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Research on Automatic Integrated Circuit Design Based on Low Voltage and Low Power FTFN

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Abstract

With the continuous improvement of China's industrial production level, higher requirements have been put forward for the performance of the motor used in industry. To improve the power factor of integrated circuit can not only improve the efficiency of the motor to save energy, still can reduce the pressure drop of line, thus reducing the distribution line losses, reduce the loss of the power supply transformer at all levels, improve the load capacity of power supply equipment, improve the quality of power supply save electricity, reduce the load switch equipment, prolong the service life of the appliance and save non-ferrous metal consumption.At the same time, since most of the load in the power network is low voltage and low power consumption motor load, increasing the power factor of the motor can reduce reactive power in the power network, so as to improve the power factor of the power network. Therefore, under the situation of continuous development of industrial production and increasingly tense demand for electric energy in China, improving the power factor of the motor not only has a positive effect on the power system and power enterprises, but also can greatly alleviate the energy shortage, which is of great practical significance for improving the national economic benefits.

Keywords: *Integrated Circuit, Frequency Conversion Control,FTFN Applications, Automation, Process Design;*

1. Introduction

In recent years, with the rapid development of the industrial production level in various countries, people have higher and higher requirements for the quality of electric energy, and the demand is also increasing. Therefore, the development of new energy and the saving of electric energy have attracted the attention of various countries.As a driving device, integrated circuit is widely used in industrial and agricultural production.Because the three-phase integrated circuit is inductive, in order to generate electromagnetic torque, a certain amount of reactive power is required. A large amount of reactive power (reactive current) flowing on the line causes very large active power loss, and also increases the load of the power grid and transformer[1].In addition, if the reactive power needed by low-voltage and low-power motors is provided by the power grid, it will occupy a part of the capacity of transmission and transformation equipment (transmission lines and transformers), and the loss of the lines will increase, especially resulting in the decrease of voltage quality and power factor of the power grid.According to statistics, the electric motor reserve in China is about 1.9 billion kW, and the total power consumption accounts for more than 50% of the country's total power consumption, so the electric motor consumption is relatively large.

2. Analogy integrated circuit automation integrated process

Reactive compensation is carried out on integrated circuits to improve the power factor of integrated circuits, which has the following functions:

2.1. Reduce the energy consumption of the system

When the load and supply voltage are constant, if the power factor is too low and the loss on the line is too large, the voltage quality of the user side cannot be

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guaranteed. $\cos\varphi$ In addition, most motors are selected according to the designed rated load, but in practical use, most motors work under the condition of low load rate. When the motor is under no load, its power factor is only about 0.2. When the load is close to the rated load, its power factor is the largest, reaching about 0.7~0.9.If the load rate of the motor is not high, the power factor and efficiency of the motor will be low, thus resulting in the waste of electric energy. Because of the effective value of the current in the line, the current I in the line will decrease after increasing the power factor. $I = P/\sqrt{3}U\cos\varphi$ $\cos\varphi$ At the same time, when the impedance of the line and transformer is unchanged, the active power consumed in the transmission line and transformer will be reduced accordingly, thus reducing the energy consumption of the system. $P_R = I^2R$

2.2. Improve voltage quality and ensure starting torque

In the circuit, its voltage loss is calculated as follows:

$$\Delta U = \frac{PR + QX}{U} \quad (1)$$

In Formula (1) :R is the line resistance;P is active power;U is the rated voltage;Q is reactive power;X is the circuit sensitivity.It can be seen from Equation (1) that the decrease of reactive power will lead to the decrease of voltage loss △U in the circuit.At the same time, since the starting torque of the motor is proportional to the square of the stator voltage of the motor, improving the power supply quality ensures the starting torque and shorens the starting time of the motor, which is beneficial to the start of the motor.

2.3. The motor shall be compensated for reactive power

As a result, the stator current of the motor will be reduced and the transformer or power supply will have a larger margin. The copper loss of the motor itself will be reduced with the decrease of stator current, and the loss of the motor itself will be reduced, the efficiency will be improved, the temperature rise of the motor will be reduced, the service life will be extended, the overload capacity will be increased, and the effect of energy saving and consumption reduction will be produced.

2.4. Savings in electricity charges

Because the line loss is reduced, the expenditure on electricity is saved. On the other hand, through reactive compensation of the motor, the power factor of the motor can meet the requirements of "Power factor Adjustment method for Electricity Charges", so as to avoid punishment and save users' electricity charges.

Above all, to improve the power factor of integrated circuit can not only improve the efficiency of the motor to save energy, still can reduce the pressure drop of line, thus reducing the distribution line losses, reduce the loss of the power supply transformer at all levels, improve the load capacity of power supply equipment, improve the quality of power supply save electricity, reduce the load switch equipment, prolong the service life of the appliance and save non-ferrous metal consumption.At the same time, since most of the load in the power network is low voltage and low power consumption motor load, increasing the power factor of the motor can reduce reactive power in the power network, so as to improve the power factor of the power network.Therefore, under the situation of continuous development of industrial production and increasingly tense demand for electric energy in China, improving the power factor of the motor not only has a positive effect on the power system and power enterprises, but also can greatly alleviate the energy shortage, which is of great practical significance for improving the national economic benefits[2, 3].

3. Features of analog IC ontology design

Compared with ordinary integrated circuits, the design features of analog integrated circuit automation integrated circuits are as follows:

Compared with common integrated circuit of the analog integrated circuit automation integrated circuit can be carried out within a certain range of frequencies in normal work, therefore, in the process of its design, not only requires low voltage low power motor at a particular frequency can be normal work,

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but also to ensure low low voltage motor power consumption in a wide frequency range with high work efficiency, in the design, characteristics to fully consider, thus improve the quality of the design of the low voltage low power consumption of the motor[4].

The analog integrated circuit can automatically reduce the power supply frequency at low speed, and then adjust the maximum torque to the starting position, which can greatly reduce the difficulty of motor starting and is conducive to the smooth start of the motor.Therefore, in the motor design, there is no need to specially consider the starting performance of the analog integrated circuit automatic integrated circuit, so the rotor slot does not need to be deepened design, according to the general depth design.

When the analog integrated circuit is working, it can effectively adjust the working voltage and frequency of the motor according to the actual working requirements to improve the coordination degree between the voltage and the working condition of the motor.Analog integrated circuit Automatic integrated circuit has a variety of different operating modes corresponding to a point of operation, with a number of slip frequency, therefore, corresponding to different speeds can always find the most appropriate slip frequency, to ensure that the motor can always maintain high operating efficiency, so as to be able to carry out the maximum power output.The power factor and efficiency of the analog integrated circuit can be effectively guaranteed, and the power density can be further improved.

In FTFN inverter power supply, power harmonic smooth running of the motor can cause great influence, in order to ensure the analog integrated circuit automation the smooth operation of the integrated circuit can always, therefore, should notice when in the analog integrated circuit design of harmonic inhibition, adopt targeted design improvements, maximum limit reduces the analog integrated circuit automation integrated circuit in the process of running by adverse effects.In the actual design process, the stator impedance can be increased as much as possible in the groove design to effectively suppress the high-order harmonics, avoid excessive influence on the low-voltage and low-power motors, and ensure the stable operation of the low-voltage and low-power motors[5, 6].

In the process of variable frequency device for power supply, the input current contains a large number of higher harmonic, low in the low voltage motor power consumption within the more space charge and partial discharge phenomenon, increased heat dissipation and electromagnetic vibration motor medium power, greatly accelerated the aging speed of insulation materials, therefore, in the design of analog integrated circuit automation integrated circuit process, want to combine the work actual situation, effectively improve the strength of the insulation of the motor, to at least F above, avoid excessive space charge formation, reduce impact on insulation materials,Ensure that the low voltage low power motor can always be in a good working state.

4. Development and current situation of analog integrated circuit automation technology

4.1. Overview of the development of analog IC automation technology

However, with the passage of time, many problems have been exposed in use. Motor speed is restricted, and every working index, such as speed, position, torque and other parameters, needs accurate control to achieve the desired effect. In addition, with the power electronic technology, control technology and the rapid development of the microcomputer and the development of large scale integrated circuit, in the development of modern technology, communication technology will be eliminated, dc control must come out, the digital era has passed, now are analog era, it is also a kind of the status quo, people can't to change, only to adapt, to keep up with the trend of The Times. As a result, people are turning to integrated circuits, which are simple, reliable, easy to maintain and inexpensive.

It is difficult to achieve high efficiency by adjusting the ac motor speed. Communication speed regulation technology has been studied since the 1930s.Since the 1960 s, especially since the 70 s, the rapid development of new since shut off the power

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electronic device, in terms of smart power integrated circuits, has made a series of important research results, the development of modern control theory and the application of computer technology and the development of new control strategies have also been great progress, which makes the ac speed regulation, and find a new research direction, and to overcome several big difficult problem, achieved great results, vigorously promoted the progress of all walks of life.Ac speed regulation technology has high efficiency and energy saving effect, good speed regulation performance, it quickly occupy the motor speed regulation market, become the leader of the leading technology in the field of electric drive.

4.2. Status quo of analog integrated circuit automation technology

The development of FTFN frequency converter technology in foreign countries is relatively early. This technology has become more and more extensive, and the market scope has been developed into a comprehensive module, among which its power has reached tens of thousands of kilowatts.Nowadays, GBT, SGCT, IGCT and other technologies have become the main force in FTFN inverter devices are basically everywhere.The latest technology and exquisite workmanship are the driving force for FTFN inverter, which is rich and colorful.In the rectifier part of the pulse, inverter output is multilevel, using the superposition principle. The most commonly used modules are placed at the inverter end. After the filter controls the high-voltage induction low-voltage low-power motors and high-voltage synchronous low-voltage low-power motors, there are no input and output values.The motor in the rectifier can be controlled.

4.3. Overview of relevant theories

4.3.1. Model structure of integrated circuits

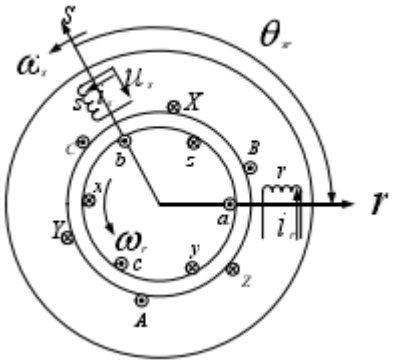

Figure 1. Structure of integrated circuit.

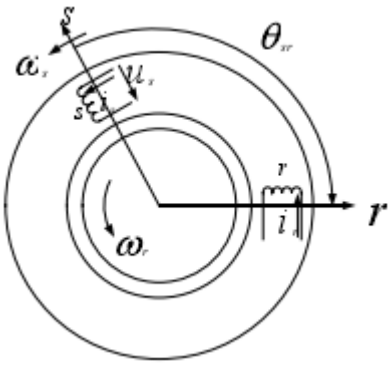

Figure 2. Physical model.

Figure. 2 shows the structure of low-voltage and low-power motors.When is equal to, then the stator rotating magnetic field can no longer be induced in the three-phase rotor winding out of the current, electromagnetic torque will not exist, so induction low current low power consumption motor is also known as integrated circuit. ω ω_1 When the speed is stable, the speed difference is, and the slip rate can be used to express this relationship, namely: ω $\Delta\omega = \omega_1 - \omega$ $\Delta\omega$

$$S = \frac{\omega_1 - \omega}{\omega_1} \quad (2)$$

When the IC is running, the stator axis S is ahead of the rotor axis R in the spatial phase and the phase difference is maintained to run forward together. θ_{sr} The torque is the result of the interaction of these two axes.

$$t_e = -i_s i_r M_{sr} \sin\theta_{sr} \quad (3)$$

If the effective turns of these two coils are equal, then, where, and are the equivalent inductance of coil R and coil S respectively, they are equal, and can be denoted as. $M_{sr} = L_{ms} = L_{mr} = L_m$ L_{mr} L_{ms} L_m

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Therefore, equation (3) can be rewritten as follows:

$$t_e = -i_s i_r L_m \sin_{sr} \quad (4)$$

In formula (3) and formula (4), "-" represents the direction of electromagnetic torque, that is, the integrated circuit can be judged to be in the state of electric power or power generation.The generation of electromagnetic torque tends to reduce the Angle between the two axes. It can be seen from Figure 2-2 that the direction of electromagnetic torque is counterclockwise.

4.3.2. Principle analysis of analog integrated circuit automation

There are many controls in the analog integrated circuit automation system, but the most direct and influential one is the frequency of ac power. Its structure diagram is shown in FIG. 3. FTFN converter is added to the low-voltage low-power motor, so that the alternating current of the power supply must go through FTFN converter.Is an important of the analog integrated circuit automation equipment, it is first to convert alternating current to direct current, then inverter into converter power source, the power supply has the function of the variable frequency and voltage, it mainly consists of power module, large-scale specialized singlechip, FTFN inverter can feel the speed feedback signal, this signal to the frequency of the power supply change, therefore, it can realize the promise within a wide frequency control of motor speed.

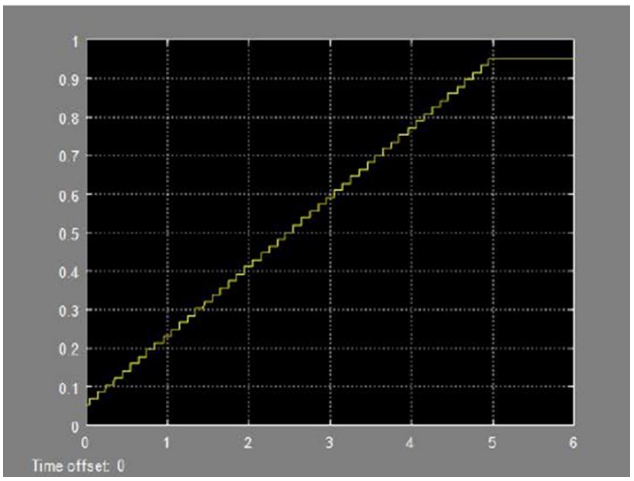

Figure 3. Analog IC automation diagram.

Integrated circuit by controlling the stator power frequency can slowly adjust the synchronous speed, however, with the change, low voltage low power consumption of the mechanical properties of the motor will be how to change, can satisfy the requirement of production machinery and other issues must be studied, in order to better understand the physical mechanism of our mechanical properties of low voltage low power motor, production machinery technology needs further research. f_1 f_1

We know that the rated operating flux of any motor and FTFN converter is generally designed to be near the critical point between the linear region of the magnetization curve and the saturation region, as shown in FIG. 4. φ_N The size of the core should match the strength of the magnetic flux, otherwise it will lead to unsatisfactory results. Large or small magnetic flux will affect the service life of the motor. Therefore, an important factor to be considered in motor speed regulation is to make the air gap flux of each stage of the motor equal to the above critical value, and always keep the rating at this time unchanged. φ_m

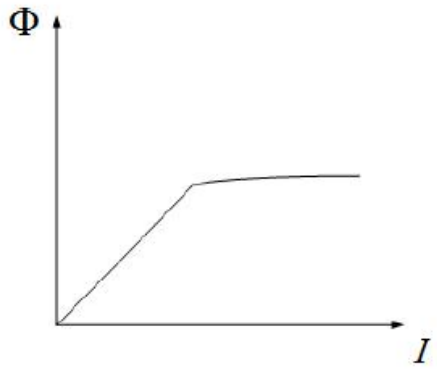

Figure 4. Magnetization curve of iron core.

When the object of study for dc motor, excitation can be controlled separately, how the armature reaction has the right to add, ensure the flux invariant conditions is easy to implement, as the research object is the three-phase integrated circuit, the problem becomes very difficult, when a stator magnetomotive force and rotor magnetomotive force each other, will have spirit of gap magnetic flux.Another way must be found if the flux is to remain unchanged. How can we keep the flux constant? This requires careful study and specialized control.

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According to the motor science, the formula of stator voltage of integrated circuit is, if the stator impedance drop is omitted, there is $E = 4.44 f_1 N_1 \phi_m$

$$U \approx E = 4.44 f_1 N_1 \phi_m \quad (5)$$

According to Formula (5), it can be seen from the above formula that the stator voltage is constant except the frequency and magnetic flux. When the stator end voltage remains unchanged, it will decrease with the increase. f_1 ϕ_m ϕ_m Reduction will lead to low voltage, low power motor torque reduction, the worst motor will burn out phenomenon.A curious idea arose, therefore, to control both the stator voltage and frequency in order to keep the main magnetic flux constant during the speed regulation process. For the flux to be stable at a normal value, the parameter voltage and frequency must also be stable at a normal value.

4.3.3. Speed regulation below fundamental frequency

Constant pressure frequency than speed requirements, when a relatively high, the stator resistance can be ignored, because, in order to ensure that the low voltage low power consumption when the analog integrated circuit automation motor overload capacity is changeless, need to meet before and after considering the constant torque frequency conversion speed regulating mode, in the ability of the motor load, on the basis of using the control mode of this chapter, and got that magnetic flux is constant. $\frac{U_s}{f_1} = \frac{E_s}{f_1} = const$ f_1 R_s $T_{em} = K_T T_N$ $T_N^{'} = T_N$

It can be seen from the above formula that the maximum torque is constant at different frequencies, and the rotational speed corresponding to the maximum torque does not change. Therefore, the slope of their mechanical characteristic curves is the same, and they are arranged once, as shown in FIG. 5.

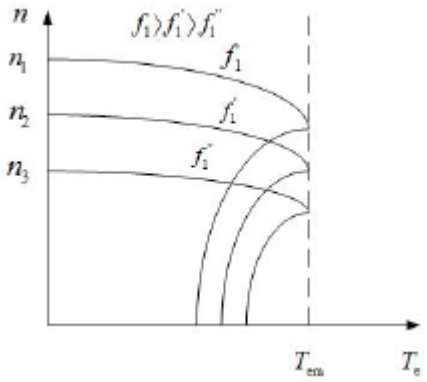

Figure 5. Mechanical characteristics of baseband down analog IC automation.

It can be seen from Figure 5 that the speed regulation below fundamental frequency is constant torque speed regulation.

4.3.4. Speed regulation above fundamental frequency

When the frequency is increased from the base frequency, it is impossible to continue to maintain the same value because the voltage cannot exceed the rated voltage. f_1 f_{1N} E_1 / f_1 U_1 U_{1N} Similarly, the voltage can only be kept unchanged, and the result is that the maximum air gap flux will decrease with the increase of frequency, the synchronous speed of the low-voltage low-power motor will increase, the direct torque will be reduced, and the output power will basically remain unchanged. U_1 Φ_m Therefore, the speed regulation above fundamental frequency belongs to weak magnetic constant power speed regulation, and its mechanical characteristics are shown in Figure 2-6.

The control strategy of keeping the stator voltage constant should be adopted for the speed regulation above the fundamental frequency, that is, the maximum torque can be obtained by ignoring the stator resistance due to the high stator voltage $U_s = U_N$ f_1 R_s

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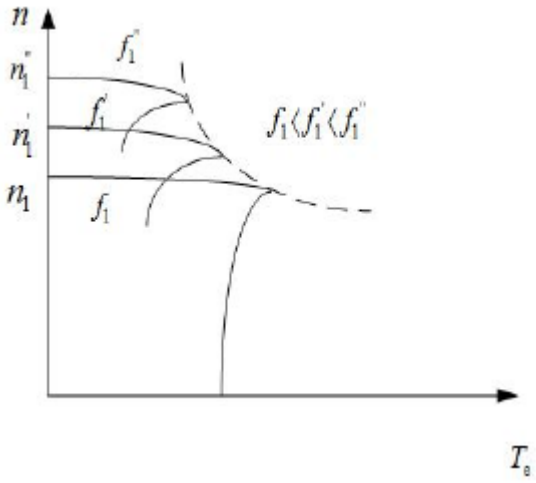

Figure 6. Mechanical characteristics of baseband upwardly analog INTEGRATED circuit automation.

The control strategy of keeping the stator voltage constant should be adopted for the speed regulation above the fundamental frequency, that is, the maximum torque can be obtained by ignoring the stator resistance due to the high stator voltage. $U_S = U_N\ f_1 R_S$ According to the function relation of constant voltage and frequency ratio, we can know that the simulation result is the same as the theoretical analysis result.

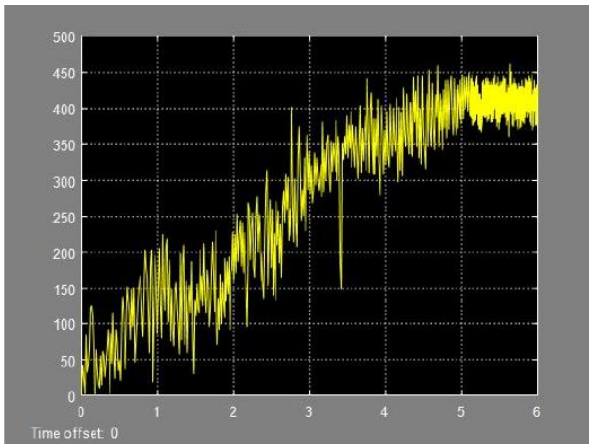

Figure 7. Waveform of Uab.

It can be seen from waveform figure 7 that although the voltage is a bit jitter in part, it rises steadily as a whole. When the rise time is 5 seconds, it starts to change steadily and keeps a certain value, which is very close to the actual analysis result and basically the same.

5. Conclusion

From the simulation waveform in the figure above, it can be seen that the actual waveform is very close to the waveform analyzed in theory, which proves the feasibility of the constant voltage and frequency ratio governing system model.Through the three-phase modulation signal, PWM generator generates inverter driving fluctuations, generating frequency and voltage, ac low voltage low power consumption motor as we expected.When the provided frequency is power frequency, the system runs for 5 seconds. Within a certain value of the frequency fluctuation, the modulated signal changes greatly and the rotation speed deforms from it.At the end of a modulated signal, it is not certain that there is a change in frequency.

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