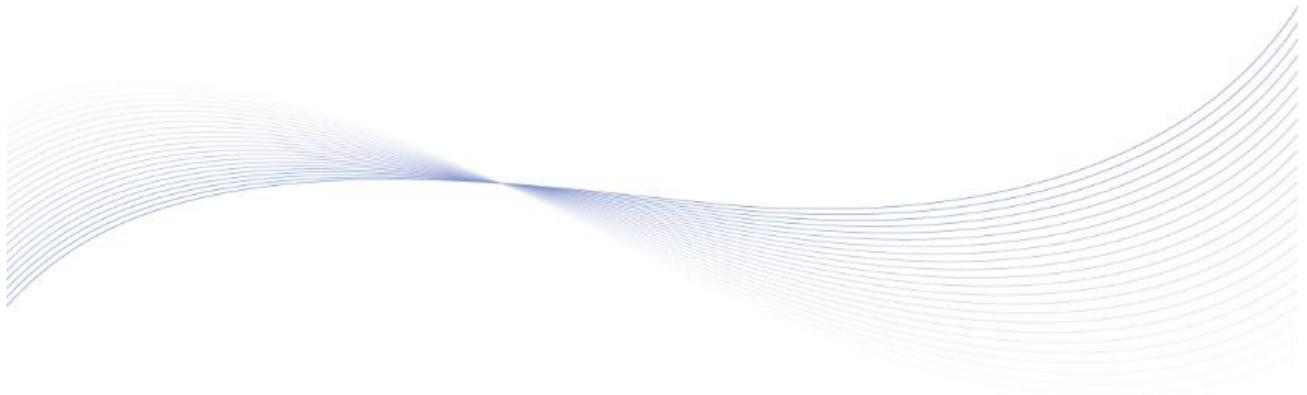# SmartGen
MAKING CONTROL SMARTER

HPA100-16
Lithium Battery Protection Board
COMMUNICATION PROTOCOL

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SMARTGEN(ZHENGZHOU)TECHNOLOGY CO.,LTD.

SmartGen **Registered trademark**

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Table 1 Software Version

Date	Version	Content
2024-01-30	V1.0	Original release.

CONTENT

1 DESCRIPTION

This protocol describes the board RS485 half-duplex serial ports' read and write command format, and the definition of internal information & data for the third-party to develop and use.

The HPA100-16 board has two RS485 ports, and both follow the same protocol.

The board works as a slave module, and uses Modbus-RTU protocol, but it doesn't support other protocols, such as Modbus-ASCII, etc.

Communication address: 1~15

Baud rate: 9600/19200bps/115200 (Default: 9600bps)

Start bit: 1 bit

Data bit: 8 bits

Parity bit: no bit for no parity, 1 bit for even or odd parity (Default: no parity)

Stop bit: 1 bit or 2 bits (Default: 1 bit)

Function code supported: 0X03, 0X06.

Error checking method: CRC16.

The register data inside the controller are packed as two bytes per register.

Transmission distance: At a baud rate of 9600bps, the maximum distance can reach up to 1,000 meters with 120-ohm shielded twisted pair cable.

It can support the communication of 15 networked controllers.

RS485 cabling must use 120-ohm shielded twisted pair cable, and one end of the shield should be grounded.
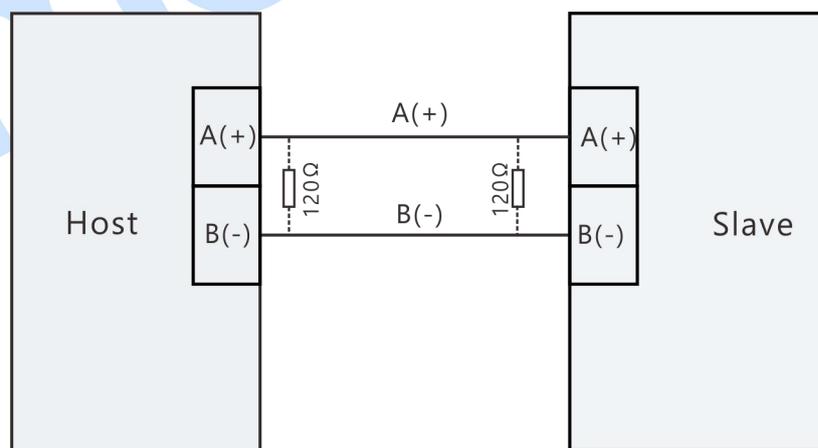
2 WIRING DIAGRAM

Figure 1 Single Device Communication Wiring Diagram

Note 1: Two 120-ohm resistors can be connected on both ends of the cable according to the site's requirement.

Note 2: The diagram shown is for the RS485-1, and the diagram of RS485-2 is the same as above.

3 CONTROLLER INTERNAL REGISTER ADDRESS AND DATA

3.1 FUNCTION CODE 03 MAPPING ALARM AND STATUS OF DATA FIELD

Table 2 Alarm and Status of Data Field

Address	PLC Address	Item	Description	Bytes	Remark
0100	40101	Common Alarm	1 as active (low order)	1 bit	"1" means there are alarms "0" means there is no alarm
		Alarm	1 as active	1 bit	"1" means there are alarms "0" means there is no alarm
		Protection		1 bit	
		Fault	1 as active	1 bit	"1" means the protection action is performed "0" means the protection action isn't performed
		Reserved	1 as active	1 bit	"1" means there are faults "0" means there is no fault
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0101	40102	Cell Overvoltage Warning	1 as active (low order)	1 bit	"1" means the cell voltage is over the threshold "0" means the cell voltage is normal.
		Cell Undervoltage Warning	1 as active	1 bit	"1" means the cell voltage is under the threshold "0" means the cell voltage is normal.
		Module Overvoltage Warning	1 as active	1 bit	"1" means the module voltage is over the threshold "0" means the module voltage is normal
		Module Undervoltage Warning	1 as active	1 bit	"1" means the module voltage is under the threshold "0" means the module voltage is

Address	PLC Address	Item	Description	Bytes	Remark
					normal
		Charge Overcurrent Warning	1 as active	1 bit	"1" means the charge current is over the threshold "0" means the charge current is normal
		Discharge Overcurrent Warning	1 as active	1 bit	"1" means the discharge current is over the threshold "0" means the discharge current is normal
		High Charge Temp. Warning	1 as active	1 bit	"1" means the charge temperature is over the threshold "0" means the charge temperature is normal
		High Discharge Temp. Warning	1 as active	1 bit	"1" means the discharge temperature is over the threshold "0" means the discharge temperature is normal
		Low Charge Temp. Warning	1 as active	1 bit	"1" means the charge temperature is under the threshold "0" means the charge temperature is normal
		Low Discharge Temp. Warning	1 as active	1 bit	"1" means the discharge temperature is under the threshold "0" means the discharge temperature is normal
		High Ambient Temp. Warning	1 as active	1 bit	"1" means the ambient temperature is over the threshold "0" means the ambient temperature is normal
		Low Ambient Temp. Warning	1 as active	1 bit	"1" means the ambient temperature is under the threshold "0" means the ambient temperature is normal
		High MOS Temp. Warning	1 as active	1 bit	"1" means the MOS temperature is over the threshold "0" means the MOS temperature is normal
		Low Battery Warning	1 as active	1 bit	"1" means the battery capacity is under the threshold "0" means the battery capacity is normal

Address	PLC Address	Item	Description	Bytes	Remark
		Reserved		1 bit	
		Reserved		1 bit	
0102	40103	Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0103	40104	Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0104	40105	Cell Overvoltage Protection	1 as active (low order)	1 bit	"1" means the cell voltage is over the threshold "0" means the cell voltage is normal
		Cell Undervoltage Protection	1 as active	1 bit	
		Module Overvoltage Protection	1 as active	1 bit	
		Module	1 as active	1 bit	

Address	PLC Address	Item	Description	Bytes	Remark
		Undervoltage Protection			
		Charge Overcurrent Protection	1 as active	1 bit	
		Discharge Overcurrent Protection	1 as active	1 bit	
		Short Circuit Protection	1 as active	1 bit	
		Reserved		1 bit	
		Reverse Charger Connection Protection	1 as active	1 bit	
		High Charge Temp. Protection	1 as active	1 bit	
		High Discharge Temp. Protection	1 as active	1 bit	
		Low Charge Temp. Protection	1 as active	1 bit	
		Low Discharge Temp. Protection	1 as active	1 bit	
		High MOS Temp. Protection	1 as active	1 bit	
		High Ambient Temp. Protection	1 as active	1 bit	
		Low Ambient Temp. Protection	1 as active (high order)	1 bit	
0105	40106	Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	

Address	PLC Address	Item	Description	Bytes	Remark
0106	40107	Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0107	40108	Reserved	1 as active (low order)	1 bit	
		Reserved	1 as active	1 bit	
		NTC Fault	1 as active	1 bit	"1" means NTC is abnormal "0" means NTC is normal
		Cell Fault	1 as active	1 bit	
		Reserved	1 as active	1 bit	
		Reserved	1 as active	1 bit	
		MOS Temp. Fault	1 as active	1 bit	
		Ambient Temp. Sensor Fault	1 as active	1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0108	40109	Short Circuit Signal	1 as active	1 bit	
		Reserved	1 as active	1 bit	
		Reserved		1 bit	
		Heating Status	1 as active	1 bit	
		Charger Connection Signal	1 as active	1 bit	
		Reverse Charger Connection Signal	1 as active	1 bit	

Address	PLC Address	Item	Description	Bytes	Remark
		Reverse Load Connection Signal	1 as active	1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0109	40110	Main Power Supply Output	1 as active	1 bit	"1" means main power supply has outputted "0" means main power supply doesn't output
		Reserved		1 bit	
		Pre-charge MOS Output	1 as active	1 bit	
		Charge MOS Output	1 as active	1 bit	
		Discharge MOS Output	1 as active	1 bit	
		Current Limiting MOS Output	1 as active	1 bit	
		Power Supply Current Limiting Output	1 as active	1 bit	
		Current Limiting Set Point	0: 5A 1: 10A	1 bit	
		Reserved	1 as active	1 bit	
		Reserved	1 as active	1 bit	
		Main Positive Relay Output (Relay Board)	1 as active	1 bit	
		Pre-charge Relay Output (Relay Board)	1 as active	1 bit	
		Main Negative Relay Output (Relay Board)	1 as active	1 bit	
		Relay Board Power Supply Output	1 as active	1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0110	40111	Reserved	1 as active	1 bit	
		Reserved	1 as active	1 bit	
		Reserved	1 as active	1 bit	

Address	PLC Address	Item	Description	Bytes	Remark
		Reserved	1 as active	1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Aux. Input 1 Status	1 as active	1 bit	
		Aux. Input 2 Status	1 as active	1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0111	40112	Aux. Output 1 Status	1 as active	1 bit	"1" means the port has outputted "0" means the port doesn't output
		Aux. Output 2 Status	1 as active	1 bit	
		Aux. Output 3 Status	1 as active	1 bit	
		Aux. Output 4 Status	1 as active	1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
		Reserved		1 bit	
0112	40113	Balance Status of Cell 1-16	bit0: Status of Cell 1 bit15: Status of Cell 16	2Bytes	1 as active 0 as inactive
0113	40114	Balance Status of Cell 17-32 (Reserved)	1 as active	2Bytes	
0114-0129	40115-40130	Reserved			

3.2 FUNCTION CODE 03 & 06 MAPPING DATA FIELD

Table 3 Data Field

Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0130	40131	Module Current	-30000~30000	0.01	A	16-bit Signed Negative number as discharge Positive number as charge	
0131	40132	Module Total Voltage	0~8000	0.01	V	16-bit Unsigned	
0132	40133	Remaining Capacity	0~60000	0.01	Ah	16-bit Unsigned	
0133	40134	Total Capacity	0~60000	0.01	Ah	16-bit Unsigned	
0134	40135	Cycles	0~60000	1	/	16-bit Unsigned	
0135	40136	SOC of Module	0~1000	0.1	/	16-bit Unsigned	
0136	40137	SOH of Battery	0~1000	0.1	/	16-bit Unsigned	
0137	40138	Charge/ Discharge Status	0~3	1	/	0: Sleep Mode 1: Standby 2: Charging 3: Discharging	
0138	40139	Reserved					
0139	40140						
0140	40141	Reserved					
0141	40142						
0142	40143	Reserved					
0143	40144						
0144	40145	Reserved					
0145	40146						
0146	40147	Reserved					
0147	40148						
0148	40149	Max. Charge Current	-30000~30000	0.01	A	16-bit Unsigned	
0149	40150	Max. Discharge Current	-30000~30000	0.01	A	16-bit Unsigned	
0150	40151	Max. Charge Voltage	-30000~30000	0.01	V	16-bit Unsigned	
0151	40152	Min. Discharge Voltage	-30000~30000	0.01	V	16-bit Unsigned	

Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0152	40153	Quantity of Cells		/	/	16-bit Unsigned	
0153	40154	Quantity of Cell Temp.		/	/	16-bit Unsigned	
0154	40155	Max. Cell Voltage	0~5000	1	mV	16-bit Unsigned	
0155	40156	Min. Cell Voltage	0~5000	1	mV	16-bit Unsigned	
0156	40157	Battery Average Voltage	0~5000	1	mV	16-bit Unsigned	
0157	40158	Module Voltage Difference	0~5000	1	mV	16-bit Unsigned	
0158	40159	Cell No. of the Max. Voltage		/	/	16-bit Unsigned	
0159	40160	Cell No. of the Min. Voltage		/	/	16-bit Unsigned	
0160	40161	Max. Cell Temp.	-400~1250	0.1	°C	16-bit Signed	
0161	40162	Min. Cell Temp.	-400~1250	0.1	°C	16-bit Signed	
0162	40163	Average Temp.	-400~1250	0.1	°C	16-bit Signed	
0163	40164	Cell Temp. Difference	-400~1250	0.1	°C	16-bit Unsigned	
0164	40165	Cell No. of the Max. Temp.		/	/	16-bit Unsigned	
0165	40166	Cell No. of the Min. Temp.		/	/	16-bit Unsigned	
0166-0181	40167-40182	Voltage of Cell 1-16	0~5000	1	mV	16-bit Unsigned	
0182	40183	Cell Temp. 1	-400~1250	0.1	°C	16-bit Signed	
0183	40184	Cell Temp. 2	-400~1250	0.1	°C	16-bit Signed	
0184	40185	Cell Temp. 3	-400~1250	0.1	°C	16-bit Signed	
0185	40186	Cell Temp. 4	-400~1250	0.1	°C	16-bit Signed	
0186	40187	MOS Temp.	-400~1250	0.1	°C	16-bit Signed	
0187	40188	Ambient Temp.	-400~1250	0.1	°C	16-bit Signed	
0188	40189	Reserved					
0189	40190						
0190	40191	Reserved					
0191	40192						
0192	40193	Reserved					

Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0193	40194						
0194	40195	Reserved					
0195	40196						
0196	40197	Reserved					
0197	40198						
0198	40199	Reserved					
0199	40200						
0200	40201	Reserved					
0201	40202	Reserved					
0202	40203	Reserved					
0203	40204	Reserved					
0204	40205	Reserved					
0205	40206	Controller Software Version	0~65535	/	/	16-bit Unsigned	
0206	40207	Controller Hardware Version	0~65535	/	/	16-bit Unsigned	
0207	40208	Release Year	0~65535	/	/	16-bit Unsigned	Save the last two digits of the Year only.
0208	40209	Release Month	0~65535	/	/	16-bit Unsigned	
0209	40210	Released Day	0~65535	/	/	16-bit Unsigned	
0210	40211	Real-time Clock - Year	0~65535	/	/	16-bit Unsigned	Save the last two digits of the Year only.
0211	40212	Real-time Clock - Month	0~65535	/	/	16-bit Unsigned	
0212	40213	Real-time Clock - Day	0~65535	/	/	16-bit Unsigned	
0213	40214	Real-time Clock - Week	0~65535	/	/	16-bit Unsigned	
0214	40215	Real-time Clock - Hour	0~65535	/	/	16-bit Unsigned	
0215	40216	Real-time Clock - Minute	0~65535	/	/	16-bit Unsigned	
0216	40217	Real-time Clock - Second	0~65535	/	/	16-bit Unsigned	
0217	40218	Reserved					
0218	40219	Reserved					
0219	40220	Reserved					

Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0220	40221	Reserved					

Note 1: Actual value = data received * ratio. Take the Voltage as the example: if the data received is 5256 (1488H), ratio is 0.01V, then the actual voltage value is 52.56V (5256*0.01V).

Example:

If "Module Total Voltage" need to be read, check the table above and find its address is 0131.

Assuming the slave address is 01, the master request command is as following:

Table 4 Master Request Command

Slave Address	Function Code	Start Address(0)		Request Data Length(2)		CRC 16	
		MSB	LSB	MSB	LSB	LSB	MSB
01	03	00	83	00	01	75	E2

The slave response command is as following:

Table 5 Slave Response Command

Slave Address	Function Code	Data Length (Bytes)	Data		CRC 16	
			Data of Address 0000 MSB	Data of Address 0000 LSB	LSB	MSB
01	03	02	14	88	B7	22

Fill the data received into the address respectively, as shown in the table below.

Table 6 Data Analysis

Item	Address	Data Received (Hex)
Module Total Voltage	0083H	1488H

4 FAQ

4.1 GROUNDING OF THE CABLE SHIELD

To prevent the coupling of interference on the cable, one end of the cable shield should be grounded.

4.2 TERMINATION RESISTOR

At both ends of the linear network (between the two communication ports furthest apart), two 120-ohm termination resistors need to be installed in parallel. According to the signal transmission theory, the termination resistor can avoid the signal reflections and improve the signal integrity effectively. The value of two termination resistor in parallel is basically equal to the characteristic impedance of the transmission cable.

A standard RS-485 network will usually use the termination resistor. The resistor can be avoided while the cable is too short, or it is a temporary or lab test.

4.3 RS485 TO USB CONVERTER

It can communicate with PC via the SmartGen SG72A converter.

4.4 EXTEND TRANSMISSION DISTANCE

Adding two SmartGen SGCAN300 repeaters can extend the communication distance to at most 10 kilometers.
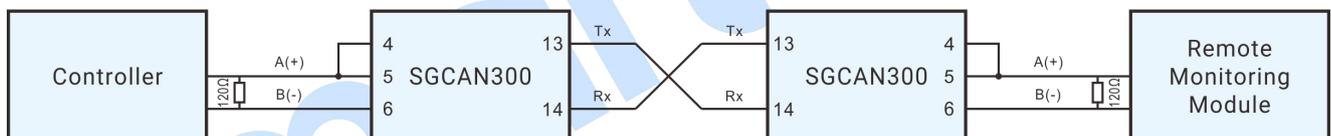

Figure 2 SGCAN300 Application Diagram

4.5 SOLUTIONS FOR COMMUNICATION FAILURE

1) Check whether the positive and negative of RS485 is connected correctly;
2) Check whether the communication parameters setting is correct;
3) Check the RS485 converter (if any) is normal;
4) Check whether the termination resistors are connected correctly;
5) Disconnect the RS485 cables to the controller, test the voltage difference of RS485 Terminal A and B on the controller, if the result is between -200mV and +200mV, it means the communication port is abnormal;
6) It is recommended to download third-party communication test software to verify whether the communication is normal, such as Modscan32, Modbus Poll, etc.

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