

Research on a Standard Signal Source of Circuit Breaker

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Abstract. Circuit breaker is a very important control and protective equipment in the field of grid system. When the electric equipment or circuit are in accident, the relay protection and circuit breaker will cut the fault section from grid rapidly and guarantee the grid running safely. However, there are a mount of high voltage circuit breakers. According to the traditional planned overhaul model to inspect circuit breaker, there will be some phenomenons such as large workload, high expense and so on. At the same time, different circuit breakers need different signal sources. During maintenance, this character will lead to the waste of human resource and cause artificial errors. Therefore, the paper presents a new standard signal source of circuit breaker. It realized the integrated, informational and intelligent reform for the various kinds of signal sources. Utilize standard signal source to realize the calibration for common equipment can reduce the maintenance workload and improve the pertinence of maintenance. It is very helpful for improving the running reliability and economy of electric equipment.

Introduction

The definition of circuit breaker is that: the designed partial and composite device, realize division and combination, bearing, guide circuit and breaking in certain time. Circuit breaker is a very important control and protective equipment in the field of grid system. The function of control means that put some electric equipment or circuit into use or exit the running state. When the electric equipment or circuit are in accident, the relay protection and circuit breaker will cut the fault section from grid rapidly and protect the grid running safely. The objects that circuit breaker protect is diversiform, such as generator, distribution system and electric equipment. Therefore, the reliable running of circuit breaker is very important to the electric system.

In order to promote the reliability of circuit breaker operation, one method is improve the quality of circuit breaker, the other one is that conduct necessary inspection and maintenance of the circuit to avoid the accident.

In electric power system, there are a mount of high voltage circuit breaker. According to the traditional planned overhaul model to inspect circuit breaker, there will be some phenomenons such as large workload, high spend and so on. At the same time, different circuit breakers need different signal sources. During maintenance, this character will lead to the waste of human resource and cause artificial errors. Therefore, the paper presents a new standard signal source of circuit breaker. It realized the integrated, informational and intelligent reform for the various kinds of signal sources. Utilize standard signal source to realize the calibration to common equipment can reduce the maintenance workload and improve the pertinence of maintenance. It is very helpful for improving the running reliability and economy of electric equipment[1-2].

Status and Problems

(1)Traditional method

Adopt simulation method. The single hardware implements signal source. The defects are lack of the signal reliability, amplitude and precision. At the same time, this kind of signal source relies on hardware excessively and is easy to cause serious distortion. The peripheral circuits are too complex.

The equipment is bulky and difficult to modify and upgrade. At last, it can only produce several simple waves.

(2) Signal source based on DSP chip

DSP plays an important role in signal treatment field. DSP is characterized by the ability of programmable, high flexibility and so on. However, its instruction execution is serial structure, it will cost a lot of time when complete the operation of FIR filter and FFT calculation which need parallel structure.

(3) Signal source based on special chip

In the market, there are many special integrated chips that can complete special modulation mode. Users can select different chips to complete the design of signal source. However, the single chip just only complete seldom modulation modes and frequency is too simple, lack of enough ability of programmable. This method will cause inconvenience to engineers.

(4) Signal source based on DDS chip

DDS adopts digital manner to realize simulation carrier. Through inputting the different control signal, chip will generate sine wave of corresponding frequency and get the control right of signal phase by changing control signal. This method can realize some simple modulation modes such as QPSK, FM etc. While the control signals of DDS need the provision from GPLD, DSP and so on, it will improve the flexibility of hardware. At the same time, DDS chip that work at high frequencies will cost much more money[3-4].

Function introduction

In order to make up for deficiency of existing signal sources such as kinds of signal source is various, low automation, low work efficiency and waste of human resource, this paper presents a standard signal source of circuit breaker.

Standard signal source of circuit breaker simulates every parameters during circuit working normally and abnormally: primary circuit breaking current, switching closing coil current, storage motor current, stroke sensor voltage signal/current signal.

(1) Need three switch signals output.

(2) 1 channel switching closing coil current output: simulate the current output that circuit breaker conducts switching closing operation. Output current is 0~5A. Precision is 1%. Output current needs to be feedback.

(3) 1 channel storage motor current output: simulate the circuit breaker stroke signal output(current output). Precision is 1%. Output current needs to be feedback.

(4) 1 channel 4-20ma output: simulate the current output that circuit breaker conducts storage motor operation. Output current is 0~5A. Precision is 1%. Output current needs to be feedback.

(5) 1 channel 0-5V output: simulate the current output that circuit breaker conducts storage motor operation. Output current is 0~5A. Precision is 1%. Output voltage needs to be feedback.

(6) The above outputs should guarantee the precision and stimulate the time sequence output of circuit breaker.

(7) Signal source can exchange data with host computer through WIFI interface.

(8) 5 groups of different waves can be prestored.

(9) Receive the 5 groups of different waves prestored from host computer.

(10) Have the function of liquid crystal display.

Hardware design

(1) General scheme

The architecture of sample arm11+fpga, 3 channels dac output, 3 channels ad sample, 2 channels large current based on opa549 constant current source, 1 channels 4-20ma or 0v-10v output based on 4-20ma constant current source or 0v-10v constant voltage source. Logic block diagram as is shown in figure 1.

(2) Control of time precision. Utilize fpga design, adopt 12mhz frequency, minimum interval is

8ns. Because of the restriction of instruments, the real minimum interval is 1ms.

(3)DAC circuit

Adopt DAC7731E chip from ADI company. DAC7731E chip is 16 bit resolution DAC. It is characterized by lower exhaustiveness. Maximum power is 150mw, internal reference voltage is 10v. DAC7731E chip supports single-polarity output and double-polarity output(± 10 v, ± 5 v or ± 10 v). DAC7731E chip communicates with fpga through spi interface and has the function of buffer data input.

(4)Following circuit

Before pressure and temperature entering ADC, use first order following circuit to improving precision. The first order following circuit adopts OP482 from ADI company. OP482 is a kind of 4 channels operational amplifier. It is characterized by the excellent speed and the very low source current. Slew rate is more than 7 V/ μ s, the source current of amplifier is less than 250 μ A[5].

These amplifiers are unit gain stable angina, typical gain bandwidth is 4 MHz. The JFET input stage of OP482 can ensure typical bias current is only some pA and less than 500 pA during the whole temperature range. Offset voltage of double channels is less than 3 mV. Offset voltage of 4 channels is less than 4 mV. Wide output swing , low power and high slew rate make OP-282/OP-482 are very suitable for the application of battery power and power limited.

(5)Fpga chip type

Adopt EP3C5E144C8N from ALTERA. LAC/CLB number:321. Logical element/unit number: 5136. RAM bit number: 423649. Input/output number: 94.

(6)0-5A output constant current circuit

Adopt OPA549 high power amplifier from ADI. PA549 is a high voltage and large current power operational amplifier. It can provide excellent low level signal, output high voltage, large current. It can also drive many kinds of load. The continuous output current can reach 8A. Peak current can reach 10A. The range of work voltage is extensive. Single supply is $+8V\sim+60V$. Double supply is $\pm 8V\sim\pm 60V$. It has the function of regulate the overheat. Conversion efficiency can reach 9V/ μ s . Work temperature range is $-40^{\circ}C\sim+85^{\circ}C$. This instrument is mainly used to drive large loads such as industrial equipment, test equipment, power supply, video power amplification and so on.

(7)0-10V constant voltage source/5-20ma constant current source/ current and voltage mining circuit.

OP37 can provide the high performance just like OP27. But the former is aiming at optimizing the circuit that the gain is more than 5. This design will improve slew rate to 17V/ μ s and gain-bandwidth product to 63 MHz. OP37 not only has OP07 low offset voltage and drift characteristics,but also has a higher speed and lower noisy. Offset voltage is 25 μ V. Maximum drift is 0.6 μ V/ $^{\circ}$ C. Therefore, this instrument is a ideal selection of precision instrumentation application. The low noisy and high gains can amplify the high gain which is from low level signal. Utilize offset current can eliminate circuit. OP37 can realize ± 10 nA low input offset current and 7nA offset current. In the range of military temperature,this circuit can keep IB and IOS at ± 20 nA and 15 nA. The output level has a excellent ability of load drive.

Low noisy: 80nV peak value(0.1 Hz to 10 Hz), 3 nV/ \sqrt Hz (1 kHz)

Low drift: 0.2 μ V/ $^{\circ}$ C

High speed: 17 V/ μ s slew rate, 63 MHz gain broadband

Low input offset voltage: 10 μ V

Excellent CMRR: 126 dB

High open ring gain: 1,800,000

The application which gain is more than 5 can be replaced by 725、 OP-07、 SE5534

(8)arm11

Adopt arm11 can operate linux perfectly and realize more intelligent program design.

(9)Power supply

Adopt 200w switching supply to provide energy. 1 channel 12 rounds 5.5V power supply provides energy to arm11.

A group of 12V150W power supply provide energy to 2 constant current.

A group of $\pm 12\text{v}$ (dc/dc) power supply provide energy to other instruments on the stimulation card. The power supply work flow as is shown in figure 2.

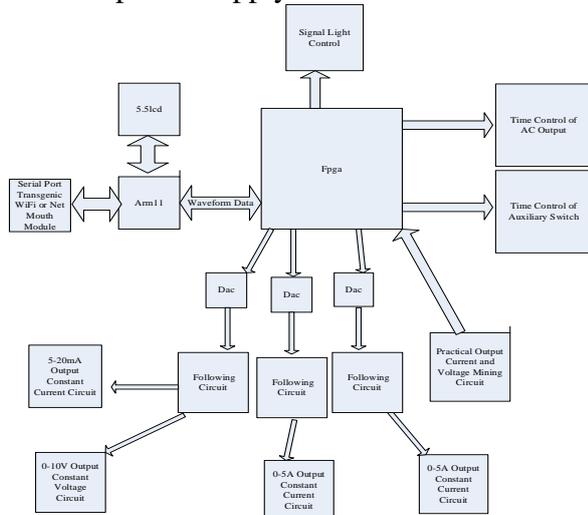


Fig 1: Logic block diagram

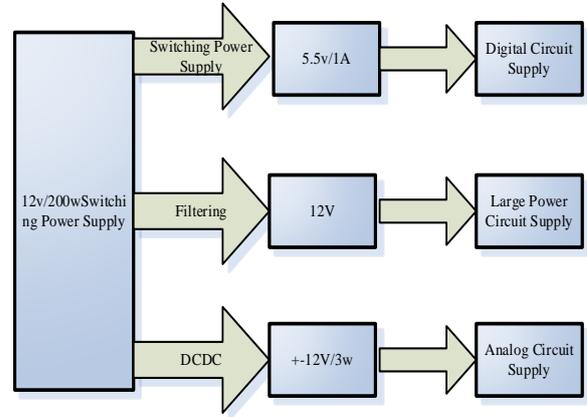


Fig 2: The power supply work flow

Conclusion

Circuit breaker is very important to the reliable operation of grid system. Research on this device can reduce premature or unnecessary power cut, maintenance workload and expense. At the same time, It meets the need of intelligent signal source of circuit breaker and has a very wide market.

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