HAC-ML Wireless Remote Meter Reading System

V1.0

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Content

1.System Overview

The HAC-ML (LoRa) wireless remote meter reading system (hereinafter referred to as HAC-ML system) integrates acquisition,measurement,two-way communication,meter reading and valve control. The system includes: wireless meter reading module HAC-ML, concentrator HAC-GW-L, handheld unit (handheld unit meter reading terminal) HAC-RHU, iHAC-ML meter reading charging system (WEB server).

Main features of HAC-ML system:

1) Ultra long-distance communication

- LoRa modulation mode,long communication range.
- Concentrator and meter communication distance: 3-5km in urban environment; 10-15km in rural environment.
- Handheld unit and meter communication distance: 3km.

2) Ultra low power consumption and long service life

- The average power consumption of meter module is ≤20uA.
- Three working modes of system: LOP1, LOP2, LOP3, response time: 12s, 24h-12s, 24h; according to ER18505 battery only use 50% capacity, the lifespan of meter module is 8 years, 10 years, 12 years. In actual use, user can switch any working mode by the concentrator.

3) Anti-interference, high reliability

- Frequency hopping technology avoids co-channel interference and improves transmission reliability.
- Utilizing the patented technology of TDMA time division multiple access communication, the communication time unit is automatically synchronized to avoid data collision.
- Adopt the transmission rate and transmission distance adaptive algorithm to prevent

interference and increase system capacity.

4) Large management capacity

- The concentrator can support up to 5,000 meters. The concentrator stores 5000 pieces of data; stores each meter with a 10-year annual freeze and a monthly freeze data for the last 12 months.
- The transmission rate and transmission distance adaptive algorithm are adopted to effectively increase the system capacity.
- The system is easy to expand: it is compatible with water, gas and heat meters, and it is convenient to increase or decrease; neighboring cells can share concentrators.

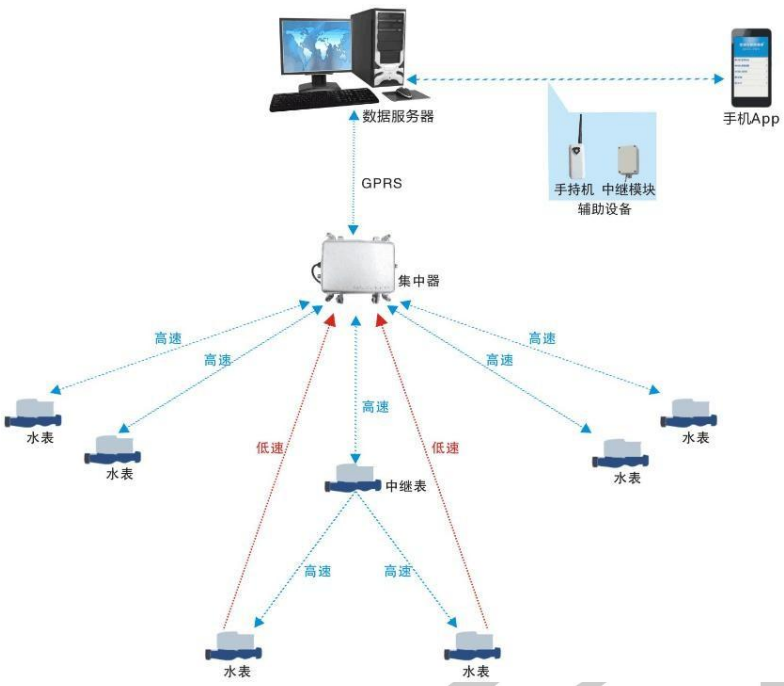
5) Easy installation and high success rate of meter reading

- Dual meter reading mode: 24h active reporting of metering data; real-time meter reading control valve (switching valve).
- Concentrator multi-core RF design, receiving multi-frequency, multi-rate data at the same time.
- Meter reading by handheld unit and meter reading by single point

2.System Topology

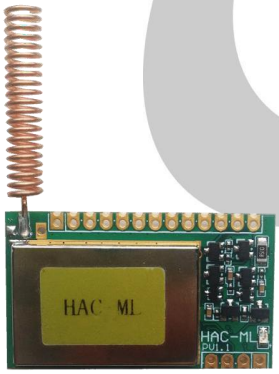
The HAC-ML module and the HAC-GW concentrator adopt the networking mode of uplink star network and downlink simple mesh network,simplify the uplink data transmission channel,improve the system channel utilization rate, optimize the downlink communication network, and reduce system data transmission delay, improve network reliability. At the same time, the synchronous network is adopted to avoid collision probability during data transmission, improve transmission efficiency, realize precise downlink control, and further reduce system power consumption.

The HAC-ML networking system is convenient, concise, and flexible. The network has no boundaries and is convenient for maintenance, adjustment and expansion.



3. HAC-ML Module

The HAC-ML module is a new generation wireless communication product based on LoRa communication technology and combined with practical application requirements, including data acquisition and wireless transmission functions, with long transmission distance, ultra low power consumption, anti-interference, reliable performance ,easy to install, small size and so on.



3.1. HAC-ML Module Feature

1) Active bubbling transmit data every 24 hours.

2) Provide multi-channel, multi-rate automatic switching, effectively improve system capacity.

3) TDMA time division multiple access communication mode, automatic synchronization communication time unit, can completely avoid data collision.

4) Adopt frequency hopping technology to avoid co-channel interference.

5) Three working modes:

LOP1 (remote wake-up in real-time , 12 seconds copy control, battery life is more than 8 years)

LOP2 (the response time of valve-off is up to 24h, the response time of valve-on is 12s, and the battery life is more than 10 years)

LOP3 (the response time of valve on/off is up to 24h, the battery life is greater than 12 years)

1)It has functions such as acquisition, measurement, valve control , wireless communication, soft clock, ultra-low power consumption, power management, and anti-magnetic attack.

- Support single and dual dry pulse metering, or user can purchase direct-reading metering method, fixed metering method before leaving the factory.
- Power management function, detect the transmit status or control valve voltage and report.
- The magnetic attack detection function generates an alarm flag when detecting a malicious magnetic attack.
- Supports power-off storage function. After the module is powered off, it is not necessary to re-initialize the measurement value.
- Support frozen data reading, the monthly and annual forzen data can be read via concentrator.
- With valve dredging function, which is configured by the supported software.
- Support wireless near or remote parameter settings.

2)Utilizing the magnetic trigger meter data reporting or meter automatically bubble data.

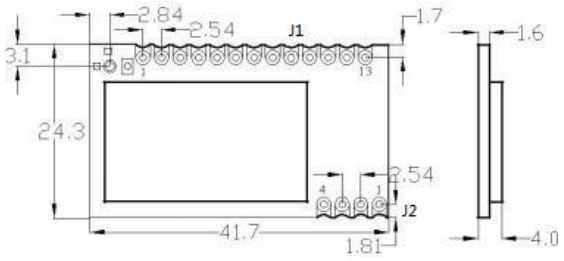
3)With standard spring antenna, flexible circuit board antenna or other metal antenna can also be customized according to user products.

4)Optional welding farad capacitor (or user own can solder it).

5)Optional 3.6Ah capacity lithium ER18505 battery, the waterproof connector can be customized.

6)If the user adopts 4 dry batteries, 6V power supply is required, and the corresponding power management circuit can be customized.

3.2. HAC-ML Module Structure and Interface Definition



The two directions of antenna can be selected (the unit of dimension:mm).

Interface definition and description J1 (J2 is reserved)

Pin No.	Name	Pin description
1	EPW	External power supply output
2	GND	Ground
3	MR1	S1 access terminal of reed switch
4	MR2	S2 access terminal of reed switch
5	GND	Ground
6	OPEN	Valve open position detection
7	CLOSE	Valve close position detection
8	C-	Farad capacitor is negative
9	GND	Ground
10	VCC	+2.8~6.0VDC
11	V-	Valve control is negative
12	V+	Valve control is positive
13	C+	Farad capacitor is positive

Note: The farad capacitor withstand voltage must be greater than the supply voltage.

- VCC: Standard 3.6V ER18505 battery positive or 4.5V dry battery, 6V power supply needs to be customized.
- EPW: The standard is to provide a 3.0V regulated power supply to the outside, the maximum current is 100mA, this function needs to be customized and opened.
- S1 and S2 access terminals of reed switch: When the dual reed switch is metering, only one metering pulse is generated after the interleaved low pulse respectively. If it is low for more

than 2 seconds at the same time, it will not be metering and suggests a magnetic attack alarm state. For a single reed switch, S1 is pulse metering and S2 can be used as a magnetic attack detection input terminal.

- The detection end of valve control. V+/V- is used to control the valve switch, and OPEN/CLOSE detects if the valve is in place. For gauges that are not connected to position detection, the valve control controls the valve in a controlled timeout (water valve is 20 seconds, gas valve is 3 seconds). The valve controls the limited flow function and limits the valve drive current to no more than 160mA.
- HAC-ML module can be widely applied to wireless remote meter reading system, the module can be integrated into the meter, or it can be installed in the appropriate position.

3.3. HAC-ML Module Technical Parameters

Working frequency	865-867Mhz
Effective transmit power	17dBm
Frequency stability	±5PPM
Sensitivity	<-136dBm
Operating temperature	-20～70℃
Working banwidth	125kHz/250kHz
Working voltage	+2.8～6V
Receive current	≤20mA
Transmit current	≤130mA
Transmit time	The maximum transmit time is ≤1.5s
Transmit distance	3-5km in urban area；10-15km in rural area.
Valve electrical parameters	Voltage is 2.8～6V，current is≤160mA
Sleep current	≤8uA
Average working current	≤20uA
Dimension	42.1mm*24.8mm*3.2mm

3.4. HAC-ML Module Instructions

1) Initialization setting

- When the module is used for the first time, the data is randomly reported once a day, waiting for the concentrator to allocate time slices, and after doing this, the data is reported every day according to the allocated time.
- The HAC-ML module provides multiple channels and rates, and the module autonomously switches the working channel and rate by analyzing the current communication quality and signal strength.
- After changing the battery, there is no need to reset the metering value. The module supports the function of saving data when power is off.

2) Workflow

- When the module is powered on, the LED flashes once every 60 milliseconds, and it enters the normal working mode after detecting the normal voltage or up to 30 seconds.
- The HAC-ML periodically transmits once every 24 hours, waiting to receive feedback from the concentrator to determine whether there is a control command.
- After the HAC-ML is installed in the field, user can use the button or magnetic switch trigger mode to transmit data once, which can be used as an installation test.

4. HAC-GW-L Concentrator

Based on LoRa wireless communication technology,HAC-GW-L (concentrator) adopts multi-core RF simultaneous operation design to realize long-distance, high efficient and reliable data transmission. The HAC-ML system adopts a star network structure and node management is very simple. Networking communication uses node time slice design to avoid data collision probability and improve the overall stability of the system.

4.1. HAC-GW-L Main Features

1) With multi-core RF design, it can receive multiple frequency points and multiple rates of data at the same time.
2) Effective communication distance with the acquisition module: 3-5km in urban environment; 10-15km in rural environment
3) The uplink planetary network structure, the downlink one level meter routing, the data communication path is simple, and the network operation is convenient.
4) The meter module ID registration management automatically filters the meter data.
5) The HAC-GW-L concentrator can support up to 5,000 meters and store 5000 uplink data. It can query the storage data of a specific time period through the server. At the same time, it can save the annual freeze data of each meter for nearly 10 years and the monthly freeze data of nearly 12 months.
6) Save the data that needs to be downlinked, and save 1000 data at the same time. The server can query, delete, and increase the downlink data of the specified node or all nodes at any time.
7) It is possible to broadcast all the meters, or select some parts for broadcasting.
8) GPRS or LTE communication functions, it can be operated remotely: broadcast information management, uplink and downlink data management, system remote upgrade and other functions.
9) The customer can set the network connection parameters (IP, domain name, port) through the serial port.
10) We HAC provides a corresponding dynamic data link library to support server development.
11) Support upgraded remotely. After the gateway connects to the server, the server can remotely upgrade the gateway program.
12) IP67 waterproof metal case for outdoor use.
13) Power indicator, wireless communication indicator, GSM/LTE online indicator.
14) Industrial power supply with 110V-220V AC/DC, dimension: 160mm × 110mm × 60mm.

4.2. HAC-GW-L Basic Function

The concentrator mainly includes three functions: meter ID management, meter uplink data management, and server downlink command management.
1) Meter ID management: download, delete, add and read. The management of meter ID stores parameters such as the ID value of management node and the corresponding time slice interval of the current concentrator. The time slice parameter is sent to meter each time the data is reported to the ACK returned by the concentrator.
2) Meter uplink data management: storage and read. Each time the matched bubble data is

automatically backed up to FRAM (Ferroelectric Memory), all data within a certain period of time can be read remotely by the server.

3) Broadcast information management: download of broadcast content, download, delete, and read of broadcast ID. The broadcast information includes the broadcast data content part and the broadcast meter ID part. The two parts of the content need to be sent to the concentrator separately. Only the nodes that are within the broadcast ID will be broadcasted. After a successful broadcast, the node will automatically expire and will not be repeated. Broadcast data is not been sent repeatably.

4) Server downlink data management: read, delete, and increase the downlink data of specified or all meter IDs. The concentrator can store up to 1000 downlink data, and can read, add, delete, etc. the data stored by the specified or all nodes.

4.3. HAC-GW-L Connection Port Definition

4.4. HAC-GW-L LoRa Module Technical Parameters

Working voltage	+4.75～5.25V
Working frequency	865-867Mhz
Frequency stability	±2.5PPM
Working bandwidth	125KHz
Transmit power	17dBm/27dBm
Transmit current	<350mA
Receive sensitivity	-136dBm
Receive current	<60mA
Working temperature	-40℃～80℃

4.5. HAC-GW-L GPRS Module Technical Parameters

Working frequency	EGSM900/DCS1800MHz
Maximum transmit power	EGSM900 Class 4 (2 W)

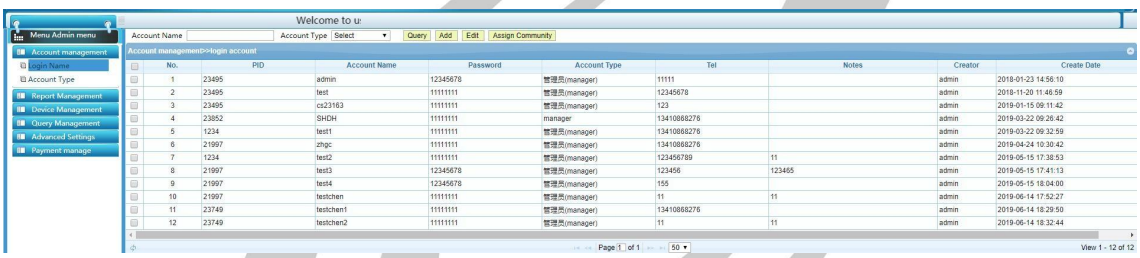
	GSM1800 Class 1 (1 W)
Receive sensitivity	<-106dBm
Voltage	4.0V
Working temperature	-40°C ～80°C

5. iHAC-ML Meter Reading Charging System(WEB server)

5.1. iHAC-ML Account Management

5.1.1. Login Account

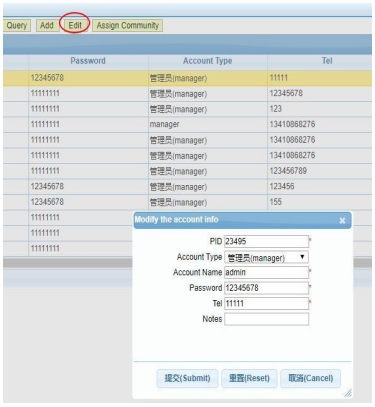
Account and password maintenance, create a new account, user can assign cells to existing or new accounts. Accounts established by different administrators are independent of each other.

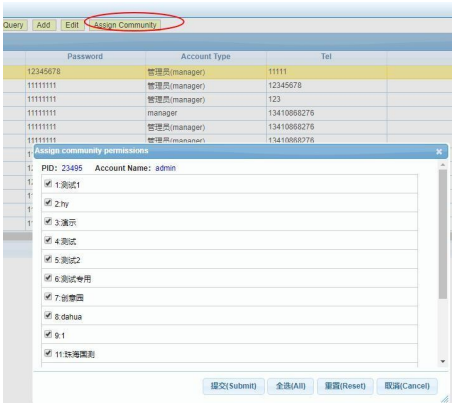


1) User can directly enter the number of pages and jump. In this column, the display is the total number of lists.

2) The account number is unique and cannot be repeated.

3) When creating a new account, be sure to determine the user type of the account so that it can use the supported software as expected. The account and password cannot have Chinese.

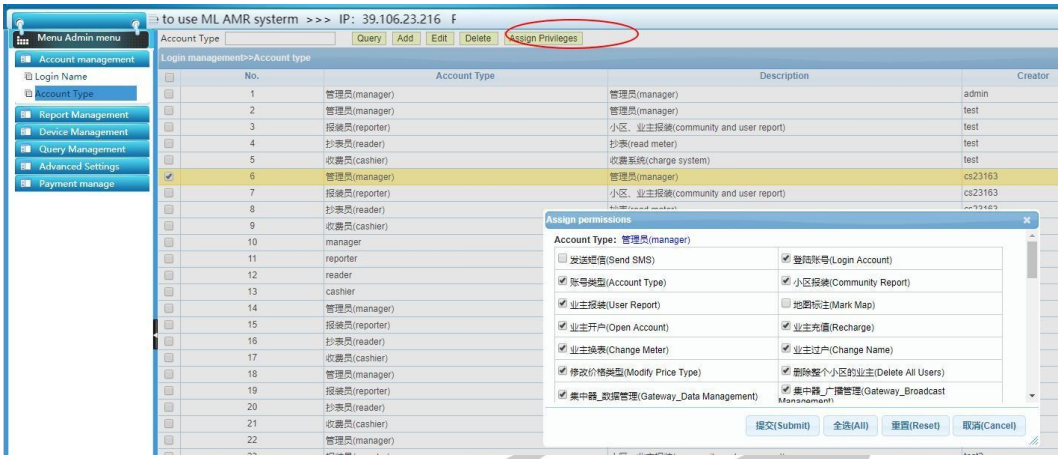




5.1.2 Account Type

The account type is divided into four basic types: administrator, reporter, meter reading staff,

and charger. User can also customize other account types and assign permissions to their types. Only when permissions are assigned, user can see the related menu on the left. And including the button function of some pages, the administrator can assign permissions to his subordinate account types.



5.2. iHAC-ML Registration and Installation Management

5.2.1 Community registration and installation management

In the list of community registration and installation management, user can see the number of meters, which is calculated by the supported software combined owner's register and install. (In the add operation, one concentrator can manage multiple communities, but the concentrator number between different administrators cannot be the same, otherwise the concentrator number already exists. The super administrator belongs to the global and cannot add communities.)

5.2.2 Proprietor’s registration and installation management

1) Add: add proprietor’s information individually

2) Modification: modify the proprietor’s information. For the proprietor who has opened the account, only the address, phone number and remarks can be modified.

3) Open an account: for the proprietor has been registered and installed to choose the price type to open an account, before opening the account,the price type must be set in the current payment

management, and the account can be opened in batches.

4) Delete an account : users who have not owed money can cancel their accounts.

5) Delete: a single unopened owner can be deleted.

6) Change the meter: after adding the complete frozen data, the meter can be changed.

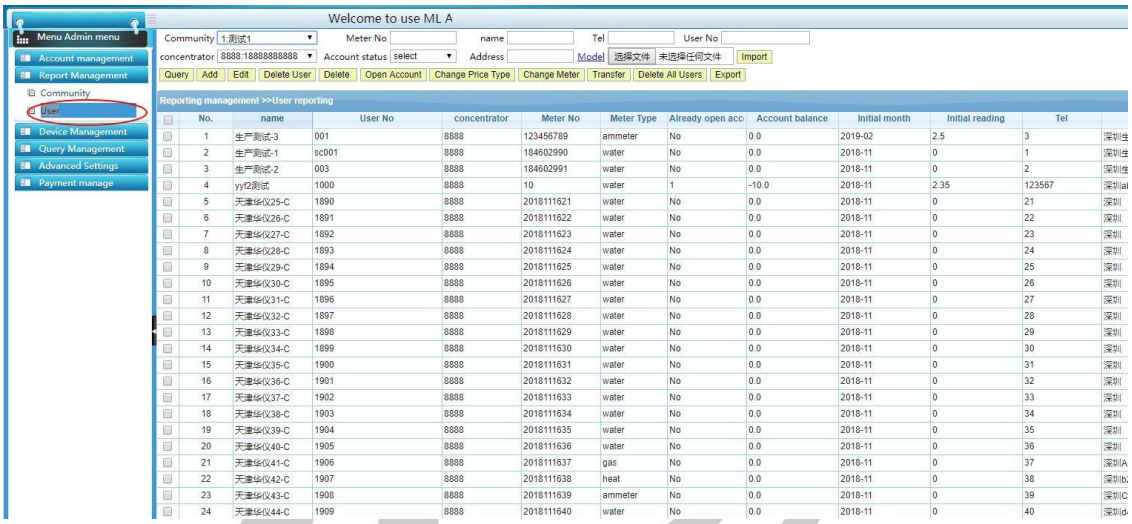
7) Transfer an account : An account can be transferred after settling the cost.

8) Modify the price type: modify the price type of the user after opening the account.

9) Delete the entire community proprietor: If there is a proprietor who owes money, it will not be able to delete it.

10) Import: add proprietor information in batches, support registration and installation in batches, format can refer to the downloaded template.

11) Export: export all proprietor information of the current community.



No.	name	User No	concentrator	Meter No	Meter Type	Already open acc	Account balance	Initial month	Initial reading	Tel
1	生产测试-3	001	8888	123456789	ammeter	No	0.0	2019-02	2.5	3
2	生产测试-1	sc001	8888	184602990	water	No	0.0	2018-11	0	1
3	生产测试-2	003	8888	184602991	water	No	0.0	2018-11	0	2
4	yyf2测试	1000	8888	10	water	1	-10.0	2018-11	2.35	123567
5	天津华仪25-C	1890	8888	2018111621	water	No	0.0	2018-11	0	21
6	天津华仪26-C	1891	8888	2018111622	water	No	0.0	2018-11	0	22
7	天津华仪27-C	1892	8888	2018111623	water	No	0.0	2018-11	0	23
8	天津华仪28-C	1893	8888	2018111624	water	No	0.0	2018-11	0	24
9	天津华仪29-C	1894	8888	2018111625	water	No	0.0	2018-11	0	25
10	天津华仪30-C	1895	8888	2018111626	water	No	0.0	2018-11	0	26
11	天津华仪31-C	1896	8888	2018111627	water	No	0.0	2018-11	0	27
12	天津华仪32-C	1897	8888	2018111628	water	No	0.0	2018-11	0	28
13	天津华仪33-C	1898	8888	2018111629	water	No	0.0	2018-11	0	29
14	天津华仪34-C	1899	8888	2018111630	water	No	0.0	2018-11	0	30
15	天津华仪35-C	1900	8888	2018111631	water	No	0.0	2018-11	0	31
16	天津华仪36-C	1901	8888	2018111632	water	No	0.0	2018-11	0	32
17	天津华仪37-C	1902	8888	2018111633	water	No	0.0	2018-11	0	33
18	天津华仪38-C	1903	8888	2018111634	water	No	0.0	2018-11	0	34
19	天津华仪39-C	1904	8888	2018111635	water	No	0.0	2018-11	0	35
20	天津华仪40-C	1905	8888	2018111636	water	No	0.0	2018-11	0	36
21	天津华仪41-C	1906	8888	2018111637	gas	No	0.0	2018-11	0	37
22	天津华仪42-C	1907	8888	2018111638	heat	No	0.0	2018-11	0	38
23	天津华仪43-C	1908	8888	2018111639	ammeter	No	0.0	2018-11	0	39
24	天津华仪44-C	1909	8888	2018111640	water	No	0.0	2018-11	0	40

5.3. iHAC-ML Device Management

5.3.1 Concentrator management

5.3.1.1 Information Management

Register, delete, bulk register and read of meter ID.

1) Export the proprietor meter ID, and export the meter ID registered and installed by the proprietor for batch registration to the concentrator.

2) Download the meter ID, user can first save the template file to the local by clicking the template, fill in the meter ID that needs to be downloaded in batches (up to 5000), click to select the file, select according to the storage location, click the download meter ID button after the selection is completed. The download meter ID is a batch add. Note that the new download meter ID will overwrite all meter IDs that existed before in the concentrator.

3) Register \ delete the meter ID, the meter ID set can fill in one or more meter IDs, when multiple meter IDs, separated by English commas.

4) Read all the meter IDs, read all registered meter numbers from the concentrator, and export, view, update, etc.

5.3.1.2 Data Management

1) **The command to be sent**: there is no need to enter the meter number, click to read, all the

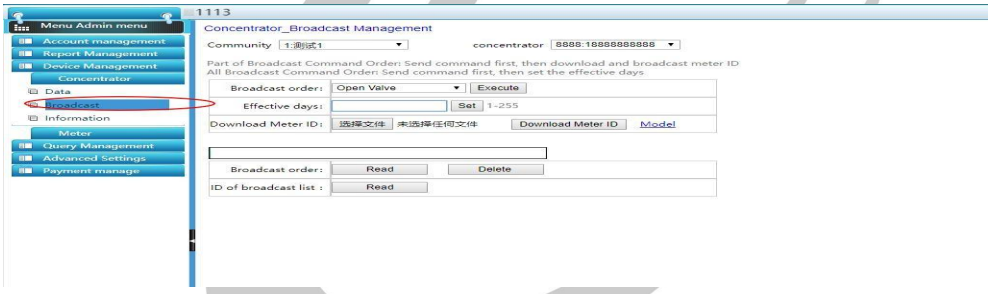
pending instructions can be read in the concentrator (here is the delay control valve command issued to the concentrator).

2) **Frozen data:** user can read the data of a single meter when meter number is input,if not input, the frozen data of all the meters will be read in the concentrator (the frozen data will be automatically classified, it's divided into monthly and annual freeze, when all frozen data is read, it will take a long time).

3) **Flow data:** read the uplink data for a certain period of time, starting from the selected time and ending at the current time of the system.

5.3.1.3 Broadcast Management

The page download meter ID operation are somewhat similar with the information management page batch registered ID function operation. The meter ID of broadcast operation will be required to be registered to the concentrator first, and the specific broadcast operation can be performed according to the gray text reminder.



5.3.2 Meter management

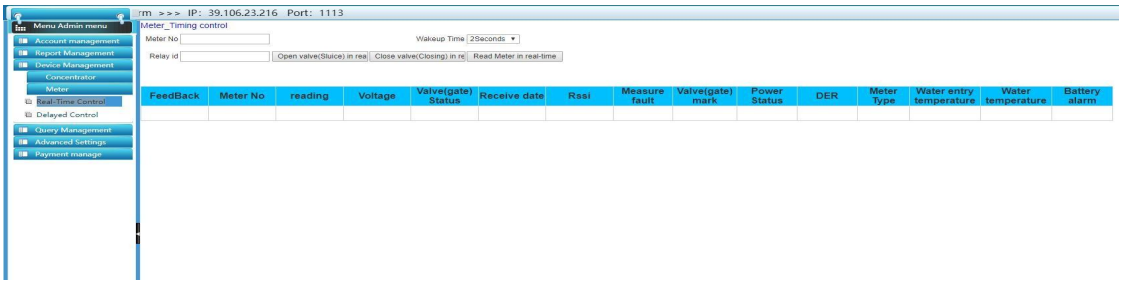
5.3.2.1 Real-time control valve

1) Real-time control valve, the relay number is queried by the routing table information. If the control valve meter has relay routing information, the relay information is obtained by database analysis, without knowing the relay or without the relay meter,there is no need to input any information, the system automatically fills 0.

2) If the meter and concentrator time are not synchronized, select the preamble to 12s before sending the real-time command.

3) Real-time control valve, after receiving the real-time command, the concentrator will send the command to the meter.

4) Real-time meter reading, which can read the meter information in real time.



5.3.2.2 Delay Control Valve

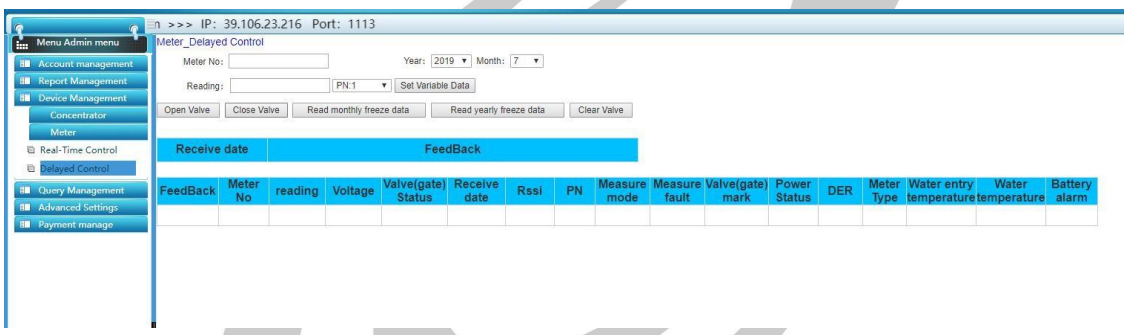
Main functions: open valve, close valve, read monthly/annual frozen data, read firmware version information, dredge valve, etc.

The operation process is as follows:

1) After filling in the meter information to be controlled, click the corresponding action button.

2) When the "concentrator storage data operation succeeds", it indicates that the control meter instruction has been sent to the concentrator.

3) After receiving the delay control valve command, the concentrator saves the instruction to the concentrator, and waits for the concentrator to receive the data reported by the corresponding meter before delivering the instruction to the meter.

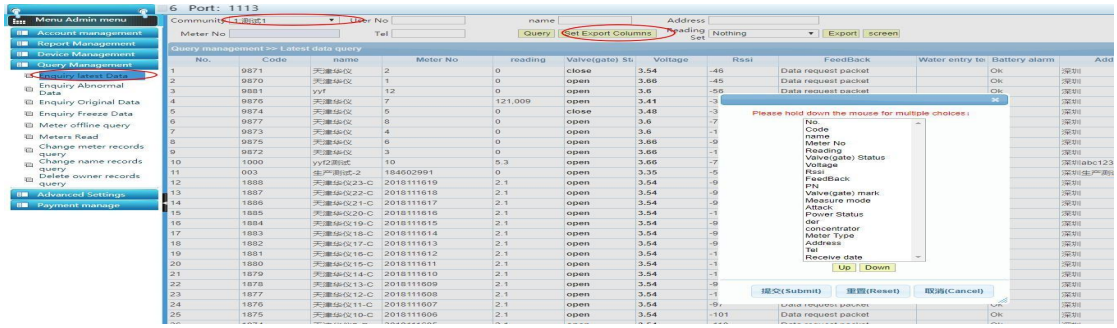


5.4. iHAC-ML Query Management

5.4.1 Latest data query

1) Querying the information reported in the meter and finally reporting the information, so that user can know the report information in a timely manner.

2) Support excel export function (click the export column information setting, user can export the column with personalized settings)



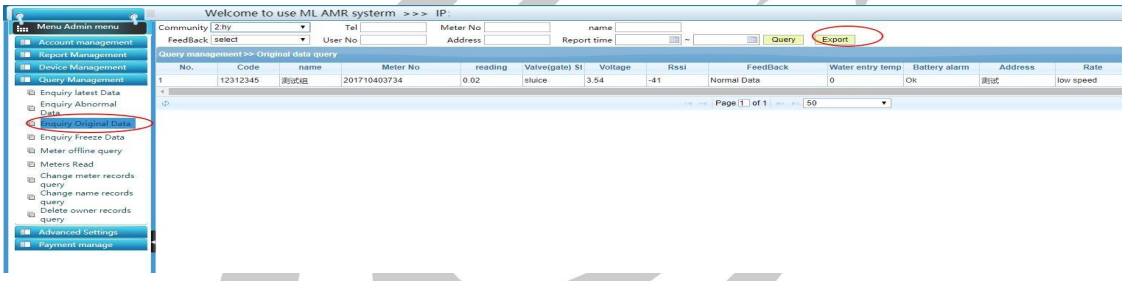
5.4.2 Abnormal Data Query

The query information is abnormal situation when meter information is reported.

Abnormal situation: the voltage is lower than 3.1 safety voltage, the valve mark is faulty, the metering mark is faulty, there is magnetic attack, power off, metering open circuit fault, current measurement data error, etc.

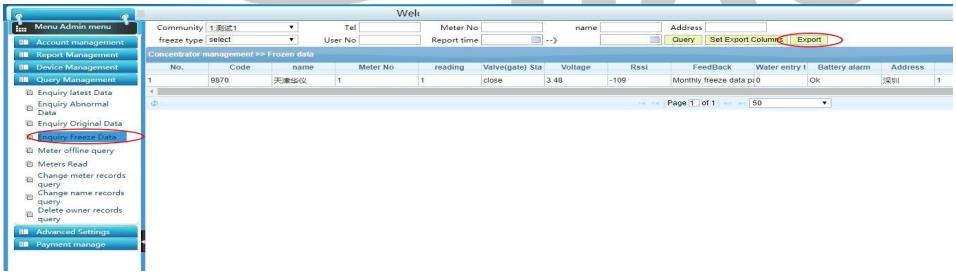
5.4.3 Raw data query

The query is the report information of all meters.



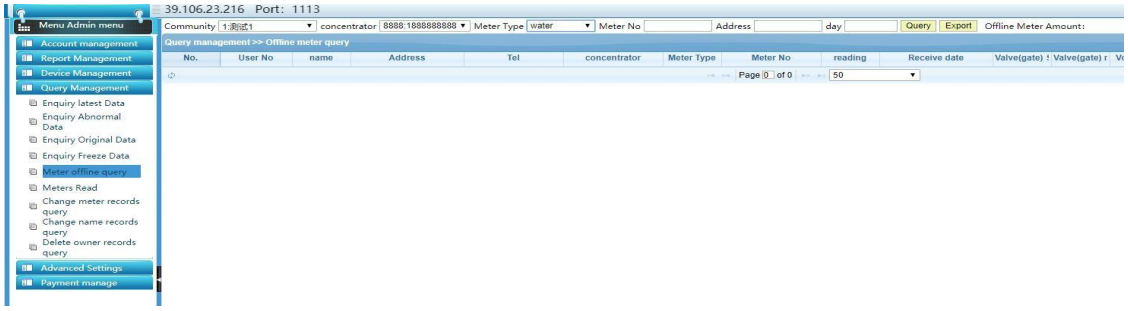
5.4.4 Frozen data

The monthly/annual freeze data is queried which is reported by meters.



5.4.5 Query the meter that is offline

Query the meter that is not online for a certain period of time.

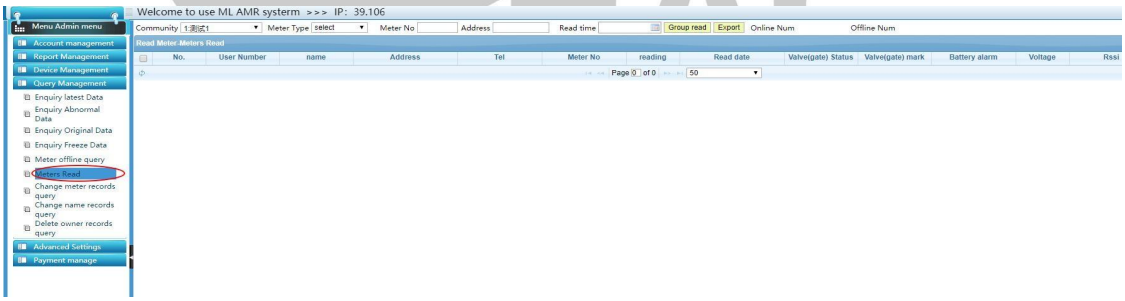


5.4.6 No registration meter data query

There are two kinds of data saved in the no registration. One is that the concentrator is in the normal working mode, the meter ID has been registered in the concentrator, but the meter information reported by the owner is not used, and the other is that all meters' information are received when the concentrator is in the debugging mode. (the meter is not been registered and installed).

5.4.7 Daily Data Query

Count online and offline meter numbers and display data of online meters.

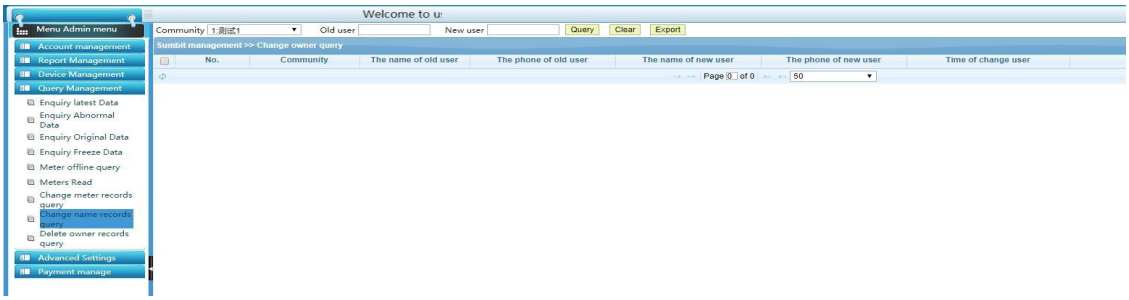


5.4.8 Meter Change Record Query

Query historical meter change records, which can be exported.

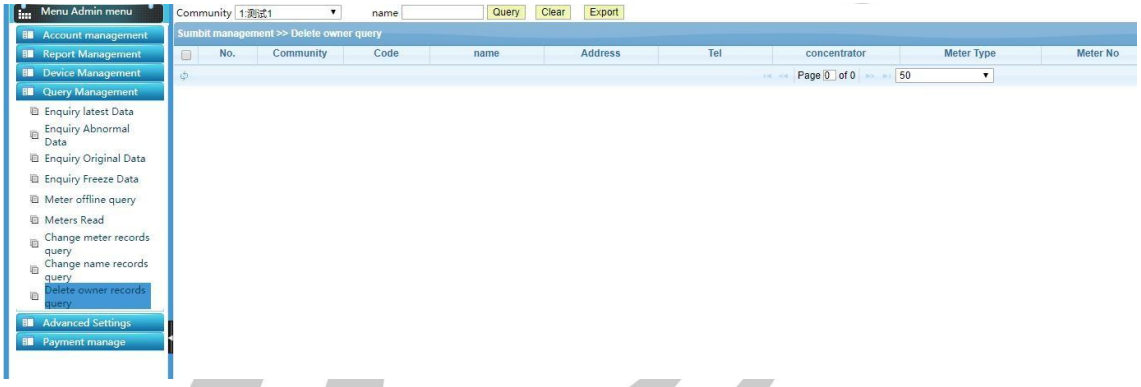
5.4.9 Transfer Record Query

Query historical transfer records.



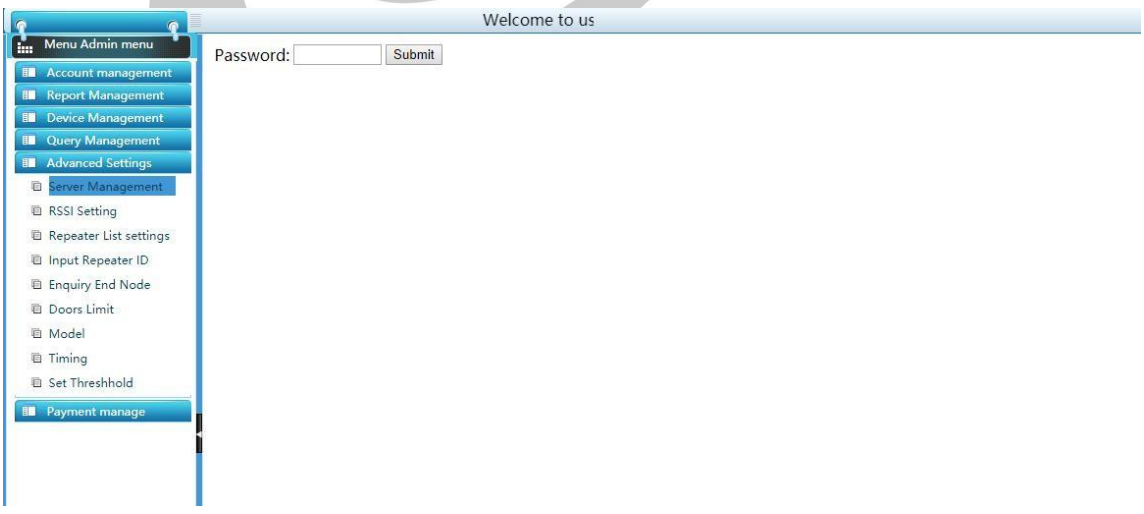
5.4.10 Account record deletion query

Query historical account deletion record



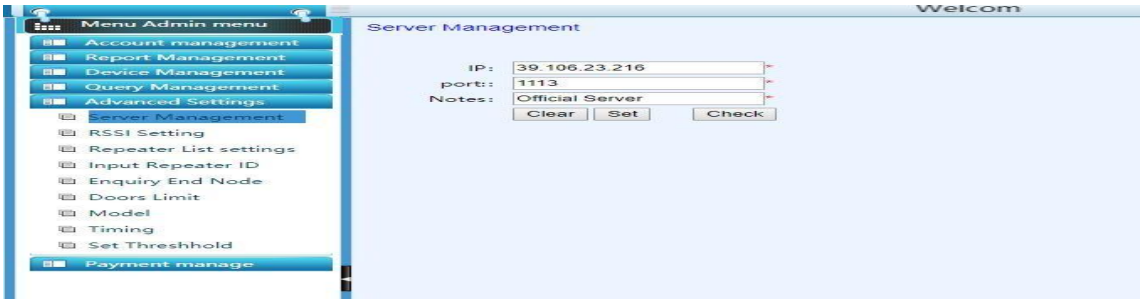
5.5. iHAC-ML Advanced Settings

Advanced setting module, where user need to enter a password, the default is "456789"

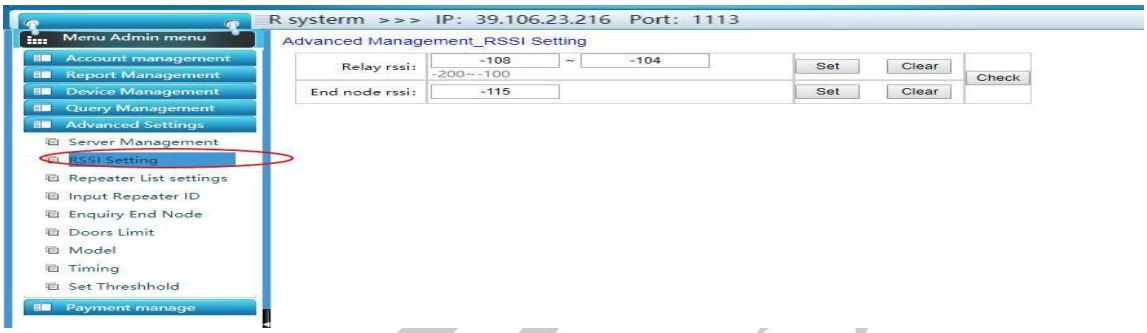


5.5.1 Server Background Management

The page shows the server address which is currently in use and the server background address can be set.



5.5.2 Relay Field Strength Setting

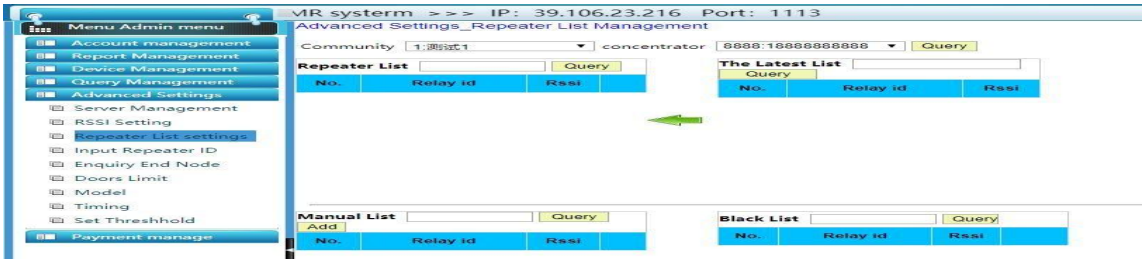


Relay field strength: The field strength value is a meter in this range and can be used as a repeater. The default range is -108 ~ -104

End node field strength: When the field strength is less than or equal to -115, this meter will be set as the end node.

5.3 Relay List Management

The relay list includes:
A it has a relay list suitable for screening the field strength range;
B it has a meter suitable for the latest data, which is manually transferred to the relay list;
C it can also be manually added to the relay list;
At the same time, there is also a relay blacklist. If it is in the relay blacklist, it indicates that this meter is not used as a relay, although its conditions are met.

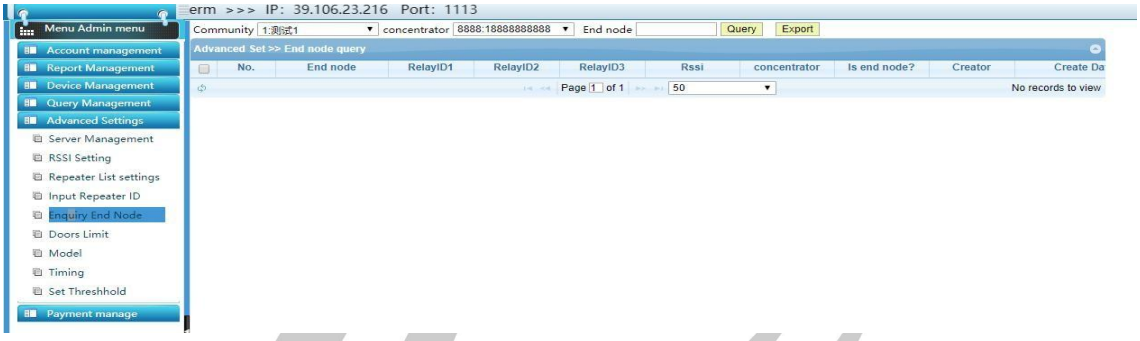


5.5.3 Importing Relay ID

First, user can register to the concentrator with single or multiple relay IDs, and can also download them to the concentrator in batches.

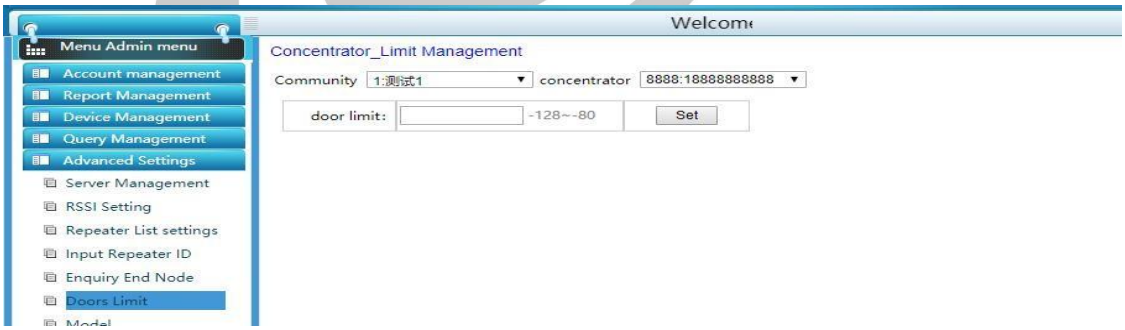
5.5.4 End Node Query

By comparing the field strength of end node, the data from each bubble is compared to determine whether it is an end node, and if so, it is saved in the end node table.



5.5.5 Threshold management

Set the concentrator threshold.



5.5.6 Debugging mode: Debugging mode and working mode.

Energy consumption settings, energy consumption levels are LOP I, LOP II, LOP III;

Mode setting, debugging mode and working mode; when the concentrator is in debugging mode, the data of all received meters will be reported to the server. When the concentrator is in working mode, only the data of meter whose report ID has been registered to the concentrator is registered.

The current working state of the concentrator can be read.

5.5.7 School time management

Calibrate the time of the concentrator and server

5.6. iHAC-ML Payment Management

5.6.1 Payment

Regular payment

User can inquire about the proprietor's arrears and the remaining amount, click the regular payment to recharge, click the regular reduction to deduct, both operations have the function of printing the detailed payment of amount, the arrears reminder setting function can be set after the current arrears amount exceeds a certain value, the amount of the arrears is displayed in red; there is an export report function.

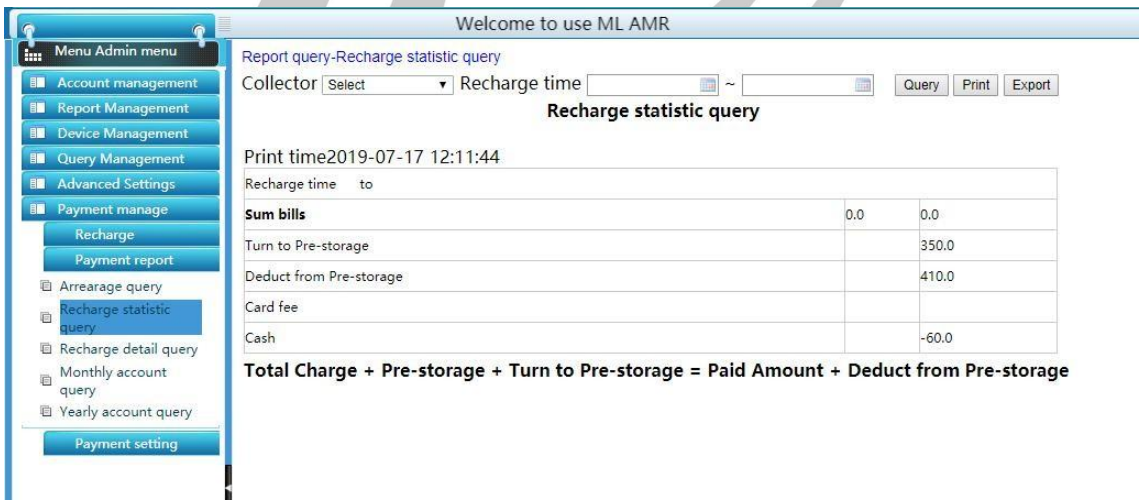
5.6.2 Payment Report

5.6.2.1 Proprietor's arrears inquiry

Inquire about the information of proprietor who owns money.

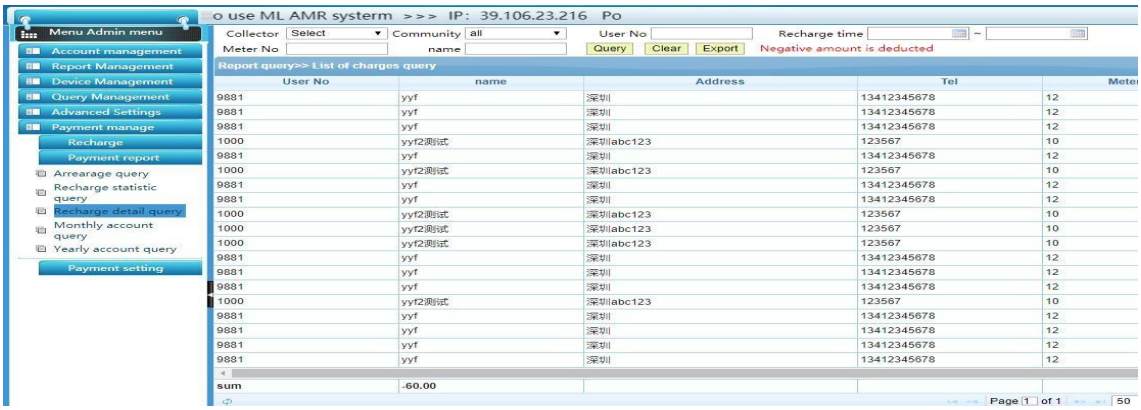
5.6.2.2 Charge Statistics Query

According to the selected toll collectors and charging time period, the charging statistics can be queried, and the statistical results can be printed and exported.



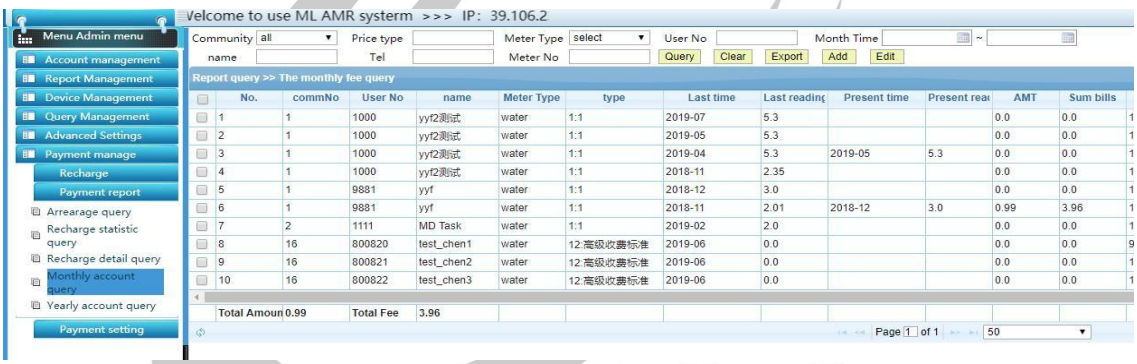
5.6.2.3 Charge Details Query

Query the payment details of each proprietor

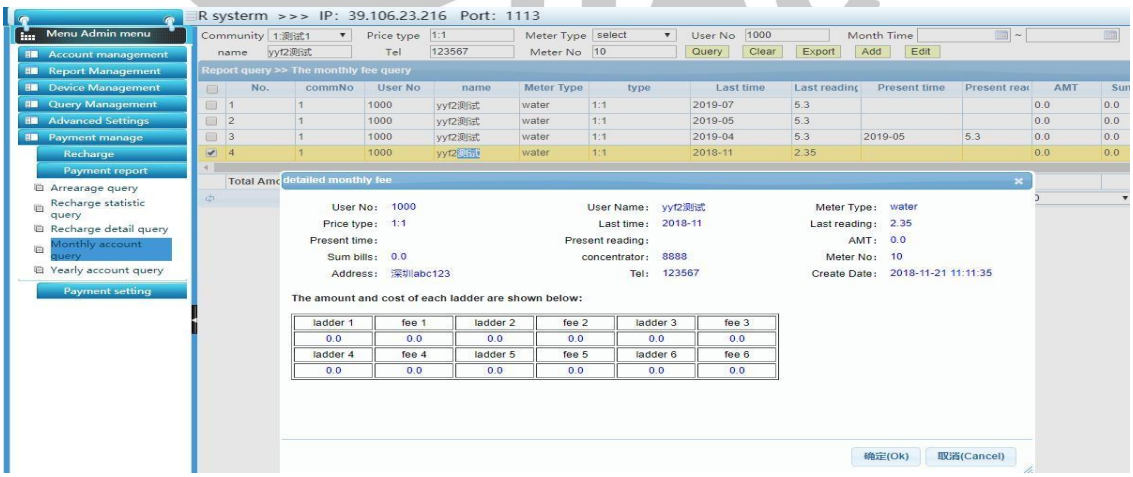


5.6.2.4 Monthly Cost Query

1) Generate a record based on the frozen data and price type. Each month, a record will be generated and the data of the previous month will be updated. If the TCP/IP server does not automatically report the frozen data, click Add to manually insert the frozen data. User can manually modify the frozen data of the current month before freezing the data report next month;there is the current user status identifier at the end of each column, (such as in use, meter changed, transferred, etc.), after account deletion, meter changed and transferred, the previous meter information will display different colors,there will have the total amount and cost in the last line.



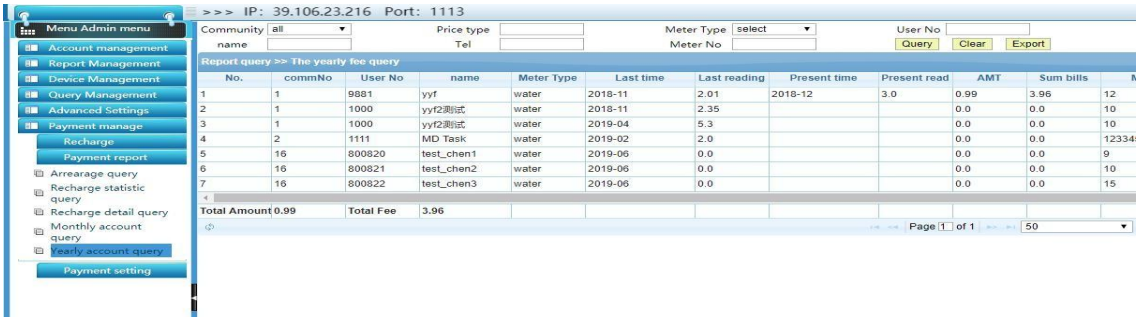
2) Double-click on a single monthly fee to display detailed usage and charges for each ladder



5.6.2.5 Annual Cost Query

To query the user's annual fee, double-click on a single annual fee to display the detailed usage and

charge for each segment; there is the current user status indicator at the end of each column. (such as in use, meter changed, meter transferred, etc.)



5.6.3 Payment Settings

Price type setting

The price type that is modified each time will take effect in the next month, and the price type generated by the add operation will take effect in the current month.