



Corporate
Presentation

DESIGN OF YAW AND PITCH MOTOR FOR WIND TURBINE APPLICATION

#How it's started



#How it's going

1997

By switching to the QS Engine series

2002

EFF1 energy efficiency level

2008

R&D center established

2009

IE2 energy efficiency level

2010

IE3 energy efficiency level

2014

IE4 energy efficiency level

2018

WAT Motor Transformational Moves

Turkey



1965



Koc

1989

Worldwide

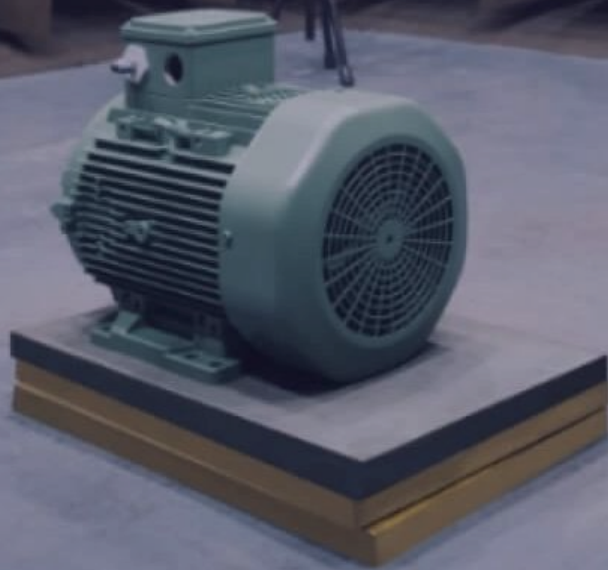


Koc

TODAY

#Transformati

Turkey's Largest* Motor Company Europe's Nr. 1 Choice from Turkey



40.000m²

Greater
Istanbul
Turkey



Tota	956
1	
R&D	102



+30 Countries

+200 Accounts



79 International
Customers

+6k Nr.
SKU's

**In terms of Export.*

Locations

Greater
İstanbul

We Are
Here!

Offic



Çerkezköy
Sütlüce
Tuzla



Factory

Çerkezköy



Warehouse

Çerkezköy
9800m²



R&D
Centers

1. Çerkezköy
2. Tuzla



Liaison



Office
İstanbul
Ankara
Hannover



- 163 km to EU border
- 87 km to İstanbul
- 168 km to İstanbul Sabiha Gökçen airport

Çerkezköy
Tekirdağ

Sütlüce
İstanbul

Tuzla
İstanbul

Multiple Certifications



Defence Compatibility



*A+ 96 Score



*TEI Assessment



Business Segments



Sectors



Industry

General Purpose Motors
 Definite Purpose Motors
 EC Motors

Renewable

Wind Generators & Components
 Wind Auxiliary Systems

Motion Control

Servo Motors (BLDC)
 Servo Drivers
 Intralogistics Solutions
 Motion Control Algorithms & Embedded System Design

Defence

payload Servo Solutions
 Ground Vehicle Solutions
 Aviation Alternator Systems
 Guidance & Air Domain Systems

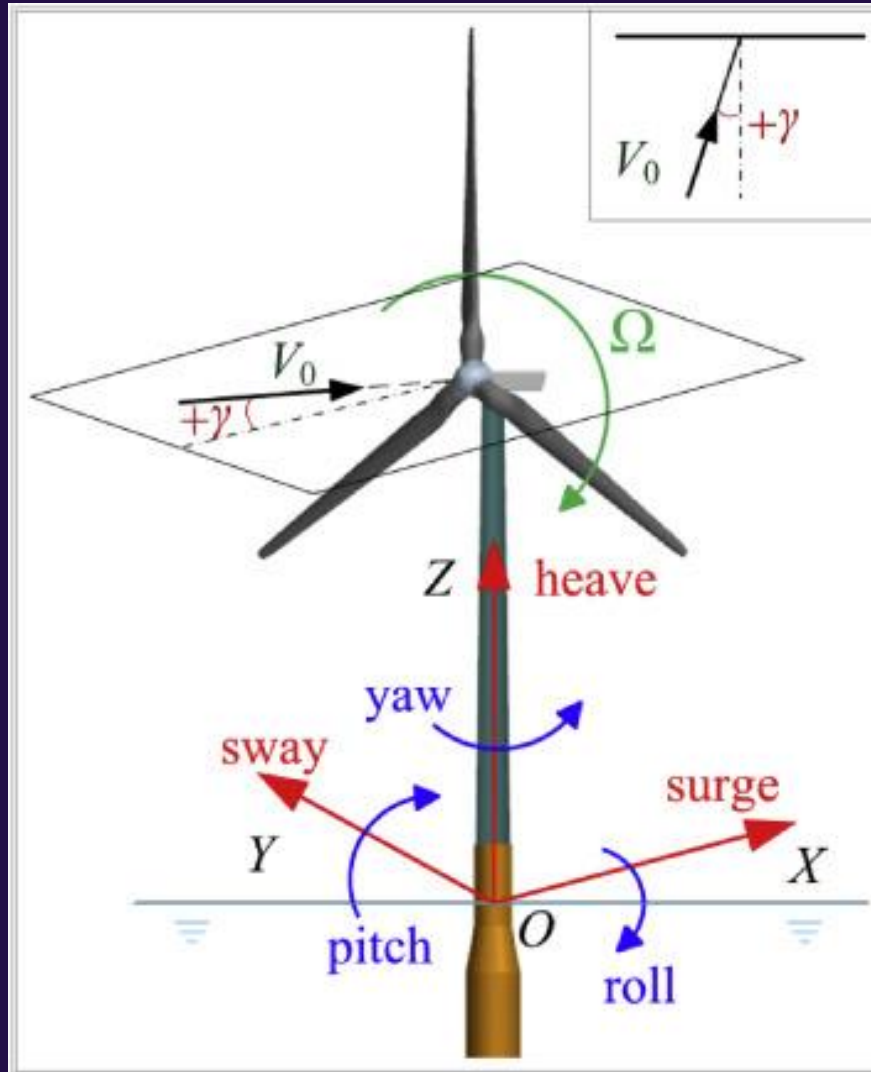
Mobility

Light E-Mobility Electrification
 Automotive Traction Auxiliary Systems

EV

Chargers & Charging Infrastructure
 AC EV Chargers
 DC EV Chargers
 Digital Platform

WHAT ARE MEANINGS OF YAW AND PITCH?

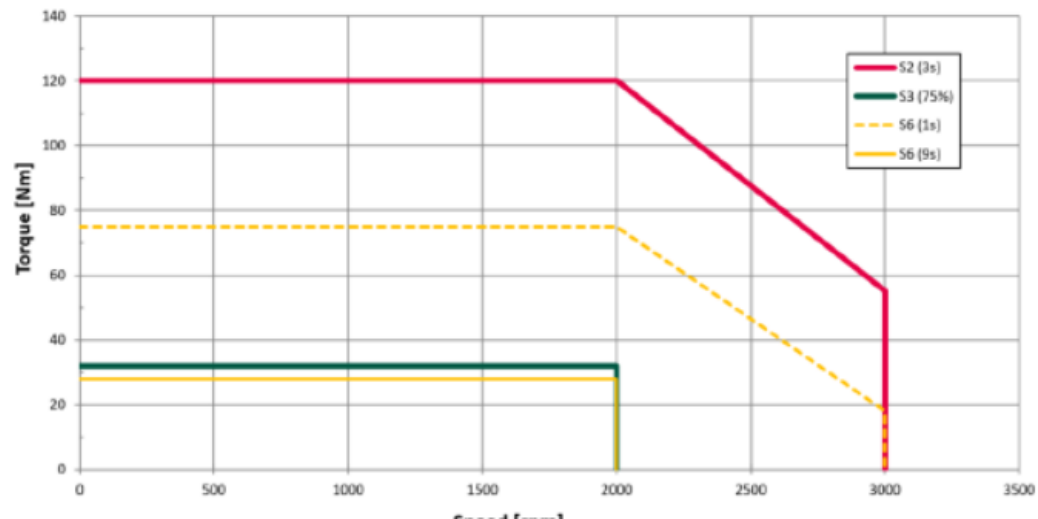


REQUIREMENTS

The motor shall have the following shaft torque-speed-curve for the Motor 32/120:

Rotational speed [rpm]	Torque (S3) 75% [Nm]	S6 Peak torque [Nm]	S6 Base torque [Nm]	Torque (S2) [Nm]
Cycle time	45s on / 15s off	1s	9s	3s
0	32	75	28	120
2000	32	75	28	120
3000	0	18	0	55

Motor 32/120

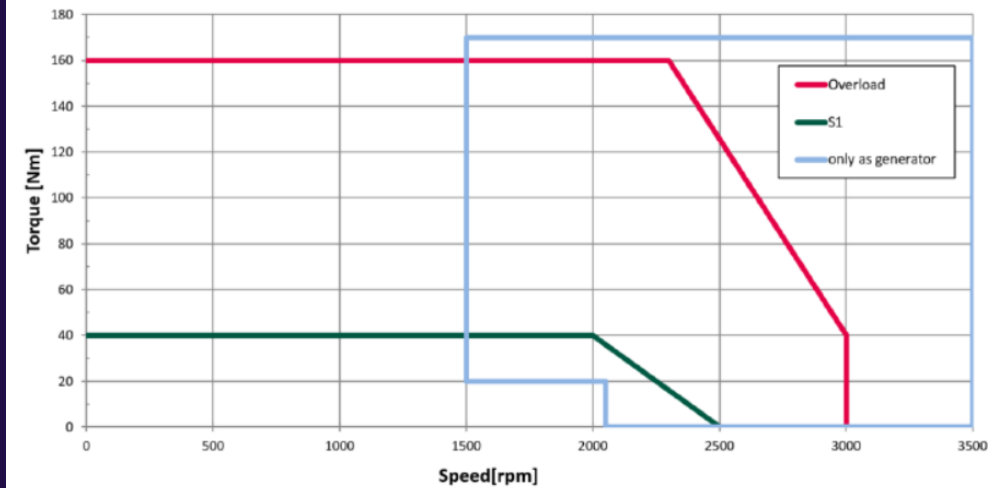


Pitch motor requirements

The motor shall have the following shaft torque and shaft speed curve:

Rotational shaft speed [rpm]	Shaft torque S1 [Nm]	Overload [Nm]
0	40	160
2000	40	160
2300	15	160
2500	0	125
3000		40

Yaw Motor



Yaw motor requirements

MULTIPHYSICS DESIGN

The interface is divided into several functional areas:

- Top Navigation:** Includes icons for saving, undo, and a camera. Below these are three tabs: **DESIGN** (active), **TEST**, and **EXPORT**.
- Component Selection:** A row of tabs for **MACHINE**, **ROTOR**, **STATOR**, **COOLING**, and **MATERIALS**. Each tab contains icons for specific components:
 - MACHINE:** TOPOLOGY, HOUSING, SHAFT
 - ROTOR:** MAGNET, POLARIZATION
 - STATOR:** SLOT, WINDING
 - COOLING:** EXTERNAL, INTERNAL
 - MATERIALS:** MATERIALS
- SECTIONS Panel:** Located on the left, it has two sub-sections:
 - Views:** Radial, Axial, Winding
 - Data:** Structural, General
- MACHINE - TOPOLOGY Panel:** The main workspace, currently showing a **View** of the machine's cross-section. It features two side-by-side views: a circular cross-section on the left and a rectangular cross-section on the right. The circular view shows a central shaft surrounded by a stator with slots and a rotor with poles. The rectangular view shows a different perspective of the same components.
- TOPOLOGY Panel:** Located on the right, it provides a configuration table for the selected topology. It includes a "Dimension input mode" section with three radio buttons. Below are sections for **STATOR**, **AIRGAP**, and **ROTOR**, each with input fields for dimensions and a checkmark button.

MULTIPHYSICS DESIGN

DESIGN

TEST

EXPORT

CHARACTERIZATION

OPEN CIRCUIT

MODEL

DATASHEET

THERMAL

WORKING POINT

SINE WAVE

SQUARE WAVE

PERFORMANCE MAPPING

SINE WAVE

MECHANICS

NVH

SECTIONS

Configuration

Inputs

Settings

Magnets

Main results

Mag. flux

Cogging torque

Graphs & tables

Cogging torque

Cogging torq. harm.

Cogging torq. harm.

CHARACTERIZATION - OPEN CIRCUIT - MOTOR AND GENERATOR - COGGING TO...

Overview
Current

Inputs

Context			
Family	Characterizat...	Package	Open circuit
Test	Cogging		
Advanced parameters			
No. comp. / cogging period	45	Max. harmonic order	20
Rotor initial position (deg)	0.0	Airgap mesh coefficient	0.45

Settings

Thermal			
Magnet temperature Tmag (°C)	20.0		

Magnet characteristics

Magnets			
Magnet temperature Tmag (°C)	20.0		
Magnet name	Magnet	Material name	REF.SmCo_10...
Remanent induction at Tref (T)	1.04	Intrinsic coercive field at Tref (A/m)	1.8 E6
Remanent induction at Tmag (T)	1.04	Intrinsic coercive field at Tmag (A/m)	1.8 E6

OPEN CIRCUIT

✓ MOTOR & GENERATOR

✓ Cogging

Back emf

Thermal

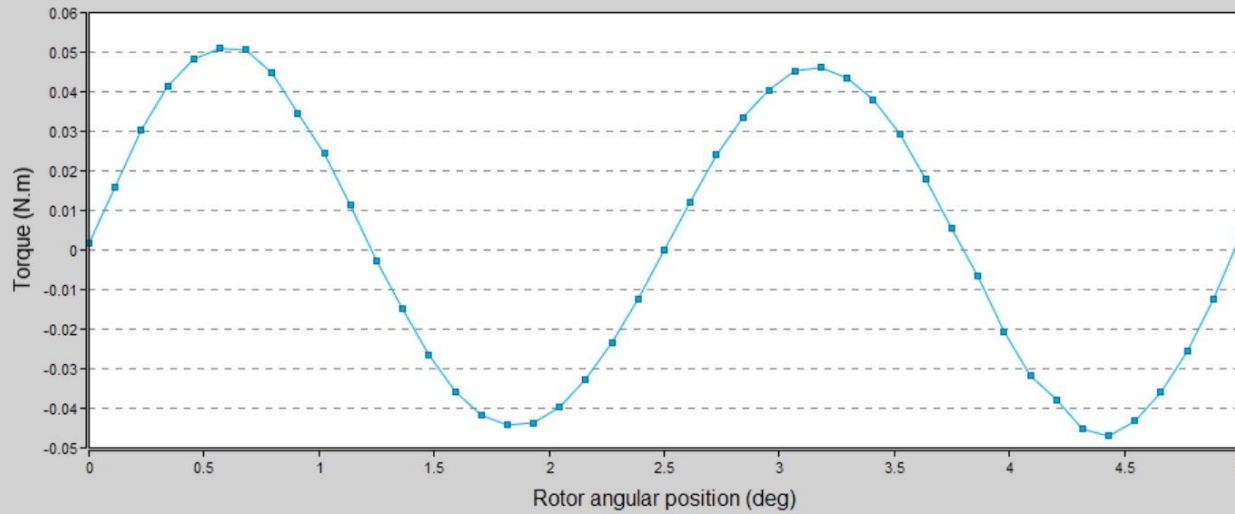
INPUTS

No parameters for this test

+

COGGING TORQUE AND BACK EMF ANALYSIS

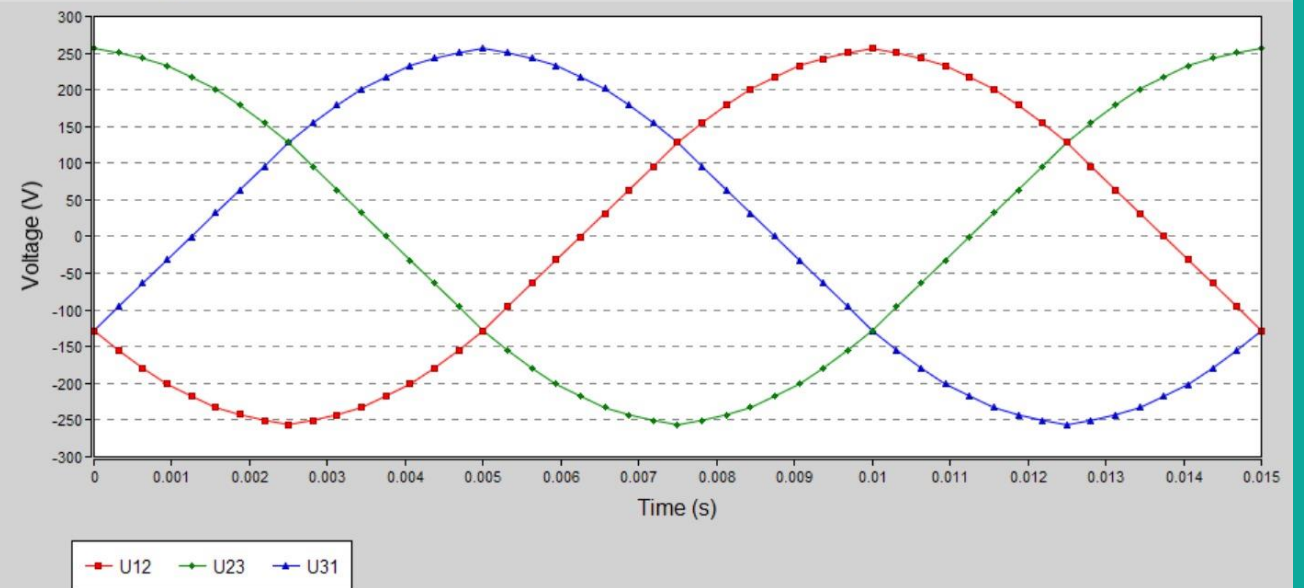
Cogging torque versus rotor angular position



COGGING TORQUE

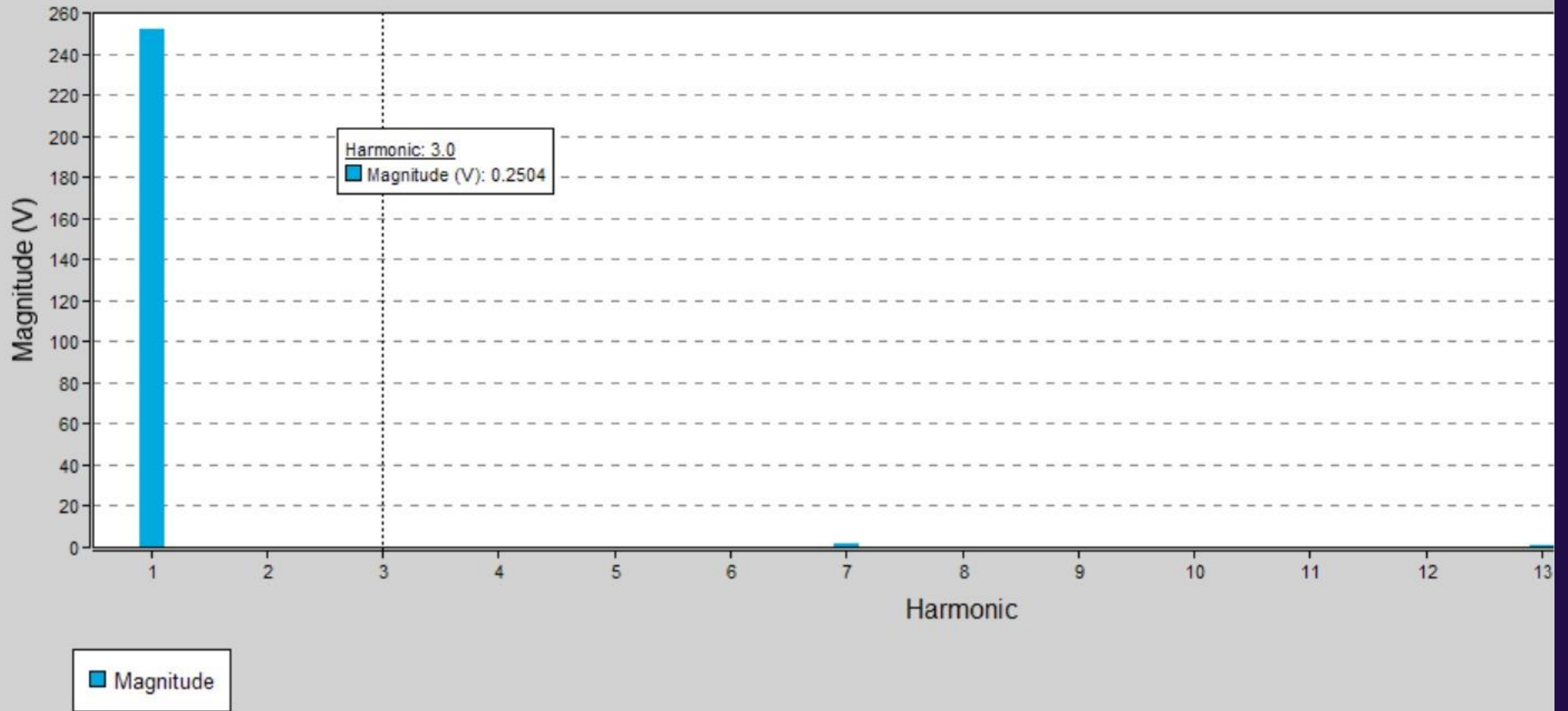
BACK EMF

Line-Line voltage versus time - Open circuit



BACK EMF HARMONICS

Line-Line voltage harmonic analysis - Open circuit

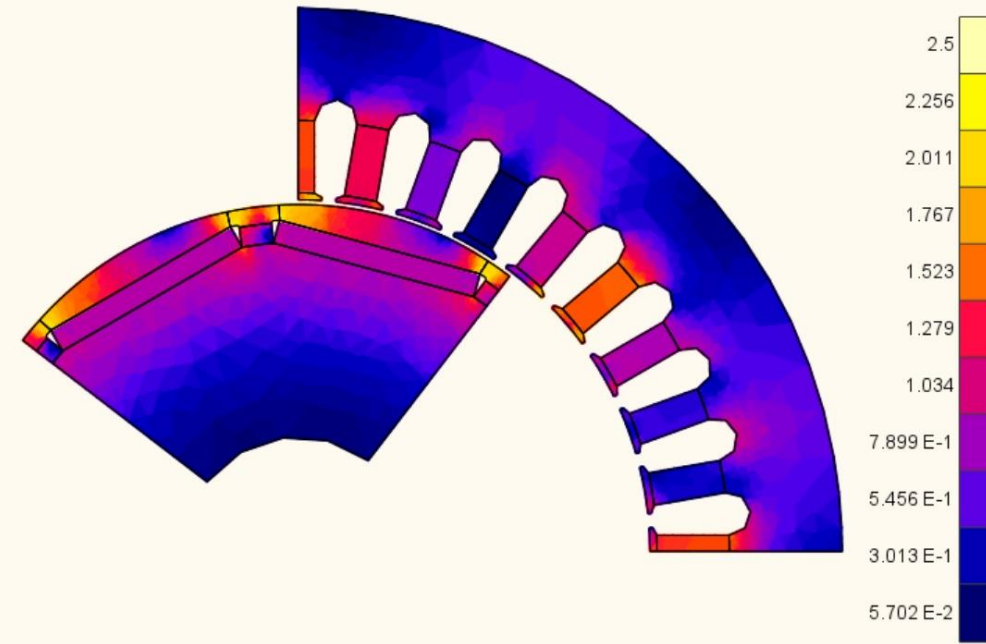


WORKING POINT ANALYSIS RESULTS

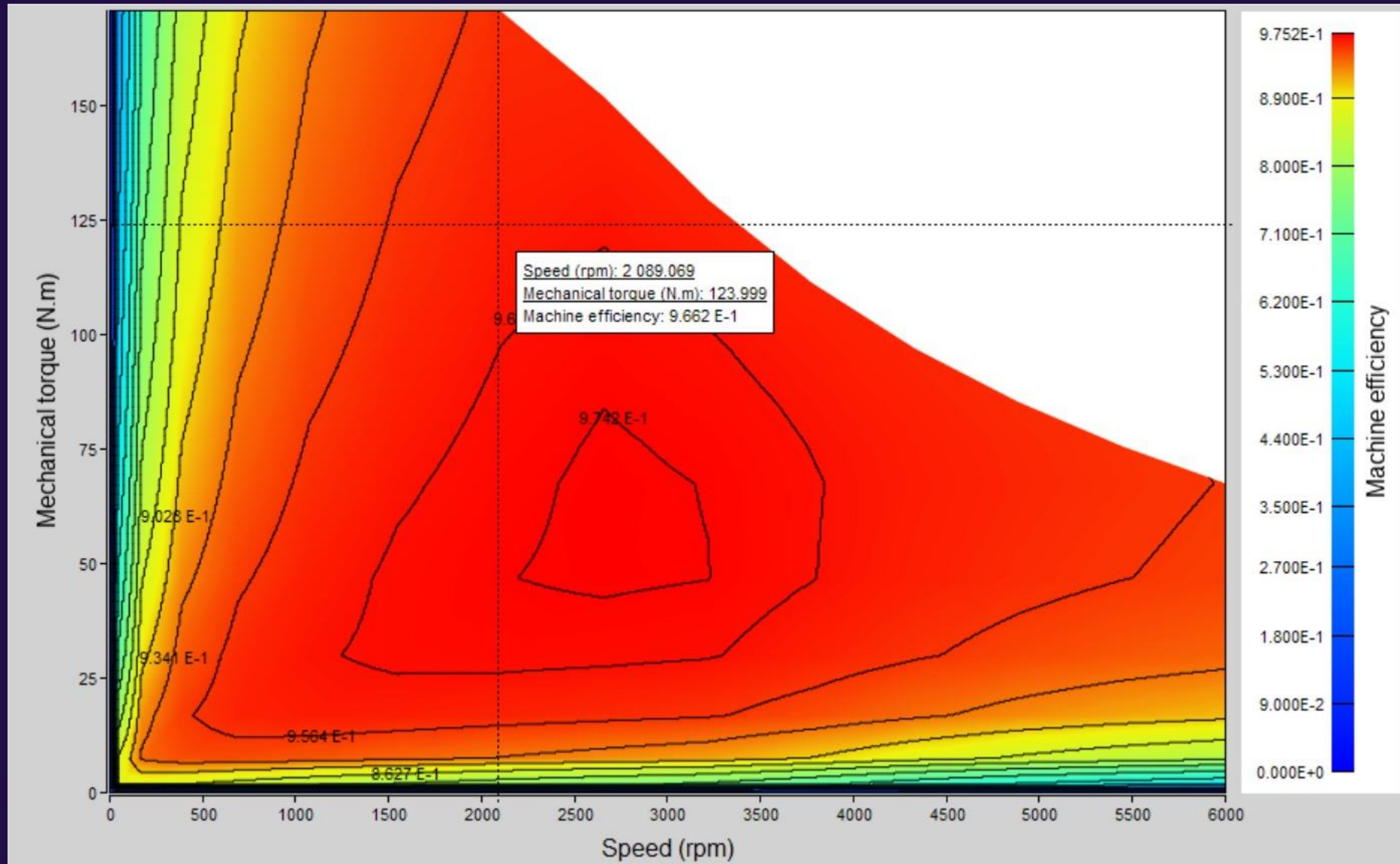
Machine performance - Working point

General data				
Operating mode	Motor			
Mechanical torque (N.m)	40.697	Speed (rpm)	2 800.0	Electrical frequency (Hz)
Mechanical power (W)	11 932.852	Machine electrical power (W)	12 279.933	Machine total losses (W)
Machine efficiency (%)	97.174	Apparent power (VA)	12 414.377	Reactive power (VAr)
Control angle (deg)	26.0	Power factor	9.892 E-1	Phase angle (deg)
Line current, rms (A)	14.6	Phase current, rms (A)	14.6	
Line-Line voltage, rms (V)	490.921	Phase voltage, rms (V)	283.433	
Machine constants				
Current density, rms (A/mm ²)	3.254	Electrical loading, rms (A/m)	17 623.28	Power density (W/kg)
kT (N.m/A)	1.971			
Power balance				
Machine total losses (W)	347.082	Joule losses (W)	163.88	
Mechanical losses (W)	0.0	Total Iron losses (W)	183.202	Additional losses (W)
Flux in airgap				
Flux density, ARV (T)	4.568 E-1	Flux density 1st harm., rms (T)	4.893 E-1	Flux density, peak (T)
Flux / pole, ARV (Wb)	4.058 E-3	Flux / pole 1st harm., rms (Wb)	4.347 E-3	Flux / pole, peak (Wb)
Flux density in iron				
Stator tooth, max (T)	1.504	Stator tooth, mean (T)	8.253 E-1	
Stator foot tooth, max (T)	1.913	Stator foot tooth, mean (T)	8.516 E-1	
Stator yoke, max (T)	1.472	Stator yoke, mean (T)	4.935 E-1	
Rotor yoke, max (T)	1.446	Rotor yoke, mean (T)	4.964 E-1	
Rotor bridge, max (T)	2.3	Rotor bridge, mean (T)	1.648	
Rotor pole shoe, max (T)	2.291	Rotor pole shoe, mean (T)	1.132	
Interpole, max (T)	1.730	Interpole, mean (T)	7.571 E-1	

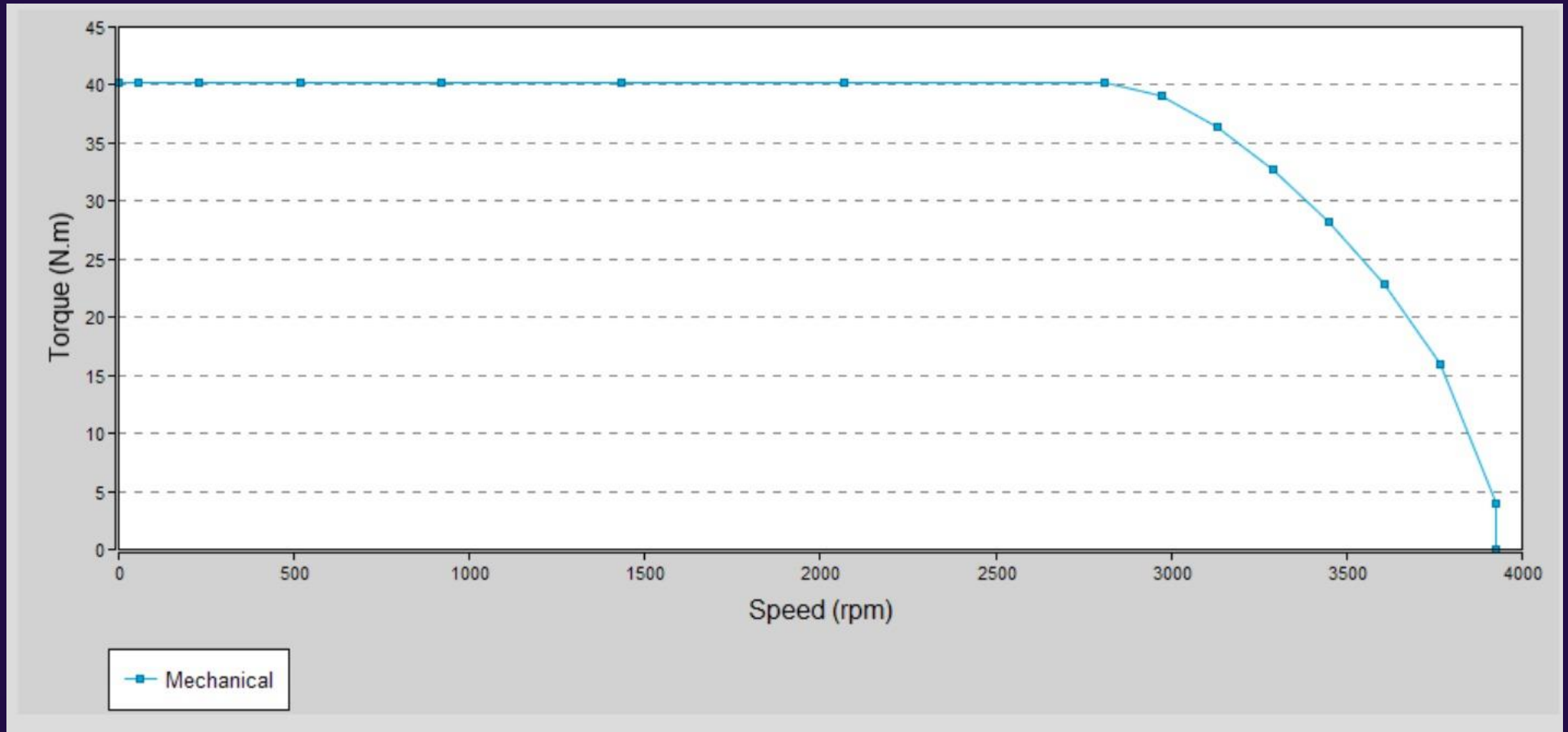
Isovalues



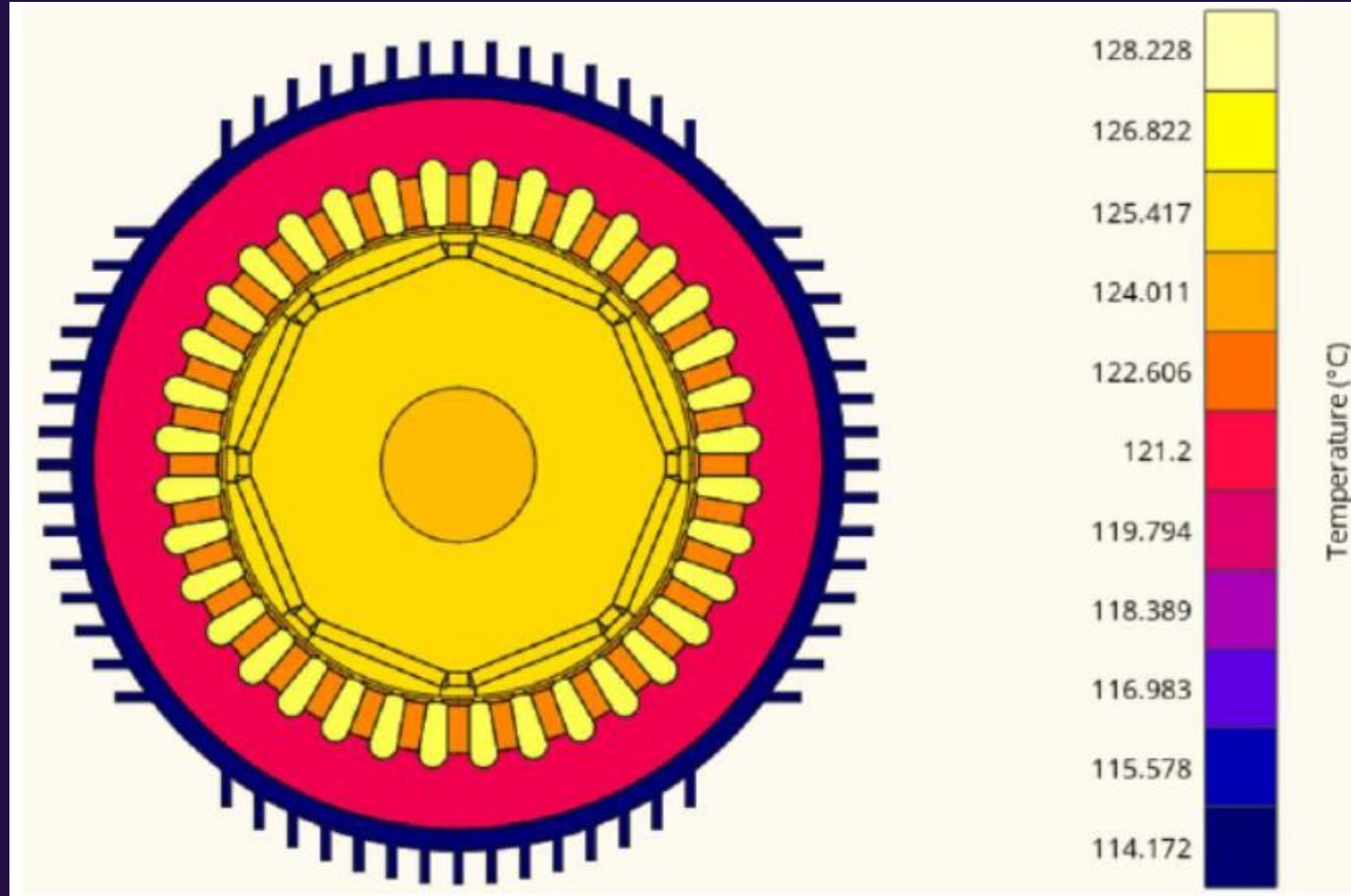
EFFICIENCY MAP



TORQUE VS SPEED MAP



THERMAL RESULTS



FEA ANALYSIS

The screenshot displays a finite element analysis (FEA) software interface, likely ANSYS Maxwell, showing a simulation of a circular rotor assembly. The main window displays a color-coded magnetic flux density distribution. The rotor is a circular assembly with a central core and an outer ring, with a complex internal structure. The flux density is highest in the central region and lowest in the outer regions. A color scale legend is visible on the left, ranging from 1.700 (yellow) to 18.177E-6 (dark blue). The right panel shows the properties for the selected object, '4_ISOVAL_NO_INFINITE', with a maximum value of 1.7E0 and a minimum value of 18.176858E-6. The bottom panel shows the output window with the text 'Integral along the curve = -1460.49' and the PyFlux Command window with a command prompt and a log file showing the command 'EvolutionaryCurve2D(name='EvolutionaryCurve2D_4', ... formula=['U(PHASE_1_PP_1)-U(PHASE_2...

Data Tree

- General data
 - Geometry
 - Mesh
 - Physics
 - Parameter/Quantity
 - Solver
 - Post processing
 - Tools
 - Extensions

Graphic

4_ISOVAL_NO_INFINITE
Magnetic flux density / Vector in T

Magnetic flux density / Vector in T
1.700
1.600
1.500
1.400
1.300
1.200
1.100
1.000
900.009E-3
800.010E-3
700.011E-3
600.012E-3
500.013E-3
400.014E-3
300.015E-3
200.016E-3
100.017E-3
18.177E-6

4_ISOVAL_NO_INFINITE : Magnetic flux density / Vector in T

Displayed values

Default values

Max: 1.7E0

Min: 18.176858E-6

Colour scale

Flux colour scale

2 10 20 30 40 50 60

Save properties

Load properties

GeometryFlux2DView CircuitView EVOLUTIVECURVE2D_1 EVOLUTIVECURVE2D_2 EVOLUTIVECURVE2D_3 EVOLUTIVECURVE2D_4

Output

Integral along the curve = -1460.49

PyFlux Command

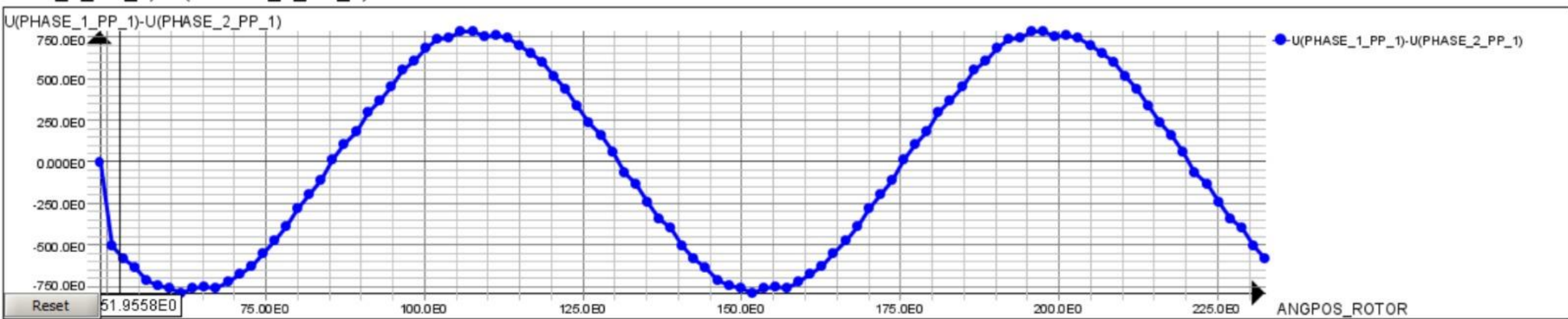
Command prompt

```
1
```

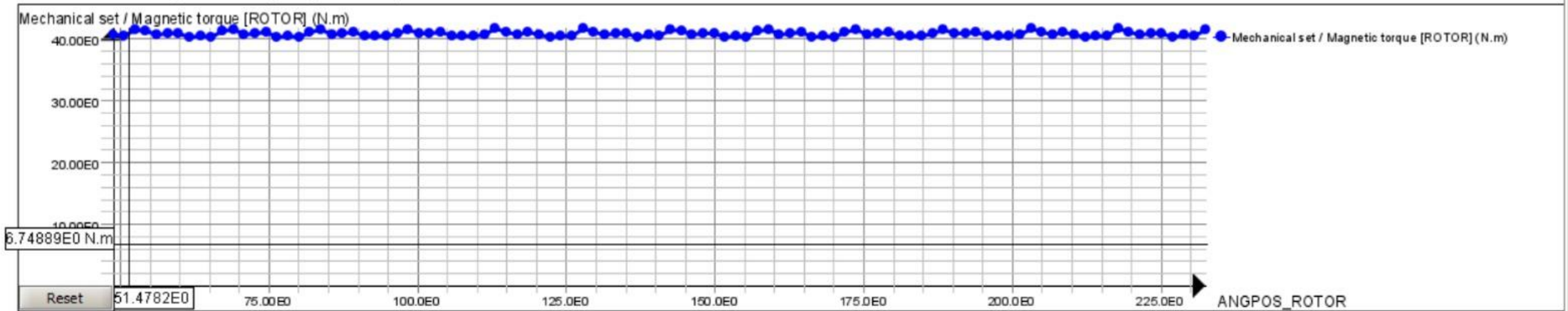
Flux2D_log.py | Project_PyFlux_Log.py

```
21  
22 EvolutionaryCurve2D(name='EvolutionaryCurve2D_4',  
23 .....evolutionaryPath=EvolutionaryPath(paramet  
24 .....  
25 .....  
26 ..... formula=['U(PHASE_1_PP_1)-U(PHASE_2  
27 .....  
28 .....
```

FEA ANALYSIS



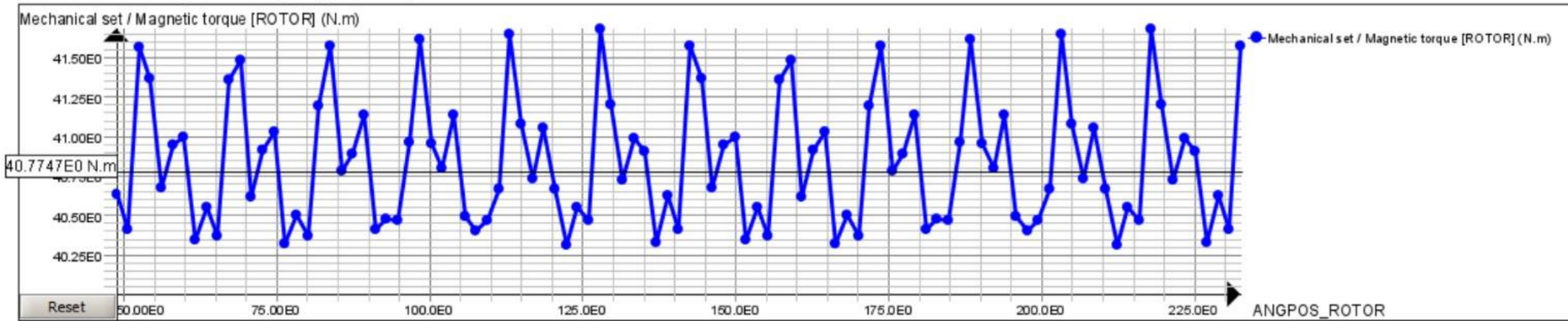
Mechanical set / Magnetic torque [ROTOR]



TORQUE RIPPLE ANALYSIS

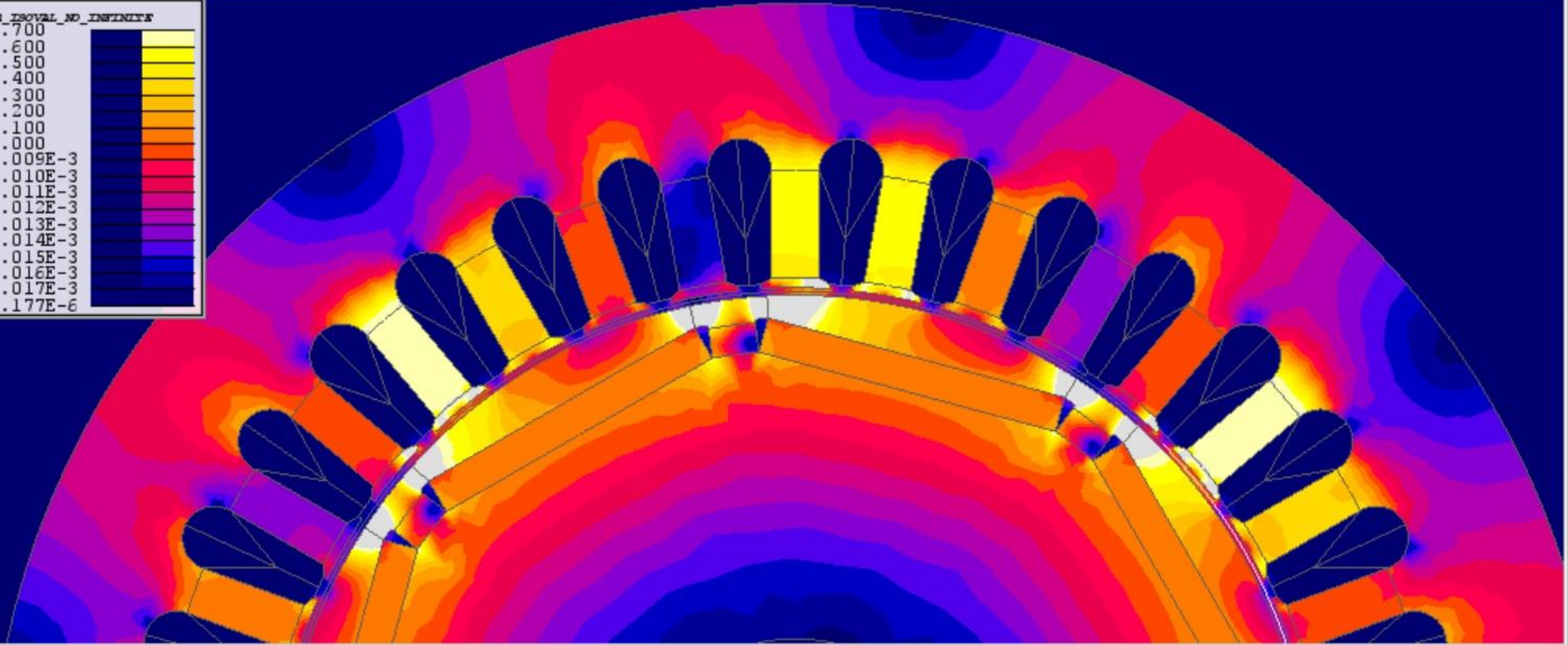
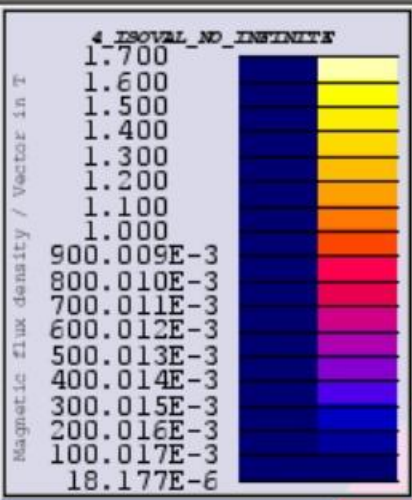
EVOLUTIVECURVE2D_1

Mechanical set / Magnetic torque [ROTOR]



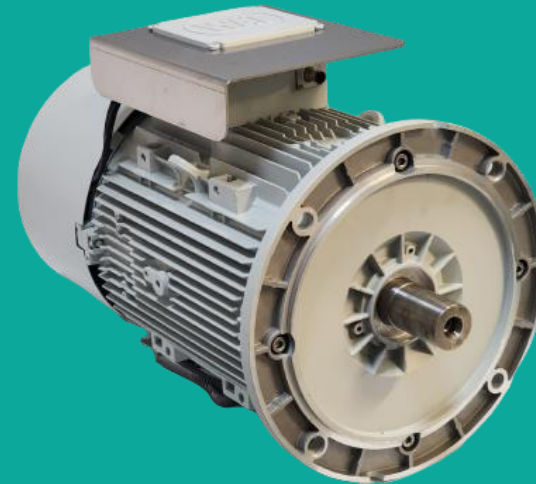
Torque Ripple = 3,06

MAGNETIC SATURATION



DESIGN RESULTS

	Design Requirements	Design Results
Max. Current	<15 A	14.6 A
Maximum speed	<4400 rpm	4000 rpm
Maximum torque	160 Nm	160 Nm
Minimum Efficiency	92	96,67
Cooling Type	Self cooling	Self cooling decided



Contact Us



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