

Data Acquisition Practical Session



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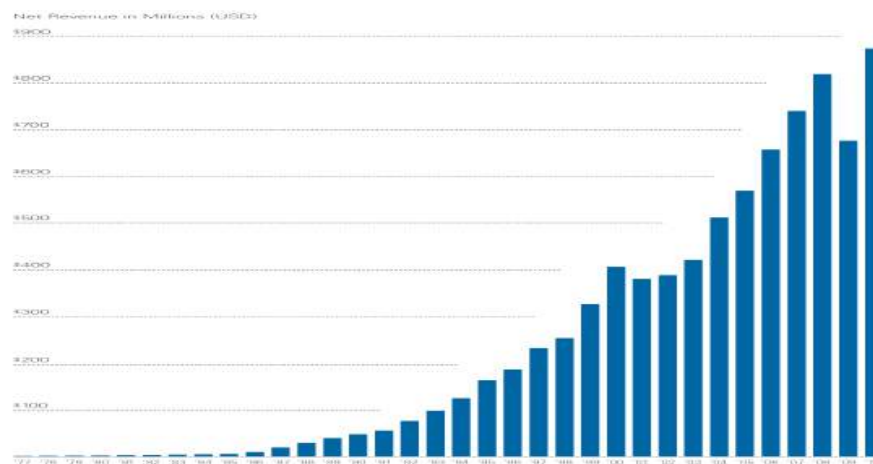
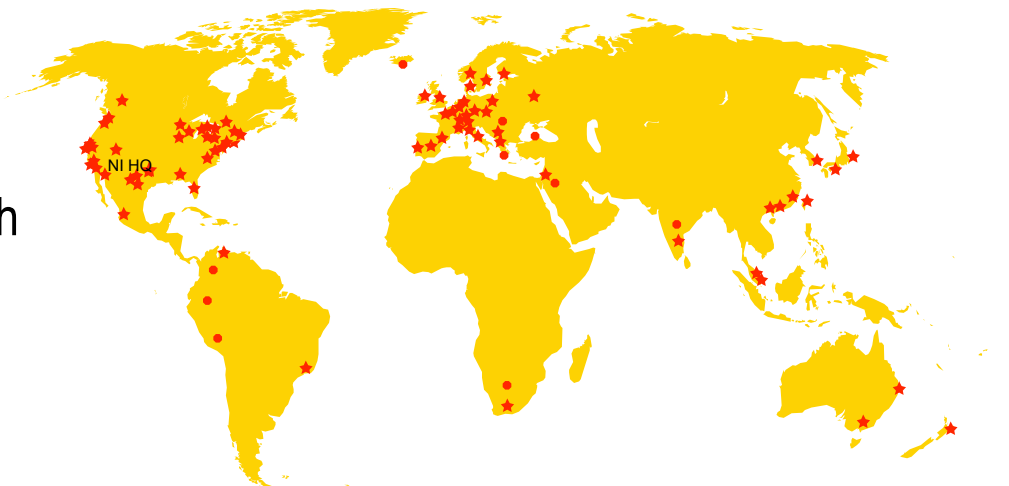
Agenda

- Brief introduction to NI and LabVIEW
 - *Exercise 1 – Working with LabVIEW*
- Brief introduction to CompactDAQ architecture
 - *Exercise 2 – Taking measurements with CompactDAQ*
- Overview on the graphical interface
 - *Exercise 3 – Programming structures in LabVIEW*
 - *Exercise 4 – Acquire different signals simultaneously*
- Resources for your application
- Questions and comments



National Instruments at a Glance

- Leaders in Computer-Based Measurement and Automation
- Long-term Track Record of Growth and Profitability
- Record Revenue: \$1.24B in 2014
- Fortune “100 Best Companies to Work For” eleven years in a row
- More than 6000 employees; operations in 40+ countries
- Founded in 1976 with focus on Instrument Control
- LabVIEW 1.0 released in 1986



Virtual Instrumentation Everywhere

More than 30,000 companies annually, including
>90% of Fortune 500 manufacturing companies

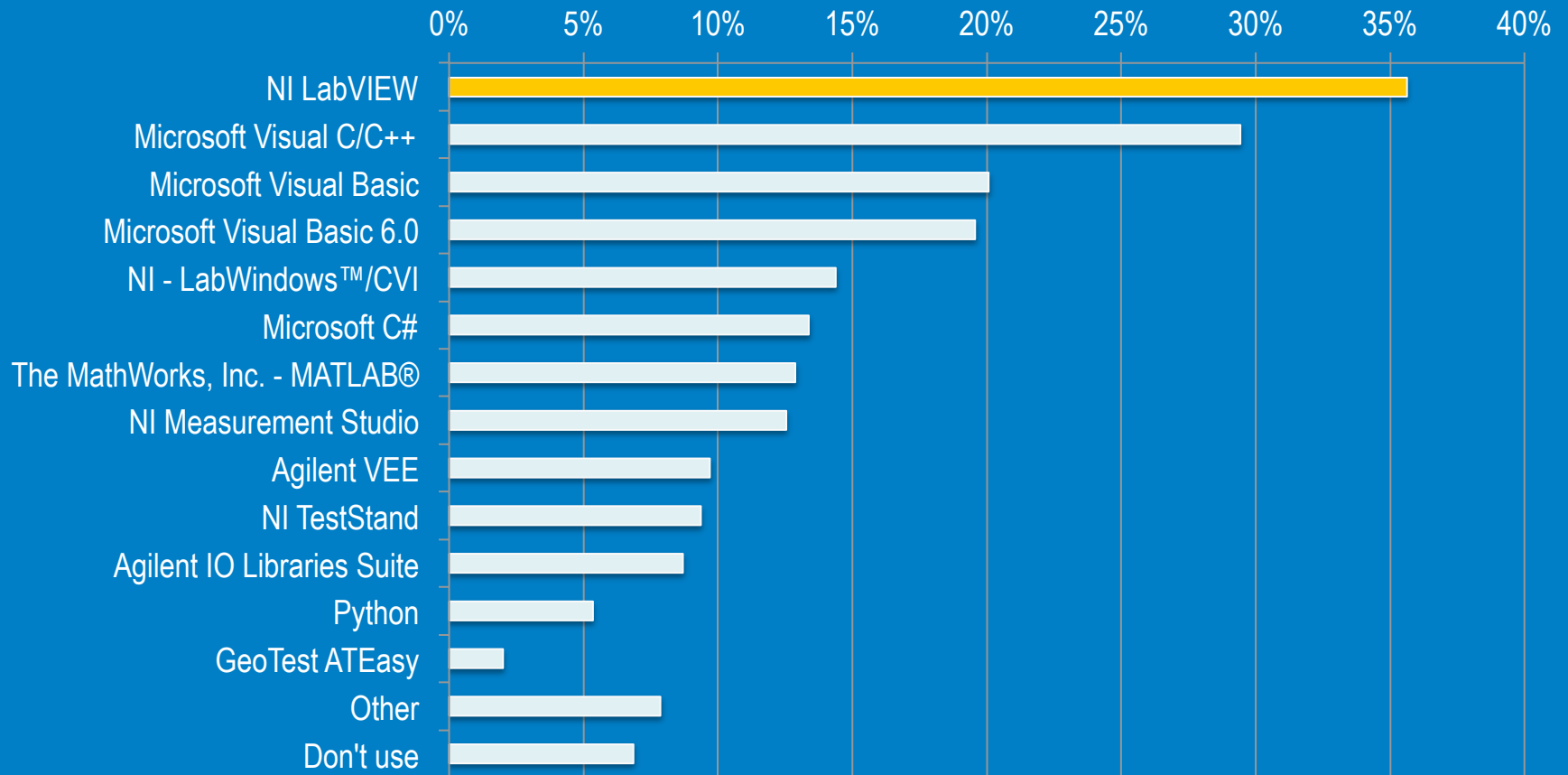


What is LabVIEW?

- LabVIEW is a Programming Language such as C/C++, Visual Basic, .NET, etc.
- Graphical programming
- For test and measurement and automatization
- Import libraries such as DLL, ActiveX
- Connects to Hardware I/O
- Manage features of O.S. (multicore, etc.)

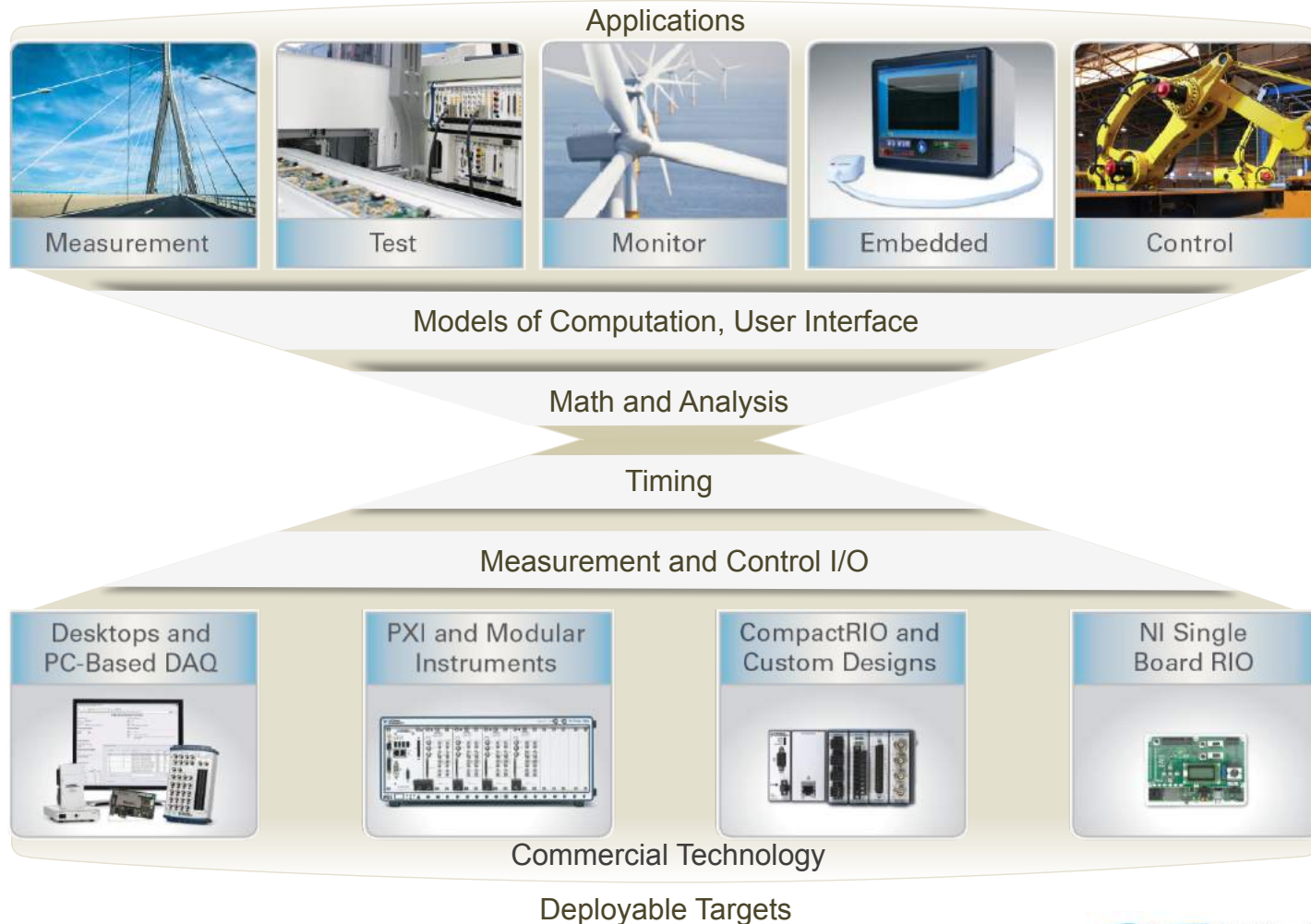
...LabVIEW Is the Standard for Making Measurements

Software Used for Data Acquisition and Instrument Control



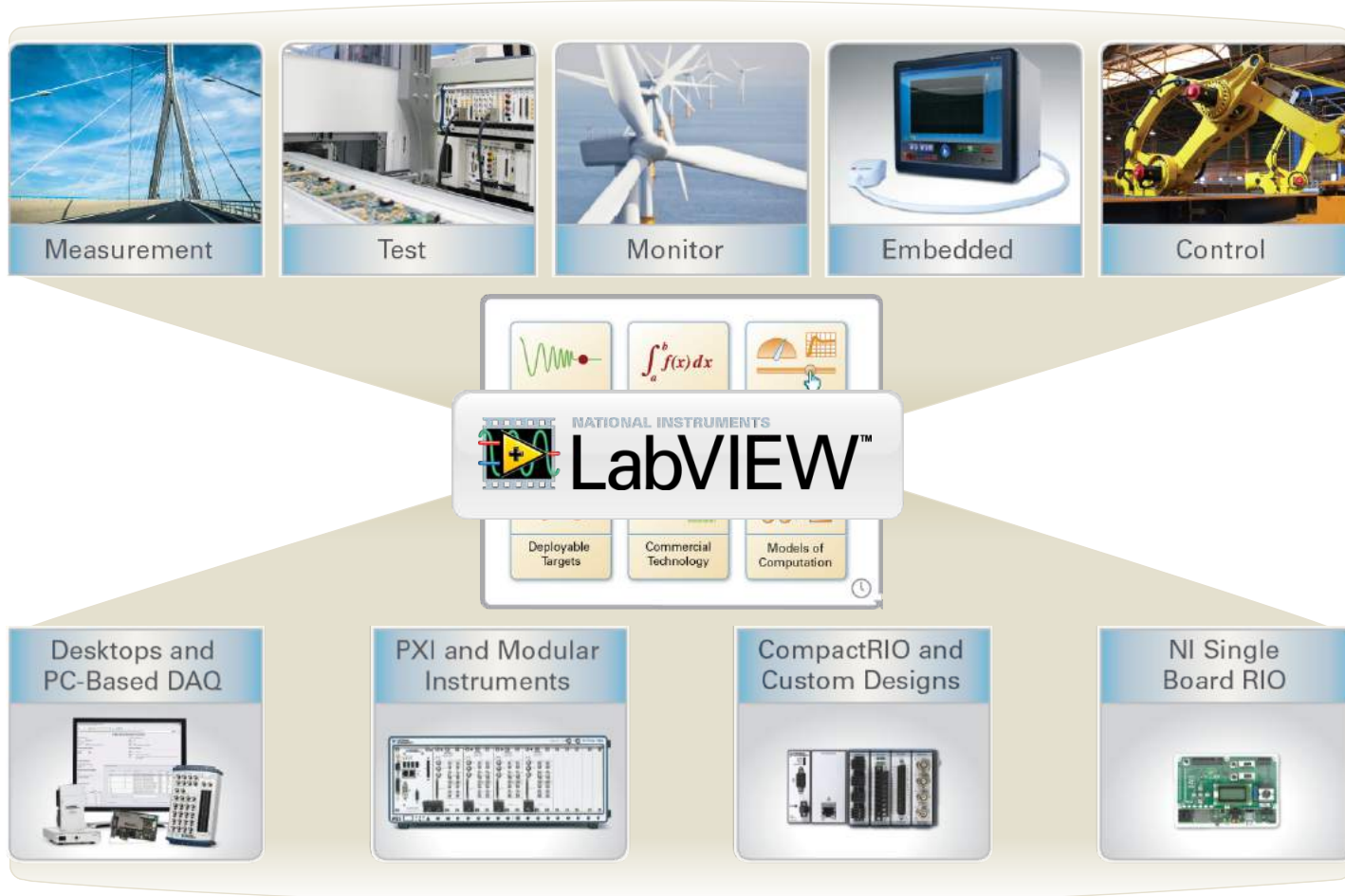
Graphical System Design

A platform-based approach for measurement and control



Graphical System Design

A platform-based approach for measurement and control



LabVIEW Everywhere



Graphical Systems Design Platform

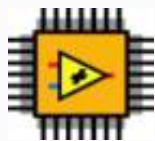
Desktop



Real-Time



FPGA



Microprocessor/DSP



Vision



Mobile



Touch Panel



WSN



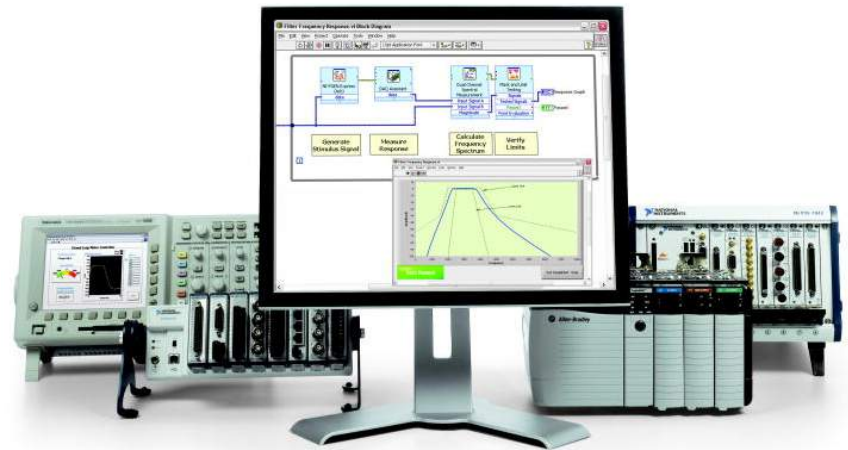
Different Hardware Access Modules

Hardware



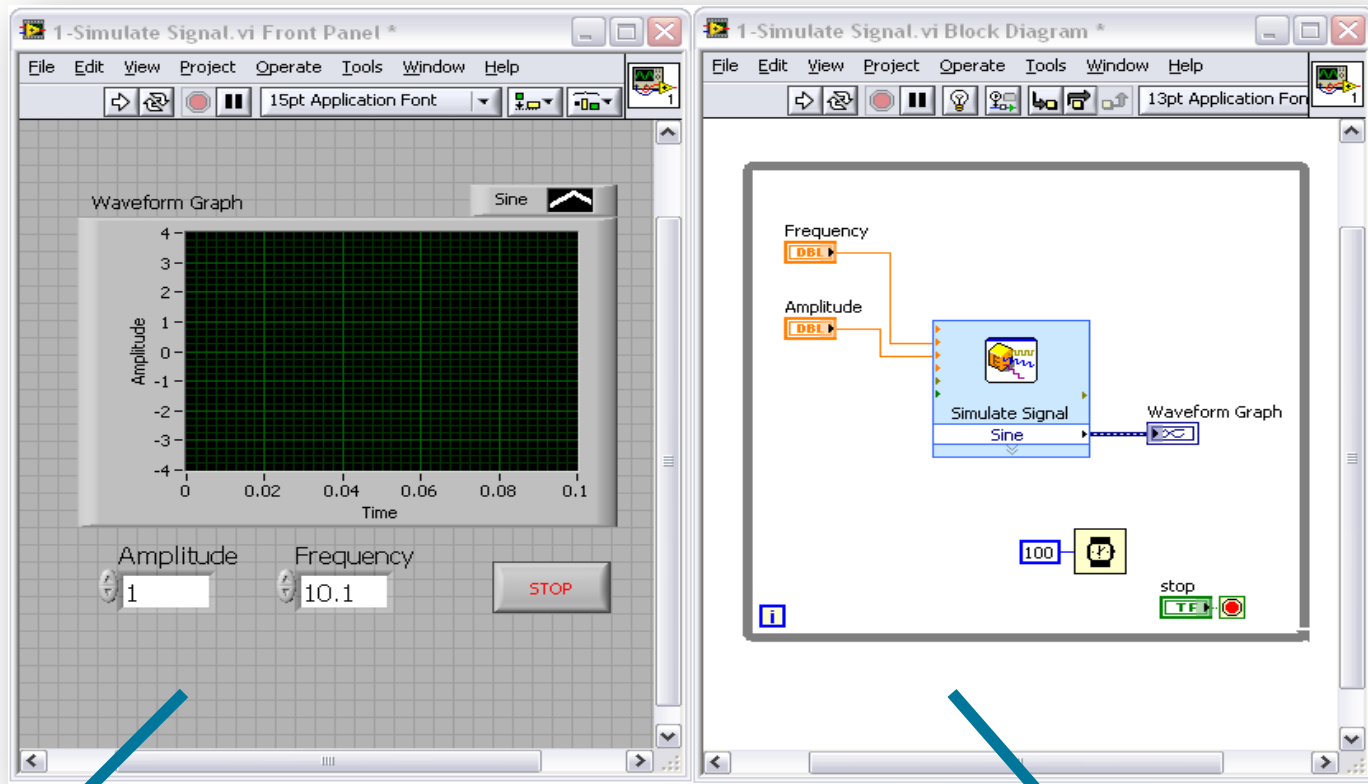
LabVIEW Easily Connects to Hardware I/O

- 6000+ instruments from over 250 vendors
- PCI, PCIe, PXI, USB, Ethernet, serial, GPIB, and CAN devices
- Modular data acquisition hardware from DC to the GHz range
- Motion control stages
- Cameras
- Hundreds of PLCs



The LabVIEW Environment

“VI” = program or function

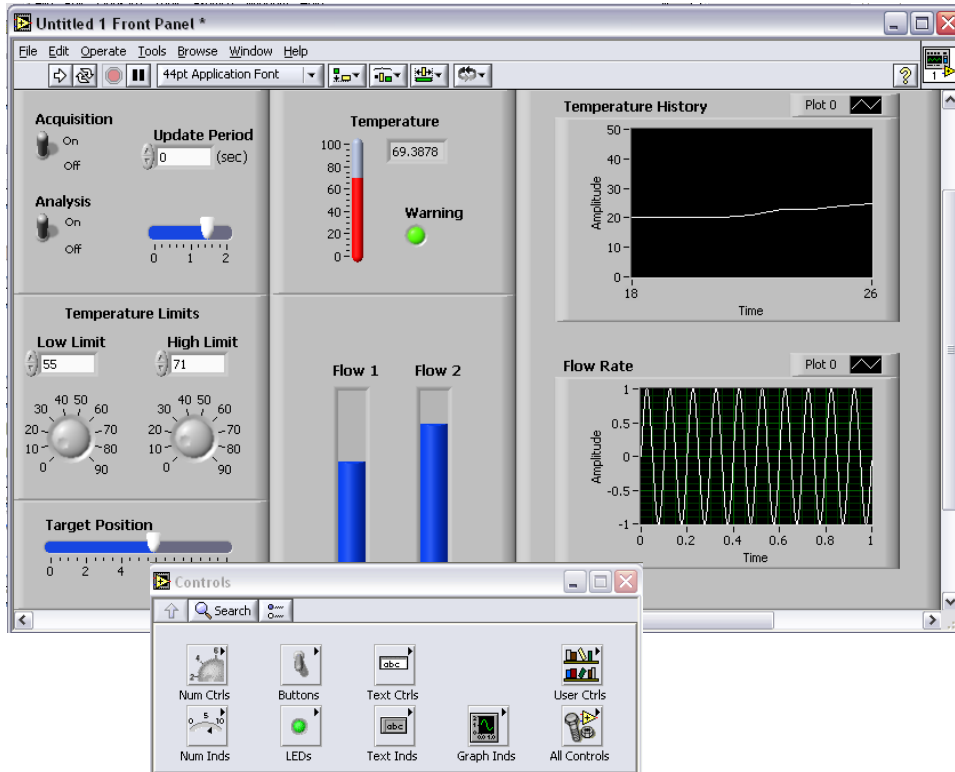


“Front Panel” = user interface

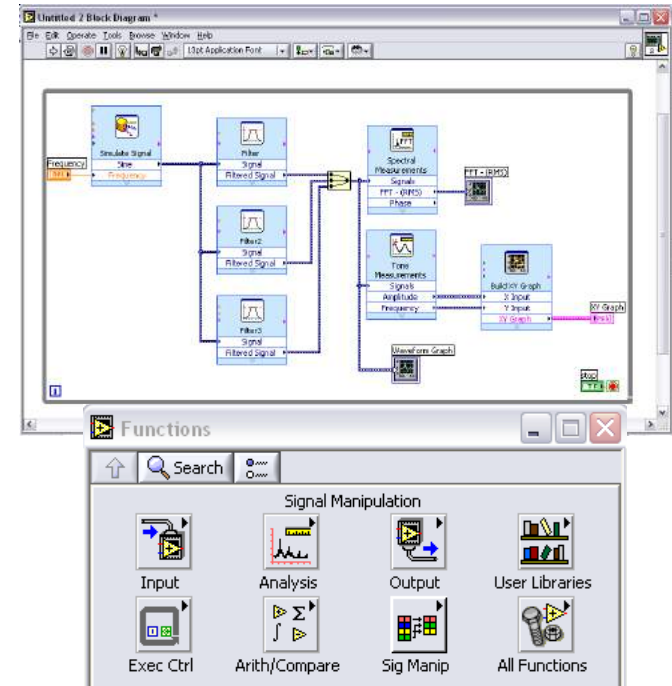
“Block Diagram” = code

The LabVIEW Environment

Front Panel – User Interface

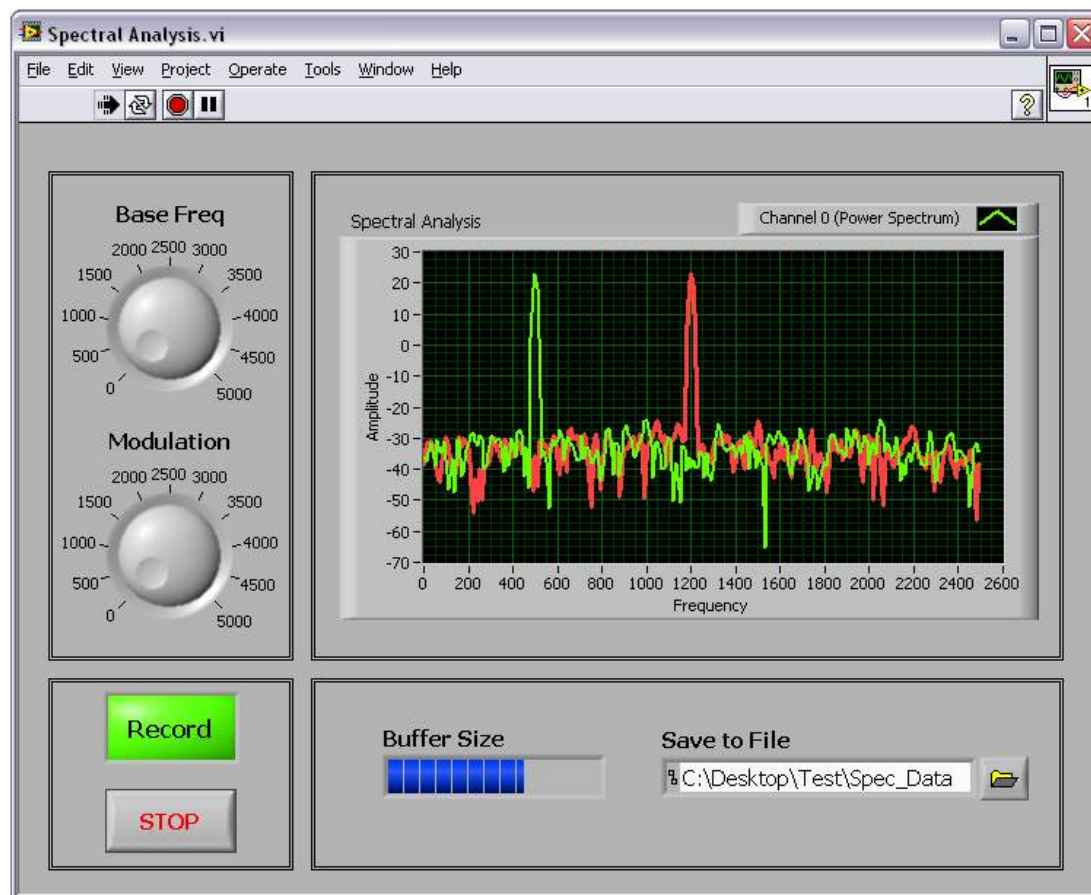


Block Diagram – Program Logic

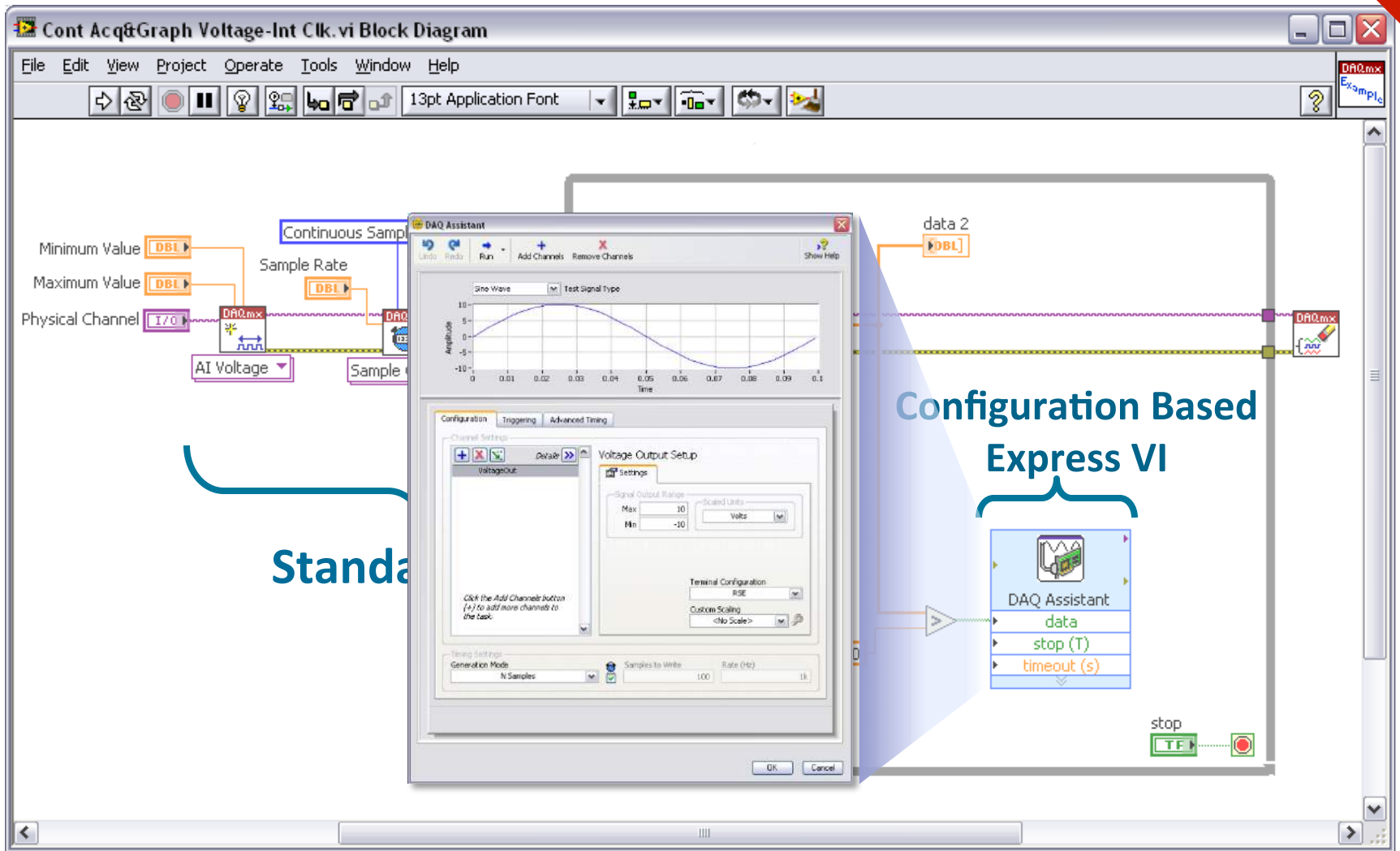


Controls & Indicators

- Knobs/Dials
- Graphs/Charts
- Buttons
- Digital Displays
- Sliders
- Thermometers
- Customize and create your own



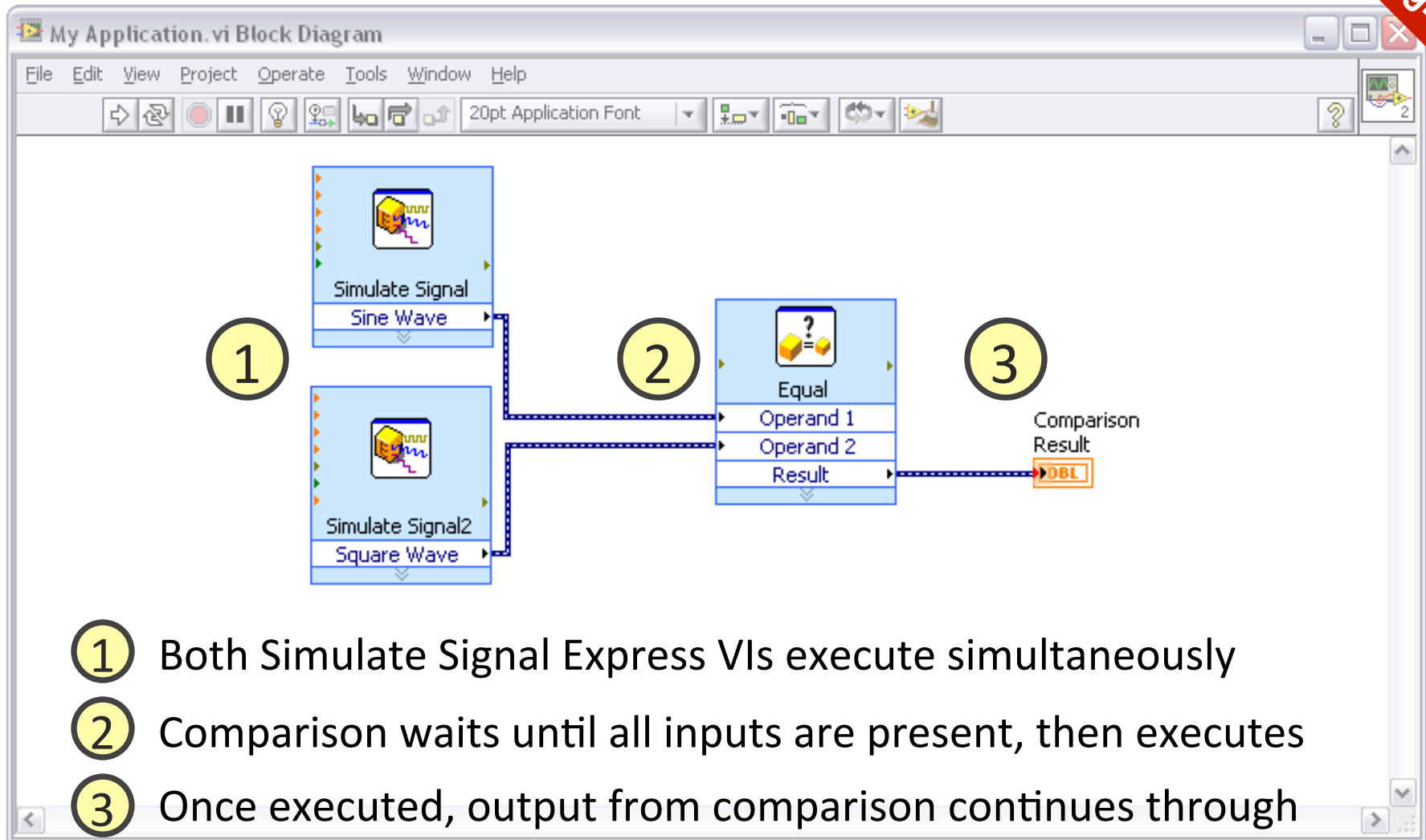
Functions and Express VIs



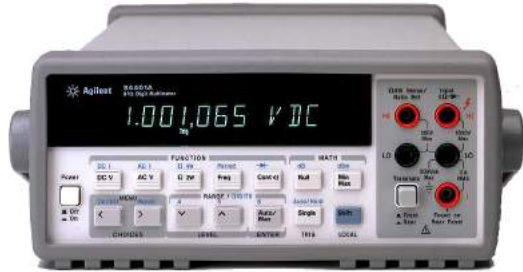
Standard

Configuration Based Express VI

Dataflow Programming



- 1 Both Simulate Signal Express VIs execute simultaneously
- 2 Comparison waits until all inputs are present, then executes
- 3 Once executed, output from comparison continues through code



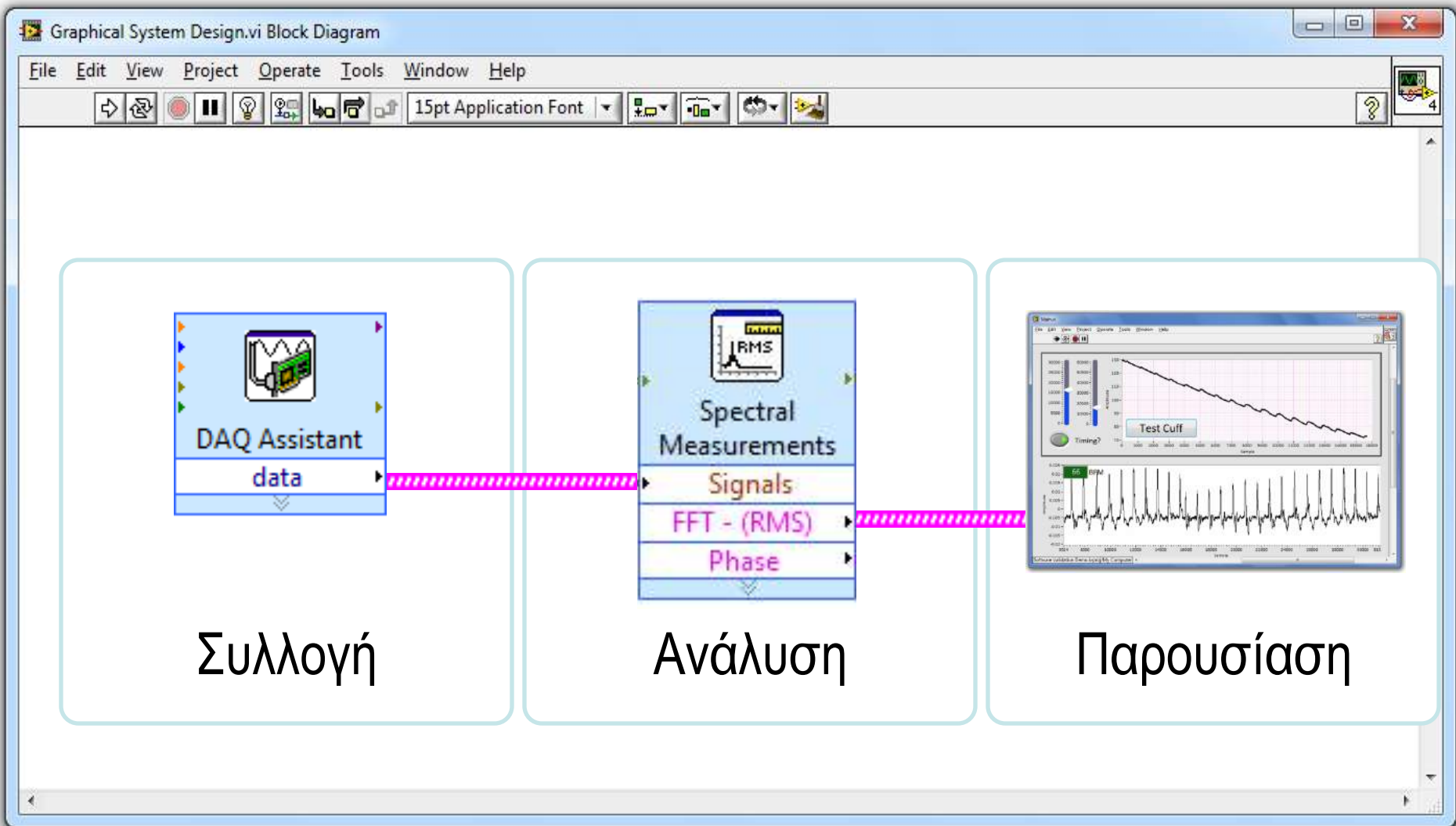
Συλλογή



Ανάλυση












Παρουσίαση



Wires and Data Types

- Transfer data between block diagram objects through wires
- Wires are different colors, styles, and thicknesses, depending on their data types
- A broken wire appears as a dashed black line with a red X in the middle



	DBL Numeric	Integer Numeric	String
Scalar			
1D Array			
2D Array			

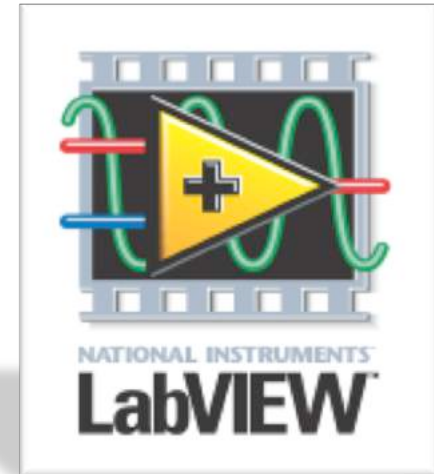
Exercise 1: Create a simple VI in LabVIEW

What will we learn?

- Working with LabVIEW environment

Create an application that:

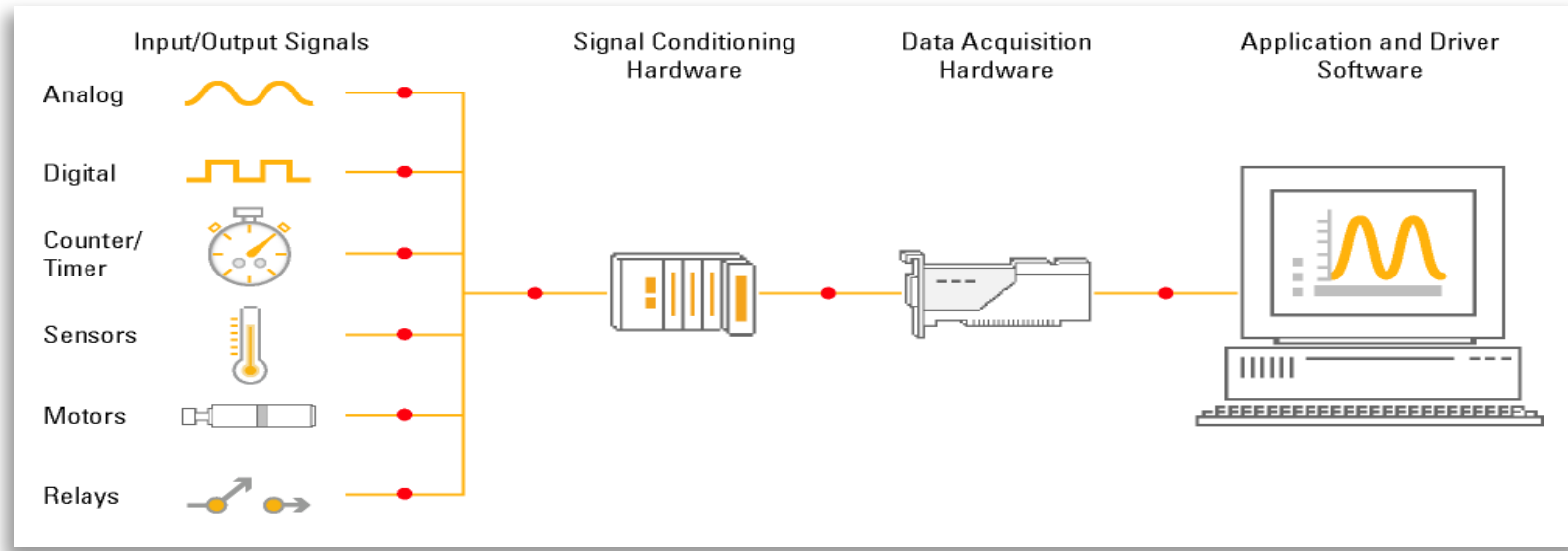
- Simulates a signal
- Calculate the RMS value
- Show the value in the front panel of LabVIEW



Data Acquisition with LabVIEW

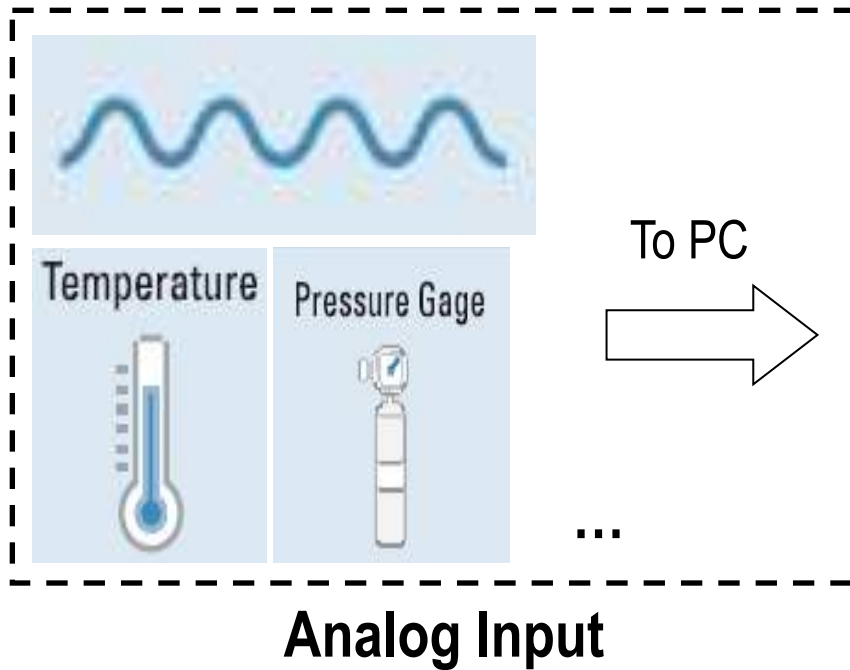


PC-Based Data Acquisition (DAQ)



Measuring Analog Input Signals

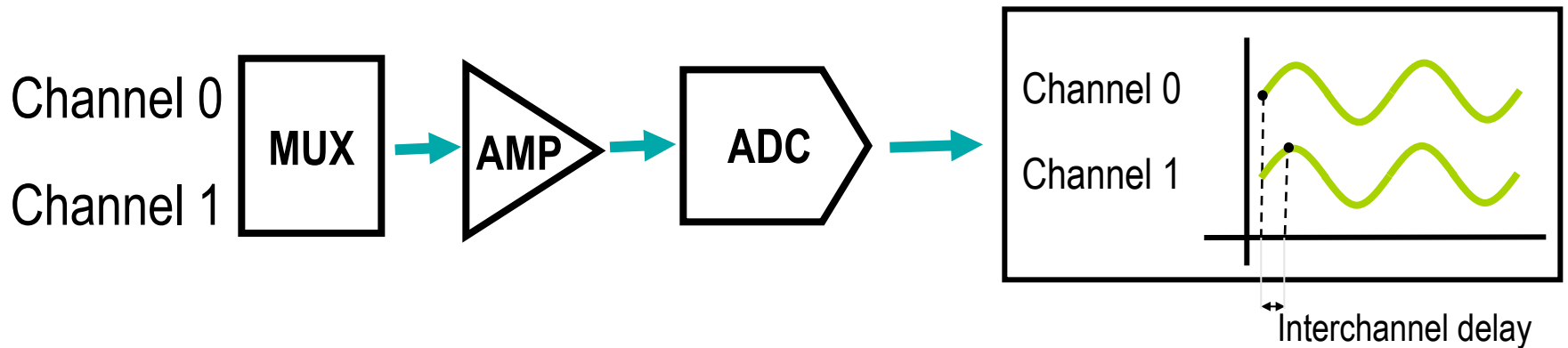
Important Factors to Consider



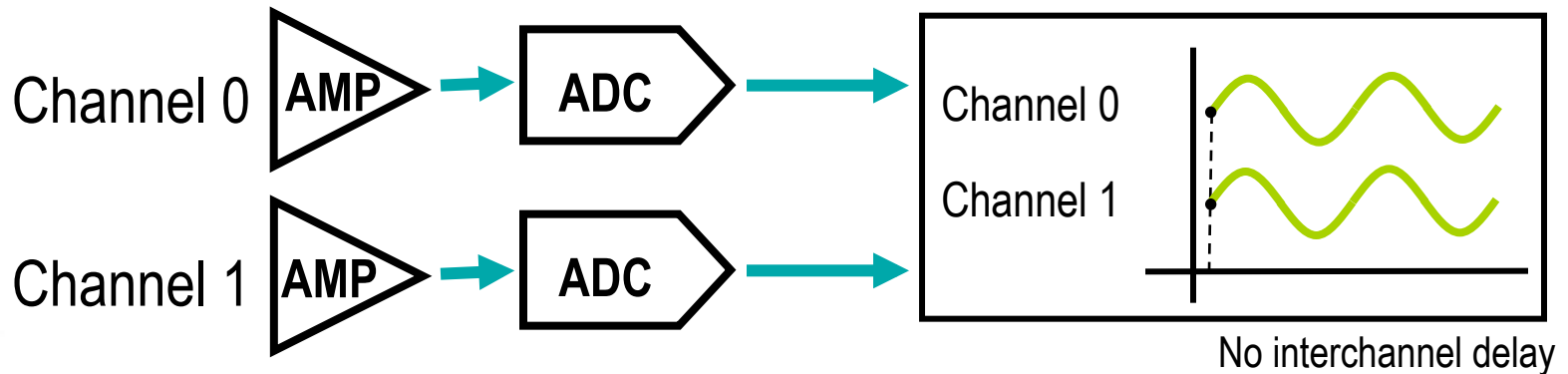
- Architecture
 - multiplexed
 - simultaneous sampling
- Sampling rate
- Resolution
- Signal conditioning

Analog Input – Architectures

Multiplexed

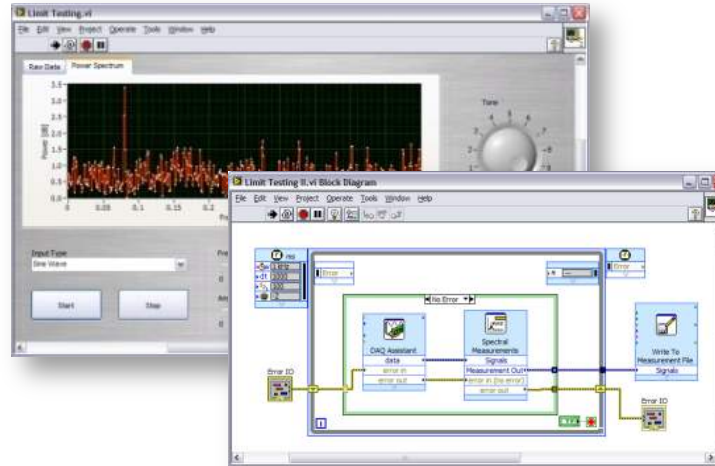


Simultaneous sampling



NI DAQ Platforms

One application,
multiple targets



USB



Wireless



PCI/PCIe



Compact DAQ



PXI/PXIe

NI DAQ Platforms

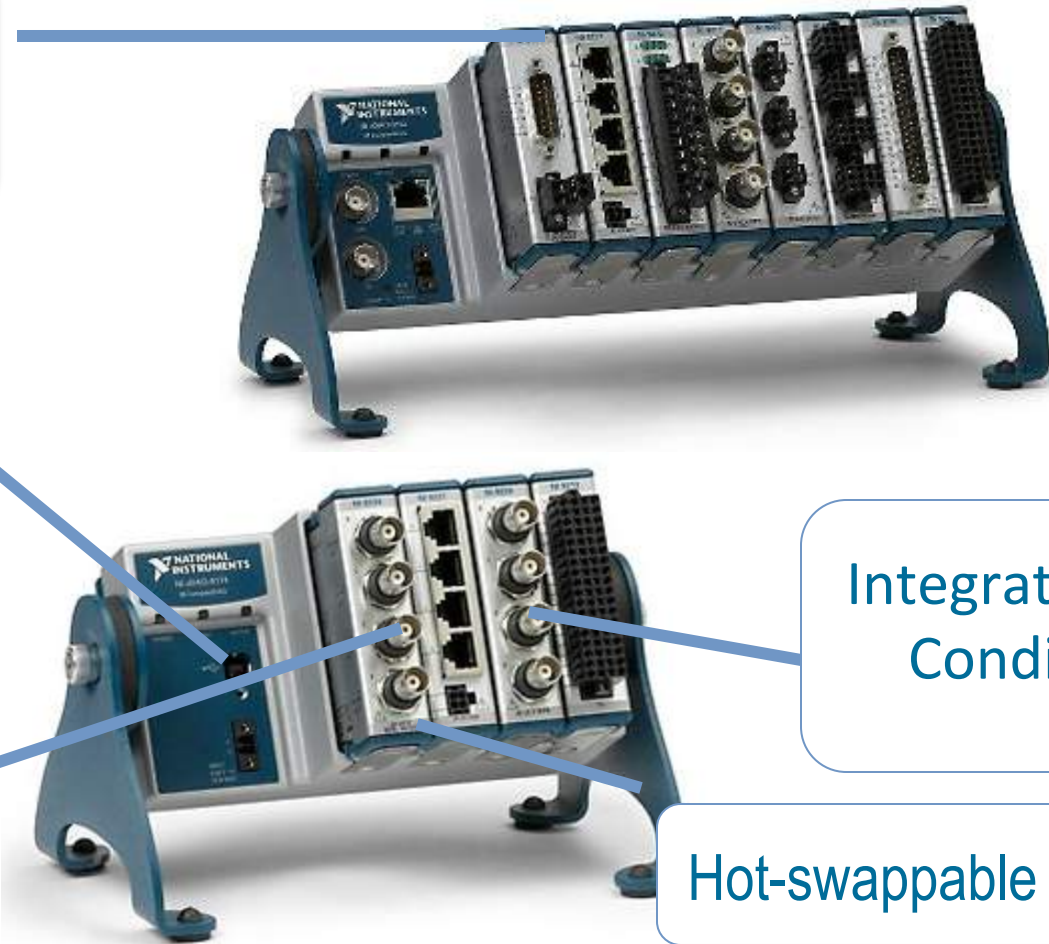
Support more than 100 modules

Hi-Speed USB 2.0

Signal Connectivity

Integrated Signal Conditioning

Hot-swappable modules



Data Acquisition with LabVIEW

NI-DAQmx driver software provides connectivity between LabVIEW and your hardware

Configuration Based



Programmatic Interface



NI-DAQmx driver configures

- Triggering
- Sample rates
- Clocking
- Buffering
- Signal routing
- etc...

Exercise 2: Introduction to data acquisition with LabVIEW

What will we learn

- Take measurements using LabVIEW and NI CompactDAQ

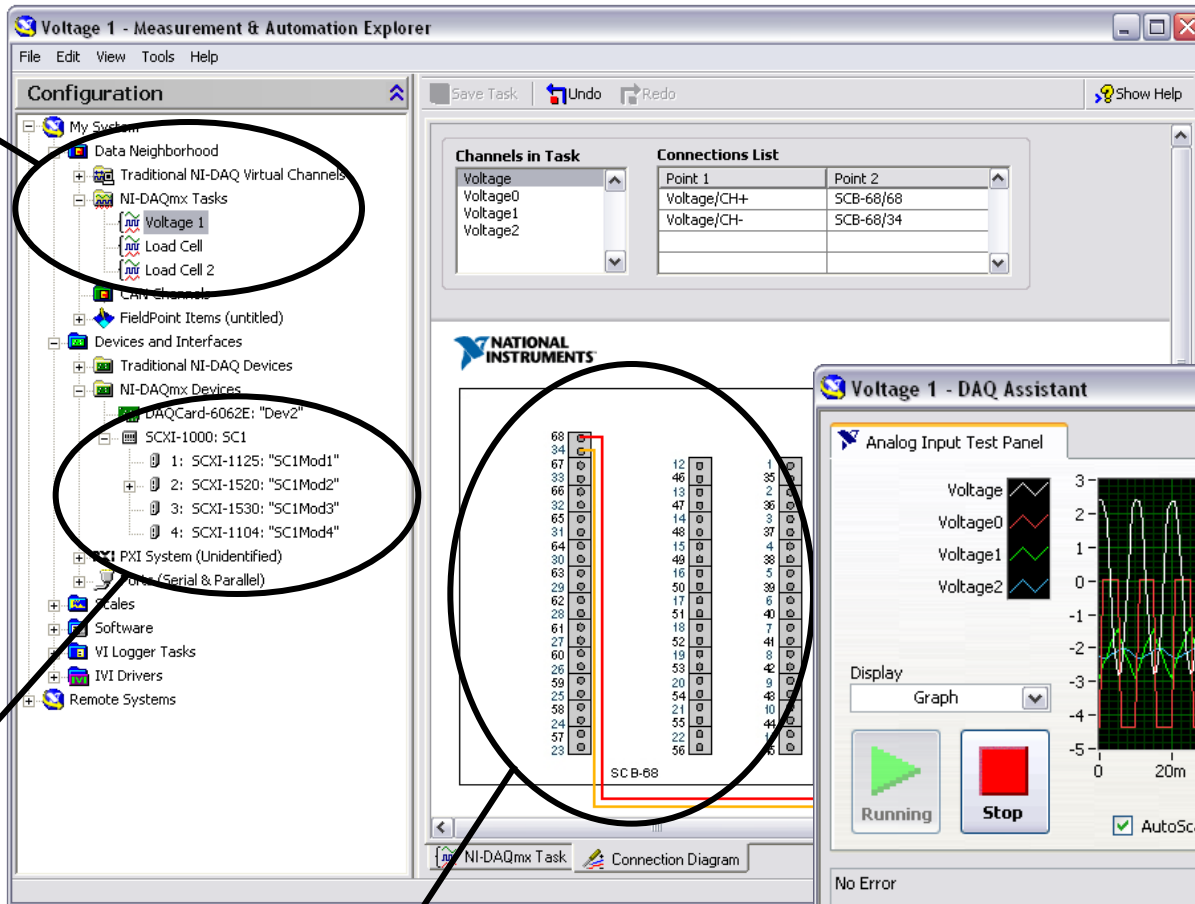
Create an application that :

- Takes measurements from a thermocouple and store measurements into a file

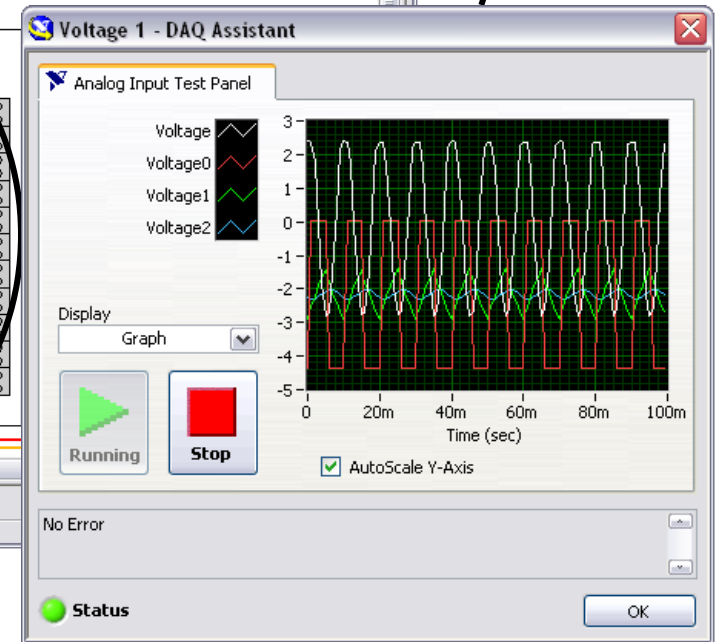


Measurement and Automation Explorer (MAX)

DAQmx Task creation



Built-in test panel windows



Device configuration and connection management

Signal connection diagrams

NI Getting Started



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Getting Started with NI Products

Follow the steps below to install, set up, and configure your NI data acquisition (DAQ), NI CompactRIO, GPIB, or instrument control hardware and learn the basics of NI LabVIEW software.

1 Install Software and Drivers

The first step to getting started is making sure you get the right software and drivers installed for your project.

[Start Here](#)

2 Connect and Set Up Hardware

The next step is to physically connect and set up your hardware.

[Go](#)

3 Learn LabVIEW Basics

Reading through this introduction to LabVIEW and graphical programming for beginners gives you the background you need to understand the many examples available.

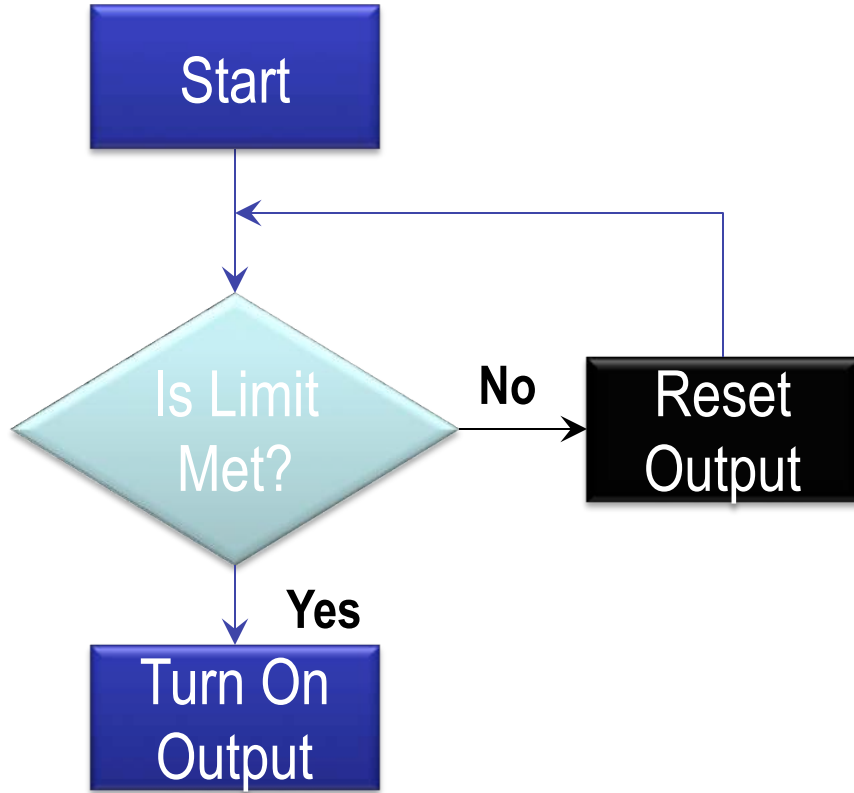
[Go](#)

4 Begin Your Application

View additional resources to help you develop your application, including video demonstrations and tutorials.

[Go](#)

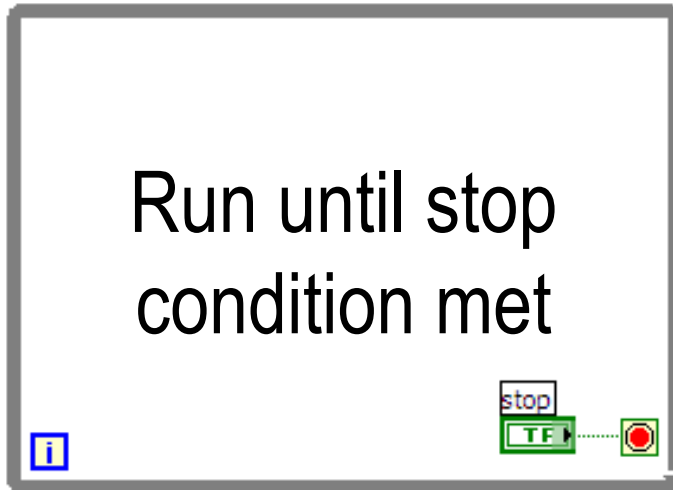
Controlling Program Execution



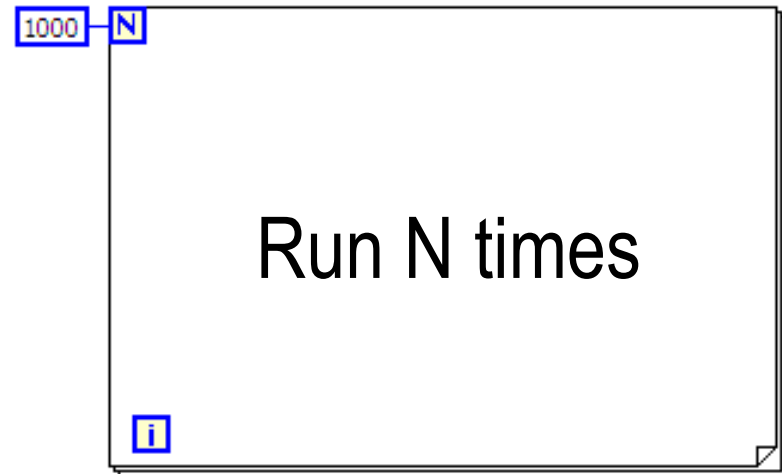
- Looping (For and While)
- Case structure
- Sequence structure
- State machines
- Event structure
- State diagram editor
- Timed loop

LabVIEW Looping Basics

While Loop



For Loop



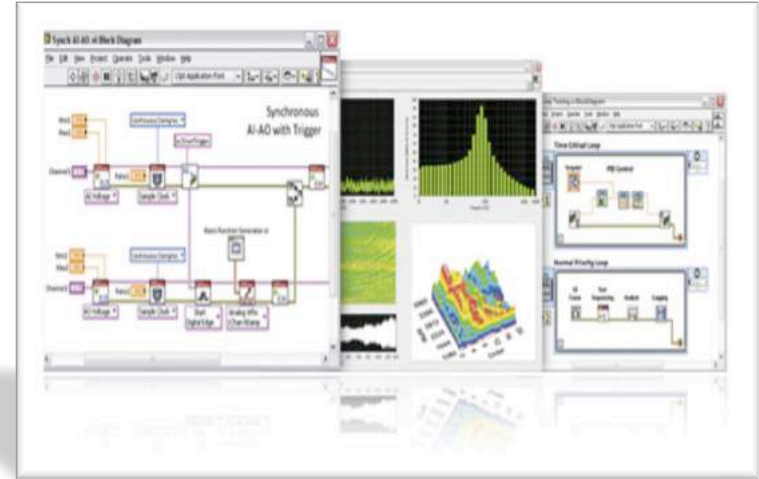
Exercise 3: Execution of a program

What will we learn

- How to create an application in LabVIEW

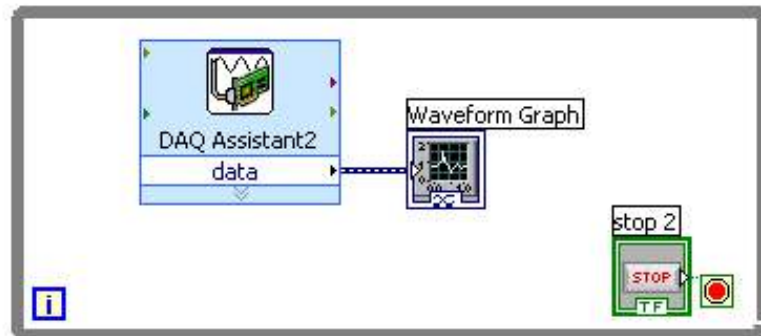
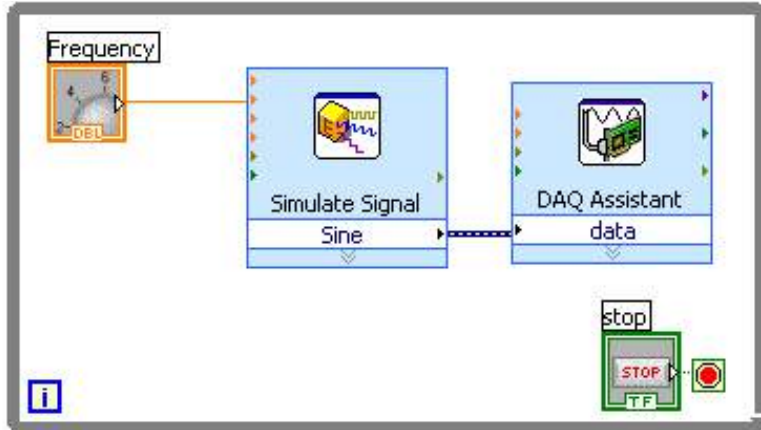
Create an application that:

- Reads temperature from Thermocouple/RTD
- Turn on/off digital lines



Parallel Operations with LabVIEW

LabVIEW



C

```

/* Copyright (c) 1993, 1994 Ron Winecott
/* This program may be used, copied, modified, and redistributed freely
/* for ANY purpose, so long as this notice remains intact.
*/

#define _REENTRANT

#include <stdio.h>
#include #define FR_RECUR 0x00200
#include #define FU_UNSORT 0x00400
#include #define FK_STDIR 0x00800
#include #define TG_BATCH 0x01000
#include #define TG_FILEPAT 0x02000
#include #define FC_REEXP 0x04000
#include #define FS_STATS 0x80000
#include #define FR_RECUR 0x00200
#include #define FU_UNSORT 0x00400
#include #define FK_STDIR 0x00800
#include #define TG_BATCH 0x01000
#include #define TG_FILEPAT 0x02000
#include #define FC_REEXP 0x04000
#include #define FS_STATS 0x80000
#include #define FR_RECUR 0x00200
#include #define FU_UNSORT 0x00400
#include #define FK_STDIR 0x00800
#include #define TG_BATCH 0x01000
#include #define TG_FILEPAT 0x02000
#include #define FC_REEXP 0x04000
#include #define FS_STATS 0x80000

typedef struct
{
    int running = 0;
} out_t;

#define BM_PATT
#define BAPPAAT #define A pthread_mutex_t stat_lk;
#define extern BH pthread_mutex_t st_start = 0;
#define extern CH int st_dir_search = 0;
#define extern VO int st_file_search = 0;
#define extern VO int st_line_search = 0;
#define extern VO int st_cascade = 0;
#define extern VO int st_cascade_pool = 0;
#define extern VO int st_cascade_destroy = 0;
#define extern VO int st_search = 0;
#define extern VO int st_pool = 0;
#define extern VO int st_axrun = 0;
#define extern VO int st_worknull = 0;
#define extern VO int st_workids = 0;
#define extern VO int st_worklimit = 0;
#define extern VO int st_destroy = 0;

while (iRetVal != NIDAQVScaleUICount, piBuffer,
iRetVal = NIDAQErrorIgnorewarning);
iRetVal = DAQClear(iDevice);
iRetVal = NIDAQPlotWaveform(pdvolBuffer, ulCount, WFM_DATA_F64);
printf(" The data is available in 'pdvolBuffer'.\n");
}

#include "debug.h" /* must be included AFTER the
pthread_mutex_t debug_lock line */

work_t *search_q = NULL;
pthread_mutex_t search_q_lk;
pthread_cond_t search_q_cv;
int search_pool_cnt = 0; /* the count in the pool now */
int search_thr_limit = 0; /* the max in the pool */

work_t *cascade_q = NULL;
pthread_mutex_t cascade_q_lk;
pthread_cond_t cascade_q_cv;
int cascade_pool_cnt = 0;
int cascade_thr_limit = 0;

running = 0;
pthread_mutex_t running_lk;

pthread_mutex_t stat_lk;
time_t st_start = 0;
int st_dir_search = 0;
int st_file_search = 0;
int st_line_search = 0;
int st_cascade = 0;
int st_cascade_pool = 0;
int st_cascade_destroy = 0;
int st_search = 0;
int st_pool = 0;
int st_axrun = 0;
int st_worknull = 0;
int st_workids = 0;
int st_worklimit = 0;
int st_destroy = 0;

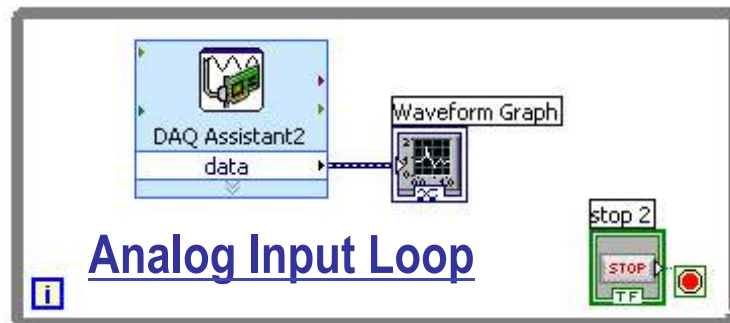
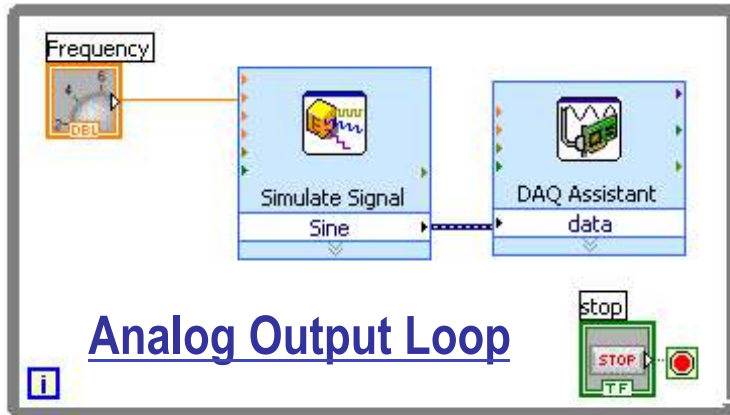
all_done = 0;
work_cnt = 0;
current_open_files = 0;
tglimit = UNLIMITED; /* if -B limit the number of
threads */
progress_offset = 1;
progress = 0; /* protected by the print_lock */
flags = 0;
regexp_cnt = 0;

```

(does not include code to generate UI)

Parallel Operations in LabVIEW

Configuring and visualizing multiple tasks graphically is easier



Parallel loops automatically take advantage of multithreading and multi-core processors for higher performance

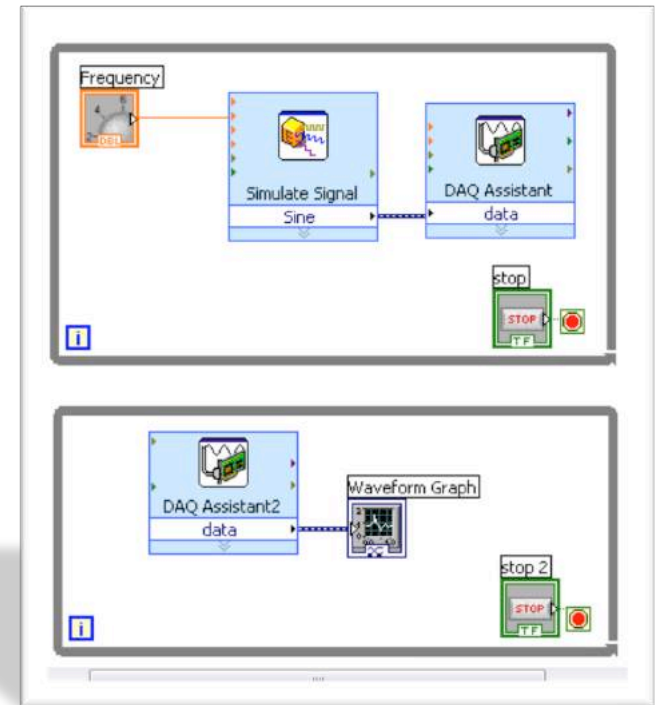
Exercise 4: Multiple operations on analog input channels

What will we learn

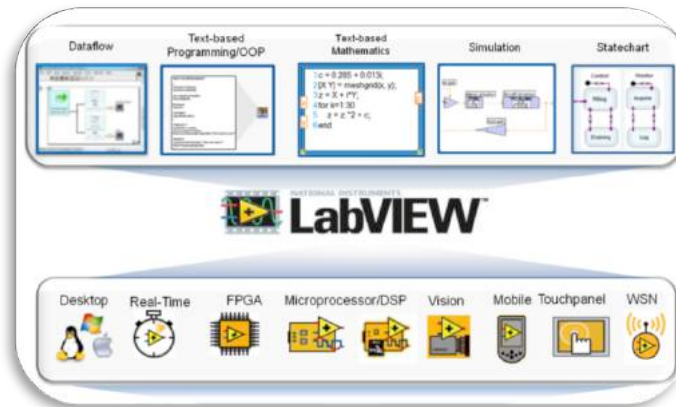
- Create parallel operations with LabVIEW

Create an application based on multiple tasks

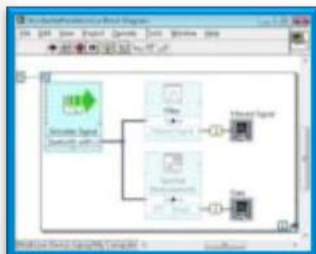
- Acquire Temperature Measurements
- Acquire Acceleration Measurements



Modules and Toolkits in LabVIEW



Dataflow



Text-based Programming/OOP



Text-based Mathematics

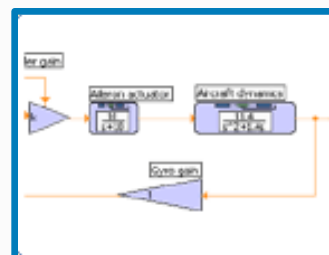
```

1 c = 0.285 + 0.013i;
2 [X Y] = meshgrid(x, y);
3 Z = X + i*Y;
4 for k = 1:3
5     Z = Z.*2 + c;
6 end

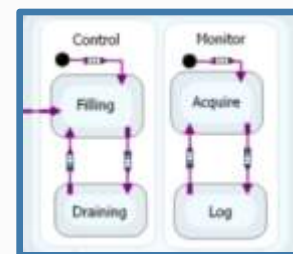
```

Toolkit

Simulation



Statechart



NATIONAL INSTRUMENTS

LabVIEW™

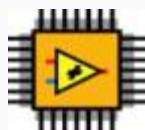
Desktop



Real-Time



FPGA



Microprocessor/DSP



Modules

Vision



Mobile Touchpanel



WSN



Hardware

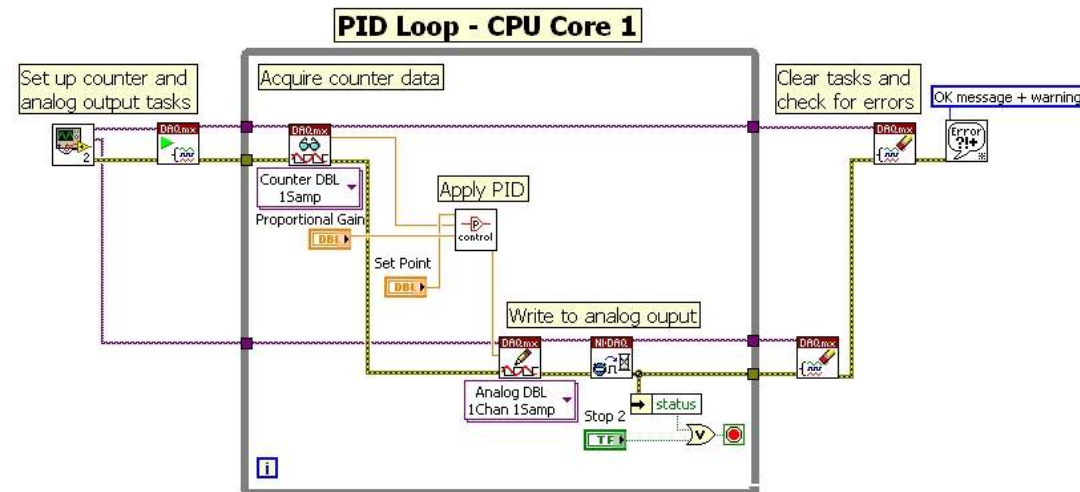
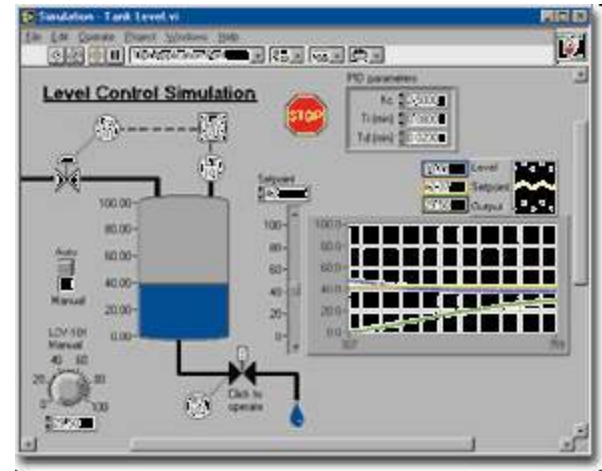
PID & Fuzzy Logic Toolkit

PID Control

- Autotuning
- Gain scheduling

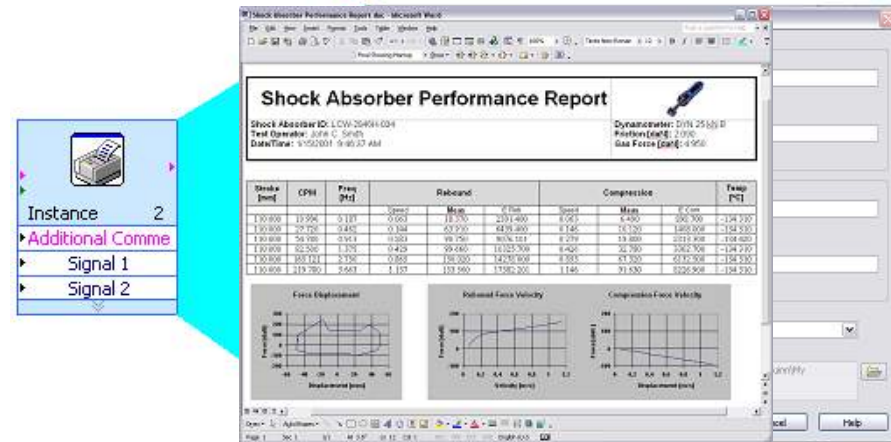
Fuzzy Logic

- Control strategies
- Decision making



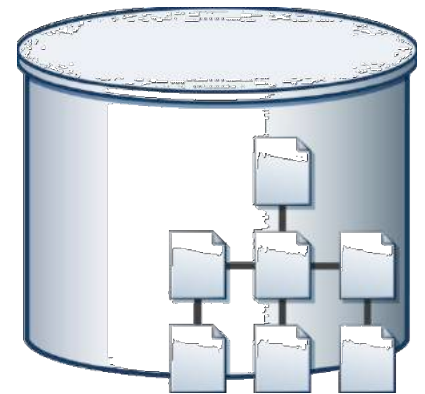
Report Generation Toolkit for Microsoft Office

- Programmatically create and edit reports in Microsoft Word and Excel
- Populate report templates
- Manage report layout, format, and appearance
- E-mail reports and run macros
- Express VI included



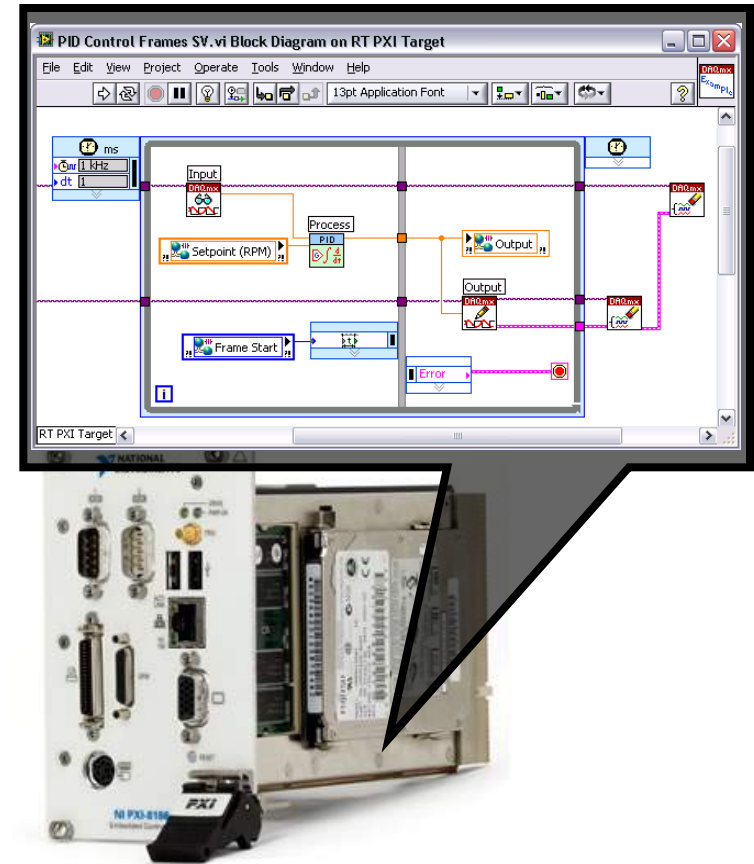
Database Connectivity Toolkit

- Insert, select data from OLE DB, ODBC databases
 - Microsoft Access, SQL Server, Oracle, etc.
- Create, drop tables
- Save records in XML format
- Execute SQL queries
 - Immediate, parameterized
- Execute stored procedures
- Accept, reject multiple operations (transactions)



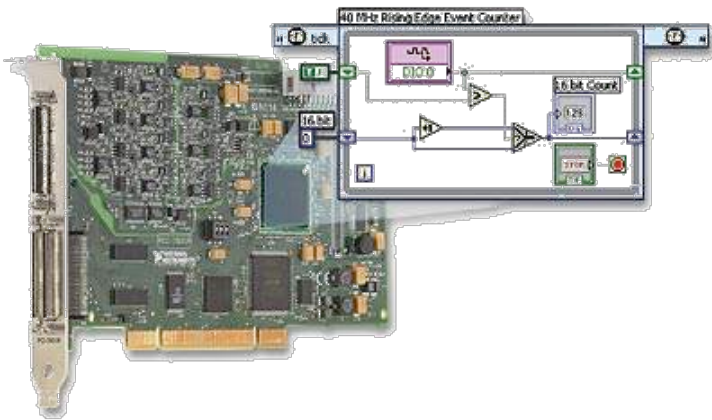
LabVIEW Real-Time Module

- Rapidly develop deterministic applications with graphical programming
- Easily architect distributed control and monitoring systems
- Eliminate time spent integrating diverse I/O



LabVIEW FPGA Module

- Define custom FPGA I/O without VHDL programming
- Achieve hardware deterministic response within 25ns
- Execute tasks with true parallelism

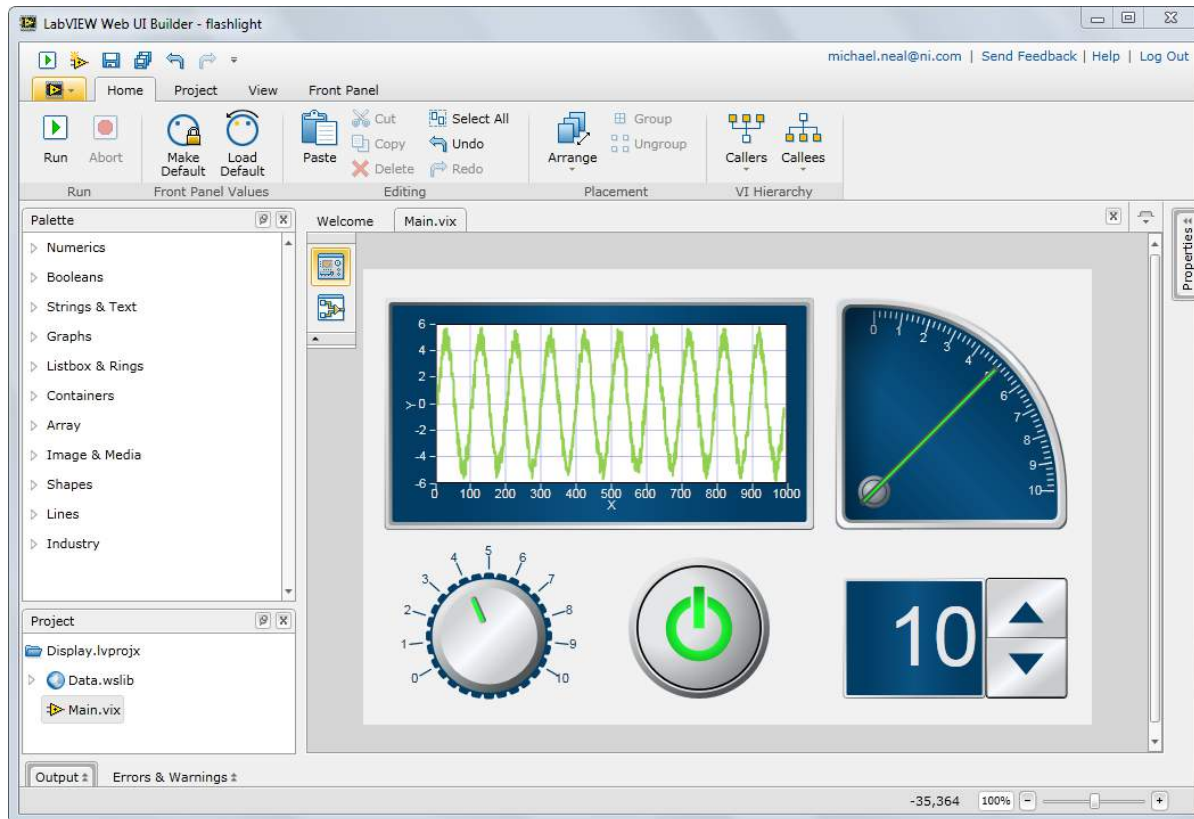


R Series Intelligent DAQ



NI CompactRIO

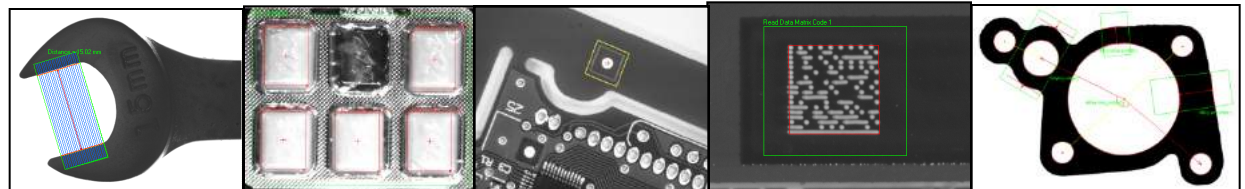
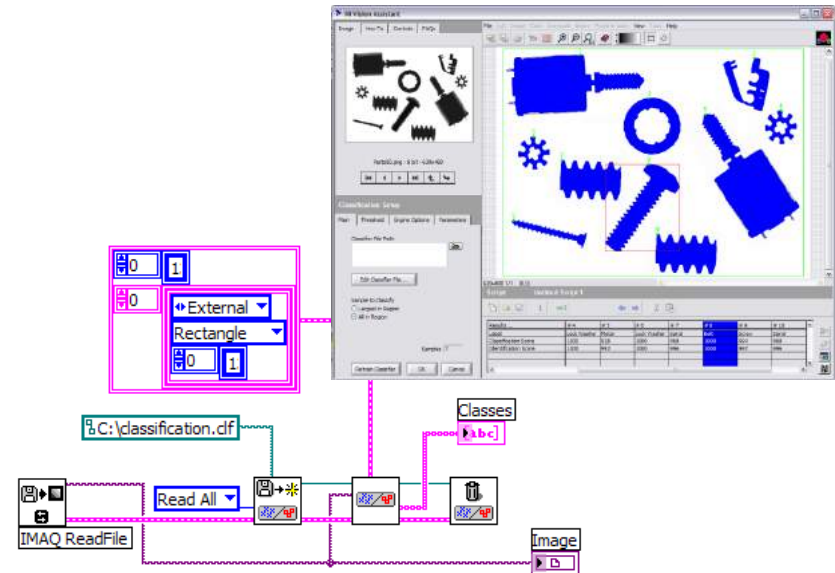
LabVIEW Web UI Builder



- Build LabVIEW-based web thin clients
- Monitor or control from your smartphone

NI Vision Development Module

- LabVIEW programming libraries for machine vision and image processing
- Includes Vision Assistant
 - Prototypes and benchmarks applications
 - Generates complete code for LabVIEW, Visual Basic, and C
- Hundreds of tools to:
 - Enhance images
 - Check for presence
 - Locate features
 - Identify parts
 - Measure objects



Motion Control with LabVIEW

- **NI Motion Assistant**

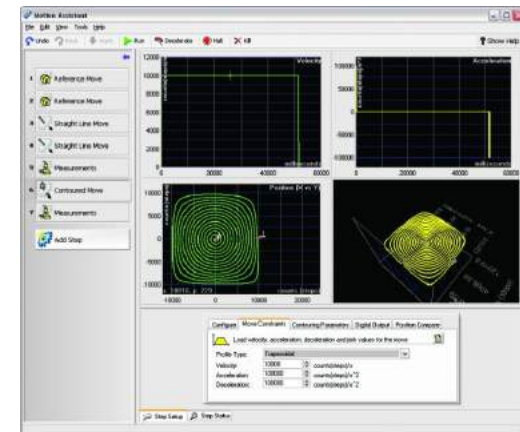
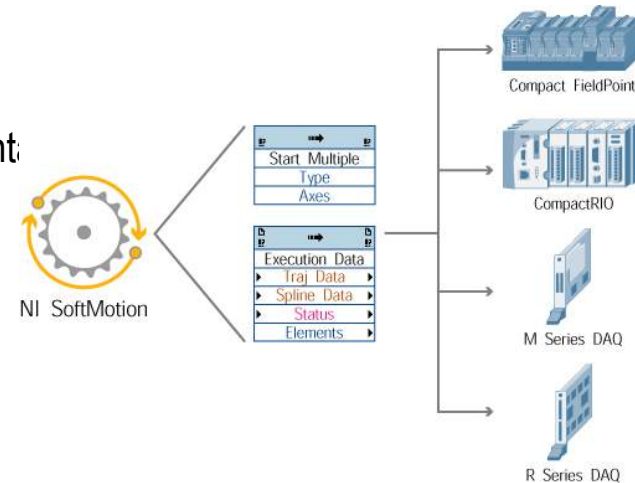
- Interactive environment with 3D visualization
- Ready-to-run LabVIEW or C code creation
- Easy trapezoidal or S-curve velocity profile implementation
- Teach pendant for easy prototyping

- **NI SoftMotion Controller for CANopen and IEEE 1394**

- Use LabVIEW and NI Motion Assistant to program distributed motion control applications
- Compatible with intelligent CANopen drives from Copley and IEEE 1394 drives from ORMEC

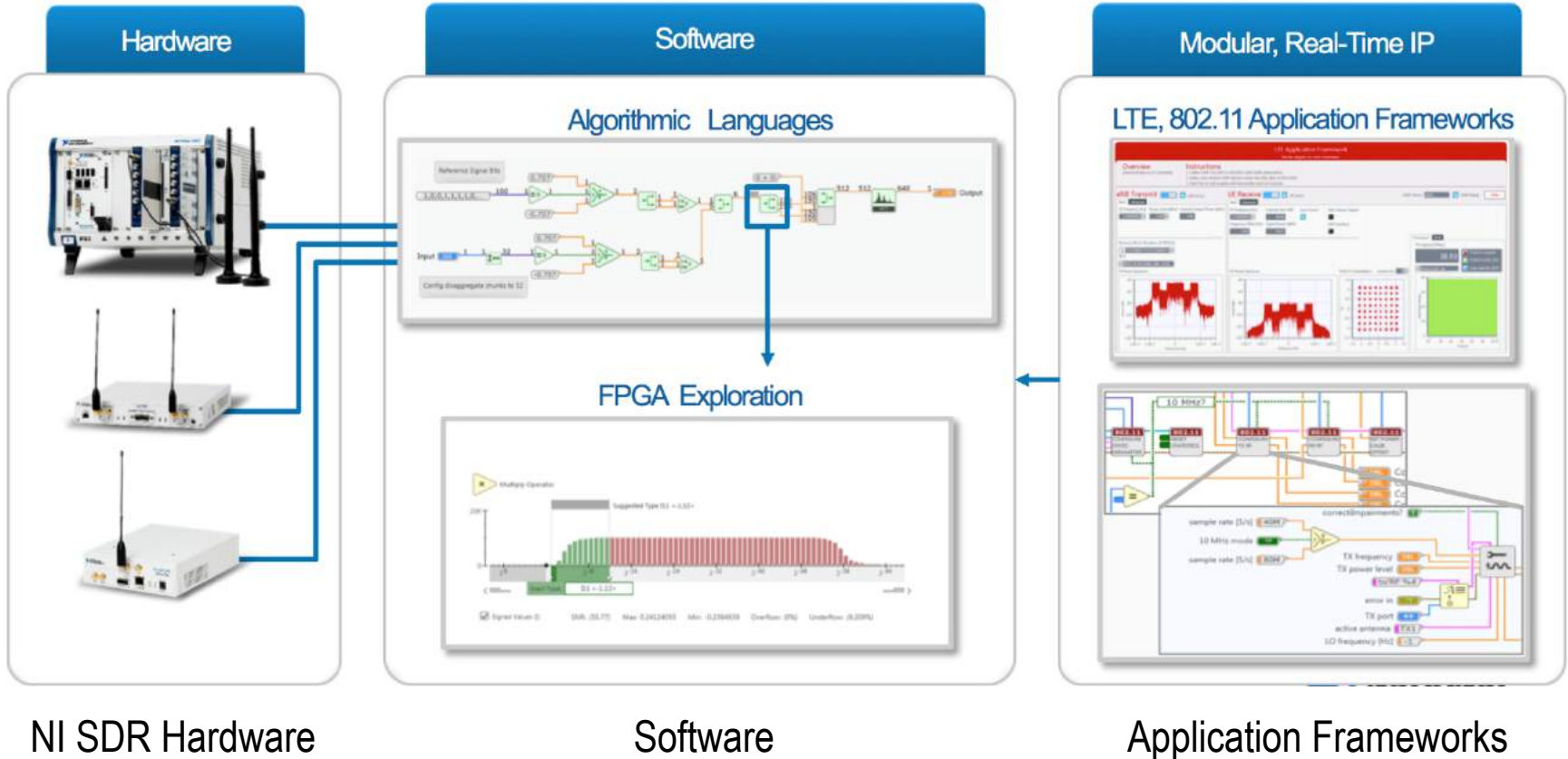
- **NI SoftMotion Development Module**

- Develop custom motion controllers in LabVIEW Real-Time or LabVIEW FPGA
- Use trajectory generation, spline interpolation, position, velocity control, and encoder implementation VIs



LabVIEW Communications System Suite

The Revolution in Rapid Prototyping



NI SDR Hardware

Software

Application Frameworks

Resources



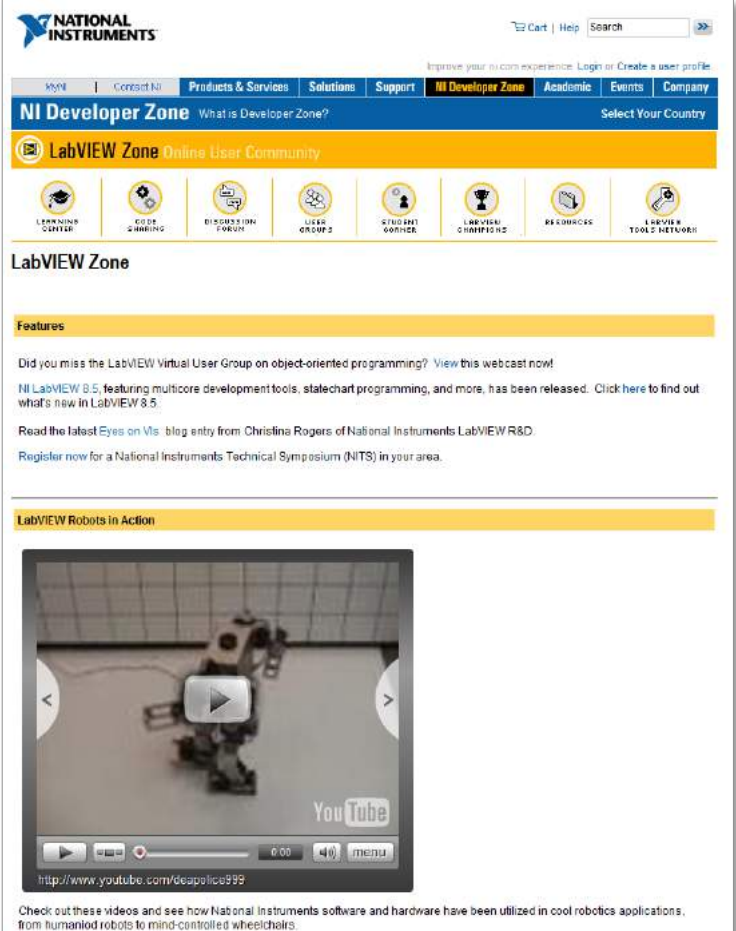
NI LabVIEW – Useful Links

What is LabVIEW: www.ni.com/labview

Download LabVIEW: <http://www.ni.com/labviewse/>

Worldwide LabVIEW User Community

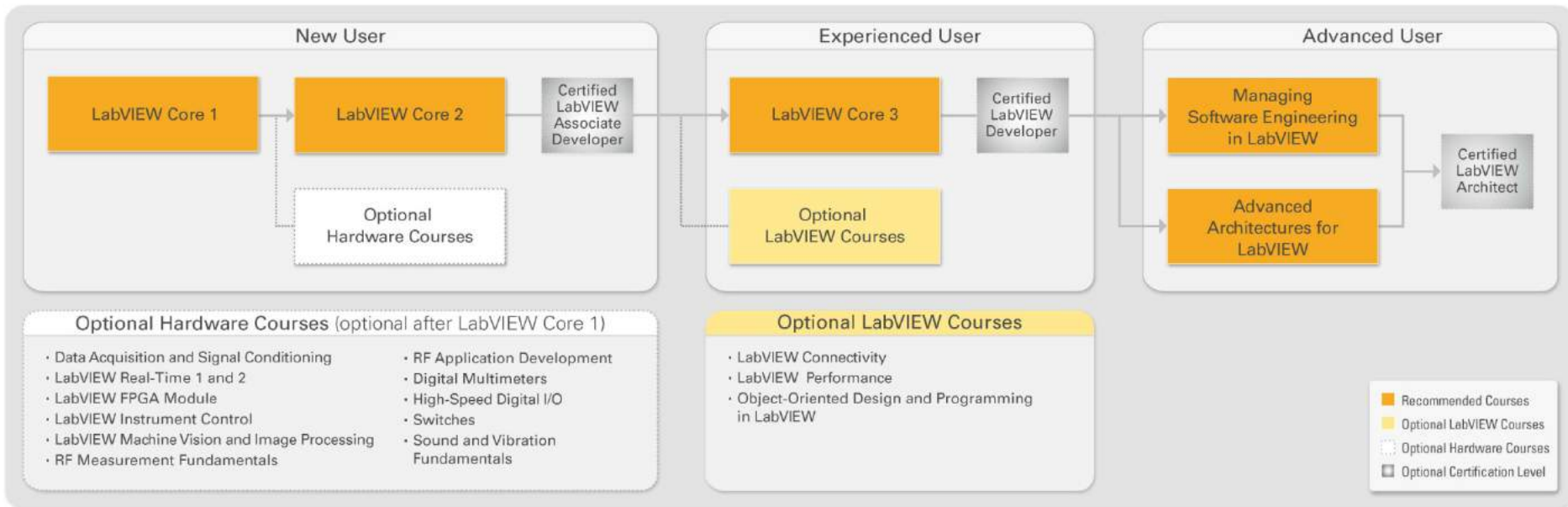
- Over 50,000 members on award-winning NI Discussion Forums
- NI and LabVIEW user-contributed blogs
- More than 100 LabVIEW User Groups
- Third-party community web sites in over 15 languages
- Hundreds of third-party add-on tools on the LabVIEW Tools Network



The screenshot displays the NI Developer Zone website. At the top, the National Instruments logo is visible on the left, and a search bar is on the right. Below the logo, there are navigation tabs for 'MY NI', 'Contact NI', 'Products & Services', 'Solutions', 'Support', 'NI Developer Zone', 'Academic', 'Events', and 'Company'. The 'NI Developer Zone' tab is selected, and a sub-tab 'LabVIEW Zone Online User Community' is highlighted. Below this, there are several icons representing different community features: Learning Center, Code Sharing, Discussion Forum, User Groups, Student Partner, LabVIEW Champions, Feedback, and LabVIEW Tools Network. The main content area is titled 'LabVIEW Zone' and includes a 'Features' section with text about the LabVIEW Virtual User Group, LabVIEW 8.5, and a technical symposium. A video player is embedded in the 'LabVIEW Robots in Action' section, showing a robot in a wheelchair-like configuration. The video player has a play button and a URL: <http://www.youtube.com/decapico999>. Below the video, there is a caption: 'Check out these videos and see how National Instruments software and hardware have been utilized in cool robotics applications, from humanoid robots to mind-controlled wheelchairs.'

ni.com/labview/community

Training



Objectives:

- Accelerate learning
- Decrease development time and application maintenance
- Reliable, escalable and maintainable applications
- Validate skills and standarize developement procedure

Thank you for your attention!

Questions?