

Study of Detection Method about PMSM Rotating Angle Based on AD2S1210

Yang Bo

Electronic Information Department
Foshan University
Foshan Guang Dong, China e-mail: fsttww@sohu.com

Abstract : The article introduces a new method of detection for the angular displacement of the permanent magnet synchronous motor (PMSM), which converts the angular displacement to digital quantity by using the resolver-to-digital converter AD2S1210. It focuses on the working principle of the system and the design of the system circuit. The experimental results show that the detection method is accurate and stable, and can satisfy requirements of high accurate measuring system of shaft angle, the unreliability and other issues brought by photoelectric encoder in the poor working conditions are solved.

Keywords: Resolver; PMSM; Angular displacement; AD2S1210

1. Introduction

With the development of high performance permanent magnetic materials, not only the permanent magnet synchronous motor (PMSM) realizes brushless, and the permanent magnet synchronous motor (PMSM) and asynchronous motor has the advantages of simple structure, high reliability; At the same time because it doesn't need excitation winding, significantly reduced the size, weight, loss, fever and improves the efficiency and power factor, has obvious energy saving effect. In recent years, the application of PMSM at home and abroad are vigorously promoted, has become the main force of AC servo system, it is widely used in servo system, electric vehicles, rail transportation, mining, shipbuilding industry, wind power, aerospace and other fields. To obtain accurate rotor position is determined the servo control performance, even is the main factor of system stability, the angle measurement sensors commonly have grating encoders, Hall sensors and resolver, the rotor position is converted into a digital signal by grating encoders, the response is simple and convenient, but because of the environment, price and other factors can not be widely used, Hall sensor has the advantages of simple structure, but it is difficult to achieve high precision angle measurement requirements and is restricted, the resolver is widely used because of its advantages of high temperature resistance, humidity resistant, anti-interference, simple structure and so on. This paper presents a novel high-precision resolver-to-digital conversion chip for high

precision resolver to achieve high precision and high reliable PMSM angle measuring system.

2. Angle measuring system design

Resolver is an AC micro-motor on its output of the rotor position corresponding to a certain electrical functional relation, and electrical schematic shown in Figure 1,

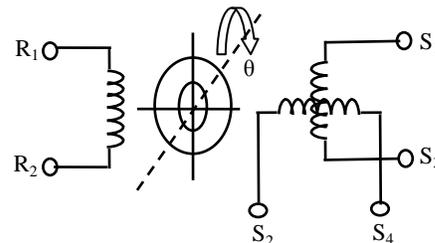


Fig.1 Resolver electrical schematic

A resolver primary field winding (R1-R2) and a secondary winding magnetically induced (S2-S4, S3-S1) are located on the stator. Excitation signal (R1-R2) is input to the primary winding, two secondary windings machinery dislocation 90° , due to the special design of the rotor, the secondary winding has an induced electromotive force, and the size is proportional to the sine and cosine Angle between the stator and rotor winding axis, followed by the output signal level is:

$$E_{R_1 R_2} = U \sin \omega t \quad (1)$$

$$E_{S_2 S_4} = U \sin \omega t \sin \theta \quad (2)$$

$$E_{S_3 S_1} = U \sin \omega t \cos \theta \quad (3)$$

Where, θ is the rotor position angle, ω is the rotor excitation frequency, U is the electric induction amplitude, the excitation signal size of resolver is AC7mv, and the frequency is 2kHz in the design.

AD2S1210 using Type II tracking loop to work continuously track the location of data, and can track a constant speed input without inherent errors, the converter generates the output angle Φ , the feedback output angle Φ is compared with the input θ , when the output angle Φ is equal to the input angle θ , the difference was 0. by Formula 1 to 3 and the output angle Φ combined with formula:

$$E_{S_3S_1} \times \cos \phi = U \sin \omega t \sin \theta \cos \phi \quad (4)$$

$$E_{S_4S_2} \times \sin \phi = U \sin \omega t \cos \theta \sin \phi \quad (5)$$

Since the signal generated by the internal incentive, according to the difference between the two formulas (4) and (5) where an internal synthetic reference amount demodulation, when $\theta - \Phi$ is small, and its value is approximated by $U(\theta - \Phi)$, referred to as the error E_{rr} of the rotor angle and the digital output angle as defined in formula:

$$E_{rr} = U \sin(\theta - \phi) \approx U(\theta - \phi) \quad (6)$$

This error signal by the phase detector generates a DC error signal proportional to $\sin(\theta - \Phi)$, it generates an output voltage increases with time to control the VCO output pulse frequency by the integrator, pulse calculating reversible counter, when the error signal is greater than zero that $\theta > \Phi$, counters accumulate; when the error signal is less than zero, ie, $\theta < \Phi$, the counter decrements; thus changing the frequency and the counter direction, because the entire system is a digital servo system, and ultimately makes the $\sin(\theta - \Phi) = 0$, ie $\theta = \Phi$, complete simulation angle to TTL level output digital angle conversion.

The system is mainly composed of a resolver, signal preprocessing, range control, AD2S1210 RDC conversion, interface circuit, power supply module, LCD module, etc., its core AD2S1210 conversion module can accurately and effectively the angle information into digital, using TMS320F28335 as a data output interface, after decoding display the measurement results, the system structure is shown in Figure 2 as shown.

The system adopts TMS320F28335 as the main control chip, the chip has abundant digital port, suitable for motor

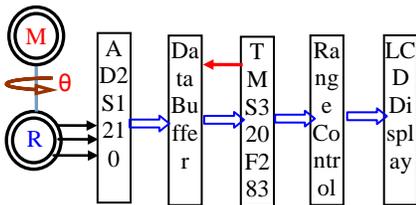


Fig.2 Block diagram of the system control. AD2S1210 provides the interface level pin, configurable digital logic operating voltage can be directly connected with the target chip, simplifying the interface buffer circuit, Figure 3 is a circuit block diagram of a digital interface.

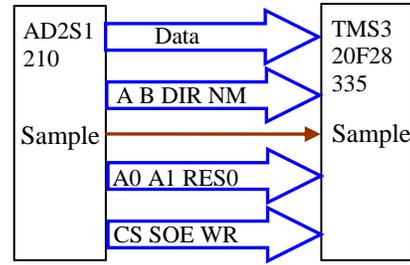


Fig.3 Digital interface circuit

Figure 3, AD2S1210 of V_i received + 3.3v level, which makes chips for digital logic interface of the operating voltage control to 3.3v, with TMS320F28335 and other I/O operating voltage of 3.3v master chip direct docking. AD2S1210 4-wire serial bus can be used for communication, communication baud rate reaches a maximum 25MHz, SOE grounding enable serial communication mode, this mode under the RD must then high, then low while CS to enable the chip to work, AD2S1210 have flexible working patterns, by setting A0, A1 pin allows the chip to enter configuration mode or normal mode, Configuration mode can read and write chip registers, programming configuration AD2S1210 works, such as an error threshold information, Normal mode can simplify operations, transmit timing pulses can get the position, speed information. Normal mode RESO, RESO used to configure the position, velocity output resolution at 10, 12, 14, 16 in change. AD2S1210 work at 8.192MHz crystal frequency, pin configuration and function definitions in Table 1 table 2. When the DSP needs to sampling location and speed, To send 'Sample' first low level and keep at least three clock pulse, then the 'Sample' up, and then to carry on the serial communication, get the current position and speed.

By the control signal time series analysis, if the use of DSP to read AD2S1210 16-bit number of output data, first of all to make all AD2S1210's INHIBIT into a low level, and then wait to 600 ns, again make to read AD2S1210's ENABLE signal into a low level, wait 110 ns to read the output data, For instruction cycle only dozens of ns of DSP, this will waste a lot of machine cycle, this is more serious in the case of multi-channel. To solve the problem between AD2S1210 and DSP used 4 D flip-flop and 2 16 3 state latch to implement the logic timing design between them. When the BUSY signal changes from high to low or from low to high at the moment, latch contents will change, then read it may get the wrong data. Here let the BUSY signal delay output by D flip-flop, it can avoid the error above. Also can at the same time using multiple series D flip-flop, and cooperate with the clock signal CLK obtain appropriate blocking signal pulse width. DSP output signal INHI for high level, it didn't read the data, for the low level AD2S1210 DSP is read data, When the DSP does not need to read data, INHI is set to a high level, BUSY falling edge

of each pulse triggers a latch, so it can be transformed every angle to each latch latches, When DSP needs to read data from each channel, first INHI is set to low level, thus prohibiting a change in the content of the latch, and then through the output enable end to read each latch data, without any wait states, greatly improving the real-time control system, only after reading INHI is set to a high level. The main software flow chart shown in Figure 4.

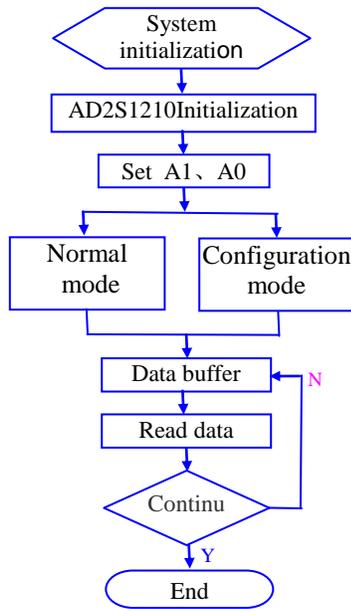


Fig.4: The main software flow chart

3. Conclusion

The research and development of the absolute angular position measuring system composed of the resolver and RDC, which has the advantages of high precision, high reliability, and good anti vibration, , waterproof and anti interference ability, and use its angular displacement detection method in combination with the resolver, replace the traditional detection method of photoelectric encoder,

solved the photoelectric encoder is unreliable work in the bad environment, and successfully realized the digital interface with PLC, the experiment shows that the detection method to satisfy the detection and control precision of system, improve the stability of the equipment, the test method has been widely used at present, have a certain practical and promotional value.

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