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# Design of Simple Multifunctional Digital Frequency Meter

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**Abstract:** In the past, most of the functions were realized by logic circuits and sequential circuits, which would result in the performance and effect of the whole operation being greatly reduced. The efficiency would be slower, and the measurement range would be smaller. These reasons led me to design an STC89C52 single chip computer as the core of the control, and introduced the working principles of each module of the circuit. Then the final result is transmitted to LCD1602 LCD, which shows the measured frequency value.
**Keywords:** Micor-computer, Frequency, Measure, Signal.

## 1. Introduction

Frequency meter is a kind of laboratory instrument that we often use when we do some circuit design. Its main functions are the numerical value of positive basalt wave, triangular wave and square wave. It can measure the numerical range of 0HZ-10KHZ, and then display the final measurement results through LCD1602 LCD display. The modules of the system include: amplification and shaping module, single chip computer control module. Module, switch control module, display module. In order to realize the accuracy and convenience of this measurement, the 52 single chip computer is used as the information of some schemes and practical applications of the digital frequency meter designed in this paper. The measurement of the frequency meter is divided into high frequency measurement and low frequency measurement, and the methods they are applied to are different. In the measurement of high frequency, it is measured by external frequency division, if the measurement is compared. When the frequency value is low, it is counted directly by the single chip computer, so it is no longer necessary to divide the frequency externally. The design of this paper is to process various input signals through the pretreatment circuit, so that the signals can be transformed into high-level and low-level rectangular wave signals, and then docked with the single-chip computer, using the interruption of the single-chip computer and various programs to do calculations, to obtain the final measurement results.

## 2. Specific Module Classification

This design includes two parts of hardware and software design. The hardware system design includes several modules: amplification and shaping module, MCU control module, switch control module and display module. Each module has its own working principle and function.

(1) The principle and function of the amplification and shaping module can be understood as two parts: the amplification circuit: the amplification circuit is actually the amplification of the current through the transistor, and the basic amplification circuit composed of the transistor is the amplification of the voltage, how to amplify the current into the amplification of the voltage. There are three types of transistor amplifier: common-emitter amplifier circuit, common-base amplifier circuit and common-collector amplifier circuit. This design uses a common emitter amplifier circuit, which consists of a triode, a capacitor, a power supply and a resistor. So when the required model is input, a signal can be obtained through the circuit with the same waveform and different amplitude. Shaping circuit: can be divided into two kinds: Schmidt flip-flop and monostable flip-flop. The shaping circuit can make the edge of the pulse signal steeper and form a prescribed rectangular pulse.

(2) SCM control module principle and function: This design is to use STC89C52 SCM as the core of the whole control, it has several serial communication transmission direction, divided into single, half-duplex and full-duplex. Simple work means that data transmission can only follow one direction, and can not achieve reverse transmission, just like the transmission of TV and remote control, which can only be controlled by remote control, while TV can not control the remote control. Half duplex means that data can be transmitted in two directions, but it needs to be carried out separately, just like a walkie-talkie, it needs to be carried out separately, and it can not be said at the same time. Full duplex means that data can be transmitted in both directions at the same time, just like mobile phone communication, telephone can speak at the same time. Of course, it is realized by different pins. SCM STC89C52 has two 16-bit timing counters, which can achieve this function very well.

(3) Switch control module principle and function: there are three keys, S0 is a reset switch, calculation can be clicked at the end, restart, S1 is an amplifier circuit connected to the clock circuit, can adjust the measurement frequency range, and a K0 is a power switch, control the power supply of the entire circuit board.

(4) Principle and function of display module: Then the display module used in this design is a common

LCD1602 LCD display. Its operation is simple, convenient, light, and the display of data can be seen at a glance.

## 3. System Hardware Design

### 3.1 Working Principle of Digital Frequency Meter

Digital Cymometer can be said to be a very common instrument in measuring frequency in the development of electronic information nowadays. It is used as a basic portal in both laboratories and some school curricula. Then the framework and principles of the whole design can also be made in a sequence. Of course, we need to input a measured signal first, after entering the amplification and shaping circuit, it can be converted into a pulse signal that can be accepted by the counter circuit. This is then entered into a counter circuit controlled by the control circuit, which can be identified by the counter and start counting. Finally, through the control of the control circuit, the signal is transmitted to the display circuit for display.

The signal is transmitted to the display circuit by amplifying and shaping circuit, then through the counter circuit controlled by the controlled circuit. In this process, the signal is converted to form a signal waveform that can be accepted by all circuits. The signal entering the counter circuit is converted into a pulse signal to be read accurately by the counter, and then the result is transmitted to the display circuit. But the whole process can not be without control circuit, it is the key to control the whole design and operation.

The purpose of the whole design is to improve the accuracy of the frequency value of our measurement, and this process is to design our control circuit, so as to improve the effect of our measurement. The purpose of the design is to get more accurate and reliable data. So the core of the whole design is to do around the 52 single chip computer, some others. The circuit only needs a little operation, in order to assist the microcontroller. In order to get a reliable and stable digital frequency meter, the whole design uses 52 single-chip computer as the core control circuit of the digital frequency meter, and some external control circuits can be used as auxiliary circuits. So the whole system has amplification and shaping circuit, SCM STC89C52 counter circuit, LCD display circuit and so on. To input a measured signal, after entering the amplification and shaping circuit, it can be converted into a pulse signal that can be accepted by the counter circuit. This will then enter a counter circuit controlled by the control circuit, which can be recognized by the counter and start counting. Finally, the signal is transmitted to the display circuit through the control of the control circuit for display.

### 3.2 Circuit Principle

Digital frequency meter includes many circuits, such as amplifier and shaping circuit for converting signals, multiplexer, single chip counter for counting, and display circuit.The design of digital frequency meter is based on 52 single-chip computer. The circuit is divided into several modules: amplification and shaping module, 52 single-chip computer counting module and LCD1602 display module.

### 3.3 Amplifying and Shaping Circuit

The actual measurement signals are various, including pulse wave, sine wave and triangle wave. However, the counting of single-chip computer can only be based on the technology of pulse wave. In this process, a circuit which can convert the measured signal into pulse wave counting is needed.

Amplification circuit is actually the amplification of current through transistors. The basic amplification circuit composed of transistors is the amplification of voltage. There are three types of transistor amplifier: common-emitter amplifier circuit, common-base amplifier circuit and common-collector amplifier circuit. This design uses a common emitter amplifier circuit, which consists of a triode, a capacitor, a power supply and a resistor. So when the required model is input, a signal can be obtained through the circuit with the same waveform and different amplitude.

Shaping circuit can be divided into Schmidt flip-flop and monostable flip-flop. The shaping circuit can make the edge of the pulse signal steeper and form a prescribed rectangular pulse. The shaping circuit can make the edge of the pulse signal steeper and form a prescribed rectangular pulse.

### 3.4 Single chip

MCU used to be called single board computer. It is composed of CPU chips, memory chips, I/O interface chips and some simple I/O devices, that is, those keyboards and some monitors. Then, with a monitoring program, a single board microcomputer is formed. This is the most original single board computer, because its equipment is relatively simple, practical and convenient. Originally used for teaching and simple measurement and control systems of microcomputers, it is rarely used now.

This design uses STC89C52 single-chip computer, STC89C52 is a kind of low-level and high-frequency measurement, there are two kinds of frequency in the digital circuit, the single-chip computer also

uses a chip called MAX232 level conversion chip, that is, the highest voltage of the single-chip computer and the lowest voltage of the computer can not be directly connected, need to use MAX232 level conversion. There are four 8-bit parallel I/O ports in MCS-52 series MCU, which are represented by $P_0$, $P_1$, $P_2$ and $P_3$ respectively. The corresponding register addresses of $P_0$, $P_1$, $P_2$ and $P_3$ can be addressed. Each I/O port can use either a single pin or eight pins in bytes.

STC89C52 gives P3 port a variety of special functions at the same time, each pin has different I/O functions, not only as an address and data, as a communication, it has a path. P3.0 port can also be used as data serial input port RXD, P3.1 can also be used as data serial output port TXD, P3.2 can also be used as external interrupt port 0, P3.3 can also be used as external interrupt port 1, P3.4 can also be used as timer T0, a clock and a data. P3.5 can also be used as timer T1, a clock and a data P3.6 can also be used as external data memory write-on/WR, and P3.7 can also be used as external data memory read-on/RD.

### 3.5 Display Circuit

The measured frequency is eventually displayed on 1602 LCD. The physical and electrical circuits of the basic display screen of the 1602 digital tube display are shown in Figures 1 and 2, respectively.


Figure 1. 1602 LCD

LCD1602 LCD is mainly used to display the data we measured. The data can be displayed in two lines, and the characters in each line can display 16 characters. So when displaying the data, two lines will be displayed. This requires the analysis of the display module to better complete the design.

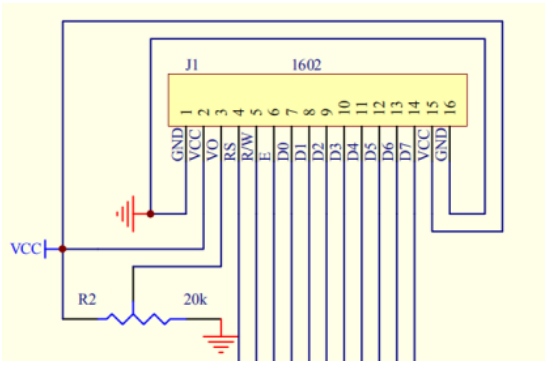


Figure 2. LCD1602 Display Pin Diagram

## 4. System simulation and debugging

### 4.1 Hardware Circuit Simulation

The whole circuit needs to be simulated before it works. This is to ensure that better data and the normal operation of the system can be measured, so the waveform circuits should be simulated.

Proteus is a simulation software which can be used to debug MCU in this design. There are many electronic simulation software on the market. In this design, this software can simulate the multi-function of MCU.

### 4.2 Error Analysis

Amplification and shaping circuit and single-chip timer bring errors, which become the main source of errors in the design of digital frequency meter. More improvements and improvements are needed in the design process.

Timing Counting Error of Single Chip Microcomputer: In order to achieve the whole design process, the whole design can be counted and timed by single chip microprocessor, but the single chip microprocessor counting will produce data errors. But the factors that determine the size of this error are not different. In order to achieve the whole design process, the counting and timing of the whole design can be completed by the single chip computer, which is determined by the internal clock of the 52 single chip computer. If the high-frequency crystal oscillator circuit is used to provide an internal clock for the 52 single chip computer, it can actually

reduce the deviation of the error. In this design, we use 12 MHz crystal oscillator circuit, and the range of frequency measurement data is 0 Hz ~ 20 kHz. So this error can be neglected.

## 5. Conclusion

In the design process, we need to analyze and compare the design topics. We can design many aspects, especially the software and hardware of the computer, how to realize the functions. The basic design scheme of a multi-function digital frequency meter based on single chip computer is presented. The corresponding hardware circuits such as amplification and shaping circuit, synchronization circuit and main control gate circuit are designed and debugged.

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