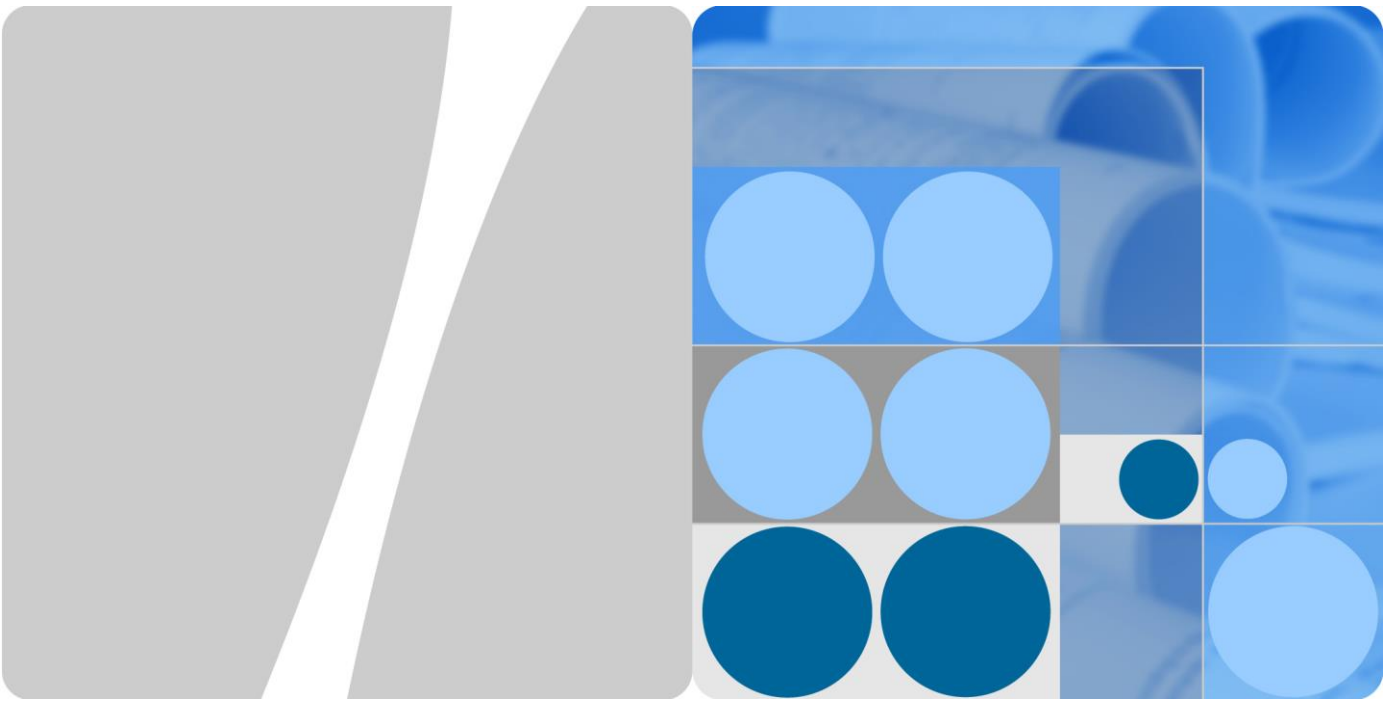

Solar Inverter Modbus

Interface Definitions (V2.0)

Issue 01

Date 2019-10-31

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Contents

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

Table 1-1 Supported models and firmware versions

Model	Model ID	Earliest Firm Version	P_{max} (kW)	Q_{max} (kVar)	S_{max} (kVA)	P_n (kW)	Number of PV Strings
SUN2000-8KTL	5	SUN2000 V100R001C81	8.8	5.28	8.8	8	4
SUN2000-10KTL	4	SUN2000 V100R001C81	11	6.6	11	10	4
SUN2000-12KTL	3	SUN2000 V100R001C81	13.2	7.92	13.2	12	4
SUN2000-15KTL	2	SUN2000 V100R001C81	16.5	9.9	16.5	15	6
SUN2000-17KTL	1	SUN2000 V100R001C81	18.7	11.22	18.7	17	6
SUN2000-20KTL	0	SUN2000 V100R001C81	22	13.2	22	20	6

Model	Model ID	Earliest Firm Version	P_{max} (kW)	Q_{max} (kVar)	S_{max} (kVA)	P_n (kW)	Number of PV Strings
SUN2000-22KTL-US	25	SUN2000 V200R001C02	22.2	14.64	24.4	22.2	6
SUN2000-23KTL	17	SUN2000 V100R001C81	23	13.8	23	23	6
SUN2000-24.5KTL	16	SUN2000 V100R001C81	24.5	14.7	24.5	24.5	6
SUN2000-24.7KTL-JP	32	SUN2000 V200R002C00	24.7	15	25	24.7	8
SUN2000-25KTL-US	21	SUN2000 V200R001C02	25	16.5	27.5	25	6
SUN2000-28KTL	18	SUN2000 V100R001C81	27.5	16.5	27.5	27.5	6
SUN2000-29.9KTL	60	SUN2000 V200R002C00	29.9	17.94	29.9	29.9	8
SUN2000-30KTL-US	22	SUN2000 V200R001C02	30	19.8	33	30	6
SUN2000-30KTL-A	23	SUN2000 V200R001C90	30	19.8	33	30	6
SUN2000-33KTL	19	SUN2000 V200R001C90	33	19.8	33	30	6
SUN2000-33KTL-A	43	SUN2000 V200R002C00	33	19.8	33	30	8
SUN2000-33KTL-E001	44	SUN2000 V200R001C90	30	19.8	33	30	6
SUN2000-33KTL-JP	28	SUN2000 V200R002C00	33.3	22.8	38	33.3	8

Model	Model ID	Earliest Firm Version	P_{max} (kW)	Q_{max} (kVar)	S_{max} (kVA)	P_n (kW)	Number of PV Strings
SUN2000-33KTL-US	36	SUN2000 V200R002C20	36.6	21.96	36.6	33.3	8
SUN2000-40KTL	20	SUN2000 V200R001C90	40	24	40	36	6
SUN2000-36KTL	27	SUN2000 V200R002C00	40	24	40	36	8
SUN2000-36KTL-US	37	SUN2000 V200R002C20	40	24	40	36	8
SUN2000-40KTL-JP	29	SUN2000 V200R002C00	40	27.6	46	40	8
SUN2000-40KTL-US	35	SUN2000 V200R002C20	44	26.4	44	40	8
SUN2000-42KTL	26	SUN2000 V200R002C00	47	28.2	47	42	8
SUN2000-43KTL-IN-C1	31	SUN2000 V200R002C00	52.5	31.5	52.5	43	8
SUN2000-45KTL-US-HV-D0	34	SUN2000HA V100R001C00	50	30	50	45	8
SUN2000-50KTL	30	SUN2000 V200R002C00	50.5	30.3	50.5	46	8
SUN2000-50KTL-C1	24	SUN2000 V200R002C00	52.5	31.5	52.5	47.5	8
SUN2000-55KTL-HV-D1	38	SUN2000HA V100R001C00	60	36	60	55	8
SUN2000-55KTL-IN-HV-D1	39	SUN2000HA V100R001C00	66	39.6	66	55	8

Model	Model ID	Earliest Firm Version	P_{max} (kW)	Q_{max} (kVar)	S_{max} (kVA)	P_n (kW)	Number of PV Strings
SUN2000-55KTL-HV-D1-001	40	SUN2000HAV100R001C00	66	39.6	66	55	8
SUN2000-60KTL-HV-D1	33	SUN2000HAV100R001C00	66	39.6	66	60	8
SUN2000-60KTL-HV-D1-001	41	SUN2000HAV100R001C00	66	39.6	66	60	8

NOTE

The maximum active power (P_{max}), maximum reactive power (Q_{max}), maximum apparent power (S_{max}), and rated power (P_n) of each model are for reference only. For details, see the corresponding model specifications.

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 Communications Protocol Overview.

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
Bitfield16	16-bit data expressed by bit
Bitfield32	32-bit data expressed by bit

Name	Description
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	Address	Quantity	Scope
1	Model ID	RO	U16	N/A	1	32001	1	-
2	Output mode	RO	U16	N/A	1	32002	1	-
3	SN	RO	STR	N/A	1	32003	10	-
4	PN	RO	STR	N/A	1	32153	10	-
5	System time	RO	EPOCHTIME	N/A	1	32200	2	-
6	PV1 voltage	RO	I16	V	10	32262	1	-
7	PV1 current	RO	I16	A	10	32263	1	-
8	PV2 voltage	RO	I16	V	10	32264	1	-
9	PV2 current	RO	I16	A	10	32265	1	-
10	PV3 voltage	RO	I16	V	10	32266	1	-
11	PV3 current	RO	I16	A	10	32267	1	-
12	PV4 voltage	RO	I16	V	10	32268	1	-
13	PV4 current	RO	I16	A	10	32269	1	-
14	PV5 voltage	RO	I16	V	10	32270	1	-
15	PV5 current	RO	I16	A	10	32271	1	-
16	PV6 voltage	RO	I16	V	10	32272	1	-
17	PV6 current	RO	I16	A	10	32273	1	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
18	Line voltage between phases A and B	RO	U16	V	10	32274	1	-
19	Line voltage between phases B and C	RO	U16	V	10	32275	1	-
20	Line voltage between phases C and A	RO	U16	V	10	32276	1	-
21	Phase A voltage	RO	U16	V	10	32277	1	-
22	Phase B voltage	RO	U16	V	10	32278	1	-
23	Phase C voltage	RO	U16	V	10	32279	1	-
24	Phase A current	RO	U16	A	10	32280	1	-
25	Phase B current	RO	U16	A	10	32281	1	-
26	Phase C current	RO	U16	A	10	32282	1	-
27	Grid frequency	RO	U16	Hz	100	32283	1	-
28	Power factor	RO	I16	N/A	1000	32284	1	-
29	Inverter efficiency	RO	U16	%	100	32285	1	-
30	Internal temperature	RO	I16	℃	10	32286	1	-
31	Device status	RO	U16	N/A	1	32287	1	-
32	Peak active power of current day	RO	I32	kW	1000	32288	2	-
33	Active power	RO	I32	kW	1000	32290	2	-
34	Reactive power	RO	I32	kVar	1000	32292	2	-
35	Input power	RO	U32	kW	1000	32294	2	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
36	Current energy yield collection time	RO	EPOCHTIME	N/A	1	32296	2	-
37	Energy yield in current hour	RO	U32	kWh	100	32298	2	-
38	Daily energy yield	RO	U32	kWh	100	32300	2	-
39	Monthly energy yield	RO	U32	kWh	100	32302	2	-
40	Annual energy yield	RO	U32	kWh	100	32304	2	-
41	Accumulated energy yield	RO	U32	kWh	100	32306	2	-
42	PV7 voltage	RO	I16	V	10	32314	1	-
43	PV7 current	RO	I16	A	10	32315	1	-
44	PV8 voltage	RO	I16	V	10	32316	1	-
45	PV8 current	RO	I16	A	10	32317	1	-
46	State 1	RO	Bitfield16	N/A	1	32319	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

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
47	State 2	RO	Bitfield16	N/A	1	32320	1	Bit 0: locking status (0: locked; 1: unlocked)
48	State 3	RO	Bitfield16	N/A	1	32321	1	Bit 0: ZVRT protection Bit 1: LVRT protection Bit 2: anti-islanding protection
49	State 4	RO	Bitfield16	N/A	1	32322	1	Bit 0: grid-connected Bit 1: grid-connected (compatible and reserved)
50	Insulation resistance	RO	U16	MΩ	1000	32323	1	-
51	Startup time	RO	EPOCHTIME	s	1	32325	2	-
52	Shutdown time	RO	EPOCHTIME	s	1	32327	2	-
53	Energy yield collection time for previous hour	RO	EPOCHTIME	N/A	1	32343	2	-
54	Energy yield in previous hour	RO	U32	kWh	100	32345	2	-
55	Energy yield collection time for previous day	RO	EPOCHTIME	N/A	1	32347	2	-
56	Energy yield on previous day	RO	U32	kWh	100	32349	2	-
57	Energy yield collection time for previous month	RO	EPOCHTIME	N/A	1	32351	2	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
58	Energy yield in previous month	RO	U32	kWh	100	32353	2	-
59	Energy yield collection time for previous year	RO	EPOCHTIME	N/A	1	32355	2	-
60	Energy yield in previous year	RO	U32	kWh	100	32357	2	-
61	[Active] Adjustment mode	RO	U16	N/A	1	32402	1	0: percentage 1: fixed value **NOTICE** Addresses 32402 to 32405 need to be read at a time.
62	[Active] Adjustment value	RO	U32	N/A	*	32403	2	Percentage: 0.1% Fixed value: 0.001 kW **NOTICE** For details about the adjustment value precision, see the corresponding adjustment command precision.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
63	[Active] Adjustment command	RO	U16	N/A	1	32405	1	42320: active power derating by percentage (local) 40125: active power derating by percentage (0.1%) 40119: active power derating by percentage (1%) 40232: command for active power derating by percentage (0.1%) 40234: command for active power derating by percentage (1%) 42332: local active power derating by fixed value 40120: active power derating by fixed value 40235: command for active power derating by fixed value 42178: maximum active power

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
64	[Reactive] Adjustment mode	RO	U16	N/A	1	32406	1	0: power factor 1: absolute value 2: Q/S 3: Q-U characteristic curve (command ID: 0) 4: cosφ-P/P_n characteristic curve (command ID: 0) 5: PF-U characteristic curve (command ID: 0) 6: Q-P characteristic curve (command ID: 0) **NOTICE** Addresses 32406 to 32409 need to be read at a time.
65	[Reactive] Adjustment value	RO	U32	N/A	*	32407	2	Power factor: 0.001 Absolute value: 0.001 kVar Q/S: 0.001 Q-U characteristic curve: 0 cosφ-P/P_n characteristic curve: 0 PF-U characteristic curve: 0 Q-P characteristic curve: 0 **NOTICE** For details about the adjustment value precision, see the corresponding adjustment command precision.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
66	[Reactive] Adjustment command	RO	U16	N/A	1	32409	1	42321: local power factor adjustment 40122: power factor adjustment 40237: power factor command 40129: reactive power compensation at night (kVar) 40123: Q/S adjustment 40236: Q/S command 42809: reactive power compensation at night (Q/S)
67	MPPT1 total input power	RO	U32	kW	1000	33022	2	-
68	MPPT2 total input power	RO	U32	kW	1000	33024	2	-
69	MPPT3 total input power	RO	U32	kW	1000	33026	2	-
70	MPPT4 total input power	RO	U32	kW	1000	33070	2	-
71	System time	RW	EPOCHTIME	N/A	1	40000	2	[946684800, 3155759999] Epoch seconds, local time
72	[Power grid scheduling] Reactive power compensation mode	RW	U16	N/A	1	40117	1	[0, 8] **NOTICE** Stores data but does not support high-frequency write operations.
73	[Power grid scheduling] Active power control mode	RW	U16	N/A	1	40118	1	[0, 4] **NOTICE** Stores data but does not support high-frequency write operations.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
74	[Power grid scheduling] Active power percentage derating (1%)	RW	U16	%	1	40119	1	[0, 100] **NOTICE** Stores data but does not support high-frequency write operations.
75	[Power grid scheduling] Fixed active power derated	RW	U16	kW	10	40120	1	[0, P_{max}] **NOTICE** Stores data but does not support high-frequency write operations.
76	[Power grid scheduling] Active power change gradient	RW	U16	%/s	10	40121	1	[0.1, 1000]* **NOTICE** Stores data but does not support high-frequency write operations.
77	[Power grid scheduling] Reactive power compensation (PF)	RW	I16	N/A	1000	40122	1	(–1, –0.8]U[0.8, 1] **NOTICE** Stores data but does not support high-frequency write operations.
78	[Power grid scheduling] Reactive power compensation (Q/S)	RW	I16	N/A	1000	40123	1	[–1, 1] **NOTICE** Stores data but does not support high-frequency write operations.
79	[Power grid scheduling] Reactive power adjustment time	RW	U16	s	1	40124	1	[1, 1000] **NOTICE** Stores data but does not support high-frequency write operations.
80	[Power grid scheduling] Active power percentage derating (0.1%)	RW	U16	%	10	40125	1	[0, 100] **NOTICE** Stores data but does not support high-frequency write operations.
81	[Power grid scheduling] cosφ-P/P_n characteristic curve	RW	BYTES	N/A	1	40133	21	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
82	[Power grid scheduling] Q-U characteristic curve	RW	BYTES	N/A	1	40154	21	-
83	[Power grid scheduling] Q-U power percentage to exit scheduling*	RW	U16	%	1	40198	1	[0, 100]
84	Startup	WO	U16	N/A	1	40200	1	-
85	Shutdown	WO	U16	N/A	1	40201	1	-
86	[Power grid scheduling] Active power percentage derating command (0.1%)	WO	U16	%	10	40232	1	[0, 100] Supports high-frequency write operations but does not store data.
87	[Power grid scheduling] Fixed active power derating command (1%)	WO	U16	%	1	40234	1	[0, 100] Supports high-frequency write operations but does not store data.
88	[Power grid scheduling] Fixed active power derating command	WO	U16	kW	10	40235	1	[0, P_{max}] Supports high-frequency write operations but does not store data.
89	[Power grid scheduling] Reactive power compensation command (Q/S)	WO	I16	N/A	1000	40236	1	[–1, 1] Supports high-frequency write operations but does not store data.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
90	[Power grid scheduling] Reactive power compensation command (PF)	WO	I16	N/A	1000	40237	1	(–1, –0.8]U[0.8, 1] Supports high-frequency write operations but does not store data.
91	Level-1 OV protection time	RW	U32	ms	1	42045	2	[50, 7200000]*
92	Level-2 OV protection time	RW	U32	ms	1	42047	2	[50, 7200000]*
93	Level-1 UV protection time	RW	U32	ms	1	42049	2	[50, 7200000]*
94	Level-2 UV protection time	RW	U32	ms	1	42051	2	[50, 7200000]*
95	Level-1 OF protection time	RW	U32	ms	1	42053	2	[50, 7200000]*
96	Level-2 OF protection time	RW	U32	ms	1	42055	2	[50, 7200000]*
97	Level-1 UF protection time	RW	U32	ms	1	42057	2	[50, 7200000]*
98	Level-2 UF protection time	RW	U32	ms	1	42059	2	[50, 7200000]*
99	10-minute OV protection time	RW	U32	ms	1	42061	2	[50, 7200000]*
100	Level-1 OV protection	RW	U16	V	10	42063	1	[1 x V_n, 1.36 x V_n]
101	Level-2 OV protection	RW	U16	V	10	42064	1	[1 x V_n, 1.36 x V_n]
102	Level-1 UV protection	RW	U16	V	10	42065	1	[0.15 x V_n, 1 x V_n]

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
103	Level-2 UV protection	RW	U16	V	10	42066	1	[0.15 x V_n, 1 x V_n]
104	Level-1 OF protection	RW	U16	Hz	100	42067	1	[1 x F_n, 1.15 x F_n]
105	Level-2 OF protection	RW	U16	Hz	100	42068	1	[1 x F_n, 1.15 x F_n]
106	Level-1 UF protection	RW	U16	Hz	100	42069	1	[0.85 x F_n, 1 x F_n]
107	Level-2 UF protection	RW	U16	Hz	100	42070	1	[0.85 x F_n, 1 x F_n]
108	10 minute OV protection	RW	U16	V	10	42071	1	[1 x V_n, 1.36 x V_n]
109	Grid code	RW	U16	N/A	1	42072	1	[0, 93]
110	Insulation resistance protection	RW	U16	MΩ	1000	42074	1	[0.033, 1.5]*
111	Unbalance voltage protection	RW	U16	%	10	42075	1	[0, 50]
112	Soft start time after grid failure	RW	U16	s	1	42083	1	[20, 800]
113	LVRT	RW	U16	N/A	1	42084	1	0: disable 1: enable
114	Soft start time	RW	U16	s	1	42085	1	[20, 1800]
115	Grid connection duration after grid recovery	RW	U16	s	1	42086	1	[0, 7200]
116	Active islanding protection	RW	U16	N/A	1	42087	1	0: disable 1: enable
117	LVRT reactive power compensation power factor	RW	U16	N/A	10	42089	1	[0, 10]

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
118	Reactive power compensation (cosφ-P) trigger voltage	RW	U16	%	1	42090	1	[100, 110]
119	Reactive power compensation (cosφ-P) exit voltage	RW	U16	%	1	42091	1	[90, 100]
120	Trigger frequency of overfrequency derating	RW	U16	Hz	100	42092	1	50 Hz: [45, 55) 60 Hz: [55, 65)
121	Quit frequency of overfrequency derating	RW	U16	Hz	100	42093	1	50 Hz: [45, 55) 60 Hz: [55, 65)
122	Power recovery gradient of overfrequency derating	RW	U16	%/min	1	42094	1	[1, 6000]
123	Q-U characteristic curve mode	RW	U16	N/A	1	42095	1	[0, 1]
124	Q-U scheduling trigger power percent	RW	U16	%	1	42096	1	[0, 100]
125	MPPT multi-peak scanning	RW	U16	N/A	1	42097	1	[0, 1]
126	MPPT scanning interval	RW	U16	min	1	42101	1	[5, 30]
127	AFCI	RW	U16	NA	1	42125	1	[0, 1]
128	Level-3 OV protection	RW	U16	V	10	42151	1	[1 x V_n, 1.36 x V_n]
129	Level-3 OV protection time	RW	U32	ms	1	42152	2	[50, 7200000]*

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
130	Level-4 OV protection	RW	U16	V	10	42154	1	[1 x V_n, 1.36 x V_n]
131	Level-4 OV protection time	RW	U32	ms	1	42155	2	[50, 7200000]*
132	Level-3 UV protection	RW	U16	V	10	42157	1	[0.15 x V_n, 1 x V_n]
133	Level-3 UV protection time	RW	U32	ms	1	42158	2	[50, 7200000]*
134	Level-4 UV protection	RW	U16	V	10	42160	1	[0.15 x V_n, 1 x V_n]
135	Level-4 UV protection time	RW	U32	ms	1	42161	2	[50, 7200000]*
136	Shutdown at 0% power limit	RW	U16	N/A	1	42174	1	[0, 1]
137	System time: year	RW	U16	N/A	1	42300	1	[2000, 2069]
138	System time: month	RW	U16	N/A	1	42301	1	[1, 12]
139	System time: day	RW	U16	N/A	1	42302	1	[1, 31]
140	System time: hour	RW	U16	N/A	1	42303	1	[0, 23]
141	System time: minute	RW	U16	N/A	1	42304	1	[0, 59]
142	System time: second	RW	U16	N/A	1	42305	1	[0, 59]
143	[Power grid scheduling] Active power percentage derating	RW	U16	%	1	42320	1	[0, 100]
144	[Power grid scheduling] Power factor	RW	I16	N/A	1000	42321	1	(–1, –0.8]U[0.8, 1]
145	Remote power scheduling	RW	U16	N/A	1	42333	1	0: disable 1: enable

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
146	AFCI self check	WO	U16	N/A	1	42731	1	-
147	Alarm 1	RO	Bitfield16	N/A	1	50000	1	-
148	Alarm 2	RO	Bitfield16	N/A	1	50001	1	-
149	Alarm 3	RO	Bitfield16	N/A	1	50002	1	-
150	Alarm 4	RO	Bitfield16	N/A	1	50003	1	-
151	Alarm 5	RO	Bitfield16	N/A	1	50004	1	-
152	Alarm 6	RO	Bitfield16	N/A	1	50005	1	-
153	Alarm 7	RO	Bitfield16	N/A	1	50006	1	-
154	Alarm 8	RO	Bitfield16	N/A	1	50007	1	-
155	Alarm 9	RO	Bitfield16	N/A	1	50008	1	-
156	Alarm 10	RO	Bitfield16	N/A	1	50009	1	-
157	Alarm 11	RO	Bitfield16	N/A	1	50010	1	-
158	Alarm 12	RO	Bitfield16	N/A	1	50011	1	-
159	Alarm 13	RO	Bitfield16	N/A	1	50012	1	-
160	Alarm 14	RO	Bitfield16	N/A	1	50013	1	-
161	Alarm 15	RO	Bitfield16	N/A	1	50014	1	-
162	Alarm 16	RO	Bitfield16	N/A	1	50015	1	-
163	Alarm 17	RO	Bitfield16	N/A	1	50016	1	-

NOTICE

For some models, ranges marked with * may be wider than the actual ranges. The interface result code prevails.

4 Interface Instructions

4.1 Alarm Information

Table 4-1 Alarm information

No.	Alarm	Bit	Alarm Name	Alarm ID	Cause ID	Level
1	50000	1	Abnormal String 1	106	1	Warning
2	50000	2	Abnormal String 2	107	1	Warning
3	50000	3	Abnormal String 3	108	1	Warning
4	50000	4	Abnormal String 4	109	1	Warning
5	50000	5	Abnormal String 5	110	1	Warning
6	50000	6	Abnormal String 6	111	1	Warning
7	50000	10	Software Ver. Unmatch	504	1	Minor
8	50000	12	Upgrade Failed	505	1	Major
9	50000	13	Flash Fault	61440	1	Minor
10	50000	14	License Expired	506	1	Warning
11	50001	1	Software Ver. Unmatch	504	2	Minor
12	50001	2	Software Ver. Unmatch	504	3	Minor
13	50001	3	System Fault	400	1	Major
14	50001	4	System Fault	400	27	Major
15	50001	5	Abnormal DC Circuit	200	16	Major
16	50001	6	Abnormal Inv. Circuit	202	20	Major
17	50001	7	Abn. Residual Curr.	318	1	Major
18	50001	8	Overtemperature	321	1	Major
19	50001	10	System Fault	400	28	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Cause ID	Level
20	50001	11	Fan Fault	320	1	Minor
21	50001	12	Abnormal SPI Comm.	322	1	Major
22	50001	14	System Fault	400	29	Major
23	50002	0	Low Insulation Resistance	313	1	Major
24	50002	1	AFCI Self-Check Failure	411	1	Major
25	50002	2	DC Arc Fault	412	1	Major
26	50002	3	AFCI Self-Check Failure	411	2	Major
27	50002	4	AFCI Self-Check Failure	411	3	Major
28	50002	5	Abnormal Inv. Circuit	202	21	Major
29	50002	7	System Fault	400	30	Major
30	50002	8	System Fault	400	31	Major
31	50002	9	String 3 Reversed	122	1	Major
32	50002	12	DC Arc Fault	412	2	Major
33	50002	13	DC Arc Fault	412	3	Major
34	50002	14	DC Arc Fault	412	4	Major
35	50002	15	System Fault	400	23	Major
36	50003	1	String 1 Reversed	120	1	Major
37	50003	2	String 2 Reversed	121	1	Major
38	50003	3	Abnormal DC Circuit	200	12	Major
39	50003	6	String 4 Reversed	123	1	Major
40	50003	7	String 5 Reversed	124	1	Major
41	50003	8	String 6 Reversed	125	1	Major
42	50003	9	High DC Input Voltage	103	1	Major
43	50003	10	High DC Input Voltage	103	2	Major
44	50003	11	High DC Input Voltage	103	3	Major
45	50003	12	High DC Input Voltage	103	4	Major
46	50003	15	Abnormal DC Circuit	200	15	Major
47	50004	2	String 1 Reversed	120	2	Warning

No.	Alarm	Bit	Alarm Name	Alarm ID	Cause ID	Level
48	50004	3	String 2 Reversed	121	2	Warning
49	50004	4	String 7 Reversed	126	1	Major
50	50004	5	String 7 Reversed	126	2	Warning
51	50004	6	String 8 Reversed	127	1	Major
52	50004	7	String 8 Reversed	127	2	Warning
53	50004	8	Abnormal PV String Connection	413	1	Major
54	50004	9	Abnormal PV String Connection	413	2	Major
55	50004	10	Abnormal PV String Connection	413	3	Major
56	50004	11	Abnormal PV String Connection	413	4	Major
57	50004	12	String 3 Reversed	122	2	Warning
58	50004	13	String 4 Reversed	123	2	Warning
59	50004	14	String 5 Reversed	124	2	Warning
60	50004	15	String 6 Reversed	125	2	Warning
61	50005	1	Abnormal DC Circuit	200	3	Major
62	50005	2	Abn. Auxiliary Power	410	4	Major
63	50005	4	Abnormal DC Circuit	200	10	Major
64	50005	5	Abnormal DC Circuit	200	11	Major
65	50005	6	Abnormal DC Circuit	200	30	Major
66	50005	7	BST Inductor Cable Connection Abnormal	414	1	Major
67	50005	8	BST Inductor Cable Connection Abnormal	414	2	Major
68	50005	9	BST Inductor Cable Connection Abnormal	414	3	Major
69	50005	10	BST Inductor Cable Connection Abnormal	414	4	Major
70	50006	6	System Fault	400	3	Major
71	50006	10	Abnormal Inv. Circuit	202	13	Major
72	50006	12	Abnormal Inv. Circuit	202	14	Major
73	50007	1	Abnormal Inv. Circuit	202	16	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Cause ID	Level
74	50007	5	System Fault	400	21	Major
75	50008	0	Abnormal Grid Voltage	301	4	Major
76	50008	3	Abnormal Grid Voltage	301	16	Major
77	50008	6	Abnormal Grid Frequency	305	2	Major
78	50008	7	Abnormal Grid Frequency	305	4	Major
79	50008	8	Abnormal Grid Voltage	301	28	Major
80	50008	9	Abnormal Grid Voltage	301	29	Major
81	50008	10	Abnormal Grounding	326	1	Major
82	50008	11	Abnormal Grid Voltage	301	26	Major
83	50008	12	Abnormal Grid Frequency	305	5	Major
84	50009	0	Abnormal Grid Voltage	301	31	Major
85	50009	1	Abnormal Grid Voltage	301	32	Major
86	50009	2	Abnormal Grid Voltage	301	33	Major
87	50009	8	Abnormal Grid Voltage	301	19	Major
88	50016	0	Abnormal String 1	106	1	Warning
89	50016	1	Abnormal String 2	107	1	Warning
90	50016	2	Abnormal String 3	108	1	Warning
91	50016	3	Abnormal String 4	109	1	Warning
92	50016	4	Abnormal String 5	110	1	Warning
93	50016	5	Abnormal String 6	111	1	Warning
94	50016	6	Abnormal String 7	112	1	Warning
95	50016	7	Abnormal String 8	113	1	Warning

4.2 Power Grid Scheduling

This section describes the active power adjustment, reactive power adjustment, and curve configuration formats and precautions for power grid curve scheduling.

4.2.1 Active Power Adjustment

The solar inverter provides five active power adjustment modes. The active power adjustment response speed can be modified by setting Active power derating gradient (register 40121).

Table 4-2 Signal information for active power adjustment

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Restraints
1	Active power control mode	RW	U16	N/A	1	40118	1	Stores data but does not support high-frequency write operations.
2	Active power percentage derating (1%)	RW	U16	%	1	40119	1	
3	Fixed active power derating	RW	U16	kW	10	40120	1	
4	Active power change gradient	RW	U16	%/s	10	40121	1	
5	Active power percentage derating (0.1%)	RW	U16	%	10	40125	1	
6	Active power percentage derating command (0.1%)	WO	U16	%	10	40232	1	Supports high-frequency write operations but does not store data.
7	Active power percentage derating command (1%)	WO	U16	%	1	40234	1	
8	Fixed active power derating command	WO	U16	kW	10	40235	1	

NOTE

- If a storage interface that needs to be written frequently is required, ensure that the solar inverter version is V100R001C81SPC107, V200R001C00SPC106, or a later version.
- If the Fixed active power derating command interface is required, ensure that the solar inverter version is V100R001C81SPC107, V200R001C00SPC106, or a later version.

4.2.1.1 Disabling Active Power Limitation

The solar inverter does not accept any derating command. It can run with power up to P_{max}. Other register interfaces are not required.

Operation:

Set Active power control (register 40118) to 0.

NOTE

After the mode of Active power control (register 40118) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.

4.2.1.2 Communication Limit by Percentage

The solar inverter switches to remote control mode and receives the active power derating command in percentage. The reference value of the percentage is the reported P_{max}. P_{max} varies depending on the solar inverter model. For details, see 1.1 Model Description.

Operation:

- Scenario in which the derating precision is 1%: Change the value of Active power control (register 40118) to 1, and change the value of Active power percentage derating command (1%) (register 40234) to the target value (%).
- Scenario in which the derating precision is 0.1%: Change the value of Active power control (register 40118) to 1, and change the value of Active power percentage derating command (0.1%) (register 40232) to the target value (%).

NOTE

- After the mode of Active power control (register 40118) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- Active power percentage derating command (1%) (register 40234) and Active power percentage derating command (0.1%) (register 40232) need to be sent by the host periodically at intervals no more than 10 minutes. Otherwise, the solar inverter will automatically restore the active output to 100% of P_{max}. The solar inverter does not save the derating command set in this mode. After the solar inverter is powered on again, the power is restored to 100% of P_{max}.

4.2.1.3 Communication Limit by Fixed Value

The solar inverter switches to remote control mode. It receives the active derating command in the form of a fixed value measured in kW. The adjustment precision is 0.1 kW. The maximum value is P_{max} of the solar inverter, and the minimum value is 0.

Operation:

Change the value of Active power control (register 40118) to 4, and then change the value of Fixed active power derating (register 40235) to the target value (kW).

NOTE

- After the mode of Active power control (register 40118) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- Fixed active power derating (register 40235) needs to be sent by the host at intervals no more than 10 minutes. Otherwise, the inverter will automatically restore active power output to 100% of P_{max}. The solar inverter does not save the derating command set in this mode. After the solar inverter is powered on again, the power is restored to 100% of P_{max}.

4.2.1.4 Parameter Setting by Percentage

The host sends an active power derating command in percentage. The reference value of the percentage is the reported P_{max}. P_{max} varies depending on the solar inverter model. For details, see 1.1 Model Description.

Operation:

- Scenario in which the derating precision is 1%: Change the value of Active power control (register 40118) to 3, and change the value of Active power percentage derating command (1%) (register 40119) to the target value (%).
- Scenario in which the derating precision is 0.1%: Change the value of Active power control (register 40118) to 3, and change the value of Active power percentage derating command (0.1%) (register 40125) to the target value (%).

NOTE

- After the mode of Active power control (register 40118) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- After Active power percentage derating (1%) (register 40119) or Active power percentage derating (0.1%) (register 40125) is set, the solar inverter applies and saves the setting. The value does not need to be sent periodically. If you need to send a value periodically, send the value at intervals greater than 12 minutes.

4.2.1.5 Parameter Setting by Fixed Value

The host delivers the active scheduling target value, which is an absolute value measured in kW. The adjustment precision is 0.1 kW. The maximum value is the reported P_{max}, and the minimum value is 0.

Operation:

Change the value of Active power control (register 40118) to 2, and then change the value of Fixed active power derating (register 40120) to the target value (kW).

NOTE

- After the mode of Active power control (register 40118) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- After Fixed active power derating (register 40120) is set, the solar inverter applies and saves the setting. The value does not need to be sent periodically. If you need to send a value periodically, send the value at intervals greater than 12 minutes.

4.2.2 Reactive Power Adjustment

The solar inverter provides multiple reactive power adjustment modes. The reactive power adjustment response speed can be modified by setting Reactive power adjustment time (register 40124).

Table 4-3 Signal information for reactive power adjustment

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Restraints
1	Reactive power compensation	RW	U16	N/A	1	40117	1	Stores data but does not support high-frequency write operations.
2	Reactive power compensation (PF)	RW	I16	N/A	1000	40122	1	
3	Reactive power compensation (Q/S)	RW	I16	N/A	1000	40123	1	

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Restraints
4	Reactive power adjustment time	RW	U16	s	1	40124	1	
5	Reactive power compensation command (Q/S)	WO	I16	N/A	1000	40236	1	Supports high-frequency write operations but does not store data.
6	Reactive power compensation command (PF)	WO	I16	N/A	1000	40237	1	

NOTE

- If a storage interface that needs to be written frequently is required, ensure that the solar inverter version is V100R001C81SPC107, V200R001C00SPC106, or a later version.
- If the Reactive power compensation command (Q/S) interface is required, ensure that the solar inverter version is V100R001C81SPC107, V200R001C00SPC106, or a later version.

4.2.2.1 Disabling Reactive Power Output

The solar inverter does not provide reactive power. The on-grid power factor is 1. Additional register interfaces are not required.

Operation:

Change the value of Reactive power control (register 40117) to 0.

NOTE

After the mode of Reactive power control (register 40117) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.

4.2.2.2 Communication Adjustment Power Factor

The solar inverter switches to remote control mode and receives the reactive power derating command in the form of a power factor.

Operation:

Change the value of Reactive power control (register 40117) to 1 and then change the value of Reactive power compensation command (PF) (register 40237) to the target value for power adjustment.

NOTE

- After the mode of Reactive power control (register 40117) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- Reactive power compensation (PF) (register 40237) needs to be sent by the host at intervals no more than 10 minutes. Otherwise, the solar inverter will automatically disable reactive power output.

4.2.2.3 Communication Adjustment Q/S

The solar inverter switches to remote control mode and receives the reactive power adjustment command in the form of Q/S.

Operation:

Change the value of Reactive power control (register 40117) to 6 and then change the value of Reactive power compensation command (Q/S) (register 40236) to the target value for power adjustment.

NOTE

- After the mode of Reactive power control (register 40117) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- Reactive power compensation command (Q/S) (register 40236) needs to be sent by the host at intervals no more than 10 minutes. Otherwise, the solar inverter will automatically disable reactive power output.

4.2.2.4 Parameter Setting Power Factor

The host sends a reactive power adjustment command in the form of a power factor. The output reactive power of the solar inverter is related to the output active power.

Operation:

Change the value of Reactive power control (register 40117) to 3 and then change the value of Reactive power compensation (PF) (register 40122) to the target value for power adjustment.

NOTE

- After the mode of Reactive power control (register 40117) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- After Reactive power compensation (PF) (register 40122) is set, the solar inverter applies and saves the setting. The value does not need to be sent periodically. If you need to send a value periodically, send the value at intervals greater than 12 minutes.

4.2.2.5 Parameter Setting Q/S

The host sends a reactive power adjustment command in the form of Q/S. Q is the reactive power target value (kVar), and S is the maximum apparent power of the solar inverter (kVA). For details about the maximum apparent power of different models, see the signal definition table.

Operation:

Change the value of Reactive power control (register 40117) to 2 and then change the value of Reactive power compensation (Q/S) (register 40123) to the target value for power adjustment.

NOTE

- After the mode of Reactive power control (register 40117) is changed, the solar inverter automatically saves the register value. You do not need to write the value repeatedly. If you need to send a value periodically, send the value at intervals greater than 12 minutes.
- After Reactive power compensation (Q/S) (register 40123) is set, the solar inverter applies and saves the setting. The value does not need to be sent periodically. If you need to send a value periodically, send the value at intervals greater than 12 minutes.

4.2.3 Curve Adjustment

4.2.3.1 cosφ-P/P_n Characteristic Curve

Table 4-4 cosφ-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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ 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]
cosφ value at point 10	I16	1000	N/A	(–1, –0.8]U[0.8, 1]

4.2.3.2 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]

Description	Data Type	Gain	Unit	Value Range
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]
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]

NOTICE

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.

4.2.3.3 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]U[0.8, 1]
U/U_n value at point 2	U16	10	%	[80, 136]

Description	Data Type	Gain	Unit	Value Range
PF value at point 2	I16	1000	N/A	(–1, –0.8]U[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]U[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]U[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]U[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]U[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]U[0.8, 1]
U/U_n value at point 8	U16	10	%	[80, 136]
PF value at point 8	I16	1000	N/A	(–1, –0.8]U[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]U[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]U[0.8, 1]

4.3 Grid Codes

Table 4-5 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

No.	Standard	Applicable Country or Region
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
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

No.	Standard	Applicable Country or Region
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
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

No.	Standard	Applicable Country or Region
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
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

No.	Standard	Applicable Country or Region
102	CHINA-MV500-STD	China
103	CHINA-MV480-STD	China
104	Mexico-MV480	Mexico
105	Malaysian	Malaysia
106	Malaysian-MV480	Malaysia
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-MV600-50Hz	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

No.	Standard	Applicable Country or Region
133	NRS-097-2-1-MV800	South Africa
134	SA_RPPs-MV800	South Africa
135	Jordan-Transmission-MV800	Jordan
136	Jordan-Distribution-MV800	Jordan
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

No.	Standard	Applicable Country or Region
164	Jordan-Transmission-HV480	Jordan
165	Jordan-Transmission-HV800	Jordan
166	TUNISIA	Tunisia
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

No.	Standard	Applicable Country or Region
195	Mexico-MV600	Mexico
196	Vietnam-MV800	Vietnam
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

No.	Standard	Applicable Country or Region
226	Kuwait	Kuwait
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

NOTICE

Set the grid code based on local laws and regulations.

4.4 Energy Storage Specifications

Table 4-6 Format description of parameters for time-of-use electricity price periods

Description	Data Type	Gain	Unit	Value Range
Number of periods	U16	1	N/A	[0, 10]
Start time of period 1	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.

Description	Data Type	Gain	Unit	Value Range
End time of period 1	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
Electricity price in period 1	U32	1000	N/A	-
Start time of period 2	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
End time of period 2	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
Electricity price in period 2	U32	1000	N/A	-
...	-	-	-	-
Start time of period 10	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
End time of period 10	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
Electricity price in period 10	U32	1000	N/A	-

Table 4-7 Format description of parameters for fixed charging and discharging periods

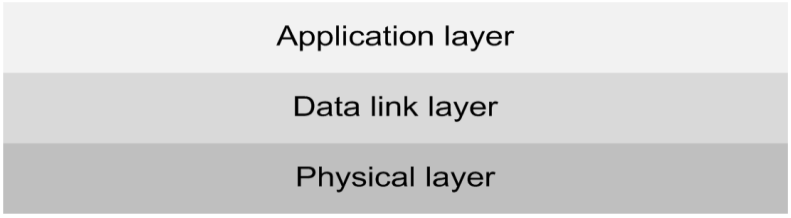
Description	Data Type	Gain	Unit	Value Range
Number of periods	U16	1	N/A	[0, 10]
Start time of period 1	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
End time of period 1	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
Charging and discharging power in period 1	I32	1	W	[Discharging power limit, Charging power limit]. For details, see the description of the supported model.

Description	Data Type	Gain	Unit	Value Range
Start time of period 2	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
End time of period 2	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
Charging and discharging power in period 2	I32	1	W	[Discharging power limit, Charging power limit]. For details, see the description of the supported model.
...	-	-	-	-
Start time of period 10	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
End time of period 10	U16	1	min	[0, 1440]. The value is the elapsed minutes since 00:00 a.m. The start time should be earlier than the end time.
Charging and discharging power in period 10	I32	1	W	[Discharging power limit,Charging power limit]. For details, see the description of the supported model.

5 Overview of the Communications Protocol

The Modbus communications protocol consists of the following layers.

Figure 5-1 Modbus protocol layers



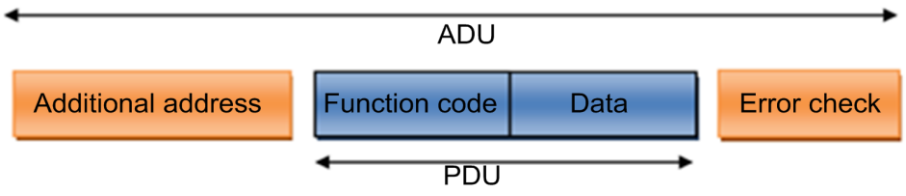
5.1 Physical Layer

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

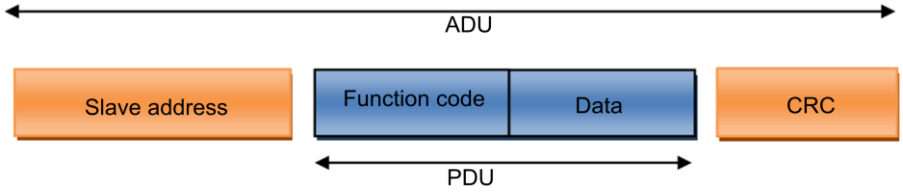
The following figure shows the generic frame structure of the Modbus protocol.

Figure 5-2 Modbus generic frame format



5.2.1 Modbus-RTU

Figure 5-3 Modbus-RTU frame format



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, 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, 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, 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,
```



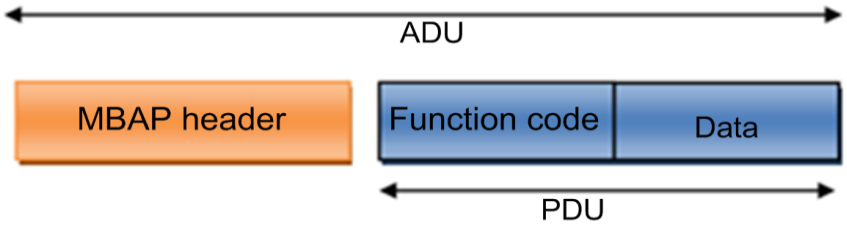
```
0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C,
0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81,
0x80,   0x40
};

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 uIndex ; /* will index into CRC lookup table */
while (usDataLen--) /* pass through message buffer */
{
uIndex = uchCRCLo ^ *puchMsg++ ; /* calculate the CRC */
uchCRCLo = uchCRCHi ^ auchCRCHi[uIndex] ;
uchCRCHi = auchCRCLo[uIndex] ;
}
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.

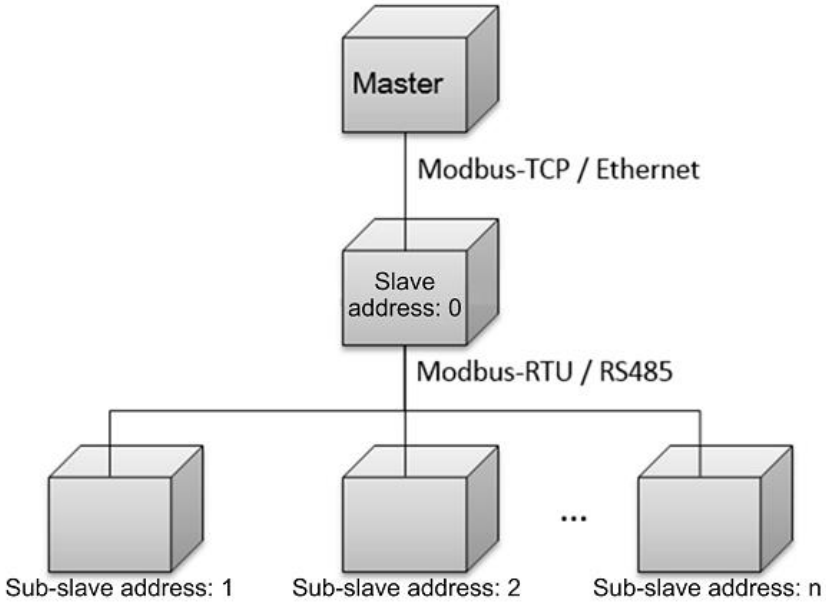
Table 5-2 MBAP definition

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.

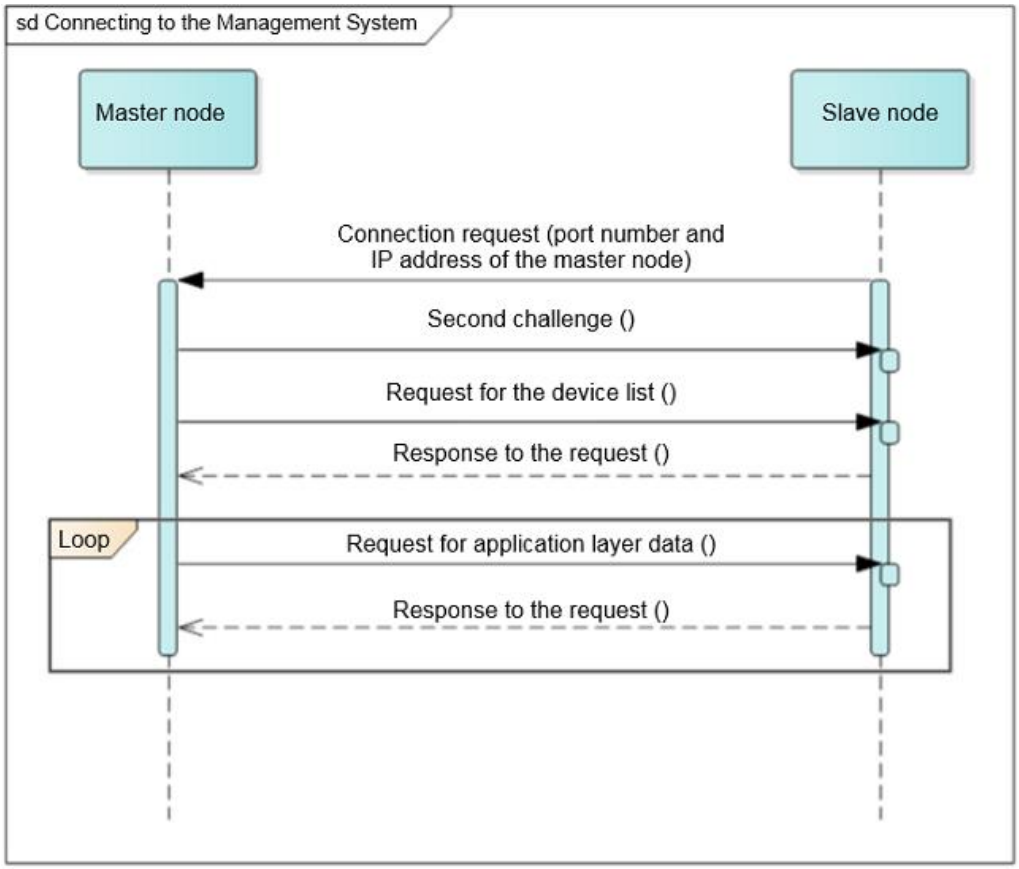
In a non-VPN environment across the public network, the device deployed on the internal network needs to initiate TCP socket link establishment to the master node exposed on the public network. In this case, you need to preset the fixed access port number of the master node on the slave node. To ensure 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	Description	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 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
		01

Description		Frame Data
	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 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
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 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

Description		Frame Data
	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: In addition to the 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	-

Data Field			Length (Byte)	Description
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 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	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.
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	-	-
-	-	-	-

Object ID	Object Name	Type	Description
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

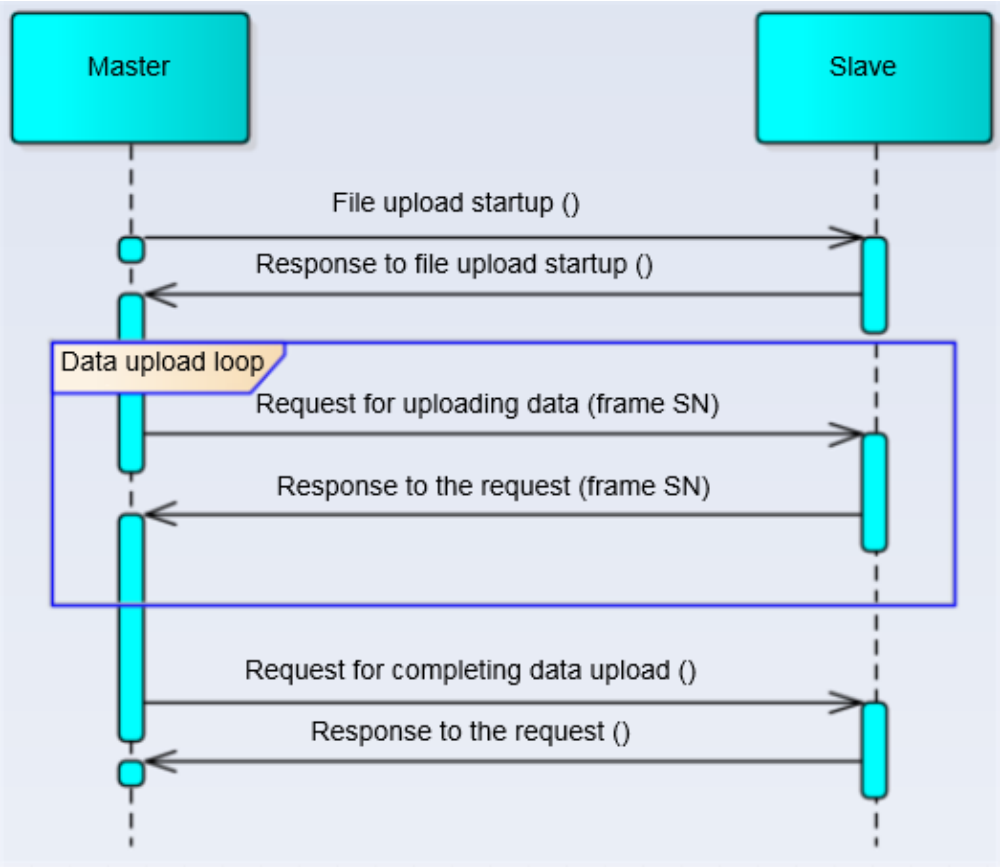
Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See Exception Code List.

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

PDU Data Field	Length (Byte)	Description
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 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 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

PDU Data Field	Length (Byte)	Description
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 Exception Code List.

5.3.7.1.4 Timeout Processing

Table 5-24 Processing specifications of sub-process timeout

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

