

# Tutorial:

## Software - Data Acquisition (DAQ)

### MEC100x-Lectures 11

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# Aims

1. DAQ Software :

2. NI Device Monitor

- Digital input test
- Digital output test
- Analog input test
- Analog output test

3. MATLAB/SIMULINK and Hardware in Loop with DAQ

- Digital input
- Digital output
- Analog input
- Analog output



**AND and XOR gate in simulink**



**Closed-loop control and PID controller in Simulink**

# DAQ SOFTWARE : INSTALLATION

1- First; Download DAQNavi-offline software from the Advantech website:

<https://www.advantech.com/en/support/details/driver?id=I-IYXXIAO>

2- Second; Install DAQNavi-offline software.

## DAQNavi-offline\_Test Only

2020-10-12 | Driver | Document No.1-4289600976

### Related OS:

Win10, Win7, WinXP, WinServer2003, WinServer2008

### Related Product:

DAQNavi/SDK

### Solution:

DAQNavi-offline\_Test Only

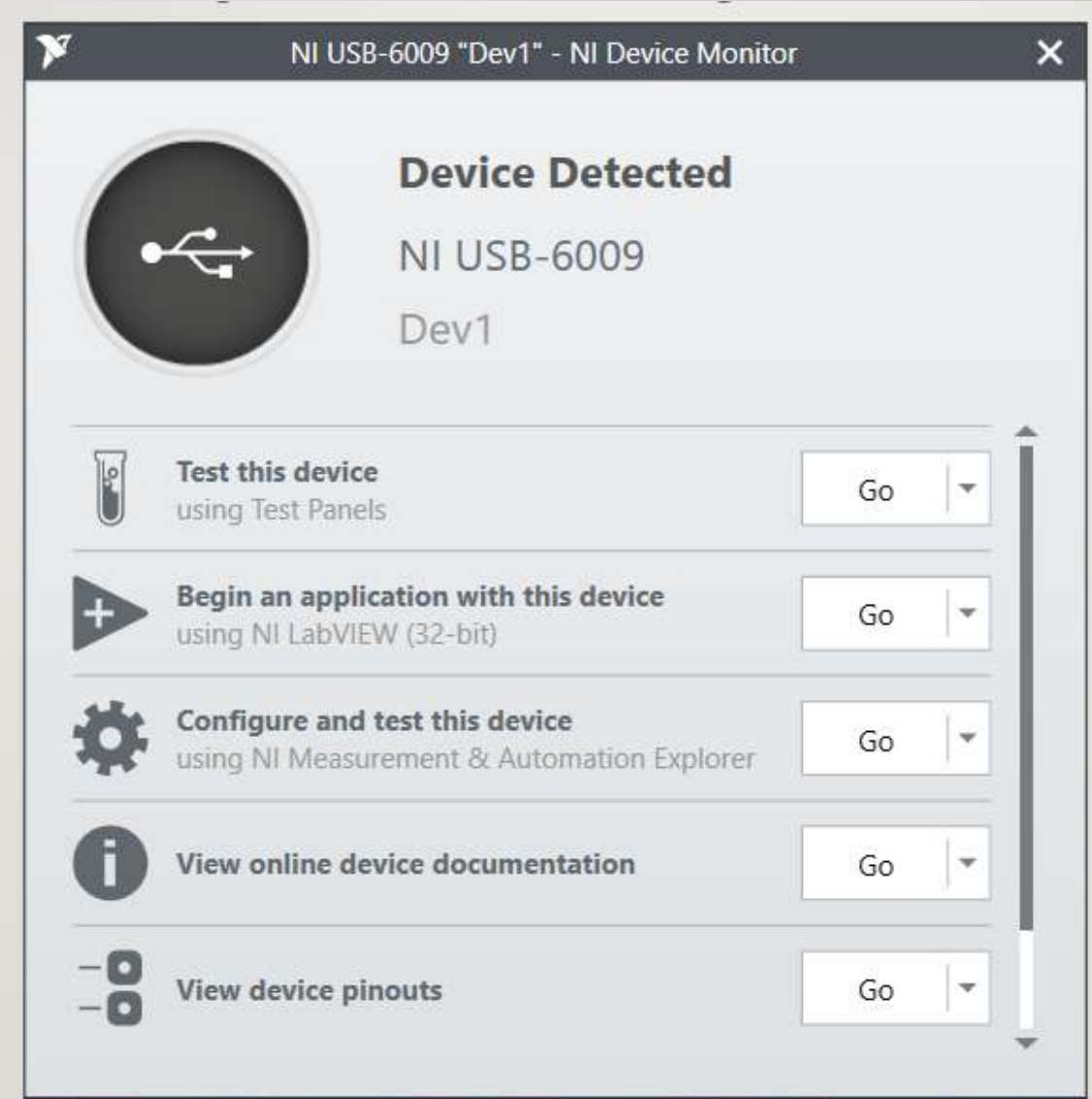
This is for internal test

### DAQNavi-offline

2020-09-24

Download

# DAQ SOFTWARE : NI DEVICE MONITOR/ TEST



# TEST NI USB 6009

**ANALOG INPUT TAB:**

**Channel selection**

**Type of input:**

- Differential type
- Single ended type

The screenshot displays the 'Test Panels : NI USB-6009: "Dev1"' window. The 'Analog Input' tab is selected and highlighted with a red dashed circle. Below it, the 'Channel Name' is set to 'Dev1/ai0', 'Mode' is 'On Demand', and 'Input Configuration' is 'RSE', all of which are also circled in red. The 'Max Input Limit' is 10 and the 'Min Input Limit' is -10. The 'Rate (Hz)' is 1000 and 'Samples To Read' is 1000. To the right, the 'Amplitude vs. Samples Chart' is shown with a y-axis from -10 to -8.6 and an x-axis from 0 to 99. The chart area is currently black. At the bottom right, there are 'Start' and 'Stop' buttons, and at the bottom center, 'Close' and 'Help' buttons.

# TEST NI USB 6009

**ANALOG INPUT TAB:**

Test Panels : NI USB-6009: "Dev1"

Analog Input | Analog Output | Digital I/O | Counter I/O

Channel Name: Dev1/ai0

Mode: On Demand

Input Configuration: RSE

Max Input Limit: 10 | Min Input Limit: -10

Rate (Hz): 1000 | Samples To Read: 1000

Amplitude vs. Samples Chart | Auto-scale chart

Start | Stop

Close | Help

**Input range limitation:**

**Start and stop for test:**

# TEST NI USB 6009

**ANALOG INPUT TAB:**



**1.4V to 5V measuring of AI0**

# TEST NI USB 6009

**ANALOG OUTPUT TAB:**

**Channel selection**

**Output voltage changing:**

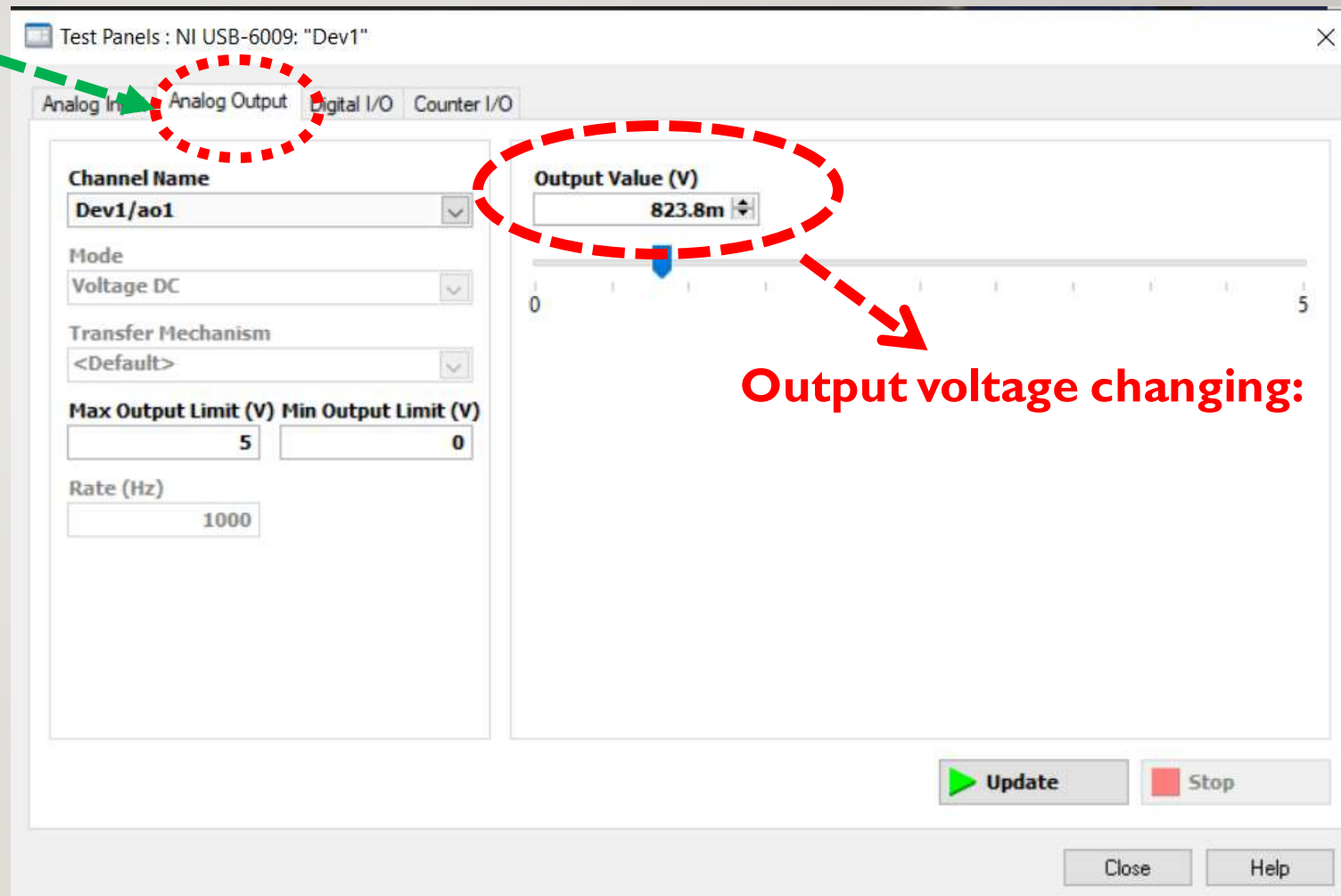
**Output range limitation:**

The screenshot shows the 'Test Panels : NI USB-6009: "Dev1"' window. The 'Analog Output' tab is selected. The 'Channel Name' is set to 'Dev1/ao1'. The 'Mode' is 'Voltage DC'. The 'Transfer Mechanism' is '<Default>'. The 'Max Output Limit (V)' is 5 and the 'Min Output Limit (V)' is 0. The 'Rate (Hz)' is 1000. The 'Output Value (V)' is 823.8m. A slider below the output value shows the voltage being adjusted. The 'Update' and 'Stop' buttons are visible at the bottom right.



# TEST NI USB 6009

**ANALOG OUTPUT TAB:**



**Output voltage changing:**

**Output voltage and LED module test**

# TEST NI USB 6009

## DIGITAL I/O TAB

Port 0/I selection

Digital Input selection

Digital output selection

Digital Input indicators

Test Panels : NI USB-6009: "Dev1"

Analog Input Analog Output **Digital I/O** Counter I/O

1. Select Port

Port Name  
port0

2. Select Direction

Port/Line Direction  
port0/line0:7

Input (1) port0/line0:7  
Output (0) 7 0

All Input  
All Output

port0 Direction  
11111111  
7 0

3. Select State

Port/Line State  
port0/line0:7

High (1) port0/line0:7  
Low (0) 7 0

All High  
All Low

port0 State  
11111111  
7 0

Start Stop

Close Help

# TEST NI USB 6009

## DIGITAL I/O TAB

The screenshot shows the 'Test Panels : NI USB-6009: "Dev1"' window with the 'Digital I/O' tab selected. The interface is divided into three main sections: '1. Select Port', '2. Select Direction', and '3. Select State'. In the '1. Select Port' section, 'port0' is selected in the 'Port Name' dropdown. In the '2. Select Direction' section, 'port0/line0:7' is selected in the 'Port/Line Direction' dropdown. The 'Input (1)' and 'Output (0)' radio buttons are selected and circled in red. Below this, the 'port0 Direction' is shown as '00000000' with '7' and '0' below it. In the '3. Select State' section, 'port0/line0:7' is selected in the 'Port/Line State' dropdown. The 'High (1)' and 'Low (0)' radio buttons are selected and circled in red. Below this, the 'port0 State' is shown as '00000000' with '7' and '0' below it. At the bottom right, there are 'Start' and 'Stop' buttons. At the bottom center, there are 'Close' and 'Help' buttons.

**Digital output selection**

**Digital output Keys for sending command**

**High**

**Low**

# TEST NI USB 6009

## DIGITAL I/O EXPANSION

Digital output port 1

The screenshot shows the 'Test Panels : NI USB-6009: "Dev1"' window with the 'Digital I/O' tab selected. It is divided into three sections:

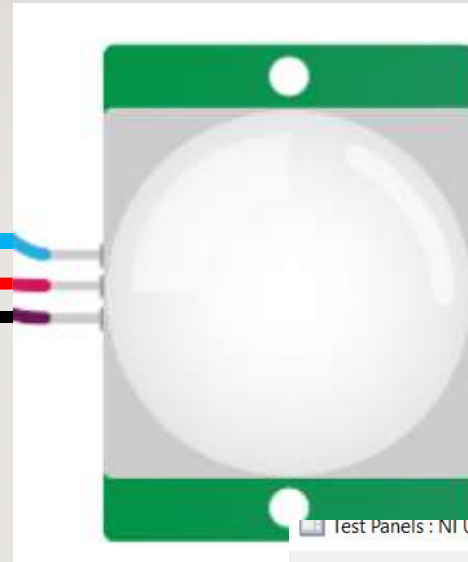
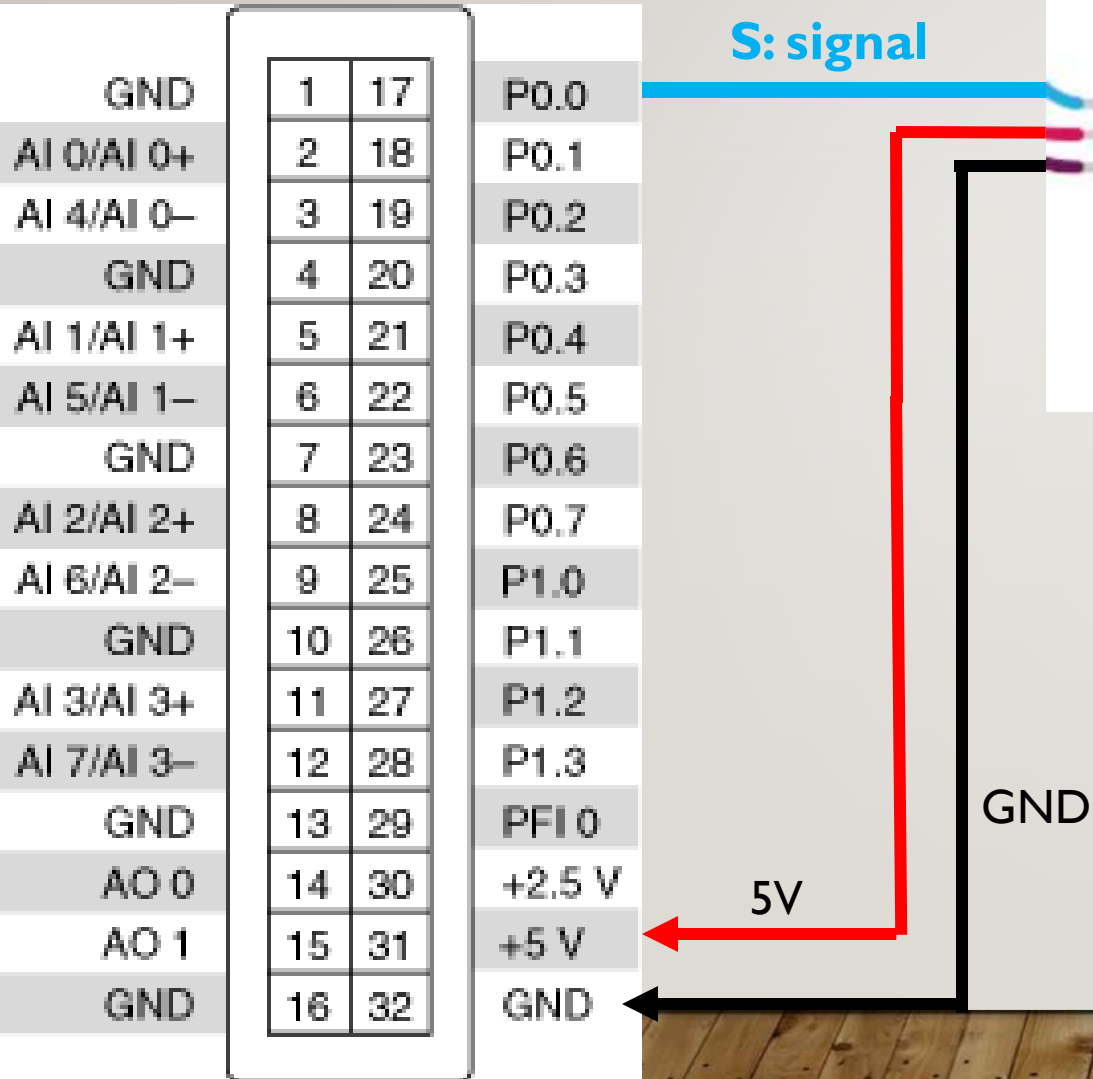
- 1. Select Port:** A dropdown menu for 'Port Name' is set to 'port1' and is circled in red. A dashed arrow points from the text 'Digital output port 1' to this menu.
- 2. Select Direction:** The 'Port/Line Direction' list contains 'port1/line0:3'. To the right, there are two rows of indicator lights: 'Input (1)' and 'Output (0)'. The 'Output (0)' row has 8 lights, with the rightmost one (line 0) being lit. Below this, a 'port1 Direction' field shows 'xxxx1111' for lines 7-0.
- 3. Select State:** The 'Port/Line State' list contains 'port1/line0:3'. To the right, there are two rows of indicator lights: 'High (1)' and 'Low (0)'. The 'High (1)' row has 8 lights, with the rightmost one (line 0) being lit. Below this, a 'port1 State' field shows 'xxxx0000' for lines 7-0.

At the bottom right, there are 'Start' and 'Stop' buttons. At the bottom center, there are 'Close' and 'Help' buttons.

Digital input expansion

# PIR motion sensor and DAQ Navi

## Digital Input 0



PIR sensor

The screenshot shows the DAQ Navi software interface. The "Digital I/O" tab is selected. The "1. Select Port" section shows "port0" selected. The "2. Select Direction" section shows "port0/line0:7" selected with the "Input" direction. The "3. Select State" section shows "port0/line0:7" selected with the "High (1)" state. The "port0 State" is displayed as "11111110" with the "0" bit circled in red, indicating the sensor is ON. The "Start" button is highlighted.

Sensor=ON

# DAQ SOFTWARE: MATLAB / SIMULINK

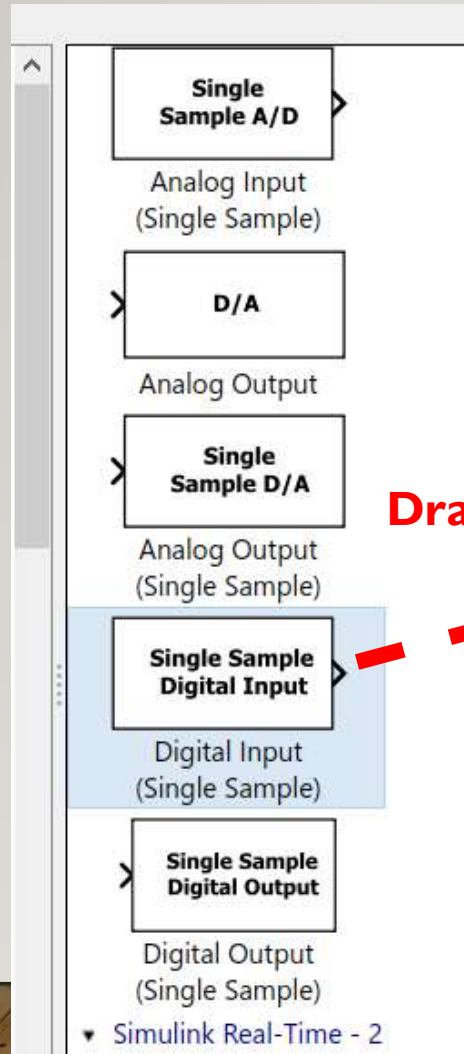
Data acquisition search in the SIMULINK/ Library

The screenshot shows the Simulink Library Browser window. The search results for 'Data acquisition' are displayed. The 'Data Acquisition Toolbox - 6' section is expanded, showing various blocks: A/D, Single Sample A/D, D/A, Single Sample D/A, Single Sample Digital Input, and Single Sample Digital Output. A red dashed oval highlights this section. A red arrow points to the search bar containing 'Data acquisition'.

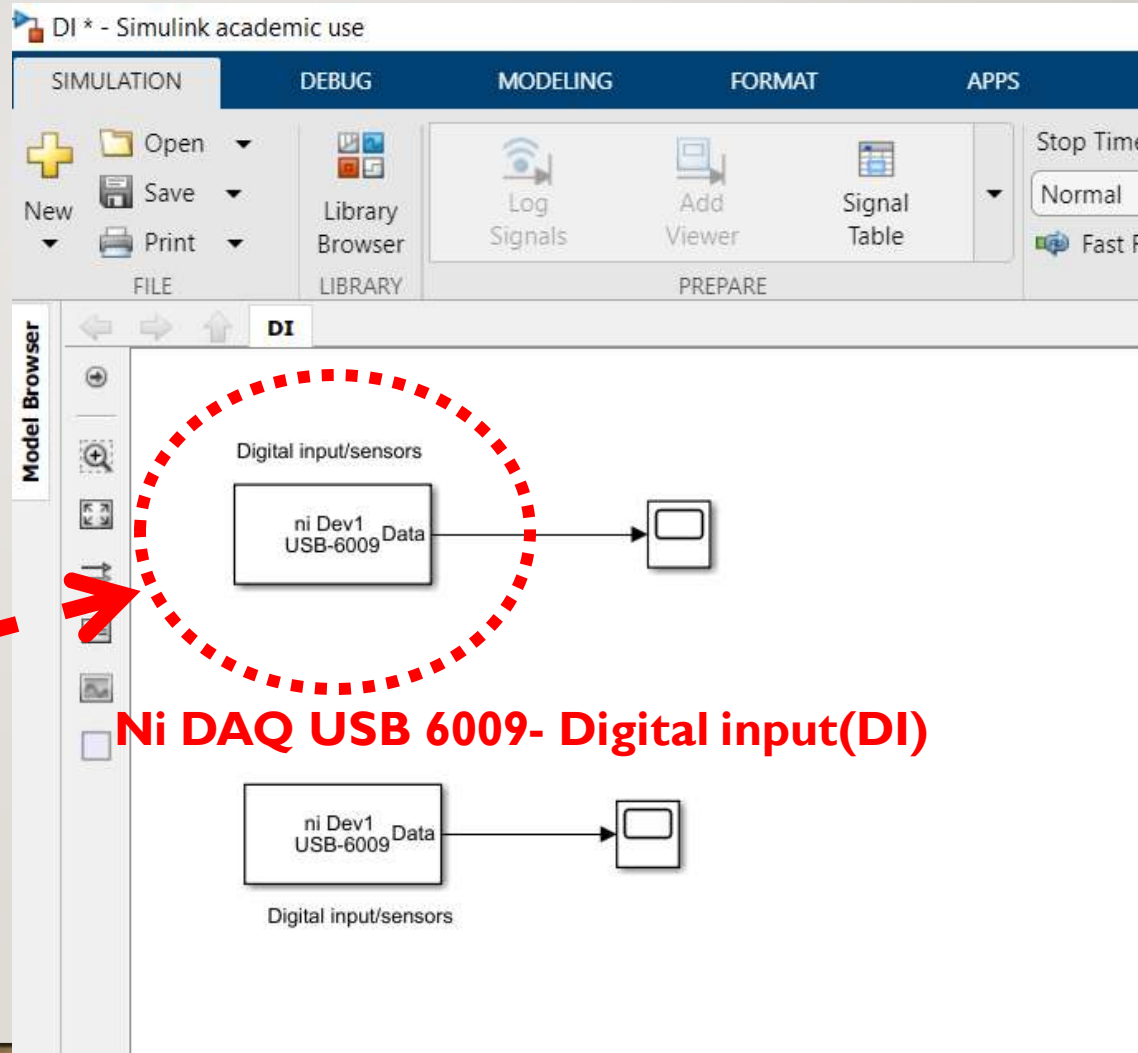
**AI/AO/DI/DO**  
**Components in MATLAB/SIMULINK**

# DAQ SOFTWARE: MATLAB / SIMULINK

## I- Digital input(DI)



Drag and drop



Ni DAQ USB 6009- Digital input(DI)

# DAQ SOFTWARE: MATLAB / SIMULINK

## Digital input (DI) configuration:

Block Parameters: Digital Input (Single Sample)1

**Digital Input (Single Sample)**  
Acquire latest set of values from multiple digital lines of a data acquisition device.

**Parameters**

Device: **ni Dev1 (USB-6009)**

**Lines:** Select All Unselect All

	Line ID	Name	Module
<input type="checkbox"/>	port0/line0	DI 0	Dev1
<input checked="" type="checkbox"/>	port0/line1	DI 1	Dev1
<input type="checkbox"/>	port0/line2	DI 2	Dev1
<input type="checkbox"/>	port0/line3	DI 3	Dev1
<input type="checkbox"/>	port0/line4	DI 4	Dev1

Number of ports: **1 for all lines**

Sample time: **0.02**

Output Timestamp

OK Cancel Help Apply

Type of device selection

Chanel selection

Open "DI.slx" file in "DAQ Simulink files" folder



# DAQ SOFTWARE: MATLAB / SIMULINK

## 2- Digital output (DO)

Library browser showing various digital output blocks:

- Single Sample D/A
- Single Sample Digital Input
- Single Sample Digital Output (highlighted)
- XCP CAN Data Acquisition
- XCP UDP Data Acquisition
- XCP CAN Data Acquisition

**Drag and drop**

Simulink model showing digital output configuration:

- Model Browser: DO
- Block 1: Constant (1) -> convert -> Digital out/actuators (ni Dev1 USB-6009)
- Block 2: Constant (0) -> convert -> Digital out/actuators (ni Dev1 USB-6009)

**Ni DAQ USB 6009- Digital output(DO)**

# DAQ SOFTWARE: MATLAB / SIMULINK

## Digital output (DO) configuration:

Channel selection

Block Parameters: Digital Output (Single Sample)

**Digital Output (Single Sample)**  
Output a set of values to multiple digital lines of a data acquisition device.

Parameters

Device: ni Dev1 (USB-6009)

Lines: Select All Unselect All

	Line ID	Name	Module
<input type="checkbox"/>	port0/line0	DO 0	Dev1
<input checked="" type="checkbox"/>	port0/line1	DO 1	Dev1
<input type="checkbox"/>	port0/line2	DO 2	Dev1
<input type="checkbox"/>	port0/line3	DO 3	Dev1
<input type="checkbox"/>	port0/line4	DO 4	Dev1

Number of ports: 1 for all lines

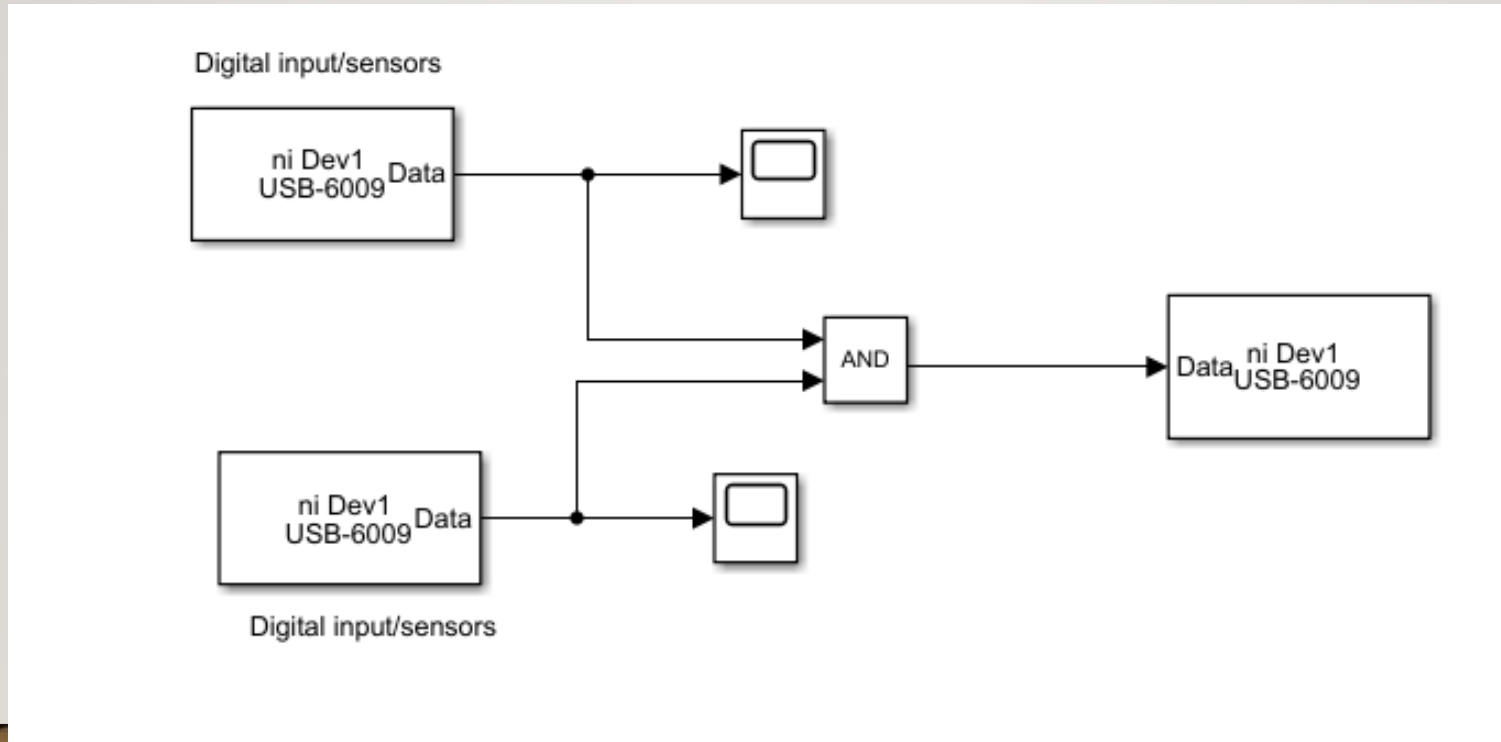
Sample time: 1

OK Cancel Help Apply

Open "DO.slx" file in "DAQ Simulink files" folder

# EXAMPLE 1

1- **IF** “sensor 1 (PIR motion sensor) and sensor 2 (water vapor sensor) are activated, **THEN** LED digital output should light up”.

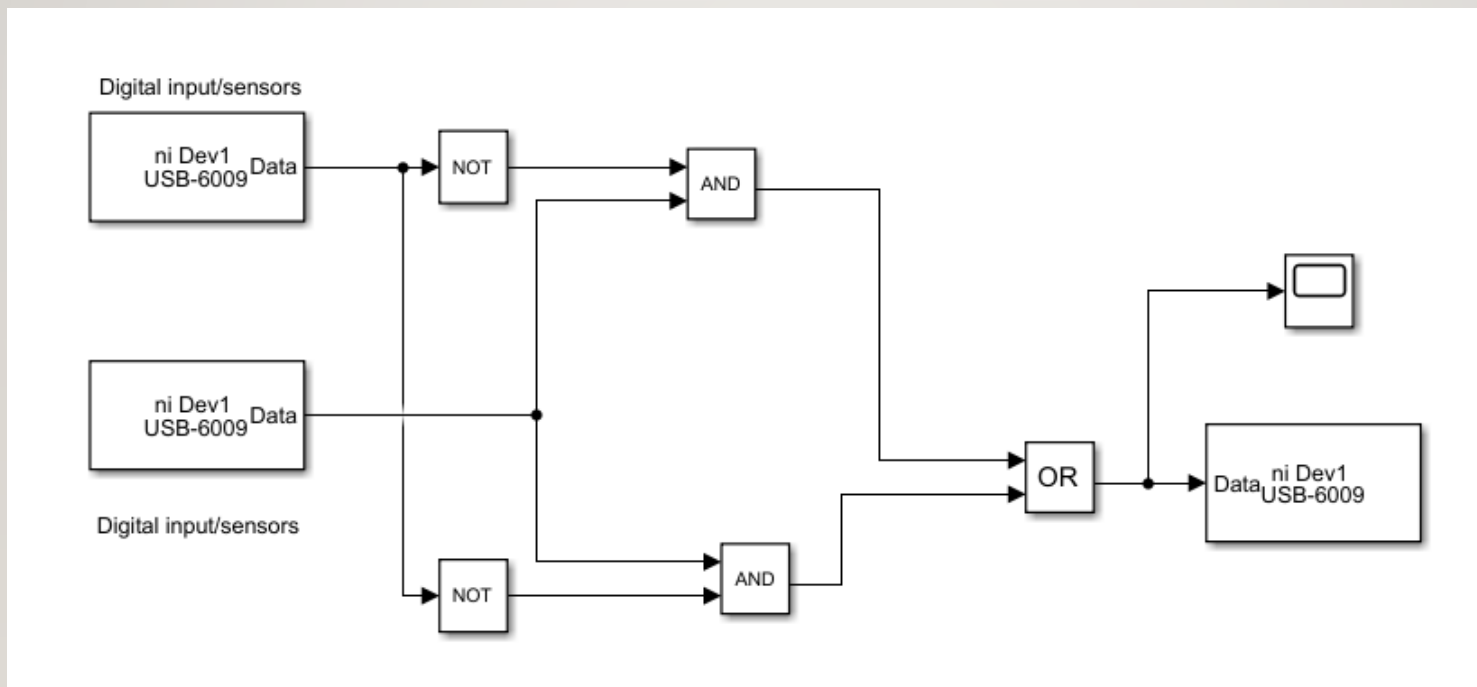


# EXAMPLE 2

2- **IF** “sensor 1 (PIR motion sensor) is activated **and** sensor 2 (water vapor sensor) is not activated

**OR**

“sensor 1 (PIR motion sensor) is not activated **and** sensor 2 (water vapor sensor) is activated **THEN**, the **LED digital output** should light up”.



# DAQ SOFTWARE: MATLAB / SIMULINK

## 3- Analog Input (AI)

The screenshot displays the Simulink Library Browser window. The search results are filtered to 'Data acquisition' and show 10 blocks. The 'Single Sample A/D' block is highlighted in blue. A red dashed arrow points from this block to a 'ni Dev1 USB-6009 Data' block in a Simulink model. A red arrow points from the highlighted block to the text 'Drag and drop'.

Simulink Library Browser

Data acquisition

Search Results: Data acquisition

<< >> Page 1 of 1 (10 Blocks found)

- Simulink
  - Commonly Used Blocks
  - Continuous
  - Dashboard
  - Discontinuities
  - Discrete
  - Logic and Bit Operations
  - Lookup Tables
  - Math Operations
  - Messages & Events
  - Model Verification
  - Model-Wide Utilities
  - Ports & Subsystems
  - Signal Attributes
  - Signal Routing
  - Sinks
  - Sources
  - String
  - User-Defined Functions
  - Additional Math & Discrete
  - Quick Insert
  - Aerospace Blockset
  - Audio Toolbox
  - Automated Driving Toolbox
- Data Acquisition (Single Sample)
  - A/D
  - Analog Input
  - Single Sample A/D**
  - Analog Input (Single Sample)
  - D/A
  - Analog Output
  - Single Sample D/A
  - Analog Output (Single Sample)
  - Single Sample Digital Input
  - Digital Input (Single Sample)

ni Dev1 USB-6009 Data

Sesnor measurement

Drag and drop

# DAQ SOFTWARE: MATLAB / SIMULINK

Analog input (AI) configuration:

Single-ended/ differential type measuring

**Block Parameters: Analog Input (Single Sample)**

Analog Input (Single Sample)  
Acquire single sample from multiple analog channels of a data acquisition device every simulation time step.

Parameters

Device: **ni Dev1 (USB-6009)**

Channels: **Select All** **Unselect All**

	Channel ID	Name	Module	Measurement Type	Terminal Config	Input Range	Coupling
<input checked="" type="checkbox"/>	ai0		Dev1	Voltage	SingleEnded	-5.0 to +5.0 Volts	DC
<input type="checkbox"/>	ai1		Dev1	Voltage	Differential	-20 to +20 Volts	DC
<input type="checkbox"/>	ai2		Dev1	Voltage	Differential	-20 to +20 Volts	DC
<input type="checkbox"/>	ai3		Dev1	Voltage	Differential	-20 to +20 Volts	DC
<input type="checkbox"/>	ai4		Dev1	Voltage	SingleEnded	-10 to +10 Volts	DC
<input type="checkbox"/>	ai5		Dev1	Voltage	SingleEnded	-10 to +10 Volts	DC
<input type="checkbox"/>	ai6		Dev1	Voltage	SingleEnded	-10 to +10 Volts	DC
<input type="checkbox"/>	ai7		Dev1	Voltage	SingleEnded	-10 to +10 Volts	DC

Number of ports: **1 for all channels**

Sample time: **0.01**

Output Timestamp

OK Cancel Help Apply

**Sensor measurement**

**Channel selection**

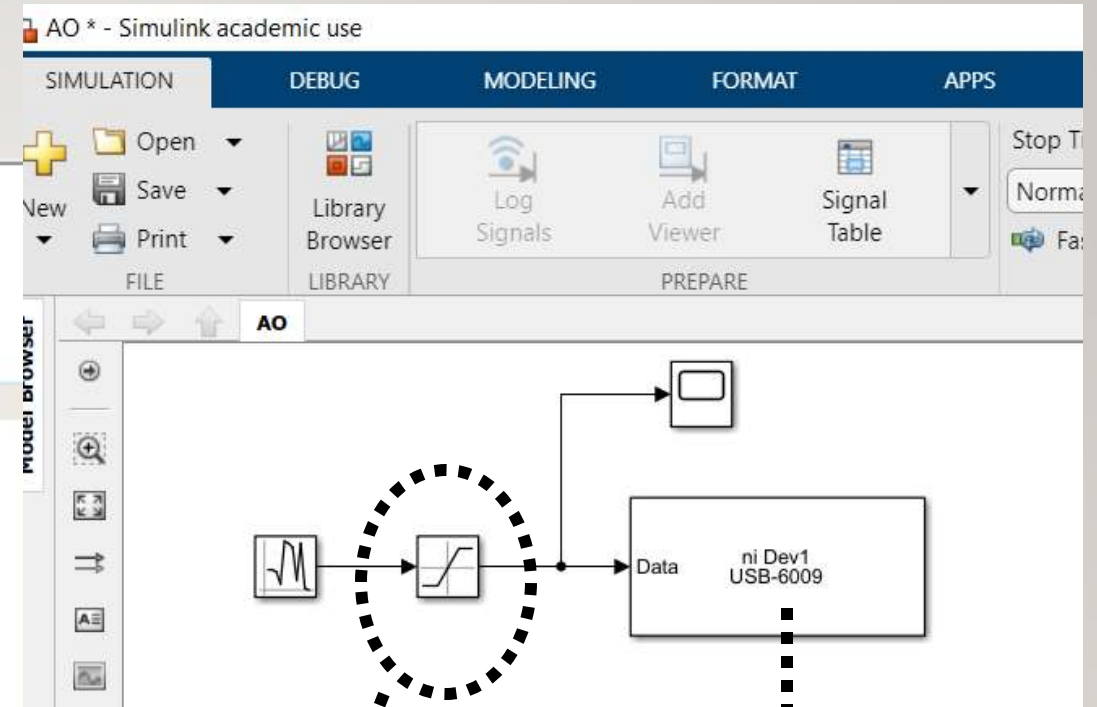
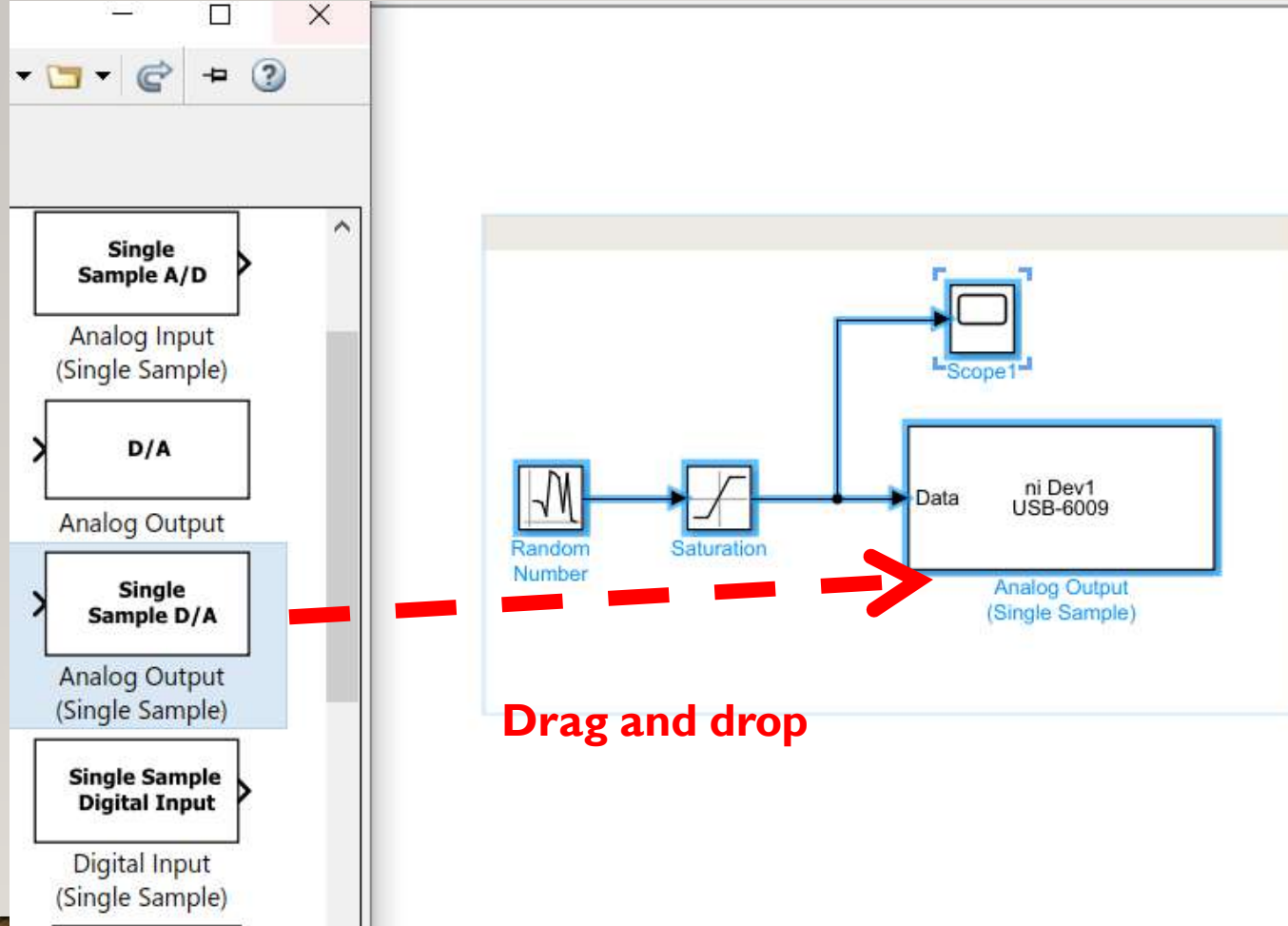
**Measuring type**

**Voltage range**

Open "AI.slx" file in "DAQ Simulink files" folder

# DAQ SOFTWARE: MATLAB / SIMULINK

## 4- Analog output (AO)



Analog Output- Channel 1

Output voltage limitation

# DAQ SOFTWARE: MATLAB / SIMULINK

## Analog output (AO) configuration:

**Channel selection**

**Measuring type**

**Voltage range**

**Block Parameters: Analog Output (Single Sample)**

**Analog Output (Single Sample)**  
Output single sample to multiple analog channels of a data acquisition device every simulation time step.

**Parameters**

Device: **ni Dev1 (USB-6009)**

**Channels:** Select All Unselect All

	Channel ID	Name	Module	Measurement Type	Output Range
<input type="checkbox"/>	ao0		Dev1	Voltage	0 to +5.0 Volts
<input checked="" type="checkbox"/>	ao1		Dev1	Voltage	0 to +5.0 volts

Number of ports: **1 for all channels**

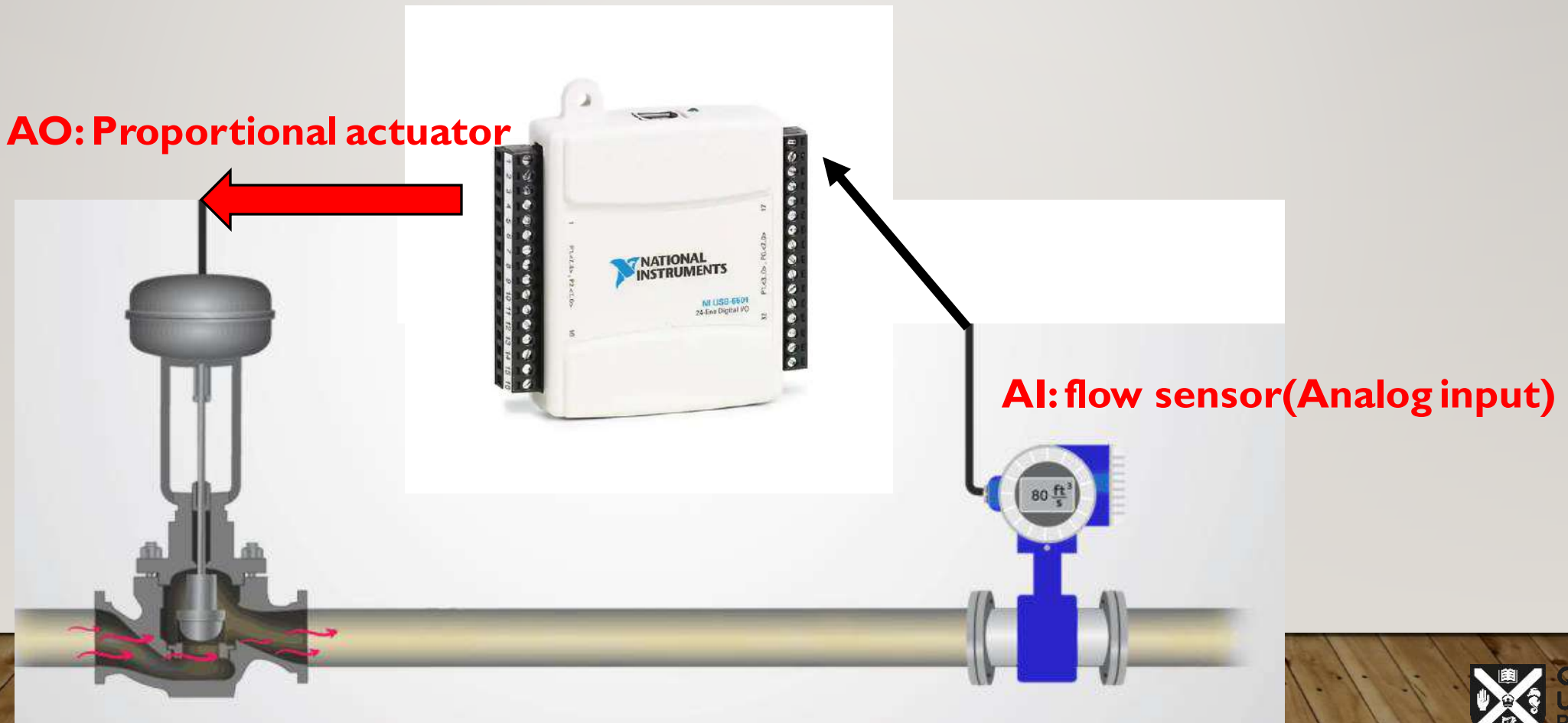
Sample time: **0.01**

**OK** **Cancel** **Help** **Apply**

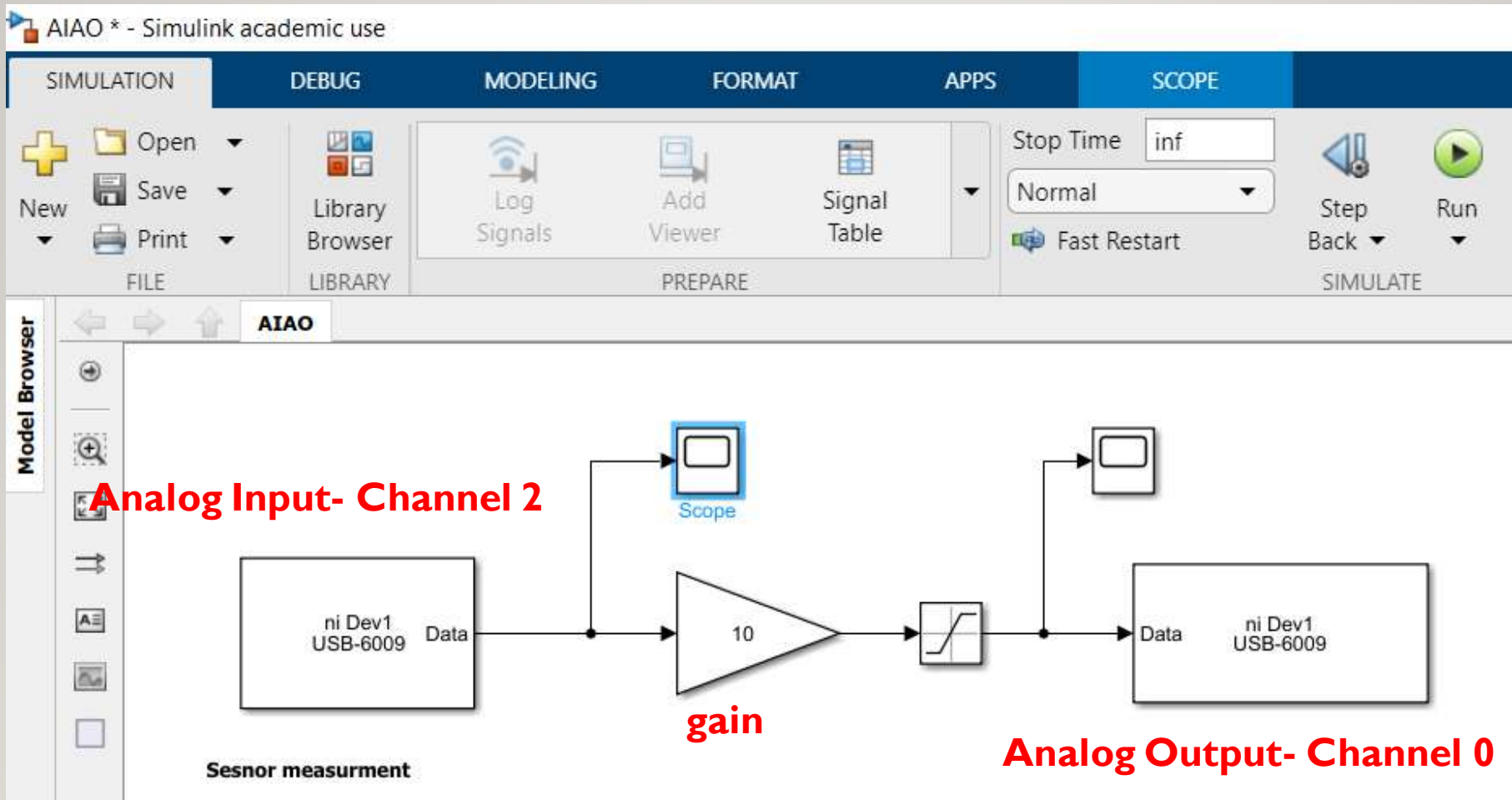


# EXAMPLE 3

- Let's measure the flow sensor(Analog input) then the measured signal should amplify and then send a command to the Analog output (Proportional actuator).

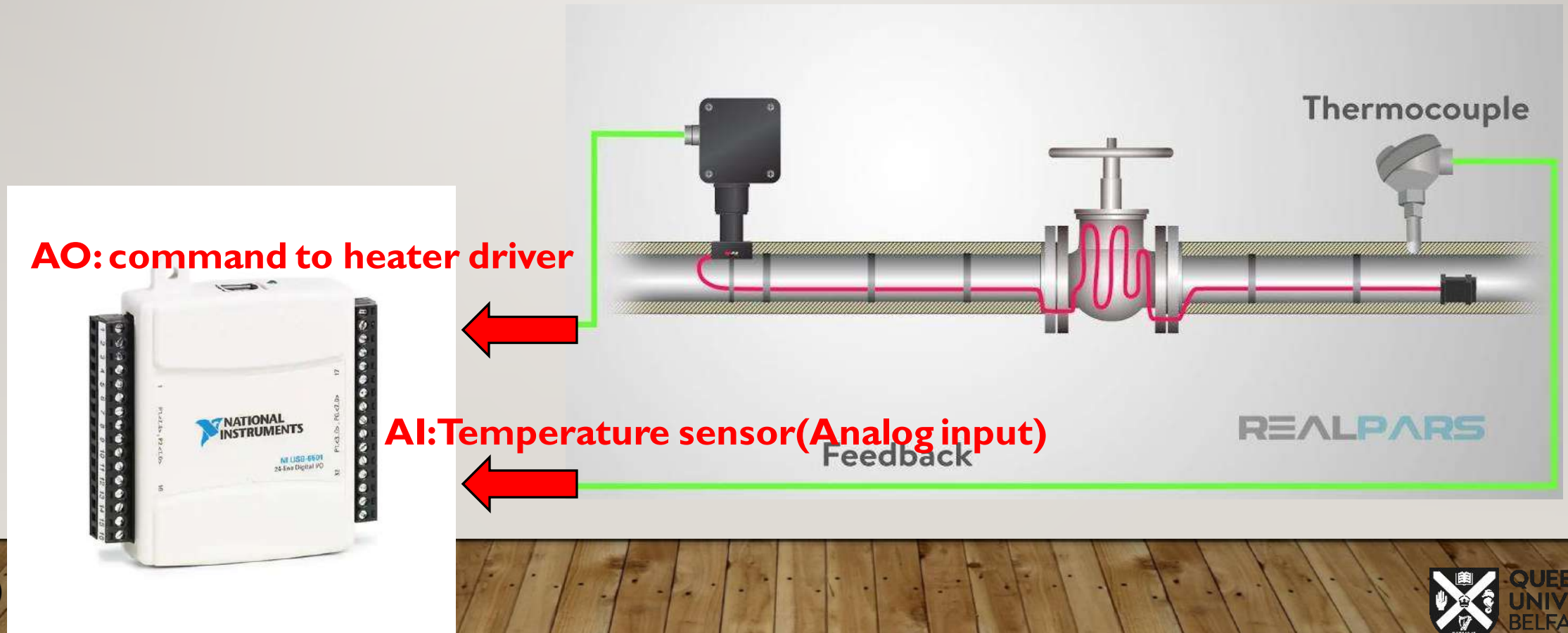


# EXAMPLE 3

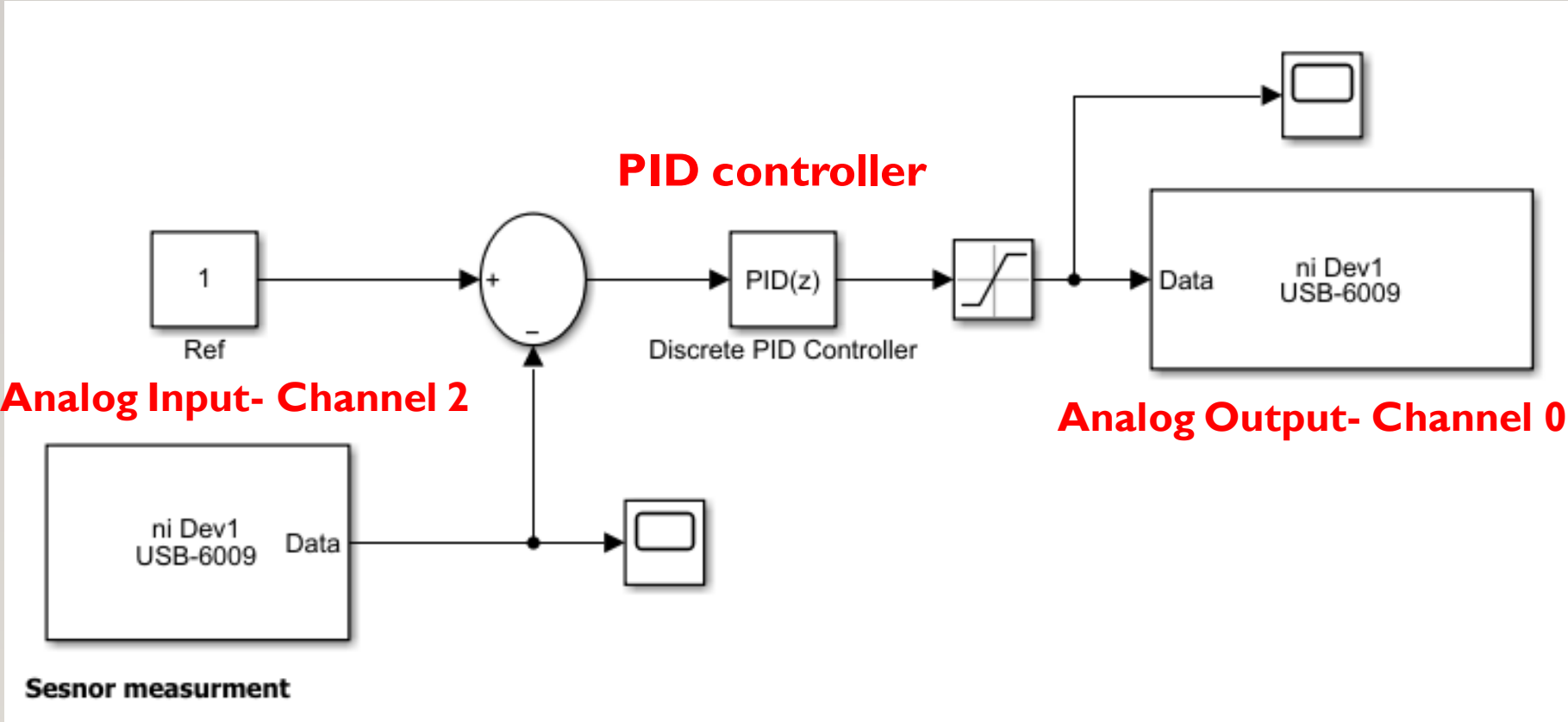


# EXAMPLE 4

- Here is a closed-loop control system that used a PID control to generate a control signal:
- The temperature sensor (analog input) measures temperature then PID control sends a command to the analog output (heater driver) to control the heat.



# EXAMPLE 4



**Thank You For Your Attention!**

**Any Question?**

