Analysis and diagnosis of Manual Pulse Generator based on XKA714

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Abstract. The manual pulse generator is the main part of CNC machine tool, the manual mode of the Fanuc CNC milling machine is noneffective, and the working principle and fault analysis are discussed to provide reference for the similar failure of the actual machine.

Introduction

Usually, there is a emergency stop button on the machine operator panel and the handheld unit of the CNC machine tools, which plays an important role in the control of CNC machine tools. For instance, when program coordinate calculation error occurs and cutting tool collsion fault is about to happen, pressing the emergency stop button can avoid causing damages to mechanical components; pressing the emergency stop button before CNC system shuts down can avoid glides by self-gravity of the Z-axis. That is to say, the emergency stop button is designed for protecting people and machine from danger in emergencies. After pressing the button, the system will be halted and all the feed shafts and spindle will enter the braking state; some of the servo drive high voltage power supply circuits will be cut down. Only when the trouble has been removed, people unscrew the emergency stop button, and the numerical control system will return to normal. In practical use, alarm cannot remove the failure is more common, but only when it is solved can restart the machine into normal use. Emergency stop control of FANUC 0I CNC system is the first machine tool protection signal that needs to be dealt with to ensure the smooth function of the interruption system in emergency during the adjustment process. There are two types of emergency stop signal * ESP (emergency stop): software signal, which is G8.4, and hardware signal, which is X8.4. CNC machine tools directly read signal X8.4 and PMC input signal G8.4. When either one of the two signals the signal is low, the system will alarm. This paper constructs fault analysis towards the hardware-related emergency stop alarm signal X8.4 control principle and its failure.

Working principle analysis of HANDLE

The handwheel structure and wiring of the XKA714 nc milling machine are shown in figure 1, and its model is ZSY1469-001-100B-5l. The structure can be divided into two parts, one is the above two band switches, the implementation feeding axis selection and the multiplier control; One is the pulse generator, by controlling the direction, number and frequency of pulse, realize the handwheel mode of feed axis direction, speed and position control.

Figure 1 Structure and wiring diagram

The operation of the XKA714 milling machine in the handwheel mode to the axis movement is as follows:1)In the operation panel, the working mode band switch is placed in the "HANDLE" mode,

so that the movement of the feed shaft is controlled by the Manual Pulse Generator;2）Rotate the two band switches above the handwheel**,** determine the feed axis and feed rate;3）Rotate the pulse generator below the wheel to determine direction, speed and position. The operating procedure can be achieved by moving the corresponding distance along the fixed (positive or negative) direction of the fixed shaft.

As you can see from the analysis above,in order to realize "HANDLE" woek mode,need to build with the signal transmission channel between feed servo motor and handwheel,control signals between the even interview as shown in figure 2. It can see form figure 2, The "handwheel" work mode converts the signal, the shaft selection signal, and the multiplier signal is the input signal that passes through the I/O module, PMC to the Numerical control system; The manual pulse generator establishes contact with the numerical control through the I/O module independent JA3 interface. Then the axis direction, speed and position control signal through numerical control and servo drive unit FSSB between high-speed serial data channel to the servo drive system, so as to realize the movement of the handwheel mode of feed shaft. Working in the "HANDLE" mode, the control of feeding shaft used in CNC machine tool structure parts with CNC ,I/O module, the handwheel, servo amplifier, servo motor, and mechanical structure parts of motion transformation.
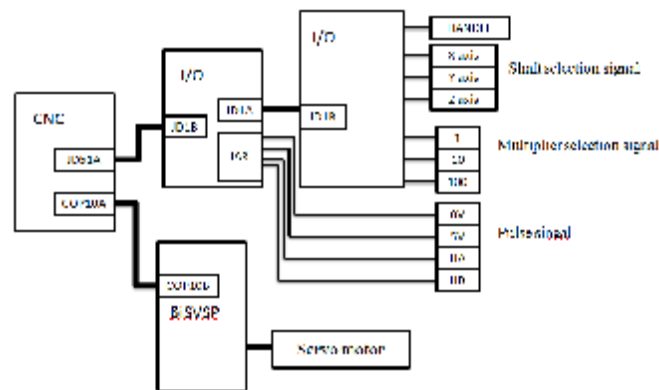

Figure 2 Signal transmission and connection schematics between handwheel and motor

The process of signal transmission between parts of the machine tool is as follows: first, the set value of 8131 #0 is set by the system parameter, which determines that the machine can be controlled by hand wheel. Then, through the hardware connection and software definition, the X signal that indicates the choice of handwheel, shaft, and feed rate is sent to the PMC, and the PMC converts X signal to G signal to CNC; Second, the shaft position signal is transmitted through the PMC to CNC by rotating the Manual pulse generator. The CNC and servo system transmit position signals through the FSSB high-speed serial channel. The system parameter, 8131#0 (HPG), indicates whether to use the handwheel, which is the value of 1 for use, and 0 for not using; The X and G signal addresses used in the handwheel function are shown in table 1.

Table1 X and G signal address and the meaning

Signal type	Signal address	Signal meaning
Handwheel selection signal	X1.3	Handle mode is effective
	G43#0、#1、#2	
Axis selection signal	X2.6 （MPGX.M）	X/Y/Z axis signal is effective
	X2.7 （ MPGY.M）	
	X6.6 （MPGZ.M）	
	G18#0 and #1	
Feed rate signal	X10.1（x1rate）	The X1, X10, and X100 multiplying select the signal （In handle mode, switch the amount of movement per step）
	X10.2 （ x10 rate）	
	X10.3 （ x100 rate）	
	G19#4、#5	

Failure Analysis of handle Failure

1）Fault phenomenon   When a fault is analyzed and diagnosed ,it is first necessary to communicate with the machine operator to understand the situation. The failure phenomenon is as follows: CNC machine starts, "handle" manner during the movement of the shaft, screen coordinates first showed a small change, then stop, but the real axis did not move; When switching to other "JOG" or "MDI" ways, the feed movement is normal.

2）Failure Analysis   According to failure phenomena, combined with the analysis of the working principle, It can be determined that the servo amplifier, servo motor and mechanical structure parts without failure, That is, the feed axis control signal transmission channel from the CNC , through the servo drive system to reach the mechanical transmission mechanism is no problem. The cause of the failure may be that the handwheel control signal is not transmitted to the CNC system and the signal transmission channel between the handwheel and the numerical control device is not established. Therefore, the analysis with the fault can be carried out as shown in Figure3. Combined with the machine running and no parameters to modify, so you can check the status of the point to determine whether the hardware line or PMC failure; by checking the pulse generator signal is normal, to determine whether the pulse generator line failure or hardware damage.
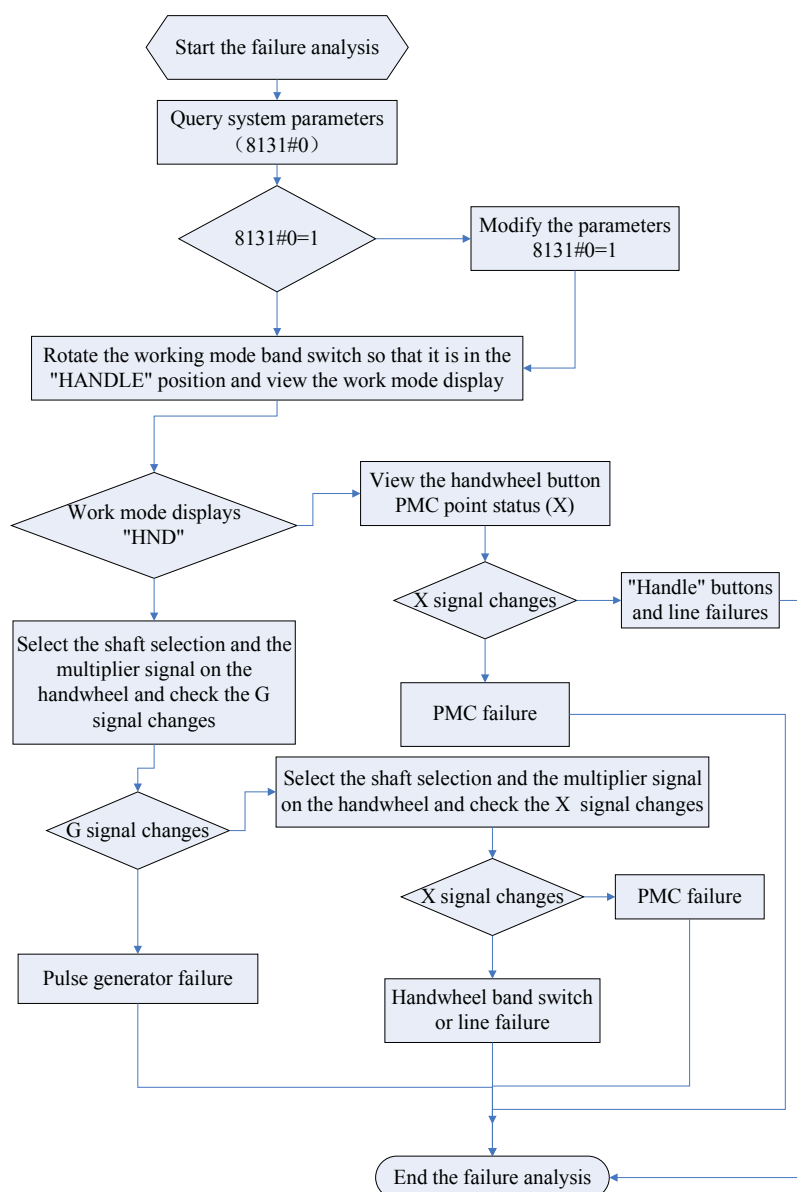
Figure 3 Failure analysis flow chart

Diagnosis of handle failure

According to the process of the failure analysis in figure 3, the fault diagnosis is carried out one by one. According to the simple and complicated principle of the fault diagnosis, the point state and the PMC program diagram should be viewed first.Working mode band switch in the "handle" way, CNC status display "HND", through the diagnosis screen to view the G43 signal is normal, thus diagnosing the "handle" working mode switch is normal;Rotating the axis and the ratio of hand vein units selection switch, view the corresponding X, G signal change (see table 1), diagnosis of feed shaft and ratio selection signal transmission is normal, thus judging that the handwheel pulse generator may be faulty causing the axis of the movement control signal can not be generated.

When the hand pulse generator is working normally, the pulse generator of the rotating handle will output the image 4 pulse signal. The pulse number controls the distance of the axis, the pulse
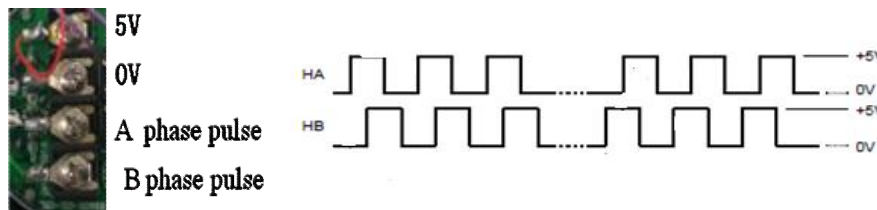
Figure 4 Manual pulse generator terminal and pulse output diagram

interval frequency controls the movement velocity, and the A and B control the movement direction in sequence. According to Figure 2 can be seen to determine whether the hand pulse generator failure, need to detect the terminals 0,5 V, HA and HB signal is normal. Which 0,5 V to form a 5V pulse voltage, HA, HB to produce two-phase rectangular pulse wave. For the failure of the manual pulse signal, the fault analysis and diagnosis of the multimeter and oscilloscope can be used, and the process is: The backboard of the handwheel is opened, and the voltage between A/B and the 0V is tested in the case of the CNC machine system to start. When measuring the multimeter black table pen placed with 0V terminal, red pen were placed in the A or B terminals, in the process of shaking the hand wheel, the voltage should be 0-5V level changes. Through the detection found that A phase voltage does not always change, and B phase voltage changes in the level. In order to further determine whether the fault is A phase pulse, it is need to use the oscilloscope to check A and B phase waveform.Through the
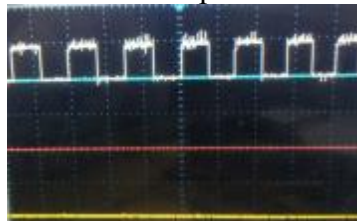

Figure 5 Oscilloscope test waveform

oscilloscope found only one phase waveform, as shown in Figure 5, the blue line position shows the B phase output waveform, the yellow line position without waveform, the position should be A phase output waveform, which can determine the "Handle" Invalid fault for the pulse output pulse fault.

After determining the cause of the fault, the "exchange" method commonly used in the fault diagnosis is used to exchange the two same type of hand-shaking pulse generator.After the exchange, a fault migration occurred ,which can be diagnosed that the machine tool failure due to hand pulse damage.

Conclusion

Through the analysis of the working principle of the "handle" working mode to control the movement of the feed axis, it can be understood that when the "handle" mode failure occurs, the cause of the fault is analyzed first, combined with the specific fault phenomena and the use of the machine before and after , The cause of the failure can be determined. Of course in the actual fault analysis and diagnosis process, with the increase of practical experience, combining with the fault diagnosis method, the fault analysis of the process may be shortened, see failure phenomenon may be able to quickly find the cause of the problem.In short, in order to analysis the cause of failre, It is necessary to understand the working principle of NC machine tool, the function of machine tool and the corresponding signal flow to the relationship, and have a certain fault diagnosis and analysis method.

Acknowledgment

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