SIMULINK MODELLING OF A INVERTER-FLUX REVERSAL DOUBLY SALIENT PERMANENT MAGNET MICROMOTOR SYSTEM

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ABSTRACT In this paper a Simulink model of the assembly inverter-flux reversal doubly salient permanent magnet motor is presented. The aim of this paper is to prove the functional characteristics in the dynamic regime of the FRDSPM motor, supplied by a three-phase bridge inverter, with two phase on conduction mode. This kind of machine, which belongs to the new class of PMs machines with concentrated windings and permanent magnets on the stator, has the main features: robustness, easy to manufacture structure, high power density and a wide speed range of operation. Therefore, a small three phase FRDSPM prototype with six stator poles and eight rotor pole has been designed and built. The phase voltage, phase back e.m.f., electromagnetic torque, self inductances and dynamic equations of the motor have been developed. Based on these equations, the simulation scheme of the motor and the voltage inverter has been built and, as numerical results, the dynamic behavior of the FRDSPM motor is presented.

1.INTRODUCTION

In this paper a Simulink model of a inverter +FRDSPM motor is presented.
The autocommutation strategy adopted for the FRDSPM micromotor prototype is for a 120^0 electrical-degrees conduction-mode feeding scheme.This is because of its simpler implementation with or without the rotoric position transducer.Some simulation results are compared with those FEA obtained.

2.FLUX REVERSAL DOUBLY SALIENT PERMANENT MAGNET MICROMOTOR

Researches on the FRDSPM micromotors has been performed in the last years[1].

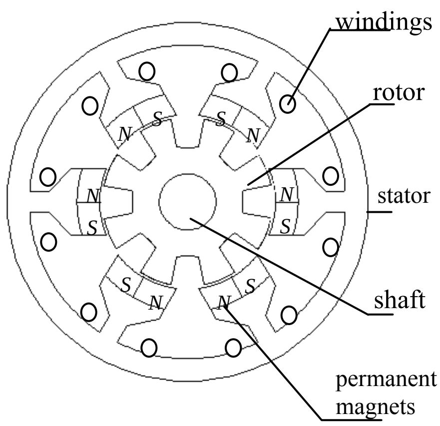

Fig. 1 Schematic configuration of a small three-phase FRDSPM motor**.**

Based on the anterior researches and especially on the design guidelines provided in [2],[3] one small three-phase FRDSPMM prototype has been built with the geometry from Fig.1 .Main dimensions are listed below:
Airgap length 1.5 mm
PM material sintered NdFeB
PM radial thickness 3 mm
Number of turns per coil 30
Stator outer diameter 64 mm
Rotor pole height 6 mm
Stator and rotor stack length length 40 mm
Stator phase resistance 0.31Ω
Stator phase inductance 0.3 mH

3. MODEL OF THE INVERTER - FRDSPM MICROMOTOR

The mathematical model of the FRDSPM micromotor is implemented in Matlab –Simulink for a supplying scheme with cvasi-rectangular voltages : for an autocommutation sequence of 120^0 electrical degrees.The inputs of the three phased voltage inverter are : the rotor position indicated by the electric angle θ_e, the three phases' currents i_a, i_b, i_c and the back-emfs e_a, e_b, e_c.The outputs are the supplying voltages u_a, u_b, u_c.The FRDSPM micromotor inputs are the supplying voltages u_a, u_b, u_c and the resistant torque and as outputs the three phases' currents i_a, i_b, i_c, the back-emfs e_a, e_b, e_c, the rotor position indicated by the electric angle θ_e and the rotor speed n.

The model is presented in Fig.2.

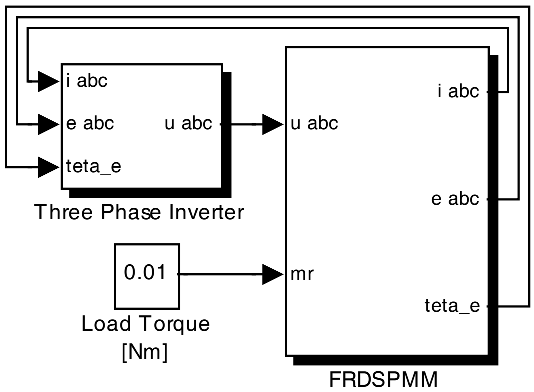

Fig 2. Model of the micromotor+inverter system

5.SIMULATION RESULTS

Some of the simulation results are presented using the following FRDSPM micromotor having with the parameters:

- the rated voltage: 7 V
- phases' resistance: 0,25 Ω
- mutual inductance :0.028 mH
- medium phase inductance: 0,2026
- inductance variation of amplitude : 0,003
- mutual inductance variation of amplitude:0.0012 mH

- constanta tensiunii electromotoare: 0,0023
- permanent magnet flux :0.013 Wb
- moment of inertia: 0,000015
- number of rotor tooth
-the coefficient of viscous friction: 0,000045.

In Fig.3 the numerical simulation of the start-up and operating regime on load for a 120 electrical degrees sequence.It was considered the start-up process up to a speed about 2000 rpm (reached in about 0.4 s).Then a resistant torque of 0.01 N was applied.

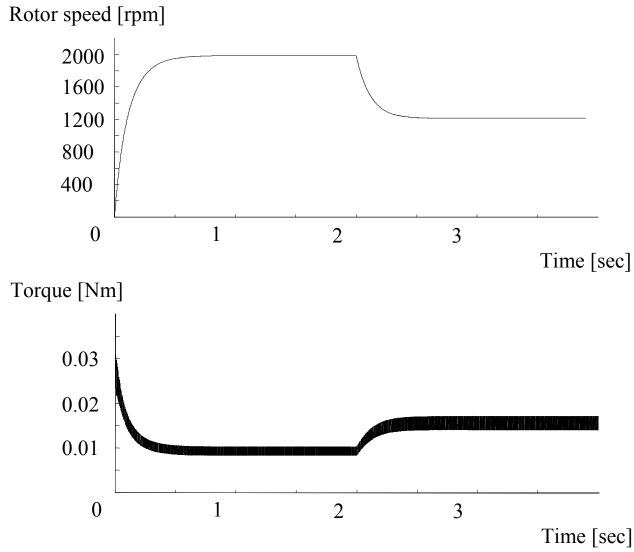

Fig 3. Rotor speed and torque characteristics of the three phase FRDSPMM prototype with two phase on conduction mode

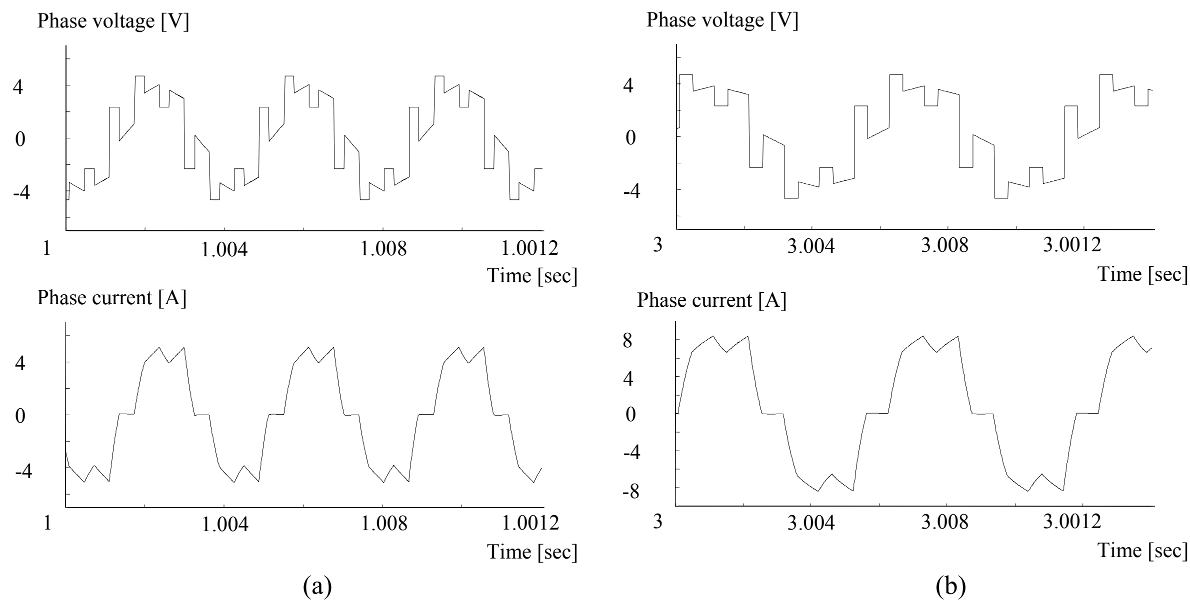

Fig 4 Phase voltage and phase current characteristics at maximum speed (with no load), (a), and in the dynamic regime (0.01Nm load torque applied) ,(b), stimulatory obtained, of the three phase FRDSPMM prototype with two phase on conduction mode

.More, these results are confirmed by the FEAobtained results[4] from fig.5, where it can be seen the speed, torque, phase voltage and phase current characteristics for the FRDSPM motor start-up. Specific to the 120^o commutation, from the current and voltage

variations Fig.4, it can be seen that at a certain moment from the commutation period, only two phases are supplied.

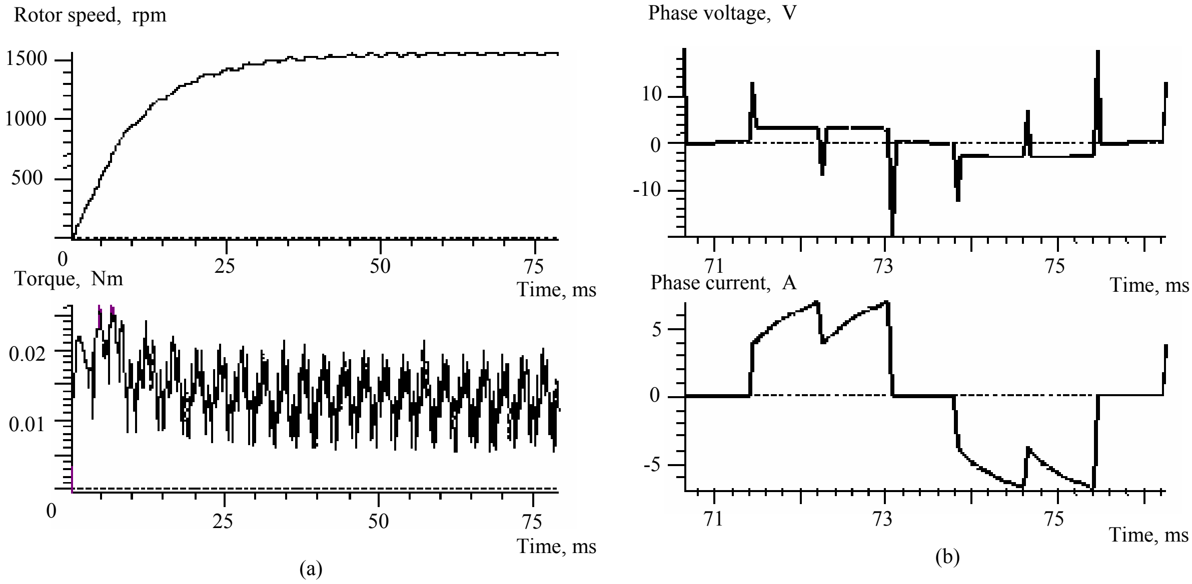

Fig 5 FEA obtained, rotor speed, torque, (a), phase voltage and phase current, (b), characteristics, of the three phase FRDSPMM prototype, at maximum speed (with no load), with two phase on conduction mode

6. CONCLUSIONS

The control-strategy study confirms the operation mode of the three phase star-connected FRDSPMM, supplied from a conventional three-phase bridge-type voltage-source inverter. The obtained results reflect the performances of this motor, relatives to the speed response, developed electromagnetic torque, manufacturing and control simplicities, and encourage the future efforts in order to develop and implement the FRDSPMM in industrial drives. One future approach is to use for simulation the s function facility of Simulink.
They represent powerful way of describing a system as a set of mathematical equations.
For two Simulink simulations performing the same calculations an S-function representation has faster execution time then the same system built using Simulink blocks.

7. REFERENCES

[1] M.M. Radulescu, F. Laza, I. Husain, Mihaela Scortescu and Emilia Luchian, “Design and performance of a small three-phase flux-reversal doubly-salient permanent-magnet motor”, *Proceedings of the 4th International Symposium on Advanced Electromechanical Motion Systems, Electromotion‘01*, Bologna, Italy, 19-20 June 2001, Vol. 2, pp. 515-518.

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