SPM93 Three Phase Energy Meter

Installation & Operation Manual

V 1.7

ZHUHAI PILOT TECHNOLOGY CO., LTD.

Danger and warning!

This device can be installed only by professionals.

The manufacturer shall not be held responsible for any accident caused by the failure to comply with the instructions in this manual.

Risks of electric shocks, burning, or explosion

- This device can be installed and maintained only by qualified people.
- Before operating the device, isolate the voltage input and power supply and short-circuit the secondary windings of all current transformers.
- Use appropriate voltage tester to make sure the voltage has been cut-off.
- Put all mechanical parts, doors, or covers in their original positions before energizing the device.
- Always supply the device with the correct working voltage during its operation.

Failure to take these preventive measures could cause damage to equipment or injuries to people.

CONTENTS

1. Product Description

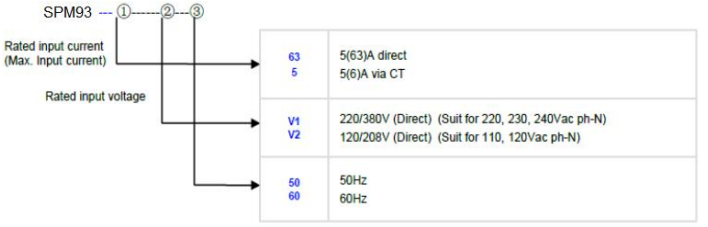
SPM93 DIN rail energy meter is a kind of new style three phase whole electronic type meter. The meter is completely conformed to the relative requirements of the International Standard IDT IEC 62053-21:2003 (Class 1), IDT IEC 62053-22:2003(Class 0.5S). It is an integration of up-to-date micro-electronics technique, special large scale integra rcuit, advanced technique of digital sampling technique and SMT techniques etc.

SPM93 three phase energy meter is used for measuring active energy power consumption in a rated frequency of 50Hz or 60Hz three phase alternating current circuit. LCD display total kWh (Imp. & Exp.), total kWh (Imp. & Exp.), Multi-tariff energy, voltage, current, power, power factor, frequency. It is characterized with good reliability, compact size, light weight, specious nice appearance and easy installation.

2. Features

- 35mm DIN installing, in accordance with Standard DIN EN50022
- High accuracy, active energy accuracy up to class 1 ,class 0.5S
- 7+1 digits LCD display (9999999.9 kWh)
- 2 Passive pulse output, output signal is in accordance with Standard DIN43864
- LED indicates pulse (Settable for kWh or kvarh)
- Key-press for local parameter setting and clean energy, password protection
- RS485 communication port, Modbus protocol
- Record historical energy for last 31days, last 12 month and last 10 years
- Freeze data per 15 min daily

3. Order Information



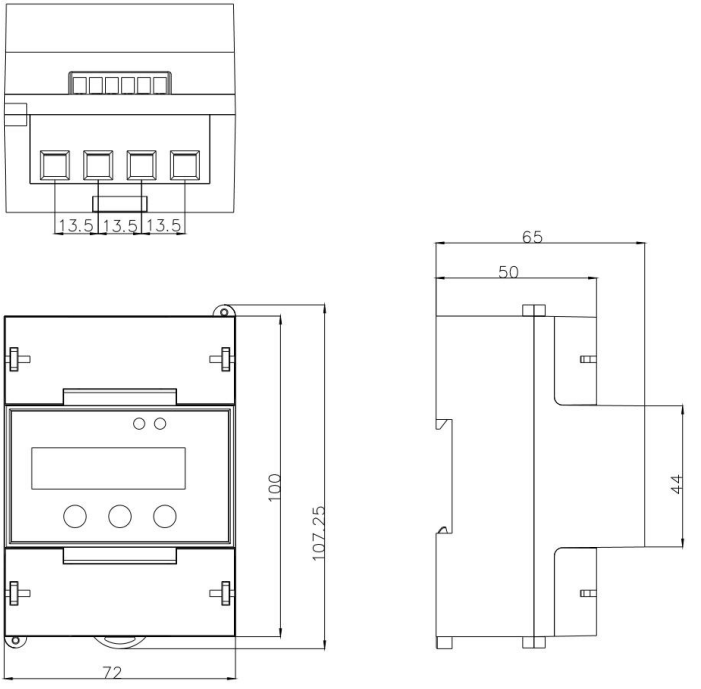
Note:

1. SPM93 default rated voltage 220V, frequency 50Hz.

Example 1: Model No. DFPM93-63-V1-50, which indicates the device provides basic function, accuracy class 1, rated current is 5(63)A , provides optional TOU (Multi-tariff) function and rated voltage input is 220/380V, 50Hz.

4. Figure and Installation Dimension

SPM93 dimension:



5. Wiring

There are two connection modes: direct connection and indirect connection through CT.

(1) For Model 5(63)A, SPM93 should be connected directly. Direct connection drawing, in 3-phase 4-wire system.

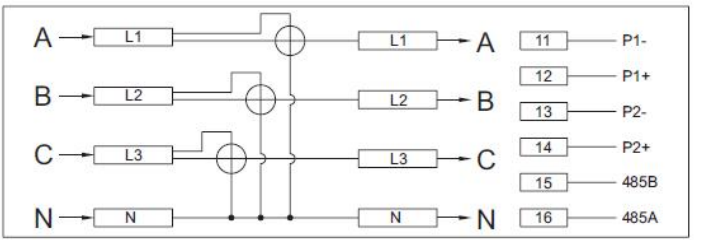


Figure 5-1 Direct connection type

(2) For model 5(6)A, SPM93 should be connect though external CT. Indirect connection drawing through CT, in 3-phase 4-wire system (Suggest to connect all 3 phase).

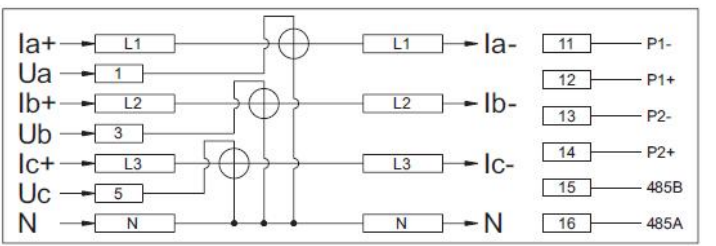


Figure 5-2 Current transformer connection type

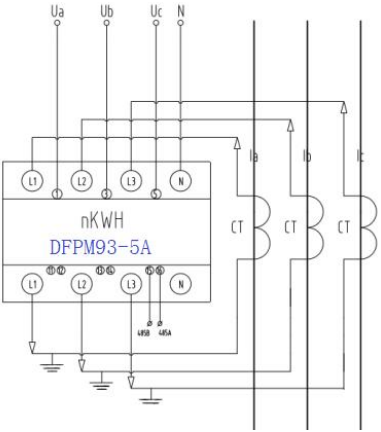


Figure 5-2 Current transformer connection type

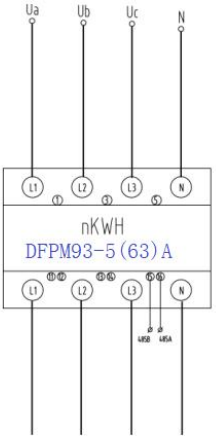


Figure 5-1 Direct connection type

Note:

(1) For both 5(6)A and 5(63)A model, terminal 11, 12 and terminal 13, 14 can be set as pulse output port of kWh or kvarh. And pulse constant is settable.

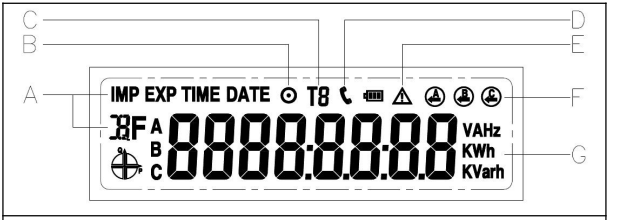
(2) All Pulse output port are passive pulse output, power supply range 5~30Vdc.

(3) Terminal 15,16 is 485 communication terminal, 485B:485-, 485A:485+

(4) One bus is not recommended to connect more than 30pcs DFPM93, the total length of the communication line is not recommended more than 800 meters

6. Display and Keys

6.1 LCD display instruction



A：Data type prompt

B：Running prompt

C：Multi-tariff prompt

D: Communication prompt, 1Hz frequency means communication normal

E：Device failure prompt

F：Phase sequence error prompt

G：Data unit prompt

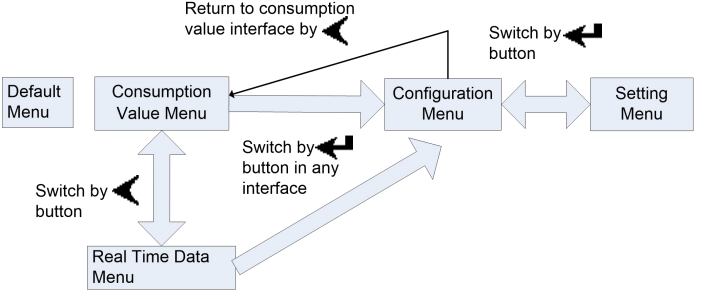
The device also has is two LED light : PULSE1, PULSE2

6.2 Data Display

There has 4 categories for display menu:

1. Consumption value menu (default interface)
2. Real-time value menu
3. Configuration menu
4. Setting menu

How to switch to each menu?

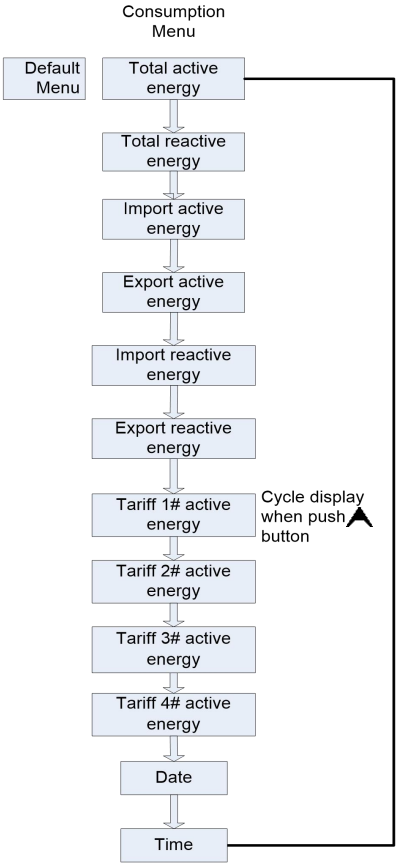


6.2.1 Keys

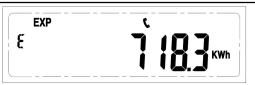
Menu definition / Key	Consumption value menu	Real-time value menu	Configuration menu	Setting menu
	Switch to Real-time value Menu	Switch to Consumption value menu	Switch to Consumption value menu	Move cursor /Exit to Configuration menu
	Turn page	Turn page	Turn page	Turn page/modify value
	Switch to configuration menu	Switch to configuration menu	Switch to setting menu (>3s)	Modify / Save

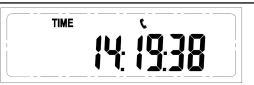
Note1: if the input wrong password, then user can't modify parameter, LCD will prompt password error. After 5s later, it will return to the interface inquiry.

6.2.2 Real-time consumption value interface

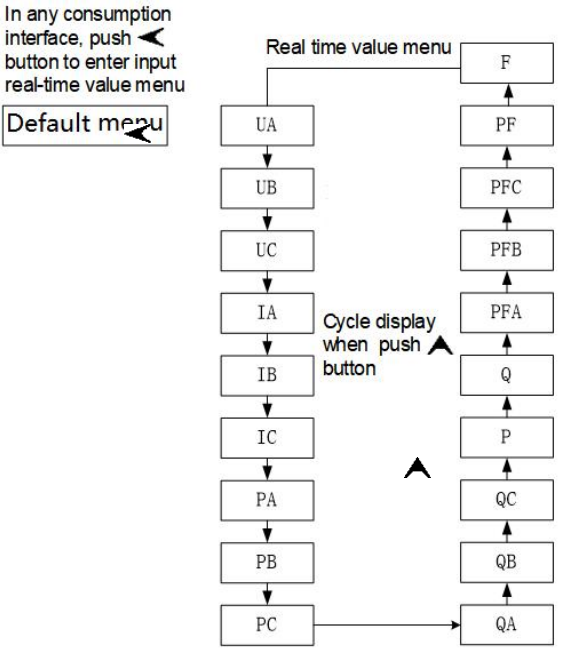


Push ^ display as below:

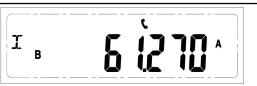
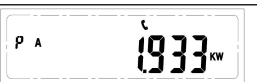
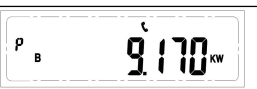
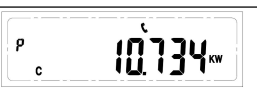
Item	LCD display	Remark
Total active energy		7+1 digit display Max. 9999999.9kWh
Total reactive energy		
Import active energy		
Export active energy		
Import reactive energy		
Export reactive energy		
T1=Tariff 1# active energy		
T2=Tariff 2# active energy		

T3=Tariff 3# active energy		
T4=Tariff 4# active energy		
Date		
Time		

6.2.3 Real-time value interface

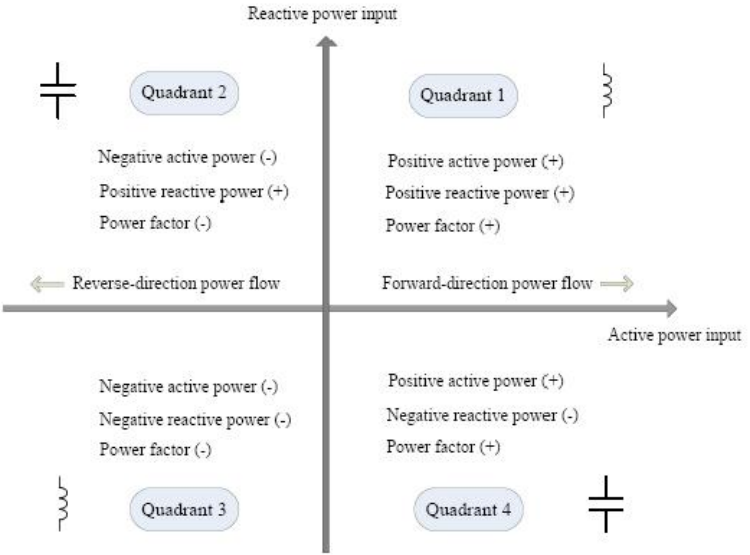


In any consumption value interface, Push to enter into real-time value menu.

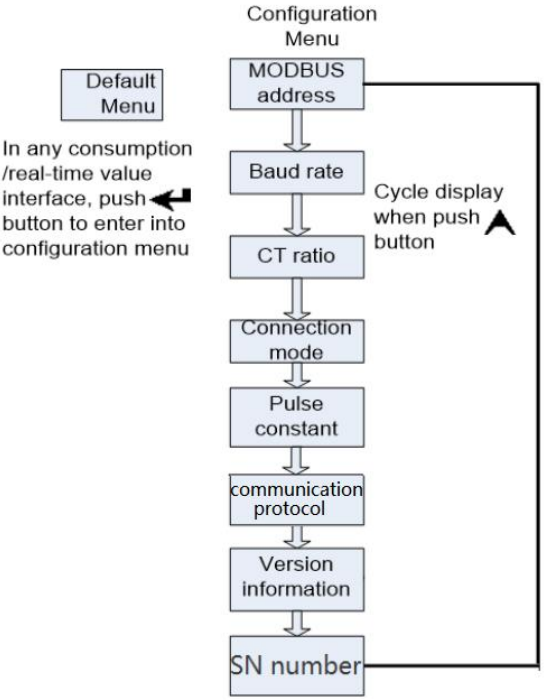
Item	LCD display	Remark
Phase A voltage		Voltage data display two decimal, Unit: V, Unsigned 16-digit integer
Phase B voltage		
Phase C voltage		
Phase A current		Current data display three decimal, Unit: A, Unsigned 32-digit integer
Phase B current		
Phase C current		
Phase A active power		Active power data display three decimal, Unit: kW, Signed 32-digit integer. When it is negative data, only display two decimal.
Phase B active power		
Phase C active power		

Phase A reactive power		
Phase B reactive power		
Phase C reactive powe		
Total active power		
Phase A power factor		Power factor data display three decimal, Signed 16-digit integer.
Phase B power factor		
Phase C power factor		
Total power factor		
Frequency		Frequency data display three decimal, Unsigned 16-digit integer.

Note: Definition of data type for active power, reactive power and power factor as below:

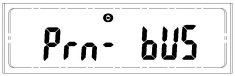
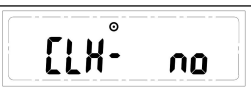


6.2.4 Configuration interface

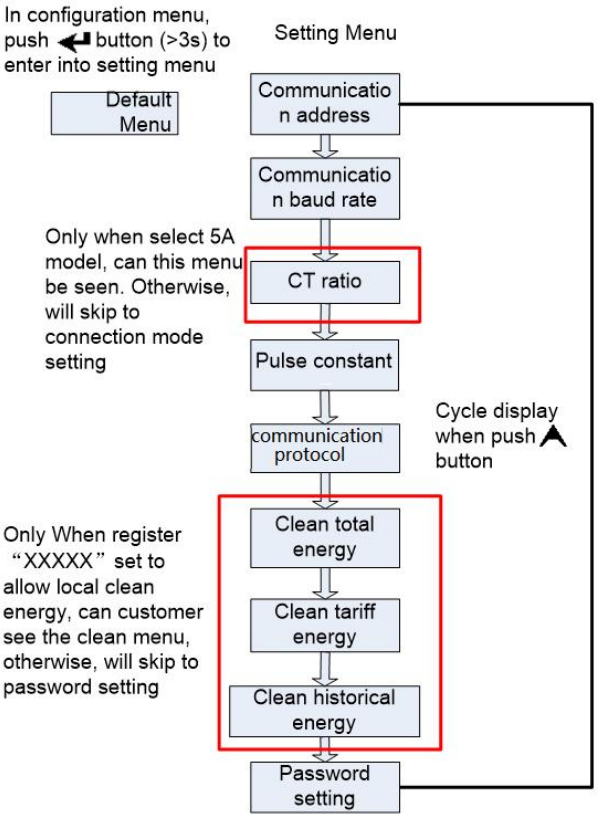


In any consumption / real time value interface, Push ↵ to enter into configuration menu

Item	LCD display	Remark
MODBUS address		MODBUS address, range: 1~247, default 1
MODBUS baud rate		MODBUS baud rate, range: 9600, 4800, 2400,1200 default 9600bps
CT ratio		CT ratio is the ratio of current primary and secondary. Range 1~1000, default 1. When select 5(6)A model, should connect with external CT.
Connection mode		Fixed to 3 phase 4 wire
Pulse constant		63A:Pulse output constant, default 400 5A:Pulse output constant, default 6400

communication protocol		standard MODBUS protocol,and it's default
		DLT:645-2007 protocol
Version information		Version number, can't change
SN number	 	Display SN code in two screens
Clean energy	 	Clean consumption energy (total energy, import / export energy)) When select "YES" and confirm, then the meter will clean the energy.
Clean historical energy	 	Clean historical energy, including daily energy, monthly, yearly energy. When select "YES" and confirm, then the meter will clean the energy.

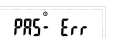
6.2.5 Setting interface



In configuration menu, press >3s to enter into setting menu

Password	 	4 digit password Supper password: 4567 Default: 0000 Only when input right password, can user modify parameter Otherwise it will prompt password error, then return to configuration interface after 5s later.

Note 1: Only in configuration interface, can user enter into password input interface after press ↵. Then LCD will display  , the farthest right “0” flashing, customer can press ∧ to modify flashing digit (circle display from 0~9) and press ‹ to move cursor.

Note 2: If input wrong password, user can’t modify parameter, display  , then return to configuration interface after 5s later.

Note 3: If input correct password, LCD display will skip to MODBUS address interface, the farthest right digit flashing, customer can press ∧ to modify flashing digit (circle display from 0~9) and press ‹ to move cursor.

Note 4: In setting interface, press ↵ to enter setting status or save and exit setting status.

Note 5: Press ‹ to exit to real-time consumption value interface, when in non-modify status.

7. Functions

7.1 Historical energy data

1. SPM93 records the historical energy data as below:
   1) Monthly total kWh (imp. & exp.), total kvarh (imp. & exp.), total kWh, total kvarh. (last 12 months)
   2) Yearly total kWh (imp. & exp.), total kvarh (imp. & exp.), total kWh, total kvarh. (last 10 years)

2. SPM93 support freeze daily energy data and provide 2 kinds of data:
   1) Freeze yesterday energy data from 22:00 to 24:00
   2) Freeze day energy data per 15min from 00:00, and refresh data daily.

Note: User can inquiry historical energy data via MODBUS register.

7.2 TOU (Multi-tariff Energy)

SPM93 statistics energy of different tariffs.

SPM93 supports 2 tariff lists. Users can set the 2 lists separately. Each tariff list can be set max. 8 periods in one day and 4 different tariff (F1, F2, F3, F4 means 4 kinds of tariff, and F1 for Sharp, F2 for Peak, F3 for Flat, F4 for Valley).

Below example for setting the tariff lists:

Tariff List	Num. of period	Period order	Starting time (to end time)	Tariff
Tariff List 1	8	1st period	00:00 (to 03:00)	F1

		2nd period	03:00 (to 06:00)	F2
		3rd period	06:00 (to 09:00)	F4
		4th period	09:00 (to 12:00)	F3
		5th period	12:00 (to 15:00)	F1
		6th period	15:00 (to 18:00)	F4
		7th period	18:00 (to 21:00)	F2
		8th period	21:00 (to 00:00)	F3
Tariff List 2	5	1st period	06:00 (to 10:00)	F1
		2nd period	10:00 (to 12:00)	F2
		3rd period	12:00 (to 14:00)	F1
		4th period	14:00 (to 20:00)	F3
		5th period	20:00 (to 06:00 of next day)	F4

There are 2 modes to calculate the multi-tariff energy: Date Mode and Holiday Mode.

Under Date Mode, it divides one year (365 days) into 2 periods

Under Holiday Mode, it divides the days by working day and holiday. There has 2 mode in Holiday Mode.

1. Working day is from Monday to Friday. Holiday is from Saturday to Sunday.
2. Working day is from Sunday to Thursday. Holiday is from Friday to Saturday.

Below example for setting the mode:

Mode	Time Zone 1 (use the Tariff List 1)	Time Zone 2 (use the Tariff List 2)
Date Mode	From Apr.1 to Sep. 30	From Oct.1 to Mar.31 of next year
Holiday Mode 1	From Mon. to Fri.	From Sat. to Sun.
Holiday Mode 2	From Sun. to Thurs.	From Fri. to Sat.

Attention
1. Users can divide one day (24 hours) up to 8 periods, and set 4 tariff maximum.
2. Each period must >15 minutes, and the duration must be a multiple of 15.
3. The starting time of each period must be in ascending order
4. The multi-tariff only can be set from communication. It can't be set on panel.
5. If 2 different periods use the same tariff, the meter will combine the energy of 2 periods together.
6. The system default that: Time Zone 1 uses the Tariff List 1, and Time Zone 2 use the Tariff List 2. User can't change it.

8. Main Technical Parameter

Rated voltage	3×220Vph-N, direct 3×120Vph-N, direct (optional)
Rated (Max.) current	3×5(6) A/ CT 3×5(63) direct
Input frequency	50Hz or 60Hz
Power supply	self-supply 220V, (176V-275V) 120V, (96V-140V) If only connect 1 phase, RS485 port will not work.
Starting current	0.4%Ib
Power consumption	<10VA
Insulating property	Power frequency withstand voltage: AC 2 kV Impulse withstand voltage: 6 kV
Accuracy	Class 1
Pulse output	1000imp
Communication	RS485 output, Modbus-RTU protocol Address: 1~247 Baudrate: 2400bps, 4800bps, 9600bps
Connection mode	3-phase 4-wire
Dimension	72×100×65mm

Installation mode	Standard 35mm DIN rail
Operating environment	Operating temperature: -10℃~+55℃ Storage temperature: -40℃~+70℃ Relative humidity: 5%~95%,non-condensing

Electrostatic discharge immunity test	IEC61000-4-2,Level 4
Radiated immunity test	IEC61000-4-3,Level 3
Electrical fast transient/ burst immunity test	IEC61000-4-4,Level 4
Surge immunity test (1,2/50μs~8/20μs)	IEC61000-4-5,Level 4
Conducted Emission test	EN55022, Class B
Radiated Emission test	EN55022, Class B

9. Communication Protocol

9.1. Introduction

This part describes the Modbus communications protocol employed by the SPM93 and how to pass information into and out of the SPM93 in a Modbus network.

9.1.1 Purpose of the Communication Protocol

The purpose of the SPM93 Modbus communications protocol is to allow setup information and measured data to be efficiently transferred between a Modbus Master Station and a DFPM93. This includes:

1) Allowing configuration and interrogation of all SPM93 set-up parameters from a Modbus Master Station.

2) Allowing interrogation of all data measured by DFPM93.

9.1.2 Version of Communication Protocol

The version is proper for all DFPM93, which have leaved Pilot. If any change happens later, it will be indicated.

9.2. Detailed Description of SPM93 Modbus Protocol

9.2.1 SPM93 Modbus Protocol Rules

The following rules define the protocol for information transfer between a Modbus Master device and the SPM93 in a RS-485 serial communications loop.

1) All communications on the RS-485 loop conforms to a Master/ Slave scheme. In this scheme, information and data is transferred between a Modbus Master device and up to 32 Slave monitoring devices.

2) The Master will initiate and control all information transfer on the RS-485 communications loop.

3) Under no circumstances will a Slave device initiate a communications sequence.

4) All communications activity on the RS-485 loop occurs in the form of "Packet", a packet being simply a serial string of 8-bit bytes. The maximum number of bytes contained within one packet is 128. The bytes that comprise a packet consist of standard asynchronous serial data, which are generated using equipment similar to that used for RS-232C.

5) The packages from Master are named request. The packages from Slave are named response.

6) Under any circumstance, Slave can just respond one request.

9.2.2 Modes of Transmission

Modbus protocol supports ASCII and RTU modes of transmissions. The SPM93 supports only the RTU mode of transmission with **8 data bits, no parity, and 1 stop bit.**

9.2.3 Description of the Modbus Packet Structure

Every Modbus packet consists of four fields:

1) The Address Field

2) The Function Field

3) The Data Field

4) The Error Check Field

9.2.3.1 Address Field

The Address Field is 1-byte long and identifies which Slave device the packet is for. Valid addresses range between 1 and 247. The Slave device whose address matches the value in this field will perform the command specified in the Packet.
The respond packet of Slave should be its own address.

9.2.3.2 Function Field

The Function Field is 1-byte long and tells the addressed slave which function to perform. The Modbus functions supported by the SPM93 are listed in below Figure.

Function	Meaning	Action
0x01	Read Relay Output Status	Obtains ON/ OFF information of one or more relay output in SPM93 (0/1)
0x03	Read Registers	Obtains the current value in one or more holding registers of the DFPM93.
0x05	Relay control	Write 0xFF00 to close (ON) the relay Write 0x0000 to open (OFF) the relay
0x10	Preset Registers	Places specific binary values into a series of consecutive holding registers of the SPM93

9.2.3.3 Data Field

The Data Field varies in length depending on whether the message is a request or a response packet. This field typically contains information required by the Slave device to perform the command specified in a request packet or data being passed back by the Slave device in a response packet.

In general, registers are transmitted in the order of high-order byte first, low order

byte second.

For Example 2.1

One 16-bit register has the content 0x12AB, the register is transmitted:

High order byte = 0x12

Low order byte = 0xAB

9.2.3.4 Error Check Field (Checksum)

This field allows the receiving device to determine if a packet has been corrupted with transmission errors. In Modbus RTU mode, the 16-bit Cyclic Redundancy Check (CRC-16) is used. The sending device calculates a 16-bit value, based on the information stored in the address, function and data fields using the CRC-16 algorithm and appends it to the end of the packet. The receiving device performs the same calculation upon the reception of a packet. If the result does not match the checksum stored in the packet, transmission errors have occurred and the packet will be ignored by the receiving device.

9.2.4 Exception Responses

If a Modbus master device sends a noneffective command to a SPM93 or attempts to read a noneffective holding register, an exception response will be generated. The exception response consists of the slave address, function code, error code, and error check field. The high order bit of the function code is set to 1 to indicate that the packet is an exception response. Below Figure describes the exception codes

supported by the SPM93 and their possible causes.

Name of Function Code	Meaning
01H	SPM93 only support function code: 01H, 02H, 03H, 05H. This code indicates the Slave device receives noneffective function code, or receives an error command.
02H	Receive a noneffective operation or the length of package exceeds 128 bytes.
03H	The requested data start from an uncompleted address

9.2.5 Broadcast Packets

The SPM93 supports broadcast commands when communicating in MODBUS mode. Do write command 0x10 for timing.

9.3. Packet Communication

Two MODBUS functions are supported by the DFPM93. The standard MODBUS protocol supports only 16-bit registers, which limit the maximum value of any measurement to 65535.

Section 9.3.1 will describe the format of Read/ Response Packet of relay output.

Section 9.3.2 will describe the format of Read/ Response Packet of holding register.

Section 9.3.3 will describe the relay control command

Section 9.3.4 will describe Preset Multiple Registers packet and the acknowledge packet.

9.3.1 Read the Relay Output Status (Function Code 01H)

Use 01 command to read the relay status. Relays are addressed starting at 0: relay 1 is addressed as 0.

The relay status data in response packet is packed as one bit for one relay. 1= ON, 0 = OFF.

The LSB (Least Significant Bit) of the first data byte contains the request addressing output. Other relay is same as this, until to the high bit of this byte, and rank from low bit to high bit in the followed byte.

If the return output Num. is not a multiple of 8, it will use zero to fill in the remainder bit of last data byte (until to the high bit of the byte). The byte count field specifies all byte num. of the data.

Request Packet (Master→DFPM93)		**Response Packet (DFPM93→Master)**	
Unit ID/ Slave	1 byte	Unit ID/ Slave	1 byte

address		address	
01H (Function Code)	1 byte	01H (Function Code)	1 byte
Starting address	2 bytes	Byte num. (N)	1 byte
Relay num.	2 bytes	Relay status	N bytes
CRC check code	2 bytes	CRC check code	2 bytes

N = output num. ÷ 8, if remainder ≠0, then N=N+1.

9.3.2. Read Holding Registers (Function Code 03H)

This command packet requests that the SPM93 responds all valid registers. The value of reserved registers is 0.

Request Packet (Master→DFPM93)		**Response Packet (DFPM93→Master)**	
Unit ID/ Slave address	1 byte	Unit ID/ Slave address	1 byte
03 H (Function Code)	1 byte	03 H (Function Code)	1 byte
Start register address	2 bytes	Byte num. (2 * register num.)	1 byte
Registers num.	2 bytes	First register data	2 bytes
CRC check code	2 bytes	Second register data	2 bytes
		... ...	
		CRC check code	2 bytes

9.3.3 Relay Control (Function Code 05H)

Use 05 command to control the relay. Relays are addressed starting at 0: relay 1 is addressed as 0.

The requested ON/OFF relay is specified by a constant in the data field.

Data Field is 0xFF00, request the relay to be ON.

Data Field is 0x0000, request the relay to be OFF.

All other values are illegal and will not affect the relay.

Request Packet (Master→DFPM93)		**Response Packet (DFPM93→Master)**	
Unit ID/ Slave address	1 byte	Unit ID/ Slave address	1 byte
05 H (Function Code)	1 byte	05 H (Function Code)	1 byte
Start register address	2 bytes	Start register address	2 bytes
Data field	FF	Data field	FF
Data field	00	Data field	00
CRC check code	2 bytes	CRC check code	2 bytes

9.3.4 Preset Multiple Registers (Function code 10H)

This command packet allows the Master to program the SPM93 setup parameters.

Preset Registers Format (Master→DFPM93)		**Response Format (DFPM93→Master)**	
Unit ID/ Slave address	1 byte	Unit ID/ Slave address	1 byte
10 H (Function Code)	1 byte	10 H (Function Code)	1 byte
Start register address	2 bytes	Start register address	2 bytes
Register num.	2 bytes	Register num.	2 bytes
Byte num. (2 * register num.)	1 byte	CRC check code	2 bytes
First register data	2 bytes		
Second register data	2 bytes		
...			
CRC check code	2 bytes		

Note: SPM93 presume all registers are continuous from the first one.

9.4. Calculating the CRC-16 Error Check Field

This section describes the procedure for obtaining the CRC-16 error check field. A packet can be considered as a continuous, serial stream of binary data (ones and zeros). The 16-bit checksum is obtained by multiplying the serial data stream by 216 (10000000000000000) and then dividing it by the ***generator polynomial***

($X^{16}+X^{15}+X^2+1$), which can be expressed as a binary data 11000000000000101. The quotient is ignored and the 16-bit remainder is the checksum and is appended to end of the packet. The receiving device performs the same operation on the entire packet including the checksum. The packet, when divided by the generator polynomial, should give a zero remainder if no transmission errors have occurred. In calculating the CRC, all arithmetic operations (additions and subtractions) are performed using MODULO TWO, or EXCLUSIVE OR operation.

Steps for generating the CRC-16 checksum:

1) Form a new polynomial by dropping the MSB (Most Significant Bit) of the generator polynomial and reversing the bit sequence. This yields the binary number 1010 0000 0000 0001 or A0 01 Hex.
2) Load a 16-bit register with initial value FF FF Hex.
3) Exclusive OR the first data byte with the loworder byte of the 16-bit register, storing the result in the 16-bit register.
4) Shift the 16-bit register one bit to the right.
5a) If the bit shifted out to the right is one, Exclusive OR the 16-bit register with the new generator polynomial, with result stored in the16-bit register. Return to step 4.
5b) If the bit shifted out to the right is zero, return to step 4.
6) Repeat steps 4 and 5 until 8 shifts have been performed.
7) Exclusive OR the next data byte with the 16-bit register.
8) Repeat steps 4 through 7 until all bytes of the packet have been Exclusive ORed

with the 16-bit register and shifted 8 times.

9) The content of the 16-bit register is the checksum and is appended to the end of the packet.

Below is an example to calculate CRC checksum for a hexadecimal byte 6403:

Steps	Byte	Operation	Register	Bit#	Shifts
2		Initial value	1111 1111 1111 1111		
	1	Load the first data byte	0000 0000 0110 0100		
3		XOR	1111 1111 1001 1011		
4		Shift 1 bit to right	0111 1111 1100 1101	1	1
5a		XOR generator polynomial	1101 1111 1100 1100		
4		Shift 1 bit to right	0110 1111 1110 0110	2	0
4		Shift 1 bit to right	0011 0111 1111 0011	3	0
4		Shift 1 bit to right	0001 1011 1111 1001	4	1
5a		XOR generator polynomial	1011 1011 1111 1000		
4		Shift 1 bit to right	0101 1101 1111 1100	5	0
4		Shift 1 bit to right	0010 1110 1111 1110	6	0
4		Shift 1 bit to right	0001 0111 0111 1111	7	0
4		Shift 1 bit to right	0000 1011 1011 1111	8	1
5a		XOR generator polynomial	1010 1011 1011 1110		

	2	Load the second data byte	0000 0000 0000 0011		
7		XOR	1010 1011 1011 1101		
4		Shift 1 bit to right	0101 0101 1101 1110	1	1
5a		XOR generator polynomial	1111 0101 1101 1111		
4		Shift 1 bit to right	0111 1010 1110 1111	2	1
5a		XOR generator polynomial	1101 1010 1110 1110		
4		Shift 1 bit to right	0110 1101 0111 0111	3	0
4		Shift 1 bit to right	0011 0110 1011 1011	4	1
5a		XOR generator polynomial	1001 0110 1011 1010		
4		Shift 1 bit to right	0100 1011 0101 1101	5	0
4		Shift 1 bit to right	0010 0101 1010 1110	6	1
5a		XOR generator polynomial	1000 0101 1010 1111		
4		Shift 1 bit to right	0100 0010 1101 0111	7	1
5a		XOR generator polynomial	1110 0010 1101 0110		
4		Shift 1 bit to right	0111 0001 0110 1011	8	0
		CRC-16	0111 0001 0110 1011		

9.5. SPM93 Register List

All SPM93 measured and setup parameters are treated as HOLDING REGISTERS having addresses **4xxxx** when communicating in Modbus protocol. According to the MODBUS Protocol, in response to a request for register **4xxxx** of a particular slave device, the MODBUS master reads register **xxxx-1** from the slave. For example register 40011 corresponds to register 10.

Data Type:

Items	Access and Type	Description
1	RO	Read only
2	WO	Write only
3	RW	Read or Write
4	UINT16	Unsigned 16 digits integer
5	INT16	Signed 16 digits integer
6	LUINT32	Unsigned 32 digits integer
7	LINT32	Signed 32 digits integer
8	WORD16	Bit denotation word, applicable to on-off or relay channel. D0 refers to the first on-off or relay channel. D1 refers to the second on-off or relay channel

		The rest bits may be deduced by analogy Bit 0 refers to “off”, and bit 1 refers to “on”

Note: LUINT32 including 2 register address

LINT32 including 2 register addres

9.5.1 Real-time value register list

9.5.1.1 Common used real time value register

Register No.	Access	Definition	Data Type	Remarks
40001	RO	Va (ph-N)	UINT16	× 0.01, unit: V
40002	RO	Vb (ph-N)		× 0.01, unit: V
40003	RO	Vc (ph-N)		× 0.01, unit: V
40004	RO	Ia	LUINT32	× 0.001, unit: A
40005	RO			× 0.001, unit: A
40006	RO	Ib		× 0.001, unit: A
40007	RO			× 0.001, unit: A
40008	RO	Ic		× 0.001, unit: A
40009				
40010	RO	Frequency	UINT16	× 0.01, unit: Hz, Secondary

				value
40011	RO	Total Power Factor	INT16	× 0.001, Secondary value
40012	RO	Total apparent power	LUINT32	× 0.01, Unit: VA, Secondary value
40013	RO			
40014	RO	Total active energy	LUINT32	× 0.1, unit: kWh, primary value
40015				
40016	RO	Total reactive energy	LUINT32	× 0.1, unit: kvarh, primary value
40017				
40018	RO	Phase A active power	LINT32	× 0.01, unit: W
40019				
40020	RO	Phase B active power		× 0.01, unit: W
40021				
40022	RO	Phase C active power		× 0.01, unit: W
40023				
40024	RO	Total active power	LINT32	× 0.01, unit: W
40025				

40026 40027	RO	Phase A reactive power	LINT32	× 0.01, unit: var
40028 40029	RO	Phase B reactive power	LINT32	× 0.01, unit: var
40030 40031	RO	Phase C reactive power	LINT32	× 0.01, unit: var
40032 40033	RO	Total reactive power	LINT32	× 0.01, unit: var

9.5.1.2 All Real time value register

Register No.	Access	Definition	Data Type	Remarks
40101	RO	Va (ph-N)	UINT16	× 0.01, unit: V
40102	RO	Vb (ph-N)		× 0.01, unit: V
40103	RO	Vc (ph-N)		× 0.01, unit: V
40104	RO	Vab (ph-ph)		× 0.01, unit: V
40105	RO	Vbc (ph-ph)		× 0.01, unit: V
40106	RO	Vca (ph-ph)		× 0.01, unit: V
40107 40108	RO	Ia	LUINT32	× 0.001, unit: A
40109	RO	Ib		× 0.001, unit: A

40110				
40111	RO	Ic		× 0.001, unit: A
40112				
40113	RO	Average current		× 0.001, unit: A
40114				
40115	RO	Phase A active power	LINT32	× 0.01, unit: W
40116				
40117	RO	Phase B active power		× 0.01, unit: W
40118				
40119	RO	Phase C active power		× 0.01, unit: W
40120				
40121	RO	Total active power		× 0.01, unit: W
40122				
40123	RO	Phase A reactive power		× 0.01, unit: var
40124				
40125	RO	Phase B reactive power		× 0.01, unit: var
40126				
40127	RO	Phase C reactive power		× 0.01, unit: var
40128				
40129	RO	Total reactive		× 0.01, unit:

40130		power		var
40131 40132	RO	Phase A apparent power	LUINT32	× 0.01, unit: VA
40133 40134	RO	Phase B apparent power		× 0.01, unit: VA
40135 40136	RO	Phase C apparent power		× 0.01, unit: VA
40137 40138	RO	Total apparent power		× 0.01, unit: VA
40139	RO	Phase A power factor	INT16	× 0.001
40140	RO	Phase B power factor		× 0.001
40141	RO	Phase C power factor		× 0.001
40142	RO	Total power factor		× 0.001
40143	RO	Frequency	UINT16	× 0.01, unit: Hz

9.5.2 Energy Data Registers

Register No.	Access	Description	Data Type	Remark
41001 41002	RO	Imp. kWh	LUINT32	× 0.1, unit: kWh
41003 41004	RO	Exp. kWh		× 0.1, unit: kWh
41005 41006	RO	Total kWh		× 0.1, unit: kWh
41007 41008	RO	Imp. kvarh		× 0.1, unit: kvarh
41009 41010	RO	Exp. kvarh		× 0.1, unit: kvarh
41011 41012	RO	Total kvarh		× 0.1, unit: kvarh
41013 41014	RO	Total kWh of tariff 1#		× 0.1, unit: kWh
41015 41016	RO	Total kWh of tariff 2#		× 0.1, unit: kWh

41017 41018	RO	Total kWh of tariff 3#		× 0.1, unit: kWh
41019 41020	RO	Total kWh of tariff 4#	LUINT32	× 0.1, unit: kWh
41021 41022	RO	Total kvarh of tariff 1#		× 0.1, unit: kvarh
41023 41024	RO	Total kvarh of tariff 2#		× 0.1, unit: kvarh
41025 41026	RO	Total kvarh of tariff 3#		× 0.1, unit: kvarh
41027 41028	RO	Total kvarh of tariff 4#		× 0.1, unit: kvarh
41029 41030	RO	Reserve		× 0.1, unit: kWh
41031 41032	RO	Reserve		× 0.1, unit: kvarh

9.5.3 Historical Energy Data Registers

9.5.3.1 Daily Energy Data Registers

Register No.	Access	Description	Remark
41201	RO	Num. of the record	Must read this register alone
41202-41215	RO	Record of last 1st day	Must read this 14 registers together
41216-41229	RO	Record of last 2nd day	Must read this 14 registers together
41230-41621	RO	…	…
41622-41635	RO	Record of last 31st day	Must read this 14 registers together

Content of the daily energy data:

Register No.	Access	Description	Data type	Remark
1	RO	Time	LUINT32	Unix time, year, month
2				
3	RO	Total Imp. kWh		× 0.1, unit: kWh
4				
5	RO	Total Exp.		× 0.1, unit: kWh

6		kWh		
7	RO	Total kWh		× 0.1, unit: kWh
8				
9	RO	Total Imp. kvarh		× 0.1, unit: kvarh
10				
11	RO	Total Exp. kvarh		× 0.1, unit: kvarh
12				
13	RO	Total kvarh		× 0.1, unit: kvarh
14				

9.5.3.2 Monthly Energy Data Registers

Register No.	Access	Description	Remark
42001	RO	Num. of the record	Must read this one register alone
42002-42015	RO	Record of last 1st month	Must read this 14 registers together
42016-42029	RO	Record of last 2nd month	Must read this 14 registers together
42030-42155	RO	…	…
42156-42169	RO	Record of last 12th month	Must read this 14 registers together

Content of the monthly energy data:

Register No.	Access	Description	Data Type	Remark
1	RO	Time	LUINT32	Unix time, year, month
2				
3	RO	Imp. kWh		× 0.1, unit: kWh
4				
5	RO	Exp. kWh		× 0.1, unit: kWh
6				
7	RO	Total kWh		× 0.1, unit: kWh
8				
9	RO	Imp. kvarh		× 0.1, unit: kvarh
10				
11	RO	Exp. kvarh		× 0.1, unit: kvarh
12				
13	RO	Total kvarh		× 0.1, unit: kvarh
14				

9.5.3.3 Yearly Energy Data Registers

Register No.	Access	Description	Remark
43001	RO	Num. of the record	Must read this one register alone
43002-43015	RO	Record of last 1st year	Must read this 14 registers together
43016-43029	RO	Record of last 2nd year	Must read this 14 registers together
43030-43127	RO	…	…
43128-43141	RO	Record of last 10th year	Must read this 14 registers together

Content of the yearly energy data:

Register No.	Access	Description	Data Type	Remark
1	RO	Time	LUINT32	Unix time, year, month
2				
3	RO	Imp. kWh		× 0.1, unit: kWh
4				
5	RO	Exp. kWh		× 0.1, unit: kWh
6				
7	RO	Total kWh		× 0.1, unit: kWh
8				
9	RO	Imp. kvarh		× 0.1, unit: kvarh
10				

11	RO	Exp. kvarh		× 0.1, unit: kvarh
12				
13	RO	Total kvarh		× 0.1, unit: kvarh
14				

9.5.3.4 Day Freeze Energy Data Registers

Register No.	Access	Description	Remark
43501	RO	Present day Freezed kWh value	
43502	RO	Time	Unix Time
43503			
43504	RO	Present day 0:00 Total Active Energy	
43505			
43506	RO	Present day 0:15 Total Active Energy	
43507			
43508	RO	Present day 0:30 Total Active Energy	
43509			
43510	RO	Present day 0:45 Total Active Energy	
43511			
43512	RO	Present day 1:00 Total Active Energy	
43513			

43514 43515	RO	Present day 1:15 Total Active Energy	
43516 43517	RO	Present day 1:30 Total Active Energy	
43518 43519	RO	Present day 1:45 Total Active Energy	
43520 43521	RO	Present day 2:00 Total Active Energy	
43522 43523	RO	Present day 2:15 Total Active Energy	
43524 43525	RO	Present day 2:30 Total Active Energy	
43526 43527	RO	Present day 2:45 Total Active Energy	
43528 43529	RO	Present day 3:00 Total Active Energy	
43530 43531	RO	Present day 3:15 Total Active Energy	
43532 43533	RO	Present day 3:30 Total Active Energy	

43534 43535	RO	Present day 3:45 Total Active Energy	
43536 43537	RO	Present day 4:00 Total Active Energy	
43538 43539	RO	Present day 4:15 Total Active Energy	
43540 43541	RO	Present day 4:30 Total Active Energy	
43542 43543	RO	Present day 4:45 Total Active Energy	
43544 43545	RO	Present day 5:00 Total Active Energy	
43546 43547	RO	Present day 5:15 Total Active Energy	
43548 43549	RO	Present day 5:30 Total Active Energy	
43550 43551	RO	Present day 5:45 Total Active Energy	
43552 43553	RO	Present day 6:00 Total Active Energy	

43554 43555	RO	Present day 6:15 Total Active Energy	
43556 43557	RO	Present day 6:30 Total Active Energy	
43558 43559	RO	Present day 6:45 Total Active Energy	
43560 43561	RO	Present day 7:00 Total Active Energy	
43562 43563	RO	Present day 7:15 Total Active Energy	
43564 43565	RO	Present day 7:30 Total Active Energy	
43566 43567	RO	Present day 7:45 Total Active Energy	
43568 43569	RO	Present day 8:00 Total Active Energy	
43570 43571	RO	Present day 8:15 Total Active Energy	
43572 43573	RO	Present day 8:30 Total Active Energy	

43574 43575	RO	Present day 8:45 Total Active Energy	
43576 43577	RO	Present day 9:00 Total Active Energy	
43578 43579	RO	Present day 9:15 Total Active Energy	
43580 43581	RO	Present day 9:30 Total Active Energy	
43582 43583	RO	Present day 9:45 Total Active Energy	
43584 43585	RO	Present day 10:00 Total Active Energy	
43586 43587	RO	Present day 10:15 Total Active Energy	
43588 43589	RO	Present day 10:30 Total Active Energy	
43590 43591	RO	Present day 10:45 Total Active Energy	
43592 43593	RO	Present day 11:00 Total Active Energy	

43594 43595	RO	Present day 11:15 Total Active Energy	
43596 43597	RO	Present day 11:30 Total Active Energy	
43598 43599	RO	Present day 11:45 Total Active Energy	
43600 43601	RO	Present day 12:00 Total Active Energy	
43602 43603	RO	Present day 12:15 Total Active Energy	
43604 43605	RO	Present day 12:30 Total Active Energy	
43606 43607	RO	Present day 12:45 Total Active Energy	
43608 43609	RO	Present day 13:00 Total Active Energy	
43610 43611	RO	Present day 13:15 Total Active Energy	
43612 43613	RO	Present day 13:30 Total Active Energy	

43614 43615	RO	Present day 13:45 Total Active Energy	
43616 43617	RO	Present day 14:00 Total Active Energy	
43618 43619	RO	Present day 14:15 Total Active Energy	
43620 43621	RO	Present day 14:30 Total Active Energy	
43622 43623	RO	Present day 14:45 Total Active Energy	
43624 43625	RO	Present day 15:00 Total Active Energy	
43626 43627	RO	Present day 15:15 Total Active Energy	
43628 43629	RO	Present day 15:30 Total Active Energy	
43630 43631	RO	Present day 15:45 Total Active Energy	
43632 43633	RO	Present day 16:00 Total Active Energy	

43634 43635	RO	Present day 16:15 Total Active Energy	
43636 43637	RO	Present day 16:30 Total Active Energy	
43638 43639	RO	Present day 16:45 Total Active Energy	
43640 43641	RO	Present day 17:00 Total Active Energy	
43642 43643	RO	Present day 17:15 Total Active Energy	
43644 43645	RO	Present day 17:30 Total Active Energy	
43646 43647	RO	Present day 17:45 Total Active Energy	
43648 43649	RO	Present day 18:00 Total Active Energy	
43650 43651	RO	Present day 18:15 Total Active Energy	
43652 43653	RO	Present day 18:30 Total Active Energy	

43654 43655	RO	Present day 18:45 Total Active Energy	
43656 43657	RO	Present day 19:00 Total Active Energy	
43658 43659	RO	Present day 19:15 Total Active Energy	
43660 43661	RO	Present day 19:30 Total Active Energy	
43662 43663	RO	Present day 19:45 Total Active Energy	
43664 43665	RO	Present day 20:00 Total Active Energy	
43666 43667	RO	Present day 20:15 Total Active Energy	
43668 43669	RO	Present day 20:30 Total Active Energy	
43670 43671	RO	Present day 20:45 Total Active Energy	
43672 43673	RO	Present day 21:00 Total Active Energy	

43674 43675	RO	Present day 21:15 Total Active Energy	
43676 43677	RO	Present day 21:30 Total Active Energy	
43678 43679	RO	Present day 21:45 Total Active Energy	
43680 43681	RO	Present day 22:00 Total Active Energy	
43682 43683	RO	Present day 22:15 Total Active Energy	
43684 43685	RO	Present day 22:30 Total Active Energy	
43686 43687	RO	Present day 22:45 Total Active Energy	
43688 43689	RO	Present day 23:00 Total Active Energy	
43690 43691	RO	Present day 23:15 Total Active Energy	
43692 43693	RO	Present day 23:30 Total Active Energy	

43694	RO	Present day 23:45 Total Active Energy	
43695			

note:

1. Present day freeze kWh data will refresh and update day by day, the data will be freeze each 15 mins, register 43502 & 43503 is present data start time.

2. The amount of present day freeze kWh be used to indicate the freezed kWh times. Each time freeze will add + 1

3. Freeze total active energy is aggregate value

9.5.3.5 Yesterday Freeze Energy Data Registers

Register No.	Access	Description	Remark
43901	RO	Time	Unix Time
43902			
43903	RO	Yesterday 22:00 Total Active Energy	
43904			
43905	RO	Yesterday 22:15 Total Active Energy	
43906			
43907	RO	Yesterday 22:30 Total Active Energy	
43908			

43909	RO	Yesterday 22:45 Total Active Energy	
43910			
43911	RO	Yesterday 23:00 Total Active Energy	
43912			
43913	RO	Yesterday 23:15 Total Active Energy	
43914			
43915	RO	Yesterday 23:30 Total Active Energy	
43916			
43917	RO	Yesterday 23:45 Total Active Energy	
43918			

note:

1. Yesterday freeze kWh data is yesterday last two hours data saving [register 43901 & 43902]

2. Freeze total active energy is aggregate value

9.5.4 System parameter registers

Register No.	Access	Description	Data Type	Remark
44001	RO	Wiring mode	UINT16	0--1 0: 3-phase 4-wire 1: 3-phase 3-wire
44002	RW	CT ratio		1~999
44003	RW	Address		1--247
44004	RW	Baud rate		0--3 0: 2400 1: 4800 2: 9600 3:1200
44005	RW	Pulse constant		63A:400-800(imp/kWh)(imp/kvarh) 5A:6400-10000(imp/kWh)(imp/kvarh) default： 63A:400(imp/kWh)(imp/kvarh 5A:6400(imp/kWh)(i

				mp/kvarh
44006	RW	Pulse width		20—80(ms)
44007	RW	Object of pulse output-1		0--1 0: total kWh 1: total kvarh
44008	RW	Object of pulse output-2	UINT16	0--1 0: total kWh 1: total kvarh
44009	RW	Reserve		
44010	RW	Reserve		
44011	RW	Reserve		
44012	RW	Reserve		
44013	RW	Reserve		
44014	RW	Multi-tariff mode		0--3, default 1 0: Time zone mode (Max. 2 time zone per year) 1: Holiday mode1 (Mon.-Fri. Working day, Sat. - Sun. holiday)

				2: Holiday Mode2 (Sun. - Thu. Working day. Fri. - Sat. holiday) 3: Holiday Mode3 (Mon. - Sat. Working day. Sun. holiday)
44015	RW	Start time of Time zone-1: month	UINT16	1--12 (only avaliable when in multi tariff mode)
44016	RW	Start time of Time zone-1: day		1--31 (only avaliable when in multi tariff mode)
44017	RW	Start time of Time zone-2: month		1--12 (only avaliable when in multi tariff mode)
44018	RW	Start time of Time zone-2: day		1--31 (only avaliable when in multi tariff mode)
44019	RW	Num. of period for tariff list -1		1--8
44020	RW	The rate at 1st period,		0--3

		tariff list-1		
44021	RW	Start time (hour), 1st period, tariff list-1		0--23
44022	RW	Start time (minute), 1st period, tariff list-1	UINT16	0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44023	RW	The rate at 2nd period, tariff list-1		0--3
44024	RW	Start time (hour), 2nd period, tariff list-1		0--23
44025	RW	Start time (minute), 2nd period, tariff list-1		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44026	RW	The rate at 3rd period, tariff list-1		0--3
44027	RW	Start time (hour), 3rd period, tariff list-1		0--23
44028	RW	Start time (minute), 3rd period, tariff list-1		0 means 0 min. 1 means 15 min.

				2 means 30 min. 3 means 45 min.
44029	RW	The rate at 4th period, tariff list-1	UINT16	0--3
44030	RW	Start time (hour), 4th period, tariff list-1		0--23
44031	RW	Start time (minute), 4th period, tariff list-1		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44032	RW	The rate at 5th period, tariff list-1		0--3
44033	RW	Start time (hour), 5th period, tariff list-1		0--23
44034	RW	Start time (minute), 5th period, tariff list-1		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44035	RW	The rate at 6th period, tariff list-1	UINT16	0--3
44036	RW	Start time (hour), 6th		0--23

		period, tariff list-1		
44037	RW	Start time (minute), 6th period, tariff list-1		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44038	RW	The rate at 7th period, tariff list-1		0--3
44039	RW	Start time (hour), 7th period, tariff list-1		0--23
44040	RW	Start time (minute), 7th period, tariff list-1		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44041	RW	The rate at 8th period, tariff list-1	UINT16	0--3
44042	RW	Start time (hour), 8th period, tariff list-1		0--23
44043	RW	Start time (minute), 8th period, tariff list-1		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.

44044	RW	Num. of period for tariff list -2		1--8
44045	RW	The rate at 1st period, tariff list-2		0--3
44046	RW	Start time (hour), 1st period, tariff list-2		0--23
44047	RW	Start time (minute), 1st period, tariff list-2	UINT16	0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44048	RW	The rate at 2nd period, tariff list-2		0--3
44049	RW	Start time (hour), 2nd period, tariff list-2		0--23
44050	RW	Start time (minute), 2nd period, tariff list-2		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44051	RW	The rate at 3rd period, tariff list-2		0--3
44052	RW	Start time (hour), 3rd		0--23

		period, tariff list-2		
44053	RW	Start time (minute), 3rd period, tariff list-2	UINT16	0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44054	RW	The rate at 4th period, tariff list-2		0--3
44055	RW	Start time (hour), 4th period, tariff list-2		0--23
44056	RW	Start time (minute), 4th period, tariff list-2		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44057	RW	The rate at 5th period, tariff list-2		0--3
44058	RW	Start time (hour), 5th period, tariff list-2		0--23
44059	RW	Start time (minute), 5th period, tariff list-2		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.

44060	RW	The rate at 6th period, tariff list-2	UINT16	0--3
44061	RW	Start time (hour), 6th period, tariff list-2		0--23
44062	RW	Start time (minute), 6th period, tariff list-2		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44063	RW	The rate at 7th period, tariff list-2		0--3
44064	RW	Start time (hour), 7th period, tariff list-2		0--23
44065	RW	Start time (minute), 7th period, tariff list-2		0 means 0 min. 1 means 15 min. 2 means 30 min. 3 means 45 min.
44066	RW	The rate at 8th period, tariff list-2	UINT16	0--3
44067	RW	Start time (hour), 8th period, tariff list-2		0--23
44068	RW	Start time (minute), 8th		0 means 0 min.

		period, tariff list-2		1 means 15 min. 2 means 30 min. 3 means 45 min.
44069	RW	kWh refresh to ZERO by Panel Operation		0--1 0: No 1: YES
44070	RW	Energy decimal point display setting		Default is 1,settable range 1-3

Note: (1) When multi tariff mode be set as time zone mode, 1st time mode default tariff #1, 2nd time mode default tariff #2

(2) If the starting time of 1st time zone is not January 1st , then default 2nd time zone goes to new year

(3) When multi-tariff mode be set as holiday mode, working day default 1st day's tariff, holiday day default tariff #2

(4) If starting time of tariff #1 is not 0, then default the last tariff will pass 0' o clock.

9.5.5 Device information registers

Register No.	Access	Description	Data Type	Remark
49001	RW	Model No.	LUINT32	
49002				
49003	RW	S/N		
49004				
49005	RW	Hardware version No.	UINT16	
49006	RO	Software version No. for domestic market		
49007	RO	Reserve		Reserve
49008				
49009				
49010				
49011	RW	Timing	LUINT32	1 The Num. of second from Jan. 1, 1970, Greenwich mean time, support radio command
49012				
49013	RO	Error code	UINT16	

49014	RW	Second		0-59
49015	RW	Minute		0-59
49016	RW	Hour		0-23
49017	RW	Day		1-31
49018	RW	Month		1-12
49019	RW	Year		0-99

Note:

1. The UNIX system time register 49011~49012 must write simultaneously.

2. The Clock register 49014~49019 must read/ write simultaneously. Time of origin: Jan 1, 2000.

9.5.6 Command data registers

Register No.	Access	Description	Remark
46001	WO	Clean Energy	Write 888
46002	WO	Clean historical energy	Write 888
46003	WO	Reserve	Reserve
46004	WO	Reserve	Reserve
46005	WO	Reserve	Reserve
46006	WO	Recover user default parameter	Write 888

Notice:

- PILOT reserves the right to modify this manual without prior notice in view of continued improvement.

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