LabVIEW Reference

I. LabVIEW Help

To access the LabVIEW help reference, click **LabVIEW Tutorial** on the **startup box** (**Find Examples** is also a helpful resource with example VIs) or select **Help >> VI, Function, & How-To Help…** from either the **front panel** or **block diagram**. There are also **LabVIEW manuals** under **Help >> Search the LabVIEW Bookshelf…** for an even more in-depth study of LabVIEW mechanics.

To access help on individual nodes of a **VI**, **select Help >> Show Context Help** to display **context help**. **Context help** is a window that displays reference information for the LabVIEW element near the cursor. It will help you figure out what each **node** does and understand how the **VI** (LabVIEW code has a .vi extension) works when you are trying to examine example code. It also contains a link to more information about the element.

The LabVIEW help reference is an incredible resource for learning and understanding LabVIEW mechanics. Included in the reference are a number of example **VIs** and many step-by-step tutorials. You will most likely be able to find an example somewhere that nearly implements the function you want to program using LabVIEW—the Internet is a good resource as well. The LabVIEW help reference is nearly all you will need to learn LabVIEW. This reference sheet will point out the things that LabVIEW can do and describe some of its mechanics without the depth the LabVIEW help reference has.

II. Interface

When you create a new VI, two windows will pop up. The first window is known as the **front panel** and the second as the **block diagram**.

Front Panel

The purpose of the **front panel** is user-interface. On the **front panel** you will place the **controls**, **indicators**, **charts and graphs**, etc. that the user needs to see and possibly use. You can access the **front panel** from the **block diagram** by selecting **Window >> Show Panel**.

You can align **controls** on the **front panel** using the **Align Objects** pull-down button on the **tool bar**.

Block Diagram

The **block diagram** contains the meat of the program. Herein lie all the internal workings and background operations of the code. On the **block diagram** you will place **nodes**, **wires**, **structures**, etc. You can access the **block diagram** from the **front panel** by selecting **Window >> Show Diagram**.

Palettes

To display a palette select **Window >> Show [Palette Name] Palette**. This will display the palette in **locked** mode, which means that the palette will remain in that position until it is closed (if you are using the **controls palette** and switch to the **block diagram**, the **controls palette** will be closed and the **functions palette** opened.) Another way to display the **controls palette/functions palette** is to **right-click** using any tool on either the **front panel** or **block diagram**, and the corresponding palette will be displayed in **unlocked** mode. When I direct you to **Controls Palette** or **Functions Palette** to access a certain **control** or **Function** I will write it like **Controls >> [Section] >> [Control Name]** or **Functions >> [Section] >> [Function Name]**. To change a palette to **locked** mode, click the **pushpin** in the **upper-left corner**.

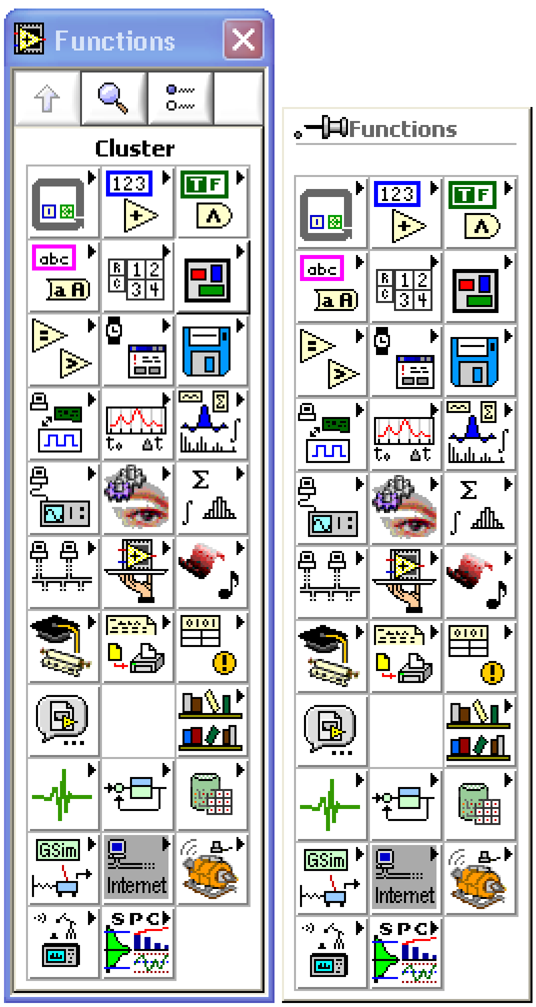


Figure 1. Functions Palette

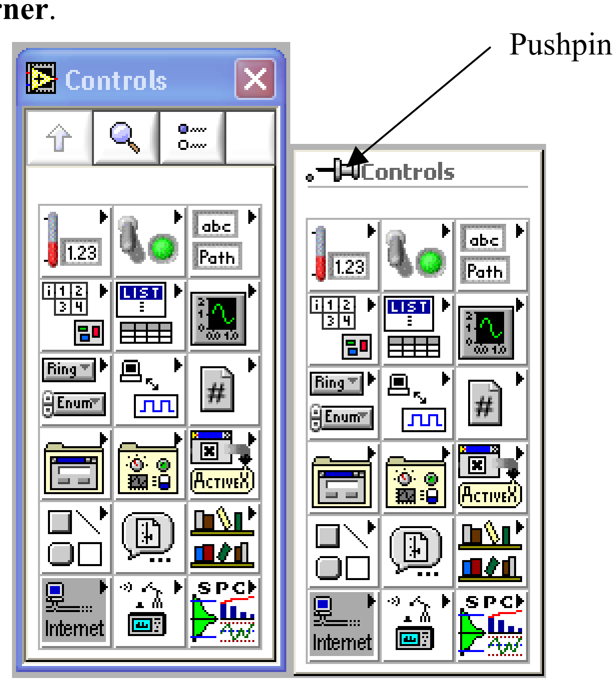
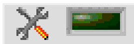


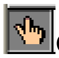
Figure 2. Controls Palette

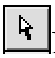
Figure 3. Tools Palette

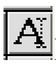
Tools and Shortcuts

LabVIEW uses different tools to program your **VI**. These can be accessed from the **Tools Palette**—if it is open—or by pressing **tab** until the tool you want is displayed as the cursor (I have set the small button on the left side of the mouse in this lab as the tab button to make this oft used task quicker). To display the **Tools Palette**, select **Window >> Show Tools Palette**. Below is a description of the tools in the **Tools Palette**. From this list, only the **operate value**, **position/size/select**, **edit text**, and **connect wire** tools are available when using the **tab** key in the **block diagram**, and only the **operate value**, **position/size/select**, **edit text**, and **set color** tools are available when using the **tab** key in the **front panel**.

**Automatic Tool Selection** – This option is the top button of the Tools Palette. It automatically selects the tools based on the context of the cursor location.

**Operate Value** – Use this tool to change the value of a **control** or **constant**, click on buttons, switch between the **frames** of a structure, etc. This will be one of the tools—along with the **probe data** tool—available when the **VI** is running.

**Position/Size/Select** – This is the tool you will use most often. Use it to position **nodes**, move **wires**, resize **structures** and **constant** boxes, switch between the **frames** of a structure, resize a **node** to include more **input**/**output connectors**, select a section of code to copy it (with **Ctrl | C**), etc.

**Edit Text** – This tool edits any text in the **VI**, including values in a **control** or **constant** (that aren't symbolic), and **case** headings.

**Connect Wire** – This tool is only used on the **block diagram**. Use it to connect **nodes** in the **block diagram** by selecting one **output connector** and one **input connector**. When you place the **connect wire** tool over a **node**, the **connector** that you are on top of will begin **blinking**. Also, if **context help** is open, the **connector** will **blink** in that window as well. This will help you make sure to select the correct **connector**.

After you connect two **connectors**, one of two things will happen. Either a **wire** will form between them color-coded with the **data type** it is carrying, or the wire will become a **dashed line**. If the wire is a **dashed line**, this means that you have made an **error**. Usually, the **error** will be that you connected two different **data types** or you connected two **input connectors** (or two **output connectors**) together.

If you hold the **connect wire** tool over a **wire**, **context help** will show you what **data type** is flowing through the **wire**. If you hold the tool over a **dashed wire**, a dialog will appear describing the error that is causing the **wire** to be **dashed**.

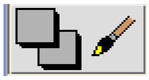
**Object Shortcut Menu** – This tool is the same thing as a **right-click** using any tool on either the **front panel** or **block diagram**. It displays the **Controls Palette**/**Functions Palette** depending on whether you are in the **front panel** or **block diagram**.

**Scroll Window** – This tool has the same function as the hand in Adobe Acrobat: it allows you to move around the **front panel**/**block diagram** by **clicking** and **dragging**.

**Set/Clear Breakpoint** – This tool, represented by the stop sign, is used for troubleshooting the VI. Refer to the LabVIEW help reference.

**Probe Data** – This tool, represented by the circled 'p' with an arrow through it, is used for troubleshooting the VI. Refer to the LabVIEW help reference.

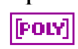
**Get Color** – This tool is useful for changing background colors in the VI.

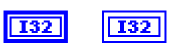
**Set Color** – This tool is useful for changing background colors in the VI.

III. Data Types

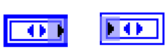
Below is a list of the data types used in LabVIEW. The first image before each **data type** represents a **control** on the **block diagram**, which outputs that **data type** (note the solid outer line). The second image represents an **indicator** on the **block diagram**, which inputs that **data type**. Both symbols are rectangles, color-coded, and the **data type** is written on the inside. LabVIEW also draws an arrow on either the right or the left side of these symbols to indicate if the symbol represents an **input** or an **output connector** (e.g.  represents an **output connector** of the type **double** and  represents an **input connector** of the type **double**).

- - - - Dashed Line: indicates an error either in mismatched datatypes or connector types.

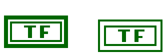
Polymorphic: means that this node can accept multiple data types. A 'POLY' indicator in brackets, , indicates an array of any data type. It is the generic data type for most of the array nodes.



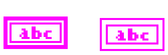
Numeric: there are many numeric data types—unsigned integer, signed integer, double, extended, complex, etc.—and you can change the type of a numeric **control**, **connector**, or **indicator** by **right-clicking** the **control** etc. >> **Representation** >> **[data type]**. Non-integer data types are color-coded orange (e.g. ) while integer data types are color-coded blue.



Enum: is a special **data type** that allows you to assign values to menu selections. After placing an **Enum** control, use the **edit text** tool to change the name of the first item in the list. Then, **right-click** >> **Add Item After** and **type** a name for every additional item you want added to the list. To wire two enum connectors together the items in each list must be equivalent.



Boolean



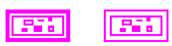
Character String

1D Array: the array data type represents the number of dimensions of the array by the size of the wire.

2D Array: An array is color-coded according to the **data type** that the array consists of (e.g. the data on the left are double while the type could also be numeric, , or cluster as shown below).

3D Array

4D Array

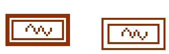


Cluster: A **cluster** is a **data type** that contains elements of other **data types**. It is generally used to group related data elements together to eliminate clutter on the **block diagram**. You can use the **Build Cluster** node to input data into a **graph** or **chart**, since they have only one connector and require multiple data, but you don't have to (see **Graphs and Charts**). You can think of a cluster as a bundle of wires. (LabVIEW User Manual)

Cluster of Arrays (There is a special cluster that represents error data. File input and output nodes have connectors for error in and error out. The wire representing an error cluster is .)

File Path

Refnum



Signal

Conversions

If you are trying to connect different **data types** that are closely related, and LabVIEW won't let you, try using a **conversion** node (for example if you are trying to convert from a **character string** to a **file path**). There are **conversion** nodes in the **numeric**, **Boolean**, **array**, **cluster**, and **string** sections of the **Functions** palette.

IV. Controls and Indicators

When the **front panel** is being displayed you can add **controls** and **indicators** using one of two methods. Select them from the **Controls** palette—if it is open—and click on the **front panel** at the location that you want it, or **right-click** anywhere on the **front panel** to display the **Controls** palette. Another way to create **controls** or **indicators** from the **block diagram** is to **right-click** on a **node**'s **connector** that you want wired to the **control/indicator** >> **Create Control** or **Create Indicator**. You can also create **constants**, which are manipulated only from the **block diagram**.

NOTE: the **controls** and **indicators** on the **front panel** are also displayed on the **block diagram** and can be wired to other **nodes**; however, you can only delete **controls** and **indicators** from the **front panel**; if you are working in the front panel and would like to display the location of a **control** or **indicator** on the **block diagram**—or vice versa—either **right-click** the **control** or **indicator** >> **Find Control** or **Find Indicator** or **double-click** the **control** or **indicator**.

Controls

Controls allow the user to input information that the **VI** needs to do a calculation or complete a task. They usually need to be changed by the user before the program runs or updated on each cycle of a loop. There are five basic types of **controls** that you will use: **numeric**, **Boolean**, **string and path**, **list**, and **ring controls**. **List** and **ring controls** differ only in format and are used for similar tasks.

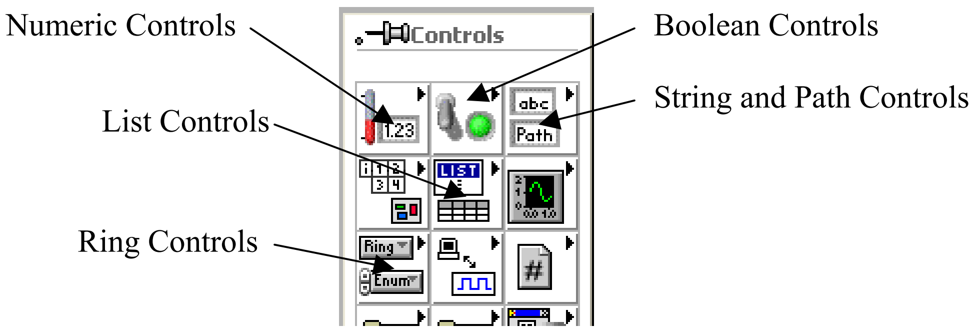


Figure 4. Basic Controls

On the **block diagram** a **control** is indicated by a rectangle with the data type written on the inside, color-coded according to data type, and a solid line around the outside of the rectangle (e.g. 

represents a **control** of the type **double**). The value of a **control** is changed using the **operator tool**. To change the default value of a **control** on the **control**, **right-click** >> **Make Current Value Default**.

NOTE: not all the **nodes** in the **Controls** palette are **controls** by default: some are **indicators**. If you aren't sure, place the **control** on the **front panel** and look at the **block diagram** to evaluate if a **node** is a **control** or an **indicator**, based on the symbols given in the **Data Types** section. However, **indicators** can generally be changed to **controls** with the same design by simply **right-clicking** the **node** after it has been created—from either the **front panel** or **block diagram**—and selecting **Change to Indicator** or vice versa.

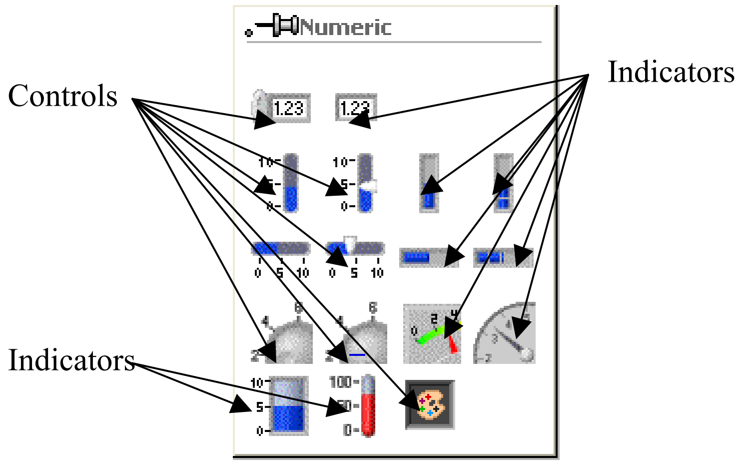


Figure 5. Numeric Controls Palette

Numeric Controls

Use **numeric controls** when a calculation needs to be performed or a decimal number is required. **Numeric controls** are accessed from **Controls >> Numeric >> [Control Name]**. The data type of a **numeric control** is **numeric**.

Boolean Controls

A **Boolean control** is a switch; it is either on or off, 1 or 0. The design of the **Boolean controls** is generally in the form of push buttons or switch. Use these **with case structures**, **event structures**, connected to a **while loop**'s **conditional terminal**, etc. **Boolean controls** are accessed from **Controls >> Boolean >> [Control Name]**. The data type of a **Boolean control** is **Boolean**.

Array Controls

Array controls are just like **numeric controls** only in an array format.

Graphs and Charts

Graphs and **charts** are accessed from **Controls >> Graph >> [Graph or Chart Name]**. They are used to display a plot of data. "Graphs and charts differ in the way they display and update data. VIs with graphs usually collect the data in an array and then plot the data to the graph, which is similar to a spreadsheet that first stores the data then generates a plot of it. In contrast, a chart appends new data points to those already in the display. On a chart, you can see the current reading or measurement in context with data previously acquired." (LabVIEW User Manual)

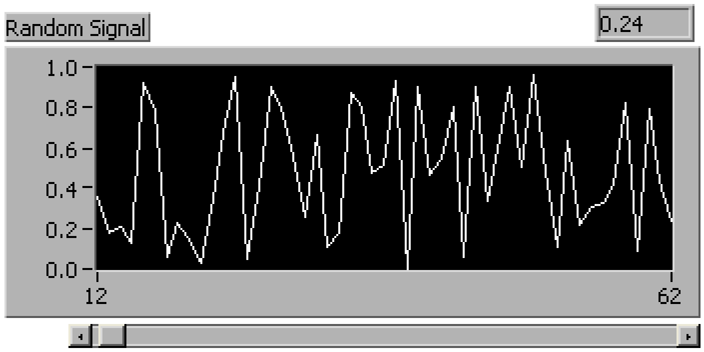


Figure 6. A Chart Displaying a Random Signal and a Digital Readout

If you feed a **graph** a **1D** array, the **graph** will display the data with the values on the x-axis representing the index of the data element, beginning with zero. That is, if the **graph** shows a point at (2,5), this means that the third number in the array is a five. The same goes for **charts**.

If you feed a **graph** a **2D** array, the **graph** will display multiple plots using the same scheme as for a **1D** array—i.e. the values on the x-axis will increment by one for each element in the array.

You can also feed the **graph cluster** data using a **Bundle** node (Figure 7). **Cluster** the initial x-value you want your graph to start with, the amount you want to increment x for each point, and an array of y-values. This specific **bundle** (of x_0, Δx, y array) is classified as **WDT** (waveform data type). The **AI Acquire Waveform** node, and other nodes like it, outputs this type of data, so you can wire it directly to a chart.

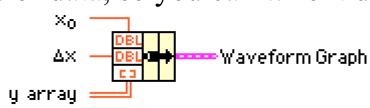


Figure 7. WDT Bundle

V. Mathematics

There are multiple ways of doing mathematic operations in LabVIEW depending on your design intent. If you only need to do a few simple mathematical operations (add, multiply, increment, etc.) use the **operator nodes**; you need to do some complex math or a lot of operations at a time use either the **formula node** or the **Matlab node** (if you need the functionality of Matlab).

Operator Nodes

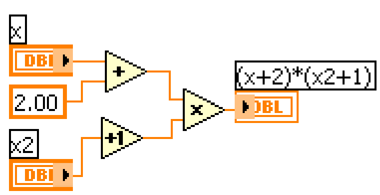


Figure 8. An Example of a Mathematical Operation Using Operator Nodes

Figure 8 shows the operation (x+2)*(x2+1) using **operator** nodes, two **numeric controls**—*x* and *x2*—and a **constant**—equal to 2.00. A **numeric indicator** displays the result on the **front panel**. When the **block diagram** is being displayed you can place **operator nodes** using one of two methods. Select them from the **Functions Palette**—if it is open—and click on the **front panel** at the location that you want it, or **right-click** anywhere on the **front panel** to display the **Functions** palette.

Arrays

You can use a **for loop** to build an array—see the section on **for loops**—or you can initialize an array with **Functions >> Array >> Initialize Array**. The **Initialize Array** node will initialize an array of the size you tell it (by **wiring constants** to the right **connectors**) with the value you set in every index. Use the **position/size/select** tool to make a higher dimension **array** by **dragging** the bottom of the **node** down to reveal more **connectors**. You can also build an array by feeding many elements or arrays to the **Build Array** node (**Functions >> Array >> Build Array**). If you are feeding the **Build Array** node arrays, select whether you want the node to concatenate the arrays or not by **right-clicking** on the node **>> Concatenate Inputs**. If you do not choose to **concatenate inputs**, **Build Array** will add a new dimension to the output array (make sure all input arrays have the same dimensions). For example, if you connect two **2D** arrays to a **build array node**, the **node** will output a 3D array if you do not **concatenate inputs**, but if you select **concatenate inputs**, the node will output a larger 2D array.

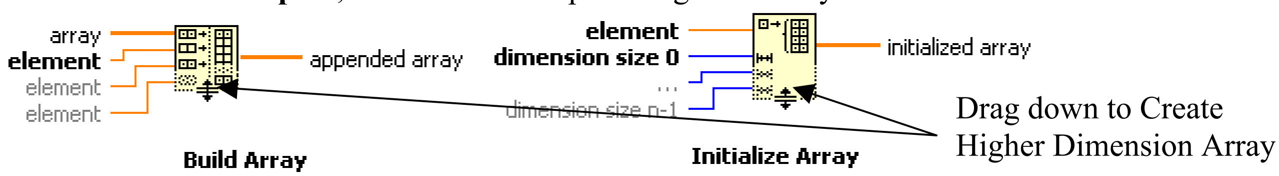


Figure 9. Build Array and Initialize Array Nodes

Formula Node

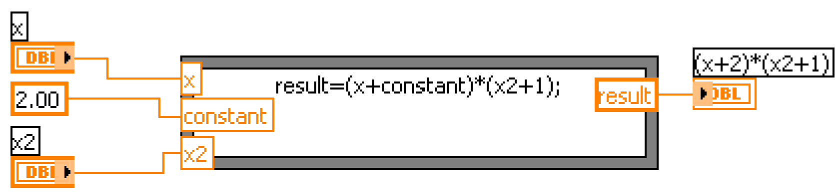


Figure 10. An Example of a Mathematical Operation Using a Formula Node

Figure 10 shows the operation (x+2)*(x2+1) using a **formula** node, two **numeric controls**—*x* and *x2*—and a **constant**—equal to 2.00. A **numeric indicator** displays the result on the **front panel**. To add input or output variables to a formula node, **right-click** the border of the node >> **Add Input** or **Add Output**. Then type a name for the variable and **wire** it to the **output connector** of another **node** or a **constant** if the variable is an **input** or an **input connector** of another **node** if the variable is an **output**. Now enter mathematical statements you want the node to execute inside the node using the **edit text** tool—end statements with a **semicolon**. The formula can do operations similar to those used in C code.

Matlab Node

The **Matlab** node is just like the **formula** node except that a VI with a **Matlab** node in it requires that Matlab be running in the background (open) in order operate correctly and the statements must be written in the format of a Matlab script.

VI. Programmatic Control

When you want to control how your program operates or the order of events use the following techniques.

Sequential Control

Data Transfer

The first, obvious, form of control over the order of operations in LabVIEW is **data transfer**. Before any **node** runs, it waits for data to be passed to all the **connectors** that are wired. Therefore, any **node** which has an **output connector wired** to another **node**'s input connector will complete its operation before the other node can begin. Any **node** that has no **input connectors** wired will automatically operate as soon as the **VI** is started (unless the **VI** contains another form of programmatic control, discussed in the following sections).

Sequence Structure

Sometimes, however, you need two or more operations to happen sequentially even though they are not wired together. To do this place a **sequence** structure on the **block diagram** (**Functions >> Structures >> Sequence**). After picking the **sequence** structure, drag out an area on the **block diagram** that the structure will take up. Anything on the **block diagram** within the boundary of the **sequence** structure will be included in the current **frame** of the **sequence**. At this point there is only one **frame** in the **sequence**. LabVIEW will run only one **frame** at a time and move to the next **frame** only after every node on the current **frame** has ended its operation. To add another **frame** after this one, **right-click** on the border of the **sequence** structure **>> Add Frame After**. A new, empty **frame** will be displayed, and all of the nodes on the first frame will be hidden. Also, a **heading** is added to the structure. On the outsides of the **heading** are arrows. Click on them to browse through the **frames** of the **sequence**. In the middle is written the current **frame** number followed by the set of possible **frames** in the following format: "1[0..1]," where 1 is the current frame and there are two frames, the first called '0' and the second '1.' In the blank space within the second **frame** (**frame** number '1') place the **nodes** that you want to operate after the first **frame** has completed. You can continue to add more **frames** and code by **right-clicking** the border **>> Add Frame After** or **Add Frame Before** whichever frame is currently displayed.

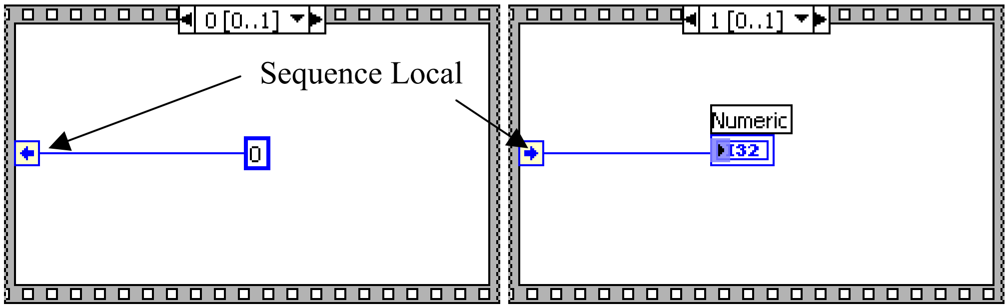


Figure11. Frame 0 and Frame 1 of a Sequence

There will be times when you want to use **sequence** structures and **data transfer** at the same time—i.e. pass data between the **frames** of a **sequence**. This is easily done by creating **sequence locals**. **Sequence locals** are variables on the boundary of the **sequence** that are available to all **frames**. Place one by **right-clicking** the boundary >> **Add Sequence Local**. On one of the **frames** the data will be loaded into the **sequence local** by **wiring** a **node** to that **sequence local** and then any of the **nodes** on the **frames** after the **frame** from which the data is loaded can access that data by **wiring** from the **sequence local** to an **input connector** on the correct **node**.

Repetition

For Loop Structure

To place a **for loop** select **Functions** >> **Structures** >> **For Loop**. After picking the **for loop** structure, drag out an area on the **block diagram** that the structure will take up. Anything on the **block diagram** within the boundary of the **for loop** will be included in the **for loop**.

The **for loop** in LabVIEW operates just like a for loop would in another programming language. In the top-left corner is a boxed '**N**.' It is an **input connector** that accepts a **integer data type** (represented by the color **blue**), and the loop will complete as many iterations as the value **wired** to it. In the lower-left corner is a boxed '**i**.' It is an **output terminal** that also outputs an **integer data type**. Use this **terminal** to keep track of the current iteration number—beginning at zero—or to do calculations with its value. The loop will iterate as long as long as **i<N**.

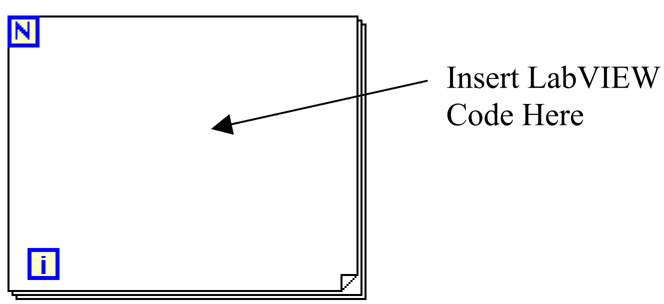


Figure 12. For Loop Structure

While Loop Structure

To place the **while loop** select **Functions** >> **Structures** >> **While Loop**. After picking the **while loop** structure, drag out an area on the **block diagram** that the structure will take up. Anything on the **block diagram** within the boundary of the **while loop** will be included in the **while loop**.

Like the **for loop**, the **while loop** has a **terminal** in the lower-left corner (a boxed '**i**') which increments with each iteration, beginning at zero. The **while loop**, however, does **not** have a boxed '**N**,' because it operates not a specific number of times, but, instead, until the **conditional terminal** receives a certain **Boolean** value. The **conditional terminal** is in the lower right of the **while** structure, represented by either a **boxed circular arrow** or a **boxed stop sign**. If the **conditional terminal** is a **circular arrow**, then the **while loop** is set to run until a False, Boolean data type, is passed to the **terminal**. If the **terminal** is a **stop sign**, the loop is set to run only as long as a False is passed to the terminal. Change this setting by **right-clicking** the terminal >> **Stop If True** or **Continue If True**. You must **wire** this **terminal** to some **control** for the **VI** to run. If you want the loop to run forever simply **right-click** the **terminal** >> **Create Constant**, and switch the **constant** to the correct value with the **operate value** tool.

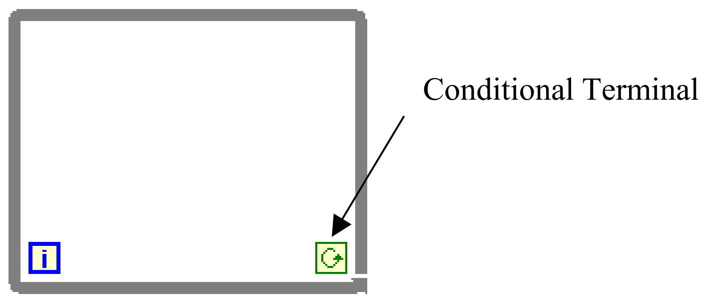


Figure 13. While Loop Structure

Tunnels

If you want a **while loop** or a **for loop** to build an array as it cycles simply **wire** a **number generator** from inside the loop to outside the loop. Where the **wire** crosses the boundary of the loop LabVIEW will create a **tunnel**. On the tunnel **right-click** >> **Enable Indexing**, and the output will become the data type of a 2D array. (There is a **random number generator** node in **Functions** >> **Numeric**.)

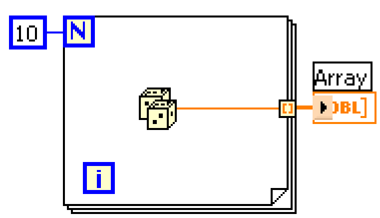


Figure 14. For Loop With a Random Number Generator Node

Feedback

If you want **feedback** in your loop: that is, you want to use a variable that your loop updated on its last cycle, use **shift registers**. On the boundary of your loop, **right-click >> Add Shift Register**. The left **shift register** will produce the value that was sent to the **right shift** register on the last cycle of the loop. "If you do not initialize the register, the loop uses the value written to the register when the loop last executed or the default value for the data type if the loop has never executed." (LabVIEW help reference) To **initialize** the **register**, **wire** an input from outside the loop to the left **register**. NOTE: if you are using nested loops or running a loop more than once during the time the **VI** is run, the **shift register** will start the new loop with the value that it ended with the last time the loop was executed. Figure 15 shows how to use a **while loop** with a **Build Array** node to build an array using **feedback**. 'Array' is a **control** of the type 1D array, and 'Array 2' is an **indicator** of the type 2D array, because the **Build Array** node is not set to concatenate inputs.

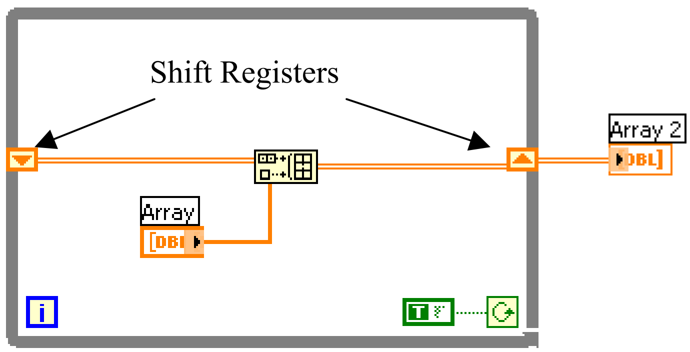


Figure 15. Using Feedback in a While Loop

Conditional Control

Case Structure

"[The case structure] has one or more subdiagrams, or cases, exactly one of which executes when the structure executes. Whether it executes depends on the value of the Boolean, string, or numeric scalar you wire to the external side of the terminal or selector." (LabVIEW help reference) The **case** structure allows conditional control in a **VI**—like an if-then statement. On the left side of the **case** structure is a question mark **terminal**. Wire into this **terminal** any numeric, Boolean, or string data. During runtime the **VI** will wait for data to be passed to the **case** structure, and then compare the data it receives to the **titles** of each **case**. NOTE: There must be a **case** for each possible value that the structure may receive. To do this, make one of the cases a **default case** by **right-clicking** on the case **>> Make This Case the Default…**, and in this case simply wire the input **tunnels** to the output **tunnels**, without modifying the data. You can add **cases** in the same way that you add **frames** in a **sequence** structure (**right-click** on the **case >> Add Case After** or **Add Case Before**). The **case** structure by default has two **cases**, True and False, and accepts **Boolean** values (**Boolean case** structures do not need a **default case**). Change this by **wiring** a different **data type** to the question mark **terminal**. To change the name of each **case**, use the **edit text** tool.

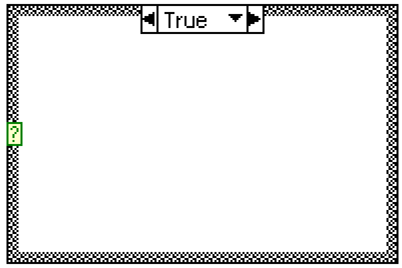


Figure 16. The Case Structure

VII. Input/Output

Files

The two most common methods of saving data in LabVIEW are in text format and spreadsheet format. You can create a file in LabVIEW using either method and it will be accessible to Excel. To create a spreadsheet file format, you must have data in array form. Use the **Write To Spreadsheet File** node (**Functions >> File I/O >> Write To Spreadsheet File**) and wire it to **array** data and a **file path**. The **Write To Spreadsheet File** node also allows other functionality, such as **appending** to a file that already exists, saving the data in a certain **format** that your spreadsheet program requires, etc.

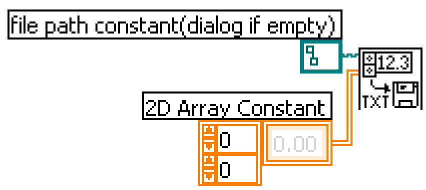


Figure 17. Using Write To Spreadsheet File

To create a generic, text-based file is more difficult. First you have to place the **New File node** on the **block diagram** (**Functions >> File I/O >> Advanced File Functions >> New File**), or use the **Open File** node (**Functions >> File I/O >> Advanced File Functions >> New File**) if the file already exists. Wire this node to a **file path control/constant**. Next place the **Write File** node (**Functions >> File I/O >> Write File**) on the **block diagram**, and **wire** the **refnum output connector** from the **New File** node to the **refnum input connector** on the **Write File** node. Also **wire** in some data (of any **data type**). Finally close the file using **Close File** (**Functions >> File I/O >> Close File**), again **wiring** a **refnum** from the **Write File** to **Close File**. NOTE: these operations will happen in the correct order because each **node** must wait until the previous **node** sends it data—in the form of a **refnum**—if you wired the **refnum** from the **Open File** node to the **Close File** node instead of from the **Write File** to the **Close File**, the file may be closed before it is written (see the section on **Data Transfer**). The **Write To Spreadsheet File** node does all of these steps for you.

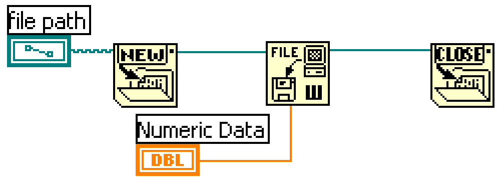


Figure 18. Creating a File

ata Acquisition

To acquire data from the **breakout boards** use the **Analog Input** and **Output** nodes found in **Functions >> Data Acquisition >> Analog Input** or **Analog Output**. You will need to **wire** them the **device number**, usually **1**, and the **channel number**, usually **0**, using **constants** or **controls** (see the section on **Controls and Indicators**). The **Analog Input** nodes will output the **voltage** it read from the specified **input channel** at the time it ran, and the **Analog Output** nodes will output a **voltage** to some specified **output channel** (reference the **National Instruments breakout board reference card** to find which **channels** are **input** and which are **output** and where they are on the **board**). You can also use the **Acquire Waveform** node and **average** the **array** it outputs with the **Mean** node.

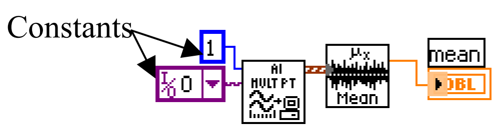


Figure 19. Using The Acquire Waveform Node