

# HDL Coder™ Release Notes



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# R2017a

**Version: 3.10**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## For Each Subsystems: Reduce block replication and improve code reuse in HDL-targeted designs

HDL Coder™ supports the For Each Subsystem block for code generation. The block:

- Supports vector processing that enables you to process individual elements or subarrays of an input signal simultaneously. You no longer need to split the signals or create and connect replicas of a subsystem to model the same algorithm.
- Improves readability of code by using a `for-generate` loop in the generated HDL code that iterates through each element of the input signal. The elements can be scalars or subarrays of the input signal. The `for-generate` loop is cleaner and reduces the number of lines of code, which can otherwise result in hundreds of lines of code for large vector signals.
- Supports HDL code generation for all data types, Simulink® blocks, and predefined and user-defined system objects.
- Supports optimizations on and inside the block, such as resource sharing and pipelining. The parallel processing capability of the For Each Subsystem block combined with the optimizations that you specify provides high performance on the target FPGA device.

The For Each Subsystem block is available as part of the **Ports & Subsystems** block library in HDL Coder.

For an example that shows how to generate HDL code for the For Each Subsystem, see “Generate HDL Code for Blocks Inside For Each Subsystem”.

## Data Type Support for AXI4 Slave: Map floating-point signals and vector signals to AXI4 slave interfaces in IP core generation

When using the IP Core Generation workflow, in the **Target platform interface table**, you can map single and vector signals at the DUT ports to AXI4 or AXI4-Lite interfaces.

The workflow for vector signals includes an **IP Core Generation** report that displays:

- Address offsets of AXI4 interface accessible registers generated for each input, output, and strobe signal in the **Register Address Mapping** section. The additional strobe register for each input and output vector data maintains the synchronization across

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multiple, sequential AXI4 read and write operations. For each input and output vector signal, this section displays the size of the vector, and the starting and ending address offsets.

- A **Vector Data Read/Write with Strobe Synchronization** subsection in the **IP Core User's Guide** section that shows how HDL Coder handles vector data and synchronizes read and write operations across the AXI4 interface.

See also “Custom IP Core Generation”.

When you use signals that have a single data type, specify the floating-point library. In the Configuration Parameters dialog box, on the **HDL Code Generation > Global Settings > Floating Point Target** tab, for **Library**, choose Altera Megafunctions (Altera FP Functions), Altera Megafunction (ALTFP), Native Floating Point, or Xilinx LogiCORE.

## **HDL Floating Point Operations Library: Easily find additional and existing single-precision floating-point blocks supported for HDL code generation**

HDL Coder provides a **HDL Floating Point Operations** block library that consists of Simulink blocks configured for HDL code generation with the native floating-point support.

In R2017a, HDL Coder added native floating-point support for these blocks in the **HDL Floating Point Operations** Library.

- Discrete FIR Filter with Fully Parallel as **HDL Architecture**
- Discrete-Time Integrator
- Discrete PID Controller
- Rounding Function
- Trigonometric Function with **Function** as `cos + jsin`
- Sign
- Math Function block with **Function** as:
  - `mod`
  - `rem`

See also “HDL Floating Point Operations”.

## Incremental Vivado Synthesis: Enable IP caching for faster synthesis of Xilinx Vivado reference designs

When creating a Xilinx® Vivado® project with the IP Core Generation workflow, you can enable IP caching to speed up synthesis of the reference design. To accelerate reference design synthesis when using the workflow for the second time:

- 1 Before running the **Create Project** task the first time, select the **Enable IP caching** check box. When running this task, the workflow creates an empty IP cache folder.
- 2 Run the **Build FPGA Bitstream** task to populate the IP cache folder with synthesis logs and design checkpoint files generated for the HDL IP core and other IP blocks in the reference design.
- 3 To accelerate reference design synthesis, run the **Build FPGA Bitstream** task a second time. Make sure that you use the same `hdl_prj` folder as the first time you ran the workflow.

The Xilinx Vivado tool then checks and reuses the design checkpoint files in the IP cache, which speeds up reference design synthesis.

If you are using your own custom reference design, you can accelerate reference design synthesis when running through the workflow the first time.

- 1 In the IP cache folder, delete the IP core files generated for the DUT. Extract the remaining files in this folder into a zip file, name it `ipcache.zip`, and save the file in the reference design folder.
- 2 Make sure that the `IPCacheZipFile` property of the `hdlcoder.ReferenceDesign` class points to the `ipcache.zip` folder.

In the workflow, HDL Coder uses the files in this IP cache, which speeds up reference design synthesis. For more information, see “IP Caching for Faster Reference Design Synthesis”.

## HDL Optimized Filters: Model and generate optimized hardware implementations for FIR filters (requires DSP System Toolbox)

This release introduces the Discrete FIR Filter HDL Optimized block and `dsp.HDLFIRFilter` System object™, which model FIR filter structures optimized for HDL code generation. The filter is sample-based. Control signals are provided for flow control. Resource sharing options allow tradeoffs between throughput and resource utilization.

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The block and object provide cycle-accurate models of the generated HDL code, including clock rates and latency.

## **HDL Channelizer Block and System Object: Isolate narrowband channels from a wideband signal and generate HDL with efficient multiplier usage (requires DSP System Toolbox)**

This release introduces the Channelizer HDL Optimized block and `dsp.HDLChannelizer` System object, which model a polyphase filter bank and fast Fourier transform and support HDL code generation. The algorithm provides an efficient hardware implementation and hardware-friendly control signals. You can achieve giga-sample-per-second (GSPS) throughput with vector input.

## **Gigasample per Second (GSPS) Signal Processing: Increase throughput of FIR decimation algorithms by using frame input**

You can now generate HDL code from the FIR Decimation block when the block uses frame input. The block accepts a column vector of input data. Each element of the vector represents a sample in time. The coder implements a parallel HDL architecture for the filter. This capability increases throughput in hardware designs. To configure the block for frame input:

- 1 Connect a column vector signal to the FIR Decimation block input port.
- 2 Specify **Input processing** as `Columns as channels (frame based)`.
- 3 Set **Rate options** to `Enforce single-rate processing`.
- 4 Right-click the block and open **HDL Code > HDL Block Properties**. Set the **Architecture** to `Frame Based`. The block implements a parallel HDL architecture. See “Frame-Based Architecture”.

## **Native Floating-Point Testbench: Generate SystemVerilog DPI, cosimulation, and FPGA-in-the-loop test benches with single-precision data types (requires HDL Verifier)**

Before generating code, if you enable the native floating-point support, you can now verify the HDL implementation of your design by using any of these testbenches:

- SystemVerilog DPI test bench
- Cosimulation

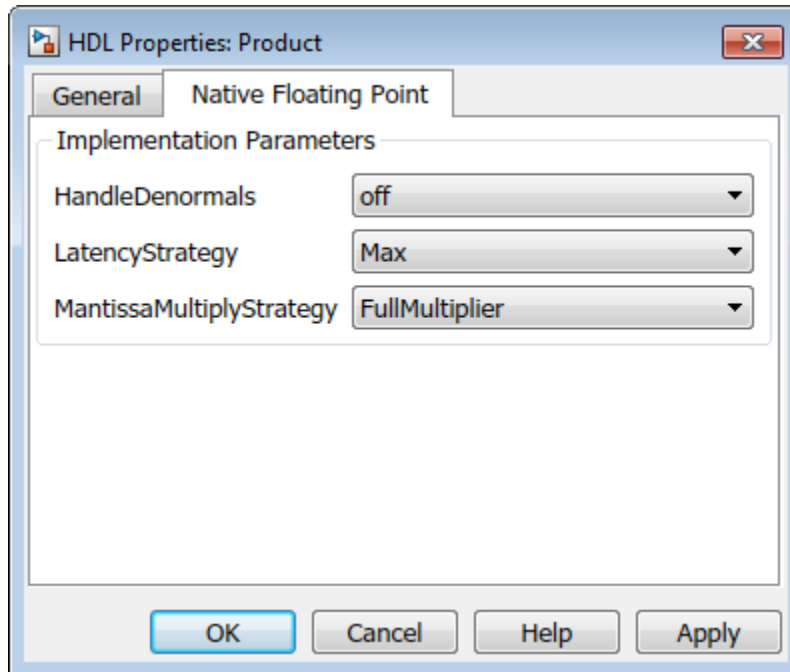
- FPGA-in-the-loop

See also “Verify the Generated Code from Native Floating-Point”.

## Floating-Point Latency Customization at Block-Level

For blocks that support code generation in native floating-point mode, you can now specify custom block-level settings. By default, the blocks in your design inherit the native floating-point settings that you specify in the Configuration Parameters dialog box. To specify custom settings for these blocks, right-click the block and open **HDL Code > HDL Block Properties**, and then select the **Native Floating Point** tab. Using custom settings for the blocks, you can optimize your design implementation on the target FPGA device for area and speed.

For most blocks, the **Native Floating Point** tab contains the **HandleDenormals** and **LatencyStrategy** settings. If there are multipliers in your design, you can specify how you want HDL Coder to implement the mantissa multiplication operation for individual blocks by using the **MantissaMultiplyStrategy** setting. This figure shows the HDL Block Properties dialog box for a Product block.



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## Additional Block and System Object Support with Native Floating Point

HDL Coder now supports these blocks and system objects with native floating point.

- All RAM blocks, which include:
  - Single Port RAM
  - Dual Port RAM
  - Simple Dual Port RAM
  - Dual Rate Dual port RAM
- Serializer1D and Deserializer1D
- `hdl.RAM`

See Also “Operators and Simulink Blocks Supported for Native Floating-Point”.

## Enhancements to MATLAB Function block support in synchronous subsystems

For a MATLAB Function block inside a synchronous subsystem, you can now use the combinational and sequential logic portions in one MATLAB<sup>®</sup> function. Previously, you created two separate MATLAB Function blocks, one for the combinational logic, and the other for the sequential logic.

To use the combinational and sequential logic portions inside one MATLAB Function block, in the Ports and Data Manager dialog box, select the **Allow direct feedthrough** check box. The output function can then depend on inputs and persistent variables. For example, you can now use this MATLAB function that has two outputs, with one output depending on the input, and the other output depending on a persistent variable.

```
function [y1, y2] = fcn(u, v)

persistent p;
if isempty(p)
    p = uint8(0);
end

y1 = p;
y2 = v;

p = u;
```

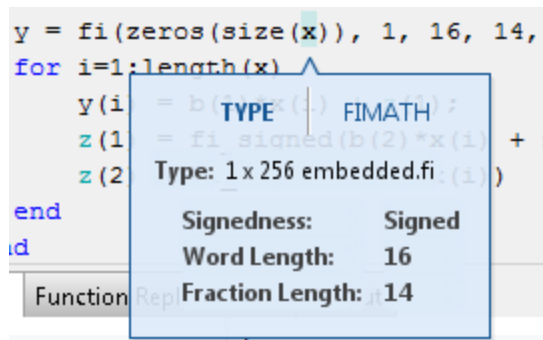
Using the MATLAB Function block inside a synchronous subsystem generates cleaner HDL code and uses fewer hardware resources. For an example that shows how to use the block inside the synchronous subsystem, see .

See also State Control.

## More fixed-size variable information in Fixed-Point Conversion step of HDL Coder App

In R2017a, when you convert floating-point MATLAB code to fixed-point MATLAB code, the target interface step provides information about the converted fixed-point code. Previously, in the target interface step, the app displayed the original floating-point MATLAB code.

In the **Fixed-Point Conversion** step, after fixed-point conversion, if you place your cursor over a converted variable or expression, the app displays the fixed-point type information.



The screenshot shows MATLAB code in a function block. A tooltip is displayed over the variable `z(1)`, showing the following information:

```

y = fi(zeros(size(x)), 1, 16, 14,
for i=1:length(x)
    y(i) = b(TYPE^x(i) FIMATH);
    z(1) = fi_signed(b(2)*x(i) + z
    z(2) Type: 1 x 256 embedded.fi (i)
end
id
Function Rep

```

The tooltip displays the following fixed-point type information:

Type:	1 x 256 embedded.fi
Signedness:	Signed
Word Length:	16
Fraction Length:	14

For a variable with a fixed-point type in the original code, when you place your cursor over the variable before or after conversion, the app displays the fixed-point type information.

## HDL Coder support for blocks that support bus signal treated as vector

HDL Coder can now generate code for blocks that support the **Bus signal treated as vector** setting. These blocks are not bus-capable, but they can accept a vector signal. Previously, to generate HDL code for these blocks, you used a Bus to Vector block to convert the bus signals to vectors for input to the block.



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When you use these blocks with buses, ensure that:

- Input to the blocks is a virtual bus.
- Constituent signals of the bus have the same attributes.
- **Bus signal treated as vector** is set to `none` or `warning`. This setting is available in the **Diagnostics > Connectivity** pane in the Configuration Parameters dialog box. See also “Bus signal treated as vector” (Simulink).

## HDL code generation support for Bus Assignment block with nonvirtual bus

In your Simulink model, you can now use Bus Assignment blocks with nonvirtual bus signals for HDL code generation. Previously, when you used Bus Assignment blocks, to generate HDL code, you converted the nonvirtual buses to virtual buses.

## Additional HDL Coder bus support

HDL Coder now supports the:

- Ground block with bus input
- Constant block with a value of 0 and bus as **Output data type**

## HDL code generation support for System Objects with enumeration types

You can now generate HDL code for System objects with enumeration types:

- From MATLAB, by using the **HDL Coder** app or MATLAB to HDL Workflow Advisor
- From Simulink, for System objects that are used with MATLAB System or MATLAB Function blocks

You can also use array of enumeration types and enumeration types as fields in Simulink bus data types for HDL code generation.

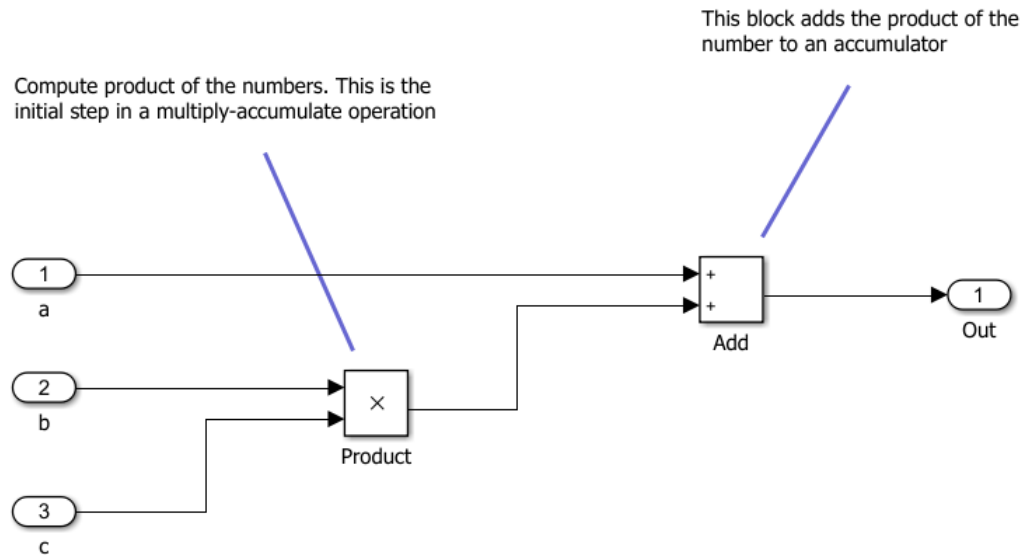
## Comments in generated HDL code for MATLAB System blocks

In R2017a, if you have comments in your MATLAB System block, HDL Coder passes these comments to the generated HDL code. These comments make it easier to map your algorithm in MATLAB to the generated HDL code.

## Comments in HDL code for Simulink blocks with text annotations

If you add text annotations with connecting lines to Simulink blocks, HDL Coder generates comments in the HDL code for the blocks. The comments make it easier to map your algorithm in Simulink to the generated code.

Previously, the comments were grouped together on top of the process declaration statement in Verilog or the entity declaration statement in VHDL. For example, consider this Simulink model that performs a multiply-accumulate operation.



This table shows the generated Verilog code from the model for R2017a and earlier releases.

R2017a	Releases before R2017a
<pre>module MAC     (a,      b,      c,</pre>	<pre>module MAC     (      a,      b,</pre>

R2017a	Releases before R2017a
<pre> Out);  input  [15:0] a; // uint16 input  [15:0] b; // uint16 input  [15:0] c; // uint16 output [31:0] Out; // uint32  wire [31:0] Product_out1; // uint32 wire [31:0] Add_1; // ufix32 wire [31:0] Add_out1; // uint32  // Initial product computation assign Product_out1 = b * c;  // Adds product of the numbers to an ac assign Add_1 = {16'b0, a}; assign Add_out1 = Add_1 + Product_out1;  assign Out = Add_out1;  endmodule // MAC </pre>	<pre> c, Out );  input  [15:0] a; // uint16 input  [15:0] b; // uint16 input  [15:0] c; // uint16 output [31:0] Out; // uint32  wire [31:0] Product_out1; // uint32 wire [31:0] Add_1; // ufix32 wire [31:0] Add_out1; // uint32  // Adds the product of the number to an ac // // Initial product computation  assign Product_out1 = b * c;  assign Add_1 = {16'b0, a}; assign Add_out1 = Add_1 + Product_out1;  assign Out = Add_out1;  endmodule // MAC </pre>

See also “Generate Code with Annotations or Comments”.

## Global reset signals minimization in generated HDL Code

In R2017a, you can use the **Minimize global resets** setting to minimize or remove global reset signals in the generated HDL code. To specify this setting, in the Configuration Parameters dialog box, on the **HDL Code Generation > Global Settings > Ports** tab, select the **Minimize global resets** check box.

See also `MinimizeGlobalResets`

## HDL code generation support for DUT subsystem with custom HDL properties

For any DUT subsystem, you can now specify custom HDL block property settings and generate HDL code. To specify these custom settings, right-click the subsystem and select **HDL Code > HDL Block Properties**.

Previously, to generate HDL code for any DUT subsystem, the subsystem used the default HDL block property settings.

## Custom reference model prefix specification

For module names or files that are generated for a model reference, you can now specify a custom reference model prefix. Previously, HDL Coder prefixed the referenced model with `modelName_`.

To add a prefix for the referenced model, in the HDL Block Properties dialog box, for **ReferenceModelPrefix**, specify the prefix as a text. When generating code, HDL Coder applies this prefix to the names of generated HDL files for submodels, package names, and HDL identifiers. By default, the prefix is the name of the top-level subsystem.

See also [Model](#).

## Improvements to delay balancing in multirate regions

If you have local multirate regions in your design or introduce them through clock-rate pipelining, HDL Coder improves delay optimization in these regions by reducing excessive matching delays. This optimization results in area, timing, and power-efficient designs, particularly in cases with significant rate differences.

## IP core generation support for Altera Megafunction

When mapping your floating-point algorithm in Simulink to Altera® Megafunction floating-point IP, you can now generate an HDL IP core with the **IP Core Generation** workflow. To use this workflow, map your Simulink model to **Altera Megafunctions (Altera FP Functions)** or **Altera Megafunctions (ALTFP)** floating-point libraries.

To specify the floating-point library, in the Configuration Parameters dialog box, on the **HDL Code Generation > Global Settings > Floating Point Target** tab, for

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**Library**, choose Altera Megafunctions (Altera FP Functions) or Altera Megafunctions (ALTFP).

## Custom IP repository specification

With the IP Core Generation workflow, by using the `addIPRepository` method of the `hdlcoder.ReferenceDesign` class, you can add your own custom IP repository to your custom reference design.

Previously, to add IP modules, you used the `CustomFiles` property of the `hdlcoder.ReferenceDesign` class. Starting in R2017a, you can still use the `CustomFiles` property, but it is recommended to use the `addIPRepository` method instead. Using this method, you can include IP from a shared repository folder, or include multiple repository folders in your reference design.

See also “Define and Add IP Repository to Custom Reference Design”.

## Xilinx Virtex-2 FPGA board support being removed

HDL Coder no longer supports the Xilinx ISE 10.1 synthesis tool and target platforms that use the Xilinx Virtex<sup>®</sup>-2 FPGA board. For example, Speedgoat I0314 and older Speedgoat boards use Xilinx Virtex-2 FPGA, and are no longer supported with the Simulink Real-Time FPGA I/O workflow.

## Compatibility Considerations

If you load a pre-R2017a model that was saved with a target platform that used the Xilinx Virtex-2 FPGA, and then open the HDL Workflow Advisor, HDL Coder generates a warning. To avoid this warning, use a newer FPGA board and synthesis tool. With the Simulink Real-Time FPGA I/O workflow, use the Speedgoat I0321 or a later Speedgoat board.

## GenerateWebview parameter name changed to HDLGenerateWebview

To include a model Web view in the HDL Code Generation report programmatically, you now use the `HDLGenerateWebview` parameter. This parameter corresponds to the **Generate model Web view** setting on the **HDL Code Generation** pane in the

Configuration Parameters dialog box. Previously, you used the `GenerateWebview` parameter.

HDL Coder now distinguishes the `HDLGenerateWebview` parameter from the `GenerateWebview` parameter that Embedded Coder<sup>®</sup> uses.

## Compatibility Considerations

In R2017a, if you run a previously saved MATLAB script that used `hdlset_param` or `makehdl` with the `GenerateWebview` parameter, HDL Coder generates an error. To fix the error, change the parameter name to `HDLGenerateWebview`, and then run the script.

If you load a pre-R2017a model that was saved with the `GenerateWebview` parameter enabled, HDL Coder ignores the parameter setting. To generate the model Web view, enable the `HDLGenerateWebview` parameter.

## Changes in HDL Code Generation Panel in Configuration Parameters Dialog Box

### Parameters Added

- Minimize global resets in the **Global Settings > Ports** tab
- In the **Test Bench** pane Test Bench Generation Output section:
  - SystemVerilog DPI test bench
  - HDL code coverage check box

### Parameters Moved

These parameters moved from the **Target and Optimizations > General** tab to the **Global Settings > Ports** tab:

- Minimize clock enables
- Use Trigger as clock

### Parameters Removed

Cosimulation model for use with:

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## Updates to supported software

HDL Coder has been tested with:

- Xilinx Vivado Design Suite 2016.2
- Altera Quartus II 16.0

See Supported Third-Party Tools and Hardware.

## Syntax Highlighting of Generated HDL Code in HTML Report

In R2017a, enhancements in syntax highlighting greatly improve the readability of the generated HDL code. To see the syntax highlighting, before generating HDL code, in the Configuration Parameters dialog box, on the **HDL Code Generation** pane, select the **Generate traceability report** check box.

Previously, the Code Generation report used two highlighting colors: blue for code and green for comments. With this change, HDL-specific keywords are highlighted in blue and the rest of the HDL code is in black. Comments in the code are still highlighted in green.

## Functionality Being Removed or Changed

Functionality	Result	Use Instead	Compatibility Considerations
MaxComputa	Still runs. The code generator displays a warning.	Oversampling with clock-rate pipelining.	Replace all instances of MaxComputationLatency with Oversampling.
MaxOversam	Still runs. The code generator displays a warning.	Oversampling with clock-rate pipelining.	Replace all instances of MaxOversampling with Oversampling.





# R2016b

**Version: 3.9**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## **Native Floating Point: Generate target-independent synthesizable RTL from single-precision floating-point models**

In R2016b, if you use single-precision data types in your Simulink model, HDL Coder can generate target-independent HDL code without converting to fixed point. You can deploy the generated code on any generic ASIC or FPGA platform.

In your Simulink model:

- You can have a combination of integer, fixed-point, and floating-point operations. By using Data Type Conversion blocks, you can perform conversions between single-precision and fixed-point data types.
- If your design does not use denormal numbers, you can specify that HDL Coder does not have to add the additional logic to check for denormal numbers, which improves area on the target hardware platform.
- By using the latency strategy setting, customize the latency of the native floating-point library.

The generated code:

- Complies with the IEEE-754 standard of floating-point arithmetic.
- Does not require floating-point processing units or hard floating-point DSP blocks on the target ASIC or FPGA.

When you verify the generated code, use HDL testbench to check for floating-point tolerance based on `relative error` or `ulp error`, and to ensure accuracy of your design with Simulink.

To specify native floating-point support, in the Configuration Parameters dialog box, on the **HDL Code Generation > Global Settings > Floating Point Target** tab, for **Library**, specify **NATIVE FLOATING POINT**.

For more information, see [Native Floating Point](#).

## **Adaptive Pipelining: Specify synthesis tool and target clock frequency for automatic pipeline insertion and balancing**

You can now specify adaptive pipelining for your Simulink model, or for an individual subsystem in your Simulink model, to improve area and timing on the target FPGA

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device. To insert adaptive pipelines, specify the synthesis tool and the target frequency. HDL Coder inserts the required number of pipelines for potential area and timing improvements for these blocks:

- Lookup Table
- Product, Gain, and Multiply-Add
- Rate Transition and Downsample

You can enable adaptive pipelining by using the `AdaptivePipelining` property from the command line, or by using the **AdaptivePipelining** HDL block property for the Subsystem. See also Adaptive Pipelining.

HDL Coder displays a report that shows the adaptive pipelining status and whether HDL Coder successfully inserted pipeline registers. For more information, see Optimization Report.

## **Logic Analyzer: Visualize, measure, and analyze transitions and states over time for Simulink signals**

If you have DSP System Toolbox™, by using the **Logic Analyzer** visualization tool, you can view the transitions of signals. Use the **Logic Analyzer** to:

- Debug and analyze models.
- Trace and correlate many signals simultaneously.
- Detect and analyze timing violations.
- Trace system execution.

## **Gigasample Per Second (GSPS) Signal Processing: Increase throughput of HDL code generated from Discrete FIR Filter and Integer Delay blocks by using frame input**

You can now generate HDL code from the Discrete FIR Filter block when using frame input. Set **Input processing** to `Columns as channels (frame based)`. Then, right-click the block and open **HDL Code > HDL Block Properties**. Set the **Architecture** to `Frame Based`. The block accepts vector input data, where each element of the vector represents a sample in time. The coder implements a parallel HDL architecture for the filter. See Discrete FIR Filter.

The Delay block also supports HDL code generation with frame input data. Set **Input processing** to **Columns as channels (frame based)**. The block accepts vector input data, where each element of the vector represents a sample in time.

This capability increases throughput in hardware designs.

## **AXI4-Stream Video Interface: Generate HDL code with the AXI4-Stream Video interface by using the IP core generation workflow**

In R2016b, when your synthesis tool is Xilinx Vivado, HDL Coder can generate an IP core with an AXI4-Stream Video interface for your video algorithm. To generate an IP core, model your video algorithm by using the streaming pixel protocol. Then, in the **Target platform interface table** map the pixel data and pixel control bus ports to the AXI4-Stream Video Master or AXI4-Stream Video Slave interfaces.

You can integrate the generated IP core into the **Default video system** reference design or your own custom video reference design.

For more information, see [Model Design for AXI4-Stream Video Interface Generation](#).

## **Bit-reversed input order for HDL-optimized FFT**

For vector input data, the HDL-optimized FFT now supports bit-reversed input with natural order output. For scalar input data, you can select any input order with any output order. The default is natural order input with bit-reversed output.

This change affects these blocks and System objects:

- FFT HDL Optimized
- IFFT HDL Optimized
- dsp.HDLFFT
- dsp.HDLIFFT

## **High-throughput polyphase filter bank for HDL example**

The Generate HDL Code for High Throughput Signal Processing example shows how to design a Polyphase Filter Bank to achieve gigasample per second (GSPS) data rates in

---

the generated HDL implementation. The model uses the FFT HDL Optimized block with vector input.

## **HDL support for reset port on Discrete FIR Filter**

You can now generate HDL code from the Discrete FIR Filter block when you configure the block to have an external reset port.

## **HDL Coder support for array of buses**

In your Simulink model, you can now use an array of buses for HDL code generation.

When your Simulink model uses an array of buses, in the generated code, HDL Coder expands the array of buses into the corresponding scalars. For more information, see [Generating HDL Code for Subsystems with Array of Buses](#).

To learn more about array of buses and supported blocks, see [Combine Buses into an Array of Buses](#).

## **Synchronous behavior for Resettable Subsystem with State Control block**

You can specify synchronous hardware behavior and generate cleaner HDL code for a Resettable Subsystem with the State Control block. If you specify synchronous hardware behavior, the HDL code uses fewer hardware resources, because HDL Coder does not generate bypass registers.

The Resettable Synchronous Subsystem block is now available as part of the HDL Subsystems block library in HDL Coder. The Resettable Synchronous Subsystem block uses the synchronous hardware behavior of the State Control block with the Resettable Subsystem block.

For an example that shows how to use the Resettable Synchronous Subsystem block, see [Resettable Subsystem Support in HDL Coder™](#).

## **HDL optimized Sine and Cosine blocks**

In the Lookup Tables block library in HDL Coder, the Sine HDL Optimized and Cosine HDL Optimized blocks replace the Sine and Cosine blocks respectively. You can still use the Sine and Cosine blocks from the Lookup Tables block library in Simulink for HDL code generation.

The new blocks are optimized for area and speed because you can configure them with Lookup Tables that have an exact power of two as its number of elements. In the generated code, the Lookup Tables precede a register without reset so that they map efficiently to RAM blocks on the target hardware platform.

## **HDL Coder support for creating and attaching configuration sets**

Starting in R2016b, HDL Coder supports configuration set management workflow on the Model Explorer, or from the command line. You can create an active configuration set with the preferred HDL Configuration Parameters on a standard Simulink model, and export and copy this configuration set for Simulink models that you create.

Previously, you created a configuration set for each Simulink model, and ensured that the configuration set had similar contents for all your Simulink models.

## **VHDL Architecture Name available in Configuration Parameters dialog box**

You can now specify the **VHDL architecture name** in the Configuration Parameters dialog box.

- **Commonly Used Parameters** tab: **HDL Code Generation > Global Settings > General** tab.
- **All Parameters** tab: Search for VHDLArchitectureName.

## **RAM with generic ports enhancement**

Starting in R2016b, when generating code for RAM blocks in your Simulink model, HDL Coder adds parameters in Verilog and generics in VHDL for the RAM address and data widths. This means that HDL Coder generates only one generic RAM file for RAM blocks that differ in address widths, data widths, or both.

## **HDL Coder support for tunable parameters in data dictionary**

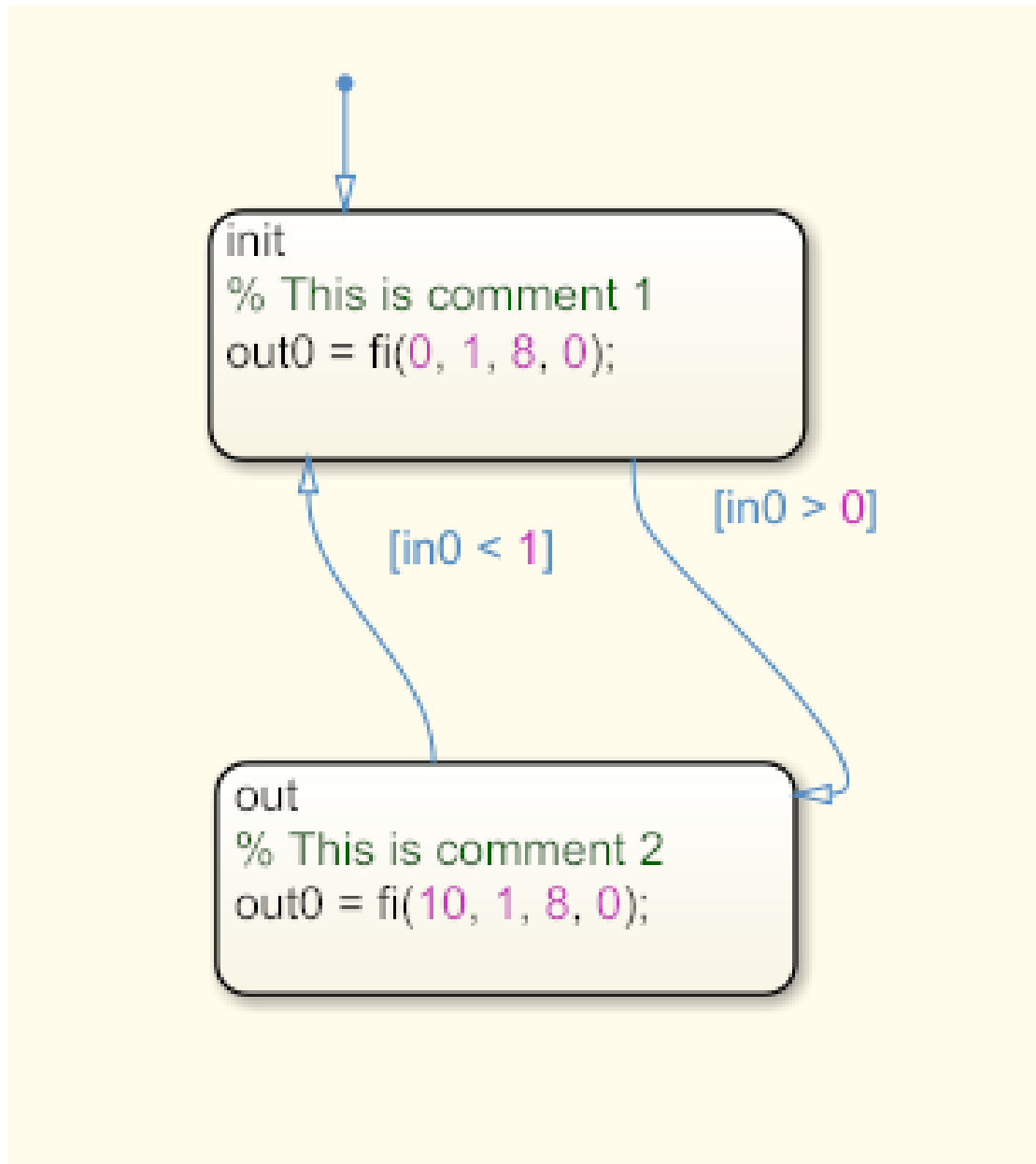
Starting with R2016b, you can manage and define tunable parameters in a Simulink data dictionary for HDL code generation.

To learn more about data dictionary, see [What Is a Data Dictionary?](#).

---

## **Stateflow comments generated as comments in HDL**

When your Simulink model contains a Stateflow<sup>®</sup> Chart that uses comments, HDL Coder generates comments in the HDL code. For example, consider this Moore Stateflow Chart in your Simulink model.





When you generate Verilog code from the model, HDL Coder displays the comments in the Stateflow Chart inline beside the corresponding Stateflow object.

R2016b	R2016a
<pre> always @(is_AL_Chart) begin     out0_1 = 8'sb00000000;     case ( is_AL_Chart)         is_AL_Chart_IN_init :             begin                 // This is comment 1                 out0_1 = 8'sb00000000;             end         default :             begin                 // This is comment 2                 out0_1 = 8'sb00001010;             end     endcase end </pre>	<pre> always @(is_AL_Chart) begin     out0_1 = 8'sb00000000;     case ( is_AL_Chart)         is_AL_Chart_IN_init :             begin                 out0_1 = 8'sb00000000;             end         default :             begin                 out0_1 = 8'sb00001010;             end     endcase end </pre>

## Tolerance check for floating-point libraries

When mapping your Simulink model to floating-point libraries, you can specify the tolerance check when you generate the testbench.

For operators such as trigonometric sine and cosine, there can be small rounding errors or numeric differences with the correct rounding range of values that the IEEE-754 standard specifies. To check for numerical accuracy in the generated testbench by using HDL testbench, specify the floating-point tolerance check.

You can perform the floating-point tolerance check based on the `relative error` or `ulp error`.

- `relative error`: Relative error is the rounding error when approximating a nonzero real number. By default, the tolerance value is `1e-07`. You can specify a tolerance value less than or equal to `1e-07`.
- `ulp error`: ulp (unit in the last place) is the gap between two floating-point numbers nearest  $x$ , even if  $x$  is one of the numbers. By default, the tolerance value is zero. You can specify a tolerance value greater than or equal to zero.

To check for floating-point tolerance, in the Configuration Parameters dialog box, on the Configuration section of **HDL Code Generation > Test Bench** tab, for **Floating point**

**tolerance check based on**, specify `relative error` or `ulp error`, and enter the **Tolerance Value**.

For more information, see `FPToleranceValue` and `FPToleranceStrategy`.

## Generic ports for DUT mask parameters

In R2016b, HDL Coder supports mask parameters at the DUT as generic ports for HDL code generation.

## Code Generation Report enhancements

### Delay Balancing Report

HDL Coder now displays the path delay balancing information in the Delay Balancing section of the Optimization Report. Previously, the Optimization Report displayed the delay balancing information in the Path Delay Summary subsection of the Streaming and Sharing report.

See also Optimization Report.

### Shift Operators in Resource Report

The High-level Resource Report Summary shows the number of Static Shift operators and Dynamic Shift operators. The Detailed Report shows the number of static left shift, static right shift, dynamic left shift, and dynamic right shift operators.

## Comprehensive documentation for HDL coding standard rules

The HDL Coder documentation provides a comprehensive list of coding standard rules with recommendations for each of the rules. The coding standard rules fall under three categories:

- **Basic Coding Practices:** Checks for conformance of modeling constructs with general naming conventions and basic coding guidelines. See [Basic Coding Practices](#).
- **RTL Description Techniques:** Checks for conformance with RTL description rules and guidelines. See [RTL Description Techniques](#).
- **RTL Design Methodology Guidelines:** Includes guidelines for creating and using function libraries, and test facilitation design. See [RTL Design Methodology Guidelines](#).

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To learn more about HDL coding standards, see HDL Coding Standards and HDL Coding Standard Report.

## Simpler method to call System objects

You can now call a System object with arguments, as if it were a function, instead of using the `step` method to perform the operation defined by the object. The `step` method continues to work. This capability improves the readability of scripts and functions that use many different System objects.

For example, if you create a `hdl.RAM` System object named `ramsingle`, and then call the System object as a function with that name:

```
ramsingle = hdl.RAM('RAMType','Single port', ...  
    'WriteOutputValue','Old data');  
ramsingle(x)
```

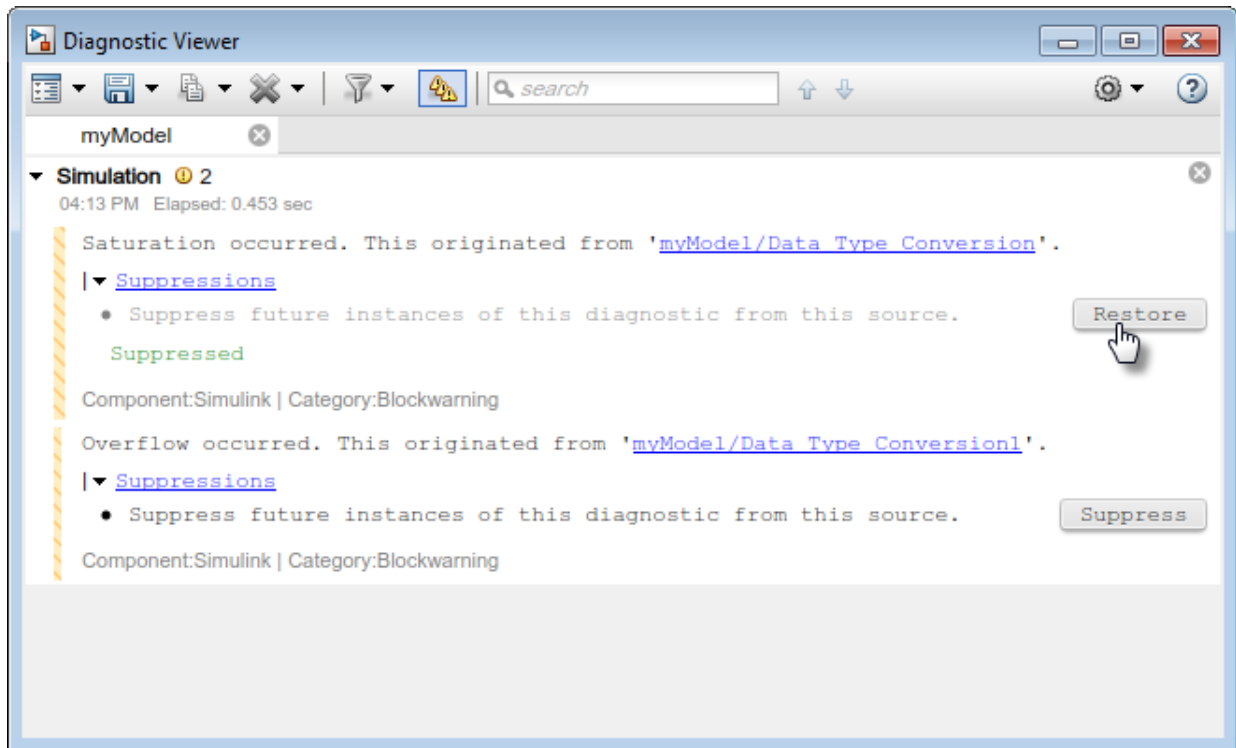
The equivalent operation with the `step` method is:

```
ramsingle = hdl.RAM('RAMType','Single port', ...  
    'WriteOutputValue','Old data');  
step(ramsingle,x)
```

When the `step` method has the System object as its only argument, the function equivalent has no arguments. You must call this function with empty parentheses. For example, `step(sysobj)` and `sysobj()` perform equivalent operations.

## Simulink diagnostic suppressor option

The Diagnostic Viewer in Simulink now includes an option to suppress certain diagnostics. You can suppress warnings for specific objects in your model. In the Diagnostic Viewer, click the **Suppress** button next to the warning to suppress the warning from the specified source. You can restore the warning from the source by clicking **Restore**.



You can also control the suppressions from the command line. To view the existing suppressions on the model, use the `Simulink.getSuppressedDiagnostics` function.

```
Suppressed = Simulink.getSuppressedDiagnostics('myModel')
```

```
Suppressed =
```

```
SuppressedDiagnostic with properties:
```

```
    Source: 'myModel/Data Type Conversion'
    Id: 'SimulinkFixedPoint:util:Saturationoccurred'
    LastModifiedBy: ''
    Comments: ''
    LastModified: '2016-Apr-26 10:31:22'
```

Suppress diagnostics by using the `Simulink.suppressDiagnostic` function.

```
Simulink.suppressDiagnostic('myModel/Data Type Conversion1', 'SimulinkFixedPoint:util:')
```

---

Suppressed

Suppressed =

1×2 SuppressedDiagnostic array with properties:

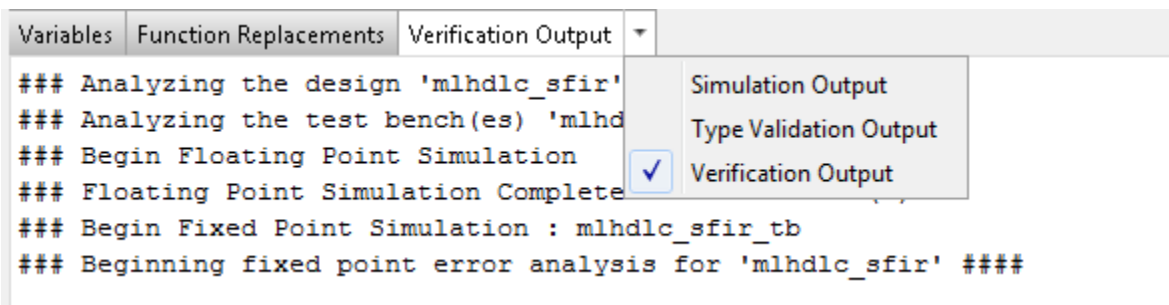
```
Source
Id
LastModifiedBy
Comments
LastModified
```

Restore a diagnostic by using the `Simulink.restoreDiagnostic` function.

```
Simulink.restoreDiagnostic('myModel/Data Type Conversion1', 'SimulinkFixedPoint:util:O
```

## More discoverable logs and reports for fixed-point conversion in HDL Coder app

Previously, in the HDL Workflow Advisor **Fixed-Point Conversion** task, the **HDL Coder** app displayed logs and report links for range analysis, fixed-point conversion, and verification on separate tabs that were placed on top of each other. To see a hidden tab, you opened a menu and selected the tab.



In R2016b, the app displays logs and report links for range analysis and fixed-point conversion on the **Output** tab. It displays logs and report links for verification on the **Verification Output** tab. These tabs are next to each other so that you can more easily find them.

Variables	Function Replacements	Output	Verification Output
-----------	-----------------------	--------	---------------------

---

Verification Output (4/25/16 4:48 PM)

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```
### Analyzing the design 'mlhdlc_sfir'  
### Analyzing the test bench(es) 'mlhdlc_sfir_tb'  
### Begin Floating Point Simulation  
### Floating Point Simulation Completed in 2.1091 sec(s)  
### Begin Fixed Point Simulation : mlhdlc_sfir_tb  
### Beginning fixed point error analysis for 'mlhdlc_sfir' ####
```

## Clock-rate pipelining enhancements

### Subsystem level control of clock-rate pipelining

You can now specify clock-rate pipelining for individual subsystems in your Simulink model. With this optimization, you can selectively apply clock-rate pipelining to subsystems in your model design that are on the critical path, and improve timing.

To disable clock-rate pipelining for an individual subsystem, in HDL Block Properties for the subsystem, set **ClockRatePipelining** to *off*.

To learn more about the HDL block property, see [ClockRatePipelining](#).

### Optimization of Downsample block with nonzero offset

In R2016b, when you have a Downsample block with a nonzero **Sample offset** at the boundary of a clock-rate pipelining region, HDL Coder does not introduce the additional latency or generate a Rate Transition block. This optimization improves timing and area.

For more information, see [Clock-Rate Pipelining](#).

---

## Resource sharing enhancements

### Sharing of multipliers with different word-lengths

HDL Coder now shares Product blocks and Gain blocks in your Simulink model that have different word-lengths. This optimization shares more multipliers, which saves area on the target platform.

To share multipliers that have different word-lengths, in the Configuration Parameters dialog box, on the **HDL Code Generation > Target and Optimizations > Resource Sharing** tab, specify the **Multiplier promotion threshold**. The **Multiplier promotion threshold** is the maximum word-length by which HDL Coder promotes a multiplier for sharing with other multipliers.

Previously, for successful resource sharing, you used Product blocks or Gain blocks with the same word-length.

See also `MultiplierPromotionThreshold` and `Resource Sharing`.

### Sharing of floating-point IP

HDL Coder now shares floating-point IP blocks in the target hardware based on the `SharingFactor` that you specify. This optimization saves area on the target hardware by sharing more floating-point IP blocks.

If you do not want to share floating-point IP blocks, in the Configuration Parameters dialog box, on the **Resource Sharing** tab, clear **Floating-point IPs**.

See also `ShareFloatingPointIP`.

## Delay balancing failures reported as errors

Starting in R2016b, if delay balancing is unsuccessful, HDL Coder generates an error. To see the block or subsystem in your Simulink model that caused delay balancing to fail, in the **Delay Balancing** section of the Optimization report, click the link to that block or subsystem.

## Compatibility Considerations

Previously, HDL Coder reported delay balancing failures as warnings. Now, if you load a pre-R2016b model for which delay balancing was unsuccessful, HDL Coder generates an error.

To learn more about possible reasons for delay balancing to fail, see [Delay Balancing](#).

## Optimization of Delay blocks with nonzero initial condition

In the generated code, HDL Coder now replaces a Delay block that has nonzero initial condition in your Simulink model with a Delay block that has zero initial condition and some additional logic. With this replacement, optimizations such as sharing, distributed pipelining, and clock-rate pipelining can work more effectively, and prevent an assertion from being triggered in the validation model.

To disable this optimization, in the Configuration Parameters dialog box, on the **HDL Code Generation > Target and Optimizations > General** tab, clear **Transform non zero initial value delay**.

For more information, see [TransformNonZeroInitDelay](#).

## Initialization script specification for Delay blocks without reset

Starting with R2016b, to initialize the registers, you can use the **no-reset registers initialization** setting to specify `Generate an external script`, `Do not initialize`, or `Generate initialization inside module`. When you select `Generate initialization inside module`, in Verilog, HDL Coder initializes the registers by using an initial block in each module. In VHDL, HDL Coder initializes the registers as part of the signal declaration statements.

Previously, if you had Delay blocks in your Simulink model with `ResetType` set to `None`, HDL Coder generated an external script to initialize the Delay blocks for ModelSim<sup>®</sup> simulation.

The **no-reset registers initialization** setting is available in the Configuration Parameters dialog box, on the **HDL Code Generation > Global Settings > Coding style** tab.

To learn more, see [NoResetInitializationMode](#).

## Enhancements in generated model for Lookup Tables

In R2016b, you can flatten masked subsystems and library blocks that contain Lookup Tables to enable further optimizations and file reduction.



---

## Customizable FPGA floating-point target configuration

You can customize the floating-point target IP settings by using the floating-point target configuration that you specify for the library. When you customize the IP settings, you can choose from different combinations of IP names and data types, and specify the latency or the target frequency that you want the IP to achieve. You can customize the IP settings from:

- **Floating Point Target** tab in Configuration Parameters dialog box: When you specify an Altera or Xilinx FPGA floating-point library, specify your custom settings in the **IP Settings** section.
- Command-line interface: By using the `hdlcoder.createFloatingPointTargetConfig` class, you can create a floating-point target configuration object for a given FPGA floating-point library or the HDL Coder native floating-point. In the `IPConfig` property of this object, use the `customize` function to customize the IP settings.

For more information, see [Customize Floating-Point IP Configuration](#).

## Additional block support for FPGA floating-point target library mapping

For FPGA floating-point target library mapping, HDL Coder supports these Simulink blocks and block modes:

- MinMax block.
- Unary Minus block.
- Add block with - ports.

See also [HDL Coder Support for FPGA Floating-Point Library Mapping](#).

## Default video system reference design

You can use a new Default video system (requires HDMI FMC module) reference design with these target platforms:

- Xilinx Zynq ZC702 evaluation kit
- Xilinx Zynq ZC706 evaluation kit
- ZedBoard

You must have Embedded Coder and the Computer Vision System Toolbox™ Support Package for Xilinx Zynq®-Based Hardware.

## Custom reference design enhancements

For your custom reference design, by using the `hdlcoder.ReferenceDesign` class, specify your own custom parameters and custom callback functions. Therefore, you can customize the settings that HDL Coder uses to create the project, generate the software interface model, and build the FPGA bitstream.

The IP Core Generation workflow has these enhancements:

- The **Set Target Interface** task is split into two tasks. One task is the original **Set Target Interface**, and the other task is a new **Set Target Reference Design**. In the **Set Target Reference Design** task, you can specify the parameters and supported tool version for the target reference design.

The **reference design** setting has moved from the **Set Target Interface** task to the **Set Target Reference Design** task.

- The new task **Set Target Frequency** means that you can specify the **Target Frequency (MHz)** for your design.

To learn more, see [Define Custom Parameters and Callback Functions for Custom Reference Design](#) and `hdlcoder.ReferenceDesign`.

## Compatibility Considerations

In the **Generate Software Interface Model** task, the **Add IP core device driver** check box has been removed. To add the device driver, in the task **Program Target Device**, specify a new **Download Programming method**. The **Download Programming method** copies the generated FPGA bistream, device tree, and system initialization scripts to the SD card on the Zynq board, and keeps the bitstream on the SD card persistently.

The reference design names no longer contain a tool version number. If you load a pre-R2016b model that was saved with a reference design containing a version number in its name, and then open the HDL Workflow Advisor, HDL Coder generates a warning. To avoid this warning, select the reference design that does not have the tool version number, and save the model.

---

## IP Core Generation workflow for Xilinx and Altera FPGA devices

You can use the IP Core Generation workflow to generate an HDL IP core for any supported Xilinx or Altera FPGA device. You can integrate the generated IP core into the Default system reference design, or create a custom board and reference design definition for your own FPGA board.

- With a new task **Set Target Frequency**, you can specify the **Target Frequency (MHz)** for your design.
- If the target device does not have an embedded ARM processor, there is no longer the **Generate Software Interface Model** task.

To learn more, see IP Core Generation Workflow for Standalone FPGA Devices.

## Additional FPGA board support for IP Core Generation workflow

You can target the following FPGA boards for the IP core generation workflow:

- Xilinx Kintex-7 KC705 development board
- Arrow DECA MAX 10 FPGA evaluation kit

For examples that show how to target the FPGA boards, see Using IP Core Generation Workflow with Xilinx FPGA Boards: Xilinx Kintex-7 KC705.

## Target clock frequency specification

By using the **Target Frequency (MHz)** setting in the **Target and Optimizations** pane in the Configuration Parameters dialog box, you can specify the target frequency for:

- FPGA floating-point target library mapping: Specify the target frequency that you want the IP to achieve when you use ALTERA MEGAFUNCTION (ALTERA FP FUNCTIONS).
- Adaptive pipelining: Specify the target frequency for HDL Coder to insert required number of pipelines to improve area and timing on the target platform.

Previously, you specified the target frequency for floating-point library mapping in the Configuration Parameters dialog box, on the **HDL Code Generation > Global Settings > Floating Point Target** tab.

By using the new **Set Target Frequency** task in the HDL Workflow Advisor, you can now specify the target frequency for the following workflows:

- Generic ASIC/FPGA
- IP Core Generation

From the command line, use the TargetFrequency property to save the target frequency on the model.

## Simulink Real-Time FPGA I/O workflow support for Xilinx Vivado

For the new Speedgoat boards, the Simulink Real-Time FPGA I/O workflow supports Xilinx Vivado by using the IP Core Generation workflow.

See also IP Core Generation Workflow for Speedgoat Boards.

## Speedgoat IO333–325K target hardware support

You can target the Speedgoat IO333–325K board with Xilinx Kintex7 for the Simulink Real-Time FPGA I/O workflow.

## Target and Optimizations pane in HDL Coder Configuration Parameters

In the Configuration Parameters dialog box, on the **HDL Code Generation** pane, HDL Coder has a new **Target and Optimizations** pane where you can specify the target device and optimization settings.

- Parameters that were previously in the **General**, **Pipelining**, and **Resource Sharing** sections of the **Optimization** tab of **Global Settings** pane have moved to a **General** tab, a **Pipelining** tab, and a **Resource Sharing** tab respectively in the **Optimizations** section of **Target and Optimizations** pane.
- In the **Target and Optimizations** pane, you now specify the target device settings in the **Tool and Device** section and the **Target Frequency** in the **Objectives** section respectively.

For more information, see HDL Code Generation Pane: Target and Optimizations.

## Updates to supported software

HDL Coder has been tested with:

- 
- Xilinx Vivado Design Suite 2015.4
  - Altera Quartus II 15.1

For a list of supported third-party tools and hardware, see Supported Third-Party Tools and Hardware.

## **Link to Code Generation Report after HDL code generation**

In the Configuration Parameters dialog box, on the **HDL Code Generation** pane, when you select **Generate resource utilization report** and generate HDL code, HDL Coder displays a link to the Code Generation report. If you happen to close the report after code generation, you can click the link to open the report from the MATLAB Command Window.



# R2016a

**Version: 3.8**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Synchronous Subsystem Toggle: Specify enable and reset behavior for cleaner HDL code by using State Control block

With the State Control block, you can toggle a subsystem between the default Simulink reset and enable behavior and the synchronous hardware reset and enable behavior. How you set the State Control block affects blocks within the subsystem that have state and have reset or enable ports.

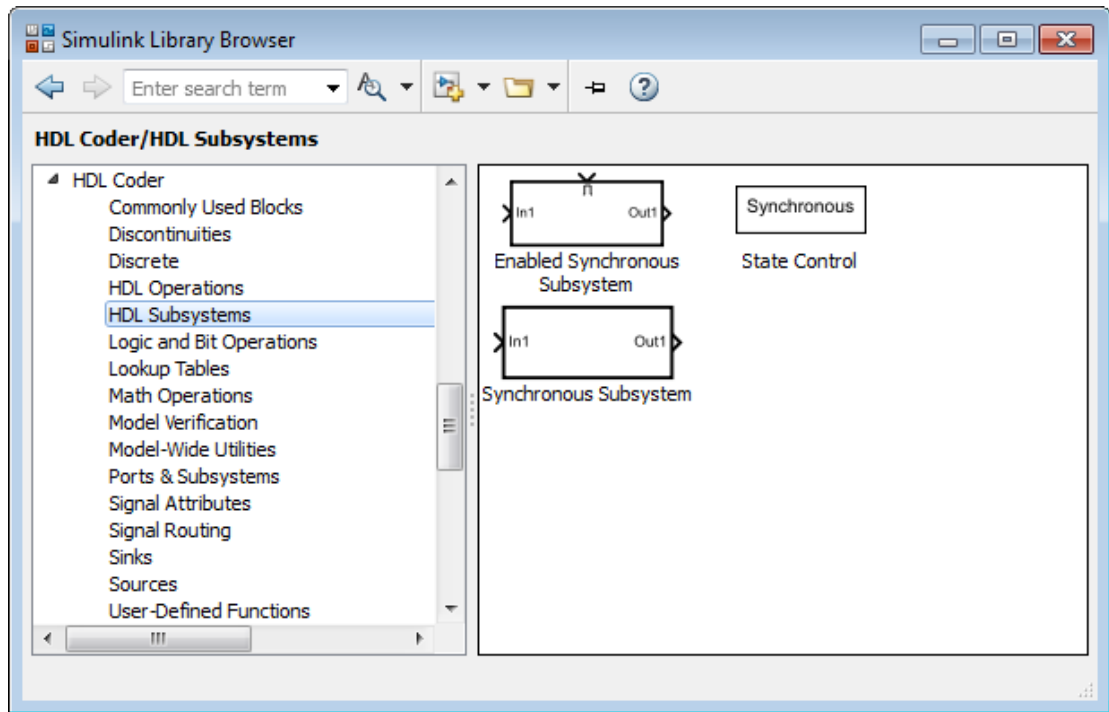
If you specify synchronous hardware behavior, the HDL code is cleaner and requires fewer resources because HDL Coder does not generate bypass registers for enabled subsystems or multiplexers for blocks with reset ports.

To toggle a subsystem between synchronous hardware behavior and default Simulink behavior, add a State Control block to the subsystem:

- For synchronous hardware behavior, in the State Control block, set **State control** to **Synchronous**.
- For default Simulink behavior, in the State Control block, set **State control** to **Classic**.

The State Control, Enabled Synchronous Subsystem, and Synchronous Subsystem blocks are available as part of the HDL Subsystems block library in HDL Coder. The Synchronous Subsystem and Enabled Synchronous Subsystem blocks use the synchronous hardware behavior of the State Control block with the Subsystem and Enabled Subsystem blocks respectively.





Use the State Control block with Simulink, DSP System Toolbox, Communications System Toolbox™, or Vision HDL Toolbox™ blocks that support HDL code generation.

For more information, see State Control and Synchronous Subsystem Behavior with the State Control Block.

## **Gigasample per Second (GSPS) Signal Processing: Increase throughput of HDL-optimized FFT and IFFT algorithms using frame input**

You can increase the throughput of the FFT and IFFT calculation by using vector input and output ports. The internal algorithm computes the FFT or IFFT of each vector element in parallel.

The FFT implementation is now a Radix  $2^2$  architecture which improves performance for vector input. The table compares hardware implementation resources between the old Radix 2 architecture and the new Radix  $2^2$  architecture.

Architecture	Multipliers	Adders	Memory	Control Logic For Vector Input
Radix 2 Hybrid	$\log_4(N-1)$	$3 \times \log_4(N)$	$17N/16 - 1$	Complicated
Radix 2 <sup>2</sup> (SDF)	$\log_4(N-1)$	$4 \times \log_4(N)$	$N - 1$	Simple

This change affects these blocks and System objects:

- FFT HDL Optimized
- IFFT HDL Optimized
- dsp.HDLFFT
- dsp.HDLIFFT

## Hard Floating-Point IP Targeting: Generate HDL to map to Altera Arria 10 floating-point units at user-specified target frequency

HDL Coder can now map your Simulink model to Altera floating-point IP (ALTERA FP FUNCTIONS) at the target frequency that you specify.

Previously, when mapping to Altera megafunction IP (ALTFP) or Xilinx LogiCORE<sup>®</sup> IP, you could specify only whether to optimize the Simulink model for minimum or maximum latency and for speed or area.

For more information, see [FPGA Floating-Point Library Mapping and TargetFrequency](#).

## Compatibility Considerations

Previously, you chose the floating-point target library by selecting the **Set Target Library (for floating-point synthesis support)** check box from the HDL Workflow Advisor.

You now specify the floating-point target library from the **HDL Code Generation > Global Settings > Floating Point Target** tab in the Model Configuration Parameters dialog box.

---

## Resource Sharing Enhancements: Share multipliers and gain operations that have different data types

HDL Coder can now share multiply and gain blocks that have the same word length but different fraction lengths and different signs. This optimization reduces the resource utilization by sharing more multipliers and gain operations.

Previously, the word length, fraction length, and signs of the multiply or gain blocks had to be the same.

See Requirements and Limitations for Resource Sharing in Resource Sharing.

## Faster Test Bench Generation and HDL Simulation: Generate SystemVerilog DPI test benches for large data sets with HDL Verifier

Reduce test bench generation and simulation time, especially when using large data sets. When you call the `makehdltb` function, set the `GenerateSVDPItestBench` property. The coder generates a DPI component for your entire Simulink model, including your DUT and data sources. Your entire model must support C code generation with Simulink Coder™. The coder generates a SystemVerilog test bench that compares the output of the DPI component with the output of the HDL implementation of your DUT. The tool also generates a build script for your simulator. You can specify 'ModelSim', 'VCS', or 'Incisive'.

```
makehdltb(gcb, 'GenerateSVDPItestBench', 'ModelSim', 'GenerateHDLTestbench', 'off')
```

You must have an HDL Verifier™ license and a Simulink Coder license to use this feature.

## End-to-end scripting for Simulink Real-Time FPGA I/O workflow

You can use the HDL Workflow Command Line Interface (CLI) to script the entire Simulink Real-Time™ FPGA I/O workflow.

To create the script to configure your design using the HDL Workflow Advisor, generate a target hardware bitstream or project from your Simulink model, and then export a script. Run the exported script, which contains HDL Workflow CLI commands, to replicate your HDL Workflow Advisor settings and generate the same target hardware bitstream or project.

## Code Generation Report enhancements

The Code Generation Report has these enhancements:

- A new Code Interface Report shows the DUT input and output port names, data types, and bit widths.
- The High-level Resource Report shows the number of 1-bit registers and I/O bits. It includes resource usage for model references.

See Code Interface Report and High-level Resource Report in Resource Utilization Report.

- For each group of streamed or shared blocks, the Sharing and Streaming report provides more details:
  - For shared blocks, the report shows the resource type, block word length, number of blocks in the group, and a traceability link to the blocks in the original model and generated model. It includes a **Highlight shared resources and diagnostics** link to highlight in the original model and generated model the shared blocks and blocks that are barriers to resource sharing.
  - For streamed blocks, the report links to the group of streamed blocks and shows the streaming factor. It includes a **Highlight streaming groups and diagnostics** link to highlight in the original model and generated model the streamed blocks and blocks that are barriers to streaming.

See Streaming and Sharing Report in Optimization Report.

## Changes to Fixed-Point Conversion Code Coverage

If you use the HDL Coder app to convert your MATLAB code to fixed-point code and propose types based on simulation ranges, the app shows code coverage results. In previous releases, the app showed the coverage as a percentage. In R2016a, the app shows the coverage as a line execution count.

```

11 persistent current_state
12 if isempty( current_state )
13     current_state = S1;           1 calls
14 end                               51 calls
15
16 % switch to new state based on the value state register
17 switch uint8( current_state )
18     case S1
19         % value of output 'Z' depends both on state and inputs
20         if (A)
21             Z = true;             37 calls
22             current_state( 1 ) = S1;
23         else                       7 calls
24             Z = false;
25             current_state( 1 ) = S2;
26         end
27     case S2                       51 calls
28         if (A)
29             Z = false;           7 calls
30             current_state( 1 ) = S1;
31         else                       0 calls
32             Z = true;
33             current_state( 1 ) = S2;
34         end
35     case S3                       51 calls
36         if (A)
37             Z = false;           0 calls
38             current_state( 1 ) = S2;
39         else
40             Z = true;
41             current_state( 1 ) = S3;
42         end

```

See Code Coverage in Automated Fixed-Point Conversion.

Fixed-point conversion requires the Fixed-Point Designer™ software.

## Progress indicator for HDL test bench generation

HDL Coder displays a series of dots to show progress during HDL test bench generation for test benches with a long simulation time.

HDL test bench generation simulates the Simulink model to collect data for every signal in the DUT. This data collection phase can therefore significantly impact HDL test bench generation time. The progress indicator dots help as visual indicators during this long phase of testbench generation.

## **Test bench generation with updated model stop time**

If you generate a test bench, update the stop time in your model, and regenerate the test bench. The generated test bench uses the updated stop time.

Previously, test bench generation used the original stop time even if the stop time was updated.

## **Performance improvement for MATLAB to HDL test bench generation**

In the MATLAB to HDL workflow, HDL Coder uses MEX code for data logging to speed up HDL test bench generation.

## **SoC device programmed by using Ethernet connection**

When using the IP core generation workflow in the HDL Workflow Advisor, you can program the target SoC device by using an Ethernet connection.

You must have Embedded Coder and the Embedded Coder Support Package for Altera SoC Platform.

## **Custom programming method for IP Core Generation workflow**

Using the `CallbackCustomProgrammingMethod` method of the `hdlcoder.ReferenceDesign` class, you can define your own function to program the target device in your custom reference design.

## **Interface connection name and type for custom reference designs**

Using the `AXI4SlaveInterface` method of the `hdlcoder.ReferenceDesign` class, you can specify the type of an AXI4 slave interface in a custom reference design. The type can be AXI4, or AXI4-Lite. You can also name the interface.

---

## Region-of-interest selection and grayscale morphology

Vision HDL Toolbox introduces a new block, ROI Selector, that selects a region of interest (ROI) from a video stream. You can specify one or more regions by using input ports or mask parameters. The block returns each new region as streaming pixel data and a corresponding `pixelcontrol` bus.

The `visionhdl.ROISelector` System object provides equivalent MATLAB functionality.

Vision HDL Toolbox includes new blocks and System objects that perform morphology operations on grayscale input data.

Block	System object
Grayscale Closing	<code>visionhdl.GrayscaleClosing</code>
Grayscale Dilation	<code>visionhdl.GrayscaleDilation</code>
Grayscale Erosion	<code>visionhdl.GrayscaleErosion</code>
Grayscale Opening	<code>visionhdl.GrayscaleOpening</code>

These blocks and System objects support HDL code generation.

## Biquad Filter block participates in subsystem HDL optimizations

The Biquad Filter block is now included in subsystem optimizations for speed and area of the generated HDL. To specify resource sharing, streaming, and pipeline options, right-click the subsystem containing the Biquad Filter block and open the **HDL Code > HDL Properties** dialog box. To use these optimizations you must set the **Architecture** of the Biquad Filter block to `Fully parallel`.

The optimizations work the same way as the optimizations for the Discrete FIR Filter block. You can share resources between Biquad Filter and Discrete FIR Filter blocks in the same subsystem.

## More functions for Multiply-Add block to map to DSP

You can now choose from three different functions for the Multiply-Add block to map to the DSP blocks in Altera and Xilinx FPGA libraries. The three functions are `c+(a.*b)`, `c-(a.*b)`, and `(a.*b)-c`.

For details, see Multiply-Add.

## Generation of Multiply-Add blocks for complex multiply operations

If you have Product or Gain blocks with complex input signals in your Simulink model, HDL Coder generates a model with Multiply-Add blocks. These Multiply-Add blocks map efficiently to the DSP blocks in Altera and Xilinx FPGA libraries.

## RAM mapping for pipeline and floating-point delays

To optimize for area by mapping pipeline registers to RAM, in the Configuration Parameters dialog box, select the **Map pipeline delays to RAM** check box from the **HDL Code Generation > Global Settings > Optimization** tab. See `MapPipelineDelaysToRAM`.

HDL Coder also maps design delays and the pipeline registers in floating-point type to RAM.

## Initialization script generated for Delay blocks without reset for ModelSim simulation

If you have delay blocks with in your model with `ResetType` set to `None`, HDL Coder generates a script to initialize these delay blocks for simulation with ModelSim.

Previously, you either modified the generated code or wrote your own script to initialize these delay blocks.

## Reusable HDL code enhancements for subsystems with tunable mask parameters

In R2016a, to generate one reusable HDL file for Subsystem blocks that contain Gain and Constant blocks for different values of tunable mask parameters, set the `MaskParameterAsGeneric` option.

Previously, in addition to setting the `MaskParameterAsGeneric` option, you used Atomic Subsystem blocks and selected the **tunable** attribute in the Mask Editor **Parameters & Dialog** tab for the Atomic Subsystem block.

See `MaskParameterAsGeneric`.



---

## Coding standard check for length of control flow statements in a process block

When you enable the **Industry** coding standard, HDL Coder checks for the length of control flow statements, such as if-else, case and loops, which are described separately within a process block (for VHDL code) or an always block (for Verilog code). If the length of control flow statements in your design exceeds the specified limit, the coder displays an error in the HDL coding standard report.

See HDL Coding Standard Rules.

## HDL Coder support for nondirect feedthrough setting in MATLAB Function blocks

HDL Coder now supports code generation from MATLAB Function blocks that use the nondirect feedthrough setting. With nondirect feedthrough, you can use MATLAB Function blocks in a feedback loop and prevent algebraic loops.

By default, MATLAB Function blocks have direct feedthrough enabled. To disable it, in the Ports and Data Manager pane, clear the **Allow direct feedthrough** check box.

Nondirect feedthrough enables semantics to ensure that outputs rely only on current state. For additional information, see Use Nondirect Feedthrough in a MATLAB Function Block.

## Nested bus support enhancements

In R2016a, HDL Coder supports all nested virtual and nonvirtual buses. For example, you can now generate HDL code for a Delay block with a nested virtual bus signal input in your Simulink model.

## Tunable and nontunable parameter enhancements

You can generate HDL code for:

- Stateflow Charts, State Transition Tables, or Truth Tables that use a tunable parameter.
- MATLAB Function blocks that use a tunable or nontunable parameter with vector, array, `struct`, enumeration, or complex data type.

- MATLAB System blocks containing a System object with tunable properties.

See Generate DUT Ports for Tunable Parameters.

## Block support enhancements

You can generate HDL code for:

- A Bus to Vector block.
- A Dot Product block with `Tree` architecture when input signals are a mix of row and column vectors.
- A Shift Arithmetic block when **Bits to shift: Number** is a vector of bit shift values or **Bits to shift: Source** is `Input port`.
- Masked Inport and Outport blocks.
- A Matrix Concatenate block with `Multidimensional array` mode.
- A Bus Assignment block with bus signal input containing a nested bus signal.
- A MATLAB System block containing a user-defined System object with bus inputs or outputs.
- An n-D Lookup Table block with the `Breakpoints specification` parameter or a Prelookup block with the `Specification` parameter set to `Explicit values` or `Even spacing`.
- A Subsystem block with `BlackBox` architecture and a cell array variable in the `GenericList` field as input to the Subsystem block.

## Updates to supported software

HDL Coder has been tested with:

- Xilinx Vivado Design Suite 2015.2
- Altera Quartus II 15.0

For a list of supported, third-party tools and hardware, see Supported Third-Party Tools and Hardware.

## Automatic generation of FPGA top-level wrapper based on workflow

For the FPGA Turnkey and Simulink Real-Time FPGA I/O workflows, HDL Coder generates a top-level HDL code wrapper and a constraint file that contains pin mapping

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and clock constraints. In the HDL Workflow Advisor, for the FPGA Turnkey and Simulink Real-Time FPGA I/O workflows, the name of the **Generate RTL Code and Testbench** task is now **Generate RTL Code**.

To run the **Annotate Model with Synthesis Result** task, your target workflow must be Generic ASIC/FPGA.

## Compatibility Considerations

For all workflows, the **Generate FPGA top level wrapper** check box and `GenerateTopLevelWrapper` of the `hdlcoder.WorkflowConfig` class have been removed.

For the Generic ASIC/FPGA workflow, if you specify the `GenerateTopLevelWrapper` property of the `hdlcoder.WorkflowConfig`, HDL Coder displays a warning. In a future release, specifying this property will result in an error.

For the FPGA Turnkey or Simulink Real-Time FPGA I/O workflow, if you specify the following `hdlcoder.WorkflowConfig` properties, HDL Coder displays a warning. In a future release, specifying these properties will result in an error:

- `RunTaskGenerateRTLCodeAndTestbench`
- `RunTaskVerifyWithHDLCosimulation`
- `RunTaskAnnotateModelWithSynthesisResult`
- `GenerateRTLTestbench`
- `GenerateCosimulationModel`
- `CosimulationModelForUseWith`
- `GenerateValidationModel`
- `GenerateTopLevelWrapper`
- `CriticalPathSource`
- `CriticalPathNumber`
- `ShowAllPaths`
- `ShowDelayData`
- `ShowUniquePaths`
- `ShowEndsOnly`

## **Warnings for non-ASCII characters in generated HDL code**

If you have non-ASCII content in model annotations and Model Info blocks, HDL Coder issues warnings during `checkhdl` and `makehdl`. Non-ASCII characters in the generated HDL code can cause RTL simulation and synthesis tools to fail to compile the code.

## **Japanese translation for resource report**

For Japanese versions of HDL Coder, the resource utilization report is in Japanese.

# R2015aSP1

Version: 3.6.1

Bug Fixes



# R2015b

**Version: 3.7**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## **Tunable Parameters: Map to AXI4 interfaces to enable hardware run-time tuning by the embedded software on the ARM processor**

For Xilinx Zynq or Altera SoC hardware, you can map tunable parameters in your Simulink model to an AXI4, AXI4-Lite, or external interface in the generated IP core. You can then use the embedded software to dynamically tune the parameter in hardware.

You can also map tunable parameters to the PCI interface in the Simulink Real-Time FPGA I/O workflow.

The HDL Workflow Advisor Target Platform Interface Table shows tunable parameters in the Port Name column. You can map each tunable parameter to a target platform interface as you can with any DUT port.

To make a tunable parameter available for mapping to a target interface, use it in a Gain, Constant, or MATLAB Function block.

## **Expanded Bus Support: Generate HDL for enabled or triggered subsystems with bus inputs and for black boxes with bus I/O**

You can now generate HDL code for the following blocks with bus input or output signals:

- Enabled Subsystem
- Triggered Subsystem
- Subsystem with black box implementation

## **Quality of Results Improvement: Stream and share resources more broadly and efficiently**

The streaming optimization works with:

- Subsystems that contain nested subsystems. Previously, the streamed subsystem had to be a leaf subsystem.
- A streaming factor that is divisible by vector width. Previously, the streaming factor had to be a divisor of the vector width.
- Blocks that are not supported for streaming. Instead, the optimization can work around unsupported blocks. Previously, the presence of unsupported blocks caused streaming to fail.



---

The resource sharing area optimization can implement shared resources at the clock rate within clock-rate pipelining regions, without using oversampling.

The resource sharing optimization can now share a subset of all the identical atomic subsystems in your design. Previously, you had to share all of the atomic subsystems, or none.

The hierarchy flattening optimization can operate on individual atomic subsystems, even if there are other identical atomic subsystems in the design.

## **Model Arguments: Parameterize instances of model reference blocks**

You can generate VHDL<sup>®</sup> generic or Verilog<sup>®</sup> parameter syntax for model arguments you use in a masked or unmasked Model block. In the model, you can use the model arguments in Gain or Constant blocks.

For details, see Generate Parameterized Code for Referenced Models.

## **End-to-end scripting from design through IP core generation, FPGA Turnkey, and generic ASIC/FPGA workflows**

You can use the HDL Workflow Command Line Interface (CLI) to script the entire generic ASIC/FPGA, IP core generation, and FPGA Turnkey workflows.

The simplest way to create the script is to configure your design using the HDL Workflow Advisor, generate a target hardware bitstream or project from your Simulink model, then export a script. You can run the exported script, which contains HDL Workflow CLI commands, to replicate your HDL Workflow Advisor settings and generate the same target hardware bitstream or project.

For details, see Run HDL Workflow with a Script.

## **Integration with Xilinx Vivado System Generator for DSP blocks**

You can generate code for subsystems containing Xilinx System Generator for DSP blocks when Xilinx Vivado is your synthesis tool. For setup information, see Xilinx System Generator Setup for ModelSim Simulation.

## Library Browser view shows blocks supported for HDL code generation

In the Library Browser, you can enable a filtered view that shows all the blocks that are compatible with HDL code generation. The view shows only those blocks for which you have a license. To use this filtered view, at the command prompt, enter `hdl1ib`.

After using the `hdl1ib` command, if you close and reopen the Library browser, the view that shows only those blocks that are compatible for HDL code generation persists. To display all blocks in the Library Browser, enter `hdl1ib('off')`.

For more information, see [Show Blocks Supported for HDL Code Generation](#).

## Compatibility Considerations

Previously, the `hdl1ib` command created a supported blocks library called `hdl1supported`. The `hdl1ib` command now opens the Library Browser with a view that shows the supported blocks for HDL code generation, but does not create a block library.

To create the supported blocks library, at the command prompt, enter `hdl1ib('librarymodel')`.

## HDL Coder Configuration Parameters in list view

The Configuration Parameters list view shows HDL Code Generation parameters. In list view, you can search, filter, sort, and edit parameters. You can also get command-line parameter names for use in scripts. To use the list view, click the **List** button at the top of the Configuration Parameters dialog box.

Some of the HDL Code Generation parameters, such as the lint script, synthesis script, and HDL coding standard parameters, are unavailable in list view. To see all the HDL Code Generation parameters, use the category view.

To learn about Configuration Parameters list view, see [Configuration Parameters Dialog Box Overview](#).

## struct input and output for top-level MATLAB design function

You can generate HDL code for a top-level MATLAB design function that has `struct` inputs or outputs. You can also generate HDL code for a test bench that uses `struct`

---

data. Previously, `struct` data was supported within the design, but not at the top-level inputs or outputs.

For example, in Vision HDL Toolbox, this removes the requirement to flatten the `pixelcontrol` structure into the component signals, as shown here.

```
function [pixOut,hStartOut,hEndOut,vStartOut,vEndOut,validOut] = ...  
        HDLTargetedDesign(pixIn,hStartIn,hEndIn,vStartIn,vEndIn,validIn)
```

With HDL code generation support for structures, the arguments can now include the control signal structure.

```
function [pixOut,ctrlOut] = HDLTargetedDesign(pixIn,ctrlIn)
```

The structure is flattened to the individual control signals in the generated Verilog or VHDL code.

## Trigonometric Function block with sin or cos function can have vector inputs

You can generate code for a Trigonometric Function block with vector inputs when the **Function** is `sin`, `cos`, `cos + jsin`, or `sincos`, and the **Approximation method** is `CORDIC`.

In the HDL Block Properties dialog box, you can also set **UsePipelinedKernel** to `Off` for zero-latency combinatorial HDL code. To avoid delay balancing errors, you can set **UsePipelinedKernel** to `Off` if the block is in a feedback loop.

See Trigonometric Function.

## Tunable parameters in MATLAB Function block

When you generate code for a MATLAB Function block that uses a tunable parameter, the coder creates a top-level DUT port for the tunable parameter in the generated code.

For details, see Generate DUT Ports for Tunable Parameters.

## Support for configuration parameter Default parameter behavior

HDL code you generate for models that use the configuration parameter **Default parameter behavior**, which was previously called **Inline parameters**, follows the new behavior.

To learn more about the **Default parameter behavior** name and functionality change, see Configuration parameter Inline parameters name and functionality change.

## Compatibility Considerations

Sample time propagation for `Inf` rates in Simulink can differ from previous releases. If you have a model with `Inf` sample times, check the sample time legend to make sure it shows the rates you expect.

To fix code generation issues from such models, fully specify the sample time. For example, specify the sample time for any Constant blocks with `Inf` sample time.

## Synthesis objective for synthesis tool target optimization

You can specify a high-level synthesis objective that maps to your third-party synthesis tool can use to optimize the target hardware. The following high-level synthesis objectives are available from the HDL Workflow Advisor and the HDL Workflow Command Line Interface:

- Area Optimized
- Compile Optimized
- Speed Optimized
- None (default)

For details about how the synthesis objective maps to Tcl commands, see Synthesis Objective to Tcl Command Mapping.

## Multiply-Add block

A new block, Multiply-Add, that performs a hardware optimized multiplication-addition operation, is available in the HDL Operations block library. Using this block can help your design map to DSPs in hardware. The resource sharing optimization can also share Multiply-Add blocks.

To learn about the Simulink behavior, see Multiply-Add.

To learn about the hardware implementation and HDL block properties, see Multiply-Add.

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## **Hierarchy flattening for masked subsystems and user library blocks**

For masked subsystems and user library blocks, you can flatten hierarchy to enable further speed and area optimization.

For details, see [Hierarchy Flattening](#).

## **Loop optimization improvement**

The loop streaming implementation now uses fewer multiplexers and therefore uses less area.

## **Complex Gain speed optimization**

Register retiming for a complex Gain block inserts a register between the multiplier and adder.

## **Redesigned serializer for streaming and resource sharing**

The serializer used in streaming and resource sharing is redesigned as a combinational switch to use less area. It no longer uses registers in its implementation.

## **Tapped Delay optimization**

The Tapped Delay block is supported for streaming, retiming, and floating-point library mapping. It also no longer inhibits clock-rate pipelining.

## **AXI4-Stream vector interface**

In the hardware-software codesign workflow, for streaming applications, you can use vector ports to connect the hardware DUT to the rest of the model. With an Embedded Coder license, you can then generate a software interface model that includes the embedded software DMA driver block for the generated IP core.

In the hardware DUT, connect the top-level input and output vector ports to Serializer1D and Deserializer1D blocks. HDL Coder detects this modeling pattern, and generates a software interface model that replaces the Serializer1D, Deserializer1D, and DUT.

For details, see [Model Design for AXI4-Stream Interface Generation](#).

## Connect IP core with other IP blocks in custom reference designs

Using the `hdlcoder.ReferenceDesign.addInternalIOInterface` method, you can define a connection between your generated IP core and other IP in a custom reference design. You can use this method for Altera Quartus II, Xilinx Vivado, and Xilinx ISE hardware targets.

## Discrete FIR Filter supports HDL optimizations

You can now optimize speed and area of the generated HDL for the Discrete FIR Filter block. Right-click the subsystem containing the Discrete FIR Filter block, and open the **HDL Code > HDL Properties** dialog to specify resource sharing, streaming, and pipeline options. You can use these optimizations when the **Architecture** is **Fully parallel**. This feature requires an HDL Coder license. See Reduce Critical Path with Distributed Pipelining, Resource Sharing of Multipliers to Reduce Area, and HDL Block Properties.

## HDL-optimized FIR Rate Conversion block and System object

FIR Rate Conversion HDL Optimized block in DSP System Toolbox upsamples, filters, and downsamples a signal using an efficient polyphase FIR structure. The block operates on one sample at a time and provides hardware control signals to pace the flow of samples in and out of the block. The `dsp.HDLFIRRateConverter` System object provides equivalent MATLAB functionality. Both the block and System object support HDL code generation.

## Test bench performance improvements with file I/O

Infrastructure improvements in test bench generation with file I/O have improved test bench performance by reducing:

- Simulation time
- Memory use
- Code generation time

HDL Coder writes the DUT stimulus and reference data from your MATLAB or Simulink simulation to data files (`.dat`). During HDL simulation, the HDL test bench reads the saved stimulus from the `.dat` files.

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To learn more about Simulink test bench generation, see [Test Bench Generation](#).

To learn more about MATLAB test bench generation, see [Test Bench Generation](#).

## Compatibility Considerations

The HDL test bench code generated for a design in a previous release may differ from the code generated for the same design in the current release.

Previously, by default, DUT stimulus and reference data was generated as constants in the test bench code. To generate test bench data that used file I/O, you had to set the `UseFileIOInTestBench` property to 'on'.

The `UseFileIOInTestBench` property is now 'on' by default.

## Kintex UltraScale and Virtex UltraScale device family support in generic ASIC/FPGA and IP core generation workflows

In the generic ASIC/FPGA workflow and IP core generation workflow, you can target Xilinx Kintex<sup>®</sup> UltraScale and Virtex UltraScale devices.

## Image processing examples

Five examples of image processing and HDL code generation using Vision HDL Toolbox are added in this release.

- Gamma Correction
- Histogram Equalization
- Edge Detection and Image Overlay
- Edge Detection and Image Overlay with Impaired Frame
- Noise Removal and Image Sharpening

## Output initialization requirement for Stateflow Moore Charts

If you have a model with a Stateflow Moore Chart, select the **Initialize Outputs Every Time Chart Wakes Up** chart property. By selecting this property, HDL Coder prevents latching of outputs, generates more readable HDL code, and provides better synthesis results.

## Compatibility Considerations

In previous versions, you did not have to set the chart property. Starting in R2015b, If you do not select the **Initialize Outputs Every Time Chart Wakes Up** check box, HDL Coder generates an error.

## Enforce ASCII character requirement for model property values

For HDL model properties that require ASCII character strings, HDL Coder now generates an error if you assign a non-ASCII string value.

The following model properties accept non-ASCII character strings:

- `BlocksWithNoCharacterizationFile`
- `CriticalPathEstimationFile`
- `DateComment`
- `DistributedPipeliningBarriersFile`
- `HighlightFeedbackLoopsFile`
- `SimulationLibPath`
- `SynthesisProjectAdditionalFiles`
- `TargetDirectory`

## Compatibility Considerations

Previously, HDL Coder did not generate an error if you assigned a non-ASCII character string to a model property that required ASCII characters.

To fix the error, at the command prompt, enter: `hdlset_param (gcs, model_property_name, 'ASCII_value')`.



# R2015a

**Version: 3.6**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Mac OS X platform support

You can install and run HDL Coder to generate code on the 64-bit Mac OS X platform.

## Critical path estimation without running synthesis

Critical path estimation helps you to find the timing critical path in your design without running third-party synthesis tools.

If you enable critical path estimation when you generate code, HDL Coder computes the timing critical path and generates a script that highlights the estimated critical path in the generated model.

To find your estimated critical path, in **HDL Workflow Advisor > HDL Code Generation > Set Code Generation Options > Set Basic Options**, select **Generate high-level timing critical path report**.

The estimated critical path is calculated using static timing analysis. In the current release, the timing data for each block is based on Xilinx Virtex-7, speed grade -1 hardware.

If a block in your design does not have timing data, the coder generates a second block highlighting script. To see the uncharacterized blocks in your design, click the script link displayed in the MATLAB command window or HDL Workflow Advisor **Result** pane.

For more information, see Find Estimated Critical Paths Without Synthesis Tools.

## AXI4-Stream interface generation for Xilinx Zynq IP core

You can generate an IP core with an AXI4-Stream interface when you target the Xilinx Zynq-7000 platform and your synthesis tool is Xilinx Vivado.

For an example that shows how to generate an HDL IP core with an AXI4-Stream interface, see Getting Started with AXI4-Stream Interface in Zynq Workflow.

## Custom reference design and custom SoC board support

You can now define a custom SoC board or a custom reference design.

In the HDL Workflow Advisor, you can generate an IP core for a custom board, insert it into a custom reference design, and generate an FPGA bit stream for the SoC hardware.

---

To learn more about defining and registering a custom board or custom reference design, see:

- Board and Reference Design Registration System
- Register a Custom Board
- Register a Custom Reference Design

For an example, see Define and Register Custom Board and Reference Design for SoC Workflow.

## Localized control using pragmas for pipelining, loop streaming, and loop unrolling in MATLAB code

You can use pragmas in your MATLAB code to specify pipelining, loop streaming, and loop unrolling optimizations for specific operations.

For a loop statement, you can use `coder.hdl.loopspec` to specify loop unrolling or loop streaming.

For an operation or expression, you can use `coder.hdl.pipeline` to insert one or more pipeline registers.

The following example shows how to use these two pragmas:

```
function y = hdltest(x)
    pv = uint8(1);
    pv = coder.hdl.pipeline(pv + x, 4);

    y = uint8(zeros(1,10));

    coder.hdl.loopspec('stream', 5);
    for i = 1:10
        y(i) = pv + i;
    end
end
```

To learn more, see:

- Pipeline MATLAB Expressions
- Optimize MATLAB Loops

## Compatibility Considerations

If you have a model that uses the VariablesToPipeline HDL block property, or a MATLAB design that uses the HDL Workflow Advisor **Pipeline variables** field, the software displays a warning when you generate code.

Replace instances of Variables ToPipeline or **Pipeline variables** with coder.hdl.pipeline. VariablesToPipeline and **Pipeline variables** will be removed in a future release.

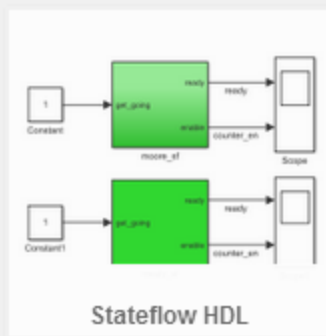
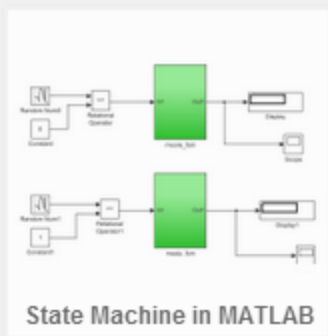
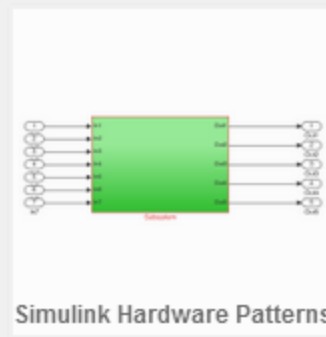
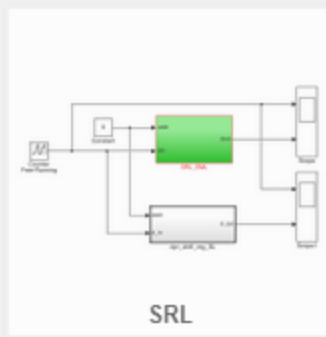
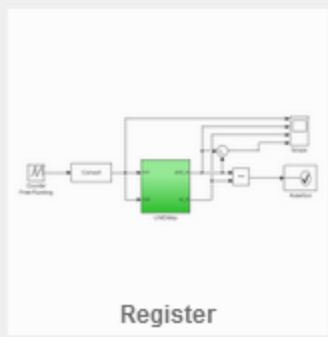
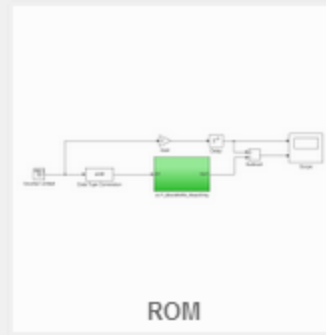
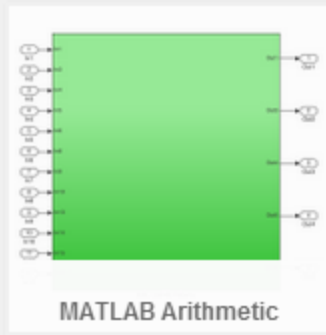
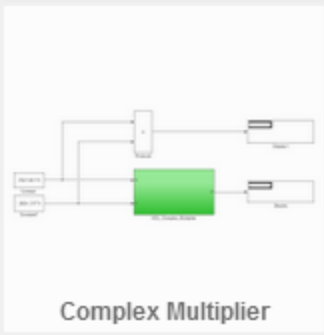
## Model templates for HDL code generation

Model templates are available for you to use when designing a model for HDL code generation. These model templates show design patterns for using Simulink blocks to model hardware and generate efficient HDL code.

For example, the Simulink Template Gallery contains model templates for ROM, state machines, shift registers, and multipliers that map to DSP48s.

To view the HDL Coder model templates, open the Simulink Library Browser, click the New Model button arrow, and select **From Template**. In the Simulink Template Gallery, browse to the HDL Coder folder.

▼ HDL Coder



For more information, see [Simulink Templates For HDL Code Generation](#).

## Enumeration support at DUT ports

You can use enumerated data at the top-level DUT ports for your design, whether the DUT is a MATLAB design function, or a Simulink subsystem or model reference.

## Tunable parameter data type and model reference support enhancements

You can generate a DUT port for tunable parameters that have the following data types:

- Complex
- Vector
- Structure
- Enumeration

You can also generate a DUT port for tunable parameters when your DUT is a model reference.

To learn how to generate code for tunable parameters, see [Generate DUT Ports For Tunable Parameters](#).

## Include custom or legacy code using DocBlock

You can integrate custom or legacy HDL code into your design with a black box subsystem that contains DocBlock.

In the DocBlock HDL Block Properties dialog box, set **Architecture** to HDLText and **TargetLanguage** to your target HDL language. Specify the interface to your custom code by customizing the black box subsystem interface.

For details, see [Integrate Custom HDL Code Using DocBlock](#).

## Coding standard check for X and Z constants

When you enable the **Industry** coding standard, HDL Coder checks for unknown or high-impedance constants in your design. If your design uses these constants, the coder displays a warning.

For VHDL, the coder checks for X, Z, U, W, H, L, and -. For Verilog, the coder checks for X and Z.

---

## Single library for VHDL code generated from model references

You can generate VHDL code for model references in your design into a single library. To generate code into a single library, set the `UseSingleLibrary` property to `on` using `makehdl` or `hdlset_param`.

## Map to multiple RAM banks

You can map an `hdl.RAM System` object in your MATLAB code to multiple RAM banks.

If you specify vector inputs to the `step` method, the `hdl.RAM` maps to RAM banks. The number of RAM banks is the same as the number of elements in each input vector.

## Code generation for bus output from Bus Selector and Constant blocks

You can generate code for:

- Bus Selector with **Output as bus** enabled.
- Constant with **Output data type** set to Bus.

## Timing controller architecture and postfix options in Configuration Parameters dialog box and HDL Workflow Advisor

You can specify the timing controller architecture and timing controller postfix in the Configuration Parameters dialog box and HDL Workflow Advisor, from both Simulink and MATLAB.

You can also specify these timing controller options at the command line.

## Initial condition for Deserializer1D

For the Deserializer1D block, you can specify the **Initial condition**.

## Block support enhancements

Additional Simulink block features are supported for HDL code generation:

- Delay with delay length of 0
- Delay with **Show enable port** enabled
- Dot Product within a delay balancing region

- Model reference block Description field maps to a comment
- Deserializer1D and Serializer1D support enumeration data.

## Coding style improvements

The generated code has the following coding style improvements:

- Stateflow charts for Moore machines generate code that follows the coding style guidelines from Altera and Xilinx. Open the `hdlcoder_fsm_mealy_moore` model to see an example of a Moore chart that generates this style of HDL code.
- Comments for a Simulink block appear with the main body of the associated generated code.
- For Unit Delay Resettable, Unit Delay Enabled Resettable, and Delay with **External reset** set to `Level`, the reset signal is applied within the clocked region for better synthesis results.
- Fewer temporary variables for improved multiplier mapping and readability.
- Expressions of the form  $(a+1) - 1$  are reduced to `a`.
- One-line boolean expressions are generated when they can replace if-else statements.
- Verilog code generated for arrays of constants is more compact. The number of lines of generated code is reduced by 50%.

## Code generation for predefined System objects in MATLAB System block

You can generate code for the following predefined System objects when you use them in a MATLAB System block:

- `hdl.RAM`
- `comm.HDLCRCDetector`
- `comm.HDLCRCGenerator`
- `comm.HDLRSDecoder`
- `comm.HDLRSEncoder`
- `dsp.DCBlocker`
- `dsp.HDLComplexToMagnitudeAngle`
- `dsp.HDLFFT`
- `dsp.HDLIFFT`
- `dsp.HDLNCO`



---

## Partitioning for large multipliers to improve clock frequency and DSP reuse on the FPGA

You can partition large multipliers by specifying a maximum multiplier bit width for your design.

To specify the maximum multiplier bit width, in the HDL Workflow Advisor **Optimization** tab, for **Multiplier partitioning threshold**, enter an integer value greater than or equal to 2. See also `MultiplierPartitioningThreshold`.

## Clock-rate pipelining enhancements

The following clock-rate pipelining enhancements are available:

- MATLAB Function blocks that do not have state can be pipelined at the clock rate.
- DUT output ports can be pipelined at the clock rate. In the Simulink HDL Workflow Advisor **Optimizations** tab, enable the **Allow clock-rate pipelining of DUT output ports** option, or set the `ClockRatePipelineOutputPorts` property to `on`.
- HDL Coder generates a MATLAB script that highlights blocks that are inhibiting clock-rate pipelining. You can run the script by clicking the associated link the optimization report.

## Highlighting for blocks in the model that prevent retiming

With distributed pipelining, HDL Coder generates a MATLAB script that highlights blocks that are inhibiting the optimization, and displays messages for highlighted blocks that describe why the block is inhibiting the optimization. The script highlights blocks in your original model and generated model.

To run the highlighting script, click the associated link in optimization report.

Script generation is on by default. You can disable script generation by setting the `DistributedPipeliningBarriers` property to `off` with `makehdl` or `hdlset_param`.

## Resource sharing for adders and more control over shareable resources

You can now specify the types of blocks or operations to share in the parts of your design that have resource sharing enabled. You can enable or disable resource sharing for adders, multipliers, atomic subsystems, and MATLAB Function blocks.

You can also specify minimum bit widths for shared adders and multipliers.

## **Speed and area optimizations for designs that use Unit Delay Enabled, Unit Delay Resettable, and Unit Delay Enabled Resettable**

You can use speed and area optimizations in designs that contain Unit Delay Enabled, Unit Delay Resettable, and Unit Delay Enabled Resettable blocks. For example, you can use the following optimizations:

- Resource sharing
- Streaming
- Distributed pipelining or retiming
- Input, output, and constrained output pipelining
- Clock-rate pipelining

## **Resource sharing for multipliers and adders with input data types in different order**

You can share multipliers or adders when their input ports have the same data types, but in a different order. For example, you can share the following two multipliers:

- Multiplier A, with `uint8` data on port X and `uint16` data on port Y.
- Multiplier B, with `uint16` data on port X and `uint8` data on port Y.

## **Vector streaming for MATLAB code**

When the loop streaming optimization is enabled in MATLAB code, HDL Coder applies the streaming optimization to vector operations to minimize multiplexer and register usage.

The following types of vector operations benefit from vector streaming:

- Single vector operations.

For example:

```
y = u .* v;
```

- Chained vector operations.

---

For example:

```
t = u .* v;  
y = t + w;
```

- Chained vector operations across a persistent variable.

For example:

```
persistent acc;  
if isempty(acc)  
    acc = uint16(zeros(size(u)));  
end  
  
t = u .* v;  
acc = t + acc;  
y = acc;
```

## Automatic iterative optimization for IP core generation and FPGA Turnkey workflows

After you achieve your clock frequency target using automatic iterative optimization, you can generate a custom IP core or use the FPGA Turnkey workflow with the optimized design.

### Speedgoat IO331-6 digital I/O interface target

When you target the Speedgoat IO331-6 board, in the HDL Workflow Advisor **Target platform interface table**, you can select TTL I/O Channel [0:15] to connect your design interface to digital I/O pins.

### IP core settings saved with model

For the IP core generation workflow, when you specify IP core settings, HDL Coder saves the information with your model. The following HDL Workflow Advisor fields are saved with the model as HDL block properties of the DUT block.

HDL Workflow Advisor field	HDL Block Property
IP core name	IPCoreName
IP core version	IPCoreVersion

HDL Workflow Advisor field	HDL Block Property
Additional source files	IPCoreAdditionalFiles
Processor/FPGA synchronization	ProcessorFPGASynchronization

For the DUT block, you can set and view **IPCoreName**, **IPCoreVersion**, **IPCoreAdditionalFiles**, and **ProcessorFPGASynchronization** with the HDL Block Properties dialog box or `hdlset_param` and `hdlget_param`. To learn more about the block properties, see Atomic Subsystem or Subsystem

For an example that shows how to configure target hardware settings in your model, see Save Target Hardware Settings in Model.

## Support for 'inherit via internal rule' data type setting on FIR Decimation and Interpolation blocks

FIR Decimation and FIR Interpolation blocks now support HDL code generation with data types specified by **Inherit via internal rule**. These blocks are available in DSP System Toolbox.

## Specify filter coefficients using a System object

For Biquad Filter, FIR Decimation, FIR Interpolation, CIC Decimation, and CIC Interpolation blocks, HDL code generation is supported for **Coefficient source** set to **System object**. These blocks and objects are available in DSP System Toolbox.

## Libraries for HDL-supported DSP System Toolbox and Communications System Toolbox blocks

Find blocks that support HDL code generation, in the 'DSP System Toolbox HDL Support' and 'Communications System Toolbox HDL Support' libraries, in the Simulink library browser. Alternately, you can type `dsphdllib` and `commhdllib` at the MATLAB command prompt to open these libraries.

The blocks in `dsphdllib` and `commhdllib` have their parameters set for HDL code generation.

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## **Support for image processing, video, and computer vision designs in new Vision HDL Toolbox product**

Vision HDL Toolbox provides pixel-streaming algorithms for the design and implementation of vision systems on FPGAs and ASICs. It provides a design framework that supports a diverse set of interface types, frame sizes, and frame rates, including high-definition (1080p) video. The image processing, video, and computer vision algorithms in the toolbox use an architecture appropriate for HDL implementations.

The toolbox algorithms are designed to generate readable, synthesizable code in VHDL and Verilog (with HDL Coder). The generated HDL code can process 1080p60 in real time.

Toolbox capabilities are available as MATLAB System objects and Simulink blocks.

See Vision HDL Toolbox

## **Example HDL implementation of LTE OFDM modulator and detector with LTE System Toolbox**

The Verification of HDL Implementation of LTE OFDM Modulator and Detector example uses Simulink blocks that support HDL code generation to implement a hardware-friendly LTE Orthogonal Frequency Division Multiplexing (OFDM) modulator and detector. Running this example requires LTE System Toolbox™.

## **Updates to supported software**

HDL Coder has been tested with:

- Xilinx Vivado Design Suite 2014.2
- Altera Quartus II 14.0

For a list of supported third-party tools and hardware, see Supported Third-Party Tools and Hardware.

## Functionality Being Removed or Changed

Functionality	What Happens When You Use This Functionality	Use This Functionality Instead	Compatibility Considerations
AlteraBlackBox architecture for Subsystem block	The software displays an error.	Create an Altera DSP Builder Subsystem	Replace all instances of <b>AlteraBlackBox</b> with <b>Module</b> , and follow the procedure in Create an Altera DSP Builder Subsystem.
XilinxBlackBox architecture for Subsystem block	The software displays an error.	Create a Xilinx System Generator Subsystem	Replace all instances of <b>XilinxBlackBox</b> with <b>Module</b> , and follow the procedure in Create a Xilinx System Generator Subsystem.
<b>VariablesToPipeline</b> block property or <b>Pipeline variables</b> field	Still runs.	<code>coder.hdl.pipeline</code>	Replace all instances of <b>VariablesToPipeline</b> or <b>Pipeline variables</b> with <code>coder.hdl.pipeline</code> . See “Localized control using pragmas for pipelining, loop streaming, and loop unrolling in MATLAB code” on page 6-3.

# R2014b

**Version: 3.5**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Clock-rate pipelining to optimize timing in multi-cycle paths

In the Simulink to HDL workflow, for speed optimizations that insert pipeline registers, the coder identifies multi-cycle paths in your design and inserts pipeline registers at the clock rate instead of the data rate. When the optimization is in a slow-rate region or multi-cycle path of the design, clock rate pipelining enables the software to perform optimizations without adding extra latency, or by adding minimal latency. It also enables optimizations such as pipelining and floating-point library mapping inside feedback loops.

Clock-rate pipelining is enabled by default. You can disable clock-rate pipelining in one of the following ways:

- In the HDL Workflow Advisor, in the **HDL Code Generation > Set Code Generation Options > Set Advanced Options > Optimization** tab, select **Clock-rate pipelining**.
- At the command line, use `makehdl` or `hdlset_param` to set the `ClockRatePipelining` parameter to `off`.

For details, see [Clock-Rate Pipelining](#).

## Support for Xilinx Vivado

The HDL Coder software is now tested with Xilinx Vivado Design Suite 2013.4. You can:

- Generate a custom IP core for the Zynq-7000 platform and automatically integrate it into a Vivado project for use with IP Integrator.
- Program FPGA hardware supported by Vivado using the HDL Workflow Advisor.
- Perform back-annotation analysis of your design.
- Generate synthesis scripts.

## IP core generation for Altera SoC platform

You can generate a custom IP core with an AXI4 interface for the Altera SoC platform.

HDL Coder can also insert your custom IP core into a predefined Qsys project to target the Altera Cyclone V SoC development kit or Arrow SoCKit development board. The coder can connect the IP core to the ARM processor via the AXI interface within the project.



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The software provides add-on support for Altera SoC hardware via the HDL Coder Support Package for Altera SoC Platform. For more details, see HDL Coder Support Package for Altera SoC Platform.

## **Custom or legacy HDL code integration in the MATLAB to HDL workflow**

You can use a black box System object, `hdl.BlackBox`, to integrate custom HDL code into your design in the MATLAB to HDL workflow. For example, you can integrate handwritten or legacy HDL code that you previously generated from MATLAB code or a Simulink model.

For an example that shows how to use `hdl.BlackBox`, see [Integrate Custom HDL Code Into MATLAB Design](#).

## **Custom HDL code for IP core generation from MATLAB**

You can integrate custom HDL code, such as handwritten or legacy HDL code, into your design in the MATLAB to HDL IP core generation workflow. Use one or more `hdl.BlackBox` System objects in your MATLAB design, and add the HDL source files in the **Additional source files** field.

To learn how to use the **Additional source files** field, Generate a Board-Independent IP Core from MATLAB.

## **Model reference as DUT for code generation**

You can directly generate code for a model reference, without placing it in a Subsystem block. Previously, the code generation DUT had to be a Subsystem block.

## **Code generation for HDL optimized FFT/IFFT System object and HDL optimized Complex to Magnitude-Angle System object and block**

You can generate code for the `dsp.HDLFFT` and `dsp.HDLIFFT` System objects, Complex to Magnitude-Angle HDL Optimized block, and `dsp.ComplexToMagnitudeAngle` System object, which are available in the DSP System Toolbox.

## Added features to HDL optimized FFT/IFFT blocks, including reduced latency

For details of the updates to the FFT HDL Optimized and IFFT HDL Optimized blocks, see the DSP System Toolbox release notes.

### Compatibility Considerations

The FFT HDL Optimized and IFFT HDL Optimized blocks take fewer cycles to compute one frame of output than in previous releases. For instance, for the default 1024-point FFT, the latency in R2014a was 1589 cycles whereas in R2014b the latency is 1148. The latency is displayed on the block icon.

If you have manually matched latency paths in models using the R2014a version of the FFT HDL Optimized and IFFT HDL Optimized block, adjust the delay on those paths to accommodate the lower FFT latency.

### Tunable parameter support for Gain and Constant blocks

The coder generates a top-level DUT port for each tunable parameter in your DUT that you use as the **Gain** parameter in a Gain block, or the **Constant value** parameter in a Constant block.

For details, see [Generate Code For Tunable Parameters](#).

### Code generation for Stateflow active state output

If you enable active state output to show child activity or leaf state activity for a Stateflow block, the coder generates code for the active state output. See [Active State Output](#).

### Coding standards customization

If you enable HDL coding standard rule checking, you can enable or disable specific rules. You can specify rule parameters. For example, you can specify the maximum nesting depth for if-else statements. See [HDL Coding Standard Customization](#).

### HDL Designer script generation

You can now generate a lint tool script for Mentor Graphics® HDL Designer.

---

To learn about HDL lint script generation for your Simulink design, see [Generate an HDL Lint Tool Script](#).

To learn about HDL lint script generation for your MATLAB design, see [Generate an HDL Lint Tool Script](#).

## Clock enable minimization for code generated from MATLAB designs

You can minimize clock enable logic in your generated code by setting the `MinimizeClockEnables` property of the `coder.HdlConfig` object to `true`, or by enabling the **Minimize clock enables** option in the HDL Workflow Advisor.

For details, see [Minimize Clock Enables](#).

## HDL Block Properties dialog box shows only valid architectures

For each block supported for code generation, the HDL Block Properties dialog box **Architecture** drop-down list shows only the architectures that are valid for the block based on mask parameter settings. Previously, all architectures were available for selection regardless of mask parameter settings, and invalid settings caused errors during code generation.

## HDL Reciprocal block with Newton-Raphson Implementation

The HDL Reciprocal block is available with Simulink. Use this block to implement division operations in models intended for HDL code generation. HDL Reciprocal has two Newton-Raphson HDL implementations, `ReciprocalNewton` and `ReciprocalNewtonSingleRate`. The new implementations use fewer hardware resources and can achieve higher clock frequency than `Divide` or `Math Function` HDL block implementations.

For the `Divide` and `Math Function` blocks, the names of the Newton-Raphson HDL block implementations have changed:

- `RecipNewton` is now `ReciprocalRsqrBasedNewton`.
- `RecipNewtonSingleRate` is now `ReciprocalRsqrBasedNewtonSingleRate`.

If you open a model from a previous release, HDL Coder automatically maps the `RecipNewton` and `RecipNewtonSingleRate` implementation names to

`ReciprocalRsqrBasedNewton` and `ReciprocalRsqrBasedNewtonSingleRate`, respectively.

To learn about the HDL Reciprocal block, see HDL Reciprocal.

To learn about the `ReciprocalNewton` and `ReciprocalNewtonSingleRate` implementations, see HDL Reciprocal.

## Serializer1D and Deserializer1D blocks

The following new blocks are available from the HDL Operations library for simulation and code generation:

- `Serializer1D`
- `Deserializer1D`

## Additional blocks supported for code generation

The following blocks are now supported for code generation:

- Backlash
- Bus assignment
- Coulomb and Viscous Friction
- DC Blocker
- Dead Zone/Dead Zone Dynamic
- Discrete PID Controller
- Hit Crossing
- HDL Reciprocal
- `Serializer1D/Deserializer1D`
- Wrap to Zero

## Traceable names for RAM blocks and port signals

When you generate code for a RAM block from the HDL Operations library, the name in the generated code reflects the name in the model. Similarly, port signal names in the generated code are inherited from your model.

---

For each RAM block of a particular size, the coder generates an HDL module. The module file name reflects the name and size of the RAM block or persistent variable in your design.

For example, suppose `DPRAM_foo` is the name of a Dual Port RAM block in your model. The generated code for the instance is:

```
u_DPRAM_foo : DualPortRAM_Wrapper_256x8b
```

The RAM module name and wrapper name also match the name of the Simulink block:

```
DualPortRAM_256x8b.vhd  
DualPortRAM_Wrapper_256x8b.vhd
```

## **for-generate statements in generated VHDL code**

When you generate VHDL code for block architectures that use replicated structures, the coder generates `for-generate` statements for better readability. For example, VHDL code generated for the Add and Product blocks uses `for-generate` statements.

## **Composite user-defined System object support**

You can generate code for user-defined System objects that contain child user-defined System objects.

## **System object output and update method support**

You can generate code for the output and update methods in user-defined System objects that inherit from the `matlab.system.mixin.Nondirect` class.

## **RAM mapping for user-defined System object private properties**

Private properties in user-defined System objects can map to RAM. For details, see [Implement RAM Using a Persistent Array or System object Properties](#).

## **hdlram renamed to hdl.RAM**

The `hdlram` System object has been renamed to `hdl.RAM` and is now available with MATLAB. Previously, `hdlram` required a Fixed-Point Designer license.

## Compatibility Considerations

If you open a design that uses `hdlram`, the software displays a warning. For continued compatibility with future releases, replace instances of `hdlram` with `hdl.RAM`.

## Target platform interface mapping information saved with model

For the IP core generation workflow, FPGA turnkey workflow, or Simulink Real-Time FPGA I/O workflow, when you map each of your DUT top-level ports to a platform interface, HDL Coder saves the interface mapping information as port properties in your model. The coder also saves workflow and target platform information with the model.

For DUT Inport and Outport blocks, you can set and view **IOInterface** and **IOInterfaceMapping** with the HDL Block Properties dialog box or `hdlset_param` and `hdlget_param`.

For an example that shows how to configure target platform interface settings, see <http://www.mathworks.com/help/releases/R2014b/hdlcoder/examples/save-target-hardware-settings-in-model.html>.

## Highlighting for feedback loops that inhibit optimizations

You can generate a MATLAB script that highlights feedback loops that may inhibit delay balancing or speed and area optimizations. The script highlights feedback loops in your original model and generated model.

You can also save the highlighting information in a MATLAB script.

For details, see Find Feedback Loops.

## Optimizations available for conditional-execution subsystems

The following optimizations are now supported for enabled subsystems and triggered subsystems:

- Resource sharing
- Streaming
- Constrained overclocking
- Floating-point library mapping

- 
- Hierarchy flattening
  - Delay balancing
  - Automatic iterative optimization

## Variable pipelining in conditional MATLAB code

HDL code generation now supports variable pipelining inside conditional MATLAB code for the MATLAB to HDL workflow and the MATLAB Function block in the Simulink to HDL workflow.

## 2-D matrix types in HDL generated for MATLAB matrices

When you have matrices in your MATLAB code, you can generate 2-D matrices in HDL code. By default, the software generates HDL vectors with additional index computation logic, which can use more area in the synthesized hardware than HDL matrices.

To generate 2-D matrix types in HDL in the MATLAB to HDL workflow:

- In the HDL Workflow Advisor, in the **HDL Code Generation > Coding Style** tab, select **Use matrix types in HDL code**.
- At the command line, set the `UseMatrixTypesInHDL` property of the `coder.HdlConfig` object to `true`.

Previously, 2-D matrix types could be generated in HDL for the Simulink MATLAB Function block, but not in the MATLAB to HDL workflow.

## Optimizations available with `UseMatrixTypesInHDL` for MATLAB Function block

When you enable 2-D matrix types in the generated HDL code, for the MATLAB to HDL workflow and Simulink to HDL workflow, speed and area optimizations are available. Previously, for the MATLAB Function block, the `UseMatrixTypesInHDL` parameter was incompatible with speed and area optimizations.

## Validation model generation regardless of delay balancing results

When you enable the **Generate validation model** option, HDL Coder generates the validation model even if delay balancing is unsuccessful. In previous releases, if delay balancing was unsuccessful, the coder did not generate the validation model.

## Documentation installation with hardware support package

Starting in R2014b, each hardware support package that you install comes with its own documentation. For a list of support packages available for HDL Coder, with links to documentation, see [HDL Coder Supported Hardware](#).

## Functionality Being Removed or Changed

Functionality	What Happens When You Use This Functionality	Use This Functionality Instead	Compatibility Considerations
HDL Streaming FFT	Still runs. The block is forwarded from <code>hdlldemolib</code> to <code>dsp.obsolete</code> .	FFT HDL Optimized block, which is available in the DSP System Toolbox.	This block will be removed in a future release.
HDL FFT	Still runs. This block is renamed “HDL Minimum Resource FFT”. It is forwarded from <code>hdlldemolib</code> to <code>dsp.obsolete</code> .	FFT HDL Optimized block, which is available in the DSP System Toolbox.	This block will be removed in a future release.



# R2014a

**Version: 3.4**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## **Code generation for enumeration data types**

You can generate code for Simulink, MATLAB, or Stateflow enumerations within your design. In the current release, you cannot generate code if your design uses enumerations at the top-level DUT ports.

To learn more about code generation support for enumerations in Simulink designs, see [Enumerations](#).

To learn more about code generation support for enumerations in MATLAB designs, see [Data Types and Scope](#).

## **ZC706 target for IP core generation and integration into Xilinx EDK project**

You can target the Xilinx Zynq-7000 AP ZC706 Evaluation Board for IP core generation and Xilinx EDK project integration. After you install the HDL Coder Support Package for Xilinx Zynq-7000 Platform, ZC706 hardware support is available.

## **Automatic iterative clock frequency optimization**

You can use the `hdlcoder.optimizeDesign` function to achieve either your target clock frequency or a maximum clock frequency. Based on your clock frequency goal and target device, the software iteratively generates and synthesizes code, retrieves back annotation data, and inserts delays into your Simulink model to break the critical path.

To learn more, see [Automatic Iterative Optimization](#).

## **Code generation for FFT HDL Optimized and IFFT HDL Optimized blocks**

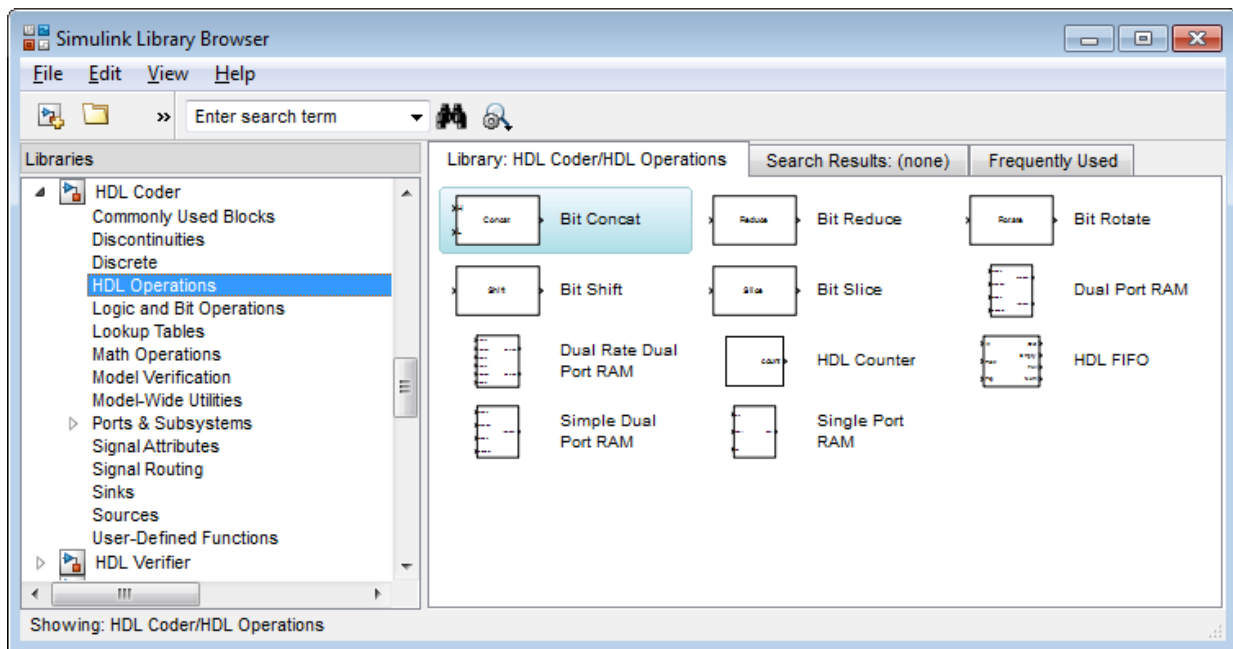
You can generate code for the FFT HDL Optimized and IFFT HDL Optimized blocks, which are available in the DSP System Toolbox.

## **HDL block library in Simulink**

The HDL Coder library, which contains blocks supported for HDL code generation, is available in Simulink. When you create a model using the HDL Coder library, the blocks are preconfigured with settings suitable for code generation.

The HDL Operations library, previously called `hdldemo.lib`, is available in Simulink as part of the HDL Coder library. Previously, the HDL Operations blocks were available only with an HDL Coder license.

To view the HDL Operations block library from the Simulink Library Browser, open the **HDL Coder** folder and select **HDL Operations**.



## Bus support improvements

You can generate code for designs that contain:

- DUT ports connected to buses.
- Buses that are not defined with a bus object.
- Nonvirtual buses.

To learn more, see [Buses](#).

## Variant Subsystem support for configurable models

You can generate code for designs containing Variant Subsystem blocks. Using Variant Subsystem blocks enables you to explore and generate code for different component implementations and design configurations.

## Trigger signal can clock triggered subsystems

You can generate code that uses the trigger signals in Triggered Subsystem blocks as clocks. Using triggers as clocks enables you to partition your design into different clock regions in the generated code, but can cause a timing mismatch during testbench simulation.

For details, see [Use Trigger As Clock in Triggered Subsystems](#).

## 2-D matrix types in code generated for MATLAB Function block

You can now generate 2-D matrices in HDL code when you have MATLAB matrices in a MATLAB Function block. By default, the software generates HDL vectors with additional index computation logic, which can use more area in the synthesized hardware than HDL matrices.

For details, see [UseMatrixTypesInHDL](#).

## 64-bit data support

You can generate code for `uint64` and `int64` data types in MATLAB code, both in the MATLAB-to-HDL workflow and for the MATLAB Function block in the Simulink-to-HDL workflow.

MATLAB Function block ports must use `sfix64` or `ufix64` types for 64-bit data, because `uint64` and `int64` are not yet supported in Simulink.

## HDL code generation from MATLAB System block

The MATLAB System block, which you use to include System objects in Simulink models, now supports HDL code generation.

For details, see [MATLAB System](#).

---

## System object methods in conditional code

HDL code generation now supports System object `step` method calls inside conditional code regions.

## Persistent keyword not needed in HDL code generation

If your MATLAB code includes a System object that does not have states, you do not need to include the `persistent` keyword for HDL code generation.

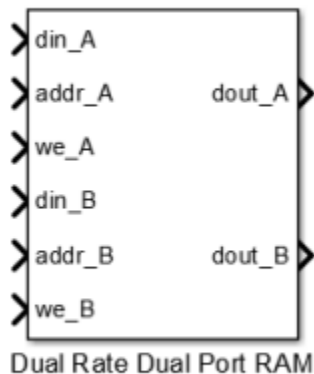
For details, see [Limitations of HDL Code Generation for System Objects](#).

## Dual Rate Dual Port RAM block

A new block, Dual Rate Dual Port RAM, is available for simulation and code generation.

The Dual Rate Dual RAM supports two simultaneous read or write accesses at two Simulink rates. When you generate code, the Dual Rate Dual Port RAM block infers a dual-clock dual-port RAM in most FPGAs.

To view the block, open the HDL Operations block library.



For more information about the block, see [Dual Rate Dual Port RAM](#). For HDL code generation details, see [Dual Rate Dual Port RAM](#).

## Negative edge clocking

You can clock your design on the falling edge of the clock.

To generate code that clocks your design on the negative edge of the clock, in the Configuration Parameters dialog box, for **HDL Code Generation > Global Settings > Clock Edge**, select **Falling edge**.

Alternatively, at the command line, set the `ClockEdge` property to 'Falling' using `makehdl` or `hdlset_param`.

For details, see `ClockEdge`.

## Bidirectional port specification

You can specify bidirectional ports for Subsystem blocks that have Architecture set to `BlackBox`. In the FPGA Turnkey workflow, you can use the bidirectional ports to connect to external RAM.

In the generated code, the ports have the Verilog or VHDL `inout` keyword. However, Simulink does not support bidirectional ports, so you cannot simulate the bidirectional behavior in Simulink.

To learn more, see `Specify Bidirectional Ports`.

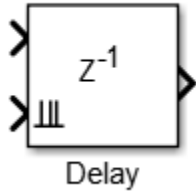
## Port names in generated code match signal names

You can use the **Icon display** block parameter on Inport and Outport blocks to make your code more readable. When you set the **Icon display** parameter to **Signal name**, **Port number**, or **Port number and signal name**, the port names in the generated code match the display names of the connected signals.

## Additional blocks and block implementations supported for code generation

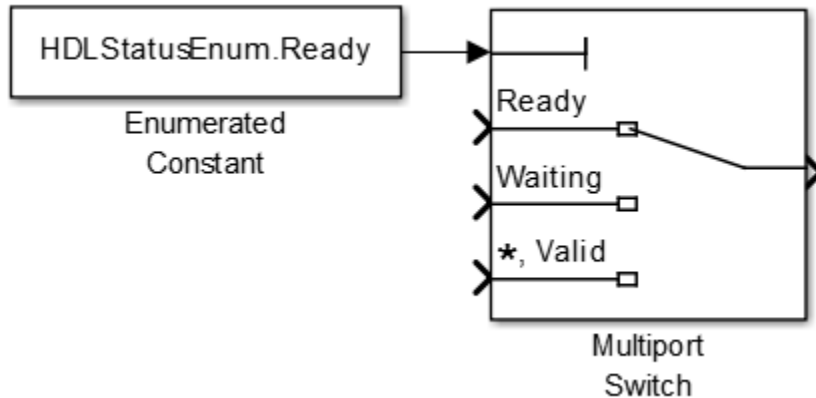
The following blocks and block implementations are now supported for code generation:

- Sine, Cosine
- Enumerated Constant
- Delay with **External reset** set to `Level`.



- Multiport Switch with enumerated type at control input.

You can set **Data port order** to **Specify indices**, and enter enumeration values for the **Data port indices**. For example, you can connect the Enumerated Constant block to the Multiport Switch control port and use the enumerated types as data port indices.



The HDL FIFO block no longer requires a DSP System Toolbox license. The HDL FIFO block is available in the HDL Operations library.

## Errors instead of warnings for blocks not supported for code generation

If your design contains blocks or block architectures that are not supported for HDL code generation, the software shows an error and does not generate code. Previously, the

software showed a warning, but still generated code, with black box interfaces for the unsupported blocks or block architectures.

## Compatibility Considerations

If you want to generate code for models containing unsupported blocks or block architectures, you must **Comment out** the unsupported blocks in Simulink.

## ModelReference default architecture for Model block

The Model block default architecture is `ModelReference`. Previously, the default architecture was `BlackBox`.

## Compatibility Considerations

When you open a model created in a previous release, a Model block in that design changes architecture from `BlackBox` to `ModelReference` if all the HDL block properties are set to default settings.

To keep the `BlackBox` architecture for Model blocks, use one of the following workarounds:

- Open the model using the current release, specify the `BlackBox` architecture for the affected Model blocks, and save the model.
- Open the model using a previous release, specify a nondefault setting for each Model block, and save the model.

## Reset port optimization

The coder does not generate a top-level reset port when the code generation subsystem does not contain resettable delays or blocks.

To generate code without a top-level reset port:

- Set the `ResetType` HDL block parameter to `none` for all blocks in the DUT with the `ResetType` parameter.
- For MATLAB Function blocks in your DUT, do not enable block level HDL optimizations, which insert resettable registers.



---

For details, see `ResetType`.

## Reset for timing controller

You can generate a reset port for the timing controller, which generates the clock, clock enable, and reset signals in a multirate DUT.

To generate a reset port for the timing controller, set the `TimingControllerArch` property to `resettable` using `makehdl` or `hdlset_param`.

To learn more, see [Generate Reset for Timing Controller](#).

## Synthesis attributes for multipliers

You can now generate code that includes synthesis attributes to specify multipliers in your design that you want to map to DSPs or logic in hardware. If you specify resource sharing, the software does not share multipliers that have different synthesis attribute settings.

For Xilinx targets, the generated code uses the `use_dsp48` attribute. For Altera targets, the generated code uses the `multstyle` attribute.

For details, see `DSPStyle`.

## Ascent Lint script generation

You can now generate a lint tool script for Real Intent Ascent Lint.

To learn about HDL lint script generation for your Simulink design, see [Generate an HDL Lint Tool Script](#).

To learn about HDL lint script generation for your MATLAB design, see [Generate an HDL Lint Tool Script](#).

## RAM mapping scheduler improvements

The RAM mapping scheduling algorithm now minimizes overclocking when your MATLAB code maps to multiple RAMs. In addition, multiple persistent variables with cyclic read-write dependencies can now map to RAM.

## Incremental code generation and synthesis

In the Simulink-to-HDL workflow, and hardware-software codesign workflow, HDL Coder does not rerun code generation or synthesis tasks unless you have changed your model or other hardware-related project settings. You can save time when you want to regenerate HDL code or FPGA programming files without changing your model, code generation options, or hardware target.

Similarly, in the hardware and software codesign workflow, when you modify the embedded software part of your design without changing the hardware part, HDL Coder does not rerun HDL code generation or synthesis tasks.

When the coder skips code generation or synthesis tasks, the HDL Workflow Advisor shows a message. The message contains a link you can click to force the coder to rerun the task.

## Custom HDL code for IP core generation

You can integrate custom HDL code into your design in the Simulink-to-HDL IP core generation workflow. You can integrate handwritten or legacy HDL code into an IP core that you generate from a Simulink model.

To include custom HDL code in your IP core design, use one or more Model or Subsystem blocks with Architecture set to **BlackBox**. Use the **Additional source files** field in the HDL Workflow Advisor to specify corresponding HDL file names.

For details of the IP core generation workflow, see [Generate a Custom IP Core from Simulink](#).

## Performance-prioritized retiming

When you enable distributed pipelining, you can specify a priority for **Distributed pipelining priority**: **Numerical integrity**, or **Performance**. In the previous release, the distributed pipelining algorithm prioritized numerical integrity.

For details, see [DistributedPipeliningPriority](#).

---

## Retiming without moving user-created design delays

You can use the **Preserve design delays** option to prevent distributed pipelining from moving design delays in your Simulink or MATLAB design. If you specify **Preserve design delays**, distributed pipelining does not move the following design delays:

- Persistent variable in MATLAB code, a MATLAB Function block, or a Stateflow Chart
- Unit Delay block
- Integer Delay block
- Memory block
- Delay block from DSP System Toolbox
- `dsp.Delay System` object from DSP System Toolbox

For details, see `PreserveDesignDelays`.

## Resource sharing factor can be greater than number of shareable resources

With the resource sharing area optimization, the software shares the maximum number of shareable resources within your overclocking constraints, even if the sharing factor that you specify is not an integer divisor of the number of shareable resources. This capability can increase resource sharing, and therefore reduce area.

For example, if your subsystem has 11 multipliers, and you set **SharingFactor** to 4, the coder can implement your design with 3 multipliers: 2 multipliers shared 4 ways, and 1 multiplier shared 3 ways. In the previous release, the coder implemented the design with 5 multipliers: 2 multipliers shared 4 ways, and 3 unshared multipliers. The resulting implementation requires overclocking by a factor of 4.

To learn more, see `Resource Sharing For Area Optimization`.

## Reduced area with multirate delay balancing

When the coder balances delays in a multirate model, it now inserts a single delay at the transition from a much faster rate to a slow rate, and passes through the data samples aligned with the slow rate. Previously, the coder inserted a large number of delays at the faster rate.

## Serializer-deserializer and multiplexer-demultiplexer optimization

The coder removes back-to-back serializer-deserializer and multiplexer-demultiplexer pairs introduced by the implementation of optimizations such as resource sharing and streaming. This results in more area-efficient HDL code.

## Synthesis and simulation tool addition and detection after opening HDL Workflow Advisor

In the Simulink-to-HDL workflow, you can set up and add a synthesis tool without having to close and reopen the HDL Workflow Advisor. In the HDL Workflow Advisor, in the **Set Target > Set Target Device and Synthesis Tool** task, click **Refresh** to detect and add the new tool.

You can also set up and add a simulation tool after creating a MATLAB-to-HDL project without having to close and reopen the project. In the HDL Workflow Advisor, in the **HDL Verification > Verify with HDL Test Bench** task, click **Refresh list** to detect and add the new tool.

## Automatic C compiler setup

In earlier releases, to set up a compiler to accelerate test bench simulation for MATLAB algorithms, you were required to run `mex -setup`. Now, the code generation software automatically locates and uses a supported installed compiler. You can use `mex -setup` to change the default compiler. See [Changing Default Compiler](#).

## xPC Target is Simulink Real-Time

The **xPC Target FPGA I/O** workflow is now called the **Simulink Real-Time FPGA I/O** workflow. This change reflects the xPC Target™ product name change to Simulink Real-Time. For details about the product name change, see [New product that combines the functionality of xPC Target and xPC Target Embedded Option](#).

## Updates to supported software

HDL Coder has been tested with:

- Xilinx ISE 14.6

- Altera Quartus II 13.0 SP1

For a list of supported third-party tools and hardware, see Supported Third-Party Tools and Hardware.

## Functionality Being Removed or Changed

You cannot save a model that uses an attached control file to apply HDL model or block parameters.

Since the R2010a release, if you open a model that uses a control file, the software shows a warning, and updates the model by applying the HDL parameters to your model and removing the control file. For continued compatibility with future releases, save the updated model.

Functionality	What Happens When You Use This Functionality	Use This Instead	Compatibility Considerations
hdlapplycontrolfile	Still runs	hdlset_param, hdlget_param	Do not use control files for model or block configuration. Instead, use hdlset_param and hdlget_param to configure your model.
hdlnewblackbox	Still runs	hdlset_param, hdlget_param	Do not use control files for model or block configuration. Instead, use hdlset_param and hdlget_param to configure your model.
hdlnewcontrol	Still runs	hdlset_param, hdlget_param	Do not use control files for model or block configuration. Instead, use hdlset_param and

<b>Functionality</b>	<b>What Happens When You Use This Functionality</b>	<b>Use This Instead</b>	<b>Compatibility Considerations</b>
			hdlget_param to configure your model.
hdlnewcontrolfile	Still runs	hdlset_param, hdlget_param	Do not use control files for model or block configuration. Instead, use hdlset_param and hdlget_param to configure your model.
hdlnewforeach	Still runs	hdlset_param, hdlget_param	Do not use control files for model or block configuration. Instead, use hdlset_param and hdlget_param to configure your model.

# R2013b

**Version: 3.3**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Model reference support and incremental code generation

You can generate HDL code from referenced models using the Model block. To use a referenced model in a subsystem intended for code generation, in the HDL Block Properties dialog box, set **Architecture** to **ModelReference**.

The coder incrementally generates code for referenced models according to the **Configuration Parameters dialog box > Model Referencing pane > Rebuild** options. However, the coder treats **If any changes detected** and **If any changes in known dependencies detected** as the same. For example, if you set **Rebuild** to either **If any changes detected** or **If any changes in known dependencies detected**, the coder regenerates code for referenced models only when the referenced models have changed.

To learn more, see Model Referencing for HDL Code Generation.

## Code generation for user-defined System objects

You can now generate HDL code from user-defined System objects written in MATLAB. System objects enable you to create reusable HDL IP.

The `step` method specifies the HDL implementation behavior. It is the only System object method supported for HDL code generation.

User-defined System objects are not supported for automatic fixed-point conversion.

To learn how to define a custom System object, see Generate Code for User-Defined System Objects.

## RAM inference in conditional MATLAB code

The coder now infers RAM from persistent array variables accessed within conditional statements, such as if-else or switch-case statements, for both MATLAB designs and MATLAB Function blocks in Simulink.

If you have nested conditional statements, the persistent array variables can map to RAM if accessed in the topmost conditional statement, but cannot map to RAM if accessed in a lower level nested conditional statement.



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## **Code generation for subsystems containing Altera DSP Builder blocks**

You can now generate HDL code for subsystems that include blocks from the Altera DSP Builder Advanced Blockset.

For details, see [Create an Altera DSP Builder Subsystem](#).

To see an example that shows HDL code generation for an Altera DSP Builder subsystem, see [Using Altera DSP Builder Advanced Blockset with HDL Coder](#).

## **IP core integration into Xilinx EDK project for ZC702 and ZedBoard**

When you generate an IP core from your MATLAB design or Simulink model, HDL Coder can automatically insert the IP core into a predefined Xilinx ZC702 or ZedBoard™ EDK project for the Zynq-7000 platform. The coder automatically connects the IP core to the AXI interface and ARM processor in the EDK project.

For an overview of the hardware and software codesign workflow, see [Hardware and Software Codesign Workflow](#).

For an example that shows how to deploy your MATLAB design in hardware and software on the Zynq-7000 platform, see [Getting Started with HW/SW Co-design Workflow for Xilinx Zynq Platform](#).

For an example that shows how to deploy your Simulink model in hardware and software on the Zynq-7000 platform, see [Getting Started with HW/SW Co-design Workflow for Xilinx Zynq Platform](#).

## **FPGA Turnkey and IP Core generation in MATLAB to HDL workflow**

You can now generate a custom IP core with an AXI4-Lite or AXI4-Stream Video interface from a MATLAB design. You can integrate the generated IP core into a larger design in your Xilinx EDK project.

You can also automatically program an Altera or Xilinx FPGA development board with code generated from your MATLAB design, using the HDL Workflow Advisor FPGA Turnkey workflow. To learn how to use this workflow, see [Program Standalone FPGA with FPGA Turnkey Workflow and mlhdlc\\_tutorial\\_turnkey\\_led\\_blinking](#).

Previously, IP core generation and FPGA Turnkey were available only for the Simulink to HDL workflow.

## Module or entity generation for local functions in MATLAB Function block

You can now generate instantiable Verilog modules or VHDL entities when you generate code for local functions in a MATLAB Function block, or for functions on your path that are called from within a MATLAB Function block.

To enable this feature, in the HDL Block Properties dialog box, set **InstantiateFunctions** to **on**. For details, see `InstantiateFunctions`.

## Bus signal inputs and outputs for MATLAB Function block and Stateflow charts

MATLAB Function blocks and Stateflow charts with bus signal inputs or outputs are now supported for code generation. The bus must be defined with a bus object.

## Coding style for improved ROM mapping

The coder now automatically inserts a no-reset register at the output of a constant matrix access. Many synthesis tools infer a ROM from this code pattern. For details, see `Map Matrices to ROM`.

## Reset port optimization

The coder no longer generates a top level reset port when the `ResetType` HDL block parameter is set to `none` for all RAM blocks in the DUT.

In previous releases, the generated code included a reset port even when the RAM reset logic was suppressed.

## Pipeline registers between adder or multiplier and rounding or saturation logic

The coder now places a pipeline register between an adder or multiplier and associated rounding or saturation logic when distributing pipelining registers. This register placement can significantly improve clock frequency.

## Coding style improvements according to industry standard guidelines

The coder now follows these industry standard coding style guidelines when generating HDL code:

- 
- Division by a power of 2 becomes a bit shift operation.
  - Constants with double data types in the original design are automatically converted to their canonical fixed-point types as long as there is no loss of precision.
  - SystemVerilog keywords are treated as reserved words.
  - Intermediate signals and latches are reduced when **HDLCodingStandard** is set to **Industry**.
  - Real data types generate warnings, except when you target an FPGA floating-point library.

## **Coding standard report target language enhancement and text file format**

HDL Coder now generates the coding standard report according to target language. Coding standard errors, warnings, and messages that do not pertain to your target language no longer appear in the report.

The coding standard report is generated in text file format, in addition to HTML format, to enable easier comparison between multiple runs.

## **Load constants from MAT-files**

HDL Coder now generates code for the `coder.load` function, which you can use to load compile-time constants from a MAT-file. You no longer have to manually type in constants that were stored in a MAT-file.

To learn how to use `coder.load` for HDL code generation, see [Load constants from a MAT-File](#).

## **UI for SpyGlass, Leda, and custom lint tool script generation**

You can now use the UI to generate Atrenta SpyGlass, Synopsys® Leda, or custom lint scripts in the Simulink-to-HDL and MATLAB-to-HDL workflows.

To learn about HDL lint script generation for your Simulink design, see [Generate an HDL Lint Tool Script](#).

To learn about HDL lint script generation for your MATLAB design, see [Generate an HDL Lint Tool Script](#).

## **Synthesis tool addition and detection after MATLAB-to-HDL project creation**

You can now set up and add a synthesis tool after creating a MATLAB-to-HDL project without having to close and reopen the project. In the HDL Workflow Advisor, in the **Set Code Generation Target** task, click **Refresh list** to detect and add the new tool. For details, see [Add Synthesis Tool for Current MATLAB Session](#).

## **Synthesis script generation for Microsemi Libero and other synthesis tools**

You can now generate a Microsemi Libero or custom synthesis tool script during Simulink-to-HDL and MATLAB-to-HDL code generation.

In the MATLAB-to-HDL workflow, you can now generate synthesis tool scripts customized for Xilinx ISE, Microsemi Libero, Mentor Graphics Precision, Altera Quartus II, and Synopsys Synplify Pro<sup>®</sup>. The coder populates the scripts with default options, but you can further customize the scripts as needed. In previous releases, you had to enter the synthesis tool commands manually. For details, see [Generate Synthesis Scripts](#).

## **File I/O to read test bench data in VHDL and Verilog**

You can now specify the generated VHDL or Verilog test bench to use file I/O to read input stimulus and output response data during simulation, instead of including data constants in the test bench code. Doing so improves scalability for designs requiring long simulations and large test vectors.

This feature is available for Simulink-to-HDL and MATLAB-to-HDL code generation.

To learn about test bench generation with file I/O in the Simulink-to-HDL workflow, see [Generate Test Bench With File I/O](#).

To learn about test bench generation with file I/O in the MATLAB-to-HDL workflow, see [Generate Test Bench With File I/O](#).

## **Floating-point library mapping for mixed floating-point and fixed-point designs**

When you enable FPGA target-specific floating-point library mapping, you can now generate code from a design containing both floating-point and fixed-point components.

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The coder determines whether to map to a floating-point IP block based on the data types in your model.

## **xPC Target FPGA I/O workflow separate from FPGA Turnkey workflow**

The HDL Workflow Advisor target workflow that programs Speedgoat boards to run with xPC Target is now called the **xPC Target FPGA I/O** workflow. This workflow is separate from the FPGA Turnkey workflow for Altera and Xilinx FPGA boards.

For an example that shows how to use the xPC Target FPGA I/O workflow, see [Generate Simulink Real-Time Interface for Speedgoat Boards](#).

## **AXM-A75 AD/DA module for Speedgoat IO331 FPGA board**

The AXM-A75 AD/DA module for Speedgoat IO331 FPGA board is now available as a hardware target for the **xPC Target FPGA I/O** workflow.

## **Speedgoat IO321 and IO321-5 target hardware support**

The xPC Target FPGA I/O workflow now supports the Speedgoat IO321 board and its variant, Speedgoat IO321-5, as separate hardware targets. Previously, the name of the IO321-5 board was IO325.

To learn more about the IO321 and IO321-5 boards, see [Speedgoat IO321](#).

## **Distributed pipelining improvements with loop unrolling in MATLAB Function block**

When you enable distributed pipelining for a MATLAB Function block without persistent variables, set the **Loop Optimization** option to **Unrolling** for better timing results.

## **HDL Counter has specifiable start value**

You can now specify a start value for the HDL Counter block. When the counter initializes or wraps around, it counts from the specified start value.

## Maximum 32-bit address for RAM

For the Single Port RAM block, Simple Dual Port RAM block, Dual Port RAM block, and `hdlram` System object, the maximum address width is now 32 bits. For more information, see:

- `hdlram`
- RAM Blocks

## Removing HDL Support for NCO Block

HDL support for the NCO block will be removed in a future release. Use the NCO HDL Optimized block instead.

## Compatibility Considerations

In the current release, if you generate HDL code for the NCO block, a warning message appears. In a future release, any attempt to generate HDL code for the NCO block will cause an error.

## Fixed-point file name change

The suffix for generated fixed-point files is now `_fixpt`. Previously, the suffix was `_FixPt`.

## Compatibility Considerations

If you have MATLAB-to-HDL projects from previous releases that depend on the generated fixed-point file name, you can use the `FixPtFileNameSuffix` property to set the suffix to `_FixPt`.

## Support package for Xilinx Zynq-7000 platform

Generate a custom IP core for the ZC702 or ZedBoard on the Xilinx Zynq-7000 platform using the IP core generation workflow.

To install this support package for MATLAB-to-HDL code generation:

- 1 In the HDL Workflow Advisor, in the **Select Code Generation Target** task, set **Workflow** to **IP Core Generation**.

- 
- 2 For **Platform**, select **Get more**.
  - 3 Use Support Package Installer to install the HDL Coder Support Package for Xilinx Zynq-7000 Platform.

To install this support package for Simulink-to-HDL code generation:

- 1 In the HDL Workflow Advisor, in the **Set Target > Set Target Device and Synthesis Tool** task, set **Target workflow** to **IP Core Generation**.
- 2 For **Target platform**, select **Get more**.
- 3 Use Support Package Installer to install the HDL Coder Support Package for Xilinx Zynq-7000 Platform.

## Support package for Altera FPGA boards

Program Altera FPGA boards with your generated HDL code using the FPGA Turnkey workflow.

To install this support package for MATLAB-to-HDL code generation:

- 1 In the HDL Workflow Advisor, in the **Select Code Generation Target** task, set **Workflow** to **FPGA Turnkey**.
- 2 For **Platform**, select **Get more boards**.
- 3 Use Support Package Installer to install the HDL Coder Support Package for Altera FPGA Boards.

To install this support package for Simulink-to-HDL code generation:

- 1 In the HDL Workflow Advisor, in the **Set Target > Set Target Device and Synthesis Tool** task, set **Target workflow** to **FPGA Turnkey**.
- 2 For **Target platform**, select **Get more boards**.
- 3 Use Support Package Installer to install the HDL Coder Support Package for Altera FPGA Boards.

## Compatibility Considerations

Previous versions of HDL Coder had built-in support for Altera FPGA boards in the FPGA Turnkey workflow. The current version of HDL Coder does not have built-in support for Altera FPGA boards. To get support for Altera FPGA boards, install the HDL Coder Support Package for Altera FPGA Boards.

## Support package for Xilinx FPGA boards

Program Xilinx FPGA boards with your generated HDL code using the FPGA Turnkey workflow.

To install this support package for MATLAB-to-HDL code generation:

- 1 In the HDL Workflow Advisor, in the **Select Code Generation Target** task, set **Workflow** to **FPGA Turnkey**.
- 2 For **Platform**, select **Get more boards**.
- 3 Use Support Package Installer to install the HDL Coder Support Package for Xilinx FPGA Boards.

To install this support package for Simulink-to-HDL code generation:

- 1 In the HDL Workflow Advisor, in the **Set Target > Set Target Device and Synthesis Tool** task, set **Target workflow** to **FPGA Turnkey**.
- 2 For **Target platform**, select **Get more boards**.
- 3 Use Support Package Installer to install the HDL Coder Support Package for Xilinx FPGA Boards.

## Compatibility Considerations

Previous versions of HDL Coder had built-in support for Xilinx FPGA boards in the FPGA Turnkey workflow. The current version of HDL Coder does not have built-in support for Xilinx FPGA boards. To get support for Xilinx FPGA boards, install the HDL Coder Support Package for Xilinx FPGA Boards.

## Floating point for FIL and HDL cosimulation test bench generation

With the R2013b release, HDL Coder HDL workflow advisor for Simulink supports double and single data types on the DUT interface for test bench generation using HDL Verifier.

## Additional FPGA board support for FIL verification, including Xilinx KC705 and Altera DSP Development Kit, Stratix V edition

Several FPGA boards have been added to the HDL Verifier FPGA board support packages, including Xilinx KC705 and Altera DSP Development Kit, Stratix V edition.



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You can select these boards for FIL verification using the HDL workflow advisor for Simulink.



# R2013a

**Version: 3.2**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Static range analysis for floating-point to fixed-point conversion

The coder can now use static range analysis to derive fixed-point data types for your floating-point MATLAB code.

The redesigned interface for floating-point to fixed-point conversion enables you to use simulation with multiple test benches, static range analysis, or both, to determine fixed-point data types for your MATLAB variables.

For details, see Automated Fixed-Point Conversion.

## User-specified pipeline insertion for MATLAB variables

You can now specify pipeline register insertion for variables in your MATLAB code. This feature is available in both the MATLAB to HDL workflow and the MATLAB Function block.

To learn how to pipeline variables in the MATLAB to HDL workflow, see Pipeline MATLAB Variables.

To learn how to pipeline variables in the MATLAB Function block, see Pipeline Variables in the MATLAB Function Block.

## Resource sharing and streaming without over clocking

You can now constrain the resource sharing and streaming optimizations to prevent or reduce overclocking. The coder optimizes your design based on two parameters that you specify: maximum oversampling ratio, `MaxOversampling`, and maximum computation latency, `MaxComputationLatency`.

For single-rate resource sharing or streaming, you can set `MaxOversampling` to 1.

To learn more about constrained overclocking, maximum oversampling ratio, and maximum computation latency, see:

- Optimization With Constrained Overclocking
- Maximum Oversampling Ratio
- Maximum Computation Latency

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## Generation of custom IP core with AXI4 interface

You can now generate custom IP cores with an AXI4-Lite or AXI4-Stream Video interface. You can integrate these custom IP cores with your design in a Xilinx EDK environment for the Xilinx Zynq-7000 Platform.

For more details, see Custom IP Core Generation.

To view an example that shows how to generate a custom IP core, at the command line, enter:

```
hdlcoder_ip_core_led_blinking
```

## Coprocessor synchronization in FPGA Turnkey and IP Core Generation workflows

The coder can now automatically synchronize communication and data transfers between your processor and FPGA. You can use the new **Processor/FPGA synchronization mode** in the FPGA Turnkey workflow with xPC Target, or when you generate a custom IP core.

For more details, see Processor and FPGA Synchronization.

## Code generation for System objects in a MATLAB Function block

You can now generate code from a MATLAB Function block containing System objects.

For details, see System Objects under MATLAB Language Support, in MATLAB Function Block Usage.

## Resource sharing for the MATLAB Function block

You can now specify a resource sharing factor for the MATLAB Function block to share multipliers in the MATLAB code.

For details, see Resource Sharing and Specify Resource Sharing.

## Finer control for delay balancing

You can now disable delay balancing for a subsystem within your DUT subsystem.

For details, see Balance Delays.

## **Complex multiplication optimizations in the Product block**

You can now share multipliers used in a single complex multiplication in the Product block. Distributed pipelining can also move registers between the multiply and add stages of a complex multiplication.

## **Speedgoat IO331 Spartan-6 FPGA board for FPGA Turnkey workflow**

You can now use the Speedgoat IO331 Spartan-6 FPGA board in the FPGA Turnkey workflow with xPC Target.

You must have an xPC Target license to use this feature.

## **Cosimulation and FPGA-in-the-Loop for MATLAB HDL code generation**

With the MATLAB HDL Workflow Advisor, the HDL Verification step includes automation for the following workflows:

- **Verify with HDL Test Bench:** Create a standalone test bench. You can choose to simulate a model using ModelSim or Incisive<sup>®</sup> with a vector file created by the Workflow Advisor.
- **Verify with Cosimulation:** Cosimulate the DUT in ModelSim or Incisive with the test bench in MATLAB.
- **Verify with FPGA-in-the-Loop:** Create the FPGA programming file and test bench, and, optionally, download it to your selected development board.

You must have an HDL Verifier license to use these workflows.

## **HDL coding standard report and lint tool script generation**

You can now generate a report that shows how well your generated HDL code conforms to an industry coding standard. Errors and warnings in the report link to elements in your original design so you can fix problems.

You can also generate third-party lint tool scripts to use to check your generated HDL code. In this release, you can generate Leda, SpyGlass, and generic scripts.

To learn more about the coding standard report, see HDL Coding Standard Report.

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To learn how to generate a coding standard report and lint tool script in the Simulink to HDL workflow, see:

- Generate an HDL Coding Standard Report
- Generate an HDL Lint Tool Script

To learn how to generate a coding standard report and lint tool script in the MATLAB to HDL workflow, see:

- Generate an HDL Coding Standard Report
- Generate an HDL Lint Tool Script

## **Output folder structure includes model name**

When you generate code for a subsystem within a model, the output folder structure now includes the model name.

For example, if you generate code for a subsystem in a model, `Mymodel`, the output folder is `hdlsrc/Mymodel`.

## **Compatibility Considerations**

If you have scripts that depend on a specific output folder structure, you must update them with the new structure.

## **File I/O to read test bench data in Verilog**

You can now specify the generated HDL test bench to use file I/O to read input stimulus and output response data during simulation, instead of including data constants in the test bench code. Doing so improves scalability for designs needing long simulations.

This feature is available when Verilog is the target language.

For details, see [Test Bench Generation with File I/O](#).

## **Prefix for module or entity name**

You can now specify a prefix for every module or entity name in the generated HDL code. This feature helps you to avoid name clashes when you want to have multiple instances of the HDL code generated from the same block. For details, see [ModulePrefix](#).

## Single rate Newton-Raphson architecture for Sqrt, Reciprocal Sqrt

The Sqrt, Reciprocal Sqrt, reciprocal Divide, and reciprocal Math Function blocks now have a single-rate pipelined architecture. The new architecture enables you to use the high-speed Newton-Raphson algorithm without multirate or overclocking.

The following table lists each block with its new block implementation.

Block	Implementation Name	Details
Sqrt	SqrtNewtonSingleRate	See Sqrt.
Reciprocal Sqrt	RecipSqrtNewtonSingleRate	See Reciprocal Sqrt.
Divide (reciprocal)	RecipNewtonSingleRate	See Divide (reciprocal).
Math Function (reciprocal)	RecipNewtonSingleRate	See Math Function (reciprocal).

## Additional System objects supported for code generation

Effective with this release, the following System objects provide HDL code generation:

- comm.HDLCRCGenerator
- comm.HDLCRCDetector
- comm.HDLRSEncoder
- comm.HDLRSDecoder
- dsp.HDLNCO

## Additional blocks supported for code generation

The following blocks are now supported for HDL code generation:

- NCO HDL Optimized
- Bias
- Relay
- Dot Product
- Sum with more than two inputs with different signs
- MinMax with multiple input data types



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## Functionality being removed

Property Name	What Happens When You Use This Property?	Use This Property Instead	Compatibility Considerations
RAMStyle	Error	RAMArchitecture	The new property syntax differs. Replace existing instances of RAMStyle with the correct RAMArchitecture syntax.
GainImpls	Error	ConstMultiplierOptimization	The new property syntax differs. Replace existing instances of GainImpls with the correct ConstMultiplierOptimization syntax.



# R2012b

Version: 3.1

New Features

## **Input parameter constants and structures in floating-point to fixed-point conversion**

Floating-point to fixed-point conversion now supports structures and constant value inputs.

## **RAM, biquad filter, and demodulator System objects**

### **HDL RAM System object**

With release 2012b, you can use the `hdlram` System object for modeling and generating fixed-point code for RAMs in FPGAs and ASICs. The `hdlram` System object provides simulation capability in MATLAB for Dual Port, Simple Dual Port, and Single Port RAM. The System object also generates RTL code that can be inferred as a RAM by most synthesis tools.

To learn how to model and generate RAMs using the `hdlram` System object, see [Model and Generate RAM with `hdlram`](#).

### **HDL System object support for biquad filters**

HDL support has been added for the following System object:

- `dsp.BiquadFilter`

### **HDL support with demodulator System objects**

HDL support has been added for the following System objects:

- `comm.BPSKDemodulator`
- `comm.QPSKDemodulator`
- `comm.PSKDemodulator`
- `comm.RectangularQAMDemodulator`
- `comm.RectangularQAMModulator`

## **Generation of MATLAB Function block in the MATLAB to HDL workflow**

You can now generate a MATLAB Function block during the MATLAB to HDL workflow. You can use the generated block for further design, simulation, and code generation in Simulink.

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For details, see MATLAB Function Block Generation.

## **HDL code generation for Reed Solomon encoder and decoder, CRC detector, and multichannel Discrete FIR filter**

### **HDL code generation**

In R2012b, HDL code generation support has been added for the following blocks:

- General CRC Syndrome Detector HDL Optimized

For an example of using the HDL-optimized CRC generator and detector blocks, see Using HDL Optimized CRC Library Blocks.

- Integer-Input RS Encoder HDL Optimized
- Integer-Output RS Decoder HDL Optimized

### **Multichannel Discrete FIR filters**

The Discrete FIR Filter block accepts vector input and supports multichannel implementation for better resource utilization.

- With vector input and channel sharing option `on`, the block supports multichannel fully parallel FIR, including direct form FIR, sym/antisym FIR, and FIRT. Support for all implementation parameters, for example: multiplier pipeline, add pipeline registers.
- With vector input and channel sharing option `off`, the block instantiates one filter implementation for each channel. If the input vector size is  $N$ ,  $N$  identical filters are instantiated.

Applies to the fully parallel architecture option for FIR filters only.

## **Targeting of custom FPGA boards**

The FPGA Board Manager and New FPGA Board Wizard allow you to add custom board information so that you can use FIL simulation with an FPGA board that is not one of the pre-registered boards. See FPGA Board Customization.

## **Optimizations for MATLAB Function blocks and black boxes**

The resource sharing optimization now operates on MATLAB Function blocks. For details, see Specify Resource Sharing.

The delay balancing and distributed pipelining optimizations now operate on black box subsystems. To learn how to specify latency and enable distributed pipelining for a black box subsystem, see [Customize the Generated Interface](#).

## **Generate Xilinx System Generator Black Box block from MATLAB**

You can now generate a Xilinx System Generator Black Box block during the MATLAB-to-HDL workflow. You can use the generated block for further design, simulation, and code generation in Simulink.

For details, see [Xilinx System Generator Black Box Block Generation](#).

## **Save and restore HDL-related model parameters**

Two new functions, `hdlsaveparams` and `hdlrestoreparams`, enable you to save and restore nondefault HDL-related model parameters. Using these functions, you can perform multiple iterations on your design to optimize the generated code.

For details, see [hdlsaveparams](#) and [hdlrestoreparams](#).

## **Command-line interface for MATLAB-to-HDL code generation**

You can now convert your MATLAB code from floating-point to fixed-point and generate HDL code using the command-line interface.

To learn how to use the command line interface, open the tutorial:

```
showdemo mlhdlc_tutorial_cli
```

## **User-specifiable clock enable toggle rate in test bench**

You can now specify the clock enable toggle rate in your test bench to match your input data rate or improve test coverage.

To learn how to specify your test bench clock enable toggle rate, see [Test Bench Clock Enable Toggle Rate Specification](#).

## **RAM mapping for dsp.Delay System object**

The `dsp.Delay` System object now maps to RAM if the RAM mapping optimization is enabled and the delay size meets the RAM mapping threshold.

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To learn how to map the `dsp.Delay` System object to RAM, see [Map Persistent Arrays and dsp.Delay to RAM](#).

## **Code generation for Repeat block with multiple clocks**

You can now generate code for the DSP System Toolbox Repeat block in a model with multiple clocks.

## **Automatic verification with cosimulation using HDL Coder**

With the HDL Coder HDL Workflow Advisor, you can automatically verify using your Simulink test bench with the new verification step **Run Cosimulation Test Bench**. During verification, the HDL Workflow Advisor and HDL Verifier verify the generated HDL using cosimulation between the HDL Simulator and the Simulink test bench. See [Automatic Verification](#) in the HDL Verifier documentation.

## **ML605 Board Added To Turnkey Workflow**

The Xilinx Virtex-6 FPGA ML605 board has been added for Turnkey Workflow in the HDL Workflow Advisor.





# **R2012a**

**Version: 3.0**

**New Features**

**Compatibility Considerations**

## Product Name Change and Extended Capability

HDL Coder replaces Simulink HDL Coder and adds the HDL code generation capability directly from MATLAB.

To generate HDL code from MATLAB, you need the following products:

- HDL Coder
- MATLAB Coder
- Fixed-Point Toolbox™
- MATLAB

To generate HDL code from Simulink, you need the following products:

- HDL Coder
- MATLAB Coder
- Fixed-Point Toolbox
- Simulink Fixed Point™
- Simulink
- MATLAB

## Code Generation from MATLAB

You can now generate HDL code directly from MATLAB code.

This workflow provides:

- Verilog or VHDL code generation from MATLAB code.
- Test bench generation from MATLAB scripts.
- Automated conversion from floating point code to fixed point code.
- Automated HDL verification through integration with ModelSim and ISim.
- HDL code generation for a subset of System objects from the Communications System Toolbox and DSP System Toolbox.
- A traceability report mapping generated HDL code to your original MATLAB code.

The MATLAB to HDL workflow provides the following automated HDL code optimizations:

- 
- Area optimizations: RAM mapping for persistent array variables, loop streaming, resource sharing, and constant multiplier optimization.
  - Speed optimizations: input pipelining, output pipelining, and distributed pipelining.

The coder can also generate a resource utilization report, with RAM usage and the number of adders, multipliers, and muxes in your design.

See also HDL Code Generation from MATLAB.

## **Code Generation from Any Level of Subsystem Hierarchy**

You can now generate HDL code from a subsystem at any level of the subsystem hierarchy. In previous releases, you could generate HDL code from the top-level subsystem only.

This feature also enables you to check any level subsystem for code generation compatibility, and to automatically generate a testbench.

## **Automated Subsystem Hierarchy Flattening**

You can now generate code with a flattened subsystem hierarchy, while preserving hierarchy in nested subsystems.

This option enables you to perform more extensive area and speed optimization on the flattened component. It also enables you to reduce the number of HDL output files.

See also Hierarchy Flattening.

## **Support for Discrete Transfer Fcn Block**

You can now generate HDL code from the Discrete Transfer Fcn block.

For details, see Discrete Transfer Fcn Requirements and Restrictions.

## **User Option to Constrain Registers on Output Ports**

A new property, `ConstrainedOutputPipeline`, enables you to specify the number of registers you wish to have on an output port without introducing additional delay on the input to output path. The coder redistributes existing delays within your design to try to meet the constraint. This behavior is different from the `OutputPipeline` property, which introduces additional delay on the input to output path.

If the coder is unable to meet the constraint using existing delays, it reports the difference between the number of desired and actual output registers in the timing report.

## **Distributed Pipelining for Sum of Elements, Product of Elements, and MinMax Blocks**

The Sum of Elements, Product of Elements, and MinMax blocks can now participate in distributed pipelining if their architecture is set to `Tree`.

## **MATLAB Function Block Enhancements**

### **Multiple Accesses to RAMs Mapped from Persistent Variables**

You can now perform multiple reads and writes to a persistent variable, and the persistent variable will still be mapped to RAM. In previous releases, a RAM mapped from a persistent variable could be accessed only once.

### **Streaming for MATLAB Loops and Vector Operations**

You can now perform streaming on MATLAB loops and loops created from vector operations for improved area efficiency.

For details, see [Loop Optimization](#).

### **Loop Unrolling for MATLAB Loops and Vector Operations**

You can now unroll user-written MATLAB loops and loops created from vector operations. This enables the coder to perform area and speed optimizations on the unrolled loops.

For details, see [Loop Optimization](#).

## **Automated Code Generation from Xilinx System Generator for DSP Blocks**

You can now automatically generate HDL code from subsystems containing Xilinx System Generator for DSP blocks.

For details, see [Code Generation with Xilinx System Generator Subsystems](#).

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## Altera Quartus II 11.0 Support in HDL Workflow Advisor

The HDL Workflow Advisor has now been tested with Altera Quartus II 11.0. In previous releases, the HDL Workflow Advisor was tested with Altera Quartus II 9.1.

## Automated Mapping to Xilinx and Altera Floating Point Libraries

The coder can now map Simulink floating point operations to synthesizable floating point Altera Megafunctions and Xilinx LogiCORE IP Floating Point Operator v5.0 blocks. To learn more, see [FPGA Target-Specific Floating-Point Library Mapping](#).

For a list of supported Altera Megafunction blocks, see [Supported Altera Floating-Point Library Blocks](#).

For a list of supported Xilinx LogiCORE IP blocks, see [Supported Xilinx Floating-Point Library Blocks](#).

## Vector Data Type for PCI Interface Data Transfers Between xPC Target and FPGA

In the FPGA Turnkey workflow, you can now use vector data types with the **Scalarize Vector Ports** option to automatically generate PCI DMA transfers on the PCI interface between xPC Target and FPGA. You no longer need to manually insert multiplexers, demultiplexers and provide synchronization logic for vector data transfers.

If the **Scalarize Vector Ports** option is disabled when the code generation subsystem has vector ports, the coder displays an error.

## New Global Property to Select RAM Architecture

There is a new global property, `RAMArchitecture`, that enables you to generate RAMs either with or without clock enables. This property applies to every RAM in your design, and replaces the block level property, `RAMStyle`. By default, RAMs are generated with clock enables.

To generate RAMs without clock enables, set `RAMArchitecture` to `'WithoutClockEnable'`. To generate RAMs with clock enables, either use the default, or set `RAMArchitecture` to `'WithClockEnable'`. For more information, see [Implement RAMs With or Without Clock Enable](#).

## Compatibility Considerations

The coder now ignores the block level property, `RAMStyle`.

If a block's `RAMStyle` property is set, the coder generates a warning.

## Turnkey Workflow for Altera Boards

HDL Workflow Advisor now supports Altera FPGA design software and the following Altera development kits and boards:

- Altera Arria II GX FPGA development kit
- Altera Cyclone III FPGA development kit
- Altera Cyclone IV GX FPGA development kit
- Altera DE2-115 development and education board

This workflow has been tested with Altera Quartus II 11.0.

## HDL Support For Bus Creator and Bus Selector Blocks

Release R2012a provides HDL code generation for the Bus Creator and Bus Selector blocks. You must use these blocks for your buses if you want HDL support.

## HDL Support For HDL CRC Generator Block

Release R2012a provides HDL code generation for the new HDL CRC Generator block.

## HDL Support for Programmable Filter Coefficients

When using filter blocks to generate HDL code, you can specify coefficients from input port(s). This feature applies to FIR and BiQuad filter blocks only. Fully Parallel and all serial architectures are supported.

Follow these directions to use programmable filters:

- 1 Select `Input port(s)` as coefficient source from the filter block mask.
- 2 Connect the coefficient port with a vector signal.
- 3 Specify the implementation architecture and parameters from the HDL Coder property interface.

---

#### 4 Generate HDL code.

##### Notes

- For fully parallel implementations, the coefficients ports are connected to the dedicated MAC directly.
- For serial implementation, the coefficients ports first go to a mux, and then to the MAC. The mux decides the coefficients that used at current time instant
- For Discrete FIR filters, this feature is not supported under the following conditions:
  - Implementations having coefficients specified by dialog parameters (for example, complex input and coefficients with serial architecture)
  - Filters using DA architecture
  - CoeffMultipliers specified as `csd` or `factored-csd`
- For Biquad filters, this feature is not supported when CoeffMultipliers are specified as `csd` or `factored-csd`.

## Synchronous Multiclock Code Generation for CIC Decimators and Interpolators

You can specify multiple clocks in one of the following ways:

- Use the model-level parameter `ClockInputs` with the function `makehdl` and specify the value as 'Multiple'.
- In the Clock settings section of the **Global Settings** pane in the HDL Code Generation Configuration Parameters dialog box, set **Clock inputs** to **Multiple**.

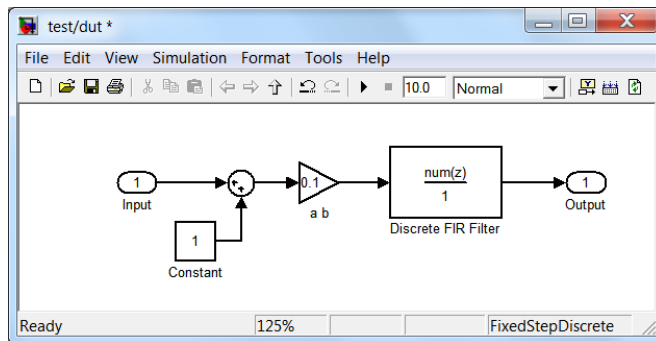
When you use single-clock mode, HDL code generated from multirate models uses a single master clock that corresponds to the base rate of the DUT. When you use multiple-clock mode, HDL code generated from multirate models use one clock input for each rate in the DUT. The number of timing controllers generated in multiple-clock mode depends on the design in the DUT.

The `ClockInputs` parameter supports the values 'Single' and 'Multiple', where the default is 'Single'. In the default single-clock mode, the coder behavior is unchanged from previous releases.

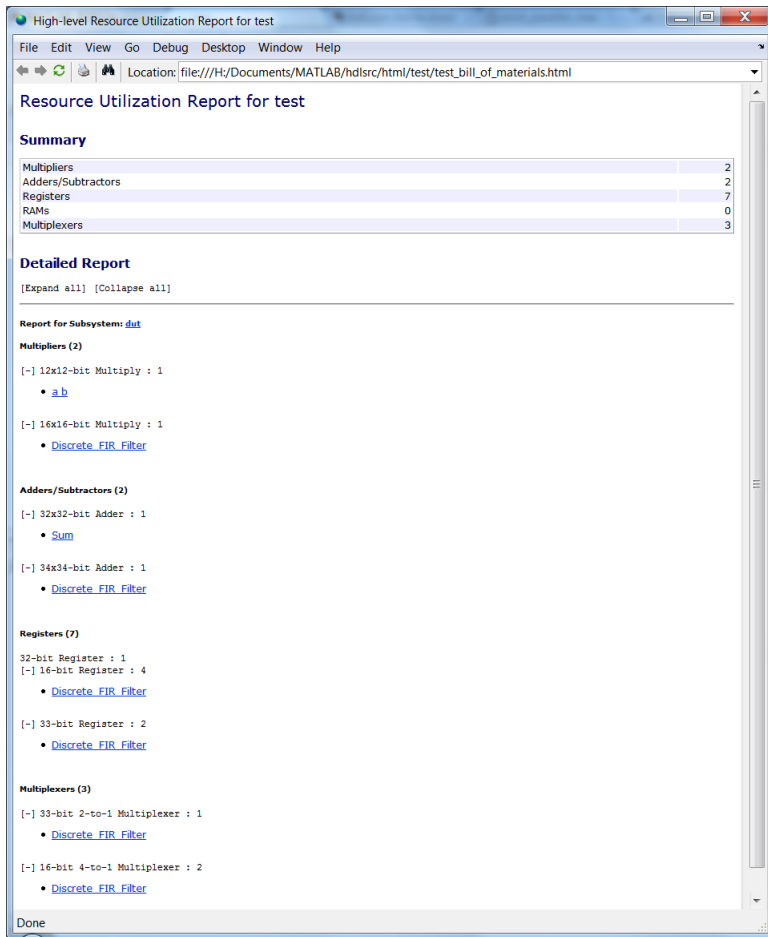
## Filter Block Resource Report Participation

Resource reports include the HDL resource usage for filter blocks. The report includes adders, subtractors, multipliers, multiplexers, registers. This feature covers all filter blocks, and all implementations for the block.

You can turn on the report feature using the command line (`ResourceReport`) or GUI (**Generate resource utilization report**). The following illustrations show a report for a model that includes a Discrete FIR Filter block.







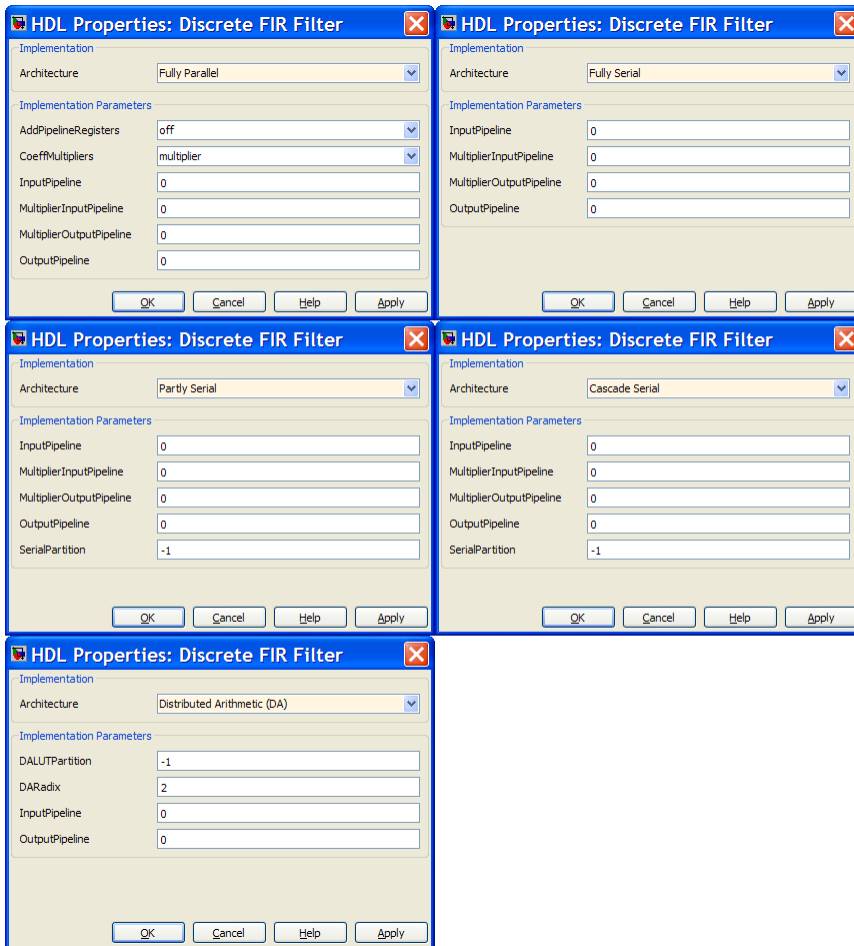
## HDL Block Properties Interface Allows Choice of Filter Architecture

You can choose from several filter architectures for FIR Decimation and Discrete FIR Filter blocks. Choices are:

- Fully Parallel
- Distributed Architecture (DA)
- Fully Serial
- Party Serial

- Cascade Serial

The availability of architectures depends on the transfer function type and filter structure of filter blocks. For Partly Serial and DA, specify at least **SerialPartition** and **DALUTPartition**, respectively, so that these architectures are inferred. For example, if you select **Distributed Arithmetic (DA)**, make sure to also set **DALUTPartition**.



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## **HDL Support for FIR Filters With Serial Architectures and Complex Inputs**

HDL support for serial implementations of a FIR block with complex inputs.

## **HDL Support for External Reset Added for Proportional-Integral-Derivative (PID) and Discrete Time Integrator (DTI) Blocks**

External reset support added for level mode.

