

Communication protocol for BMS and PCS

| Version | Description | Date | Auther |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------|
| V2.0 | Init | 2017-02-25 | |
| V3.0 | Add insulation value register; Separate Temperature Fault From Charge State and Discharge State; Add Slave Unit Functional Fault Warning and Error; | 2017-04-25 | |
| V3.1 | Increase alarm informations | 20190705 | |

1. Brief introduction:

1. This document is designed for the communication between Battery Management System(BMS) and PCS in the Energy Storage System;
2. The protocol is based on standard Modbus communication protocol, and defines the register address and specific meaning;
3. For the method and sequenceto read/write one or more register values, you can get detail information from the standard Modbus protocol;
4. Physical Layer: RS485/MODBUS-RTU;
5. Default Communication port baud rates 57600 bit/s
6. The communication port link is eight data bits, 1 stop bit, no parity bit;
7. BMS works as the slave device, while the PCS is the master device;
8. BMS has a default address for this protocol, which is 0x01, you can contact us if there is a conflict in the address distribution;
9. The interval time between two different read/write operation cannot be less than 300ms;

2. Message Format

Modbus protocol message format:

| Device Address | Function Code | Data | CRC |
|----------------|---------------|------|-----|
| 1B | 1B | NB | 2B |

Device Address:

In the communication net, devices cannot share a same address. Each device must have its unique device address in the network, and the value must be between 0 to 255;

Function Code:

Function code describes the method of each operation. Part of the function codes and methods are listed below:

| Function code | Method | Description |
|---------------|-----------------------|-----------------------------------------------|
| 03H | Read registers | Read values from registers |
| 06H | Write single register | Write single value to the specific register |
| 10H | Write multi registers | Write multi values to corresponding registers |

CRC

polynomial :CRC-16/MODBUS $x^{16}+x^{15}+x^2+1$;

3. Register read/write method:

Read register(03H)

Request:

| | | |
|-----------------------|----|----------------------|
| Address | 1B | 0x01 (default) |
| Function code | 1B | 0x03 |
| Starting address Hi. | 1B | 0x0000 to 0xFFFF |
| Starting address Lo. | 1B | |
| Register Quantity Hi. | 1B | 1 to 127 |
| Register Quantity Lo. | 1B | |
| | | 2 bytes per register |
| CRC | 2B | Low byte first |

Normal respond:

| | | |
|----------------|------|-----------------------|
| Address | 1B | 0x01 (default) |
| Function code | 1B | 0x03 |
| Byte count | 1B | 2 to 254 |
| Register value | 2*nB | n = register quantity |
| CRC | 2B | Low byte first |

Exception respond:

| | | |
|----------------|----|--------------------------|
| Address | 1B | 0x01 (default) |
| Error code | 1B | 0x83 |
| Exception type | 1B | See table 3.0 for detail |
| CRC | 2B | Low byte first |

Single register write(06H)

Request:

| | | |
|----------------------|----|------------------|
| Address | 1B | 0x01 (default) |
| Function code | 1B | 0x06 |
| Starting address Hi. | 1B | 0x0000 to 0xFFFF |
| Starting address Lo. | 1B | |
| Register value Hi. | 1B | |
| Register value Lo. | 1B | |
| CRC | 2B | Low byte first |

Normal respond:

| | | |
|----------------------|----|------------------|
| Address | 1B | 0x01 (default) |
| Function code | 1B | 0x06 |
| Starting address Hi. | 1B | 0x0000 to 0xFFFF |
| Starting address Lo. | 1B | |
| Register value Hi. | 1B | |
| Register value Lo. | 1B | |
| CRC | 2B | Low byte first |

Exceptionrespond:

| | | |
|----------------|----|------------------------|
| Address | 1B | 0x01 (default) |
| Error code | 1B | 0x86 |
| Exception type | 1B | Seetable3.0 for detail |
| CRC | 2B | Low byte first |

Multi register write(10H)

Request:

| | | |
|-----------------------|------|-----------------------|
| Address | 1B | 0x01(default) |
| Function code | 1B | 0x10 |
| Starting address Hi. | 1B | 0x0000 to 0xFFFF |
| Starting address Lo. | 1B | |
| Register quantity Hi. | 1B | 1 to 127 |
| Register quantity Lo. | 1B | 2 bytes per register |
| Byte count | 1B | 2 to 254 |
| Register value | 2*nB | n = register quantity |
| CRC | 2B | Low byte first |

Respond:

| | | |
|-----------------------|----|----------------------|
| Address | 1B | 0x01(default) |
| Function code | 1B | 0x10 |
| Starting address Hi. | 1B | 0x0000 to 0xFFFF |
| Starting address Lo. | 1B | |
| Register quantity Hi. | 1B | 0 to 127 |
| Register quantity Lo. | 1B | 2 bytes per register |
| CRC | 2B | Low byte first |

Exception respond:

| | | |
|----------------|----|--------------------------|
| Address | 1B | 0x01(default) |
| Error code | 1B | 0x90 |
| Exception type | 1B | See table 3.0 for detail |
| CRC | 2B | Low byte first |

Exception code and type

Table3.0 Exception code

| Exception code | Description |
|----------------|---------------------------|
| 01 | Invalid function code |
| 02 | Illegal register address |
| 03 | Invalid register quantity |
| 04 | Error during operation |

3. Register definition:

Register address = base address + offset address

Each battery cluster base address is listed below:

| Cluster number | Base address |
|----------------|--------------|
| Cluster 1 | 0x2000 |

We only list one cluster information in the further document, you can get access to any cluster information by changing the base address, if there are more than one cluster.

BMScontrol register:

| Offset address | Name | r/w | Description |
|----------------|-----------------------------------|-----------|-----------------|
| 0x0010 | 主回路接触器控制 Power circuit control | 读写 R/W | 0x1:0n, 0x0:0ff |

Main status information of a single battery cluster(Only Read)

| Offset | Name | Description |
|--------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| 0x0100 | 电池总电压 Battery stack Voltage | 例: VOL =6912, 对应电压为 691.2V Unit:0.1V which 6912 means 691.2V |
| 0x0101 | 电池主回路电流 Battery circuit Current | 16 位有符号整型 范围:-500A~ 500A Unit: 0.1A signed value Scale: -500A to 500A 例: CUR=1234:123.4A CUR=-1234:-123.4A |
| 0x0102 | 充放电指示 Battery work State | 0x0:standby; 0x1:discharge; 0x2:charge |
| 0x0103 | Battery stack SOC | scale: 0%~100% unit 1% |
| 0x0104 | Battery stack SOH | scale: 0%~100% unit 1% |
| 0x0105 | 单体电压最高节电池序号 Position of Maximum cell voltage | 范围: 1#~224# 1 to 224 |
| 0x0106 | 单体最高电压值 Maximum cell voltage | 例: VOL=3201, 对应电压为 3.201v Unit: 1mV, 3201 = 3201mV |
| 0x0107 | 单体最低电压值电池序号 Position of Minimum cell voltage | 范围: 1#~224# 1 to 224 |

| | | |
|--------|---------------------------------------------|--------------------------------------------------------|
| 0x0108 | 单体最低电压值 Minimum cell voltage | 例：VOL=3201，对应电压为 3.201v Unit: 1mV, 3201 = 3201mV |
| 0x0109 | 最高电池温度采样点序号 Maximum temperature position | 范围：1#~224# 1 to 224 |
| 0x010A | 最高电池温度值 Maximum temperature value | 16 位有符号整型 范围：-40~ 150℃ Unit: 0.1℃signed value |
| 0x010B | 最低电池温度采样点序号 Minimum temperature position | 范围：1#~224# 1 to 224 |
| 0x010C | 最低电池温度值 Minimum temperature value | 16 位有符号整型 范围：-40~ 150℃ Unit: 0.1℃signed value |
| 0x0116 | 系统绝缘 System Insulation value | Unit:1K/bit |
| 0x011D | 电池补电状态 Battery Charge State | 0x1:Need Charge; other:Useless |

Warning and error alarm information registers

| Offset address | Name | description |
|----------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0x0140 | 电池系统一级报警信息 1 Alarm level 1_1 | Bit11:: 充电电流过高报警 Charge Current High Alarm Bit10: 放电电流过高报警 Discharge Current High Alarm Bit9: 极耳温度过高报警 Pole Temperature Over High Alarm Bit8: 备用 Bit7: 电池温度差过大报警 Temperature Diff Over High Alarm Bit6: 充电:电池温度过低报警 Under Temperature Alarm (charge); Bit5: 充电:电池温度过高报警 Over Temperature Alarm(charge); Bit4: 电池温度过低报警 Under Temperature Alarm(discharge); bit3: 电池温度过高报警 Over Temperature Alarm (discharge); bit2: 单体压差过大报警 Battery cells unbalance alarm bit1: 单体电压过低报警 Battery Cell Under Voltage Alarm bit0: 单体过压报警 Battery Cell Over Voltage Alarm 其中:0-正常(no alarm),1-报警有效(valid alarm) |
| 0x0141 | 电池系统二级报警信息 1 Alarm level 2_1 | Bit11:: 充电电流过高报警 Charge Current High Alarm Bit10: 放电电流过高报警 Discharge Current High Alarm Bit9: 极耳温度过高报警 Pole Temperature Over High Alarm Bit8: 备用 Bit7: 电池温度差过大报警 Temperature Diff Over High Alarm Bit6: 充电电池温度过低报警 Under Temperature Alarm (charge); Bit5: 充电电池温度过高报警 Over Temperature Alarm(charge); Bit4: 电池温度过低报警 Under Temperature Alarm(discharge); bit3: 电池温度过高报警 Over Temperature Alarm (discharge); bit2: 单体压差过大报警 Battery cells unbalance alarm bit1: 单体电压过低报警 Battery Cell Under Voltage Alarm bit0: 单体过压报警 Battery Cell Over Voltage Alarm 其中:0-正常(no alarm),1-报警有效(valid alarm) |

| | | |
|--------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0x0142 | 本支路运行状态 ClusterXRun State | 0x0: 正常 Normal 0x1: 充满 Full 0x2: 放空 Empty 0x3: 待机 Standby 0x4: 停机 Stop |
| 0x0143 | 电池系统三级报警信息 1 Alarm level 3_1 | Bit11:: 充电电流过高报警 Charge Current High Alarm Bit10: 放电电流过高报警 Discharge Current High Alarm Bit9: 极耳温度过高报警 Pole Temperature Over High Alarm Bit8: 备用 Bit7: 电池温度差过大报警 Temperature Diff Over High Alarm Bit6: 充电:电池温度过低报警 Under Temperature Alarm (charge); Bit5: 充电:电池温度过高报警 Over Temperature Alarm(charge); Bit4: 电池温度过低报警 Under Temperature Alarm(discharge); bit3: 电池温度过高报警 Over Temperature Alarm (discharge); bit2: 单体压差过大报警 Battery cells unbalance alarm bit1: 单体电压过低报警 Battery Cell Under Voltage Alarm bit0: 单体过压报警 Battery Cell Over Voltage Alarm 其中:0-正常(no alarm),1-报警有效(valid alarm) |
| 0x0144 | 其它报警信息 Other Alarm Info | Bit9:熔断器故障 Bit9:Fuse Alarm Bit8:隔离开关状态 Bit8:Shielded Switch State Bit7:BAU 通信故障 Bit7:BAU Communication Fault Bit6:绝缘检测故障 Bit6:Insulation Check Fault Bit5:电流传感器故障 Bit5:Current Sensor Fault Bit4:EEPROM 故障 Bit4:EEPROM Fault Bit3:内网通信故障 Bit3:Bcu-Bmu Communication Fault Bit2:接触器粘连状态 Bit2:Contactor Adhesion Fault Bit1:主控 NTC 故障 Bit1:BCU NTC Fault |

| | | |
|--------|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | <p>Bit0:从控概要故障</p> <p>Bit0:SlaveCtrl Summary Fault</p> <p>其中: 0-正常 (no alarm), 1-报警有效 (valid alarm)</p> |
| 0x0145 | <p>电池系统一级报警信息 2</p> <p>Alarm level 1_2</p> | <p>Bit11:: 单体电压极低报警</p> <p>Battery Cell Very High Alarm</p> <p>Bit10: 单体电压极高报警</p> <p>Battery Cell Very Low Alarm</p> <p>Bit9: 高压箱温度过高报警</p> <p>Pack Temperature Over High Alarm</p> <p>Bit8: SOH 过低报警</p> <p>SOH Lower Alarm</p> <p>Bit7: SOC 过高报警</p> <p>SOC Over High Alarm</p> <p>Bit6:SOC 过低报警</p> <p>System SOC Lower Alarm;</p> <p>Bit5: 负端绝缘阻值过低报警</p> <p>Neg Insulation Resistance Lower Alarm;</p> <p>Bit4: 正端绝缘阻值过低报警</p> <p>Pos Insulation Resistance Lower Alarm;</p> <p>bit3: 绝缘阻值过低报警</p> <p>Insulation Resistance Lower Alarm;</p> <p>bit2: 总电压压差过大报警</p> <p>System Voltage unbalance alarm</p> <p>bit1: 总压过低报警</p> <p>SystemUnder Voltage Alarm</p> <p>bit0: 总压过高报警</p> <p>System Over Voltage Alarm</p> <p>其中:0-正常(no alarm),1-报警有效(valid alarm)</p> |
| 0x0146 | <p>电池系统二 级报警信息 2</p> <p>Alarm level 2_2</p> | <p>Bit11:: 单体电压极低报警</p> <p>Battery Cell Very High Alarm</p> <p>Bit10: 单体电压极高报警</p> <p>Battery Cell Very Low Alarm</p> <p>Bit9: 高压箱温度过高报警</p> <p>Pack Temperature Over High Alarm</p> <p>Bit8: SOH 过低报警</p> <p>SOH Lower Alarm</p> <p>Bit7: SOC 过高报警</p> <p>SOC Over High Alarm</p> <p>Bit6:SOC 过低报警</p> <p>System SOC Lower Alarm;</p> <p>Bit5: 负端绝缘阻值过低报警</p> <p>Neg Insulation Resistance Lower Alarm;</p> <p>Bit4: 正端绝缘阻值过低报警</p> <p>Pos Insulation Resistance Lower Alarm;</p> <p>bit3: 绝缘阻值过低报警</p> <p>Insulation Resistance Lower Alarm;</p> <p>bit2: 总电压压差过大报警</p> <p>System Voltage unbalance alarm</p> <p>bit1: 总压过低报警</p> <p>SystemUnder Voltage Alarm</p> <p>bit0: 总压过高报警</p> <p>System Over Voltage Alarm</p> |

| | | |
|--------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | 其中:0-正常(no alarm),1-报警有效(valid alarm) |
| 0x0147 | 电池系统三级报警信息 2 Alarm level 3_2 | Bit11: 单体电压极低报警 Battery Cell Very High Alarm Bit10: 单体电压极高报警 Battery Cell Very Low Alarm Bit9: 高压箱温度过高报警 Pack Temperature Over High Alarm Bit8: SOH 过低报警 SOH Lower Alarm Bit7: SOC 过高报警 SOC Over High Alarm Bit6: SOC 过低报警 System SOC Lower Alarm; Bit5: 负端绝缘阻值过低报警 Neg Insulation Resistance Lower Alarm; Bit4: 正端绝缘阻值过低报警 Pos Insulation Resistance Lower Alarm; bit3: 绝缘阻值过低报警 Insulation Resistance Lower Alarm; bit2: 总电压压差过大报警 System Voltage unbalance alarm bit1: 总压过低报警 System Under Voltage Alarm bit0: 总压过高报警 System Over Voltage Alarm 其中:0-正常(no alarm),1-报警有效(valid alarm) |
| 0x016C | 最大充电电流 Max Charge Current | Unit: 0.1A signed value |
| 0x016D | 最大放电电流 Max Discharge Current | Unit: 0.1A signed value |

从控故障信息:

Slave unit fault information

| | | |
|--------|--------------------------------------------------------------------------|-----------------------------------------|
| 0x0183 | 主控与从控通信告警 2 Master control and Slave control Communication fault 2 | Bit0-Bit15: SlaveCtrl17、...、SlaveCtrl32 |
|--------|--------------------------------------------------------------------------|-----------------------------------------|

| | | |
|--------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0x0184 | 主控与从控通信告警 1 Master control and Slave control Communication fault 1 | Bit0-Bit15: SlaveCtrl1、...、SlaveCtrl16 |
| 0x0185 | 从控告警设备故障 Slave unit function fault | Bit11:主动均衡故障 Bit11:Active Balance Fault Bit10:被动均衡温度故障 Bit10:Passive Balance Temperature Fault Bit9:被动均衡故障 Bit9:Passive Balance Fault Bit8:EEPROM 故障 Bit8:EEPROM Fault Bit7:接触器故障 Bit7:Contactor Fault Bit6:温度传感器故障 Bit6:Temperature Sensor Fault Bit5: 电池温度采样故障 Bit5: Temperature sampling fault Bit4: 电压采样故障 Bit4:Voltage sampling fault Bit3: 采样芯片故障 Bit3:Sampleing Chip Fault Bit2: 连接线故障 Bit2:Connecting Line Fault Bit1: 采样线故障 Bit1:Voltage sampling Line fault Bit0:从控初始化故障 Bit0:Slave unit initialization fault 其中: 0-正常 (no fault), 1-报警有效(valid alarm) |

电压寄存器 cell voltage register

| Offset address | Name | description |
|----------------|-----------------------------------------|---------------------------------------------------------------|
| 0x0800 | 当前组第 1 节电池电压 Battery Voltage: cell 1 | 例: VOL=3201, 对应电压为 3.201v; Unit:1mV 3201 stands for 3201mV |

| | | |
|--------|---------------------------------------------|--|
| ... | ... | |
| 0x08D7 | 当前组第 216 节电池电压 Battery Voltage: cell 216 | |
| ... | ... | |

We only support 224cells in one cluster for now.

温度寄存器 temperature register

| 偏移地址 | 数据名 | 说明 |
|--------|------------------------------------------------|--------------------------------------------------------------------|
| 0x0C00 | 当前组第 1 个温度测量点温度值 Battery Temperature: 1 | 16 位有符号整型 范围: -40~150℃ 单位 0.1℃ Unit: 0.1℃, significant value |
| ... | ... | |
| 0x0C6b | 当前组第 108 个温度测量点温度值 Battery Temperature: 108 | |
| ... | ... | |

We only support 224 temperature sensors in one cluster for now.

注: 以上寄存器若未指明数据类型的默认均为无符号整形

Tip: All register values are unsigned numbers, unless otherwise noted.