Altair® FluxMotor® 2023.1

Synchronous Machines with wound field – Inner salient pole - Inner rotor

Motor Factory – Design

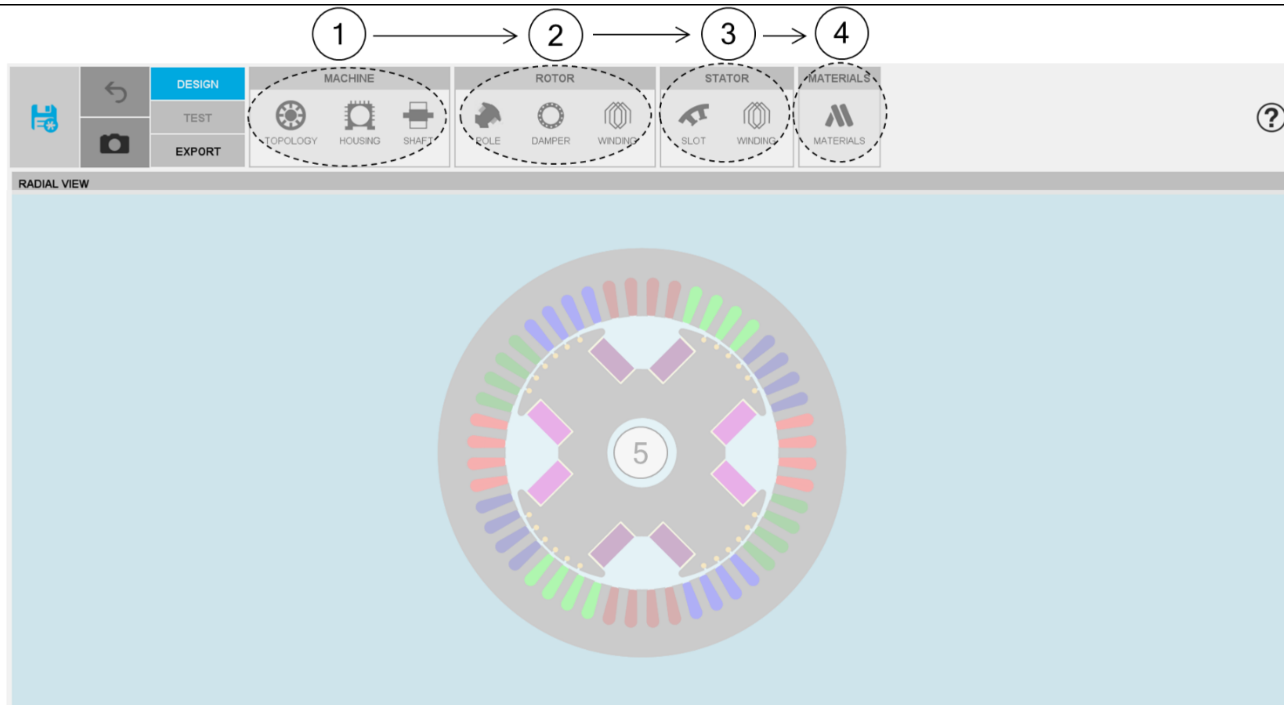
General user information

Contents

1 SYNCHRONOUS MACHINE WITH WOUND FIELD – INNER SALIENT POLE – INNER ROTOR

1.1 Home page view

The Motor Factory – DESIGN area is the first environment of the Motor Factory.
For a synchronous machine with wound field inner salient poles, it is composed of four main zones. This is the guideline for designing your machine.



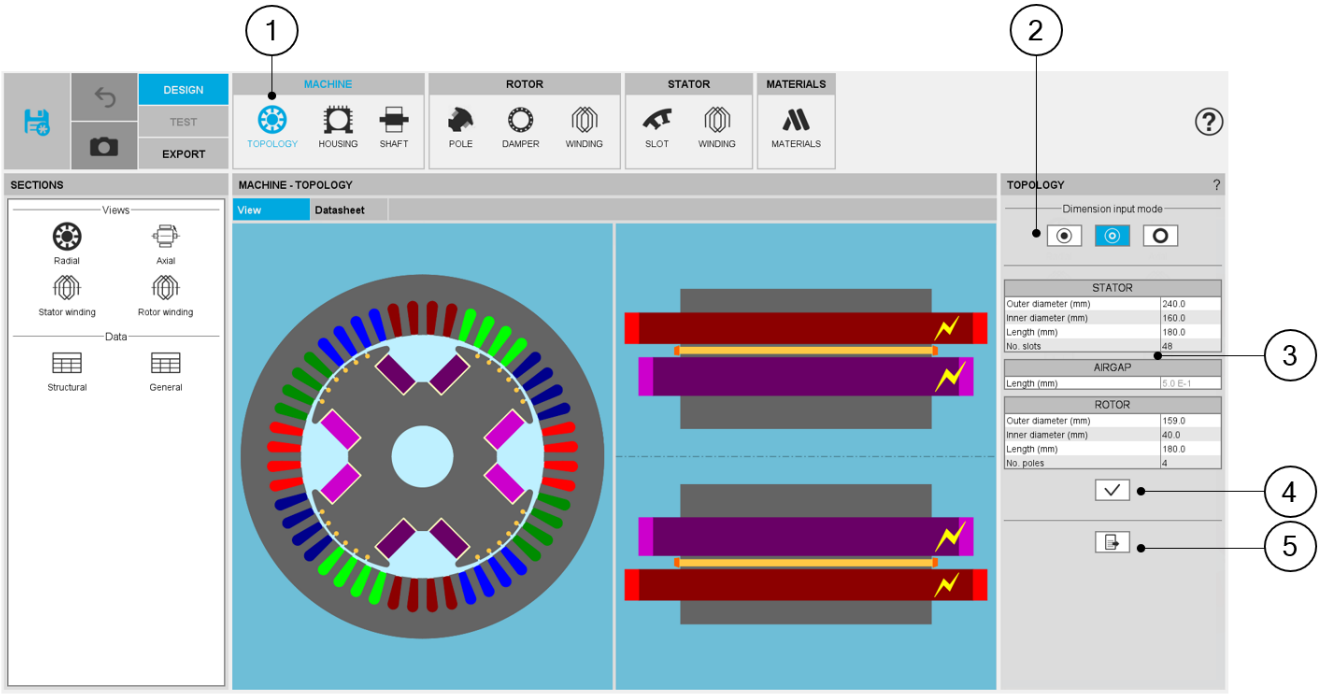
Motor Factory – DESIGN area view – Example for synchronous machine with wound field, inner salient pole, and inner rotor

Zone 1 **MACHINE**	Definition of general data of the machine depending on the considered type of machine • Topology with overall dimensions, No. slots, No. poles, • Housing, Frame and dimensions • Shaft type, and dimensions
Zone 2 **ROTOR**	Access to the main functions to design the ROTOR mainly defined by: • Pole • Damper • Winding
Zone 3 **STATOR**	Access to the main functions to design the STATOR and its corresponding subsets: • Slot • Winding
Zone 4 **MATERIALS**	Area to select all the materials required to build the machine, the rotor, and the stator
Zone 5 **VIEW**	Visualization of the motor radial view. The winding (automatically defined) is shown. Note: Graphic functions like export picture and zoom are available in this view by right-clicking on mouse (right part of the panel). See system functions, graphic management to get more information.

1.2 Topology

1.2.1 Overview

The first step of the design consists of defining structural data of the machine.
However, at any time, it is possible to reach and modify the structural data from the Motor Factory design environment.
Here is the process to modify the structural data from the general data panel.



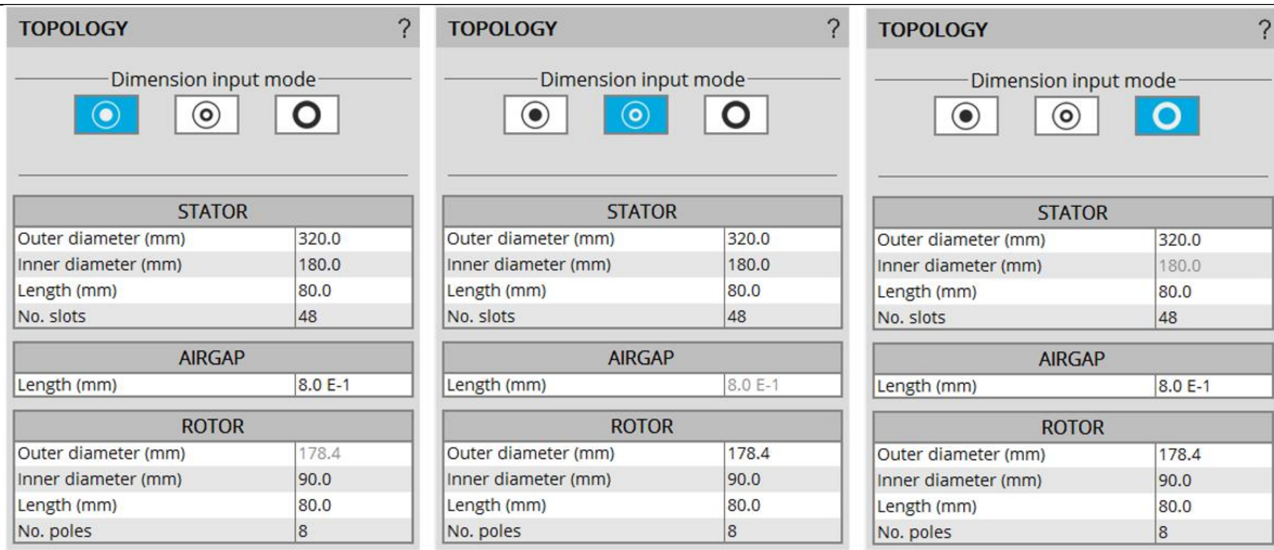
Process to modify the structural data	
1	Open the TOPOLOGY panel (Click on the icon TOPOLOGY)
2	Choose a way to define the diameters of the machine and the airgap. See additional information below.
3	Modify the values of structural data – When relevant, the corresponding arrow is displayed on the view.
4	Button to apply inputs.
5	Icon to export data into *.txt or *.xlsx file - Please see above illustration.

For more details concerning general functions of Motor Factory Design environment, please refer to the document MotorFactory_Introduction".

1.2.2 Inputs

1.2.2.1 Method to define the airgap

In the topology sub area, three ways are possible to define the structural data of the machine based upon the diameters and the airgap. They are illustrated below.



1 2 3

Method to define the diameters of the machine and the airgap Example for machines like Synchronous Machine with Wound Field, Inner Salient Pole, and Inner Rotor or Synchronous Machines with Permanent Magnets with Inner Rotor	
1	User defines the inner diameter of the stator and the airgap. The outer diameter of the rotor is automatically deduced (automatically computed value is displayed in grey color).
2	User defines the inner diameter of the stator and the outer diameter of the rotor. The airgap is automatically deduced (automatically computed value is displayed in grey color).
3	User defines the outer diameter of the rotor and the airgap. The inner diameter of the stator is automatically deduced (automatically computed value is displayed in grey color).

1.2.2.2 Structural data

Here are the user input parameters to define the structural data of the machine:

- Stator outer diameter
- Stator inner diameter
- Stator length
- Number of slots
- Airgap length
- Rotor outer diameter
- Rotor inner diameter
- Rotor length
- Number of poles

The modification of the structural data can lead to the modification of the user input parameters in defining dimensions of parts like slots or poles. When modifications occur, a warning is displayed.
The application ranges for structural data are defined below.

1.2.3 Advice for use

The choice of diameters is possible over the range [1, 20000] mm.
The number of slots is possible over the range [3, 2400].
The number of poles is possible over the range [2, 400].

For more information, see the list of allowed combinations between the number of slots and the number of poles, synthesized in the section dedicated to winding.

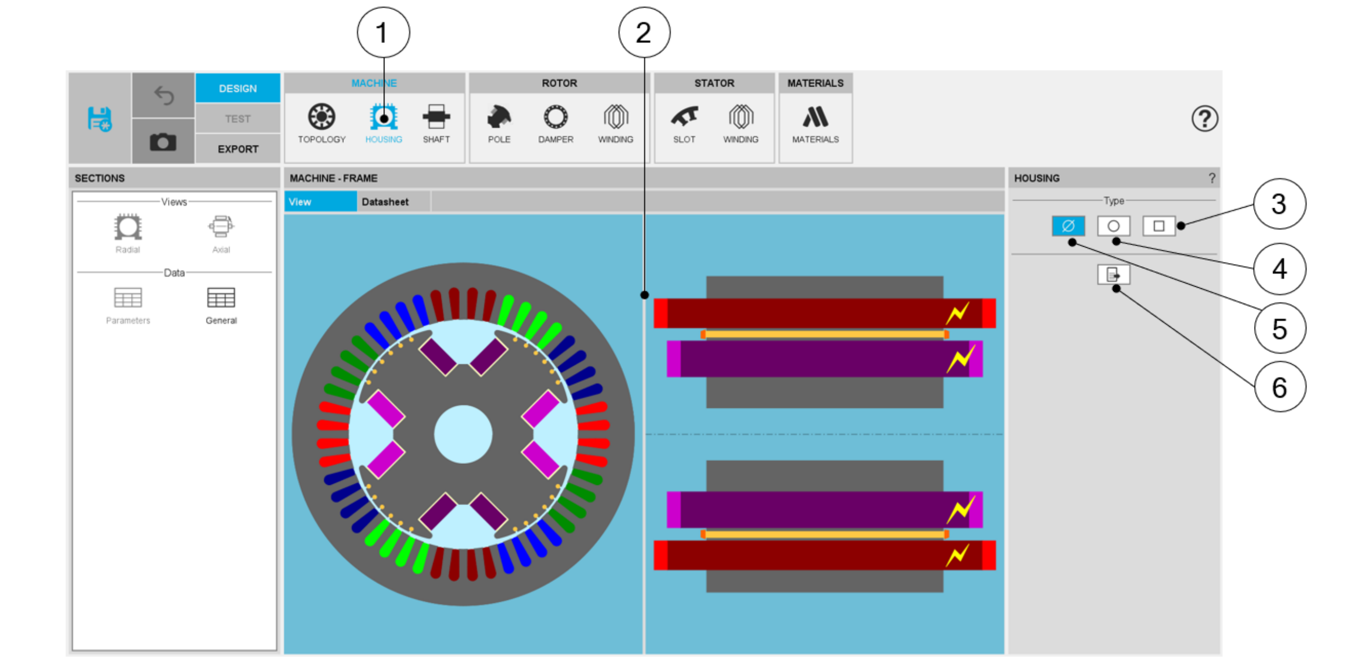
Note: Our processes for building and computations have been qualified over the following data ranges:

Range for diameters [1, 1000] mm.
Range for number of slots [3, 90].
Range for number of poles [2, 80].

Working beyond these limits is possible but accurate results are the responsibility of the user.

1.3 Housing

1.3.1 Overview



HOUSING design area	
1	Selection of the MACHINE subset: HOUSING panel (Click on the icon HOUSING)
2	Radial and axial view of the motor.
3-4-5	Three choices are available to define the lamination topology: None, Circular and Square
3	Choice of a square shape lamination. See additional information below
4	Choice of a circular shape lamination. See additional information below
5	Choice of “None” meaning that the outer shape of lamination is circular. Outer dimensions of lamination are indicated in general data (structural data part).
6	Icon to export lamination data into *.txt or *.xlsx files.

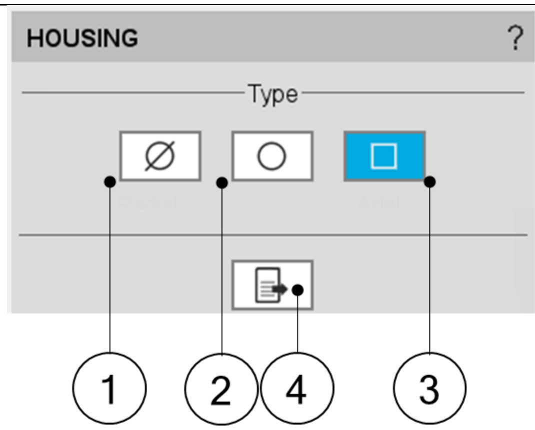
1.3.2 Housing - Frame

1.3.2.1 Type of frame

The tools available in the housing tab allow defining the frame topology.
Three choices are available to define this topology: None, Circular or Square.

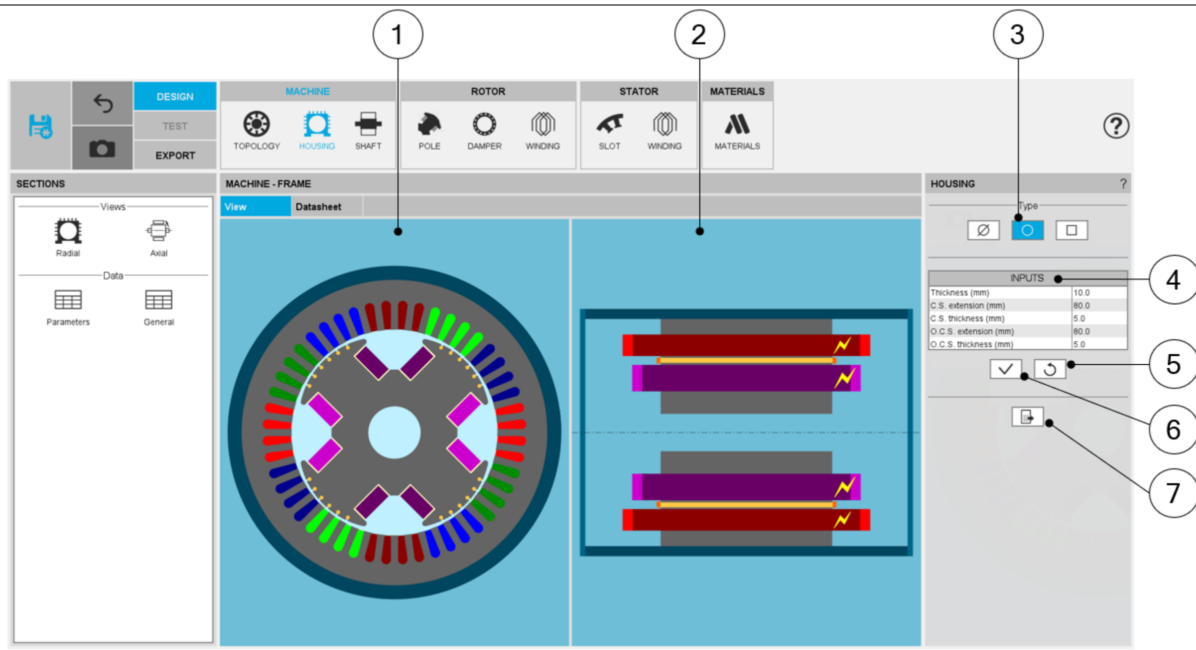
By default, housing type is set to “None”. There is no frame.

Important note: When “None” is selected, accesses to External cooling and Internal cooling environments are locked.



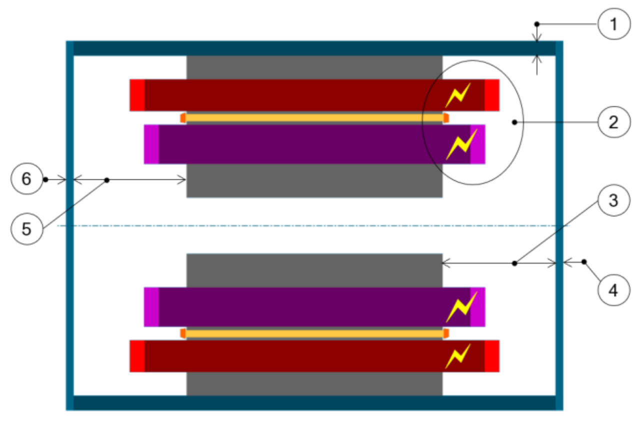
1	Default setting : Housing type is « None » The machine has no frame.
2	Button to select a Circular shape frame.
3	Button to select a Square shape frame.
4	Icon to export frame data into *.txt or *.xlsx files.

Frame type available



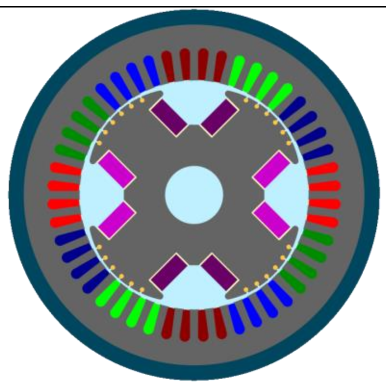
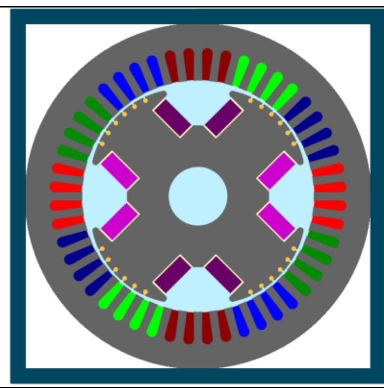
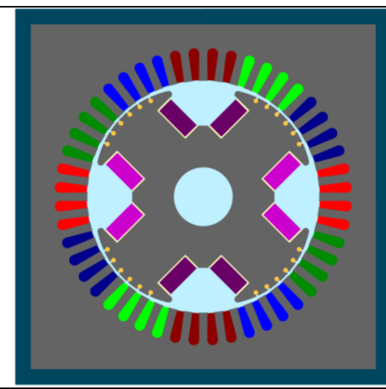
Circular shape frame design area

1	Radial view of the motor, including the housing topology and dimensions.
2	Axial view of the motor, including the housing topology and dimensions.
3	Selected button to set a circular shape frame.
4	User input parameters to define the frame dimensions. For more information see below.
5	Button to restore default input values.
6	Button to apply inputs. Pressing the enter key twice applies inputs too.
7	Icon to export frame data into *.txt or *.xlsx files.

<table>
<tr><td rowspan="6">
</td><td>1</td><td>Thickness of the frame.
Allowed range of values]0, 50] mm.</td></tr>
<tr><td>2</td><td>Connection side (C.S.) is identified by yellow lightning.</td></tr>
<tr><td>3</td><td>Connection side extension.
Allowed range of values [0, 20000] mm.</td></tr>
<tr><td>4</td><td>Connection side – End-plate thickness.
Allowed range of values [0, 50] mm.</td></tr>
<tr><td>5</td><td>Opposite connection side extension.
Allowed range of values [0, 20000] mm.</td></tr>
<tr><td>6</td><td>Opposite connection side – End-plate thickness.
Allowed range of values [0, 50] mm.</td></tr>
<tr><td colspan="3">User input parameters to define frame dimensions in the axial view</td></tr>
</table>

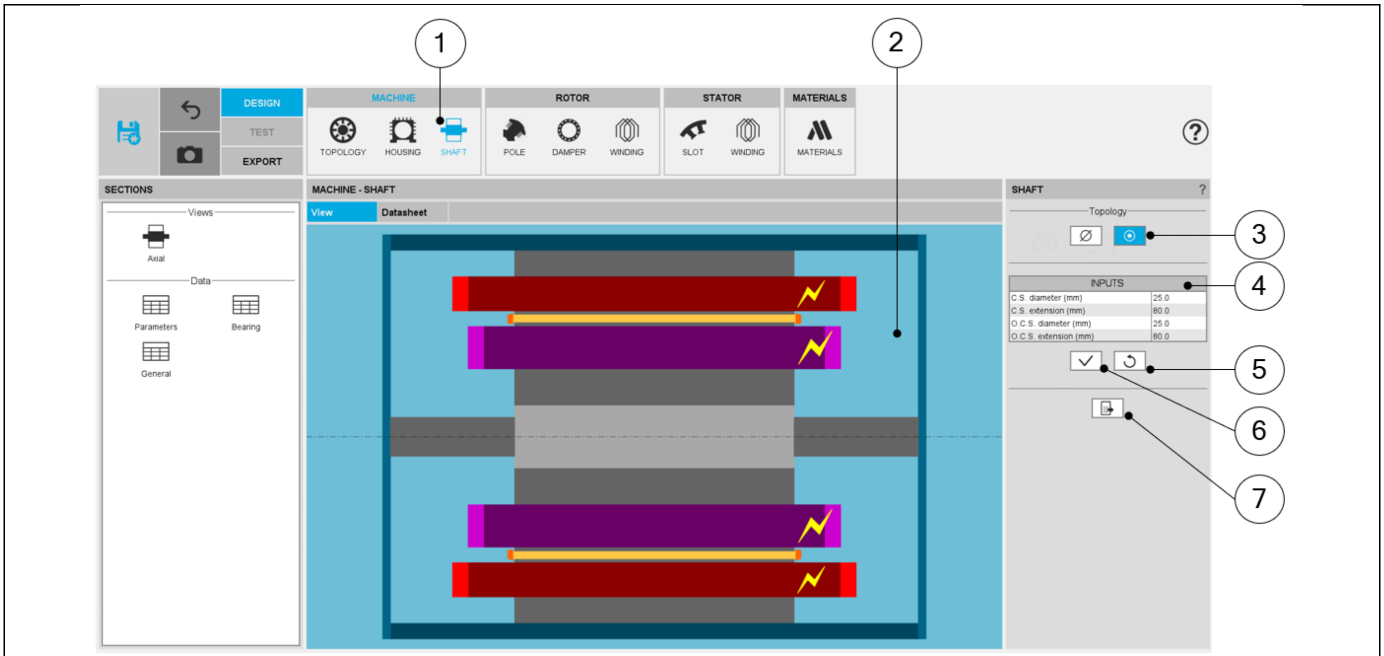
1.3.2.2 Combination between lamination outer shape and frame types

<table>
<tr><td></td><td></td><td colspan="3">Frame type</td></tr>
<tr><td></td><td></td><td>None</td><td>Circular</td><td>Square</td></tr>
<tr><td rowspan="3">Lamination outer shape</td><td>None</td><td>v</td><td>v</td><td>v</td></tr>
<tr><td>Circular</td><td>v</td><td>v</td><td>v</td></tr>
<tr><td>Square</td><td>v</td><td>Not possible</td><td>v</td></tr>
</table>

		
Circular shape lamination & Circular shape frame	Circular shape lamination & Square shape frame	Square shape lamination & Square shape frame

1.4 Shaft

1.4.1 Overview

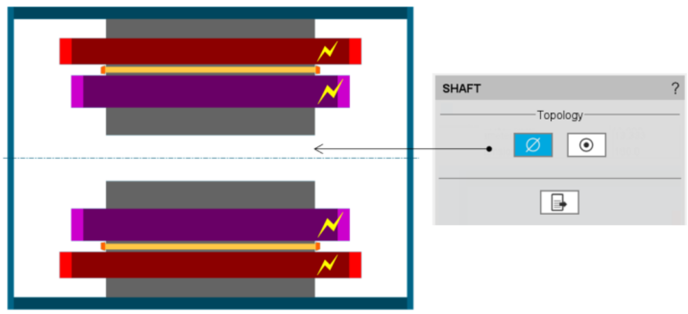


SHAFT design area	
1	Selection of the MACHINE subset: SHAFT panel (Click on the icon SHAFT)
2	Visualization of the motor axial view to visualize the shaft topology and dimensions.
3	Choice of the shaft type. Two types are available: • None: No dimensions to be declared. Shaft is replaced by fluid material • Solid: End-shaft must be defined - Structural data of the shaft are then edited If shaft type is solid, end-shaft must be defined. Note 1: Connection side (C.S.) is identified by yellow lightning. Note 2: Range of definition for dimensions: [0, 20000] mm.
4	Shaft input data to be defined
5	Button to restore default input values
6	Button to Apply inputs. Pressing the enter key twice applies inputs too.
7	Icon to export shaft data into *.txt or *.xlsx files.

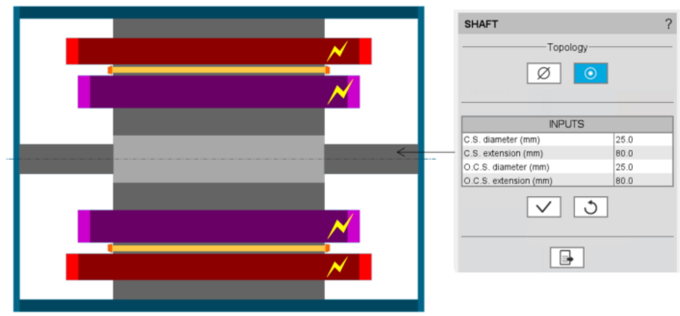
1.4.2 Shaft type

Two types of shaft can be selected:

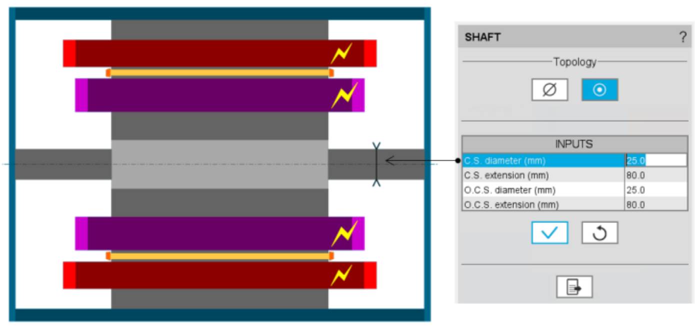
- None: A shaft is not represented in the rotor design. It is replaced by a fluid (like air)
- Solid: Shaft is represented and considered in the rotor design. It is built with a solid material or laminations.



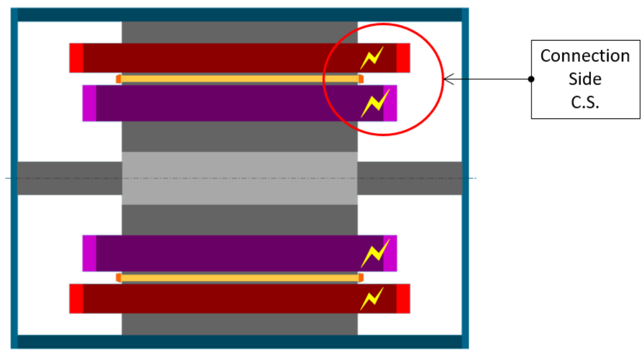
Shaft type: None



Shaft type: Solid



Dimensions are illustrated with arrows



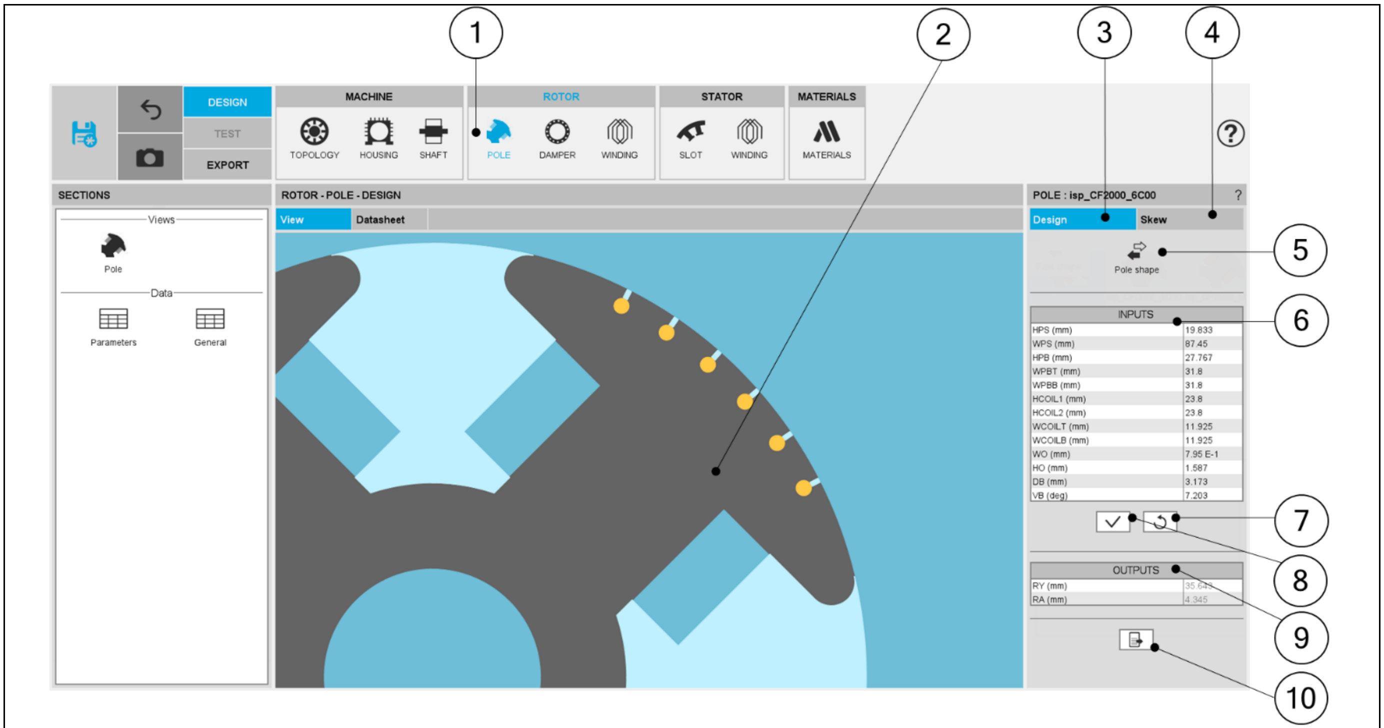
Connection side (C.S.) is identified by yellow lightning.

1.4.3 Shaft - Inputs

Label	Symbol	Tooltip, note, formula
C.S. diameter	D1	Connection side end-shaft diameter.
C.S. extension	L1	Connection side end-shaft extension.
O.C.S. diameter	D2	Opposite connection side end-shaft diameter.
O.C.S. extension	L2	Opposite connection side end-shaft extension.

1.5 Pole

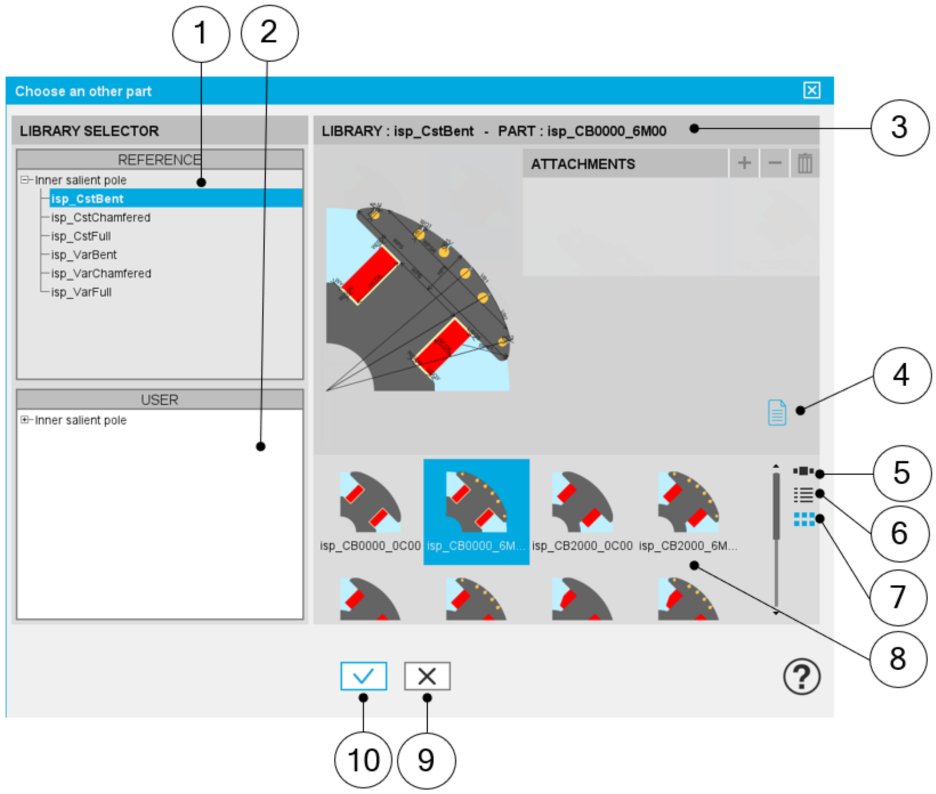
1.5.1 Overview



POLE design area	
1	Selection of the ROTOR subset: POLE panel (click on the icon POLE)
2	Visualization of the motor radial view to view the pole topology and dimensions.
3	The DESIGN tab indicates the tools to define the pole topology and parameter values. Note: By default, the DESIGN tab is selected.
4	The SKEW tab indicates the tools to define the rotor skew angle
5	"Pole shape" button allows accessing the pole libraries to change the pole topology. See additional information below.
6	User input parameter fields to enter the values.
7	Button to restore default input values.
8	Button to apply inputs. Pressing the “enter key” twice applies inputs too.
9	Output parameters (read only data) to complete the description of the topology. In this section, some dimensions considered important for the dimension of the topology are given.
10	Icon to export pole data into *.txt or *.xlsx files.

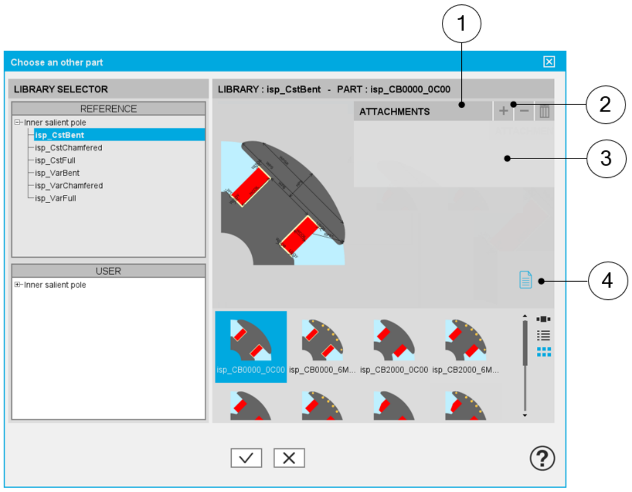
1.5.2 Pole – Design

Clicking on the "Pole shape" button opens a dialog box, allowing access to the bar libraries.
It allows visualizing, comparing, choosing, and importing another pole topology to modify the current rotor design.



	How to choose another pole topology?
1	Visualization of reference libraries, i.e., the libraries of pole topologies provided with FluxMotor®. Select them to view their content and choose the bar among their content. See the “Part Library” application for more information.
2	Visualization of user libraries. The default user library is “Inner salient pole”. See the “Part Library” application for more information.
3	Area where the selected pole is displayed (static picture) – Topology + dimension labels.
4	Button to manage the list of documents attached to the part. See additional information below.
5	Button to display thumbnails as a slide show.
6	Button to display thumbnails as a list.
7	Button to display thumbnails as a matrix view of pictures.
8	Area to visualize all the topologies of poles from the selected library.
9	Button to close the dialog box and come back to Motor Factory – DESIGN – Pole area.
10	Button to choose and import the selected pole to modify the current rotor design.

1.5.2.1 Attached documents – Additional information

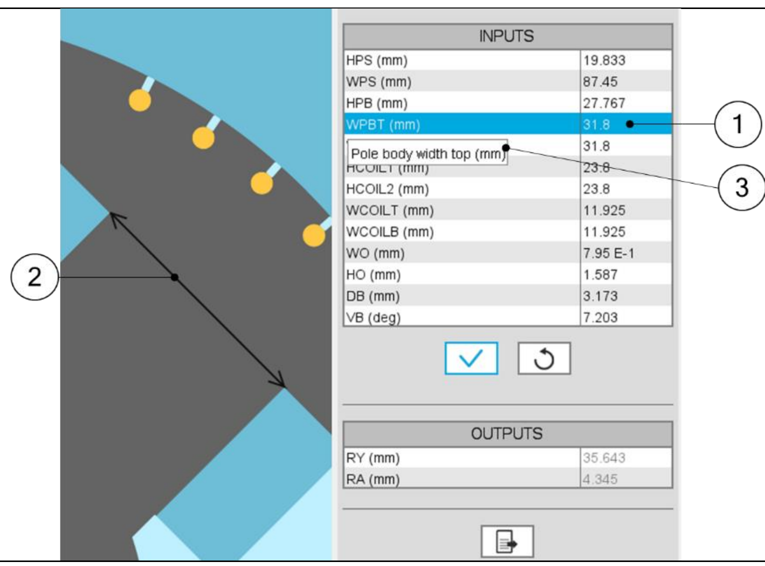


1	List of attached documents after having clicked on button to display them (4).
2	“+” or “-“ non-active buttons from “Motor Factory” See the “Part Library” application for more information.
3	List of attached documents (if it exists) A double click on the selected document opens it. Documents can be added only from the Part Library application. See the “Part Library” application for more information.
4	Button to show or hide the attached document list.

Visualization of attached documents

1.5.2.2 Inputs / outputs

Specific inputs and outputs are considered for the pole topology.
The relevance of input parameter values can be evaluated by using the “Part Factory” application.
See the “Part Factory” application for more information.
Outputs are read only data. They complete the description of the topology.

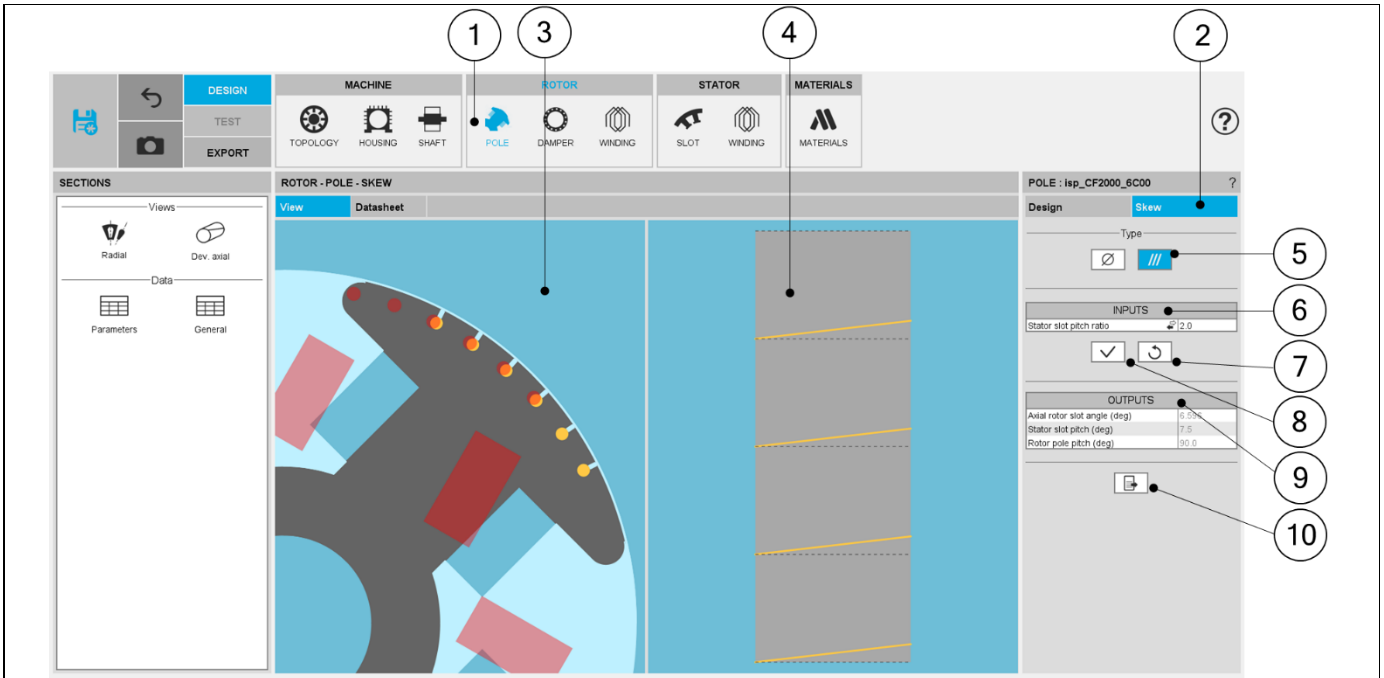


Inputs / Outputs of a pole

1	The selection of a parameter label highlights it.
2	The selection of a parameter label displays the corresponding arrow on the picture.
3	The selection of a parameter label displays the corresponding tooltip which provides information about the parameter.

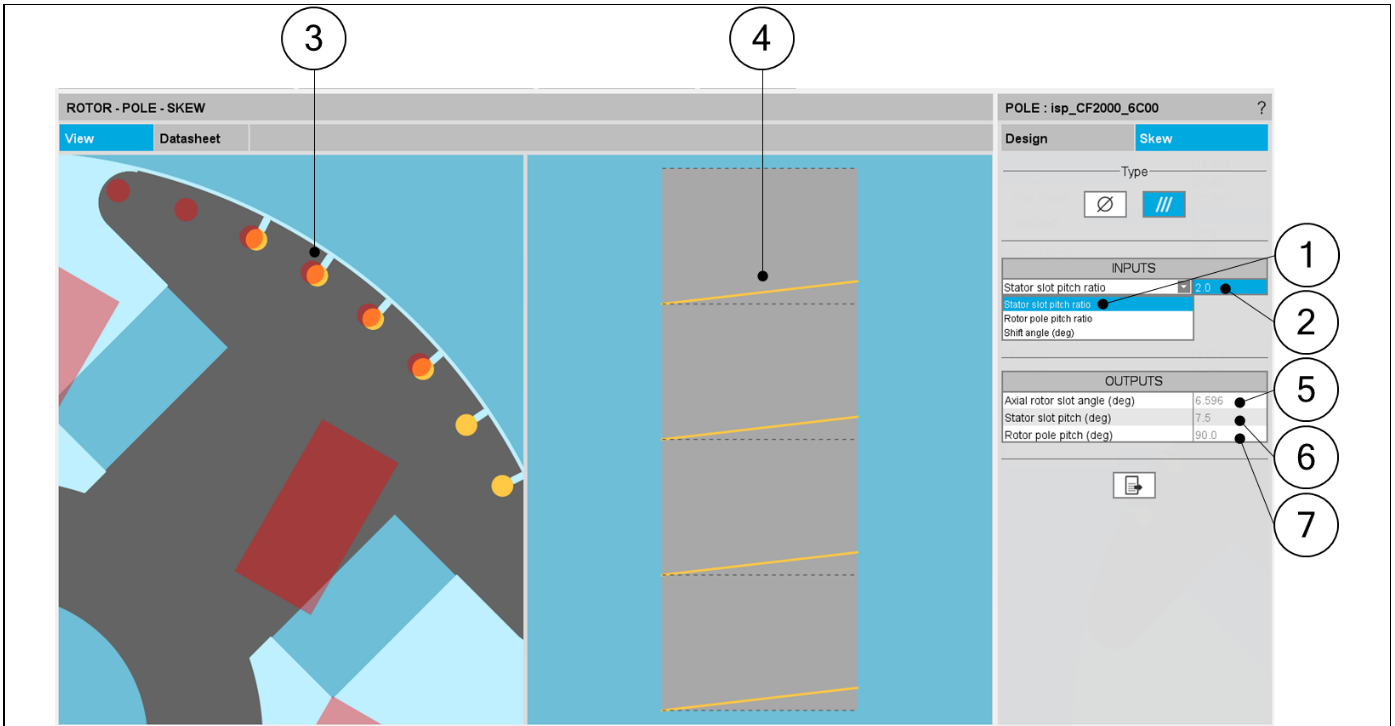
1.5.3 Pole – Skew

1.5.3.1 Overview



POLE – SKEW design area	
1	Selection of the ROTOR subset: POLE panel (click on the icon POLE)
2	The Skew tab indicates the tool to define the pole skew angle
3	Visualization of the machine radial view to visualize the pole skew
4	Visualization of the rotor developed view to visualize the pole skew
5	Choices to define a skew: None – Continuous (Continuous in our example)
6	Skew inputs to be defined
7	Buttons to restore the default input values.
8	Buttons to validate the inputs (pressing the “enter key” twice applies inputs too).
9	Skew outputs (read only)
10	Button to export the skew data into *.txt or *.xlsx files.

1.5.3.2 Set a skew angle



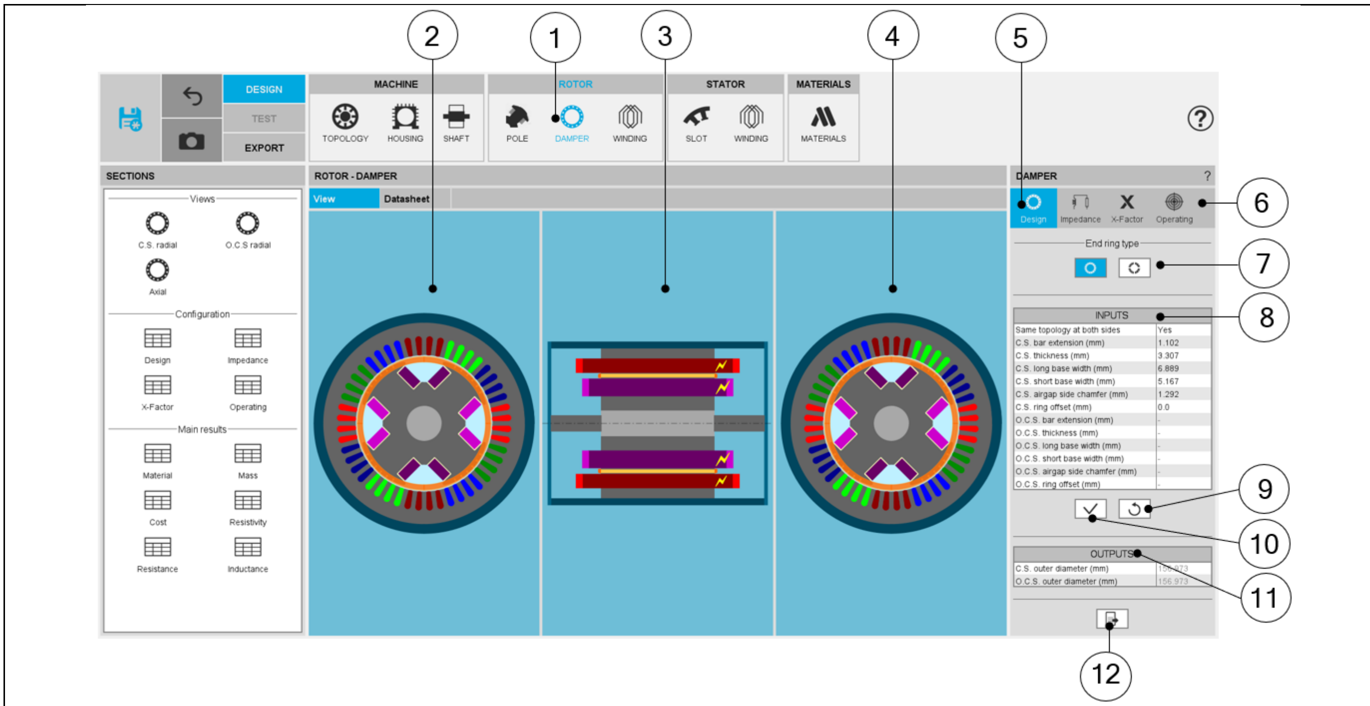
How to set a skew angle?	
1	Choose the definition mode of the skew: Stator slot – Rotor slot – Shift angle
2	Definition of the skew angle, depending on the definition mode
3	Visualization of the chosen skew angle on the machine radial view
4	Visualization of the equivalent axial slot angle on the rotor developed view
5	Equivalent axial rotor slot angle (read only)
6	Equivalent stator slot pitch (read only)
7	Equivalent rotor slot pitch (read only)

Note: The user can add a skew angle on the rotor or on the stator. If a skew is already defined in the stator when setting a skew on the rotor, the stator skewing will be automatically reset to “None”.

1.6 Damper

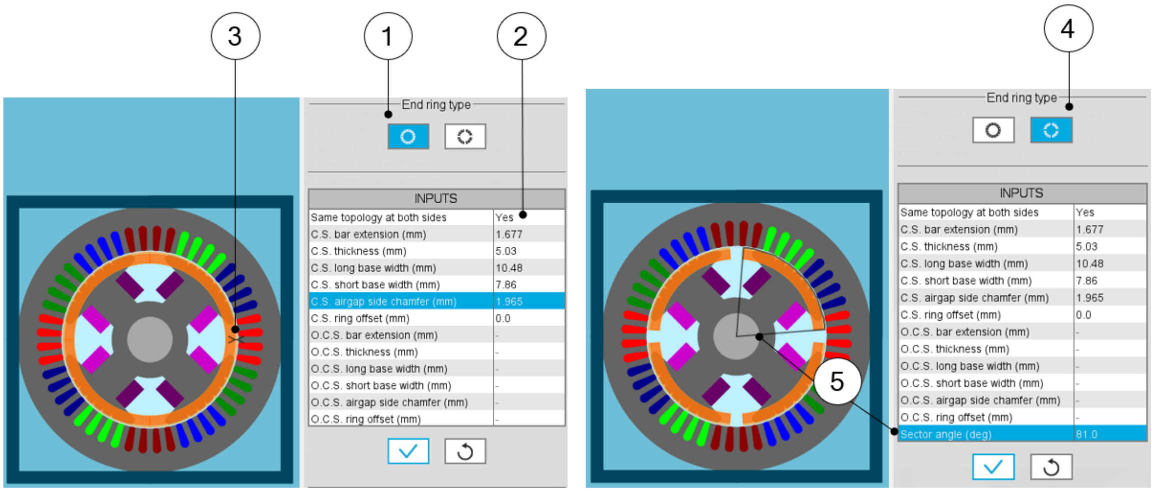
1.6.1 Overview

This Damper context allows designing the end rings of the damper circuit. The context is disabled if there is no bar (solid conductor) in the pole topology.



DAMPER - DESIGN - Overview	
1	Selection of the ROTOR subset: DAMPER panel (click on the icon DAMPER)
2	Visualization of the radial view of the machine from the Connection Side (C.S.)
3	Visualization of the axial view of the machine
4	Visualization of the radial view of the machine from the Opposite Connection Side (O.C.S.)
5	Design settings allow for describing the dimensions of the end rings on both sides of the machine. Note: By default, the DESIGN tab is selected
6	A section scrolling bar allows choosing the section in which user inputs are defined. Scrolling selection bar where Design, Impedance, X-Factor, and Operating conditions sections can be selected.
7	Buttons to choose the end ring topology; it can be a full ring topology or a segment topology
8	Definition of the end ring dimensions on both sides of the machine. Definition of each end ring geometrical input, with the corresponding arrow on the axial view of the machine
9	Buttons to restore default input values.
10	Buttons to apply inputs (pressing the “enter key” twice applies inputs too).
11	End ring outputs (read only)
12	Icon to export end ring data into *.txt or *.xlsx files.

1.6.2 Damper – Design – Inputs / Outputs

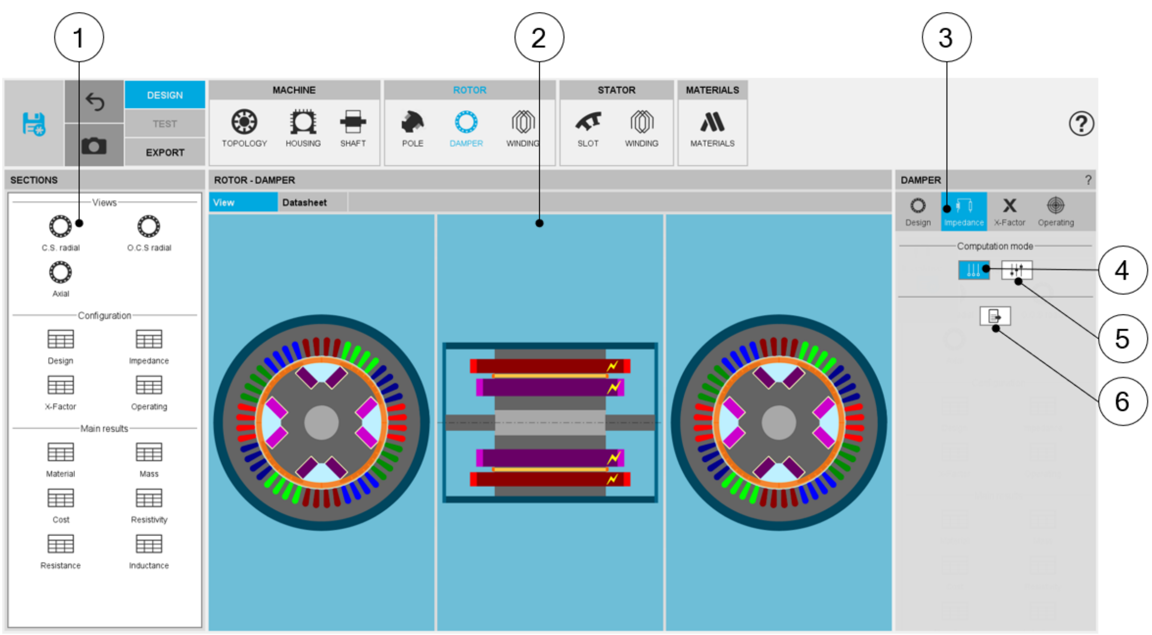


END RING - DESIGN – design area	
1	Full ring topology is selected for the end ring
2	Selector to choose the same end ring topologies on both sides
3	Definition of each end ring geometrical input, with the corresponding arrow on the axial view of the machine
4	Segment topology is selected for the end ring
5	The parameter for “Sector angle” is enabled only if the segment topology is selected

1.6.3 Damper – Impedance

1.6.3.1 Overview

The aim of this section is to compute the inter bar and inter pole impedance of the damper circuit end rings.



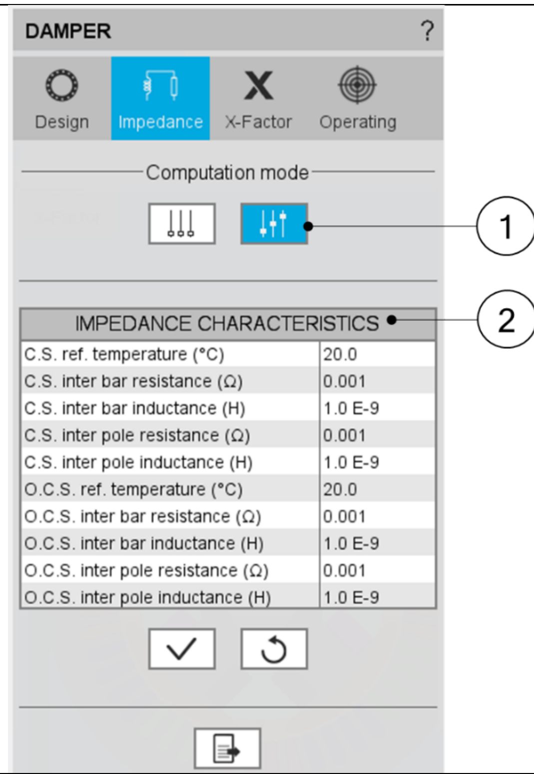
END RING - IMPEDANCE area	
1	Shortcut panels to navigate in the impedance results
2	Main window for visualizing the machine axial view
3	Section dedicated to inter bar and inter pole impedance definition
4	“Automatic” computation mode selection
5	Constant computation mode
6	Icon to export end ring impedance data into *.txt or *.xlsx files.

1.6.3.2 Automatic computation mode

When automatic computation mode is set, inter bar and inter pole end-ring impedances are computed by internal processes. They are determined for the synchronous operation of the machine, meaning that there is no slip between the rotor and the stator. The temperature at the end ring (at Connection Side and Opposite Connection Side), and the material of the end ring are considered for the internal calculation process.
Note: Even if bars are not evenly distributed, only an average value is provided for the inter bar impedance based on the average distance between the bars.

1.6.3.3 Constant computation mode

When constant computation mode is set, the inter-bar and inter pole end-ring resistance and inductance values must be set by the user. The values are given for a reference temperature. In this case the inter bar end ring resistances and inductances are always a function of temperature (function depending on the material of the end-ring). Once again, the inter bar impedance can only take an average value, even if bars are not evenly distributed.

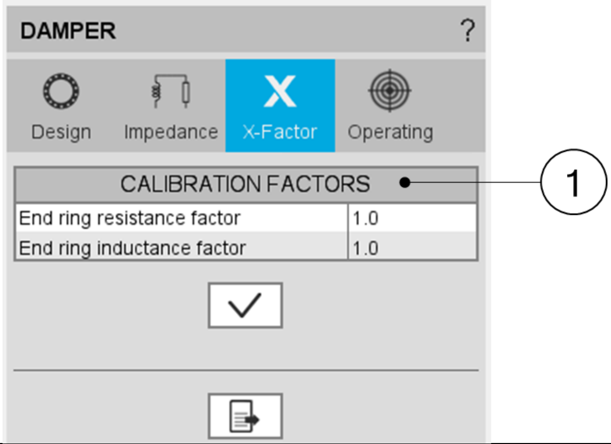


END RING – Constant computation mode

1	“Constant” computation mode selection
2	Impedance characteristic to be defined

1.6.3.4 Damper – Calibration factors

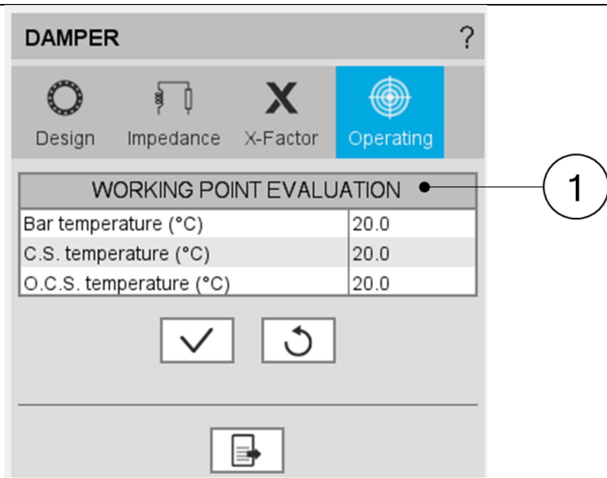
The calibration factors (X-factors) are user coefficients to tune the inter bar end ring resistances and inductances.



END RING - IMPEDANCE area – X-factor window	
1	Calibration factors to be defined

1.6.3.5 Damper – Working point evaluation

The inter bar end ring impedances must be defined for a working point.
A table allows the user to describe a working point, defined by the temperature of the bars, and the two end rings.



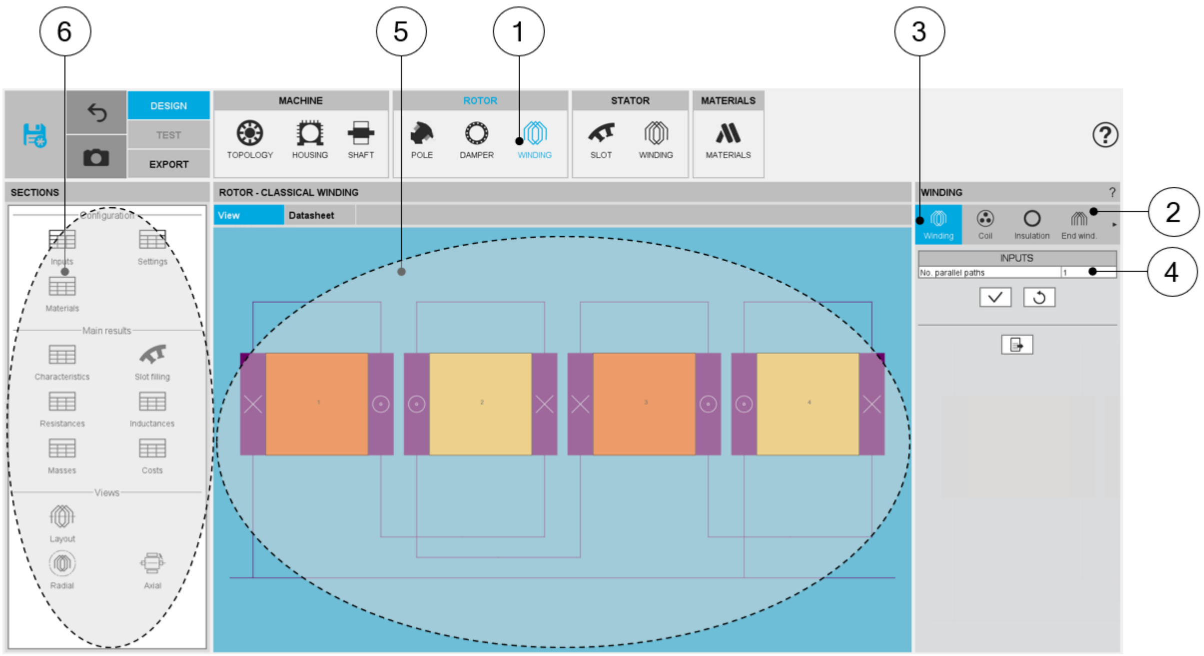
DAMPER – Definition of operating conditions for evaluating the end ring characteristic	
1	Definition of the temperatures (Bars and end rings) for which the impedances will be evaluated

1.7 Rotor Winding

1.7.1 Overview

The rotor DC winding has a lot of similarities with the 3-phase winding. Therefore, in each sub-section of the Rotor Winding context, only the differences compared to the 3-phase winding are mentioned.
For further information regarding basic knowledge and terminology about electrical winding, please refer to the user help guide: “Windings” section Field winding, which is dedicated to the winding design General user information.

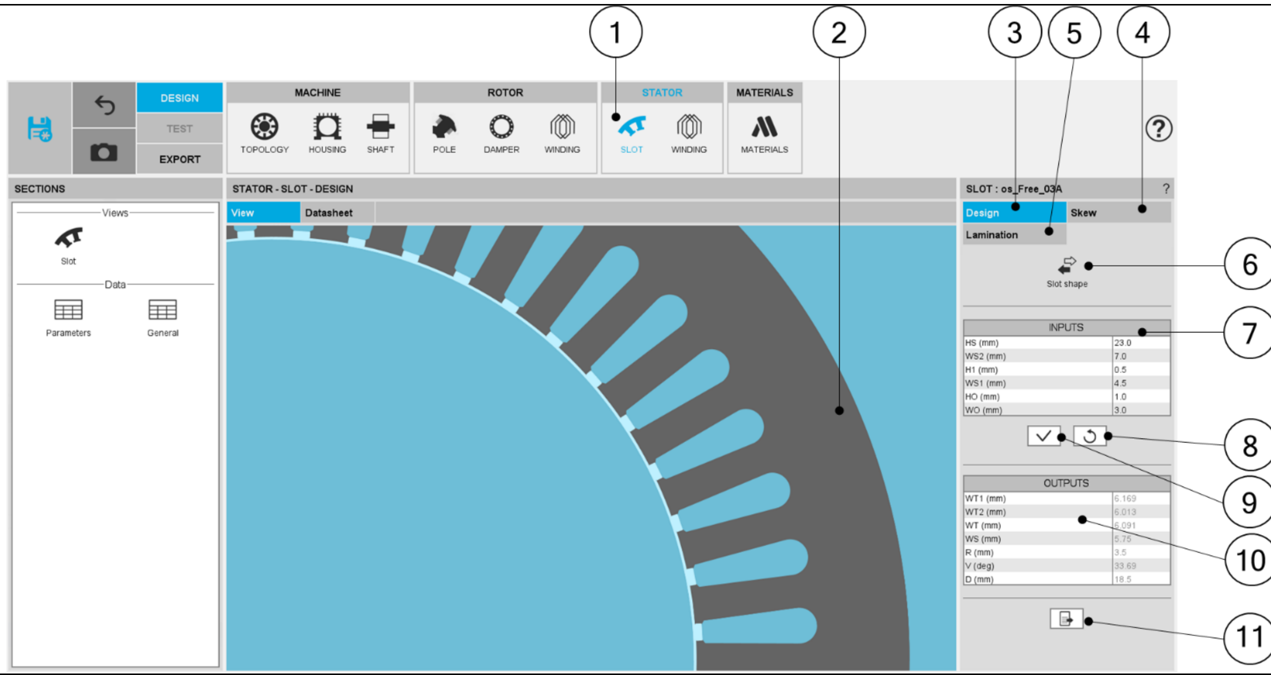
Here is the homepage for the design of the rotor winding.



ROTOR WINDING design area	
1	Selection of the ROTOR subset: WINDING panel (click on the icon WINDING)
2	A section scrolling bar allows choosing the section in which user inputs are defined. Scrolling selection bar where Winding architecture, Coil, Insulation, End-winding, X-Factor and Potting sections can be selected
3-4	Winding input parameter panel dedicated for designing of the winding architecture (mainly the number of parallel paths)
5	Once a winding is defined, the corresponding results are automatically displayed in the form of a winding report. Visualization of the winding characteristics (inputs, settings, materials, etc) is possible. Scrollbars allow browsing the whole document rapidly and give an overview of all the results. Using scrollbars, complete data can be accessed and visualized.
6	Shortcuts to easily navigate in the output sections

1.8 Slot

1.8.1 Overview

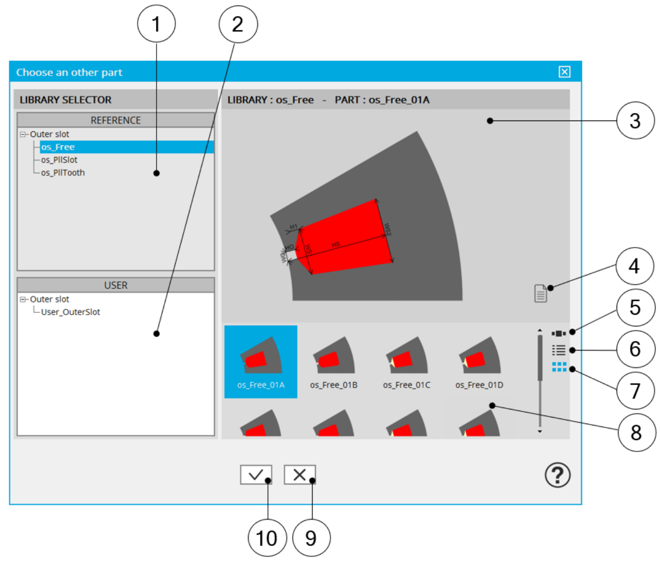


SLOT design area	
1	Selection of the STATOR subset: SLOT panel (Click on the icon SLOT)
2	Visualization of the motor radial view to see the slot topology and dimensions.
3	DESIGN tab indicates the tools to define the slot parameters. Note: By default, Design tab is selected.
4	SKEW tab indicates the tools to define the slot skew angle
5	LAMINATION tab indicates the tools to define the shape of the lamination. Note: By default, Circular lamination is selected.
6	"Slot shape" button allows accessing the slot libraries to change the slot topology. See additional information below.
7	User input parameter fields to enter the value.
8	Button to restore default input values.
9	Button to Apply inputs. Pressing the enter key twice applies inputs too.
10	Output parameters (read only data) to complete the description of the topology.
11	Icon to export slot data into *.txt or *.xlsx files.

1.8.2 Slot - Design

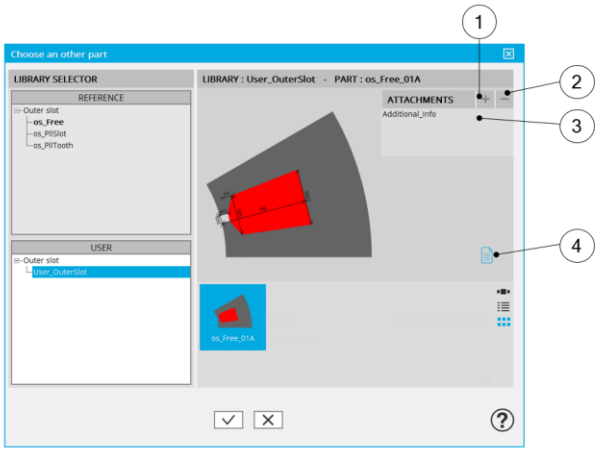
1.8.2.1 Slot shape - Choose a slot topology

Clicking on the "Slot shape" button opens a dialog box, allowing access to the slot libraries.
It allows visualizing, comparing, choosing, and importing another slot topology to modify in the current stator design.



How to choose another slot topology?	
1	Visualization of reference libraries i.e., the libraries of slot topologies provided with FluxMotor®. Select them to view their content and choose the slot among them. See “Part Library” application for more information.
2	Visualization of user libraries. The default user library is “User_OuterSlot” See “Part Library” application for more information.
3	Area where the selected slot is displayed (static picture) – Topology + dimension labels.
4	Button to visualize the list of documents attached to the part. See additional information below.
5	Button to display thumbnails as a slide show.
6	Button to display thumbnails as a list.
7	Button to display thumbnails as a matrix view of pictures.
8	Area to visualize all the topologies of slots from the selected library (ref. 1).
9	Button to close the dialog box and come back to Motor Factory – DESIGN – Slot area.
10	Button to choose and import the selected slot to modify the current stator design.

1.8.2.2 Attached documents – Additional information



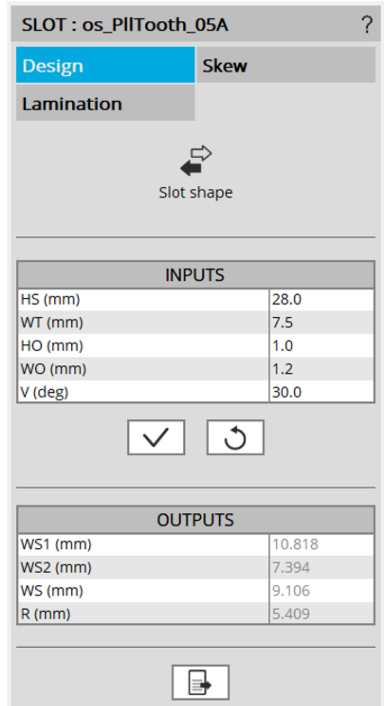
1	Attached document list after having clicked on button to display it (4).
2	“+” or “-“ non-active buttons from “Motor Factory”. See “Part Library” application for more information.
3	List of attached documents (if present). A double click on the selected document opens it. Documents can be added only from Part Library application. See “Part Library” application for more information.
4	Button to show or hide the attached document list.

Visualization of attached documents

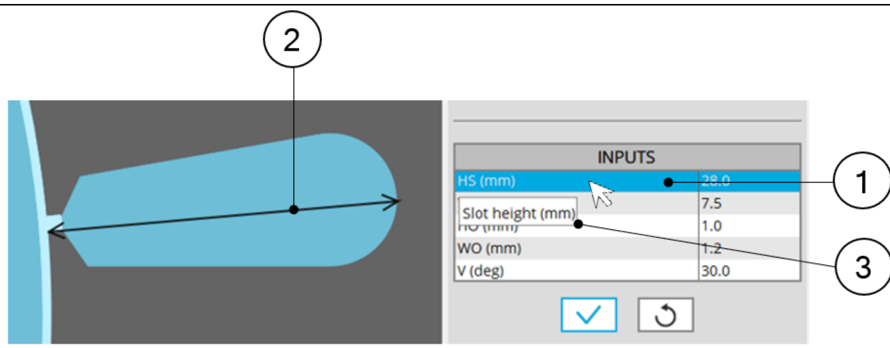
1.8.2.3 Inputs / Outputs

Specific inputs and outputs are considered for each slot topology.
The relevance of input parameters values can be evaluated by using “Part Factory” application.
See “Part Factory” application for more information.

Outputs are read only data. They complete the description of the topology.



Inputs / Outputs of parts

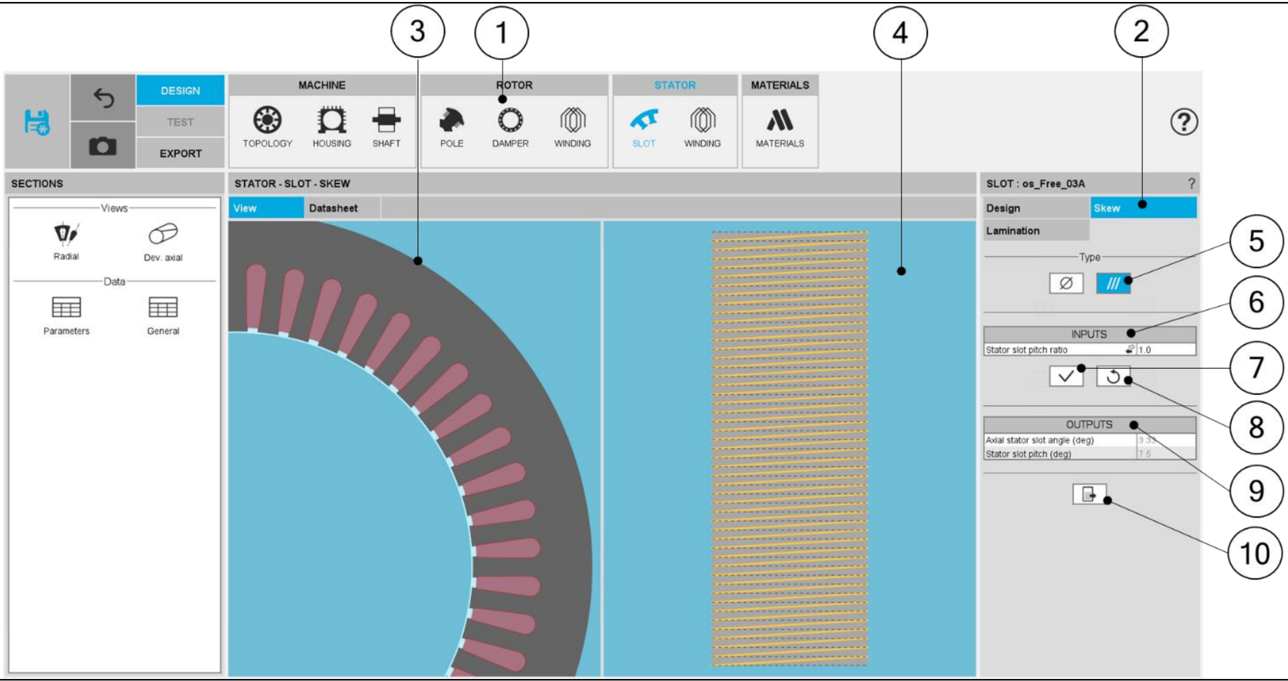


Inputs / Outputs stator slot

1	Select a parameter highlights it.
2	Select a parameter label displays the corresponding arrow on the picture.
3	Select a parameter displays the corresponding tooltip which completes information about the parameter.

1.8.3 Slot – Skew

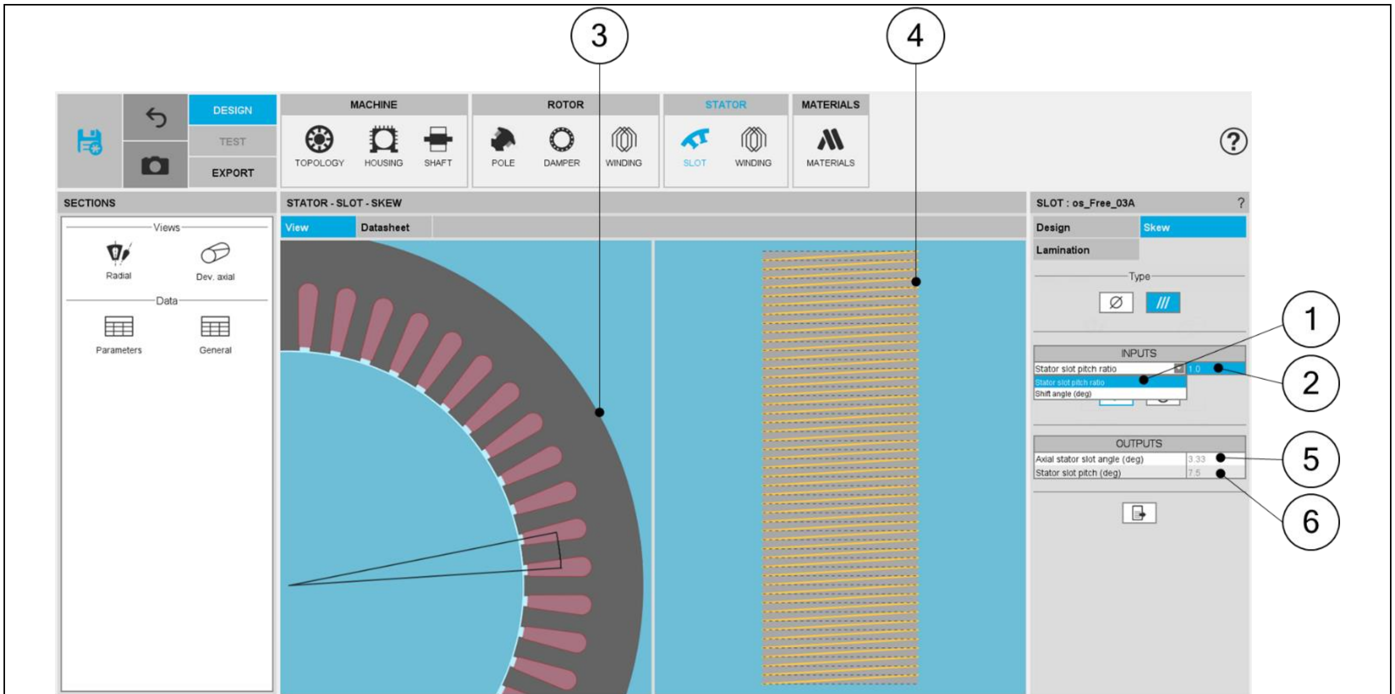
1.8.3.1 Overview



SLOT – SKEW design area

1	Selection of the STATOR subset: SLOT panel (Click on the icon SLOT)
2	Skew tab indicates the tool to define the slot skew angle
3	Visualization of the machine radial view to visualize the slot skew
4	Visualization of the stator developed view to visualize the slot skew
5	Choices to define a skew: None – Continuous (Continuous in our example)
6	Skew inputs to be defined
7	Buttons to validate the inputs (Pressing the “enter key” twice applies inputs too).
8	Buttons to restore the default input values.
9	Skew outputs (read only)
10	Button to export the skew data into *.txt or *.xlsx files.

1.8.3.2 Setting a skew angle



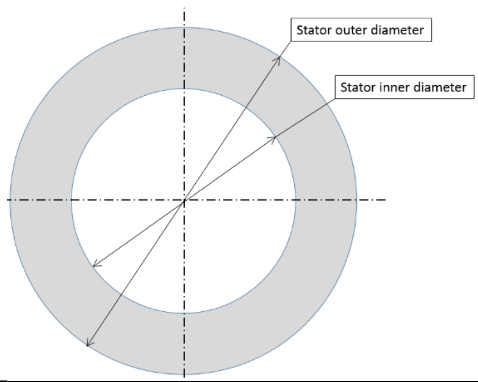
How to set a skew angle?	
1	Choose the definition mode of the skew: Stator slot – Shift angle
2	Definition of the skew angle depending on the definition mode
3	Visualization of the chosen skew angle on the machine radial view
4	Visualization of the equivalent axial slot angle on the rotor developed view
5	Equivalent axial stator slot angle (read only)
6	Equivalent stator slot pitch (read only)

Note: The user can add a skew angle on the rotor or on the stator. If a skew is already defined in the rotor when setting a skew on the stator, the rotor skewing will be automatically reset to “None”.

1.8.4 Slot – Lamination

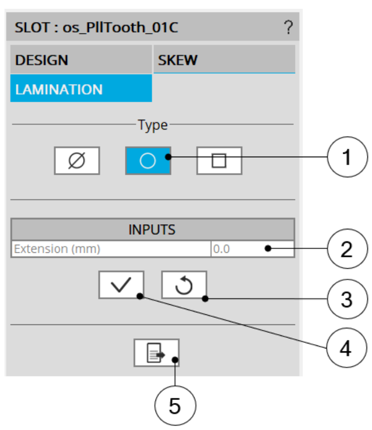
1.8.4.1 Overview

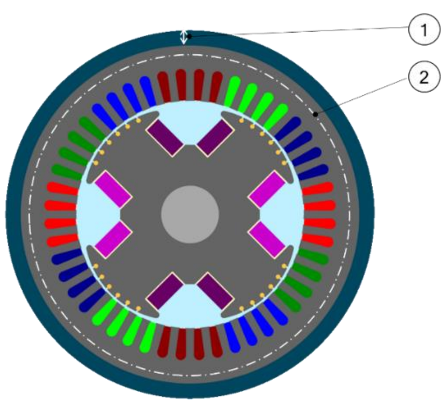
The tools available in the lamination tab allow defining the outer shape of the lamination.
Three choices are available to define the lamination topology: None, Circular or Square.
By default, the outer shape of the lamination is defined by considering the outer diameter of the stator (defined in structural data).
When the choice of lamination is “None”, original structural data of the stator are considered.
In that case outer shape of lamination is circular without extensions. Outer dimensions of lamination are indicated in general data (structural data part). See illustration below.



Original structural data of the stator: Outer and inner stator diameters

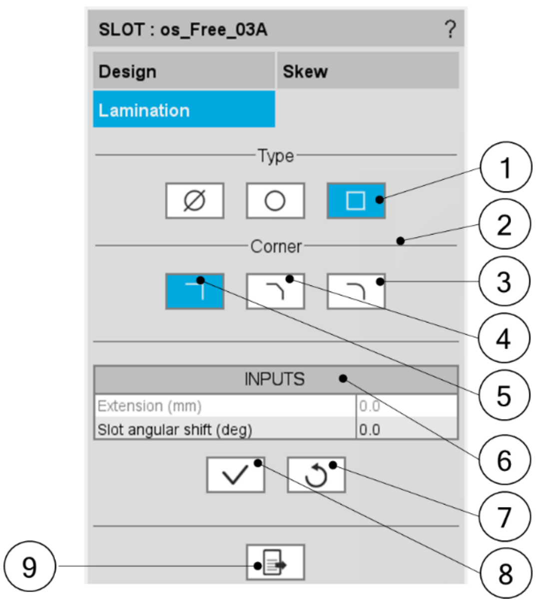
1.8.4.2 Circular shape lamination

	1	Choice of a circular shape lamination
	2	Additional lamination extension. This corresponds to a diameter extension from the original stator outer diameter defined in the general data (structural data of the machine). See illustration below. For new design, this input won’t be available anymore.
	3	Button to restore default input values.
	4	Button to Apply inputs. Pressing the enter key twice applies inputs too.
	5	Icon to export lamination data into *.txt or *.xlsx files.

	1	Extension = Diameter extension from the original stator outer diameter. **Note: For new design, this input won’t be available anymore.**
	2	Original stator outer diameter defined in the general data (structural data of the machine).

1.8.4.3 Square shape lamination

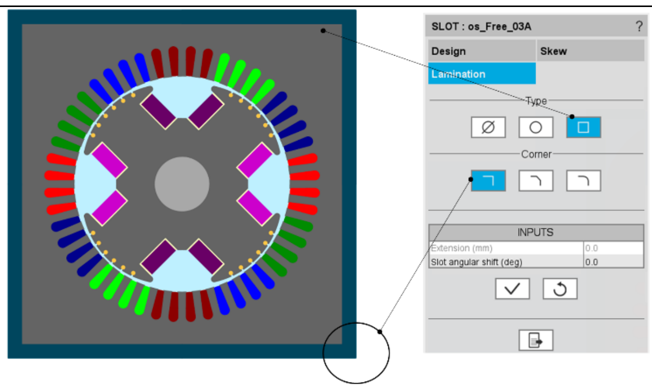
1) Main inputs



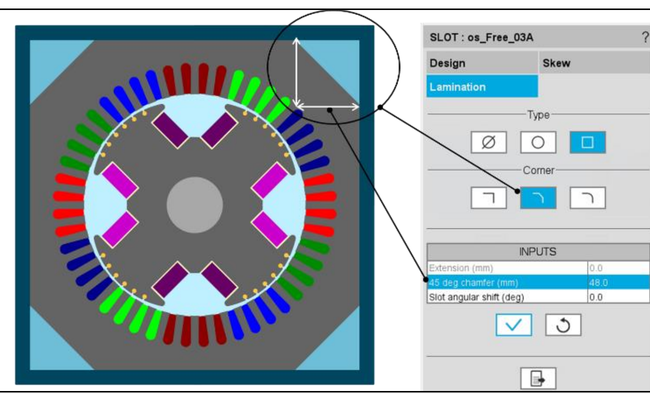
1	Choice of a square shape lamination.
2	Corner type available (Right, Chamfer, Fillet).
3	Button to select “fillet” type corner.
4	Button to select “chamfer” type corner.
5	Button to select “right” type corner.
6	User input parameters to define the angular shifting of the stator. **Note: For new design, extension won’t be available any more.**
7	Button to restore default input values.
8	Button to apply inputs. Pressing the enter key twice applies inputs too.
9	Icon to export lamination data into *.txt or *.xlsx files.

Dialog box to define the square shape lamination

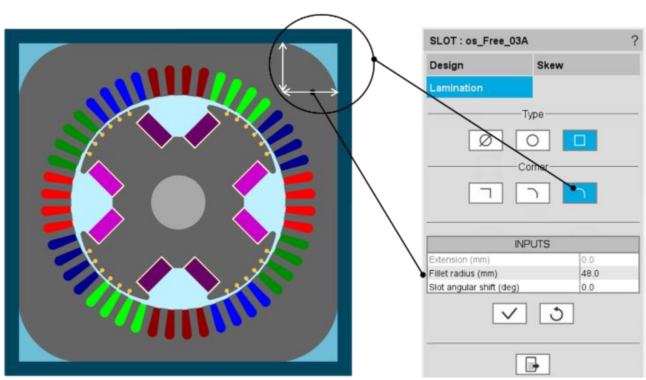
2) Description of the different kinds of square shape lamination available



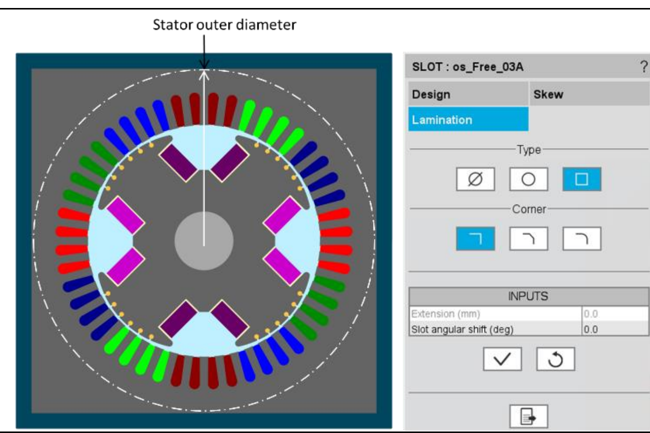
Square shape lamination with right corner



Square shape lamination with chamfer corner
Setting of the length corresponding to a 45° chamfer



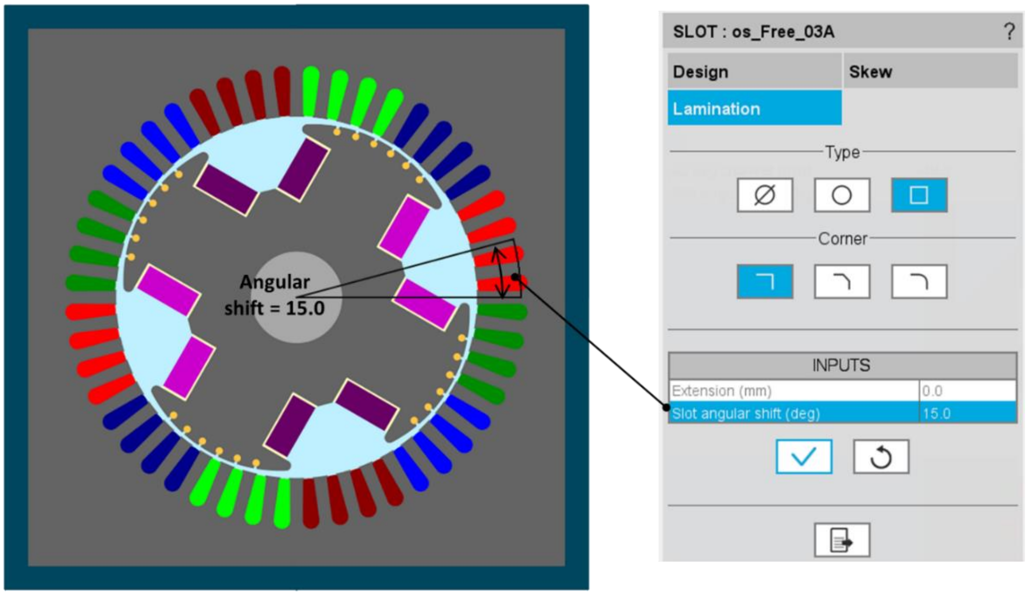
Square shape lamination with fillet corner
Setting of the lamination fillet radius



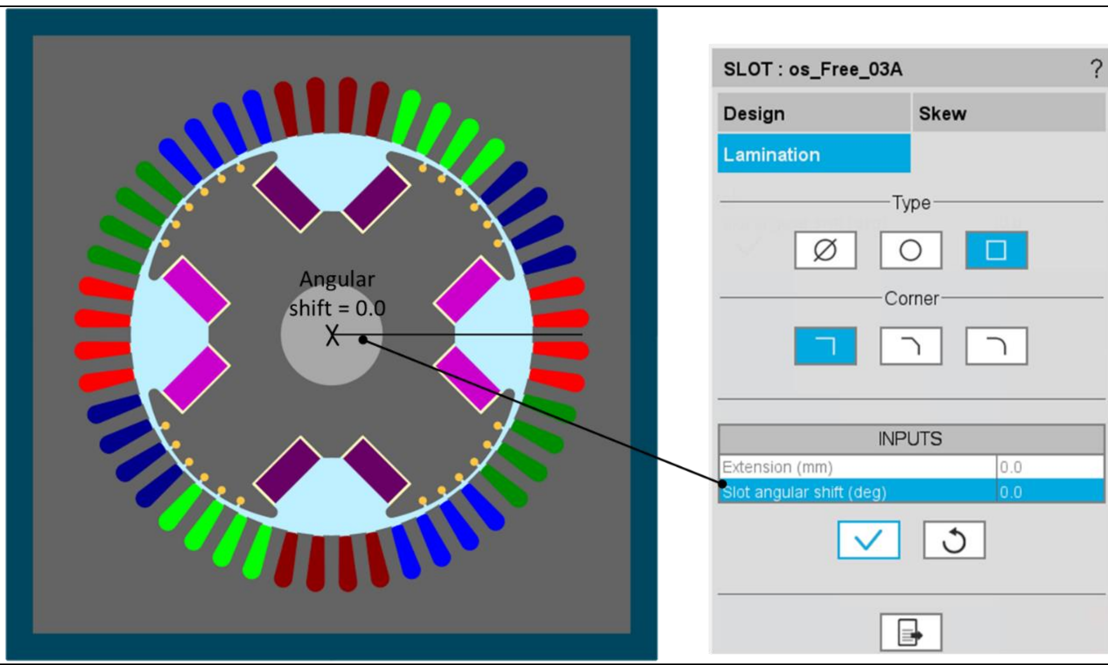
Square shape lamination with right corner
See the link with stator outer diameter

3) Definition of the slot angular shift

With a square shape lamination, it is possible to set a slot angular shift. It is advised to keep an angular shift lower than one slot pitch. This parameter allows adjusting outer dimension (Δ) between outer border of the lamination and the bottom part of slots. For more details see the illustrations below.



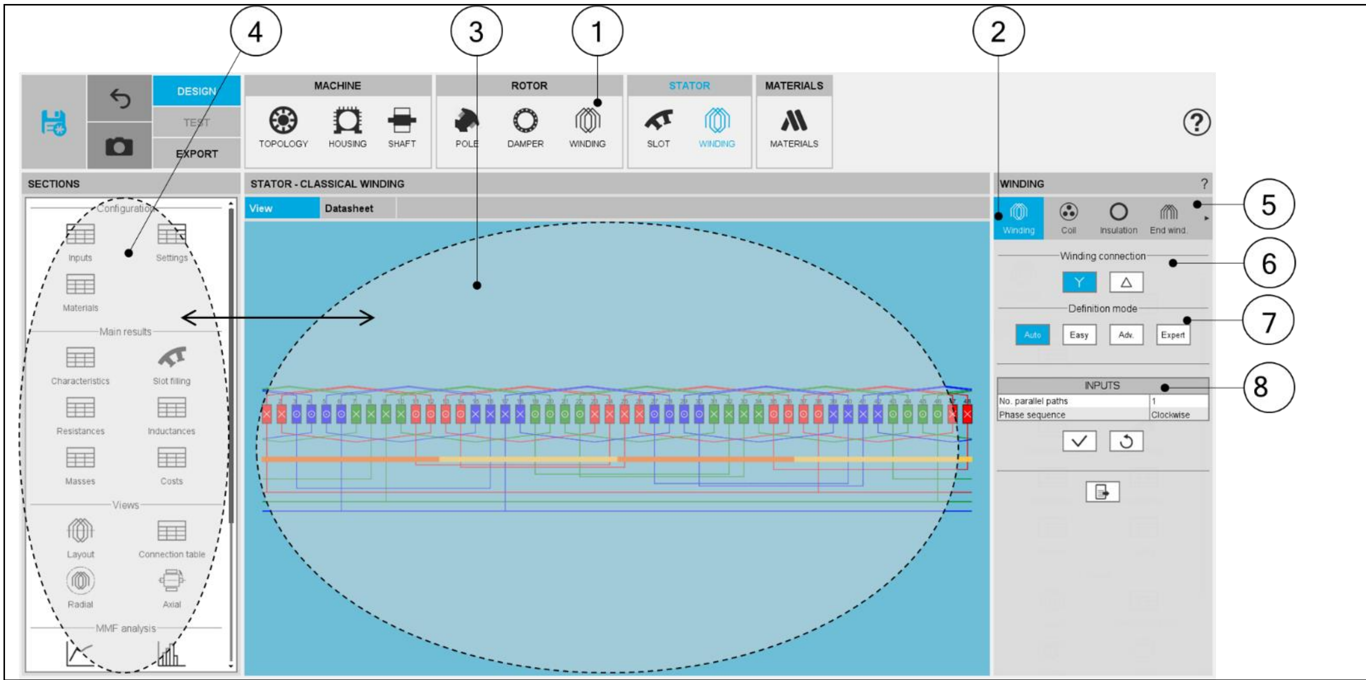
Square shape lamination
Definition of the slot angular shift = 15.0 i.e., half value of the slot pitch.



Square shape lamination
Definition of the slot angular shift = 0 i.e., original default value.

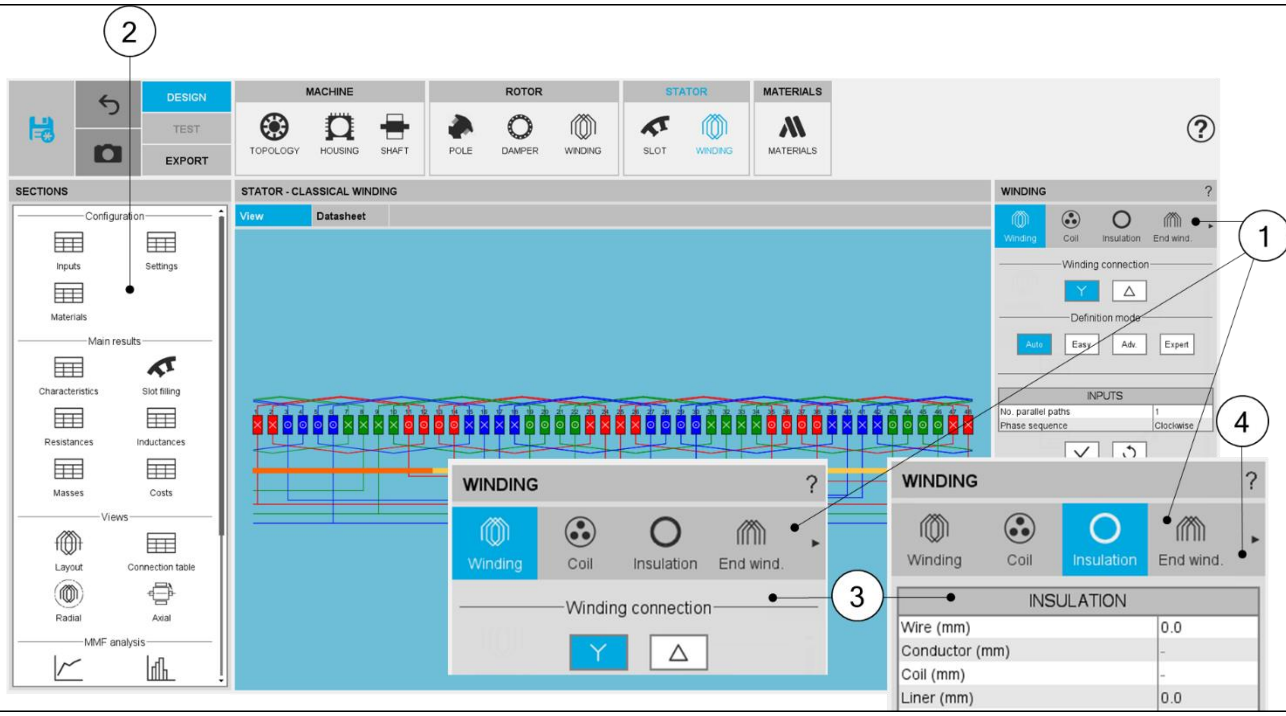
1.9 Winding

Please refer to the user help guide “Windings” to get more detailed general user information about winding design.
The following picture illustrates the main areas of the home page which is displayed for the classical winding.



WINDING design area – Classical winding - Overview

1	Selection of the STATOR subset: WINDING panel (Click on the icon WINDING)
2	All the required user inputs to define the winding are available in the “WINDING” panel (right part).
3	Once a winding is defined, the corresponding results are automatically displayed in the form of a winding report. Visualization of the winding characteristics (inputs, settings, materials, etc) are possible. Scrollbars allow browsing the whole document rapidly and giving an overview of all the results. Using scrollbars, complete data can be accessed and visualized.
4	Shortcuts for displaying the corresponding section of the winding report.
5	A section scrolling bar allows choosing the section in which user inputs are defined. Scrolling selection bar where Winding architecture, Coil, Insulation, End-winding, X-Factor and Potting sections can be selected
6	Choice of the winding connection: Y (Wye) or Δ (Delta)
7	Four modes of winding allow to **define and build the winding architecture**.
Auto	**Automatic** mode, used as default.
Easy	**Easy** mode, to choose solution among those FluxMotor® proposes.
Adv.	**Advanced** mode, to allow the user to define any specific input parameters.
Expert	**Expert** mode, to set the connection table.
8	User input parameter fields to enter the values according to the considered mode.

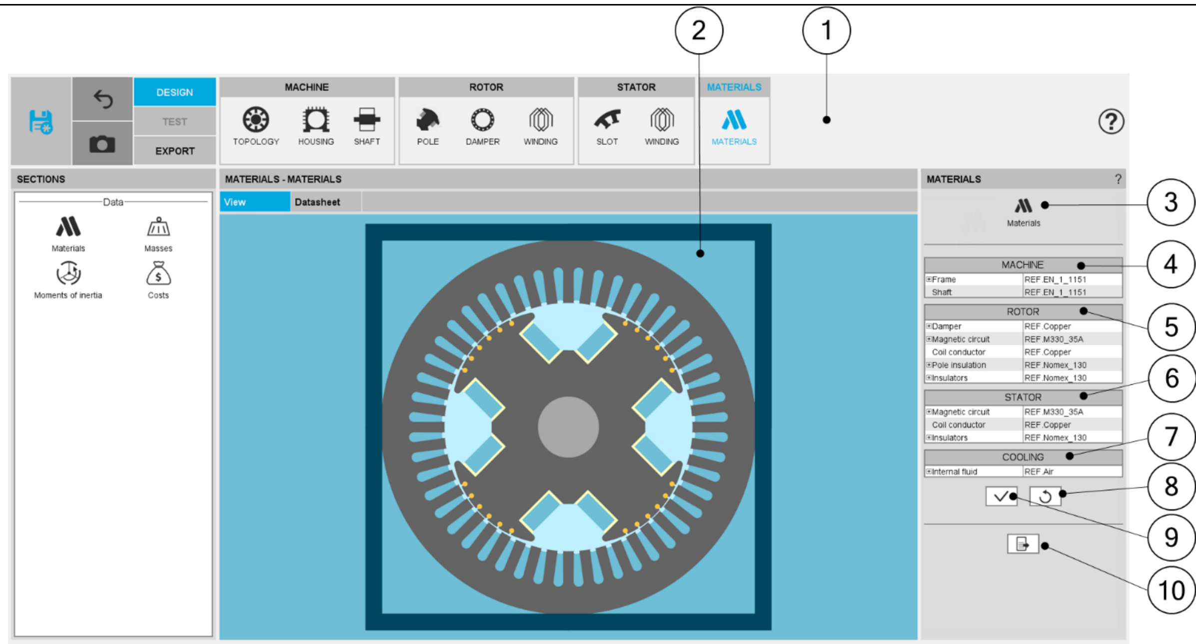


Scrolling selection bar – Winding environment

1	Scrolling selection bar where Winding, Coil, Insulation, End-winding, X-Factor and Potting sections can be selected
2	Section data can be reached thanks to shortcuts
3	Arrow allows scrolling the bar to reach other sections (on the right or the left) when needed
4	The bar slides on the right to allow reaching Potting section

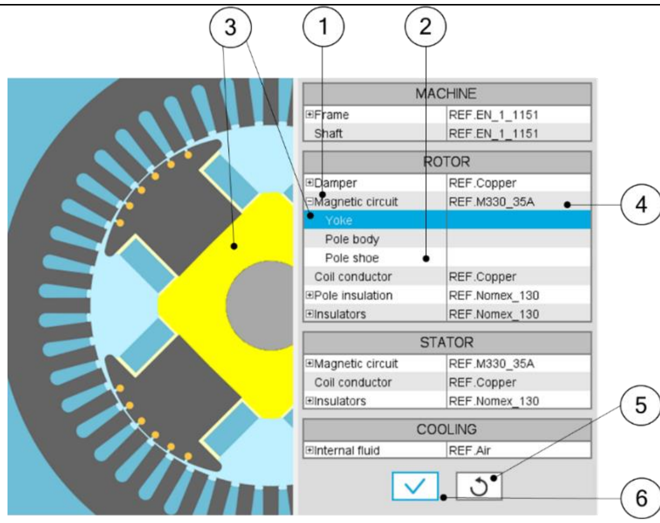
1.10 Materials

1.10.1 Overview



MATERIALS design area	
1	Selection of the Material subset: MATERIALS panel (Click on the icon MATERIALS)
2	Visualization of the machine regions.
3	Direct access to open material manager. It allows seeing properties of materials.
4	Area to assign materials to machine regions (frame, shaft, bearings). See additional information below.
5	Area to assign materials to rotor regions (magnetic circuit). See additional information below.
6	Area to assign materials to Stator regions (magnetic circuit, coil conductor, insulators). See additional information below.
7	Area to assign materials to the cooling fluids (internal fluid). See additional information below.
8	Button to restore default materials. Default materials are those defined as favorite materials in Material manager. See “Materials” application for more information.
9	Button to validate assignment of materials. Pressing the Enter key twice applies inputs too.
10	Icon to export material data into *.txt or *.xlsx files.

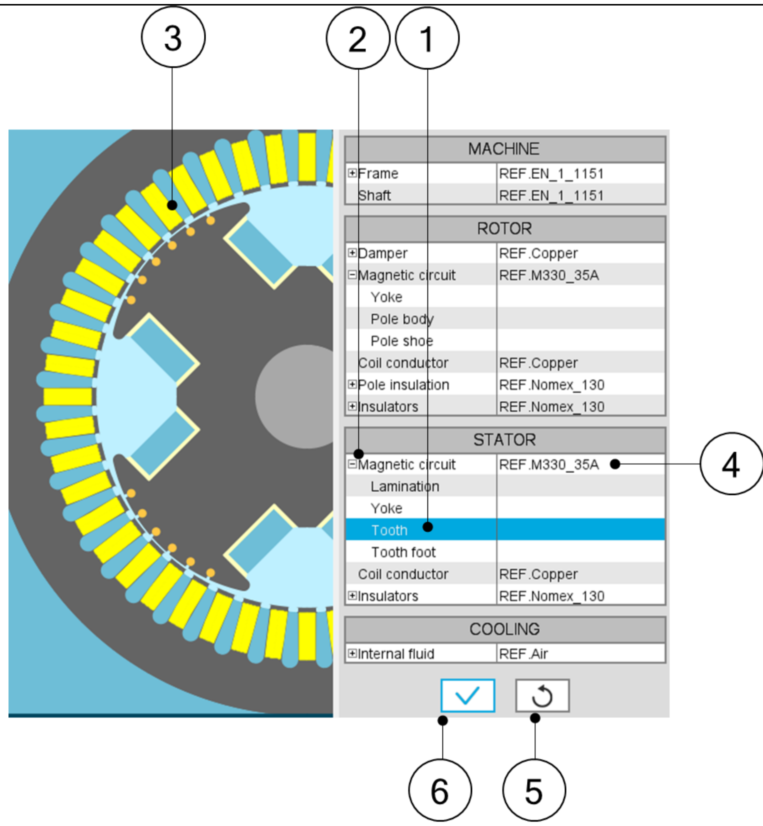
1.10.2 How to assign materials – Example for rotor lamination



Assign materials to the rotor magnetic circuit

1	Expand the section dedicated to the magnetic circuit. Different materials (LAMINATION type or SOLID type) can be assigned to it.
2	The magnetic circuit can be subdivided into several parts. (Yoke, Bridge, Web etc.)
3	By selecting a region name (Yoke for example) the corresponding face region is highlighted.
4	Expand the material list to choose a material to assign to the magnetic circuit. Only one material can be assigned to the rotor magnetic circuit. In our example it is not possible to assign different materials to sub regions like Yoke and Web.
5	Button to restore default materials. Default materials are those defined as favorite materials in Material manager. See “Materials” application for more information.
6	Button to validate assignment of materials. Pressing the enter key twice applies inputs too.

1.10.3 How to assign materials – Example for stator lamination



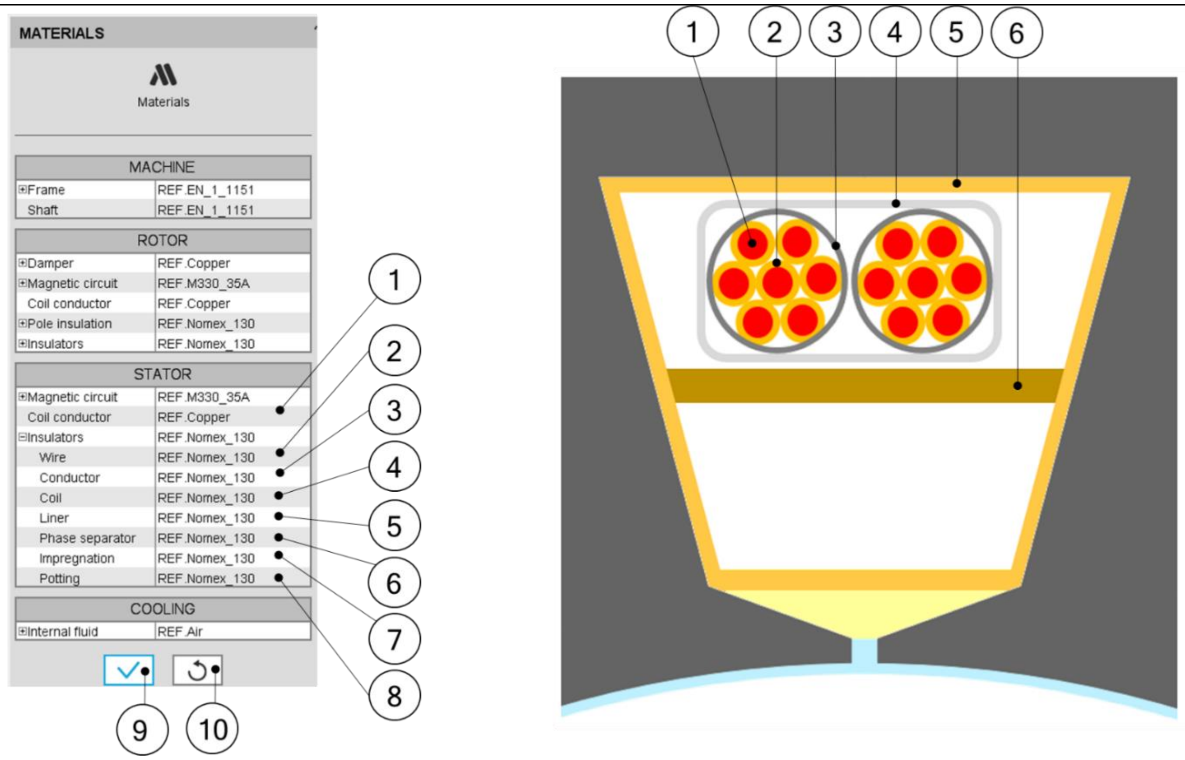
Assign materials to the stator magnetic circuit	
1	Expand the section dedicated to the magnetic circuit. Different materials (LAMINATION type or SOLID type) can be assigned to it.
2	The magnetic circuit of the stator can be subdivided into several parts (Yoke, Tooth, Tooth foot etc.).
3	By selecting a region name (Tooth for example) the corresponding face region is highlighted.
4	Expand the material list to choose a material to assign to the magnetic circuit. Only one material can be assigned to the stator magnetic circuit. In our example, it is not possible to assign different materials to sub regions like Yoke, Tooth and Tooth foot for example.
5	Button to restore default materials. Default materials are those defined as favorite materials in Material database. See “Materials” application for more information.
6	Button to validate assignment of materials. Pressing the enter key twice applies inputs too.

For more information about the rules leading to the building of parts like slots, please refer to Part Factory application.

1.10.4 Materials for the winding

All the materials are selected in the material database.

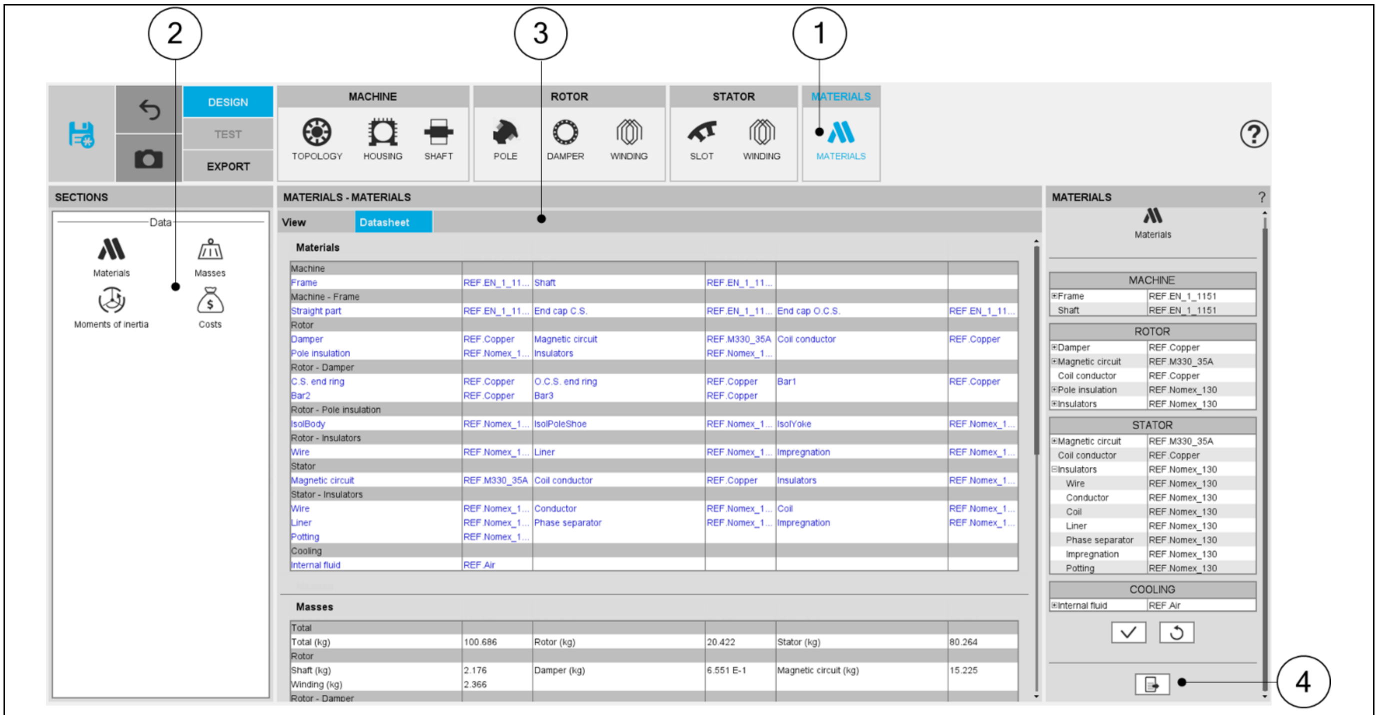
Conductor materials are selected in the “Electrical Conductor” type material family.
Insulator materials are selected in the “Electrical Insulator” type material family.
Thicknesses of insulations are defined inside the winding settings panel – COIL tab.
Insulation materials are considered only if a corresponding thickness is defined.



Building the winding architecture – **Choice of winding MATERIALS -** Conductor and insulation

1	Conductor materials
2	Wire insulation
3	Conductor insulation
4	Coil insulation
5	Liner
6	Phase separator
7	Impregnation inside the slot
8	Material used for encapsulating the end-windings (potting)
9	Button to validate assignment of materials. Pressing the enter key twice applies inputs too.
10	Button to restore default materials. Default materials are those defined as favorite materials in Material database. See “Materials” application for more information.
*	Insulators: If all the above choices are same material, then the corresponding material name is written in the insulators field. Otherwise “Diversified” is written in the insulators field which means there are different materials.

1.10.5 Material datasheet



	MATERIALS design area
1	Selection of the STATOR subset: MATERIALS panel (Click on the icon MATERIALS)
2	Shortcuts to reach material datasheet sections
3	Material datasheet where materials, masses, moment of inertia and costs are displayed
4	Icon to export stator material data into *.txt or *.xlsx files.