Lab(4)
Faculty of Engineering,
Ain Shams University
Design of Measurement Systems, Sp. 2015

March 23, 2015

Disclaimer

- Part of this work is based on a Digital Electronics and Computer Interfacing course taken at the University of Alabama by Tim Mewes.
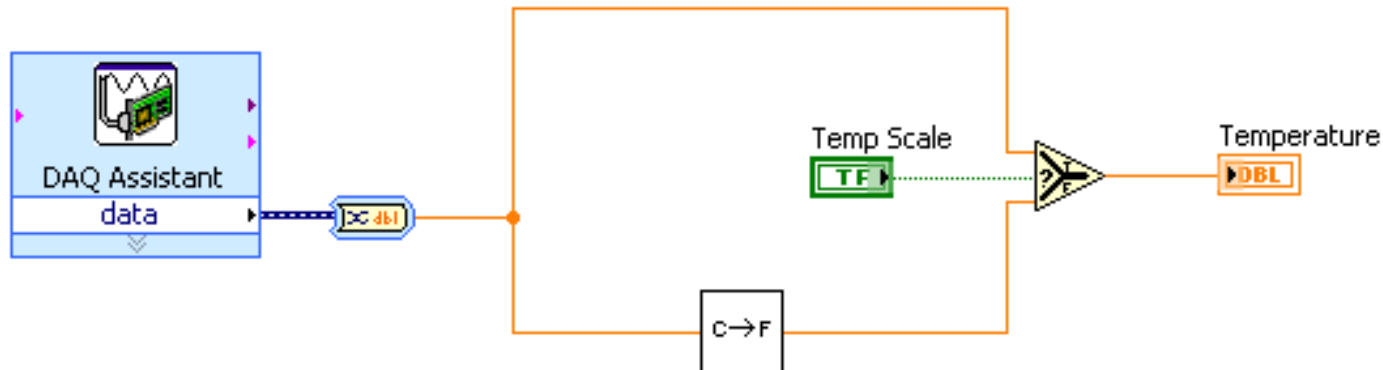
LAB Goals:

Understanding:

- How to make decisions with LabVIEW
- Case Structure
- Formula Node
- MATLAB Script
- Data Acquisition Device Selection
- Aliasing
- Nyquist Theorem

Making Decisions

Simple Decision: Select Function

▸ If Temp Scale is TRUE, pass top input;
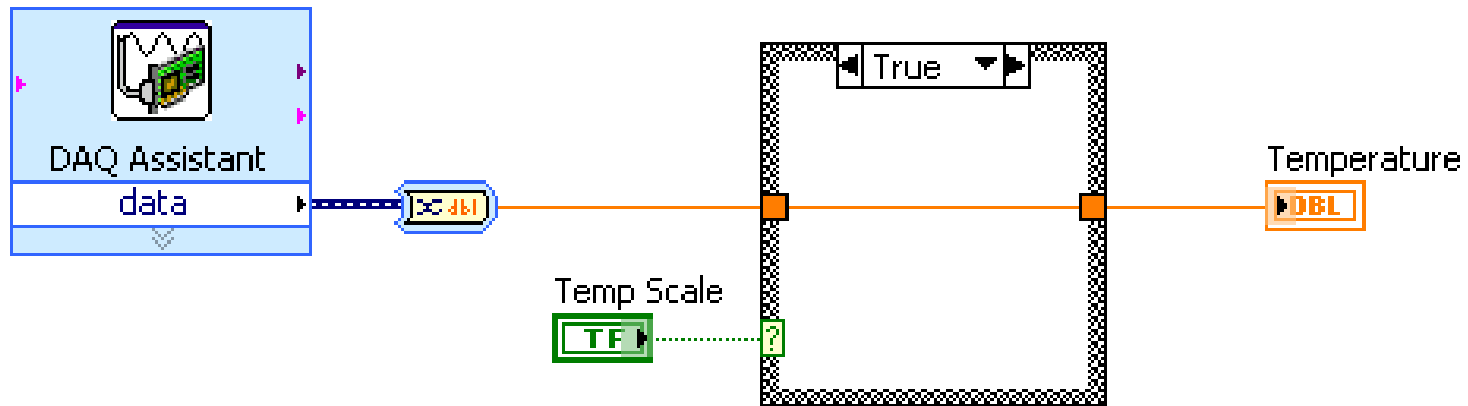 if temp scale is FALSE, pass bottom input.

▸ If the decision to be made is more complex than a Select function can execute, a Case Structure may be what is required.
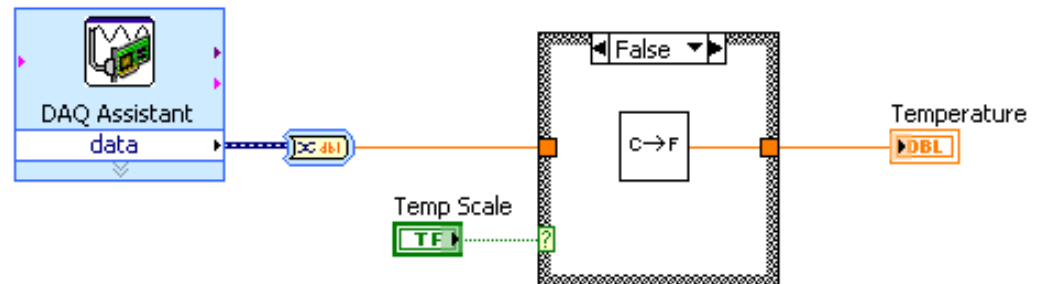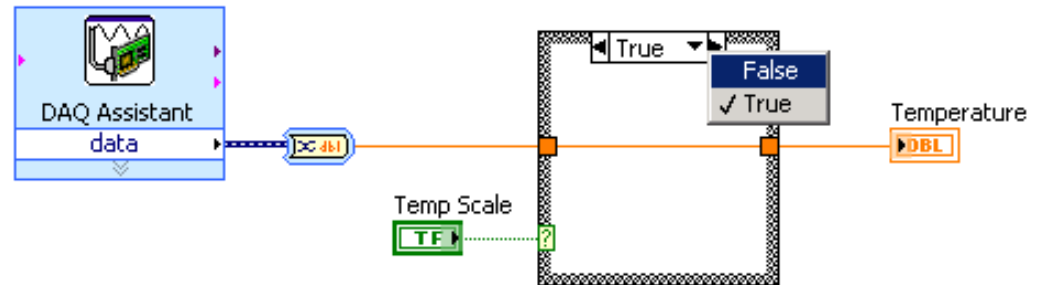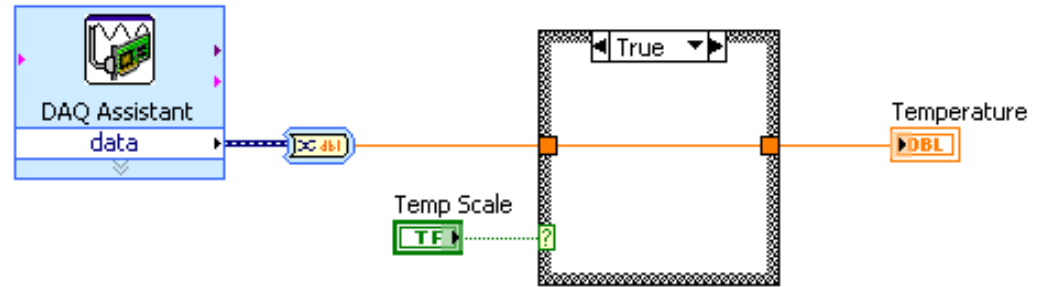
Case Structures

Boolean Case Structure Example:

If Temp Scale is TRUE, execute True case;
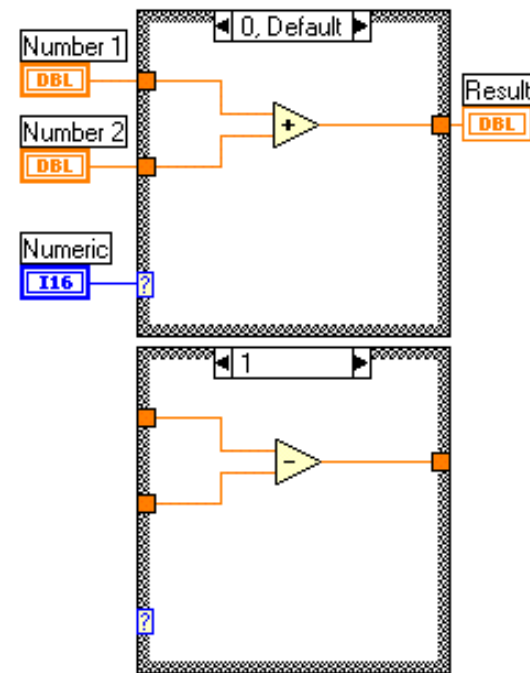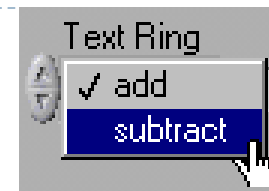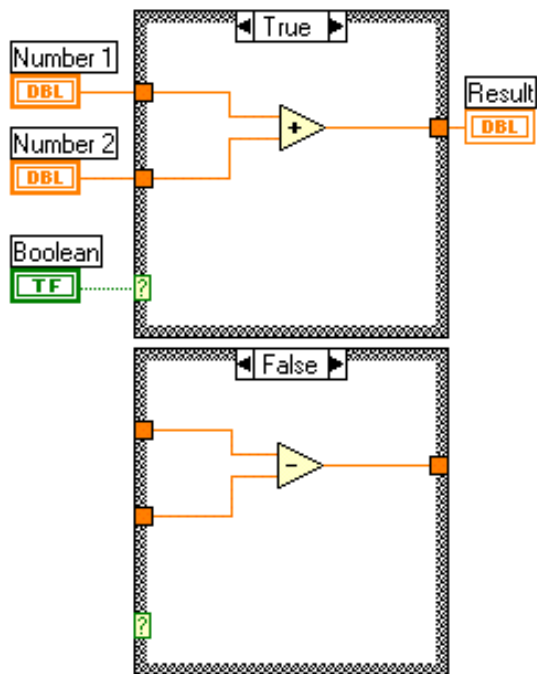if temp scale is FALSE, execute False case.

Case Structures

- In the Structures subpalette of Functions palette

- Enclose nodes or drag them inside the structure

- Stacked like a deck of cards, only one case visible at a time
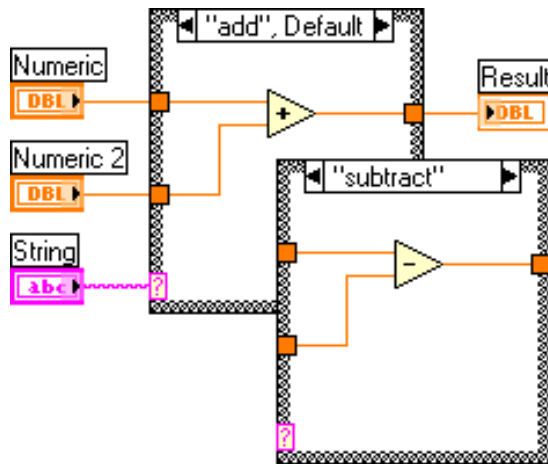
Boolean and Numeric Cases
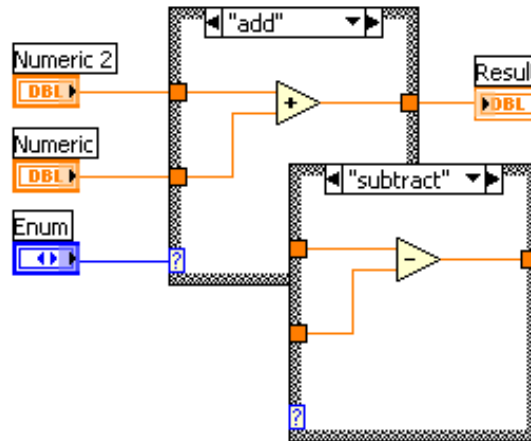

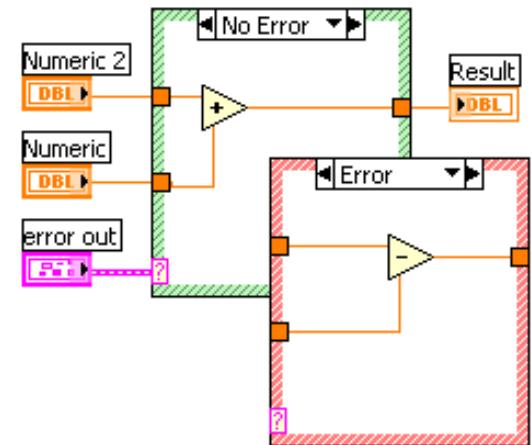Wire all possible outputs of the case structure

String, Enum, and Error Cases

String Case   **Enum Case**   **Error Case**
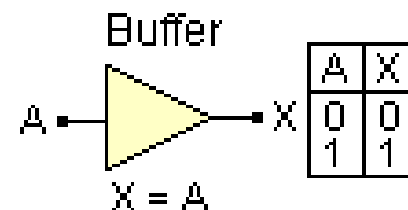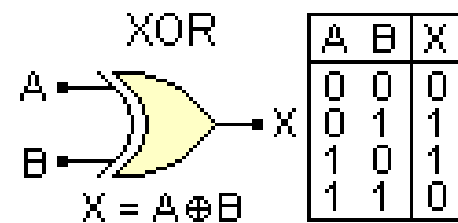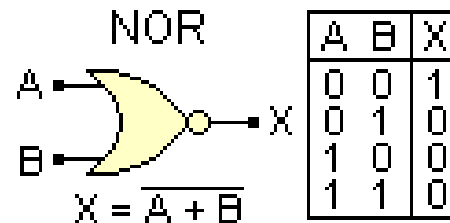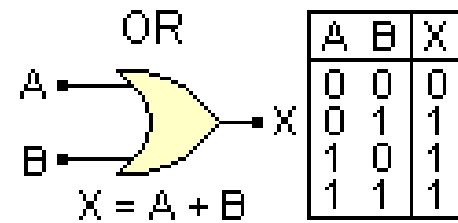
Summary

- The Select function is used to choose between two inputs dependant on a boolean input.

- A Case structure has two or more cases. Only one case is visible at a time, and the structure executes only one case at a time.

- If the case selector terminal is Boolean, the structure has a TRUE case and a FALSE case. If the selector terminal is an integer, string, or enumerated type value, the structure can have up to $2^{31}-1$ cases.

- Inputs are available to all cases, but cases do not need to use each input. If at least one output tunnel is not defined, all output tunnels on the structure appear as white squares.

- Formula Nodes are useful for complicated equations and for using existing text-based code. A semicolon (;) must terminate each statement.

Digital Logic Operations

AND

A ⟶
B ⟶ [AND gate] ⟶ X

$X = A \cdot B$

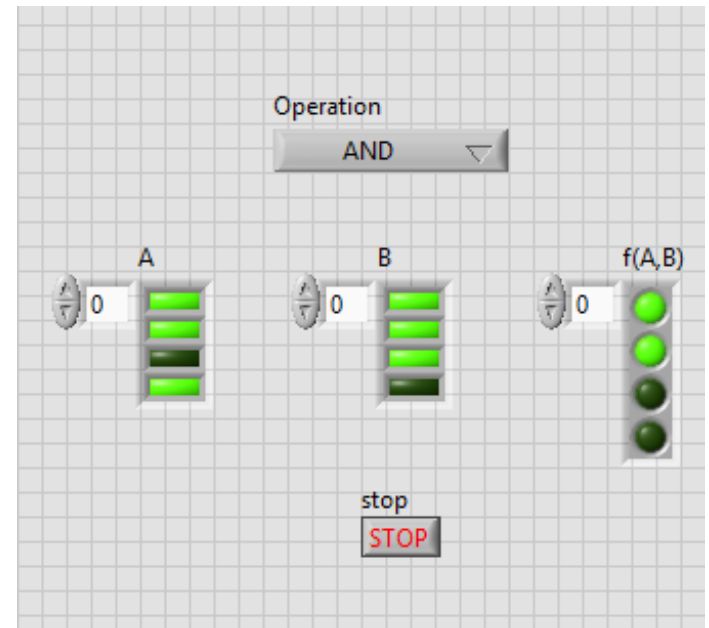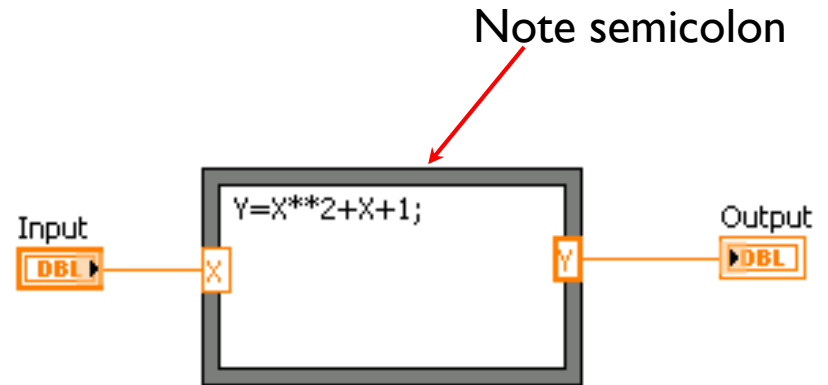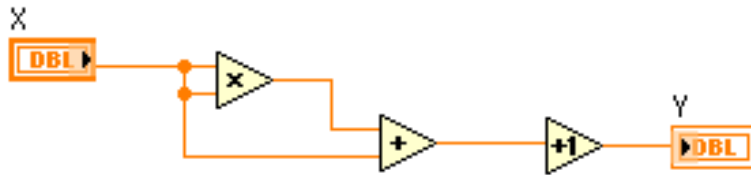| A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

NAND

A ⟶
B ⟶ [NAND gate] ⟶ X

$X = \overline{A \cdot B}$

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

OR

A ⟶
B ⟶ [OR gate] ⟶ X

$X = A + B$

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

NOR

A ⟶
B ⟶ [NOR gate] ⟶ X

$X = \overline{A + B}$

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

XOR

A ⟶
B ⟶ [XOR gate] ⟶ X

$X = A \oplus B$

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

Buffer

A ⟶ [Buffer] ⟶ X

$X = A$

A	X
0	0
1	1

Inverter (NOT)

A ⟶ [Inverter] ⟶ X

$X = \overline{A}$

A	X
0	1
1	0

Exercise (1)

▸ Implement a VI that consists of two arrays of led controls (Every array consists of 4 leds). This VI is intended to calculate the appropriate Boolean operation based on the user input, and display the result in an array of led indicators. The required operations are:

  ▸ AND
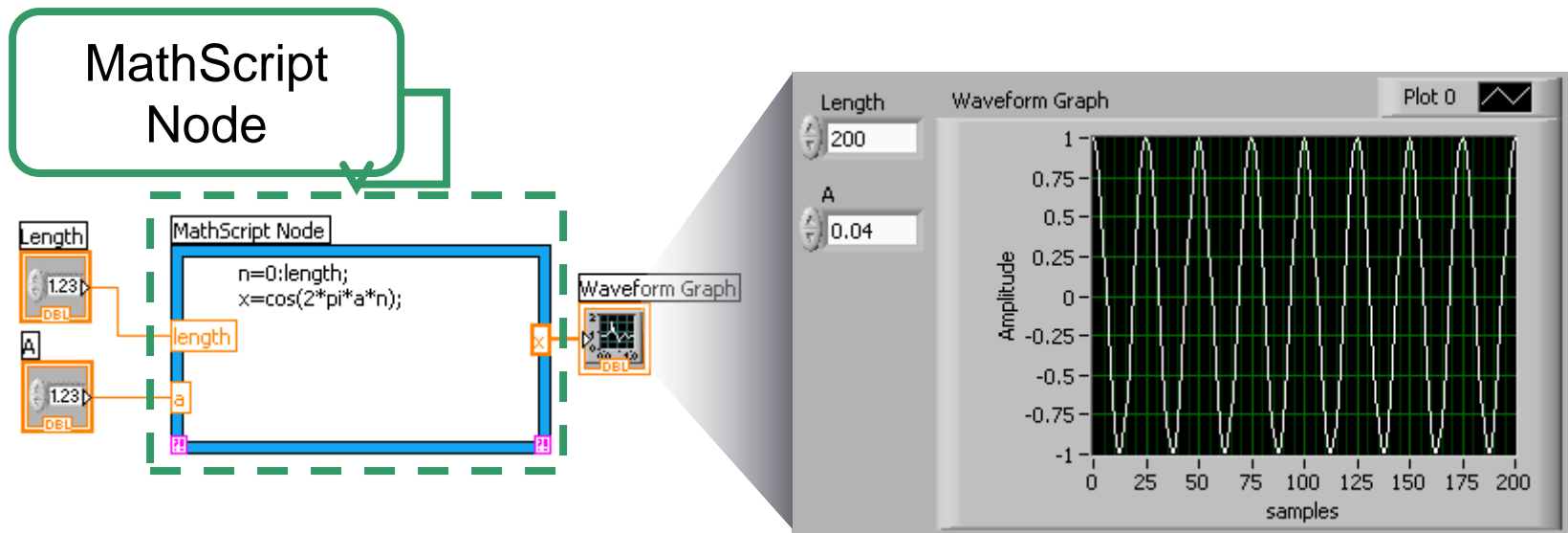 ▸ OR
  ▸ XOR
  ▸ NAND
  ▸ NOR

Formula Node

Note semicolon

- In the Structures subpalette
- Implement complicated equations
- Variables created at border
- Variable names are case sensitive
- Each statement must terminate with a semicolon (;)
- Context Help Window shows available functions

MathScript Node

- Combine graphical system design with textual math
- Implement equations and algorithms with text
- Deploy with LabVIEW graphical programming
  - Input and Output variables created on the border

Exercise (2)

▸ Develop a VI that takes the temperature from the user in Celsius and convert it to Fahrenheit using Formula Node
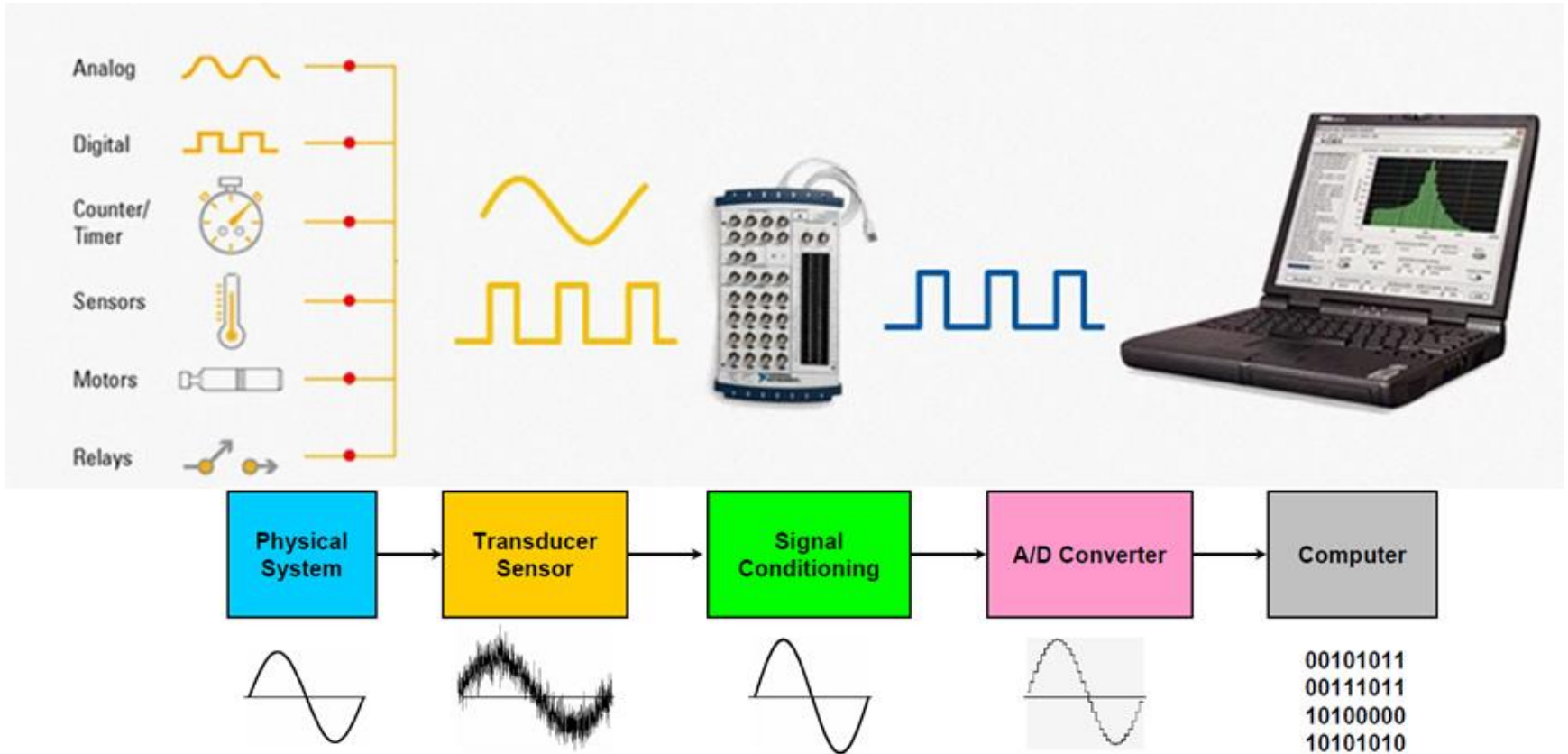
What is Measurement?

▸ Measurement is the process of quantifying physical variables such as temperature, gas pressure, force or velocity by means of sensors and data acquisition systems.

▸ Measurement signals can either be used for analyzing data and storage, for monitoring different process variables in a process control system, or to understand a system performance and consequently in the next step to generate signals to the actuators to act in a desired manner.
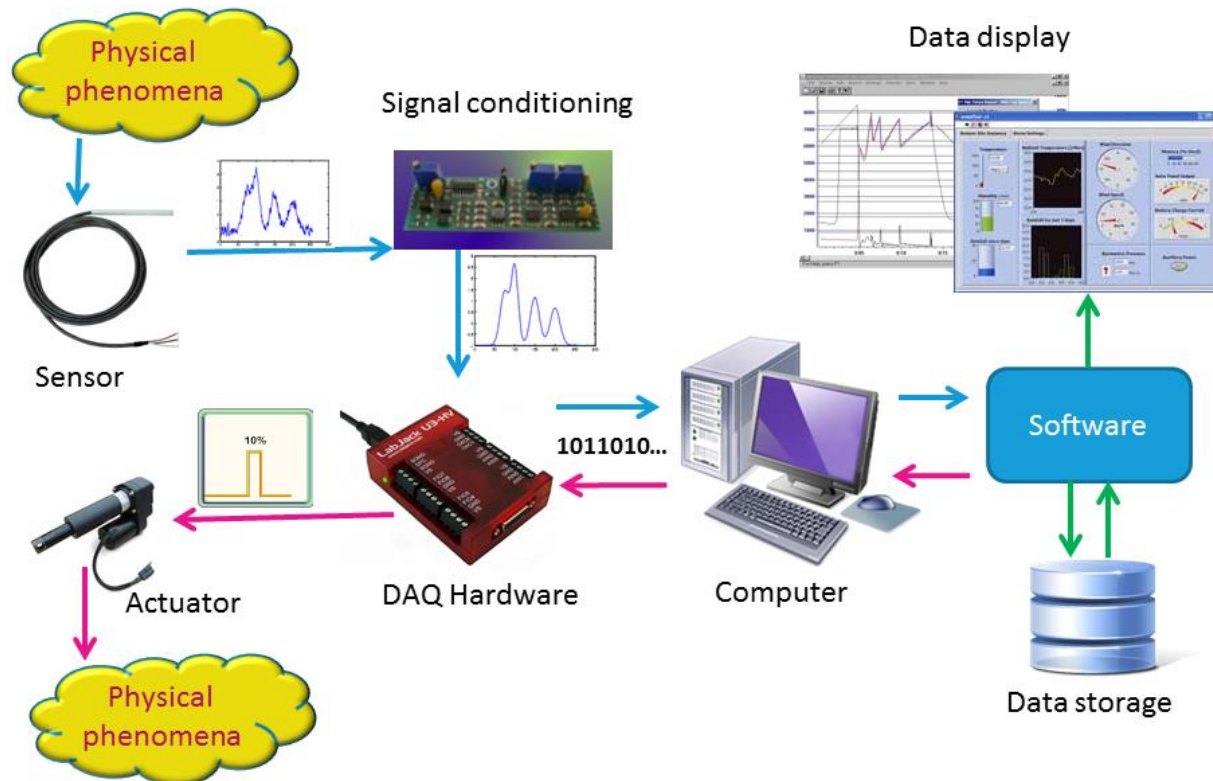
▸

What is Measurement?

Data Acquisition

▸ Data Acquisition (DAQ) is the process that involves receiving signals from the real world to analyze, understand and process them.
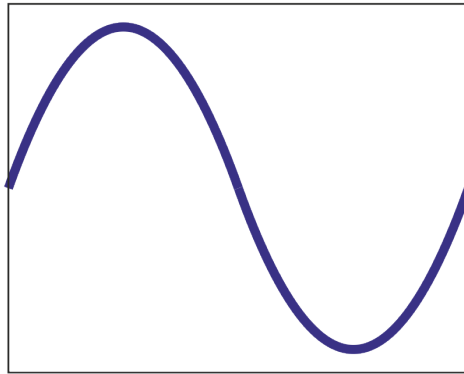
Data Acquisition

DAQ Card Selection

1. Sampling rate
2. Resolution
3. No. of channels
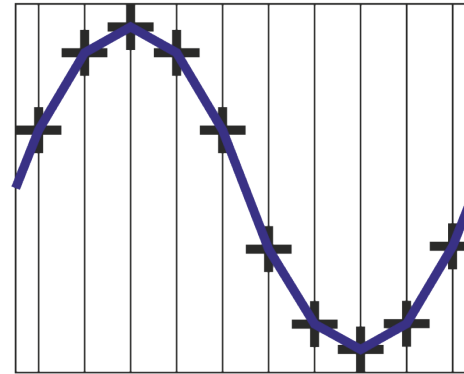4. Communication Bus
5. Portability

1. Sampling Rate

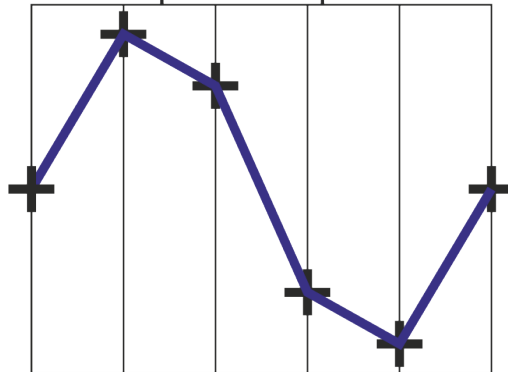▸ Defined in Hertz, KHz,…etc (Ex: 2 Hz sampling rate means 2 samples per second)
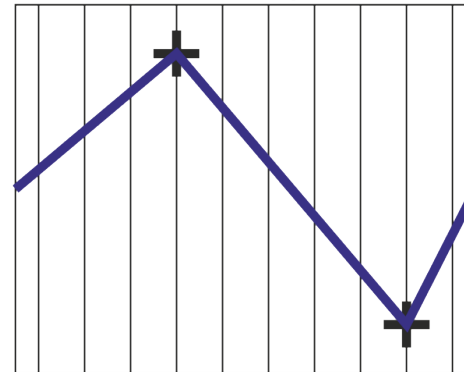

Original Waveform

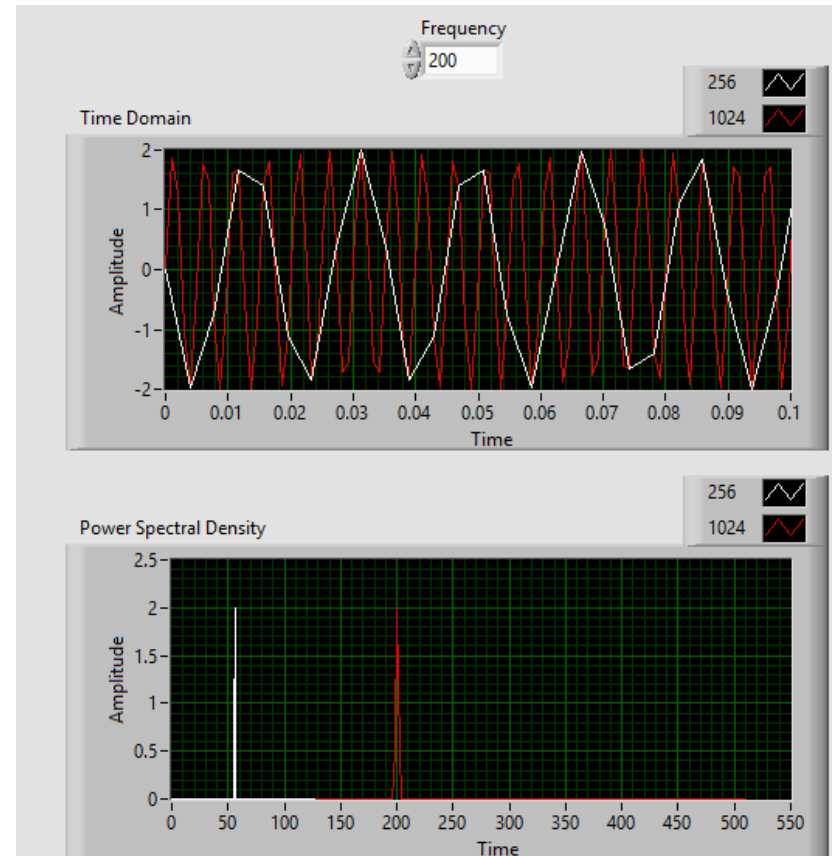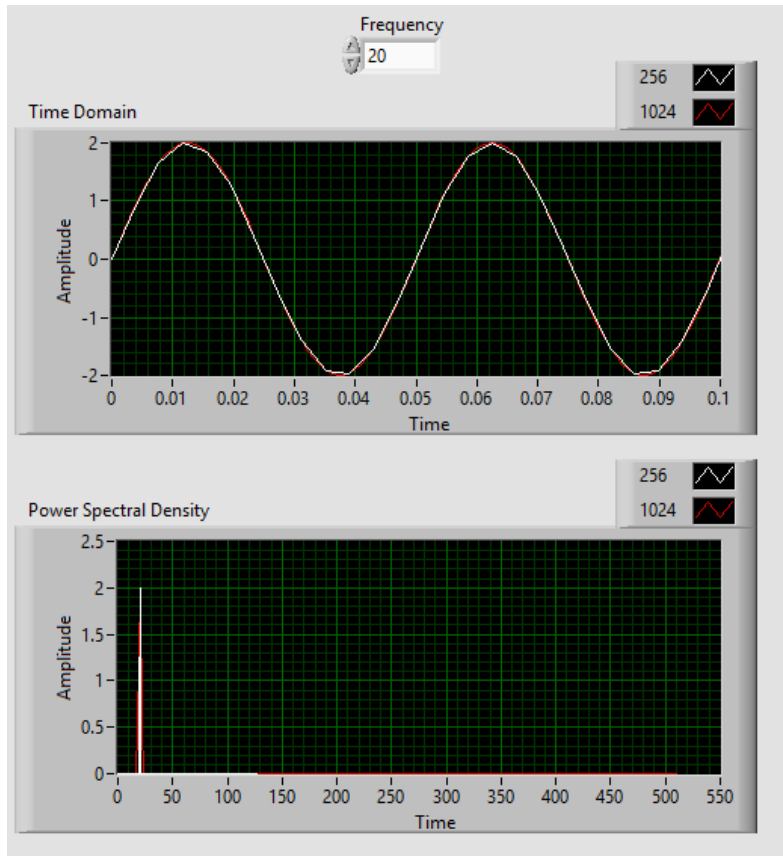Sampled at 10 points

Sampled at 6 points

Sampled at 2 points

Aliasing Demonstration

▸ If the signal not sampled fast enough a problem known as aliasing will occur.
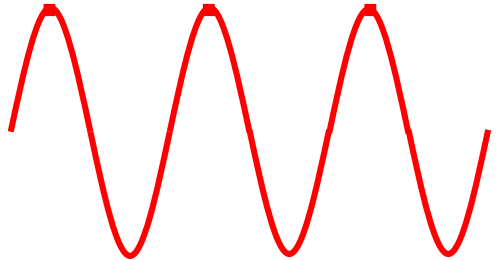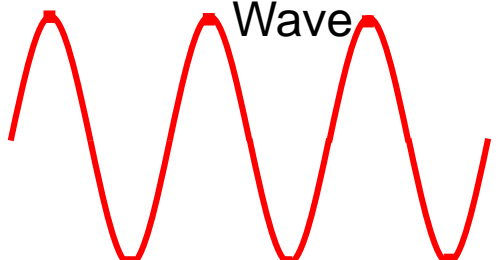
Nyquist Theorem

- You must sample at greater than 2 times the maximum frequency component of your signal to accurately represent the FREQUENCY of your signal.
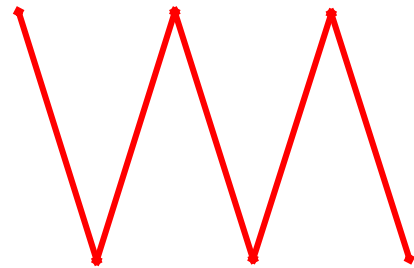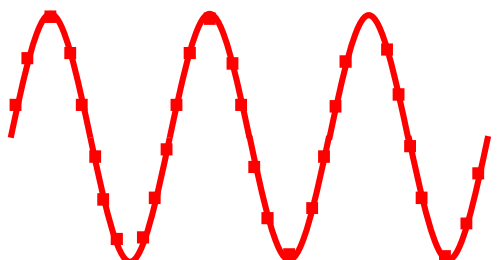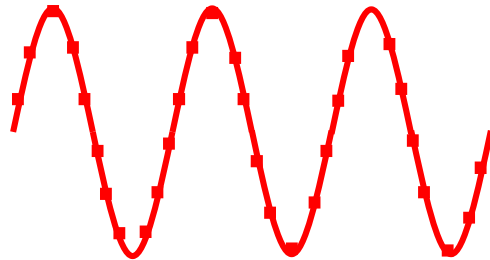
- NOTE: You must sample between 5 - 10 times greater than the maximum frequency component of your signal to accurately represent the SHAPE of your signal.

Nyquist Theorem

2. Resolution

▸ The resolution of a n-bit analog-to-digital Converter (ADC) is a function of how many parts the maximum signal can be divided into. The formula to calculate resolution is 2^n. For example, a 12 bit ADC has a resolution of 2^12 = 4,096. Therefore, our best resolution is 1 part out of 4,096, or 0.0244% of the full scale.

2. Resolution

- Resolution limits the precision of a measurement. The higher the resolution (number of bits), the more precise the measurement. An 8-bit ADC divides the vertical range of the input amplifier into 256 discrete levels. With a vertical range of 10 V, the 8-bit ADC cannot ideally resolve voltage differences smaller than 39 mV. In comparison, a 14-bit ADC with 16,384 discrete levels can ideally resolve voltage differences as small as 610 μV.

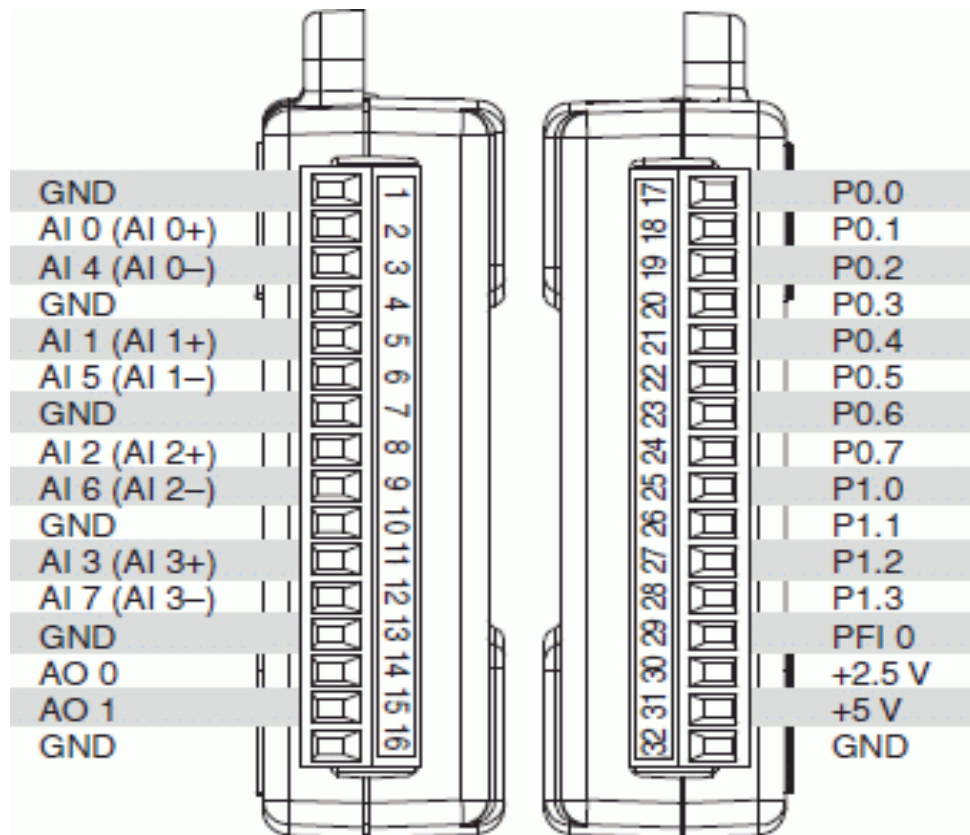# 3. No. of Channels

▸ Analog (Input or Output), or Digital?

NI (National Instruments) USB-6008 DAQ

- Specs:
  - 8 analog inputs (12-bit, 10,000 Sample/sec)
  - 2 analog outputs (12-bit, 150 Sample/sec)
  - 12 digital I/O (Bi-directional)
  - Successive Approximation ADC
  - Communication Bus: USB
  - NI-DAQmx driver software

NI (National Instruments) USB-6008 DAQ

Next Labs !

▸ The next Monday will be a LabVIEW EXAM.

Get Prepared

▸ For the labs that follow, instead of using NI-USB 6008 DAQ device, we will use ARDUINO as of its less cost and easier availability.

▸ We will make use of already built libraries to interface Arduino with Labview.

▸ Necessary components List will be released soon.