Thermostat Parts Selection

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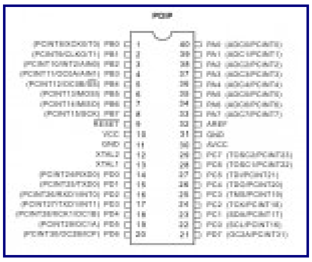
By definition, the digital thermostat design will consist of a wide variety of electronic components. Many of these parts will be used over and over again in various THAT modules. This post discusses the selection of parts which are (mostly) unique to the thermostat design.

Microcontroller



The microcontroller I've selected for this digital thermostat design is the 8-bit Atmel ATmega324P [Datasheet]. I selected the Atmel AVR family of microcontroller for this design for three main reasons: 1) The AVR family is powerful and affordable, 2) The AVR family is commonplace and widely used by hobbyists and professionals alike, 3) The AVR family has many open-source and low-cost development hardware and software options available for it.

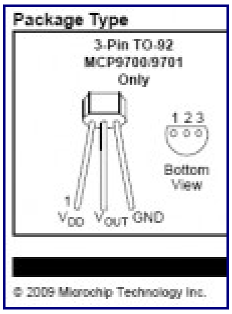
The choice to use the ATmega324 mainly comes down to the fact that the ATmega324 has a large number of I/O pins while boasting large memory sizes. Sister models are available with less and more memory; the ATmega164 and ATmega 644, respectively. Additionally, the ATmega164/324/644 have many peripherals onboard. The main features of the ATmega164/324/644 family are as follows:

- 16 / 32 / 64 kB of program memory
- 1 / 2 / 4 kB of RAM space
- 512 / 1000 / 2000 Bytes of non-volatile EEPROM space
- 8 MHz internal oscillator (supports up to 20 MHz clock)
- Operates from 1.8 to 5.5 Volts DC
- JTAG and In System Programming (ISP) interfaces
- Peripherals:
    - 8-channel, 10-bit Analog to Digital Converter
    - Analog Comparator
    - 2-wire serial bus (I2C)
    - 3-wire serial bus (SPI)
    - (2) Hardware serial UART ports
    - Watchdog timer
    - (2) 8-bit timers w/ 2 PWM outputs
    - 16-bit timer w/ 2 PWM outputs
    - Pin-change interrupts for every pin
    - Real Time Clock w/ separate oscillator

Sensors

This thermostat design will include both an on-board temperature sensor and an on-board humidity sensor. In the future, I'd like to see through the development of a "sub-module" for the thermostat which could directly interface to it to provide remote temperature and humidity readings.

Temperature Sensor:



The temperature sensor I have selected for this design is the Microchip MCP9700A analog sensor [Datasheet]. I chose an analog sensor because they are inexpensive and simple to use. In addition, the microcontroller I will be using has an integral Analog to Digital Converter (ADC), so there is no additional hardware needed there.

This analog sensor is only accurate to +/- 1 degrees Celsius at best (+/- 2 degrees C worst case), but will allow for a reasonable resolution when coupled with the microcontroller's 10-bit ADC.

The temperature sensor will operate in the range of -40 to 125 degrees C, which is a much wider range than my target operating range of about 0 to 45 degrees C. Lastly, the MCP9700A will operate happily from either the 3.3V or 5V power supply.

Humidity Sensor:

For the humidity sensing, I have selected the Honeywell HCH-1000 humidity sensor [Datasheet]. This sensor can measure 10 to 95% relative humidity within the temperatures range of -40 to 120 degrees C. It has about 2% linearity within its measuring range.

Additionally, the HCH-1000 is economically feasible and easy to interface to. The sensor is basically a humidity-dependent capacitor with nominal capacitance of 330pF. Reading of the sensor can easily be achieved with a single ADC-enabled microcontroller pin.The microcontroller pin will be set high for a very short, precise amount of time. This will charge the sensor (through a series resistor) with a constant current. Then, the pin will be switched to an input and the voltage will be immediately read by the ADC. The read voltage and charging time will then be used to compute the capacitance of the sensor, and thus the current relative humidity. The sensor will then be "discharged", and the measuring cycle will repeat.

User Interface

The physical user interface for the digital thermostat will consist of an LCD screen, 5 or 6 pusbutton switches, and 5 LEDs. The LEDs will be standard 3mm or 5mm "ultrabright" LEDs. The reason for using "ultrabight" LEDs is that, compared to standard LEDs, they will be more visible when driven at their rated forward current and more efficient when driven at reduced forward currents.

Switches:

The pushbutton switches that the user interacts with would eventually be moulded or injected plastic parts which use plungers to depress miniture PCB-mounted switches. I have chosen to use Omron B3F momentary pushbutton switches [Datasheet]. These switches are inexpensive, consume little circuit board space, and have reasonable life spans for this application.

LCD Screen:

My physical concept design for the digital thermostat module demands that the LCD screen is square and centered in the thermostat casing. However, I subsequently discovered that finding perfectly square LCD screens (especially inexpensive ones) is difficult.

I eventually decided on using a nice Chip-On-Glass style LCD screen from Newhaven Display International. The model is NHD-C128128BZ-FSW-GBW [Datasheet]. This LCD module contains a 128×128 pixel display with a white LED backlight. The display's active area is about 56mm x 56mm and the overall module is 71.3mm x 75.41mm.

I chose this display because it was one of the only economically-
feasible displays that was both square and in the size range I was looking for. Additionally the screen has nice features such as a selectable 8-bit parallel or 3 or 4-wire serial interfaces, and the ability to display 16 shades of gray.

The connectivity for the LCD interface is a 30-pin, 0.5mm pitch ribbon cable. To make working with the display easier, I've purchased a breakout board from Newhaven Displays (part NHD-FFC30) which converts the (surface-mount) ribbon connector to pads for a standard, 2.54mm pitch pin header.