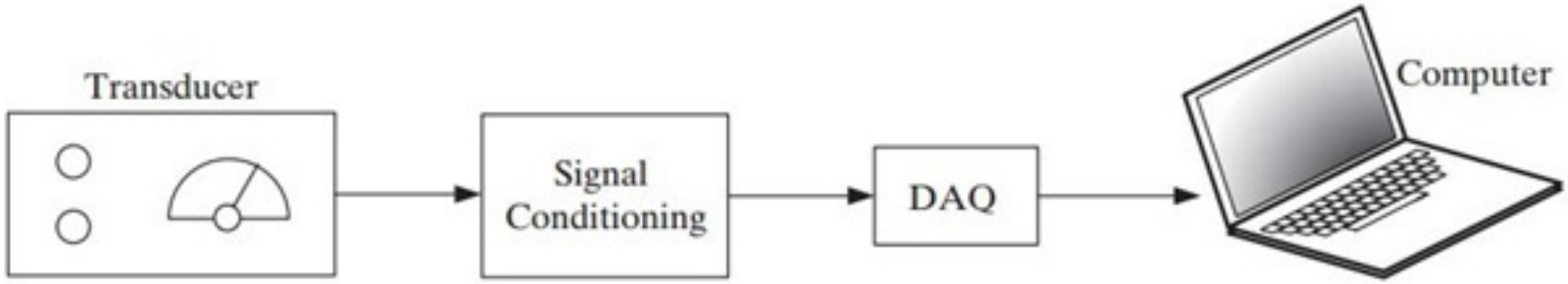
Data Acquisition Process

- Data acquisition is a process of automatically obtaining data from one or more sensors or transducers directly into the computer system.
- A sensor is a device that responds to a physical change and outputs an electrical signal
- A transducer is a device that converts energy from one form to another.



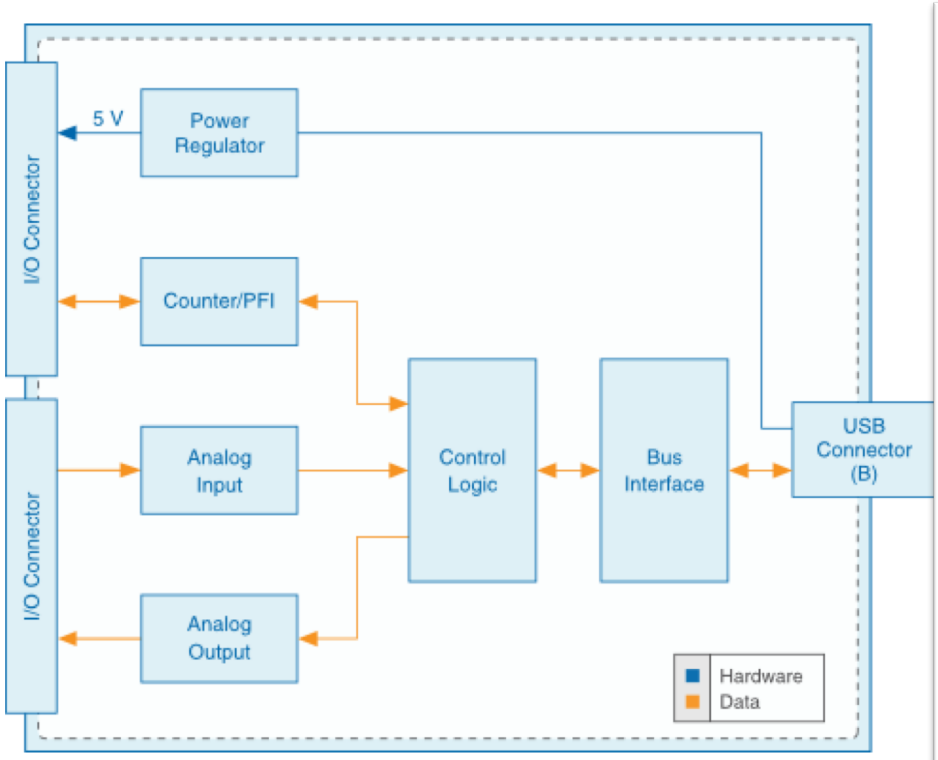
Signal Conditioning

- The process of modifying the output of a sensor is called signal conditioning.
- Signal condition is required for dealing with noisy signal
- We can deal signal noise in following ways:
  - Modifying the system (expensive approach)
  - Using better quality sensor (expensive)
  - Ignoring the noise (not ideal)
  - Using a bunch of readings so that result can be averaged (using software)
  - Filtering the signal (hardware or software)

DAQ Hardware

- When considering which data acquisition system to use, there are several things to consider:
  - What types of signals will the data acquisition system need to handle?
  - How many AI channels (analog inputs) are required
  - How many AO channels (analog outputs) are required
  - How many DI channels (digital inputs) are required
  - How many DO channels (digital outputs) are required
  - Will your AI channels be wired as differential inputs or single-ended?
  - What level of precision is required in the analog-to-digital converter?
  - How fast will you need to take samples?

DAQ System Block Diagram & Spec

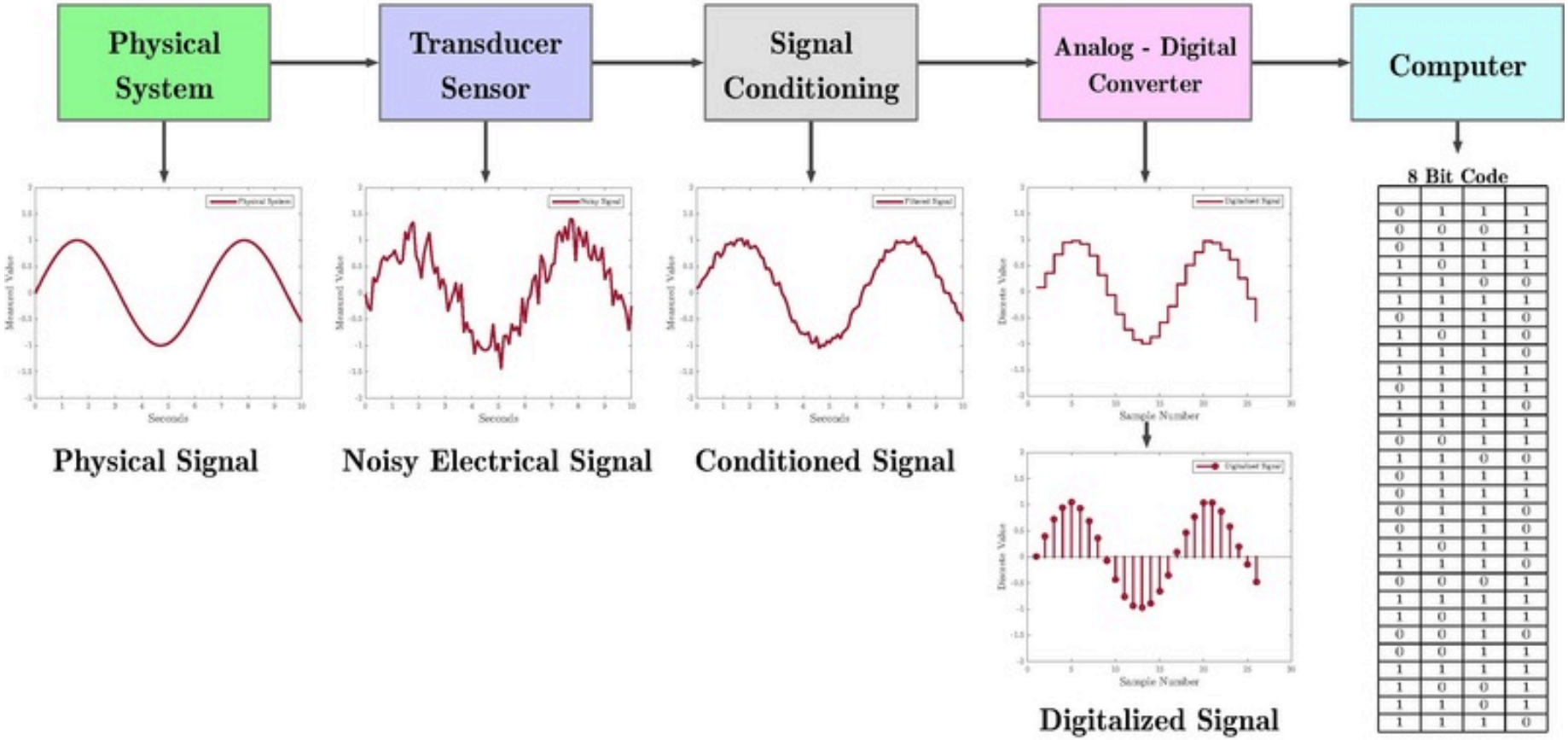


http://www.ni.com/documentation/en/multifunction-io-device/latest/specs-usb-6008/specs/

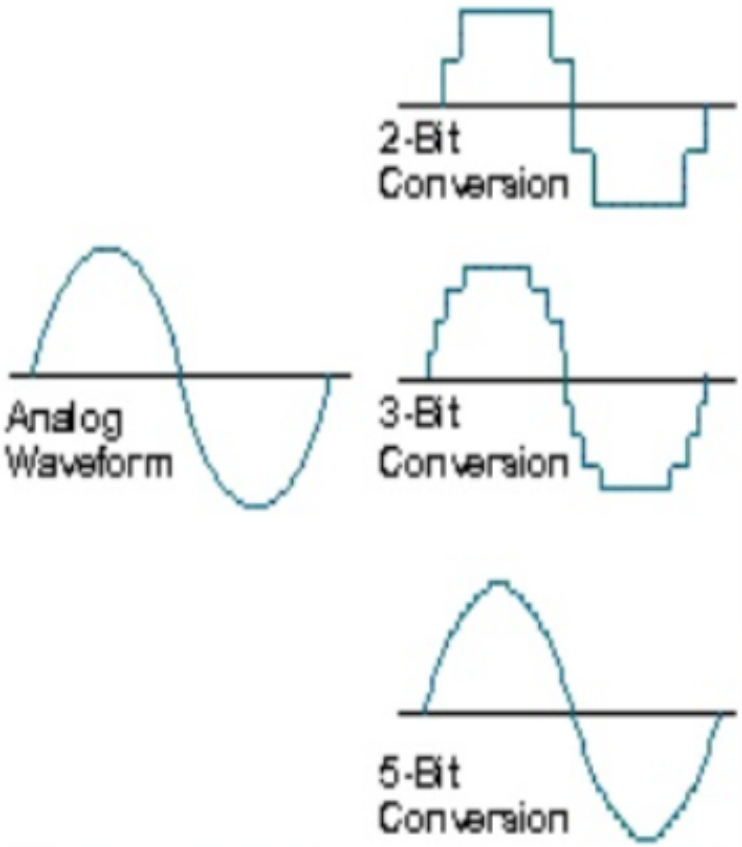
Analog Input

Analog inputs	
Differential	4
Single-ended	8, software-selectable
Input resolution	
Differential	12 bits
Single-ended	11 bits
Maximum sample rate (aggregate)	10 kS/s, system dependent
Converter type	Successive approximation
AI FIFO	512 bytes
Timing resolution	41.67 ns (24 MHz timebase)
Timing accuracy	100 ppm of actual sample rate
Input range	
Differential	±20 V[1], ±10 V, ±5 V, ±4 V, ±2.5 V, ±2 V, ±1.25 V, ±1 V
Single-ended	±10 V
Working voltage	±10 V
Input impedance	144 kΩ
Overvoltage protection	±35 V
Trigger source	Software or external digital trigger

Digital Data Acquisition System

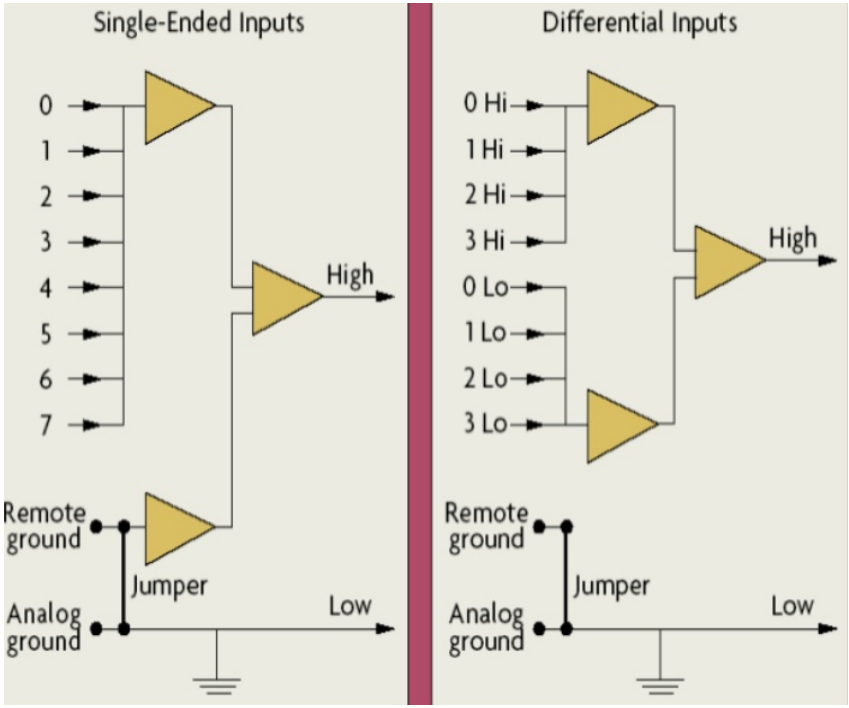


Resolution of ADC



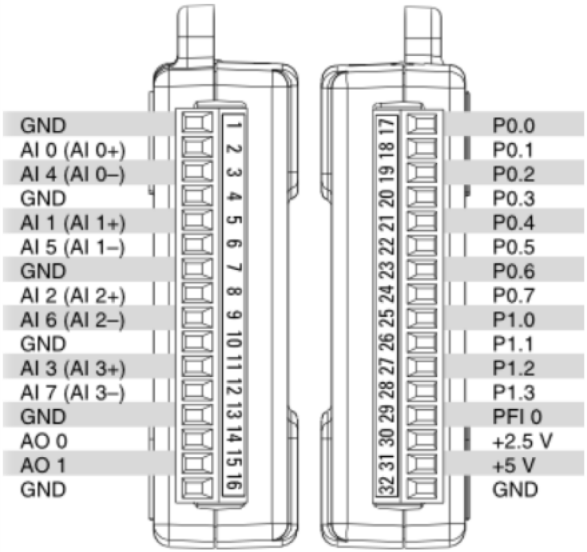
DAQ Hardware

- **Differential Inputs:**
- When AIs are wired as differential inputs, the two signal wires are connected to two AI channels that are configured to work together to measure the voltage difference between the two wires.
- **Single-Ended Inputs:**
- Single-ended inputs only require one AI channel per measurement and can work under the right conditions.
- **Analog to Digital Converters:**
- Once the signal passes through the AI port, it must be converted to a digital value corresponding to the signal voltage. An ADC performs this action. One of the characteristics of an ADC is the number of bits used to describe the voltage level. The higher the bit count, the greater the resolution of the ADC. Common ADCs are 12–22 bit devices.
- **Sample Rate:**
  Another consideration when selecting a data acquisition system is the required sampling rate. The analog-to-digital conversion process takes a finite amount of time. If you want to take one sample a second, any data acquisition system will work fine.



DAQ System Example

Signal	Reference	Description
GND	—	Ground—The reference point for the single-ended analog input measurements, analog output voltages, digital signals, +5 VDC supply, and +2.5 VDC at the I/O connector, and the bias current return point for differential mode measurements.
AI <0..7>	Varies	Analog Input Channels—For single-ended measurements, each signal corresponds to one analog input voltage channel. For differential measurements, AI 0 and AI 4 are the positive and negative inputs of differential analog input channel 0. The following signal pairs also form differential input channels: AI <1,5>, AI <2,6>, and AI <3,7>.
AO <0,1>	GND	Analog Output Channels—These terminals supply voltage output.
P0.<0..7>	GND	Port 0 Digital I/O Channels—You can configure each signal individually as an input or output.
P1.<0..3>	GND	Port 1 Digital I/O Channels—You can configure each signal individually as an input or output.
PFI 0	GND	Programmable Function Interface—This terminal is configurable as either a digital trigger or an event counter input.
+2.5 V	GND	+2.5 V External Reference—Provides a reference for wrap-back testing.
+5 V	GND	+5 V Power Source—Provides +5 V power up to 200 mA.



Choose the right Data Acquisition System

- **Portable Data Acquisition Systems**
  Bluetooth wireless transmitters that connect with smart phones or tablets to log and monitor and record measurements, turning mobile devices into portable data acquisition systems. These transmitters measure different sensor inputs, including but not limited to pH, RTD, relative humidity. The data transmission is performed via Bluetooth wireless technology to a smart phone or tablet with the app installed. The app will allow the smart phone to pair and set up multiple transmitters.

- **Wireless Data Acquisition Systems**
  Wireless data acquisition systems can eliminate costly and time consuming field wiring of process sensors. These systems consist of one or more wireless transmitters sending data back to a wireless receiver connected to a remote computer. Wireless transmitters are available for ambient temperature and relative humidity, thermocouples, RTDs, pulse output sensors, 4 to 20 mA transmitters and voltage output transducers. Receivers can be connected to the USB or Ethernet port on the PC

Choose the right Data Acquisition System

- **Serial Communication Data Acquisition Systems**
  Serial communication data acquisition systems are a good choice when the measurement needs to be made at a location which is distant from the computer. There are several different communication standards, RS232 is the most common but only supports transmission distances up to 50 feet. RS485 is superior to RS485 and supports transmission distances to 5,000 feet.

- **USB Data Acquisition Systems**
  The Universal Serial Bus (USB) is a new standard for connecting PCs to peripheral devices such as printers, monitors, modems and data acquisition devices. USB offers several advantages over conventional serial and parallel connections, including higher bandwidth (up to 12 Mbits/s) and the ability to provide power to the peripheral device. USB is ideal for data acquisition applications.

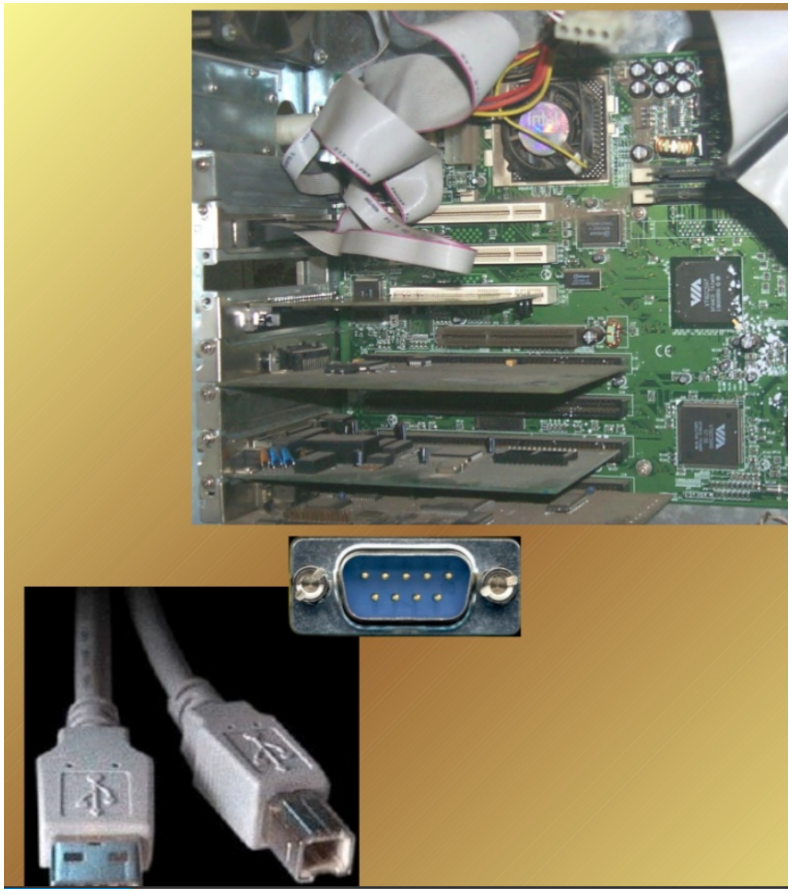
- **Data Acquisition Plug-in Boards**
  Computer data acquisition boards plug directly into the computer bus. Advantages of using boards are speed (because they are connected directly to the bus) and cost (because the overhead of packaging and power is provided by the computer).

DAQ Interface to a PC

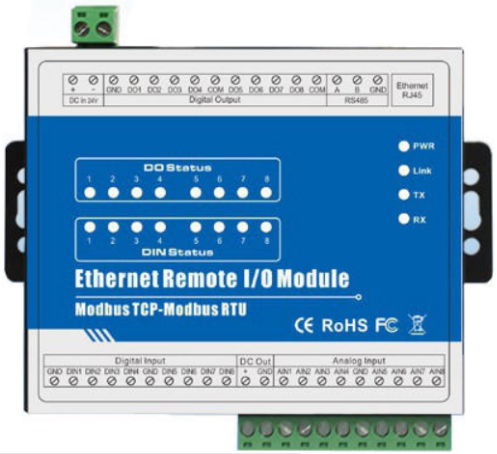
- PC interface can be in the form of modules that can be connected to the computer's ports (parallel, serial, USB, etc.)
- PC interface can also be in form of cards connected to slots (S-100 bus, AppleBus, ISA, MCA, PCI, PCI-E, etc.) in the motherboard. lding.
- DAQ cards often contain multiple components (multiplexer, ADC, DAC, TTL-IO, high speed timers, RAM).
- These are accessible via a bus by a microcontroller, which can run small programs.

PC Interfaces

- Add-On Card Plug-in Slots,
- COM ports (RS-232C); further add Modem for long distances,
- Universal Serial Bus (USB),
- Parallel Port (Centronics / Printer),
- LAN / Ethernet (TCP/IP) interface,
- Add GPIB or IEEE-488 Interface,
- Add SCSI or may be built-in,
- Add HART, FIELDBUS or other Interfaces



Different DAQ Systems



Portable DAS System

Comparison

- Comparing NI DAQ Systems
  - http://www.ni.com/en-us/shop/select/multifunction-io-device