

# Design and Development of a Small Portable Pulse Monitor

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**Abstract:** In this paper, a portable human pulse signal monitoring equipment is designed, using piezoresistive sensor acquisition of pulse, pulse signal of human body by using the method of accurate measurement of weak filtering technology and signal processing. It can realize the pulse measurement is less than 1min, the measurement results display by digital method. The experimental results show that the device can effectively monitor the pulse signal of the human body. It provides the basis for the clinical diagnosis of the hospital.

**Keywords** Pulse monitor; Piezoresistive pressure sensor; Portable

## INTRODUCTION

The pulse is a palpable artery beating on the surface. The circulatory system is made up of heart, blood vessel and blood. It is responsible for the transportation of oxygen, carbon dioxide, nutrients and waste. [Tamura, *et. al.*, 2017] Blood is squeezed into the aortic artery through the left ventricle of the heart and transmitted to the systemic artery. [Constant, *et. al.*, 2015] The artery is a pipeline formed by elastic connective tissue and muscles. When a large amount of blood enters the artery, it will increase the pressure of the artery and cause the diameter of the artery to dilate, which can be felt in the superficial part of the body surface, the so-called pulse.

Pulse is a basic life index. So the pulse instrument is widely used in clinical treatment, daily health elderly etc. [Fu, *et. al.*, 2018] Normal person's pulse rate is 60 ~ 80 times per minute ,when the babies is 90 ~ 140 and the elder lies is 100~150. [Al-Ali, *et. al.*, 2018] Therefore, the signal processing of pulse instrument belongs to the low frequency weak signals and under strong noise background. This paper

designs a simple electronic pulse instrument, which Using micro piezoresistive pressure sensor. [Wu, *et. al.*, 2015] By using the method of pulse signals accurately measuring body weak filtering technology and signal processing, They Can realize the pulse measurement is less than 1min, The measurement results with digital display.

## SYSTEM DESIGN SCHEME

According to the pulse signal acquisition and processing, process measurement and control, the system can bedivided into the following modules: The sensor module, will be measured conversion pulse signal object for the simulation of electric pulse signal and the corresponding; Filtering and amplifying and shaping circuit, weak sensor signal amplification, filtering and power frequency signal spurious noise background; Shaping circuit, the analogy signal into a pulse signal; Multiplier, pulse signal after shaping the frequency increase, so as to reduce the measurement time; The reference time generating circuit, control circuit, counter circuit and decoding display.

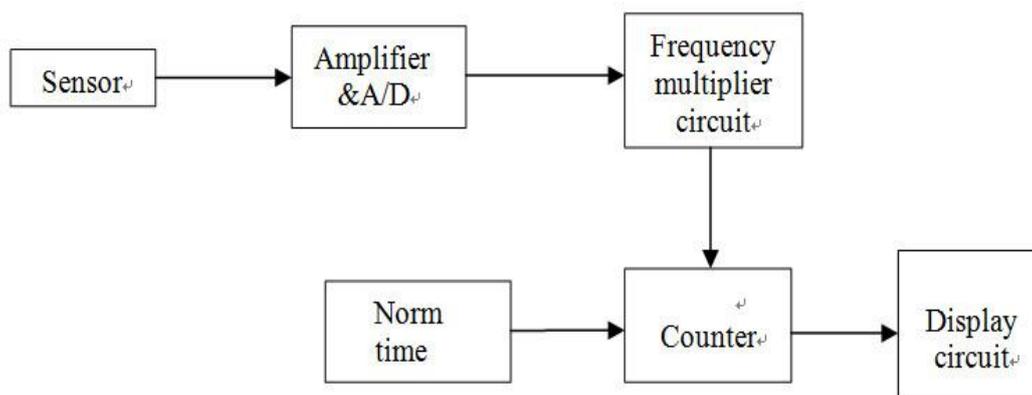


Figure 1 Diagram of functional block

## HARDWARE CIRCUIT DESIGN

### Sensor module

Pulse sensor is the role of the pulse signal is converted into electric pulse signal corresponding, To show its performance has a direct impact on the processing and the results of post circuit. There are three kinds of typical: photoelectric pulse sensor, piezoresistive and piezoelectric, this design uses the piezoresistive sensor.

### The signal amplifying circuit

Pulse voltage amplitude of the signal collected by the sensor is usually between 0-10mV, This part of the main circuit to complete the input signal magnified 1000 times, so that it can drive CMOS digital circuit follow-up.

Using operational amplifier LM324 inverting amplifier. The circuit diagram shown in figure 2.

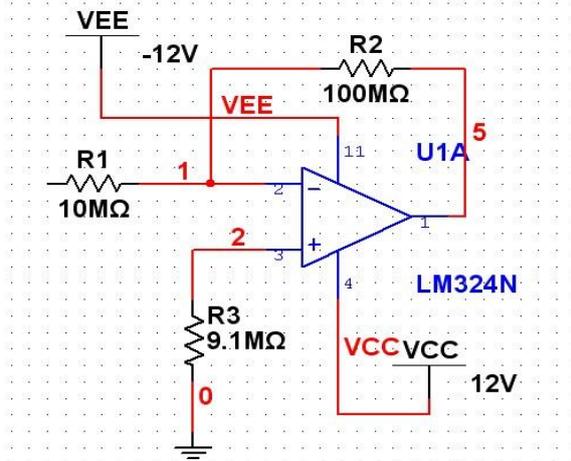


Figure 2 The signal amplifying circuit

### Filter circuit

The pulse signal changes so slowly and weakly that submerged in noise, such as the background interference and power frequency signal etc.. The low-frequency signal pulse signal is weak change, frequency in 0.05Hz-20Hz, Therefore need to design a filter circuit to the high frequency signal frequency is higher than 20Hz and lower than the low frequency signal frequency filter 0.05Hz, The schematic diagram shown in figure 3.

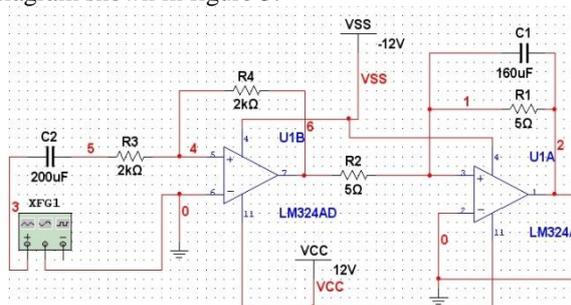


Figure 3: filter circuit

The filter circuit, generally active filter circuit is much better than the filtering effect of passive filter circuit, this design adopts active filter. R3, R4, C2 low-pass filter, R1, R2, C1 to form a high pass filter. Parameters are selected as follows: C1=160 F, C2=200 F, R1=R2=50, R3=R4=20k.

### Signal shaping circuit

In the part of the input signal amplification circuit though has been magnified, voltage is sufficient to meet the subsequent circuit to drive with, but still the waveform is sine wave, as analog, must the analog into digital pulse for use by digital part of the circuit, trigger circuit can realize the function of Schmidt, this design uses the 74LS14 Schmidt trigger.

### Frequency multiplier circuit

The output of the digital pulse shaping circuit with the same pulse frequency, if the measured counts per minute, at least should be measured for a minute before they can achieve, in order to shorten the measurement time, must will double the frequency of the signal after shaping. Obviously, if the signal frequency into the original N times, then the measuring time can be shortened to the original 1/N. Therefore, to complete the measurement within 5S, need to increase 12 times the signal frequency, frequency part should use the 12 doubling circuit, the circuit shown in figure 4.

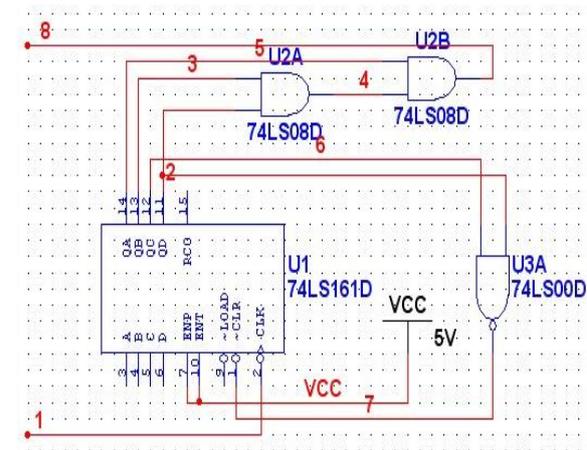


Figure 4 Frequency circuit

The 1 line input signal, the 8 line output signal.

### Counting decoding display circuit

This part of the main circuit to complete the square wave pulse counting, counting the features will be displayed. Counter selection of decimal counter 74ls160; for the decoder, since the output of 74LS160 is the 8421BCD code, so we should choose the one can be translated into 8421BCD code 7 segment output signal to drive digital control chip, CD4511 can meet this requirement.

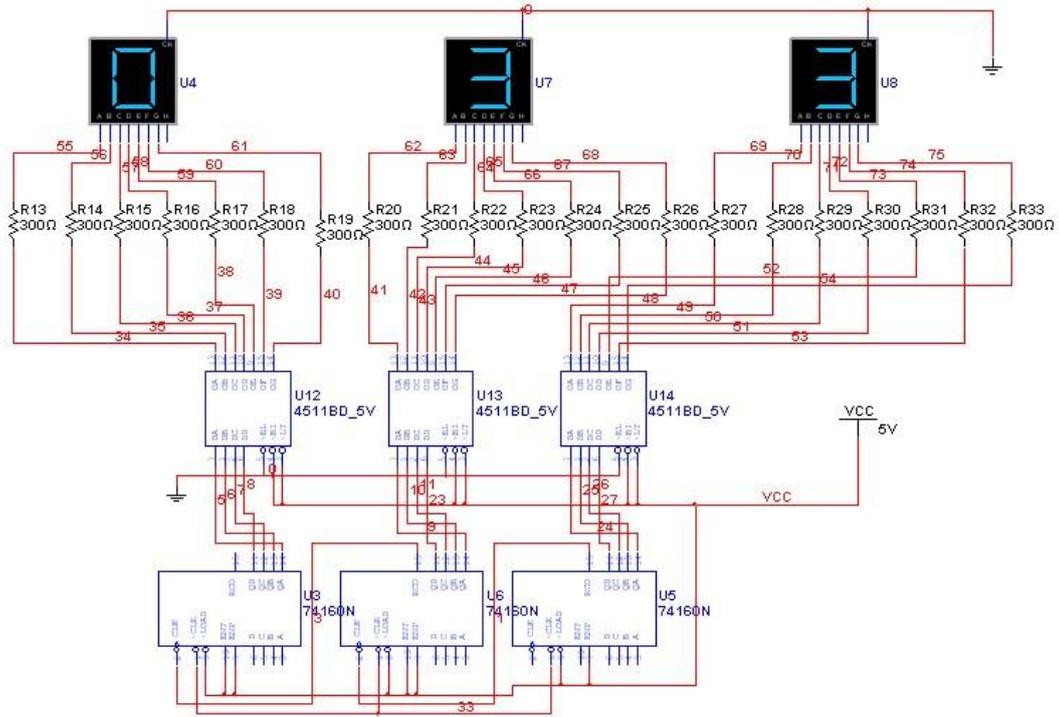


Figure 5 the counting and decoding circuit

**Time control circuit**

Counter and decoding display circuit need time control circuit to control the entire circuit operation, reset, automatic start, this task is achieved by the part of the circuit. Counting time the circuit adopts a monostable trigger to control counter, a monostable trigger to control the automatic reset, a multi harmonic oscillator to control two monostable trigger to start, this design uses three 555 timer circuit, the circuit as shown in figure 6.

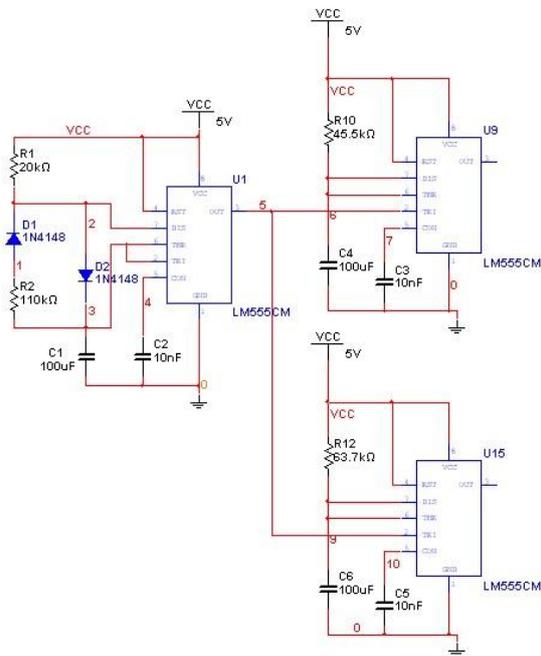


Figure 6 Norm time circuit

**INTEGRATED CIRCUIT**

Such as the whole circuit above, from the sensor biomedical signal after three stage amplifier, and then filtering,shaping, frequency into the counting decoding display part circuit, a time control circuit to control the entire circuit operation, reset and self starting.

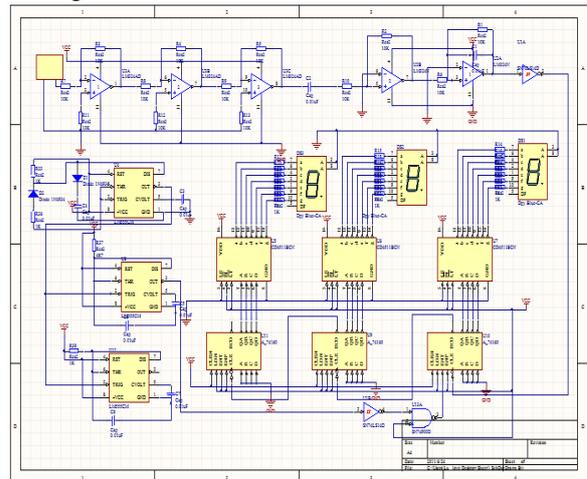


Figure 7 The whole circuit

**SUMMARY**

This paper designed a simple and portable electronic pulsometer, using piezoresistive sensor acquisition of pulse, pulse signal of human body by using the method of accurate measurement of weak filtering technology and signal processing, joined the circuit in the frequency multiplier circuit, can be in 5 seconds to a minute pulse beat frequency

measurement, the measurement results with digital display, pulse meter with automatic reset and self starting function. The simple pulse meter has the advantages of simple manufacture, use fewer components, stable and reliable work, low cost, convenient for people carry on and using.

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