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Development of a Multipoint Digital Thermometer by Microcontroller

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Abstract

This paper describes about the title that the development of a multipoint digital thermometer by microcontroller. In this project, a digital thermometer is constructed with the temperature sensors connected to different points of a process. A microcontroller controls the switching action of the temperature sensors. There is a common display to show the temperature of different place or point, which is connected at different switch with temperature sensor. When one switch is pressed the temperature sensor detect the desired point and show the corresponding temperature in the display by means of microcontroller. For multi-temperature the number of switch is increased as necessary with the observation point. The device is used where the temperature in the range of (-20^0 C ~ 150^0 C).

Keywords: *Digital Thermometer, Microcontroller, Sensor.*

1. Introduction

A thermometer is a device that measures temperature or temperature gradient using a variety of different principles. Digital thermometers are a quick, simple and effective way of obtaining temperature information. Most commonly-used electrical temperature sensors are difficult to apply. For example, thermocouples have low output levels and require cold junction compensation. Thermostats are nonlinear. In addition, the outputs of these sensors are not linearly proportional to any temperature scale. Early monolithic sensors, such as the LM3911, LM134 and LM135, overcame many of these difficulties, but their outputs are related to the Kelvin temperature scale rather than the more popular Celsius and Fahrenheit scales [1]. Fortunately, in 1983 two I.C.'s, the LM34 Precision Fahrenheit Temperature Sensor and the LM35 Precision Celsius Temperature Sensor, were introduced.

2. Experimental Setup

Project Board, At mega 32 chip, Temperature sensor LM35, LCD display (20*4) / 7segment display, Burner, Resistance 10KΩ, Wire.

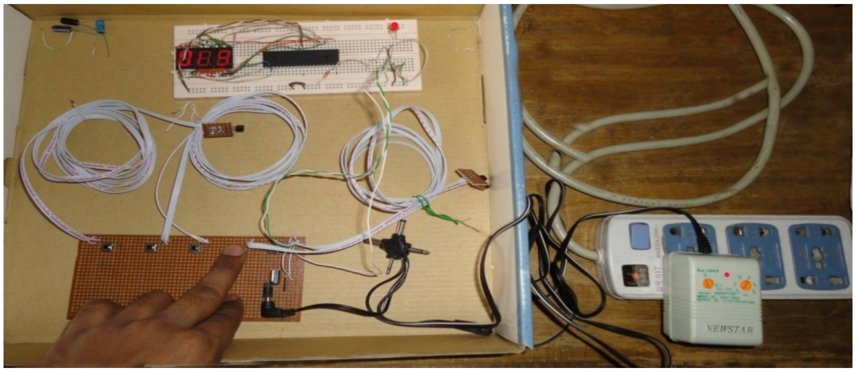


Figure 1: Multipoint Digital Temperature

2.1. Microcontroller

A microcontroller has a dedicated input device and often (but not always) has a small LED or LCD display for output. A microcontroller also takes input from the device it is controlling and controls the device by sending signals to different components in the device. A microcontroller is often small and low cost**.** The components are chosen to minimize size and to be as inexpensive as possible. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to control digital way even more devices and processes are available.

2.2 Segments display

7-Segments display is most widely used in displaying digits. There are mainly two types of 7-Segments display.

- Common anode
- Common cathode

We have used common anode 7-Segments display with our micro-controller. It has 10 legs and 8 of them are connected to MCU with resistors. By programming we can manipulate its digits.

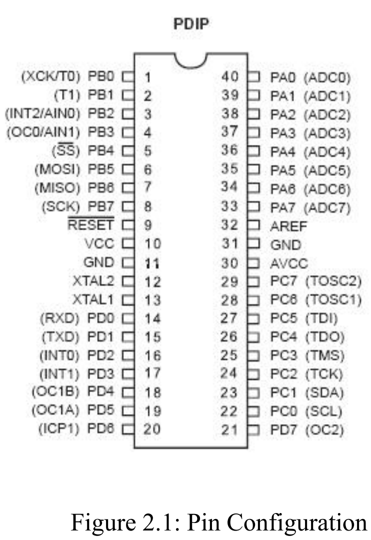


Figure 2.1: Pin Configuration

Figure 2.2: At mega 32

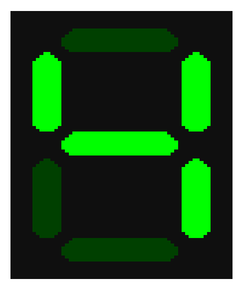


Figure 2.3: Segments

2.3 Temperature Sensors

There are two temperature sensors:

- **LM34** : calibrated in Fahrenheit
- **LM35** : calibrated in Celsius

These sensors have no moving parts, they are precise, never wear out, don't need calibration, work under many environmental conditions. They are very inexpensive and quite easy to use.

2.3.1 Temperature sensors (LM34)

The LM34 has an output of 10 mV/˚F with a typical nonlinearity of only ±0.35˚F over a −50 to +300˚F temperature range, and is accurate to within ±0.4˚F typically at room temperature(77˚F) [2]. The LM34's low output impedance and linear output characteristic make interfacing with readout or control circuitry easy. For instance, many monolithic temperature sensors have an output of only 1 µA/˚K. This leads to a1˚K error for only 1 µ-Ampere of leakage current. On the other hand, the LM34 may be operated as a current mode device providing 20 µA/˚F of output current.

Figure 3: LM-34 Sensors

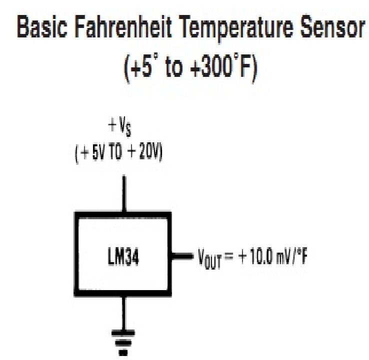


Figure 4: Fahrenheit temperature sensor

2.3.2 Fahrenheit temperature sensors

The LM34 is easy to use and may be operated with either single or dual supplies. Figure 4 shows a simple Fahrenheit temperature sensor using a single supply. The output in this configuration is limited to positive temperatures. The sensor can be used with a single supply over the full −50˚F to +300˚F temperature range, as seen in Figure 5, simply by adding a resistor from the output pin to ground, connecting two diodes in series between the GND pin and the circuit ground, and taking a differential reading [3]. This allows the LM34 to sink the necessary current required for negative temperatures. If dual supplies are available, the sensor may be used over the full temperature range by merely adding a pull-down resistor from the output to the negative supply as shown in Figure 6.

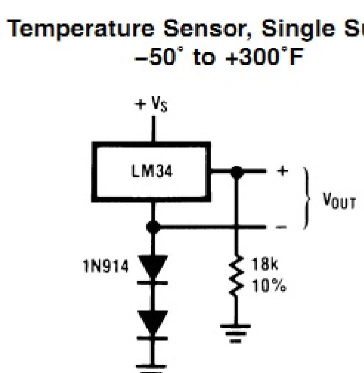


Figure 5: Temperature sensor single supply

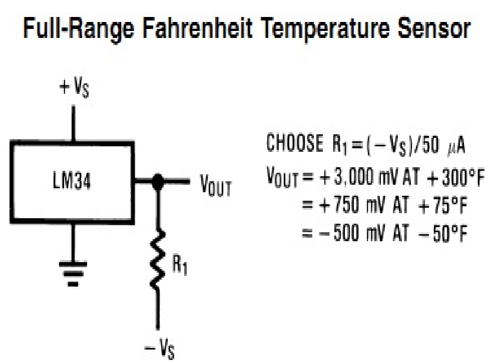
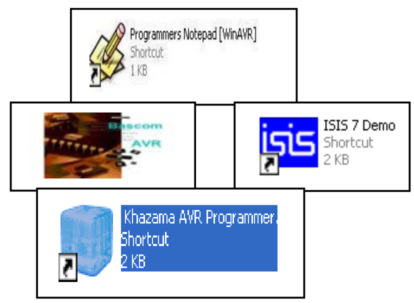


Figure 6: Temperature sensor full-range

2.4 Software used

- Win- AVR
- BASCOM-AVR
- Proteus 7 Demonstration
- 232 ANALYSER



For Burn Program

- Khazama AVR

2.5 Temperature to digital converters

For interfacing with digital systems, the output of the LM34 may be sent through an analog to digital converter (ADC) to provide either serial or parallel data outputs as shown in Figure 7 , circuits have a 0 to +128˚F scale. The scales are set by adjusting an external voltage reference to each ADC so that the full 8 bits of resolution will be applied over a reduced analog input range [4, 5]. The serial output ADC uses an LM385 micro power voltage reference diode to set its scale adjust (VREF pin) to 1.28V, while the parallel output ADC uses half of an LM358 low power dual amp configured as a voltage follower to set its VREF/2 pin to 0.64V. This circuit is operated with standard 5V supplies.

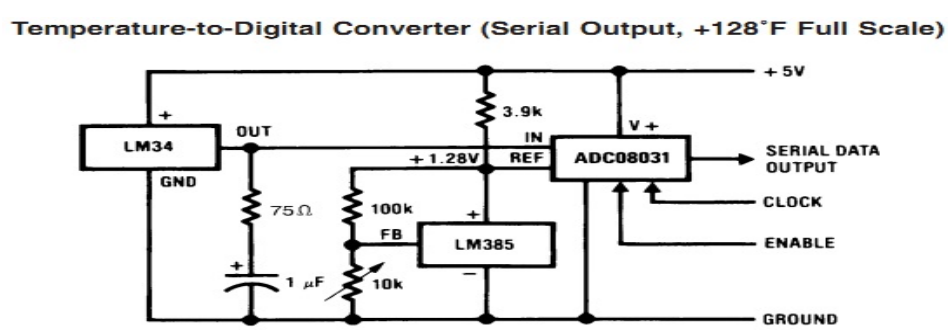


Figure 7: Temperature to digital converters

3. Circuit Diagram

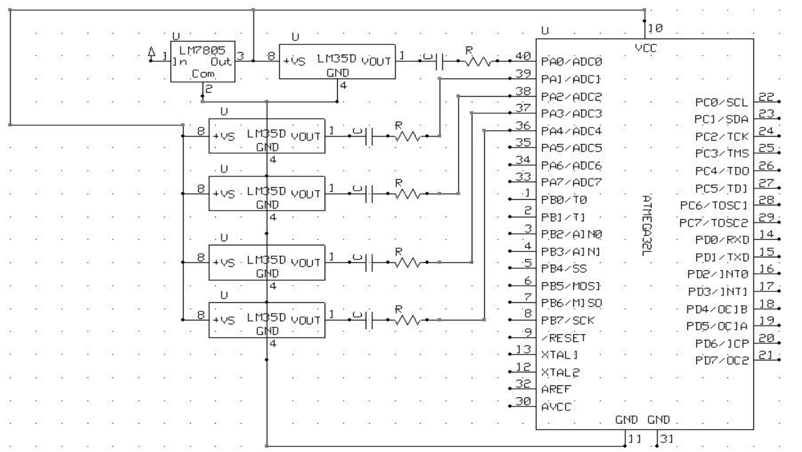


Figure 8: Circuit diagram

4. Calibration Data

Table 1: Calibration data

Observation No.	Calibrated Digital thermometer (^{0}c)	Thermometer reading (^{0}c)
01	30	34
02	34	36
03	39	41
04	43	44
05	45	47
06	47	50
07	50	53
08	53	55
09	57	59
10	58	63
11	61	65
12	63	66
13	65	67
14	68	69
15	70	72

5. Calibration Graph

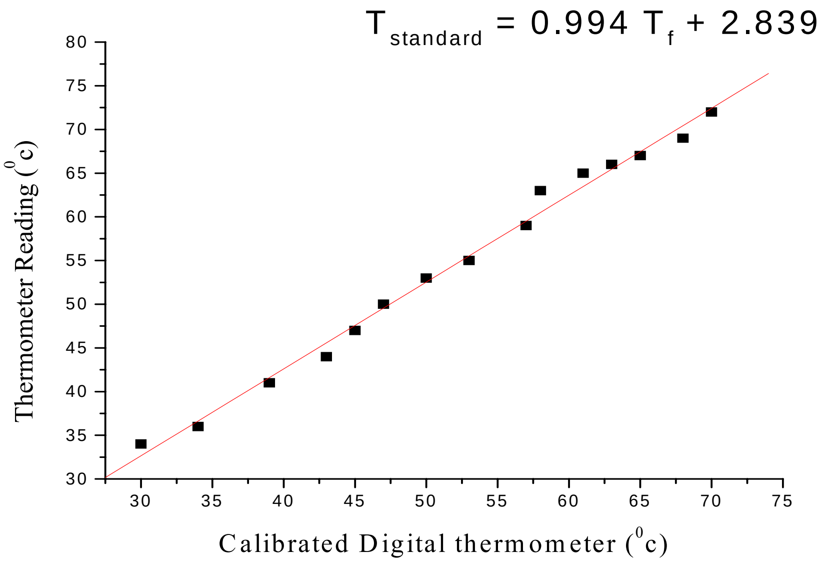


Figure 9: Calibration of Digital Thermometer against Standard Thermometer

6. Calibration Process

$T_{Standard} = A \times T_{Fabricate} + B$

$T_{Standard} = 0.994 \times T_{Fabricate} + 2.839$

The values of $T_{Standard}$ and $T_{Fabricate}$ which put in the program display at the above equation.

7. Conclusion

The device can measure temperature at five points at a time by five temperature sensor. In future development of our project can be done by the following ways- more than five temperature sensor can be used, instead of LM35 , another sensor LM34 can be used, instead of project board, the PCB board can be used, instead of 7 segment display, the display monitor can be used. If more than five temperature sensor and the display monitor are used then the cost will be high. If PCB board is used instead of project board more precision accuracy will be obtained.

- Temperature range (-20^0 c ~ 150^{0}c)
- Required Voltage (0 volt ~ 5 volt)

- Multipoint temperature and Small size & Cost comparative low.
- Surface contract & Point contract.
- Measuring temperature more accurately than a using a thermostat.
- The sensor circuitry is sealed and not subject to oxidation.
- The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.

Temperature measurement in-

- Duct system and any cold storage.
- Any kinds of Plate Temperature.
- Water Bath Temperature and Room Temperature.
- Solar Air and Water heater.

8. References

[1] R.A. Pease, "A Fahrenheit Temperature Sensor", pre-sented at the ISSCC Conference, February 24, 1984.

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[4] R.P. Benedict (1984) *Fundamentals of Temperature, Pressure, and Flow Measurements*, 3rd ed, ISBN 0-471-89383-8, chapter 11 "Calibration of Temperature Sensors".

[5] Gerard C.M. Meijer, "An IC Temperature Sensor with an Intrinsic Reference", IEEE Journal of Solid State Circuits, VOL SC-15, June 1980, pp. 370–373.