ETAS VECU-BUILDER V1.7

User Guide

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VECU-BUILDER V1.7 I User Guide R11 EN I 07.2024

Contents

1 Introduction

In this chapter you can find information about the intended use, the addressed target group and information about safety and privacy related topics.

1.1 Intended Use

The product is designed to produce a virtual ECU for microcontrollers from existing ECU source code or from precompiled binaries. The virtual ECU is designed for simulation, debugging and pre-calibration of ECU software in a computer-based virtual simulation environment.
In general, virtual ECUs may not be real-time capable. If you control physical devices with a virtual ECU, the system may respond unexpectedly. Take suitable precautions to ensure safe operation.
ETAS GmbH cannot be made liable for damage which is caused by incorrect use and not adhering to the safety information. Please adhere to the ETAS Safety Advice (see `documentation` folder).

1.2 Target Group

This product is directed at trained qualified personnel in development of automotive ECU software (e.g., function developer, application engineer, ECU software integrator, system engineer or calibration engineer) at OEMs, tier-1 or tier-2 suppliers in the auto-motive industry. Technical knowledge in control unit engineering is a prerequisite. In addition, programming knowledge in C/C++ is required. AUTOSAR Classic knowledge is helpful.

1.3 Data Protection

If the product contains functions that process personal data, legal requirements of data protection and data privacy laws shall be complied with by the customer. As the data controller, the customer usually designs subsequent processing. Therefore, he must check if the protective measures are sufficient.

1.4 Data and Information Security

To securely handle data in the context of this product, see the next sections about data and storage locations as well as technical and organizational measures.

1.4.1 Data and Storage Locations

The following sections give information about data and their respective storage locations for various use cases.

License Management

When using the ETAS License Manager in combination with user-based licenses that are managed on the FNP license server within the customer's network, the following data are stored for license management purposes:

Data

- Communication data: IP address
- User data: User ID

Storage location

- FNP license server log files on the customer network

When using the ETAS License Manager in combination with host-based licenses that are provided as FNE machine-based licenses, the following data are stored for license management purposes:

Data

- Activation data: Activation ID
  - Used only for license activation, but not continuously during license usage

Storage location

- FNE trusted storage

  Windows:
  `C:\ProgramData\ETAS\FlexNet\fne\license\ts`

  Linux:
  `/usr/share/ETAS/LiMa/fne/license/ts/`

1.4.2 Technical and Organizational Measures

We recommend that your IT department takes appropriate technical and organizational measures, such as classic theft protection and access protection to hardware and software.

2 About VECU-BUILDER

VECU-BUILDER is designed to build a virtual ECU (vECU). The vECU can be used for simulation, debugging and pre-calibration of ECU software in a computer-based virtual simulation environment.

VECU-BUILDER supports the generation of Level-1, Level-2, and Level-3 vECUs according to the Prostep Definition of vECUs. Level-4 vECUs, i.e., HEX files for a specific target, are not supported.

VECU-BUILDER is based on Python and CMake. The inputs can either be C/C++ source codes or binaries like object files or shared libraries including symbol information. In contrast to AUTOSAR Classic, the configuration of a vECU is done in a single YAML file (`vEcuConf.yaml`). No ARXML files are processed. The properties are configured in this text-based file. This file is used to define the supported features of the vECU such as an XCP slave or initial data as part of simulated NVRAM. VECU-BUILDER wraps the binaries of the vECU into an FMU. These FMUs can be integrated into any FMI-compliant simulation master.

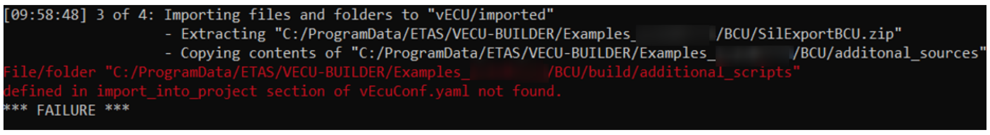
2.1 VECU-BUILDER on YouTube

A playlist about VECU-BUILDER and its features is available on YouTube. To open the playlist, click the image below.

2.2 Warning and Error Messages

VECU-BUILDER may encounter situations in which an Error or a Warning message is displayed.

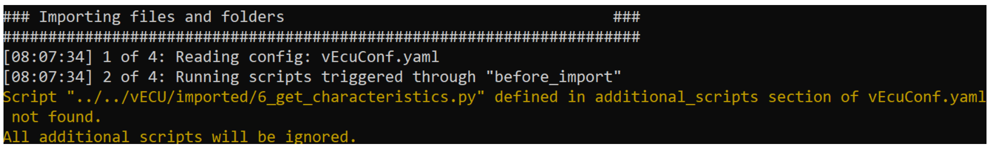
Errors are printed in red and indicate a severe issue which prevents the build from succeeding.



```
[09:58:48] 3 of 4: Importing files and folders to "vECU/imported"
                   - Extracting "C:/ProgramData/ETAS/VECU-BUILDER/Examples_[redacted]/BCU/SilExportBCU.zip"
                   - Copying contents of "C:/ProgramData/ETAS/VECU-BUILDER/Examples_[redacted]/BCU/additonal_sources"
File/folder "C:/ProgramData/ETAS/VECU-BUILDER/Examples_[redacted]/BCU/build/additional_scripts"
defined in import_into_project section of vEcuConf.yaml not found.
*** FAILURE ***
```

Fig. 2-1: Error message

Warnings are printed in yellow and are meant to draw the attention to a certain issue during the build. The issue is not as severe as an error and thus the build continues.



```
### Importing files and folders                                    ###
######################################################################
[08:07:34] 1 of 4: Reading config: vEcuConf.yaml
[08:07:34] 2 of 4: Running scripts triggered through "before_import"
Script "../../vECU/imported/6_get_characteristics.py" defined in additional_scripts section of vEcuConf.yaml
 not found.
All additional scripts will be ignored.
```

Fig. 2-2: Warning message

2.3 Basics

The basic principle is to keep the data lean in a simple and smart way. The concept is the simplification of the ECU software stack and the ARXML file. The A2L file is patched by removing all hardware dependencies and updating memory addresses of all inputs, outputs, measurements, and characteristics. The software stack layers are represented by C and H files. These files are reflected in the `imported` folder (`vECU\imported`) in the vECU build process.

The result is a stand-alone FMU containing

- the model description (e.g. its variables) as XML file
- the access to calibration and measurement variables via patched A2L file
- an executable model as DLL/SO file

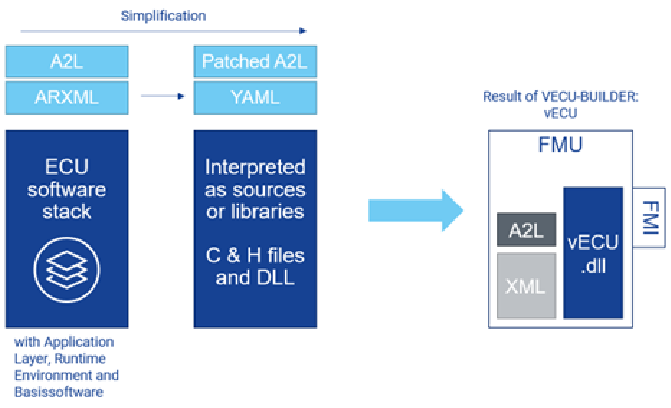

Simplification
A2L
ARXML
ECU software stack
with Application Layer, Runtime Environment and Basissoftware
Patched A2L
YAML
Interpreted as sources or libraries
C & H files and DLL
Result of VECU-BUILDER: vECU
FMU
A2L
XML
vECU .dll
FMI

Fig. 2-3: Basic concept and result of VECU-BUILDER

2.4 Virtual ECU

A vECU is a virtualized ECU which can be used as a real ECU. With the vECU you can test the ECU software and execute the software functionality without hardware. This gives you the possibility to test the communication between the ECUs before prototypes or hardware is available. The vECU contains the code, the parameters and the XCP slave as an alternative path to the HEX code.

2.5 vECU Creation Process Workflow

The whole workflow is an iterative process to get to the final configuration of the YAML file. The listed points give a rough overview of the workflow. Section A and F are taking place out of the VECU-BUILDER.

A. Prepare sources
   - Directives that refer to header files in code must be fixed
   - Generate a script collecting the files you need from the various locations you found

B. Compile sources, incompatible sources must be removed
   - Generate new workspace
   - Copy sources into workspace
   - Build
   - Check error messages
   - Remove or patch code

C. Link sources and create stubs
   - Solve link errors with empty stubs

D. Define Inputs and Outputs (I/O) to make the vECU runnable
   - Use symbol information to generate I/O
   - Manually patch the sources of virtual devices
   - Use the C notation of the variables (e.g., `sensor.*`)

E. Create task model to run the tasks
   - Use text format to define task model

F. Operate for first time, apply SiL specific code changes
   - Debug code
   - Fill some stub functions with code or apply SiL specific code changes

After building the first iteration of an vECU it can be used to perform further steps like (out of VECU-BUILDER):

– Integrate vECU with plant models and execute it in Co-Simulation-environment
– Run and test the vECU in an experiment environment
– Measurement and calibration of vECU
– Debugging with source code editor

2.6 Functional Mock-up Interface (FMI)

The Functional Mock-up Interface is a free specification that defines a container and interface for exchanging dynamic simulation models. VECU-BUILDER supports Co-simulation (CS). The FMU is delivered with its own solver in Co-simulation.

More information about FMI can be found here.

Fig. 2-4 shows the general steps for Co-Simulation in FMI version 2 and version 3.

Steps 4-6 are repeated until `fmi2Terminate` or `fmi3Terminate` function is called.

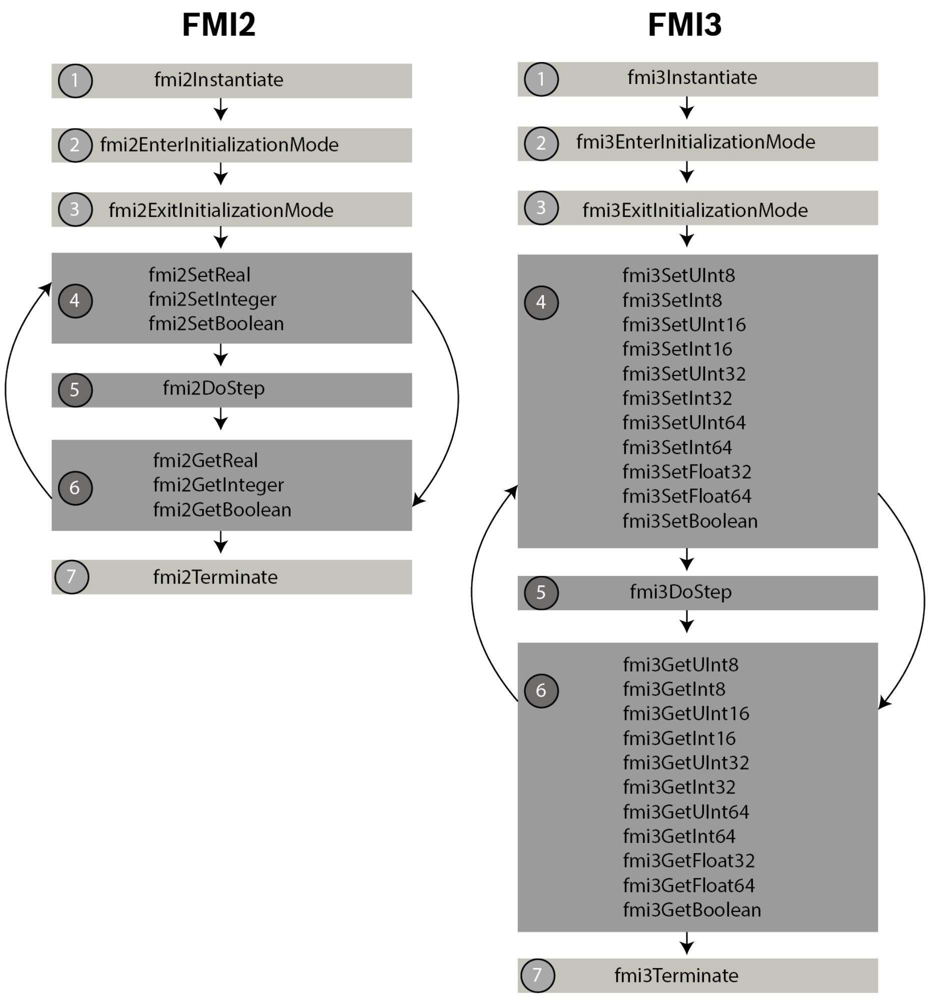

FMI2
1 fmi2Instantiate
2 fmi2EnterInitializationMode
3 fmi2ExitInitializationMode
4 fmi2SetReal fmi2SetInteger fmi2SetBoolean
5 fmi2DoStep
6 fmi2GetReal fmi2GetInteger fmi2GetBoolean
7 fmi2Terminate
FMI3
1 fmi3Instantiate
2 fmi3EnterInitializationMode
3 fmi3ExitInitializationMode
4 fmi3SetUInt8 fmi3SetInt8 fmi3SetUInt16 fmi3SetInt16 fmi3SetUInt32 fmi3SetInt32 fmi3SetUInt64 fmi3SetInt64 fmi3SetFloat32 fmi3SetFloat64 fmi3SetBoolean
5 fmi3DoStep
6 fmi3GetUInt8 fmi3GetInt8 fmi3GetUInt16 fmi3GetInt16 fmi3GetUInt32 fmi3GetInt32 fmi3GetUInt64 fmi3GetInt64 fmi3GetFloat32 fmi3GetFloat64 fmi3GetBoolean
7 fmi3Terminate

Fig. 2-4: General steps for Co-Simulation

VECU-BUILDER supports FMI2 and FMI3 by a plugin concept. For more information about plugin concept, see Template for Plugin V1 (FMI2) and Template for Plugin V2 (FMI3).

3 Installation

This chapter provides information for preparing and performing the installation and for licensing the software. The installation can be fulfilled for the following operating systems:

- Windows 10
- Ubuntu 20.04 LTS
- WSL for Windows

3.1 Hardware Requirements

The following Hardware Requirements need to be met:

Processor	min. 2 GHz 3 GHz Dual-Core or higher recommended
Memory	min. 8 GB RAM 32 GB RAM recommended
Free Disk Space	5 GB (not including the size for application data) >100 GB recommended

3.2 Preparation

Before the installation, check that your computer meets the hardware and software Requirements. Depending on the operating system used and network connection, you must ensure that you have the required user rights.

Note

Ensure that you have the necessary access privileges for the installation of the software. If in doubt, contact your system administrator.

3.3 Installation Content

The installation content can be downloaded from ETAS license and download portal by login via your E-mail address and then be installed.

It contains information about the open-source software attributions, important information like Safety Advice or the User Guide and the executable installation files.

Note

If the download files or download link are not available, contact Technical Support.

3.4 Licensing

A valid license is required to use the software. You can obtain a license in one of the following ways:

- from your tool coordinator
- via the self-service portal on the ETAS website at www.etas.-com/support/licensing
- via the ETAS License Manager

To activate the license, you must enter the Activation ID that you received from ETAS during the ordering process.

For more information about ETAS license management, see the ETAS License Management FAQ or the ETAS License Manager help.

To open the ETAS License Manager help

The ETAS License Manager is available on your computer after the installation of any ETAS software.

1. From the Windows Start menu, select **E** > **ETAS** > **ETAS License Manager**.

   or

   or under Linux, use `LiMaQt.sh`, which you can find at the following location: `./usr/share/ETAS/LiMa/x32/bin/`.

   The ETAS License Manager opens.
2. Click in the ETAS License Manager window and press F1.

   The ETAS License Manager help opens.

VECU-BUILDER checks

- the product license when building FMUs.
- the run-time license during run-time of the vECU.
- the XCP license before establishing an XCP connection.
- the GO license during build-time. If it is valid, it will prevent all license checks during run-time.

3.5 Installation on Windows 10

3.5.1 Software Requirements for Windows 10

The following Software Requirements need to be met:

Required Software	ETAS License Manager CMake (version ≥3.15)
Recommended Software	Notepad++
Optional Software	Visual Studio 2015, 2017, 2019, 2022 Visual Studio Code Python

3.5.2 Manual Installation of VECU-BUILDER

1. Go to the directory where the installation file is located and execute the `VECU_BUILDER_installer_1.7.0.exe` file.

⇨ The Setup Wizard opens.

2. Click **Next**.

⇨ The "Safety Advice" window opens.

3. Read the Safety Advice carefully, then select "I read and accept the Safety Advice".
4. Click **Next**.

⇨ The "Installation Path" window opens.

5. Accept the default path (click **Next**) or click **Browse** to select a custom location.

⇨ The "Ready to Install" window opens.

6. Click **Install**.

⇨ The installation is performed, its progress is shown via a progress bar.

7. Click **Next**.

⇨ The "Third-party Software" window opens.

8. Install CMake (required) and Notepad++ (recommended).

   See the links below in the installation dialog:

   CMake (version 3.15 or higher)

   Notepad++

9. Click **Next**.

⇨ The "Completing VECU-BUILDER Setup" window opens.

10. Optionally, activate the Open VECU-BUILDER documentation checkbox to open the documentation folder.
11. Click Finish.

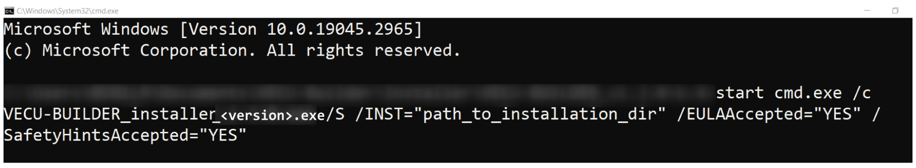
⇨ The installation is completed, and the VECU-BUILDER can now be used.

3.5.3 Silent Installation of VECU-BUILDER

Besides the Manual Installation, you also can use the Silent Installation. Installation differs between using the Command Prompt and the PowerShell.

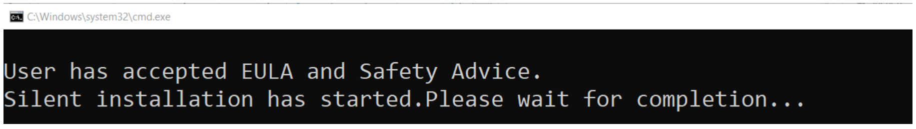
Silent Installation using Command Prompt

1. Open the command prompt.
2. Navigate to the directory where the installer (`VECU-BUILDER_installer_1.7.0.exe`) is located.
3. Execute the following command:
   ```
    start cmd.exe /c VECU-BUILDER_installer_1.7.0.exe /S
   /INST="path_to_installation_dir" /EULAAccepted="YES"
   /SafetyHintsAccepted="YES"
   ```
   where `path_to_installation_dir` contains a path to a directory where the software is to be installed.



```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19045.2965]
(c) Microsoft Corporation. All rights reserved.

[redacted] start cmd.exe /c
VECU-BUILDER_installer_<version>.exe/S /INST="path_to_installation_dir" /EULAAccepted="YES" /
SafetyHintsAccepted="YES"
```

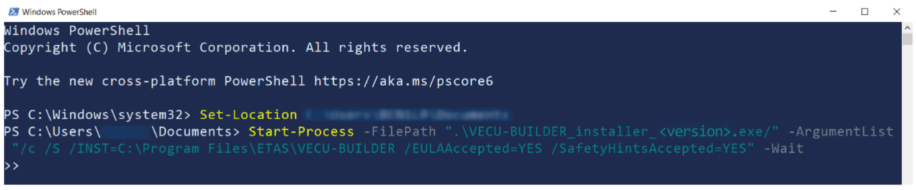
⇨ A new command prompt window opens and installation starts.



```
C:\Windows\system32\cmd.exe

User has accepted EULA and Safety Advice.
Silent installation has started.Please wait for completion...
```

Silent Installation using PowerShell

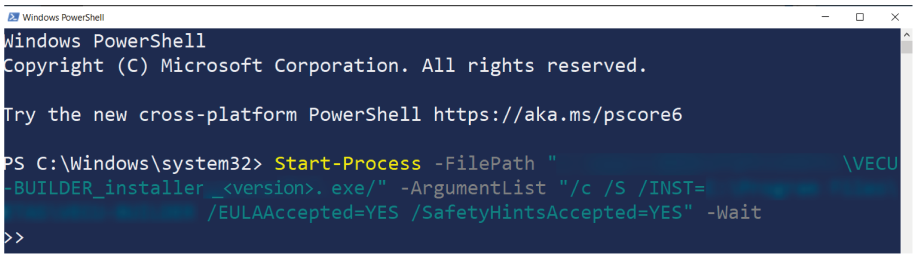
1. Open the PowerShell.
2. Navigate to the directory where the installer (`VECU-BUILDER_installer_1.7.0.exe`) is located.
3. Execute the following command:
   `Start-Process -FilePath".\VECU-BUILDER_installer_1.7.0.exe/" -ArgumentList "/c /S /INST= path_to_installation_dir /EULAAccepted=YES /SafetyHintsAccepted=YES" -Wait`
   where `path_to_installation_dir` contains a path to a directory where the software is to be installed.



```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Windows\system32> Set-Location [redacted]
PS C:\Users\[redacted]\Documents> Start-Process -FilePath ".\VECU-BUILDER_installer_<version>.exe/" -ArgumentList
 "/c /S /INST=C:\Program Files\ETAS\VECU-BUILDER /EULAAccepted=YES /SafetyHintsAccepted=YES" -Wait
>>
```

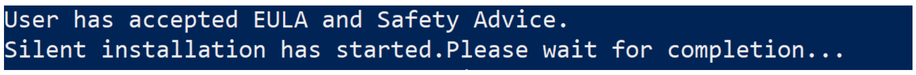
Or

4. Execute the following command:
   `Start-Process -FilePath " path_to \VECU-BUILDER_installer_1.7.0.exe/" -ArgumentList "/c /S /INST= path_to_installation_dir /EULAAccepted=YES /SafetyHintsAccepted=YES" -Wait`
   where `path_to` contains the path where the installer (`VECU-BUILDER_installer_1.7.0.exe`) is located and `path_to_installation_dir` contains a path to a directory where the software is to be installed.



```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Windows\system32> Start-Process -FilePath "[redacted]\VECU
-BUILDER_installer_<version>. exe/" -ArgumentList "/c /S /INST=[redacted]
[redacted] /EULAAccepted=YES /SafetyHintsAccepted=YES" -Wait
>>
```

⇨ Installation starts.



```
User has accepted EULA and Safety Advice.
Silent installation has started.Please wait for completion...
```

3.5.4 Uninstalling VECU-BUILDER on Windows 10

1. Open the location where you installed VECU-BUILDER.
   If you used the default installation location, you can find it under
   `C:/Program Files/ETAS/VECU-BUILDER`
2. Execute the `uninstall.exe` with double-click.

3.6 Installation on Ubuntu 20.04 LTS

3.6.1 Software Requirements for Ubuntu 20.04 LTS

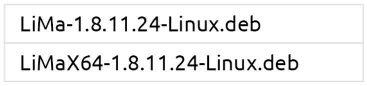
The following Software Requirements need to be met:

Required Software	ETAS License Manager cmake build-essential gcc-multilib g++-multilib libssl-dev:i386 linux-libc-dev:i386 xterm
Optional Software	Visual Studio Code Python nano

3.6.2 Installing License Manager (LiMa) on Ubuntu 20.04 LTS

In order to use VECU-BUILDER, you need to install **ETAS License Manager** manually prior to installation of VECU-BUILDER.

The installation debian packages for LiMa are delivered next to the VECU-BUILDER installation debian package.



LiMa-1.8.11.24-Linux.deb
LiMaX64-1.8.11.24-Linux.deb

Fig. 3-1: LiMa installation debian packages

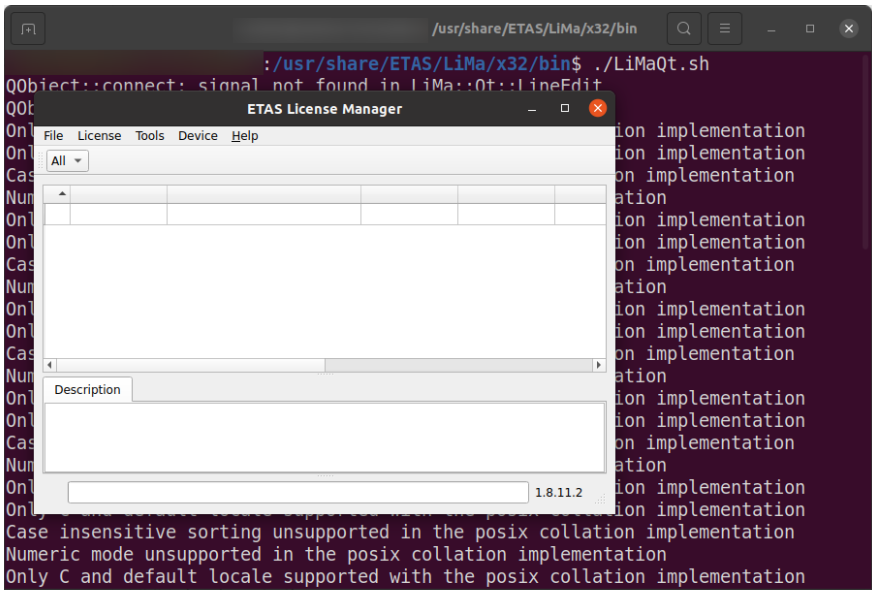
1. Navigate to the directory where the LiMa debian Package files are located.
2. Install LiMa using the following command:
   ```
   sudo apt install ./LiMa-1.8.11.24-Linux.deb
   ```
3. Install LiMaX64 unsing the following command:
   ```
   sudo apt install ./LiMaX64-1.8.11.24-Linux.deb
   ```
4. Fix broken installs using the following command:
   ```
   sudo apt --fix-broken install
   ```

⇨ LiMa and all its components are installed.

3.6.3 Opening ETAS License Manager on Ubuntu 20.04 LTS

1. Navigate to the following direction:
   `/usr/share/ETAS/LiMa/x32/bin`
2. Open a new terminal.
3. Enter the following command:
   `./LiMaQt.sh`

⇨ LiMa was opened.



```
[redacted]:/usr/share/ETAS/LiMa/x32/bin$ ./LiMaQt.sh
QObject::connect: signal not found in LiMa::Qt::LineEdit
QOb
Onl                                                  ion implementation
Onl                                                  ion implementation
Cas                                                  on implementation
Nun                                                  ation
Onl                                                  ion implementation
Onl                                                  ion implementation
Cas                                                  on implementation
Nun                                                  ation
Onl                                                  ion implementation
Onl                                                  ion implementation
Cas                                                  on implementation
Nun                                                  ation
Onl                                                  ion implementation
Onl                                                  ion implementation
Cas                                                  on implementation
Nun                                                  ation
Onl                                                  ion implementation
Onl                                                  ion implementation
Case insensitive sorting unsupported in the posix collation implementation
Numeric mode unsupported in the posix collation implementation
Only C and default locale supported with the posix collation implementation
```

3.6.4 Activating the LiMa License

There are several possibilities to activate the license. For more information about ETAS license management, see the ETAS License Management FAQ or the ETAS License Manager help.

3.6.5 Installing VECU-BUILDER on Ubuntu 20.04 LTS

1. Navigate to the directory where the Debian Software Package file `VECU-BUILDER_installer_1.7.0.deb` is located.
2. Open a new terminal.
3. Execute the following command:

   ```
   sudo apt install ./VECU-BUILDER_installer_1.7.0.deb
   ```

   Note

   VECU-BUILDER has dependencies on other software. The dependent software packages will be installed during the installation. An Internet connection is required to install the dependent software packages.

4. Accept the installation of dependent packages.

⇨ The packages are selected and unpacked.

5. Accept the Safety Advice.

⇨ The VECU-BUILDER package deployment is completed.

6. Logout and login to enable environment variables to be set.

3.6.6 Uninstalling VECU-BUILDER on Ubuntu 20.04 LTS

1. Open a new terminal.
2. Execute the following command:

   ```
   sudo apt remove vecu-builder
   ```

⇨ You are asked if you want to continue uninstalling.

3. To continue, enter `Y` and hit **Enter**.

⇨ The VECU-BUILDER package is removed.

3.7 Installation on Ubuntu 20.04 LTS for WSL

It is possible to create a Linux-vECU from a Windows host. To be able to create a Linux-vECU from a Windows host, the following prerequisites must be met:

- WSL is installed on Windows.
- Ubuntu 20.04 LTS is installed on WSL.
- LiMa is installed on WSL.
- VECU-BUILDER is installed on WSL.

3.7.1 Software Requirements for Ubuntu 20.04 LTS on WSL

The following Software Requirements need to be met:

Required Software	ETAS License Manager cmake build-essential gcc-multilib g++-multilib libssl-dev:i386 linux-libc-dev:i386 gnome-terminal (for dialog mode applications)
Optional Software	Visual Studio Code (for debugging, installed on Windows PC Host) Python nano gdb (for debugging)

3.7.2 Installing WSL on Windows

To install WSL on Windows, see Install WSL command.

3.7.3 Installing Ubuntu 20.04 LTS on WSL

1. Open PowerShell.
2. Check what distributions are available online in PowerShell using the following command:
   ```
   wsl --list --online
   ```
3. Install Ubuntu 20.04 LTS on WSL using the following command:
   ```
   wsl --install -d ubuntu-20.04
   ```

⇨ Ubuntu 20.04 LTS is installed.

3.7.4 Installing Dependent Software Packages

In order to install VECU-BUILDER you need to install dependent software packages.

Note

The installation of depended software packages only works if you have unrestricted access to the internet. The `sudo apt` commands will fail if your computer is not allowed to connect your Linux to the official package repositories. In this case, ask your IT department for help.

Note

Downloading dependencies or installing VECU-BUILDER only runs in WSL1, using VECU-BUILDER only runs in WSL2. Make sure that the WSL version matches the respective action. If necessary, you need to change the version.

– For WSL1:
- wsl --set-version Ubuntu-20.04 1

– For WSL2:
- wsl --set-version Ubuntu-20.04 2

1. In PowerShell, check the WSL Ubuntu version using the following command:
   ```
   wsl -l -v
   ```
   If it is not 1, set the version to 1, using the following command:
   ```
   wsl --set-version Ubuntu-20.04 1
   ```
2. Open Ubuntu 20.04 LTS command line interface.
3. Install the `i386` architecture using the following command:
   ```
   sudo dpkg --add-architecture i386
   ```
4. Install `libc6-i386` using the following command:
   ```
   sudo apt install -y libc6-i386
   ```
5. Install `lsb` using the following command:
   ```
   sudo apt install -y lsb
   ```
6. Run a package update using the following command:
   ```
   sudo apt update
   ```
7. Run a package upgrade using the following command:
   ```
   sudo apt upgrade
   ```
8. Install `gnome-terminal` using the following command:
   ```
   sudo apt install gnome-terminal
   ```

You need `gnome-terminal` for debugging, ETAS License Manager (LiMa) and the Dialog mode.)

9. Install `gdb` using the following command:

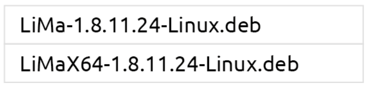
   ```
   sudo apt install gdb
   ```

   You need `gdb` for debugging.

3.7.5 Installing License Manager (LiMa) on Ubuntu 20.04 LTS for WSL

In order to use VECU-BUILDER, you need to install **ETAS License Manager** manually prior to installation of VECU-BUILDER.

The installation debian packages for LiMa are delivered next to the VECU-BUILDER installation debian package.



LiMa-1.8.11.24-Linux.deb
LiMaX64-1.8.11.24-Linux.deb

Fig. 3-2: LiMa installation debian packages

1. In order to install LiMa copy the required installation debian packages for LiMa to user home on Ubuntu.
2. Open Ubuntu 20.04 LTS command line interface.
3. Install LiMa using the following command:

   ```
   sudo apt install ./LiMa-1.8.11.24-Linux.deb
   ```

4. Install LiMaX64 using the following command:

   ```
   sudo apt install ./LiMaX64-1.8.11.24-Linux.deb
   ```

5. Fix broken installs using the following command:

   ```
   sudo apt --fix-broken install
   ```

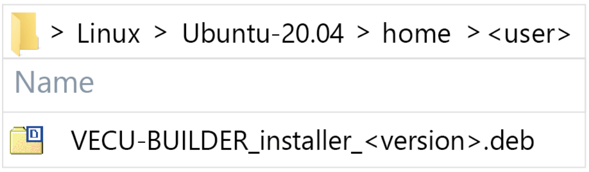
⇨ LiMa and all its components are installed.

3.7.6 Installing VECU-BUILDER on Ubuntu 20.04 LTS for WSL

Note

The installation of VECU-BUILDER only works if you have unrestricted access to the internet. The `sudo apt` commands will fail if your computer is not allowed to connect your Linux to the official package repositories. In this case, ask your IT department for help.

1. In order to install VECU-BUILDER copy VECU-BUILDER_installer_1.7.0.deb to user home on Ubuntu.



> Linux > Ubuntu-20.04 > home > <user>

Name

VECU-BUILDER_installer_<version>.deb

2. Install VECU-BUILDER using the following command:

```
sudo apt install ./VECU-BUILDER_installer_1.7.0.deb
```

Note

VECU-BUILDER has dependencies on other software. The dependent software packages will be installed during the installation. An Internet connection is required to install the dependent software packages.

3. Close and restart Ubuntu 20.04 LTS.

To create a workspace using WSL Ubuntu 20.04 LTS, see Ubuntu 20.04 LTS Command Line Interface.

3.7.6.1 Opening ETAS License Manager on Ubuntu 20.04 LTS for WSL

Prerequisites:

- Make sure to have the latest Ubuntu 20.04 LTS version and all related packages installed.
- Make sure to have XTerm (Ubuntu-20.04) installed.
- Make sure to have UXTerm (Ubuntu-20.04) installed.

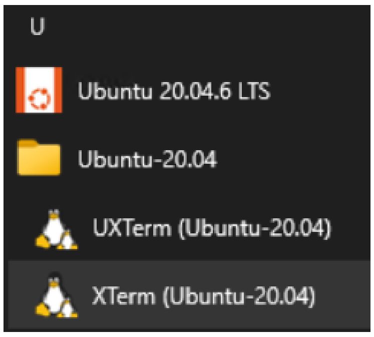


Fig. 3-3: UXTerm and XTerm for Ubuntu 20.04

More information about running Linux GUI apps on the Windows Subsystem for Linux can be found here.

1. Open PowerShell and set WSL Ubuntu 20.04 LTS version to 2 using the following command:

   ```
   wsl --set-version Ubuntu-20.04 2
   ```

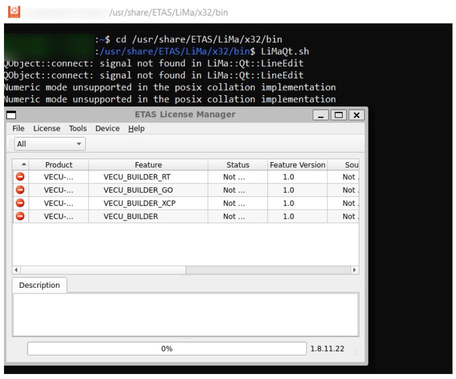
2. Open Ubuntu 20.04 LTS and change directory using the following command:

   ```
   cd /usr/share/ETAS/LiMa/x32/bin
   ```

3. Open `LiMaQt.sh` using the following command:

   ```
   LiMaQt.sh
   ```

⇨ LiMa was opened.



[redacted] /usr/share/ETAS/LiMa/x32/bin

```
[redacted]:~$ cd /usr/share/ETAS/LiMa/x32/bin
[redacted]:/usr/share/ETAS/LiMa/x32/bin$ LiMaQt.sh
QObject::connect: signal not found in LiMa::Qt::LineEdit
QObject::connect: signal not found in LiMa::Qt::LineEdit
Numeric mode unsupported in the posix collation implementation
Numeric mode unsupported in the posix collation implementation
```

	Product	Feature	Status	Feature Version	Sou
⛔	VECU-...	VECU_BUILDER_RT	Not ...	1.0	Not .
⛔	VECU-...	VECU_BUILDER_GO	Not ...	1.0	Not .
⛔	VECU-...	VECU_BUILDER_XCP	Not ...	1.0	Not .
⛔	VECU-...	VECU_BUILDER	Not ...	1.0	Not .

3.7.7 Activating the LiMa License

There are several possibilities to activate the license. For more information about ETAS license management, see the ETAS License Management FAQ or the ETAS License Manager help.

3.7.8 Uninstalling VECU-BUILDER on Ubuntu 20.04 LTS for WSL

1. Open Ubuntu 20.04 LTS command line interface.
2. Execute the following command:

   ```
   sudo apt remove vecu-builder
   ```

⇨ You are asked if you want to continue uninstalling.

3. To continue, enter `Y` and hit **Enter**.

⇨ The VECU-BUILDER package is removed.

3.8 Installed Files and Folders

VECU-BUILDER Tool

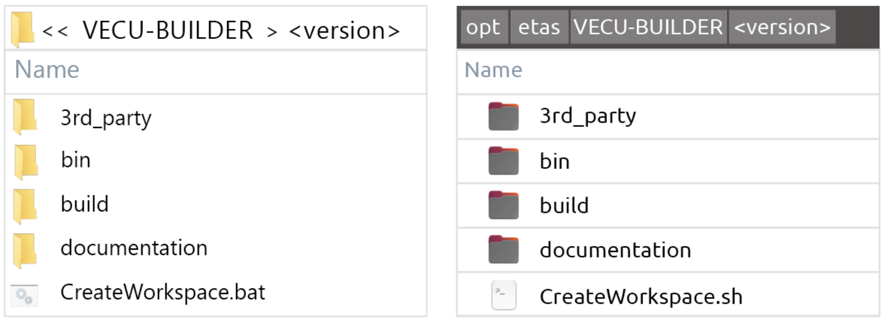
The default installation location is
`C:/Program Files/ETAS/VECU-BUILDER/1.7.0` on **Windows**

Or

`/opt/etas/VECU-BUILDER/1.7.0` on **Ubuntu 20.04 LTS** and **Ubuntu 20.04 on WSL**.

It is recommended not to alter the installation location.

An environment variable of `VECUBUILDER_HOME` points to this folder.



<< VECU-BUILDER > <version>

Name

3rd_party
bin
build
documentation
CreateWorkspace.bat

opt etas VECU-BUILDER <version>

Name

3rd_party
bin
build
documentation
CreateWorkspace.sh

Fig. 3-4: Installation content (left: Windows, right: Ubuntu 20.04 LTS)

The content of this folder consists of several subfolders and one command/shell script:

- `3rd_party`: Contains the third party tools of FMPy and MinGW.
- `bin`: Contains library and execution files for the build process. These files are important for the build and must not be altered.
- `build`: Contains templates, resources, and scripts for the build process. These files are important for the build and must not be altered.
- `documentation`: Contains the VECU-BUILDER User Guide, the OSS Attribution and the ETAS Safety Advice documents.
- `CreateWorkspace.bat` (Windows) / `CreateWorkspace.sh` (Ubuntu 20.04 LTS): Creates a new workspace. After executing, you will be guided through the process step by step.

VECU-BUILDER Examples/Templates

You can find ready-to-use examples in the following location:

`C:/ProgramData/ETAS/VECU-BUILDER/Examples_1.7.0` on **Windows**

Or

`/opt/etas/VECU-BUILDER/Examples_1.7.0` on **Ubuntu 20.04 LTS** and **Ubuntu 20.04 on WSL**.

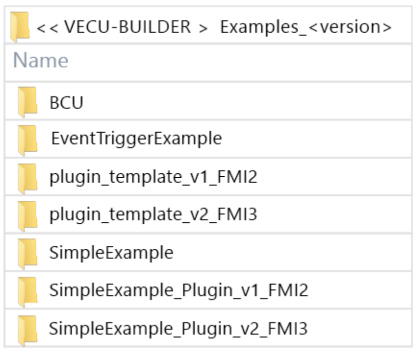
An environment variable of `VECUBUILDER_EXAMPLES` points to this folder.

The following examples are delivered along with the tool:

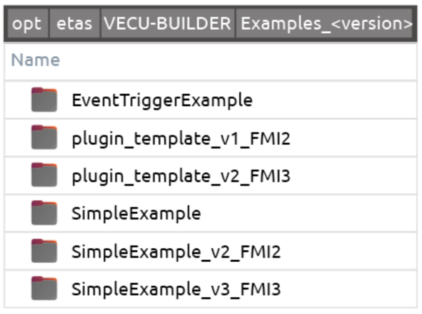
- BCU (Body Control Unit) only for Windows
- EventTriggerExample:
- SimpleExample
- SimpleExample_Plugin_v1_FMI2
- SimpleExample_Plugin_v2_FMI3

The following templates are delivered along with the tool:

- plugin_template_v1_FMI2
- plugin_template_v2_FMI3


<< VECU-BUILDER > Examples_<version>

Name
BCU
EventTriggerExample
plugin_template_v1_FMI2
plugin_template_v2_FMI3
SimpleExample
SimpleExample_Plugin_v1_FMI2
SimpleExample_Plugin_v2_FMI3


opt etas VECU-BUILDER Examples_<version>

Name
EventTriggerExample
plugin_template_v1_FMI2
plugin_template_v2_FMI3
SimpleExample
SimpleExample_v2_FMI2
SimpleExample_v3_FMI3

Fig. 3-5: Delivered examples/templates (left: Windows, right: Ubuntu 20.04 LTS)

VECU-BUILDER Workspaces

As location for all your workspaces we recommend the default folder, where you should create a dedicated subfolder for each workspace.

The default folder is created during the installation process on **Windows** under `C:/Users/Public/Documents/VECU-BUILDER_Workspaces`

Or

`/opt/etas/VECU-BUILDER_Workspaces` on **Ubuntu 20.04 LTS** and **Ubuntu 20.04 on WSL**.

Access to Artefacts in Windows

You can access all artefacts in Windows via their respective Start Menu entries.

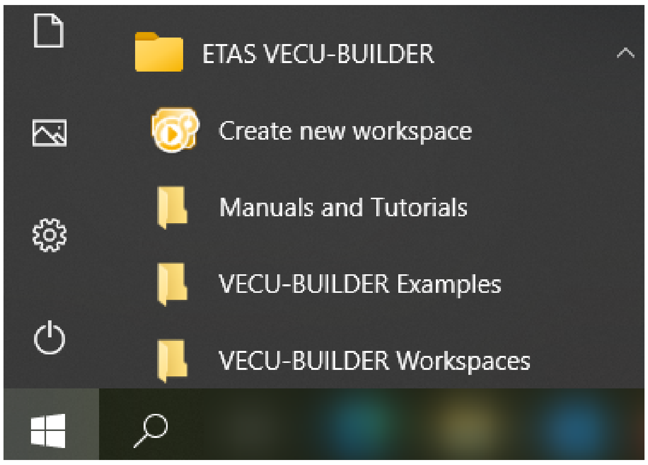


Fig. 3-6: Start Menu entries

3.9 VECU-BUILDER Without Admin Credentials

It is possible to use VECU-BUILDER without Admin credentials. If you do not have admin credentials, you can use the VECU-BUILDER as portable version even without these rights. An installation is not needed.

3.9.1 Use of Portable Version Without Admin Credentials on Windows

Prerequisites:

- Make sure ETAS License Manager (LiMa)is installed and a valid license is available.

To use VECU-BUILDER portable version:

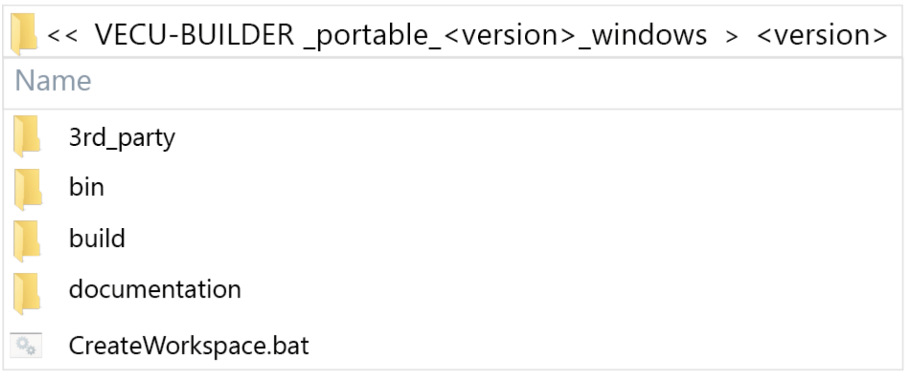
1. Extract `VECU-BUILDER_portable_1.7.0_windows.zip` to some folder. You can use `C:/PortableTools/`.
2. Open a new command prompt.
3. Set environment variables using the following commands:

   ```
   SET VECUBUILDER_EXAMPLES=<C:/PortableTools/>/VECU-BUILDER_portable_1.7.0_windows\$LOCALAPPDATA\ETAS\VECU-BUILDER\EXAMPLES_1.7.0
   ```

   ```
   SET VECUBUILDER_HOME=<C:/PortableTools/>VECU-BUILDER_portable_1.7.0_windows\1.7.0
   ```

4. Log off and log on again.

⇨ You can now create a new workspace using `CreateWorkspace.bat` under `VECU-BUILDER_portable_1.7.0_windows\1.7.0`.



<< VECU-BUILDER _portable_<version>_windows > <version>

Name

- 3rd_party
- bin
- build
- documentation
- CreateWorkspace.bat

For more information about Working with VECU-BUILDER and VECU-BUILDER Examples/Templates, see VECU-BUILDER Tool, VECU-BUILDER Examples/TemplatesWorking With VECU-BUILDER and Exploring the Examples/Templates.

3.9.2 Use of Portable Version Without Admin Credentials on Ubuntu 20.04 LTS

Prerequisites:

- Make sure ETAS License Manager (LiMa)is installed and a valid license is available.
- To install LiMa on Ubuntu 20.04, see Installing License Manager (LiMa) on Ubuntu 20.04 LTS.

To use VECU-BUILDER portable version:

1. Navigate to the directory where the Debian Software Package file `VECU-BUILDER_installer_1.7.0.deb` is located.
2. Extract the directory to some folder.
   You can use `/home/<your user>/PortableTools`.

   To extract use the follwoing command:
3. `dpkg-deb -R ./VECU-BUILDER_installer_1.7.0.deb /home/<your user>/PortableTools`
4. Navigate to the following path:

   `/etc/profile.d`
5. Create a shellscript file named `vecubuilder-conf.sh`.
6. Enter the following contents into the shellscript file:

   ```
   #!/bin/bash

   export VECUBUILDER_HOME=/home/<your user-
   >/PortableTools/opt/etas/VECU-BUILDER/1.7.0/

   export VECUBUILDER_EXAMPLES=/home/<your user-
   >/PortableTools/opt/etas/VECU-BUILDER/Examples_1.7.0/
   ```
7. Log out and login again.
8. Copy the contents of `/home/<your user>/PortableTools>/usr` to any location in the home(~) folder.

   Note

   You can find SW and examples under `/home/<your user->/PortableTools/opt/etas/VECU-BUILDER/`.

⇨ You can now create a new workspace.

For more information about Working with VECU-BUILDER and VECU-BUILDER Examples/Templates, see VECU-BUILDER Tool, VECU-BUILDER Examples/TemplatesWorking With VECU-BUILDER and Exploring the Examples/Templates.

4 Working With VECU-BUILDER

To commence your learning, we recommend following the bellow path:

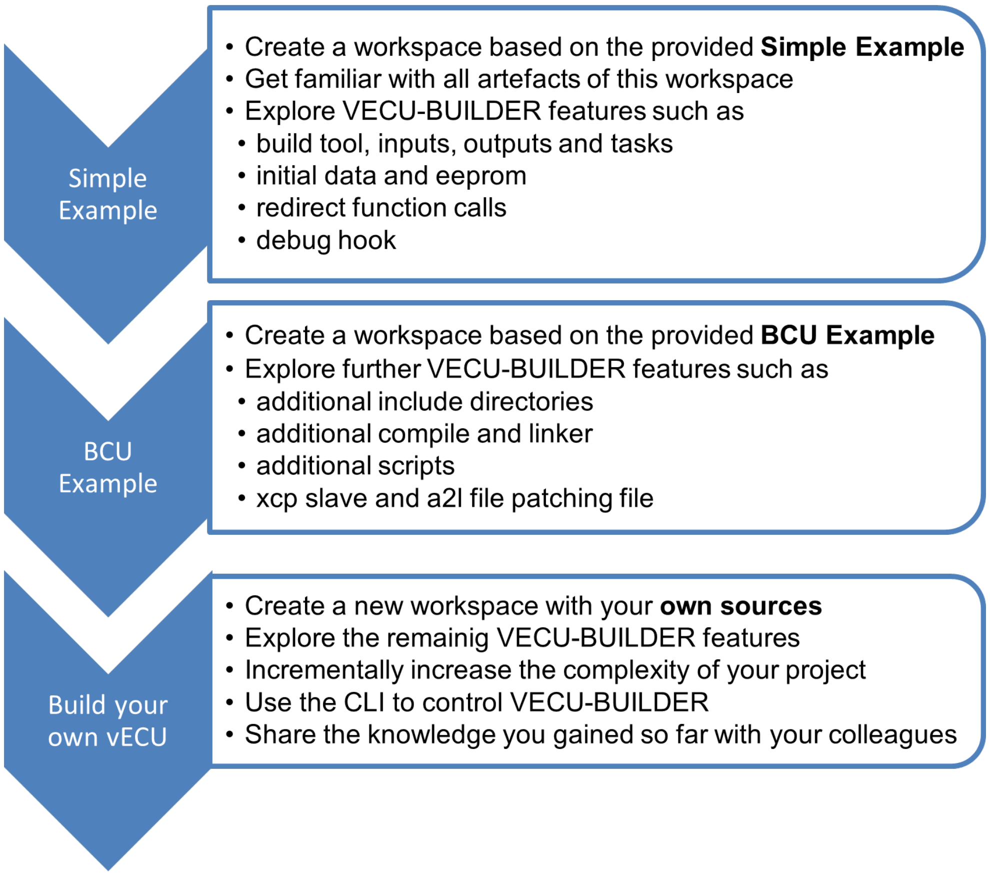

Simple Example
• Create a workspace based on the provided **Simple Example**
• Get familiar with all artefacts of this workspace
• Explore VECU-BUILDER features such as
• build tool, inputs, outputs and tasks
• initial data and eeprom
• redirect function calls
• debug hook
BCU Example
• Create a workspace based on the provided **BCU Example**
• Explore further VECU-BUILDER features such as
• additional include directories
• additional compile and linker
• additional scripts
• xcp slave and a2l file patching file
Build your own vECU
• Create a new workspace with your **own sources**
• Explore the remainig VECU-BUILDER features
• Incrementally increase the complexity of your project
• Use the CLI to control VECU-BUILDER
• Share the knowledge you gained so far with your colleagues

Fig. 4-1: The learning path

This section guides you through the process of creating a vECU in four distinct stages. Each stage can be triggered individually, and you can choose to continue with the next one.

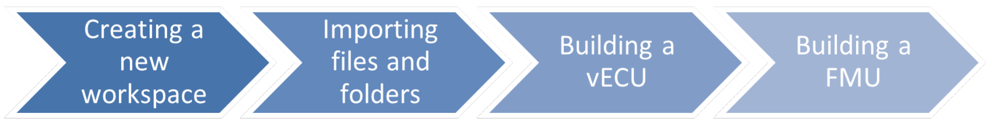


Fig. 4-2: VECU-BUILDER stages

By following the steps described in the next chapters, you will build your first vECU based on the Simple Example. This is the ideal starting point for your virtualization leaning journey.

4.1 Creating a New Workspace

The very first step, required at the beginning of every project, is to create a workspace.

Note

Workspaces are designed for parallel use.

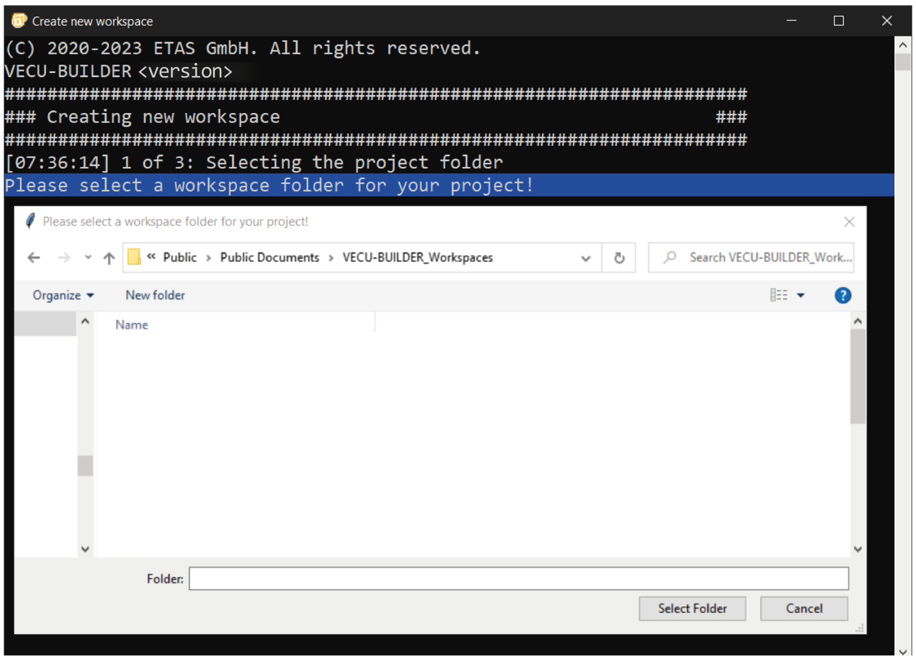
A single workspace cannot be used for tasks running in parallel.

4.1.1 Creating a Workspace on Windows

1. Launch “Create new workspace” from the Start Menu.

⇨ A console window opens providing details on the overall process, various stages it goes through and their individual steps.

⇨ In the first step of “Create new workspace” you will be asked to select a folder where your workspace will be saved.



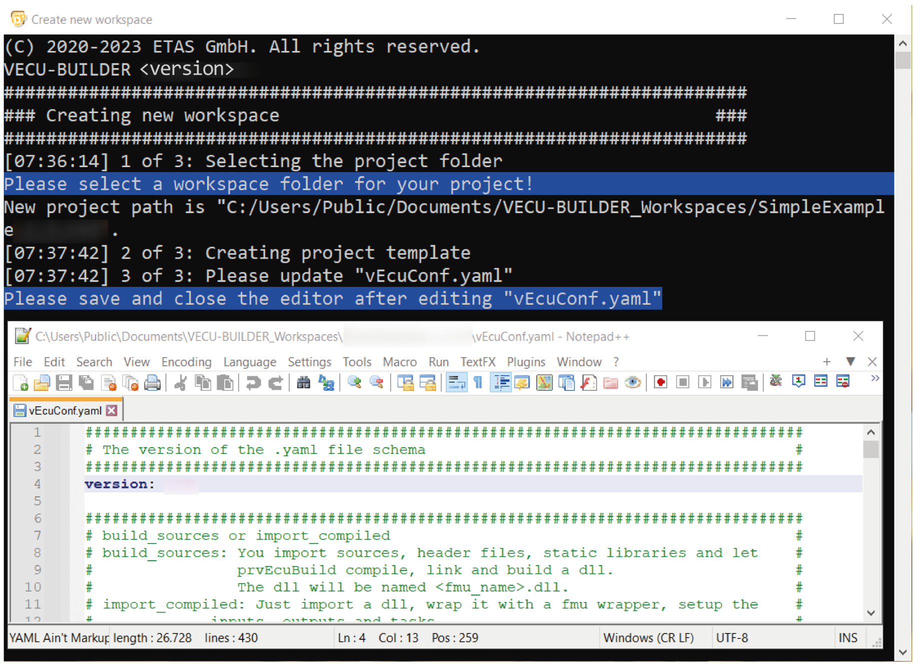
```
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
######################################################################
### Creating new workspace                                         ###
######################################################################
[07:36:14] 1 of 3: Selecting the project folder
Please select a workspace folder for your project!
```

Create new workspace
Please select a workspace folder for your project!
« Public › Public Documents › VECU-BUILDER_Workspaces
Search VECU-BUILDER_Work...
Organize
New folder
Name
Folder:
Select Folder
Cancel

2. Navigate to the default location of your workspaces
`C:/Users/Public/Documents\VECU-BUILDER_Workspaces`
and select an existing folder or create a new one.

⇨ The configuration file `vEcuConf.yaml` opens in Notepad++.

⇨ Per default, this is the configuration file of the Simple Example.


Create new workspace

```
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>[redacted]
######################################################################
### Creating new workspace                                         ###
######################################################################
[07:36:14] 1 of 3: Selecting the project folder
Please select a workspace folder for your project!
New project path is "C:/Users/Public/Documents/VECU-BUILDER_Workspaces/SimpleExampl
e[redacted].
[07:37:42] 2 of 3: Creating project template
[07:37:42] 3 of 3: Please update "vEcuConf.yaml"
Please save and close the editor after editing "vEcuConf.yaml"
```

C:\Users\Public\Documents\VECU-BUILDER_Workspaces\[redacted]\vEcuConf.yaml - Notepad++

```
################################################################################
# The version of the .yaml file schema                                         #
################################################################################
version: [redacted]

################################################################################
# build_sources or import_compiled                                             #
# build_sources: You import sources, header files, static libraries and let    #
#                prvEcuBuild compile, link and build a dll.                    #
#                The dll will be named <fmu_name>.dll.                         #
# import_compiled: Just import a dll, wrap it with a fmu wrapper, setup the    #
#              inputs, outputs and tasks                                       #
```

YAML Ain't Markup length : 26.728 lines : 430 Ln : 4 Col : 13 Pos : 259 Windows (CR LF) UTF-8 INS

3. Keep the configuration file as is and close the Notepad ++ application.

⇨ Your new workspace is now created.

The process will automatically continue with the next stage.

4.1.2 Creating a Workspace on Ubuntu 20.04 LTS

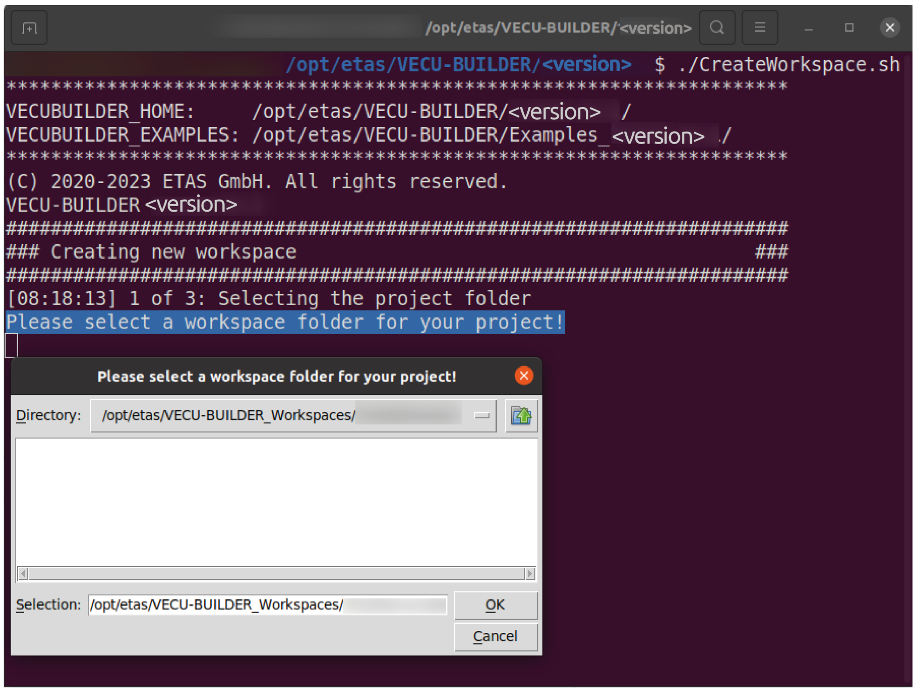
Note

In Ubuntu 20.04 LTS LTS the folder, that should be used as workspace, needs to exist before the workspace creation is proceeded.

1. Navigate to the folder, where the `CreateWorkspace.sh` is located. The default path is `opt/etas/VECU-BUILDER/1.7.0`.
2. Open a new terminal. VECU-BUILDER will use the editor found under `/usr/bin/editor`.
3. Enter `./CreateWorkspace.sh`.

➯ In the first step of “Create new workspace” you will be asked to select a folder where your workspace will be saved.

4. Navigate to the default location of your workspaces `/opt/etas/VECU-BUILDER_Workspaces` and select an existing folder.



```
/opt/etas/VECU-BUILDER/<version>  $ ./CreateWorkspace.sh
**********************************************************************
VECUBUILDER_HOME:     /opt/etas/VECU-BUILDER/<version>  /
VECUBUILDER_EXAMPLES: /opt/etas/VECU-BUILDER/Examples_<version> ./
**********************************************************************
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
######################################################################
### Creating new workspace                                         ###
######################################################################
[08:18:13] 1 of 3: Selecting the project folder
Please select a workspace folder for your project!
```

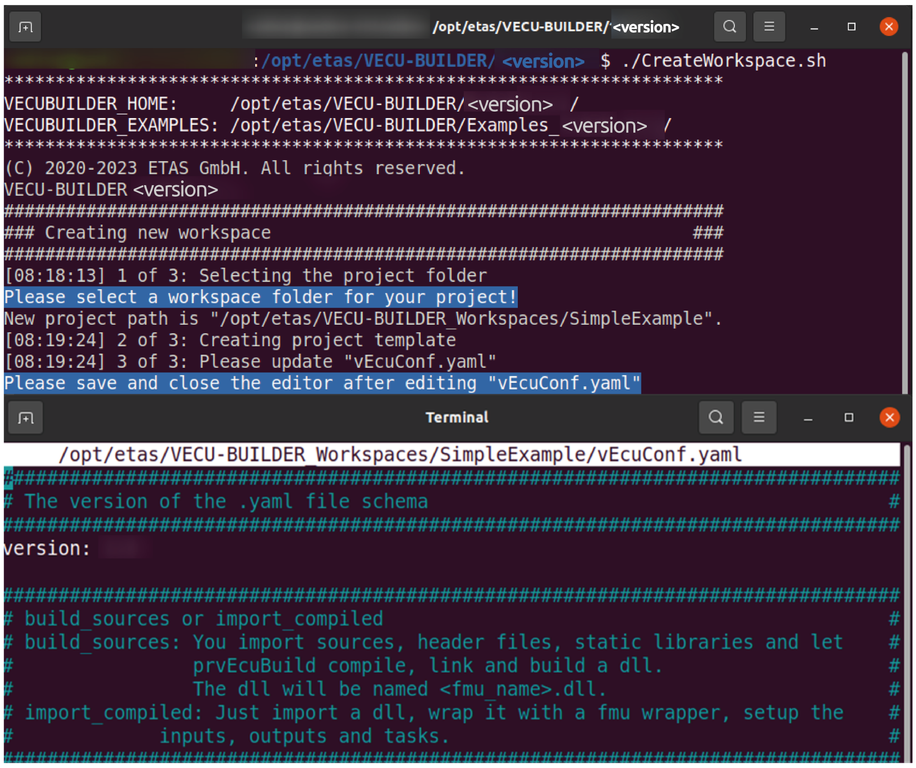
Please select a workspace folder for your project!

Directory: /opt/etas/VECU-BUILDER_Workspaces/

Selection: /opt/etas/VECU-BUILDER_Workspaces/

⇨ The configuration file `vEcuConf.yaml` opens.

⇨ Per default, this is the configuration file of the Simple Example.



```
[redacted] /opt/etas/VECU-BUILDER/<version>
[redacted]:/opt/etas/VECU-BUILDER/ <version> $ ./CreateWorkspace.sh
**********************************************************************
VECUBUILDER_HOME:     /opt/etas/VECU-BUILDER/<version>  /
VECUBUILDER_EXAMPLES: /opt/etas/VECU-BUILDER/Examples_<version>  /
**********************************************************************
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
######################################################################
### Creating new workspace                                         ###
######################################################################
[08:18:13] 1 of 3: Selecting the project folder
Please select a workspace folder for your project!
New project path is "/opt/etas/VECU-BUILDER_Workspaces/SimpleExample".
[08:19:24] 2 of 3: Creating project template
[08:19:24] 3 of 3: Please update "vEcuConf.yaml"
Please save and close the editor after editing "vEcuConf.yaml"
```

```
Terminal
     /opt/etas/VECU-BUILDER_Workspaces/SimpleExample/vEcuConf.yaml
#######################################################################
# The version of the .yaml file schema                                #
#######################################################################
version: [redacted]

#######################################################################
# build_sources or import_compiled                                    #
# build_sources: You import sources, header files, static libraries and let  #
#                prvEcuBuild compile, link and build a dll.           #
#                The dll will be named <fmu_name>.dll.                #
# import_compiled: Just import a dll, wrap it with a fmu wrapper, setup the  #
#               inputs, outputs and tasks.                            #
#######################################################################
```

5. Keep the configuration file as is and close it.

⇨ Your new workspace is now created.

The process will automatically continue with the next stage.

4.2 Importing Files and Folders

During this stage, the sources defined in your `vEcuConf.yaml` are copied to the "`vEcu/imported`" folder in your workspace.

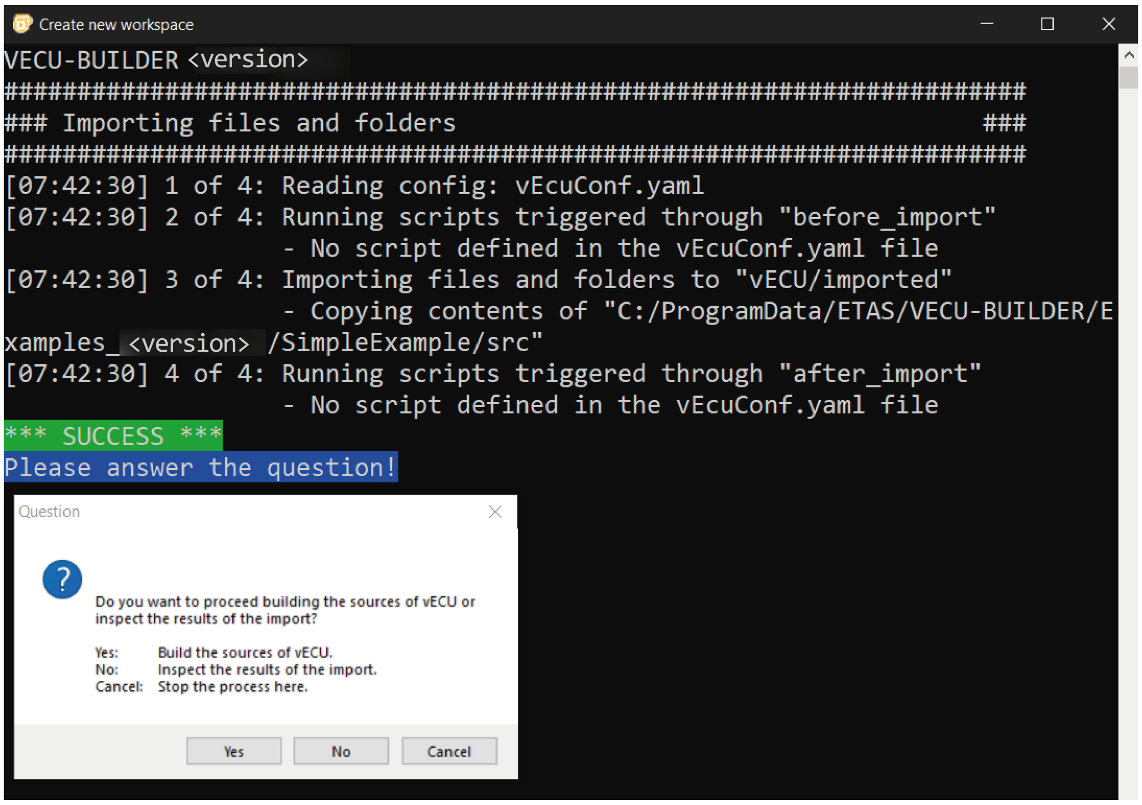
Note

During the import stage, files and folders get copied into the workspace. For reasons of portability, it is recommended to create workspaces that are self-contained.

After successful completion of the previous stage Creating a New Workspace you were forwarded to the next stage Importing Files and Folders and the process continues.

If you work in an already existing workspace, you can trigger this stage by running `1_Import.bat` on **Windows** or `1_Import.sh` on **Ubuntu 20.04 LTS**.

After successful completion of this stage **Importing Files and Folders** a dialog opens. It asks whether you want to continue with the next stage Building the vECU or inspect the results of this stage.



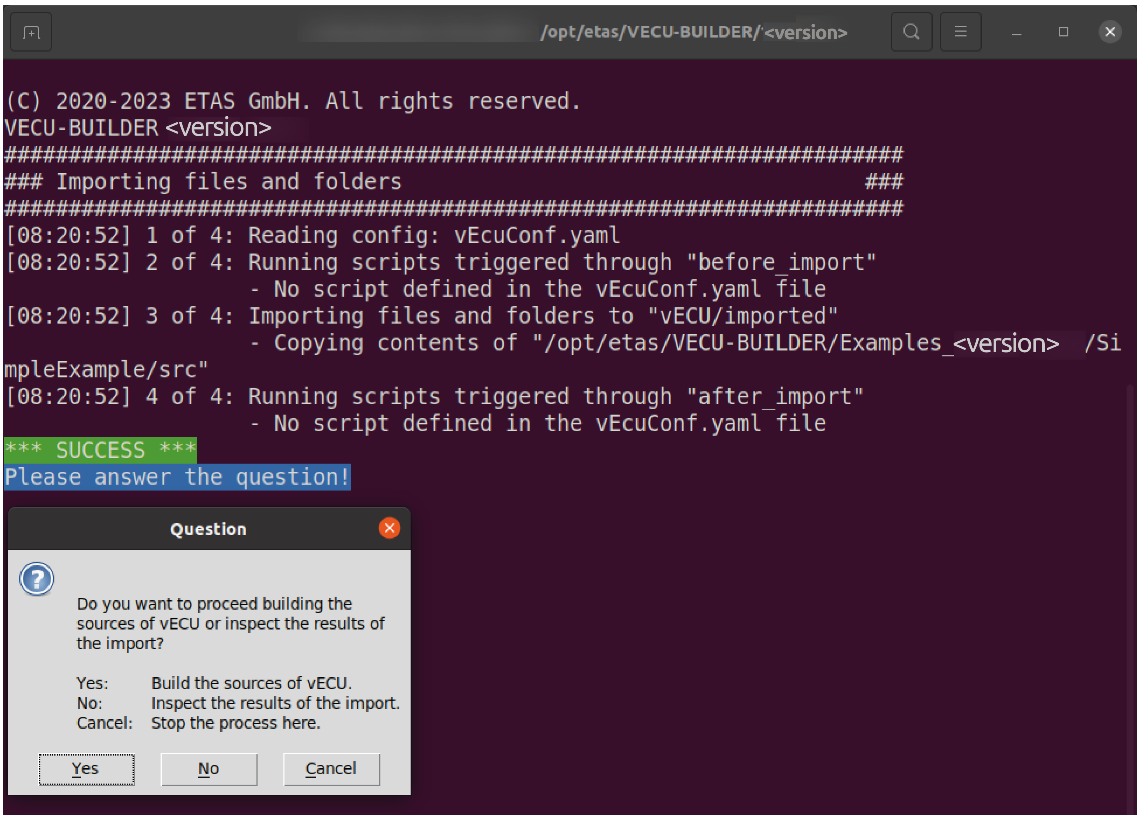
```
VECU-BUILDER <version>
######################################################################
### Importing files and folders                                    ###
######################################################################
[07:42:30] 1 of 4: Reading config: vEcuConf.yaml
[07:42:30] 2 of 4: Running scripts triggered through "before_import"
                   - No script defined in the vEcuConf.yaml file
[07:42:30] 3 of 4: Importing files and folders to "vECU/imported"
                   - Copying contents of "C:/ProgramData/ETAS/VECU-BUILDER/E
xamples_<version> /SimpleExample/src"
[07:42:30] 4 of 4: Running scripts triggered through "after_import"
                   - No script defined in the vEcuConf.yaml file
*** SUCCESS ***
Please answer the question!
```

Question

Do you want to proceed building the sources of vECU or inspect the results of the import?

Yes:	Build the sources of vECU.
No:	Inspect the results of the import.
Cancel:	Stop the process here.

Fig. 4-3: Proceed with vECU Build dialog or inspect the results (Windows)



```
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
######################################################################
### Importing files and folders                                    ###
######################################################################
[08:20:52] 1 of 4: Reading config: vEcuConf.yaml
[08:20:52] 2 of 4: Running scripts triggered through "before_import"
                   - No script defined in the vEcuConf.yaml file
[08:20:52] 3 of 4: Importing files and folders to "vECU/imported"
                   - Copying contents of "/opt/etas/VECU-BUILDER/Examples_<version>  /Si
mpleExample/src"
[08:20:52] 4 of 4: Running scripts triggered through "after_import"
                   - No script defined in the vEcuConf.yaml file
*** SUCCESS ***
Please answer the question!
```

Question

Do you want to proceed building the sources of vECU or inspect the results of the import?

```
Yes:     Build the sources of vECU.
No:      Inspect the results of the import.
Cancel:  Stop the process here.
```

Fig. 4-4: Proceed with vECU Build dialog or inspect the results (Ubuntu 20.04 LTS)

1. Click **Yes**.

⇨ Your new workspace is now created.

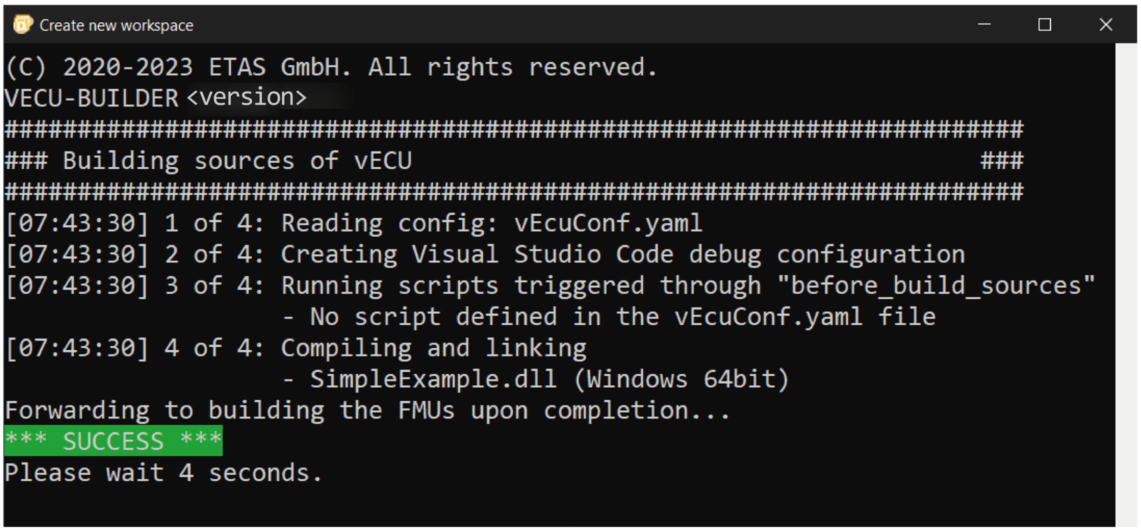
The process will continue with the next stage.

4.3 Building the vECU

During this stage, the sources imported into your workspace are compiled. Also they are linked into a DLL/SO file forming the core functionality of your future vECU.

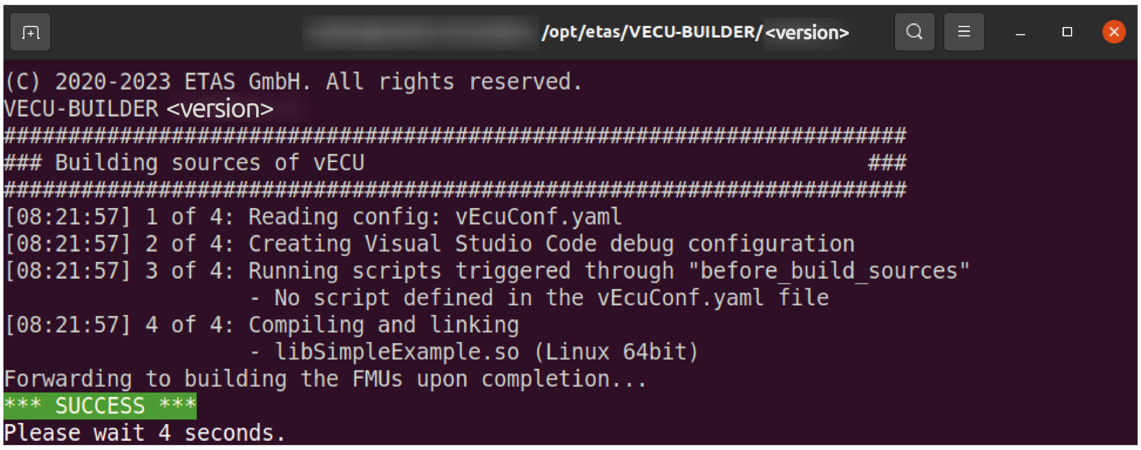
After successful completion of the previous stage Importing Files and Folders and selecting to proceed with the build of the vECU you are forwarded to the next stage Building the FMU and the process continues.

If you work in an already existing workspace, you can trigger this stage by running `2_Build.bat` on **Windows** or `2_Build.sh` on **Ubuntu 20.04 LTS**



```
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
#######################################################################
### Building sources of vECU                                        ###
#######################################################################
[07:43:30] 1 of 4: Reading config: vEcuConf.yaml
[07:43:30] 2 of 4: Creating Visual Studio Code debug configuration
[07:43:30] 3 of 4: Running scripts triggered through "before_build_sources"
                   - No script defined in the vEcuConf.yaml file
[07:43:30] 4 of 4: Compiling and linking
                   - SimpleExample.dll (Windows 64bit)
Forwarding to building the FMUs upon completion...
*** SUCCESS ***
Please wait 4 seconds.
```

Fig. 4-5: Building vECU completed (Windows)



```
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
#######################################################################
### Building sources of vECU                                        ###
#######################################################################
[08:21:57] 1 of 4: Reading config: vEcuConf.yaml
[08:21:57] 2 of 4: Creating Visual Studio Code debug configuration
[08:21:57] 3 of 4: Running scripts triggered through "before_build_sources"
                   - No script defined in the vEcuConf.yaml file
[08:21:57] 4 of 4: Compiling and linking
                   - libSimpleExample.so (Linux 64bit)
Forwarding to building the FMUs upon completion...
*** SUCCESS ***
Please wait 4 seconds.
```

Fig. 4-6: Building vECU completed (Ubuntu 20.04 LTS)

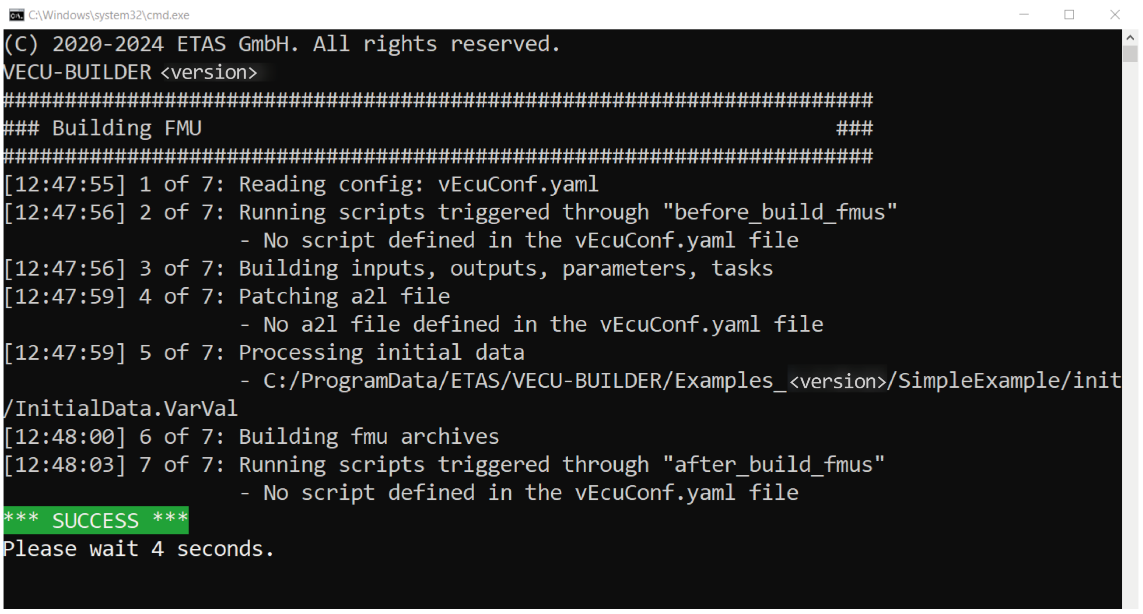
The process will automatically continue with the next stage.

If the process will not automatically continue with the next stage and error messages are displayed, see Building Sources Failed for more details.

4.4 Building the FMU

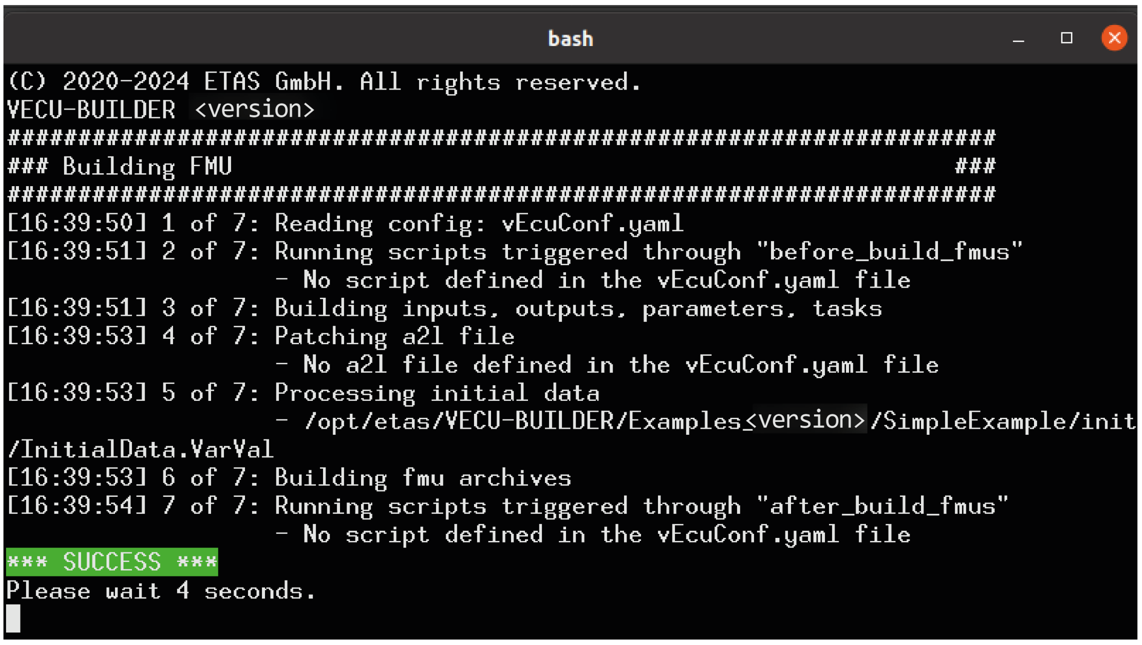
During this stage, the DLL/SO file created in the previous stage will be wrapped into an FMU container representing your vECU.

After successful completion of the previous stage Building the vECU and selecting to proceed with the build of the vECU you were forwarded to the next stage Building the FMU where the process completes.



```
(C) 2020-2024 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
#######################################################################
### Building FMU                                                    ###
#######################################################################
[12:47:55] 1 of 7: Reading config: vEcuConf.yaml
[12:47:56] 2 of 7: Running scripts triggered through "before_build_fmus"
                   - No script defined in the vEcuConf.yaml file
[12:47:56] 3 of 7: Building inputs, outputs, parameters, tasks
[12:47:59] 4 of 7: Patching a2l file
                   - No a2l file defined in the vEcuConf.yaml file
[12:47:59] 5 of 7: Processing initial data
                   - C:/ProgramData/ETAS/VECU-BUILDER/Examples_<version>/SimpleExample/init
/InitialData.VarVal
[12:48:00] 6 of 7: Building fmu archives
[12:48:03] 7 of 7: Running scripts triggered through "after_build_fmus"
                   - No script defined in the vEcuConf.yaml file
*** SUCCESS ***
Please wait 4 seconds.
```

Fig. 4-7: Building FMU completed (Windows)

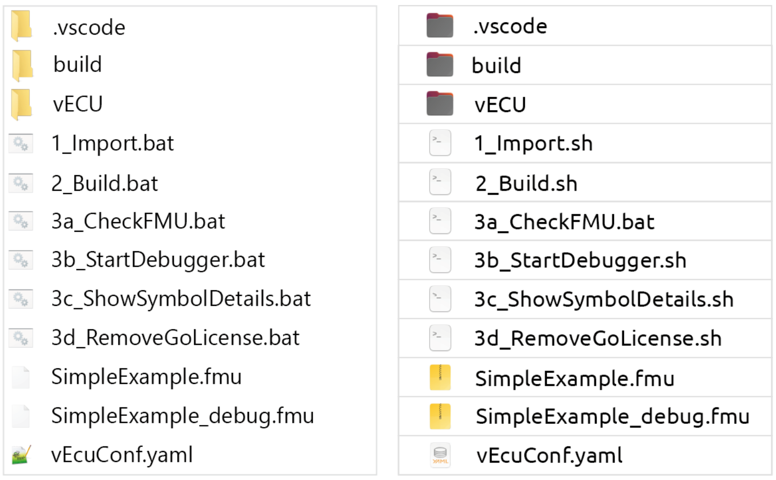


```
(C) 2020-2024 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
#######################################################################
### Building FMU                                                    ###
#######################################################################
[16:39:50] 1 of 7: Reading config: vEcuConf.yaml
[16:39:51] 2 of 7: Running scripts triggered through "before_build_fmus"
                   - No script defined in the vEcuConf.yaml file
[16:39:51] 3 of 7: Building inputs, outputs, parameters, tasks
[16:39:53] 4 of 7: Patching a2l file
                   - No a2l file defined in the vEcuConf.yaml file
[16:39:53] 5 of 7: Processing initial data
                   - /opt/etas/VECU-BUILDER/Examples_<version>/SimpleExample/init
/InitialData.VarVal
[16:39:53] 6 of 7: Building fmu archives
[16:39:54] 7 of 7: Running scripts triggered through "after_build_fmus"
                   - No script defined in the vEcuConf.yaml file
*** SUCCESS ***
Please wait 4 seconds.
```

Fig. 4-8: Building FMU completed (Ubuntu 20.04 LTS)

4.5 Workspace Content

You have now successfully created the VECU-BUILDER workspace and built your first vECU based on the provided Simple Example sources. In this chapter, you find a description of the workspace contents for Windows and Ubuntu 20.04 LTS.



.vscode	.vscode
build	build
vECU	vECU
1_Import.bat	1_Import.sh
2_Build.bat	2_Build.sh
3a_CheckFMU.bat	3a_CheckFMU.bat
3b_StartDebugger.bat	3b_StartDebugger.sh
3c_ShowSymbolDetails.bat	3c_ShowSymbolDetails.sh
3d_RemoveGoLicense.bat	3d_RemoveGoLicense.sh
SimpleExample.fmu	SimpleExample.fmu
SimpleExample_debug.fmu	SimpleExample_debug.fmu
vEcuConf.yaml	vEcuConf.yaml

Fig. 4-9: Workspace contents

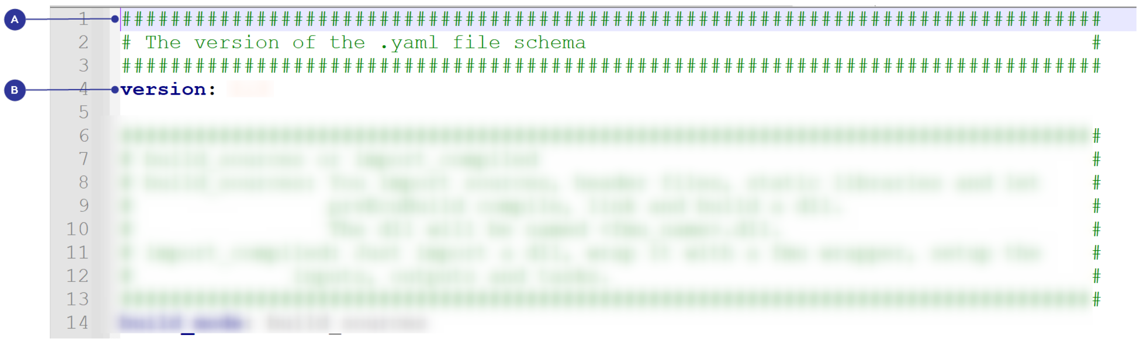
The content of the workspace consists of several artefacts:

- `vscode` folder:
  - `launch.json` file for vECU debugging in VS Code
- `build` folder:
  - `additional_scripts` folder: location for your project specific additional scripts
  - `log` folder:
    log files from executed stages
  - `scripts` folder: command and shell scripts to perform the individual stages
  - `last_build_footprint.txt`: details of last performed build stage
  - `RawSymbolDetails.txt`: subset of `SymbolDetails` and for internal purposes only
  - `SymbolDetails.txt`: symbols within your sources and their attributes
- `vECU` folder:
  - `buildArtifacts` folder: Library file and its associated debug information
  - `CMake` folder: CMake project artifacts
  - `imported` folder: all imported artifacts
  - `CMakeLists.txt`: set of directives and instructions for building your sources
- `1_Import.bat`/`1_Import.sh`
  file to trigger the Importing Files and Folders stage.

- `2_Build.bat`/`2_Build.sh`
  file to trigger the Building the vECU stage.
- `3a_CheckFMU.bat`/`3a_CheckFMU.sh`
  file to call FMPy and inspect the vECU outputs.
- `3b_StartDebugger.bat`/`3b_StartDebugger.sh`
  file to call MSVC or VS Code as debugger.
- `3c_ShowSymbolDetails.bat`/`3c_ShowSymbolDetails.sh`
  file to call Notepad++ (Windows) / new Terminal (Ubuntu 20.04 LTS) and display the Symbol Details.
- `3d_RemoveGoLicense.bat`/`3d_RemoveGoLicense.sh`
  file to remove the GO license from the vECU (only relevant if vECU was built with GO-license).
- `SimpleExample.fmu`
  release version of your vECU, for more details see Simple Example.
- `SimpleExample_debug.fmu`
  debug version of your vECU, for more details see Simple Example.
- `vEcuConf.yaml`
  the YAML configuration file, for more details see Configuration.

4.6 Configuration

The YAML file contains the configurations for the import and build process as well as for the vECU itself. It is the only configuration you need to create and maintain. The YAML file is divided into several sections, each section configuring a particular attribute. You are guided through the YAML file with comments on each section and configuration attributes. Every section is structured in a standardized way:



```
################################################################################
# The version of the .yaml file schema                                         #
################################################################################
version: [illegible]

[illegible]
```

A: comment with information on the corresponding section

B: configuration attributes and values

The following is a list of all attributes available in the YAML file:

- `version`

  This is the version of the used YAML file schema and must not be changed.

- `build_mode`

  You can select between 2 modes:

  `build_sources`: You import source code (either as AUTOSAR Classic compliant or legacy C-code), header files, and static libraries. VECU-BUILDER then builds your vECU in the form of an FMU container.

  The vECU will be named `<fmu_name>.fmu`.

  `import_compiled`

  You import an existing, already compiled and linked, software in the form of a DLL/SO containing the functionality of your vECU.

  VECU-BUILDER then wraps it in an FMU container, sets up the inputs, outputs and tasks, patches the A2L file, sets up the XCP slave port, etc.

- `fmu_name`

  Enter the name of your vECU.

  The code of your vECU is located inside the FMU in the folder" `resources/<fmu_name>.dll`".

  This and other DLL/SO files are loaded and executed by the FMU runner.

- `import_into_project`

  Enter the paths to the files and folders to be imported.

  You can specify paths to folders and/or individual files such as `*.c`, `*.h`, `*.cpp`, `*.hpp` or `*.zip` archives which will be extracted during import.

  The import target is the "`vEcu/imported`" folder in your workspace.

  Environment variables can be used like this:

  "`${VECUBUILDER_EXAMPLES}\SimpleExample\src`"
- `additional_resources`

  Additional resources can be used to resolve dependencies by making `.dll/.so` libraries your application depends on part of the build and execution process. It is possible to reference files and folders, that the vECU assembly needs to run. A folder is copied recursively (not just the content of the folder) to the root of the resources folder. A file is copied to the root of the resources folder. any number of additional resources can be added.

  > **Note**
  >
  > additional_resources does not support wildcards.

  Specify all additional resources that are to be included in the FMU. They will be copied to the resources folder of the FMU during the Building FMU stage i.e.

  `${VECUBUILDER_WORKSPACE}/vECU/imported/additional_DLLs/UsedByVECU.dll` for **Windows**

  Or

  `${VECUBUILDER_WORKSPACE}/vECU/imported/additional_DLLs/UsedByVECU.so` for **Ubuntu 20.04 LTS**.

  It is possible to use plugins. You can include plugins as additional ressources the same way. For more details, see Template for Plugin V1 (FMI2).
- `import_external_compiled_vecu`

  Only needed if you selected `import_compiled` as `build_mode`.

  That DLL/SO already contains the code of your vECU. You can skip the compiling and linking and just import your DLL/SO into the FMU wrapper. Here you enter the DLL name and the path for updates:

  `dll_so_name`: The name of the DLL/SO. There must exist a corresponding pdb file with the same filename.

  `get_updates_from`: If VECU-BUILDER can find a DLL/SO and the pdb file in this folder, it will update the imported DLL/SO.

  Environment variables can be used like this:"`${SystemDrive}/Sandbox`".

- `architecture`

  Specify the architecture.

  When importing sources, the setting of this attribute has to match the integration and simulation system where the vECU is to be used.

  In case you are importing an DLL/SO precompiled for either 32-bit or 64-bit architecture, this attribute must be set to the same.

  Note

  For Ubuntu 20.04 LTS only 64-bit is supported.

- `xcp_slave`

  Enter the port and IP address of the XCP Slave to be setup in your vECU.

  These values are transferred to the patched A2L file. The used protocol is TCP. For more details, see A2L File Patching.

  Note

  - A socket (IP address + port + protocol) for the XCP connection between INCA and XCP slave can only be used once. If a port is busy, you must define another port in the YAML file.
  - xcp_slave is supported for Windows only.

- `operating_system`

  Enter the operating system. Currently only Windows and Ubuntu 20.04 LTS supported.

- `build_tool`

  Enter your preferred build tool. `Build_tool` differs between Windows and Ubuntu 20.04 LTS.

  Windows:

  Set up the build tool to be used for your build.

  Note

  VECU-BUILDER configures the build tool for the underlying CMake.

  In case Visual Studio is selected, a Visual Studio Solution is generated.

  If you choose MinGW Makefiles, a CMake project is generated.

  These artefacts are stored in the "`vECU/CMake`" folder in your workspace.

- `path_to_mingw`: If the user-specific MinGW is defined, CMake builds the sources using this MinGW version.

  Ubuntu 20.04 LTS:

  You can choose Unix Makefiles.

- `cmake_generator_toolset`

  Define which toolset should be used by CMake during the build process.

  For more details, see CMAKE_GENERATOR_TOOLSET.

- `inputs, outputs, parameters, locals`

  Enter the variables you want to expose as ports of your FMU.

  Inputs, outputs, parameters, and locals refer to the causality of the FMI.

  Wildcards of `*` and `?` are allowed. Arrays can be added using `myArray*`, the same goes for structures. If your wildcard expression breaks the YAML compatibility, put it in single apostrophes.

  Example: "`*a`" finds all symbols ending with an "a".

  Aliases can be defined for variables, which results in renaming of FMI ports. The aliases are used in the `modelDescription.xml` and the original variable names are used in the `resources.txt`.

  Note

  Variables of type enumeration will be interpreted as integers in the `modelDescription.xml` file of the FMU. The name-value mapping of enumerations will be ignored when enumerations are used as interfaces. Only the integer value will be exchanged.

- `initial_data`

  Enter the path for source and target destination to define the initial values of calibration variables.

  The initial data is virtually flashed into memory during initialization. The data file in the FMU (defined by destination) is read and its values are written to RAM. This simulates a part of the NVRAM (non-volatile RAM).

  `source`: Where to get the file. During build-time this file will be copied from source.

  `destination`: Where to store the file inside the FMU, relative to the resources folder of the FMU (optional). This file is used during run-time.

  `encoding`: DCM file character encoding (optional). In the context of a DCM file, the encoding field specifies the character encoding standard used for the text content within the file. In case the encoding is not defined, default utf-8 encoding is used.

  Supported formats:

  `VarVal`: list of pairs separated by one space, where the lhs refers to the C variable and the rhs to the value.

  `DCM`: format containing ASAP2 labels and their values in physical form which are processed according to information in A2L file.

  For more details, see InitialData Functionality.

- `eeprom`

  Specify the eeprom simulation attributes.

  `source`: Path where to get the file. This is used during the build.

  `destination`: Path where to store the file relative to the resources folder of the FMU. This is the working copy (optional).

  `sync`: This can be a UNC Path or a regular path name. When the vECU is initializing, this file is copied to the "destination", if it exists. When the vECU terminates, the updated file in "destination" is copied to the "sync" location (optional). To setup the UNC Path, see Windows Cannot Access Localhost While Using Sync Attribute in EEPROM.

  `c_variables`: The C variable names that store the eeprom data.

  Supported format:

  `.txt`: A line starting with "#" is a comment. All other lines store the data stream to be flashed to the C variables. The order of the data stream lines is the same as the order of the c_variables listed.

  A data stream is a sequence of bytes in HEX format. Each byte is separated by a space. E.g.: 01 02 ee 4f. In the default YAML file the sync is commented out.

  For more information about eeprom, see eeprom Functionality.

- `tasks`

  Note

  Task functions must have no arguments.

  Define the tasks that are to be executed and their attributes. To simulate the microcontroller behavior with its periodically executed functions of your software, these functions are to be defined as tasks in this section. A function can be defined as a task only once, duplicated functions will be ignored.

  `function_name`: "<function name>", without brackets, set in apostrophes, no arguments allowed.

  `trigger`: Choose between cyclic, initial or terminate, the default is cyclic.

  `initial`: Functions are called from `fmi2DoStep` before cyclic tasks.

  `cyclic`: Functions are called from `fmi2DoStep` before terminate tasks.

  Note

  The period of a cyclic task must not be less than 1 ns.

  `terminate`: Functions are called from `fmi2Terminate`.

  `fmi2_enter_init`: Functions are called from `fmi2EnterInitializationMode`.

`fmi2_exit_init`: Functions are called from `fmi2ExitInitializationMode`.

`period`: ‹number› [in seconds], the default is 1.0.

`first_call`: ‹number› [in seconds] for the cyclic tasks, the default is period.

`priority`: The lower the number the higher the priority, the default is 0.

> **Note**
>
> If two functions run at the same time, the one with the lower priority runs first.

`max_calls`: ‹number›, -1 means infinite, 0 means no call.

`trigger_function`: The function is written in `Multiply.c`. trigger_function only can be used if "trigger" is "event". The trigger function predicts when the next event might occur and returns if the next events needs to be triggered. You can find the defined arguments of the trigger function in `Multiply.c`

`trigger_inputs`: A list of additional inputs that refer to variables accessible via symbol details. Trigger inputs must be included in the symbol details text file.

For more information, see EventTrigger Example.

– `redirect_function_calls`

Enter the names functions to be replaced and their substitutes.

The function signatures of the two functions must be identical. This allows you to test the behavior of your software using alternative implementation without changing the original source code. Also you don't need to replace unfinished or hardware-dependent functions with mock functions.

`replaced_function`: Enter the function name of the function to be replaced.

`substitute_function`: The function name of the function that substitutes the replaced function.

> **Note**
>
> Sometimes `redirect_function_calls` does not work as expected. For more details, see additional_compile_flags in this chapter and Redirecting Function Calls Did Not Work as Expected.

– Only usable if you selected `build_sources` as `build_mode`.

You can select files and/or folders that should be included or excluded in/-from the vECU build process.

Files are only included into the build if they are matched by at least one `build_include_filter` and are not matched by any `build_exclude_filter`.

- `assembly_list_files`

  Specify your assembly list files for the build process.

  Of the given sources defined by "`build_include_filters`" and "`build_exclude_filters`", only those listed in a file are passed to the compiler.

  If no assembly list files are configured, all sources are compiled.

- `additional_include_directories`

  Only usable if you selected `build_sources` as `build_mode`.

  With `additional_include_directories` a directory is added to the list of directories that will be searched for include files. Specify the path of the to be added directory. Additional include directories are passed to the preprocessor. Wildcards "`*`" and "`?`" are allowed. The environment variable `${VECUBUILDER_WORKSPACE}` points to the workspace.

- `additional_defines`

  Only usable if you selected `build_sources` as `build_mode`.

  Specify the preprocessor macro definitions you want to add. These definitions are passed to the preprocessor. This is useful if you need to set or unset some of the definitions to adapt them to the new Windows target.

  Brackets "(', ')" must be escaped as "\(', '\)".

- `additional_compile_flags`

  Only usable if you selected `build_sources` as `build_mode`. `additional_compile_flags` will be applied to C and C++.

  Specify how the compiler should work. Each individual flag must be written in a separate line and put in single apostrophes, i.e. "`/ZI`".

  The flags are written into the CMakeLists.

  For more details, see MSVC compiler options or gcc compiler options.

  A successful use of `redirect_function_calls` depends on `additional_compile_flags`. Only if `additional_compile_flags` is set correctly, `redirect_function_calls` will work.

  To prevent the GNU compiler from using incompatible optimizations when `redirect_function_calls` feature is enabled, optimizations are disabled by using the following flags:

  `# - '-O0'` for gcc

  For more details, see Options That Control Optimization and Redirecting Function Calls Did Not Work as Expected.

- `additional_c_compile_flags`

  The same prerequisites as for "additional_compile_flags" above must be met. `additional_c_compile_flags` will be applied only to C.

A successful use of `redirect_function_calls` depends on `additional_c_compile_flags`. Only if `additional_c_compile_flags` is set correctly, `redirect_function_calls` will work.

To prevent the GNU compiler from using incompatible optimizations when `redirect_function_calls` feature is enabled, optimizations are disabled by using the following flags:

`# - '-fhosted'`

- `additional_cxx_compile_flags`

  The same prerequisites as for "additional_compile_flags" on the previous page must be met. `additional_cxx_compile_flags` will be applied only to C++.

  A successful use of `redirect_function_calls` depends on `additional_cxx_compile_flags`. Only if `additional_cxx_compile_flags` is set correctly, `redirect_function_calls` will work.

  To prevent the GNU compiler from using incompatible optimizations when `redirect_function_calls` feature is enabled, optimizations are disabled by using the following flags:

  `# - '-fpermissive'`

- `additional_static_libraries`

  Only usable if you selected `build_sources` for `build_mode`.

  The libraries need to be located in the folder "`./projects/vEcu/imported`".

- `environment_variables`

  You can define process-level environment variables that are set by the build process and by the FMI wrapper during the vECU execution.

  Example: `PATH=c:/Temp;${PATH}`

  These variables can be configured and modified in one location and can be accessed from scripts and configuration files. Process-level environment variable of `VECUBUILDER_WORKSPACE` is created automatically during the build process with its value pointing to the current workspace.

- `additional_scripts`

  Define additional scripts to be executed at various phases of the import and/or the build stage.

  Use batch files on Windows and shell scripts on Ubuntu. These scripts facilitate the execution of your project-specific scripts implemented for example in Python, Perl, etc., if these are executable on your system. Leverage these scripts for tasks like file manipulation, addition of files to the FMU archive, parsing, etc.

  `command`:The script to be executed by the OS, the default search path is `${VECUBUILDER_WORKSPACE}/build/additional_scripts/` (utf-8 only).

`trigger`: Select when should your script be executed from these options:

- `before_import`
- `after_import`
- `before_build_sources`
- `after_build_sources`
- `before_build_fmus`
- `after_build_fmus`

`priority`**:** Define with which priority should your script be executed. The lower the number the higher the priority. Default value is 1.

For more details, see Example of Additional Scripts: A2L Characteristics as Parameters.

– `patch_a2l_file`

  An A2L file is required to connect an MCD tool such as INCA to the running vECU. The A2L file needs to be located in the folder: "`vEcu/imported`".

– `filename`: Enter the name of your A2L file to be patched.

– `symbol_name_mapping`

  When using A2L or DCM files, ASAP2 labels might differ from the symbol names. If both, DCM and A2L, files are provided, then for each DCM entry, an A2L entry of the identical ASAP2 label name must exist.

  based_on_csv:

  CSV file, where lhs is the symbol name and rhs is the ASAP2 label. The CSV file must follow the following format: `SYMBOL_name;ASAP2_label`. You need to use a semicolon as a delimiter.

  When using a CSV file, you only can use simple string search & replace. Make sure that there are no header or any comments in the CSV file and every line is treated as a data record.

  Note

  VECU-BUILDER removes all leading and trailing spaces before and after the first character.

  Example:

  `my_symbol ; ASAP2_LABEL_5`

  This is a valid entry and will be treated as defined below:

  `my_symbol;ASAP2_LABEL_5`

  based_on_adx:

  If mapping between ASAP2 labels and symbols is available in an adx file format (proprietary format of Bosch, only used within Bosch projects), this file can be made part of the build in order to apply the mappings. For mappings in adx file format, simple string search & replace is applied.

Note

The content of an adx file will be processed as is, no interpretation or validation will be performed by VECU-BUILDER. The file is assumed to be complete and correct.

based on symbol_links (only available for Windows):

In A2L files, SYMBOL_LINK information refers to the linkage between symbols or variables defined in the file. It provides information about how different symbols are related or connected to each other.

based_on_assignments:

If the right side includes a dollarsign "`$`" (like in a reference to a group, e.g. (`$1`), then a regular expression search & substitute is applied. Else a simple string search and replace is applied.

One such regular expression allows to map multiple names at once. To see an example, see the following table.

RegEx	(array)\[(\d+)\]	->	$1_$2
Mapping	array[1]	->	array_1

The mappings can be verified by examining the json files appended to the debug FMU, located in `resources\mappings` folder.

VECU-BUILDER will update the memory addresses of entries in the provided A2L file. The original A2L file is renamed by appending `.bak` to its name. For more details, see `A2L File Patching` and `A2L Name Mapping`.

– `debug_hook`

  Specify whether to enable or disable a debug hook. When enabled, the FMU execution is interrupted when the FMU is instantiated until a debugger is attached. For more details, see `Debugging vECU`.

– `additional_link_flags`

  Only usable if you selected build_sources as build_mode.

  Specify how the linker should work. Each individual flag must be written in a separate line and put in single apostrophes, i.e. "`/DEBUG`".

  The flags are written into the `CMakeLists.txt`.

  For more details, see MSVC linker options or gcc linker options.

– `simple_file_modifications`

  Specify file modifications that must be applied to files imported in “`vECU/imported`” folder.

  In case you specify multiple modifications, they will be applied sequentially following the order in which they were specified.

  The next two attributes are mandatory for all types of modifications.

`file_regex`: Specify the search RegEx for a file or a set of files that must be modified.

`trigger`: Specify when the modification must be applied from the 2 below options:

- `after_import` (default)
- `before_build_sources`

You can specify a single or multiple actions (modification types) from the 4 below options:

- `comment_line`: Comment out a single line of code by adding "`//`" at the beginning of the line.
- `search_and_replace`: Replace a line of code that matches the `Search_regex` with the `replacement`.
- `insert_code_above`: Insert code above a matched line.
- `insert_code_below`: Insert code below a matched line.

You must specify `line_regex` and to which match(es) the modification are to be applied to (`apply_to`) for each action from the below 3 options:

- `all_matches` (default)
- `last_match`
- `first_match`

For `insert_code_above` and `insert_code_below`, you must specify the code section that is to be inserted.

When using `simple_file_modifications`, consider the following procedure to make sure, modifications are not included in `.bak` file.

1. Get the set of files and apply the file filter.

2. Revert backups for all files to be modified: Move the `.bak` files to overwrite the normal filename.

→ The backup file is deleted.

3. Create the backup on all files that need to be modified, excluding files ending with `.bak`.

4. Apply the file modifications to all files that need to be modified.

Note

If you need more sophisticated file modifications, use a project-specific script via the `additional_scripts`.

– `include_symbol_details`

The use of plugins may require that the release FMU contains symbol information. For example, if you want to change the cycle time of "`task_10ms`" using a plugin, then the symbol name "`task_10ms`" must be disclosed in the release vECU.

For more details about release FMU, see Difference Between Debug and Release vECUs and Keeping Symbol Information in a Release FMU.

`fmi_<type>`: disabled (default) or enabled. When enabled, all symbol details of that fmi type will be included.

`symbol_names`: All symbol details matching the regular expressions will be included.

- `fmi`

  You can use the functional mockup interface. Default version is 2.0. The use of version 3.0 is also possible. Use the following convention:

  ```
  #fmi: '2.0'
  ```

  More information about FMI can be found here.

5 Exploring the Examples/Templates

This chapter contains details on examples/templates that are designed for users to get to know the features of VECU-BUILDER.

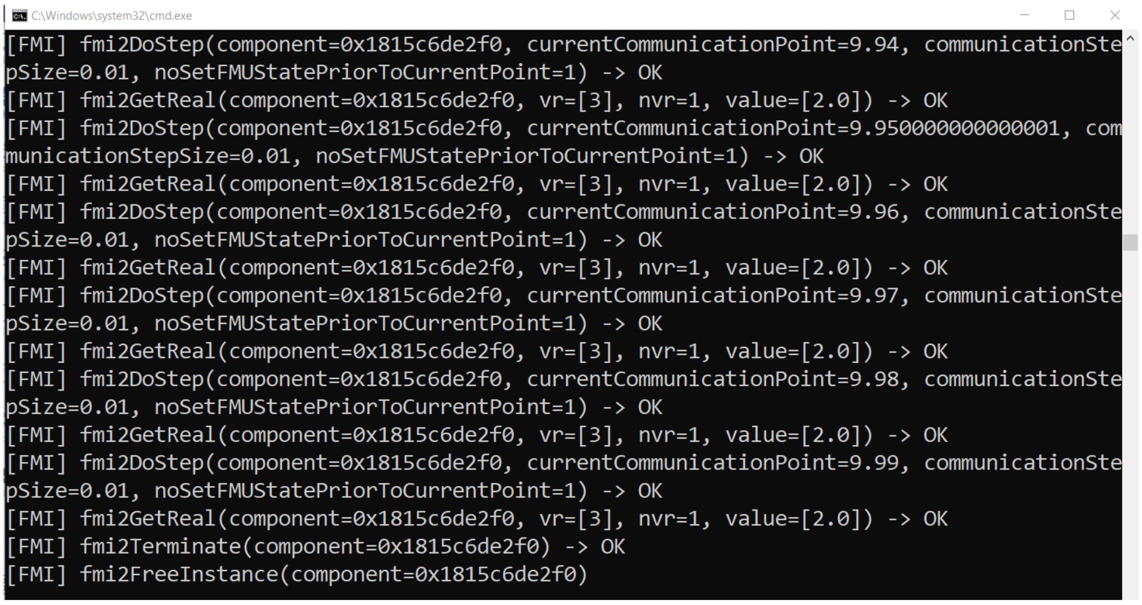
5.1 Simple Example

If you followed the instructions in the chapter Working with VECU-BUILDER, you now have a workspace on your computer based on the Simple Example.

5.1.1 FMPy

To conduct a quick smoke test of the created vECU, FMPy is delivered along with VECU-BUILDER. This tool can be invoked via the `3a_CheckFMU.bat` on **Windows** or `3a_CheckFMU.sh` on **Ubuntu 20.04 LTS**. Execute this file to run the release vECU. Or drag-and-drop the debug vECU into this batch/shell script file to run the debug vECU.

FMPy opens a terminal where details of the FMU are displayed. Furthermore a graph showing the time and values of defined outputs is displayed in a browser window.



```
[FMI] fmi2DoStep(component=0x1815c6de2f0, currentCommunicationPoint=9.94, communicationSte
pSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x1815c6de2f0, vr=[3], nvr=1, value=[2.0]) -> OK
[FMI] fmi2DoStep(component=0x1815c6de2f0, currentCommunicationPoint=9.950000000000001, com
municationStepSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x1815c6de2f0, vr=[3], nvr=1, value=[2.0]) -> OK
[FMI] fmi2DoStep(component=0x1815c6de2f0, currentCommunicationPoint=9.96, communicationSte
pSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x1815c6de2f0, vr=[3], nvr=1, value=[2.0]) -> OK
[FMI] fmi2DoStep(component=0x1815c6de2f0, currentCommunicationPoint=9.97, communicationSte
pSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x1815c6de2f0, vr=[3], nvr=1, value=[2.0]) -> OK
[FMI] fmi2DoStep(component=0x1815c6de2f0, currentCommunicationPoint=9.98, communicationSte
pSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x1815c6de2f0, vr=[3], nvr=1, value=[2.0]) -> OK
[FMI] fmi2DoStep(component=0x1815c6de2f0, currentCommunicationPoint=9.99, communicationSte
pSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x1815c6de2f0, vr=[3], nvr=1, value=[2.0]) -> OK
[FMI] fmi2Terminate(component=0x1815c6de2f0) -> OK
[FMI] fmi2FreeInstance(component=0x1815c6de2f0)
```

Fig. 5-1: FMPy output

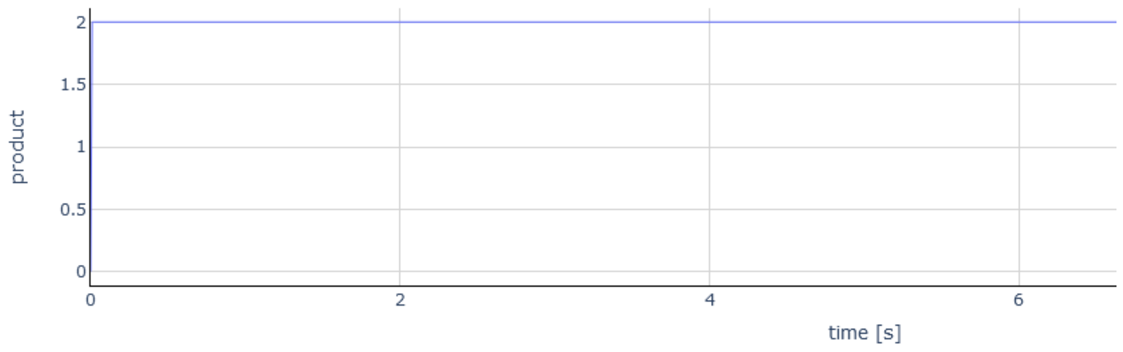


Fig. 5-2: Graph of defined outputs

An FMU, that is built by VECU-BUILDER will set the environment variable `VECUBUILDER_FMURESOURCES`. The environment variable is set for the process that runs the FMU. It is not set on system-level or user-level.

This environment variable stores the absolute path to the resources folder of the FMU. The environment variable can be found when inspecting the process properties in a process monitor tool.

5.1.2 Difference Between Debug and Release vECUs

You find two FMUs in this workspace. One named `SimpleExample.fmu` (which will be referred to as "release vECU" and the other one named `SimpleExample_debug.fmu` (which will be referred to as "debug vECU").

Extract each of these two FMU archives into its own folder and let's explore what they contain and how they differ.

The functional behavior of both vECUs is identical.

The debug vECU contains symbol information and additional artefacts, e.g., PDB (when build tool is MSVC) or DIE (when build tool is MinGW). Use the debug vECU to debug and step through your code.

When you compare the two extracted folders, you will notice that the main difference is in the resources folder.

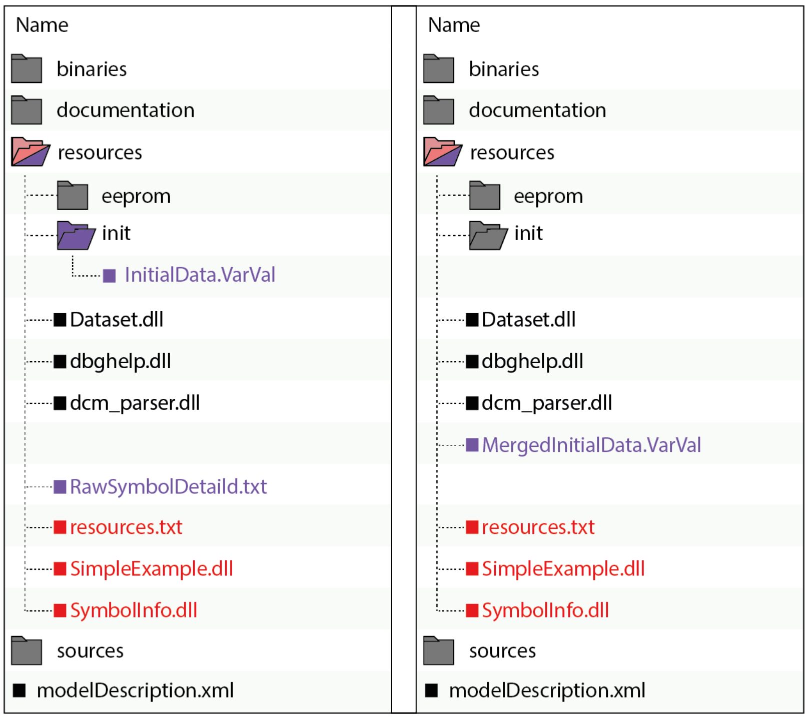
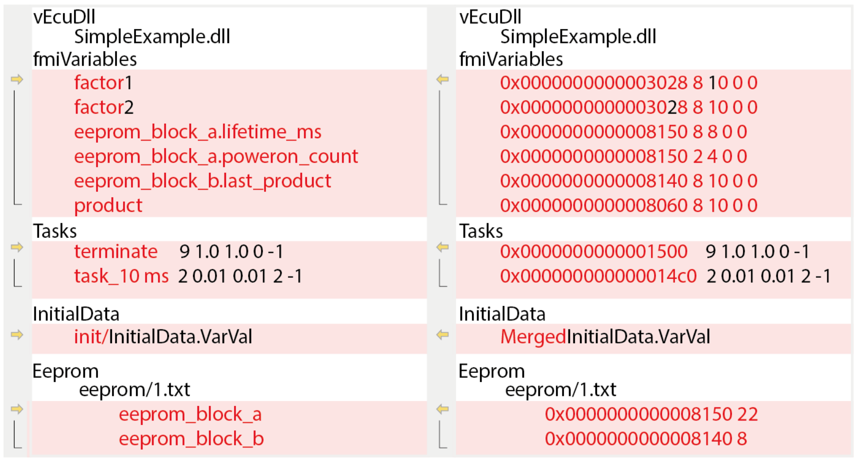


Fig. 5-3: Comparison of debug and release vECU (GCC compiler)

The release vECU contains only address information, unlike the debug vECU which contains the variables and function names. The release vECU protects the IP contained in the vECU and does not contain symbol information. Use the release vECU if you want to share it with others.



```
vEcuDll                                    vEcuDll
      SimpleExample.dll                          SimpleExample.dll
fmiVariables                               fmiVariables
      factor1                                    0x0000000000003028 8 10 0 0
      factor2                                    0x0000000000003028 8 10 0 0
      eeprom_block_a.lifetime_ms                 0x0000000000008150 8 8 0 0
      eeprom_block_a.poweron_count               0x0000000000008150 2 4 0 0
      eeprom_block_b.last_product                0x0000000000008140 8 10 0 0
      product                                    0x0000000000008060 8 10 0 0
Tasks                                      Tasks
      terminate    9 1.0 1.0 0 -1                0x0000000000001500    9 1.0 1.0 0 -1
      task_10 ms  2 0.01 0.01 2 -1               0x00000000000014c0  2 0.01 0.01 2 -1

InitialData                                InitialData
      init/InitialData.VarVal                    MergedInitialData.VarVal

Eeprom                                     Eeprom
       eeprom/1.txt                               eeprom/1.txt
            eeprom_block_a                             0x0000000000008150 22
            eeprom_block_b                             0x0000000000008140 8
```

Fig. 5-4: Comparison of resources.txt

5.1.2.1 Keeping Symbol Information in a Release FMU

When using a plugin in your vECU, variables and functions are accessed by name. This is possible in a debug FMU, but not in a release FMU.

Searching for symbols in the plugin it is done by name. In the release FMU all symbols names are replaced by their memory addresses. When FMU Runner runs in release mode, it accesses the symbols directly by addresses and not by symbol names. As a reason, SymbolDetails file like `RawSymbolDetails.txt` file has to be kept in `release.fmu` file

Note that the release FMU does not contain the PDB/DWARF file. Thus, you can not debug the release FMU. `RawSymboldetails.txt` is a subset of `SymbolDetails.txt` and is used by the plugin.

For more details, see include_symbol_details in Configuration chapter.

For more details about the Plugin Feature, see Template for Plugin V1 (FMI2)

5.1.3 InitialData Functionality

Typically, software function and its data are separated. While the logic of the software function is defined in the source files, the data is stored in separate files in various formats. Common formats for such calibration data are DCM and CDF.

VECU-BUILDER provides support of DCM format, more details can be found in DCM File Format. A `.dcm` file stores the data in their physical form that typically need to be processed into ECU-internal form. This processing is done based on COMPU_METHOD and RECORD_LAYOUT entries in an A2L file. You need to provide the A2L file in the `patch_a2l_file` attribute of the yaml file.

In case the Symbols do not match the ASAP2 labels (entries in the `.dcm` and `.a2l` files), you can resolve this by applying mappings. These mappings are then used to map ASAP2 labels to their respective symbols and can be defined in one of these three ways:

- direct definition in the yaml file making use of regular expressions
- via .adx file
- via .csv file
- via symbol_link (only available for Windows)

More details on these options can be found under symbol_name_mapping section in Configuration chapter.

You also can define the initial data in the VARVAL format. These initial data will not be processed based on entries in the A2L file neither will any mapping be applied. Thus the VARVAL file must contain the symbols and the ECU-internal values.

Simple Example contains sample files of both supported formats which can be found in folder

`C:/ProgramData/ETAS\VECU-BUILDER/Examples_1.7.0/SimpleExample/init` for **Windows**

Or

`/opt/etas/VECU-BUILDER/Examples_1.7.0` for **Ubuntu 20.04 LTS**.

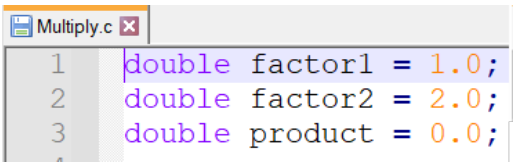
The `.yaml` file is preconfigured to make use of the `InitialData.VarVal`.

<ins>To experiment with VARVAL functionality</ins>

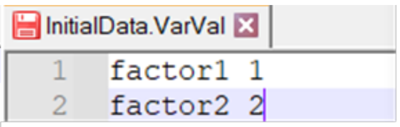
1. Open `Multiply.c` file located within your workspace in folder `vECU/imported`.

   In `Multiply.c` the variables are defined. Variables **factor1** and **factor2** are the two inputs with the assigned values of 1 and 2. Variable **product** is the output and is calculated as the product of **factor1** and **factor2**.

   As `InitialData.VarVal` file is already activated in the `.yaml` file, it is already used in the default Simple Example vECU.



```
double factor1 = 1.0;
double factor2 = 2.0;
double product = 0.0;
```



```
factor1 1
factor2 2
```

2. Close the source file and navigate back to the workspace.
3. You can check the output using

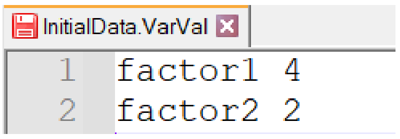
   `3a_CheckFMU.bat` on **Windows**

   Or

   `3a_CheckFMU.sh` on **Ubuntu 20.04 LTS**, described in FMPy.

⇨ The output for SimpleExample is 2.

4. Change the value for factor 1 to 4.



```
factor1 4
factor2 2
```

5. Save the change.

6. Rebuild the the vECU using

   `2_Build.bat` in the workspace on **Windows**

   Or

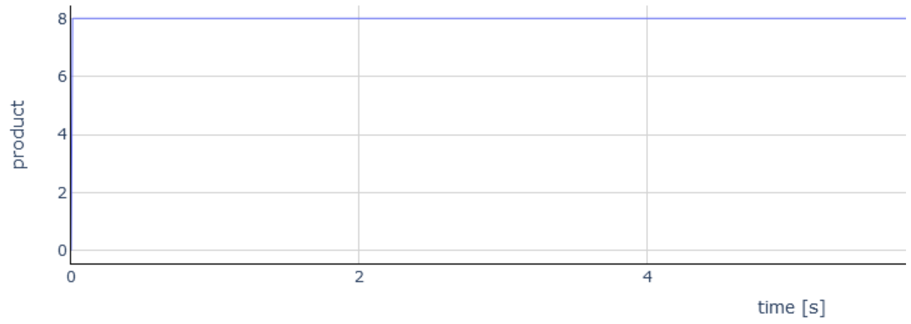
   `2_Build.sh` in the workspace on **Ubuntu 20.04 LTS**.

7. To show the changed output in the FMU, execute `3a_CheckFMU.bat` on **Windows**

   Or

   `3a_CheckFMU.sh` on **Ubuntu 20.04 LTS**.

⇨ The new output is now 8.

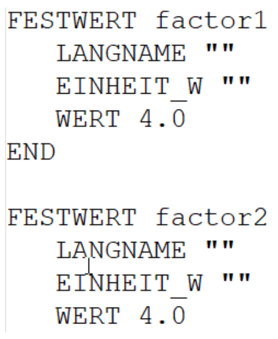


⇨ The initial data set in the VARVAL file are thus correctly used in the vECU.

⇨ The sources in `Multiply.c` stay the same. The variables are overwritten at run-time by the values of the `InitialData.VarVal`.

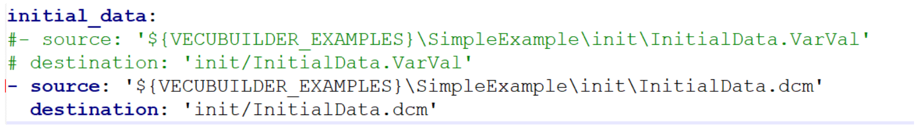
To experiment with intialData.dcm

1. Open the `.InitialData.dcm` in `Examples/SimpleExample/init`.
2. Change the value for factor 1 to 4.
3. Change the value for factor 2 to 4.
4. Save the changes.



```
FESTWERT factor1
   LANGNAME ""
   EINHEIT_W ""
   WERT 4.0
END

FESTWERT factor2
   LANGNAME ""
   EINHEIT_W ""
   WERT 4.0
```

5. Uncomment the source and destination for `InitialData.VarVal`.
6. Comment the source and destination for `InitialData.dcm`.



```
initial_data:
#- source: '${VECUBUILDER_EXAMPLES}\SimpleExample\init\InitialData.VarVal'
# destination: 'init/InitialData.VarVal'
- source: '${VECUBUILDER_EXAMPLES}\SimpleExample\init\InitialData.dcm'
  destination: 'init/InitialData.dcm'
```

7. Rebuild the the vECU using

   `2_Build.bat` in the workspace on **Windows**

Or

`2_Build.sh` in the workspace on **Ubuntu 20.04 LTS**.

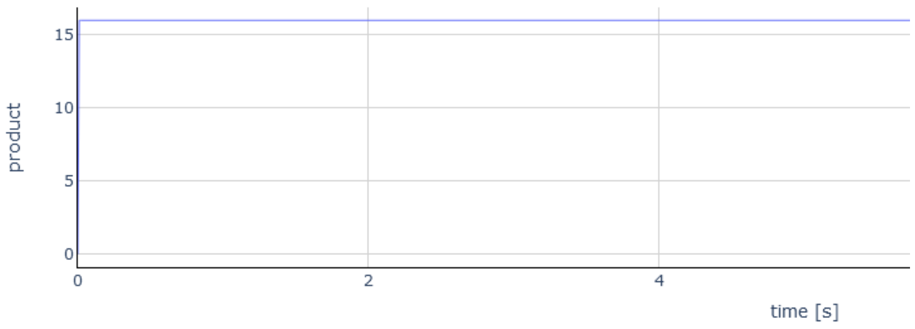
8. To show the changed output in the FMU, execute

   `3a_CheckFMU.bat` on **Windows**

Or

   `3a_CheckFMU.sh` on **Ubuntu 20.04 LTS**.

⇨ The new output is now 16.



⇨ The initial data set in the DCM file are thus correctly used in the vECU.

⇨ The sources in `Multiply.c` stay the same. The variables are overwritten at run-time by the values of the `InitialData.dcm`.

Note

Several files and formats can be defined. If one variable is set in multiple files, the value of the last file is used.

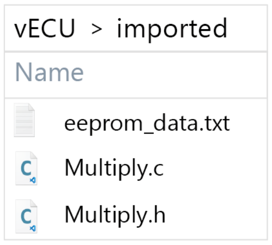
For release vECU all initial data is merged into `MergedInitialData.VarVal`. This VARVAL file protects the IP. Release and debug vECU behave the same. To get the different folder structures, see Difference Between Debug and Release vECUs .

5.1.4 eeprom Functionality

The eeprom data is loaded from a file to RAM during vECU initialization. The data is saved to the file before running terminate tasks and when unloading the vECU. This can be used to simulate a soft reset behavior where EEPROM stored data are preserved and not lost once the simulation of vECU terminates. A typical application of this feature is the storage of total mileage information in the ESP controller.

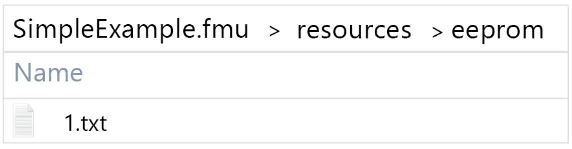
1. Open `vEcuConf.yaml` file of SimpleExample and navigate to eeprom section.

   With standard configuration, `eeprom_data.txt` was copied from `VECUBUILDER_EXAMPLES/SimpleExample/src` into the workspace to `vECU/imported` during the import. During `SimpleExample.fmu` build, `eeprom_data.txt` file is integrated into the FMU as `1.txt` in `resources/eeprom` folder. This happens because optional **destination** attribute is active. You can change the destination path and file name accordingly. This file is the working copy.



vECU > imported

Name
eeprom_data.txt
Multiply.c
Multiply.h

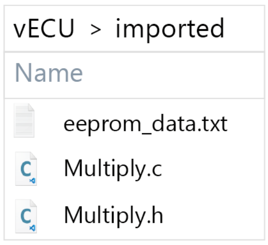


SimpleExample.fmu > resources > eeprom

Name
1.txt

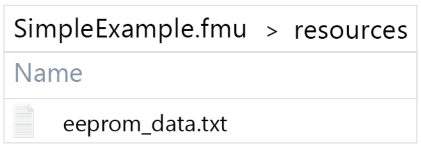
   Note

   If destination attribute is deactivated, `eeprom_data.txt` is integrated into the FMU in`resources` folder.



vECU > imported

Name
eeprom_data.txt
Multiply.c
Multiply.h



SimpleExample.fmu > resources

Name
eeprom_data.txt

2. Open `eeprom_data.txt` in `imported` folder and check the content.

   Note

   `eeprom_data.txt` must include the relevant data in expected HEX format.

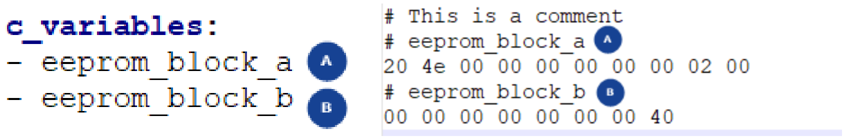
3. Go back to yaml file.

   In the standard configuration the following **c_variables** are used:

- eeprom_block_a: Shows the lifetime of the vECU in ms and counts, how often vECU was powered on.
- eeprom_block_b: Shows the last value of product calculated in the previous execution.

`eeprom_data.txt` contains the data stream that should be used for the c_variables.

Make sure that the order of **c_variables** in `vEcuConf.yaml` file matches the order of the data stream in `eeprom_data.txt`.



```
c_variables:
 - eeprom_block_a A
 - eeprom_block_b B
```

```
# This is a comment
# eeprom_block_a A
20 4e 00 00 00 00 00 00 02 00
# eeprom_block_b B
00 00 00 00 00 00 00 40
```

4. In `eeprom_data.txt`, make sure that the size of the variables in HEX format matches with the size defined in `SymbolDetails.txt`.

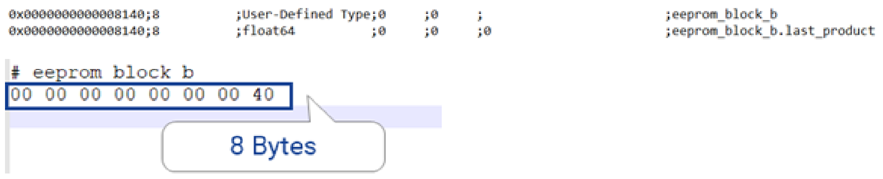
   To open `SymbolDetails.txt`, run

   `3c_ShowSymbolDetails.bat` on **Windows**

or

   `3c_ShowSymbolDetails.sh` on **Ubuntu 20.04 LTS**.

   i.e. eeprom_block_b has a size of 8 bytes and comprises eeprom_block_b.last_product which also has a size of 8 bytes.



```
0x0000000000008140;8          ;User-Defined Type;0    ;0    ;                 ;eeprom_block_b
0x0000000000008140;8          ;float64          ;0    ;0    ;0                ;eeprom_block_b.last_product
```

```
# eeprom block b
00 00 00 00 00 00 00 40
```

5. Delete the comment under sync and use the following:

   `sync:'C:/TEMP/eeprom_data.txt'` on **Windows**

or

   `sync: '//localhost/c$/TEMP/eeprom_data.txt'` on **Ubuntu 20.04 LTS**.

> **Note**
>
> Data from the imported eeprom file is used as initial data for the first simulation. After this step, the data will be always written back to the sync path at the end of each simulation and used by the next one.
>
> – If the file is not existing in sync location, it will be created.
>
> – If the file is already existing in sync location, this file will be taken by the first simulation run.

6. Save the changes.
7. Rebuild the workspace using

   `2_Build.bat` in the workspace on **Windows**

or

`2_Build.sh` in the workspace on **Ubuntu 20.04 LTS**.

8. To start the simulation, execute

   `3a_CheckFMU.bat` on **Windows**

   or

   `3a_CheckFMU.sh` on **Ubuntu 20.04 LTS**.

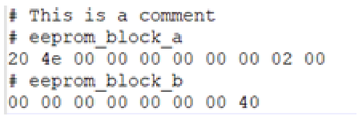
9. Navigate to

   `C:/TEMP` on **Windows**

   or

   `//localhost/c$/TEMP` on **Ubuntu 20.04 LTS**.

⇨ `eeprom_data.txt` was added to sync location.



```
# This is a comment
# eeprom_block_a
20 4e 00 00 00 00 00 00 02 00
# eeprom_block_b
00 00 00 00 00 00 00 40
```

5.1.5 Features to Explore in the Simple Example Workspace

Now start experimenting with the following features in this current workspace:

- build tool, inputs, outputs and tasks
- Initial data and eeprom
- redirect function calls
- debug hook

5.2 BCU Example (Only Available for Windows)

To create a workspace based on the BCU example, follow the steps described in Creating a New Workspace to the point where the YAML file opens in Notepad++.

1. Replace the entire content of the YAML file with the content of prepared BCU configuration YAML file located in:

   `C:/ProgramData/ETAS/VECU-BUILDER/Examples_1.7.0/BCU` for **Windows**.

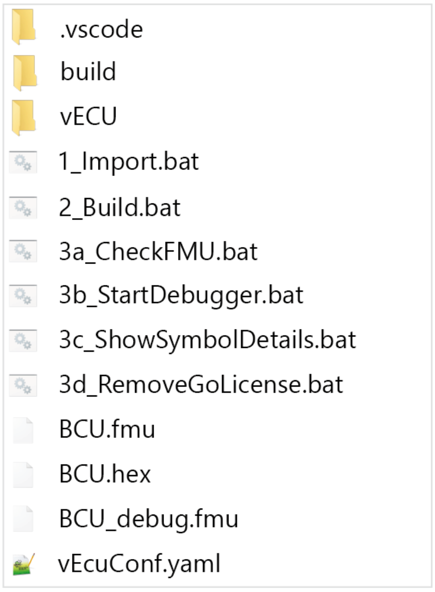
   In the `.yaml` file A2L file patching is enabled.

2. Continue the process as described in Working With VECU-BUILDER.

⇨ With the enabled A2L file patching, HEX file is generated during the build process and is available in the workspace after the build. For more information see patch_a2l_file and HEX File Generation.

Note

The HEX file will only be part of the workspace if the A2L file patching is activated.



.vscode
build
vECU
1_Import.bat
2_Build.bat
3a_CheckFMU.bat
3b_StartDebugger.bat
3c_ShowSymbolDetails.bat
3d_RemoveGoLicense.bat
BCU.fmu
BCU.hex
BCU_debug.fmu
vEcuConf.yaml

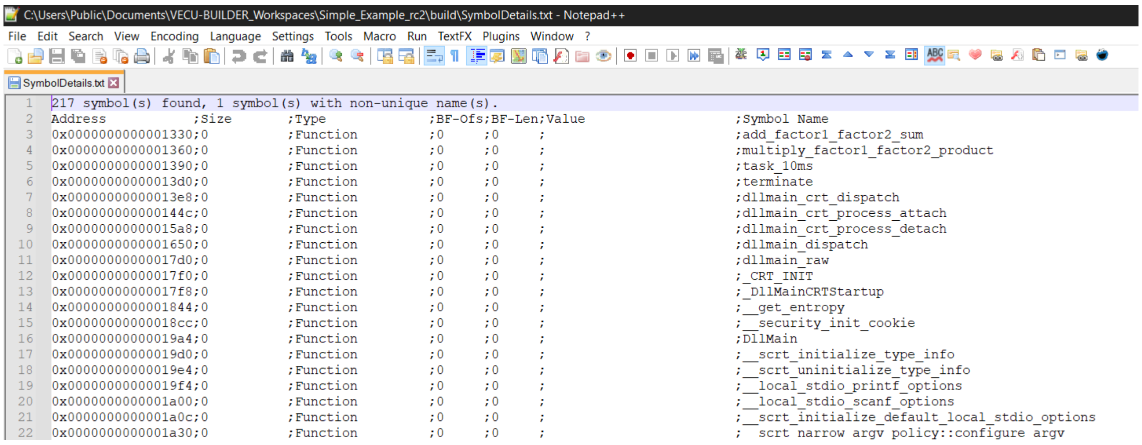
5.2.1 Show Symbol Information

To see all the symbols available in your vECU, open the `SymbolDetails` file.

1. Run the command:

   `3c_ShowSymbolDetails.bat` on **Windows**.

⇨ A text editor window (Windows) / a new terminal (Ubuntu 20.04 LTS) opens, and symbol details are shown.


C:\Users\Public\Documents\VECU-BUILDER_Workspaces\Simple_Example_rc2\build\SymbolDetails.txt - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run TextFX Plugins Window ?
SymbolDetails.txt

```
217 symbol(s) found, 1 symbol(s) with non-unique name(s).
Address           ;Size       ;Type             ;BF-Ofs;BF-Len;Value                   ;Symbol Name
0x0000000000001330;0          ;Function         ;0     ;0     ;                        ;add_factor1_factor2_sum
0x0000000000001360;0          ;Function         ;0     ;0     ;                        ;multiply_factor1_factor2_product
0x0000000000001390;0          ;Function         ;0     ;0     ;                        ;task_10ms
0x00000000000013d0;0          ;Function         ;0     ;0     ;                        ;terminate
0x00000000000013e8;0          ;Function         ;0     ;0     ;                        ;dllmain_crt_dispatch
0x000000000000144c;0          ;Function         ;0     ;0     ;                        ;dllmain_crt_process_attach
0x00000000000015a8;0          ;Function         ;0     ;0     ;                        ;dllmain_crt_process_detach
0x0000000000001650;0          ;Function         ;0     ;0     ;                        ;dllmain_dispatch
0x00000000000017d0;0          ;Function         ;0     ;0     ;                        ;dllmain_raw
0x00000000000017f0;0          ;Function         ;0     ;0     ;                        ;_CRT_INIT
0x00000000000017f8;0          ;Function         ;0     ;0     ;                        ;_DllMainCRTStartup
0x0000000000001844;0          ;Function         ;0     ;0     ;                        ;__get_entropy
0x00000000000018cc;0          ;Function         ;0     ;0     ;                        ;__security_init_cookie
0x00000000000019a4;0          ;Function         ;0     ;0     ;                        ;DllMain
0x00000000000019d0;0          ;Function         ;0     ;0     ;                        ;__scrt_initialize_type_info
0x00000000000019e4;0          ;Function         ;0     ;0     ;                        ;__scrt_uninitialize_type_info
0x00000000000019f4;0          ;Function         ;0     ;0     ;                        ;__local_stdio_printf_options
0x0000000000001a00;0          ;Function         ;0     ;0     ;                        ;__local_stdio_scanf_options
0x0000000000001a0c;0          ;Function         ;0     ;0     ;                        ;__scrt_initialize_default_local_stdio_options
0x0000000000001a30;0          ;Function         ;0     ;0     ;                        ;  scrt narrow argv policy::configure argv
```

Fig. 5-5: Symbol Details of BCU example (Windows)

5.2.2 A2L File Patching

Most ECU software authoring tools can generate an A2L file for you. It contains the addresses of your labels for a specific target. In addition, it can contain tool-specific statements or even non-standard clauses. The label addresses of a vECU target differ from the addresses of a physical ECU target. This means that the original A2L file cannot be used for an XCP connection with a vECU target.

the generation of A2L files is an intricate task, VECU-BUILDER excludes this functionality completely. Instead, VECU-BUILDER reads, modifies, and writes a given A2L file. This patching procedure preserves most of the original contents of the A2L file but changes all addresses to those of the vECU target. A backup copy of the original A2L file is preserved (named as `*.a2l.bak`).

Note

The A2L patching leads to an A2L file that works in ETAS INCA. This file may not work in Vector CANoe or CANape.

VECU-BUILDER includes its own XCP slave software component. Currently, it supports TCP connections only. The communication parameters for an XCP connection are part of an A2L file. VECU-BUILDER patches in the values for TCP port and IP address, which are specified in the YAML file. For instance:

Original A2L file	Patched A2L file

`/begin XCP_ON_TCP_IP`
` 0x0100 /* XCP on IP 1.0 */`
` `**‹TCPPORT›**` /* Port */`
` /ADDRESS "`**‹IPADDR›**`"`
`/end XCP_ON_TCP_IP`
	`/begin XCP_ON_TCP_IP`
	` */0x0100 /* XCP on IP 1.0 */`
	` 12345 /* Port */`
	` ADDRESS "127.0.0.1"`
	`/end XCP_ON_TCP_IP`

If your A2L file contains an “`XCP_ON_UDP_IP`” clause, then VECU-BUILDER rewrites it to an “`XCP_ON_TCP_IP`” clause. The integrated XCP slave supports a limited subset of the commands of the ASAM MCD-1 (XCP) standard version 1.0. It supports a limited subset of the clauses from ASAM MCD-2 (ASAP2 / A2L) standard version 1.7.1.

If your ECU software already includes an XCP slave, it is possible to remove this software component from the vECU software stack.

5.2.3 A2L Name Mapping

By default, the A2L file contains the symbol names of characteristics and measurements. Sometimes the symbol names in the A2L file are renamed. Because the addresses in the A2L must refer to the original symbol names, one must map them.

Original A2L file	Mapped and patched A2L file

`/begin CHARACTERISTIC Hysteresis_LightOffIntensity`
` "unsigned integer 16bit"`
` VALUE`
` 0x00000000`
` RTAA2L_Internal_Scalar_UnsignedWord`
` 0`
` CompuMethods_STEP_100_OFFSET_0`
` 0`
` 100`
` DISPLAY_IDENTIFIER Hysteresis_LightOffIntensity`
`/end CHARACTERISTIC`
	`/begin CHARACTERISTIC HystLiOfInt`
	` "unsigned integer 16bit"`
	` VALUE`
	` 00x00003016`
	` RTAA2L_Internal_Scalar_UnsignedWord`
	` 0`
	` CompuMethods_STEP_100_OFFSET_0`
	` 0`
	` 100`
	` DISPLAY_IDENTIFIER Hysteresis_LightOffIntensity`
	`/end CHARACTERISTIC`

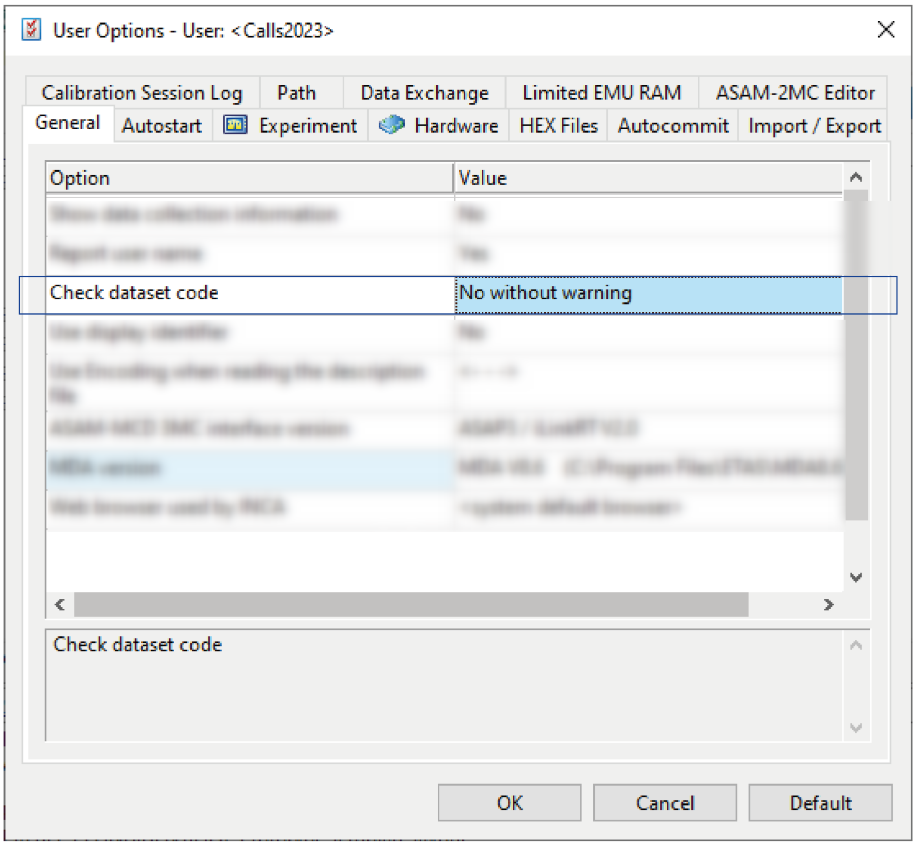
5.2.4 HEX File Generation

When the A2L patching mechanism is activated, VECU-BUILDER creates a HEX file. The HEX file (`BCU.hex`) is located in the corresponding workspace. You can use the HEX file for working with ETAS INCA. The HEX file contains the data INCA considers as the so-called reference page. INCA uses these data to calculate CRC check.

You can upload this generated HEX file while creating an INCA experiment. After uploading the file, workflows within INCA will be enabled. For more information about INCA and HEX file upload with INCA, see the corresponding INCA User Guides available in the ETAS Download Center.

Use the following settings in INCA for a successful HEX file upload:

1. Open **User Options**.
2. Click the **General** tab.
3. Go to **Check dataset code**.
4. Make sure that the value is **No without warning**.
5. Click **OK**.



Option	Value
Check dataset code	No without warning

Check dataset code

> **Note**
>
> If the settings are not as described, INCA will display an error and the HEX file will not be accepted.

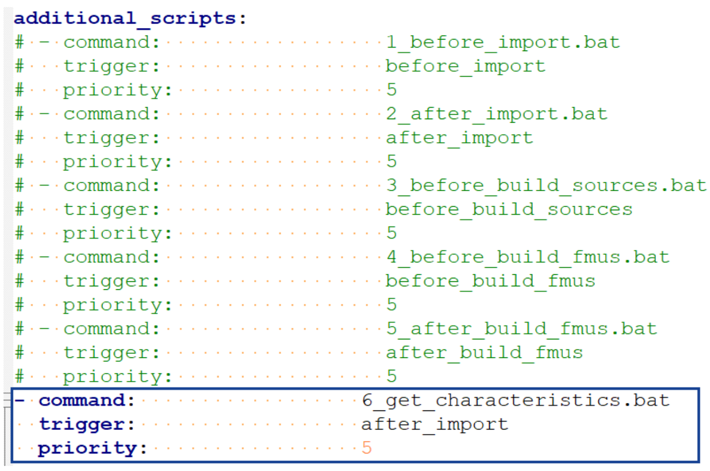
5.2.5 Example of Additional Scripts: A2L Characteristics as Parameters

This is an example of how additional scripts can be used. With the following script, it is possible to use A2L characteristics as parameters of a vECU.

To run the script

1. Follow the steps described in BCU Example (Only Available for Windows) to create a BCU workspace.
2. Copy from `${VECUBUILDER_EXAMPLES}/BCU/additional_scripts`
   - `6_get_characteristics.bat`
   - `6_get_characteristics.py`

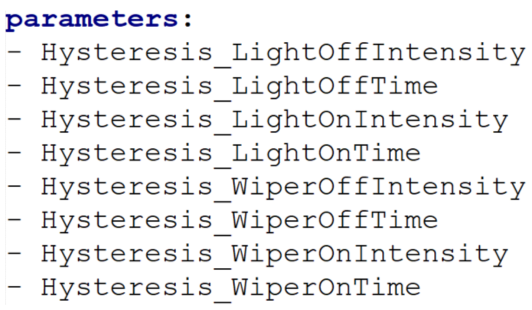
   to `<My_BCU_Workspace>/build/additional_scripts`.
3. Open `<My_BCU_Workspace>/build/additional_scripts/6_get_characteristics.bat` script and adapt the path to the python interpreter according to your specific python installation.
4. In `vEcuConf.yaml` file uncomment the following lines in the `additional_scripts` section.



```
additional_scripts:
# - command:                  1_before_import.bat
#   trigger:                  before_import
#   priority:                 5
# - command:                  2_after_import.bat
#   trigger:                  after_import
#   priority:                 5
# - command:                  3_before_build_sources.bat
#   trigger:                  before_build_sources
#   priority:                 5
# - command:                  4_before_build_fmus.bat
#   trigger:                  before_build_fmus
#   priority:                 5
# - command:                  5_after_build_fmus.bat
#   trigger:                  after_build_fmus
#   priority:                 5
- command:                  6_get_characteristics.bat
  trigger:                  after_import
  priority:                 5
```

5. Start building your workspace using `1_Import.bat` for **Windows**.

⇨ Characteristics were added in `parameters` section of `vEcuConf.yaml` file and are also available as parameters in the built `BCU.fmu`.



```
parameters:
- Hysteresis_LightOffIntensity
- Hysteresis_LightOffTime
- Hysteresis_LightOnIntensity
- Hysteresis_LightOnTime
- Hysteresis_WiperOffIntensity
- Hysteresis_WiperOffTime
- Hysteresis_WiperOnIntensity
- Hysteresis_WiperOnTime
```

5.2.6 Features to Explore in the BCU Workspace

Now start experimenting with the following features in the current workspace:

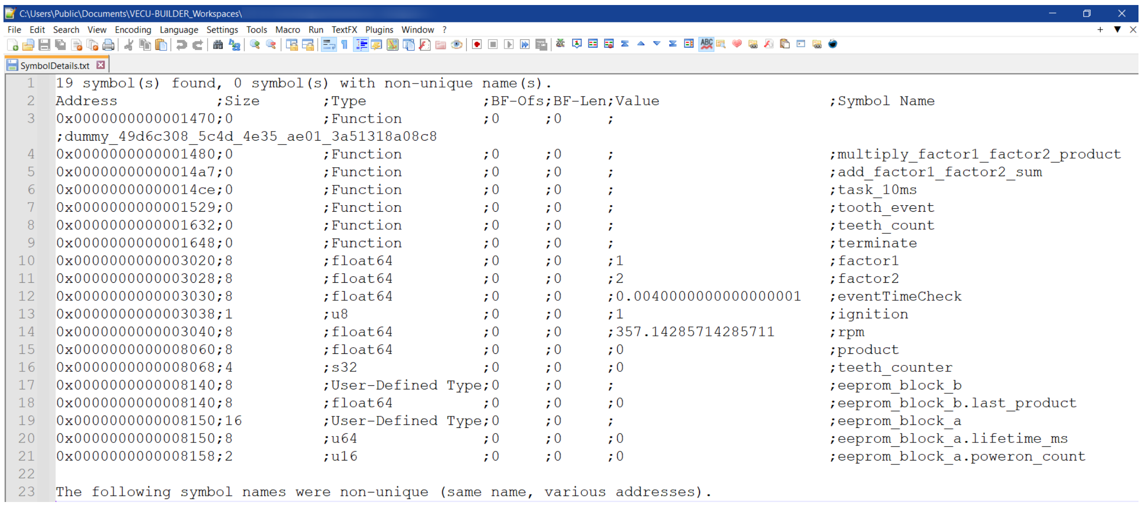
- additional include directories
- additional compile and linker flags
- additional scripts
- XCP slave and A2L file patching and mapping
- HEX file generation
- Characteristics as inputs

5.3 EventTrigger Example

This example shows the possibility of using event-triggered tasks. Therefore a function and a trigger function are needed. The use of trigger inputs is optional. You can add up to 16 trigger inputs. This trigger function predicts when the next event might occur and returns if the next events needs to be triggered. You can find the event-triggered task in the `task` section in the `.yaml` file.

The function name is `teeth_count` and the trigger function is `tooth_event`.

The function and the trigger function are defined in the `Multiply.c` file in `vECU` folder of the corresponding workspace. Optional inputs of `trigger_function` must be included in `SymbolDetails.txt`.


C:\Users\Public\Documents\VECU-BUILDER_Workspaces\
File Edit Search View Encoding Language Settings Tools Macro Run TextFX Plugins Window ?
SymbolDetails.txt

```
19 symbol(s) found, 0 symbol(s) with non-unique name(s).
Address             ;Size        ;Type              ;BF-Ofs;BF-Len;Value                 ;Symbol Name
0x0000000000001470;0            ;Function          ;0     ;0     ;
;dummy_49d6c308_5c4d_4e35_ae01_3a51318a08c8
0x0000000000001480;0            ;Function          ;0     ;0     ;                      ;multiply_factor1_factor2_product
0x00000000000014a7;0            ;Function          ;0     ;0     ;                      ;add_factor1_factor2_sum
0x00000000000014ce;0            ;Function          ;0     ;0     ;                      ;task_10ms
0x0000000000001529;0            ;Function          ;0     ;0     ;                      ;tooth_event
0x0000000000001632;0            ;Function          ;0     ;0     ;                      ;teeth_count
0x0000000000001648;0            ;Function          ;0     ;0     ;                      ;terminate
0x0000000000003020;8            ;float64           ;0     ;0     ;1                     ;factor1
0x0000000000003028;8            ;float64           ;0     ;0     ;2                     ;factor2
0x0000000000003030;8            ;float64           ;0     ;0     ;0.0040000000000000001 ;eventTimeCheck
0x0000000000003038;1            ;u8                ;0     ;0     ;1                     ;ignition
0x0000000000003040;8            ;float64           ;0     ;0     ;357.14285714285711    ;rpm
0x0000000000008060;8            ;float64           ;0     ;0     ;0                     ;product
0x0000000000008068;4            ;s32               ;0     ;0     ;0                     ;teeth_counter
0x0000000000008140;8            ;User-Defined Type;0     ;0     ;                      ;eeprom_block_b
0x0000000000008140;8            ;float64           ;0     ;0     ;0                     ;eeprom_block_b.last_product
0x0000000000008150;16           ;User-Defined Type;0     ;0     ;                      ;eeprom_block_a
0x0000000000008150;8            ;u64               ;0     ;0     ;0                     ;eeprom_block_a.lifetime_ms
0x0000000000008158;2            ;u16               ;0     ;0     ;0                     ;eeprom_block_a.poweron_count

The following symbol names were non-unique (same name, various addresses).
```

Fig. 5-6: Symbol Details of EventTrigger Example(Windows)

It is checked if the defined conditions of the trigger function are met. The default check time is 4 ms. If the conditions are met, the function is called. E.g. if the conditions of trigger function `tooth_event` are met, the function `teeth_count` is called.

5.3.1 Event-Triggered Tasks

To create a workspace based on the EventTrigger example, follow the steps described in Creating a New Workspace to the point where the YAML file opens in Notepad++.

1. Replace the entire content of the YAML file with the content of prepared EventTrigger configuration YAML file located in:

   `C:/ProgramData/ETAS/VECU-BUILDER/Examples_1.7.0/EventTriggerExample` for **Windows**

Or

`/opt/etas/VECU-BUILDER/Examples_1.7.0/EventTrig-gerExample` for **Ubuntu 20.04 LTS**.

2. Continue the process as described in Working With VECU-BUILDER.

⇨ The workspace was created.

5.4 Template for Plugin V1 (FMI2)

5.4.1 Plugin Feature

With VECU-BUILDER plugin feature it is possible to implement an own logic at run-time into the following phases of FMU Runner:

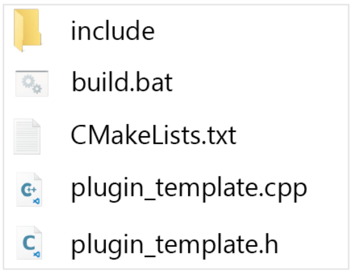
- Instantiation
- Initialization
- Step execution
- Task execution

The phases follow the rules of FMI2 standard. More information about FMI can be found here.

The user-configured plugin implementation occurs in form of a CMake project. This CMake project needs to be used to implement the functionality of plugin interface. For more details, see Plugin Interface.

Within `plugin_template_v1_FMI2` folder (see Installed Files and Folders for installation path), the following files and folders are installed:

- `include` folder: Contains the header files containing VECU-BUILDER type definitions which must not be modified by the plugin implementor.
- `build.bat/build.sh`: Script, that contains a small list of commands which builds plugin_template shared object (DLL / SO).
- `CMakeLists.txt`: File, which contains CMake configuration for the plugin_template project.
- `plugin_template.cpp` and `plugin_template.h`: Main files dedicated for plugin user implementation.

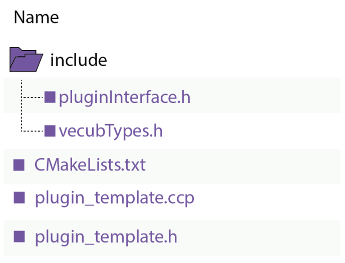


include
build.bat
CMakeLists.txt
plugin_template.cpp
plugin_template.h

Fig. 5-7: Installed files and folders for plugin

The plugin project uses two header files that define VECU-BUILDER types. They are located in the `include` folder of the project template:

- `plugininterface.h`
- `vecubTypes.h`



Name
- include
  - pluginInterface.h
  - vecubTypes.h
- CMakeLists.txt
- plugin_template.ccp
- plugin_template.h

Fig. 5-8: plugin_template folder

Once you implemented your own logic, the plugin can be included in VECU-BUILDER as an additional resource.

As plugin feature is supported for FMI2 and FMI3, the functions for each plugin are grouped in `pluginInterface.h`.

For plugin version V1 (FMI2) look for `#define FMI_2_VERS_1` and `#ifdef FMI_2_VERS_1` (obsolete:`#define FMI2` and `#ifdef FMI2`.)

Note

When using the plugin, the use of include_symbol_details is mandatory.

For example, if you want to change the cycle time of `"task_10ms"` using a plugin, then the symbol name `"task_10ms"` must be disclosed in the release vECU.

5.4.2 Plugin Configuration

You can include plugins as additional ressources, i.e.:

– `additional_resources:`

  `- ${VECUBUILDER_EXAMPLES}\plugin_template\CMake\Debug\plugin_template.dll` for **Windows**

or

– `additional_resources:`

  `- ${VECUBUILDER_EXAMPLES}/Linux/plugin_template/CMake/libplugin_template.so` for **Ubuntu 20.04 LTS**.

Note

The plugin could reside in a different location than `${VECUBUILDER_EXAMPLES}\....` and in `vEcuconf.yaml` you need to give the absolute path to the location of the build plugin.

Note

A plugin can be renamed. However it is mandatory to follow the conventions mentioned below in any case:

- A `*.dll` file (for Windows) must start with **`plugin`**. It then will be managed as plugin by VECU-BUILDER.
- A `*.so` file (for Linux) must start with **`libplugin`**. It then will be managed as plugin by VECU-BUILDER.

If the plugin does not follow this naming convention,VECU-BUILDER will not consider the `*.dll` or `*.so` as plugin.

The files are saved in `.fmu` file in `resources` folder. From here VECU-BUILDER will load them as plugins.

5.4.3 Plugin Interface

To see and use the plugin interface, open `pluginInterface.h` in `include` folder.

Plugin Functions

You can use several plugin functions. There are optional and mandatory plugin functions and therefore not all functions from plugin interface have to be implemented.

Pointer and Function Pointers

For Visual Studio Compiler on Windows and GNU Complier from MinGW on Ubuntu:

All plugin interface functions have one argument as a pointer of type `struct VecubCallbacks1`.

For Visual Studio Compiler on Windows and GNU Compiler on Ubuntu and GNU Compiler from MinGW on Windows and Linux

All plugin interface functions have one argument as a pointer of type `struct VecubCallbacks1`. Furthermore, the structure also contains conditional compilation instructions that only define certain function pointers if the `PLUGIN_EXTENSION` macro is defined.

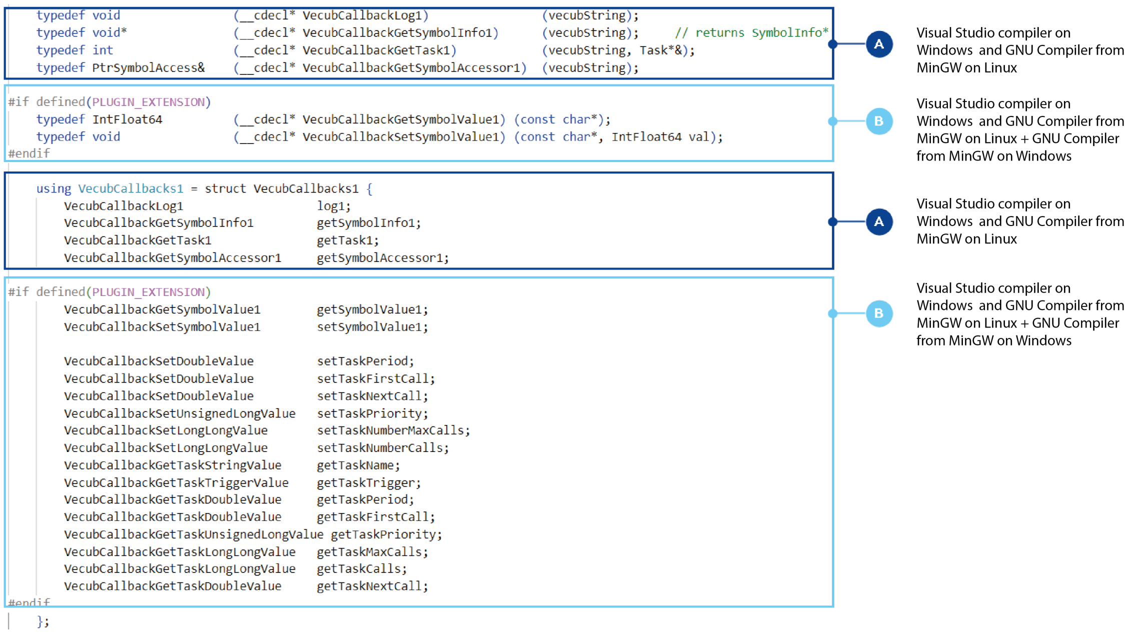
The following Plugin Callback Functions are available. The trigger for each Plugin function call is related to the FMI protocol.

Callback Function Name	**Trigger**	**Priority**
vecubPluginVersion	During "fmi2Instantiate" and before "vecubInstantiate1"	mandatory
vecubInstantiate1	During "fmi2Instantiate" and after "vecubPluginVersion"	mandatory
vecubFmi2EnterInit1	During "fmi2EnterInitializationMode"	optional
vecubFmi2ExitInit1	During "fmi2ExitInitializationMode"	optional
vecubPreDoStep1	At the beginning of “fmi2DoStep”	optional
vecubPostDoStep1	At the end of "fmi2DoStep"	optional
vecubPreTask1	Before calling a task	optional
vecubPostTask1	After calling a task	optional
Terminate1	During "fmi2Terminate"	mandatory

`VecubCallbacks1` pointer keeps a list of function pointers which could be used in order for plugin to grab information from VECU-BUILDER.

Available functionalities (callbacks) are:

- logging
- accessing symbol information like: address, size, symbol type, bitfield_offset, bitfield_length
- managing task objects
- handling symbols data like read and write their values


A
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux
B
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux + GNU Compiler from MinGW on Windows
A
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux
B
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux + GNU Compiler from MinGW on Windows

```
    typedef void              (__cdecl* VecubCallbackLog1)              (vecubString);
    typedef void*             (__cdecl* VecubCallbackGetSymbolInfo1)    (vecubString);     // returns SymbolInfo*
    typedef int               (__cdecl* VecubCallbackGetTask1)          (vecubString, Task*&);
    typedef PtrSymbolAccess&  (__cdecl* VecubCallbackGetSymbolAccessor1) (vecubString);

#if defined(PLUGIN_EXTENSION)
    typedef IntFloat64        (__cdecl* VecubCallbackGetSymbolValue1) (const char*);
    typedef void              (__cdecl* VecubCallbackSetSymbolValue1) (const char*, IntFloat64 val);
#endif

    using VecubCallbacks1 = struct VecubCallbacks1 {
        VecubCallbackLog1                  log1;
        VecubCallbackGetSymbolInfo1        getSymbolInfo1;
        VecubCallbackGetTask1              getTask1;
        VecubCallbackGetSymbolAccessor1    getSymbolAccessor1;

#if defined(PLUGIN_EXTENSION)
        VecubCallbackGetSymbolValue1       getSymbolValue1;
        VecubCallbackSetSymbolValue1       setSymbolValue1;

        VecubCallbackSetDoubleValue        setTaskPeriod;
        VecubCallbackSetDoubleValue        setTaskFirstCall;
        VecubCallbackSetDoubleValue        setTaskNextCall;
        VecubCallbackSetUnsignedLongValue  setTaskPriority;
        VecubCallbackSetLongLongValue      setTaskNumberMaxCalls;
        VecubCallbackSetLongLongValue      setTaskNumberCalls;
        VecubCallbackGetTaskStringValue    getTaskName;
        VecubCallbackGetTaskTriggerValue   getTaskTrigger;
        VecubCallbackGetTaskDoubleValue    getTaskPeriod;
        VecubCallbackGetTaskDoubleValue    getTaskFirstCall;
        VecubCallbackGetTaskUnsignedLongValue getTaskPriority;
        VecubCallbackGetTaskLongLongValue  getTaskMaxCalls;
        VecubCallbackGetTaskLongLongValue  getTaskCalls;
        VecubCallbackGetTaskDoubleValue    getTaskNextCall;
#endif
    };
```

Fig. 5-9: function pointers

Example for Usage of Callbacks for Visual Studio Compiler on Windows and GNU Compiler on Ubuntu

The following code visualizes how callbacks can be used for Plugin Version 1.

```
// ===== plugin vers. 01 =====
DllExport vecub1Status __cdecl vecubFmi2EnterInit1(const VecubCall-
backs1* vecubCallbacks)
{
    if (!vecubCallbacks)
        return vecub1Status::vecubError;
```

The code defines the function `vecubFmi2EnterInit1` that takes a pointer to the structure `VecubCallbacks1` as input. It checks if the passed pointer `vec-ubCallbacks` is valid. If not, it returns `vecub1Status::vecubError`.

```
// logging
if (vecubCallbacks->log1)
 {
   vecubCallbacks->log1("user message");
 }
```

It checks if the `log1` function is defined in `vecubCallbacks` structure. If yes, it calls the function with the argument `user message`.

```
// get symbol info
SymbolInfo* symbol = static_cast<SymbolInfo*>(vecubCallbacks->getSym-
bolInfo1("factor1"));
std::cout << "The symbol has address: " << std::hex << symbol->addr <<
std::endl;
```

It calls `getSymbolInfo1` function to obtain information about a symbol named `factor1`. The returned symbol is stored in the variable `symbol`. The address of the symbol is printed using `std::cout`.

```
// get symbol accessor
PtrSymbolAccess& symbolAccessor = vecubCallbacks->getSymbolAccessor1
("factor1");
IntFloat64 val = (*symbolAccessor).get();
´val.f = 5;
(*symbolAccessor).set(val);
```

It calls `getSymbolAccessor1` function to obtain an accessor for the `factor1` symbol. The accessor is stored in the reference variable `symbolAccessor`. It reads a value of type `IntFloat64` from the symbol and assigns the value `5` to it. Then, it writes the value back to the symbol.

Note

`PtrSymbolAccess` and `symbolAccessor` with its own methods became obsolete but are still supported. They are replaced by methods like:

vecubCallbacks->getSymbolValue1

vecubCallbacks->setSymbolValue1

```
// get task object
Task* task{nullptr};
vecubCallbacks->getTask1("task_10ms", task);
task->setTNextCall(123);
 if (task) {
  std::cout << "FOUND! task: " << " ~ " << task->getName() <<
std::endl;
  }
```

It calls `getTask1` function to obtain a task object with the name `task_0ms`. The task object is stored in the pointer variable `task`. `setTNextCall` function is called on the task object with the value `123` as the argument. If the task object is valid, a message is printed with the task's name.

```
return vecub1Status::vecubOK;
}
```

It returns `vecub1Status::vecubOK`.

Example for Usage of Callbacks for Visual Studio Compiler on Windows and GNU Compiler on Ubuntu and GNU Compiler from MinGW on Windows and Ubuntu

The following code visualizes how callbacks can be used for Plugin Version 1.

```
// ===== plugin vers. 01 =====
DllExport vecub1Status __cdecl vecubFmi2EnterInit1(const VecubCall-
backs1* vecubCallbacks)
{
    if (!vecubCallbacks)
        return vecub1Status::vecubError;
```

The code defines the function `vecubFmi2EnterInit1` that takes a pointer to the structure `VecubCallbacks1` as input. It checks if the passed pointer `vecubCallbacks` is valid. If not, it returns `vecub1Status::vecubError`.

```
// logging
if (vecubCallbacks->log1)
 {
   vecubCallbacks->log1("user message");
  }
```

It checks if the `log1` function is defined in `vecubCallbacks` structure. If yes, it calls the function with the argument `user message`.

```
// get symbol info
SymbolInfo* symbol = static_cast<SymbolInfo*>(vecubCallbacks->getSym-
bolInfo1("factor1"));
std::cout << "The symbol has address: " << std::hex << symbol->addr <<
std::endl;
```

It calls `getSymbolInfo1` function to obtain information about a symbol named `factor1`. The returned symbol is stored in the variable `symbol`. The address of the symbol is printed using `std::cout`.

```
// get symbol accessor
IntFloat64 symbolValue = vecubCallbacks->getSymbolValue1("factor1");
symbolValue.f = 10.00;
vecubCallbacks->setSymbolValue1("factor1", symbolValue);
```

It isusing `getSymbolValue1` function pointer to retrieve the value of a symbol named "`factor1`" and stores it in a variable called `symbolValue`. It is assumed that `symbolValue` is a structure containing an integer and a float value, and the code is accessing the float value using the "`.f`" notation and setting it to 10.00. Secondly, it is using `setSymbolValue1` function pointer to update the value of the "`factor1`" symbol with the modified `symbolValue`.

```
// get task object
Task* tasknullptr{};
vecubCallbacks->getTask1("task_10ms", task);
std::cout << "Task getTaskNextCall: " << vecubCallbacks->getTaskNex-
tCall(&task) << std::endl;
std::cout << "Task setTaskNextCall: " << vecubCallbacks->setTaskNex-
tCall(&task, 1) << std::endl;
std::cout << "Task getTaskNextCall: " << vecubCallbacks->getTaskNex-
tCall(&task) << std::endl;
```

A variable "task" of type "task*" is created and initialised with the value "`nullptr`". Then the "`getTask1`" method of the "`vecubCallbacks`" object is called to retrieve the task named "`task_10ms`" and store it in the "`task`" variable. The methods "`getTaskNextCall`" and "`setTaskNextCall`" of the "`vecubCallbacks`" object are then called to get and set the next call time of the task. The results of these method calls are then output to the console using "`std::cout`".

```
return vecub1Status::vecubOK;
}
```

It returns `vecub1Status::vecubOK`.

5.4.4 What a Plugin Can Do With Tasks

A plugin can access a task defined in VECU-BUILDER and can change different properties of a task at run-time.

As described in Plugin Functions, you can use several functions. One of these functions is used to get a task. The used function pointer is `getTask1`, which returns a task type. For more details, see Fig. 5-9

Once the plugin access a task, it can manage through the task interface and the behavior of a task during run-time.

The interface of the task is available in Plugin template project through the definition of `task` class in `include/vecubTypes.h` file.

In this class, you can see specific functions of task class which manage i.e the task name, task period, or task priority.

5.5 Template for Plugin V2 (FMI3)

5.5.1 Plugin Feature V2

With VECU-BUILDER plugin feature it is possible to implement an own logic at run-time into the following phases of FMU Runner:

- Instantiation
- Initialization
- Step execution
- Task execution

The phases follow the rules of FMI3 standard. More information about FMI can be found here.

The user-configured plugin implementation occurs in form of a CMake project. This CMake project needs to be used to implement the functionality of plugin interface. For more details, see Plugin Interface.

Within `plugin_template_v2_FMI3` folder (see Installed Files and Folders for installation path), the following files and folders are installed:

- `include` folder: Contains the header files containing VECU-BUILDER type definitions which must not be modified by the plugin implementor.
- `build.bat/build.sh`: Script, that contains a small list of commands which builds plugin_template shared object (DLL / SO).
- `CMakeLists.txt`: File, which contains CMake configuration for the plugin_template project.
- `plugin_template.cpp` and `plugin_template.h`: Main files dedicated for plugin user implementation.

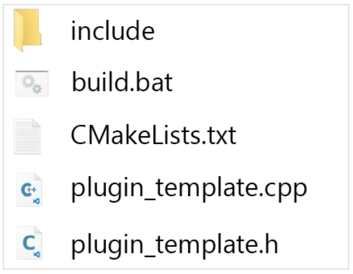

include
build.bat
CMakeLists.txt
plugin_template.cpp
plugin_template.h

Fig. 5-10: Installed files and folders for plugin

The plugin project uses two header files that define VECU-BUILDER types. They are located in the `include` folder of the project template:

- `plugininterface.h`
- `vecubTypes.h`

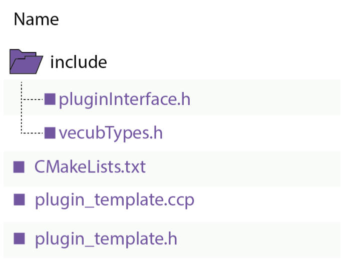


Fig. 5-11: plugin_template folder

Once you implemented your own logic, the plugin can be included in VECU-BUILDER as an additional resource.

As plugin feature is supported for FMI2 and FMI3, the functions for each plugin are grouped in `pluginInterface.h`.

For plugin version V2 (FMI3) look for `#define FMI_3_VERS_2` and `#ifdef FMI_3_VERS_2` (obsolete:`#define FMI3` and `#ifdef FMI3`.)

Note

When using the plugin, the use of include_symbol_details is mandatory.

For example, if you want to change the cycle time of `"task_10ms"` using a plugin, then the symbol name `"task_10ms"` must be disclosed in the release vECU.

5.5.2 Plugin Confuguration V2

You can include plugins as additional ressources:

– `additional_resources:`

  `- ${VECUBUILDER_EXAMPLES}\plugin_template\CMake\Debug\plugin_template.dll` for **Windows**

or

– `additional_resources:`

  `- ${VECUBUILDER_EXAMPLES}/Linux/plugin_template/CMake/libplugin_template.so` for **Ubuntu 20.04 LTS**.

Note

The plugin could reside in a different location than `${VECUBUILDER_EXAMPLES}\....` and in `vEcuconf.yaml` you need to give the absolute path to the location of the build plugin.

Note

A plugin can be renamed. However it is mandatory to follow the conventions mentioned below in any case:

– A `*.dll` file (for Windows) must start with **`plugin`**. It then will be managed as plugin by VECU-BUILDER.
– A `*.so` file (for Ubuntu) must start with **`libplugin`**. It then will be managed as plugin by VECU-BUILDER.

If the plugin does not follow this naming convention,VECU-BUILDER will not consider the `*.dll` or `*.so` as plugin.

The files are saved in `.fmu` file in `resources` folder. From here VECU-BUILDER will load them as plugins.

5.5.3 Plugin Interface V2

To see and use the plugin interface, open `pluginInterface.h` in `include` folder.

Plugin Functions

You can use several plugin functions. There are optional and mandatory plugin functions and therefore not all functions from plugin interface have to be implemented.

Pointer and Function Pointers

For Visual Studio Compiler on Windows and GNU Complier from MinGW on Ubuntu:

All plugin interface functions have one argument as a pointer of type `struct VecubCallbacks2`.

For Visual Studio Compiler on Windows and GNU Compiler on Ubuntu and GNU Compiler from MinGW on Windows and Ubuntu

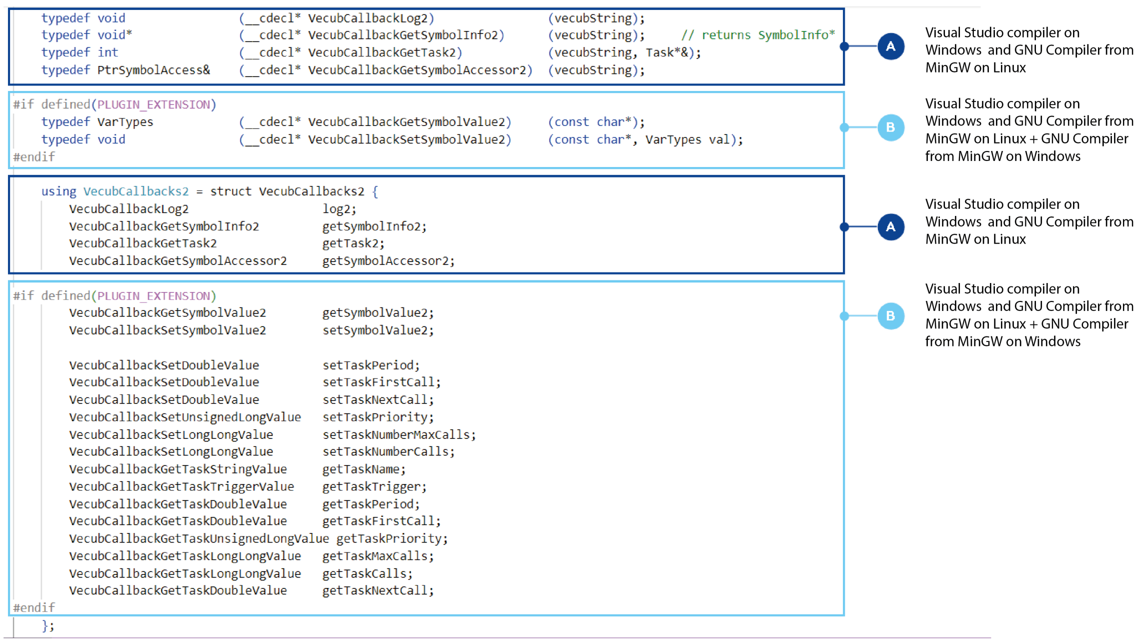
All plugin interface functions have one argument as a pointer of type `struct VecubCallbacks2`. Furthermore, the structure also contains conditional compilation instructions that only define certain function pointers if the `PLUGIN_EXTENSION` macro is defined.

Callback	Trigger	Priority
vecubPluginVersion	During "fmi3Instantiate" and before "vecubInstantiate2"	mandatory
vecubInstantiate2	During "fmi3Instantiate" and after "vecubPluginVersion"	mandatory
vecubFmi3EnterInit2	During "fmi3EnterInitializationMode"	optional
vecubFmi3ExitInit2	During "fmi3ExitInitializationMode"	optional
vecubPreDoStep1	At the beginning of “fmi3DoStep”	optional
vecubPostDoStep2	At the end of "fmi3DoStep"	optional
vecubPreTask2	Before calling a task	optional
vecubPostTask2	After calling a task	optional
Terminate2	During "fmi3Terminate"	mandatory

This `VecubCallbacks2` pointer keeps a list of function pointers which could be used in order for plugin to grab information from VECU-BUILDER.

Available functionalities (callbacks) are:

- logging
- accessing symbol information like: address, size, symbol type, bitfield_off-set, bitfield_length
- managing task objects
- handling symbols data like read and write their values


A
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux
B
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux + GNU Compiler from MinGW on Windows
A
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux
B
Visual Studio compiler on Windows and GNU Compiler from MinGW on Linux + GNU Compiler from MinGW on Windows

```
    typedef void                (__cdecl* VecubCallbackLog2)               (vecubString);
    typedef void*               (__cdecl* VecubCallbackGetSymbolInfo2)     (vecubString);     // returns SymbolInfo*
    typedef int                 (__cdecl* VecubCallbackGetTask2)           (vecubString, Task*&);
    typedef PtrSymbolAccess&    (__cdecl* VecubCallbackGetSymbolAccessor2) (vecubString);

#if defined(PLUGIN_EXTENSION)
    typedef VarTypes            (__cdecl* VecubCallbackGetSymbolValue2)    (const char*);
    typedef void                (__cdecl* VecubCallbackSetSymbolValue2)    (const char*, VarTypes val);
#endif

    using VecubCallbacks2 = struct VecubCallbacks2 {
        VecubCallbackLog2                  log2;
        VecubCallbackGetSymbolInfo2        getSymbolInfo2;
        VecubCallbackGetTask2              getTask2;
        VecubCallbackGetSymbolAccessor2    getSymbolAccessor2;

#if defined(PLUGIN_EXTENSION)
        VecubCallbackGetSymbolValue2       getSymbolValue2;
        VecubCallbackSetSymbolValue2       setSymbolValue2;

        VecubCallbackSetDoubleValue        setTaskPeriod;
        VecubCallbackSetDoubleValue        setTaskFirstCall;
        VecubCallbackSetDoubleValue        setTaskNextCall;
        VecubCallbackSetUnsignedLongValue  setTaskPriority;
        VecubCallbackSetLongLongValue      setTaskNumberMaxCalls;
        VecubCallbackSetLongLongValue      setTaskNumberCalls;
        VecubCallbackGetTaskStringValue    getTaskName;
        VecubCallbackGetTaskTriggerValue   getTaskTrigger;
        VecubCallbackGetTaskDoubleValue    getTaskPeriod;
        VecubCallbackGetTaskDoubleValue    getTaskFirstCall;
        VecubCallbackGetTaskUnsignedLongValue getTaskPriority;
        VecubCallbackGetTaskLongLongValue  getTaskMaxCalls;
        VecubCallbackGetTaskLongLongValue  getTaskCalls;
        VecubCallbackGetTaskDoubleValue    getTaskNextCall;
#endif
    };
```

Fig. 5-12: function pointers

Example for Usage of Callbacks for Visual Studio Compiler on Windows and GNU Compiler on Ubuntu

The following code visualizes how callbacks can be used for Plugin Version 2.

```
// ===== plugin vers. 02 =====
DllExport vecub2Status __cdecl vecubFmi3EnterInit2(const VecubCall-
backs2* vecubCallbacks)
{
    if (!vecubCallbacks)
        return vecub2Status::vecubError;
```

The code defines the function `vecubFmi3EnterInit2` that takes a pointer to the structure `VecubCallbacks2` as input. It checks if the passed pointer `vec-ubCallbacks` is valid. If not, it returns `vecub1Status::vecubError`.

```
// logging
if (vecubCallbacks->log2)
{
 vecubCallbacks->log2("user message");
}
```

It checks if the `log2` function is defined in `vecubCallbacks` structure. If yes, it calls the function with the argument `user message`.

```
// get symbol info
SymbolInfo* symbol = static_cast<SymbolInfo*>(vecubCallbacks->getSym-
bolInfo2("factor1"));
std::cout << "The symbol has address: " << std::hex << symbol->addr <<
std::endl;
```

It calls `getSymbolInfo2` function to obtain information about a symbol named `factor1`. The returned symbol is stored in the variable `symbol`. The address of the symbol is printed using `std::cout`.

```
// get symbol accessor
PtrSymbolAccess& symbolAccessor = vecubCallbacks->getSymbolAccessor2
("factor1");
VarTypes val = (*symbolAccessor).get();
val.f64 = 5;
(*symbolAccessor).set(val);
```

It calls `getSymbolAccessor2` function to obtain an accessor for the `factor1` symbol. The accessor is stored in the reference variable `symbolAccessor`. It reads a value of type `IntFloat64` from the symbol and assigns the value `5` to it. Then, it writes the value back to the symbol.

Note

`PtrSymbolAccess` and `symbolAccessor` with its own methods became obsolete but are still supported. They are replaced by methods like:

vecubCallbacks->getSymbolValue2

vecubCallbacks->setSymbolValue2

```
// get task object
Task* task{nullptr};
 vecubCallbacks->getTask2("task_10ms", task);
task->setTNextCall(123);
 if (task) {
  std::cout << "FOUND! task: " << " ~ " << task->getName() <<
std::endl;
  }
```

It calls `getTask2` function to obtain a task object with the name `task_0ms`. The task object is stored in the pointer variable `task`. `setTNextCall` function is called on the task object with the value `123` as the argument. If the task object is valid, a message is printed with the task's name.

```
return vecub2Status::vecubOK;
}
```

It returns `vecub1Status::vecubOK`.

Example for Usage of Callbacks for Visual Studio Compiler on Windows and GNU Compiler on Ubuntu and GNU Compiler from MinGW on Windows and Ubuntu

The following code visualizes how callbacks can be used for Plugin Version 2.

```
// ===== plugin vers. 02 =====
DllExport vecub2Status __cdecl vecubFmi3EnterInit2(const VecubCall-
backs2* vecubCallbacks)
{
    if (!vecubCallbacks)
        return vecub2Status::vecubError;
```

The code defines the function `vecubFmi3EnterInit2` that takes a pointer to the structure `VecubCallbacks2` as input. It checks if the passed pointer `vec-ubCallbacks` is valid. If not, it returns `vecub1Status::vecubError`.

```
// logging
if (vecubCallbacks->log2)
  {
    vecubCallbacks->log2("user message");
   }
```

It checks if the `log2` function is defined in `vecubCallbacks` structure. If yes, it calls the function with the argument `user message`.

```
// get symbol info
SymbolInfo* symbol = static_cast<SymbolInfo*>(vecubCallbacks->getSym-
bolInfo2("factor1"));
std::cout << "The symbol has address: " << std::hex << symbol->addr <<
std::endl;
```

It calls `getSymbolInfo2` function to obtain information about a symbol named `factor1`. The returned symbol is stored in the variable `symbol`. The address of the symbol is printed using `std::cout`.

```
// get symbol accessor
 VarTypes val2 = vecubCallbacks->getSymbolValue2("factor1");
std::cout << "symbol has value: " << val2.f64 << std::endl;
 val2.f64 = 123.45;
 vecubCallbacks->setSymbolValue2("factor1", val2);
```

It retrieves the symbol value associated with the key "`factor1`" using "`getSym-bolValue2`" method and stores it in a variable called "`val2`" of type VarTypes. It then prints the value of the symbol to the console using `std::cout`. It modifies the value of the symbol by assigning a new value (123.45) to the "`f64`" field of the "`val2`" variable. Finally, it uses the "`setSymbolValue2`" method to update the value of the symbol associated with the key "`factor1`" to the new value stored in the "`val2`" variable.

```
// get task object
Task* tasknullptr{};
vecubCallbacks->getTask1("task_10ms", task);
std::cout << "Task getTaskNextCall: " << vecubCallbacks->getTaskNex-
tCall(&task) << std::endl;
std::cout << "Task setTaskNextCall: " << vecubCallbacks->setTaskNex-
tCall(&task, 1) << std::endl;
std::cout << "Task getTaskNextCall: " << vecubCallbacks->getTaskNex-
tCall(&task) << std::endl;
```

A variable "task" of type "task*" is created and initialised with the value "`nullptr`". Then the "`getTask1`" method of the "`vecubCallbacks`" object is called to retrieve the task named "`task_10ms`" and store it in the "`task`" variable. The methods "`getTaskNextCall`" and "`setTaskNextCall`" of the "`vec-ubCallbacks`" object are then called to get and set the next call time of the task. The results of these method calls are then output to the console using "`std::cout`".

```
return vecub2Status::vecubOK;
}
```

It returns `vecub1Status::vecubOK`.

5.5.4 What a Plugin Can Do With Tasks V2

A plugin can access a task defined in VECU-BUILDER and can change different properties of a task at run-time.

As described in Plugin Functions, you can use several functions. One of these functions is used to get a task. The used function pointer is `getTask2`, which returns a task type. For more details, see Fig. 5-12

Once the plugin access a task, it can manage through the task interface and the behavior of a task during run-time.

The interface of the task is available in Plugin template project through the defin-ition of `task` class in `include/vecubTypes.h` file.

In this class, you can see specific functions of task class which manage i.e the task name, task period, or task priority.

6 Controlling VECU-BUILDER

6.1 Manual Interaction

You can operate VECU-BUILDER via the provided command and batch/shell scripts. For some user inputs, such as selecting a workspace directory, the tool may display dialogs.

6.2 Command Line Interface

Besides the manual Interaction method you can also operate VECU-BUILDER via a Command Line Interface (CLI). VECU-BUILDER is a CLI native application, and the command and batch/shell scripts allow manual interaction. For more information about the Installation using CLI, see Silent Installation of VECU-BUILDER.

The following arguments exist:

`--new-project-path`: Path where the workspace is to be created.

`--no-dialogs`: Suppress all dialogs and always select the default option.

`--stop-on-success`: Prevent automatic forwarding to the next stage (create workspace, import, build).

`--version`: Print the version information.

`-h`: Print list of all optional arguments.

To see all CLI optional arguments and their description

1. Open a command prompt on **Windows**

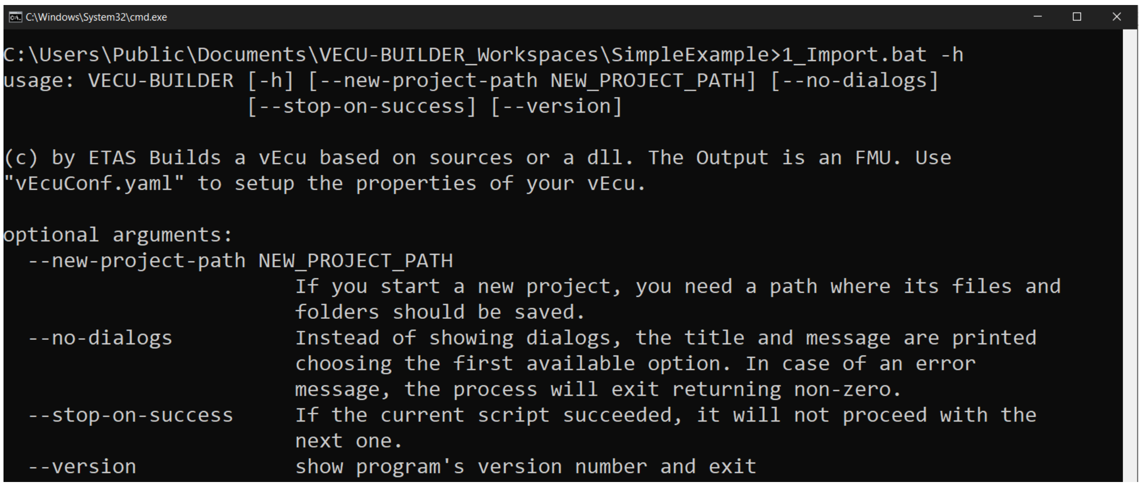
   or

   a terminal on **Ubuntu 20.04 LTS**.
2. Execute the following command:

   `1_Import.bat -h` for **Windows**

   or

   `1_Import.sh -h` for **Ubuntu 20.04 LTS**.



```
C:\Users\Public\Documents\VECU-BUILDER_Workspaces\SimpleExample>1_Import.bat -h
usage: VECU-BUILDER [-h] [--new-project-path NEW_PROJECT_PATH] [--no-dialogs]
                    [--stop-on-success] [--version]

(c) by ETAS Builds a vEcu based on sources or a dll. The Output is an FMU. Use
"vEcuConf.yaml" to setup the properties of your vEcu.

optional arguments:
  --new-project-path NEW_PROJECT_PATH
                        If you start a new project, you need a path where its files and
                        folders should be saved.
  --no-dialogs          Instead of showing dialogs, the title and message are printed
                        choosing the first available option. In case of an error
                        message, the process will exit returning non-zero.
  --stop-on-success     If the current script succeeded, it will not proceed with the
                        next one.
  --version             show program's version number and exit
```

Fig. 6-1: CLI optional arguments (Windows)

The CLI control method is ideal for integrating VECU-BUILDER into an automation pipeline. The CLI behaviour is the same as running the scripts manually. Each script calls the next script to proceed through the stages of create a workspace, import, build. To change this behaviour, use `--stop-on-success`.

The following table gives an overview of which batch file uses which arguments:

argument	CreateWorkspace	1_Import	2_Build
--new-project-path	Used (required)	Ignored	Ignored
--no-dialogs	Used (optional)	Used (optional)	Used (optional)
--stop-on-success	Used (optional)	Used (optional)	Ignored
--version	Used (optional)	Used (optional)	Used (optional)
-h	Used (optional)	Used (optional)	Used (optional)

Tab. 6-1: Mapping of CLI arguments to scripts

To build the SimpleExample via two command lines

After creating the workspace, stop the process so you can copy a specific YAML file into your workspace. Then trigger the import without `stop-on-success` and let it finish the build automatically.

1. Open a command prompt on **Windows**

   or

   a terminal on **Ubuntu 20.04 LTS**.
2. Navigate to the directory where the installer is located executing the following command:

   `cd %VECUBUILDER_HOME%.`
3. Execute the following command:

   `CreateWorkspace.bat` on **Windows**

   or

   `CreateWorkspace.sh` on **Ubuntu 20.04 LTS**.

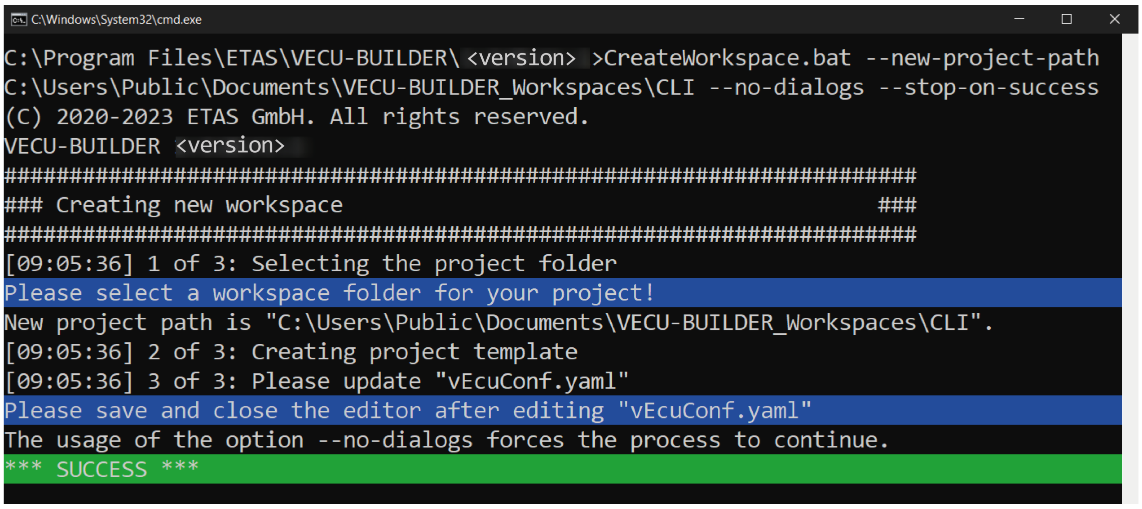
   with the arguments

   `--new-project-path <destination>`

   `--no-dialogs`

   `--stop-on-success`

   where `<destination>` points to your workspace folder.



```
C:\Program Files\ETAS\VECU-BUILDER\ <version> >CreateWorkspace.bat --new-project-path
C:\Users\Public\Documents\VECU-BUILDER_Workspaces\CLI --no-dialogs --stop-on-success
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
######################################################################
### Creating new workspace                                         ###
######################################################################
[09:05:36] 1 of 3: Selecting the project folder
Please select a workspace folder for your project!
New project path is "C:\Users\Public\Documents\VECU-BUILDER_Workspaces\CLI".
[09:05:36] 2 of 3: Creating project template
[09:05:36] 3 of 3: Please update "vEcuConf.yaml"
Please save and close the editor after editing "vEcuConf.yaml"
The usage of the option --no-dialogs forces the process to continue.
*** SUCCESS ***
```

Fig. 6-2: Workspace creation via CLI (Windows)

Note

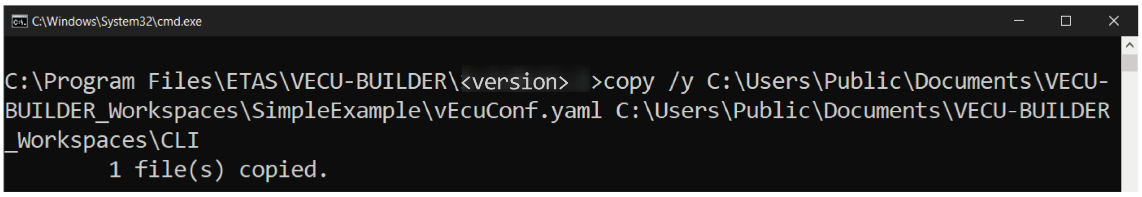
A default YAML file is used in all newly created workspaces.

Project specific YAML file can be either prepared manually or in the previous step of your automation pipeline.

To use your project specific YAML file in this newly created workspace:

1. Execute the following command:

   `copy /y <source> <destination>`.



```
C:\Program Files\ETAS\VECU-BUILDER\<version>  >copy /y C:\Users\Public\Documents\VECU-
BUILDER_Workspaces\SimpleExample\vEcuConf.yaml C:\Users\Public\Documents\VECU-BUILDER
_Workspaces\CLI
        1 file(s) copied.
```

Fig. 6-3: Copy your project specific YAML file (Windows)

Note

The argument `/y` suppresses the prompt and thus overwrites the destination file.

To continue building your workspace:

1. Navigate to this new workspace by executing the following command:

   `cd <destination>`.

2. Run the command:

   `1_Import.bat --no-dialogs` for **Windows**

   or

   `1_Import.sh --no-dialogs` for **Ubuntu 20.04 LTS**.

6.3 Ubuntu 20.04 LTS Command Line Interface

It is possible to create a new workspace on WSL Ubuntu 20.04 LTS using the Ubuntu Command Line Interface.

Note

Downloading dependencies or installing VECU-BUILDER only runs in WSL1, using VECU-BUILDER only runs in WSL2. Make sure that the WSL version matches the respective action. If necessary, you need to change the version.

– For WSL1:
- wsl --set-version Ubuntu-20.04 1

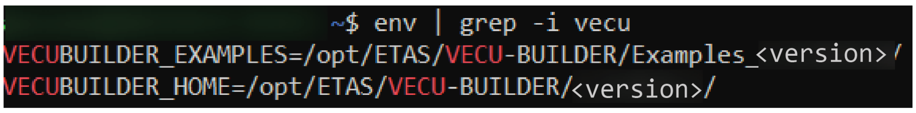
– For WSL2:
- wsl --set-version Ubuntu-20.04 2

1. Open PowerShell and set WSL Ubuntu 20.04 LTS version to 2 using the following command:

   ```
   wsl --set-version Ubuntu-20.04 2
   ```

2. Open Ubuntu 20.04 LTS and make sure that the environment variables are set correctly using the following command:

   ```
   env | grep -i vecu
   ```



```
~$ env | grep -i vecu
VECUBUILDER_EXAMPLES=/opt/ETAS/VECU-BUILDER/Examples_<version>/
VECUBUILDER_HOME=/opt/ETAS/VECU-BUILDER/<version>/
```

3. Change directory using the following command:

   ```
   cd $VECUBUILDER_HOME
   ```

4. Create a new workspace using the following command:

   ```
   ./CreateWorkspace.sh --no-dialogs --new-project-path /op-
   t/etas/VECU-BUILDER_Workspaces/SimpleExample/
   ```

Or

With installed Gnome Terminal workspace creation also works in Dialog Mode using the following command:

```
./CreateWorkspace.sh --new-project-path /opt/etas/VECU-
BUILDER_Workspaces/SimpleExample/
```

⇨ A new workspace was created. For more details about workspace content, see Workspace Content.

7 Debugging vECU

VECU-BUILDER provides useful functionalities to debug your vECU. It is possible to debug the vECU by using an Integrated Development Environment (IDE), such as Visual Studio Code or Visual Studio.

As the folder `<workspace>/vECU` is a CMake project, any IDE that can import CMake projects can be used for debugging.

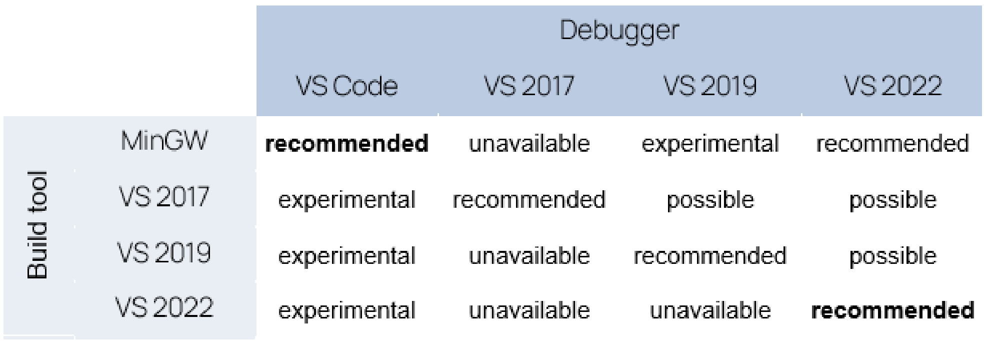
During the Build stage, the debugging environment and batch/shell script files are created enabling you to enter a debugging session in just a few clicks.

You can use the `debug_hook` attribute, which can be enabled in the YAML file. vECUs built with this attribute enabled enter their instantiation and wait for a debugger to be attached by the user before continuing.

Note

The VECU-BUILDER debugging functionality is intended to be used for debugging of a single vECU within its workspace. If your vECU is integrated into a simulation, the `debug_hook` might be the best option for debugging,

The below table summarizes the possible combinations of build tool and debugger:



		Debugger			
		VS Code	VS 2017	VS 2019	VS 2022
Build tool	MinGW	**recommended**	unavailable	experimental	recommended
	VS 2017	experimental	recommended	possible	possible
	VS 2019	experimental	unavailable	recommended	possible
	VS 2022	experimental	unavailable	unavailable	**recommended**

Tab. 7-1: Debugging possibilities

Combinations marked as experimental, are neither tested nor supported and their use is solely your responsibility.

Among the recommended combinations, two are particularly recommended for use and are described in detail in the following chapters.

7.1 Debugging with Visual Studio 2019

This chapter describes how to debug vECU built with Visual Studio 2019 using Visual Studio 2019 as the debugger.

More information about Visual Studio 2019 can be found here.

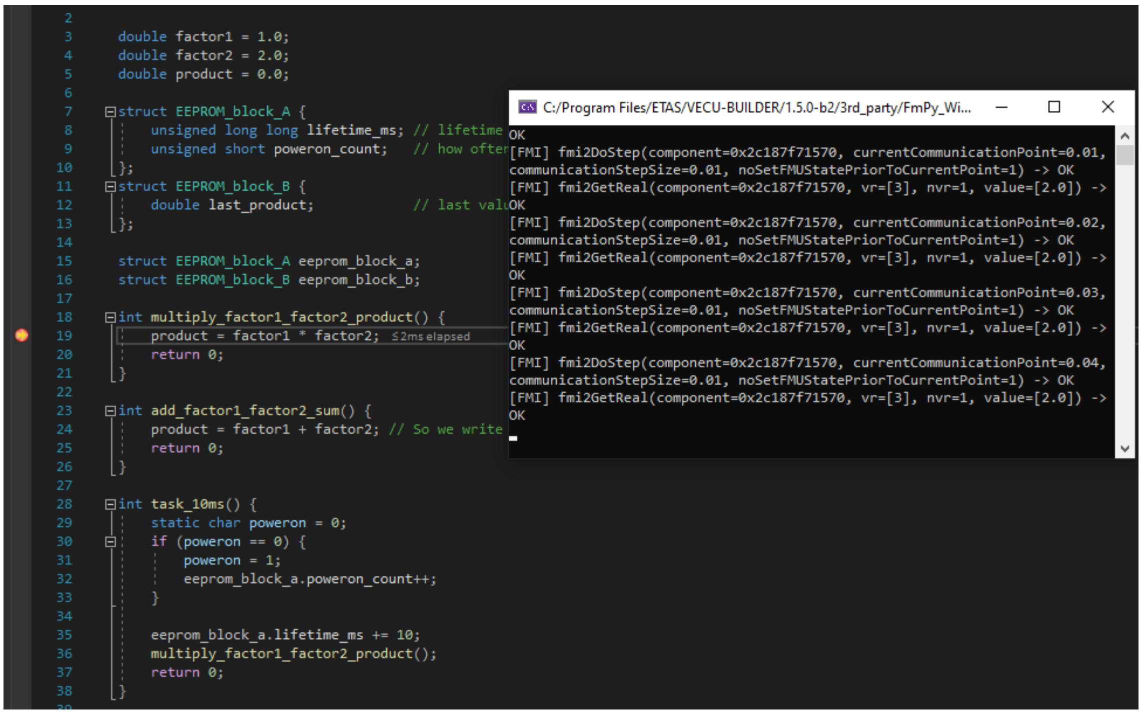
To debug with Visual Studio 2019

1. Navigate to your workspace.
2. Execute the `3b_StartDebugger.bat` file on **Windows** or `3b_StartDebugger.sh` on **Ubuntu 20.04 LTS**.

⇨ The VS2019 debugger is invoked and loads the CMake project.

3. Navigate to where you want to start debugging and place a breakpoint there.
4. In the “Menu” tab **click Debug › Start Debugging (F5)**.

⇨ FMPy is invoked and the debugger is attached.



```
double factor1 = 1.0;
double factor2 = 2.0;
double product = 0.0;

struct EEPROM_block_A {
    unsigned long long lifetime_ms; // lifetime
    unsigned short poweron_count;   // how often
};
struct EEPROM_block_B {
    double last_product;            // last valu
};

struct EEPROM_block_A eeprom_block_a;
struct EEPROM_block_B eeprom_block_b;

int multiply_factor1_factor2_product() {
    product = factor1 * factor2;  ≤2ms elapsed
    return 0;
}

int add_factor1_factor2_sum() {
    product = factor1 + factor2; // So we write
    return 0;
}

int task_10ms() {
    static char poweron = 0;
    if (poweron == 0) {
        poweron = 1;
        eeprom_block_a.poweron_count++;
    }

    eeprom_block_a.lifetime_ms += 10;
    multiply_factor1_factor2_product();
    return 0;
}
```

C:/Program Files/ETAS/VECU-BUILDER/1.5.0-b2/3rd_party/FmPy_Wi...

```
OK
[FMI] fmi2DoStep(component=0x2c187f71570, currentCommunicationPoint=0.01,
communicationStepSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x2c187f71570, vr=[3], nvr=1, value=[2.0]) ->
OK
[FMI] fmi2DoStep(component=0x2c187f71570, currentCommunicationPoint=0.02,
communicationStepSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x2c187f71570, vr=[3], nvr=1, value=[2.0]) ->
OK
[FMI] fmi2DoStep(component=0x2c187f71570, currentCommunicationPoint=0.03,
communicationStepSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x2c187f71570, vr=[3], nvr=1, value=[2.0]) ->
OK
[FMI] fmi2DoStep(component=0x2c187f71570, currentCommunicationPoint=0.04,
communicationStepSize=0.01, noSetFMUStatePriorToCurrentPoint=1) -> OK
[FMI] fmi2GetReal(component=0x2c187f71570, vr=[3], nvr=1, value=[2.0]) ->
OK
```

Fig. 7-1: VS 2019 Debugger attached

7.2 Debugging with Visual Studio Code

This chapter describes how to debug vECU built with MinGW using Visual Studio Code as the debugger.

Prerequisites for Debugging with Visual Studio Code

It is obligatory to install the following packages in Visual Studio Code:

- Microsoft C/C++ Extension Pack

For Debugging in WSL Ubuntu with Visual Studio Code additionally install the following packages:

- C/C++ extensions for Visual Studio Code and WSL Ubuntu in Windows PC Host
- CMake extensions for Visual Studio Code and WSL Ubuntu in Windows PC Host
- CMAKE Tools extensions for Visual Studio Code and WSL Ubuntu in Windows PC Host
- gdb in Ubuntu WSL (see Installing Dependent Software Packages.)

Without the installation of this package debugging is not possible.

Visual Studio Code requires some further extensions and will prompt you to install them by default.

More information about Visual Studio Code can be found here.

To debug with Visual Studio Code in Windows

1. Navigate to your workspace.
2. Right-click in your workspace and select **Open with Code**.

⇨ Visual Studio Code opens.

3. Navigate to where you want to start the debugging and place a breakpoint there.
4. Click **Start Debugging (F5)**.
5. In the menu panel on the left click **Run and Debug**.

⇨ FMPy is invoked and the debugger is attached.

To debug with Visual Studio Code in Ubuntu 20.04 LTS

1. Navigate to your workspace.
2. Start debugging using the following command:

   ```
   $ ./3b_StartDebugger.sh
   ```

⇨ Visual Studio Code opens.

3. Navigate to where you want to start the debugging and place a breakpoint there.
4. In the menu panel on the left click **Run and Debug**.
5. Click **Start Debugging (F5)**.

⇨ FMPy is invoked and the debugger is attached.

To debug with Visual Studio Code in WSL

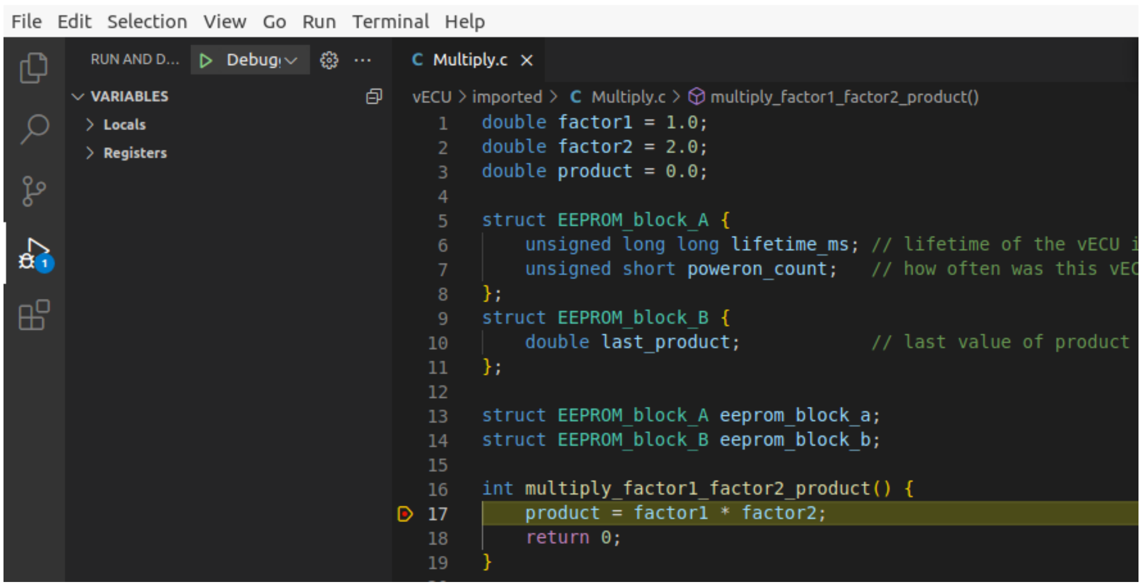
1. Check if gnome-terminal and gdb are installed. If not installed, see Installing VECU-BUILDER on Ubuntu 20.04 LTS for WSL.
2. Navigate to your workspace.
3. Start debugging using the following command:

   ```
   ./3b_StartDebugger.sh
   ```

⇨ Visual Studio Code opens.

4. Navigate to where you want to start the debugging and place a breakpoint there.
5. Click **Start Debugging (F5)**.
6. In the menu panel on the left click **Run and Debug**.

⇨ FMPy is invoked and the debugger is attached.


File Edit Selection View Go Run Terminal Help
RUN AND D...
Debug
VARIABLES
Locals
Registers
Multiply.c
vECU > imported > Multiply.c > multiply_factor1_factor2_product()

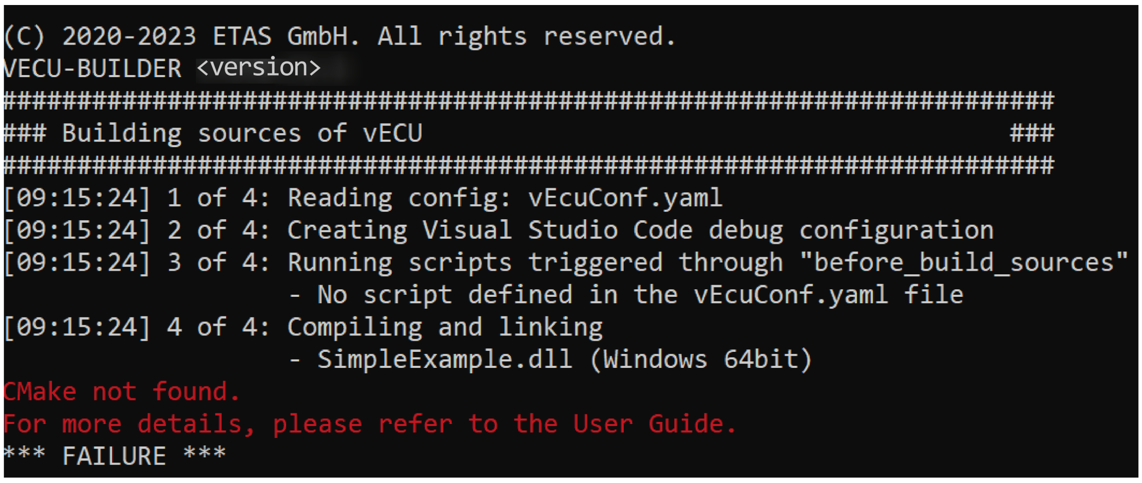
```
double factor1 = 1.0;
double factor2 = 2.0;
double product = 0.0;

struct EEPROM_block_A {
    unsigned long long lifetime_ms; // lifetime of the vECU i
    unsigned short poweron_count;   // how often was this vEC
};
struct EEPROM_block_B {
    double last_product;            // last value of product
};

struct EEPROM_block_A eeprom_block_a;
struct EEPROM_block_B eeprom_block_b;

int multiply_factor1_factor2_product() {
    product = factor1 * factor2;
    return 0;
}
```

Fig. 7-2: VS Code Debugger attached

8 Troubleshooting

This chapter lists possible warning or error messages, their possible reasons and a possible solution to fix the issue.

8.1 CMake Not Found



```
(C) 2020-2023 ETAS GmbH. All rights reserved.
VECU-BUILDER <version>
######################################################################
### Building sources of vECU                                       ###
######################################################################
[09:15:24] 1 of 4: Reading config: vEcuConf.yaml
[09:15:24] 2 of 4: Creating Visual Studio Code debug configuration
[09:15:24] 3 of 4: Running scripts triggered through "before_build_sources"
                   - No script defined in the vEcuConf.yaml file
[09:15:24] 4 of 4: Compiling and linking
                   - SimpleExample.dll (Windows 64bit)
CMake not found.
For more details, please refer to the User Guide.
*** FAILURE ***
```

Fig. 8-1: CMake not found error

Possible Reason

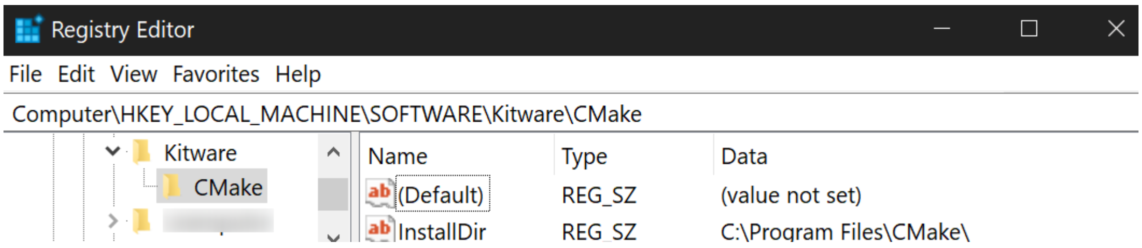
A CMake installation is required and must be registered properly. (Software Requirements for Windows 10). This registry entry is used to locate the CMake installation. If it does not exist, the build fails.

It appears as if CMake is not installed or is not properly registered on your computer.

Possible Solution

Ensure the following:

- CMake is installed (version 3.15 or higher).
- Kitware and CMake keys exist in the Windows Registry.
- The CMake registry key `Computer\HKEY_LOCAL_MACHINE\SOFTWARE\Kitware\CMake` contains the string value `InstallDir` pointing to the CMake installation path:



Computer\HKEY_LOCAL_MACHINE\SOFTWARE\Kitware\CMake

Name	Type	Data
(Default)	REG_SZ	(value not set)
InstallDir	REG_SZ	C:\Program Files\CMake\

Fig. 8-2: Windows Registry with Kitware\CMake registry key

8.2 Notepad++ Does Not Open During Workspace Creation

Notepad++ is the recommended text editor to be used along with VECU-BUILDER. For it to work as intended, it must be installed and registered properly.

If Notepad++ does not open during the Workspace Creation stage, but Windows Notepad opens instead it is either not installed at all or is not properly registered on your computer.

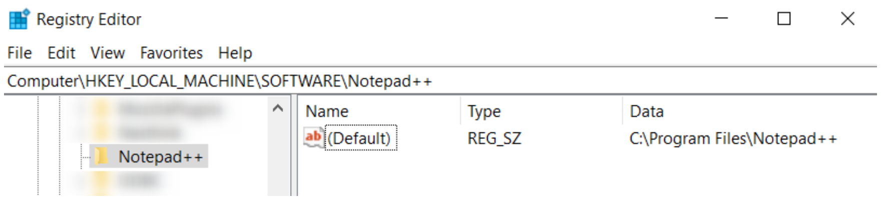
Possible Solution

Ensure the following:

- Notepad++ is installed.
- Notepad++ key exists in the Windows Registry.

A. **For 64-bit version:**

- The Notepad++ registry key `Computer/HKEY_LOCAL_MACHINE/SOFTWARE/Notepad+` contains the string value (Default) pointing to the Notepad++ installation path:

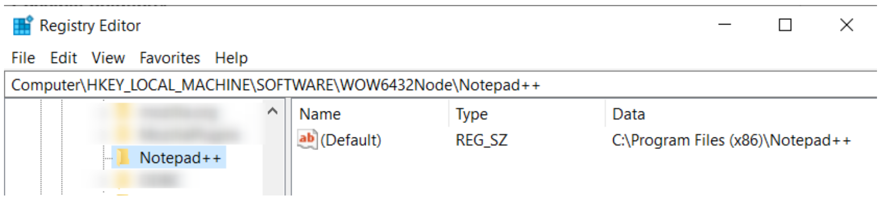


Computer\HKEY_LOCAL_MACHINE\SOFTWARE\Notepad++

Name	Type	Data
(Default)	REG_SZ	C:\Program Files\Notepad++

B. **For 32-bit version:**

- The Notepad++ registry key `Computer/HKEY_LOCAL_MACHINE/SOFTWARE/WOW6432Node/Notepad++` contains the string value (`Default`) pointing to the Notepad++ installation path:



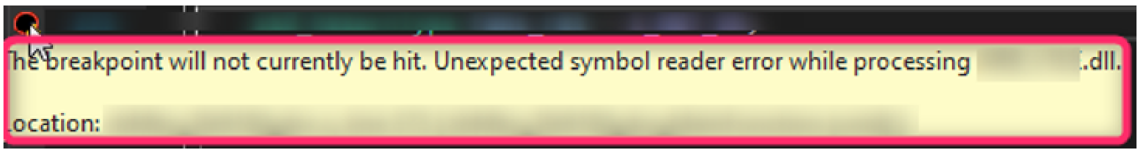
Computer\HKEY_LOCAL_MACHINE\SOFTWARE\WOW6432Node\Notepad++

Name	Type	Data
(Default)	REG_SZ	C:\Program Files (x86)\Notepad++

8.3 Some Breakpoints Not Being Hit

Possible Reason

Depending on your compiler configurations, the resulting vECU may be built so that some debugging information is not available. This may result in the debugger not being able to hit some breakpoints.



he breakpoint will not currently be hit. Unexpected symbol reader error while processing [redacted].dll.

ocation: [redacted]

Fig. 8-3: Breakpoint not being hit

Possible Solution

In order to prevent such compiler optimization, include the following pragma statements:

- For MSVC compiler: `#pragma optimize("", off)`
- For MinGW compiler: `#pragma GCC optimize ("O0")`

8.4 (SymbolInfo.dll) The *.die File Is Too Large to Load

Possible Reason

The operating system does not provide sufficient amount of memory required to load the `*.die` file.

Possible Solution

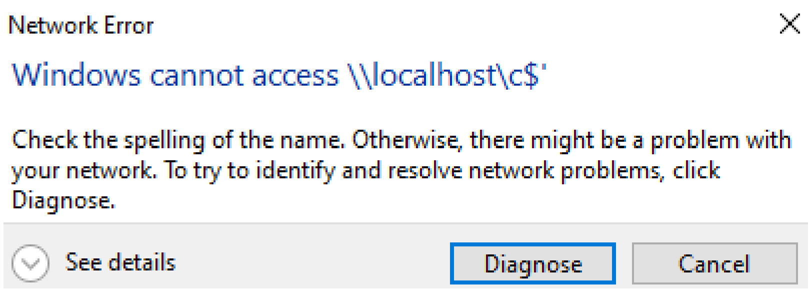
Use a computer with sufficient amount of memory.

8.5 Windows Cannot Access Localhost While Using Sync Attribute in EEPROM

Possible Reason

EEPROM simulation feature requires entering the value of sync sub-attribute as UNC path.

If the defined location (e.g., `C:/drive` of your localhost) cannot be accessed during the vECU execution, the data defined by the sync sub-attribute cannot be used.



Network Error

Windows cannot access \\localhost\c$'

Check the spelling of the name. Otherwise, there might be a problem with your network. To try to identify and resolve network problems, click Diagnose.

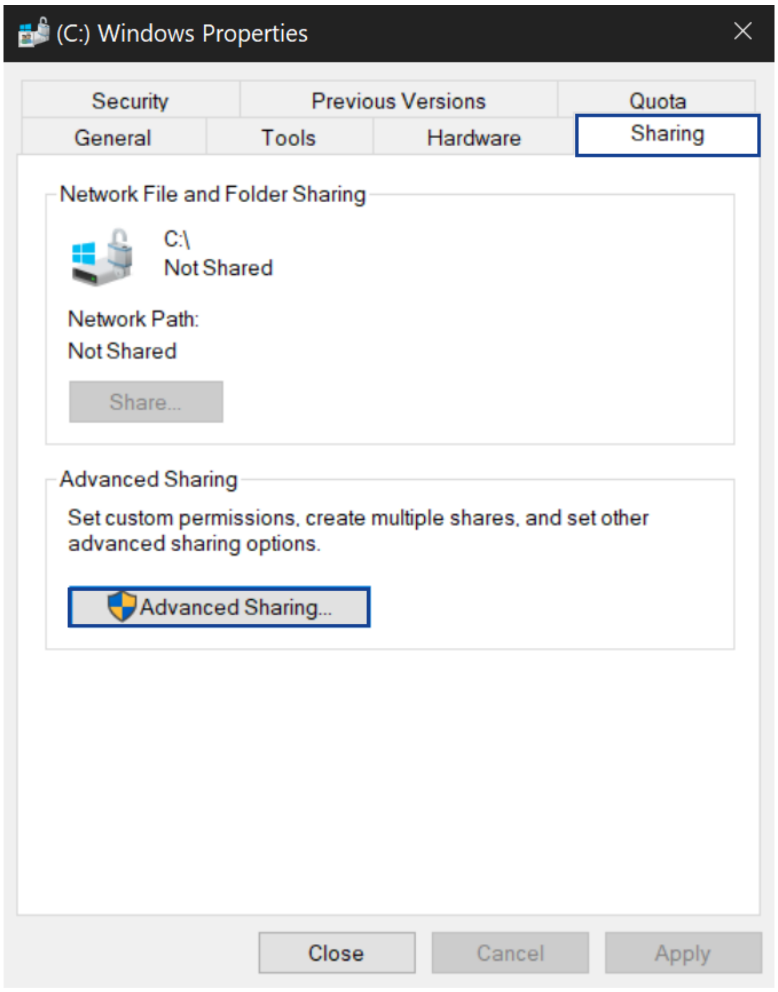
Fig. 8-4: Network Error - Localhost cannot be accessed

Possible Solution

Setup the local share and obtain the UNC pathname.

To setup a local share:

1. Navigate to the drive, you want to share. (e.g., (`C:/drive`)
2. Right-click in the drive and click **Properties**.
3. Click the **Sharing tab**.
4. Click **Advanced Sharing**. You will need Admin Rights to proceed.



Network File and Folder Sharing

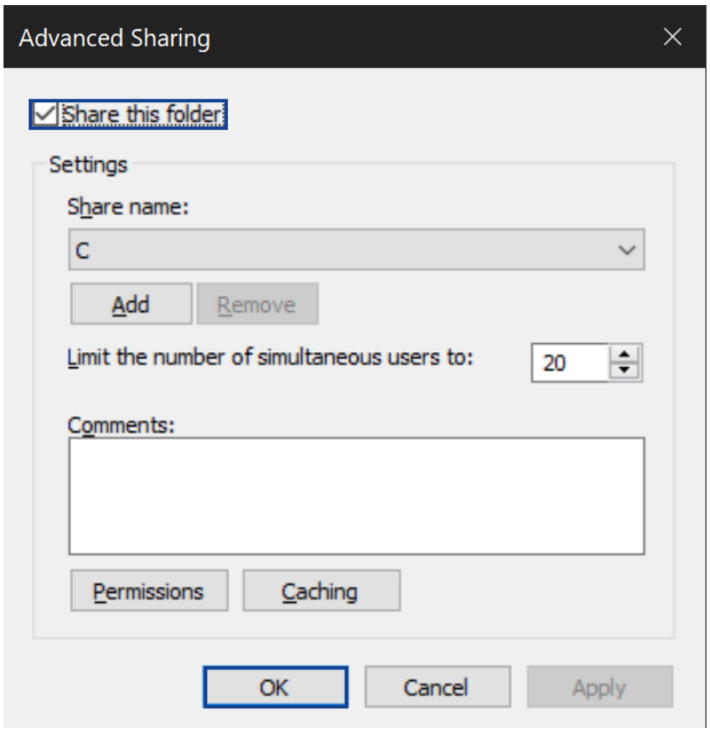
C:\
Not Shared

Network Path:
Not Shared

Advanced Sharing

Set custom permissions, create multiple shares, and set other advanced sharing options.

5. Activate **Share this folder**.
6. Click **OK**.


Advanced Sharing

[✓] Share this folder

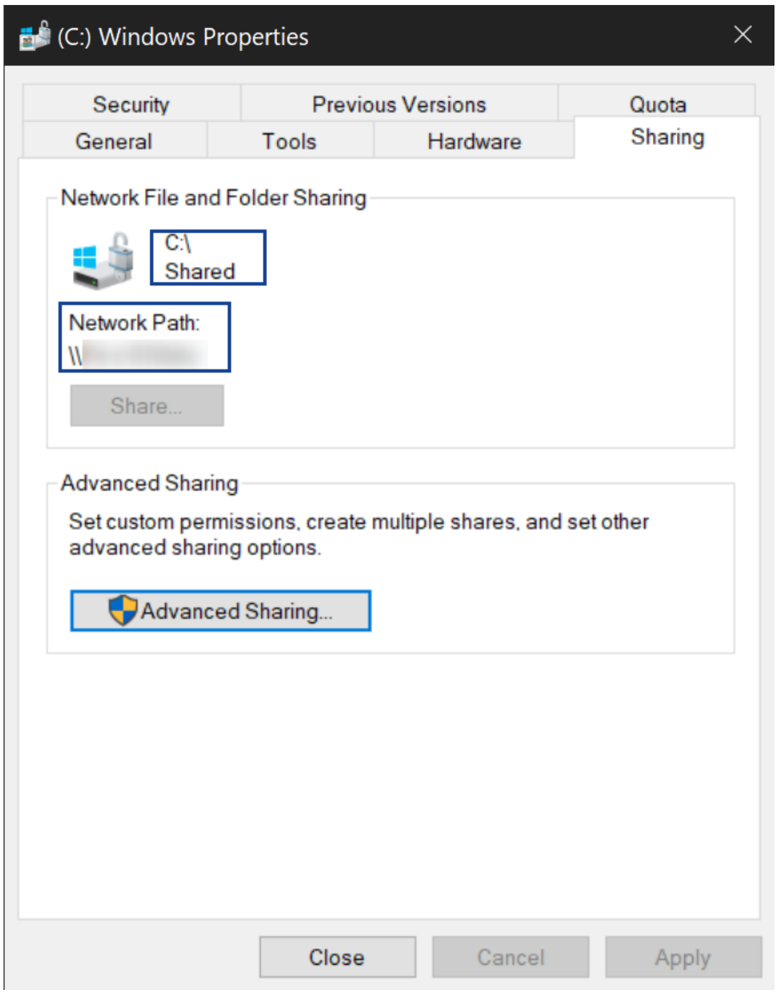
Settings

Share name: C

Limit the number of simultaneous users to: 20

Comments:

⇨ The drive is now shared and the Network Path is displayed.


(C:) Windows Properties

Network File and Folder Sharing

C:\
Shared

Network Path:
\\[redacted]

Advanced Sharing

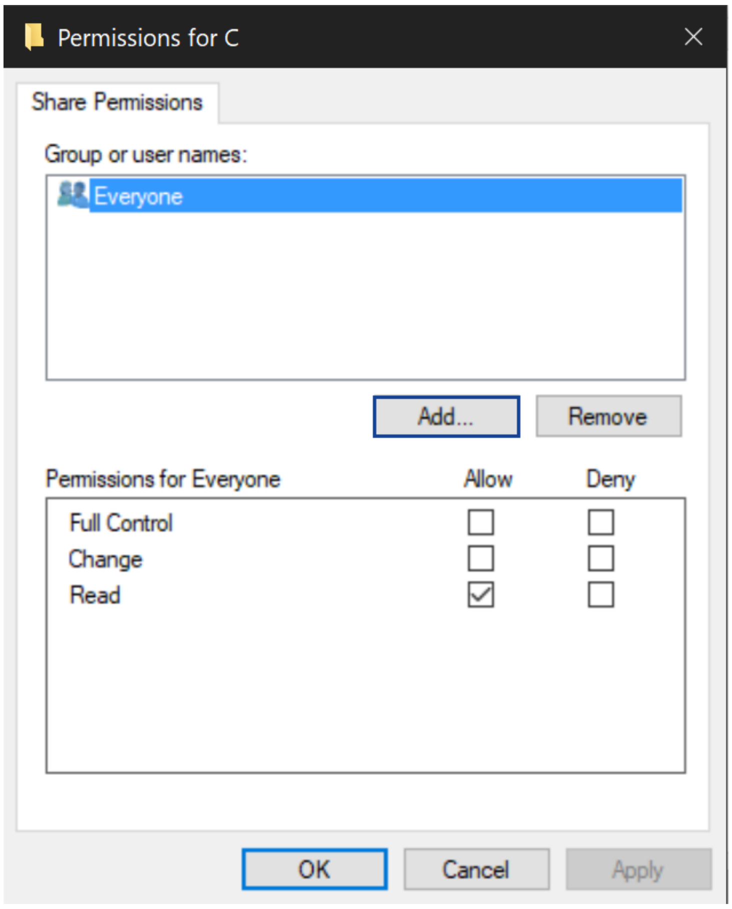
Set custom permissions, create multiple shares, and set other advanced sharing options.

The user, which will be logged in during the execution of the vECU, needs to be given full control permissions to the shared location.

Per default, Windows will provide permissions to "everyone". The permissions should only be provided to the user, that will be logged in during the execution of the vECU. Therefore, the permissions must to be changed for security reasons.

To change the permissions

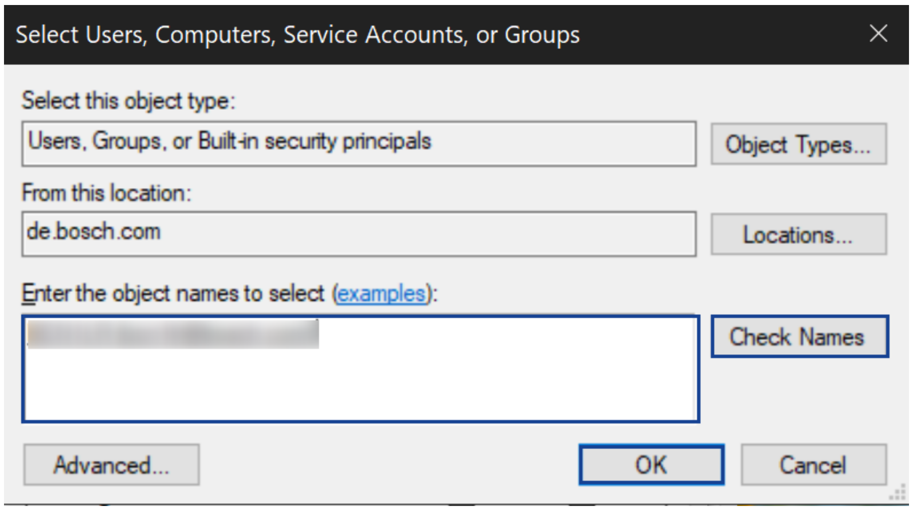
1. Click **Advanced Sharing**. You might need Admin Rights to proceed.
2. Click **Permissions**.
3. Click **Add**.



Everyone

Permissions for Everyone	Allow	Deny
Full Control	☐	☐
Change	☐	☐
Read	☑	☐

4. Enter the object name (username) to be selected.
5. Click **Check Names**.
6. Chose the displayed name.
7. Click **OK**.



Select Users, Computers, Service Accounts, or Groups

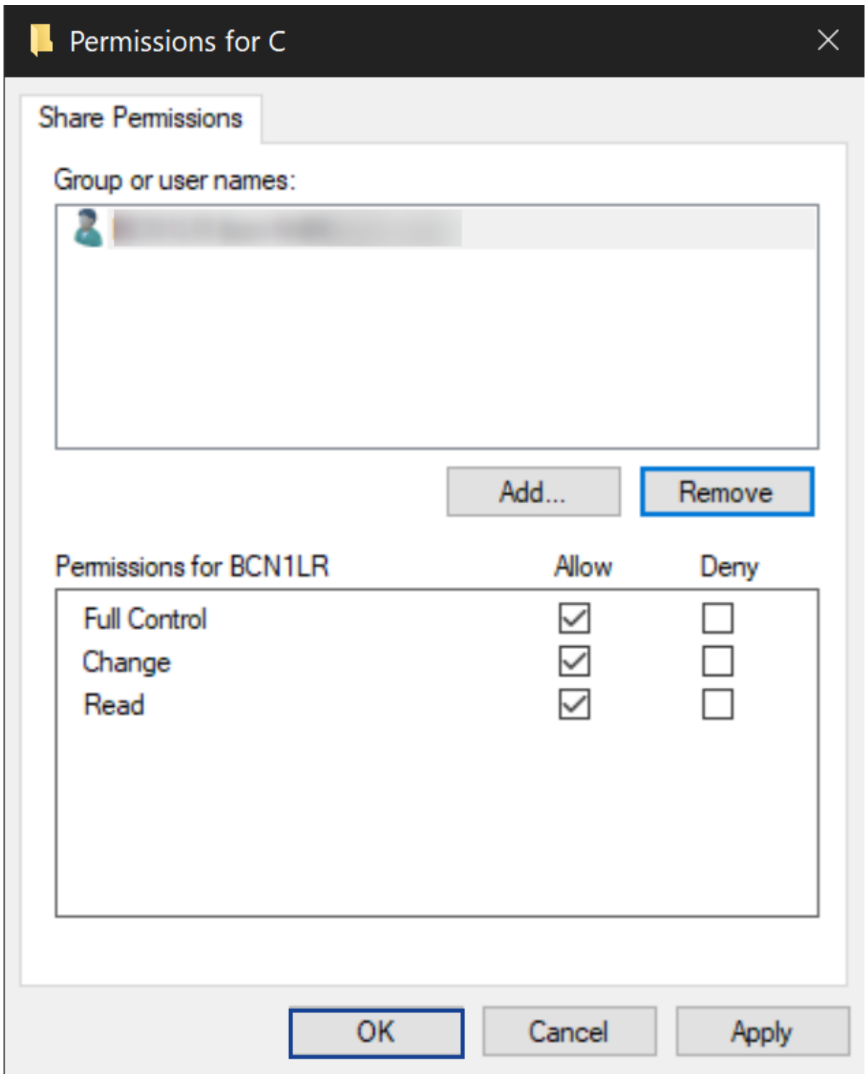
Select this object type:
Users, Groups, or Built-in security principals

From this location:
de.bosch.com

Enter the object names to select (examples):

8. Click the username to mark the entry.
9. Activate the permissions **Full Control** and **Change**.
10. To mark the entry, click **Everyone**.
11. To remove the permission for "everyone", click **Remove**.

⇨ The group Everyone is removed and the selected user has now full permissions.



Permissions for BCN1LR

	Allow	Deny
Full Control	✓	
Change	✓	
Read	✓	

12. To confirm the **User Selection**, click **OK**.
13. To confirm the updated **Advanced Sharing properties**, click **OK**.
14. Close the **Properties** window.

8.6 Redirecting Function Calls Did Not Work as Expected

Possible Reason

The GNU compiler optimization level 2 (**-O2**) includes `inline-small-functions` which is incompatible with `redirect_function_calls`.

By default VECU-BUILDER uses the compile settings `RelWithDebInf`, which includes some optimizations. For gcc this would use the setting **-O2**, which includes `inline-small-functions`.

Possible Solution

Change the settings in `additional_compile_flags` to enable `redirect_function_calls`.

There are 3 ways to deactivate the optimization:

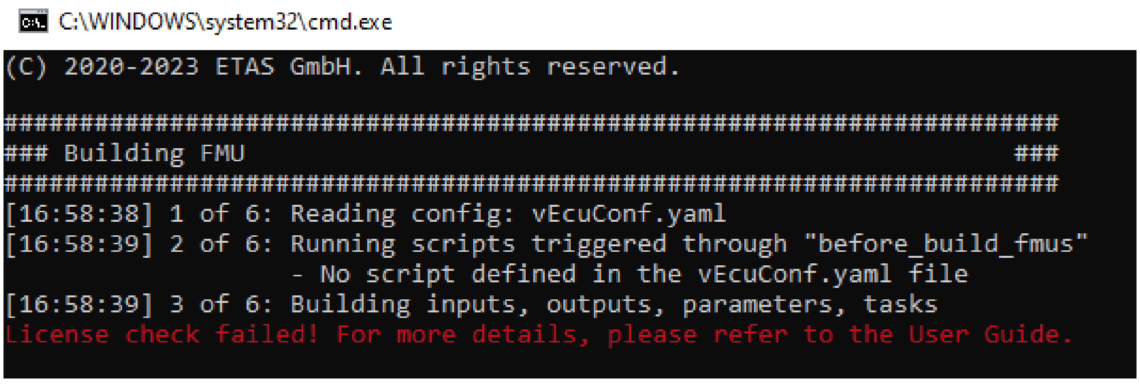
A. **-O0**: Completely deactivates optimization. This has the advantage that the compiler time of user workspace decreases.

B. **-O1**: Reduces the level of optimization from default 2 to 1.

C. **-O2 -f-no-inline-small-functions**: Keeps optimization to level 2 but only disables the special optimization with `-f-no-inline-small-functions`.

For more details, see Options That Control Optimization.

8.7 License Check Failed



```
(C) 2020-2023 ETAS GmbH. All rights reserved.

######################################################################
### Building FMU                                                   ###
######################################################################
[16:58:38] 1 of 6: Reading config: vEcuConf.yaml
[16:58:39] 2 of 6: Running scripts triggered through "before_build_fmus"
                   - No script defined in the vEcuConf.yaml file
[16:58:39] 3 of 6: Building inputs, outputs, parameters, tasks
License check failed! For more details, please refer to the User Guide.
```

Possible Reason

- The LiMa installation is corrupt.
- LiMa might not reach the license server.

Possible Solution

- Reinstall VECU-BUILDER described in Installation on Windows 10 and Installation on Ubuntu 20.04 LTS or contact Technical Support.
- Check network settings to get a connection to the license server.

8.8 Building Sources Failed

Possible Reason

In some cases, building sources fails with various error messages. To save time, CMake uses caches, e.g. a link to the build-tool is stored.

Possible Solution

To fix a broken CMake cache, delete the cache and rebuild the sources.

1. Navigate to the `vECU` folder.
2. Delete everything except the `imported` folder.
3. Rebuild the sources using `2_Build.bat` on **Windows** or `2_Build.sh` on **Ubuntu 20.04 LTS**.

If the build fails due to CMake reason, you can find more details in `build/-log/build_cmake.log` file.

8.9 Indentation Errors in YAML File

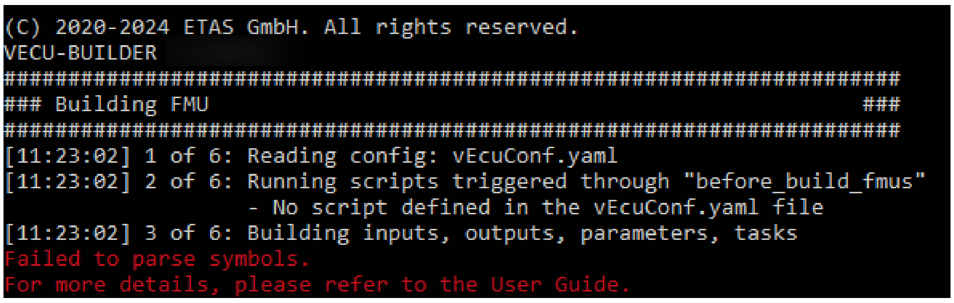
Indentation errors may occur and they are difficult to detect.

Possible Solution

To check for indentation errors in yaml file, use a YAML Checker. There are online tools available. You can search for "yaml checker" in any search engine. To search, you also can use this link. Follow the instructions given by the selected YAML Checker.

8.10 Failed to Parse Symbols

It can happen that symbol/debug information is missing in the binary. The error message below treats the missing debug information during build process when `build_mode` is `import_compiled`.



```
(C) 2020-2024 ETAS GmbH. All rights reserved.
VECU-BUILDER
##########################################################################
### Building FMU                                                       ###
##########################################################################
[11:23:02] 1 of 6: Reading config: vEcuConf.yaml
[11:23:02] 2 of 6: Running scripts triggered through "before_build_fmus"
                   - No script defined in the vEcuConf.yaml file
[11:23:02] 3 of 6: Building inputs, outputs, parameters, tasks
Failed to parse symbols.
For more details, please refer to the User Guide.
```

Possible Reason

The error occurs due to some mishandling of DLL/SO when `build_mode` in yaml file is set to `import_compiled`.

Possible Solution

– If the used `build_tool` is one of the Visual Studio compile versions (like 16 2016 or 17 2022), make sure that besides the DLL loaded, there must also exist a mandatory PDB file. The source location for DLL & PDB is given by yaml settings `import_external_compiled_vecu` and `get_updates_from`.
– If the `build_tool` used is **MinGW Makefiles for Windows** or **Unix Makefiles for Ubuntu**, only the DLL/SO is required. Make sure that the DLL/SO mandatorily contains debug information. A DIE file is created locally when building FMUs runs. Afterwards also `SymbolDetails.txt` is created.
– Make sure the `build_tool` yaml settings match the compiler used to build the DLL:
  - If the imported DLL was built with the GNU compiler from MinGW, make sure that `build_tool` is **MinGW Makefiles** (`build_tool: MinGW Makefiles`).
  - If the imported DLL was built with a Visual Studio compiler, make sure that `build_tool` is **Visual Studio xx xxxx** (`build_tool: Visual Studio xx xxxx`).

For more information see import_external_compiled_vecu in Configuration chapter.

8.11 Could not Load the vECU Binary

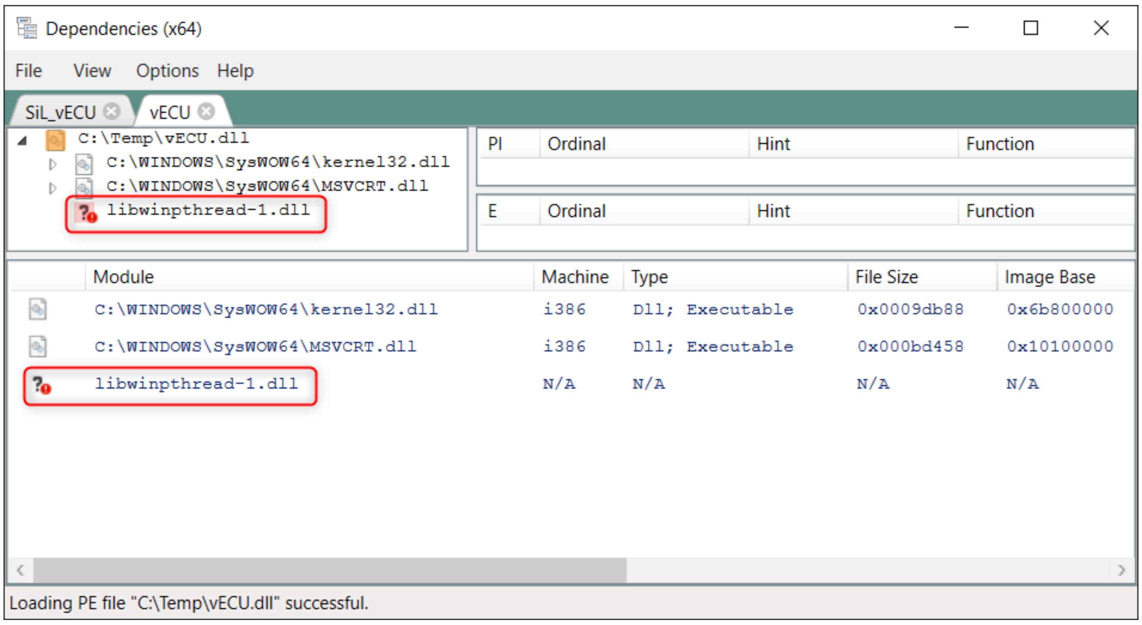
During the vECU FMU build the `SymbolDetails.txt` variables are updated with the initial values by loading of the `vECU.dll` binary and reading the values from RAM. In cases where the `vECU.dll` cannot be loaded, the SymbolDetails.txt variables receive the default value 0. You are informed with an appropriate message in the `build_fmu.log` file. In this case, the FMU build is possible, but the generated FMU execution will not work due to the same `vECU.dll` loading problem as during the build.

Possible Reason

One or more dynamic libraries, required for the `vECU.dll` execution are missing / could not be found by the OS.

Possible Solution for Windows:

Check by loading the `vECU.dll`, which dynamic libraries are missing using the open source SW "Dependencies".



```
C:\Temp\vECU.dll
    C:\WINDOWS\SysWOW64\kernel32.dll
    C:\WINDOWS\SysWOW64\MSVCRT.dll
    libwinpthread-1.dll
```

PI	Ordinal	Hint	Function

E	Ordinal	Hint	Function

Module	Machine	Type	File Size	Image Base
C:\WINDOWS\SysWOW64\kernel32.dll	i386	Dll; Executable	0x0009db88	0x6b800000
C:\WINDOWS\SysWOW64\MSVCRT.dll	i386	Dll; Executable	0x000bd458	0x10100000
libwinpthread-1.dll	N/A	N/A	N/A	N/A

Loading PE file "C:\Temp\vECU.dll" successful.

Provide the missing info about the dynamic library to the system using the `vECUConf.yaml` options:

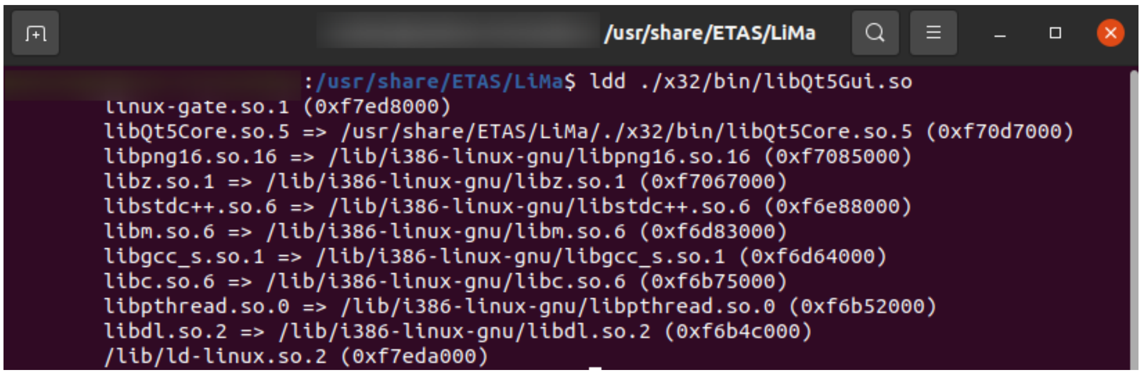
Option 1: (most recommended): Add the library to the resources folder of the `vECU.fmu` using "`additional_resources`".

Option 2: Provide the corresponding path to the missing library using "`environment_variables`".

Possible Solution for Ubuntu 20.04 LTS

To check the dependencies in Linux run `ldd` command on a `*.so` file.

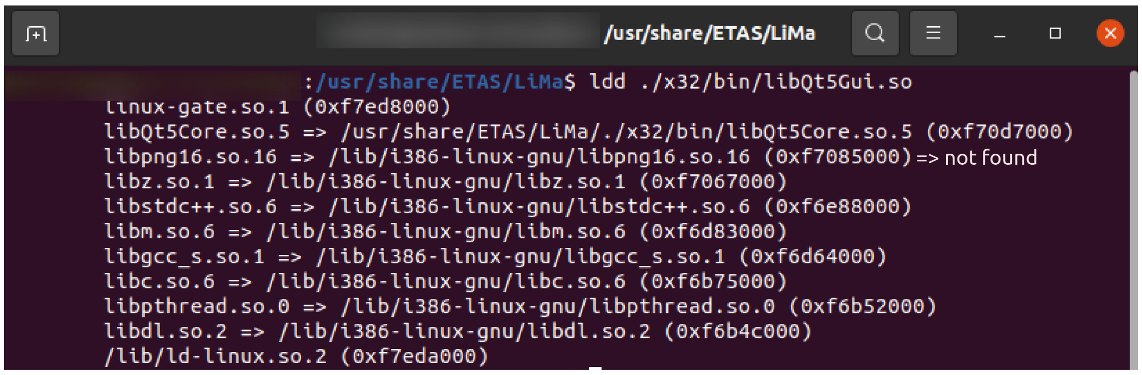
Example: `ldd libQt5Gui.so`



```
[redacted] /usr/share/ETAS/LiMa
[redacted]:/usr/share/ETAS/LiMa$ ldd ./x32/bin/libQt5Gui.so
        linux-gate.so.1 (0xf7ed8000)
        libQt5Core.so.5 => /usr/share/ETAS/LiMa/./x32/bin/libQt5Core.so.5 (0xf70d7000)
        libpng16.so.16 => /lib/i386-linux-gnu/libpng16.so.16 (0xf7085000)
        libz.so.1 => /lib/i386-linux-gnu/libz.so.1 (0xf7067000)
        libstdc++.so.6 => /lib/i386-linux-gnu/libstdc++.so.6 (0xf6e88000)
        libm.so.6 => /lib/i386-linux-gnu/libm.so.6 (0xf6d83000)
        libgcc_s.so.1 => /lib/i386-linux-gnu/libgcc_s.so.1 (0xf6d64000)
        libc.so.6 => /lib/i386-linux-gnu/libc.so.6 (0xf6b75000)
        libpthread.so.0 => /lib/i386-linux-gnu/libpthread.so.0 (0xf6b52000)
        libdl.so.2 => /lib/i386-linux-gnu/libdl.so.2 (0xf6b4c000)
        /lib/ld-linux.so.2 (0xf7eda000)
```

Fig. 8-5: Check dependencies in Linux

This command will give you the list of the dependencies. If one file is missing, this command will give a "**not found**" message.

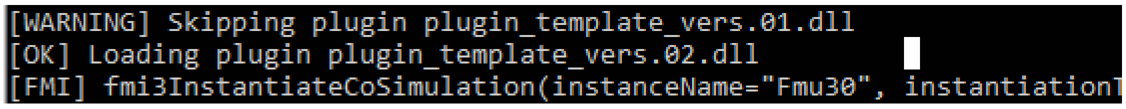


```
[redacted] /usr/share/ETAS/LiMa
[redacted]:/usr/share/ETAS/LiMa$ ldd ./x32/bin/libQt5Gui.so
        linux-gate.so.1 (0xf7ed8000)
        libQt5Core.so.5 => /usr/share/ETAS/LiMa/./x32/bin/libQt5Core.so.5 (0xf70d7000)
        libpng16.so.16 => /lib/i386-linux-gnu/libpng16.so.16 (0xf7085000) => not found
        libz.so.1 => /lib/i386-linux-gnu/libz.so.1 (0xf7067000)
        libstdc++.so.6 => /lib/i386-linux-gnu/libstdc++.so.6 (0xf6e88000)
        libm.so.6 => /lib/i386-linux-gnu/libm.so.6 (0xf6d83000)
        libgcc_s.so.1 => /lib/i386-linux-gnu/libgcc_s.so.1 (0xf6d64000)
        libc.so.6 => /lib/i386-linux-gnu/libc.so.6 (0xf6b75000)
        libpthread.so.0 => /lib/i386-linux-gnu/libpthread.so.0 (0xf6b52000)
        libdl.so.2 => /lib/i386-linux-gnu/libdl.so.2 (0xf6b4c000)
        /lib/ld-linux.so.2 (0xf7eda000)
```

Fig. 8-6: "Not found" message

One way to tell to an application where to search for its SO dependencies is to set `LD_LIBRARY_PATH` to the location where these SO resides.

8.12 Skipping Plugin



```
[WARNING] Skipping plugin plugin_template_vers.01.dll
[OK] Loading plugin plugin_template_vers.02.dll
[FMI] fmi3InstantiateCoSimulation(instanceName="Fmu30", instantiationT
```

Possible Reason

The FMI version set in yaml file configuration does not fit to the plugin version.

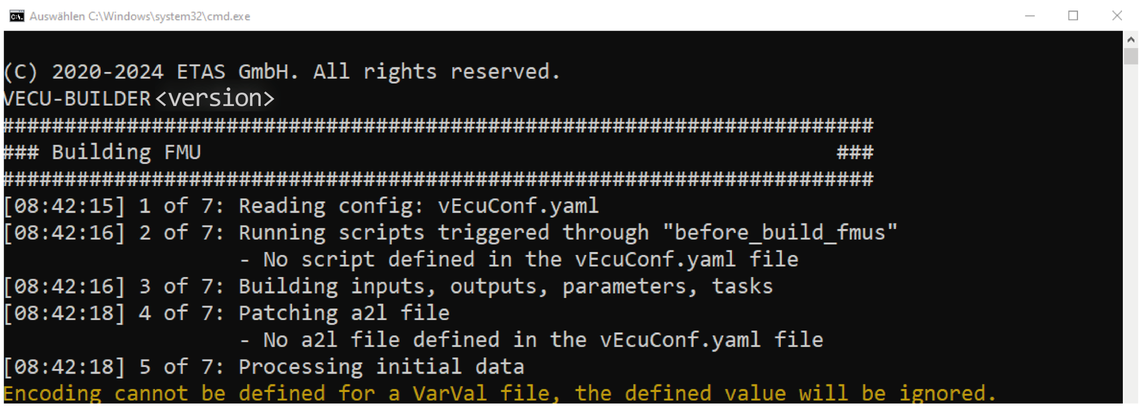
Possible Solution

Check the selected FMI version in the yaml file and make sure that it corresponds to the correct and required plugin version.

- If FMI version is set to 2 in yaml file, then the plugin version must be 1.
- If FMI version is set to 3 in yaml file, then the plugin version must be 2.

If there is no correspondence between FMI version and plugin version, change it accordingly.

8.13 Encoding Cannot Be Defined For a VarVal File



```
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VECU-BUILDER <version>
########################################################################
### Building FMU                                                     ###
########################################################################
[08:42:15] 1 of 7: Reading config: vEcuConf.yaml
[08:42:16] 2 of 7: Running scripts triggered through "before_build_fmus"
                   - No script defined in the vEcuConf.yaml file
[08:42:16] 3 of 7: Building inputs, outputs, parameters, tasks
[08:42:18] 4 of 7: Patching a2l file
                   - No a2l file defined in the vEcuConf.yaml file
[08:42:18] 5 of 7: Processing initial data
Encoding cannot be defined for a VarVal file, the defined value will be ignored.
```

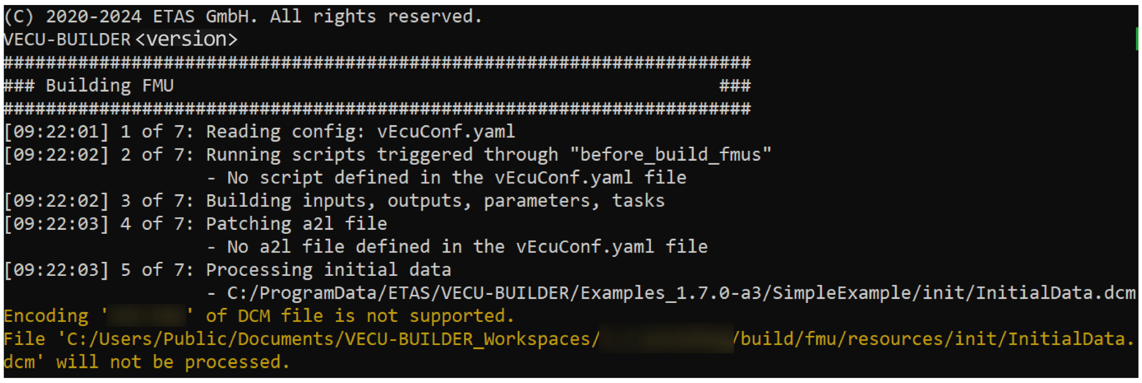
Possible Reason

The encoding was used for VARVAL file and not for DCM file.

Possible Solution

Make sure the encoding is defined for DCM file. For more information, see initial_ data in Configuration chapter.

8.14 Encoding of DCM File is Not Supported



```
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VECU-BUILDER <version>
######################################################################
### Building FMU                                                   ###
######################################################################
[09:22:01] 1 of 7: Reading config: vEcuConf.yaml
[09:22:02] 2 of 7: Running scripts triggered through "before_build_fmus"
                   - No script defined in the vEcuConf.yaml file
[09:22:02] 3 of 7: Building inputs, outputs, parameters, tasks
[09:22:03] 4 of 7: Patching a2l file
                   - No a2l file defined in the vEcuConf.yaml file
[09:22:03] 5 of 7: Processing initial data
                   - C:/ProgramData/ETAS/VECU-BUILDER/Examples_1.7.0-a3/SimpleExample/init/InitialData.dcm
Encoding '[redacted]' of DCM file is not supported.
File 'C:/Users/Public/Documents/VECU-BUILDER_Workspaces/[redacted]/build/fmu/resources/init/InitialData.
dcm' will not be processed.
```

Possible Reason

The used encoding is not supported or there is a misspelling in the encoding.

Possible Solution

Make sure the encoding is supported and there is no misspelling in the encoding.

For more information, see initial_data in Configuration chapter.

9 Contact Information

Technical Support

For details of your local sales office as well as your local technical support team and product hotlines, take a look at the ETAS website:

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