# Section 1: General Requirements

## Hardware Details

For the practical exam, you will be provided with an exam hardware kit. This hardware kit will consists of two NI sbRIO-9623’s, power supplies and Ethernet cables. The NI sbRIO will be designated as follows:

### Simulator

This NI sbRIO will have a startup executable of the plant simulation. On the kit, the Ethernet connection of the simulator will be masked with a label to prevent the candidate from connecting.

### Controller

This controller will connect to the simulator and the candidate will provide to download the written code to monitor and control the simulator FPGA.

The IP address of the controller will be: 192.168.0.2.

Candidate must not change this IP address.

The analog outputs of the simulator are connected to the analog inputs of the controller.

DIO pins of the simulator are connected to the DIO pins of the controller.

## Software Details

* LabVIEW PDS
* LabVIEW Real-Time Module
* LabVIEW FPGA Module
* NI-RIO driver

### The exam computer must have two connections:

* To connect the sbRIO controller via the following static address: 192.168.0.1

### To connect the evaluation computer to an existing account to Compile Cloud Server for compiling LVFPGA code.

## Grading

### The CLED exam consists of a total of 100 points which are allocated as below. The passing grade is 70%.

* Functionality: 50%
* Design: 30%
* Programming Style: 15%
* Documentation: 5%

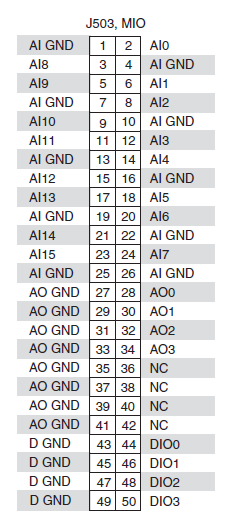
### Time allocation: 4 hrs.

# Section 2: Applications Requirements

## Objective

Create an embedded pH and temperature monitor and controller. The system is intended to be used in with a user interface that views, monitors data and controls the embedded controller. The system will monitor two analog input channels, one for pH and one for temperature and trigger a creation of a data log file if the value of either channel exceeds a certain threshold.

## Exam Setup

The exam kit consists of two (2) sbRIOs wired as follows:

|  |  |  |
| --- | --- | --- |
| AI0 | Input | Temperature voltage |
| AI1 | Input | pH Voltage |
| DIO0 | Output | Controller Heartbeat |
| DIO1 | Input | Simulator Heartbeat |

The simulator will begin execution on power-up, generating a simulated voltage the will be used as pH and temperature readings.

## Requirements

### Controller Requirements

#### Controller shall have the following states:

##### Idle

Executes on startup. Also returns from safe state when all faults are cleared. Displays the current values of the measured data.

##### Running

Executes when the override button is pressed ON. Displays the overridden values for pH and temperature.

##### Safe

Executes when either of the pH and temperature values exceeds the threshold.

Idle

Running

Safe

Override Enable

Override Disable

Fault

Fault Clear

Fault

|  |  |  |
| --- | --- | --- |
| **States** | **Description** | **Transition** |
| Idle | Displays current values of measure data | At startup,  After faults are cleared |
| Running | Override is enabled for temperature and pH | Override button is ON |
| Safe | Does not accept inputs for override | Exceeds values of temp and pH |

### Communication Requirements

* The controller shall publish its current state. This value shall be updated on every state change.
* The controller shall publish live data for both channels.
* The controller shall publish the recent fault that occurred in the RT controller.

### Acquisition Requirements

* Temperature voltage measured shall be converted to 1mV/deg C.
* pH voltage measured shall be converted to 2V @ 7pH. pH will be shifted 1 every 59.2mV away from pH 7.

### Log File Requirements

* The controller shall log the values if the pH or temperature exceeds the threshold.
* Log file should have the format of DDHHMMSS.csv.
* Logging should stop when the values have returned to normal values.

### Availability Requirements

* Controller must start as an executable on the RT target.
* Controller shall output a heartbeat signal on DIO0. The signal shall toggle at 1 Hz.
* Controller shall monitor an incoming heartbeat signal on DIO1. This signal will toggle at 1 Hz.

#### Controller shall reboot when critical faults occurs.

* Controller shall reboot when memory exceeds limit or below.
* Controller shall reboot at 80% usage.
* Controller shall reboot if the RT applications stops.

### Host Requirements

#### User Interface (UI) Requirements

* The UI must the front panel included in the project file.
* UI shall display if RT is connected.
* UI shall display the status of the controller and the faults that occurred last.
* Override button shall be able to send override values to the controller. Values shall not be accepted if the RT is in fault.
* UI shall stop when stop button is pressed.

|  |  |  |
| --- | --- | --- |
| Faults | Alert on Host | Reboot |
| Memory exceeds limit or below | √ | √ |
| CPU exceeds 80% usage | √ | √ |
| RT application stops | √ | √ |
| Temperature exceeds limit | √ | × |
| pH exceeds limit | √ | × |

#### Data Requirements

* Override values can be input on the UI.
* Live data can be seen on the UI.

### Connectivity Requirements

* The system must be tolerant of intermittent network connectivity between controller and host.
* The controller must be able to handle disconnection and reconnection of the host machine at any time and continue to function properly.
* The host must be able to recognize disconnections and allow the user to manually attempt to reconnect by pressing connect button.