Single Chip Microprocessor Based Electric Power Monitoring and Controlling Meter

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Abstract: **The paper introduces a four-function electric power monitoring and controlling meter, which is composed of an induction watt-hour meter and a single chip microprocessor, and packed in two boxes. The sampling pulses sent by the induction watt-hour meter are fed to the single chip microprocessor, and the microprocessor measures the pulses to complete monitor and control.**

Keywords **– Meter, Microprocessor, Single chip.**

I. INTRODUCTION

The rise in economic importance of electric energy has resulted in the development of more instruments for electric energy monitoring, controlling and measurement. In China, electric energy management instruments have more and more effect on unity of electricity generation, supplying and consuming, and therefore efficiency of electricity production has been distinctly improved. From the late of 1980's microprocessor based electric energy management meters were put into application. This kind of meters has multi-function, small volume and is programmable. The use of them has saved labors and increased the management level, which will make wide application of microprocessor based electric energy management meters in the near future. In the other aspect, the new management meter now has some problems in reliability, which happens in the following situation.

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1) when large inductive load switches on or off in power supply circuit, the microprocessor run"fly "and"lock "(can't work correctly).

2) When electricity in the meters controlled power supply is switched on or off, the data, like maximum demand are lost in the meters.

To overcome the problems, shielding technique and microprocessor system reliability design technique must be adopted and developed.

Because the developed shielding theory now can be used in a design, we focus our attention on reliability design of microprocessor system in this paper.

II. CONSTRUCTION OF THE METER

The meter is mainly composed of an induction watt-hour meter and an 89C51 single chip microprocessor system, as illustrated in Fig.1.

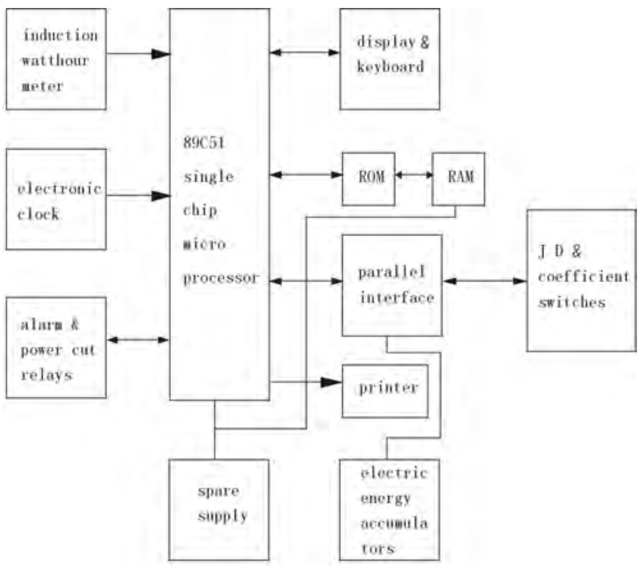

Fig.1 Block diagram of the electric energy monitoring and controlling meter

Other parts of the meter are electronic clock, printer, electric energy accumulators, display and relays. The induction watt-hour meter sends a sampling pulse every turn. The microprocessor receives the pulse, and performs the following function.

1) Display the instant electric power.

2) Display maximum demand, i.e. MD.

3) According to the time periods divided, record KWh separately in peak period, in valley period and in normal period.

4) In peak period, monitor consumer power, when consumer power exceeds stipulated kilowatt, the micro-process gives an alarm. If the consumer power is not decreased in ten minutes, the microprocessor cuts off power supply of the consumer.

5) At the end of every month, reserve the MD, electric energy KWh in peak, valley and normal periods and total energy KWh for printing values of them in the later time.

The turn speed of the induction watt-hour meter is in proportion to the power, so by measuring sampling pulse cycle the instant electric power is obtained. Supposing constant of the induction watt-hour meter is C turn/KWh, the electric power can be expressed as

$$P = \frac{3600 \times f}{C \times n} \qquad (1)$$

Where p instant electric power (KWh),

c constant of a induction watt-hour meter(turn/KWh),

f counting pulse frequency(Hz),

n value in counter between two sampling pulses.

Stipulated kilowatt, i.e. JD, is set in percent rated power of the induction watt-hour meter by two decimal switches. Supposing J is the percentage, the count up to the alarm in power counter can be calculated by the following equation.

$$n_0 = \frac{3600 \times f}{C \times J \times P_0} \qquad (2)$$

Where: n_0 the alarm count value:

J percentage:

P_0 rated power of induction watt-hour meter (KW).

Program design bases on the equation (1) and (2). Fig .2 shows block diagram of the instant power measurement, power exceeding alarm and power exceeding cut program.

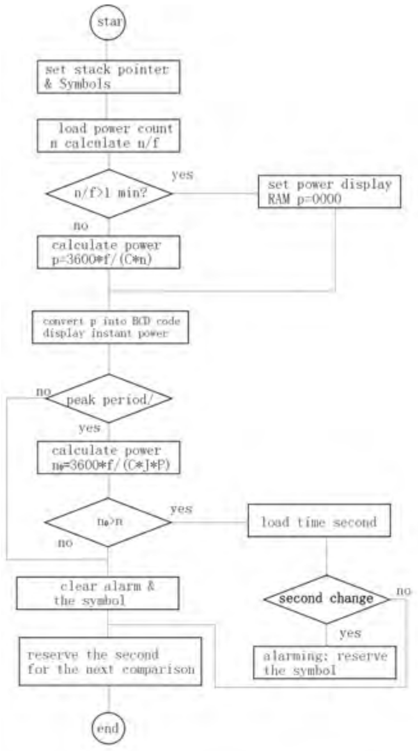

Fig.2 Block diagram of the instant power measurement, power exceeding alarm and cut program

III. Reliability design of the microprocessor system

Single chip microprocessor is the kernel of the meter. In the microprocessor system design, its reliability is put in the most important position and method is using overlap of the program memory address, parted address between data and program memory and self-reset technique [(1)]. The memory of the 89C51 microprocessor has two different configurations, which is shown in Fig.3. This microprocessor memory structure is easy to "run fly and lock " (program is not executed) in the appearance of disturbance. The reasons are described in the following.

1) CPU executes the machine code not in the sequence of program design.

2) CPU executes the random code beyond the memory address of the program and data.

3) CPU executes the code in data memory.

4) The state of symbol data changes, so the CPU can't executes the program correctly.

For the first situation, CPU can enter the designed program flow after it executes 3~5 instructions, i.e. the execution of code program is recoverable. The microprocessor system is working after disturbance. For the second situation, execution of the random code makes CPU run randomly also, as a result that microprocessor system is locked. For the third situation, the result is the same as the second situation. For the fourth situation, if the symbol data is not recoverable, the measurement and control is out of order. In order to overcome the second wrong working state, the program memory address must be overlap, which means that the unused program memory space is merged into memory space occupied by the program. This method makes CPU access the program only from used memory space. In the meter described here the overlapped program address space is only 8K byte. In order to overcome the third wrong working state, the program memory space must be parted from data memory space, which means the CPU can't load program code from date memory. This memory configuration is shown in fig.3. (b).

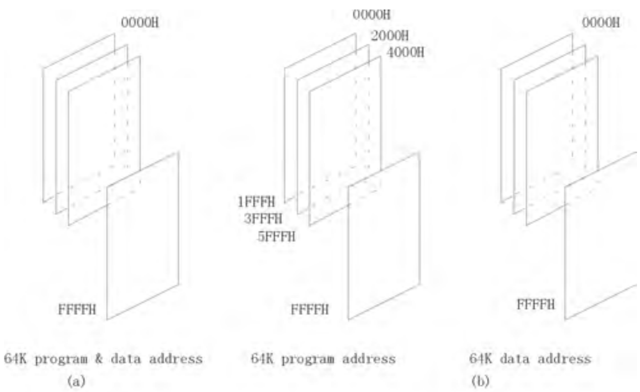

Fig.3 The two configuration of the 89C51 microprocessor memory

In order to overcome the fourth wrong working state, every symbol data is reserved in memory three-ply. When CPU reads the data, it compares the data with other two copies, and if two of the three data are identical, the data is usable, and if the three copies of the data is different, the data is useless and CPU sends wrong indication (Light a lamp).

For the sake of preventing CPU from going into dead loop, self-reset circuit was designed. Schematic diagram is shown in Fig.4.

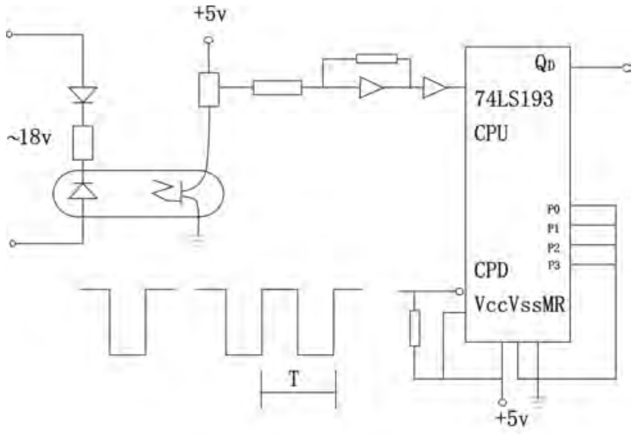

Fig.4 Self-reset circuit diagram

The 18V A.C. voltage passing through the photocopier and buffers is converted into square wave with 20ms cycle. The counter 74ls193 counts the square wave pulses and pin Q_D output pulses with the cycle 320ms. When CPU works, it sends clear pulse every T Millisecond. If the T<320ms, pin Q_D outputs low, no reset Pulse is sent to the CPU. When CPU does not work, no clear pulse is sent to the counter, the pulse on the pin Q_D restart the microprocessor system immediately.

IV. THE ANTI-DISTURBANCE EXPERIMENT

To proof anti-disturbance microprocessor system design theory proposed in the above section, three electric power monitoring and controlling meters were used to try the property of anti-disturbance on condition that disturbance generator and three meters used the same A.C. Supply and distance between them is no more than three meters. The shielding system of the meter is designed carefully. The disturbance generator is the pulse source in laser and the pulse strength is 10KV, 2KA and 50ns, therefore the disturbance is very strong. Ten group experiments were carried out with 20 min interval. Every group experiment was 10 min and pulse source discharged every second. In the disturbance period, the electric power monitoring and controlling meter worked in the normal condition, at the same time, the other electronic apparatus in the same room is out of order, Electric arc interference on the meter is also observed, when the power supply was switched on or off. In the experiments, the maximum demand, watt-hour and power display were right and data reserved were correct in this condition.

V. Conclusion

The electric power monitoring and controlling meter was put into application at the beginning of 1988, and worked more than two years. Practice shows that the microprocessor based electric power monitoring and controlling meter is capable of substituting the old electric energy management meters.

Reference

(1) Wang Xuewei, Sun Yingda and Wang Lin, No. 1 1990 " The Anti-interference System in single Chip Computer ", Journal of Harbin University of Science and Technology, Vol.14, Sum No, 29, pp33 – 37.