PCS2000HA
V200R024C10

Smart PCS Modbus Port Definitions

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Contents

1 Change History

Document Version	Change Description
01 (2024-09-30)	This issue is the first release.

2 Supported Models

This chapter describes the power control system (PCS) models that use the Modbus protocol and the minimum firmware versions. When connecting a host to a PCS, ensure that the firmware version meets the requirement.

2.1 Model Description

Table 2-1 Supported models and firmware versions

Model	Model ID	Minimum Firmware Version
LUNA2000-213KTL-H0	586	PCS2000HA V200R024C10

NOTE

The model ID is the unique code of the model.

3 Introduction

Modbus is a widely used protocol for device communications. This document describes the Modbus protocol used by Huawei PCS, and can be used to regulate subsequent development for third-party integration. Huawei PCS complies with the standard Modbus protocol, and this document focuses on the information specific to Huawei PCS. For other information about Modbus, see the standard documents about the Modbus protocol. For details about the interaction modes and examples of the standard protocol and customized part used in Huawei PCS, see **6 Overview of the Communications Protocol**.

3.1 Terms and Abbreviations

Table 3-1 Terms and abbreviations

Term	Description
Master node	In the master-slave communication, the party that initiates the communication is called 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	String
MLD	Multiple bytes
Bitfield16	16-bit data

Term	Description
Bitfield32	32-bit data
-	N/A
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

4 Register Definitions

Table 4-1 Register definitions

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
1	Model	RO	STR	-	1	30000	15	See **2.1 Model Description**.
2	SN	RO	STR	-	1	30015	10	-
3	PN	RO	STR	-	1	30025	10	-
4	Model ID	RO	U16	-	1	30070	1	See **2.1 Model Description**.
5	Rated power (P_n)	RO	U32	kW	1000	30073	2	-
6	Maximum active power (P_{max})	RO	U32	kW	1000	30075	2	-
7	Maximum apparent power (S_{max})	RO	U32	kVA	1000	30077	2	-
8	Maximum reactive power (Q_{max}, fed to the power grid)	RO	I32	kVar	1000	30079	2	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
9	Maximum reactive power (Q_{max}, supplied from the power grid)	RO	I32	kVar	1000	30081	2	-
10	Real-time charge power	RO	U32	kW	1000	30087	2	-
11	Reverse rectifier maximum active power (RPmax)	RO	U32	kW	1000	30166	2	-
12	Real-time discharge power	RO	U32	kW	1000	30189	2	-
13	PCS running status	RO	Bitfield16	-	1	32000	1	Bit 0: standby Bit 1: grid-connected Bit 2 – 4: reserved Bit 5 – 7: reserved Bit 8: shutdown Bit 9: terminal-test Bit 10: Off-grid running Bit 11: hot spare running
14	Locked state	RO	Bitfield16	-	1	32002	1	Bit 0: locking status (0: locked; 1: unlocked)
15	Alarm 1	RO	Bitfield16	-	1	32008	1	See **5.1 Alarm Information**.
16	Alarm 2	RO	Bitfield16	-	1	32009	1	See **5.1 Alarm Information**.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
17	Alarm 3	RO	Bitfield16	-	1	32010	1	See **5.1 Alarm Information**.
18	Alarm 4	RO	Bitfield16	-	1	32011	1	See **5.1 Alarm Information**.
19	Alarm 5	RO	Bitfield16	-	1	32012	1	See **5.1 Alarm Information**.
20	Alarm 6	RO	Bitfield16	-	1	32013	1	See **5.1 Alarm Information**.
21	A-B line voltage of grid	RO	U16	V	10	32066	1	This parameter is valid when the output mode is three-phase three-wire.
22	B-C line voltage of grid	RO	U16	V	10	32067	1	This parameter is valid when the output mode is three-phase three-wire.
23	C-A line voltage of grid	RO	U16	V	10	32068	1	This parameter is valid when the output mode is three-phase three-wire.
24	Phase A voltage of grid	RO	U16	V	10	32069	1	This parameter is valid when the output mode is three-phase four-wire.
25	Phase B voltage of grid	RO	U16	V	10	32070	1	This parameter is valid when the output mode is three-phase four-wire.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
26	Phase C voltage of grid	RO	U16	V	10	32071	1	This parameter is valid when the output mode is three-phase four-wire.
27	Phase A current of grid	RO	I32	A	1000	32072	2	-
28	Phase B current of grid	RO	I32	A	1000	32074	2	-
29	Phase C current of grid	RO	I32	A	1000	32076	2	-
30	Active power	RO	I32	kW	1000	32080	2	-
31	Reactive power	R	I32	kVar	1000	32082	2	-
32	Power factor	RO	I16	-	1000	32084	1	-
33	Grid frequency	RO	U16	Hz	100	32085	1	-
34	Efficiency	RO	U16	%	100	32086	1	-
35	Internal temperature	RO	I16	°C	10	32087	1	-
36	Insulation resistance	RO	U16	MΩ	1000	32088	1	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
37	Device status	RO	U16	-	1	32089	1	0x0000 standby: initializing 0x0001 standby: insulation resistance testing 0x0003 standby: grid detection 0x0005 standby: wiring inspection 0x0006 standby: in slow start 0x0100 starting 0x0204 runs: hot standby 0x0205 runs: hot standby reactive power compensation 0x0206 runs: PQ running 0x0207 runs: VSG running 0x0208 runs: power limited 0x0209 runs: elf-derating 0x0300 shut down: unexpectedly shut down 0x0301 shut down: shut down on command 0x0302: shut down: shut

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
								down via OVGR 0x0303 shut down: communication interrupted 0x0304 shut down: power limited 0x0305 shut down: shut down unless started manually 0x0401 power grid scheduling: cosϕ-P characteristic curve 0x0402 power grid scheduling: Q-U characteristic curve 0x0403 power grid scheduling: PF-U characteristic curve 0x0405 power grid scheduling: Q-P characteristic curve 0x0600 inspection in progress 0xA001 standby: no DC input

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
38	DC power	RO	I32	kW	1000	32064	2	
39	Error code	RO	U16	-	1	32090	1	-
40	Startup time	RO	U32	-	1	32091	2	Epoch seconds, local time
41	Shutdown time	RO	U32	-	1	32093	2	Epoch seconds, local time
42	DC voltage	RO	U16	V	10	32097	1	-
43	DC current	RO	I32	A	100	32098	2	-
44	Total power supply from grid	RO	U32	kWh	100	32104	2	-
45	Total yield	RO	U32	kWh	100	32106	2	-
46	Yield today	RO	U32	kWh	100	32114	2	-
47	Yield this month	RO	U32	kWh	100	32116	2	-
48	Yield this year	RO	U32	kWh	100	32118	2	-
49	Power supply from grid today	RO	U32	kWh	100	32122	2	-
50	Power supply from grid this month	RO	U32	kWh	100	32124	2	-
51	Power supply from grid in this year	RO	U32	kWh	100	32126	2	-
52	port reactive powe	RO	I32	kVar	1000	32456	2	N/A
53	battery low voltage limit	RO	U16	V	10	32459	1	-
54	battery high voltage limit	RO	U16	V	10	32460	1	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
55	battery cluster charge end SOC	RO	U16	%	10	32461	1	[90.0,100.0] directly connected battery cluster information read from the BCU
56	Battery cluster discharge end SOC	RO	U16	%	10	32462	1	[0.0,15.0] directly connected battery cluster information read from the BCU
57	battery cluster SOC	RO	U16	%	10	32463	1	[0.00,100.0] directly connected battery cluster information read from the BCU
58	battery cluster SOH	RO	U16	%	10	32464	1	[0.00,100.0] directly connected battery cluster information read from the BCU
59	rated Ah capacity of the battery cluster	RO	U32	Ah	10	32465	2	directly connected battery cluster information read from the BCU
60	Rated kWh capacity of the battery cluster	RO	U32	kWh	1000	32467	2	directly connected battery cluster information read from the BCU

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
61	power derating cause	RO	U16	-	1	32469	1	
62	actual charge power capability	RO	U32	kW	1000	32502	2	
63	actual discharge power capability	RO	U32	kW	1000	32504	2	
64	battery cluster identifier	RO	U32	-	1	32512	2	directly connected battery cluster information read from the BCU. The upper 16 bits indicate the container information, and the lower 16 bits indicate the cluster information.
65	[Active] Adjustment mode	RO	U16	-	1	35300	1	0: percentage 1: fixed value Addresses 35300 to 35303 need to be read in one go.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
66	[Active] Adjustment value	RO	U32	-	*	35301	2	Percentage: 0.01% Fixed value: 0.001 kW Note: For details about the adjustment value precision, see the corresponding adjustment command precision.
67	[Active] Adjustment command	RO	U16	-	1	35303	1	40039: active power in percentage (0.01%) 40043: active power in fixed value

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
68	[Reactive] Adjustment mode	RO	U16	-	1	35304	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) Addresses 35304 to 35306 need to be read in one go.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
69	[Reactive] Adjustment value	RO	U32	-	*	35305	2	Power factor: 0.001 Absolute value: 0.001 kVar Q/S: 0.01% Q-U characteristic curve: 0 cosϕ-P/P_n characteristic curve: 0 PF-U characteristic curve: 0 Q-P characteristic curve: 0
70	[Reactive] Adjustment command	RO	U16	-	1	35307	1	40122: power factor 40040: Q/S adjustment 40129: fixed nighttime reactive power (kVar)
71	System time	RW	U32	-	1	40000	2	[946684800, 3155759999] Epoch seconds, local time
72	[Power grid scheduling] Q-U characteristic curve mode	RW	U16	-	1	40037	1	0: non-hysteresis 1: hysteresis
73	[Power grid scheduling] Q-U dispatch trigger power (%)	RW	U16	%	1	40038	1	[0,100]

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
74	[Power grid scheduling] Active power in percentage	RW	I16	%	100	40039	1	Range: [–100,100] Interface for fine adjustment of active power
75	[Power grid scheduling] Reactive power compensation (Q/S)	RW	I16	%	100	40040	1	[–100, 100] The device converts the value to a fixed value of Q for reactive power control. S indicates S_{max}.
76	[Power grid scheduling] Fixed active power	RW	I32	kW	1000	40043	2	Range: [–RP_{max}, P_{max}]
77	[Power grid scheduling] Reactive power compensation (PF)	RW	I16	N/A	1000	40122	1	(–1, –0.8]U[0.8, 1]
78	[Power grid scheduling] Fixed nighttime active power	RW	I32	kVar	1000	40129	1	[–Qmax, Qmax]
79	[Power grid scheduling] cosϕ-P/P_n characteristic curve	RW	MLD	-	1	40133	21	See **5.2 Power Grid Scheduling**.
80	[Power grid scheduling] Q-U characteristic curve	RW	MLD	-	1	40154	21	See **5.2 Power Grid Scheduling**.

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
81	[Power grid scheduling] PF-U characteristic curve	RW	MLD	-	1	40175	21	See **5.2 Power Grid Scheduling**.
82	[Power grid scheduling] Reactive power adjustment time	RW	U16	s	1	40196	1	[1, 120] Default value: 10
83	[Power grid scheduling] Power percentage for exiting Q-U scheduling	RW	U16	%	1	40198	1	[0, 100]
84	On	WO	U16	-	1	40200	1	-
85	OFF	WO	U16	-	1	40201	1	-
86	insulation resistance diagnosis	WO	U16	N/A	1	40206	1	1: start
87	insulation resistance detection mode	RW	U16	-	1	40209	1	0: disabled 1: enabled
88	Hot standby mode	RW	U16	-	1	40210	1	0: zero power operation 1: slotted hot spare 2: seamless hot spare
89	Hot standby scheduling reactive power	RW	I32	-	1	40211	2	-

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
90	Industry mode	RW	U16	-	1	40214	1	0: self-developed mode 1: cooperation Mode
91	grid-connected/off toggle Mode	RW	U16	N/A	1	42044	1	0: automatic switchover 1: manually switchover
92	[Power grid scheduling] Q-P characteristic curve	RW	MLD	-	1	40354	21	See **5.2 Power Grid Scheduling**.
93	Grid code	RW	U16	N/A	1	42000	1	See **5.3 Grid Codes**.
94	[Power grid scheduling] Reactive power change gradient	RW	U32	%/s	1000	42015	2	[0.1, 1000]
95	[Power grid scheduling] Active power change gradient	RW	U32	%/s	1000	42017	2	[0.1, 1000]
96	[Power grid scheduling] Validity period of scheduling instruction	RW	U32	s	1	42019	2	[0, 86400] The value 0 indicates that the command is valid permanently.
97	Local Time Zone	RW	I16	min	1	43006	1	[–720, 840]
98	Operating mode	RW	U16	-	1	42409	1	0: PQ 1: VSG

No.	Signal Name	Read/ Write	Type	Unit	Gain	Address	Quantity	Scope
99	Power Control Priority	RW	U16	-	1	42094	1	0: Reactive power first 1: Active power first
100	upgrade anti-rollback	RW	U16	-	1	42589		0: disabled 1: enabled
101	AC topology group ID	RW	U16	-	1	43820	1	[0~65535]
102	AC topology device identifier	RW	U16	-	1	43821	1	[0~65535]

5 Interface Usage Description

5.1 Alarm Information

Table 5-1 Alarm information

No.	Alarm	Bit	Alarm Name	Alarm ID	Severity
1	Alarm 1	6	Phase wire short-circuited to PE	2031	Major
2	Alarm 1	7	Grid failure	2032	Major
3	Alarm 1	8	Grid undervoltage	2033	Major
4	Alarm 1	9	Grid overvoltage	2034	Major
5	Alarm 1	10	Grid voltage imbalance	2035	Major
6	Alarm 1	11	Grid overfrequency	2036	Major
7	Alarm 1	12	Grid underfrequency	2037	Major
8	Alarm 1	13	Unstable grid frequency	2038	Major
9	Alarm 1	14	AC overcurrent	2039	Major
10	Alarm 1	15	DC component overhigh	2040	Major
11	Alarm 2	0	Abnormal residual current	2051	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Severity
12	Alarm 2	1	Abnormal grounding	2061	Major
13	Alarm 2	2	Low insulation resistance	2062	Major
14	Alarm 2	3	Overtemperature	2063	Major
15	Alarm 2	4	Device fault	2064	Major
16	Alarm 2	5	Update failure	2065	Minor
17	Alarm 2	7	Faulty monitoring unit	61440	Minor
18	Alarm 3	3	External fan abnormal	2086	Major
19	Alarm 3	7	Internal fan abnormal	2087	Major
20	Alarm 4	0	DC overvoltage	2004	Major
21	Alarm 4	1	DC in reverse polarity	2005	Major
22	Alarm 4	2	DC short-circuited or in reverse polarity	2006	Major
23	Alarm 4	3	DC connected in series	2007	Major
24	Alarm 4	4	DC not securely connected	2008	Major
25	Alarm 4	5	Invalid certificate	2095	Warning
26	Alarm 4	6	Certificate about to expire	2096	Major
27	Alarm 4	7	Certificate expired	2097	Major
28	Alarm 4	8	Parallel system communication failure	2098	Major
29	Alarm 5	14	communication interrupted	2102	Minor
30	Alarm 6	7	fuse abnormality	2111	Major

No.	Alarm	Bit	Alarm Name	Alarm ID	Severity
31	Alarm 6	9	FASTIO self-check exception	2114	Major
32	Alarm 6	10	DC bus short-circuit fault	2115	Major
33	Alarm 6	11	DC input undervoltage	2116	Major
34	Alarm 6	12	surge arrester fault	2117	Major
35	Alarm 6	14	DC side power abnormal wiring	2118	Major

5.2 Power Grid Scheduling

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

5.2.1 cosϕ-P/Pn Characteristic Curve

Table 5-2 cosϕ-P/P_n characteristic curve definition

Description	Data Type	Gain	Unit	Range
Number of points on the cosϕ-P/Pn characteristic curve	U16	1	-	[2, 10]
P/P_n value at point 1 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 1 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 2 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 2 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 3 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 3 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 4 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]

Description	Data Type	Gain	Unit	Range
Cosϕ value at point 4 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 5 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 5 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 6 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 6 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 7 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 7 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 8 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 8 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 9 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 9 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
P/P_n value at point 10 on the cosϕ-P/P_n curve	U16	10	%	[0, 100]
Cosϕ value at point 10 on the cosϕ-P/P_n curve	I16	1000	-	(–1, –0.8] U [0.8, 1]

5.2.2 Q-U Characteristic Curve

Table 5-3 Q-U characteristic curve definition

Description	Data Type	Gain	Unit	Range
Number of points on the Q-U curve	U16	1	-	[2, 10]

Description	Data Type	Gain	Unit	Range
U/U_n value at point 1 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 1 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 2 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 2 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 3 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 3 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 4 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 4 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 5 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 5 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 6 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 6 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 7 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 7 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 8 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 8 on the Q-U curve	I16	1000	-	[–0.6, 0.6]
U/U_n value at point 9 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 9 on the Q-U curve	I16	1000	-	[–0.6, 0.6]

Description	Data Type	Gain	Unit	Range
U/U_n value at point 10 on the Q-U curve	U16	10	%	[80, 136]
Q/S value at point 10 on the Q-U curve	I16	1000	-	[–0.6, 0.6]

NOTE

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

5.2.3 PF-U Characteristic Curve

Table 5-4 PF-U characteristic curve definition

Description	Data Type	Gain	Unit	Range
Number of points on the PF-U characteristic curve	U16	1	-	[2, 10]
U/U_n value at point 1 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 1 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 2 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 2 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 3 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 3 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 4 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 4 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 5 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 5 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]

Description	Data Type	Gain	Unit	Range
U/U_n value at point 6 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 6 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 7 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 7 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 8 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 8 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 9 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 9 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]
U/U_n value at point 10 on the PF-U curve	U16	10	%	[80, 136]
PF value at point 10 on the PF-U curve	I16	1000	-	(–1, –0.8] U [0.8, 1]

5.2.4 Q-P Characteristic Curve

Table 5-5 Q-P characteristic curve definition

Description	Data Type	Gain	Unit	Range
Number of valid points on the Q-P characteristic curve	U16	1	-	[2, 10]
P/P_n value at point 1 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 1 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 2 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 2 on the Q-P curve	U16	1000	-	[–0.6, 0.6]

Description	Data Type	Gain	Unit	Range
P/P_n value at point 3 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 3 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 4 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 4 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 5 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 5 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 6 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 6 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 7 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 7 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 8 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 8 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 9 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 9 on the Q-P curve	U16	1000	-	[–0.6, 0.6]
P/P_n value at point 10 on the Q-P curve	U16	1000	-	[0, 1]
Q/P_n value at point 10 on the Q-P curve	U16	1000	-	[–0.6, 0.6]

5.3 Grid Codes

Table 5-6 List of grid codes

Enumerated Value	Standard	Applicable Country or Region
329	CHINA-GBT34120-MV800	China

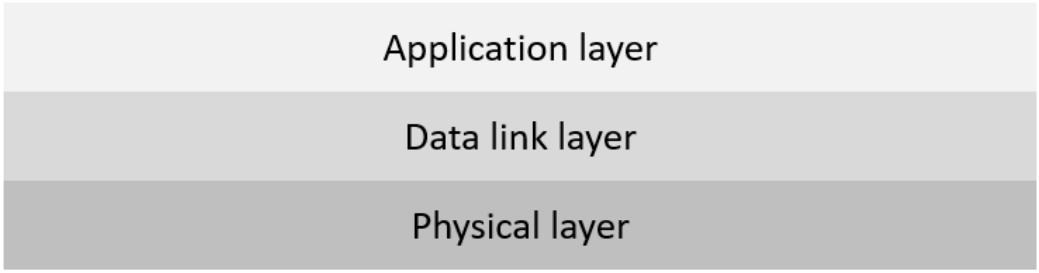
NOTE

The grid code needs to be set based on local laws and regulations.

6 Overview of the Communications Protocol

The Modbus communications protocol consists of the following layers.

Figure 6-1 Modbus protocol layers



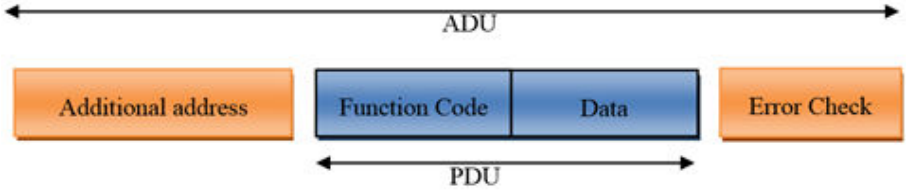
6.1 Physical Layer

Huawei PCS provides Modbus communication based on physical media such as PE. The communication is based on the TCP link and complies with the Modbus-TCP format.

6.2 Data Link Layer

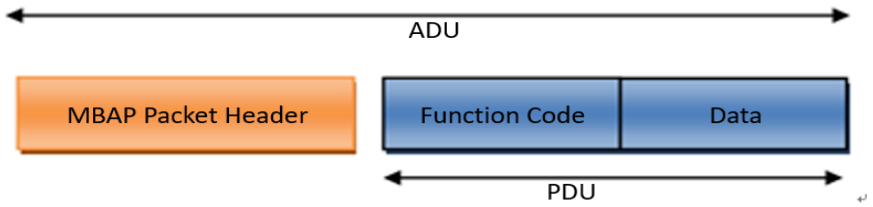
The following figure shows the generic frame structure of the Modbus protocol.

Figure 6-2 Modbus generic frame format



6.2.1 Modbus-TCP

Figure 6-3 Modbus-TCP frame format



6.2.1.1 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 available resources to improve network transmission efficiency. The ADU length is indicated by the length field in the MBAP packet header.

6.2.1.2 MBAP Packet Header

When Modbus runs on top of 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 6-1 MBAP definition

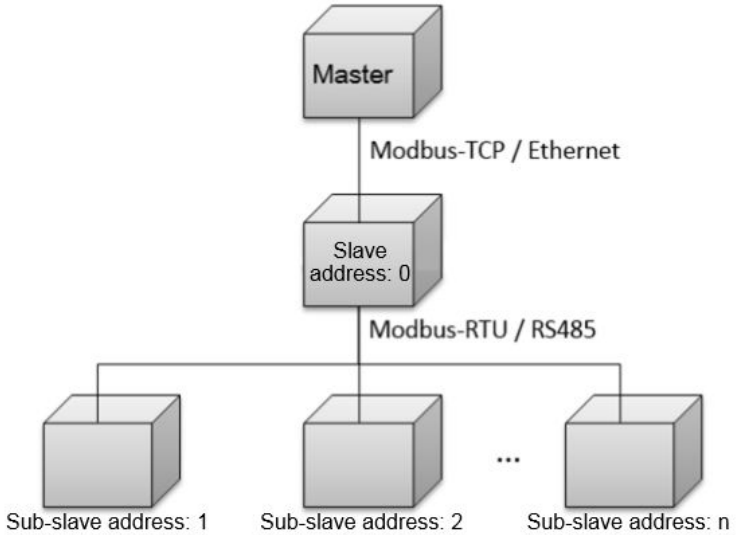
Data Field	Length (Byte)	Description	Client	Server
Transmission identifier	2	Uniquely identifies each request so that the response can be uniquely assigned to the request.	Assigned by the client. It is recommended that each frame be assigned with a unique identifier.	The identifier of the response frame from the server must be the same as that of the corresponding request frame.
Protocol	2	0 = MODBUS protocol	Assigned by the client and defaults to 0.	The identifier of the response frame from the server must be the same as that of the corresponding request frame.

Data Field	Length (Byte)	Description	Client	Server
Data length	2	Identifies the number of bytes in the message to follow	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 the same as that of the corresponding request frame.

6.2.1.3 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 configurable.

Figure 6-4 Three-layer communications addresses



6.2.1.4 TCP Port

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

In a non-VPN environment across the Internet, the TCP socket connection needs to be initiated to the master node by the device in the internal network. In this case,

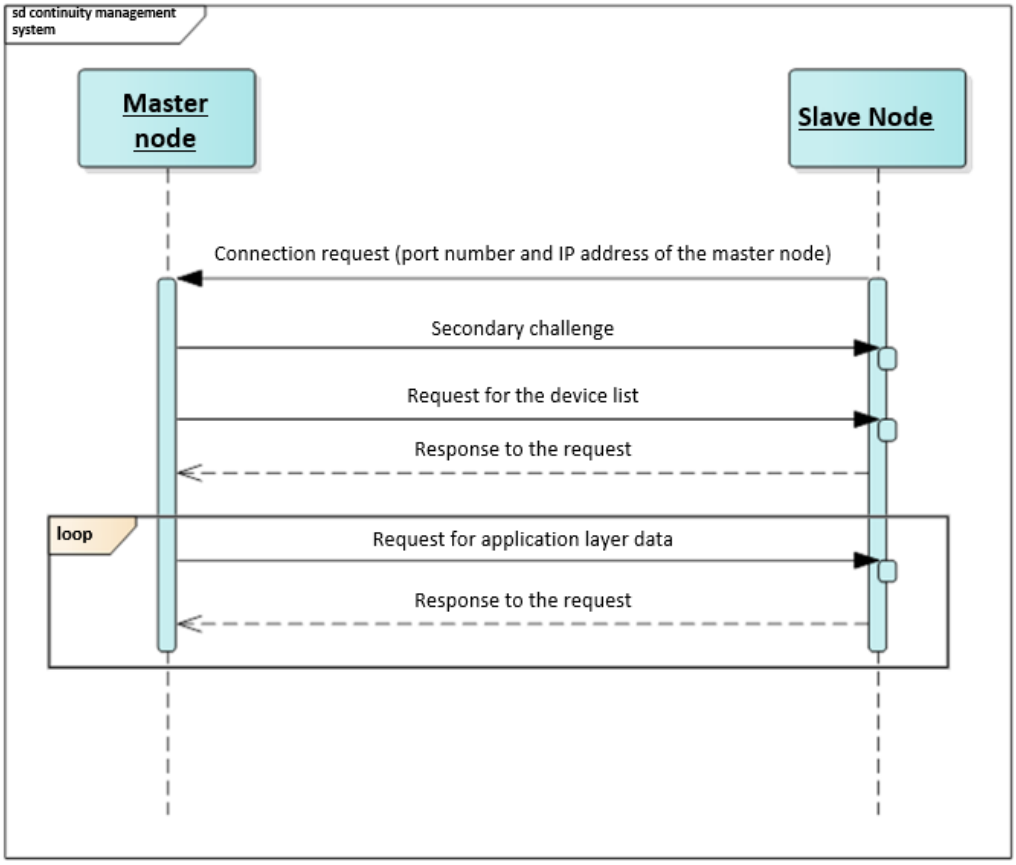
you need to specify the port number of the master node on the slave node. To ensure security and minimize traffic, the master node must provide at least one encrypted port and one non-encrypted port.

6.2.1.5 TCP Link Establishment Process

This section focuses on the cross-Internet scenario.

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

Figure 6-5 Process of establishing a secure TCP connection



6.3 Application Layer

6.3.1 Function Code

Table 6-2 Function code

Function Code	Description	Remarks
0x03	Reading registers	Reads a single register or a block of contiguous registers.
0x06	Writing a single register	Writes a single register.

Function Code	Description	Remarks
0x10	Writing multiple registers	Writes a block of contiguous registers.

6.3.2 Exception Code

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 documents. Different versions of the same NE type must be backward compatible. Exception codes in use cannot be assigned to other exceptions.

Table 6-3 Exception codes returned by an NE (0x00–0x8F are for common exception codes)

Code	Term	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.

Code	Term	Description
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. The client application determines whether and when to retransmit the request.
0x80	No permission	An operation is not allowed because of a permission authentication failure or permission expiration.
0x90	The southbound access device response times out.	The response from the southbound device times out or the communication is disconnected.
0X91	The internal unit response times out.	The response from the internal unit times out or the communication is interrupted.

6.3.3 Read Holding Registers (0x03)

6.3.3.1 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

6.3.3.2 Frame Format of a Normal Response From a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x03

Data Field	Length (Byte)	Description
Bytes	1	2×N
Register value	2×N	N/A

NOTE

N refers to the number of registers.

6.3.3.3 Frame Format of an Abnormal Response From a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x83
Exception code	1	See **6.3.2 Exception Code**.

6.3.3.4 Example

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 is also true for subsequent examples.

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

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

Abnormal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol	00
		00
	Data length	00
		03
	Logical device ID	00
Function code		83
Data	Error code	03

6.3.4 Write Single Register (0x06)

6.3.4.1 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

6.3.4.2 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

6.3.4.3 Frame Format of an Abnormal Response From a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x86
Exception code	1	See **6.3.2 Exception Code**.

6.3.4.4 Example

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

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol	00
		00
	Data length	00
		06
	Logical device ID	00
Function code		06

Description		Frame Data
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	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	00
		00
	Data length	00
		03
	Logical device ID	00

Description		Frame Data
Function code		86
Data	Error code.	04

6.3.5 Write Multiple Registers (0x10)

6.3.5.1 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
Bytes	1	2xN
Register value	2xN	Value

NOTE

N refers to the number of registers.

6.3.5.2 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

6.3.5.3 Frame Format of an Abnormal Response From a Slave Node

Data Field	Length (Byte)	Description
Function code	1	0x90
Exception code	1	See **6.3.2 Exception Code**.

6.3.5.4 Example

The master node sets the address of the slave node to 00, value of register 40118/0X9CB6 to 2, and value of register 40119/0X9CB7 to 50. The request frame format is as follows.

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

Normal response from the slave node

Description		Frame Data
MBAP header	Protocol identifier	00
		01
	Protocol	00
		00
	Data length	00
		06

Description		Frame Data
	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	00
		00
	Data length	00
		03
	Logical device ID	00
Function code		90
Data	Error code	04

6.3.6 Read Device Identification (0X2B)

This function code allows reading the identification and additional information relative to the physical and functional description of a remote device.

The Read Device Identification interface is modeled as an address space composed of a set of addressable data elements. The data elements are called objects and an object ID identifies them.

The interface consists of 3 categories of objects:

1. Basic device identification. All objects of this type are mandatory, such as the vendor name, product code, and revision version.
2. Regular device identification. In addition to the basic data objects, the device provides additional and optional identifiers and data object description. All of the objects of this category are defined in the standard but their implementation is optional.

3. Extended device identification. In addition to regular data objects, the device provides additional and optional identification and description private data about the physical device itself. All the data is related to the device.

Table 6-4 Reading device identifiers

Object ID	Object Name/ Description	Type	M/O	Type
0x00	Manufacturer	ASCII string	Mandatory	Basic
0x01	Product code	ASCII string	Mandatory	
0x02	Main revision version	ASCII string	Mandatory	
0x03–0x7F	--	--	--	Normal
0x80–0xFF	--	--	--	Expansion

6.3.6.1 Command for Querying Device Identification

Table 6-5 Request frame format

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

Table 6-6 Frame format for a normal response

Data Field	Length (Byte)	Description
Function code	1	0x2B
MEI type	1	0x0E
ReadDevId code	1	01
Conformity level	1	01
More	1	--
Next object ID	1	--
Object quantity	1	--

Data Field			Length (Byte)	Description
Object list	First object	Object ID	1	0x00
		Object length	1	N
		Object value	N	--
	...	...	...	...

Table 6-7 Object list

Object ID	Object Name/ Description	Description	Type
0x00	Manufacturer	"HUAWEI"	Basic
0x01	Product code	"SUN2000" or "LUNA2000-P"	
0x02	Main revision version	ASCII string, software version	

Table 6-8 Frame format for an abnormal response

Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See **6.3.2 Exception Code**.

6.3.6.2 Command for Querying a Device List

Table 6-9 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 6-10 Frame format for a normal response

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

Table 6-11 Object list

Object ID	Object Name	Type	Description
0x80–0x86	Reserved	--	Returns a null object with a length of 0.
0x87	Number of devices	int	Returns the number of devices connected to this address.
0x88	Description about the first device	ASCII string. See the following device description definitions.	Returns only description about the first device if a NE allows only one device to be connected to each address.
0x8A	Description about the second device	--	--
--	--	--	--
0xFF	Description about the 120th device	--	--

6.3.6.3 Device Description Definition

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

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

Example: "1= LUNA2000-200KTL-H0; 2=V800R021C10; 3=P1.0-D5.0; 4=123456789ABC; 5=1; 6=1.0; 8=LUNA2000-P"

Table 6-12 Attribute definition

Attribute ID	Attribute Name	Type	Description
1	Device model	ASCII string	--
2	Device software version	ASCII string	--
3	Interface protocol version	ASCII string	See the interface protocol version definitions.
4	ESN	ASCII 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 string	--
8	Device type	ASCII string	LUNA2000-P or SUN2000

Table 6-13 Frame format for an abnormal response

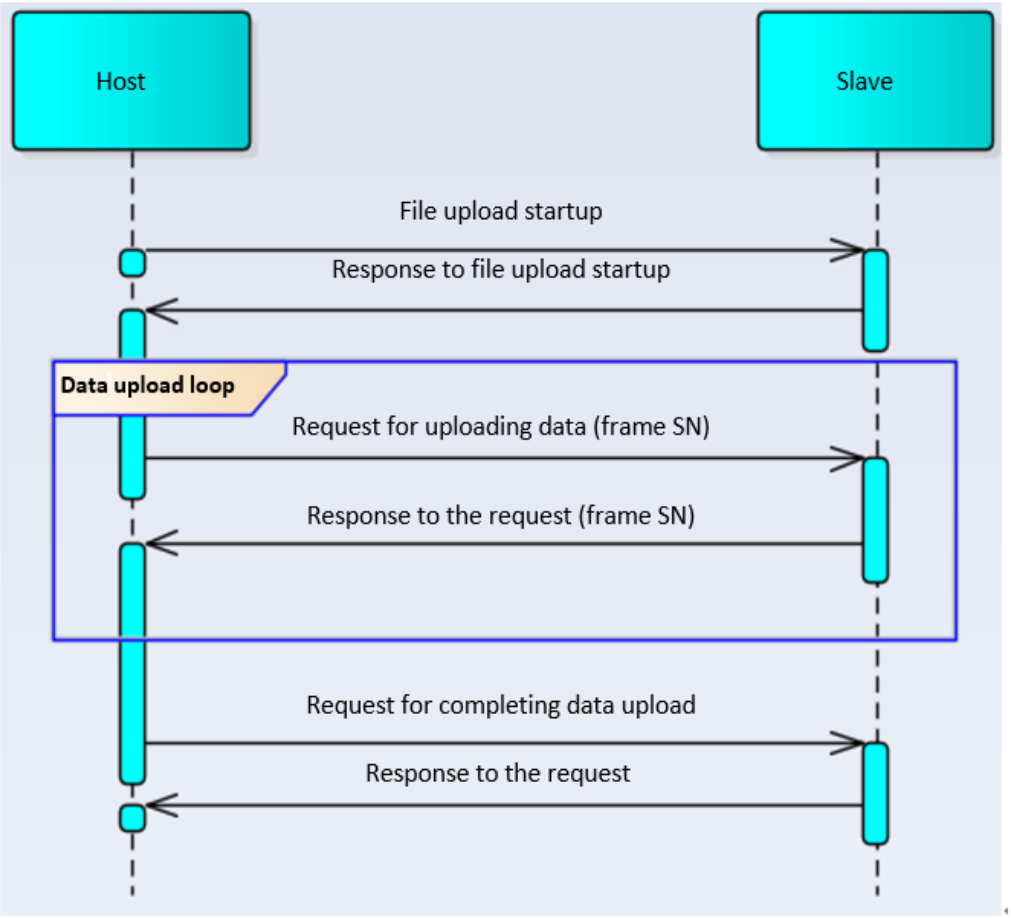
Data Field	Length (Byte)	Description
Function code	1	0xAB
Exception code	1	See **6.3.2 Exception Code**.

6.3.7 Huawei-defined Functions (0x41)

6.3.7.1 Uploading Files

Uploading files means uploading from a slave node to a master node through stream access. The following figure shows the file uploading process.

Figure 6-6 File uploading process



6.3.7.1.1 Starting the Upload

Frame format of a request from a master node

Table 6-14 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 6-15 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 6-16 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 **6.3.2 Exception Code**.

NOTE

If the exception code is 0x06, the request will be retransmitted in 10 seconds. A maximum of six retransmission attempts are supported.

6.3.7.1.2 Uploading Data

Table 6-17 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 6-18 Response frame for uploading data (0x06)

PDU Data Field	Length (Byte)	Description
Function code	1	0x41

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

Table 6-19 Abnormal response frame for uploading data

PDU Data Field	Length (Byte)	Description
Error code	1	0xC1
Exception code	1	See **6.3.2 Exception Code**.

6.3.7.1.3 Completing the Data Upload

Table 6-20 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 6-21 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 6-22 Abnormal response frame for completing the data upload

Data Field	Length (Byte)	Description
Error code	1	0xC1
Exception code	1	See **6.3.2 Exception Code**.

6.3.7.1.4 Timeout Processing

Table 6-23 Processing specifications for sub-process timeout

Name	Restraints
Response timeout period for starting an upload	10s
Response timeout period for uploading data	10s
Maximum retransmission attempts for data upload command	6
Response timeout period for completing a data upload	10s