

Agenda

- Introductions
- LabVIEW Overview
- Common tools in LabVIEW (Theory)
- LabVIEW exercises
- FIRST specific code
- Robot demonstrations

National Instruments Everywhere

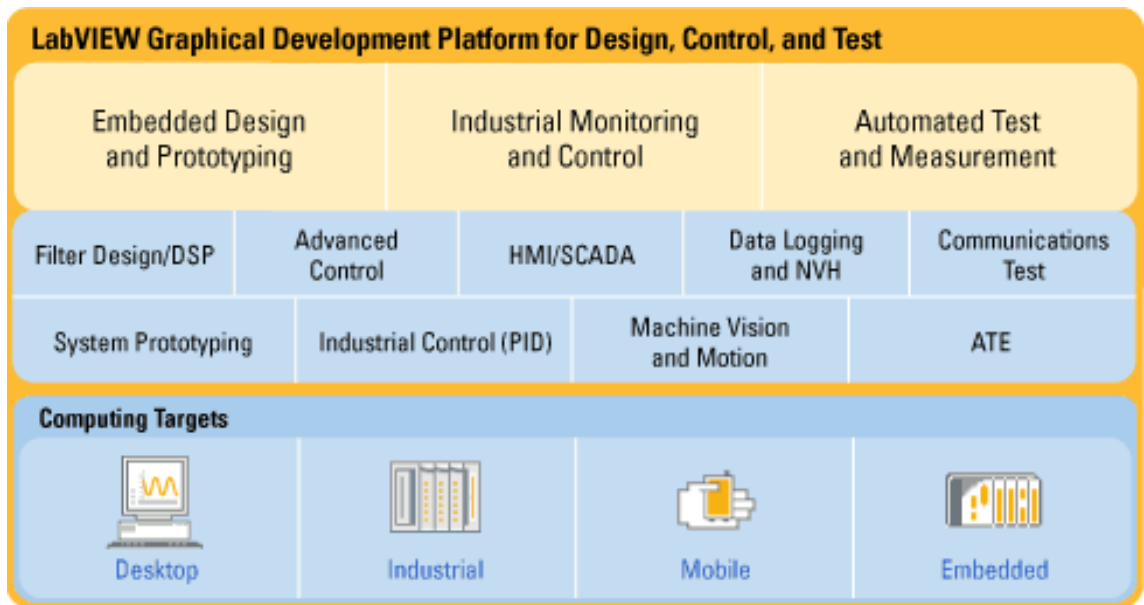
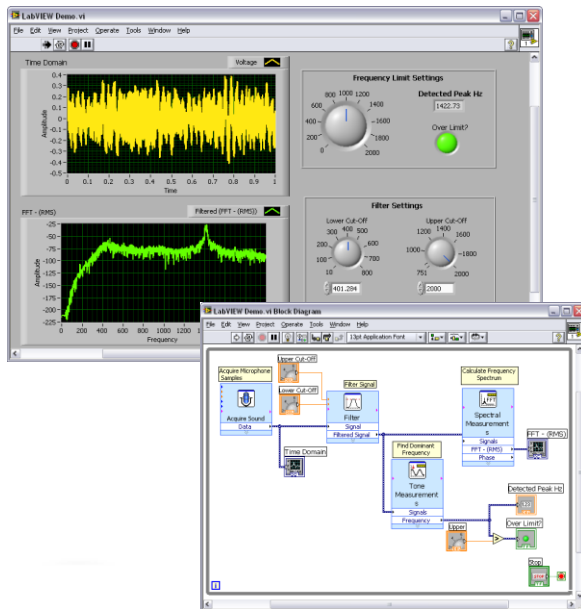
More than 30,000 companies, including 90% of Fortune 500 manufacturing companies use virtual instrumentation



Intro to LabVIEW Environment

LabVIEW Graphical Development System

- Graphical programming environment
- Compiles code for multiple OS and devices
- Useful in a broad range of applications



Open and Run LabVIEW

Start»All Programs»National Instruments LabVIEW 8.6



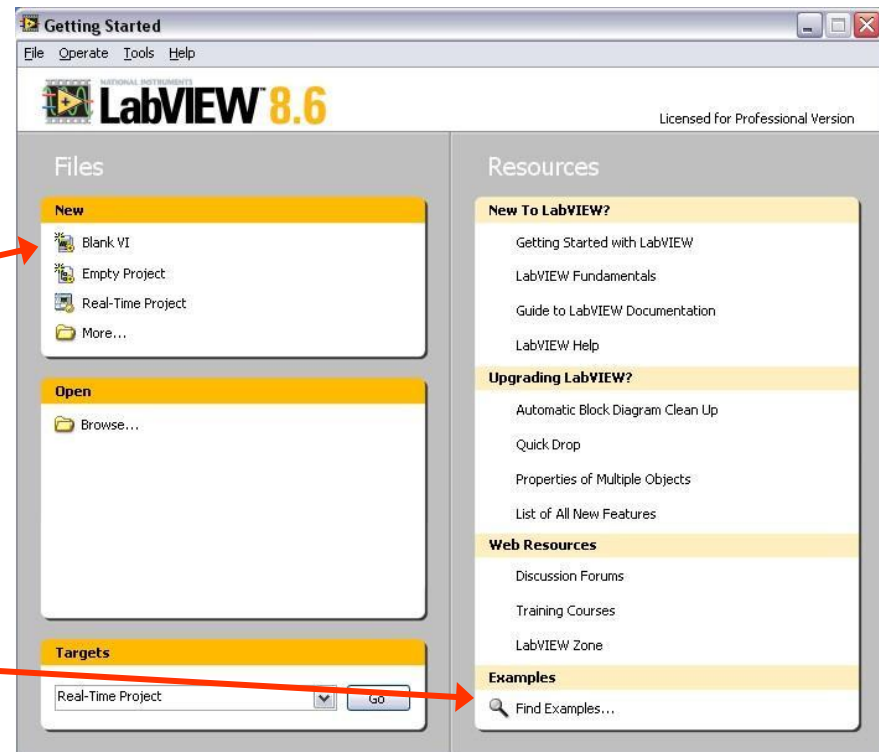
National Instruments LabVIEW 8.6

Startup Screen:

Start from a blank VI:
New»Blank VI

or

Start from an example:
Examples»Find
Examples...

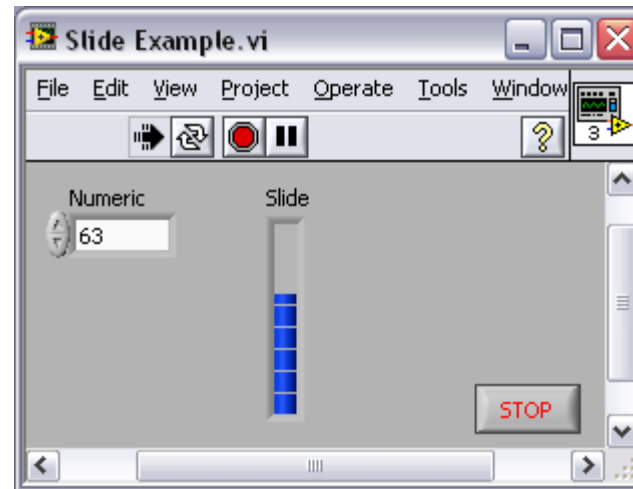


LabVIEW Programs Are Called Virtual Instruments (VIs)

Each VI has 2 windows

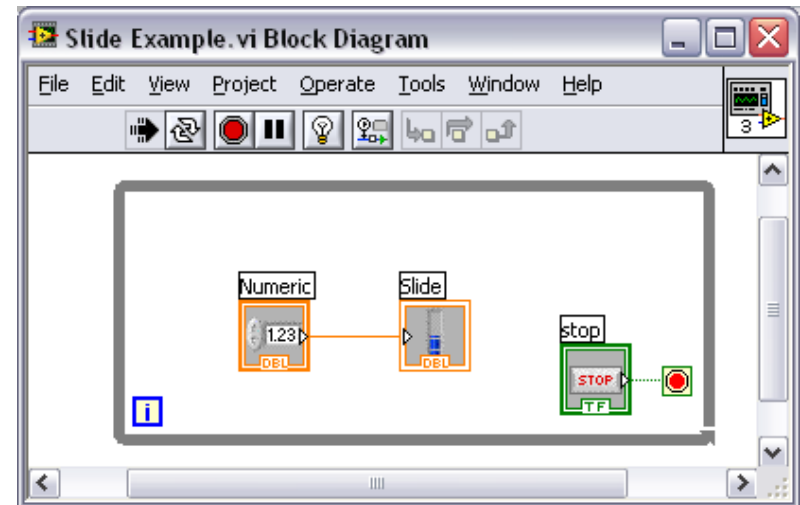
Front Panel

- User interface (UI)
 - Controls = inputs
 - Indicators = outputs



Block Diagram

- Graphical code
 - Data travels on wires from controls through functions to indicators
 - Blocks execute by data flow

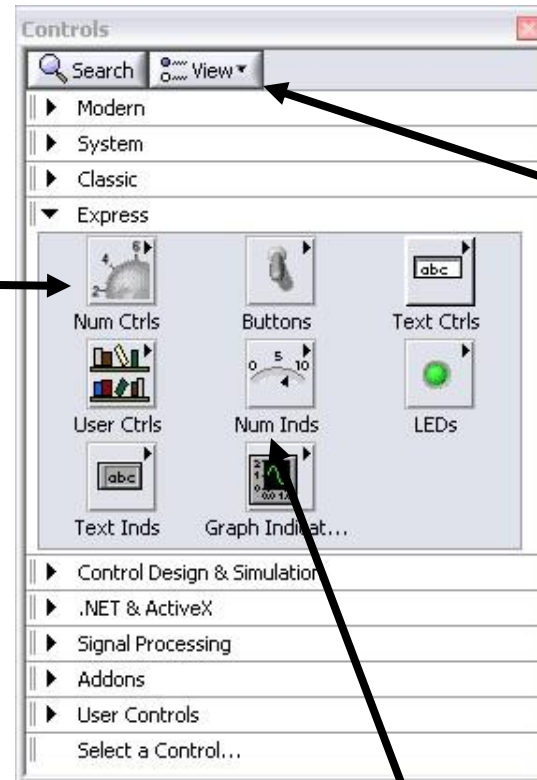
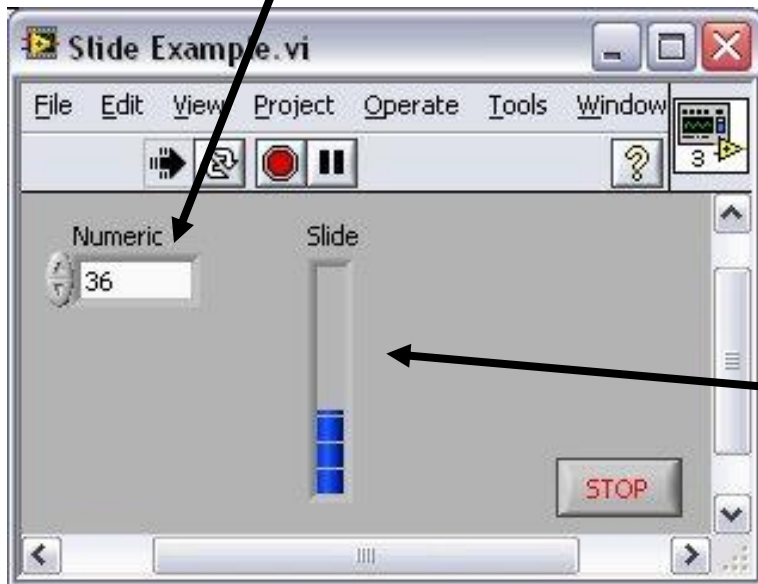


Controls Palette

(Place items on the front panel window)

**Control:
Numeric**

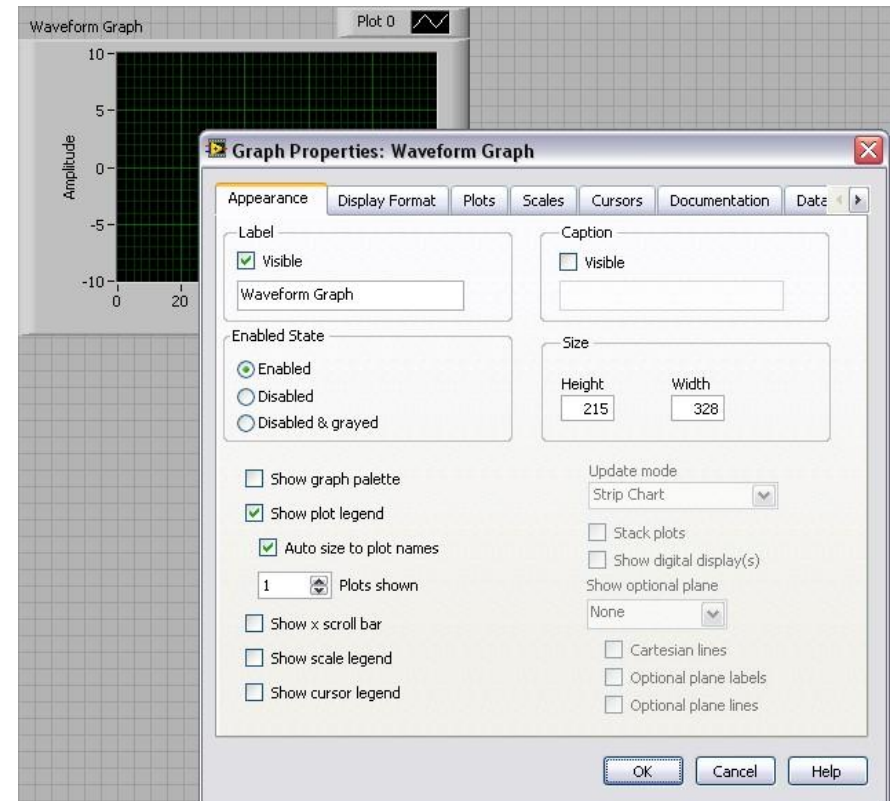
**Customize
Palette
View**



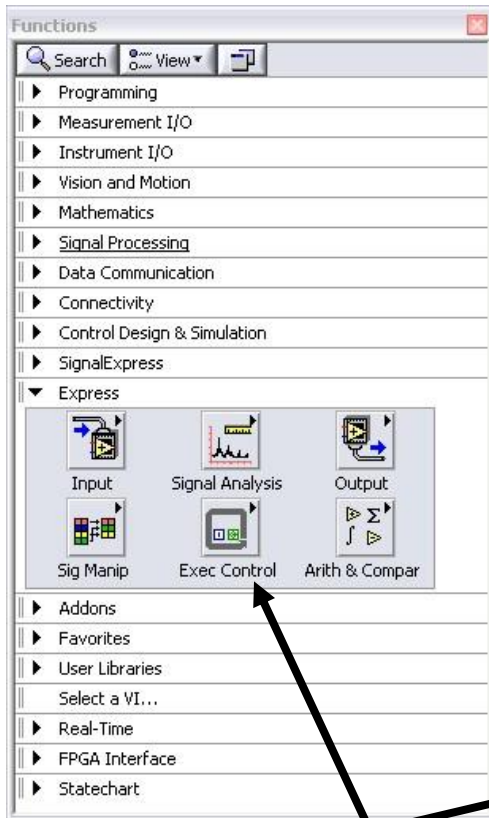
**Indicator:
Numeric Slide**

Control and Indicator Properties

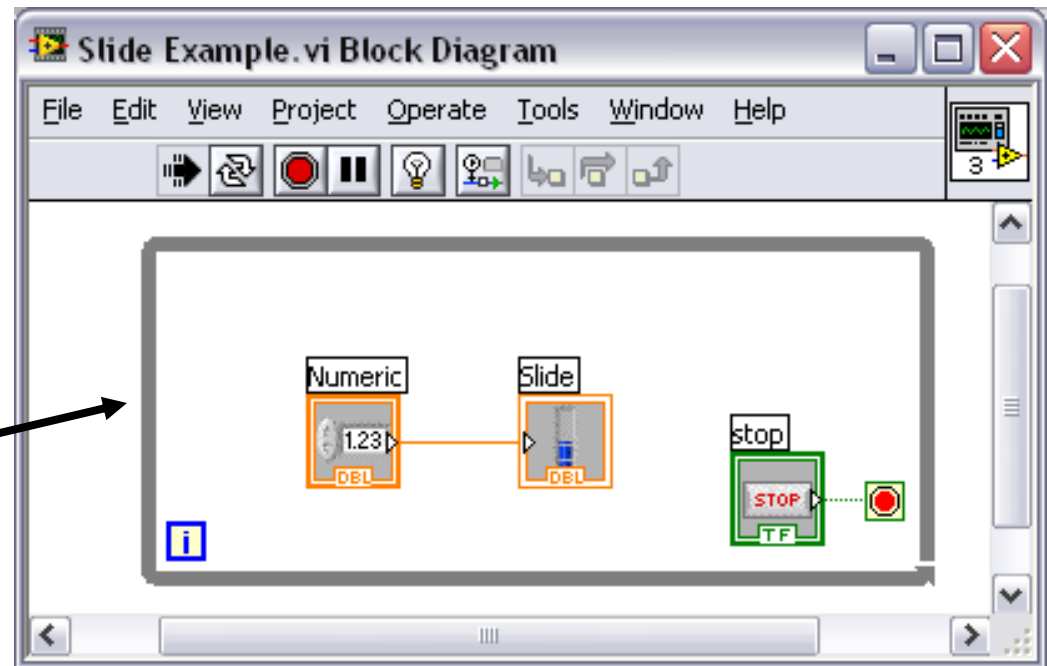
- Properties are characteristics or qualities about an object
- Properties can be found by right-clicking on a control or indicator
- Properties include:
 - Size
 - Color
 - Plot style
 - Plot color
- Features include:
 - Cursors
 - Scaling



Functions (and Structures) Palette



(Place items on the
block diagram window)

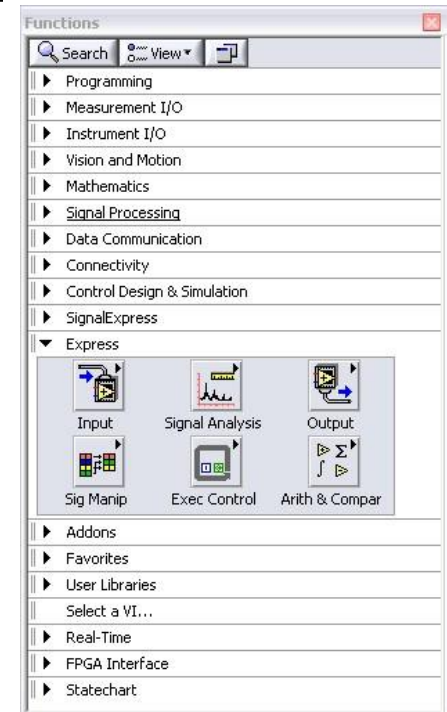


**Structure:
While Loop**

What Types of Functions Are Available?

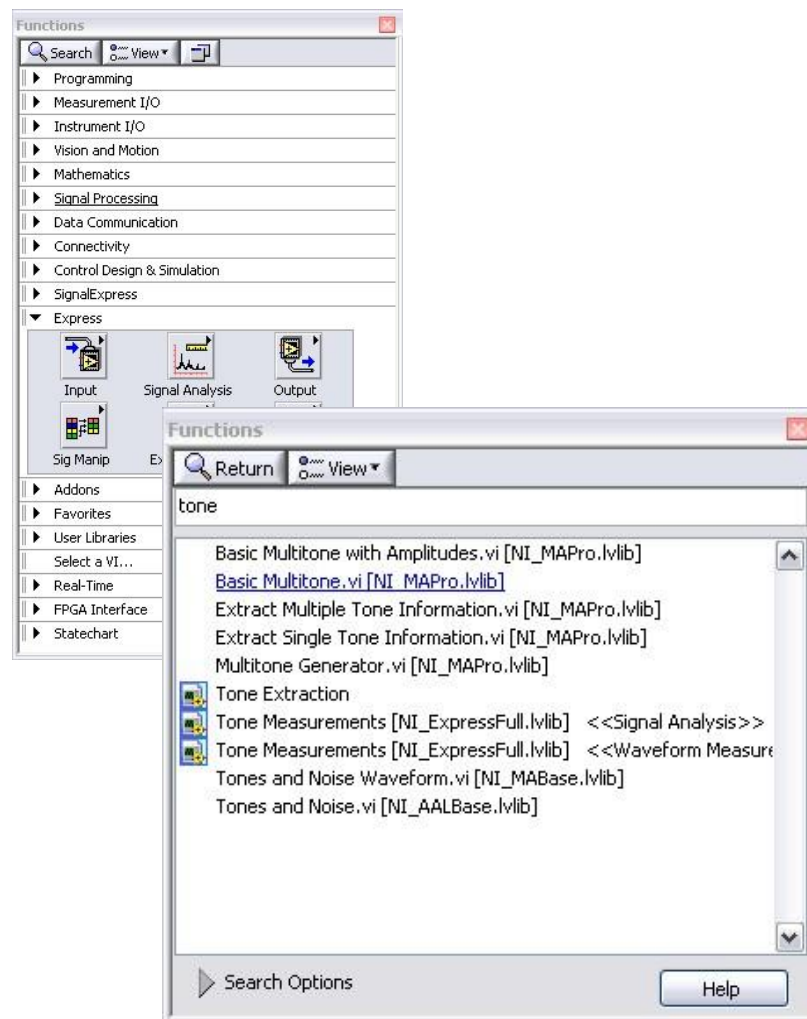
- **Input and Output**
 - Signal and data simulation
 - Real signal acquisition and generation with DAQ
 - Instrument I/O Assistant (Serial and GPIB)
 - ActiveX for communication with other programs
- **Analysis**
 - Signal processing
 - Statistics
 - Advanced math and formulas
 - Continuous time solver
- **Storage**
 - File I/O

Express Functions Palette








Searching for Controls, VIs, and Functions

- Palettes are filled with hundreds of VIs
- Press the search button to index all VIs for text searching
- Click and drag an item from the search window to the block diagram
- Double-click an item to open the owning palette









Status Toolbar

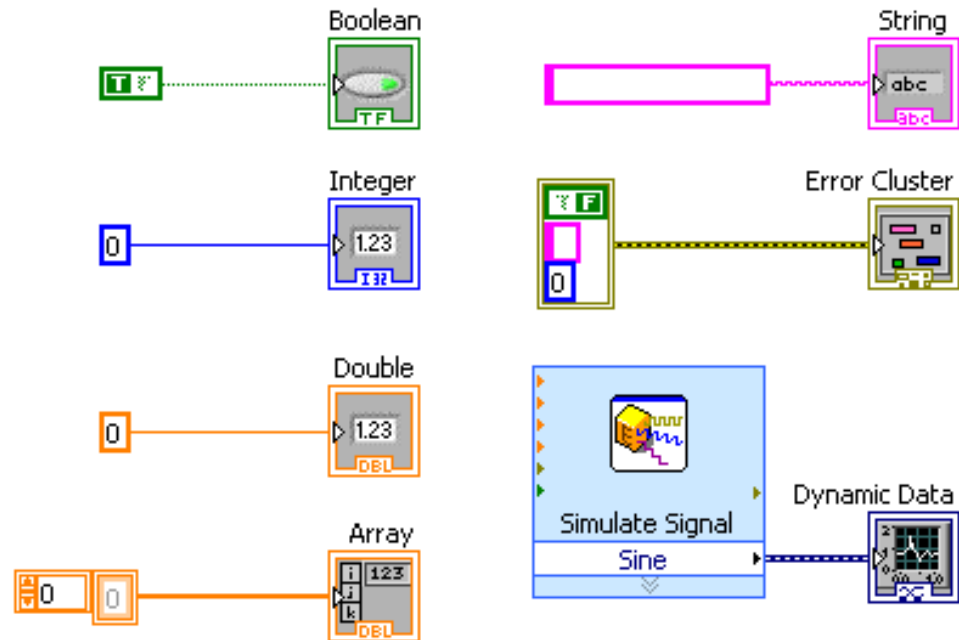


		Run Button
		Continuous Run Button
		Abort Execution

Additional Buttons on the Diagram Toolbar

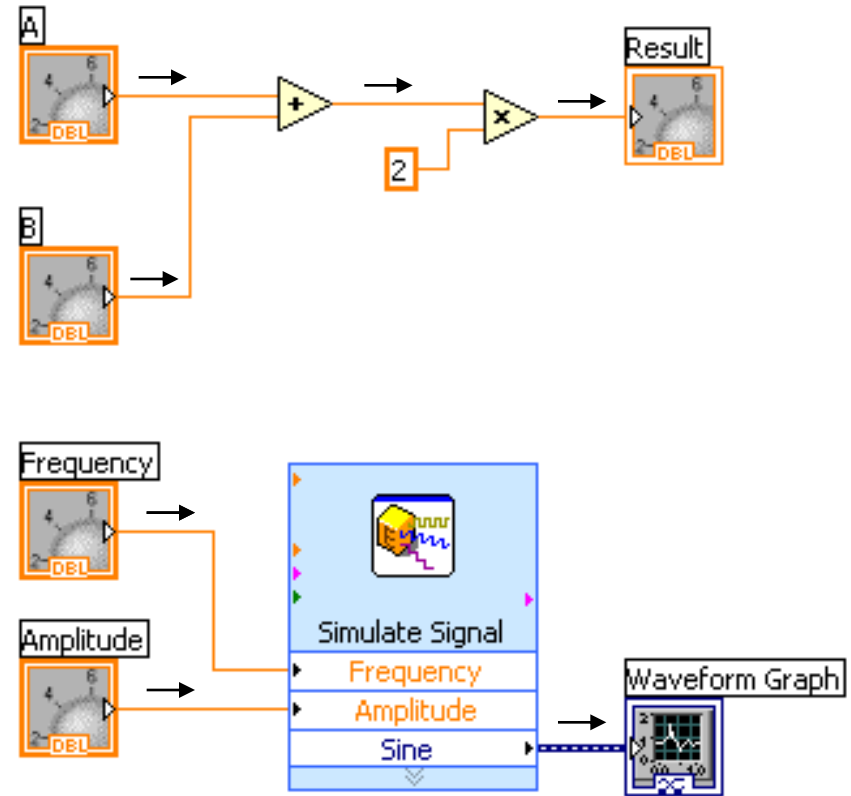
		Execution Highlighting Button	
		Retain Wire Values Button	
			Step Function Buttons

Common Data Types Found in LabVIEW



Dataflow Programming

- Block diagram execution
 - Dependent on the flow of data
 - Block diagram does NOT execute left to right
- Node executes when data is available to ALL input terminals
- Nodes supply data to all output terminals when done



Debugging Techniques

- **Finding Errors**



Click on broken **Run** button.
Window showing error appears.

- **Execution Highlighting**



Click on **Execution Highlighting** button; data flow is animated using bubbles. Values are displayed on wires.

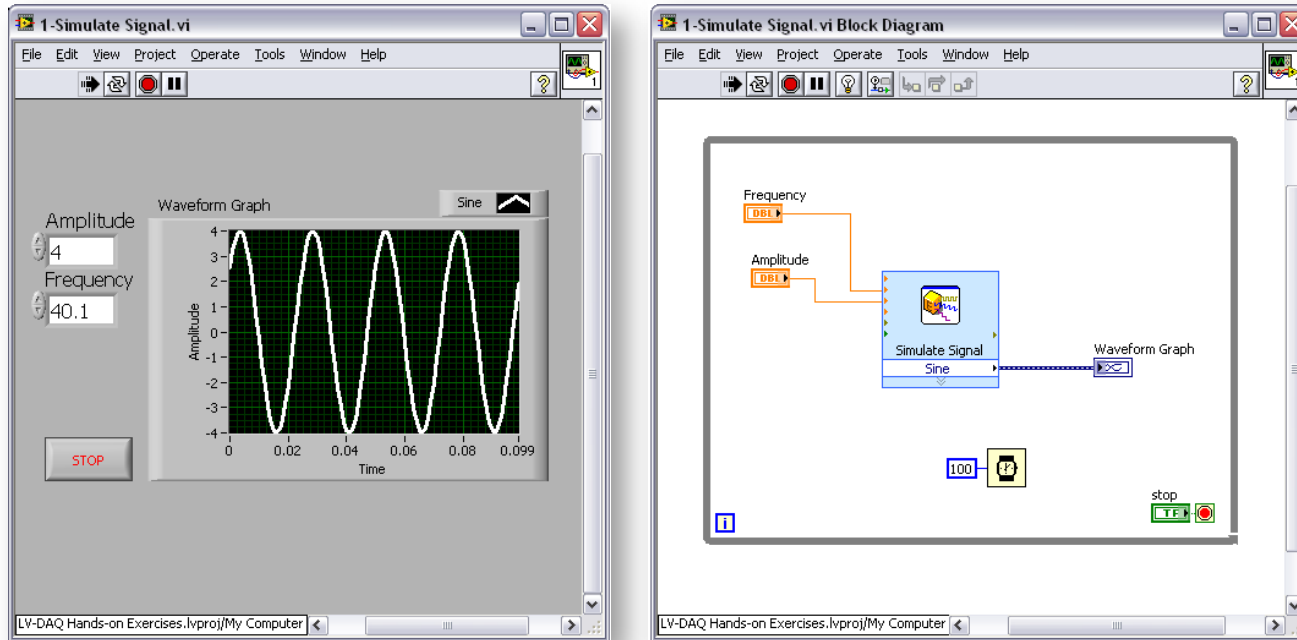
- **Probes**



Right-click on wire to display probe; it shows data as it flows through wire segment.

You can also select Probe tool from Tools palette and click on wire.

Demo: Simulate Signal to Graph



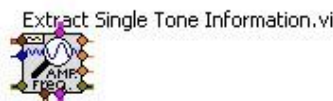
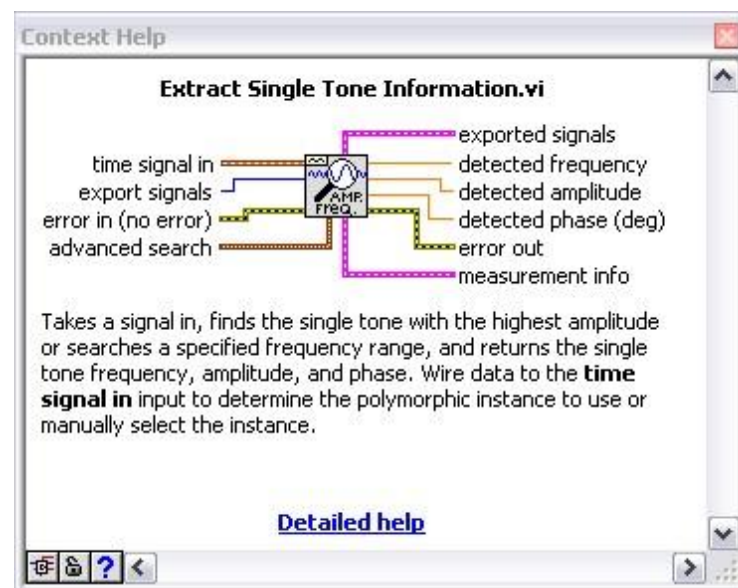
- Simulate various signals
 - Write to Graph

Context Help Window

- **Help»Show Context Help**, press the <Ctrl-H> keys
- Hover cursor over object to update window

Additional Help

- Right-click on the VI icon and choose **Help**, or
- Choose “**Detailed help**” on the context help window




Tips for Working in LabVIEW

- Keystroke Shortcuts
 - <Ctrl-H> – Activate/Deactivate Context Help Window
 - <Ctrl-B> – Remove Broken Wires from Block Diagram
 - <Ctrl-E> – Toggle between Front Panel and Block Diagram
 - <Ctrl-Z> – Undo (also in Edit menu)
- **Tools»Options...** – Set Preferences in LabVIEW
- **File»VI Properties** – Configure VI Appearance, Documentation, and so on

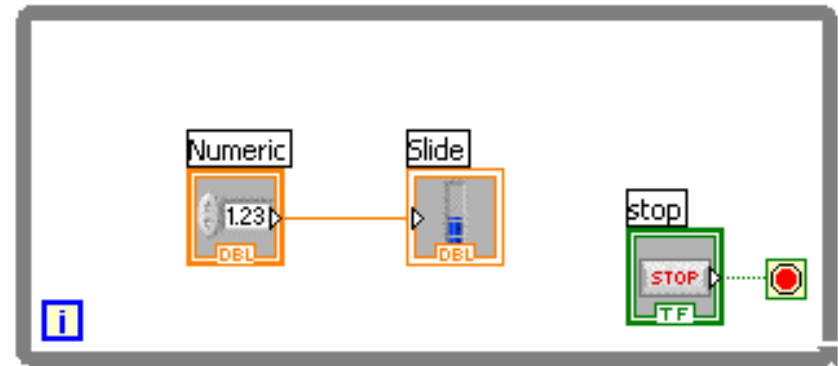
Elements of Typical Programs

Loops

- While Loop

- **i** Terminal counts iterations
- Always runs at least once
- Runs until stop condition is met 

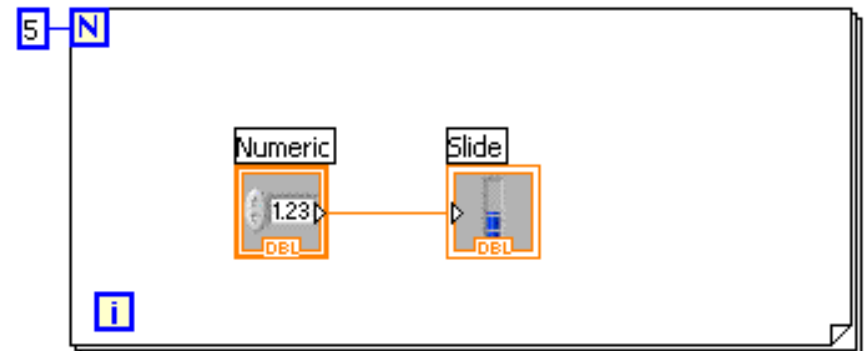
While Loop



- For Loop

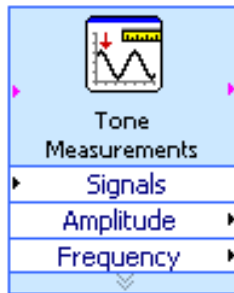
- **i** Terminal counts iterations
- Runs according to input **N** of count terminal **N**

For Loop

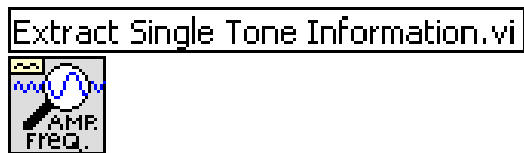


Three Types of Functions (from the Functions Palette)

Express VIs: interactive VIs with configurable dialog page (**blue border**)



Standard VIs: modularized VIs customized by wiring (**customizable**)

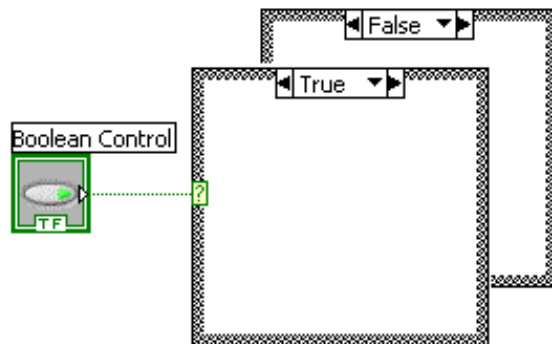


Functions: fundamental operating elements of LabVIEW; no front panel or block diagram (**yellow**)

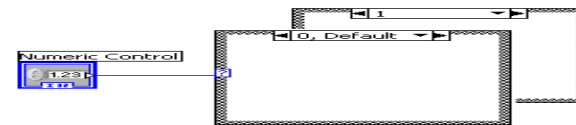


How Do I Make Decisions in LabVIEW?

1. Case Structures

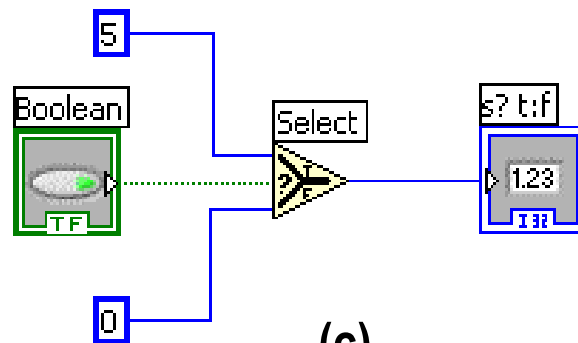


(a)



(b)

2. Select



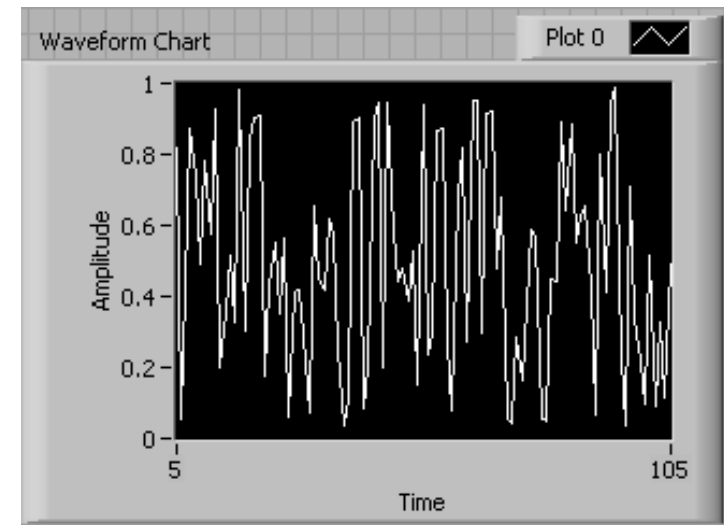
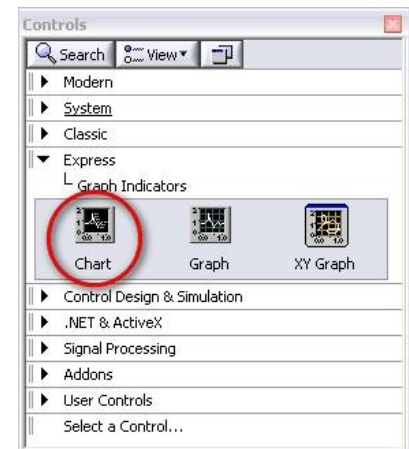
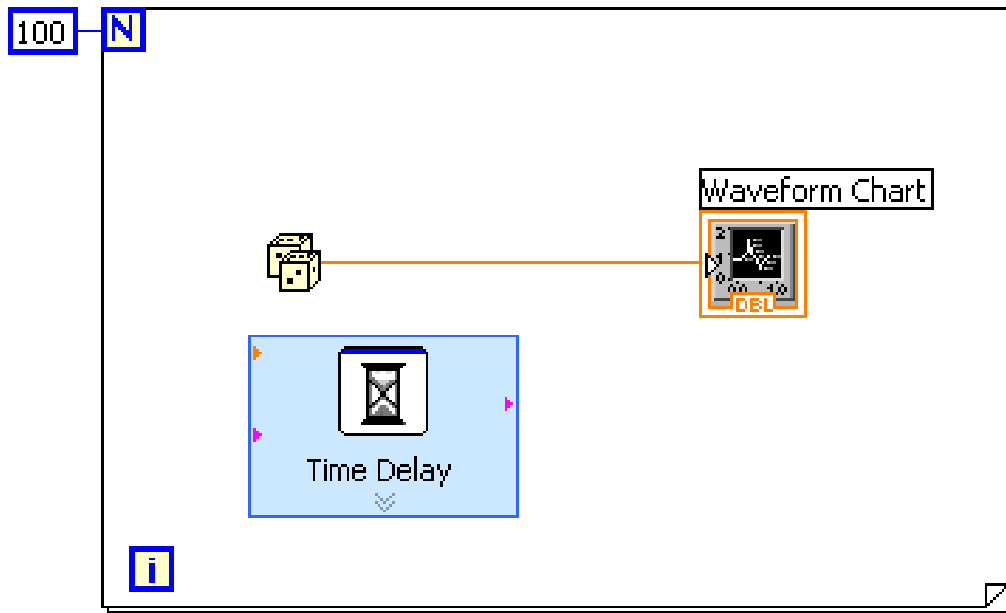
(c)

Charts – Add 1 Data Point at a Time with History

Waveform chart – special numeric indicator that can display a history of values

- Chart updates with each individual point it receives

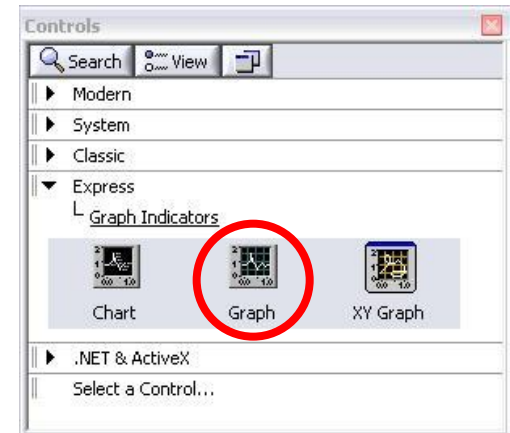
Controls»Express»Graph Indicators»Chart



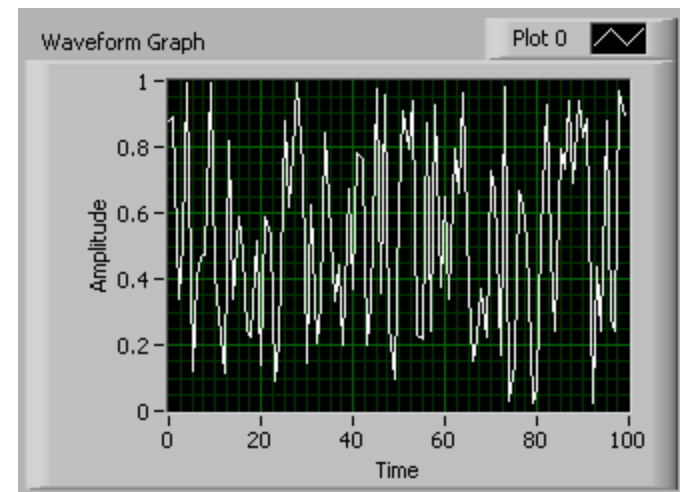
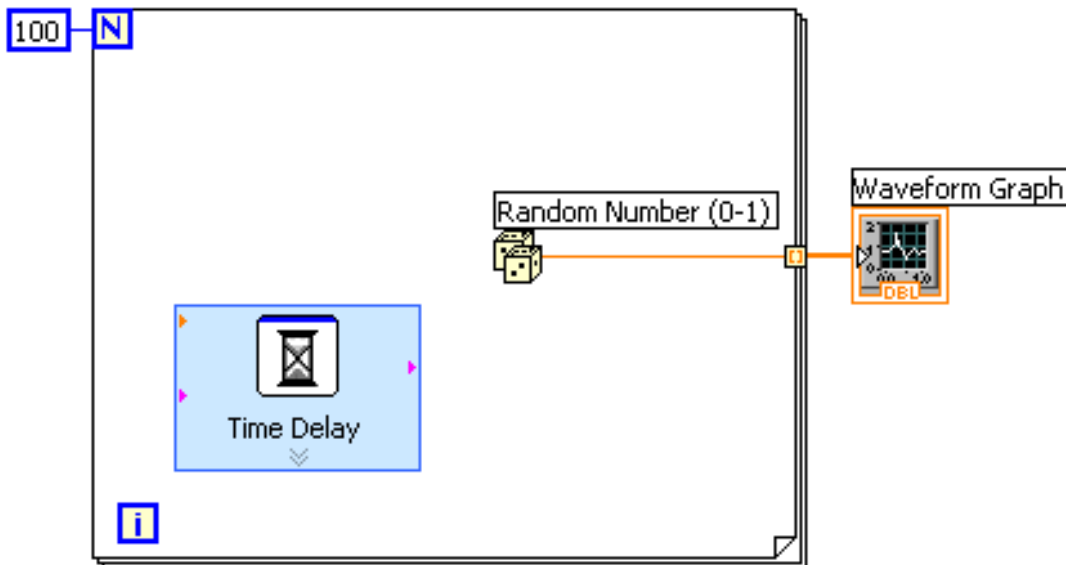
Graphs – Display Many Data Points at Once

Waveform graph – special numeric indicator that displays an array of data

- Graph updates after all points have been collected
- May be used in a loop if VI collects buffers of data

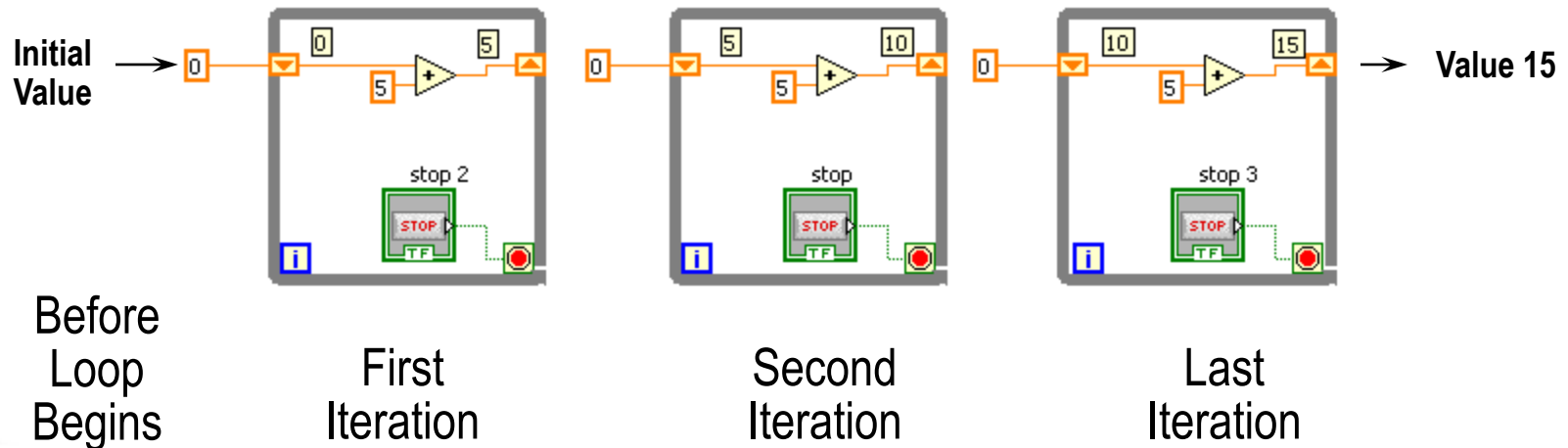


Controls»Express»Graph Indicators»Graph



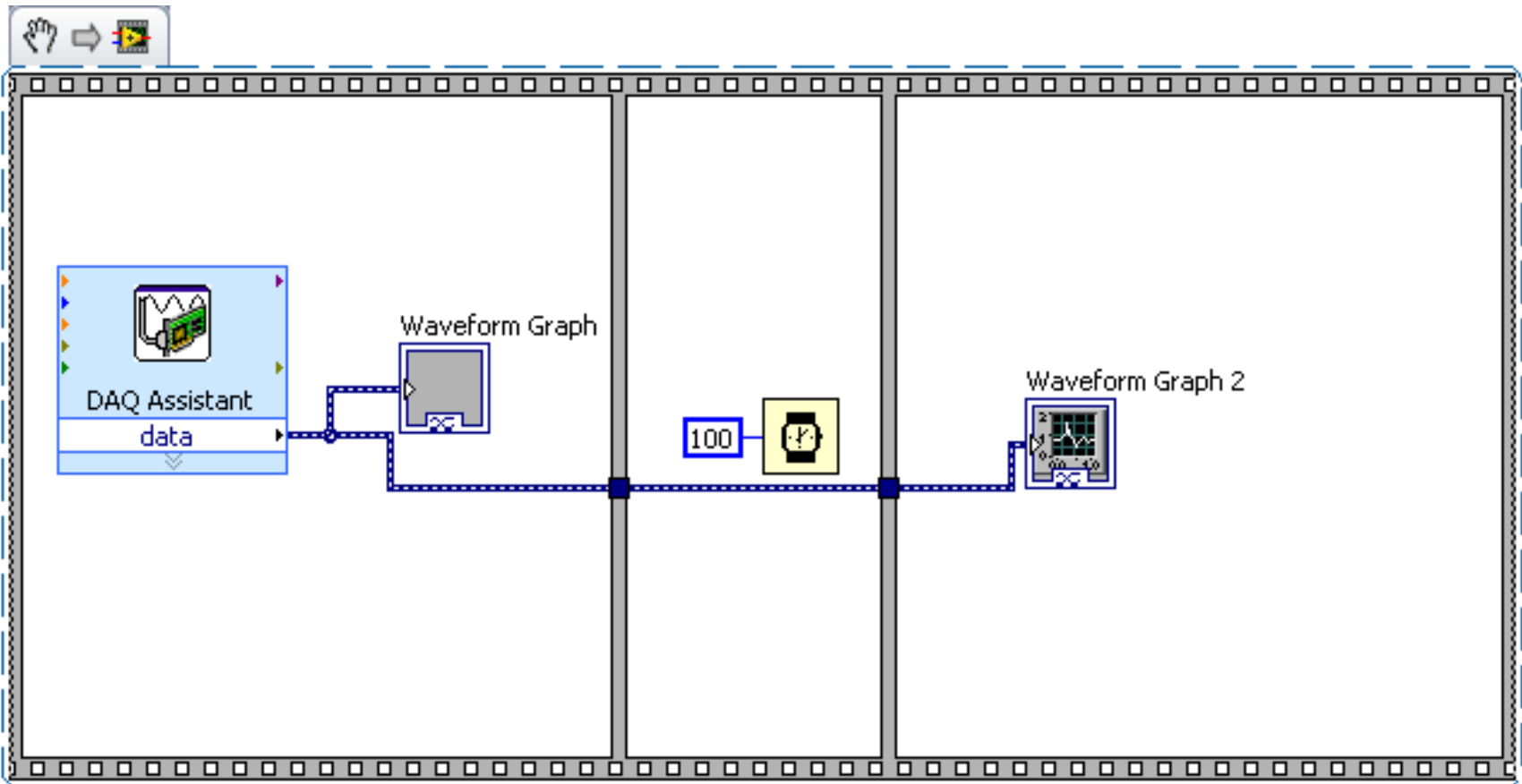
Shift Register – Access Previous Loop Data

- Available at left or right border of loop structures
- Right-click the border and select **Add Shift Register**
- Right terminal stores data on completion of iteration
- Left terminal provides stored data at beginning of next iteration



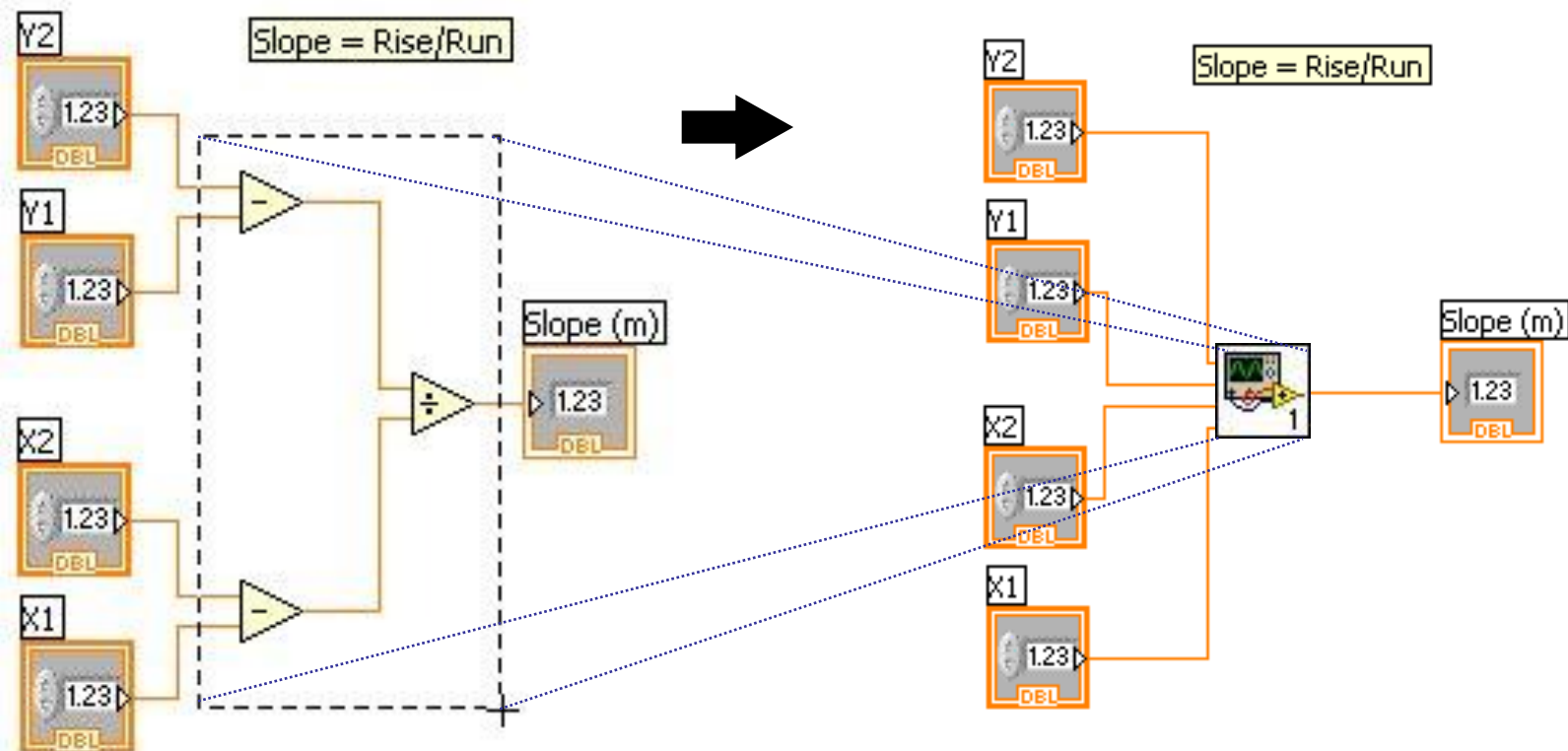
Sequence Structures

- Control execution sequences in LabVIEW



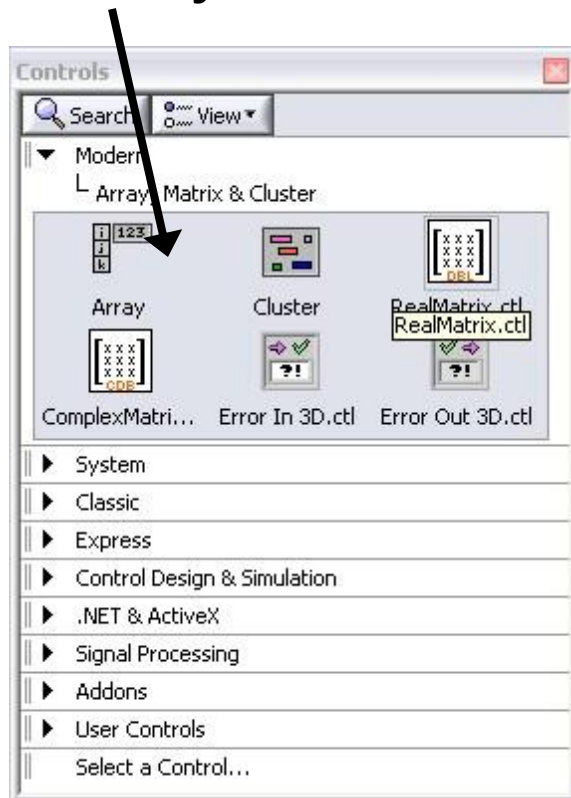
Creating SubVIs

- Enclose area to be converted into a subVI
- Select **Edit»Create SubVI** from the Edit menu

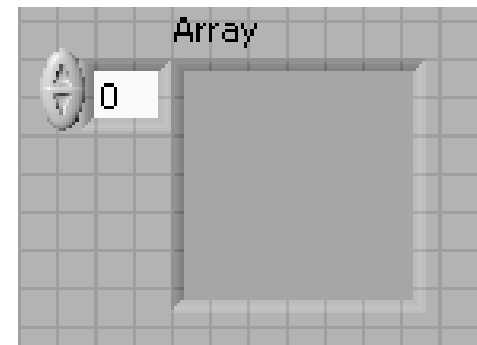


Creating an Array (Step 1 of 2)

From the **Controls»Modern»Array, Matrix, and Cluster** subpalette, select the **Array** icon.

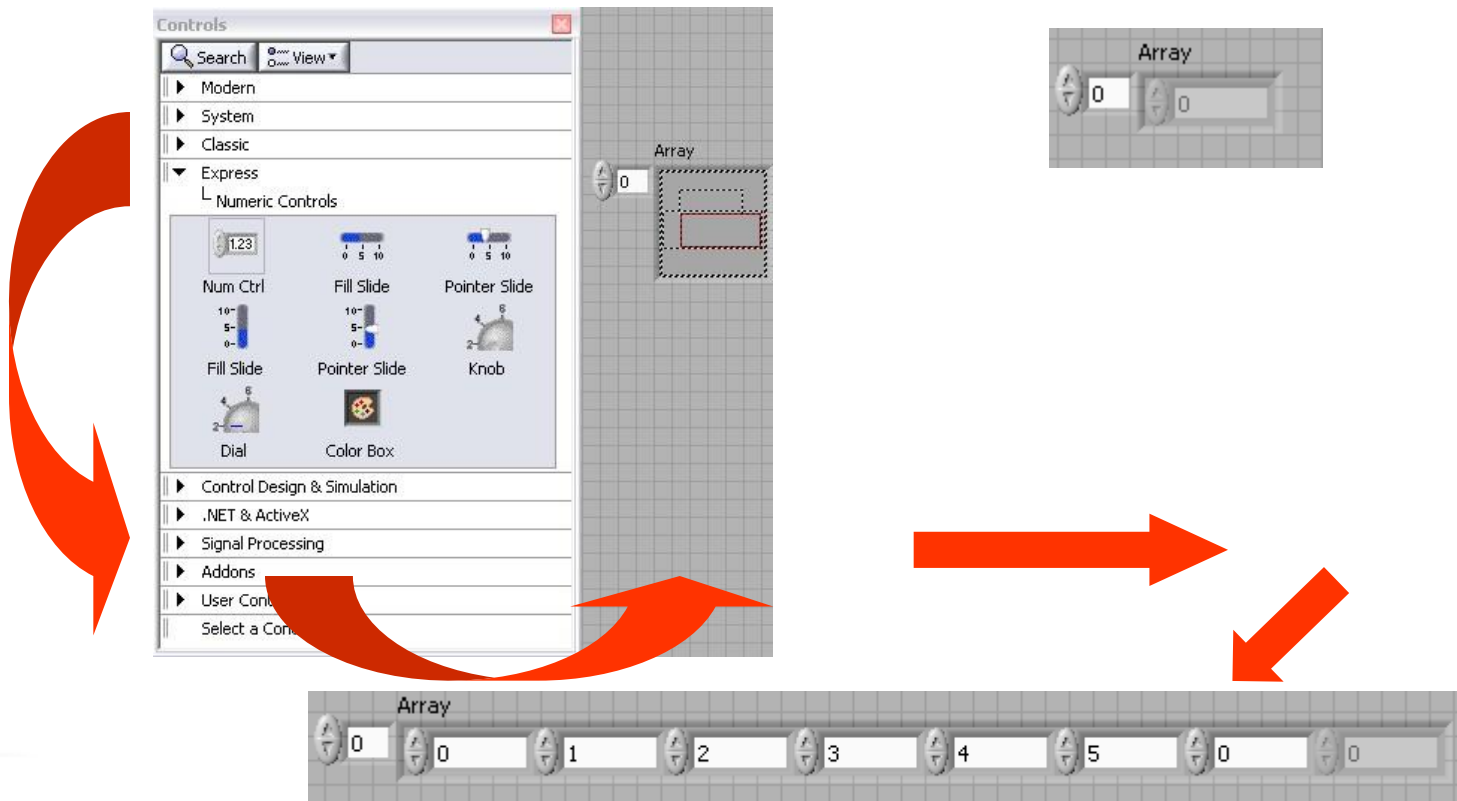


Drop it on the front panel.



Create an Array (Step 2 of 2)

1. Place an array shell.
2. Insert data type into the shell (i.e., numeric control).



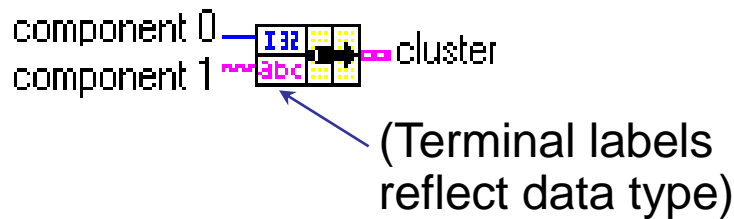
Introduction to Clusters

- Data structure that groups data together
- Data may be of different types
- Analogous to *struct* in ANSI C
- Elements must be either all controls or all indicators
- Thought of as wires bundled into a cable
- **Order is important**

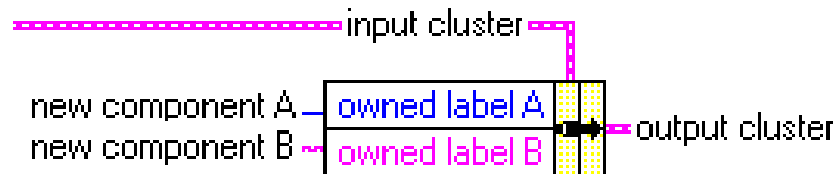


Cluster Functions

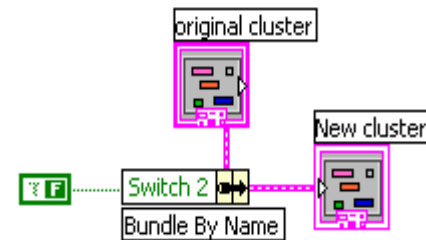
- In the **Cluster & Variant** subpalette of the **Programming** palette
- Can also be accessed by right-clicking the cluster terminal



Bundle

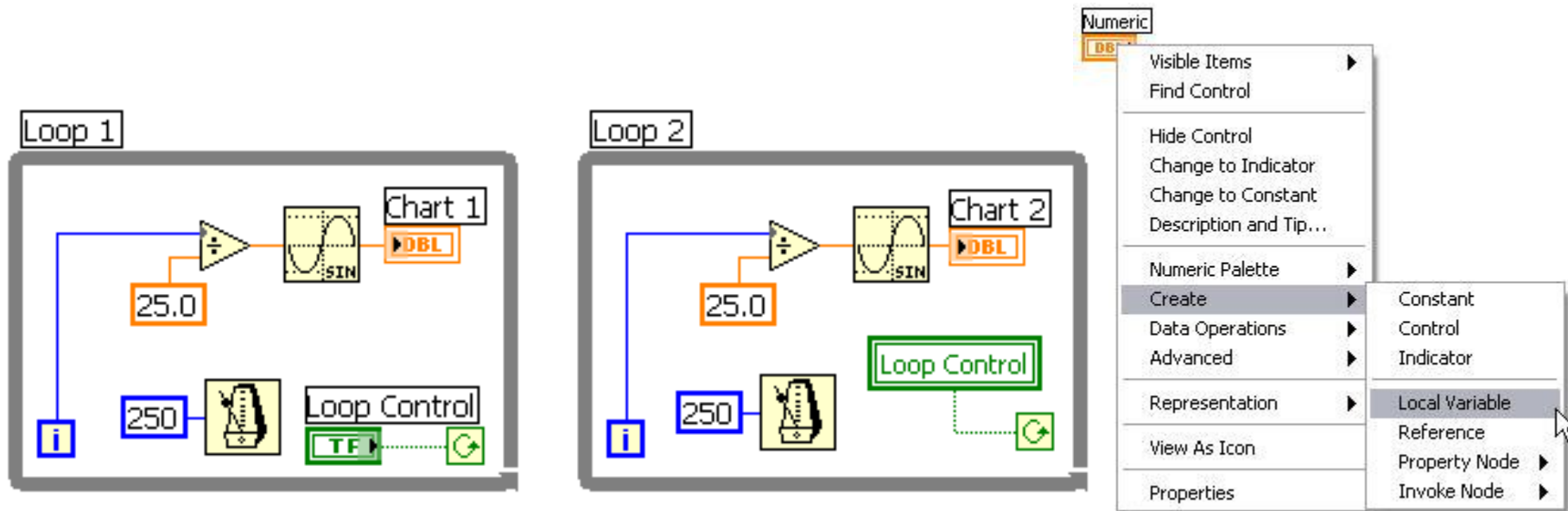


Bundle By Name



Local Variables

- Local variables allow data to be passed between parallel loops
- You can read or write a single control or indicator from more than one location in the program
 - Local variables break the dataflow paradigm and should be used sparingly



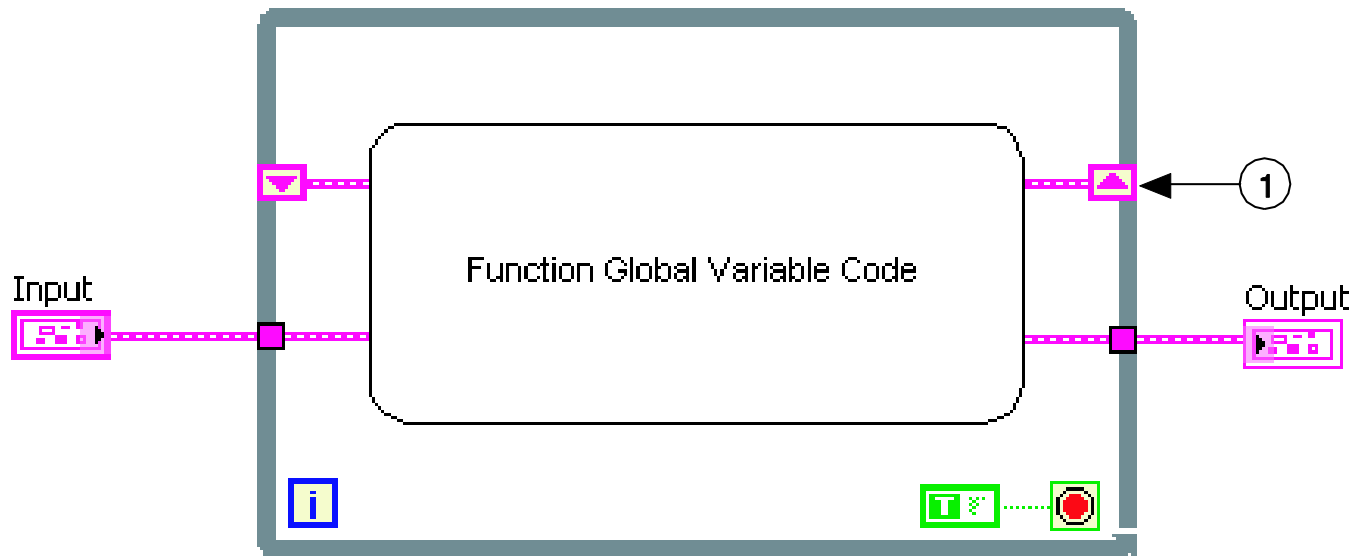
Global Variables

- **Use very sparingly!!**
- **Used to communicate between VI's in a project**
 - **Can cause race conditions**
 - **When using - call in a subVI**
 - **Can cause performance problems**
 - **Not the most efficient use of memory**

Variable Exercise

C. Functional Global Variables

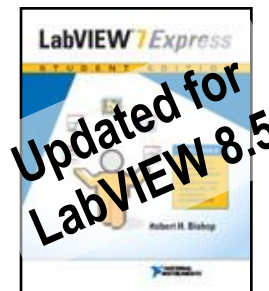
- The general form of a functional global variable includes an uninitialized shift register (1) with a single iteration For or While Loop



SAVE YOUR FILES!!

Additional Resources

- NI FIRST Community
 - <http://www.ni.com/first>
 - Tutorials, Support, Specifications, etc.
- Connexions: Full LabVIEW Training Course
 - www.cnx.rice.edu
 - Or search for “LabVIEW basics”
- Get your own copy of LabVIEW Student Edition
 - www.ni.com/academic



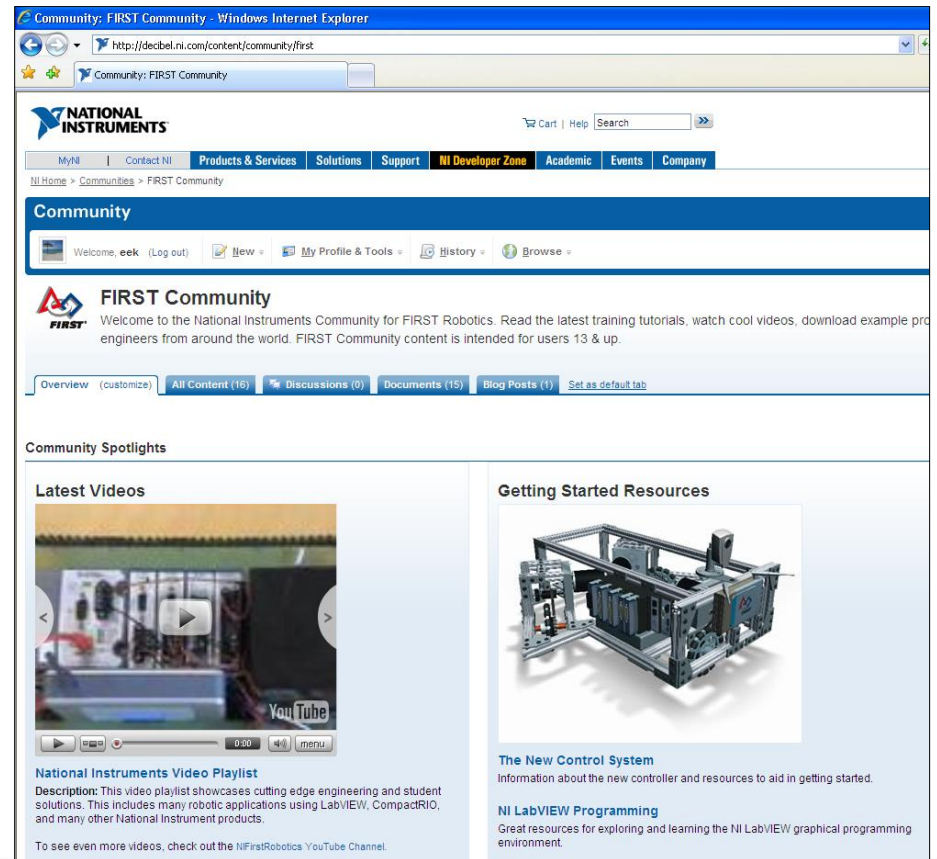
By [Robert H Bishop](#).

Published by [Prentice Hall](#).

Ensuring YOUR Success

Join the **NI FIRST Community** online

- **ni.com/first**
- Ask support questions
- Access training material and technical documentation
- Interact with other teams and mentors



The screenshot displays the NI FIRST Community website. At the top, there's a navigation bar with links for 'MyNI', 'Contact NI', 'Products & Services', 'Solutions', 'Support', 'NI Developer Zone', 'Academic', 'Events', and 'Company'. Below this is a 'Community' section with a welcome message and user options like 'Log out', 'New', 'My Profile & Tools', 'History', and 'Browse'. The main content area features a 'FIRST Community' header with a welcome message. Below that, there are tabs for 'Overview', 'All Content (16)', 'Discussions (0)', 'Documents (15)', and 'Blog Posts (1)'. The page is divided into two columns: 'Latest Videos' on the left, which includes a video player for 'National Instruments Video Playlist', and 'Getting Started Resources' on the right, which includes a link to 'The New Control System' and 'NI LabVIEW Programming'.

Q & A