# Altair® FluxMotor® 2023.1

## Release Notes

Updated: 12/05/2023

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2023.1

September 14, 2023

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### Altair Community

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When contacting Altair support, specify the product and version number you are using along with a detailed description of the problem. It is beneficial for the support engineer to know what type of workstation, operating system, RAM, and graphics board you have, so include that in your communication.

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|---|---|---|
| Australia | +61 3 9866 5557 | anzsupport@altair.com |
| Brazil | +55 113 884 0414 | br_support@altair.com |

| Location | Telephone | E-mail |
|---|---|---|
| Canada | +1 416 447 6463 | support@altairengineering.ca |
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# Contents

# Introduction

1

This chapter covers the following:

# 1.1 Overview

This document gives the major information about Altair® FluxMotor® 2023.1. The main highlights of this new version are described below.

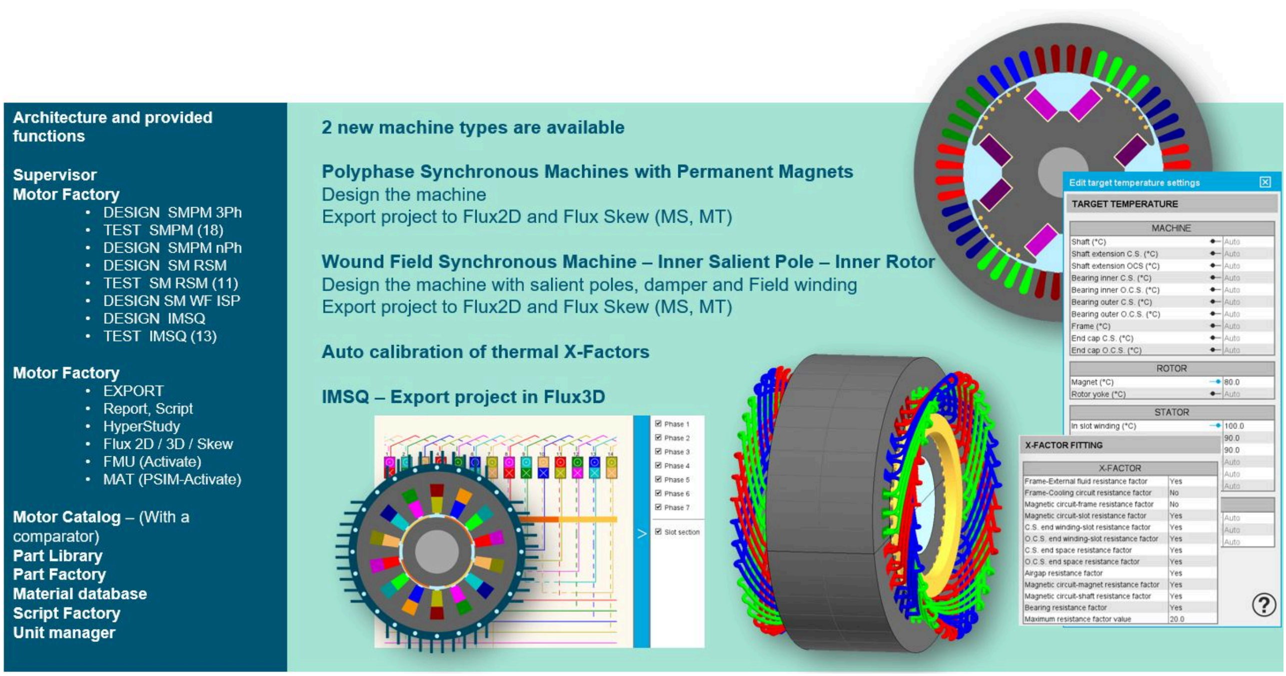
For more detailed information, please refer to the user help guides. The list of documents to read is presented below.

Here are the highlights of the new version:

- Two new machine types are available:
  - The polyphase synchronous machine with permanent magnets (Inner and Outer Rotor)
  - The wound field synchronous machine with inner salient pole (Inner Rotor)

  Part Library, Part Factory and Motor Catalog have been updated to include these new machines.
- A new test allows us to automatically compute and apply thermal calibration factors to reach targeted temperatures.
- Export to Flux 3D – Induction machines with squirrel cage
- Correction of issues

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




FluxMotor 2023.1 – The main highlights

# 1.2 Documents to read

It is highly recommended to read the user guides given below before using Altair® FluxMotor®. Each user help document can be downloaded from the online user help.

Below is a list of documents that are available.

### General user guides for any type of machine

- InstallationGuide_Flux_FluxMotor_2023.1.pdf (Installation for both Altair® Flux® and Altair® FluxMotor®)
- Supervisor_2023.1.pdf
- MotorCatalog_2023.1.pdf
- PartLibrary_2023.1.pdf
- PartFactory_2023.1.pdf
- Materials_2023.1.pdf
- ScriptFactory_2023.1.pdf
- MotorFactory_2023.1_Introduction.pdf
- MotorFactory_2023.1_Windings.pdf

### User guides dedicated to Synchronous Machines with Permanent Magnets (SM PM) - Inner and Outer Rotor

- MotorFactory_2023.1_SMPM_IOR_Design.pdf
- MotorFactory_2023.1_SMPM_IOR_3PH_Test_Introduction.pdf
- MotorFactory_2023.1_SMPM_IOR_3PH_Test_Characterization.pdf
- MotorFactory_2023.1_SMPM_IOR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2023.1_SMPM_IOR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2023.1_SMPM_IR_3PH_Test_Mechanics.pdf
- MotorFactory_2023.1_SMPM_IOR_Export.pdf

### User guides dedicated to Reluctance Synchronous Machines (SM RSM) - Inner Rotor

- MotorFactory_2023.1_SMRSM_IR_3PH_Design.pdf
- MotorFactory_2023.1_SMRSM_IR_3PH_Test_Introduction.pdf
- MotorFactory_2023.1_SMRSM_IR_3PH_Test_Characterization.pdf
- MotorFactory_2023.1_SMRSM_IR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2023.1_SMRSM_IR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2023.1_SMRSM_IR_3PH_Test_Mechanics.pdf
- MotorFactory_2023.1_SMRSM_IR_3PH_Export.pdf

### User guides dedicated to Wound Field Synchronous Machines (SM WF) - Inner Salient Poles - Inner Rotor

- MotorFactory_2023.1_SMWF_ISP_IR_3PH_Design.pdf
- MotorFactory_2023.1_SMWF_ISP_IR_3PH_Export.pdf

### User guides dedicated to Induction Machines with Squirrel Cage (IM SQ) - Inner and Outer Rotor

- MotorFactory_2023.1_IMSQ_IOR_3PH_Design.pdf
- MotorFactory_2023.1_IMSQ_IOR_3PH_Test_Introduction.pdf
- MotorFactory_2023.1_IMSQ_IOR_3PH_Test_Characterization.pdf
- MotorFactory_2023.1_IMSQ_IOR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2023.1_IMSQ_IOR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2023.1_IMSQ_IR_3PH_Test_Mechanics.pdf
- MotorFactory_2023.1_IMSQ_IOR_3PH_Export.pdf

# List of new features

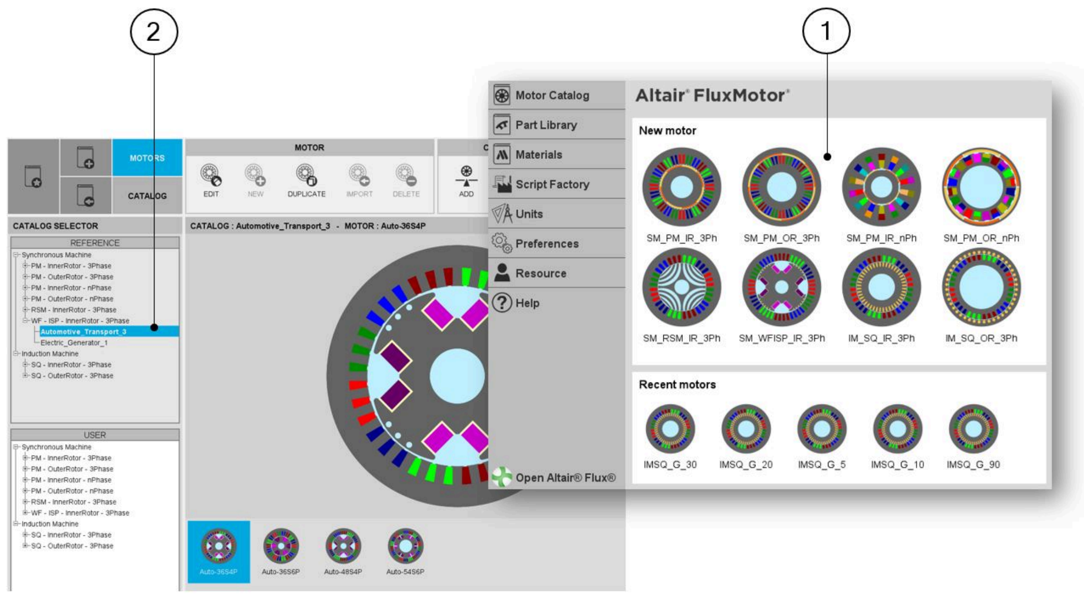
2

This chapter covers the following:

# 2.1 Two new machine types are available

**Two new machine types are available**

- The polyphase synchronous machine with permanent magnets (Inner and Outer Rotor)
- The wound field synchronous machine with inner salient pole (Inner Rotor)




List of available machines from the Altair® FluxMotor® supervisor (1) and in Motor Catalog (2)

From the supervisor, the user can click on a type of motor (1) and get into Motor Factory for designing motors.

8 types are currently available, including 3 new ones (in bold font below):

- SM_PM_IR_3Ph: 3-Phase synchronous machines with permanent magnets – Inner rotor
- SM_PM_OR_3Ph: 3-Phase synchronous machines with permanent magnets – outer rotor
- **SM_PM_IR_nPh: 3-Phase synchronous machines with permanent magnets – Inner rotor**
- **SM_PM_OR_nPh: 3-Phase synchronous machines with permanent magnets – outer rotor**
- SM_RSM_IR_3Ph: 3-Phase Reluctance Synchronous Machines – Inner rotor
- **SM_WF_ISP_IR_3Ph: 3-Phase Wound Field Inner Salient Pole Synchronous Machines – Inner rotor**
- IM_SQ_IR_3Ph: 3-Phase induction machines with squirrel cage – Inner rotor
- IM_SQ_OR_3Ph: 3-Phase induction machines with squirrel cage – outer rotor

**Note:** Motor Catalog has been updated to include these new machines.

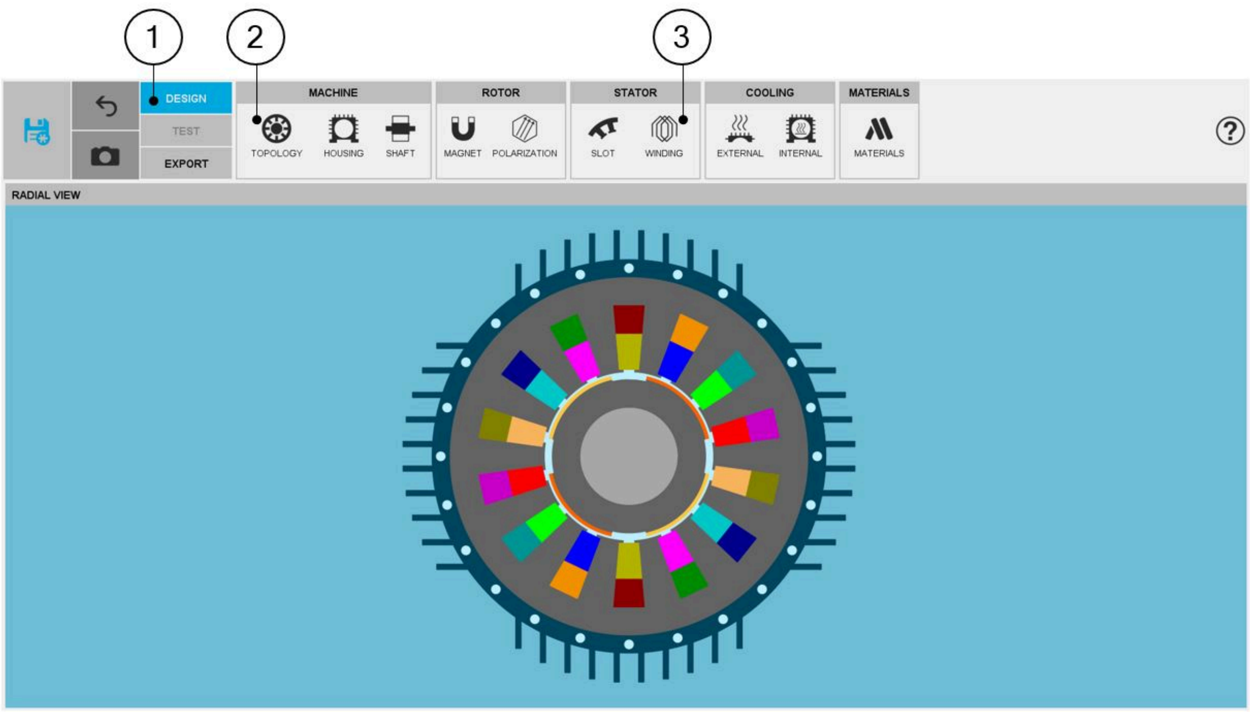
# 2.2 Polyphase Synchronous Machines - Permanent Magnets (Inner and Outer Rotor)

### Motor Factory - The design

The Polyphase Synchronous Machine with Permanent Magnets (Inner or Outer Rotor) can be designed in Motor Factory.

The design environment is almost the same as for the 3-Phase Synchronous Machine with Permanent Magnets.

> **Note:** The Polyphase Synchronous Machines with Permanent Magnets (Inner or Outer Rotor) are considered two new kinds of machines different from the 3-Phase Synchronous Machine with Permanent Magnets.

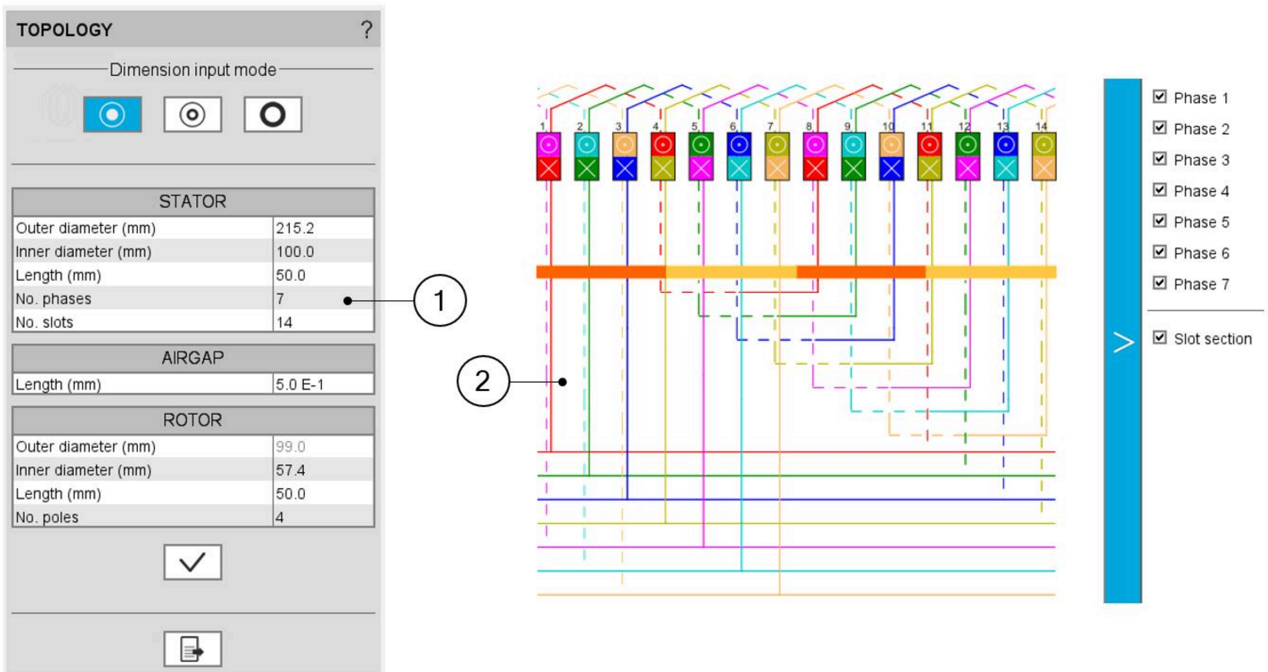



The Polyphase Synchronous Machine with Permanent Magnets (Inner Rotor) –The design environment in Motor Factory

| | |
|---|---|
| 1 | The design environment |
| 2 | In Machine / Topology area, the structural data considers the number of phases. |
| 3 | In Stator / Winding area, the architecture and definition of the winding consider the number of phases. |

In Motor Factory / Design area, the main difference between a 3-Phase and Polyphase Synchronous Machine with Permanent Magnets is when defining the structural data. For polyphase machines the number of phases can be defined from 3 to 15 (the odd number) in the section Machine / Topology (see the illustration below).

The definition and characteristics of the winding architecture are adapted to the polyphase machine as well. The winding area has been adapted accordingly.




The Polyphase Synchronous Machine with Permanent Magnets
(Inner Rotor) –The winding environment in Motor Factory

| | |
|---|---|
| 1 | The number of phases can be defined in the structural data. |
| 2 | The main characteristics and results consider polyphase machine. |

### Motor Factory – Export area

1. Export Documents

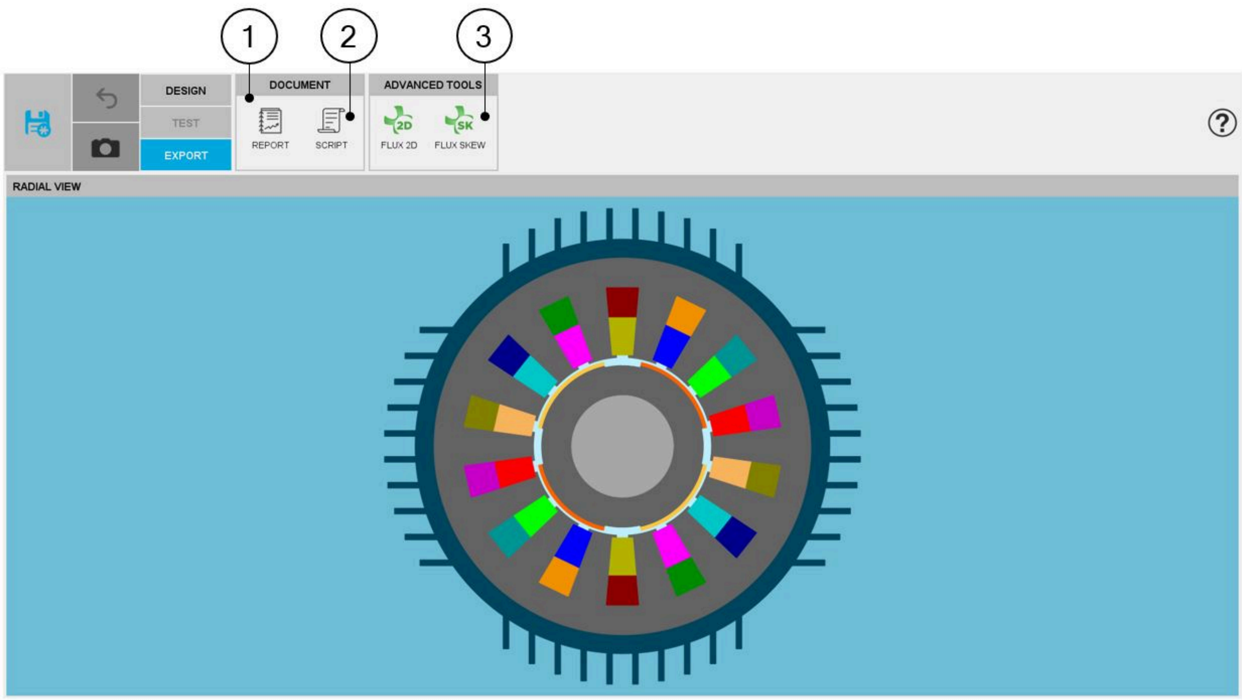
   In the EXPORT area of Motor Factory, and like for all the machine types, it is possible to automatically build reports to describe all the work achieved for designing the machines topology.

   At the same level, an export of a python script of a current motor in the application Script Factory can also be automatically generated.

2. Export projects from FluxMotor® to Flux® 2D and Flux® Skew

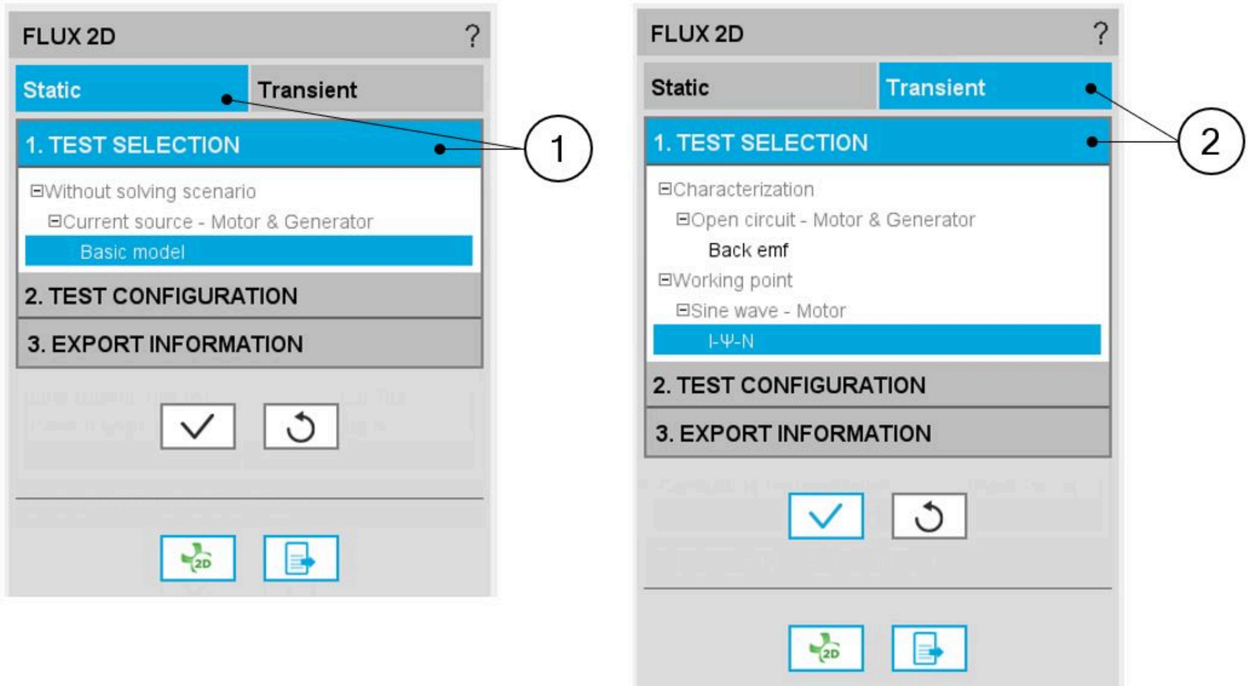
On the other hand, once the design of the machine is achieved, it is possible to export their models in Flux 2D or Flux Skew for solving tests in magnetostatic or transient applications.

Then in Flux 2D or Flux Skew, tests like the computation of the back emf or the computation of a working point can be done.




The Polyphase Synchronous Machine with Permanent Magnets (Inner Rotor) –The Export area in Motor Factory

| | |
|---|---|
| 1 | Export documents: The report |
| 2 | Export documents: The script |
| 3 | Export projects from FluxMotor® to Flux® 2D and Flux® Skew |

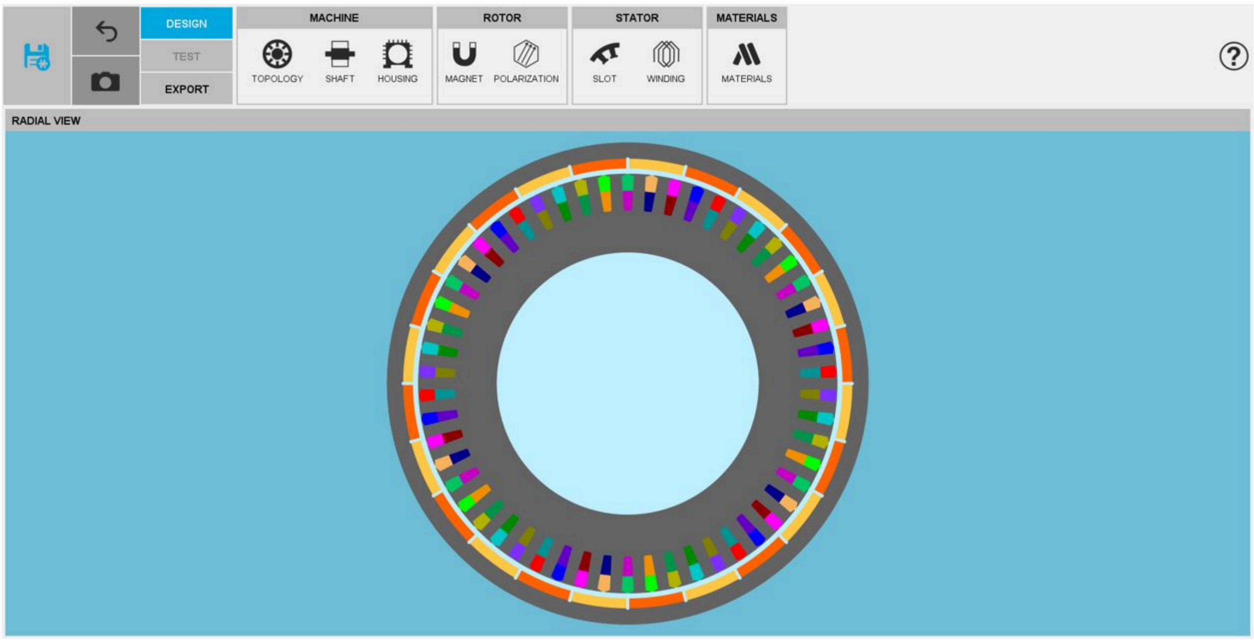



The Polyphase Synchronous Machine with Permanent Magnets.

Export projects from FluxMotor® to Flux® 2D and Flux® Skew

| | |
|---|---|
| 1 | In the Magneto Static application, one basic test for exporting to Flux® 2D (and Flux® Skew) is available. |
| 2 | In the Transient application, two tests for exporting are available: The working point and the back emf computations are available for exporting to Flux® 2D (and Flux® Skew). |

The Polyphase Synchronous Machine with Permanent Magnets (Outer Rotor) is also available in FluxMotor. See the illustration below.




The Polyphase Synchronous Machine with Permanent Magnets (Outer Rotor) – Motor Factory

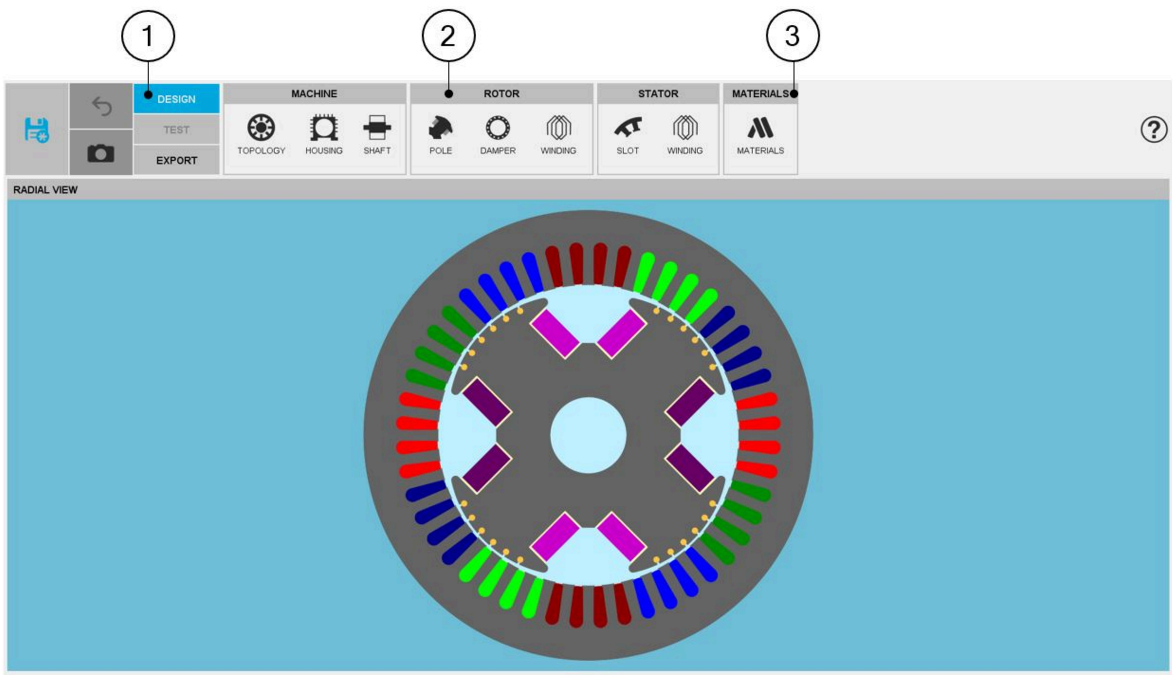
# 2.3 The 3-Phase Wound Field Synchronous Machines – Inner Salient Poles (Inner Rotor)

### Motor Factory - The design

### Introduction

For the 3-Phase Wound Field Synchronous Machines with Inner Salient Poles (Inner Rotor), all the sections in the rotor area are new.

- The "POLE" section is for designing the pole topology and dimensions.
- The "DAMPER" section is for defining the topology and dimensions of the dampers (bars and rings on both sides of the machine)
- The "WINDING" section is for defining the field winding architecture and the design of the associated coils.



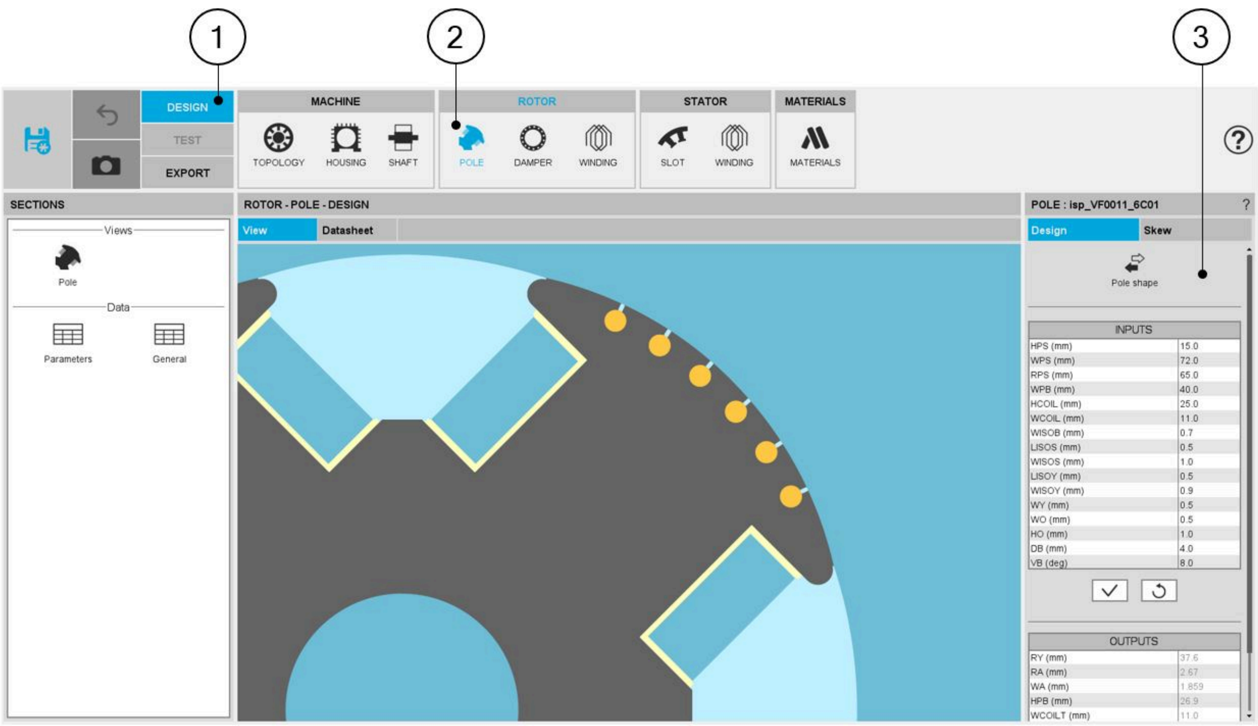

The 3-Phase Wound Field Synchronous Machines – Inner Salient Poles (Inner Rotor)

The design environment in Motor Factory

| | |
|---|---|
| 1 | The design environment |
| 2 | In the rotor area, three new sections are available: The POLE, the DAMPER, and the WINDING. |
| 3 | In the material section, the new active regions of the machine are considered. |

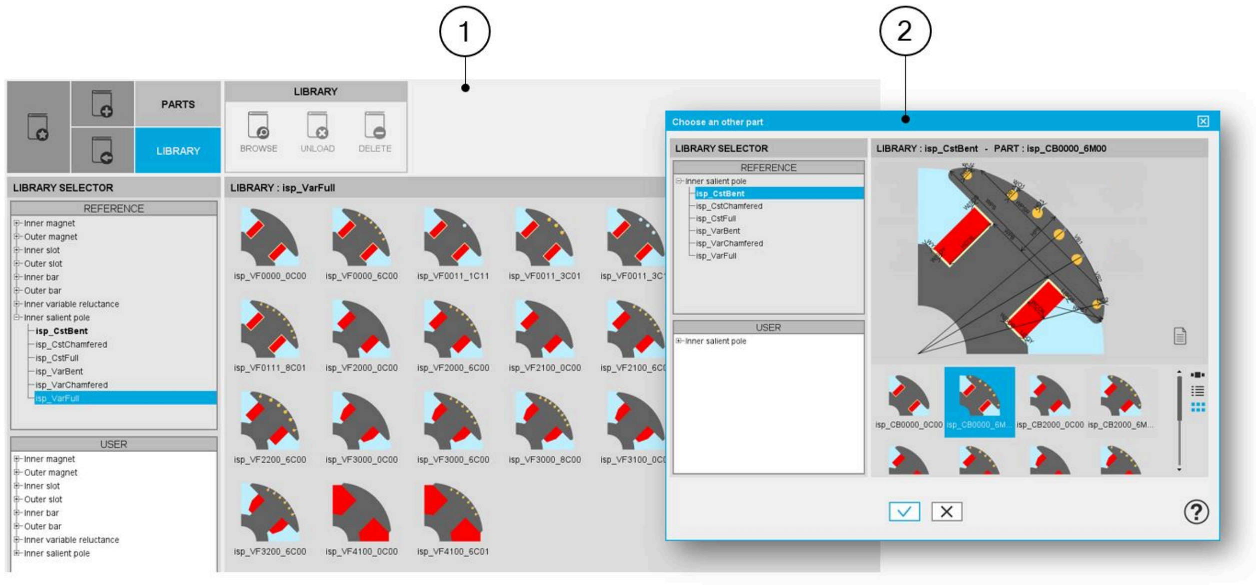
## The Pole topology and dimensions

The section POLE is dedicated to the definition of the pole topology and dimensions.




| | |
|---|---|
| The 3-Phase Wound Field Synchronous Machines - Topology and dimensions of the Inner Salient Poles | |
| 1 | The design environment. |
| 2 | Rotor area, the POLE section. |
| 3 | Inputs for defining the topology and the dimensions of the pole. |

> **Note:** The pole topology can be selected in the Part Library. Six libraries allow us to identify several kinds of pole shoe shapes, but also the coil shape, the number of damper bars, etc....

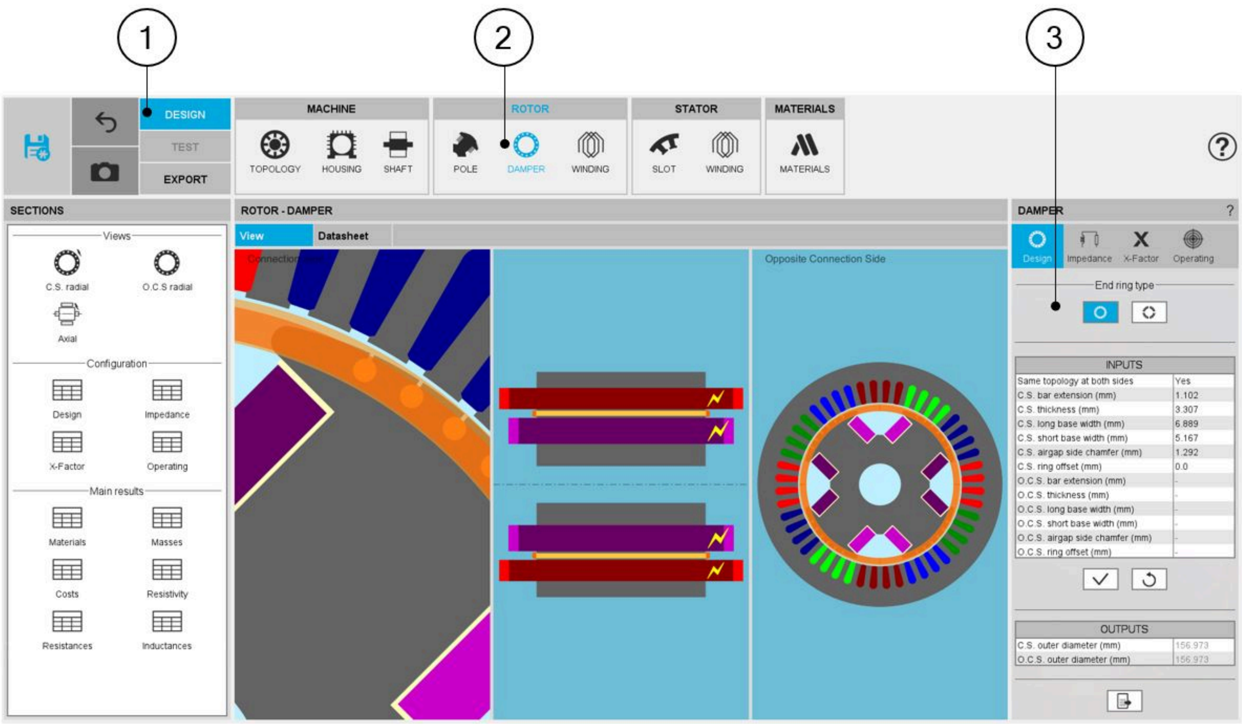



| The rotor Inner Salient Poles are available from the Part Library | |
|---|---|
| 1 | A lot of Inner Salient Pole topologies are available in Inner Salient Pole libraries. |
| 2 | The Inner Salient Poles can be selected in Motor Factory, among six libraries, to build the machine. |

## The damper topology and dimensions

The section DAMPER is dedicated to the definition of the damper located in the "pole shoe". This allows us to define the end ring type (full ring or sector), the position, and the section of the rings on both sides of the machines.

The section scrolling bars allow you to define the characteristics of the damper needed to model them.




| The 3-Phase Wound Field Synchronous Machines - Topology and dimensions of the damper end rings | |
|---|---|
| 1 | The design environment. |
| 2 | Rotor area, the DAMPER section. |
| 3 | Inputs for defining the topology and dimensions of the damper end rings. |

**Note:** The number of damper bars and their sections are intrinsically linked to the definition of the part in part Factory / Part Library. This gives the user the capability to customize the damper when needed.

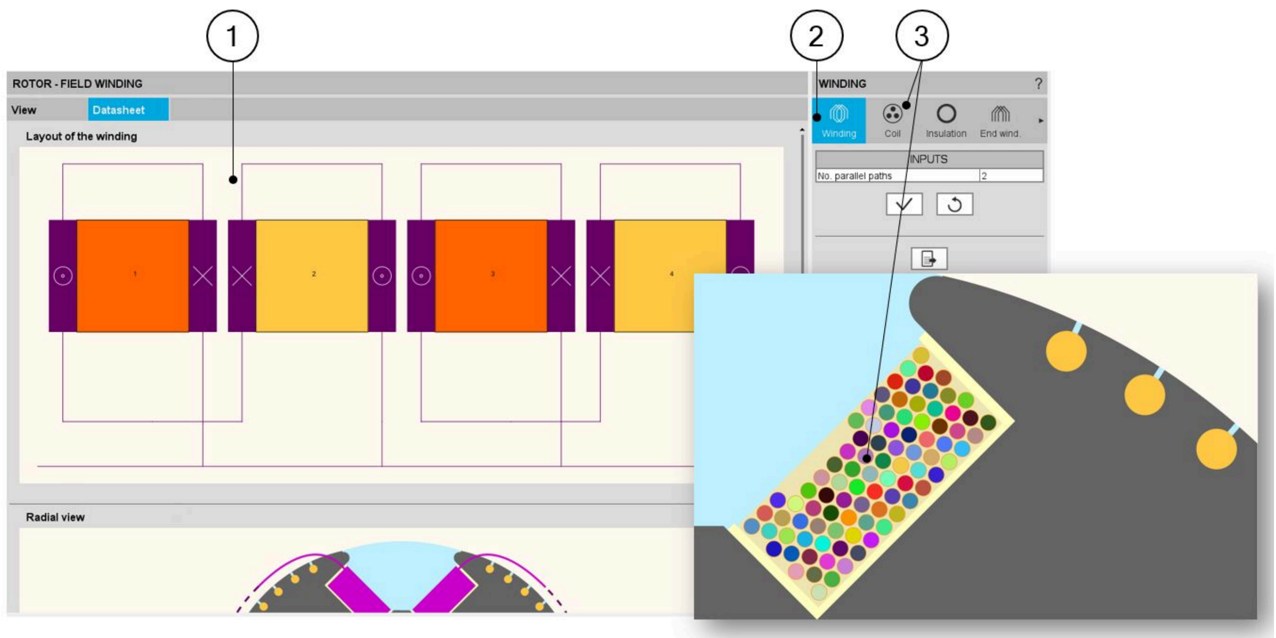
### The field winding in the rotor

The section WINDING is dedicated to the definition of field winding.

The field winding architecture is used to build the rotor poles of the wound field synchronous machines.

For further information regarding basic knowledge and terminology about electrical winding, please refer to the user help guide: "Windings" which is dedicated to the winding design General user information.

The rotor field winding has a lot of similarities with the 3-phase winding. The section scrolling bars allow you to define the winding architecture, the characteristics of the coils, the insulation, and the end-winding dimensions. X-factors allow you to calibrate the field winding resistance if needed.




| | |
|---|---|
| | The 3-Phase Wound Field Synchronous Machines – Field winding characteristics |
| 1 | Field winding layout. |
| 2 | Winding architecture: how many parallel paths? |
| 3 | Characteristics of the coils: how is it wound? |

### Motor Factory – Export area

1. Export Documents

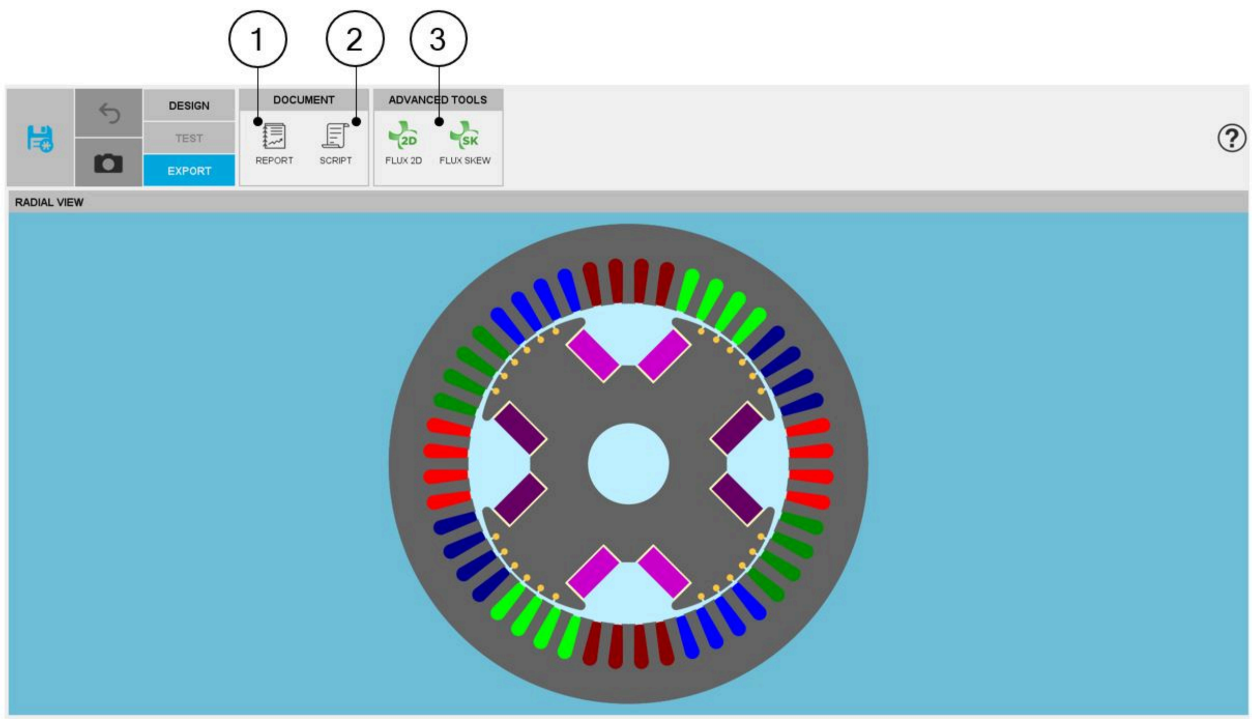
   In the EXPORT area of Motor Factory, and like for all the machine types, it is possible to automatically build reports to describe all the work achieved for designing the machine's topology.

   At the same level, an export of a python script of a current motor in the application Script Factory can also be automatically generated.

2. Export projects from FluxMotor® to Flux® 2D and Flux® Skew

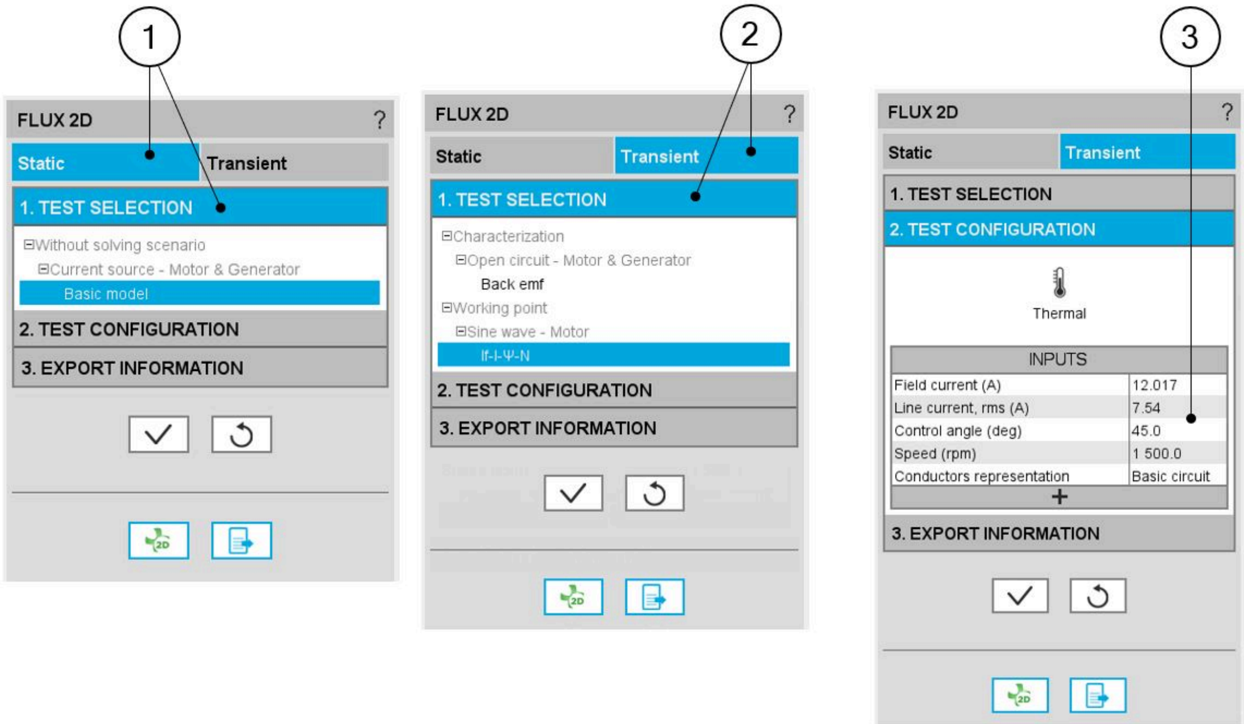
   On the other hand, once the design of the machine is achieved, it is possible to export their models in Flux 2D or Flux Skew for solving tests in magnetostatic or transient applications.

   Then in Flux 2D or Flux Skew, tests like the computation of the back emf or the computation of a working point can be done.




The Wound Field Synchronous Machine with Inner Salient Poles (Inner Rotor) –The Export area in Motor Factory

| | |
|---|---|
| 1 | Export documents: The report |
| 2 | Export documents: The script |
| 3 | Export projects from FluxMotor® to Flux® 2D and Flux® Skew |



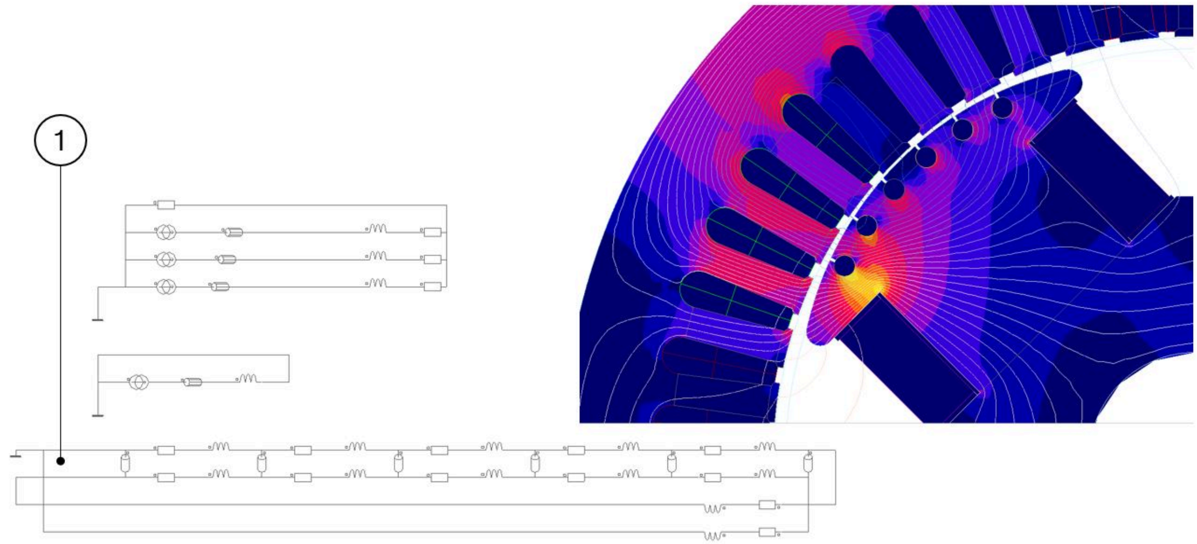

The Wound Field Synchronous Machine with Inner Salient Poles (Inner Rotor).

Export projects from FluxMotor® to Flux® 2D and Flux® Skew

| | |
|---|---|
| 1 | In the Magneto Static application, one basic test for exporting to Flux® 2D (and Flux® Skew) is available. |
| 2 | In the Transient application, two tests for exporting are available: the working point and the back emf computations are available for exporting to Flux® 2D (and Flux® Skew). |
| 3 | While computing a working point, the main user's inputs are the field current, the line current, the control angle and the speed. The temperatures of all the active regions like the windings and the dampers must be set. |

**Note:** The exported project in Flux® 2D or Flux® Skew are ready to be solved and postprocessed.

The electrical circuit is automatically done including the modeling of the dampers whatever is the considered configuration (number of poles, bars, …).




The Wound Field Synchronous Machine with Inner Salient Poles (Inner Rotor).

Electrical circuit and results

| | |
|---|---|
| 1 | The building of the electrical circuit is automatically done, including the modeling of the dampers. |

# 2.4 Auto Calibration of Thermal X-Factors

**Overview**

The aim of the "Characterization – Thermal – Motor & Generator – Fitting" test is based on a steady state thermal computation.

Whatever the considered machine, 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 user can adjust the calibration factors step by step, and evaluate the final temperatures by performing a manual iterative process.

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 after a modification of the internal thermal architecture model.

With the test Characterization – Thermal – Motor & Generator - Fitting, the calibration for the X-factors is fully automatic. The user must target the temperatures to be obtained and the X-Factors that can be used to reach this goal. As a result, one gets X-Factors values to be applied for reaching the targeted temperatures.

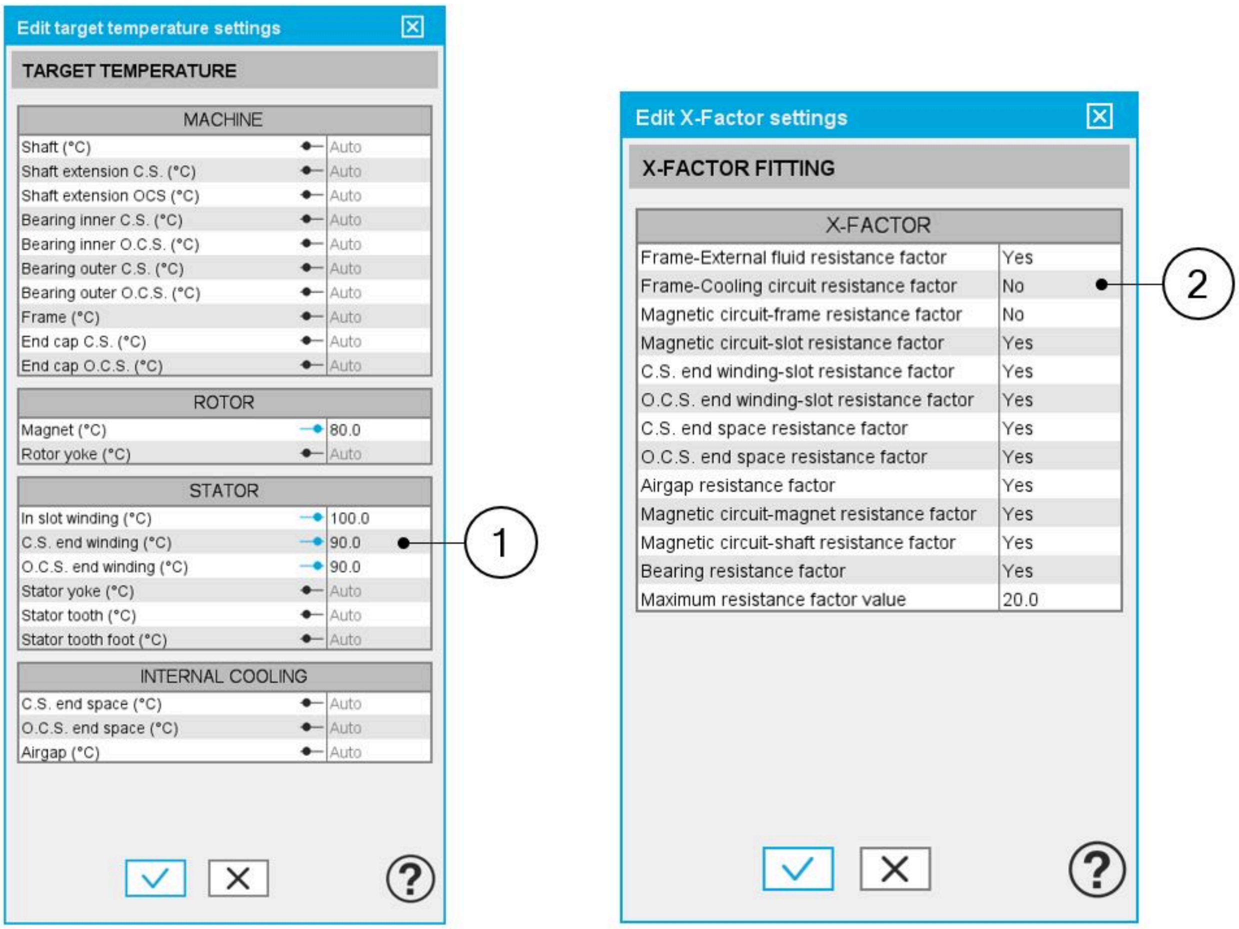
This can be used either when the users want to impose the reference temperatures that are coming from measurements or when the users want to keep the same temperatures whatever the modifications to the internal thermal model architecture.

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

**Note:** In a first step, this test is dedicated to the Synchronous Machines with Permanent Magnets – Inner Rotor.

### Targeted temperatures and X-Factors

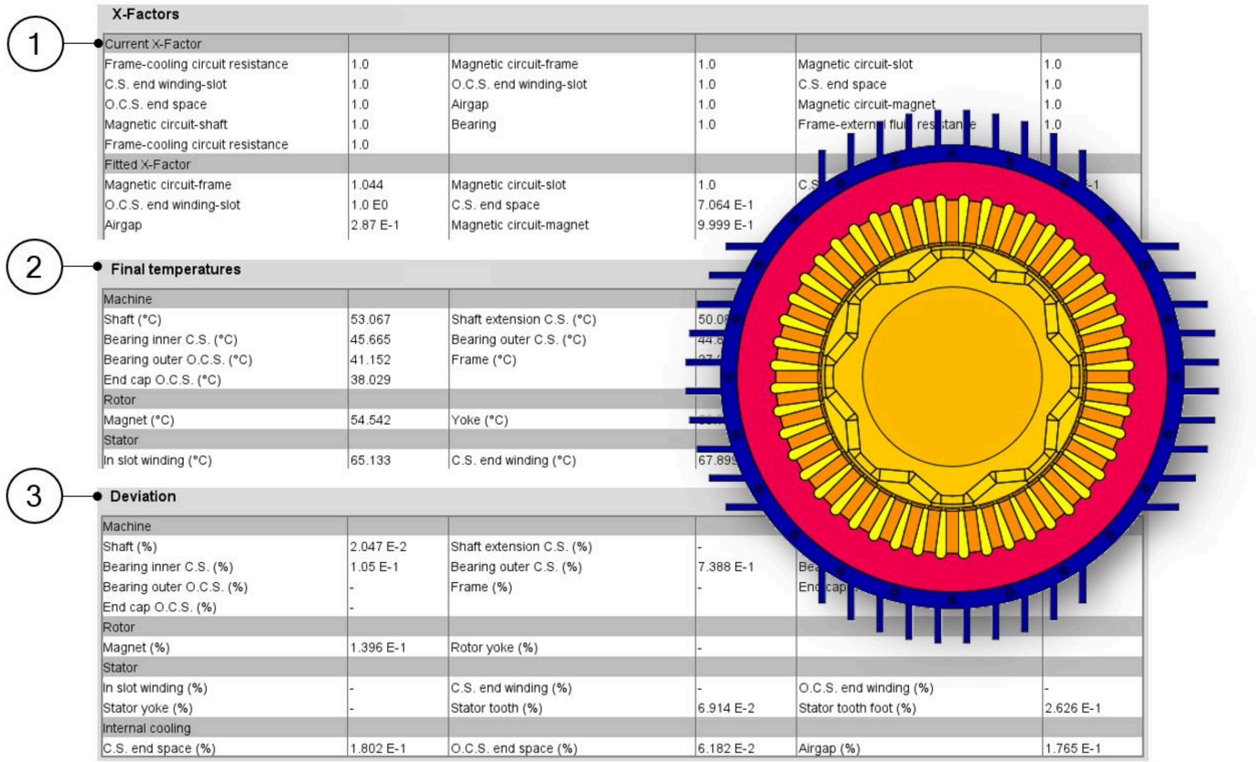
The aim of this dialog box is to collect the targeted temperatures to be reached. They are defined at each main node of the internal thermal network. See the illustration below.




List of targeted temperature and list of the calibration factors (X-Factors) to be considered during the fitting process.

| | |
|---|---|
| 1 | Auto/User mode switches allow you to select the thermal nodes and set the corresponding target temperatures. |
| 2 | 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. |

Illustrations of the results are presented below.




| Illustration of results | |
|---|---|
| 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. |

# 2.5 Export to Flux 3D – Induction machines with squirrel cage

The export of the project from FluxMotor to Flux 3D is now available for induction machines with squirrel cage.

The aim of this export is to provide a python file that allows us to get a fully parametrized model ready to be used in the Altair® Flux® 3D environment or to directly get into Flux 3D for solving and postprocessing the resulting 3D project.

> **Note:** In the current version, one test can be considered: the computation of a working point defined by the Line-Line voltage, the speed and the power supply frequency.

While exporting the project from FluxMotor to Flux 3D, after having defined the project name and the folder in which it must be stored, the user has two possible choices to make:

- Export full geometry or not. If the answer is “No”, the resulting project in Flux 3D is a reduced one in terms of periodicity based on the number of poles and the number of slots.
- Consider half the topology along the axial direction or not. If the answer is “Yes”, only half of the topology is represented.

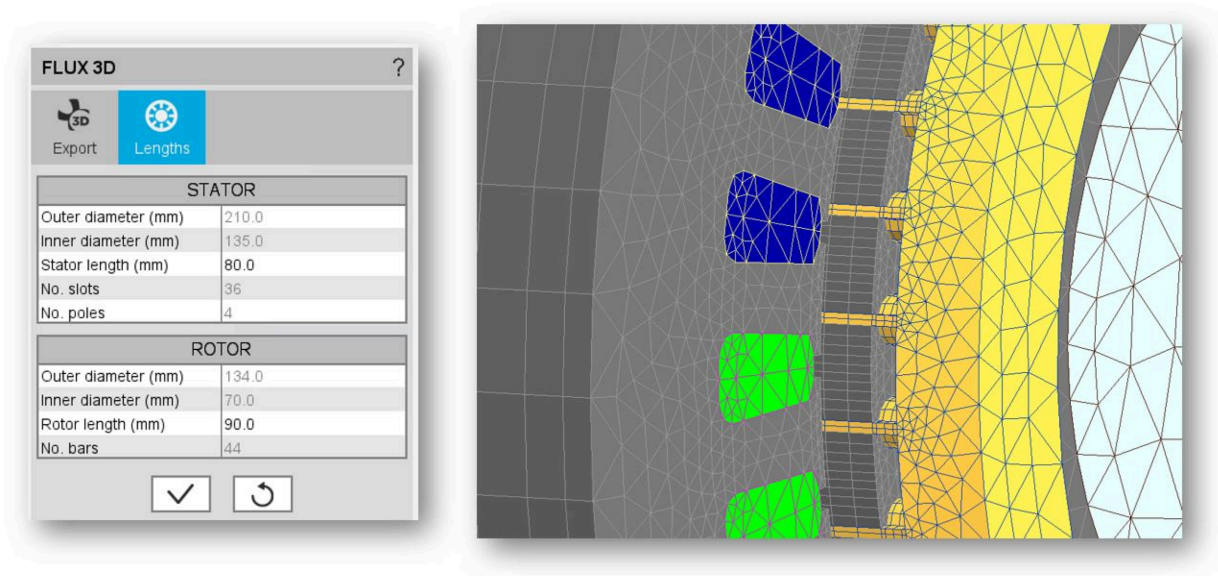
> **Note:** This is possible only when all the dimensions are equal on both sides of the machine (Connection Side and Opposite Connection Side), especially regarding the end winding and the end ring dimensions.

If the answer is “No” the whole machine is represented along the axial direction. This allows us to consider the differences there can be on both sides of the machine especially regarding the end winding and the end ring dimensions.


Export project to Flux 3D environment – Export information

A dialog box is provided for defining the lengths of the stator, the rotor, and the magnets. These three lengths can be different.

The illustration below shows the resulting topology in the Flux 3D environment where the three lengths are different. This is automatically managed and built from the export area of FluxMotor.



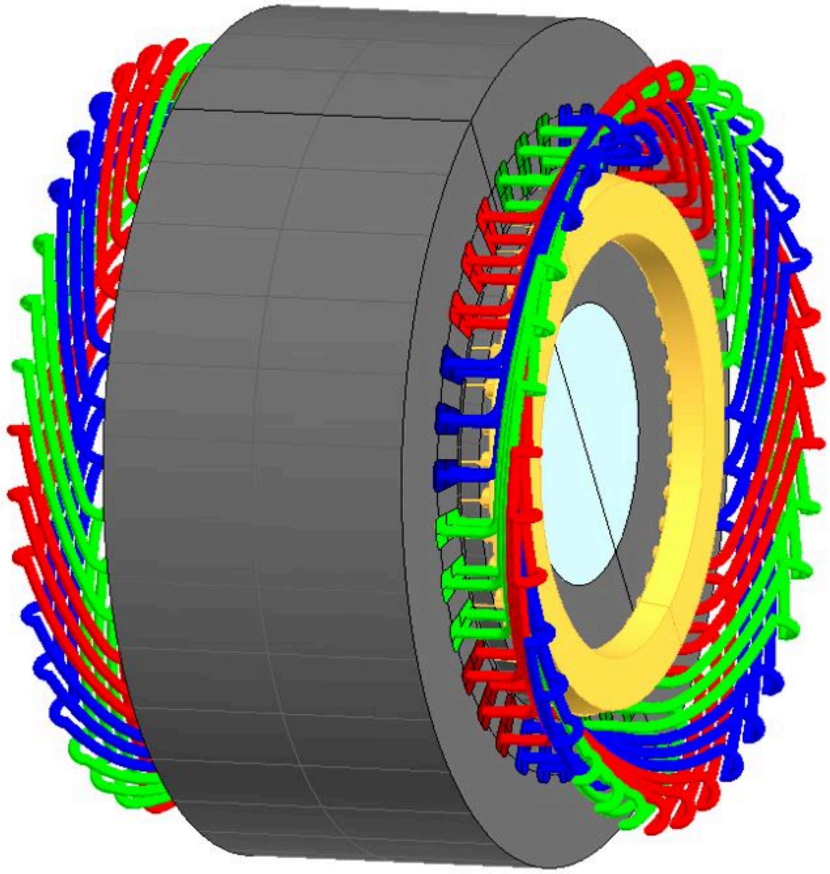

Export project to Flux 3D environment – The stator and the rotor can have different lengths

**Warning:**

When a motor with a skewed topology is considered, on the rotor side or stator side, the export to Flux 3D is not possible. In that case, only the export to Flux Skew is accessible.

When the machine topology is not symmetric, especially, with the end winding lengths, the whole machine must be modeled in Flux 3D. The choice of symmetry "Yes" is not available.

In that case, end-windings can be represented with different dimensions on the "Connection Side" and the "Opposite Connection Side".



3D modelling of the induction machine with squirrel cage: Magnetic circuit + squirrel cage + stator winding

**Note:**

A warning message is provided in the "Design environment" each time an asymmetric topology is defined. This is to warn the user that the default value of the export inputs dealing with the symmetry has been set to "No". This also occurs when the asymmetry is due to the end shafts, even if the end shafts are not represented in the 3D environment.

# List of fixed issues and major improvements

3

This chapter covers the following:

# 3.1 All machines

**A motor created with the Japanese language cannot be opened.**

When we create a catalog and a motor with the Japanese language enabled, the catalog of the motor cannot be opened if the user switches back to the English language (ref.: FXM-15827).

This issue has been corrected.

**The memory preferences are not kept consistent with the execution of a long test**

When several instances of batch are run in parallel, we regularly observed that the memory preferences are not kept consistent between two subsequent executions of Flux Jobs (ref.: FXM-15777).

This issue has been corrected.

**Full geometry is provided although periodicity would be possible.**

While exporting a project to Flux 2d or Skew, the periodicity is multiplied by 2 when the number of represented poles is odd and different from 1 (ref.: FXM-15566).

This issue has been corrected.

**Unable to execute test with Skew enabled in certain machine models (SMPM-OR)**

Sometimes, for certain kinds of machines, it is not possible to execute test with a skewed topology. In such cases, the error message contains the following message: “Please decrease the "Relative epsilon for distance between Points” (ref.: FXM-15475).

This issue has been corrected.

**Bad meshing while representing wires inside the slots.**

When exporting a project from FluxMotor to Flux 2D, the mesh in the slot can sometime be very bad in the region surrounding the represented wires inside the coil conductors (ref.: FXM-15151).

We keep the same process, since the solid conductors are well meshed; indeed, the bad meshing only concerns air regions inside the slots. As a conclusion, we must keep a low level of number of nodes to decrease the computation time as much as possible.

**Installation folder - Warning about the path name**

Non-Ascii characters are not allowed in the path name while creating the folder in which FluxMotor is installed.

Failure to comply with this instruction may cause the software to malfunction (FXM-15935).

This warning has been written in the Installation Guide for Flux and FluxMotor as well as in the online user help guide.

### Network server license activation

To use a network server license (port@host information), one must specify this license with the Windows environment variable: ALTAIR_LICENSE_PATH.

Setting the network server license into the FluxMotor license setup window doesn't allow running Flux2D or Flux Skew in the backend of FluxMotor, nor opening HyperStudy solution from the export area of Motor Factory. (FXM-15895) -

This issue has been corrected.

# 3.2 Synchronous machines – Motor Factory – Export environment

### Export LUT MAT - Error in FLUX_ID0 variable in thermal solving.

This issue occurs in the EXPORT / SYSTEM / LUT while exporting a MAT-PSIM-Activate format file with thermal solving (with several magnet temperatures).

One of the variables contained in the .mat file (FLUX_ID0) is only generated for the maximum magnet temperature.

In other words, if Tmag = [20, 100, 200], the values stored in FLUX_ID0 correspond to Tmag = 200 but the user is not informed about this fact (ref.: FXM-15886).

This issue has been corrected.

# 3.3 Induction machines – Motor Factory – Test environment

### Computation of power balance

When we subtract the total losses from the supplied electrical power one doesn't find the correct mechanical power on the shaft.

This issue was observed with the fast mode computation (ref.: FXM-16072) as well as with the accurate mode computation (ref.: FXM-16121).

This issue has been corrected.

### Current Max is not respected in IMSQ Scalar control.

In the scalar control for induction machines with squirrel cage, the imposed maximum current is not respected (ref.: FXM-15701).

This issue has been corrected.

### Working Point - UfN – Error while saving the test

For induction machines with an outer rotor, when performing the computation of a working point by using the Accurate with 1

phase Mode, then if you save the test and then perform the computation of the working point by using the Fast test, the computation fails.

If we use the inverse sequence: Fast > Save > Accurate, there is no error (ref.: FXM-15868).

This issue has been corrected.

# List of warnings

4

This chapter covers the following:

# 4.1 All machines

### Distribution of computations cannot be used for computing NVH spectrogram (FXM-15772).

#### Winding – Expert mode – defining of several circuit 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, unbalance 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.

#### Transient thermal computations - Displaying of iso-temperatures.

In the test "Performance mapping – Sine wave – Motor – Efficiency map", when a cycle is considered with transient thermal solving, the representation of the temperature iso-values inside the machine can be visualized all along the cycle with an animation.

The animation can run for both the axial and radial views. However, both animations are not well synchronized. Therefore, there can be troubles while using both at the same time.

#### 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.

### Preferences – Beta level mode

In the tab "Advanced settings / Preferences", Altair® FluxMotor® "User Level" can be Standard or Beta. By default, the user level is Standard. In Beta level, the entire qualified features are not available for evaluation.

The FluxMotor® Beta level mode allows performing NVH computations for induction machines – Inner rotor. It gives access to the application "Script Factory".

### Export a model into Flux® environment with represented elementary wires.

1. 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).

### Hairpin architecture

Solving tests or exporting projects to Flux is not allowed when the Hairpin winding is built with two layers. This will be fixed for the next version (FXM-15516).

### Export environment – HyperStudy®

1. 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_2023.1_Introduction.pdf"
2. New test and connectors for HyperStudy®

   Connectors for coupling FluxMotor® and HyperStudy® are not yet available for the new 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".
3. Mandatory synchronization between connector and FluxMotor versions

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

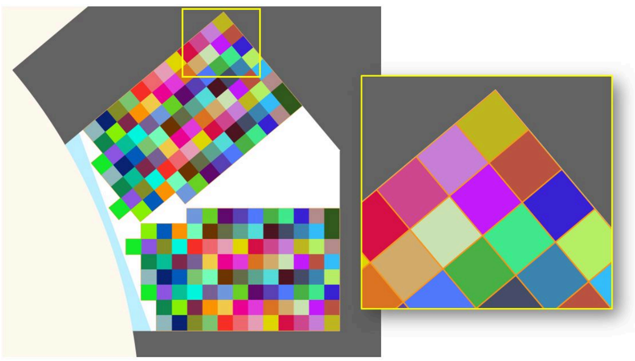
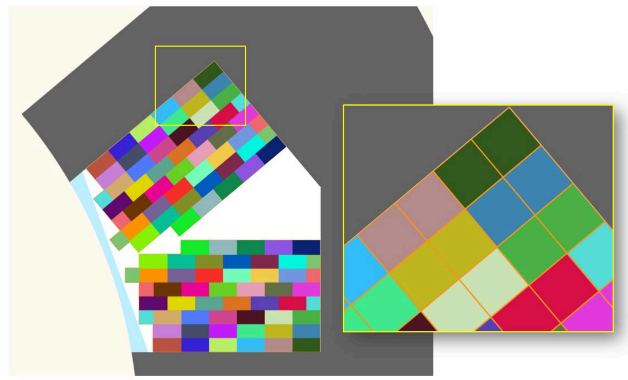
   An error message (inside the log files) is generated while performing HyperStudy studies with a connector provided with a former version of the FluxMotor solver.

### 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 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 test "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 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 $W/m^3$ while it is in W/kg for other machines SMPM, 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® 2023.

# List of main issues

5

This chapter covers the following:

# 5.1 All machines

### Negative end winding resistance with low value of X-Factors.

Here are a few explanations for this issue:

This issue has been introduced while considering the solid conductors inside the slot. Since the solid conductors are considered, the corresponding resistance (in the straight part of the machine) is deduced from the material properties and the size of the wires.

With X-factor=1, we have (Rphase 0)=(Rstraight 0)+(R end winding 0)

- Rphase 0 is the initial value of the phase resistance (with X-Factor = 1)
- RStraight 0 is the initial value of the phase resistance in the straight part of the machine (with X-Factor = 1)
- R end winding 0 is the initial value of the phase resistance in the straight part of the machine (with X-Factor = 1)

With X-factor≠1, we have (Rphase 1)=(Rstraight 1)+(R end winding 1)

- Rphase 1 is the initial value of the phase resistance (with X-Factor ≠1)
- RStraight 1 is the initial value of the phase resistance in the straight part of the machine (with X-Factor ≠1)
- R end winding 1 is the initial value of the phase resistance in the straight part of the machine (with X-Factor ≠1)

The target is to get the following results:

(Rphase 1)=XFactor×(Rstraight 0)

With

(Rstraight 1)= (Rstraight 0)

This leads to the value for the end winding resistance:

- (R end winding 1)=XFactor×(Rstraight 0+R end winding 0)-(Rstraight 0)
- (R end winding 1)=Rstraight 0×(XFactor-1)+XFactor×(R end winding 0)

When X-Factor is very low, the end winding resistance can be negative.

We will reconsider how to apply the calibration factor to the winding resistance. Perhaps this will lead to applying the X-Factor only to the end winding and the winding connections not to then straight part.

Note that this problem doesn't impact the phase resistance value, nor the resulting computations, like the total Joule losses in the winding. (ref.: FXM-16113).

### Thermal computations - Problem of convergency

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

### Wrong thermal analysis

Zero values are allowed for housing, bearing or shaft dimensions but lead to the wrong thermal analysis (ref.: FXM-14705).

### Trouble with Script - Export script - Export python - Export python in ScriptFactory

Removing selected folders in which are stored python files leads to troubles while suing the "Search directory function" (ref.: FXM-16164).

### When creating a Flux skewed project, issue with project

=> If you save and close your project, it is impossible to open and solve it

=> If you solve the project, it is impossible to delete results and rerun the project (ref.: FXM-15638).

### Hairpin architecture

Solving tests or exporting projects to Flux is not allowed when the Hairpin winding is built with two layers. This will be fixed for the next version (ref.: FXM-15516).

### 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).

### Excel export does not work for the test Model - Maps

For the Synchronous machines with Permanent Magnets – SMPM (ref.: FXM-15465).

### Fault in the coupling FluxMotor-HyperStudy

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

### Script Factory does not stop correctly.

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)

### 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).

### 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 considered inputs (ref.: FXM-14705).

### 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).

### The interwire space is not well defined.

The resulting value of the interwire space applied in the finite element model is twice the value set in the user inputs (ref.: FXM-14672).

### 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 settings "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 counter-clockwise 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 is not right.

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

### Export a project is not possible for polyphase machines.

Sometimes, the test working point (I, #, N) from the Export to Flux and Flux Skew area is not possible for polyphase synchronous machines.

However, this issue is very difficult to reproduce. When it occurs, close and reopen the project to fix the issue (ref.: FXM-16136).

### 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).

### 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.

# 5.3 Induction machines – Motor Factory – Test environment

**Run the basic test twice consecutively can lead to wrong results.**

When you run the test Characterization / Model / Basic twice consecutively by only changing the line-line voltage, the results you get at the end of the second run are wrong.

Indeed, in that case, you will see that the line-line voltage is inconsistent with the phase voltage meaning that our internal process considers that the voltage has not been modified especially for computing the no-load performance leading to wrong results for the equivalent scheme parameters (ref.: FXM-16302).

> **Note:**
>
> - If you run the test only once,
> - or if you modify the voltage and the frequency at the same time,
> - or if you modify other user input parameters but not the voltage,
>
> In these three conditions the results will be right.

So that, the workaround consists in performing the second computation with not only a new value for the voltage but also a new value for the frequency very close to the one initially considered.

For instance, 50.001 Hz instead of 50.0 Hz.

In that case our internal process will consider that the line-line voltage has also been modified.

**The computation of power balance for IMSQ in "accurate mode" is not well balanced.**

In the test "working point – sine wave – motor – U, f, N", while computing the power balance with the accurate mode (i.e., with the transient application) the results are not well balanced. Indeed, the difference between the electrical power and the power on the shaft is not exactly equal to the total amount of losses.

Depending on the considered slip the difference can be about a few percent (ref.: FXM-16121).

> **Note:** The number of computation points per electrical period and the number of considered electrical periods (user's inputs) have an impact on the accuracy of the results.

> **Note:** The displayed value (in FluxMotor) of the mechanical torque is based on the Finite Element computations and considers the iron losses and the mechanical losses.

> **Note:** The rotor Joule losses (squirrel cage) result from the Finite Element computations.

### Computation of working point using the accurate mode is not possible for slips higher or equal to 1.

The internal process is not compatible with such values of slip (ref.: FXM-16163).

### 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).

### IMSQ - Scalar Maps or Efficiency map (U,f) tests fails 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).

### 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).

### 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).

# 5.4 Part Factory

**Wrong management of part borders**

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

# 5.5 Script Factory

### Scripts cannot be executed.

If the path to the batch file or the working directory in ScriptFactory contains spaces, the script cannot be executed (ref.: FXM-16120).

### Script Factory does not stop correctly.

Script Factory does not stop correctly if FluxMotor has been killed (ref.: FXM-15140).

### Sometimes the store button status is bad.

The store button is not enabled when a file is opened without modification (ref.: FXM-15136).

### 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).

# 5.6 Supervisor – Preferences

### Reboot after changing language fails

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