LabVIEW Graphical Programming

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Chapter 1

Introduction

1.1 LabVIEW[1]

LabVIEW programs are called **virtual instruments**, or **VIs**, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. LabVIEW contains a comprehensive set of tools for acquiring analyzing, displaying, and storing data, as well as tools to help you troubleshoot your code.

LabVIEW VIs contain three components-the **front panel**, the **block diagram**, and the **icon** and **connector pane**. This lesson describes the front panel and the block diagram; refer to Modular Programming (Section 2.1) for more information about the icon and the connector pane.

In LabVIEW, you build a user interface, or front panel, with controls and indicators. Controls are knobs, push buttons, dials, and other input devices. Indicators are graphs, LEDs, and other displays. After you build the user interface, you add code using VIs and structures to control the front panel objects. The block diagram contains this code. In some ways, the block diagram resembles a flowchart.

Use LabVIEW to communicate with hardware such as data acquisition, vision, and motion control devices, and GPIB, PXI, VXI, RS-232, and RS-484 devices. LabVIEW also has built-in features for connecting your application to the Web using the LabVIEW Web Server and software standards such as TCP/IP networking and ActiveX.

Using LabVIEW, you can create test and measurement, data acquisitions, instrument control, datalogging, measurement analysis, and report generation applications. You also can create stand-alone executables and shared libraries, like DLLs, because LabVIEW is a true 32-bit compiler.

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[1]This content is available online at <http://cnx.org/content/m12192/1.2/>.

1.2 LabVIEW Environment[2]

When you launch LabVIEW, the navigation dialog box (Figure 1.1) appears that includes introductory material and common commands.

Figure 1.1: LabVIEW Dialog Box

The LabVIEW dialog box includes the following components:

- A menu with standard items such as `File≫Exit`.
- A set of buttons for creating and opening VIs, configuring data acquisition devices, and finding helpful information.
    - Click the `New` button to create a new VI. Click the arrow on the `New` button to choose to open a blank VI or to open the `New` dialog box.
    - Click the `Open` button to open an existing VI. Click the arrow on the `Open` button to open recent files.
    - Click the `Configure` button to configure your data acquisition devices. Click the arrow on the `Configure` button to configure LabVIEW.
    - Click the `Help` button to launch the *LabVIEW Help*. Click the arrow on the `Help` button for other Help options, including the `NI Example Finder`.

1.2.1 Creating and Saving a VI

When you click the `New` button in the `LabVIEW` dialog box, the `New` dialog box appears. You also can select `File≫New` to display this dialog box. When you select a template in the `Create new` list, previews of the

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[2]This content is available online at <http://cnx.org/content/m12193/1.3/>.

VI appear in the `Front panel preview` and the `Block diagram preview` sections, and a description of the template appears in the `Description` section. Figure 1.2 shows the `New` dialog box and the `SubVI with Error Handling VI` template.
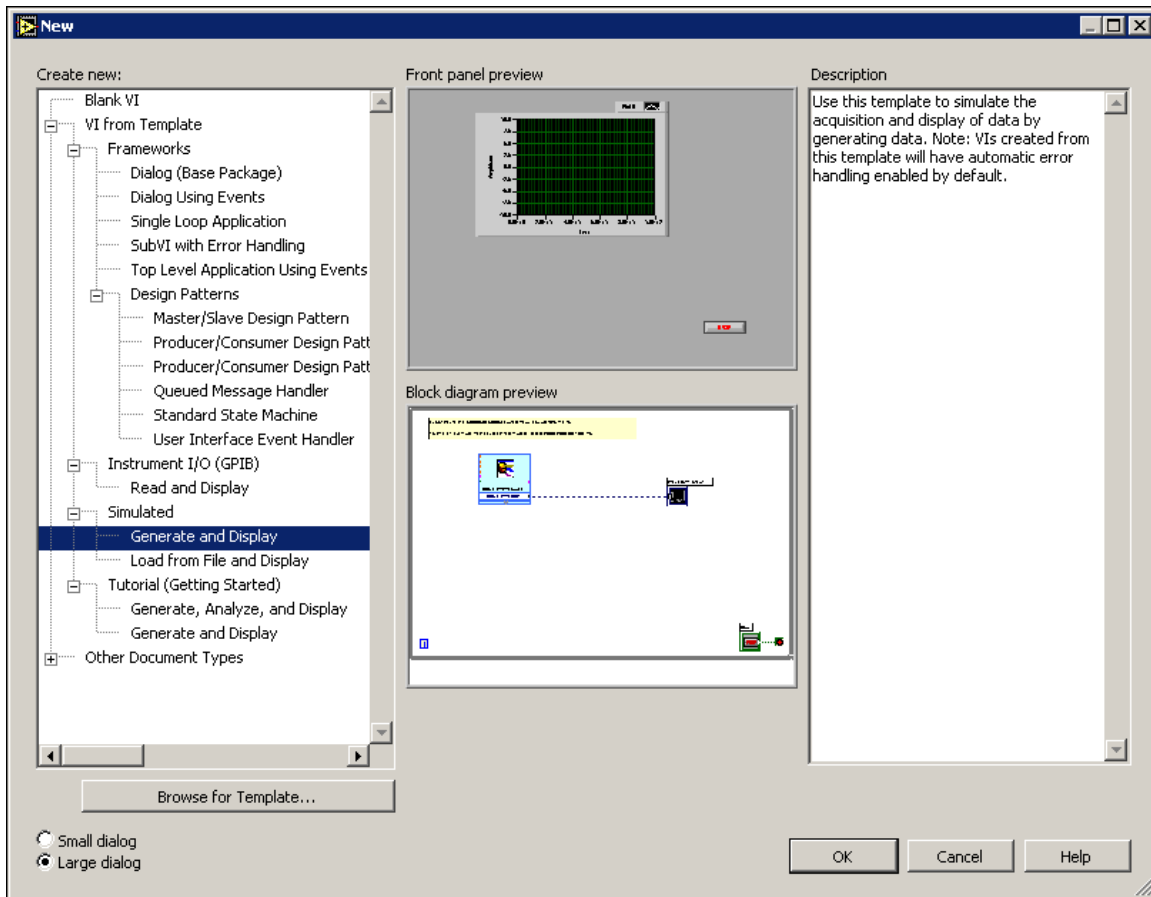
Figure 1.2: New Dialog Box

Click the `OK` button to open the template. You also can double-click the name of the template VI in the `Create new` list to open the template. If no template is available for the task you want to create, you can start with a blank VI and create a VI to accomplish the specific task. In the `LabVIEW` dialog box, click the arrow on the `New` button and select `Blank VI` from the shortcut menu or press the `Ctrl-N` keys to open a blank VI.

NOTE: You also can open a blank VI by selecting `Blank VI` from the `Create new` list in the `New` dialog box or by selecting `File≫New VI`.

1.2.1.1 Open/Templates

Use the `New` dialog box to create different components in LabVIEW to help you build an application. You can start with a blank VI to write a VI from scratch, or start with a template to simplify the programming.

The `New` dialog box includes the following components:

Create new - Displays templates you can use to start building VIs and other LabVIEW documents. Select from the following templates and click the `OK` button to start building a VI or other LabVIEW document.

> **Blank VI -** Opens a blank front panel and blank block diagram.
>
> **VI from Template -** Opens a front panel and block diagram with components you need to build different types of VIs.
>
> **Other Document Types -** Opens the tools you use to build other LabVIEW objects.

Browse for Template - Displays the `Browse` dialog box so you can navigate to a VI, control, or template. If you previously have browsed for and selected a template from this dialog box, use the pull-down menu of the `Browse` button to select a template to reopen it.

Front panel preview - Displays the front panel for the VI template you selected in the `Create new` list.

Block diagram preview - Displays the block diagram for the VI template you selected in the `Create new` list.

Description - Displays a description of the template you selected in the `Create new` list if the template includes a description.

1.2.1.2 Opening an Existing VI

You load a VI into memory by selecting `File≫Open`. In the `Choose the VI to open` dialog box that appears, navigate to the VI you want to open.

The VIs you edit in this course are located in the `C:\Exercises\LabVIEW Basics I` directory.

As the VI loads, a status dialog box similar to Figure 1.3 might appear.
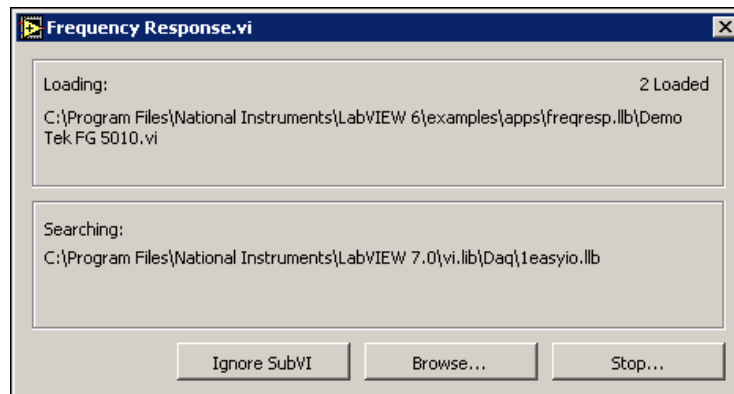
Figure 1.3

The `Loading` section lists the subVIs of the VI as they are loaded into memory. `Number Loaded` is the number of subVIs loaded into memory so far. You can cancel the load at any time by clicking the `Stop` button.

If LabVIEW cannot immediately locate a subVI, it begins searching through all directories specified by the `VI Search Path`. You can edit the `VI Search Path` by selecting `Tools≫Options` and selecting `Paths` from the top pull-down menu. The `Searching` section lists directories or VIs as LabVIEW searches through

them. You can have LabVIEW ignore a subVI by clicking the `Ignore SubVI` button, or you can click the `Browse` button to search for the missing subVI.

1.2.1.3 Saving VIs

Select `Save`, `Save As`, `Save All`, or `Save with Options` from the `File` menu to save VIs as individual files or group several VIs together and save them in a VI library. VI library files end with the extension `.llb`. National Instruments recommends that you save VIs as individual files, organized in directories, especially if multiple developers are working on the same project.

LabVIEW uses the native file dialog boxes so they act similar to other applications on the computer. You can disable this feature by selecting `Tools≫Options` and selecting `Miscellaneous` from the top pull-down menu. If you disable native file dialogs, LabVIEW uses its own platform-independent file dialog boxes with some convenient features, such as providing a list of recent paths and reducing the steps necessary to save VIs in VI libraries.

1.2.1.4 Moving VIs Across Platforms

You can transfer VIs from one platform to another, such as from Mac OS to Windows. LabVIEW automatically translates and recompiles the VIs on the new platform.

Because VIs are files, you can use any file transfer method or utility to move VIs between platforms. You can port VIs over networks using FTP, Z or XModem protocols, or similar utilities. Such network transfers eliminate the need for additional file translation software. If you port VIs using magnetic media, such as floppy disks or a moveable external hard drive, you need a generic file transfer utility program, such as the following:

- (**Windows**) MacDisk and TransferPro transfer Mac OS files to the PC format and vice versa.
- (**Mac OS**) DOS Mounter, MacLink, and Apple File Exchange convert PC files to the Mac OS format and vice versa.
- (**Sun**) PC File System (PCFS) converts PC files to the Sun format and vice versa.

  NOTE: Certain operating system-specific VIs are not portable between platforms, such as DDE (Dynamic Data Exchange) VIs, ActiveX VIs, and AppleEvents.

Refer to the *Porting and Localizing LabVIEW VIs* Application Note, available by selecting `Help≫Search the LabVIEW Bookshelf`, for more information about porting VIs.

1.2.2 Menus

The menus at the top of a VI window contain items common to other applications, such as `Open`, `Save`, `Copy`, and `Paste`, and other items specific to LabVIEW. Some menu items also list shortcut key combinations.

(**Mac OS**) The menus appear at the top of the screen.

(**Windows** and **UNIX**) The menus display only the most recently used items by default. Click the arrows at the bottom of a menu to display all items. You can display all menu items by default by selecting `Tools≫Options` and selecting `Miscellaneous` from the top pull-down menu.

  NOTE: Some menu items are unavailable while a VI is in run mode.

- The `File` menu contains items used for basic file operations, such as opening, closing, saving, and printing files.
- The `Edit` menu contains items that allow you to search for and modify LabVIEW files and their components.
- The `Operate` menu contains items you use to control the operation of VIs.

- The `Tools` menu contains items for configuring LabVIEW, your projects, and your VIs.
- The `Browse` menu contains items that allow you to view aspects of the current VI and its hierarchy.
- The `Window` menu contains items that allow you to configure the appearance of the current windows and palettes. You also can access the `Error List` window and view the contents of the clipboard.
- The `Help` menu contains items to explain and define LabVIEW features and other components, provide full LabVIEW documentation, and access National Instruments technical support.

1.2.3 Front Panel and Block Diagram Windows

When you open a blank VI, an untitled front panel window appears. This window displays the front panel and is one of the two LabVIEW windows you use to build a VI. The other window contains the block diagram. The illustration in Figure 1.4 shows a front panel and its corresponding block diagram with front panel and block diagram components.
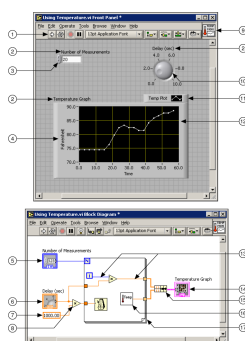

Figure 1.4: 1. Toolbar, 2. Owned Label, 3. Numeric Control, 4. Free Label, 5. Numeric Control Terminal, 6. Knob Terminal, 7. Numeric Constant, 8. Multiply Function, 9. Icon, 10. Knob Control, 11. Plot Legend, 12. XY Graph, 13. Wire Data Path, 14. XY Graph Terminal, 15. Bundle Function, 16. SubVI, 17. For Loop Structure

1.2.4 Front Panel Toolbar

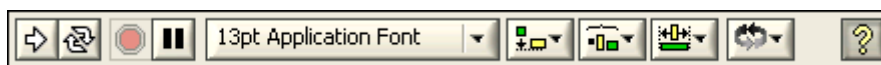Use the toolbar buttons to run and edit a VI. The toolbar in Figure 1.5 appears on the front panel.

Figure 1.5

Click the `Run` button to run a VI. LabVIEW compiles the VI, if necessary. You can run a VI if the Run button appears as a solid white arrow. The solid white arrow, shown above, also indicates you can use the VI as a subVI if you create a connector pane for the VI.

While the VI runs, the `Run` button appears as shown at left if the VI is a top-level VI, meaning it has no callers and therefore is not a subVI.

If the VI that is running is a subVI, the `Run` button appears as shown at left.

The `Run` button appears broken, shown at left, when the VI you are creating or editing contains errors. If the `Run` button still appears broken after you finish wiring the block diagram, the VI is broken and cannot run. Click this button to display the `Error list` window, which lists all errors and warnings.

Click the `Run Continuously` button, shown at left, to run the VI until you abort or pause execution. You also can click the button again to disable continuous running.

While the VI runs, the `Abort Execution` button, shown at left, appears. Click this button to stop the VI immediately if there is no other way to stop the VI. If more than one running top-level VI uses the VI, the button is dimmed.

NOTE: Avoid using the `Abort Execution` button to stop a VI. Either let the VI complete its data flow or design a method to stop the VI programmatically. By doing so, the VI is at a known state. For example, place a button on the front panel that stops the VI when you click it.

Click the `Pause` button, shown at left, to pause a running VI. When you click the `Pause` button, Lab-VIEW highlights on the block diagram the location where you paused execution, and the `Pause` button appears red. Click the button again to continue running the VI.
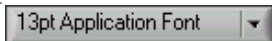
Select the `Text Settings` pull-down menu, shown at left, to change the font settings for the selected portions of the VI, including size, style, and color.

Select the `Align Objects` pull-down menu, shown at left, to align objects along axes, including vertical, top edge, left, and so on.

Select the `Distribute Objects` pull-down menu, shown at left, to space objects evenly, including gaps, compression, and so on.

Select the `Resize Objects` pull-down menu, shown at left, to resize multiple front panel objects to the same size.

Select the `Reorder` pull-down menu, shown at left, when you have objects that overlap each other and you want to define which one is in front or back of another. Select one of the objects with the Positioning tool and then select from `Move Forward`, `Move Backward`, `Move To Front`, and `Move To Back`.

Select the `Show Context Help Window` button, shown at left, to toggle the display of the `Context Help` window.

`Type` appears to remind you that a new value is available to replace an old value. The Enter button disappears when you click it, press the `Enter` key, or click the front panel or block diagram workspace.

1.2.5 Block Diagram Toolbar

When you run a VI, buttons appear on the block diagram toolbar that you can use to debug the VI. The toolbar in Figure 1.6 appears on the block diagram.
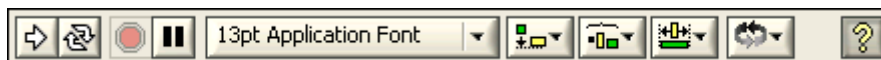
Figure 1.6

Click the `Highlight Execution` button, shown at left, to display an animation of the block diagram execution when you click the `Run` button. see the flow of data through the block diagram. Click the button again to disable execution highlighting.

Click the `Step Into` button, shown at left, to open a node and pause. When you click the `Step Into` button again, it executes the first action and pauses at the next action of the subVI or structure. You also can press the `Ctrl` and down arrow keys. Single-stepping through a VI steps through the VI node by node. Each node blinks to denote when it is ready to execute. By stepping into the node, you are ready to single-step inside the node.

Click the `Step Over` button, shown at left, to execute a node and pause at the next node. You also can press the `Ctrl` and right arrow keys. By stepping over the node, you execute the node without single-stepping through the node.

Click the `Step Out` button, shown at left, to finish executing the current node and pause. When the VI finishes executing, the `Step Out` button becomes dimmed. You also can press the `Ctrl` and up arrow keys. By stepping out of a node, you complete single-stepping through the node and go to the next node.

The `Warning` button, shown at left, appears if a VI includes a warning and you placed a checkmark in the `Show Warnings` checkbox in the `Error List` window. A warning indicates there is a potential problem with the block diagram, but it does not stop the VI from running.

1.2.6 Palettes

LabVIEW has graphical, floating palettes to help you create and run VIs. The three palettes include the `Tools`, `Controls`, and `Functions` palettes. You can place these palettes anywhere on the screen.

1.2.6.1 Tools Palette

You can create, modify, and debug VIs using the tools located on the floating Tools (Figure 1.7) palette. The `Tools` palette is available on both the front panel and the block diagram. A tool is a special operating mode of the mouse cursor. The cursor corresponds to the icon of the tool selected in the `Tools` palette. Use the tools to operate and modify front panel and block diagram objects.

Select `Window≫Show Tools Palette` to display the `Tools` palette.

NOTE: Press the `Shift` key and right-click to display a temporary version of the `Tools` palette at the location of the cursor.

Figure 1.7: Tools Palette

If automatic tool selection is enabled and you move the cursor over objects on the front panel or block diagram, LabVIEW automatically selects the corresponding tool from the `Tools` palette. You can disable automatic tool selection and select a tool manually by clicking the tool you want on the `Tools` palette.

If you want to use the `Tab` key to cycle through the four most common tools on the `Tools` palette, click the `Automatic Tool Selection` button, shown at left, on the `Tools` palette to disable automatic tool selection. Press the `Shift-Tab` keys or click the `Automatic Tool Selection` button to enable automatic tool selection again. You also can manually select a tool on the `Tools` palette to disable automatic tool selection. Press the `Tab` or `Shift-Tab` keys or click the `Automatic Tool Selection` button on the `Tools` palette to enable automatic tool selection again. If automatic tool selection is disabled, you can press the spacebar to switch to the next most useful tool.

Use the `Operating` tool, shown at left, to change the values of a control or select the text within a control. The `Operating` tool changes to the icon shown at left when it moves over a text control, such as a numeric or string control.

Use the `Positioning` tool, shown at left, to select, move, or resize objects. The `Positioning` tool changes to resizing handles when it moves over the edge of a resizable object.

Use the `Labeling` tool, shown at left, to edit text and create free labels. The `Labeling` tool changes to the following icon when you create free labels.

Use the `Wiring` tool, shown at left, to wire objects together on the block diagram.

Use the `Object Shortcut Menu`, shown at left, tool to access an object shortcut menu with the left mouse button.

Use the `Scrolling` tool, shown at left, to scroll through windows without using scrollbars.

Use the `Breakpoint` tool, shown at left, to set breakpoints on VIs, functions, nodes, wires, and structures to pause execution at that location.

Use the `Probe` tool, shown at left, to create probes on wires on the block diagram. Use the `Probe` tool to check intermediate values in a VI that produces questionable or unexpected results.

Use the `Color Copy` tool, shown at left, to copy colors for pasting with the `Coloring` tool.

 Use the `Coloring` tool, shown at left, to color an object. It also displays the current foreground and background color settings.

1.2.6.2 Controls and Functions Palettes

The `Controls` and `Functions` palettes contain subpalettes of objects you can use to create a VI. When you click a subpalette icon, the entire palette changes to the subpalette you selected. To use an object on the palettes, click the object and place it on the front panel or block diagram.

The `Controls` palette, shown in Figure 1.8, is available only on the front panel. The `Controls` palette contains the controls and indicators you use to build the front panel. Refer to the Front Panel (Section 1.3) section for more information about the using the `Controls` palette on the front panel. The controls and indicators located on the `Controls` palette depend on the palette view currently selected.
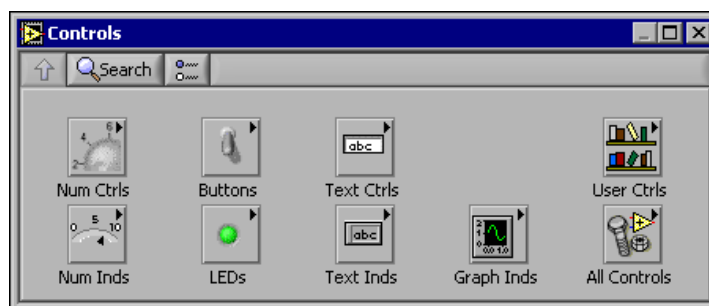

Figure 1.8: Controls Palette

The `Functions` palette, shown in the Figure 1.9, is available only on the block diagram. The `Functions` palette contains the VIs and functions you use to build the block diagram. Refer to the Block Diagram (Section 1.4) section of this lesson for more information about using the `Functions` palette on the block diagram. The VIs and functions located on the `Functions` palette depend on the palette view currently selected. The VIs and functions are located on subpalettes based on the types of VIs and functions.

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