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# Implementation and Calculation of General Electricity Prices on Industry with Fee Charging Terminal

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***Abstract***

*The calculation of general electricity prices on industry has great significance in cost control, energy conservation and emission reduction, as well as high efficiency management of electricity for the key electric power customers. Traditional solution has specific defections in time-consuming, convenience, and readout, however, the fee charging terminal has provided a more reasonable solution in interaction interface and abundant parameters settings with high efficiency.*

***Keywords****: cost control; general electricity prices on industry; fee charging terminal*

## 1. Introduction

The commonly recognized application scope for general electricity prices on industry is restricted within industrial customers based on electricity as motivation and Smelting, baking, welding, electro-chemical and electrolysis. As well as those customers with total capacity of transformer is 315 kV or above[1].

Due to the complex calculation of general electricity prices on industry and where a look-up table is required in power factor regulation tariff, also customers may doubt about the accurate and specific cost on electricity per month. It is also a time-consuming event on checking, calculation and explanation about charge between customers and related electricity department, and in addition, this case would be more serious with increment of customers in great need of electricity. Accurate and efficient calculation for general electricity prices on industry has significance in both actual meaning and promotion value.

## 2. Brief Introduction of Fee Charging Terminal

Fee charge terminal for customers in great need of electricity, short for fee charge terminal, is functioned with actual electricity application of customers and high speed embedded micro controller and advanced digital process technology in dealing with acquired data. The terminal can conduct accurate analysis on application data of electricity and corresponding fee charge of customers last month, which is well prepared for customers in great need of electricity in terms of time and energy consuming [13].

The basic construction of fee charge of electricity on industry is composed with two-part tariff, including basic charge, fee charge per degree and power factor regulating tariff measures shown in figure 1.

The basic charge is defined following basic charge with the max demand of customers and corresponding capacity of facilities. Fee charge per degree is defined following the actual electricity consumption with electricity prices per degree. And power factor regulating tariff measures is defined following the actual power factor of customers with Suggestions about power factor regulating tariff measures with specific fee charge[2].

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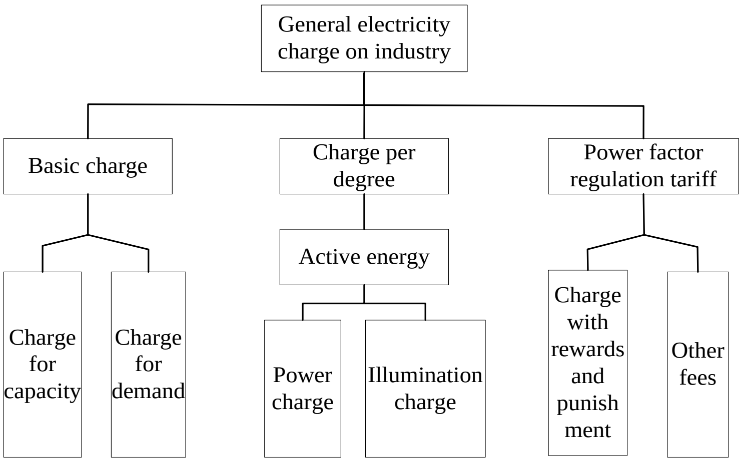


**Figure 1. The Compose of Fee Charge of Customers**

## 3. Function Instruction of Fee Charge Terminal

The fee charge terminal has adopted standard charging system embraced with electricity meter file management, fee charge rate management, data acquisition and storage and fee charging calculation. The terminal can conduct data acquisition and analysis with periodic check for regular electricity consumption real-timely, which enables customers with surveillance of charge overdue and electricity quality.

### 3.1. Electricity Meter File Management

In common cases, customers may possess multi-meter and involve quantitative measurement independence among different meters. The terminal may treat power consumption on electricity and illumination charge differently that each meter would possess sole file in the system, ensuring assurance in fee charging measurement.

File management of electricity meter has involved serial number of electricity devices, information of the measurement location, communication rate and corresponding port number, the related communication protocol, the communication address, and communication password, as well as the concrete number of charge fee rate and charge rate on electricity[3-5].

### 3.2. Display of Data Real-timely

Total information of charge for electricity, basic charge, charge per degree, power consumption and power factor regulation tariff last month in details, as well as the information of total power consumption, real-time data from electricity meter of specific location of measurement, and freezing data per day and month in current month, including basic information of active and reactive energy of positive and negative, positive and negative active demand, monthly freezing active and reactive energy of positive and negative and corresponding indicating value, voltage and current power[6].

### 3.3. Parameters Setting

Some basic information should be specific on initial installation due to the complexity of calculation of fee charge on general electricity on industry, including the charge standard over facility capacity and max demand of customers, and the rate standard over power factor regulation tariff.

The pre-set parameters are defined as follows:

(1)Account date of meter reading

 

(2)Period of meter reading
(3)Cycle of meter reading
(4)Rate of CT/PT of measurement terminal
(5)Parameters of basic charge
(6)Parameters of charge per degree
(7)Parameters of power factor regulation tariff
(8)Other fee charge

### 3.4. Calculation of Fee Charge

Standard fee charge system is applied as the core function of fee charge terminal, which can conduct data acquisition and analysis periodically on the basis of parameters set by customers. The acquired data can be checked on the interface and upstream channel (optional selection).

The construction of general fee charge of electricity on industry is composed by basic charge, charge per degree and power factor regulation tariff (with reward and punishment).

(1) Calculation of basic charge

Basic charge is conducted from either capacity or demand of customers, where the default approach can be set in the initial setting for subsequent calculation and for storage[7].

Charge with capacity: the capacity of transformer (kVA)*basic fee per unit capacity (Yuan per kVA).

Charge with demand: specific charge demand (kVA)*rate*basic fee per unit demand (Yuan per kVA). Please note that the fee charge would be doubled when the actual consumption exceeds the request value.

(2) Calculation of charge per degree

The terminal would conduct periodic meter reading operation as settings for active energy, reactive energy and illumination energy on account day, where the charge for illumination is conducted with power factor without power factor regulation tariff. The detailed calculation is defined as: Charge per degree=consumption energy*unit electricity price[8-9].

For special conditions that the customers carried out peak-valley price should conduct extra calculation in the unit electricity price.

(3) Calculation of power factor regulation tariff

The key factor is obtained from active energy and reactive energy, where reactive energy should be calculated without compensation module, in addition, transformer loss should be taken into consideration with massive quantity power supply customers.

Electricity fee charge of reward and punishment can be obtained by querying Suggestions about changes of power factor regulation tariff. Detailed calculation is shown below:

Electricity fee charge with rewards and punishment=(basic charge+ charge per degree) * (±)power factor regulation tariff variation rate per month.

Where, amount of charge is defined by the comparison result between power factor and standard that if actual power factor is bigger than the standard value, extra fee charge is required.

(4) Calculation of total charge

Total charge is the sum of three fees described above with extra fee, where the extra fee stands for Three Gorges construction funds, rural power grid transformation charge and hydraulic engineering construction charge. The concrete charge type mentioned above is defined by local policy, which can be conduct in the interface settings in the terminal, and the default value is 0.

The general working principle of meter reading of the terminal is shown in figure 2 below.

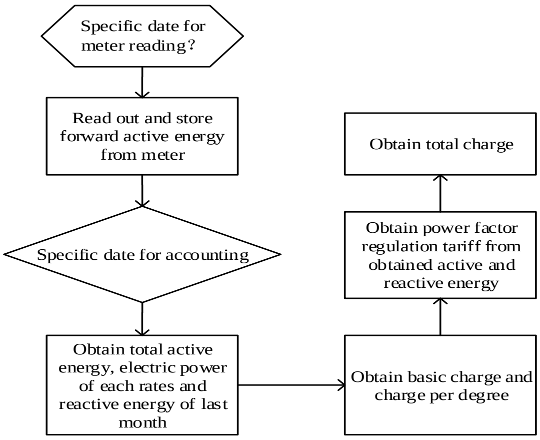


**Figure 2. Flow Chart of Meter Reading Terminal**

### 3.5. Management and Maintenance

Concrete management and maintenance service includes version query, information of meter reading terminal, settings review, reset and initialization operation, which enables field debugging and utilizing. In addition, remote and local software update is supported with specific request.

Concrete calculation method is set with specific property, capacity and measurement of electricity consumption of customers, in which those with great need are the most complex in the calculation. Accurate calculation of fee charge is essential for reduction of electricity cost, as well as to help in formulation of cost control strategy.

## 4. Hardware Design and Implementation of the Terminal

The designed terminal is composed with central controller and peripheral circuits, where the peripheral circuits include power supply, communication ports and Flash storage and display unit. The basic principle is shown below in figure 3.

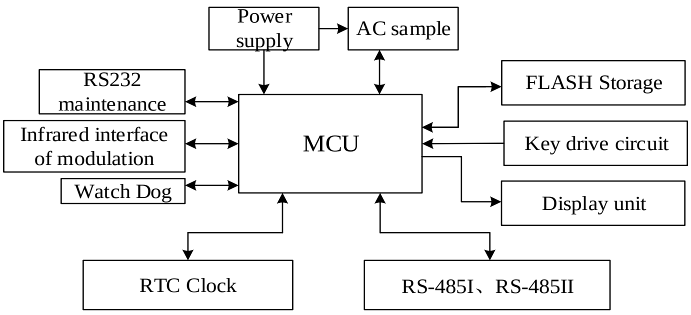


**Figure 3. Flow Chart of basic Principle of Terminal**

### 4.1. Main Controller

The designed terminal has adopted the high-performance 32-bit PIC32MX695F512L as core MCU, applying independent development embedded system TC-EOS with digital communication for data acquisition and analysis, focus on rapid operation, high reliance and interference rejection, which can meet the development request of customers.

### 4.2. Power Supply

The designed system has adopted linear transformer and constant voltage chip for reliable power supply for the terminal. The design circuits are shown in figure 4 and 5.

 

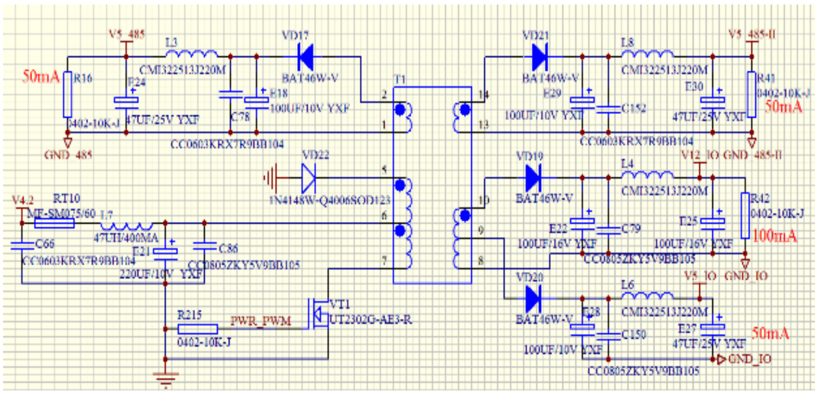

**Figure 4. Power Supply Part 1**

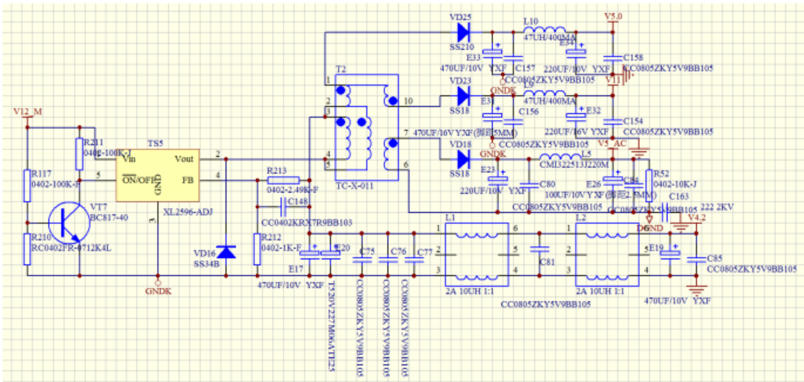

**Figure 5. Power Supply Part 2**

### 4.3. Maintenance Circuit and Interface

Maintenance interface is defined as local and remote ones, including RS232, infrared, USB and remote GPRS circuits shown in below. The maintenance interface is applied for parameters setting, data enquiry and software update.

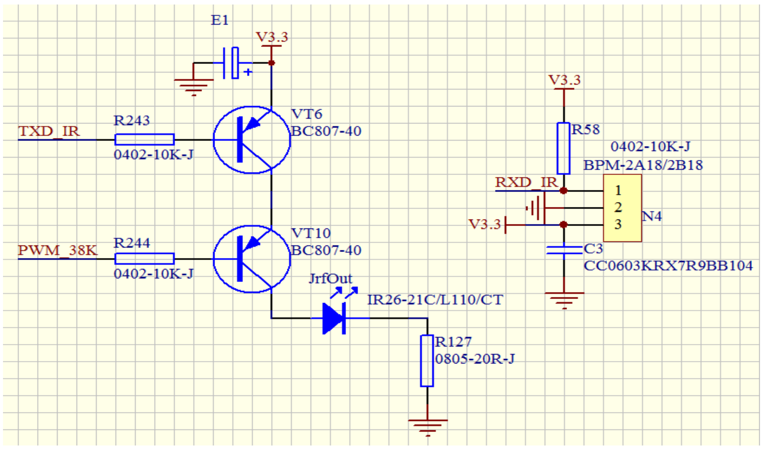


**Figure 6. Infrared Interface of Modulation**

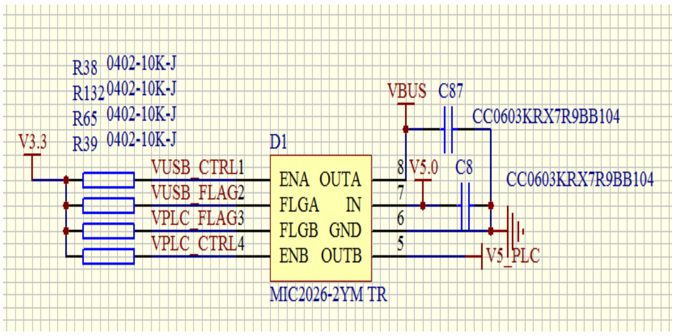


**Figure 7. USB Power Supply Management**

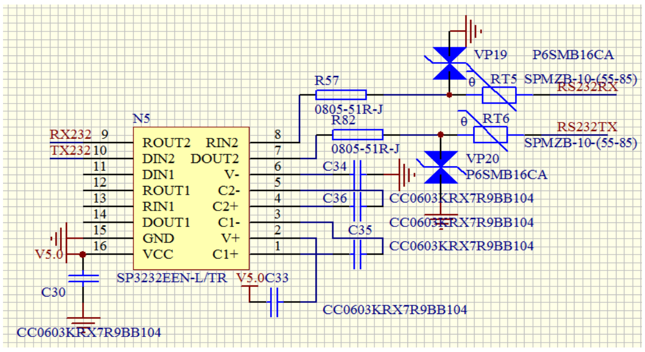


**Figure 8. Maintenance Interface of RS232**

## 4.4. 485 circuit for Readout and Flash Storage Design

The readout of electricity consumption and related calculation and storage is important part of terminal, for which 64 MB Flash is adopted with 485-BUS with photoelectric isolation. The chip can acquire all the data within 62 days daily data and 12 months fee charge data from controlled electricity meter for customers to check, which helps solve the potential doubt on the fee charge of customers.

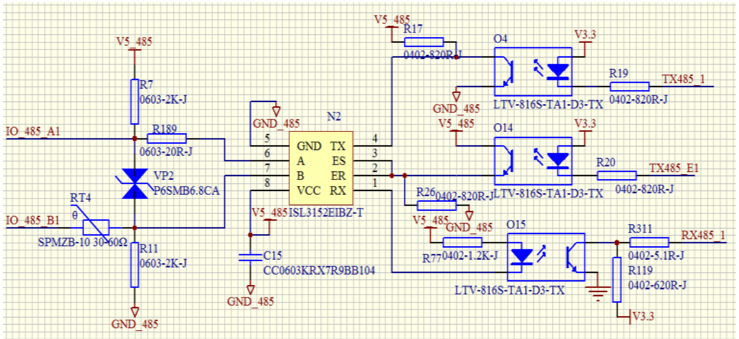


**Figure 9. 485 Circuit for Readout**

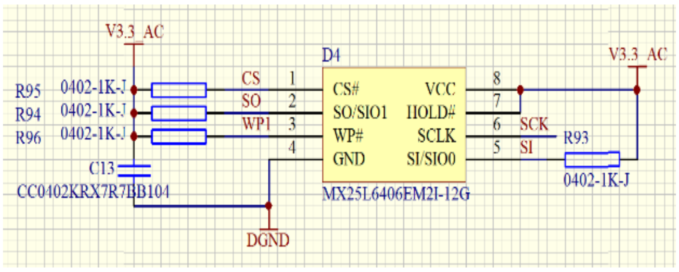


**Figure 10. Flash Storage Circuit**

### 4.5. Key and Display Unit Circuit

160*160 monochrome LCD screen with dot matrix is adopted in the terminal with LED backlight, where recent electricity consumption and fee charge details can be checked by customers. Main interface is shown in figure 11.

Data cable, along with signal wire is being secured in the consideration of PCB design for system stability and in case crash and white screen problem with interference and jittering.

Key drive circuit is controlled by MCU directly with de-twitter programs for high stability. Six buttons are embraced in the terminal system, including navigation keys, confirm and cancel key, shown in figure 13.

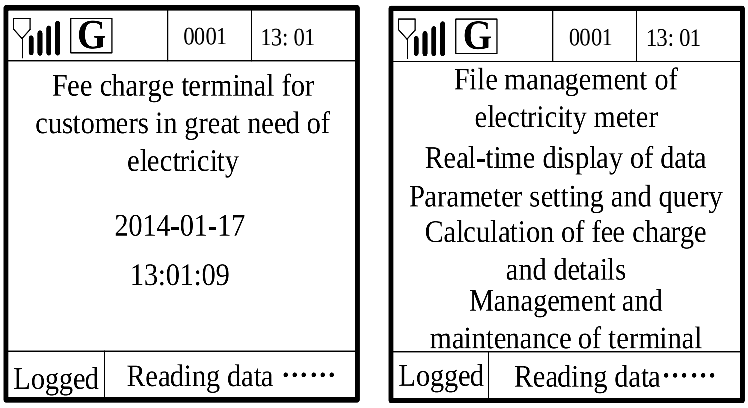


**Figure 11. Main Interface and Parameters Setting**

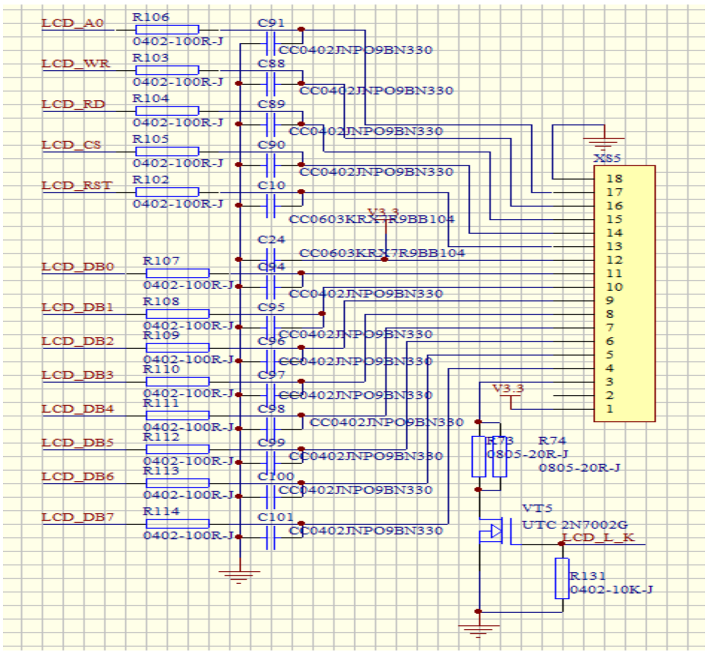


**Figure 12. Display Circuit**

 

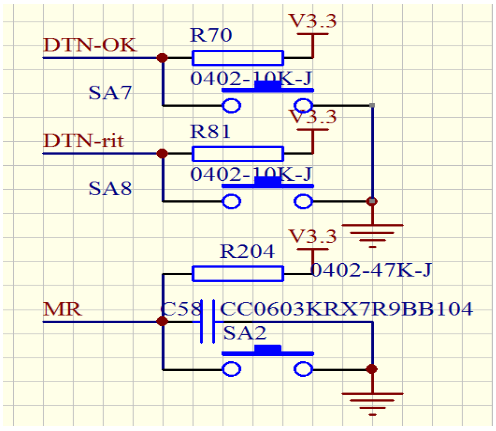


**Figure 13. Key Drive Circuit**

### 4.6. DS3231RTC Circuit

The RTC circuit is applied to provide real-time clock for system and external, and indication of real temperature inside the terminal in case key chip, such as MCU and Flash storage overheats. Then Flash is forced to sleep mode when the case occurs, and it may reset to normal when temperature returns to specific value.

DS3231 chip is applied to establish a highly accurate digital temperature sensor within the hardware, owing to its especial accurate clock system and temperature compensation module, the chip of which can be accessed with I2C bus. The external circuit design is shown in figure 14.

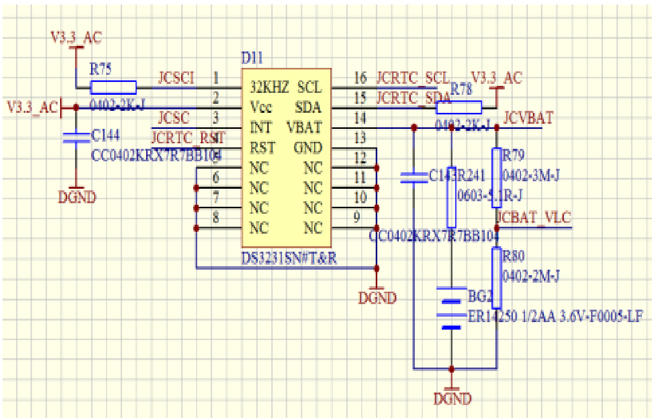


**Figure 14. RTC Clock Circuit**

### 4.7. External Watch Dog Circuit

The terminal has applied state protection and task care method in designing the programs for general stability, and MAX706SESA is adopted as hardware protection. When power supply decreases from +12V to +7.5V, data protection operation may conduct with under-voltage notification of voltage change in the pin, and chip reset signal would also take effects when regular resets signal fails to access Watch Dog in 1.6s[14].

MAX706SESA chip is designed for voltage monitoring and integrated with Watch Dog by MAXIM Company, where WDI pin is the input of Watch Dog. Reset signal may output from WDO pin when WDI pin fails to get a regular signal in 1.6s. PFI pin is the power supply comparison pin, from which a low voltage signal may output when the source voltage from resistance divider is lower than 1.25V. Circuit design is shown in figure 15.

 

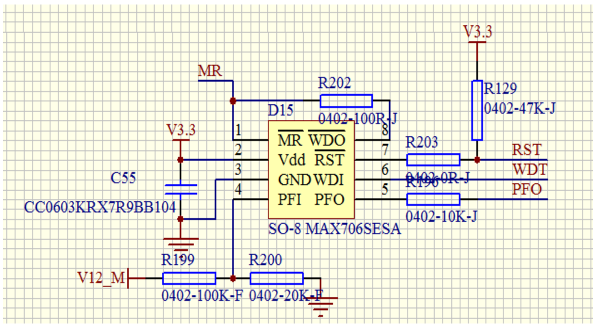


**Figure 15. External Watch Dog Circuit and LV Circuit**

## 5. Conclusion

The paper has done detailed research in the composition and calculation of general fee charge of electricity on industry, aiming to clear the concern of customers to obtain a transparent deal with customers [10-12]. The terminal is designed based on the concept above, which integrates the whole calculation process into a complete system with automatic management, human interface, extendable circuit and optional module[15]. The comprehensive function has enables the terminal with rapid and convenient characters, which has instructive meaning for effective electricity management and cost control for customers.

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