DRIVING **EMBEDDED EXCELLENCE**

LABCAR-MODEL-PMSM V4.3.0

Release Notes

Copyright

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Contents

1 Introduction

1.1 Definitions and Abbreviations

Term/Abbreviation	Definition
EHI	**E**TAS **H**elp Desk **I**nternational
FPGA	Field Programmable Gate Array
HW	Hardware
IGBT	Insulated-Gate Bipolar Transistor
KIR	**K**nown **I**ssue **R**eport – For severe Problem Reports which occur after a release, ETAS has introduced the Known Issue Report to inform affected customer immediately. The current Known Issues of former versions can be found on the ETAS website: http://www.etas.com/kir
LVM	ETAS LABCAR VARIANT MANAGEMENT
LUT	Lookup table
MCU	Motor Control Unit
PDF	Portable Document Format
PMSM	Permanent Magnet Synchronous Motor
PR	Problem Report
RT	Realtime
SW	Software
LCO	ETAS LABCAR-OPERATOR

1.2 References

The following references are used in this document:

[1] Documentation of FlexibleFPGA V3.0.0. It is installed along with the product documentation as "FlexibleFPGA_V3.0.0_EN.pdf".

1.3 Conventions

The following typographical conventions are used in this document:

Choose **File → Open**.	Menu commands are shown in boldface.
Click **OK**.	Buttons are shown in boldface.
Press <ENTER>.	Keyboard commands are shown in angled brackets.
The "Open File" dialog box is displayed.	Names of program windows, dialog boxes, fields, etc. are shown in quotation marks.
`Select the file setup.exe`	Text in drop-down lists on the screen, program code, as well as path- and file names are shown in the Courier font.
A *distribution* is always a one-dimensional table of sample points.	General emphasis and new terms are set in italics.

1.4　　　User Documentation

The LABCAR-MODEL-PMSM user's documentation in PDF format is available on the DVD.

2　　　Product Definition

2.1　　　Functions at a glance

LABCAR-MODEL-PMSM is an FPGA-based simulation model of a permanent magnet synchronous electrical motor with a three-phase e-motor system. It is capable of running in real-time simulations and allows for a closed-loop operation with an MCU at the signal level. It includes component models for an inverter, for a PMSM e-motor, and for a drivetrain.

The simulation model considers the operating battery/DC voltage in a range of 0…1000 V, operating phase currents of ±8191 A, operating torques in a range of ±400 Nm, and an operating range of a (mechanical) rotor speed of ±30,000 rpm.

LABCAR-MODEL-PMSM uses a flux model in rotor coordinate system to emulate PMSM motor behaviour. The temperature effect on resistances of the motor can be parameterized. The non-linear behaviour of the iron core – caused by saturation effects – can be considered for simulation with a LUT (I_D and I_Q w.r.t to flux in D and Q-axis, respectively) in the FPGA to cover the fast dynamics. The model can be operated in a linear mode, where the inductances L_D and L_Q are constant, or in a non-linear mode, where saturation effects are considered and I_D and I_Q are functions of the fluxes in D- and Q-axis. A Simulink module is provided to download the I_D and I_Q parameter variation w.r.t fluxes in D-and Q-axis to the FPGA.

The following inverter fault conditions can be simulated: (i) IGBT is stuck on "High", (ii) IGBT is stuck on "Low", (iii) anti-parallel diode is stuck on "High", (iv) anti-parallel diode is stuck on "Low". The resistances of the inverter IGBTs, of the antiparallel diodes and of the intermediate circuit effect can be considered in a simulation.

The drivetrain has the following features: (i) two-mass-spring-damper system transforming the engine torque into a velocity of the connected masses, (ii) elastic shaft simulation with spring damper characteristics, (iii) an interface to connect to an external drivetrain simulation via speed interface.

Various signals like phase currents, DC bus voltage etc. are available at analogue output multiplexer to simulate the sensors behaviour/characteristics. The simulation model does not take frequency dependent effects, like skin effect and spatial harmonics of PMSM motor, into consideration.

2.2　　　General Description

2.2.1　　System Prerequisites

The following minimum system prerequisites have to be met:

Required Hardware	1,0 GHz PC (x86_64)
	1 GB RAM
	DVD-ROM drive
	Network adapter
	Graphics with a resolution of at least 1024 x 768, 32 MB RAM

	ETAS ES5340.2-M
	FlexibleFPGA Runtime License

Required Free Disk Space	1 GB (not including the size for application data)

The following system prerequisites are recommended:

Recommended Hardware	2,0 GHz Dual-Core PC or equivalent (x86_64)
	2 GB RAM
	DVD-ROM drive
	Network adapter
	Graphics with a resolution of 1920 x 1280, 1 GB RAM
	ETAS ES5340.2-M
	FlexibleFPGA Runtime License

Recommended Free Disk Space	>2,0 GB

2.2.2 Software Prerequisites

The following software prerequisites are recommended:

Operating System	Microsoft Windows 10 Version 1703 or higher
ETAS LABCAR-OPERATOR	V5.4.10
ETAS RTPC	V6.4.0

2.2.3 Release Test Configuration

The simulation model has been developed and tested using ETAS LABCAR-OPERATOR V5.4.10 and MATLAB 2018b 64bit.

The model may also work with other versions of this software.

2.2.4 Restrictions

Not applicable

2.2.5 Miscellaneous

Not applicable

2.3   Delivery

The software is delivered on a DVD including LABCAR-MODEL-PMSM software, documentation, tools, utilities, and further information. All software documentation is available in the Portable Document Format (PDF), which requires Adobe Reader.

The DVD contains the following items:

Directory	Meaning / Explanation
Documentation	General and model-specific user documentation
Documentation \ OSS	Source codes of used open source components
Installation	Installation files for this product

2.3.1   Used 3rd Party Software

Not applicable

2.4   Installation

2.4.1   Installation Hints

Installation is required to use ETAS LABCAR-MODEL products. Please execute the file setup.exe in the Installation folder of this DVD. Please take a look at the Chapter "Installation" in the User's Guide to learn about the files and folders that will be installed by this procedure.

LABCAR-MODEL-PMSM is a FlexibleFPGA-based model. Hence, the installation of the model to the ES5340.2-M follows the standard process of all FlexibleFPGA based models. You can find all details in the documentation of FlexibleFPGA V3.0.0, cf. chap. "3.5. Flashing the ES5340 FPGA onto the Board" on page 56 [1].

2.5   Licensing

The LABCAR-MODEL-PMSM runtime depends on the serial number of your ES5340.2-M board. This serial number can be obtained from the "HSP" tool using the "Hardware" windows. Please report this serial number to ETAS when requesting a license for this model.

Once the license is available, please refer LABCAR-MODEL User's Guide Section 6.5.4 License Key interface and Section 6.6.1 PMSM Runtime License to know the description of license key interface and how to configure the PMSM runtime license in experimentation.

3   Changes

This chapter describes changes with respect to the previous version of LABCAR-MODEL-PMSM.

3.1   What's New

Changes from V4.2.0 to V4.3.0:
- Enhanced Product documentation for migration from V1.0 to V4.x.
- RPM output of drive train load available in experimentation

Changes from V4.1.1 to V4.2.0:
- Enhanced Product Documentation

Changes from V4.0.1 to V4.1.1:
- Fixed incorrect inverter computation
- Tool for inverting flux current maps added
- Sample LCO projects added
- Enhancement of documentation
- Updated licensing mechanism
- Standard installation of the product

Changes from V4.0.0 to V4.0.1:
- Extended states computations with fixed-point arithmetic
- Reduced computational latency
- Support of LABCAR VARIANT MANAGEMENT

Changes from V1.0.0 to V4.0.0:
- Linear and non-linear behaviour of e-machine with LUT inside FPGA and iron losses.
- Ideal and Ohmic behaviour of inverter.
- Fault insertions for IGBT and diode.
- Temperature dependency on resistances of inverter (IGBT switch, diode) and motor.
- New licensing mechanism

3.2   Compatibility to Earlier Releases

This release of LABCAR-MODEL-PMSM supersedes all older PMSM releases. Please refer to LABCAR-MODEL User's Guide Section 6.7 for a detailed migration guide from older PMSM models. Get in contact with the user support if you need further support to upgrade from an older release.

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3.3 Fixed Problems

This section describes the set of fixed problems of the released version of LABCAR-MODEL-PMSM.

Version	JIRA/TFS No.	Title
4.3.0	EHI 639498	RPM-Modus „Master with Angle Adaptation" not working
	EHI 636537	PMSM V4.1.1 not working at customer site due to BASIC example project does not work correctly
	LM-2808	Incorrect version number shown in HSP
4.2.0	EHI 637606	Documentation should explain how to save license keys
	EHI 636714	Shift "PMSM Debug" layer to separate file
	EHI 636537	Example project does not work correctly
	EHI 632304	Case specifier can lead to over voltage in inverter
4.1.1	EHI 616199	PMSM inverter issues correction
	EHI 624376	LCO Projects contained on ISO use recommended LCO version
4.0.1	LM-431, LM-622	5A current flowing when PMSM is shutdown

3.4 Known Issue Reports

If a product issue develops, ETAS will prepare a Known Issue Report (KIR) and post it on the internet. The report includes information regarding the technical impact and status of the solution. Therefore, you must check the KIR applicable to this ETAS product version and follow the relevant instructions prior to operation of the product.

The Known Issue Report (KIR) is available online: http://www.etas.com/kir

3.5 Known Issues

This section describes the set of known problems of the released version of LABCAR-MODEL-PMSM.

3.5.1 Software related Items

Problem Number	Title
LM-2950	Drivetrain simulation modes switching issue:
	The drivetrain of the LABCAR-MODEL-PMSM model offers two operations modes. Torque Input and Speed Input. They differ fundamentally in their calculation and could lead to a situation to partially break the physics of the model when switching the mode. Hence mode switching could lead to overall model instability.

3.5.2 Hardware related Items

Problem Number	Title
-	-

4 Hints

Not applicable.

5 Hotfix Information

LABCAR-MODEL-PMSM V4.3.0 contains all the fixes included in LABCAR-MODEL-PMSM V4.2.0 HF1.

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6   **Contact, Support and Problem Reporting**

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:

ETAS subsidiaries   WWW: www.etas.com/en/contact.php
ETAS technical support   WWW: www.etas.com/en/hotlines.php