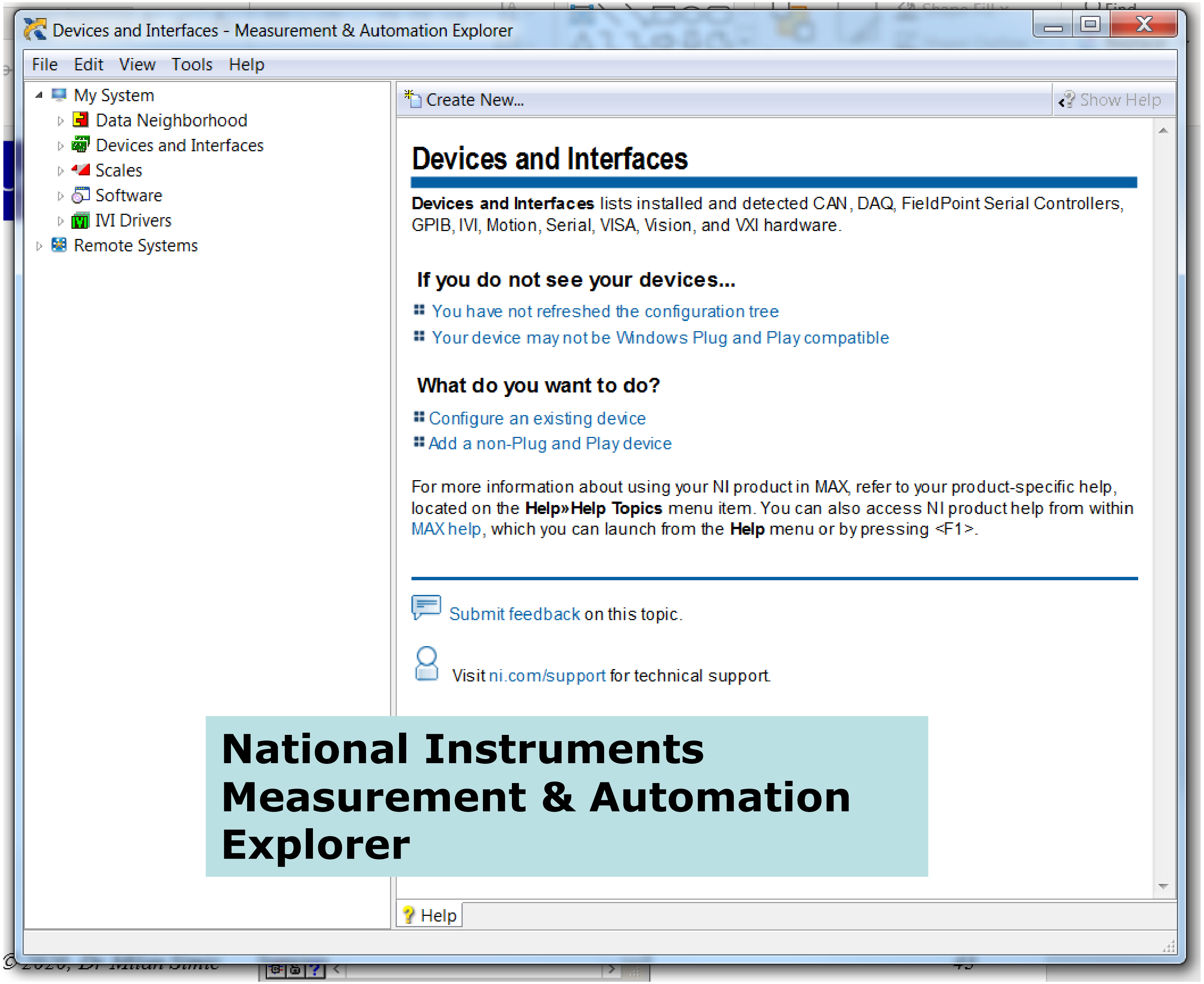
# Advanced Mechatronics Design

## Software Tools – LabVIEW Intro

## Simulated Devices

# NI MAX



## Devices and Interfaces

**Devices and Interfaces** lists installed and detected CAN, DAQ, FieldPoint Serial Controllers, GPIB, IVI, Motion, Serial, VISA, Vision, and VXI hardware.

### If you do not see your devices...

- You have not refreshed the configuration tree
- Your device may not be Windows Plug and Play compatible

### What do you want to do?

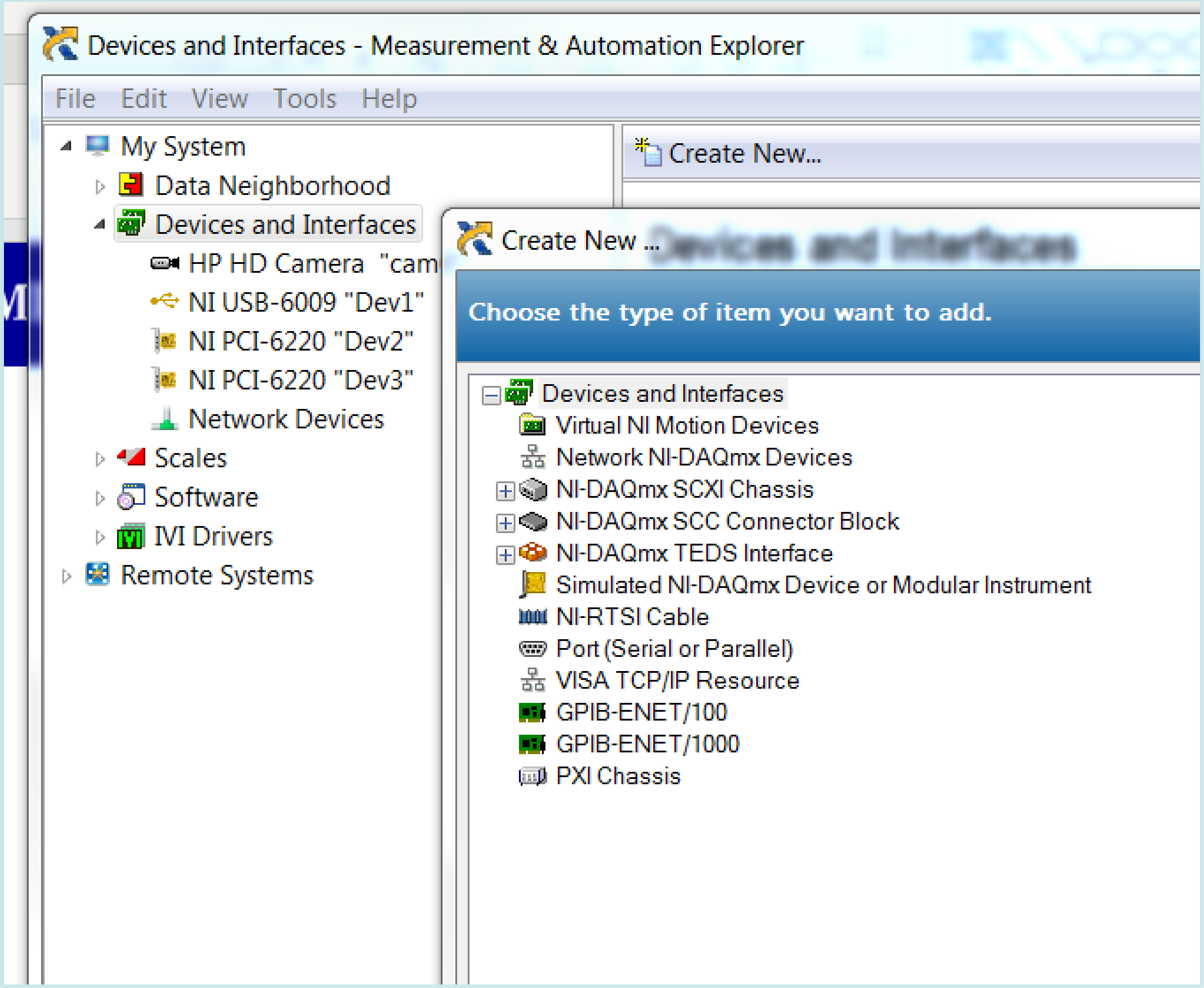
- Configure an existing device
- Add a non-Plug and Play device

For more information about using your NI product in MAX, refer to your product-specific help, located on the **Help»Help Topics** menu item. You can also access NI product help from within MAX help, which you can launch from the **Help** menu or by pressing <F1>.

Submit feedback on this topic.

Visit ni.com/support for technical support.

**National Instruments Measurement & Automation Explorer**



Devices and Interfaces - Measurement & Automation Explorer

- My System
  - Data Neighborhood
  - Devices and Interfaces
    - HP HD Camera "cam
    - NI USB-6009 "Dev1"
    - NI PCI-6220 "Dev2"
    - NI PCI-6220 "Dev3"
    - Network Devices
  - Scales
  - Software
  - IVI Drivers
- Remote Systems

Create New ... Devices and Interfaces

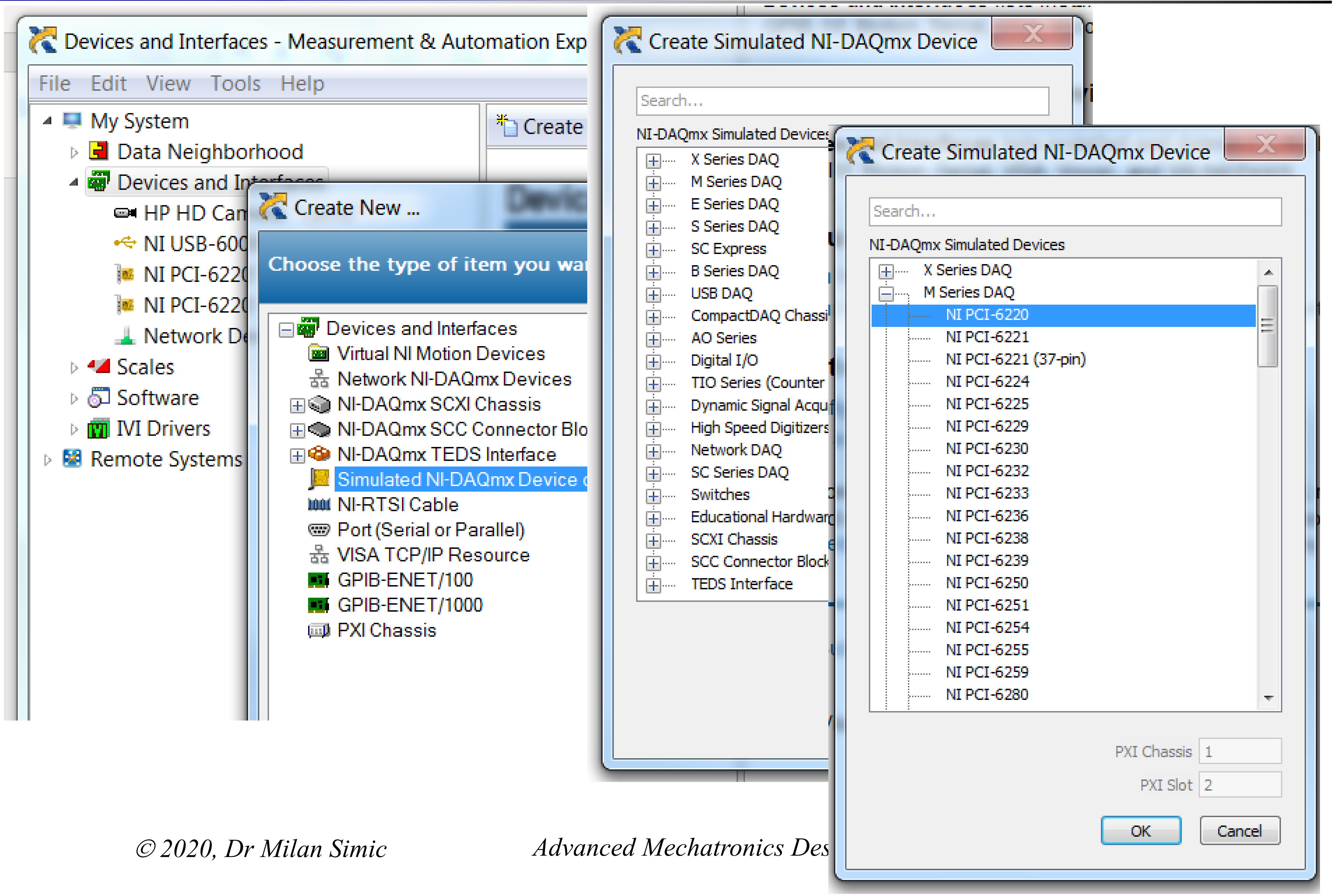
Choose the type of item you want to add.

- Devices and Interfaces
  - Virtual NI Motion Devices
  - Network NI-DAQmx Devices
  - NI-DAQmx SCXI Chassis
  - NI-DAQmx SCC Connector Block
  - NI-DAQmx TEDS Interface
  - Simulated NI-DAQmx Device or Modular Instrument
  - NI-RTSI Cable
  - Port (Serial or Parallel)
  - VISA TCP/IP Resource
  - GPIB-ENET/100
  - GPIB-ENET/1000
  - PXI Chassis

# What Type of Device Should I Use?

| | Sound Card* | NI USB DAQ | NI PCI DAQ | Instruments* |
|---|---|---|---|---|
| AI Bandwidth | 8 to 44 kS/s | 10 kS/s to 1.25 MS/s | 20 kS/s to 10 MS/s | 100 S/s to 2 GS/s |
| Accuracy | 12 to 16 bits | 12 to 18 bits | 12 to 18 bits | 8 to 26 bits |
| Portable | √ | √ | — | some |
| AI Channels | 2 | 8 to 80 | 2 to 80 | 1 to 80 |
| AO Channels | 2 | 2 to 4 | 2 to 8 | 2 to 8 |
| AC or DC | AC | AC/DC | AC/DC | AC/DC |
| Triggering | — | √ | √ | √ |
| Calibrated | — | √ | √ | √ |

* The above table may not be representative of all device variations that exist in each category



Devices and Interfaces - Measurement & Automation Exp

- My System
  - Data Neighborhood
  - Devices and Interfaces
    - HP HD Can
    - NI USB-600
    - NI PCI-622
    - NI PCI-622
    - Network De
  - Scales
  - Software
  - IVI Drivers
- Remote Systems

Create New ...

Choose the type of item you wa

- Devices and Interfaces
  - Virtual NI Motion Devices
  - Network NI-DAQmx Devices
  - NI-DAQmx SCXI Chassis
  - NI-DAQmx SCC Connector Blo
  - NI-DAQmx TEDS Interface
  - Simulated NI-DAQmx Device o
  - NI-RTSI Cable
  - Port (Serial or Parallel)
  - VISA TCP/IP Resource
  - GPIB-ENET/100
  - GPIB-ENET/1000
  - PXI Chassis

Create Simulated NI-DAQmx Device

NI-DAQmx Simulated Devices

- X Series DAQ
- M Series DAQ
- E Series DAQ
- S Series DAQ
- SC Express
- B Series DAQ
- USB DAQ
- CompactDAQ Chassi
- AO Series
- Digital I/O
- TIO Series (Counter
- Dynamic Signal Acqu
- High Speed Digitizers
- Network DAQ
- SC Series DAQ
- Switches
- Educational Hardwar
- SCXI Chassis
- SCC Connector Block
- TEDS Interface

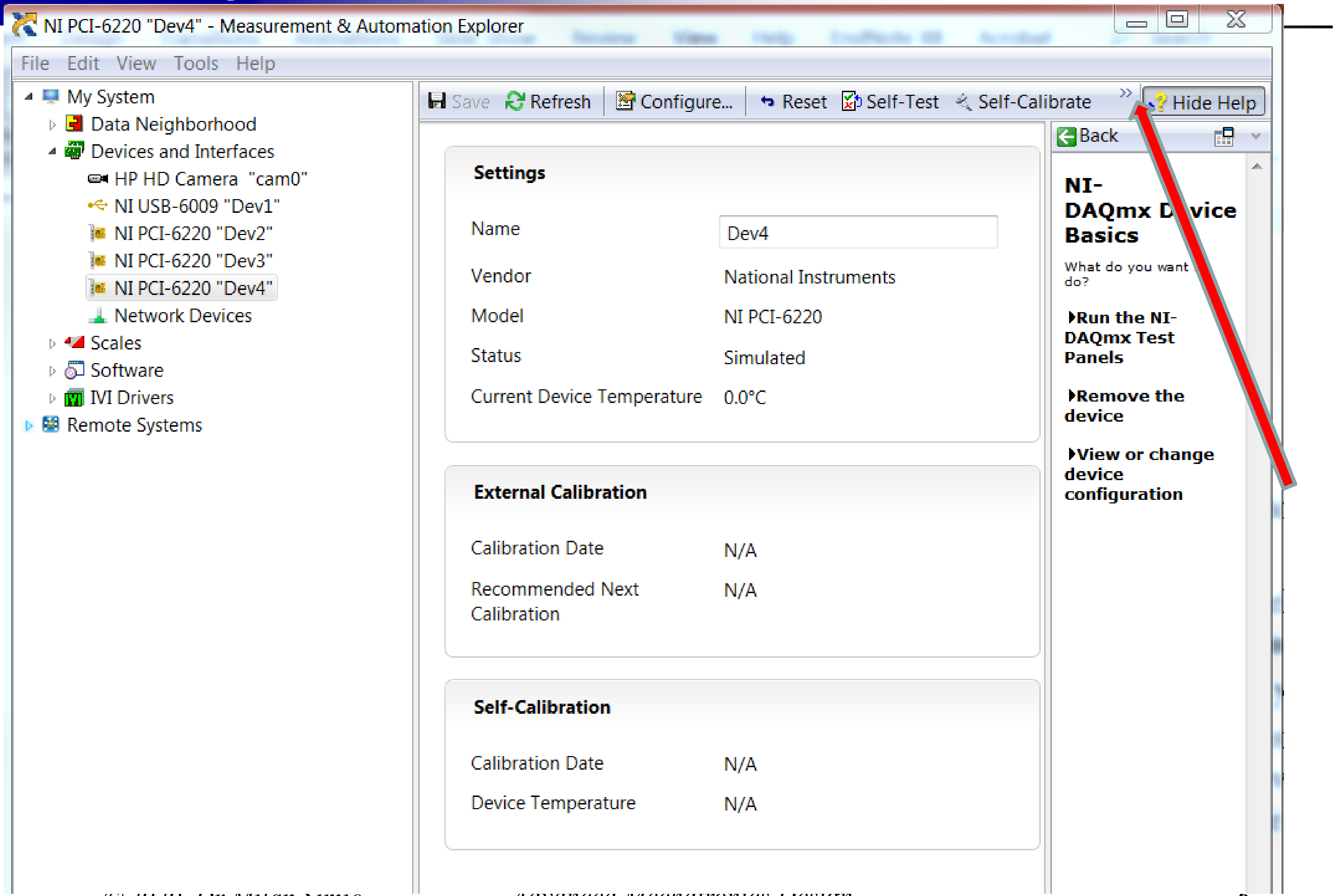
Create Simulated NI-DAQmx Device

NI-DAQmx Simulated Devices

- X Series DAQ
- M Series DAQ
  - NI PCI-6220
  - NI PCI-6221
  - NI PCI-6221 (37-pin)
  - NI PCI-6224
  - NI PCI-6225
  - NI PCI-6229
  - NI PCI-6230
  - NI PCI-6232
  - NI PCI-6233
  - NI PCI-6236
  - NI PCI-6238
  - NI PCI-6239
  - NI PCI-6250
  - NI PCI-6251
  - NI PCI-6254
  - NI PCI-6255
  - NI PCI-6259
  - NI PCI-6280

PXI Chassis 1

PXI Slot 2



NI PCI-6220 "Dev4" - Measurement & Automation Explorer

**Settings**

| | |
|---|---|
| Name | Dev4 |
| Vendor | National Instruments |
| Model | NI PCI-6220 |
| Status | Simulated |
| Current Device Temperature | 0.0°C |

**External Calibration**

| | |
|---|---|
| Calibration Date | N/A |
| Recommended Next Calibration | N/A |

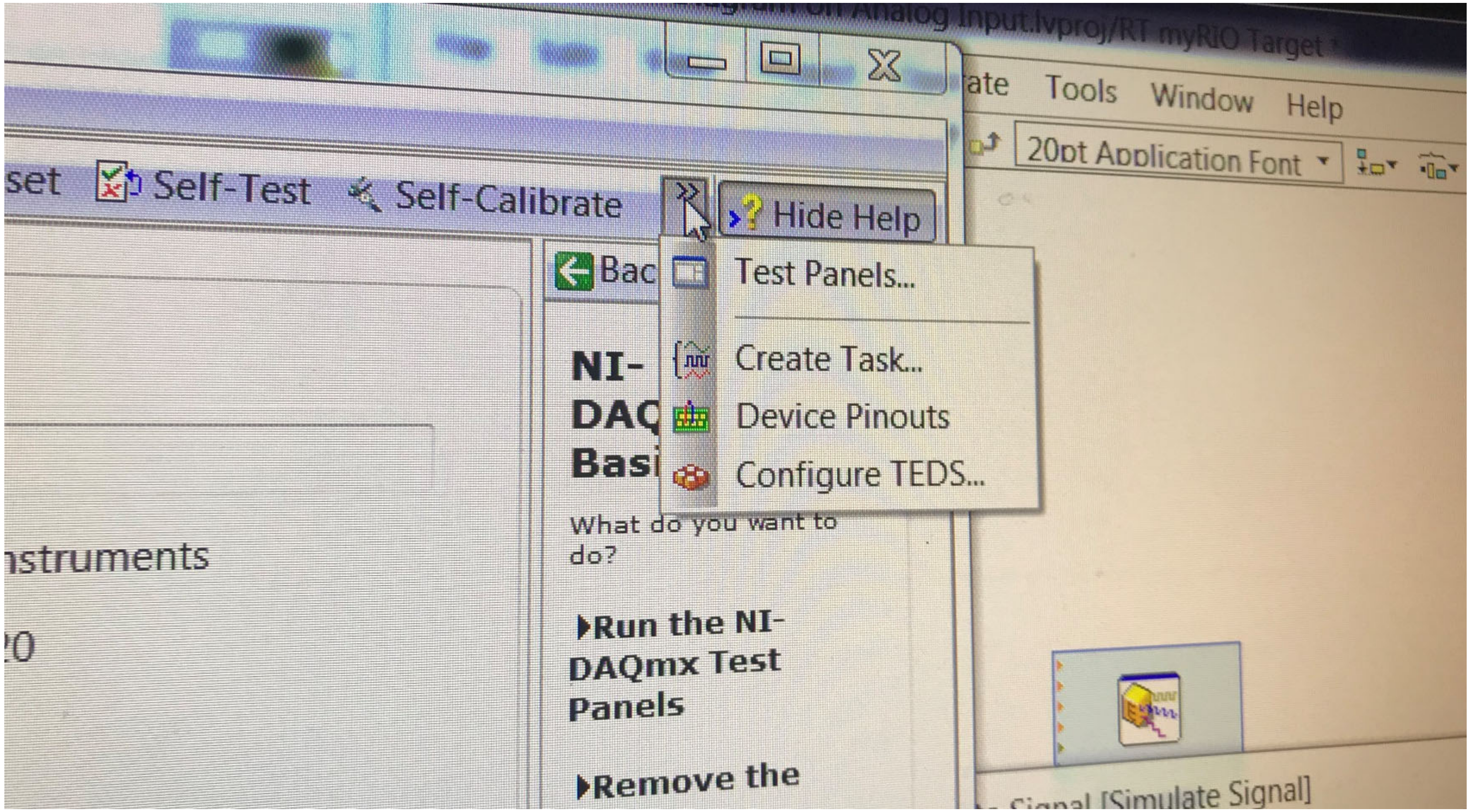
**Self-Calibration**

| | |
|---|---|
| Calibration Date | N/A |
| Device Temperature | N/A |

**NI-DAQmx Device Basics**

What do you want do?

- ▸Run the NI-DAQmx Test Panels
- ▸Remove the device
- ▸View or change device configuration



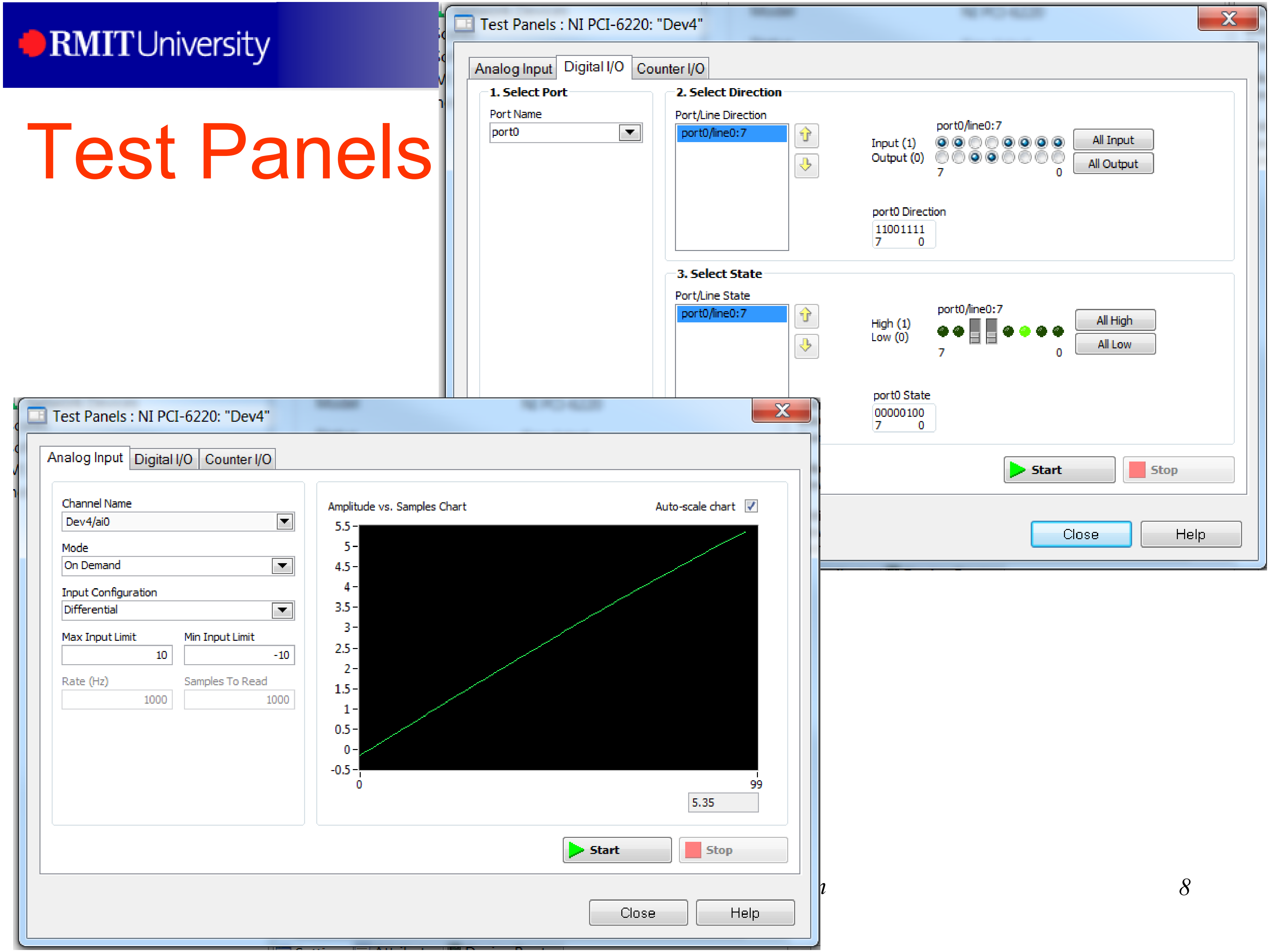
Explore

Test Panels

Device Pinouts

RMIT University

# Test Panels



Test Panels : NI PCI-6220: "Dev4"

1. Select Port

Port Name: port0

2. Select Direction

Port/Line Direction: port0/line0:7

port0/line0:7

port0 Direction: 11001111 (7 … 0)

3. Select State

Port/Line State: port0/line0:7

port0/line0:7

port0 State: 00000100 (7 … 0)

Test Panels : NI PCI-6220: "Dev4"

Channel Name: Dev4/ai0

Mode: On Demand

Input Configuration: Differential

Max Input Limit: 10

Min Input Limit: -10

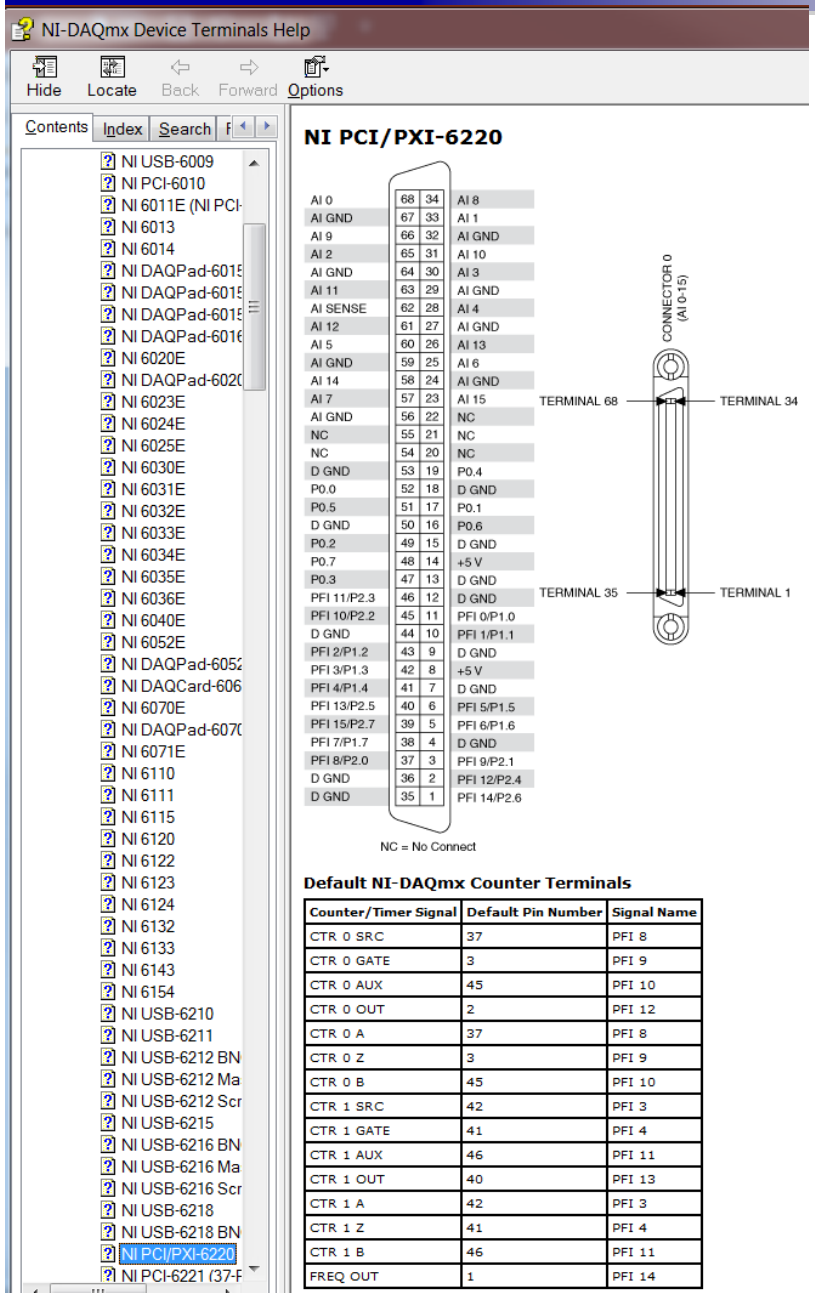
Rate (Hz): 1000

Samples To Read: 1000

Amplitude vs. Samples Chart

Auto-scale chart ☑

RMIT University



NI-DAQmx Device Terminals Help

- NI USB-6009
- NI PCI-6010
- NI 6011E (NI PCI-
- NI 6013
- NI 6014
- NI DAQPad-6015
- NI DAQPad-6015
- NI DAQPad-6015
- NI DAQPad-6016
- NI 6020E
- NI DAQPad-6020
- NI 6023E
- NI 6024E
- NI 6025E
- NI 6030E
- NI 6031E
- NI 6032E
- NI 6033E
- NI 6034E
- NI 6035E
- NI 6036E
- NI 6040E
- NI 6052E
- NI DAQPad-6052
- NI DAQCard-606
- NI 6070E
- NI DAQPad-6070
- NI 6071E
- NI 6110
- NI 6111
- NI 6115
- NI 6120
- NI 6122
- NI 6123
- NI 6124
- NI 6132
- NI 6133
- NI 6143
- NI 6154
- NI USB-6210
- NI USB-6211
- NI USB-6212 BN
- NI USB-6212 Ma
- NI USB-6212 Scr
- NI USB-6215
- NI USB-6216 BN
- NI USB-6216 Ma
- NI USB-6216 Scr
- NI USB-6218
- NI USB-6218 BN
- NI PCI/PXI-6220
- NI PCI-6221 (37-P

## NI PCI/PXI-6220

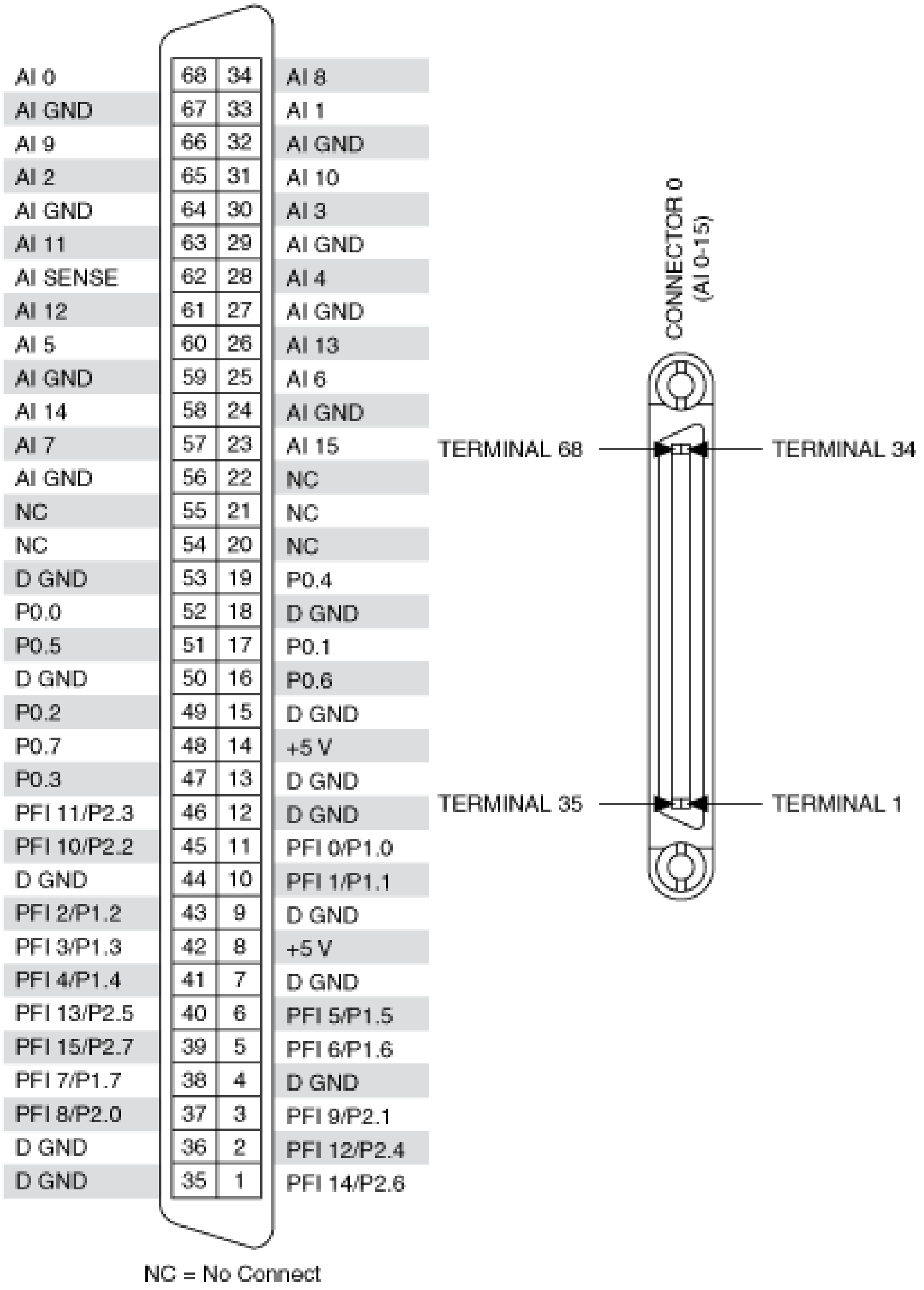
| | | | |
|---|---|---|---|
| AI 0 | 68 | 34 | AI 8 |
| AI GND | 67 | 33 | AI 1 |
| AI 9 | 66 | 32 | AI GND |
| AI 2 | 65 | 31 | AI 10 |
| AI GND | 64 | 30 | AI 3 |
| AI 11 | 63 | 29 | AI GND |
| AI SENSE | 62 | 28 | AI 4 |
| AI 12 | 61 | 27 | AI GND |
| AI 5 | 60 | 26 | AI 13 |
| AI GND | 59 | 25 | AI 6 |
| AI 14 | 58 | 24 | AI GND |
| AI 7 | 57 | 23 | AI 15 |
| AI GND | 56 | 22 | NC |
| NC | 55 | 21 | NC |
| NC | 54 | 20 | NC |
| D GND | 53 | 19 | P0.4 |
| P0.0 | 52 | 18 | D GND |
| P0.5 | 51 | 17 | P0.1 |
| D GND | 50 | 16 | P0.6 |
| P0.2 | 49 | 15 | D GND |
| P0.7 | 48 | 14 | +5 V |
| P0.3 | 47 | 13 | D GND |
| PFI 11/P2.3 | 46 | 12 | D GND |
| PFI 10/P2.2 | 45 | 11 | PFI 0/P1.0 |
| D GND | 44 | 10 | PFI 1/P1.1 |
| PFI 2/P1.2 | 43 | 9 | D GND |
| PFI 3/P1.3 | 42 | 8 | +5 V |
| PFI 4/P1.4 | 41 | 7 | D GND |
| PFI 13/P2.5 | 40 | 6 | PFI 5/P1.5 |
| PFI 15/P2.7 | 39 | 5 | PFI 6/P1.6 |
| PFI 7/P1.7 | 38 | 4 | D GND |
| PFI 8/P2.0 | 37 | 3 | PFI 9/P2.1 |
| D GND | 36 | 2 | PFI 12/P2.4 |
| D GND | 35 | 1 | PFI 14/P2.6 |

NC = No Connect

### Default NI-DAQmx Counter Terminals

| Counter/Timer Signal | Default Pin Number | Signal Name |
|---|---|---|
| CTR 0 SRC | 37 | PFI 8 |
| CTR 0 GATE | 3 | PFI 9 |
| CTR 0 AUX | 45 | PFI 10 |
| CTR 0 OUT | 2 | PFI 12 |
| CTR 0 A | 37 | PFI 8 |
| CTR 0 Z | 3 | PFI 9 |
| CTR 0 B | 45 | PFI 10 |
| CTR 1 SRC | 42 | PFI 3 |
| CTR 1 GATE | 41 | PFI 4 |
| CTR 1 AUX | 46 | PFI 11 |
| CTR 1 OUT | 40 | PFI 13 |
| CTR 1 A | 42 | PFI 3 |
| CTR 1 Z | 41 | PFI 4 |
| CTR 1 B | 46 | PFI 11 |
| FREQ OUT | 1 | PFI 14 |

# NI PCI/PXI-6220

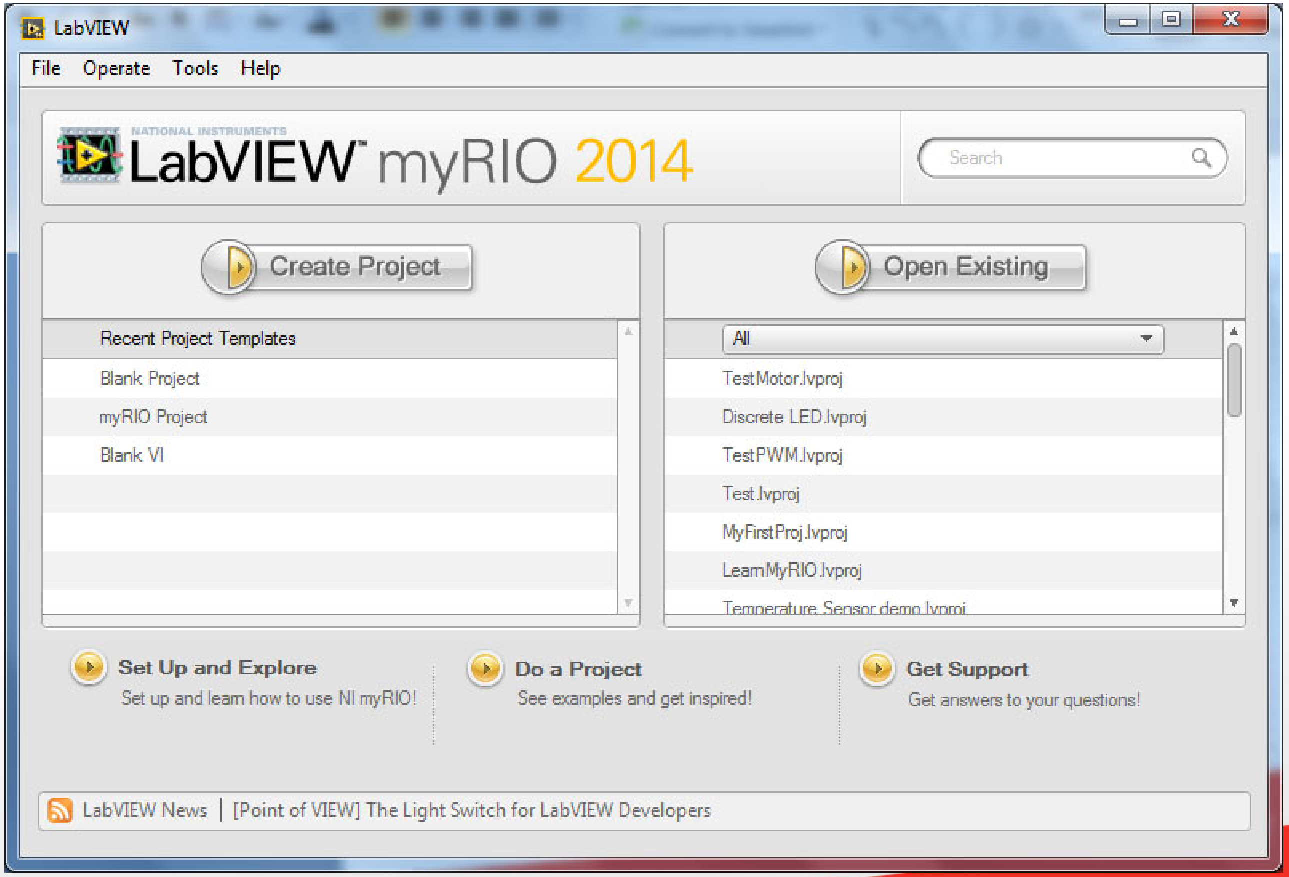


| | | | |
|---|---|---|---|
| AI 0 | 68 | 34 | AI 8 |
| AI GND | 67 | 33 | AI 1 |
| AI 9 | 66 | 32 | AI GND |
| AI 2 | 65 | 31 | AI 10 |
| AI GND | 64 | 30 | AI 3 |
| AI 11 | 63 | 29 | AI GND |
| AI SENSE | 62 | 28 | AI 4 |
| AI 12 | 61 | 27 | AI GND |
| AI 5 | 60 | 26 | AI 13 |
| AI GND | 59 | 25 | AI 6 |
| AI 14 | 58 | 24 | AI GND |
| AI 7 | 57 | 23 | AI 15 |
| AI GND | 56 | 22 | NC |
| NC | 55 | 21 | NC |
| NC | 54 | 20 | NC |
| D GND | 53 | 19 | P0.4 |
| P0.0 | 52 | 18 | D GND |
| P0.5 | 51 | 17 | P0.1 |
| D GND | 50 | 16 | P0.6 |
| P0.2 | 49 | 15 | D GND |
| P0.7 | 48 | 14 | +5 V |
| P0.3 | 47 | 13 | D GND |
| PFI 11/P2.3 | 46 | 12 | D GND |
| PFI 10/P2.2 | 45 | 11 | PFI 0/P1.0 |
| D GND | 44 | 10 | PFI 1/P1.1 |
| PFI 2/P1.2 | 43 | 9 | D GND |
| PFI 3/P1.3 | 42 | 8 | +5 V |
| PFI 4/P1.4 | 41 | 7 | D GND |
| PFI 13/P2.5 | 40 | 6 | PFI 5/P1.5 |
| PFI 15/P2.7 | 39 | 5 | PFI 6/P1.6 |
| PFI 7/P1.7 | 38 | 4 | D GND |
| PFI 8/P2.0 | 37 | 3 | PFI 9/P2.1 |
| D GND | 36 | 2 | PFI 12/P2.4 |
| D GND | 35 | 1 | PFI 14/P2.6 |

NC = No Connect

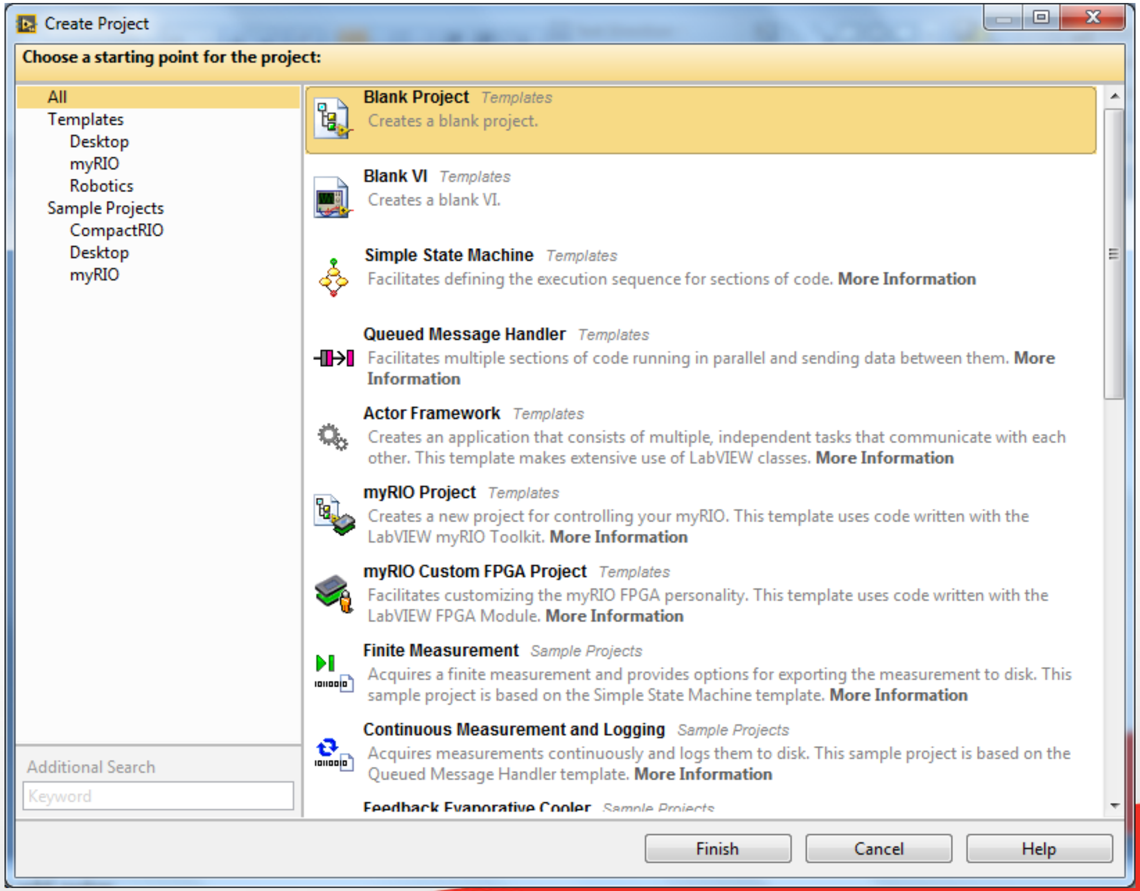
# Setting up myRIO Projects

- Click on “Create Project”



# Setting up the Project

- Choose blank project.



Create Project

Choose a starting point for the project:

**Blank Project** *Templates*
Creates a blank project.

**Blank VI** *Templates*
Creates a blank VI.

**Simple State Machine** *Templates*
Facilitates defining the execution sequence for sections of code. **More Information**

**Queued Message Handler** *Templates*
Facilitates multiple sections of code running in parallel and sending data between them. **More Information**

**Actor Framework** *Templates*
Creates an application that consists of multiple, independent tasks that communicate with each other. This template makes extensive use of LabVIEW classes. **More Information**

**myRIO Project** *Templates*
Creates a new project for controlling your myRIO. This template uses code written with the LabVIEW myRIO Toolkit. **More Information**

**myRIO Custom FPGA Project** *Templates*
Facilitates customizing the myRIO FPGA personality. This template uses code written with the LabVIEW FPGA Module. **More Information**

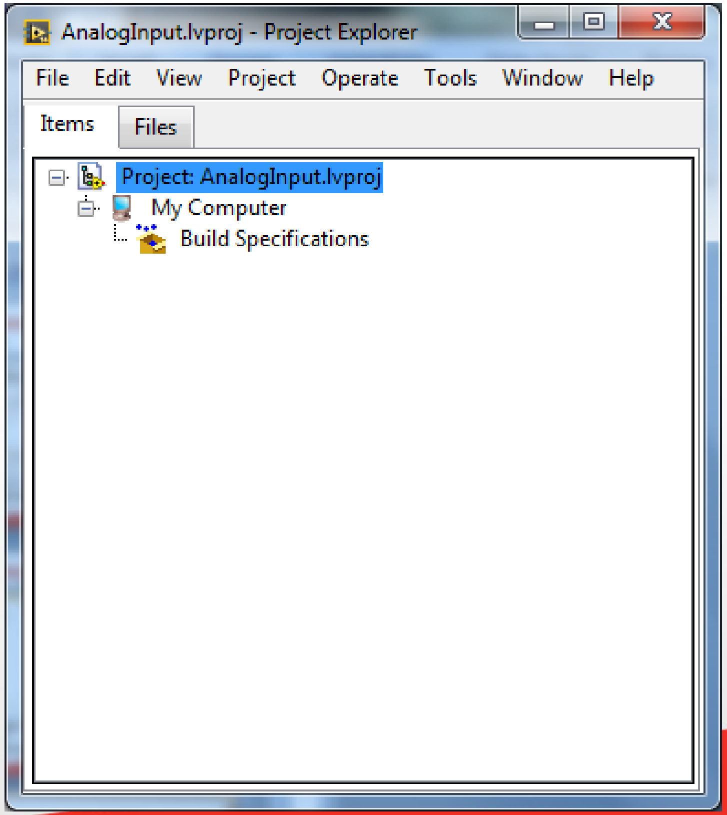
**Finite Measurement** *Sample Projects*
Acquires a finite measurement and provides options for exporting the measurement to disk. This sample project is based on the Simple State Machine template. **More Information**

**Continuous Measurement and Logging** *Sample Projects*
Acquires measurements continuously and logs them to disk. This sample project is based on the Queued Message Handler template. **More Information**

**Feedback Evaporative Cooler** *Sample Projects*

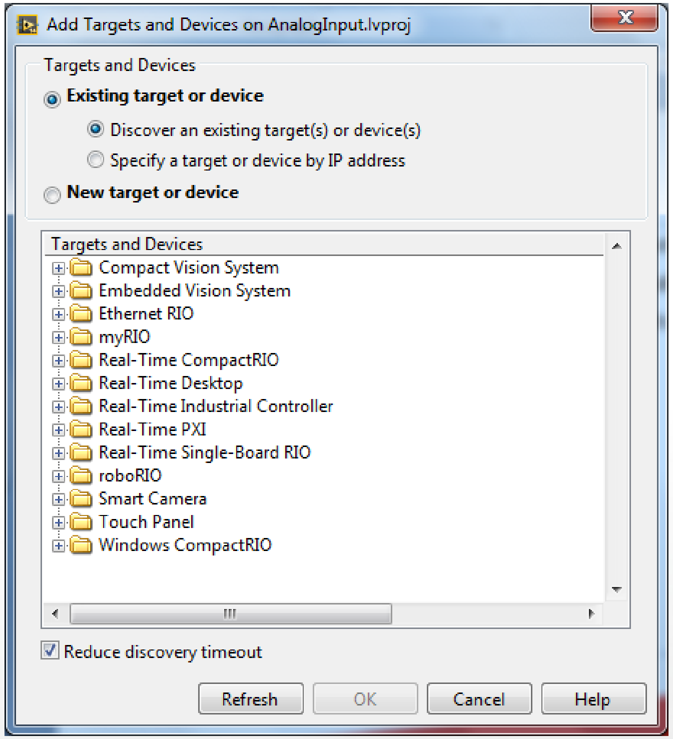
# Setting up the Project

- You will see the project window.
- Right click on “Project: Untitled Project 1” → Save as → “AnalogInput”.



# Setting up the Project with myRIO

- Right click on Project AnalogInput → New → Targets and Devices



Add Targets and Devices on AnalogInput.lvproj

Targets and Devices

● Existing target or device

● Discover an existing target(s) or device(s)

○ Specify a target or device by IP address

○ New target or device

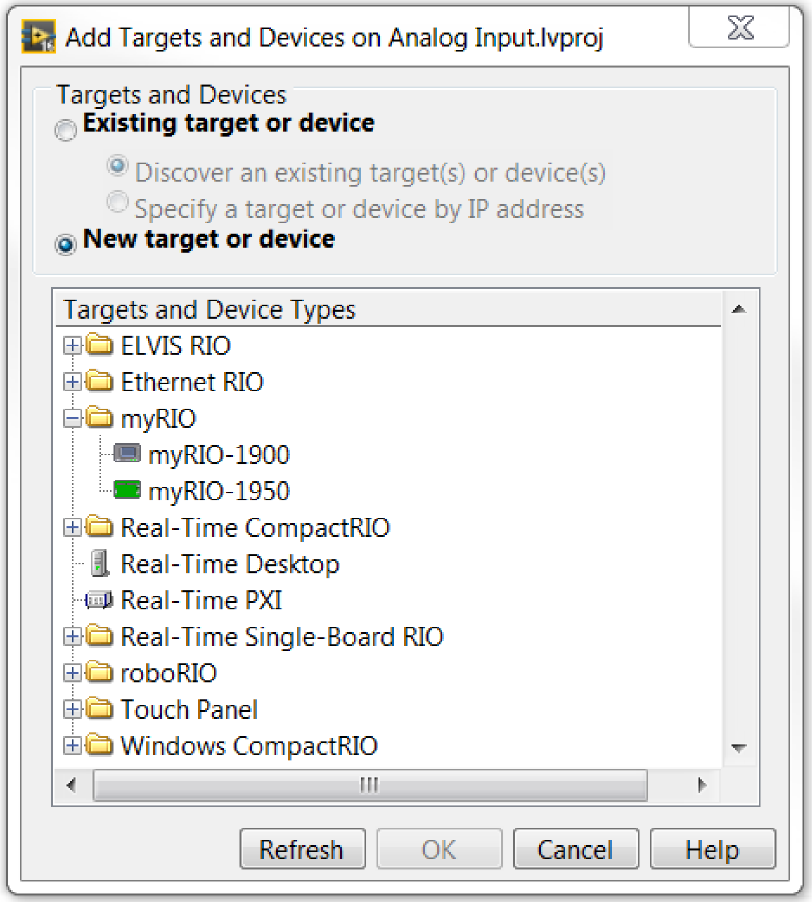
Targets and Devices
- Compact Vision System
- Embedded Vision System
- Ethernet RIO
- myRIO
- Real-Time CompactRIO
- Real-Time Desktop
- Real-Time Industrial Controller
- Real-Time PXI
- Real-Time Single-Board RIO
- roboRIO
- Smart Camera
- Touch Panel
- Windows CompactRIO

☑ Reduce discovery timeout

- Existing target or device:
  - Discover an existing target or device.
  - Or specify a target or device by IP address. (myRIO's IP is 172.22.11.2)
- Click the "+" sign before myRIO.

# Project with Simulated myRIO

- Right click on Project AnalogInput → New → Targets and Devices



Add Targets and Devices on Analog Input.lvproj

Targets and Devices

○ **Existing target or device**

● Discover an existing target(s) or device(s)

○ Specify a target or device by IP address

● **New target or device**

Targets and Device Types

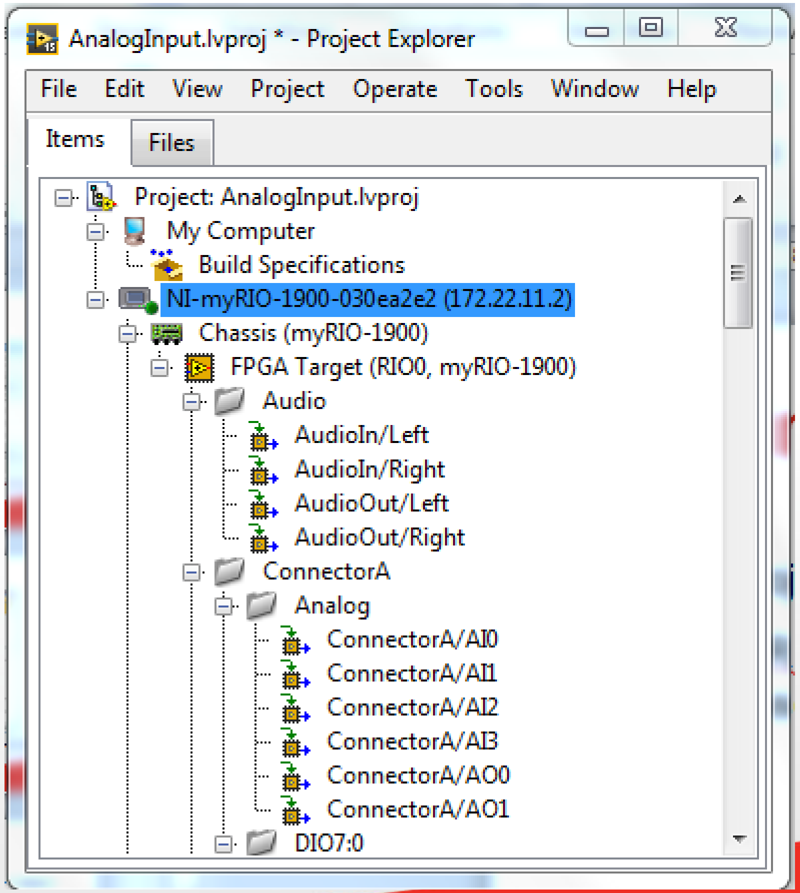
- ELVIS RIO
- Ethernet RIO
- myRIO
  - myRIO-1900
  - myRIO-1950
- Real-Time CompactRIO
- Real-Time Desktop
- Real-Time PXI
- Real-Time Single-Board RIO
- roboRIO
- Touch Panel
- Windows CompactRIO

- New (Simulated) target or device:
  - Create **New target or device**.

Click on green myRIO-1950.

# Setting up the Project

- The project tree now looks like this:

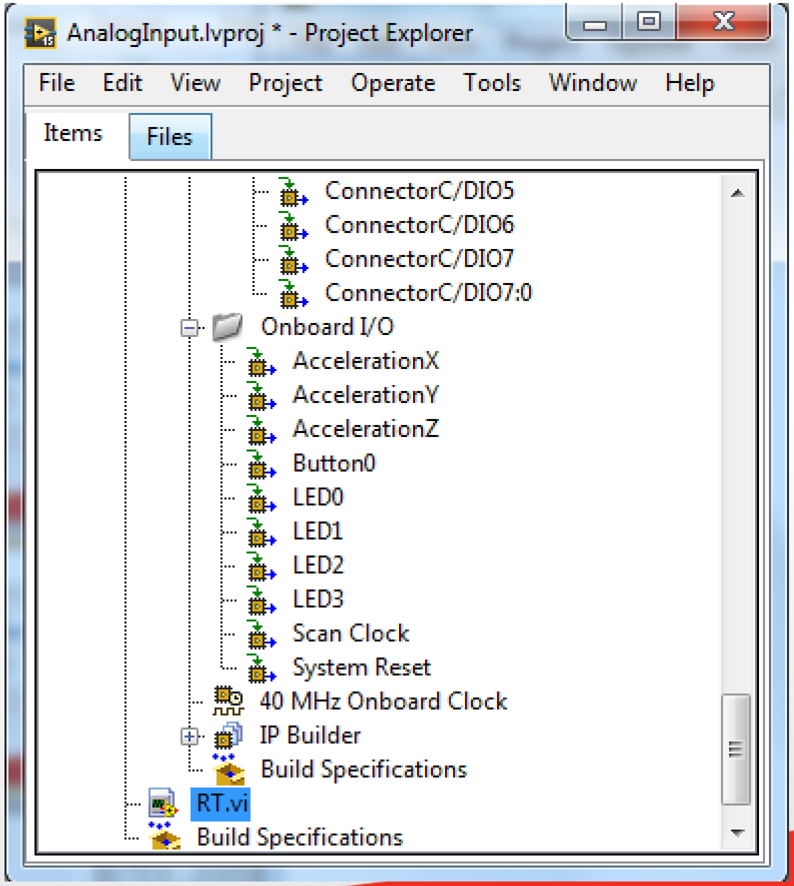


AnalogInput.lvproj * - Project Explorer
File Edit View Project Operate Tools Window Help
Items Files

```
Project: AnalogInput.lvproj
  My Computer
    Build Specifications
  NI-myRIO-1900-030ea2e2 (172.22.11.2)
    Chassis (myRIO-1900)
      FPGA Target (RIO0, myRIO-1900)
        Audio
          AudioIn/Left
          AudioIn/Right
          AudioOut/Left
          AudioOut/Right
        ConnectorA
          Analog
            ConnectorA/AI0
            ConnectorA/AI1
            ConnectorA/AI2
            ConnectorA/AI3
            ConnectorA/AO0
            ConnectorA/AO1
          DIO7:0
```

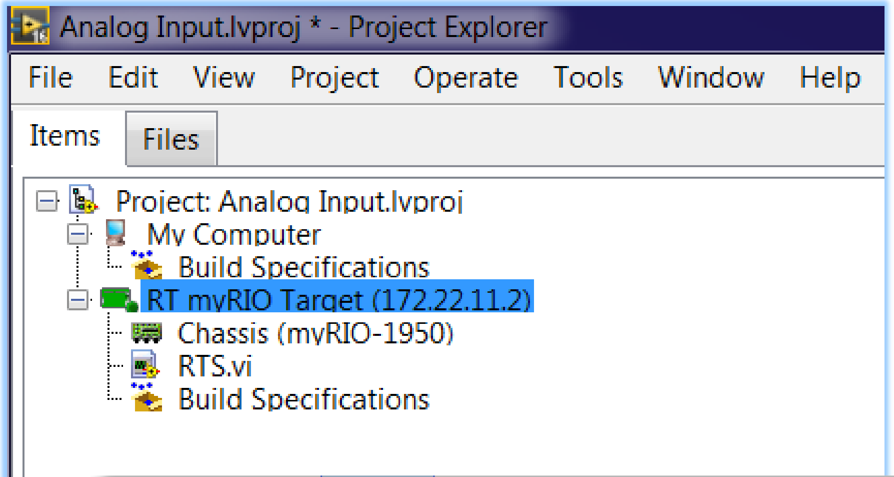
# Setting up the Project

- Right click on “NI-myRIO-1900…” → New → VI
- A VI will open.
- Save it as RT.vi.
- Now we are ready to program the VI for reading analog inputs.



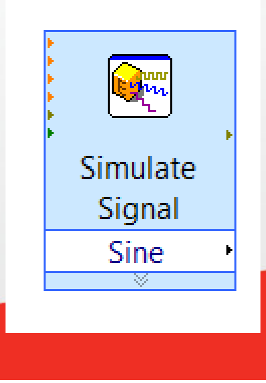
# Project with Simulated myRIO

- Set myRIO's IP as 172.22.11.2
- Right click on "NI-myRIO-1950…" → New → VI
- A VI will open.
- Save it as RTS.vi.
- Now we are ready to program the VI
- Instead of Input signals as with physical myRIO you will Simulate Signals



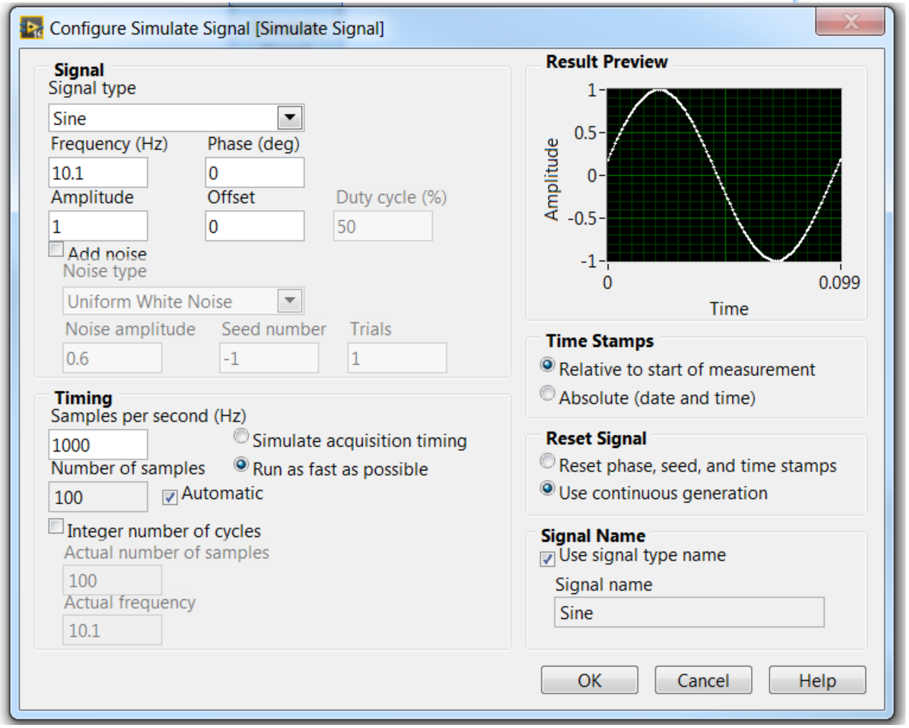
Analog Input.lvproj * - Project Explorer

- Project: Analog Input.lvproj
  - My Computer
    - Build Specifications
  - RT myRIO Target (172.22.11.2)
    - Chassis (myRIO-1950)
    - RTS.vi
    - Build Specifications



Simulate Signal

Sine



Configure Simulate Signal [Simulate Signal]

**Signal**

Signal type: Sine

Frequency (Hz): 10.1

Phase (deg): 0

Amplitude: 1

Offset: 0

Duty cycle (%): 50

□ Add noise

Noise type: Uniform White Noise

Noise amplitude: 0.6

Seed number: -1

Trials: 1

**Timing**

Samples per second (Hz): 1000

○ Simulate acquisition timing

● Run as fast as possible

Number of samples: 100

☑ Automatic

□ Integer number of cycles

Actual number of samples: 100

Actual frequency: 10.1

**Result Preview**

**Time Stamps**

● Relative to start of measurement

○ Absolute (date and time)

**Reset Signal**

○ Reset phase, seed, and time stamps

● Use continuous generation

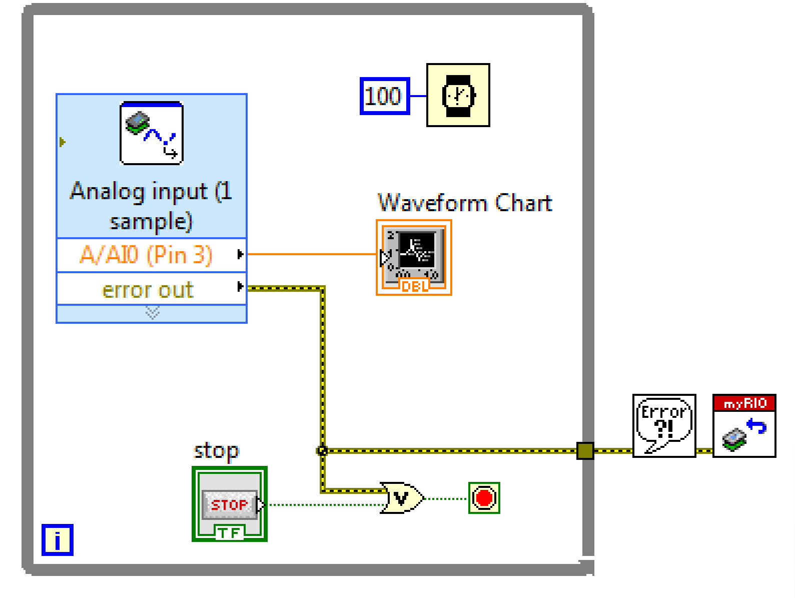
**Signal Name**

☑ Use signal type name

Signal name: Sine

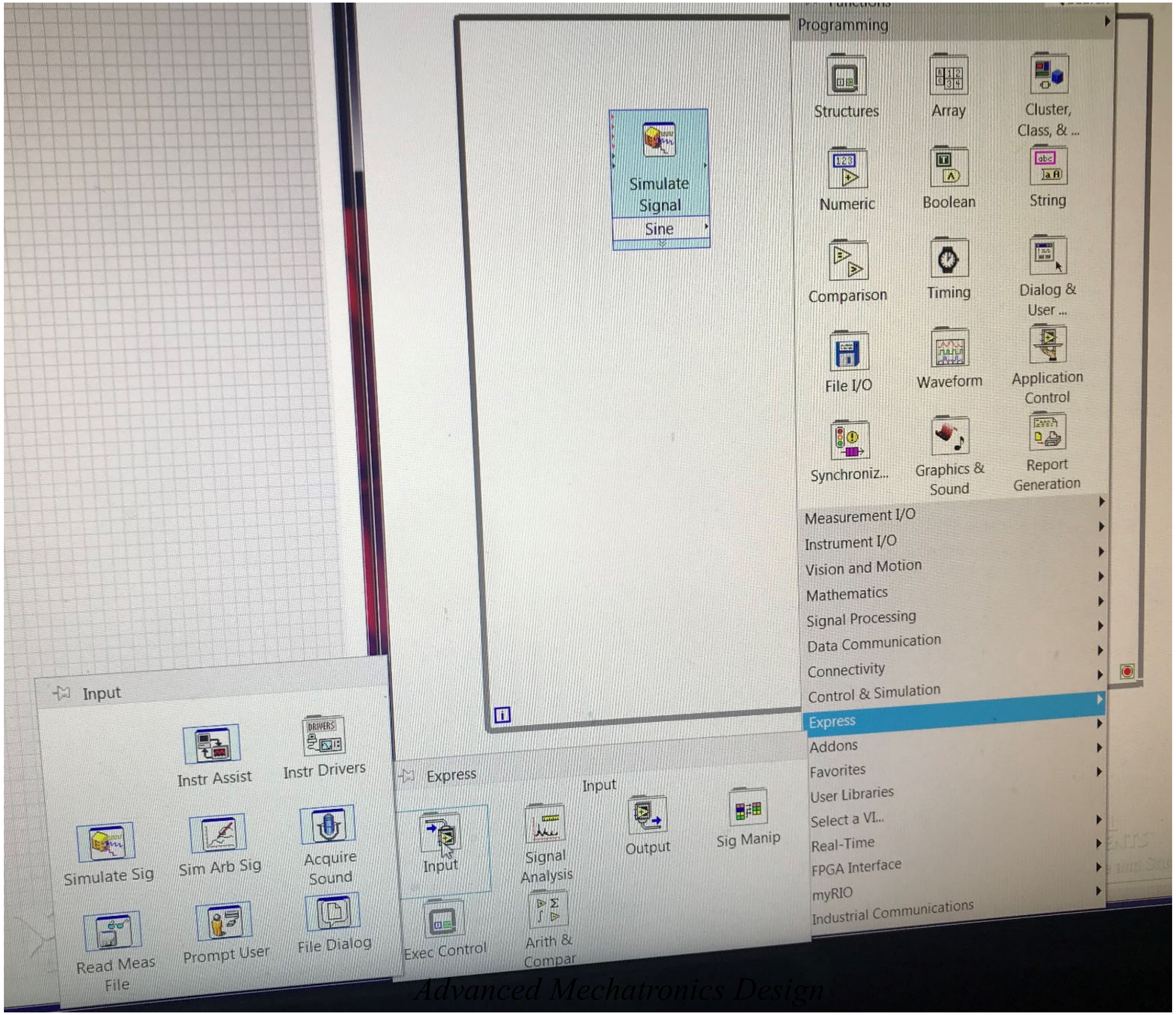
# Reading & Calibrating Range Sensor

- Next, create the following VI in RT.vi:

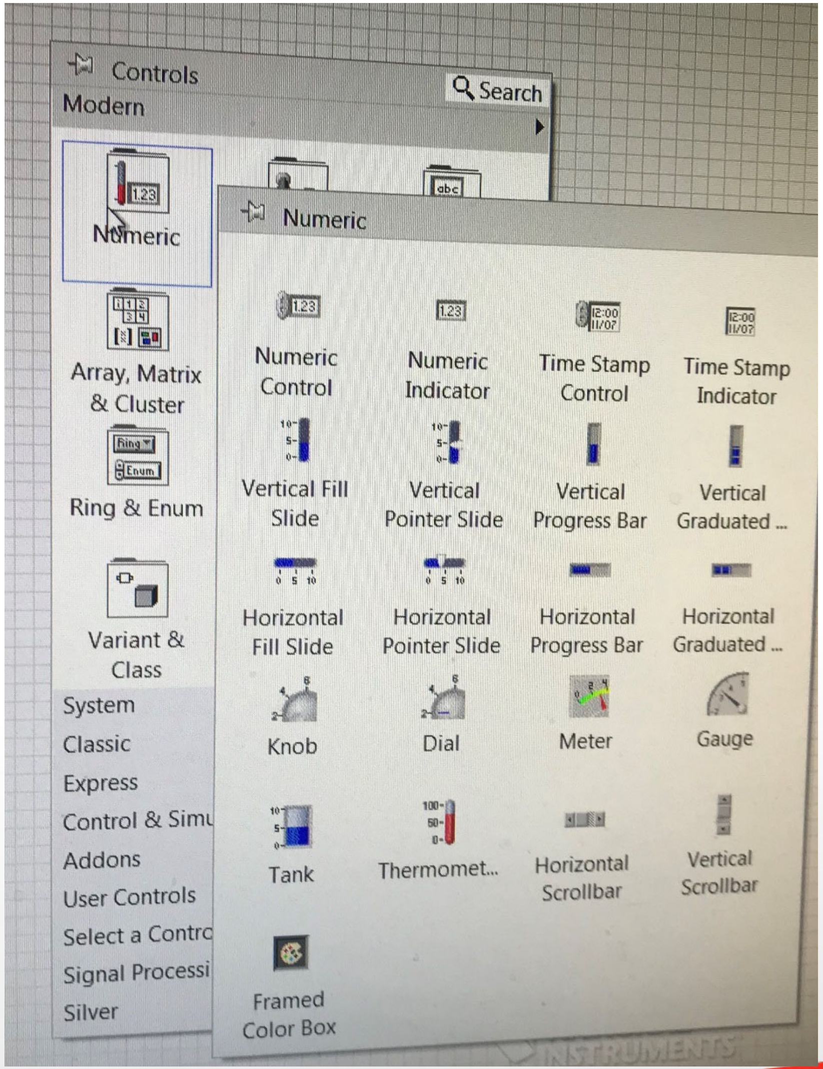


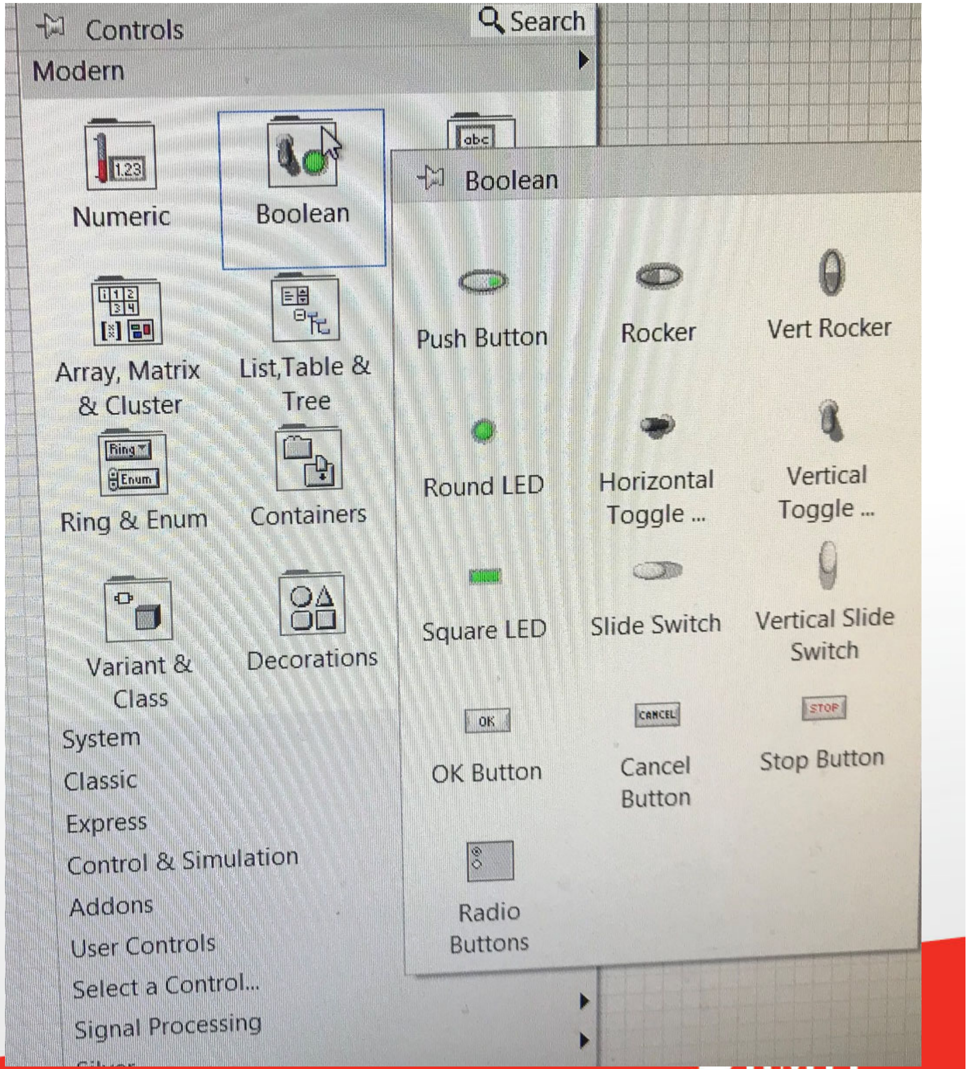
- Connect the IR Range Sensor to the myRIO board as follows:
  - Red → 5V
  - Black → Ground
  - White → AI 0

# Project with Simulated I/O



# Project with Simulated I/O





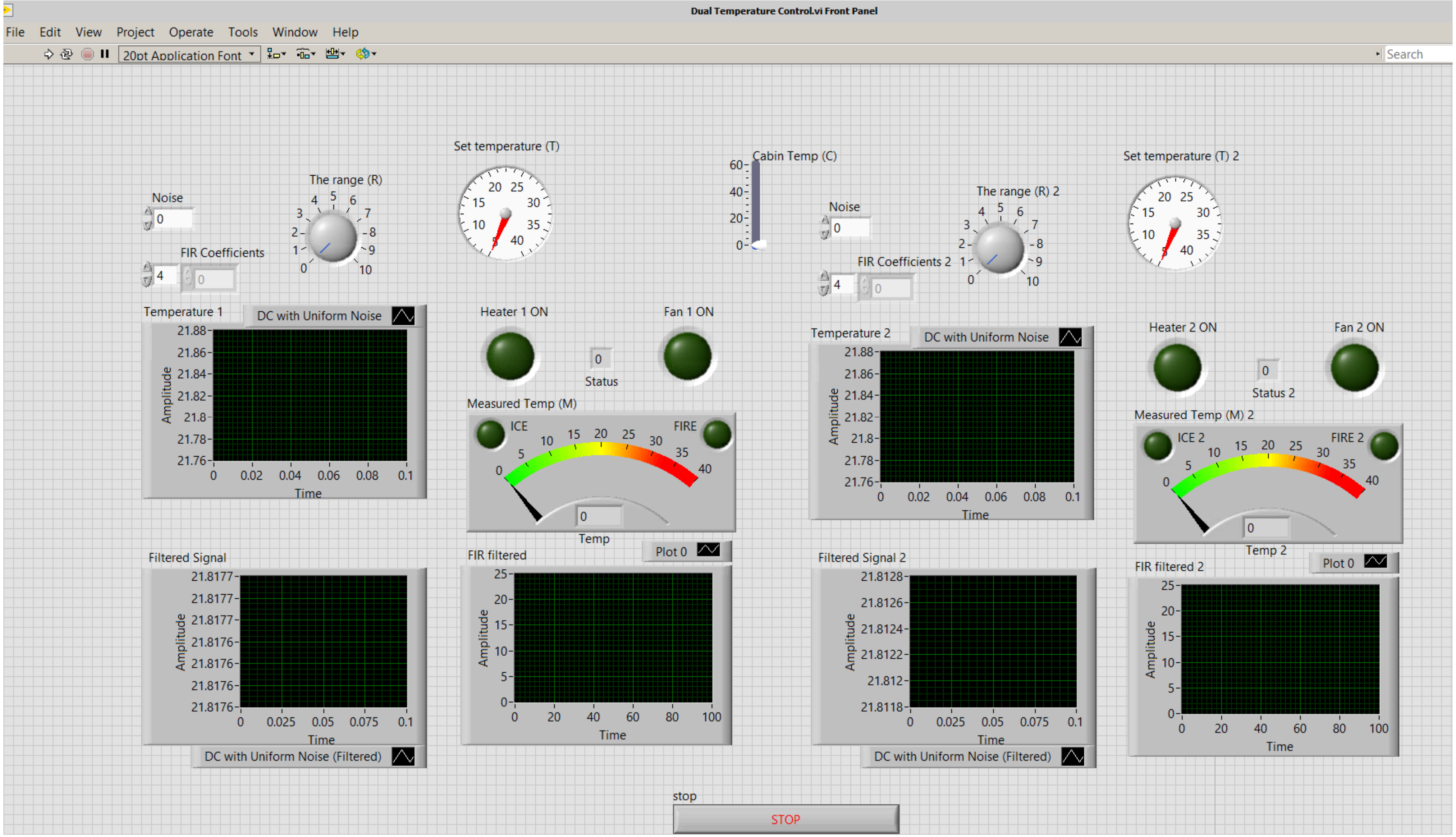
# A Control System Design

Your task is to design a control system. Use LabVIEW to simulate temperature data acquisition and control, in modern cars, where you have two temperature control loops. Controlled variables are temperatures, $T_1$ and $T_2$. Your program should perform the following:

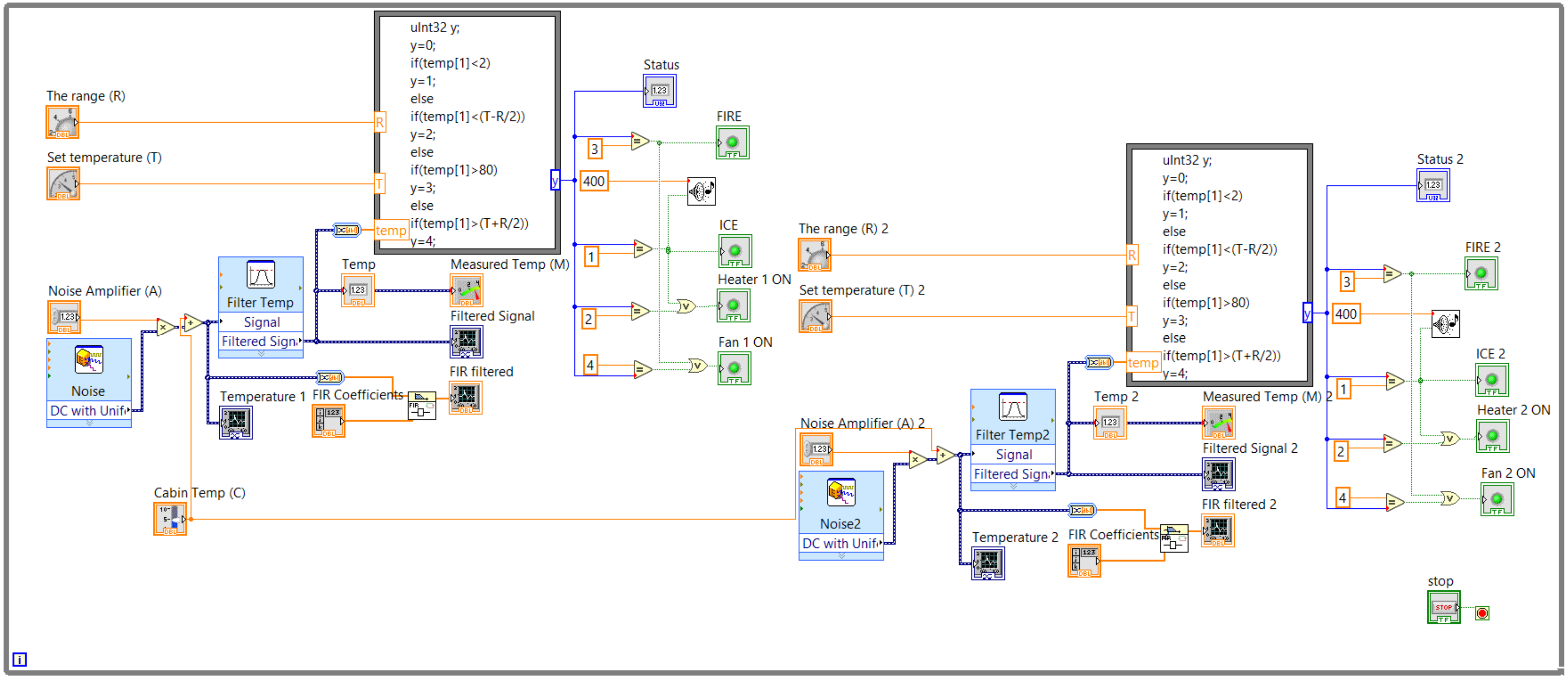
- Simulate data acquisition, with noise,
- Has an interface to set up the target value of the controlled variable, and offset

  $T=T_{target} \pm T_{offset}$ for example $T=20\pm 1\ ^0C$
- Filter the signal using FIR filter, or other,
- Display the temperature value before and after the filtering using graph representation,
- Display the temperature value using a numerical indicator,
- If the measured (simulated) value is below the target activate the heater, simulated by a red diode
- If the measured value is above  the target activate the fan, simulated by a blue diode
- When the controlled variable is at the target range both diodes should be OFF
- Add two more diodes for warning when the temperature is too low ($T<2^0C$), or too high ($T>80^0C$)
- BONUS, for HD: Add sound warning for both cases: ($T<2^0C$) & ($T>80^0C$).
- If your control system for the temperature $T_1$ is working well, add one more control system for the temperature $T_2$.

# Dual Temperature Control



# Dual Temperature Control



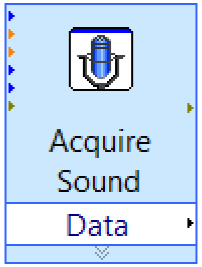
```
uInt32 y;
y=0;
if(temp[1]<2)
y=1;
else
if(temp[1]<(T-R/2))
y=2;
else
if(temp[1]>80)
y=3;
else
if(temp[1]>(T+R/2))
y=4;
```

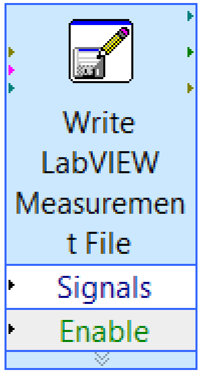
```
uInt32 y;
y=0;
if(temp[1]<2)
y=1;
else
if(temp[1]<(T-R/2))
y=2;
else
if(temp[1]>80)
y=3;
else
if(temp[1]>(T+R/2))
y=4;
```

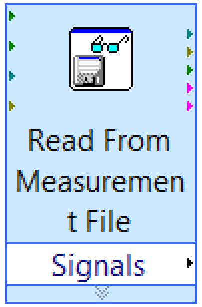
# Exercise

Redevelop temperature control program so that

- Two temperatures are measured
- Case structure is used instead if else constructions
- Add sound warning: In order to do that you need to







# Thank you, Questions