Altair® FluxMotor® 2025.1

Release Notes

Updated: 06/10/2025

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Contents

Introduction

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This chapter covers the following:

1.1 What's new in Altair® FluxMotor® 2025.1

Overview

The main information about Altair® FluxMotor® 2025.1 are described below.

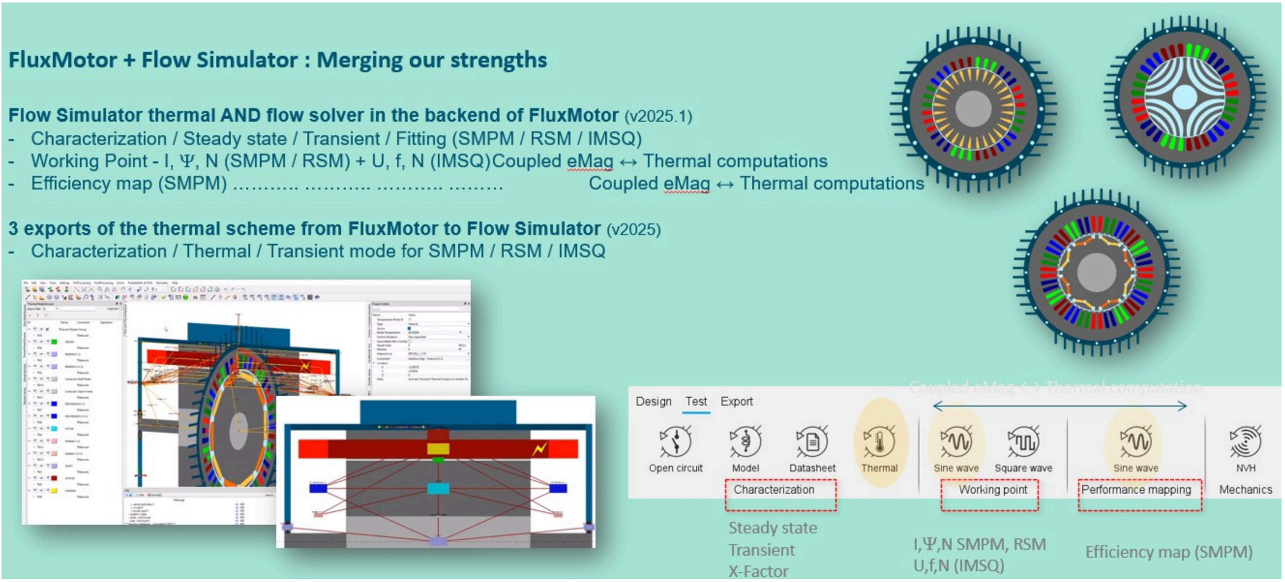
For more detailed information, please refer to the user help guides. The list of documents to read is presented below.

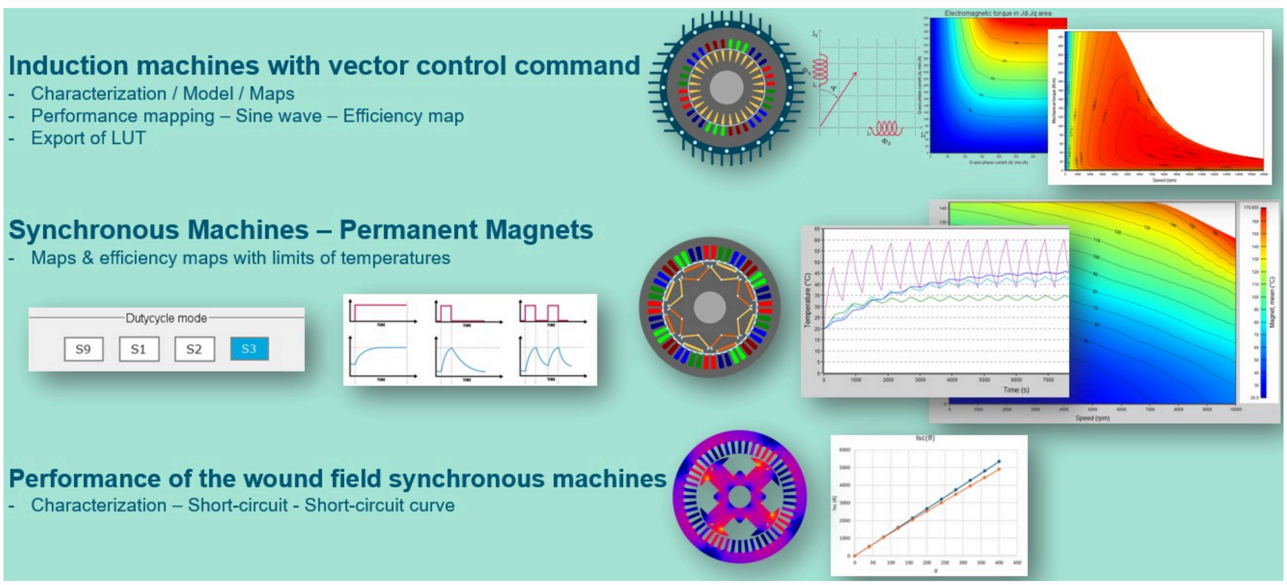
Here are the highlights of the new version:

- **Flow Simulator thermal and flow solver in the back end of FluxMotor (v2025.1)**
    - Characterization / Steady state / Transient / Fitting (SMPM / RSM / IMSQ)
    - Working Point - I, Ψ, N (SMPM / RSM) + U, f, N (IMSQ) - Coupled eMag ↔ Thermal computations
    - Efficiency map (SMPM) - Coupled eMag ↔ Thermal computations
- **Induction machines with vector control command**
    - Characterization / Model / Maps
    - Performance mapping – Sine wave – Efficiency map
    - Export of LUT
- **Synchronous Machines - Permanent Magnets**
    - Maps & efficiency maps with limits of temperatures
- **Performance of the wound field synchronous machines**
    - Characterization – Short-circuit - Short-circuit curve
- **Sketcher SimLab - FluxMotor**
    - To make the part topology definition easier
    - Parameterized parts (Except structural data) for SMPM – Library of slot is available in SimLab
- **Material management improvements**
    - Multi-segment lamination model
    - Management of the stacking factor at the design stage
- **New Supervisor / GUI / Workflow**
- **New connector for HyperStudy dedicated to one test of the wound field synchronous machines**
    - The computation of a Working Point (P/Sn, Pf, U, N) – Motor or Generator operating mode
- **Correction of issues**

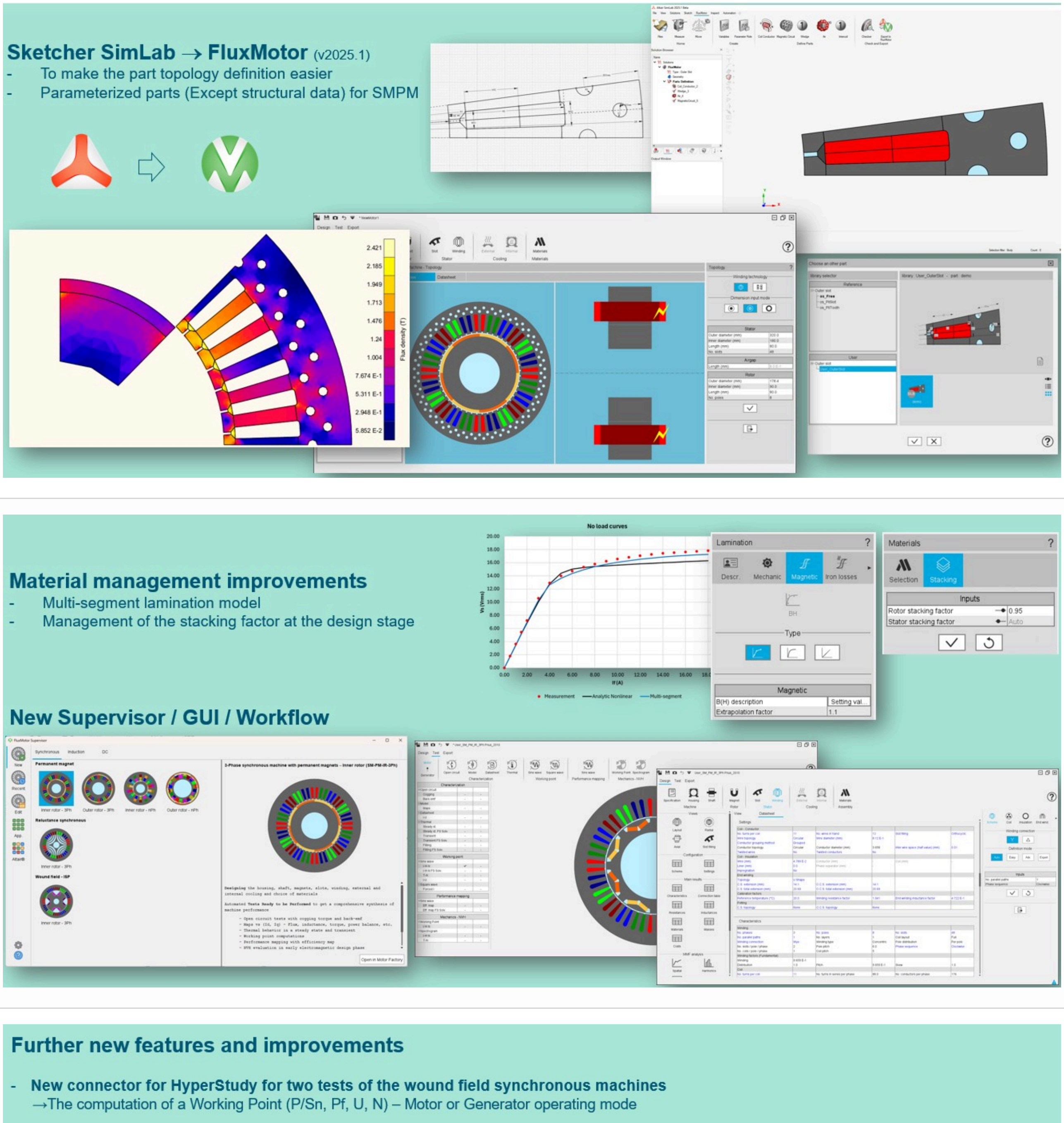
All the added new features are briefly described below, followed by an update on issues and bugs.

Brief illustration of the key new features





FluxMotor 2025.1 – The key features



FluxMotor 2025.1 – The key features

1.2 Documents to read

It is highly recommended to read the following user guides before using Altair® FluxMotor®:

Installation Guide

- InstallationGuide_Flux_FluxMotor_2025.1.pdf

General user guides for any type of machine - Inner and Outer Rotor

- Supervisor_2025.1.pdf
- MotorCatalog_2025.1.pdf
- PartLibrary_2025.1.pdf
- PartFactory_2025.1.pdf
- Materials_2025.1.pdf
- ScriptFactory_2025.1.pdf
- MotorFactory_2025.1_Introduction.pdf
- MotorFactory_2025.1_Test_BestPractices.pdf
- MotorFactory_2025.1_Windings.pdf

Synchronous Machines with Permanent Magnets (SM PM) - Inner and Outer Rotor

- MotorFactory_2025.1_SMPM_IOR_Design.pdf
- MotorFactory_2025.1_SMPM_IOR_3PH_Test_Introduction.pdf
- MotorFactory_2025.1_SMPM_IOR_3PH_Test_Characterization.pdf
- MotorFactory_2025.1_SMPM_IOR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2025.1_SMPM_IOR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2025.1_SMPM_IR_3PH_Test_Mechanics.pdf
- MotorFactory_2025.1_SMPM_IOR_Export.pdf

Reluctance Synchronous Machines (SM RSM) - Inner Rotor

- MotorFactory_2025.1_SMRSM_IR_3PH_Design.pdf
- MotorFactory_2025.1_SMRSM_IR_3PH_Test_Introduction.pdf
- MotorFactory_2025.1_SMRSM_IR_3PH_Test_Characterization.pdf
- MotorFactory_2025.1_SMRSM_IR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2025.1_SMRSM_IR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2025.1_SMRSM_IR_3PH_Test_Mechanics.pdf
- MotorFactory_2025.1_SMRSM_IR_3PH_Export.pdf

Wound Field Synchronous Machines (SM WF) - Inner Salient Poles - Inner Rotor

- MotorFactory_2025.1_SMWF_ISP_IR_3PH_Design.pdf
- MotorFactory_2025.1_SMWF_ISP_IR_3PH_Test_Introduction.pdf
- MotorFactory_2025.1_SMWF_ISP_IR_3PH_Test_Characterization.pdf
- MotorFactory_2025.1_SMWF_ISP_IR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2025.1_SMWF_ISP_IR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2025.1_SMWF_ISP_IR_3PH_Export.pdf

Induction Machines with Squirrel Cage (IM SQ) - Inner and Outer Rotor

- MotorFactory_2025.1_IMSQ_IOR_3PH_Design.pdf
- MotorFactory_2025.1_IMSQ_IOR_3PH_Test_Introduction.pdf
- MotorFactory_2025.1_IMSQ_IOR_3PH_Test_Characterization.pdf
- MotorFactory_2025.1_IMSQ_IOR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2025.1_IMSQ_IOR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2025.1_IMSQ_IR_3PH_Test_Mechanics.pdf
- MotorFactory_2025.1_IMSQ_IOR_3PH_Export.pdf

DC Permanent Magnet machines (DC PM) – Inner Rotor

- MotorFactory_2025.1_DCPM_IR_Design.pdf
- MotorFactory_2025.1_DCPM_IR_Test_Introduction.pdf
- MotorFactory_2025.1_DCPM_IR_Test_WorkingPoint.pdf
- MotorFactory_2025.1_DCPM_IR_Export.pdf

List of new features 2

This chapter covers the following:

2.1 New thermal and flow solver

Introduction

Altair® FluxMotor® 2025 introduces a significant enhancement to thermal analysis capabilities by replacing our legacy thermal solver with a new solution based on a generalized lumped parameter model powered by Altair® Flow Simulator. While the frontend interface and workflow remain unchanged, this upgrade brings enhanced accuracy thanks to the integration of a powerful backend solver that couples a lumped thermal network with a fluid flow network.

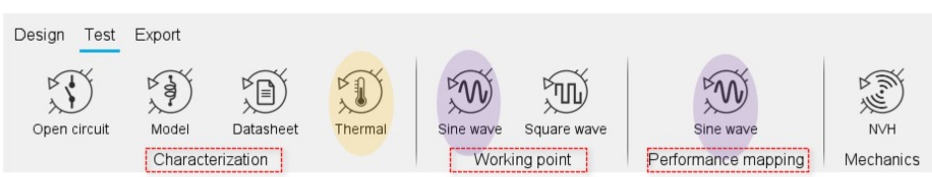
The previous solver already generated a lumped parameter network adapted to machine geometry. Building on this solid foundation, the new backend model introduces an additional fluid network that enhances our ability to simulate complex convective heat transfer mechanisms - such as cooling circuits and thermal exchanges between the frame and ambient, further improving accuracy.

Enhanced tests

This backend upgrade benefits all the tests, including thermal resolution (both pure thermal and coupled electromagnetic – thermal simulation) for all machine topologies supporting thermal analysis. In other words, our previous solver is no longer used.

Below, one will find the complete list of impacted tests:

- Characterization – Thermal (thermal simulation)
  - Steady State
  - Transient
  - Fitting
- Working point – Sine wave (coupled electromagnetic – thermal simulation)
  - I-Ψ-N
- Performance mapping – Sine wave
  - Efficiency map



Test families enhanced by the backend solver update.

In yellow thermal tests and in pink coupled electromagnetic-thermal tests

Reminder – The proposed thermal / flow network

1. Customizable thermal network – the constellation method

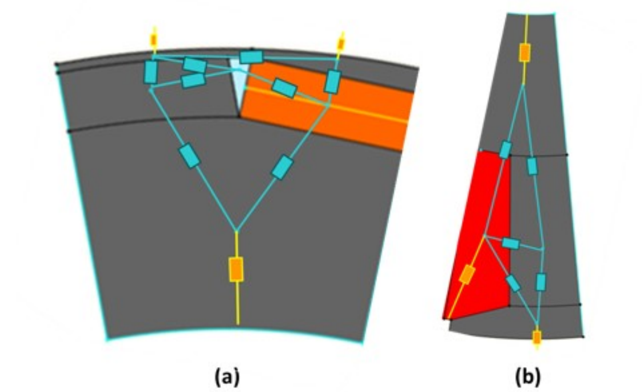
   The proposed thermal network is based on a general scheme where the number of thermal resistances is fixed for some well-known regions in which geometrical changes can be modeled through variable parametrization. These regions are the shaft, the bearings, and the housing (end caps included).

   On the contrary, the local grid of some regions is highly dependent on the chosen topology and should be particularized to achieve the essential goals of maximum customization and versatility during the design stage. These regions are mainly the rotor and the stator (including the winding). Due to their high interaction with these areas, the airgap and the end-spaces also require a customized grid.

   Stator and rotor geometries, especially the latter, are subject to big changes during predesign, even for a fixed number of slots or poles. Different shapes and number of magnets per pole, the existence of holes in the active parts and shoes next to the airgap are usual. These modifications, which have an important impact on the machine's performance, are usually difficult to parametrize.

   The best solution to this challenge is the use of a customizable grid defined using the constellation method, which can be summarized in the next points:

   - Since only radial electric machines are considered, the radial cut of the rotor and stator are defined as the rotor part and stator part, respectively. These parts are composed of different surfaces, which are represented by their material (generally steel, air, magnets or conductor) and their central point (i.e., their barycenter).
   - Barycenters of neighboring surfaces will be connected by a thermal resistance. These resistances will form the part constellation. Thermal resistances between non-neighboring surfaces are supposed to be infinite.
   - Surfaces in contact with external frontiers will be connected to them by thermal resistances (i.e., in the radial plane, these frontiers are the airgap and the shaft for the rotor part and the airgap and the frame for the stator part).
   - It is considered that every surface in stator and rotor parts is in contact with both end-spaces; therefore, thermal resistance must link them to these regions. These resistances are the only ones that are not contained in the considered radial plane.



Thermal constellation of a rotor (a) and stator (b) part.

In blue, thermal resistances link internal surfaces. In yellow, resistances link surfaces with part frontiers.

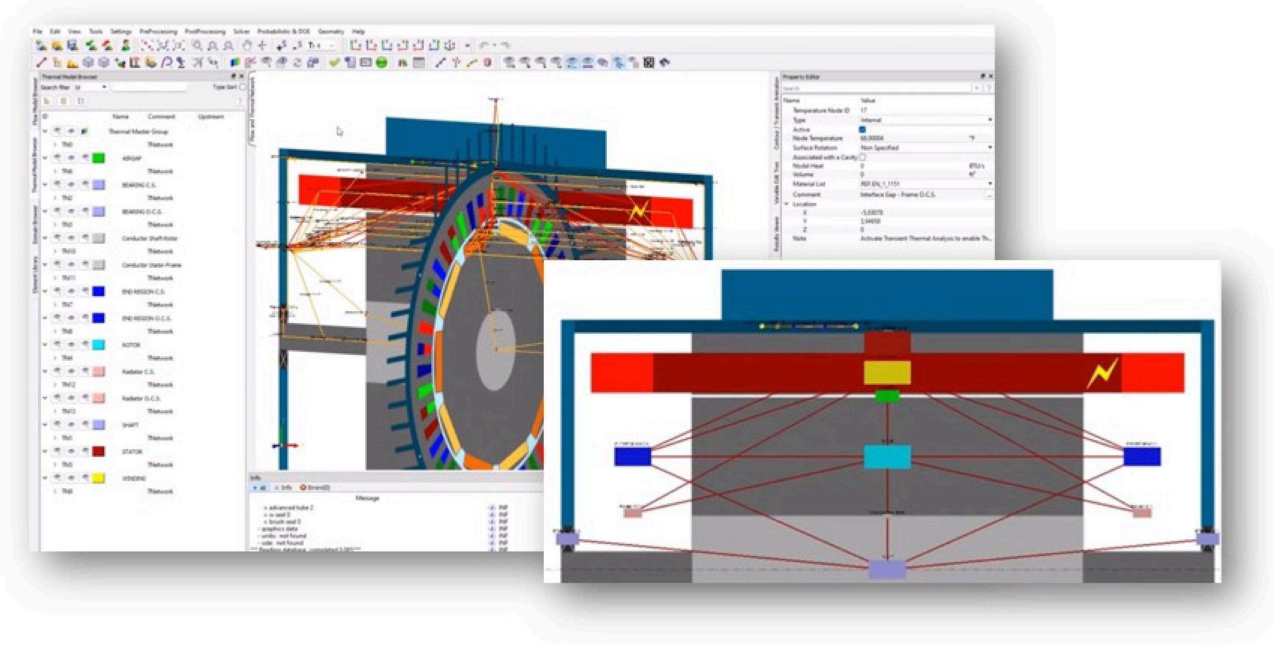
2. Coupling with flow network

   The fluidic network is coupled with the thermal one at specific points where convection plays a critical role in heat dissipation, most notably between the stator and the cooling circuit and in the interaction between the housing and the ambient air. These areas involve complex and often non-uniform fluid behavior, which significantly impacts the overall thermal performance. By integrating a flow network, the solver can accurately compute fluid temperatures, pressure and speed, leading to more reliable estimations of heat transfer in scenarios where the cooling fluid properties or flow conditions may vary along the considered paths.
3. Visualization of the thermal network

   The global network can be displayed in a 3D view in Flow Simulator through the dedicated exports.

   A dual view is proposed, where the components can be visualized independently or as part of dedicated functional blocks (stator, rotor, shaft, etc.). This visualization allows, at the same time the possibility to show a meaningful global view containing the main heat paths or, on the contrary, to have the deepest insight into one or several regions of interest. Each group can be expanded or collapsed independently.

   Once in Flow Simulator, the thermal circuit can be solved, and any kind of modification in thermal resistance values or grid connections can be added.



Examples of visualization of thermal networks in Altair® Flow Simulator

Disclaimer: thermal and coupled tests run with previous versions

As a result of this transition, some differences may be observed in the temperature results when comparing simulations run with the previous solver and those using the updated backend. While these differences are expected, a review of thermal results is recommended; if necessary, models could be updated through thermal X factors.

For this purpose, a dedicated process is proposed in a test: Characterization -> Thermal -> Thermal Fitting, now available for all machine topologies supporting thermal analysis: SMPM, RSM, and IMSQ. This test enables easy calibration to align your results with experimental data or legacy expectations when needed.

Looking ahead, this transition not only strengthens the robustness of current thermal simulations but also lays the groundwork for future developments. The inclusion of a lumped flow network will allow the modeling of more sophisticated cooling strategies, which will be progressively integrated into upcoming versions.

2.2 Auto calibration of thermal X-Factors

Introduction

The "Characterization – Thermal – Motor & Generator – Fitting" test has been generalized for IMSQ IR and RSM IR machines.

Whatever the machine considered, FluxMotor creates a thermal network based on the machine topology design. However, if needed, it is possible to adjust the thermal resistances with some calibration factors (X-Factors, for external cooling as well as internal cooling) to be consistent with the measurement results, for instance. This has an impact on the resulting temperatures one gets in steady state or transient mode.

The aim of Characterization – Thermal – Motor & Generator – Fitting test is a fully automatic calibration for the X-factors. A set of target temperatures is proposed; the test output is the set of X-Factors to be applied for reaching the targeted temperatures.

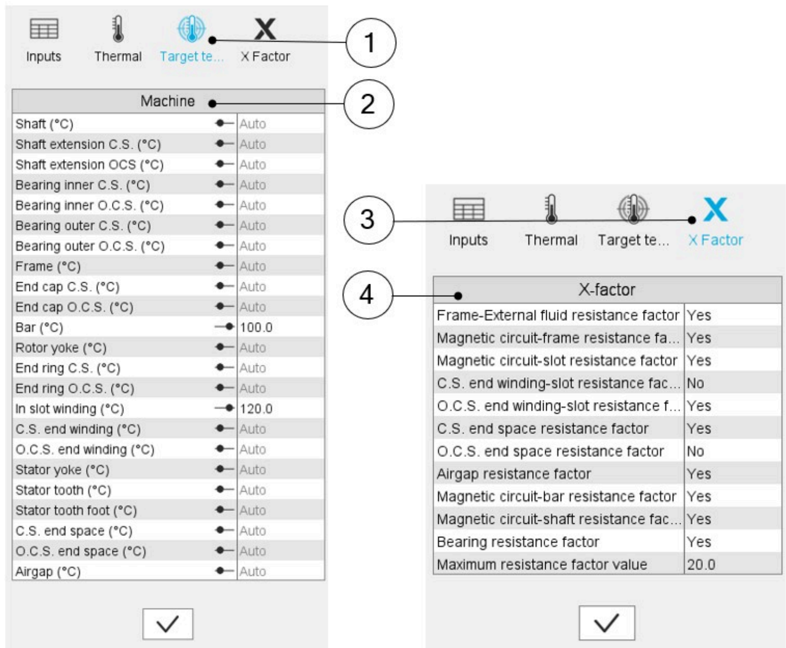
This can be used either when the users want to impose the reference temperatures that are coming from measurements or when the users want to keep the same temperatures whatever the modifications to the internal thermal model architecture.

> **Note:** This test is based on a steady state thermal computation.

> **Note:** This test is especially useful to fit the results obtained with thermal tests obtained from computations done with previous FluxMotor versions since version 2025.1 uses a new backend thermal solver (Altair® Flow Simulator™).

Targeted temperatures and X-Factors

The aim of this dialog box is to collect the targeted temperatures to be reached. They are defined at each main node of the internal thermal network. See the illustration below.



List of targeted temperatures and list of the calibration factors (X-Factors) to be considered. Example of an IMSQ machine

1	Selection of target temperatures
2	Auto/User mode switches allow you to select the thermal nodes and set the corresponding target temperatures.
3	Selection of calibration factors (X-Factors)
4	List of the calibration factors (X-Factors) to be considered during the fitting process. By default, all the X-Factors are considered for the fitting process. The user must select the ones that must not be considered while operating the process. Set the value to No when the corresponding X-Factors must not be considered during the process.

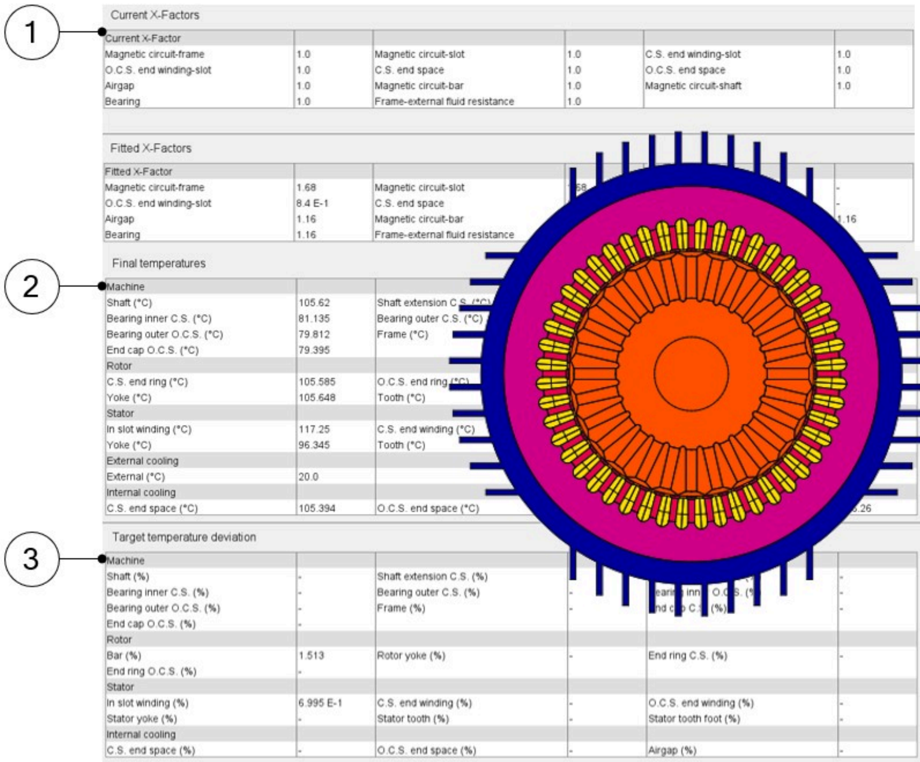


Illustration of results. Example of a RSM machine	
1	Calibration factors – Initial and final values are displayed.
2	Final temperatures resulting from the fitting process.
3	Resulting deviation between the initial temperature values and the final ones. This allows us to evaluate the impact of the fitting process.

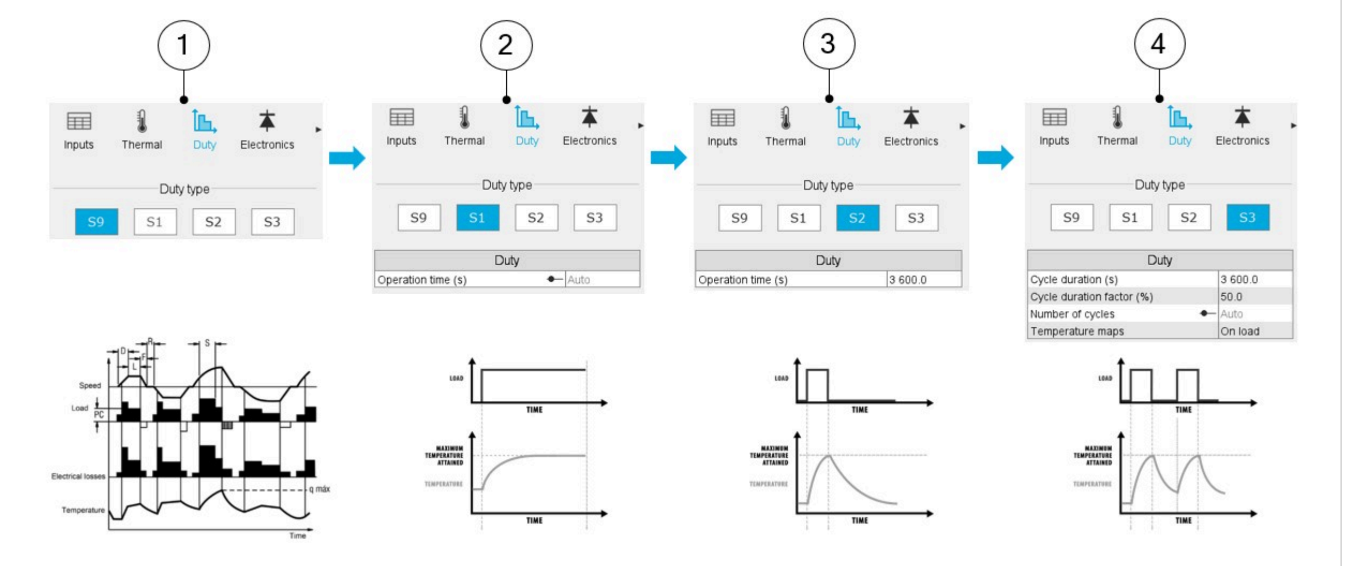
2.3 Efficiency map & temperature limits

In the current version, a powerful enhancement to the Efficiency Map Test is introduced: the integration of standard duty types and the corresponding thermal limit analysis.

This new feature brings together electromagnetic and thermal simulation by enabling users to visualize temperature maps over the entire operating range of a motor under standardized duty cycles (S1, S2, S3). The feature provides deep insight into the thermal limits of the machine that are critical for optimizing reliability, cooling strategies, and motor performance in real-world industrial applications.

Users will find the following key functionalities:

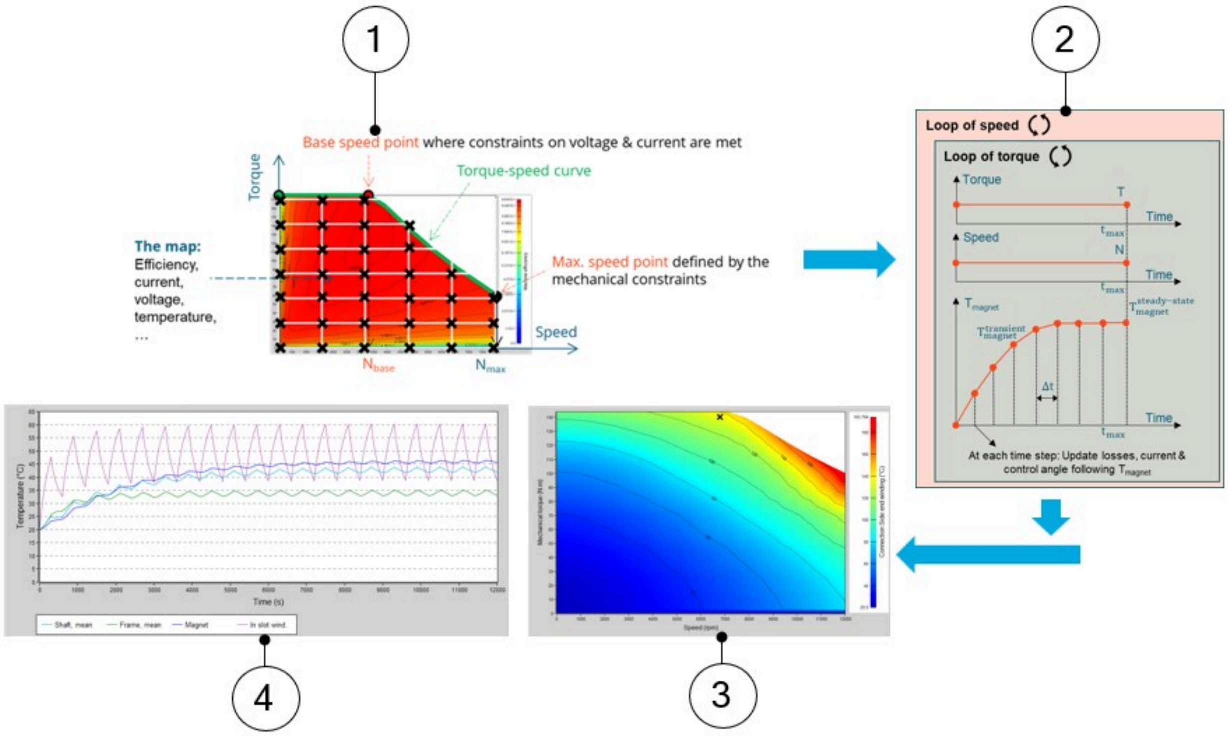
- Standard Duty Cycle Integration: In addition to the user-defined S9 mode, users can now select from three commonly used IEC-standard duty types:
    - S1 (Continuous)
    - S2 (Short-Time)
    - S3 (Intermittent Periodic)



New Duty settings with the four choices S9, S1, S2, and S3

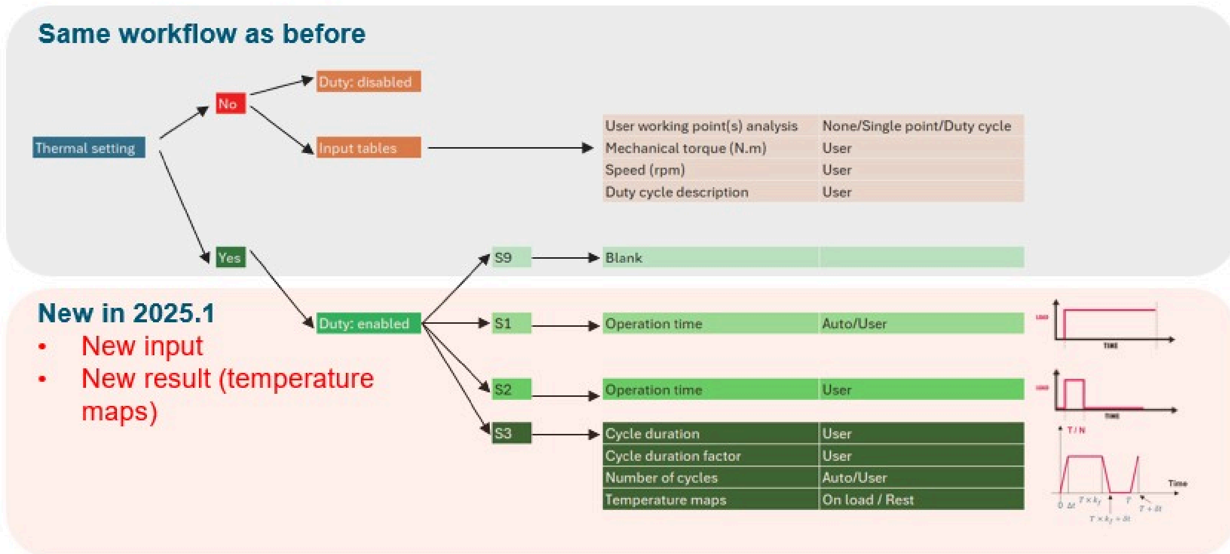
- Temperature Map Generation:
    - For each torque-speed operating point, the motor is simulated under the chosen duty.
    - At the end of the duty pattern, the steady-state or cycle-end temperature is recorded.
    - A complete thermal map is produced, visualizing hot zones and thermal risks.
- Auto Mode Support:
    - For S1 and S3, automatic cycle duration estimation is available based on the thermal time constant of the machine (typically 5× time constant), ensuring sufficient time to reach steady-state or periodic stability.

- Temperature Evolution Curves:
  - Users can select any working point to plot temperature vs. time, enabling assessment of heating and cooling dynamics across different duty profiles.



Workflow to include the temperature maps in the efficiency map test of SMPM	
1	Electromagnetic computation to deduce the efficiency map test
2	Looping through all working points to find the machine temperature using selected duty (S1/S2/S3)
3	Collect temperature at all thermal nodes to display temperature maps with contours
4	Run a final duty computation to analyze the time evolution of temperatures at a specific working point required by users

- Flexible Input & Familiar Workflow:
  - The same torque-speed input table is retained for ease of use.
  - Clear configuration path: enable/disable thermal coupling, select duty type, and adjust thermal components with intuitive inputs.



Flexible input & familiar workflow even with the added features

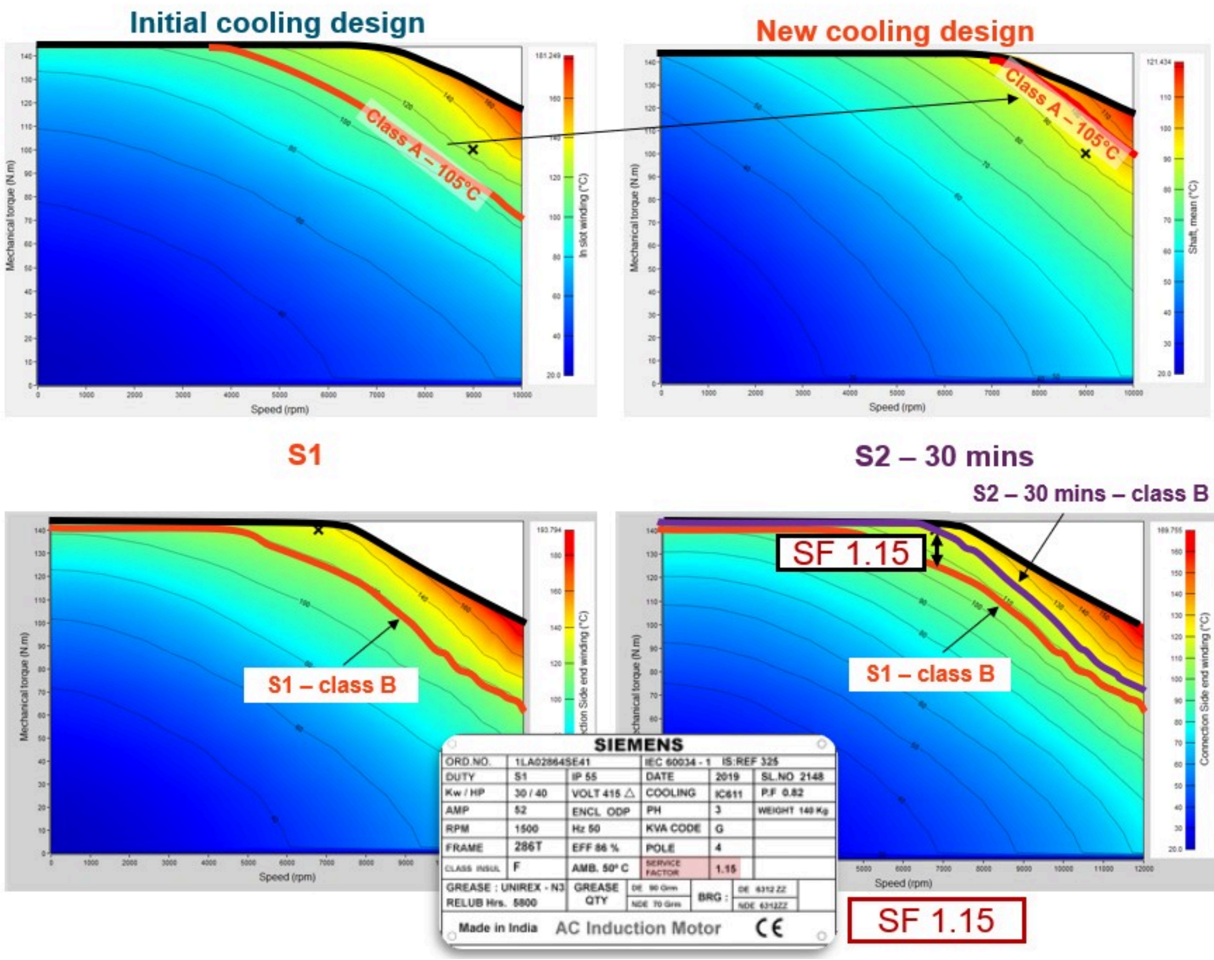
- Thermal Class & Design Decisions:
  - Temperature maps support direct comparison with winding thermal classes.
  - Users can quickly identify if a winding upgrade or cooling system modification is required to meet performance goals.

In terms of performance and computation time, here below is a list of rules of thumb:

- Computation time is influenced only by the thermal simulation layer.
- On average, each temperature point requires ~3 seconds to compute.
- Total time = (torque points x 2 × speed points × 3 seconds).
- Default configurations typically run in 10–12 minutes, with faster or more detailed options available via grid refinement.

With these new features, users can have a lot of benefits, such as:

- Early detection of thermal risks and temperature hotspots
- Faster decision-making regarding thermal class and cooling strategies
- Improved accuracy in motor dimensioning under real-world operating profiles
- Optimized design without excessive prototyping or late-stage thermal surprises



Applications of the temperature maps: adjusting thermal class, cooling system or exploring service factor

This feature is available for SMPM in FluxMotor 2025.1. Expansion to additional motor types is planned in future releases, alongside ongoing GUI improvements and visualization tools for thermal data.

2.4 Short-circuit curve - Wound field synchronous machines

The aim of the test "Characterization – Short circuit – Generator – Short-Circuit" is to characterize the behavior of the machine when running in a three-phase short-circuit state and to provide the short-circuit curve by considering several field currents.

The analysis of the machine's short-circuit characteristics is a first step to evaluate the relevance of the machine design regarding not only parameters such as topology, winding architecture, composition of coils and choice of materials, but also the impact of the applied field current value on the short-circuit characteristics of the machine - including potential non-linear behavior.

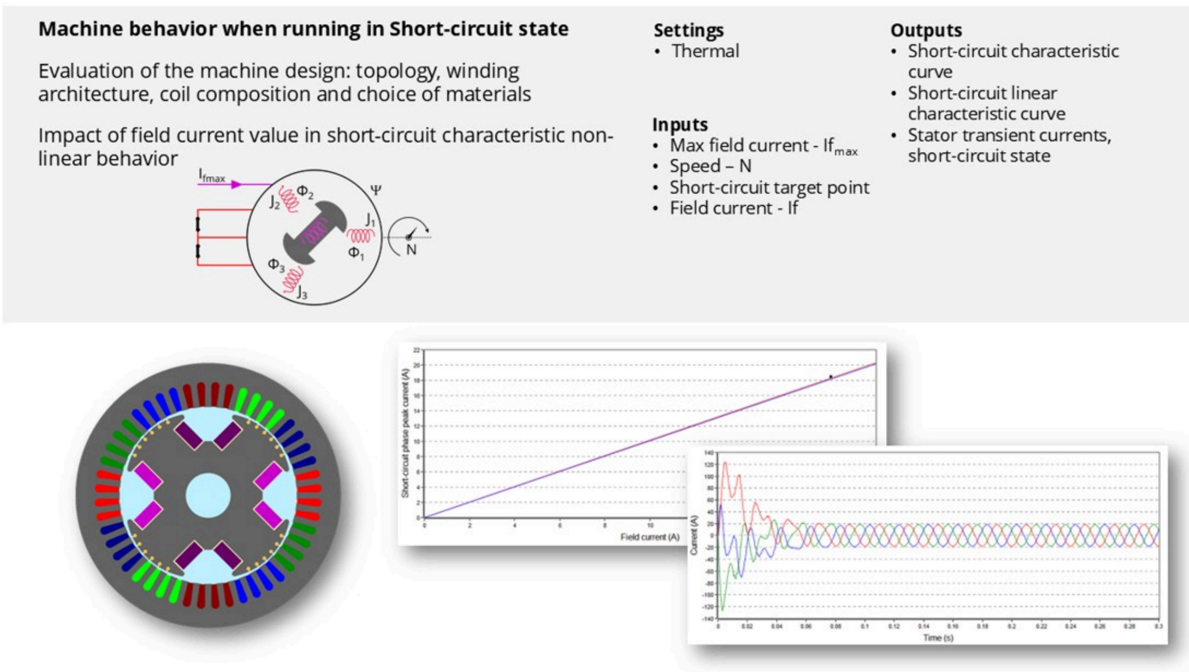
> **Warning:** When a delta winding connection is considered, the computation doesn't consider circulation currents. That can lead to a different result than what was expected in transient computation.
>
> In such a case, it is recommended to perform a transient computation in Flux® environment. The application "Export to Flux" allows exporting the model with the corresponding scenario ready to be solved.

- User inputs

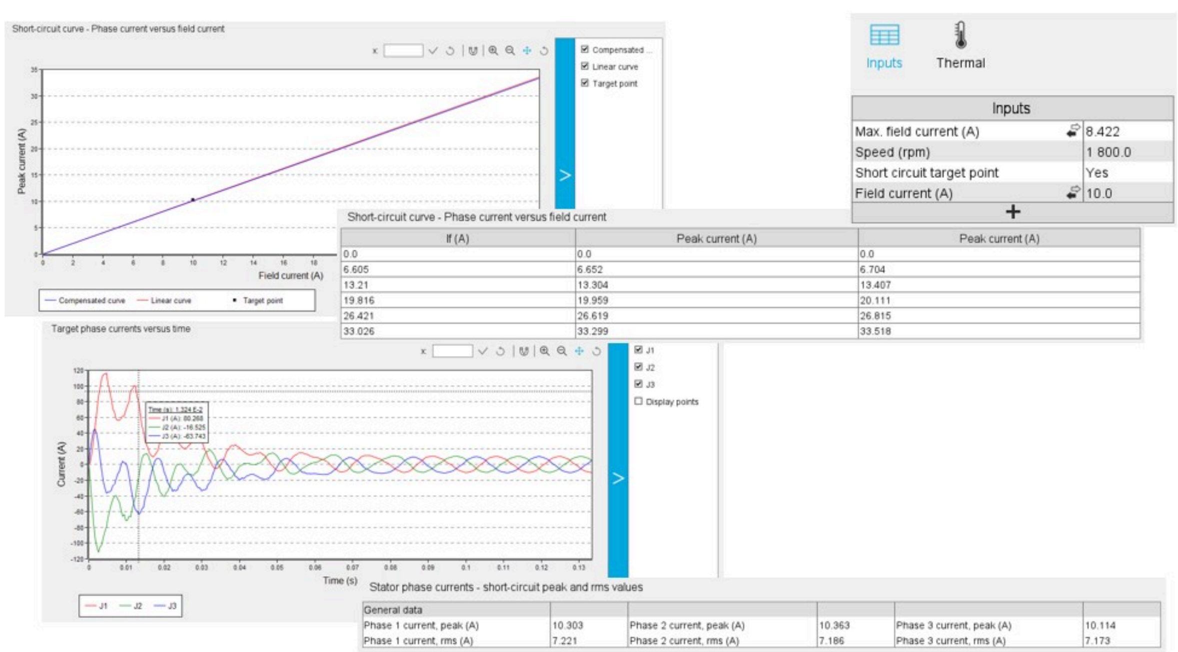
  The maximum field current value (or equivalent maximum field current density) and the rotation speed are the only necessary standard input parameters to run this test. The operating temperature of the field winding and damper bars, if existing, can be defined in the settings "Thermal".

  Additionally, if the user wants to run a complete short-circuit test for a single point, performing a magneto-transient simulation specified with a field current value, the two concerned inputs are available as standard inputs as well.
- Computation of non-linear behavior

  Although the short-circuit characteristic is ideally linear, non-linear behavior could become significant if the field current value is high enough, depending on the machine topology. A systematic approach based on small signal modelling is performed to compensate for the linear characteristic with any existing non-linear behavior displayed by the machine according to the maximum field current value provided.



Characterization - Short circuit – Generator – Short-Circuit - Overview



Characterization - Short circuit – Generator – Short-circuit – The main outputs

2.5 Sketcher SimLab and FluxMotor

Structural parameters are unlocked for adjustments via FluxMotor, and the outer slot part catalog is now available in the FluxMotor solution of SimLab.

FluxMotor Solution of SimLab is a dedicated workflow for designing user parts and using them in FluxMotor. The solution enables users to design and parameterize a part very efficiently and intuitively.

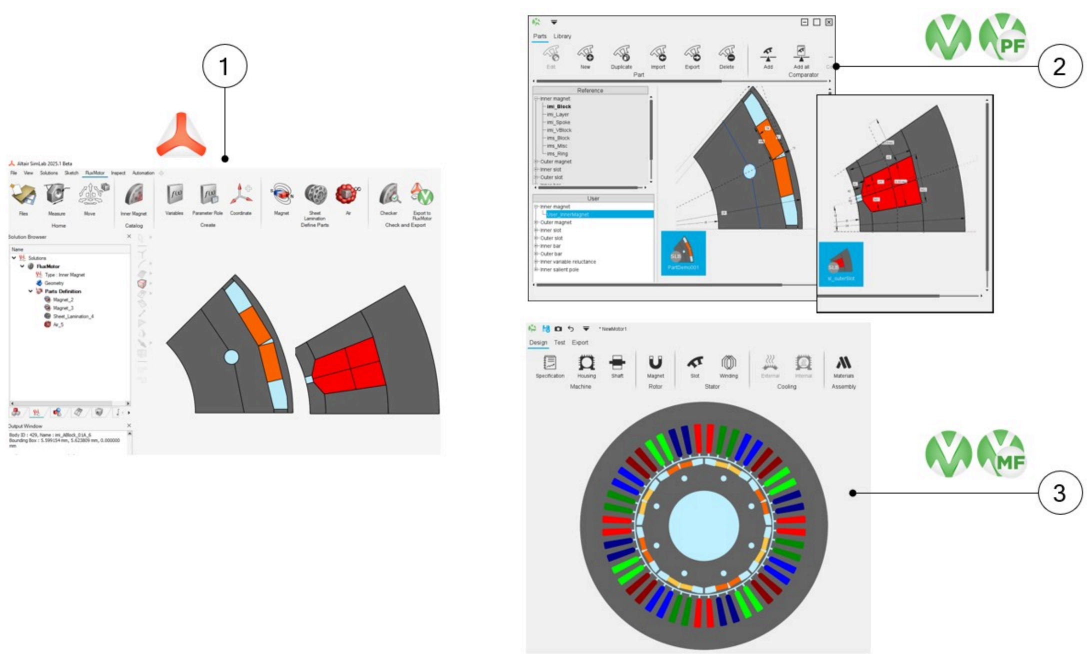
In the current version, the outer slot part catalog is added to the SimLab solution. Together with the inner magnet part that has been available since 2025.0, the synchronous machine with permanent magnet and inner rotor (3-phase or n-phase) in FluxMotor can be fully described and parameterized via SimLab.

Note: The inner magnet part can be imported to FluxMotor for all types of machines with inner rotor containing magnets, including:

- 3-Phase / n-Phase synchronous machine with permanent magnets – Inner rotor

Note: The outer slot can be imported to FluxMotor for all types of machines with inner rotor (in other words, outer stator), including:

- 3-Phase / n-Phase synchronous machine with permanent magnets – Inner rotor
- 3-Phase reluctance synchronous machine – Inner rotor
- 3-Phase wound field synchronous machine – Inner salient pole – Inner rotor
- 3-Phase induction machine with squirrel cage – Inner rotor



Workflow between SimLab sketcher (1), Part Library (2) and Motor Factory (3)

In the version FluxMotor 2025.1, structural parameters (stator outer diameter, stator inner diameter, No. slots, rotor outer diameter, rotor inner diameter, No. poles) are adjustable in FluxMotor. Users can modify these parameters within FluxMotor.

> **Note:** For SimLab part in FluxMotor, it is advised to modify parameters one by one instead of applying multiple changes simultaneously to ensure the transaction works well.

For additional information, please refer to SimLab user help guide.

2.6 Material management improvements

Introduction

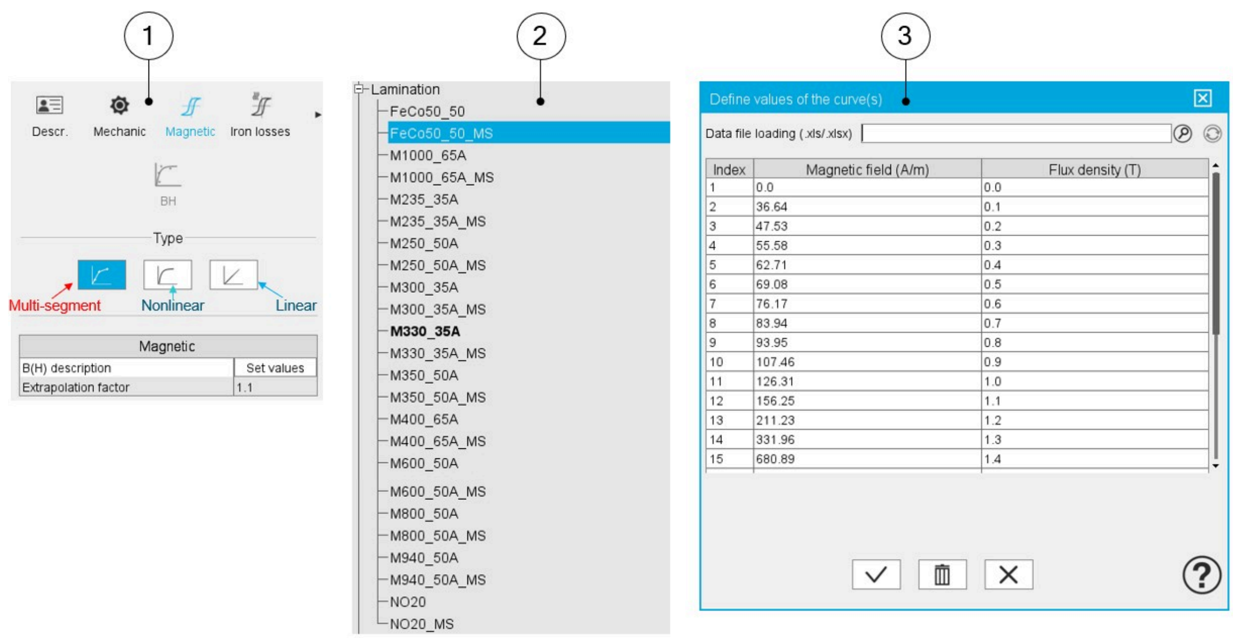
In the current version of FluxMotor, major improvements have been made for the material management. It is now possible to use the multi-segment model to describe lamination and adjust the stacking factor of that lamination within the design environment of FluxMotor. These improvements are promising to bring the user experience to a higher level in FluxMotor, more accurate and more flexible.

Multi-segment lamination model

The so-called spline model of Flux is now available in FluxMotor under the name multi-segment. From now on, users can describe a lamination by three types:

- Multi-segment: by providing a list of B-H points
- Nonlinear: by proving the three coefficients of the nonlinear analytical model
- Linear: by proving the slope of the B-H curve

The database of lamination within Material Manager is also enriched with the addition of laminations defined by the multi-segment model. Users now have 13 new laminations added.



New model of lamination in FluxMotor

1	Multi-segment model added to the Magnetic section of lamination
2	Three new lamination templates added, the NO20 coming along with both nonlinear and multi-segment models
3	The table format allowing defining the multi-segment model

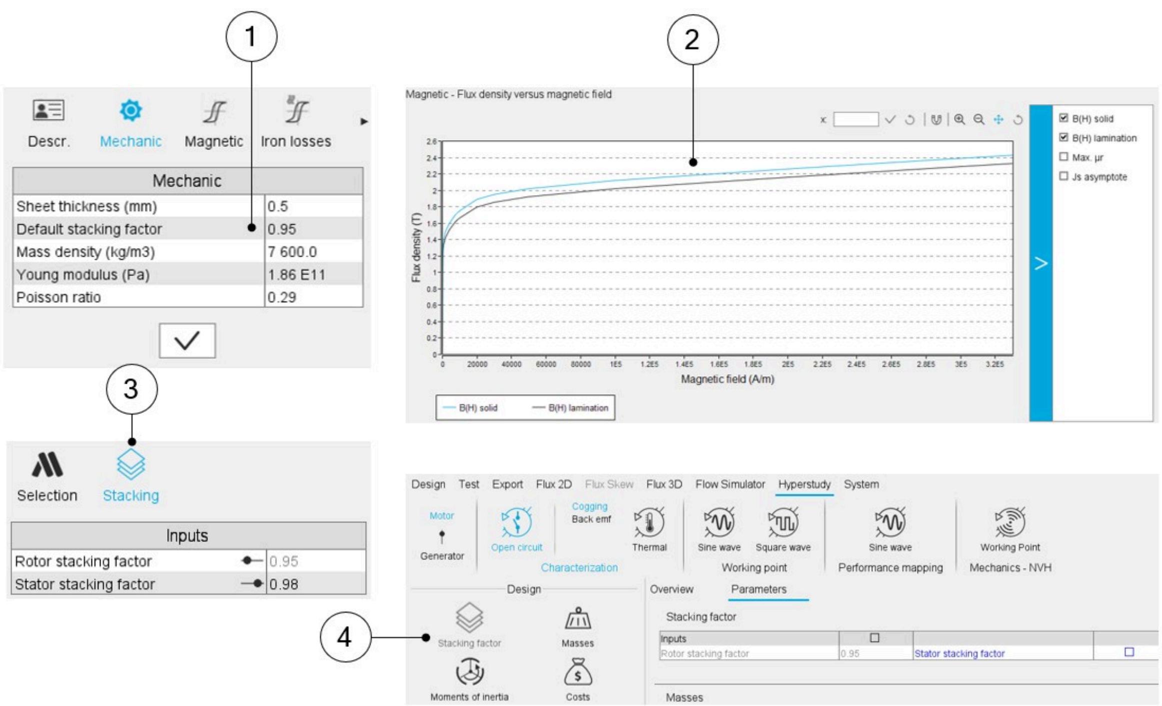
The computing time of FluxMotor tests is not impacted by the new multi-segment model. In some cases, users can even observe a better computing time performance with this model compared to the nonlinear model. This result is highly beneficial for users, as the test results are closer than ever to reality without any sacrifices for computing time.

Management of the stacking factor at the design stage

The stacking factor of a lamination can now be modified directly in the design context of Motor Factory.

The workflow with a new user lamination is comprehensive. The user will define a default stacking factor for the lamination in Material Manager. Then, use it for any motor in Motor Factory and adjust the stacking factor in the same environment if users are not happy with the default value.

By the fact that the stacking factor is now adjustable in Motor Factory, it can be considered as input of any HyperStudy connectors. Consequently, users can study the influence of the stacking factor on machine performance automatically via HyperStudy.



	New way to manage the stacking factor in FluxMotor
1	Give the default value of stacking factor in Material Manager
2	The solid and lamination B-H curves are provided automatically
3	Adjust the stacking factor of both rotor & stator in Motor Factory; when the value is greyed, it takes the default value of the lamination
4	Stacking factor can be considered as input for HyperStudy connectors if the user mode is selected

2.7 Induction machines - Characterization model maps

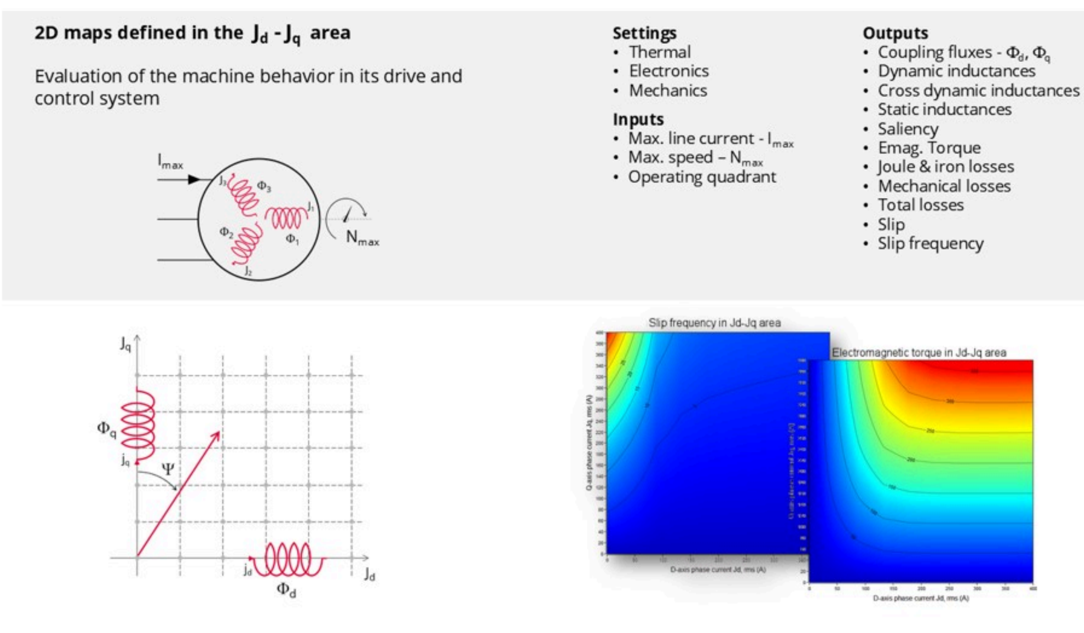
Positioning and objective

The aim of the “Characterization - Model - Motor - Maps” test is to obtain maps along the two dimensions, Jd-Jq, for characterization of a 3-Phase induction machines.

The identification of the maps is done in order to obtain a rotor field-oriented control (R-FOC), i.e., to model an induction machine with the same vector field reference as for a synchronous machine. In other words, the behavior of the machine is computed with the rotor flux aligned along the d-axis (rotor flux in the q-axis equal to zero). From this point of view, we can say that the FluxMotor test maps for all major machine types are based on the same modeling principles; we speak about a "unified vector model".

Maps computed in Jd-Jq, plane allow to predict the behavior of the electrical rotating machine at a system level.

In this test, engineers will find a system integrator and / or control-command tool adapted to their needs and able to provide accurate maps ready to be used in system simulation software like PSIM or Activate. One of the great advantages of this test is that it allows a vector model of an induction machine to be created, as for a synchronous machine, and then vector control to be applied using the same principles.



“Characterization - Model - Motor - Maps” - Overview

The performance of the machine in steady state can be deduced from the results obtained in this test in association with the drive and control mode to be considered.

Main inputs, settings and outputs

- Inputs

  Maps are mainly a function of the following user inputs: the maximum value of the line current, the speed and the number of quadrants to be considered.
- Settings
  - Temperature of active components: winding and squirrel cage
  - Definition of the power electronics parameters
  - Definition of mechanical loss model parameters

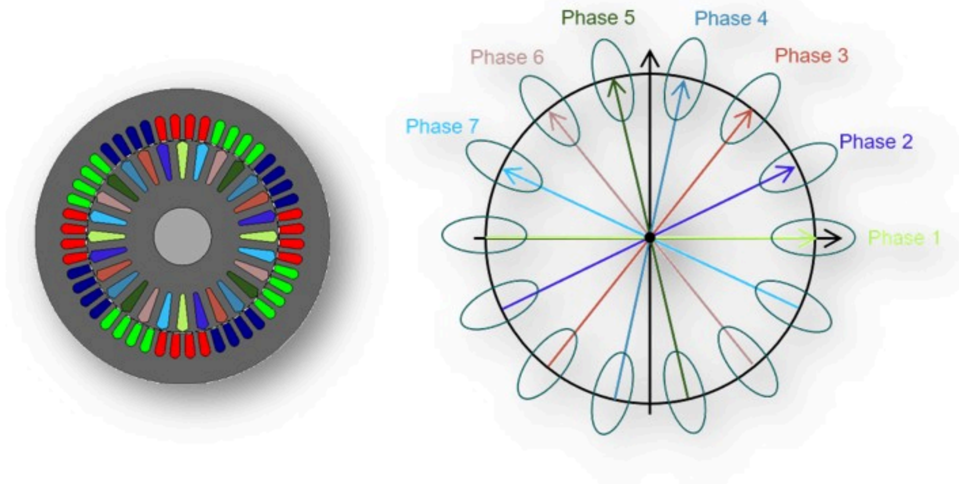
> **Note:** It is possible to import the current inputs and results from the test "Performance mapping – Sine wave – Motor – Efficiency map". This will save the computation time related to the identification of the non-linear model; in other words, it will save the computation time related to the finite element solving, which generally represent the main part of the computation time of the test.

- Outputs – maps in Jd-Jq plane and curves
  - Stator and rotor flux linkage
  - Inductances
  - Saliency
  - Torque
  - Stator and rotor losses
  - Power electronics losses
  - ...

Brief introduction about the main principles of computation

This test is based on rotor field-oriented control condition, i.e. the rotor field is set to be aligned along the d-axis. (rotor flux in the q-axis equal to zero). As previously explained, this results in an identical vector model for IMSQ and synchronous machines (SMPM, SMRSM and SMWF), with the same reference in the Park Jd-Jq plane according to the stator reference phase A. This modelling approach allows a "unified vector modelling" to be obtained for all the FluxMotor test "Maps".

To be able to align the rotor field with the d-axis, it is necessary to pilot it. To be able to do this for any machine configuration (number of bars) requires a specific modelling method. One of the most efficient and accurate ways is to model the rotor cage with an "n-phase equivalent rotor winding" supplied by an "n-phase sinusoidal current system".



“n-phase equivalent rotor winding” - Principle diagram

Indeed, an “n-phase equivalent rotor winding” supplied by an “n-phase sinusoidal current system”, allows to obtain a rotor current distribution in slots equivalent to the rotor current distribution in bars of a squirrel cage. In addition, the Park transformation is used to control the current in the Jd-Jq plane and to compute the rotor flux linkage component Φrd -Φrq.

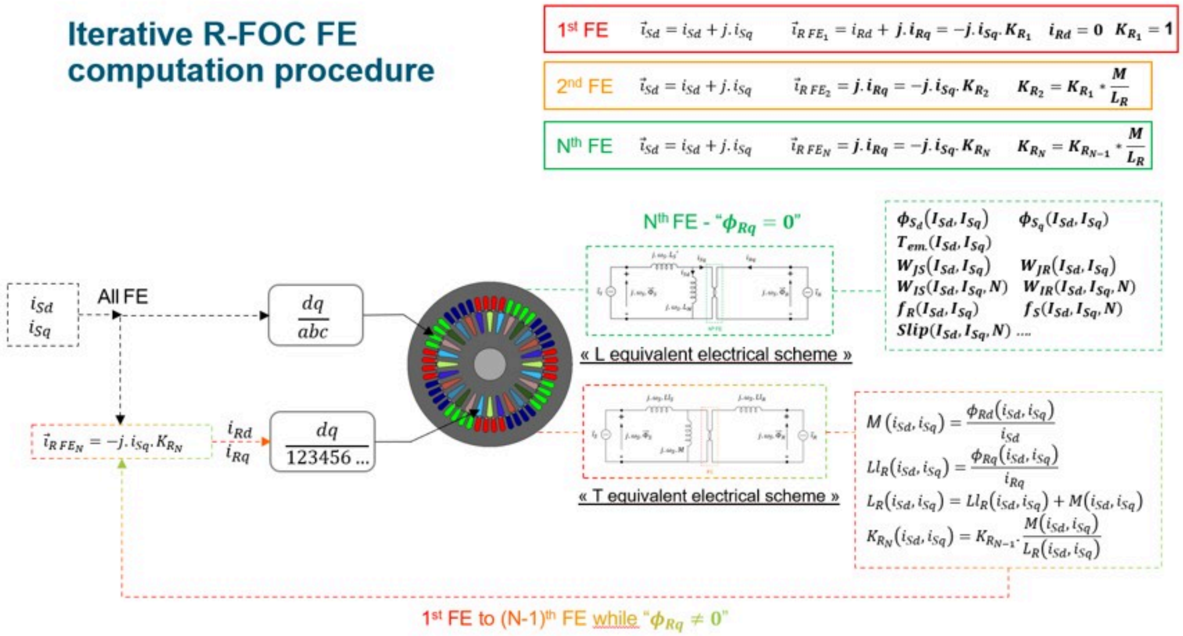
The n-phase equivalent rotor winding is automatically designed and supplied by FluxMotor through an internal process. The ampere-turns are automatically computed according to the classical equation of the stator and rotor magnetomotive force balance between those 2 windings.

The main principle of computation of the model is to supply the stator and the rotor currents over a grid of values (Jd, Jq) and then solve the finite element (FE) model.

After the FE solving, evaluate from the rotor flux computed the “T equivalent scheme” inductances. Inductances allow to compute the Kr coefficient which corresponds to the coefficient that allows to switch from a “T equivalent scheme (any FOC condition)” to an “L equivalent scheme (R-FOC condition)”.

The Kr coefficient is called the “rotor field-oriented control non-linear correction coefficient”. So, Kr is used to correct the rotor current value and then solve a new FE simulation, which must be aligned with the “L equivalent scheme” and ensure the R-FOC condition.

In our experience, due to the non-linearity of the soft magnetic materials, the first use of Kr is generally not accurate enough and an iterative process of computation is used to accurately ensure the R-FOC conditions. The number of iterations required is generally 2, but an advanced input, “Number of iterations for Kr evaluation” allows this to be increased if necessary.



Iterative rotor field-oriented control finite element computation procedure

2.8 Induction machines - Efficiency maps vectorial UI

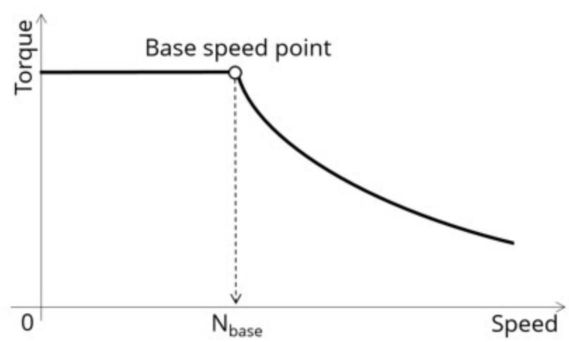
Positioning and objective

The aim of the test "Performance mapping – Sine wave – Motor – Efficiency map" is to characterize the behavior of the machine in the "Torque-Speed" area.

Input parameters like the "Maximum line current", "Maximum Line-Line voltage", and the desired "Maximum speed" of the machine are considered.

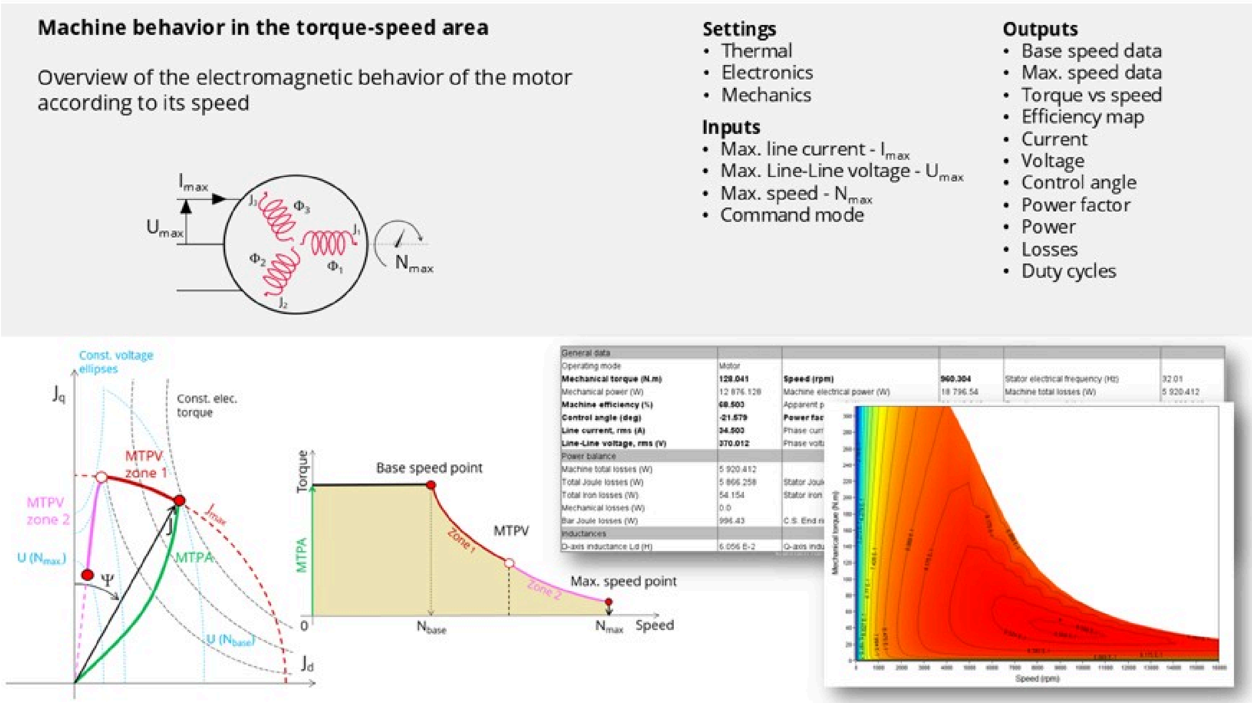
Only the Maximum Torque Per Volt command mode (MTPV) is available in this version. The Maximum Torque Per Amps command mode (MTPA) will be available as soon as possible.

Input parameters define the torque-speed area in which the evaluation of the machine's behavior is performed.



Characterization of the corner point on the torque-speed curve

Here is an overview of the test, given below.



Performance mapping / Efficiency map – Induction machine with squirrel cage - Inner rotor (IMSQ - IR) - Overview

Main inputs, settings and outputs

- Inputs

  The main user input parameters needed to perform this test are the maximum allowed supply line current, line-line voltage, the targeted maximum speed, and the command mode. Winding and cage temperatures must also be set.

  When required, the location of the working points (single point or duty cycle) to be evaluated must be defined as inputs.

  > **Warning:**
  >
  > The default values of advanced inputs have been set to get the best compromise between accuracy and computation time.
  >
  > Four advanced user input parameters allow adjusting the compromise between accuracy and computation time: the number of iterations for Kr evaluation, the number of computations for Jd-Jq, for speed, and for torque.

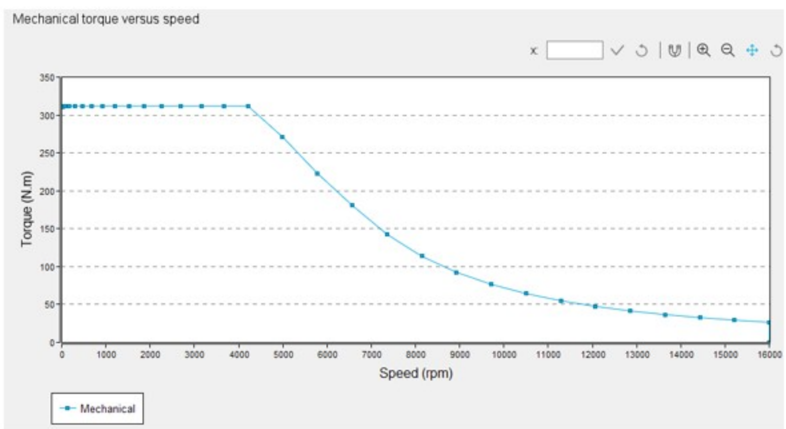
> **Note:** It is possible to import the current inputs and results from the test "Characterization – Model – Motor – Maps". This will save computation time related to the identification of the non-linear model; in other words, it will save the computation time related to the finite element solving, which generally represents the main part of the computation time of the test.

- Settings
  - Temperature of active components: winding and squirrel cage
  - Definition of the power electronics parameters
  - Definition of mechanical loss model parameters
  - Import functionality
- Outputs

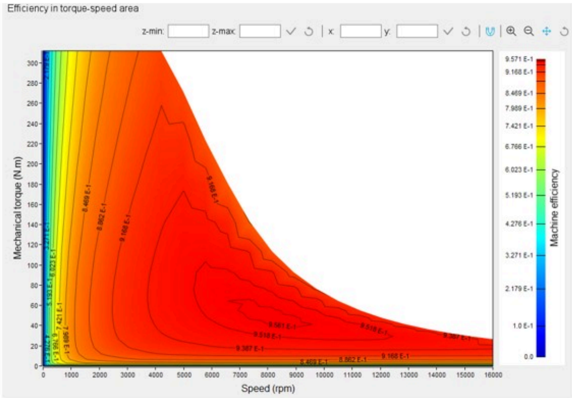
  Tables, curves and maps are computed and displayed as illustrated below.

  In the results, the performance of the machine at the base point (the base speed point) and for the maximum speed set by the user are presented. A set of curves (like Torque-Speed curve) and maps (like Efficiency map) are computed and displayed.

  Here are below illustrations of some results that can be provided in the test.



Mechanical torque versus speed - Example



Efficiency in torque-speed area - Example

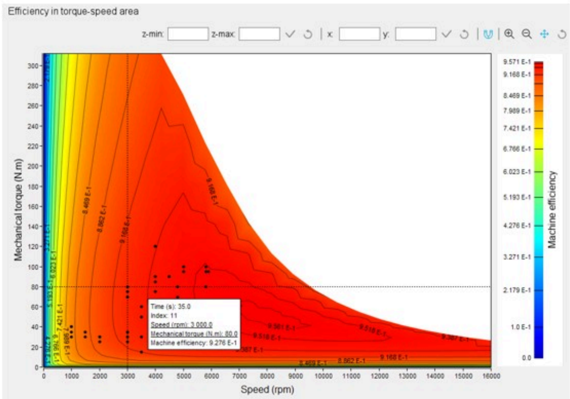
Two additional features are available in this test. The first one allows extracting one torque-speed point from the efficiency map to get the machine performance for this specific working point (general data + power balance).

Note: The working point considered is then displayed on all the maps available. The working point can be selected to visualize the corresponding main information.

The second feature allows the user to define a duty cycle by giving a list of working points (speed, torque) versus time. The displayed results illustrate the machine performance over the considered duty cycle (mean, min, and max values).

The time variation of the main quantities is also displayed (mechanical torque, speed, control angle, current, voltage, power, efficiency, and losses).

All the corresponding points are displayed on the different maps provided. Each working point can be selected to visualize the corresponding main information.



A “Duty cycle” displayed on the efficiency map - Example

Performance data are computed and provided:

- Machine performance at the base speed point, at the maximum speed and at a user working point
- Duty cycle
- Torque-speed curves
  - Mechanical torque versus speed
  - Current versus speed (J, Jd, Jq)
  - Voltage versus speed (V, Vd, Vq)
  - Control angle versus speed
  - Power versus speed (Mechanical power, Machine electrical power, System electrical power)
  - Power factor versus speed
  - Losses versus speed (Total machine and system, Stator Joule, Rotor Joule, Stator iron, Mechanical, Power electronics)
  - Rotor Joule losses versus speed (Rotor Joule, Bars Joule, End ring C.S. Joule, End ring O.C.S. Joule)
  - Slip versus speed
  - Frequency versus speed (Slip frequency, Stator frequency)
  - Inductances versus speed (Ld static, Lq static)
  - Saliency versus speed
- Characteristic curves
  - Electromagnetic torque versus current and control angle (#) according to base speed point
  - Characteristic curves in Jd-Jq area - Evolution of the working points in Jd-Jq plane, with iso-torque, iso-current and iso-voltage.

Brief introduction about the main principles of computation

The process to get the torque-speed curves and maps (For example - efficiency map) is separated into the two following parts:

- Raw data provided by the solving of the test “Characterization - Model - Motor - Maps”
- Principle for computing the torque-speed curves and maps
- MTPV vector command
  1. Raw data and Park’s model

     The first step corresponds to the solving of the test “Characterization - Model - Motor - Maps” which consists of computing the raw data that characterize the machine in the Jd-Jq plane. This is done using Finite Element modelling (Flux® – Magnetostatic application).

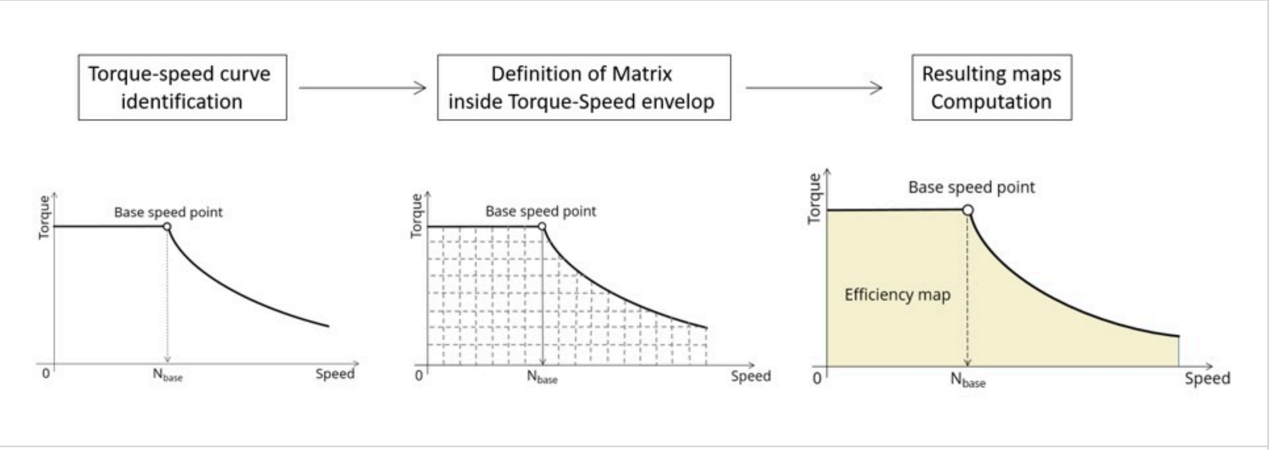
     For additional information, please refer to the explanation above.

2. Identification process for the torque-speed curves and maps under vector control

Below are the three main steps involved in building the efficiency map and other associated results.

These steps are based on the computed raw data (see previous section) with optimization processes.

- Building of the torque-speed curve and other associated results
- Define the grid in the area under the torque-speed curve
- Building of the efficiency map and other associated results



Main steps of the computation algorithm

3. MTPV vector command

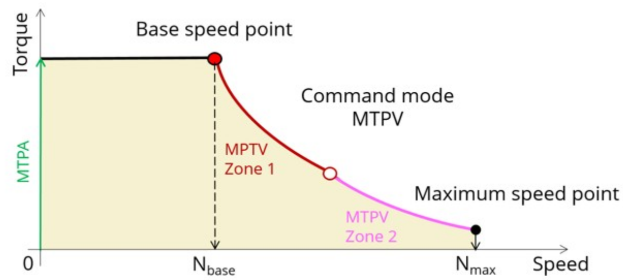
The Maximum Torque Per Voltage command mode (MTPV) allows to compute the torque-speed curve, which corresponds to the maximum potential of mechanical torque (or mechanical power) of a motor from the base speed point to the maximum speed point.

This command mode shows the full potential of the machine, but it is also the most difficult command mode to implement in terms of control and drive.

This command is used to compute the torque speed curve from the base speed point to the maximum speed.

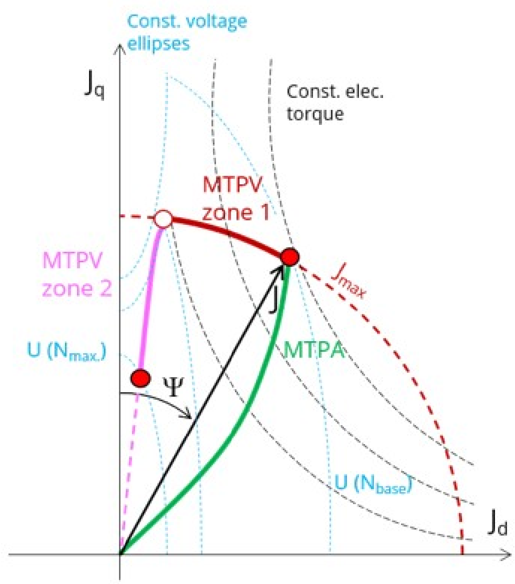
Upstream the base speed point, the torque speed curve is obtained by imposing the useful torque computed at the base speed point and by maximizing the efficiency.

The maps bounded by the considered torque-speed curve are computed by maximizing the efficiency for each paired value (Torque, Speed).



Torque speed curve with MTPV command mode

Over the speed range [Nbase, Nmax.] we distinguish two main zones, the Zone 1 commonly called “Flux weakening” and the Zone 2 commonly called “MTPV curve”.



Evaluation of the working point in Jd-Jq plane by considering iso-torque, iso-current and iso-voltage

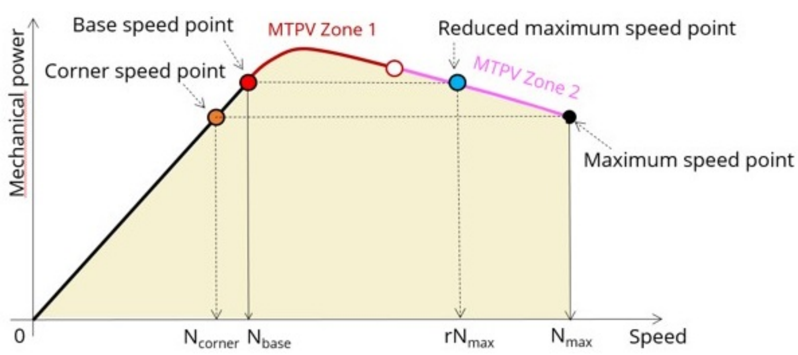
In the first zone (MTPV zone 1), the maximization of the mechanical torque for a given speed is reached by keeping the maximum values of voltage and current, and by driving the control angle (Ψ). In a second zone (MTPV zone 2), the maximization of the mechanical torque is reached by keeping the maximum values of voltage and by decreasing the line current below the maximum allowed value and by driving the control angle (Ψ). In FluxMotor, the MTPV label is used to mention the combination of these two zones (for both, the maximum torque is computed, at the maximum voltage available). The optimization process automatically deduces the best working zone according to the following constraints:

$$U = U_{max}$$
$$I \leq I_{max}$$

With MTPV command mode the mechanical power is not imposed over the speed range [Nb, Nmax.] as commonly done.

In fact, over Zone 1 and Zone 2, the MTPV command mode imposes to maximize the mechanical torque at maximum voltage. Maximizing the mechanical torque at an imposed speed is equivalent to maximizing the mechanical power.

In conclusion, the MTPV command mode allows to spotlight the potential of mechanical power that the machine can provide over a speed range from the base speed point to the maximum speed point with a given maximum line-line voltage and a maximum line current.



Mechanical power with MTPV command mode

Thanks to the MTPV results, we can easily deduce the maximum mechanical power that the machine is able to provide over a range of speed.

For examples, referring to the previous figure:

- If we want to impose the mechanical power obtained at the maximum point speed, we can easily deduce the bound at low speed. We called this point the corner speed point (Orange point on the previous figure).
- If we want to impose the mechanical power obtained at the base speed point, we are able to deduce the bound at high speed. We called this point the reduced maximum speed point (Blue point on the previous figure).

2.9 Induction machines - Export System LUT

The area SYSTEM, in the EXPORT environment of Motor Factory, allows exporting data like constants, curves and maps in lookup table (LUT) formats, such as FMU and MAT format files.

Such an export is now available for the induction machine with squirrel cage (IMSQ).

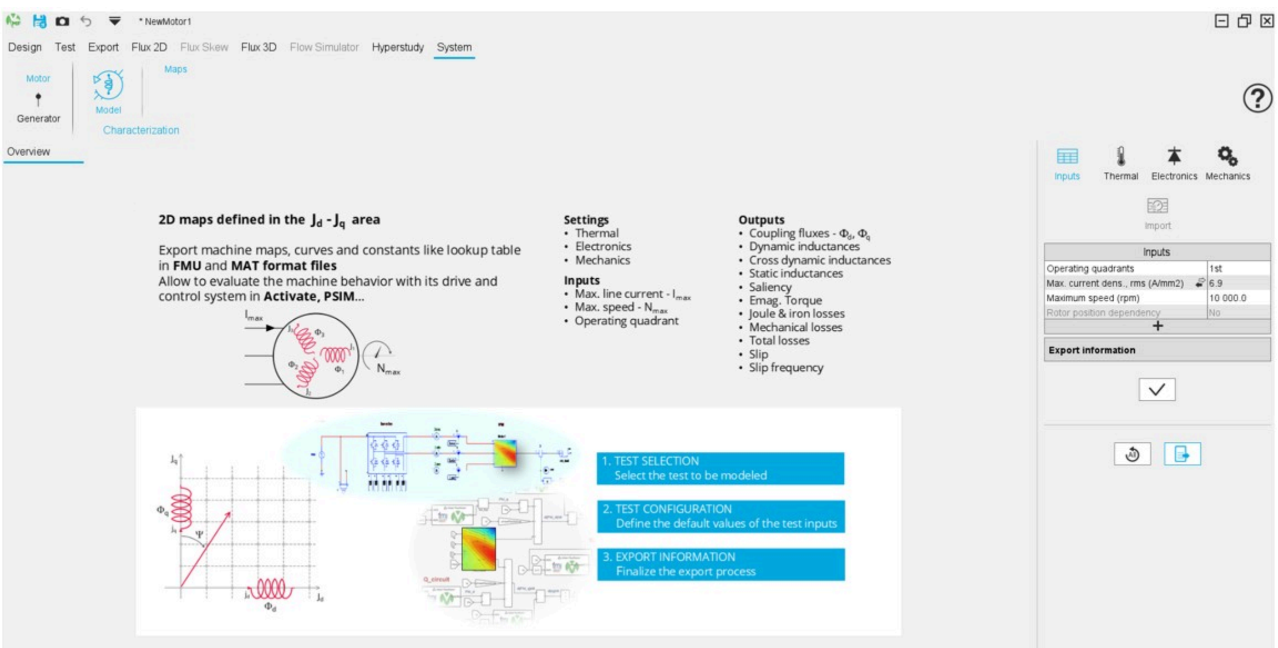
The test Characterization/Model/Maps can be selected for exporting the data.

Constants, curves and maps" given in Jd-Jq plane for characterizing the 3-Phase IMSQ are computed and exported.

These files can be imported directly into environments like Altair® Twin Activate®, Altair® Compose® or Altair® PSIMTM as binary variables files (.mat) or inside block functions, ready to be integrated into schemes to represent the model of the corresponding rotating electrical machine.

These functionalities are useful to represent the machine at the system level. Therefore, electrical machines and other system components, such as the drive and the control command, can be represented altogether in the same area for evaluating their behaviors and performance.

In the "Test configuration" Operating quadrants to be considered can be selected. Hence, Export / System LUT (Activate or PSIM) allows exporting data based on 1, 2 or 4 quadrants.



Motor Factory – EXPORT AREA – Export data in LUT formats
available for the induction machine with squirrel cage

2.10 New GUI and workflows

Introduction

The new version, FluxMotor 2025.1 features a significantly modified GUI and workflows.

One of our main objectives is to make FluxMotor even easier to use by homogenizing the different definition spaces within design and test environments while modernizing our user interfaces and workflows.

The main applications affected by these changes are as follows:

FluxMotor supervisor, Motor Factory (Design area, Test Area, Export Area) as well as the satellite applications like Motor Catalog, Part Library, Materials, Units, Script Factory, etc.

> **Notice:**
>
> This work is still in progress, and it will be finalized with the next version - FluxMotor 2026.
>
> Therefore, the new user help guide is not yet available. We apologize for the inconvenience.
>
> However, gradually in the next weeks and months, the online user help guide will be updated and directly available for users.
>
> In the meantime, it is still possible to refer to the former user help documents in FluxMotor online help: **Access to the former user help guide**.

2.10.1 A new supervisor

A new supervisor has been developed to enable easier and faster viewing and access to projects and rotating electrical machines.

Five new main entrances have been defined:

- "New": to create a new motor from a default topology.

  Rotating electrical machines are classified according to the families to which they belong: synchronous, induction and DC machines. Within each family, a further classification is used to distinguish between different types of machines, e.g., for synchronous machines, one finds permanent-magnets machines, variable-reluctance machines, machines with wound field, etc.

  The topology of the selecting machine is displayed with a brief introduction.

  Double clicking on the icon of the machine or clicking on the button Open in Motor Factory edits the machine in Motor Factory design environment.

- "Recent": to edit a recent project. Up to 100 projects can be stored in this list.

  A brief description of the project is done with the Catalog name, the type of machine and the Created + Modified date.

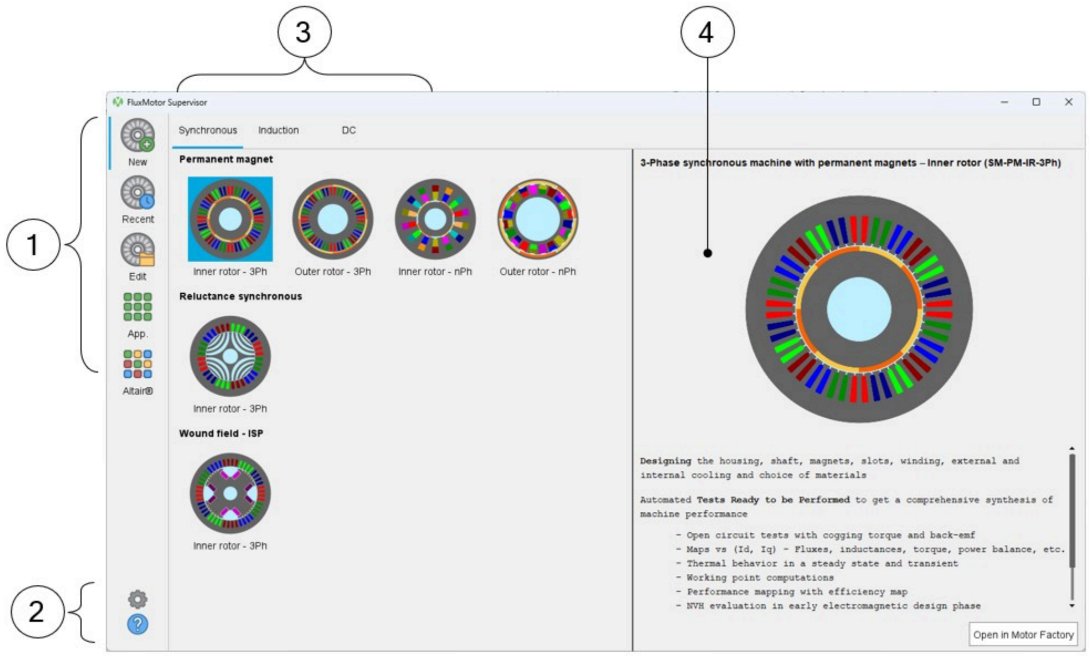
- "Edit": To select and edit a project from the catalogs, standard and user catalogs like what can be done when using Motor Catalog. This allows the user to access past studies quickly directly from the supervisor.

  Double clicking on the icon of the machine or clicking on the button Open in Motor Factory edits the machine in Motor Factory design environment.

- "App": to access the FluxMotor satellite applications like Motor Catalog, Part Library, Materials, Units, Script Factory, etc.
- "Altair®": A dedicated section to give access to Altair solutions that are needed and complementary for FluxMotor like:

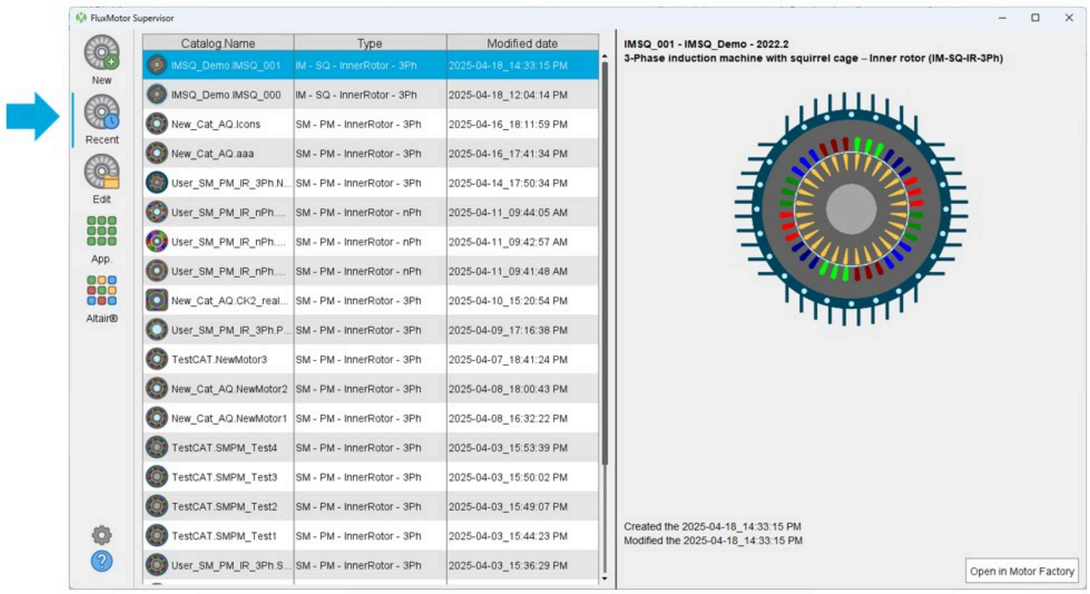
  Flow SimulatorTM, Flux®, HyperStudyTM, PSIMTM, SimLab®, Twin Activate®

  > **Note:** For each solution, a picture and a text help to introduce it. There are also the following three links:
  >
  > - "Overview" (link to get into the corresponding altair.com web page)
  > - "Community" (link to get into the corresponding Forum – Community)
  > - "Download" (link to the corresponding download area or marketplace)

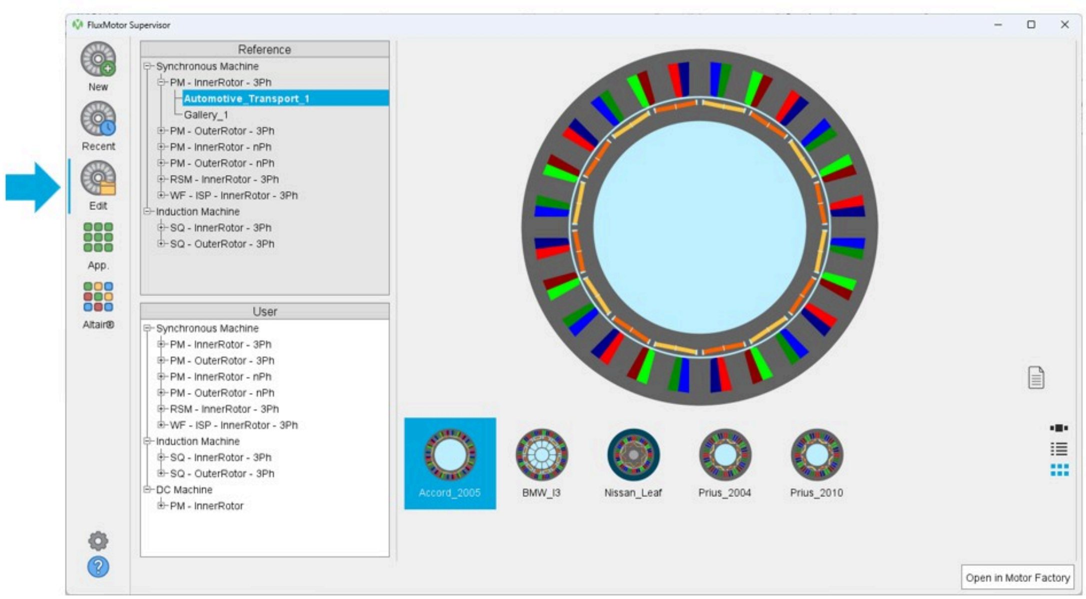


FluxMotor – New supervisor – Create a New motor

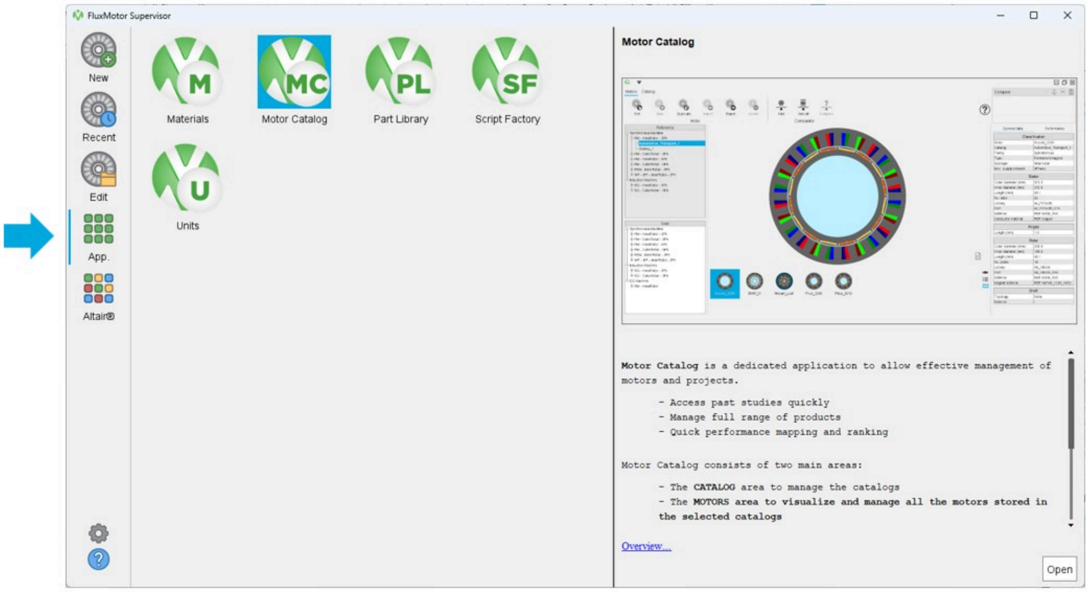
1	Main entry points of the supervisor – New motor in Motor Factory, edit a Recent motor, Edit a motor from catalogs, Open FluxMotor satellite Applications, Open Altair® solutions.
2	Access to user's preferences and to help information
3	Classification and selection of Rotating Electrical Machines – Three families – Synchronous, Induction and DC machines
4	The topology of the selecting machine is displayed with a brief introduction.



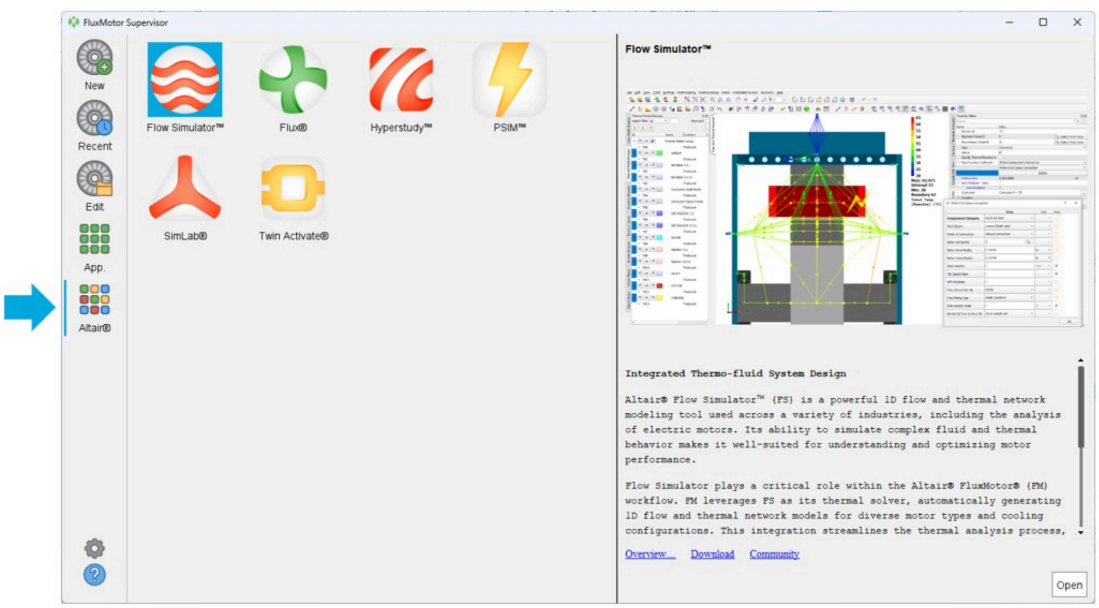
FluxMotor – New supervisor – Edit Recent Motors



FluxMotor – New supervisor – Edit a motor from catalogs



FluxMotor – New supervisor – Open FluxMotor satellite Applications



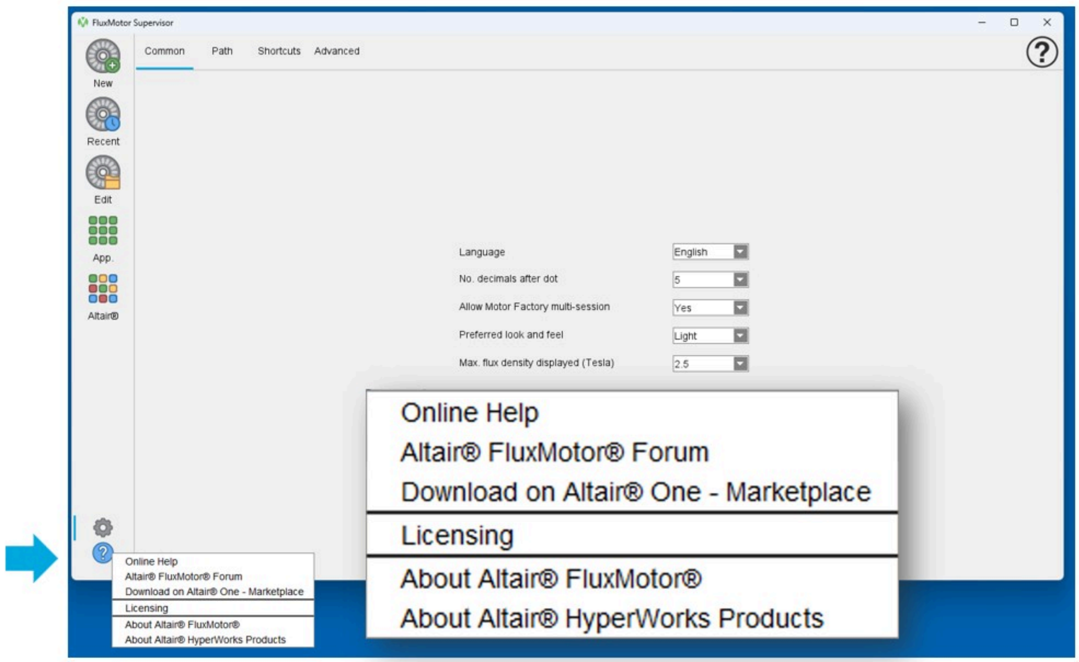
FluxMotor – New supervisor – Open Altair® solutions

As in the previous supervisor version, there is access to user preferences to set the common preferences, to define the paths preferences, to see the shortcuts preferences, and to set the advanced preferences.

At last, there is access to help information like

User help guide, licensing, access to the Forum – Community and the download on Altair® one Marketplace,

+ information about Altair® FluxMotor® and Altair® HyperWorks products with Customer Support, Web pages, copyright and legal notices, and third party libraries.



FluxMotor – New supervisor – Help information

Access to the User help guide, licensing, access to the Forum – Community and the download on Altair® one Marketplace,

+ information about Altair® FluxMotor® and Altair® HyperWorks products with Customer Support, Web pages, copyright and legal notices, and third party libraries.

2.10.2 Motor Factory

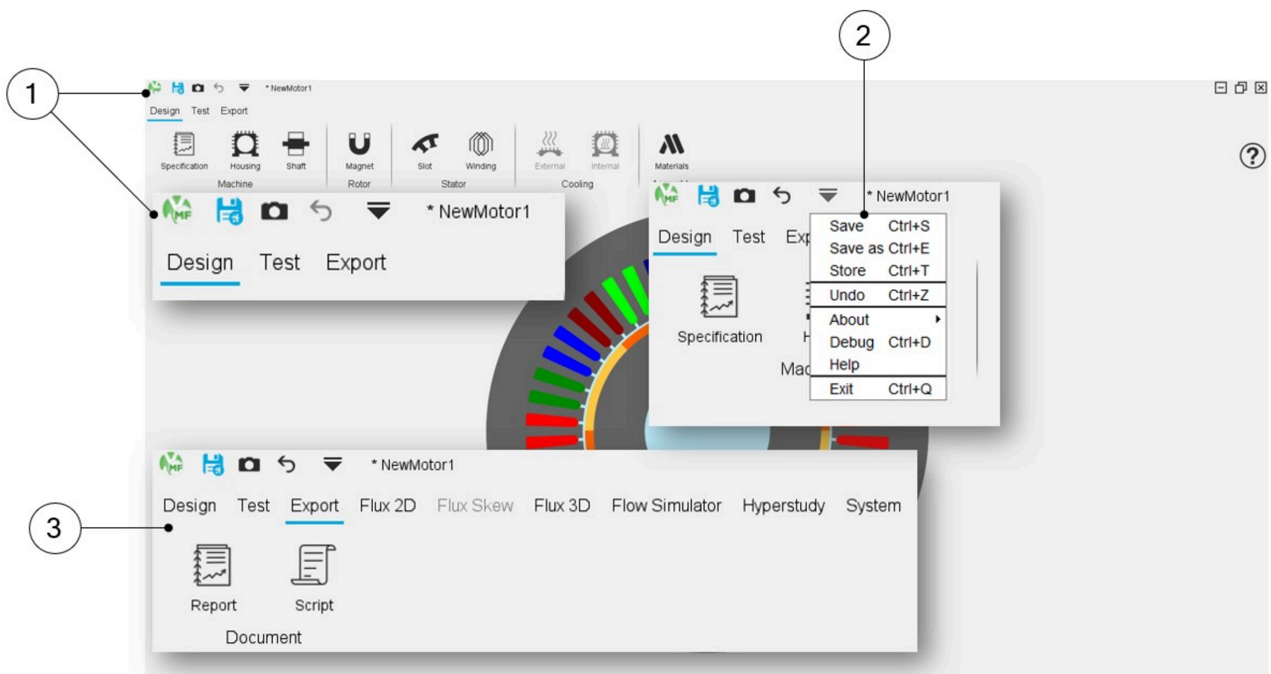
Generic functions

Save, Store, Undo are also available in the top left-hand corner of the screen next to the drop-down menu in which generic functions such as Save, Save as, Store, Undo, About, Debug, Help and Exit can be selected as well.

Access to Motor Factory's three main environments - Design, Test and Export - is located at the top left of the screen. Clicking on any of these elements opens the corresponding environment.

> **Note:** a click on Export displays the list of applications to which exports are possible, such as Flux 2D, Flux Skew, Flux 3D, Flow Simulator, HyperStudy, System (for PSIM and Twin Activate).

> **Note:** A single online help button is now available for each environment. It provides access to global documentation for the zone in question.



FluxMotor – Motor Factory – GUI and workflows - Generic functions

1	Access to the generic functions such as Save, Save as, Store, Undo, About, Debug, Help and Exit
2	Drop-down menu in which generic functions can be reached
3	Clicking on Export displays the list of applications to which exports are possible.

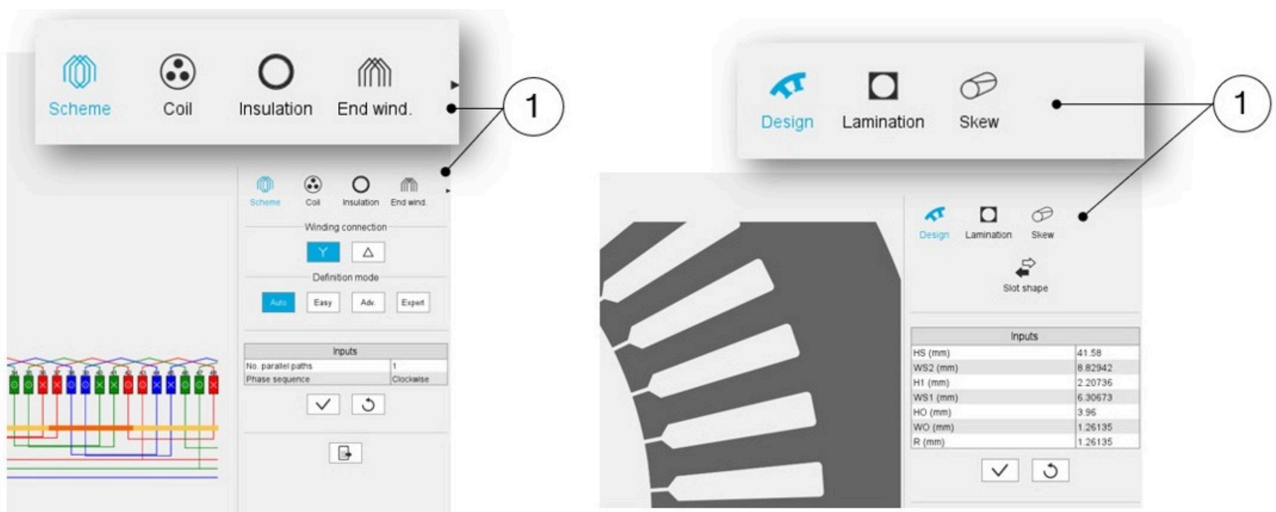
Design area

Interface graphics have been lightened. The number of grayscales has been reduced, and separator bars have been removed.

Selection scrollbars have been deployed and homogenized in all design environments (Machine, Rotor, Stator, Cooling and Assembly).

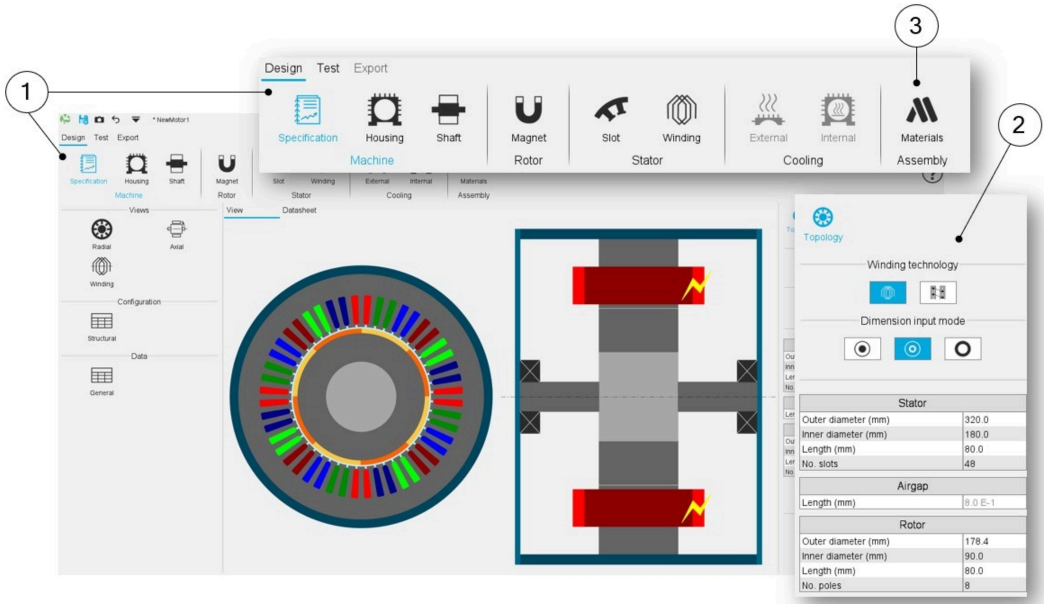
A new environment has been created: Specification, in which we find the definition of what was previously called Topology, which enables us to define the machine's structural data.

Another environment has been added: Assembly, in which one can select the materials needed to build the machine, as well as define the stacking factor to be considered for the stator and the rotor.



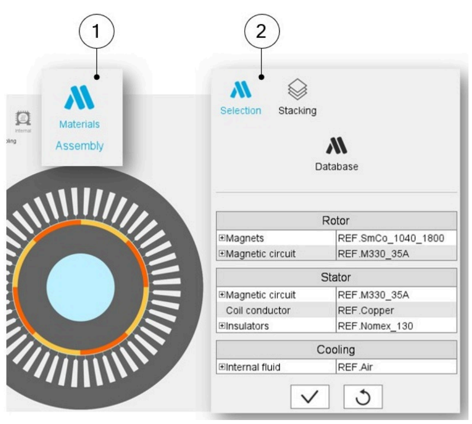
FluxMotor – Motor Factory – GUI and workflows – Design – Selection scrollbars

1	Selection scrollbars have been deployed and homogenized in all design environments (examples for winding and slot).



FluxMotor – Motor Factory – GUI and workflows – Design

1	Specification is a new area in which we find the definition of what was previously called Topology, which enables us to define the machine's structural data.
2	Topology enables the user to define the machine's structural data.
3	Assembly, is a new area to select the materials needed to build the machine, as well as define the stacking factor to be considered for the stator and the rotor



FluxMotor – Motor Factory – GUI and workflows – Design - Assembly

1-2	Assembly, is a new area to select the materials needed to build the machine, as well as define the stacking factor to be considered for the stator and the rotor.

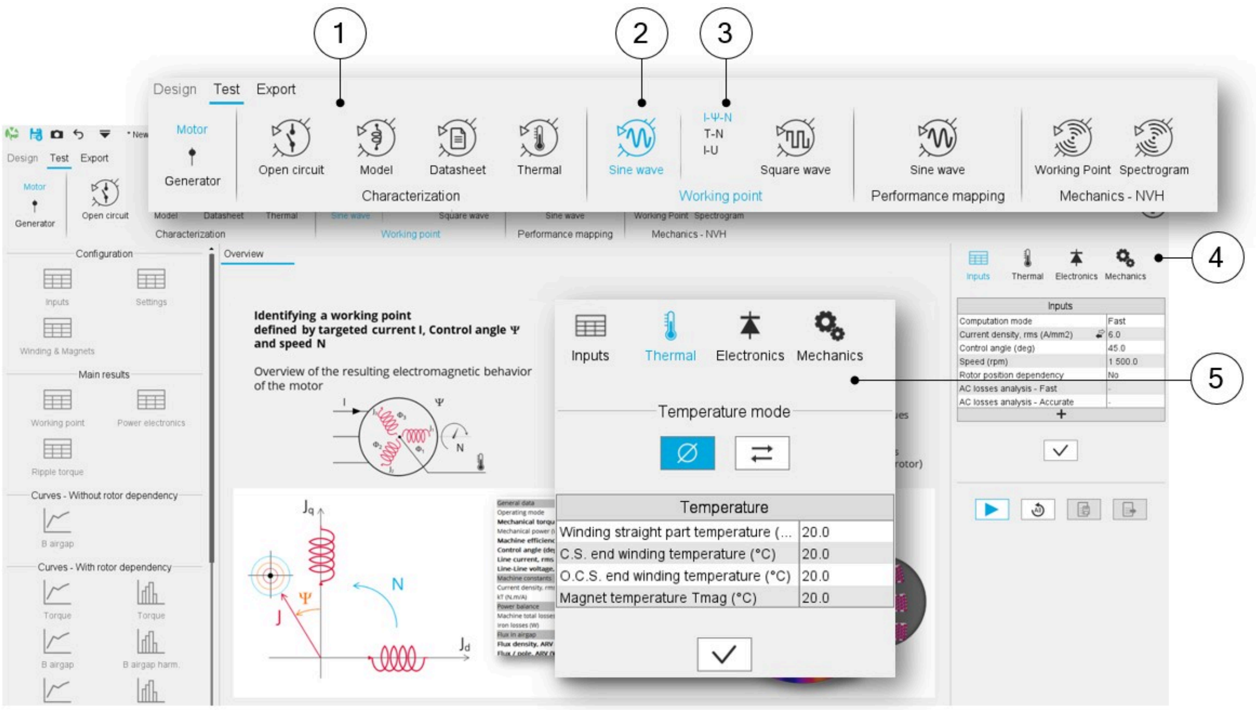
Test Area

As for the Design environment, interface graphics have been lightened.

However, the most significant change in the test space is that now, the selection of tests to run is done from the top bar.

For each test family, clicking on a package of tests deploys the list of available tests. Then, clicking on a test opens the dedicated environment where all the elements necessary for its execution (settings and input parameters) are available below.

Another important change is that settings are now accessible via a Selection scrolling bar, similar to what's found in the Design environment. When one clicks on a setting section, the associated user inputs are directly available below.



FluxMotor – Motor Factory – GUI and workflows – Test area - Selection of tests to run	
1	The selection of tests to run is done from the top bar.
2-3	Clicking on a package of tests deploys the list of available tests.
4	The settings are now accessible via a Selection scrolling bar, similar to what's found in the Design environment.
5	When one clicks on a setting section, the associated user inputs are directly available below.

On the other hand, to simplify the presentation of user inputs, the selection of the operating mode and/or associated convention of the machine has been moved to the top left of the screen.

A button allows the user to switch from Motor mode to Generator mode.

Given the position of the button (Motor or Generator), the available tests are filtered on the top part of the screen and also in the left zone, where all the test names are displayed and classified under test families and test packages.

FluxMotor – Motor Factory – GUI and workflows - Test area – Motor/Generator mode	
1	Selection of the operating mode and/or associated convention of the machine.
2	The available tests are filtered according to the selection of the operating mode, Motor or Generator.

Finally, the Mechanics test family has been modified; it is called Mechanics – NVH and two packages are defined: one to evaluate NVH performance for an operating point and the other to calculate spectrograms for a series of speeds.

FluxMotor – Motor Factory – Test area - Mechanics – NVH

Export Area

The Export environment was built according to the same principles as those adopted for the other areas (Design and Test). The objective is to standardize Motor Factory environments in order to simplify user workflows regardless of where you are located in Motor Factory (Design, Tests and Export).

When one clicks on Export, the list of applications to which exports are possible, is displayed next to the label "Export" (such as Flux 2D, Flux Skew, Flux 3D, Flow Simulator, HyperStudy, System (for PSIM and Twin Activate).

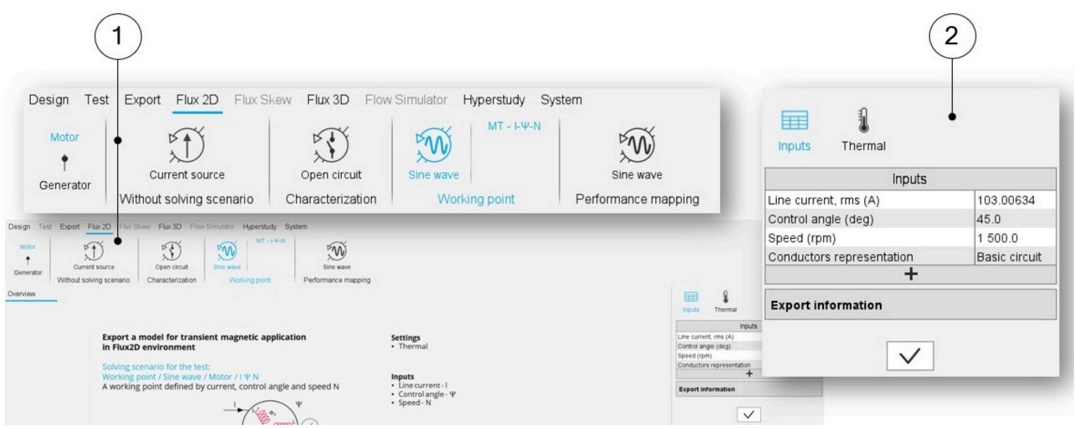
By default, when no application is selected, the automatic report and script export options are available.

FluxMotor – Motor Factory – GUI and workflows - Export area – Report and Script

Then, the procedure is identical to that proposed in the Test environment.

When selecting an application, the test families and the test packages available for export are displayed and the associated tests can be selected.

As in the Test area, a button allows the user to select the operating mode and/or the associated convention to consider. Thus, the tests available for export are filtered for a more efficient selection.



FluxMotor – Motor Factory – GUI and workflows – Export area

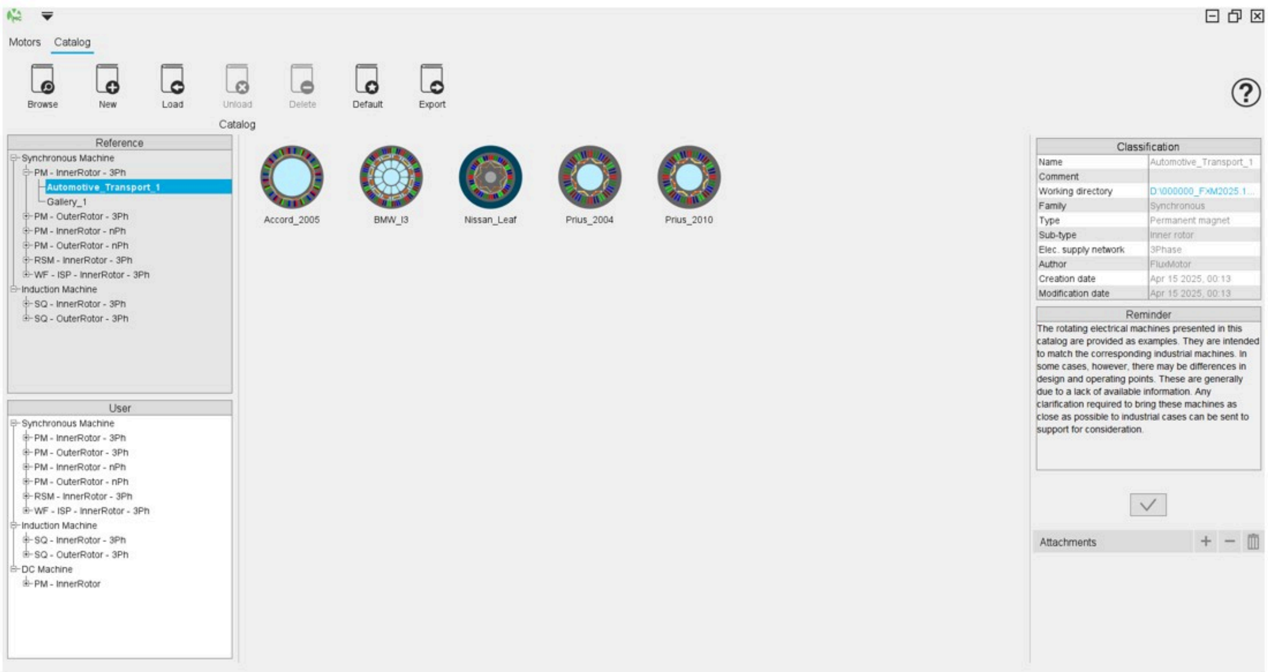
1	The test families, the test packages and the associated tests are available for export.
2	Once a test is selected, the corresponding settings and input parameters are displayed.

2.10.3 Satellite applications

The satellite applications are: Motor Catalog, Part Library, Materials, Units, and Script Factory.

All are accessible from the supervisor via the App (Applications Access FluxMotor) entry.

Their GUI has also been lightened. They adopt the same graphic charter as in the Motor Factory environments.



FluxMotor – Satellite applications – New GUI and workflows

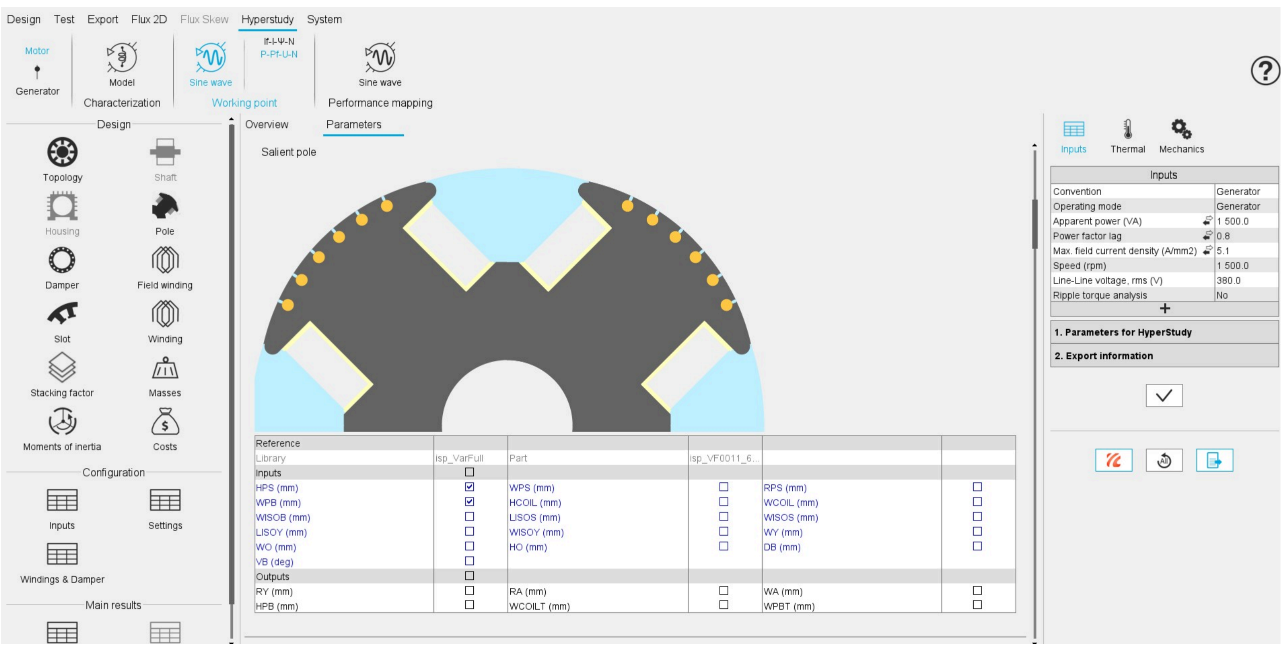
2.11 New connectors for HyperStudy

New connectors for HyperStudy for one test of the wound field synchronous machines

One new connector for coupling FluxMotor and HyperStudy has been implemented for the wound field synchronous machine.

The new connector HyperStudy is dedicated to the test: working point (P/Sn, Pf, U, N) - Motor or generator operating mode.

Thus, it is now possible to optimize the design of a wound field synchronous machine with inner salient pole to target a specific working point.



Creating a connector for HyperStudy dedicated to the test working point (P/Sn, Pf, U, N) - Motor or generator operating mode (Wound field synchronous machine)

List of fixed issues and major improvements

3

This chapter covers the following:

3.1 All machines

When a machine with linear ferromagnetic materials is built with version N, it cannot be opened with version N+1.

For example, if such a machine has been built with FluxMotor version 2024.1, it cannot be opened with version 2025.

This problem will be corrected in the next version.

There are two workarounds:

1. Export the project script with version N-1 and run it with version N (solved tests will not be saved).
2. Replace the linear materials with non-linear materials in version N-1 so that it can be opened with version N. The tests must have been saved beforehand (ref.: FXM-17466).

This issue has been corrected.

3.2 Synchronous machines – Motor Factory – Test environment

Difference between map and torque-speed envelop

In the efficiency map with thermal coupling and duty cycle, the base speed table + torque speed envelope don't match with the map (ref.: FXM-17188).

This issue has been corrected.

The Duty cycle index plot is not displayed; NaN is always displayed instead.

In the test Performance mapping-Efficiency map & Duty cycle with thermal coupling, the duty cycle index plot is not displayed: NaN is always displayed instead (ref.: FXM-17246).

This issue has been corrected.

Export - HyperStudy – A wrong setting for the working point (I, Ψ, N)

For SMPM and SMRSM in the export for HyperStudy, when selecting the working point I,PSI,N, while exporting the connector, the setting “thermal iterative” is available but should not be. Note that the connector can be generated but doesn’t work (ref.: FXM-17277).

This issue has been corrected.

3.3 Materials

Material library issue for BH property after clicking linear mode button.

While clicking the linear button for choosing the linear B(H) curve, this removes the value defined in nonlinear mode and it is not possible to return to the previously specified inputs (ref.: FXM-17090).

This issue has been corrected.

3.4 Supervisor

Reboot after changing language fails.

While changing the language to Chinese and then to Japanese, the automatic reboot of FluxMotor fails (ref.: FXM-15088).

This issue has been corrected.

List of warnings

4

This chapter covers the following:

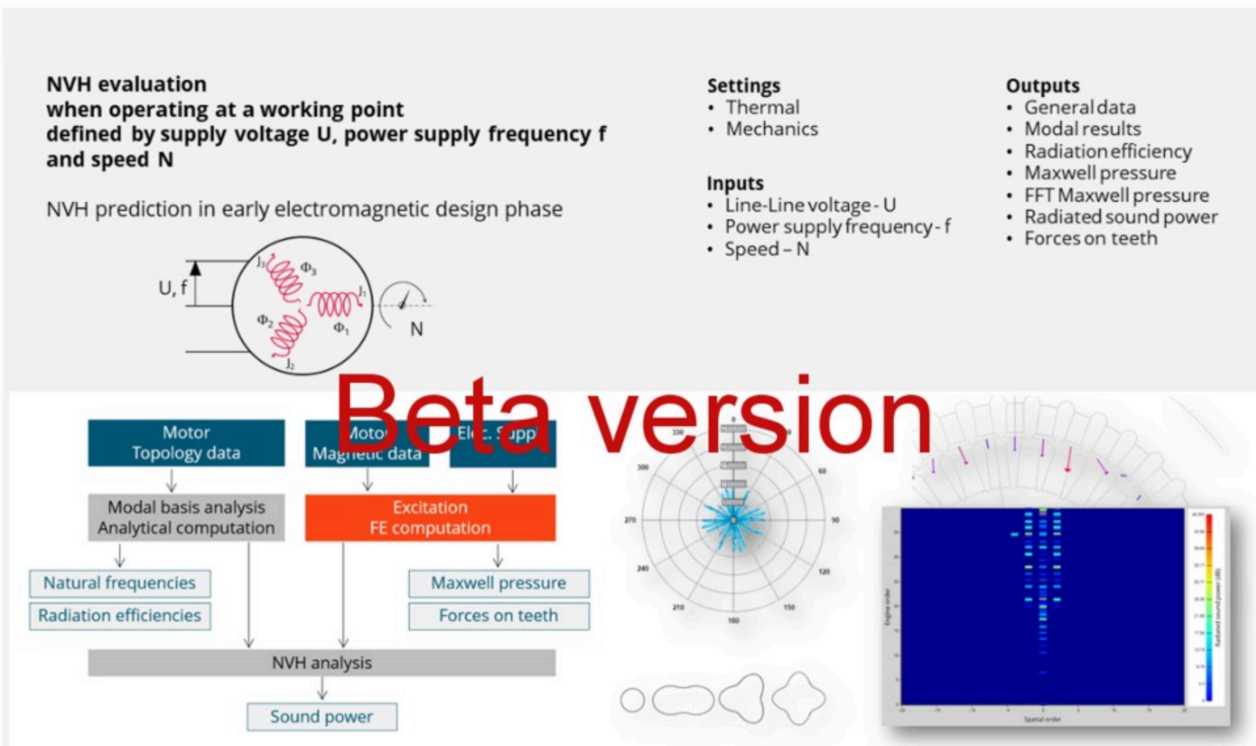
4.1 All machines

Features available in beta mode.

Sometimes, a new test is provided in beta mode, meaning that it is not entirely qualified. However, we make it available for testing, and we invite the users to give us their feedback and comments for improving this feature even more.

To indicate the "Beta mode" status of the test, "**BETA VERSION**" is written in the overview of the considered test, as illustrated below.

Here is an overview of the test, as shown below.



Example of a test provided in beta mode

For information here is the list of the features available in beta mode in the current version of FluxMotor:

Synchronous Machines with Permanent Magnets – Inner Rotor:

- The process for importing parameterized part (Magnet) from SimLab sketcher is in beta mode.

Wound Field Synchronous Machines - Inner Salient Poles – Inner Rotor:

- Test – Mechanics – NVH – Working point If, I, Ψ, N
- Test – Mechanics – NVH – Spectrogram If, I, Ψ, N

Induction Machines with Squirrel Cage – Inner and Outer Rotor:

- Test – Characterization - Model – Motor – Scalar
- Test – Performance mapping – Sine wave – Motor – Ems U-f (Efficiency map)
- Test – Performance mapping – Sine wave – Motor – Ems U-I (Efficiency map)
- Test – Mechanics – NVH – Working point U, f, N
- Test – Mechanics – NVH – Working point I, f, N
- Test – Mechanics – NVH – Spectrogram U, f, N
- Test – Mechanics – NVH – Spectrogram I, f, N

DC Permanent Magnet machines – Inner Rotor:

- Test – Working point – Constant speed – Motor & Generator – U-N
- Export – Flux 2D – Transient – Working point – Voltage source – Motor & Generator – Constant speed

All changes to Motor Factory GUI are not reflected in the user help guide. This will be done in the future versions.

Distribution of computations cannot be used for computing NVH spectrogram

(FXM-15772)

Winding – Expert mode – defining of several circuits per sector.

In Expert mode, several parallel circuits can be defined in a sector, and moreover, several coils can be built in one circuit.

Such circuits can be connected in parallel according to the user's input No. parallel paths.

In that case, it is mandatory to balance all the parallel paths well while building and connecting the coils inside all the circuits.

Indeed, our internal process of computation doesn't manage the unbalance between parallel paths, i.e., in the case of unbalanced parallel paths, the results of computations are wrong.

> **Note:** For example, imbalance between parallel paths can be due to the number of coils per circuit, which can be different from one circuit to another. It can also be induced by the building of coils (differences in conductor lengths...).

Natural convection for end winding

While choosing a model where the end spaces are cooled with natural convection, the FluxMotor® model uses quite a low rotor tip speed ratio (a value of 5) to describe the fluid velocity far from the rotating components. This may lead to an overestimation of the cooling of the end winding on high-speed machines.

When a tip speed ratio of 5 seems to overestimate the end winding cooling, it is advised to switch to forced convection mode.

This mode allows forcing some higher tip speed ratios for areas far from the rotor but reduces the efficiency of the cooling on the end winding.

This model will be improved for future versions.

Modification of units

To take the change of units into account in a test, the user must reopen Motor Factory. The modification is not considered instantaneous in applications of Altair FluxMotor® like Motor Factory.

Export a model into Flux® environment with represented elementary wires

Building time of the model in Flux®:

When slots are filled out with a lot of elementary wires, and all the phases need to be represented with solid conductors inside the Flux® 2D model, the resulting python file can be very long. Therefore, the process of building the corresponding model in the Flux® environment can take a longer time.

Browse function

Sometimes, opening a folder from FluxMotor® applications via the browser function requires a longer time (several seconds).

Export environment – HyperStudy®

Compatibility of HyperStudy connectors with respect of FluxMotor solver versions

The process that describes how to update the HyperStudy connector is written in the user help guide “MotorFactory_Introduction.pdf”.

New test and connectors for HyperStudy®

Connectors for coupling FluxMotor® and HyperStudy® are not yet available for the newly added tests, like those with transient thermal computations or the tests for induction machine like the “Characterization – Model – Motor – Scalar” and the “Performance mapping – Sine wave – Motor – Efficiency map scalar”.

Mandatory synchronization between connector and FluxMotor versions

The connectors used in HyperStudy must be synchronized with the FluxMotor solver version.

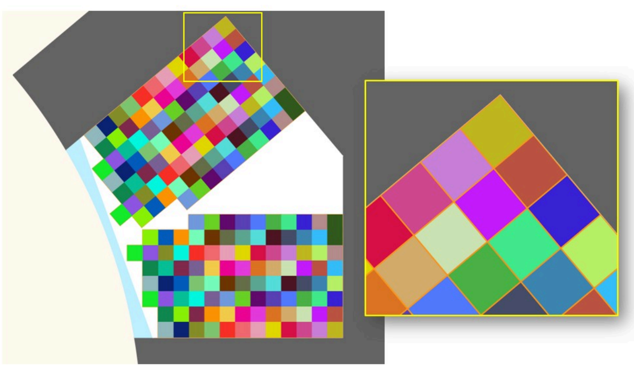
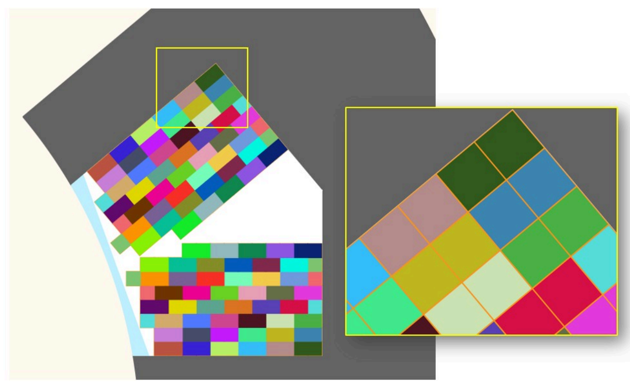
An error message (inside the log files) is generated while performing HyperStudy studies with a connector provided with a former version of the FluxMotor solver.

Problems with slot filling

1. Slot filling is not yet possible with a non-symmetric parallel slot.
2. When a toothed winding design is considered with rectangular shape wires, the conductor grouping method "horizontal" doesn’t work properly, leading to the wrong visualization of conductors. In that case, it is recommended to select the conductor grouping method "vertical".

   All work well with circular shaped wires.

Example with a toothed winding design (i.e., the coil pitch = 1) and with 2 wires in hand.

	
Horizontal filling – wrong visualization, but the total number of wires is right	Vertical filling – good visualization

NVH computations - Advice for use

The modal analysis and the radiation efficiency are based on analytical computation, where the stator of the machine is considered a vibrating cylinder.

The considered cylinder behavior is weighted by the additional masses, like the fins or the winding, and the subtractive masses, like the slots and the cooling circuit holes.

This assumption allows for a faster evaluation of the behavior of machine in connection to NVH. But in no way can this replace mechanical finite element modeling and simulation.

Possible reasons for deviations in results can be the following:

- The limits of the analytical model are reached or exceeded.
- Unusual topology and/or dimensions of the teeth/slots
- Complexity of the stator-frame structure when it is composed of several components, for instance.
- The ratio between the total length of the frame Lframe and the stack length of the machine Lstk. In any case, this ratio must be lower than 1.5:

  L_Frame/L_stk ≤1.5

4.2 Synchronous machines – Motor Factory – Test environment

Working point – Square wave – Forced I – and delta connection.

When running the test “Working point – Square wave – Motor – Forced I” with a delta winding connection, two electrical periods are considered for reaching the steady state behavior of the motor. However, sometimes two periods are not enough to get a good convergence of the process, and therefore, the displayed results may not correctly represent the steady state.

Motors built and tested with previous versions can be loaded with the current version. The existing "current tests" are removed and transformed into "saved tests" with reference to the original version (all the previous versions).

Sometimes, the results of the current tests are removed. The test must be executed again to get the corresponding results.

Delta winding connection

When a delta winding connection is considered, the computation doesn’t consider the circulating currents. This can lead to a different result than expected in transient computation for the test "Characterization - Open-circuit - back-emf".

In such a case, it is recommended to perform a transient computation in the Altair® Flux® environment. The application “Export to Flux®” thereby allows exporting this kind of model to the corresponding scenario ready to be solved.

Evaluation of the maximum achievable speed

The aim of this result is to give a rough estimation of the maximum reachable speed that can be achieved by the machine. This computation is performed by considering the MTPV command mode. However, when the resulting control angle is low (no saliency in the airgap of the machine), the evaluation of the maximum achievable speed may be far away from the maximum speed given by the “Performance mapping – Sine wave – Motor - Efficiency map” test.

Export to FeMT

The export of projects to FEMT is limited to SMPM inner rotor machines.

Furthermore, when there is more than one parallel path, export to FeMT is blocked because the two electric circuit models are not yet compatible in the electric circuit built by FluxMotor. Here, parallel paths are built to represent the corresponding parallel circuits.

4.3 Induction machines – Motor Factory – Design environment

Computation of inter bar impedance.

For induction machines, inter bar impedance (resistance and inductance) is computed by considering characteristics defined in the Motor Factory. However, while exporting the model into Flux® 2D or into Flux® Skew, the inter bar impedance will remain constant, even if a parametric study is performed in the Flux® environment. The topology parameter as well as the temperature variations won't impact the inter bar impedance.

4.4 Induction machines – Motor Factory – Test environment

Computation of tests for induction machines with skewing

When the squirrel cage or the slots are skewed for induction machines, the tests are computed with Altair® Flux® Skew at the back end of the FluxMotor®.

This leads to an increase in computation time.

For the tests "Performance Mapping – Sine wave – Motor – T(Slip)" and the test "Characterization – Model – Motor – Linear", the computation time can be greater than 45 minutes depending on the concerned machine and is generally lower than 5 minutes when it is without skewing of the squirrel cage or slot.

The computation time for computing a working point is generally close to 8 minutes with the skewing of a squirrel cage or slots and lower than 1 minute when it is without skewing.

The required allocated memory is higher when Flux® Skew computations are performed at the back end of the FluxMotor®.

By default, the maximum allocated memory for Flux® Skew software and Flux® 2D software is set to DYNAMIC (user's preferences - Advanced tab).

Computation of power density for induction machines

There was an issue in the process of computing or displaying the power density for induction machines.

The result was given in W/m3 while it is in W/kg for other machines, such as SMPM and RSM.

This issue has been corrected.

However, it won't be possible to use a connector for HyperStudy®, generated with an older version, for driving the FluxMotor® 2022.2.

List of the main issues

5

This chapter covers the following:

5.1 All machines

Computation of maps may be incompatible with the Flux distribution mode

It is highly recommended to not use the Flux distribution mode while computing maps.

This restriction must be applied for the test Characterization / Model / maps test as well as for the export of maps to System (ref.: FXM-17954).

The graphs displayed in the test Mechanics / NVH have bad quality

Immediately after obtaining the results, the quality of the graphics is good. It deteriorates when you change windows and then come back to see the results (ref.: FXM-17258).

Import input function doesn’t work

In the Export / HyperStudy area, the import input function doesn’t work for thermal settings (ref.: FXM-17724).

Problem while exporting project to Flux2D

When the machine has a high number of slots and when the machine is fully represented, sometimes, the export of the project to Flux 2D (or Flux Skew) takes a huge computation time and fails (ref.: FXM-17694).

Issue with the number of decimals after dot

When setting the common user preferences "No. decimal after dot" equal to 5, the numbers less than 1 written with an exponent (1E-X) become equal to 0 (ref.: FXM-17838).

Export LUT – Issue with the temperature dependency of the stator resistance

While exporting the LUT, the value of the stator resistance doesn’t consider the temperature, which is defined in the thermal settings (ref.: FXM-17692).

Thermal computations - Problem of convergency

When losses are very high, there is a convergence issue with the thermal computations (ref.: FXM-15900).

This issue will be reevaluated since the thermal solver has been changed.

Null values are not well managed while designing the Frame and shaft.

Null values are allowed for designing the housing, bearing, or shaft dimensions, but this leads to the wrong thermal analysis. It is highly recommended not to use null values for the inputs considered (ref.: FXM-14705).

Export to FeMT with too long output path

The Flux script crashes when the output path for FeMT export is too long (ref.: FXM-15471).

Fault in the coupling FluxMotor-HyperStudy

An error in the FluxMotor process doesn't stop the HyperStudy execution (ref.: FXM-15402).

Issue with exported Flux Skew projects

After exporting a Flux Skew project, if the user solves the project, deletes the results, and then solves again, the running of the project fails (ref.: FXM-15075).

The color of wires is bad

The color of wires displayed in the slots is not correct while using Flux Skew export (ref.: FXM-16942).

Error while opening a motor (2020.1) with null shaft extension.

Opening a motor built with version 2020.1 (or older) with a null shaft extension leads to an error. With new versions, a null shaft extension is forbidden (ref.: FXM-14684).

Air material properties are wrong for high temperature.

This issue impacts our internal computation processes during transient thermal solving. Indeed, some iterations involve very high temperature (more than 3000 °K), according to the Newton Raphson non-linear solving method. During the resolution, this can lead to negative conductivity and viscosity, which may make the computation fail (ref.: FXM-14465).

> **Note:** In case of a problem, an "Air material" with the right parameters can be provided.

When an IO cannot be loaded, the test results are not accessible.

When an IO cannot be loaded, the whole process that loads all the test results is stopped. As a result, no test is visible, although the issue may concern one result in a particular test (ref.: FXM-13941).

A wedge and/or inter-coil insulation region leads to a wrong slot equivalent thermal conductivity.

The slot radial thermal conductivity, which is automatically provided by the FluxMotor® in the "Cooling-Internal" context and used in all thermal tests, is wrong if the slot contains faces "wedge" or "inter-coil insulator" (ref.: FXM-13896).

Power electronics and coupling with HyperStudy®

For tests where the setting "Electronics" is available, data like power electronics stage, maximum efficiency, and its rated power can be selected for generating a connector for HyperStudy®, but it should not be.

In the Export-HyperStudy® area, when the selected test is "Working Point, T-N", the settings of "Electronics" - "Max efficiency", and "Rated Power" - are exported even if the associated option is not selected (ref.: FXM-13726).

Winding environment – MMF computation

The counterclockwise sequence (MMF computation) is not considered in the Altair® Flux® model, which one can export. Only the clockwise phase sequence is considered (ref.: FXM-10280).

Using "phase sequence" set to "Counterclockwise" leads to wrong results in tests (ref.: FXM-13358).

Flux density isovalues

When a skewed topology is considered (synchronous machines or induction machines), the flux density isovalues, the vector potential isolines, and the rotor bars current density isovalues are not displayed (ref.: FXM-12564).

5.2 Synchronous machines – Motor Factory – Test environment

In accurate mode the sign of the reactive power, and the phase angle are not right.

The sign conventions are not respected for defining the reactive power and phase angle (ref.: FXM-16143, FXM-16542).

SMPM - Working point – Square wave – Forced I – Average computation of quantities.

The computation of average quantities like iron losses, the Joule losses in magnets, and torque is not executed over a full electrical period. That can lead to wrong results (ref.: FXM-14091).

SMPM - Maximum speed computation

The estimation of the maximum speed is wrong for the tests "Working point - Sine wave – Motor - U-I" and "Working point - Sine wave – Motor - T-N" when the control mode MTPA is selected (ref.: FXM-10916). The computation is always performed by considering the MTPV command mode.

Wound field machine - Wrong thermal settings for the test "NVH Spectrogram"

The thermal settings should be the same that those available for the test "NVH Working point" (ref.: FXM-17932).

Wound field machine - SSFR - Negative values of the equivalent scheme

We met a few cases where the parameters of the resulting equivalent scheme were negative. (ref.: FXM-10916).

SM-RSM - Issue in the displaying of the characteristic curves in Jd-Jq area

In the test efficiency map, there is an issue in the displaying of the characteristic curves in Jd-Jq area where the location of the second working point is wrong (ref.: FXM-17801).

5.3 Synchronous machines – Motor Factory – Export environment

Export from FluxMotor to FEMT - Issue when exporting the Efficiency map test in case of parallel paths.

This problem occurs when there is more than one circuit in parallel for the periodic portion of the model under consideration (ref.: FXM-17103).

SMPM - issue while exporting a 3D machine with a shaft

The shaft is not represented in the resulting 3D project (ref.: FXM-17953).

5.4 Induction machines – Motor Factory – Test environment

Efficiency map vector control – Bad computation for Ld

The computation of the d-axis and q-axis inductances has been implemented in the framework of the new test Effciency map – vector control U-I.The computation of Ld via the d-axis flux linkage response surface gives bad results (ref.: FXM-17679).

The computation of the efficiency map (U, I) with mechanical losses can fail.

This issue raises a null-pointer exception (ref.: FXM-16157).

The flux density is not displayed in accurate mode computation.

While computing a working point (U, f, N) for an induction machine with a skewed squirrel cage and outer rotor, the flux density inside the airgap is not displayed. (ref.: FXM-16154).

Error when exporting and solving a project in Flux Skew – Transient application.

This issue occurs when the user input “Represented coil conductors” is set to All phases (ref.: FXM-15877).

Scalar Maps or Efficiency map (U,f) tests fail with hairpin winding technology

Sometimes, the tests Scalar Maps and Efficiency map (U,f) are not correctly solved with a hairpin winding configuration, like for the Motor M1 of the reference catalog (ref.: FXM-15843).

Scalar maps test can provide bad results

Note: This test is still in beta mode (ref.: FXM-17587).

Power balance of No-load working point

Sometimes, computation of the no-load working point (slip = 0.1%) leads to a NaN (Not a Number) result. The computed amount of iron losses is not consistent with the power balance (ref.: FXM-12600).

Issue while computing the efficiency map (scalar control – U, f or U, I)

This problem occurs when there are 3 poles represented for the periodic portion of the model under consideration (ref.: FXM-17150).

Issue while computing the efficiency map (scalar control – U,f or U,I) – IMSQ

The scalar model gives wrong results when hairpin winding technology is considered compared to results obtained with an equivalent classical winding (ref.: FXM-17183).

Torque slip curve

Test results are not continuously consistent over a torque slip curve. This occurs with the test Performance mapping T(Slip) - induction machines with a skewed squirrel cage. When the user targets a working point as an added value to be computed with the whole Torque-slip curve, sometimes this additional working point doesn't belong to the curve (ref.: FXM-12599).

5.5 Part Factory

Wrong management of part borders

An inner part with an air region on the bottom border is not allowed (ref.: FXM-13445; FXM-17661).

5.6 Script Factory

Script Factory does not stop correctly.

Script Factory does not stop correctly if FluxMotor has been killed. This occurs if the FluxMotor process has been killed externally. Then, Script Factory is not able to get back to a valid state, neither automatically nor after a kill of the process (ref.: FXM-15140).

Script Factory freezes temporarily when running a script.

When running a script, the Script Factory gives the impression of freezing (while still running in the background). The editing window of the script becomes unresponsive until the script is done executing (ref.: FXM-13138).

Testing and exporting projects should be prohibited for certain use cases.

For example, testing and exporting of projects with scripts should be prohibited when slot filling is bad, or when the End-windings X-Factor leads to negative end-windings resistance (ref.: FXM-16455).

The new files are not visible in the tree if the folder is empty.

When we open an empty directory, the workspace tree is empty. Using the ‘New file’ button does not make visible the created files. (ref.: FXM-16901).