Solinteg Hybrid Inverter MODBUS RTU Protocol

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Version Log

Version	Date	Modifier	Modified Content
00.01	20220826	Yong.Liu	First release
00.02	20221206	Yong.Liu	1. Table 3.3 add 10120 (Fault FLAG3) description 2. Table 3.4 add registers 25000 、28000~28015, etc. Add table3.10 National Safety Code Description 3. Add table 3.10, National safety code description

Contents

1. Description

The Solinteg hybrid inverter EMS communication uses RS485 bus connection and supports standard ModBus-RTU protocol. The inverter acts as the slave device and the EMS device acts as the master.

ModBus-RTU protocol is the broadly used communication protocol in the industry field and is a common language used in electrical communication terminals. Communication between inverters and other devices can be realized through this protocol, a common industry standard. With the ModBus-RTU protocol, inverters from different manufacturers can form an industrial network for centralized monitoring. This protocol describes how the master and slave nodes were defined, the process of the main node using various methods to access other devices, how the slave node responds to the request from other devices, and how both parties detect and record errors. It defines the detailed definition of the message field pattern and data content.

This document describes and explains Solinteg hybrid inverter EMS communication protocol, used to normalize and constrain the third-party integration development and customization.

2.Overview of Communication Protocol

The ModBus communication protocol can be divided into three layers: physical, datalink, and application.

2.1 Physical Layer

- Communication by serial port with standard 2 cables(pins) RS485 connection.
- Default baud rate 9600.
- RTU data transfer based on asynchronous mode.
- 1 start bit
- 8 data bits
- No verification
- 1 stop bit.

2.2 Datalink Layer

2.2.1 Addressing mode

The protocol supports unicast and broadcast modes, and the allocation rules are as follows:

Broadcast addr.	Slave addr.	Reserved
0	1~247	248~255

2.2.2 Frame structure

Addr.	Function code	Data	CRC check code
1 byte	1 byte	2*N bytes	2 bytes

Note:

- No more than 256 bytes for each data frame.
- CRC check code, low byte first and high byte last.
- All data frames in this protocol only consist of function code and data.

2.2.3 Data coding

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

Register	Value
16 bits	0xABCD

The first sending bytes is 0xAB and the second bytes is 0xCD.

2.2.4 Exchange Procedure

In any mode, the communication process shall only be initiated by the master node while the slave node never does.

In the unicast mode, the slave node responds to the master node command by the approach of "a question and an answer" and it will take as communication timeout if the main node didn't receive the response from the slave node within 5s.

In the broadcast mode, the slave node only receives the main node command and does not respond to it.

2.2.5 CRC Checkout

```
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,
                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
                };

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, 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
                    };

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

2.3 Application Layer

MODBUS has three category function codes and they are:

Public function code: A well-defined function code, guaranteed to be unique, MODBUS organization is modifiable, publicly demonstrated, with available conformance tests, proven in the MB IETF RFC, and contains public assigned function codes and unassigned function codes reserved for future use.

User-defined function code: There're two ranges of user-defined function code, which are 65-72 and 100-110, and users can select and implement a function code without any permission of MODBUS organization but cannot guarantee the usage of the selected function code is unique.

Reserved function code: A function code that some companies commonly used in their

traditional products and invalid for public use.

The public function codes used in this protocol are as follows:

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

Items and Definitions:

Items	Description
Register Address	One Register for 2 bytes data
U16	Unsigned 16 bits int Data
U32	Unsigned 32 bits int Data
I16	Unsigned 32 bits int Data
I32	Signed 32 bits 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	Length(byte)	Description
Slave node addr.	1	1~247
Function code	1	0x03
Register start addr.	2	0x0000~0xFFFF
Register numbers	2	1~125
CRC	2	N/A

Slave node normal respond data frame:

Data Field	Length(byte)	Description
Slave node addr.	1	1~247
Function code	1	0x03
Bytes	1	2*N
Register value	2*N	N/A
CRC	2	N/A

Slave node abnormal respond data frame:

Data Field	Length(byte)	Description
Slave node addr.	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 request data frame:

Data Field	Length(byte)	Description
Slave node addr.	1	1~247
Function code	1	0x06
Register addr.	2	0x0000~0xFFFF
Register value	2	0x0000~0xFFFF
CRC	2	N/A

Slave node normal respond data frame:

Data Field	Length(byte)	Description
Slave node addr.	1	1~247
Function code	1	0x06
Register addr.	2	0x0000~0xFFFF
Register value	2	0x0000~0xFFFF
CRC	2	N/A

Slave node abnormal respond data frame:

Data Field	Length(byte)	Description
Slave node addr.	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 node request data frame:

Data Field	Length(byte)	Description
Slave node addr.	1	0~247
Function code	1	0x10
Register addr.	2	0x0000~0xFFFF
Register numbers	2	0x0000~0x007b
Byte(s)	1	2*N
Register value	2*N	Value
CRC	2	N/A

Note: N is register numbers (0x0000~0x007b).

Slave node normal respond data frame:

Data Field	Length(byte)	Description
Slave node addr.	1	1~247
Function code	1	0x10
Register addr.	2	0x0000~0xFFFF
Register numbers	2	0x0000~0x007b
CRC	2	N/A

Slave node abnormal respond data frame:

Data Field	Length(byte)	Description
Slave node addr.	1	1~247
Function code	1	0x90
Abnormal code	1	1/2/3
CRC	2	N/A

3.Register Table

Table 3.1 Solinteg hybrid inverter RO registers table

No.	Addr.	Bytes	Description	R/W	Type	Unit	Accuracy	Note
1	10000	8	Device SN	RO	STR	N/A	1	Read bytes to string
	.....							
2	10008	1	Inverter Model	RO	U16	N/A	1	Please refer to table 3.2
3	10011	2	Firmware Version	RO	U32	N/A	1	Read bytes
	10012							
4	10100	1	Date: Y/M	RO	U16	N/A	1	Continuous read
5	10101	1	Time: D/H	RO	U16	N/A	1	
6	10102	1	Time: M/S	RO	U16	N/A	1	
7	10104	1	Safety Code	RO	U16	N/A	1	
8	10105	1	Inverter Working Status	RO	U16	N/A	1	0: Wait for grid connection 1: Self-checking 2: On-grid generating 3: Device fault 4: Firmware upgrade 5.Off-grid generating
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	Pmeter on phase A	RO	I32	kW	1000	
	10995							
13	10996	2	Pmeter on phase	RO	I32	kW	1000	

			B					
	10997							
14	10998	2	Pmeter on phase C	RO	I32	kW	1000	
	10999							
15	11000	2	Pmeter of three phases	RO	I32	kW	1000	
	11001							
16	11002	2	Total Grid-Injection Energy on Meter	RO	U32	kWh	100	
	11003							
17	11004	2	Total Purchasing Energy from Grid on Meter	RO	U32	kWh	100	
	11005							
18	11006	1	AB line voltage	RO	U16	V	10	
19	11007	1	BC line voltage	RO	U16	V	10	
20	11008	1	CA line voltage	RO	U16	V	10	
21	11009	1	Phase A Voltage	RO	U16	V	10	
22	11010	1	Phase A Current	RO	U16	A	10	
23	11011	1	Phase B Voltage	RO	U16	V	10	
24	11012	1	Phase B Current	RO	U16	A	10	
25	11013	1	Phase C Voltage	RO	U16	V	10	
26	11014	1	Phase C Current	RO	U16	A	10	
27	11015	1	Grid Frequency	RO	U16	Hz	100	
28	11016	2	P_AC	RO	I32	kW	1000	
	11017							
29	11018	2	Energy-today	RO	U32	kWh	10	
	11019							
30	11020	2	Energy-total	RO	U32	kWh	10	
	11021							
31	11022	2	Total Generation Hours	RO	U32	H	1	
	11023							
32	11028	2	Total PV Input Power	RO	U32	kW	1000	

	11029							
33	11032	1	Temp.1	RO	I16	℃	10	
34	11033	1	Temp.2	RO	I16	℃	10	
35	11034	1	Temp.3	RO	I16	℃	10	
36	11035	1	Temp.4	RO	I16	℃	10	
37	11038	1	PV1 Voltage	RO	U16	V	10	
38	11039	1	PV1 Current	RO	U16	A	10	
39	11040	1	PV2 Voltage	RO	U16	V	10	
40	11041	1	PV2 Current	RO	U16	A	10	
41	11062	2	PV1 Input Power	RO	U32	kW	1000	
	11063							
42	11064	2	PV2 Input Power	RO	U32	kW	1000	
	11065							
43	18000	2	ARM Fault FLAG1	RO	U32	N/A	1	Please refer to table 3.3
	18001							
	……							
44	30200	1	Backup_A_V	RO	U16	V	10	AC Voltage
45	30201	1	Backup_A_I	RO	U16	A	10	AC Current
46	30202	1	Backup_A_F	RO	U16	Hz	100	Frequency
47	30204	2	Backup_A_P	RO	I32	kW	1000	AC Active Power
	30205							
48	30210	1	Backup_B_V	RO	U16	V	10	AC Voltage
49	30211	1	Backup_B_I	RO	U16	A	10	AC Current
50	30212	1	Backup_B_F	RO	U16	Hz	100	Frequency
51	30214	2	Backup_B_P	RO	I32	kW	1000	AC Active Power
	30215							
52	30220	1	Backup_C_V	RO	U16	V	10	AC Voltage
53	30221	1	Backup_C_I	RO	U16	A	10	AC Current
54	30222	1	Backup_C_F	RO	U16	Hz	100	Frequency
55	30224	2	Backup_C_P	RO	I32	kW	1000	AC Active Power
	30225							
56	30230	2	Total_Backup_P	RO	I32	kW	1000	Total Active Power
	30231							
57	30236	2	Invt_A_P	RO	I32	kW	1000	Phase A Active Power

	30237							
58	30242	2	Invt_B_P	RO	I32	kW	1000	Phase B Active Power
	30243							
59	30248	2	Invt_C_P	RO	I32	kW	1000	Phase C Active Power
	30249							
60	30254	1	Battery_V	RO	U16	V	10	Battery Voltage
61	30255	1	Battery_I	RO	I16	A	10	Battery Voltage
62	30256	1	Battery_Mode	RO	U16	N/A	1	0:discharge;1:charge
63	30258	2	Battery_P	RO	I32	kW	1000	Battery Power
	30259							
64	31000	1	Daily Energy Injected to Grid	RO	U16	kWh	10	
65	31001	1	Daily Purchased Energy	RO	U16	kWh	10	
66	31002	1	Daily Energy Output on Backup Port	RO	U16	kWh	10	
67	31003	1	Daily Battery Charging Energy	RO	U16	kWh	10	
68	31004	1	Daily Battery Discharging Energy	RO	U16	kWh	10	
69	31005	1	Daily PV Generation	RO	U16	kWh	10	
70	31006	1	Daily Load Consumption	RO	U16	kWh	10	
71	31008	1	Daily Energy Purchased from Grid at Inverter Side	RO	U16	kWh	10	
72	31102	2	Total Energy Injected into Grid	RO	U32	kWh	10	
	31103							
73	31104	2	Total Purchased Energy from Grid	RO	U32	kWh	10	

	31105							
74	31106	2	Total Output Energy on Backup Port	RO	U32	kWh	10	
	31107							
75	31108	2	Total Battery Charging Energy	RO	U32	kWh	10	
	31109							
76	31110	2	Total Battery Discharging Energy	RO	U32	kWh	10	
	31111							
77	31112	2	Total PV Generation	RO	U32	kWh	10	
	31113							
78	31114	2	Total Load Consumption	RO	U32	kWh	10	
	31115							
79	31118	2	Total Energy Purchased from Grid at Inverter Side	RO	U32	kWh	10	
	31119							
	…							
80	32000	1	Battery Type Codes	RO	U16	N/A	1	
81	32001	1	Battery strings	RO	U16	N/A	1	
82	32002	1	Battery protocol	RO	U16	N/A	1	
83	32003	1	Software Version	RO	U16	N/A	1	
84	32004	1	Hardware Version	RO	U16	N/A	1	
85	32005	1	BMS Charge Imax	RO	U16	A	10	
86	32006	1	BMS Discharge Imax	RO	U16	A	10	
87	33000	1	SOC	RO	U16	%	100	
88	33001	1	SOH	RO	U16	%	100	
89	33002	1	BMS Status	RO	U16	N/A	1	
90	33003	1	BMS Pack Temperature	RO	U16	℃	10	

91	33008	1	Max Cell Temperature ID	RO	U16	N/A	1	
92	33009	1	Max Cell Temperature	RO	U16	℃	10	
93	33010	1	Min Cell Temperature ID	RO	U16	N/A	1	
94	33011	1	Min Cell Temperature	RO	U16	℃	10	
95	33012	1	Max Cell Voltage ID	RO	U16	N/A	1	
96	33013	1	Max Cell Voltage	RO	U16	V	1000	
97	33014	1	Min Cell Voltage ID	RO	U16	N/A	1	
98	33015	1	Min Cell Voltage	RO	U16	V	1000	
99	33016	2	BMS ERROR CODE	RO	U32	N/A	1	
	33017							
100	33018	2	BMS WARN CODE	RO	U32	N/A	1	
	33019							

Table 3.2 Device Model Info

Inverter Type （10008 high bit）		Three-phase Two MPPTs Hybrid	Single-phase hybrid	Three-phase Four MPPTS 25-50K
		30	31	32
Model info （10008 low bit）	0	MHT-4K-25	MHS-3K-30D	MHT-25K-100
	1	MHT-5K-25	MHS-3.6K-30D	MHT-30K-100
	2	MHT-6K-25	MHS-4.2K-30D	MHT-36K-100
	3	MHT-8K-25	MHS-4.6K-30D	MHT-40K-100
	4	MHT-10K-25	MHS-5K-30D	MHT-50K-100
	5	MHT-12K-25	MHS-6K-30D	N/A
	6	MHT-10K-40	MHS-7K-30D	N/A
	7	MHT-12K-40	MHS-8K-30D	N/A
	8	MHT-15K-40	MHS-3K-30S	N/A
	9	MHT-20K-40	MHS-3.6K-30S	N/A
Inverter Type （10008 high bit）		Three-phase AC-coupled inverter	Single-phase AC-coupled	Three-phase AC-coupled inverter

			inverter	
		40	41	42
Model info （10008 low bit）	0	MRT-4K-25	MRS-3K-30	MRT-25K-100
	1	MRT-5K-25	MRS-3.6K-30	MRT-30K-100
	2	MRT-6K-25	MRS-4.2K-30	MRT-36K-100
	3	MRT-8K-25	MRS-4.6K-30	MRT-40K-100
	4	MRT-10K-25	MRS-5K-30	MRT-50K-100
	5	MRT-12K-25	MRS-6K-30	N/A
	6	MRT-10K-40	MRS-7K-30	N/A
	7	MRT-12K-40	MRS-8K-30	N/A
	8	MRT-15K-40	N/A	N/A
	9	MRT-20K-40	N/A	N/A

Table 3.3 Troubleshooting

Fault Code	Register Addr.	BIT	HEX	DEC	Fault Description	English Display
1	10112 (FAULT FLAG1)	BIT0	0x00000001	1	Mains Lost	Mains Lost
2		BIT1	0x00000002	2	Grid Voltage Fault	Grid Voltage Fault
3		BIT2	0x00000004	4	Grid Frequency Fault	Grid Frequency Fault
4		BIT3	0x00000008	8	DCI Fault	DCI Fault
5		BIT4	0x00000010	16	ISO Over Limitation	ISO Over Limitation
6		BIT5	0x00000020	32	GFCI Fault	GFCI Fault
7		BIT6	0x00000040	64	PV Over Voltage	PV Over Voltage
8		BIT7	0x00000080	128	Bus Voltage Fault	Bus Voltage Fault
9		BIT8	0x00000100	256	Inverter Over Temperature	Inverter Over Temperature
1	10114 (FAULT FLAG2)	BIT1	0x00000002	2	SPI Fault	SPI Fault
2		BIT2	0x00000004	4	E2 Fault	E2 Fault
3		BIT3	0x00000008	8	GFCI Transducer Fault	GFCI Device Fault

4		BIT4	0x00000010	16	AC Transducer Fault	AC Transducer Fault
5		BIT5	0x00000020	32	Relay Fault	Relay Check Fail
6		BIT6	0x00000040	64	Internal Fan Fault	Internal Fan Fault
7		BIT7	0x00000080	128	External Fan Fault	External Fan Fault
	10120 (FAULT FLAG3)	BIT0	0x00000001	1	Bus Hardware Fault	Bus Hardware Fault
		BIT1	0x00000002	2	PV Power Low	PV Power Low
		BIT2	0x00000004	4	Batt.Voltage Fault	Batt.Voltage Fault
		BIT3	0x00000008	8	BAK Voltage Fault	BAK Voltage Fault
		BIT4	0x00000010	16	Bus Voltage Lower	Bus Voltage Lower
		BIT5	0x00000020	32	Sys Hardware Fault	Sys Hardware Fault
		BIT6	0x00000040	64	BAK Over Power	BAK Over Power
		BIT7	0x00000080	128	Inverter Over Voltage	Inverter Over Voltage
		BIT8	0x00000100	256	Inverter Over Freq	Inverter Over Freq
		BIT9	0x00000200	512	Inverter Over Current	Inverter Over Current
		BIT10	0x00000400	1024	Phase Order Err	Phase Order Err
1	18000 (ARM FAULT FLAG1)	BIT0	0x00000001	1	SCI Fault	SCI Fault
2		BIT1	0x00000002	2	FLASH Fault	FLASH Fault
3		BIT2	0x00000004	4	Meter Comm Fault	Meter Comm Fault

Table 3.4 Solinteg Hybrid Inverter RW Registers Map

No.	Addr.	Bytes	Function Description	R/W	Type	Unit	Accuracy	Note
1	20000	1	Inverter RTC date and time (Continuous read in)	RW	U16	N/A	1	High Bit Year [19-99] Low Bit Month [1-12]
2	20001	1				N/A	1	High Bit Day [1-31] Low Bit Hour [0-23]
3	20002	1				N/A	1	High Bit Minute [0-59] Low Bit Second [0-59]
4	25000	1	Safety Code	RW	U16	N/A	1	Please refer to table 3.10
5	25015	1	Overload Method Setting	RW	1	N/A	1	0:Rated 1: 110% OverLoading 2: Limit
6	25100	1	Grid Injection Power Limit Switch	RW	U16	N/A	1	0:OFF; 1:ON
7	25103	1	Grid Injection Power Limit % Setting	RW	U16	N/A	1000	[0.0%-100.0%]
8	25104	1	Smart Meter COM. Status	WO	U16	N/A	1	0: Meter abnormal 1: Meter normal
9	25105	2	Pmeter on Phase A	WO	I32	W	1	
10	25107	2	Pmeter on Phase B	WO	I32	W	1	
11	25109	2	Pmeter on Phase C	WO	I32	W	1	
12	25118	1	• Reactive power limit	RW	I16	N/A	1000	[-600, +600] accuracy to 0.1%

			percentage					
13	25120	1	PF Setting	RW	I16	N/A	1000	(-1000, -800]U[800,1000]
14	25121	1	Reactive power Control Mode	RW	U16	N/A	1	0:OFF 1: PF 2: Qt 3:Q(P) 4:Q(U)
	…							
15	28000	1	Fault recovery voltage lower limit	RW	U16	V	10	550 - 2300
16	28001	1	Fault recovery voltage upper limit	RW	U16	V	10	2300-3000
17	28002	1	Fault recovery frequency lower limit	RW	U16	Hz	100	4500-6500
18	28003	1	Fault recovery frequency upper limit	RW	U16	Hz	100	4500-6500
19	28004	1	Level-1 undervoltage protection threshold	RW	U16	V	10	550 - 2300
20	28005	1	Level-1 undervoltage protection duration	RW	U16	Prd	1	1-50000
21	28006	1	Level-1 overvoltage protection threshold	RW	U16	V	10	2300-3000
22	28007	1	Level-1 overvoltage	RW	U16	Prd	1	1-50000

			protection duration					
23	28012	1	Level-1 underfrequency protection threshold	RW	U16	Hz	100	4500-6500
24	28013	1	Level-1 underfrequency protection duration	RW	U16	Prd	1	1-50000
25	28014	1	Level-1 overfrequency protection threshold	RW	U16	Hz	100	4500-6500
26	28015	1	Level-1 overfrequency protection duration	RW	U16	Prd	1	1-50000
	…							
27	50000	1	Hybrid Inverter Working Mode Setting	RW	U16	N/A	1	Please refer to table 3.6
28	50001	1	Enable UPS Function Switch	RW	U16	N/A	1	0: OFF; 1: ON
29	50004	1	Off-grid Voltage Setting	RW	U16	V	10	
30	50005	1	Off-grid Frequency Setting	RW	U16	Hz	100	[45.00-65.00]Hz
31	50006	1	On-Grid Unbalanced Output Switch	RW	U16	N/A	1	0: OFF; 1: ON
32	50007	1	Peak Load Shifting Switch	RW	U16	N/A	1	0: OFF; 1: ON
33	50009	1	Max. Grid Power Value Setting	RW	U16	kVA	10	

34	50010	1	Parallel Master-Slave Sign	RW	U16	N/A	1	0: Independent Operating 1: Parallel (Slave) 2: Parallel (Master)
	…							
35	50202	1	AC Power Scheduling Mode Setting	RW	U16	N/A	1	0: Off 1: Total Power Setting, Register: 50203 2: Power Setting on each Phase, Registers: 50204-50206
36	50203	1	Total AC Power Scheduling Setting	RW	I16	kW	100	Total AC Power Scheduling Setting
37	50204	1	Phase A Power Scheduling Setting	RW	I16	kW	100	Phase A Power Scheduling Setting
38	50205	1	Phase B Power Scheduling Setting	RW	I16	kW	100	Phase B Power Scheduling Setting
39	50206	1	Phase C Power Scheduling Setting	RW	I16	kW	100	Phase C Power Scheduling Setting
40	50207	1	Battery Power Scheduling Setting	RW	I16	kW	100	
41	50208	1	Max. AC Power Limit Setting	RW	I16	kW	100	
42	50209	1	Min. AC Power Limit Setting	RW	I16	kW	100	
43	50210	1	Priority of Power Output Setting	RW	U16	NA	1	0: PV Output Priority 1 : Battery Output Priority
44	50211	1	PV Power Scheduling	RW	U16	kW	100	

			Setting					
	…							
45	52500	1	Battery Configuration	RW	U16	N/A	1	Please refer to table 3.7
46	52501	1	Battery Protocol configuration	RW	U16	N/A	1	
47	52502	1	On-grid SOC Protection	RW	U16	N/A	1	0: OFF 1: ON
48	52503	1	On-grid Battery End SOC	RW	U16	N/A	1000	[0.0%-100.0%]
49	52504	1	Off-grid SOC Protection	RW	U16	N/A	1	0: OFF 1: ON
50	52505	1	Off-grid Battery End SOC	RW	U16	N/A	1000	[0.0%-100.0%]
	…							
51	53006	1	Period Enable Flag	RW	U16	N/A	1	bit0- bit5 stands for period1-period6, bit7-bit15 reserved; 0: disable 1: enable
52	53007	1	Charge/Discharge Setting	RW	U16	N/A	1	Period1: 0:NONE 1:charge 2:discharge
53	53008	1	Battery Charge By		U16	N/A	1	Period1: 0:PV 1:PV+GRID
54	53009	1	rsved		U16	N/A	1	Period1: Reserved: 0xFF
55	53010	1	Power Limit		U16	N/A	1000	Period1: [0.0-100.0%]
56	53011	1	rsved		U16	N/A	1	Period1: Reserved: 0xFF
57	53012	1	Start Time		U16	N/A	1	Period1: High
58	53013	1	Stop Time		U16	N/A	1	

								8bits(Hour):[0,23] Low 8bits(Mins):[0,59]
59	53014	1	Charge/Discharge	RW	U16	N/A	1	Period2 Note Same as Period1
60	53015	1	Battery Charge By		U16	N/A	1	
61	53016	1	rsved		U16	N/A	1	
62	53017	1	Power Limit		U16	N/A	1000	
63	53018	1	rsved		U16	N/A	1	
64	53019	1	Start Time		U16	N/A	1	
65	53020	1	Stop Time		U16	N/A	1	
66	53021	1	Charge/Discharge	RW	U16	N/A	1	Period3 Note Same as Period1
67	53022	1	Battery Charge By		U16	N/A	1	
68	53023	1	rsved		U16	N/A	1	
69	53024	1	Power Limit		U16	N/A	1000	
70	53025	1	rsved		U16	N/A	1	
71	53026	1	Start Time		U16	N/A	1	
72	53027	1	Stop Time		U16	N/A	1	
73	53028	1	Charge/Discharge	RW	U16	N/A	1	Period4 Note Same as Period1
74	53029	1	Battery Charge By		U16	N/A	1	
75	53030	1	rsved		U16	N/A	1	
76	53031	1	Power Limit		U16	N/A	1000	
77	53032	1	rsved		U16	N/A	1	
78	53033	1	Start Time		U16	N/A	1	
79	53034	1	Stop Time		U16	N/A	1	
80	53035	1	Charge/Discharge	RW	U16	N/A	1	Period5 Note Same as Period1
81	53036	1	Battery Charge By		U16	N/A	1	
82	53037	1	rsved		U16	N/A	1	
83	53038	1	Power Limit		U16	N/A	1000	
84	53039	1	rsved		U16	N/A	1	

85	53040	1	Start Time		U16	N/A	1	
86	53041	1	Stop Time		U16	N/A	1	
87	53042	1	Charge/Discharge	RW	U16	N/A	1	Period6 Note Same as Period1
88	53043	1	Battery Charge By		U16	N/A	1	
89	53044	1	rsved		U16	N/A	1	
90	53045	1	Power Limit		U16	N/A	1000	
91	53046	1	rsved		U16	N/A	1	
92	53047	1	Start Time		U16	N/A	1	
93	53048	1	Stop Time		U16	N/A	1	
	…							
94	53500	8	BMSVersion	WO	STR	N/A	1	Only for BMS access to EMS
95	53508	1	BMS Status		U16	N/A	1	Please refer to Table 3.8 Only for BMS access to EMS
96	53509	2	BMS ErrorCode		U32	N/A	1	Please refer to Table 3.9 Only for BMS access to EMS
97	53511	2	BMS ProtectionCode		U32	N/A	1	
98	53513	2	BMS WarnCode		U32	N/A	1	
99	53515	1	BMSChargeVoltLimit		U16	V	10	Only for BMS access to EMS
100	53516	1	BMSChargeCurrMax		U16	A	10	
101	53517	1	BMSDishargeVoltLimit		U16	V	10	Only for BMS access to EMS
102	53518	1	BMSDishargeCurrMax		U16	A	10	
103	53519	1	BMSBatSOC		U16	%	100	
104	53520	1	BMSBatSOH		U16	%	100	
105	53521	1	BMSBatVoltage		U16	V	10	
106	53522	1	BMSBatCurrent		I16	A	10	
107	53523	1	BMSBatTemp		I16	℃	10	

Table 3.5 Solinteg Hybrid Inverter WO Registers Map

No.	Addr.	Bytes	Function Description	R/W	Type	Unit	Accuracy	Note
1	50200	1	Off-grid function Switch	WO	U16	N/A	1	0: OFF；1: ON
2	50201	1	Clear Off-grid Over-loading Protection Flag	WO	U16	N/A	1	Write 1 to clear

Table 3.6 Hybrid Inverter Working Mode

No.	Hybrid Inverter Working Mode		English Display	Note
	50000 high 8bits	50000 low 8bits		
1	01	01	General Mode	
2		02	Economic Mode	
3		03	UPS Mode	
4	02	N/A	Off Grid Mode	
5	03	01	EMS_ACCtrlMode	Valid Registers: 50202-50206
6		02	EMS_GeneralMode	
7		03	EMS_BattCtrlMode	Valid Registers:50207-50211
8		04	EMS_OffGridMode	

Table 3.7 Battery Configuration (52500)

Battery Brand (52500)		Battery model（Protocol）Configuration(52501)		Description
1	Solinteg	0-1	N/A	
		2	EBS-5150	
2	EMS	N/A		Only for BMS access to EMS
10	Wattsonic Li-HV			
11	AOBOET			
12	DYNESS			
13	Pylon			

14	Soluna		
15	SheenPlus		
16	WECO		
17--			
18--			

Table 3.8 BMS Status (53508)

Register Addr. (53508)	Bits	Function	Description
High 8 bits BMS Control Status	Bit15	Rsved	
	Bit14		
	Bit13		
	Bit12		
	Bit11	Force Charge	1: Force Charge Command (Charge Command Bit10 must write 1) 0: Invalid (Null)
	Bit10	Charge Command	1: Enable 0: Disable
	Bit9	Off-grid Discharge Command	1: Enable 0: Disable
	Bit8	On-grid Discharge Command	1: Enable 0: Disable
Low 8bits BMS Running Status	Bit0~Bit7	0:Sleep 1:Charge 2:Discharge 3:Standby 4:Fault	

Table 3.9 BMS Troubleshooting

Register Addr.	Bits	Hex	Dec	Fault Description	Note
53509 (BMS Error Code)	BIT0	0x00000001	1	Internal COM Fault	
	BIT1	0x00000002	2	Voltage Sensor Fault	
	BIT2	0x00000004	4	Temperature Sensor Fault	
	BIT3	0x00000008	8	Relay Fault	
	BIT4	0x00000010	16	Cells Damage Fault	
53511 (BMS	BIT0	0x00000001	1	Cells Low Voltage Protection	

Protection Code)	BIT1	0x00000002	2	Cells High Voltage Protection	
	BIT2	0x00000004	4	Battery Module Discharge Low Voltage Protection	
	BIT3	0x00000008	8	Battery Module Charge Over Voltage Protection	
	BIT4	0x00000010	16	Charge Low Temperature Protection	
	BIT5	0x00000020	32	Charge High Temperature Protection	
	BIT6	0x00000040	64	Discharge Low Temperature Protection	
	BIT7	0x00000080	128	Discharge High Temperature Protection	
	BIT8	0x00000100	256	Battery Module Charge Over-current Protection	
	BIT9	0x00000200	512	Battery Module Discharge Over-current Protection	
	BIT10	0x00000400	1024	Battery Module Low Voltage Protection	
	BIT11	0x00000800	2048	Battery Module Over Voltage Protection	
	BIT12	0x00001000	4096	Power Terminal Over Temperature Protection	
	BIT13	0x00002000	8192	Ambient Low Temperature Protection	
	BIT14	0x00004000	16384	Ambient High	

				Temperature Protection	
	BIT15	0x00008000	32768	Leakage Current Protection	
53513 (BMS Alarm Code)	BIT0	0x00000001	1	Cells Low Voltage Warning	
	BIT1	0x00000002	2	Cells High Voltage Warning	
	BIT2	0x00000004	4	Battery Module Discharge Low Voltage Warning	
	BIT3	0x00000008	8	Battery Module Charge Over Voltage Warning	
	BIT4	0x00000010	16	Charge Low Temperature Warning	
	BIT5	0x00000020	32	Charge High Temperature Warning	
	BIT6	0x00000040	64	Discharge Low Temperature Warning	
	BIT7	0x00000080	128	Discharge High Temperature Warning	
	BIT8	0x00000100	256	Battery Module Charge Over Current Warning	
	BIT9	0x00000200	512	Battery Module Discharge Over Current Warning	
	BIT10	0x00000400	1024	Battery Module Low Voltage Warning	
	BIT11	0x00000800	2048	Battery Module High Voltage Warning	
	BIT12	0x00001000	4096	Power Terminal	

				Over Temperature Warning	
	BIT13	0x00002000	8192	Ambient Low Temperature Warning	
	BIT14	0x00004000	16384	Ambient High Temperature Warning	

Table 3.10 National Safety Code Description

No.	Safety Code	Note
0~3	RSVED	• Disable Setting
4	Customized code 1	Domestic users can customize the extend of the protection limitation, so that the inverter can be connected to the grid
6	Customized code 2	Domestic users can customize the extend of the protection limitation, so that the inverter can be connected to the grid
10	50Hz Default	Overseas users can customize the extend of the protection limitation, so that the inverter can be connected to the grid
11	60Hz Default	Overseas users can customize the extend of the protection limitation, so that the inverter can be connected to the grid
12	VDE4105	German safety code, can be also used by some other countries/regions.
13	AS4777.2(A)	Australia safety code
14	AS4777.2(NZ)	New Zealand safety code
16	EN50549	European safety code
18	IEC61727(50Hz)	IEC standards apply to 50Hz power grids in India, Southeast Asia, the Middle East and parts of Africa
19	IEC61727(60Hz)	IEC standards apply to 60Hz power grids in India, Southeast Asia, the Middle East and parts of Africa
24	Italy	Italy safety code
25	Czech(A1)	Czech safety code
26	Czech(A2)	Czech safety code
29	EN50549(PL)	Poland safety code
31	Belgium	Belgium safety code，C10/11

35	VDE0126	Greece VDE0126-1-1
36	Italy(MV)	ItalyCEI 0-16
37	South Africa	South AfricaNRS 097-2-1
40	G98	England
41	G99	England
42	Austria	Austria TOR Erzeuger
46	AS4777.2(B)	Australia
47	ES:UNE217002	Spain
48	AS4777.2(C)	Australia
49	ES:NTS631	Spain

Note: This table contains all the safety codes of Solinteg energy storage inverter, the safety codes supported by each model are subject to the actual issuance of the certification certificate, if the inverter does not support the code, screen setting page will prompt "Please Set Grid Code"

Appendix-1（EMS Applications）

Application 1 ：AC Power Control

EMS_ACCtrlMode						
AC Power Setting	Register Addr.					Note
	Power Scheduling Mode Setting（50202）	Total Power Scheduling Setting （50203）	Phase A Power Scheduling Setting （50204）	Phase B Power Scheduling Setting （50205）	Phase C Power Scheduling Setting （50206）	
AC Total Power Scheduling	1	Set Power	--	--	--	
	Note：Set Power is to set the total input/output power of inverter Pinv(1) = Set Power Set; PowerA = PowerB = PowerC = Set Power /3					
AC Three Phases Independent Scheduling	2	--	Set PowerA	Set PowerB	Set PowerC	
	Note: Set PowerA, Set PowerB, Set PowerC is to set PhaseA/B/C power independently, which shall follow the rule as below Pinv = Set PowerA+ Set PowerB+ Set PowerC					

Application 2：General Mode

EMS_GeneralMode						
Control Mode	Register Addr.					Note
	--	--	--	--	--	
General Mode	Note: For maximum PV Self-consumption, shall follow the rule as below: Pload(2) = Ppv(3) + Pbat(4) - Pmeter(5)					

Application 3：Battery Charge/Discharge Control

EMS_BattCtrlMode					
Battery Charge/Discharge	Register Addr.				Note: • Pbat<0, battery charging; • Pbat>0, battery discharging; • Pinv<0, purchasing power from grid; • Pinv>0, power injection to
	Battery Power Scheduling Setting （50207）	AC Power UP Setting （50208）	AC Power Lower Setting（50209）	Power Supply Priority （50210）	
Battery Charge	Set Pbat	Set PupLimit	Set PlowerLimit	0: PV Supply with Priority	
	Eg:				

<table>
<tr><td></td><td colspan="4">Parameter Setting: Set Pbat = -1000W; Set PupLimit = 10000W; Set PlowerLimit = -500W; PV supply with priority;
Control Target: Battery Charge 1000W， Maximum Grid Injection: 10000W, Maximum Gird Purchasing: 500W;
(1) E.g. Ppv = 0W, battery charge power is 500W(Pbat = -500W), Inverter Grid Purchasing 500W(Pinv =-500W);
(2) E.g. Ppv = 200W, battery charge power is 700W(Pbat = -700W), Inverter Grid Purchasing is 500W(Pinv = -500W);
(3) E.g. Ppv = 2000W, battery charge power is 1000W(Pbat = -1000W), Inverter Grid Injection Power is 1000W (Pinv = 1000W)</td><td rowspan="6">• grid;
• Set PupLimit is setting the UP limit of Pinv, Set PlowerLimit is setting the lower limit of Pinv, please make sure Set PupLimit >= Set PlowerLimit
According to inverter power balance formula: Pinv = Pbat + Ppv, when Pbat is confirmed, as well as the Pinv limits set(Set PupLimit and Set PlowerLimit) and Ppv priority, EMS can confirm the inverter running logic with much flexibility.</td></tr>
<tr><td rowspan="2">Battery Discharge</td><td>Set Pbat</td><td>Set PupLimit</td><td>Set PlowerLimit</td><td>0: PV Supply with Priority</td></tr>
<tr><td colspan="4">Eg:
Parameter Setting: Set Pbat = 1000W; Set PupLimit = 2000W; Set PlowerLimit = -10000W; PV Supply with Priority
Control Target: Battery Discharge: 1000W, Max. Grid Injection Power: 2000W, Max. Grid Purchasing Power: 10000W;
(1) E.g. Ppv = 0W, Battery Discharge Power: 1000W(Pbat = 1000W), Inverter Grid Injection Power: 1000W(Pinv = 1000W)
(2) E.g. Ppv = 500W, Battery Discharge Power: 1000W(Pbat = 1000W), Inverter Grid Injection Power: 1500W(Pinv = 1500W)
(3) E.g. Ppv = 1500W, Battery Discharge Power: 500W(Pbat = 500W), Inverter Grid Injection Power 2000W(Pinv = 2000W);</td></tr>
<tr><td rowspan="2">Battery Force Charge</td><td>Set Pbat</td><td>Set PupLimit</td><td>Set PlowerLimit</td><td>0: PV Supply with Priority</td></tr>
<tr><td colspan="4">Eg.
Parameter Setting: Set Pbat = -1000W; Set PupLimit = 10000W; Set PlowerLimit = -500W; PV Supply with Priority
Control Target: Battery Charge Power:1000W, Max. Grid Injection Power: 10000W, release inverter grid purchasing power limit and Set PlowerLimit = -Pn;
(1) E.g. Ppv = 0W, battery charge power is 1000W(Pbat = -1000W), Inverter Grid Purchasing Power: 1000W(Pinv = -1000W);
(2) E.g. Ppv = 200W, battery charge power is 1000W(Pbat = -1000W), Inverter Grid Purchasing Power: 800W(Pinv = -800W);
(3) E.g. Ppv = 2000W, battery charge power is 1000W(Pbat = -1000W), Inverter Grid Injection Power:1000W(Pinv = 1000W)</td></tr>
<tr><td rowspan="2">Battery Force Discharge</td><td>Set Pbat</td><td>Set PupLimit</td><td>Set PlowerLimit</td><td>1: Battery Supply with Priority</td></tr>
<tr><td colspan="4">Eg.</td></tr>
</table>

	Parameter Setting: Set Pbat = 1000; Set PupLimit = 2000; Set PlowerLimit = -10000; Bat PV Supply with Priority; Control Target: Battery Discharge Power:1000W, Max. Inverter Grid Injection Power: 2000W, Max. Grid Purchasing Power: 10000W; (1) E.g.Ppv=0W, Battery Discharge Power: 1000W(Pbat=1000W), Grid Injection Power:1000W(Pinv = 1000W); (2) E.g.Ppv=500W, Battery Discharge Power:1000W(Pbat=1000W), Grid Injection Power:1500W(Pinv =1500W); (3) E.g. Ppv =1500W(Limit Ppv<=1000W, battery supply with priority), Battery Discharge Power: 1000W(Pbat = 1000W), Grid Injection Power: 2000W(Pinv = 2000W);	

Application 4：Off-grid Mode

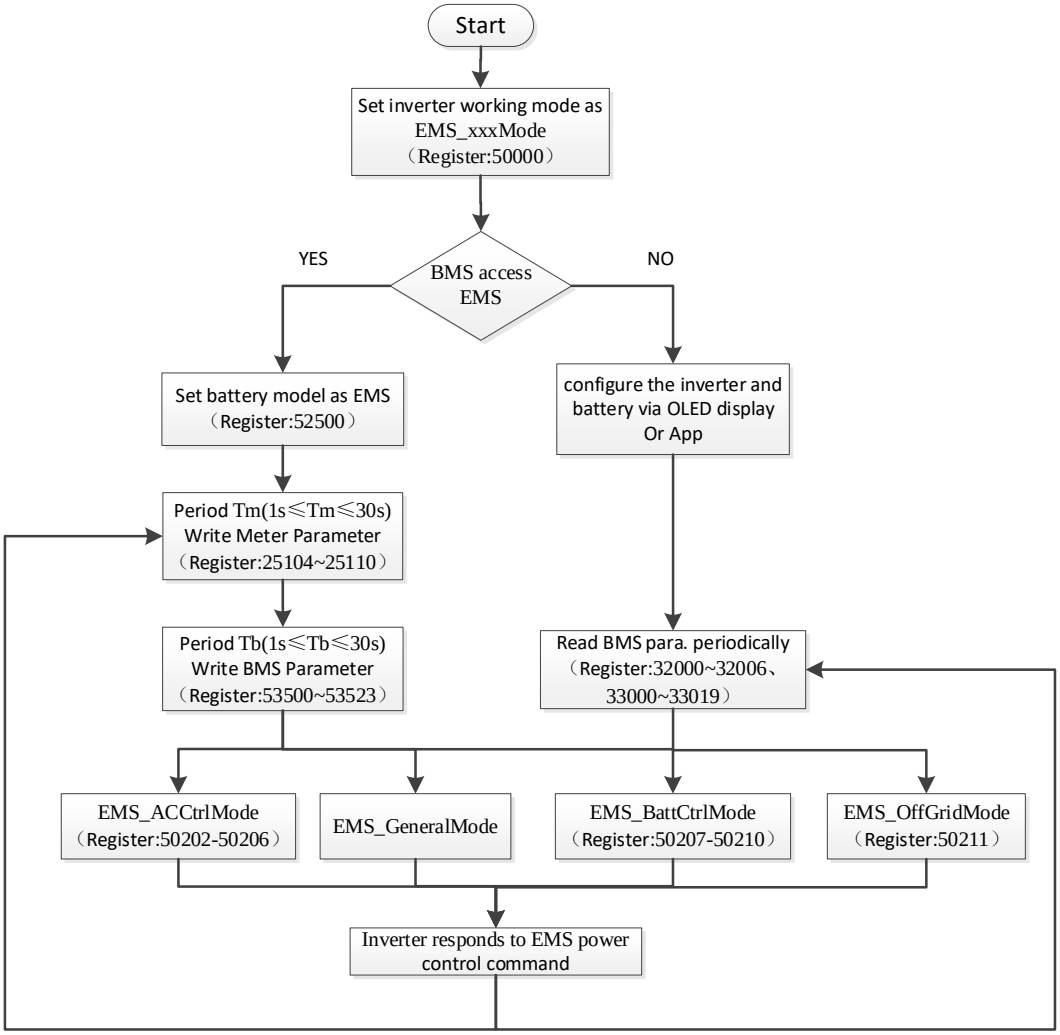
EMS_OffGridMode						
Control Mode	Register Addr.					Note
	PV Power Scheduling Setting（50211）	--	--	--	--	
	Set Ppv					
Off-grid Mode	Ppv = Set Ppv Note: Pbackup(6) = Pbat + Ppv					

Note:

(1) Hybrid Inverter AC Power
(2) Total Load Power (on-grid load + backup load)
(3) PV Output Power
(4) Battery Charge/Discharge Power
(5) Gird Injection/Purchasing Power
(6) Hybrid inverter backup loading Power

Appendix-2（EMS Control Procedure）

Procedure：EMS Access Control Procedure



Flow Chart 1：EMS Control Flow Chart

Note: When the smart meter and BMS access the EMS, if the EMS failed to write in the smart meter data (register: 25104~25110) and BMS data (53500~53523) in real-time according to the specified time period, it will trigger inverter protection or follow the default parameter operation.