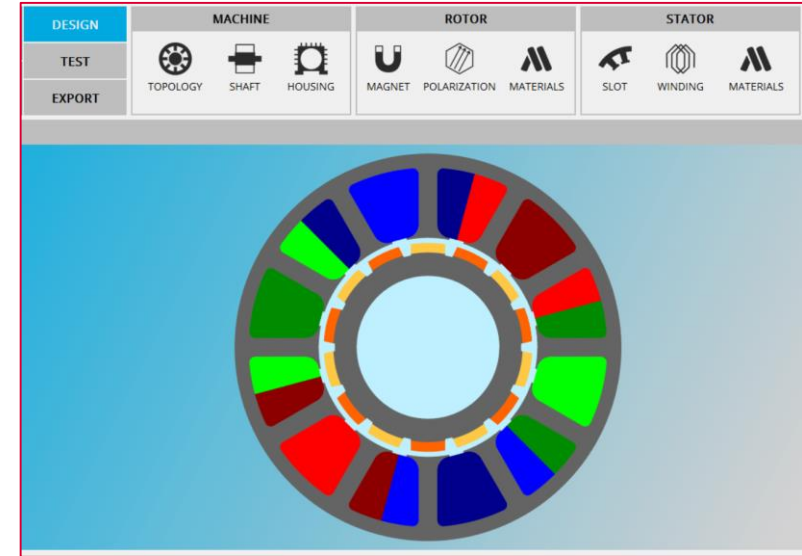
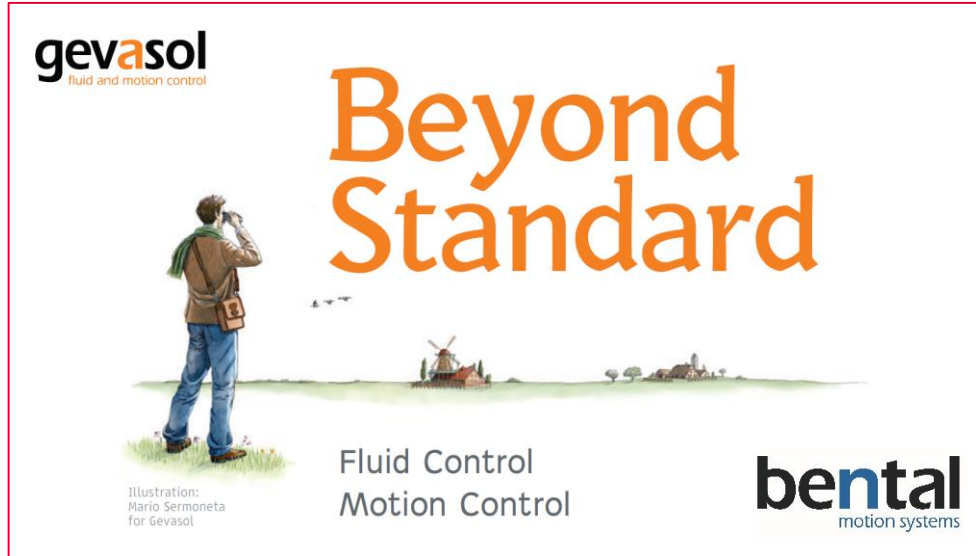
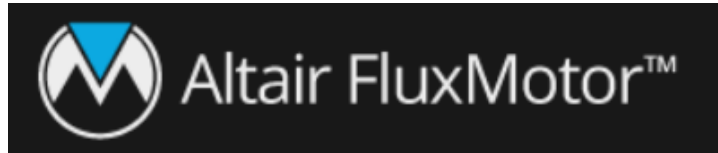




Altair Technology Conference

Israel 2019



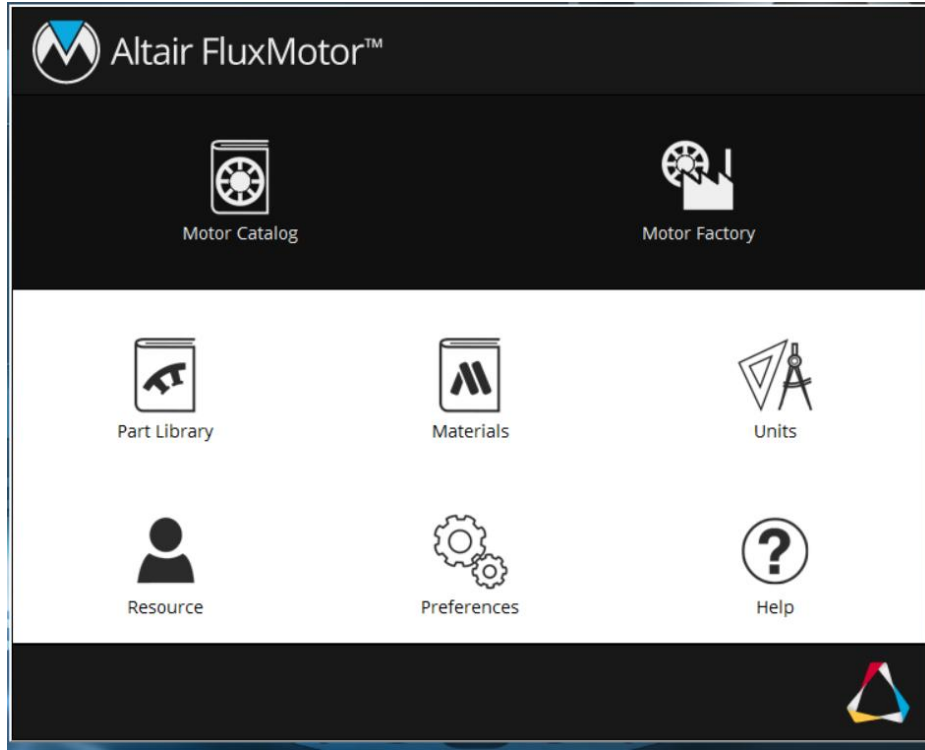
Conceptual design of electric motor

Kobi Ingarm

30.10.2019



Flux motor Supervisor



- Built-in and user defined
- Unit control
- Part library
 - Slots
 - Magnets
- Material library
 - Soft magnetic
 - Permanent magnet
 - Steels
 - isolation

Motor Catalog

MOTOR

EDIT NEW DUPLICATE IMPORT DELETE

COMPARATOR

ADD ADD ALL COMPARE

CATALOG SELECTOR

REFERENCE

- Synchronous Machine
 - PM-InnerRotor-3Phase
 - PM-OuterRotor-3Phase
- Induction Machine
 - SQ-InnerRotor-3Phase
 - SQ-OuterRotor-3Phase

USER

- Synchronous Machine
 - PM-InnerRotor-3Phase
 - PM-OuterRotor-3Phase
 - User_SM_PM_OR_3Ph
- Induction Machine
 - SQ-InnerRotor-3Phase
 - SQ-OuterRotor-3Phase

CATALOG : User_SM_PM_OR_3Ph - MOTOR : SHRKN_V01

SHRKN_V01

GENERAL DATA

CLASSIFICATION	
Motor	SHRKN_V01
Catalog	User_SM_PM_OR_3Ph
Family	Synchronous
Type	Permanent magnet
Sub-type	Outer rotor
Elec. supply network	3Phase

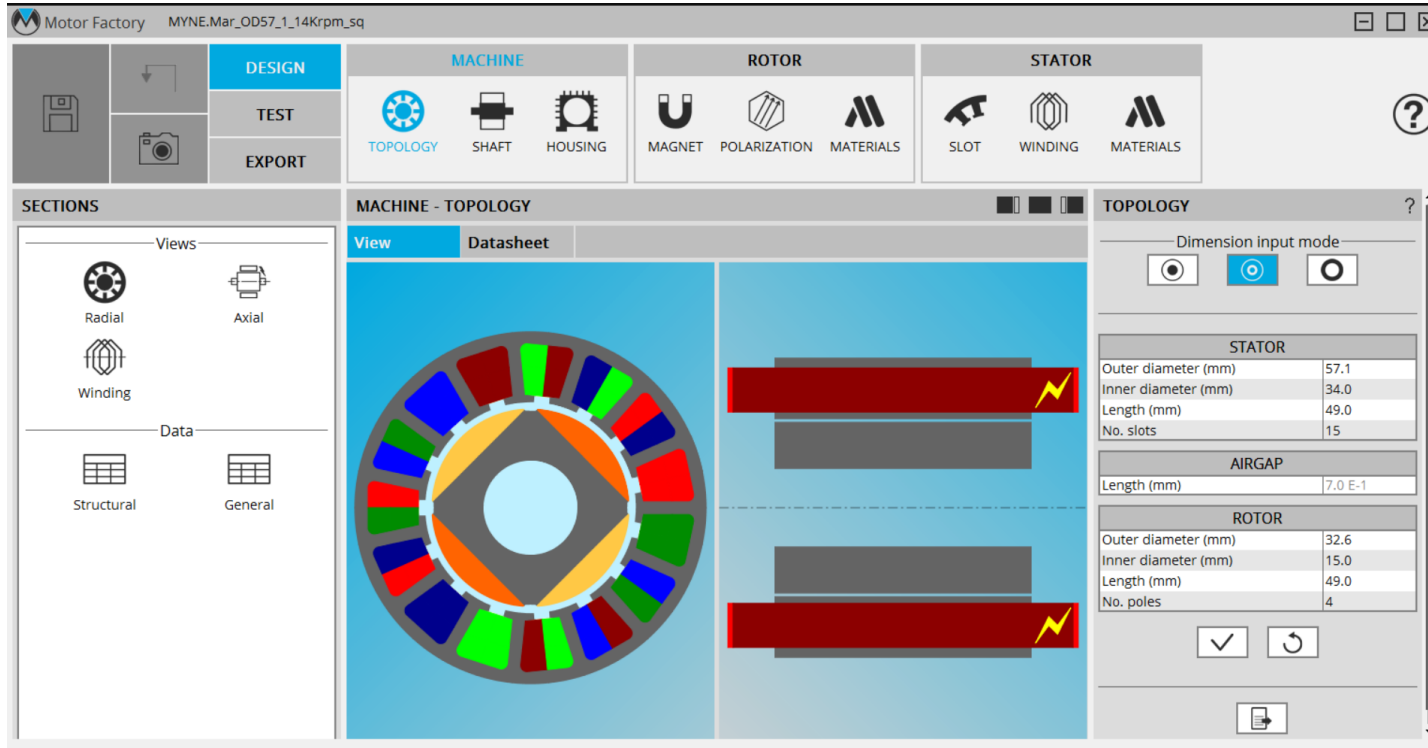
STATOR	
Outer diameter (mm)	73.5
Inner diameter (mm)	30.0
Length (mm)	24.0
No. slots	12
Library	is_P11Tooth
Part	is_P11Tooth_01A
Material	USER.M270_35A
Conductor material	REF.Copper

AIRGAP	
Length (mm)	7.5 E-1

ROTOR	
Outer diameter (mm)	89.0
Inner diameter (mm)	75.0
Length (mm)	24.0
No. poles	14
Library	is_P11Tooth

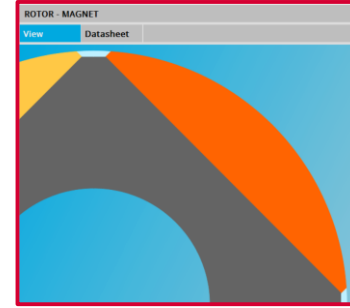
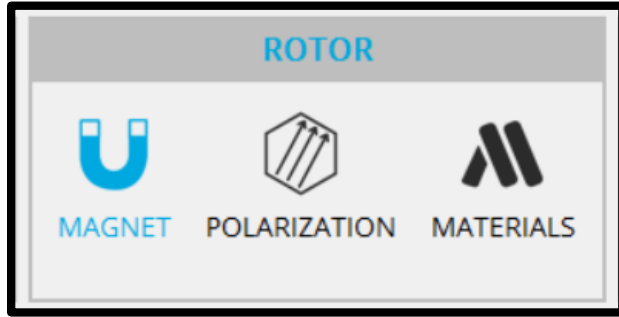
- Catalog
 - File management
- Motors
 - Types
 - Data
 - Performance
 - Library
 - Comparison

Motor Factory – Design - Machine

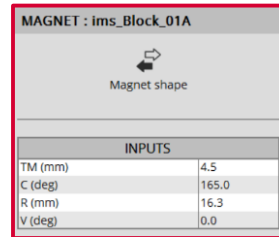
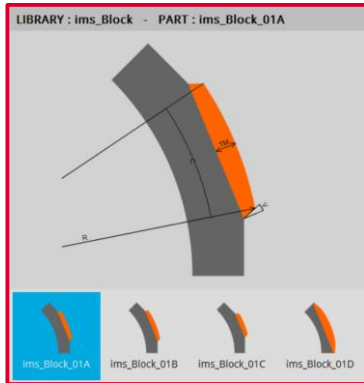


- Dimension
- input
- Views
- Data
- Help
- Housing for thermal

Motor Factory – Design – Rotor - Magnet



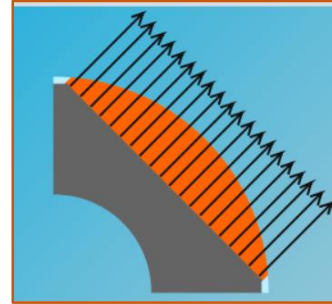
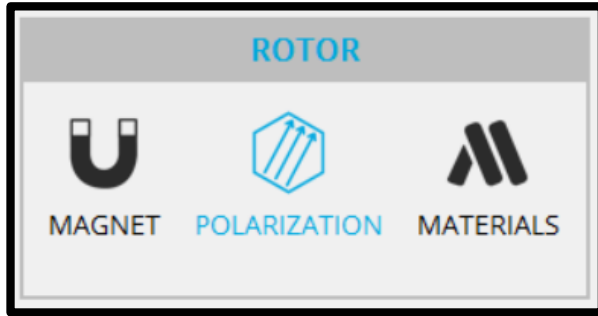
- Magnet shape
- Dimensions
- Polarization of magnetize
- Rotor materials
 - PM
 - Yoke



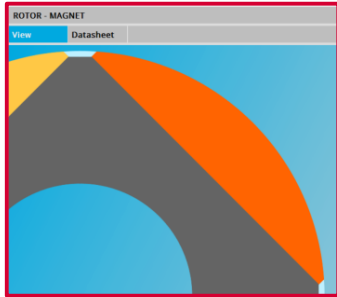
The image shows an "OUTPUTS" table with magnet dimensions.

OUTPUTS	
T1 (mm)	4.3
T2 (mm)	8.443
VP (deg)	90.0
W1 (mm)	21.495
W2 (mm)	21.495
W3 (mm)	1.489
V1 (deg)	84.654

Motor Factory – Design – Rotor - Polarization

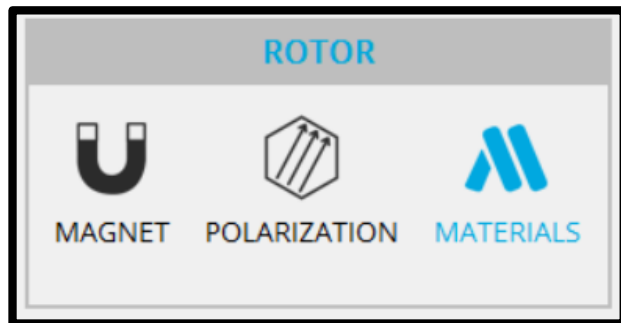


- Magnet shape
- Dimensions
- Polarization of magnetize
- Rotor materials
 - PM
 - Yoke

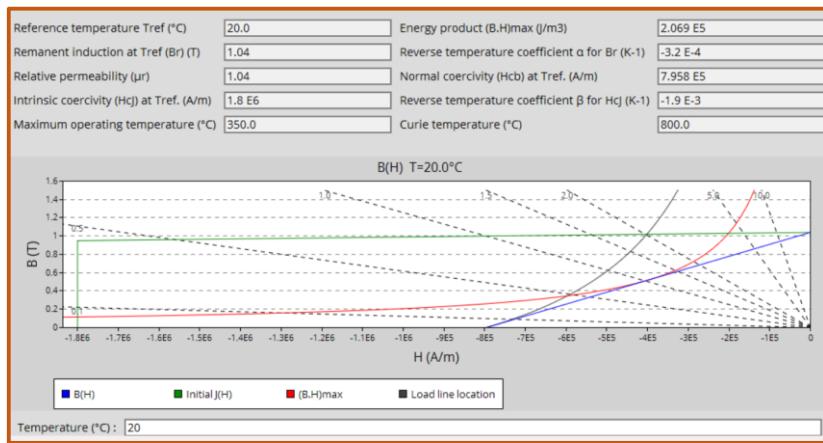


POLARIZATION	
Magnet	
Coord. system	Local
Orientation	Direction
Angle (deg)	90.0

Motor Factory – Design – Rotor - Materials



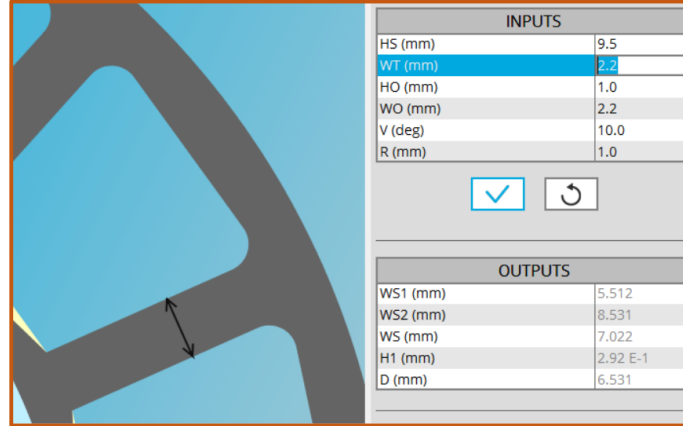
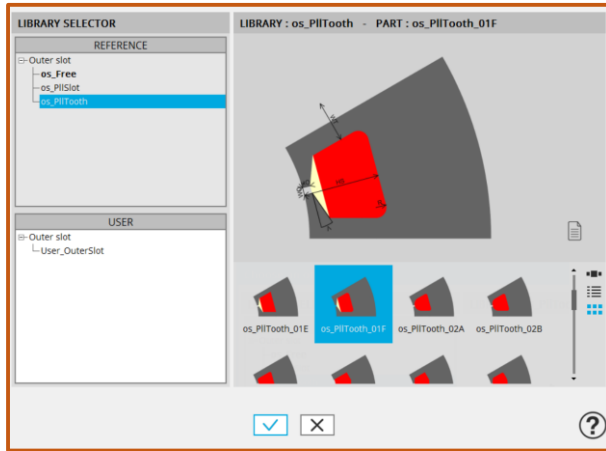
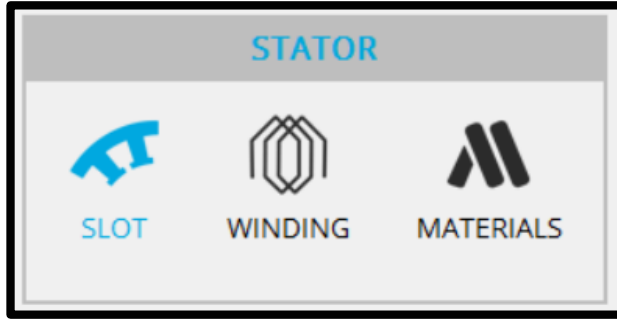
MATERIALS	
Shaft location	REF.Air
⊖ Magnets	REF.SmCo_1040_1800
Magnet	REF.SmCo_1040_1800
⊖ Magnetic circuit	REF.EN_1_4005
Yoke	
Airgap	REF.Air



REFERENCE	
NdFeB_1050_2800	
NdFeB_1110_2500	
NdFeB_1230_1400	
NdFeB_1320_1400	
NdFeB_1370_1273	
SmCo_1040_1800	
SmCo_1100_1800	
SmCo_880_2000	
USER	
E. insulator	
Fluid	
Lamination	
⊖ Magnet	
NdFeB_N40SH_20deg	
NdFeB_N44SH_20deg	
SmCo_22	
SmCo_28	
SmCo_32	

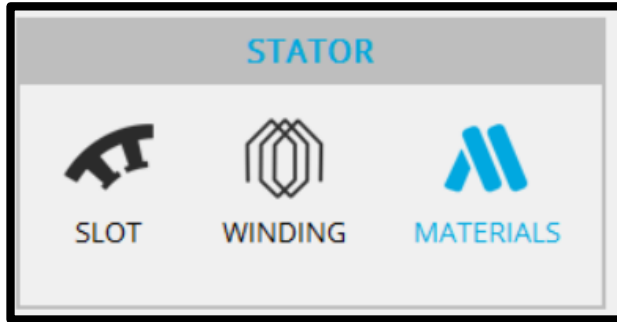
- Magnet shape
- Dimensions
- Polarization of magnetize
- Rotor materials
 - PM
 - Yoke

Motor Factory – Design – Stator - Slot



- Slot shape
- Dimensions
- Stator materials
- Lamination
- Wire
- Insulators
- Winding wizard

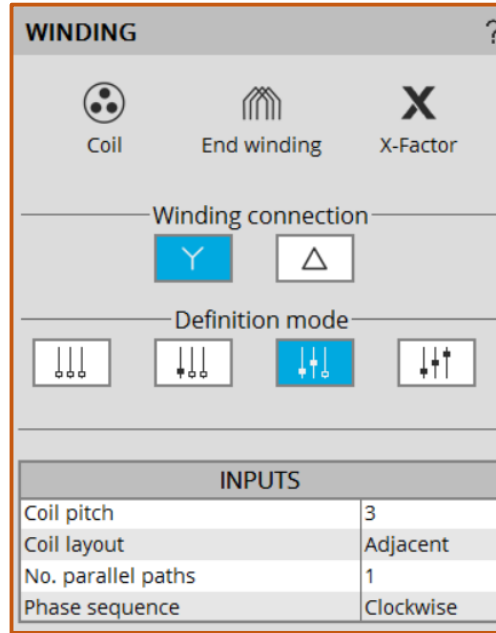
Motor Factory – Design – Stator - Materials



- Slot shape
 - Dimensions
- Stator materials
 - Lamination
 - Wire
 - Insulators
- Winding wizard

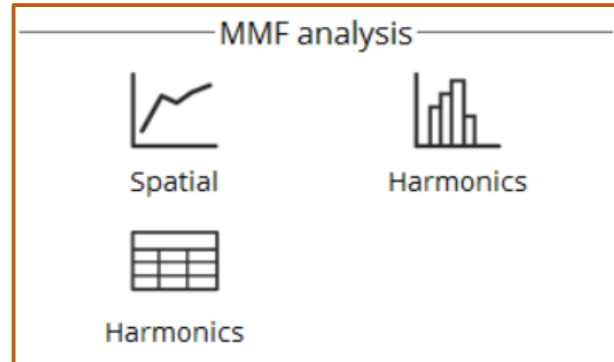
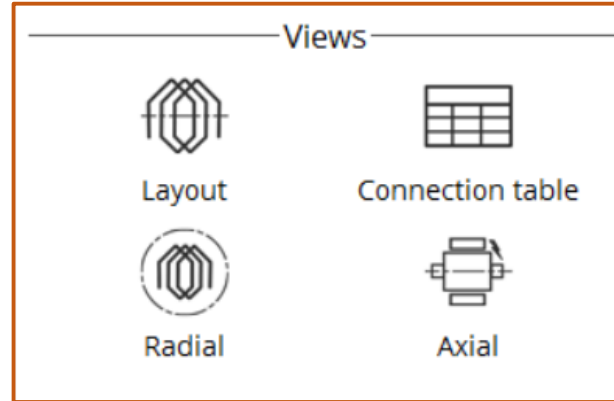
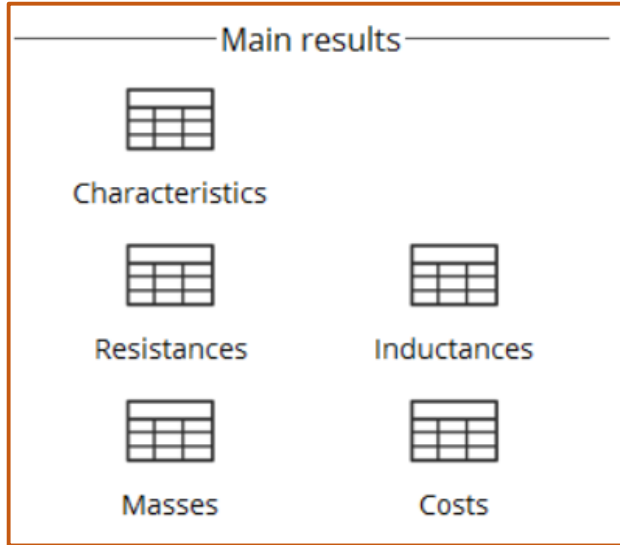
MATERIALS	
Airgap	REF.Air
<input checked="" type="checkbox"/> Magnetic circuit	USER.M270_35A
Coil conductor	REF.Copper
<input checked="" type="checkbox"/> Insulators	REF.Nomex_130

Motor Factory – Design – Stator - Winding



- Slot shape
- Dimensions
- Stator materials
 - Lamination
 - Wire
 - Insulators
- Winding wizard

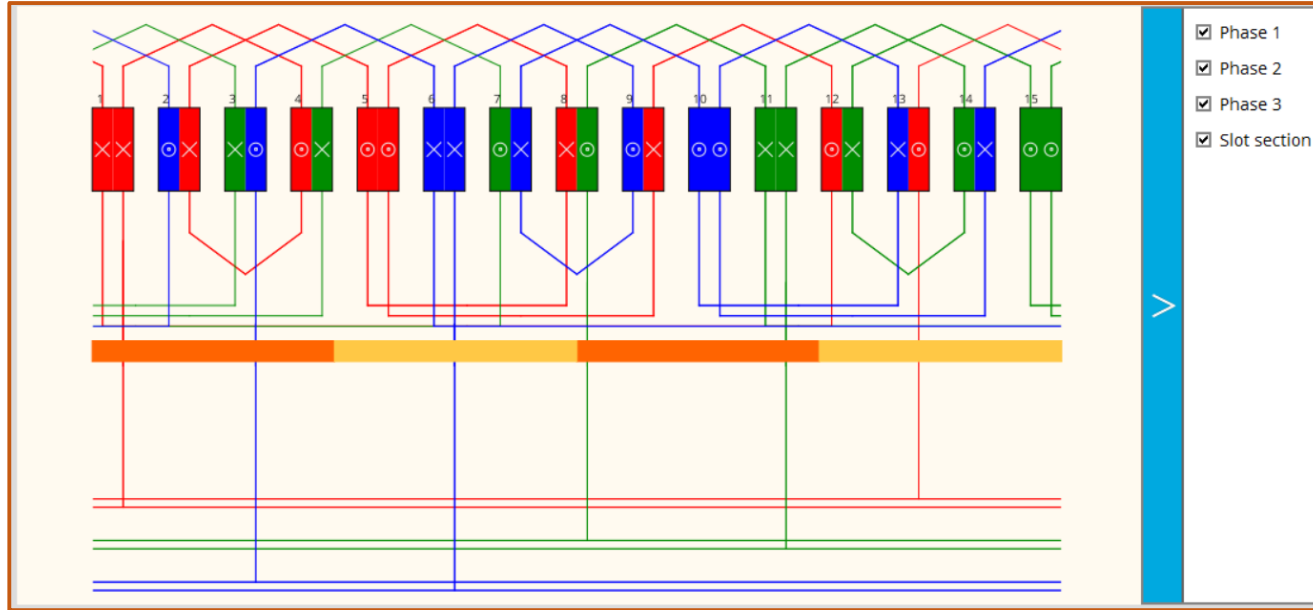
Motor Factory – Design – Stator - Winding



- Slot shape
- Dimensions
- Stator materials
 - Lamination
 - Wire
 - Insulators
- Winding wizard







Motor Factory – Design – Stator - Winding

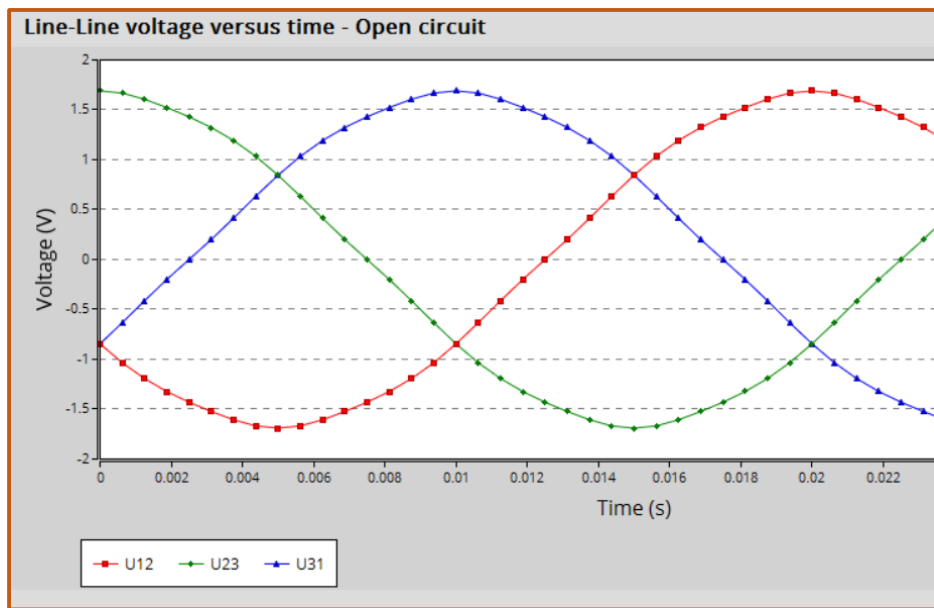
Layout of the winding



- Slot shape
- Dimensions
- Stator materials
 - Lamination
 - Wire
 - Insulators
- Winding wizard







Motor Factory – Test – Open Circuit - BackEMF

DESIGN	CHARACTERIZATION			WORKING POINT		PERFORMANCE MAPPING
TEST	 OPEN CIRCUIT	 MODEL	 DATASHEET	 SINE WAVE	 SQUARE WAVE	 SINE WAVE
EXPORT						



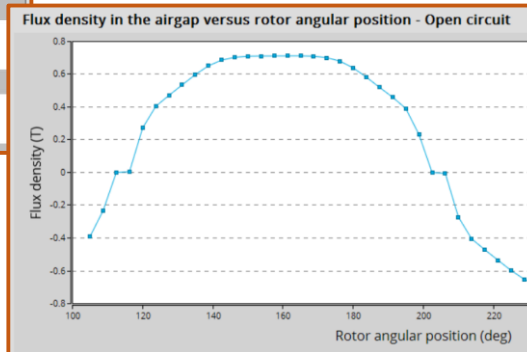
- Charactization
 - Open Circuit
 - Cogging
 - BackEMF
 - Datasheet
- Working Points
 - Sine wave
 - Six step
- Performance
 - Maps
 - Duty cycle

Motor Factory – Test – Datasheet

DESIGN	CHARACTERIZATION			WORKING POINT		PERFORMANCE MAPPING
TEST						
EXPORT	OPEN CIRCUIT	MODEL	DATASHEET	SINE WAVE	SQUARE WAVE	SINE WAVE







Machine performance - Base speed point

General data			
Operating mode	Motor		
Mechanical torque (N.m)	1.21	Speed (rpm)	13 576.213
Mechanical power (W)	1 719.56	Machine electrical power (W)	1 909.437
Machine efficiency (%)	90.056	Apparent power (VA)	1 913.917
Control angle (deg)	11.479	Power factor	9.986 E-1
Line current, rms (A)	65.0	Phase current, rms (A)	65.0
Line-Line voltage, rms (V)	17.0	Phase voltage, rms (V)	9.815
Machine constants			
Current density, rms (A/mm ²)	14.368	Electrical loading, rms (A/m)	36 512.016
kT (N.m/A)	1.316 E-2	kE (V.s/rad)	1.614 E-2
Power balance			
Machine total losses (W)	189.877	joule losses (W)	111.636
Iron losses (W)	78.241	Additional losses (W)	0.0



- Characterization
 - Open Circuit
 - Cogging
 - BackEMF
 - Datasheet
- Working Points
 - Sine wave
 - Six step
- Performance
 - Maps
 - Duty cycle

Motor Factory – Test – Working points – sine wave

DESIGN	CHARACTERIZATION			WORKING POINT		PERFORMANCE MAPPING
TEST	 OPEN CIRCUIT	 MODEL	 DATASHEET	 SINE WAVE	 SQUARE WAVE	 SINE WAVE
EXPORT						

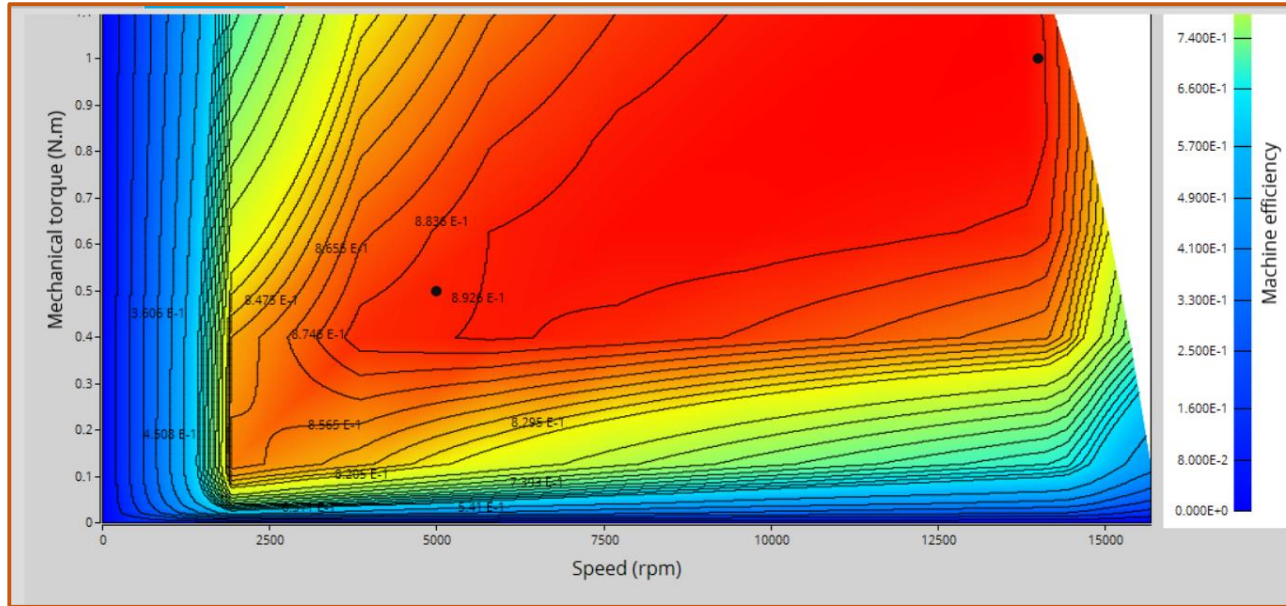
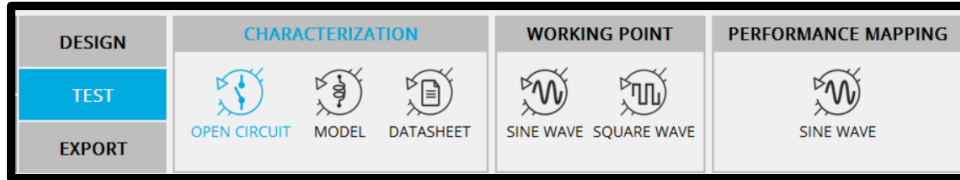
Overview

Machine performance - Working point

General data			
Operating mode	Motor		
Mechanical torque (N.m)	1.0	Speed (rpm)	14 000.0
Mechanical power (W)	1 466.079	Machine electrical power (W)	1 625.414
Machine efficiency (%)	90.197	Apparent power (VA)	1 627.736
Control angle (deg)	9.169	Power factor	9.986 E-1
Line current, rms (A)	54.101	Phase current, rms (A)	54.101
Line-Line voltage, rms (V)	17.371	Phase voltage, rms (V)	10.029

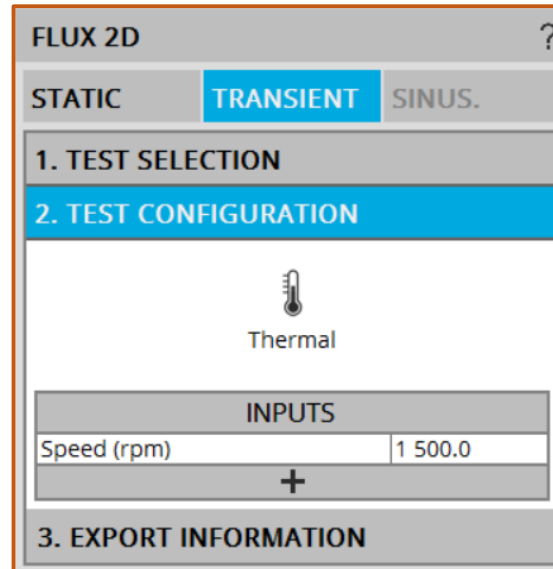
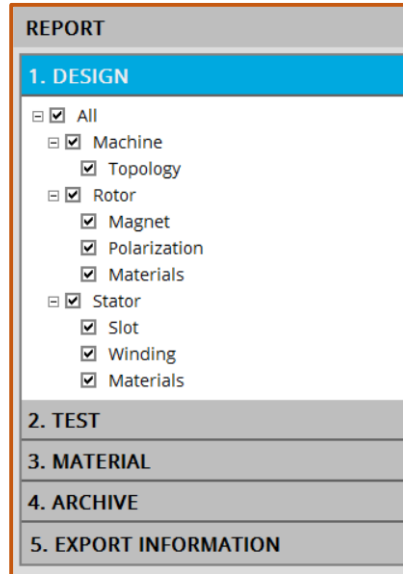
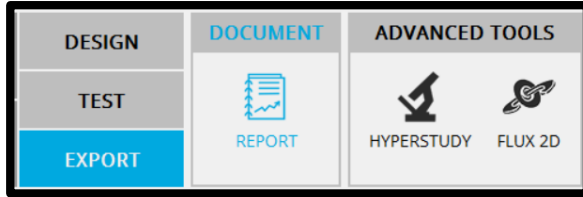
- Characterization
 - Open Circuit
 - Cogging
 - BackEMF
 - Datasheet
- Working Points
 - Sine wave
 - Six step
- Performance
 - Maps
 - Duty cycle

Motor Factory – Test – Performance



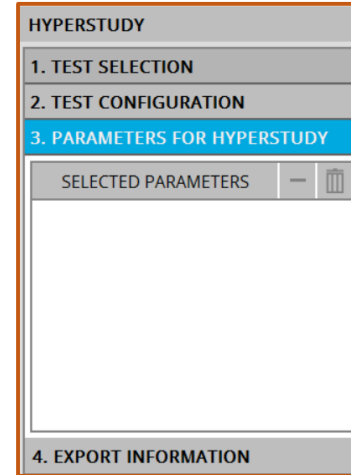
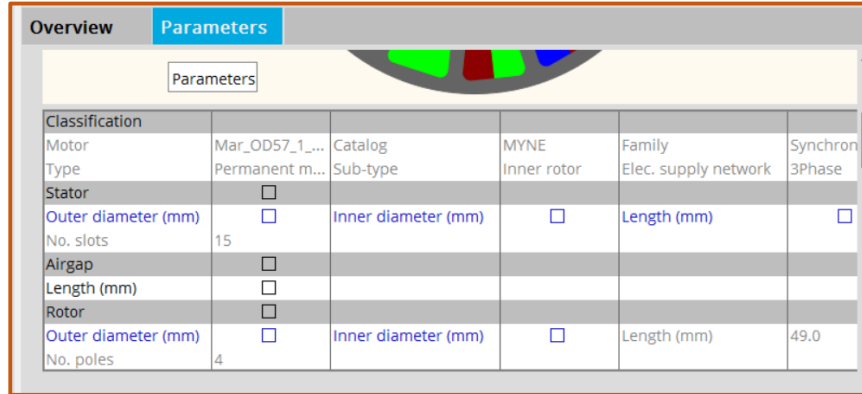
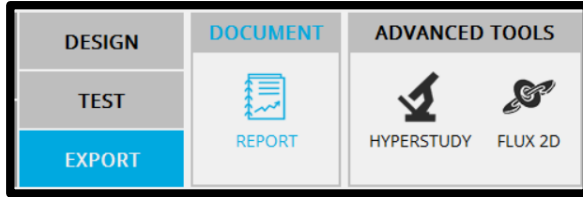
- Characterization
 - Open Circuit
 - Cogging
 - BackEMF
 - Datasheet
- Working Points
 - Sine wave
 - Six step
- Performance
 - Maps
 - Duty cycle

Motor Factory – Export



- Export
 - Document
 - Report
 - Advance tools
 - HyperStudy
 - Flux 2D

Motor Factory – Export



- Export
 - Document
 - Report
 - Advance tools
 - HyperStudy
 - Flux 2D

Thank you Questions?

