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# Study of Digital Protractor Based on PSOC for angle Measurement

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***Abstract—*** *The angles measurement is used extensively in industry or daily life. For example, exact elevator, aileron, rudder throws, compare wing and tail incidence, etc. they can all use it. The conventional method that is used to measure angles is called as a protractor. The protractor is the common method which is used to measure an angle. This presents a new design scheme of angles measurement. A novice approach that an electronic protractor includes two swing arms and one variable resistor located on the top of swing arms for measuring angles. The varistor connects the LCD screen through an angle-to-voltage (A/V) controlled circuit, an analog-to-digital (A/D) converter, a single chip processor, and a LCD driver. PSoC 3 have an immense selection of ADCs that can be used depending on the application, ADCINC, ADCINCVR, ADCINC14, DELSIG8.*

***Keywords— Angle Measurement, Electronic Proctor, Phase angle, PSOC.***

## I. INTRODUCTION

A new design approach that an electronic protractor includes two swing arms and one varistor located on the top of swing arms for measuring angles. The variable resistor connects the liquid crystal display (LCD) screen through an angle-to-voltage (A/V) controlled circuit, an analog-to-digital (A/D) converter, a single chip processor, and a LCD driver. The protractor can change the resistance of the variable resistor simultaneously and display the measuring angle on the LCD screen through the processing of the A/V controlled circuit, the A/D converter, single chip processor, and the LCD driver when the swing arms are open or close to make the angular deviations. The present electronic protractor is claimed on those measuring devices through the above process.

## II. HISTORY & BACKGROUND

The angles measurement is used extensively in industry or daily life. For example, exact elevator, aileron, rudder throws, compare wing and tail incidence, etc. they can all use it. The traditional tool that is used to measure angles is called as a protractor. The protractor is the common tool which is used to measure an angle. This paper presents a new design scheme of angles measurement. The new, patent-pending Electric Angle Meter can measure precisely to 1/10 of a degree and displays the angle clearly on its easy-to-read digital screen. The design of electric angle meter is based on potentiometer method. Cypress PsoC3 as its core component, the whole design is flexible and simple, has very few peripheral devices and a high reliability. And meanwhile, we realize equal precision measurement of signals by potentiometer measurement method. Most if not all of the microcontroller designs that involve analog signal processing will require an ADC to convert an analog signal into a digital value that can be processed by the CPU. PSoC 3 has a vast selection of ADCs that can be used depending on the application, ADCINC, ADCINCVR, ADCINC14, DELSIG8, DELSIG11, DelSig to name a few. Most of the users, beginners to experts face some or other problem while using an ADC like ADC not completing the conversion, ADC result always zero, ADC result incorrect etc. Below are Five Golden Rules that will help us to tame the PSoC ADC. They are the global interrupts, analog power parameter sets, clock source selects, clock phase operation, and waiting for the result inside the ISR. We choose one of them, for instance analog power parameter sets to tame the PSoC.

## III. MATHEMATICAL MODEL

There are two major problems

1. More precise angle measurement.

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2. Most of the users, beginners to experts face some or other problem while using an ADC like ADC not completing the conversion, ADC result always zero, ADC result incorrect etc.

In order to implement the Electric Angle Meter can measure precisely to 1/11 of a degree and displays the angle clearly on its easy-to-read digital screen. The design of electric angle meter is based on potentiometer method. PSoC has a vast selection of ADCs that can be used directly depending on the application. The above mentioned problems can be overcome by using PSoC.

For the purpose of the angle detect, we select the variable resistor as the potentiometer. We can change the resistance of the variable resistor simultaneously and display the measuring angle on the LCD screen through the processing of the A/V controlled circuit, the A/D converter, single chip processor, and the Liquid Crystal Display driver when the swing arms are open or close to make the angular deviations. The present electronic protractor is claimed on those measuring devices through the above process. The display part is a character type liquid crystal display and we use the single I/O port of main control chip CY8C29466 as the interface of industry standard HD44780ALCD controller. The interface is composed of 8data bits, read/write (R/W), register selection "RS" and enable signal "E". Considering the number of character bits to be displayed and refresh speed, etc, a 4-bit interface mode is adopted in this design.

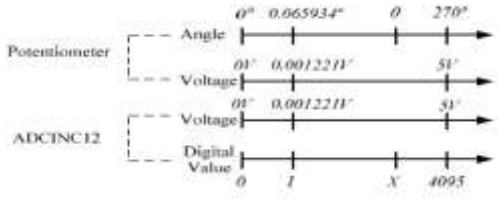


**Fig. The Relative Relation of Potentiometer and ADCINC12**

The operation process of this circuit is that the output voltage of potentiometer is firstly digitized through ADCINC12, transformed to the measured angle, and then displayed on the LCD. Since the range of the input voltage is between 0 and 5 volts. The range of the measured angle is between 0 and 270 degrees and the ADC is with 12 bits, the data range is within -2048 and 2047. To simplify the computation, the digitized values would be added with 2048 to modify the range from 0 to 4095. The relationship of potentiometer and ADCINC12 is shown in Fig. In such case, the relationship of transformation between measured angle θ and digitized value *X* is

$$\theta = X(27000/4095)$$

$$=0.065934X \quad (1)$$

It means when the digitized value *X* is obtained from ADCINC12, the measured angle θ can be calculated with multiplying by 0.065934. For the data display, it can be observed from the following example. Assume that the measured angle θ in (1) is 24.5° . Since the process to display data on the LCD is digit by digit, it is necessary to multiply θ by 100 to become 2450 and then display ten thousand digits, thousands digit, hundreds digit, tens digit, respectively. After putting the decimal point behind the hundreds digit, the data on the LCD display would be 24.5°. In this way, the quantity in (1) would be modified to 6.5934X.

## IV. DESIGN AND ALGORITHM

This is a new design of angles measurement, which was realized on base of an easy way of measurement. Up to now, almost all the angles measurement apparatus are No matter contact or Contact-free, not just optics type, exactly electromagnetic type. They are either complex, or the cost too high. The angles measurement is composed of potentiometer structure, PSoC (programmable system on chip) and LCD display. The block diagram of design is shown as Fig.1

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The potentiometer is a continuous operation device destined for angles detection and signal varying that is proportional to angles to clip from both sides. It is calibrated and sends a message if the angle is change. The design of device is very simple due to use PSoC with analog interface.

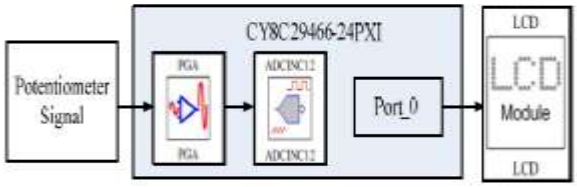


Figure 1. Block Diagram of Design

That has provided high accuracy and low prime cost of the device as a whole. The operation process of this circuit is that the output voltage of potentiometer is firstly digitized through ADCINC12, transformed to the measured angle, and then displayed on the LCD. Since the range of the input voltage is between 0 and 5 volts. The range of the measured angle is between 0 and 270 degrees and the ADC is with 12 bits, the data range is within -2048 and 2047. To simplify the computation, the digitized values would be added with 2048 to modify the range from 0 to 4095.

This paper introduces a design scheme of electric angle meter based on potentiometer which can measure precisely to 1/10 of a degree and displays the angle clearly on its easy-to read digital screen. We select PSoC kit as its core component, which embodies the flexibility and simplicity of the unique programmable system on chip design, greatly simplifies the workflow of the design and shortens the development cycle of the system. In addition, it has advantages of low cost, expandability and high reliability, etc.

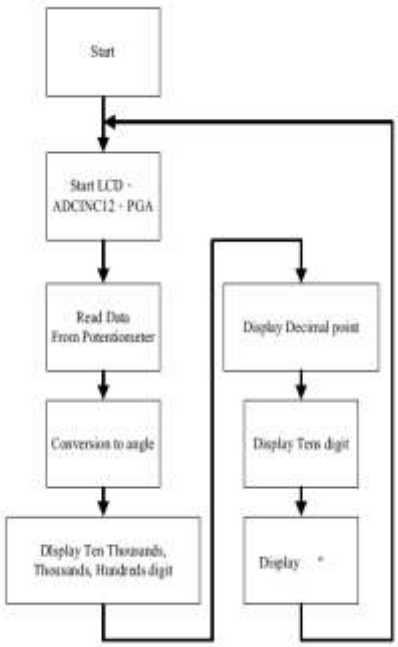


**Fig. 3: Workflow Diagram of System Main Program**

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According to the principle of synchronous measurement and user module configuration in PSoC chip, this paper gives the design scheme of system main program and the workflow diagram of main program is shown as Fig. 3. In the main program design of CY8C29466 chip, after the system is powered up, its internal start-up file boot. asm initializes system programs, including C language global variable, after start-up is finished, the system operates normally. First, declared character array as index value of display; start LCD, PGA and ADCINC12; set ADCINC12 to continuous mode; when it is detected that the transfer in the ADCINC12 is completed, transform into the measured angle, and then displayed on the LCD.

## V. CONCLUSION

In this, Electric Angle Meter system is implemented by using single PSoC chip. By doing so, there are several distinctive achievements: Flexibility to enhance. Reduced number of external interfaces. Reduction in power consumption of the system. In addition, it has advantages of low cost, expandability and high reliability, etc. It's simplicity and effectiveness makes it suitable for fast prototyping and low cost solutions. This introduces a design scheme of electric angle meter based on potentiometer which can measure precisely to 1/10 of a degree and displays the angle clearly on its easy-to read digital screen. This methodology widely used in Robotics and Mechatronics applications.

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