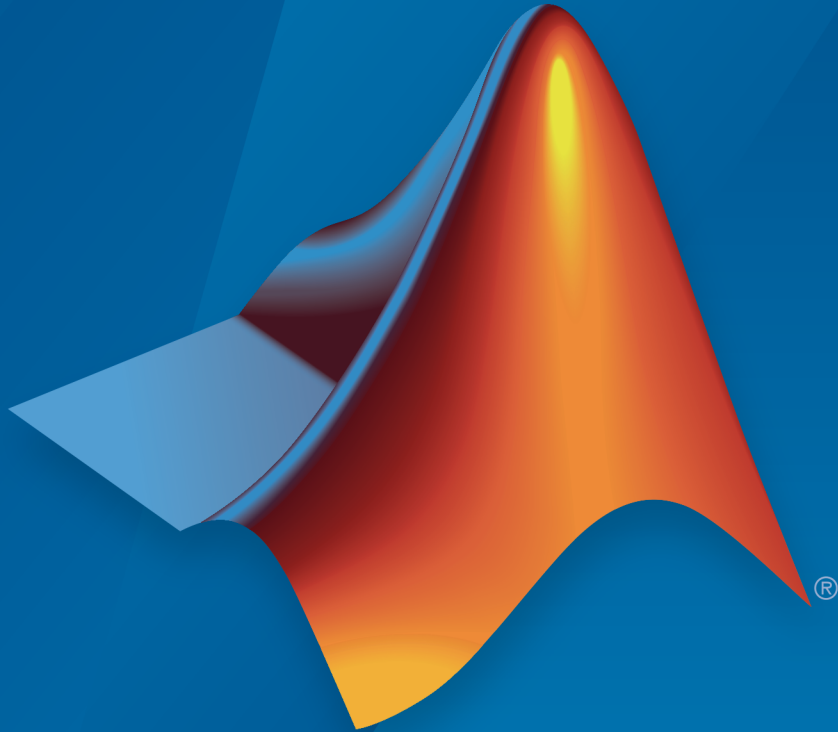


# Fixed-Point Designer™ Release Notes



# MATLAB®

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# R2015b

**Version: 5.1**

**New Features**

**Bug Fixes**

## Simulink Fixed-Point Tool workflow simplification: Propose signedness and data types for inherited and floating-point types

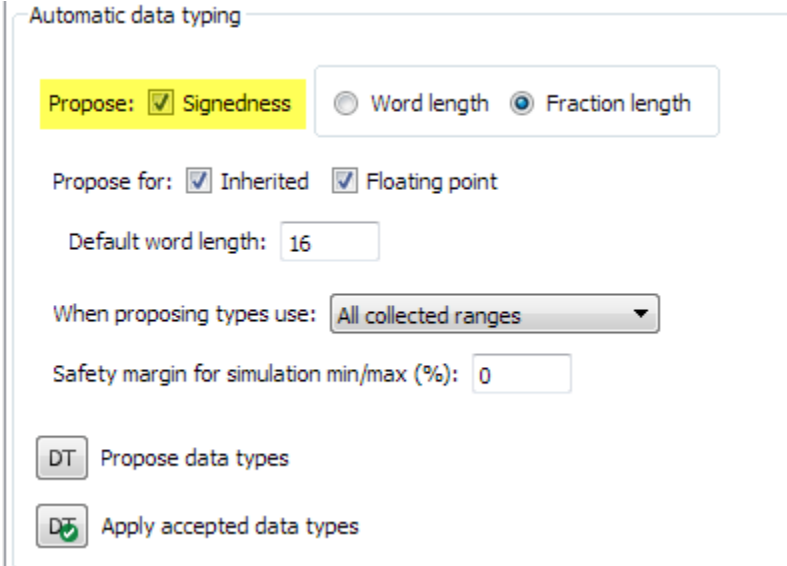
### System under design (SUD) specification

Upon opening the Fixed-Point Tool, you must now select the system under design for fixed-point conversion. Once selected, the system name will appear highlighted in green in the **Model Hierarchy** pane. The Fixed-Point Tool will propose and apply data types for the selected system only.

To change the system under design, click **Change**. In the dialog, select the system you want to convert.

### Signedness proposals

The Fixed-Point Tool now proposes signedness for blocks in your system under design. To get signedness proposals for blocks in your model, in the **Automatic data typing** pane, select the **Signedness** check box.



The screenshot shows the "Automatic data typing" dialog box. It contains the following elements:

- Propose:** A group box containing three options:  Signedness (highlighted in yellow),  Word length, and  Fraction length.
- Propose for:** Two checked checkboxes:  Inherited and  Floating point.
- Default word length:** A text input field containing the value "16".
- When proposing types use:** A dropdown menu currently set to "All collected ranges".
- Safety margin for simulation min/max (%):** A text input field containing the value "0".
- Two buttons at the bottom: "DT Propose data types" and "DT Apply accepted data types".

The Fixed-Point Tool bases its signedness proposals on collected range information and block constraints. Signals that are always strictly positive now get an unsigned data type proposal, gaining an additional bit of precision compared to previous releases.

---

By default, the **Signedness** check box is selected. If you clear the check box, the Fixed-Point Tool proposes a signed data type for all results that currently specify a floating-point or an inherited output data type unless other constraints are present. If a result specifies a fixed-point output data type, the Fixed-Point Tool will propose a data type with the same signedness as the currently specified data type unless other constraints are present.

### Proposals for objects using inherited and floating-point types

You can now elect to receive proposals for objects in your model that use floating-point data types or one of the inherited data types for block outputs. To get proposals for objects using floating-point or inherited data types, in the **Automatic data typing** pane, select the corresponding check boxes.

Automatic data typing

Propose:  Signedness  Word length  Fraction length

Propose for:  Inherited  Floating point

Default word length: 16

When proposing types use: All collected ranges

Safety margin for simulation min/max (%): 0

Propose data types

Apply accepted data types

By default, the **Inherited** and **Floating point** check boxes are selected. If you clear the **Inherited** or **Floating point** check boxes, the Fixed-Point Tool will not propose a fixed-point data type for results that use an inherited or floating-point data type respectively.

### Two-way traceability between model and Fixed-Point Tool

You can now trace between Simulink® blocks in your model and their corresponding results in the Fixed-Point Tool. This capability simplifies the task of debugging overflows

and other data type propagation issues in your model. Right-click on a block in your Simulink model and select **Fixed-Point Tool Result** to highlight the result in the **Contents** pane of the Fixed-Point Tool. You can also trace a result back to the model by right-clicking a result in the **Contents** pane and selecting **Highlight in Editor**.

### **New configurations for model settings**

Under **Configure model settings** in the Fixed-Point Tool, use the configurations to set up your model for range collection.

- The **Range collection using double override** configuration overrides the data types in your model to doubles and enables instrumentation of your model. Use these settings to collect simulation ranges using ideal floating-point data types.
- The **Range collection with specified data types** configuration removes data type override and enables instrumentation of your model. Use this shortcut to collect simulation ranges using the data types specified in your model and to validate current behavior.
- The **Remove overrides and disable range collection** configuration restores your model to its specified numeric behavior and disables instrumentation to restore maximum speed. Use this shortcut to clean up model settings after conversion.

## **Double-precision to single-precision conversion: Convert double-precision MATLAB code to single-precision MATLAB code using the command line**

In R2015b, you can use the `convertToSingle` function to convert double-precision MATLAB<sup>®</sup> code to single-precision MATLAB code.

You can verify the behavior of a single-precision version of your code without modifying the original algorithm. When a double precision operation cannot be removed, the report highlights the MATLAB expression that results in that operation.

For example, to generate single-precision MATLAB code from a double-precision function `myfunction` that takes two double arguments:

```
convertToSingle myfunction -args {1 2}
```

To use verification options, create a `coder.SingleConfig` object that you pass to `convertToSingle`. You can:

- Test numerics by running the test file with the single-precision types applied.
- Compare double-precision and single-precision test results using the Simulation Data Inspector or your own plotting functions.

---

```
scfg = coder.config('single');
scfg.TestBenchName = 'myfunction_test';
scfg.TestNumerics = true;
scfg.LogIOForComparisonPlotting = true;
convertToSingle -config scfg myfunction -args {1 2}
```

If you also have a MATLAB Coder™ license, you can:

- Generate single-precision C code using the MATLAB Coder app. Use this workflow if your goal is to generate single-precision C code in the most direct way and you do not want to see the intermediate single-precision MATLAB code.
- Generate single-precision C code using `codegen` with the `-singleC` option. Use this workflow when you want to generate single-precision C code in the most direct way and you do not want to see the intermediate single-precision MATLAB code
- Generate single-precision MATLAB code using `codegen` with a `coder.SingleConfig` object. Use this workflow if you want to see the single-precision MATLAB code or use verification options.
- Generate single-precision C code using `codegen` with a `coder.SingleConfig` object and a code configuration object. Use this workflow to generate single-precision C code when you also want to see the single-precision MATLAB code or use verification options.

For more information about single-precision conversion using MATLAB Coder, see the MATLAB Coder release notes.

## **MATLAB Fixed-Point Converter app streamlined workflow: Restore project state and minimize regeneration of MEX files**

### **Saving and restoring fixed-point conversion workflow state in the app**

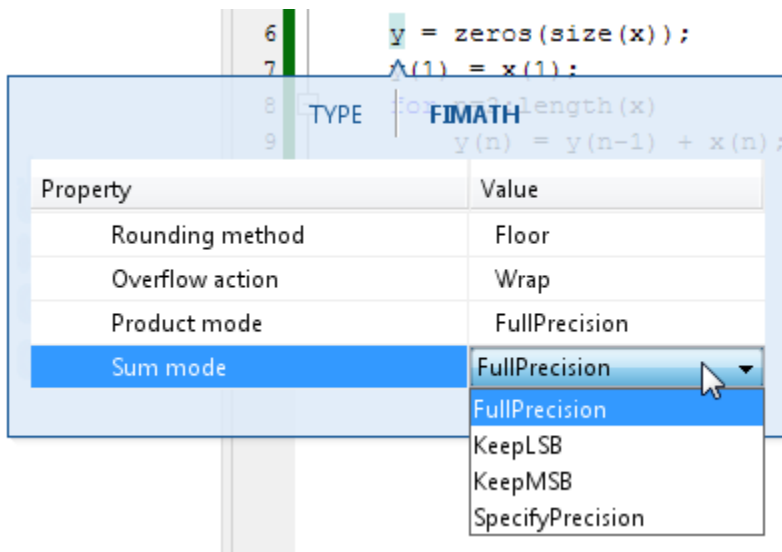
If you close a project before completing the fixed-point conversion process, the app saves your work. When you reopen the project, the app restores the state. You do not have to repeat the fixed-point conversion steps that you completed in a previous session. For example, suppose you close the project after data type proposal. When you reopen the project, the app shows the results of the data type proposal and enables conversion. You can continue where you left off.

### **Minimized regeneration of MEX files**

The Fixed-Point Converter app now optimizes when it regenerates MEX files. The app will only rebuild the MEX file when required by changes in your code.

## Specification of additional `fimath` properties in app editor

You can now control all `fimath` properties of variables in your code from within the Fixed-Point Converter app editor. To modify the `fimath` settings of a variable, select a variable and click **FIMATH** in the dialog that appears. You can alter the Rounding method, Overflow action, Product mode, and Sum mode properties. You can also modify these properties from the settings pane. For more information on these properties, see `fimath`.

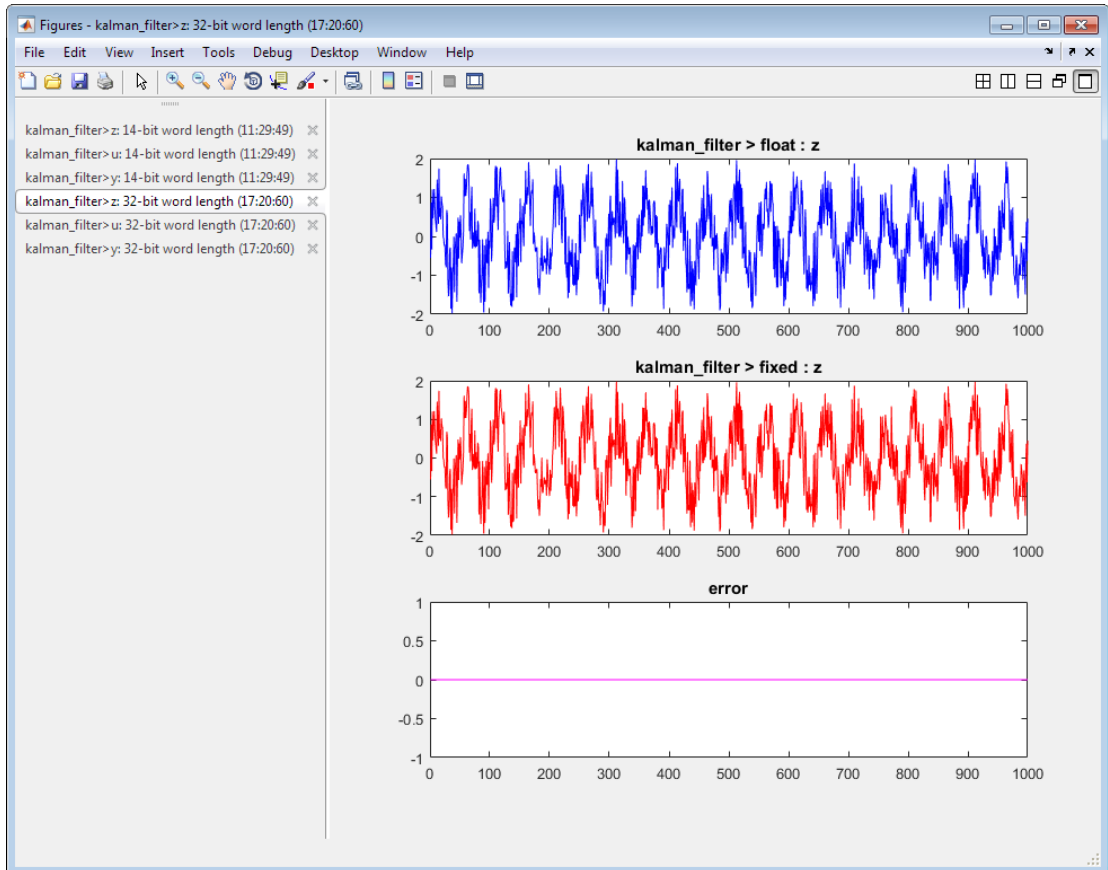


## Improved management of comparison plots

The Fixed-Point Converter app now docks plots generated during the testing phase of your fixed-point code into separate tabs of one figure window. Each tabbed figure represents one input or output variable and is labeled with the function, variable, word length, and a timestamp. Each tab contains three sub plots. The plots use a time series based plotting function to show the floating-point and fixed-point results and the difference between them.

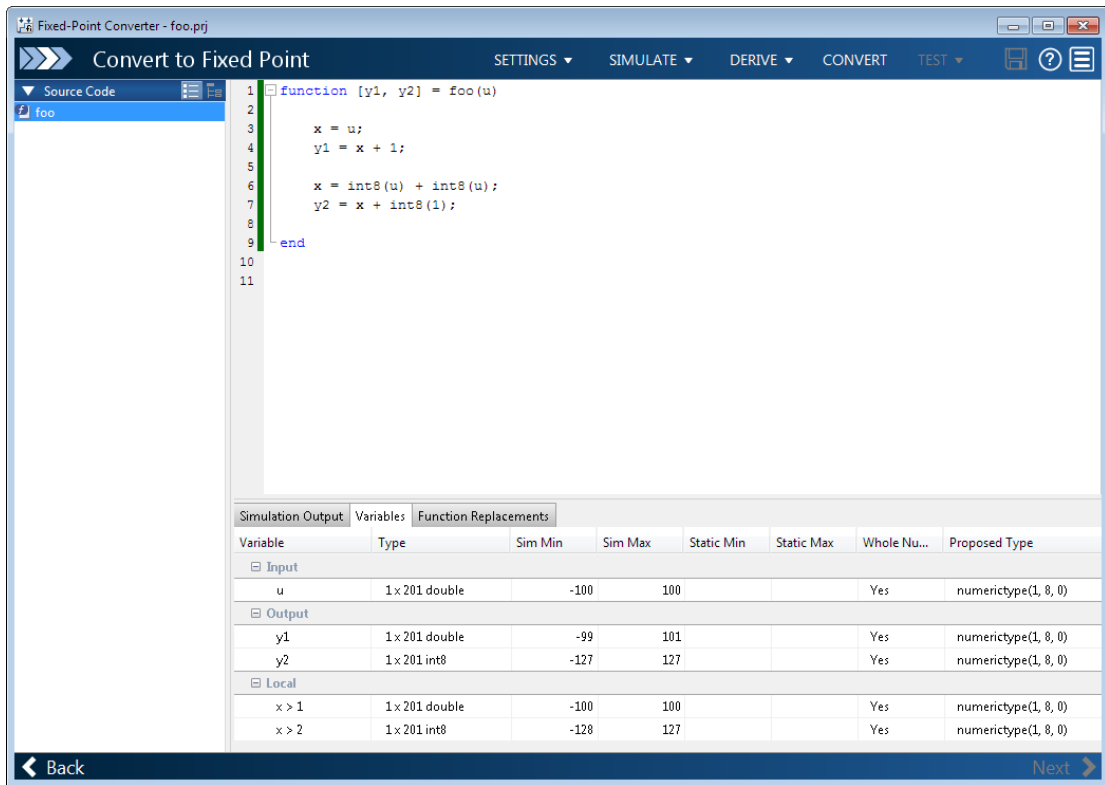
Subsequent iterations are also plotted in the same figure window.





## Variable specializations

On the **Convert to Fixed Point** page, in the **Variables** table of the app, you can now view variable specializations.



## Improvements to Readability of Generated Code

### Structs

- When struct copies exist in the design, a separate function is now created to perform the copy.
- Copies of structs are now avoided when the types of all fields match, improving both readability and efficiency of the generated code.

### fimath

- `fimath` settings are now specified in a separate function to improve the readability of the generated fixed-point code.
- To avoid a mismatch of `fimath` settings in an expression, the generated code now uses the `removefimath` function.

---

```

function [y] = my_add_fixpt(a,b)
%Adds a and b
fm = getConversionFimath();

y=fi(removefimath(a)+b, 0, 8, 0, fm);
end

function fm = getConversionFimath()
fm = fimath('RoundingMethod', 'Floor', 'OverflowAction', 'Wrap',...
'ProductMode', 'FullPrecision', 'MaxProductWordLength', 128,...
'SumMode', 'FullPrecision', 'MaxSumWordLength', 128);
end

```

### Matrices

Growth and deletion of matrices within a design are now supported for fixed-point conversion.

```

function matrix_deletion_fixpt(a,i)
    fm = getConversionFimath();

    var = fi([1, 2, 3], 0, 2, 0, fm);
    coder.varsize('var');
    var(2) = []; %matrix deletion.
    var(2) = fi(2, 0, 2, 0, fm);
end

function [out] = matrix_growth_fixpt( x )
    fm = getConversionFimath();
    out = fi([], 0, 4, 0, fm);
    for ii = 1:10
        out = [ out x];
    end
end

```

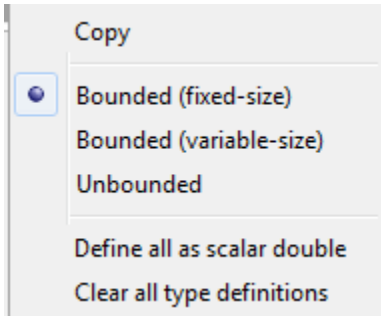
### Tab completion for specifying files

On the **Select Source Files** and **Define Input Types** pages of the Fixed-Point Converter app, you can now use tab completion to specify your entry-point functions and test bench file.

### Improvements for manual type definition

Improvements for manual type definition include:

- New right-click menus options to specify array size.



- Easier definition of structure types. You can:
  - Use the new **+** icon to add fields.
  - See the structure type name in the table of input variables.

|        |                      |                 |
|--------|----------------------|-----------------|
| x      | <b>struct(1 x 2)</b> | myname <b>+</b> |
| field1 | double(1 x 1)        |                 |

- Easier definition of embedded `.fi` types. You can:
  - See the `numericType` properties in the table of input variables.

|   |                  |                                     |
|---|------------------|-------------------------------------|
| x | <b>fi(1 x 1)</b> | <code>numericType(1, 16, 15)</code> |
|---|------------------|-------------------------------------|

- Use the new icon to change the `numericType` properties.

### Compatibility between the app colors and MATLAB preferences

The app uses colors that are compatible with the **Desktop tool colors** preference in the MATLAB preferences. For information about MATLAB preferences, see “Preferences”.

## Range analysis for Delay blocks: Improve accuracy and speed of range analysis on models using Delay blocks

Using the Fixed-Point Tool, you can now derive ranges for models that use Delay blocks with greater precision. The Fixed-Point Tool can also derive ranges for certain

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configurations of cascading Delay blocks with greater theoretical accuracy and speed. For more information on range analysis in the Fixed-Point Tool, see “How Range Analysis Works”.


## Control of signed shifts in fixed-point scaling operations: Control the use of signed shifts in generated code

You can now control the use of signed right shifts in your generated code. Some coding standards do not allow bitwise operations on signed integers. Disabling the use of signed shifts in generated code increases the likelihood of compliance with MISRA. When you specify that signed right shifts should not be used in your generated code, the software replaces signed shifts with a call to a function that performs the operation without the use of signed shifts.

This feature requires an Embedded Coder<sup>®</sup> license.

### MATLAB

To specify that MATLAB Coder not use signed right shifts:

- Using the MATLAB Coder app:
  - 1 On the **Generate Code** page, to open the **Generate** dialog box, click the **Generate** arrow .
  - 2 Set **Build type** to one of the following:
    - Source Code
    - Static Library (.lib)
    - Dynamic Library (.dll)
    - Executable (.exe)
  - 3 Click **More Settings**.
  - 4 On the **Code Appearance** tab, clear the **Allow right shifts on signed integers** check box.
- Using the command-line interface:
  - 1 Create a code configuration object for 'lib', 'dll', or 'exe'.

```
cfg = coder.config('lib','ecoder',true); % or dll or exe
```

- 2 Set the `EnableSignedRightShifts` property to `false`.

```
cfg.EnableSignedRightShifts = false;
```

### Simulink

To specify that the code generator not use signed right shifts, in the Configuration Parameters dialog box, on the **Code Generation > Code Style** pane, clear “Allow right shifts on signed integers” or set the parameter `EnableSignedRightShifts` to `off`.

To improve coding standard compliance for bitwise operations on signed integers, run the following checks:

- “Check for bitwise operations on signed integers” - Check to identify blocks that contain bitwise operations on signed integers.
- “Check configuration parameters for MISRA C:2012” - Check that verifies that you cleared **Code Generation > Code Style > Allow right shifts on signed integers**.

## Access full-precision value of `fi` object in decimal and string format

You can now set and get full-precision real-world values of `fi` objects using the new `Value` property. This provides easy access to exact values in decimal format.

The `toString` function now accepts `fi` object inputs allowing you to convert `fi` objects to a string that you can copy and paste into a MATLAB script or function. The `mat2str` function now also supports `fi` object inputs allowing you to convert `fi` objects to strings without first converting to a double value.

## Detection of multiword operations

When an operation has an input or output larger than the largest word size of your processor, the generated code contains multiword operations. Multiword operations can be inefficient on hardware. In both MATLAB and Simulink, you can now detect operations that will result in multiword code.

### MATLAB

The expensive fixed-point operations check now highlights expressions in your MATLAB code that could result in multiword operations in generated code. For more information on enabling this check, see “Find and Address Multiword Operations”.

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## Simulink

The Identify questionable fixed-point operations check in the Model Advisor now detects multiword operations in generated code. For more information, see “Identify Questionable Fixed-Point Operations”.

## Enhanced Model Advisor check for implementing strict single-precision designs

The Model Advisor **Modeling Single-Precision Systems > Identify questionable operations for strict single-precision design** check now verifies the status of additional model settings that will help you achieve a strict single-precision design.

- The Model Advisor warns you if **Configuration Parameters > Optimization > Default for underspecified data type** is set to Double.
- The Model Advisor warns you if your model uses library standard that is not optimal for strict-single precision designs.
- The Model Advisor warns you if **Configuration Parameters > Optimization > Implement logic signals as Boolean data** is not selected.

The settings suggested by the Model Advisor prevent the introduction of doubles into your generated code, which is optimal for strict-single designs.

## System object instrumentation in Fixed-Point Tool

The Fixed-Point Tool now collects simulation ranges and proposes data types for select DSP System Toolbox™ System objects used inside a MATLAB Function block. You cannot propose data types based on derived range data.

Use of these System objects requires a DSP System Toolbox license. To learn more about using the Fixed-Point Tool to convert System objects and to learn which System objects are supported, see “Convert a System Object to Fixed Point Using the Fixed-Point Tool”.





# R2015a

**Version: 5.0**

**New Features**

**Bug Fixes**

## Derived Ranges for MATLAB Function Blocks in Simulink

Using the Fixed-Point Tool, you can now derive ranges for variables inside a MATLAB Function block in Simulink. The Fixed-Point Tool uses design ranges to derive ranges for MATLAB variables in a MATLAB Function block. The tool can also propose data types for the variables based on the derived range data. You must manually apply the proposed data types to the variables. For more information, see [Derive Ranges of MATLAB Function Block Variables](#).

## Fixed-Point Converter app enhancements, including detection of dead and constant folded code, support for projects with multiple entry point functions and support for global variables

The following enhancements have been added to the Fixed-Point Converter app:

### Support for projects with multiple entry-point functions

You can now specify multiple entry-point functions in a Fixed-Point Converter app project. If your end goal is to generate fixed-point C/C++ library functions, conversion with multiple entry-point functions facilitates integration with larger applications. For more information, see [Generate Fixed-Point MATLAB Code for Multiple Entry-Point Functions](#).

### Support for global variables

You can now specify global variables in the Fixed-Point Converter app workflow and convert algorithms which contain global variables without modifying your code. For more information, see [Convert Code Containing Global Variables to Fixed-Point](#).

### Code coverage based translation

The Fixed-Point Converter app now detects dead and constant folded code within your project and warns you if any parts of your code were not executed during the simulation of your test file. This can help you verify if your test file is testing the algorithm over the intended operating range. The app uses this code coverage information during the translation of your code from floating-point MATLAB code to fixed-point MATLAB code. The app inserts inline comments in the fixed-point code to mark the dead and untranslated regions and includes the code coverage information in the generated fixed-point conversion html report. This code coverage information is also available from the

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command-line workflow. For more information, see Detect Dead and Constant-Folded Code.

### **Conversion from project to MATLAB scripts for command-line fixed-point conversion**

Using the `-tocode` option of the `fixedPointConverter` command, you can convert a fixed-point conversion project to the equivalent MATLAB code in a MATLAB script. You can use the script to repeat the project workflow in a command-line workflow. For more information, see Convert Fixed-Point Conversion Project to MATLAB Scripts.

### **Generated fixed-point code enhancements**

The generated fixed-point code now:

- Uses colon syntax for multi-output assignments, reducing the number of `fi` casts in the generated fixed-point code.
- Preserves the indentation and formatting of your original algorithm, improving the readability of the generated fixed-point code.

### **Integration with MATLAB Coder app interface**

The Fixed-Point Converter app has been integrated into the new MATLAB Coder app workflow. This integration allows for a smoother conversion process from floating-point MATLAB code to fixed-point C/C++ code.

## **Automated conversion of additional DSP System objects using the Fixed-Point Converter app**

You can now convert the following DSP System Toolbox System objects to fixed-point using the Fixed-Point Converter app:

- `dsp.FIRDecimator`
- `dsp.FIRInterpolator`
- `dsp.FIRFilter`, direct form and direct form transposed only
- `dsp.LUFactor`
- `dsp.VariableFractionalDelay`
- `dsp.Window`

You can propose and apply data types for these System objects based on simulation range data. During the conversion process, you can view simulation minimum and

maximum values and proposed data types for these System objects. You can also view whole number information and histogram data. You cannot propose data types for these System objects based on static range data. This requires a DSP System Toolbox license.

## Fixed-Point SimState logging and root logging improvements

The Simulink `SimState` feature allows you to save all run-time data necessary for restoring the simulation state of the model. A `SimState` includes both the logged and internal state of every block and the internal state of the Simulink engine. The Fixed-Point Tool now supports `SimState` logging while fixed-point instrumentation is turned on. For more information, see [Save and Restore Simulation State as SimState](#).

## Flexible structure assignment of buses

When a non-tunable structure is assigned to a bus signal (such as a block which uses a structure for its initial condition parameter), the data type of the fields of the structure no longer need to match the data type of the bus elements. The software now performs an automatic casting of the data type of the structure field so that it matches the data type of the bus signal. This flexible structure assignment simplifies the fixed-point conversion workflow by automatically casting the data type of the fields of the structure when using data type override and autoscaling your model.

## `eye(m, 'like', a)` syntax supported for fixed-point inputs

The `eye` function now works with fixed-point data types as well as built-in data types. The function can now return an output whose class matches that of a specified numeric variable or `fi` object. For built-in data types, the output assumes the numeric data type, sparsity, and complexity (real or complex) of the specified numeric variable. For `fi` objects, the output assumes the `numericType`, complexity (real or complex), and `fiMath` of the specified `fi` object.

## New interpolation method for generating lookup table MATLAB function replacements

The `coder.approximation` function now offers a 'Flat' interpolation method for generating lookup table MATLAB function replacements. This fully-specified lookup table achieves high speeds by discarding the pre-lookup step and reducing the use of multipliers in the data path. This interpolation method is available from both the

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command-line workflow, and in the **Function Replacements** tab of the Fixed-Point Converter app.

## **Fixed-point scaling information in Code Interface Report**

Fixed-point scaling information is added to the code generation report in the Code Interface Report section. Better accessibility to this information makes it easier for you to integrate with generated code containing fixed-point data types. Each fixed-point entry in the report table has a value in the new **Scaling** column giving its data type and fraction length using Simulink fixed-point data type notation.

Access to the Code Interface Report requires an Embedded Coder license.



# R2014b

**Version: 4.3**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Fixed-Point Converter app for automated conversion of floating-point MATLAB code


The Fixed-Point Converter app enables you to convert floating-point MATLAB code to fixed-point MATLAB code.

You can choose to propose data types based on simulation range data, static range data, or both.

During fixed-point conversion, you can:

- Propose fraction lengths based on default word lengths.
- Propose word lengths based on default fraction lengths.
- Optimize whole numbers.
- Specify safety margins for simulation min/max data.
- Test numerics by running the test file with the fixed-point types applied.
- Compare floating-point and fixed-point test results using the Simulation Data Inspector or your own plotting functions.
- View a histogram of bits used by each variable.
- Specify replacement functions and generate approximate functions for functions in the original MATLAB algorithm that are not supported for fixed point.

To open the app:

- In the MATLAB Toolstrip, on the **Apps** tab, under **Code Generation**, click  .
- At the MATLAB command prompt, enter `fixedPointConverter`.

For more information, see [Fixed-Point Converter](#).

## Commands for scripting fixed-point conversion and accessing the collected data in Simulink

You can now use the `DataTypeWorkflow.Converter` class to collect simulation and derived data, propose and apply data types to the model, and analyze results.

This class performs the same fixed-point conversion tasks as the Fixed-Point Tool. This facilitates scripting of the automatic conversion workflow and accessing data for analysis. For more information, see [Convert a Model to Fixed Point Using the Command-Line](#).



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## Automated fixed-point conversion for commonly used DSP System objects, including Biquad Filter, FIR Filter, and FIR Rate Converter

You can now convert the following DSP System Toolbox System objects to fixed point using the Fixed-Point Converter app.

- `dsp.BiquadFilter`
- `dsp.FIRFilter`, direct form only
- `dsp.FIRRateConverter`
- `dsp.LowerTriangularSolver`
- `dsp.UpperTriangularSolver`
- `dsp.ArrayVectorAdder`

You can propose and apply data types for these System objects based on simulation range data. During the conversion process, you can view simulation minimum and maximum values and proposed data types for these System objects. You can also view whole number information and histogram data. You cannot propose data types for these System objects based on static range data. This requires a DSP System Toolbox license. For more information, see [Convert a System object to Fixed-Point Using the Fixed-Point Converter App](#).

## Simulation range collection and data type proposals for MATLAB Function blocks in Simulink

The Fixed-Point Tool can now collect and display simulation ranges for variables inside a MATLAB Function block. The tool can also propose data types for the variables based on the simulation data. You must manually apply the proposed data types to the variables. For more information, see [Convert Model Containing MATLAB Function Block to Fixed Point](#).

## Overflow diagnostics to distinguish between wrap and saturation in Simulink

You can now separately control the diagnostics for overflows that wrap and overflows that saturate by setting each diagnostic to `error`, `warning`, or `none`. These controls simplify debugging models in which only one type overflow is of interest. For example, if you need to detect only overflows that wrap, in the **Data Validity** pane of the

Configuration Parameters dialog box you can set **Wrap on overflow** to error or warning, and set **Saturate on overflow** to none.

## Highlighting of potential data type issues in generated HTML report

You can now highlight potential data type issues in the generated HTML report. The report highlights MATLAB code that requires single-precision, double-precision, or expensive fixed-point operations. The expensive fixed-point operations check identifies optimization opportunities by highlighting expressions in the MATLAB code that require cumbersome multiplication or division, or expensive rounding.

For more information, see [Find Potential Data Type Issues in Generated Code](#)

## Code generation of for loops using fixed-point loop indices

Fixed-point data types are now supported as for-loop indices in `codegen`. This capability requires a MATLAB Coder license. For more information, see [for](#).

## Cast net slope computations using rational numbers

This new option improves the numerical accuracy and the readability of the C code generated for certain fixed-point conversions having nonbinary net slopes. Normally, net slope computation uses an integer multiplication followed by shifts. Enabling this optimization replaces the multiply and shift operation with a multiply and divide sequence that uses a rational number under certain simplicity and accuracy conditions.

For example, applying a net slope of 0.9, which traditionally would have generated

```
Vc = (int16_T)(Va * 115 >> 7);
```

becomes

```
Vc = (int16_T)(Va * 9/10);
```

This optimization affects both simulation and code generation. For more information, see [Handle Net Slope Computation](#).

## Lock Column View option in the Fixed-Point Tool

This option prevents the Fixed-Point Tool from automatically changing the column view of the contents pane. To enable this option, in the Fixed-Point Tool menu, click **View > Lock Column View**. This setting is preserved across sessions.

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## Fixed-Point Advisor enhancements

- Improved support for interaction with Simulink data objects, including bus objects
- Block replacement recommendations for blocks with CORDIC support

## hdlram renamed hdl.RAM

The `hdlram` System object™ has been renamed `hdl.RAM`. This System object no longer requires 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`.

## Changes to data type strings

### Signal data type display

Signals using fixed-point data types with slope and bias scaling now always display the slope value in the data type name. In previous releases, the display decomposed the slope into slope adjustment factor and fixed exponent when it led to a more compact string. For example, the data type `fixdt(1,32,0.01953125,0)` now gets the name `sfix32_S0p01953125`. In previous releases, the name was in the decomposed format `sfix32_F1p25_en6`.

### tostring function now uses 0 and 1 to represent signedness

The string representation of `numerictype` and `fixdt` objects returned by the `tostring` function now use 0 and 1 to represent signedness rather than `true` and `false`.

```
T = numerictype(true,16,15);
T.tostring
```

```
ans =
```

```
numerictype(1,16,15)
```

When programmatically processing data types, best practice is to convert string representations to `numerictype` objects. The string changes for this release do not change the object that the strings are converted to. To convert a data type name string

to an object, pass the string as the input argument to `fixdt` or `numerictype`. For example, `fixdt('sfix32_S0p01953125')` and `fixdt('sfix32_F1p25_En6')` return identical `numerictype` objects. To convert the results of the `tostring` function back to an object, use the `eval` function. For example, the `numerictype` objects returned by `eval('numerictype(1,16,15)')` and `eval('numerictype(true,16,15)')` are identical.

## Compatibility Considerations

If your code converts data type strings to objects before doing any processing, then you will not have any compatibility issues related to the string changes. If you depend on the exact text returned by the `tostring` function or the exact text of a Simulink data type name, then you must modify your code to account for the changes described here. Alternatively, you can convert the string to a `numerictype` object before doing any additional processing.

## New featured examples

The Fixed-Point Conversion Using Fixed-Point Tool and Derived Range Analysis example demonstrates using derived range analysis and the Fixed-Point Tool to convert a corner detection model to fixed point.

# R2014a

**Version: 4.2**

**New Features**

**Bug Fixes**

## Data type override and automatic data typing for bus objects

### Data type override for bus objects

You can now apply data type override to models and subsystems that use virtual and non-virtual buses. The bus element types obey the data type override settings. This capability allows you to:

- Obtain the idealized floating-point behavior of models that use buses.
- Obtain the ideal derived ranges for models that use buses.
- Easily compare the idealized floating-point behavior with the fixed-point behavior of models that use buses.
- Use data type override to share fixed-point models that use buses with users who do not have a fixed-point license.

### Autoscaling for bus objects

You can autoscale models that use virtual and non-virtual buses. This capability facilitates fixed-point conversion and optimization of models. The Fixed-Point Tool automatically proposes fixed-point data types for bus elements which removes the need to perform manual analysis and conversion of bus element data types.

For more information, see [Refine Data Types of a Model with Buses Using Simulation Data](#).

## Derived ranges for complex signals in Simulink

Using the Fixed-Point Tool, you can now derive ranges for complex signals in Simulink. For more information, see [Conversion Using Range Analysis](#).

## **cordicsqrt** function for fixed-point CORDIC-based square root functionality

The `cordicsqrt` function provides a CORDIC-based approximation of square root for use in fixed-point applications. For more information, see [cordicsqrt](#) and [Compute Square Root Using CORDIC](#).

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## **Overflow detection with scaled double data types in MATLAB Coder projects**

The MATLAB Coder Fixed-Point Conversion tool now provides the capability to detect overflows. At the numerical testing stage in the conversion process, the tool simulates the fixed-point code using scaled doubles. It then reports which expressions in the generated code produce values that would overflow the fixed-point data type. For more information, see [Detect Overflows Using the Fixed-Point Conversion Tool](#) and [Detecting Overflows](#).

You can also detect overflows when using the `codegen` function. For more information, see `coder.FixptConfig` and [Detect Overflows at the Command Line](#).

These capabilities require a MATLAB Coder license.

## **Fixed-point ARM Cortex-M code replacement support for DSP System Toolbox FIR filters**

Fixed-point ARM<sup>®</sup> Cortex<sup>®</sup>-M code replacement library support is now available for the Discrete FIR block and the `dsp.FIRFilter` System object.

These capabilities require a DSP System Toolbox license.

## **Fixed-Point Advisor support for referenced configuration sets**

The Fixed-Point Advisor now supports referenced configuration sets. For more information, see [Preparing for Data Typing and Scaling](#).

## **Enhancements to automated conversion of MATLAB code**

R2014a includes the following enhancements to the fixed-point conversion capability in MATLAB Coder projects.

These capabilities require a MATLAB Coder license.

### **Support for MATLAB classes**

You can now use the MATLAB Coder Fixed-Point Conversion tool to convert floating-point MATLAB code that uses MATLAB classes. For more information, see [Fixed-Point Code for MATLAB Classes](#).

## Generated fixed-point code enhancements

The generated fixed-point code now:

- Uses subscripted assignment (the colon(:) operator). This enhancement produces concise code that is more readable.
- Has better code for constant expressions. In previous releases, multiple parts of an expression were quantized to fixed point. The final value of the expression was less accurate and the code was less readable. Now, constant expressions are quantized only once at the end of the evaluation. This new behavior results in more accurate results and more readable code.

For more informations, see [Generated Fixed-Point Code](#).

## Fixed-point report

In R2014a, when you convert floating-point MATLAB code to fixed-point C/C++ code, the code generation software generates a fixed-point report in HTML format. For the variables in your MATLAB code, the report provides the proposed fixed-point types and the simulation or derived ranges used to propose those types. For a function, `my_fcn`, and code generation output folder, `out_folder`, the location of the report is `out_folder/my_fcn/fixpt/my_fcn_fixpt_Report.html`. If you do not specify `out_folder` in the project settings or as an option of the `codegen` command, the default output folder is `codegen`.

## Automatic C compiler setup

In earlier releases, to set up a compiler before using `fiaccl` to accelerate 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](#).

## More flexible control of `dsp.LMSFilter` System object fixed-point settings

For all `dsp.LMSFilter` System object fixed-point settings, you can now specify independent fixed-point data types.

This capability requires a DSP System Toolbox license.



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## Derived ranges for For Each and For Each Subsystem blocks

Range analysis supports For Each and For Each Subsystem blocks, with the following limitations:

- When For Each Subsystem contains another For Each Subsystem, not supported.
- When For Each Subsystem contains one or more Simulink Design Verifier™ Test Condition, Test Objective, Proof Assumption, or Proof Objective blocks, not supported.



# R2013b

**Version: 4.1**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## C99 long long integer data type for embedded code generation

If your target hardware and your compiler support the C99 long long integer data type, you can use this data type for code generation. Using long long results in more efficient generated code that contains fewer cumbersome operations. Multi-line fixed-point helper functions can be replaced by simple expressions. This data type also provides more accurate simulation results for fixed-point and integer simulations. If you are using Microsoft® Windows® (64-bit), using long long improves performance for many workflows including:

- Using Accelerator mode in Simulink
- Working with Stateflow® software
- Generating C code with Simulink Coder
- Accelerating fixed-point code using `fiaccel`
- Generating C code and MEX functions with MATLAB Coder

For more information about enabling long long in Simulink, see the **Enable long long** and **Number of bits: long long** configuration parameters on the Hardware Implementation Pane.

For more information about enabling long long for MATLAB Coder, see `coder.HardwareImplementation`.

## Model Advisor fixed-point checks with additional coverage and optimization awareness

The Model Advisor fixed-point checks now cover additional blocks in base Simulink and System Toolboxes. The checks also now include the MATLAB Function block, System objects, Stateflow, and `fi` objects. These improved checks consider model settings such as hardware configuration and code generation settings. These updated checks also avoid false negative results.

These checks require an Embedded Coder license.

For more information, see:

- Identify blocks that generate expensive rounding code
- Identify questionable fixed-point operations
- Identify blocks that generate expensive fixed-point and saturation code

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## **fi object as an index in colon expressions and an argument to numel and bit index functions**

### **fi object as an index in colon expressions**

You can now use `fi` objects in colon expressions. When you use `fi` in a colon expression, all colon operands must have integer values. See the `fi` and colon reference pages for examples.

### **fi objects as bit index input argument**

The `bitget`, `bitset`, `bitsliceget`, `bitandreduce`, `bitorreduce`, and `bitxorreduce` functions now accept `fi` objects as the bit index argument.

### **fi objects as shift-value input argument**

The `bitsra`, `bitsrl`, `bitsll`, `bitrol`, and `bitror` functions now accept `fi` objects as the shift-value input argument. You can use `fi` and built-in data type shift values interchangeably in MATLAB functions. This new capability facilitates fixed-point conversion.

### **numel function support for fi inputs**

Effective R2013b, the `numel` function returns the number of elements in a `fi` array. Using `numel` in your MATLAB code returns the same result for built-in types and `fi` objects. Use `numel` to write data-type independent MATLAB code for array handling; you no longer need to use the `numberofelements` function.

The `numel` function is supported for simulation and code generation and with the MATLAB Function block in Simulink.

For more information, see `numel`.

## **Improved efficiency of data type internal rules for Lookup Table blocks**

Blocks in the Lookup Tables library have a new internal rule for fixed-point data types to enable faster hardware instructions for intermediate calculations (with the exception of the Direct Lookup Table (n-D), Prelookup and Lookup Table Dynamic blocks). To use this new rule, select **Speed** for the **Internal Rule Priority** parameter in the dialog box. To use the R2013a internal rule, select **Precision**.

## Derived ranges for complex variables in MATLAB Coder projects

Using the Fixed-Point Conversion tool in MATLAB Coder projects, you can now derive ranges for complex variables. For more information, see [Propose Data Types Based on Derived Ranges](#). This capability requires a MATLAB Coder license.

## Simplified modeling of single-precision designs

Fixed-Point Designer now uses strict single-precision algorithms for operations between singles and integer or fixed-point data types. Operations, such as cast, multiplication and division, use single-precision math instead of introducing higher-precision doubles for intermediate calculations in simulation and code generation. You no longer have to explicitly cast integer or fixed-point inputs of these operations to single precision. To detect the presence of double data types in your model, use the Model Advisor Identify questionable operations for strict single-precision design check.

## Compatibility Considerations

In R2013b, for both simulation and code generation, Fixed-Point Designer avoids the use of double data types to achieve strict single design for operations between singles and integers or fixed-point types. In previous releases, Fixed-Point Designer used double data types in intermediate calculations for higher precision. You might see a difference in numerical behavior of an operation between earlier releases and R2013b.

For example, when you cast from a fixed-point or integer data type to single or vice versa, the type used for intermediate calculations can significantly affect numerical results. Consider:

- Input type: `ufix128_En127`
- Input value: 1.99999999254942 — Stored integer value is  $(2^{128} - 2^{100})$ .
- Output type: `single`

| Release           | Calculation performed by Fixed-Point Designer  | Output Result | Design Goal                               |
|-------------------|--|---------------|---|
| R2013b            | <code>Y = single(2<sup>-127</sup>) * single(2<sup>128</sup>-2<sup>100</sup>)</code><br><code>= single(2<sup>-127</sup>) * Inf</code>                           | Inf           | Strict singles                            |
| Previous releases | <code>Y = single( double(2<sup>-127</sup>) * double(2<sup>128</sup> - 2<sup>100</sup>))</code><br><code>= single(2<sup>-127</sup> * 3.402823656532e+38)</code> | 2             | Higher-precision intermediate calculation |

---

There is also a difference in the generated code. Previously, Fixed-Point Designer allowed the use of doubles in the generated code for a mixed multiplication that used single and integer types.

```
m_Y.Out1 = (real32_T)((real_T)m_U.In1*(real_T)m_U.In2);
```

In R2013b, it uses strict singles.

```
m_Y.Out1=(real32_T)m_U.In1*m_U.In2;
```

You can revert to the numerical behavior of previous releases, if necessary. To do so, insert explicit casting from integer and fixed-point data types to doubles for the inputs of these operations.

## Range analysis support on Mac platforms

You can now perform derived range analysis of your model on Mac platforms. For more information, see Conversion Using Range Analysis.

## Changes to showInstrumentationResults function options

### New option to suppress display of MATLAB code

When generating a printable instrumentation report, you can now choose to display only the tables that show information about logged variables. Used with the `-printable` option, the `-nocode` option suppresses display of the MATLAB code. Displaying only the logged variable information is useful for large projects with many lines of code.

### Removal of `-browser` option

The `showInstrumentationResults` function `-browser` option has been removed. Use the `-printable` option instead. The `-printable` option creates a printable report and opens it in the system browser.

For more information, see `showInstrumentationResults`.

## Changes to Continuous state-space block family range analysis support

The Continuous Simulink blocks State-Space, Transfer Fcn, and Zero-Pole are not supported and not stubbable for range analysis. For more information on blocks that are supported for range analysis, see Supported and Unsupported Simulink Blocks.

## Compatibility Considerations

If you have a model that contains one or more continuous State-Space, Transfer Fcn, or Zero-Pole blocks, your model is incompatible with range analysis. Consider analyzing smaller portions of your model to work around this incompatibility.

## Enhanced `fiaccel` support for `int64` and `uint64` functions

The `fiaccel` function now supports `int64` and `uint64` with `fi` inputs.

## Support for LCC compiler on Microsoft Windows (64-bit) machines

If you are using Microsoft Windows (64-bit), LCC-64 is now available as the default compiler. You no longer have to install a separate compiler to perform fixed-point acceleration using `fiaccel`.

## Warning for use of inexact `fi` and `fimath` property names

All `fi` and `fimath` property names are case sensitive and require that you use the full property names. Effective R2013b, if you use inexact property names, Fixed-Point Designer generates a warning.

## Compatibility Considerations

To avoid seeing warnings for `fi` and `fimath` properties, update your code so that it uses the full names and correct cases of all these properties. The full names and correct cases of the properties appear when you display a `fi` or `fimath` object on the MATLAB command line.

## Conversion of numeric variables into `Simulink.Parameter` objects

You can now convert a numeric variable into a `Simulink.Parameter` object using a single step.

```
myVar = 5; % Define numerical variable in base workspace
myObject = Simulink.Parameter(myVar); % Create data object and assign variable value to data object value
```

Previously, you did this conversion using two steps.

```
myVar = 5; % Define numerical variable in base workspace
myObject = Simulink.Parameter; % Create data object
```



---

```
myObject.Value = myVar; % Assign variable value to data object value
```

## Fixed-point conversion test file coverage results

The MATLAB Coder Fixed-Point Conversion tool now provides test file coverage results. After simulating your design using a test file, the tool provides an indication of how often the code is executed. If you run multiple test files at once, the tool provides the cumulative coverage. This information helps you determine the completeness of your test files and verify that they are exercising the full operating range of your algorithm. The completeness of the test file directly affects the quality of the proposed fixed-point types.

This capability requires a MATLAB Coder license.

For more information, see [Code Coverage](#).

## Fixed-point conversion workflow supports designs that use enumerated types

Using the Fixed-Point Conversion tool in MATLAB Coder projects, you can now propose data types for enumerated data types using derived and simulation ranges.

For more information, see [Propose Fixed-Point Data Types Based on Derived Ranges](#) and [Propose Fixed-Point Data Types Based on Simulation Ranges](#). This capability requires a MATLAB Coder license.

## Fixed-point conversion of variable-size data using simulation ranges

Using the Fixed-Point Conversion tool in MATLAB Coder projects, you can propose data types for variable-size data using simulation ranges.

For more information, see [Propose Fixed-Point Data Types Based on Simulation Ranges](#). This capability requires a MATLAB Coder license.

## Error checking improvements for `bitconcat`, `bitandreduce`, `bitorreduce`, `bitxorreduce`, `bitsliceget` functions

The `bitconcat`, `bitandreduce`, `bitorreduce`, `bitxorreduce`, and `bitsliceget` functions now check that all input arguments are real. If any inputs are complex, these functions generate an error.

The `bitconcat` function now generates an error in the unary syntax case, `bitconcat(a)`, if the input argument `a` is a scalar or is empty. To use `bitconcat` with one input argument, the argument must have more than one array element available for bit concatenation (that is, `length(a)>1`).

## Legacy data type specification functions return numeric objects

In previous releases, the following functions returned a MATLAB structure describing a fixed-point data type:

- `float`
- `sfix`
- `sfrac`
- `sint`
- `ufix`
- `ufrac`
- `uint`

Effective R2013b, they return a `Simulink.NumericType` object. If you have existing models that use these functions as parameters to dialog boxes, the models continue to run as before and there is no need to change any model settings.

These functions do not offer full Data Type Assistant support. To benefit from this support, use `fixdt` instead.

| Function                     | Return Value in Previous Releases — MATLAB structure | Return Value Effective R2013b — <code>NumericType</code>                                    |
|------------------------------|--|---|
| <code>float('double')</code> | Class: 'DOUBLE'                                      | DataTypeMode: 'Double'  |
| <code>float('single')</code> | Class: 'SINGLE'                                      | DataTypeMode: 'Single'  |
| <code>sfix(16)</code>        | Class: 'FIX'<br>IsSigned: 1<br>MantBits: 16          | DataTypeMode: 'Fixed-point: unspecified scaling'<br>Signedness: 'Signed'<br>WordLength: 16  |
| <code>ufix(7)</code>         | Class: 'FIX'<br>IsSigned: 0<br>MantBits: 7           | DataTypeMode: 'Fixed-point: unspecified scaling'<br>Signedness: 'Unsigned'<br>WordLength: 7 |

| Function    | Return Value in Previous Releases — MATLAB structure         | Return Value Effective R2013b — NumericType   |
|-------------|--|---|
| sfrac(33,5) | Class: 'FRAC'<br>IsSigned: 1<br>MantBits: 33<br>GuardBits: 5 | DataTypeMode: 'Fixed-point: binary point scaling'<br>Signedness: 'Signed'<br>WordLength: 33<br>FractionLength: 27   |
| ufrac(44)   | Class: 'FRAC'<br>IsSigned: 0<br>MantBits: 44<br>GuardBits: 0 | DataTypeMode: 'Fixed-point: binary point scaling'<br>Signedness: 'Unsigned'<br>WordLength: 44<br>FractionLength: 44 |
| sint(55)    | Class: 'INT'<br>IsSigned: 1<br>MantBits: 55                  | DataTypeMode: 'Fixed-point: binary point scaling'<br>Signedness: 'Signed'<br>WordLength: 55<br>FractionLength: 0    |
| uint(77)    | Class: 'INT'<br>IsSigned: 0<br>MantBits: 77                  | DataTypeMode: 'Fixed-point: binary point scaling'<br>Signedness: 'Unsigned'<br>WordLength: 77<br>FractionLength: 0  |

## Compatibility Considerations

### MATLAB Code

MATLAB code that depends on the return arguments of these functions being a structure with fields named **Class**, **MantBits** or **GuardBits** no longer works correctly. Change the code to access the appropriate properties of a **NumericType** object, for example, **DataTypeMode**, **Signedness**, **WordLength**, **FractionLength**, **Slope** and **Bias**.

### C Code

Update C code that expects the data type of parameters to be a legacy structure to handle **NumericType** objects instead. For example, if you have S-functions that take legacy structures as parameters, update these S-functions to accept **NumericType** objects.

### MAT-files

Effective R2013b, if you open a Simulink model that uses a MAT-file that contains a data type specification created using the legacy functions, the model uses the same data types and behaves in the same way as in previous releases but Simulink generates a warning.

To eliminate the warning, recreate the data type specifications using `NumericType` objects and save the MAT-file.

You can use the `fixdtupdate` function to update a data type specified using the legacy structure to use a `NumericType`. For example, if you saved a data type specification in a MAT-file as follows in a previous release:

```
oldDataType = sfrac(16);
save myDataTypeSpecification oldDataType
use fixdtUpdate to recreate the data type specification to use NumericType:

load DataTypeSpecification
fixdtUpdate(oldDataType)
```

```
ans =
```

```
    NumericType with properties:
```

```
        DataTypeMode: 'Fixed-point: binary point scaling'
           Signedness: 'Signed'
           WordLength: 16
    FractionLength: 15
           IsAlias: 0
           DataScope: 'Auto'
           HeaderFile: ''
           Description: ''
```

For more information, at the MATLAB command line, enter:

```
fixdtUpdate
```

## **numberofelements function being removed in a future release**

The `numberofelements` function will be removed in a future release of Fixed-Point Designer software. Use `numel` instead.

# R2013a

**Version: 4.0**

**New Features**

**Bug Fixes**

**Compatibility Considerations**

## Product restructuring

The Fixed-Point Designer product replaces two pre-existing products: Fixed-Point Toolbox™ and Simulink Fixed Point™. You can access archived documentation for both products on the MathWorks® Web site.

## Histogram logging in instrumented MATLAB Code Generation report

The `buildInstrumentedMex` and `showInstrumentationResults` instrumentation functions now can generate log2 histograms. A histogram is generated for each named and intermediate variable and for each expression in your code. The code generation report **Variables** tab includes a link to the histogram for each variable. You can use this histogram to determine the word and fraction lengths for your fixed-point values. Refer to the `buildInstrumentedMex` and `showInstrumentationResults` reference pages for information.

## fi object in indexing and switch-case expressions

Effective this release, you can use `fi` objects as indices to arrays of built-in types and `fi` types. You can also use `fi` objects in switch-case expressions. These changes let you use `fi` objects without having to convert them. See the `fi` reference page for examples.

## zeros, ones, and cast code reuse for floating-point and fixed-point types

The `zeros`, `ones`, and `cast` functions now work with fixed-point data types as well as built-in data types. The functions can now return an output whose class matches that of a specified numeric variable or `fi` object. For built-in data types, the output assumes the numeric data type, sparsity, and complexity (real or complex) of the specified numeric variable. For `fi` objects, the output assumes the `numericType`, complexity (real or complex), and `fimath` of the specified `fi` object.

For example:

```
>> a = fi([],1,24,12);  
>> c = cast(pi,'like',a)
```

```
c =
```

---

3.1416

```
    DataTypeMode: Fixed-point: binary point scaling
    Signedness: Signed
    WordLength: 24
    FractionLength: 12
```

```
>> z = zeros(2,3,'like',a)
```

```
z =
```

```
    0    0    0
    0    0    0
```

```
    DataTypeMode: Fixed-point: binary point scaling
    Signedness: Signed
    WordLength: 24
    FractionLength: 12
```

```
>> o = ones(2,3,'like',a)
```

```
o =
```

```
    1    1    1
    1    1    1
```

```
    DataTypeMode: Fixed-point: binary point scaling
    Signedness: Signed
    WordLength: 24
    FractionLength: 12
```

This capability allows you to cleanly separate algorithm code in MATLAB from data type specifications. Using separate data type specifications enables you to:

- Reuse your algorithm code with different data types.
- Switch easily between fixed-point and floating-point data types to compare fixed-point behavior to a floating-point baseline.
- Try different fixed-point data types to determine their effect on the behavior of your algorithm.
- Write clean, readable code.

For more information, see Implement FIR Filter Algorithm for Floating-Point and Fixed-Point Types using cast and zeros.

## Code generation for $x.^n$ when $n$ is a variable and $x$ is a fi object

If the output type can be derived from the input settings, the `mpower` and `power` functions no longer require a constant exponent input. For more information, see `mpower` and `power`.

## Fixed-Point Advisor support for model reference

The Fixed-Point Advisor now performs checks on referenced models. It checks the entire model reference hierarchy against fixed-point guidelines. The Advisor also provides guidance about model configuration settings and unsupported blocks to help you prepare your model for conversion to fixed point.

## Automated conversion of floating-point to fixed-point types in MATLAB Coder projects

You can now convert floating-point MATLAB code to fixed-point C code using the fixed-point conversion capability in MATLAB Coder projects. You can choose to propose data types based on simulation range data, static range data, or both.

---

**Note:** You must have a MATLAB Coder license.

---

During fixed-point conversion, you can:

- Propose fraction lengths based on default word lengths.
- Propose word lengths based on default fraction lengths.
- Optimize whole numbers.
- Specify safety margins for simulation min/max data.
- Validate that you can build your project with the proposed data types.
- Test numerics by running the test file with the fixed-point types applied.
- View a histogram of bits used by each variable.

For more information, see [Propose Fixed-Point Data Types Based on Simulation Ranges](#) and [Propose Fixed-Point Data Types Based on Derived Ranges](#).



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## Improved autoscaling for models with virtual bus signals

Autoscaling with the Fixed-Point Tool now handles data type constraints for virtual buses that do not have any associated bus objects. The data type proposals take into account the constraints introduced by these bus signals.

This improved autoscaling reduces data type mismatch errors. It also enables the Fixed-Point Tool to provide additional diagnostic information when you accept autoscaling proposals. For more information, see [Shared Data Type Summary](#).

## Data Type Override for MATLAB Function block using built-in doubles and singles

The data type override rules for MATLAB Function block input signals and parameters have changed. If the input signals and parameters are `double` or `single`, and you specify data type override to be `Double` or `Single`, the overridden data types are now built-in `double` or built-in `single`, not `fi double` and `fi single` as in previous releases. If the input signals and parameters are `fi` objects or fixed-point signals, and you specify data type override to be `Double` or `Single`, the overridden data types are `fi double` and `fi single` as in previous releases. For more information, see [MATLAB Function Block with Data Type Override](#).

## Compatibility Considerations

If you have MATLAB Function block code from previous releases that contains special cases for `fi double` or `fi single`, and you specify data type override to be `Double` or `Single`, you might have to update this code to handle built-in `double` and `single`.

## Instrumentation for arrays of structs

The `buildInstrumentedMex` and `showInstrumentationResults` instrumentation functions now show instrumentation results for arrays of structs. Each field of each struct is logged and appears in the code generation report on the **Variables** tab.

## File I/O function support

The following file I/O functions are now supported for code acceleration and generation:

- `fclose`

- `fopen`
- `fprintf`

To view implementation details, see [Functions Supported for Code Acceleration or Generation](#).

## Support for nonpersistent handle objects

You can now accelerate code using `fiaccel` for local variables that contain references to handle objects or System objects. In previous releases, accelerating code for these objects was limited to objects assigned to persistent variables.

## Load from MAT-files for code acceleration

`fiaccel` now supports a subset of the `load` function for loading run-time values from a MAT-file. It also provides a new function, `coder.load`, for loading compile-time constants. This support facilitates code generation from MATLAB code that uses `load` to load constants into a function. You no longer have to manually type in constants that were stored in a MAT-file.

To view implementation details for the `load` function, see [Functions Supported for Code Acceleration or Generation](#).

## New toolbox functions supported for code acceleration and generation

To view implementation details, see [Functions Supported for Code Acceleration or Generation](#).

### Bitwise Operation Functions

- `flintmax`

### Computer Vision System Toolbox Classes and Functions

- `binaryFeatures`
- `insertMarker`
- `insertShape`

### Data File and Management Functions

- `computer`

- 
- `fclose`
  - `fopen`
  - `fprintf`
  - `load`

### **Image Processing Toolbox Functions**

- `conndef`
- `imcomplement`
- `imfill`
- `imhmax`
- `imhmin`
- `imreconstruct`
- `imregionalmax`
- `imregionalmin`
- `iptcheckconn`
- `padarray`

### **Interpolation and Computational Geometry**

- `interp2`

### **MATLAB Desktop Environment Functions**

- `ismac`
- `ispc`
- `isunix`

### **String Functions**

- `strfind`
- `strrep`

### **Function to be removed in a future release**

The `saveglobalfimathpref` will be removed in a future release.

## Compatibility Considerations

Do not save `globalfimath` as a MATLAB preference. If you have previously saved `globalfimath` as a MATLAB preference, use `removeglobalfimathpref` to remove it.

## Function being removed

The `emlmex` function has been removed.

## Compatibility Considerations

The `emlmex` function generates an error in R2013a. Use `fiaccel` instead.