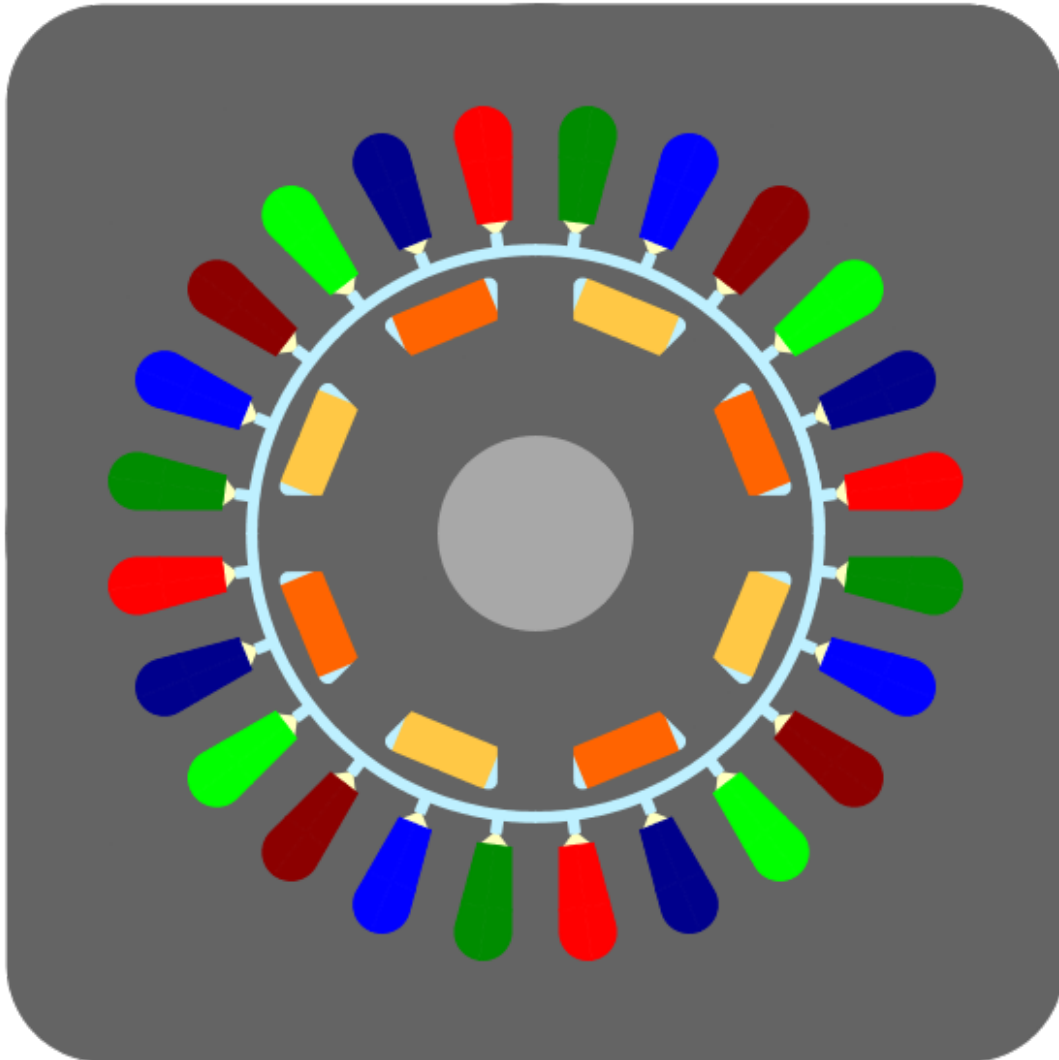


## Report



Motor name : Test\_Motor

Created on 2020/10/24

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## 1 Design

### 1.1 Machine - Topology

#### 1.1.1 Views

##### 1.1.1.1 Radial view

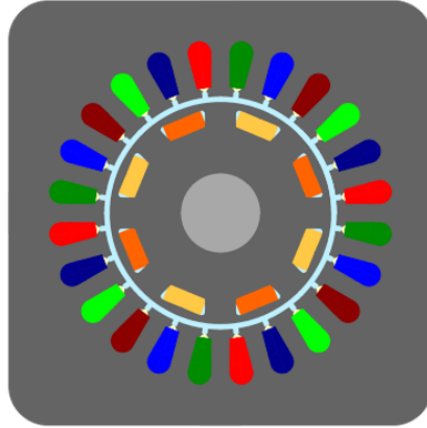


Fig. 1 Radial view

##### 1.1.1.2 Axial view

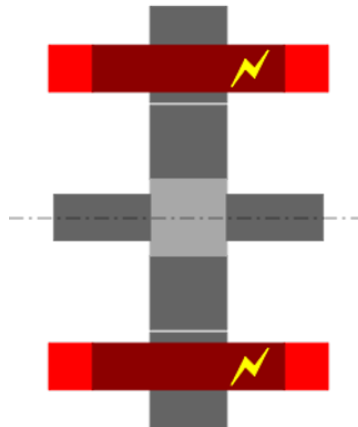


Fig. 2 Axial view

### 1.1.1.3 Winding view

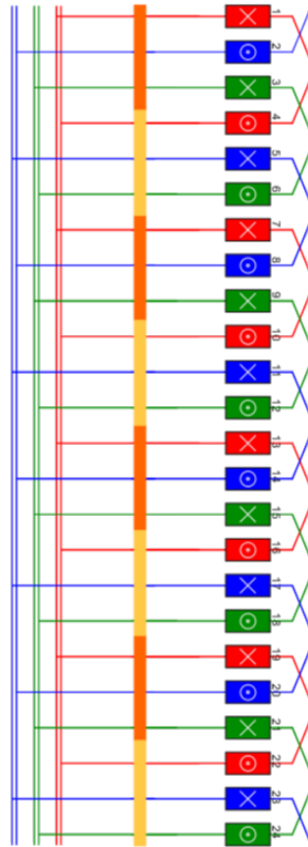


Fig. 3 Winding view

### 1.1.2 Data

#### 1.1.2.1 Structural data

Name	Value	Name	Value	Name	Value
Stator					
Outer diameter (mm)	110.0	Inner diameter (mm)	60.0	Length (mm)	20.0
No. slots	24				
Airgap					
Length (mm)	8.0 E-1				
Rotor					
Outer diameter (mm)	58.4	Inner diameter (mm)	20.0	Length (mm)	20.0
No. poles	8				

#### 1.1.2.2 General data

Name	Value	Name	Value	Name	Value
Classification					
Motor	Test_Motor	Catalog	User_SM_PM_IR_3Ph	Family	Synchronous
Type	Permanent magnet	Sub-type	Inner rotor	Elec. supply network	3Phase
Stator					
Part	os_Free_03C	Library	os_Free	Material	REF.M330_35A
Conductor material	REF.Copper				
Rotor					
Part	imi_Block_02B	Library	imi_Block	Material	REF.M400_65A
Magnet material	REF.NdFeB_1320_1400				
Shaft					
Topology	Solid	Material	REF.EN_1_1151		
Masses					
Total (kg)	1.669	Stator (kg)	1.24	Rotor (kg)	4.294 E-1
Costs					
Total (USD)	0.0	Stator (USD)	0.0	Rotor (USD)	0.0
Moments of inertia					
Rotor (kg.m2)	1.615 E-4	Shaft (kg.m2)	3.274 E-6		

1.2 Machine - Shaft

1.2.1 Views

1.2.1.1 Axial view

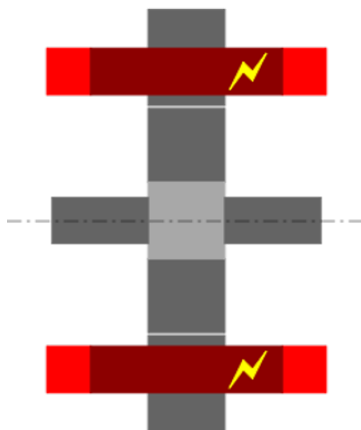


Fig. 4 Axial view

1.2.2 Data

1.2.2.1 Parameters

Name	Value	Name	Value	Name	Value
Inputs					
C.S. diameter (mm)	12.0	C.S. extension (mm)	25.0		
O.C.S. diameter (mm)	12.0	O.C.S. extension (mm)	25.0		

1.2.2.2 General data

Name	Value	Name	Value	Name	Value
Reference					
Topology	Solid				
Rotor					
Outer diameter (mm)	58.4	Inner diameter (mm)	20.0	Length (mm)	20.0
No. poles	8				

1.3 Machine - Housing - Lamination

1.3.1 Views

1.3.1.1 Radial view

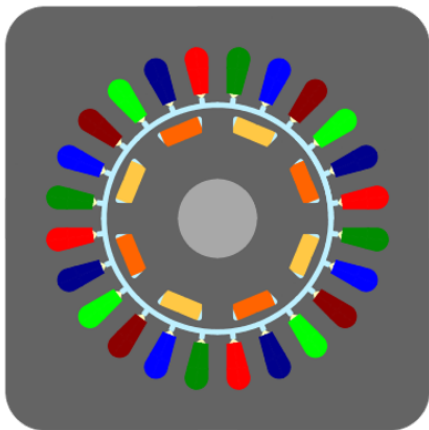


Fig. 5 Radial view

1.3.2 Data

1.3.2.1 Parameters

Name	Value	Name	Value	Name	Value
Inputs					
Extension (mm)	0.0	Fillet radius (mm)	10.0	Slot angular shift (deg)	0.0

### 1.3.2.2 General data

Name	Value	Name	Value	Name	Value
Reference					
Type	Square	Corner	Fillet		
Stator					
Outer diameter (mm)	110.0	Inner diameter (mm)	60.0	Length (mm)	20.0
No. slots	24				

## 1.4 Rotor - Magnet

### 1.4.1 Views

#### 1.4.1.1 Magnet view

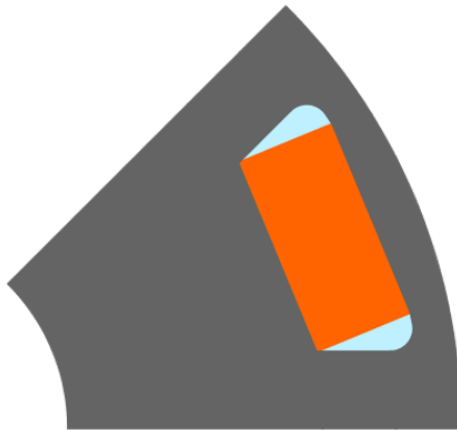


Fig. 6 Magnet view

### 1.4.2 Data

#### 1.4.2.1 Parameters

Name	Value	Name	Value	Name	Value
Inputs					
TM (mm)	5.0	WM (mm)	10.0	H (mm)	2.312
R (mm)	1.128				
Outputs					
T1 (mm)	11.888	W (mm)	7.514	R1 (mm)	27.349
VP (deg)	45.0				

#### 1.4.2.2 General data

Name	Value	Name	Value	Name	Value
Reference					
Part	imi_Block_02B	Library	imi_Block		
Rotor					
Outer diameter (mm)	58.4	Inner diameter (mm)	20.0	Length (mm)	20.0
No. poles	8				

## 1.5 Rotor - Polarization

### 1.5.1 Views

#### 1.5.1.1 Local view

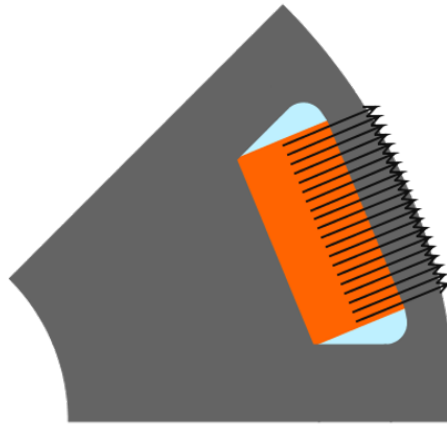


Fig. 7 Local view

#### 1.5.1.2 Global view

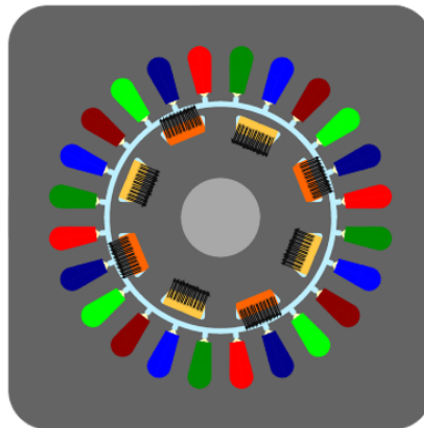


Fig. 8 Global view

### 1.5.2 Data

#### 1.5.2.1 Polarization

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

### 1.6 Rotor - Materials

#### 1.6.1 Data

##### 1.6.1.1 Materials

Name	Value	Name	Value	Name	Value
Rotor		Magnets		Magnetic circuit	
Shaft	REF.EN_1_1151		REF.NdFeB_1320_1400		REF.M400_65A
Edge	REF.Air	Airgap	REF.Air		
Rotor - Magnets					
Magnet	REF.NdFeB_1320_1400				

##### 1.6.1.2 Masses

Name	Value	Name	Value	Name	Value
Total					
Rotor (kg)	4.294 E-1				
Rotor					
Shaft (kg)	9.395 E-2	Magnets (kg)	6.0 E-2	Magnetic circuit (kg)	2.754 E-1
Rotor - Magnets					
Magnet (kg)	6.0 E-2				

##### 1.6.1.3 Moments of inertia

Name	Value	Name	Value	Name	Value
Rotor					
Rotor (kg.m2)	1.615 E-4	Shaft (kg.m2)	3.274 E-6		

#### 1.6.1.4 Costs

Name	Value	Name	Value	Name	Value
Total					
Rotor (USD)	0.0				
Rotor					
Shaft (USD)	0.0	Magnets (USD)	0.0	Magnetic circuit (USD)	0.0
Rotor - Magnets					
Magnet (USD)	0.0				

### 1.7 Stator - Slot

#### 1.7.1 Views

##### 1.7.1.1 Slot view



Fig. 9 Slot view

#### 1.7.2 Data

##### 1.7.2.1 Parameters

Name	Value	Name	Value	Name	Value
Inputs					
HS (mm)	14.85	WS2 (mm)	5.874	H1 (mm)	1.414
WS1 (mm)	3.524	HO (mm)	1.414	WO (mm)	8.391 E-1
Outputs					
WT1 (mm)	5.075	WT2 (mm)	5.067	WT (mm)	5.071
WS (mm)	4.699	R (mm)	2.937	V (deg)	46.49
D (mm)	10.499				

##### 1.7.2.2 General data

Name	Value	Name	Value	Name	Value
Reference					
Part	os_Free_03C	Library	os_Free		
Stator					
Outer diameter (mm)	110.0	Inner diameter (mm)	60.0	Length (mm)	20.0
No. slots	24				

### 1.8 Stator - Winding

#### 1.8.1 Configuration

##### 1.8.1.1 Inputs

Name	Value	Name	Value	Name	Value
Context					
Winding connection	Wye	Definition mode	Automatic		
Inputs					
No. parallel paths	4	Phase sequence	Clockwise		



### 1.8.1.2 Settings

Name	Value	Name	Value	Name	Value
Coil - Conductor					
No. turns per coil	200	No. wires in hand	1		
Wire topology	Circular	Wire diameter (mm)	3.894 E-1		
Conductor topology	Circular	Conductor diameter (mm)	4.507 E-1		
Coil - Insulation thicknesses					
Wire (mm)	3.064 E-2	Conductor (mm)	0.0	Coil (mm)	0.0
Liner (mm)	0.0	Phase separator (mm)	0.0		
End winding					
Topology	U Shape				
C.S. extension (mm)	14.971	O.C.S. extension (mm)	14.971		
C.S. total extension (mm)	26.416	O.C.S. total extension (mm)	26.416		
Calibration factors					
Reference temperature (°C)	20.0	Winding resistance factor	1.0	End winding inductance factor	1.0

### 1.8.1.3 Materials

Name	Value	Name	Value	Name	Value
Electrical conductor					
Conductor	REF.Copper				
Electrical insulator					
Wire	REF.Nomex_130	Conductor	REF.Nomex_130	Coil	REF.Nomex_130
Liner	REF.Nomex_130	Phase separator	REF.Nomex_130	Wedge	REF.Nomex_130

## 1.8.2 Main results

### 1.8.2.1 Characteristics

Name	Value	Name	Value	Name	Value
Winding					
No. phases	3	No. poles	8	No. slots	24
No. parallel paths	4	No. layers	1	Coil layout	Full
Winding connection	Wye	Winding type	Concentric	Pole distribution	Consequent
No. slots / pole / phase	1	Pole pitch	3.0	Phase sequence	Clockwise
No. coils / pole / phase	1	Coil pitch	3		
Winding factors (Fundamental)					
Winding	1.0				
Distribution	1.0	Pitch	1.0	Skew	1.0
Coil					
No. turns per coil	200	No. turns in series per phase	200	No. conductors per phase	1 600
Lengths					
Total conductor (mm)	4.386 E5	Mean turn (mm)	181.985	Coil connection (mm)	1 831.328
Axial overall (mm)	72.832				
Areas in slot					
Conductive (mm2)	23.819	Conductor conductive (mm2)	1.191 E-1	Wire conductive (mm2)	1.191 E-1
Slot (mm2)	59.547	Insulation (mm2)	11.173	Free (mm2)	24.555
Fill factors					
Gross (%)	40.0	Net (%)	58.763		

### 1.8.2.2 Resistances

Name	Value	Name	Value	Name	Value
Resistances at 20°C					
Phase (Ω)	1.323	Line-Line (Ω)	2.645	Winding straight part (Ω)	2.895 E-1
End winding (Ω)	1.033	C.S. end winding (Ω)	5.194 E-1	O.C.S. end winding (Ω)	5.138 E-1
Resistances at ref. temperature					
Reference temperature (°C)	20.0				
Phase (Ω)	1.323	Line-Line (Ω)	2.645	Winding straight part (Ω)	2.895 E-1
End winding (Ω)	1.033	C.S. end winding (Ω)	5.194 E-1	O.C.S. end winding (Ω)	5.138 E-1

### 1.8.2.3 Inductances

Name	Value	Name	Value	Name	Value
Inductances					
End winding (H)	6.066 E-4	C.S. end winding (H)	3.033 E-4	O.C.S. end winding (H)	3.033 E-4

### 1.8.2.4 Masses

Name	Value	Name	Value	Name	Value
Masses					
Total (kg)	4.811 E-1	Electrical conductor (kg)	4.644 E-1	Total insulation (kg)	1.672 E-2
Wire insulation (kg)	1.543 E-2	Conductor insulation (kg)	0.0	Coil insulation (kg)	0.0
Liner insulation (kg)	0.0	Phase separator insulation (kg)	0.0	Wedge insulation (kg)	1.288 E-3

### 1.8.2.5 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	Wedge insulation (USD)	0.0

### 1.8.3 Views

#### 1.8.3.1 Layout of the winding

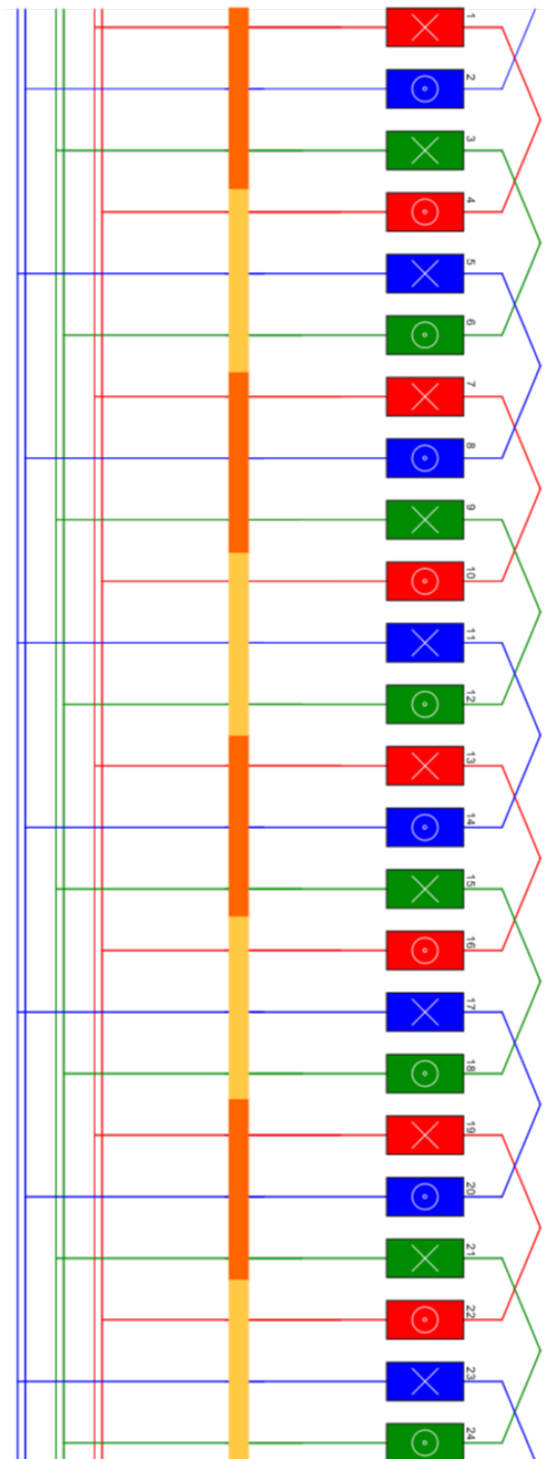


Fig. 10 Layout of the winding

1.8.3.2 Winding connection table

Coil	Input slot	Output slot
1	1(Full)	4(Full)
2	7(Full)	10(Full)
3	13(Full)	16(Full)
4	19(Full)	22(Full)

Coil	Input slot	Output slot
1	3(Full)	6(Full)
2	9(Full)	12(Full)
3	15(Full)	18(Full)
4	21(Full)	24(Full)

Coil	Input slot	Output slot
1	5(Full)	8(Full)
2	11(Full)	14(Full)
3	17(Full)	20(Full)
4	23(Full)	2(Full)

1.8.3.3 Radial view

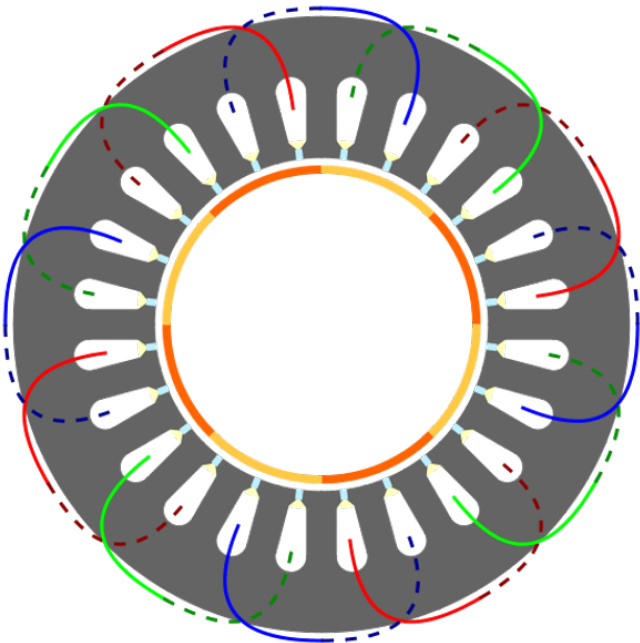


Fig. 11 Radial view

1.8.3.4 Axial view

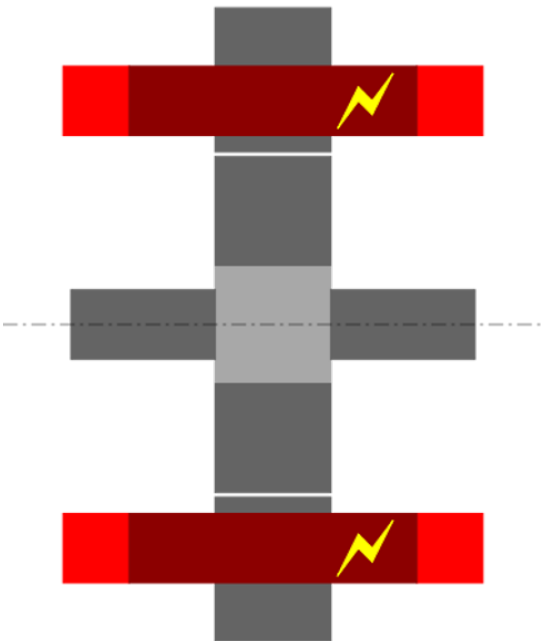


Fig. 12 Axial view

## 1.8.4 MMF analysis

### 1.8.4.1 MMF - Spatial representation

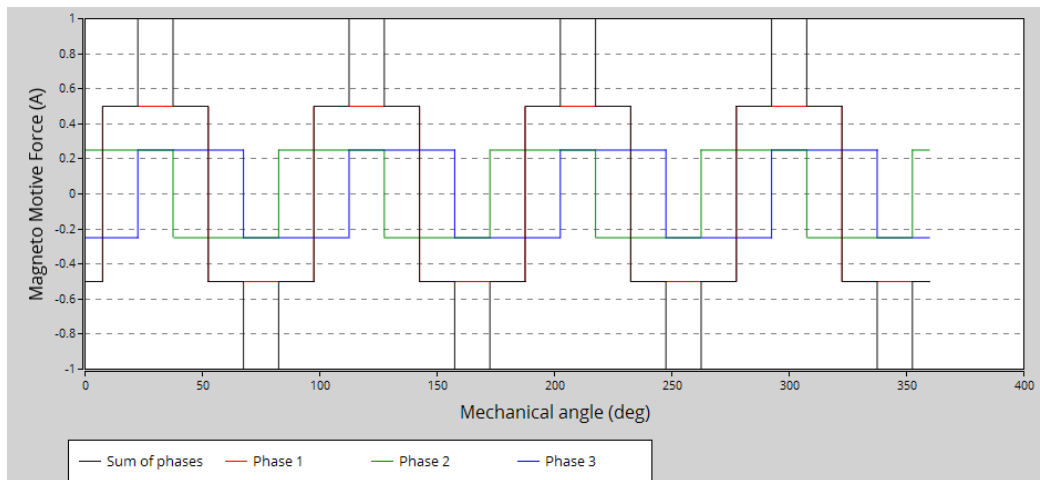


Fig. 13 MMF - Spatial representation

### 1.8.4.2 MMF - Harmonic analysis

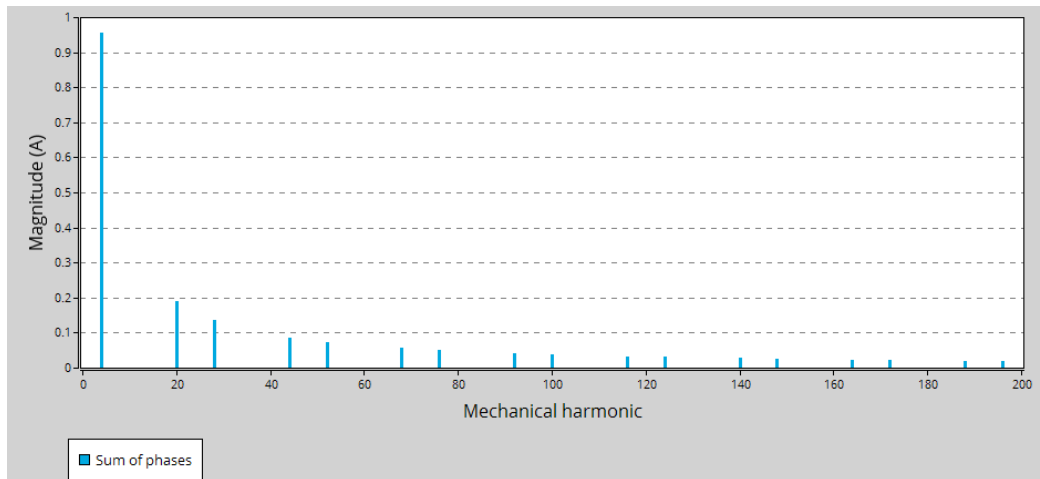


Fig. 14 MMF - Harmonic analysis

### 1.8.4.3 MMF - Sum of phases - Harmonic analysis

Mech. harmonic	Elec. harmonic	Magnitude (A)	Phase (deg)	Mech. frequency (deg-1)	Elec. frequency (deg-1)
4	1	9.549 E-1	-120.0	1.111 E-2	2.778 E-3
20	5	1.91 E-1	120.0	5.556 E-2	1.389 E-2
28	7	1.364 E-1	60.0	7.778 E-2	1.944 E-2
44	11	8.681 E-2	-60.0	1.222 E-1	3.056 E-2
52	13	7.346 E-2	-120.0	1.444 E-1	3.611 E-2
68	17	5.617 E-2	120.0	1.889 E-1	4.722 E-2
76	19	5.026 E-2	60.0	2.111 E-1	5.278 E-2
92	23	4.152 E-2	-60.0	2.556 E-1	6.389 E-2
100	25	3.82 E-2	-120.0	2.778 E-1	6.944 E-2
116	29	3.293 E-2	120.0	3.222 E-1	8.056 E-2
124	31	3.08 E-2	60.0	3.444 E-1	8.611 E-2
140	35	2.728 E-2	-60.0	3.889 E-1	9.722 E-2
148	37	2.581 E-2	-120.0	4.111 E-1	1.028 E-1
164	41	2.329 E-2	120.0	4.556 E-1	1.139 E-1
172	43	2.221 E-2	60.0	4.778 E-1	1.194 E-1
188	47	2.032 E-2	-60.0	5.222 E-1	1.306 E-1
196	49	1.949 E-2	-120.0	5.444 E-1	1.361 E-1

## 1.8.5 Quality criteria

### 1.8.5.1 Winding factors - Harmonic analysis

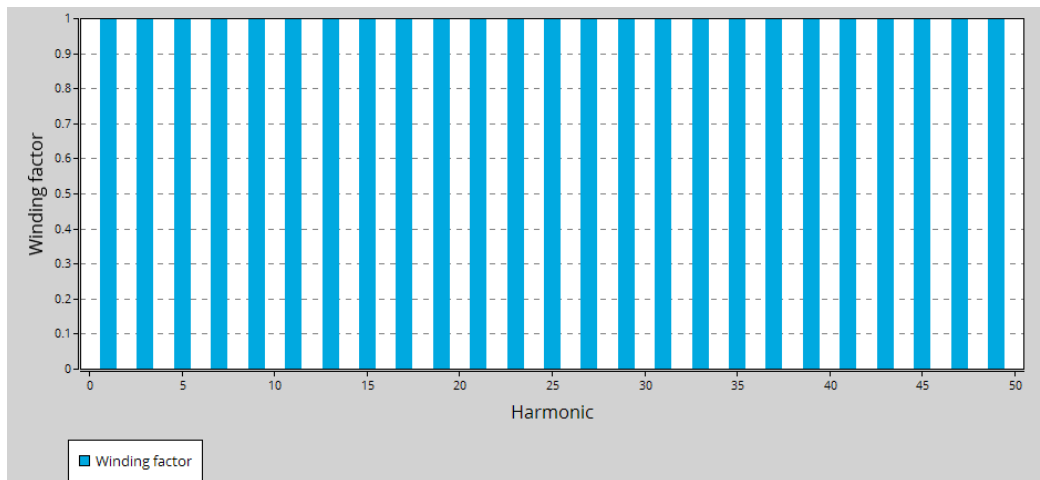


Fig. 15 Winding factors - Harmonic analysis

### 1.8.5.2 Winding factors - Harmonic analysis

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

### 1.8.5.3 Slot star

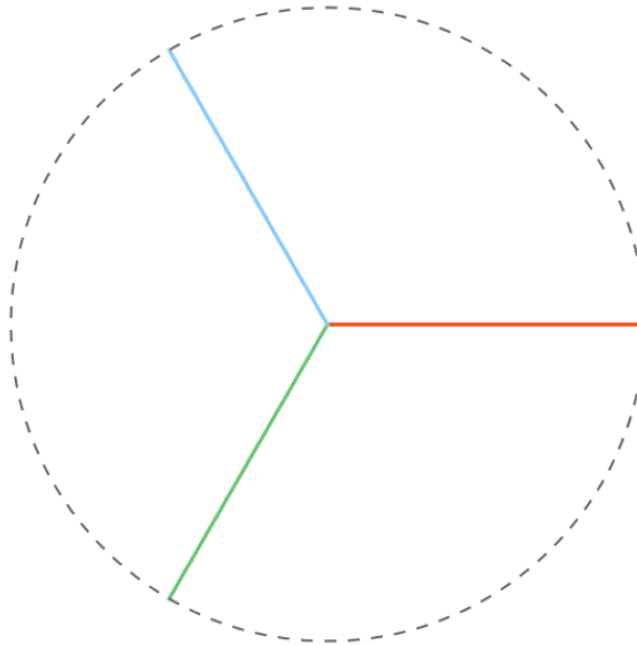


Fig. 16 Slot star

## 1.9 Stator - Materials

### 1.9.1 Data

#### 1.9.1.1 Materials

Name	Value	Name	Value	Name	Value
Stator					
Airgap	REF.Air	Magnetic circuit	REF.M330_35A	Coil conductor	REF.Copper
Insulators	REF.Nomex_130				
Stator - Insulators					
Wire	REF.Nomex_130	Conductor	REF.Nomex_130	Coil	REF.Nomex_130
Liner	REF.Nomex_130	Phase separator	REF.Nomex_130	Insulating wedge	REF.Nomex_130

#### 1.9.1.2 Masses

Name	Value	Name	Value	Name	Value
Total					
Stator (kg)	1.24				
Stator					
Magnetic circuit (kg)	7.585 E-1	Winding (kg)	4.811 E-1		
Stator - Winding					
Electrical conductor (kg)	4.644 E-1	Total insulation (kg)	1.672 E-2		

#### 1.9.1.3 Costs

Name	Value	Name	Value	Name	Value
Total					
Stator (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		