FXM HOW TO PARAMETRIZE A PART FACTORY EXCEL FILE

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Introduction

In this tutorial, users will learn :

- *How to modify a part Excel file to make the part parametrized in FluxMotor*

The following training materials will be provided to you:

- *A simple rotor Flux model*
- *Its part factory excel file created with the CreateFluxMotorInnerMagnet macro*
- *This step-by-step presentation*

At the end of the tutorial, you are expected to:

- *Import the simple motor part in FluxMotor and be able to modify its dimension in Part Factory*

Related support documents:

- *Online user notes and technical documents of FluxMotor*

Model Presentation

Geometric Parameters

The tutorial will be run on a simple IPM model with one magnet surrounded by air areas.

ID : Inner Diameter

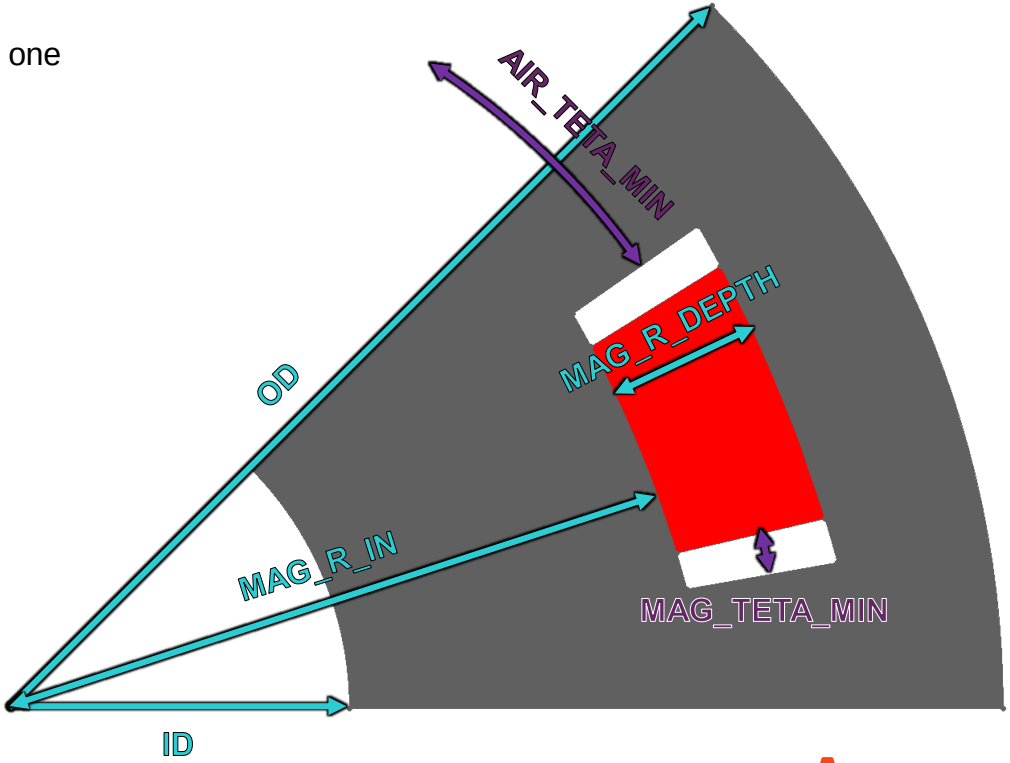
OD : Outer Diameter

MAG_R_IN : Magnet Inner Radius

MAG_R_DEPTH : Magnet Depth

AIR_TETA_MIN : Magnet area opening angle

MAG_TETA_min : Magnet opening angle



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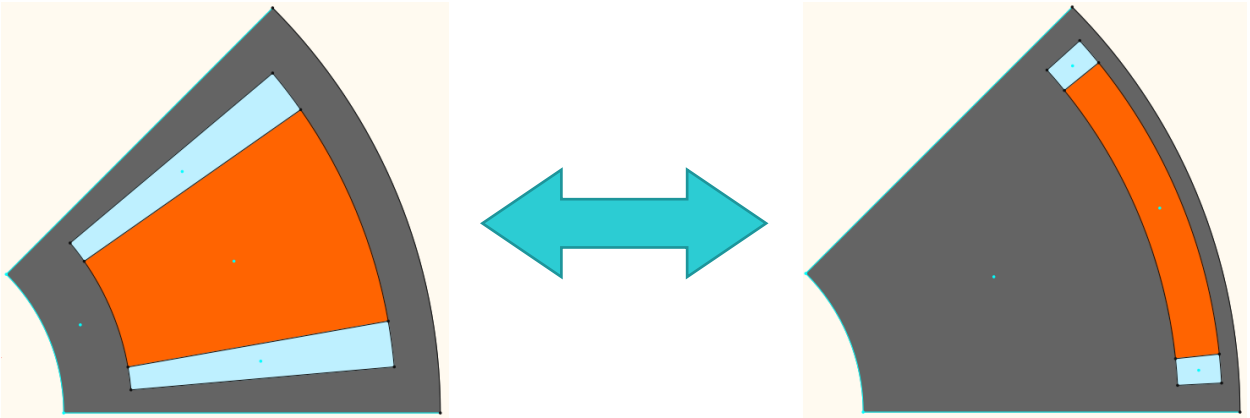
Introduction

What is a parametrized part ?

A parametrized part is a part which dimensions can be modified by the user in FluxMotor. Geometric parameters are linked with formulas so that changing one of them affects the others.



PARAMETERS	
MAG_R_IN (mm)	30.0
MAG_R_DEPTH (mm)	30.0
AIR_TETA_MIN (deg)	5.0
MAG_TETA_MIN (deg)	5.0

PARAMETERS	
MAG_R_IN (mm)	58.0
MAG_R_DEPTH (mm)	5.0
AIR_TETA_MIN (deg)	3.0
MAG_TETA_MIN (deg)	3.0

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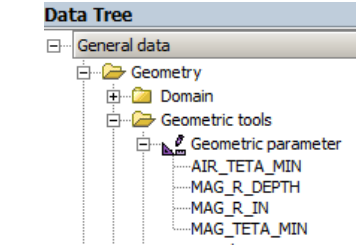
EXCEL FILE SECTIONS OVERVIEW

User Parameters

Point coordinates are based on the values given in the « User Parameters » tables. These parameters are not exported by the Flux-FluxMotor macros and needs to be recreated to para*metrize* the part.

User parameter			
Label	Comment	Unit	Expression



User parameter			
Label	Comment	Unit	Expression
MAG_R_IN		mm	45
MAG_R_DEPTH		mm	10
AIR_TETA_MIN		deg	10
MAG_TETA_MIN		deg	3.125

*For parameters with no Unit such as pole number for instance, add "1" in the Unit column.

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User Parameters – Adding constraints

Constraints put bounds to the possible values for user parameters (to avoid topological problems in Motor Factory and make the process more robust).

- At most 3 constraints per parameter
- A constraint used two columns
  - One for the Type: Strictly inferior, Inferior, Strictly superior, Superior
  - One for the formula of the bound

Constraints after an empty constraint are ignored
Constraint formulas can refer to Unity functions, structural data and ALL user parameters

User parameter			
Label	**Comment**	**Unit**	**Expression**
TM	Magnet thickness	mm	TM_imp
C	Magnet outer arc (Elec. angle)	deg	C_imp
R	Magnet outer radius	mm	R_imp
V	Magnet edge angle	deg	V_imp

Constraint 1		Constraint 2		Constraint 3	
Type	**Expression**	**Type**	**Expression**	**Type**	**Expression**
Strictly inferior	(OD-ID)/2	Strictly superior	OD/2*(1-Cosd(C/PN))		
Strictly inferior	180*uv	Strictly superior	0*uv		
Inferior	OD/2	Strictly superior	Max([OD/2*Sind(C/PN)/(1+Sind(C/PN)),TM])		
Superior	0*uv				

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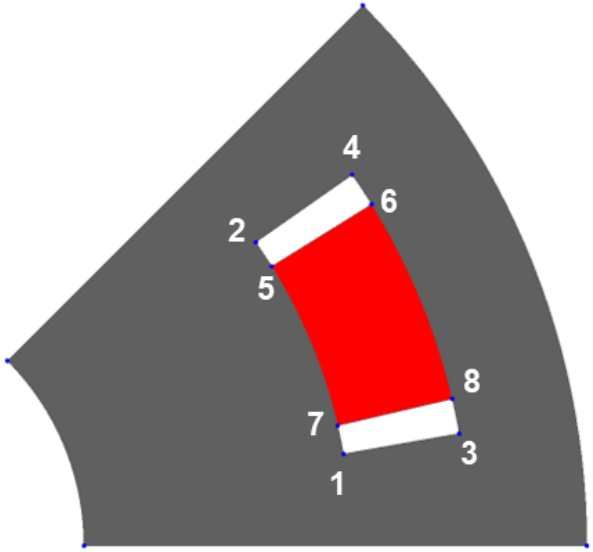
Parameters Formula Definition

For a non-parametrized parts, points coordinates value are directly given in the Point Coordinate tab.

This tab is used to define formulas that are needed to parametrized points coordinates.

These expressions can be found in Flux or in your CAD Sketcher.

Internal formula			
Label	**Comment**	**Unit**	**Expression**
OR	Outer radius	mm	OD/2
IR	Inner radius	mm	ID/2
VE	Angle of sector	deg	(360*uv)/PN
PX1	x-coordinate	mm	(MAG_R_IN)*Cos(AIR_TETA_MIN)
PY1	y-coordinate	mm	(MAG_R_IN)*Sin(AIR_TETA_MIN)
PX2	x-coordinate	mm	(MAG_R_IN)*Cos(VE-AIR_TETA_MIN)
PY2	y-coordinate	mm	(MAG_R_IN)*Sin(VE-AIR_TETA_MIN)



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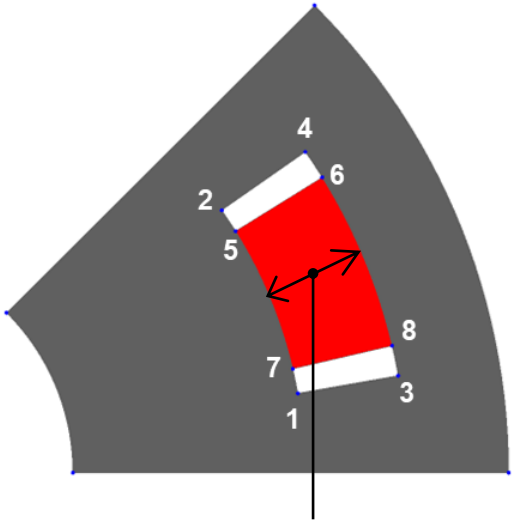
Resulting parameters – Output formula

Output formula			
Label	**Comment**	**Unit**	**Expression**
TM	Magnet thickness	mm	1.0

The output formulas allows the define information that help the user to evaluate the topology dimensions which are not defined as inputs.



Magnet thickness

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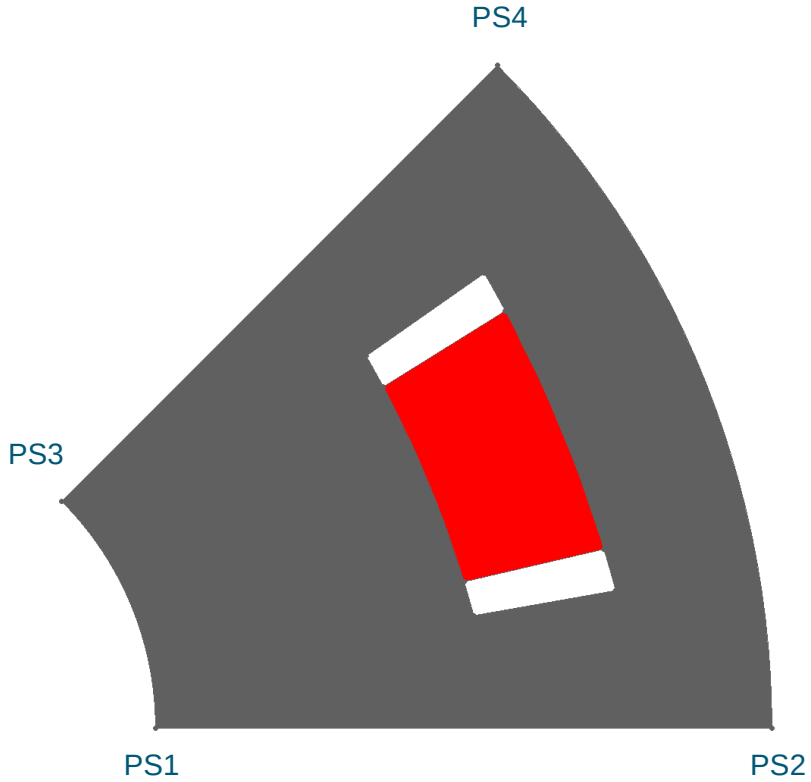
Sector outer coordinates

Sector point	Coordinate type	Polar		
Label	Comment	Unit	Expression	Property
PSC	Radial coordinate	mm	0	Invisible
	Angular coordinate	deg	0	
PS1	Radial coordinate	mm	IR	Invisible
	Angular coordinate	deg	0	
PS2	Radial coordinate	mm	OR	Visible
	Angular coordinate	deg	0	
PS3	Radial coordinate	mm	OR	Visible
	Angular coordinate	deg	VE	
PS4	Radial coordinate	mm	IR	Invisible
	Angular coordinate	deg	VE	

This table defines the coordinates of the outer points of the geometry.

Theses parameters are automatically written during the Excel sheet creation process and remain the same whether the part is parametrized or not.



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Points Coordinates Definition

For Non-Parametrized part, a single value is given for the points coordinates. To make your part parametrized, you will need to replace those numerical coordinates with the corresponding formula that has been defined in the Internal Formula tab.

Non-Parametrized Part

Point	Coordinate type	Cartesian	
Label	Comment	Unit	Expression
P6	x-coordinate	mm	44.3163488855*ul
	y-coordinate	mm	7.81416799501*ul
P7	x-coordinate	mm	36.861841993*ul
	y-coordinate	mm	25.8109396358*ul

Parametrized Part

Point	Coordinate type	Cartesian	
Label	Comment	Unit	Expression
P6	x-coordinate	mm	PX1
	y-coordinate	mm	PY1
P7	x-coordinate	mm	PX2
	y-coordinate	mm	PY2

Points coordinates can also be defined directly with a formula in this tab

Point	Coordinate type	Cartesian	
Label	Comment	Unit	Expression
P6	x-coordinate	mm	(MAG_R_IN)*Cos(AIR_TETA_MIN)
	y-coordinate	mm	(MAG_R_IN)*Sin(AIR_TETA_MIN)
P7	x-coordinate	mm	(MAG_R_IN)*Cos(VE-AIR_TETA_MIN)
	y-coordinate	mm	(MAG_R_IN)*Sin(VE-AIR_TETA_MIN)

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Geometric Lines Definition

Geometric lines, in FluxMotor can only be segment or arcs. They are respectively defined with its start and end points for segments and start, end and center points for arcs.

For the given model, the Center Point of the arc is the motor center, but in the case that it is a different one, this center point and its coordinates must be defined respectively in the Point and Internal formula tabs.

Their definition is the same whether it is parametrized or not as coordinates doesn't intervene here.

Complex splines must be simplified or discretized as a combination of arc lines to be considered in FluxMotor.

Line				
Label	**Type**	**Start point**	**End point**	**Center point**
LINE1	Segment	P12	P13	
LINE3	Segment	PS3	PS4	
LINE2	Arc	PS2	PS3	PSC
LINE4	Arc	PS1	PS4	PSC

Magnets polarization definition

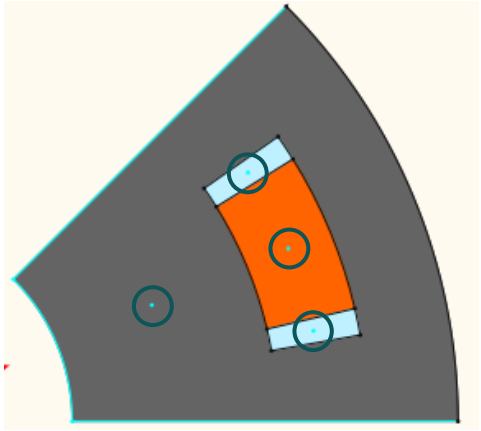
For every magnet, a coordinate system must be given. The x or r axis of this system carries the orientation of the magnet face region.

3 coordinates are necessary to define the coordinate system : the coordinates of its center and its rotation in relation to the reference coordinate system. (Ref : Center (0, 0) Rotation 0°)

If several magnets have their orientation carried by the same coordinate system, this latter must be repeated in the table for each one of them.

Polarization coor. system	**Coordinate type**	**Cartesian**	
Label	**Comment**	**Unit**	**Expression**
MAGNET	Center - x coordinate	mm	(0.0)*ul
	Center - y coordinate	mm	(0.0)*ul
	Rotation	deg	(22.5)*uv

Face Region Assignation



Face regions physic assignation is done by giving the coordinates of a point which is inside the respective region. This coordinates must be chosen wisely for parametrized parts as this point might end up outside of the region for a particular set of parameters.

For Non-Parametrized part, the coordinates of an arbitrary point is given. We advice you to choose the center of the region, if it has one.

This points coordinates can be parametrized to be sure that they will remain within the face region domain.

Face location	Coordinate type	Cartesian							
Label	Comment	Unit	Expression	Nature	Exploitation line	Local coor. system	Polarisation mode	Ref. coord. system	Angle vs x-axis
Yoke_1	x-coordinate	mm	20.6598132933*ul	Yoke					
	y-coordinate	mm	9.19238815543*ul						
Magnet_1	x-coordinate	mm	45.5769790201*ul	Magnet	LINE6	MAGNET	Direction	Local	0
	y-coordinate	mm	18.8786028421*ul						
Hole_1	x-coordinate	mm	41.7088556454*ul	Hole					
	y-coordinate	mm	27.541107175*ul						
Hole_2	x-coordinate	mm	48.9671183072*ul	Hole					
	y-coordinate	mm	10.0181110175*ul						

Face location	Coordinate type	Polar							
Label	Comment	Unit	Expression	Nature	Exploitation line	Local coor. system	Polarisation mode	Ref. coord. system	Angle vs x-axis
Yoke_1	Radial coordinate	mm	(IR+MAG_R_IN)/2	Yoke					
	Angular coordinate	deg	VE/2						
Magnet_1	Radial coordinate	mm	MAG_R_IN+MAG_R_DEPTH/2	Magnet	LINE6	MAGNET	Direction	Local	0
	Angular coordinate	deg	VE/2						
Hole_1	Radial coordinate	mm	MAG_R_IN+MAG_R_DEPTH/2	Hole					
	Angular coordinate	deg	AIR_TETA_MIN+MAG_TETA_MIN/2						
Hole_2	Radial coordinate	mm	MAG_R_IN+MAG_R_DEPTH/2	Hole					
	Angular coordinate	deg	VE-(AIR_TETA_MIN+MAG_TETA_MIN/2)						

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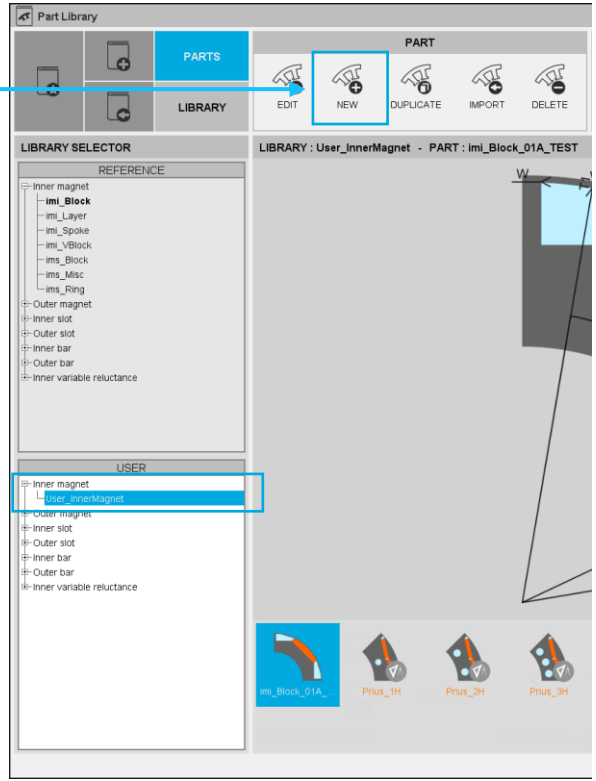
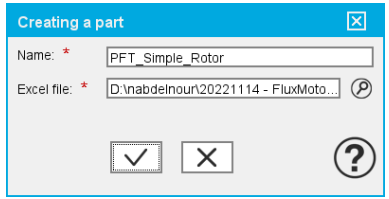
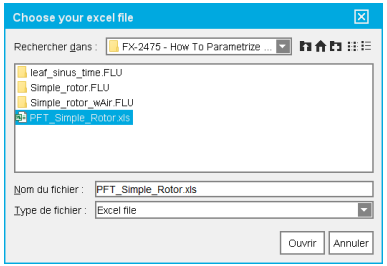
IMPORT THE PART IN FLUXMOTOR

Import Part in FluxMotor







Step	Action
1	Place yourself in the Inner Magnet User Part Catalogue
2	Click on New to import your part
3	Name the Part and browse to choose the Excel part file
4	Import the part

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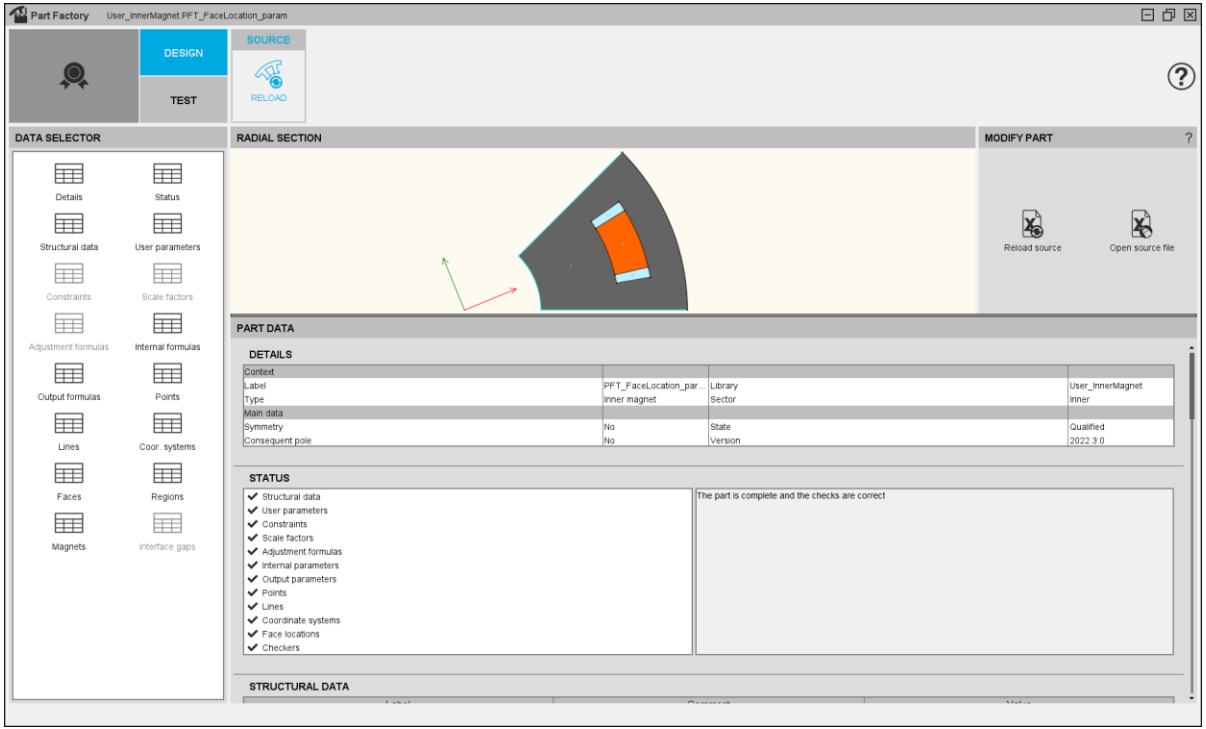
Import Part in FluxMotor

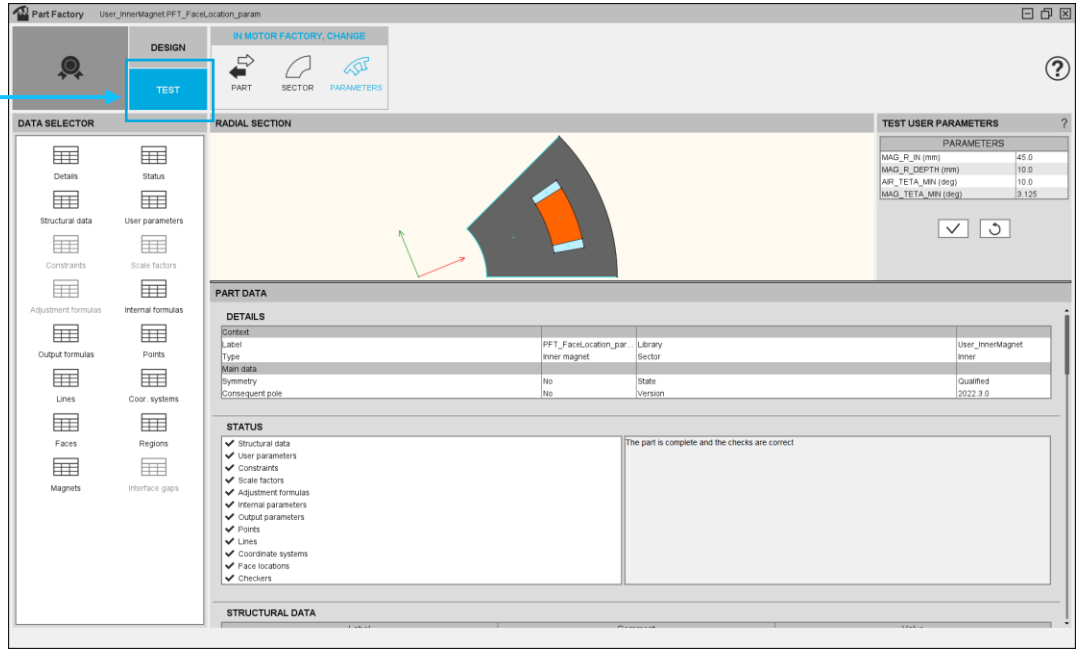
A Part Factory window where you can see a radial section of your part opens if it is correctly defined.



Import Part in FluxMotor

Part Parametrization Test Area

In the Test area user can modify the part parameters and see its effect on the radial section. If the parametrization have been done correctly, every dimension of the part should be editable.



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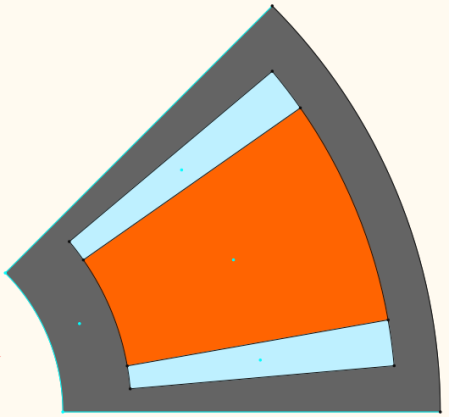
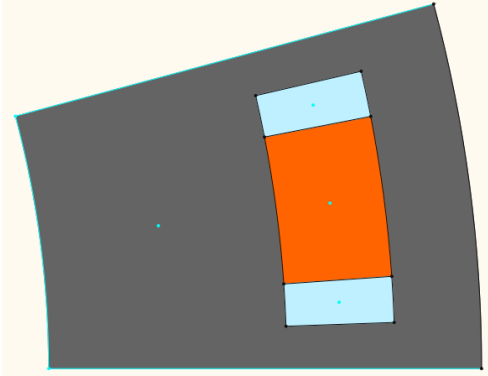
Part Factory – Part Test Area

Modifying the parameters in the right area of the window allows the user to test the structural data and the user parameters of the part to ensure its correct parametrization.

These parameters will be the same that the ones found in Motor Factory when you will import your part in a project.

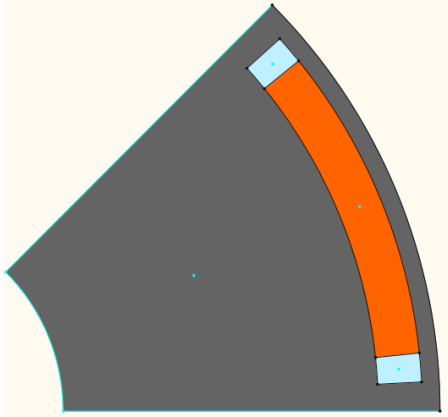


PARAMETERS	
MAG_R_IN (mm)	30.0
MAG_R_DEPTH (mm)	30.0
AIR_TETA_MIN (deg)	5.0
MAG_TETA_MIN (deg)	5.0



PARAMETERS	
OD (mm)	130.0
ID (mm)	90.0
PN	24

PARAMETERS	
MAG_R_IN (mm)	56.0
MAG_R_DEPTH (mm)	5.0
AIR_TETA_MIN (deg)	2.0
MAG_TETA_MIN (deg)	2.0



PARAMETERS	
MAG_R_IN (mm)	58.0
MAG_R_DEPTH (mm)	5.0
AIR_TETA_MIN (deg)	3.0
MAG_TETA_MIN (deg)	3.0

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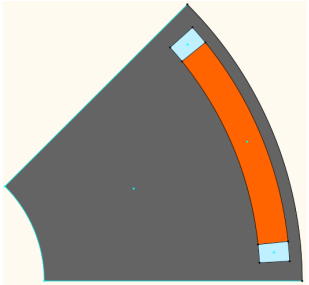
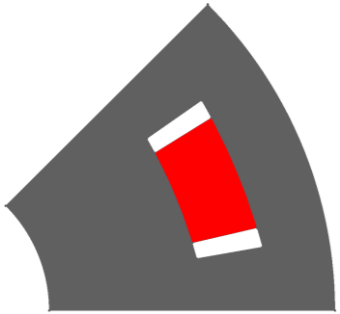
Conclusion

This tutorial explains how to modify a Part Factory Excel File to make the part parametrized in FluxMotor.

User can see the steps that allows him to :

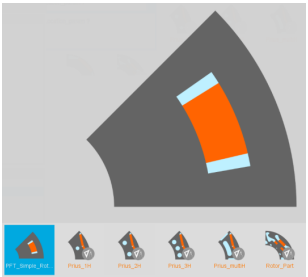
- *Write the parametrized formulas in the right area of the Part Excel File.*
- *Import the Parametrized Part in FluxMotor Part Factory.*
- *Validate the Parametrization in the Part Factory Test Area.*





Point	
Label	Expression
P6	44.3163488855*ul
	7.81416799501*ul
P7	36.861841993*ul
	25.8109396358*ul

Point	
Label	Expression
P6	(MAG_R_IN)*Cos(AIR_TETA_MIN)
	(MAG_R_IN)*Sin(AIR_TETA_MIN)
P7	(MAG_R_IN)*Cos(VE-AIR_TETA_MIN)
	(MAG_R_IN)*Sin(VE-AIR_TETA_MIN)



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THANK YOU

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#ONLYFORWARD

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