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Design and Implementation of Signal Generator based on AD9834

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Abstract

The main function of signal generator based on AD9834 is to output sinusoidal wave, square wave and triangle wave of different frequencies. The system uses STM32F103 as the main control chip. The output waveform can be switched by pressing the key, and the real-time output frequency can also be changed to meet the design requirements. It also has an OLED display to display the current waveform type and frequency in real time. The overall design of small volume, low power consumption, all functions and parameters meet the design requirements, has a strong practical value.

Keywords

STM32; AD9834 Module; DDS Signal Generator.

1. Introduction

With the development and application of semiconductor integrated circuit, as well as the increasing demand in the field of industrial control, expanding the application areas of signal generator, but as a result of professional volume is larger, the signal generator is expensive, most are implemented in pure hardware, precision of frequency, waveform and portability cannot meet the needs of practical application, Disadvantages such as poor portability are difficult to cover all application scenarios. It is possible for us to design a kind of high-precision, low-power and portable multifunctional signal generator.

2. The overall

This design takes AD9834 as the core chip, and by combining with STM32, outputs sinusoidal, square and triangular waves of different frequencies. Keyboard set frequency and waveform information, STM32 keyboard input data processing, and then control THE AD9834 chip output corresponding waveform. And display the information on the OLED screen in real time. Finally, the required signal is output through the SMA signal output port on the AD9834 module [1].

3. System hardware design

3.1 STM32F103C8T6 chip

The chip used in this system is STM32F103C8T6, which is designed and developed on the basis of ARM kernel. It has the advantages of low cost and high performance. It can be embedded in the circuit and has the advantage of low power consumption [2,3].

3.2 AD9834 module

The module adopts DC-5V power supply and SPI serial communication protocol. The maximum system frequency is 75MHz. It has a 10-bit DAC resolution and a 28-bit phase accumulator. There are three SMA signal output ports. Any of the two ports on the right can output sine wave and triangle wave, while square wave occupies a separate port. Sinusoidal band 30MHz low pass filter. Square wave coupled output. Square wave and triangle wave cannot be output at the same time. Output with

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DC component, access to rf equipment need to add straighter, can also be connected with SMA to BNC signal line oscilloscope measurement.

3.3 OLED display module

In the design of the system, we choose the 0.96 inch OLED display module of Zhongjingyuan, with a resolution of 128*64, connected with STM32 through SPI interface. Through the mold program, not only can display letters, numbers and other simple graphics, but also can display Chinese characters, pictures and other complex graphics. According to the requirements of system design, the type and frequency of current waveform will be displayed on the screen, which makes the whole system more vivid and intuitive, and easy to operate and manage.

3.4 The key module

Due to the few adjustment parameters in the design of the system, the matrix keyboard is abandoned, and the micro switch is selected to form an independent key circuit. Each key occupies a processor I/O port, which can realize non-interference when working.You can move the cursor and set the type and frequency of the current output waveform [4]. You can switch between different waveform types by pressing the key. You can output sine wave, square wave, and sine wave, and adjust the specific value of the frequency.

3.5 Power supply module

The power supply module is integrated in the STM32 system board and is powered by miniUSB interface, which can transmit data and record programs. A forward low-voltage drop regulator is used to convert 5V supply voltage into 3.3V working voltage. A 0.1uF capacitor and a 10uF capacitor are connected in parallel, which plays a filtering function and makes the circuit more stable.Since the working voltage of AD9834 module is 5V, while the output voltage of STM32 system board is 3.3V, a 3.3V to 5V booster module is added to the external circuit.

4. System software design

4.1 System software Functions

The software design of multifunctional signal generator can be divided into main control program, LCD program and keyboard scanning program.According to the required output signal waveform can be set through the keyboard, and can be set through the keyboard frequency value.

The function of the main control program is to control the AD9834 module to change the output frequency and waveform according to the set value of the keyboard according to the waveform and frequency to be realized. Keyboard scan program to complete the analysis and judgment of keys.The display program displays the required waveform and frequency on the LCD, see Fig. 1. Subroutine module, see Fig. 2

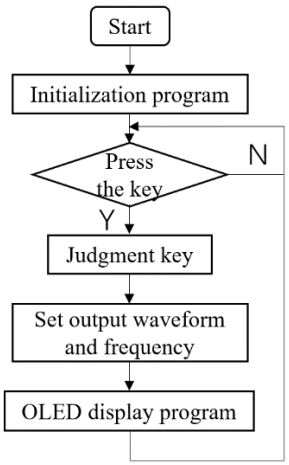

Fig. 1 Software Design Flowchart

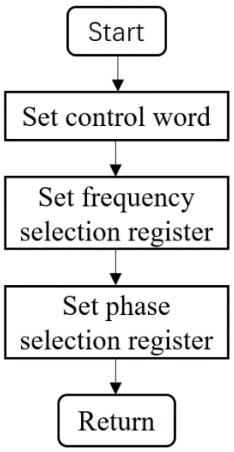

Fig. 2 DDS design flowchart

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4.2 DDS module subroutine

To generate the required frequency and waveform, the main register of DDS should be controlled as follows:

1. Frequency and phase registers: AD9834 contains two frequency registers and two phase registers. FREQ0 and FREQ1 are frequency registers, and PHASE0 and PHASE1 are phase registers. When FSEL bit or FSELEC=0, select the frequency register 0, which defines the output frequency. Select frequency register 1 when FSEL bit or FSELE=1, and also define the output frequency of the register.

When PSEL bit or PSELECT=0, the phase register 0, which defines the output phase.

When PSEL bit or PSELECT=1, the phase register 1 is selected and the phase of the output is defined.

The selection of frequency and phase registers is controlled by the PIN. If the control bit PIN/SW=1, the PIN controls this function; otherwise, PIN/SW=0, the data bit controls the common energy. The details are shown in Table 1 and Table 2. If the pins corresponding to these two bits are connected to high level or low level [5].

Table 1. Frequency register bit table

PSELEC	PSEL	PIN/SW	Selwcted Register
0	x	1	PHASE0 REG
1	x	1	PHASE1 REG
x	0	0	PHASE0 REG
x	1	0	PHASE1 REG

Table 2. Phase register bit table

FSELEC	FSEL	PIN/SW	Selwcted Register
0	x	1	FHASE0 REG
1	x	1	FHASE1 REG
x	0	0	FHASE0 REG
x	1	0	FHASE1 REG

2. Write to the frequency register: if the user wants to change the contents of this frequency register, he must write to the same address twice in a row, because the frequency register is 28 bits. The first write is 14 bits, and the second write is 14 bits. For this mode, the control is B28, which should be set to 1, see Table 3.

Table 3. Frequency register bit table

DB15	DB14	DB13...DB0
0	1	14FREQ0 REGBITS
1	0	14FREQ1 REGBITS

In some applications, users may not want to change the frequency register is 28, so only change high 14 coarse adjustment, by setting the control bits B28 is 0, the 28 frequency can be used as two independent registers, a high contains 14, a low contains 14, which means that the high frequency register 14 14, The lower 14 bits can be set separately, and the HLB bits of the control register indicate whether to write 14 bits lower or 14 bits higher [6].

RESET function:RESET the internal corresponding register bit 0, RESE not RESET, frequency and phase registers, when the AD9834 is powered on, it should be RESET, to RESET the AD9834, should set the RESET pin 1. If you take it out of the RESET state and set the PIN or bit to 0, the D/A converter outputs the corresponding signal after the RESET is indicated at 0,7 clocks. The RESET function is RESET by the PIN or control. If the control is PIN/SW=0, the RESET function is RESET.If this bit is 1, RESET controls the RESET function. Table 4 lists the parameters..

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Table 4. Reset pin function

RESET Pin	RESET Bit	PIN/SW Bit	Result
0	x	1	No reset applied
1	x	1	Internal register reset
x	0	0	No reset applied
x	1	0	Internal register reset

5. Conclusion

This design is based on the signal generator AD9834, the overall realization of the required different waveform output and the corresponding frequency adjustment. However, the current traditional signal generator is large in size and expensive, and most of them are realized by pure hardware. The frequency accuracy, waveform types and portability can not meet the needs of practical applications. This design adopts the combination of software and hardware to meet the design requirements of energy saving and environmental protection, and the cost is low, with strong use value.

Acknowledgments

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