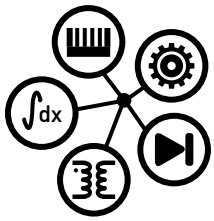

NI VeriStand Target

DEMO MODEL

Engine Demo

Multi-domain model of a simple engine with NI VeriStand displays and sequencing tools

Last updated in NI VeriStand TSP 1.0.1

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- Get the latest NI VeriStand Target Support Package
- Check the PLECS and NI VeriStand documentation

index.html

1 Overview

This demo model represents the mechanical and thermal behavior of a simple engine responding to changes in a speed set point.

The PLECS Coder can generate C code representing physical systems from a PLECS model. The PLECS simulation model, which represents the mechanical, thermal, and control behavior of the engine, is converted into a compiled model that can be imported into NI VeriStand and deployed to NI real-time hardware.

2 Model

The top level schematic of the model is shown in Fig. 1. The “Engine” subsystem represents the model that will be deployed to NI VeriStand. In the offline simulation, external signals are connected to the engine model so the user can simulate the engine’s response prior to deploying the model to a real-time target. The “Engine” subsystem is enabled for code generation from the **Edit + Subsystem + Execution settings...** menu. This step is necessary to generate the model code for a subsystem via the PLECS Coder.

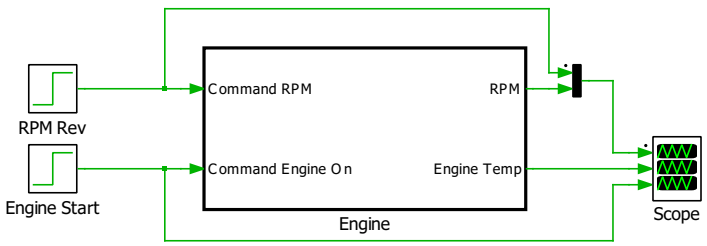

Figure 1: Top-level schematic of the model

The engine model is shown in detail in Fig. 2.

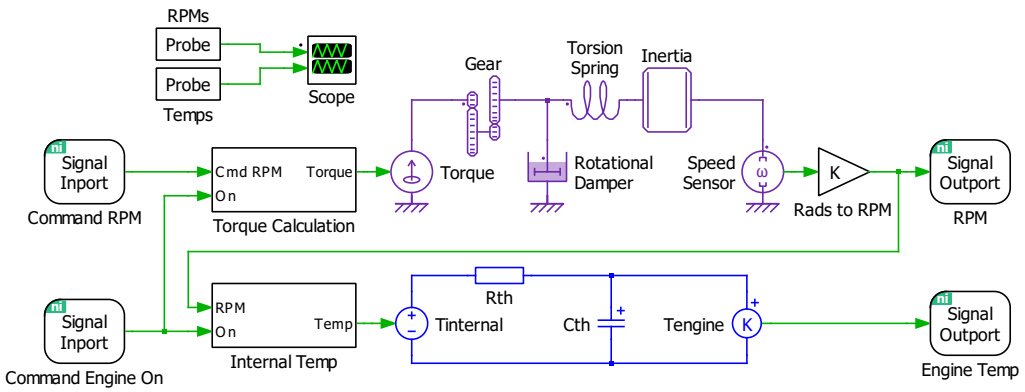

Figure 2: Simple engine model

The Signal Inport and Signal Outport components from the NI VeriStand Target Support Library configure the input and output signals to the model. When the compiled model is imported into NI VeriStand the user can connect the model inputs to a numeric control or an external hardware signal.

The commanded revolutions per minute (RPM) and an engine on signal are inputs to the engine model. When the engine is on, a torque is applied to the motor shaft. In the “Torque Calculation” subsystem the desired RPM is converted into a torque value. An idle speed is also set so that when the engine is on a minimal amount of torque is applied.

The shaft consists of an ideal gearbox, a damper modeling mechanical losses, and a spring representing the limited stiffness of the shaft. A lumped inertia models components attached to the shaft.

The engine's RPM is used to calculate an internal temperature. A first order thermal impedance then models the displayed engine temperature, which has a time constant of 10 seconds.

3 Simulation

The demo model runs both in offline mode on a PC or in real-time on NI target hardware.

3.1 Offline simulation

Fig. 3 shows the response of the offline model. The engine is turned on at 10 seconds with an initial RPM set point of 2000 RPM, which is then stepped to 8000 RPM at 50 seconds. The plot shows the engine shaft has a second-order response and the temperature has a first-order response characteristic.

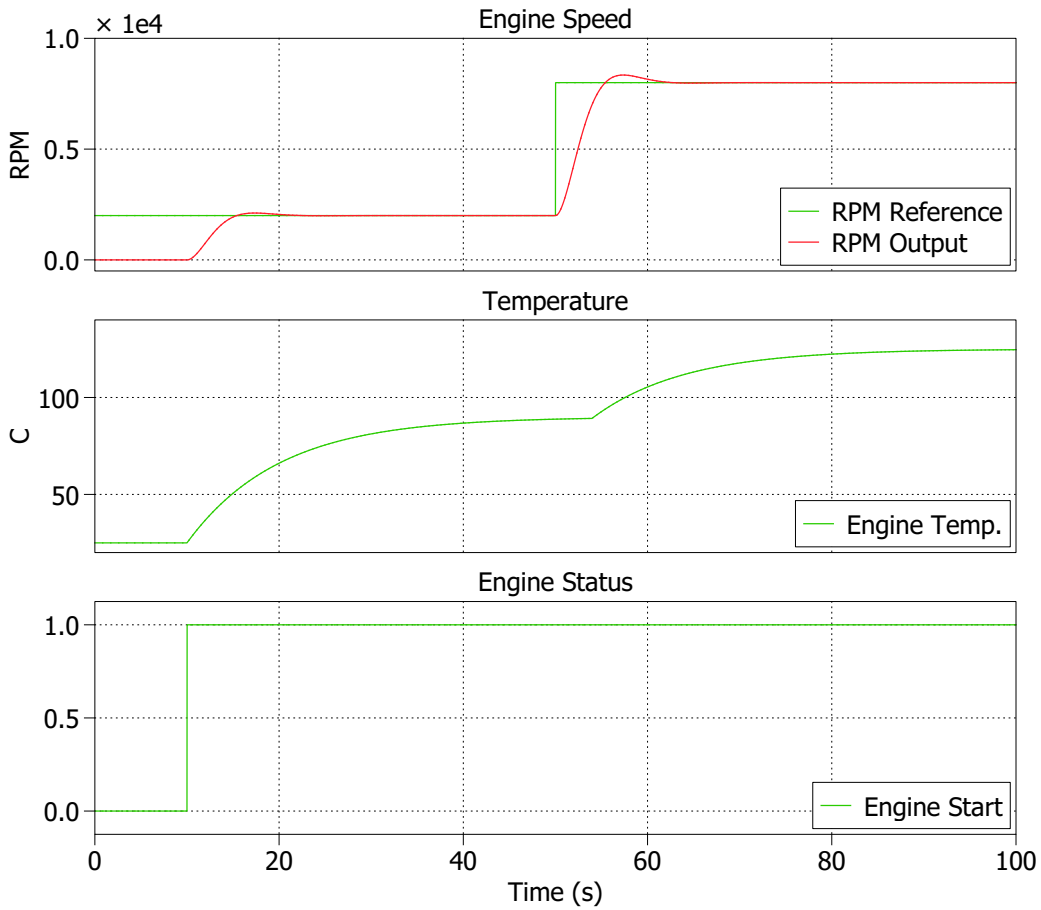

Figure 3: Offline simulation results

3.2 Execution on NI hardware

The PLECS Coder is used to create a NI VeriStand compatible model for the "Engine" subsystem. The generated model will have inport and outport signals corresponding to the blocks shown in Fig. 2. Scopes and displays in the model are automatically converted to signals when the model is imported

into VeriStand. Several parameter values are specified as tunable in the model by default. The parameters can then be adjusted on the fly when the model executes on a real-time target.

To configure additional parameters as tunable, open the **Coder + Coder options...** menu and navigate to the **Parameter Inlining** tab. When a component from the schematic is dragged and dropped into the **Exceptions** list, tunable parameters associated with that component will be tunable during runtime. Note this behavior depends on the **Default behavior** setting, as the **Exceptions** list specifies components which have opposite behavior of the default setting.

The model is configured for the `Model only` build type, but instructions on how to configure the model for all build types are provided below. Detailed instructions on configuring the hardware target and other build options are available in the NI VeriStand Target Support User Manual [2].

Model only

The instructions below show the steps to manually import a model into NI VeriStand using the `Model only` build type:

- Open the **Coder + Coder options...** drop-down menu and select the "Engine" subsystem from the **System** tab visible in the left-hand side of the window.
- Navigate to the **Target** tab and set the build type to `Model only` and click **Build**.
- The default path to the generated model is a directory titled `engine_demo_codegen` next to the model file. The name of the generated model will correspond that of the "Engine" subsystem and will have a `*.so` extension.
- Open NI VeriStand and import the model. Refer to the *Adding and Configuring a Model* section of the NI VeriStand manual [1] for step-by-step instructions on how to import the model generated from PLECS.

VeriStand Engine

The instructions below highlight the steps to automatically create a complete VeriStand project using the `Veristand engine` build type:

- Open the **Coder + Coder options...** drop-down menu and select the "Engine" from the **System** tab visible in the left-hand side of the window.
- Navigate to the **Target** tab and set the build type to `Veristand engine`. Enter in the settings of the NI real-time target and generate a new hardware configuration file if necessary. Refer to the *Quickstart* section of the NI VeriStand Target Support User Manual [2] for instructions on how generate a new configuration file.
- Select if the model will automatically be deployed to the target. If so, then open the NI VeriStand application. Once the application is open, click **Build**.
- Open the generated VeriStand project. The default directory is titled `engine_demo_codegen` next to the model file. The generated project will be titled "Engine" and have a `*.nivsprj` extension.
- The VeriStand application or PLECS can be used to interact with the model when it is executing on the NI real-time target. To connect via the PLECS External Mode open the **Coder + Coder options...** window and select the **External Mode** tab. Enter `localhost` for the **Target device** and click **Connect**.

A screen file (`engine_demo.nivisscr`) compatible with this model is included in the demo model folder. Fig. 4 shows the engine dynamics in the included VeriStand screen file following a step to 5000 RPM.

Custom Engine

The instructions below detail the steps deploy a model to NI real-time hardware using the `Custom engine` build type:

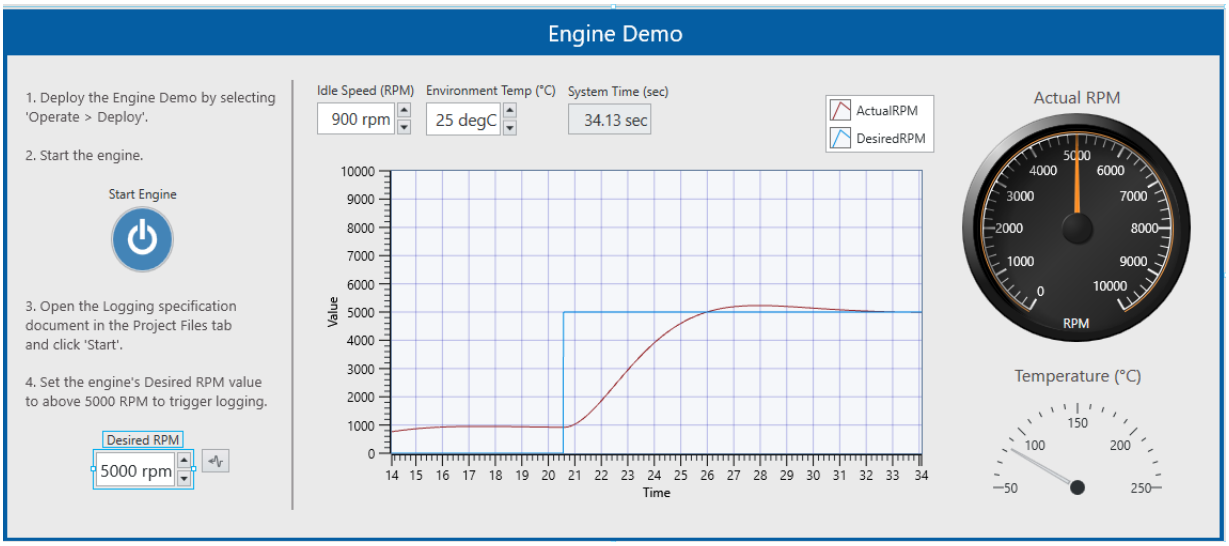

Figure 4: Offline simulation results

- Open the **Coder + Coder options...** drop-down menu and select the "Engine" from the **System** tab visible in the left-hand side of the window.
- Navigate to the **Target** tab and set the build type to `Custom engine`. Enter in the settings of the NI real-time target and generate a new hardware configuration file if necessary. Refer to the *Quickstart* section of the NI VeriStand Target Support User Manual [2] for instructions on how generate a new configuration file.
- Select if the model will automatically be deployed to the target and click **Build**.
- To connect to a model executing on the real-time target via the PLECS External Mode, open the **Coder + Coder options...** window and select the **External Mode** tab. Enter the IP address of the remote target (e.g. `192.168.0.105`) for the **Target device** and click **Connect**.

Note Signal inports and outports in the custom engine do not map to any hardware. To make the model more interactive in real-time replace the Signal Inport blocks with DAQ Analog In or DAQ Digital In components. Alternatively, the RPM and engine on commands can be generated by other standard PLECS components. Use the **Parameter inlining** option to make the components run-time configurable.

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4 Conclusion

This demonstration showed how to simulate a simple engine model in PLECS and generate a real-time model that executes on NI hardware. Step-by-step instructions are provided to deploy the model to a real-time target or manually import the model into NI VeriStand for further configuration.

References

[1] NI, *VeriStand Manual*, 2020,
URL: https://www.ni.com/documentation/en/veristand/latest.

[2] Plexim, *NI VeriStand Target Support User Manual*,
URL: https://www.plexim.com/download/documentation.

Revision History:

NI VeriStand TSP 1.0.1	First release

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NI VeriStand TSP Demo Model