POSITION CONTROL OF A TWO-PHASE INDUCTION MOTOR WITH THREE PHASE INVERTER

Ciprian AFANASOV  
Ştefan cel Mare University of Suceava

Mihai RAŢĂ  
Ştefan cel Mare University of Suceava

ABSTRACT. The aim of this paper is to present a position control structure for two-phase induction motors. A simple, but robust structure enables a position control of the driving system. The rotor flux field oriented control is realized by using indirect vector control based on the two-phase induction motor model. The control structure was implemented on a computer system, based on a fixed point digital signal processor (DSP). To verify the performances of the proposed driving system, are presented results obtained from simulation and practical determinations.

Keywords: indirect vector control of induction machine, two-phase induction motor, three phase inverter.

1. INTRODUCTION

In most of industrial drive control applications, the standard method to control induction squirrel cage motors is based on the field-oriented principle in order to achieve the best dynamic behavior [1]. In the indirect vector control method, the synthesis of unit vectors does not depend on the machine terminal conditions and therefore distortion problems do not exist [2]. This allows designing a simple and more robust control structure.

2. INDIRECT VECTOR CONTROL OF THE TWO-PHASE INDUCTION MOTOR WITH THREE PHASE INVERTER

The use of representative space phasors simplifies the mathematical model of the motors with cylindrical symmetry, as is the induction motor. The main advantage is that it facilitates the understanding of the phenomena occurring in the motor, through the direct link between the representative space phasor of the current and the magnetic voltage produced by a polyphased winding. These advantages are best illustrated within the “field control” of the induction motor [3]. Fig. 1 shows the structure of the indirect vector controlled two-phase induction motors, fed by an PI current controlled PWM voltage fed converter. The field orientation was made according to the rotor flux vector [4]. To control position of two-phase induction motor with three phase inverter, the induction motor is connected as an unbalanced load between the three arms of the inverter.

Control strategy seeks to maintain a constant 90 ° phase shift between currents in two phases and adjust the position. It is envisaged also maintain a certain torque irrespective of rotational speed of the induction motor [5].

Power circuit of this type of drive system is presented in Fig.2.
3. SIMULINK STRUCTURE CONTROL SYSTEM

The working environment MATLAB allows complete simulation of digital systems control for induction motors. All models block are provided by software libraries. Fig. 1 presents the scheme for the vector control of two phase induction motor operating in a position loop that was implemented in the MATLAB-Simulink development environment.

Throughout the simulation, the two-phase induction motor was applied to the rotor a resistant torque of 0.2Nm. Parameters correspond to an induction motor with power of 370W. Drive system includes in addition to two-phase induction motor powered by a PWM inverter, two blocks performing transformations of axes, a block is to compensate the rotor slip (SLIP COMPENSATION), a block (A/D) which is to convert the currents of the two phase of analog to digital, and two PI regulators. A PID block is designed for position regulator and the other two PI block serve as current regulators, one for component $I_q$ and one for component $I_d$. The entire drive system simulating vector control of induction motor through a DSP. For this reason all units with working digital signal processor are converted into bits and scaled with the appropriate scale factor.

4. EXPERIMENTAL RESULTS

Following the simulation in Matlab-Simulink of vector drive system were obtained some results which are presented below in Fig.3. In Fig.3a it is shown in blue color the prescribed position and in green color the rotor position that was established, where 1000 bits is 3,14[rad]. It is noted that the rotor position is closely prescribed, even if rapid jumps from one stable value to another. Fig.3b shows how the rotor speed varied during the transitional regime of position change.
Fig. 3c shows how the rotor angle varied in time during the transitional regime of position change.

In Fig. 3a is shown as the variation of two phase stator currents. Note that currents go to high levels during the regimes of speed variation between two constant values of position.

In Fig. 3d is shown as the variation of two phase stator currents.

In Fig. 4 are presented the results of practical implementation of drive system on digital signal processor TMS320F2812.

To make a comparison as well between the values obtained by simulating the control system and the values obtained by direct measurements, have been prescribed as a reference position the same reference that was used and for simulation. In Fig. 4a it is shown in black color the prescribed rotor position and in red color the position at which the motor worked. In Fig. 4b it is shown how varied the stator current component $I_q$ and the $I_q$ reference.

If a comparison is made between results obtained by simulation and the results of practical implementation almost finds no major differences.

In Fig. 4a the prescribed position and the real position of two-phase induction motor.
5. CONCLUSIONS

The test results demonstrate that the drive system with the indirect vector controlled two-phase induction motor and PI position controller has good dynamic behavior. The control software has a shorter running time and the system seems to be robust with a PI speed controller. By using a fixed-point processor based configuration we have a relative great computing speed and a good performance/cost ratio. We can conclude, the advantages and disadvantages of the designed and implemented control structure are:

- robustness of control;
- standard construction of three phase inverter
- complete control of two-phase induction motor including position control, possibilities of operating under generator regime or brake;
- high control precision;
- control scheme requires a relatively complicated software

APPENDIX

Photographs of the experimental stand

REFERENCES