Altair® FluxMotor® 2022.2

Release Notes

Contents

1 INTRODUCTION

1.1 Overview

This document gives the major information about Altair® FluxMotor® 2022.2. 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:

- Transient thermal computations for Reluctance Synchronous Machines
  Power step, Thermal time constants & Chart of temperature
- Computation of AC losses in winding – Hybrid method
- Induction machines – A new option for the SSFR test
- A new application "Materials"
- A new application "Script Factory"
- A new EXPORT/DOCUMENT/Script
  The full script for building a project, just a click away
- Export to Flux 3D – Synchronous Machines - Permanent Magnets
- Export to Flux 3D – Reluctance Synchronous Machines
- A new EXPORT / SYSTEM environment
  Export of LUT for Activate and PSIM
- Correction of issues

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

FluxMotor 2022.2 – 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, here is the list of documents which are available.

General user guides for any type of machine:

- Installation_guide_en.pdf (= Installation for both Altair® Flux® and Altair® FluxMotor®)

- Supervisor_2022.2.pdf
- MotorCatalog_2022.2.pdf
- PartLibrary_2022.2.pdf
- PartFactory_2022.2.pdf
- Materials_2022.2.pdf
- ScriptFactory_2022.2.pdf

- MotorFactory_2022.2_Introduction.pdf
- MotorFactory_2022.2_3Phase_Winding.pdf

User guides dedicated to Synchronous Machines with Permanent Magnets – Inner and Outer Rotor:

- MotorFactory_2022.2_SMPM_IOR_3PH_Design.pdf

- MotorFactory_2022.2_SMPM_IOR_3PH_Test_Introduction
- MotorFactory_2022.2_SMPM_IOR_3PH_Test_Characterization.pdf
- MotorFactory_2022.2_SMPM_IOR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2022.2_SMPM_IOR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2022.2_SMPM_IR_3PH_Test_Mechanics.pdf

- MotorFactory_2022.2_SMPM_IOR_3PH_Export.pdf

User guides dedicated to Reluctance Synchronous Machines – Inner Rotor:

- MotorFactory_2022.2_SMRSM_IOR_3PH_Design.pdf

- MotorFactory_2022.2_SMRSM_IR_3PH_Test_Introduction.pdf
- MotorFactory_2022.2_SMRSM_IR_3PH_Test_Characterization.pdf
- MotorFactory_2022.2_SMRSM_IR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2022.2_SMRSM_IR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2022.2_SMRSM_IR_3PH_Test_Mechanics.pdf

- MotorFactory_2022.2_SMRSM_IOR_3PH_Export.pdf

User guides dedicated to Induction Machines with Squirrel Cage – Inner and Outer Rotor:

- MotorFactory_2022.2_IMSQ_IOR_3PH_Design.pdf

- MotorFactory_2022.2_IMSQ_IOR_3PH_Test_Introduction
- MotorFactory_2022.2_IMSQ_IOR_3PH_Test_Characterization.pdf
- MotorFactory_2022.2_IMSQ_IOR_3PH_Test_WorkingPoint.pdf
- MotorFactory_2022.2_IMSQ_IOR_3PH_Test_PerformanceMapping.pdf
- MotorFactory_2022.2_IMSQ_IR_3PH_Test_Mechanics.pdf

- MotorFactory_2022.2_IMSQ_IOR_3PH_Export.pdf

2 LIST OF NEW FEATURES

2.1 Transient thermal computation for Reluctance Synchronous Machines

2.2 Computation of AC losses in winding – Hybrid method

2.3 A new option for characterizing the equivalent scheme of induction machines

2.4 A new application “Materials”

2.5 A new application “Script Factory” in standard mode

2.6 A new Export / Document / Script file

2.7 Export to Flux 3D is available

2.8 A new Export / SYSTEM environment for providing LUT

2.9 Further new functions

2.9.1 Special script functions for filling the slots

2.9.2 A flag to raise non consistent winding architecture and/or slot filling

3 LIST OF FIXED ISSUES AND MAJOR IMPROVEMENTS IN FLUXMOTOR® 2022.2

3.1 All machines

3.1.1 Tests with the solid conductors in slots - Current in parallel paths is wrong

While computing a working point with elementary wires modeled with solid conductors, the computed electrical current in the branches in parallel is wrong if the following conditions are met (ref.: FXM-14728):

- There are parallel paths,
- The “Accurate mode” of computation is selected
- The “AC losses analysis” in “One” or “All phases” is selected
- The resulting finite element model doesn’t represent the full geometry

This issue has been corrected.

3.1.2 Building and export of a report failed

While adding multiple new tests, and simultaneously executing the previously saved tests (12) along with assigning material in the report and saved test (12) + Materials in the report, the building and the export of the resulting report can fail (ref.: FXM-11574) + (ref.: FXM-14117).
Note: In that case it is recommended to increase the allocated memory for Motor Factory in the user’s preferences.
These issues have been corrected. (à verifier!!!)

3.1.3 Inner slots with 2 layers winding and a liner can be infeasible

Rarely, while adding a liner inside an inner slot inside of which there are 2 layers can fail (ref.: FXM-14100).
This issue has been corrected.

3.1.4 Issue with report generation

Sometimes, the report generation freezes
This is mainly due to the management of memory. An increase in the allocated memory for Motor Factory can solve the problem (ref.: FXM-13585).
This issue has been corrected.

3.1.5 Save motor doesn’t work

Sometimes, saving a motor doesn’t work.
This is mainly due to the management of memory. Increasing the allocated memory for Motor Factory can solve the problem (ref.: FXM-13584).
This issue has been corrected.

3.2 Synchronous machines – Motor Factory – Test environment

3.2.1 Duty cycle with many working points fails

Run a computation of a duty cycle with many working points via scripting crashes (ref.: FXM-14435).
This issue has been corrected.

3.2.2 FMU LuT data Export: Flux_D and Flux_Q are incorrect

The flux linkage related to the end winding inductances on FMU side is not considered as it is done on the test map side (ref.: FXM-14041).
This issue has been corrected.

3.3 Induction machines – Motor Factory – Test environment

3.4 Induction machines – Motor Factory – Export environment

3.5 Part Factory

4 LIST OF WARNINGS

4.1 All machines

4.1.1 Natural convection for end winding

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

4.1.2 Transient thermal computations - Displaying of iso-temperatures

In the test "Performance mapping – Sine wave – Motor – Efficiency map", when a cycle is considered with a transient thermal solving, the representation of the temperature isovalues inside the machine can be visualized all along the cycle with an animation.
The animation can run for the axial and radial views. However, both the animations are not well synchronized. Therefore, there can be troubles when using both at the same time.

4.1.3 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 instantaneously in the applications of Altair FluxMotor® like Motor Factory.

4.1.4 Preferences – Beta level mode

In the tab “Advanced 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 and gives access to the application “Scripting Factory”.

4.1.5 Export a model into Flux® environment with represented elementary wires

4.1.5.1 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 Flux® 2D model, the resulting python file can be very long. Therefore, the process for building the corresponding model into Flux® environment can take a long time.

4.1.5.2 Export into Flux® Skew

Export a model with represented elementary wires into Flux® Skew environment is not yet possible.

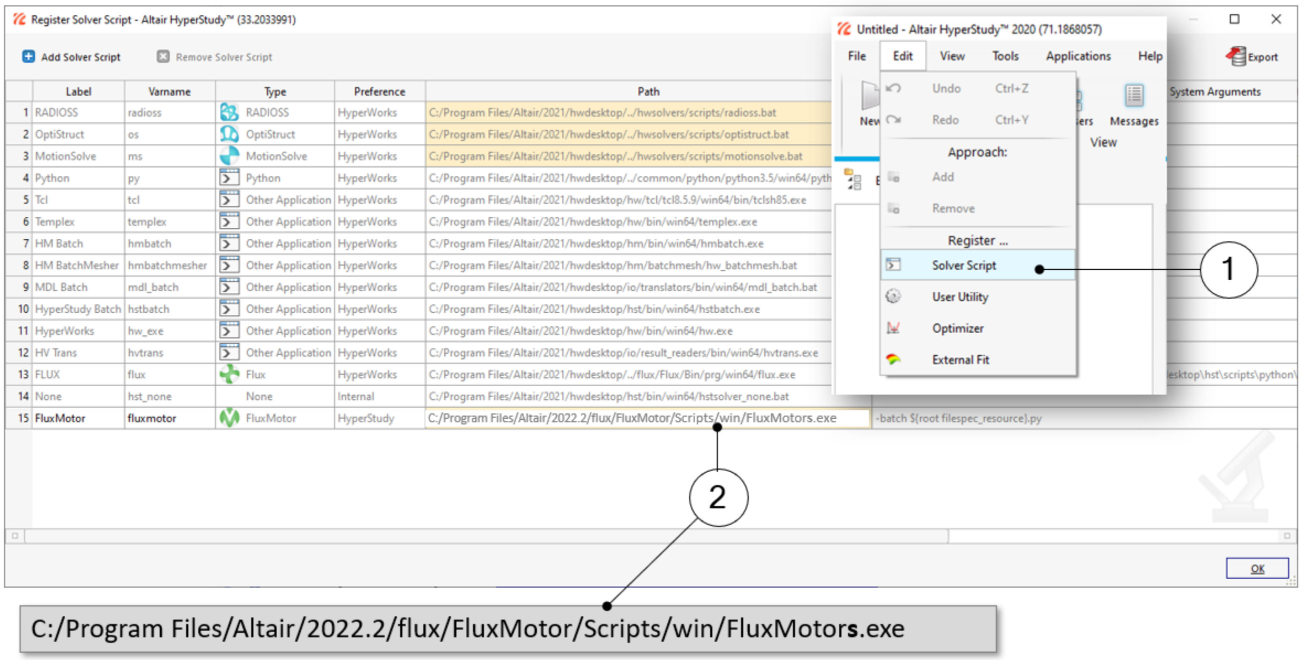
4.1.6 Browse function

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

4.1.7 Export environment – HyperStudy®

4.1.7.1 New solver script to be registered

Before starting new studies in Altair® HyperStudy® by using connectors exported from Altair® FluxMotor®, FluxMotor® must be registered as a new solver script in HyperStudy®. This must be defined only while using the coupling for the first time.



Connection between Altair® FluxMotor® and Altair® HyperStudy®

1	Open the area in HyperStudy® to register FluxMotor® 2022.2 script
2	Path where FluxMotor**s**.exe must be selected to be registered as a new solver in HyperStudy®. **Note**: FluxMotor**s**.exe with an “s” at the end of FluxMotor**s.** This must be defined only when using the coupling for the first time.

Note: from the version 2022.1 of HyperStudy, the FluxMotor solver script is automatically registered when the default path installation is selected while installing Flux and FluxMotor.

4.1.7.2 New test and connectors for HyperStudy®

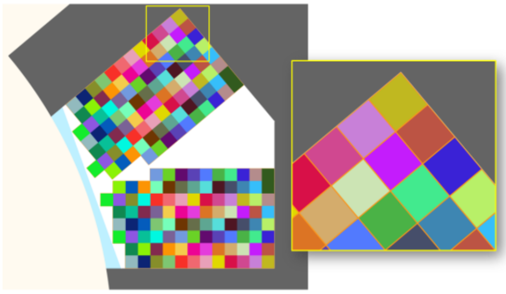
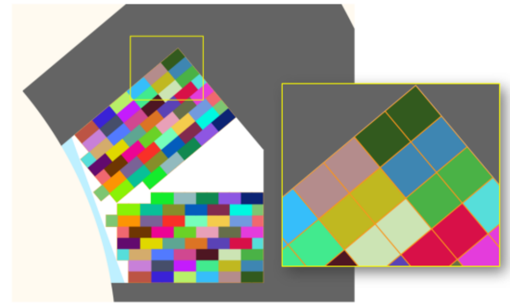
Connectors for coupling FluxMotor® and HyperStudy® are not yet available for the new implemented tests, like those with transient thermal computations.

4.1.8 Problems with slot filling

a) The slot filling is not yet possible with a non-symmetric parallel slot.

b) When a toothed winding design is considered with rectangular shape wires the conductor grouping method "horizontal" doesn’t work properly leading to wrong visualization of conductors. In that case, it is recommended to select the conductor grouping method "vertical".
All works well with circular shape 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

4.2 Synchronous machines – Motor Factory – Test environment

4.2.1 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 a 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 as "saved tests" with reference to the original version (All the previous versions).
Sometimes results of the current tests are removed. The test must be executed again to get the corresponding results.

4.2.2 Delta winding connection

When a delta winding connection is considered, the computation doesn’t consider circulating currents. This can lead to a different result than what expected in transient computation for the test "Characterization - Open-circuit - back-emf".
In such case, it is recommended to perform a transient computation in Altair® Flux® environment. The application “Export to Flux®” thereby allows exporting this kind of model with the corresponding scenario ready to be solved.

4.2.3 Evaluation of the maximum achievable speed

The aim of this result is to give a rough estimation of the maximum reachable speed, which can be achieved by the machine. This computation is performed by considering a 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.

4.2.4 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 as 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 getting faster evaluation of the behavior of machine in connection to NVH. But, in no way this can replace a mechanical finite element modeling and simulation.

Possible reasons for deviations of results can be the following ones:

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

$$\frac{L_{Frame}}{L_{stk}} \leq 1.5$$

4.3 Induction machines – Motor Factory – Design environment

4.3.1 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, inter bar impedance will remain constant, even if a parametric study is performed in Flux® environment. The topology parameter as well as the temperature variations won't impact the inter bar impedance.

Moreover, when the 'inter bar' computation is done with the user mode, the reference temperatures are not updated while exporting the project in Flux® 2D /Flux® Skew environment.

4.4 Induction machines – Motor Factory – Test environment

4.4.1 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 increase the 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 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 is equal to 8192 MB when the maximum allocated memory for Flux® 2D software is equal to 4096 MB.
In case, the user needs more memory, these values can be increased (user’s preferences - Advanced tab)

Perhaps, it is required to allocate the memory from 10.24 GB to 15.36 GB to run tests without failure.

4.4.2 Computation of power density for induction machines

There was an issue in the process for 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 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® 2022.2.

5 LIST OF THE MAIN ISSUES

5.1 All machines

5.1.1 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 a wrong thermal analysis. It is highly recommended not to use null values for the considered inputs (ref.: FXM-14705).

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

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

5.1.3 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).

5.1.4 Transient thermal computation

Sometimes, there is an issue with nonlinear thermal resolution. The convergence criteria doesn't reach from a certain time iteration leading to non-physical results then making the physical properties interpolations impossible. This can occur for duty cycle inside of which there are a huge number of working points for instance (ref.: FXM-14570).

5.1.5 Air material properties are wrong for high temperature

This issue impacts our internal computation processes while transient thermal solving. Indeed, some iterations involve very high temperature (more than 3000 °K) according to Newton Raphson non-linear solving method. During the resolution, this can lead to negative conductivity and viscosities which may make the computation fail (ref.: FXM-14465).
Note: in case of problem, we can provide you an "Air material" with the right parameters.

5.1.6 Building and export of a report failed

While adding multiple new tests, and simultaneously executing the previously saved tests (12) along with assigning material in the report and saved test (12) + Materials in the report, the building and the export of the resulting report can fail (ref.: FXM-11574) + (ref.: FXM-14117).
Note: In that case it is recommended to increase the allocated memory for Motor Factory in the user's preferences.
A verifier!!!

5.1.7 Internal optimization processes can crash

Sometimes, when FluxMotor® launches an optimization in the back end with HyperStudy®, and if there is an error in the internal process (evaluation of the objective functions), this makes FluxMotor® crash.
Moreover, without any log file to explain the issue one cannot understand the cause of system crash (ref.: FXM-13949).

5.1.8 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).

5.1.9 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 "Cooling-Internal" context, and used in all thermal tests, is wrong if the slot contains faces "wedge" or "inter-coil insulator" (ref.: FXM-13896).

5.1.10 Bad management of sequential inputs in HyperStudy® connector

Some configurations of parameterized topologies can be obtained manually in Motor Factory but cannot be created from HyperStudy® for some connectors (ref.: FXM-13612).

5.1.11 Power electronics and coupling with HyperStudy®

For tests where 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 (ref.: FXM-13726).

5.1.12 Management of multi-parametric settings with HyperStudy® coupling

One must be able to manage the case of sequential input update in HyperStudy® connector, especially for topology definitions (ref.: FXM-13612).

5.1.13 Script Factory freeze temporarily when running a script

When running a script, 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).

5.1.14 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).

5.1.15 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

5.2.1 Working point – Square wave – Forced I – Average computation of quantities

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

5.2.2 Wrong data in HyperStudy® export area

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

5.2.3 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 a MTPV command mode.

5.3 Induction machines – Motor Factory – Test environment

5.3.1 Power balance of No-load working point

Sometimes, computation of 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).

5.3.2 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 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 Induction machines – Motor Factory – Export environment

5.4.1 End-ring impedance – Reference temperature is not well applied

While exporting a model from FluxMotor® to Flux® 2D or Flux® Skew environment, if the end-ring impedance has been defined with the “constant computation mode” (= user mode) instead of the automatic one, the reference temperatures set by the user are not used in the resulting Flux® project. Instead, the default values are automatically considered (ref.: FXM-13713)

5.5 Part Factory

5.5.1 Wrong management of part borders

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