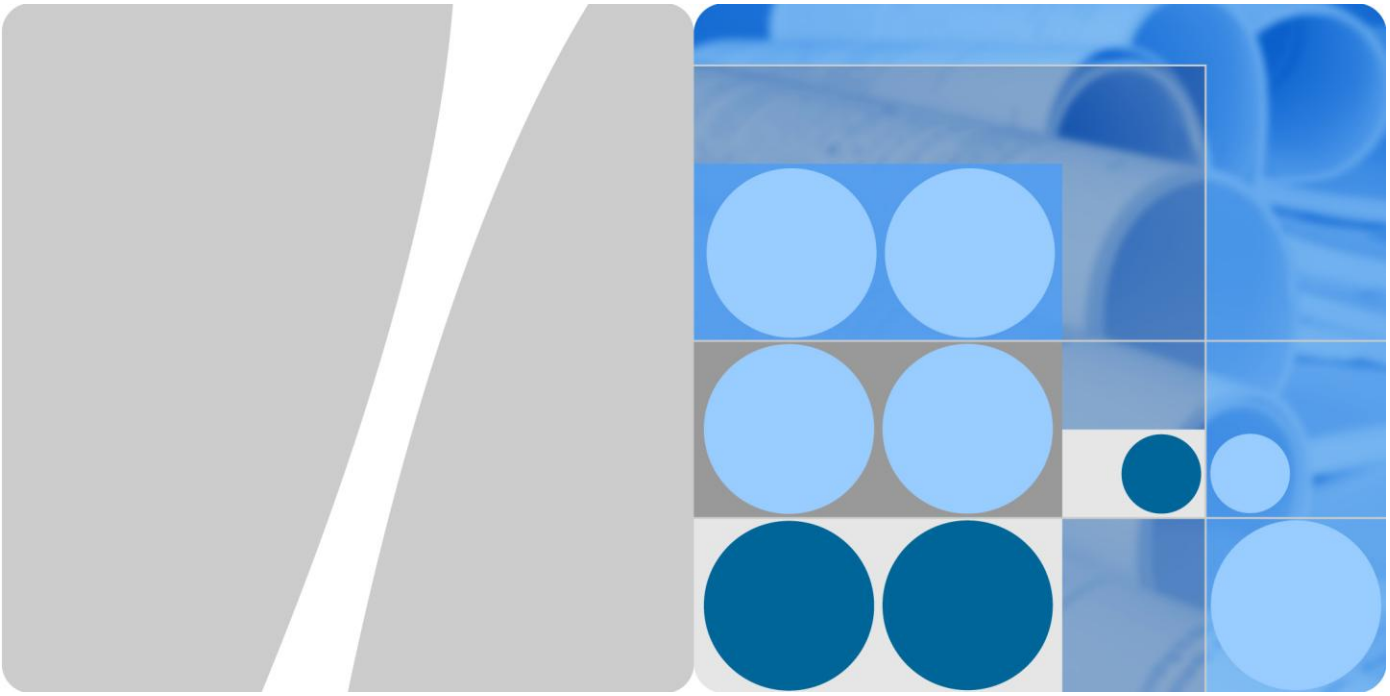

SUN2000MA
V100R001

MODBUS Interface Definitions

Issue 01

Date 2019-01-02

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Contents

1 Introduction

This document describes the Modbus protocol used by Huawei inverters and provides standards and constraints for future third-party integration, development, and customization. Huawei inverters comply with the standard Modbus protocol, and this document describes only the information special for Huawei inverters. For other information about Modbus, see the documents about the standard Modbus protocol.

1.1 Terms and Abbreviations

Table 1-1 Terms and Abbreviations

Name	Description
Master node	During master-slave communication, the party that initiates a communication request is referred to as the master node.
Slave node	During master-slave communication, the party that responds to a communication request is referred to as the slave node.
Broadcast address	Fixed to 0.
Register address	The address of a register is recorded in two bytes.
U16	Unsigned integer (16 bits)
U32	Unsigned integer (32 bits)
I16	Signed integer (16 bits)
I32	Signed integer (32 bits)
STR	String

Name	Description
MLD	Multiple bytes
N/A	Not applicable
s	Second
Epoch seconds	The number of seconds that have elapsed since 1970-01-01 00: 00: 00
RO	Value can only be read
RW	Value can be read and written

1.2 System Requirements

Software version:SUN2000MA V100R001C00 or later

1.3 Inverter Models and Rated Power

Table 1-2 Rated inverter capacity

Model ID	Model Name
400	SUN2000-5KTL-M0
401	SUN2000-5KTL-M0
402	SUN2000-6KTL-M0
403	SUN2000-6KTL-M0
404	SUN2000-8KTL-M0
405	SUN2000-8KTL-M0
406	SUN2000-10KTL-M0
407	SUN2000-10KTL-M0
408	SUN2000-12KTL-M0
410	SUN2000-3KTL-M0
411	SUN2000-4KTL-M0

NOTE

The maximum active power (Pmax), maximum reactive power (Qmax), and rated power (Pn) corresponding to each model can be obtained through the register interface.

2 Register Definitions

Table 2-1 Register Definitions

SN	Signal Name	Read /Write	Type	Unit	Gain	Address	Quantity	Scope
1	Model Name	RO	STR	N/A	1	30000	15	1.3 Inverter Models and Rated Power
2	SN	RO	STR	N/A	1	30015	10	N/A
3	PN	RO	STR	N/A	1	30025	10	N/A
4	Model ID	RO	U16	N/A	1	30070	1	1.3 Inverter Models and Rated Power
5	String Number	RO	U16	N/A	1	30071	1	N/A
6	MPPT Number	RO	U16	N/A	1	30072	1	N/A
7	Rated power (Pn)	RO	U32	kW	1000	30073	2	N/A
8	Maximum active power (Pmax)	RO	U32	kW	1000	30075	2	N/A
9	Maximum apparent power (Smax)	RO	U32	kVA	1000	30077	2	N/A
10	Maximum reactive power (Qmax, fed to the power grid)	RO	I32	kVar	1000	30079	2	N/A
11	Maximum reactive power (Qmax, absorbed from the power grid)	RO	I32	kVar	1000	30081	2	N/A
12	Standalone teleindication	RO	U16	N/A	1	32000	1	Bit 0: standby

SN	Signal Name	Read /Write	Type	Unit	Gain	Address	Quantity	Scope
								Bit 1: grid connection Bit 2: normal grid connection Bit 3: grid connection with derating due to power rationing Bit 4: grid connection with derating due to inverter internal causes Bit 5: normal stop Bit 6: stop due to faults Bit 7: stop due to power rationing Bit 8: shutdown Bit 9: spot check
13	Operating status	RO	U16	N/A	1	32002	1	Bit 0: locking status (0: locked; 1: unlocked) Bit 1: PV connection status (0: disconnected; 1: connected) Bit 2: DSP data collection (0: no; 1: yes)
14	Alarm 1	RO	U16	N/A	1	32008	1	3 Alarms
15	Alarm 2	RO	U16	N/A	1	32009	1	3 Alarms
16	Alarm 3	RO	U16	N/A	1	32010	1	3 Alarms
17	PV1 Voltage	RO	I16	V	10	32016	1	N/A
18	PV1 Current	RO	I16	A	100	32017	1	N/A
19	PV2 Voltage	RO	I16	V	10	32018	1	N/A
20	PV2 Current	RO	I16	A	100	32019	1	N/A
21	PV3 Voltage	RO	I16	V	10	32020	1	N/A
22	PV3 Current	RO	I16	A	100	32021	1	N/A
23	PV4 Voltage	RO	I16	V	10	32022	1	N/A
24	PV4 Current	RO	I16	A	100	32023	1	N/A
25	Input power	RO	I32	kW	1000	32064	2	N/A
26	Uab	RO	U16	V	10	32066	1	N/A
27	Ubc	RO	U16	V	10	32067	1	N/A
28	Uca	RO	U16	V	10	32068	1	N/A

SN	Signal Name	Read /Write	Type	Unit	Gain	Address	Quantity	Scope
29	Ua	RO	U16	V	10	32069	1	N/A
30	Ub	RO	U16	V	10	32070	1	N/A
31	Uc	RO	U16	V	10	32071	1	N/A
32	Ia	RO	I32	A	1000	32072	2	N/A
33	Ib	RO	I32	A	1000	32074	2	N/A
34	Ic	RO	I32	A	1000	32076	2	N/A
35	Active power peak of current day	RO	I32	kW	1000	32078	2	N/A
36	Active power	RO	I32	kW	1000	32080	2	N/A
36	Reactive power	RO	I32	kVar	1000	32082	2	N/A
37	Power factor	RO	I16	N/A	1000	32084	1	N/A
38	Frequency	RO	U16	Hz	100	32085	1	N/A
39	Inverter efficiency	RO	U16	%	100	32086	1	N/A
40	Cabinet temperature	RO	I16	℃	10	32087	1	N/A
41	Insulation resistance	RO	U16	MΩ	1000	32088	1	N/A
42	Device status	RO	U16	N/A	1	32089	1	0x0000:Idle: Initializing 0x0001:Idle: Detecting ISO 0x0002:Idle: Detecting irradiation 0x0003:Idle: Grid detecting 0x0100:Starting 0x0200:On-grid 0x0201:On-grid: Power limit 0x0202:On-grid:self derating 0x0300:Shutdown: Fault 0x0301:Shutdown: Command 0x0302:Shutdown: OVGR 0x0303:Shutdown:

SN	Signal Name	Read /Write	Type	Unit	Gain	Address	Quantity	Scope
								Communication disconnected 0x0304:Shutdown: Power limit 0x0305:Shutdown: Start manually 0x0306:Shutdown: DC switch OFF 0x0401:Grid dispatch: cos(Phi)-P curve 0x0402:Grid dispatch: Q-U curve 0xA000:Idle: No irradiation 0x0500:Spot-check 0x0501:Spot-checking 0x0600:Inspecting 0X0700:AFCI self-check 0X0800:IV scanning 0X0900:DC input detection
43	Fault code	RO	U16	N/A	1	32090	1	N/A
44	Startup time	RO	U32	N/A	1	32091	2	Epoch seconds, local time
45	Shutdown time	RO	U32	N/A	1	32093	2	Epoch seconds, local time
46	E-Total	RO	U32	kWh	100	32106	2	N/A
47	E-Day	RO	U32	kWh	100	32114	2	N/A
48	System Time	RW	U32	N/A	1	40000	2	[946684800, 3155759999] Epoch seconds, local time
49	Reactive power compensation (PF)	RW	I16	N/A	1000	40122	1	(-1,-0.8]U[0.8,1]
50	Reactive power compensation(Q/S)	RW	I16	N/A	1000	40123	1	(-1,1]
51	Active power derating percent(0.1%)	RW	U16	%	10	40125	1	[0,100]
52	Active power derating (fixed	RW	U32	W	1	40126	2	[0,Pmax]

SN	Signal Name	Read /Write	Type	Unit	Gain	Address	Quantity	Scope
	value W)							
53	Power on	WO	U16	N/A	1	40200	1	N/A
54	Power off	WO	U16	N/A	1	40201	1	N/A
55	Time zone	RW	I16	min	1	43006	1	[-720,840]

3 Alarms

Table 3-1 Alarms List

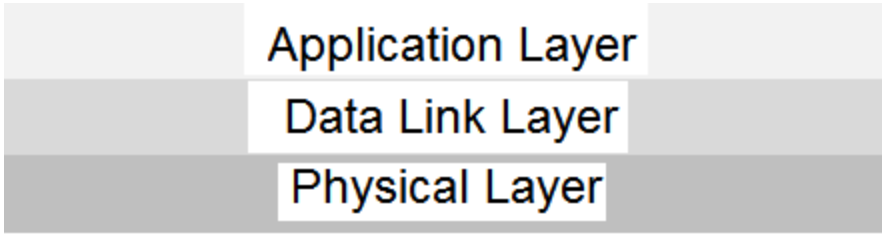
SN	Alarm	Bit	Alarm Name	Alarm ID	Severity
1	Alarm 1	0	High String Voltage	2001	Major
2	Alarm 1	1	DC Arc Fault	2002	Major
3	Alarm 1	2	String Reversed	2011	Major
4	Alarm 1	3	PV String Backfeed	2012	Warning
5	Alarm 1	4	Abnormal String	2013	Warning
6	Alarm 1	5	AFCI Self-test Fault	2021	Major
7	Alarm 1	6	Short circuit between phase to PE	2031	Major
8	Alarm 1	7	Power Grid Failure	2032	Major
9	Alarm 1	8	Grid Undervoltage	2033	Major
10	Alarm 1	9	Grid Overvoltage	2034	Major
11	Alarm 1	10	Unbalanced Grid Voltage	2035	Major
12	Alarm 1	11	Grid Overfrequency	2036	Major
13	Alarm 1	12	Grid Underfrequency	2037	Major
14	Alarm 1	13	Grid Frequency Instability	2038	Major
15	Alarm 1	14	Output Overcurrent	2039	Major
16	Alarm 1	15	Large DC of Output current	2040	Major
17	Alarm 2	0	Abnormal Leakage Current	2051	Major
18	Alarm 2	1	Abnormal Ground.	2061	Major
19	Alarm 2	2	Low Insulation Res.	2062	Major
20	Alarm 2	3	High Temperature	2063	Major
21	Alarm 2	4	Abnormal Equipment	2064	Major

SN	Alarm	Bit	Alarm Name	Alarm ID	Severity
22	Alarm 2	5	Upgrade Failed	2065	Minor
23	Alarm 2	6	License Expired	2066	Warning
24	Alarm 2	7	Abnormal Monitor Unit	61440	Minor
25	Alarm 2	8	Power collector fault	2067	Major
26	Alarm 2	9	Abnormal energy storage device	2068	Minor
27	Alarm 2	10	Active islanding	2070	Major
28	Alarm 2	11	Passive islanding	2071	Major
29	Alarm 2	12	Transient AC overvoltage	2072	Major
30	Alarm 2	15	Abnormal PV module configuration	2080	Major

4 Communication Protocol Overview

The ModBus-TCP communication protocol consists of the following layers:

Figure 4-1 Layers of the ModBus-TCP communication protocol



4.1 Physical Layer

Communicates over an Ethernet.

4.2 Data Link Layer

4.2.1 Addressing Mode

NOTE
The address of device is 0.

4.2.2 Frame Structure

Data Field	Length	Description
MBAP Header	7 byte	Table 4-1

Data Field	Length	Description
Function Code	1 byte	N/A
Data	N byte	N/A

WARNING

A ModBus-TCP frame can contain a maximum of 256 bytes.

The following table describes the format of an MBAP header:

Table 4-1 MBAP Definitions

Data Field	Length (Bytes)	Description	Master Node	Slave Node
Transmission identifier	2	Matching identifier between a request frame and a response frames	Assigned by the master node; better be unique for each data frame.	The identifier of the response frame from the slave node must be consistent with that of the request frame.
Protocol type	2	0 = Modbus protocol	Assigned by the master node; 0 by default.	The identifier of the response frame from the slave node must be consistent with that of the request frame.
Data length	2	Follow-up data length	Assigned by the master node based on the actual data frame.	Assigned by the slave node based on the actual frame length.
Logic device ID	1	0	Assigned by the master node based on the actual data frame request.	The identifier of the response frame from the slave node must be consistent with that of the request frame.

4.2.3 Data Encoding

Modbus uses a big-Endian to represent addresses and data. When multiple bytes are sent, the payload digit leftmost is sent first.

Example:

Register Size	Value

Register Size	Value
16 bits	0x1234

The system sends 0x12, and then sends 0x34.

4.2.4 Interaction Process

A communication process is always initiated by a master node. Slave nodes do not initiate communication processes.

A slave node returns one response for each request from the master node. If the master node does not receive any response from the slave node in 5s, the communication process is regarded as timed out.

4.3 Application Layer

4.3.1 Function Code List

Table 4-2 Function code list

Function Code	Meaning	Remarks
0x03	Read registers.	Supports continuous reading of single or multiple registers.
0x06	Write a single register.	Supports writing into a single register.
0x10	Write multiple registers.	Supports continuous writing into multiple registers.

4.3.2 Exception Code List

The exception codes must be unique for each NE type. The names and descriptions are provided in the NE interface document. Different versions of the same NE type must be backward compatible. Exception codes in use cannot be assigned to other exceptions.

Table 4-3 Table of exception codes returned by an NE (0x00–0x8F are for common exception codes)

Code	Name	Meaning
0x01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the server. This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server is in the wrong state to process a

Code	Name	Meaning
		request of this type, for example because it is unconfigured and is being asked to return register values.
0x02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the server. More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, the PDU addresses the first register as 0, and the last one as 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 4, then this request will successfully operate (address-wise at least) on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 5, then this request will fail with Exception Code 0x02 "Illegal Data Address" since it attempts to perform operations on registers 96, 97, 98, 99 and 100, and there is no register with address 100.
0x03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for server. This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does not mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the Modbus protocol is unaware of the significance of any particular value of any particular register.
0x04	SERVER DEVICE FAILURE	An unrecoverable error occurred while the server was attempting to perform the requested action.
0x06	SERVER DEVICE BUSY	The server does not accept a ModBus request PDU. A client application determines when to resend the request.
0x80	NO PERMISSION	An operation is not allowed because of a permission

Code	Name	Meaning
		authentication failure or permission expiration.

4.3.3 Reading Registers (0X03)

4.3.3.1 Frame Format for a Request from a Master Node

Data Field	Length	Description
Function code	1 byte	0x03
Register start address	2 byte	0x0000–0xFFFF
Number of registers	2 byte	1–125

4.3.3.2 Frame Format for a Normal Response from a Slave Node

Data Field	Length	Description
Function code	1 byte	0x03
Number of bytes	1 byte	2×N
Register value	2xN byte	N/A

NOTE
N indicates the number of registers.

4.3.3.3 Frame Format for an Abnormal Response from a Slave Node

Data Field	Length	Description
Function code	1 byte	0x83
Exception code	1 byte	See the Exception Code List

4.3.3.4 Example

A master node sends a request to a slave node (logic device ID: 00) to query register whose address is 32306/0X7E32. The request frame format is as follows:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01

Description		Frame data
	Protocol Type	00
		00
	Data Length	00
		06
	Logic Device ID	00
Function Code		03
Data	Register Address	7E
		32
	Number of Registers	00
		02

Frame format of a normal response from the slave node:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01
	Protocol Type	00
		00
	Data Length	00
		07
	Logic Device ID	00
Function Code		03
Data	Number of bytes	04
	Register Value	00
		00
		00
		01

Frame format of an abnormal response from the slave node:

Description		Frame data
MBAP Header	Protocol Identifier	00

Description		Frame data
		01
	Protocol Type	00
		00
	Data Length	00
		03
	Logic Device ID	00
Function Code		83
Data	Error Code	03

4.3.4 Writing a Single Register (0X06)

4.3.4.1 Frame Format for a Request from a Master Node

Data Field	Length	Description
Function code	1 byte	0x06
Register Address	2 bytes	0x0000–0xFFFF
Register Value	2 bytes	0x0000–0xFFFF

4.3.4.2 Frame Format for a Normal Response from a Slave Node

Data Field	Length	Description
Function code	1 byte	0x06
Register Address	2 bytes	0x0000–0xFFFF
Register Value	2 bytes	0x0000–0xFFFF

4.3.4.3 Frame Format for an Abnormal Response from a Slave Node

Data Field	Length	Description
Function code	1 byte	0x86
Exception code	1 byte	See the Exception Code List

4.3.4.4 Example

A master node sends instruction(register address: 40200/0X9D08) to a slave node whose address is 00. The request frame format is as follows:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01
	Protocol Type	00
		00
	Data Length	00
		06
	Logic Device ID	00
Function Code		06
Data	Register Address	9D
		08
	Register Value	00
		00

Frame format of a normal response from the slave node:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01
	Protocol Type	00
		00
	Data Length	00
		06
	Logic Device ID	00
Function Code		06
Data	Register Address	9D
		08
	Register Value	00
		00

Frame format of an abnormal response from the slave node:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01
	Protocol Type	00
		00
	Data Length	00
		03
	Logic Device ID	00
Function Code		86
Data	Error Code	04

4.3.5 Writing Multiple Registers(0X10)

4.3.5.1 Frame Format for a Request from a Master Node

Data Field	Length	Description
Function code	1 byte	0x10
Register start address	2 byte	0x0000–0xFFFF
Number of registers	2 byte	0x0000–0x007b
Number of bytes	1 byte	2×N
Register value	2×N byte	Value

NOTE
N indicates the number of registers.

4.3.5.2 Frame Format for a Normal Response from a Slave Node

Data Field	Length	Description
Function code	1 byte	0x10
Register address	2 bytes	0x0000–0xFFFF
Number of registers	2 bytes	0x0000–0x007b

4.3.5.3 Frame Format for an Abnormal Response from a Slave Node

Data Field	Length	Description
Function code	1 byte	0x90
Exception code	1 byte	See the Exception Code List

4.3.5.4 Example

A master node sends an instruction to a slave node whose address is 00 to set (register address: 40118/0X9CB6) to 2, and set (register address: 40119/0X9CB7) to 50. The request frame format is as follows:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01
	Protocol Type	00
		00
	Data Length	00
		0B
	Logic device ID	00
Function Code		10
Data	Register Address	9C
		B6
	Number of Registers	00
		02
	Number of Bytes	04
	Register Value	00
		02
		00
		32

Frame format of a normal response from the slave node:

Description		Frame data
MBAP Header	Protocol Identifier	00

Description		Frame data
		01
	Protocol Type	00
		00
	Data Length	00
		06
	Logic device ID	00
Function Code		10
Data	Register Address	9C
		B6
	Number of Registers	00
		02

Frame format of an abnormal response from the slave node:

Description		Frame data
MBAP Header	Protocol Identifier	00
		01
	Protocol Type	00
		00
	Data Length	00
		03
	Logic Device ID	00
Function Code		90
Data	Error Code	04

4.3.6 Reading Device Identifiers (0X2B)

This command code allows reading identifiers and added packets 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 objects:

- Basic device identifier: All objects of this type 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. Normal device identifiers define all types of objects according to standard definitions, but the execution of this type of objects is optional.
- Extensive device identifier:Except the basic data objects, the device provides additional and optional identifiers and special data object description. All these data objects are related to the device.

Table 4-4 Reading Device Identifiers

Object ID	Object Name or Description	Type	M/O	Category
0x00	Manufacturer name	ASCII character string	M	Basic
0x01	Product code	ASCII character string	M	
0x02	Main revision	ASCII character string	M	
0x03–0x7F	N/A	N/A	N/A	Normal
0x80–0xFF	N/A	N/A	N/A	Extensive

4.3.6.1 Commands for Querying Device Identifiers

Table 4-5 Request frame format

Data Field	Length (Byte)	Description
Function code	1	0x2B
MEI type	1	0x0E
ReadDevId code	1	01
Object ID	1	0x00

Table 4-6 Frame format for a normal response

Data Field	Length (Byte)	Description
Function code	1	0x2B
MEI type	1	0x0E
ReadDevId code	1	01

Data Field			Length (Byte)	Description
Consistency level			1	01
More			1	N/A
Next object ID			1	N/A
Number of objects			1	N/A
Object list	First object	Object ID	1	0x00
		Object length	1	N
		Object value	N	N/A
	...	...	...	...

Table 4-7 Object list

Object ID	Object Name or Description	Description	Category
0x00	Manufacturer name	HUAWEI	Basic
0x01	Product code	SUN2000	
0x02	Main revision	ASCII character string, software version	

Table 4-8 Frame format for an abnormal response

Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See **Exception Code List**

4.3.6.2 Command for Querying a Device List

Table 4-9 Request frame format

Data Field	Length (Byte)	Description
Function code	1	0x2B
MEI type	1	0x0E

Data Field	Length (Byte)	Description
ReadDeviId code	1	03
Object ID	1	0x87

Table 4-10 Frame format for a normal response

Data Field			Length (Byte)	Description
Function code			1	0x2B
MEI type			1	0x0E
ReadDeviId code			1	03
Consistency level			1	03
More			1	N/A
Next object ID			1	N/A
Number of objects			1	N/A
Object list	First object	Object ID	1	0x87
		Object length	1	N
		Object value	N	N/A
	...	...	...	...

Table 4-11 Object list

Object ID	Object Name	Type	Description
0x80-0x86	Reserved		Returns a null object with a length of 0.
0x87	Number of devices	int	Returns the number of devices connected to the RS485 address.
0x88	Information about the first device	ASCII character string See the device description definitions below.	Returns information only for the first device if a network element allows only one device to be connected to each RS485

Object ID	Object Name	Type	Description
			address.
0x8A	Information about the second device	N/A	N/A
……	……	……	……
0xFF	Information about the 120th device	N/A	N/A

4.3.6.3 Device Description Definitions

Each device description consists of all"attribute = value" strings.

Attribute label=%s;attribute label=%s;…attribute label=%s

For example:1=SUN2000L-XXKTL;2=V100R001C00SPC100;3=P1.0-D5.0;4=123232323;5=1;6=1.1

Table 4-12 Attribute definitions

Attribute Label	Attribute Name	Type	Description
1	Device Model	ASCII character string	SUN2000
2	Software version	ASCII character string	N/A
3	Version of the communications protocol	ASCII character string	See the interface protocol version definitions.
4	ESN	ASCII character string	N/A
5	Device number	int	0,1,2,3...(Assigned by NE; 0 indicates the master device to which the ModBus card is inserted)
6	Character version	ASCII character string	N/A

Table 4-13 Frame format for an abnormal response

Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See **Exception Code List**

