HW1 Calibrated Temperature

Johns Hopkins University

Real Time Software for Embedded Systems

Fall 2014

Tony Florida

2014-09-16

Requirements

Hardware

- The temperature sensor shall be connected to an Arduino microcontroller circuit

Software

- The software running on the Arduino shall use a Round Robin design
- The software shall capture the temperature to $1/10^{th}$ of a degree
- The software shall wait to record temperature until the temperature has stabilized
- The software shall record temperature at a rate of 10 seconds

Test

- The test should begin at room temperature for 5 minutes, then record in a refrigerator for 5 minutes, then record room temperature for 5 minutes
- The deliverable should be a plot of temperature vs time

Parts List

- (1) Arduino Uno
- (2) 2.2k resistors
- (1) DS18B20 Temperature Sensor
- (5) hobby wires of length 3” or greater
- (1) USB 2.0 A/B cable
- (1) breadboard

Required Software

- Arduino Sketch v1.0
- Microsoft Excel 2010

Architecture

Hardware

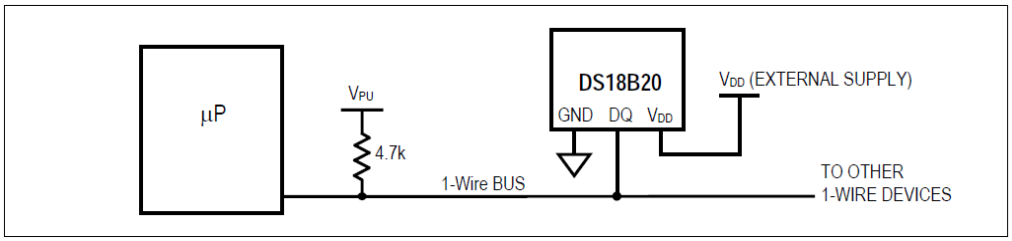


Figure 1 - Circuit Schematic [1]

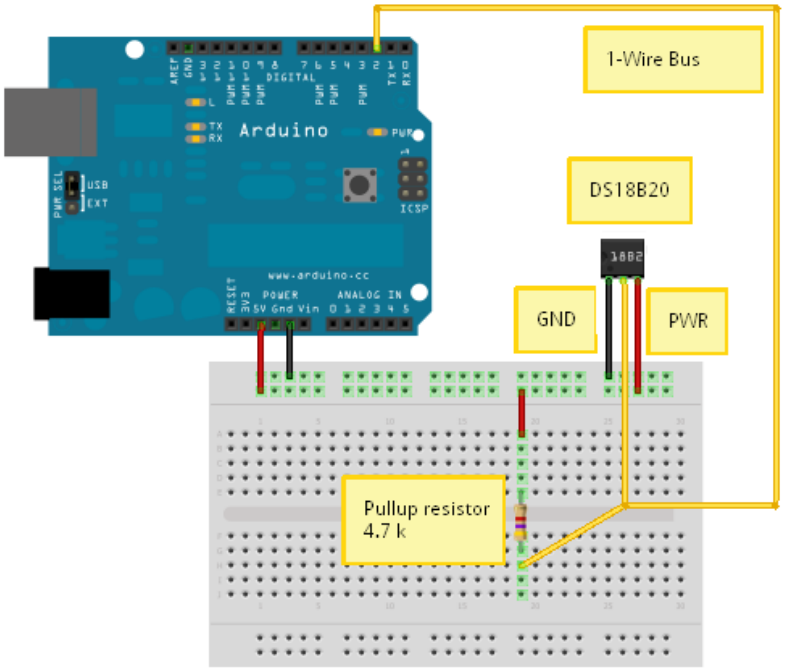


Figure 2 – Physical Schematic [1]

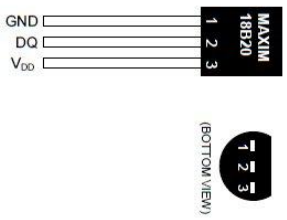


Figure 3 - Temperature Sensor

Software

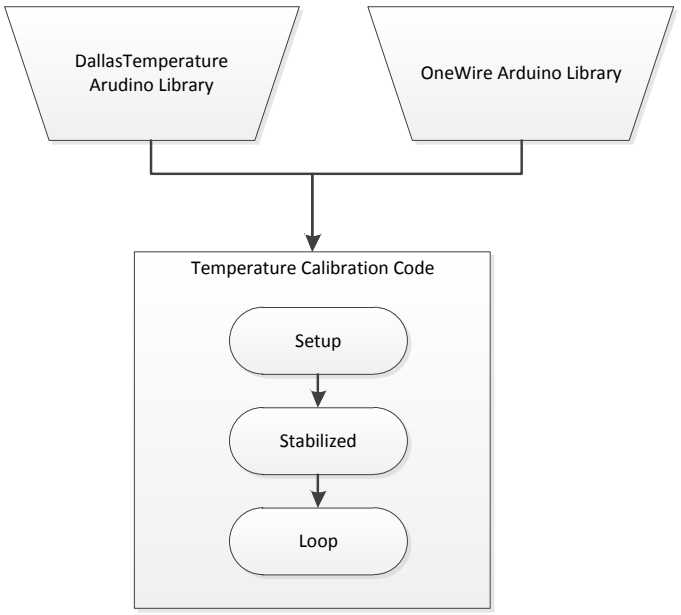


Figure 4 - Software Architecture Diagram

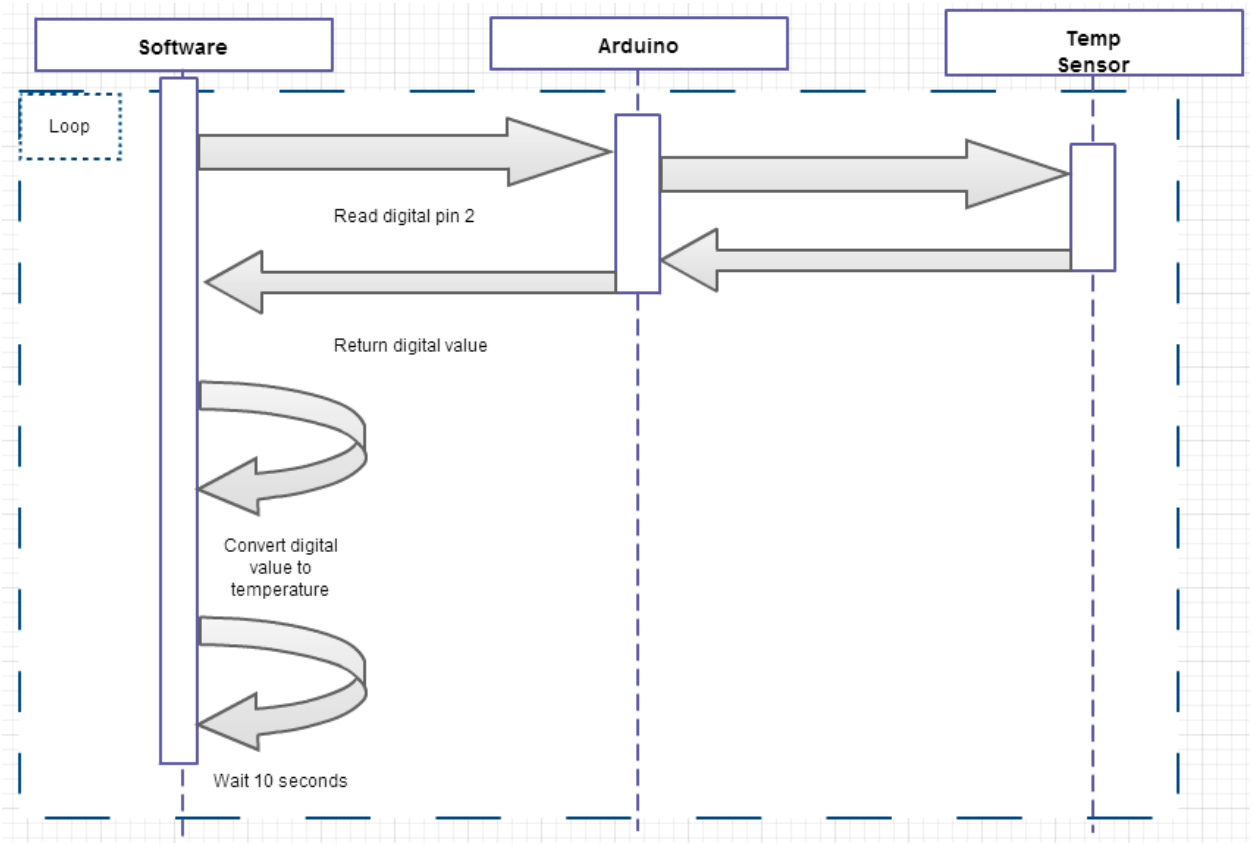


Figure 5 - Hardware/Software Sequence Diagram

Design

Software

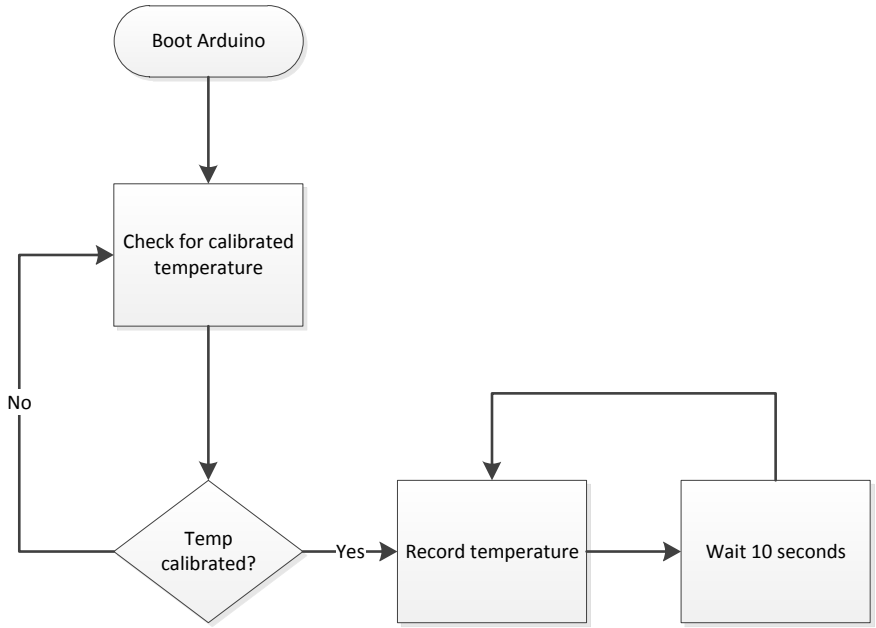


Photo of the Hardware

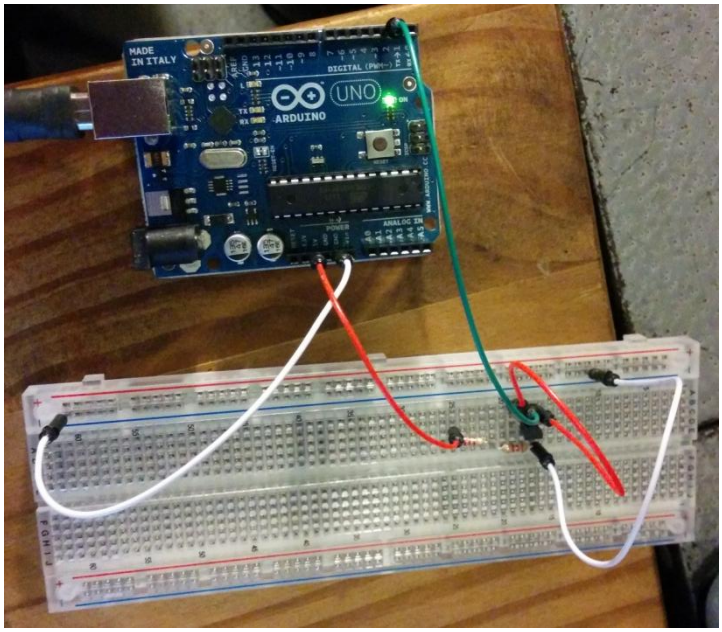


Figure 6 - Photo of the hardware in action

Implementation

```
#include <OneWire.h>
#include <DallasTemperature.h>

//JHU RTSW HW 1 - Calibrated Temperature
//Tony Florida
//2014-09-17
//References: http://www.hobbytronics.co.uk/ds18b20-arduino

// Data wire is plugged into pin 2 on the Arduino
#define ONE_WIRE_BUS 2

// Setup a oneWire instance to communicate with any OneWire devices
// (not just Maxim/Dallas temperature ICs)
OneWire oneWire(ONE_WIRE_BUS);

// Pass our oneWire reference to Dallas Temperature.
DallasTemperature sensors(&oneWire);

void setup(void)
{
  // start serial port
  Serial.begin(9600);
  Serial.println("JHU RTSW HW1");
  Serial.println("Tony Florida");
  Serial.println("2014-09-17");

  // Start up the library
  sensors.begin();
}

//remember the most recent temperatures
int ARRAY_LEN = 5;
int recent_temperatures[] = {0.0, 0.0, 0.0, 0.0, 0.0};
int index = 0; //index into temperature array
boolean temp_stabilized = false; //remember once the temp has stablilize

//function to check if the temperature has stabilized
boolean stabilized()
{
  //get the first
  double temp = recent_temperatures[0];
  for(int i = 1; i < ARRAY_LEN; i++)
  {
    if(recent_temperatures[i] != temp)
    {
      return false;
    }
  }
  temp_stabilized = true;
  return true;
}

//convert celsius to fahrenheit
double convert2fahrenheit(double celsius)
```

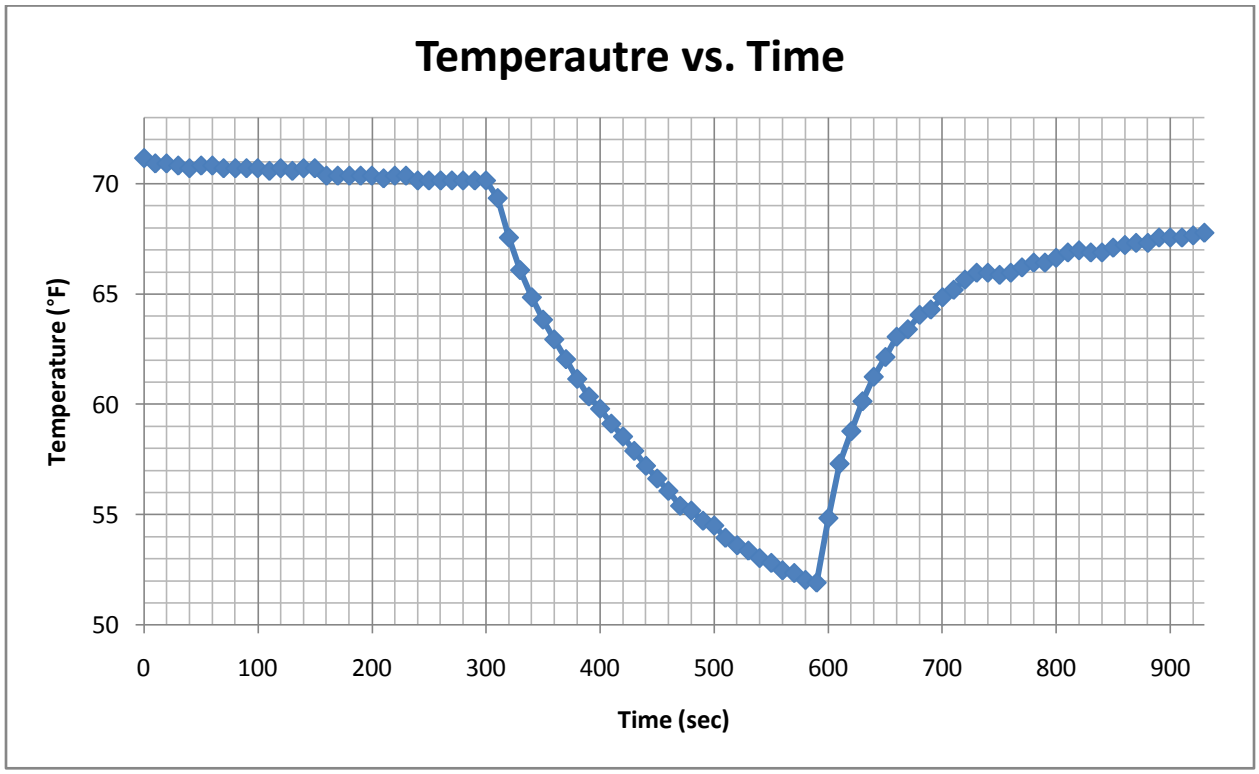
```
{
  return (celsius * 1.8) + 32;
}

//main round robin loop
void loop(void)
{
  // call sensors.requestTemperatures() to issue a global temperature
  sensors.requestTemperatures();

  double temp = sensors.getTempCByIndex(0);

  //wait until the temperature stabilizes
  if(!temp_stabilized)
  {
    //keep index between 0 and 5
    index++;
    if(index > ARRAY_LEN)
    {
      index = 0;
    }

    //save the temperature into the array
    recent_temperatures[index] = temp;

    //check stabilization
    stabilized();

    Serial.println("Waiting for temperature to stabilize...");
  }
  else
  {
    Serial.print("Temperature is: ");
    // 0 refers to the first IC on the wire
    Serial.println(convert2fahrenheit(temp));

    delay(10000); //delay 10 seconds
  }
}
```

Results

Log

JHU RTSW HW1
Tony Florida
2014-09-17
Waiting for temperature to stabilize...
Waiting for temperature to stabilize...
Waiting for temperature to stabilize...
Waiting for temperature to stabilize...
Waiting for temperature to stabilize...
Waiting for temperature to stabilize...
Temperature is: 71.15
Temperature is: 70.93
Temperature is: 70.93
Temperature is: 70.81
Temperature is: 70.70
Temperature is: 70.81
Temperature is: 70.81
Temperature is: 70.70
Temperature is: 70.70
Temperature is: 70.70
Temperature is: 70.70
Temperature is: 70.59
Temperature is: 70.70
Temperature is: 70.59
Temperature is: 70.70
Temperature is: 70.70
Temperature is: 70.36
Temperature is: 70.36
Temperature is: 70.36
Temperature is: 70.36
Temperature is: 70.36
Temperature is: 70.25
Temperature is: 70.36
Temperature is: 70.36
Temperature is: 70.14
Temperature is: 70.14
Temperature is: 70.14
Temperature is: 70.14
Temperature is: 70.14
Temperature is: 70.14
Temperature is: 70.14
Temperature is: 69.35
Temperature is: 67.55
Temperature is: 66.09
Temperature is: 64.85
Temperature is: 63.84
Temperature is: 62.94
Temperature is: 62.04
Temperature is: 61.14
Temperature is: 60.35
Temperature is: 59.79
Temperature is: 59.11
Temperature is: 58.55
Temperature is: 57.88
Temperature is: 57.20
Temperature is: 56.64
Temperature is: 56.07
Temperature is: 55.40
Temperature is: 55.18
Temperature is: 54.72
Temperature is: 54.50
Temperature is: 53.94
Temperature is: 53.60
Temperature is: 53.38
Temperature is: 53.04
Temperature is: 52.81
Temperature is: 52.47
Temperature is: 52.36
Temperature is: 52.03
Temperature is: 51.91
Temperature is: 54.84
Temperature is: 57.31
Temperature is: 58.78
Temperature is: 60.13
Temperature is: 61.25
Temperature is: 62.15
Temperature is: 63.05
Temperature is: 63.39
Temperature is: 64.06
Temperature is: 64.29
Temperature is: 64.85
Temperature is: 65.19
Temperature is: 65.64
Temperature is: 65.97
Temperature is: 65.97
Temperature is: 65.86
Temperature is: 65.97
Temperature is: 66.20
Temperature is: 66.43
Temperature is: 66.43
Temperature is: 66.65
Temperature is: 66.87
Temperature is: 66.99
Temperature is: 66.87
Temperature is: 66.87
Temperature is: 67.10
Temperature is: 67.21
Temperature is: 67.32
Temperature is: 67.32
Temperature is: 67.55
Temperature is: 67.55
Temperature is: 67.55
Temperature is: 67.66
Temperature is: 67.77

Plot



Video Presentation

https://www.youtube.com/watch?v=xrLxqQUe-Ro

References

[1] http://tushev.org/articles/arduino/item/52-how-it-works-ds18b20-and-arduino

[2] http://www.hobbytronics.co.uk/ds18b20-arduino