Examination # 100929-00

Certified LabVIEW Developer Examination

Examinee _____ Date: _____

Administrator _____ Date: _____

Instructions:
If you did not receive this exam in a sealed envelope stamped "NI Certification," **DO NOT ACCEPT** this exam. Return it to the proctor immediately. You will be provided with a replacement exam.

- **Please do not detach the binding staple of any section. If any part of the exam paper is missing or detached when returned to National Instruments, you will be deemed to have failed the exam**.
- This examination may not be taken from the examination area or reproduced in any way. You may not keep any portion of this exam after you have completed it.
- Please do not ask the proctor for help. If you believe the intent of any part of the exam is not clear, you may make appropriate assumptions. Please document your assumptions either on the question paper or on the LabVIEW block diagram.
- The exam requires you to develop a LabVIEW application based on a set of specifications.
- A computer with a standard installation of LabVIEW is the only reference allowed for the examination. Externally developed code and third party tools are not allowed in the exam.
- You may use LabVIEW design patterns, templates, and examples available in the development environment as a guide/resource for the application development.
- The application must be specifically developed for the exam submission.
- Submit your finished application on the disk provided.
- Total time allocated for the exam: 4 hours
- Exam passing grade: 75%

Grading:
The application development exam consists of a total of 40 points which are allocated as follows:

- Programming style **(15 points)**
- Functionality **(15 points)**
- Documentation **(10 points)**

IMPORTANT:

- **When you have completed the exam, place the exam document, the disk with the saved application, and any deliverables in the envelope provided.**
- **Please SEAL the envelope.**
- **Give the sealed envelope to your proctor.**

Application Development
Section I: General Requirements

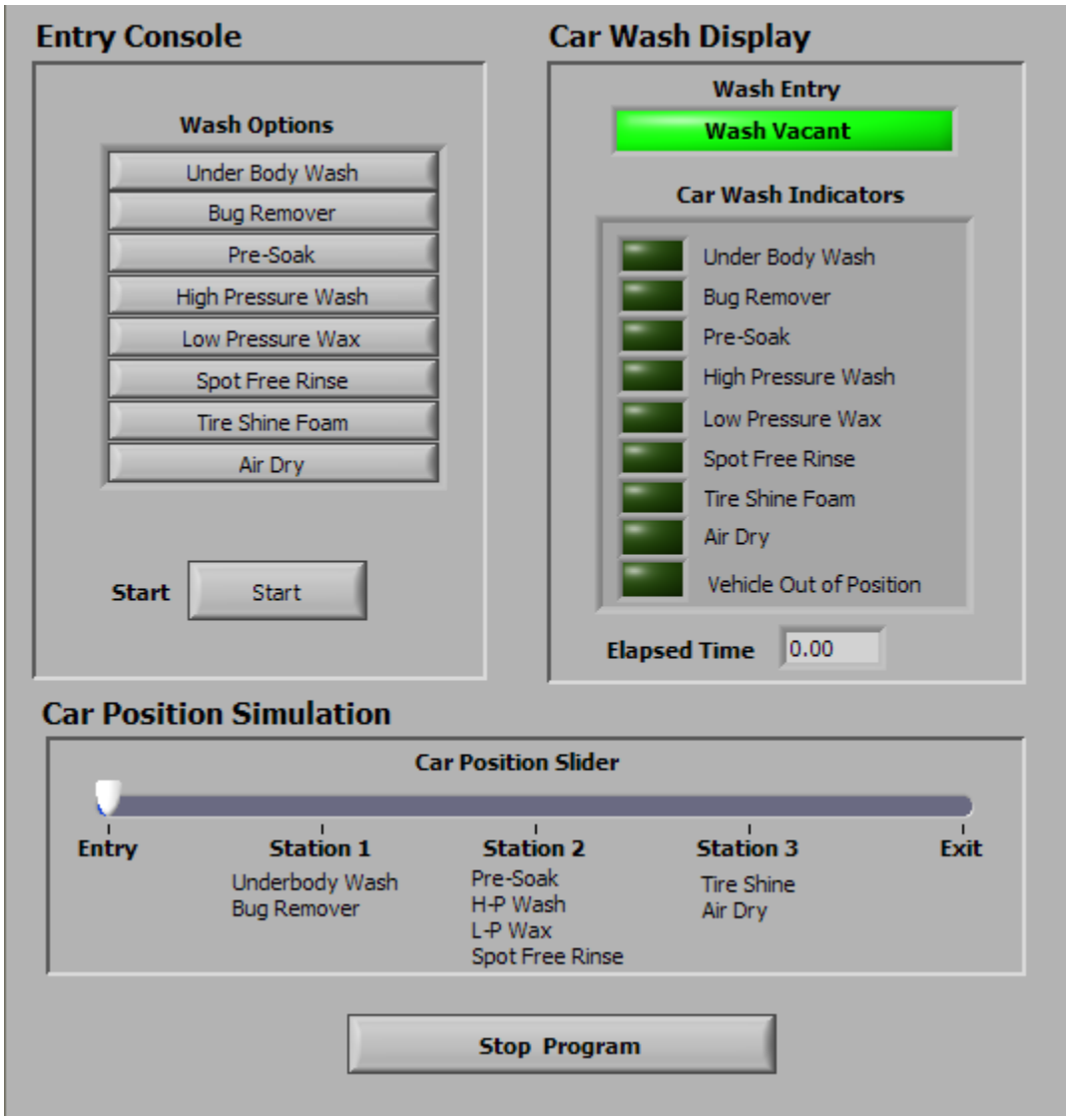
The Certified LabVIEW Developer exam tests your ability to develop a LabVIEW application.

The application should do the following:

- Function as specified in *Section II: Application Requirements* of this document.
- Conform to LabVIEW coding style and documentation standards (found in LabVIEW documentation –Refer to the *Development Guidelines* section of the *LabVIEW Help*.
- Be created expressly for this exam using VIs and functions available in LabVIEW. Templates, examples, or code developed outside the bounds of this exam are not acceptable for use in the application.
- Be hierarchical in nature. All major functions should be performed in subVIs.
- Use a state machine, queued message handler, or an Event structure for state management. States should be type defined enumerations.
- User defined data types must also be saved as type defined custom controls.
- Be easily scalable to add more states / features without having to manually update the hierarchy.
- Minimize the excessive use of structures, variables (locals / globals) and Property Nodes.
- Respond to front panel controls (within 100 ms) and not utilize 100 % of CPU time.
- Close all opened references and handles where used.
- Be well-documented and include the following:
    - Labels on appropriate wires within the main VI and subVIs.
    - Descriptions for each algorithm.
    - Documentation in **VI Properties»Documentation** for both the main VI and subVIs.
    - Tip strips and descriptions for front panel controls and indicators.
    - Labels for constants

Application Development
Section II: Application Requirements
Car Wash

Task:
Design a car wash controller using LabVIEW. The front panel of the controller should look similar to the following front panel.



General Operation:
The car wash controller simulates the control system of an automated car wash. The user interacts with controls and indicators on the front panel to select the car wash options and simulate the travel of the vehicle in the car wash.

The controller should perform the following general operations:
- Indicate on the **Wash Entry** LED if the car wash is vacant or a wash is in progress.
- Allow the user to select **Wash Options**
- Start the washing process when the user clicks **Start**
- Indicate the current wash step on the **Car Wash Indicators** LEDs and display the **Elapsed Time** on the indicator
- Turn ON the **Vehicle Out of Position** LED and pause the elapsing time if the vehicle moves from the designated position during a cycle

Sequence of Operation:

Start (Application Run): When the application starts, the front panel controls and indicators should be in the following states:
- **Entry Console**: All controls should be enabled.
- **Car Wash Display:** The **Wash Entry** LED should be green and display `Wash Vacant`. All **Car Wash Indicators** should be turned OFF and the **Elapsed Time** indicator should display `0.00`.
- **Car Position Simulation:** The **Car Position Slider** should be at the **Entry** position.

Select Wash Options: Click the **Wash Options** buttons to select the washing steps. The buttons should remain clicked until the completion of the wash cycles.

Start: Click the **Start** button to begin the car wash process. This should configure the controller to execute the steps selected by the **Wash Options** buttons**.**

Note The High Pressure Wash step is the default wash. If the user did not select High Pressure Wash, or if the user did not select any options, High Pressure Wash must be added to the options programmatically after the use clicks **Start**.

The controller should disable the **Wash Options** buttons.
The controller should signal the start of the wash by changing the color of the **Wash Entry** LED to red and displaying `Wash In Progress`.
The controller should check if the vehicle is at the appropriate station for the first step in the selected wash type by monitoring the **Car Position Slider**.

Note Refer to the *Car Wash Step Timing and Station Positions* table at end of the specification for a list of stations that correspond to the car wash steps.

If the vehicle is not at the appropriate station, the controller should turn ON the **Vehicle Out of Position** LED and not begin timing.

If the vehicle is at the appropriate station, the appropriate wash step LED should turn ON and the **Elapsed Time** indicator should count up from zero to indicate elapsed time for that step.

Upon completion of a step, the **Elapsed Time** indicator should reset to zero.
Each wash step should not last for more than the time allocated in the *Car Wash Step Timing and Station Positions* table at the end of the specification.

Upon completion of a step, if the vehicle is in the appropriate station, the controller should continue to the next wash step by resetting and restarting the elapsed timer.

Upon completion of a step, if the vehicle is not in the appropriate station, the controller should turn ON the **Vehicle Out of Position** LED and not begin timing.

If the vehicle moves away from the wash station in the middle of a wash step, the elapsed time should pause, the **Vehicle Out of Position** LED should turn ON and the appropriate wash step LED should turn OFF. When the vehicle position is restored to the correct position by moving the **Car Position Slider**, the **Vehicle Out of Position** LED should turn OFF, the appropriate wash step LED should turn ON, and timing should continue from the paused time until completion of the step.

When all the wash steps are complete, the **Vehicle Out of Position** LED should turn ON, indicating to the user to exit the car wash. When the user moves the **Car Position Slider** to the **Exit** position, all **Car Wash Indicators** should turn OFF and the **Car Position Slider** should reset to the **Entry** position. The **Wash Entry** indicator should turn green and display `Wash Vacant`, and the controls in the **Wash Entry Console** should be enabled to allow the user to select and start another car wash process.

Stop Program: Click **Stop Program** to abort the car wash process at *any time* and stop the application. When the application stops, the front panel controls and indicators should be in the following states:
Entry Console: All controls should be enabled.
Car Wash Display: The **Wash Entry** LED should be green and display `Wash Vacant`, all **Car Wash Indicators** should be turned OFF, and the **Elapsed Time** indicator should reset to zero.
Car Position Simulation: The **Car Position Slider** should reset to the **Entry** position.

Description of Controls/Indicators:

<table>
<tr><th>Control Name</th><th>Control Description — Function</th></tr>
<tr><td>Wash Options</td><td>Cluster of Buttons — Allows the user to customize the car wash</td></tr>
<tr><td>Start</td><td>Button — Allows user to start car wash process</td></tr>
<tr><td>Car Position Slider</td><td>Horizontal Pointer Slide —Allows user to simulate travel of car during the car wash process.
Note Use Text Labels for Scale Markers
<table>
<tr><th>Labels</th><th>Values</th></tr>
<tr><td>Entry</td><td>0</td></tr>
<tr><td>Station 1</td><td>1</td></tr>
<tr><td>Station 2</td><td>2</td></tr>
<tr><td>Station 3</td><td>3</td></tr>
<tr><td>Exit</td><td>4</td></tr>
</table>
Note Refer to the front panel figure provided for car wash steps corresponding to the stations</td></tr>
<tr><td>Stop Program</td><td>Button — Stops the program</td></tr>
<tr><td>Wash Entry</td><td>Square LED — Indicates if the car wash is operational
OFF Color: Green
OFF Text: Wash Vacant
ON Color: Red
ON Text: Wash In Progress</td></tr>
<tr><td>Car Wash Indicators</td><td>Cluster of square LEDs — Indicates the current step in the wash cycle
<table>
<tr><th>Cluster Order</th><th>Square LED Label</th></tr>
<tr><td>0</td><td>Under Body Wash</td></tr>
<tr><td>1</td><td>Bug Remover</td></tr>
<tr><td>2</td><td>Pre-Soak</td></tr>
<tr><td>3</td><td>High Pressure Wash</td></tr>
<tr><td>4</td><td>Low Pressure Wax</td></tr>
<tr><td>5</td><td>Spot Free Rinse</td></tr>
<tr><td>6</td><td>Tire Shine Foam</td></tr>
<tr><td>7</td><td>Air Dry</td></tr>
<tr><td>8</td><td>Vehicle Out of Position</td></tr>
</table></td></tr>
<tr><td>Elapsed Time</td><td>Numeric.
Representation: DBL, Digits of Precision: 2</td></tr>
</table>

Car Wash Step Timing and Station Positions:

Wash Steps	Step Time	Station
Under Body Wash	5 seconds	Station 1
Bug Remover	5 seconds	Station 1
Pre-Soak	5 seconds	Station 2
High Pressure Wash	5 seconds	Station 2
Low Pressure Wax	5 seconds	Station 2
Spot Free Rinse	5 seconds	Station 2
Tire Shine Foam	5 seconds	Station 3
Air Dry	5 seconds	Station 3