# A design of intelligent multi-function electric meter

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## Abstract

The role of electricity in life is becoming important, traditional electric energy meter will not meet the increasing requirements of users. In this paper, the STM32 microcontroller is used as the main chip, and the modular design idea is adopted to design a practical multi-functional smart energy meter. The hardware part of this smart energy meter mainly includes the main control module, electric voltage and current sampling module, storage module and communication module. And it also uses MDK to design the software part, mainly including the main program, initialization program, power processing program.

## Keywords

Intelligent multi-function electric meter, STM32F103, sampling circuit.

## 1. Introduction

In the fierce market economy, single-function electric energy meters can no longer meet the needs of the market and users. In order to adapt to the development of the market, multi-function electric energy meters are quickly created and applied. By definition, in addition to the measurement of basic voltage, current, active power and reactive power, multi-function meters should also have the functions of storage, display, transmission and communication.

Although multi-function electric meters are widely used in various countries, there are still some problems: high cost, safety problem and limited flexibility. This requires the electric energy meter to be further improved in terms of accuracy, reliability and convenience. This paper theoretically studies a powerful, easy-to-use, low-power energy meter that is conducive to social resource conservation and environmental friendliness.

## 2. Overall Design

The hardware of the three-phase smart meter designed in this paper is composed of main control module, power conversion module, current and voltage sampling module, display module, communication interface module, button output module and storage module, as shown in Fig 1.

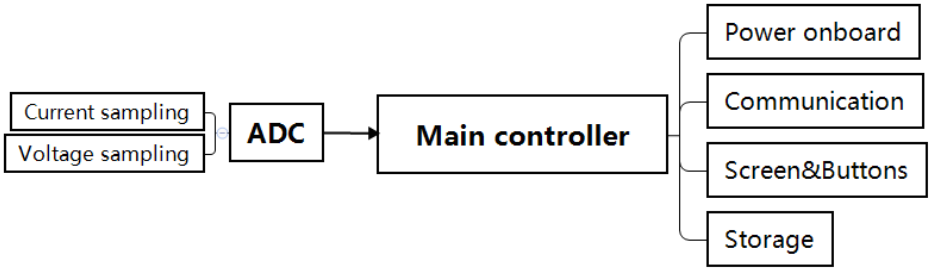


Fig. 1 Overall design

# 3. Hardware

## 3.1 Introduction of STM32

Designs based on the ARM7 and ARM9 cores is a typical trend in microcontroller development[3]. The Cortex family has three main branches, the A branch, the R branch, and the M branch. The STM32 used in this paper belongs to the M branch and belongs to the microcontroller series. The STM32 is also divided into two different versions, basic and upgraded. Among them, the STM32 has a small number of basic plug-ins, which can only withstand a clock frequency of 36MHz, while the upgraded STM32 has a complete external device while the CPU can operate at a clock frequency of up to 72MHz. The energy meter implemented in this paper uses an upgraded type.

In the physical part, the model established in this paper uses the main control chip of model STM32F103RC. Transformers is also used to sample the voltage signal and current signal in sampling circuit. Under the premise of ensuring current and voltage sampling accuracy, this design avoids complicated and variable circuits, and the PCB board is easy to operate and the design is low in cost.

## 3.2 Main control circuit

The tasks required for each of the above modules need to be designed and implemented in the main control chip. The schematic diagram of the master chip is shown in figure. The minimum system of the STM32F103RC microcontroller consists of a reset circuit, a clock circuit, a power conversion circuit, and a download circuit (shown in Fig 2) [3]. The first two are responsible for the initialization of the master chip and the clock reference. The power conversion circuit is responsible for converting a given power source as a driving source; the download port is used to download the program to the circuit board for debugging and verification.

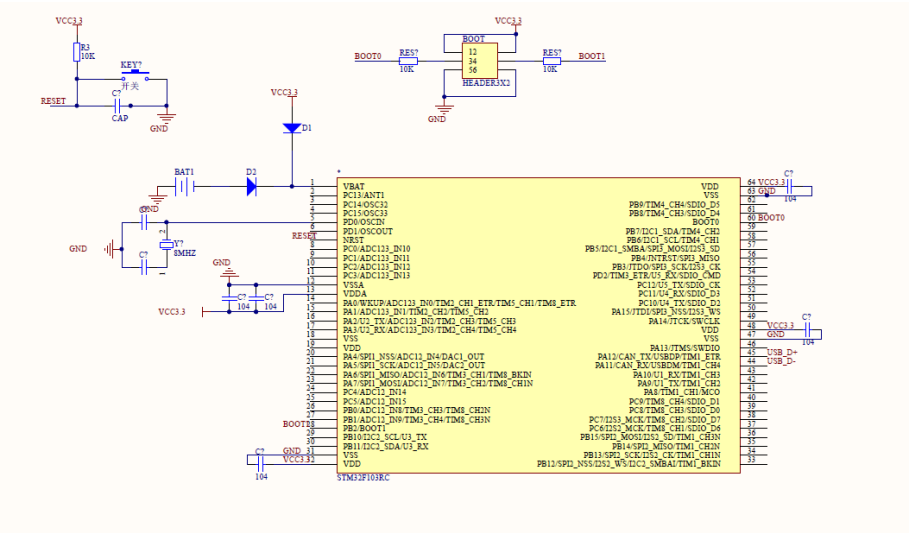


Fig 2 Main control circuit of STM32

Based on the above description, the supporting modules of STM32 are very mature. The display and communication modules are easily available in the market and are inexpensive. The uniqueness of implementing this meter with conventional STM32 is the acquisition of voltage and current signals and the calculation of power quality indicators.

## 3.3 Sampling module

Power sampling is the key technology to realize the function of the energy meter. Only the accuracy of sampling can ensure the function of the energy meter. The current transformer is used for large current. The reason why current transformer is selected instead of forming a sampling network is that the

resistance is subject to temperature and other external factors after the long-term operation[1]. Fig 3 and Fig 4 are schematic diagrams of the sampling circuit designed in this paper.

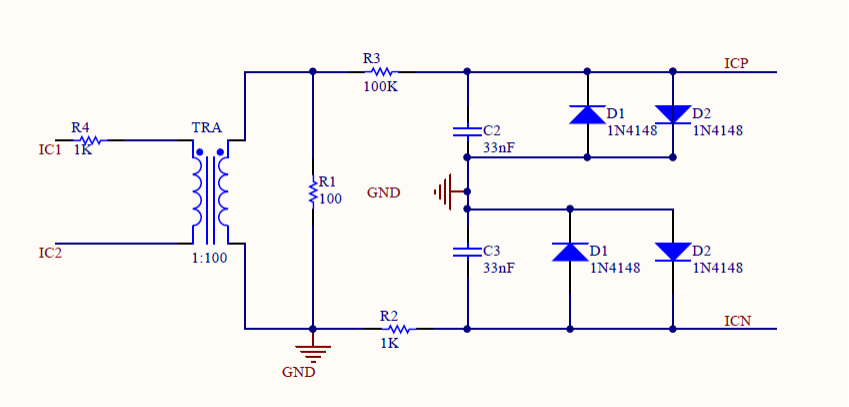


Fig 3 Current sampling circuit

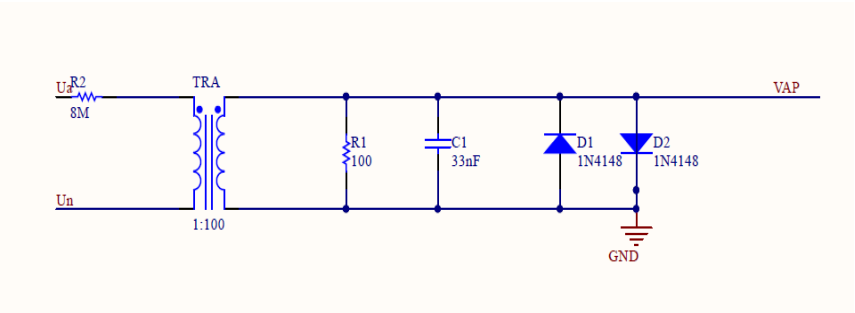


Fig 4 Voltage sampling circuit

Not only the current, voltage signal is also a large voltage. If a large voltage is directly connected to the chip pin, it may cause damage. Therefore, the sampled voltage signal is processed, which requires a voltage conditioning circuit that uses a transformer ,too.

Fig 5 and Fig 6 are examples of signals of voltage and current.

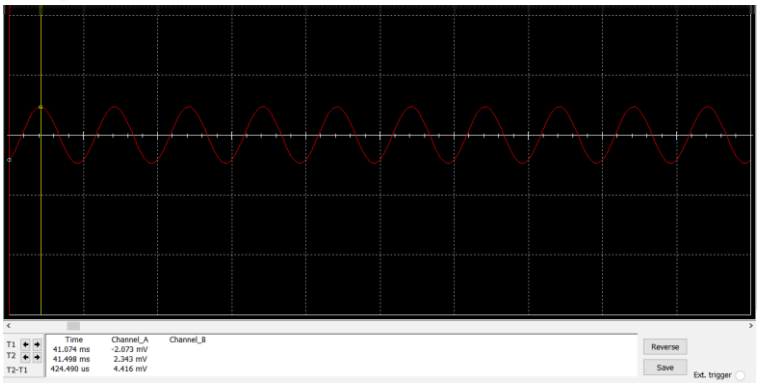

Fig 5 Current sample

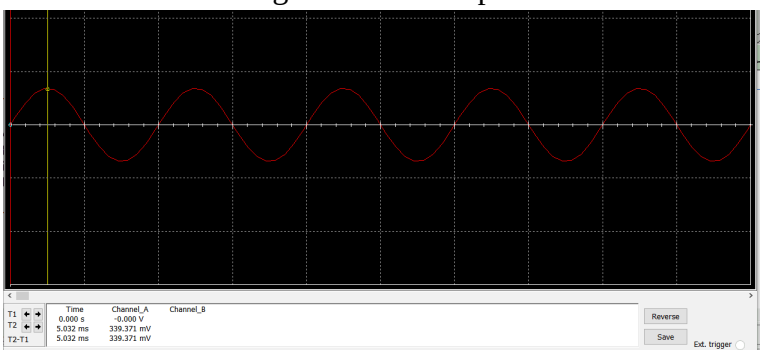

Fig 6 Voltage sample

## 4. Software

After the system is powered on, each module is initialized and the timing refresh time (usually 100ms) is set[2]. System monitors whether the timing time arrives: if it arrives, the data is processed and saved. After the data is saved, the display screen refresh time is monitored in real time. If the refresh time is up, the refresh display is performed; at the same time, it continuously check whether there is a button action or if communication is required, as soon as a corresponding event is detected, it will immediately enter the corresponding program for processing.

For example, if the button action is detected, it must be transferred to the corresponding button processing program. It is necessary to continuously check whether there is a button action or whether communication is required. If the button action is detected, the corresponding button processing program should be transferred to select the page switching; when the communication request signal is detected, it must be transferred to the RS485 communication program for processing.

## 5. Conclusion

Electric energy is one of the indispensable energy sources in our life. The acceleration of modern life rhythm promotes the development of electric energy and increases our dependence on electric energy. It is of great practical value to design a multi-function electric energy meter based on STM32 in a society that advocates the concept of "energy saving, green consumption". This paper has designed this aspect and basically completed the function of the expected energy meter.

## References

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