EPROM BASED TEMPERATURE DETECTION USING R.T.D. AS SENSOR

RAJESH KUMAR PANWAR*, R.K. JAISWAL AND S.C.. SHARMA*****

** JRA, Ganga Plains Regional Centre, NIH, Patna*
*** SRA, Ganga Plains Regional Centre, NIH, Patna*
**** Lecturer, Institute of Paper Technology (UOR), Saharanpur*

ABSTRACT

Climate is an active factor in the physical environment of all living things. It influences on human welfare ranges from the immediate effects of weather events to complex responses associated with climatic changes. Several observable elements aid the description of weather and climate. These elements are, intensity and duration of solar radiation, temperature, humidity, evaporation, cloudiness and fog, precipitation, visibility, barometric pressure and winds etc. Among all those elements temperature is an important phenomenon for climatological studies. In case of environmental hydrology, temperature plays a key role in various chemical and biological activities.

To measure temperature various instruments are used for example thermometer, thermocouples, thermistors, thermograph R.T.D. etc. In the thermometer group mercury-in-glass or alcohol-in-glass thermometers are used. Thermocouple and thermistors indicate temperature electrically. Thermograph is used when permanent records are desired.

In this paper an attempt has been made to describe EPROM (Erasable Programmable Read Only Memory) based temperature detection using R. T.D. (Resistance Temperature Detector) as sensor. R.T.D. is selected for sensing temperature. The change of resistance of R.T.D. with temperature can be measured as the change in voltage in mV. For handling the signal, the digital form has been used because any kind of interfacing with a microprocessor or computer is only possible with the digital signal. The use of microprocessor reduces the hardware considerably and we can also store the information in any desired form. The response time of the system also gets reduced by the use of microprocessors.

1. INTRODUCTION

1.1 Background to The Problem

In hydrological research institutes, various parameters are measured and detected. These parameters are intensity and duration of solar radiation, temperature, humidity, evaporation, cloudiness and fog, precipitation, visibility, barometric pressure and winds.

Temperature is an important parameter for various climatological, hydrological and environmental studies. There are various sensors for measuring temperature such as thermocouple, thermometer, thermistor, Resistance Temperature Detector etc. An EPROM based temperature detector can be used as a modern technique for automatic detection of temperature.

This method reduces the hardware considerably and we can store also the information in any desired form. The response time of the system also gets reduced. There are two ways of handling the signal. These are either use the signal in the analog form or use it in the digital form. We have adopted the digital signal form because most of the electronic controllers are digital nowadays and also any kind of interfacing with microprocessors or computers is only possible with the digital signal. The use of microprocessors reduces the hardware considerably and we can also store the information in any desired form. The response time of the system also gets reduced by the use of microprocessors.

1.2 Statement of The Problem

The phase wise plan for the interfacing of EPROM based temperature detector is as follows:

1. The generation of the signal from the sensor R.T.D. or thermocouple in mV. For this, a constant current source is required for the R.T.D. so that change in resistance of R.T.D. with temperature can be measured as a change in voltage in mV.

2. The production of digital signal with the help of A/D converter. This signal should be a hexadecimal one.

3. The display of value of temperature in seven segment LED with the help of a microprocessor and also storage of data whenever required.

4. The generation of the control signal, as required with the help of a microprocessor controlling the ON-OFF control of the system.

1.3 Execution of The Problem

1. The R.T.D. gives the change in resistance corresponding to the change in temperature.
2. The change in voltage in mV is obtained by connecting a constant current source in series with the R.T.D.
3. The mV signal obtained is then converted into a digital signal with the help of A/D converter IC 0804. The output is in the form of hexadecimal signal which is directly compatible with the microprocessor, without using any interfacing device.
4. The hexadecimal signal is taken up from the parallel port of the microprocessor and then multiplied with a multiplication factor and displayed which gives the actual value of temperature in centigrade.
5. The value of temperature is stored in a particular location and then compared with the required set point. When this value is attained, a control signal is produced, amplified and used for the ON-OFF control.

2. SENSOR AND SIGNAL CONDITIONING UNITS (S.C.U.) USED

Sensor and signal conditioning blocks used in the EPROM based temperature detection are as follows:

2.1 Resistance Temperature Detector (R.T.D.)

R.T.D. is any device where resistance changes with temperature. It has reasonably linear positive temperature coefficient. It consists of a small sensing element assembled into a protective enclosure. The element is usually wound from a small diameter wire. The wire is generally wound or supported within a small diameter ceramic cylinder. The assembly is closed and coated with ceramic materials for ruggedness and insulation. It is the most stable temperature sensor. The operating temperature range is –400°F to 1700°F. A change in temperature will produce an equivalent change in resistance over a long range of temperatures. The best R.T.D. is the platinum R.T.D. This is used for measurements between –272°C to 660°C. Ordinary copper wire is used to connect the sensor to the read out instrument.

The advantages of using RTDs are the following:

1. Linearity over a wide operating range.
2. Wide operating temperature range.
3. High temperature operation.
4. Interchangeable over a wide range than other temperature transducers.
5. Better stability at high temperatures.

2.2 Constant Current Supply

A constant current supply is a regulated power supply that helps to maintain constant, output current despite change in load, line, temperature, and so on. With constant, current, for a change in load resistance the output current remains constant, while the output voltage changes by whatever amount necessary to maintain the same output current. An ideal constant current source has internal impedance, provides the same current at any load. According to Ohm's law I_L the current through load resistance (R_L) is given by the expression:

$$I=E/(R_{INT} + R_L)$$

Now if $R_{INT} >>> R_L$

Then $I_L = E/ R_{INT}$ (approx.)

It means that a voltage source with very high internal resistance behaves like a constant current source which sends a current that is independent of the value of the load resistance connected. In a constant current source 723 IC (Precision Voltage Regulator) is used. The uA 723 is a monolithic precision voltage regulator capable of operation in positive or negative supply as a series, shunt, switching, or floating regulator. It consists of a temperature compensated reference amplifier, series pass transistor and a current limiter. Additional NPN or PNP pass elements may be used when output current exceeding 150 mA are required. Provisions are made for adjustable current limiting and remount shunt down. It features low standby current drain, low temperature drift and high ripple rejection.

2.3 Analog To Digital Converter

A/D converters can be classified into two general groups based on the conversion technique. One technique involves comparing a given analog signal with the internally generated equivalent signal. This group includes successive approximation counter and flash type convertors. The second technique involves changing the analog signal into time or frequency convertors. The trade off between the two techniques are accuracy vs speed. This group includes integrator, convertor and voltage to frequency convertors. The successive approximation and the flash type are faster but generally less accurate than the integrator and the voltage to frequency type convertors. The flash type is expensive and difficult to design for high accuracy.

2.4 Micro-Processor (8085)

The 8085 is an 8-bit microprocessor available as a 40-lead plastic ceramic package. The data bus is 8 bits wide. This implies that 8 bits byte of data can be transferred to or from the 8085 parallel. There are eight pins dedicated to transmit the most significant 8 bits of the memory address. The least significant 8 bits of the address area transmitted on the eight lines on which data is transmitted over a set of shared lines. It is obvious that the data and address (least significant 8 bits) are transmitted at different points of time. Due to this multiplexing, the 8085 bus is also referred to as multiplexed bus.

Thus the 8085 has a 16-bit address transmission capability. This implies that a total of 2^{16} (65536) memory location can be addressed directly by 8085. Each location is a byte as 8 bits of data, is transferred in parallel between the 8085 and the memory.

2.5 Interfacing Device (8255A)

The 8255A programmable peripheral interface (PPI) with the micro-processor on one side and with the peripheral on the other side. Data is transferred between the microprocessor and the 8255A on the D0–D7 bus. The RD and WR signals are used for indicating to the 8255A whether a read or a write operation is being performed. Before the microporocessor can read or write any data, the 8255A chip must be selected using the CS input. When CS is high, the D0–D7 lines are tristated.

The A0 and A1 inputs are used by the chip to decide the port to or from which data is to be transferred. These are termed as A, B and

C. The three ports can be programmed to operate in any one of the following three modes:

Mode 0 Basic input/output

Mode 1 Strobed input/output

Mode 2 Bidirectional data bus.

Mode 0 : Ports A, B (upper half) and C (lower half) can be used individually in mode 0. If a port is in mode 0, data can be written or read from the port without any control signals.

Mode 1 : This is known as the strobed input/output mode. Only ports A and B can be programmed to operate in this mode. When a Port is in mode 1 data transfer to or from this Port takes place using certain control signals.

Mode 2 : This is known as the strobed bidirectional bus PC_3–PC_7 serve as control signals for data transfer in this mode.

3. SOFTWARE PART

The data from A/D converter is received on a parallel port on jack "j3." The configurations are so set that:

Port A is used for input.

Port B is used for output.

Port C (upper and lower) is used for output.

The address of Port A,B,C is 00, 01 and 02 respectively. From Port A data in hexadecimal formats is read by IN statement then the data are multiplied by a multiplying factor and then a display can be obtained in hexadecimal on the address held by the microprocessor.

The signal is compared with set point (stored in D) and if the incoming signal is greater than or equal to the set point then a control signal "LOW" is sent to Port C i.e. at 02 Port otherwise the high signal is sent to Port C.

Port B(01) can be used for B.C.D. display on a seven segment display after designing a card of hexadecimal to the B.C.D. converter. This can be done in future.

1

```
6000  MVI   A,90
6002  OUT   03
6004  IN    00
6006  STA   7000
6009  MVI   H,00
600B  MVI   L,00
600D  MVI   D,03
600F  MVI   B,00
6011  MOV   C,A
6012  MVI   A,00
6014  MVI   E,01
6016  DAD   B
6017  DCR   P
6018  JZ    601E
601B  JMP   6016
601E  MOV   A,H
601F  STA   6770
6022  MOV   A,L
6023  STA   6771

6026  NOP
6027  MOV   A,C
6028  CMP   D
6029  JC    6033
602C  MVI   A,04
602E  OUT   02
6030  JMP   603A
6033  MVI   A,02
6035  OUT   02
6037  JMP   603A
603A  CALL  6092
603D  CALL  078B
6040  JMP   6000
6043  RST   5
6044  RST   5
```

2

```
6092  MVI   L,10
6094  NOP
6095  MVI   B,10
6097  MOV   A,C
6098  CMP   B
6099  JC    60A4
609C  NOP
609E  MOV   A,B
609F  ADD   L
60A0  MOV   B,A
60A1  JMP   6097
60A4  MOV   A,B
60A5  SUB   L
60A6  MOV   B,A
60A7  MOV   D,B
60A8  MOV   A,C
60A9  SUB   B
60AA  MOV   E,A
60AB  MVI   L,09
60AD  MOV   A,L
60AE  CMP   E
60AF  JC    60B5
60B2  JMP   60BB
60B5  MOV   A,E
60B6  DAA
60B7  MVI   L,60
60B9  SUB   L
60BA  MOV   E,A
60BB  MVI   A,00
60BD  CMP   D
60BE  JZ    60C4
60C1  JMP   60C9
60C4  MOV   H,A
60C5  MOV   L,E
60C6  JMP   6128
60C9  MVI   B,10
60CB  MOV   A,B
60CC  MOV   A,B
60CD  CMP   D

60CE  JZ    60F1
60D1  MVI   B,06
60D3  MOV   A,B
60D4  CMP   D
60D5  MVI   B,30
60D7  MOV   A,B
60D8  CMP   D
60D9  JZ    60FF
60DC  MVI   B,40
```

3

```
60DE  MOV   A,B
60DF  CMP   D
60E0  JZ    6106
60E3  MVI   B,50
60E5  MOV   A,B
60E6  CMP   D
60E7  JZ    610D
60EA  MVI   H,90
60EC  JMP   6111
60F1  MVI   H,10
60F3  MVI   L,06
60F5  JMP   6111
60F8  MVI   H,30
60FA  MVI   L,02
60FC  JMP   6111
60FF  MVI   H,40
6101  MVI   L,08
6103  JMP   6111
6160  MVI   H,60
6108  MVI   L,40
610A  JMP   6111
610D  MVI   H,80
610F  MVI   L,00
6111  MOV   A,E
6112  ADD   L
6113  MOV   L,A
6114  MVI   A,09
6116  CMP   L
6117  JC    611D
611A  JMP   61123
611D  MOV   A,L
611E  DAA
611F  MVI   L,60
6121  SUB   L
6122  MOV   L,A
6123  MOV   A,L
6124  ADD   H
6125  MOV   L,A
6126  MVI   H,00
6128  RET
```

5. RESULTS AND CONCLUSIONS

The constant current source gives a 50 mA current to R.T.D. at 0°C the resistance of R.T.D. is 100 ohm hence at 0°C the voltage signal obtained is 50mA 100 ohm 5V. A 5V voltage compensation is applied and by this we can get the increase in Mv with a rise in per °C temperature.

The constant current source has input of 220V and 5A and an output of 50mA (constant).

The A/D converter IC 0804 has input between 0–5V and output is in the form of hexadecimal. Due to the range, 0–5V controller can measure the temperature between 0–250°C.

The microprocessor has an input of hexadecimal coming from A/D converter. The absolute value of temperature of 0°C is displayed and a control signal of around 4V is generated to operate a relay.

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