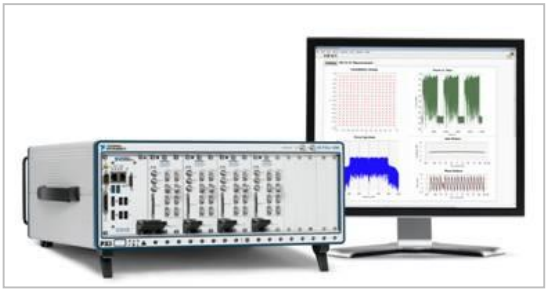
LabVIEW™
Custom Exercises



LabVIEW™ Custom Exercises

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For further support information, refer to the *Additional Information and Resources* appendix. To comment on National Instruments documentation, refer to the National Instruments Web site at ni.com/info and enter the info code feedback.

Contents

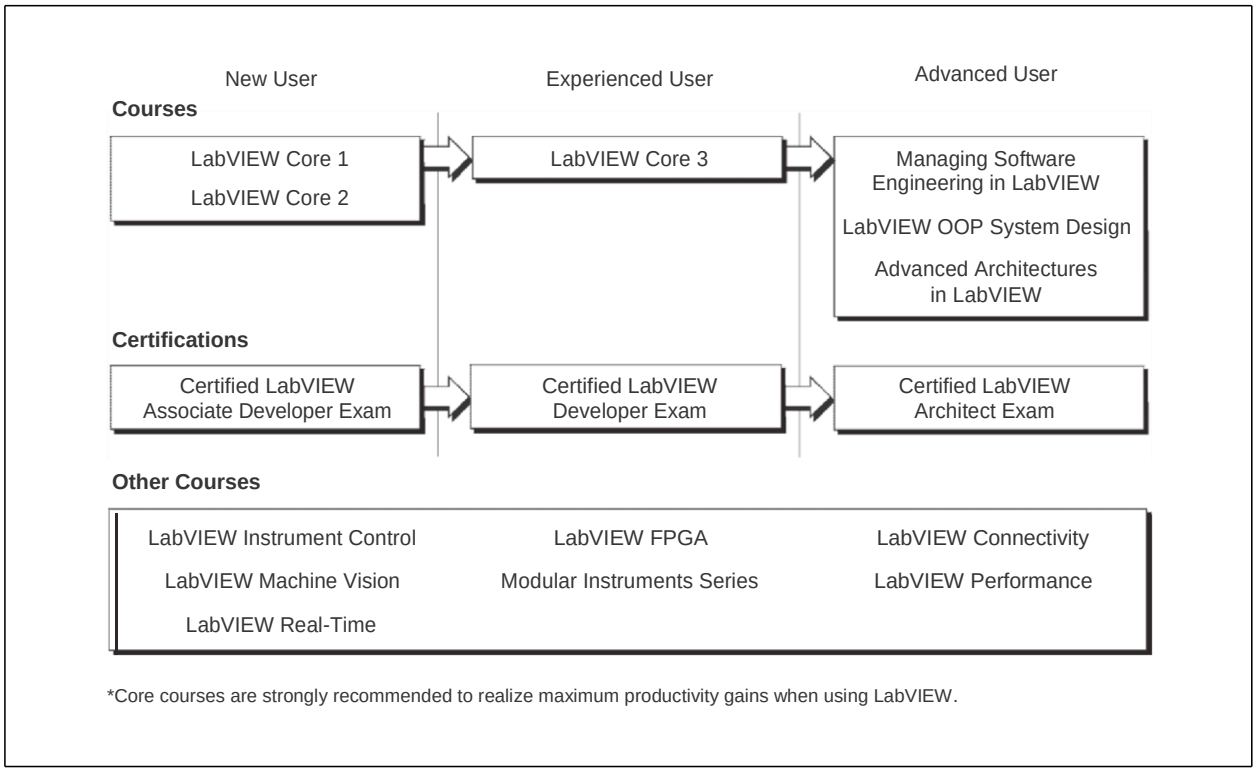
Student Guide

Thank you for purchasing the *LabVIEW Core 1* course kit. You can begin developing an application soon after you complete the exercises in this manual. This exercise manual and the accompanying course manual and software are used in the three-day, hands-on *LabVIEW Core 1* course.

You can apply the full purchase of this course kit toward the corresponding course registration fee if you register within 90 days of purchasing the kit. Visit `ni.com/training` for online course schedules, syllabi, training centers, and class registration.

Note For course and exercise manual updates and corrections, refer to `ni.com/info` and enter the info code `core1`.

The *LabVIEW Core 1* course is part of a series of courses designed to build your proficiency with LabVIEW and help you prepare for NI LabVIEW certification exams. The following illustration shows the courses that are part of the LabVIEW training series. Refer to `ni.com/training` for more information about NI Certification.



Exercise 1 Temperature Simulation VI

Implementation

Build the following front panel and modify the controls and indicators as shown on the front panel in Figure 4-5 and described in the following steps.

1. Open a blank VI.

2. Save the VI as `Simulate Temperature.vi` in the `<Exercises>\LabVIEW Exercises` directory.

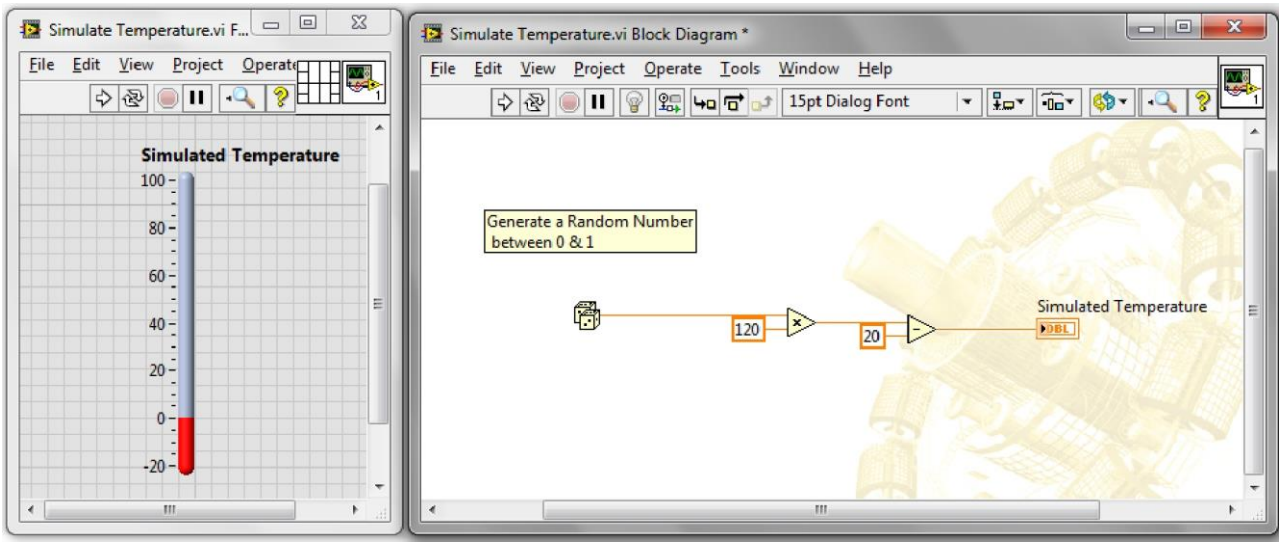
3. Create the **Simulated Temperature** output.

   ❑ Add a numeric thermomoter indicator to the front panel window.

   ❑ Label the control `Simulated Temperature`.

   ❑ Modify the Lower Limit of the Indicator by clicking on the 0 showing on the scale and selecting -20.

Create the following block diagram. Refer to the following steps for instructions.



4. Generate a random number integer between -20 and 100.

- ❑ Add the Random Number (0-1) function to the block diagram. The Random Number (0-1) function generates a random number between 0 and 1.

- ❑ Add the Multiply function to the block diagram. The Multiply function multiplies the random number by the **y** input to produce a random number between 0 and **y**.

- ❑ Wire the output of the Random Number function to the **x** input of the Multiply function.

- ❑ Right-click the **y** input of the Multiply function, select **Create»** **Constant** from the shortcut menu, enter `120`, and press the <Enter> key to create a numeric constant.

Add the subtract function to the block diagram. The subtract function modifies the random number range by subtracting the **y** input to produce a random number between -20 and **100**.

- ❑ Wire the output of the Multiply function to the **x** input of the Subtract function.

- ❑ Right-click the **y** input of the Multiply function, select **Create»** **Constant** from the shortcut menu, enter `20`, and press the <Enter> key to create a numeric constant.

- ❑ Wire the output of the Subtract Function to the **Simulated Temperature** Indicator which was previously created.

15. Save and run the VI.

Exercise 2 Continuous Temperature Simulation VI

Implementation

1. Open the Simulate Temperature VI and modify the block diagram by following the steps below.

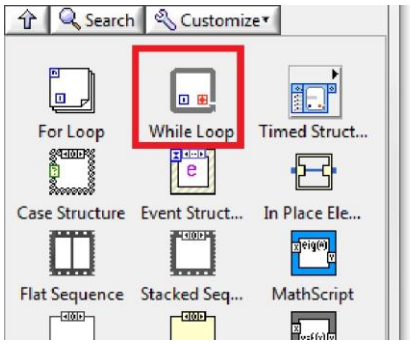
2. Save the VI as `Continuous Simulate Temperature.vi` in the `<Exercises>\LabVIEW Exercises` directory.

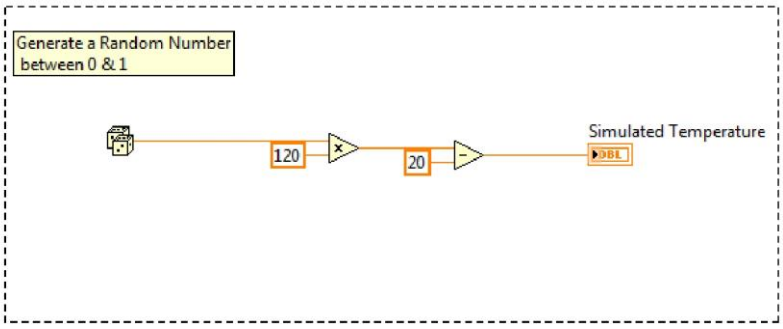
3. Create the **While Loop**.

   ❑ Locate the **While Loop** structure in the functions palette under Programming >> Structures.

   ❑ Select the while loop by left clicking on it.

   ❑ Click and drag the loop over the entire code present on the block diagram.



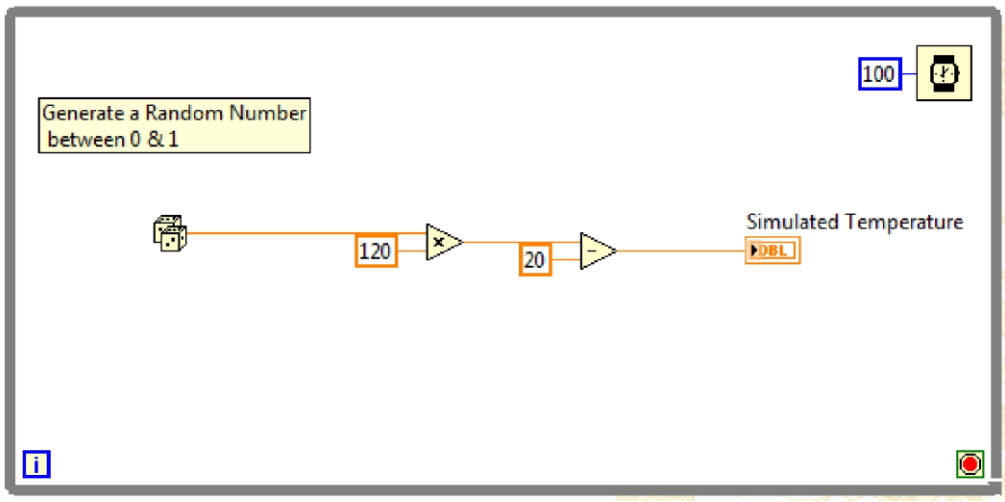


4. Create a 100 ms iteration time.

   ❑ Open the functions palette and go to Programming >> Timing and select the Wait Function

   ❑ Place the Wait Function inside the while loop

   ❑ Right Click on the Wait function Left Terminal and select create Constant and chage the value of the constant to 100



5. Run the VI

   ❑ Notice that the Run button shows an a broken arrow indicating an error

   ❑ Click on the error to see what is its cause.

   ❑ Correct the error by right clicking on the while loops conditional terminal and selecting Create >> Control.

Exercise 3 Arrays

Implementation

1. Open the Continuous Temperature Simulation VI and modify the block diagram by following the steps below.

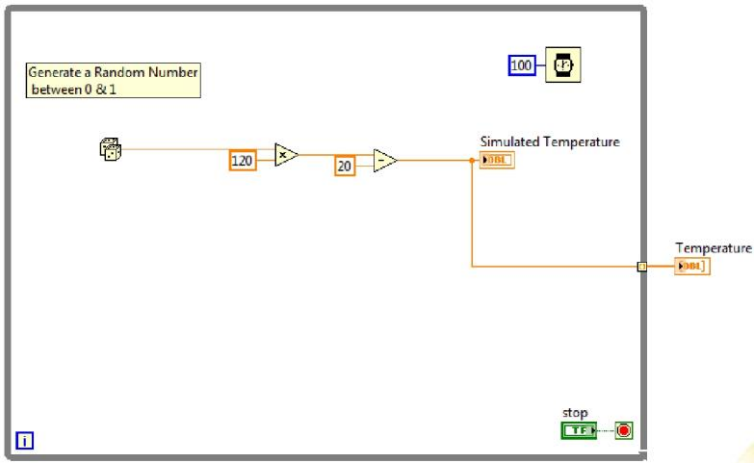
2. Save the VI as `Arrays.vi` in the `<Exercises>\LabVIEW Exercises` directory.

3. Create an array containing the temperature data

   ❑ Wire the output of the subtract function to the border of the while loop.

   ❑ Now you will see a solid color tunnel on the right border.

   ❑ Right click on the tunnel and select enable indexing.



4. Create and Array Indicator

   ❑ On the front panel, open the controls palette and go to the Array, Cluster and Matrix Category and place an Array on the front panel.

   ❑ Go to the numeric category, choose a Numeric Indicator and drag the indicator into the empty array container on the front panel

   ❑ Now the two items will merge to form a Numeric Array Indicator.

   ❑ On the block diagram, wire the right terminal of the tunnel of the while loop to the array indicator (Make sure the array indicator is outside the while loop.).

5. Run the VI and monitor the Array Indicator

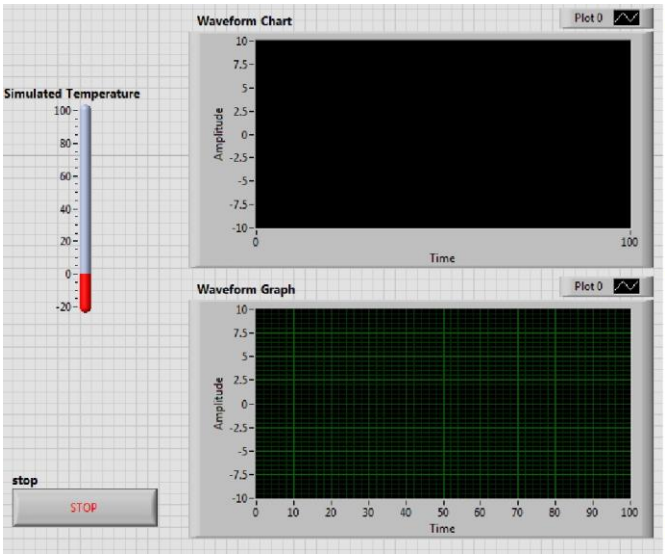
   ❑ Notice that the indicator will not contain any values until you stop running the program, This is because the while loops tunnel will not generate any output until the loop stops execution. Thus the info will only be available after the loops stops.

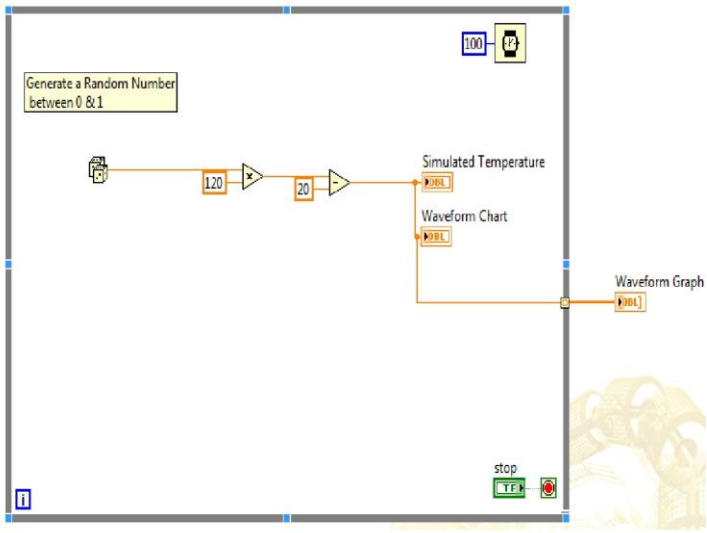
Exercise 4 Graphs and Charts

Implementation

1. Open the Arrays VI and modify the block diagram by following the steps below.

2. Save the VI as `Graphs and Charts.vi` in the `<Exercises>\LabVIEW Exercises` directory.





3. Add a Waveform Chart to display the Temperature data.

   ❑ On the front panel, go to the Graph Category and choose Waveform Chart and place it on the front panel.

   ❑ Right click on the chart and select Visible Items. Check the graph palette in the shown list.

   ❑ On the block diagram, connect the output of the subtract function to the Waveform Chart

4. Add a Waveform Graph to display the Temperature data.

   ❑ On the front panel, go to the Graph Category and choose Waveform Graph and place it on the front panel.

   ❑ On the block diagram, connect the right terminal of the tunnel to the Waveform Graph.

5. Run the VI and monitor the Array, Chart and Graph Indicator

   ❑ During runtime, right click on the Waveform Chart and select Update Mode. Examine how different update modes affect the output display.

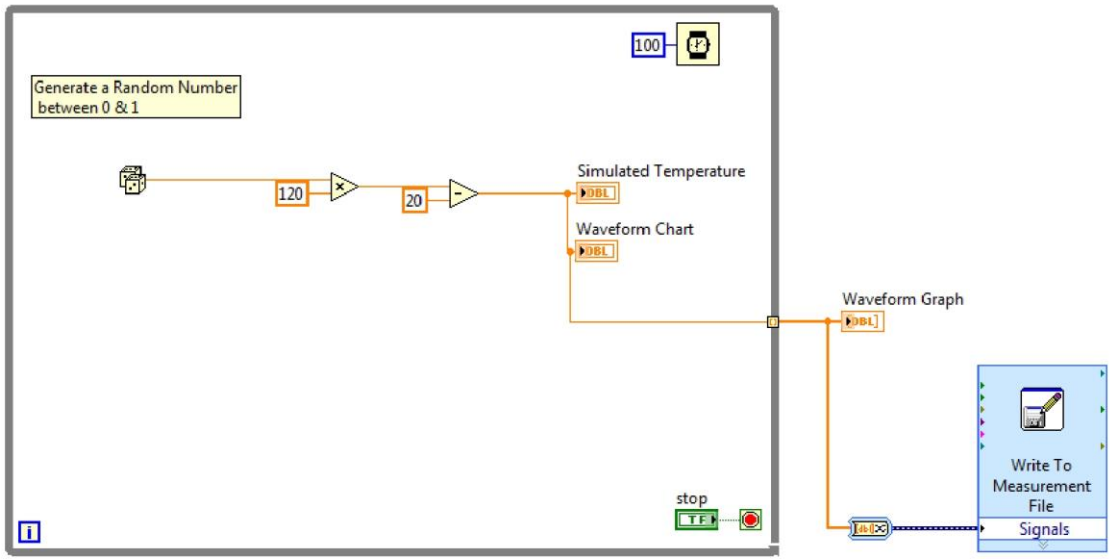
   ❑ During runtime, right click on the Waveform Chart and disable Autoscaling for X and Y the use the graph palette to zoom in and out into specific parts of the chart.

Exercise 5 File Input Output

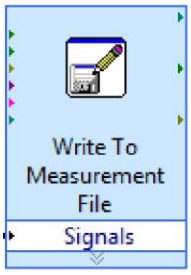
Implementation

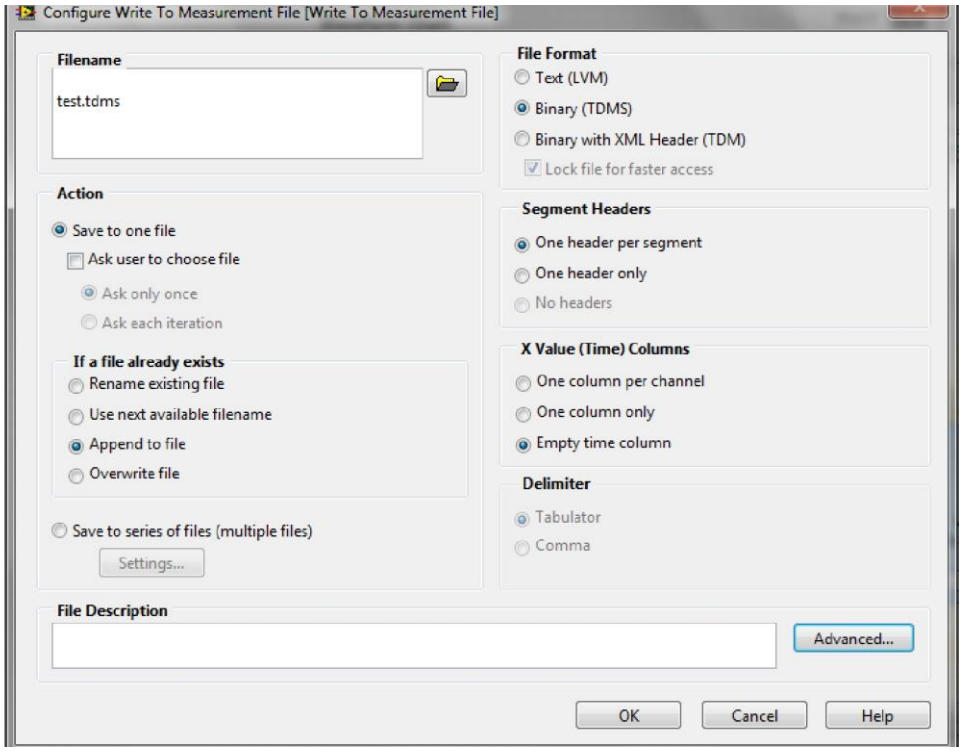
1. Open the Graphs and Charts VI and modify the block diagram by following the steps below.

2. Save the VI as `Save Data File.vi` in the `<Exercises>\LabVIEW Exercises` directory.



3. On the block diagram, search for the Write Measurement File Express VI and place it on the block diagram.





- ❑ In the File Format choose the Binary (TDMS) Format.
- ❑ In the left side, choose to Append to File under If a file already exists.
- ❑ Wire the right terminal of the tunnel to the Signal Input of the Express VI

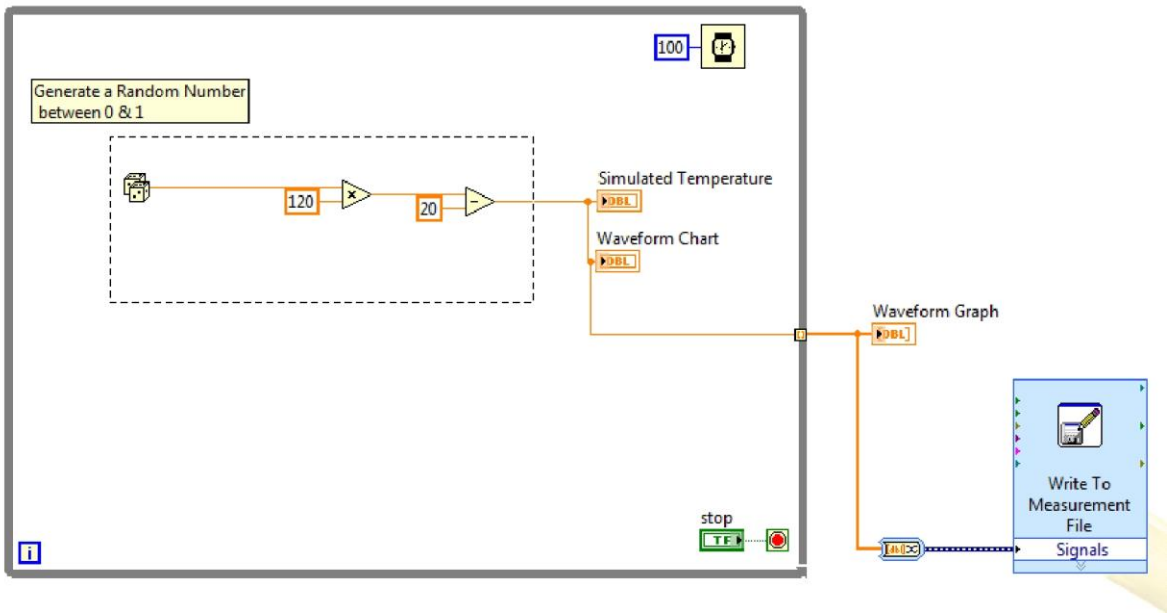
6. Run the VI.
   - ❑ After stopping the VI, open the saved file and examine the temperature data stored inside.

Exercise 6 (No Hardware) SubVIs

Implementation

1. Open the Save Data File VI and modify the block diagram by following the steps below.

2. Save the VI as `Complete Program.vi` in the `<Exercises>\LabVIEW Exercises` directory.



3. Transform the Temperature Simulator to a subVI

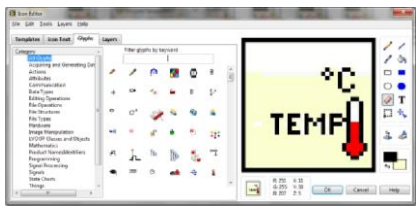
❑ Click and drag on the part of the code responsible for simulating the temperature data. ❑ Go to the edit menu and choose Create SubVI.

4. Give the VI a meaningful icon and connector block.

❑ Double click on the block that appears where the selected code was located to open the subVI front panel.

❑ On the upper terminal, you'll see the connector pane where you can link specific terminals to the Controls and Indicators.

❑ Next to the connector pane is the subVIs icon, Right click on the icon and chose Edit Icon and then modify the icon to look like the following.

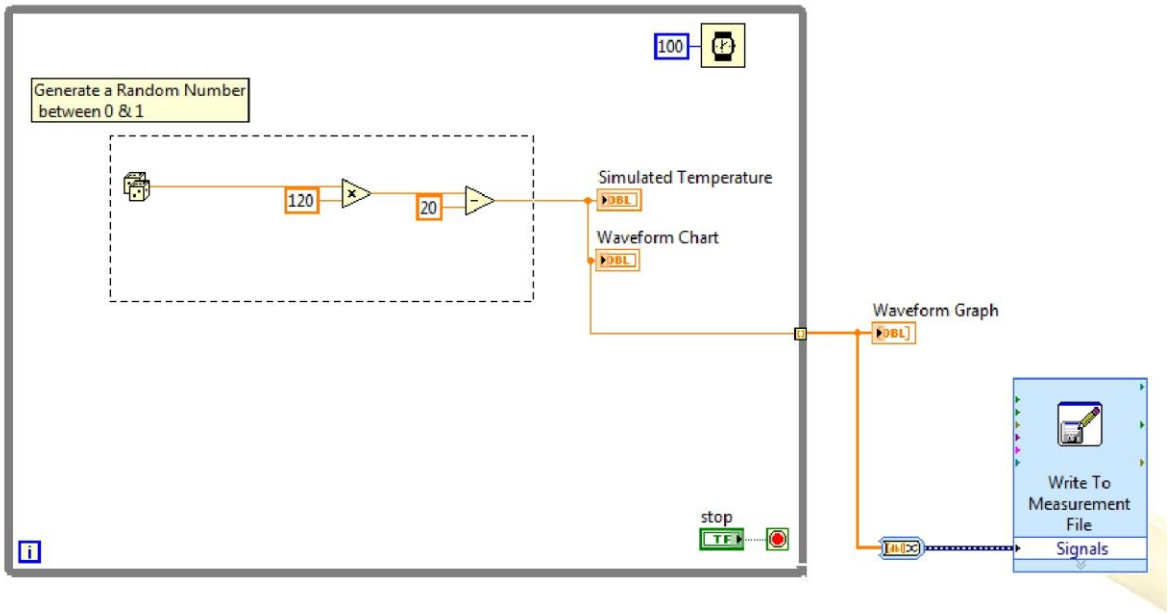


Exercise 6 (Hardware) Acquiring Real Temperature

Implementation

3. Open the Save Data File VI and modify the block diagram by following the steps below.

4. Save the VI as `DAQ.vi` in the `<Exercises>\LabVIEW Exercises` directory.



3. Remove the Temperature Simulator part.

❑ Click and drag on the part of the code responsible for simulating the temperature data.

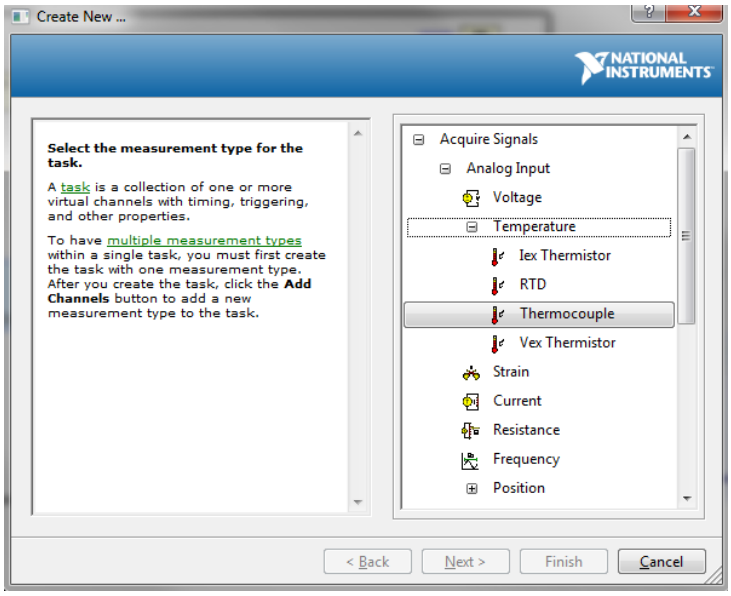
❑ Delete the selected code.

4. Add the data Acquisition part.

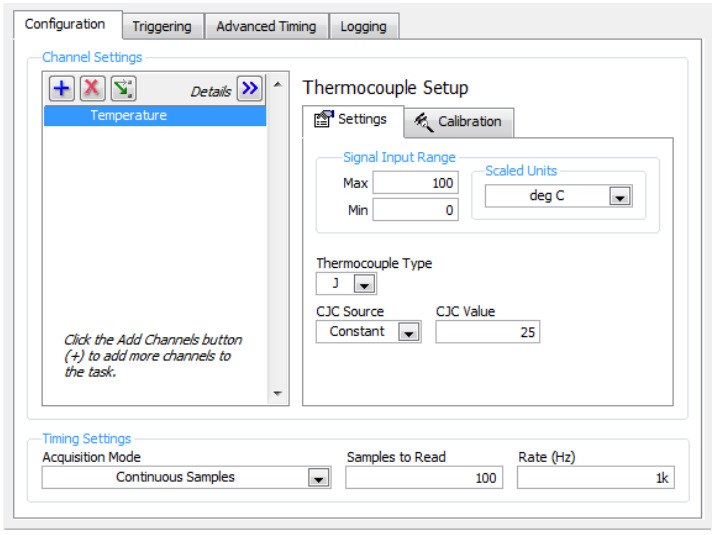
❑ Right click on the block diagram and Navigate to Express > Input > DAQ Assistant.

❑ In the configuration window select Acquire Signals > Analog > Temperature > Thermocouple.

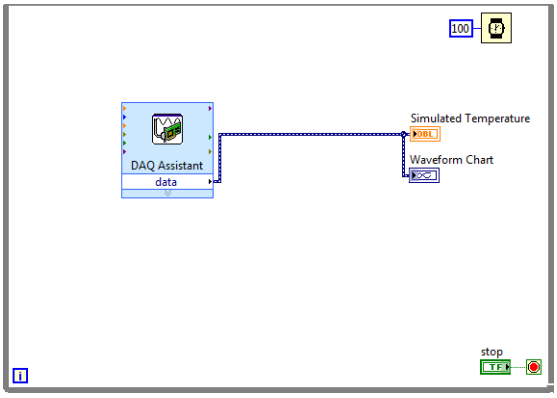
❑ Select ai0 as the physical channel.



❑ In the configuration window, select the Acquisition mode to be Continuous Samples as shown below and finish the configuration by pressing Finish.



❑ Wire the output of the DAQ Assistant VI to the place of the deleted wire. Delete all the parts outside the while loop.



Testing the VI.

❑ Make sure the switch of CH0 on the terminal block in front of you is set to temperature Sensor.

❑ Run the VI.

❑ Place your hand on the temperature sensor to change the measured temperature.

Exercise 7 Case Structures

Implementation

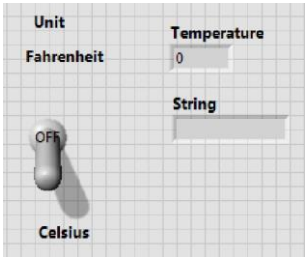
1. Open the Simulate Temperature subVI and modify the block diagram by following the steps below.

2. Save the VI as `Simulate Temperature Improved.vi` in the `<Exercises>\LabVIEW Exercises` directory.

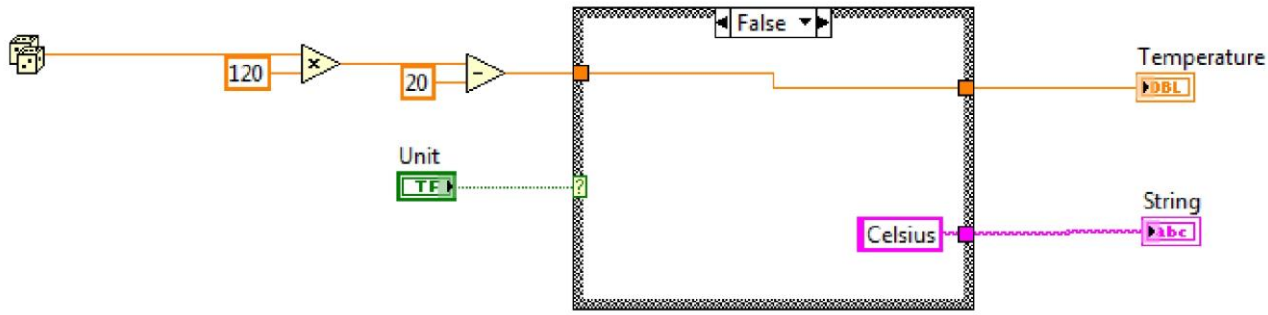
3. Modify the Front Panel as follows.

❑ Add a Boolean Toggle Switch and Name it Unit.

❑ Add a string Indicator and call it Temperature Unit.



4. Modify the Block Diagram to Contain a Temperature Conversion code.



❑ Go to Programming >> Structures and choose the Case Structure and place it on the Block Diagram.

❑ Wire the Unit Boolean control to the case structure select terminal.

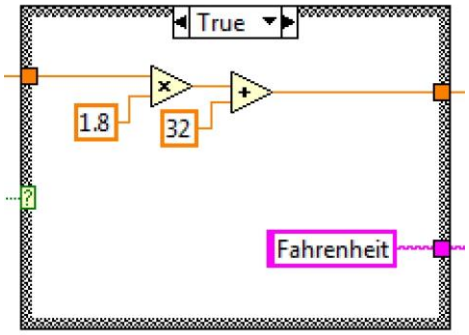
❑ Disconnect the Temperature output from the Subtract Output by deleting the wire in between.

❑ In the upper border of the structure choose the False case. then wire the output of the subtract function through the structure and to the Temperature Indicator.

❑ Create a String Constant inside the False case and Write Celsius inside it then wire it to the

String Indicator outside the structure.

❑ In the upper border of the structure choose the True Case then construct the following code inside the True Case and wire the output of the code to the previously created tunnel.



❑ For the second tunnel, right click and create a constant and call it Fahrenheit.

5. On the front panel Assign Input and Output Terminals in the connector pane to the newly created Controls and Indicators.

6. Save and Close the VI.

7. Replace the old subVI with the new one.

❑ Open the main VI called Complete Program.vi, Right click on the old subVI and choose Replace >> All Palettes >> Select a VI and then browse to the newly created subVI and select it.

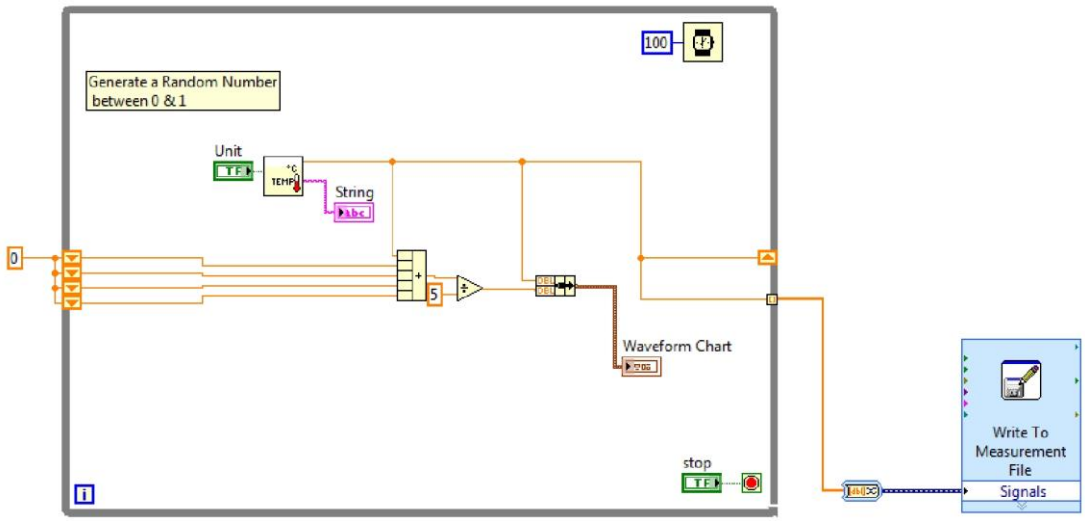
❑ Right Click on the Terminals of the New subVI and create the necessary Controls and Indicator

Exercise 8 Shift Registers

Implementation

1. Open the Complete Program Improved VI and modify it to calculate the average of temperature while running.

2. Save the VI as Complete Program Improved with Processing.



2. On the block diagram add a code to calculate the average of 5 temperature data points.

❑ Wire the Output of Simulate Temperature subVI to the right border of the while loop.

❑ Right click on the tunnel and select Replace with Shift Register. This will automatically create

a tunnel with an arrow on the left border. Wire the output of the Simulate Temperature subVI to the input of the Right Shift Register

❑ On the left shift register tunnel, Right click and choose Add Element. Repeat this until you have 4 shift register tunnels.

❑ Go to programming >> Numeric and choose Compound Arithmetic. Expand the compound

arithmetic block to have 5 terminals and then wire the 4 shift registers terminals and the output of the Simulate Temperature subVI to its input.

❑ Go to programming >> Clusters, Classes and Variants and choose the Bundle function.

❑ Wire the output of the Simulate Temperature subVI to one input of the bundle function, and the output of the Compound Arithmetic function to the other.

❑ Wire the output of the Bundle function to the Waveform Chart to display the Measurements and the average at the same time.

Appendix

Additional Information and Resources

This appendix contains additional information about National Instruments technical support options and LabVIEW resources.

National Instruments Technical Support Options

Visit the following sections of the award-winning National Instruments Web site at `ni.com` for technical support and professional services:

- **Support**—Technical support at `ni.com/support` includes the following resources:

  – **Self-Help Technical Resources**—For answers and solutions, visit `ni.com/support` for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on. Registered users also receive access to the NI Discussion Forums at `ni.com/forums`. NI Applications Engineers make sure every question submitted online receives an answer.

  – **Standard Service Program Membership**—This program entitles members to direct access to NI Applications Engineers via phone and email for one-to-one technical support, as well as exclusive access to eLearning training modules at `ni.com/eLearning`. NI offers complementary membership for a full year after purchase, after which you may renew to continue your benefits. For information about other technical support options in your area, visit `ni.com/services` or contact your local office at `ni.com/contact`.

- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. The NI Alliance Partners joins system integrators, consultants, and hardware vendors to provide comprehensive service and expertise to customers. The program ensures qualified, specialized assistance for application and system development. To learn more, call your local NI office or visit `ni.com/alliance`.

You also can visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events

Other National Instruments Training Courses

National Instruments offers several training courses for LabVIEW users. These courses continue the training you received here and expand it to other areas. Visit `ni.com/training` to purchase course materials or sign up for instructor-led, hands-on courses at locations around the world.

National Instruments Certification

Earning an NI certification acknowledges your expertise in working with NI products and technologies. The measurement and automation industry, your employer, clients, and peers recognize your NI certification credential as a symbol of the skills and knowledge you have gained through experience. Visit `ni.com/training` for more information about the NI certification program.

LabVIEW Resources

This section describes how you can receive more information regarding LabVIEW.

LabVIEW Publications

LabVIEW Books

Many books have been written about LabVIEW programming and applications. The National Instruments Web site contains a list of all the LabVIEW books and links to places to purchase these books.

Visit `http://zone.ni.com/devzone/cda/tut/p/id/5389` for more