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Design and Implementation of an Intelligent Socket Based onSTM32 Microcontroller

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ABSTRACT: *The system design is composed of STM 32 microprocessor core board module, AC voltage and current detection module, WIFI module and indicator light module. The AC voltage and AC current value are detected respectively by the voltage transformer TV1005M and the current transformer TA1005M. After the mobile phone APP is connected to the system design WIFI, the AC voltage, AC current, power and electric power can be displayed on the mobile phone in real time. The relay is automatically disconnected when the power exceeds 200W. When the power does not exceed 200W, the switch of the relay can be controlled manually. After the phone is connected to the WiFi module, the service time of the socket is displayed on the phone. After testing, the system design intelligent socket can play a role in protecting the user's personal and property safety, can be widely used in households. Its low cost, easy to operate, it is easy to be recognized by people, and it has a broad application prospect.*

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I. INTRODUCTION

Most of the traditional sockets used now have single functions, can only stop the use of electrical appliances through simple power interruption, there are many disadvantages and deficiencies: poor security, when the user uses the electrical appliances beyond the rating of the electrical circuit burned, endanger the personal and property safety; the convenience is poor, when the user suddenly forgot to remove the electrical equipment, the emergency can not be dealt with in time.

Smart socket is a very popular intelligent home product, it can establish communication with the mobile phone through the wireless network, and control the switch of the smart socket through the app, so as to control the electricity consumption of household appliances. The socket is closely linked to people's life, whether it is the ordinary work and study, the use of family life and the production of the factory are inseparable from the socket. Therefore, in the design and learning process, we have an intelligent design of the socket. Through the voltage transformer and current transformer to detect the current and voltage, the mobile phone can display the corresponding current value in real time, indirectly control the relay switch to achieve safe, energy saving, economic purposes.

II. SYSTEM DESIGN

The design of the system needs to detect the current and voltage values in the line and analyze and process the numerical value, so not only the hardware detection and also the software data processing in the design process. The specific control scheme consists of STM 32 SU core board circuit, AC voltage and current detection module circuit, WIFI module circuit and indicator light circuit.

The control chip used in this design is STM 32 single-chip microcomputer. Ordinary hardware facilities can easily enter the Internet with WIFi wireless module, which is an essential part of the completion of intelligent interconnection. Using WIFI wireless communication module has the following advantages: (1) stable performance, rapid data acquisition speed (2) not only fast and high reliability (3) wave transmission does not need wiring (4) When using WiFi wireless communication, it cannot reach the set 100 mW for health and safety. The WiFi wireless network operates through radio wave propagation and has a certain level of security.

The specific framework diagram of the system and the architecture design Overall system structure is shown in Figure 1:

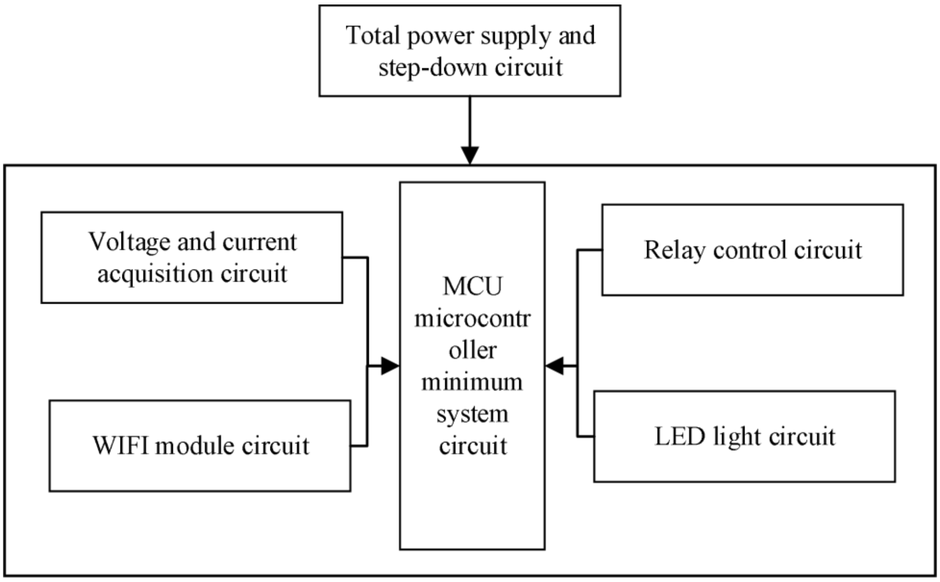

Fig. 1 System framework diagram

System function analysis：
This design consists of STM 32 CM core board circuit + AC voltage and current detection module circuit + WIFI module circuit + indicator light circuit. The specific functions of the system design are described as follows.

(1) AC voltage and AC current values are detected by voltage transformer TV1005M and current transformer TA1005M respectively,

(2) After the interconnection of the mobile phone APP and the WiFi module, the AC voltage, AC current, power and electric power can be displayed on the mobile phone in real time.

(3) When the power exceeds the set rated power, the relay will automatically break. When the power does not exceed the rated power, the relay can be manually controlled to open again through the APP.

(4) After the mobile phone and the WiFi module are connected, the timing time is displayed on the mobile phone.

III. DESIGN AND IMPLEMENTATION OF SYSTEM HARDWARE AND SOFTWARE UNITS

3.1 STM 32

The MCU selected in this design is STM 32 chip, and the principle of STM 32 MCU is easy to understand and cost-effective. Based on the requirements to strong function, cheap cost of embedded applications specially designed Arm Cortex-M3 kernel, at the same time has a powerful interface, in power consumption and integration has outstanding advantages, because of its simple structure and practical development tools welcomed by users and love, STM series based on ARM 7 architecture of 32, produced by the semiconductor company support simulation and tracking microprocessor. STM 32 is shown in diagram 2.

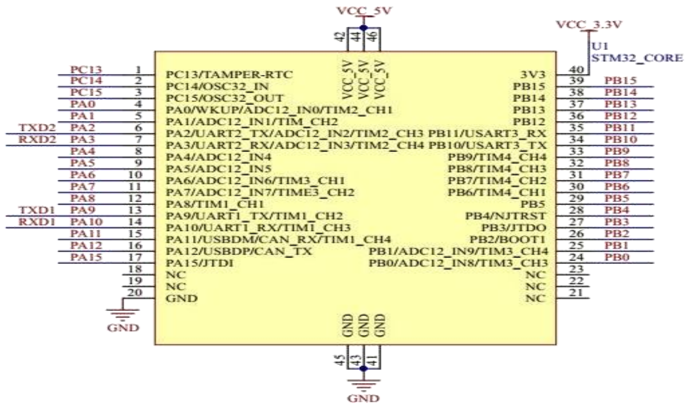

Fig. 2 Internal circuit diagram of the core board of STM 32

STM 32 MCU is based on rtex-M3CPU kernel, the highest working frequency of 72MHz1.25DMIPS/MHz fully meet the design requirements, and uses the division of single cycle multiplication and hardware division, the response time interval is very short. Its crystal vibration circuit is shown in Figure Figure 3.

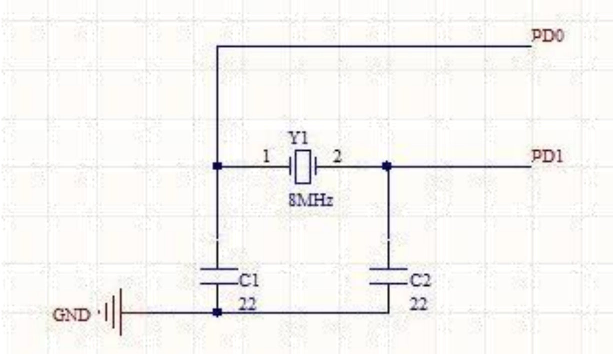

Fig. 3 Crystal vibration circuit

3.2 Circuit design of the AC voltage and current transformer module

This design detects the AC voltage and AC current values through the AC voltage current transformer module and through the 5V relay circuit. AC voltage transformer model is TV1005M, AC current transformer model is TA1005M. The schematic diagram of its specific circuit is shown in Figure 4.

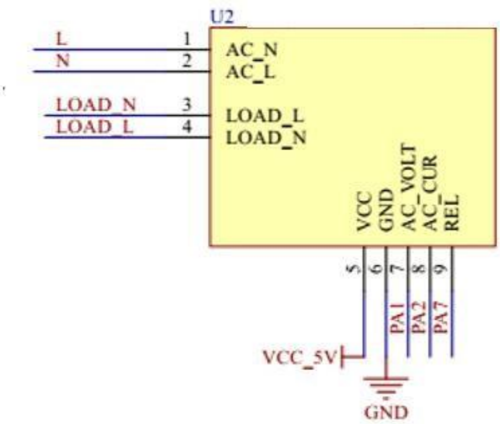

Fig. 4 Interface diagram of the AC voltage and current transformer module

3.3 ESP8266WIFI module circuit design

In this design, the wireless WIFI transmission module chose the low price powerful ESP8266WIFI, ESP8266WIFI transmission power is low and external transparent transmission, transparent transmission is the data in the process of transmission whether any message data can be transmitted to the purpose interface, so in the system design process can be the system sensor module and network interconnection, and data interaction with the network. The working principle is shown in Figure Figure 55:

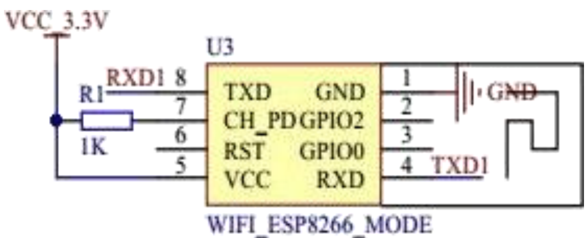

Fig 5. The WiFi module circuit diagram

3.4 System PCB circuit diagram

After completing the circuit design of each module, the PCB circuit diagram corresponding to the system design is drawn, as shown in Figure 6.

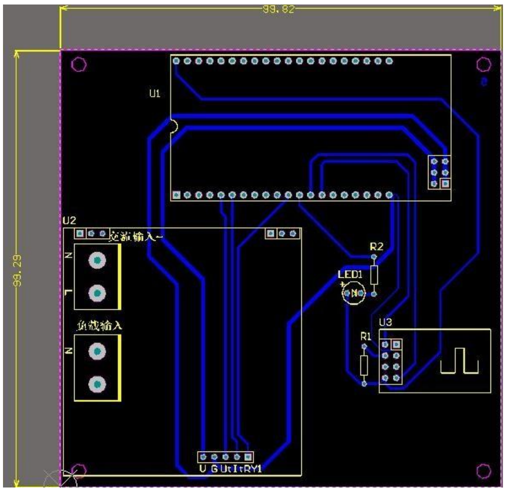

Fig 6. The PCB circuit diagram

3.5 Software design

Due to the complex design of the system design, the calculation is complicated, and a lot of floating point calculation, because the c language can directly operate the hardware, high portability, so the program design of the system uses C language.

In the development of microCM, the development of various software, among which Kail software is welcomed by the world MCCM developers. Because Keil software has a very convenient development environment and many available program interfaces, Keil software can save developers a lot of time and effort and reduce development costs. The Keil software is shown in Figure Figure 77.

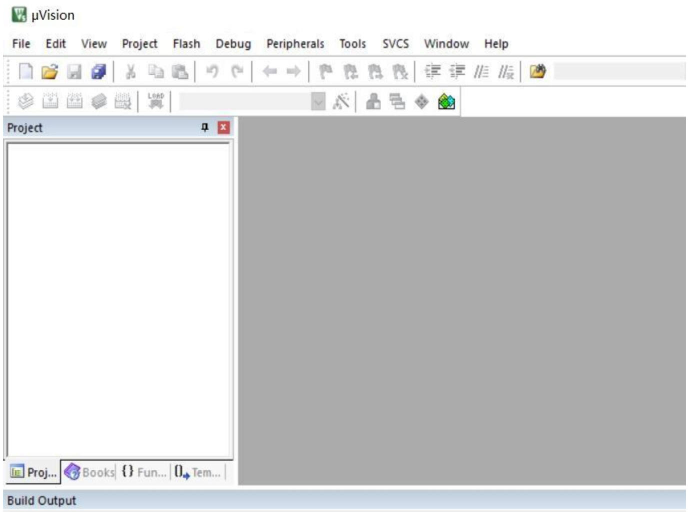

Figure 7 The interface diagram of the Keil software

IV. TESTING AND RESULT ANALYSIS

4.1 Hardware testing

The next step is hardware testing, which requires careful inspection of whether each component is working properly. During hardware testing, an ammeter, power supply, and oscilloscope are required to be used. The overall test is carried out in several steps.

(1) Observe whether the welding node is welding welding or pin adhesion between components.

(2) Use the ammeter to see whether there is a line problem in the measurement system circuit.

(3) Connect the system to the power supply for further testing, and observe whether each circuit module on the circuit board is working normally.

ST

After a power-on test, the system runs normally. As shown in Figure 8.

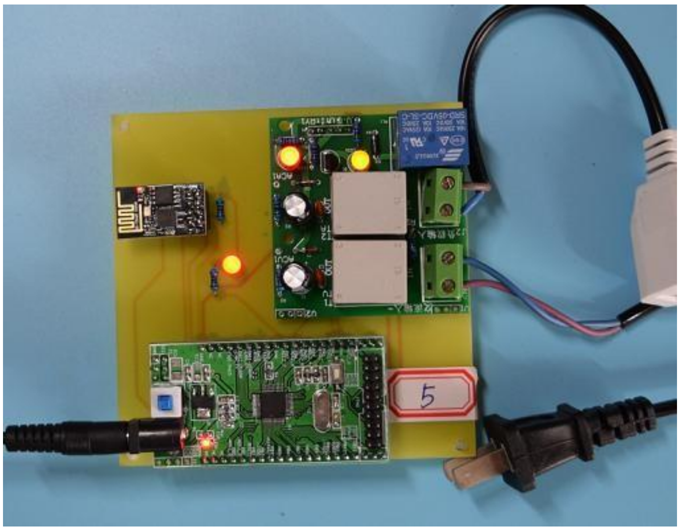

Figure 8. Physical test diagram

4.2 Software testing

After the system design welding is completed and the welding is carefully checked for no problem, the next step is the power test. First, do the software debugging. Select Project in the Keil software menu box, then click "New uVision Project" in the drop-down menu to establish the project name, select the new project name and save it in the appropriate hard disk directory; then select the controller model required for the system design. To create the source file of the project user, the file prefix must be in the form of c file. Select the compilation function. If it appears as shown in Figure-3, the compilation is successful; otherwise, carefully check the writtencode until the prompt information appears in Figure 9.

```
Build Output
Build target 'Target 1'
compiling main.c...
linking...
Program Size: data=59.0 xdata=100 code=1436
creating hex file from "89c51"...
"89c51" - 0 Error(s), 0 Warning(s).
```

Figure 9. Program debugging diagram

When the mobile phone is connected through the WIFI wireless module and the STM 32 MCU, the testis shown in Figure 10

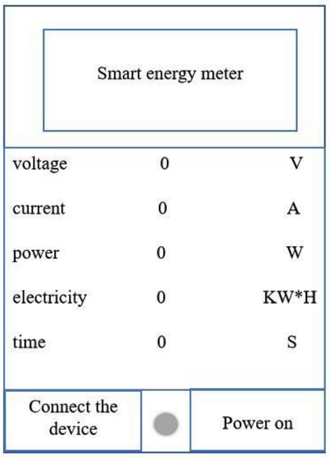

Fig. 10 Software connection diagram

V. CONCLUSION

The system design interacts with the users and the system with the core module STM 32 and the ac voltage transformer and ac current transformer through the WiFI wireless data module. After several months of learning and debugging, the design is finally completed. Overall, the first part of the design is the selection of microU model and wireless transmission module. The second part is the selection of hardware circuit, mainly the circuit design of each module. The third part is the software design, which conducts various parameters testing, interconnection and calculation. The last part of the system welding and debugging, circuit welding and system debugging. Finally, the functions of the system design have been basically realized. When the user uses electrical appliances more than the set 200w power, the single chip microcomputer will close the relay in a state, at this time the socket can no longer be used by electrical appliances. After the system is connected to the mobile phone through the wireless WIFI module, the mobile phone can display the AC voltage, AC current and real-time power in the mobile phone and start the timing. This design can roughly meet the requirements of ordinary residents, with low cost and good application prospect.

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REFRENCES

[1]. Zhao Xiaolan, Hu Zheng, Wang Peikun, et al. Design of a multifunctional bicycle computer [J]. Electronic Testing, 2013(10x): 1-2.
[2]. Li Zeguang. Design of an infrared remote control decoder based on a microcontroller [J]. Modern Electronics Technology, 2007(09): 36-37+40.
[3]. Wang Yanqing, Yu Haiyang. Overview of computer software system testing techniques [J]. Electronic Technology and Software Engineering, 2017(22): 47-48.
[4]. Wang Kequan, Zhang Li, Teng Daoxiang, et al. Design of a new type of household intelligent remote control energy-saving timing socket [J]. Shandong Industrial Technology, 2013(11): 254-256.
[5]. Zheng Xian, Yao Ming. Research status and development trends of smart home networks [J]. Intelligent Building and Urban Information, 2006(8): 109-112.
[6]. Xu Wei, Jiang Yuanjian, Wang Bin. Design and application of intelligent sockets in smart home systems [J]. Chinese Instrumentation, 2010(10): 45-47.
[7]. Yao Wenxuan, Teng Zhaosheng, Xiong Jingwen, et al. Design of a multifunctional smart socket [J]. Enterprise Technology Development, 2010, 29(11): 28-30.
[8]. Du Haitao, Tian Zhongshuai, Li Chuanming. Design of a self-following socket for infrared remote control [J]. China Science and Technology Information, 2011(24): 115-115.
[9]. Lu Peng, Yang Hailiang. Mobile phone testing control system based on STM32 and CPLD [J]. Electronic Technology and SoftwareEngineering, 2013(16): 57-57.
[10]. Yang Shiyuan. Dissecting smart homes [J]. China Economic and Information, 2002(35): 28-28.
[11]. Ye Shuo, She Xinping. Design of an intelligent meter reading collection system based on STM32 [J]. Journal of Yangtze University(Natural Science Edition), 2018(1): 18-22.
[12]. Jiang Bin. Application of intelligent sockets in pump station management [J]. Electrician Technology, 2017(4): 43-43.
[13]. Li Hongnian. Design of a smartphone remote control intelligent socket [J]. Information and Computer (Theoretical Edition), 2017(23).
[14]. Zhou Lida, Zhang Jiaqing, Li Bo. Design and implementation of an intelligent socket based on power measurement [J]. Microcomputer Applications, 2017, 33(6): 71-73.
[15]. Shao Xin. Design of an intelligent charger based on a microcontroller [J]. Henan Science and Technology, 2014(02): 83-84.