The motor testing system design based on SINAMICS S120 inverter

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Abstract. In this paper, an induction motor testing system based on Sinamics S120 inverter is designed and implemented. This system adopts Siemens S7-300 programmable controller as the main control unit, and the Sinamics S120 inverter as the actuator of the companion and subject motors. Because the whole working process is fully automatic controlled by PLC, it has high working reliability. All inverters on one DC generatrix decrease power consumption and have remarkable energy-saving effect and practical value.

1. Introduction

Another section of your paper Motor testing uses professional testing equipment to test the technical indicators of the motor based on the motor test standards [1]. Because the technical indicators of the motor can truly reflect the characteristics of the motor, therefore, it is of great significance to design a motor testing system with advanced technology, reliable operation and accurate test. Motor testing mainly includes no-load testing, stop-turn testing and load characteristic testing. The load characteristic testing is the most important testing and through load testing, the mechanical characteristic of the motor can be obtained which is directly related to operation state of the motor [2].

The traditional motor testing system has the disadvantages of complex structure, low efficiency and high energy consumption [3]. The motor testing system designed in this paper can effectively deal with the above problems.

2. Related work

2.1. Architecture of motor testing system

Figure 1 shows the hardware structure of the proposed motor testing system. The motor testing system is mainly composed of power supply unit, the host computer monitoring unit, the signal collection unit, the lower computer control unit (PLC-S7-300), S120 inverter, the subject motor and companion motor. The power supply unit of AC380-50Hz supplies electric power for the motor testing system. The host computer monitoring unit realizes the issuing of system control instructions and the monitoring of system status data through monitoring software. The signal collection unit is used to realize the value detection of voltage, current in the high voltage circuit of the system. The lower computer control unit PLC realizes the automatic control of the whole testing system and it can calculate and transform the sampled data, and upload the final result to the host computer monitoring unit for display.
2.2. S120 inverter

Figure 2 shows the structure of the proposed S120 inverter. Sinamics S120 inverter is a vector control inverter with modular structure. Its function modules can be selected according to actual needs. According to the actual control requirements of this testing system, the S120 inverter is composed of control module CU320, rectifier module, filtration module, inverter module 1 and inverter module 2. The control module CU320 is the control center of S120 inverter, by which the four-quadrant rectifier control algorithm and motor vector control algorithm are realized. The final calculation results of the four-quadrant control algorithm are applied to the rectifier module to realize the two-way flow of energy by controlling the bus voltage and input current. The final results of the inverter control algorithm are used to control the motor speed and torque on the inverter modules. The control module CU320, rectifier module, inverter module 1, and inverter module 2 are connected through DRIVE_CLIQ cable to achieve internal data communication.

In this testing system, PLC (S7-300) is the control center, while Sinamics S120 is in a subordinate position and is controlled by PLC. The data communication between PLC and S120 inverter is realized by using profibus-dp data bus. When performing the hardware configuration of the motor testing system, the station address of the PLC must be set synchronously with the same value of the dial code address of the control module CU320 to achieve address matching. The proper message structure is necessary to realize the transmission of control instruction and the reception of status...
information. The hardware configuration of PLC needs to match the settings of the S120 inverter which are the message structure and data content completely consistent to ensure the normal transmission of data. The specific message configuration is shown in figure 3 and figure 4.

Figure 3. The diagram of S120 inverter message structure

Figure 4. The diagram of S7-300 hardware configuration

2.3. The principle of energy recycling
The energy recycling principle of the testing system as shown in figure 5, three-phase 380V~50 Hz AC as the input of the rectifier module, and the 600V DC as the output to the DC bus. On the DC bus, there are two inverter modules. The inverter module 1 drives the companion motor which works in speed mode (braking condition), and the inverter module 2 drives the subject motor which works in torque mode (traction condition). When the motor testing system works, with companion motor in power generation mode and subject motor in electric motor mode, the energy flows from the subject motor to the companion motor by the DC bus which is in form of the main circuit structure to realize the energy recycling. The input power consumption of the rectifier module is only for the heat dissipation and the system energy consumption is low.

Figure 5. The flow chart of Adhoc working mode
3. Software implementation of motor testing system

The software of the motor testing system includes the automatic control software of the lower computer PLC and the monitoring software of the upper computer. The function of the automatic control software includes motors start and stop control, the speed adjustment of companion motor, the torque adjustment of subject motor, input power supply voltage amplitude adjustment, motor speed and torque signal collection, AC Contactor switch control, emergency stop, fault diagnosis and so on. The specific flow chart of the load testing is shown in figure 6.

![Flow chart of load testing](image)

Figure 6. The flow chart of the load testing

The upper computer monitoring software uses Siemens Simatic WinCC development platform to build. The platform has a friendly interface which can be easy to operate, has perfect expansibility, good compatibility and many other advantages. It can be very convenient to achieve the supporting application with Siemens other industrial control software. The control commands and given data for motor testing are all input into the system monitoring software of the upper computer to participate in the control and calculation. The complete process of motor testing can also be monitored in real time through the monitoring software of the upper computer. When the testing is completed, the system software by calculating and analyzing the collected data, automatically generates the testing report.

4. Conclusion

This research has presented the structure of the motor testing system based on Sinamics S120 inverter, and introduces the software implementation of the motor testing system in detail. The motor testing system adopts PLC to automatically control the whole testing process, and uses the WinCC platform of Siemens to build the upper computer monitoring interface. The motor testing system overcomes the shortcomings of the traditional motor testing system, such as poor dynamic response, low automation, and high energy consumption. The design of energy recycling effectively saves energy and the whole system is stable and reliable.

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