

**Wattsonic Hybrid Inverter Protocol
For External Control**

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Date: 20210312

Version History

Version	Date	Editor	Update
00.01	20210312	Lee	First Launch

目录

1. General Introduction.....	4
2. Protocol Description.....	5
2.1 Hardware Layer.....	5
2.2 Data Layer.....	5
2.2.1 Addressing Mode.....	5
2.2.2 Data Frames Structure.....	5
2.2.4 Data exchange procedure.....	5
2.2.5 CRC.....	5
2.3 Application Layer.....	6
2.3.1 Function Code 03(0x03).....	7
2.3.2 Function Code 06(0x06).....	8
2.3.3 Function Code 16(0x10).....	9
3. Registers Map.....	10

1. General Introduction

Wattsonic Hybrid inverter set up the COM with external control device based on RS485 ModBus(RTU).
Inverter works as slave while external control device works as Master.

2. Protocol Description

The ModBus Protocol consists of hardware layer, data layer and application layer.

2.1 Hardware Layer

- Through serial port by standard 2 cables(pins)RS-485 connection.
- Baud Rate 9600.
- RTU data transfer based on asynchronous mode.
- 1 start bit
- 8 data bits
- No checkout code
- 1 stop bit

2.2 Data Layer

2.2.1 Addressing Mode

Protocol supports both unicasting and multicasting broad approaches with below addressing rules:

Master Address	Slave Address	Reserved
0	1~247	248~255

2.2.2 Data Frames Structure

Address	Function Code	Data	CRC Check-out Code
1 byte	1 byte	2*N bytes	2 bytes

Note:

- No more than 256 bytes for each data frame.
- CRC Check-out Code, low byte+high byte.
- All data frames in this protocol only consists of function code and data.

2.2.3 Data Coding

MODBUS use one 'big-Endian' to show address and data value, which mean when sending multi bytes, most significant bit will be delivered firstly, e.g. as below:

Register	Value
16 bits	0xABCD

When sending first byte as 0xAB, the second byte will be 0xCD

2.2.4 Data exchange procedure

- All the communication request shall always being and can only being activated by Master node.
- Under unicast broadcasting, it shall follow "request→reply" from master node to slave node, and the reply from slave node shall be within 5s, or master node will take it as time-out.
- Under multicast broadcasting, slave nodes only receive master request, but not reply.

2.2.5 CRC

```
const INT8U auchCRCHi[256] = { 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,
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,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40
};

const INT8U auchCRCLo[256] = { 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, 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
};

INT16U CRC16(INT8U *puchMsg, INT16U usDataLen)
{
    INT8U uchCRCHi = 0xFF ;
    INT8U uchCRCLo = 0xFF ;
    INT8U ulIndex=0 ;
    while (usDataLen--)
    {
        ulIndex = uchCRCLo ^ *puchMsg++;
        uchCRCLo = uchCRCHi ^ auchCRCHi[ulIndex];
        uchCRCHi = auchCRCLo[ulIndex];
    }
    return (((INT16U)uchCRCHi << 8) | (INT16U)uchCRCLo) ;
}

```

2.3 Application Layer

Function Code

Function Code	Description
03(0x03)	Read Register
06(0x06)	Write Single Register
16(0x10)	Write Multi Registers

Items and Definition

Items	Definition
Register/Address	One Register store 2bytes value
U16	Unsigned 16bits int Data
U32	Unsigned 32bits int Data
I16	Signed 16bits int Data
I32	Signed 32bits int Data
STR	String
N/A	None
RO	Read only
WO	Write only
RW	Read and write

2.3.1 Function Code 03(0x03)

Master Node Request Data Frame:

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x03
Register Start Address	2	0x0000~0xFFFF
Register Numbers	2	1~125
CRC	2	N/A

Slave Node Normal Reply Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x03
Bytes	1	2*N
Register Value	2*N	N/A
CRC	2	N/A

Slave Node Abnormal Reply Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x83
Abnormal Code	1	1/2/3
CRC	2	N/A

2.3.2 Function Code 06(0x06)

Master Node Normal Request Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x06
Register Address	2	0x0000~0xFFFF
Register Value	2	0x0000~0xFFFF
CRC	2	N/A

Slave Node Normal Reply Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x06
Register Address	2	0x0000~0xFFFF
Register Value	2	0x0000~0xFFFF
CRC	2	N/A

Slave Node Abnormal Reply Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x86
Abnormal Code	1	1/2/3
CRC	2	N/A

2.3.3 Function Code 16(0x10)

Master Normal Request Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	0~247
Function Code	1	0x10
Register Address	2	0x0000~0xFFFF
Register Numbers	2	0x0000~0x007b
Byte(s)	1	2*N
Register Value	2*N	Value
CRC	2	N/A

N stands for register numbers (0x0000~0x007b)

Slave Node Normal Reply Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x10
Register Address	2	0x0000~0xFFFF
Register Numbers	2	0x0000~0x007b
CRC	2	N/A

Slave Node Abnormal Reply Data Frame

Data Field	Byte(s)	Description
Slave Node Address	1	1~247
Function Code	1	0x90
Abnormal Code	1	1/2/3
CRC	2	N/A

3. Registers Map

ID	Address	Bytes	Description	R/W	Data Type	Unit	Accuracy	Note
1	10000	8	Inverter SN	RO	STR	N/A	1	
2	10008	1	Equipment Info	RO	U16	N/A	1	Please refer to table 3.2
3	10011	2	Firmware Version	RO	U32	N/A	1	
4	10100	1	Date: Year/Month	RO	U16	N/A	1	
5	10101	1	Time: Day/Hour	RO	U16	N/A	1	
6	10102	1	Time: Mins/Seconds	RO	U16	N/A	1	
7	10104	1	Grid Regulation	RO	U16	N/A	1	
8	10105	1	Inverter Running Status	RO	U16	N/A	1	0: wait, wait for on-grid; 1: check, self-test; 2: On Grid; 3: fault; 4: flash, firmware update 5. Off Grid;
9	10112	2	Fault FLAG1	RO	U32	N/A	1	Please refer to table 3.3
	10113							
10	10114	2	Fault FLAG2	RO	U32	N/A	1	
	10115							
11	10120	2	Fault FLAG3	RO	U32	N/A	1	
	10121							
12	10994	2	Phase A Power on Meter	RO	I32	kW	1000	
13	10996	2	Phase B Power on Meter	RO	I32	kW	1000	
14	10998	2	Phase C Power on Meter	RO	I32	kW	1000	
15	11000	2	Total Power on Meter	RO	I32	kW	1000	
16	11002	2	Total Grid-Injection Power on Meter	RO	U32	kWh	100	
17	11004	2	Total Purchasing Power from grid on Meter	RO	U32	kWh	100	
	11005							
18	11006	1	Grid Lines A/B Voltage	RO	U16	V	10	
19	11007	1	Grid Lines B/C Voltage	RO	U16	V	10	
20	11008	1	Grid Lines C/A Voltage	RO	U16	V	10	
21	11009	1	Grid Phase A Voltage	RO	U16	V	10	
22	11010	1	Grid Phase A Current	RO	U16	A	10	
23	11011	1	Grid Phase B Voltage	RO	U16	V	10	
24	11012	1	Grid Phase B Current	RO	U16	A	10	

25	11013	1	Grid Phase C Voltage	RO	U16	V	10	
22	11014	1	Grid Phase C Current	RO	U16	A	10	
23	11015	1	Grid Frequency	RO	U16	Hz	100	
24	11016	2	P_AC	RO	I32	kW	1000	
25	11018	2	Total PV Generation on that day	RO	U32	kWh	10	
26	11020	2	Total PV Generation from installation	RO	U32	kWh	10	
27	11022	2	Total PV generation time from installation	RO	U32	H	1	
28	11028	2	PV Input total Power	RO	U32	kW	1000	
29	11032	1	Temperature Sensor 1	RO	I16	°C	10	
30	11033	1	Temperature Sensor 2	RO	I16	°C	10	
31	11034	1	Temperature Sensor 3	RO	I16	°C	10	
32	11035	1	Temperature Sensor 4	RO	I16	°C	10	
33	11038	1	PV1 Voltage	RO	U16	V	10	
34	11039	1	PV1 Current	RO	U16	A	10	
35	11040	1	PV2 Voltage	RO	U16	V	10	
36	11041	1	PV2 Current	RO	U16	A	10	
37	11062	2	PV1 Input Power	RO	U32	kW	1000	
38	11064	2	PV2 Input Power	RO	U32	kW	1000	
39	18000	2	ARM Fault FLAG1	RO	U32	N/A	1	Please refer to Table 3.3
40	40200	1	Backup_A_V	RO	U16	V	10	Phase A Voltage on back-up Port
41	40201	1	Backup_A_I	RO	U16	A	10	Phase A Current on back-up Port
42	40202	1	Backup_A_F	RO	U16	Hz	100	Phase A Frequency on back-up Port
43	40204	2	Backup_A_P	RO	I32	kW	1000	Phase A Power on back-up Port
44	40210	1	Backup_B_V	RO	U16	V	10	Phase B Voltage on back-up port
45	40211	1	Backup_B_I	RO	U16	A	10	Phase B Current on back-up Port
46	40212	1	Backup_B_F	RO	U16	Hz	100	Phase B Frequency on back-up Port
47	40214	2	Backup_B_P	RO	I32	kW	1000	Phase B Power on back-up Port
48	40220	1	Backup_C_V	RO	U16	V	10	Phase C Voltage on back-up Port
49	40221	1	Backup_C_I	RO	U16	A	10	Phase C Current on back-up Port
50	40222	1	Backup_C_F	RO	U16	Hz	100	Phase C Frequency on back-up Port
51	40224	2	Backup_C_P	RO	I32	kW	1000	Phase C Power on back-up Port
52	40230	2	Total_Backup_P	RO	I32	kW	1000	Total Power on Back-up Port
53	40236	2	Invt_A_P	RO	I32	kW	1000	Phase A Power on grid port
54	40242	2	Invt_B_P	RO	I32	kW	1000	Phase B Power on grid port

55	40248	2	Invnt_C_P	RO	I32	kW	1000	Phase C Power on grid port
56	40254	1	Battery_V	RO	U16	V	10	Battery Voltage
57	40255	1	Battery_I	RO	I16	A	10	Battery Current
58	40256	1	Battery_Mode	RO	U16	N/A	1	0:discharge;1:charge
59	40258	2	Battery_P	RO	I32	kW	1000	Battery Power
60	41000	1	Grid injection energy on that day [Meter]	RO	U16	kWh	10	
61	41001	1	Grid Purchasing energy on that day [Meter]	RO	U16	kWh	10	
62	41002	1	Backup output energy on that day	RO	U16	kWh	10	
63	41003	1	Battery Charge Energy on that day	RO	U16	kWh	10	
64	41004	1	Battery Discharge Energy on that day	RO	U16	kWh	10	
65	41005	1	PV Generation Energy on that day	RO	U16	kWh	10	
66	41006	1	Loading Energy on that day	RO	U16	kWh	10	
67	41008	1	Energy Purchased from Grid on that day	RO	U16	kWh	10	
68	41102	2	Total Energy injected to grid	RO	U32	kWh	10	
69	41104	2	Total Energy Purchased from Grid from Meter	RO	U32	kWh	10	
70	41106	2	Total Output Energy on backup port	RO	U32	kWh	10	
71	41108	2	Total Energy Charged to Battery	RO	U32	kWh	10	
72	41110	2	Total Energy Discharged from Battery	RO	U32	kWh	10	
73	41112	2	Total PV Generated Energy	RO	U32	kWh	10	
74	41114	2	Total Loading consumed Energy on grid side	RO	U32	kWh	10	
75	41118	2	Total Energy Purchased from Grid at inverter side	RO	U32	kWh	10	
76	42003	1	BMS Software Version	RO	U16	N/A	1	
77	42004	1	BMS Hardware Version	RO	U16	N/A	1	
78	42005	1	BMS Charge I _{max}	RO	U16	A	10	
79	42006	1	BMS Discharge I _{max}	RO	U16	A	10	
80	43000	1	SOC	RO	U16	%	100	
81	43001	1	SOH	RO	U16	%	100	
82	43002	1	BMS Status	RO	U16	N/A	1	
82	43003	1	BMS Pack Temperature	RO	U16	°C	10	
83	43008	1	Max Cell Temperature ID	RO	U16	N/A	1	

84	43009	1	Max Cell Temperature	RO	U16	°C	10	
85	43010	1	Min Cell Temperature ID	RO	U16	N/A	1	
86	43011	1	Min Cell Temperature	RO	U16	°C	10	
87	43012	1	Max Cell Voltage ID	RO	U16	N/A	1	
88	43013	1	Max Cell Voltage	RO	U16	V	1000	
89	43014	1	Min Cell Voltage ID	RO	U16	N/A	1	
90	43015	1	Min Cell Voltage	RO	U16	V	1000	
91	43016	2	BMS ERROR CODE	RO	U32	N/A	1	
92	43018	2	BMS WARN CODE	RO	U32	N/A	1	

Table 3.2 Equipment Info

Inverter Type (10008 high bit)		Three Phase Bi-directional hybrid inverter	
		30	
Model Info (10008 low bit)	0	WTS-4P-3P	
	1	WTS-5KW-3P	
	2	WTS-6KW-3P	
	3	WTS-8KW-3P	
	4	WTS-10KW-3P	
	5	WTS-12KW-3P	

Table 3.3 Fault Registers Map

Fault Code	Registers	BIT	Hex	DEC	Fault Description
1	10112 (Fault FLAG1)	BIT0	0x00000001	1	Mains Lost
2		BIT1	0x00000002	2	Grid Voltage Fault
3		BIT2	0x00000004	4	Grid Frequency Fault
4		BIT3	0x00000008	8	DCI Fault
5		BIT4	0x00000010	16	ISO Over Limitation
6		BIT5	0x00000020	32	GFCI Fault
7		BIT6	0x00000040	64	PV Over Voltage
8		BIT7	0x00000080	128	Bus Voltage Fault
9		BIT8	0x00000100	256	Inverter Over Temperature
34	10112 (Fault FLAG2)	BIT1	0x00000002	2	SPI Fault
35		BIT2	0x00000004	4	E2 Fault
36		BIT3	0x00000008	8	GFCI Device Fault
37		BIT4	0x00000010	16	AC Transducer Fault
38		BIT5	0x00000020	32	Relay Check Fail
39		BIT6	0x00000040	64	Internal Fan Fault
40		BIT7	0x00000080	128	External Fan Fault
10001	18000 (ARM Fault FLAG1)	BIT0	0x00000001	1	SCI Fault
10002		BIT1	0x00000002	2	FLASH Fault
10003		BIT2	0x00000004	4	Meter Comm Fault

Table 3.4 wattsonic hybrid inverter RW registers map

NO.	Address	Bytes	Function	R/W	Type	Unit	Accuracy	Note
1	20000	1	Inverter RTC date and time	RW	RW	U16	N/A	High Bit Year[19-99] Low Bit Month[1-12]
2	20001	1		RW	RW	U16	N/A	High Bit Day[1-31] Low Bit Hour[0-23]

3	20002	1		RW	RW	U16	N/A	High Bit Minute[0-59] Low Bit Second[0-59]
4	25100	1	Grid Injection Power Limit Switch	RW	U16	N/A	1	0:Off; 1:ON
5	25103	1	Grid Injection Power Limit setting	RW	U16	N/A	1000	[0.0%-100.0%]
6	50000	1	Inverter running mode setting	RW	U16	N/A	1	Please refer to table 3.6
7	50001	1	Off-grid running switch	RW	U16	N/A	1	0:Off; 1:ON
8	50004	1	Off-grid Output Voltage	RW	U16	V	10	
9	50005	1	Off-grid Output Frequency	RW	U16	Hz	100	[45.00-65.00]Hz
10	50006	1	Asymmetric Output Switch	RW	U16	N/A	1	0: Off; 1: On
11	50007	1	Peak Load Shift Function Switch	RW	U16	N/A	1	0: Off; 1: On
12	50009	1	Maximum Grid Power Limit	RW	U16	kVA	10	
13	50010		Inverter Power Setting	RW	U16	N/A	1	0: Off 1: Total Power Setting,50011 2: Power on each phase Setting,50012~50014
14	50011		Total Power Setting	RW	l16	kW	100	
15	50012		Phase A power setting	RW	l16	kW	100	
16	50013		Phase B power setting	RW	l16	kW	100	
17	50014		Phase C power setting	RW	l16	kW	100	
18	52502	1	On-grid SOC Protection	RW	U16	N/A	1	0:Off, 1:On
19	52503	1	On-grid battery DOD setting	RW	U16	N/A	1000	[0.0%-100.0%]
20	52504	1	Off-grid SOC Protection	RW	U16	N/A	1	0:Off, 1:On
21	52505	1	Off-grid battery DOD setting	RW	U16	N/A	1000	[0.0%-100.0%]
22	53000	1	Charge Start Time	RW	U16	N/A	1	High 8bit (Hour): [0,23] Low 8bit (Mins): [0,59]
23	53001	1	Charge Stop Time	RW	U16	N/A	1	
24	53002	1	Charge Power Limit	RW	U16	N/A	1000	[0.0-100.0%]
25	53003	1	Discharge Start Time	RW	U16	N/A	1	High 8bit (Hour): [0,23] Low 8bit (Mins): [0,59]
26	53004	1	Discharge Stop Time	RW	U16	N/A	1	
27	53005	1	Discharge Power Limit	RW	U16	N/A	1000	[0.0-100.0%]

Table 3.5 wattsonic Hybrid Inverter WO registers map

NO.	Address	Bytes	Function	W/R	Type	Unit	Accuracy	Note
1	50200	1	Enable off-grid running function	WO	U16	N/A	1	0:Disable; 1:Enable

2	50201	1	Clear over-loading protection flag	WO	U16	N/A	1	Write 1 to clear
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Table 3.6

NO.	Hybrid Inverter Running Mode Code		Running Mode	Description
	50000 High 8 bit	50000 Low 8 bit		
1	01	01	General Mode	
2		02	Economic Mode	
3		03	UPS Mode	
4	02	N/A	Off Grid Mode	