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THE RESEARCH OF PULSE SIGNAL PARAMETER MEASURING INSTRUMENT BASED ON FPGA AND STM32

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Abstract:-
Using the principle of measurement accuracy, combined with EDA technology and microcomputer control technology, we designed the pulse signal measuring instrument. The accuracy of frequency the measurement method not only has high measurement accuracy, but also in the frequency measurement accuracy of the frequency bandwidth can be kept constant.As a result of the front-end circuit and good isolation circuit and other technical measures, and In a wide range of frequencies in the range of frequency and amplitude, period, duty cycle and other parameters were measured accurately, and can be preset by adjusting the gate time measurement accuracy. After experimental verification and data measurement, results show that our scheme is feasible and can achieve higher measurement accuracy in a wide bandwidth.

Keywords:- *equal precision measurement, single chip microcomputer, digital frequency meter, FPGA*

1. INTRODUCTION

The measurement precision of traditional frequency measurement principle based on general with reduced with the increasing frequency of the measured signal, the measurement bandwidth is small. There are a lot of limitations in practical applications. In recent years, the rapid development of the digital frequency measurement technology, is to replace the analog frequency meter trend in most areas[1-3]

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In the measurement of the pulse parameters， the design of front-end acquisition and amplification circuit is an essential factor about increase bandwidth.We use the high speed integrated amplifier as the core device, the signal through the amplifier hysteresis comparator and into the back-end FPGA acquisition.Measurement accuracy is an important determinant of the accuracy of measuring instruments and whether it meets the requirements of measurement.Equal precision measurement is introduced and used in this study.Precision frequency measurement method is developed based on the direct frequency measurement method[4]. Precision frequency measurement of counting gate time is not a fixed value, but the whole cycle times of the measured signal, which is synchronized with the measured signal in time at the same time to allow count, the standard signal and the measured signal count then, the frequency of the measured signal is obtained by the mathematical formula.Because the gating signal is integer times of the measured signal, the elimination of the measured signal generated by counting the positive and negative 1 errors, but will cause the error to the standard signal + 1. Therefore, as long as the improved source frequency standard signal, it can greatly improve the measurement accuracy, and achieve the measurement accuracy of the entire frequency band.So we use FPGA technology to achieve equal precision frequency measurement can not only achieve accurate measurement, but also easy to operate, has important scientific research value[5-7].

The rest of this paper is organized as follows. In the second part, we introduce the core component of the circuit design, the second part introduces algorithm design and analysis of main functions, then we consider some parameter data as the test set of conditions in different environments. The results of experiment and analysis in the fourth quarter, important conclusions in section fifth.

2.The core components and circuit design

The operational amplifier OPA2690 and high speed comparator TLV3502 are the core components of this circuit.The measurement range of this experiment is increased because of the front-end circuit composed of OPA2690 operational amplifier and resistor, comparator. This experiment can be a good measurement of the amplitude of 0.1-10V, 10HZ-2MHZ frequency. Using the principle of the measurement accuracy, combined with the EDA technology and microcomputer control technology, the DDS function generator as the measured signal made by FPGA network front-end amplifier, cyclone IV and STM32 to realize the frequency,the pulse width and the duty ratio, and the rise time of the pulse signal and other parameters are measured accurately, and displayed in the TFTLCD. The system block diagram as shown below：

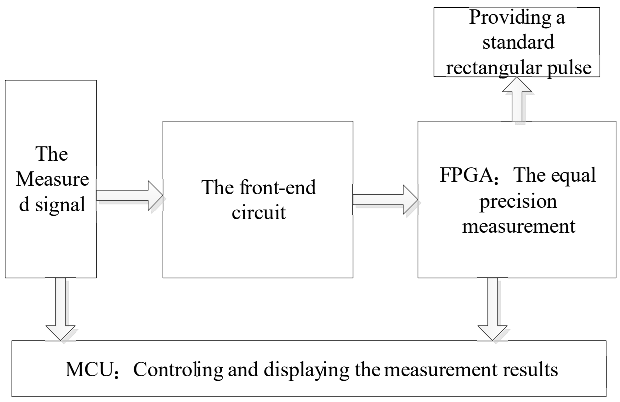

Figure 1 the system block diagram

The main function of this module is to realize the description of the measurement parameters.Four modules are included in this part, namely EPD, switch, pll2, etsester.There are 9 input ports (PA, PB, MCLK, SEL,SPUL, CL, p_fswitch,DCLK,CLR) and three output ports (fend, fstart, DATA).According to the parameters required to be measured, the measured signal is input from the PA, PB, and the measurement results are obtained at the output DATA.

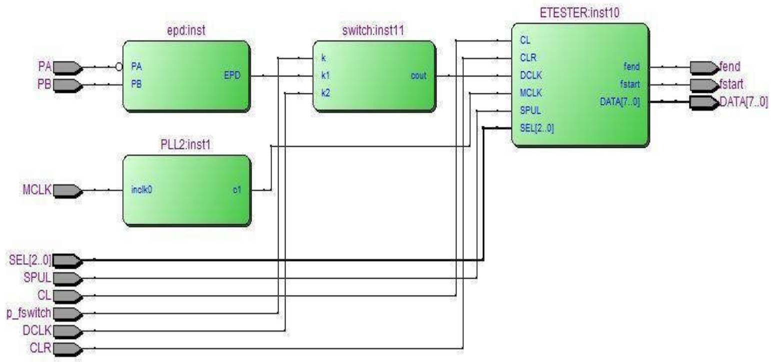

Figure 2 the system block diagram of FPGA

The control of the measurement process, as well as the measurement results show are implemented in this module.When the button is pressed, a command is sent to FPGA from MCU. When the FPGA is completed, the results are transmitted to the MCU through the data bus, and the results are displayed on the LCD screen.The flow chart of the algorithm is as follows：

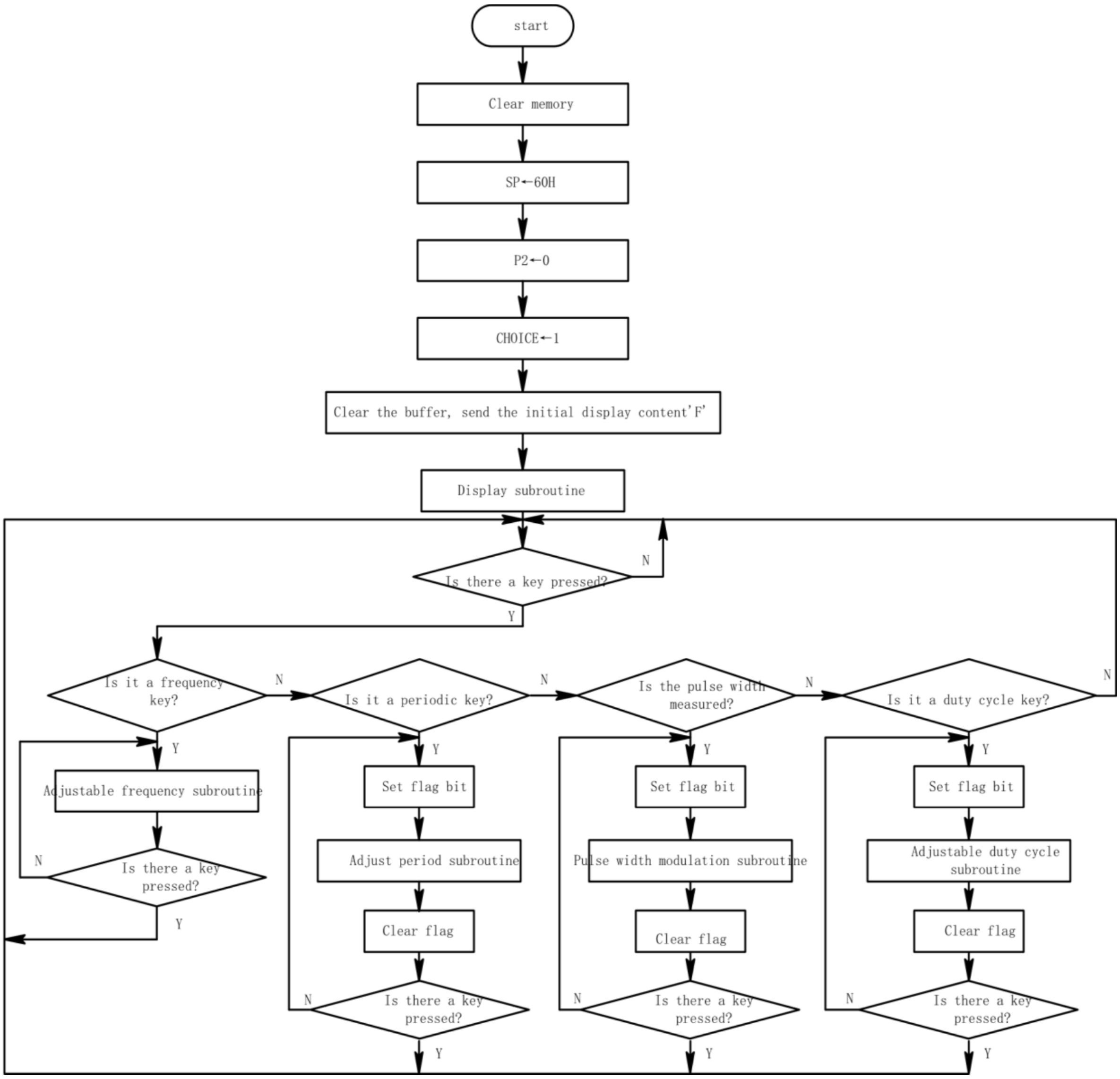

Figure 3 the system block diagram of STM32

3. The experiment and Analysis

3.1. Experimental Platform.

The software platforms used in the experiment were the Quartus II development environment,the Professional MDK-ARM,the Protel 99 SE,and the Multisim12.0 circuit simulation platform.The hardware platforms used in the experiment were as follows:

Instrument name	Model	Number
Oscilloscope	DS1042C	1
Digital synthesis function waveform generator	DDS YB1605H	1
Digital multimeter	VC890D	1

3.2. Sample Data Acquisition.

①Measuring the pulse signal frequency (input frequency range 10Hz-2MHz)

Table 1: Actual frequency measurement data

Input frequency / input voltage / Actual frequency	10Hz	100Hz	1KHz	10KHz	100KHz	1MHz
100mV	9.991	99.985	999.301	9.996k	99.954K	0.999M
2V	10.009	99.998	1000.183	9.992k	99.969K	0.992M
8V	10.003	99.909	1000.064	10.001k	100.031K	1.001M

②Measuring the pulse signal duty cycle (measurement range 10%--90%)

Table 2: Actual measurement data when the duty cycle was 50%

Input frequency / input voltage / Actual duty cycle	10Hz	100Hz	10KHz	1MHz	2MHz
100mV	49.51	49.32	49.58	49.99	49.64
2V	49.86	49.86	49.86	49.85	49.86
8V	50.21	50.22	50.18	50.45	50.31

Table 3: Actual measurement data when the duty cycle was in the range of 10% to 90%

Input frequency / input duty cycle (%) / Actual duty cycle (%)	10Hz	100Hz	10KHz	1MHz	2MHz
10	9.98	9.92	10.01	9.96	9.92
40	39.99	39.97	39.97	39.92	39.88
60	60.01	59.91	60.02	59.92	60.02
90	89.92	89.94	89.95	89.95	89.94

③Measuring the pulse signal rise time； (The input voltage amplitude was U, the duty cycle was 50%)

Table 4: Actual rise time measurement data

Input frequency (hz) / Given Time (ns) / Actual time (ns)	100	500	1k	5k	10k
50	47.996	49.998	50.902	51.003	50.362
100	95.103	99.634	104.561	104.284	102.743
300	294.763	294.298	294.762	295.009	295.108

3.3. The test analysis

From the experimental data analysis,when the input voltage was in the range of 0.1V ~ 10V, the error of the frequency, the error of the period and the error of the duty cycle were all very small.The frequency measurement range can reach 10Hz~2MHz when the other parameters were constant and the error was satisfied.For the majority of pulse signal measuring instruments，the Schmidt trigger and transistor as the core device, the circuit can be converted into high frequency sinusoidal wave, small signal amplification for large signal, so that the back-end FPGA signal acquisition. This scheme after the test can be used 50MHz signal acquisition, cannot deal with higher frequency expansion request signal.The field effect transistor and transistor by capacious coupling, low-frequency signals below 100Hz cannot. But if the capacitor short off or inductance, will lead to between field effect tube and transistor working point contain each other, resulting in circuit system cannot work properly.So we proved the effectiveness of the front-end circuit used in this paper.

In this paper we can see that the actual measurement errors of the parameters were not more than 0.01%, and the measured values can be accurate to 0.001. From Tables 2 to 4.The three experiment proved the feasibility of the proposed scheme. Compared with the other methods listed above, our scheme has higher speed, smaller error and wider measurement range. Therefore, our method meet the measurement requirements.

4. Conclusions

This paper describes the design of the pulse signal measuring instrument, it is better than some of the pulse signal measuring instrument in measuring range and accuracy. The core principle is to use the front-end circuit for the small signal amplification and application of equal precision measurement algorithm. The advantages of this design are as follows: Firstly, the front signal acquisition and amplification circuit board has good circuit stability and wide bandwidth. Secondly, the equal precision frequency measurement method can eliminate the error caused by the measured signal. The measurement accuracy is greatly improved, and the constant error can be realized in the whole frequency range without the need to modify the measurement range. Finally, the pulse signal measuring instrument is more rapid and flexible combined with the use of FPGA and the MCU operation and control functions.

The Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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