



SmartGen[®]
ideas for power

BACM2420A
BATTERY CHARGER
COMMUNICATION PROTOCOL

SmartGen

SMARTGEN (ZHENGZHOU) TECHNOLOGY CO., LTD



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Table 1 Software Version

Date	Version	Content
2020-03-03	1.0	Original release.



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1 OVERVIEW

This protocol describes read and write command format of PC serial port and the definition of internal information data for the third-party to develop and use.

MODBUS communication protocol allows the module to transfer information and data effectively with PLC, RTU, SCADA system of international brands (such as, Schneider, Siemens, and Modicon etc.), and DCS or third-party monitoring system which is compatible with MODBUS. The monitoring system can be set up if a central PC (or IPC)-based communication master software is added (such as Kingview, Intouch, FIX, Synall etc.).

2 MODBUS BASIC RULES

- All communication loops should follow the master-slave mode. In this way, data can be transferred between a master (e.g. PC) and 32 slaves.
- The master will initialize all information transferred by the device on the communication loop.
- No communication can start from slaves.
- In communication loop, all communication should be transmitted in “information frame”.
- If master or slave receives information frame with unknown command, no response will be given

3 DATA FRAME FORMAT

Communication is asynchronously transferred by the unit of byte (data frame). Each data frame is a serial data stream of 10 bits (stop bit: 1) or 11 bits (stop bit: 2) between master and slave.

Table 2 Data Frame Format

Item	Bits
Start Bit	1-bit
Data Bit	8-bit
Parity Bit	None
Stop Bit	1-bit, 2-bit can be set
Baud Rate	9600bps

4 COMMUNICATION PROTOCOL

4.1 ILLUSTRATION

When communication command is sent to the instrument, device who accords with the address code receives the communication command, and removes the address code to read information. If nothing goes wrong, it shall conduct the task, and then send implementation result to the sender. The returned information includes address code, function code of implemented action, data after implemented action, and CRC. If an error occurs, then nothing shall be sent.



4.2 INFORMATION FRAME FORMAT

Table 3 Information Frame Format

Initiating Structure	Address Code	Function Code	Data Field	CRC	End Structure
Delay (equivalent to 4 bytes)	1 byte 8-bit	1byte 8-bit	N bytes N*8-bit	2 bytes 16-bit	Delay (equivalent to 4 bytes)

4.3 ADDRESS CODE

Address code is the first data frame (8-bit) in each transmitted information frame. The device address range is 1-255, which means that slave device whose address code is defined by users will receive the information sent by the master. Each slave has a unique address code, and each response begins with its address code. The address code issued by the master means the slave address to be sent to, while address code issued by slave means the responded slave address.

4.4 FUNCTION CODE

4.4.1 ILLUSTRATION

Function code is the second data of each communication transmission. ModBus communication protocol defines function code as 1-255 (01H-0FFH). This controller uses a part of it. By master request master can tell slave to conduct certain action. By slave response slave can show that it has responded to the master and conducted the action as the function code issued by the slave is the same as the one issued by the master. If the function code MSB is 1 (function code>127), it means slave does not respond, or response has an error.

The following table shows the specific signification and operation of function code.

Table 4 ModBus Partial Function Codes

Function Code	Definition	Operation
03H	Read Registers	Read single or multiple register data
05H	Place Single Coil	Place single coil
06H	Write Single Register	Write a 16-bit binary number to register

4.4.2 03H READ REGISTERS

With communication command of function code 03H, master can read the numerical registers (all kinds of collected analog and parameter setting values are stored in the register) inside the device. Input register value of 03H mapping data field is 16-bit (2 bytes). So register values read from the device are 2 bytes. For each time maximum readable register values are 125.

Command format of slave response is slave address, function code, data field, and CRC code. Data in data field are double bytes in a group of 2 bytes and high byte is in the front.

4.4.3 05H PLACE SINGLE COIL

With this command master can store single coil data to bit registers (e.g. Coil for ATS control). Slave also can respond information to the master with this function code.



4.4.4 06H WRITE SINGLE REGISTER

With this command master can store single data to bit registers in the device. Register in ModBus communication protocol refers to 16-bit (2 bytes) and high byte is in the front. In this way all points in the device are 2 bytes. Command format is slave address, function code, data field and CRC code.

4.5 DATA FIELD

4.5.1 ILLUSTRATION

Data field varies with different function codes.

4.5.2 CORRESPONDING DATA FIELD FORMAT TO FUNCTION CODE 03H

Table 5 Master Request

Data Sequence	Data Signification	Byte Count
1	Starting Address	2
2	Read Register Numbers	2

Table 6 Slave Response

Data Sequence	Data Signification	Byte Count
1	Loopback Byte Count	1
2	N Register Data	N

4.5.3 CORRESPONDING DATA FIELD FORMAT TO FUNCTION CODE 05H

Table 7 Master Request

Data Sequence	Data Signification	Byte Count
1	Coil Address	2
2	Forced Single Coil Value	2

Table 8 Slave Response

Data Sequence	Data Signification	Byte Count
1	Coil address	2
2	Single Coil Value	2

4.5.4 CORRESPONDING DATA FIELD FORMAT TO FUNCTION CODE 06H

Table 9 Master Request

Data Sequence	Data Signification	Byte Count
1	Register Address	2
2	Register Value (2 bytes)	2

Table 10 Slave Response

Data Sequence	Data Signification	Byte Count
1	Register Address	2
2	Register Value (2 bytes)	2



4.6 ERROR CHECK CODE (CRC)

Master or slave can detect whether the received information is wrong or not with CRC. Sometimes due to electric noise or other interference, information will have imperceptible changes in the transmission process. CRC ensures master or slave does not respond to the wrong information in the transmission process. In this way system safety and efficiency are guaranteed. CRC applies CRC-16 calibration method.

For 2 bytes CRC, low byte is in the front and high byte is in the back.

▲NOTE: All information frame formats are same: address code, function code, data field and CRC code.

CRC includes 2 bytes, which is 16-bit binary number. CRC is counted by the sender and placed at the end of the transmitted information. Responded device will recalculate whether the CRC code of the received information is the same as that received. If they are different, then it means there is an error.

CRC counting method: first place 16-bit register as 1. Then gradually tackle with 8-bit data information. Only 8-bit of data is used in the process of CRC counting. Start bit and stop bit are not included.

In the process of CRC counting, 8-bit data is Exclusive OR with the register data. The obtained result moves 1 bit to the low byte direction and fill MSB with 0. Check LSB again and if LSB is 1, then make register contents Exclusive OR with the preset values. If LSB is 0, then do not do Exclusive OR counting.

This process is repeated for many times. After the eighth bit move, the next 8-bit shall Exclusive OR with the current register contents. This also repeated for 8 times as the last one. Until all data information is handled, the last register contents are CRC code value.

CRC-16 Code Calculation Procedure:

- a) Place a 16-bit CRC register as FFFF hex;
- b) Make the first 8-bit data Exclusive OR with the low 8-bit of the CRC register, and put the result in the CRC register;
- c) Shift the CRC register one bit to the right, and fill MSB with 0. Examine the moved-out bit;
- d) If LSB was 0: repeat Step 3 (another shift);
- e) If LSB was 1: Exclusive OR the CRC register with A001 hex;
- f) Repeat Step 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit data are processed;
- g) Repeat Step 2 to 5 for the next data processing;
- h) The final CRC register value is the CRC code. Low-order 8-bit data is transmitted first and high-order 8-bit data is at the last.

▲NOTE: The calculation of CRC code starts from <slave address> and except for all bytes of <CRC code>.



4.7 EXAMPLES OF INFORMATION FRAME FORMAT

4.7.1 FUNCTION CODE 03H

Slave address is 01 and starting address is 3 data of 0026H (each data is 2 bytes).

Table 11 Data Address

Address	Data (Hex)
0026H	0014
0027H	0014
0028H	0005

Table 12 Function Code 03H Master Request Example

Request	Bytes	Example (Hex)
Slave Address	1	01 Send to slave 01
Function Code	1	03 Read point register
Starting Address	2	00 Starting address is 0026H 26
Read Number	2	00 Read 3 data (total 6 bytes) 03
CRC Code	2	E4 CRC code which calculated by master 00

Table 13 Function Code 03H Slave Response Example

Response	Bytes	Example (Hex)
Slave Address	1	01 Respond slave address 01
Function Code	1	03 Read point register
Read Bytes	1	06 3 data (total 6 bytes)
Point 1 Data	2	00 The contents of address 0026H 14
Point 2 Data	2	00 The contents of address 0027H 14
Point 3 Data	2	00 The contents of address 0028H 05
CRC Code	2	91 CRC code which calculated by slave 71



4.7.2 FUNCTION CODE 05H

Slave address is 01 and starting address is 1 coil of 0002H, place 0002H unit as 1.

Table 14 Coil Data Address

Address	Data (Hex)
0000	0
0001	1
0002	0

NOTE: FF00 hex coil is forced to 1 and 0000H is forced to 0. Other values are illegal and will not affect the coil.

Table 15 Function Code 05H Master Request Example

Request	Bytes	Example (Hex)	
Slave Address	1	01	Send slave address 01
Function Code	1	05	Forced coil
Starting Address	2	00 00	Starting address is 0000H
Data	2	FF 00	Place coil as 1
CRC Code	2	CD FB	CRC code which calculated by master

Table 16 Function Code 05H Slave Response Example

Response	Bytes	Example (Hex)	
Slave Address	1	01	Respond slave address 01
Function Code	1	05	Forced coil
Starting Address	2	00 00	Starting address is 0000H
Data	2	FF 00	Place coil as 1
CRC Code	2	CD FB	CRC code which calculated by master



4.7.3 FUNCTION CODE 06H

Slave address is 01 and place the 1 point content of starting address 00E3H as 0002H.

Table 17 Function Code 06H Master Request Example

Request	Bytes	Example (Hex)
Slave Address	1	01 Send slave address 01
Function Code	1	06 Write single register
Starting Address	2	00 Starting address is 00E3H E3
Data	2	00 Place 1 point data (total 2 bytes) 02
CRC Code	2	F9 CRC code which calculated by master FD

Table 18 Function Code 06H Slave Response Example

Response	Bytes	Example (Hex)
Slave Address	1	01 Respond slave address
Function Code	1	06 Write single register
Starting Address	2	00 Starting address is 00E3H E3
Data	2	00 Place 1 point data (total 2 bytes) 02
CRC Code	2	F9 CRC code which calculated by master FD



4.8 ERROR HANDLING

When device detects other errors except the CRC code, the slave must send information to the master. The function code MSB is 1, which means the response function code by slave should add 128 based on the function code sent by the master. The following codes show that unexpected errors have occurred.

If CRC error occurs for the information received by the slave, then the device will ignore.

Table 19 Error Code Format of Slave Response (CRC excluded)

Type	Bytes
Address Code	1 byte
Function Code	1 byte (MSB is 1)
Error Code	1 byte
CRC Code	2 bytes

Wrong Function Code:

01 Illegal Function Code

The function code received in the query is not an allowable action for the slave.

02 Illegal Data Address

The data address received in the query is not an allowable address for the slave.

03 Illegal Data Value

A value contained in the query data field is not an allowable value for the slave.



5 ATTACHMENT: ADDRESS AND DATA

5.1 FUNCTION CODE 03H MAPPING DATA FIELD

Table 20 Function Code 03H Mapping Data Field

Address	Item	Description	Bytes	Remark
1000	Battery Voltage	03H	Signed (*100)	
1001	Charging Current	03H	Signed (*100)	
1002	Output Voltage	03H	Signed (*100)	
1003	Battery Temperature	03H	Signed (*1)	
1004	Battery Temp Sensor Resistance Value	03H	Signed (*10)	
1005	COM Voltage	03H	Signed (*100)	
1006	Charging Status	03H	0: Standby 1: Trickle 2: Quick Charge 3: Absorption Charge 4: Float Charge	
1007	BOOST Status	03H	0: Inactive; 1: Active	
1008	Aux. Inputs Status	03H	0: Inactive; 1: Active	
1009	Mains Failure	03H	0: Inactive; 1: Active	
1010	Charging Failure	03H	0: Inactive; 1: Active	
1011	Shutdown	03H	0: Inactive; 1: Active	
1012	Battery Detection Enable	03H	0: Inactive; 1: Active	
1013	Battery High Temp Warning	03H	0: Inactive; 1: Active	
1014	Battery Undervoltage Warning	03H	0: Inactive; 1: Active	

5.2 FUNCTION CODE 03H, 06H MAPPING DATA FIELD

Table 21 Function Code 03H, 06H Mapping Data Field

Address	Item	Function Code	Range	Defaults	Remark
2000	Rated Output Current	03H	(0-200.0)A	20.0A	
2001	Charging Current	03H/06H	(0-100)%	100%	
2002	Battery Select	03H	(0-1)	1	0: 12V; 1: 24V.
2003	Charge Stages	03H/06H	(2-3)	3	
2004	Absorption Voltage	03H/06H	(20.00-32.00)V	28.20V	
2005	Float Voltage	03H/06H	(20.00-32.00)V	27.00V	
2006	Absorption Time Enable	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2007	Absorption Time	03H/06H	(0.1-100.0)h	1.0h	
2008	Current Enable after Absorption	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2009	Absorption Current	03H/06H	(0.20-3.00)A	0.50A	



Address	Item	Function Code	Range	Defaults	Remark
2010	Auto BOOST Voltage	03H/06H	(20.00-32.00)V	25.60V	Less than float voltage.
2011	Auto BOOST Voltage Delay	03H/06H	(0-3600)s	20s	
2012	Low-voltage Trickle Charging	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2013	Low-voltage Trickle Charging Voltage	03H/06H	(20.00-32.00)V	22.00V	Less than auto BOOST voltage.
2014	Low-voltage Trickle Charging Current	03H/06H	(0-100)%	50%	
2016	Battery Detection	03H/06H	(0-1)	0	0: Disabled; 1: Enabled.
2017	Battery Undervoltage Alarm	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2018	Battery Undervoltage Alarm Threshold	03H/06H	(16.00-32.00)V	23.00V	
2019	Battery Undervoltage Alarm Delay	03H/06H	(0-3600)s	120s	
2020	Battery Undervoltage Alarm Return Threshold	03H/06H	(16.00-32.00)V	24.00V	
2021	Battery Undervoltage Alarm Return Delay	03H/06H	(0-3600)s	10s	
2022	Temperature Sensor	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2023	Temperature Compensation	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2024	Temperature Compensation Value	03H/06H	(0.010-0.030) V/°C	0.018V/°C	Voltage drop value per degree of temperature rise.
2025	High Temp Alarm	03H/06H	(0-1)	1	0: Disabled; 1: Enabled.
2026	High Temp Alarm Threshold	03H/06H	(0-80)°C	55°C	
2027	High Temp Alarm Delay	03H/06H	(0.0-60.0)s	0.5s	
2028	High Temp Return Threshold	03H/06H	(0-80)°C	50°C	
2029	High Temp Return Delay	03H/06H	(0-60.0)s	1.0s	



Address	Item	Function Code	Range	Defaults	Remark
2030	Aux. Inputs Setting	03H/06H	(0-3)	3	0: Not used 1: Shutdown 2: Enable voltage detection 3: Manual BOOST
2031	Aux. Input Delay	03H/06H	(1.0-60.0)s	2.0s	
2032	Comm. Address	03H/06H	(1-254)	10	
2033	Comm. Baud Rate	03H/06H	(0-2)	0	0: 9600bps 1: 19200bps 2: 38400bps
2034 2053	Charger Description	03H/06H			40 characters

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