

A Single Prepaid Electricity Meter with LoRa Communication Module

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Abstract: In order to achieve the goal of long-distance communication, low power consumption and lowcost of single-phase prepaid energy meter, this paper presents a single-phase prepaid energy meter with LoRa communication module based on the analysis of the existing energy meter communication methods. The LoRa communication module uses the SX1278 chip, which is briefly introduced in this article. The single-phase prepaid energy meter added to the LoRa communication module is powerful and has broad application prospects.

1 INTRODUCTION

With the development of Smart Grid, the Prepaid electric energy meter is promote and popularize widely. At present, the main recording way of wire communication includes power line carrier communication and RS485 communication. The subsistent power grid could utilize Power line carrier communication to finish, which do not need extra investment of layout and in low price. Otherwise, there are several shortcomings about it, such as loud intermittent noise (Starting and stopping or working time of electric appliance), fast signal attenuation, circuit fluctuation and impedance etc. RS485 communication system is easily to operation to ammeter record. However, great workload and high priced maintaining, frequent circuit burn-in and damage are big problems. GPRS and ZigBee is major communication for power information acquisition. GPRS could spread over great distance with super security and stability as wireless constructed through telecom operator. Construction of base station is a precondition of GPRS. Building a base station require a big sum of funds and should pay high maintain cost. So we could know this technology is not adaptive used in remote and rural area because there are not strong signal. Although we could decrease the cost of base station construction depend on ZigBee wireless

communication, short-distance communication limit the function of the technology. It is not suit to spread.

Thus we should find a new way to deal with meter record, it must keep in low cost and energy consumption meantime, can finish long-distance communication. LoRa possess these characters, it is a new wireless communication technology with low energy consumption and cost, moreover has extremely well network Extensibility and communication ability. LoRa be used in free frequency that is non-authorized band, include 433MHz、868MHz、915MHz etc. Because of the minimum receive current about 10mA and sleep current less than 200nA, we could utilize advanced Spread spectrum modulation technology and coding way to enhance Anti-jamming performance and increase link budget. LoRa could enhance the stability of Deep fading and Doppler shift, it can received the communication distance up from 15km. So we could know the LoRa communication technology have so extremely excellent performance that meter could be promote widely.

2 LORA COMMUNICATION ELECTRIC CIRCUIT

LoRa communication chip be product by Semtechcompany in USA. The chip and transceiver

circuit constitute the module of Wireless transceiver. The main disposal system of SX1278 transceiver is LoRa Remote modem, it could be used in long-distance spread spectrum communication with strong anti-interference performance and reduce current consumption. Depend on LoRa technology, SX1278 in the low price crystal and material have more higher sensitivity than 148dBm. It is become the best choice of long distance communication and high-tech applications.

LoRa modem technology have remarkable advantage in diffraction, it tackle the problem of long distance, weak anti-interference ability and large energy consumption. Compared with similar products, SX1278 not only reduce electric current consumption also optimize the function of phase noise、Selectivity, receiver linearity, 3order input interception(IIP3), as fig.1 and fig.2.

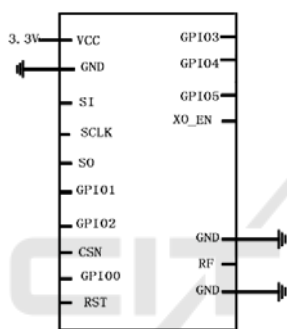


Fig.1 SX1278 pin.

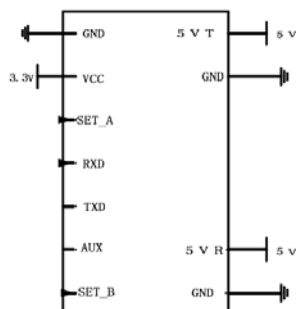


Fig.2 LoRa wireless module.

2.1 SX1278 Receive and Transmission Switch Circuit

The fig.3 show the operating principle of SX1278 reception and transmission switch current. It is half duplex communication chip, so it must work in one alternative pattern of data reception or transmission. The behalf of radio switch, it could work in data

reception or transmission pattern through control the level of CTRL pin and VDD pin.

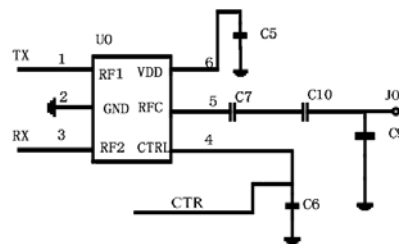


Fig.3 Radio switch circuit.

2.2 SX1278 Receive Circuit

The fig.4 illustrates the construction of SX1278 reception current. L1, L2, C3, C4 are components of filter. Base on the really communicational frequency, these parts could choose suitable parameter. Because different electrical applicants be used in there, the actual wireless communicational environment is complex-the radio signals of various frequencies could be received through antenna. This situation will impact the distance of communication. In this picture, U1 is SAW filter that be used for filter the frequency signal of outside could make Specific frequency signal through. If there are not SAW Filter, external signal can interfere the work of SX1278.

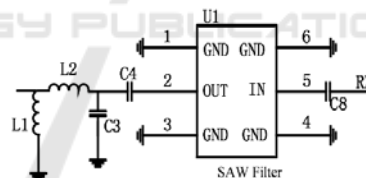


Fig.4 SX1278 receive circuit.

2.3 SX1278 Transmission Circuit

The content of fig.5 about SX1278 transmit circuit, which consist of several filters. L3 and C11 constitute the series resonance current. C16, L5 and C17, L6 construct two group of Parallel resonance current. The equipment could choose suitable device parameter according to different communication frequency.

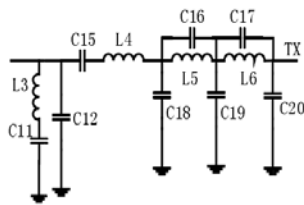


Fig.5 SX1278 transmission circuit.

3 OVERALL DESIGN SCHEME

In this paper, a sort of Monophasic prepaid electric energy meter with LoRa communicational module be accepted, which include micro-processor, basic module, Electric energy metering module, relay controlled module, power module, pay-in advance module, LoRa communicational module. The way of connection showed like fig.6. The function of different modules as follows:

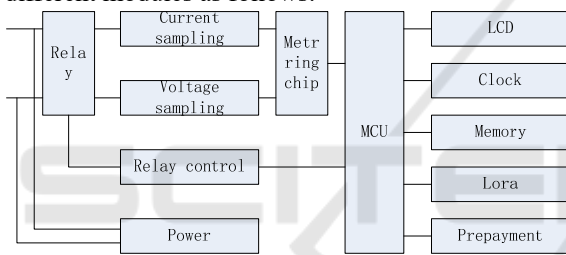


Fig.6 Design scheme.

3.1 MCU Module

Micro-Control Unit is the key device of meter, it could connect other modules as a uniform system through powerful compute ability. In this process, Electric energy meter, data display, relay control and prepayment control of electric energy meter and wireless communication function could be finished.

3.2 Basic Module

The basic module include LCD unit, clock unit, memory unit, direction unit, pulse output unit. The LCD unit used for display the data of different fee ratio in Accumulative energy and total data of Accumulative energy, moreover, including The maximum demand. The direction, date, term, Accumulative energy, the information of relay communication signal, pay-in advanced information, address etc.

Clock unit consist of Built-in hardware clock circuit with temperature compensation function that can transfer the date and time automatically. The outputting frequency of inner clock port is 1Hz (among the temperature range about $-25^{\circ}\text{C} \sim +60^{\circ}\text{C}$), and the accuracy rating of clock $\leq \pm 3\text{s/d}$ (under the 23°C , the accuracy rating of clock $\leq \pm 1\text{s/d}$).

Store unit used EEPROM that can erasure 1million again. It can Save power, area code, numbering, and other data and states so that these data cannot lose after power cut.

Direction unit used LED as instructional light, in there, the pulse direction light is red, it does not blink in normal time, but blinking on the time of measurement of active power. Alarming light also is red, it will blinking only in alarming time. Trip instruction light is yellow, it blinking in the time of Load switch.

3.3 Electric Energy Module

The electric energy metering module includes Current sampling, voltage sampling and energy metering chip. The main duty of current sampling is sampling of neutral wire and live wire. Voltage sampling gathers the sample of voltage between neutral wire and live wire. Electric energy metering chip could collect voltage and current signal through the process of enlargement of gain amplifier. And then it will transfer analogue signal into digital signal through AD converter. After filter the result of active power could be get through the way of current statistics multiply by voltage statistics. This information will be submitted to micro-processor in the form of high pulse.

3.4 Relay Control Module

Relay control module include relay and control which main function about control the circulation turn on or off. The microprocessor will give disconnect command, when it receive the signal submitted by upper computer about delinquent fee. After MCU sent disconnect signal, relay control reception instruction and then it execute the order to interrupt the supply of power.

3.5 Power Module

Power module could be support by power line supply and Li batter supply, in general condition, power module supply electricity to meter through power line. When power cut due to line fault, the Li

batter could support current to meter for keep work of meter.

3.6 Prepayment Module

This part could fulfill prepayment function through insert IC card. The main functions include:

Intelligent control: IC meter calculate energy used of customer through pulse counter automatically.

Pre-alarm function: If remaining power in the record of IC card less than alarming quality, warning signal will be sent. The user could purchase power as soon as possible.

Load control function: when load continually exceed the setting value of meter, the load switch will disconnect automatically, which could protect the circuit and facilities against destroy. When load be limited in controlling range, meter switches off automatically. It is convenient to customer.

Energy call-backs function: IC card will record the data of remaining amount again for supporting inquiry of manage system, when user insert IC card in machine every time. Please remember that all the papers must be in English and without orthographic errors.

Security protection function: it use memory cards, encryption cards, CPU cards as a power purchase card, key security authentication in the IC card and meter, which has a high degree of security. In this way, a household only has one card and each purchase card only valid once.

Replacement card function: When the electric card lost, the clerk can replenish the electricity generation card for the user through the electricity sales network.

Inspection function: The electricity sales network can issue inspection cards and regularly check the operation of the user's IC card and meter.

Electricity-freezing function: The power sales department have right to freeze the amount of electricity generated through the order of IC card, then the frozen electricity data will write back to the line loss statistics, meantime, electricity billing will be computed.

Load statistics function: The power sales department can issue a conduction of load freezing to the IC card power meter through the data communication channel. The IC card power meter can calculate the user's power at a certain moment according to the instruction, and then it can freeze the information that transmit it to the power sales department for resident power load analysis.

3.7 Lora Module

According to the analysis above, Lora module adopt SX1278 chip product by Semtech Company in USA. This chip and external transceiver circuit compose LoRa wireless transceiver module. It could use in data transmission meter send upper computer in electric sale. Meantime, it could receive the data coming from the power sales department. In this process, the remote control of meter could be finished.

4 CONCLUSIONS

In this paper, we analysed the advantage and disadvantage of limited communication and wireless communication, we could know that the most of meter communication ways are not meet the requirement of remote communication that must have low power consumption, low-cost, long-distance. So a sort of Single-phase prepayment meter with LoRa communication module is inferred. After brief introduction of a signal prepayment meter with LoRa wireless communication module (SPM-LWM), we generate a design schedule of SPM-LWM, and introduce the function in different module briefly. With the development of smart power grid, this power meter has great applicability in future.

REFERENCES

1. YuTian.Design of PLC Centralized Meter Reading System[A].*InformationEngineeringResearch Institute,USA.Proceedings of 2013rdInternational Conference on EducationandEducation Management(EEM2013)Volume25[C]*2013:6
2. Ti S.,Kaiqi S.,Jianhua L.*New Technology and Application of Electric Energy metering*.China Electric Power Press,2010.
3. Yiyan Y., Yongchang Z.A Brief Analysis of the Development of Remote Meter Reading Technology.*Electronic production*,2014,09:119+114.
4. Kuiying W., Zhanping L., Yanwei Y.HFC-based Remote Automatic Meter Reading System Architecture. *Electronic Test*,2013,18:59-61
5. Lewark U. J.,Antes J.,WalheimJ.,et al.Link Budget Analysis ForfutureE-band Gigabit Satellite Communicate Kinks. *CEAS Space Journal*,2013,4(1) : 41-46.
6. Mohamed A.,Axwl S. Free Range Measurements with SemtechLoRa Technology.*2014 2nd International*

Symposium on Technology and Applications (IDAACS-SWS).Offenburg,2014: 19-23.

7. Tianping G. Long Distance and Low Power Wireless Communication Base on Lora Technology. *Electronics World,2016,82(10): 115-117.*

