Lab(1)

Faculty of Engineering,
Ain Shams University
Design of Measurement Systems, Sp. 2015

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NATIONAL INSTRUMENTS
LabVIEW

LAB(1) Objective:

- Getting familiarized with LabVIEW and realize its capabilities and functionalities.
- Understanding Dataflow Programming
- Giving general overview on LabVIEW graphical interface.
- Understanding front panels, block diagrams, and connectors/icons
- Demonstrating LabVIEW as a programming language using several examples

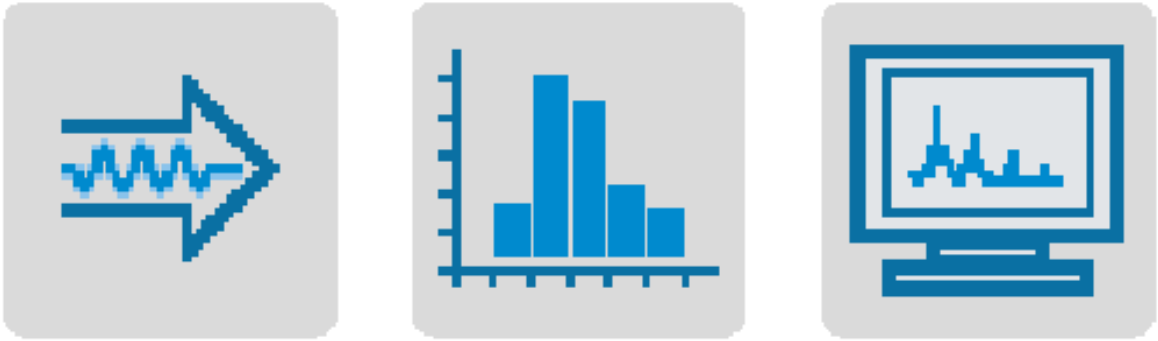
What is LabVIEW ?

- LabVIEW is a Graphical Programming (G-Programming) environment used by millions of engineers and scientists to develop sophisticated measurement, test, and control systems using intuitive graphical icons and wires that resemble a flowchart

LabVIEW, short for **L**aboratory **V**irtual **I**nstrument **E**ngineering **W**orkbench,

LabVIEW Capabilities

- LabVIEW is specifically designed to take measurements, analyze data, and present results to the user. And because it has such a versatile graphical user interface and is so easy to program with, it is also ideal for simulations, presentation of ideas, general programming, or even teaching basic programming concepts.



Acquire, Analyze, and Present

LabVIEW Capabilities (cont.)

- Libraries of signal processing, analysis, and control algorithms
- Libraries of communication, file I/O, and connectivity

In addition to the standard programming language constructs, LabVIEW contains functions for:

- String, array, and waveform manipulation
- Signal processing, including filters, windowing, spectral analysis, and transforms
- Mathematical analysis, including curve fitting, statistics, differential equations, linear algebra, and interpolation
- Report generation, file I/O, and database connectivity

Add-on packages supplement the core functionality for more specialized disciplines, such as:

- Control design and simulation
- Sound and vibration analysis
- Machine vision and image processing
- RF and communication

Relocating Ramses II with the Help of LabVIEW and PXI

Gallery

Ramses Square in 2005

"The flexibility of the LabVIEW programming environment and the ruggedness of the PXI system provided an ideal solution for the safe transportation of the statue. "

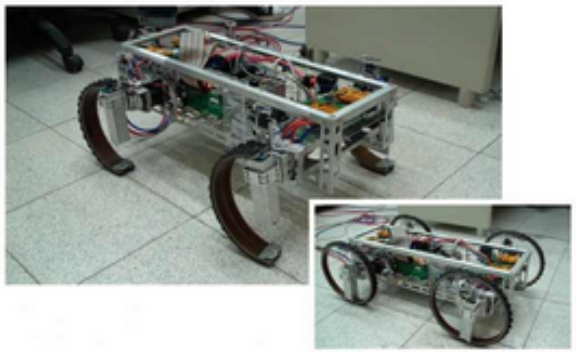
- Tamer Elnady, Ain Shams University Sound and Vibration Lab

The Challenge:
Moving a priceless, 83 ton statue over a distance of 35 kilometers without subjecting it to unnecessary damage.

The Solution:
Developing a highly sensitive vibration monitoring system using LabVIEW and PXI to indicate when the statue is in danger of being damaged.

Read the Full Case Study

Developing a Leg-Wheel Hybrid Mobile Robot Using LabVIEW and CompactRIO



Gallery

Figure 1. Quattroped - A Leg-Wheel Hybrid Mobile Platform

"The rugged and modular CompactRIO system is extremely suitable for mobile robot development, where size, weight and performance are important factors. Well-defined integration between LabVIEW and the NI hardware significantly reduces the time and efforts of developers in performing system integration."

- Pei-Chun Lin, Department of Mechanical Engineering, National Taiwan University

The Challenge:
Developing an energy-efficient leg-wheel hybrid mobile robot that can drive quickly and smoothly on flat terrain and can stably negotiate natural or artificial uneven terrain.

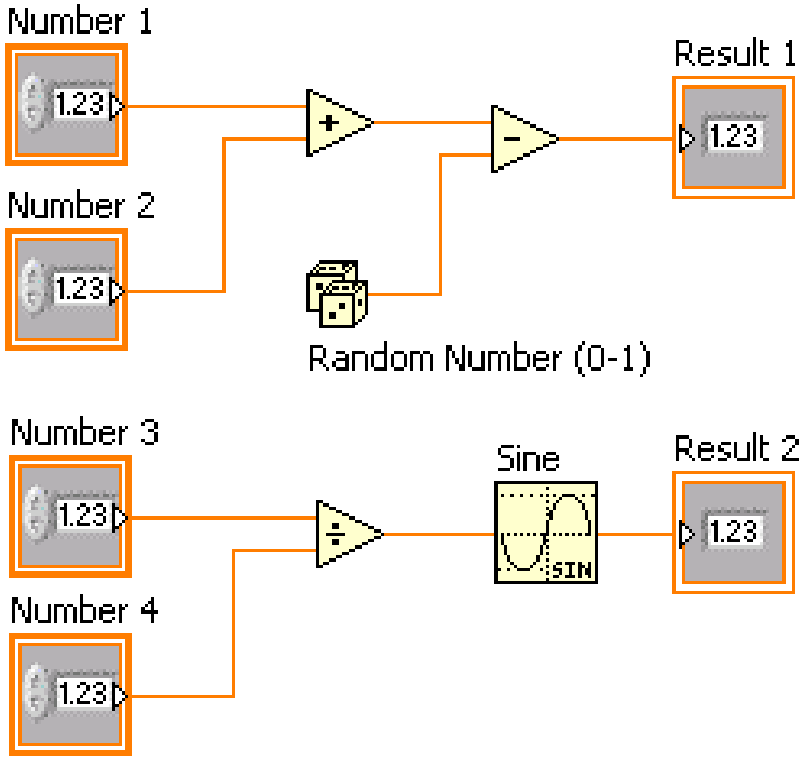
The Solution:
Using NI LabVIEW and CompactRIO with various I/O modules to rapidly integrate the mechanical, electrical and software elements of our design into a functional robot prototype

Dataflow Programming

- The LabVIEW program development environment is different from standard C or Java development systems in one important respect: While other programming systems use text-based languages to create lines of code, LabVIEW uses a graphical programming language, often called "G," to create programs in a pictorial form called a block diagram.
- **Dataflow** means that functions execute only after receiving the necessary data.

Dataflow Programming (cont.)

- Block diagram executes 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



LabVIEW Terms and Their Conventional Equivalents

LabVIEW	***Conventional Language***
VI	program
subVI	subroutine, subprogram, object
Front panel	user interface
Block diagram	program code
G	C, C++, Java, Pascal, BASIC, etc.
Control	Input
Indicator	Output

Examples of NI Data Acquisition Devices

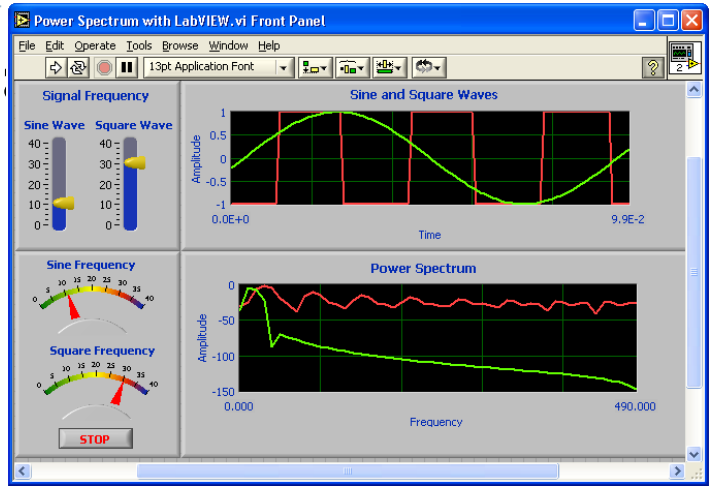
NI 6008

NI 6221

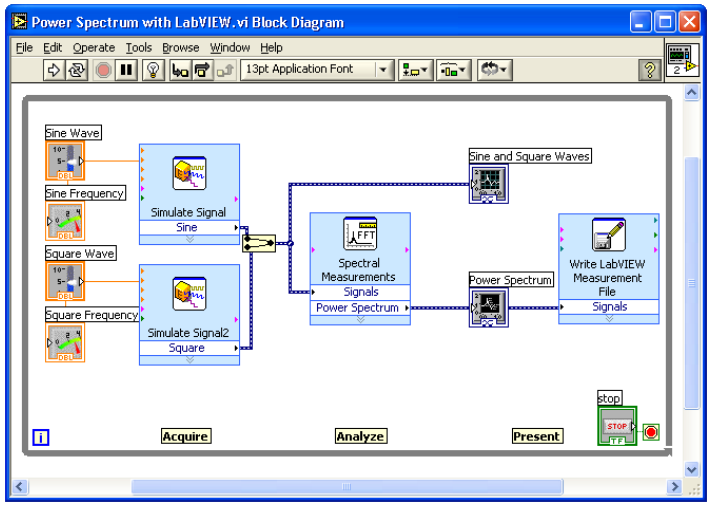
LabVIEW Programs Are Called Virtual Instruments (VIs)

Called VI because their appearance imitate actual physical instruments.

- **Front Panel**
  - **Controls = Inputs**
  - **Indicators = Outputs**

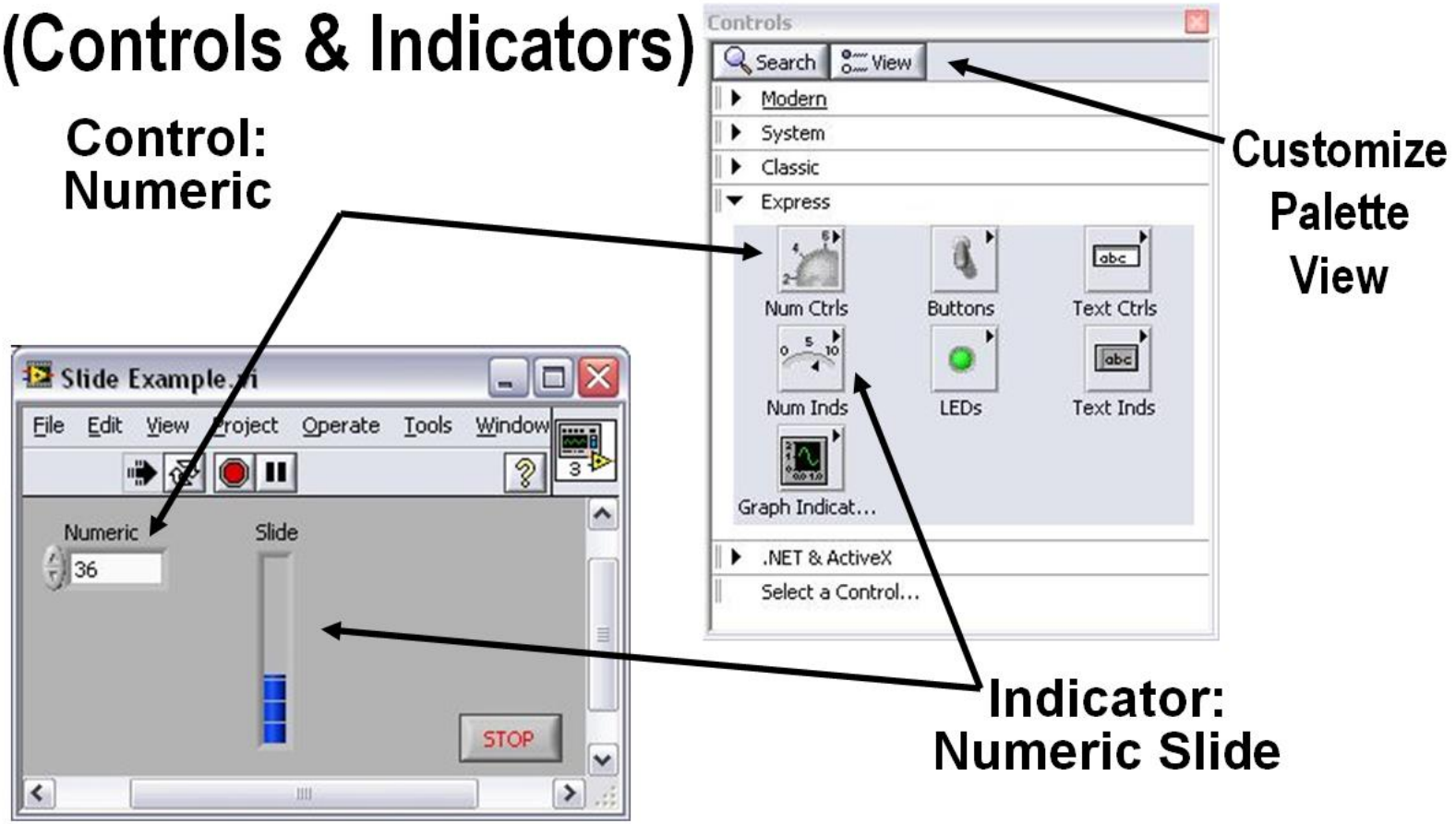


- **Block Diagram**
  - **Accompanying "program" for front panel**
  - **Components "wired" together**



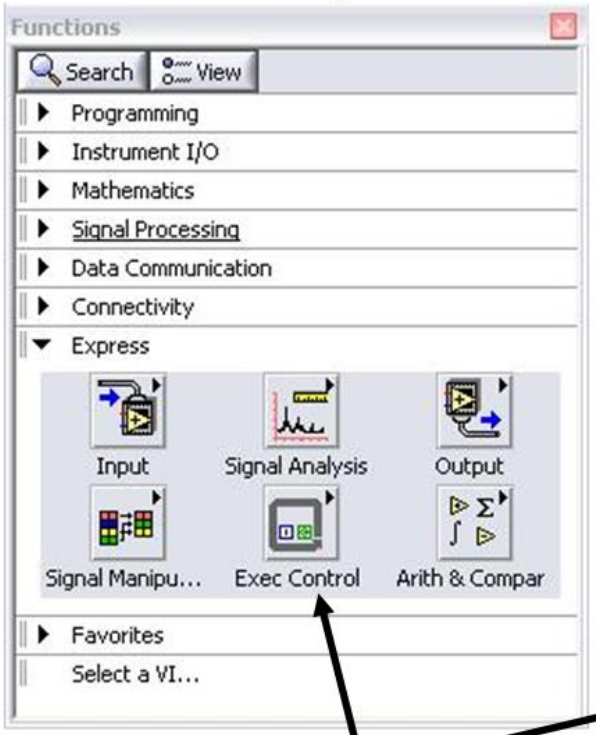
VI Front Panel

Controls Palette (Controls & Indicators) (Place items on the Front Panel Window)

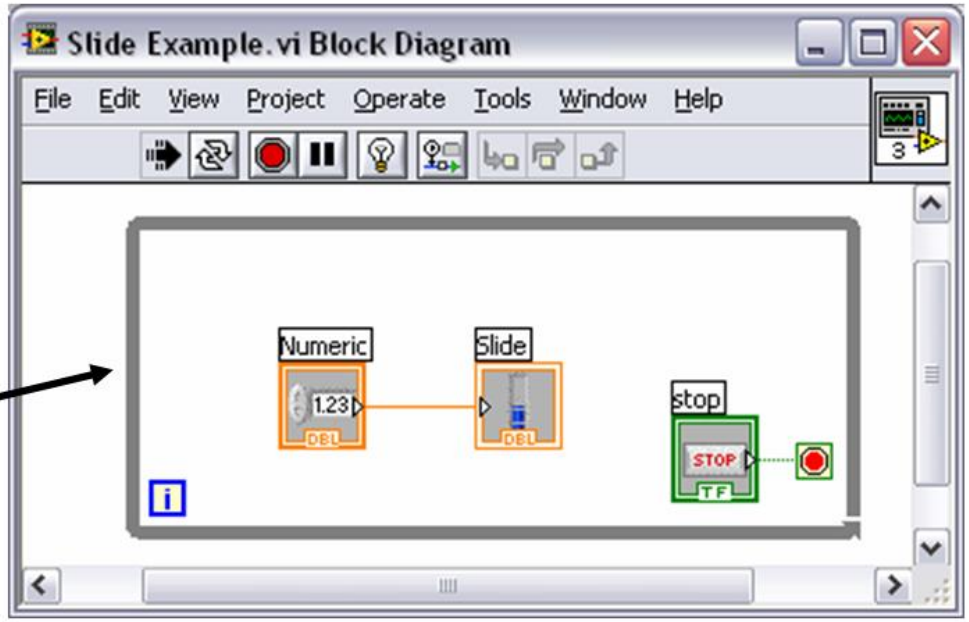


VI Block Diagram

Functions (and Structures) Palette



(Place items on the Block Diagram Window)



Structure: While Loop

Tools Palette

Tools Palette

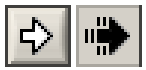
- Recommended: Automatic Selection Tool
- Tools to operate and modify both front panel and block diagram objects

Automatic Selection Tool

Automatically chooses among the following tools:

- **Operating Tool**
- **Positioning/Resizing Tool**
- **Labeling Tool**
- **Wiring Tool**

Status Toolbar

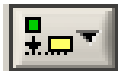

Run Button


Continuous Run Button


Abort Execution


Pause/Continue Button

Text Settings


Align Objects


Distribute Objects


Reorder


Resize front panel objects

Additional Buttons on the Diagram Toolbar


Execution Highlighting Button

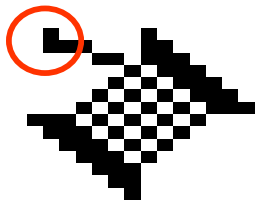

Step Into Button


Step Over Button

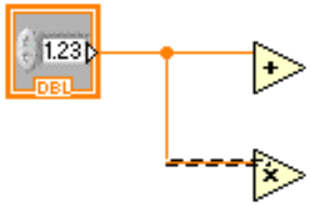

Step Out Button

Wiring Tips – Block Diagram

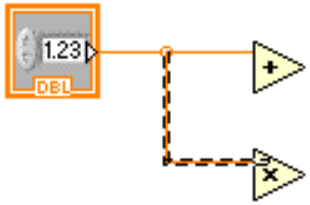
Wiring "Hot Spot"



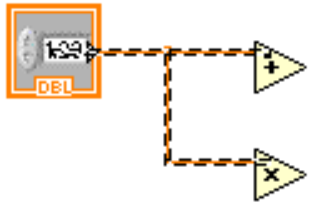
Click To Select Wires



single-click

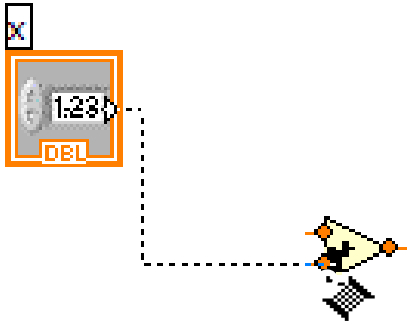


double-click

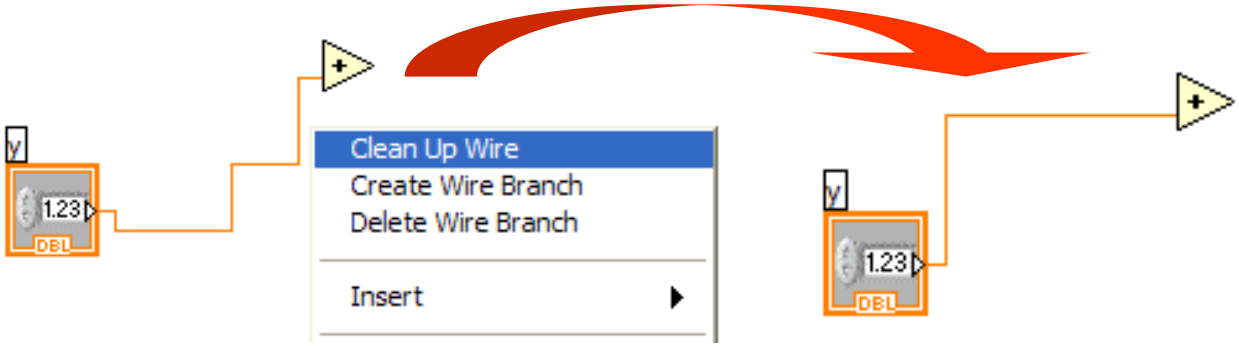


triple-click

Use Automatic Wire Routing



Clean Up Wiring

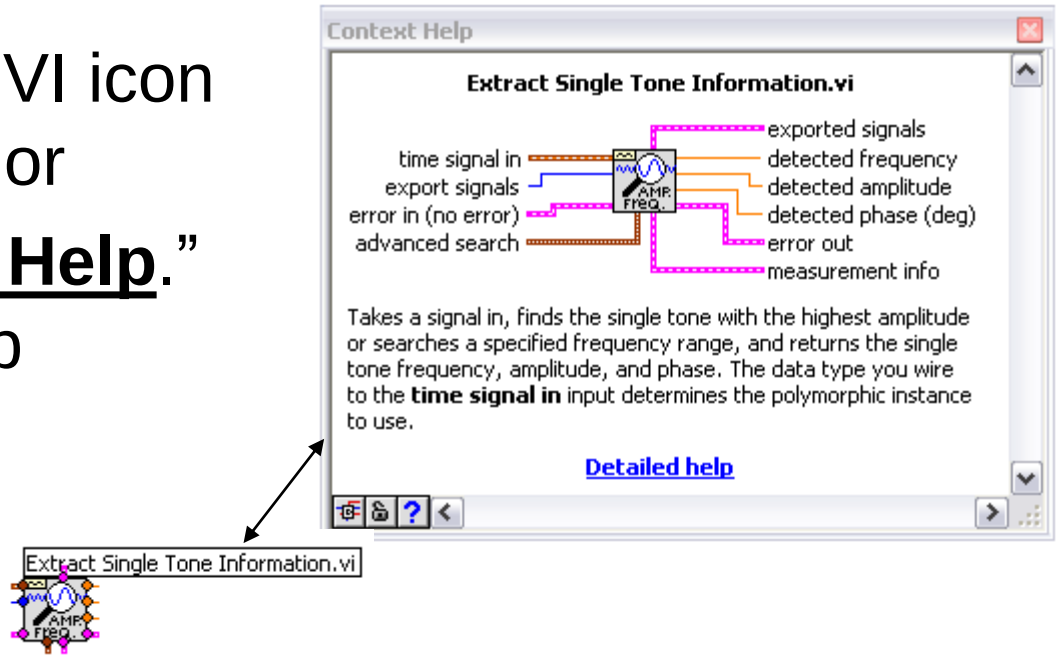


Help

- **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

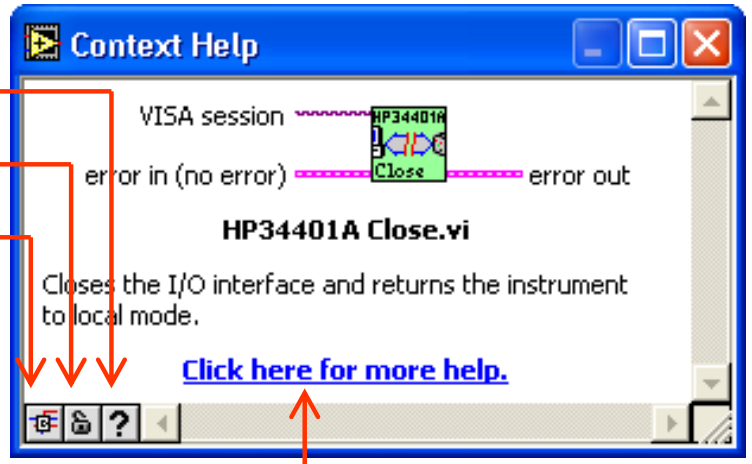


Help Options

To display the **Context Help** window, select **Help»Show Context Help** or press the <Ctrl-H> keys.

Context Help

- **Online help**
- **Lock help**
- **Simple/Complex Diagram help**
- **Ctrl + H**



Online reference

- **All menus online**
- **Pop up on functions in diagram to access online info directly**

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.

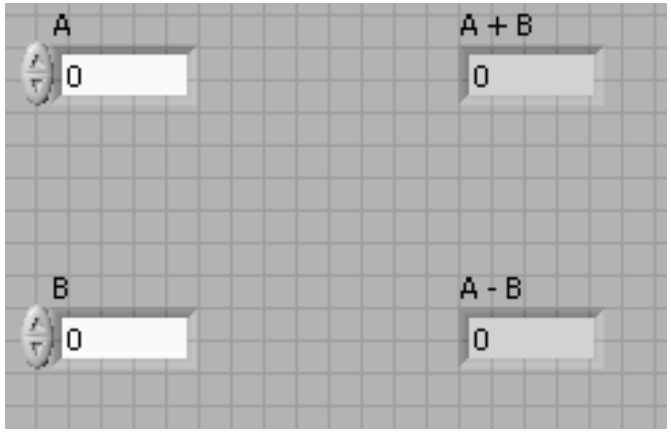
Tips for Working in LabVIEW

- 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
- VI Properties – Configure VI Appearance, Documentation, etc.

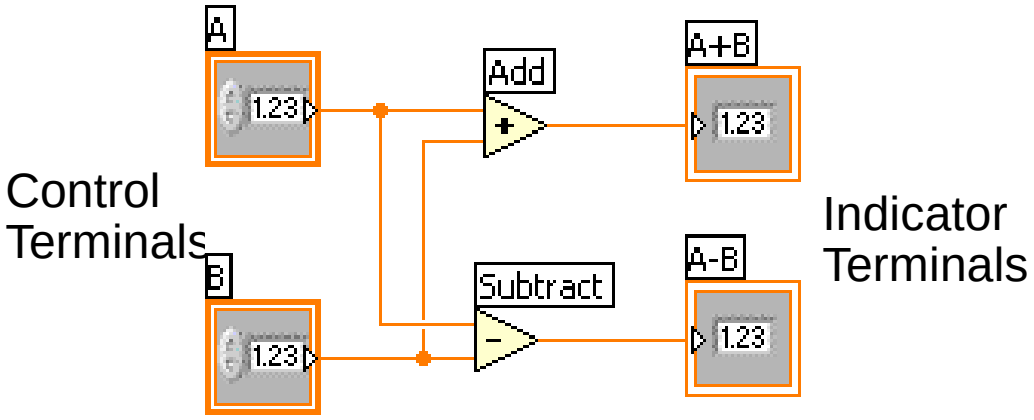
Solved Example

- Design a VI that sums and subtracts two inputs: A and B
- Solution:

Front Panel Window

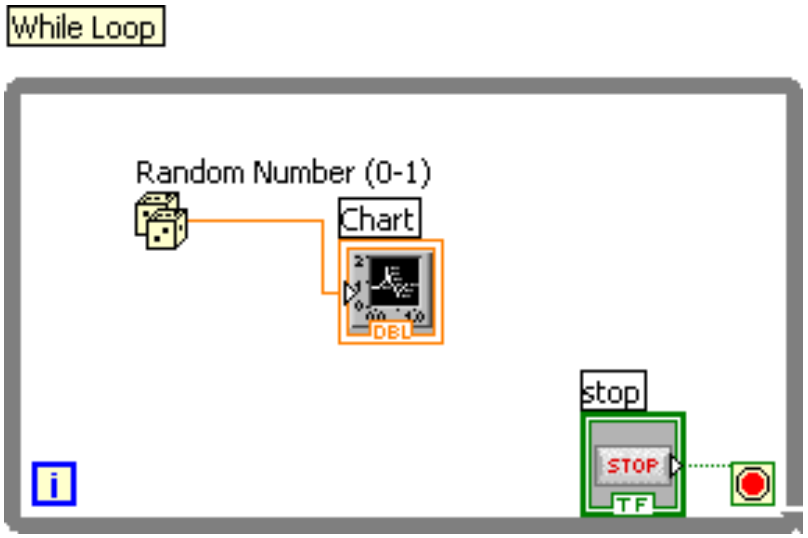


Block Diagram Window

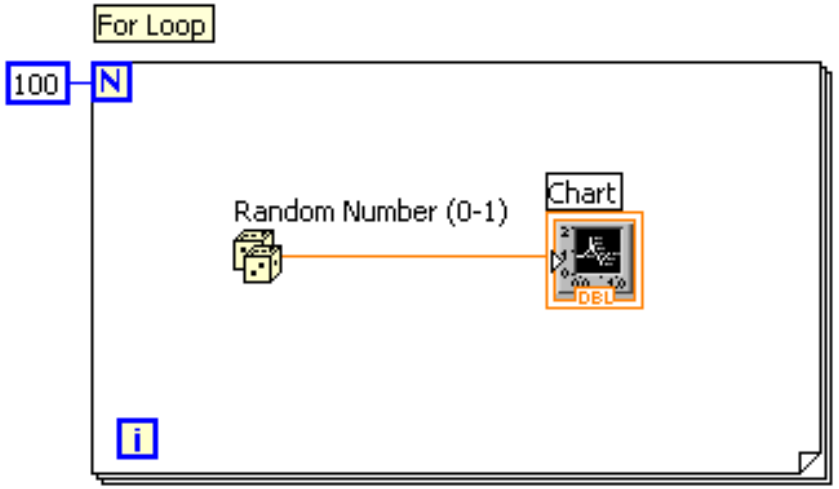


Loops

- While Loops
  - Have Iteration Terminal
  - Always Run at least Once
  - Run According to Conditional Terminal

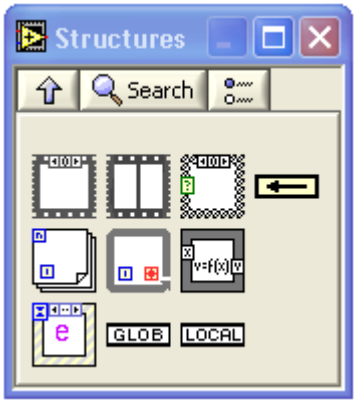


- For Loops
  - Have Iteration Terminal
  - Run According to input N of Count Terminal

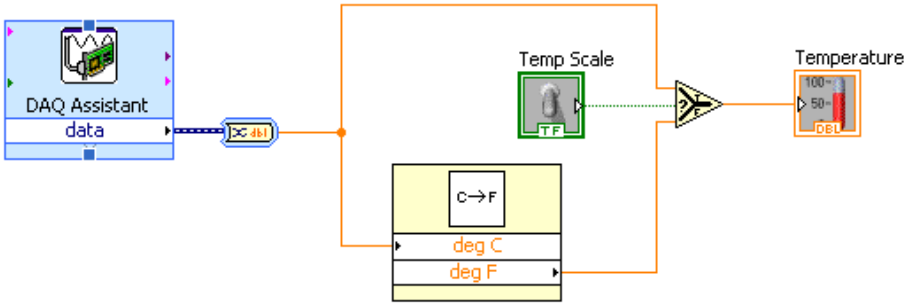


Loops (cont.)

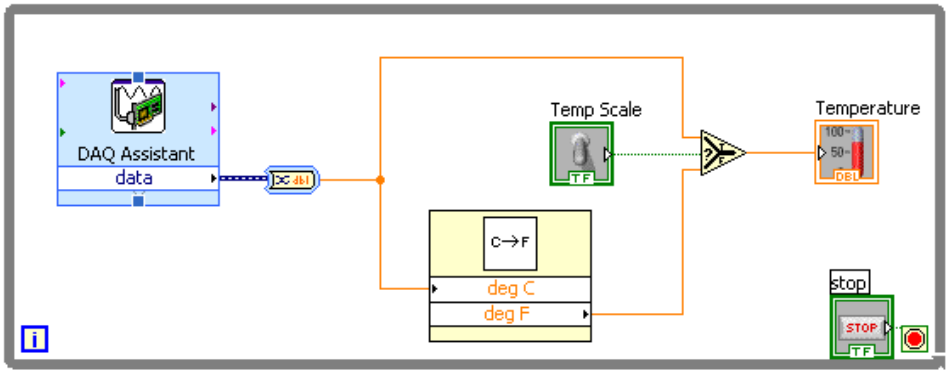
1. Select the loop



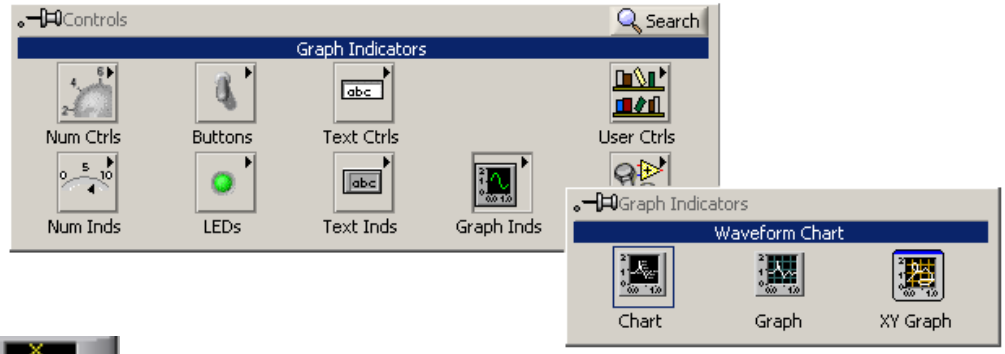
2. Enclose code to be repeated

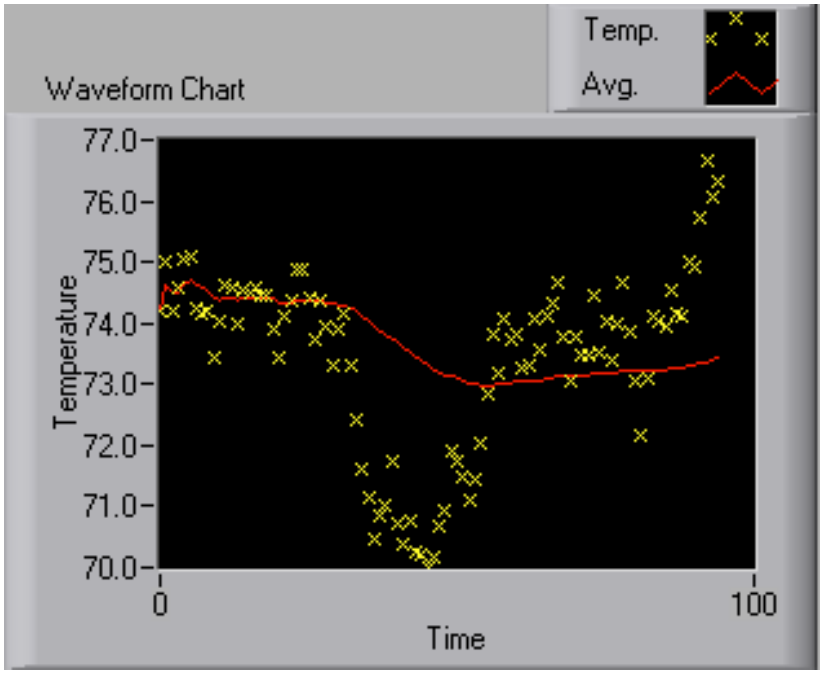


3. Drop or drag additional nodes and then wire



Waveform Charts



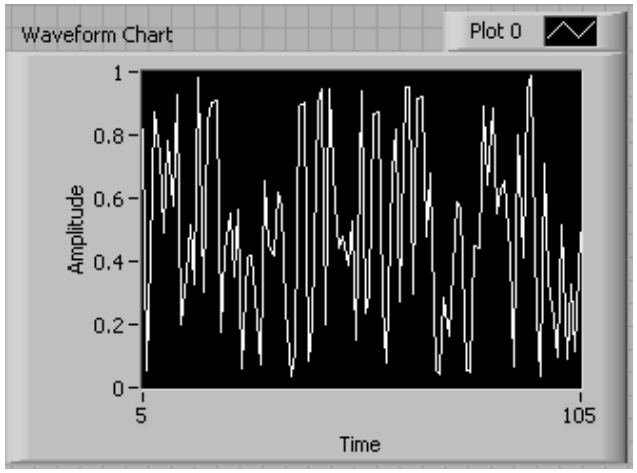


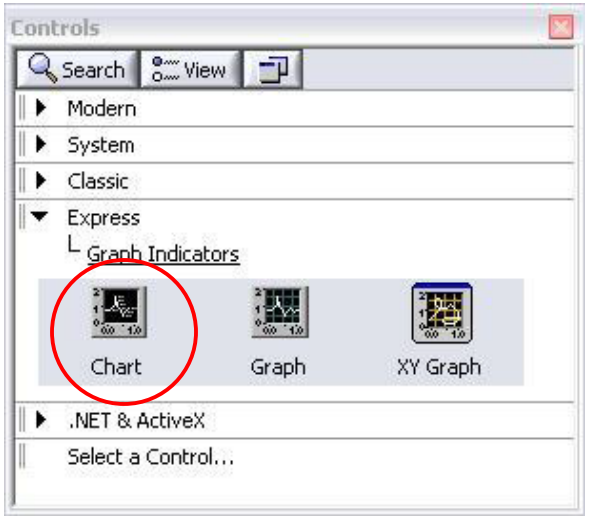
Waveform chart – special numeric indicator that can display a history of values

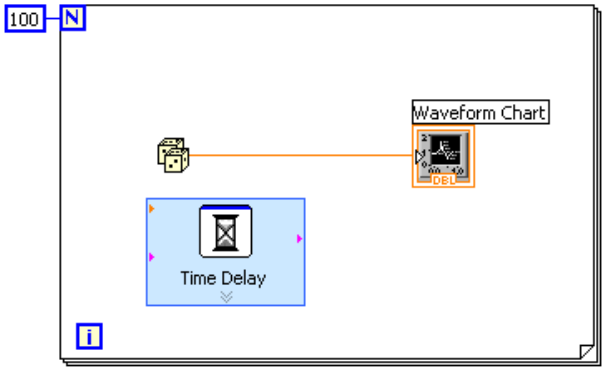
Controls >> Graph Indicators >> Waveform Chart

Waveform Charts

- Waveform chart–special numeric indicator that can display a history of values
- •Chart updates with each individual point it receives
- Functions»Express»Graph Indicators»Chart

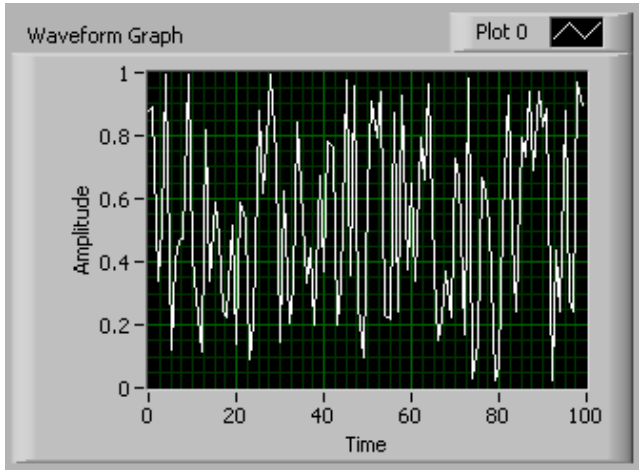


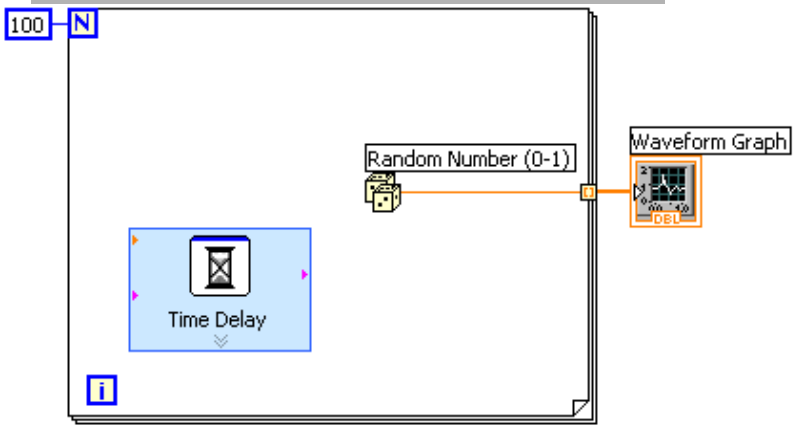


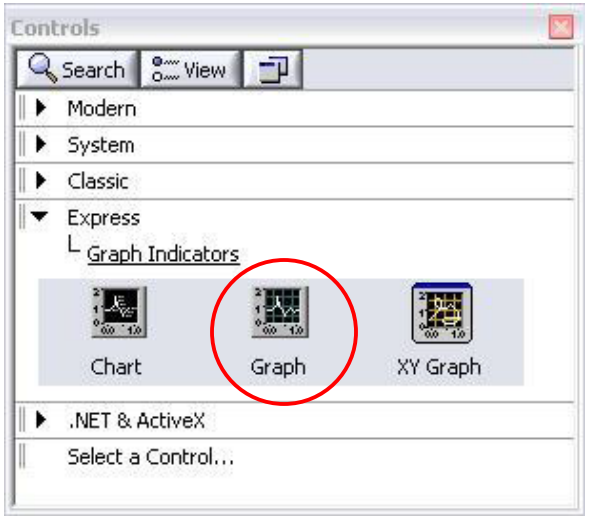


Waveform Graphs

- 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
- Functions»Express»Graph Indicators»Graph







Example (2)

- Simulate a sine wave in which you can control its amplitude and frequency