITALS; to ensure uninterrupted power supply during surgical operation and other emergency situation.
2. In BANKS; to ensure uninterrupted cash transactions and other services rendered by the bank.
3. It is used in areas where the reliability of electrical power supply is low.
4. In areas where lifts and elevators are being used.

C. *Methodology*

The methodology employed in realizing electric kettle with automatic temperature indicator includes the subsequent steps:

i. Study of previous literatures on the project to better understand the concept and functionality of the project.
ii. Understanding the entire system of hardware and software sequences.
iii. Designing the system circuit and developing the control algorithm.
iv. Testing the functionality of the varied sections of the system.
v. Combining the both hardware and software components of the system.
vi. Documenting the Research/Project

II. TEMPERATURE

Temperature measure of hotness or coldness expressed in terms of any of several arbitrary scales and indicating the direction during which heat energy will spontaneously flow—i.e., from a hotter body (one with a higher temperature) to a colder body (one with a lower temperature). Temperature isn't the equivalent of the energy of a thermodynamic system; e.g., a burning match is much higher temperature than an iceberg, but the sum heat energy contained in an iceberg is much greater than the energy contained in a match. Temperature, like pressure or density, is called an intensive property—one that is independent of the quantity of matter being considered—as distinguished from extensive properties, such as mass or volume.

Three temperature scales are in general use today. The Fahrenheit (°F) scale is employed in the US and a couple of other English-speaking countries. The Celsius (°C) scale is standard in virtually all countries that have adopted the metric system of measurement, and it's widely utilized in the sciences. The Kelvin (K) scale, an absolute temperature scale (obtained by shifting the Celsius scale by −273.15° so that absolute zero

A. The Thermistor

The Thermistor is another sort of temperature sensor, whose name is a combination of the words THERM-ally sensitive res-ISTOR. A thermistor is a special sort of resistor which changes its physical resistance when exposed to changes in temperature.

Fig 2.2: Thermistor

Thermistors are generally made made up of ceramic materials like oxides of nickel, manganese or cobalt coated in glass which makes them easily damaged. Their main advantage over snap-action types is their speed of response to any changes in temperature, accuracy and repeatability.

Most sorts of thermistor's have a *Negative Temperature Coefficient* of resistance or *(NTC)*, that's their resistance value goes DOWN with a rise in the temperature, and of course there are some which have a *Positive Temperature Coefficient, (PTC)*, therein their resistance value goes UP with a rise in temperature.

Thermistors are constructed from a ceramic type semiconductor material using metal oxide technology like manganese, cobalt and nickel, etc. The semiconductor material is usually formed into small pressed discs or balls which are hermetically sealed to offer a comparatively fast response to any changes in temperature.

Thermistors are rated by their resistive value at temperature (usually at 25^{o}C), their time constant (the time to react to the temperature change) and their power rating with respect to the current flowing through them. Like resistors, thermistors are available with resistance values at room temperature from 10's of MΩ right down to just a few Ohms, except for sensing purposes those types with values in the kilo-ohms are generally used.

Thermistors are passive resistive devices which means passing a current through it to produce a measurable voltage output. Then thermistors are generally connected in series with a appropriate biasing resistor to form a potential divider network and therefore the choice of resistor gives a voltage output at some pre-determined temperature point or value

B. The Boiling Point of Water

This article is about the boiling point of water. First, it'll note both the Celsius and Fahrenheit temperatures at which water boils. Then, it will briefly explain how the temperature at which water boils may differ from location to location or from elevation to elevation. Finally, it'll check out how boiling water are often used and its efficacy as a sterilization process for drinking or cooking water.

Conventionally, the water temperature at which water boils is considered to be 100 degrees Celsius or 212 degrees Fahrenheit. However, these numbers are only valid at sea level. As atmospheric pressure changes so too does the boiling point of water. For instance, as elevation increases the boiling point lowers. On the top of Mount Everest, for example, boiling water is possible at a water temperature of 68 degrees Celsius or 154 degrees Fahrenheit.

Conversely, in deep ocean vents, water can be much hotter than that without boiling.

Boiling water is beneficial for cooking pasta, vegetables or potatoes. In addition, some people boil water so as to sterilize it. This method can be effective, but certain precautions must be kept in mind. First of all, most bacteria and microorganisms will die when the water is boiled. However, in some cases their death is depends on the temperature of the water instead of whether or not it's boiling. Thus, at certain elevations, boiling water isn't hot enough to kill some organisms. Second of all, other organisms are simply immune to boiling water at any temperature. To promote the death of those organisms in either of those circumstances, it's advised that the water is boiled for a minimum of ten minutes to make sure that the majority if not all bacteria are destroyed.

Essentially, boiling water is water than is changing from a liquid to a gas. During that change, it can often be used for a spread of purposes like cooking and sterilization. As noted above, the quality temperatures for boiling are 212 degrees Fahrenheit or 100 degrees Celsius, but those numbers differ in certain conditions.

C. *Effect of Impurities on Boiling Point*

When an impurity is added its boiling point is elevated i.e. its boiling point is increased.

The elevation in boiling point increases with increase in concentration of the solute because on adding the solute vapor pressure of the solution becomes less than pure solvent. Thus the solution has got be heated more to form the vapor pressure adequate to air pressure. Thus the boiling point gets elevated.

For example boiling point of water is 100^{o}C under normal air pressure. If we add sugar or salt to the present water its vapor pressure becomes lower and boiling point increases.

Generally, when 1 mole of any non-electrolyte is dissolved in 1 litre of water the elevation of boiling point is 0.53^{0}

III. SYSTEM UNIT DESIGN

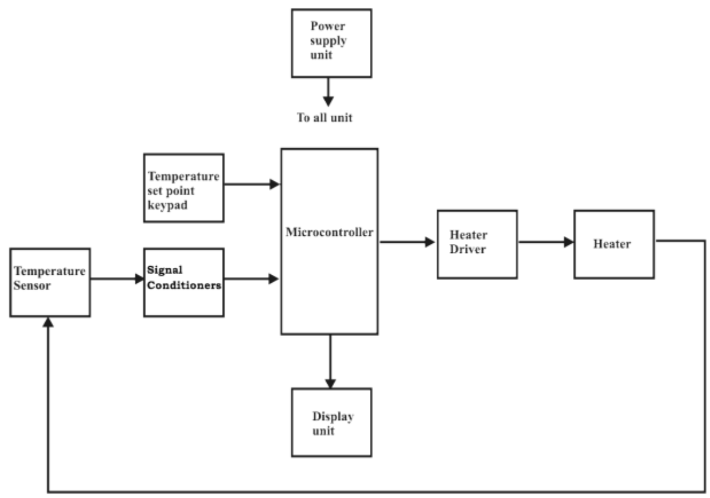


Fig. 1.0: Block Diagram temperature calibrated kettle with temperature 0 – 100^{0}c

1. **Temperature Sensor:** The temperature sensor used is RTD. It senses the change in temperature of water and gives the required output to the comparing unit. The resistance change of RTD is linear. Change in RTD requires change in hardware reconfiguring. With the change in temperature there is a change in the resistance of the sensor. The temperature sensor element can be thermocouple, RTD, thermistor, solid-state devices or a simple thermometer. The temperature sensor should give a correct output so as to regulate the process for controlling.

2. **Signal Conditioners:** The signal conditioner is basically an analogue to digital converter. It receives analogue signals from the temperature sensors and

converts the analogue signals received into digital readouts.

3. **Microcontroller:** The microcontroller (PIC16F84) takes the digital signals from the output of the Analogue to Digital Converter (ADC), processes it and displays the value on the display circuit.
4. **Display:** the display used for this design is the Liquid Crystal Display (LCD). It displays whatever has been processed by the micro controller and the display shows when the processes are above or below the set point on the LCD.
5. **Power supply unit:** the power supply unit provides the needed voltage for the circuit to operate. Power supply is basically made up of the transformer, rectification circuit, smoothing circuit and a voltage regulation circuit.
6. **Driver:** The driver unit consists of a driver, which drives the relay to change its contacts when the output from the comparator goes high. The driver used in the circuit is a transistor which drives the relay when the comparator output goes high as the base current starts flowing through it.
7. **Heater Control:** The heater acts as the final controlling element of a controlled loop. According to the state of relay, the heater switches 'on'/'off' to regulate the temperature of the water.

IV. DESIGN OF TEMPERATURE CALIBRATED KETTLE WITH TEMPERATURE RANGE 0 -100^{0}C

In Electrical and Electronic systems, their performance and reliability depends on the system designs and specifications, the designed parameter will conform to the operating condition of the system.

This chapter covers the detailed design and selection of the components used in the construction of this project.

A. *Design Specifications*

The design of temperature calibrated kettle with temperature technology has the following specifications:-

Input voltage	220VAC
Operating voltages	5VDC, 12VDC
Operating current	500mA
Input frequency	50Hz

The project comprises of the following units listed below:

- Power supply unit
- Sensor unit
- Switching unit
- Microcontroller unit
- Display unit
- Keypad unit

1. Selection of the Sensor

The choice or selection of the sensor depended on the following

1. Temperature range
2. Availability
3. Linearity over the temperature range
4. Cost.

The thermistor was used in this project as the thermo-sensor in the project circuit.

For temperature below 300^{0}C, the thermistor has a good temperature response and it is less costly than other temperature sensors.

2. Selection of the ADC

The ADC converts the analogue voltage into digital value. The choice of the ADC depends on the following.

1. The number of bits
2. The conversion rate
3. The accuracy

4. The resolution

The ADC0808 was used. It has a words length of 8bits, resolution of 5V, and 256 bits

Process 1: maximum temperature $= 100^0C$

Resolution $= \frac{5}{256} = 0.0195V$ per 1^0C

Voltage for 100^0

$= 0.0195v \times 100^0c = 1.96V$

Process 2: Maximum temperature $=150^0C$

Resolution $= 0.0195V$ per 1^0C

Voltage for $150^0C = 0.0195 \times 150^0C = 2.94V$

Process 3: Maximum temperature $= 200^0C$

Resolution $= 0.0195V$ per 1^0C

Voltage for 200^0C

$= 0.0195 \times 200 = 3.9V$

3. *The Alarm Unit*

This unit gives an audible sound/alert for five seconds on detection of the mains voltage. It was implemented with a 3-25v dc buzzer connected directly to the microcontroller. It was biased with a transistor and a 10k resistor to limit current from the controller to the base of the transistor. Below is the interface between buzzer and the microcontroller.

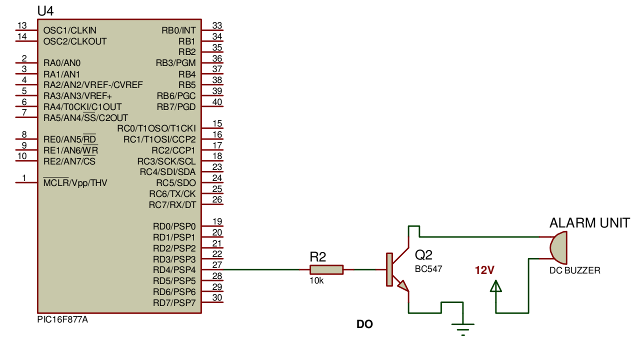


Fig 7: The Alarm Unit

a. *The Microcontroller Unit*

The microcontroller unit circuit is the heart of the project. This is where the program for the control part of the project is written and burned using C language and a universal programmer, respectively. The circuit diagram is as shown

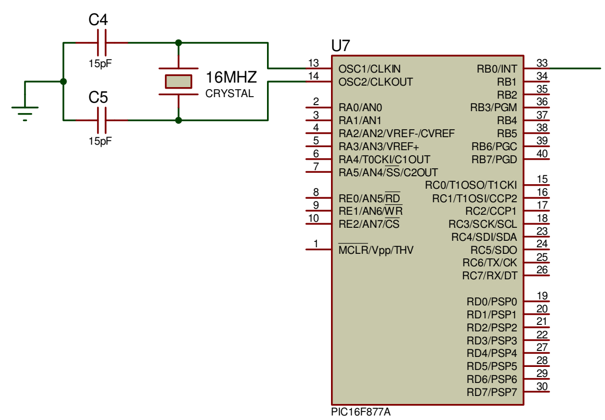


Fig. 8: The Microcontroller Unit

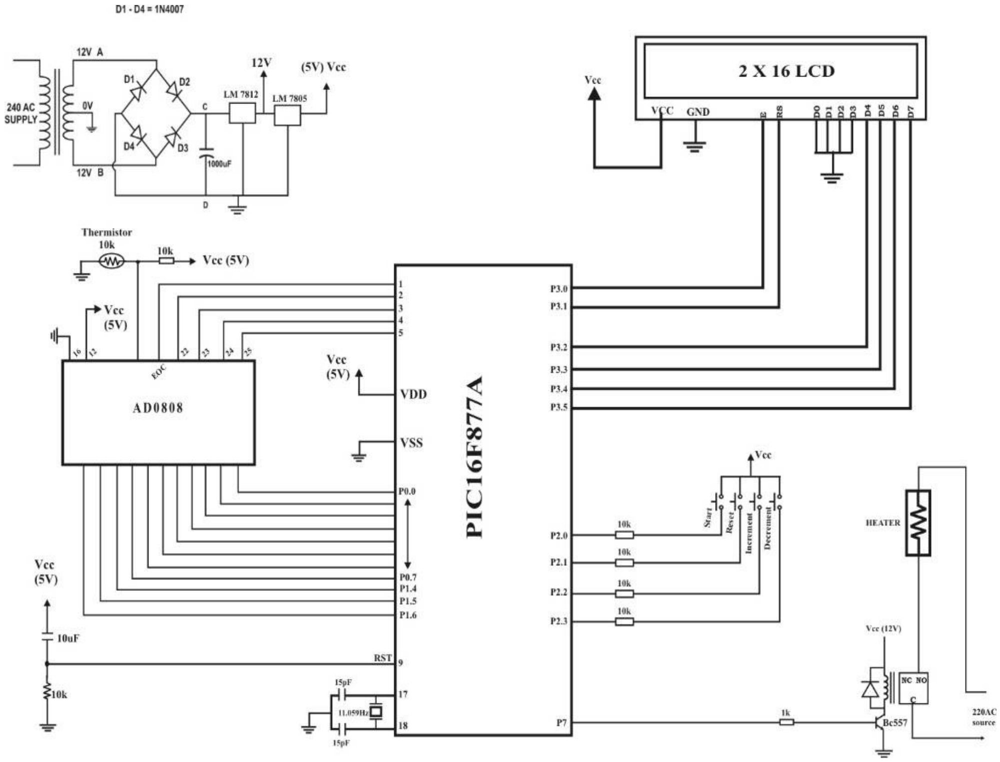
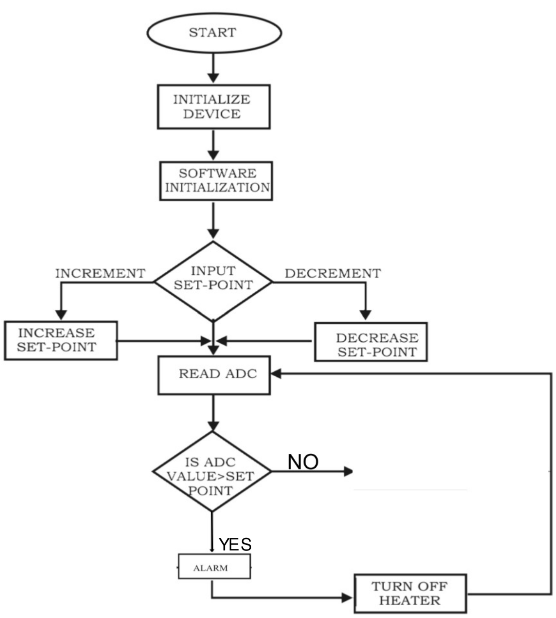


Fig.3 Flow chart of the program.

Fig.9: Circuit Diagram of a Single Phase Automatic Changeover

b. Flow Chart

The flow chart gives a graphical representation of the sequence of program execution. The flow chart is given below:



Circuit Operation

The principle of operation of the microcontroller based temperature indicator is explained below.

The thermistor which is the temperature sensor converts the change in temperature of the process to change in voltage. The output voltage from the thermistor is analogue in nature and it is converted to its digital value equivalent by the Analogue to Digital Converter (ADC) which is embedded in the microcontroller.

The microcontroller processes the digital value and displays it on the LCD (Liquid Crystal Display). The display displays 'set point reached' message showing maximum temperature has been reached. When this happens, the relay is activated which in turn cuts off power supply to the heating element in the process, then activating the buzzer to alarm.

V. RESULT

The microcontroller based kettle timer has been proven to be working effectively and as such can be recommended. Temperature indicators can also be used in household appliances like pressing iron, electric heaters, etc and other areas where temperature is needed to be controlled

VI. CONCLUSIONS

This project work shows the design and construction of automatic kettle timer capable of switching OFF an electric heater whenever the water in the kettle reaches its set point in ^{0}C. The device is automated and works independently of human attention. The aim of the work was achieved by connecting the device powered with an A.C source and observed to be carrying out its required purpose.

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