# Lesson 4
## More on Data Acquisition and Waveforms

**You Will Review:**

- **A. About plug-in data acquisition (DAQ) boards**
- **B. About the organization of the DAQ VIs**
- **C. How to perform a single analog input**
- **D. About the DAQ Wizards**
- **E. About waveform analog input**
- **F. How to write waveforms to file**
- **G. How to output an analog signal**
- **I. How to use counter/timers**



# Overview

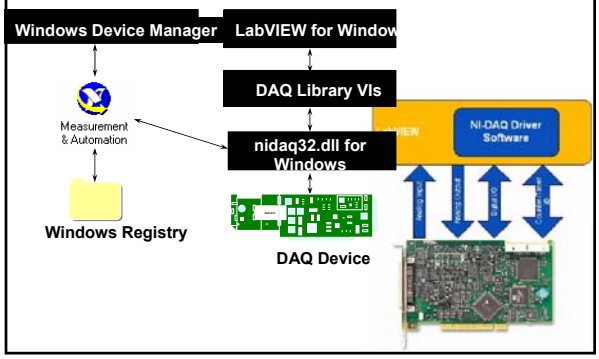
The fundamental task of all measurement systems is the measurement and/or generation of real-world physical signals. Measurement devices help you acquire, analyze, and present the measurements you take.

We acquire and convert physical signals, such as voltage, current, pressure, and temperature, into digital formats and transfer them into the computer.

Popular methods for acquiring data: plug-in DAQ and instrument devices, GPIB instruments, PXI (PCI eXtensions for Instrumentation) instruments, and RS-232 instruments.

- **Data acquisition (DAQ) library supports all DAQ boards**
- **LabVIEW uses the NI-DAQ driver-level software**
- **DAQ boards for**
  - **Analog I/O**
  - **Digital I/O**
  - **Counter/timer I/O**
- **Data acquisition system components**

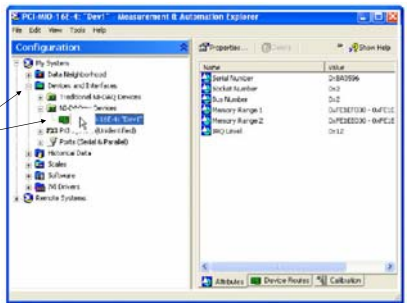
# DAQ Software Architecture – Windows




# DAQ Hardware Configuration

- **Measurement & Automation Explorer (MAX) by selecting Tools>>Masurement & Automation Explorer…in LabVIEW**

View Configure and Test



# Hardware Connections

**BNC-2120**

**SC-2075**

**SCB-68**



# Hardware Connections

Note:
The channels available depends on the DAQ card we use.

For instance, DAQCard-AI-16E-4 NI lent to us, there is no output channels available

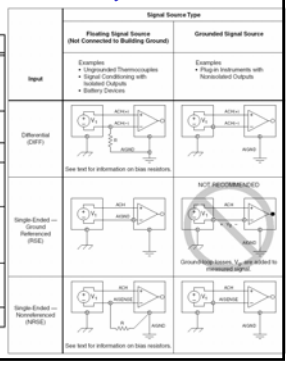
Let's configure the Card with **Measurement & Automation Explorer**

## Measurement Fundamentals

In Analytical Instrumentation, we convert physical phenomena into data, using a **transducer** to convert a physical phenomenon into an electrical

| Phenomena | Transducer |
|---|---|
| Temperature | Thermocouples<br>Resistance temperature detectors (RTDs)<br>Thermistors<br>Integrated circuit sensors |
| Light | Vacuum tube photosensors<br>Photoconductive cells |
| Sound | Microphones |
| Force and pressure | Strain gages<br>Piezoelectric transducers<br>Load cells |
| Position (displacement) | Potentiometers<br>Linear voltage differential transformers (LVDT)<br>Optical encoders |
| Fluid flow | Head meters<br>Rotational flowmeters<br>Ultrasonic flowmeters |
| pH | pH electrodes |

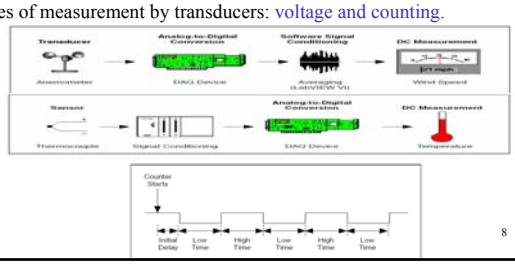
Summary of signal sources and masurement systems



## Measurement Fundamentals

There are two types of voltage: direct current (DC) and alternating current(AC). DC signals are analog signals that slowly vary with time. Common DC signals include voltage, temperature, pressure, and strain. AC signals are alternating analog signals that continuously increase, decrease, and reverse polarity on a repetitive basis.

However, any physical signals will be converted into almost two types of measurement by transducers: voltage and counting.





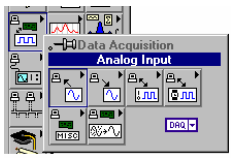
## DAQ VI Organization in LabVIEW software

- **Analog Input**
- **Analog Output**
- **Digital I/O**
- **Counter**
- **Calibration and Configuration**
- **Signal Conditioning**

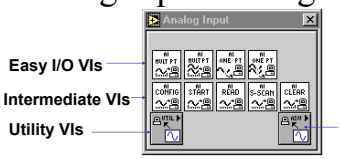
**NI DAQ**

NI-DAQ contains two data acquisition drivers--Traditional NI-DAQ and NI-DAQmx--each with its own application programming interface (API), hardware configuration, and software configuration.

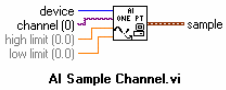

A. labVIEW Traditional NI-DAQ



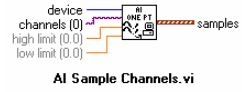

## Analog Input VI Organization




- **Single-point VIs**



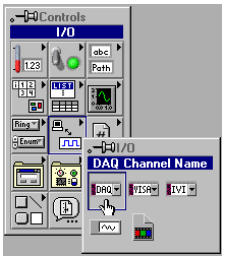

AI Sample Channel.vi




AI Sample Channels.vi



## DAQ Channel Name Control

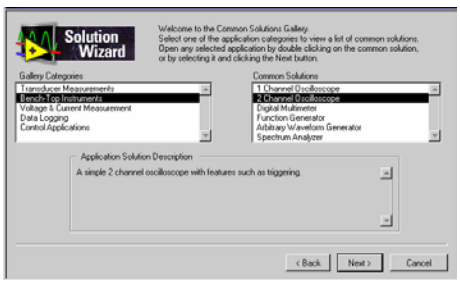



- **Data type used to communicate with DAQ boards**
- **Enter channel names by number or by virtual channel name defined in MAX**



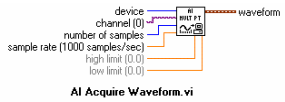

## DAQ Wizards

- **DAQ Channel Wizard**
- **DAQ Solution Wizard**

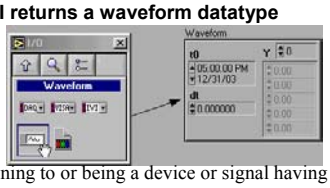


# Waveform Analog Input

- **AI Acquire Waveform**
- **VI displays a dialog box if an error occurs**




- **VI returns a waveform datatype**




Analog-Pertaining to or being a device or signal having the property of continuously varying in strength or quantity, such as voltage or audio.



# DAQ – Data Acquisition

Let's do Simple Acquisition Example Test.vi

Click to see

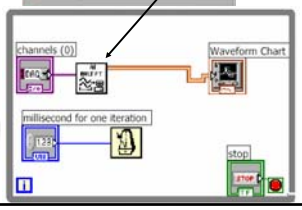
Two parameters

- Device = 1
- Channel = 0

with

**SCB-68**

connection board

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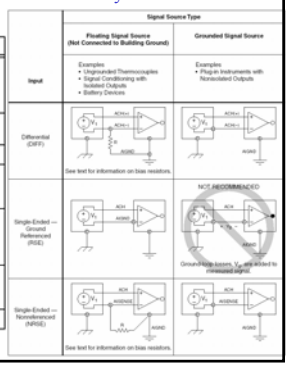



# DAQ – Data Acquisition

Simple Acquisition Example Test.vi

We can try different input modes

Single ended

Differential by configuring MAX and the board

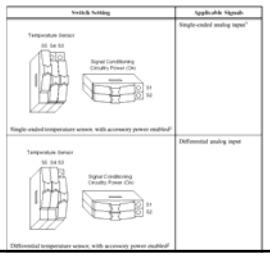
Two parameters

- Device = 1
- Channel = 0

with

**SCB-68**

connection board




# Writing Waveform Data to File

**…Not anymore**


- **Waveform File I/O subpalette of the Waveform palette**
- **Three VIs for writing waveform data to file but Write To Spreadsheet File.vi is the most important**

Enable indexing


## Data Acquisition Terminology

- **Resolution** - Determines How Many Different Voltage Changes Can Be Measured
  - Larger Resolution → More Precise Representation of Signal
- **Range** - Minimum and Maximum Voltages
  - Smaller range → More Precise Representation of Signal
- **Gain** - Amplifies or Attenuates Signal for Best Fit in Range
- **Quiz** - what's the resolution with a 16 bits board in the range of ±12 V?

# Analog Output VIs ...Not anymore

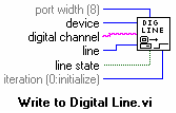
- **Single-point VI**

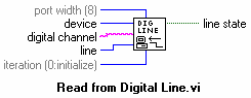




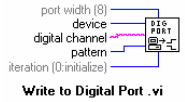
# Digital Input and Output VIs

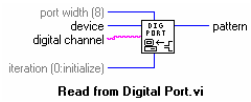
- **Line = single TTL signal**




- **Port = collection of lines (4 or 8)**

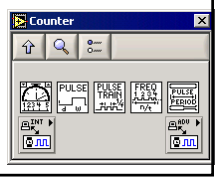


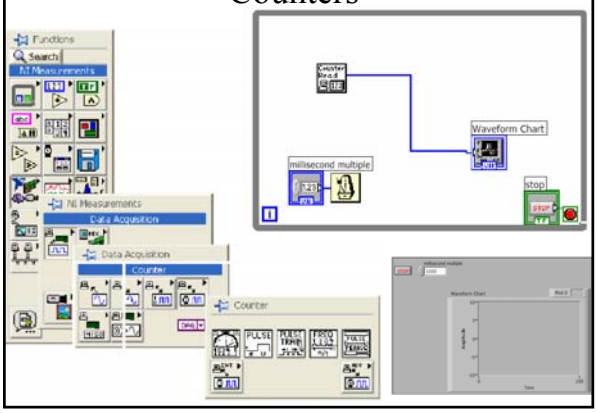



# Counters

- **A counter is a digital timing device.**
- **Typically used for:**
  - **event counting for PMT, EMT**
  - **frequency measurement**
  - **period measurement**
  - **position measurement**
  - **pulse generation**

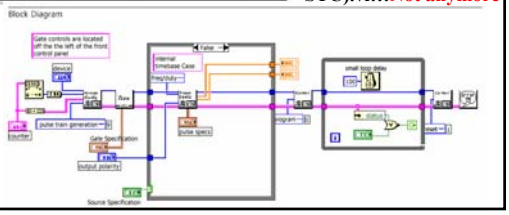



# Counters



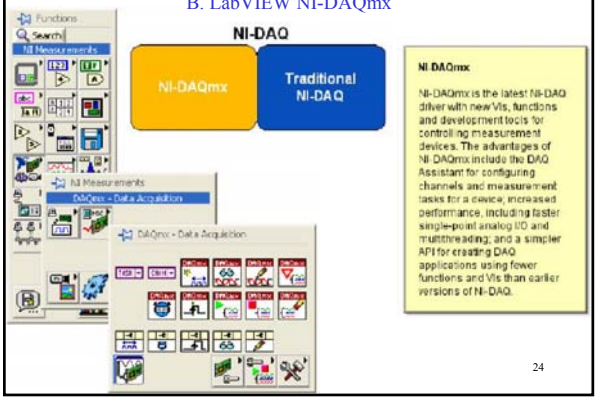

# Counters-pulse generation

1. Find the **VI from Help»Find Examples...»Search**
2. **Type in "**counter**" and search**
3. Choose **Generate Pulse Train (DAQ-STC).vi…Not anymore**



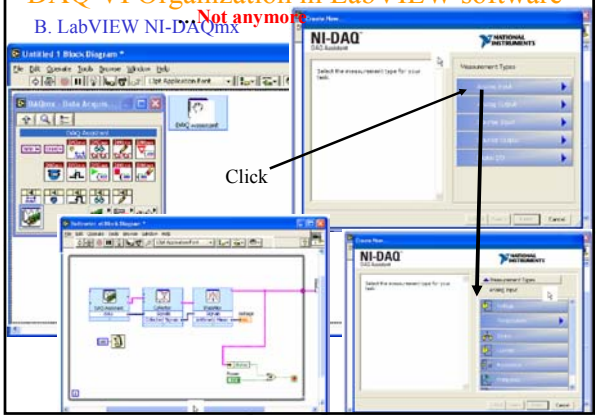

# DAQ VI Organization in LabVIEW software

## B. LabVIEW NI-DAQmx



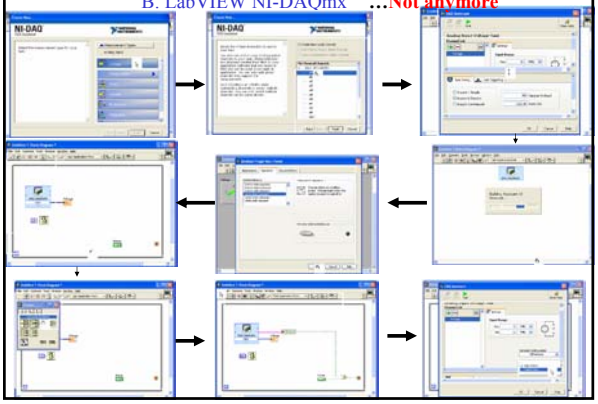
## DAQ VI Organization in LabVIEW software

B. LabVIEW NI-DAQmx …Not anymore



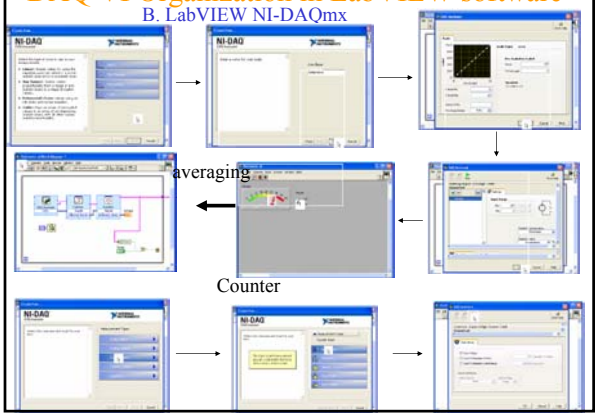

## DAQ VI Organization in LabVIEW software

B. LabVIEW NI-DAQmx …Not anymore




## DAQ VI Organization in LabVIEW software

B. LabVIEW NI-DAQmx




## Summary

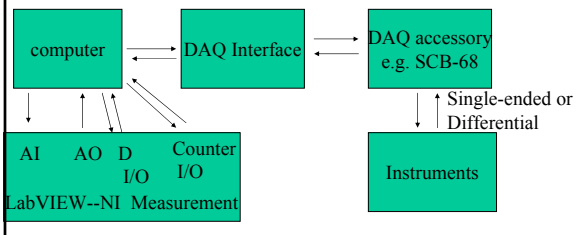
- **Use the Measurement & Automation Explorer to configure DAQ boards and virtual channels**
- **DAQ VIs organized into six subpalettes – Analog Input, Analog Output, Digital I/O, Counter, Configuration and Calibration, and Signal Conditioning**
- **Analog Input and Output subpalettes are divided into levels – Easy I/O, Intermediate, Advanced, and Utility VIs**
- **Easy I/O contains VIs for**
  - **Single-channel analog input and output**
  - **Single-channel waveform input and output**
  - **Multichannel waveform input and output**
  - **Digital input and output**
  - **Counter / Timers**



## Summary

Connections and configuration

Connections:




Configuration: 1. Traditional NI-DAQ …Not anymore
2. NI-DAQmx