Dymola

Dynamic Modeling Laboratory

Dymola Release Notes

Dymola 2021

The information in this document is subject to change without notice.

Document version: 1

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1 Important notes on Dymola

Installation on Windows

To translate models on Windows, you must also install a supported compiler. The compiler is not distributed with Dymola. Note that administrator privileges are required for installation. Three types of compilers are supported on Windows in Dymola 2021:

Microsoft Visual Studio C++

This is the recommended compiler for professional users. Both free and full compiler versions are supported. Refer to section "Compilers" on page 54 for more information. **Note** that from Dymola 2020x, Visual Studio C++ compilers older than version 2012 are no longer supported.

Intel

Dymola 2021 has limited support for the Intel Parallel Studio XE compiler. For more information about this compiler, see section "Compilers" on page 54; the section about Intel compilers.

GCC

Dymola 2021 has limited support for the MinGW GCC compiler, 32-bit and 64-bit. For more information about GCC, see section "Compilers" on page 54; the section about GCC compilers.

Installation on Linux

To translate models, Linux relies on a GCC compiler, which is usually part of the Linux distribution. Refer to section "Supported Linux versions and compilers" on page 57 for more information.

2 About this booklet

This booklet covers Dymola 2021. The disposition is similar to the one in Dymola User Manuals; the same main headings are being used (except for, e.g., Libraries and Documentation).

3 Dymola 2021

Note! *From this version of Dymola, Microsoft Windows 7 is not officially supported.*

3.1 Introduction

3.1.1 Additions and improvements in Dymola

A number of improvements and additions have been implemented in Dymola 2021. In particular, Dymola 2021 provides:

- Option to display connector names in the diagram (page 8)
- Saving periodic snapshots during simulation (page 32)
- Improvements to simulation analysis:
    - Numeric integration: Plotting the scaled local error estimate from the integrator (page 13)
    - Event log: Filtering of efficient minor events (page 15)
- GUI for sweeping more than two parameters (page 45)
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3.1.2 New and updated libraries

New libraries

There are no new libraries in this Dymola version.

Updated libraries

The following libraries have been updated:

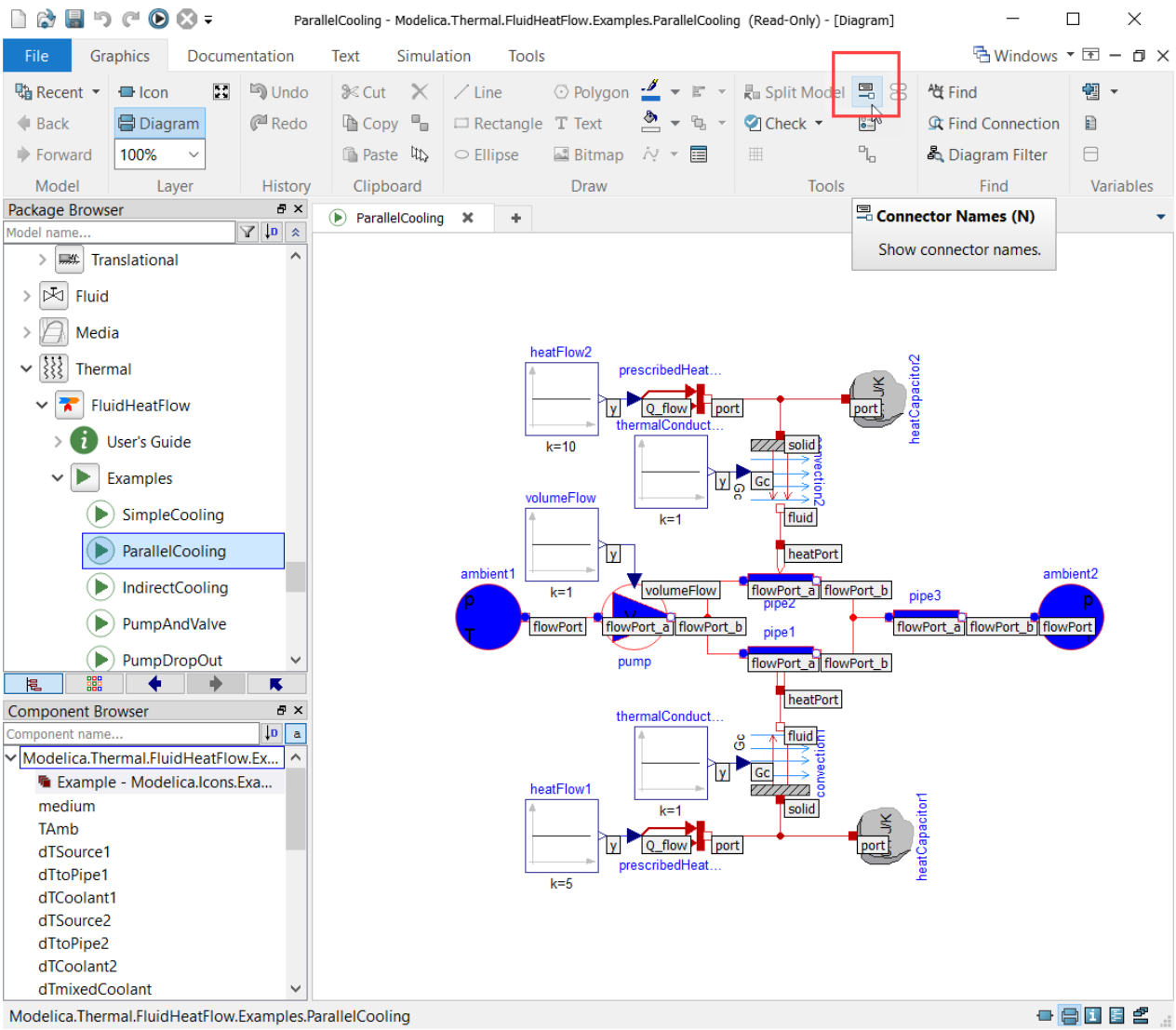
- Battery Library, version 2.1.4
- Brushless DC Drives Library, version 1.1.1
- ClaRa DCS Library, version 1.3.0
- ClaRa Grid Library, version 1.3.0
- ClaRa Plus Library, version 1.3.0
- Claytex Library, version 2019.2
- Claytex Fluid Library, version 2020.1
- Cooling Library, version 1.4
- Dassault Systemes Library, version 1.4
- Dymola Commands Library, version 1.9
- Dymola Models Library, version 1.1
- Electric Power Systems Library, version 1.3.1
- Electrified Powertrains Library (ETPL), version 1.3.2
- Fluid Dynamics Library, version 2.9.0
- Fluid Power Library, version 2020.1
- FTire Interface Library, version 1.0.4
- Human Comfort Library, version 2.9.0
- HVAC (Heating, Ventilation, and Air Conditioning) Library, version 2.9.0
- Hydrogen Library, version 1.3.2
- Modelica_DeviceDrivers, version 1.8.2
- Pneumatic Systems Library, version 1.4
- Testing Library, version 1.3
- Thermal Systems Library, version 1.6.0
- Thermal Systems Mobile AC Library, version 1.6.0
- VeSyMA (Vehicle Systems Modeling and Analysis) Library, version 2019.2
- VeSyMA - Engines Library, version 2020.1
- VeSyMA - Powertrain Library, version 2020.1
- VeSyMA - Suspensions Library, version 2020.1
- VeSyMA2ETPL Library, version 2020.1
- Visa2Base, version 1.8
- Visa2Paper, version 1.8
- Visa2Steam, version 1.8

For more information about the updated libraries, please see the Release Notes section in the documentation for each library, respectively.

3.2 Developing a model

3.2.1 Displaying connector names in the diagram

By the new command **Graphics > Connector Names** you can display the connector names in the diagram. The command works in toggle mode. By default, connector names are not shown.

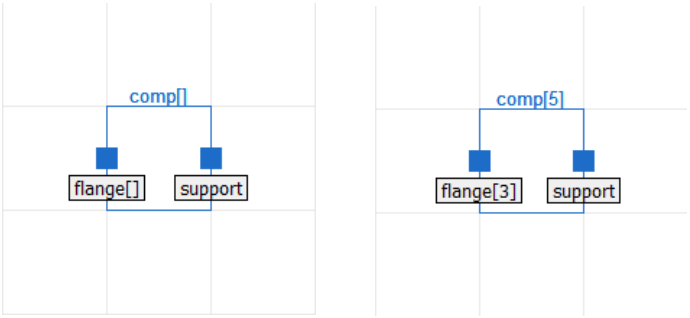


A corresponding flag `Advanced.Editor.ConnectorNameDisplay` is available. The flag is by default false.

Note that array components/connectors are shown with empty brackets by default. By setting the flag

```
Advanced.ArraySizeInName = true
```

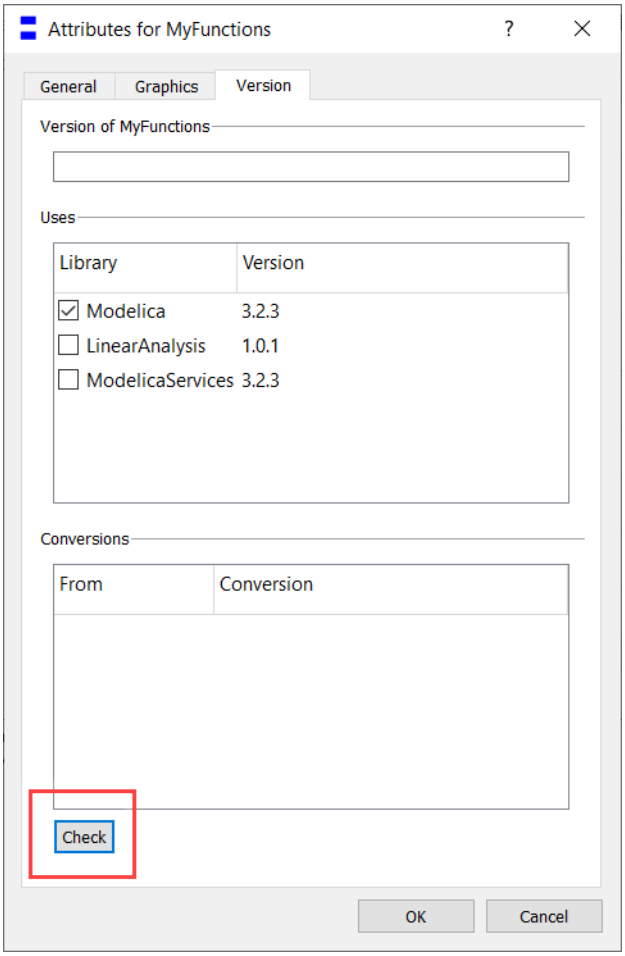
the array size is also displayed in the brackets (compare the images below).



This flag is by default `false`.

3.2.2 Checking conversion scripts

A new command button **Check** is available in the **Version** tab of the **Attributes** dialog. This dialog can be reached by **Graphics > Attributes** or **Text > Attributes**:



Selecting the conversion script and clicking **Check** opens a browser for selecting the package to convert from. When this package is selected, a check of the conversion script is performed, and the result is displayed.

If the old library is converted to additional libraries you should ideally open them before checking the conversion, e.g. Modelica normally converts some parts to the ObsoleteModelica library.

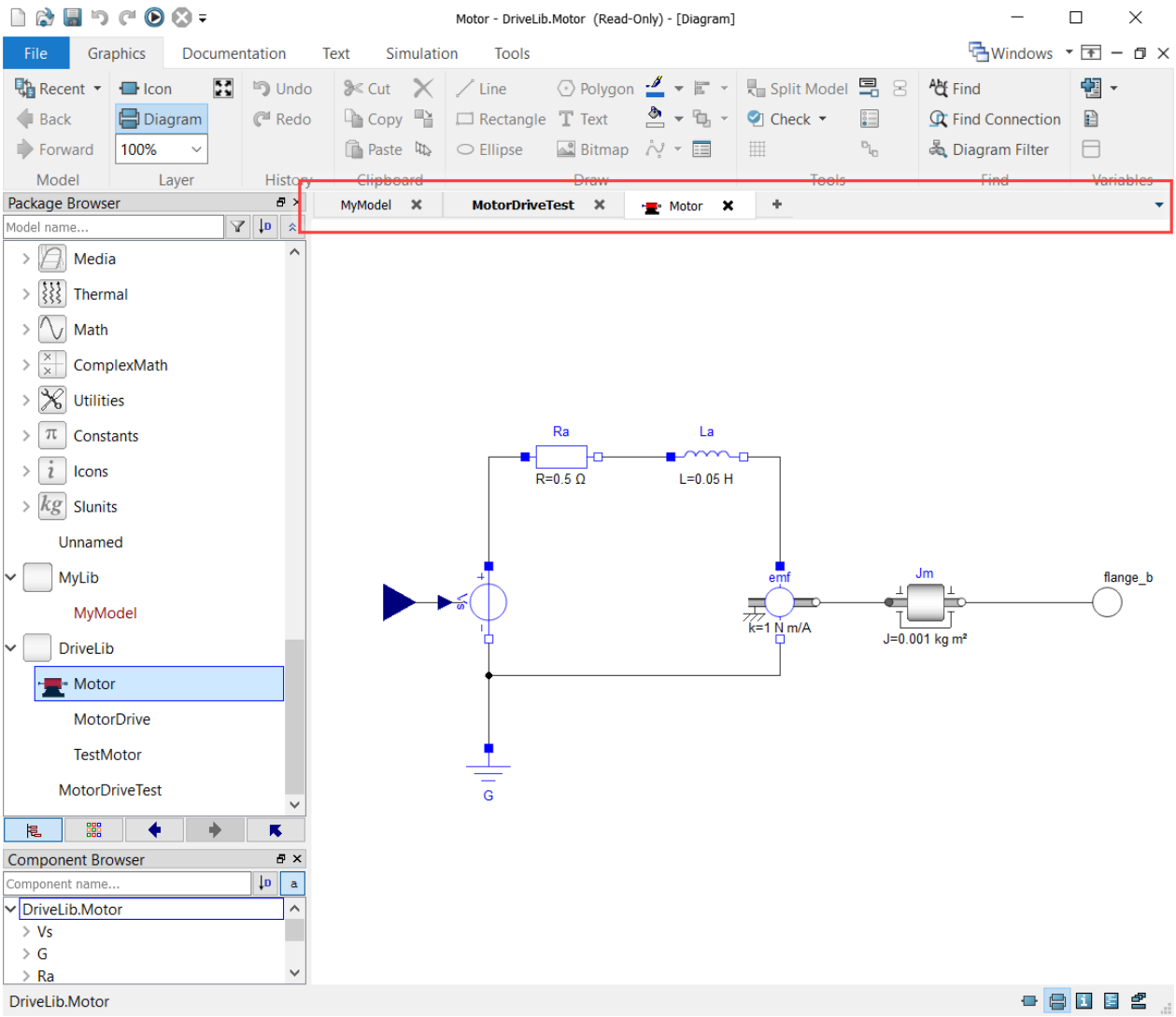
When prompted for the old library you will first be prompted for the old library (including the version number). If other libraries were merged into the library, you will also be prompted for them (without version number).

Selecting these libraries are optional.

3.2.3 Minor improvements

The Model tabs moved to top of Edit window

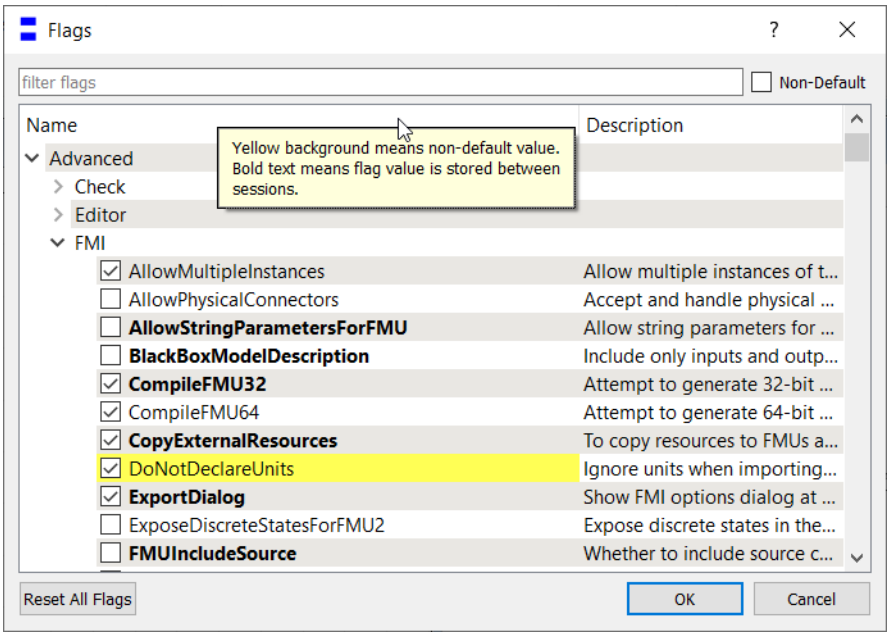
The Model tabs are now moved to the top of the Edit window:



This change is valid for all tabs and selections where the model tabs are displayed in the Edit window.

Indication what flags are stored between sessions

The dialog for setting of flags, reached by **Tools > Options > Flags…**, now also indicates, by name in bold, what flags are stored between sessions:



(The dialog above also contains clicking on the "?" and displaying "What´s This" for the dialog.)

Improved display unit handling

Dymola supports several display units, which are defined at start-up through setup scripts. To make it easier to use display units suitable for a given application, the user can now control which setup scripts are executed by setting a variable in Dymola. For example, to run the two scripts available in the Dymola distribution:

```
Advanced.DisplayunitSetupPath="$DYMOLA/insert/displayunit.mos;
$DYMOLA/insert/displayunit_us.mos"
```

By default, `$DYMOLA/insert/displayunit.mos` is executed at start-up.

Displaying alternatives using Ctrl+Space available in Edit Text dialog

Previously you could display, for example, signal alternatives by the code completion command **Ctrl+Space** in the text boxes of the parameter dialog. However, this was not possible in the text boxes displayed by the context command **Edit Text** of such input boxes. This possibility is now added.

Improved connectorSizing annotation

The connectorSizing annotation now handles a single connection from parametrically sized component/connector by propagating the parameter.

Improvement of smart connect

The smart connect feature "Connect to connection" is now independent of the flag `Advanced.SmartConnect`. The flag now only controls the two features:

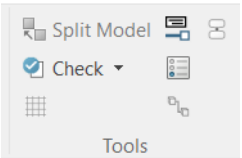
- Automatic connect when subcomponents are on top of each other
- Drop components on connection

Improved drawing of arrow heads

The drawing of arrow heads has been changed to follow the Modelica Specification. This means that the default arrow head size is 5 drawing units, which is slightly bigger than in previous releases of Dymola. The drawings of arrows in small icons (e.g. in the package browser) has also been improved.

Minor reorganization of commands in the Tools section of the Graphics tab

The commands in the Tools section have been somewhat reorganized:

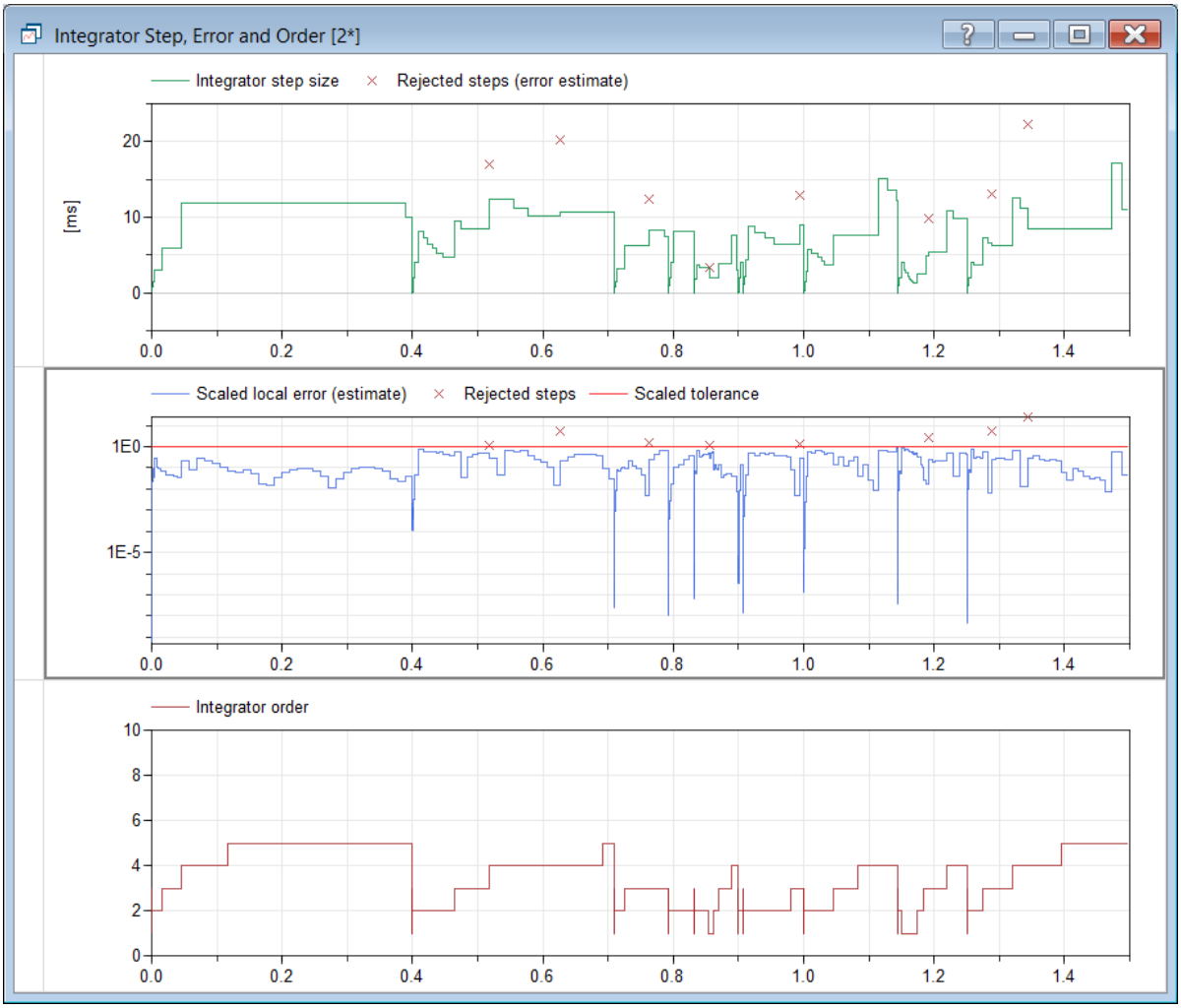


3.3 Simulating a model

3.3.1 Analyzing numeric integration

Scaled local error estimate from the integrator

When you have given the command **Simulation > Simulation Analysis**, you can, in the **Numeric Integration** tab, click **Plot Integrator Step Size**. In Dymola 2021 a new diagram is available in the resulting plot. In the figure below, it is the second diagram. In this diagram, the blue "Scaled local error (estimate)" plots the error estimate from all successful steps. The red crosses "Rejected steps" marks error estimates from rejected steps. The red line "Scaled tolerance" is always constant 1.0 representing the limit for a step to be rejected. The integrator computes local error estimates during simulation, these are rescaled using the tolerance provided by the user. Thus all local error estimates larger than 1.0 result in a failed step, whereas all smaller results in a successful step.

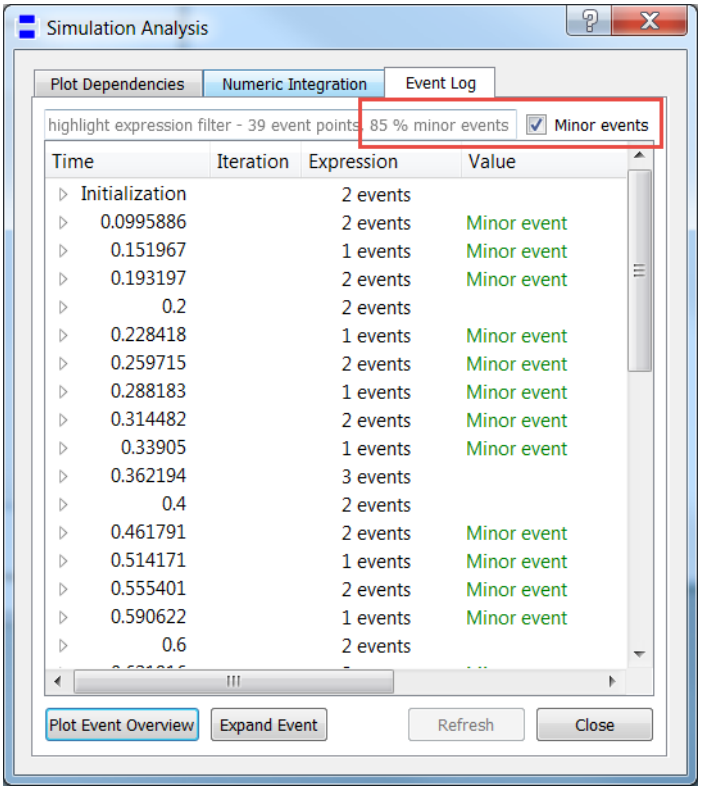


The error estimate can for example be used to see if the integration step size is being limited by the error estimate or something else, like frequent restarts due to events.

3.3.2 Even logging user interface

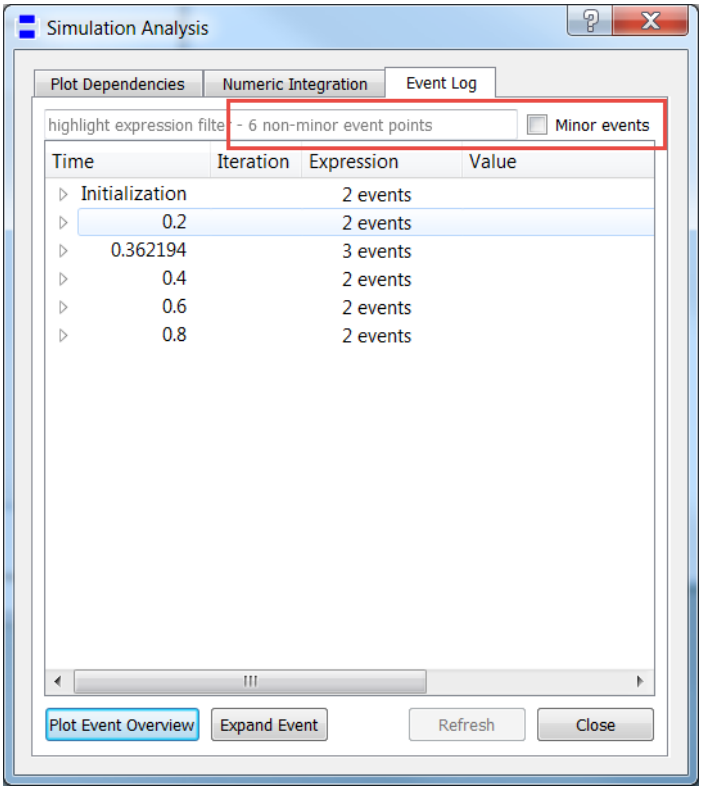
Improved display of minor events in the event log

By default, efficient minor events are displayed in the event log. They were displayed also in previous versions, but now they are specifically marked as “minor events” which makes them more visible. Also the percentage of efficient minor events is now presented:



Filtering of minor events in the event log

In Dymola 2021, you can deselect **Minor events** to display only the non-minor events in the list (compare the figure above):



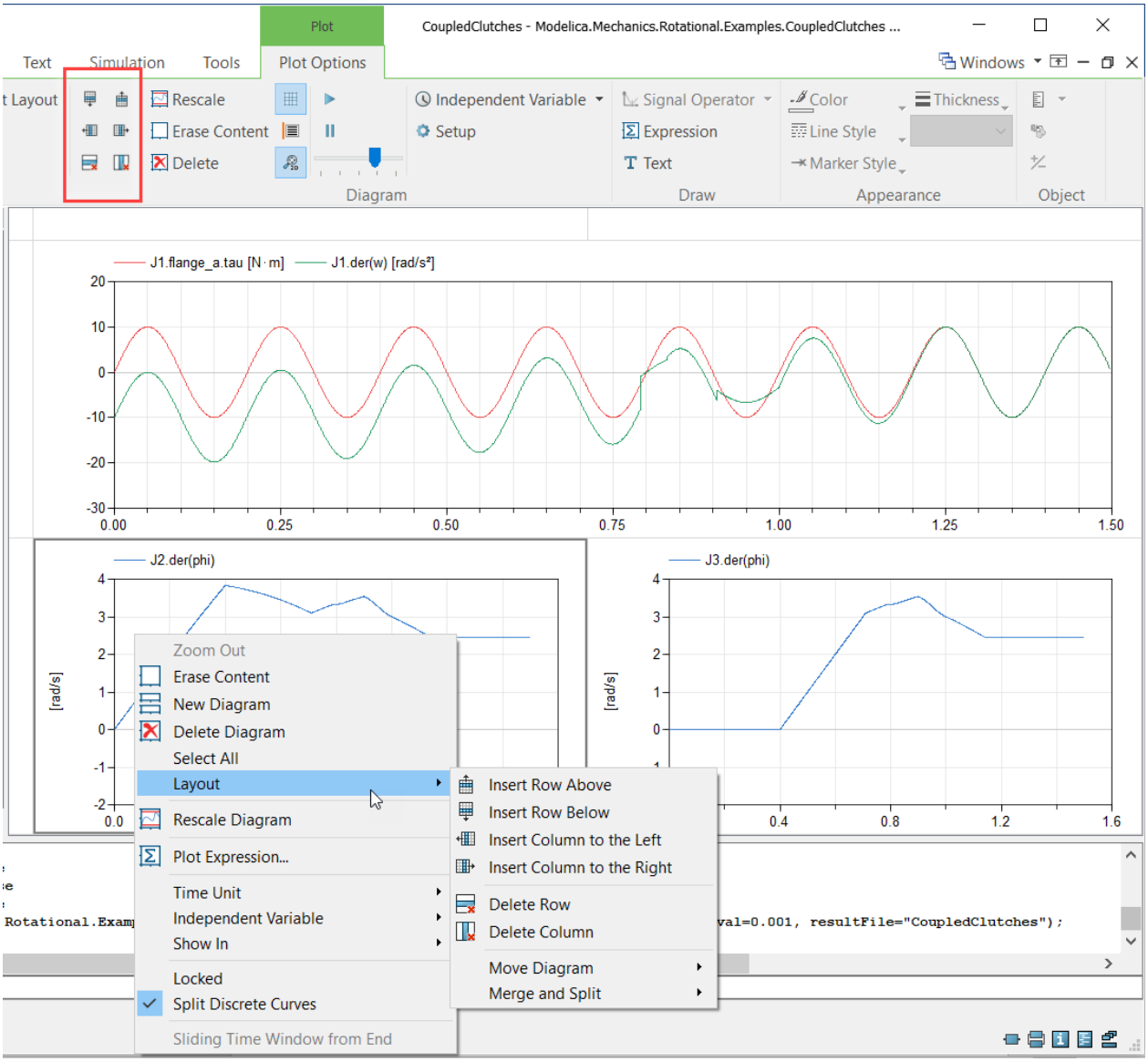
3.3.3 Plot tab

Support of 2D layout of plot windows

Creating the 2D layout

2D layout of plot windows is now supported, using the following new commands:

- To insert or delete rows and columns, the plot diagram context command **Layout**, or corresponding buttons in the **Plot** tab (see the next figure below).
- To insert a diagram in an empty space in a plot window, the context command (for the empty space) **New Diagram**.
- To merge diagrams in a plot window, the plot diagram context subcommand **Layout > Merge and Split** (see the second next figure below).
- To move a diagram in a 2D plot layout window, two more commands in the new diagram context subcommand **Layout > Move Diagram** (for this command, see section “Additional commands for moving diagrams in a plot window” on page 39).



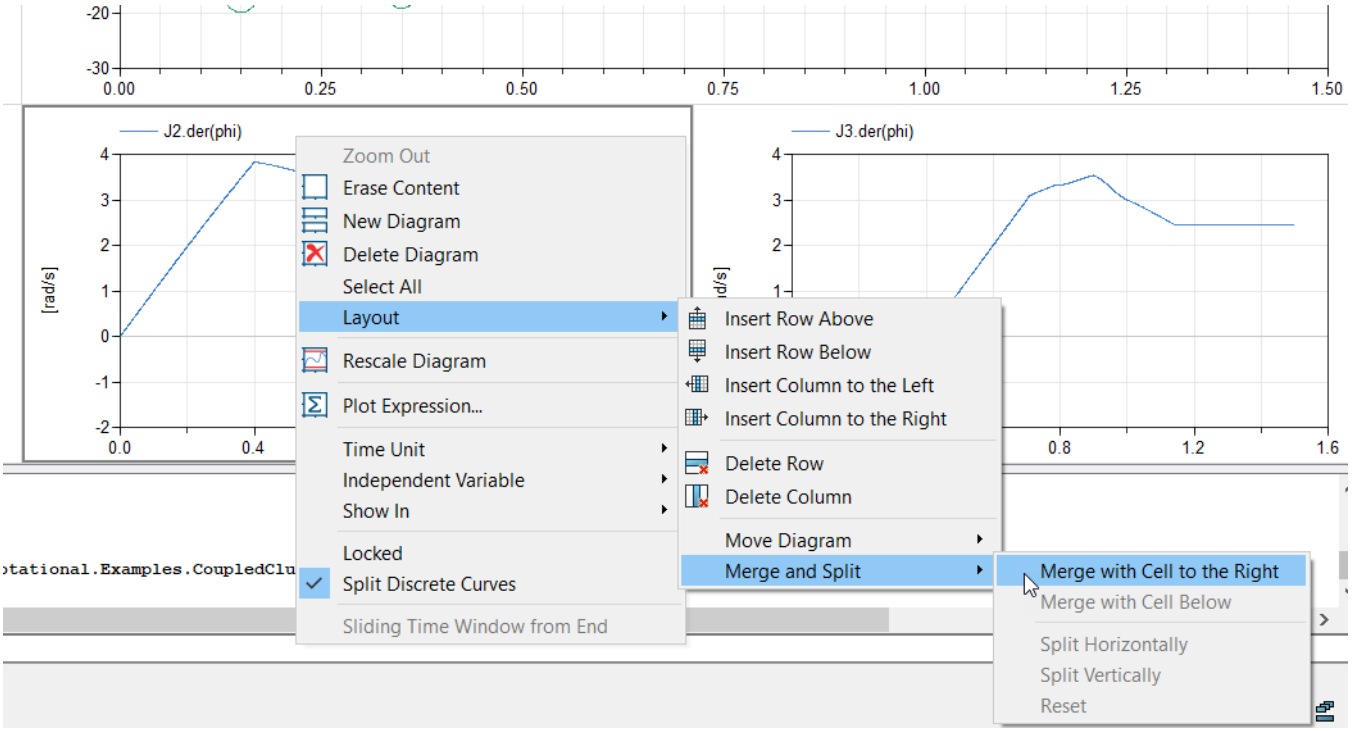
The above 2D layout was achieved by, from a plot window with one diagram:

- Right-clicking and selecting **Layout > Insert Column to the Right**
- Right-clicking the diagram to the right and selecting **Layout > Insert Row Below**
- Right-clicking the upper left diagram and selecting **Layout > Merge and Split > Merge with Cell to the Right**

Notes about merging cells:

- There is no scripting support for merging cells.

- Merging of cells only merges the cells, not the content. The base cell takes over the space and deletes the overtaken diagram. Illustrating the last command by displaying it for the left diagram in the *second* row gives:



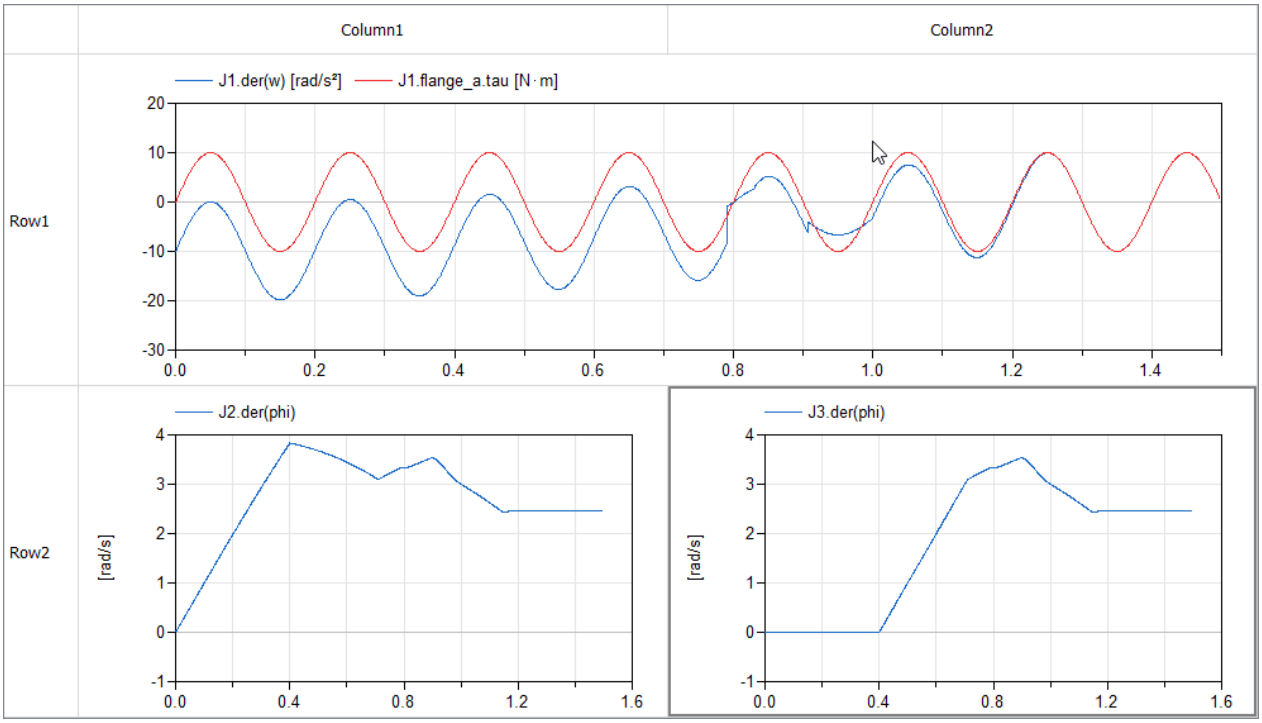
For scripting, see section “Scripting support for 2D layout of plot windows” on page 31.

Setting header titles in 2D layout plot windows

You can set headers in 2D layout plot windows using the built-in function `plotRowColumnLabels`. As an example, applying, to the example above, the function call (by, for example, typing it in the command input line of the command window and pressing return)

```
plotRowColumnLabels({"Column1", "Column2"}, {"Row1", "Row2"})
```

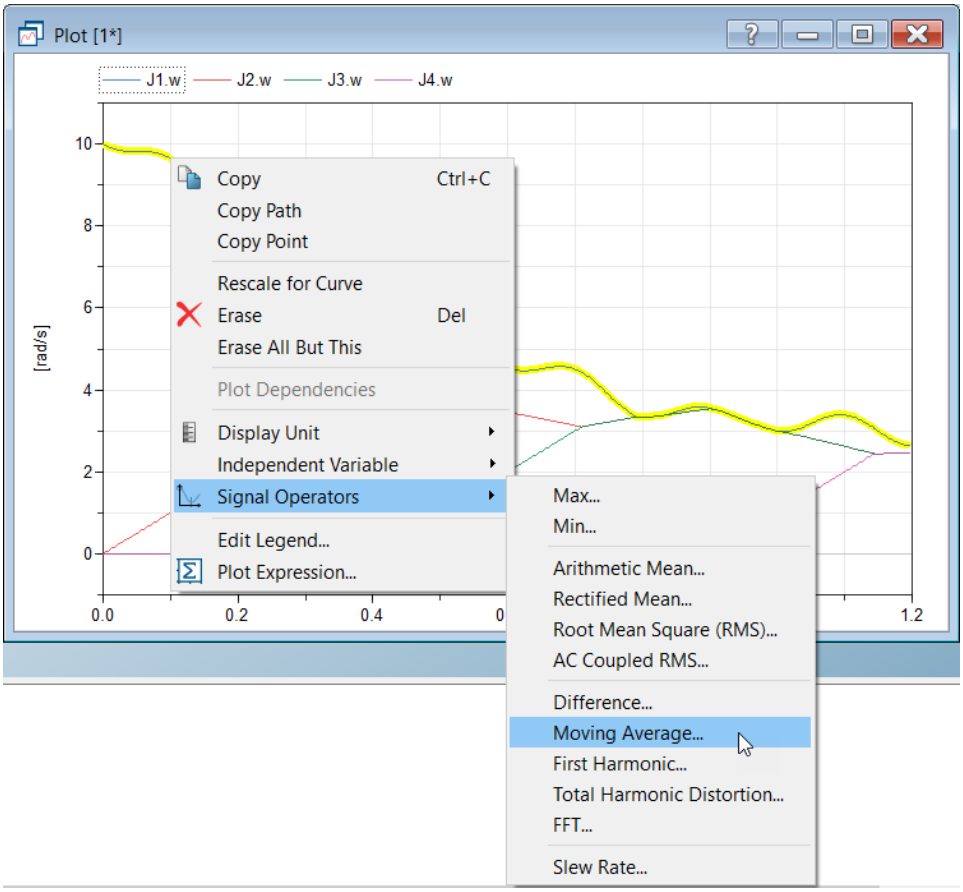
the result will be:



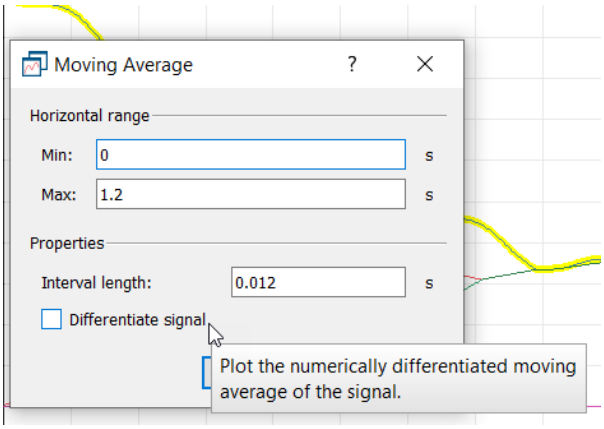
For details about the built-in function `plotRowColumnLabels`, see “Scripting support for 2D layout of plot windows” on page 31.

New signal operator: Moving Average

A new signal operator **Moving Average** is available from the context menu of a curve:



Selecting this signal operator as in the figure above, you get:



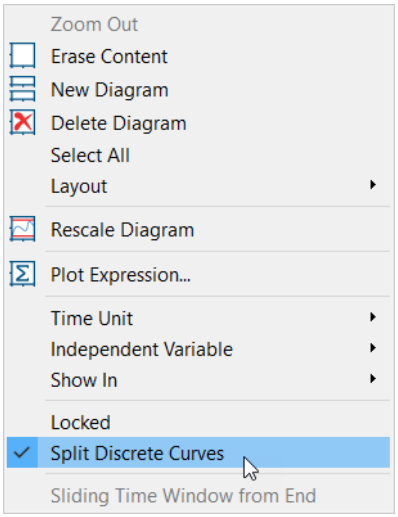
You can specify the horizontal range as well as the interval length. Note that you can also compute first-order derivatives by activating **Differentiate signal** in the dialog.

In general, the signal operator is implemented as Centered Moving Average. If any endpoint is missing for the calculation, it is calculated by interpolation.

The signal operator is also implemented as a built-in function. See “Scripting support for the signal operator Moving Average” on page 31.

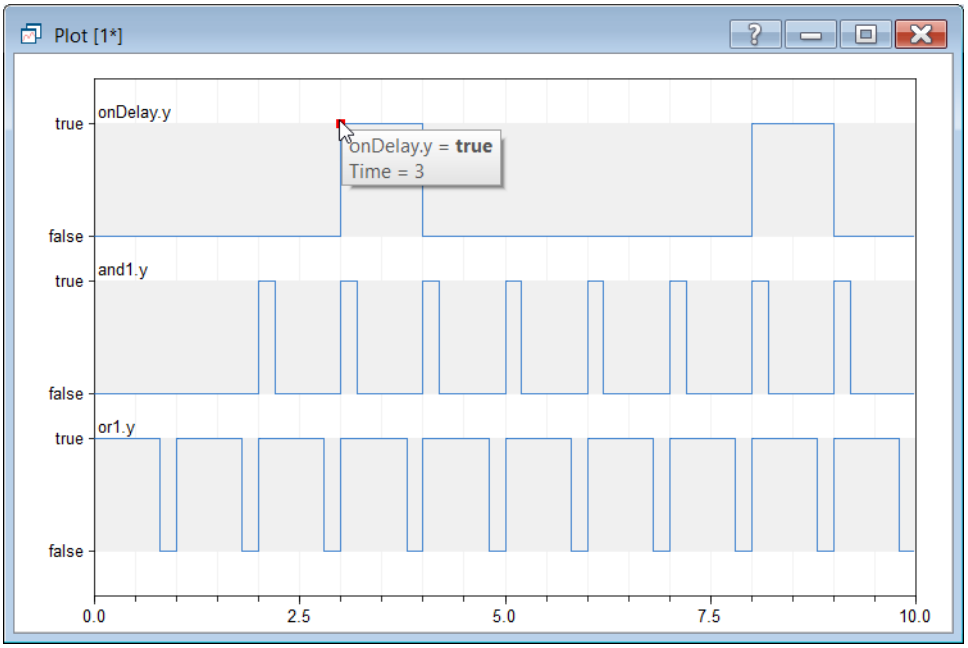
Option to plot Boolean and Integer signals overlapping

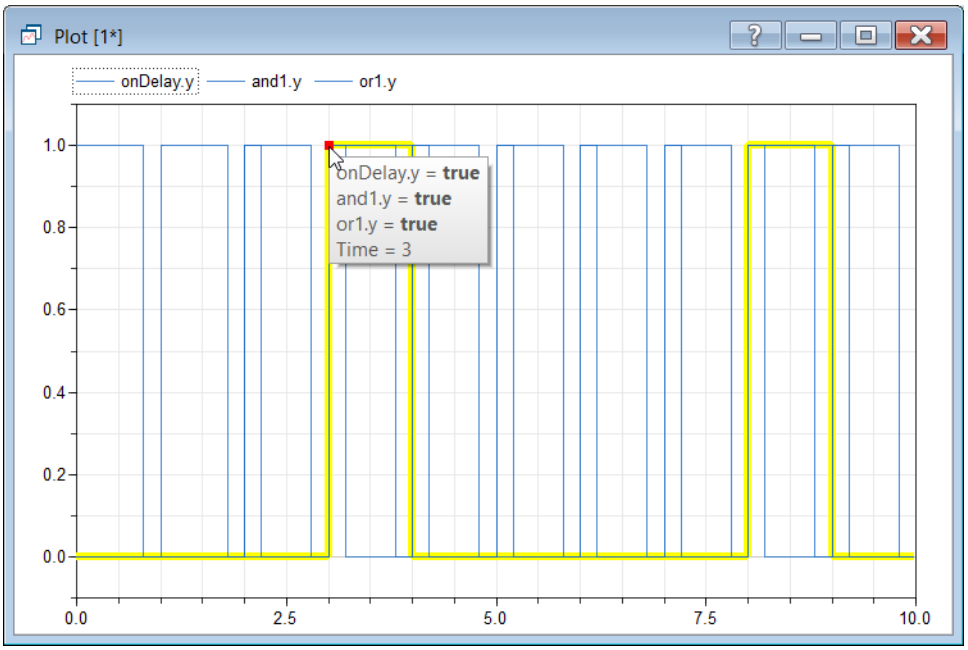
In previous Dymola versions, Boolean and Integer signals were only possible to plot using a special pretty-plotting mode. Now it is possible to display them overlapping by using the plot diagram context command **Split Discrete Curves**:



By default, this setting is activated, meaning that the previous behavior of handling the plotting of the Boolean and Integer signals separately is kept. By deactivating this setting, Boolean and Integer signals are plotted overlapping in the diagram.

Example with this setting activated (first plot below) and this setting deactivated:





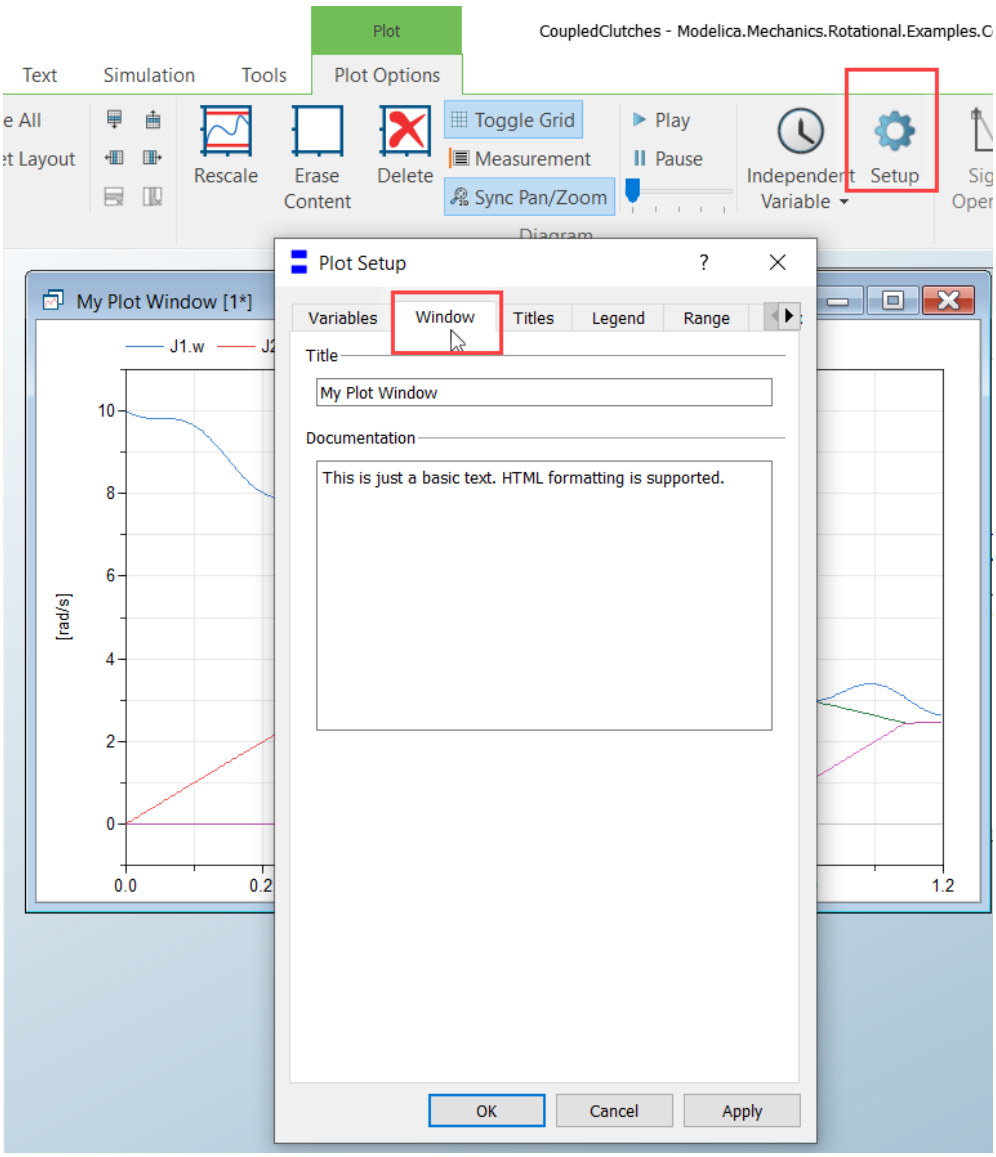
The setting corresponds to the flag `Advanced.Plot.SplitDiscreteCurves`. The flag is by default `true`.

The setting/flag is persisted between sessions.

Adding titles and documentation to plot windows

It is possible to add titles (text in the title bar), and documentation, to plot windows.

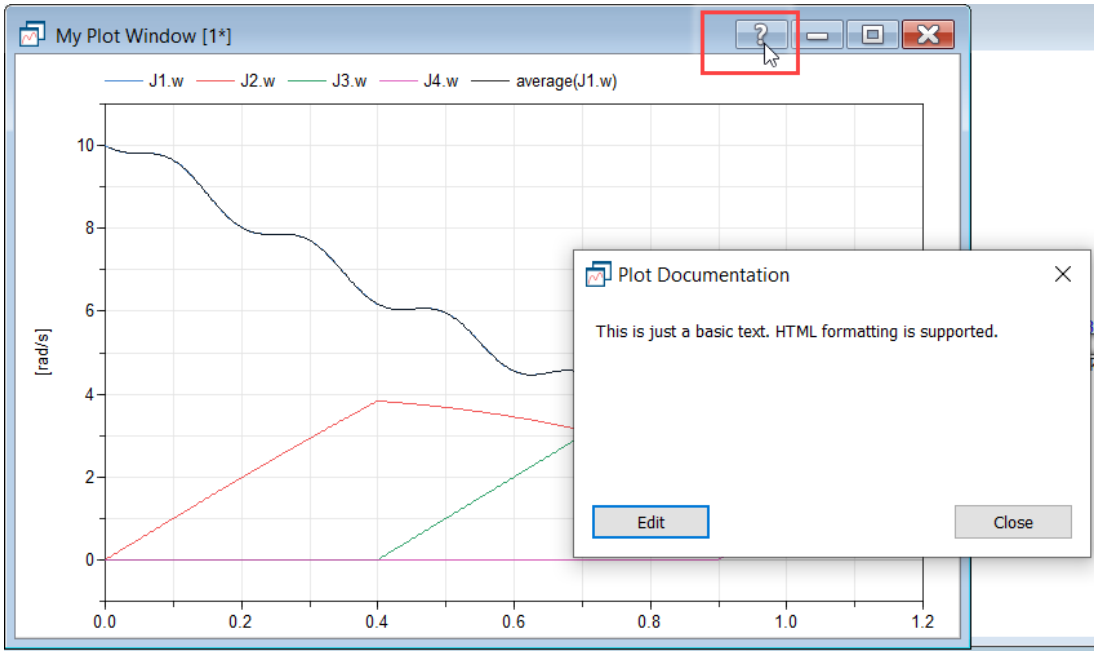
To add title and documentation to the active plot window, use the command **Plot > Setup**, and select the new **Window** tab:



Now you can add a window title and documentation, as in the example above. Note that HTML formatting is supported for the documentation.

The plot window title is seen immediately after clicking **OK**, as in the plot window title in the figure above.

To see the plot window documentation, click the question mark in the header of the plot window. You will get the following:



Note the **Edit** button, clicking this will open the Window tab of the plot setup, as in the first figure in this section.

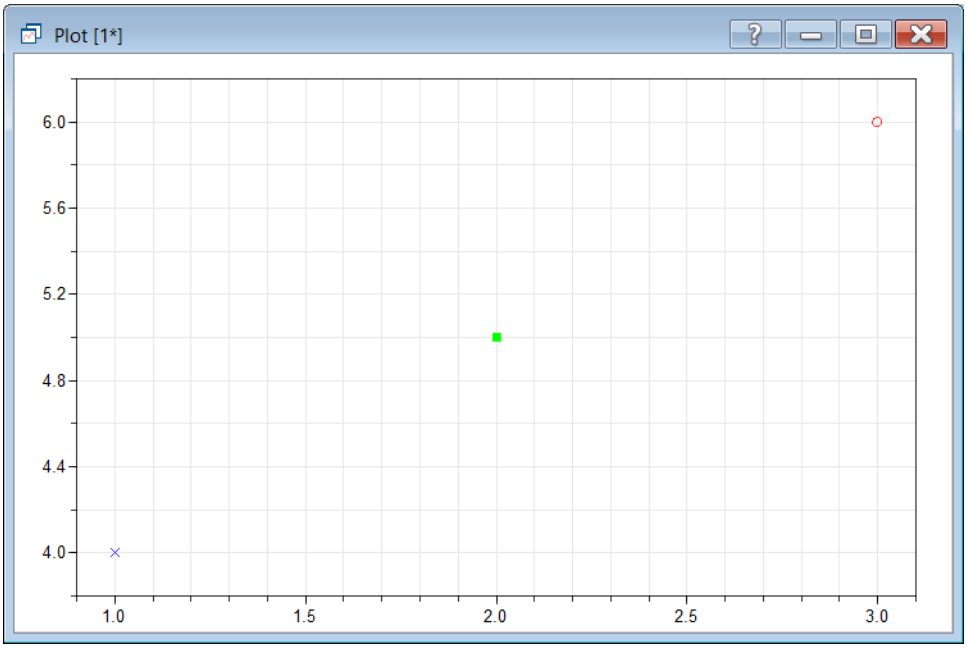
The window title and documentation features are also supported by scripting, see “Adding titles and documentation to plot windows by scripting” on page 31.

Scatter plots

You can create scatter plots using the new built-in function `plotScatter`. As an example, the function call

```
plotScatter(x={1,2,3}, y={4,5,6}, colors={{0,0,255}, {0,255,0},
{255,0,0}}, markers={MarkerStyle.Cross,
MarkerStyle.FilledSquare, MarkerStyle.Circle})
```

will result in the plot:



For details about the built-in function `plotScatter`, see “Scripting support for scatter plots” on page 32.

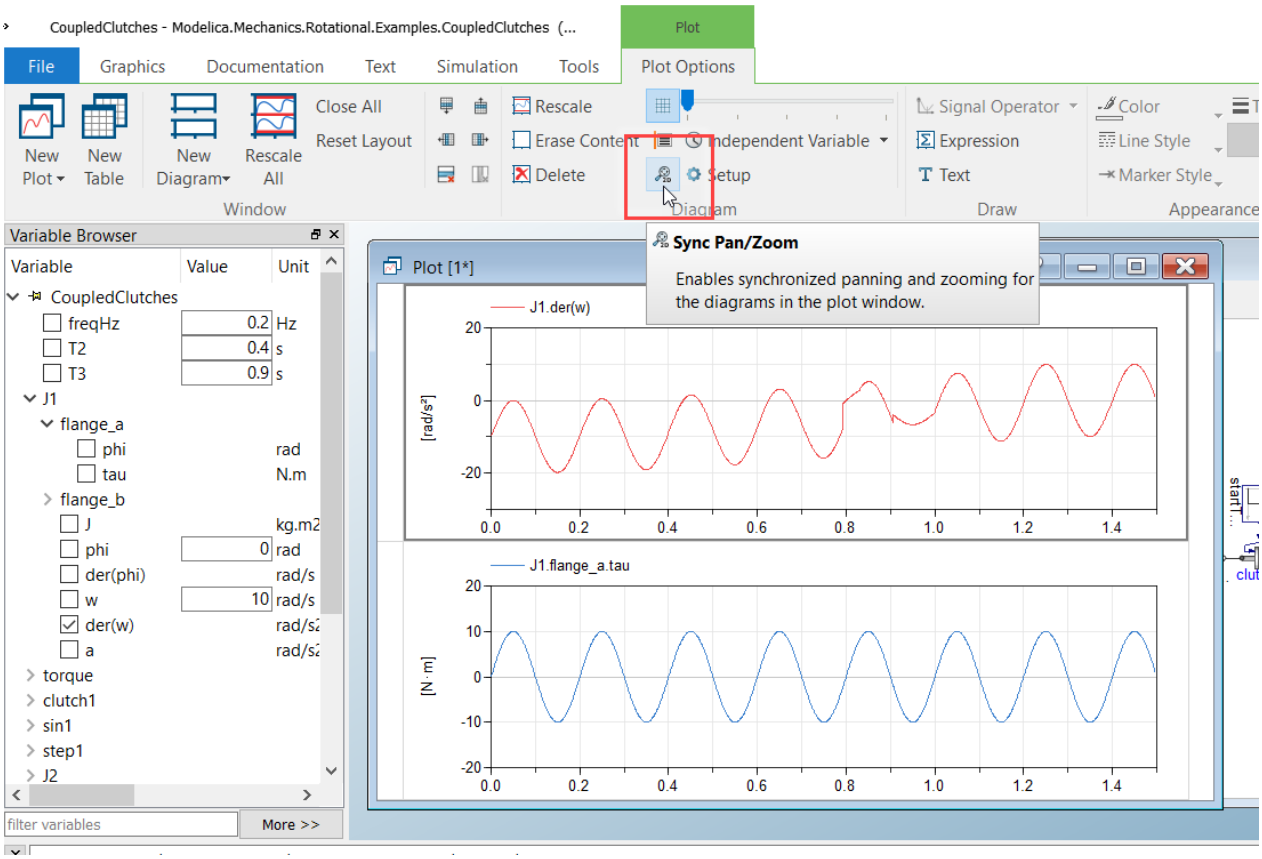
Note that the feature scatter plots is now also available in the Design package, when sweeping more than two parameters, and also for Monte Carlo Analysis. See “Scatter plots support in the Design package” starting on page 44.

Option to synchronize horizontal panning and zooming for the diagrams in a plot window

In previous versions, horizontal zooming was always synchronized for all diagrams in a plot window.

In Dymola 2021, you can also have synchronized horizontal panning/scrolling.

Both are controlled by the new command button **Sync Pan/Zoom** in the **Plot** tab:



The command works in toggle mode. By default, the feature is activated; that is, you have synchronized panning/scrolling and zooming for all diagrams in the currently active plot window.

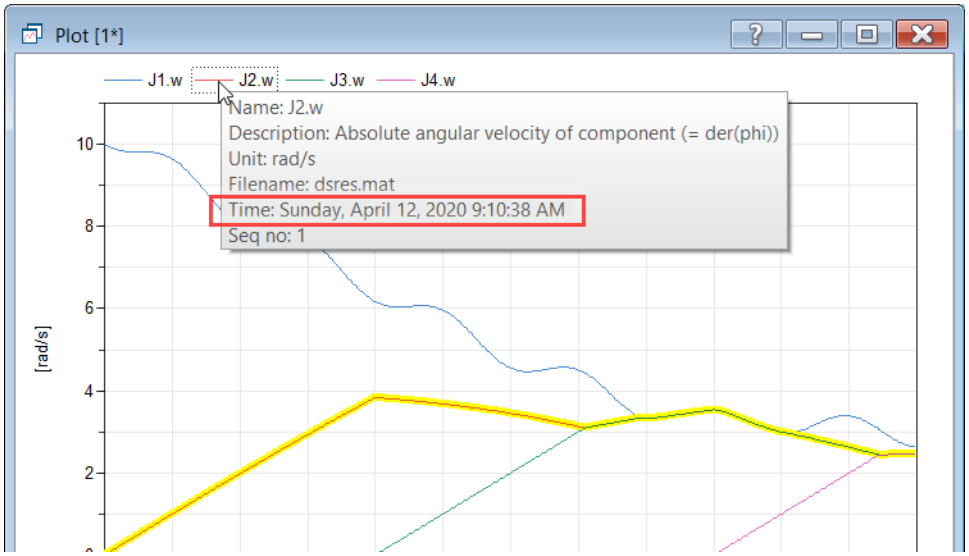
The command is individual for each plot window.

The command button controls the following commands:

- Horizontal zoom: **Shift+Drag** (with mouse)
- Zoom to curve: **Alt+Drag** (with mouse)
- Horizontal panning/scrolling: **Shift+Mouse wheel**

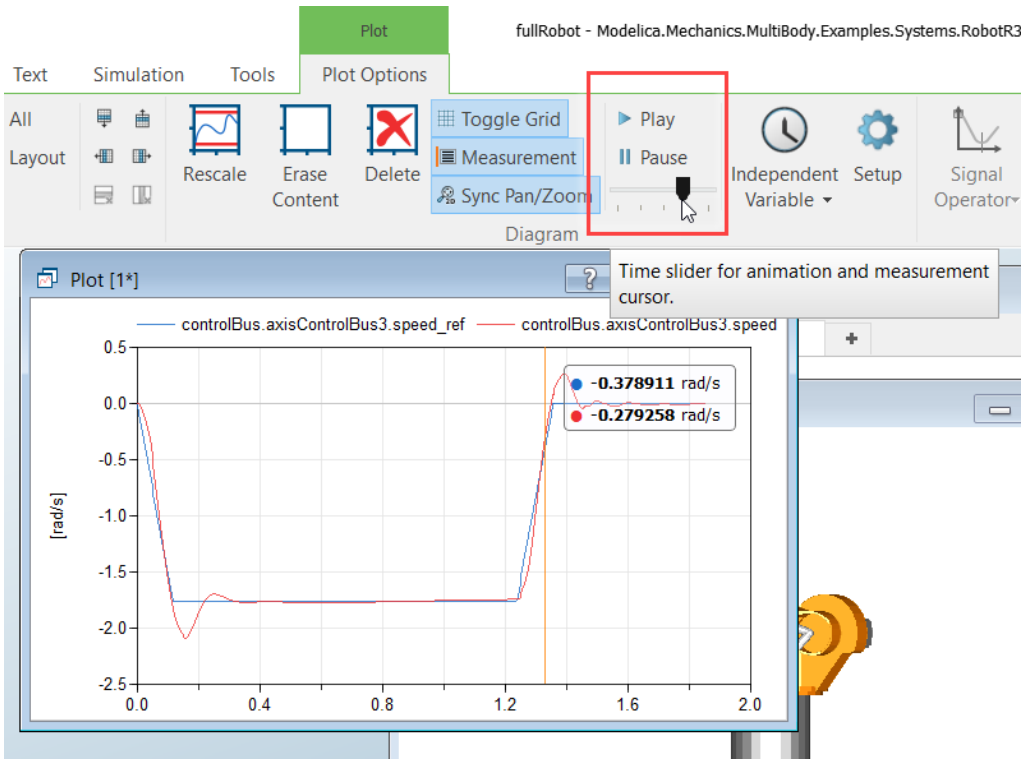
Improved identification of result files

The tooltip for the legend of plotted signals now includes the timestamp (last modified) of the result file. This makes it easier to identify signal from different result files if the result files have the same name:



Time slider, Play button, and Pause button available in the Plot tab

The time slider, the **Play** button and the **Pause** button from the **Simulation** tab is now also present in the **Plot** tab:



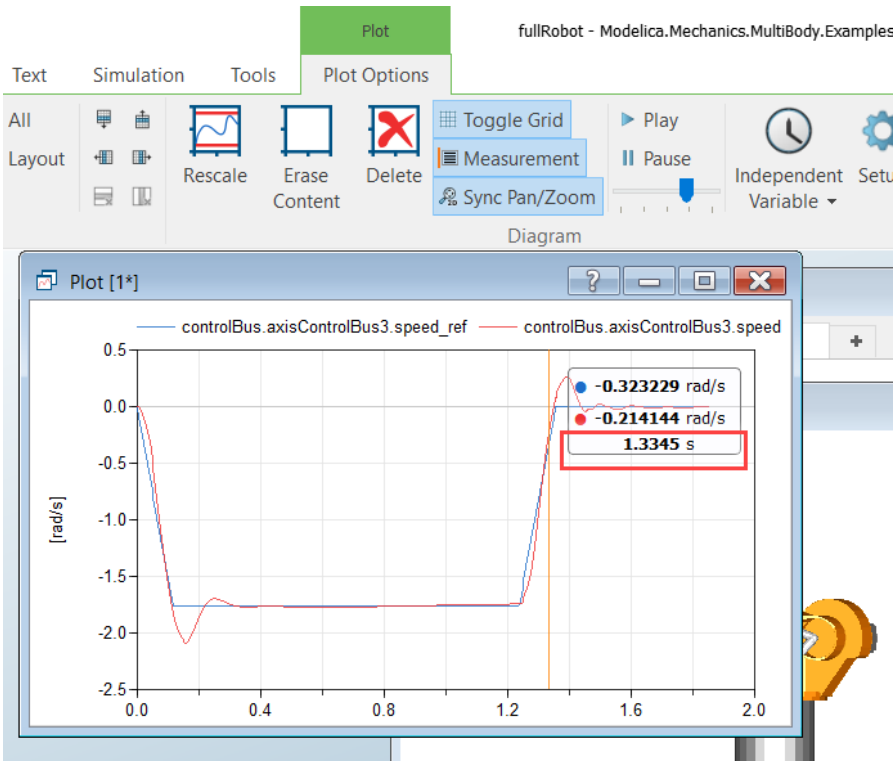
Note that the time input field and speed setup is however still only available in the **Simulation** tab.

Time available in the measurement cursor

By setting the flag

```
Advanced.Plot.MeasurementTime = true
```

you will see the time directly in the measurement cursor, like:

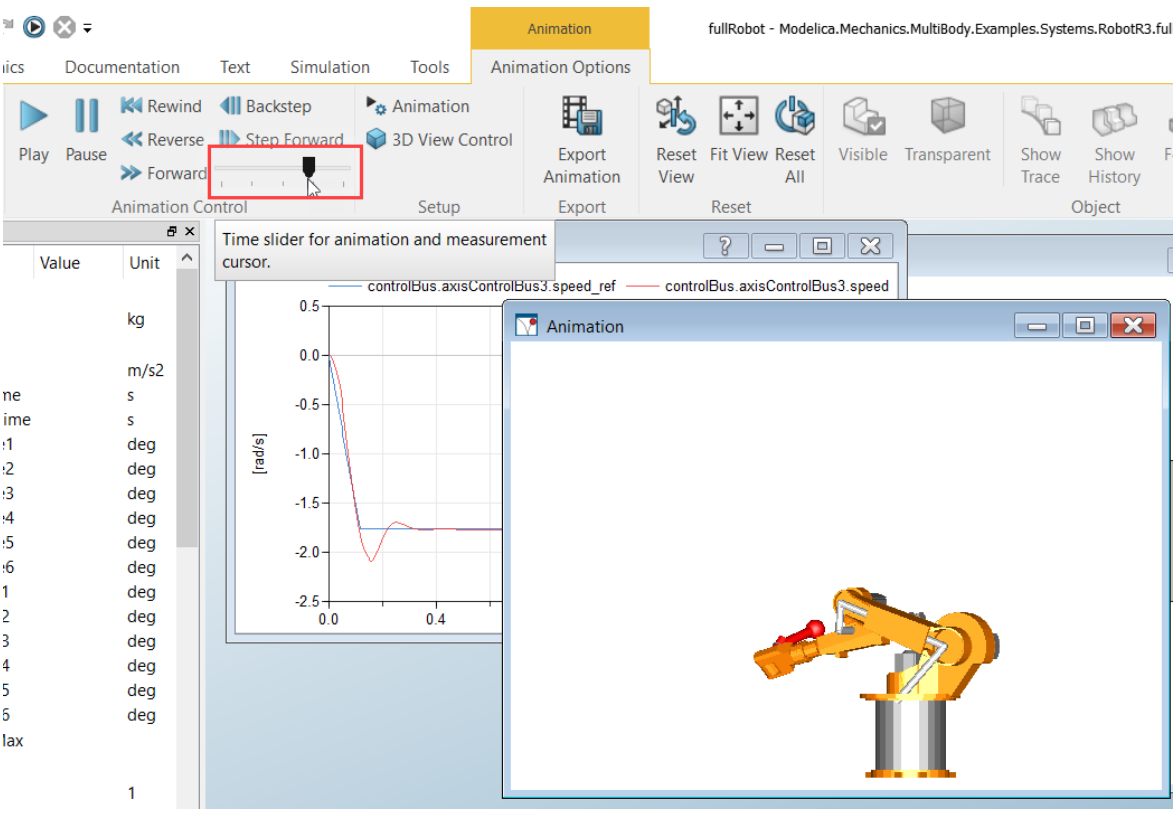


The flag is by default false. The flag is saved between sessions.

3.3.4 Animation tab

Time slider available in the Animation tab

The time slider from the **Simulation** tab is now also present in the **Animation** tab:

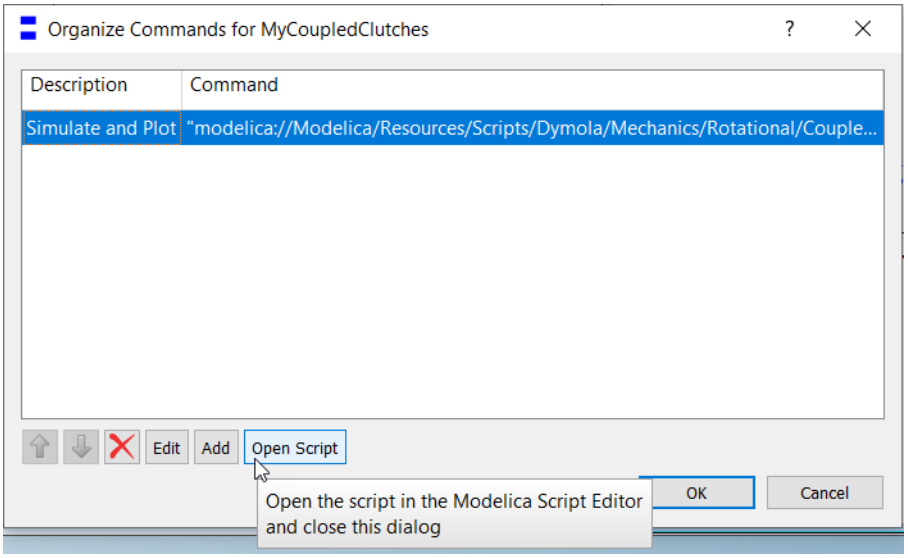


Note that the time input field and speed setup is however still only available in the **Simulation** tab.

3.3.5 Scripting

A command Open Script available in the Organize Commands dialog

The command **Simulation > Commands > Organize Commands** opens a dialog for working with the commands stored in the model. Now this dialog contains a new button **Open Script** that can be used to open the `.mos` script of a command stored as a script:

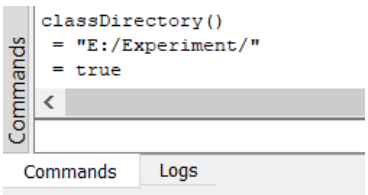


The script is opened in the Script Editor.

Getting the path of a currently executed .mos script

It is possible to get the path of a currently executed .mos script by using the `classDirectory()` function.

As an example, adding this function as a line in a script that is located in the folder `E:\Experiment` and then running the script will output, in the command log:



Note that you need to have the option **Echo Commands** activated to get this output. (The option is available in the **Script Editor** tab, in the **Options** group.)

Scripting support for 2D layout of plot windows

The built-in function `createPlot` has been extended to handle subplots. Essentially, the interpretation of the parameter `subPlot` in the function has been updated. **Note** that merging of cells are not supported by scripting.

To add header titles in 2D layout plot windows, you can use the new built-in function `plotRowColumnLabels`:

```
function plotRowColumnLabels "Set column and row labels in plot window"
  input String x[:] = fill("", 0) "Column labels";
  input String y[:] = fill("", 0) "Row labels";
  input Integer id = 0 "Identity of window (0-means last)";
  output Boolean result "true if successful";
  external "builtin";
end plotRowColumnLabels;
```

By default, the header titles are blank. Any unspecified title is blank.

Calling the function with empty titles removes the titles.

For an example, see "Setting header titles in 2D layout plot windows" on page 18.

Adding titles and documentation to plot windows by scripting

It is possible to add titles (text in the title bar) and documentation to plot windows by scripting.

To add a title, use the built-in function `plotTitle(title="", id=0)`. Setting `title` to an empty string removes the title, if any.

To add documentation, use the built-in function `plotDocumentation(doc="", id=0)`. Setting `doc` to an empty string removes the documentation, if any. HTML formatting is supported.

These features are also available in the GUI, for more about this, and an example, see "Adding titles and documentation to plot windows" on page 23.

Scripting support for the signal operator Moving Average

The signal operator **Moving Average** can be implemented by the built-in function `plotMovingAverage`. The function plots a moving average of a plot window.

```
function plotMovingAverage "Plot moving average in the active diagram of a plot window"
  input String variablePath "Variable path or legend name.";
  input Real startTime "Start time. In seconds, or base unit if independent variable.";
  input Real stopTime "Stop time. In seconds, or base unit if independent variable.";
  input Real intervalLength "Averaging interval length";
  input Integer order = 0 "Taylor series component (only 0 and 1 are currently
      supported)";
  input Integer id = 0 "Identity of window (0-means last)";
  external "builtin";
end plotMovingAverage;
```

The function is available in the DymolaCommands library, in the Plot folder.

For more information about this signal operator, see “New signal operator: Moving Average” on page 19.

Scripting support for scatter plots

To create scatter plots, you can use the new built-in function `plotScatter`:

```
function plotScatter "Scatter plot"
  input Real x[:] "X-values";
  input Real y[size(x, 1)] "Y-values";
  input Integer colors[size(x, 1), 3] = fill({-1, -1, -1}, size(x, 1)) "Line colors";
  input MarkerStyle markers[size(x, 1)] = fill(MarkerStyle.FilledCircle, size(x, 1))
    "Line markers, e.g., MarkerStyle.Cross";
  input String legend = "" "Legend describing plotted data";
  input Integer axis = 1 "Vertical axis, 1=left, 2=right";
  input String unit = "" "Unit";
  input Boolean erase = true "Erase window content before plotting";
  input Integer id = 0 "Identity of window (0-means last)";
  output Boolean result "true if successful";
  external "builtin";
end plotScatter;
```

Each point in the array can have its own color and/or marker style. The default color is the next available one in the subplot. In an empty subplot the default color is blue. The default marker style is a filled circle.

The function is available in the DymolaCommands library, in the Plot folder.

For an example, and more applications of scatter plots, see “Scatter plots” on page 24.

New built-in function getLastResultFileName

A new built-in function `getLastResultFileName` has been added. The function returns a string with the file name of the last generated simulation result.

The function is available in the DymolaCommands library, in the Trajectories folder.

New built-in function calculateNumberPrecision

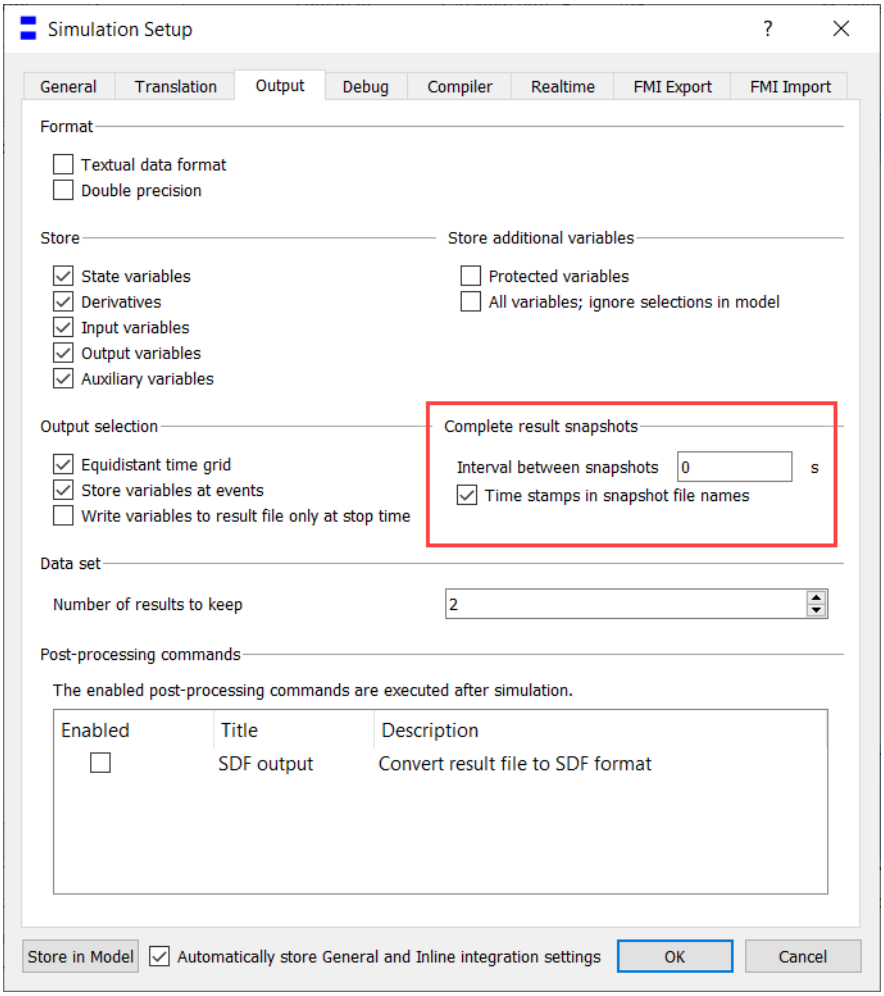
A new built-in function `calculateNumberPrecision` calculates the number of decimals needed to accurately represent the numbers, from any array of numbers. The result is the Integer output `presision`. The function can be used, for example, to adapt result file names to small parameter values to be able to differ the result files when for example plotting very small swept parameter values.

The function is available in the DymolaCommands library, in the Plot folder.

3.3.6 Saving periodic snapshots during simulation

To improve the possibility to restart a lengthy simulation from multiple time points, periodic snapshots can be saved during simulation. The reasons for such restarts could be some problems in the simulation that needs debugging, or external needs such as restart after each subtask in a training session.

The GUI for the option is available in the simulation setup, reached by the command **Simulation > Setup**, the **Output** tab:



The simulator can be instructed to print the simulation result file "dsfinal.txt" snapshots during simulation. The time interval between such snapshots is controlled by **Interval between snapshots**. The default value is 0.0, which means no snapshots. (This setting is also available as the flag `Advanced.Simulation.ResultSnapshotInterval`.)

The generated result snapshots can then be used in combination with the command **Simulation > Continue > Import Initial...** (or the function `importInitial`) to continue from the time of the chosen snapshot. For example, to perform parameter studies from that point.

It is also possible to trigger the generation of snapshots at events. Calling the built-in function `Dymola.Simulation.TriggerResultSnapshot()` at an event triggers the creation of a result snapshot after the event is fully resolved. Example:

```
when x > 0 then
       Dymola.Simulation.TriggerResultSnapshot();
end when;
```

By default, a time stamp is added to the snapshot file name, e.g.: “dsfinal_0.1.txt”. To turn off these time stamps, deactivate the setting **Time stamps in snapshot file names**. This corresponds to setting the flag

```
Advanced.Simulation.ResultSnapshotTimeInFileName =false.
```

A message will be printed in the simulation log whenever a snapshot is created, for example:

```
... "dsfinal_0.4.txt" creating (snapshot at time t = 0.4)
```

The settings/flags are persisted between sessions.

3.3.7 Profiling of function calls

It is possible to activate profiling of function calls. This can be used to, for example, investigate external function calls, especially FMUs. Another usage can be to find time-consuming media functions.

To activate profiling of function calls, set the flag

```
Advanced.GenerateFunctionTimers = true
```

(The flag is by default `false`.)

This profiling can be used together with the profiling available in previous versions, activated by

```
Advanced.GenerateBlockTimers = true
```

The new profiling of functions can also be used on its own.

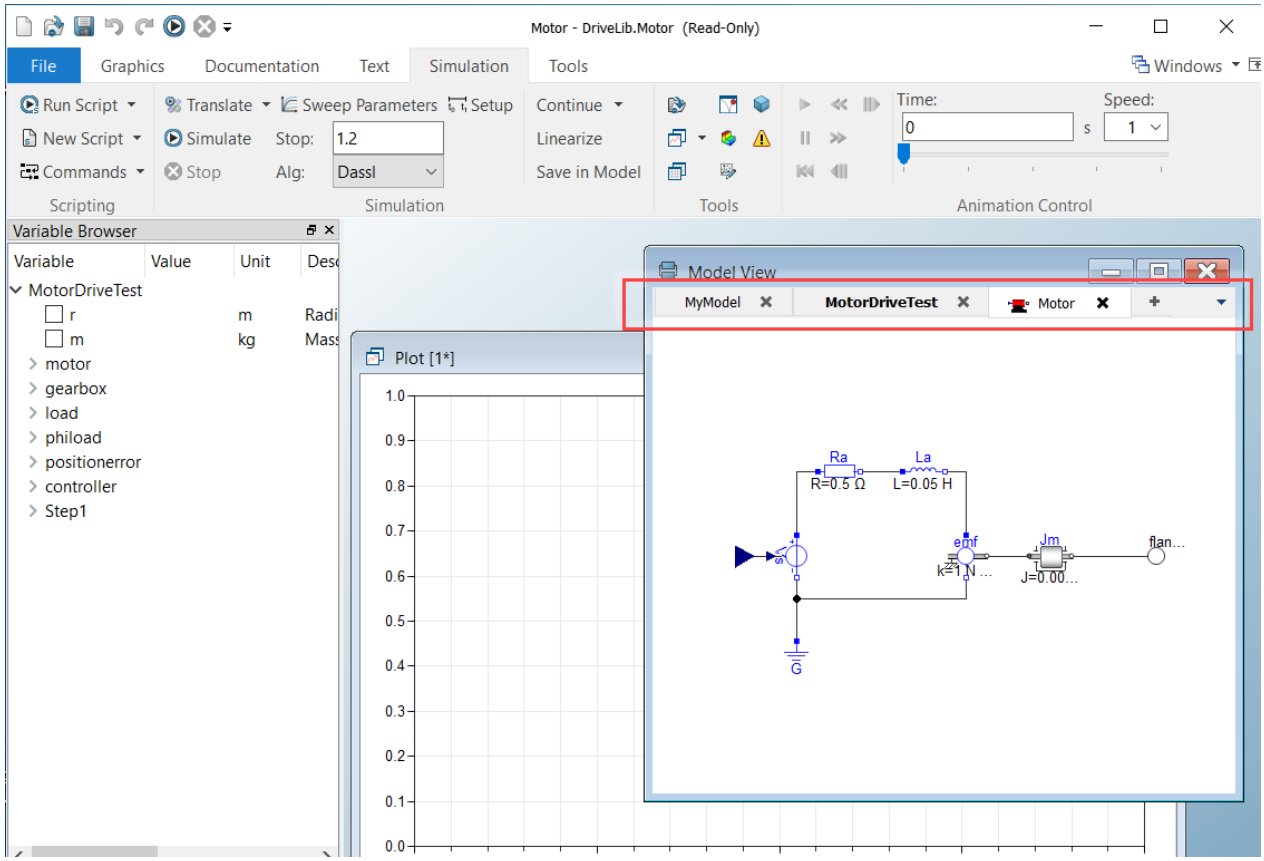
Note however that any profiling demands the flag

```
Advanced.Define.PrecisionTiming = true
```

3.3.8 Minor improvements

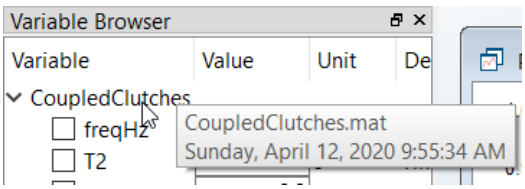
Model tabs in Model View window

Model tabs are now also present in the Model View window:



Improved identification of result files in the variable browser

The tooltip for the result (file) in the variable browser now includes the timestamp (last modified) of the result file. This makes it easier to identify signals from different result files if the result files have the same name.



Variable frequency of output points

Normally the interval length (or indirectly the number of output points) determines the frequency of results.

By setting the flag:

```
Advanced.Simulation.VariableInterval=true;
```

And in the model use

```
when time>=… then
   Dymola.Simulation.SetOutputInterval(…);
end when;
```

the frequency can be controlled from the model.

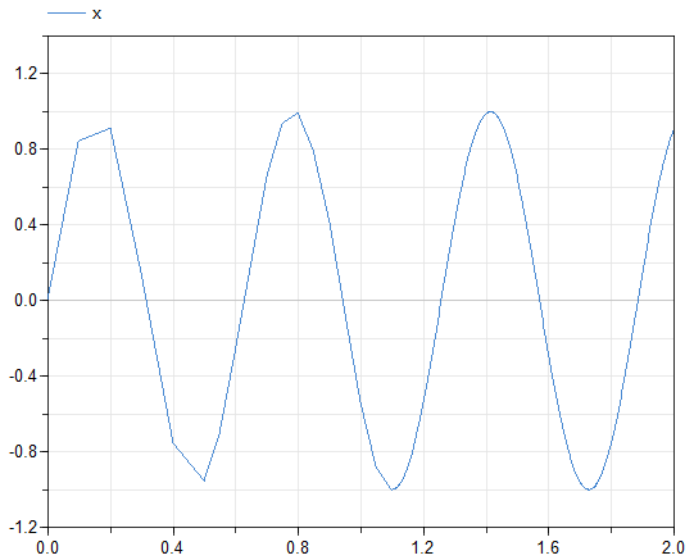
Note that the simulation setup is used until the first call of `Dymola.Simulation.SetOutputInterval(…);`

A full example, with stop time set to 2 and interval length set to 0,002 in the simulation setup, and then running:

```
model VariableOutputInterval
  "demonstrate the use of variable output interval in a model"
  Real x;
equation
  x = sin(10*time);

  when initial() then
    Dymola.Simulation.SetOutputInterval(0.1);
  end when;
  when time >= 0.5 then
    Dymola.Simulation.SetOutputInterval(0.05);
  end when;
  when time >= 1.1 then
    Dymola.Simulation.SetOutputInterval(0.002);
  end when;
end VariableOutputInterval;
```

will give the below curve when plotted:

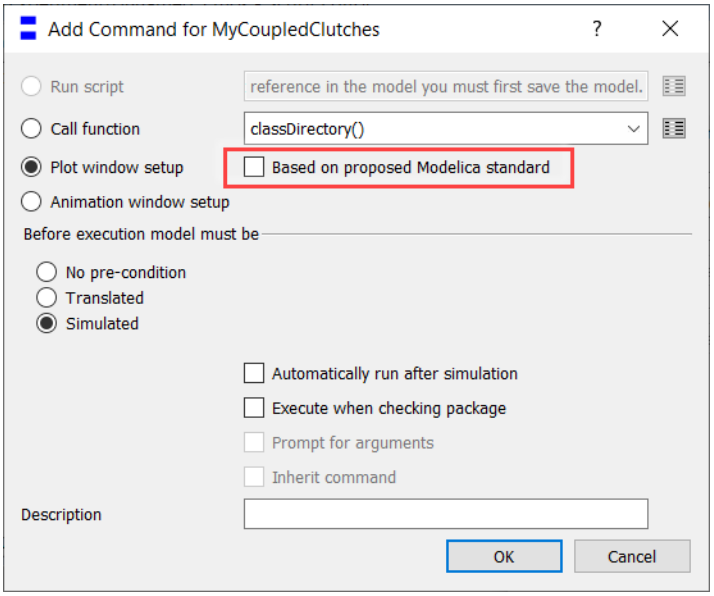


Notes:

- The only way to "reset" the interval length to the one in the simulation setup is to explicitly set that interval, this is done in the last `when` statement above.
- You must have a separate `when` statement for each time.

Option to save plot window setup as a command based on the proposed Modelica standard

You can save the plot window setup based on the proposed Modelica standard for pre-defined plots by activating the setting **Based on proposed Modelica standard** in the dialog for saving a command to the model.



You can get the dialog above by the command **Simulation > Commands > Add Command...**.

Option to let the Simulate button in the quick access toolbar switch to Simulation tab

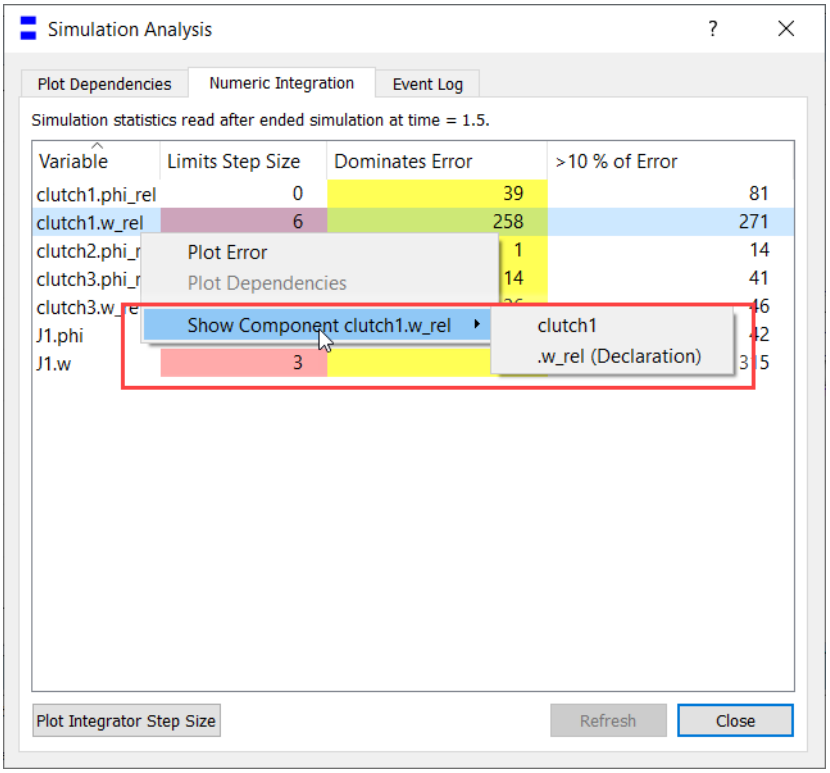
By using the flag `Advanced.Simulation.SwitchToSimulation` you can decide if using the **Simulate** button in the quick access toolbar should also switch to displaying the **Simulation** tab.

By default, the flag is `false`, meaning there is no switching of display to the **Simulation** tab.

Analyzing Numeric Integration: Showing the component from the context menu of a variable in the Numeric Integration tab

In the previous version of Dymola, you could, in the **Event Log** tab of the **Simulation Analysis** window, right-click a variable and select **Show Component** to show either the corresponding component highlighted in the diagram, or show the corresponding variable highlighted (search hits) in the Modelica Text code.

This context menu entry is now also available for the variables in the **Numeric Integration** tab of the **Simulation Analysis** window:



The command Analyze Numerics is renamed to Simulation Analysis

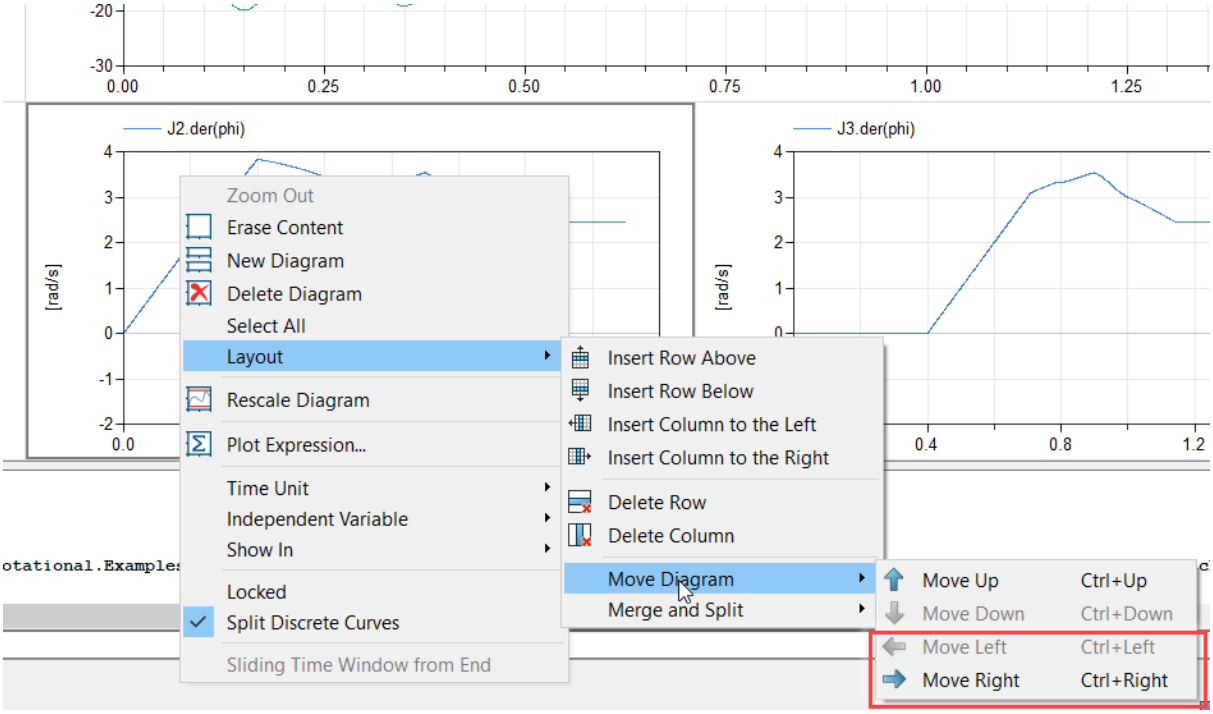
The command **Simulation > Analyze Numerics** is now renamed to **Simulation > Simulation Analysis** to be more consistent with the content and the title of the corresponding dialog.

Rearrangement of the Output tab of the simulation setup

In the Output tab of the simulation setup, the **Store additional variables** group has been moved, to enable the addition of the **Complete result snapshots** group. Please see the image in section “Saving periodic snapshots during simulation” on page 32 for the new location.

Additional commands for moving diagrams in a plot window

Because of the new option to have 2D layout of plot windows, two new commands for moving a diagram in a plot window have been added. The commands have also been grouped to a new subcommand entry **Layout > Move Diagram** in the plot diagram context command:



The two new commands are framed in the image above.

Improved handling of nonlinear model equations

Improvements have been made to Dymola's solver of nonlinear model equations. The solver is now more reliable, accurate, and efficient. Models with large and nonlinear algebraic loops may simulate faster. Similarly, inline simulations using implicit methods may run faster.

3.4 Installation

For the current list of hardware and software requirements, please see chapter "Appendix – Installation: Hardware and Software Requirements" starting on page 54.

3.4.1 Installation on Windows

For the full list of supported compilers, see "Compilers" on page 54.

Discontinued support for Windows 7

This version of Dymola does not officially support Microsoft Windows 7 operating system.

Option to use a custom setup file

In Dymola 2021 it is possible run Dymola with a custom setup file. This enables having setups for different project; for example:

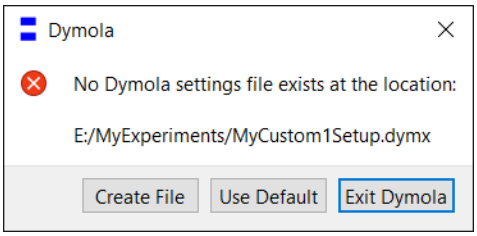
- Preloading project-specific libraries
- Maintaining conflicting and alternative library versions by having different Modelica paths
- Setups tailored for simulation, customer-specific presentations, or with GUI layout optimized for projectors
- Using different compiler settings for different customers

You can in fact copy the whole Dymola installation to another location, and use a custom setup file when starting the copy, using the command line as below. This copy of Dymola will be totally independent from the original, except for the licensing.

To specify the path to the custom `setup.dymx` file, the command line argument `-setup` is used; for example

```
Dymola.exe -setup "E:\MyExperiments\MyCustom1Setup.dymx"
```

If this file cannot be found, an error message appears:



You have the following alternatives:

- **Create File** tries to create an empty `setup.dymx` at the specified location.
- **Use Default** uses the default setup file, on Windows typically:

  ```
  C:\Users\<user>\AppData\Roaming\DassaultSystemes\Dymola\2021\
  setup.dymx
  ```

- **Exit Dymola** exits Dymola. if Dymola is started with any of the command line arguments `-nowindow` or `-externalinterface` then Dymola is exited with an error code.

Option to not save any changes in the setup file

There is a new command line argument `-nosavesettings` in Dymola 2021 that loads the setup file but does not save it. Any changes that you do in Dymola will thus not be changed in the settings file.

Note the command line argument `-nosettings` that specifies that the setup should not be loaded or saved. This argument has existed since a few versions.

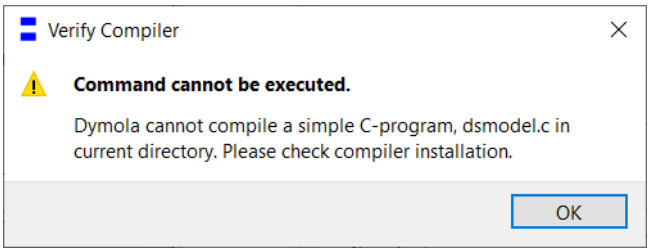
Updated Qt version

Dymola 2021 is built with Qt 5.14.1.

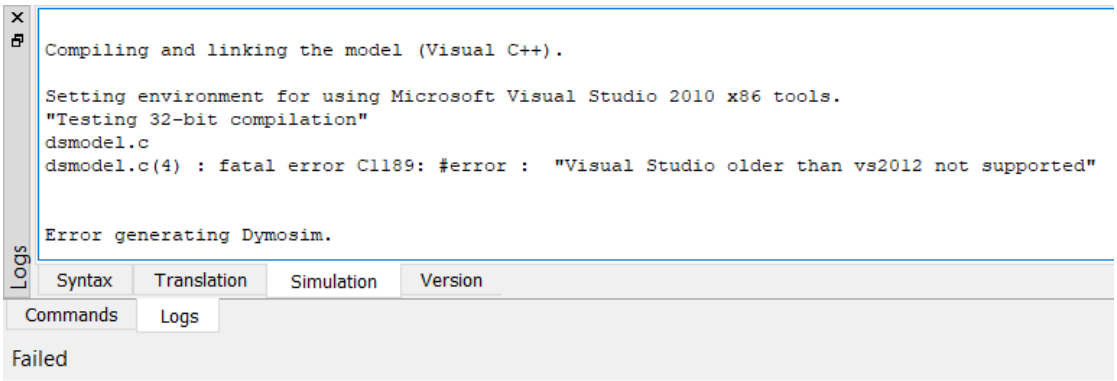
Microsoft Visual Studio compilers

Extended checking when using Verify Compiler

Using the **Verify Compiler** command button now also checks if an unsupported Visual Studio compiler version has been selected by using the Visual Studio Custom alternative. For example, specifying the path to a Visual Studio 2010 compiler and clicking **Verify Compiler** gives the message:



In the command log the following message is given:



3.4.2 Installation on Linux

GUI for selecting and testing of compiler

You can now use a dialog to select compiler, set linker flags, and test the compiler by the **Verify Compiler** button, like in Windows. This is done by the command **Simulation > Setup**, in the **Compiler** tab.

Option to use a custom setup file

The feature is the same as for Windows, see above, except that Linux have other paths; for example, the default path for the default setup file in Linux is, under the user´s home directory:

```
.dassaultsystemes/Dymola/2021/setup.dymx
```

Option to not save any changes in the setup file

See the corresponding section for Windows above.

Updated Qt version

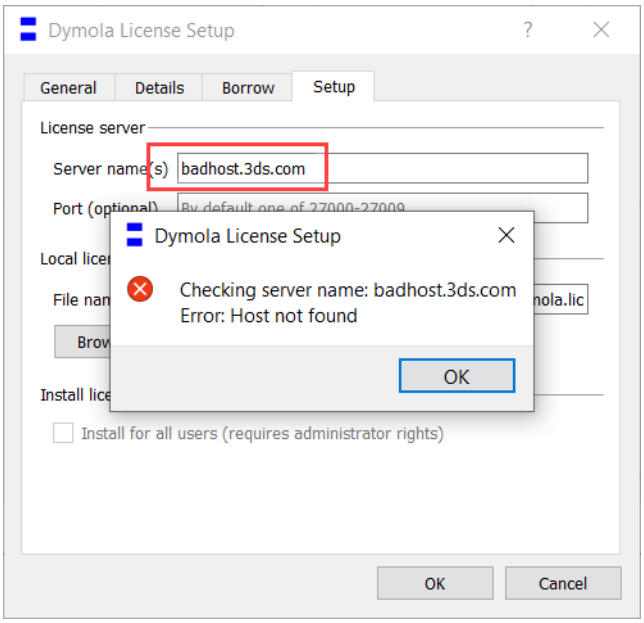
Dymola 2021 is built with Qt 5.14.1.

3.4.3 Dymola license server on Windows and Linux

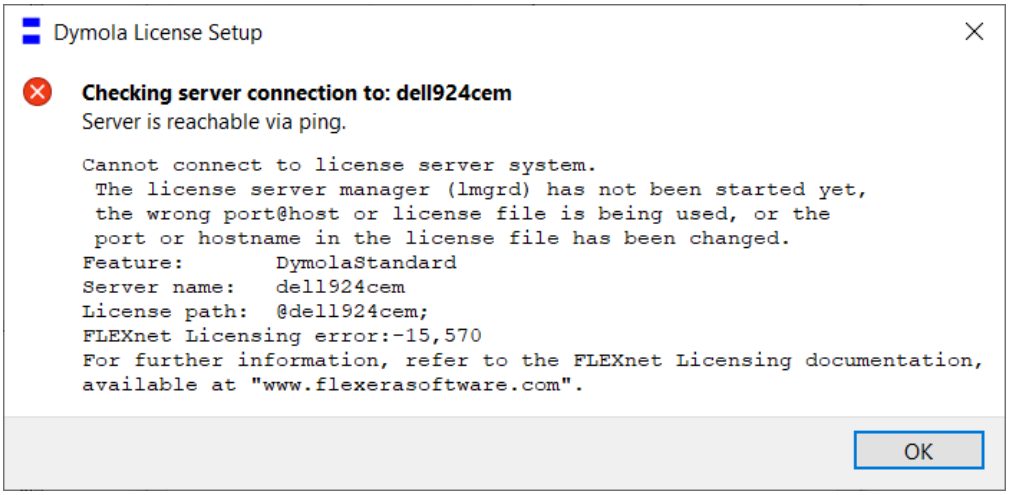
Testing the license server at setup

Basic DNS lookup check for server host name

When trying to connect to the license server host; a basic DNS lookup check is performed. If the host cannot be found, the following message appears:



If the host is found, a ping test is performed, and a test checkout of Dymola Standard license is requested from this server. An example with successful ping test but failed Dymola license checkout test:



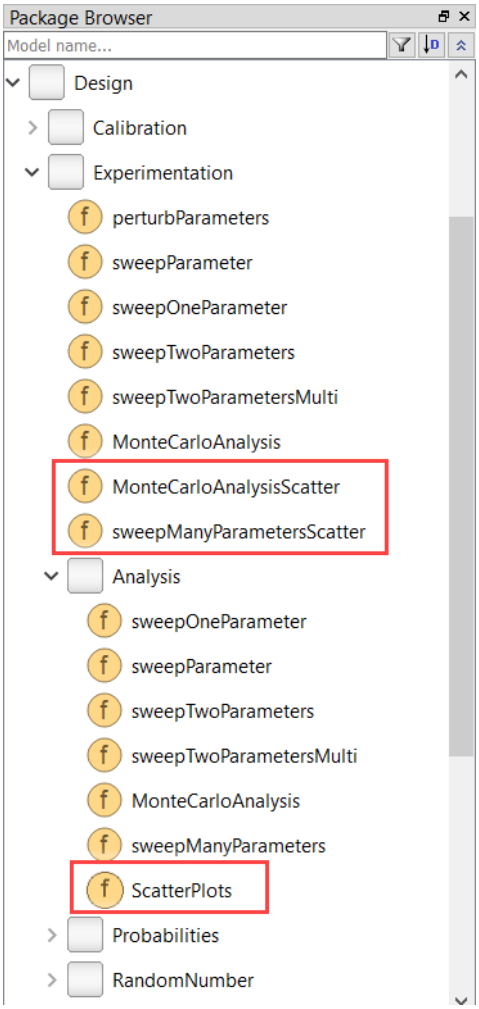
It is still possible to change the license file by answering **Change Server Settings** on the following question whether to update the license server. This can be used for additional testing.

3.5 Model Experimentation

3.5.1 Scatter plots support in the Design package

New functions

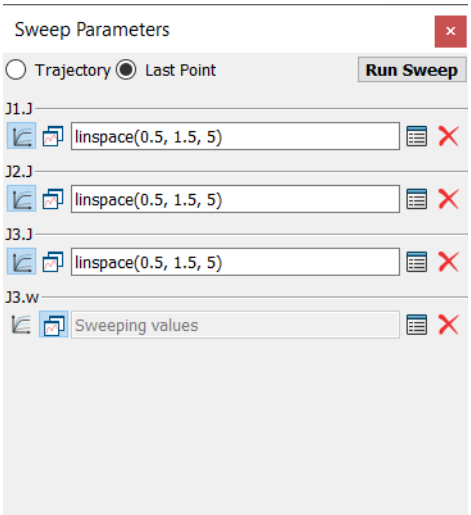
The scatter plots support is included in the Design.Experimentation package, as three new functions:



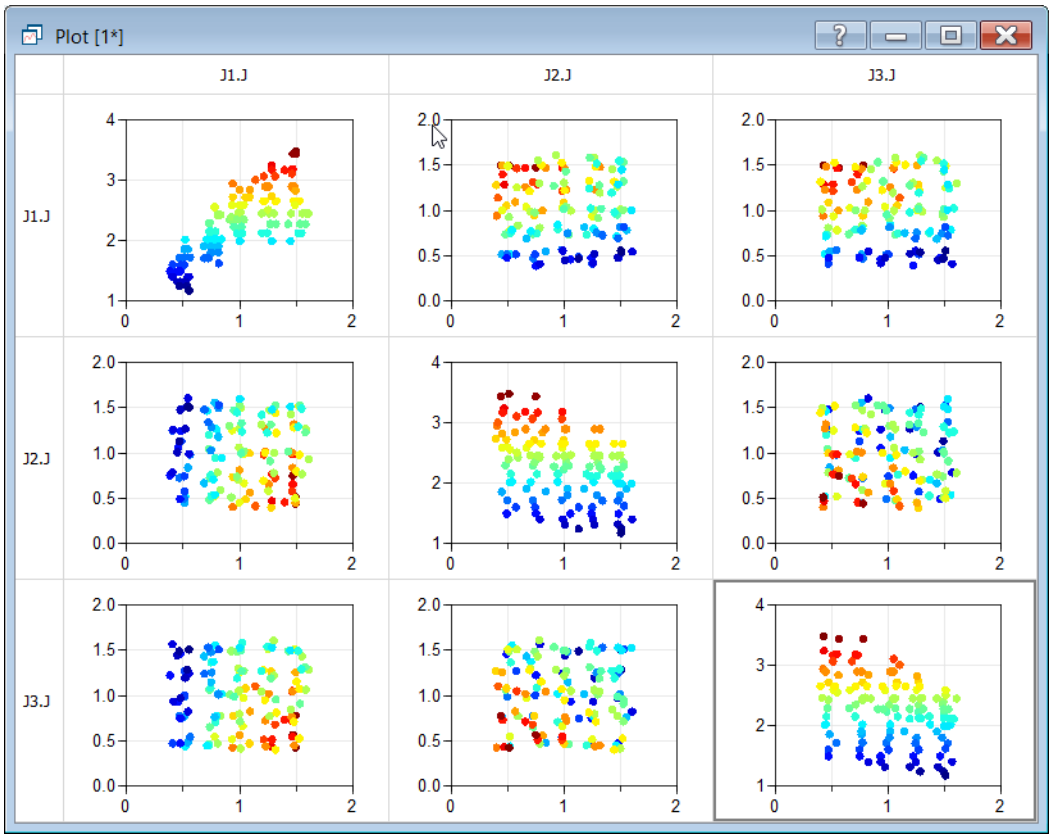
- **MonteCarloAnalysisScatter** – performs a Monte Carlo analysis and presents the result as a matrix of color-coded scatter plots.
- **sweepManyParametersScatter** – sweeps more than two parameters and presents the result as a matrix of color-coded scatter plots (see example below).
- **ScatterPlots** (in the **Analysis** subpackage) – this function is used by the two functions above, but can also be used to produce color-coded scatter plots from results from other sources.

Example: GUI for sweeping more than two parameters

Already previous Dymola versions supported sweeping more than two parameters but there was no support for any corresponding plotting. Now, with the scatter plots functionality, that support is available. As an example, for the Coupled Clutches demo, with the following sweeping setup:



you will get the following plot:



The problem we want to solve is to understand how variations in many parameters explain the variation in the output variable, and it's not simply explained by changes in individual variables. Thus we take the next step and see whether pairs of variables explain the variation in the "output" variable.

That explains the non-diagonal entries in the matrix of scatter plots, and that part is symmetric (the pair J1.J, J2.J behave the same as J2.J, J1.J). The output value is given as the color of the dots, and since we sweep parameters the scattering of the points does not provide any useful information. There are two ways of using that information:

- Select one parameter and see which parameter combines with it to best explain the output.
- See which pair-wise combination overall are the most important.

Using the same logic for the diagonal entries would just be uninteresting straight lines since it is the same parameter on both axis; and normally a matrix of scatter plots includes something else.

In this case it is just a color-coded plot of the output variable against the parameter; there are two ways of using this information:

- It shows how much variations in that parameter explain the variation in the output variable – if the other parameters had no impact it would just be a curved line – and the other parameters would turn it into a "fatter" line.
- As references for the color-scale of the output variables.

General references:

https://www.itl.nist.gov/div898/handbook/eda/section3/eda33qb.htm

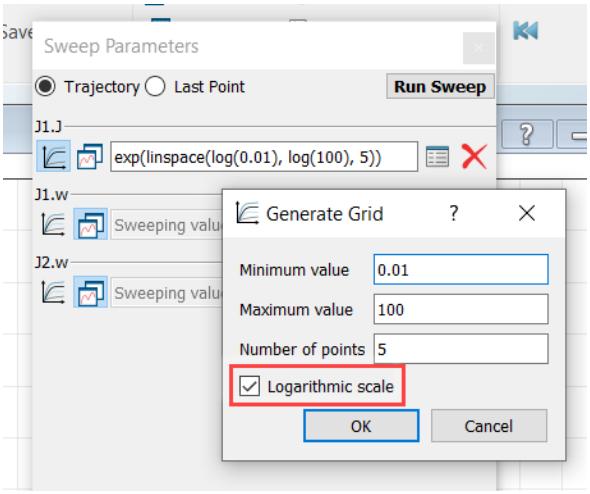
https://plot.ly/python/splom/

Note the possibility to use Monte Carlo analysis rather that sweeping when working with many variables, Monte Carlo is more efficient in such cases. In this Dymola version, as noted above, Monte Carlo analysis can also be presented by color-coded scatter plots.

3.5.2 Minor improvements

Generating grid with logarithmic scale for sweeping

You can now generate grid with logarithmic scale when setting up sweeping of parameters, by selecting **Logarithmic scale** in the dialog for the grid:



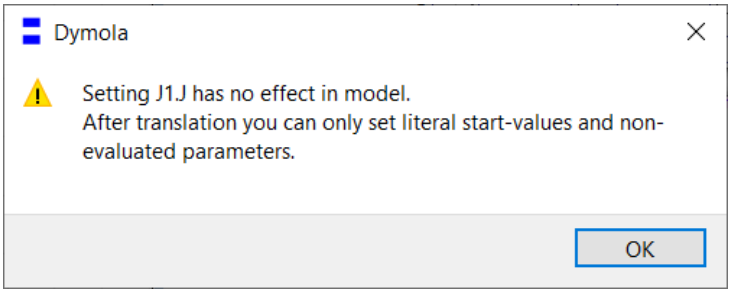
By default, this option is not activated.

Progress indicator when sweeping parameters

When sweeping parameters, the progress indicated the same way as the simulation in Dymola; there is a green progress bar in the background of the Dymola icon in the taskbar.

Error message when trying to sweep evaluated parameters

When trying to sweep an evaluated parameter, you will get an error message. As an example, opening the demo Coupled Clutches, setting `Evaluate =true` (by typing it on the command input line of the command window and pressing **Enter**), and then trying to sweep J1.J and plotting J1.w, you get the following message:



3.6 Other Simulation Environments

3.6.1 Dymola – Matlab interface

Compatibility

The Dymola – Simulink interface now supports Matlab releases from R2015a (ver. 8.5) up to R2019b (ver. 9.7). On Windows, only Visual Studio C++ compilers are supported to generate the DymolaBlock S-function. On Linux, the gcc compiler is supported. The LCC compiler is not supported, neither on Windows nor Linux.

3.6.2 Real-time simulation

Compatibility – dSPACE

Dymola 2021 officially supports the DS1005, DS1006, MicroLabBox, and SCALEXIO systems for HIL applications. For these systems, Dymola 2021 generated code has been verified for compatibility with the following combinations of dSPACE and Matlab releases:

- dSPACE Release 2015-A with Matlab R2015a
- dSPACE Release 2015-B with Matlab R2015b
- dSPACE Release 2016-A with Matlab R2016a
- dSPACE Release 2016-B with Matlab R2016b
- dSPACE Release 2017-A with Matlab R2017a
- dSPACE Release 2017-B with Matlab R2017b
- dSPACE Release 2018-A with Matlab R2018a
- dSPACE Release 2018-B with Matlab R2018b
- dSPACE Release 2019-A with Matlab R2018b and R2019a
- dSPACE Release 2019-B with Matlab R2018b, R2019a, and R2019b

The selection of supported dSPACE releases focuses on releases that introduce support for a new Matlab release and dSPACE releases that introduce a new version of a cross-compiler tool. In addition, Dymola always support the three latest dSPACE releases with the three latest Matlab releases. Although not officially supported, it is likely that other combinations should work as well.

New utility functions – dym_rti_build2 and dym_rtimp_build2

Dymola 2021 introduces a new function, `dym_rti_build2`, that replaces `dym_rti_build` for building dSPACE applications from models containing DymolaBlocks. The new function uses the new dSPACE RTI function `rti_build2` instead of the old function `rti_build`.

A corresponding new multi-processor build function, `dym_rtimp_build2`, is also introduced.

These functions are supported with dSPACE Release 2019-B and later.

Note on dym_rti_build and dSPACE Release 2017-A and later

The function `rti_usrtrcmerge` is no longer available in dSPACE Release 2017-A and later. As a consequence, it is required to run the standard `rti_build` function (with the 'CM' command) after `dym_rti_build` to get your _usr.trc content added to the main .trc file. For example:

```
>> dym_rti_build('myModel', 'CM')
>> rti_build('myModel', 'Command', 'CM')
```

Note that this note applies the new functions `dym_rti_build2` and `rti_build2` as well.

Compatibility – Simulink Real-Time

Compatibility with Simulink Real-Time has been verified for all Matlab releases that are supported by the Dymola – Simulink interface, which means R2015a (Simulink Real-Time ver. 6.2) to R2019b (Simulink Real-Time ver. 6.11). Only Microsoft Visual C compilers have been tested.

3.6.3 Java, Python, and JavaScript Interface for Dymola

A number of new and improved built-in functions are available in the interfaces.

For more information, see the corresponding section in "Scripting" on page 30.

3.6.4 FMI Support in Dymola

Unless otherwise stated, features are available both for FMI version 1.0 and version 2.0.

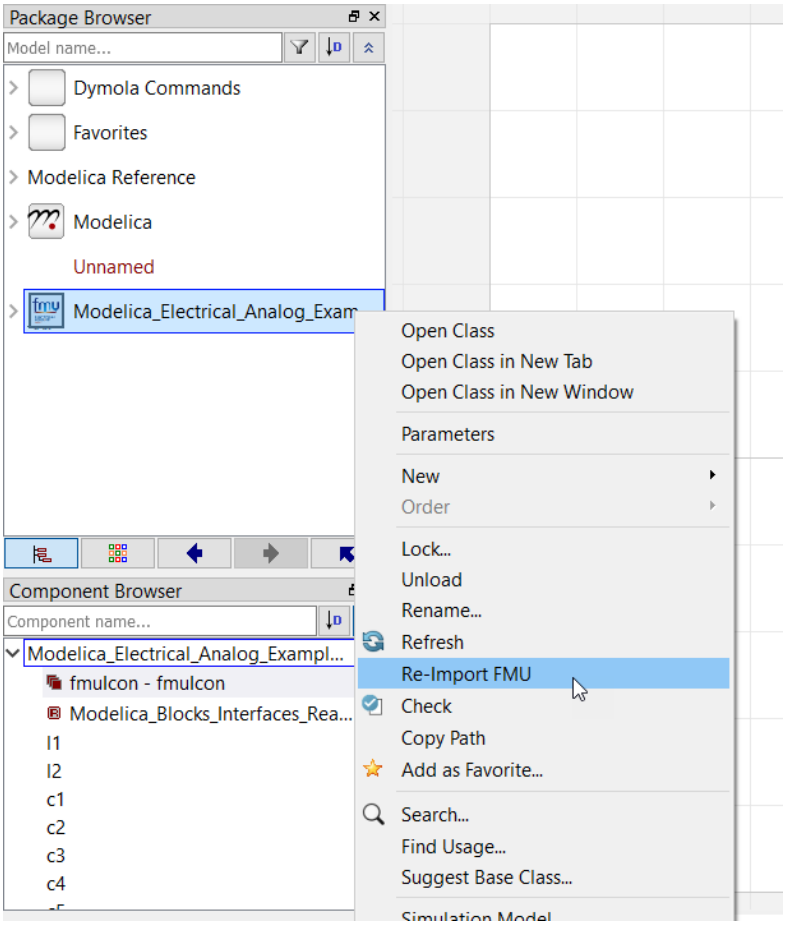
Profiling of external FMU function calls

Please see section "Profiling of function calls" on page 34.

FMU Import

Refresh of FMUs

FMU components can in Dymola 2021 be refreshed by using the FMU context command **Re-Import FMU**:

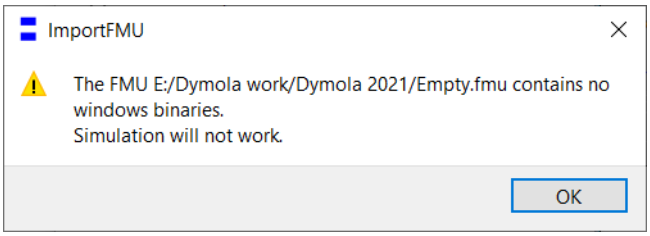


There is no scripting support for this functionality.

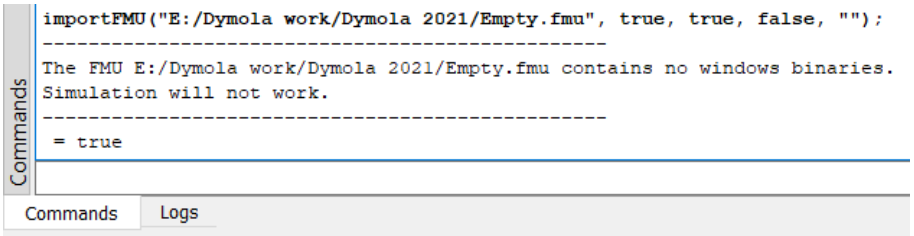
Check if Windows binaries are available when importing an FMU in Windows

When you import an FMU in Windows that contains no Windows binaries, you will get a warning.

The warning when importing by the command **File > Open > Import FMU...** or dragging the FMU into the Dymola window:



The warning in the Command log when importing the FMU by scripting:



Support for using the step size for imported co-simulation FMUs

If the step size has been set for an exported co-simulation FMU from another vendor, this step size is used when the FMU is imported to Dymola. The value is displayed in the **FMI** tab of the parameter dialog of the instantiated FMU, in the **Step time** group, the parameter **fmi_CommunicationStepSize**.

3.7 Modelica Standard Library and Modelica Language Specification

The current version of the Modelica Standard Library is version 3.2.3. The current version of the Modelica Language Specification is 3.4.

Note that the Modelica Standard Library version 3.2.3 is compliant with the Modelica Language Specification 3.4. (So this version of the Modelica Language Specification should be used for reference, and not the Modelica Language Specification 3.2, Revision 2.)

3.8 Documentation

General

In the previous version of Dymola, the former Dymola User Manual Volume 1 was split in two manuals:

- "*Dymola User Manual 1A: Introduction, Getting Started, and Installation*", containing the following chapters:
    - What is Dymola?
    - Getting started with Dymola
    - Introduction to Modelica
    - Appendix - Installation
- "*Dymola User Manual 1B: Developing and Simulating a Model*", containing the following chapters:

    - Developing a model
    - Simulating a model

In this version of Dymola, the former Dymola User Manual Volume 2 is also split, in three manuals:

- "*Dymola User Manual 2A: Model Development Tools*", containing the following chapters:
    - Model Experimentation
    - Model Calibration
    - Design Optimization
    - Model Management
- "*Dymola User Manual 2B: Simulation Interfaces and Export*", containing the following chapters:
    - FMI Support in Dymola
    - Simulation Environments
    - Scripting and Reporting
- "*Dymola User Manual 2C: Advanced Concepts*", containing the following chapters:
    - Advanced Modelica Support
    - Visualize 3D
    - User-defined GUI
    - Appendix - Migration

In the software distribution of Dymola 2021 Dymola User Manuals of version "March 2020" will be present; these manuals include all relevant features/improvements of Dymola 2021 presented in the Release Notes.

3.9 Appendix – Installation: Hardware and Software Requirements

Below the current hardware and software requirements for Dymola 2021 are listed.

3.9.1 Hardware requirements/recommendations

Hardware requirements

- At least 2 GB RAM
- At least 400 MB disc space

Hardware recommendations

At present, it is recommended to have a system with an Intel Core 2 Duo processor or better, with at least 2 MB of L2 cache. Memory speed and cache size are key parameters to achieve maximum simulation performance.

A dual processor will be enough if not using multi-core support; the simulation itself, by default, uses only one execution thread so there is no need for a "quad" processor. If using multi-core support, you might want to use more processors/cores.

Memory size may be significant for translating big models and plotting large result files, but the simulation itself does not require so much memory. Recommended memory size is 6 GB of RAM.

3.9.2 Software requirements

Microsoft Windows

Dymola versions on Windows and Windows operating systems versions

Dymola 2021 is supported, as 64-bit application, on Windows 8.1, and Windows 10. Since Dymola does not use any features supported only by specific editions of Windows ("Home", "Professional", "Enterprise" etc.), all such editions are supported if the main version is supported.

Compilers

Please note that for the Windows platform, a Microsoft C/C++ compiler, an Intel compiler, or a GCC compiler, must be installed separately. The following compilers are supported for Dymola 2021 on Windows:

Microsoft C/C++ compilers, free editions:

Note. When installing any Visual Studio, make sure that the option "C++/CLI support…" is also selected to be installed.

- Visual Studio 2012 Express Edition (11.0)

- Visual Studio 2013 Express Edition for Windows Desktop (12.0)
- Visual Studio 2015 Express Edition for Windows Desktop (14.0)
- Visual Studio 2017 Desktop Express (15) **Note!** This compiler only supports compiling to Windows 32-bit executables.
- Visual Studio 2017 Community 2017 (15)
- Visual Studio 2017 Build Tools **Notes:**
    - The recommended selection to run Dymola is the workload "Visual C++ build tools" + the option "C++/CLI Support…"
    - Installing this selection, no IDE (Integrated Development Environment) is installed, only command line features
    - This installation is not visible as a specific selection when later selecting the compiler in Dymola, the alternative to select is the same as for any Visual Studio 2017 alternative: **Visual Studio 2017/Visual C++ 2017 Express Edition (15)**.
    - For more information about installing and testing this compiler with Dymola, see www.Dymola.com/compiler.
- Visual Studio 2019 Community (16)
- Visual Studio 2019 Build Tools **Notes:**
    - The recommended selection to run Dymola is the workload "C++ build tools" + the option "C++/CLI Support…"
    - Installing this selection, no IDE (Integrated Development Environment) is installed, only command line features
    - This installation is not visible as a specific selection when later selecting the compiler in Dymola, the alternative to select is the same as for any Visual Studio 2019 alternative: **Visual Studio 2019/Visual C++ 2019 (16)**.
    - For more information about installing and testing this compiler with Dymola, see www.Dymola.com/compiler.

Microsoft C/C++ compilers, professional editions:

Note. When installing any Visual Studio, make sure that the option "C++/CLI support…" is also selected to be installed

- Visual Studio 2012 (11.0)
- Visual Studio 2013 (12.0)
- Visual Studio 2015 (14.0)
- Visual Studio Professional 2017 (15)
- Visual Studio Enterprise 2017 (15)
- Visual Studio Professional 2019 (16)
- Visual Studio Enterprise 2019 (16)

Intel compilers

The Intel compilers Intel Parallel Studio XE 2016, XE 2017, and XE 2018 are supported.

Note that you must also select a Visual Studio compiler when selecting any Intel compiler.

Supported combinations of Intel compilers and Visual Studio compilers:

- Intel Parallel Studio XE 2016: Visual Studio 2012, 2013, or 2015
- Intel Parallel Studio XE 2017: Visual Studio 2012, 2013, 2015, or 2017
- Intel Parallel Studio XE 2018: Visual Studio 2013, 2015, or 2017

Current limitations:

- Embedded server (DDE or OPC) is not supported.
- Export DLL is not supported.

GCC compilers

Dymola 2021 has limited support for the MinGW GCC compiler. The following versions have been tested:

- For 32-bit GCC: version 4.8.1, 5.3, 6.3, and 8.2
- For 64-bit GCC: version 4.9.2, 5.3, 7.3, and 8.1

Hence, at least the versions in that range should work fine.

To download any of these free compilers, please visit http://www.Dymola.com/compiler where the latest links to downloading the compilers are available. Needed add-ons during installation etc. are also specified here. Note that you need administrator rights to install the compiler.

Also note that to be able to use other solvers than Lsodar, Dassl, and Euler, you must also add support for C++ when installing the GCC compiler. Usually, you can select this as an add-on when installing GCC.

Current limitations with 32-bit and 64-bit GCC:

- Embedded servers (DDE or OPC servers) are not supported.
- Support for external library resources is implemented, but requires that the resources support GCC, which is not always the case.
- FMUs must be exported with the code export option[1] enabled.
- For 32-bit simulation, parallelization (multi-core) is currently not supported for any of the following algorithms: RadauIIa, Esdirk23a, Esdirk34a, Esdirk45a, and Sdirk34hw.
- Compilation may run out of memory also for models that compile with Visual Studio. The situation is better for 64-bit GCC than for 32-bit GCC.

In general, 64-bit compilation is recommended for MinGW GCC. In addition to the limitations above, it tends to be more numerically robust.

[1] Having the code export options means having any of the license features **Dymola Binary Model Export** or the **Dymola Source Code Generation**.

Dymola license server

For a Dymola license server on Windows, all files needed to set up and run a Dymola license server on Windows using FLEXnet, except the license file, are available in the Dymola distribution. (This includes also the license daemon, where Dymola presently supports FLEXnet Publisher version 11.14. This version is part of the Dymola distribution.)

Linux

Supported Linux versions and compilers

Dymola 2021 runs on openSUSE 42.2, 64-bit, with gcc version 5.3.1, and compatible systems (see http://doc.qt.io/qt-5/supported-platforms.html). Any later version of gcc is typically compatible. In addition to gcc, the model C code generated by Dymola can also be compiled by clang.

You can use a dialog to select compiler, set linker flags, and test the compiler by the **Verify Compiler** button, like in Windows. This is done by the command **Simulation > Setup**, in the **Compiler** tab.

You can however still change the compiler by changing the variable `CC` in `/opt/dymola-<version>-x86-64/insert/dsbuild.sh`. As an example, for a 64-bit Dymola 2021 application:

```
/opt/dymola-2021-x86_64/insert/dsbuild.sh
```

Dymola 2021 is supported as a 64-bit application on Linux.

Notes

- 32-bit compilation for simulation might require explicit installation of 32-bit libc. E.g. on Ubuntu: `sudo apt-get install g++-multilib libc6-dev-i386`
- Dymola is built with Qt 5.14.1 and thereby inherits the system requirements from Qt. Note that the library `libevent-2.0.so.5` might require explicit installation.
- For FMU export/import to work, zip/unzip must be installed.

Note on libraries

- The library UserInteraction is not supported on Linux.

Dymola license server

For a Dymola license server on Linux, all files needed to set up and run a Dymola license server on Linux, except the license file, are available in the Dymola distribution. (This also includes the license daemon, where Dymola presently supports FLEXnet Publisher 11.14.)