Development Of Multi-users Multi-function Watt-hour Meter Based On ATT7022B

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***Abstract*—According to the feature of city's apartment building in China, a kind of Multi-users Watt-hour Meter based on ATT7022B has been developed in this paper. The master-slave MCU control model and the principles of Time Sharing Multiplex are adopted in this Watt-hour Meter, its function includes the measurement of current, voltage, power, power factor and the overload protection. It supports remote reading, pre-payment, multi-rate and etc. The practice shows that this meter has high accuracy, runs stable. It has wide prospect in the future market.**

Keywords—Multi-users; ATT7022B; Time Sharing Multiplex; Master-Slave Control Mode

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1 INSTRUCTIONS

With the rapid development of China's urbanization，more and more high buildings are built, living in small residential areas has been the main life style in China. The single user Watt-hour Meters which used in the past have many disadvantages, such as the cost is high, the function is simple, and maintenance is inconvenient. According to the people's centralized way of life, the Multi-users Watt-hour Meter based on ATT7022B has been developed , its function includes the overload protection, multi-rate, pre payment, etc, and is able to complete the power energy measurement of 24 single phase users at the same time. The Watt-hour Meter that developed in this paper, is not only convenient fo r the users to buy electricity, but also makes the electrical company's measurement of electricity easy. It is the symbol of modern civilized life.

Now, the measurement model of "multi-measurement IC + single MCU" or "single-measurement IC +single MCU " is widely used, and the simplicity of hardware ,operating stability is rather poor. Owing to the above factors, the master-slave MCU control model is adopted in this paper. A high-accuracy chip (ATT7022B) which is produced by the Actions Semiconductor Co., Ltd. and the STC 12C4052 are taken as the slave control unit to complete the measurement of electric energy. Two slave modules are used in this system, each model can accomplish the measurement of 12 users' electric energy. The 89C58RD+ is taken as the core of master control module, completes functions including communications, display and control query.

2 The principles of time sharing multiplex（TSM）

It is an insensible change of the residential electricity load, so the TSM has been used in the electric energy meter. And also this principle can simplify the hardware of the meter, diminish the cost of production.

The TSM period of the measurement IC, "T", is the time that cycle gathering N households' electrical energy (N=12 in this paper). The measurement IC ATT7022B can accomplish 3 single phase users' AC data acquisition at a time, so the "T" can be divided into N/3 pieces. Set one piece time as t_1, the electricity consumption of user1 in time slot t1 value E1, then the average power in this time slot t1 is P_U, it can be presented as

$$P_U = E_1 / t_1 \quad (1)$$

We take the P_U, which can be got by formula (1), as the household's average power of the TSM period. Then, the household's electric energy in this TSM period can be gotten by multiplying P_U and "T". The household's electric energy can be gotten by the following calculation formulas,

$$E = E + \Delta E \quad (2)$$

Where ΔE is household's electric energy in this TSM period, and it can be presented as

$$\Delta E = P_U T \quad (3)$$

3 System structure and main functions

The measurement IC has been shared in divided times by multiple users in this Meter, so the precision of the Meter will be determined by the length of the TSM period. In order to shorten the time of the TSM period, reduce the load of the master MCU and elevate running reliability of the system, the

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Master/Slave control model has been used in this system.

This design adopts master-slave CPU hardware structure.STC12C4052 microcontroller (slave CPU) plays a role of AC sampling, reading parameters from ATT7022B through the SPI bus ,calculating electric parameter, and STC89C58RD+(master CPU) takes responsibility for RS485 communication and system management. Moreover, master CPU controls the switch on/off of the relay. When the user is overload or the pre-payment runs out, then the user's power will be cut off. The system structure is shown in Figure 1.

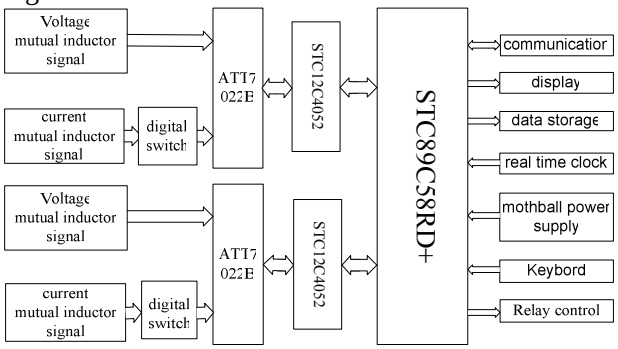

Fig. 1 System structure of the meter

4 The hardware of the Multi-users Multi-function Watt-hour Meter

4.1 Electric energy measurement circuit

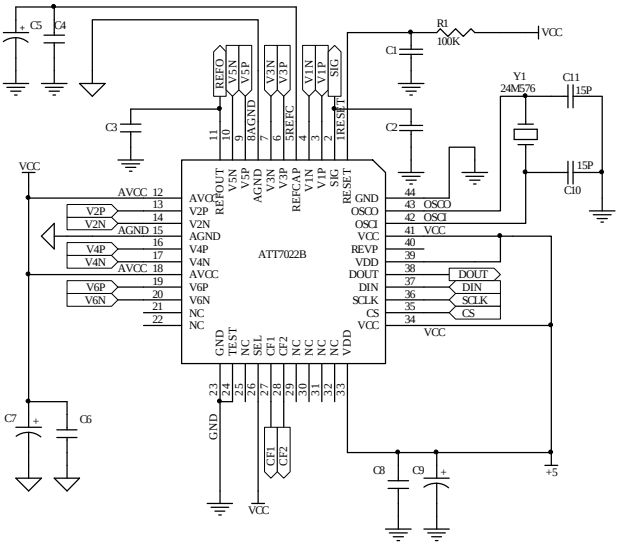

Fig.2 The application circuit of ATT7022B

ATT7022B is a high accuracy 3-phase electric energy metering chip which is suitable for 3-phase 3-wire and 3-phase 4-wire services. ATT7022B is suitable for measuring active power, reactive power, apparent power, active energy, and reactive energy for each phase and 3 phases combined. ATT7022B supports soft calibration for gain, phase. Active energy accords with 0.2S, 0.5S. The application circuit of ATT7022B is shown in figure 2.

The input of the meter is strong electric signal, but the measurement IC could allow input sample to the scope for ± 0.5V. The voltage and current transformers can transform strong signal to weak signal which can be processed conveniently. V1P/V1N, V3P/V3N, V5P/V5N, the pin of ATT7022B, is used to sample the current signal, V2P/V2N、V4P/V4N、V6P/V6N,is used to sample the voltage signal. Take the phase A for example, the voltage and current sampling circuit are shown in the Figure3 and Figure4.

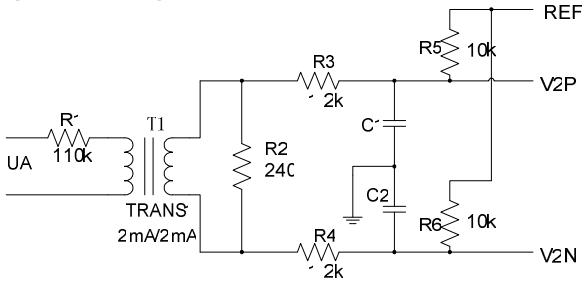

Fig . 3 The voltage sampling circuit

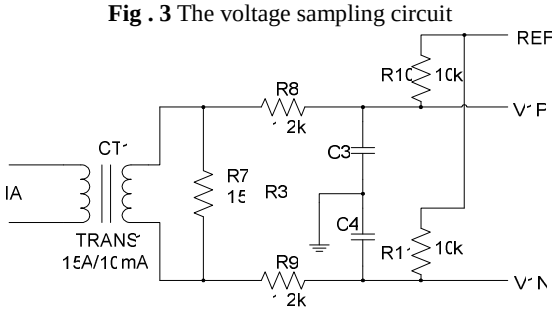

Fig.4 The current sampling circuit

4.2 The circuit of the slave MCU

The slave MCU control system uses ATT7022B which is the special chip to measure electric energy to acquire and process data. The multi-channel HEF4051 is used to switch different channels in the TSM period. The I/O ports are used to communicate between the Master and Slave MCU. The circuit of the slave MCU is shown in Figure5.

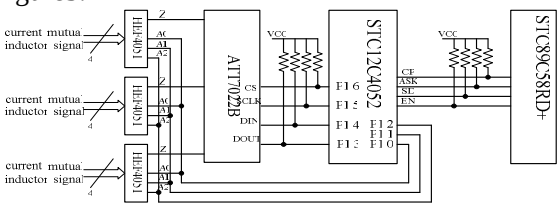

Fig.5 The circuit of the slave MCU

4.3 Master CPU and its peripheral circuits

The master CPU STC89C58RD+ and its main functions are shown in Figure1.In order to realize the centralized management of the meter, RS485 communication and infrared communication are applied to the system. Serial EEPROM 24C16 which

is based on I2C interface is used in our system, so when the system is power off, the data won't be lost. RX-8025 is a kind of real time chip produced by EPSON Company, it provides real time for the system to control the relay or to complete multi-rate function. A backup power supply is designed to ensure the accuracy of the real-time clock.

4.4 The circuit of the relay control system

The relay control system is a necessary part to pre-payment and multi-rate Watt-hour meter. The circuit of the relay control system is shown in the Figure6.

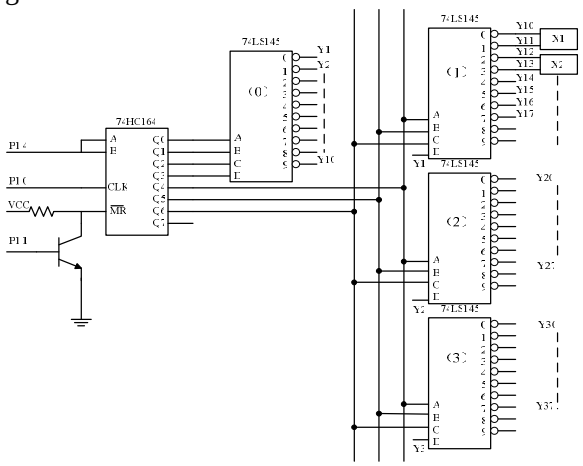

Fig.6 The circuit of the relay control system

74HC164 is the 8-Bit Serial In/Parallel Out Shift Registers. It converts a serial input into a 8-bit parallel output, the former four bits, decoded by the 74145(0), are used as the chip selecting signal, and the later three bits are used as the relays' state control code.74145 have 80-mA sink-current capability, can be used to drive the relay directly.

The consecutive two output pins of 74LS145 can control and drive one relay. Take Y2 and Y3 for example, when DCBA=0010B, then the output Y2 • Y3=01, it controls the relay switched on; when DCBA=0011B, then the output Y2 • Y3=10, it controls the relay disconnected; in the other cases, the relay will keep in an existing state.

5 Design of the system's software

The Master/Slave MCU control model is adopted in this system. It is a complex work of the meter's software, modular design is used to make the system reliable, efficient and expendable.

The structure of the software is divided into 2 big modules, electric energy measuring module and the main operation module. The electric energy measuring module can be divided into 3 modules, they are electric energy measuring module, calculate of measuring error in meter module and slave master communication module. The main operation module is composed of master slave communication module, RS-485 communication module, LED display model, load identification model.

6 Experiment and analysis

Henan star company's field test equipment for multi-functional electric energy meter is used to carry out checkout of data.24 users of the meter is checked when they are in the continuous 24 hours under diversiform load.The electric energy measuring results of the first six users' are shown in the table 1.

Tab.1 Results of electric energy measurement

account	Remaining energy	energy consump-tion	Consump-tion of the standard meter	relativ e error （%）
1	4868.0	132.0	131.9	0.0758
2	4868.4	131.6	131.5	0.0760
3	4868.4	131.6	131.4	0.1522
4	4868.2	131.8	131.5	0.2281
5	4868.2	131.8	131.2	0.4573
6	4868.3	131.7	131.4	0.2283

The maximum relative error between standard value and the value of Multi-users Multi-function Watt-hour Meter is 0.4573%, it can meet the requirements of metering electric energy at 1 class.

7 Conclusion

The meter that developed in this paper not only has the features of low power consumption, multifunction and high accuracy, but also has the protective functions against over current. RS485 is to implement the communication programming design between PC and the Multi-users Multi-function Watt-hour Meter, and the PC is to control the meter. It has the function of four-quadrant power measurement, can easily expand to the accounting meter in both directions. The meter that developed in this paper has already been applied in the building and apartments, practice proves that it runs stable and has high accuracy.

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