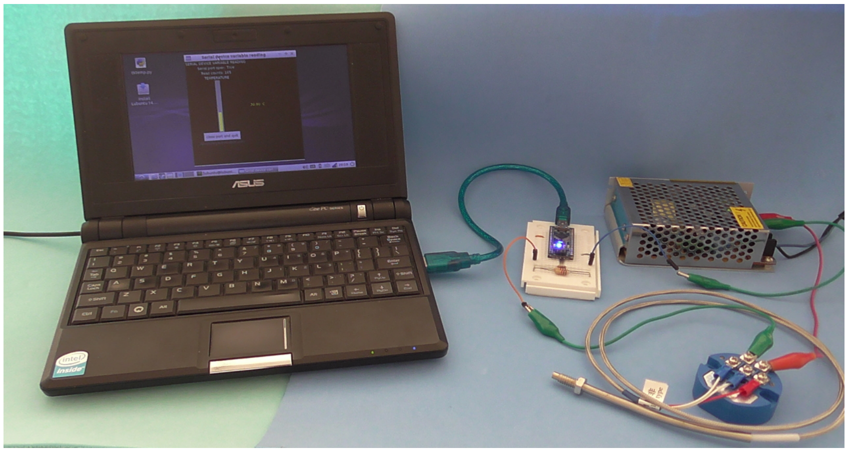
TEMPERATURE MEASUREMENT
RTD PT100, 4-20 mA TRANSMITTER,
ARDUINO



RTD

In the industrial world where broad temperature ranges and harsh working environment are predominant, the use of Thermocouples and RTDs are very common. All of them have their respective pros and cons, (there isn't an absolute winner) the final application and working conditions are who decide which one is better in every specific case.

An RTD is a thin filament, usually made of Platinum, whose resistance varies in a very way related to the temperature applied. One of the winning points of a RTDs is their high linearity across the entire working range (-200 to 850 C) and its stability over time. The most common type is the PT100, which shows a 100 Ohm resistance at 0 C

PT100 to 4 -20 mA TRANSMITTERS

knowing the temperature applied on an RTD based on its resistance is a little complex task, because the variation of the resistance is in the tenths of ohms for every Celsius degree. Precision circuits are required, like Wheatstone bridge. The main pitfall in the industrial world, is that usually the temperature measurement place (process) is very far away from measurement and control equipment cabinets. To cover this distance, very long wires are required, which resistance can affect the temperature measurement

To solve this problem, there is an old known in the industrial world: 4-20 mA temperature transmitter. This encloses all the precision electronics needed to interface the RTD and is placed as close as possible to it. This device automatically adjusts the wire resistance using the third terminal.

The transmitter "translates" signals from temperature sensor to current signals from 4 to 20 mA. A current signal can be sent over very long wires without signal disturbance due to wire resistance.

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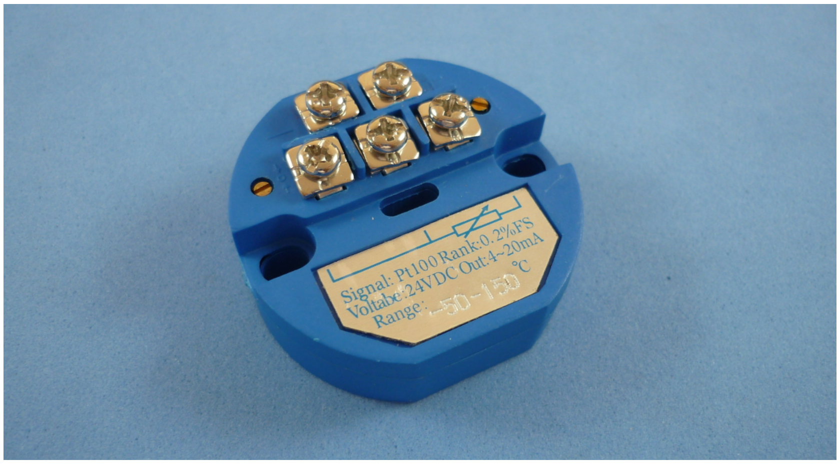
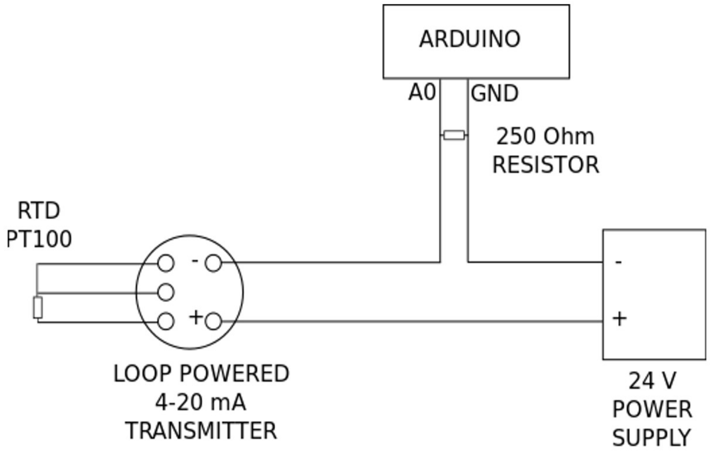


PT100, ARDUINO, 4-20 mA

A metal sheathed RTD probe was used and a 4-20 mA transmitter spanning from -50 to 150 C. To convert the current signal into voltage signal a 250 Ohm resistor was used in the ADC pin of the Arduino. When the signal is 4mA there will be 1V at the ADC and when the signal is 20mA there will be 5V at the ADC. To power the loop a 24V DC power supply was used..

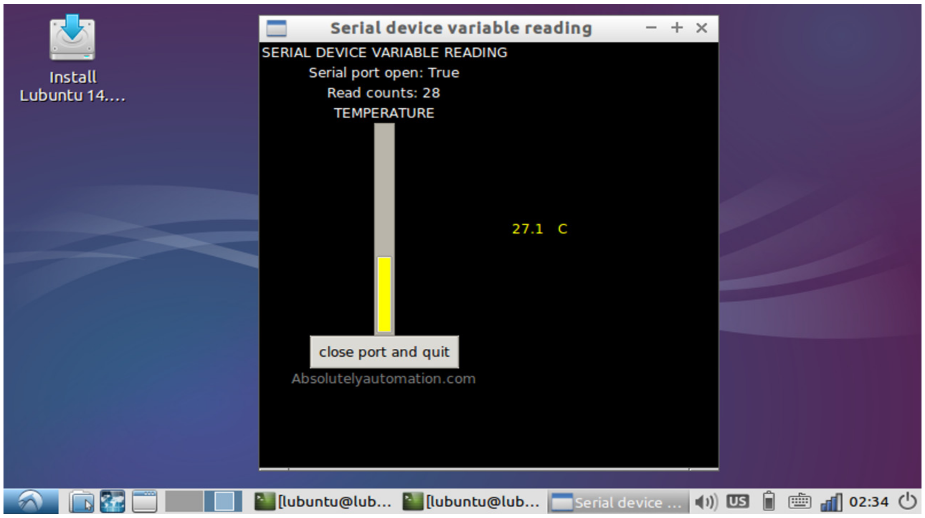
To convert voltage signals into temperature, the Arduino app does a mapping with min and max signal values. In this case -50 C is 1V, or in ADC read is 205. For 150 C the ADC reading is 1023

The Arduino app listens for a byte in the serial port, and then answers with a temperature measurement in ASCII format, so it can be visualized in a serial port terminal application



PYTHON, TKINTER

A small visual application was programmed using Python and TkInter, based on the Andreas Boesh example. This app has an independent thread to manage serial port tasks (send a byte, wait and read the temperature from Arduino) and other task related to GUI things, like update values, move progress bar, etc. To run it python serial and python tk packages are required.



Test and conclusions

Right after the application was started, ambient temperature was displayed (well surrounding stuff temperature: computer, lamps, etc.). Next the RTD was immersed in very hot water. After a minute or so the sensor is showing a temperature a few Celsius degrees below boiling point.

For the last test, a mug with a block of ice (with an orifice for the sensor) was used. After a few minutes the temperature stabilizes near water icing point.

Generally speaking RTDs give very precise measurements, however, they have a kind of slow response to temperature changes, and last but not less important, the accuracy in the measurement relies heavily on how good calibrated is the 4-20 mA transmitter, and the precision of the measuring resistor.

LINKS

Video: Connecting parts and tests: **https://youtu.be/ZKj12hfqrZQ**
RTD PT100 3 wire -50 a +150 C 4-20 mA temperature transmitter: **http://www.dx.com/es/p/zndiy-bry-sbwz-rtd-pt100-50-150-c-dc-24v-20ma-temperature-sensor-transmitter-module-deep-blue-369581?Utm_rid=24981582&Utm_source=affiliate**
Metal sheathed 3 wire RTD PT100: **http://s.click.aliexpress.com/e/maEYFuN3z**
24V DC Power Supply: **http://www.dx.com/es/p/24v-2a-48w-constant-voltage-switching-power-supply-for-led-395226?Utm_rid=24981582&Utm_source=affiliate**

ARDUINO PROGRAM

```
/*
 2016-FEB-09
 Application for reading a 4 - 20 mA current signal
 over a 250 Ohm resistor on voltage analog input pins
 this gives voltage readings from 1 to 5 volts.

 The current signal represents a temperature between -50 to +150 C
 from a PT100 connected to a 4-20 mA current transmitter

 current    voltage(250 Ohm)   ADC    Temperature
 -------------------------------------------------------
 4  mA       1 V             205    -50  C
 20 mA       5 V             1023   +150 C

 The temperature value obtained is sent over serial port in ASCII format
 every time a byte is received. (On demand)

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 */

const int AnalogInput = A0;  // Analog input where the resistor is placed


int   sensorValue = 0;
int   temperature = 0;
int   ReceivedByte = 0;
float f1 = 0;
float t1 = 0;



void setup() {
  // inicializa comunicacion serial a 9600 bps:
  Serial.begin(9600);
}

void loop() {

  // Wait until a byte is received
  // (On demand send)
  if(Serial.available() > 0){
    ReceivedByte = Serial.read();

    // Reading ADC
    sensorValue = analogRead(AnalogInput);

    // map the signals (multiplied by 10
    // to get decimal values, because map() doesn't work with floats)
    temperature=map(sensorValue,205,1023,-500,1500);

    f1 = temperature;  // Float conversion
```

```
    t1 = f1/10.0;      // dividing by 10
                   // with one decimal value

    // Printing temperature value over serial port
    Serial.print(t1);
    Serial.print("\n");

  }


}
```

PYTHON TKINTER PROGRAM

```
# Absolutelyautomation.com, 02/2016
# based on Andreas Boesch, 04/2013 code
# Display numeric values (sent as strings) from an external device
# The applications sent a buyte to the device and display the response as text also as a bar

# import packages
import Tkinter as tk    # for the GUI
import ttk                                  # for nicer GUI widgets
import tkMessageBox             # for GUI testbox
import serial                   # for communication with serial port
import time                     # for time stuff
import threading                # for parallel computing

 # A thread that continously request the status of the MWG
class myThread (threading.Thread):
   # initialize class
   def __init__(self, name, ser):
      threading.Thread.__init__(self)
      # Name of thread
      self.name = name
      # Serial port information
      self.ser  = ser
             # the received string
             self.rcvstr=''
             # printable string
             self.prnstr=''

   # gets called when thread is started with .start()
   def run(self):
      # counter of the while loop
      self.update_count = 0
      while self.ser.isOpen():

                    # increase counter ...
                    self.update_count += 1
                    # ... and set variable for label shown on the GUI
                    readCount.set("Read counts: "+str(self.update_count))

                    # for all request commands, send command

                    try:
                            # send command
                            self.ser.write("a")
                            # wait for Device to answer
                            time.sleep(0.1)
                            # create string for the answer
                            rcvstr = ''
                            # as long as an answer byte is waiting, read the byte
                            while self.ser.inWaiting() > 0:
                                    self.rcvstr= self.ser.read(self.ser.inWaiting())
                    except:
                                    # do nothing if command could not be send
                            pass

                    # set the label variables with the answers received
```

```
                        self.prnstr=self.rcvstr.rstrip('\n')
                        self.prnstr = self.prnstr +"  C"

                        #print self.prnstr
                        labelVar.set(self.prnstr)


                        try:
                                valueVar.set(float(self.rcvstr)+ offsetBar )
                        except:
                                # Do nothing in case the convertion fails due to a strange formatted string
                                pass

                        # Device interval polling time
                        time.sleep(0.5)



# an exit procedure
def mQuit():
    # ask yes/no question to confirm exit
    mExit = tkMessageBox.askyesno(title = "Quit", message = "Do you really want to quit?")
    if mExit > 0:
        # close port
        ser.close()
        # detsroy GUI
        root.destroy()
        return

# sending commands to the serial device
def mSend(command):
    try:
        ser.write(command)
    except:
        print "Could not send command. Port closed?"

    return



# ===========================
# Begin of the main program
# ===========================

# provide information for serial port
ser = serial.Serial()

# modify according to needs
ser.port = '/dev/ttyUSB0'
#ser.port = 'COM6'

ser.baudrate = 9600
ser.timeout = 0
# open port if not already open
if ser.isOpen() == False:
    ser.open()

# set up root window
root = tk.Tk()
root.configure(background='black')
root.geometry("400x400")
root.title("Serial device variable reading ")

# variables
labelVar                = tk.StringVar()
readCount               = tk.StringVar()
valueVar                = tk.DoubleVar()

# modify according to needs
maxBar                  = 150.0
minBar                  = -50.0
```

```
rangeBar                = tk.DoubleVar()
offsetBar               = tk.DoubleVar()

# Text, titles

headerTitle                     = ttk.Label(root, text = "SERIAL DEVICE VARIABLE READING",
foreground="white",background="black").grid(row=0, column=1)
headerPort                      = ttk.Label(root, text = "Serial port open: "+str(ser.isOpen()), foreground="white",background="black").grid
(row=1, column=1)
headerVarname           = ttk.Label(root, text = "TEMPERATURE", foreground="white",background="black").grid(row=3, column=1)
headerCounts                    = ttk.Label(root,textvariable = readCount, foreground="white",background="black").grid(row=2,column=1)
headerVarvalue          = ttk.Label(root, textvariable = labelVar, foreground="yellow", background="black" ).grid(row=5, column=2)
headerFooter                    = ttk.Label(root, text = "Absolutelyautomation.com", foreground="grey",background="black").grid(row=7,
column=1)

# Quit button

buttonQuit              = ttk.Button(root, text = "close port and quit", command = mQuit).grid(row=6, column=1)

#Progressbar

if maxBar > 0.0 and minBar >= 0.0 :
        rangeBar = maxBar - minBar
        offsetBar = (-1) * minBar

if maxBar > 0.0 and minBar < 0.0 :
        rangeBar = maxBar  +abs(minBar)
        offsetBar = abs(minBar)

if maxBar < 0.0 and minBar < 0.0 :
        rangeBar = abs(minBar) - abs(maxBar)
        offsetBar = abs(minBar)

s = ttk.Style()
s.theme_use('clam')
s.configure("yellow.Vertical.TProgressbar", foreground='yellow', background='yellow')
progBar =  ttk.Progressbar(root, orient="vertical",length=200,
mode="determinate",maximum=rangeBar,variable=valueVar,style="yellow.Vertical.TProgressbar" ).grid(row=5,column=1)


# wait
time.sleep(1)
# call and start update-thread
thread1 = myThread("Updating", ser)
thread1.start()

# start GUI
root.mainloop()
```