https://www.halvorsen.blog

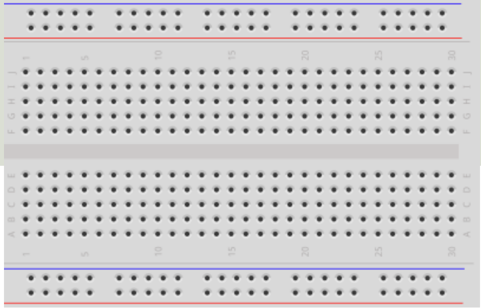
Thermistor Temperature Sensor in LabVIEW

Hans-Petter Halvorsen

Contents

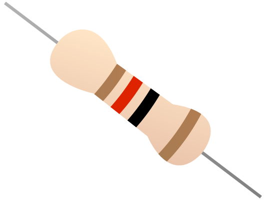
- We will use LabVIEW to read Temperature data from a Thermistor Temperature Sensor
- We will use a USB-6008 DAQ Device or I/O Module

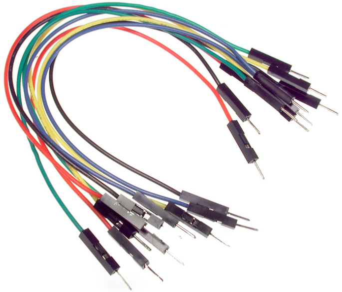
Hardware



- DAQ Device (e.g., USB-6008)
- Breadboard

- Thermistor 10K (Temperature Sensor)
- Wires (Jumper Wires)
- Resistor 10 kΩ





Software

- LabVIEW
  - Graphical Programing Environment
- DAQmx Driver
  - Driver used for Communication with external Hardware such as USB-6008

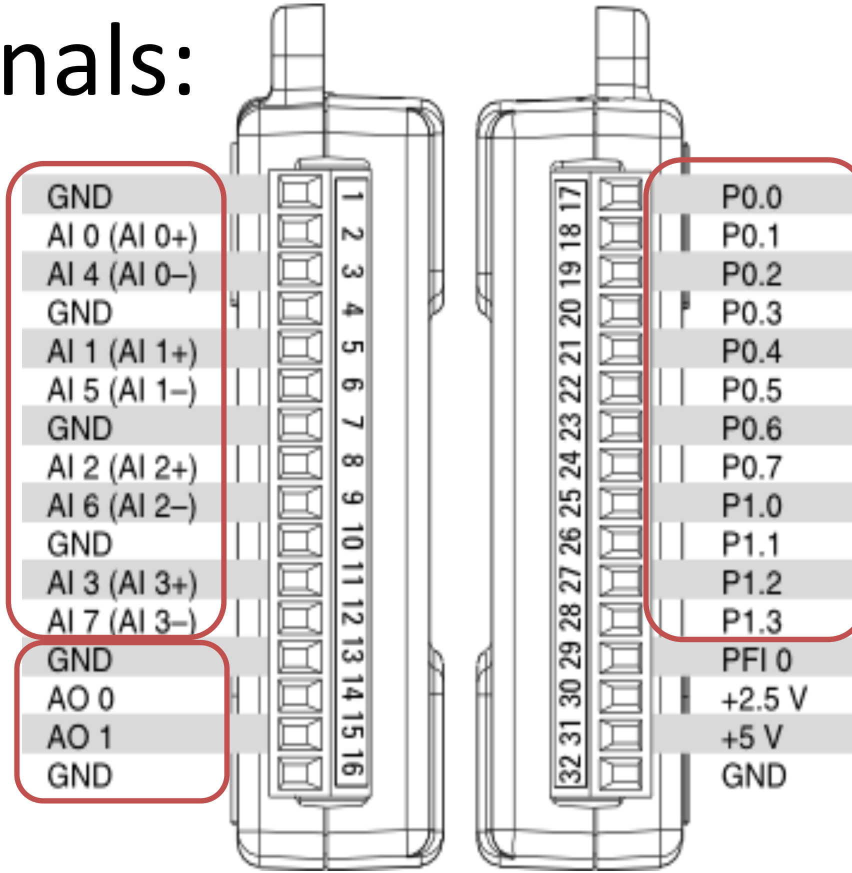
USB-6008

- USB-6008 is a DAQ Device from NI
- Can be used within LabVIEW
- NI-DAQmx Driver
- It has Analog and Digital Inputs and Outputs

USB-6008

4 different types of Signals:

- AO – Analog Output
- AI – Analog Input
- DO – Digital Output
- DI – Digital Input



Thermistor

A thermistor is an electronic component that changes resistance to temperature - so-called Resistance Temperature Detectors (RTD). It is often used as a temperature sensor.

Our Thermistor is a so-called NTC (Negative Temperature Coefficient). In a NTC Thermistor, resistance decreases as the temperature rises.

There is a **non-linear relationship** between resistance and excitement. To find the temperature we can use the following equation (**Steinhart-Hart equation**):

[Wikipedia]

$$\frac{1}{T} = A + B\ln(R) + C(\ln(R))^3$$

where A, B, C are constants given below

$A = 0.001129148, B = 0.000234125 \; and \; C = 8.76741E-08$

Steinhart-Hart Equation

To find the Temperature we can use Steinhart-Hart Equation:

$$\frac{1}{T_K} = A + B\ln(R) + C(\ln(R))^3$$

This gives:

$$T_K = \frac{1}{A + B\ln(R) + C(\ln(R))^3}$$

Where the Temperature T_K is in Kelvin

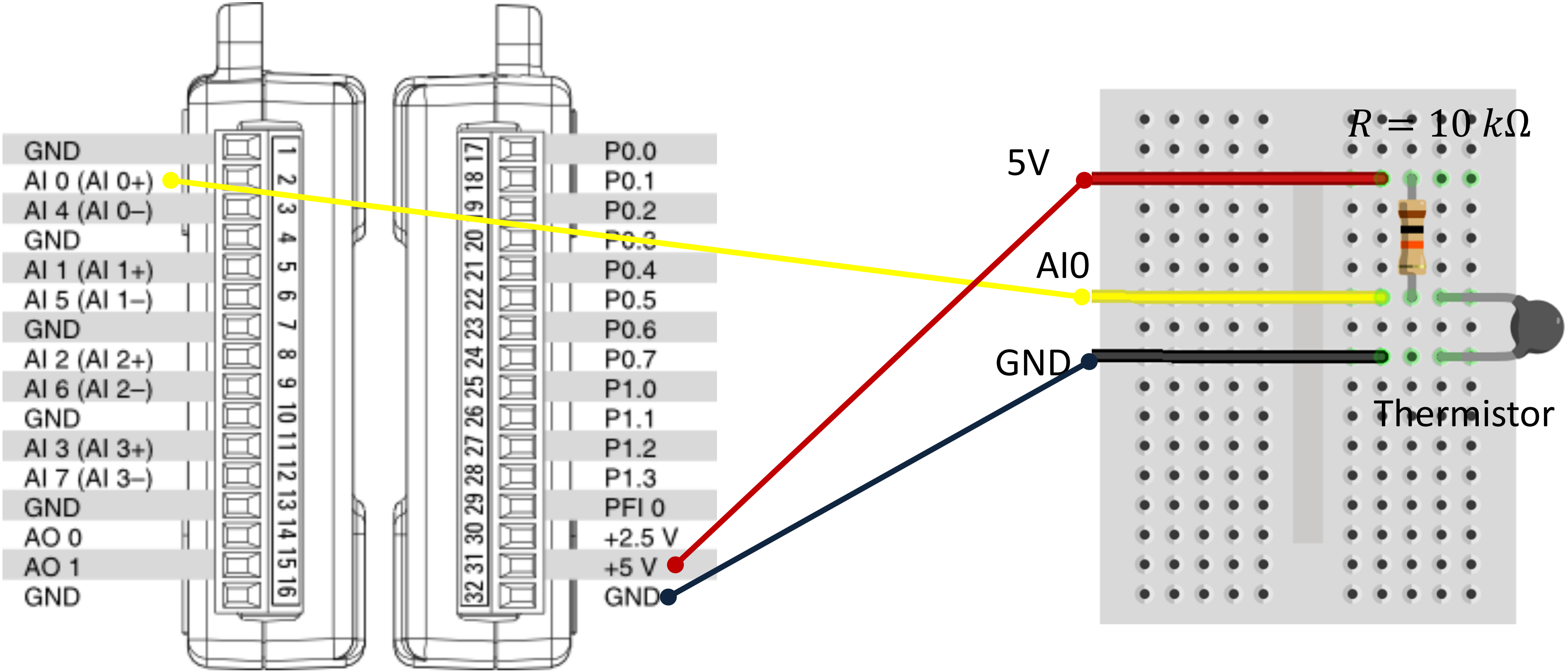
A, B *and* C are constants

$$A = 0.001129148$$
$$B = 0.000234125$$
$$C = 0.0000000876741$$

The Temperature in degrees Celsius will then be:

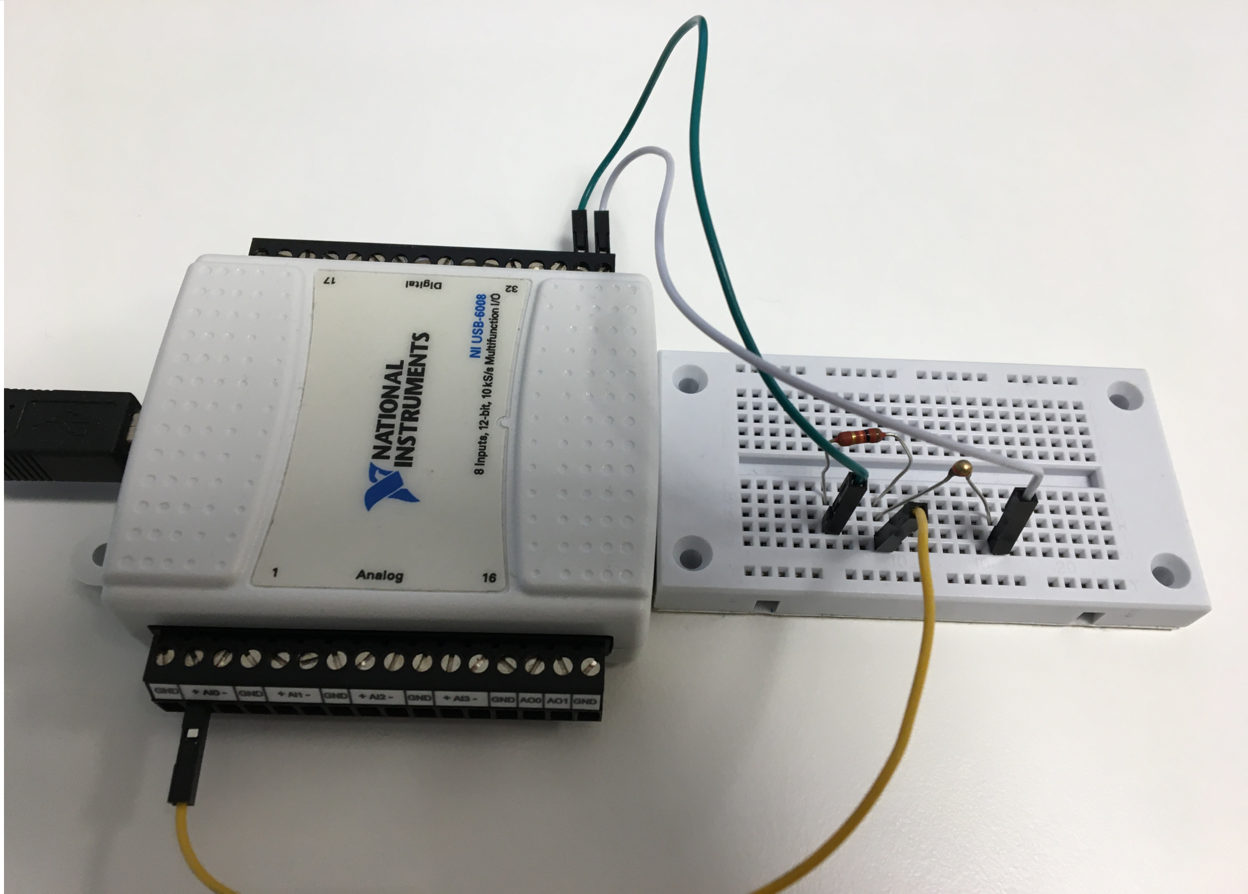
$$T_C = T_K - 273.15$$

Wiring



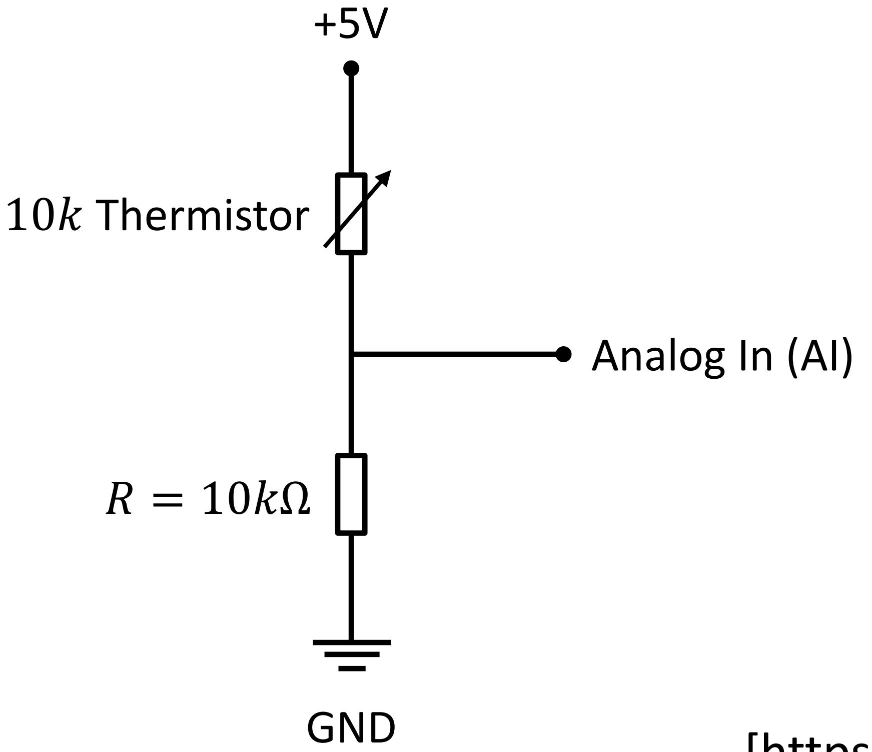
GND
AI 0 (AI 0+)
AI 4 (AI 0–)
GND
AI 1 (AI 1+)
AI 5 (AI 1–)
GND
AI 2 (AI 2+)
AI 6 (AI 2–)
GND
AI 3 (AI 3+)
AI 7 (AI 3–)
GND
AO 0
AO 1
GND
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P1.0
P1.1
P1.2
P1.3
PFI 0
+2.5 V
+5 V
GND
5V
AI0
GND
$R = 10\ k\Omega$
Thermistor

Wiring


NATIONAL INSTRUMENTS
NI USB-6008
8 Inputs, 12-bit, 10 kS/s Multifunction I/O
Digital
17
32
Analog
1
16
GND
+ AI0 -
GND
+ AI1 -
GND
+ AI2 -
GND
+ AI3 -
GND
AO0
AO1
GND

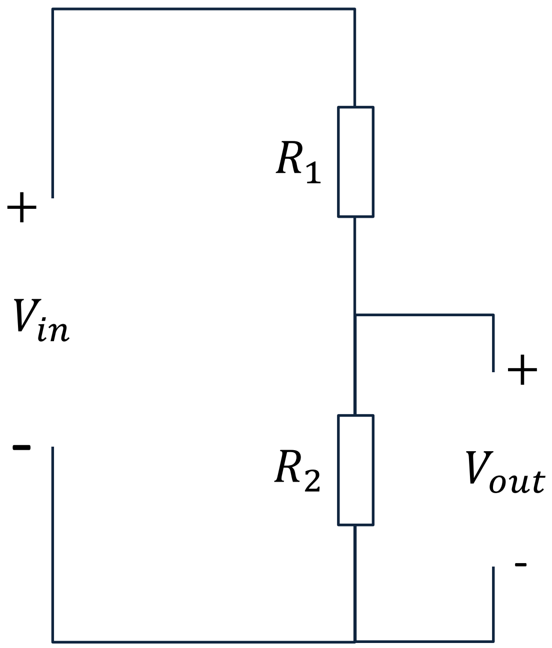
Voltage Divider

The wiring is called a “Voltage divider”:



[https://en.wikipedia.org/wiki/Voltage_divider]

General Voltage Divider



Formula:

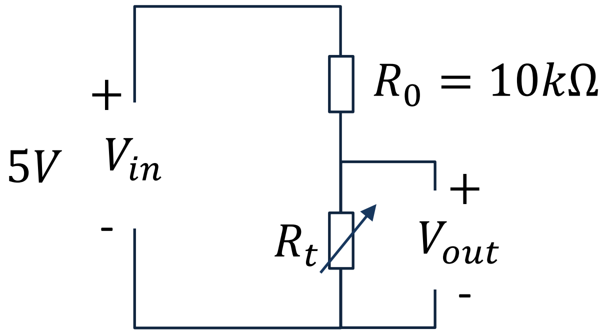
$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2}$$

https://learn.sparkfun.com/tutorials/voltage-dividers/all

Voltage Divider for our System

Voltage Divider Equation:

$$V_{out} = V_{in}\frac{R_t}{R_0 + R_t}$$



We want to find R_t:

$$R_t = \frac{V_{out}R_0}{V_{in}-V_{out}}$$

R_t - 10k Thermistor. This varies with temperature. From Datasheet we know that $R_t = 10k\Omega$ @25℃

Steps:

1. We wire the circuit on the Breadboard and connect it to the DAQ device
2. We measure V_{out} using the DAQ device
3. We calculate R_t using the Voltage Divider equation
4. Finally, we use Steinhart-Hart equation for finding the Temperature

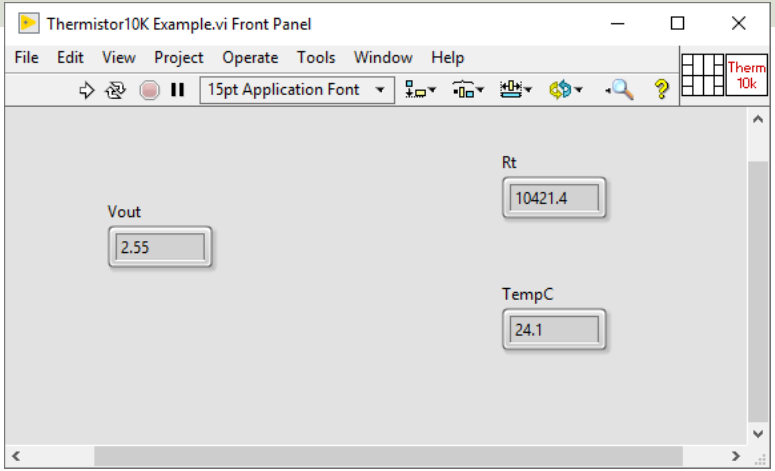
Pseudo Code

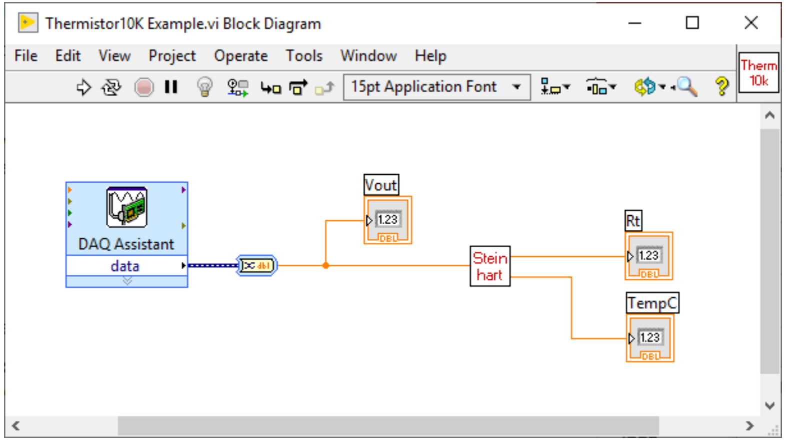
1. Get V_{out} from the DAQ device
2. Calculate $R_t = \frac{V_{out} R_0}{V_{in} - V_{out}}$
3. Calculate $T_K = \frac{1}{A + B\ ln(R_t) + C(ln(R_t))^3}$
4. Calculate $T_C = T_K - 273.15$
5. Present T_C in the User Interface

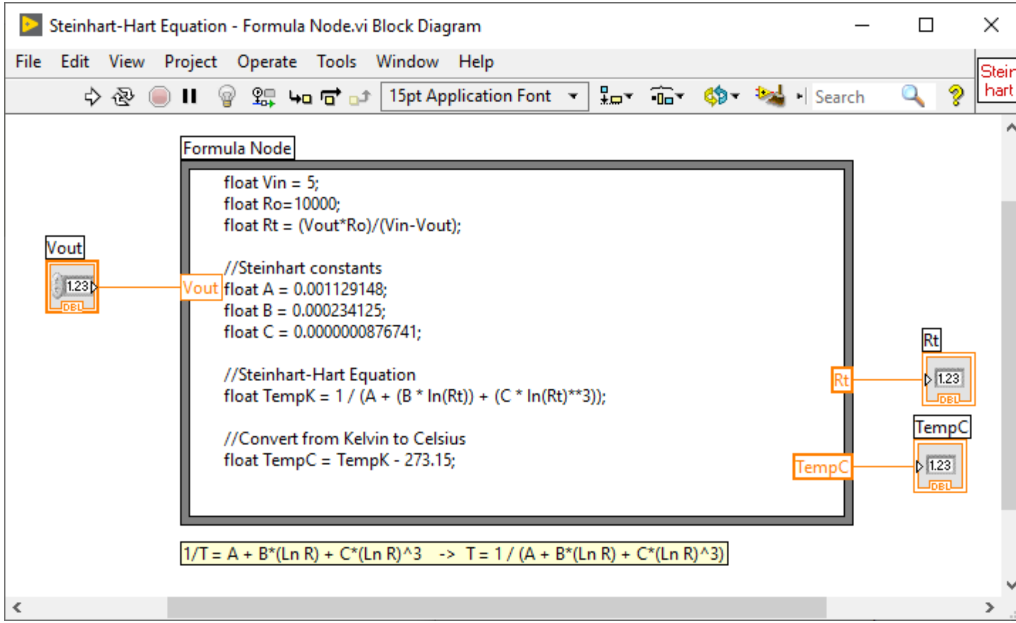
Pseudo Code

```
float Vin = 5;
float Ro=10000;
//Voltage Divider
float Rt = (Vout*Ro)/(Vin-Vout);

//Steinhart Constants
float A = 0.001129148;
float B = 0.000234125;
float C = 0.0000000876741;

//Steinhart-Hart Equation
float TempK = 1 / (A + (B * ln(Rt)) + (C * ln(Rt)**3));

//Convert from Kelvin to Celsius
float TempC = TempK - 273.15;
```

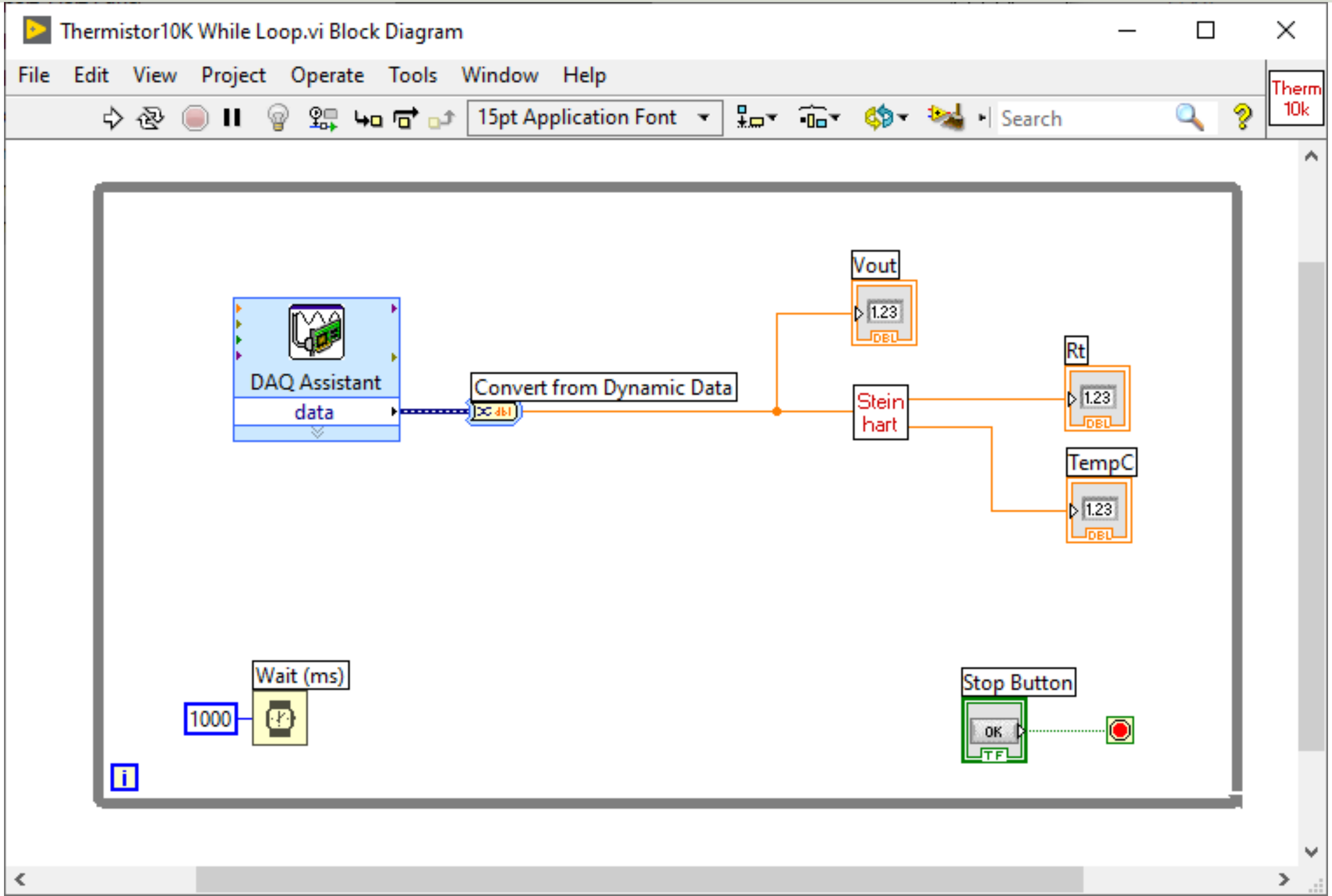
LabVIEW Example



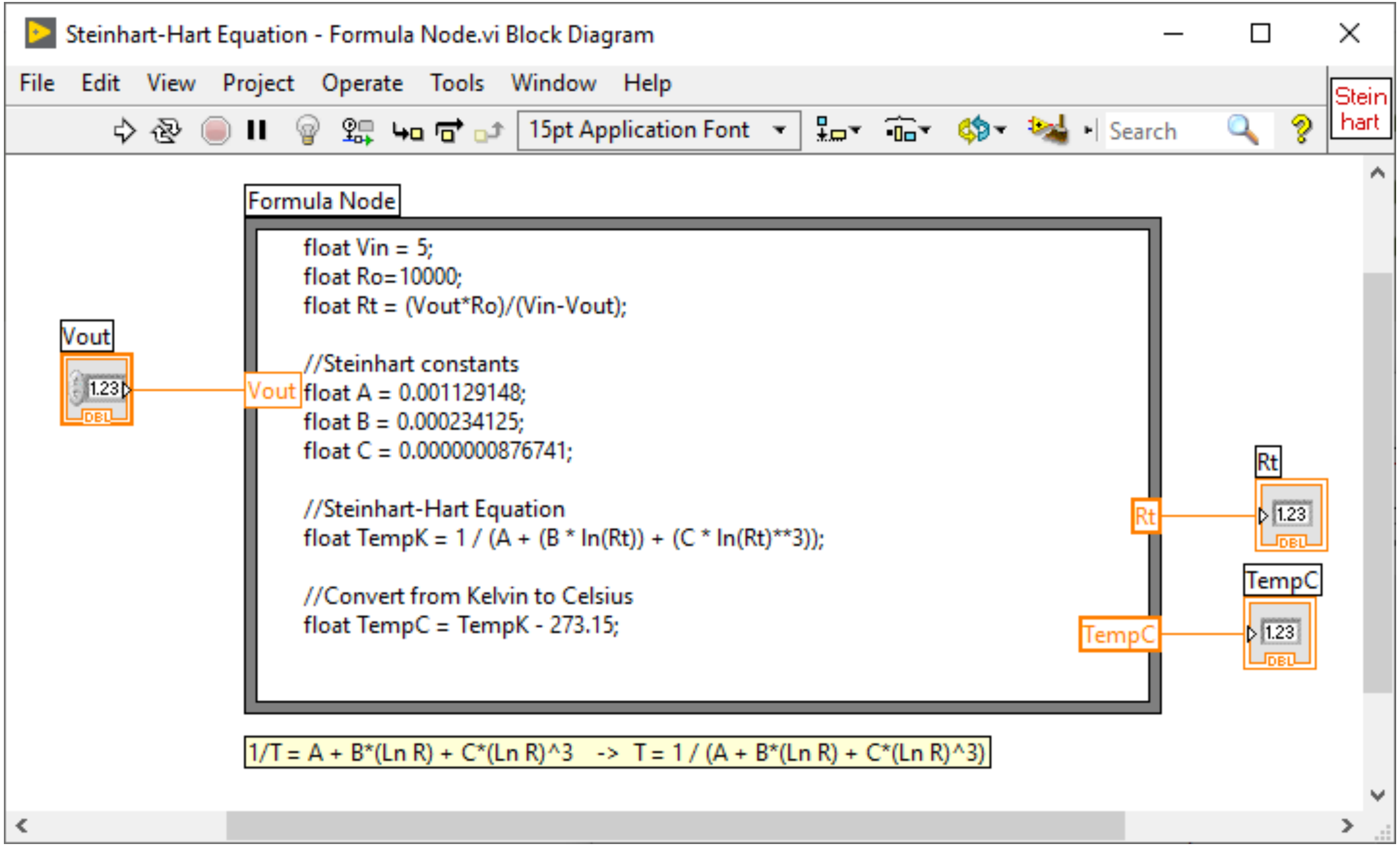




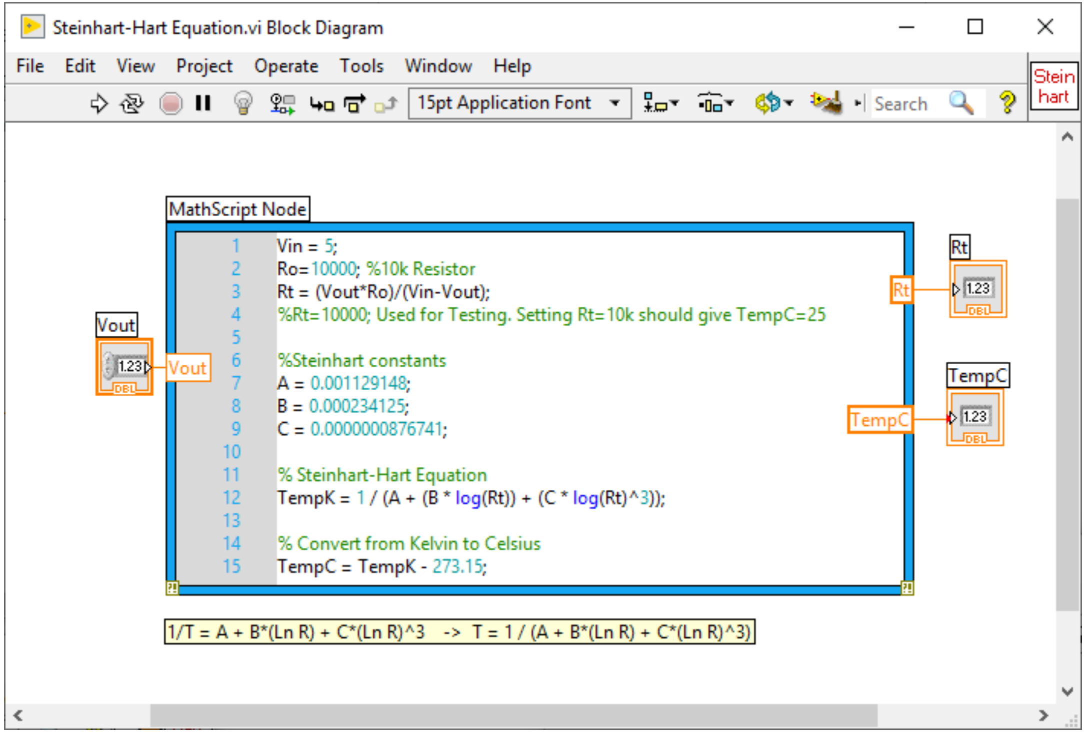
Continuous Reading



Formula Node



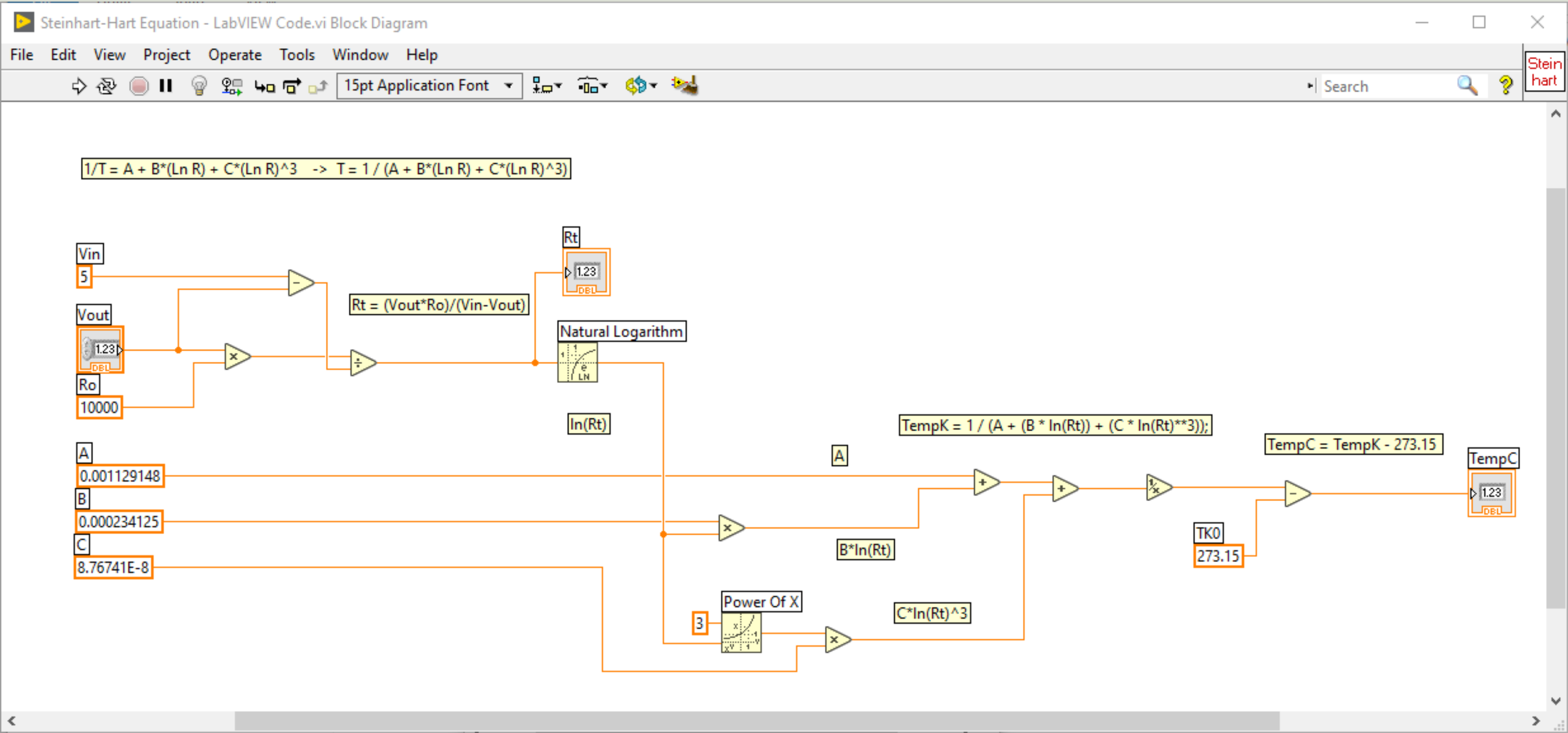
MathScript Node



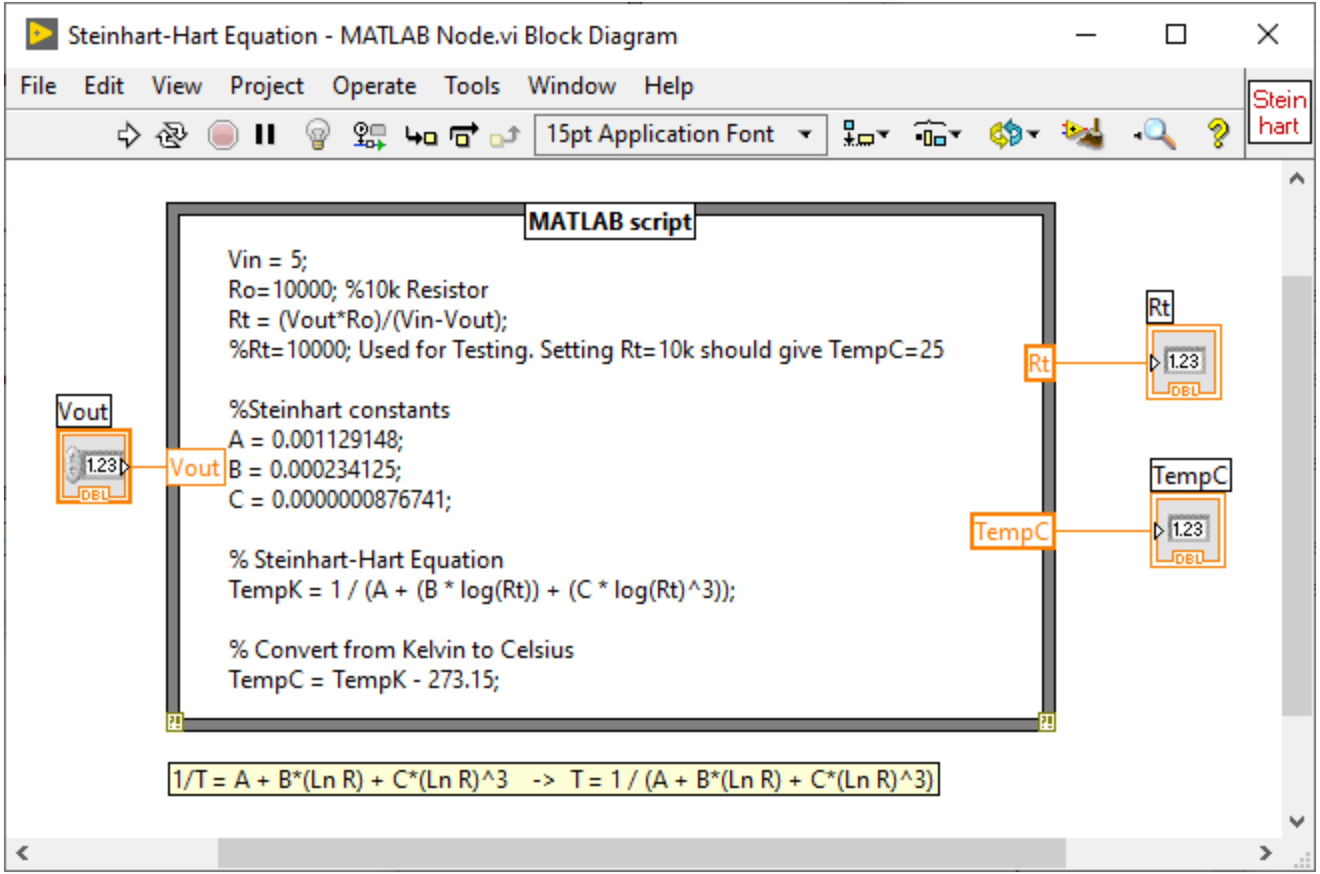
MathScript Code

```
Vin = 5;
Ro=10000; %10k Resistor
Rt = (Vout*Ro)/(Vin-Vout);

%Steinhart constants
A = 0.001129148;
B = 0.000234125;
C = 0.0000000876741;

% Steinhart-Hart Equation
TempK = 1 / (A + (B * log(Rt)) + (C * log(Rt)^3));

% Convert from Kelvin to Celsius
TempC = TempK - 273.15;
```

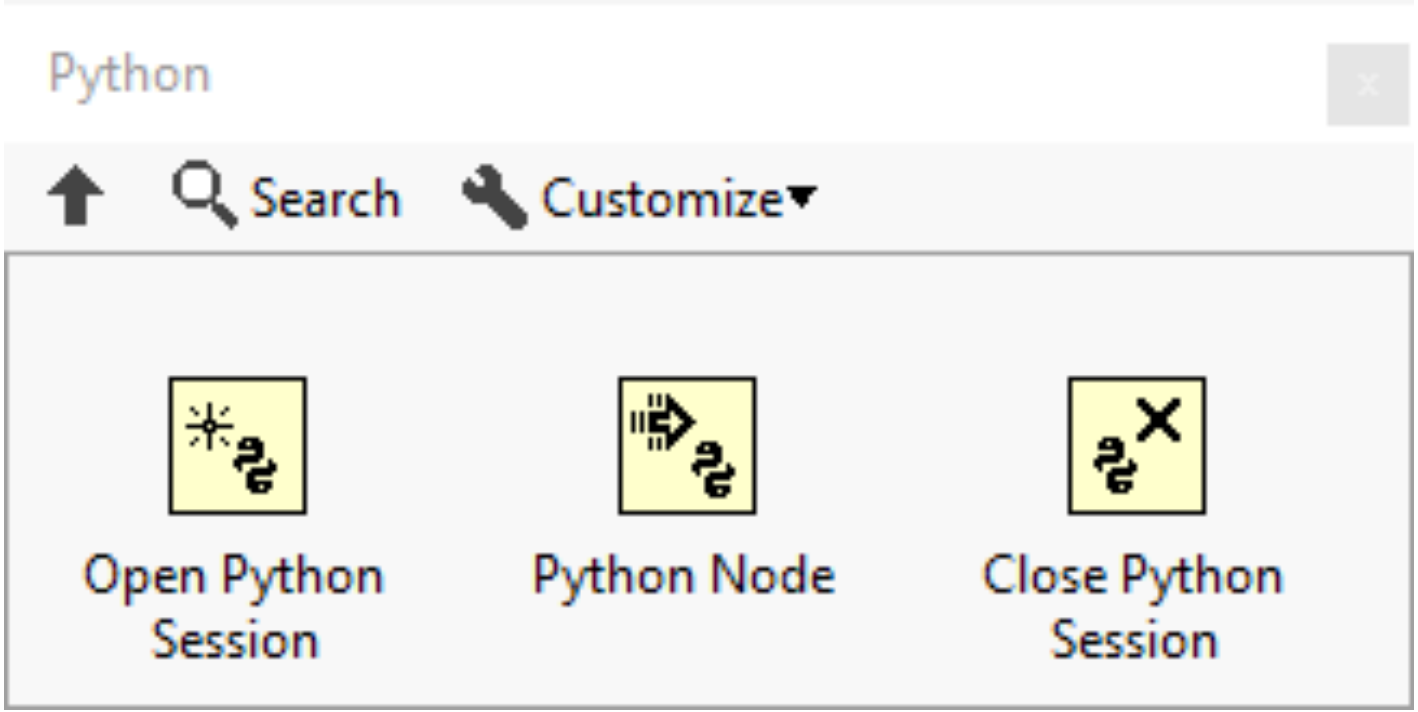
Pure LabVIEW Code



MATLAB Script



LabVIEW Python Integration

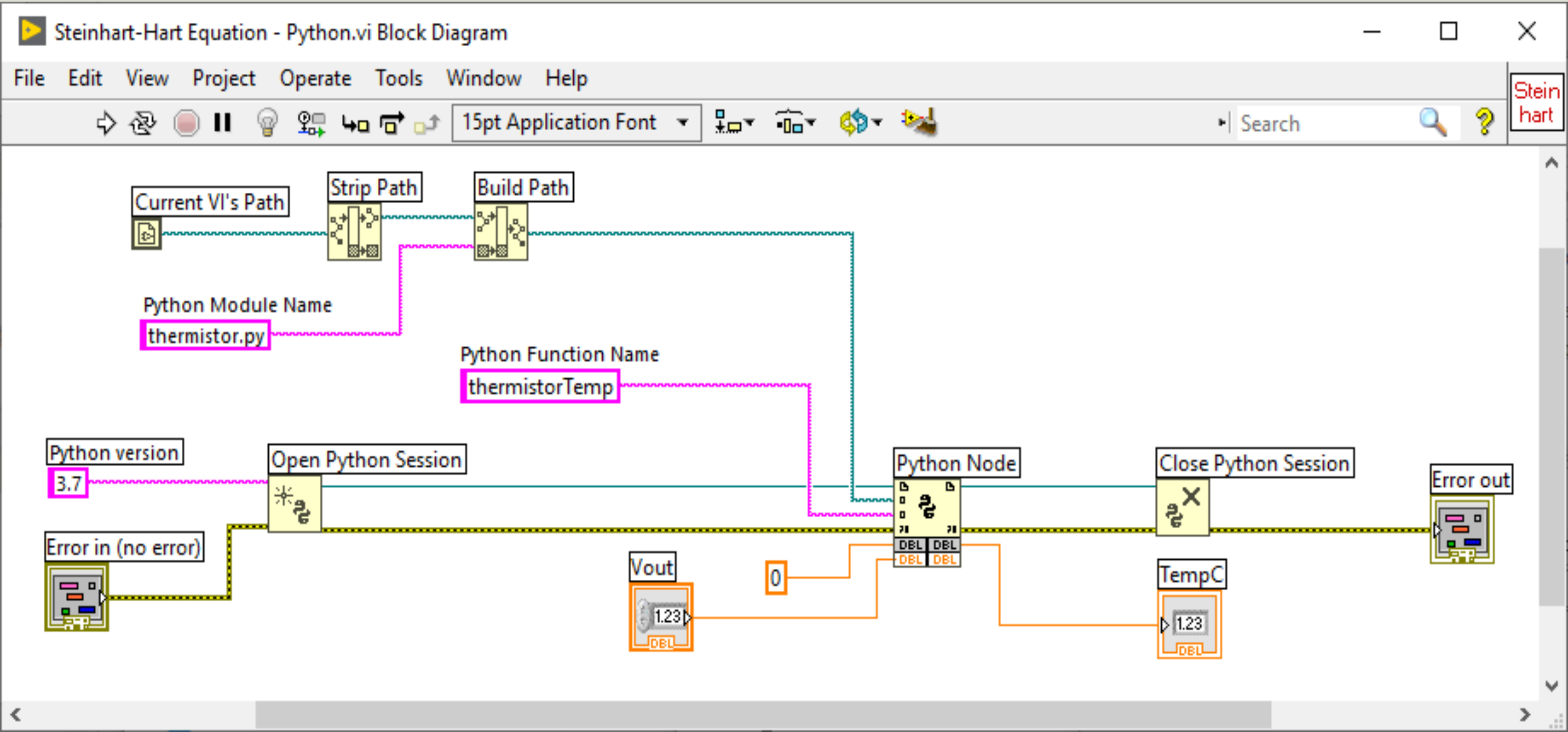


LabVIEW Python Integration

thermistor.py

```
import math as mt

# Function for finding Temperature in degrees Celsius
def thermistorTemp(Vout):
    # Voltage Divider
    Vin = 5;
    Ro = 10000 # 10k Resistor

    # Steinhart Constants
    A = 0.001129148
    B = 0.000234125
    C = 0.0000000876741

    # Calculate Resistance
    Rt = (Vout * Ro) / (Vin - Vout)

    # Steinhart - Hart Equation
    TempK = 1 / (A + (B * mt.log(Rt)) + C * mt.pow(mt.log(Rt),3))

    # Convert from Kelvin to Celsius
    TempC = TempK - 273.15

    return TempC
```

LabVIEW Python Integration



Hans-Petter Halvorsen

University of South-Eastern Norway

www.usn.no

E-mail: hans.p.halvorsen@usn.no

Web: https://www.halvorsen.blog