

FMU Model-exchange 1.0 Export

User Guide ver. 2.0

1 Introduction

This document describes the generation of a Functional Mockup Unit (FMU)¹ from a SysML block according to the Functional Mockup Interface (FMI) Model Exchange version 1.0. This document describes the step-by-step procedure for FMU export and FMU export restrictions. The correspondence between SysML element and FMI elements is described in Section 5.

2 Generating FMUs from Rhapsody

- Add the FMI profile to the model (use File → Add Profile to Model and choose FMI.sbs file from the FMI directory). The profile is located at [Rhapsody Install]\Share\Profiles\FMI
- Apply the «FMUExport» stereotype to a SysML block that should be exported.
- Optionally: set Author and Version tags (defined in «FMUExport») of the block; this information will be part of the generated FMU.
- Optionally: apply «FMUDiscrete» stereotype for all *floating point* ports that trigger change events. Any change to these ports will trigger event handling in the generated FMU. Caution: «FMUDiscrete» ports should not be connected to continuous signals sources, otherwise simulation performance will be significantly degraded because of frequent triggering of event handling.
- Optionally: add description to the block; this information will be part to the generated FMU.
- Optionally: apply «FMUParameter» stereotype to attributes to be exported as FMU parameters.
- Optionally: apply «FMUIgnore» stereotype to attributes or ports that shouldn't be exported to the FMU. This stereotype can be used to suppress warnings for unsupported interfaces, see Section 3 below.
- Right-click the block in Rhapsody (in the browser view or in a diagram) and choose FMU → Generate FMU from the pop-up menu. A generation and compilation process will follow; the last message in the log window should contain the text “FMU package created”, followed by the full path of the FMU file, whose name will be the same as the block name with the extension .fmu.

Notes:

1. In case of an error message about missing libraries, select the Code → Build Framework command from the main menu to generate the missing libraries and then regenerate again.
2. The first time that an FMU is generated, a new component and configuration are created for that block, in the package that owns the block. These are based on the configuration that was active prior to the FMU generation. In subsequent FMU export operations on the same block, that existing configuration is used so one may modify them if needed (e.g., add additional sources/incudes).

3 FMU Export Restrictions

The exported SysML block must have owned classifier behavior, or own at least one part typed by a block with owned behavior. In other words, either the block itself has a behavior described by a statechart or activity diagram, or at least one of its parts.

In addition, the block should not be active and should not have parts typed by active blocks (the entire compositional hierarchy must be sequential)

Modeling constraints on exported attributes:

- The attribute should be of primitive type.
- The attribute should have public visibility.
- The attribute should not be defined as const.

¹ For further details about Functional Mockup Units see the Functional Mockup Interface website: <https://www.fmi-standard.org>.

Modeling constraints on exported flow ports:

- The flow port should be atomic and have a primitive type.
- The direction associated with the flow port is input or output but not bi-directional.
- An attribute annotated by «FMUParameter» stereotype or associated with an input port should have an initial value.

All elements of a SysML block interface (attributes or ports) that do not obey these conditions will not be exported; a warning will be reported. However, the stereotype «FMUIgnore» can be applied to the corresponding elements and this will suppress the warning.

The exported FMU can be instantiated only once at the hosting simulator.

4 FMU Export with Animation

By default, the generated FMU and the corresponding configuration will not include animation. To export an FMU with animation, set Instrumentation mode to Animation in the generated configuration and export the FMU again. An FMU exported with animation connects to Rhapsody during simulation and waits for animation commands.

During simulation, an FMU with animation opens a connection to the Rhapsody application. Only one FMU (or other component) with animation at a time can connect to the Rhapsody application.

5 Mapping from SysML to FMI elements

The following table shows how the SysML model elements are translated to FMI elements. A floating-point port is one having the type double, float, RhpReal, or a similar type.

Table 1 – the mapping between SysML and FMI elements

SysML element	FMI element
Block	FMU
Atomic output flow port	Scalar output discrete variable
Atomic floating point input flow port without <<FMUDiscrete>> stereotype	Scalar input continuous variable
Atomic floating point input flow port with <<FMUDiscrete>> stereotype	Scalar input discrete variable
Atomic non-floating-point input flow port	Scalar input discrete variable
SysML attribute with no corresponding flow port	Scalar internal discrete variable
SysML attribute with <<FMUParameter>> stereotype	Scalar internal parameter variable
Initial value of attribute	Start value of scalar variable
Flow port or attribute with <<FMUIgnore>> stereotype	No FMU element