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INVESTIGATION OF SPEED CONTROLLED AND MINIMUM STATOR CURRENT OPERATION MODES OF ASYNCHRONOUS MOTORS

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Abstract
In this article, the integration of automated asynchronous electrical circuit block circuit devices and blocks into a single microprocessor system is highlighted, as well as increasing the functionality and speed of the electric circuit, it also leads to structural compactness.

Keywords: asynchronous motor, microprocessor, stator, frequency

Introduction
If we take into account that the magnetic flux is connected with the stator winding voltage through a nonlinear coefficient, then we differentiate the expression in the form of the ratio of the stator current corresponding to the nominal operating mode to the nominal value and make it equal to zero by differentiating the magnetic flux change:

$$\frac{d\left(\frac{I_1}{I_{1_H}}\right)}{d\phi} = 0 \qquad (1)$$

where $I_1, I_{1_H} -$ the actual and nominal values of the stator current at the corresponding stage; $\phi = \frac{\Phi_1}{\Phi_{1_H}} -$ is the relative value of the magnetic flux between the stator and rotor of the asynchronous motor, Φ_1 and Φ_{1_H} are the actual and nominal values of the magnetic flux, respectively.

As a result of the increase in the magnetic flux, the decrease in the active component of the stator current leads to a decrease in the total value of the stator current. At a certain value of the magnetic flux, the stator current operates in the minimum value mode, and the implementation of this mode is based on the fulfillment of the condition (1).

Figure 1 shows the description of the change of the asynchronous motor stator current depending on the magnetic flux when the speed is adjusted by changing the relative value of the frequency in the range of $\alpha = 0{,}2 - 1{,}0$ when the load moment is m_$\mu_c = 1{,}0$ When the asynchronous motor operates at the rated frequency and rated load, the value of the magnetic flux $\phi = 1{,}2$ ensures the minimum stator current. As the value of the frequency decreases, the minimum point of the description of the stator current moves towards the direction of the decrease of the magnetic flux. For example, when $\alpha = 0{,}2$, the minimum value of the stator current corresponds to the value of the magnetic flux $\phi = 0{,}22$.

The analysis of the descriptions shows that when the speed of an asynchronous motor is adjusted by changing the frequency at the nominal load moment, the magnetic system of the motor is saturated when the frequency value is α = 0.8 and α = 1.0, and in order for the stator current to be minimal, it is necessary to adjust the voltage supplied to the stator coil above the nominal value.

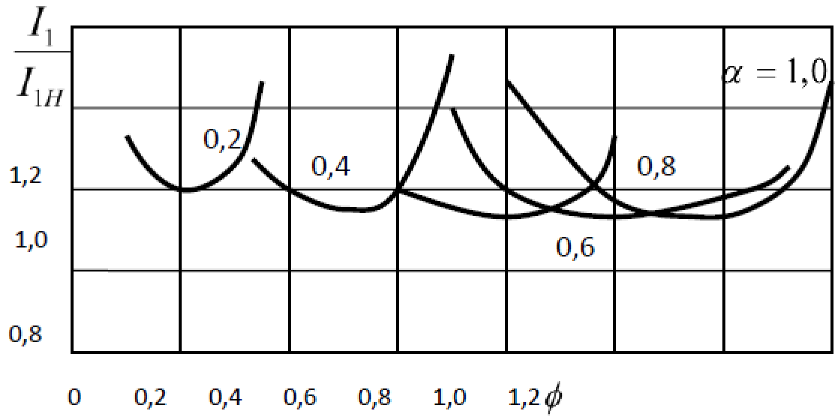

Figure 1. Characteristics of changes in the stator current depending on the magnetic field when the load moment on the axis of the 4A100L4U3 asynchronous motor is equal to μ_c = 1,0 and its speed is adjusted in the range of the frequency change $\alpha = 0{,}2 - 1{,}0$

Figure 2 shows the description of the change of the stator current depending on the magnetic flux when the speed is adjusted by changing the relative value of the frequency in the range of $\alpha = 0{,}2 - 1{,}0$ when the load moment is $\mu_c = 0{,}8$ When an asynchronous motor operates at a frequency value of $\alpha = 1{,}0$ the magnetic flux at the value of $\phi = 1{,}15$ ensures that the stator current is minimal and the magnetic system of the motor is saturated.

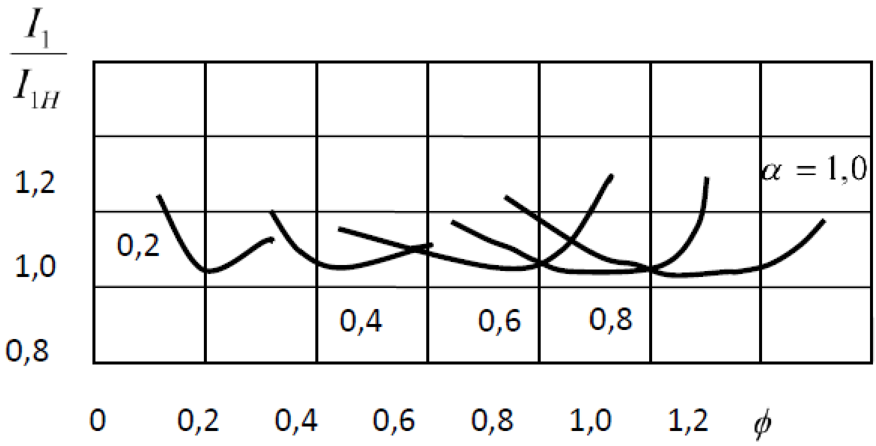

Figure 2. Descriptions of changes in the stator current depending on the magnetic field when the speed of the 4A100L4U3 asynchronous motor is adjusted in the range of frequency variation $\alpha = 0{,}2 - 1{,}0$ when the load moment is equal to $\mu_c = 0{,}8$

At other values of the frequency, that is, as the frequency decreases from the nominal value, the minimum points of the characteristics of the stator current shift towards the direction of the decrease of the magnetic flux, and the magnetic system of the motor is unsaturated. For example, when $\alpha = 0{,}2$ the minimum value of the stator current corresponds to the value of the magnetic flux $\phi = 0{,}21$

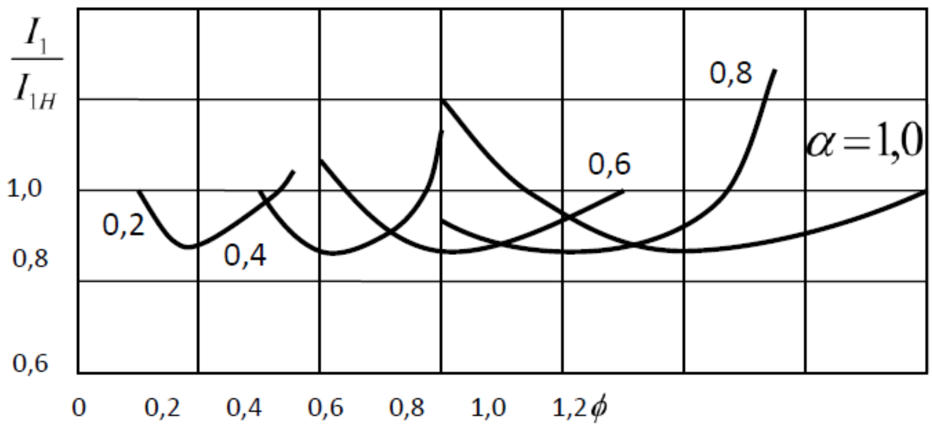

Figure 3. Characteristics of changes in the stator current depending on the magnetic field when the load torque on the 4A100L4U3 asynchronous motor shaft is equal to $\mu_c = 0,6$ and its speed is adjusted in the range of frequency change $\alpha = 0,2 - 1,0$

Figure 3 shows the description of the change of the stator current depending on the magnetic flux when the speed is adjusted by changing the relative value of the frequency in the range of $\alpha = 0,2 - 1,0$ when the load moment is $\mu_c = 0,6$

When the asynchronous motor operates at a relative value of the frequency $\alpha = 1,0$ the magnetic flux at a relative value of $\phi = 1,0$ ensures that the stator current is minimal and the magnetic system of the motor is not saturated

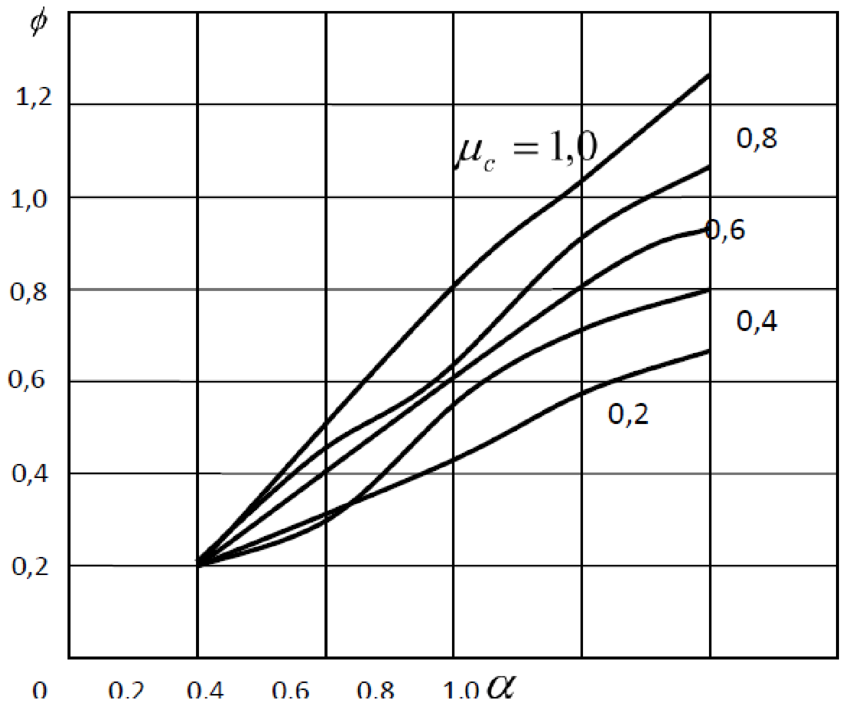

Figure 4. Descriptions of the frequency-dependent variation of the optimal values of the magnetic field, which ensure the minimum values of the stator current when the speed of the variable 4A100L4U3 asynchronous motor is adjusted in the values of the frequency $\alpha = 0,2 \div 1,0$ in the range of the load torque $\mu_c = 0,2 \div 1,0$

As the frequency decreases from the nominal value, the minimum points of the stator current characteristics shift in the direction of the decrease of the magnetic flux, the value of the magnetic flux is less than the nominal value at all the observed values of the frequency, and the magnetic system of the motor is unsaturated.

Figure 4 shows the characteristics of the frequency-dependent variation of the optimal values of the magnetic flux that ensure the minimum value of the stator current for different values of the load torque of an asynchronous motor whose speed can be adjusted by changing the frequency.

The magnetic system of an induction motor operating at different values of frequency and less than the nominal value of the load on the axis operates in the unsaturated part of the description of magnetization, and therefore, replacing the magnetic flux in equation (1) with the stator voltage, it can be written in the following form:

$$\frac{d\left(\frac{I_1}{I_{1_H}}\right)}{d\gamma} = 0 \qquad (2)$$

where is $\gamma = \frac{U_1}{U_{1_H}}$ – the relative value of the stator voltage, U_1 фтв U_{1_H} – are the actual nominal values of the stator voltage, respectively

According to the equation (1), it is necessary to use a measuring current transformer and a Hall measuring transducer as the primary measuring transducers to create energy-saving automated asynchronous electric drives, and according to the equation (2), it is enough to have current and voltage measuring transducers.

Figure 5 shows the block diagram of an automated asynchronous electric drive whose speed is controlled by changing the frequency and operates in the minimum stator current mode.

Components of the automated electrical system: asynchronous motor M, indirect thyristor frequency converter and its power circuit and frequency and voltage control systems, functional converter, memory device, division block, differentiating devices 1 and 2, voltage and current measuring converters. An asynchronous electric drive works as follows. The duty signal transmits a signal corresponding to the control frequency to the frequency control systems, and this signal is also given to the 1 functional converter at the same time, and is transmitted to the voltage control systems adjusting according to the expression $\gamma = \alpha$ according to the load torque character.

From the output part of the power circuit of the frequency converter, the stator winding of the asynchronous motor is supplied with a frequency voltage corresponding to the load torque on the motor shaft. If the load on the motor shaft is at the nominal value, that is, when $\mu_c = 0{,}1$ then the signal at the output of the memory device will be $\frac{dI_1}{dt} = 0$ If the load torque is $\mu_c < 0{,}1$ then an equivalent signal corresponding to the stator current is generated at current frequency. This signal is sent to the input of 2 differentiating devices, where it is time-differentiated and sent to the first input of the dividing block $\frac{dI_1}{dt}$ and also to the second input of the dividing block, the voltage obtained from power frequency is given as a time-differentiated $\frac{dU_Л}{dt}$ signal in the differentiating device 2 . In the division block, the division operation is performed and a time-decoupled $\frac{dI_1}{dU_Л}$ signal is generated. Fulfillment of the condition $\frac{dI_1}{dU_Л} = 0$ ensures that the asynchronous motor operates in the minimum stator current mode.

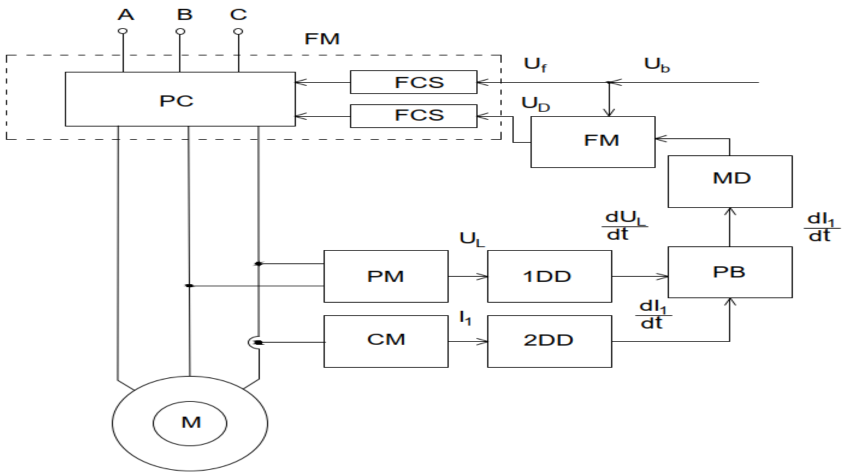

Figure 5. The operating frequency at the smallest value of the stator current

Automatic asynchronous, whose speed can be adjusted by changing block diagram of the electrical system

Failure to fulfill this condition causes $\frac{dI_1}{dU_Л}$ to have a certain value, and this signal is transmitted through the memory device to the second input of the functional converter. Here, taking into account the real load torque and frequency,

$U_Б = U_В \mp \frac{dI_1}{dU_Л}$ is involved in creating the control voltage that ensures the operation of the motor in the mode of minimum stator current. The signal $\frac{dI_1}{dU_Л}$ is stored in the memory device until the next load moment and also the change of the frequency value.

In short, connecting the devices and blocks of the automated asynchronous electric drive block scheme to a single microprocessor system increases the functionality and speed of the electric drive, as well as leads to structural compactness.

Abbreviations

FM- functional modifier

FCS- frequency control systems

MD - memory device

PM - power modifier

PD - partition block

DD - differentiating devices

M - asynchronous motor

References

1. Hashimov A.A., Imamnazarov A.T. Energy saving in electromechanical systems. T.: TGTU, 2000. 57
2. Ibrohimov U. Electric machines. Study guide. – T.: Teacher, 2001.
3. Hashimov A.A. The mode of operation is frequency-regulated asynchronous electric drive. T: Science, 1987.
4. Hashimov A.A. Special mode frequency control asynchronous electroprivodov. M: Energoatomizdat, 1994
5. Pirmatov N.B., Mustafakulova G.N., Mahmadiev G'.M. "Design of asynchronous motors" from the "Electric machines" course. Study guide. -T.: ToshDTU, 2013. -95 p.
6. Majidov S. Electric machines and electric drive. Study guide. - T.: Teacher, "Ziè-Noshir" KShK, 2002. - 408 p.
7. Ibrohimov U. Electric machines. Study guide. – T.: Teacher, 2001.
8. Majidov S. Electric machines and electric drive. Study guide.- T.: Teacher, "Ziè-Noshir" KShK, 2002. - 408 p.