CORELA

Education Platform

User Manual

Funded by the
Erasmus+ Programme
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Contents

1 Introduction

The digital age forcing the teachers and instructors to identify the new teaching methods, how the changing technology influence the knowledge and skills that will be needed in the new modern era. Regard to the many economical changes, unified market, and increasing globalization the way of the teacher role is drastically changed, which demands a re-examination of the teacher professional skills and the teaching methods. All the changes are closely related to the pervasive rise of modern technology.

The rapid development of modern technology has a profound effect on learning principles and methodology. The new era of the knowledge gain by pupils is marked with the rise of Information and Communication Technology (ICT). The new way of knowledge acquiring is no longer restricted to formal classrooms and schools. ICT allows students to attend and follow the education process irrespective of location and time. For example, online courses allow the student to arrange their studying time regardless of the formal school schedule. The Remote Virtual Laboratories (RVL) offers a unique solution to practical education. RVTs allow the participant to execute experiments at the distance over the internet at any time no matter the school working hours and employee engagement. The experiment can be repeated as many times as is needed. All the aforementioned facts are possible with fast-growing ICT. There are many conducted studies and analyses, which confirm the success of modern learning approaches and technologies. Very important is to mention that student satisfaction is on the higher level, and the higher motivation leads to thorough knowledge. All the fulfilled studied materials supported by modern technologies raise the efficiency of the obtained knowledge and speed up the education process.

The developed platform is a product of the Erasmus+ CORELA project. The project aims to develop a common platform for technical Vocational Education and Training (VET) education. The CORELA platform has an extension with integrated RVL and is specially developed for electro technical higher educational institutions. The platform offers collaboration with other pupils or groups in terms to share knowledge, experience, or compare the obtained results from the different methodologies. The final or intermediate results from the platform can be provided to the Massive Open Online Course (MOOC) platform. The MOOC platform can present the results as a freely view assignment to all pupils, as forum thread for further discussion or private/final assignment results accessible only by the teacher.

The presented platform can operate in three different modes. In the first mode, the platform allows analytical computation. The analytical computation is oriented to theoretical assignments without the involvement of the real parameters and elements. Theoretical assignments are a basis for general knowledge of a certain field and are important for further understanding and the complexity rise of the problem. The second mode introduces the simulation environment. The simulation environment is a reasonable further step from theoretical exercises. The simulation involves testing different kinds of real scenarios, like a parameter deviation, parameter, and measurement uncertainty model mismatch, etc.. The simulation is still based on the analytical basis but can identify and approximate some real effect and results. The simulation is an intermediate step between ideal analytical computation and real experiments with real components and measurement tools. The third operation mode of the platform is a real-time experiment with real-time measuring and components. The main supported acquisition device is a DAQ Card. The DAQ can be used as a digital and analog input/output interface. The platform offers a variety of connections to different measurement tools. The platform also supports standard serial communication, which spread the functionality to the custom-designed experiments and measurement equipment. All the real-time data can be stored for later analysis and examination. All three operation modes of the platform offer a connection to the MOOC system, where all data and parameters of calculation, simulation, or real-time experiments can be presented. Regard to the discipline and the teaching methodology the presented results can be used for collaborative learning and interaction with different student groups or just automated data collection platforms for teacher supervision.

In continuation of the given text, the installation, structure, and use of the platform will be presented. To be familiar with the environment operation and structure, useful examples are added at the end of the guide.

2 Installation guide

Download '.rar' file CORELA Setup and extract it with appropriate software (WinRAR, 7zip, etc.) somewhere on disk. An open folder named "CORELA Setup" and double click on setup.exe con. In the opened dialog box choose the desired directory to install CORELA.

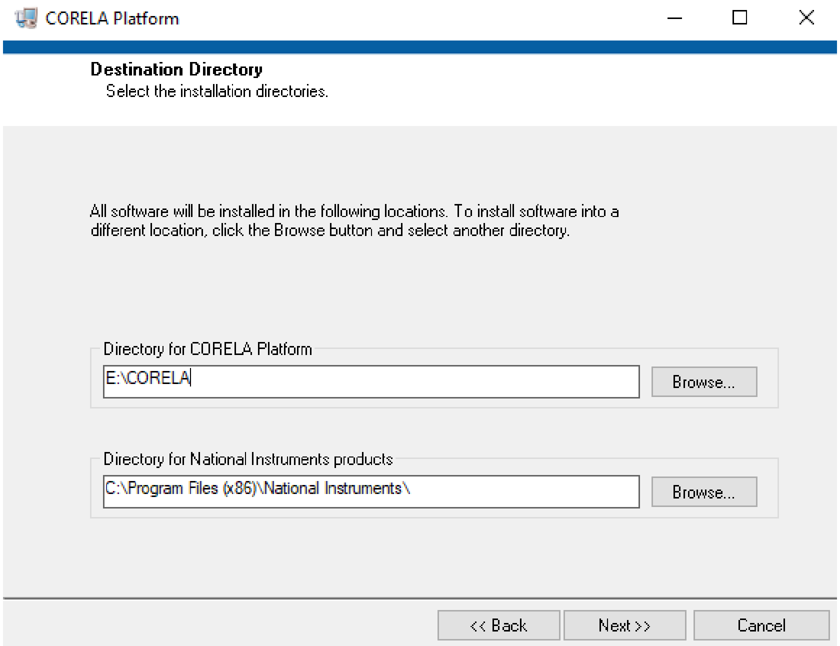


Figure 1: Select directory dialog box

Warning: *if default directory is chosen "c:\Program Files (x86)\CORELA\" then you should give to this directory administration privileges.*

In the dialog box click **next** and wait until the installation is finished. You may be asked to restart the computer.

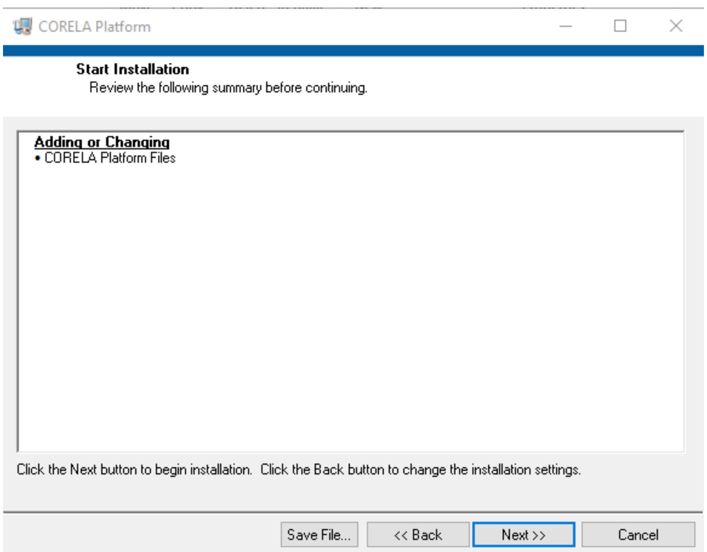


Figure 2: Choose installed components dialog box

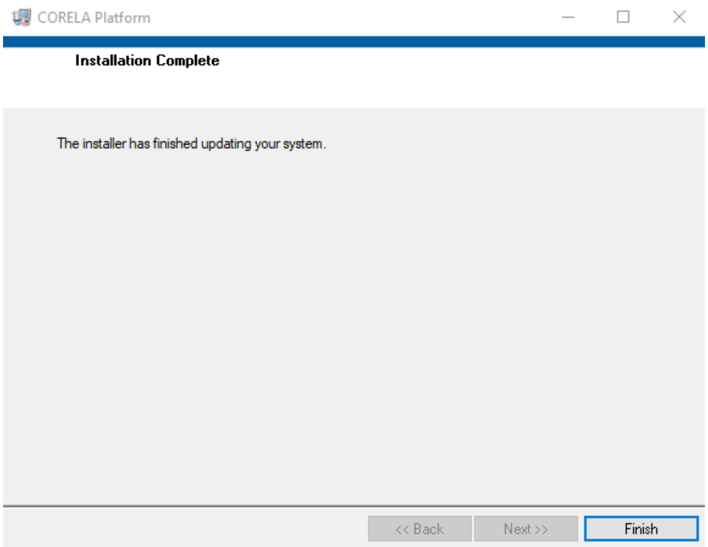


Figure 3: Installation complete dialog box

3 How to start the CORELA platform?

When the CORELA platform is installed the CORELA folder appears on the desktop. Open the folder and double click shortcut CORELA Platform and the main workspace of the CORELA platform appears.

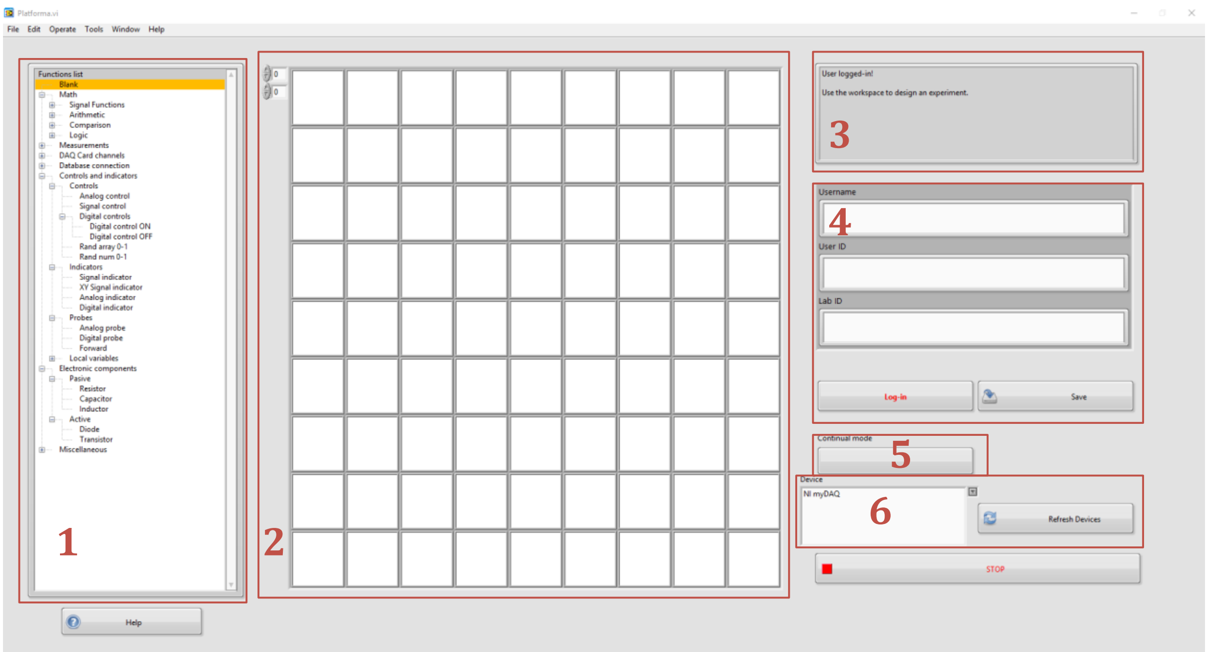


Figure 4: Main workspace

1. Function list: here you can choose the desired function from the list
2. Function workspace: selected function on the left pane (1) appears when clicking on the desired square (2)

3. Message box: all messages from the platform appear here, including calculated, simulated, or measured values.
4. Log Inbox: login with your username and user ID. Lab ID stands for several exercises for identification in Moodle.
5. Continual mode: with click on this button platform re-calculate and measure results every 2 seconds.
6. Device box: when the hardware is connected and installed to a computer, the name of the device appears here. Button “Refresh Devices” refreshes all connected devices.

4 How does the CORELA platform work?

Users familiar with LabVIEW have advantages due to CORELA platform is based on LabVIEW. However, also other users will learn to use the platform quickly. The platform is designed for basic simulation, calculation, and measurement in electrical engineering. Users can make theoretical calculations of the desired electric circuit then can simulate the circuit with different parameters and at the end can confirm calculation and simulation with real measurements. The platform supports DAQ devices from National Instruments, Arduino devices, and Red Pitaya devices.

The cells in the middle of the window are for connecting the functions. Each cell has one input and one output. Users put functions from the left pane in cells. The data flows from left to right. The basic workflow requires (i) input variable(s), (ii) function which makes calculations from inputs and (iii) indicator which represents the results (See Figure 1).

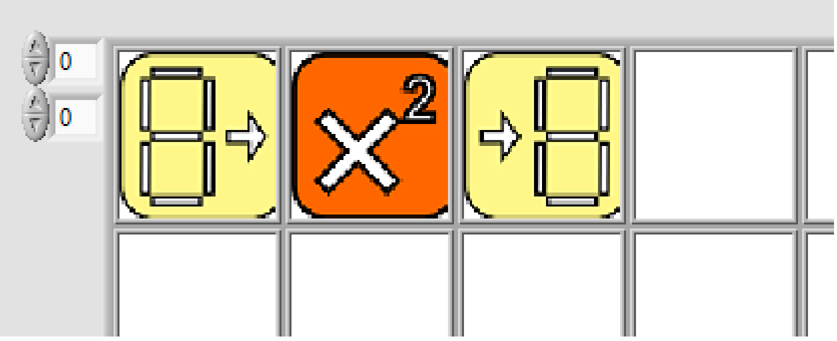


Figure 5: A basic arithmetic example using one input and one output

In case when the function has two inputs the second input is set to null by default or the user can define the second variable by adding control in one row below (See Figure 6).

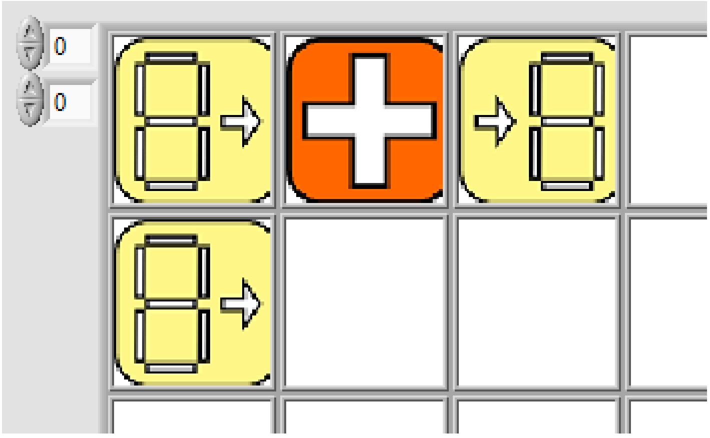


Figure 6: Summation of two variables example

CORELA platform functions support only two inputs and if the user wants to use more than two variables than more functions must be combined. An example is showed in Figure 7.

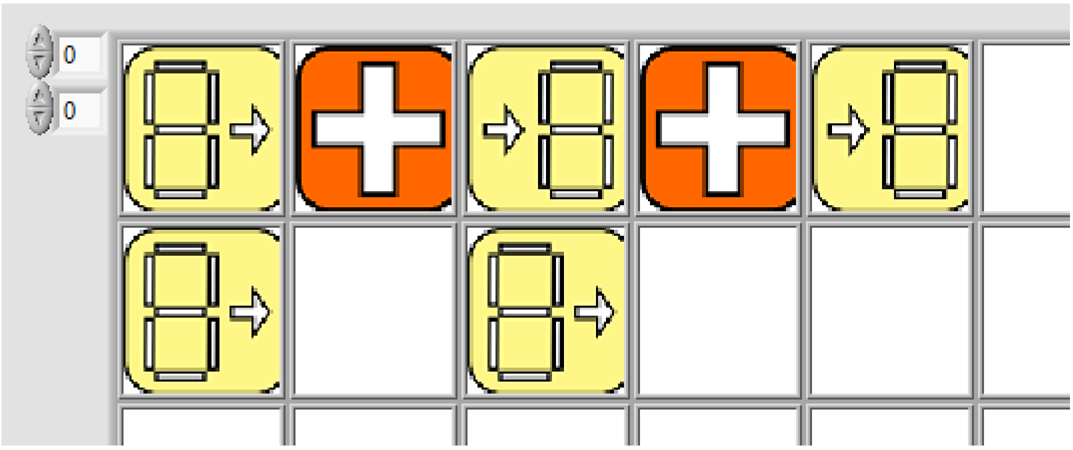
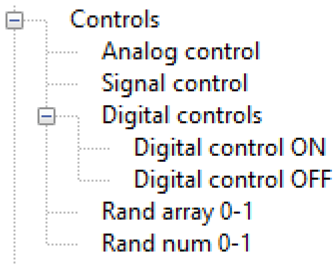


Figure 7: Addition of two variables example

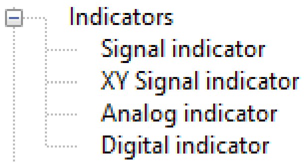
5 Functions description

There are three types of functions (selectable on the left pane):

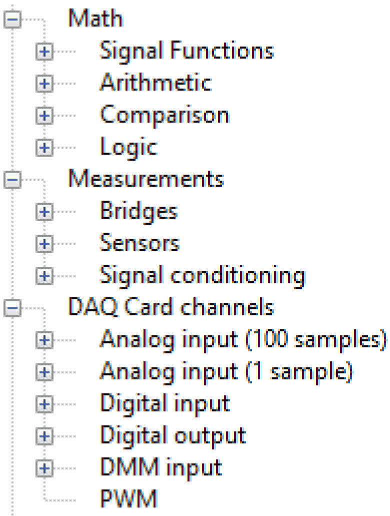
- **Controls** are intended as inputs, where users define input data sets, like constants, variables, or calculated array of variables.



- **Indicators** are outputs where the results can be represented or displayed. Indicators can display one output variable or array of variables. Also, it can display graphs and 2D variables.



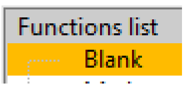
- Functions with inputs and outputs intended for calculation, measurements, acquisition, etc. Basic math functions can perform theoretical calculation, measurement functions include predefined measurement methods, DAQ card channels can sample or generate analog or digital signals.



Some functions show a pop-up window when selected. In the pop-up window,the user can define variables, parameters, etc. Each function will be described below.

a. Blank function block

The blank function is used when the user wants to erase function in the selected cells.



b. Math functions

Under the block of Math functions are next groups of functions: (i) Signal functions in which user can find a function for generating basic signals (sinus, triangle, square, saw), and functions for processing signals (MIN, MAX, Mean, RMS, Filter, etc.). The second (ii) group of functions consists of basic arithmetic functions (add, subtract, multiply, etc.). Comparison functions (iii) return logical value-dependent from inputs (Equal, Greater, Less, etc.). The last group (iv) consists of basic logic functions (AND, OR, NOT, etc.).

- Math
  - Signal Functions
    - Simulate signal
    - MIN
    - MAX
    - Frequency
    - Mean
    - Median
    - STDEV
    - RMS
    - Filter
  - Arithmetic
    - Add
    - Subtract
    - Multiply
    - Divide
    - Negate
    - Reciprocal
    - Square
    - Square root
    - Absolute value
  - Comparison
    - Equal
    - Greater
    - Less
    - Greater or equal
    - Less or equal
  - Logic
    - AND
    - OR
    - NOT
    - NAND
    - NOR
    - XOR
    - XNOR

i. Signal functions

Signal Functions → **Simulate signal** opens a pop-up window for generating four basic waveforms: sine, square, triangle and sawtooth. Users can set frequency, phase, amplitude, and offset. Also, the sampling rate can be set.

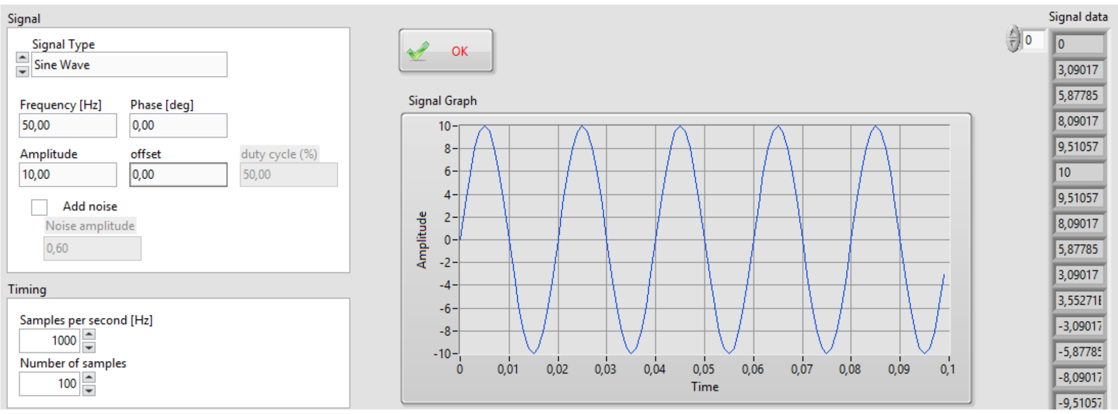
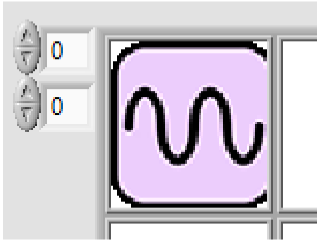
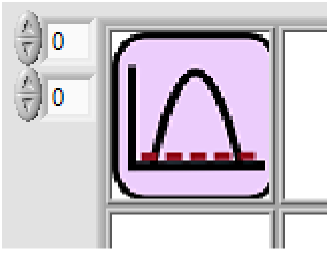


Figure 8: User interface for signal simulation

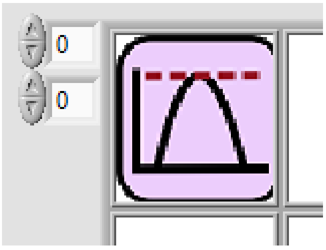
The selected waveform is displayed in the graph, right from graph wave is presented as values in the array. When the user clicks an OK button, the pop-up is closed and the Simulate signal icon is showed in the selected cell.



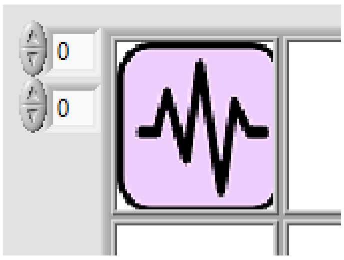
- MIN function calculate minimum value of input array/signal.



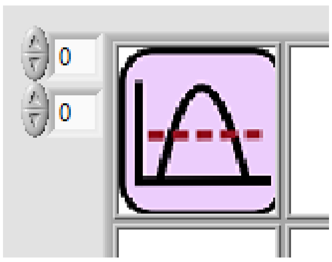
- MAX function calculate maximum value of input array/signal.



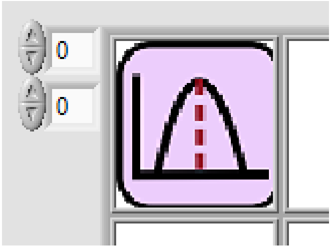
- Frequency function calculate frequency of input array/signal.



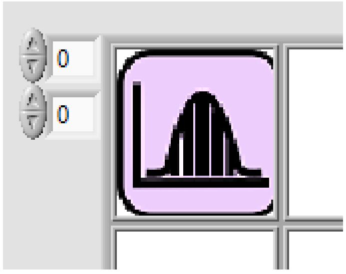
- Mean function calculate mean value of input array/signal.



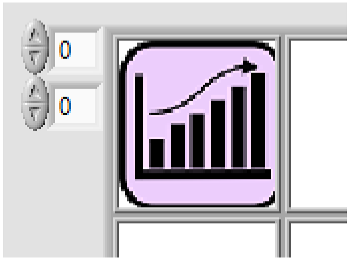
- Median function calculate median value of input array/signal.



- STDEV function calculate standard deviation value of input array/signal.



- RMS function calculate root mean square value of input array/signal.



- Filter function opens a pop-up window with settable parameters for creating the various filters (lowpass, highpass, bandpass, and bandstop). Users can set a type of filter, sampling frequency, and low and high cutoff frequencies. The selected filter is then implemented on the input signal/array and displayed in graphs.

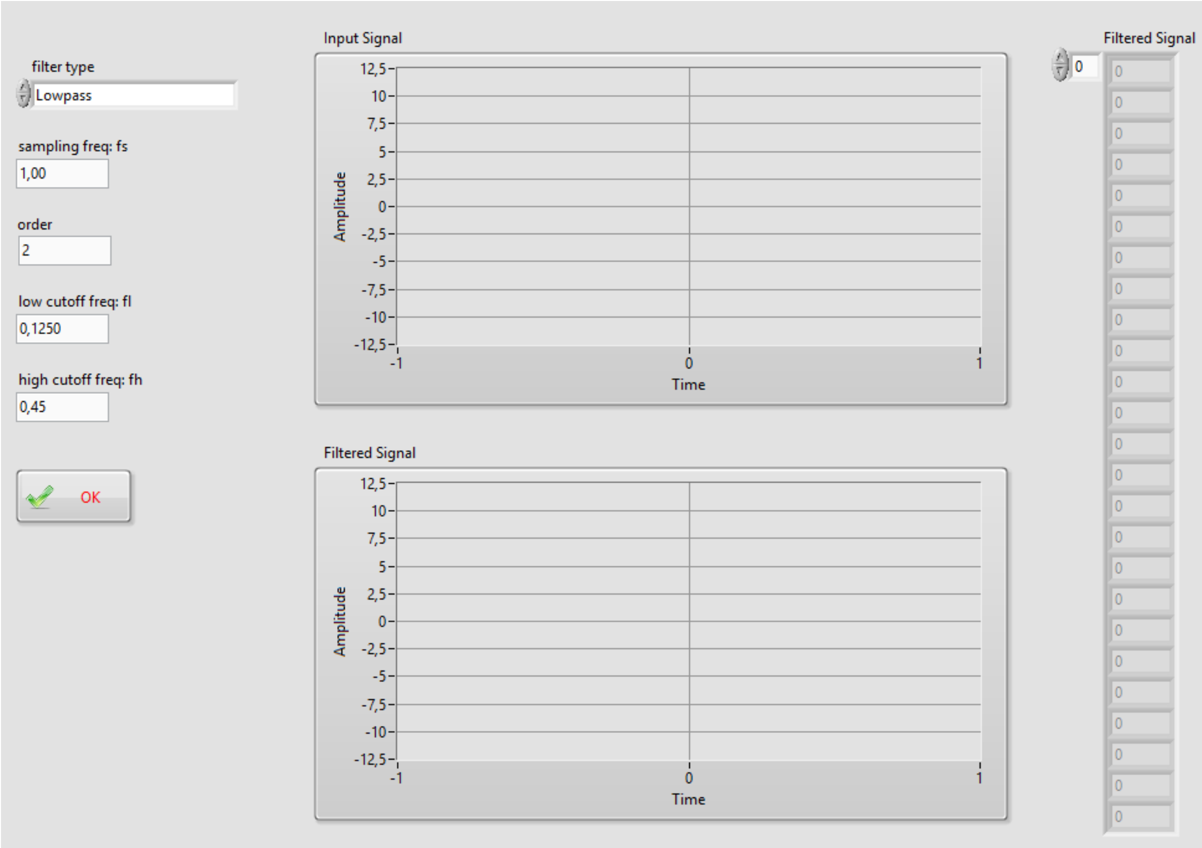
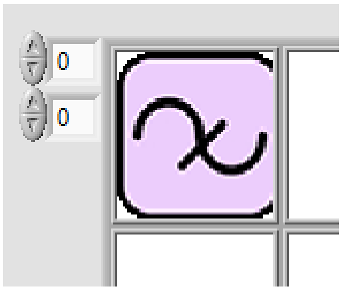


Figure 9: Low pass filter design

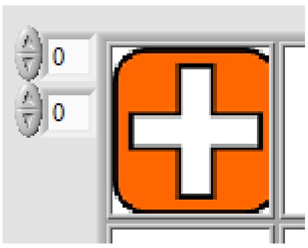
With a click on the OK button, the pop-up window is closed, and the Filter icon appears in the selected cell.



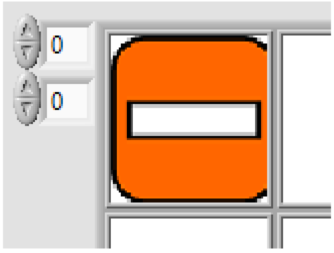
ii. Arithmetic functions

Group of basic arithmetic functions for addition, multiply, subtract, and divide of two input values. Group also consists of functions with single input value, like negate, reciprocal, square, square root, and absolute value.

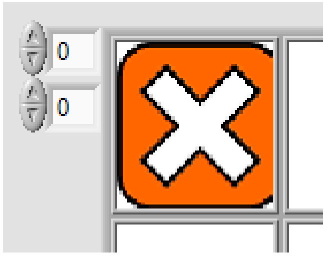
- Add function adds two input values.



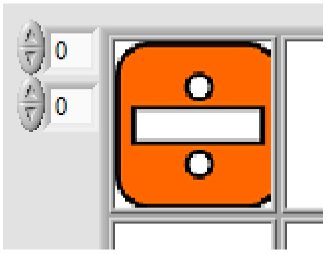
- Subtract function subtracts two input values



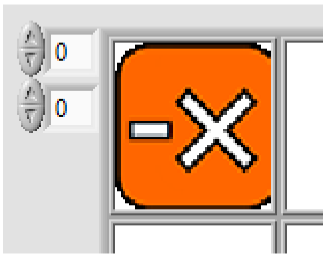
- Multiply function multiplies two input values



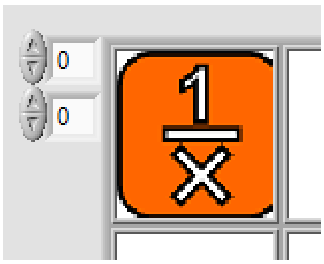
- Divide functions divide two input values



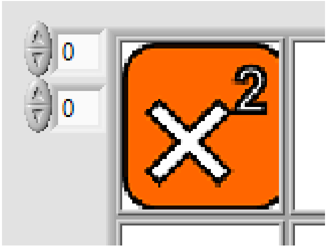
- Negate function negates single input value



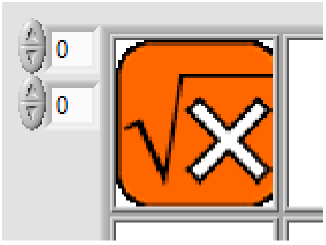
- Reciprocal function calculates the reciprocal value of single input value



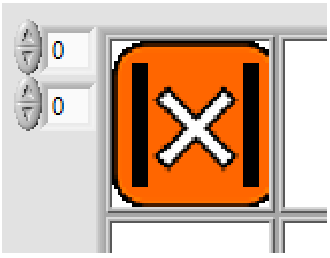
- Square function calculates the square value of single input value



- Square root function calculatesthe square root value of single input value



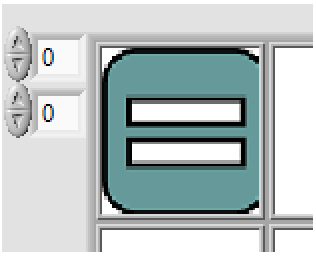
- Absolute value function calculates the absolute value of single input value



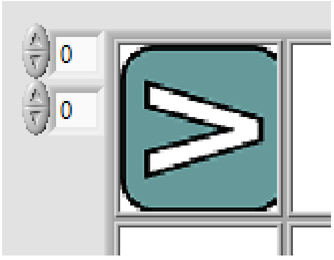
iii. Comparison functions

Comparison function returns logical high or low depending on the values in two inputs.

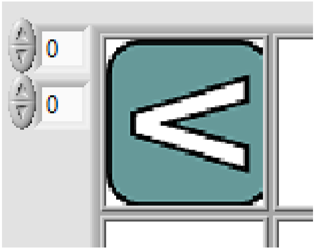
- Equal function returns logical high when two inputs values are equal.



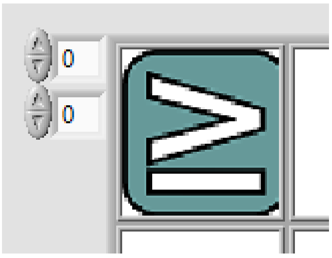
- Greater function returns logical high when upper input is greater than the bottom input.



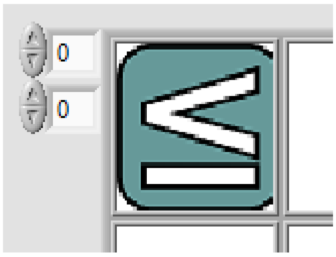
- Less function returns logical high when upper input is lower than the bottom input.



- Greater or equal function returns logical high when upper input is greater or equal than the bottom input.



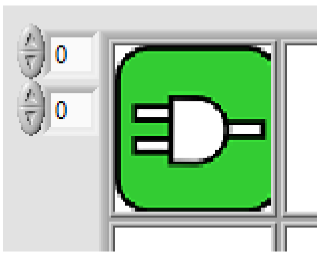
- Less or equal function returns logical high when upper input is lower or equal than bottom input.



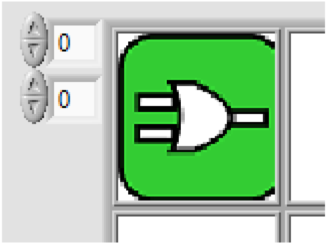
iv. Logic functions

Logic functions perform logical (and, or, nor, etc.) operation over two inputs values.

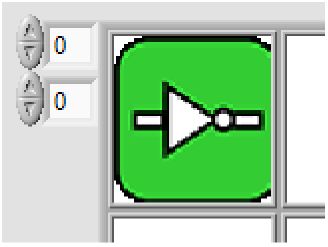
- AND function executes logical AND over two inputs digital values



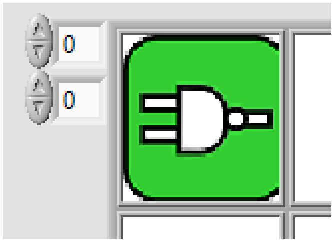
- OR function executes logical OR over two inputs digital values



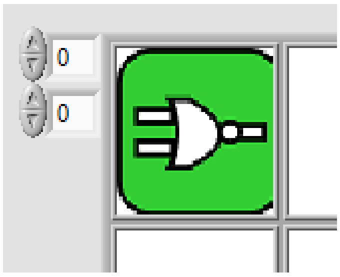
- NOT function executes logical NOT of single-input digital value



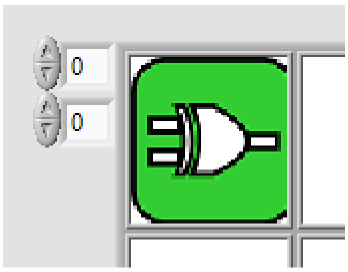
- NAND function executes logical NAND over two inputs digital values



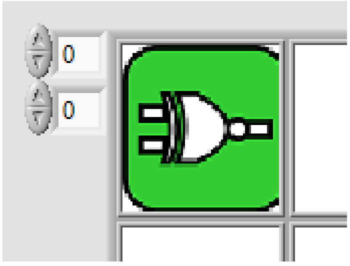
- NOR function executes logical NOR over two inputs digital values



- XOR function executes logical XOR over two inputs digital values

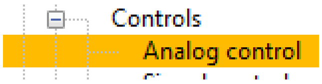


- XNOR function executes logical XNOR over two inputs digital values



c. Controls and indicators/Controls

Controls are intended as inputs for calculation functions and have one output where produces constant or array variables. Variables are analog or digital data. The control group of functions consists also of random generators.



i. Analog controls

Opens pop-up window for setting the single analog variable. Users can set the floating number by turning the knob or put the exact value in the box below the knob. With a click on button RECORD, the control produces the desired value at the output and closes the pop-up window.

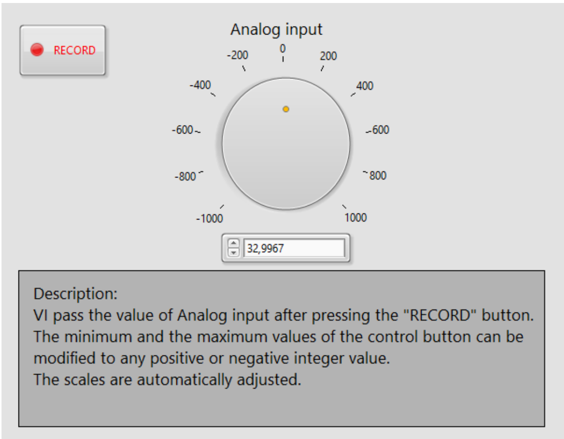
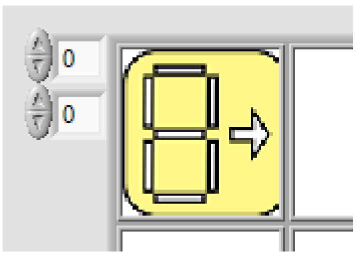


Figure 10: Analog input interface

Variable is now available as input for function in the next cell.



- Signal control opens a pop-up window for setting an array of floating variables.

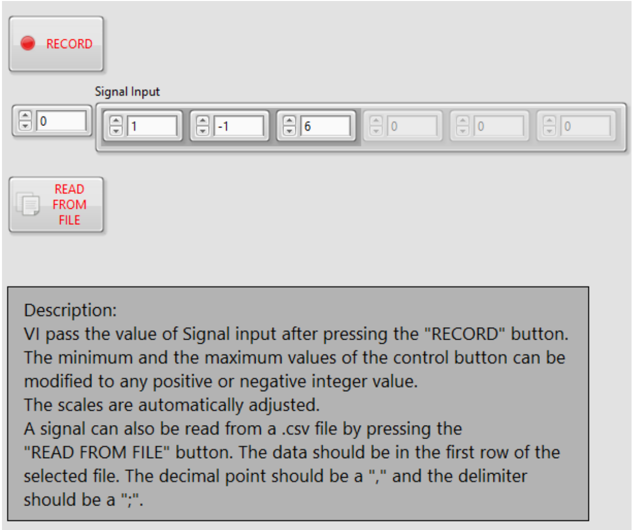
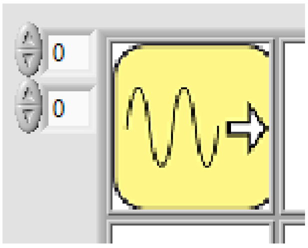


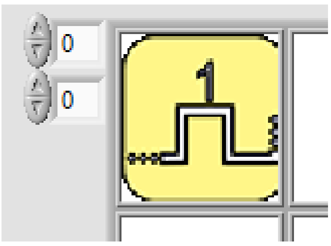
Figure 11: Variable array user interface

Users can manually set an array of variables by putting values in controls. The second option is to set the variables from the file. In that case user must have prepared .csv file with values. Values should be in the first row of the file delimited with ";". With a click on button RECORD the data are sent to output and are ready for the next function cell.

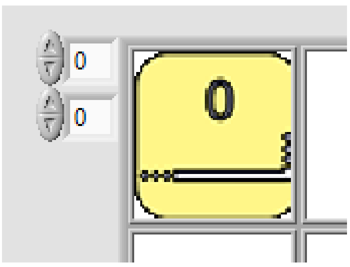


ii. Digital controls

- Digital control ON puts digital logical high value as the output of the cell.

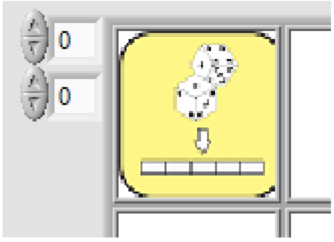


- Digital control OFF puts digital logical low value as the output of the cell.

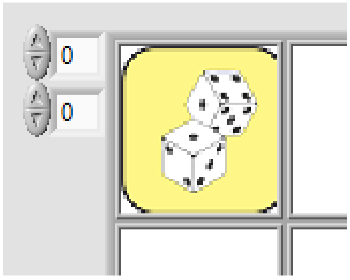


iii. Random controls

- Rand array 0-1 generates 1D array of random numbers.



- Rand num 0-1 generates a single random number.



iv. Indicators

Groups of indicators are intended for data representation. They have inputs on which user can connect outputs of desired function blocks. Indicators can display a single value or array of values, also can represent data as graphs.

v. Analog indicators

- Signal indicator opens a pop-up window with data represented as a graph. It also shows the values of the array. The data represented in the Signal indicator can be saved in a file. This file could be used as an input data set for other functions with inputs.

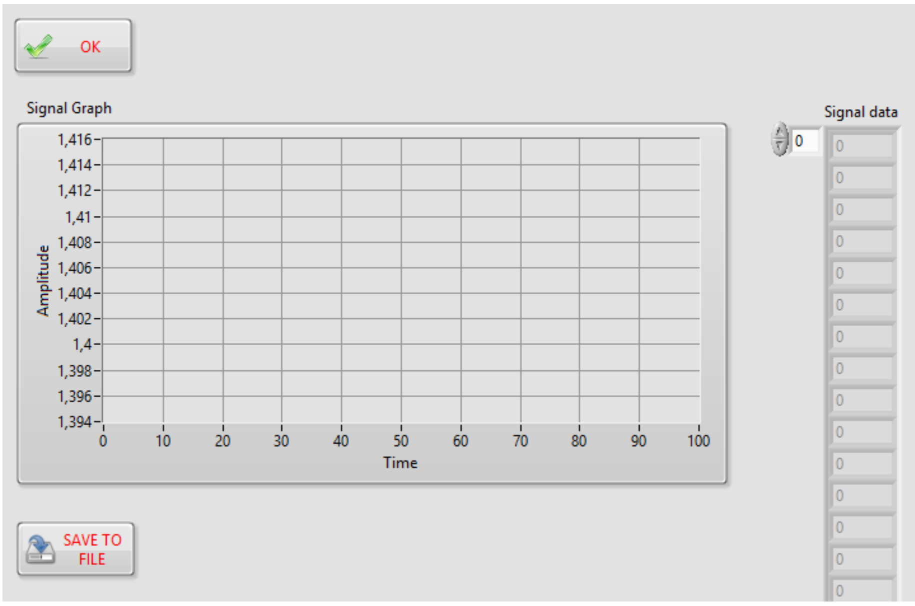
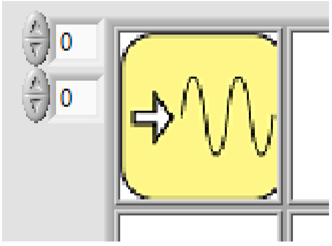


Figure 12: Graph of the analog indicator

When clicked on the button OK the pop-up window is closed and in a selected cell appears Signal indicator icon.



- XY Signal indicator is basically the same function as the Signal indicator, except it can represent a 2D array of data. The signal indicator draws the XY graph depending on the X and Y dataset. The data represented in the XY Signal indicator can be saved in a file. This file could be used as an input data set for other functions with inputs.

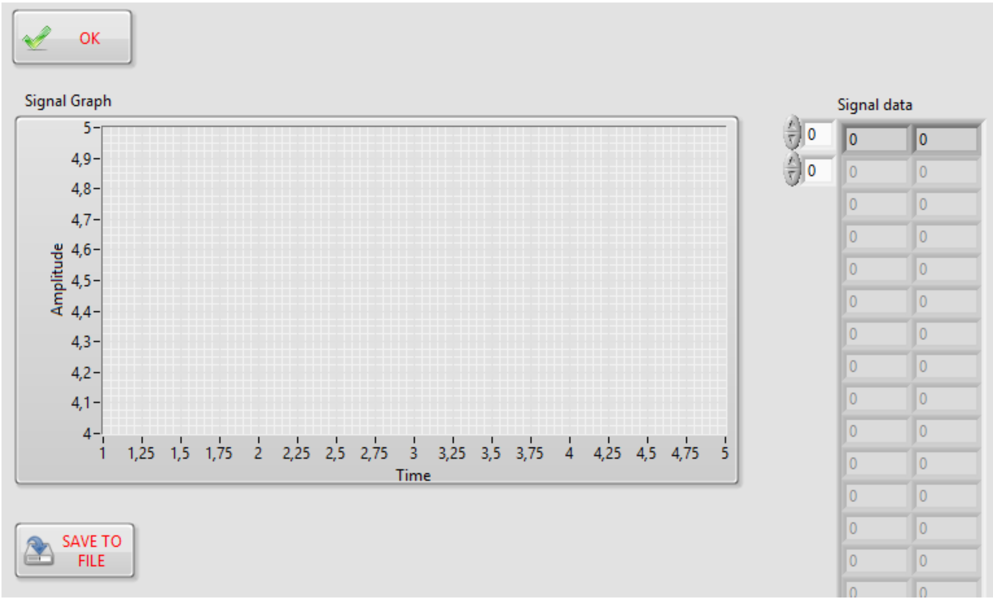
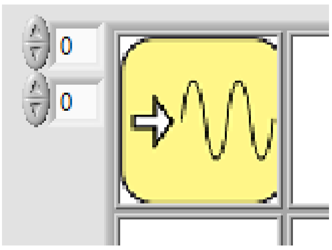


Figure 13: Graph of the XY signal indicator

When clicked on the button OK the pop-up window is closed and in a selected cell appears XY Signal indicator icon.



- Analog indicator opens a pop-up window in which is presented analog value in digital and analog displays. The analog indicator has input on which the user connectsthe output of the desired function.

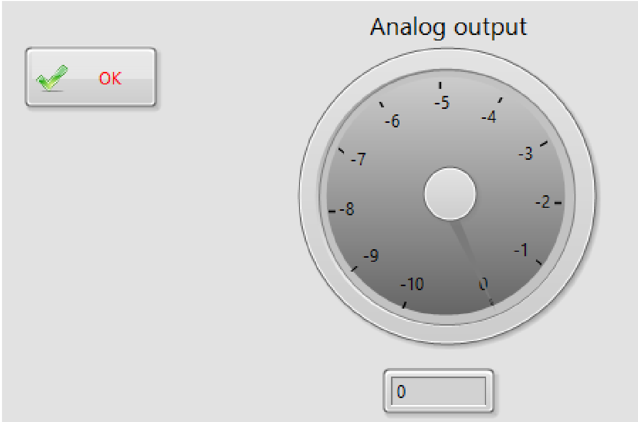
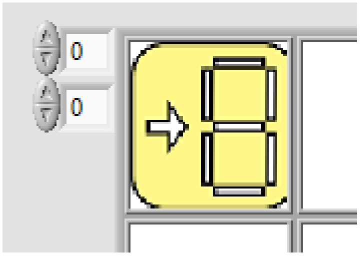


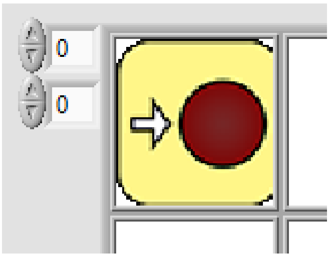
Figure 14: Analog input interface

With a click on the OK button, pop-p is closed and in the selected cell the icon appears.

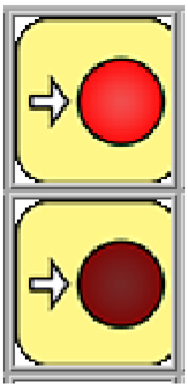


vi. Digital indicator

- Digital indicator simply display logical zero or one in the message pane.



Note: Digital indicator turn “LED ON” when connected to digital HIGH and turn “LED OFF” when connected to digital LOW.

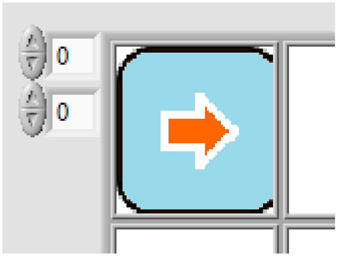


vii. Probes

Probes have similar functionality as indicators except they do not create a pop-up window and icon in the cell. Probes are analog or digital and show the current value on the selected cell. Value is shown in the message window.

- Probes
  - Analog probe
  - Digital probe
  - Forward

Under the probes group also belong Forward function block. Forward function block just forward value from input to output.



d. Measurements functions

In Measurements group user can find basic measurement methods prepared in advance. It can be seen from the picture, that some futures from measurement methodology are provided.

- Measurements
  - Bridges
    - Wheatstone-sgl
    - Wheatstone-cnt
    - Shering
    - Maxwell
  - Sensors
    - Temperature
      - Thermistor
      - Thermocouple
      - RTD
    - Illuminance
      - Photodiode
      - LDR
    - Force
      - Strain gage
  - Signal conditioning
    - Resistive divider-sgl
    - Resistive divider-cnt
    - Inverting amplifier-sgl
    - Inverting amplifier-cnt
    - Non-inverting amplifier-sgl
    - Non-inverting amplifier-cnt
    - AD converter
    - DA converter

i. Bridges

In this group user can set Wheatstone's bridges and use it in simulation or real measurement.

Bridges

- Wheatstone-sgl function opens a pop-up window with settable parameters for calculation of Wheatstone's bridge. This function requires input resistance of R1, other resistances and supply voltage could be set in a pop-up window.

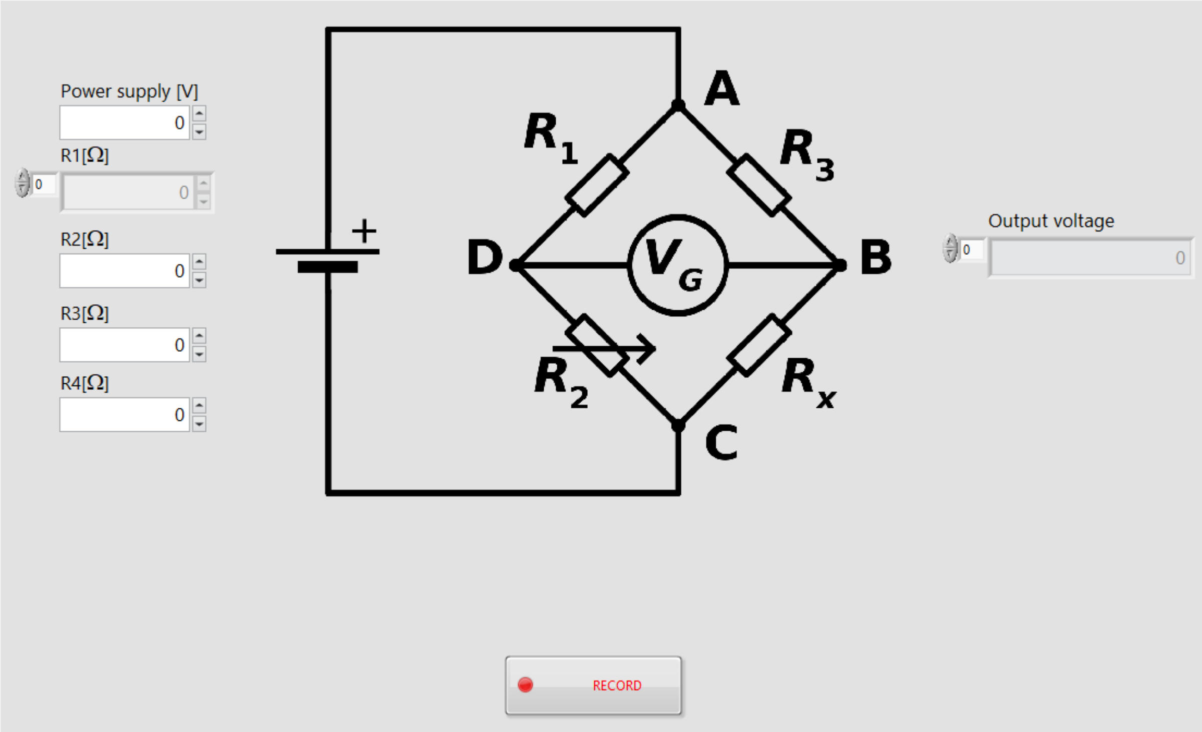
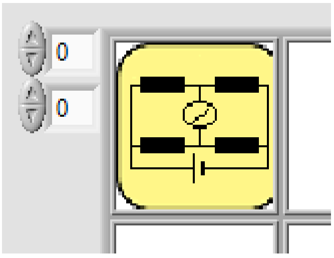


Figure 15: Wheatstone's bridge interface

With a click on the RECORD button, the calculated output voltage is sent to the output.



- Wheatstone-cnt is a continuous version of the bridge, where the unknown resistance R_x is an input and voltage V_G the output of the Wheatstone-cnt block. The block '–cnt' can be used for simulation with external signal acquisition devices.

ii. Signal conditioning

In this group of functions, the user can find resistive dividers and operational amplifiers.

Resistive dividers

- Resistive divider-sgl function implements simple resistive divider with settable voltage and resistance of R1. The resistance of R2 is defined as input in function.

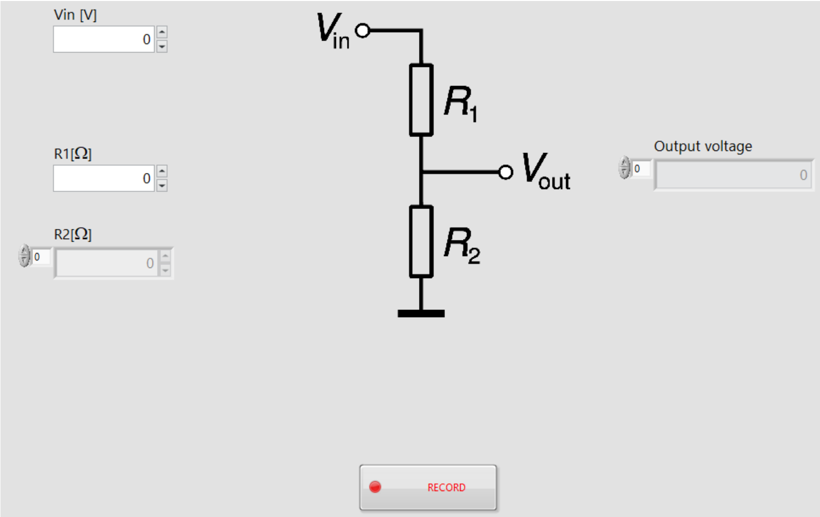
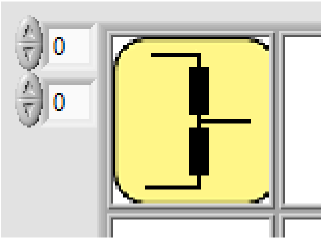


Figure 16: Resistive divider interface

When the user clicks on RECORD, the function returns Vout on output.



- Resistive divider-cnt is a continuous version of the divider, where the unknown resistance R_2 is an input and voltage V_{out} the output of the divider-cnt block. The block '–cnt' can be used for simulation and execution with external signal acquisition devices.

Operational amplifiers

- Inverting amplifier-sgl opens a pop-up window with an implemented inverting operational amplifier (op-Amp). Users can set resistance R1, meanwhile, R2 and Vin are inputs of a function.

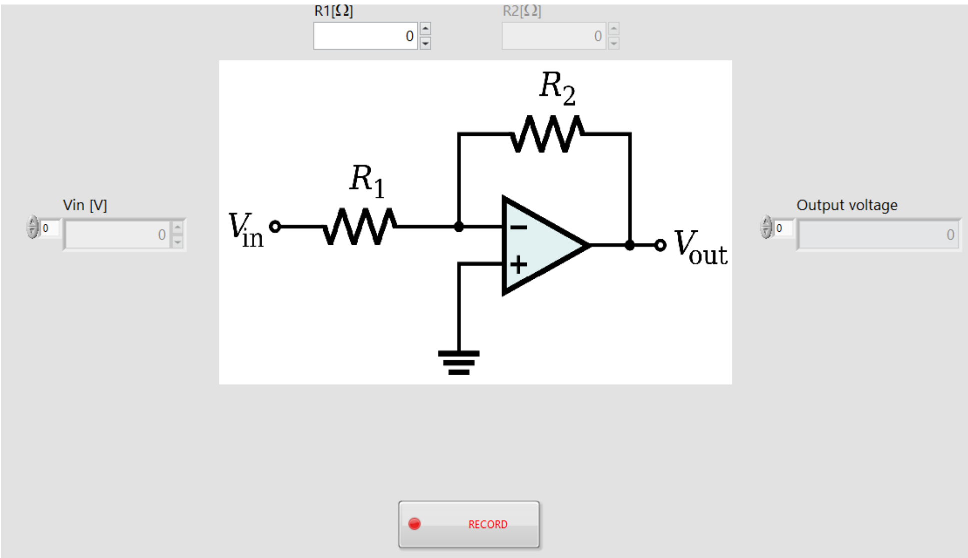
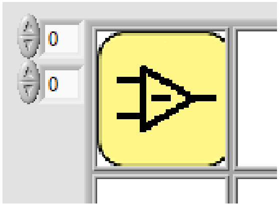


Figure 17: Inverting operational amplifier interface

With a click on RECORD, the function calculates output voltage.



- Inverting amplifier-cnt is a continuous version of the inverting op-Amp, with adjustable resistance R_1 and R_2 with continuous execution of the amplifier- V_{out}, regard to the attached input voltage V_{in}.

- Non-inverting amplifier-sgl opens a pop-up window with implemented operational non-inverting operational amplifier. Users can set resistance R1, meanwhile, R2 and Vin are inputs of a function.

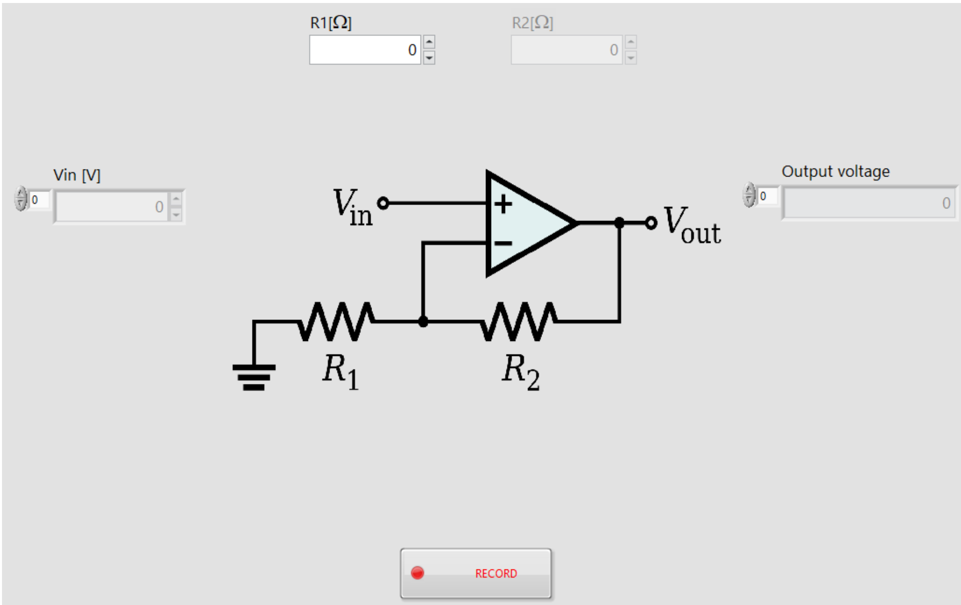
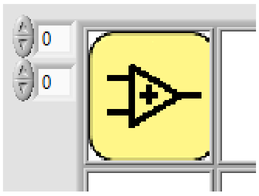


Figure 18: Non-inverting operational amplifier interface

With a click on RECORD, the function calculates output voltage.



- Non-inverting amplifier-cnt is a continuous version of the non-inverting op-Amp, with adjustable resistance R_1 and R_2 with continuous execution of the amplifier- V_{out}, regard to the attached input voltage V_{in}.

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e. DAQ Card channels

CORELA Platform supports various analog to digital devices from National Instruments. The connected devices are shown in the user interface under the Device box.

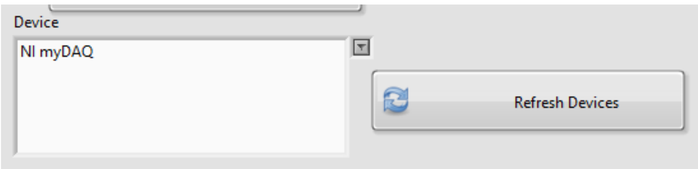


Figure 19: Device window

To convert the analog signal or generate digital signals, the user can select one of the following functions:

- DAQ Card channels
  - Analog input (100 samples)
  - Analog input (1 sample)
  - Digital input
  - Digital output
  - DMM input
    - DC Voltage
    - AC Voltage
    - DC Current
    - AC Current
    - Resistance
  - PWM

i. Analog input

Users can choose between the acquisition of a single sample or 100 samples in one of 8 analog inputs.

- Analog input (100 samples)
  - AI0 (100 samples)
  - AI1 (100 samples)
  - AI2 (100 samples)
  - AI3 (100 samples)
  - AI4 (100 samples)
  - AI5 (100 samples)
  - AI6 (100 samples)
  - AI7 (100 samples)
- Analog input (1 sample)
  - AI0
  - AI1
  - AI2
  - AI3
  - AI4
  - AI5
  - AI6
  - AI7

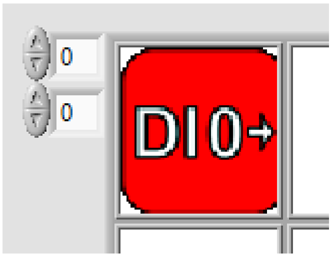
When a selected channel is chosen, the Platform takes samples at the input and saves them in function and then samples are available for processing.

ii. Digital input

Digital input functions read logic levels at inputs. Users can select one of 8 digital inputs.

- Digital input
  - DI0
  - DI1
  - DI2
  - DI3
  - DI4
  - DI5
  - DI6
  - DI7

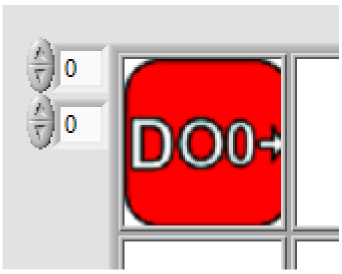
When the input is selected, the Platform reads input and store it in the selected function where value is available for future processing.



iii. Digital output

Users can set logic values on two digital outputs.

- Digital output
  - DO0



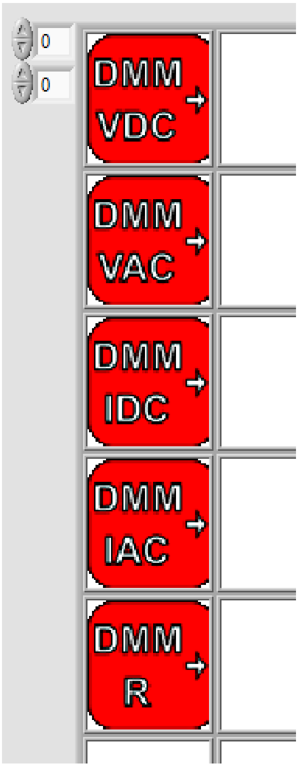
iv. DMM (digital multimeter) input

CORELA Platform supports basic measurements of DC and AC Voltage, DC and AC Current and Resistance using NI myDAQ hardware.

- DMM input
  - DC Voltage
  - AC Voltage
  - DC Current
  - AC Current
  - Resistance

Users can select DC voltage ranges from 200 mV to 60 V, AC voltage from 200 mV to 20 V, DC and AC current from 20 mA to 1 A and resistance from 200 Ohms to 20 MOhms.

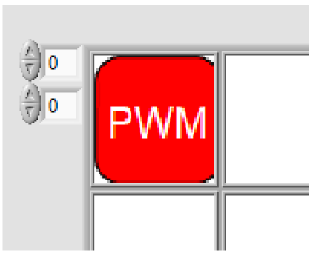
- DMM input
  - DC Voltage
    - DC Voltage (60 V)
    - DC Voltage (20 V)
    - DC Voltage (2 V)
    - DC Voltage (200 mV)
  - AC Voltage
    - AC Voltage (20 V)
    - AC Voltage (2 V)
    - AC Voltage (200 mV)
  - DC Current
    - DC Current (1 A)
    - DC Current (200 mA)
    - DC Current (20 mA)
  - AC Current
    - AC Current (1 A)
    - AC Current (200 mA)
    - AC Current (20 mA)
  - Resistance
    - Resistance (20 MOhms)
    - Resistance (2 MOhms)
    - Resistance (200 kOhms)
    - Resistance (20 kOhms)
    - Resistance (2 kOhms)
    - Resistance (200 Ohms)



f. PWM (Pulse Width Modulation)

CORELA Platform is capable to generate various PWM signals on DAQ (DA – digital to analog) outputs.

PWM Users can set the duty-cycle value of the PW-modulator. The span of the duty-cycle value is in the range of 0-100%.

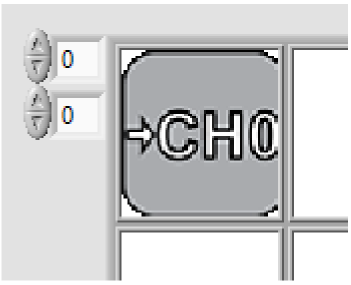


g. Database connection

The main future of the CORELA Platform is available to send calculated, simulated or measured data to the Moodle platform, where another user can access those data over the internet. For that purpose, Platform offers a set of functions under the Database connection.

- Database connection
  - Input channel
    - CH in 1
    - CH in 2
    - CH in 3
    - CH in 4
    - CH in 5
    - CH in 6
    - CH in 7
    - CH in 8
  - Output channel
    - CH out 0
    - CH out 1
    - CH out 2
    - CH out 3
    - CH out 4
    - CH out 5
    - CH out 6
    - CH out 7

When the user wants to send data to Moodle, they must choose one of 8 Output channels and vice versa if they want to read data from Moodle they must choose one of 8 Input channels.



Warning: For successful connection to Moodle, the user must have validated Username and User ID

h. Electronic components

Under Electronic components, the user can find basic passive and active electronic components.

- Electronic components
  - Pasive
    - Resistor
    - Capacitor
    - Inductor
  - Active
    - Diode
    - Transistor

i. Passive

- Resistor opens a pop-up window with the through-hole color coded resistor. Users can select colors of resistors and software to calculate the resistance.

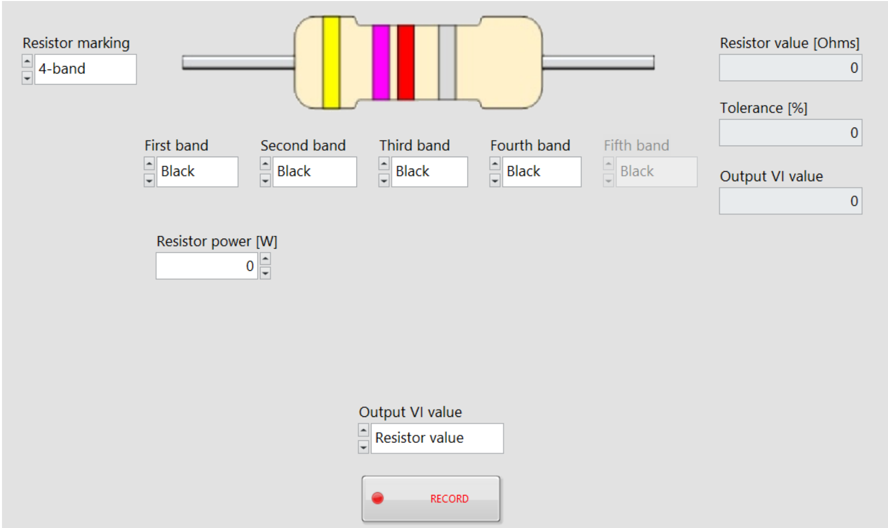
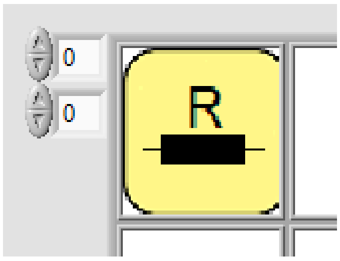


Figure 20: Resistance calculator

Selected resistance is then available as output when the RECORD button is pressed.



ii. Active

- Diode block simulates different types of diodes with real parameters, such as forward drop voltage Vd and different connection options with direct or reverse polarity.

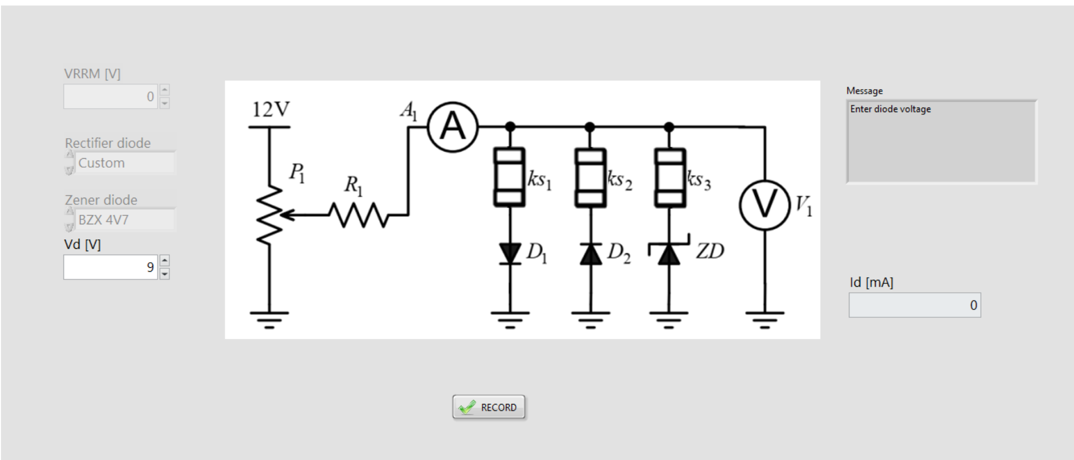
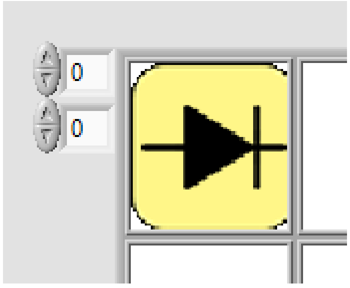
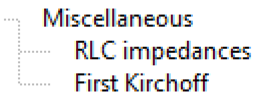


Figure 21: Diode block



iii. Miscellaneous

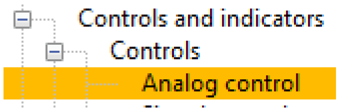
In this section, users can find custom implemented exercises like click/icon law or RLC impedances.



6 Examples

Example 1: Define two variables, multiply and display them

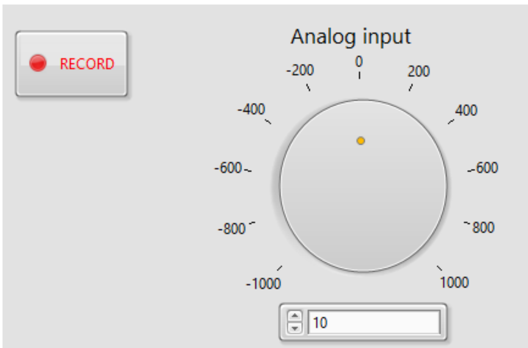
1. Start the CORELA platform and then proceed with login information. If you do not want to make a connection with Moodle, then leave the user data blank and click on 

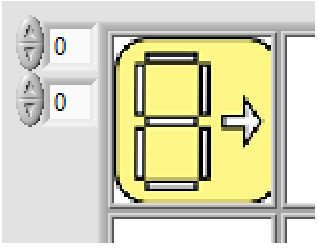
ton.
2. Define two variables by using Controls function. 

How to select and place functions?

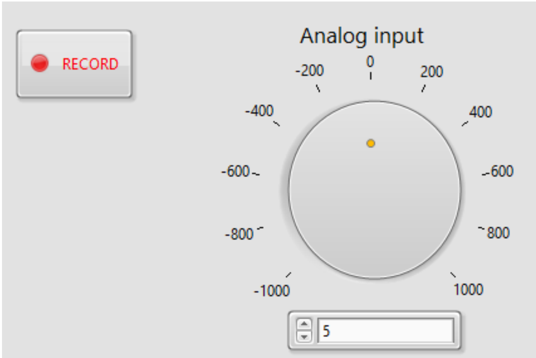
On the left pane select the desired function with click on it. When the function is selected it becomes colored. Now, choose the cell in the middle of the user interface and click on it. Depending on the function selected the pop-up window is opened for setting the parameters.

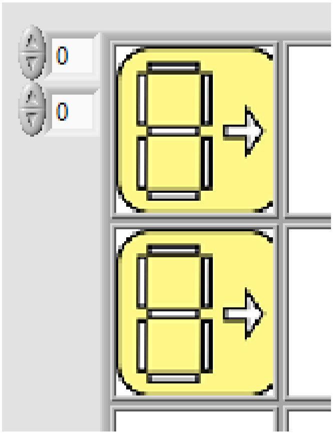
3. Place fist Analog control in the desired cell and set the desired value.



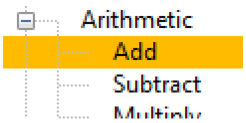


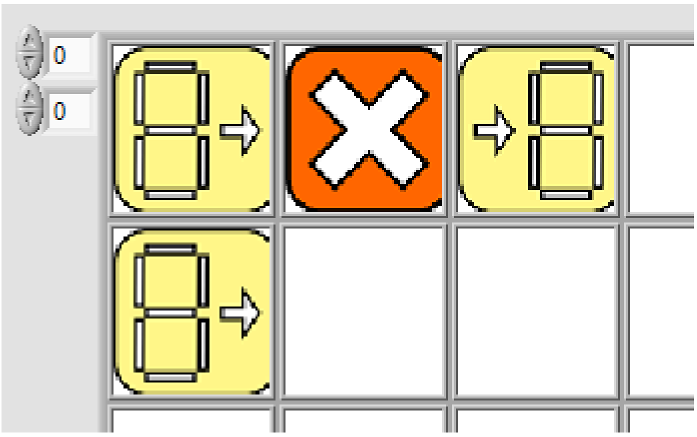
4. Repeat the procedure for the second variable and place it under the first variable.





5. Choose the arithmetic function and make the computation.





6. Display the results. There are a few ways how to represent results.
    a. The quickest way is to check the Message box on the top right corner of the screen.

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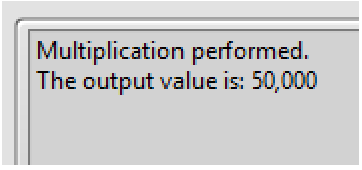
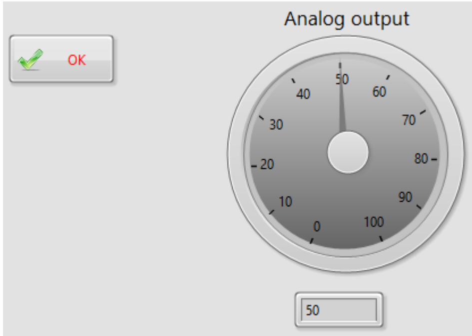
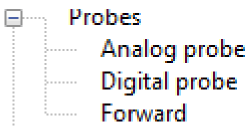


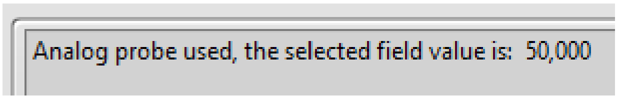
b. Another way to display the result is to use Analog indicator. When choosing Analog indicator the pop-up window display result.



c. The third way is to use probes

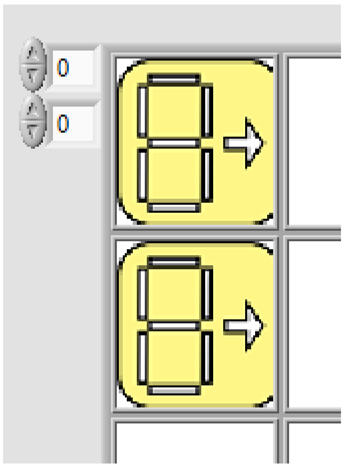


. Choose an analog probe and click on function placed in a cell on which you need to read value. The result appears in the Message box:



Example 2: Compare two analog values

1. Select two analog variables (controls), define values, and place them in cells.



2. Select the desired comparison function and place it next to the first variable.

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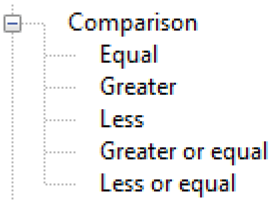
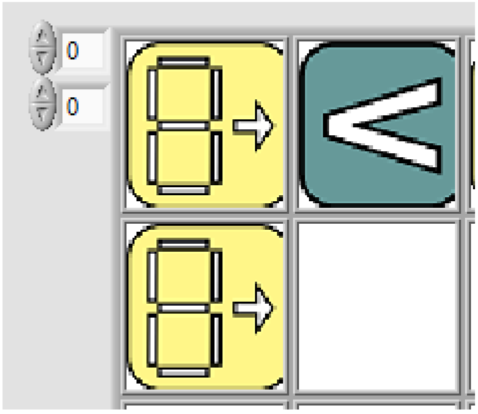
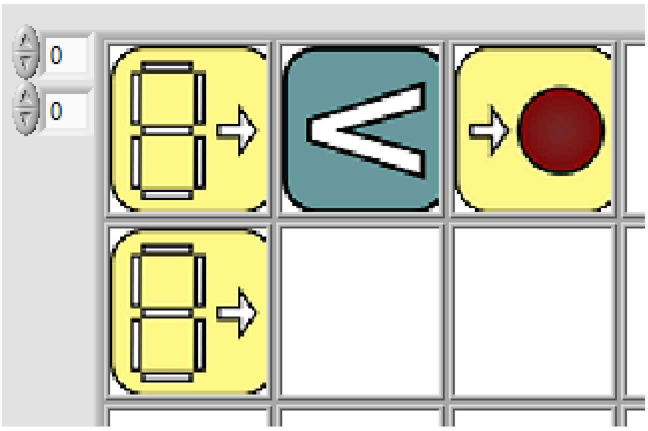




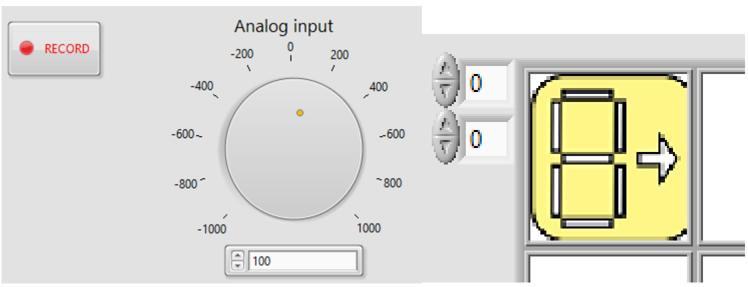
3. Select Digital indicator and check the output.



Example 3: Using of Wheatstone-sgl bridge

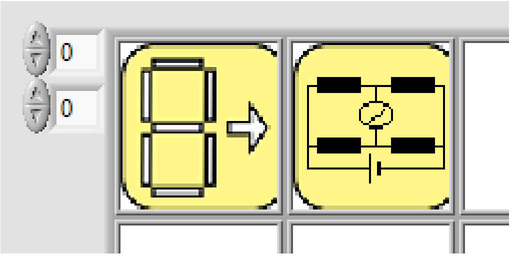
The Wheatstone-sgl bridge needs one input R1.

1. Place value of R1 in the cell.

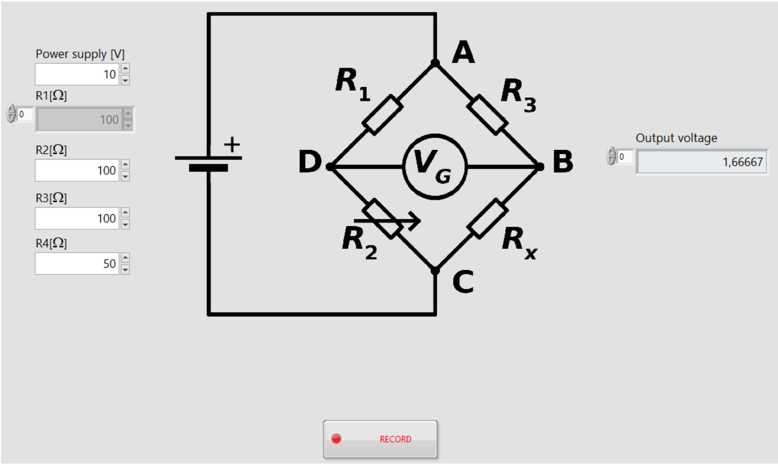


2. Open 

by placing it in the cell next to the variable.



3. Set parameters Vin, R2, R3 and R4.

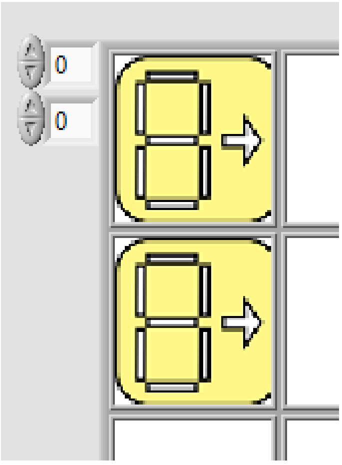


4. Click on RECORD to close the window and send calculated value to output.
5. Optionally: choose analog indicator to display the value.

Example 4: Using of Resistive divider-sgl

Resistive divider must be connected to two outputs of the analog indicator to define input voltage V_{in} and resistance of R_2.

1. Define values Vin (first cell) and R2 (second cell) using Analog controls.



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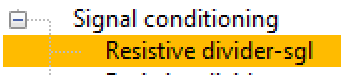
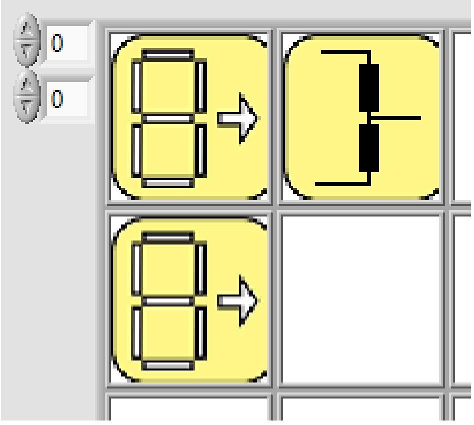
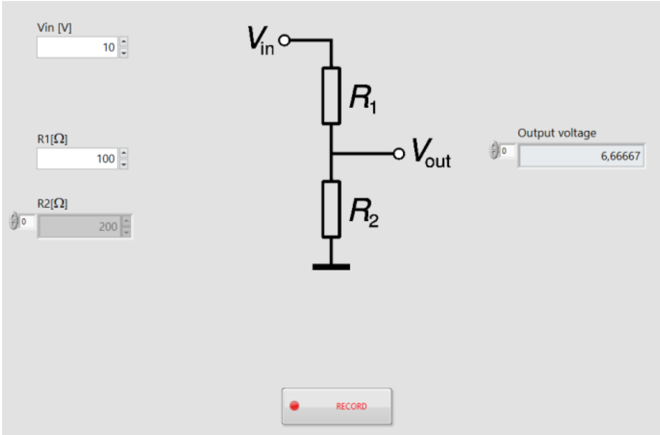
2. Select 

and put it next to the first cell.



3. Set the value of R2 and send calculated value to output by pressing RECORD.

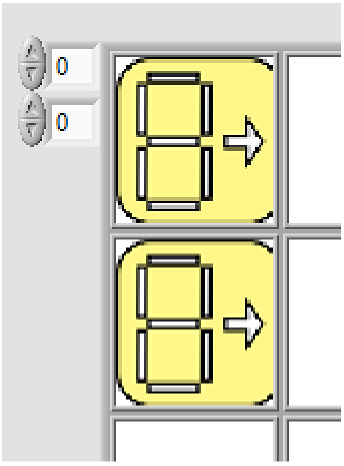


4. Optionally: choose analog indicator to display the value.

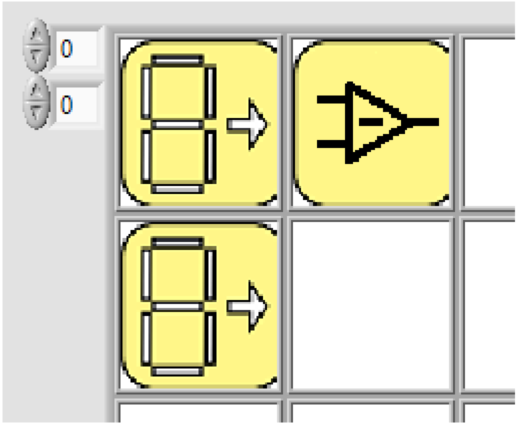
Example 5: Using of amplifiers

The platform offers a simulation of Inverting and Non-inverting amplifiers. Amplifiers demand two inputs, Vin (could be set in pop-up window) and R2.

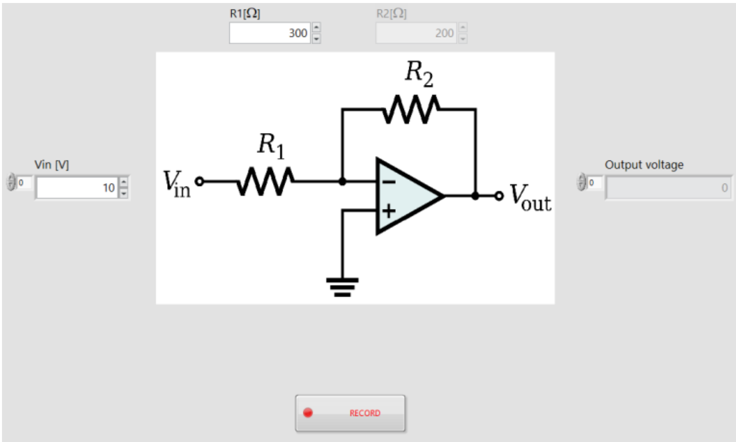
1. Define values Vin (first cell) and R2 (second cell) using Analog controls.



2. Select Inverting amplifier-sgl and put it next to the first cell.



3. Set the value of R1 and send calculated value to output by pressing RECORD.



4. Optionally: choose analog indicator to display the value.

Example 6: Using of DMM

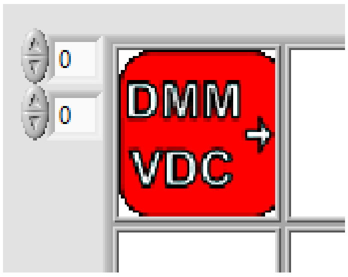
NI myDAQ connected to PC support digital multimeter measurements in the CORELA Platform. DMM functions can be found under the DAQ CARD channels tree.

- DMM input
  - DC Voltage
  - AC Voltage
  - DC Current
  - AC Current
  - Resistance

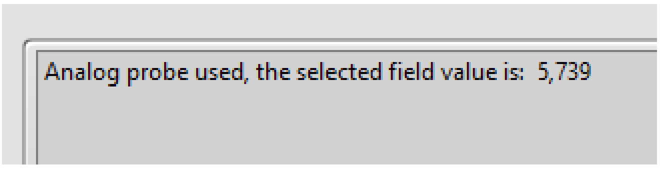
DC Voltage measurement example:

1. Connect DC voltage to input terminals of myDAQ.

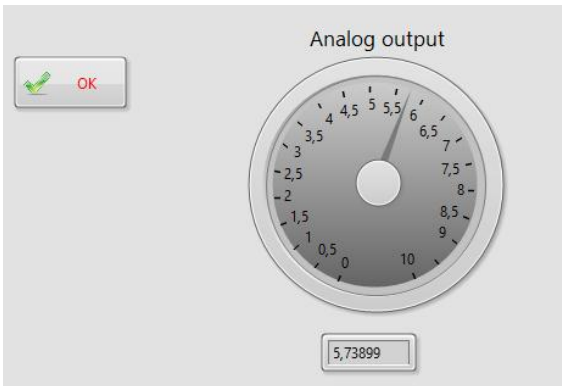
2. Select the desired DC Voltage range DC Voltage (20 V) and put it to the desired cell.



3. Display measured value with the analog probe.

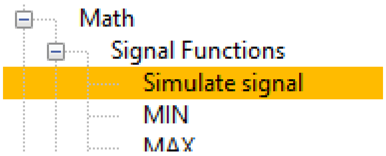


Or display value using Analog indicator.

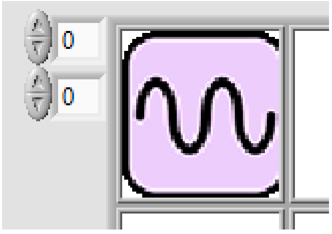


Example 7: Generate waveform and save it into the file

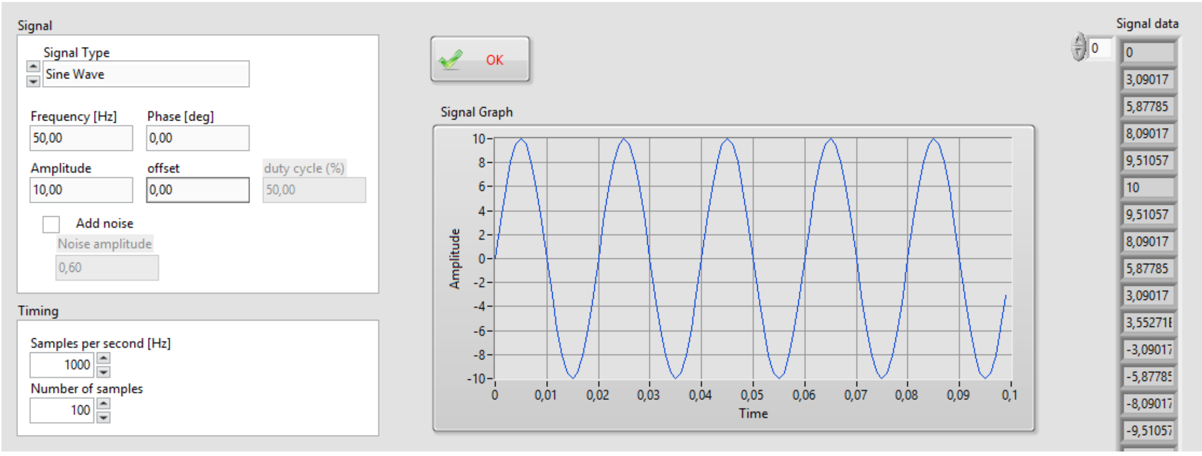
Basic signals (sine, square, triangle, saw) could be generated using Simulate signal function under Signal functions.

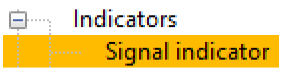


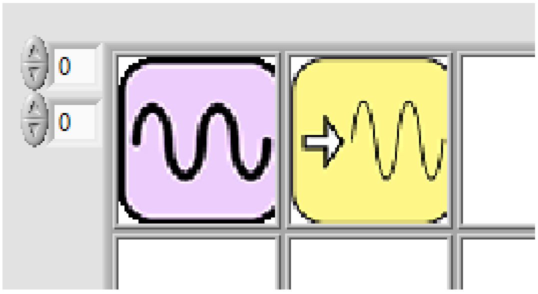
1. Select function and place it into the cell.



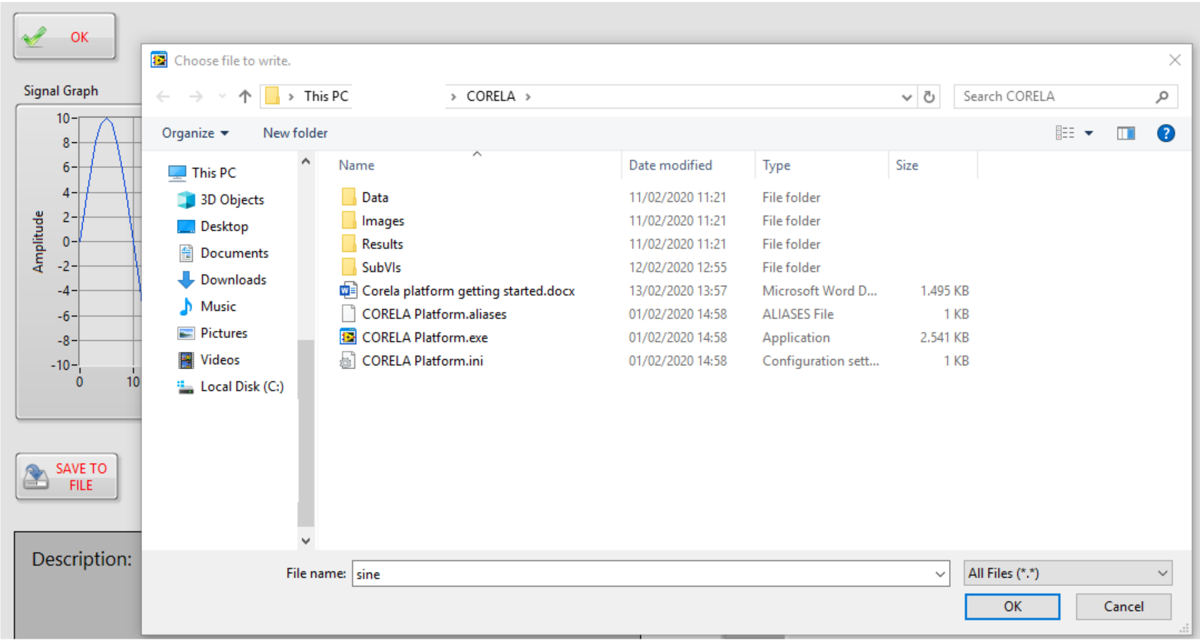
2. Select parameters of the waveform and click ok.



3. Select  under Indicators group and place it right to signal function.

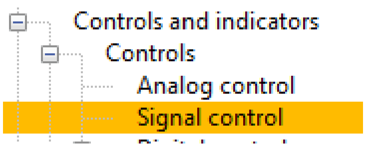


In the pop-up window select Save to file button and select folder where you want to save the file.

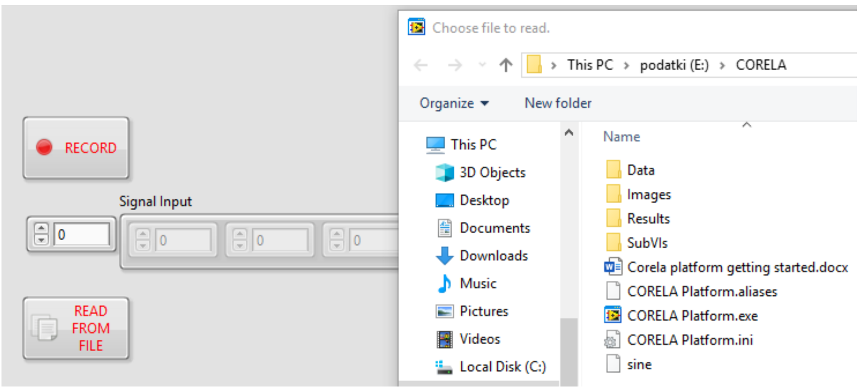


Example 8: Read waveform from file

Use the saved waveform from Example 5.

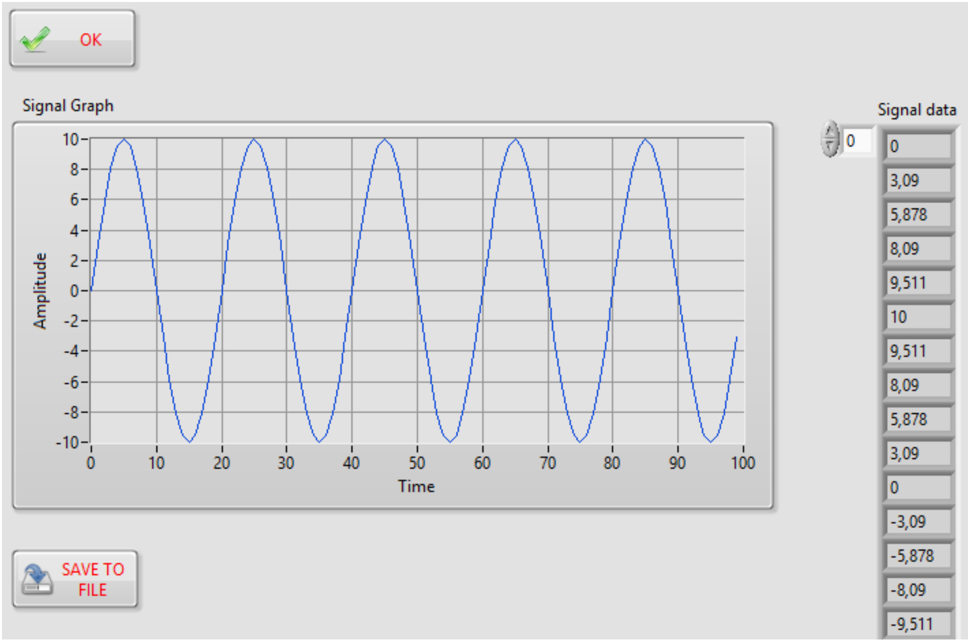
1. Select  and place it into the cell.

2. In pop-up window select read from file button and select file with saved waveform.



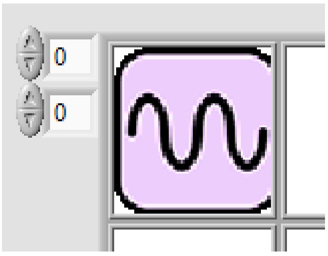
3. Click on the record button to send waveform to output.

4. Display waveform from the file. Select Indicators → Signal indicator and place it next to the Signal control function.The pop-up window shows the signal from a file.

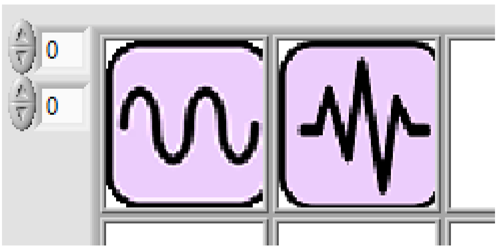


Example 9: Calculate the frequency of the signal

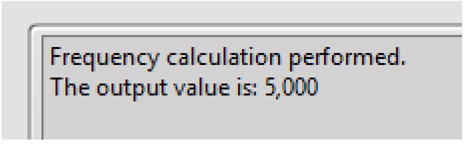
1. Generate signal using Signal Functions → Simulate signal.



2. Select Frequency function and place it next to the Simulate signal.

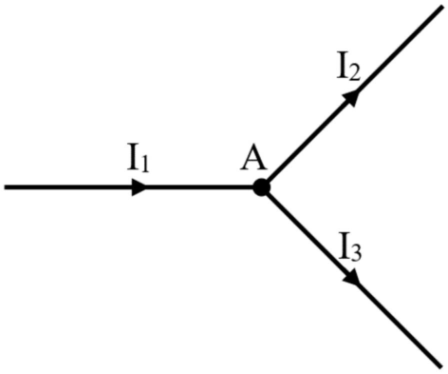


3. Results appear in the Message window.



Example 10: First Kirchhoff law

The aim of this exercise is confirmation of the first Kirchoff law by simulation and realization of a simple electrical circuit. The first Kirchoff law states “the sum of currents that enter or leave a given junction of the electrical circuit is equal to zero”. The junction is a point where at least three branches of the electrical circuits are joined.



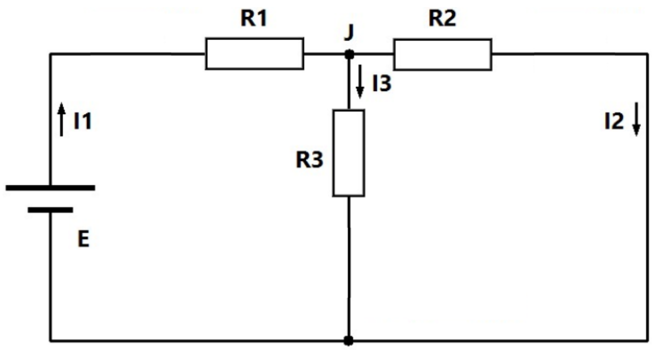
The part of the electrical circuit given in the figure above consists of three branches. The branches are joined in the junction A, and the following electrical currents are defined: I1, I2, and I3. The first Kirchoff law for the junction A of the electrical circuit is $(+I1)+(-I2)+(-I3)=0$

In the mathematical formulation of the first Kirchoff law, it is assumed then the currents entering the junction (I1 in this case) are positive, while the currents leaving the junction (I2 and I3) are negative. It is clear that the first Kirchoff law also holds in case of opposite current directions.

Work of Student 1

We are analyzing a simple electrical circuit formed by three branches. The first branch consists of a voltage generator E and resistor R1, while the remaining two branches contain the resistors R2 and R3 wired as in the figure below. The task is to determine the electrical currents I1, I2, and I3 and to check the first Kirchoff law for the junction J. To solve the electrical circuit, the following parameters are given: E=10 V, R1=100Ω, R2=470Ω, R3=47Ω.

Your task is to calculate the electrical currents in each branch of the circuit by using the recommendations given in this exercise.



The electrical currents in the circuit can be determined in different ways. One of the simpler approaches is to rearrange the electrical circuit in such a way that it contains only one branch. This can be done easily by replacing the resistors R2 and R3 with one equivalent resistor R23.

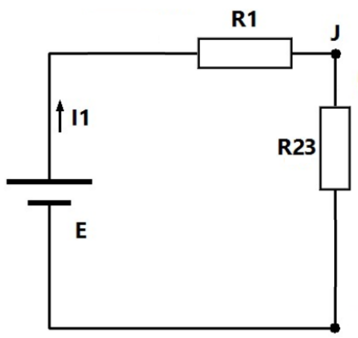
Question: in what configuration are the resistors R2 and R3?

a) Parallel b) Series

According to the configuration of the resistors R2 and R3, the equivalent resistance R23 is:

R_{23}=__________________

After replacing the resistors R2 and R3 with the equivalent resistor R23 the following electrical circuit is obtained:



By analyzes of the electrical circuit, one can conclude that we can form only one contour. The electrical current in the contour I_1 is calculated by the quotient of the voltage generators and the resistors in it:

$$I_1 = \frac{\sum E}{\sum R} = \frac{}{} = \quad mA$$

The current I_1 that flows through the circuit generates a voltage drop on the resistors R1and R23. The sum of the voltages of the resistor R1 and R23 are equal to the voltage of the generator E. To calculate the electrical currents I2and I3we initially have to determine the voltage drop of the resistor R23. Let’s calculate the voltage V23through the equivalent resistor R23:

V_{23}=__________________

It can be noticed that the voltage V23 through the equivalent resistor R23 appears at the same time to the resistors R2 and R3. Hence, by applying the Ohms law one can calculate the electrical currents I2 and I3.

Determine the electrical currents I2 and I3 through the resistors R2 and R3:

$$I_2 = \quad mA$$

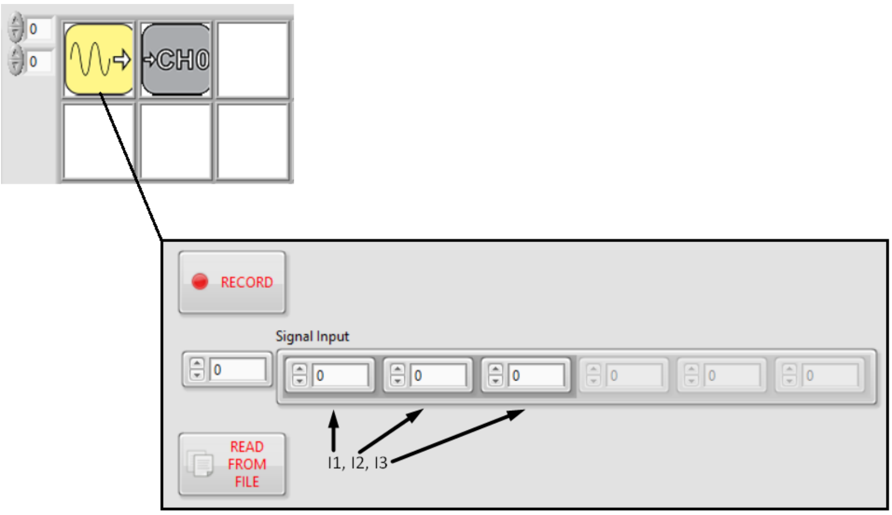
$$I_3 = \quad mA$$

Finally, we have obtained the values of the electrical currents I1, I2, and I3 from the simple electrical circuit. Now we can confirm that we know all electrical currents entering or leaving the junction J, which means that we have all the data to check the first Kirchoff law for the junction J.

Question: *what is the first Kirchoff law for junction J?*

Question: *is the first Kirchoff law fulfilled? If it is NOT fulfilled, check the calculations and solve the electrical circuit again.*

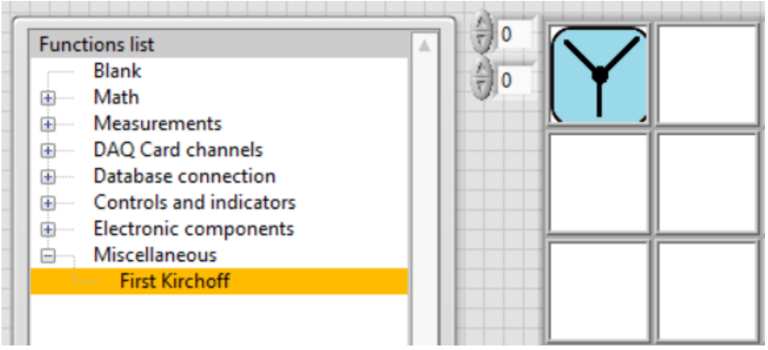
Assuming that all calculation tasks are successfully finished, and the first Kirchoff law is confirmed, the next part of the exercise is related to posting the results into the CORELA virtual platform. The task is to record the calculated electrical currents I1, I2, and I3 into the CORELA database (Channel 0). Implement the following programming sequence into the platform:



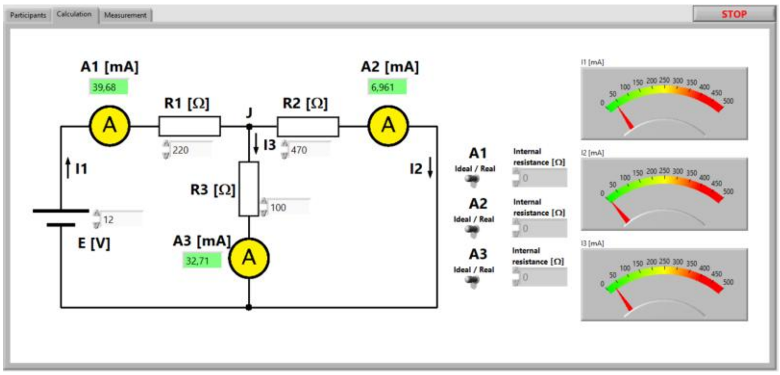
Note: *posting the results into the CORELA database is possible only after successful user registration and login. For assistance, refer to the CORELA user guide.*

Work of Student 2

In this part of the exercise, we perform a simulation of the ideal electrical circuit given in section 2. Under the “ideal” electrical circuit we assume a circuit where all elements have exact and time invariable parameters. The simulation aims to check the theoretical calculations of the electrical currents I1, I2, and I3 from section 2. The simulation of the electrical circuit is realized with the CORELA virtual platform. Run the application and insert the virtual instrument for the first Kirchoff law located in the functions list under the menu Miscellaneous -> First Kirchoff. The application appearance is as follows:



At this point, a virtual instrument intended for the first Kirchoff law will appear. The simulation of the electrical circuit is realized by the selection of the tabulator "Calculation". The front panel of the virtual instrument is given in the following figure:



The electrical current is being measured with an instrument called ampermeter. In this part of the exercise, we assume that the ampermeter is an ideal instrument, i.e. its internal impedance is equal to zero. Hence, the electrical circuit will remain identical if we replace the ampermeters with wires (short circuit). The configuration of the ideal ampermeter (A1, A2, and A3) is realized with the controls "ideal/realistic", by turning them to the "ideal" position.

Each ampermeter is wired in series in the branch whose current is being measured. Hence, the ampermeter A1 is used to measure the electrical current I1, the ampermeter A2 for the current I2, and the ampermeter A3 for the current I3. The measured electrical currents are shown on the indicators A1, A2, and A3.

Your task is to simulate the electrical circuit from section 2 and determine the electrical currents in all branches.

The simulation of the electrical circuit is realized by entering the following parameters: E=10V, R1=100Ω, R2=470Ω, R3=47Ω. Write the ampermeter readings fir the electrical currents I1, I2 and I3:
I_1=

I_2=

I_3=

Question: are the values from the simulation identical to those obtained by theoretical calculations in section 2? If they are NOT, check the simulation settings and theoretical calculations all over again.

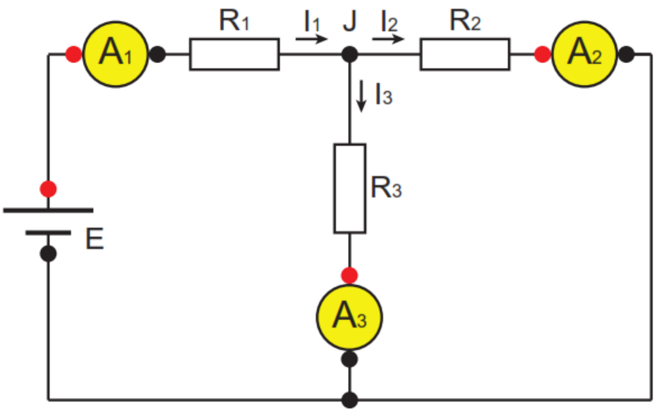
Check the first Kirchoff law by using the obtained values from the simulation:

Question: *what is the behaviour of the electrical currents I1, I2, and I3 in the electrical circuit if the voltage source decreases (from 10 V to 5 V)?*

The next part of the exercise is related to posting the simulation results into the CORELA virtual platform. The task is to record the simulated values for the electrical currents I1, I2, and I3 into the CORELA database (Channel 1). Implement the following programming sequence into the platform:

Work of Student 3

This part of the exercise is related to the practical realization of the electrical circuit and performing realistic measurements. The aim is to test the first Kirchoff law once again, but this time in realistic conditions. To experiment we use the experimental board given in the following figure:



Your task is to realize the electrical circuit from section 3 and measure the electrical currents in all branches of the circuit.

The following hardware is used to experiment:

- Experimental board
- Variable DC power supply
- Data Acquisition Card NI-myDAQ
- Digital multimeter

We notice that the electrical circuit on the board is identical to those from sections 2 and 3. The resistors R1=100Ω, R2=470Ω and R3=47Ωare integrated into the experimental boar, while the voltage source and ampermeters are externally connected.

Task: identify the resistor values according to their colour marking. What is the resistor tolerance?

Procedure for the realization of the electrical circuit and performing experimental measurements:

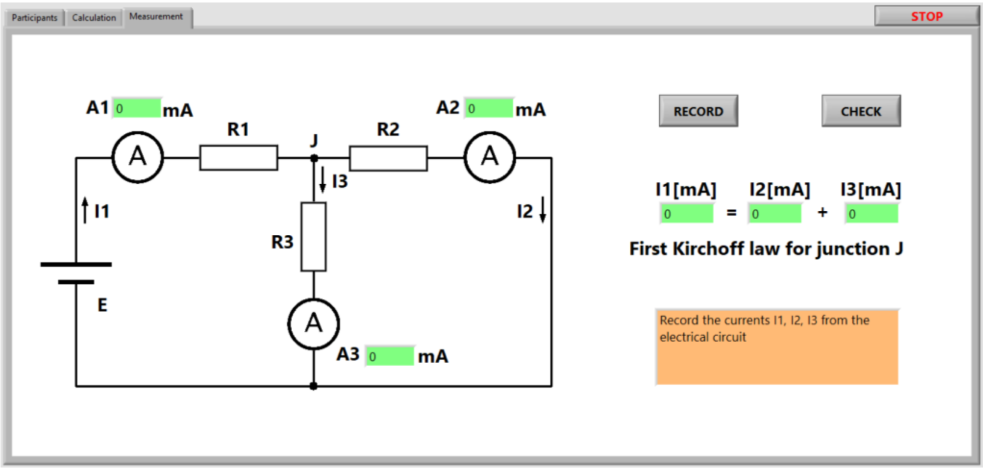
1. Configure the digital multimeter for the measurement of DC voltage and connect it in parallel with the DC power supply. Adjust the DC voltage to 10 V.

   Be careful in the proper selection of the measurement terminals and the measurement range of the instrument.

2. Put short circuits between the terminals for the amperemeters A1, A2, and A3 of the experimental board.
3. Connect the DC power supply to the voltage generator terminals E on the experimental board.
   Be careful about the polarity of the voltage generator terminals. The positive terminal on the experimental board is marked with red color, while the negative terminal with black colour.

Now we have realized the electrical circuit. The next steps are related to the measurement of the electrical currents in all branches of the circuit.

4. Activate the tabulator "Measurement" from the virtual instrument. The following front panel appears:



5. Remove the short circuit from the terminals of the ampermeter A1. The short circuits of the ampermeters A2 and A3 remain. Connect the current measurement terminals of the NI-myDAQ to the terminals of the ampermeter A1.
6. Press the symbol of the ampermeter A1 (the symbol will turn yellow). Then, press the control button "RECORD" on the virtual instrument. If this step is performed correctly, the measured current in the first branch will appear on the digital indicator I1 [mA].
7. Repeat steps 5 and 6 for the ampermeters A2 and A3 for the measurement of the electrical currents I2 and I3.Write down the measured values for the electrical currents by using the NI-myDAQ instrument:
   I_1=
   I_2=
   I_3=
8. To check the first Kirchoff law for the junction J press the control button "CHECK" on the virtual instrument. The orange text indicator delivers a text message concerning the first

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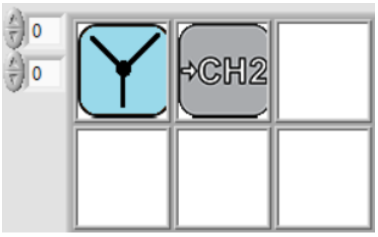
Kirchoff law for the junction J. In case the first Kirchoff law is not fulfilled, the indicators are cleared and the experiment must be repeated from step 4.

9. Compare the measurements for the electrical currents with the NI-MYDAQ with the theoretical calculations from section 2 and the simulations from section 3.

Question: *do the measured values completely match the results from the theoretical calculations and the simulations?*

Task: *Discuss with your collaborators and your teacher about the possible reasons for the mismatch between the obtained results.*

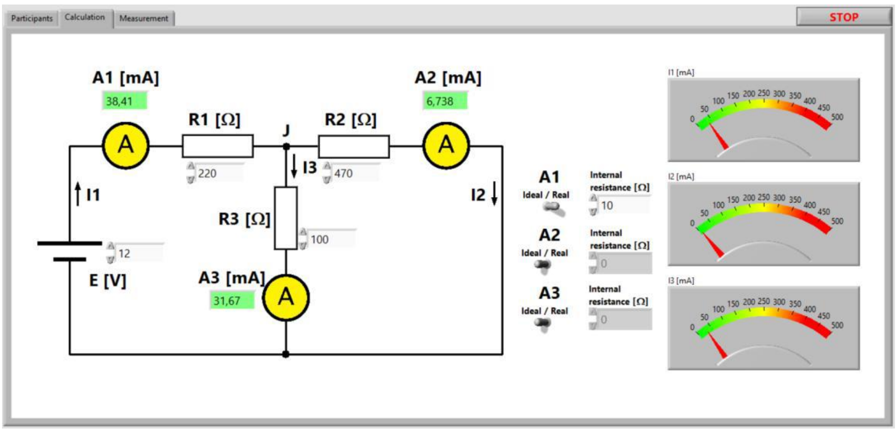
The next part of the exercise is related to posting the practical results into the CORELA virtual platform. The task is to record the measured values for the electrical currents I1, I2, and I3 into the CORELA database (Channel 2). Implement the following programming sequence into the platform:



Work of Student 2

This part of the exercise is devoted to the simulation of the electrical circuit when using realistic electrical instruments (amperemeters in this case). The real amperemeters have a small but non-zero value of the internal impedance. Such conditions change the electrical circuit and introduce differences between the expected and the measured value of the electrical current.

The simulation of the realistic electrical circuit is performed by selecting the tabulator “Calculation” from the virtual instrument. The front panel of the virtual instrument is given in the following figure:



The configuration of the realistic amperemeter for any instrument (A1, A2, and A3) is performed by using the controls “ideal/realistic”, by setting them in the “realistic” position. The internal impedance of any measuring instrument can be found in the instrument datasheet.

Your task is to perform simulation of a realistic electrical circuit and thereby to determine the electrical currents in all branches of the circuit.

Task: read (or measure it) the internal resistance of the data acquisition card NI-myDAQ when used as an amperemeter:

R_{aDAQ}=

The simulation of the realistic electrical circuit is performed by entering the measured values of the electrical components. Measure and write down the values of the electrical components of the circuit. E= _____V, R1=____Ω, R2= ____Ω, R3=____Ω. Enter the internal impedance for particular amperemeter and write down the obtained values for the electrical currents:

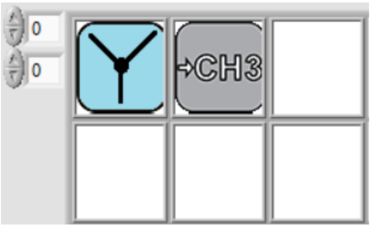
I_{1DAQ}=

I_{2DAQ}=

I_{3DAQ}=

Question: *are the obtained values from the simulation closer to the measured electrical currents from section 4? If NOT, check the simulation settings and perform the simulation again.*

The next part of the exercise is related to posting the simulated results into the CORELA virtual platform. The task is to record the measured values for the electrical currents I1, I2, and I3 into the CORELA database (Channel 3). Implement the following programming sequence into the platform:



Task: *discuss with your collaborators through the CORELA platform chat room about the issues regarding the mismatch between the calculated, simulated, and measured results.*

Conclusion

- The sum of the currents entering and leaving a given junction in the electrical circuit is equal to zero
- The amperemeter is wired in serial connection in the electrical circuit
- The realistic amperemeter has a small but non-zero internal impedance that affects the electrical circuit

7 Videos and support materials

The Corela Platform is supported by video materials, which can be freely accessed on the [Corela YouTubechannel](https://www.youtube.com/channel/UCbUJVFyf2E_s9wZSZNULbZg/) (https://www.youtube.com/channel/UCbUJVFyf2E_s9wZSZNULbZg/). The YouTube channel contains different videos and examples of how to handle and work with the platform. The videos cover many illustrative examples and operation principles of the platform, which are divided in different groups, regard to the functionality of the platform:

- Introduction and installation guide
- Math functions
- Logic functions
- Signal functions
- Measurement functions
- Real-time measurements and signal conditioning

8 Troubleshooting guide

This chapter describes the most common problems with handling a Corela platform. The solutions are given down below:

1. **Important, always run the platform with Administrative privileges (option: run as Administrator), otherwise, the platform stays inactive and no login option is allowed.**

2. **The login problem regards external hardware handling. If you have been using some external devices, which use serial interface with the COM port, they may cause the login problem in the platform. Please follow the description.**

Problem description

The workspace remains locked after the Login button press.

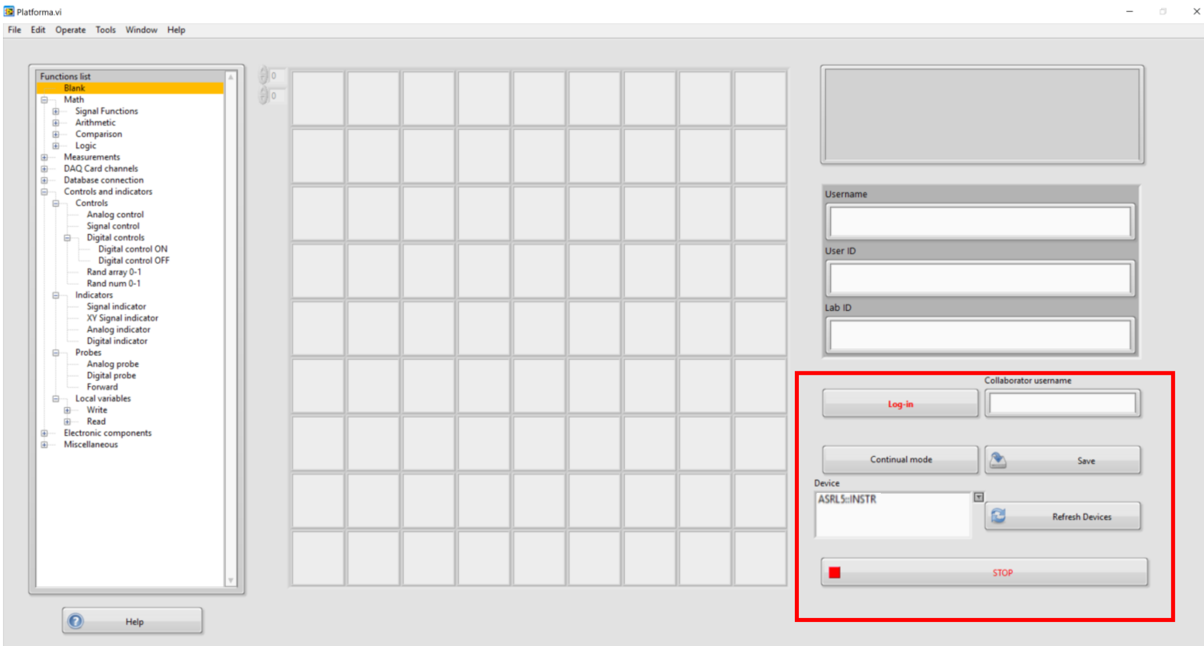


Figure 22: Inactive window after login failer

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The zoomed window of the login section of the platform. The device message box shows an external device as 'ASRL5::INSTR'.

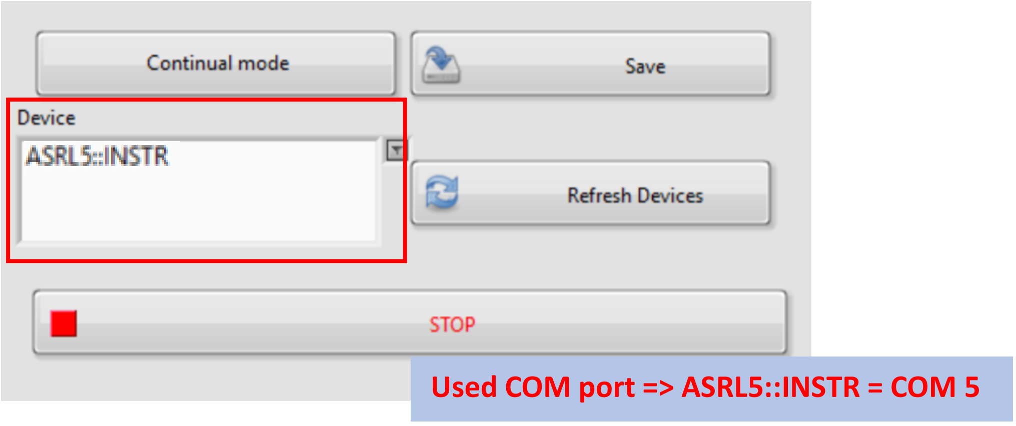

Figure 23: The device message box with an external serial device.

Further description of the problem after pressing the stop button.

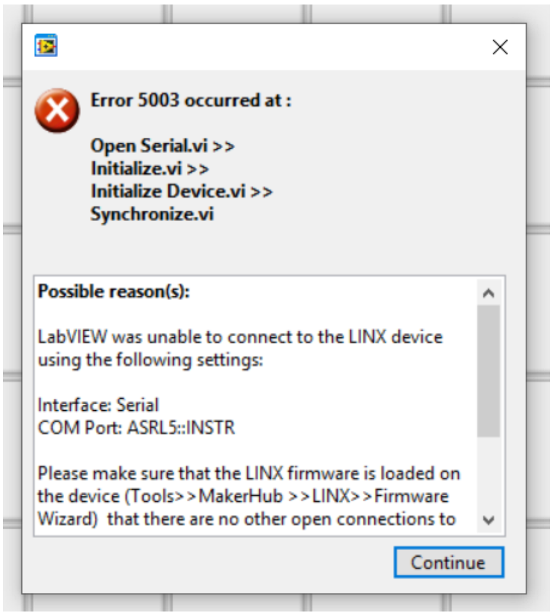

Figure 24: Platform error message.

Solution

Run Device Manager on the computer and check the serial interfaces:

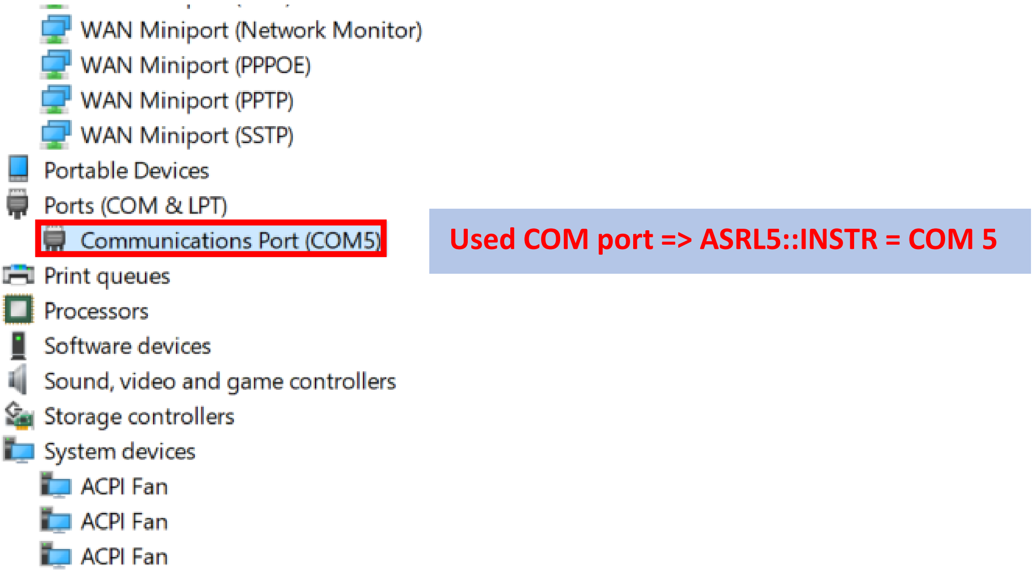

Figure 25: Device Manager with used port: COM5.

Remove or disable the assigned serial.

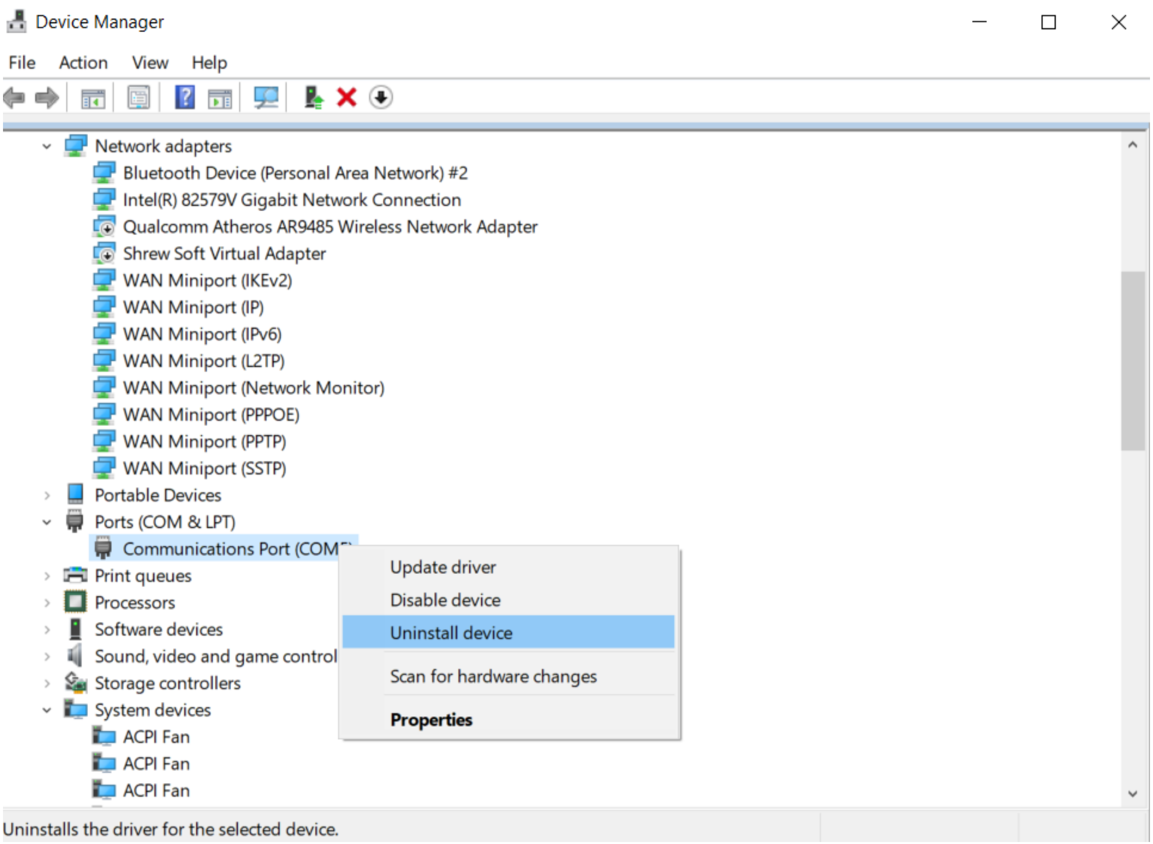

Figure 26: Remove or disable a device on port COM5.

Run CORELA platform again (*device message box need to be empty, there is no assigned or used serial port anymore*)

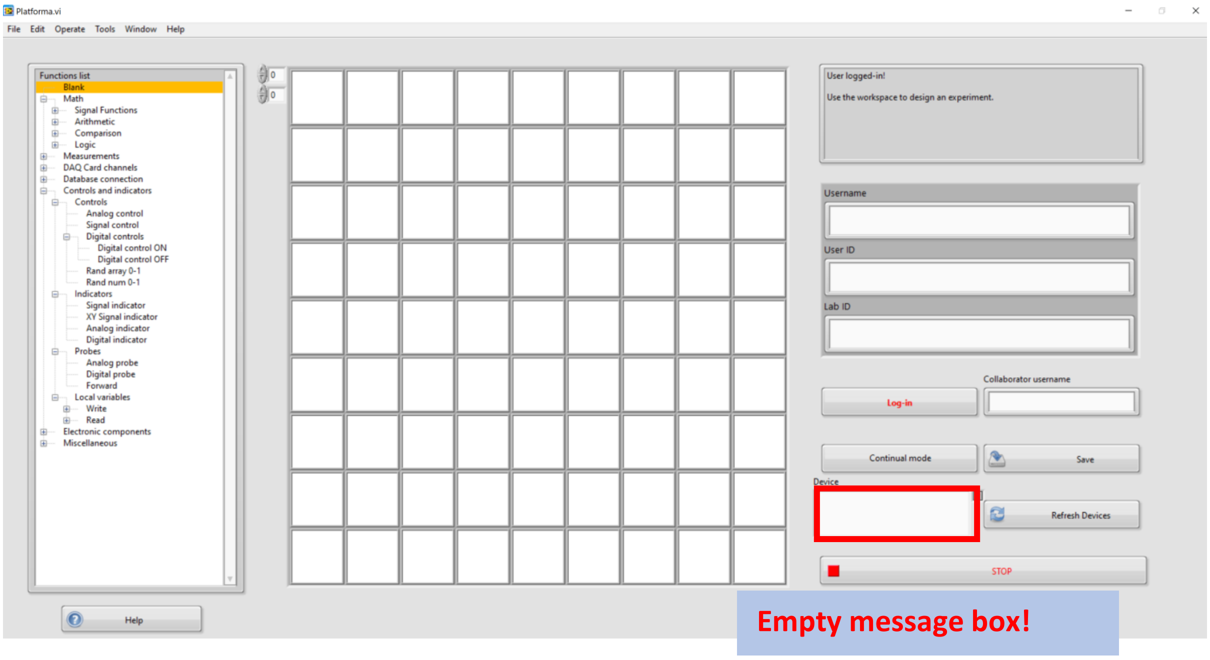

Figure 27: Working platform.