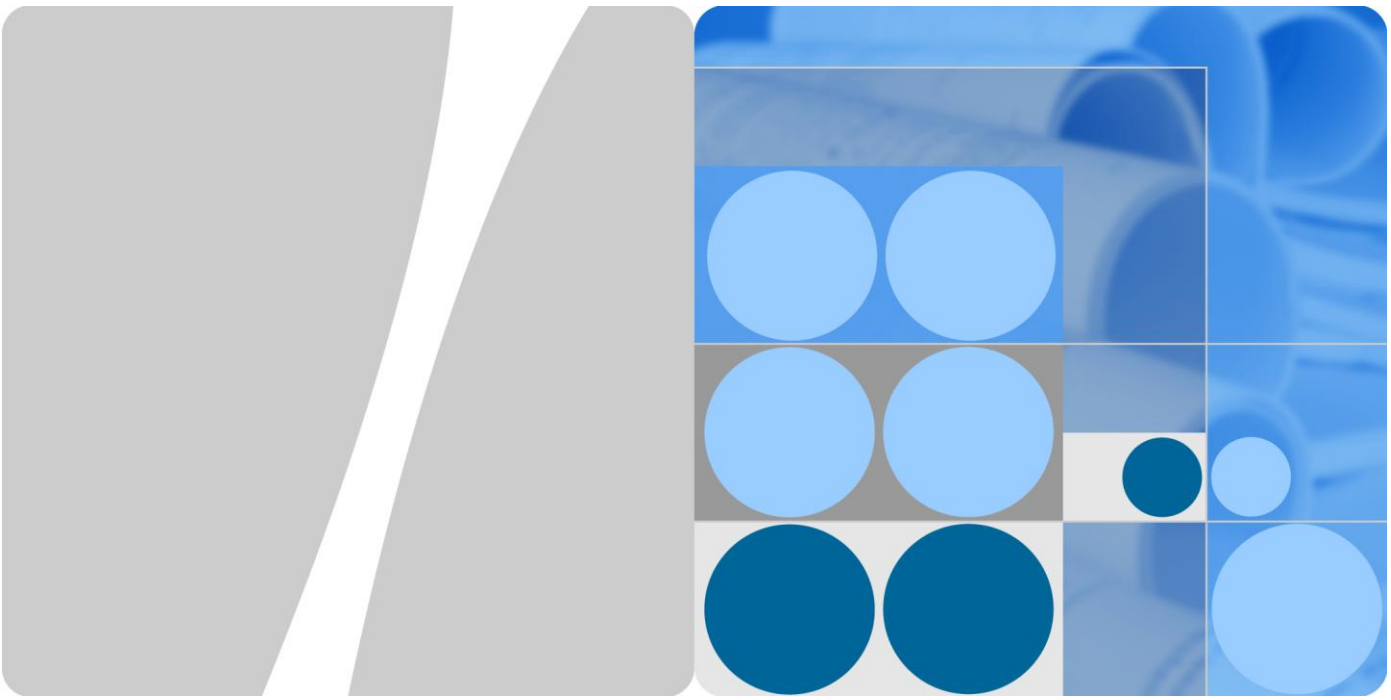

UPS2000-(6 kVA-20 kVA)

Modbus Protocol Development Guide

Issue 02

Date 2016-03-10

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About This Document

Overview

This document describes the Modbus protocol used between the RMS-MODBUS01A card, an optional component of the UPS2000-(6 kVA-20 kVA), and its host and provides examples of communication establishment processes.

Intended Audience

This document is intended for:

- Technical support engineers
- Maintenance engineers
- Users

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Calls attention to important information, best practices and tips. NOTE is used to address information not related to personal

Symbol	Description
	injury, equipment damage, and environment deterioration.

Change History

Changes between document issues are cumulative. The latest document issue contains all the changes made in earlier issues.

Issue 02 (2016-03-10)

The product type UPS2000A was added. The collection signal and alarm signal lists were updated. The examples of communication processes with the host were changed.

Issue 01 (2015-07-14)

This issue is the first release.

Contents

1 Communication Protocol

1.1 Protocol Description

This section describes the Modbus protocol used between the RMS-MODBUS01A card and its host for command control and data exchange.

The specified functions of the Modbus protocol are:

1. The host sends a read device identifier command to obtain the UPS information.
2. The host sends a read command to obtain the specified UPS information.
3. The host sends a write command to set the relevant parameters and control actions.

The host is the master device. The information exchange is done by a request and response method. The information and parameters of the slave devices are stored in the target registers. The host executes the read or write command by accessing the registers. This protocol supports one host networked with multiple slave devices. The slave devices are distinguished by address. The address setting range is from 1 to 247. Different slave nodes correspond to different addresses. The slave nodes connected to the same communication bus must not have the same address.

1.2 Glossary

Master node: runs in the background and is responsible for communicating with slave nodes. It is also the upper computer.

Slave node: in this guide, it is the RMS-MODBUS01A card. It collects information from the UPS power modules, and is used for responding to the master node.

RS485: a serial communication standard, and supports the half-duplex serial short-range communication.

Read device identifier command: the command is sent from the master node to the slave nodes, and the slave nodes return the relevant UPS information.

Read command: the command is sent from the master node to the slave nodes, and the slave nodes return the relevant register content.

Write command: the relevant parameters are packed at the master node and sent to the slave nodes to finish the parameter setting.

Register address: Every signal or parameter of the slave devices corresponds to an address. The host obtains the relevant information or sets the relevant parameters. These processes are completed by accessing these register addresses.

Slave node address: this address is the RMS-MODBUS01A card address, set by the dual in-line package (DIP) switch. The range is from 1 to 247.

1.3 Physical Interface

1.3.1 Serial Communication Electrical Standards

The slave nodes communicate with the master node through the RS485 or RS232 serial ports.

Information transmission method:

1. Use the RTU transmission mode of the Modbus.
2. The transmission mode for the character information is asynchronous mode using a frame format of one start bit, eight data bits (information byte), and one stop bit. (10 bits in total.)

1.3.2 Data Transmission Speed

The data transmission baud rate is fixed at 9600 bit/s.

NOTE
When connecting to a network management system (NMS), use an RS485/232 converter with the isolation function. A hot-swap RS485/232 converter is not recommended.

1.3.3 Cable Connection

Step 1 Set a hardware address for the Modbus card.

The hardware address is set over S2 (RS485 address DIP switch) shown in Figure 1-1. As shown in Figure 1-2, the address contains eight digits. If a toggle switch is set to ON, it stands for 0. If a toggle switch is set to OFF, it stands for 1.

Figure 1-1 DIP switch

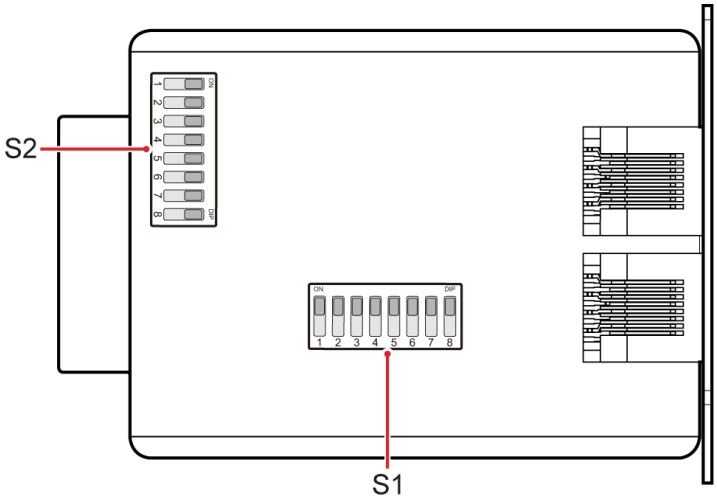
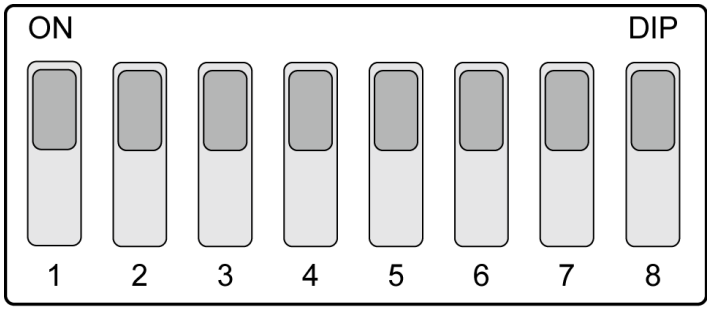


Figure 1-2 Describes the address DIP switch S2



You can use the binary method to set the DIP switch. Table 1-1 lists the mapping between addresses and toggle switches.

Table 1-1 Mapping between addresses and toggle switches

Address	Toggle Switch 1	Toggle Switch 2	Toggle Switch 3	Toggle Switch 4	Toggle Switch 5	Toggle Switch 6	Toggle Switch 7	Toggle Switch 8
1	OFF	ON	ON	ON	ON	ON	ON	ON
2	ON	OFF	ON	ON	ON	ON	ON	ON
3	OFF	OFF	ON	ON	ON	ON	ON	ON
4	ON	ON	OFF	ON	ON	ON	ON	ON
5	OFF	ON	OFF	ON	ON	ON	ON	ON
6	ON	OFF	OFF	ON	ON	ON	ON	ON
7	OFF	OFF	OFF	ON	ON	ON	ON	ON

Address	Toggle Switch 1	Toggle Switch 2	Toggle Switch 3	Toggle Switch 4	Toggle Switch 5	Toggle Switch 6	Toggle Switch 7	Toggle Switch 8
8	ON	ON	ON	OFF	ON	ON	ON	ON
9	OFF	ON	ON	OFF	ON	ON	ON	ON
10	ON	OFF	ON	OFF	ON	ON	ON	ON
11	OFF	OFF	ON	OFF	ON	ON	ON	ON
12	ON	ON	OFF	OFF	ON	ON	ON	ON
13	OFF	ON	OFF	OFF	ON	ON	ON	ON
14	ON	OFF	OFF	OFF	ON	ON	ON	ON
15	OFF	OFF	OFF	OFF	ON	ON	ON	ON
16	ON	ON	ON	ON	OFF	ON	ON	ON
17	OFF	ON	ON	ON	OFF	ON	ON	ON
18	ON	OFF	ON	ON	OFF	ON	ON	ON
19	OFF	OFF	ON	ON	OFF	ON	ON	ON
20	ON	ON	OFF	ON	OFF	ON	ON	ON
21	OFF	ON	OFF	ON	OFF	ON	ON	ON
22	ON	OFF	OFF	ON	OFF	ON	ON	ON
23	OFF	OFF	OFF	ON	OFF	ON	ON	ON
24	ON	ON	ON	OFF	OFF	ON	ON	ON
25	OFF	ON	ON	OFF	OFF	ON	ON	ON
26	ON	OFF	ON	OFF	OFF	ON	ON	ON
27	OFF	OFF	ON	OFF	OFF	ON	ON	ON
28	ON	ON	OFF	OFF	OFF	ON	ON	ON
29	OFF	ON	OFF	OFF	OFF	ON	ON	ON
30	ON	OFF	OFF	OFF	OFF	ON	ON	ON
31	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
32	ON	ON	ON	ON	ON	OFF	ON	ON

NOTE

Table 1-1 provides the methods for setting 1–32 addresses. You can follow binary DIP switch setting rules to set 33–247 addresses.

Step 2 Set the communication form for the Modbus card.

Set toggle 4 to ON, as shown in Figure 1-3. This indicates that the Modbus protocol is enabled. If both toggles 5 and 6 are set to ON, it indicates a two-wire system. If both of them are set to OFF, it indicates a four-wire system.

Figure 1-3 Functional DIP switch S1

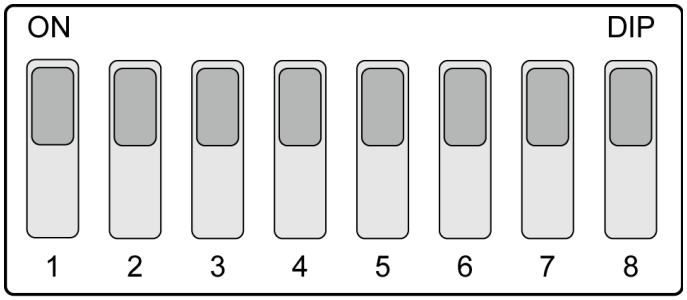


Table 1-2 Description of the functional DIP switch S1

Toggle Switch	Definition	Settings	Remarks
1	Reserved	ON: 0 OFF: 1	Toggle switches 1, 2, and 3 are used together to set a 3-bit baud rate. Currently, the software version supports only a baud rate of 9600 bits/s (in this case, toggle switches 1, 2, and 3 are ON).
2	Reserved	ON: 0 OFF: 1	
3	Reserved	ON: 0 OFF: 1	
4	RS485 protocol toggle switch	ON: 0 OFF: 1	0: Modbus protocol
5	Toggle switch for selecting a two-wire or four-wire system	ON: two-wire system OFF: four-wire system	Toggle switches 5 and 6 must be both ON or both OFF.
6	Toggle switch for selecting a two-wire or four-wire system		
7	Control area network (CAN) build-out resistor toggle switch	ON: match OFF: no match	None
8	RS485 build-out	ON: match OFF: no match	None

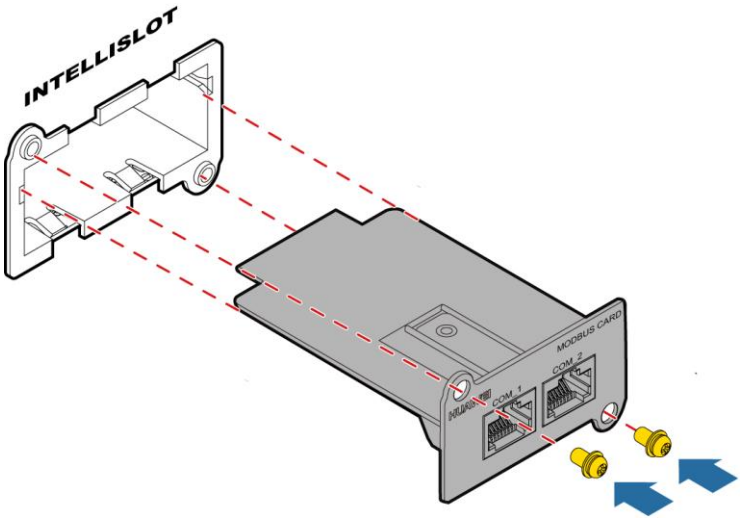
Toggle Switch	Definition	Settings	Remarks
	resistor toggle switch		

NOTE

If the RS485 build-out resistor toggle switch is set to ON, it indicates that there is a build-out resistor. Set the toggle switch as required.

Step 3 Insert the Modbus card into the extended card slot of the UPS, and tighten the screws, as shown in Figure 1-4.

Figure 1-4 Inserting the Modbus card into the optional card slot



Step 4 Set up a network, as shown in Figure 1-5.

1. Connect the COM_1 port (the COM_2 port is used for cascading) on the Modbus card to the RS485 port on the RS232-RS485 adapter over a network cable (a shielded twisted pair is recommended) that meets pin sequence requirements.
2. Connect the RS232 port on the RS232-RS485 adapter to the RS232 port on the PC over a network cable (a shielded twisted pair is recommended) that meets pin sequence requirements.

   Connecting cables for the Modbus card.

Figure 1-5 Connecting cables for the Modbus card

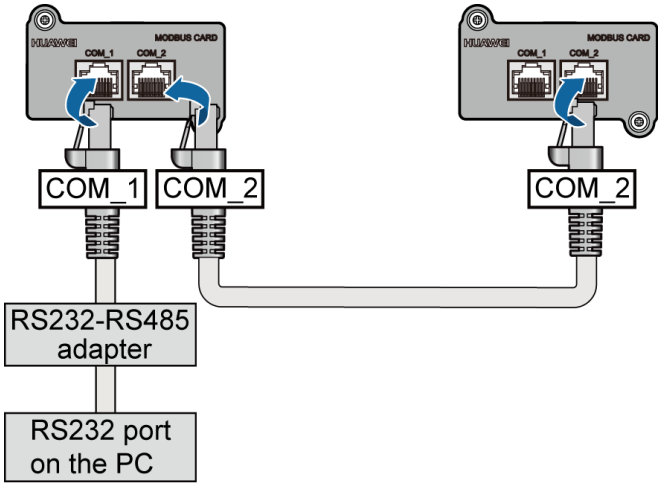


Figure 1-6 shows the RJ45 port pins. For port pin definitions and cable connections, see Table 1-3.

Figure 1-6 RJ45 ports

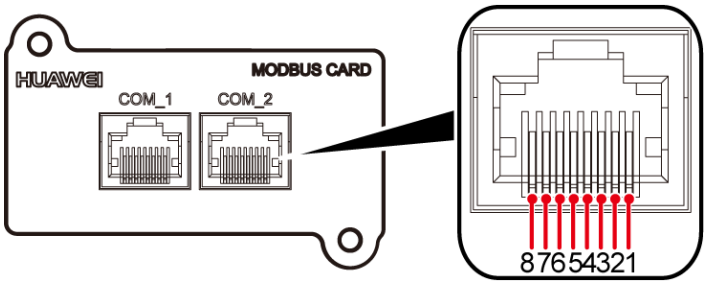


Table 1-3 Pins on an RJ45 port

Pin No.	Signal	Corresponding Signal of RS232-RS485 Adapter	
		Two-wire system	Four-wire system
1	Four-wire system: RS485 TX+ Two-wire system: A	A	RS485 RX+
2	Four-wire system: RS485 TX– Two-wire system: B	B	RS485 RX-
3	None	N/A	N/A
4	Four-wire system: RS485 RX+	N/A	RS485 TX+
5	Four-wire system: RS485 RX–	N/A	RS485 TX–
6	GND	N/A	N/A

Pin No.	Signal	Corresponding Signal of RS232-RS485 Adapter	
		Two-wire system	Four-wire system
7	None	N/A	N/A
8	None	N/A	N/A

----End

1.4 Communication Mode at the Physical Layer

After the slave nodes are powered on or reset, and run steadily, the slave nodes respond to the read or write commands. When the slave nodes receive the relevant command, the slave nodes return the queried information to the master node under normal conditions. Under abnormal conditions, the slave nodes return the specific error codes corresponding to the error types.

Table 1-4 lists the error codes.

Table 1-4 Error code list

No.	Name	Description
0x01	Invalid function code	Slave nodes received unsupported or incorrect function codes.
0x02	Invalid parameter	Slave nodes received invalid function code parameters.
0x03	Invalid data	Slave nodes received invalid data such as CRC checking error.
0x04	Slave node execution failed	Slave nodes failed to respond to the command.
0x05	Reload the start command	Slave nodes are busy.

1.5 Command Type and Format at the Application Layer

1.5.1 Function Code List

Function Code	Meaning	Remarks
0x03	Read command	Continuously read a single or multiple registers.
0x06	Write single register command	Write commands to a single register.
0x2B	Read device identifier command	N/A

1.5.2 CRC Checking Algorithm

```
unsigned short count_CRC(unsigned char *addr, int num)
{
    unsigned short CRC = 0xFFFF;
    int i;
    while (num--)
    {
        CRC ^= *addr++;
        for (i = 0; i < 8; i++)
        {
            if (CRC & 1)
            {
                CRC >>= 1;
                CRC ^= 0xA001;
            }
            else
            {
                CRC >>= 1;
            }
        }
    }
    return CRC;
}
```

1.5.3 Definition and Format for the Read Device Identifier Command

1.5.3.1 Frame Format

Command frame:

Byte	0	1	2	3	4	5	6
Field	ADDR	CMD	MEI	ReadDev ID	Target ID	LSB	MSB
Description	Controller address	Function code	MEI type	ReadDev ID	Object ID	CRC checking	

Response frame:

The response frame is not fixed. The frame depends on the object ID.

1.5.3.2 Command Definition

This command code allows reading identifiers and added packages that are relevant to the physical and function description of the remote devices.

Simulate the port of the read device identifier as an address space. This address space consists of a set of addressable data elements. The data elements are objects to be read, and the object IDs determine these data elements.

A data element consists of three elements:

- Basic device identifier: All objects are mandatory such as the manufacturer name, product code, and revision version.
- Normal device identifier: Except the basic data objects, the device provides additional and optional identifiers and data object description. Define all types of objects according to standard definitions, but the execution of this type of objects is optional.
- Extension device identifier: Except the basic data objects, the device provides additional and optional identifiers and special data object description. All these data are related to the device.

Object ID	Object Name or Description	Type	Mandatory or Optional (M/O)	Category
0x00	Manufacturer name	ASCII character string	M	Basic
0x01	Product code	ASCII character string	M	
0x02	Main revision version	ASCII character string	M	
0x03-0x7F	N/A	N/A	N/A	Normal

Object ID	Object Name or Description	Type	Mandatory or Optional (M/O)	Category
0x80-0xFF	N/A	N/A	N/A	Extension

Request PDU:

Function Code	1 byte	0x2B
MEI Type	1 byte	0x0E
ReadDevID Code	1 byte	0x01/0x02/0x03/0x04
Object ID	1 byte	0x00 to 0xFF

Request parameter description:

- Function code: 43 (decimal), 0x2B (hexadecimal).
- MEI type: The MEI type of 14 (0x0E) assigned to the device identifier port.
- The ReadDevID has four access types:
  - 0x01: request to obtain the basic device identifier (stream access)
  - 0x02: request to obtain the normal device identifier (stream access)
  - 0x03: request to obtain the extension device identifier (stream access)
  - 0x04: request to obtain the special device identifier (special access)

If the identifier data is not suitable for individual responses, you can require several request and response transactions. The object ID byte provides the first identifier code obtained. For the first transaction, the client must set the object ID to 0x00 to obtain the start of the device identifier data. For the subsequent transactions, the client must set the object ID to the value returned by the previous responded server.

If the object ID does not match any known object, the server points to the object numbered 0x00 (from the start).

For single access, the ReadDevID code is 0x04. The object ID in the requesting process provides the obtained object identifier code.

If the object ID does not match any known object, the server returns an abnormal code numbered 0x02 (invalid data address).

Response PDU:

Function Code	1 byte	0x2B
MEI Type	1 byte	0x0E
ReadDevID Code	1 byte	0x01/0x02/0x03/0x04
Consistency Level	1 byte	N/A
More	1 byte	0x00/0xFF

Next Object ID	1 byte	Object ID number
Object Number	1 byte	N/A
Object ID List	1 byte	N/A
Object Length	1 byte	N/A
Object Value	1 byte	N/A

Response parameter description:

- Function code: 43 (decimal), 0x2B (hexadecimal).
- MEI type: The MEI type of 14 (0x0E) assigned to the device identifier port.
- ReadDevID code: same as the request ReadDevID, 0x01, 0x02, 0x03, or 0x04.
- Consistency level: The consistency level for the device identifiers and types of supported accesses.
  - 0x01: basic identifier code (stream access only)
  - 0x02: normal identifier code (stream access only)
  - 0x03: extension identifier code (stream access only)
  - 0x81: basic identifier code (stream access and single access)
  - 0x82: normal identifier code (stream access and single access)
  - 0x83: extension identifier code (stream access and single access)
- More: If the identifier code is 0x01, 0x02, or 0x03 (stream access) and the identifier data does not match the single response, you can require several request and response transactions.
  - 0x00: The object is no longer usable
  - 0xFF: Other identifier objects are usable, and more Modbus transactions are required

  For the ReadDevID code 0x04 (single access), this field must be set to 0x00.
- Next object ID: If more is 0xFF, require the next object identifier code. If more is 0x00, set to 0x00 (unused).
- Object number: returned object identifier number in the response process.

  For single access, the object number is 0x01.
- Object 0.ID: the first object identifier code (stream access) or requested object identifier code (single access) returned by the PDU.
- Object 0.length: the byte length of the first object.
- Object 0.value: the value of the first object (the byte of the object 0.length).

…

- Object N.ID: the last object identifier code in the response process.
- Object N.length: the byte length of the last object.
- Object N.value: the value of the last object (the byte of the object N.length).

Abnormal response PDU:

Function Code	1 byte	0xAB

Exception Code	2 byte	N/A

1.5.3.3 Frame Format Examples

The following are some request examples of the read device identifiers of the basic device identifiers:

In this example, all objects are returned to one response PDU.

Request		**Response**	
Domain	Value	Domain	Value
Function Code	0x2B	Function Code	0x2B
MEI Type	0x0E	MEI Type	0x0E
ReadDevID Code	0x01	ReadDevID code	0x01
Object ID	0x00	Consistency Level	0x01
		More	0x00
		Next Object ID	0x00
		Object Number	0x03
		Object ID	0x00
		Object Length	0x16
		Object Value	"Company identifier"
		Object ID	0x01
		Object Length	0x0A
		Object Value	"Product code"
		Object ID	0x02
		Object Length	0x05
		Object Value	"V2.11"

If one device needs several transactions to process responses, execute the following transactions.

First transaction:

Request		**Response**	
Domain	Value	Domain	Value
Function Code	0x2B	Function Code	0x2B

Request		Response	
MEI Type	0x0E	MEI Type	0x0E
ReadDevID Code	0x01	ReadDevID code	0x01
Object ID	0x00	Consistency Level	0x01
		More	0xFF
		Next Object ID	0x02
		Object Number	0x03
		Object ID	0x00
		Object Length	0x16
		Object Value	"Company identifier"
		Object ID	0x01
		Object Length	0x1A
		Object Value	"Product code"

Second transaction:

Request		Response	
Domain	Value	Domain	Value
Function Code	0x2B	Function Code	0x2B
MEI Type	0x0E	MEI Type	0x0E
ReadDevID Code	0x01	ReadDevID code	0x01
Object ID	0x02	Consistency Level	0x01
		More	0x00
		Next Object ID	0x00
		Object Number	0x03
		Object ID	0x02
		Object Length	0x05
		Object Value	"V2.11"

1.5.3.4 Query Device Identification Information Command

1.5.3.4.1 Request Frame Format

Function Code	1 byte	0x2B
MEI Type	1 byte	0x0E
ReadDevID Code	1 byte	0x01
Object ID	1 byte	0x00

1.5.3.4.2 Response Frame Format

Function Code			1 byte	0x2B
MEI Type			1 byte	0x0E
ReadDevID Code			1 byte	0x01
Consistency Level			1 byte	0x01
More			1 byte	N/A
Next Object ID			1 byte	N/A
Object Number			1 byte	N/A
Object List	**First Object**	**Object ID**	1 byte	0x00
		Object Length	1 byte	N
		Object Value	N byte	N/A
	…	**…**	…	…

Object ID	Object Name or Description	Description	Category
0x00	Manufacturer name	"HUAWEI"	Basic
0x01	Product code	• "UPS2000" • "UPS2000A"	
0x02	Main revision version	ASCII character string, software version	

NOTE

The product code UPS2000 or UPS2000A will be returned. The signal lists for these two products are different. For details, see section 2 Modbus Card Signal List.

1.5.4 Definition and Format of Read Command

1.5.4.1 Read Command Definition

This command can be used to read a single or multiple registers.

1.5.4.2 Read Command Format

1.5.4.2.1 Request Frame Format

Byte	0	1	2	3	4	5	6	7
Field	ADDR	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Description	Controller address	Command type	Register starting address		Number of registers n		CRC checking	

NOTE

For example, the request frame is 11 03 2A F8 00 01 0F 73.

11 is the slave device address. 03 is the read command. 2AF8 is the register address. 0001 indicates the number of registers to be read is 1. 0F73 is the CRC checking value.

1.5.4.2.2 Response Frame Format

Byte	0	1	2	3	4	5	6	…	L+1	L+2	L+3	L+4
Field	ADDR	CMD	Length	MSB	LSB	MSB	LSB	…	MSB	LSB	LSB	MSB
Description	Controller address	Command type	Data length L = n x 2	First register value		Second register value		…	Last register value		CRC checking	

NOTE

For example, the response frame is 11 03 02 00 01 B8 47.

11 is the slave device address. 03 is the read command. 02 is the length of data to be read. 0001 indicates the first register value to be read. B847 is the CRC checking value.

1.5.5 Definition and Format for the Write Single Register Command

1.5.5.1 Definition for the Write Single Register Command

This command is used to write to a single register.

1.5.5.2 Format for the Write Single Register Command

1.5.5.2.1 Request Frame Format

Byte	0	1	2	3	4	5	6	7
Field	ADDR	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Description	Controller address	Command type	Register address		Data		CRC checking	

NOTE

For example, the request frame is 11 06 2B 15 00 01 52 BA.

11 is the slave device address. 06 is the write single register command. 2B15 is the register address. 0001 is the setting value. 52BA is the CRC checking value.

1.5.5.2.2 Response Frame Format

Byte	0	1	2	3	4	5	6	7
Field	ADDR	CMD	MSB	LSB	MSB	LSB	LSB	MSB
Description	Controller address	Command type	Register address		Data		CRC checking	

NOTE

The format of the request and response frames is the same for the write single device command.

For example, the response frame is 11 06 2B 15 00 01 52 BA.

11 is the slave device address. 06 is the write single register command. 2B15 is the register address. 0001 is the setting value. 52BA is the CRC checking value.

2 Modbus Card Signal List

2.1 Collection and Configuration

2.1.1 Signal List Description

The signal names are the meanings of the signals.

The parameter types are the internal storage states of the signals in the RMS-MODBUS01A card.

The gains are to ensure that in the Modbus communication, all data are transmitted in the format of unsigned short integers to avoid the Modbus frames transmitting overly complex data.

For the R/W attributes, R is read only, W is write only, and RW is read and write.

For the register addresses, N is the UPS number with a range from 1 to 4. This number is assigned by the RMS-MODBUS01A card. You can identify any UPS number by its corresponding ESN number.

NOTE

For example, the register address of the UPS 1 phase A input voltage is 11000 = 0x2AF8.

2.1.2 Collection Signal List

Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
Input phase voltage (A)	Floating point	10	V	N1000	1	R
Input phase voltage (B)	Floating point	10	V	N1001	1	R
Input phase voltage (C)	Floating point	10	V	N1002	1	R

Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
Input frequency	Floating point	10	Hz	N1003	1	R
Bypass phase voltage (A)	Floating point	10	V	N1004	1	R
Bypass phase voltage (B)	Floating point	10	V	N1005	1	R
Bypass phase voltage (C)	Floating point	10	V	N1006	1	R
Bypass frequency	Floating point	10	Hz	N1007	1	R
Output phase voltage (A)	Floating point	10	V	N1008	1	R
Output phase voltage (B)	Floating point	10	V	N1009	1	R
Output phase voltage (C)	Floating point	10	V	N1010	1	R
Output current (A)	Floating point	10	A	N1011	1	R
Output current (B)	Floating point	10	A	N1012	1	R
Output current (C)	Floating point	10	A	N1013	1	R
Output frequency	Floating point	10	Hz	N1014	1	R
Output active power (A)	Floating point	10	kW	N1015	1	R
Output active power (B)	Floating point	10	kW	N1016	1	R
Output active power (C)	Floating point	10	kW	N1017	1	R
Output apparent power (A)	Floating point	10	kVA	N1018	1	R
Output apparent power (B)	Floating point	10	kVA	N1019	1	R
Output	Floating	10	kVA	N1020	1	R

Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
apparent power (C)	point					
Load ratio (A)	Floating point	10	%	N1021	1	R
Load ratio (B)	Floating point	10	%	N1022	1	R
Load ratio (C)	Floating point	10	%	N1023	1	R
Power status	Unsigned short integer (16 bits)	1	0: No power supplied 1: Bypass mode 2: Mains mode 3: Battery mode 5: Mains ECO 6: Battery ECO	N1024	1	R
Input mode	Unsigned short integer (16 bits)	1	0: single-phase 1: three-phase The input system determines whether the mains mode is single- or three-phase.	N1025	1	R

Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
Output mode	Unsigned short integer (16 bits)	1	0: single-phase 1: three-phase The output system determines whether the bypass and output modes are single- or three-phase.	N1026	1	R
Inside-UPS temperature	Floating point	10	℃	N1027	1	R
Redundant number	Unsigned short integer (16 bits)	1	0–3	N1041	1	R
Battery voltage	Floating point	10	V	N2000	1	R
Battery current	Floating point	10	A	N2001	1	R
Battery status	Unsigned short integer (16 bits)	1	2: hibernating 3: floating charging 4: equalized charging 5: discharging	N2002	1	R

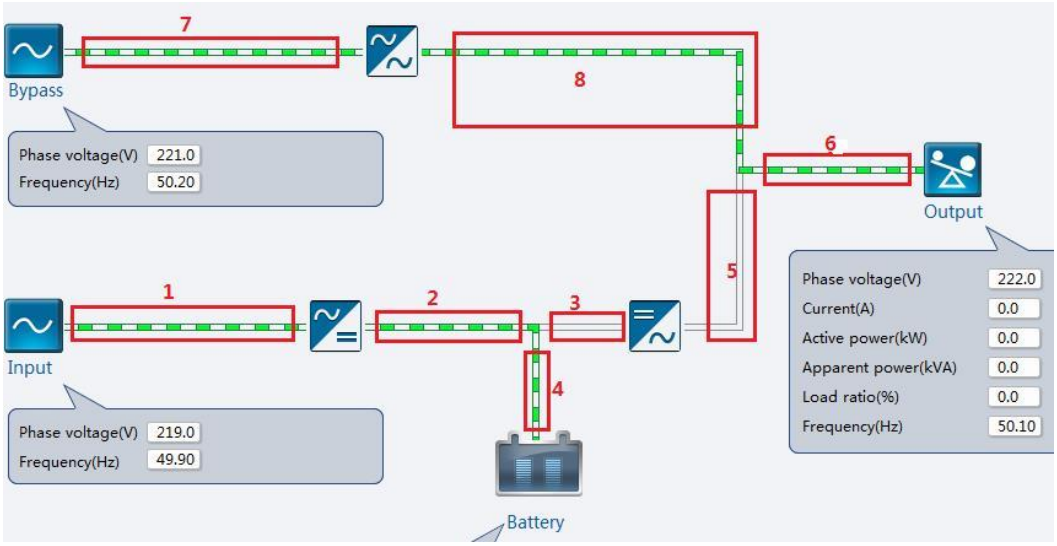
Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
Remaining capacity	Unsigned short integer (16 bits)	1	%	N2003	1	R
Battery backup time	Unsigned integer (32 bits)	1	s	N2004	2	R
Battery temperature	Floating point	10	℃	N2006	1	R
Parallel output active power (A)	Floating point	10	kW	N4000	1	R
Parallel output active power (B)	Floating point	10	kW	N4001	1	R
Parallel output active power (C)	Floating point	10	kW	N4002	1	R
Parallel output apparent power (A)	Floating point	10	kVA	N4003	1	R
Parallel output apparent power (B)	Floating point	10	kVA	N4004	1	R
Parallel output apparent power (C)	Floating point	10	kVA	N4005	1	R
Parallel load ratio (A)	Floating point	10	%	N4006	1	R
Parallel load ratio (B)	Floating point	10	%	N4007	1	R
Parallel load ratio (C)	Floating point	10	%	N4008	1	R
Device list change serial number	Unsigned short integer (16 bits)	1	N/A	N9004	1	R
Configuration signal change serial number	Unsigned short integer (16 bits)	1	N/A	N9005	1	R
Energy flow diagram	Unsigned short integer	1	00:	N9006	1	R

Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
segment 1	(16 bits)		hollow 01: solid 10: flow to the right	(bit 1, 0)		
Energy flow diagram segment 2	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow to the right	N9006 (bit 3, 2)	1	R
Energy flow diagram segment 3	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow to the right	N9006 (bit 5, 4)	1	R
Energy flow diagram segment 4	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow downwards 11: flow upwards	N9006 (bit 7, 6)	1	R
Energy flow diagram segment 5	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow to the right	N9006 (bit 9, 8)	1	R
Energy flow diagram segment 6	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow to the right	N9006 (bit 11, 10)	1	R
Energy flow diagram segment 7	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow	N9006 (bit 13, 12)	1	R

Signal Namee	Parameter Type	Gain	Unit or Range	Register Address	Address Length (Number of Digits)	R/W Attribute
			to the right			
Energy flow diagram segment 8	Unsigned short integer (16 bits)	1	00: hollow 01: solid 10: flow to the right	N9006 (bit 15, 14)	1	R
UPS hardware power level	Unsigned short integer (16 bits)	1	16: 6 kVA 32: 10 kVA 64: 20 kVA	N9007	1	R
UPS device connection state	Unsigned short integer (16 bits)	1	1: normal 0: disconnect 2: normal communication, invalid service functions Not used to determine whether the UPS is online.	N9008	1	R
UPS model	Floating point	10	(0,100]	N9009	1	R
UPS version	Character string	1	N/A	N9011	10	R

NOTE

The relationship between the state registers' serial numbers and the energy flow diagram are shown in the following figure.



NOTE

- When the RMS-MODBUS01A card is connected to only one UPS, you can use 0 as the UPS number. That is, you can directly use the basic register address to query the corresponding value.
- Some registers may return the following invalid values:

  0x7FFF: invalid value of the floating point type returned by one register

  0xFFFF: invalid value of a type other than the floating point type returned by one register

  0xFFFFFFFF: invalid value returned by two registers

2.1.3 Configuration and Control Signal List

Signal Name	Parameter Type	Range	Gain	Register Address	Address Length (Number of Digits)	R/W Attribute
Startup state	Unsigned short integer (16 bits)	00: Shutdown (you can start) 01: Starting (intermediate state, unable to perform any actions, LCD is locked) 10: startup failed (you can power on) 11: startup completed (you can power off)	1	N1028	1	R
Startup	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N1029	1	W

Signal Name	Parameter Type	Range	Gain	Register Address	Address Length (Number of Digits)	R/W Attribute
Shutdown	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N1030	1	W
Single UPS ECO	Unsigned short integer (16 bits)	0: disabled 1: enabled Only configurable when the startup state is 00 or 10.	1	N1031	1	R
EPO	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N1042	1	W
Shallow discharge test*	Unsigned short integer (16 bits)	0: disabled 1: enabled	1	N2008	1	RW
Time interval*	Unsigned short integer (16 bits)	30 ~90 Day	1	N2009	1	RW
Discharge ratio*	Unsigned short integer (16 bits)	10~50%	1	N2010	1	RW
Battery conversion from floating charging to equalized charging*	Unsigned short integer (16 bits)	0: yes Non-zero: no	1	N2011	1	R
Battery conversion from manual charging to equalized charging*	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N2012	1	W

Signal Name	Parameter Type	Range	Gain	Register Address	Address Length (Number of Digits)	R/W Attribute
Battery conversion from equalized charging to floating charging *	Unsigned short integer (16 bits)	0: yes Non-zero: no	1	N2015	1	R
Battery conversion from manual charging to floating charging *	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N2016	1	W
Battery test*	Unsigned short integer (16 bits)	0: Both a shallow discharge test and a capacity test can be conducted. If bit 15 is 1 and bits 14–8 are 0: Only a shallow discharge test can be conducted. Other cases: No test can be conducted.	1	N2019	1	R
Shallow discharge test*	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N2020	1	W
Capacity test*	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N2021	1	W
Battery test stop*	Unsigned short integer (16 bits)	0: yes Non-zero: no	1	N2022	1	R

Signal Name	Parameter Type	Range	Gain	Register Address	Address Length (Number of Digits)	R/W Attribute
Stop test*	Unsigned short integer (16 bits)	The register value is fixed at 1.	1	N2023	1	W

NOTE

The UPS2000A does not support battery tests or the switching between equalized charging and float charging. The signal name is marked with * to differentiate.

2.2 Alarms

2.2.1 Signal List Description

The definitions for the UPS alarm register addresses comply with the following rules:

Register address: basic register address + UPS number x 1024

The range of the UPS number is from 1 to 4.

NOTE

- For example, the register address of the UPS 1 mains abnormal voltage alarm is 40155 + 1024 = 41179 = 0xA0DB; the register address of the UPS 2 mains abnormal voltage alarm is 40155 + 2 x 1024 = 42203 = 0xA4DB.
- When the RMS-MODBUS01A card is connected to only one UPS, you can use 0 as the UPS number. That is, you can directly use the basic register address to query the corresponding value.

If the query is across registers, and a register is not defined in this table, the returned register value is 0.

2.2.2 Alarm Signal List

Alarm ID	Alarm Cause ID	Alarm	Basic Register Address	Bit Value
0041	1	Rectifier fault	40155	0
0041	2	Rectifier fault	40155	1
0045	3	Charger alarm	40155	4
0045	4	Charger alarm	40155	5
0045	6	Charger alarm	40155	7
0045	7	Charger alarm	40155	8
0045	8	Charger alarm	40155	9

Alarm ID	Alarm Cause ID	Alarm	Basic Register Address	Bit Value
0001	1	Abnormal mains voltage	40155	10
0006	1	Mains undervoltage	40155	11
0001	2	Abnormal mains voltage	40155	12
0001	3	Abnormal mains voltage	40155	13
0004	1	Mains phase reverse	40155	14
0005	1	Mains neutral loss	40155	15
0007	1	Battery transfer overlimit	40156	0
0008	1	Rectifier start overlimit	40156	1
0009	1	Mains overload	40156	2
0030	1	UPS internal overtemperature	40156	3
0041	3	Rectifier fault	40156	4
0065	2	Power segment	40156	5
0061	1	Inverter alarm	40158	0
0061	2	Inverter alarm	40158	1
0065	1	Power segment	40159	0
0067	1	Parallel set failure	40159	1
0084	2	Parallel cable alarm	40159	2
0084	3	Parallel cable alarm	40159	3
0094	1	Redundancy failure	40159	4
0131	1	Ambient overtemperature	40160	0
0133	1	Ambient undertemperature	40160	1
0134	1	Ambient overhumidity	40160	2
0135	1	Ambient underhumidity	40160	3
0136	1	Faulty temperature and humidity module	40160	4
0340	1	Maintenance breaker ON	40160	5
0010	1	Abnormal bypass voltage	40161	1
0010	2	Abnormal bypass voltage	40161	2
0011	1	Bypass phase reverse	40161	3
0023	1	Battery overtemperature	40163	0

Alarm ID	Alarm Cause ID	Alarm	Basic Register Address	Bit Value
0024	1	Battery undertemperature	40163	2
0025	1	Battery overvoltage	40163	3
0027	1	Battery overcurrent	40164	0
0029	1	Maintain battery	40164	1
0036	1	Battery maintenance notification	40164	2
0026	1	Battery undervoltage	40164	3
0086	1	Bypass transfer overlimit	40165	2
0012	1	Bypass neutral loss	40165	6
0096	1	Abnormal ECO voltage	40165	13
0028	1	Breaker OFF	40168	0
0028	2	Breaker OFF	40168	1
0028	3	Breaker OFF	40168	2
0105	5	Communication failure	40168	3
0125	1	Inconsistent parallel parameters	40168	4
61440	1	Flash fault	40168	5
0040	1	Rectifier fault	40169	0
0040	2	Rectifier fault	40169	1
0040	4	Rectifier fault	40169	3
0040	5	Rectifier fault	40169	4
0040	6	Rectifier fault	40169	5
0040	7	Rectifier fault	40169	6
0040	9	Rectifier fault	40169	8
0040	10	Rectifier fault	40169	9
0042	1	Internal fault	40169	13
0042	2	Internal fault	40169	14
0044	1	Incompatible version	40169	15
0044	2	Incompatible version	40170	0
0044	3	Incompatible version	40170	1
0020	1	Battery reverse	40170	2

Alarm ID	Alarm Cause ID	Alarm	Basic Register Address	Bit Value
0022	1	No battery	40170	4
0043	1	Fan fault	40170	10
0032	1	Battery OTP	40170	13
0043	6	Fan fault	40171	0
0045	9	Charger alarm	40171	1
0045	10	Charger alarm	40171	2
0042	9	Internal fault	40171	3
0042	10	Internal fault	40171	4
0042	11	Internal fault	40171	5
0042	12	Internal fault	40171	6
0042	13	Internal fault	40171	7
0159	1	Battery mode alarm	40171	8
0060	1	Inverter fault	40172	0
0060	2	Inverter fault	40172	1
0060	3	Inverter fault	40172	2
0060	4	Inverter fault	40172	3
0060	5	Inverter fault	40172	4
0060	8	Inverter fault	40172	7
0042	3	Internal fault	40172	14
0044	4	Incompatible version	40173	0
0044	5	Incompatible version	40173	1
0044	6	Incompatible version	40173	2
0064	1	Overload timeout.	40173	3
0066	1	Output overload	40173	5
0014	1	Startup timeout	40174	0
0060	7	Inverter fault	40174	1
0064	2	Overload timeout	40174	2
0066	2	Output overload	40174	3
0070	1	Bypass fault	40174	4

Alarm ID	Alarm Cause ID	Alarm	Basic Register Address	Bit Value
0070	2	Bypass fault	40174	5
0071	1	Bypass backfeed	40174	6
0083	1	Parallel cable fault	40174	7
0083	2	Parallel cable fault	40174	8
0083	4	Parallel cable fault	40174	9
0083	5	Parallel cable fault	40174	10
0083	6	Parallel cable fault	40174	11
0107	1	Module internal fault	40174	12
0158	1	Bypass mode alarm	40174	13
0031	1	Battery OTP	40179	3
0001	4	Abnormal mains voltage	40179	12
0042	14	Internal fault	40179	13
0042	15	Internal fault	40179	14
0042	17	Internal fault	40179	15
0035	1	Replace battery	40180	0
0042	18	Internal fault	40180	1
0042	19	Internal fault	40180	2
0042	20	Internal fault	40180	3
0042	23	Internal fault	40180	4
0042	24	Internal fault	40180	5
0042	27	Internal fault	40180	6
0042	28	Internal fault	40180	7
0042	29	Internal fault	40180	8
0042	30	Internal fault	40180	9
0042	31	Internal fault	40180	10
0042	32	Internal fault	40180	11
0042	34	Internal fault	40180	12
0042	36	Internal fault	40180	13
0042	37	Internal fault	40180	14

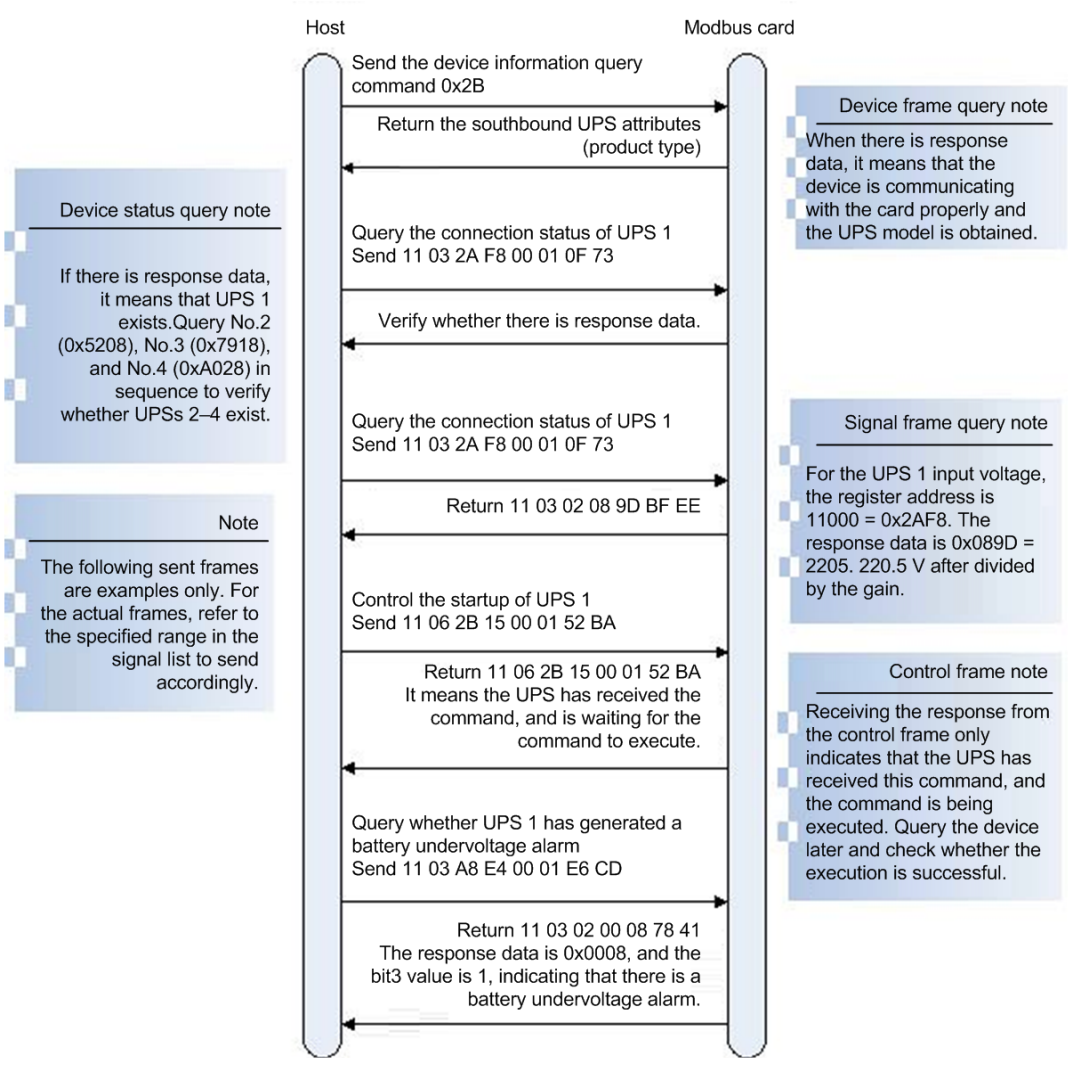
Alarm ID	Alarm Cause ID	Alarm	Basic Register Address	Bit Value
0042	38	Internal fault	40180	15
0042	39	Internal fault	40182	1
0042	40	Internal fault	40182	2
0042	41	Internal fault	40182	3
0042	42	Internal fault	40182	4
0085	1	EPO	40182	5
0042	48	Internal fault	40182	8
0042	49	Internal fault	40182	9
0042	60	Internal fault	40182	10
0043	2	Fan fault	40182	11
0058	1	Flash fault	40182	12
0066	3	Output overload	40182	13
0066	4	Output overload	40182	14
0059	1	Maintenance breaker ON	40182	15
0042	55	Internal fault	40183	0
0066	5	Output overload	40183	1
0034	1	Remaining cap. warning	40183	2

3 Examples for the Host Communication Process

According to the command types of the communication protocols, you can identify the register addresses of every UPS semaphore. There is a need for the UPS serial number offset.

Before collecting and setting the UPS semaphores, query the condition of the southbound connections between the RMS-MODBUS01A card and the UPS, and confirm the number assigned to every UPS by the RMS-MODBUS01A card, ensuring normal query of semaphores needed.

The following diagram shows a communication process for reference.



A. Query device identification information.

Query frame: 11 2B 0E 01 00 B1 B4

Response frame (for the convenience of viewing, the response frame is shown in segments):

11 2B 0E 01 01 00 00 03 00 06 48 55 41 57 45 49 01 07 55 50 53 32 30 30 30 02

13 55 50 53 32 30 30 30 20 56 31 30 30 52 30 30 31 43 30 30 D9 03

According to section 1.5.3.4 Query Device Identification Information Command the following information can be obtained.

Object ID	Object Name or Description	Description
0x00	Manufacturer name	HUAWEI
0x01	Product code	UPS2000
0x02	Main revision version	UPS2000 V100R001C00

B. Query the status of UPSs 1–4 on a regular basis.

Take querying the status of UPS 1 as an example. The signal collecting register address of the UPS 1 phase A input voltage is 11000, which is 0x2AF8 in hexadecimal format.

Query frame: 11 03 2A F8 00 01 0F 73

Response frame: 11 03 02 08 9D BF EE

When there is response data, it means that UPS 1 exists. If there is no response data, it means that No. 1 does not connect to a UPS, or the connected UPS fails in communication.

Continue to query the registers of No. 2 (0x5208), No. 3 (0x7918), and No. 4 (0xA028) to obtain the status of UPSs 2–4.

Next, according to the UPS number, you can query and set the corresponding semaphores.

C. Query the phase A input voltage of UPS 1:

Query frame: 11 03 2A F8 00 01 0F 73

Response frame: 11 03 02 08 9D BF EE

According to section 2.1.2 Collection Signal List, the register address of the UPS 1 phase A input voltage is 11000, which is 0x2AF8 in hexadecimal format. The response data is 0x089D, which is 2205 in decimal format. Divided by the gain 10, the value is 220.5, which indicates the phase A input voltage of UPS 1 is 220.5 V.

D. Control UPS 2 to switch from manual charging to equalized charging:

Set frame: 11 06 55 FC 00 01 9B 66

Response frame: 11 06 55 FC 00 01 9B 66

E. Query UPS 3 battery undervoltage alarm state:

Query frame: 11 03 A8 E4 00 01 E6 CD

Response frame: 11 03 02 00 08 78 41

The basic register address of the battery undervoltage alarm is 40164. Add the UPS 3 offset address to get:

40164 + 3 x 1024 = 43236 = 0xA8E4

The response data is 0x0008, and the bit3 value is 1, indicating the battery undervoltage alarm exists.

A Acronyms and Abbreviations

C

CRC	Cyclical Redundancy Check

E

ECO	Economic Control Operation
EOD	End Of Discharge
EPO	Emergency Power Off

U

UPS	Uninterruptible Power Supply