Modern Applied Science
www.ccsenet.org/journal.html
Vol. 2, No. 4
July 2008

The Design and Implement of Improvement for Pointer MV-meter Display Mode

Yani Gao & Ping Wang
Institute of Computer Technology&Automatization
Tianjin Polytechnic University
Tianjin 300160, China
E-mail:gaoyani1984@163.com

Abstract

Based on relative fresh foreign and domestic scientific research results about intelligent apparatus and instruments, we adopt SCM to be the main controller of the meter, utilize former DA-16 low frequency MV-meter, realize the improvement of the DA-16 low frequency MV-meter under the premise that doesn't change its work principle, and transforms the needle output of the MV-meter to digital display. The improvement of MV-meter acquires large advancements in many aspects such as the automatization of measurement process, the data processing of measurement result and the display precision, and the improved MV-meter can not only enhance the reading precision, but fully reduce the reading time, and its use is more convenient and simple in the experiment.

Keywords: Low frequency MV-meter, SCM, ADC0809, LED display

1. Introduction

At present, more digital experiment instruments are selected in academies when they select lab MV-meter. The needle MV-meter facing disuse can be as the experiment teaching material that students study the lesson of SCM, which can enrich students' experiment lesson, exercise their hand abilities, and exert the function of waste using. The digital MV-meter completed by the experiment can replace the traditional needle display, which makes the reading more visual and exactly, fully reduces the reading time, enhances the display performance of the MV-meter, and possesses good actual values to be as later experiment instrument.

2. Design and implementation

The circuit of the hardware is seen in Figure 1. The output voltage of DA-16 low frequency MV-meter in the figure is adopted from the demodulation output of the meter, i.e. the voltage that the circuit part of DA-16 low frequency MV-meter export to the two ports of the needle meter. Through actual measurement, when the needle meter is in full scale, the voltage is 150mV.

Generally, most full scale voltage of the A/D converter is 2.5V or 5V. Because the full scale voltage exported by the DA-16 low frequency MV-meter is only 150mV, so the reading needs to be amplified and transfer to the A/D converter. The requirements to the amplified circuit are small temperature excursion and small time excursion of the circuit.

The digital quantity obtained by the A/D converter is transmitted to the SCM which can confirm the position of the decimal according the classification information, implement digital scale transformation according to 100 or 300 full scale, and select the unit of the voltage.

In the process of the research, we take the usual DA-16 low frequency MV-meter as the research object, start from the changeless circuit and classification form of the former MV-meter, and mainly implement following works.

2.1 DA-16 low frequency MV-meter

The DA-16 low frequency MV-meter is a sort of low frequency electrical voltage meter in common use. Its voltage measurement scale is 1mV~300V and it has 11 shifts. Various shifts can display db number and it can measure the level, and the frequency scale of the measured voltage is 20Hz~1MHz, and the input impedance exceeds 1MΩ.

2.2 Direct current amplified circuit

The full scale simulated output signal of DA-16 low frequency MV-meter is 150mV, the full scale voltage of A/D converter is 5V, and we can compute the closed loop amplified multiple Av of the amplifier, and the circuit selects the high precision chopper-stabilized operational amplifier ICL7650 as the amplified component. ICL7650 has very small input deflection current and input maladjustment current, and it possesses very high open loop voltage gain and common-mode rejection ratio, and eliminates intrinsic maladjustment and excursion of the CMOS through the dynamic correcting null, so it is usually used in the circuit measuring the feeble signal, for example the occasion of direct current and low frequency. In this circuit, the amplified signal is the direct current signal which has no the problem of transmission bands. And the first class amplification can obtain stable amplified effect.

2.3 ADC0809A/D converter chip

The interior of the SCM 89S52 has no A/D converter, and the full span error of the DA-16 low frequency MV-meter is ±2, and the needle meter itself is the 1.5 class meter. The differentiation rate of ADC0809 is 8 bits, its precision is 7 bits, and the maximum unadjusted error is less than ±1LSB, i.e. 4‰. Adding the error of 1% in the circuit part of DA-16 low frequency MV-meter, the total error can be controlled in ±1.5%~±1, so the ADC0809 converter connected with it outside is well situated in precision, speed and price. The part circuit of A/D converter is seen in Figure 3.

In Figure 3, the IN0~IN7 is the input port of the simulated signal, and this design only uses one input, i.e. IN0. Because there are not extended memorizer and I/O interface, so the address flip-latch is not needed, and P2.4 is the selection line. D0~D7 is the output port with 8 bits after transformation, which should connect with the port of P0 in 89S52. The ALE signal locks the channel address, and when the start is effective, the A/D converter is started. To enhance the precision, a measured signal is collected ten times in the design, and the mean value is the measured voltage value after getting rid of one maximum value and one minimum value. When A/D conversion is completed, EOC port emits a plus impulse and applies for intermitting. The exterior intermitting null is used in the design, and the low level is effective, so the INT0 of 89S52 needs to be transformed to low level and started through reverse phase of 74HC02.

The sampling veracity of ADC0809 is closely correlative with the stability of the reference voltage, and the exact reference source 2DW232 offers the reference voltage in the design. The 2DW232 has stable work performance and its temperature parameter is 100PPM/℃.

2.4 Frequency division circuit

When the frequency of the exterior clock connected with ADC0809 is 640 KHz, the ADC0809 has the most stable work situation. To simplify the circuit, we don't set up another clock circuit. 89S52 adopts the crystal vibration of 12Mz, and the plus impulse signal frequency exported by the foot of ALE is one sixth of the oscillator, i.e. 2MHz, so it needs two times half frequency division through 74HC163, and the obtained frequency of 500 KHz is the clock signal of ADC0809. Every time transformation generally needs 64 clock cycles, and the transformation time is about 100μs. The circuit is shown in Figure 4.

2.5 Shift switch

In the process of digital display, the position of the decimal, the selection of the transformation formula and the display of the unit should be considered, which needs to be controlled by the shift switch. So we add the input circuit of 11 shifts of MV-meter, which is seen in Figure 5. The shift position can control the scale. When the shift is used, the signal input in the SCM 89S52 is low, and the circulation inquiring mode is used in the SCM, and when the transformation of ADC0809 and the intermitting application are completed, the SCM compute the voltage through amplification of the measured signal by the amplifier according to the shift information input by the shift switch circuit.

As viewed from the unit of the measured voltage, 11 shifts can be divided into two parts, and P1.0~P1.5 is the shift of mV, and P1.6, P1.7, P3.3, P3.4 and P3.5 are the shift of V. Inquiring by 89S52, when the signal of certain port is low, 89S52 first will judge whether it is the "mV" shift or the "V" shift and lighten the corresponding LBD. At the same time, different selective scales correspond with different formulas. The reference voltage of ADC0809 is 5V, the data scale of 8 bits A/D converter is 0~255, so the voltage value represented by every step is 19.6mV (the differentiated rate of the converter). Considering the situation of exceeded scale, we use 250 steps to correspond with the voltage of full scale. The formulas are respectively as follows:

Formula 1: the corresponding number of the measured voltage= the measured voltage value/19.6mV

Formula 2: the measured voltage value= the number× (the voltage value of full scale/250) (the scale is seen in Table 1)

The formula 1 reflects the process of ADC0809 transformation, and the formula 2 is completed in the exertion program of 89S52.

The position of the decimal is controlled by the shift. The "V" shift and the "mV" shift have same principle which is seen in Table 1. The SCM drives the corresponding LBD through the input shift signal.

2.6 89S52 SCM

The function of 89S52 SCM is basically same with traditional 80C51. Because this design doesn't use the added function of 89S52, so it can be took as 8051 to a certain extent.

27 ports of 89S52 are used in this design. And the port XYAL1 and XYAL2 connected with 12MHz quartz crystal compose a stable self-oscillator with two 33PF capacitances.

The port of P0 is connected with D0~D7 of ADC0809, which receives the data after the conversion of ADC0809.

The ports of P1, P3.3, P3.4, P3.5 and total 11 ports are the input ports of the shift selection.

The port of P2.0 and the port of P2.1 are the unit display ports. The P2.0 connects with green LED and displays mV, and the P2.1 connects with red LED and displays V.

The port of P2.4 respectively connects with the control ports of START, ALE and OE of ADC0809 which P3.7 (/RD) and P3.8 (/WR) pass 74HC02 or NOR-gate.

The port of P3.0 (RXD) and the port of P3.1 (TXD) connect with 74HC164 and export the value display data. The P3.2 (/INT0) connects with the port of EOC of ADC0809 and the low level of /INT0 is effective, and when the EOC applies for intermitting, it emits the high level, so one phase reverser is needed to be added. Utilizing the Nor-gate of 74HC02, when the level and constant low level is NOR, the output is the effective low level.

2.7 Work principle of LED

As Figure 6, the display circuit adopts the static display of common cathode eight segments digital tube.

In the process of TXD, when the first frame data are transmitted, the first 74HC164 exporting the data and the LED1 displays the data. When the second frame data are transmitted, LED1 displays the second frame data, and the first frame data are input to the second 74HC164, and LED2 displays the first frame data. In this turn, all 4 bits data are transmitted. When all data are transmitted, the first frame data are displayed in the last LED.

To protect various LED, the current limitation resistance should be added. The work current of LBD is 5mA, the work voltage is 1.5V which ignores the wasting voltage when 74HC164 exports, and the obtained current limitation resistance value is 700Ω. If the resistance with large resistance value is used, it will influence the brightness of the LED, and if the resistance with too small resistance value is used, it will burn the LED. In the design, we use the resistance of 1KΩ. The eight segments digital tube used in this design is in common cathode, so the common cathode connects with the earth. The segment selection line of every bit respectively connects with the output port of 74HC164, and various bits in the display are independent each other, and once the display character of various bits is confirmed, the output of corresponding flip-latch will keep constant. So the static display has higher brightness than the dynamic display.

Comparing with dynamic scanning, CPU needs not continually scan and frequently serve for the display, which can save the time of CPU and enhance the work efficiency. And the hardware of static display has simple structure and easy software programming, so the price of the chip is cheap. When the output display is not complex, the static display is generally adopted.

2.8 The design process of the software

The design process of the software is seen in Figure 7 and the program is omitted.

3. Conclusions

In this design, we adopt the SCM control and basically realize the digital display of DA-16 low frequency MV-meter, and fully enhance its display precision. The measured voltage of the improved MV-meter displays by four bits LED, which avoids the error produced by man-made reading angle in the former experiment. The improved MV-meter can not only enhance the reading precision, but fully reduce the reading time, and its use is more convenient and simple in the experiment.

References

Hu, Hancai. (1996). *SCM Principle and Interface Technology.* Beijing: Tsinghua University Press. p.85-113.

Li, Chaoqing. (1998). *SCM Principle and Interface Technology.* Beijing: Beijing Aviation and Spaceflight University Press. p.89-93.

Ma, Zhongmei. (2003). *C Language Application Design of SCM.* Beijing: Beijing Aviation and Spaceflight University Press. p.46-98.

Tong, Shibai & Hua, Chengying. (2000). *Analog Electronic Technology.* Beijing: Higher Education Press. p.171-296.

Table 1. The scale table of the shift

No.	Port	Scale	Poison of decimal
K1	P1.0	1 mV	After the 1st digit
K2	P1.1	3 mV	After the 1st digit
K3	P1.2	10 mV	After the 2nd digit
K4	P1.3	30 mV	After the 2nd digit
K5	P1.4	100 mV	After the 3rd digit
K6	P1.5	300 mV	After the 3rd digit
K7	P1.6	1V	After the 1st digit
K8	P1.7	3V	After the 1st digit
K9	P3.3	10V	After the 2nd digit
K10	P3.4	30V	After the 2nd digit
K11	P3.5	300V	After the 3rd digit

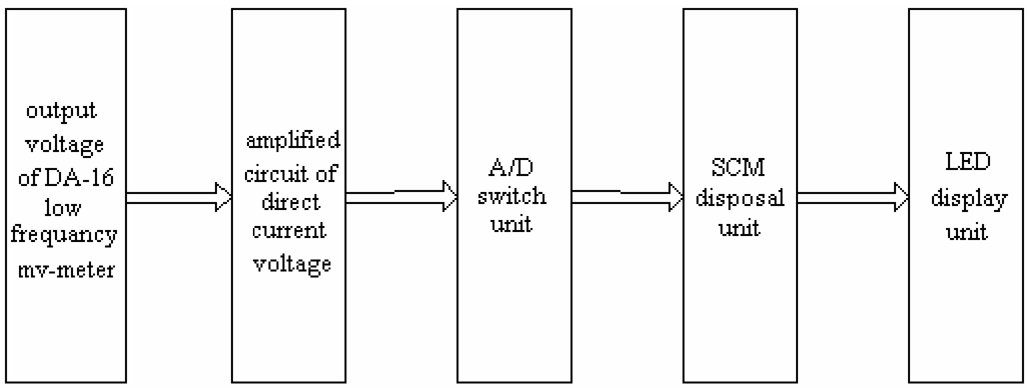

Figure 1. The Circuit of the Hardware

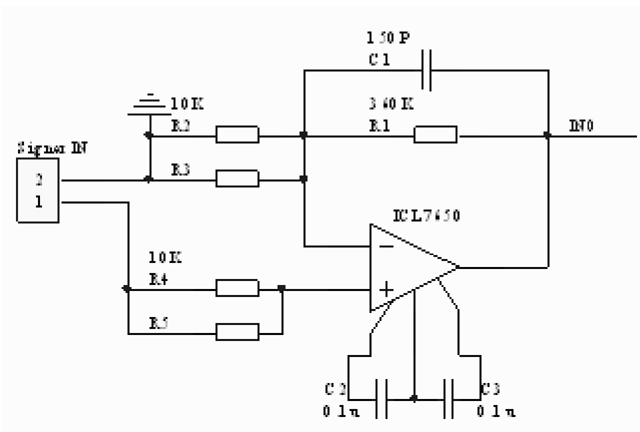

Figure 2. The Amplified Circuit

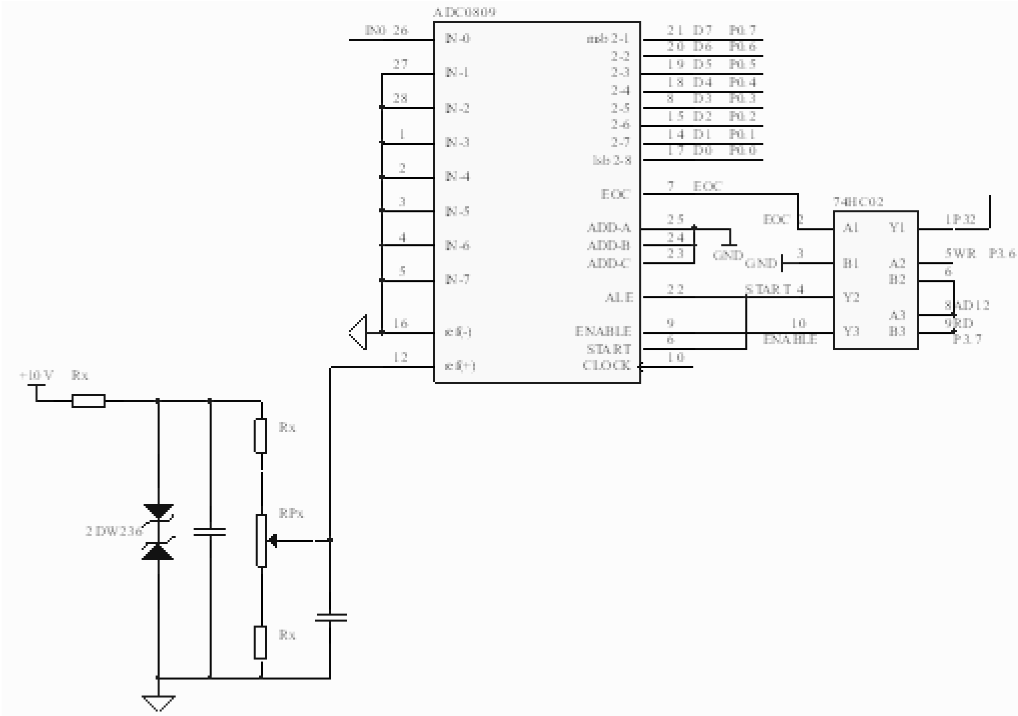

Figure 3. The Local Circuit of ADC

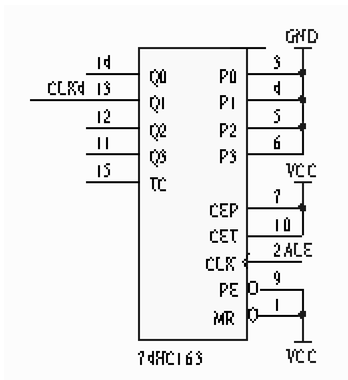

Figure 4. The Frequency Division Circuit

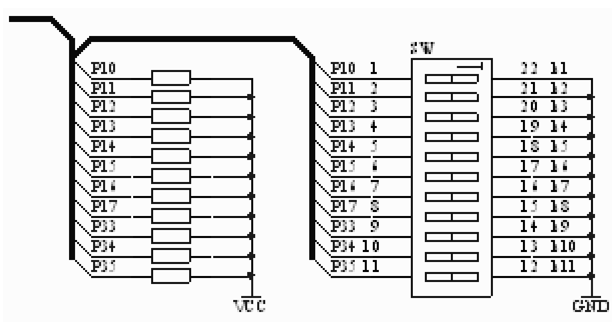

Figure 5. The Circuit of Shift Switch

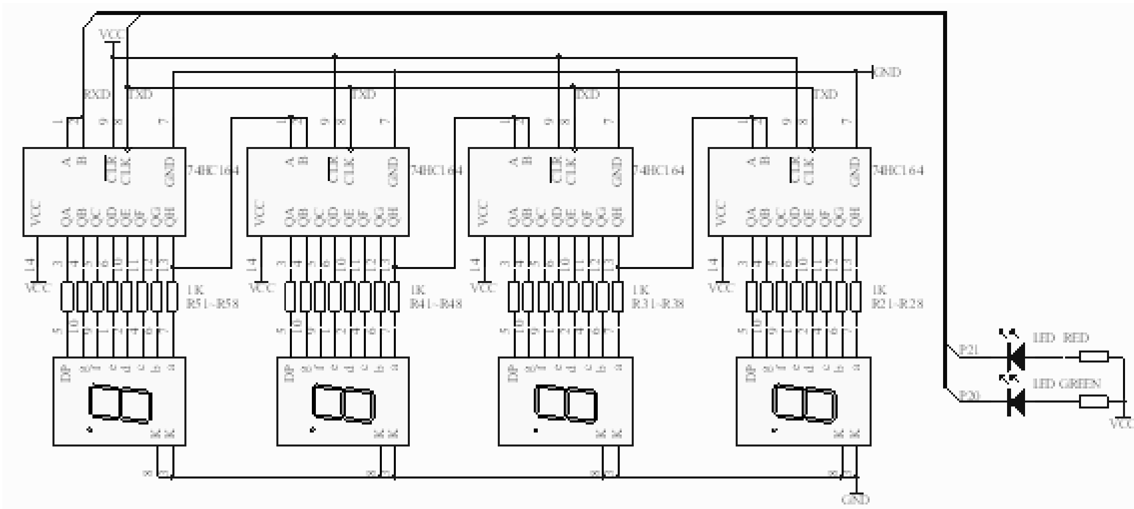

Figure 6. The LED Display Circuit

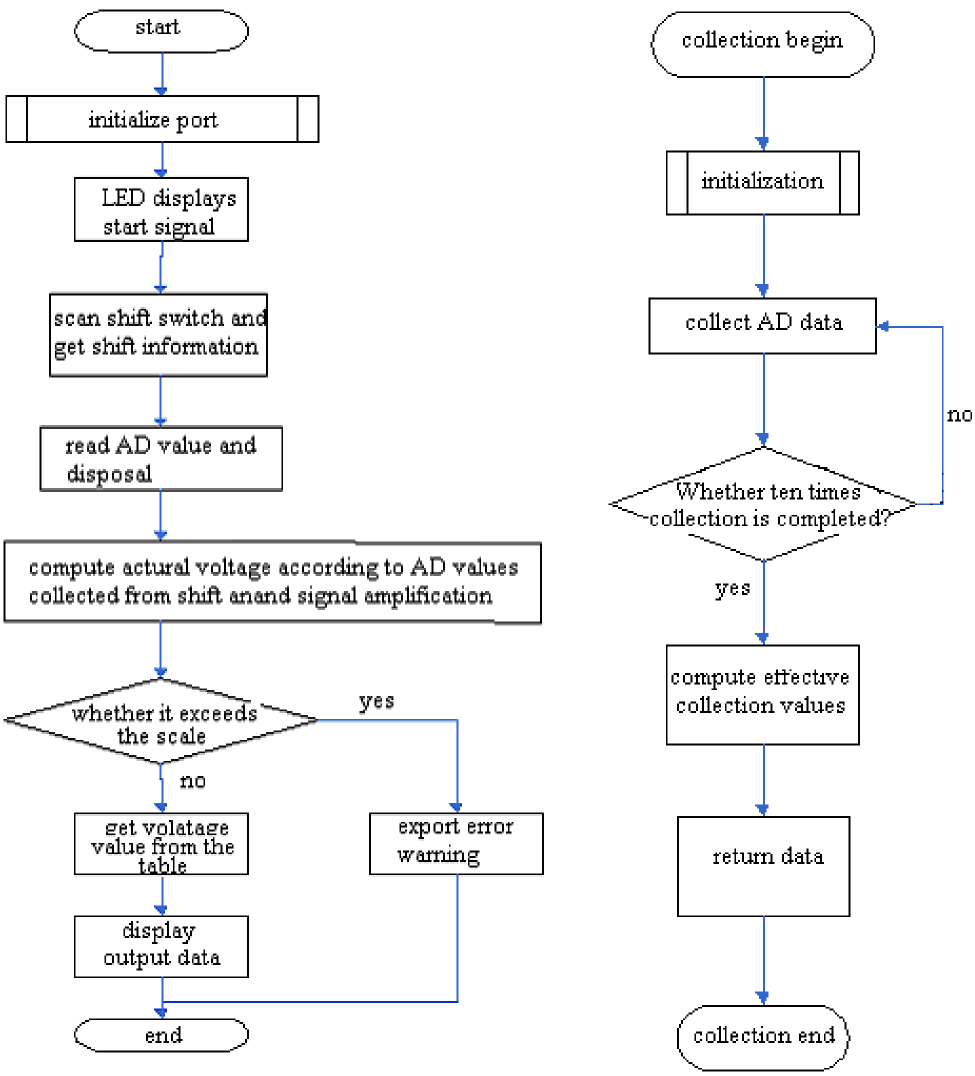

Figure 7. The Design Process of the Software