

Test, Disassembly and FEA of a Single-Phase IM

Ali Jamali Fard

<https://ComProgExpert.com>

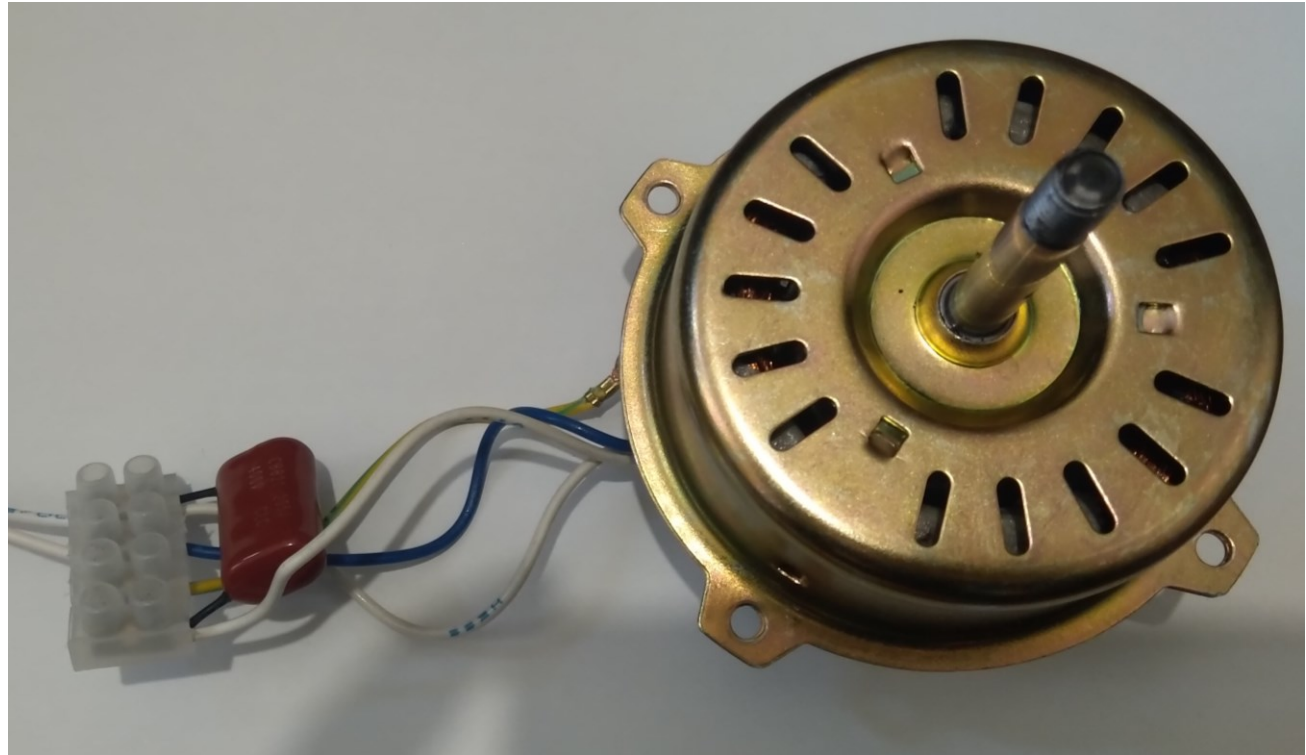
Motor nameplate

$$P_{in} = 52W$$

$$V_t = 220V @ 50Hz$$

$$Speed = 2400RPM$$

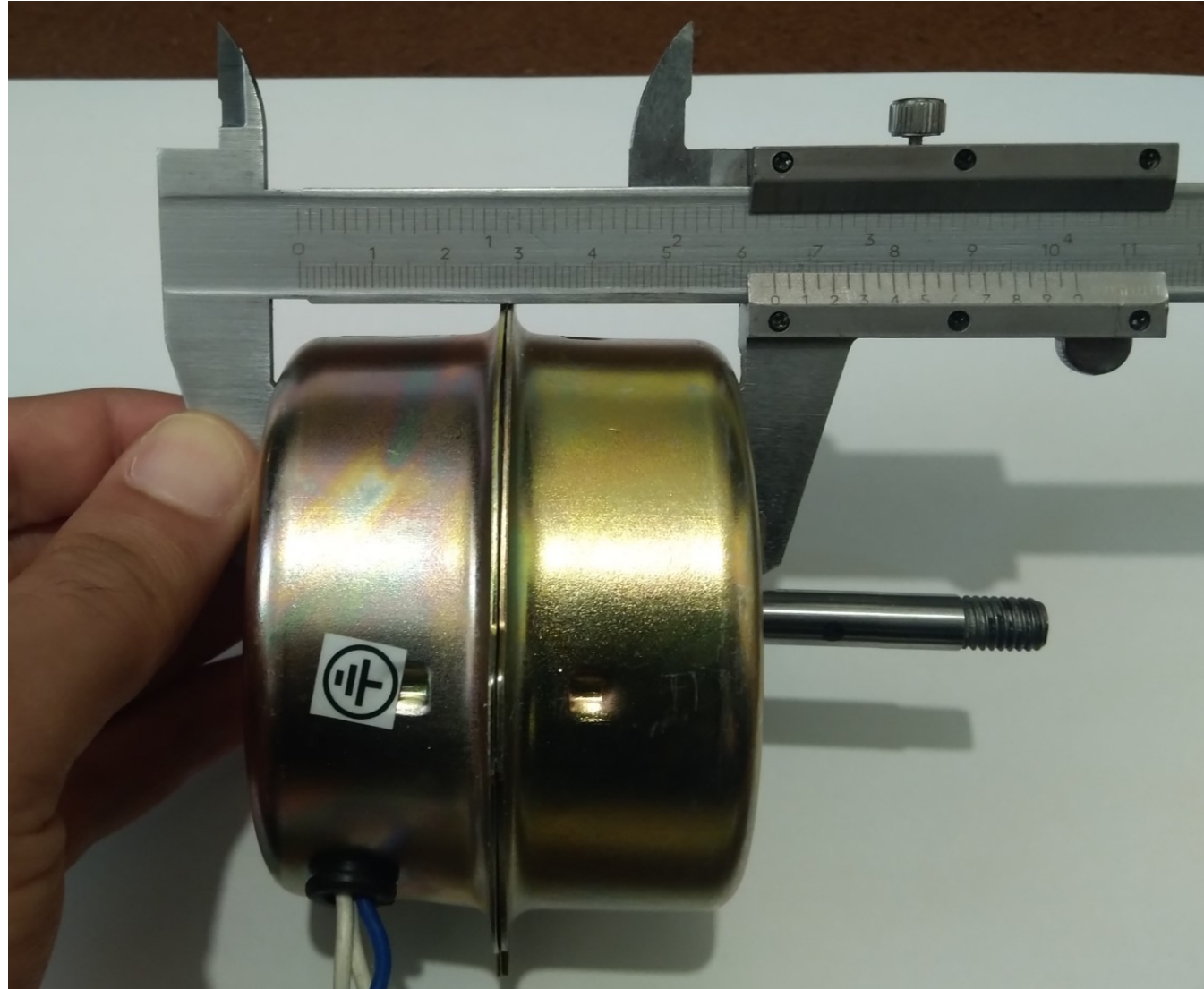
$$PF \geq 0.98$$



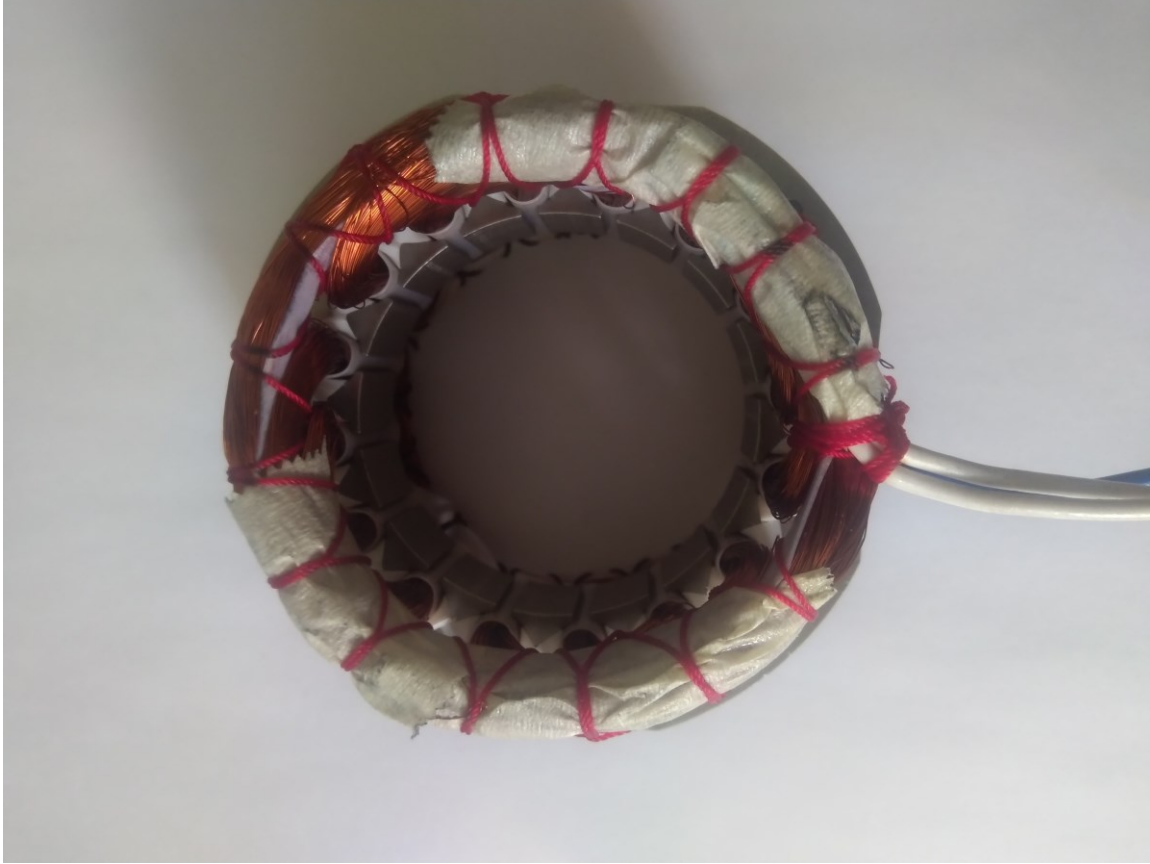
Outer diameter with housing



Axial length with housing



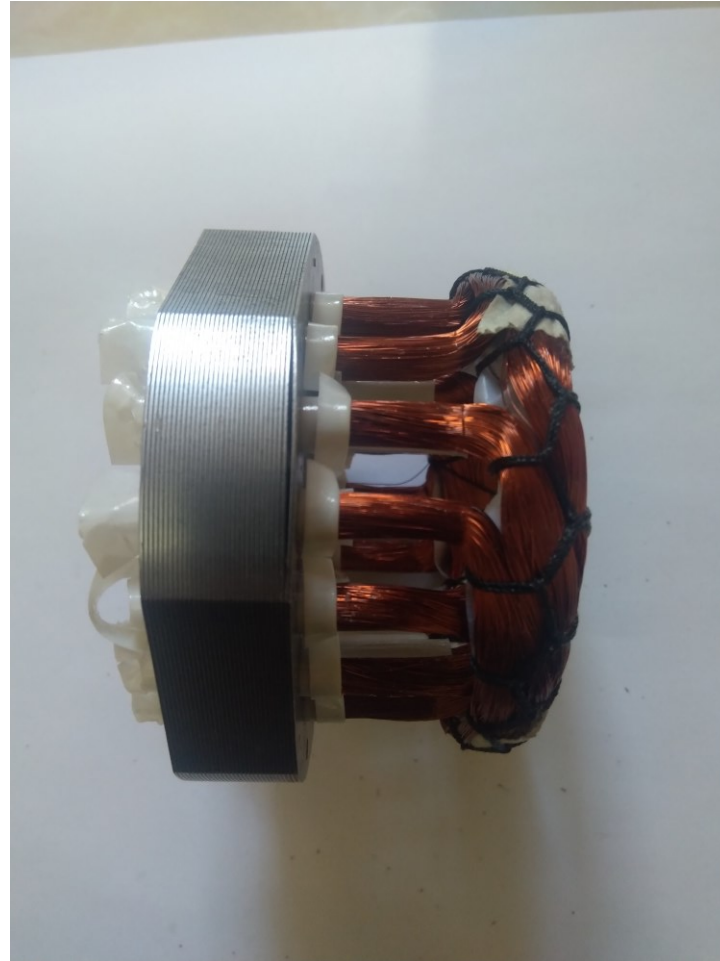
Stator & winding



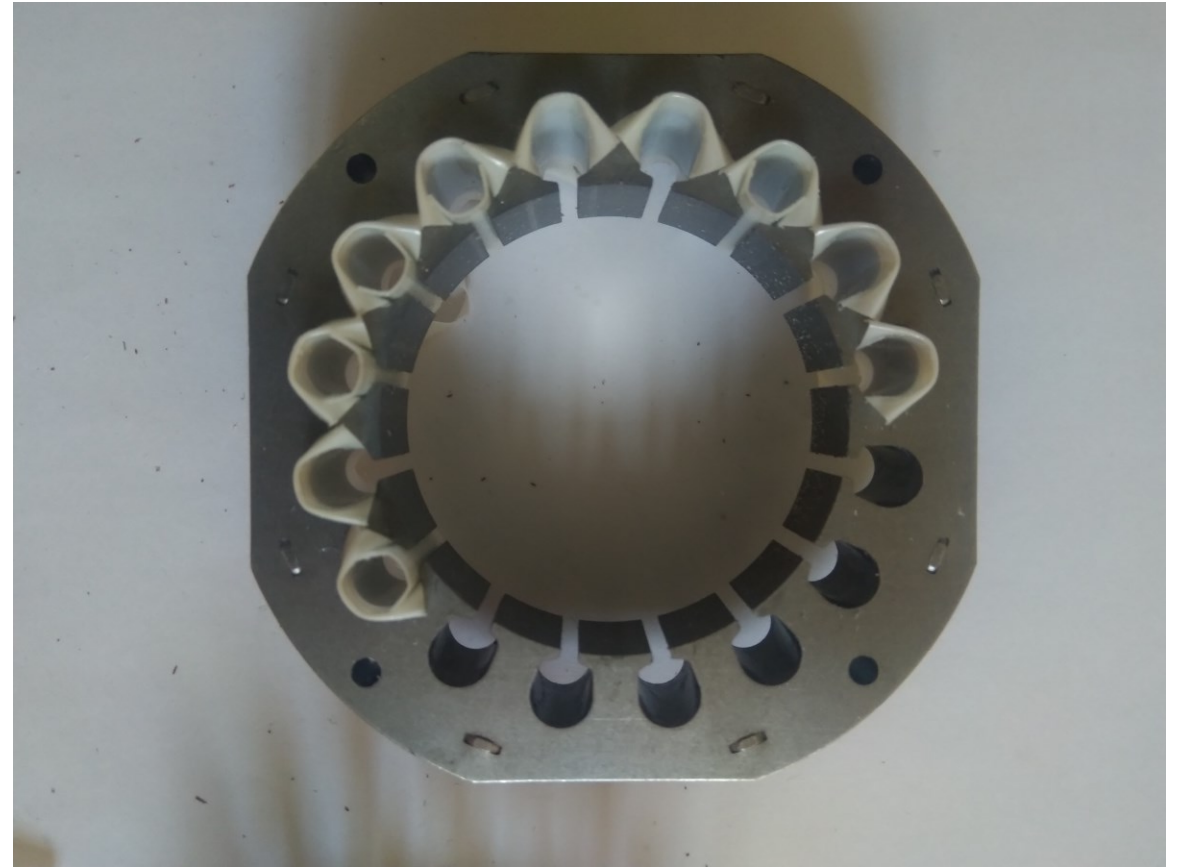
Winding destruction



Winding destruction



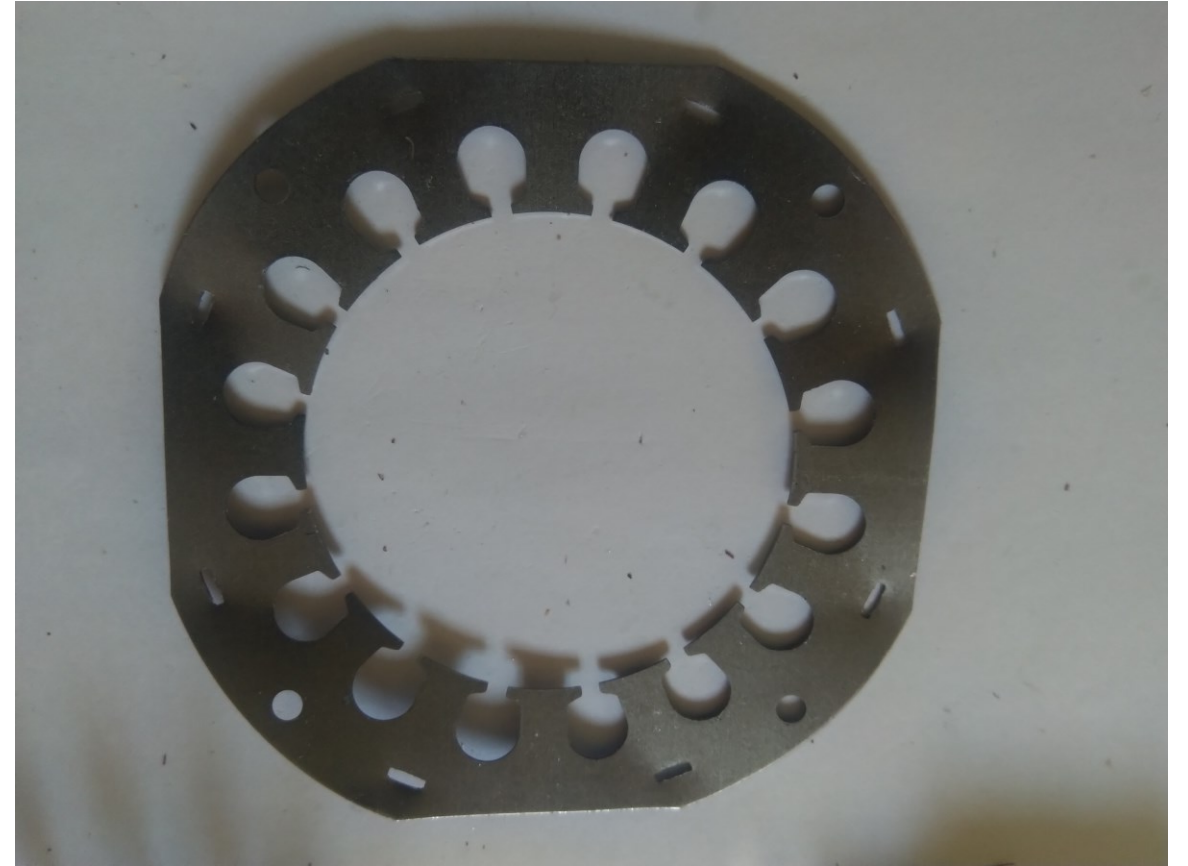
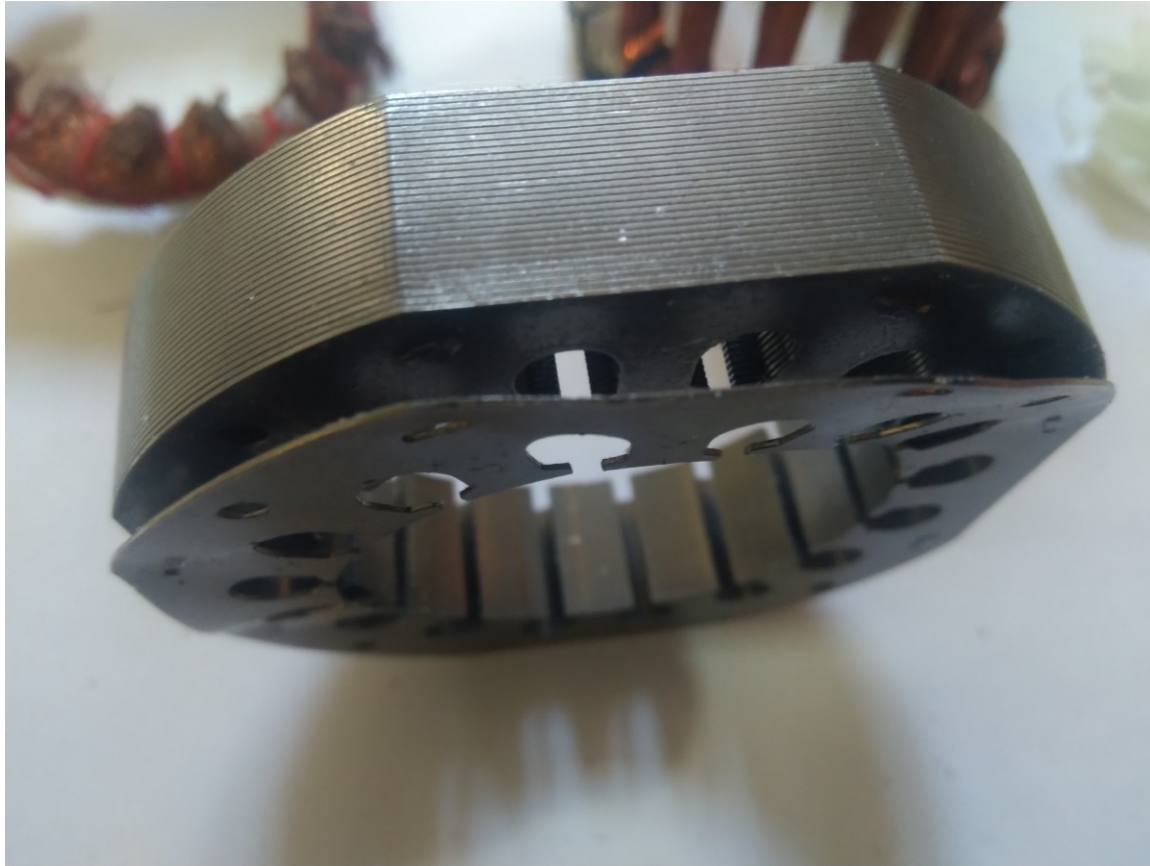
Slots insulation



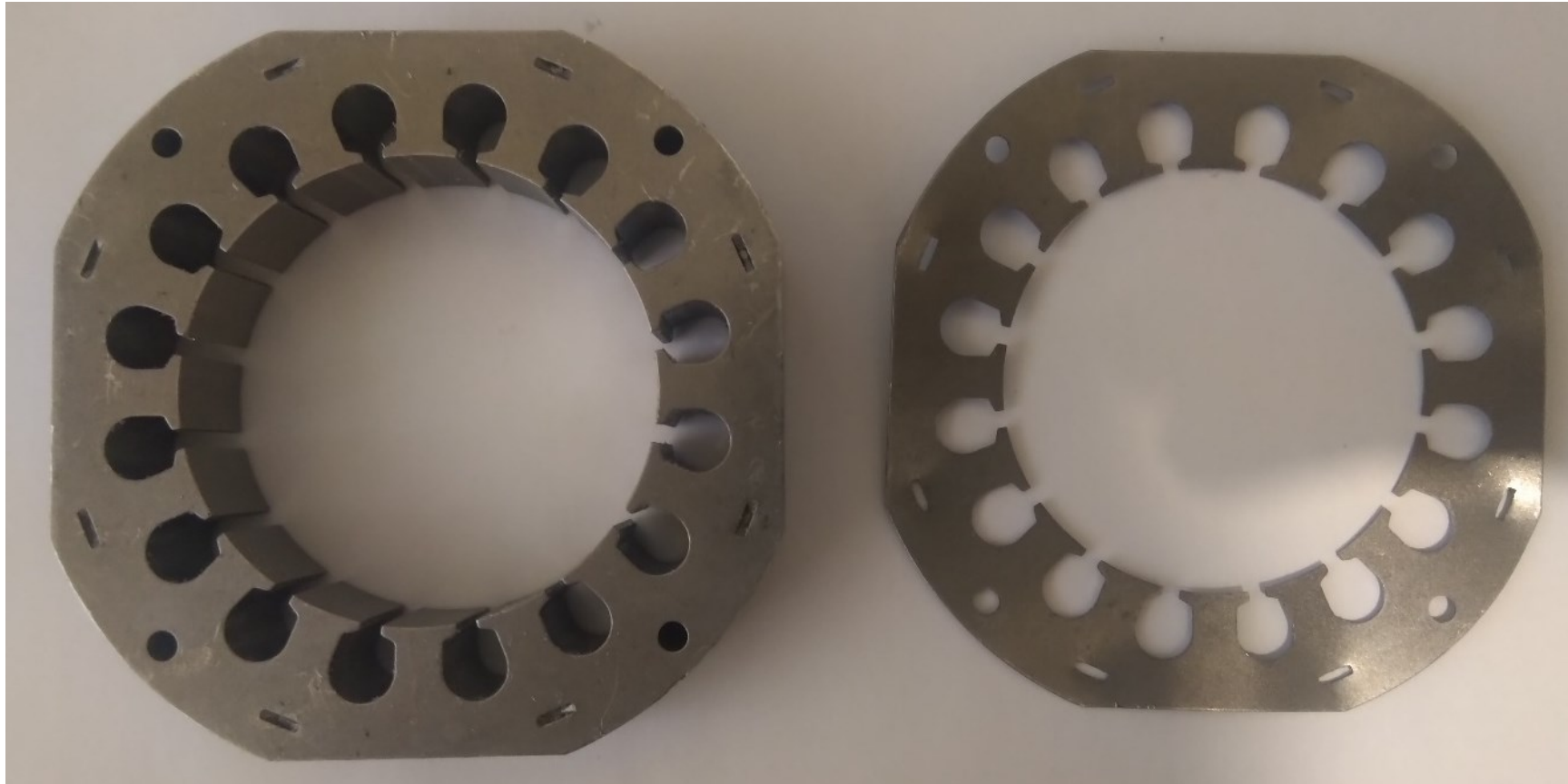
Stator parts



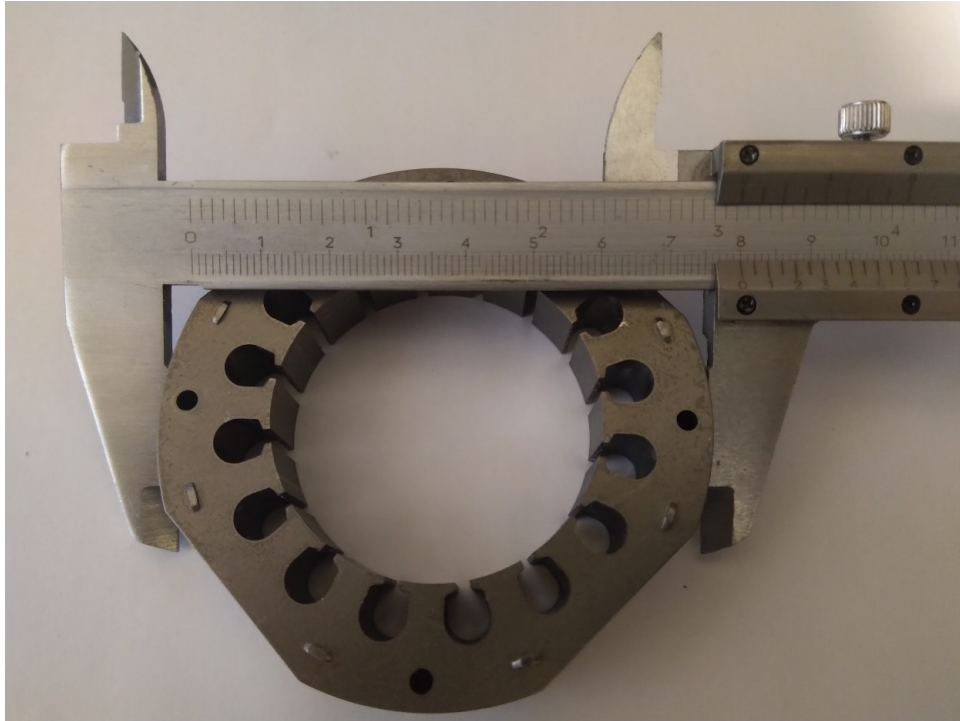
Stator lamination



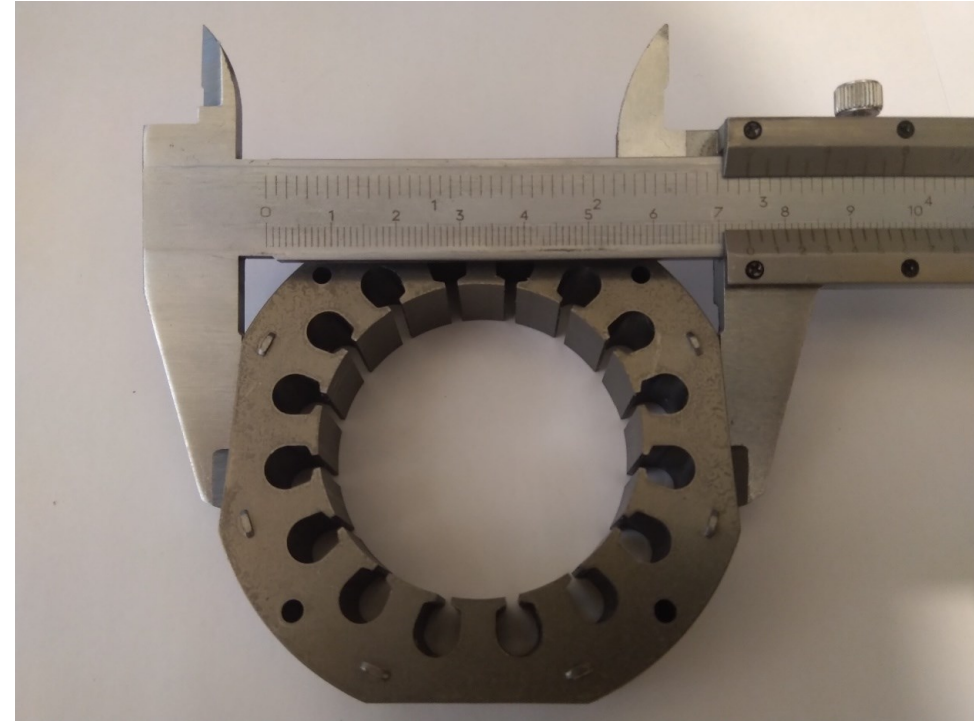
Stator core & stator lamination



Outer stator diameter & width

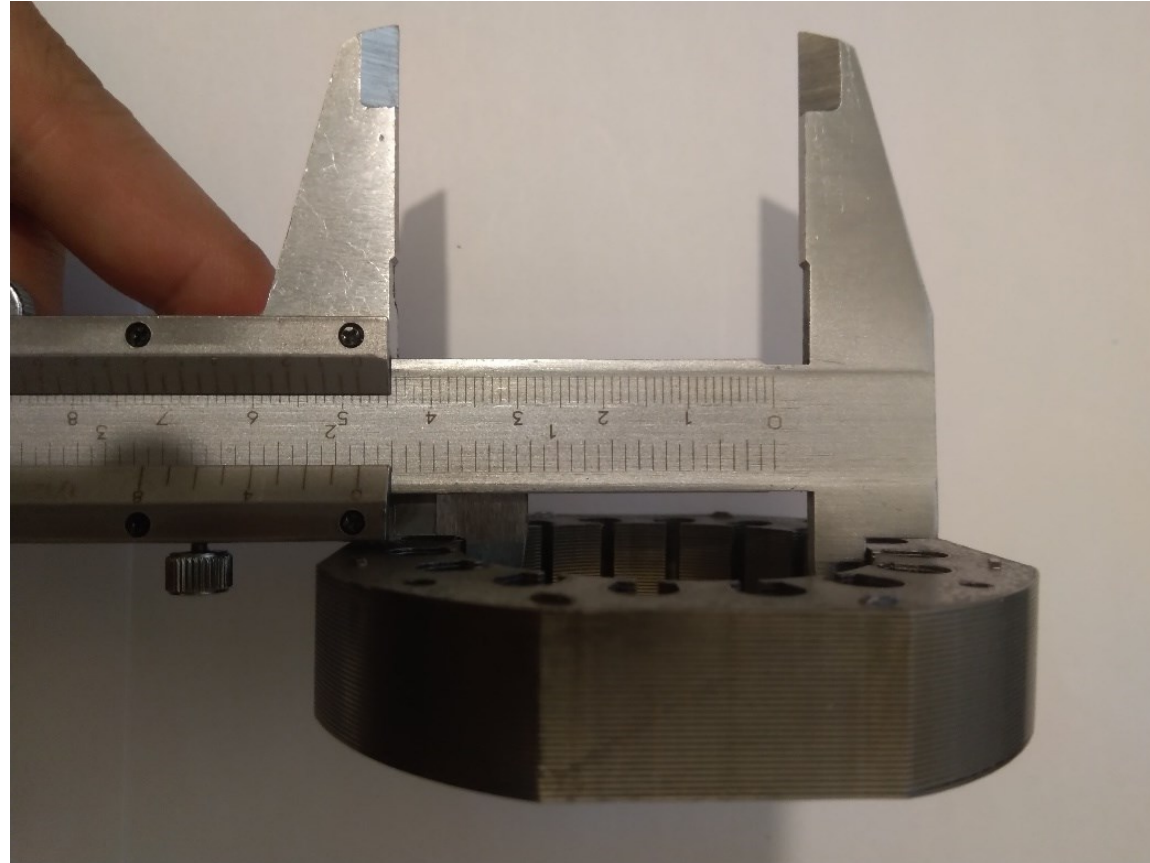


$OSD = 80mm$



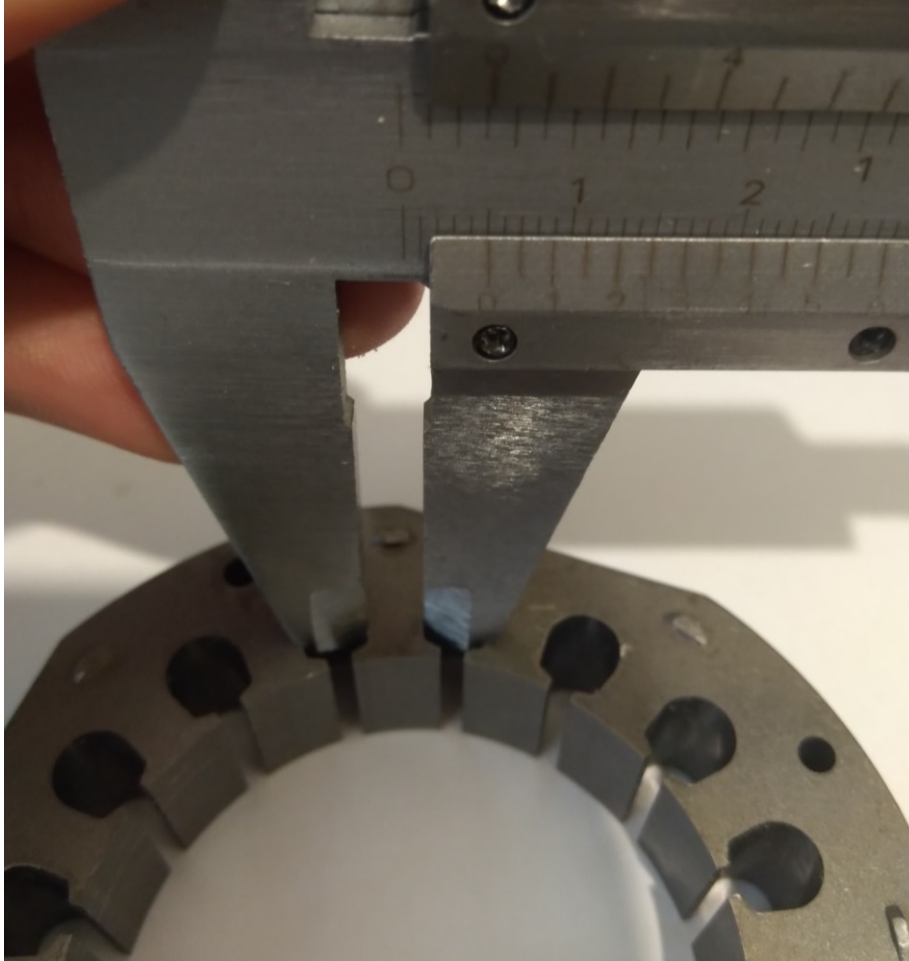
$OSW = 74mm$

Stator bore diameter

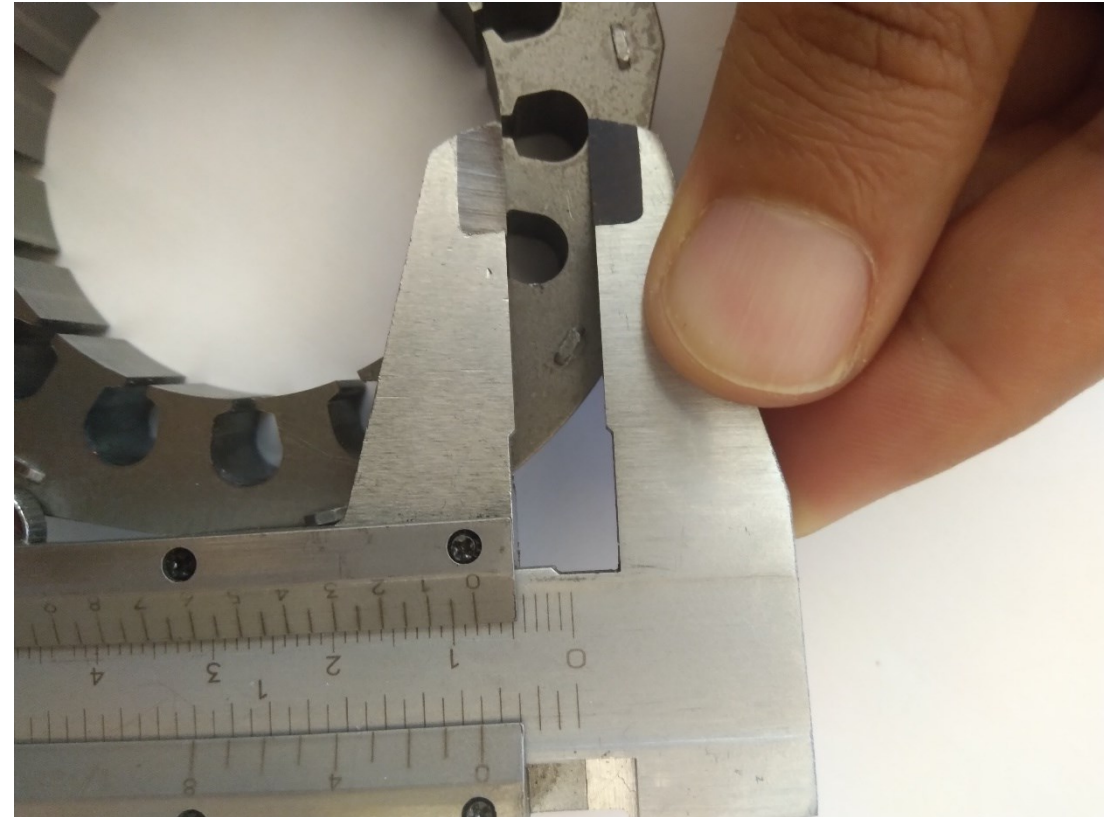


$$D = 48\text{mm}$$

Stator slot dimensions

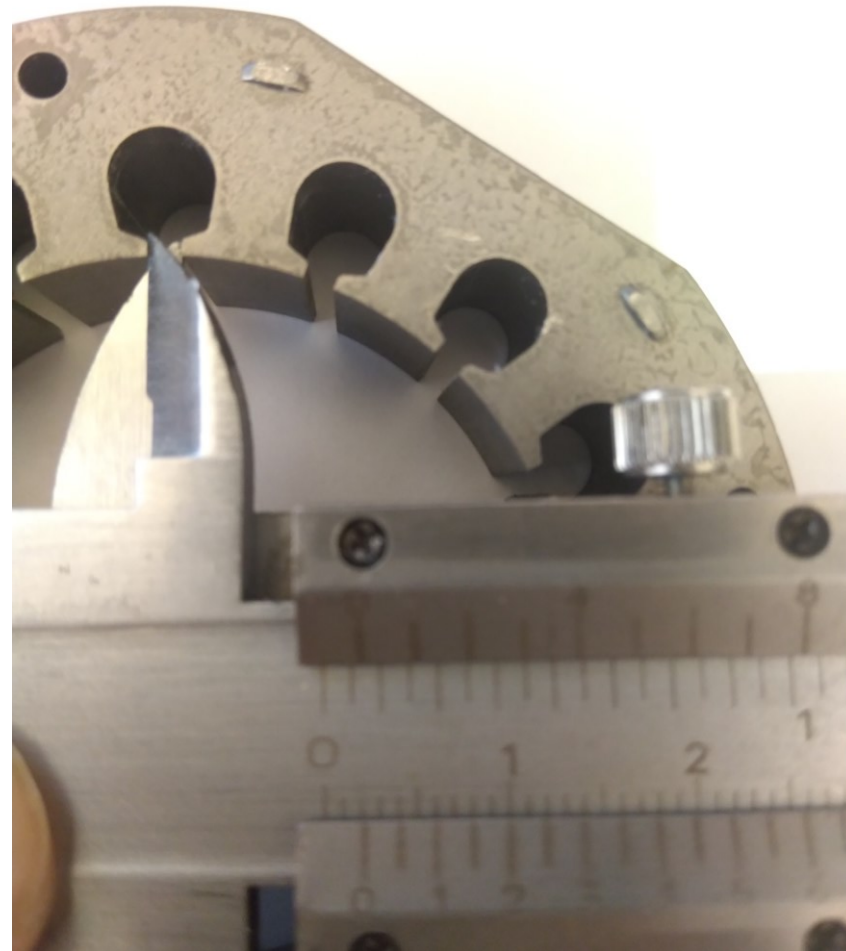


$$w_{st} = 5\text{mm}$$



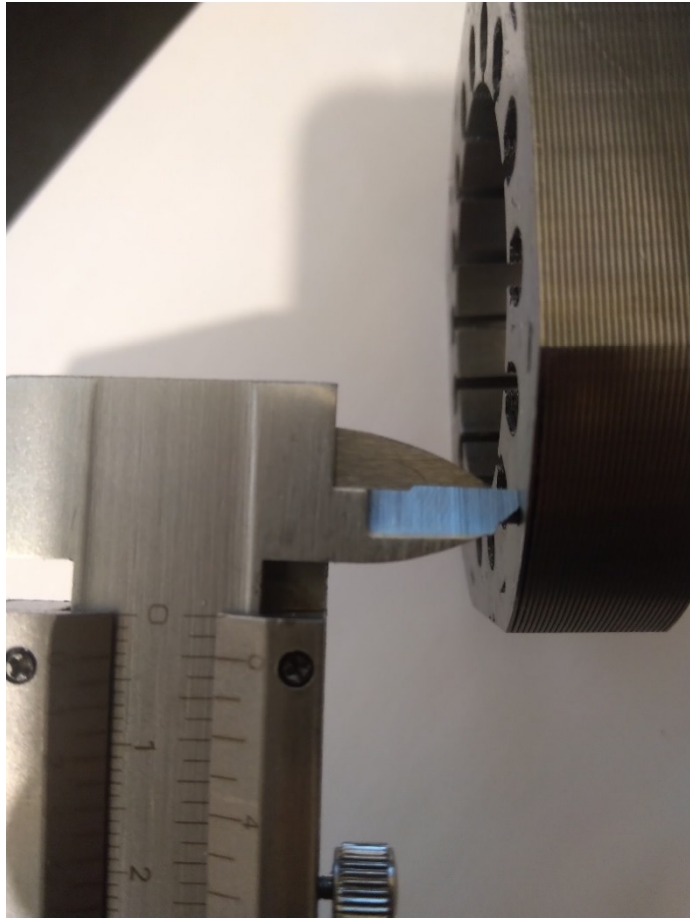
$$h_{s2} = 6\text{mm}$$

Stator slot opening

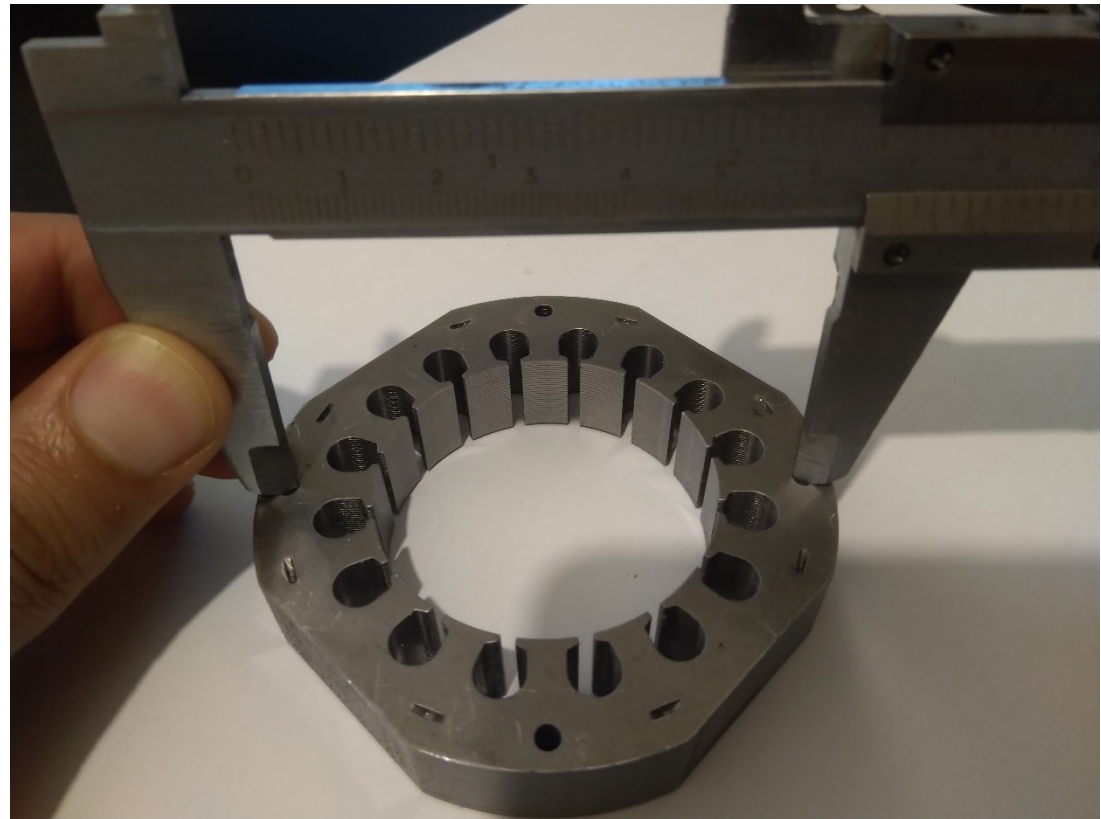


$$bs_0 = 2\text{mm}$$

Stator guide hole

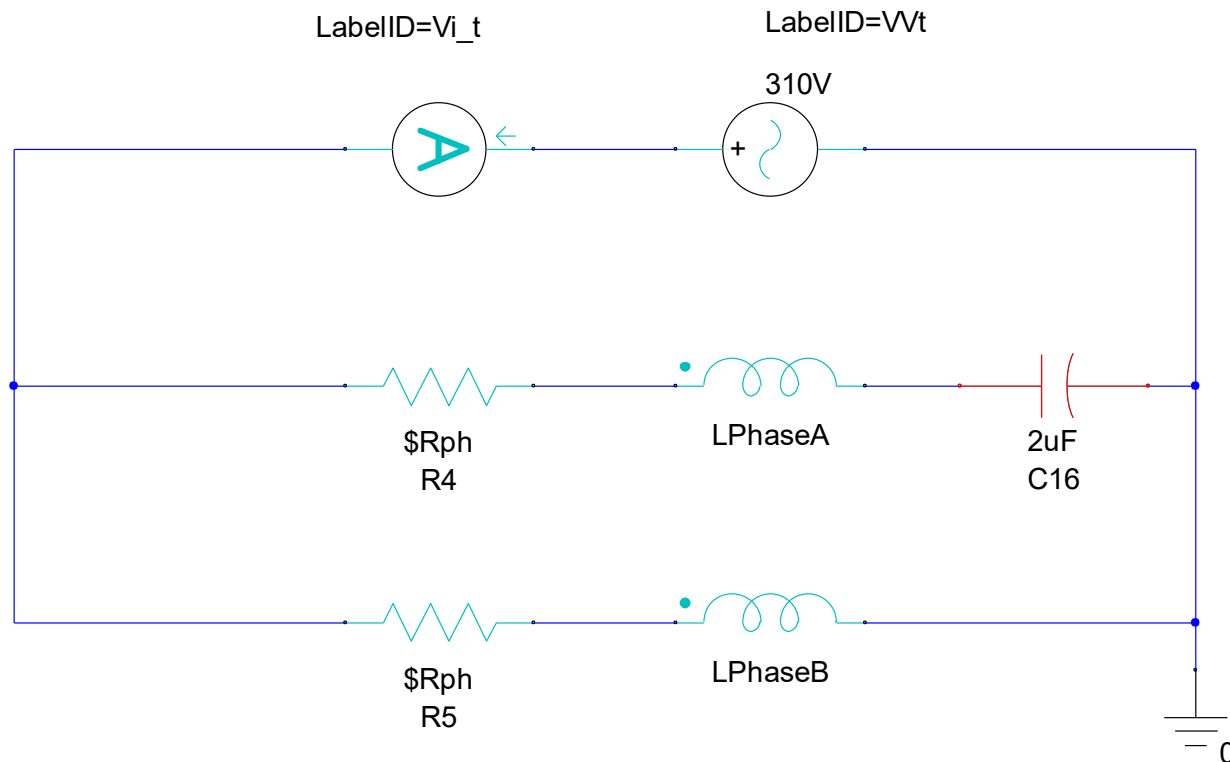


$SGHD = 3mm$



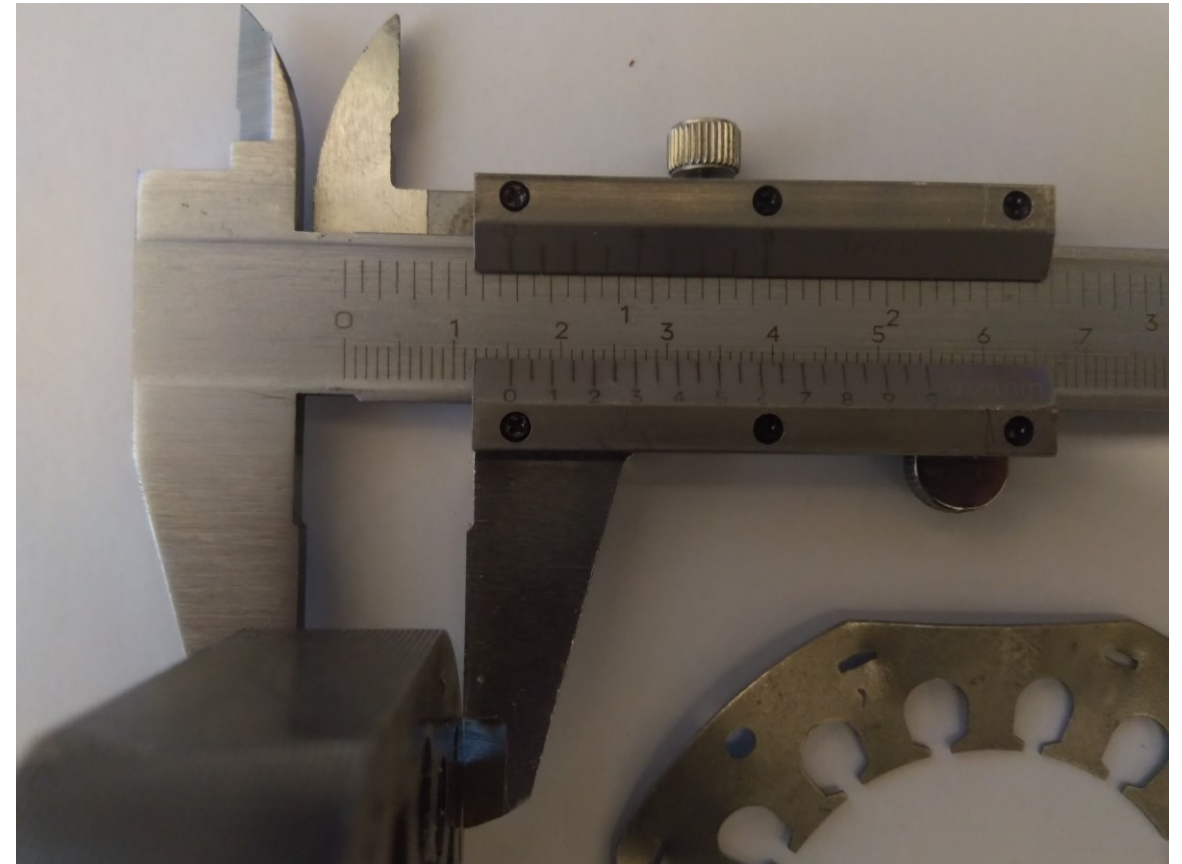
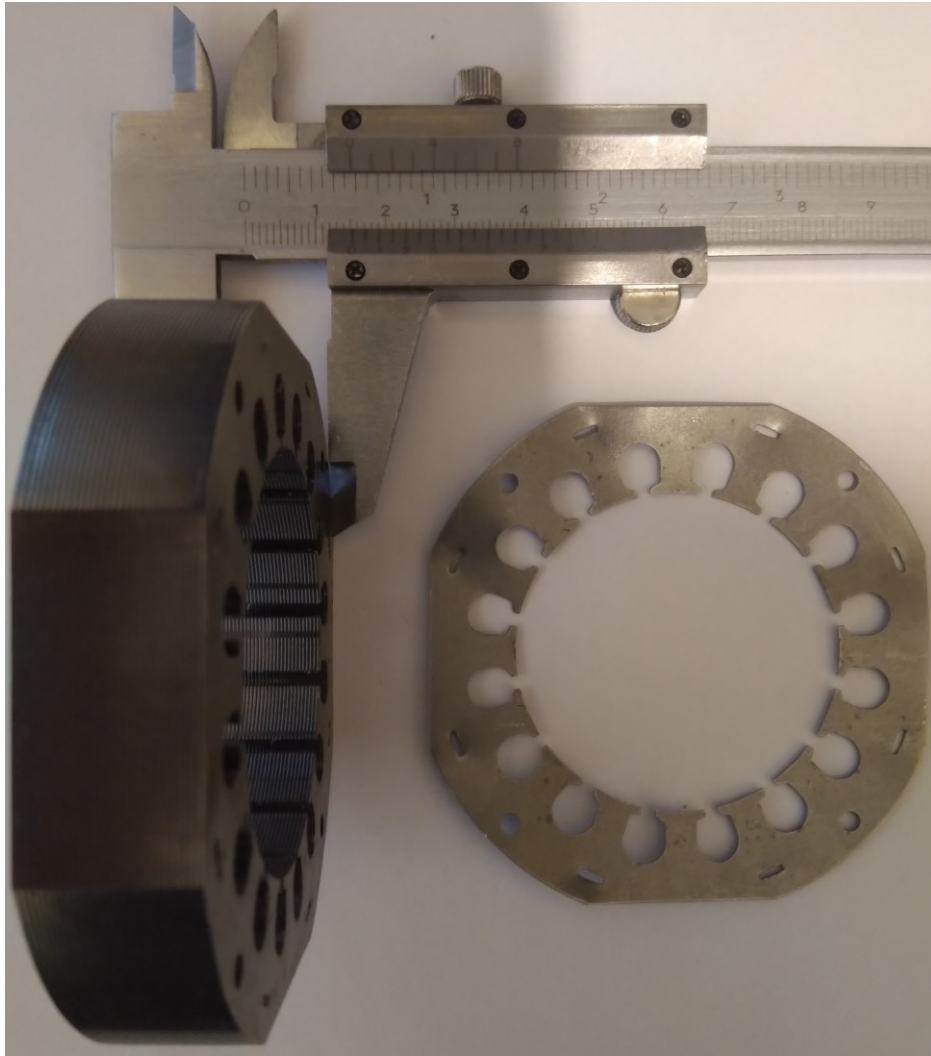
$SGHD = 70mm$

Capacitance of the series capacitor



$$C = 2\mu F$$

Motor stack length



$$L_{stk} = 16\text{mm}$$

Number of turns per coil



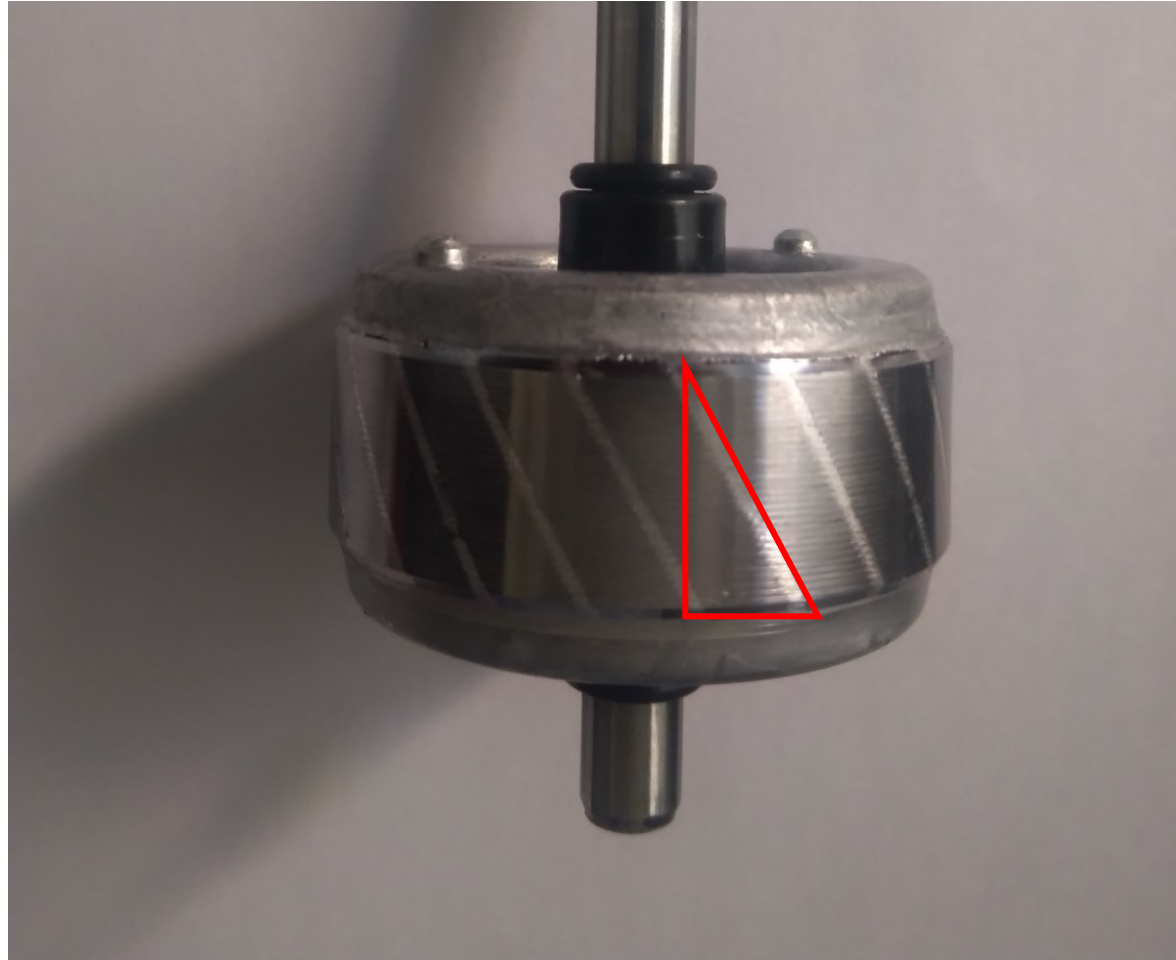
Rotor destruction



Rotor slot geometry



Skew angle



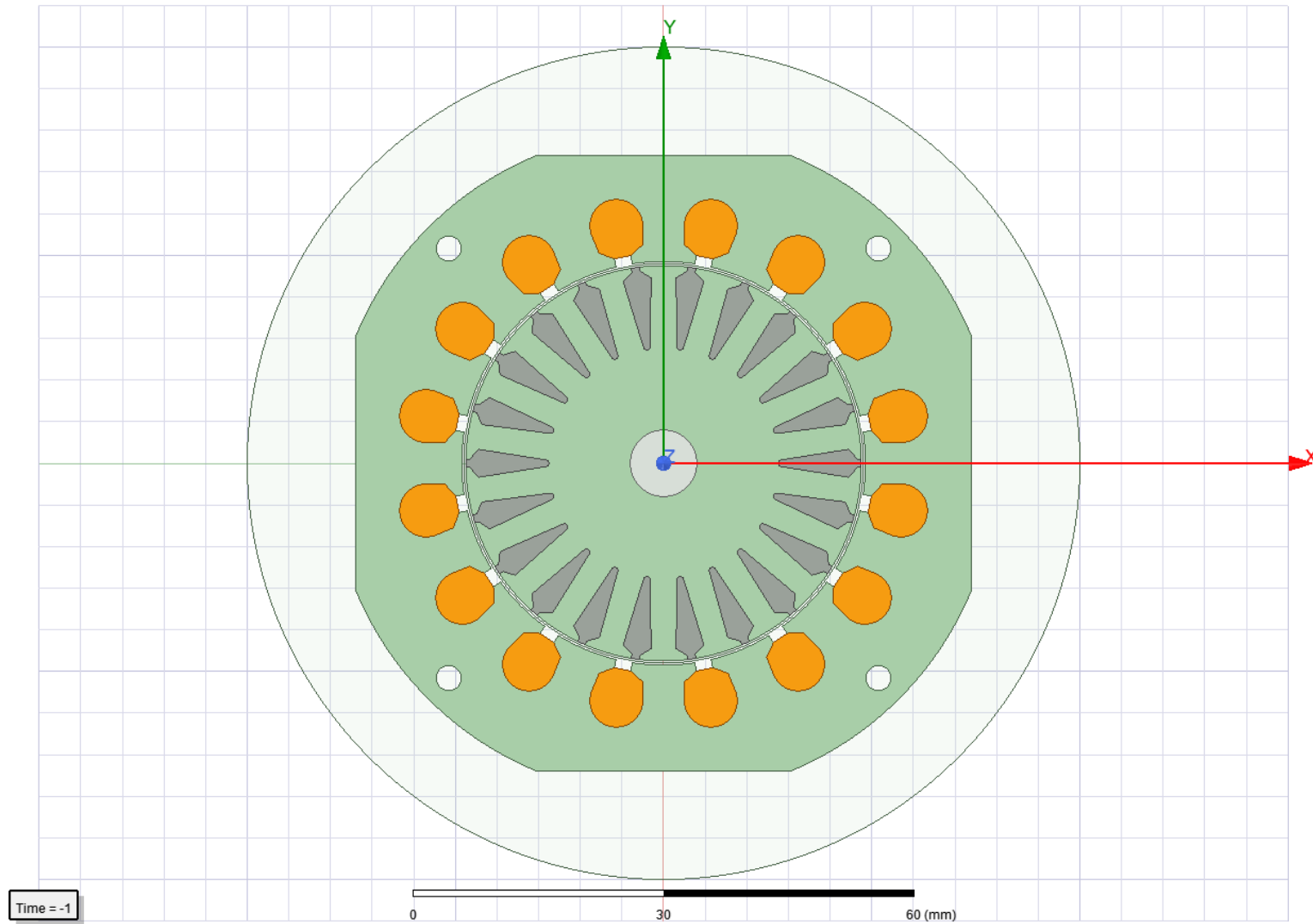
End ring impedance



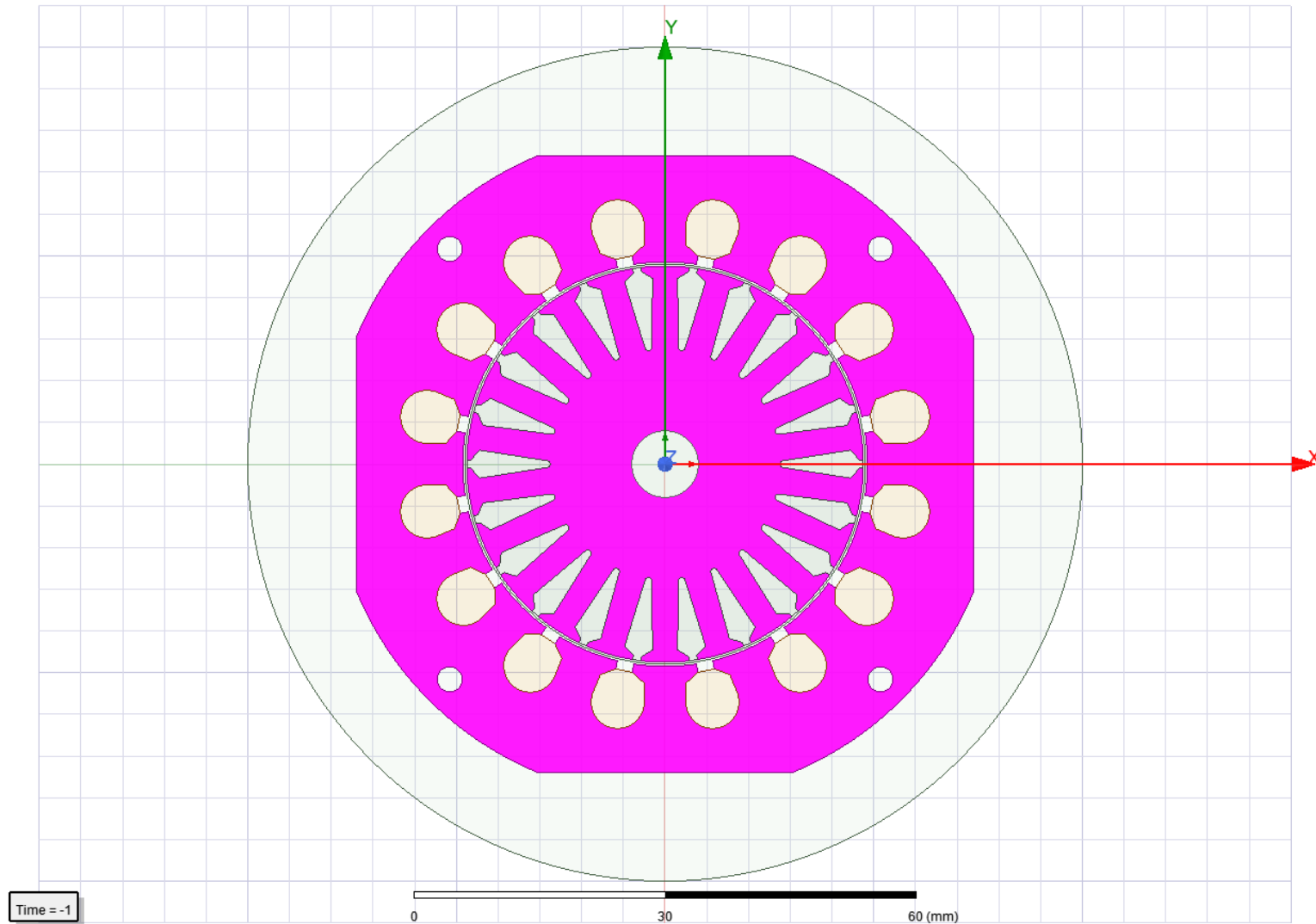
Finite element analysis

Calculation of the motor parameters & performance by FEA

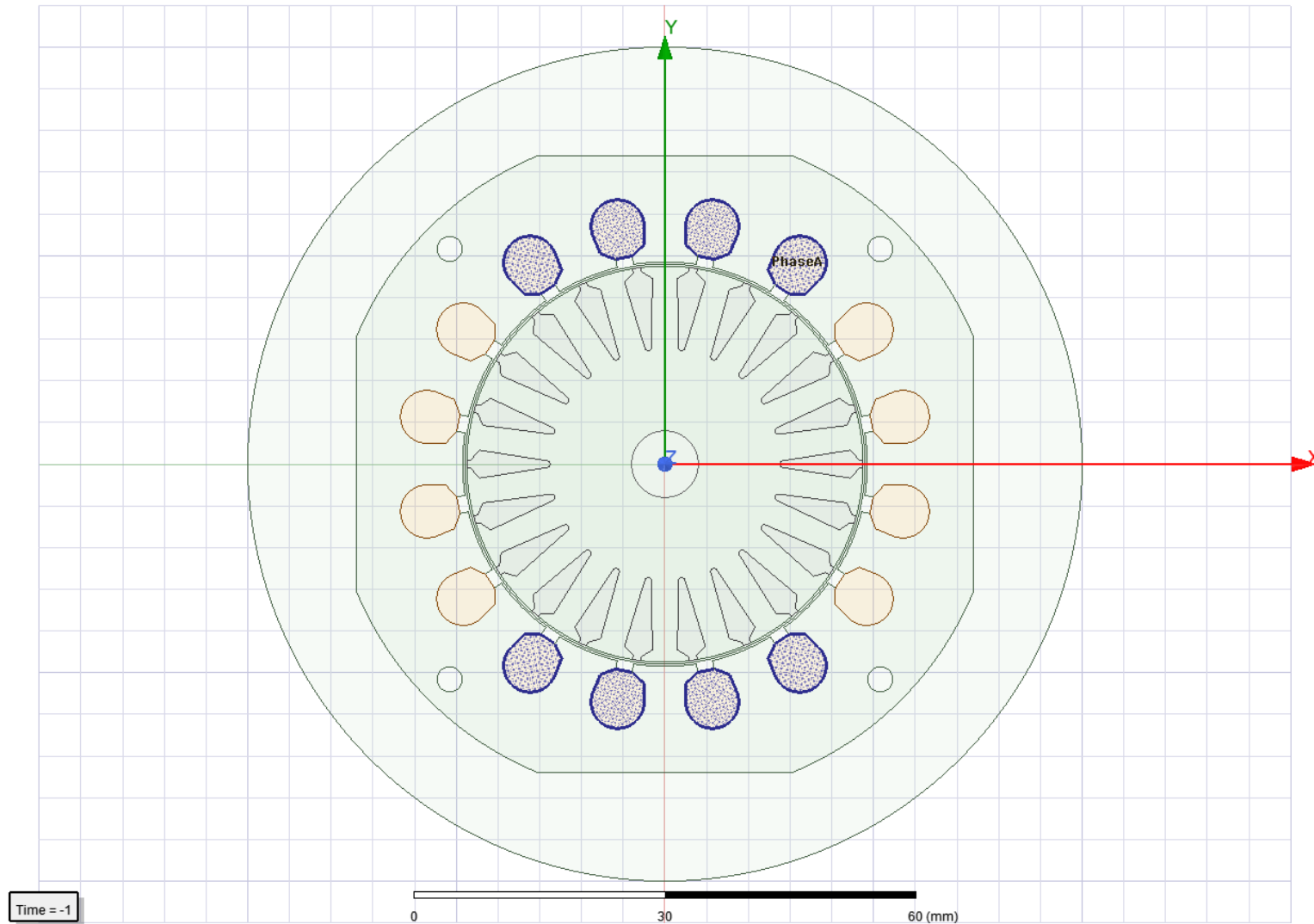
FEA Model



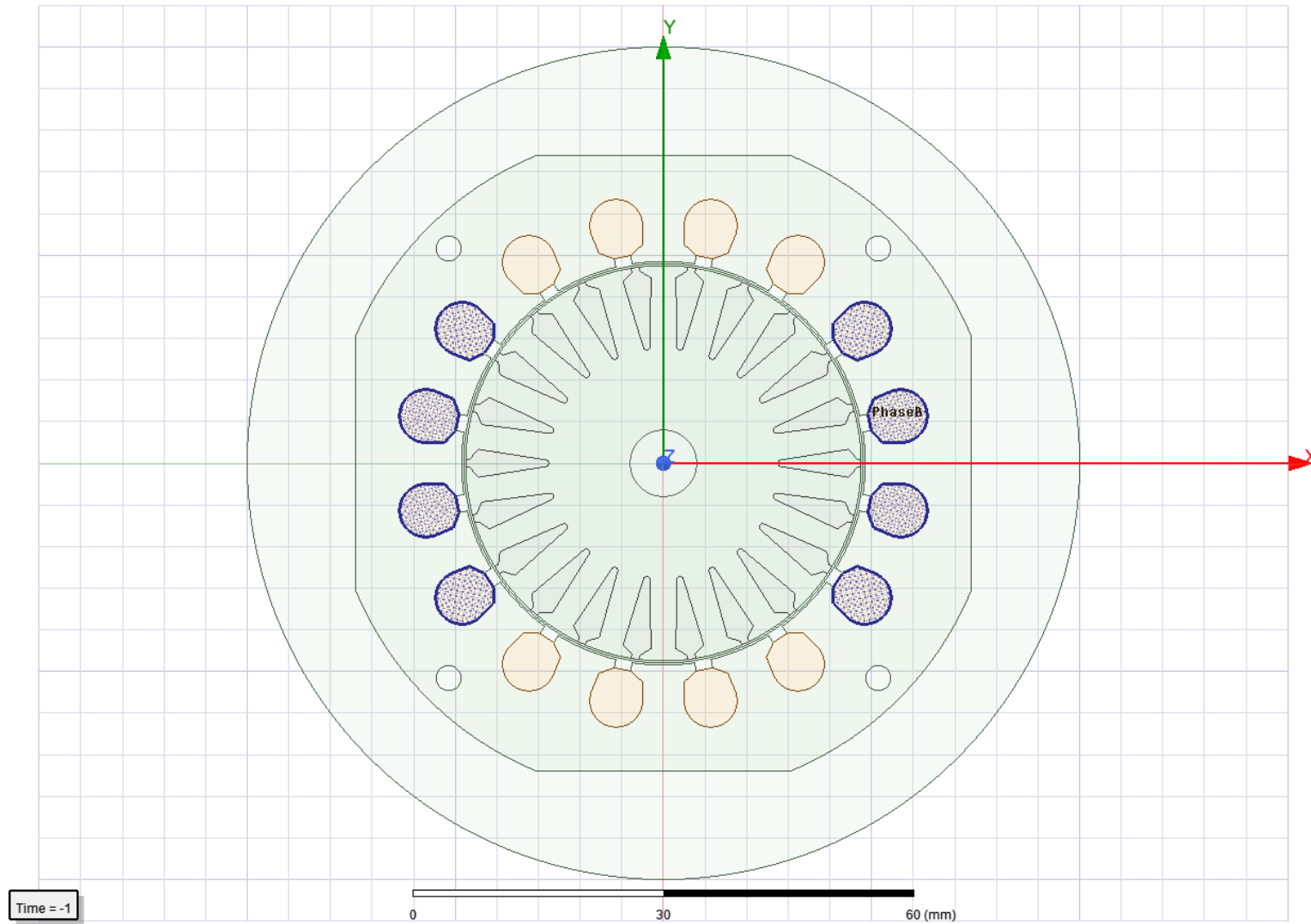
Stator and rotor lamination



Phase A



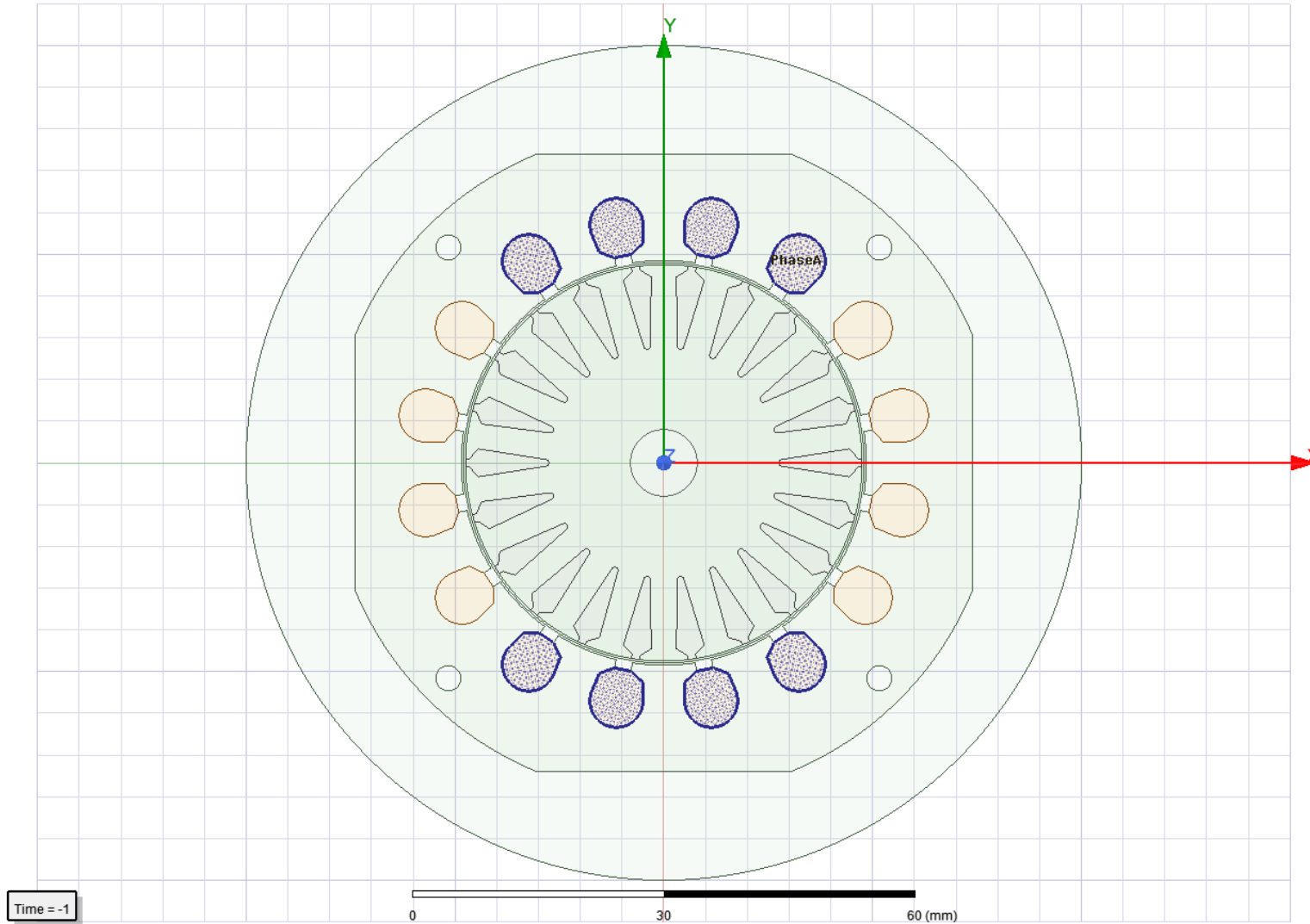
Phase B



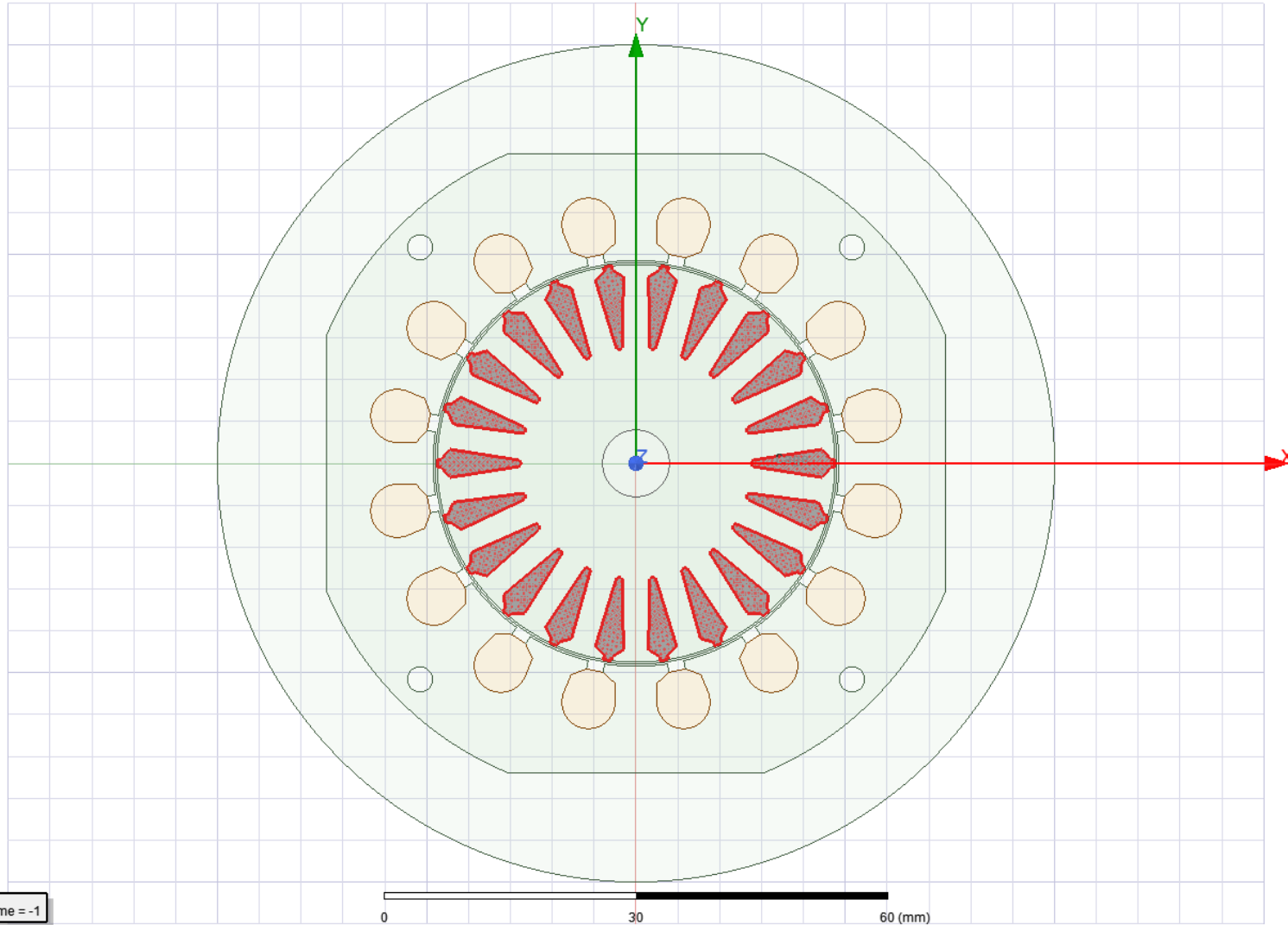
Stator winding



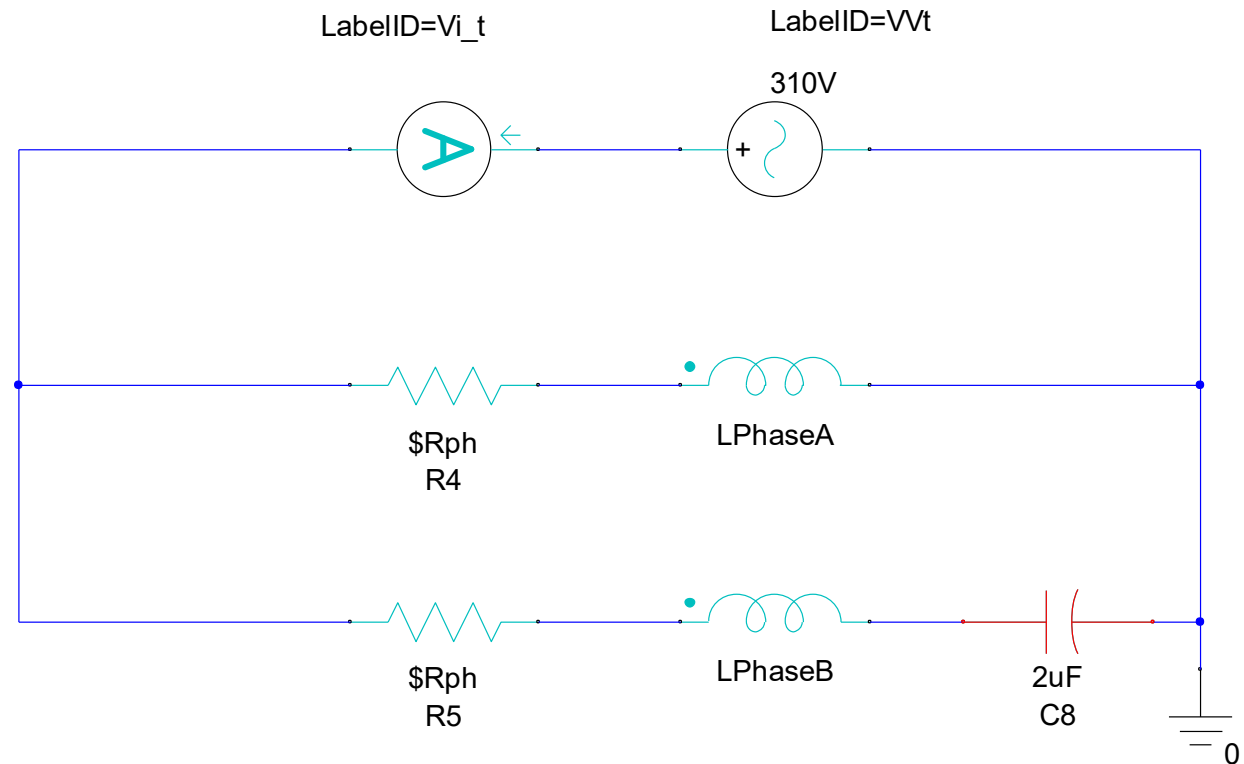
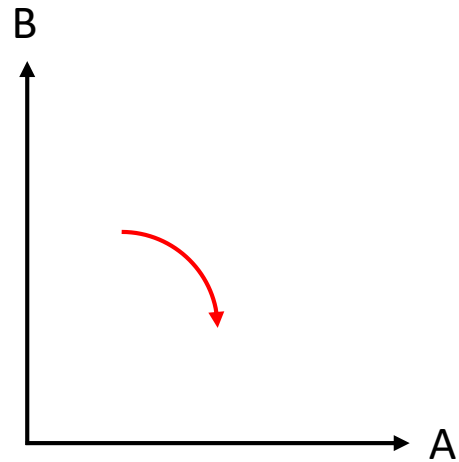
Phase A



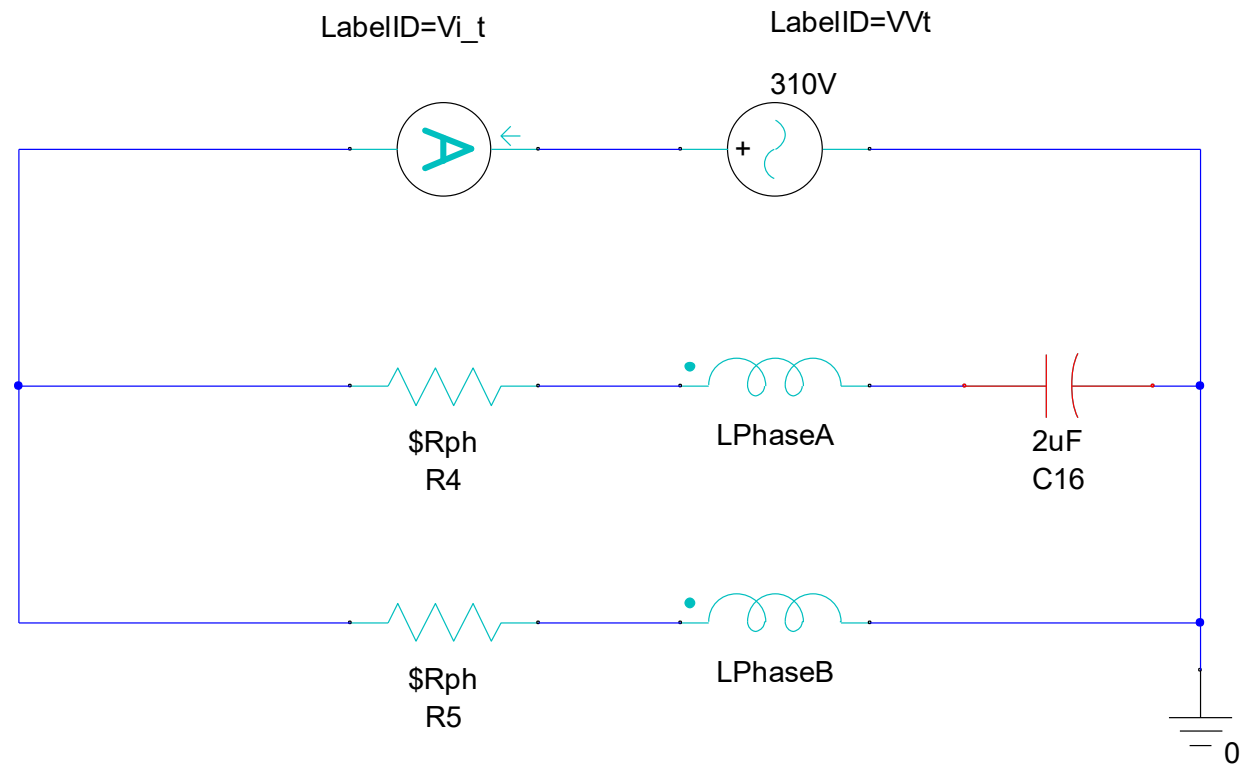
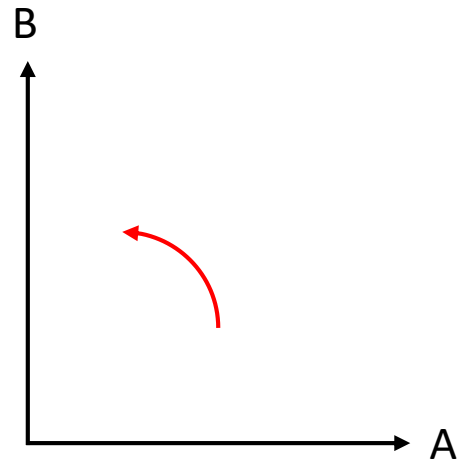
Rotor cage



Winding connections - CW



Winding connections - CCW



Load torque-speed curve

$$T_l = A\omega^2$$

$$\omega = \text{RPM} \times \frac{2\pi}{60}$$

$$P_{mech} = D\omega^2 + A\omega^3$$

$$P_{out} = A\omega^3$$

Motion Setup

Type | Data | Mechanical

Consider Mechanical Transient

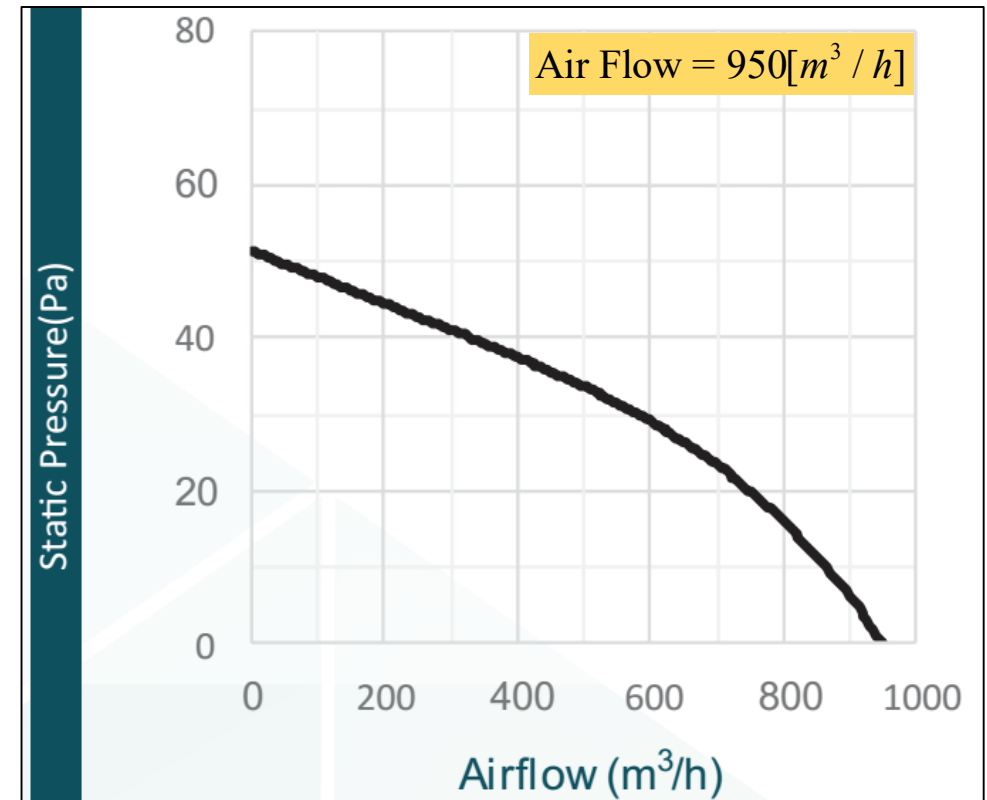
Initial Angular Velocity: 0 rpm

Moment of Inertia: 8.6225e-05 kg m² Calculate

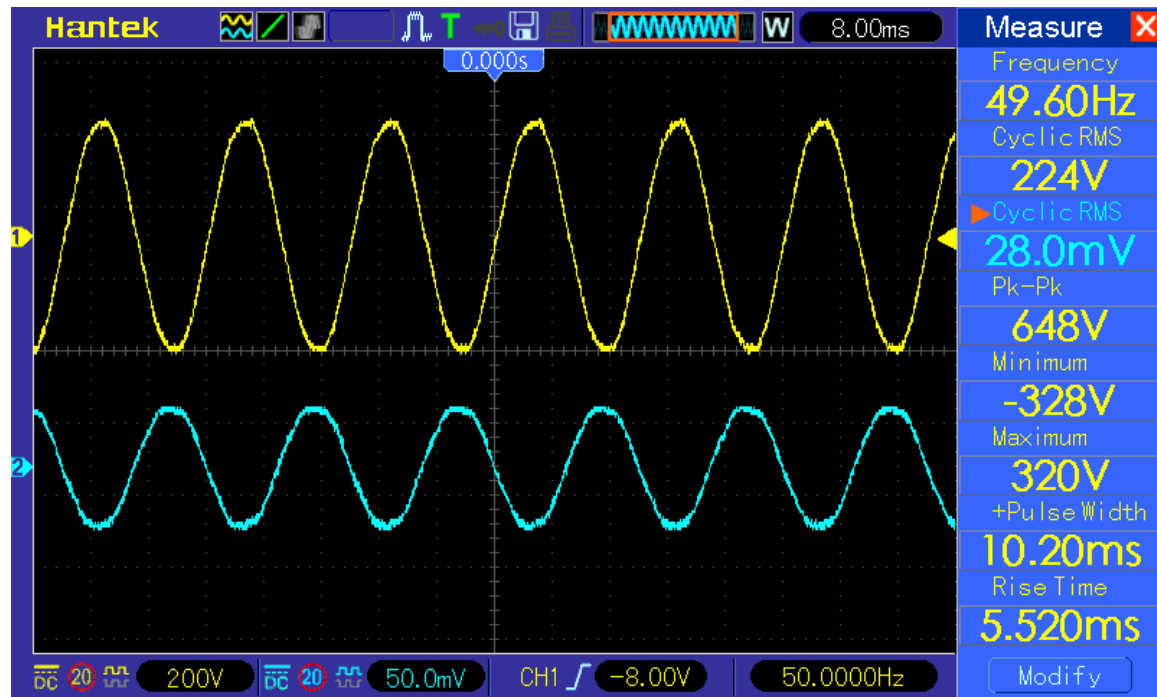
Damping: 7.91572e-06 N-m-sec/rad

Load Torque: -0.0000011338430074*speed² * sgn(speed)

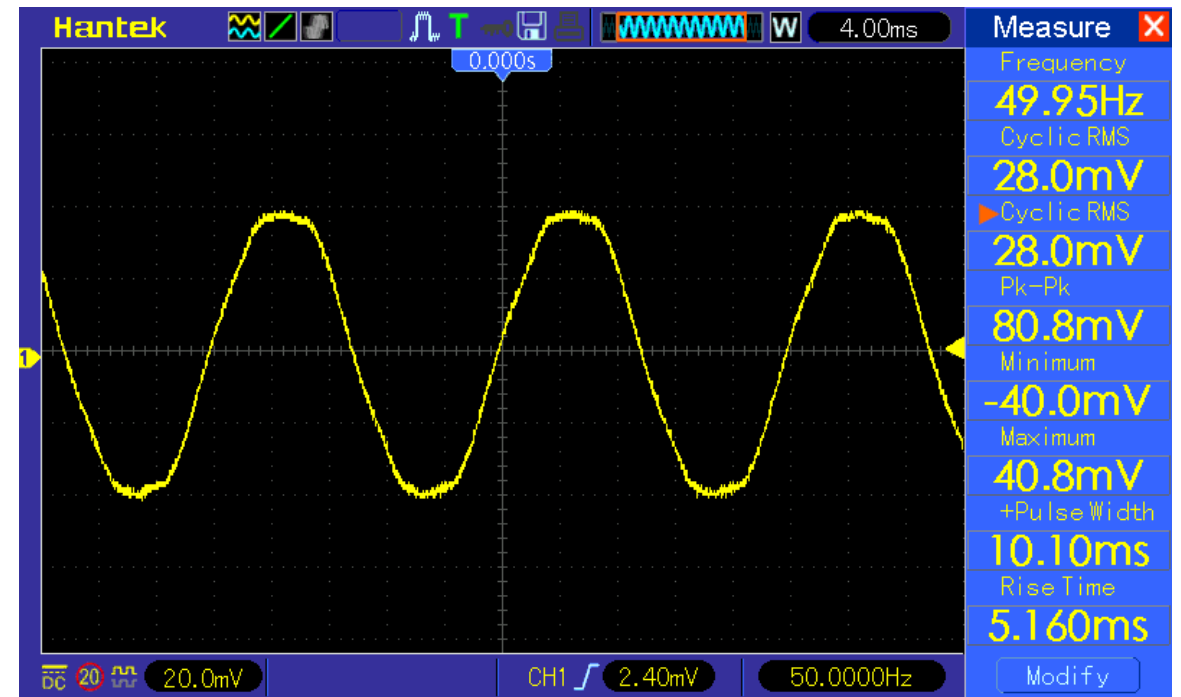
OK Cancel



Terminal voltage & current



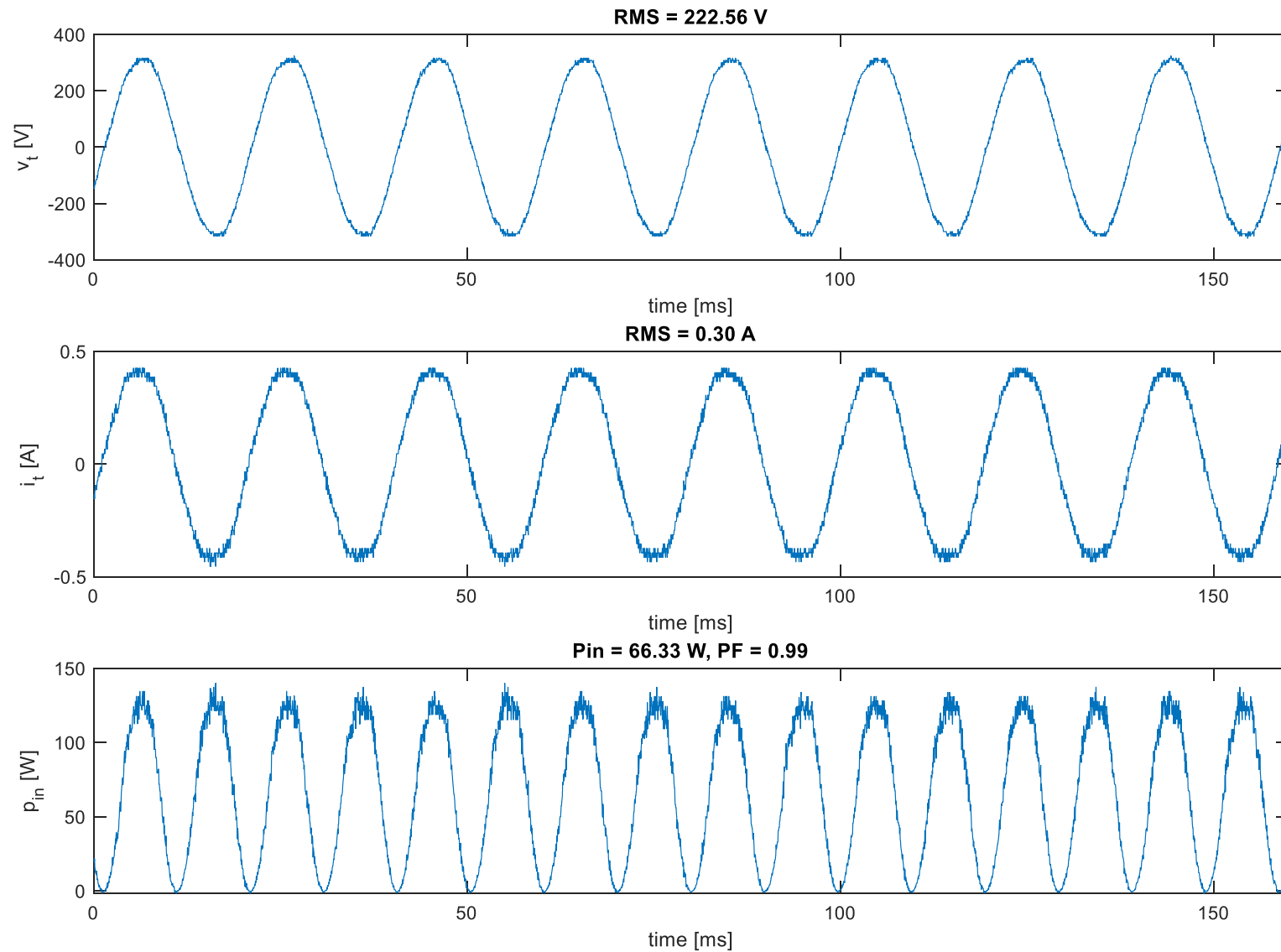
$$V_t = 224V$$



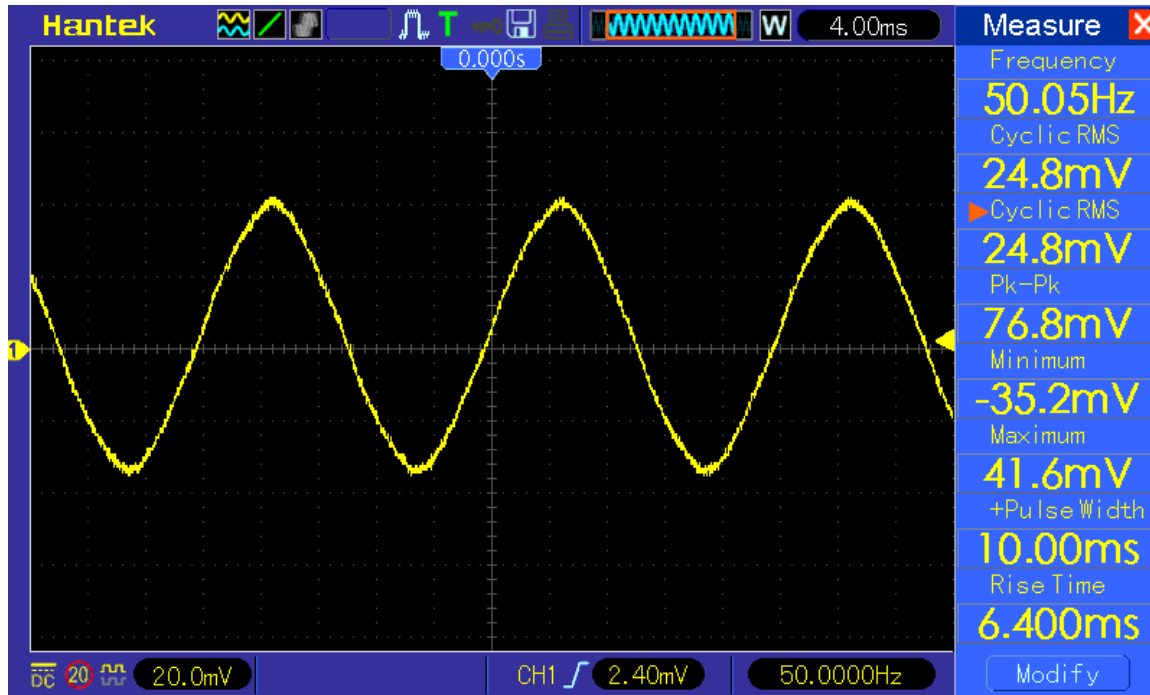
$$I_t = 280mA$$

1mV / 10mA

Input power & power factor

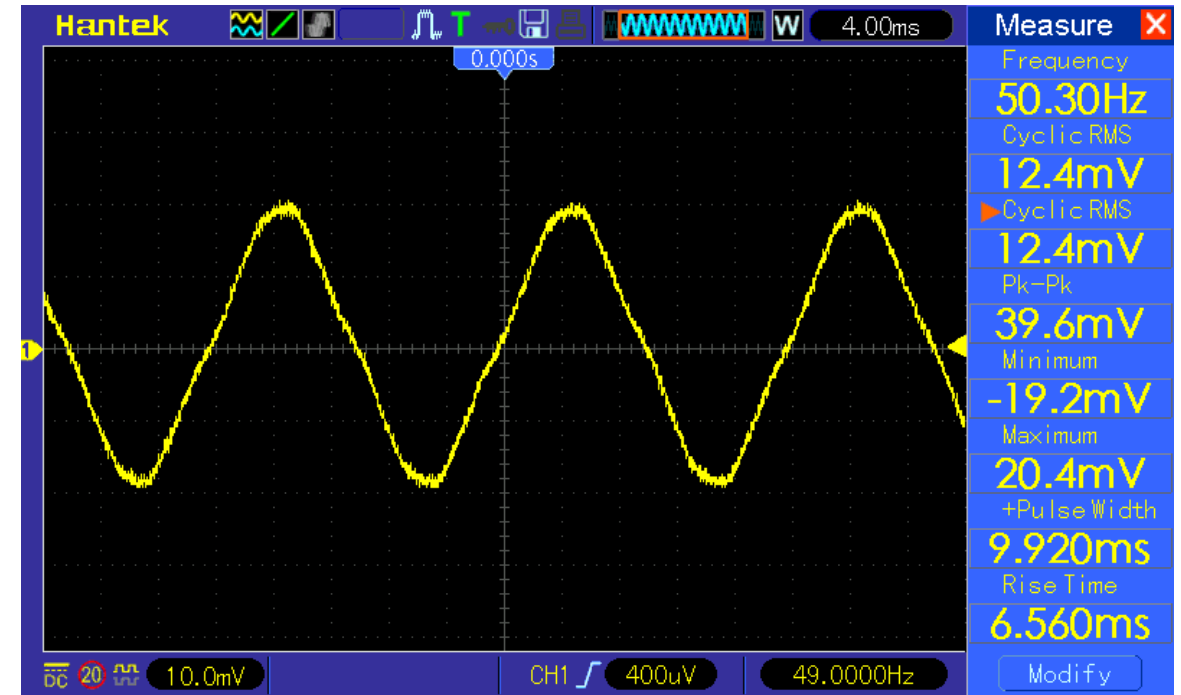


Main & auxiliary winding currents



$$I_t = 248mA$$

$$P_{cu,main} = 492 \times (248e-3)^2 = 30.26$$



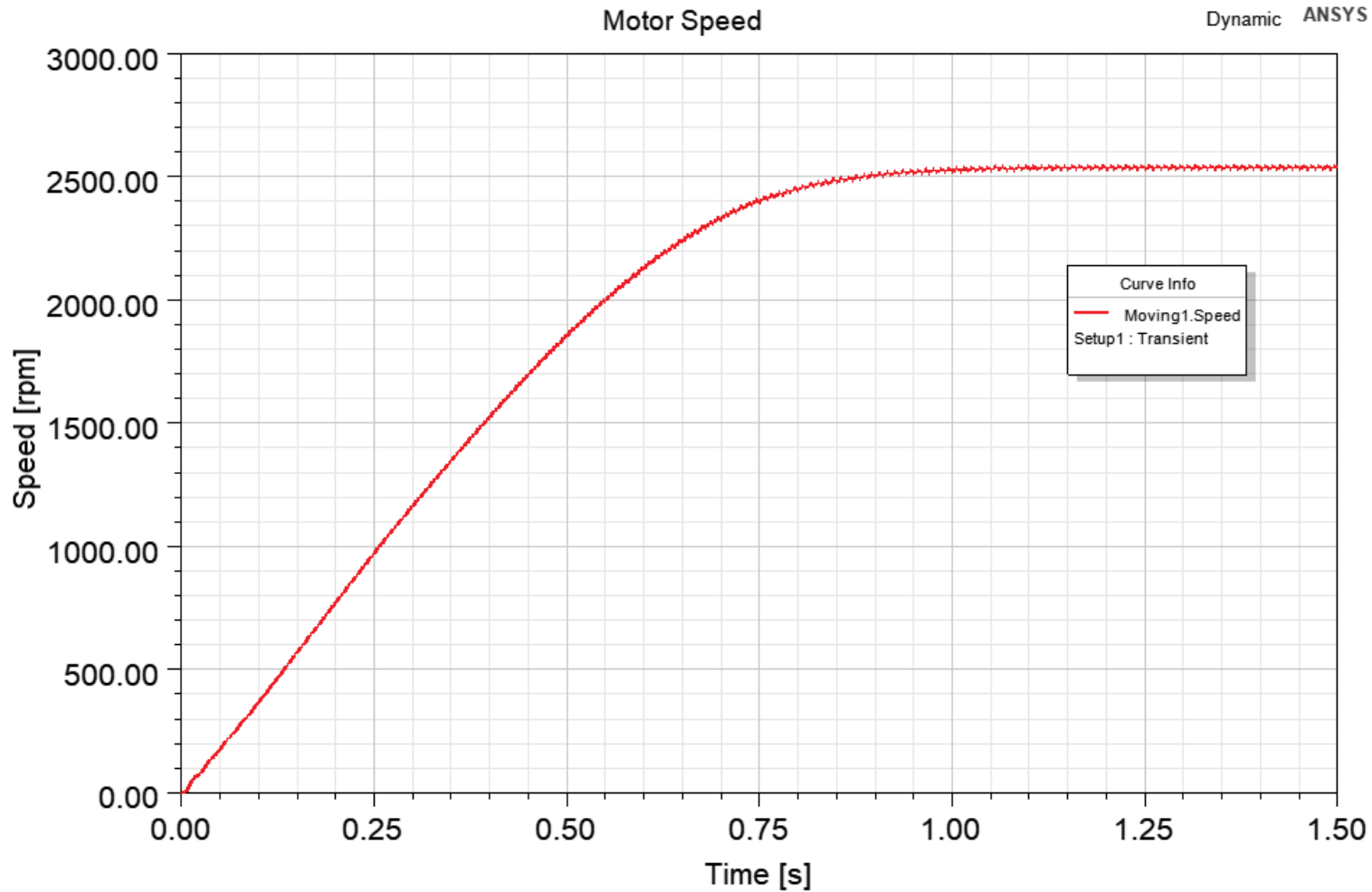
$$I_{aux} = 124mA$$

$$P_{cu,main} = 492 \times (124e-3)^2 = 7.57$$

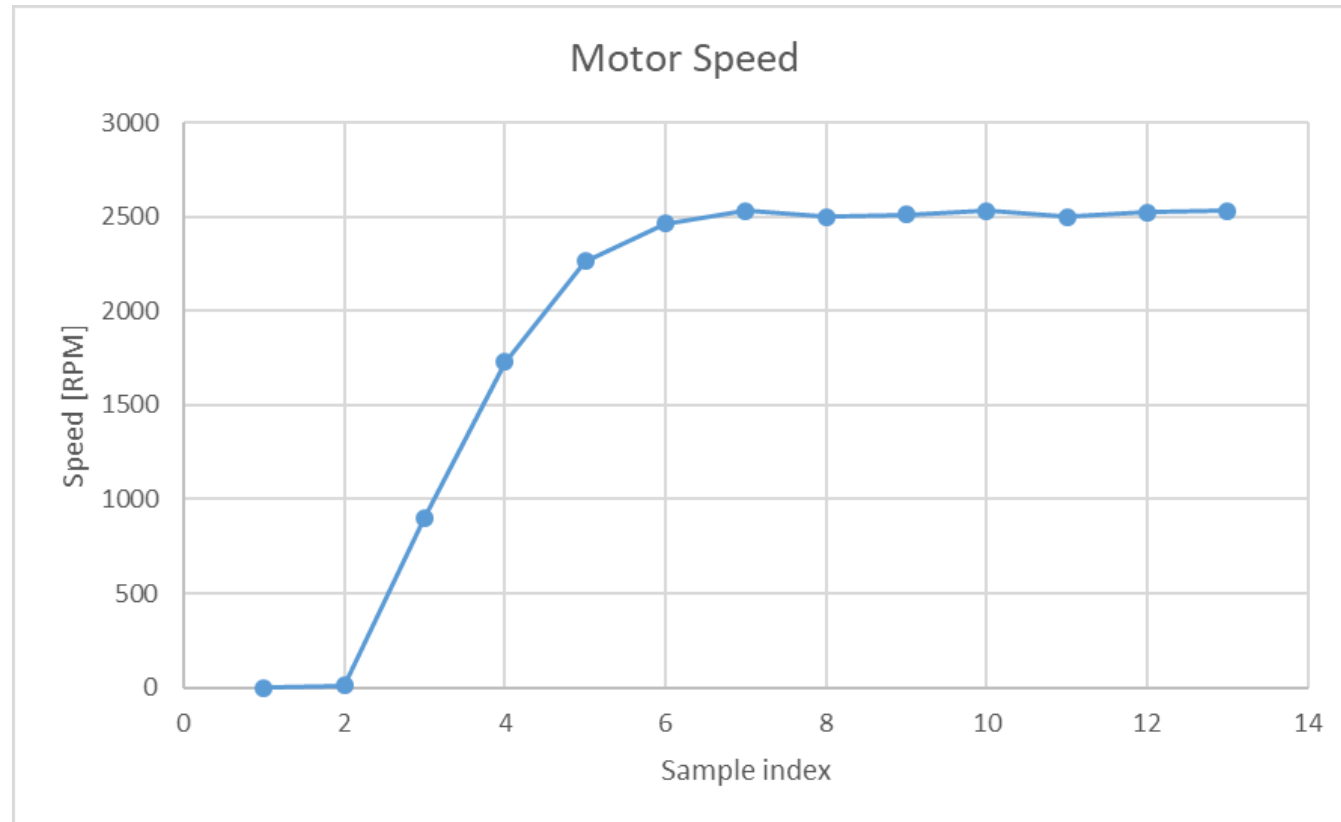
$$P_{in} - P_{cu} = 66.33 - (30.26 + 7.57) = 28.5$$

$$\eta \leq \%43$$

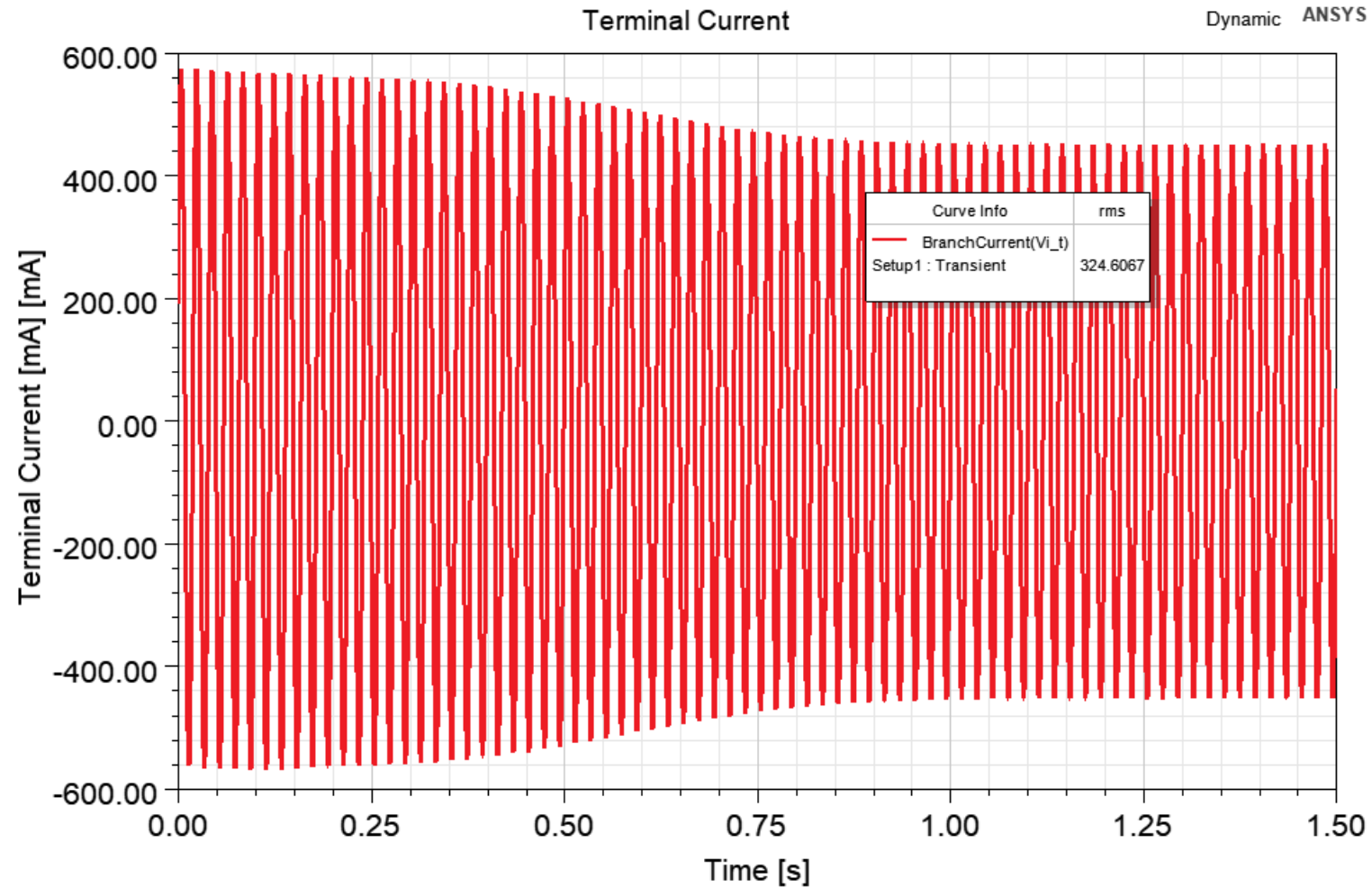
Motor speed by FEA & measurement



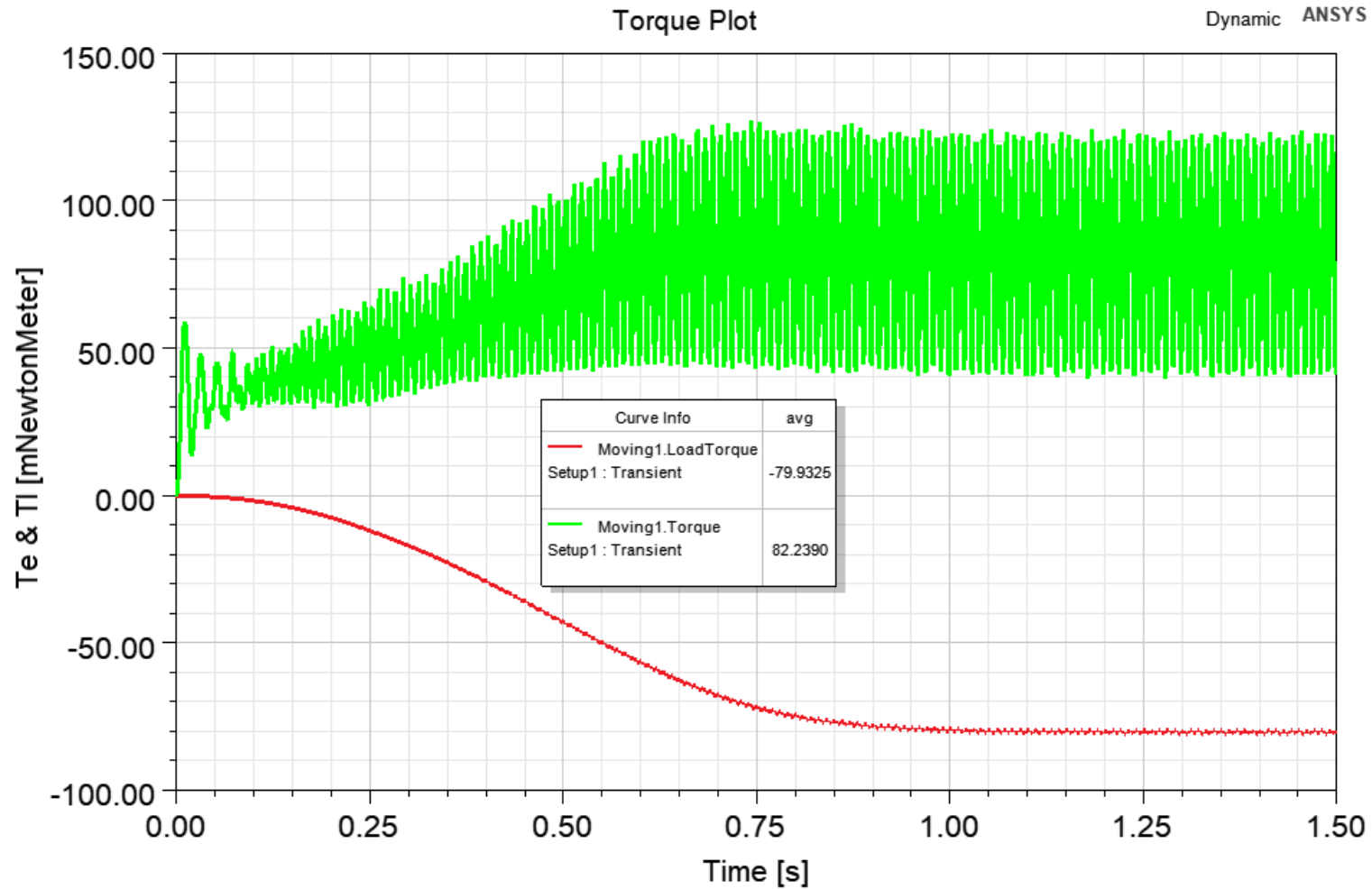
Motor speed by FEA & measurement



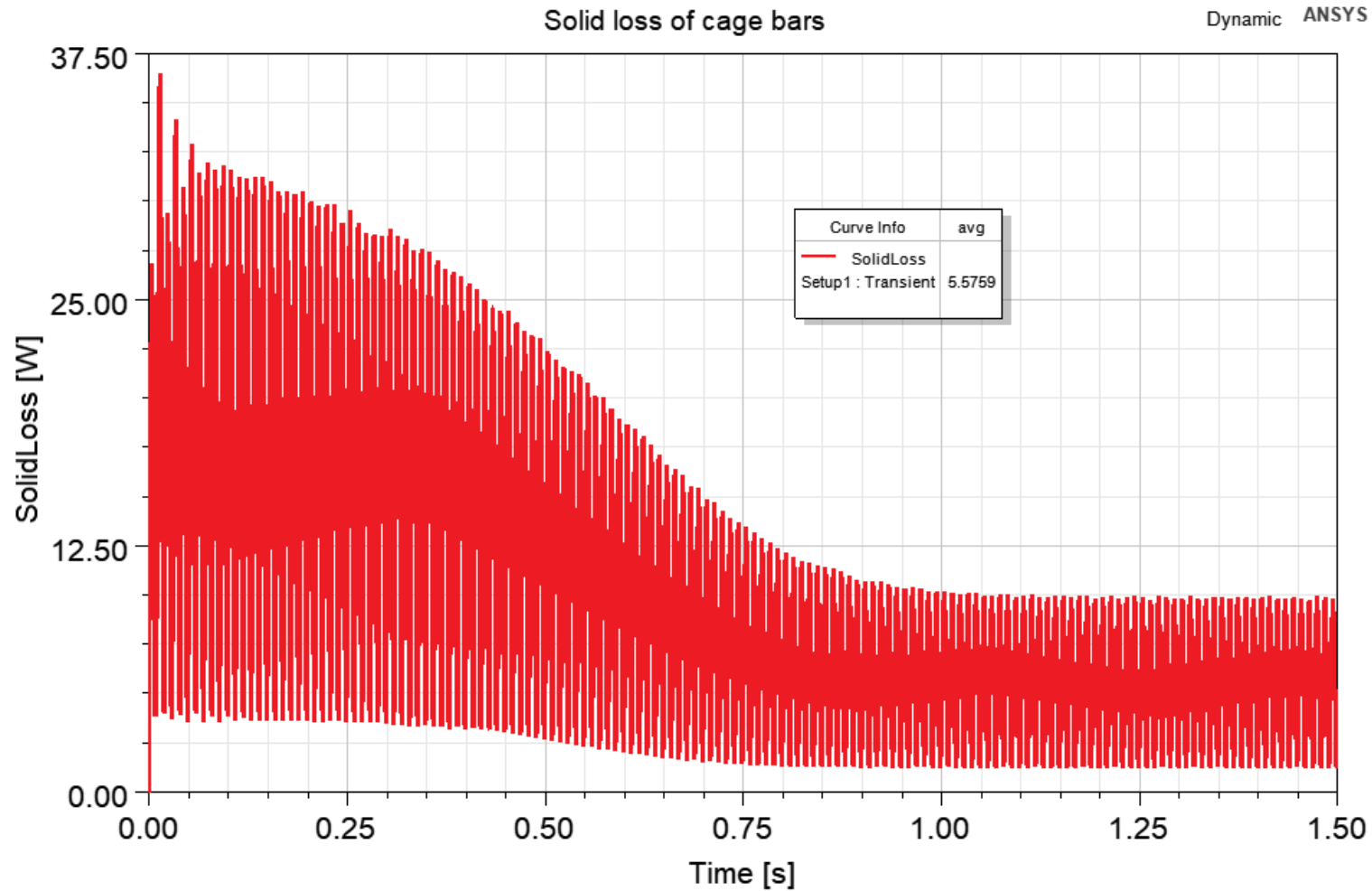
Terminal current



Electrical & load torque (full load)



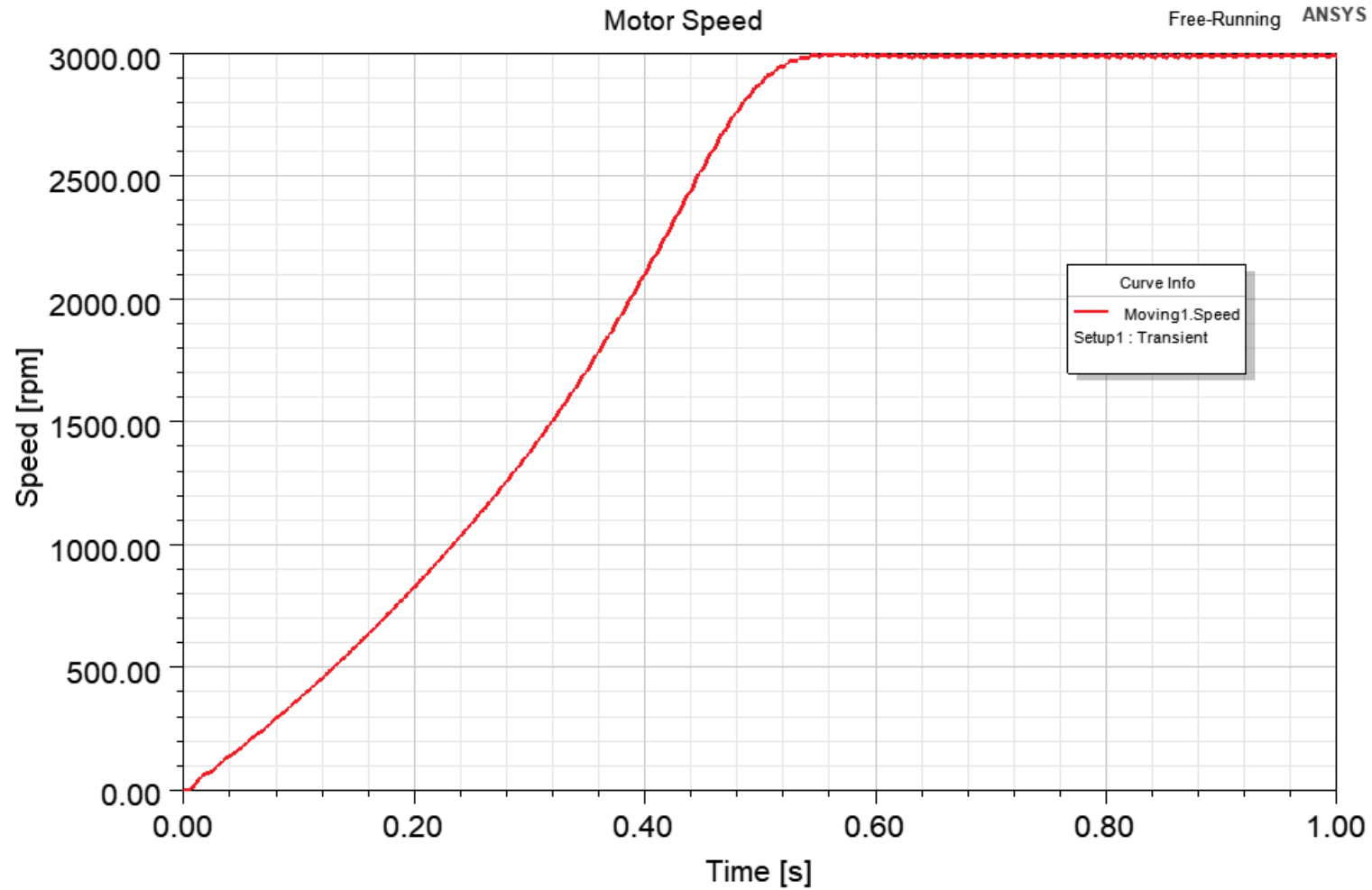
Solid loss of cage



$$P_{in} - P_{cu} - P_{cage} = 66.33 - (30.26 + 7.57) - (5.57) = 23$$

$$\eta \leq \%34$$

Free running FEA simulation



Locked rotor torque

