Altair® FluxMotor®

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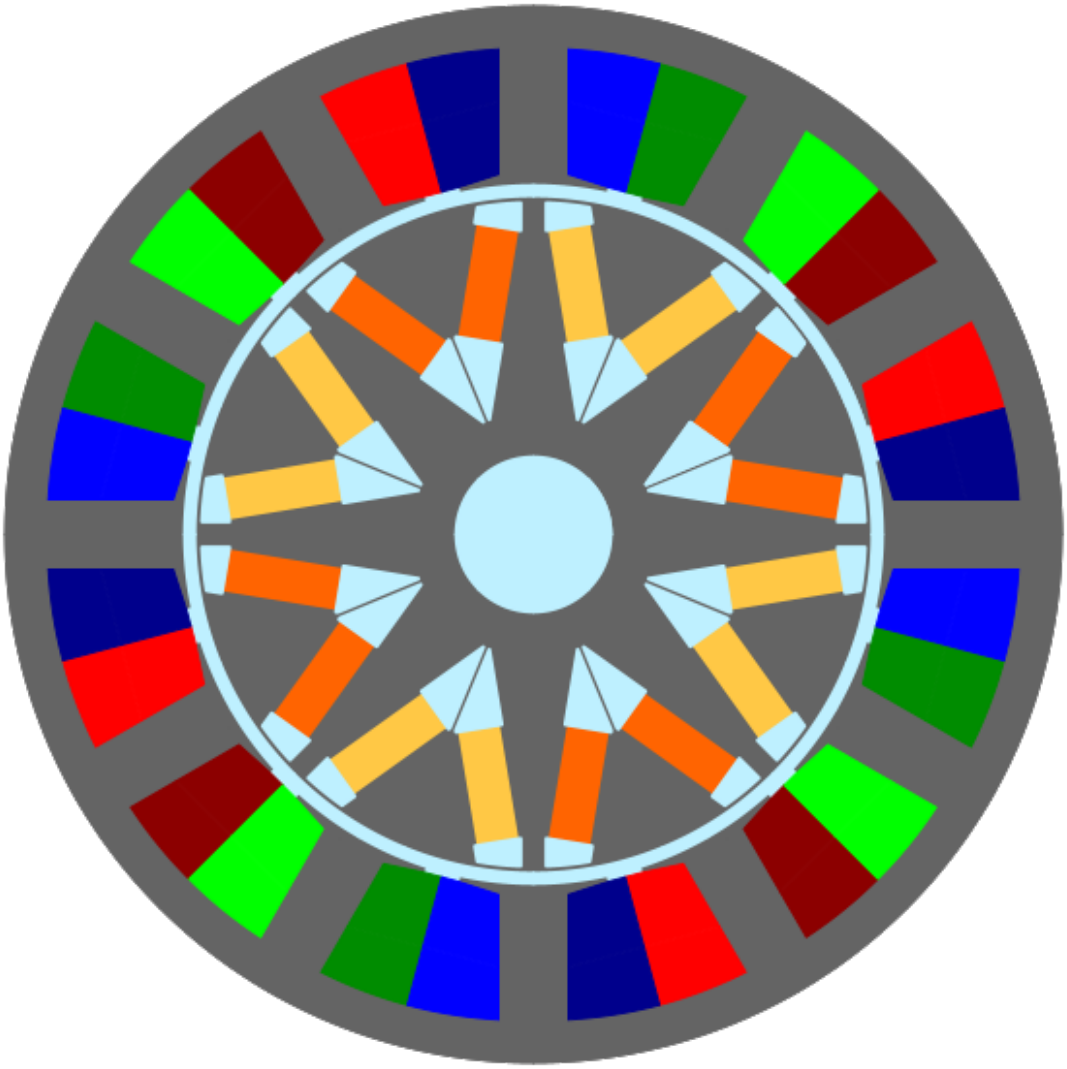
Report_SAE



Motor name : SAE_Hybrid_2024_opt3414

Created on 2024/07/15

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1 Design

1.1 Machine - Topology

1.1.1 Views

1.1.1.1 Radial view

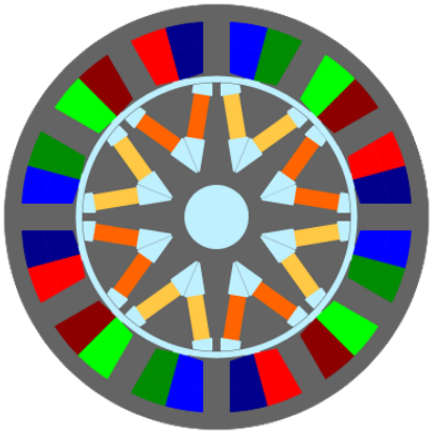

Fig. 1 Radial view

1.1.1.2 Axial view

Fig. 2 Axial view

1.1.1.3 Winding view

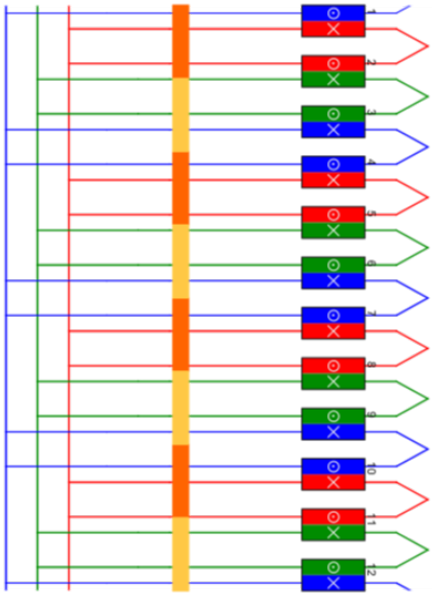

Fig. 3 Winding view

1.1.2 Data

1.1.2.1 Structural data

Name	Value	Name	Value	Name	Value
Stator					
Outer diameter (mm)	82.0	Inner diameter (mm)	54.23	Length (mm)	39.4
No. slots	12				
Airgap					
Length (mm)	7.5 E-1				
Rotor					
Outer diameter (mm)	52.73	Inner diameter (mm)	12.0	Length (mm)	39.4
No. poles	8				

1.1.2.2 General data

Name	Value	Name	Value	Name	Value
Classification					
Motor	SAE_Hybrid_2024_opt3414	Catalog	User_SM_PM_IR_3Ph	Family	Synchronous
Type	Permanent magnet	Sub-type	Inner rotor	Elec. supply network	3Phase
Stator					
Part	os_PlITooth_04A	Library	os_PlITooth	Skew type	None
Material	REF.M330_35A	Conductor material	REF.Copper	Winding technology	Classical
Rotor					
Part	imi_VBlock_03A	Library	imi_VBlock	Skew type	None
Material	REF.M330_35A	Magnet material	USER.N30SH		
Shaft					
Topology	None				
Masses					
Total (kg)	1.36	Stator (kg)	8.371 E-1	Rotor (kg)	5.233 E-1
Costs					
Total (USD)	0.0	Stator (USD)	0.0	Rotor (USD)	0.0
Moments of inertia					
Rotor (kg.m2)	1.935 E-4				

1.2 Rotor - Magnet - Design

1.2.1 Views

1.2.1.1 Magnet view

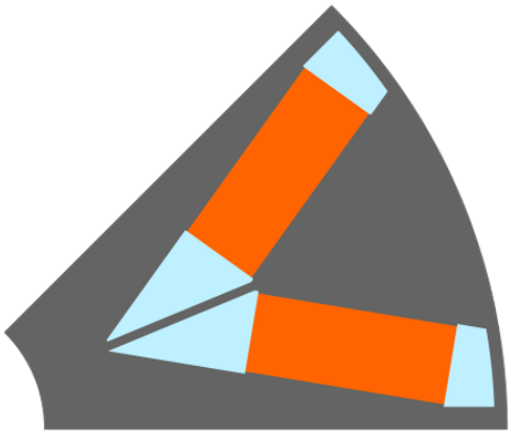

Fig. 4 Magnet view

1.2.2 Data

1.2.2.1 Parameters

Name	Value	Name	Value	Name	Value
Inputs					
TM (mm)	3.6	WM (mm)	9.0	C1 (deg)	102.16
C2 (deg)	60.0	T2 (mm)	0.57	W2 (mm)	0.5
VM (deg)	63.8				
Outputs					
T1 (mm)	9.967	T3 (mm)	3.586	W1 (mm)	2.007
VP (deg)	45.0				

1.2.2.2 General data

Name	Value	Name	Value	Name	Value
Reference					
Part	imi_VBlock_03A	Library	imi_VBlock		
Rotor					
Outer diameter (mm)	52.73	Inner diameter (mm)	12.0	Length (mm)	39.4
No. poles	8				

1.3 Rotor - Magnet - Skew

1.3.1 Views

1.3.1.1 Radial view

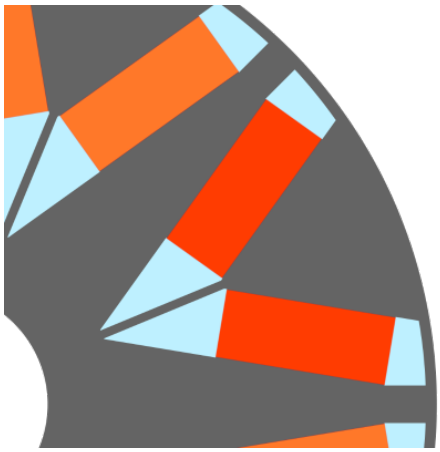

Fig. 5 Radial view

1.3.1.2 Developed axial view

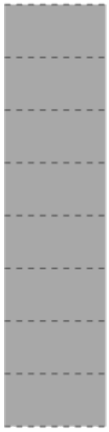

Fig. 6 Developed axial view

1.3.2 Data

1.3.2.1 General data

Name	Value	Name	Value	Name	Value
Reference					
Type	None				
Rotor					
Outer diameter (mm)	52.73	Inner diameter (mm)	12.0	Length (mm)	39.4
No. poles	8				

1.4 Rotor - Polarization

1.4.1 Views

1.4.1.1 Local view

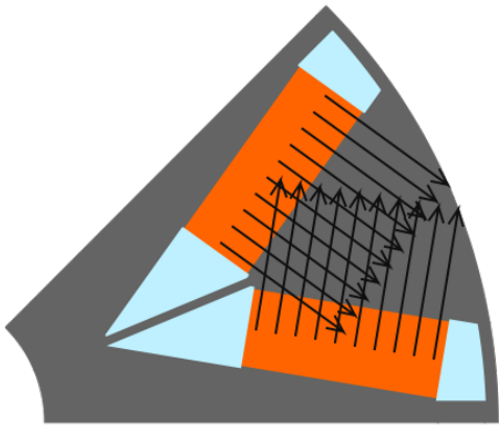

Fig. 7 Local view

1.4.1.2 Global view

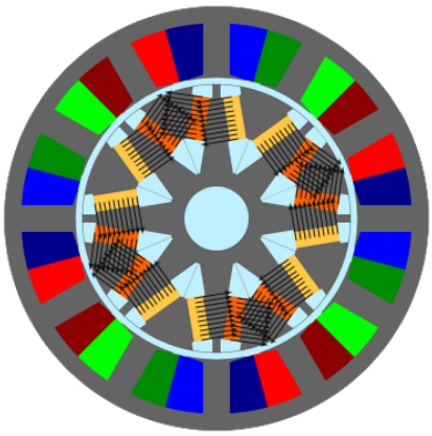

Fig. 8 Global view

1.4.2 Data

1.4.2.1 Polarization

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

1.5 Stator - Slot - Design

1.5.1 Views

1.5.1.1 Slot view

Fig. 9 Slot view

1.5.2 Data

1.5.2.1 Parameters

Name	Value	Name	Value	Name	Value
Inputs					
HS (mm)	10.8	WT (mm)	5.44	HO (mm)	0.5
WO (mm)	2.5	R (mm)	35.0	V (deg)	3.0
Outputs					
WS1 (mm)	9.246	WS2 (mm)	14.277	WS (mm)	11.762
H1 (mm)	1.768 E-1				

1.5.2.2 General data

Name	Value	Name	Value	Name	Value
Reference					
Part	os_PlITooth_04A	Library	os_PlITooth		
Stator					
Outer diameter (mm)	82.0	Inner diameter (mm)	54.23	Length (mm)	39.4
No. slots	12				

1.6 Stator - Slot - Skew

1.6.1 Views

1.6.1.1 Radial view

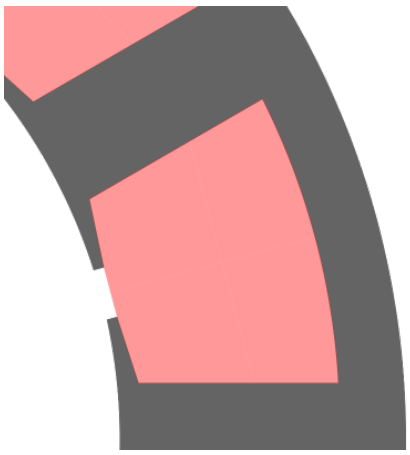

Fig. 10 Radial view

1.6.1.2 Developed axial view

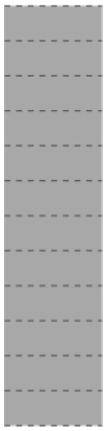

Fig. 11 Developed axial view

1.6.2 Data

1.6.2.1 General data

Name	Value	Name	Value	Name	Value
Reference					
Type	None				
Stator					
Outer diameter (mm)	82.0	Inner diameter (mm)	54.23	Length (mm)	39.4
No. slots	12				

1.7 Stator - Classical winding

1.7.1 Configuration

1.7.1.1 Inputs

Name	Value	Name	Value	Name	Value
Context					
Winding connection	Wye	Definition mode	Easy		
Inputs					
Coil pitch	1	No. parallel paths	4	Phase sequence	Clockwise

1.7.1.2 Settings

Name	Value	Name	Value	Name	Value
Coil - Conductor					
No. turns per coil	33	No. wires in hand	1	Slot filling	Random
Wire topology	Circular	Wire diameter (mm)	1.0		
Conductor grouping method	Grouped				
Conductor topology	Circular	Conductor diameter (mm)	1.14	Inter-wire space (mm)	0.005
Twist	No				
Coil - Insulation					
Wire (mm)	0.07	Conductor (mm)	0.0	Coil (mm)	0.0
Liner (mm)	0.3	Phase separator (mm)	0.0		
Impregnation	Yes	Impregnation goodness (%)	90.0		
End winding					
Topology	U Shape				
C.S. extension (mm)	5.0	O.C.S. extension (mm)	5.0		
C.S. total extension (mm)	6.5	O.C.S. total extension (mm)	6.5		
Calibration factors					
Reference temperature (°C)	20.0	Winding resistance factor	1.0	End winding inductance factor	1.0
Potting					
C.S. topology	None	O.C.S. topology	None		

1.7.1.3 Materials

Name	Value	Name	Value	Name	Value
Electrical conductor					
Conductor	REF.Copper				
Electrical insulator					
Wire	REF.Epoxy	Conductor	REF.Epoxy	Coil	REF.Epoxy
Liner	REF.Epoxy	Phase separator	REF.Epoxy		

1.7.2 Main results

1.7.2.1 Characteristics

Name	Value	Name	Value	Name	Value
Winding					
No. phases	3	No. poles	8	No. slots	12
No. parallel paths	4	No. layers	2	Coil layout	Adjacent
Winding connection	Wye	Winding type	Fractional	Pole distribution	Per pole
No. slots / pole / phase	0.5	Pole pitch	1.5	Phase sequence	Clockwise
Coil pitch	1				
Winding factors (Fundamental)					
Winding	8.66 E-1				
Distribution	1.0	Pitch	8.66 E-1	Skew	1.0
Coil					
No. turns per coil	33	No. turns in series per phase	33.0	No. conductors per phase	264
Lengths					
Total conductor (mm)	48 250.53	Mean turn (mm)	118.397	Coil connection (mm)	1 365.132
Axial overall (mm)	52.4				
Areas in slot					
Conductive (mm2)	51.836	Conductor conductive (mm2)	7.854 E-1	Wire conductive (mm2)	7.854 E-1
Slot (mm2)	118.446	Insulation (mm2)	28.107	Free (mm2)	38.503
Fill factors					
Gross (%)	43.764	Net (%)	67.493		

1.7.2.2 Slot filling

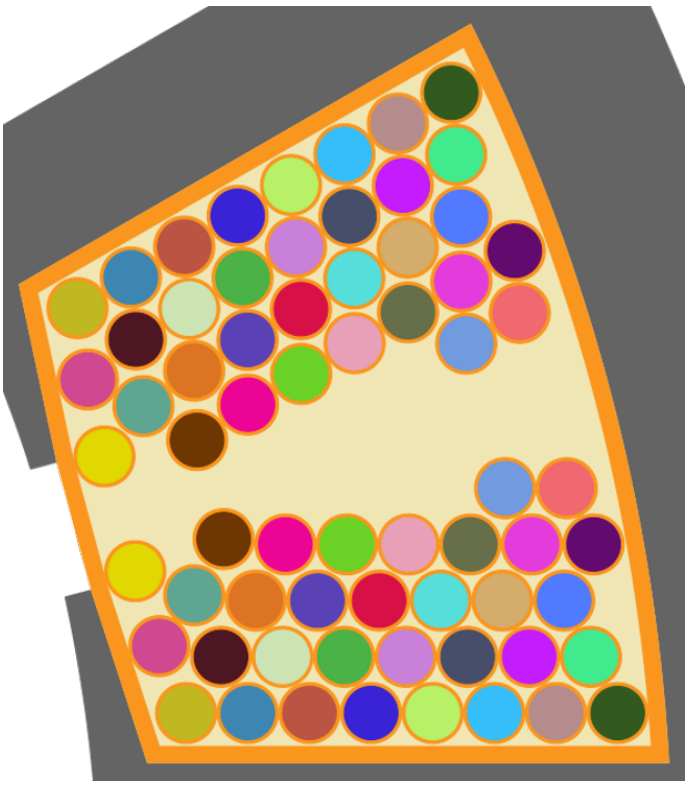

Fig. 12 Slot filling

1.7.2.3 Resistances

Name	Value	Name	Value	Name	Value
Resistances at 20°C					
Phase (Ω)	2.207 E-2	Line-Line (Ω)	4.413 E-2	Winding straight part (Ω)	1.427 E-2
End winding (Ω)	7.795 E-3	C.S. end winding (Ω)	4.21 E-3	O.C.S. end winding (Ω)	3.585 E-3
Resistances at ref. temperature					
Reference temperature (°C)	20.0				
Phase (Ω)	2.207 E-2	Line-Line (Ω)	4.413 E-2	Winding straight part (Ω)	1.427 E-2
End winding (Ω)	7.795 E-3	C.S. end winding (Ω)	4.21 E-3	O.C.S. end winding (Ω)	3.585 E-3

1.7.2.4 Inductances

Name	Value	Name	Value	Name	Value
Inductances					
End winding (H)	4.606 E-6	C.S. end winding (H)	2.303 E-6	O.C.S. end winding (H)	2.303 E-6

1.7.2.5 Masses

Name	Value	Name	Value	Name	Value
Masses					
Total (kg)	3.975 E-1	Electrical conductor (kg)	3.369 E-1	Total insulation (kg)	6.063 E-2
Wire insulation (kg)	2.044 E-2	Conductor insulation (kg)	0.0	Coil insulation (kg)	0.0
Liner insulation (kg)	1.07 E-2	Phase separator insulation (kg)	0.0	Impregnation insulation (kg)	2.949 E-2
C.S. potting (kg)	0.0	O.C.S. potting (kg)	0.0		

1.7.2.6 Costs

Name	Value	Name	Value	Name	Value
Costs					
Total (USD)	0.0	Electrical conductor (USD)	0.0	Total insulation (USD)	0.0
Wire insulation (USD)	0.0	Conductor insulation (USD)	0.0	Coil insulation (USD)	0.0
Liner insulation (USD)	0.0	Phase separator insulation (USD)	0.0	Impregnation insulation (USD)	0.0
C.S. potting (USD)	0.0	O.C.S. potting (USD)	0.0		

1.7.3 Views

1.7.3.1 Layout of the winding

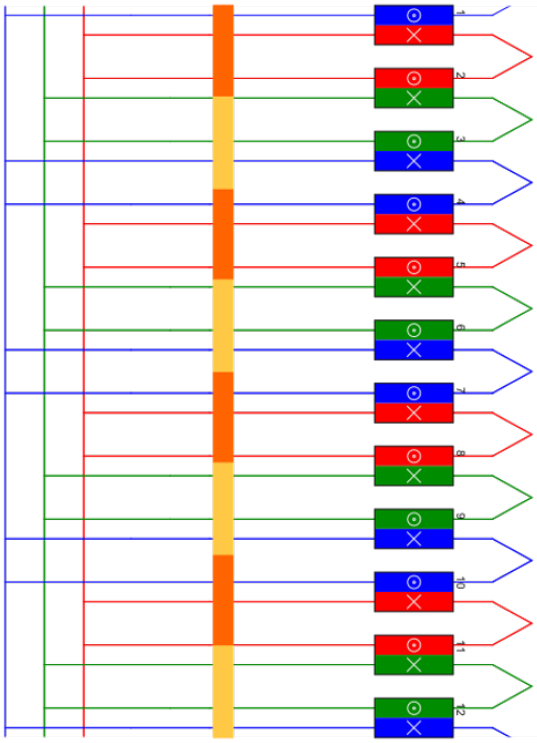

Fig. 13 Layout of the winding

1.7.3.2 Winding connection table

Coil	Input slot	Output slot	Direction
1	1(Right)	2(Left)	+
2	4(Right)	5(Left)	+
3	7(Right)	8(Left)	+
4	10(Right)	11(Left)	+

Coil	Input slot	Output slot	Direction
1	2(Right)	3(Left)	+
2	5(Right)	6(Left)	+
3	8(Right)	9(Left)	+
4	11(Right)	12(Left)	+

Coil	Input slot	Output slot	Direction
1	3(Right)	4(Left)	+
2	6(Right)	7(Left)	+
3	9(Right)	10(Left)	+
4	12(Right)	1(Left)	+

1.7.3.3 Radial view

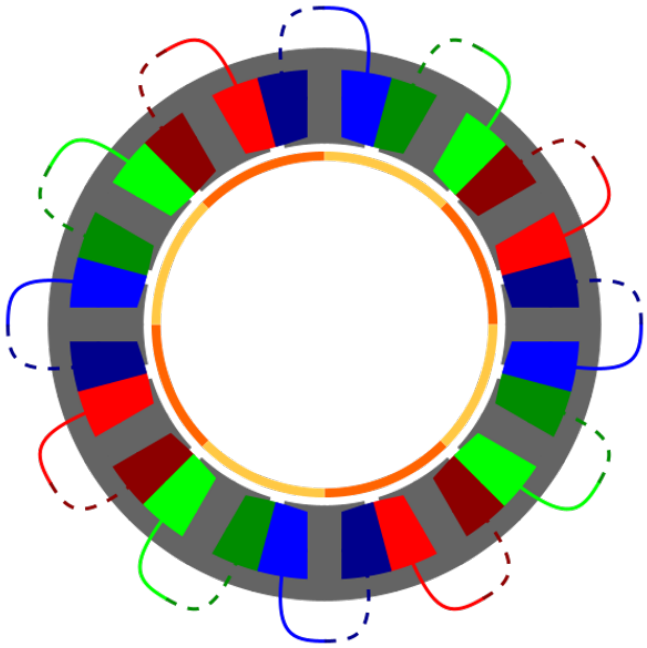

Fig. 14 Radial view

1.7.3.4 Axial view

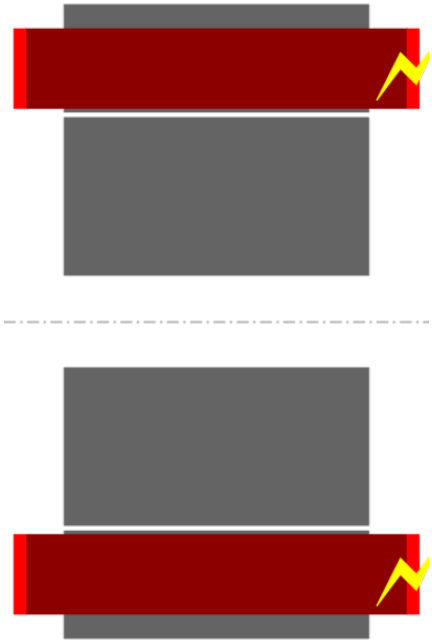

Fig. 15 Axial view

1.7.4 MMF analysis

1.7.4.1 MMF - Spatial representation

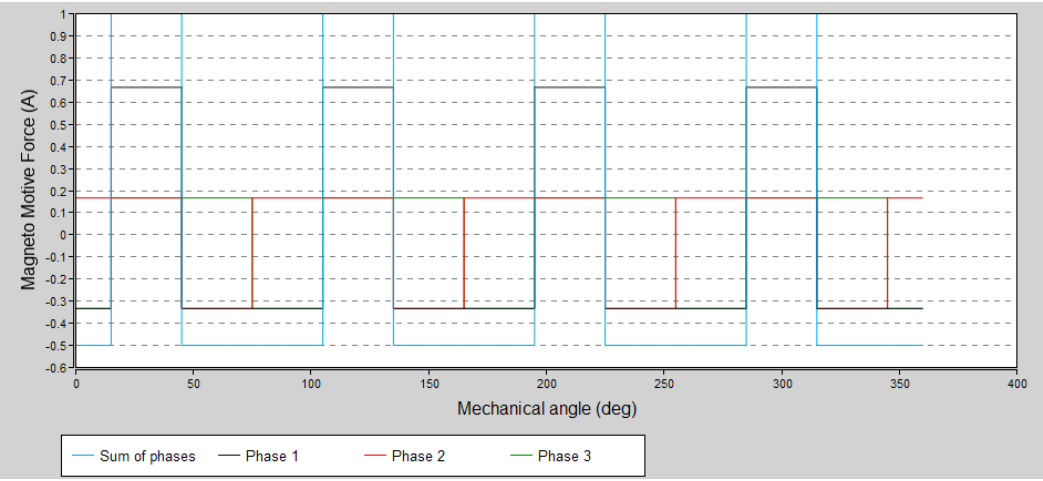

Fig. 16 MMF - Spatial representation

1.7.4.2 MMF - Harmonic analysis

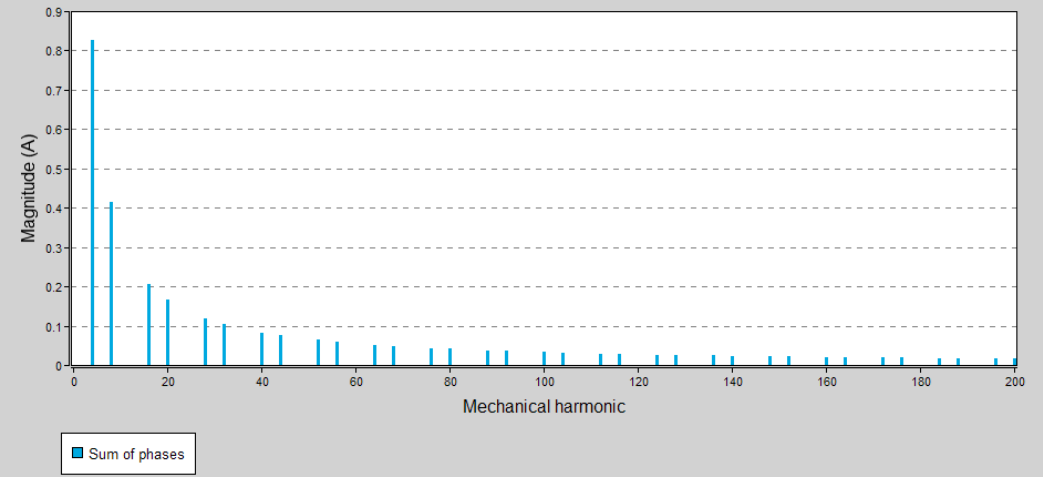

Fig. 17 MMF - Harmonic analysis

1.7.4.3 MMF - Sum of phases - Harmonic analysis

Mech. harmonic	Elec. harmonic	Magnitude (A)	Phase (deg)	Mech. frequency (deg-1)	Elec. frequency (deg-1)
4	1	8.27 E-1	-120.0	1.111 E-2	2.778 E-3
8	2	4.135 E-1	120.0	2.222 E-2	5.556 E-3
16	4	2.067 E-1	60.0	4.444 E-2	1.111 E-2
20	5	1.654 E-1	-60.0	5.556 E-2	1.389 E-2
28	7	1.181 E-1	-120.0	7.778 E-2	1.944 E-2
32	8	1.034 E-1	120.0	8.889 E-2	2.222 E-2
40	10	8.27 E-2	60.0	1.111 E-1	2.778 E-2
44	11	7.518 E-2	-60.0	1.222 E-1	3.056 E-2
52	13	6.361 E-2	-120.0	1.444 E-1	3.611 E-2
56	14	5.907 E-2	120.0	1.556 E-1	3.889 E-2
64	16	5.169 E-2	60.0	1.778 E-1	4.444 E-2
68	17	4.865 E-2	-60.0	1.889 E-1	4.722 E-2
76	19	4.353 E-2	-120.0	2.111 E-1	5.278 E-2
80	20	4.135 E-2	120.0	2.222 E-1	5.556 E-2
88	22	3.759 E-2	60.0	2.444 E-1	6.111 E-2
92	23	3.596 E-2	-60.0	2.556 E-1	6.389 E-2
100	25	3.308 E-2	-120.0	2.778 E-1	6.944 E-2
104	26	3.181 E-2	120.0	2.889 E-1	7.222 E-2
112	28	2.954 E-2	60.0	3.111 E-1	7.778 E-2
116	29	2.852 E-2	-60.0	3.222 E-1	8.056 E-2
124	31	2.668 E-2	-120.0	3.444 E-1	8.611 E-2
128	32	2.584 E-2	120.0	3.556 E-1	8.889 E-2
136	34	2.432 E-2	60.0	3.778 E-1	9.444 E-2
140	35	2.363 E-2	-60.0	3.889 E-1	9.722 E-2
148	37	2.235 E-2	-120.0	4.111 E-1	1.028 E-1
152	38	2.176 E-2	120.0	4.222 E-1	1.056 E-1
160	40	2.067 E-2	60.0	4.444 E-1	1.111 E-1
164	41	2.017 E-2	-60.0	4.556 E-1	1.139 E-1
172	43	1.923 E-2	-120.0	4.778 E-1	1.194 E-1
176	44	1.88 E-2	120.0	4.889 E-1	1.222 E-1
184	46	1.798 E-2	60.0	5.111 E-1	1.278 E-1
188	47	1.76 E-2	-60.0	5.222 E-1	1.306 E-1
196	49	1.688 E-2	-120.0	5.444 E-1	1.361 E-1
200	50	1.654 E-2	120.0	5.556 E-1	1.389 E-1

1.7.5 Quality criteria

1.7.5.1 Winding factors - Harmonic analysis

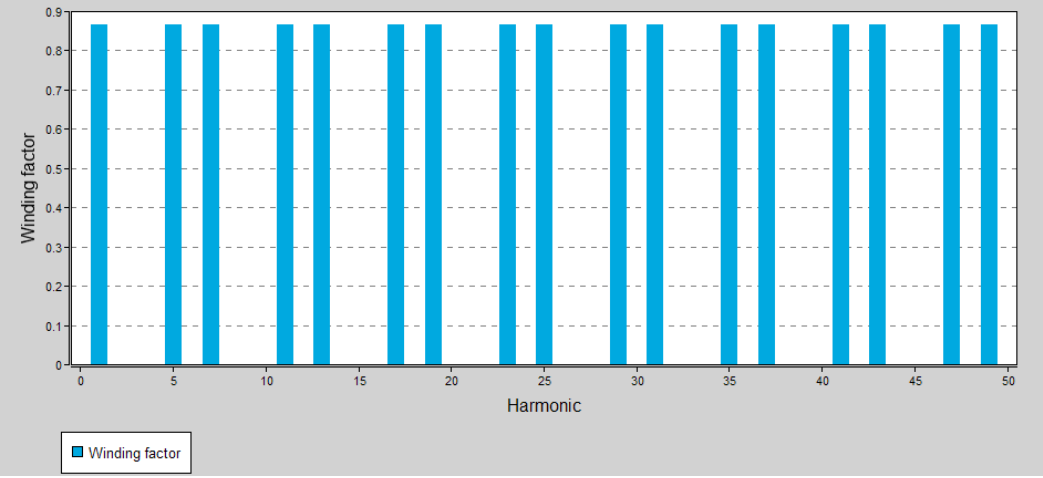

Fig. 18 Winding factors - Harmonic analysis

1.7.5.2 Winding factors - Harmonic analysis

Harmonic	Winding factor	Distribution factor	Pitch factor	Skew factor
1	8.66 E-1	1.0	8.66 E-1	1.0
3	0.0	1.0	0.0	1.0
5	8.66 E-1	1.0	8.66 E-1	1.0
7	8.66 E-1	1.0	8.66 E-1	1.0
9	0.0	1.0	0.0	1.0
11	8.66 E-1	1.0	8.66 E-1	1.0
13	8.66 E-1	1.0	8.66 E-1	1.0
15	0.0	1.0	0.0	1.0
17	8.66 E-1	1.0	8.66 E-1	1.0
19	8.66 E-1	1.0	8.66 E-1	1.0
21	0.0	1.0	0.0	1.0
23	8.66 E-1	1.0	8.66 E-1	1.0
25	8.66 E-1	1.0	8.66 E-1	1.0
27	0.0	1.0	0.0	1.0
29	8.66 E-1	1.0	8.66 E-1	1.0
31	8.66 E-1	1.0	8.66 E-1	1.0
33	0.0	1.0	0.0	1.0
35	8.66 E-1	1.0	8.66 E-1	1.0
37	8.66 E-1	1.0	8.66 E-1	1.0
39	0.0	1.0	0.0	1.0
41	8.66 E-1	1.0	8.66 E-1	1.0
43	8.66 E-1	1.0	8.66 E-1	1.0
45	0.0	1.0	0.0	1.0
47	8.66 E-1	1.0	8.66 E-1	1.0
49	8.66 E-1	1.0	8.66 E-1	1.0

1.7.5.3 Slot star

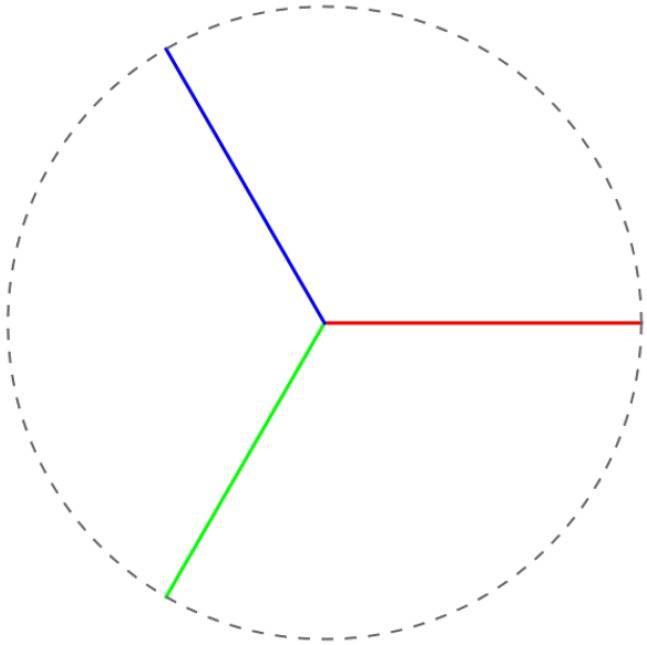

Fig. 19 Slot star

1.8 Materials - Materials

1.8.1 Data

1.8.1.1 Materials

Name	Value	Name	Value	Name	Value
Rotor					
Magnets	USER.N30SH	Magnetic circuit	REF.M330_35A		
Rotor - Magnets					
Magnet	USER.N30SH				
Stator					
Magnetic circuit	REF.M330_35A	Coil conductor	REF.Copper	Insulators	REF.Epoxy
Stator - Insulators					
Wire	REF.Epoxy	Conductor	REF.Epoxy	Coil	REF.Epoxy
Liner	REF.Epoxy	Phase separator	REF.Epoxy	Impregnation	REF.Epoxy
Potting	REF.Epoxy				
Cooling					
Internal fluid	REF.Air				

1.8.1.2 Masses

Name	Value	Name	Value	Name	Value
Total					
Total (kg)	1.36	Rotor (kg)	5.233 E-1	Stator (kg)	8.371 E-1
Rotor					
Magnets (kg)	1.552 E-1	Magnetic circuit (kg)	3.68 E-1		
Rotor - Magnets					
Magnet (kg)	1.552 E-1				
Stator					
Magnetic circuit (kg)	4.396 E-1	Winding (kg)	3.975 E-1		
Stator - Winding					
Electrical conductor (kg)	3.369 E-1	Total insulation (kg)	6.063 E-2		

1.8.1.3 Moments of inertia

Name	Value	Name	Value	Name	Value
Rotor					
Rotor (kg.m2)	1.935 E-4				

1.8.1.4 Costs

Name	Value	Name	Value	Name	Value
Total					
Total (USD)	0.0	Rotor (USD)	0.0	Stator (USD)	0.0
Rotor					
Magnets (USD)	0.0	Magnetic circuit (USD)	0.0		
Rotor - Magnets					
Magnet (USD)	0.0				
Stator					
Magnetic circuit (USD)	0.0	Winding (USD)	0.0		
Stator - Winding					
Electrical conductor (USD)	0.0	Total insulation (USD)	0.0		

2 Test

2.1 Performance mapping - Sine wave - Motor - Efficiency map

2.1.1 Configuration

2.1.1.1 Inputs

Name	Value	Name	Value	Name	Value
Context					
Family	Performance mapping	Package	Sine wave	Convention	Motor
Test	Efficiency map				
Standard parameters					
Current definition mode	Current	Max. line current, rms (A)	67.0	Max. current dens., rms (A/mm2)	21.327
Max. Line-Line voltage, rms (V)	40.0	Command mode	MTPV	Maximum speed (rpm)	16 000.0
Additional losses (%)	0.0				
User working point(s) analysis	None	Mechanical torque (N.m)	-	Speed (rpm)	-
Duty cycle description	-				
Advanced parameters					
Rotor position dependency	No	No. comp. for Jd, Jq	6	No. comp. for speed	15
No. comp. for torque	7				
Rotor initial position (deg)	52.499	Mesh order	2nd	Airgap mesh coefficient	1.2

2.1.1.2 Settings

Name	Value	Name	Value	Name	Value
Thermal					
Thermal solving	No	Winding straight part temperature (°C)	110.0	C.S. end winding temperature (°C)	110.0
O.C.S. end winding temperature (°C)	110.0	Magnet temperature Tmag (°C)	60.0		
Electronics					
Power electronics stage	Without				
Mechanics					
Mechanical loss computation mode	User				
Reference speed (rpm)	1 000.0	Losses at reference speed (W)	0.0	Speed exponent	0.5

2.1.1.3 Winding and Magnet characteristics

Name	Value	Name	Value	Name	Value
Winding					
Winding connection	Wye	Winding resistance factor	1.0		
Winding temperature (°C)	110.0				
Phase resistance (Ω)	2.987 E-2	Line-Line resistance (Ω)	5.974 E-2	End winding resistance (Ω)	1.055 E-2
Winding straight part temperature (°C)	110.0	C.S. end winding temperature (°C)	110.0	O.C.S. end winding temperature (°C)	110.0
Winding straight part resistance (Ω)	1.932 E-2	C.S. end winding resistance (Ω)	5.699 E-3	O.C.S. end winding resistance (Ω)	4.854 E-3
Magnets					
Magnet temperature Tmag (°C)	60.0				
Magnet name	Magnet	Material name	USER.N30SH	Material reference temp. Tref (°C)	20.0
Remanent induction at Tref (T)	1.125	Intrinsic coercive field at Tref (A/m)	1.592 E6	Relative permeability at Tref	1.05
Remanent induction at Tmag (T)	1.071	Intrinsic coercive field at Tmag (A/m)	1.242 E6	Relative permeability at Tmag	1.05

2.1.2 Main results

2.1.2.1 Machine performance - Base speed point

Name	Value	Name	Value	Name	Value
General data					
Operating mode	Motor				
Mechanical torque (N.m)	6.901	Speed (rpm)	5 414.805	Electrical frequency (Hz)	360.987
Mechanical power (W)	3 913.154	Machine electrical power (W)	4 353.977	Machine total losses (W)	440.823
Machine efficiency (%)	89.875	Apparent power (VA)	4 642.365	Reactive power (VAr)	1 610.968
Control angle (deg)	23.723	Power factor	9.379 E-1	Phase angle (deg)	20.305
Line current, rms (A)	67.006	Phase current, rms (A)	67.006		
Line-Line voltage, rms (V)	40.001	Phase voltage, rms (V)	23.094		
Power balance					
Machine total losses (W)	440.823	Joule losses (W)	402.322	Mechanical losses (W)	0.0
Iron losses (W)	38.502	Additional losses (W)	0.0		

2.1.2.2 Machine performance - Maximum speed point

Name	Value	Name	Value	Name	Value
General data					
Operating mode	Motor				
Mechanical torque (N.m)	2.054	Speed (rpm)	16 000.0	Electrical frequency (Hz)	1 066.667
Mechanical power (W)	3 440.996	Machine electrical power (W)	3 915.634	Machine total losses (W)	474.638
Machine efficiency (%)	87.878	Apparent power (VA)	4 642.144	Reactive power (VAr)	-2 496.278
Control angle (deg)	72.422	Power factor	8.431 E-1	Phase angle (deg)	-32.53
Line current, rms (A)	67.001	Phase current, rms (A)	67.001		
Line-Line voltage, rms (V)	40.002	Phase voltage, rms (V)	23.095		
Power balance					
Machine total losses (W)	474.638	Joule losses (W)	402.262	Mechanical losses (W)	0.0
Iron losses (W)	72.376	Additional losses (W)	0.0		

2.1.3 Torque - Speed curves

2.1.3.1 Mechanical torque versus speed

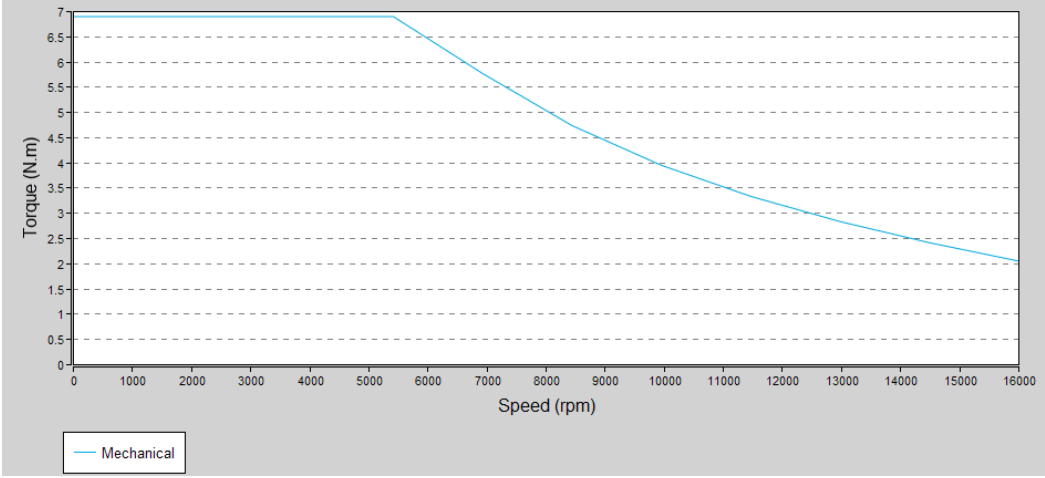

Fig. 20 Mechanical torque versus speed

2.1.3.2 Current versus speed

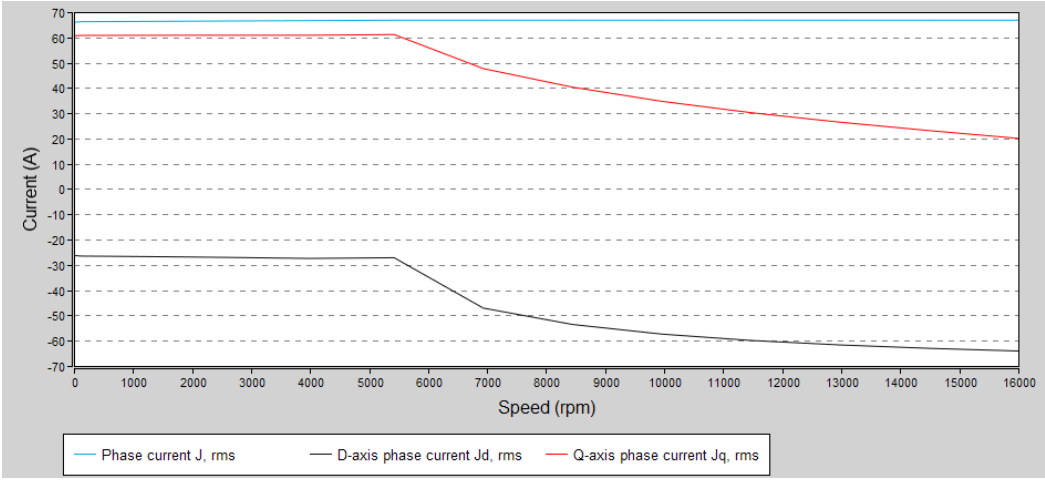

Fig. 21 Current versus speed

2.1.3.3 Voltage versus speed

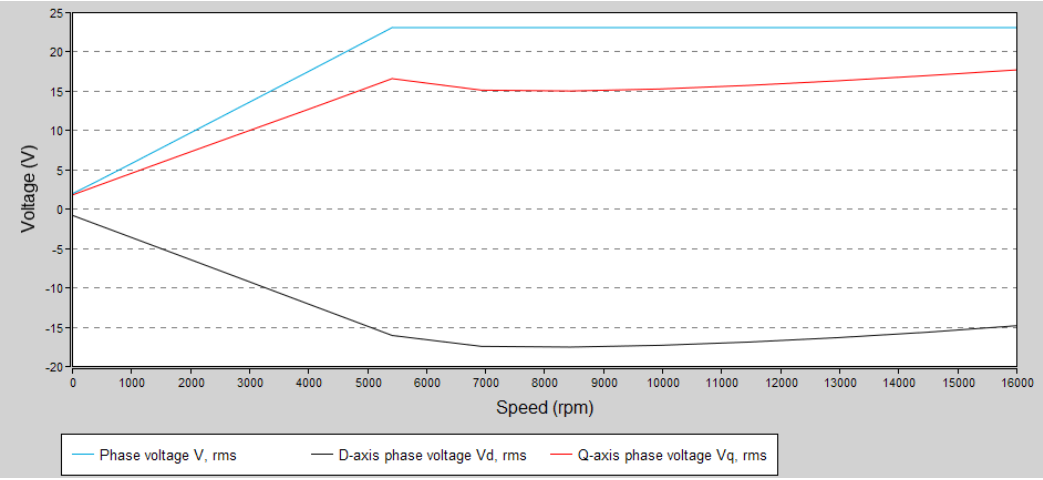

Fig. 22 Voltage versus speed

2.1.3.4 Control angle versus speed

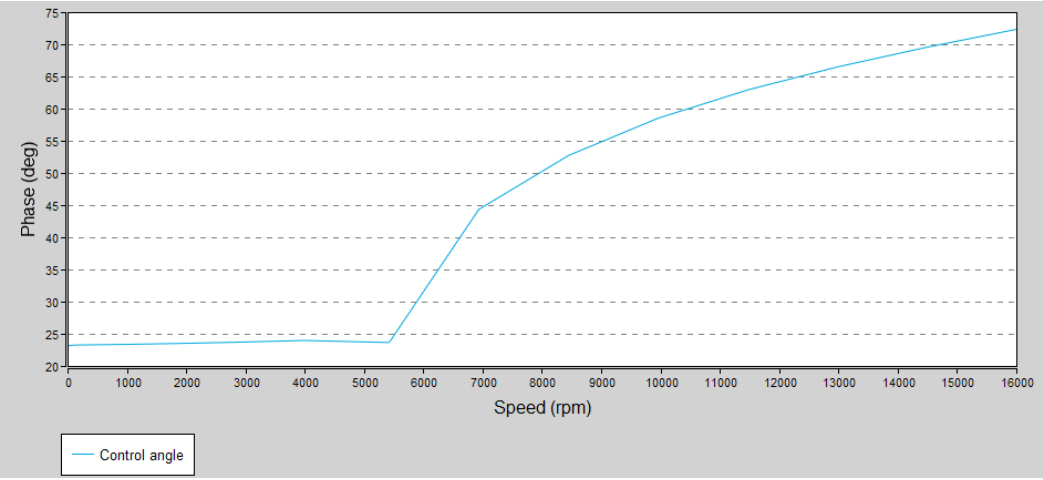

Fig. 23 Control angle versus speed

2.1.3.5 Power versus speed

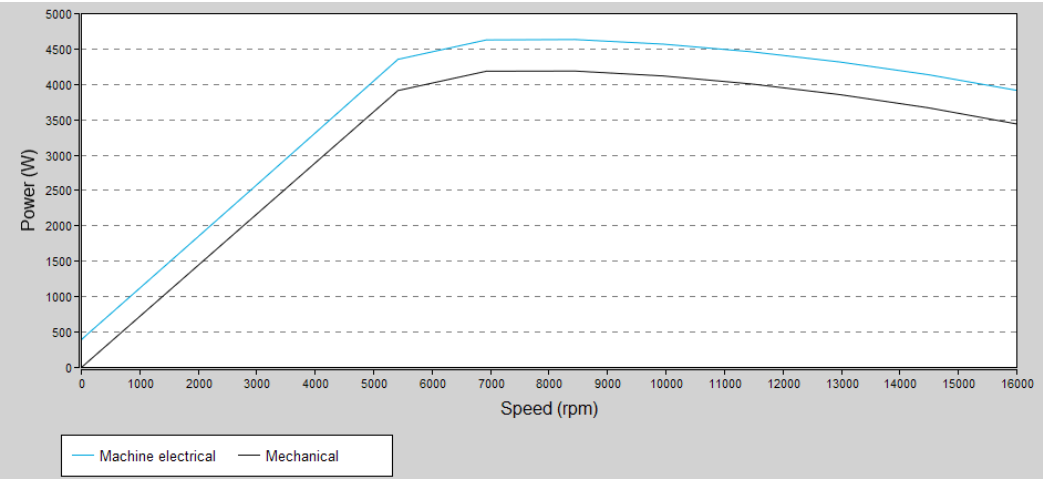

Fig. 24 Power versus speed

2.1.3.6 Power factor versus speed

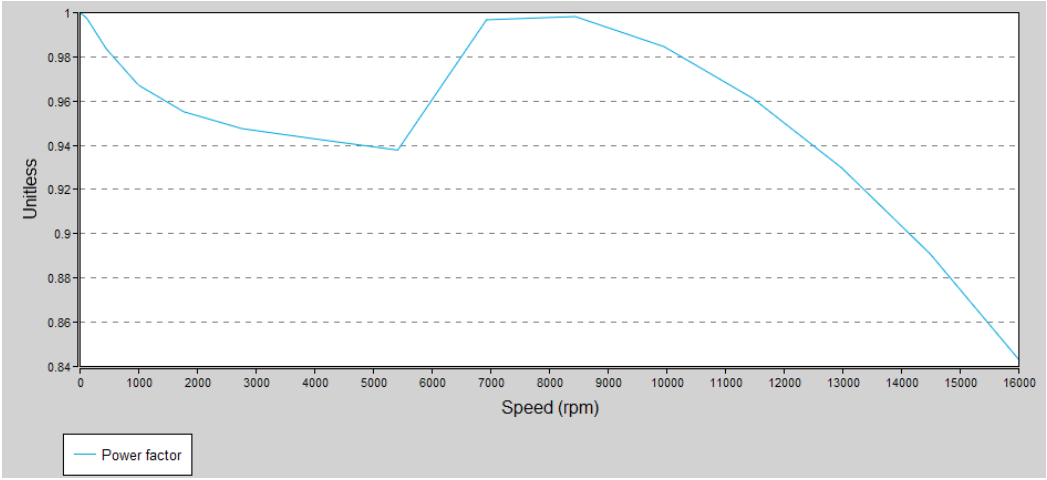

Fig. 25 Power factor versus speed

2.1.3.7 Losses versus speed

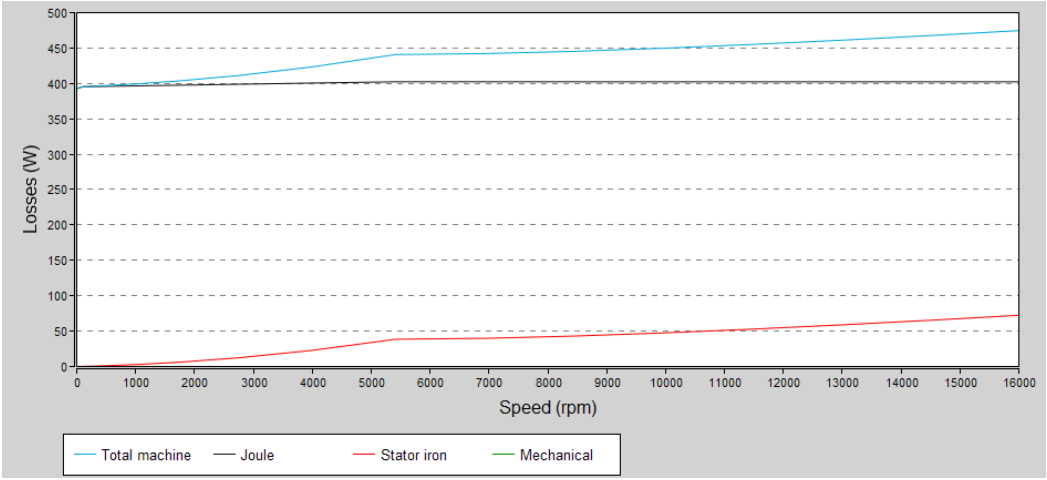

Fig. 26 Losses versus speed

2.1.4 Characteristic curves

2.1.4.1 Electromagnetic torque versus current and control angle

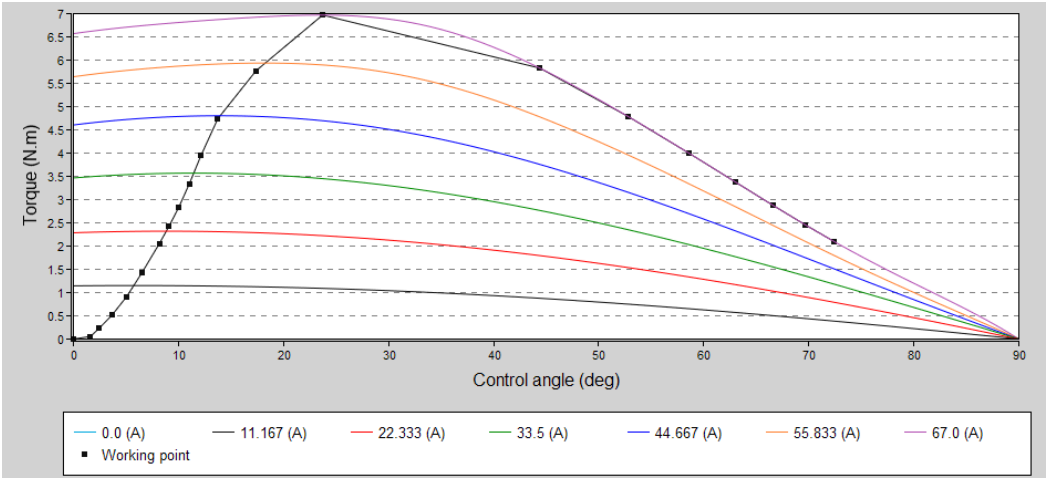

Fig. 27 Electromagnetic torque versus current and control angle

2.1.4.2 Characteristic curves in Jd-Jq area

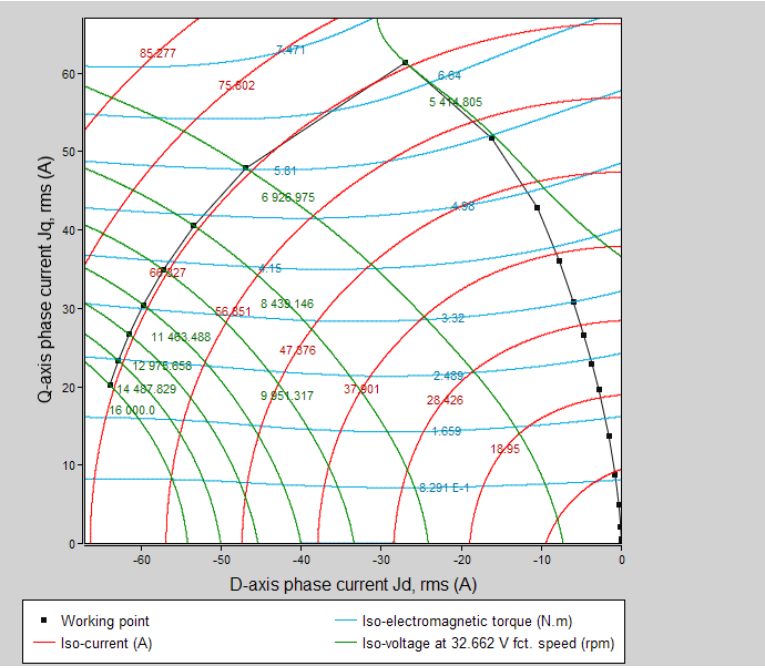

Fig. 28 Characteristic curves in Jd-Jq area

2.1.5 Torque - Speed maps

2.1.5.1 Efficiency in torque-speed area

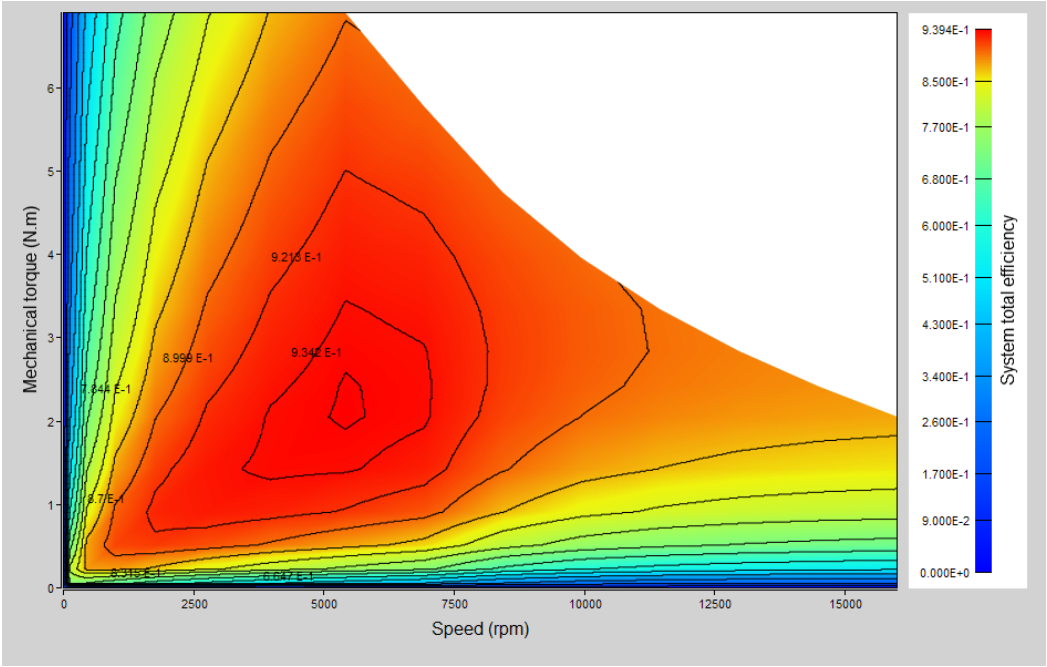

Fig. 29 Efficiency in torque-speed area

2.1.5.2 Current in torque-speed area

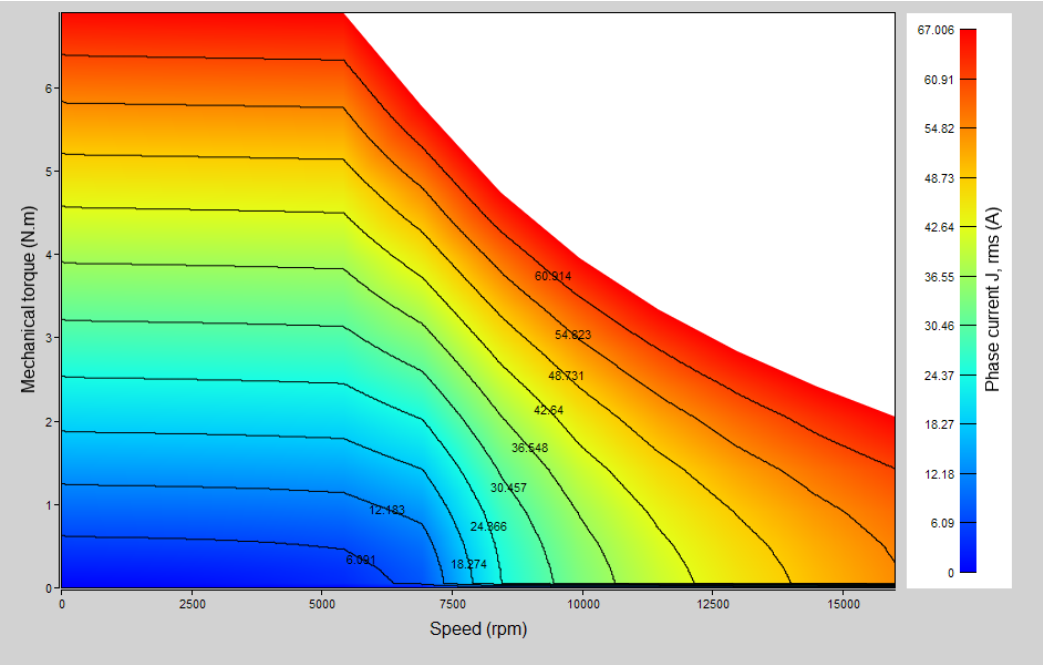

Fig. 30 Current in torque-speed area

2.1.5.3 Voltage in torque-speed area

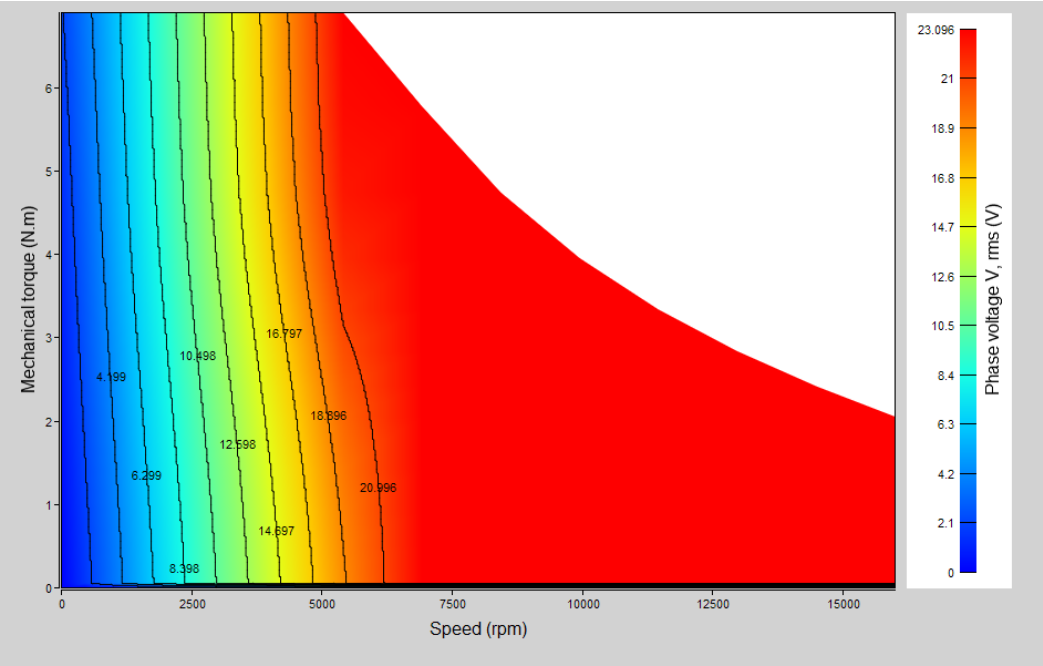

Fig. 31 Voltage in torque-speed area

2.1.5.4 Control angle in torque-speed area

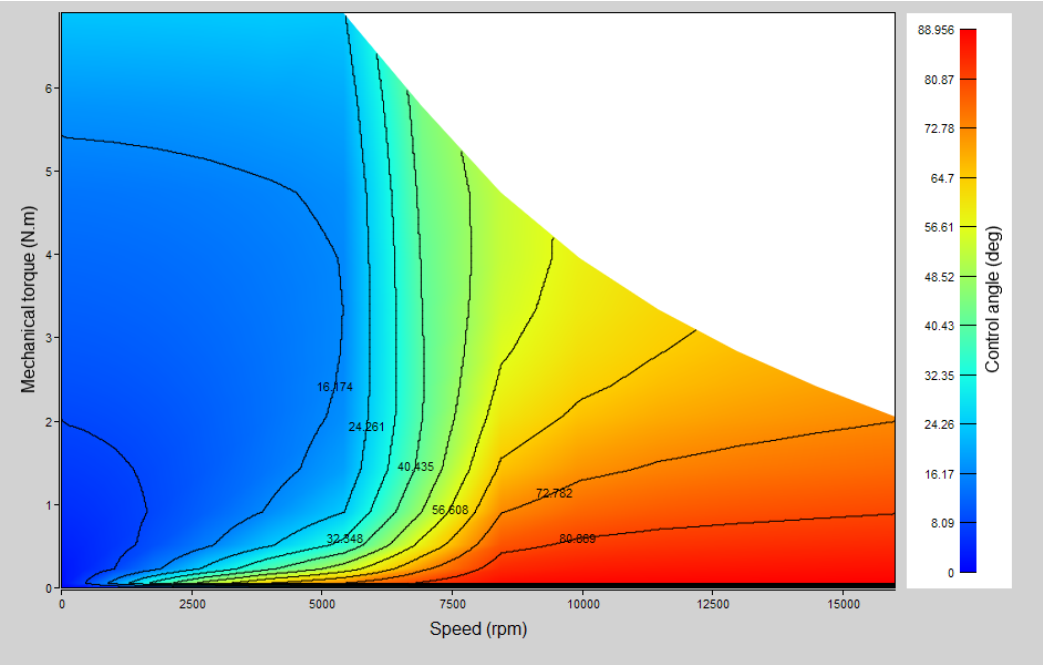

Fig. 32 Control angle in torque-speed area

2.1.5.5 Power in torque-speed area

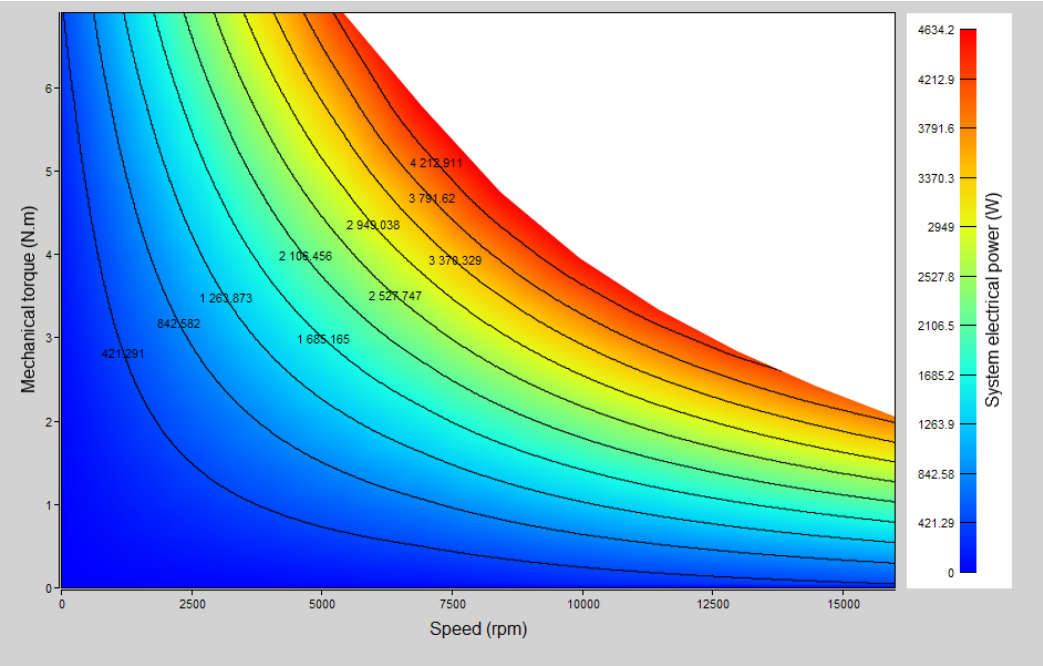

Fig. 33 Power in torque-speed area

2.1.5.6 Power factor in torque-speed area

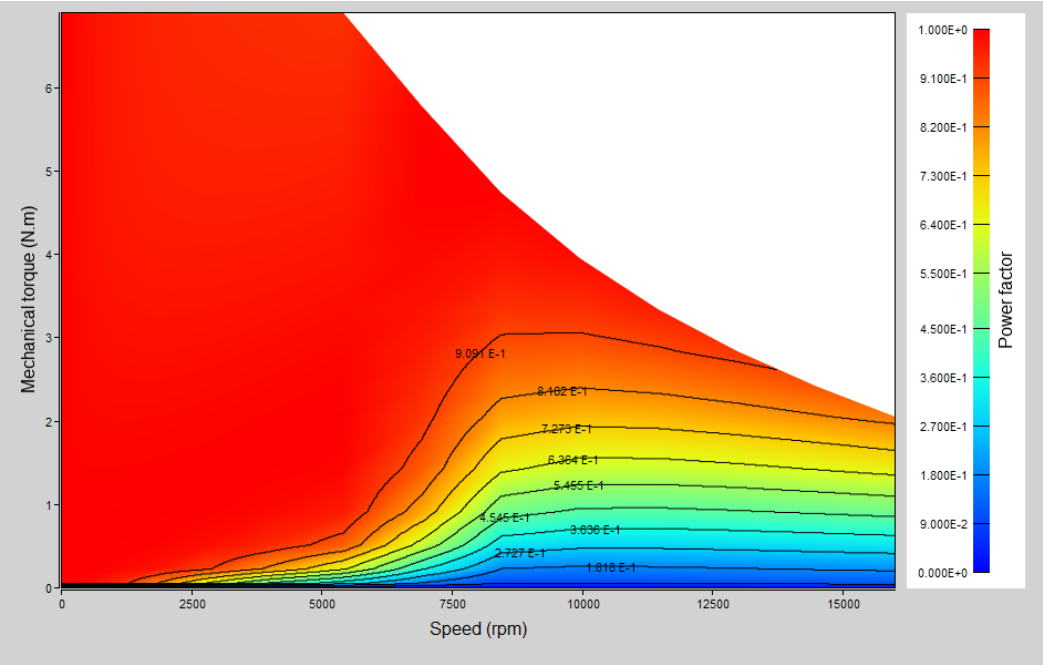

Fig. 34 Power factor in torque-speed area

2.1.5.7 Losses in torque-speed area

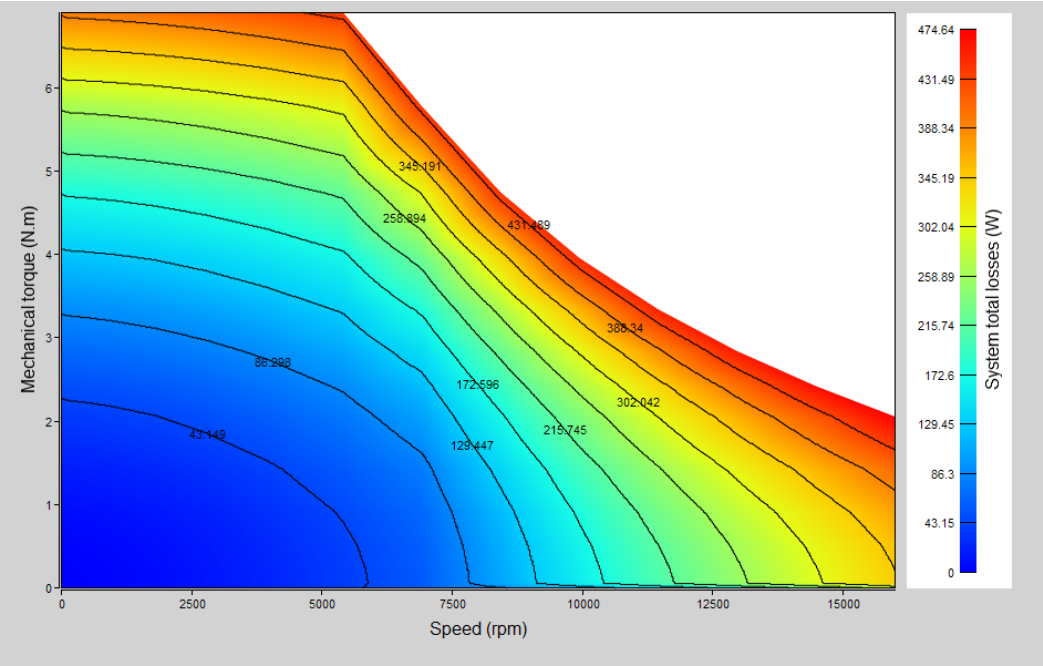

Fig. 35 Losses in torque-speed area

3 Material

3.1 Lamination

3.1.1 REF.M330_35A

3.1.1.1 Data

3.1.1.1.1 General data

Name	Value	Name	Value	Name	Value
Description					
Full name	REF.M330_35A	Family	Lamination	Author	FluxMotor
Manufacturer	FluxMotor	Price (USD/kg)	0.0	Reminder	

3.1.1.1.2 Mechanic data

Name	Value	Name	Value	Name	Value
Mechanic					
Mass density (kg/m3)	7 650.0	Stacking factor	0.95	Sheet thickness (mm)	0.35

3.1.1.1.3 Magnetic data

Name	Value	Name	Value	Name	Value
Magnetic					
Saturation mag. polarization Js (T)	1.85	Initial relative permeability µr	10 000.0	Knee coefficient	1.4

3.1.1.1.4 Iron losses data

Name	Value	Name	Value	Name	Value
Bertotti model					
Hysteresis coef.	179.0	Hysteresis exp. of flux density	1.6	Hysteresis exp. of frequency	1.0
Classical coef. (sine wave)	5.495 E-1	Classical exp. of flux density	2.0	Excess coef. (sine wave)	1.0 E-8
Excess exp. of flux density	1.5				

3.1.1.1.5 Thermal data

Name	Value	Name	Value	Name	Value
Thermal					
Reference temperature (°C)	20.0	Sheet thermal conductivity (W/K/m)	25.0	Insulation thermal conductivity (W/K/m)	0.2
Eq. conductivity in lam. depth (W/K/m)	3.472	Specific heat (J/K/kg)	460.0		

3.2 Magnet

3.2.1 USER.N30SH

3.2.1.1 Data

3.2.1.1.1 General data

Name	Value	Name	Value	Name	Value
Description					
Full name	USER.N30SH	Family	Magnet	Author	admin
Manufacturer		Price (USD/kg)	0.0	Reminder	

3.2.1.1.2 Mechanic data

Name	Value	Name	Value	Name	Value
Mechanic					
Mass density (kg/m3)	7 600.0				

3.2.1.1.3 Electric data

Name	Value	Name	Value	Name	Value
Resistivity					
Reference temperature (°C)	20.0	Isotropic resistivity (Ω.m)	1.5 E-6	Temperature coef. (K-1)	0.0

3.2.1.1.4 Magnetic

Name	Value	Name	Value	Name	Value
Magnetic					
Remanent induction Br (T)	1.125	Intrinsic coercivity HcJ (A/m)	1.592 E6	Relative permeability µr	1.05
Reference temperature (°C)	20.0	Rev. temperature coef. for Br (K-1)	-1.2 E-3	Rev. temperature coef. for HcJ (K-1)	-5.5 E-3
Maximum operating temperature (°C)	150.0	Curie temperature (°C)	350.0		

3.2.1.1.5 Thermal data

Name	Value	Name	Value	Name	Value
Thermal					
Reference temperature (°C)	20.0	Isotropic thermal conductivity (W/K/m)	5.4	Specific heat (J/K/kg)	110.0

3.3 E. conductor

3.3.1 REF.Copper

3.3.1.1 Data

3.3.1.1.1 General data

Name	Value	Name	Value	Name	Value
Description					
Full name	REF.Copper	Family	E. conductor	Author	FluxMotor
Manufacturer	FluxMotor	Price (USD/kg)	0.0	Reminder	

3.3.1.1.2 Mechanic data

Name	Value	Name	Value	Name	Value
Mechanic					
Mass density (kg/m3)	8 890.0				

3.3.1.1.3 Electric data

Name	Value	Name	Value	Name	Value
Resistivity					
Reference temperature (°C)	20.0	Isotropic resistivity (Ω.m)	1.724 E-8	Temperature coef. (K-1)	3.93 E-3

3.3.1.1.4 Thermal data

Name	Value	Name	Value	Name	Value
Thermal					
Reference temperature (°C)	20.0	Isotropic thermal conductivity (W/K/m)	385.0	Specific heat (J/K/kg)	383.0

3.4 E. insulator

3.4.1 REF.Epoxy

3.4.1.1 Data

3.4.1.1.1 General data

Name	Value	Name	Value	Name	Value
Description					
Full name	REF.Epoxy	Family	E. insulator	Author	FluxMotor
Manufacturer	FluxMotor	Price (USD/kg)	0.0	Reminder	

3.4.1.1.2 Mechanic data

Name	Value	Name	Value	Name	Value
Mechanic					
Mass density (kg/m3)	1 800.0				

3.4.1.1.3 Thermal data

Name	Value	Name	Value	Name	Value
Thermal					
Reference temperature (°C)	20.0	Isotropic thermal conductivity (W/K/m)	0.35	Specific heat (J/K/kg)	1 000.0

3.5 Gas

3.5.1 REF.Air

3.5.1.1 Data

3.5.1.1.1 General data

Name	Value	Name	Value	Name	Value
Description					
Full name	REF.Air	Family	Gas	Author	FluxMotor
Manufacturer	FluxMotor	Price (USD/kg)	0.0	Reminder	

3.5.1.1.2 Mechanic data

Name	Value	Name	Value	Name	Value
Mechanic					
Reference pressure (Pa)	1.013 E5				
Reference temperature (°C)	20.0	Mass density (kg/m3)	1.2	1st order temperature coef. (K-1)	-3.073 E-3
2nd order temperature coef. (K-2)	5.518 E-6				
Reference temperature (°C)	20.0	Dynamic viscosity (kg/m/s)	1.821 E-5	1st order temperature coef. (K-1)	2.512 E-3
2nd order temperature coef. (K-2)	-1.043 E-6				

3.5.1.1.3 Thermal data

Name	Value	Name	Value	Name	Value
Thermal					
Reference temperature (°C)	20.0	Thermal conductivity (W/K/m)	2.568 E-2	1st order temperature coef. (K-1)	2.956 E-3
2nd order temperature coef. (K-2)	-8.594 E-7				
Reference temperature (°C)	20.0	Specific heat (J/K/kg)	1 006.0	1st order temperature coef. (K-1)	6.915 E-5
2nd order temperature coef. (K-2)	2.283 E-7				