LabVIEW™ Simulation Interface Toolkit User Guide

The LabVIEW Simulation Interface Toolkit integrates LabVIEW with the software of The MathWorks, Inc. known as Simulink® and Real-Time Workshop® in a way that allows you to develop, prototype, and test control systems using models developed in the Simulink simulation environment.

This user guide contains the system requirements, installation instructions, and upgrade information for the Simulation Interface Toolkit. This user guide also provides a conceptual overview of the Simulation Interface Toolkit and the benefits in using LabVIEW with Simulink models. Exercises in this user guide teach you how to create LabVIEW user interfaces for Simulink models and run simulations on NI RT Series hardware.

For more information…

Refer to the *LabVIEW Bookshelf* for information about LabVIEW and to access the LabVIEW help resources. Access the *LabVIEW Bookshelf* by selecting **Start» Programs»National Instruments»LabVIEW»Search the LabVIEW Bookshelf**.

Contents

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System Requirements

To use the Simulation Interface Toolkit, you must be a properly licensed user of and have the following software installed on the host computer.

- The MathWorks MATLAB® 6.0 or later
- The MathWorks Simulink 4.0 or later
- The MathWorks Real-Time Workshop 4.0 or later
- Microsoft Visual C++ 5.0 or later
- National Instruments LabVIEW 7.0 or later, Full or Professional Development Systems

To use the Simulation Interface Toolkit with RT Series hardware, you must have the following software and hardware.

- National Instruments LabVIEW Real-Time Module
- National Instruments RT Series hardware

To use the Simulation Interface Toolkit for data acquisition (DAQ) applications, you must have the following software and hardware.

- NI-DAQ
- National Instruments data acquisition hardware

Installation Instructions

Complete the following steps to install the Simulation Interface Toolkit.

1. Insert the LabVIEW Simulation Interface Toolkit CD.
2. Run the `setup.exe` program.
3. Follow the instructions that appear on the screen.

If you want to run simulations on RT targets, you need to configure the RT Series devices using Measurement & Automation Explorer (MAX). Complete the following steps to install the Simulation Interface Toolkit on a networked RT Series device.

1. In MAX, select the device from the **Remote Systems** category.
2. Click the **Software** tab to see a list of software available on the host computer and the software currently on the device.
3. If **`NI-Simulation Interface Toolkit 2.0`** is not present on the remote device, click the **Install Software** button to open the **Select software to download** dialog box.
4. Follow the instructions that appear on the screen to install the software.

Refer to the *Measurement & Automation Explorer Remote Systems Help*, available by selecting **Help»Help Topics»Remote Systems** from MAX, for information about using MAX to configure remote systems.

Upgrading from Version 1.0

You cannot have both version 1.0 and 2.0 of the Simulation Interface Toolkit installed on the same computer. You must uninstall version 1.0 of the Simulation Interface Toolkit before you can install version 2.0 of the Simulation Interface Toolkit.

You must modify any application you created using version 1.0 of the Simulation Interface Toolkit because the Simulation Interface VIs changed.

The VIs located on the **Simulation Interface** palette in version 1.0 now are located on the **Model Interface** palette. Open all applications created with version 1.0 and replace the Simulation Interface VIs with the Model Interface VIs.

You also must recompile all model DLLs built in version 1.0 using version 2.0 of the Simulation Interface Toolkit.

Introduction to the Simulation Interface Toolkit

The Simulation Interface Toolkit provides methods for creating a LabVIEW user interface for a Simulink model, converting a Simulink model into a dynamic link library (DLL), and running a simulation model on an RT target. By combining the capabilities of Simulink and Real-Time Workshop with LabVIEW, the Simulation Interface Toolkit helps you import simulation models into LabVIEW.

LabVIEW, Simulink, and Real-Time Workshop

LabVIEW is a graphical programming language that uses icons instead of lines of text to create applications. LabVIEW applications often are called virtual instruments, or VIs, because their appearance and operation often imitate physical instruments, such as oscilloscopes and multimeters.

Simulink, an add-on toolkit for MATLAB, provides a graphical environment for the design and interactive execution of dynamic system models. You can create models in Simulink using customizable blocks. Using graphical wires to connect the blocks, you can specify data flow.

Real-Time Workshop is an add-on package for Simulink that generates C code from Simulink models. Real-Time Workshop then uses a C compiler to compile the C code for execution on various real-time targets.

Creating a LabVIEW User Interface for a Simulink Model

The Simulation Interface Toolkit provides a way to create a LabVIEW user interface that you can use to interact with a Simulink model. With a LabVIEW user interface, you can manipulate the model parameters and view the output data of the Simulink model.

Note The Simulation Interface Toolkit does not allow you to use a LabVIEW user interface in conjunction with a Simulink user interface.

To use the Simulation Interface Toolkit, you must have LabVIEW and MATLAB running on the host computer. The host computer is the computer where you create the LabVIEW user interface. The host computer must be a PC with a Windows operating system (OS) other than the host computer. LabVIEW exchanges data with MATLAB and Simulink using TCP/IP.

Note You can have MATLAB and Simulink running on another PC with a Windows OS. If you have LabVIEW and MATLAB running on different computers, you must install the Simulation Interface Toolkit on both computers.

For LabVIEW to communicate successfully with MATLAB and Simulink, you must have MATLAB running. When you launch MATLAB, you also start the Simulation Interface Toolkit (SIT) Server, which enables LabVIEW and MATLAB to communicate with each other.

Figure 1 displays the components involved in the interaction between LabVIEW and Simulink.

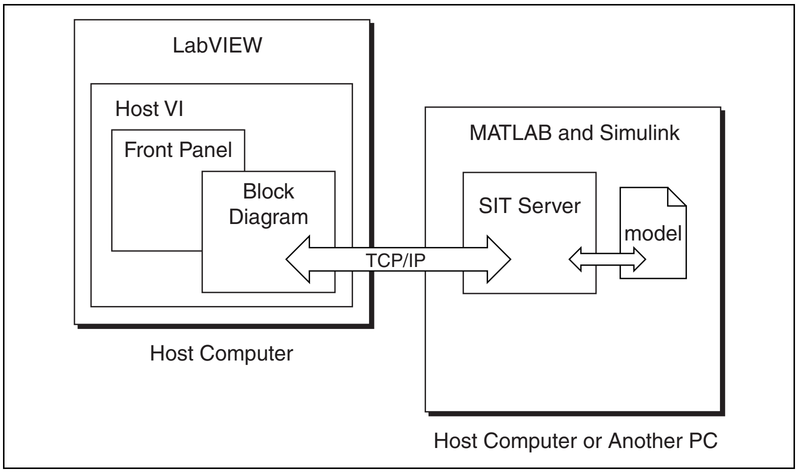


Figure 1. Running a Simulink Model in LabVIEW

On the host computer, you create a host VI, which is a LabVIEW front panel that provides the user interface to the Simulink model. This front panel contains LabVIEW controls and indicators that correspond to the Simulink parameters and sinks that you want to modify and display. You can change the values of controls and immediately view the results of that change in the indicators.

Using the **SIT Connection Manager** dialog box, you specify the relationship between the LabVIEW controls and indicators and the Simulink parameters and sinks. After you configure the **SIT Connection Manager** dialog box, the Simulation Interface Toolkit automatically generates the block diagram code necessary to establish the relationships between the LabVIEW VI and the Simulink model.

Note For advanced LabVIEW programmers, the Simulation Interface Toolkit installs a **User Interface** palette that contains VIs with which you can build customized block diagrams. You can use these User Interface VIs to replicate the block diagram code generated by the Simulation Interface Toolkit. Refer to the *Simulation Interface Toolkit Help* for information about the User Interface VIs.

Using the Simulation Interface Toolkit, you can connect multiple VIs created on the host computer to the same Simulink model. You also can connect multiple Simulink models on the same computer to a single VI created on the host computer. However, if the Simulink models are on different computers, you cannot connect the same VI to these different models.

Figure 2 illustrates the two ways you can connect LabVIEW VIs to Simulink models.

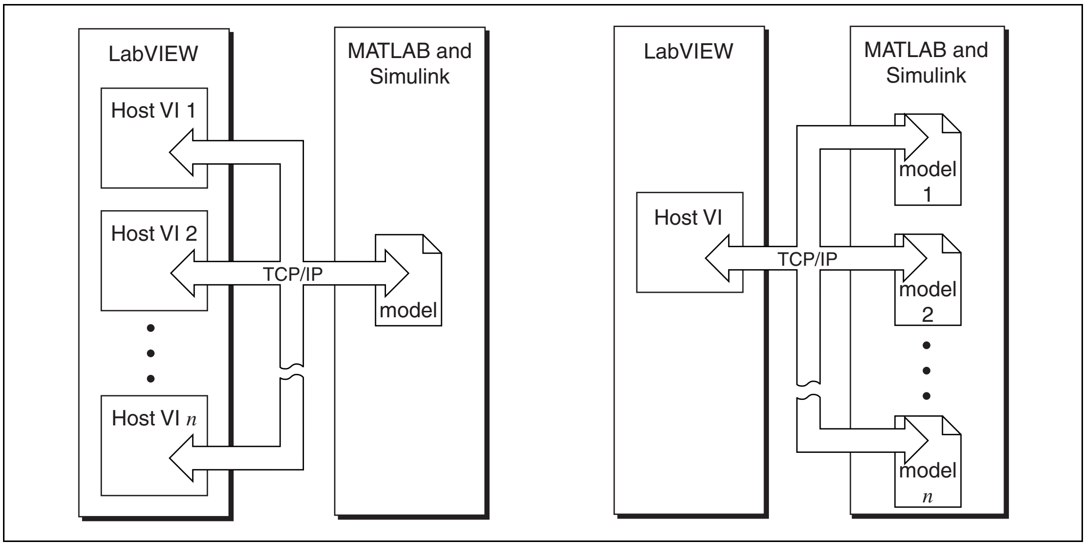


Figure 2. Connecting Multiple LabVIEW VIs and Multiple Simulink Models

The *Tutorial: Creating a User Interface for a Simulink Model* section provides step-by-step procedures that teach you how to create a user interface for a Simulink model.

Converting a Simulink Model into a DLL

If you want to run a Simulink model on an RT target, you can convert the model into a dynamic link library (DLL) that LabVIEW can call. To convert a Simulink model file, or `.mdl` file, into a DLL, you must use Real-Time Workshop.

The Simulation Interface Toolkit includes a plug-in for Real-Time Workshop that converts the `.mdl` file into C code and then compiles the C code into a model DLL using Microsoft Visual C++. The model DLL contains all aspects of the Simulink model but no longer requires Simulink to run.

The Simulation Interface Toolkit automatically builds a model VI that calls the model DLL. Figure 3 shows the steps involved in converting a model file into a model DLL.

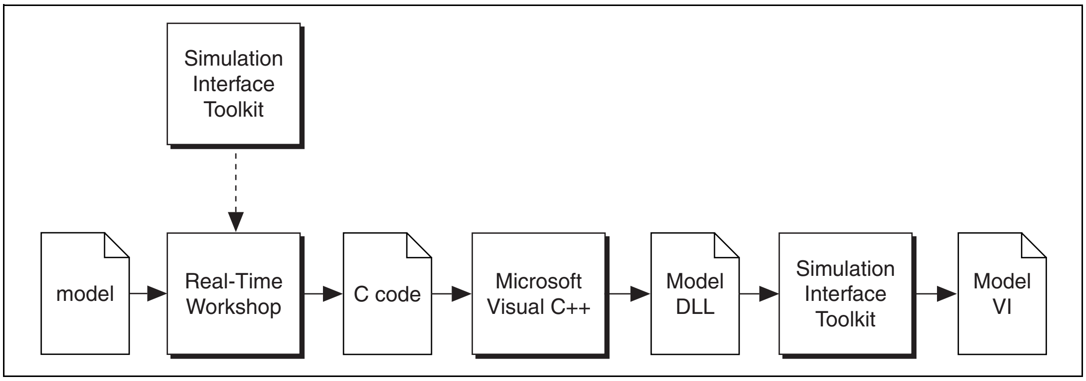


Figure 3. Converting a Simulink Model into a Model DLL

The *Tutorial: Converting a Simulink Model into a Model DLL* section provides step-by-step procedures that teach you how to convert a Simulink model into a model DLL.

Communicating with the Model DLL

To interact with the model DLL on the RT target, you can use the host VI you created for the Simulink model as the user interface. The model DLL contains the same parameters and sinks as the Simulink model, so the connections you made between the LabVIEW controls and indicators and the Simulink parameters and sinks remain the same. Using the host VI, you can modify the model DLL parameters and view the results immediately.

When you create the model DLL, you create a simulation model that can run on an RT target. When you run the host VI, you can choose to download the model DLL and model VI to an RT target. The Simulation Interface Toolkit then starts the SIT Server on the RT target. The host VI communicates with the model VI and model DLL through the SIT Server.

Figure 4 illustrates how the host computer interacts with the RT target after you download the model VI and model DLL.

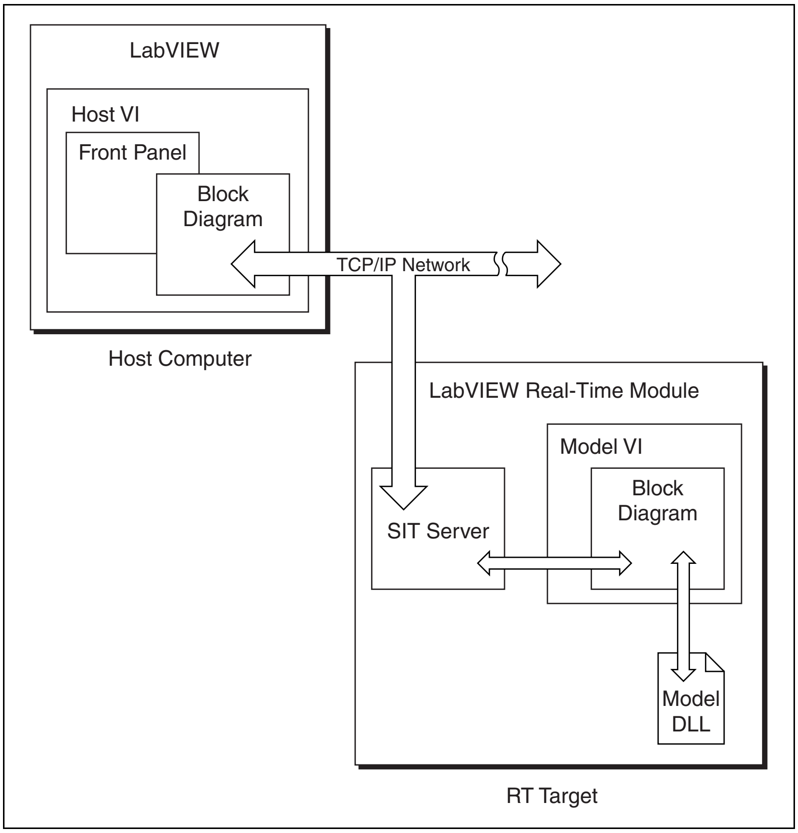


Figure 4. Running a Simulation on an RT Target

The Real-Time Module extends the capabilities of the existing TCP functions to enable communication with networked RT Series devices. However, TCP functions are non-deterministic, and using TCP communication in a time-critical VI reduces determinism. The Simulation Interface Toolkit configures the TCP/IP communication between the host VI and model VI. This TCP/IP communication, coupled with Real-Time FIFOs, is deterministic and does not affect the overall determinism of the time-critical VI. Refer to Chapter 4, *Building Deterministic Applications*, of the *LabVIEW Real-Time Module User Manual* for information about TCP communication and RT FIFOs.

The *Tutorial: Communicating with the Model DLL* section provides step-by-step procedures that teach you how to communicate with a model DLL on an RT target.

Tutorial: Creating a User Interface for a Simulink Model

In the following exercises, you will learn how to create a LabVIEW user interface for a Simulink model. You will create a model that generates a sine wave, then you will use LabVIEW to change the amplitude and frequency of the sine wave.

Building a New Simulink Model

To create a user interface in LabVIEW for a Simulink model, you first must have a Simulink model. Complete the following steps to build a new model in Simulink that generates a sine wave.

1. Launch MATLAB on the host computer.

   Notice how the MATLAB command window displays the following message:

   ```
   Starting the SIT Server on Port 6011
   SIT Server started
   ```

   Installing the Simulation Interface Toolkit configures MATLAB to launch the SIT Server when you launch MATLAB. The SIT Server transfers data between LabVIEW and MATLAB. This message indicates that the SIT Server is running.

   Refer to the *SIT Server* section for more information about the SIT Server.
2. Enter `simulink` in the MATLAB command window to launch the **Simulink Library Browser** window.
3. In a new model, place a **Sine Wave** block in the model window.
4. Place an **In1** input port in the model window.
5. Place a **Sum** function in the model window.
6. Place an **Out1** output port in the model window.
7. Place an **NISink** block, located in the **NI Toolkit Sinks** library, in the model window.

   The **NI Toolkit Sinks** library contains two blocks—the **NISink** block and the **NIXYGraph** block. These two blocks export the output of the model to LabVIEW so LabVIEW can display the data.

Note Depending on the rate at which Simulink generates the output data, you might want to change the decimation factor for the **NISink** or **NIXYGraph** block. The decimation factor specifies how many data points you want Simulink to return. This factor affects the number of data points LabVIEW receives and displays in the waveform chart or XY graph. If you want to display fewer data points, increase the decimation factor. Refer to The MathWorks documentation for more information on decimation factors.

8. Wire the sources, functions, and sinks so the model looks like the diagram in Figure 5.

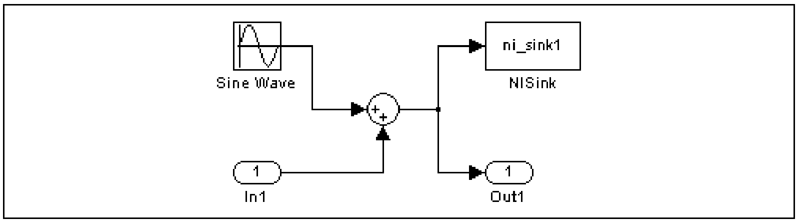


Figure 5. SineWave Model

SIT Server

By default, the Simulation Interface Toolkit starts the SIT Server on port 6011 by executing the `NiMatlabServer` command. However, you can modify the port on which the SIT Server starts by modifying the `startup.m` file. The `startup.m` file contains the command `NiMatlabServer('start',6011)`. To change the port on which the SIT Server starts, change 6011 to another port number.

If you want to temporarily change the port number, first stop the SIT Server. Then enter the `NiMatlabServer('start',XXXX)` command in the MATLAB command window, where *XXXX* is the port number. This command starts the SIT Server on the new port specified. To stop the SIT Server, enter the `NiMatlabServer('stop')` command in the MATLAB command window. You do not need to specify the port number when you stop the SIT Server.

Note The `startup.m` file is located in the `MATLAB`*xx*`\toolbox\local` directory, where *xx* is the version of MATLAB you are using.

Setting the Simulation Parameters

Complete the following steps to change the stop time and the solver type for the simulation.

1. Select **Simulation»Simulation Parameters** to open the **Simulation Parameters** dialog box.
2. On the **Solver** tab, type `inf` in the **Stop time** text box.

   By changing the **Stop time** to an infinite value, the simulation runs until you stop it. The default stop time for this simulation is 10.0 seconds. If you use the default stop time, the simulation might end before you can adjust the values of the parameters. To interact with this model, the simulation stop time might need to be longer.
3. Set the **Type** option to **Fixed-step** in the **Solver Options** section.

4. Save the model as `SineWave.mdl`.

   Refer to The MathWorks documentation for information about setting simulation parameters such as the simulation time and solver type.

Creating the User Interface

To interact with the SineWave model using a LabVIEW user interface, you need to create the user interface in LabVIEW. You need controls for manipulating parameters in the SineWave model and indicators to display the generated sine wave. Complete the following steps to create the controls and indicators that reflect the parameters and sinks of the SineWave model.

1. Launch LabVIEW on the host computer.
2. In the **LabVIEW** dialog box, click the arrow on the **New** button and select **Blank VI** from the shortcut menu.

   Notice that a blank front panel and block diagram appear.

   Refer to the *Getting Started with LabVIEW* manual for more information about the LabVIEW graphical programming environment. The *Getting Started with LabVIEW* manual helps you build VIs and introduces you to basic programming techniques in LabVIEW.
3. Select a knob control and place it on the front panel of the VI.
4. Label the knob `Amplitude`.
5. Create another knob labeled `Frequency`.
6. Select the waveform chart and place it on the front panel of the VI.

   This waveform chart displays information contained in the **NISink** block. You can use any numeric indicator to display the data contained in the **NISink** block; however, you must use an XY graph to display information contained in the **NIXYGraph** block.

   Refer to the *LabVIEW User Manual* for more information about when to use the waveform chart and when to use the XY graph in LabVIEW.
7. Label the waveform chart `Sine Wave`.
8. Save the VI as `Sine Wave.vi`.

LabVIEW and Simulink Data Types

On a non-RT target, Simulink parameters are adaptable at edit time. If you create a LabVIEW control data type that does not match the Simulink parameter data type, you still can run the simulation model. When you run the simulation model, the parameter data type adapts to the corresponding control data type. Valid LabVIEW data types include scalars, 1D arrays, 2D arrays, and strings.

However, Simulink parameters are a fixed data type at run time. If you modify a LabVIEW control whose data type does not match the parameter data type, the parameter cannot receive parameter updates from LabVIEW. Simulink generates an error and stops running.

For simulation models running on an RT target, the parameters are a fixed data type. If the control data types do not match the parameter data types, the simulation model cannot run. You must know the data type of the connected parameters when configuring the controls.

Refer to Chapter 5, *Building the Block Diagram*, of the *LabVIEW User Manual* for more information about LabVIEW data types. Refer to The MathWorks documentation for more information about Simulink parameter data types.

Specifying the Model

After creating the VI, you need to specify with which model you want the VI to communicate. Using the **SIT Connection Manager** dialog box, you can specify this model. Complete the following steps to select the SineWave model.

1. On the front panel menu bar, select **Tools»SIT Connection Manager** to launch the **SIT Connection Manager** dialog box, shown in Figure 6.

   The **SIT Connection Manager** dialog box establishes connections between LabVIEW controls and indicators and parameters and sinks in a Simulink model.

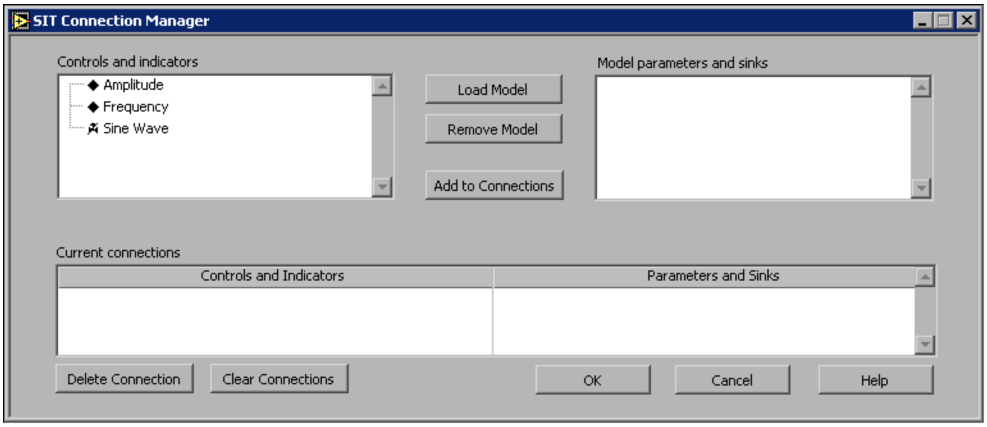


Figure 6. SIT Connection Manager Dialog Box

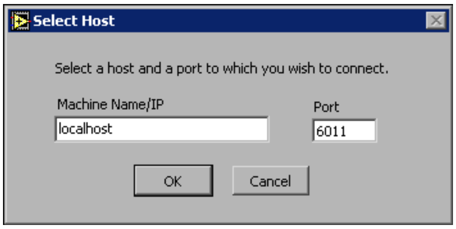
Notice how the **Controls and indicators** listbox displays the LabVIEW controls and indicators you created on the front panel of the Sine Wave VI. Also notice how the **Model parameters and sinks** listbox does not contain any items. You must load a simulation model before the Simulink parameters and sinks appear in the listbox.

2. Click the **Load Model** button to display the **Select Host** dialog box.

Note You must have MATLAB and the SIT Server running before you can load a Simulink model.

3. In the **Select Host** dialog box, shown in Figure 7, make sure the **Machine Name/IP** is **localhost** and the **Port** is **6011**.

   By selecting **localhost**, you indicate to LabVIEW that the computer on which MATLAB and Simulink reside is the host computer. You also can enter the IP address of another Windows PC if MATLAB, Simulink, and the SIT Server are running on that computer.


Select Host

Select a host and a port to which you wish to connect.

Machine Name/IP: localhost

Port: 6011

Figure 7. Select Host Dialog Box

   You can change the port number if port 6011 is not available. Refer to the *SIT Server* section for information about specifying this port number.

4. Click the **OK** button. The **Select Model** dialog box, shown in Figure 8, appears.

Note When you click the **Load Model** button for the first time, the **Select Host** dialog box asks you to specify the computer name and port of the computer containing the Simulink model with which you want to interact. If you click the **Load Model** button again, the Simulation Interface Toolkit uses the previously entered computer name and port.

5. Select **SineWave.mdl** from the **Select model** listbox.

   You might need to navigate to the directory where you saved the SineWave model.

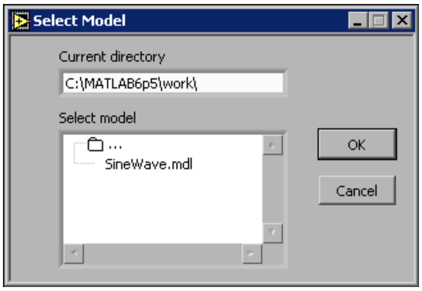


Figure 8. Select Model Dialog Box

6. Click the **OK** button or double-click the filename to select the SineWave model.

   Notice how all the parameters and sinks associated with the SineWave model appear in the **Model parameters and sinks** listbox in the **SIT Connection Manager** dialog box. You can connect controls to parameters and indicators to sinks.

Parameter	◆
Sink	⚗

   Icons next to a parameter or sink name indicate whether the variable is a parameter or a sink. The parameter icon, shown at left, indicates that you can connect LabVIEW controls to the parameter. The sink icon, shown at left, indicates that you can connect LabVIEW indicators to the sink.

Tip To remove a model from the **Model parameters and sinks** listbox, select a parameter or sink in the model that you want to remove and click the **Remove Model** button.

Creating Connections

After loading a model, you must indicate which Simulink parameters and sinks correspond with which LabVIEW controls and indicators. The **SIT Connection Manager** dialog box establishes these relationships. Complete the following steps to create the connections needed to run the simulation model using a LabVIEW user interface.

1. Select **Amplitude** in the **Controls and indicators** listbox and select **Model SineWave»Sine Wave»Amplitude** in the **Model parameters and sinks** listbox.
2. Click the **Add to Connections** button.

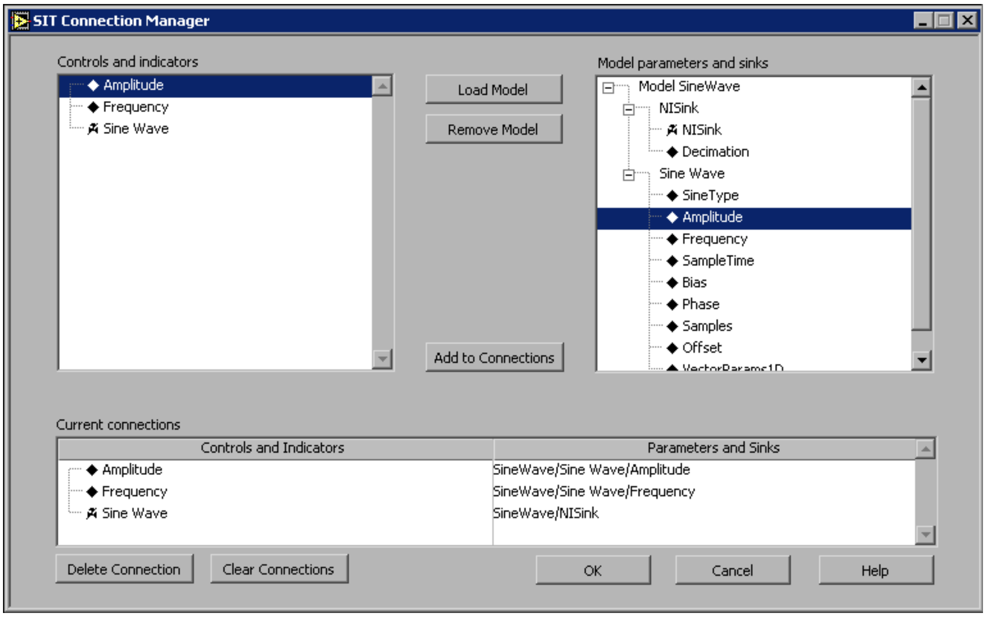
   Notice how the connection appears in the **Current connections** section, which lists all the connections you made. If you decide you do not need a connection, select that connection in the **Current connections** table and click the **Delete Connection** button. To remove all connections, click the **Clear Connections** button.

3. Select **Frequency** in the **Controls and indicators** listbox and select **Model SineWave»Sine Wave»Frequency** in the **Model parameters and sinks** listbox.
4. Click the **Add to Connections** button.

Note The **SIT Connection Manager** dialog box indicates when you create an invalid connection, such as connecting a LabVIEW control to a Simulink sink. The Simulation Interface Toolkit prevents you from creating invalid connections.

5. Select **Sine Wave** in the **Controls and indicators** listbox and select **Model SineWave»NISink»NISink** in the **Model parameters and sinks** listbox.
6. Click the **Add to Connections** button.

   The **SIT Connection Manager** dialog box should look similar to Figure 9.



Current connections

Controls and Indicators	Parameters and Sinks
Amplitude	SineWave/Sine Wave/Amplitude
Frequency	SineWave/Sine Wave/Frequency
Sine Wave	SineWave/NISink

Figure 9. SIT Connection Manager Dialog Box

7. Click the **OK** button.
8. Save this VI.

After you create connections between LabVIEW controls and indicators and Simulink parameters and sinks, the Simulation Interface Toolkit generates the block diagram code that governs the interaction between LabVIEW and Simulink.

The Simulation Interface Toolkit generates this block diagram code from a template VI. You do not need to edit this block diagram because the template VI already contains the necessary VIs and functions to interact with the Simulink model.

Refer to the *Understanding the Block Diagram of the Host VI* section for more information about the automatically generated block diagram code.

Modifying Connections

After you load a Simulink model into the **SIT Connection Manager** dialog box and configure the connections, the **SIT Connection Manager** dialog box retains the model information. Each subsequent time you launch the **SIT Connection Manager** dialog box, the **Model parameters and sinks** listbox displays the parameters and sinks of that Simulink model.

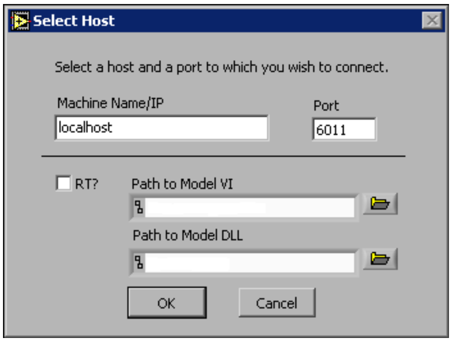
If you want to modify the existing connections between the host VI and the Simulink model, relaunch the **SIT Connection Manager** dialog box, delete the connections you want to modify, and create new connections.

If you want to create new controls and indicators on the front panel, add the controls and indicators and relaunch the **SIT Connection Manager** dialog box. The **SIT Connection Manager** dialog box recognizes the new controls and indicators and allows you to create more connections between these controls and indicators and the Simulink parameters and sinks.

Interacting with the Simulink Model

After creating connections in the **SIT Connection Manager** dialog box, you can run the VI. When you run the VI, the VI communicates with the model on the host computer and runs the simulation. Complete the following steps to run the VI.

1. Display the front panel of the VI.
2. Click the **Run** button, shown at left, to run the VI. The **Select Host** dialog box, shown in Figure 10, appears.


Select Host

Select a host and a port to which you wish to connect.

Machine Name/IP: localhost

Port: 6011

RT?

Path to Model VI

Path to Model DLL

OK

Cancel

Figure 10. Select Host Dialog Box

3. Verify that the host computer is **localhost**.
4. Click the **OK** button to continue.

   The **Select Host** dialog box appears each time you run the VI. You have the option of specifying a new host computer every time you run the VI.
5. Click the **Run** button, shown at left, on the front panel to run the simulation.
6. Adjust the values of the **Amplitude** and **Frequency** knobs and observe the changes on the **Sine Wave** waveform chart.

   Because you connected the LabVIEW controls to the Simulink parameters, when you adjust the values of the controls, the parameter values in Simulink change. Using LabVIEW, you can interactively change the parameters of the model and immediately view the results.

   While the simulation runs you can change run-time, editable parameters, such as the frequency of the sine wave. If you attempt to change the value of a parameter whose value cannot change at run time, you receive an error.
7. Click the **Pause** button, shown at left, on the front panel to pause the simulation. To resume execution, click the **Run** button on the front panel again.
8. Click the **Stop** button, shown at left, on the front panel to stop the simulation.
9. Click the **STOP VI** button, shown at left, on the front panel to stop the host VI.

Note If the simulation is running when you click the **STOP VI** button, the simulation continues to run in Simulink. You must click the **Stop** button on the front panel to stop the simulation in Simulink.

Understanding the Block Diagram of the Host VI

The host VI you created provides the user interface to the Simulink model. The Simulation Interface Toolkit automatically generates the block diagram code for this VI when you use the **SIT Connection Manager** dialog box. The block diagram always has the same structure regardless of the number of connections established in the **SIT Connection Manager** dialog box.

The block diagram initializes the simulation and defines the relationship between the LabVIEW controls and indicators and the Simulink parameters and sinks. When you change the values of the controls on the front panel, the block diagram sends the new values to the Simulink model. The block diagram then receives updates from the Simulink model and displays the values in the corresponding LabVIEW indicators.

The block diagram code consists of three main sections—the code to initialize the simulation, the code to set parameter values, and the code to receive indicator updates from the simulation model.

Initializing the Simulation

The code that initializes the simulation, shown in Figure 11, uses the SIT Initialize VI to perform tasks needed for LabVIEW to communicate with Simulink. The SIT Initialize VI, shown at left, creates the link to the Simulink model. The SIT Initialize VI initiates the TCP/IP connection to the SIT Server and establishes a database of connections to manage the sending and receiving of messages to and from the simulation model.

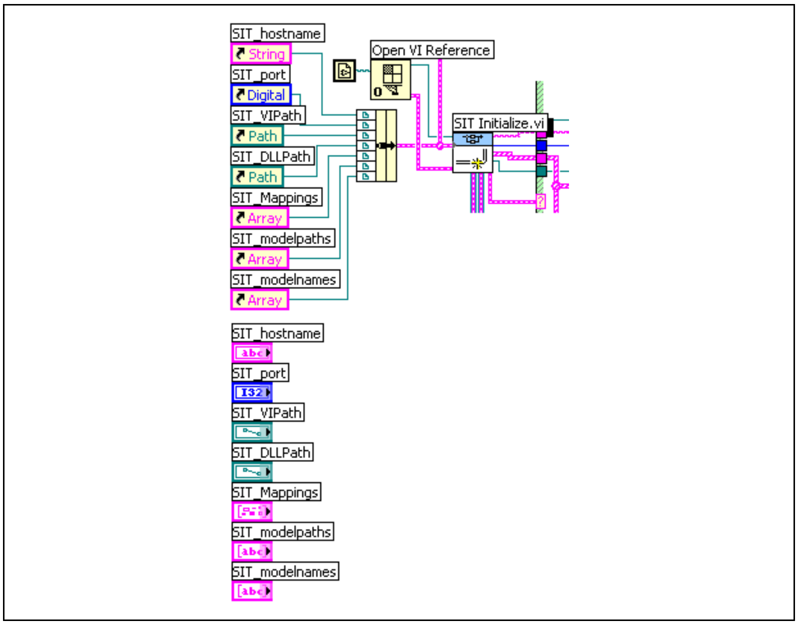


Figure 11. Block Diagram Code for Initializing the Simulation

Notice the cluster of control references wired to the SIT Initialize VI. This cluster allows the initialization code to read the values of the LabVIEW controls. The SIT Initialize VI also creates several queues that LabVIEW uses to communicate between sections of the VI that run in parallel.

Changing Parameter Values Using LabVIEW Controls

Both the code that changes the parameter values and the code that updates the indicator values reside in the outer Case structure that runs when there are no errors with the initialization code. Inside this Case structure are two While Loops that run in parallel. The While Loop containing the Event structure, shown in Figure 12, is the block diagram code that handles the user interaction with the front panel of the host VI. The While Loop in Figure 13 contains the code that updates the indicator values.

If you modify the value of a LabVIEW control connected to a Simulink parameter, the block diagram code within this While Loop sends the changed value to the Simulink model. The Simulink model sets the value of the corresponding parameter using this new value.

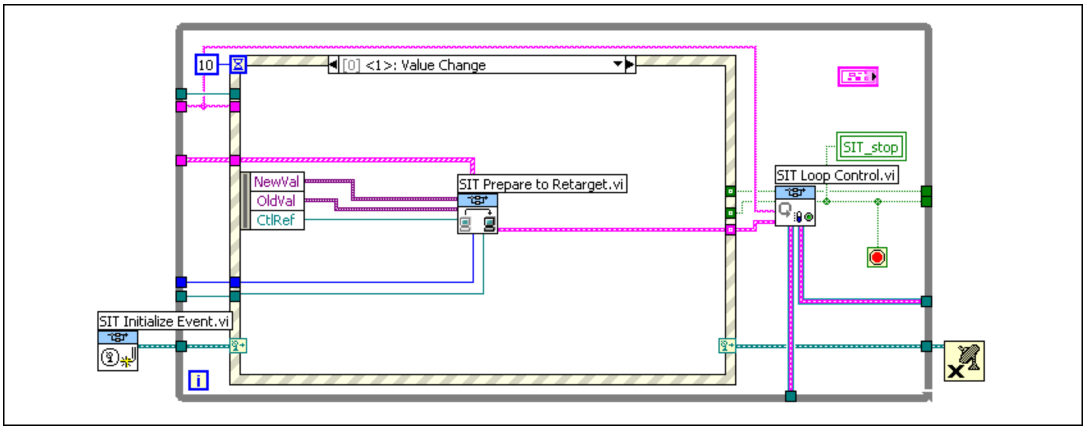


Figure 12. Block Diagram Code for Setting Parameter Values

The Event structure contains several event cases to handle various events. In particular, the Value Change event is a dynamic event created in the SIT Initialize Event VI, shown at left, to monitor changes in the values of the controls on the front panel. This event executes when a control value associated with a model parameter changes.

For example, when you change the value of the **Frequency** knob, which is associated with the model parameter **Frequency**, the Value Change event executes. The VI sends the new value of the **Frequency** knob to the simulation model and specifies that the new value applies to the **Frequency** parameter.

Also notice the SIT Loop Control VI, shown at left, located outside the Event structure. This VI controls when the two While Loops, in Figures 12 and 13, terminate. The two While Loops run in parallel until you click the **STOP VI** button or the **Stop** button. When the SIT Loop Control VI receives a stop command, it terminates the execution of both While Loops.

Note When the VI stops executing, the VI saves the final values of the controls. The next time you run the VI, the VI uses these values as the initial values of the controls.

The SIT Loop Control VI also gathers warnings, errors, and fatal errors returned by Simulink. Warnings do not interrupt the simulation. When Simulink encounters an error, the Simulation Interface Toolkit displays a dialog box that gives you the option of stopping the host VI. However, when Simulink encounters a fatal error, the Simulink application always terminates, which terminates the host VI.

Updating the Indicator Values

The second While Loop, shown in Figure 13, displays the block diagram code that reads values output by the simulation model and updates the values on LabVIEW front panel indicators. This While Loop contains a Case structure, which contains a case for each LabVIEW indicator connected to a Simulink sink.

When the VI receives an update from the SIT Server, the VI places a message into a queue for the While Loop to read. The elements in the queue contain all the information necessary to display the sink value in the corresponding LabVIEW indicator.

The While Loop also contains a timeout set to 100 ms. If the While Loop does not receive an indicator update within 100 ms of the last indicator update, the While Loop checks for a stop command.

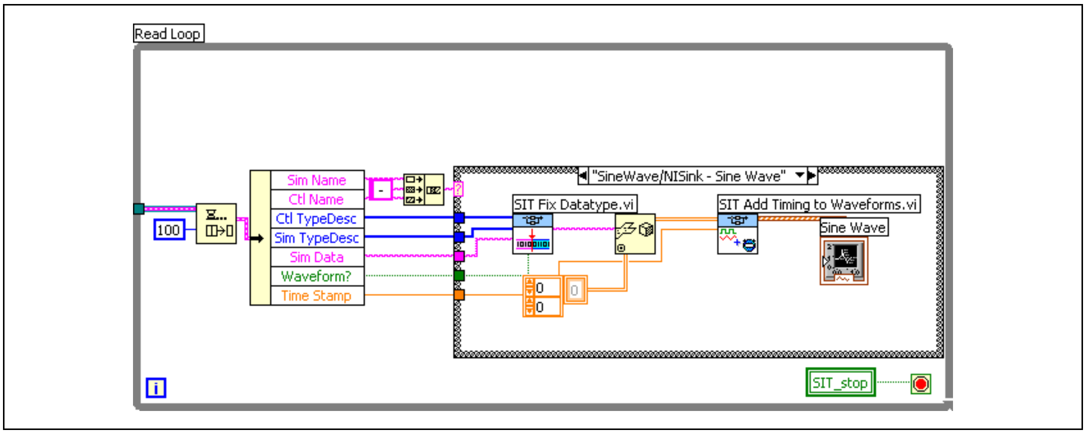


Figure 13. Block Diagram Code for Updating Indicators

When you add, delete, or modify a connection in the **SIT Connection Manager** dialog box, the Simulation Interface Toolkit regenerates this section of the block diagram code.

Tutorial: Converting a Simulink Model into a Model DLL

The Simulation Interface Toolkit enables you to create DLLs from Simulink models through Real-Time Workshop and Microsoft Visual C++. Real-Time Workshop converts the `.mdl` file into C code and then Microsoft Visual C++ compiles the C code into a DLL. The result is a DLL based on a Simulink model that you can call in LabVIEW using the VIs on the **Simulation Interface** palette.

Note If you are using a LabVIEW module, such as the LabVIEW Real-Time Module, the LabVIEW FPGA Module, or the LabVIEW PDA Module, make sure you target LabVIEW to the host computer before building a model DLL. Real-Time Workshop cannot build a model DLL if you have an open connection to a target other than the host computer.

Complete the following steps to convert the Simulink model into a DLL that you can download to an RT target.

1. If you closed the SineWave model in Simulink, open the model again. You created the SineWave model in the *Building a New Simulink Model* section.

   Notice the input port and output port you placed on the diagram when you created the SineWave model. The input port and output port blocks correspond to the inputs and the outputs of the model DLL. For example, in DAQ applications, LabVIEW uses these blocks to exchange data with a DAQ device. These blocks send data to and receive data from the model DLL and DAQ device. Refer to the *Exchanging Data with the Model DLL* section for information about sending and receiving data.
2. Select **Simulation»Simulation Parameters** to display the **Simulation Parameters** dialog box.
3. Click the **Real-Time Workshop** tab.
4. Click the **Browse** button to open the **System Target File Browser** dialog box.
5. Select **nidll.tlc—LabVIEW DLL Target** from the listbox and click the **OK** button to continue.
6. Click the **Build** button in the **Category** section to begin building the model DLL.

   The MATLAB command window displays the status of Real-Time Workshop as it builds the model DLL. The following message in the MATLAB command window indicates that Real-Time Workshop has completed building the model DLL.

   ```
   ### Successful completion of Real-Time Workshop build
   procedure for model: ModelName.
   ```

Note If you do not have a compiler set up to compile the C code, MATLAB gives you an error when trying to build the model DLL. The MATLAB command window displays a message indicating you need to run `mex -setup` before building the model DLL.

After Real-Time Workshop builds a model DLL, the Simulation Interface Toolkit places the model DLL into a project folder on the computer. The model DLL contains all aspects of the Simulink model but is independent of the Simulink `.mdl` file.

During the build process, the Simulation Interface Toolkit creates model VIs and driver VIs that you use to interact with the model DLL. These VIs also are in the project folder.

Refer to The MathWorks documentation for more information about how Real-Time Workshop generates the C code. Refer to the *Understanding Model VIs, Driver VIs, and a Model DLL* section for more information about the model VIs, driver VIs, and model DLL.

Tutorial: Communicating with the Model DLL

By converting a Simulink model into a model DLL, you create a simulation model that you can run on an RT target. Remember that this model DLL contains all aspects of the Simulink model but is no longer a Simulink model. You use the model VIs and driver VIs to communicate with the model DLL. Using the host VI, you can download the model VI, driver VI, and the model DLL to an RT target. You then can modify the parameters of the model DLL by adjusting the controls in the host VI.

Complete the following steps to download the model DLL to an RT target and communicate with the model DLL.

1. Display the front panel of the Sine Wave VI that you created in the *Tutorial: Creating a User Interface for a Simulink Model* section.
2. Run the VI.
3. While the VI is running, select **Simulation»Retarget** from the run-time menu to select a new target on which to run the simulation.

Note If the Simulink model is running when you try to retarget the host VI, the Simulation Interface Toolkit stops the Simulink model before downloading the model DLL to the RT target.

4. The **Select Host** dialog box appears. To select a new target, enter the IP address of the RT target in the **Machine Name/IP** text box.
5. Place a checkmark in the **RT?** checkbox to indicate that the target is an RT target.

Note If you place a checkmark in the **RT?** checkbox, you must select the path to the model VI. If you try to retarget the VI and do not specify a path, you cannot retarget the VI because the VI assumes that the target is not an RT target.

6. In the **Path to Model VI** path, select **SineWave_main.vi** located in the `Matlabxx/work/SineWave_nidll_rtw` directory, where *xx* is the version of MATLAB you are using.

If LabVIEW can determine the correct path to the model VI, LabVIEW automatically specifies the **Path to Model VI** path for you. LabVIEW searches in the model project folder located in the same directory as the Simulink model for the model VI.

The `SineWave_nidll_rtw` folder is the model project folder where the Simulation Interface Toolkit places all files generated by the Real-Time Workshop build procedure. The folder also includes the VIs that the Simulation Interface Toolkit generated during the build process, including the SineWave_main VI.

The SineWave_main VI, which you call to run the simulation, is a model VI that the Simulation Interface Toolkit created. Refer to the *Understanding Model VIs, Driver VIs, and a Model DLL* section for more information about the model VI.

7. In the **Path to Model DLL** path, select the **SineWave.dll** located in the `Matlabxx/work/SineWave_nidll_rtw` directory.

   Again, if LabVIEW can determine the correct path to the model DLL, LabVIEW automatically specifies the **Path to Model DLL** path for you.

   The **Select Host** dialog box should look similar to the dialog box in Figure 14.

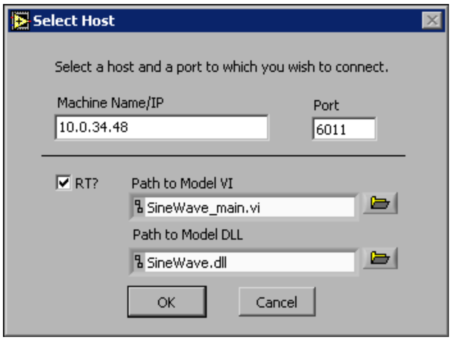


Figure 14. Downloading the Model VI and Model DLL to an RT Target

   Again, by default, the Simulation Interface Toolkit starts the SIT Server on port 6011. To change this port number, you can open SineWave_main VI and change the constant wired to the SIT Start Server VI. Then, in the **Select Host** dialog box, enter the new value in the **Port** text box.

8. Click the **OK** button.
9. Run the simulation as you did in the *Interacting with the Simulink Model* section.

Understanding Model VIs, Driver VIs, and a Model DLL

To create a model DLL, Real-Time Workshop converts the Simulink model and any of its submodels into C code. Then Microsoft Visual C++ compiles the C code into a model DLL named `*ModelName*.dll`, where `*ModelName*` is the name of the Simulink model. Real-Time Workshop then places the model DLL into a new model project folder, `*ModelName*_nidll_rtw`.

In addition to the model DLL, the Simulation Interface Toolkit creates the following model VIs and driver VIs and places them in the `*ModelName*_nidll_rtw` folder. The following model VIs and driver VIs work with the SIT Server to call the model DLL and execute the simulation.

- Model VIs
  - *ModelName*_main_daq VI
  - *ModelName*_main VI
- Driver VIs
  - *ModelName*_driver_daq VI
  - *ModelName*_driver VI
- Driver VIs that do not use the SIT Server
  - *ModelName*_driver_daq_base VI
  - *ModelName*_driver_base VI

The model VIs start the SIT Server on an RT target, call a driver VI that calls the model DLL, and then stop the SIT Server when the simulation stops. You cannot communicate with a model DLL on an RT target until the SIT Server starts running, so you always must specify a model VI in the **Path to Model VI** path in the **Select Host** dialog box, as shown in Figure 11.

The block diagram in Figure 15 is the model VI, SineWave_main VI, created for the Sine Wave example.

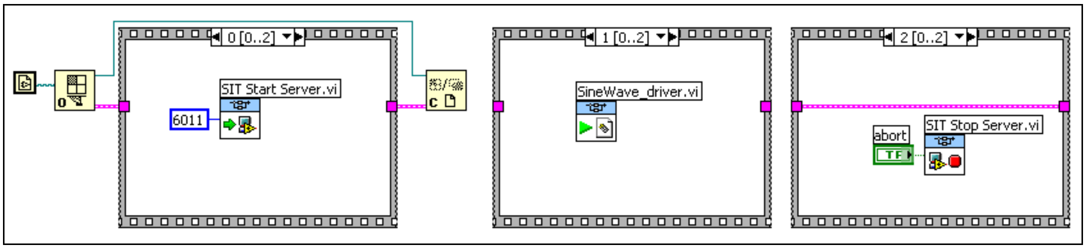


Figure 15. SineWave_main VI

The driver VIs interact with the model DLL and exchange parameter information between the host VI and the model DLL on the RT target. The *ModelName*_main_daq VI calls the *ModelName*_daq_driver VI and the *ModelName*_main VI calls the *ModelName*_driver VI.

The *ModelName*_daq_driver VI is a DAQ application that reads analog input values from a multifunction DAQ board, sends the values as inputs to the SIT Step Model VI, retrieves the outputs from the SIT Step Model VI, and writes the analog outputs to the same DAQ board.

The *ModelName*_driver VI is a version of the *ModelName*_daq_driver VI with the DAQ calls replaced by controls and indicators. Refer to the *Creating a LabVIEW VI to Call the Model DLL* and the *Creating a Real-Time Model-Based Controller* sections for more information about these driver VIs created based on the SineWave model.

The *ModelName*_daq_driver_base VI and the *ModelName*_driver_base VI are driver VIs that you can use if you want to run simulation models directly on an RT target. These VIs do not require the SIT Server to run, so you do not need to run a model VI to run the simulation. Refer to the *Running Simulations without the Simulation Interface Toolkit Server* section for more information about using these driver VIs.

Model Interface VIs

The Simulation Interface Toolkit places a set of Model Interface VIs on the **Model Interface** palette. These VIs are the building blocks for the driver VIs and help you call the model DLL from LabVIEW. In particular, the driver VIs use the Model Interface VIs to call the model DLL from LabVIEW. You can use the Model Interface VIs to initialize, finalize, and manipulate the internal parameters of the model DLL. You also can use the Model Interface VIs to single-step through the simulation model.

Refer to the *Simulation Interface Toolkit Help* for information about the Model Interface VIs. Access the *Simulation Interface Toolkit Help* by selecting **Help»Simulation Interface Toolkit Help** in LabVIEW.

Exchanging Data with the Model DLL

After you create a model DLL that LabVIEW can call, you can exchange data with the model DLL from the host VI. The SIT Server transfers the data between the model DLL and the host VI. Every call to the SIT Step Model VI, shown at left, takes one time step in the simulation model. To continuously exchange data with the model DLL, use the Model Interface VIs within a loop structure.

Any LabVIEW VI that you create can exchange data with the simulation model through the inputs and outputs of the SIT Step Model VI. The data inputs are values you want to send to the model DLL with each time step, and the data outputs are values you receive from the model DLL after each time step.

In Simulink, the inputs and outputs correspond to the generic input port and output port blocks that you added to the model window. In LabVIEW, the inputs and outputs of the model DLL correspond to arrays of double-precision values transferred to and from the SIT Step Model VI. These inputs and outputs of the model DLL accept scalar or array data.

The Simulation Interface Toolkit also creates a `ModelName_modelParamMapping.ctl` file for each model during the build process. This *ModelName*_modelParamMapping control contains the information generated by Real-Time Workshop about the parameters in the model DLL. This control is the same as the **mapping** control, shown in Figures 16 and 17, created in the automatically generated driver VIs. To include mapping information in the driver VIs you create, place this control on the block diagram and wire it to the SIT Initialize Model VI or the SIT Map Model Parameters VI.

If you make changes to the Simulink model and rebuild the model DLL, the Simulation Interface Toolkit also generates a new *ModelName*_modelParamMapping control. Make sure you update the driver VI you created to use this new control.

Note During the Real-Time Workshop build process, the Simulation Interface Toolkit creates a `ModelName_portsReadme.txt` file in the model project folder. This file describes the mapping between the LabVIEW arrays and Simulink input port and output port blocks.

Creating a LabVIEW VI to Call the Model DLL

When you created the model DLL from the SineWave model, the Simulation Interface Toolkit automatically generated the SineWave_driver VI, shown in Figure 16, and placed the driver VI in the `SineWave_nidll_rtw` folder. The SineWave_driver VI communicates with the model DLL. Each inner While Loop iteration in the SineWave_driver VI corresponds to one time step of the Simulink model.

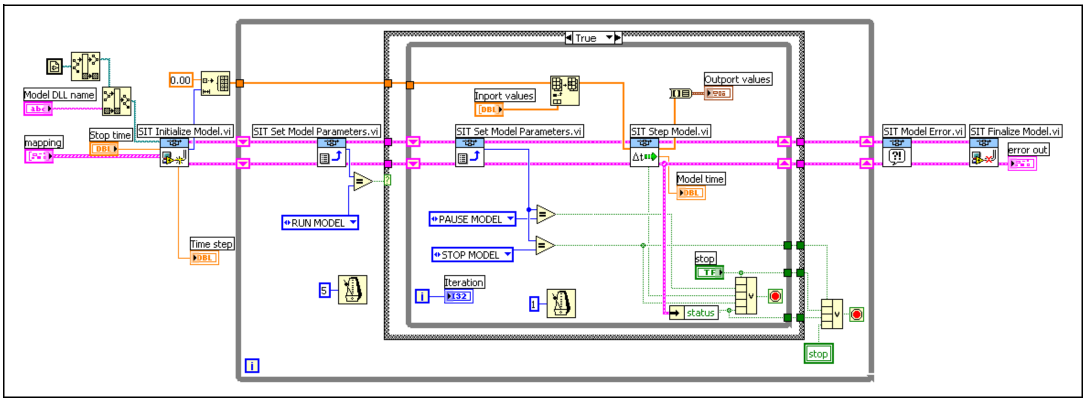


Figure 16. SineWave_driver VI

The SIT Initialize Model VI, shown at left, prepares the model DLL for execution, sets the final time for the model DLL, and returns the following information about the model DLL: the time step, number of input ports, and number of output ports.

The SIT Step Model VI takes one time step of the simulation model with each iteration of the inner While Loop, accepting the input array and returning the output array. The SIT Step Model VI also indicates if this is the final time step of the loop.

The While Loop terminates when you press the **Stop** button on the front panel or after the SIT Step Model VI indicates that the model DLL reached the specified stop time. The While Loop also terminates if it encounters an error. The SIT Finalize Model VI, shown at left, executes after the While Loop exits.

The SineWave_driver VI uses the SIT Set Model Parameters VI, shown at left, to update parameters deterministically within the model DLL as it executes. The host VI sends changes in control values to the SIT Server, and the SIT Set Model Parameters VI reads the control values sent by the host VI and then sets the parameters for the model DLL. The SIT Set Model Parameters VI also receives run, pause, and stop commands from host VI through the SIT Server.

Creating a Real-Time Model-Based Controller

By combining the Model Interface VIs with DAQ I/O, you can implement real-time control systems or hardware-in-the-loop simulations. By using the DAQ functions in LabVIEW Real-Time Module applications, the VIs execute simulation models in real time with real I/O. The driver VI, SineWave_daq_driver VI, in Figure 17, is an example block diagram of this type of VI.

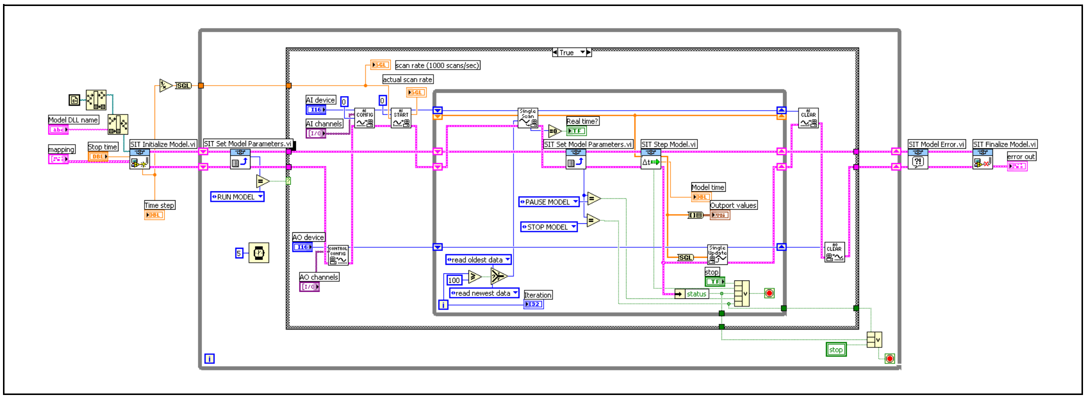


Figure 17. SineWave_daq_driver VI

Similar to the SineWave_driver VI, the SineWave_daq_driver VI uses the SIT Initialize Model VI to prepare the model DLL for execution. The SIT Step Model VI steps through the simulation model with each iteration of the inner While Loop, the SIT Set Model Parameters VI updates parameters dynamically within the model DLL as it executes, and the SIT Finalize Model VI executes when the simulation model completes execution.

The SineWave_daq_driver VI uses a continuous single-point analog input operation to control the timing of the VI. The scan clock of the analog input controls the time interval between scans of the analog output. Notice that the number of analog input channels must equal the number of input ports in the simulation model, and the number of analog output channels must equal the number of output ports.

Note By default, when generating the driver VIs for DAQ, the Simulation Interface Toolkit configures the device numbers assigned to a DAQ device. Verify that the assigned device numbers are correct for the DAQ device you are using. If the device numbers are incorrect, change the default values.

Refer to the DAQ examples located in `examples\daq\solution\control.llb` and the LabVIEW Real-Time Module examples located in `examples\rt\RT Control.llb` for additional examples of real-time control using DAQ VIs.

Running Simulations without the Simulation Interface Toolkit Server

To run the SIT Server on an RT target, the RT target must have at least 64 MB of RAM. If the RT target does not meet this memory requirement, you can switch LabVIEW execution targets and run LabVIEW directly connected to an RT target. This way you do not have a host VI and do not need the SIT Server to provide a network connection between the host computer and RT target.

You also can switch LabVIEW execution target and run LabVIEW on an RT target when you do not need to use a front panel to communicate with the simulation model. For example, if you do not need to change the model parameters or receive visual indicator updates, you do not need the front panel of the host VI.

When you do not use the host VI to communicate with the model DLL, the Simulation Interface Toolkit does not download the model DLL and driver VIs for you. You must use FTP to directly transfer the model DLL to the `c:\ni-rt\system` folder on the remote target.

When you convert the Simulink model into a model DLL, the Simulation Interface Toolkit automatically generates driver VIs that do not require the SIT Server to run the simulation on the RT target. These driver VIs, *ModelName*_daq_driver_base VI and *ModelName*_driver_base VI, are similar in functionality to the *ModelName*_daq_driver VI and *ModelName*_driver VI. However, you set the parameter values using the front panel of the driver VI rather than using a host VI and the SIT Server.

When you retarget LabVIEW to the RT target, you only need to execute a driver VI to run the simulation model. You do not need to execute a model VI because the SIT Server is not necessary.

If you decide you need a user interface for the driver VIs, you can use the RT Communication Wizard to create a user interface for the driver VIs running on the RT target. Refer to Chapter 4, *Building Deterministic Applications*, of the *LabVIEW Real-Time Module User Manual* for information about using the RT Communication Wizard.

Simple Model Interface VIs

The LabVIEW Simulation Interface Toolkit places a set of Simple Model Interface VIs on the **Simple Model Interface** palette. The Simple Model Interface VIs are the building blocks for the *ModelName*_daq_driver_base VI and *ModelName*_driver_base VI.

The Simple Model Interface VIs have the same functionality as the Model Interface VIs; however, these VIs do not require the SIT Server. The Simulation Interface Toolkit provides these Simple Model Interface VIs so advanced LabVIEW users can design customized driver VIs for RT targets on which the SIT Server is not running.

Modifying Parameters in the Model DLL Using a Driver VI

The front panel of the *ModelName*_driver_base VI and the *ModelName*_daq_driver_base VI contains all the necessary controls and indicators you need to interact with the model DLL. The front panel in Figure 18 is an example of the front panel for the

SineWave_driver_base VI. The Simulation Interface Toolkit created this driver VI when you converted the SineWave model into a model DLL.

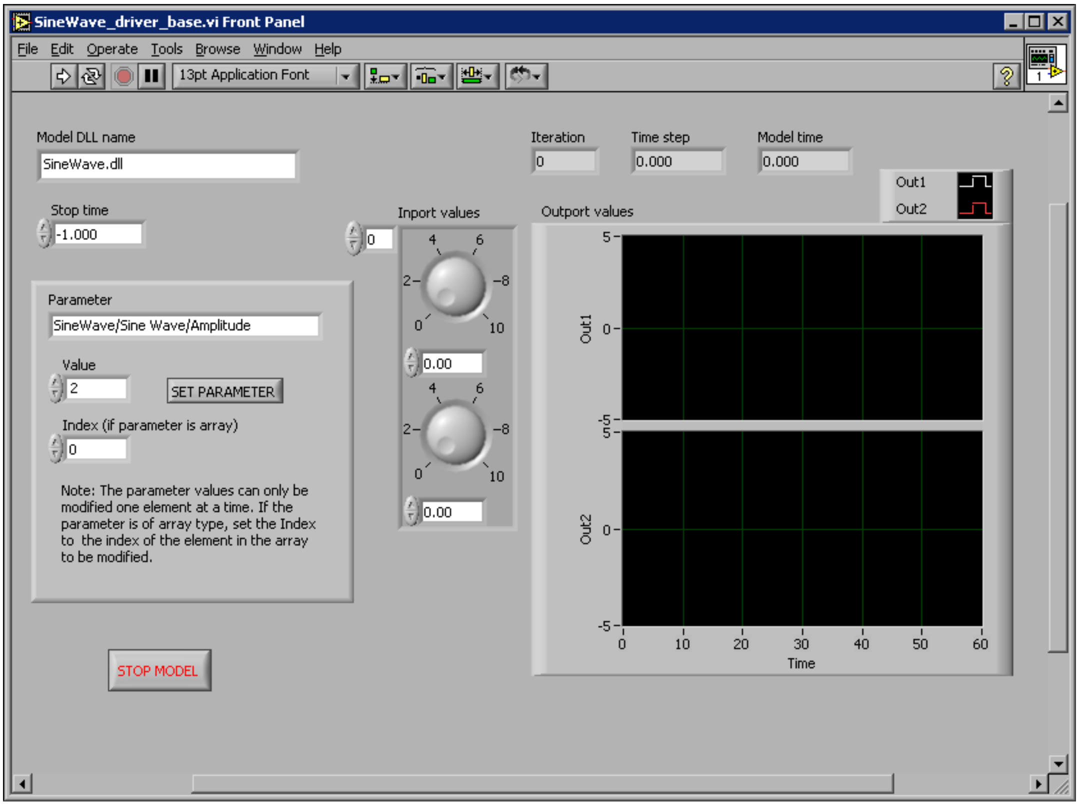

SineWave_driver_base.vi Front Panel
File Edit Operate Tools Browse Window Help
13pt Application Font
Model DLL name
SineWave.dll
Stop time
-1.000
Parameter
SineWave/Sine Wave/Amplitude
Value
2
SET PARAMETER
Index (if parameter is array)
0
Note: The parameter values can only be modified one element at a time. If the parameter is of array type, set the Index to the index of the element in the array to be modified.
STOP MODEL
Inport values
0
0.00
0.00
Iteration
0
Time step
0.000
Model time
0.000
Outport values
Out1
Out2
Time

Figure 18. Front Panel of the SineWave_driver_base VI

The name of the model DLL automatically appears in the **Model DLL name** text box. The **Inport values** correspond to the inputs of the simulation model, and the **Outport values** display the outputs of the simulation model.

You can use the **Parameter** and **Value** fields to modify the parameters for the model DLL. In the **Parameter** text box, you must specify the path to the parameter in the model DLL. In the **Value** field, you must enter the value to which you want to set that parameter. For example, if you want to set the amplitude of the generated sine wave in the model DLL to 2, you enter `SineWave/Sine Wave/Amplitude` in the **Parameter** text box and `2` in the **Value** text box.

Note To specify a parameter in a model DLL, you must use the same path that the Simulink model uses. Identify the parameter by specifying the *`model name/[subsystem`* `name]/block name/parameter name`. If the block is in a subsystem of the simulation model, then you need to specify the `[subsystem name]` in which the block is located.

After you enter the parameter information, click the **SET PARAMETERS** button to set the parameter values in the model DLL. You can set the values of all the parameters in the model DLL using the **Parameter** and **Value** fields. The data type of the parameter that you specify has to be a double-precision, floating-point number.

Note If you modify a parameter of an array data type, you can modify only one element of the array at a time. To change the value of an element in the array, use the index values to specify the element, then enter the new value.

Designing a Batch Simulation

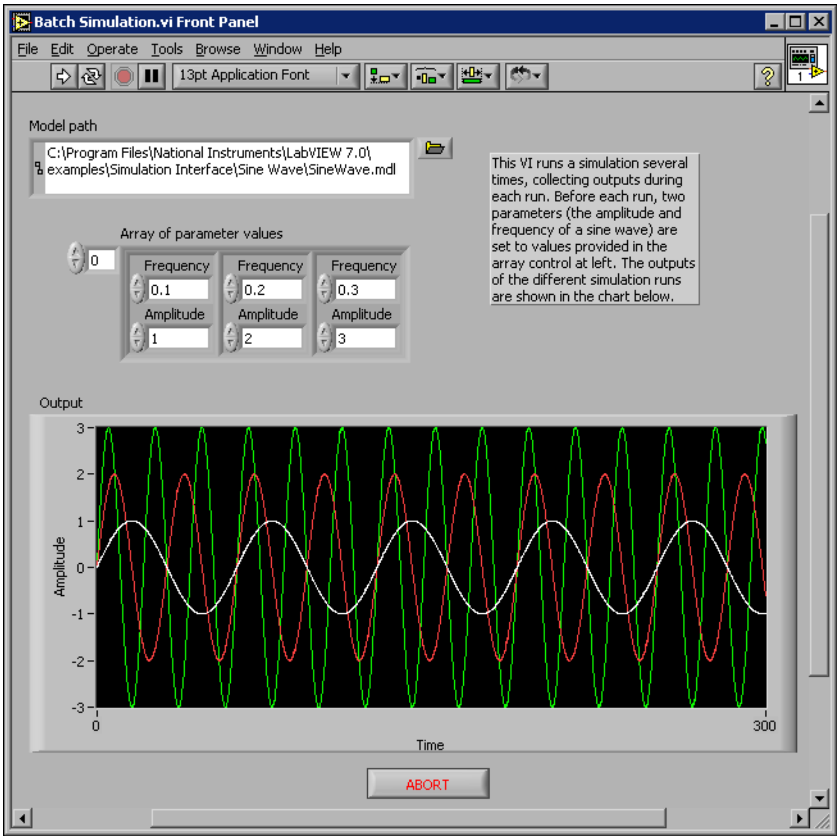
Using the Simulation Interface Toolkit, you can run a batch simulation, which is a series of simulations that have varying initial conditions or parameter values. This section describes an example batch simulation application created using the User Interface VIs. This application runs the SineWave model, which you created in the *Building a New Simulink Model* section, several times, each time with different initial parameter values for the amplitude and frequency of the sine wave. This section describes how to set the initial conditions on the front panel of the Batch Simulation VI and teaches you more about the block diagram.

Setting the Initial Conditions for the Batch Simulation

Open the Batch Simulation VI located in the `examples\Simulation Interface\Batch Simulation` directory to follow along.

The front panel of the Batch Simulation VI, shown in Figure 19, contains a **Model path** path control where you specify the path to the model you want to run. In the Batch Simulation VI, the **Model path** text box specifies the path to the SineWave model located in the `examples\SimulationInterface\SineWave` directory.

Note The `examples\SimulationInterface\SineWave` directory provides solutions to the exercises in this user guide. The folder contains examples of the Simulink model, the LabVIEW VIs, and the model DLL you created.


Batch Simulation.vi Front Panel
File Edit Operate Tools Browse Window Help
13pt Application Font
ABORT

Model path

C:\Program Files\National Instruments\LabVIEW 7.0\examples\Simulation Interface\Sine Wave\SineWave.mdl

This VI runs a simulation several times, collecting outputs during each run. Before each run, two parameters (the amplitude and frequency of a sine wave) are set to values provided in the array control at left. The outputs of the different simulation runs are shown in the chart below.

Array of parameter values

	Frequency	Amplitude
0	0.1	1
	0.2	2
	0.3	3

Figure 19. Front Panel of the Batch Simulation VI

To set the initial parameter values, you can modify the values in the **Array of parameter values** control. In this VI, the **Array of parameter values** control contains three pairs of values for the frequency and amplitude parameters. The **Array of parameter values** control indicates that the Batch Simulation VI will run the SineWave model three times using the values specified in this control. The **Output** chart displays the results of this batch simulation.

Click the **Run** button to display the results of this batch simulation.

Understanding the Block Diagram of the Batch Simulation VI

Like the block diagram generated for the host VI, the block diagram for the Batch Simulation VI has three parts—the code to initialize the batch simulation, the code to set the parameter values, and the code to receive indicator updates from the simulation model. However, the block diagram for the Batch Simulation VI differs because instead of waiting for user events to start the simulation and set parameters, this application performs these tasks programmatically.

This Batch Simulation VI uses the User Interface VIs as subVIs. Refer to the *Simulation Interface Toolkit Help* for information about the User Interface VIs.

Initializing the Batch Simulation

The initialization code, shown in Figure 20, uses the SIT Initialize Simulation VI to start the simulation. The SIT Initialize Simulation VI, shown at left, initiates a connection to the SIT Server, which resides on the computer specified by the **hostname** control. The **port** control indicates the port number through which the Batch Simulation VI communicates with the SineWave model. The **Model path** control specifies the path to the Simulink model that you want to run.

Setting the Parameter Values

The For Loop contains the other two parts of the block diagram code—the code that sets the parameter values and the code that updates the **Output** indicator. The For Loop uses automatic indexing to determine the number of times it executes. Specifically, the For Loop executes one time for every element in the **Array of parameter value** control.

The code that sets the parameter values, also shown in Figure 20, uses the SIT Register VI and the SIT Write VI, shown at left, to set the parameter values in the SineWave model. Given the path to a sink and a reference to the corresponding indicator, the SIT Register VI notifies the SIT Server what values to display in the **Output** chart.

Given a path to a Simulink parameter, the SIT Write VI sets the initial value of that parameter using the value specified in the **Array of parameters** control. After setting the initial values for the simulation, the SIT Run Simulation VI notifies the SIT Server to start running the simulation.

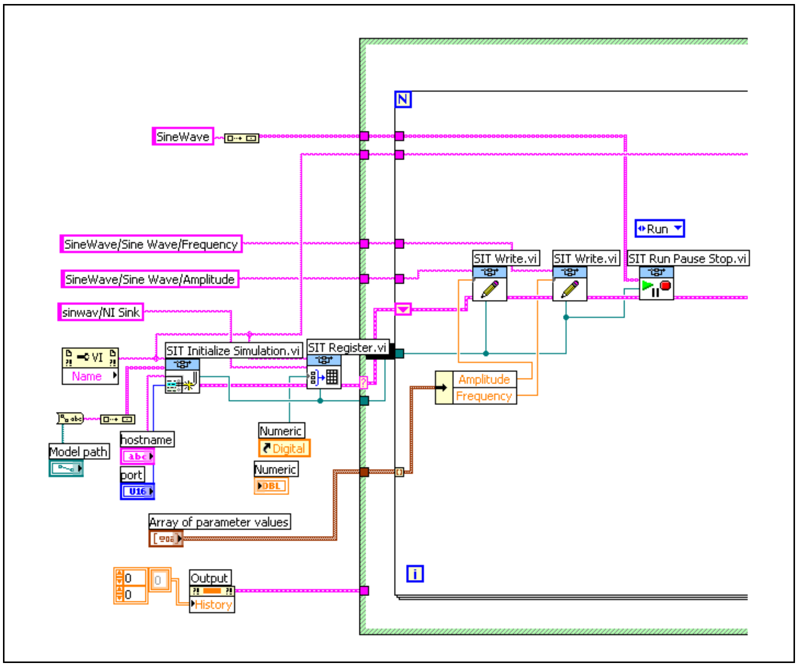


Figure 20. Block Diagram Code for Initializing the Simulation and Setting Parameters Values

Updating the Output Indicator

The code that updates the indicators, shown in Figure 21, reads the data from the Simulink parameters. The While Loop contains all the necessary block diagram code for receiving the data from the Simulink model.

The While Loop contains the SIT Read VI and a Case structure. The SIT Read VI, shown at left, receives a new value sent from the SIT Server and determines the indicator in which to display the value. The Case structure contains one case for each available indicator.

To configure the code for updating the indicators, you can create a Case structure containing cases named according to the elements in the **data** output of the SIT Read VI. The **data** output is a cluster containing information such as the name of a LabVIEW indicator and the name of the corresponding Simulink sink.

You wire an element of the **data** output to the selector terminal of the Case structure. Then you name the cases in the Case structure according to the element you chose to use. For example, when the Simulation Interface Toolkit generates this code, it uses Simulink sink name, **Sim Name**, and the LabVIEW indicator name, **Ctl Name**, in the data output to create the names for the cases in the Case structure. So the names of the cases in the Case structure are formatted as follows: `model name/sink name - indicator name`.

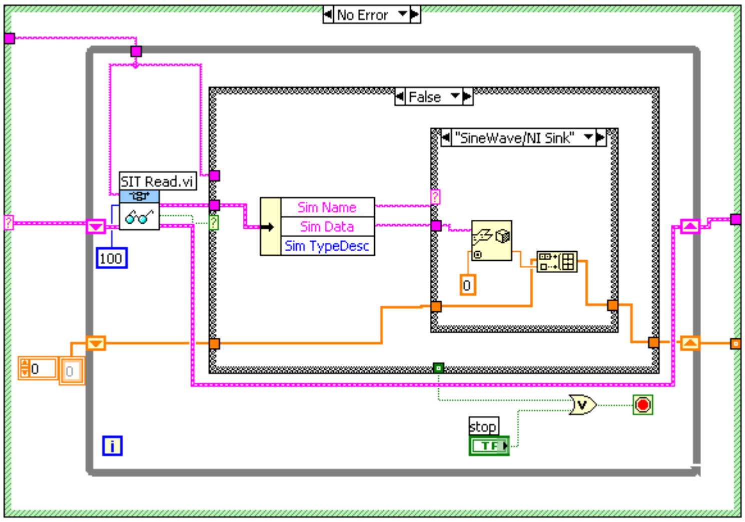


Figure 21. Block Diagram Code for Updating Indicators

The SIT Read VI executes until the While Loop receives an indication from the SIT Server that the simulation is complete. The result, for this example, is a plot of three sine waves with different amplitudes and frequencies, as shown in Figure 19.

Where to Go from Here

In addition to this user guide, the Simulation Interface Toolkit provides example VIs that you can explore to learn more about creating simulation models in LabVIEW.

Refer to the `examples\simulation interface` directory for examples using the Simulation Interface VIs. The following two folders contain VIs and examples used in this user guide.

- `SineWave` folder—Contains solutions to the exercises in the *Tutorial: Creating a User Interface for a Simulink Model*, *Tutorial: Converting a Simulink Model into a Model DLL*, and *Tutorial: Communicating with the Model DLL* sections.
- `Batch Simulation` folder—Contains the Batch Simulation VI used in the *Designing a Batch Simulation* section.
- `XY Graph` folder—Contains an example of using the NIXYGraph block in Simulink. The Lorenz UI VI uses the XYGraph in LabVIEW to display the output data of the model.

LabVIEW includes extensive documentation for new and experienced LabVIEW users. Refer to the *LabVIEW Bookshelf* for information about LabVIEW and to access the LabVIEW help resources. Access the *LabVIEW Bookshelf* by selecting **Start»Programs»National Instruments»LabVIEW»Search the LabVIEW Bookshelf**.