



SmartGen
ideas for power

**BACM SERIES
BATTERY CHARGER
COMMUNICATION PROTOCOL**

SmartGen

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Chinese trademark

SmartGen English trademark

SmartGen — make your generator *smart*

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1. INTRODUCTION

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), and DCS or third-party monitoring system compatible with MODBUS. The monitoring system can be set up if only adding central communication master software (such as Kingview, Intouch, FIX, Synal) basing on PC (or IPC).

2. MODBUS BASIC RULES

- 1) All communication loops should follow the master-slave mode. If so, data can be transferred between a master (e.g. PC) and 32 slaves.
- 2) The master will initialize all messages sent from communication coil of the device.
- 3) No communication can start from slaves.
- 4) In communication loop, all communication should be transmitted in “information frame”.
- 5) If received information frame contains unknown command, no response will be given.

3. DATA FRAME FORMAT

Communication is asynchronously transferred, using byte (data frame) as unit. Between master and slave, every transmitted data frame is 10-bit (stop bit: 1) or 11-bit (stop bit: 2) serial data stream.

Data frame format:

Item	Description
Start bit	1-bit
Data bit	8-bit
Parity bit	No parity
Stop bit	1-bit or 2-bit can be set.
Baud rate	9600bps

4. COMMUNICATION PROTOCOL

4.1 ILLUSTRATION

When communication command is sent to the slave, corresponding slave receives the communication command, then removes address code, and read the information. If no mistakes, it will execute commands, and sends the result back to the master. Response information includes address code, function code, data and error check code (CRC). If an error occurred in receipt of the command, it will send no information.

4.2 INFORMATION FRAME FORMAT

Initiating structure	Address code	Function code	Data field	CRC	End structure
Delay (equivalent to 4 bytes)	1 byte 8-bit	1 byte 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. Device address range is 1–255, this byte shows that the slave defined by users will receive the information sent by the master. Each slave has a unique address code, and responses begin with the address code. A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.

4.4 FUNCTION CODE

4.4.1 ILLUSTRATION

This is the second byte of each transmission. ModBus communication protocol defined function code as 1-255 (01H-0FFH). HGM8100N controllers use part of it. Master sends the request and the slave executes actions according to the function code. If the function code sent by slave is same as that sent by master, it means the response is active. But if the function code MSB is 1 (function code range >127), it means there is no response or response has error.

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

ModBus Partial Function Codes are as follows:

Function code	Definition	Operation
03H	Read Holding Registers	Reads the contents of holding registers
05H	Force Single Coil	Forces a single coil to either ON or OFF.
06H	Preset Single Register	Preset a value into a single holding register.

4.4.2 03H Read Holding Registers

With function code 03H command, the master can read the numerical registers inside the device (numerical registers contains various analog and parameter setting values). Input register values of function code 03H mapping data field are 16 bits (2 bytes). So, from the device reads registers values are 2 bytes. Maximum number of readable registers is 125 each time.

The slave received command format is slave address, function code, data field and the CRC code. The data of data field is in double bytes with every two bytes for a group, and high byte is in advance.

4.4.3 05H Force Single Coil

Master uses this command to save a single coil data into bit registers in the device (such as ATS transfer control). The slave also uses this function code to feedback information to the master.

4.4.4 06H Preset Single Register

Master uses this command to save a single register data into registers in the device. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits. The slave received command format is slave address, function code, data field and the CRC code.

4.5 DATA FIELD

4.5.1 ILLUSTRATION

Data field varies with different function codes.

4.5.2 Function 03H –Read Holding Registers.

Request:

Data Sequence	Data Signification	Byte Count
1	Starting address	2
2	Read registers	2

Response:

Data Sequence	Data Signification	Byte Count
1	Loopback byte count	1
2	N - register data	N

4.5.3 Function 05H –Force Single Coil

Request:

Data Sequence	Data Signification	Byte Count
1	Coil address	2
2	Forced single coil value	2

Response:

Data Sequence	Data Signification	Byte Count
1	Coil address	2
2	Single coil value	2

4.5.4 Function 06H –Preset Single Register

Request:

Data Sequence	Data Signification	Byte Count
1	Register address	2
2	Register value (2-byte)	2

Response:

Data Sequence	Data Signification	Byte Count
1	Register address	2
2	Register value (2-byte)	2

4.6 ERROR CHECK CODE (CRC)

The Error Check Code allows the receiving device to detect a packet that has been corrupted with transmission errors. Sometimes, the transmission information occur imperceptible changes due to electronic noise and other interference and the CRC code ensure the error information does not work to increase the system's safety and efficiency.

When the CRC is appended to the message, the low-order byte is appended first, followed by the high-order byte.

▲Note: All information frame format are same: address code, function code, data area and CRC code.

The CRC field is two bytes, containing a 16-bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value that received in the CRC field. If the two values are not equal, an error will result.

The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits do not apply to the CRC.

During generation of the CRC, each 8-bit character is exclusive OR with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive OR with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8-bit byte is exclusive OR with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the bytes of the message have been applied, is the CRC value.

4.7 CRC-16 CALCULATIONPROCEDURE

- 1) Load a 16-bit register with FFFF hex (all 1's). Call this the CRC register.
- 2) Exclusive OR the first 8-bit byte of the message with the low-order byte of the CRC register, putting the result in the CRC register.
- 3) Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.
- 4) (If the LSB was 0): Repeat Step 3 (another shift).
- 5) (If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
- 6) Repeat Steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
- 7) Repeat Steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
- 8) The final contents of the CRC register are the CRC value. Least Significant Byte first. When the 16-bit CRC (two 8-bit bytes) is transmitted in the message, the low-order byte will be transmitted first, followed by the high-order byte.

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

4.8 EXAMPLES OF INFORMATION FRAME FORMAT

4.8.1 FUNCTION CODE 03H

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

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

Request

Request	Bytes	Example (Hex)
Slave address	1	01 Send to the slave 01
Function code	1	03 Read Holding Registers
Starting address	2	00 Starting address is 0026H 26
No. of Points	2	00 Read 3 registers (total 6 bytes) 03
CRC code	2	E4 CRC code which calculated by PC. 00

Response

Response	Bytes	Example (Hex)
Slave address	1	01 Respond to the slave 01
Function code	1	03 Read register
Read count	1	06 3 registers (total 6 bytes)
Data 1	2	00 The content of address 0026H 14
Data 2	2	00 The content of address 0027H 14
Data 3	2	00 The content of address 0028H 05
CRC code	2	91 CRC code which calculated by slave. 71

4.8.2 FUNCTION CODE 05H

Read coil for slave address is 01 and starting address is 0002H. 0002H is addressed as 1.

Address	Data(Hex)
0000	0
0001	1
0002	0

▲ Note: A value of FF 00 hex requests the coil to be ON. A value of 00 00 requests it to be OFF. All other values are illegal and will not affect the coil.

Request

Request	Bytes	Example (Hex)
Slave address	1	01 Send to the slave 01
Function code	1	05 Force single coil
Starting address	2	00 Starting address for 0000H 00
Data	2	FF Set coil as 1 00
CRC code	2	CD CRC code which calculated by PC. FB

Response

Slave Response	Bytes	For Example (Hex)
Slave address	1	01 Respond to the slave 01
Function code	1	05 Force single coil
Starting address	2	00 Starting address is 0000H 00
Data	2	FF Set coil as 1 00
CRC code	2	CD CRC code which calculated by slave. FB

4.8.3 FUNCTION CODE 06H

Preset register as 0002H for slave address is 01 and starting address is 00E3H. Here is an example:

Request	Bytes	Example (Hex)
Slave address	1	01 Send to the slave 01
Function code	1	06 Preset Single Register
Starting address	2	00 Starting address is 00E3H E3
Data	2	00 Preset Register Data (2 bytes) 02
CRC code	2	F9 CRC code which calculated by PC. FD

Slave response	Bytes	For example (Hex)
Slave address	1	01 Respond to the slave 01
Function code	1	06 Preset Single Register
Starting address	2	00 Starting address is 00E3H E3
Data	2	00 Preset Register Data (2 bytes) 02
CRC code	2	F9 CRC code which calculated by slave. FD

4.9 ERROR HANDLING

When device detected 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. The following codes show that unexpected errors have occurred.

CRC error received from the master will be ignored by the device.

The frame format of error code that responds by slave is as follows (CRC excluded):

Type	Byte
Address code	1 byte
Function code	1 byte (MSB is 1)
Error code	1 byte
CRC code	2 bytes

Error code:

01 illegal function code

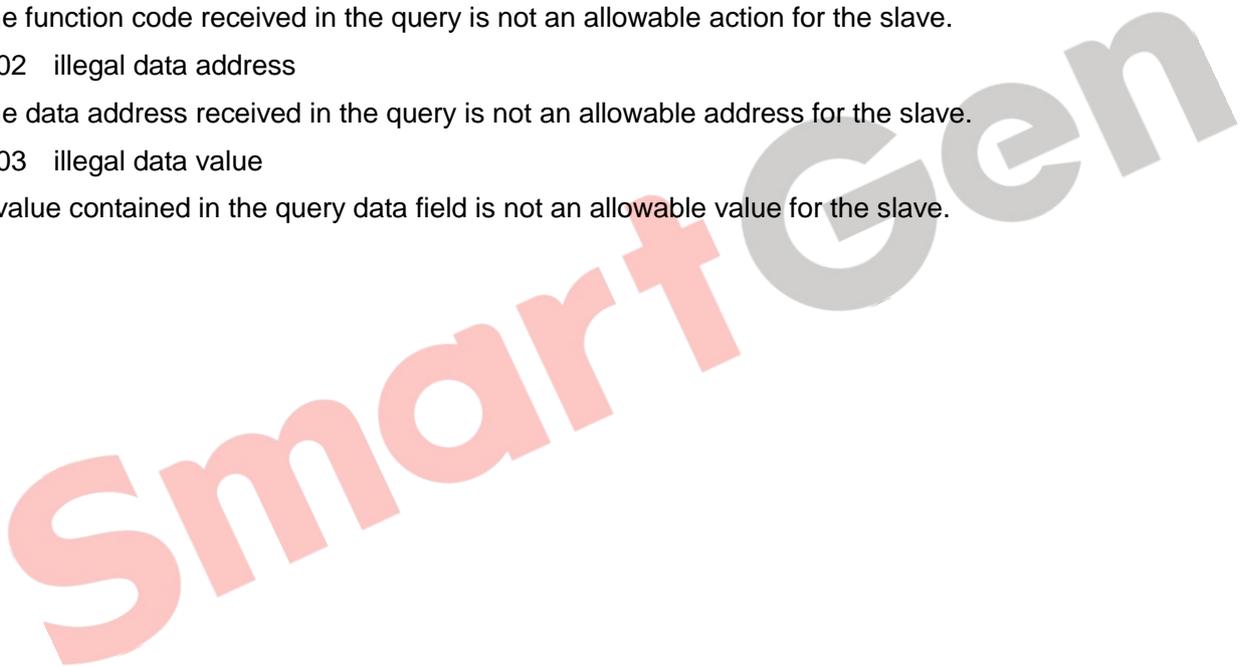
The function code received in the query is not an allowable action for the slave.

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. ADDRESS AND DATA

Function code 03h map data field,

Address	Items	Description	Bytes Count	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	03H	Signed (*10)	
1005	Common Input Port Volt	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: Deactive; 1: Active	
1008	Aux. Input Ports Status	03H	0: Deactive; 1: Active	
1009	Mains Failure	03H	0: Deactive; 1: Active	
1010	Fail to Charge	03H	0: Deactive; 1: Active	
1011	Shutdown	03H	0: Deactive; 1: Active	
1012	Battery Detection Enabled	03H	0: Deactive; 1: Active	
1013	Battery High Temp Warning	03H	0: Deactive; 1: Active	
1014	Battery Under Volt Warning	03H	0: Deactive; 1: Active	