



# **Adder Tree Module - Lattice Radiant Software**

## **User Guide**

FPGA-IPUG-02087-1.1

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## Acronyms in This Document

A list of acronyms used in this document.

Acronym	Definition
FPGA	Field Programmable Gate Array
RTL	Register Transfer Level
IP	Intellectual Property

# 1. Introduction

The Adder Tree Module is used to add large numbers of digits at one time. The module is pipelined and can operate on each clock cycle.

## 1.1. Quick Facts

Table 1.1 shows a summary of the Adder Tree Module.

**Table 1.1. Adder Tree Module Quick Facts**

<b>IP Requirements</b>	Supported FPGA Families	CrossLink™-NX, Certus™-NX
<b>Resource Utilization</b>	Targeted Devices	LIFCL-40, LIFCL-17, LFD2NX-40
<b>Design Tool Support</b>	Lattice Implementation	Lattice Radiant® Software 2.1
	Synthesis	Lattice Synthesis Engine (LSE)
		Synopsys® Synplify Pro® for Lattice
Simulation	For the list of supported simulators, see the <a href="#">Lattice Radiant Software 2.1 User Guide</a> .	

## 1.2. Features

The key features of Adder Tree Module include:

- Configurable data width
- Supports multiple number of inputs
- Configurable Reset Mode
- Supports Enable/Disable of Fully Pipeline Mode
- Supports Enable/Disable of Input and Output Registers

## 1.3. Conventions

### 1.3.1. Nomenclature

The nomenclature used in this document is based on Verilog HDL.

### 1.3.2. Signal Names

Signal names that end with:

- *\_n* are active low
- *\_i* are input signals
- *\_o* are output signals

### 1.3.3. Attribute Names

Attribute names in this document are formatted in title case and italicized (*Attribute Name*).

## 2. Functional Description

The Adder Tree Module is a pipelined adder which implements “ $data0_i + data1_i + \dots + datan_i = result_o$ ” function.

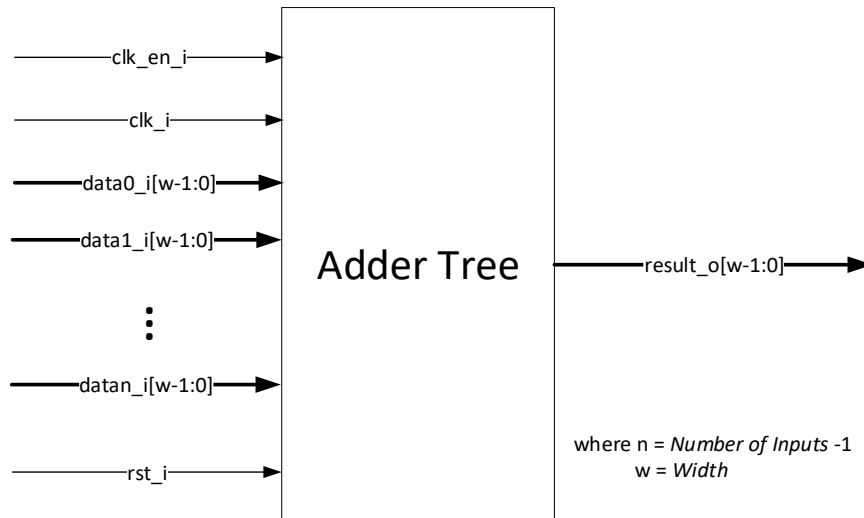


Figure 2.1. Adder Tree Block Diagram

### 2.1. Signal Descriptions

Table 2.1. Adder Tree Module Signal Description

Port Name	I/O	Width	Description
<b>Clock and Reset Ports</b>			
clk_i	In	1	System clock input. Available if any of the following attributes is/are enabled: <i>Enable Fully Pipelined Mode, Enable Input Register or Enable Output Register.</i>
rst_i	In	1	Reset input. Available if any of the following attributes is/are enabled: <i>Enable Fully Pipelined Mode, Enable Input Register or Enable Output Register.</i>
<b>User Interface Ports</b>			
clk_en_i	In	1	Clock enable input. Available if any of the following attributes is/are enabled: <i>Enable Fully Pipelined Mode, Enable Input Register or Enable Output Register.</i>
data[n]_i	In	Width*	Data input.
result_o	Out	Width*	Output Result.

\***Note:** The bit width of some signals is set by the attribute. Refer to [Table 2.2](#) for the description of these attributes.

## 2.2. Attribute Summary

The configurable attributes of the Adder Tree Module are shown in [Table 2.2](#) and are described in [Table 2.3](#). The attributes can be configured through the IP Catalog's Module/IP wizard of the Lattice Radiant Software.

**Table 2.2. Attributes Table**

Attribute	Selectable Values	Default	Dependency on Other Attributes
<b>Configuration</b>			
Width	2 – 36	8	—
Number of inputs	2 – N*	6	—
Reset Mode	Sync, Async	Sync	Active if: <i>Enable Fully Pipelined Mode</i> == Checked or <i>Enable Input Register</i> == Checked or <i>Enable Output Register</i> == Checked
Enable Fully Pipelined Mode	Checked, Unchecked	Unchecked	—
Enable Input Register	Checked, Unchecked	Checked	—
Enable Output Register	Checked, Unchecked	Checked	Active if <i>Enable Fully Pipelined Mode</i> == Unchecked

**\*Note:** The maximum *Number of Inputs* depends on the Targeted Device Type. If the Device Type is LIFCL-40 or LFD2NX-40, N is 28 else 24.

**Table 2.3. Attributes Descriptions**

Attribute	Description
<b>Configuration</b>	
Width	Specifies the width of input and output data.
Number of inputs	Specifies the number of inputs to be added together.
Reset Mode	Specifies the mode of reset to be used. <i>Reset Mode</i> can only be configured if any of the following attributes is/are enabled: <i>Enable Fully Pipelined Mode</i> , <i>Enable Input Register</i> or <i>Enable Output Register</i> .
Enable Fully Pipelined Mode	Specifies if data pipeline is enabled or not. When this is enabled, <i>Enable Output Register</i> attribute is automatically enabled.
Enable Input Register	Specifies if input register is enabled or not.
Enable Output Register	Specifies if output register is enabled or not.



### 3. IP Generation, Synthesis, and Validation

This section provides information on how to generate and synthesize this module using the Lattice Radiant Software. For more on Lattice Radiant Software, please refer to the [Lattice Radiant Software 2.1 User Guide](#) and relevant tutorials.

#### 3.1. Licensing the IP

No license is required for this module.

#### 3.2. Generating and Synthesizing the IP

The Lattice Radiant Software allows you to customize and generate modules and IPs and integrate them into the device’s architecture. The procedure for generating the Adder Tree Module in Lattice Radiant Software is described below.

To generate the Adder Tree Module:

1. Create a new Lattice Radiant Software project or open an existing project.
2. In the **IP Catalog** tab, double-click **Adder\_Tree** under **Module, DSP\_Arithmetic\_Modules** category.
3. The **Module/IP Block Wizard** opens as shown in [Figure 3.1](#). Enter values in the **Component name** and the **Create in** fields and click **Next**.

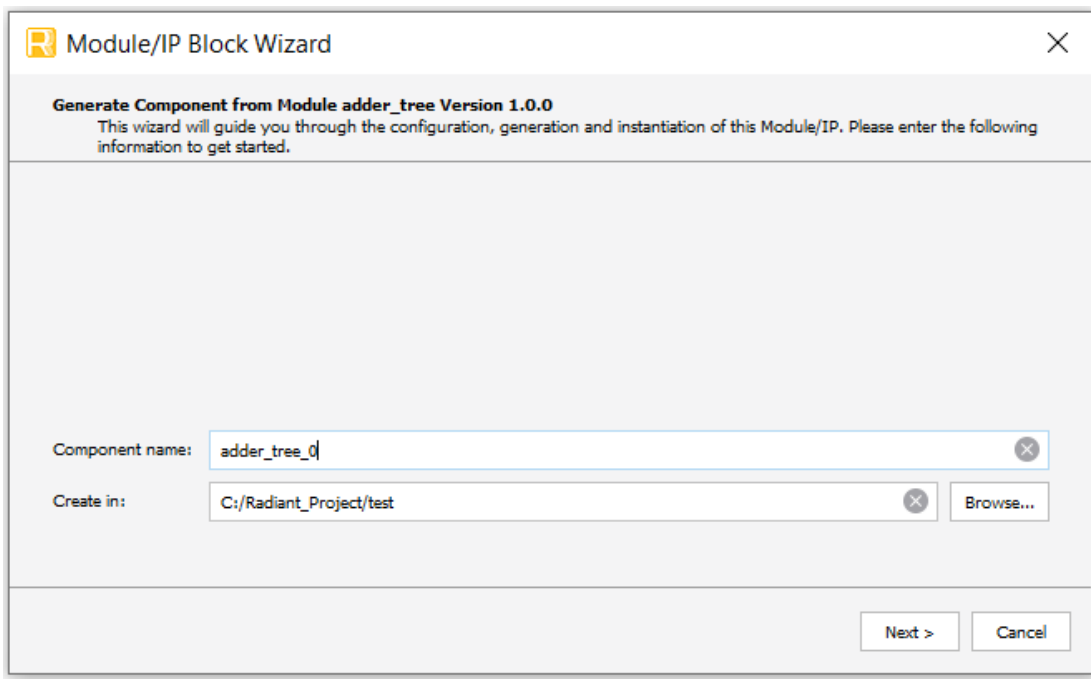


Figure 3.1. Module/IP Block Wizard

4. In the module’s dialog box, customize the selected Adder Tree Module. A sample configuration is shown in [Figure 3.2](#). For configuration options, see the [Attribute Summary](#) section.

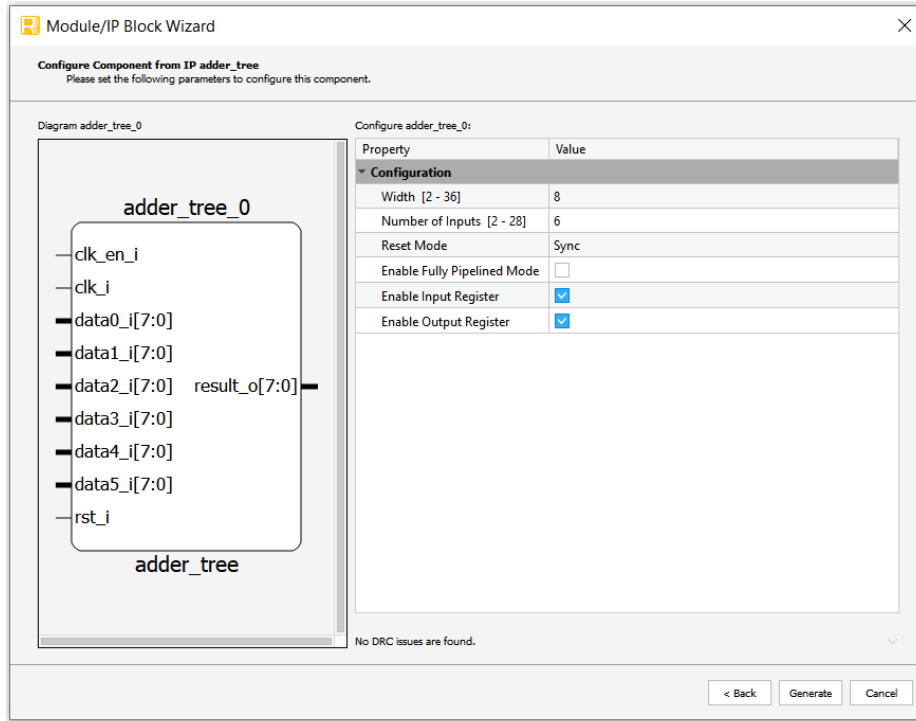


Figure 3.2. Configure User Interface of Adder Tree Module

5. Click **Generate**. The **Check Generating Result** dialog box opens. Design block messages and results are shown in Figure 3.3.

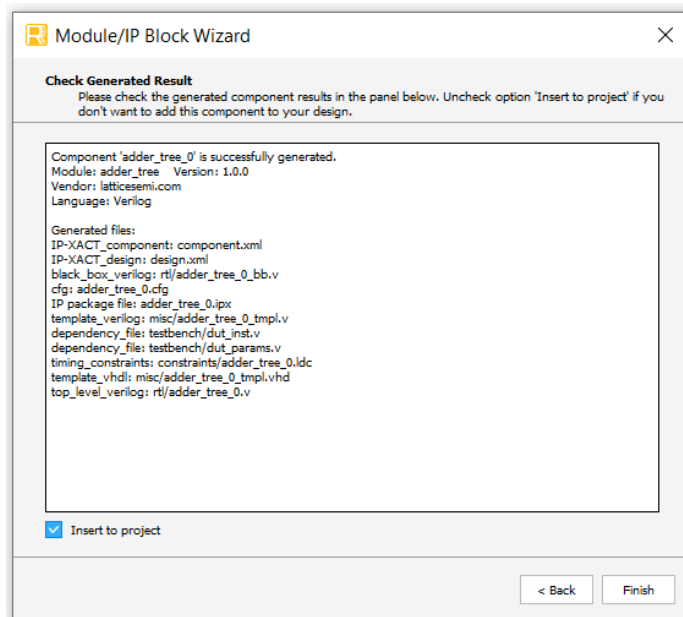


Figure 3.3. Check Generating Result

6. Click **Finish**. All the generated files are placed under the directory paths in the **Create in** and the **Instance name** fields shown in [Figure 3.1](#).

The generated Adder Tree Module package includes the black box (<Instance Name>\_bb.v) and instance templates (<Instance Name>\_tmpl.v/vhd) that can be used to instantiate the module in a top-level design. An example RTL top-level reference source file (<Instance Name>.v) that can be used as an instantiation template for the module is also provided. You may also use this top-level reference as the starting template for the top-level for their complete design. The generated files are listed in [Table 3.1](#).


**Table 3.1. Generated File List**

Attribute	Description
<Instance Name>.ipx	This file contains the information on the files associated to the generated IP.
<Instance Name>.cfg	This file contains the attribute values used in IP configuration.
component.xml	Contains the ipxact:component information of the IP.
design.xml	Documents the configuration attributes of the IP in IP-XACT 2014 format.
rtl/<Instance Name>.v	This file provides an example RTL top file that instantiates the module.
rtl/<Instance Name>_bb.v	This file provides the synthesis black box.
misc/<Instance Name>_tmpl.v misc /<Instance Name>_tmpl.vhd	These files provide instance templates for the module.

### 3.3. Running Functional Simulation

Running functional simulation can be performed after the IP is generated.

To run functional simulation:

1. Click the  button located on the **Toolbar** to initiate the **Simulation Wizard** shown in [Figure 3.4](#).

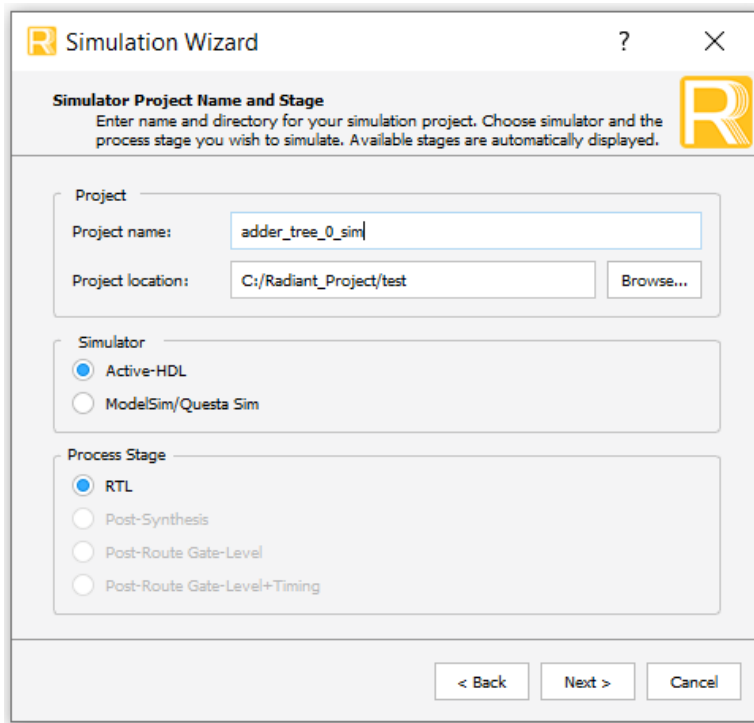


Figure 3.4. Simulation Wizard

2. Click **Next** to open the Add and Reorder Source window as shown in [Figure 3.5](#).

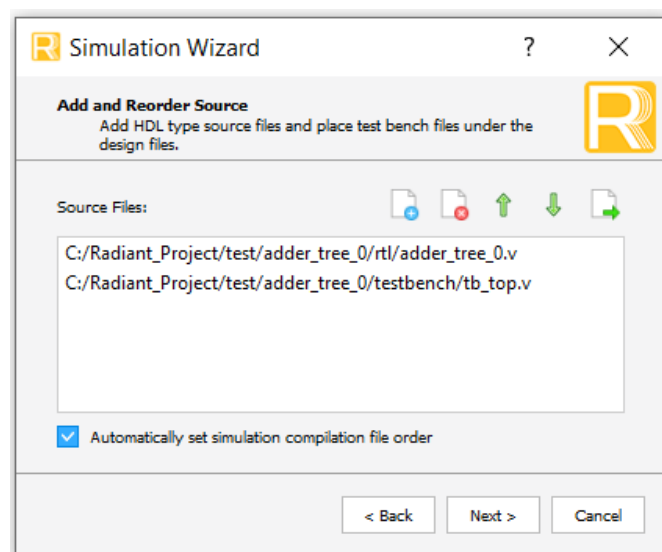
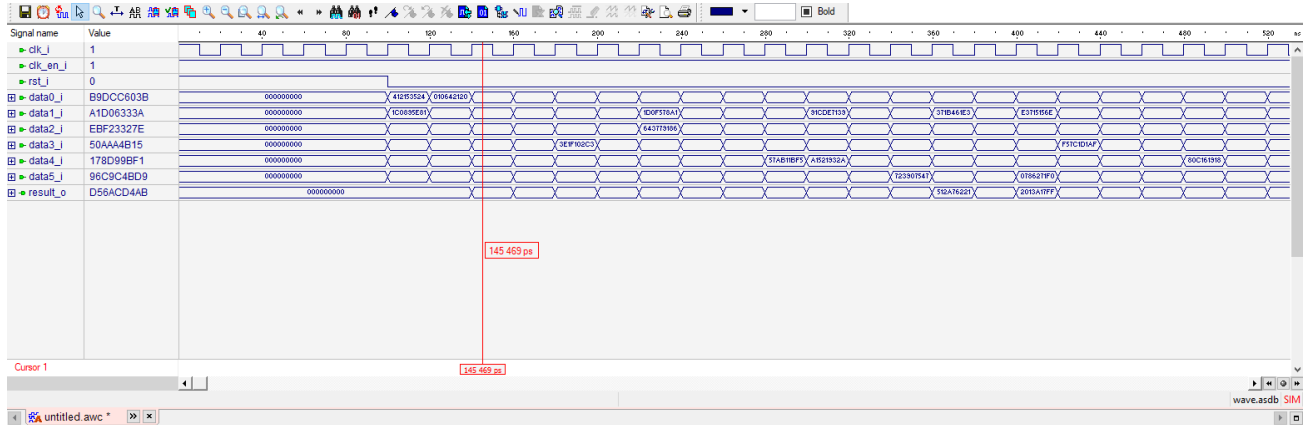


Figure 3.5. Adding and Reordering Source

3. Click **Next**. The **Summary** window is shown.
4. Click **Finish** to run the simulation.

**Note:** It is necessary to follow the procedure above until it is fully automated in the Lattice Radiant Software Suite.

The results of the simulation in our example are provided in [Figure 3.6](#).



**Figure 3.6. Simulation Waveform**

## Appendix A. Resource Utilization

Table A.1 shows the resource utilization of the Adder Tree Module for the LIFCL-40-9BG400I device, using Lattice Synthesis Engine of Lattice Radiant Software. Default configuration is used and some attributes are changed from the default value to show the effect on the resource utilization.

**Table A.1. Resource Utilization**

Configuration	Clk Fmax (MHz)*	Slice Registers	LUTs	DSP Slices
Default	164.474 MHz	0	1	2
<i>Number of Inputs = 5, Reset Mode = Async, Others = Default</i>	195.963 MHz	0	1	1
<i>Enable Fully Pipelined Mode = Checked, Width = 10, Others = Default</i>	200 MHz	40	1	2
<i>Enable Input Register = Unchecked, Enable Output Register = Unchecked, Width = 10, Others = Default</i>	N/A	0	1	2

**\*Note:** Fmax is generated when the FPGA design only contains Adder Tree Module and the target frequency is 160 MHz. These values may be reduced when user logic is added to the FPGA design.

## References

For complete information on Lattice Radiant Project-Based Environment, Design Flow, Implementation Flow and Tasks, as well as on the Simulation Flow, see the [Lattice Radiant Software 2.1 User Guide](#).

## Technical Support Assistance

Submit a technical support case through [www.latticesemi.com/techsupport](http://www.latticesemi.com/techsupport).



## Revision History

### Document Revision 1.1, Lattice Radiant SW version 2.1, June 2020

Section	Change Summary
Introduction	Updated <a href="#">Table 1.1</a> . <ul style="list-style-type: none"><li>• Added Certus-NX support.</li><li>• Updated Table 1.1 to add LFD2NX-40 as targeted device.</li><li>• Updated Lattice Implementation to Lattice Radiant 2.1.</li></ul>
Attribute Summary	Updated dependency of <i>Number of Inputs</i> to support LFD2NX-40.
Appendix A. Resource Utilization	Updated device to LIFCL-40-9BG400I.

### Document Revision 1.0, Lattice Radiant SW version 2.0, February 2020

Section	Change Summary
All	Initial release.



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