New generation single-phase charge-control intelligent electric energy meter based on remote interaction

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Abstract. The single-phase charge-control smart energy meter adopts the most advanced energy meter ASIC, microprocessor materials, non-volatile memory, permanently stored information, wide-screen LCD and other advanced technologies. A set of high-accuracy, wide-load, high-sensitivity, low-power-consumption, which is used for measuring the rated frequency of single-phase power grid 50 / 60Hz, in AC active energy meters. This single-phase electricity meter integrates multiple functions in one to realize active and active measures for energy to achieve remote real-time voltage, current, neutral current, power, power factor, and the use of remote systems to achieve sales of electricity users Pre-emptive prepayment. It can flexibly set various functions: free electricity consumption, fault alarm, automatic power off, record opening, automatic meter reading.

1. Introduction
With the acceleration of the pace of energy development and utilization, the relevant departments of energy management and energy meter performance have put forward higher requirements. In order to find an alternative to the inductive measurement mechanism, research was started in the early 1970s to try to measure AC power using electronic circuits. Because energy is the integral of electrical power over time, the first step in any electronic circuit metering procedure is to determine electrical power. Therefore, one can use the multiplier measures of electricity and energy electrons to achieve it.

2. Working principle
Figure 1 is the module composition of the single-phase charge-control intelligent electric energy meter, and each block represents a functional module. Lines without arrows represent general connection relationships (only transmission functions, not transmitting information), lines with arrows represent connection relationships with signal transmission (such as instructions given by the CPU, data reported by other chips to the CPU), and arrow directions It represents whether the signal flow is bidirectional or unidirectional.
3. Power and metering circuits

The power supply part converts high-voltage (220V) power into (5V) power to power the entire meter. The devices in this part are: a transformer, which is used to convert the 220V AC voltage (voltage value fluctuations) into 12V AC voltage. D3 and D4 are two 78L05 chips, and the final output is 5V. Note that the circuit in front of them (left) is different because D3 only powers the 485 part, and D4 powers all other 5V circuits. Therefore, D4 uses a more efficient rectifier bridge circuit, and D3 uses half-wave rectification. If the power section fails, the entire meter will not work.

RN8209 is a metering chip capable of measuring useful power, useless power, useful work, and unnecessary work. It communicates with the CPU through SPI (CS_N, SCK_N, SDI_N, SDO_N). The calibration information is sent to 485 first, and then sent by the CPU to the metering chip.

The function of the pulse output is to divide the electric energy into small parts, and output a pulse for each part. By comparing this pulse with a standard meter, the error of the meter can be calculated.

4. CPU and trip control and relay

The CPU is the commander of the meter. The peripheral circuit reports data to it, and it issues instructions to the peripheral circuit. The normal operation of the CPU requires power and clocks to function properly. The clock is provided by a crystal oscillator and a nearby capacitor, and a constant time interval voltage fluctuation is formed on the clock pin of the CPU. The CPU uses this constant time interval as a time reference. In addition to power supply and always, the reset pin may also make the CPU work abnormally. Reset is restarting. Many CPUs are reset at low level (0V). If the reset pin is always low, the CPU will keep restarting.

The trip control circuit contains four transistors, which is a bit complicated to analyze. In fact, if this part is regarded as a module, it has only two inputs: JDQON and JDQOFF, which are the opening and closing instructions from the CPU. There are also only two outputs: QA and QB, which are voltages applied across the relay.

The relay is a switch. This switch controls the on and off of the high voltage (220V). However, the signal that controls it is low-voltage (such as 5V). The internal magnetic field of the relay changes with the control signal, and a small piece of metal is drawn in (or released). In the two states of sucking and releasing, the small metal piece contacts different endpoints to form a switch.
5. Storage unit and real-time clock
The function of the storage unit of the meter is similar to that of a computer's hard disk, and it can save data even after power failure. The memory chip D17 communicates with the IIC bus (SCL and SDA). WP is a write protection signal. When this signal is high, the D17 is in a non-writable state. R45, R46, and R47 are pull-up resistors, which play a role in improving the signal quality. If these three resistors are problematic, they may cause different communications.

The real-time clock module is different from the CPU's crystal oscillator. The crystal oscillator provides the CPU's time reference (far less than one second). The real-time clock has a built-in calendar function. If the external power fails, the battery continues to supply power to ensure calendar work.

RS485 is a kind of communication equipment that can connect instruments and equipment into a network. The two differential lines A and B transmit information together. According to regulations, if B—A> 0.2V, it means to send data 1. If B—A < 0.2V, it means to send 0. D15 chip is at ordinary high and low levels and meets the 485 rule. Provides conversion between signals. Whether the 485
interface works normally is related to whether maintenance, meter reading, time calibration, remote pull-off, etc. can be performed smoothly.

![485 circuit](image)

**Figure 4. 485 circuit**

Infrared communication facilitates some operations in use and maintenance, such as modifying rate. The V13 at the transmitting end converts the electrical signal sent by the CPU into an optical signal (infrared light is also a kind of light, but it is not visible to the human eye), and the optical signal wirelessly transmits information within a short distance. When the infrared light reaches the receiving end, D18 restores it to an electrical signal and sends it to the CPU.

### 6. Technical characteristics

| Load current | Power factor | Energy error limit (%) |
|--------------|--------------|------------------------|
|              |              | 1.0 级 | 2.0 level |
| 0.051b≤1<0.1lb | 1            | ±0.6 | ±1.5 |
| 0.1lb≤1<1max  |               | ±0.5 | ±1.0 |
| 0.1lb≤1<0.2lb  | 0.5L         | ±0.6 | ±1.5 |
| 0.2lb≤1<1max  | 0.8C         | ±0.5 | ±1.0 |
Table 2. Product technical indicators

| Project                        | Technical indicators                                                                 |
|--------------------------------|--------------------------------------------------------------------------------------|
| Operating parameters           | Voltage, current, neutral circuit, power, power factor: The error is less than ± 0.6%. |
| Working voltage range          | The normal working range is 0.9Un ~ 1.1Un; the extended working range is 0.8Un ~ 1.15Un. |
| Pulse constant                 | Different specifications of energy meters have different constants.                   |
| Range of working temperature   | Normal working temperature range: -25 °C ~ 60 °C; Extreme working temperature range: -40 °C ~ 70 °C. |
| Power consumption              | ≤1.5W, 5VA in non-communication state; ≤2W, 10VA in communication state.              |
| Clock accuracy                 | Reference temperature (23 °C): ≤ ± 0.5s / d; -25 ~ + 60 °C: ≤ ± 1s / d.              |
| Clock battery                  | 1.2Ah lithium-ion battery, data retention time> 5 years, life> 10 years               |
| Communication rate             | Communication rate: RS485 interface default 2400bps: infrared interface default 1200bps. |
| Communication protocol         | Comply with DL / T 645-2007.                                                          |
| Electromagnetic Compatibility  | Comply with GB / T17215.211-2006.                                                     |

7. Conclusion
The single-phase charge-control smart meter can realize energy measurement and time-storing a large number of meter operation data according to different time settings, and promote the operation process of smart grid analysis. RS485 serial communication is used to realize automatic power-off, real-time correction, and receiving remote control commands. Based on high-performance single-chip microcomputers as the core of smart electronic watt-hour meters, compared with single electronic watt-hour meters, the technology is more advanced, compact, smaller in size, greatly improved in price-performance ratio, and has more comprehensive functions and convenience Electrical automation management is very suitable for China's national conditions and has a broad market prospect.

References
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