Experiment 2 RTD Transducer: Determination of characteristics of an RTD transducer

Learning Objectives

- To calibrate a RTD transducer
- To determine the characteristic of a resistance thermometer (RTD)

Prerequisites

- Basic operation of MATLAB and Simulink
- Knowledge of main physical laws
- Operating principles of the resistance thermometer
- Data acquisition system and signal conditioning

Methodology

- Guided experience

List of Equipment

- DL 2314
- Digital multimeter
- Set of leads
- PC with PCI-6036E, MATLAB/Simulink, Data Acquisition Toolbox

Procedure

1. Calibrate the RTD Transducer

1) Press the main switch (ON).
2) Insert one terminal of a digital multimeter (Ohmmeter) in bush N° 7 and the other one in bush N° 8 of the 0°C resistor TESTER.
3) Read the value of 100 Ohms (resistance of the PT100 at 0°C).
4) Use the multimeter as a Voltmeter, set in dc, and move one terminal in bush X3 and the other one in the earth bush.
5) Connect, through leads, bushes N° 7 and 8 of the 0°C resistor TESTER to bush N° 7 and 8 of INPUT INTERFACE.
6) Regulate the trimmer OFFSET to read 0V on the voltmeter and/or
7) Remove the leads from bushes N° 7 and 8 of TESTER and insert in the same bushes the terminals of the multimeter.
8) Insert one terminal of a digital multimeter (Ohmmeter) in bush N° 7 and the other one in bush N° 8 of the 100°C resistor TESTER, and read the value of 138.5 Ohms (resistance of the PT100 at 100°C).
9) Use the multimeter as a Voltmeter and move one terminal to bush N° 13 and the other one to the earth bush.
10) Connect bushes N° 7 and 8 of the 100°C resistor TESTER to bushes N° 7 and 8 of INPUT INTERFACE.
11) Regulate the trimmer GAIN to read on the multimeter the value of 10 V: you have now calibrated the temperature sensor establishing 1 V per 10°C.
12) Remove the leads from bushes N° 7 and 8 of the 100°C TESTER and connect them to bushes N° 7 and 8 of the temperature sensor (see **Fig. 1**).

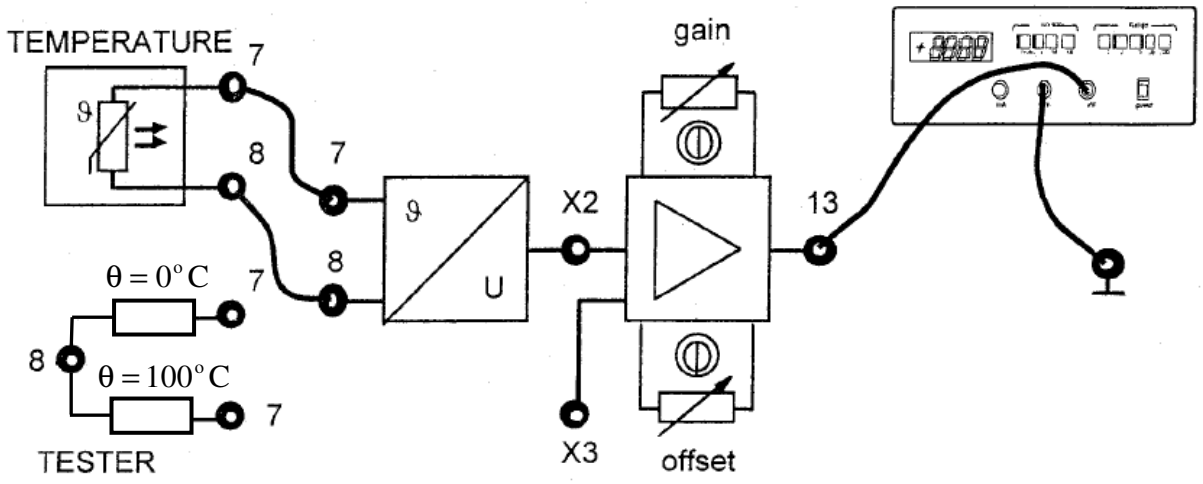
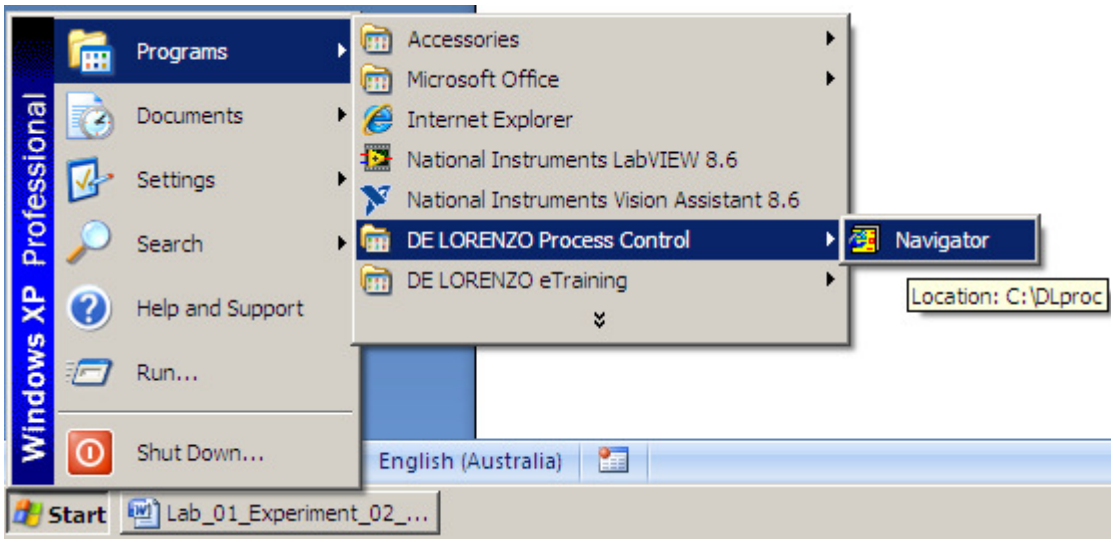


Figure 1 Connection diagram for calibration of RTD transducer

2. Connection and Run the Control Program

1. Run the De Lorenzo Process Control > Navigation (Programs > DE LORENZO Process Control > Navigator)



2. Run Unit 18 N.18 Temperature Transducer
3. Connection:
   - Connect bush Analog Out 1 of the USB DL 1893 to the bush 18 of the Pump and bush Analog Out 2 of the USB RL 1893 to bush 18 of Heater as instructed in the connection diagram in the Unit N.18 Temperature Transducer
   - Connect Channel 0 of PCI-6036E to the Temperature Transducer:
     - Pin 68 →Bush 13 of Temperature Transducer
     - Pin 67 →Bush GRD (earth) of USB DL 1893
4. Start the control program by click the RUN button
5. Enter a voltage of 10 V at SET POINT 2 (SP2) (AO-1) to start the pump. You may need to close the Drain Valve
6. Wait until the water level has reached 10 cm (on the small scale) and bring the voltage on SP 2 back to 0 V.

7. Write down in Table 1 the initial temperature value read in the control program (or on the voltmeter, 1 V = 10^{o}C)

3. Program a Simulink model to log data from the RTD transducer

1. Refer to the sample program for hands-on exercise 2, program a Simulink model to log data from the temperature transducer. It should be noted that it takes some minutes to program the Simulink model
2. Run the test the Simulink model's functionality by confirming the temperature value read in the Simulink model and in the DL Control Program), make sure that the Simulink model works properly and stop the Simulink model.

4. Collect Data

1. Clear Workspace (>>clear) and run the Simulink model to collect data
2. Regulate the voltage on SET POINT 1 (AO-2) at 10 V, the heater will start to operate (you can confirm by the operation light of heater)
3. Write down in Table 1 the voltage for each temperature values listed in the Table.

Table 1 Temperature and V

Temp (^{o}C)	Init. Temp	25	30	35	40	45	50	55	60
Voltage (V)									

4. When the temperature reaches 60^{o}C, bring the SP1 voltage back to 0 V. The heater stops to operate.
5. Stop the Simulink program.
6. Save the Workspace as a MAT-formatted file (>>save datafilename)
7. Draw the diagram of the voltage vs function of the temperature using data in Table 1
8. Plot a graph of the voltage (V) vs temperature (^{o}C) using the obtained data and compare it with the diagram as in **Fig. 2**.
9. Copy the data file to your USB flash memory stick.
10. Put the OFF main switch if no other group do this experiment!

Figure 2 Raw plotting Voltage (V) vs Temperature (^{o}C)

5. Calculation, Analysis of Data and Report

1. Calculate the coefficient α of the RTD.
2. Using formulae for the RTD ($R = R_0(1+\alpha T)$), calculate the theoretical output voltage of the RTD transducer
3. Calculate percentage errors (of measured voltage and temperature)
4. Calculate the linearity (Hints: you can also find a linear relationship using the least squares algorithm (LSA) or you can consider the theoretical output voltage the ideal output voltage)
5. Plot the diagram of the theoretical output voltage vs temperature and compare with the actual voltage and ideal voltage determined by the LSA in 4.
6. Write a report with relevant theory