

# FPGA Interface User Guide

This document explains how to use LabVIEW to build applications that run on host computers and communicate with FPGA VIs running on National Instruments Reconfigurable I/O (RIO) devices, also known as FPGA devices.

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## Introduction

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Use the FPGA Interface functions to communicate with an FPGA VI from a host VI. The VI that runs on an FPGA device is called the *FPGA VI*. Use the FPGA Module to create FPGA VIs. Refer to the *LabVIEW FPGA Module User Manual* for information about developing FPGA VIs.

A *host VI* is a VI that communicates with the FPGA VI to control the FPGA device. A host VI can run in Windows or on an RT target. To write host VIs, you first target LabVIEW for Windows or an RT target. Refer to the *LabVIEW User Manual* for information about developing VIs that run on Windows. Refer to the *LabVIEW Real-Time Module User Manual* for information about developing VIs for RT targets.

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March 2004  
370958A-01

You can use the FPGA Interface functions to programmatically control and communicate with an FPGA VI. Use the FPGA Interface functions to perform the following operations in host VIs:

- Establish communication with the FPGA VI.
- Read and write data to the FPGA VI.
- Wait for and acknowledge FPGA VI interrupts.
- Close the VI reference.

## Establishing Communication with the FPGA VI

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You must open a reference to the FPGA device before you can communicate with the host VI. Use the Open FPGA VI Reference function, available when you target LabVIEW for Windows or an RT target, to do the following:

- Select the FPGA VI with which the host VI communicates.
- Select the FPGA device on which the FPGA VI runs.
- Determine whether the host VI opens and runs the FPGA VI or just opens the FPGA VI.

### Selecting the FPGA VI

To select the FPGA VI, right-click the Open FPGA VI Reference function on the block diagram and select **Select Target VI** from the shortcut menu. Type the path or navigate to the FPGA VI on the host computer. The FPGA VI you select in the **Select Target VI** dialog box appears as a subVI in the VI hierarchy of the host VI.



**Note** You must have the FPGA VI on the host computer.

### Selecting the FPGA Device

You can select the FPGA device when you create the host VI. Right-click the Open FPGA VI Reference function on the block diagram and select an FPGA device type from the **FPGA** list in the shortcut menu. You can select a specific device by selecting **FPGA»Select** from the shortcut menu to display the **Select Board** dialog box. You can select the host computer by selecting **Local Host** from the shortcut menu.

You also can programmatically select an FPGA device when you use the Open FPGA VI Reference function using the **VISA Resource Name** input. Right-click the Open FPGA VI Reference function on the block diagram and select **External VISA Input** from the shortcut menu to add the **VISA Resource Name** input to the Open FPGA VI Reference function.

## Setting Open and Run Options

When you run the host VI, the Open FPGA VI Reference function creates the reference to the specified FPGA device and checks the device to determine if the FPGA VI is on the device. If the selected FPGA VI does not match the VI on the FPGA device, the Open FPGA VI Reference function downloads the selected FPGA VI to the FPGA device. The FPGA VI you select must be up-to-date and compiled. The Open FPGA VI Reference function downloads the latest compiled version of the FPGA VI.

You can choose to open the reference and run the FPGA VI by right-clicking the Open FPGA VI Reference function on the block diagram and selecting **Open and Run** from the shortcut menu. **Open and Run** is the default behavior.

You also can choose to open the reference without running the FPGA VI by right-clicking the Open FPGA VI Reference function on the block diagram and selecting **Open** from the shortcut menu. If you open an FPGA VI reference without running the FPGA VI, you can use the Invoke Method function from the host VI to programmatically run the FPGA VI. You also can use the Invoke Method function to download and stop FPGA VIs. Refer to the *LabVIEW Help*, available by selecting **Help»VI, Function, & How-To Help**, for more information about the Open FPGA VI Reference and Invoke Method functions.

## Reading and Writing Data to the FPGA VI

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A host VI can control and monitor only data passed through the FPGA VI front panel. You cannot access any wires on the FPGA VI block diagram that do not have controls or indicators. First use the Open FPGA VI Reference function to open a reference to the FPGA device. Then wire the **HW Exec Ref Out** parameter to the Read/Write Control function to access controls and indicators on the FPGA VI. You can read indicators and write controls. You also can write indicators and read controls. You can expand the Read/Write Control function to read or write multiple controls and indicators. When you run the host VI, the Read/Write Control function reads and writes controls and indicators in the order they appear in the function on the block diagram.

The Read/Write Control function supports scalar data, such as numeric controls, and complex data, such as arrays and clusters. You can program the FPGA VI to bundle scalar data into arrays or clusters and then read the arrays or clusters of data as a single block with the host VI to make sure all data is read at the same time. Refer to the *LabVIEW Help*, available by selecting **Help»VI, Function, & How-To Help**, for information about arrays and clusters.



**Note** The FPGA Module creates a register map specific to the FPGA VI that includes a hardware register for every control and indicator. LabVIEW uses the register map internally to communicate with the FPGA VI directly with Interactive Front Panel Communication and using the host VI with Programmatic FPGA Interface Communication. Refer to the *LabVIEW FPGA Module User Manual* for more information.

## Responding to FPGA VI Interrupts

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You can generate interrupts from the FPGA VI to notify the host VI of events, such as data being ready, an error occurring, or a task finishing. Use the Invoke Method function in a host VI to interact with an interrupt on an FPGA device. You can wait on interrupts with the Wait on IRQ method. You also can acknowledge interrupts with the Acknowledge IRQ method. Refer to the *LabVIEW FPGA Module User Manual* for information about generating interrupts in FPGA VIs.

### Waiting for Interrupts

Use the Wait on IRQ method in the host VI to wait for logical interrupts generated by the FPGA VI. For example, you might want the host VI to perform independent operations while the FPGA VI collects data. You can use the Wait on IRQ method in the host VI to detect when the FPGA VI data is ready and the host VI can retrieve the data.

You can use arrays with the Wait on IRQ method if you want to wait on multiple logical interrupts. Depending on the logical interrupt or combination of logical interrupts, the host VI can execute different code to handle the interrupts. You also can generate occurrences in the code that enable other parts of the host VI.

Use only one Wait on IRQ method at a time per FPGA device in a host VI. For example, if you control two FPGA devices with one host VI, you can use two simultaneous Wait on IRQ methods, one for each device.



**Note** You cannot use more than one Wait on IRQ method at a time in a time-critical VI running on an RT target. When you use the Wait on IRQ method in a time-critical priority thread, the entire thread sleeps while the Wait on IRQ method waits on an interrupt.

## Acknowledging Interrupts

You must use the Acknowledge IRQ method to acknowledge the logical interrupts returned by the Wait on IRQ method to allow the FPGA VI to assert those interrupts again. Acknowledge the interrupt only when the host VI is ready to accept the next interrupt from the FPGA VI. If you use the **Wait Until Cleared** option on the Interrupt VI in the FPGA VI, acknowledging the interrupt allows the FPGA VI to continue executing. For example, you might not want to acknowledge the interrupt until a certain value is written to the FPGA device. Refer to the *LabVIEW Help*, available by selecting **Help»VI, Function, & How-To Help**, for more information about the Interrupt VI.

## Closing a Reference to the FPGA VI

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Use the Close FPGA VI Reference function to close the reference to the FPGA VI after you finish communicating with the FPGA VI from the host VI. Close the VI reference before exiting the host VI.

By default, the Close FPGA VI Reference function stops the FPGA VI and closes the FPGA VI reference. You can close the FPGA VI reference without stopping the FPGA VI by right-clicking the Close FPGA VI Reference function on the block diagram and selecting **Close** from the shortcut menu. If you do not stop the FPGA VI, the FPGA VI continues executing on the FPGA device after you close the FPGA VI reference.

