Examination # 100927F-01

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.

- **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.
- Do not ask the proctor for help. If any part of the exam is not clear, you may make appropriate assumptions and document them either on the exam paper or on the LabVIEW block diagram.
- A computer with a standard installation of LabVIEW is the only reference allowed for the examination. Externally developed code or third party tools are not allowed in the exam. The exam requires you to develop a LabVIEW application based on a set of specifications.
- The front panel and associated controls for the application are provided to you in a folder hierarchy on the USB memory stick. You **must** maintain the folder hierarchy and use these components to develop your application. Solutions that do not use the hierarchy or the given components will not be graded.
- Do **not** rename the main VI or any of the provided controls. Solutions with renamed main VI or controls will not be graded. 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 provided USB memory stick.** Failure to provide the solution on the memory stick will result in an automatic fail.
- 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, and the USB memory stick with the saved application, along with any deliverables, in the envelope provided.**
- **Please SEAL and 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.

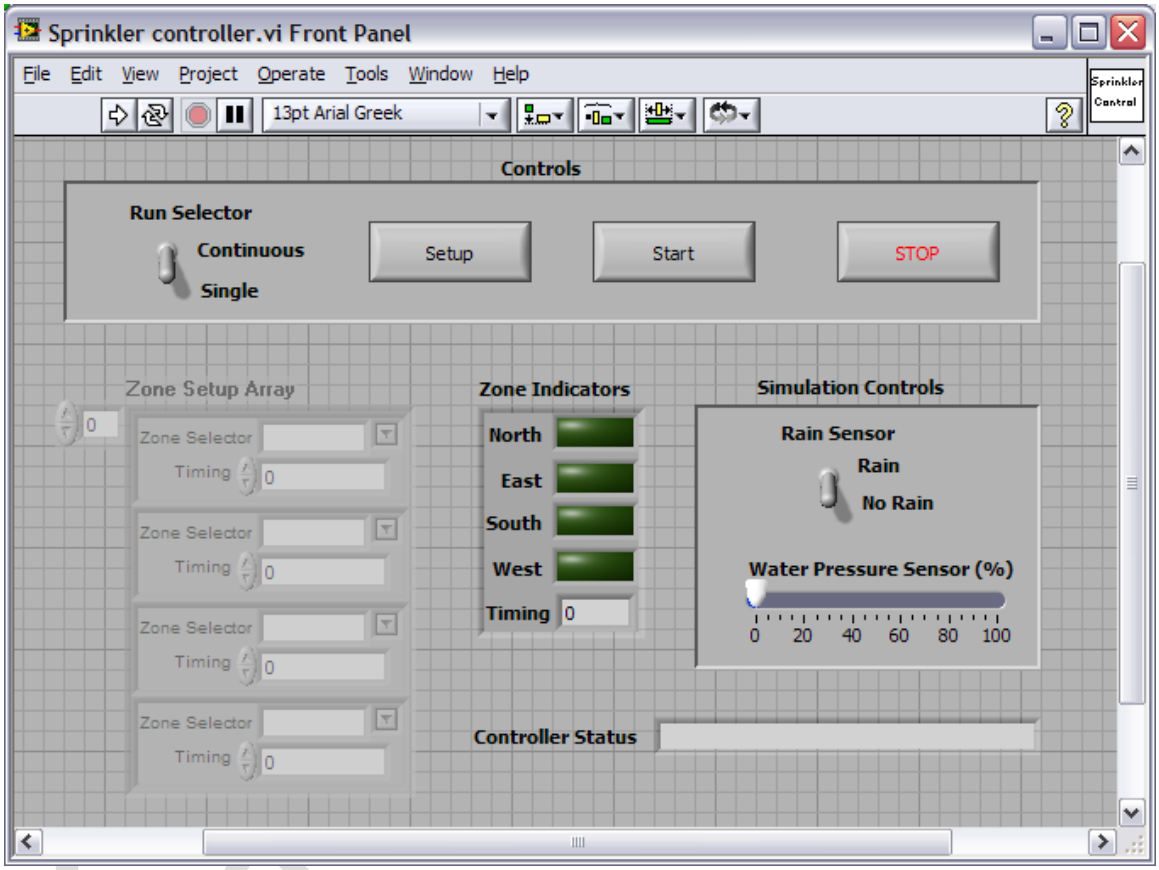
The application should do the following:

- Function as specified in Section II of this document.
- Conform to LabVIEW coding style and documentation standards (found in LabVIEW documentation – *LabVIEW Development Guidelines*).
- 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 that either uses a type defined enumerated control, queue, or Event structure for state management.
- Be easily scalable to add more states / features without having to manually update the hierarchy.
- Minimize the use of excessive 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 main VI and subVIs.
    - Tip strips and descriptions for front panel controls and indicators.
    - Labels for constants

Application Development
Section II: Application Requirements
Sprinkler Controller

Objective

Design a four zone sprinkler controller using LabVIEW. The front panel of the simulator resembling the following front panel is provided to you as a VI on the USB memory stick. **You must use the provided VI and controls to develop your application.**



General Operation

The sprinkler controller simulates a lawn sprinkler control system that services four zones: North, South, East, and West. Controls on the front panel control the zone selection and simulate external conditions. Indicators on the front panel indicate the zone that is currently being serviced and the elapsed time for that zone.

The controller must load the **Zone Setup Array** data from a Comma Separated Value (.csv) file when the VI starts. The controller runs when the user clicks the **Start** button. When the **Run Selector** switch is in the **Single** run position, the controller should service each zone for the set **Timing** and wait for user input. When the **Run Selector** switch is in the **Continuous** run position, the controller should continually cycle through the **Zone Setup** array by restarting with the first zone after servicing the last zone. The controller (application) should stop when the user clicks the **Stop** button.

Note: *The application should be scalable to handle additional elements of the* ***Zone Setup*** *array without any modification of the program.*

Sequence of Operation

VI Load: When the application loads, all controls should initialize to the default states as shown on the front panel.

Start (Application Run): When the application runs, the sprinkler controller program should read the Sprinkler Configuration file (see format in *Sprinkler Configuration File* section) and load the **Zone Setup** array with the data from the file.

- **Zone Setup Array** should be dimmed
- All indicator LEDs should be set to OFF
- The **Timing** indicator should indicate zero
- **Controller Status** should display `Controller Initialized`

Setup: Click the **Setup** button to activate the **Zone Setup** array control and allow the user to change the **Zone Selector** and the **Timing** for each zone.

The **Zone Selector** should allow a user to select and change the zone: North, East, South, or West. The controller should handle zones in any order and allow setting of a zone more than once in the **Zone Setup** array.

The **Timing** setting should be in seconds (no decimals). If **Timing** is zero, the zone should be not be serviced when the controller runs.

In this mode, the **Controller Status** should display `Setup Mode`.

Clicking the **Setup** button during a run should immediately stop the controller and activate the **Zone Setup** array.

Select Continuous or Single Run: Switch to the desired **Run Selector** mode.

When **Single** is selected, the controller should service the zones as setup in the **Zone Setup** array.

When **Continuous** is selected, the controller should continually cycle through the zones as setup in the **Zone Setup** array by repeating the cycle until the user clicks the **Stop** button.

Start: Click the **Start** button to start the controller. This action should complete the following:

- Dim the **Zone Setup** array control.
- Check the **Water Pressure Sensor** simulation control. If the water pressure is below 50 %, the **Controller Status** should display `Low Water Pressure`. If the water pressure is restored to a value greater than 50 %, the controller should start operating.
- Run the controller in the mode selected by the **Run Selector** switch.
- Display `Running` in the **Controller Status** indicator.

When the **Run Selector** switch is in the **Single** position, the controller should make one pass, sequentially, through the zones in the **Zone Setup** array. The controller should service one zone at a time, beginning with the first zone. When a single run completes, the controller should wait for a user action. The **Controller Status** indicator should continue to display `Running` even after the single run is complete.

When the **Run Selector** switch is in the **Continuous** position, the controller should continue with the first zone after the last zone has been serviced.

If the **Run Selector** switch is moved from the **Continuous** position to the **Single** position during a continuous run, the controller should stop after servicing the last zone and wait for a user action.

When a zone is being serviced, the following should occur:

- Only its respective indicator should be ON
- All other indicators should be OFF
- The **Timing** indicator should display the elapsed time in seconds
- The **Controller Status** indicator should display `Running`

***Note:** If zone **Timing** is set to zero, the zone should be skipped and the next zone in order should be serviced.*

If it begins to rain during the operation of the controller, simulated by the **Rain Sensor** switch, the controller must stop servicing the zones and display `Rain` in the **Controller Status** indicator, even if a zone has not completed its timing cycle.

If it stops raining, and the **Run Selector** switch is in the **Single** position, the controller should make a single pass and wait for user input. If the **Run Selector** switch is in the **Continuous** position, the controller should start servicing the zone beginning with the first zone.

If the water pressure sensor detects a loss in water pressure during the operation of the controller – simulated by the **Water Pressure Sensor** slider, the controller must stop servicing the zone and display `Low Water Pressure` in the **Controller Status** indicator. If the pressure is restored, the controller should start operating beginning with the first zone.

Stop: Click the **Stop** button to stop the controller (application). This action should complete the following:

- Stop servicing the zones
- Display `Stopped` in the **Controller Status** indicator
- Stop the application

Sprinkler Configuration File

Format: Comma Separated Value (.csv). See the following screenshot for initial data.