PORTLAND STATE UNIVERSITY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 411 - INDUSTRY DESIGN PROCESS

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Project Design Specification

Group #16:

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Executive Summary

Everyday medical, industrial, and home applications need a precise temperature controller. Our digital temperature controller is primarily used to control the temperature of any device whose temperature keeps fluctuating and requires a constant watch. This system can be used in any organization where it is very important to maintain specific temperatures. This system is better than analogue/ thermostat systems, which have poor accuracy. Its main use is for temperature control of an incubator where maintaining a precise temperature is very important.

The digital temperature controller provides the temperature information on a LCD display, and when the temperature exceeds the set point, the load (heater) switches off. For the purpose of our practicum project, a lamp will be used as a load for demonstration purpose. If time permits we would also add a fan to cool the device when the temperature exceeds the set limit. Therefore the system keep switching the lamp, and fan, on and off which automatically controls the temperature of the system.

The digital temperature controller uses a microcontroller from the 8051 family, which is the bulk of the application. The display unit consists of four seven segment display pins, and a temperature sensor (DS1621), which are interfaced to the microcontroller. The digital temperature sensor is interfaced to the microcontroller for sensing the temperature conditions. The system also provides four push buttons switches for adjusting, and setting, the temperature. The microcontroller then polls the temperature information through a digital temperature sensor and displays the seven segment display units. When the corresponding temperature exceeds the set point, the lamp automatically switches off.

The following are some examples of digital temperature controller using a microcontroller:

- Outdoor use involving potential chemical contamination or electrical interference.
- Outdoor use involving potential chemical contamination or electrical interference.
- Medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.
- HVAC control for industrial and residential applications.

Brief Market Analysis

While there are many uses for precision programmable temperature control units, home heating and cooling is a place where there is an available market, and a need for better more efficient thermostats. In a survey from the U.S. Energy Information Agency (EIA) it was found that while over 87%of homes were equipped with HVAC, only roughly 52% of them had programmable thermostats. There is plenty of competition in the market from industry giants such as General Electric, Honeywell, and Emerson who currently have many similar products available some even offering entire smart home systems.

Where there is room for growth in the market is in ease of use, customization, and peripherals. A few things that would make our product stand out from the rest would be: LCD touchscreens, data logging for predictive thermostat control,and RFID implementation for personalized thermostat settings from room to room.

Ideally there would be several models with the same basic TCU as the engine. The price would depend on if it was the base model or the more advanced models with more functions/peripherals. Similar products on the market range from $60 to $100 for a basic programmable thermostat, and up to $250 for the more advanced programmable models.

Requirements

Must

- Accurately detect temperatures from -55^0 C to $+125^0$ C in $\pm 0.5^0$ C increments within $\pm 2^0$ C
- Switch between heating and cooling modes within $\pm 1^0$ C
- Be user programmable (operating temperature)
- Be easy to use
- Run on 5V supply
- Use an AT89S52 micro-controller/ processing module which controls actuators based on sensors
- Use > 25% SMT components
- Have the processor on the PCB
- Have in circuit Programming capabilities
- Have one or more sensors (inputs: LM35 or DS1621, push buttons) [on daughter board]
- Have one or more actuators (outputs: 7 segment display, lamp, fan?) [on daughter board]
- Use a two or more layer PCB, with solder mask and at least a top-side silk screen
- Area between 9-900 cm^2, and a linear dimension between 2-30 cm

Should

- Be as small as possible
- Have an enclosure
- Have each component choice documented
- Output measured temperature to some interface for logging

Figure 1: *S11 Smith Chart measurement with a frequency sweep from 10 MHz to 10 GHz.*

May

- Include RFID programming
- Have an external enclosure that stays at a consistent temperature via the sensor, fan and bulb for proof of concept

System Architecture

The level 1 block diagram for our proposed design can be seen below.

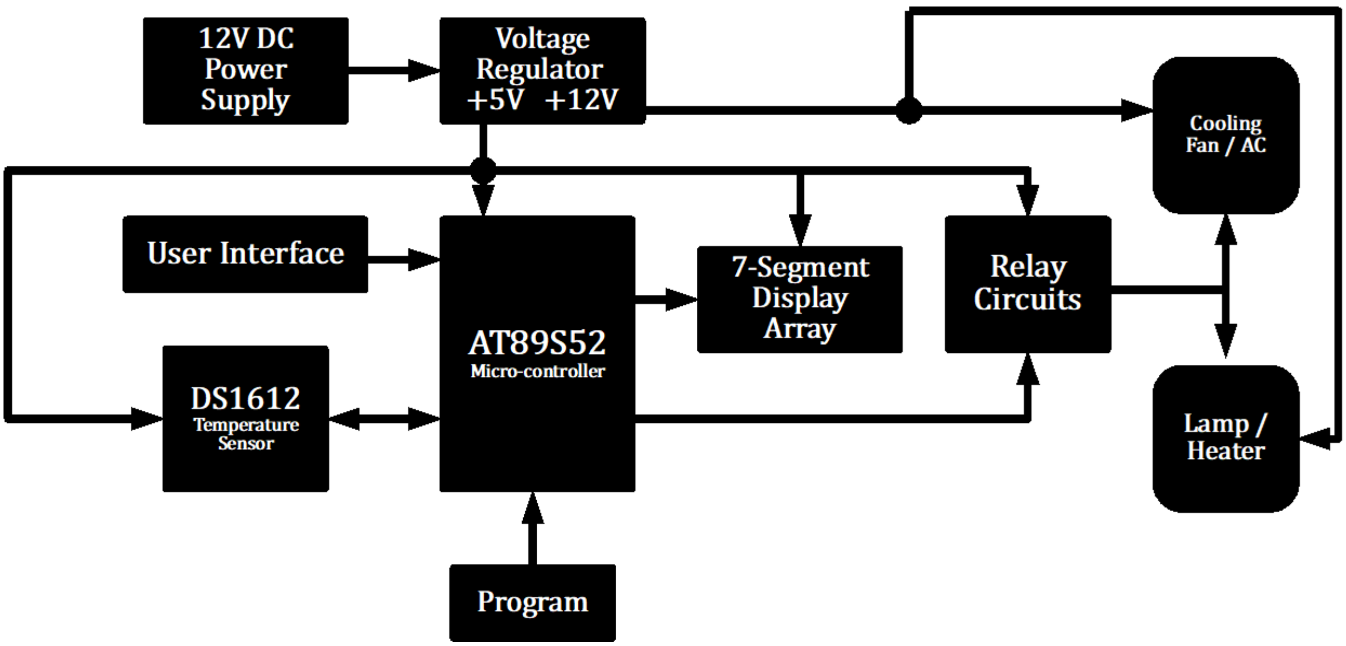

Figure 2: *Block diagram of digital temperature controller.*

Design Specifications

Sensors

- DS1621 Temperature Sensor.
- Push Buttons.

Actuators

- 7 Segment display pins
- Lamp and fan
- LEDs

Controller

- Micro-controller (AT89S52)

Additional

- Voltage regulator (LM 7805c)
- Transistors (2N2222)
- Resistors
- Capacitors