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| Research Article

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Labview Programming Language Capabilities in the World of Virtual Appliances

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Abstract: This article describes the principle of operation of a thermoresistive temperature sensor. And based on this data, a virtual temperature sensor device was created in the LabVIEW graphical software environment.

Keywords: thermoresistive sensor, thermistors, LabVIEW programming environment, virtual instrument, front panel, diagram block, control element, indicator.

Thermoresistive temperature sensors are devices designed to measure temperature. They are based on the principle of measuring the electrical resistance (of a semiconductor or conductor) when the temperature changes. The main element is a thermistor through which current flows. When the temperature of the medium changes, the resistance of the thermistor changes, and the current and voltage on it change accordingly. The measuring device to which such a sensor is connected registers changes in current or voltage at its input and outputs the result in degrees Celsius or Kelvin.

Thermistors are available in two types: PTC (with a positive temperature coefficient) and NTC (with a negative temperature coefficient). The resistance of the PTC thermistor increases with increasing temperature. The resistance of the NTC thermistor, on the contrary, decreases with increasing temperature, and this type is the most commonly used type of thermistors [1].

The main characteristic of a thermistor is the temperature dependence of its resistance (Fig. 1). It coincides with the temperature dependence of the resistivity of the semiconductor from which the thermistor is made. Over the entire operating temperature range, this dependence is precisely determined by the ratio:

$$R_T = Ae^{\left(\frac{B}{T}\right)},$$

where R_T is the resistance of the thermistor at temperature T; A is a value depending on the material and geometric dimensions of the thermistor; B is a constant characterizing the physical properties of the material.

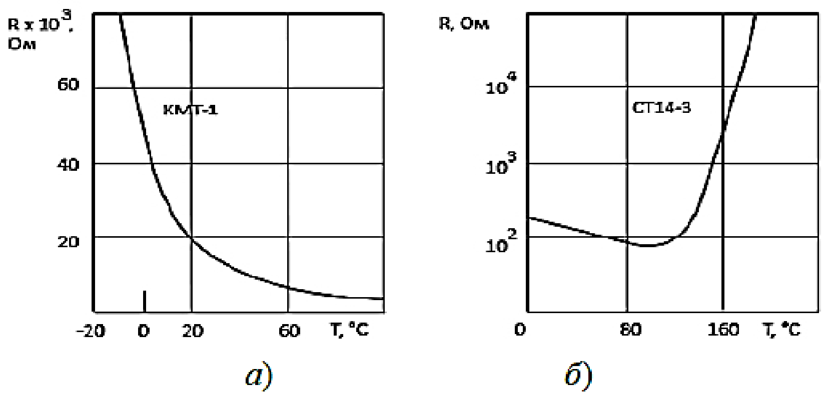

Fig. 1. Temperature dependences of the resistance of thermistors with negative (a) and positive (b) TSR.

NTC thermistors with negative TSR decrease their intrinsic resistive value as the outside temperature increases. As a rule, these devices are more often used as temperature sensors, since they are ideally suited to almost any type of electronics where temperature control is required.

A thermistor-based temperature sensor is an active type of sensor, so a reference voltage is required for its operation. One of the ways to use a thermistor is to include it in one of the arms of the voltage divider circuit. A constant voltage U_0 from the power supply is supplied to the circuit of resistor R and thermistor R_t (Fig. 2).

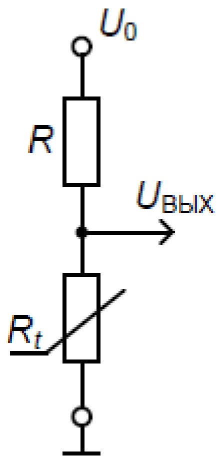

Fig. 2. Circuit diagram of the thermistor

The voltage divider circuit in Fig. 2 is an example of a simple resistance-to-voltage converter. The resistance of the thermistor depends on the temperature, followed by the formation of an output voltage proportional to the measured temperature.

Today, there are quite a large number of tools for processing and visualizing scientific data. However, few things are suitable for automating the process of data collection and processing in real time. The situation is much worse with the coupling of information collection tools (sensors) and computers.

Therefore, the task of transferring data from various measuring (and not only) devices to computers, visualizing information in real time (for management purposes), is relevant for scientists, students and engineers [2].

To solve such problems, you can use the graphical programming language LabWiew, a product of National Instruments.

The LabVIEW language is based on graphical symbols rather than text to describe programmable actions. In it, the algorithm is created graphically An icon-like shape that forms a block diagram, which allows you to eliminate many syntactic details. The fundamental principle of data flow for LabVIEW, according to which functions are performed only when they receive the necessary input, determines the operation of the algorithm [3].

To solve the problem of this work, creating a virtual temperature sensor device based on a thermistor, we use the LabWIEW language. Because this language will be understandable even to those who have not tried their hand at programming yet.

The initial data for this work:

- ✓ the output voltage range of the temperature sensor is – from 0 to 10 V;
- ✓ temperature sensor conversion function – T (°C) = $0,25e^{0.725 U_{вых}}$;

Run the LabWIEW program (File – New VI, virtual instrument) to open a new window called the virtual instrument (VI). We will see that the program interface consists of two windows: the Front panel and the Block diagram window, where the front panel serves as the user interface.

The following three palettes are available for working with these areas:

1. Controls;

2. Functions;

3. Tools.

Creating the front panel. Using the control palette (Controls-Modern-Numeric-Thermometer), we output two thermometers to the front panel and set the display elements (Controls-Modern-Numeric-Numeric Indicator) to show the temperature values. Synchronously, control terminals and an indication terminal will appear in the diagram block, respectively. The connection of the input to the output is carried out in the diagram block using a connecting thread (Connect Wire).

To simulate the changing output voltage of a temperature sensor with a thermistor (the output voltage of the sensor changes proportionally to the change in the measured temperature), install a round Knob or Dial controller from the palette of Numbers from any of the groups on the front panel: Modern, Silver, Classic or Express.

In the name field of this controller, enter the text: "Adjusting the output voltage of the temperature sensor, V". Adjust the type and font size of the entered text in order to improve the interface of the front panel of the VI.

Set the maximum output voltage of the sensor set according to the option to the last digitized mark of the regulator scale (in this example, 10 V). Select the controller and adjust its size (see Fig.6).

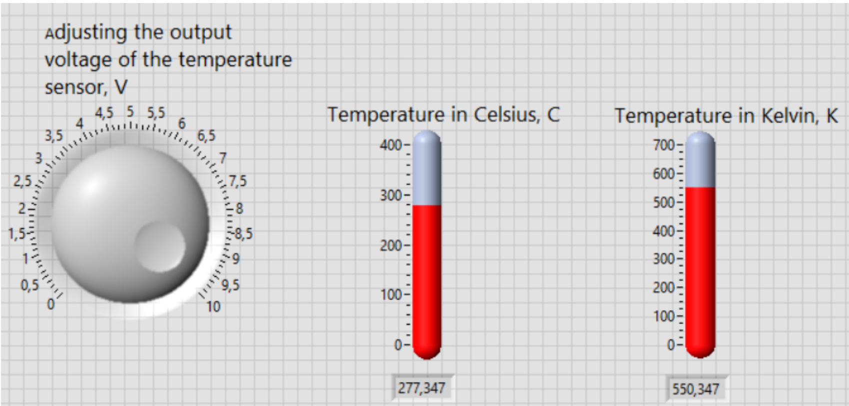

Fig.6. View of the front panel

Using the preset temperature sensor conversion function for the maximum value of the output voltage, calculate the maximum temperature value that can be measured by the VP data. In this example, Tmax = 352 °C (625 K).

Create an EAP block diagram that implements the conversion of the sensor output voltage into a temperature value. Figure 4 shows an example of a possible EAP block diagram with the conversion function specified for this example: T(°C) = $0,25e^{0.725U_{out}}$ and by converting the temperature to degrees Kelvin: T(°C) = 273 + T(K).

Implement the VP conversion function specified according to the option, as well as the function of translating temperature units, using various tools in the Functions palette. In this example, we use:

- three constants (Functions – Programming – Numeric – Numeric Constant);
- two multiplication functions (Functions – Programming – Numeric – Multiply);
- addition function (Functions – Programming – Numeric – Add);
- exponent function (Functions – Mathematics – Elementary – Elementary & Special Functions – Exponential Functions – Exponential).

Connect all the elements of the block diagram using the Wire tool from the toolbar (Tools Palette).

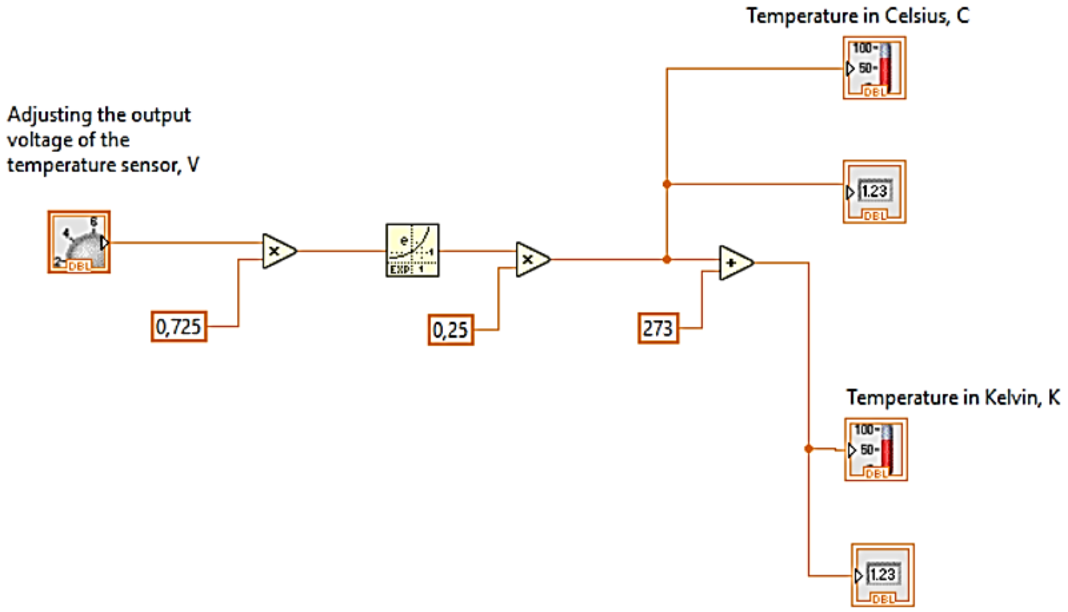

Fig.7. View of the block diagrams

To check the performance of the VP, click the Run Continuously button in the form of an arrow in the toolbar. If this arrow looks split at the end of programming, it means that the program is compiled incorrectly and you will need to debug it, that is, find the error and fix it.

By changing the output voltage regulator of the sensor, it is possible to observe changes in the readings of thermometers and numerical indicators.

Thus, it is possible to create virtual devices without typing a code, so even a person far from programming can freely implement engineering projects, measurements, calculations and controls.

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