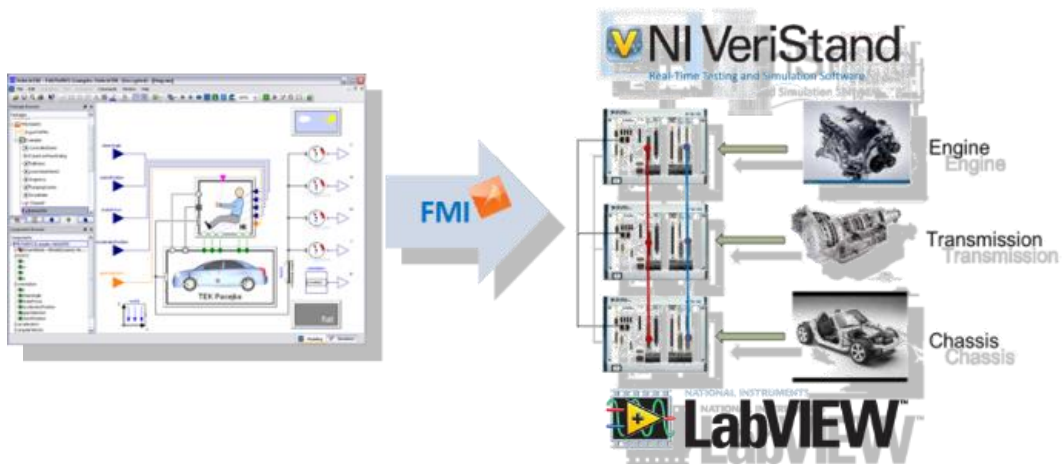




FMI to NI VeriStand™ & LabVIEW™ Add-on

User Guide



FMI To NI VeriStand™ & LabVIEW™

Import FMU Model in NI VeriStand™ and LabVIEW™

FMI To NI VeriStand™ & LabVIEW™ Add-on

Release 1.5.1

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1. Introduction

1.1. FMI Connection for NI VeriStand & LabVIEW

The FMI Connection is an add-on for NI VeriStand that enables the usage of FMU models on windows and Phar Lap ETS target platforms. From version 1.5.1 it enables also LabVIEW Model Interface Toolkit to natively import FMU models.

2. Installation

2.1. Supported Platforms

The FMI Connection is supported on the following OS:

- Windows 8 (32-bit and 64-bit)
- Windows 7 (32-bit and 64-bit)
- Windows Vista (32-bit and 64-bit)
- Windows XP Service Pack 3 (32-bit)
- Windows Server 2003 R2 (32-bit)
- Windows Server 2008 R2 (64-bit)

2.2. Required Software

If you plan to import your FMU models in VeriStand, than version 2011 or 2012 or 2013 or 2014 of NI VeriStand is required to install FMI Add-On, apart from that this software shares the same compatibilities and requirements of the VeriStand version you have installed on your machine. If you also plan to use your FMU models in LabVIEW, than you need to have installed on your machine, versions 2013 or 2014 of LabVIEW together with the corresponding version of the Model Interface Toolkit.

Both Real-Time targets of the FMI Add-On for VeriStand and LabVIEW require Phar Lap ETS on the host target to be installed.

2.3. Installation Procedure

- Run the installer *FMItO NIVS201X_1.5.1.exe*, and click *Next* on welcome page.

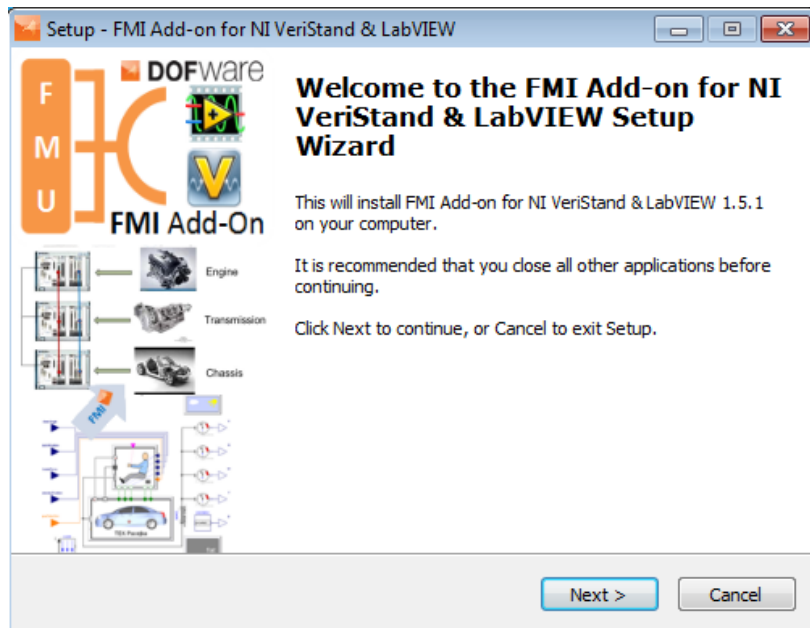


Figure 1 First installer dialog, welcome text.

- Read the license agreement, and click I Agree to agree to the terms and conditions.

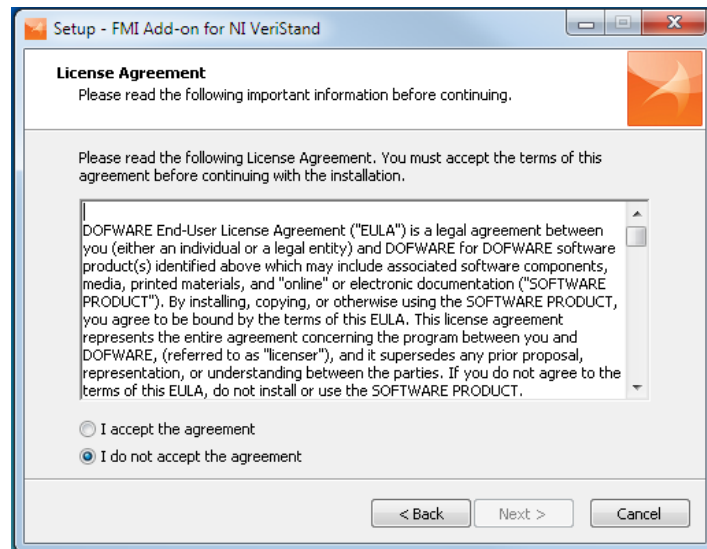


Figure 2 License agreement

- Choose the directory where the FMI Connection should be installed. The default installation directory, which will be pre-selected, is C:\Program Files\FMUtoNIVS.

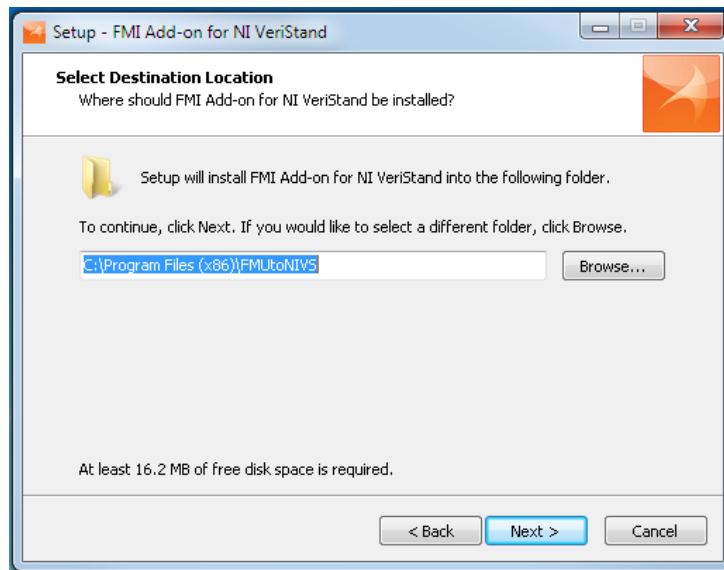


Figure 3 Third installer dialog, select installation folder.

- Select the NI VeriStand and LabVIEW Versions you had installed on your machine.

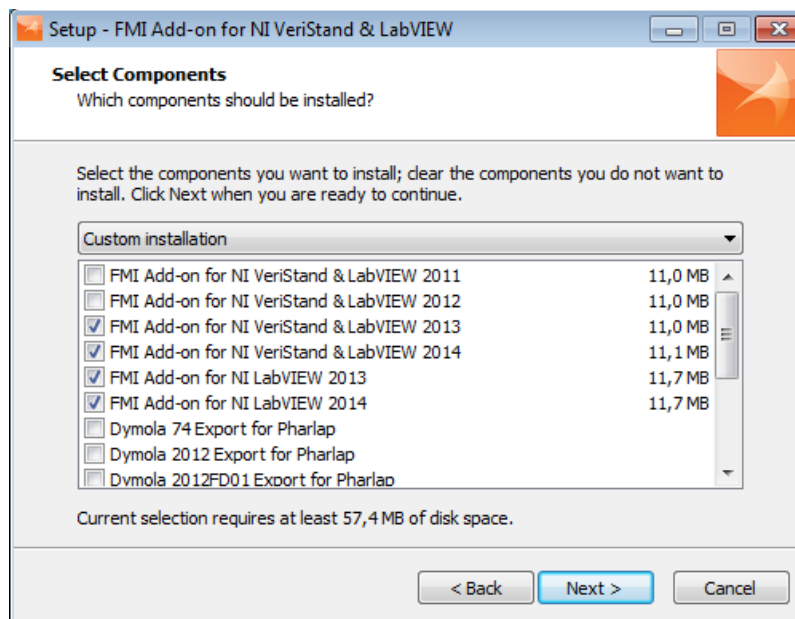


Figure 4 Fourth installer dialog, select the version to install depending on your VeriStand and LabVIEW Versions.

- Modify, if you want, the name of the menu folder that will contain the FMI

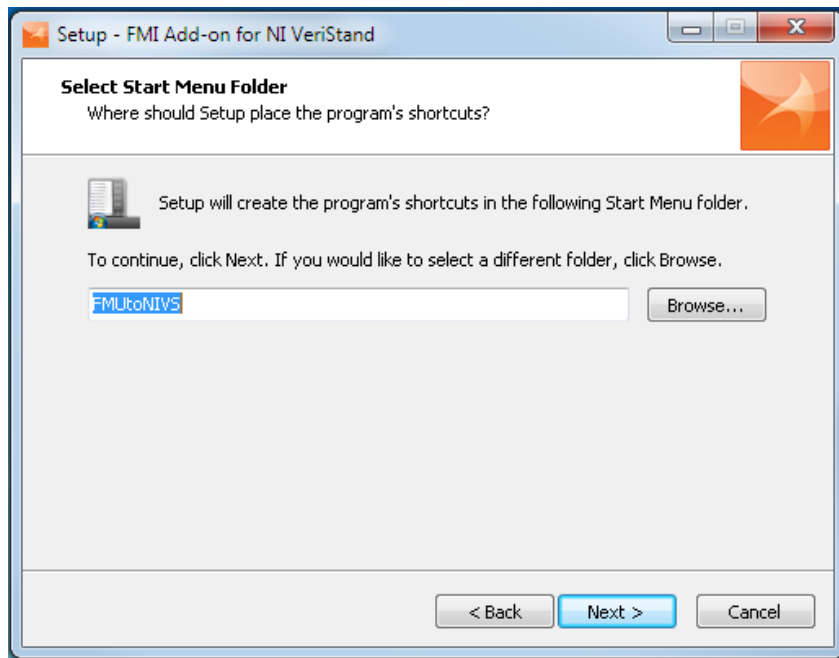


Figure 5 Fifth installer dialog, select the name you want to use for the folder that will be inserted on the Start Menu.

- Select Install if you are ready to start the installation. Select Back to redo the last step.

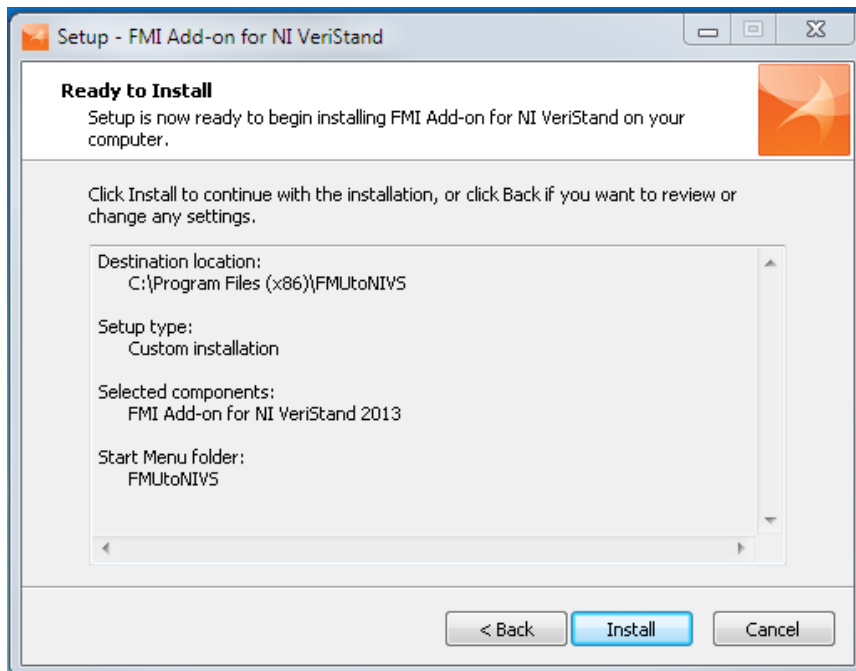


Figure 6 Sixth installer dialog, confirm your choices and start the install the product.

- After the installation has completed you will find a folder created for the FMI Connection in the Windows Start menu. Inside that folder you will find links to the uninstall procedure, to the help application, to the FMI checker application, to the NI DLL checker application, and to the installation folder that will look like image 2.7.

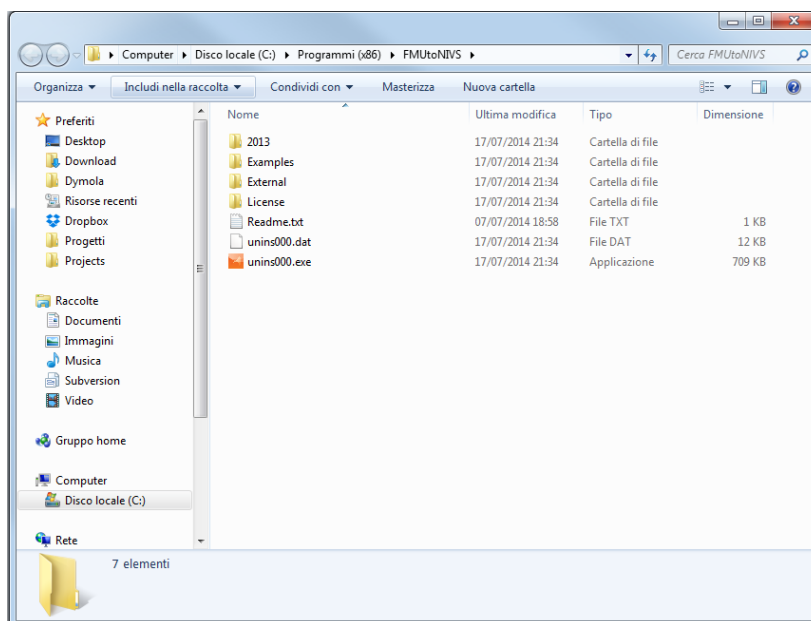


Figure 7 FMI Connection folder.

3. License file installation

After the installation procedure, FMI Connection will be in demo mode. To use the program fully, a license file must be installed. In order to activate the product, place the *license.lic* file in the *\FMUtoNIVS\License* directory that is found in the *\Program Files* on Windows x86 and *\Program Files (x86)* on Windows x64. To obtain a license file please write to sales@dofware.com or buy it from <http://sine.ni.com/nips/cds/view/p/lang/it/nid/212841>. If you have more than one license file append the content of all your license files to the *license.lic* file in the *\FMUtoNIVS\License* directory that is found in the *\Program Files* on Windows x86 and *\Program Files (x86)* on Windows x64.

4. Install FMI Add-on in NI RT-Target

In order to deploy and run fmu's on RT target, it is mandatory to install the add-on on each target. To install the add-on on a target open the Measurement & Automation Explorer:

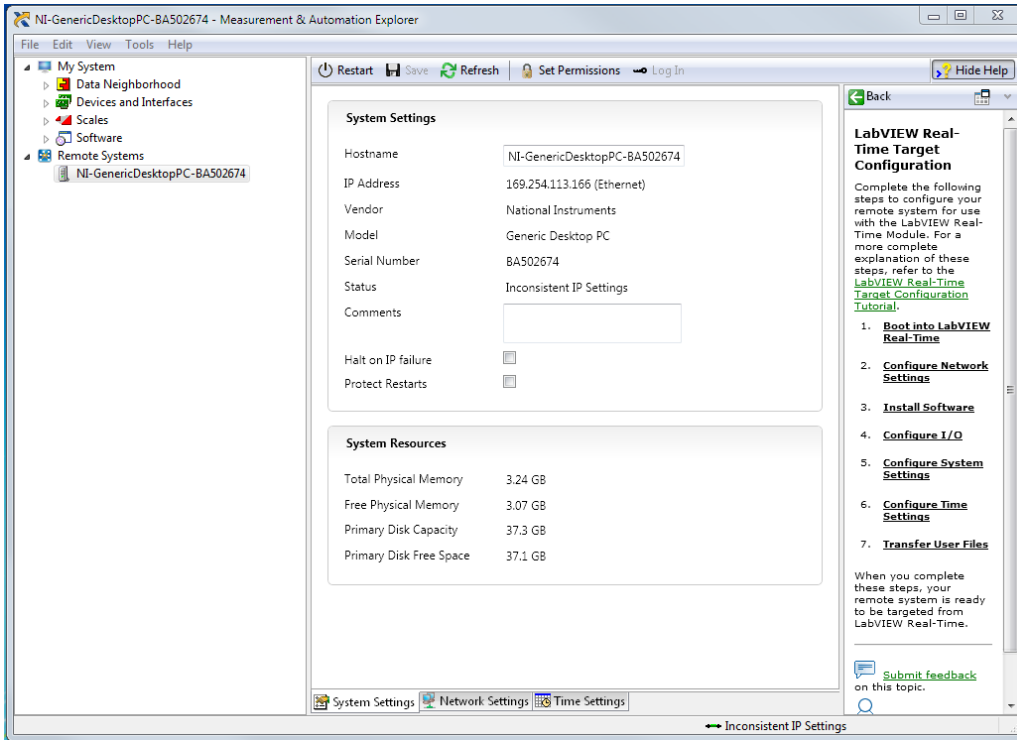


Figure 8 Measurement & Automation Explorer

Click on “*Software*” and then “*Add/Remove Software*”, locate “*FMI to VeriStand 201x*” and/or “*FMI to LabVIEW 201x*” and Install the feature:

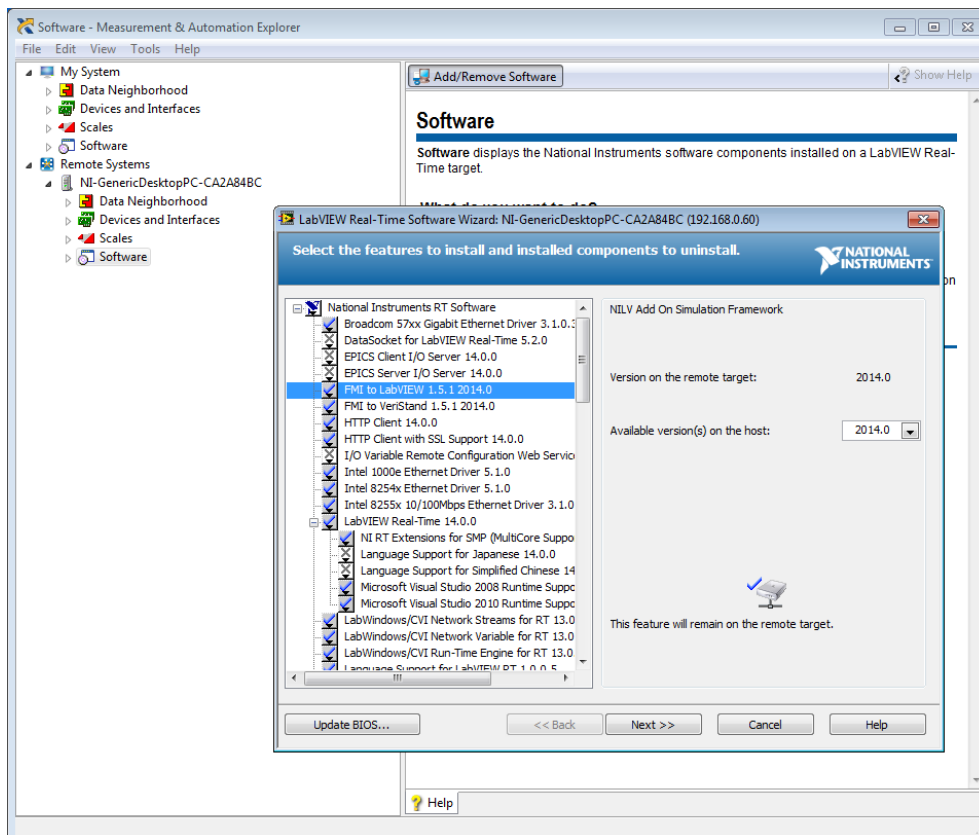


Figure 9 Install FMI Add-on on your target.

You have FMI support on your RT Target:

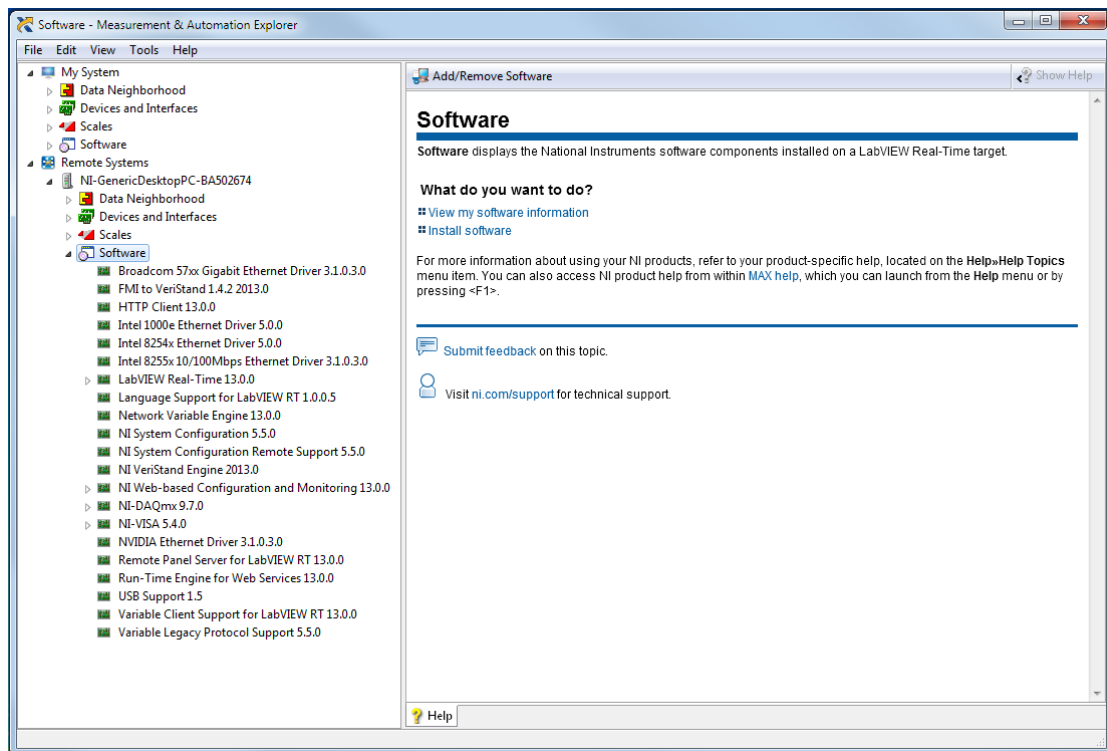


Figure 10 FMI Add-on installed.

Now you can deploy your NI projects including FMU models on your RT target.

5. Uninstallation Procedure

5.1. For Windows

FMI Connection provides an uninstaller. The following steps uninstalls the FMI Connection.

The uninstaller is found in the start menu. Click Uninstall to open the uninstaller dialog.

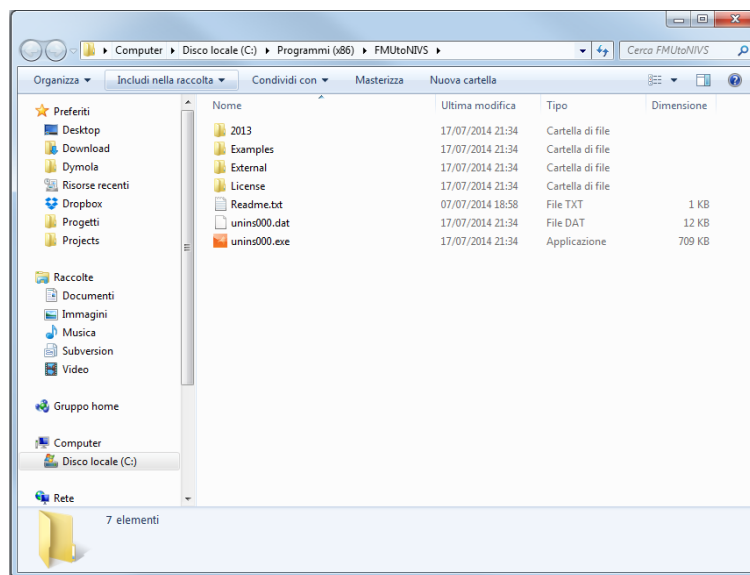


Figure 11 FMI Connection folder - unistall.

6. Support

For Dofware support plays a crucial role in the activity of design-in offer to our customers as an added value.

Dofware provides a structured support service to customers who have an active maintenance contract.

Supporting activities include:

- Information service on the product features
- Service of information about product features
- Support the installation of the product
- Support for the ordinary and extraordinary maintenance

In case you need technical support, record and report the following informations:

- License Number or Serial Number;
- Number of the invoice;
- Operating System;

- Version of the FMI - Add-on and version of VeriStand and LabVIEW;
- Eventually PXI model and installed software.

To contact Dofware for support you can write to support@dofware.com or call. +39 011 22 37 658.

Operating hours for Support:

Lun-Ven: 8:00 - 13:00 --- 14:00 - 18:00 Europe Time (Amsterdam, GMT+01:00).

The expected turnaround time on a support inquiry is 48h.

7. Export Models in FMI format

7.1. FMI standard

Several modeling tools are able to export models in FMI format, for a complete list of compliant tools see <http://fmi-standard.org/tools>. The FMI connection is compliant with the FMI for Co-Simulation 1.0, FMI for Model Exchange 1.0 and FMI 2.0 specifications. In order to test the compatibility of your models with the FMI to NI VeriStand Connection you can download the latest version of the FMI compliance checker from the Modelica Association from see <http://fmi-standard.org/> and test the fmu's you want to import into VeriStand with it. Otherwise you can use the application included into the add-on that wrap the same checker. You can find it in "Start->FMItO NIVS->FMU Checker".

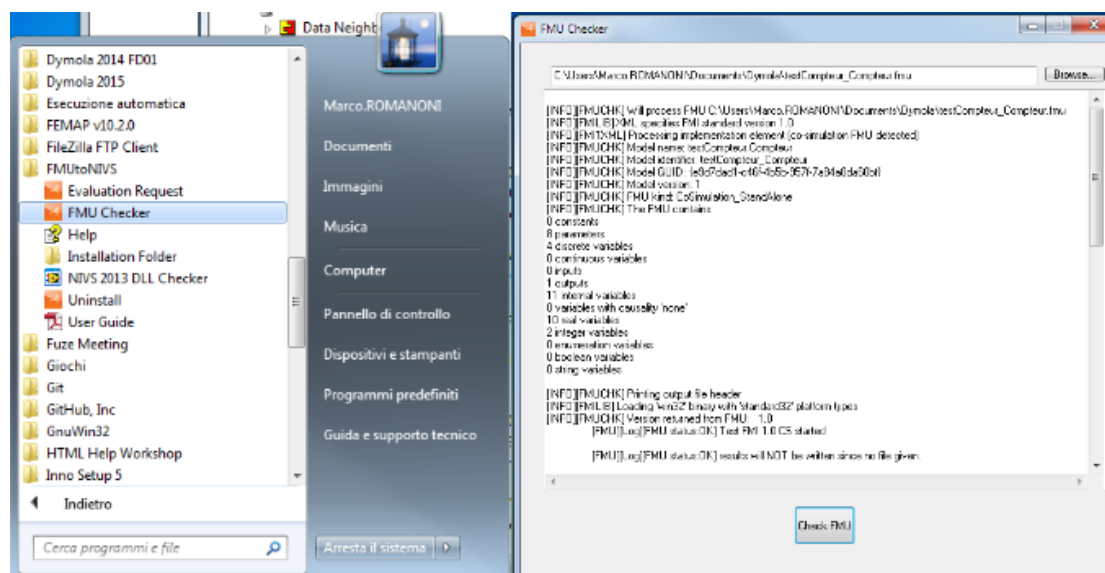


Figure 12 FMU Checker window.

In addition, if you want to execute your models into Par Lap ETS on PXI systems, it is mandatory to check the compatibility of all the dll's included into your fmu archive with the NI dll checker

(<http://digital.ni.com/public.nsf/allkb/0BF52E6FAC0BF9C286256EDB00015230>)

This checker since version 1.4.1 is also embedded into the FMI Add-on, in fact you are asked to perform a dll check at each FMU import.

7.2. Adding import Parameters into your models

In order to be able to setup configuration parameters for your import in VeriStand or LabVIEW, the FMI Add-on will read the value of some key parameters in your FMI model, if present.

In particular you can setup the target rate of your model into VeriStand or LabVIEW simply adding a top level real parameter named "FMINIVS_FixedStepModel" with your desired step execution time.

In addition, in order to be able to use fixed step solvers with fixed step time lower than 0.01 seconds in Windows target, it is possible to setup a top level real parameter named "FMINIVS_SuperSampling" in order to impose the FMI connection to super-sample your model by that integer factor of your choice. This will be used only if the FMU is executed using the FMI for Model-Exchange API.

Moreover if you export an FMU containing both Model-Exchange and Co-Simulation API, you will be able to choose which one to use into VeriStand or LabVIEW setting an integer top level parameter named "FMINIVS_FmuSimType" with the value 1 if you want to use Co-Simulation API and 2 if you intend to run the model with fixed step solvers and Model-Exchange APIs.

In particular the FMI Add-on implements the following fixed step solvers:

- Explicit Euler 1
- Heun 2
- Explicit Runge Kutta 4th order 3
- Modified midpoint 5
- Runge Kutta Cash Karp54 7
- Runge Kutta Dopri5 8
- Runge Kutta Fehlberg78 9
- Adams Bashforth 10
- Adams Bashforth Moulton 12

To choose which one do you want to use in case you are running your FMU using Model-Exchange APIs, you have to setup an integer top level parameter named "FMINIVS_Integrator". Setting the value of that parameter you will choose which integrator you will use in VeriStand or LabVIEW, accordingly to the indexes displayed before.

In addition, you can choose how depth the add-on will import model variables, this affects import time. You will be able to import only first level variables setting a Real top level parameter named "FMINIVS_LevelIOSignalParameters" equal to 0, second level parameter of type "blockname.variablename" setting its value to 1 and so on. Finally you can setup the "FMINIVS_StopTimeDefined" parameter that specifies if the model you are importing should terminate its execution when reaching the stopTime value defined in the ModelDescription file of the FMU.

7.3. FMI export from Dymola

From version 2012, Dymola FMU export functionality has been extended to also support FMI for Co-Simulation specification version 1.0 for export of models (slaves) with built-in numerical solvers.

The new functionality uses the SUNDIALS suite of numerical solvers (version 2.4.0). The SUNDIALS code is not distributed with Dymola 2012, but can be downloaded from the Sundials website (<https://computation.llnl.gov/casc/sundials/main.html>) or found into the \external\ folder.

To install the SUNDIALS libraries needed to activate the FMU for Co-Simulation export functionality in Dymola, you can follow the instruction on Dymola manuals or unzip the package "\external\sundials-2.4.0.zip" into the folder "<Dymola2012 installation folder>\Dymola 2012\Source\FMI\".

Dymola versions since 7.4 can export models in FMU format, but Dymola installations have to be modified to export FMU that are also Phar Lap ETS compliant. To do so during the installation process, simply select the Dymola version you have installed on your machine.

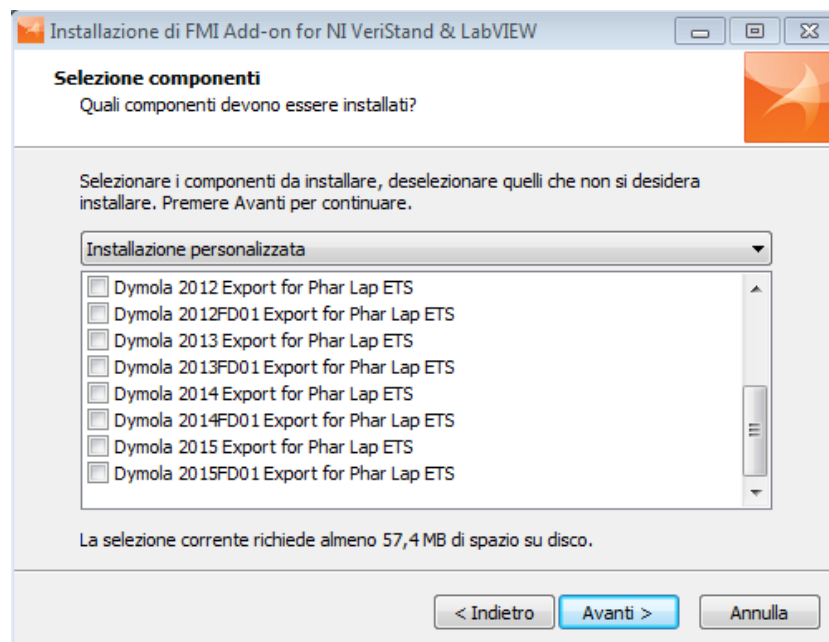


Figure 13 Dymola FMU exporter installation option.

Now you it's all set to generate Phar Lap ETS Compliant FMUs from Dymola. To generate FMU for Co-Simulation from Dymola 7.4 to 2014 please follow the instructions below:

- Open the FMIAddOn library in Dymola
- Use "File -> Open". Open FMUtoNIVS.moe library located in your FMUtoNIVS installation folder:

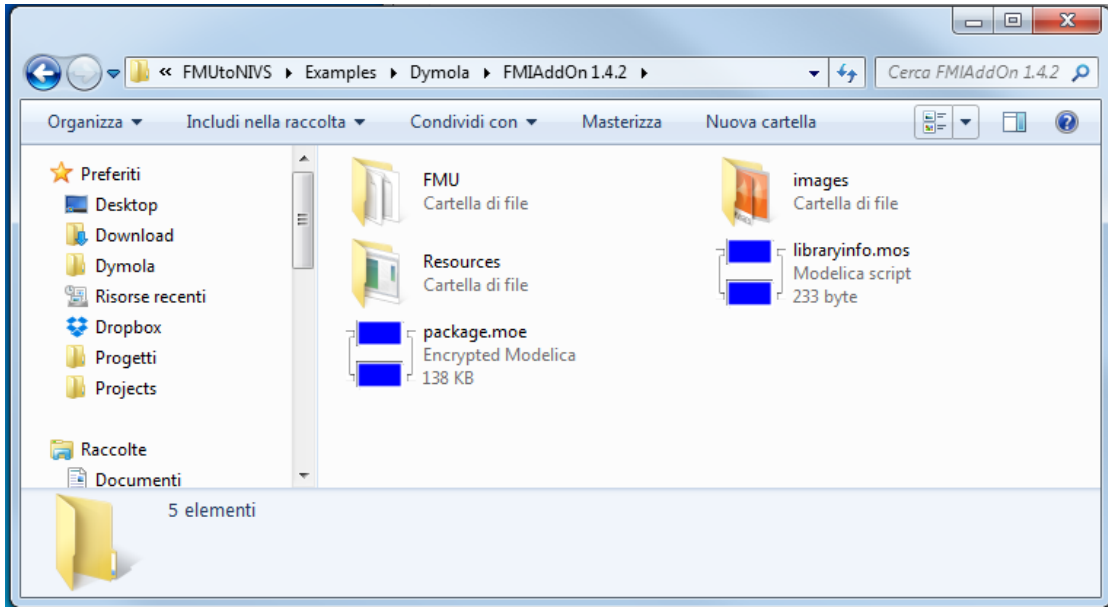


Figure 14 FMUtoNIVS Dymola example library.

- Call the “FMIAddOn.exportToFMU” function

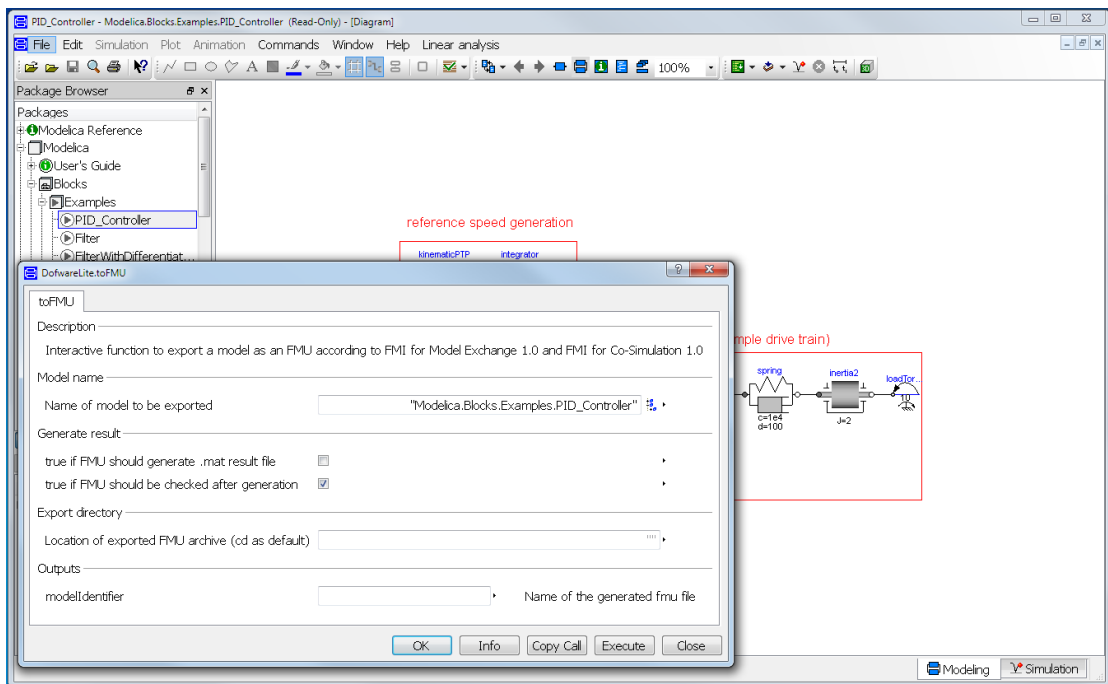


Figure 15 Translate model as FMU.

- Select from the gui the model you want to export
- Check the “checkAfterExport” flag
- See if the export procedure ended correctly with the following messages:

fmi instantiation OK
fmi Initialization OK

To generate FMU for Co-Simulation from Dymola 2014FD01 and newer versions please follow the instructions below:

- Open the simulation setup window in Dymola;
- Select the FMI tab;
- Select FMI 1.0 format (FMI 2.0 can be selected for Dymola 2015FD01, previous versions exported in Release Candidate format);
- Select Model-Exchange or Co-simulation using Dymola solvers;
- Select 32-bit platform;
- Select Compiler tab;
- Use Visual Studio Express of Professional Version 2008 or 2010;
- Export FMU in the usual way.

8. Import FMU models in NI VeriStand

To import an FMU model into NI VeriStand follow the instructions below:

- Open NI VeriStand;
- Create a New project;
- Check your FMU using the official FMU compliance Checker from the Modelica Association;
- Copy your FMU into the Project folder;
- Launch the System Explorer related to a System Definition File from the Project Explorer;
- Load the fmu model:

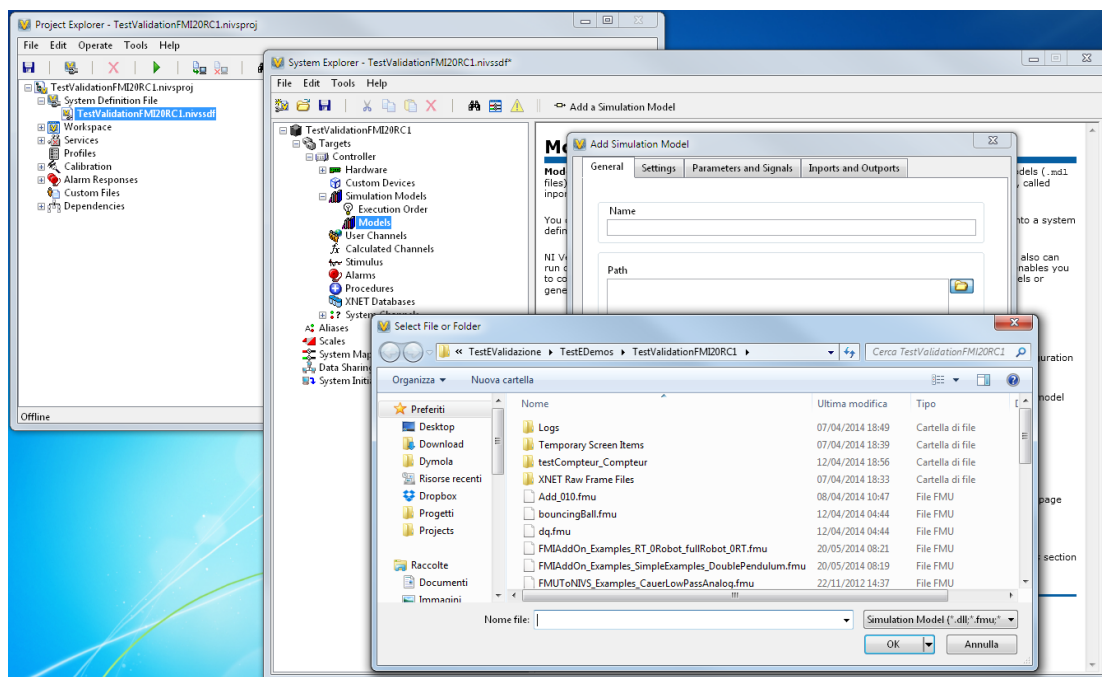


Figure 16 Import FMU.

- Save and close the System Explorer Project;
- Open and setup the workspace from the Project Explorer;
- Deploy and run the Experiment.

9. Use FMU models in NI LabVIEW

To use an FMU model into NI LabVIEW follow the instructions below:

- Open NI LabVIEW;
- Open MIT Simple Load and Run FMU Model.vi from Start->FMITONIVS->LabVIEW Examples;
- Check your FMU using the official FMU compliance Checker from the Modelica Association;
- Copy your FMU into the C:\Program Files (x86)\National Instruments\LabVIEW 2013\examples\Control and Simulation\Model Interface\Models folder;
- Modify the path of the model accordingly to the name of the fmu model that you just added into the Models folder;
- Modify the input and output array of variables accordingly to your FMU model I/O interfaces;
- Run your vi;

This is just an example to get started, if you want to use your models in more complex vi, just treat your fmu models as dll models built with Model Interface Toolkit specifications.

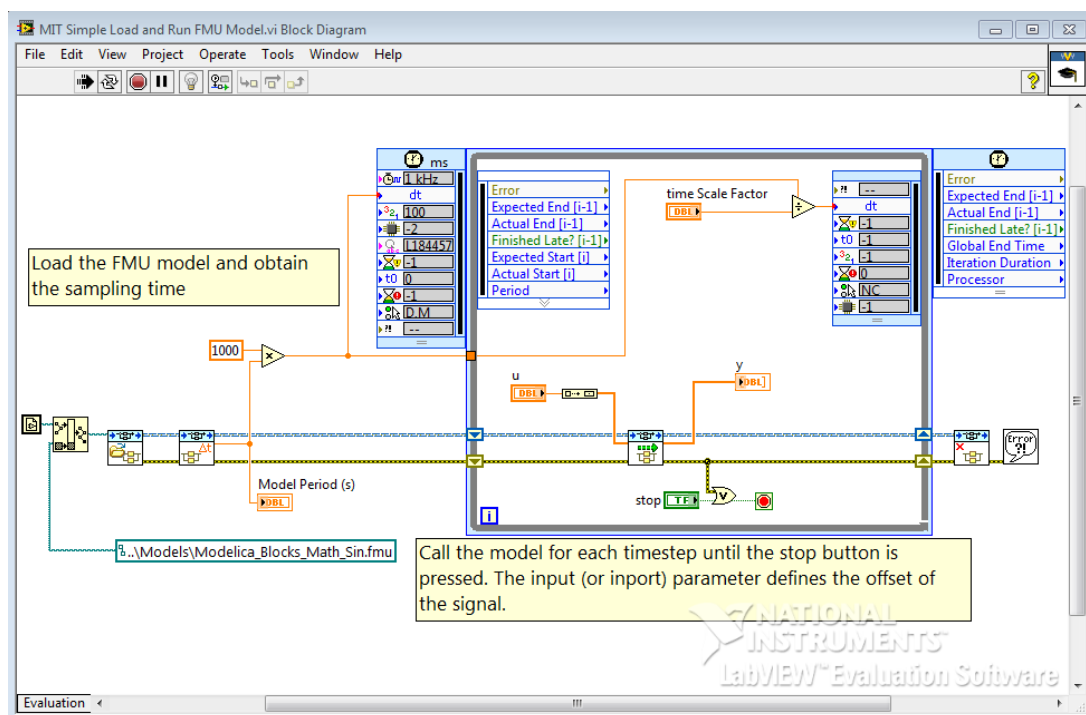


Figure 17 LabVIEW vi that calls and execute an FMU model.

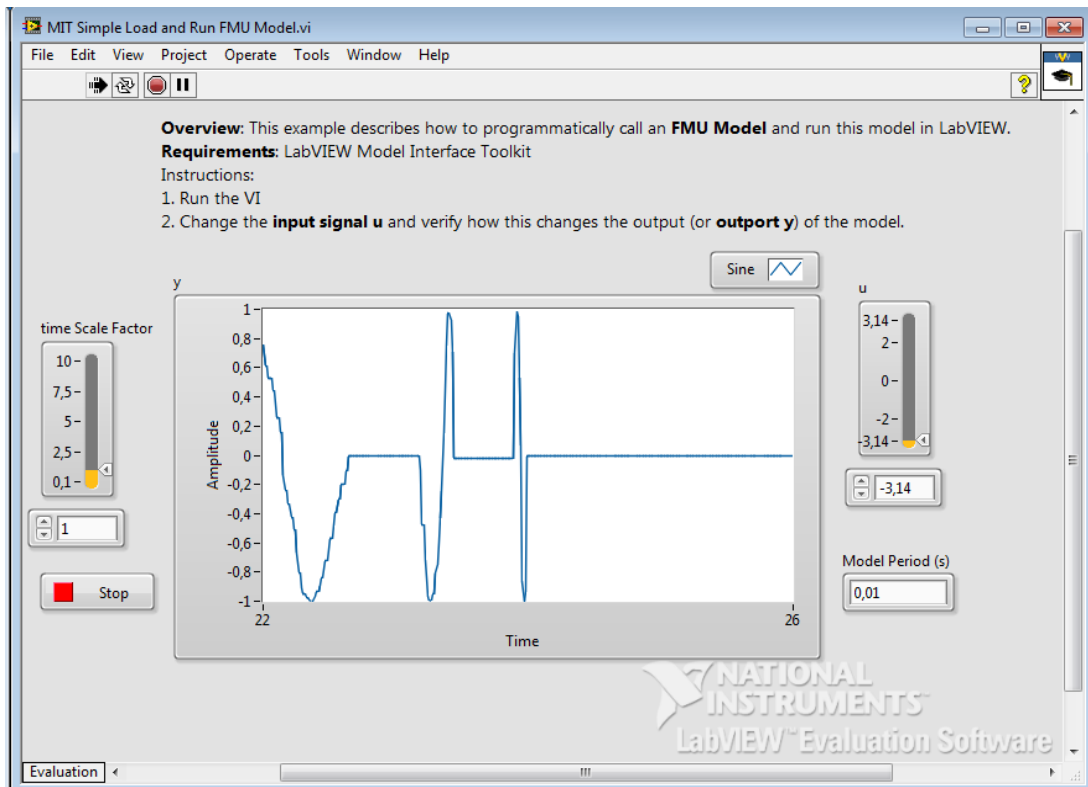


Figure 18 VI GUI execution output.

10. Getting Started

10.1. Introduction

This chapter will take you through one example in order to get you started with FMU to NI VeriStand & LabVIEW Connection.

10.2. FMU Connection: Step by Step example

10.2.1. Prerequisites

- FMU 1.0 or 2.0 compliant
- NI VeriStand 201x
- FMU to NI VeriStand & LabVIEW Connection 201x

10.2.2. Generate and check your FMU

The first step of the process consists in the generation and check of the functional mock-up unit. The FMU can be hand coded or exported from an FMI modelling tool.

In this starting tutorial we used an fmu containing the *Modelica.Mechanics.MultiBody.Examples.Systems.RobotR3.fullRobot* model example from the Modelica Standard Library version 3.2:

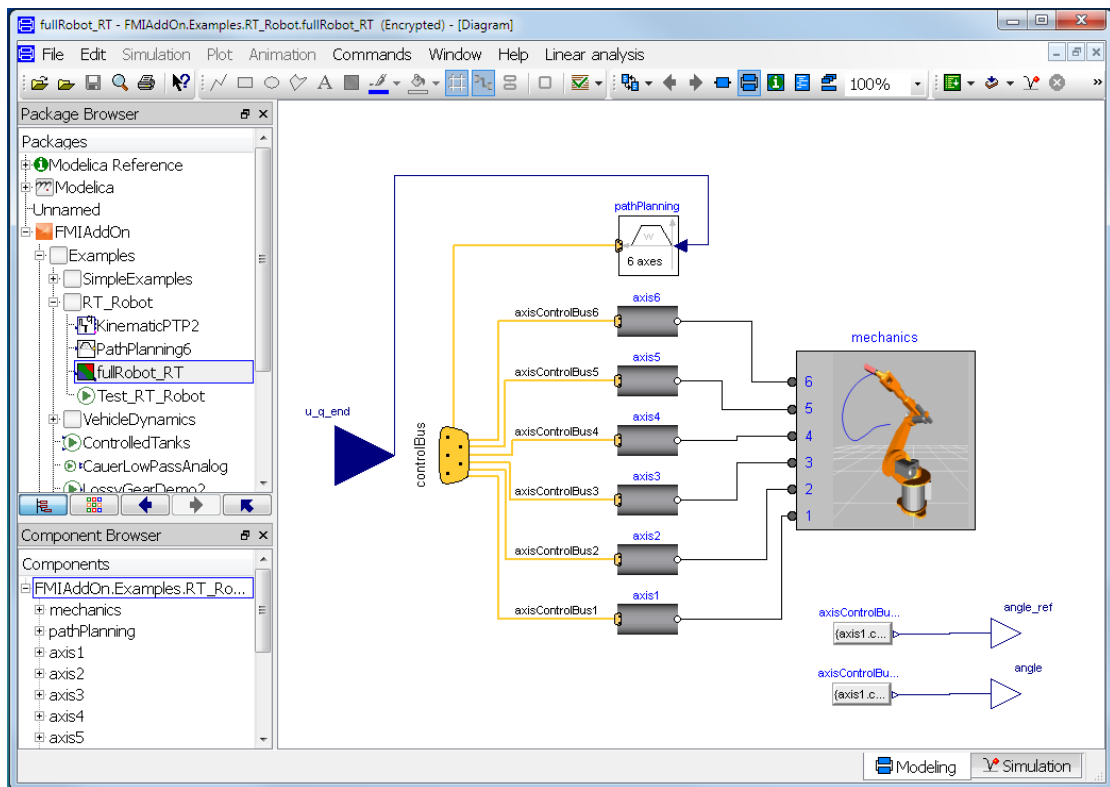


Figure 19 fullRobot example.

Once you generate the fullRobot.fmu file with your modelling tool, you have to check the compliance for the import in VeriStand using the FMI Checker.

If your FMU DLL works on a Windows machine it MAY work in LabVIEW Real-Time (NI Phar Lap ETS). However, if your code is making function calls that are not included in the Win32 subset that the real-time operating system has, then the code will fail. Use the utility you can download at <http://digital.ni.com/public.nsf/allkb/0BF52E6FAC0BF9C286256EDB00015230> to assist you in determining whether or not the function calls in your DLL are supported on the real-time operating system.

Moreover the FMI Connection works only with FMU compliant models, it is highly recommended to check the compatibility with the FMI 1.0 or 2.0 standard specifications using the official FMI compliance checker you can download at: <https://www.fmi-standard.org/downloads>, or using the application included into the add-on that wrap the version 2.0.1 of the checker. You can find it in “Start->FMItO NIVS->FMU Checker”.

Now you can use *FMUtoNIVS_Examples_fullRobot.fmu* in VeriStand. Open NI VeriStand 201x and create a new project:

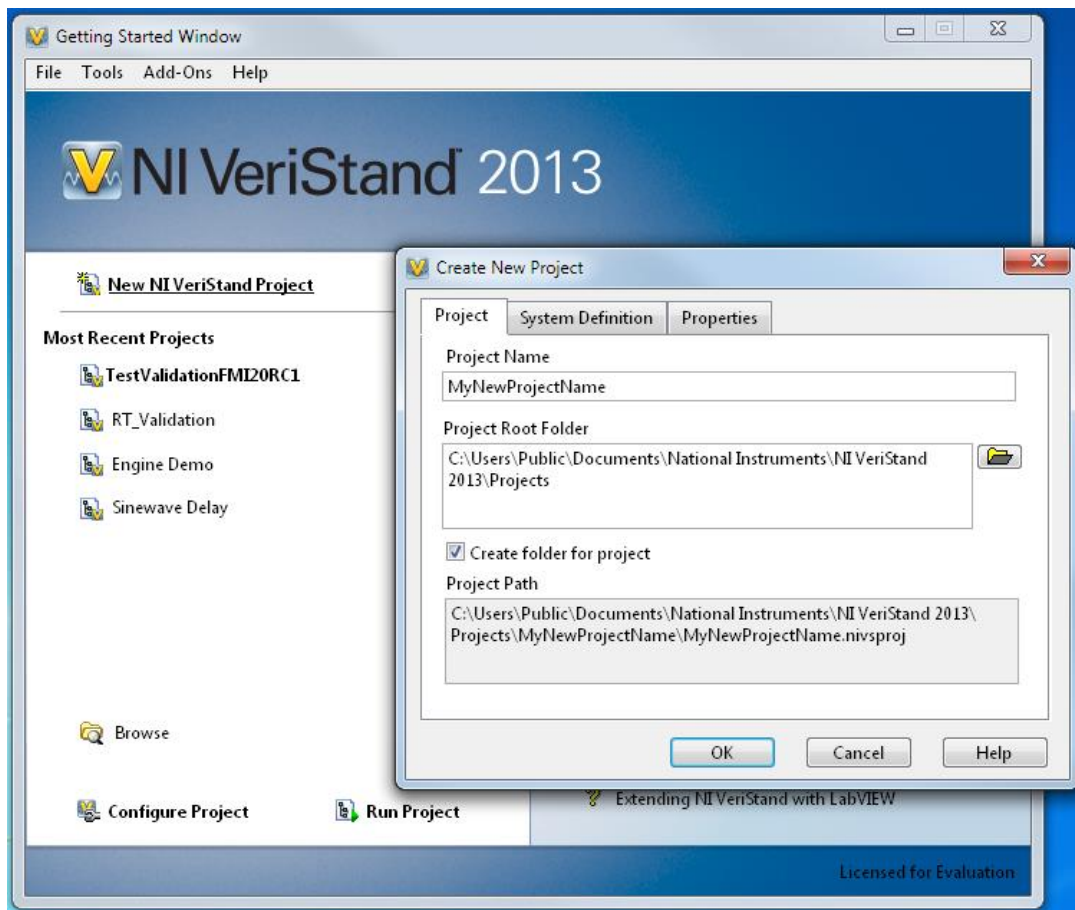


Figure 20 Open NI VeriStand and create a new project.

Copy in the folder project (by default: C:\Users\Public\Documents\National Instruments\NI VeriStand 2013\Projects\<>your project name>) the *FMUToNIVS_Examples_fullRobot.fmu* file:

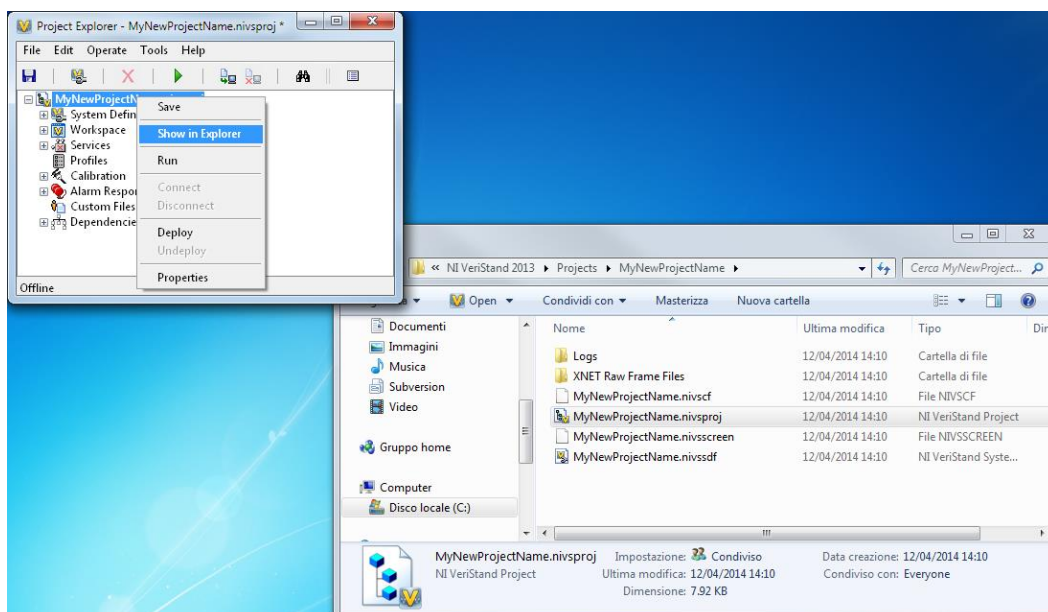


Figure 21 .fmu file in your project folder

Open the System Explorer:

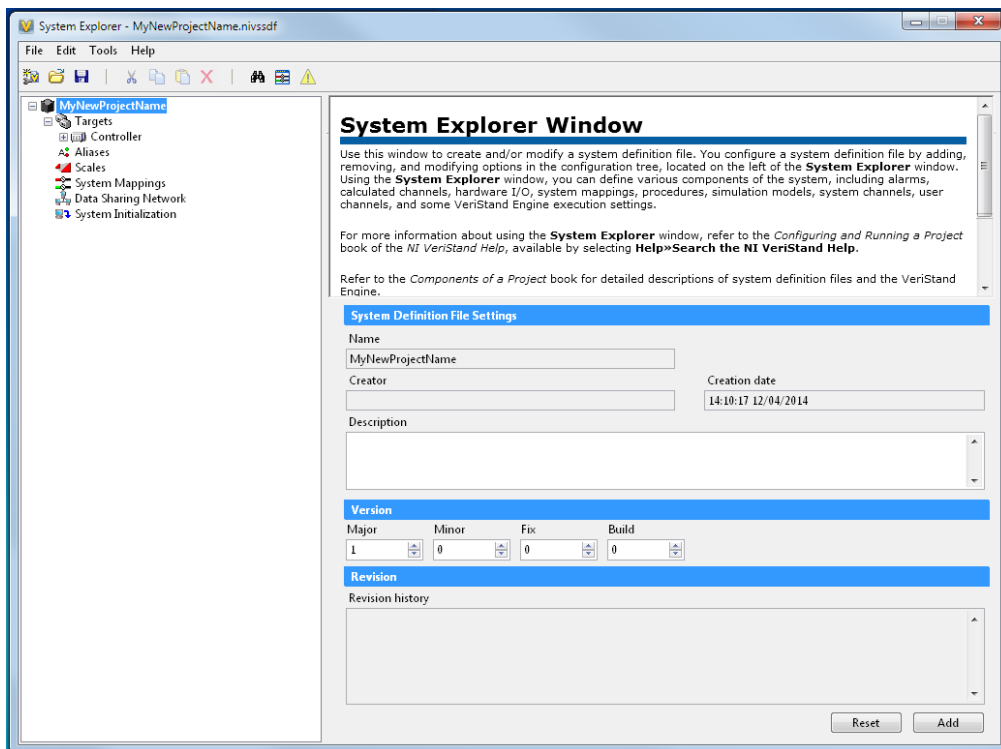


Figure 22 System Explorer

Specify the target, in this example I selected a PXI target running Phar Lap ETS:

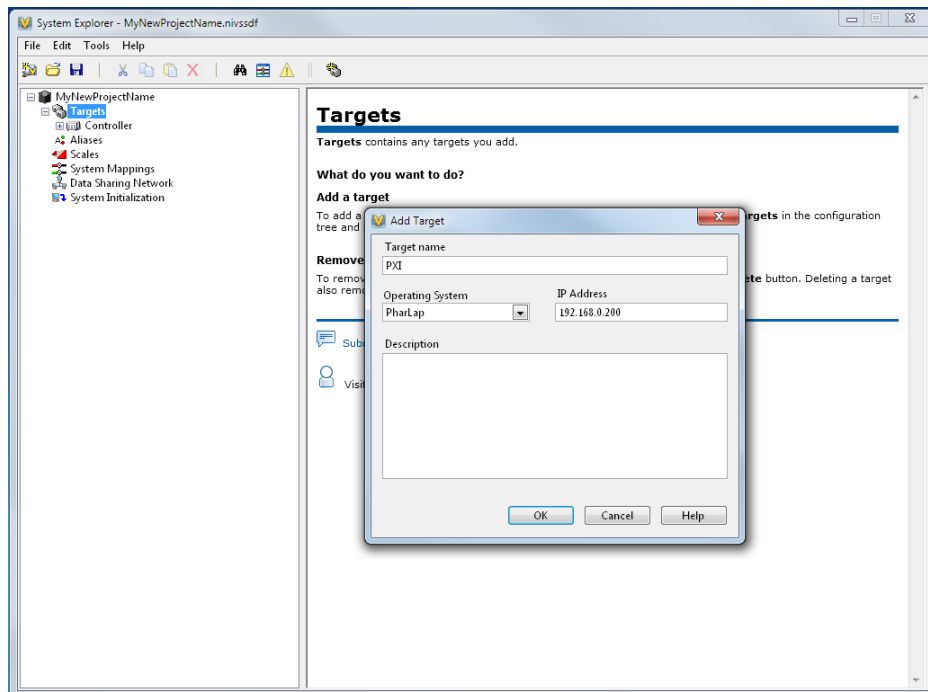


Figure 23 Define RT Target.

Select the fmu model your want to import in NI VeriStand (you should already put it in your project folder):

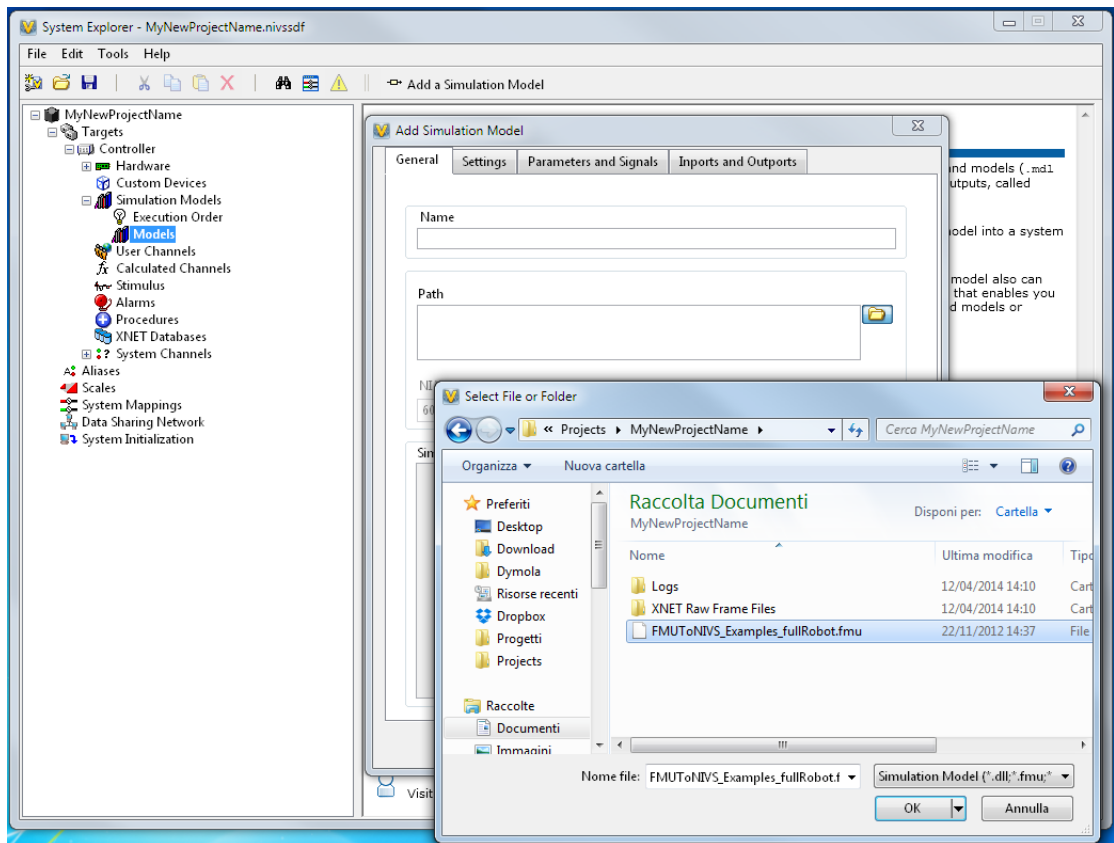


Figure 24 Load fmu model.

In this stage a message will pop-up asking you if you want to check your model for Phar Lap ETS compliancy. If you are planning to run your model selecting a Phar Lap ETS target it is highly recommended to do so, in order to be sure that the dll inside the FMU you are importing is Phar Lap ETS compliant. If the Check will fail you will be notified with a warning that you will be able to run your model only on windows target.

See your FMU model in VeriStand System Explorer Models tree:

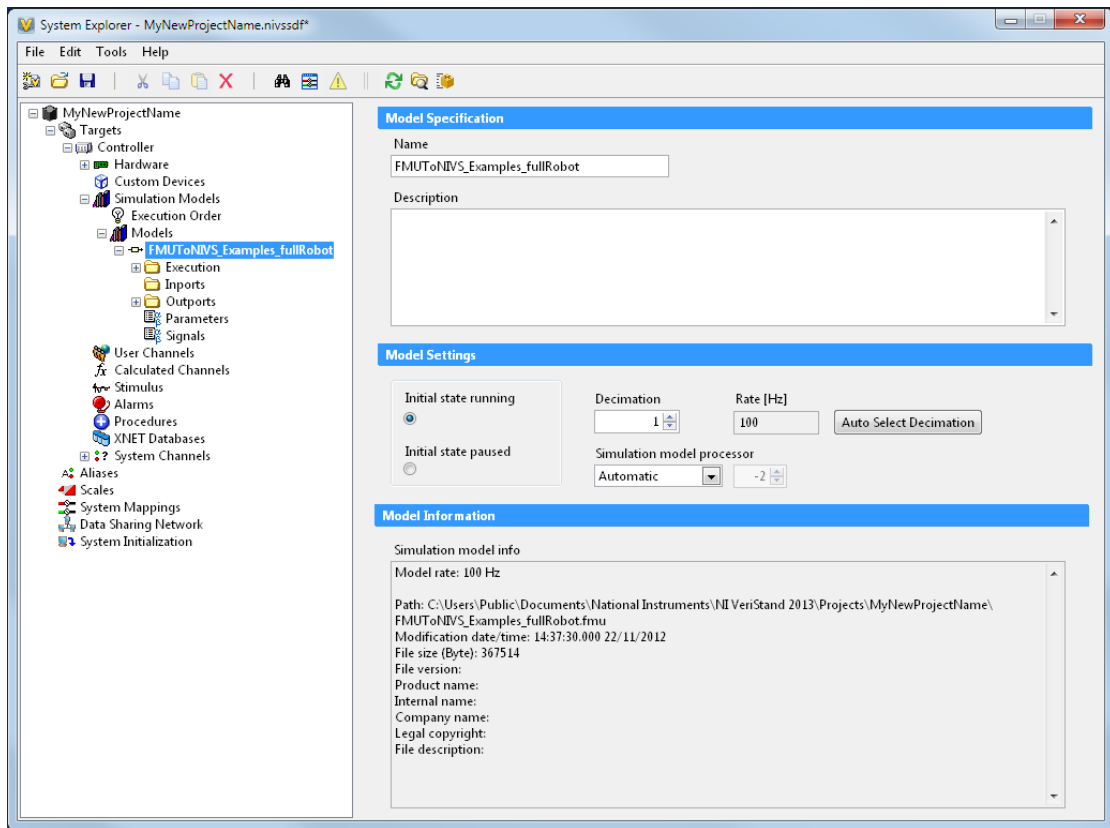


Figure 25 fmu model in VeriStand.

Save your model, close System Explorer and in the Project Explorer run the project (*Operate > Run*).

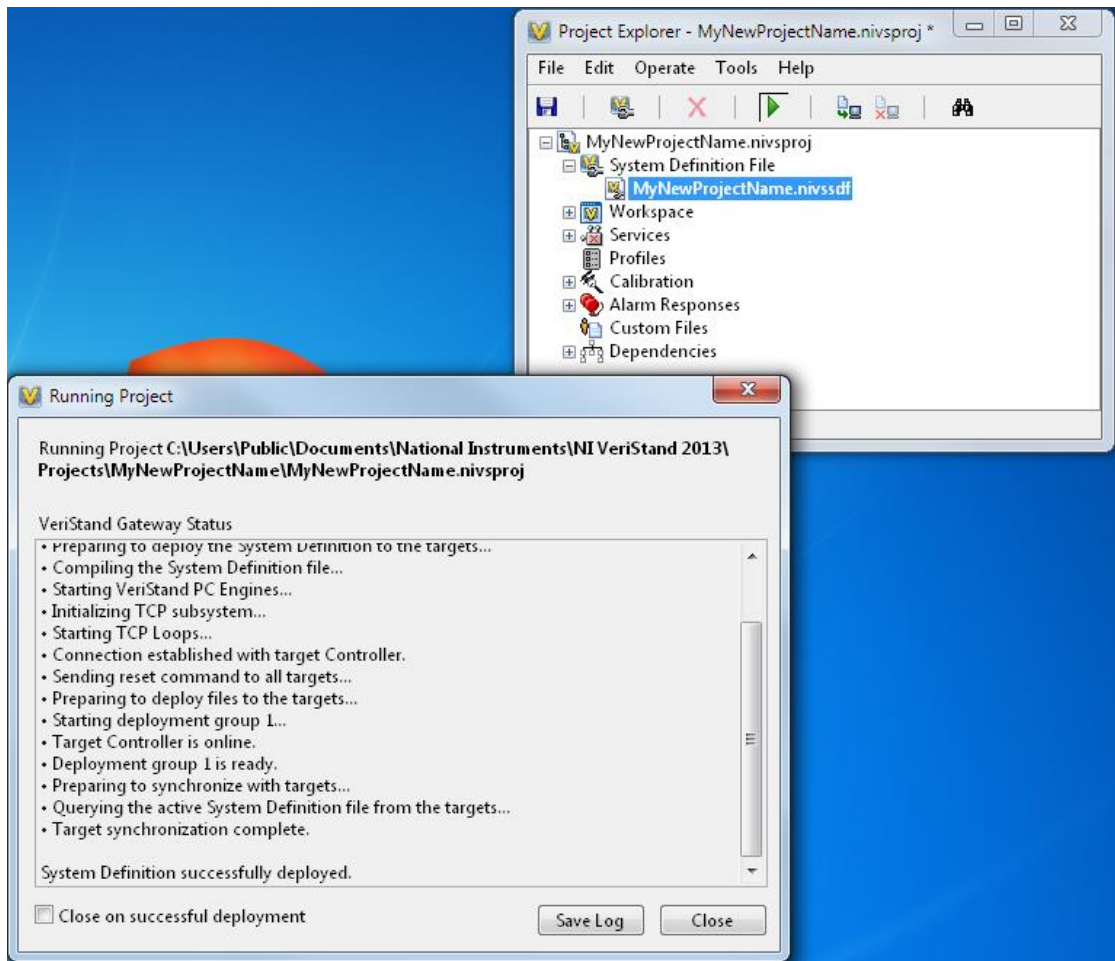


Figure 26 Running Project.

In the Workspace you can monitor and modify your I/O variables:

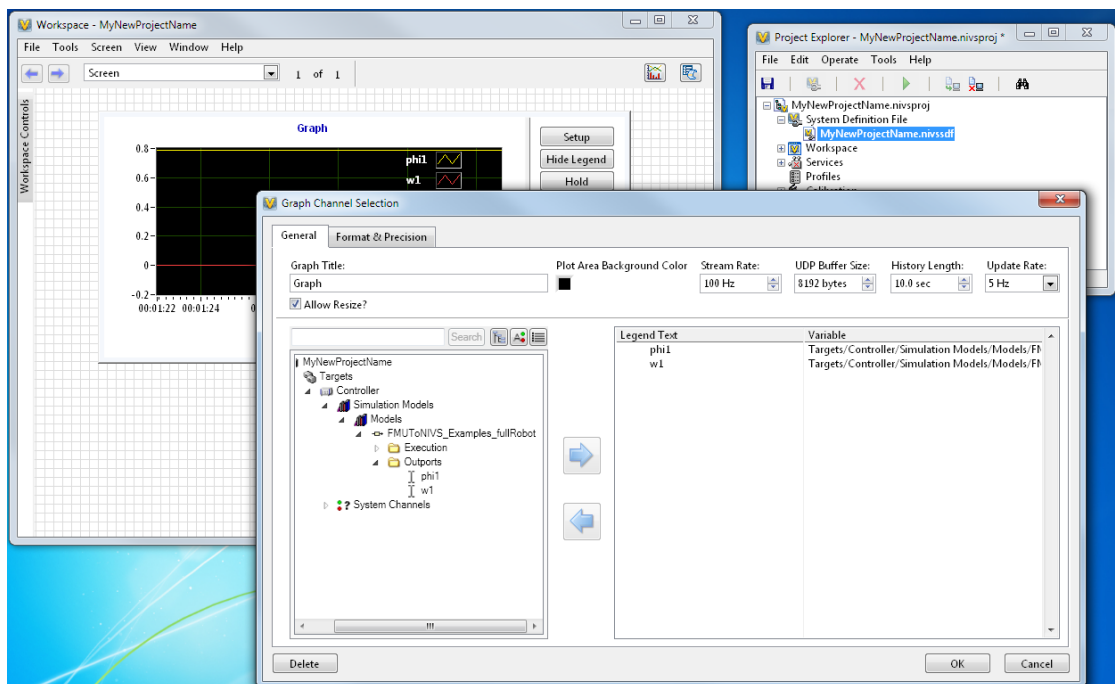


Figure 27 Load your model info.

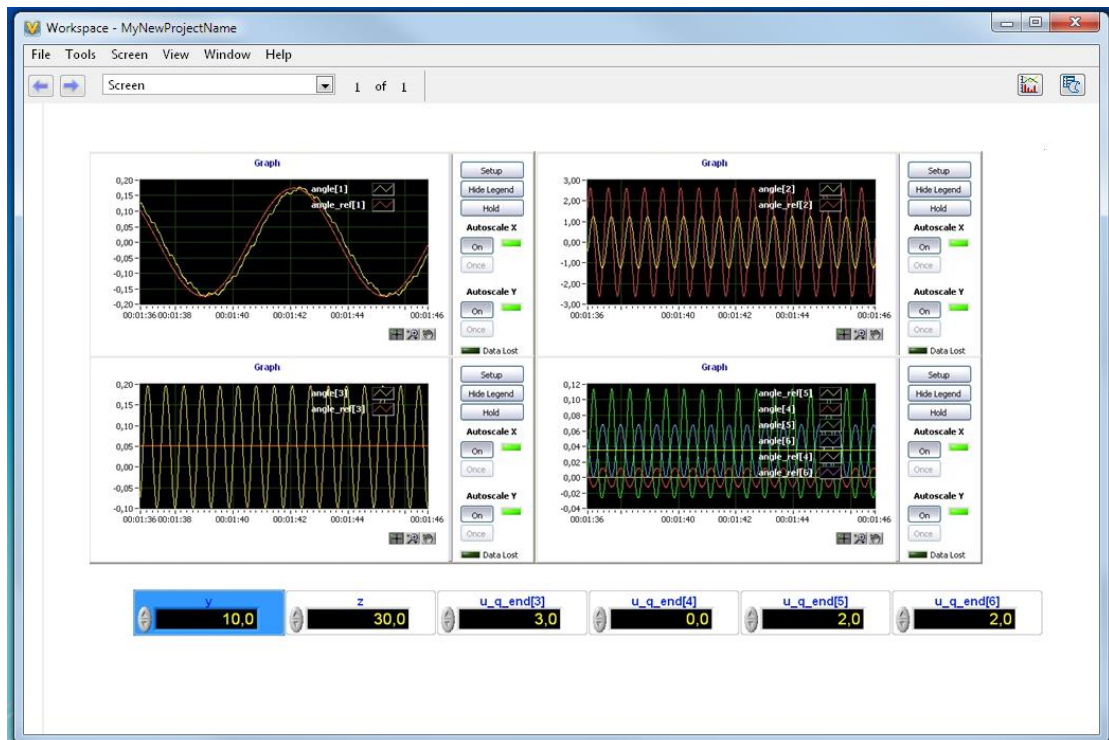


Figure 28 Your model deployed on RT Target.

11. Release Notes

11.1. Version 1.5.1

FMI To NI VeriStand™ & LabVIEW™ Add-on Version 1.5.1 enables the import of all FMU signals into VeriStand and LabVIEW, moreover the dependency of Visual Studio Runtime libraries in Windows has been eliminated.

11.2. Version 1.5

A number of improvements and additions have been implemented in FMI To NI VeriStand™ Add-on Version 1.5. In particular, FMI To NI VeriStand™ Add-on Version 1.5 provides:

- Support for the new version 2.0 of the FMI standard.
- Full compliance and Validation against all Test FMUs from fmi-standard.org website.
- New integrators for ModelExchange FMUs, in particular:
 - Modified midpoint 5
 - Runge Kutta Cash Karp54 7
 - Runge Kutta Dopri5 8
 - Runge Kutta Fehlberg78 9
 - Adams Bashforth 10
 - Adams Bashforth Moulton 12

11.3. Version 1.4.5

FMI To NI VeriStand™ Add-on Version 1.4.5 enables LabVIEW Model Interface Toolkit to import natively FMU models.

11.4. Version 1.4.4

FMI To NI VeriStand™ Add-on Version 1.4.4 is a functional delivery version, released to handle licensing support for NI VeriStand 2014.

11.5. Version 1.4.3

FMI To NI VeriStand™ Add-on Version 1.4.3 is a functional delivery version, released to include support for NI VeriStand 2014.

11.6. Version 1.4.2

FMI To NI VeriStand™ Add-on Version 1.4.2 is a functional delivery version, released to include support for handling of stop time definition on imported FMUs.

11.7. Version 1.4.1

FMI To NI VeriStand™ Add-on Version 1.4.1 is a functional delivery version, released to include support for automatic dll check for Phar Lap ETS compliance on the imported FMUs.

11.8. Version 1.4

A number of improvements and additions have been implemented in FMI To NI VeriStand™ Add-on Version 1.4. In particular, FMI To NI VeriStand™ Add-on Version 1.4 provides:

- Support for the new version 2.0 RC1 of the FMI standard.
- Compliance for the import and the tuning in Real Time during the model execution of the parameter that have variability equal to “tunable” in the modelDescription.xml file of the imported FMU.
- Full compliance and Validation against all Test FMUs from fmi-standard.org website.