

Solar Inverter Modbus Interface Definitions (V3.0)

Issue 01
Date 2023-10-17



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Huawei Technologies Co., Ltd.

Address: Huawei Industrial Base
Bantian, Longgang
Shenzhen 518129
People's Republic of China

Website: <https://e.huawei.com>

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1 Supported Models

This chapter describes the solar inverter models that use the Modbus protocol and the earliest firmware version. When a host needs to connect to these solar inverters, ensure that the firmware version is correct.

1.1 Model Description

1.1 Model Description

Table 1-1 Supported models and firmware versions

Model	Model ID	Earliest Firm Version
SUN2000-300KTL-H0	181	SUN2000HA V500R023C00
SUN2000-280KTL-H0	182	SUN2000HA V500R023C00
SUN2000-250KTL-H1	183	SUN2000HA V500R023C00
SUN2000-250KTL-H3	184	SUN2000HA V500R023C00
SUN2000-330KTL-H1	185	SUN2000HA V500R023C00
SUN2000-330KTL-H2	186	SUN2000HA V500R023C00
SUN2000-188KTL-NHH0	187	SUN2000HA V500R023C00

 NOTE

The maximum active power (P_{max}), maximum reactive power (Q_{max}), and rated power (P_n) corresponding to each model can be obtained from the register interface. The model ID is the unique code of the model.

2 Overview

Modbus is a widely used protocol for device communications. This document describes the Modbus protocol used by Huawei solar inverters, and can be used to regulate follow-up third-party integrated development. Huawei solar inverters comply with the standard Modbus protocol, and this document focuses on the information specific to Huawei solar inverters. For other information about Modbus, see the standard documents about the Modbus protocol. For details about the standard protocols used by Huawei solar inverters and customized interaction modes and examples, see chapter [5 Overview of the Communications Protocol](#).

[2.1 Terms and Abbreviations](#)

2.1 Terms and Abbreviations

Table 2-1 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	A register address 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	Character string
MLD	Multiple bytes

Name	Description
Bitfield16	16-bit data expressed by bit
Bitfield32	32-bit data expressed by bit
N/A	Not applicable
s	Second
Epoch seconds	The number of seconds that have elapsed since 1970-01-01 00:00:00
RO	Data that is readable only
RW	Data that is readable and writable
WO	Data that is writable only

3 Register Definitions

Table 3-1 Register definitions

No.	Signal Name	Read/Write	Type	Unit	Gain	Addresses	Quantity	Scope
1	Model	RO	STR	N/A	1	30000	15	For details, see 1.1 Model Description .
2	SN	RO	STR	N/A	1	30015	10	-
3	PN	RO	STR	N/A	1	30025	10	-
4	Model ID	RO	U16	N/A	1	30070	1	For details, see 1.1 Model Description .
5	Number of PV strings	RO	U16	N/A	1	30071	1	-
6	Number of MPP trackers	RO	U16	N/A	1	30072	1	-
7	Rated power (P_n)	RO	U32	kW	1000	30073	2	-
8	Maximum active power (P_{max})	RO	U32	kW	1000	30075	2	-
9	Maximum apparent power (S_{max})	RO	U32	kVA	1000	30077	2	-
10	Maximum reactive power (Q_{max} , fed to the power grid)	RO	I32	kVar	1000	30079	2	-
11	Maximum reactive power (Q_{max} , absorbed from the power grid)	RO	I32	kVar	1000	30081	2	-

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
12	State 1 Inverter Remote State	RO	Bitfield16	N/A	1	32000	1	Bit 0: standby Bit 1: grid-connected Bit 2: grid-connected normally Bit 3: grid connection with derating due to power rationing Bit 4: grid connection with derating due to internal causes of the solar inverter 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	State 2 Remote Monitor Running State	RO	Bitfield16	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	State 3 Remote Dsp Running State	RO	Bitfield32	N/A	1	32003	2	Bit 0: off-grid (0: on-grid; 1: off-grid) Bit 1: off-grid switch (0: disable; 1: enable)
15	Alarm 1	RO	Bitfield16	N/A	1	32008	1	For details, see 4.1 Alarm Information .
16	Alarm 2	RO	Bitfield16	N/A	1	32009	1	For details, see 4.1 Alarm Information .
17	Alarm 3	RO	Bitfield16	N/A	1	32010	1	For details, see 4.1 Alarm Information .

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
18	Alarm 4	RO	Bitfield16	N/A	1	32011	1	For details, see 4.1 Alarm Information .
19	Alarm 5	RO	Bitfield16	-	1	32012	1	For details, see 4.1 Alarm Information . d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001416394729d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001416394729-ctxtext
20	PV1 voltage	RO	I16	V	10	32016	1	A maximum of 28 PV strings are supported. The number of PV strings read by the host is defined by the Number of PV strings signal. The voltage and current register addresses for each PV1~PV24 string are as follows: PVn voltage: $32014 + 2n$ PVn current: $32015 + 2n$ n indicates the PV string number, which ranges from 1 to 24. The voltage and current register addresses for each PV25~PV28 string are as follows: PVn voltage: $32344 + 2n$ PVn current: $32345 + 2n$ n indicates the PV string number, which ranges from 1 to 4.
21	PV1 current	RO	I16	A	100	32017	1	
22	PV2 voltage	RO	I16	V	10	32018	1	
23	PV2 current	RO	I16	A	100	32019	1	
24	PV3 voltage	RO	I16	V	10	32020	1	
25	PV3 current	RO	I16	A	100	32021	1	
26	PV4 voltage	RO	I16	V	10	32022	1	
27	PV4 current	RO	I16	A	100	32023	1	
28	PV5 voltage	RO	I16	V	10	32024	1	
29	PV5 current	RO	I16	A	100	32025	1	
30	PV6 voltage	RO	I16	V	10	32026	1	
31	PV6 current	RO	I16	A	100	32027	1	
32	PV7 voltage	RO	I16	V	10	32028	1	
33	PV7 current	RO	I16	A	100	32029	1	
34	PV8 voltage	RO	I16	V	10	32030	1	
35	PV8 current	RO	I16	A	100	32031	1	
36	PV9 voltage	RO	I16	V	10	32032	1	
37	PV9 current	RO	I16	A	100	32033	1	
38	PV10 voltage	RO	I16	V	10	32034	1	
39	PV10 current	RO	I16	A	100	32035	1	

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
40	PV11 voltage	RO	I16	V	10	32036	1	
41	PV11 current	RO	I16	A	100	32037	1	
42	PV12 voltage	RO	I16	V	10	32038	1	
43	PV12 current	RO	I16	A	100	32039	1	
44	PV13 voltage	RO	I16	V	10	32040	1	
45	PV13 current	RO	I16	A	100	32041	1	
46	PV14 Voltage	RO	I16	V	10	32042	1	
47	PV15 voltage	RO	I16	V	10	32044	1	
48	PV15 current	RO	I16	A	100	32045	1	
49	PV15 current	RO	I16	A	100	32045	1	
50	PV16 Voltage	RO	I16	V	10	32046	1	
51	PV16 current	RO	I16	A	100	32047	1	
52	PV17 voltage	RO	I16	V	10	32048	1	
53	PV17 Current	RO	I16	A	100	32049	1	
54	PV18 voltage	RO	I16	V	10	32050	1	
55	PV18 current	RO	I16	A	100	32051	1	
56	PV19 voltage	RO	I16	V	10	32052	1	
57	PV19 current	RO	I16	A	100	32053	1	
58	PV20 voltage	RO	I16	V	10	32054	1	
59	PV20 current	RO	I16	A	100	32055	1	
60	PV21 voltage	RO	I16	V	10	32056	1	
61	PV21 current	RO	I16	A	100	32057	1	
62	PV22 Voltage	RO	I16	V	10	32058	1	
63	PV22 current	RO	I16	A	100	32059	1	
64	PV23 voltage	RO	I16	V	10	32060	1	
65	PV23 current	RO	I16	A	100	32061	1	
66	PV24 voltage	RO	I16	V	10	32062	1	
67	PV24 current	RO	I16	A	100	32063	1	

No.	Signal Name	Read/Write	Type	Unit	Gain	Addresses	Quantity	Scope
68	PV25 voltage	RO	I16	V	10	32344	1	
69	PV25 current	RO	I16	A	100	32345	1	
70	PV26 voltage	RO	I16	V	10	32346	1	
71	PV26 Current	RO	I16	A	100	32347	1	
72	PV27 voltage	RO	I16	V	10	32348	1	
73	PV27 current	RO	I16	A	100	32349	1	
74	PV28 voltage	RO	I16	V	10	32350	1	
75	PV28 current	RO	I16	A	100	32351	1	
76	Input Power	RO	I32	kW	1000	32064	2	-
77	Power grid voltage/Power grid line A/B voltage	RO	U16	V	10	32066	1	When the output mode is L/N, L1/L2/N, or L1/L2, use the name Grid Voltage.
78	Power grid BC line voltage	RO	U16	V	10	32067	1	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
79	Power grid CA line voltage	RO	U16	V	10	32068	1	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
80	Power grid phase A voltage	RO	U16	V	10	32069	1	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
81	Power grid phase B voltage	RO	U16	V	10	32070	1	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
82	Power grid phase C voltage	RO	U16	V	10	32071	1	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
83	Grid current/Grid phase A current	RO	I32	A	1000	32072	2	When the output mode is L/N, L1/L2/N, or L1/L2, the name "grid current" is used.

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
84	Grid B phase current	RO	I32	A	1000	32074	2	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
85	Phase C current of power grid	RO	I32	A	1000	32076	2	When the output mode is L/N, L1/L2/N, or L1/L2, the information is invalid.
86	active power	RO	I32	kW	1000	32080	2	-
87	reactive power	RO	I32	kVar	1000	32082	2	-
88	power factor	RO	I16	-	1000	32084	1	-
89	Grid frequency	RO	U16	Hz	100	32085	1	-
90	efficiency	RO	U16	%	100	32086	1	-
91	Internal temperature	RO	I16	°C	10	32087	1	-
92	Insulation impedance value	RO	U16	M ohms	1000	32088	1	-

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
93	Device Status	RO	U16	-	1	32089	1	0x0000 standby: initialization 0x0001 Standby: insulation impedance detection 0x0002 Standby: Illumination detection 0x0003 Standby: grid detection 0x0100 Startup 0x0200 Grid-On (Grid-Off mode: running) 0x0201: power limit (Grid-Off mode: running: power limit) 0x0202 Grid-On: self-derating (Grid-Off mode: running: self-derating) 0x0300 Shutdown: Shutdown abnormally. 0x0301 Shutdown: Shutdown by Command 0x0302 Shutdown: OVGR 0x0303 Shutdown: The communication is disconnected. 0x0304 Shutdown: power limit 0x0305 Shutdown: Manual power-on is required. 0x0306 Shutdown: The DC switch is off. 0x0307 Shutdown: Fast Shutdown 0x0308 Shutdown: Input underpower

No.	Signal Name	Read/Write	Type	Unit	Gain	Addresses	Quantity	Scope
								0x0309 Shutdown: NS protection 0x030A Shutdown: Shutdown Quickly by Command 0x0401 Power grid scheduling: cosphi-P curve 0x0402 Power grid scheduling: Q-U curve 0x0403 Power grid scheduling: PF-U curve 0x0404 Power grid dispatching: dry contact 0x0405 Power grid scheduling: Q-P curve 0x0500 Spot Check Ready 0x0501 Spot check in process 0x0600 Checking 0x0700 AFCI self-test 0x0800 IV scanning 0x0900 DC input detection 0x0A00 Running: off-grid charging 0xA000 Standby: no light
94	Fault Code	RO	U16	-	1	32090	1	-
95	Startup time	RO	U32	-	1	32091	2	epoch second, local time
96	Shutdown Time	RO	U32	-	1	32093	2	epoch second, local time
97	cumulative energy yield	RO	U32	kWh	100	32106	2	-
98	Daily energy yield	RO	U32	kWh	100	32114	2	-
99	Monthly energy yield	RO	U32	kWh	100	32116	2	

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
100	Yearly energy yield	RO	U32	kWh	100	32118	2	
101	MPPT1 Total Input Power	RO	U32	kW	1000	32324	2	
102	MPPT2 Total Input Power	RO	U32	kW	1000	32326	2	
103	MPPT3 Total Input Power	RO	U32	kW	1000	32328	2	
104	MPPT4 Total Input Power	RO	U32	kW	1000	32330	2	
105	MPPT5 Total Input Power	RO	U32	kW	1000	32332	2	
106	MPPT6 Total Input Power	RO	U32	kW	1000	32334	2	
107	MPPT7 Total Input Power	RO	U32	kW	1000	32336	2	
108	MPPT8 Total Input Power	RO	U32	kW	1000	32338	2	
109	MPPT9 Total Input Power	RO	U32	kW	1000	32340	2	
110	Grid A phase voltage	RO	U16	V	10	32453	1	
111	Grid B phase voltage	RO	U16	V	10	32454	1	
112	[4G] Monthly used flow	RO	U32	MB	100	35116	2	
113	[4G] Monthly remaining flow	RO	U32	MB	100	35118	2	
114	[4G] flow status	RO	ENUM16	MB		35122	1	0: Normal 1: Alert 2: Run out 0xFF: Unset package
115	[active] adjustment mode	RO	U16	-	1	35300	1	0: percentage 1: fixed value NOTE 35300~35303 need to be read at a time.

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
116	[Reactive Power] Regulation Mode	RO	U16	-	1	35304	1	0: power factor 1: absolute value 2: Q/S 3: Q-U characteristic curve (instruction ID: 0) 4: cosphi-P/Pn characteristic curve (fill in 0 for instruction ID) 5: PF-U characteristic curve (instruction ID: 0) 6: Q-P characteristic curve (instruction ID: 0) NOTE 35304 ~ 35306 need to be read at a time.
117	[Metric Meter Collection] Active Power*	RO	I32	W	1	37113	2	> 0: feeds power to the grid. < 0: power is obtained from the power grid.
118	System Time	RW	U32	-	1	40000	2	[946684800, 3155759999] Equich second, local time
119	[Grid Scheduling] Q-U Characteristic Curve Mode*	RW	U16	-	1	40037	1	0: non-hysteresis loop 1: hysteresis
120	[Power grid scheduling] Q-U scheduling trigger power percentage*	RW	U16	%	1	40038	1	[0, 100]
121	[Power grid scheduling] Fixed active power derating	RW	U16	kW	10	40120	1	Range: [0, Pmax]
122	[Power grid scheduling] Reactive power compensation (PF)	RW	I16	-	1000	40122	1	(-1, -0.8]U[0.8, 1]

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
123	[Power grid scheduling] Reactive power compensation (Q/S)	RW	I16	-	1000	40123	1	[- 1, 1] The equipment performs reactive power control according to the value converted into Q fixed value; where S is Smax
124	Reactive power adjustment time	RW	U16	s	10	40124	1	[1,1000]
125	[Power grid scheduling] Active power percentage derating (0.1%)	RW	U16	%	10	40125	1	Range: [0, 100] Active fine adjustment interface
126	[Grid Dispatching] Reactive Power Compensation at Night (kVar)	RW	I32	kVar	1000	40129	2	[-Qmax, Qmax]
127	[Power grid scheduling] cosphi-P/Pn characteristic curve	RW	MLD	-	1	40133	21	Refer to 5.2 Power Grid Scheduling.d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001364355100d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001364355100-ctxtext
128	Q-U characteristic curve of power grid scheduling	RW	MLD	-	1	40154	21	Refer to 5.2 Power Grid Scheduling.d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001364355100d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001364355100-ctxtext
129	[Grid scheduling] PF-U characteristic curve	RW	MLD	-	1	40175	21	Refer to 5.2 Power Grid Scheduling.d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001364355100d0e1.xml#d0e1/_ZH-CN_TOPIC_0000001364355100-ctxtext

No.	Signal Name	Read/Write	Type	Unit	Gain	Address	Quantity	Scope
130	[Power grid scheduling] Reactive power adjustment time	RW	U16	s	1	40196	1	[1, 120] Default value: 10
131	[Power grid scheduling] Q-U scheduling exit power percentage*	RW	U16	%	1	40198	1	[0, 100]
132	Power on	WO	U16	-	1	40200	1	-
133	Shutdown	WO	U16	-	1	40201	1	-
134	grid standard code	RW	U16	NA	1	42000	1	Refer to 5.3 Power Grid Standard Code.d0e1.xml#d0e1/_ZH- CN_TOPIC_0000001416 394733d0e1.xml#d0e1/_ZH- CN_TOPIC_0000001416 394733-ctxtext
135	[Grid Dispatching] Reactive Power Change Gradient	RW	U32	%/s	1000	42015	2	[0.1, 1000]
136	[Power grid scheduling] Active power change gradient	RW	U32	%/s	1000	42017	2	[0.1, 1000]
137	[Grid Dispatching] Scheduling Instruction Maintenance Time	RW	U32	s	1	42019	2	[0, 86400] Permanently valid when the value is 0.
138	Time Zone	RW	I16	min	1	43006	1	[- 720, 840]
139	Time Source	RW	ENUM16			43007	1	0: NTP 1:SMartPVMS PLANT
140	【 4G 】 card number	RW	MLD / Bytes		1	43386	10	

NOTICE

Signals marked with * are supported only by certain models or standard codes.

4 Interface Instructions

[4.1 Alarm Information](#)

[4.2 Power Grid Scheduling](#)

[4.3 Grid Codes](#)

4.1 Alarm Information

Table 4-1 Alarm information

No.	Alarm	Bit	Alarm Name	Alarm ID	Level
1	Alarm 1	0	High String Input Voltage	2001	Major
2	Alarm 1	1	DC Arc Fault ^[1]	2002	Major
3	Alarm 1	2	String Reverse Connection	2011	Major
4	Alarm 1	3	String Current Backfeed	2012	Warning
5	Alarm 1	4	Abnormal String Power	2013	Warning
6	Alarm 1	5	AFCI Self-Check Fail. ^[1]	2021	Major
7	Alarm 1	6	Phase Wire Short-Circuited to PE	2031	Major
8	Alarm 1	7	Grid Loss	2032	Major
9	Alarm 1	8	Grid Undervoltage	2033	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Level
10	Alarm 1	9	Grid Overvoltage	2034	Major
11	Alarm 1	10	Grid Volt. Imbalance	2035	Major
12	Alarm 1	11	Grid Overfrequency	2036	Major
13	Alarm 1	12	Grid Underfrequency	2037	Major
14	Alarm 1	13	Unstable Grid Frequency	2038	Major
15	Alarm 1	14	Output Overcurrent	2039	Major
16	Alarm 1	15	Output DC Component Overhigh	2040	Major
17	Alarm 2	0	Abnormal Residual Current	2051	Major
18	Alarm 2	1	Abnormal Grounding	2061	Major
19	Alarm 2	2	Low Insulation Resistance	2062	Major
20	Alarm 2	3	Overtemperature	2063	Minor
21	Alarm 2	4	Device Fault	2064	Major
22	Alarm 2	5	Upgrade Failed or Version Mismatch	2065	Minor
23	Alarm 2	6	License Expired	2066	Warning
24	Alarm 2	7	Faulty Monitoring Unit	61440	Minor
25	Alarm 2	8	Faulty Power Collector ^[2]	2067	Major
26	Alarm 2	10	Active Islanding	2070	Major
27	Alarm 2	11	Passive Islanding	2071	Major
28	Alarm 2	12	Transient AC Overvoltage	2072	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Level
29	Alarm 2	13	Peripheral port short circuit ^[3]	2075	Warning
30	Alarm 2	14	Churn output overload ^[4]	2077	Major
31	Alarm 2	15	Abnormal PV module configuration	2080	Major
32	Alarm 3	0	Optimizer fault ^[5]	2081	Warning
33	Alarm 3	1	Built-in PID operation abnormal ^[6]	2085	Minor
34	Alarm 3	2	High input string voltage to ground.	2014	Major
35	Alarm 3	3	External Fan Abnormal	2086	Major
36	Alarm 3	5	On-grid/Off-grid controller abnormal ^[4]	2082	Major
37	Alarm 3	6	PV String Loss	2015	Warning
38	Alarm 3	7	Internal Fan Abnormal	2087	Major
39	Alarm 3	8	DC Protection Unit Abnormal ^[7]	2088	Major
40	Alarm 3	9	EL cell abnormality	2089	Minor
41	Alarm 3	10	Active scheduling instruction exception	2090	Major
42	Alarm 3	11	Reactive power dispatch instruction abnormal	2091	Major
43	Alarm 3	12	Abnormal CT wiring	2092	Major
44	Alarm 3	13	DC arc fault	2003	Major
45	Alarm 3	14	The DC switch is abnormal.	2093	Minor
46	Alarm 4	0	DC overvoltage	2004	Major
47	Alarm 4	1	DC reverse connection	2005	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Level
48	Alarm 4	2	DC short circuit or reverse connection	2006	Major
49	Alarm 4	3	DC serial connection	2007	Major
50	Alarm 4	4	DC unreliable connection	2008	Major
51	Alarm 4	5	The management system certificate does not take effect.	2095	Hints
52	Alarm 4	6	Management System Certificate Is About to Expire	2096	Hints
53	Alarm 4	7	Management System Certificate Expired	2097	Major
54	Alarm 4	8	Parallel communication exception	2098	Major
55	Alarm 4	9	The local access certificate does not take effect.	2099	Hints
56	Alarm 4	10	The local access certificate is about to expire.	2100	Hints
57	Alarm 4	11	The local access certificate has expired.	2101	Major
58	Alarm 4	12	AC-side phase sequence reversal	2041	Major
59	Alarm 4	13	String short circuit to ground	2009	Major
60	Alarm 4	14	Communication link failure protection	2102	Hints
61	Alarm 4	15	The AC terminal temperature is abnormal.	2103	Major
62	Alarm 5	0	The DC terminal temperature is abnormal.	2104	Major

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The preceding table lists the alarm information about Huawei solar inverters. Some alarms can be detected only after corresponding functional modules are configured.

[1] AFCI functional unit

[2] Power collector or power meter connected to the solar inverters

[3] Detection of the external ports of the solar inverters that provide the 12 V power supply

[4] This item can be detected when a built-in or external on-grid/off-grid functional unit is configured.

[5] This item can be detected when optimizers are configured on the DC side.

[6] This item can be detected when the solar inverters are configured with PID functional units.

[7] Some models have DC protection units.

4.2 Power Grid Scheduling

This section describes the curve configuration format and precautions for power grid scheduling by curve.

4.2.1 $\cos\phi$ -P/P_n Characteristic Curve

Table 4-2 $\cos\phi$ -P/P_n characteristic curve definition

Description	Data Type	Gain	Unit	Value Range
Number of points	U16	1	N/A	[2, 10]
P/P _n value at point 1	U16	10	%	[0, 100]
$\cos\phi$ value at point 1	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 2	U16	10	%	[0, 100]
$\cos\phi$ value at point 2	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 3	U16	10	%	[0, 100]
$\cos\phi$ value at point 3	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 4	U16	10	%	[0, 100]
$\cos\phi$ value at point 4	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 5	U16	10	%	[0, 100]
$\cos\phi$ value at point 5	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 6	U16	10	%	[0, 100]

Description	Data Type	Gain	Unit	Value Range
cos ϕ value at point 6	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 7	U16	10	%	[0, 100]
cos ϕ value at point 7	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 8	U16	10	%	[0, 100]
cos ϕ value at point 8	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 9	U16	10	%	[0, 100]
cos ϕ value at point 9	I16	1000	N/A	(-1, -0.8]U[0.8, 1]
P/P _n value at point 10	U16	10	%	[0, 100]
cos ϕ value at point 10	I16	1000	N/A	(-1, -0.8]U[0.8, 1]

4.2.2 Q-U Characteristic Curve

Description	Data Type	Gain	Unit	Value Range
Number of points	U16	1	N/A	[2, 10]
U/U _n value at point 1	U16	10	%	[80, 136]
Q/S value at point 1	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 2	U16	10	%	[80, 136]
Q/S value at point 2	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 3	U16	10	%	[80, 136]
Q/S value at point 3	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 4	U16	10	%	[80, 136]
Q/S value at point 4	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 5	U16	10	%	[80, 136]
Q/S value at point 5	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 6	U16	10	%	[80, 136]
Q/S value at point 6	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 7	U16	10	%	[80, 136]
Q/S value at point 7	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 8	U16	10	%	[80, 136]

Description	Data Type	Gain	Unit	Value Range
Q/S value at point 8	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 9	U16	10	%	[80, 136]
Q/S value at point 9	I16	1000	N/A	[-0.6, 0.6]
U/U _n value at point 10	U16	10	%	[80, 136]
Q/S value at point 10	I16	1000	N/A	[-0.6, 0.6]

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In Italian standards, this curve may be used together with the **Q-U characteristic curve mode**, **Q-U dispatch trigger power (%)**, and **Q-U power percentage to exit scheduling** parameters.

4.2.3 PF-U Characteristic Curve

Description	Data Type	Gain	Unit	Value Range
Number of points	U16	1	N/A	[2, 10]
U/U _n value at point 1	U16	10	%	[80, 136]
PF value at point 1	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 2	U16	10	%	[80, 136]
PF value at point 2	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 3	U16	10	%	[80, 136]
PF value at point 3	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 4	U16	10	%	[80, 136]
PF value at point 4	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 5	U16	10	%	[80, 136]
PF value at point 5	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 6	U16	10	%	[80, 136]
PF value at point 6	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 7	U16	10	%	[80, 136]
PF value at point 7	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 8	U16	10	%	[80, 136]

Description	Data Type	Gain	Unit	Value Range
PF value at point 8	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 9	U16	10	%	[80, 136]
PF value at point 9	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]
U/U _n value at point 10	U16	10	%	[80, 136]
PF value at point 10	I16	1000	N/A	(-1, -0.8] ∪ [0.8, 1]

4.3 Grid Codes

Table 4-3 List of grid codes

No.	Standard	Applicable Country or Region
0	VDE-AR-N-4105	Germany
1	NB/T 32004	China
2	UTE C 15-712-1(A)	France
3	UTE C 15-712-1(B)	France
4	UTE C 15-712-1(C)	France
5	VDE 0126-1-1-BU	Bulgaria
6	VDE 0126-1-1-GR(A)	Greece
7	VDE 0126-1-1-GR(B)	Greece
8	BDEW-MV	Germany
9	G59-England	UK
10	G59-Scotland	UK
11	G83-England	UK
12	G83-Scotland	UK
13	CEI0-21	Italy
14	EN50438-CZ	Czech Republic
15	RD1699/661	Spain
16	RD1699/661-MV480	Spain
17	EN50438-NL	Netherlands
18	C10/11	Belgium
19	AS4777	Australia

No.	Standard	Applicable Country or Region
20	IEC61727	General
21	Custom (50 Hz)	Custom
22	Custom (60 Hz)	Custom
23	CEI0-16	Italy
24	CHINA-MV480	China
25	CHINA-MV	China
26	TAI-PEA	Thailand
27	TAI-MEA	Thailand
28	BDEW-MV480	Germany
29	Custom MV480 (50 Hz)	Custom
30	Custom MV480 (60 Hz)	Custom
31	G59-England-MV480	UK
32	IEC61727-MV480	General
33	UTE C 15-712-1-MV480	France
34	TAI-PEA-MV480	Thailand
35	TAI-MEA-MV480	Thailand
36	EN50438-DK-MV480	Denmark
37	Japan standard (50 Hz)	Japan
38	Japan standard (60 Hz)	Japan
39	EN50438-TR-MV480	Turkey
40	EN50438-TR	Turkey
41	C11/C10-MV480	Belgium
42	Philippines	Philippines
43	Philippines-MV480	Philippines
44	AS4777-MV480	Australia
45	NRS-097-2-1	South Africa
46	NRS-097-2-1-MV480	South Africa
47	KOREA	South Korea
48	IEEE 1547-MV480	USA
49	IEC61727-60Hz	General

No.	Standard	Applicable Country or Region
50	IEC61727-60Hz-MV480	General
51	CHINA_MV500	China
52	ANRE	Romania
53	ANRE-MV480	Romania
54	ELECTRIC RULE NO.21-MV480	California, USA
55	HECO-MV480	Hawaii, USA
56	PRC_024_Eastern-MV480	Eastern USA
57	PRC_024_Western-MV480	Western USA
58	PRC_024_Quebec-MV480	Quebec, Canada
59	PRC_024_ERCOT-MV480	Texas, USA
60	PO12.3-MV480	Spain
61	EN50438_IE-MV480	Ireland
62	EN50438_IE	Ireland
63	IEEE 1547a-MV480	USA
64	Japan standard (MV420-50 Hz)	Japan
65	Japan standard (MV420-60 Hz)	Japan
66	Japan standard (MV440-50 Hz)	Japan
67	Japan standard (MV440-60 Hz)	Japan
68	IEC61727-50Hz-MV500	General
70	CEI0-16-MV480	Italy
71	PO12.3	Spain
72	Japan standard (MV400-50 Hz)	Japan
73	Japan standard (MV400-60 Hz)	Japan
74	CEI0-21-MV480	Italy
75	KOREA-MV480	South Korea
76	Egypt ETEC	Egypt

No.	Standard	Applicable Country or Region
77	Egypt ETEC-MV480	Egypt
78	CHINA_MV800	China
79	IEEE 1547-MV600	USA
80	ELECTRIC RULE NO.21-MV600	California, USA
81	HECO-MV600	Hawaii, USA
82	PRC_024_Eastern-MV600	Eastern USA
83	PRC_024_Western-MV600	Western USA
84	PRC_024_Quebec-MV600	Quebec, Canada
85	PRC_024_ERCOT-MV600	Texas, USA
86	IEEE 1547a-MV600	USA
87	EN50549-LV	Ireland
88	EN50549-MV480	Ireland
89	Jordan-Transmission	Jordan
90	Jordan-Transmission-MV480	Jordan
91	NAMIBIA	Namibia
92	ABNT NBR 16149	Brazil
93	ABNT NBR 16149-MV480	Brazil
94	SA_RPPs	South Africa
95	SA_RPPs-MV480	South Africa
96	INDIA	India
97	INDIA-MV500	India
98	ZAMBIA	Zambia
99	ZAMBIA-MV480	Zambia
100	Chile	Chile
101	Chile-MV480	Chile
102	CHINA-MV500-STD	China
103	CHINA-MV480-STD	China
104	Mexico-MV480	Mexico
105	Malaysian	Malaysia
106	Malaysian-MV480	Malaysia

No.	Standard	Applicable Country or Region
107	KENYA_ETHIOPIA	East Africa
108	KENYA_ETHIOPIA-MV480	East Africa
109	G59-England-MV800	UK
110	NIGERIA	Nigeria
111	NIGERIA-MV480	Nigeria
112	DUBAI	Dubai
113	DUBAI-MV480	Dubai
114	Northern Ireland	Northern Ireland
115	Northern Ireland-MV480	Northern Ireland
116	Cameroon	Cameroon
117	Cameroon-MV480	Cameroon
118	Jordan-Distribution	Jordan
119	Jordan-Distribution-MV480	Jordan
120	Custom MV600-50 Hz	Custom
121	AS4777-MV800	Australia
122	INDIA-MV800	India
123	IEC61727-MV800	General
124	BDEW-MV800	Germany
125	ABNT NBR 16149-MV800	Brazil
126	UTE C 15-712-1-MV800	France
127	Chile-MV800	Chile
128	Mexico-MV800	Mexico
129	EN50438-TR-MV800	Turkey
130	TAI-PEA-MV800	Thailand
131	Philippines-MV800	Philippines
132	Malaysian-MV800	Malaysia
133	NRS-097-2-1-MV800	South Africa
134	SA_RPPs-MV800	South Africa
135	Jordan-Transmission-MV800	Jordan
136	Jordan-Distribution-MV800	Jordan

No.	Standard	Applicable Country or Region
137	Egypt ETEC-MV800	Egypt
138	DUBAI-MV800	Dubai
139	SAUDI-MV800	Saudi Arabia
140	EN50438_IE-MV800	Ireland
141	EN50549-MV800	Ireland
142	Northern Ireland-MV800	Northern Ireland
143	CEI0-21-MV800	Italy
144	IEC 61727-MV800-60Hz	General
145	NAMIBIA_MV480	Namibia
146	Japan (LV202-50 Hz)	Japan
147	Japan (LV202-60 Hz)	Japan
148	Pakistan-MV800	Pakistan
149	BRASIL-ANEEL-MV800	Brazil
150	Israel-MV800	Israel
151	CEI0-16-MV800	Italy
152	ZAMBIA-MV800	Zambia
153	KENYA_ETHIOPIA-MV800	East Africa
154	NAMIBIA_MV800	Namibia
155	Cameroon-MV800	Cameroon
156	NIGERIA-MV800	Nigeria
157	ABUDHABI-MV800	Abu Dhabi
158	LEBANON	Lebanon
159	LEBANON-MV480	Lebanon
160	LEBANON-MV800	Lebanon
161	ARGENTINA-MV800	Argentina
162	ARGENTINA-MV500	Argentina
163	Jordan-Transmission-HV	Jordan
164	Jordan-Transmission-HV480	Jordan
165	Jordan-Transmission-HV800	Jordan
166	TUNISIA	Tunisia

No.	Standard	Applicable Country or Region
167	TUNISIA-MV480	Tunisia
168	TUNISIA-MV800	Tunisia
169	JAMAICA-MV800	Jamaica
170	AUSTRALIA-NER	Australia
171	AUSTRALIA-NER-MV480	Australia
172	AUSTRALIA-NER-MV800	Australia
173	SAUDI	Saudi Arabia
174	SAUDI-MV480	Saudi Arabia
175	Ghana-MV480	Ghana
176	Israel	Israel
177	Israel-MV480	Israel
178	Chile-PMGD	Chile
179	Chile-PMGD-MV480	Chile
180	VDE-AR-N4120-HV	Germany
181	VDE-AR-N4120-HV480	Germany
182	VDE-AR-N4120-HV800	Germany
183	IEEE 1547-MV800	USA
184	Nicaragua-MV800	Nicaragua
185	IEEE 1547a-MV800	USA
186	ELECTRIC RULE NO.21-MV800	California, USA
187	HECO-MV800	Hawaii, USA
188	PRC_024_Eastern-MV800	Eastern USA
189	PRC_024_Western-MV800	Western USA
190	PRC_024_Quebec-MV800	Quebec, Canada
191	PRC_024_ERCOT-MV800	Texas, USA
192	Custom-MV800-50Hz	Custom
193	RD1699/661-MV800	Spain
194	PO12.3-MV800	Spain
195	Mexico-MV600	Mexico
196	Vietnam-MV800	Vietnam

No.	Standard	Applicable Country or Region
197	CHINA-LV220/380	China
198	SVG-LV	Dedicated
199	Vietnam	Vietnam
200	Vietnam-MV480	Vietnam
201	Chile-PMGD-MV800	Chile
202	Ghana-MV800	Ghana
203	TAIPOWER	Taiwan
204	TAIPOWER-MV480	Taiwan
205	TAIPOWER-MV800	Taiwan
206	IEEE 1547-LV208	USA
207	IEEE 1547-LV240	USA
208	IEEE 1547a-LV208	USA
209	IEEE 1547a-LV240	USA
210	ELECTRIC RULE NO.21-LV208	USA
211	ELECTRIC RULE NO.21-LV240	USA
212	HECO-O+M+H-LV208	USA
213	HECO-O+M+H-LV240	USA
214	PRC_024_Eastern-LV208	USA
215	PRC_024_Eastern-LV240	USA
216	PRC_024_Western-LV208	USA
217	PRC_024_Western-LV240	USA
218	PRC_024_ERCOT-LV208	USA
219	PRC_024_ERCOT-LV240	USA
220	PRC_024_Quebec-LV208	USA
221	PRC_024_Quebec-LV240	USA
222	ARGENTINA-MV480	Argentina
223	Oman	Oman
224	Oman-MV480	Oman
225	Oman-MV800	Oman
226	Kuwait	Kuwait

No.	Standard	Applicable Country or Region
227	Kuwait-MV480	Kuwait
228	Kuwait-MV800	Kuwait
229	Bangladesh	Bangladesh
230	Bangladesh-MV480	Bangladesh
231	Bangladesh-MV800	Bangladesh
232	Chile-Net_Billing	Chile
233	EN50438-NL-MV480	Netherlands
234	Bahrain	Bahrain
235	Bahrain-MV480	Bahrain
236	Bahrain-MV800	Bahrain
238	Japan-MV550-50Hz	Japan
239	Japan-MV550-60Hz	Japan
241	ARGENTINA	Argentina
242	KAZAKHSTAN-MV800	Kazakhstan
243	Mauritius	Mauritius
244	Mauritius-MV480	Mauritius
245	Mauritius-MV800	Mauritius
246	Oman-PDO-MV800	Oman
247	EN50438-SE	Sweden
248	TAI-MEA-MV800	Thailand
249	Pakistan	Pakistan
250	Pakistan-MV480	Pakistan
251	PORTUGAL-MV800	Portugal
252	HECO-L+M-LV208	USA
253	HECO-L+M-LV240	USA
254	C10/11-MV800	Belgium
255	Austria	Austria
256	Austria-MV480	Austria
257	G98	UK
258	G99-TYPEA-LV	UK

No.	Standard	Applicable Country or Region
259	G99-TYPEB-LV	UK
260	G99-TYPEB-HV	UK
261	G99-TYPEB-HV-MV480	UK
262	G99-TYPEB-HV-MV800	UK
263	G99-TYPEC-HV-MV800	UK
264	G99-TYPED-MV800	UK
265	G99-TYPEA-HV	UK
266	CEA-MV800	India
267	EN50549-MV400	Europe
268	VDE-AR-N4110	Germany
269	VDE-AR-N4110-MV480	Germany
270	VDE-AR-N4110-MV800	Germany
271	Panama-MV800	Panama
272	North Macedonia-MV800	North Macedonia
273	NTS	Spain
274	NTS-MV480	Spain
275	NTS-MV800	Spain
276	AS4777-WP	Australia
277	CEA	India
278	CEA-MV480	India
279	SINGAPORE	Singapore
280	SINGAPORE-MV480	Singapore
281	SINGAPORE-MV800	Singapore
282	HONGKONG	Hong Kong
283	HONGKONG-MV480	Hong Kong
284	C10/11-MV400	Belgium
285	KOREA-MV800	South Korea
286	Cambodia	Cambodia
287	Cambodia-MV480	Cambodia
288	Cambodia-MV800	Cambodia

No.	Standard	Applicable Country or Region
289	EN50549 - SE	Sweden
290	GREG030	colombia
291	GREG030 - MV440	colombia
292	GREG030 - MV480	colombia
293	GREG060 - MV800	colombia
294	PERU - MV800	Peru
295	PORTUGAL	Portugal
296	PORTUGAL-MV480	Portugal
297	AS4777-ACT	Australia
298	AS4777-NSW-ESS	Australia
299	AS4777-NSW-AG	Australia
300	AS4777-QLD	Australia
301	AS4777-SA	Australia
302	AS4777-VIC	Australia
303	EN50549-PL	Poland
304	Island-Grid	General
305	TAIPOWER-LV220	China Taiwan
306	Mexico-LV220	Mexico
307	ABNT NBR 16149-LV127	Brazil
308	Philippines-LV220-50Hz	Philippines
309	Philippines-LV220-60Hz	Philippines
310	Israel-HV800	Israel
311	DENMARK-EN50549-DK1-LV230	denmark
312	DENMARK-EN50549-DK2-LV230	denmark
313	SWITZERLAND-NA/EEA:2020-LV230	Switzerland
314	Japan-LV202-50Hz	Japan
315	Japan-LV202-60Hz	Japan
316	AUSTRIA-MV800	Austria

No.	Standard	Applicable Country or Region
317	AUSTRIA-HV800	Austria
318	POLAND-EN50549-MV800	Poland
319	IRELAND-EN50549-LV230	Ireland
320	IRELAND-EN50549-MV480	Ireland
321	IRELAND-EN50549-MV800	Ireland
322	DENMARK-EN50549-MV800	denmark
323	FRANCE-RTE-MV800	France
324	AUSTRALIA-AS4777_A-LV230	Australia
325	AUSTRALIA-AS4777_B-LV230	Australia
326	AUSTRALIA-AS4777_C-LV230	Australia
327	AUSTRALIA-AS4777_NZ-LV230	Australia
328	AUSTRALIA-AS4777_A-MV800	Australia
329	CHINA-GBT34120-MV800	China
330	UZBEKISTAN-MV800	Uzbekistan
331	CHINA-GBT34120-MV380	China
332	N/A	N/A
333	CHINA-MV690	China
334	IEC61727-MV720	India
335	INDIA-CEA-MV720	India
336	SA-NRS-097-MV720	South Africa
337	SA-RPPS-MV720	South Africa
338	SAUDI-MV720	Saudi Arabia
339	UZBEKISTAN-MV720	Uzbekistan
340	EGYPT-ETEC-MV720	Egypt
341	KAZAKHSTAN-MV690	Kazakhstan
342	CHINA-CUSTOM-MV800	China
343	JAPAN-MV200-50Hz	Japan
344	JAPAN-MV210-50Hz	Japan
345	JAPAN-MV230-50Hz	Japan
346	JAPAN-MV250-50Hz	Japan

No.	Standard	Applicable Country or Region
347	JAPAN-MV200-60Hz	Japan
348	JAPAN-MV210-60Hz	Japan
349	JAPAN-MV230-60Hz	Japan
350	JAPAN-MV250-60Hz	Japan
351	CZECH-EN50549-LV230	Czech Republic
352	CZECH-EN50549-MV480	Czech Republic
353	CZECH-EN50549-MV800	Czech Republic
354	CHINA_MV315	China
355	KOREA-MV690-60Hz	South Korea
356	ANRE-MV800	Romanian
357	FINLAND-EN50549-LV230	Finland
358	AUSTRIA-MV400-50Hz	Austria
359	SAUDI-LV220	Saudi Arabia
360	CHINA-MV285	China
361	CHINA-MV360	China
362	JAPAN-MV270-50Hz	Japan
363	JAPAN-MV330-50Hz	Japan
364	JAPAN-MV380-50Hz	Japan
365	JAPAN-MV270-60Hz	Japan
366	JAPAN-MV330-60Hz	Japan
367	JAPAN-MV380-60Hz	Japan
368	LITHUANIA-EN50549-MV800	Lithuania
369	FINLAND-EN50549-MV400	Finland
370	FINLAND-EN50549-MV480	Finland
371	FINLAND-EN50549-MV800	Finland
372	EN50549-SE-MV400	Sweden
373	EN50549-SE-MV480	Sweden
374	EN50549-SE-MV800	Sweden
375	CEPM	Dominican
376	CEPM-MV480	Dominican

No.	Standard	Applicable Country or Region
377	CEPM-MV800	Dominican
378	SA-BESF-L	South Africa
379	SA-BESF-L-MV480	South Africa
380	SA-BESF-L-MV800	South Africa
381	SA-BESF-H	South Africa
382	SA-BESF-H-MV480	South Africa
383	SA-BESF-H-MV800	South Africa
384	BRAZIL-P140-LV220	Brazil
385	NEWCALEDONIA-LV230	New Caledonia

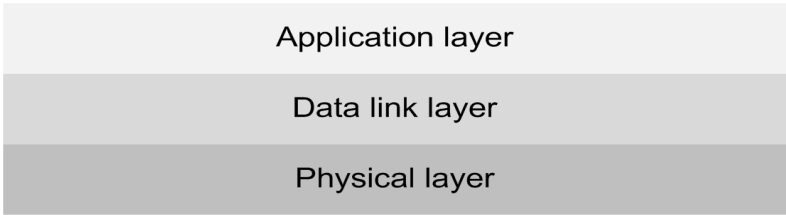
NOTICE

Set the grid code based on local laws and regulations.

5 Overview of the Communications Protocol

The Modbus communications protocol consists of the following layers.

Figure 5-1 Modbus protocol layers



- 5.1 Physical Layer
- 5.2 Data Link Layer
- 5.3 Application Layer

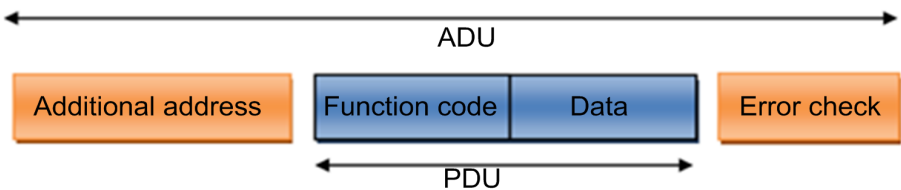
5.1 Physical Layer

Huawei solar inverters provide Modbus communication based on physical media such as MBUS, RS485, WLAN, FE, and 4G. MBUS and RS485 comply with the Modbus-RTU format. The communication through the WLAN, FE, and 4G media is based on the TCP link and complies with the Modbus-TCP format.

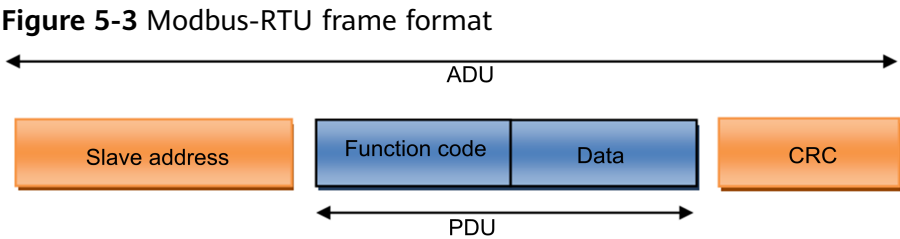
5.2 Data Link Layer

The following figure shows the generic frame structure of the Modbus protocol.

Figure 5-2 Modbus generic frame format



5.2.1 Modbus-RTU



5.2.1.1 ADU Length

The application data unit (ADU) consists of 256 bytes based on the serial bus.

- 1. Slave address: 1 byte
- 2. Cyclic redundancy check (CRC): 2 bytes
- 3. PDU: 253 bytes

5.2.1.2 Communications Address

As shown in [Figure 5-3](#), Modbus-RTU is usually used for serial communication. Slave address represents the address of a slave solar inverter. The address range is allocated as follows:

Table 5-1 Serial link address allocation

Broadcast Address	Slave Node Address	Reserved Address
0	1–247	248–255

Reserved addresses are used for access control of the communication extension modules. Huawei reserves the right to allocate the reserved addresses.

5.2.1.3 CRC

CRC applies to all bytes in front of the CRC code, which consists of 16 bits. The reference code is as follows:

```
static unsigned char auchCRCHi[] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
```

```

0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40
};
/*CRC values for the low-order byte*/
static char auchCRCLo[] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80, 0x40
};

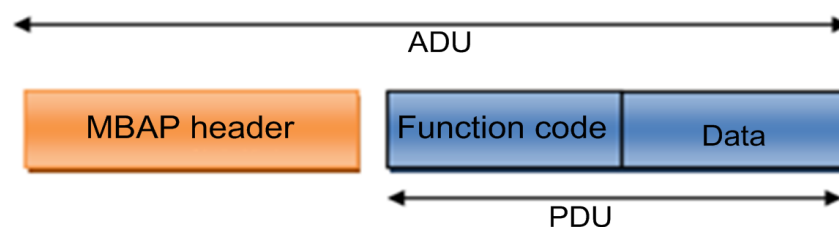
unsigned short CRC16 ( puchMsg, usDataLen ) /* The function returns the CRC as a unsigned short type */
unsigned char *puchMsg ; /* message to calculate CRC upon */
unsigned short usDataLen ; /* quantity of bytes in message */
{
    unsigned char uchCRCHi = 0xFF ; /* high byte of CRC initialized */
    unsigned char uchCRCLo = 0xFF ; /* low byte of CRC initialized */
    unsigned ulIndex ; /* will index into CRC lookup table */
    while (usDataLen--) /* pass through message buffer */
    {
        ulIndex = uchCRCLo ^ *puchMsg++ ; /* calculate the CRC */
        uchCRCLo = uchCRCHi ^ auchCRCHi[ulIndex] ;
        uchCRCHi = auchCRCLo[ulIndex] ;
    }
    return (uchCRCHi << 8 | uchCRCLo) ;
}

```

Code source: *MODBUS over Serial Line Specification and Implementation Guide V1.02*

5.2.2 Modbus-TCP

Figure 5-4 Modbus-TCP frame format



5.2.2.1 ADU Length

The recommended frame length is 260 bytes based on the standard. When some extended functions are applied, the data service provider may extend the ADU to a proper length based on the resources it possesses, to improve network transmission efficiency. The ADU length is indicated by the length field in the MBAP packet header.

5.2.2.2 MBAP Packet Header

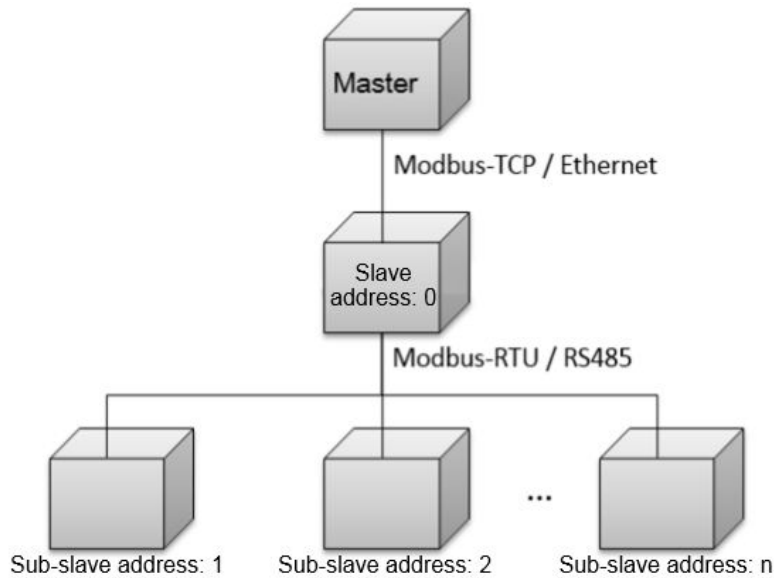
If Modbus is applied to TCP/IP, a dedicated MBAP packet header (Modbus application protocol packet header) is used to identify the Modbus ADU. The Modbus packet header consists of four fields and seven bytes, which are defined as follows.

Table 5-2 MBAP definition

Data Field	Length (Byte)	Description	Client	Server
Transmission identifier	2	Matching identifier between a request frame and a response frame	Assigned by the client; better be unique for each data frame	The identifier of the response frame from the server must be consistent with that of the request frame.
Protocol type	2	0 = Modbus protocol	Assigned by the client; 0 by default	The identifier of the response frame from the server must be consistent with that of the request frame.
Data length	2	Follow-up data length	Assigned by the client based on the actual data frame	Assigned by the server based on the actual frame length
Logical device ID	1	0	Assigned by the client based on the actual data frame request	The identifier of the response frame from the server must be consistent with that of the request frame.

5.2.2.3 Communications Address

Based on the TCP communications host, unit 0 is used by default to access the directly connected slave node, and other addresses are used to access the downstream devices of the slave node. The default address of the slave node is 0. The address is adjustable.

Figure 5-5 Communications address of the three-layer object structure

5.2.2.4 TCP Port

In a local area network or VPN environment, the master node may actively initiate TCP socket link establishment to the slave node. The master node can use the 502 port to request data services from the slave node.

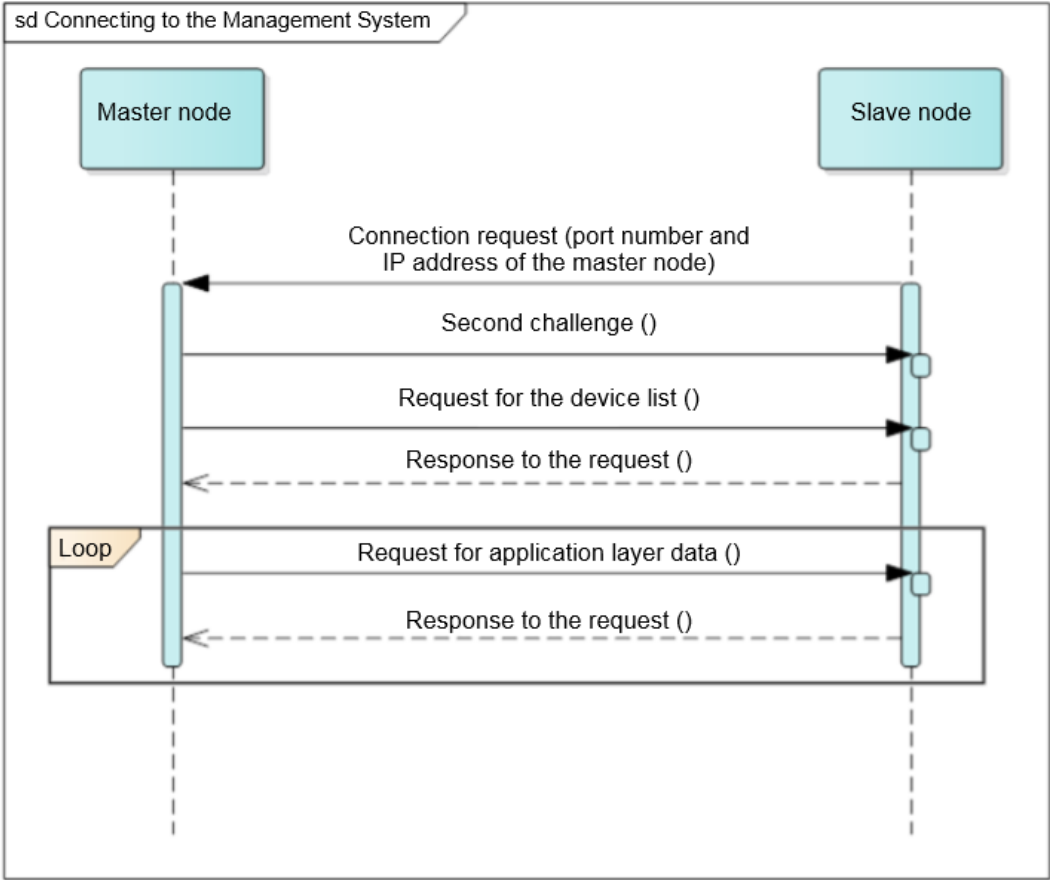
In a non-VPN environment across the public network, the device deployed on the internal network needs to initiate TCP socket link establishment to the master node exposed on the public network. In this case, you need to preset the fixed access port number of the master node on the slave node. To ensure security and reduce traffic, the master node must provide at least one encrypted port and one non-encrypted port.

5.2.2.5 TCP Link Establishment Process

This section focuses on the cross-public network application.

The following figure shows the process of connecting a slave node.

Figure 5-6 Process of establishing a secure TCP connection



5.3 Application Layer

5.3.1 Function Code List

Table 5-3 Function code list

Function Code	Meaning	Remarks
0x03	Read registers.	Continuously reads a single register or multiple registers.
0x06	Write a single register.	Writes into a single register.
0x10	Write multiple registers.	Continuously writes into multiple registers.

5.3.2 Exception Code List

The exception codes must be unique for each network element (NE) type. The names and descriptions should be provided in both the Chinese and English 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 5-4 Exception codes returned by an NE (0x00–0x8F are for common exception codes)

Code	Name	Description
0x01	Illegal function	The function code received in the query is not an allowable action for the server (or slave node). 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 (or slave node) is in the wrong state to process a request of this type, for example because it is not configured 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 operate on registers 96, 97, 98, 99 and 100, and there is no register with address 100.
0x03	Illegal data value	The value contained in the query data field is not an allowable value for the server (or slave). The value indicates a fault in the structure of the remainder of a complex request, such as an incorrectly implied length. 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	Slave node failure	An error occurred while the server was attempting to perform the requested action.
0x06	Slave device busy	The server cannot accept a Modbus request PDU. A client application determines whether and when to resend the request.
0x80	No permission	An operation is not allowed because of a permission authentication failure or permission expiration.

5.3.3 Reading Registers (0x03)

5.3.3.1 Frame Format of a Request from a Master Node

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

5.3.3.2 Frame Format of a Normal Response from a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x03
Number of bytes	1	2 x N
Register value	2 x N	N/A

NOTE

N refers to the number of registers.

5.3.3.3 Frame Format of an Abnormal Response from a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x83
Exception code	1	See 5.3.2 Exception Code List .

5.3.3.4 Examples

This section takes the Modbus-TCP communications frames as an example. The differences between Modbus-RTU and Modbus-TCP lie in the additional address field and the CRC. Pay attention to the differences when using the Modbus-RTU frames. This also works for the follow-up examples.

The master node sends a query request (register address: 32306/0X7E32) to the slave node (logical device ID: 00).

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00

Description		Frame Data
		00
	Data length	00
		06
	Logical device ID	00
Function code		03
Data	Register address	7E
		32
	Number of registers	00
		02

Normal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		07
	Logical device ID	00
Function code		03
Data	Number of bytes	04
	Register data	00
		00
		00
		01

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
	Logical device ID	00
Function code		83
Data	Error code	03

5.3.4 Writing a Single Register (0x06)

5.3.4.1 Frame Format of a Request from a Master Node

Data Field	Length (Byte)	Description
Function code	1	0x06
Register address	2	0x0000–0xFFFF
Register value	2	0x0000–0xFFFF

5.3.4.2 Frame Format of a Normal Response from a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x06
Register address	2	0x0000–0xFFFF
Register value	2	0x0000–0xFFFF

5.3.4.3 Frame Format of an Abnormal Response from a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x86
Exception code	1	See 5.3.2 Exception Code List .

5.3.4.4 Examples

A master node sends a command (register address: 40200/0X9D08) to a slave node (address: 00).

Description		Frame data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		06
	Logical device ID	00
Function code		06
Data	Register address	9D
		08
	Register data	00
		00

Normal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		06
	Logical device ID	00
Function code		06
Data	Register address	9D
		08
	Register data	00
		00

Abnormal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		03
	Logical device ID	00
Function code		86
Data	Error code	04

5.3.5 Writing Multiple Registers (0x10)

5.3.5.1 Frame Format of a Request from a Master Node

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

NOTE

N refers to the number of registers.

5.3.5.2 Frame Format of a Normal Response from a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x10
Register address	2	0x0000–0xFFFF

Data Field	Length (Byte)	Description
Number of registers	2	0x0000–0x007b

5.3.5.3 Frame Format of an Abnormal Response from a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x90
Exception code	1	See 5.3.2 Exception Code List .

5.3.5.4 Examples

The master node sets the register address 40118/0X9CB6 to 2 and the register address 40119/0X9CB7 to 50 for the slave node (address: 00). The request frame format is as follows.

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		0B
	Logical device ID	00
Function code		10
Data	Register address	9C
		B6
	Number of registers	00
		02
	Number of bytes	04
	Register data	00
		02
		00
		32

Normal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		06
	Logical device ID	00
Function code		10
Data	Register address	9C
		B6
	Number of registers	00
		02

Abnormal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol type	00
		00
	Data length	00
		03
	Logical device ID	00
Function code		90
Data	Error code	04

5.3.6 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 interface 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:

1. Basic device identifier: All objects of this type are mandatory, such as the vendor name, product code, and revision version.
2. Normal device identifier: Except basic data objects, the device provides additional and optional identifiers and data object description. Define all types of objects according to definitions in the standard, but the execution of this type of objects is optional.
3. Extended device identifier: In addition to the normal data objects, the device provides additional and optional identifiers and special data object description. All the data is related to the device.

Table 5-5 Reading device identifiers

Object ID	Object Name or Description	Type	Mandatory or Optional (M/O)	Type
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	-	-	-	Normal
0x80–0xFF	-	-	-	Expansion

5.3.6.1 Command for Querying Device Identifiers

Table 5-6 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 5-7 Frame format for a normal response

Data Field			Length (Byte)	Description
Function code			1	0x2B
MEI type			1	0x0E
ReadDevId code			1	01
Consistency level			1	01
More			1	-
Next object ID			1	-
Number of objects			1	-
Object list	First object	Object ID	1	0x00
		Object length	1	N
		Object value	N	-
	...	...	...	...

Table 5-8 Object list

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

Table 5-9 Frame format for an abnormal response

Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See 5.3.2 Exception Code List .

5.3.6.2 Command for Querying a Device List

Table 5-10 Request frame format

Data Field	Length (Byte)	Description
Function code	1	0x2B
MEI type	1	0x0E
ReadDevId code	1	03
Object ID	1 byte	0x87

Table 5-11 Frame format for a normal response

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

Table 5-12 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.

Object ID	Object Name	Type	Description
0x88	Description about the first device	ASCII character string See the device description definitions.	Returns only description about the first device if a NE allows only one device to be connected to each RS485 address.
0x8A	Description about the second device	-	-
-	-	-	-
0xFF	Description about the 120th device	-	-

5.3.6.3 Device Description Definition

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

"Attribute ID=%s; attribute ID=%s; ... attribute ID=%s"

For example: "1=SUN2000MA-XXKTL; 2=V100R001C00SPC100; 3=P1.0-D5.0; 4=123232323; 5=1; 6=1.1"

Table 5-13 Attribute definition

Attribute ID	Name	Type	Description
1	Device model	ASCII character string	SUN2000
2	Device software version	ASCII character string	-
3	Port protocol version	ASCII character string	See the interface protocol version definitions.
4	ESN	ASCII character string	-
5	Device ID	int	0, 1, 2, 3...(assigned by NEs; 0 indicates the master device into which the Modbus card is inserted)
6	Feature version	ASCII character string	-

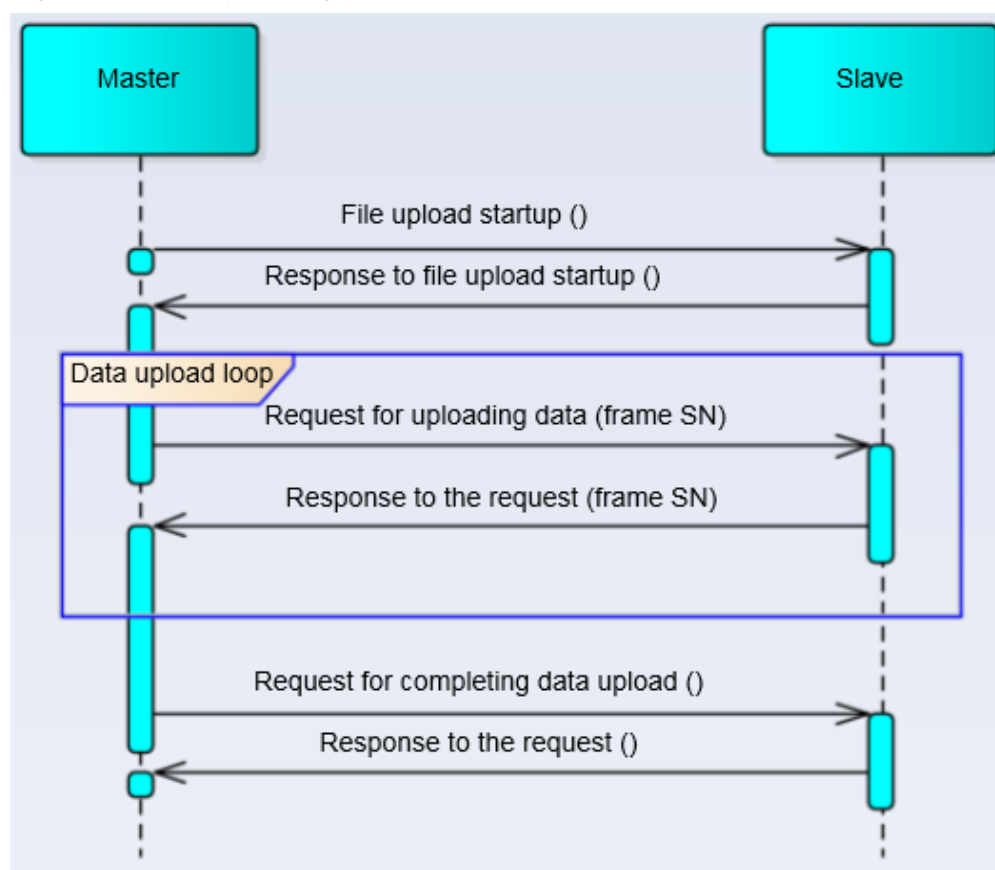
Table 5-14 Frame format for an abnormal response

Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See 5.3.2 Exception Code List .

5.3.7 Huawei-defined Functions (0x41)

5.3.7.1 Uploading Files

Uploading files means uploading them by stream data from a slave node to a master node. The following figure shows the file uploading process.

Figure 5-7 File uploading process

5.3.7.1.1 Starting the Upload

Frame format of a request from a master node

Table 5-15 PDU data field of the request frame for starting upload (0x05)

PDU Data Field	Length (Byte)	Description
Function code	1	0x41
Sub-function code	1	0x05
Data length	1	1 + N
File type	1	Unique ID of a file
Customized data	N	-

Table 5-16 PDU data field of the response frame for starting upload (0x05)

Data Field	Length (Byte)	Description
Function code	1	0x41
Sub-function code	1	0x05
Data length	1	6 + N
File type	1	Unique ID of a file
File length	4	-
Data frame length	1	-
Customized data	N	-

Table 5-17 PDU data field in the abnormal response frame of the slave node

PDU Data Field	Length (Byte)	Description
Error code	1	0xC1
Exception code	1	See 5.3.2 Exception Code List .

 NOTE

If the exception code is 0x06, resend the request after 10 seconds. A request can be resent for no more than six times.

5.3.7.1.2 Uploading Data

Table 5-18 Request frame for uploading data (0x06)

PDU Data Field	Length (Byte)	Description
Function code	1	0x41
Sub-function code	1	0x06
Data length	1	3
File type	1	Unique ID of a file
Frame No.	2	0x0000–0xFFFF

Table 5-19 Response frame for uploading data (0x06)

PDU Data Field	Length (Byte)	Description
Function code	1	0x41
Sub-function code	1	0x06
Data length	1	3 + N
File type	1	-
Frame No.	2	0x0000–0xFFFF
Frame data	N	-

Table 5-20 Abnormal response frame for uploading data

PDU Data Field	Length (Byte)	Description
Error code	1	0xC1
Exception code	1	See 5.3.2 Exception Code List .

5.3.7.1.3 Completing the Data Upload

Table 5-21 Request frame for completing the data upload

PDU Data Field	Length (Byte)	Description
Function code	1	0x41
Sub-function code	1	0x0c
Data length	1	1
File type	1	-

Table 5-22 Response frame for completing the data upload

PDU Data Field	Length (Byte)	Description
Function code	1	0x41
Sub-function code	1	0x0c
Data length	1	3
File type	1	-
File CRC	2	-

Table 5-23 Abnormal response frame for completing the data upload

Data Field	Length (Byte)	Description
Error code	1	0xC1
Exception code	1	See 5.3.2 Exception Code List .

5.3.7.1.4 Timeout Processing

Table 5-24 Processing specifications of sub-process timeout

Name	Restrains
Response timeout period for starting an upload	10s
Response timeout period for uploading data	10s
Number of times of resending a data upload command	6

Name	Restrains
Response timeout period for completing a data upload	10s