



# Design and Development of Intelligent Meter Data Acquisition Module Based on Bluetooth Technology

Xianyin Lai<sup>(✉)</sup>

University of Electronic Science and Technology of China, Zhongshan Institute,  
Zhongshan 528400, China  
Laixy081@163.com

**Abstract.** At present, the common communication interface ethernet, WIFI and so on can not meet the power requirement of the embedded device, but the Bluetooth device has the characteristics of low power consumption and strong anti-interference ability, and can meet the demand of intelligent meter wireless communication service. This design will focus on the practical application of wireless Bluetooth communication system in intelligent meter. Using the wireless Bluetooth communication system to connect the smart meter with the household appliances, the power information such as household appliances can be fed back to the power grid, which provides the possibility for the intelligent control of the smart grid.

**Keywords:** Bluetooth · Smart meter · Internet of things

## 1 Introduction

Foreign electronic meter development is very fast, Finland, Sweden, Norway and other Nordic countries and France, Britain, Germany, Spain, Belgium and Italy and other Western European countries, has completed the 100% electronic business user watt-hour meter. User tables are also making a gradual transition to electronic ones, such as those that have been discontinued in France since 2001 and those that have been updated in Italy since 2005 to automatic meter reading, while 80 per cent of British residents now use electronic meters.

Starting in 2010 as the era of smart grids, the number of smart meters installed worldwide will reach 220 million in 2015, and the main market for smart meters is expected to remain dominated by Europe and North America in the next five years, while Asian countries, driven by mainland China, will become potential markets. The following figure shows the intention of three-phase smart electricity:

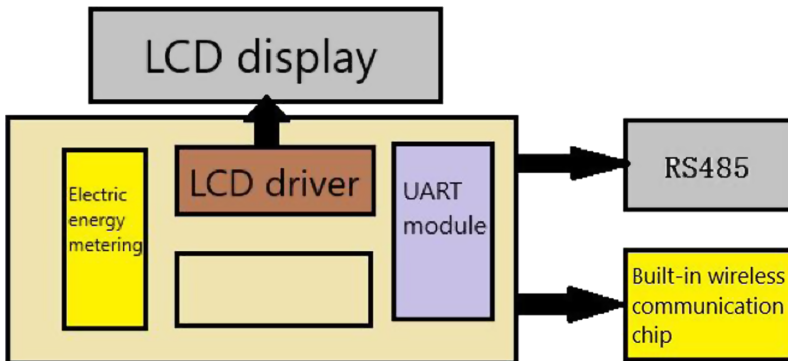
This is a change in the way of collecting electricity information, but also a change in the development of science and technology and smart grid. In July 2009, China formulated a smart grid development plan, according to the plan, by 2020, China will be fully built a unified “strong smart grid”. Moreover, China is expected to add 460 million smart meters during the 13th Five-Year Plan period, and the International Energy Agency estimates that the smart grid will cover 80° of the world’s population by 2022.

## 2 System Design

Intelligent meter data acquisition module system based on bluetooth technology consists of hardware part and software part, in which the hardware part includes bluetooth module, intelligent meter and collector. the software part includes the improved design of bluetooth protocol stack and the APP design of mobile phone. HT6015 intelligent ammeter is the main module of the main chip, processing the data transmitted through the Bluetooth module, forwarding the collector for data acquisition; after receiving the collector's response data, it is forwarded to the Bluetooth communication module.

- (1) The function of the whole project is mainly composed of two parts:
- (2) Data communication: through Bluetooth master-slave communication module;
- (3) smart phone meter reading unit: using mobile phone smart operating system, and Bluetooth module to use Bluetooth to communicate, cooperate to complete the collection and setting of electric data of watt-hour meter, and have basic viewing data and parsing services.
- (4) Smart phone meter reading unit: using the mobile phone smart operating system, and Bluetooth module to use Bluetooth to communicate, cooperate to complete the collection and setting of electricity data of watt-hour meter, and have basic viewing data and parsing services.

Considering the above system outline and the special communication mode of watt-hour meter, the characteristics of Bluetooth and smart phone, the technical scheme consists of three hardware parts: watt-hour meter, Bluetooth module and smart phone (Fig. 1).



**Fig. 1.** System design block diagram

Bluetooth module, collector and smart phone meter reading software are the core part of the design, including hardware and software design and implementation. The hardware part includes the selection and application of the module, the layout of the circuit, the software part includes the design of the communication scheduling degree between the collector and the Bluetooth main module, and the design of the transmission code between the meter or the collector and the concentration. The communication protocol is to send and receive commands between the watt-hour meter and the Bluetooth module; the bluetooth communication between the bluetooth outer module and the smart phone transmits data.

### 3 System Hardware Design and Actualize

#### 3.1 HT6015 Features

##### (1). Introduction of modules

HT6x1x series is a multi-function, high-performance, low-power single-phase intelligent meter dedicated 128k MCU chip, the internal integration of Cortex-M0 processor, clock management, power management, hardware automatic temperature compensation RTC, PLL, high-frequency RC, low-frequency RC, LCD drive and other units, as well as NVIC and DEBUG functions. The RTC unit which supports the compensation mechanism per second. the chip uses 32.768 Hz crystal oscillator clock source as the RTC clock source. through the clock automatic digital compensation unit integrated inside the chip, it helps the user to realize the RTC automatic compensation without software participation. HT6015 the basic features are as follows:

- 1) Use ARM Cortex-M0 CPU Core, 128 K Flash +8K SRAM
- 2) High Speed:CPU maximum operating frequency 22 M, program execution 0 wait.
- 3) Low Power Consumption: Minimum Power Consumption 3.3  $\mu$ A in Hold Mode: Minimum Power Consumption 2.7 $\mu$ A in Sleep Mode.
- 4) RTC: Support per second compensation mechanism.
- 5) RTC Compensate: RTC Digital compensation for built-in curves, full temperature range RTC compensation without user software participation.
- 6) LCD: Support 4COM, 6COM, 8COM LCD show, SEG Interface supports up to 37 segments (80PIN) (Fig. 2).

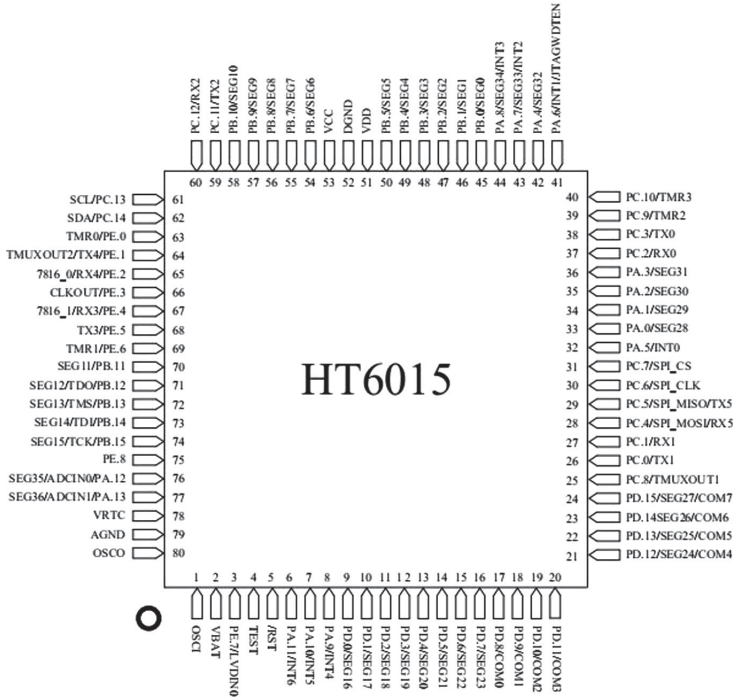
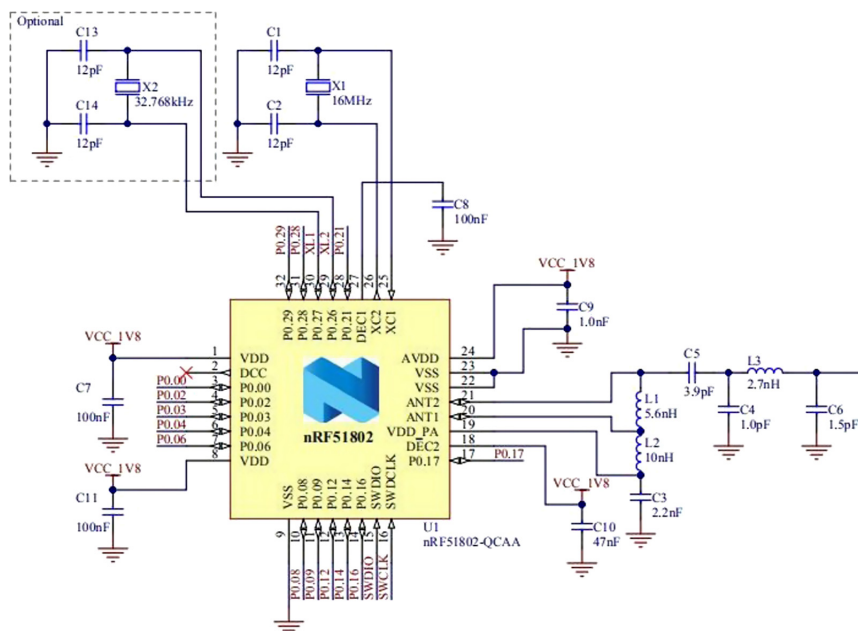


Fig. 2. HT6015 Chip block

### 3.2 Bluetooth Communication Module

nRF51802 is a universal ultra low power SoC, perfect fit Bluetooth low power consumption and 2.4 GHz proprietary wireless applications. It revolves around 32 bits arm Cortex-M0 CPU, have 256 KB Flash Memory +16 KB RAM. flexible 2.4 Ghz radio supports Bluetooth low power and 2.4 Ghz proprietary protocols such as Gazell.

The rich analog and digital peripherals are integrated, which can interact directly through a programmable peripheral interconnect (PPI) system without CPU intervention. The flexible GPIO enables you to connect SPI digital interfaces such as master/slave, TWI master device and UART to any of the 31 GPIO on the device (Fig. 3) (Table 1).



**Fig. 3.** nRF51802 module hardware circuit

**Table 1.** nRF51802 hardware connectivity of module

Designator	Value	Description
C1, C2, C13, C14	12 pF	Capacitor, NP0, $\pm 2\%$
C3	2.2 nF	Capacitor, X7R, $\pm 10\%$
C4	1.0 pF	Capacitor, NP0, $\pm 0.1\text{pF}$
C5	3.9 pF	Capacitor, NP0, $\pm 0.1\text{pF}$
C6	1.5 pF	Capacitor, NP0, $\pm 0.1\text{pF}$
C7, C8, C11	100 nF	Capacitor, X7R, $\pm 10\%$
C9	1.0 nF	Capacitor, X7R, $\pm 10\%$
C10	47 nF	Capacitor, X7R, $\pm 10\%$
L1	5.6 nH	High frequency chip inductor $\pm 5\%$
L2	10 nH	High frequency chip inductor $\pm 5\%$
L3	2.7 nH	High frequency chip inductor $\pm 5\%$
U1	nRF51802-QCAA	Multi-protocol Bluetooth Low Energy and 2.4 GHz proprietary system-on-chip
X1	16 MHz	XTAL SMD 2520, 16 MHz, 8pF, $\pm 40$ ppm
X2	32.768 kHz	XTAL SMD 3215, 32.768 kHz, 9pF, $\pm 20$ ppm

## 4 System Software Design and Actualize

### 4.1 Design of Meter Reading Software

For testing whether Bluetooth module can interact effectively with users, it is necessary to develop a practical smart phone meter reading software, using the current common android mobile phone to collect and set the meter data. Along with the popularity of embedded systems, especially the rise of mobile phones arm chips and operating systems in recent years, the development of many practical software in mobile phones has become a reality.

Cell phone meter reading unit is installed meter reading application mobile phone, mobile phone meter reading software using android system to develop, meter reading program mainly contains several large modules: build communication channels, meter reading collection and setting, follow-up information processing.

At present, most smart phones have Bluetooth module, the first step of the mobile phone meter reading program to open the Bluetooth program, the mobile phone installed meter reading application and the Bluetooth module in the meter to connect, the second step to create a good transmission channel with Bluetooth serial device, and then according to the meter to generate a variety of command flow. The instruction stream is sent to the Bluetooth module and the returned information is collected, and the mobile phone program can also find the received and set log information or send them to the remote terminal, etc.

### 4.2 Function Declaration

- ① Meter setting: the previously well-set watt-hour meter will automatically display, after selecting the meter will display the table setting log;
- ② Automatic collection: the set of data items for automatic collection, if there is a preset collection method, can automatically collect the table address, automatically read the electricity information flowing through the meter; if the automatic collection of unavailable data will automatically re-collection;
- ③ Manual collection: according to the manual set of acquisition scheme for the collection of specific items.
- ④ Query acquisition: the interface gives priority to displaying the collected watt-hour meter, and the data collected by this meter will be displayed after selecting the meter;
- ⑤ Clear log: Clean up the collection log, first there will be a system display prompt, then confirm, after the log will be cleared;
- ⑥ Open Bluetooth: Bluetooth that can be started by the software, if the software does not have access, the access dialog will be displayed;
- ⑦ Connect Bluetooth: The software will automatically search for the available Bluetooth and then request a connection to the selected Bluetooth module, and the system will display a successful dialog after the connection is successful (Fig. 4).

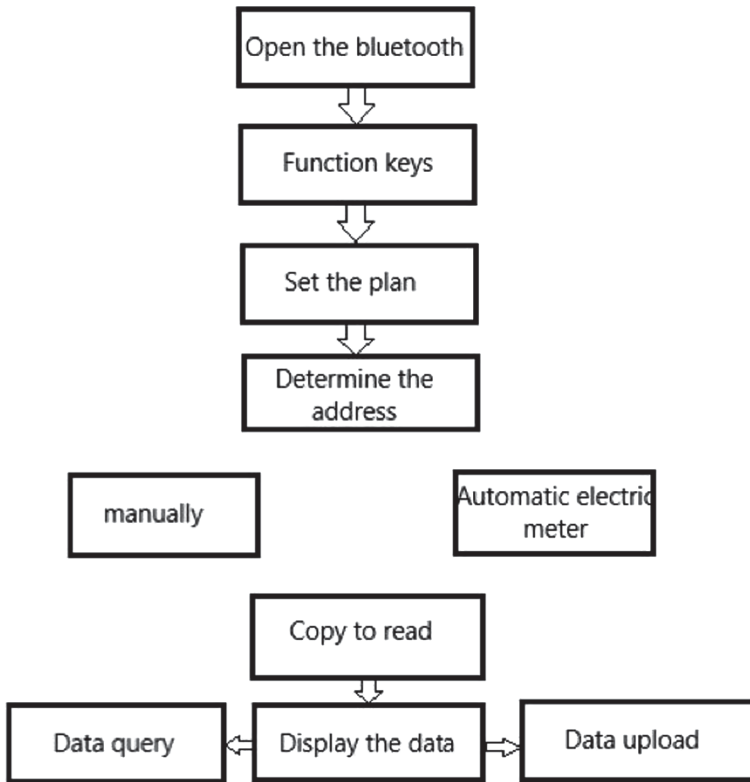


Fig. 4. Software master design block

## 5 System Debugging

As shown in Fig. 5: The burner is connected to the pc end and the Bluetooth module is connected with DuPont wire. After opening the serial port test assistant at the pc end, the baud rate, serial port number, data bit, stop bit and check bit are set.

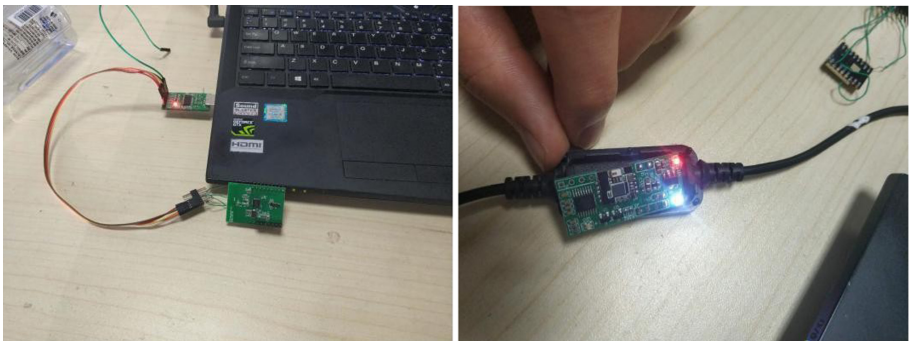


Fig. 5. System testing

Above shows the nRF51802 Bluetooth module used for this design, can be seen after the connection can normally send and receive data, signal lights also work normally. The diagram shows the watt-hour meter processing data, working properly (Fig. 6).



**Fig. 6.** System display effect

## 6 Conclusions

This paper collects the electricity demand data from the concentrator through Bluetooth module and displays it to the intelligent meter, and can also display it to the designed software to monitor the electricity consumption in real time. This paper introduces the performance of the t6015 chip and the nrf51802 module, designs the schematic diagram of the electric meter circuit part and draws pcb, designs and implements the system related driver, completes the splicing of the intelligent meter and the Bluetooth communication module, and the overall effect reaches the expected level.

## References

1. Ma, S.: Internet of things communication technology and challenges based on 5G network. *Mod. Inf. Technol.* **9**, 195–196 (2018)
2. Guo, Q., Guo, J.: Application and development of smart meter in smart grid. *Electr. Electr.* **3**, 65–67 (2017)

3. Liu, Q., Cui, L., Chen, H.: Key technologies and applications of the Internet of Things. *Comput. Sci.* (2010)
4. Shihai, Y.: Electrical instrument and its application. China Electric Power Press, Beijing, pp. 42–43, September 2009
5. Yixiu Network: Electronic Power Technology Training Course, September 2014
6. Yunpeng, Z., Nanxing, Z.: Practical Electrician Manual. China Water Conservancy and Hydropower Press, Beijing, June 2008
7. Yunhao, L.: Introduction to the Internet of Things. Science Press, Beijing (2012)
8. Shenzhen Ruineng Microtechnology Co. Ltd., single-phase metering chip m8207c user manual rev 1.1 [M]
9. Heng, Q.: Smart grid system analysis based on Internet of things technology. *Jiangxi Building Materials*, vol. 3 (2016)
10. Zhenhuan, Z.: Research and Implementation of Bluetooth-based Wireless Measurement System. Beijing University of Posts and Telecommunications (2008)
11. Ho, W.: The development of Bluetooth technology and its application prospects in the Internet of things. *Appl. Energy Technol.* (2016)