Lab 2 Notes: Introduction To Labview

•What is LabVIEW®?

-- LabVIEW® is a software product produced by National Instruments®.

-- It incorporates a *graphical user interface* (GUI) programming environment to produce programs that mimic laboratory instruments.

-- LabVIEW is programmed with set of icons that represents controls and functions, available in the menu of the software. Such a programming is called *visual programming* and National Instruments calls it *G*.

-- These programs are called *Virtual Instruments* (VI) because they imitate real benchtop instruments.

-- The user interface which is called a *vi* consists of two parts- a ***front panel*** and a ***diagram*** .

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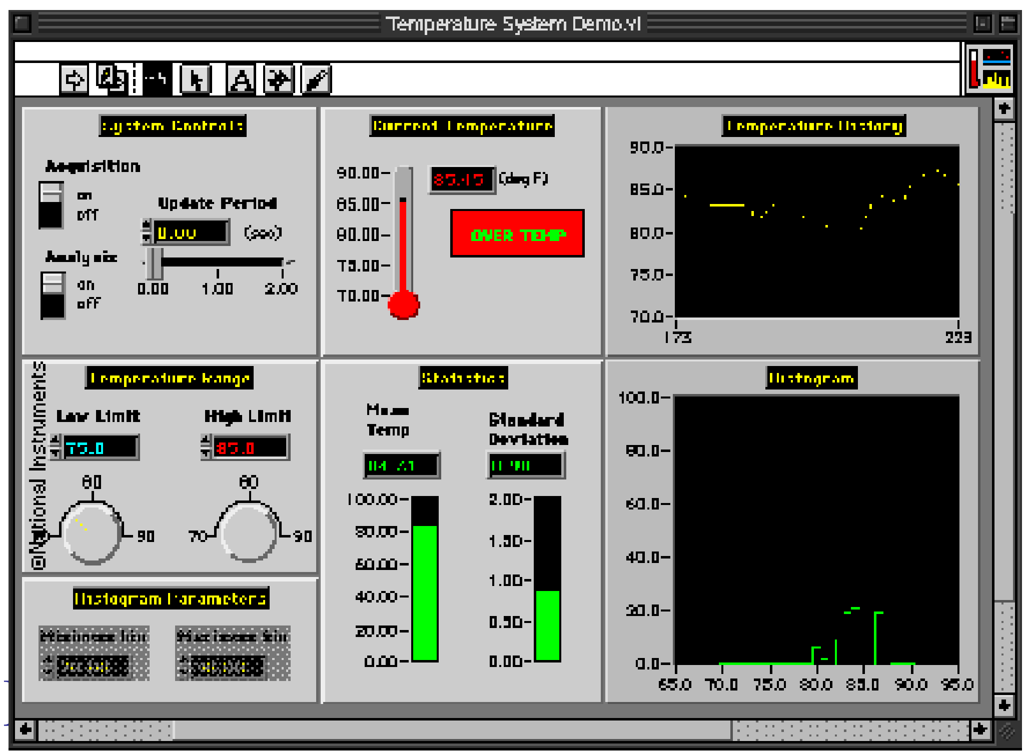
•LabVIEW® Front Panel

-- The *Front Panel* of the ***VI*** looks similar to a front panel of a real instrument.

-- Front panel is used for a input, output controls like a real instrument

-- Using the mouse, you will move the cursor around the screen to operate switches, dials, and buttons on the ***VI*** just as if it were a real instrument.



Can configure a ***vi*** to include functions and graphs that are fully customizable.

In an example shown, temperature monitoring system consists of data acquisition from a thermometer and plotting on a strip chart recorder.

The ***vi*** also calculates mean and standard deviation of the data.

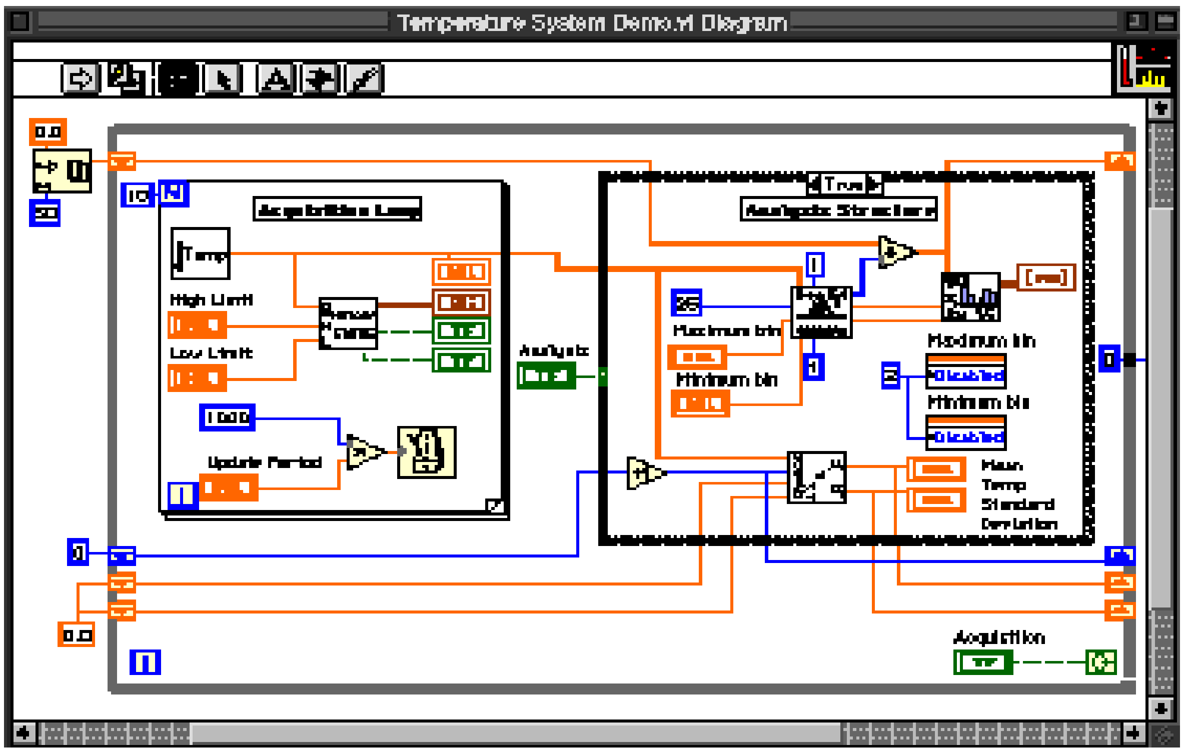
Alarms have been set up so that if the temperature falls below or above a certain set value the alarm goes ON.

•LabVIEW® Block Diagram

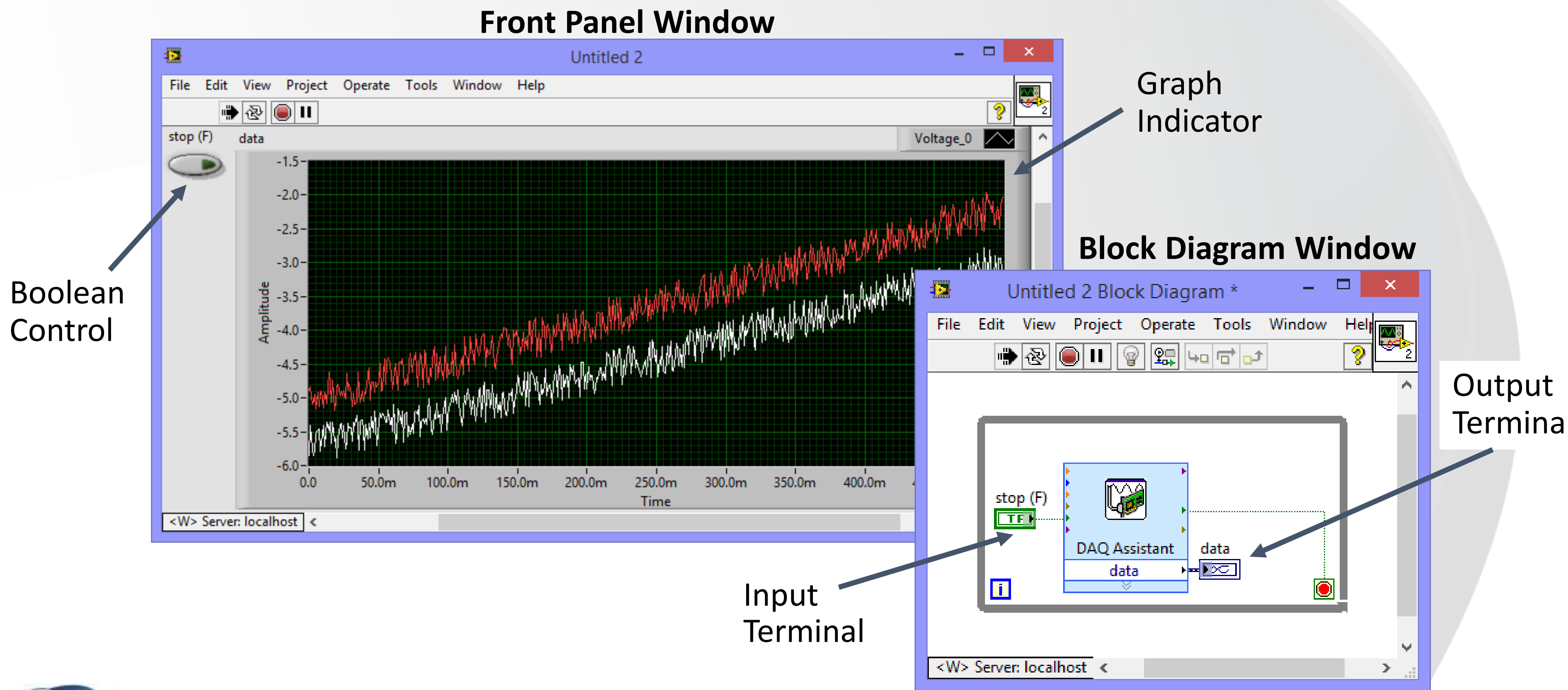
-- The *diagram* of the ***VI*** is analogous to the electronics of an actual instrument, I.e. the circuit board.

-- Diagram is where the *VI functionality* is programmed

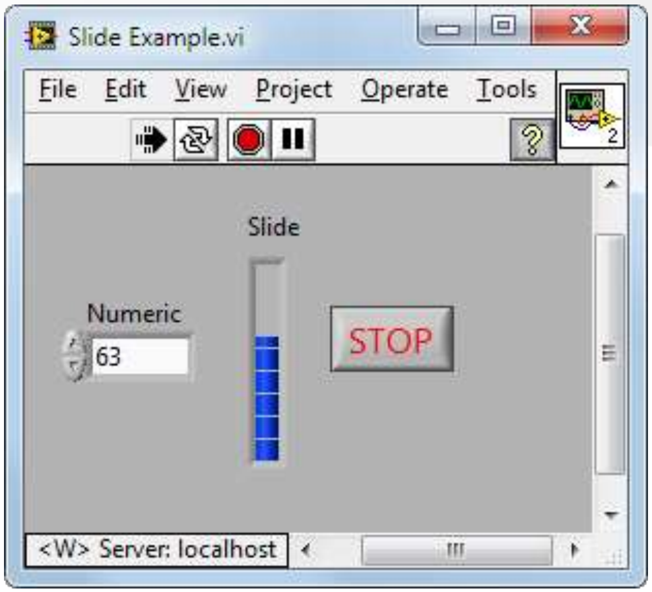
-- The diagram of such a *vi* can look very complex, and the key is using good programming practices to insure that your code is "debuggable"

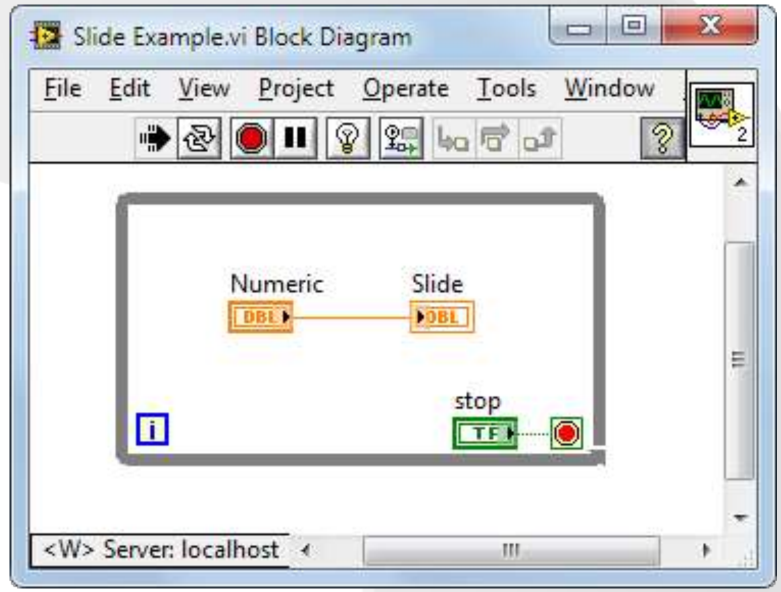


Demo: Creating our first VI



LabVIEW Environment





What is the front panel used for?

What are the inputs and outputs called?

What is the block diagram used for?

How does data travel on the block diagram?

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Labview Applications

Often LabVIEW is used to perform system simulations, since it contains many commonly used filter, digital signal processing, and statistical functions. LabVIEW compiles almost as fast as C or Matlab and therefore one can perform complete simulation within a *vi*.

• In addition to data input output, LabVIEW can access digital devices like serial ports, parallel ports and GPIB cards to read data from instruments that have a GPIB interface.

• As you can see, the possibilities of "virtual instrument" are almost limitless and they expand the measurement Capabilities of any system immensely

• *Example applications*

Space shuttle ET hydrogen senor real time monitor

X-43 Launch Panel Operator Situational Awareness Display Development

Labview Data Acquisition

"Modern" NI data acquisition is mechanized using ***NI-DAQmx*** drivers

"Best friend" here is the DAQ Assistant .. It helps to set up a particular NI device for data acquisition

- **DAQ Assistant GUI for interactively creating, editing, and running NI-DAQmx virtual channels and tasks.**

- **NI-DAQmx virtual channel consists of a physical channel on a DAQ device and the configuration information for this physical channel, such as input range and custom scaling.**

- **NI-DAQmx task is a collection of virtual channels, timing and triggering information, and other properties regarding the acquisition or generation.**

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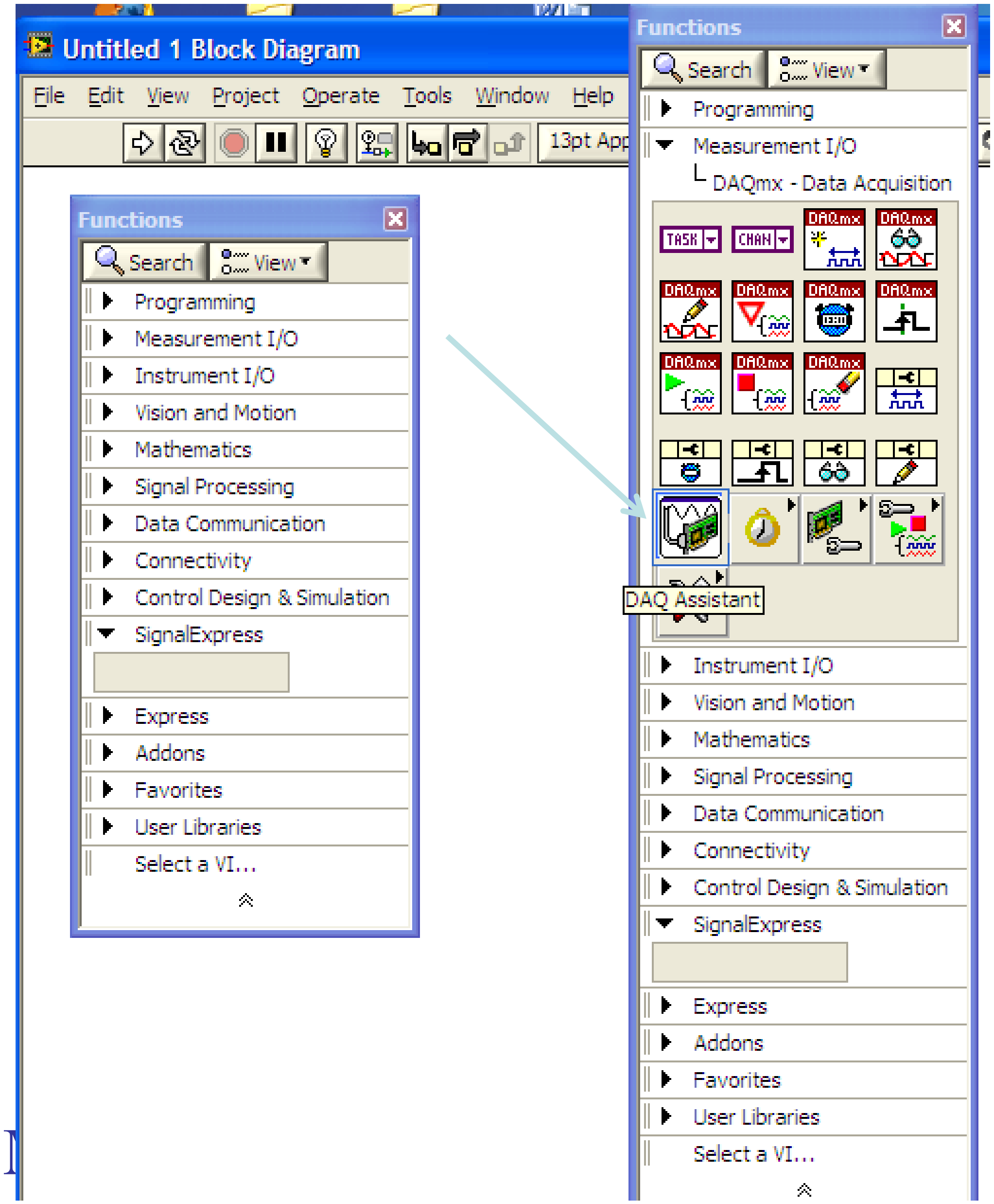
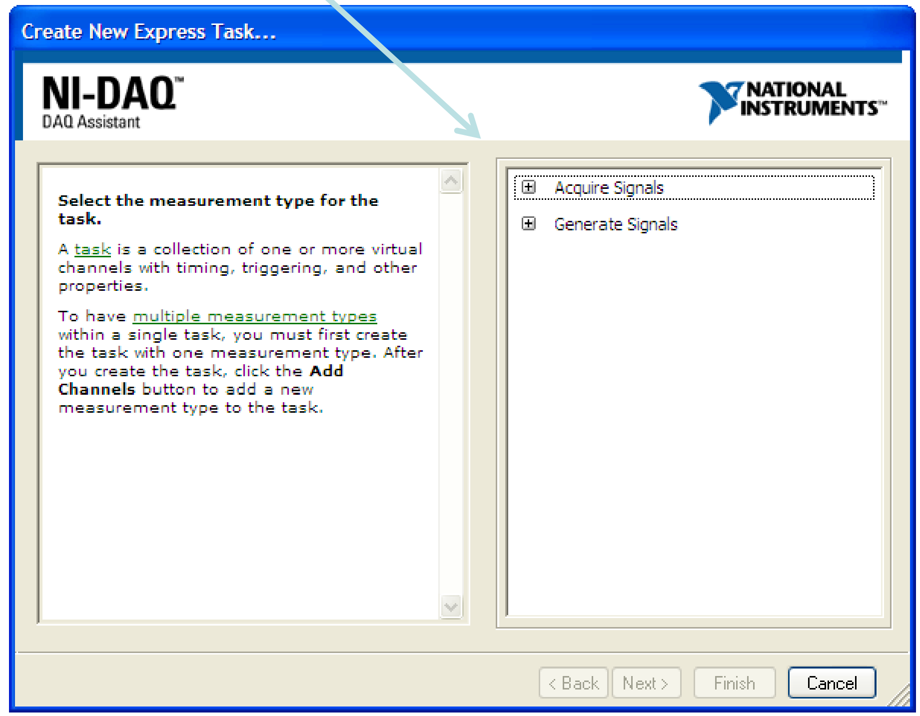
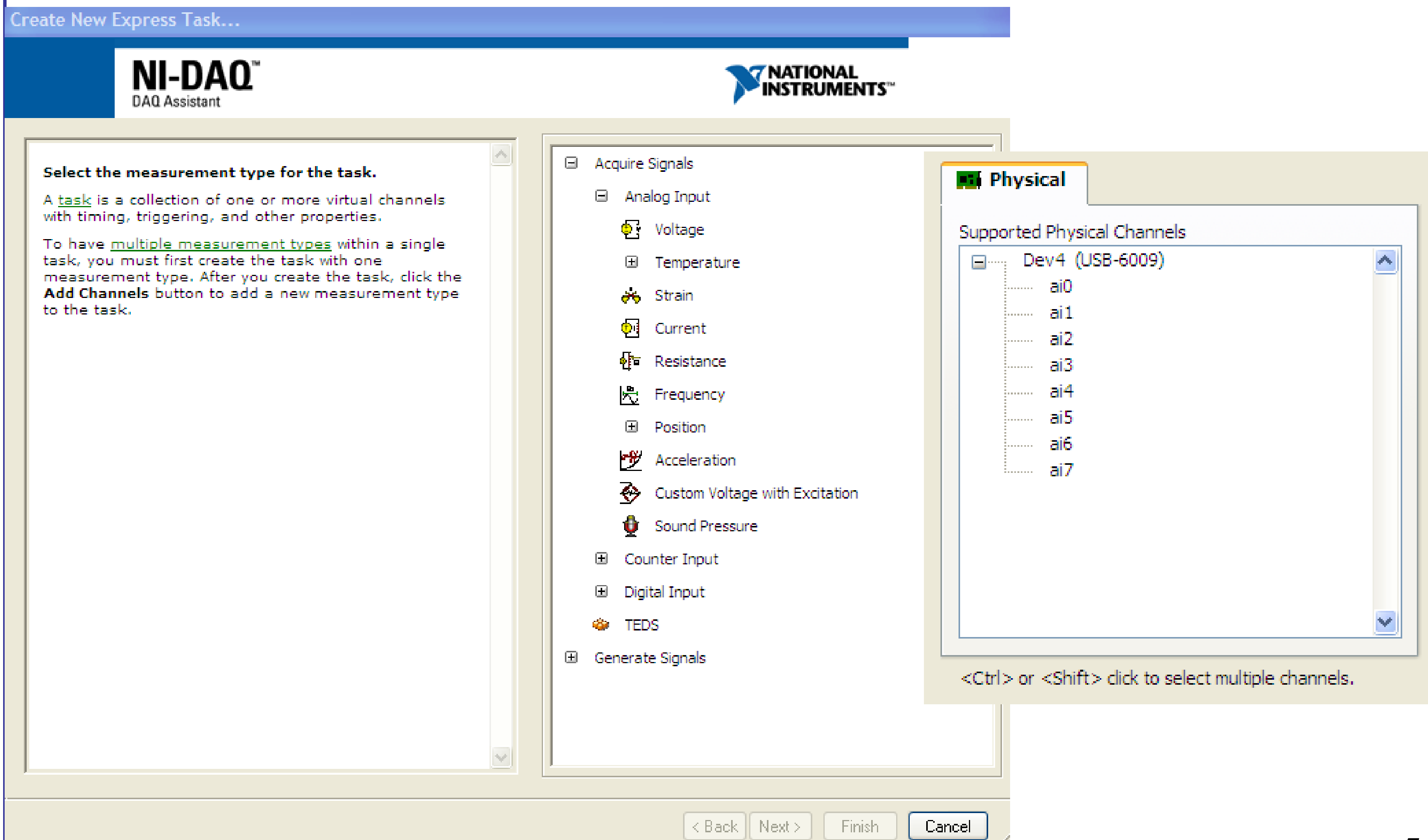
Labview Data Acquisition (2)



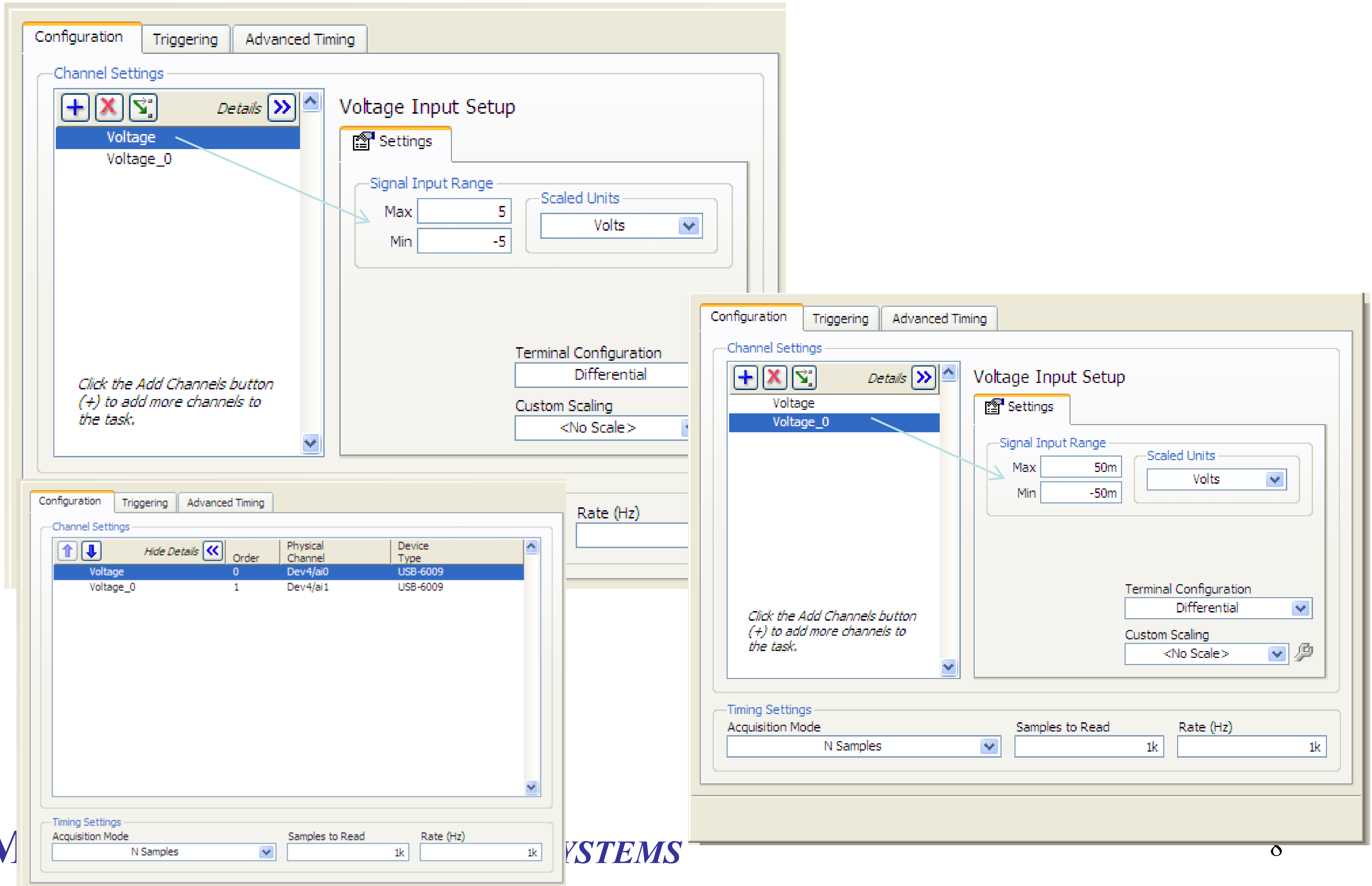
Finding DAQ Assistant



Labview Data Acquisition (3)



Labview Data Acquisition (4)



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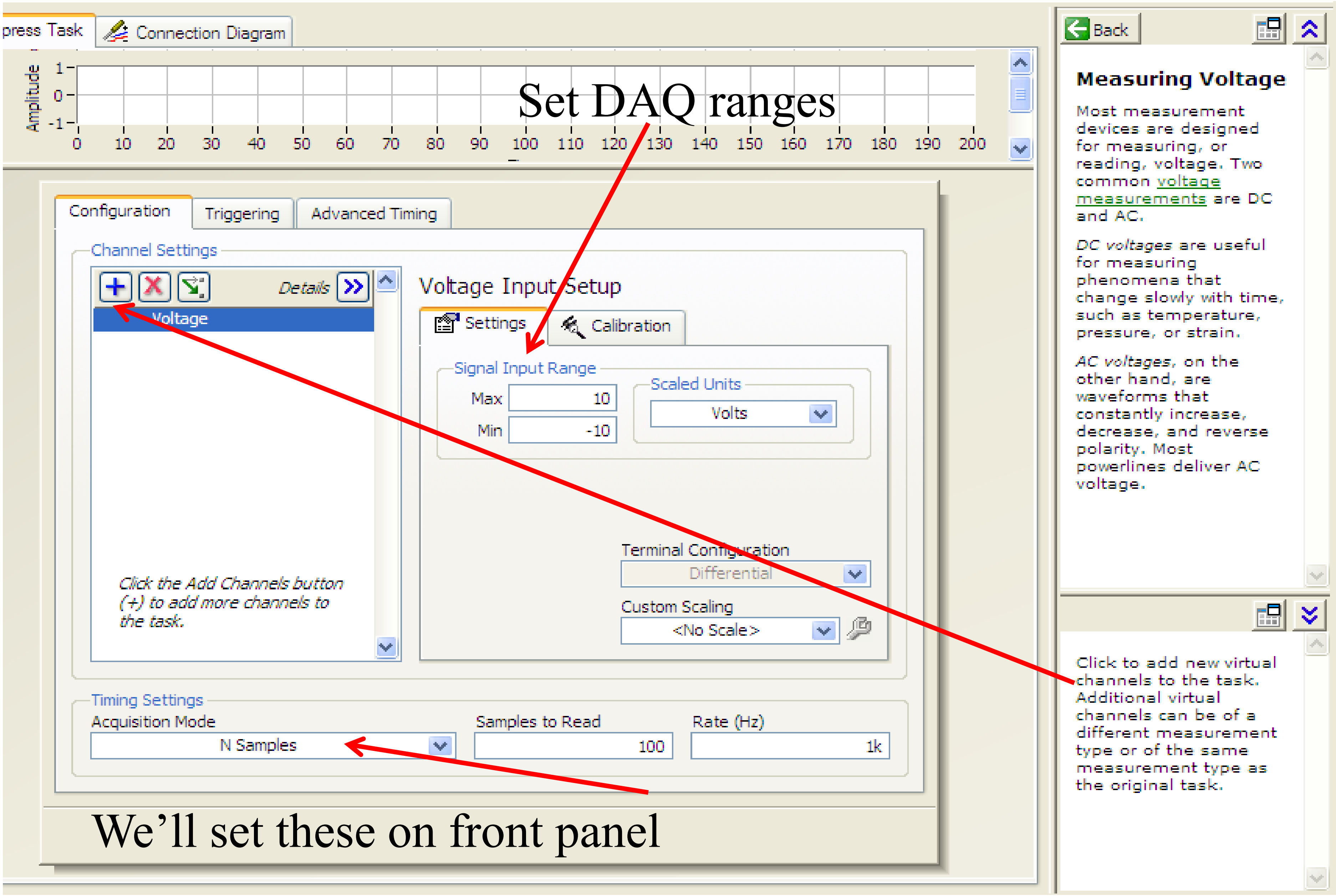
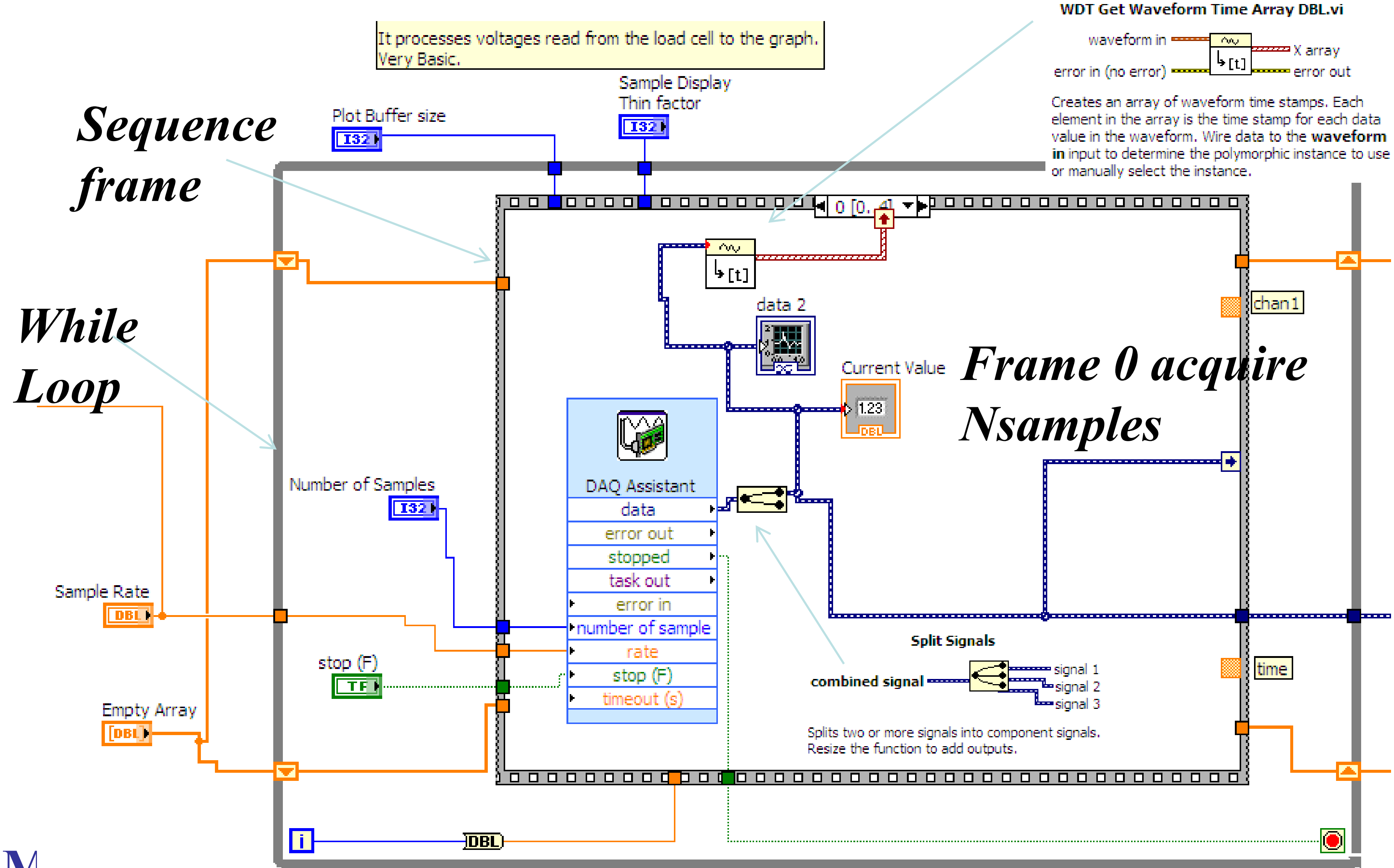
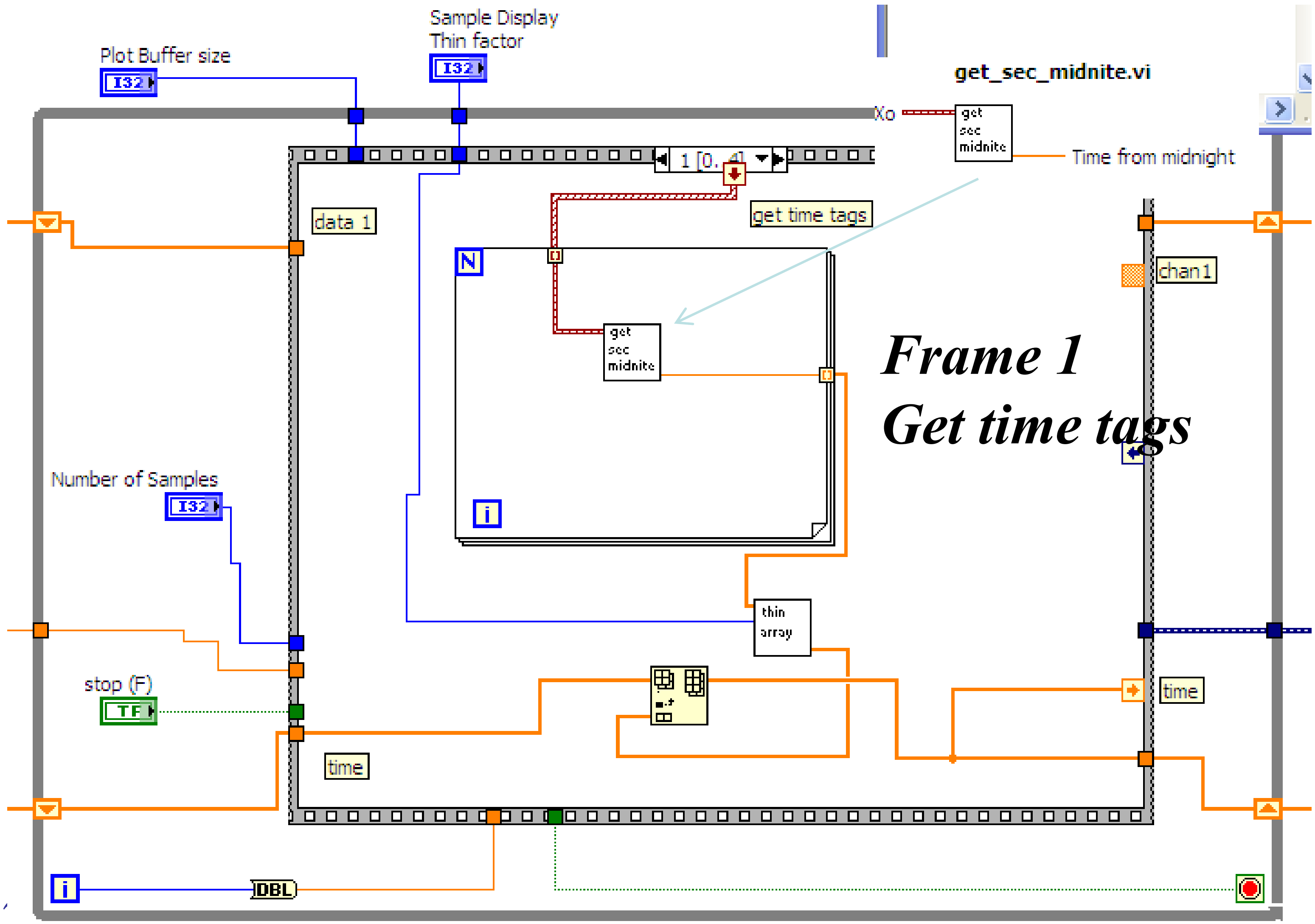
Labview Data Acquisition (6)



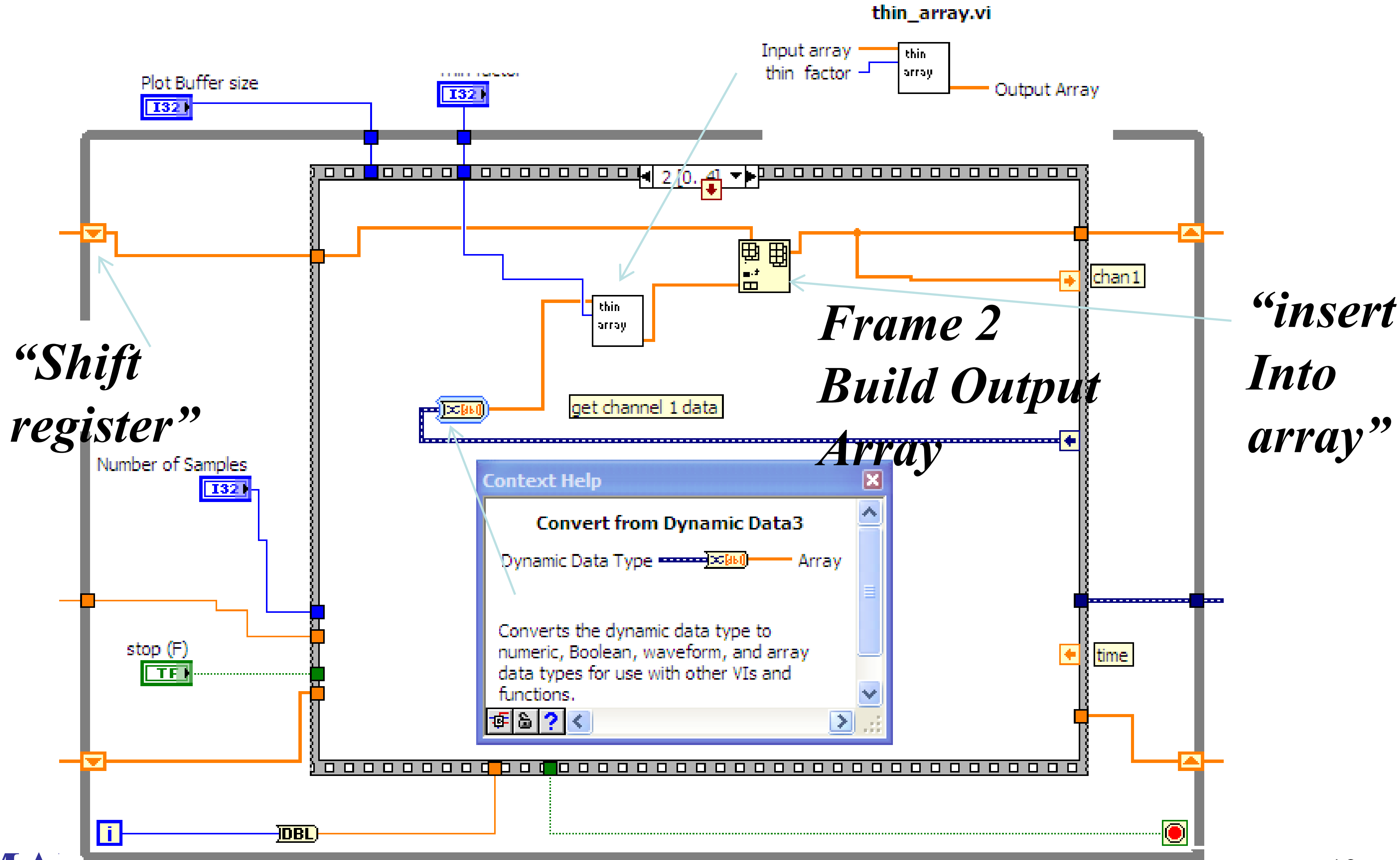
Example VI Read a Load Cells and Plots Data



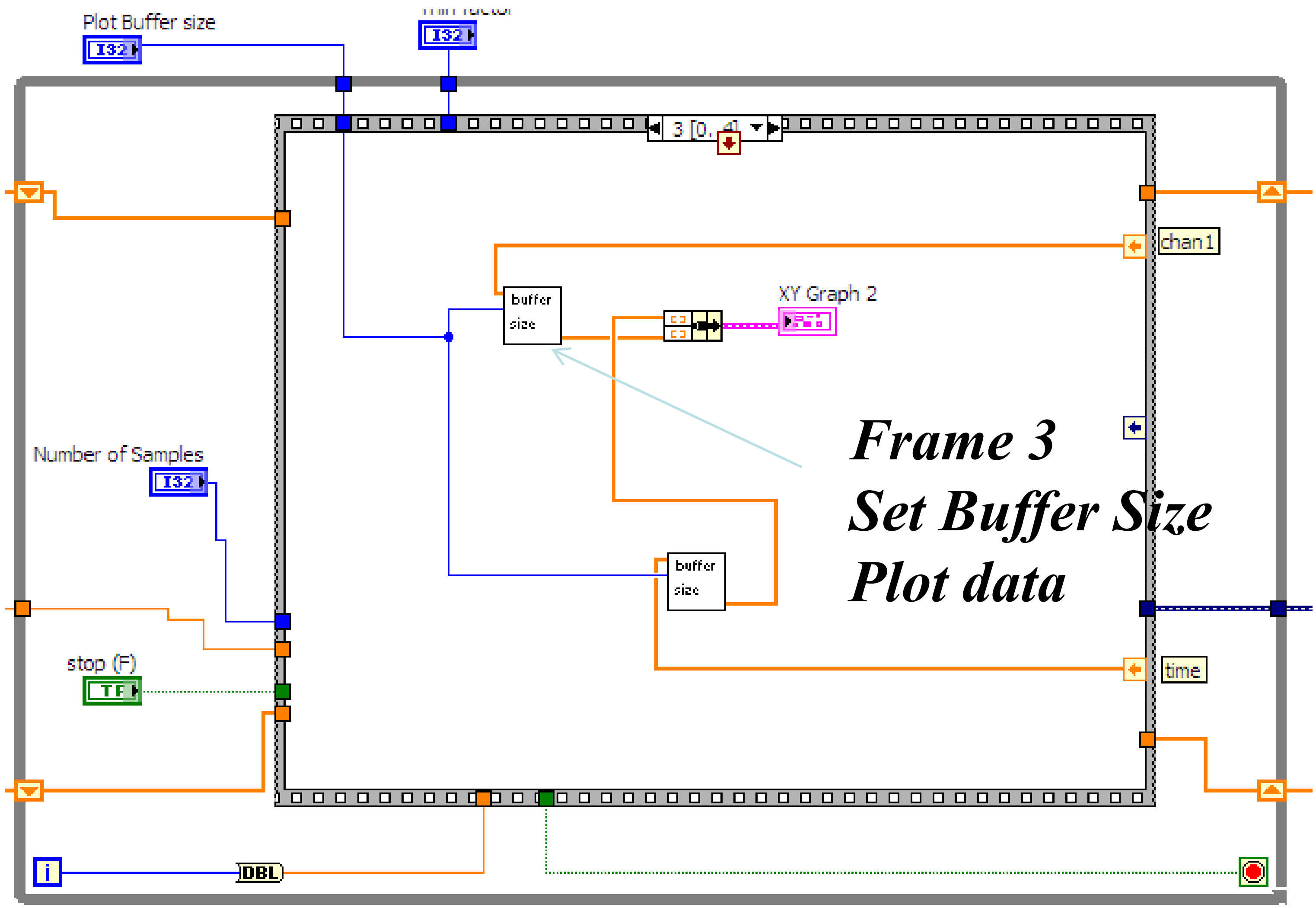
Example VI Read a Load Cells and Plots Data (2)



Example VI Read a Load Cells and Plots Data (3)



Example VI Read a Load Cells and Plots Data (4)



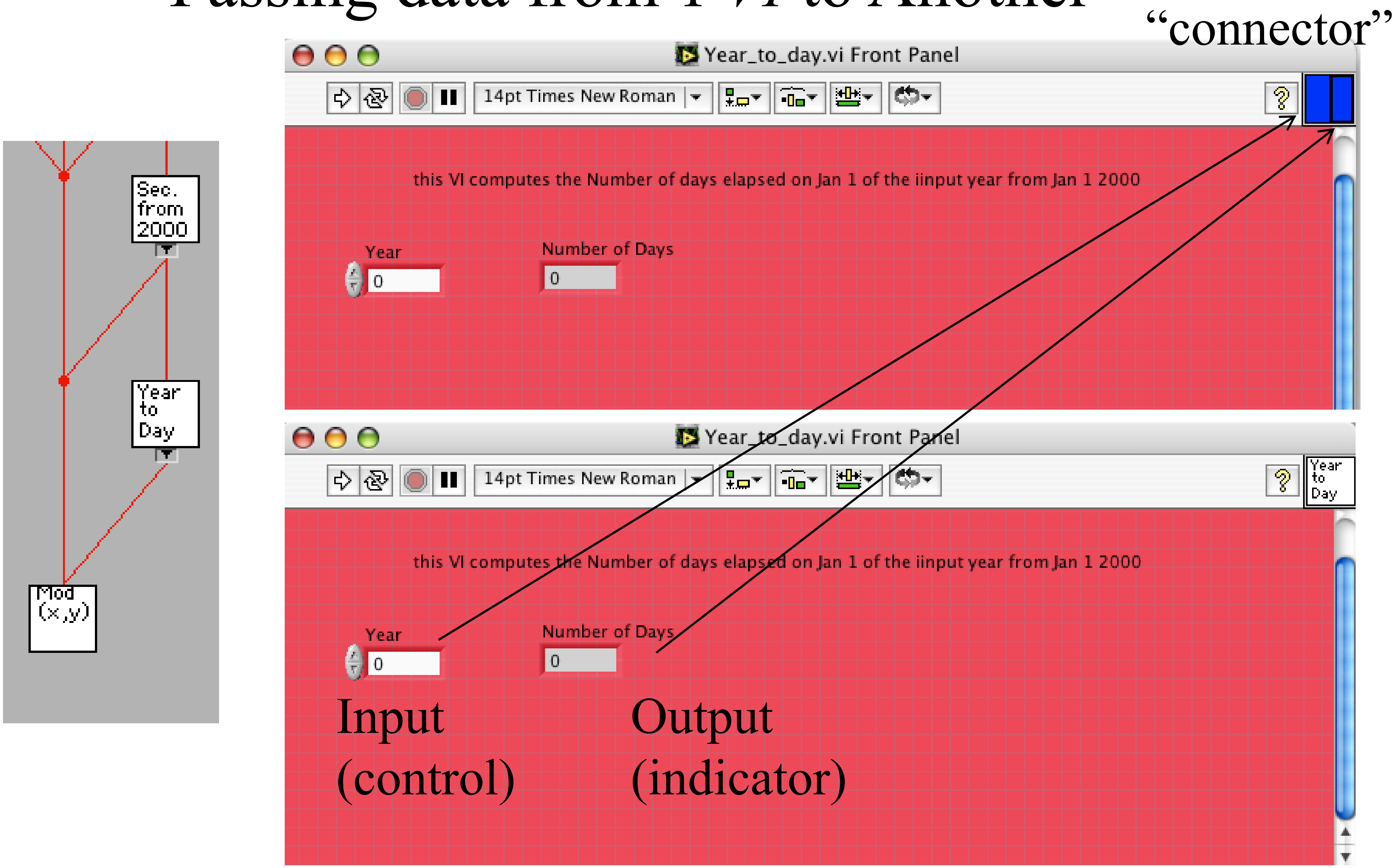
Labview Programming Tips

- **Labview is a Object Oriented Programming Language .. Computational sequence is Data Driven**

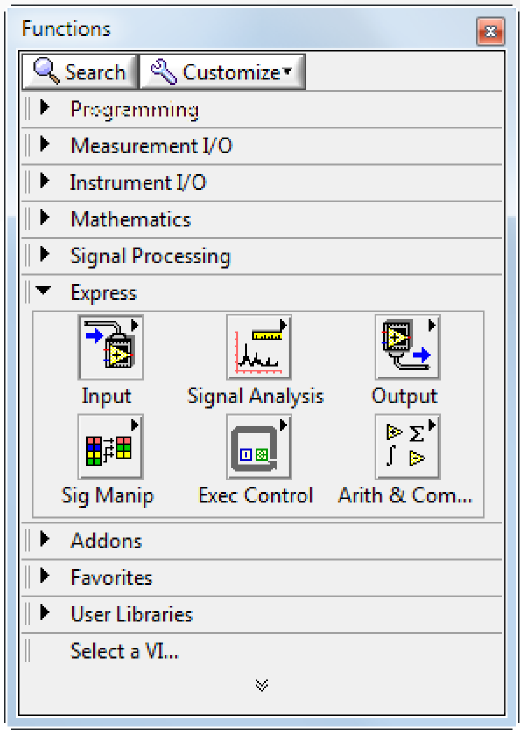
- **Each Object can work by itself or as a stand alone**

- **Calculations are passed from one linked object To another to build *truly complex* programs**

Passing data from 1 *VI* to Another

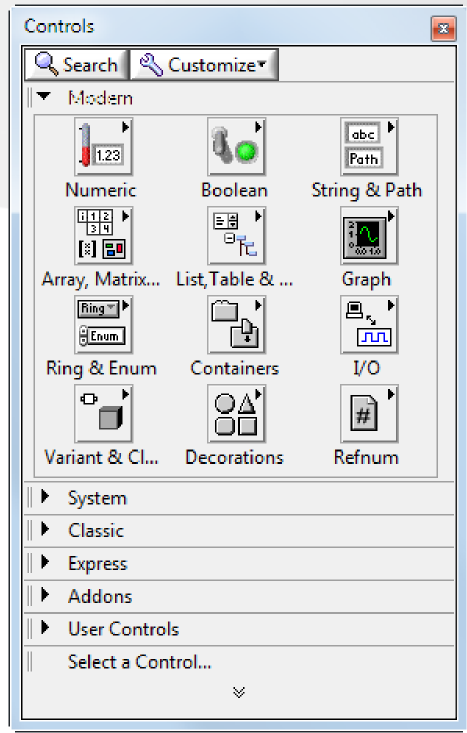


Function and Controls Palettes



Functions Palette:

Found on Block Diagram



Controls Palette:

Found on Front Panel

Tools Palette:

View >> Tools Palette

Use the "Search" buttons
At the top of the palettes
to find functions and controls

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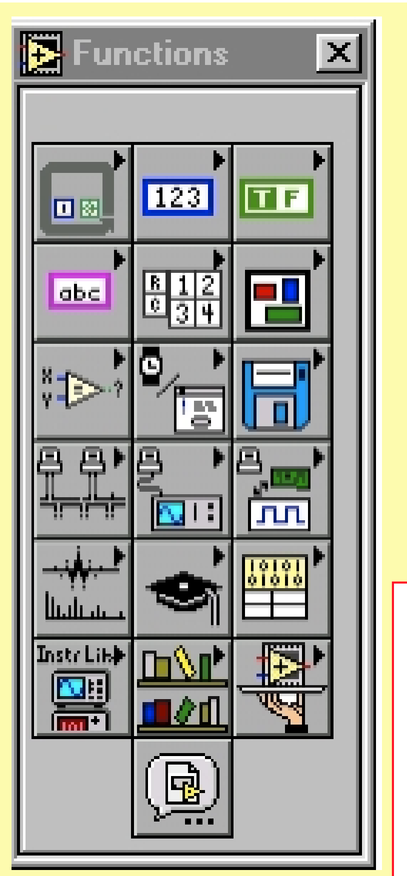
Labview for Dummies(1)

- *http://www.iit.edu/~labview/Dummies.html*

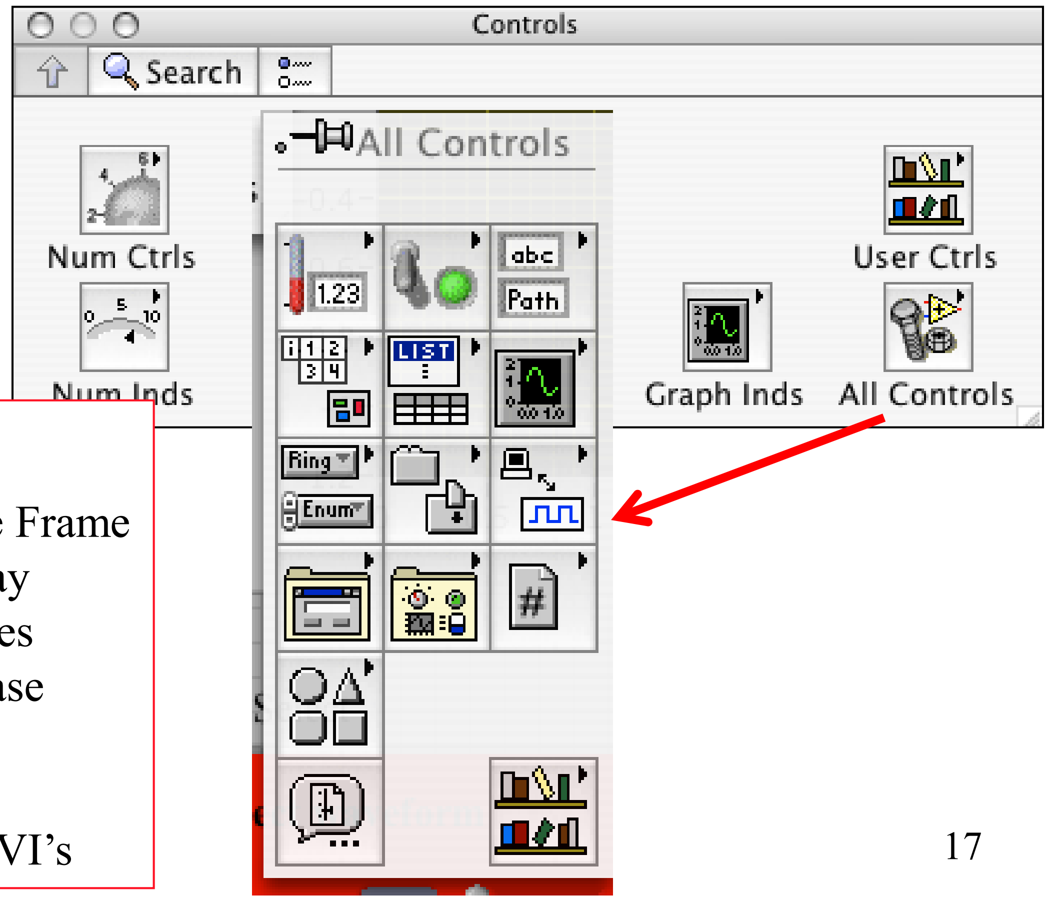
Execution bar

Functions Pallett



Tools Pallet

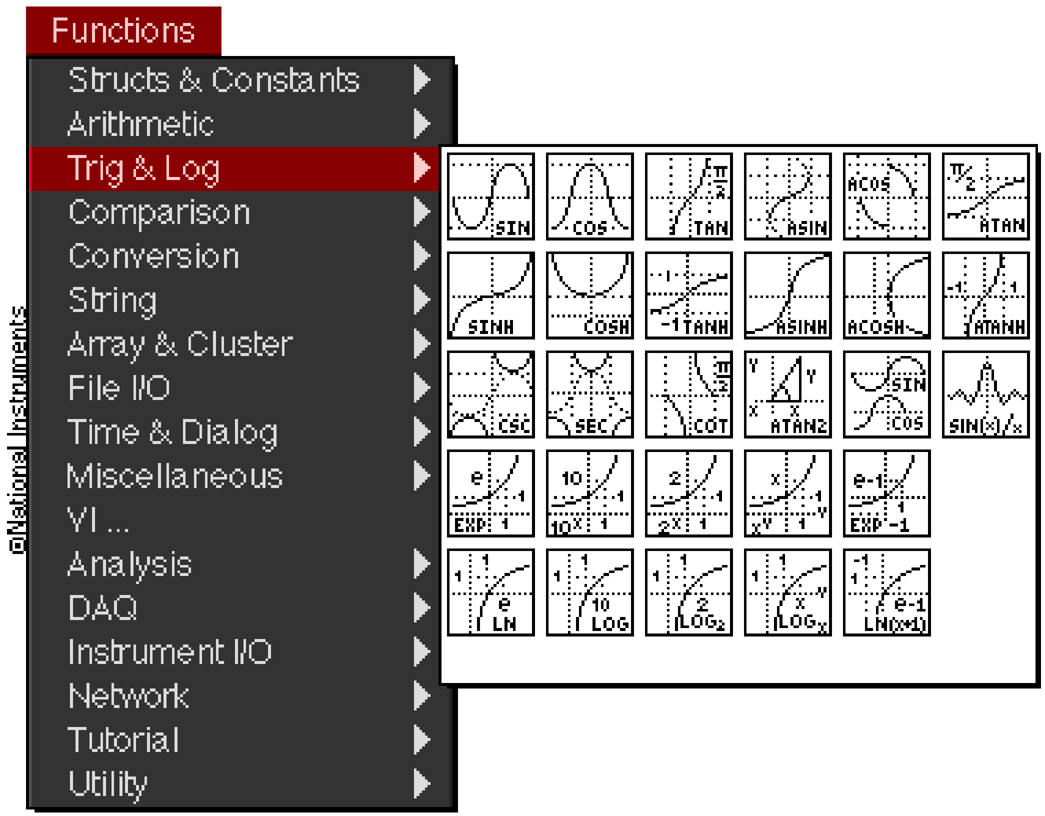
Controls Pallet



- Key skills:
  - Sequence Frame
  - Data Array
  - Data Types
  - Loops/Case
  - Clusters
  - Graphs
  - External VI's

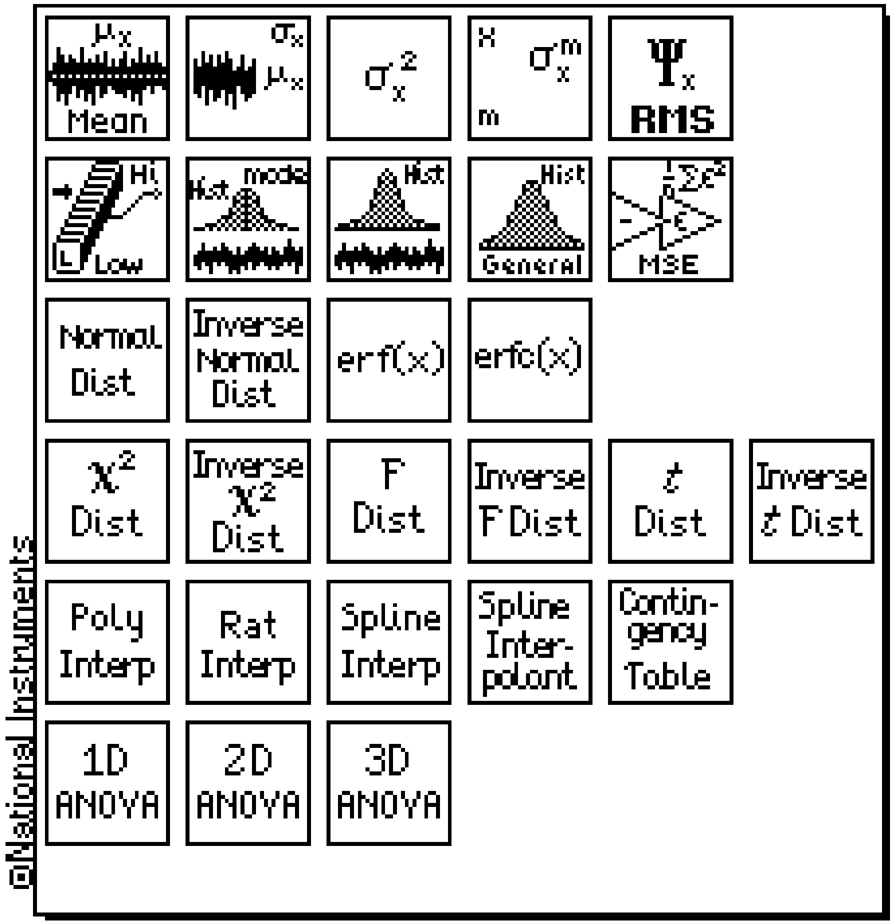
Labview Functions

- Labview contains multiple *intrinsic libraries* that aid with acquisition data display, processing, and analysis

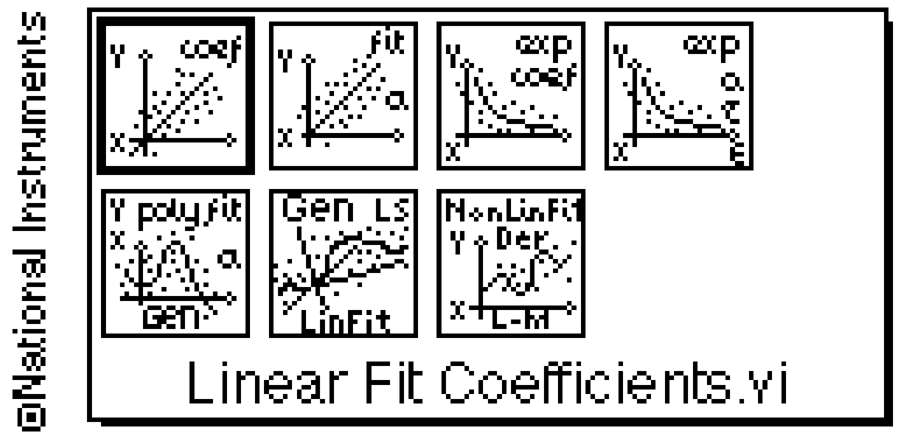


- Example: Trigonometric Functions

Labview Functions (cont'd)



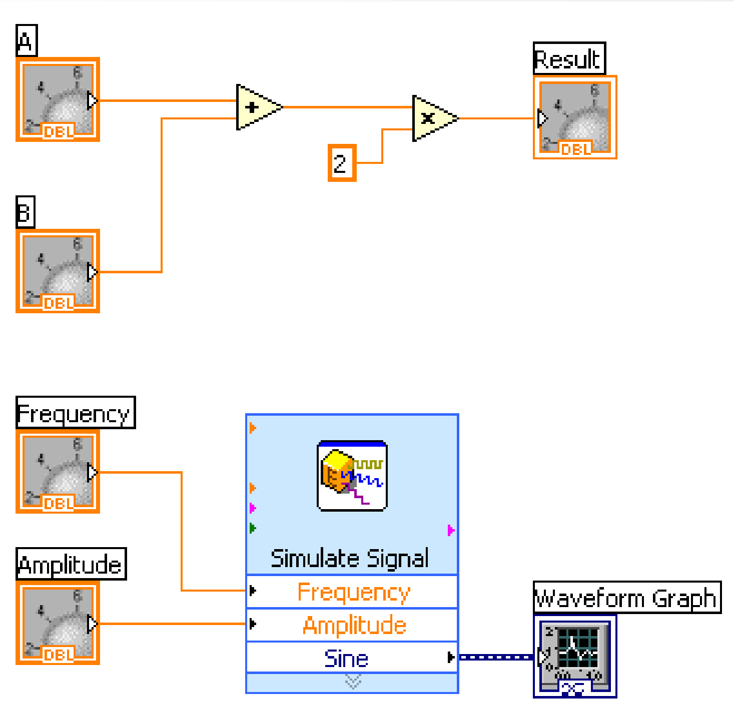
- Example: Statistical Analysis Functions



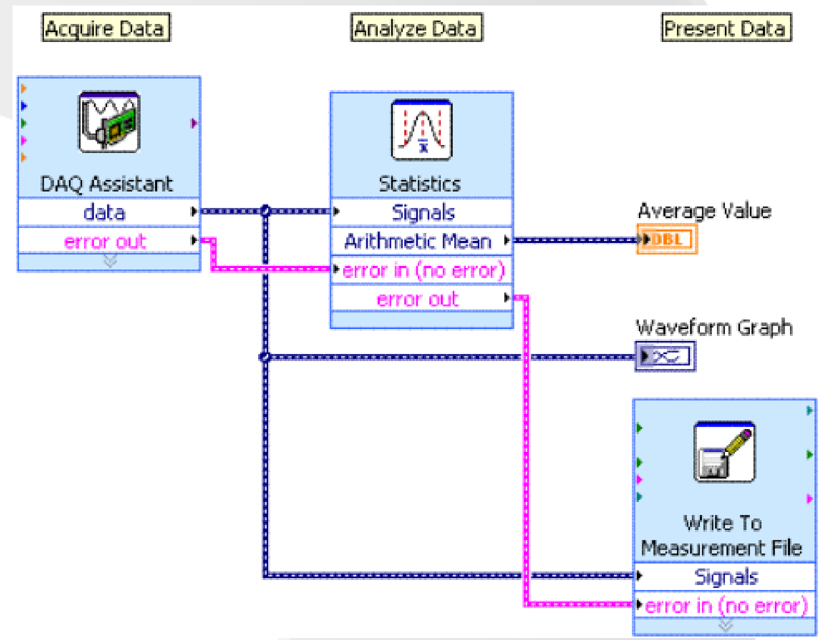
- Example: Curve Fit Functions

Dataflow Programming

Which VI(s) will execute first?



Which VI will execute last?



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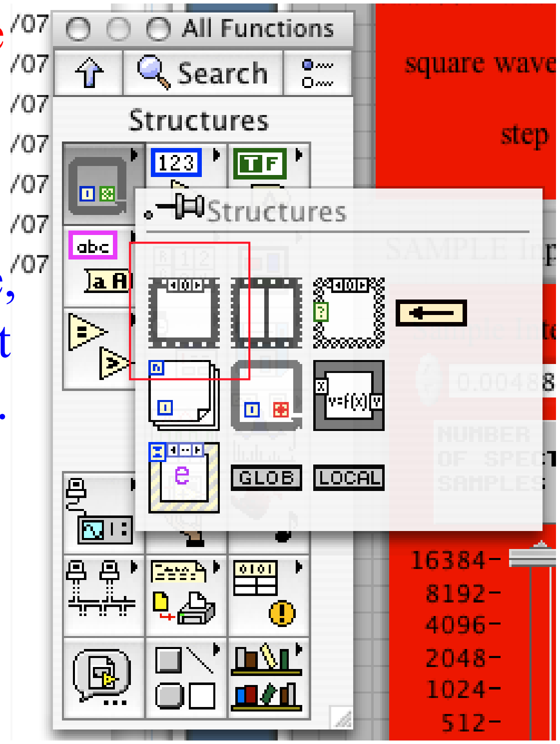
Sequence Frame

• A *Sequence Frame*, which looks like a piece of film, performs an operation after one has been completed, say after acquiring the data, analyze the data. To add a Sequence frame, right click on the frame and choose Add Frame After *or* Add Frame Before *or* Duplicate Frame. They will be used in sequential order according to the numbering scheme on the top center. Many times you will want the data from a previous frame to be used in a later sequence, Add Sequence Local, where you can attach any wire to be brought out in a later frame. An arrow will show the direction of data flow. If you move a sequence local, it will move the same way in the Other frames.

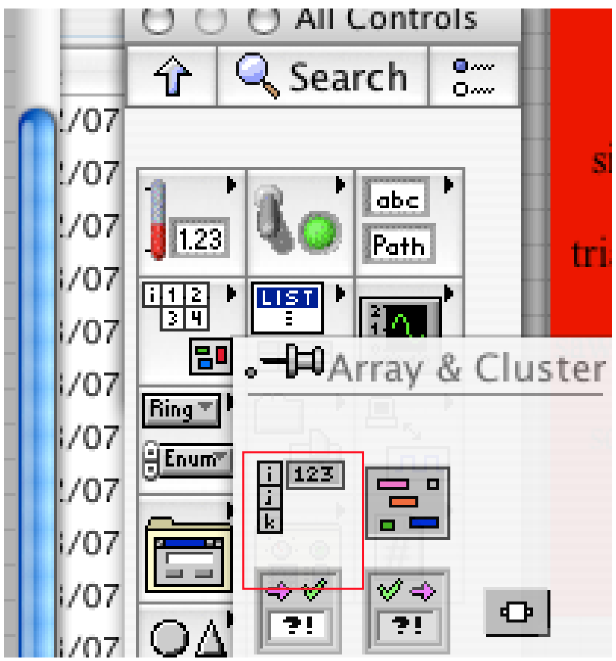


• Use of these structures is essential to keep code readable Every VI shpuld have a main sequence in which all other operations or nodes are embedded

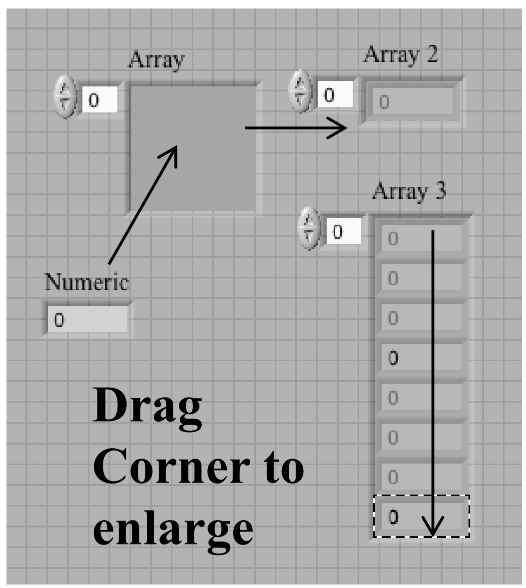
Data Array

•Arrays are invaluable. Nearly every application will need them. You can define vectors (a 1-D array) or matrices (a 2-D array) or a general N dimensional array, like tensors.

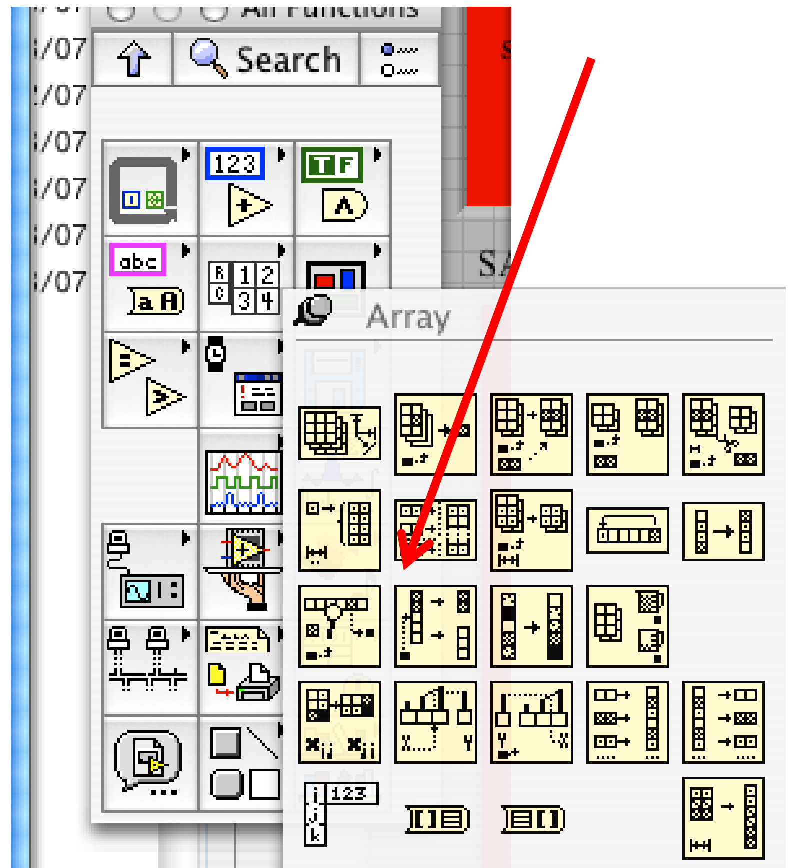
• *Build Array Control on Front Panel*



• Drag Control / indicator to array



• *Build Array in Block Diagram*



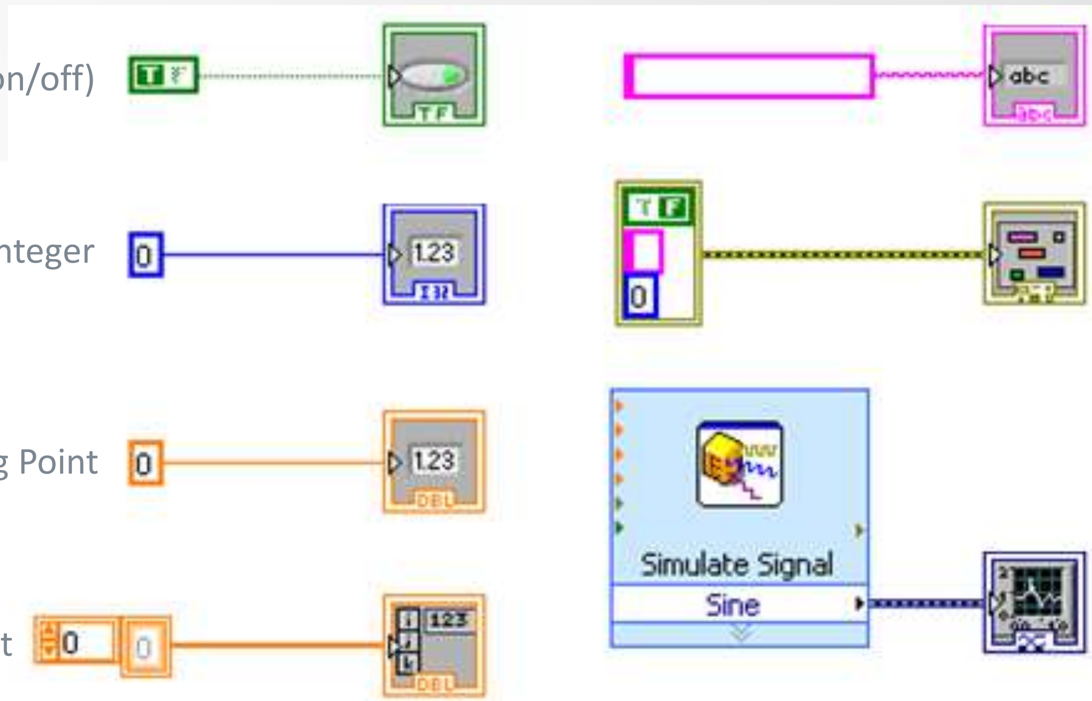
Data Types

Boolean (on/off)

Integer

Floating Point

Array of Floating Point



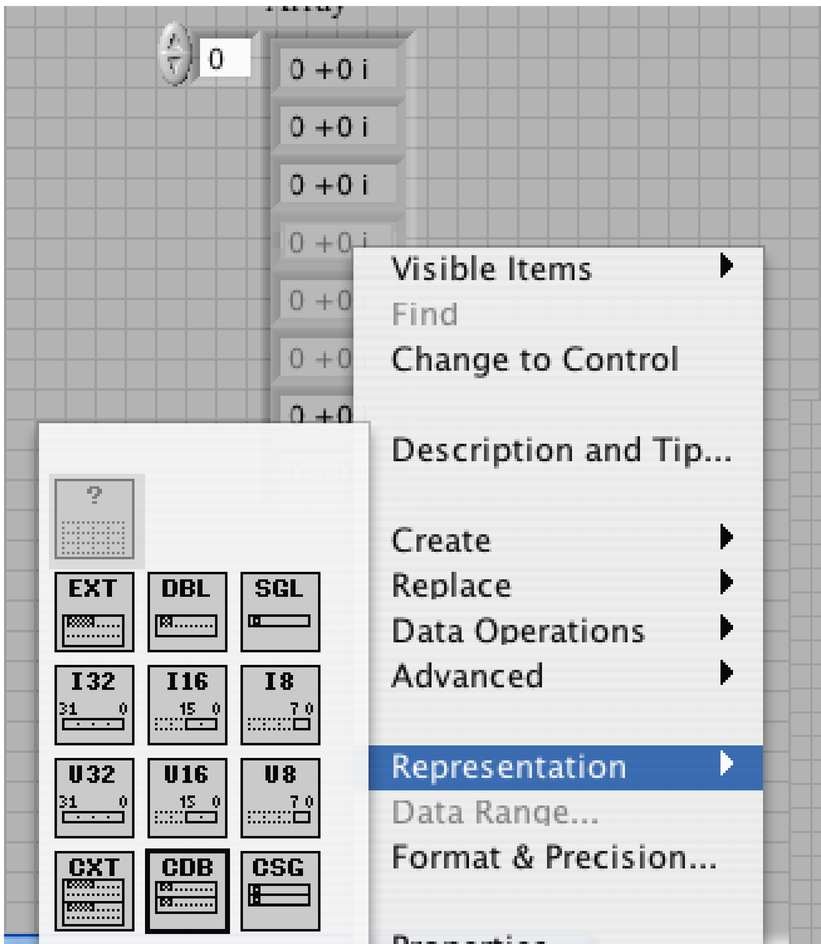
String (text)

Error Cluster

Dynamic

Data Types

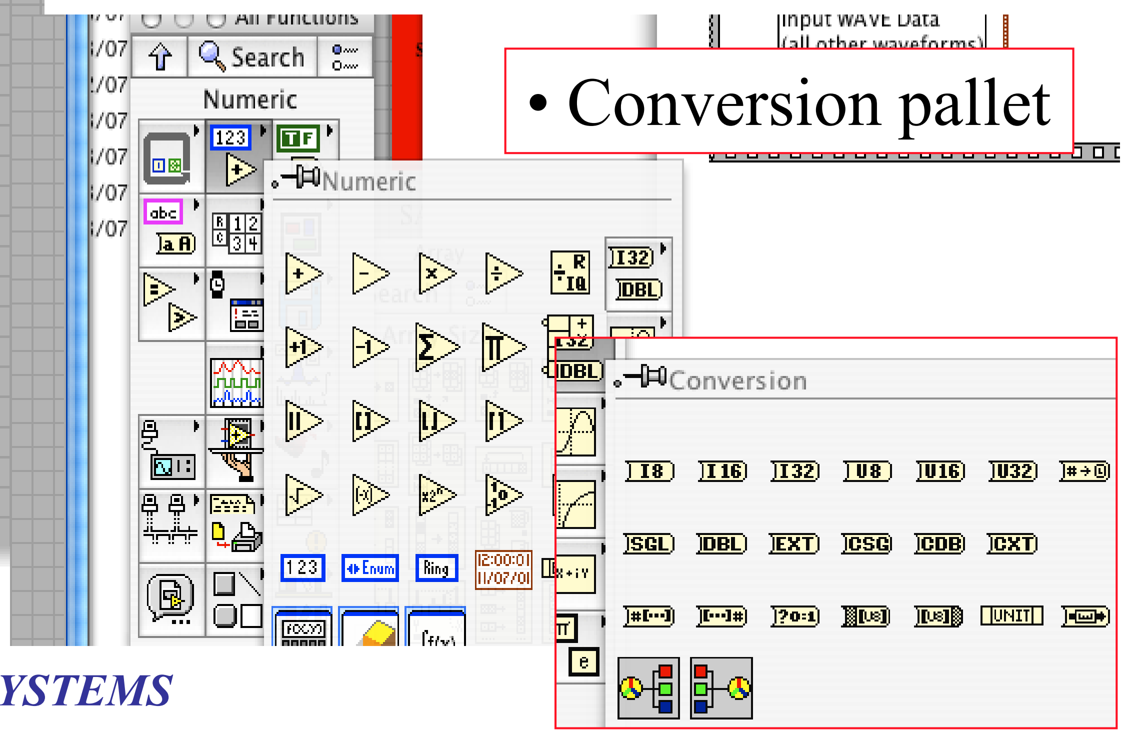
- Data Types represent how data are stored internally in the computer



- Right click on control Or indicator

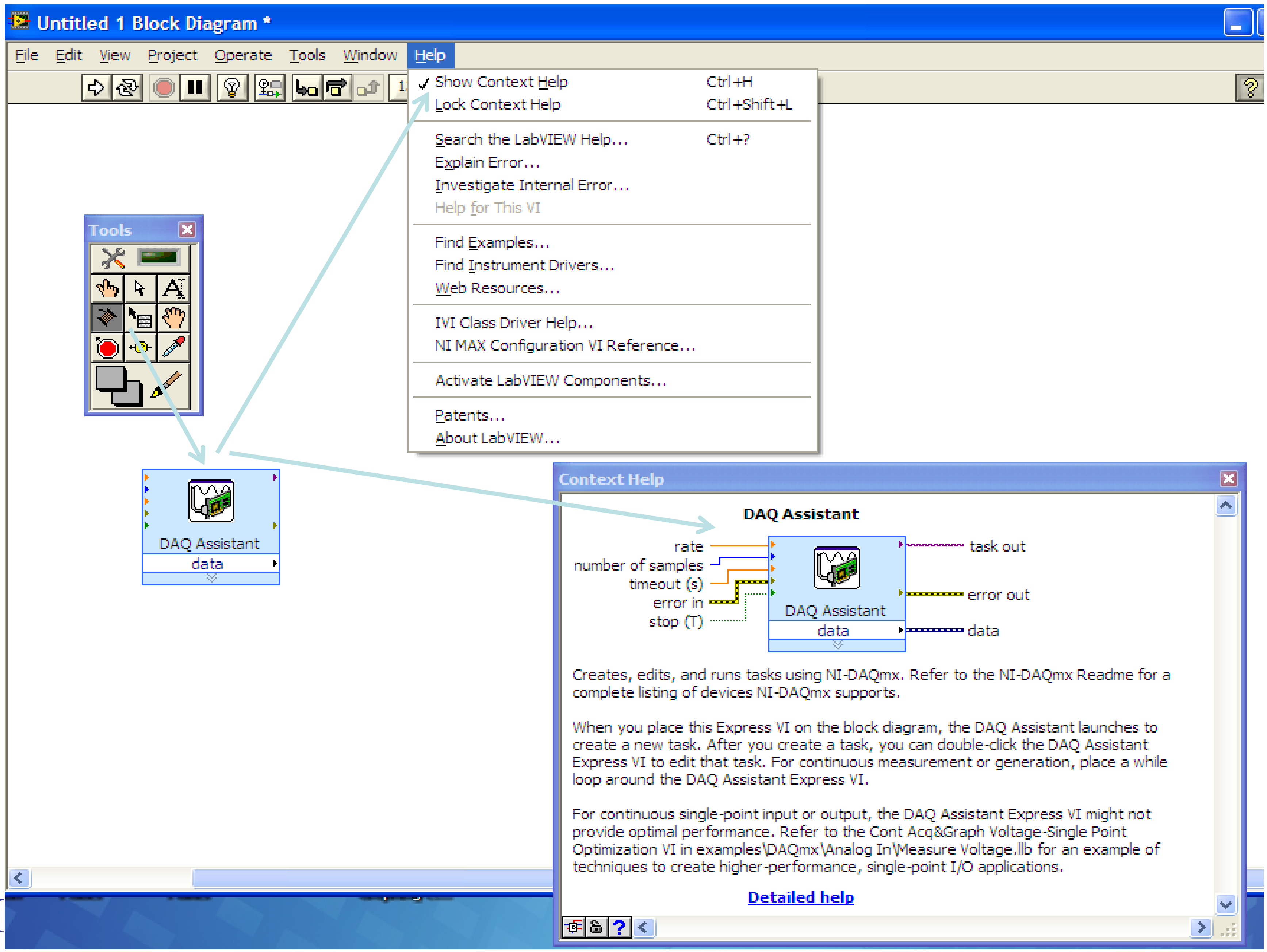
Representation … choose Data type

DBL … double precision real … (waveform)
I32 …. Double precision int (book keeping)
CDB … Double ***precision complex (spectrum)***



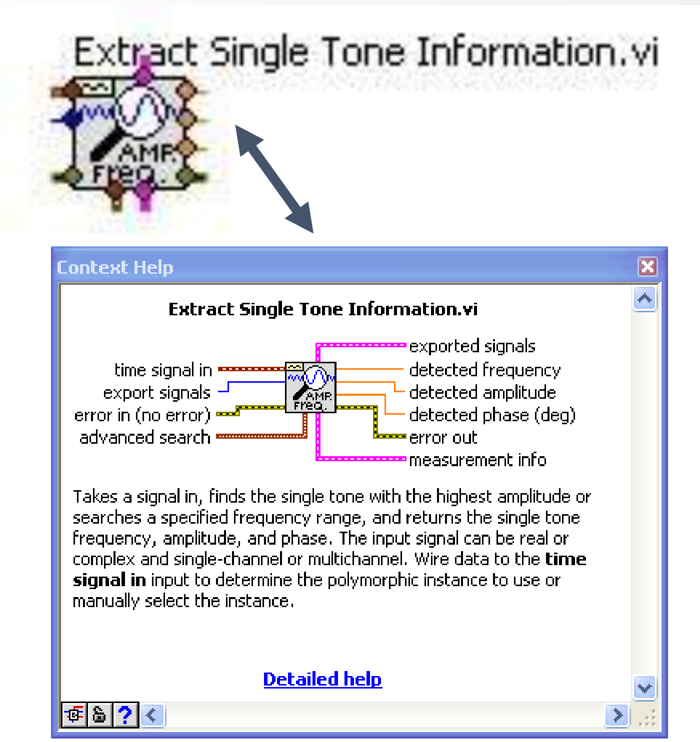
- Conversion pallet

Context Help Guide

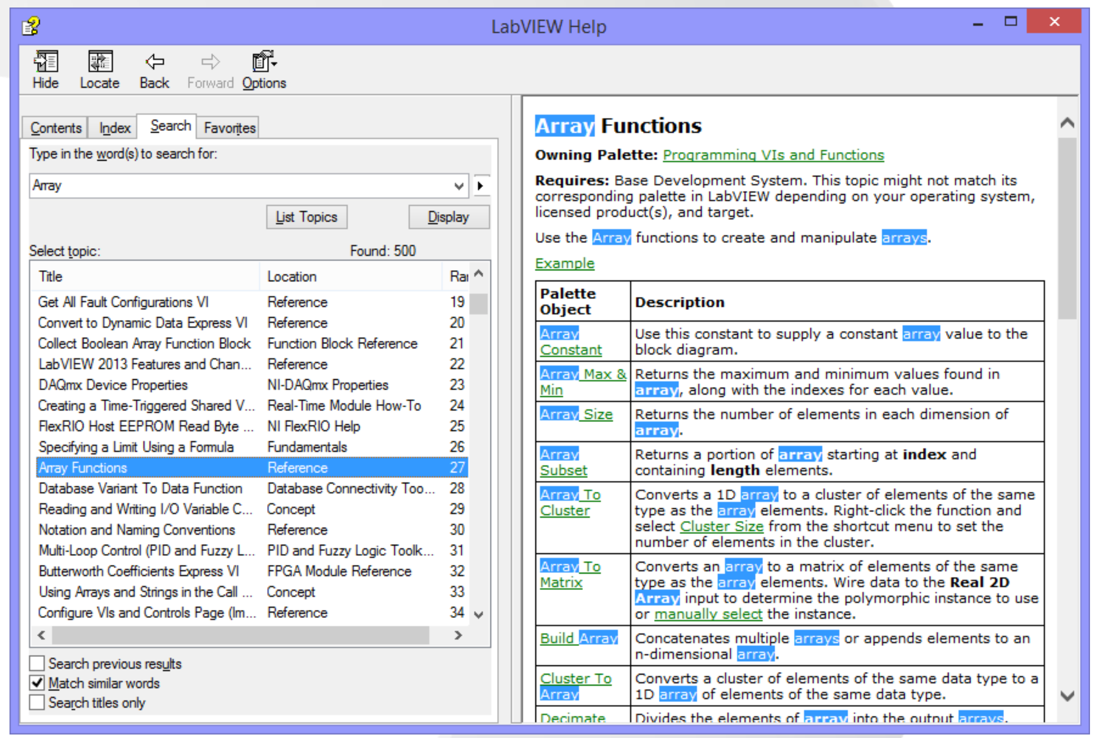


Help

Context Help Window: Ctrl-H

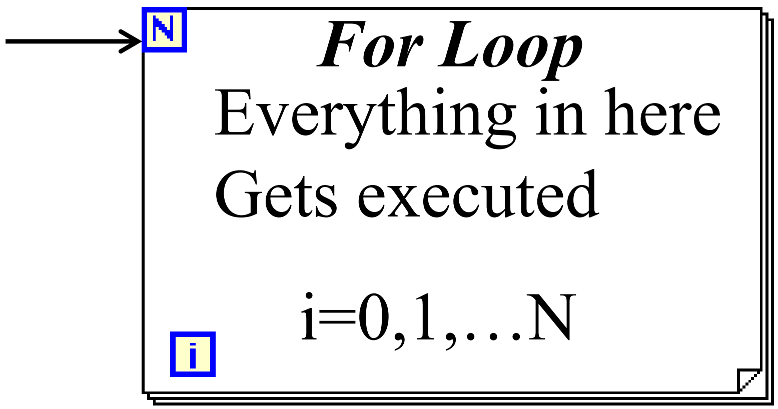


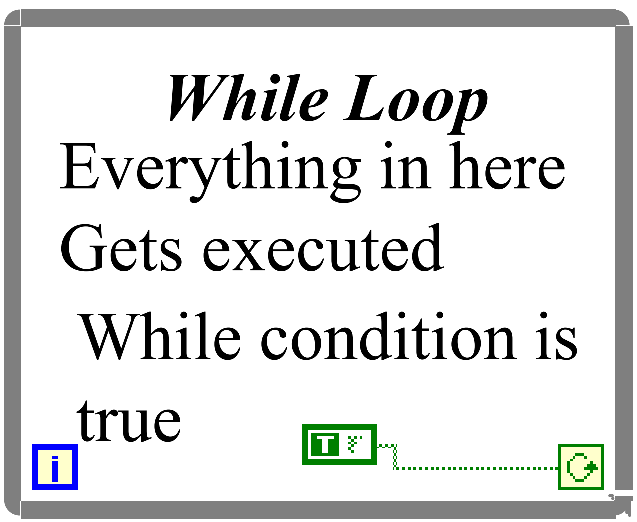
LabVIEW Help: Help >> LabVIEW Help

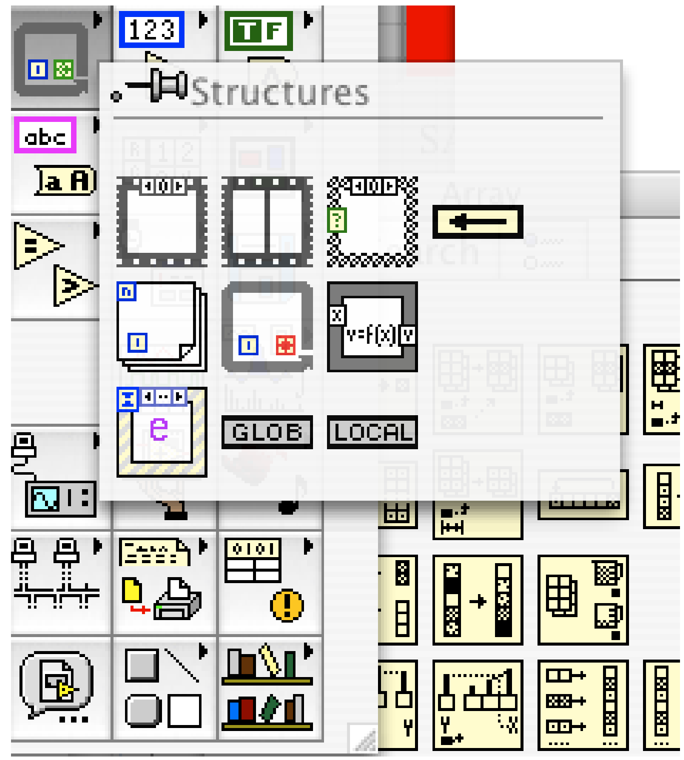


Loops/Cases (1)

- Loops *for, while* … similar to loops in FORTRAN and C++







Loops/Cases (1)

- Loops *for, while* … similar to loops in FORTRAN and C++

For Loop

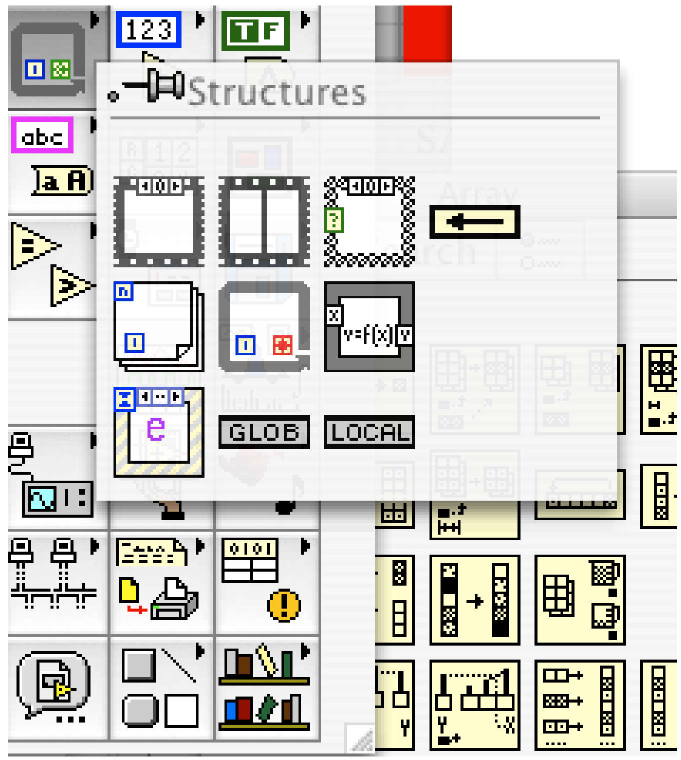
Everything in here
Gets executed

i=0,1,…N

While Loop

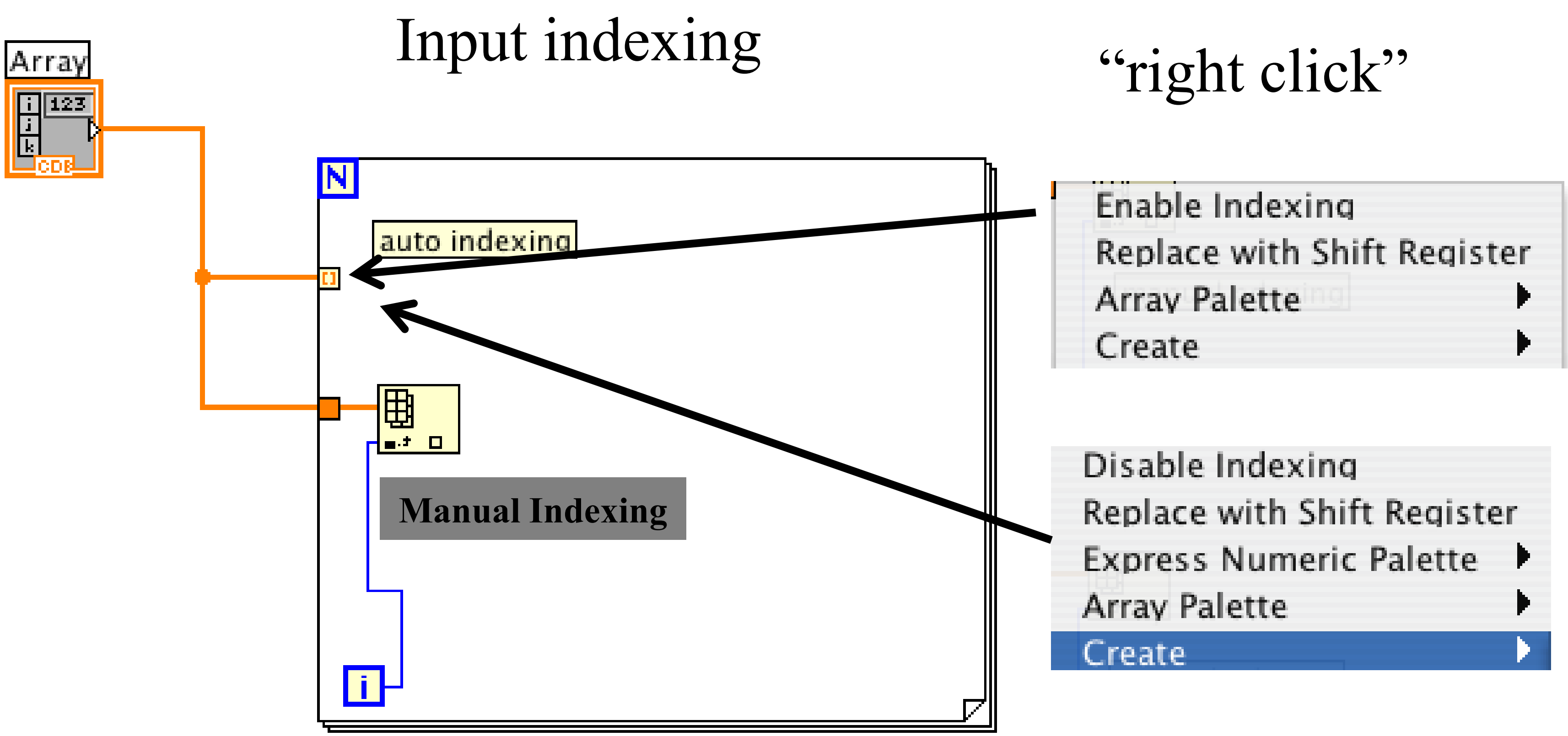
Everything in here
Gets executed

While condition is true



Loops/Cases (Input Indexing)

- Auto/manual indexing … within *for/while* loop



Loops/Cases (Output Indexing)

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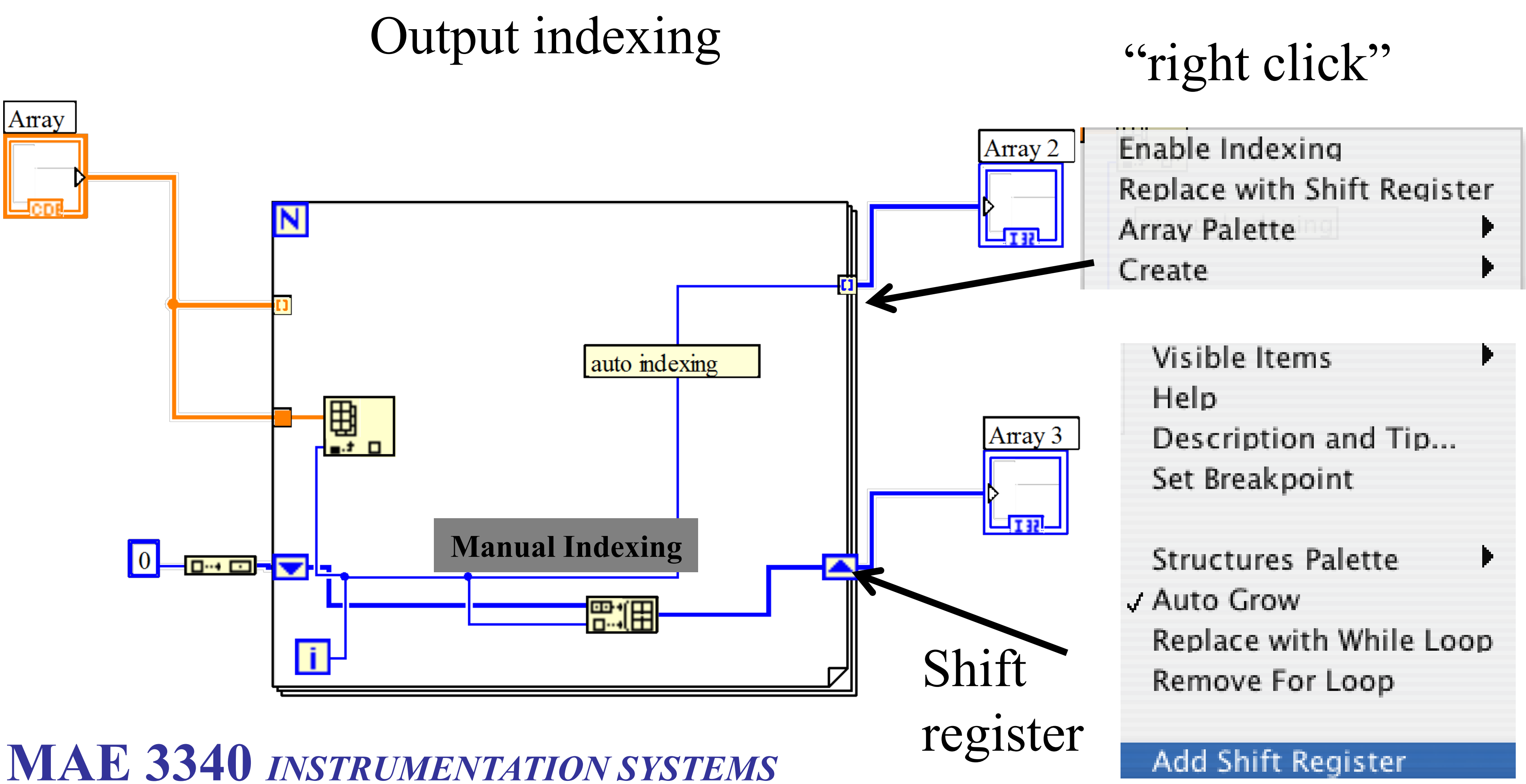
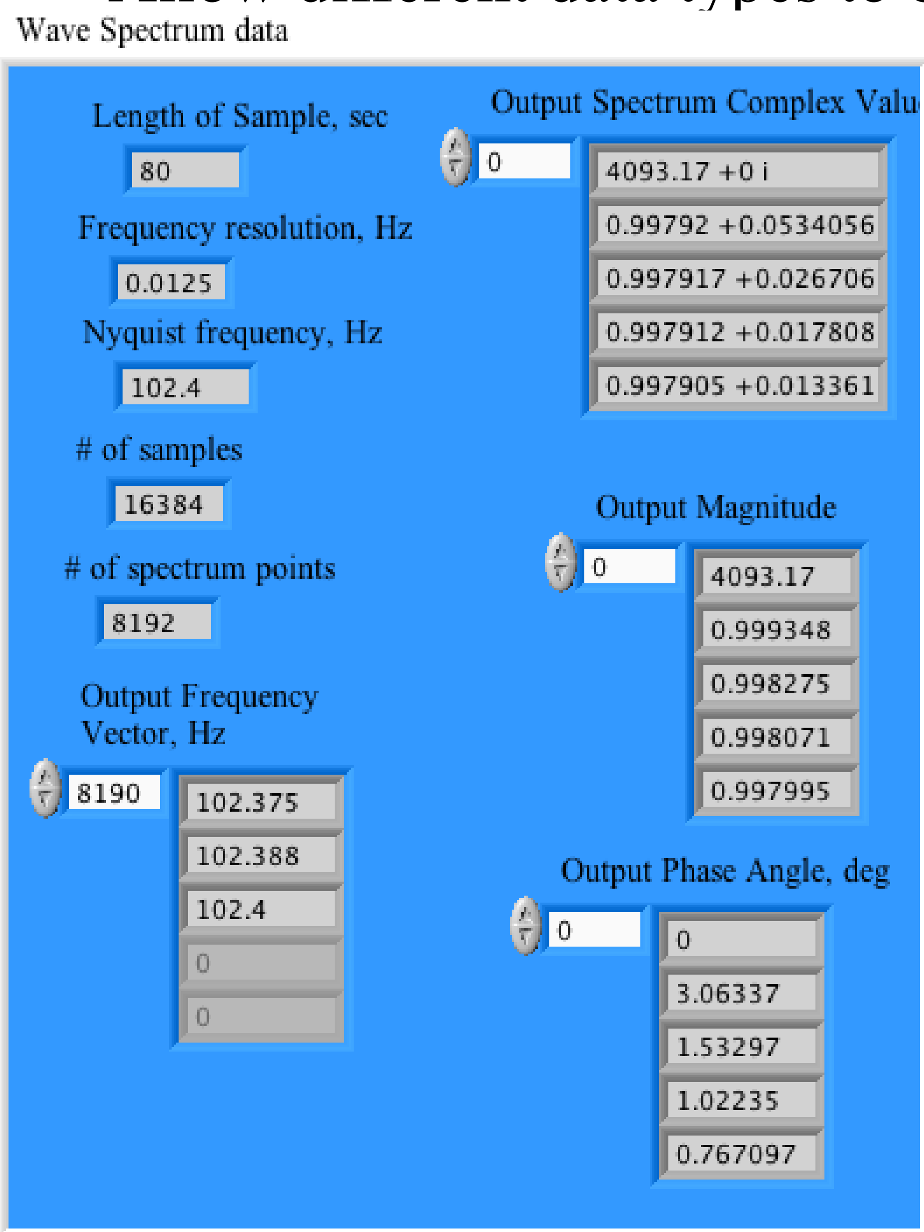
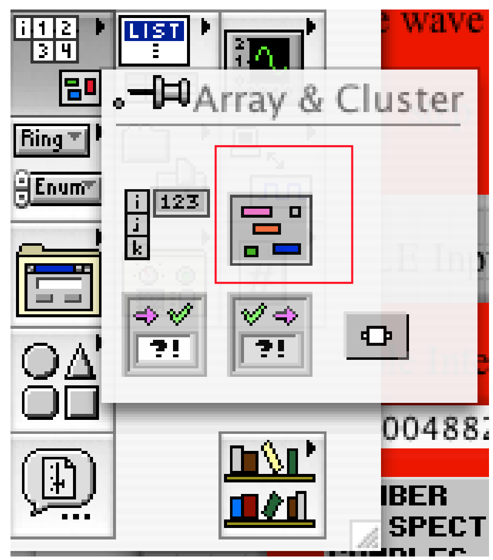


Clusters (1)

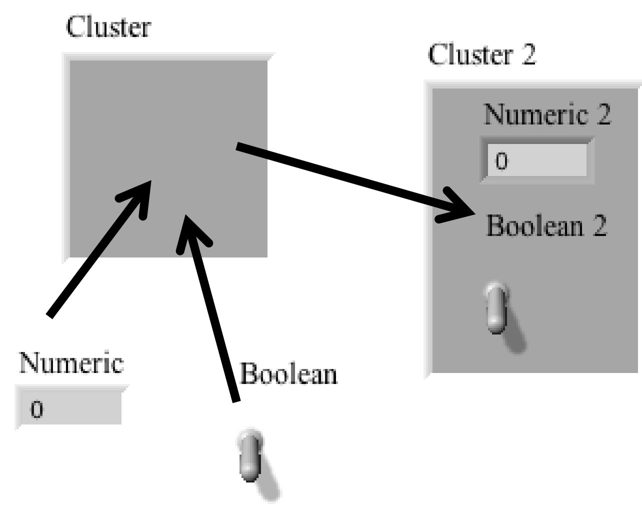
- Allow different data types to be grouped together



Controls pallet (control panel)



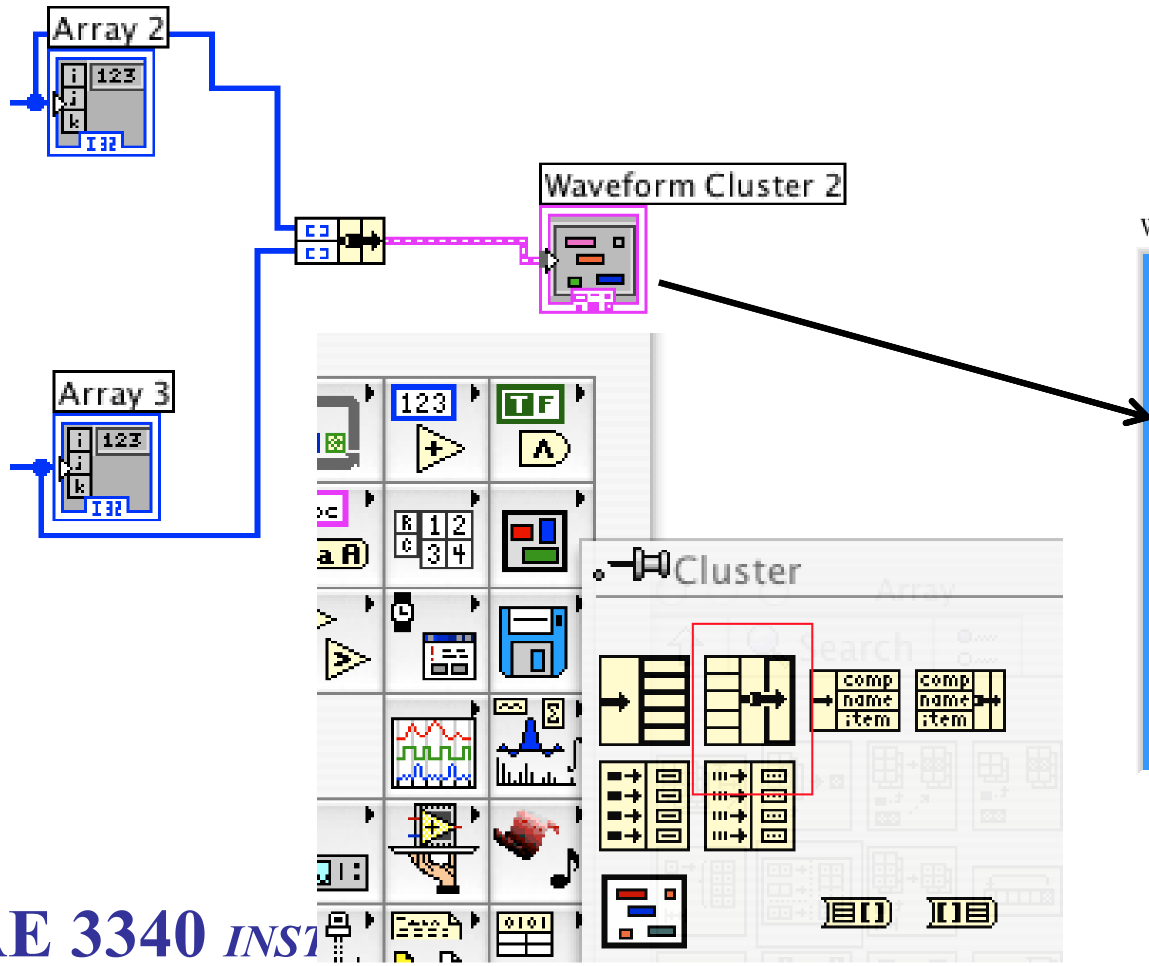
- Drag build
Similar to
Array control



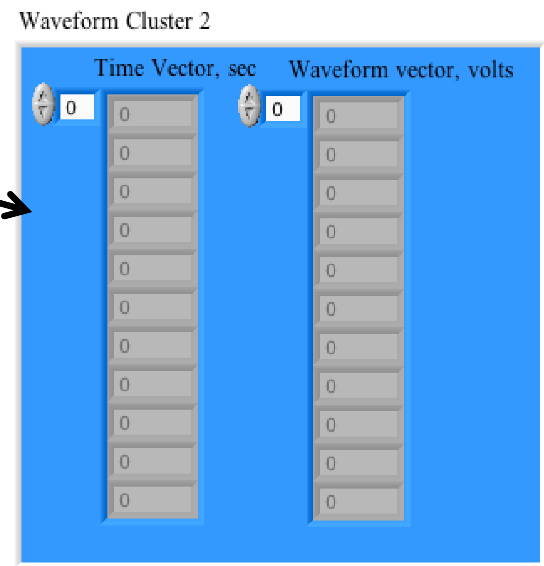
Clusters (2)

- Inserting Elements in a Cluster

  Functions Pallet (block diagram)



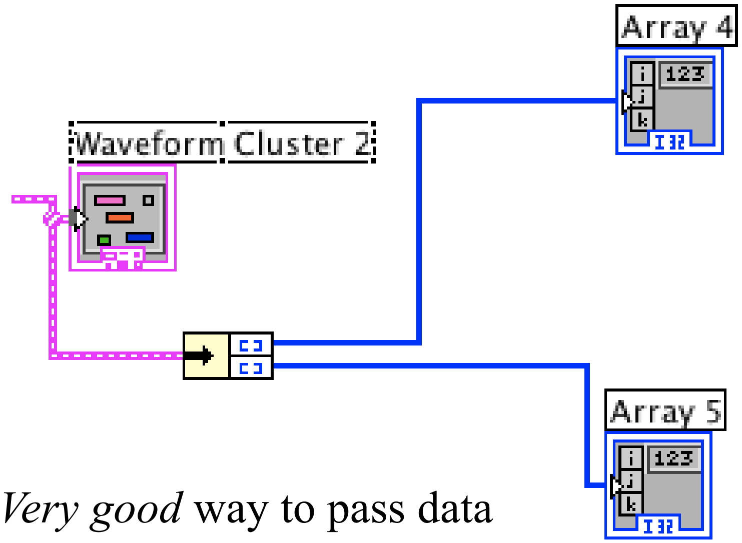
On Control panel

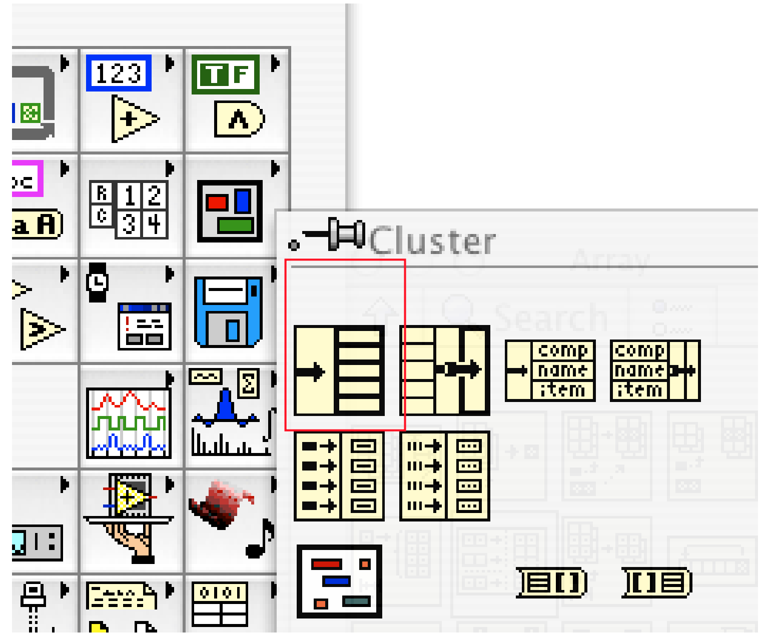


Clusters (3)

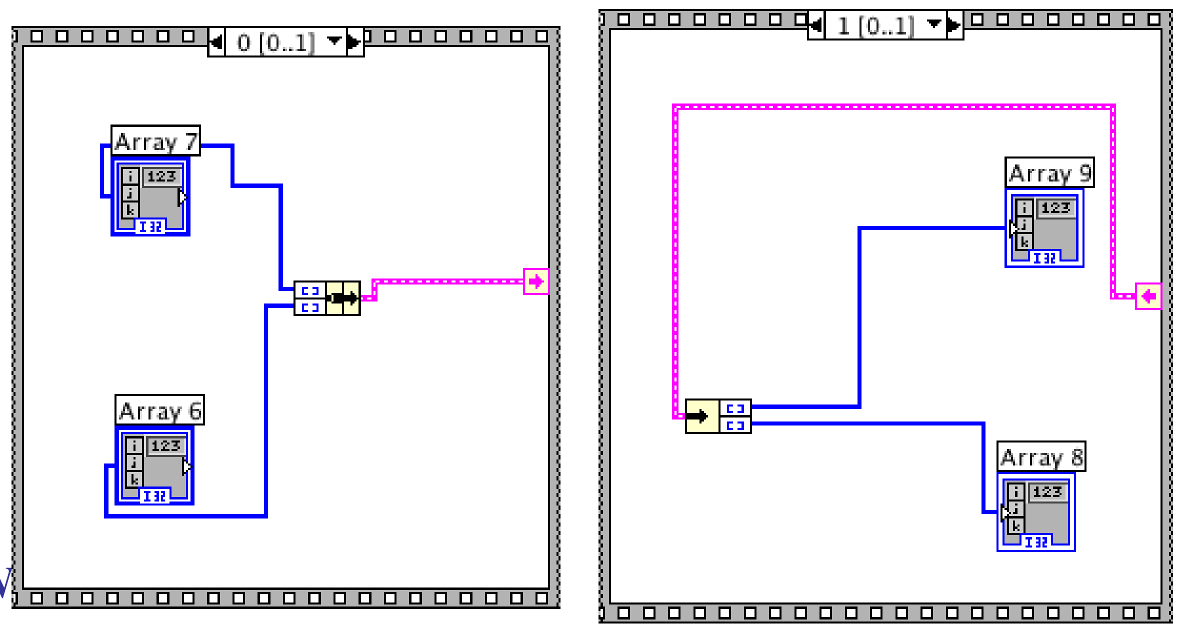
- Extracting Elements from a Cluster

diagram)





Very good way to pass data from one frame to another … makes for more readable code



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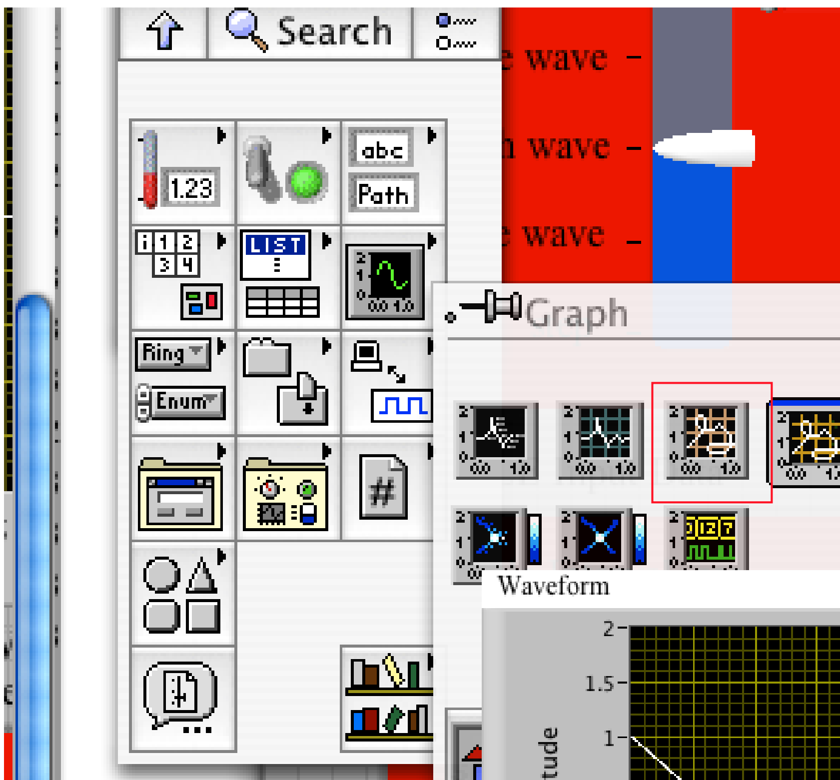
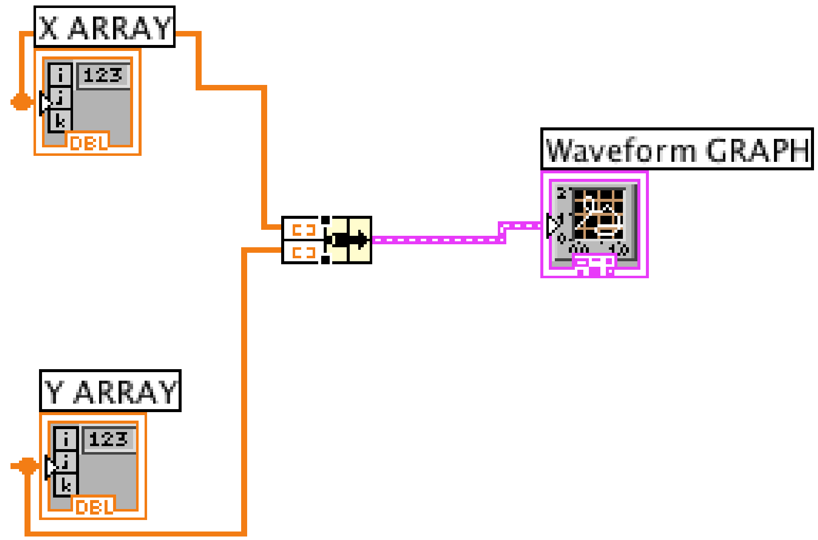
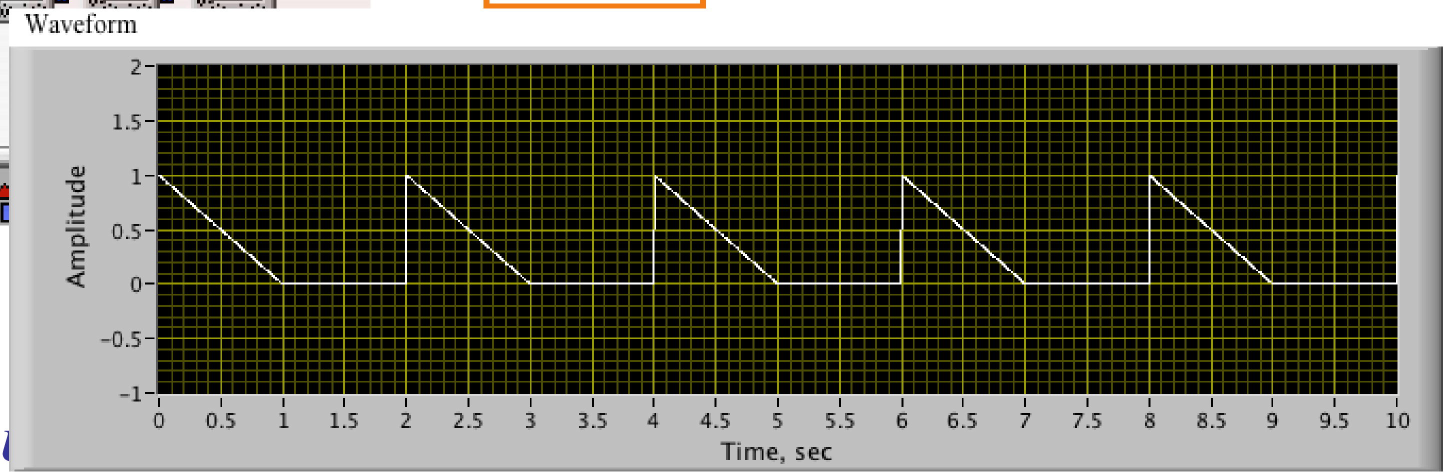
Graphs (1)

- Most Valuable is X/Y Plot

Plots X and Y vectors against each other

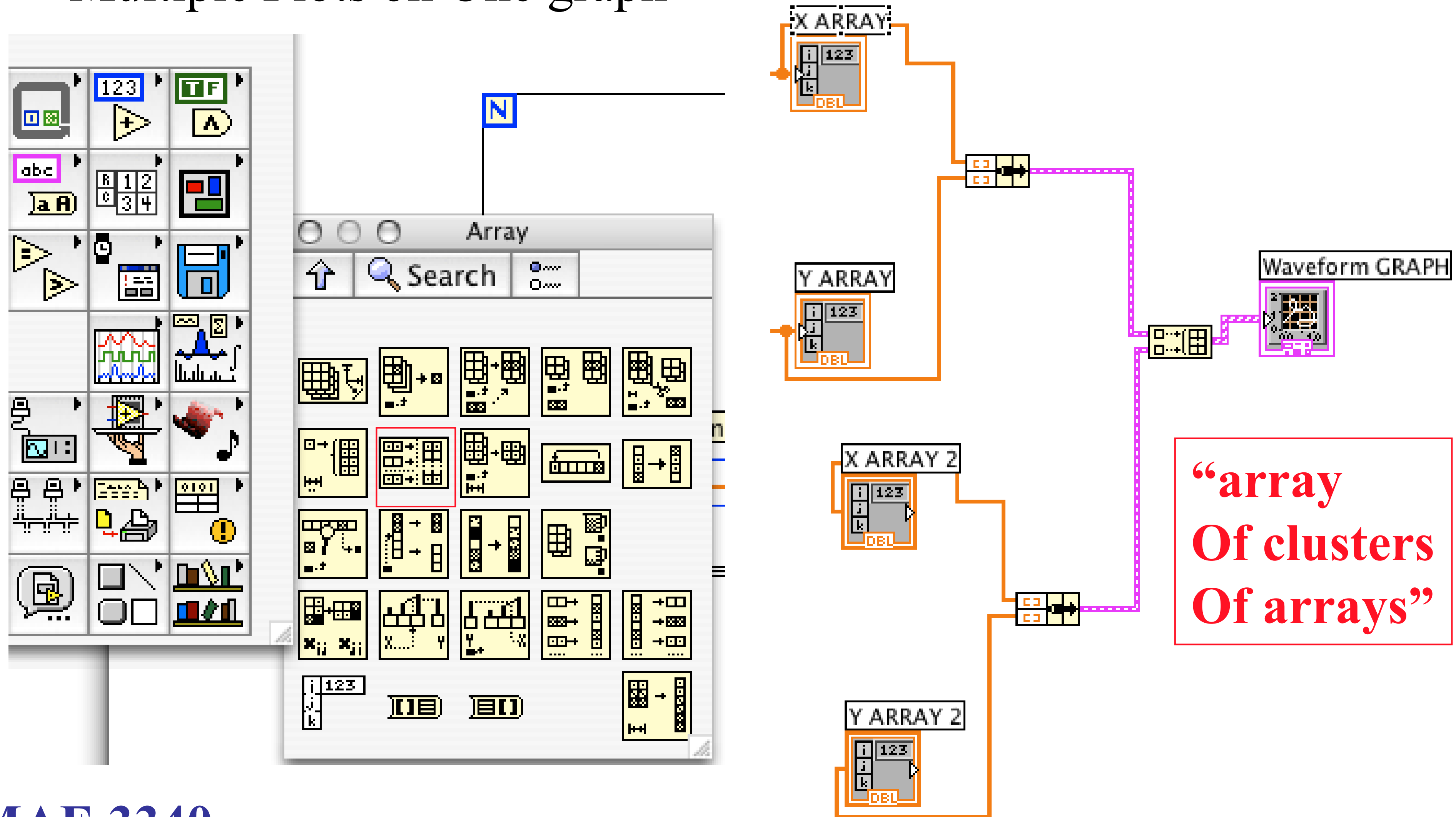






Graphs (2)

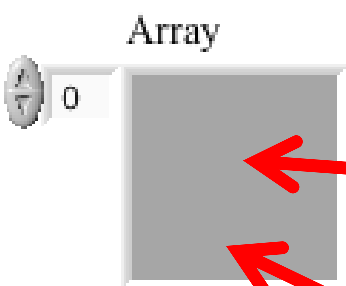
- Multiple Plots on One graph



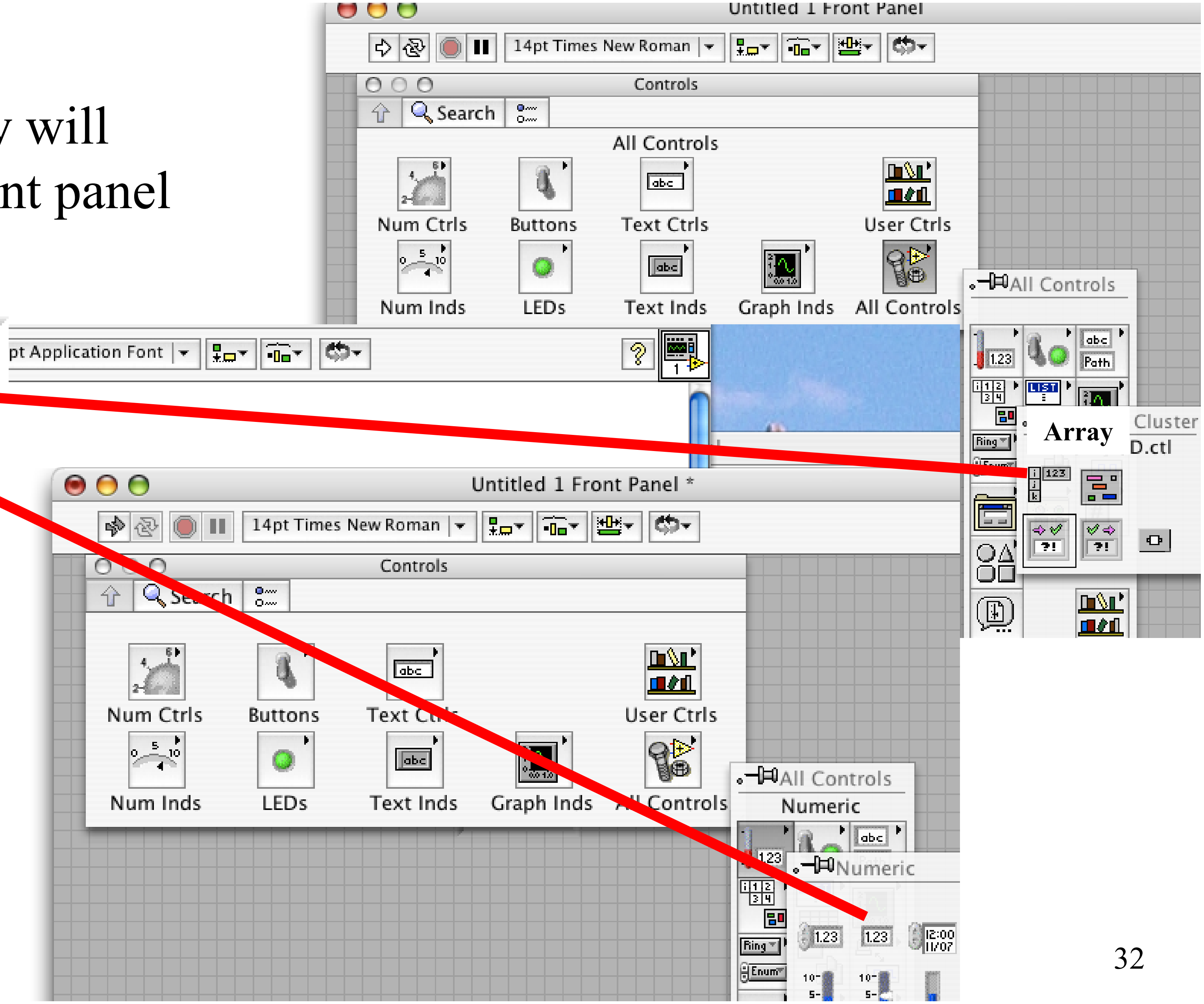
"array Of clusters Of arrays"

Plotting Data Using Labview Arrays (1)

- Empty array will appear on front panel

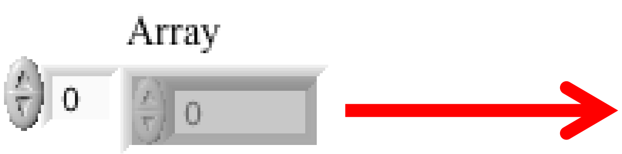


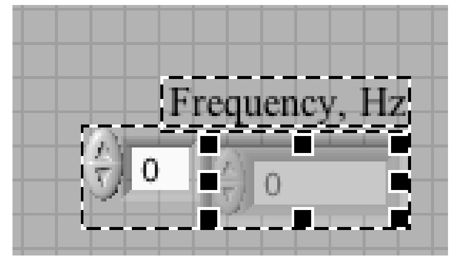
- Drag real indicator into array



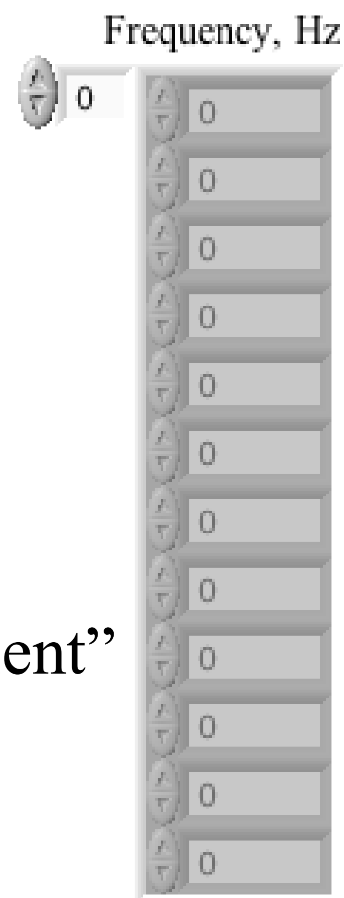
Plotting Data Using Labview Arrays (2)

- Rename Array as "Frequency, Hz"





- Drag down on array To show multiple elements



- Repeat process for an arrays called "Fourier A Coefficient", "Fourier B coefficient" "magnitude", and "Phase"

Arrays as they appear on front panel

Output Frequency Vector, Hz (index: 39)

0.48753
0.500031
0.512532
0.525032
0.537533
0.550034
0.562535
0.575035

$A(\omega_n t)$ (index: 39)

0.000117816
0.202276
0.000126117
0.000124043
0.000123351
0.000123006
0.000122799
0.000122661

$B(\omega_n t)$ (index: 39)

-1.73435E-7
0.318323
-1.52712E-7
-1.52193E-7
-1.4973E-7
-1.46905E-7
-1.44028E-7
-1.41196E-7

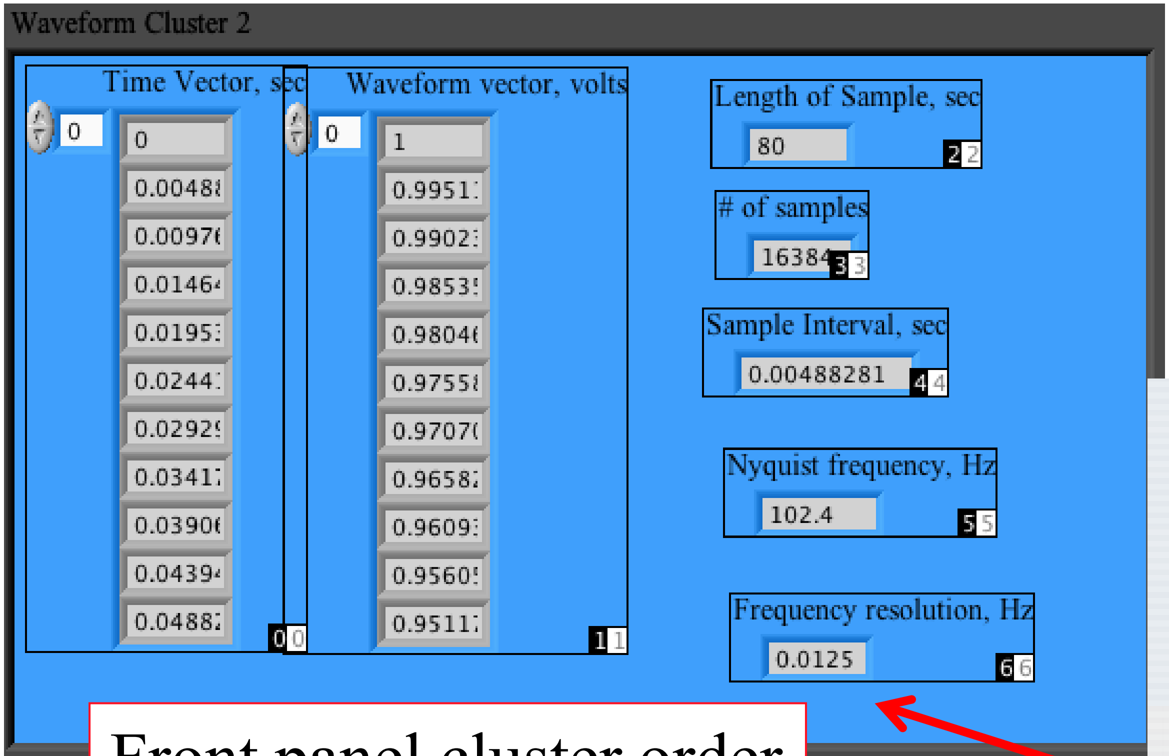
Magnitude (index: 39)

0.000117816
0.202276
0.000126117
0.000124043
0.000123351
0.000123006
0.000122799
0.000122661

Phase Angle, deg. (index: 39)

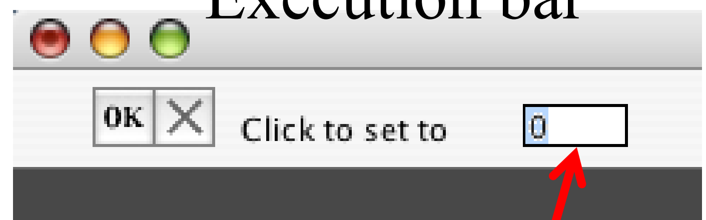
0.000117816
0.202276
0.000126117
0.000124043
0.000123351
0.000123006
0.000122799
0.000122661

Front Panel Cluster

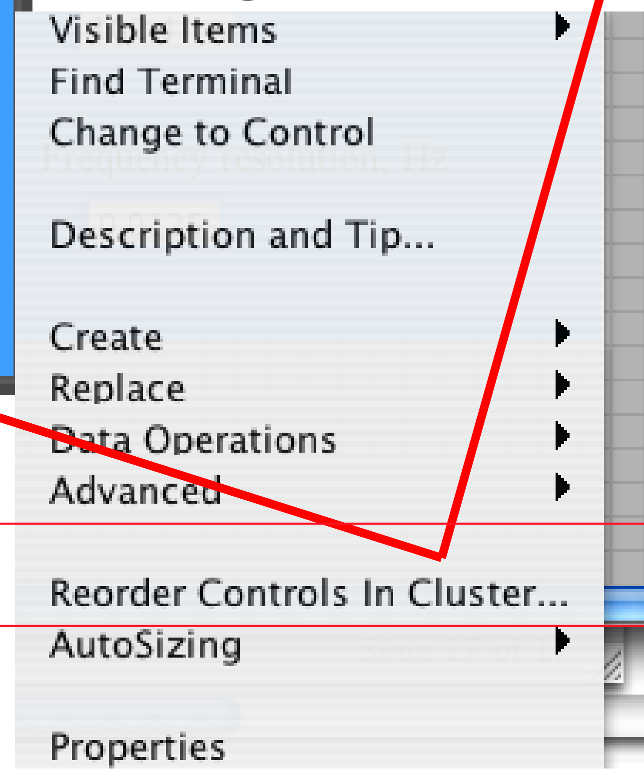


Front panel cluster order

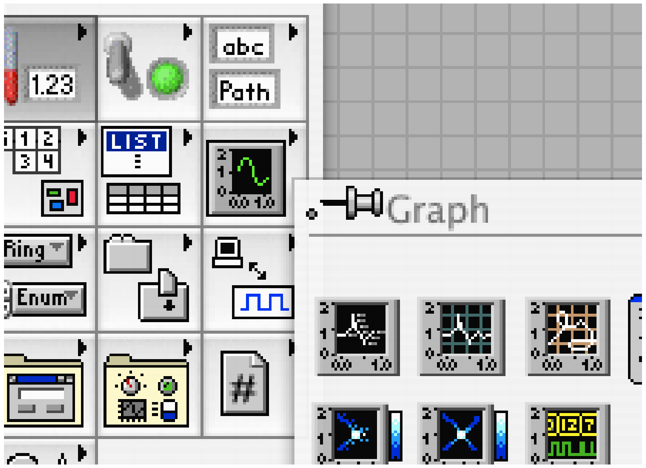
Execution bar



"Right Click"



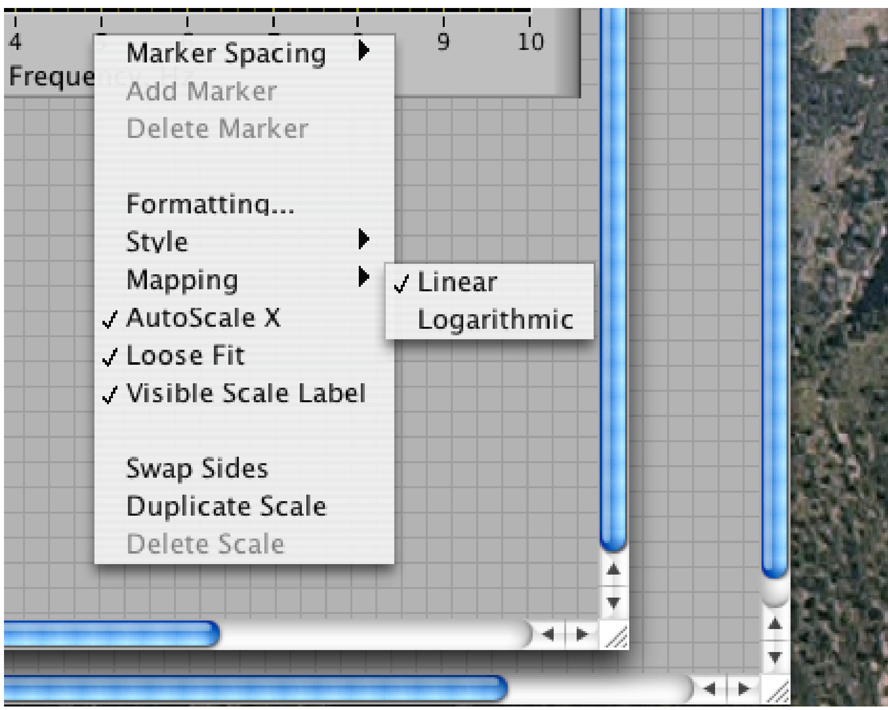
Plotting Data Using Labview Arrays (3)



Drag an X/Y
graph to your font panel

Label it:

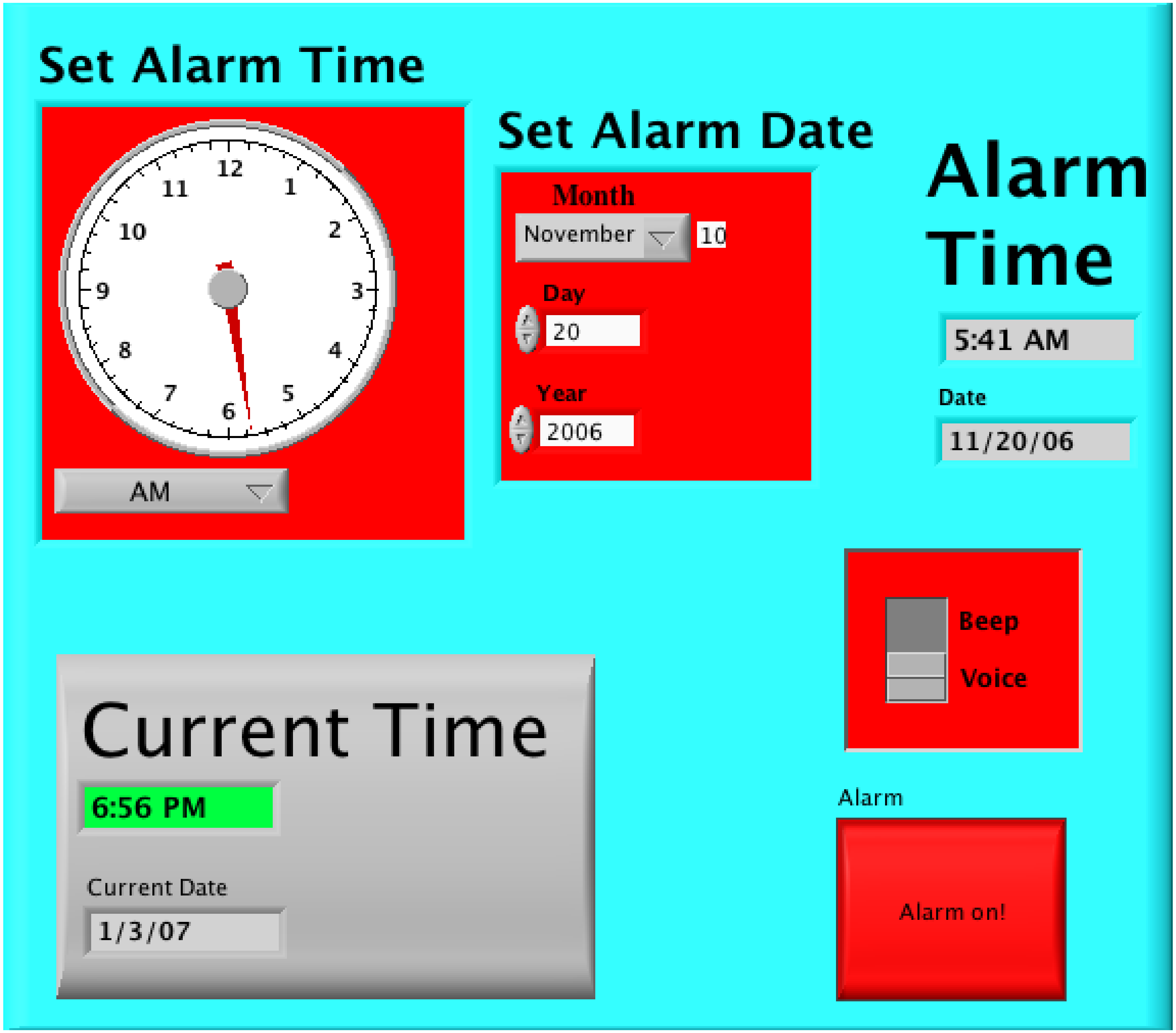
Magnitude response
Fourier Coefficients,
X Axis:frequency, Hz
Y axis: A, B Coefficient



- Right click on X-axis .. Select Mapping-> logarithmic

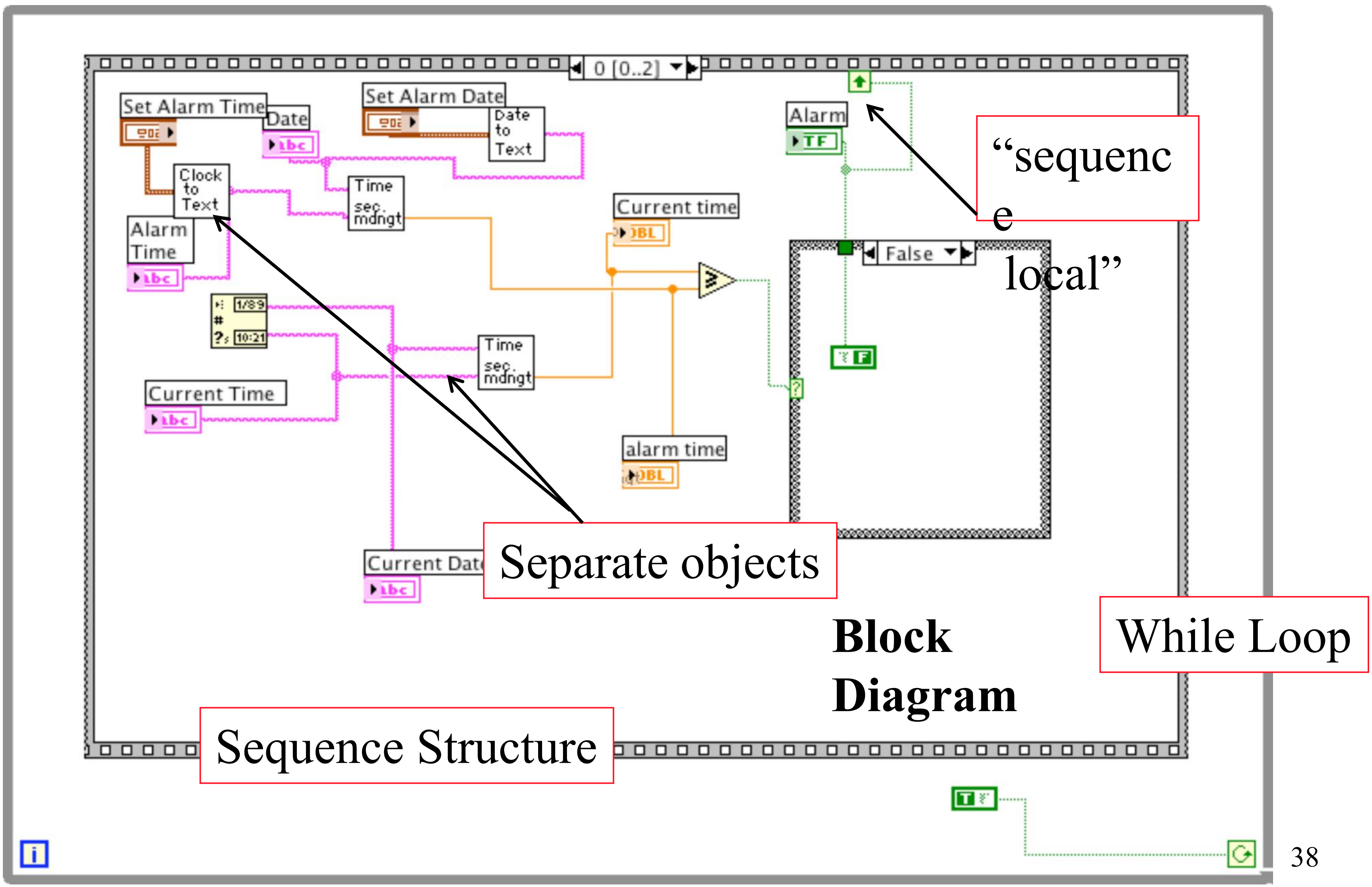
- Same with Y- axis

Example: My own alarm clock (1)



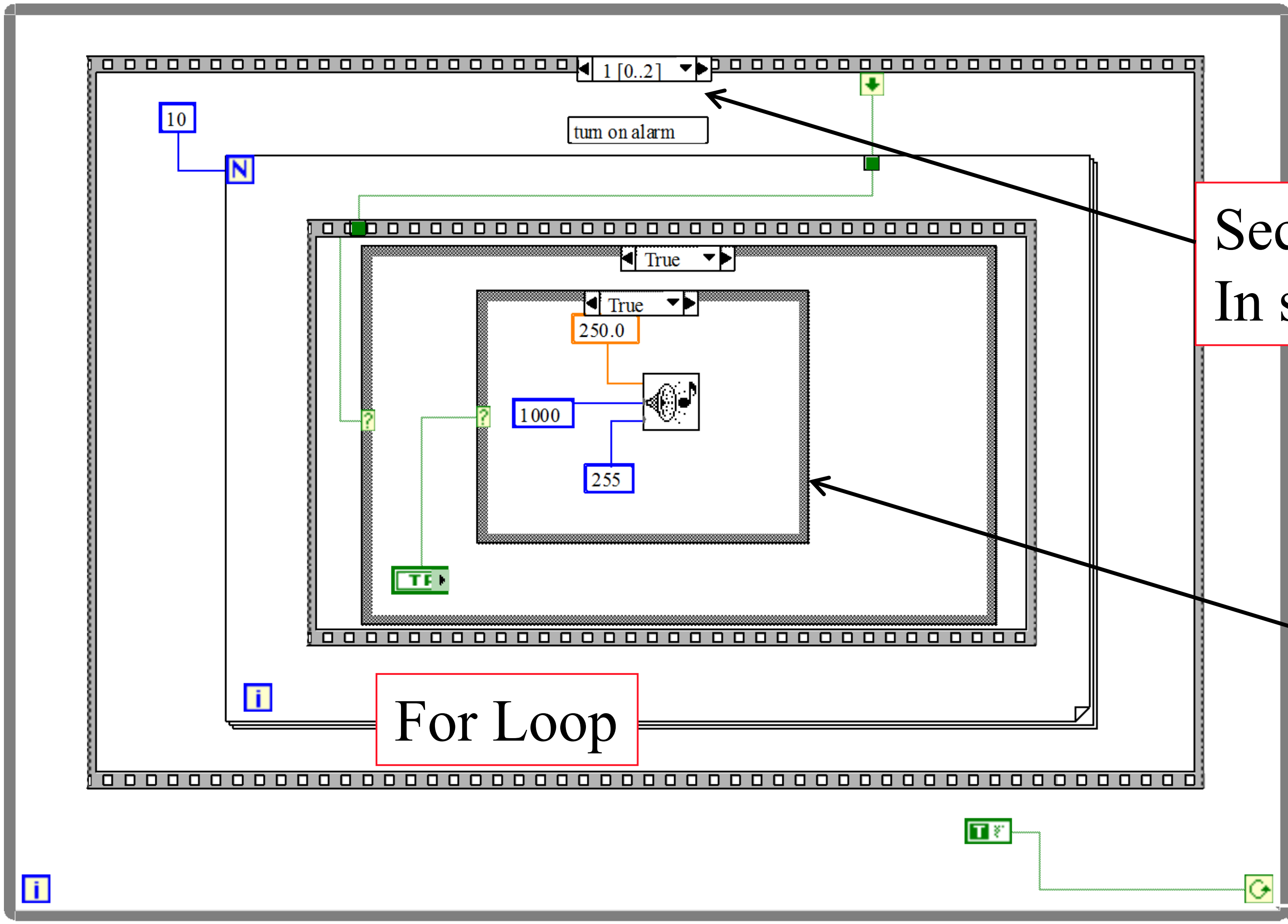
Front Panel

Example: My own alarm clock (2)



Example: My own alarm clock (3)

Block Diagram



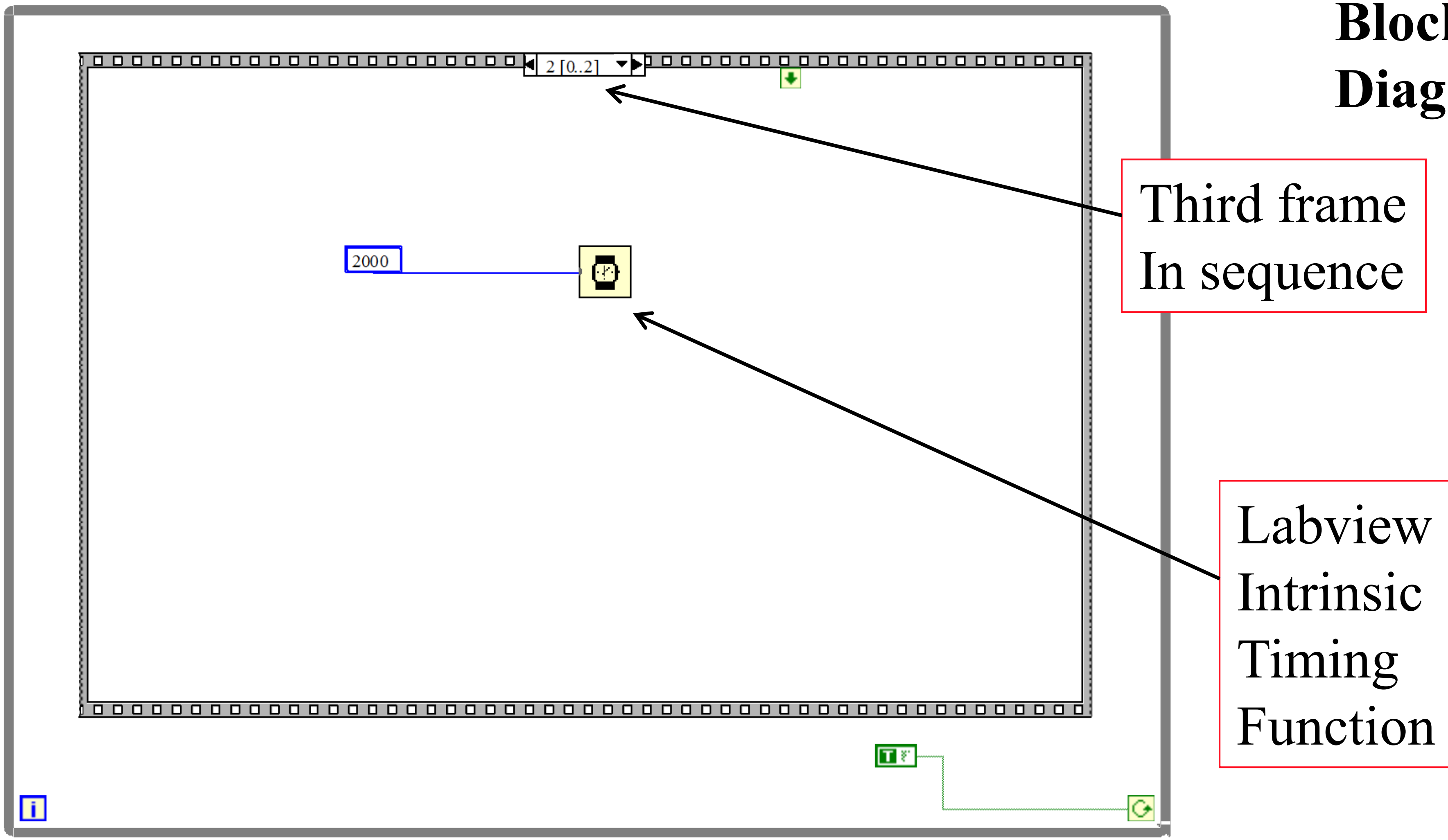
Second frame In sequence

Labview Intrinsic Finction

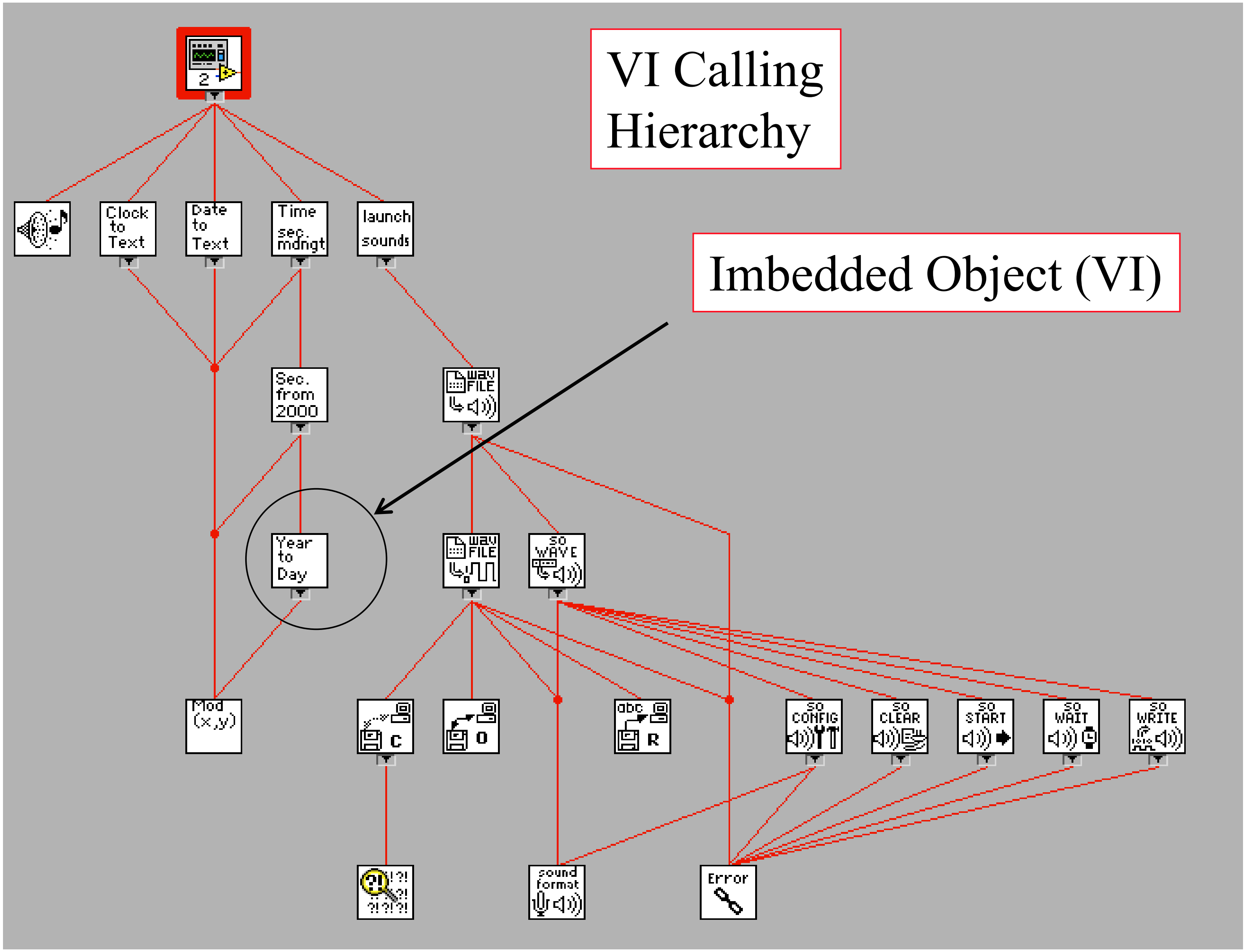
For Loop

Example: My own alarm clock (4)

Block Diagram



Example: My own alarm clock (5)



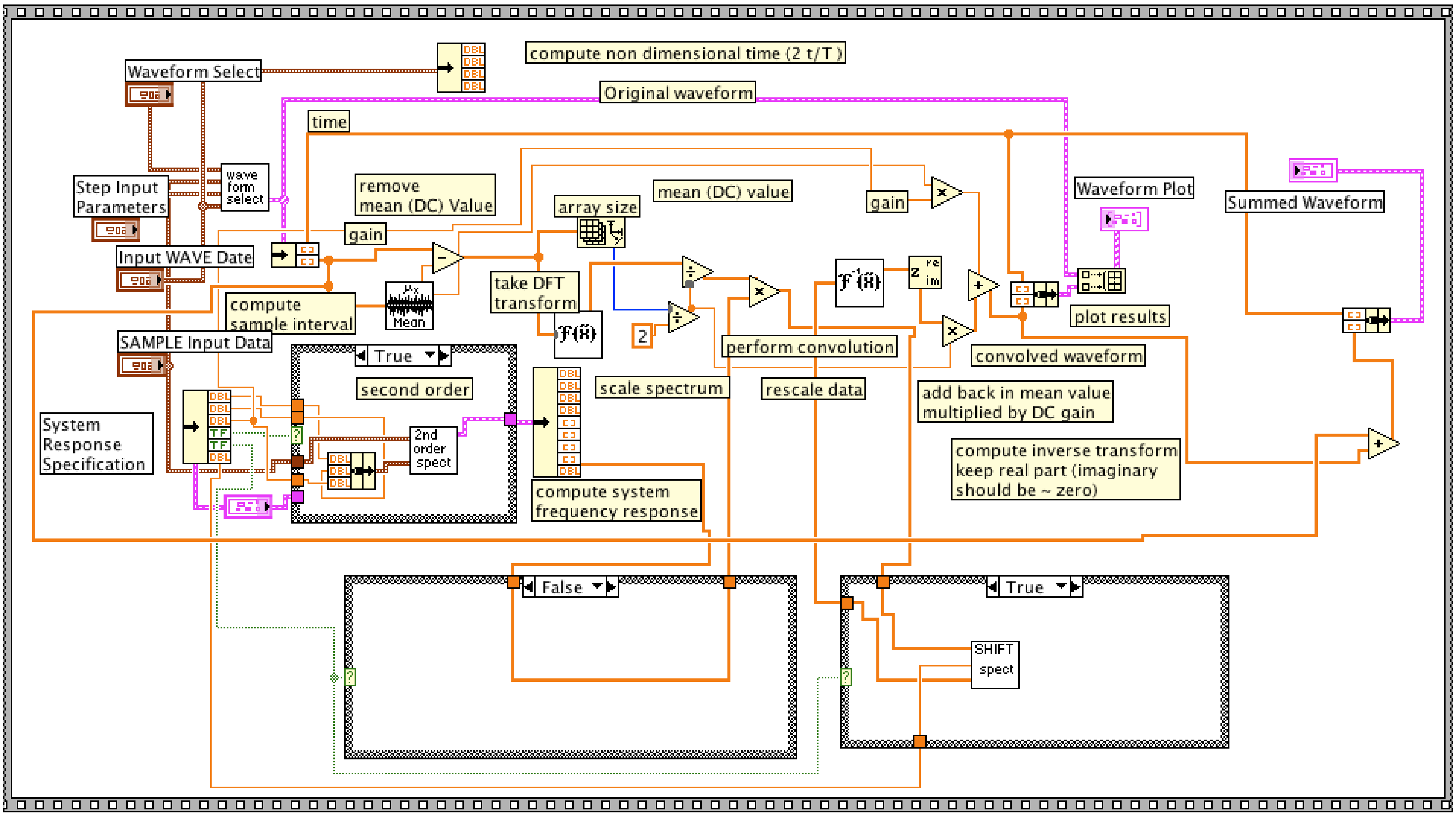
DFT Applications … Noise Canceling headsets

- Essentially, this involves using a microphone, placed near the ear, and electronic circuitry which generates an "antinoise" sound wave with the opposite polarity of the sound wave arriving at the microphone. This results in destructive interference, which cancels out the noise within the enclosed volume of the headphone

UtahState UNIVERSITY

Mechanical & Aerospace Engineering

"Simple" Noise Canceling Logic Written in Labview



Labview® Web Links

-- National Instruments Main Page
http://www.ni.com/

-- Labview Overview
http://www.ni.com/labview/whatis/

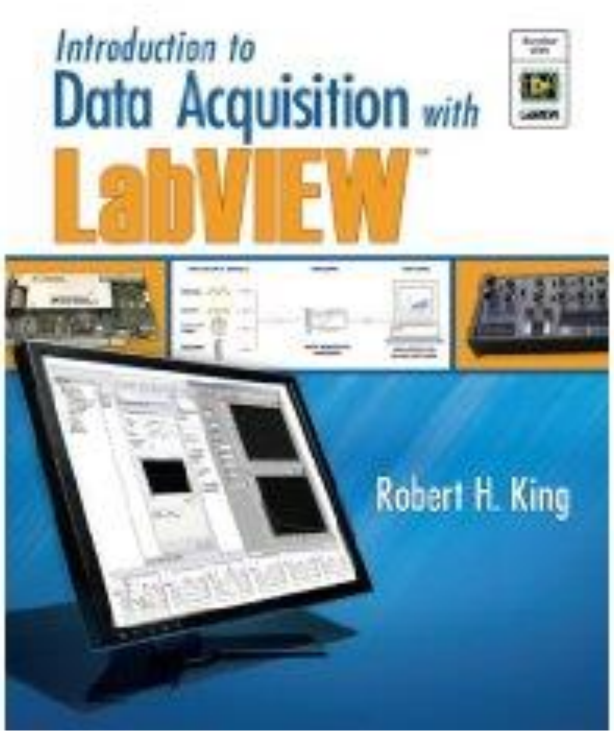
-- Classroom Resources and Courseware for Measurements and Instrumentation
http://www.ni.com/academic/measurements_curriculum.htm

-- Labview Tutorial page
http://www.ni.com/labview/whatis/intuitive_graphical.htm

UtahState UNIVERSITY

Mechanical & Aerospace Engineering

Recommended Reference Books



A copy of the Student Edition of LabVIEW is included with each textbook.

The text prepares students to pass the NI international student certification examination for LabVIEW.

The text contains numerous worked out examples that demonstrate common uses of LabVIEW with guidance for students.

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Questions?