

Application of ALPHA6000 Inverter in Numerical Control Machine

I. Introduction

A numerical control machine, NC for short, is a mechanical-electrical integrated product combining technologies in various fields such as mechanics, electricity, hydraulics, pneumatics, micro-electronics and information in the past three decades. In modern production of machine tools, the multiple-motor driven mode is generally adopted, and the spindle and various feed systems are driven by their own motors. Due to the wide processing range of the numerical control machines, different work-pieces and different procedures require the use of different tools and different speeds by the execution units of the machines. Therefore, the main motion of the machine should be able to conduct stepless speed adjustment, and the spindle speed adjustment system generally adopts an AC (alternating current) speed system.

With the development of variable frequency speed-adjustment technology, the AC driven spindle of numerical control machine can also satisfy these requirements. The spindle motor drives the spindle to rotate through the belt transmission or through the belt transmission and the reduction gear (to obtain bigger torque) in the spindle box. Due to a wide range of speed adjustment of the spindle motor and its ability of stepless speed adjustment, the structure of the spindle box is significantly simplified.

II. Technical Requirements for Numerical Control Machines

1. Requirements for the Motor

In general, a variable frequency motor is required, or a normal motor plus fan is required to satisfy the heat dissipation requirements of the motor under low frequency, and it also requires the motor to have a wide range of speed adjustments.

2. Technical Requirements for the Inverter

a. Big torque under low frequency

Under low frequency (1~10Hz), it requires an output of 150% of the rated torque.

b. High dynamic response speed of torque, stable speed and high precision

It can realize good dynamic response, and in accordance with the load change, it can quickly make response through change of the output torque to realize stable speed of the spindle speed.

c. Fast deceleration and stop

Generally speaking, the acceleration and deceleration time of the numerical control machine is short. The acceleration time is ensured by the performance of the inverter, and the deceleration time depends on external braking resistor or braking unit.

d. High reliability

The inverter has a low failure rate as well as stable and reliable operation.

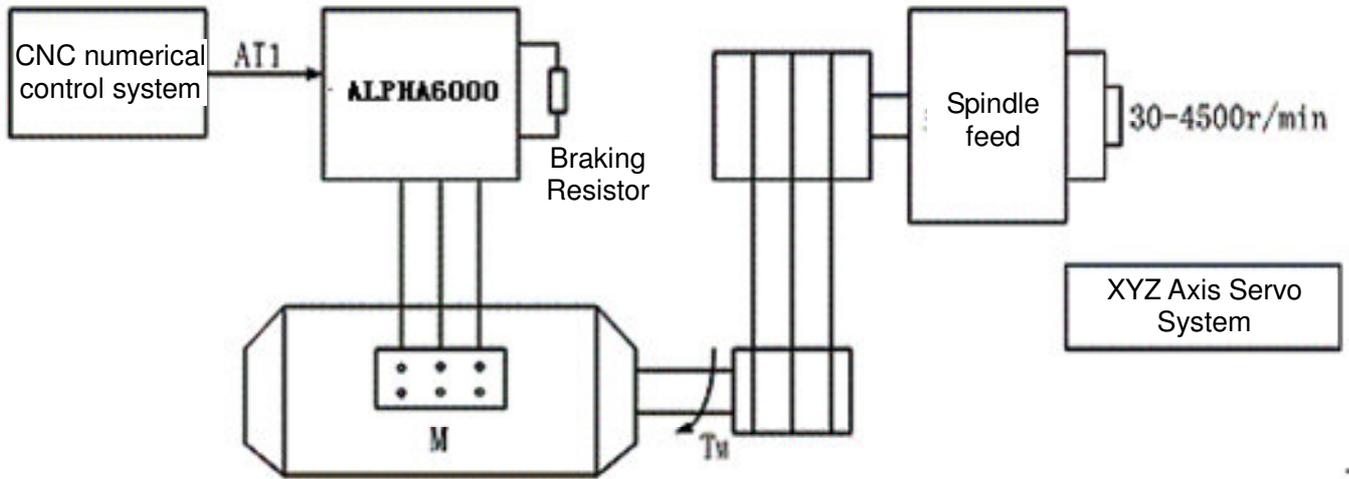
e. Electromagnetic compatibility problem

The numerical control machine is applied in industrial environments, which does not only require strong capacity for resisting disturbances but also not creating disturbances among the peripheral control equipment.

From the operating principle of inverters we know that the inverter output has a certain harmonic component, and if it is not appropriately handled during use, it may generate disturbance to other equipment. The device that most tends to be disturbed in the numerical control machine is the CNC controller. Once the CNC controller is disturbed, the system won't be able to work normally. In particular, the frequency instruction and operation instruction of the inverter might also be disturbed, and when the disturbance is very serious, it might cause unstable frequency instruction and malfunction of the inverter. The method to solve this kind of problem is to conduct strict EMC testing on the inverter before leaving the factory, and to use the inverter which have passed the EMC test.

III. System Composition

1. CNC numerical control system composition is shown in the following FIG.:



Electric System Diagram

2. Configuration:

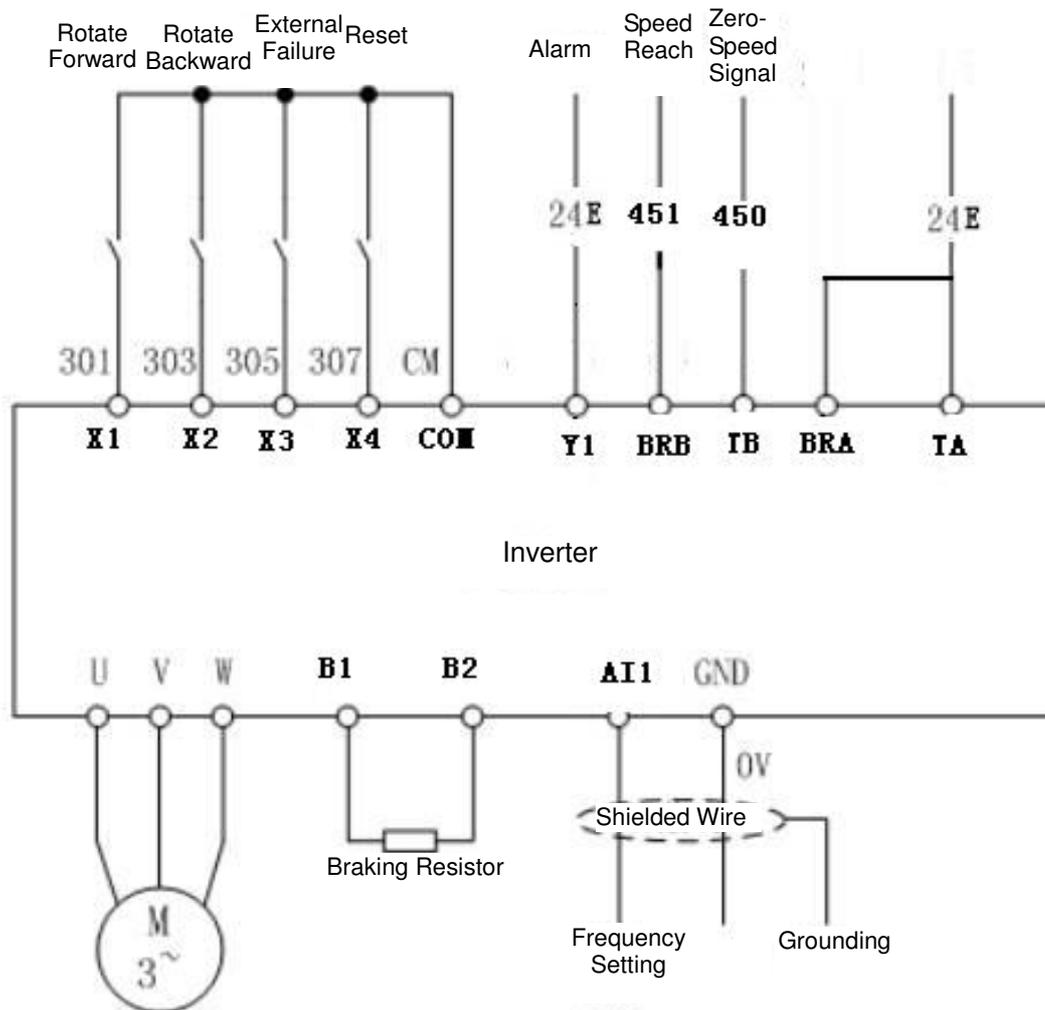
Inverter: ALPHA6000-37R5GB

Braking resistor: 80Ω/750W

7.5KW speed adjustment motor

IV. Wiring and Inverter System Setting

1. Inverter wiring schematic diagram



2. Inverter Parameter Setting:

P0.01 =2 Terminal AI1 is analog input.

P0.04=1 External terminal control

P0.07=150 (Maximum output frequency)

P3.03=14 (Stop due to external failure)

P3.17=2 (Speed reach)

P3.14=19 (Failure output)

P2.06=6 (Carrier frequency)

P9.00=100 (Slip frequency compensation gain)

P3.01=1 (X1 rotating forward)

P3.02=2 (X2 rotating backward)

P3.04=6 (X4 resetting)

V. Characteristics of the ALPHA6000 Series Inverter

The ALPHA6000 series inverter has low-frequency output, big torque, high speed and procession, reasonable price, complete functions as well as stable and reliable quality, which is an ideal choice to match the machine tools. The ALPHA6000 series inverter has the following characteristics:

1. Special CPU for motor control, PWM control of space vector, ultra silent stable operation.
2. Great performance of low-frequency torque, low-speed rated-torque output stable operation
3. Having passed the EMC test, great capacity of resisting disturbance.
4. Advanced design of automatic torque compensation function, great adaptability of load.
5. Real-time monitoring of the output current, great dynamic response capacity.
6. Complete functions, as many as 40 protection and alarm functions.

VI. Effects in Use

Through batch use of the ALPHA6000 series inverters by Shenyang Machine Tool Plant, and after a complete test by its Quality Inspection Department, our user have proved that the use of the ALPHA6000 series inverters can totally satisfy the spindle control requirements of machine tools, it has low rotation speed operation and stable output torque, which can satisfy the processing requirements of different parts, and it can totally replace the traditional spindle structure of rolling bearings. In addition, this spindle structure is simple and compact, and it can realize real stepless speed adjustment. The spindle rotation speed is controlled by an external analog signal through control of the output frequency, and different rotation speeds are required for different processing techniques (such as rough machining, finish machining, etc.); at this moment, the numerical control system can output different analog signals to the inverter to realize different rotation speeds, and in the meantime, the start/stop signal is also controlled by the numerical control system to increase the automation degree and the service life of tools. At present, a large amount of ALPHA6000 inverters have been used in Shenyang Machine Tool Plant, the user feedback is great, and the failure rate is almost zero.

VII. Conclusion

Through successful application of ALPHA6000 series inverter in the spindle of numerical control machine, the situation of high dependence on the imported products has been improved, and the product cost has been significantly reduced. The ALPHA6000 series inverter has been rapidly promoted and used in numerical control machines due to its unique properties and great cost performance.