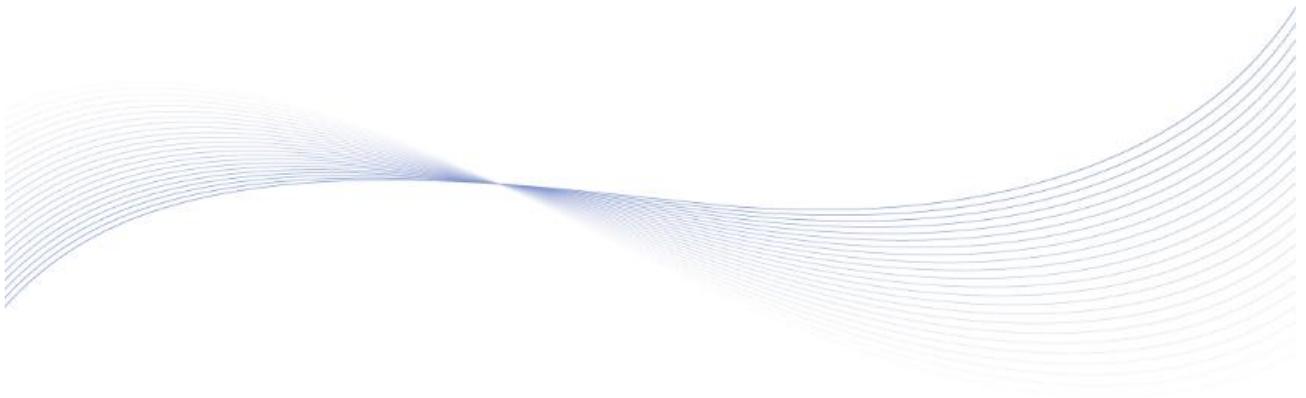

SmartGen

MAKING CONTROL SMARTER

HGM4000N
GENSET CONTROLLER
COMMUNICATION PROTOCOL



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Table 1 Software Version

Date	Version	Content
2017-07-04	1.0	Original release.
2021-05-25	1.1	1. Modify the data frame format: Stop bit: 1-bit; 2. Modify it with the latest template.
2023-04-20	1.2	Modify it with the latest template.

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1. DESCRIPTION

This protocol describes read and write command format of RS485 half-duplex serial port communication and 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, Synall) basing on PC (or IPC).

The controller has 1 RS485 port, which can be used as the slave, using Modbus-RTU protocol, and does not support other protocols such as Modbus-ASCII.

Modbus basic rules:

- All RS485 communication loops should follow the master-slave mode. If so, data can be transferred between a master (e.g. PC) and 32 slaves;
- The master will initialize all the information transmitted by the device on the communication loop;
- No communication can start from slaves;
- In communication loop, all communication should be transmitted in the way of "information frame";
- If the master and slaves receive information frame with unknown command, they shall not respond.

Data format:

Communication address: 1~254 (default: 1)

Baud rate: 9600bps

Start bit: 1-bit

Data bit: 8-bit

Parity bit: None, odd parity, even parity (default: none)

Stop bit: 1-bit

Supported function code: 01H, 03H, 05H. Function code 01H is used for reading single or multiple coils; 03H is used for reading controller alarm, status information and various power data; 05H is used for saving single coil data to the bit memory inside the device.

Data calibration method: CRC16.

When communication command is sent to the instrument, the instrument with corresponding address code shall receive it, and then remove the address code, read the information. If nothing goes wrong, it shall execute the command, and send the result back to the sender. The backward information includes address code, function code for action execution, data after the action execution and error check code (CRC). If an error occurs, no information is sent.

Internal registers of controller are in the unit of "byte (double bytes)".

Communication timeout period: over 200ms.

Communication distance: 9600 baud rate, the longest distance can reach 1,000m when using 120Ω shielding twisted pair line.

Once maximum 120 data of byte register can be read.

Up to 32 controllers can be deployed for network communication.

When RS485 is connected, 120Ω twisted pair line with shielding layer shall be used, and the shielding layer shall be grounded at one end.

2. WIRING DIAGRAM

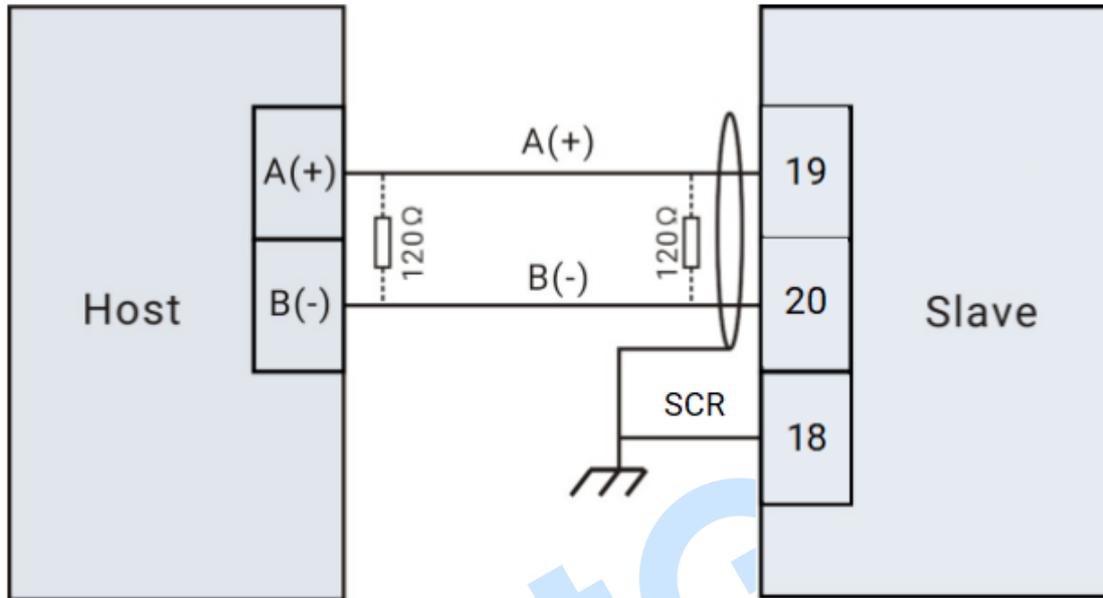


Fig.1 Single Unit Communication Wiring Diagram

NOTE1: 2 120Ω impedance resistors can be connected automatically according to site situation, details refer to the following description.

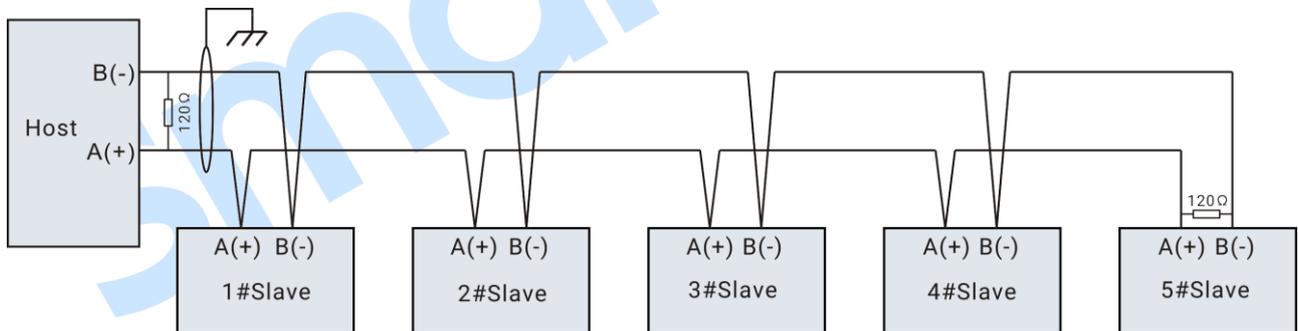


Fig.2 Multi-unit Communication Wiring Diagram

NOTE1: Please set each controller's communication module address before networking. Same module address is inhibited in the same network.

NOTE2: The shielding layer of communication line is single-end grounded on the host side.

3. CONTROLLER INTERNAL REGISTER ADDRESS AND DATA

3.1 FUNCTION CODE 01H MAPPLING COIL FIELD

Table 2 Alarm, Status Coil Data Field

Modbus Address	PLC Address	Item	Description
0000	0001	Common Alarm	0 represents there is no common alarm; 1 represents there is common alarm, and so on.
0001	0002	Common Warning Alarm	1 for active
0002	0003	Common Shutdown Alarm	1 for active
0003	0004	Remote Mode	1 for active
0004	0005	Reserved	1 for active
0005	0006	Reserved	1 for active
0006	0007	Mains On-load	1 for active
0007	0008	Gen On-load	1 for active
0008	0009	Emergency Stop	1 for active
0009	0010	Overspeed Alarm Shutdown	1 for active
0010	0011	Underspeed Alarm Shutdown	1 for active
0011	0012	Speed Signal Loss Shutdown	1 for active
0012	0013	Overfrequency Alarm Shutdown	1 for active
0013	0014	Underfrequency Alarm Shutdown	1 for active
0014	0015	Overvoltage Alarm Shutdown	1 for active
0015	0016	Undervoltage Alarm Shutdown	1 for active
0016	0017	Gen Overcurrent Shutdown	1 for active
0017	0018	Crank Failure	1 for active
0018	0019	High Water Temp. Alarm Shutdown	1 for active
0019	0020	Low Oil Pressure Alarm Shutdown	1 for active
0020	0021	Frequency Loss Alarm	1 for active
0021	0022	Input Shutdown Alarm	1 for active
0022	0023	Low Fuel Level Shutdown Alarm	1 for active
0023	0024	Low Coolant Level Shutdown Alarm	1 for active
0024	0025	High Water Temp. Warning Alarm	1 for active
0025	0026	Low Oil Pressure Warning Alarm	1 for active
0026	0027	Gen Overcurrent Warning Alarm	1 for active
0027	0028	Stop Failure Warning Alarm	1 for active
0028	0029	Low Fuel Level Warning	1 for active
0029	0030	Charging Failure Warning	1 for active
0030	0031	Battery Undervoltage Warning Alarm	1 for active
0031	0032	Battery Overvoltage Warning Alarm	1 for active
0032	0033	Input Warning Alarm	1 for active
0033	0034	Speed Signal Loss Warning	1 for active
0034	0035	Low Coolant Level Warning	1 for active
0035	0036	Temp. Sensor Open Warning	1 for active

Modbus Address	PLC Address	Item	Description
0036	0037	Oil Pressure Sensor Open Warning	1 for active
0037	0038	Fuel Level Sensor Open Warning	1 for active
0038	0039	Aux. Sensor Open Warning	1 for active
0039	0040	Aux. Sensor Warning	1 for active
0040	0041	Test Mode	1 for active
0041	0042	Auto Mode	1 for active
0042	0043	Manual Mode	1 for active
0043	0044	Stop Mode	1 for active
0044	0045	Temp. Sensor Open Shutdown	1 for active
0045	0046	Oil Pressure Sensor Open Shutdown	1 for active
0046	0047	Fuel Level Sensor Open Shutdown	1 for active
0047	0048	Aux. Sensor Open Shutdown	1 for active
0048	0049	Emergency Stop Input	1 for active
0049	0050	Aux. Input 1	1 for active
0050	0051	Aux. Input 2	1 for active
0051	0052	Aux. Input 3	1 for active
0052	0053	Aux. Input 4	1 for active
0053	0054	Aux. Input 5	1 for active
0054	0055	Reserved	1 for active
0055	0056	Reserved	1 for active
0056	0057	Crank Relay Output	1 for active
0057	0058	Fuel Relay Output	1 for active
0058	0059	Aux. Output 1	1 for active
0059	0060	Aux. Output 2	1 for active
0060	0061	Aux. Output 3	1 for active
0061	0062	Aux. Output 4	1 for active
0062	0063	Aux. Output 5	1 for active
0063	0064	Maintenance Time Due Warning	1 for active
0064	0065	Mains Fault	1 for active
0065	0066	Mains Normal	1 for active
0066	0067	Mains Overvoltage	1 for active
0067	0068	Mains Undervoltage	1 for active
0068	0069	Mains Loss Phase	1 for active
0069	0070	Mains Blackout	1 for active
0070	0071	Charger Fail to Charge Warning	1 for active
0071	0072	Overpower Warning	1 for active
0072	0073	Gen Normal	1 for active
0073	0074	Gen Overvoltage Warning	1 for active
0074	0075	Gen Undervoltage Warning	1 for active
0075	0076	Gen Overfrequency Warning	1 for active
0076	0077	Gen Underfrequency Warning	1 for active
0077	0078	Gen Overcurrent Warning	1 for active
0078	0079	Scheduled Not Run	1 for active

Modbus Address	PLC Address	Item	Description
0079	0080	ECU Warning	1 for active
0080	0081	Aux. Sensor Shutdown	1 for active
0081	0082	Maintenance Time Due Shutdown Alarm	1 for active
0082	0083	Overpower Shutdown Alarm	1 for active
0083	0084	ECU Alarm Shutdown	1 for active
0084	0085	ECU Failure Shutdown	1 for active
0085	0086	Reserved	
0086	0087	Reserved	
0087	0088	Reserved	
0088	0089	Reserved	
0089	0090	Reserved	
0090	0091	Reserved	
0091	0092	Reserved	
0092	0093	Reserved	
0093	0094	Reserved	
0094	0095	Reserved	
0095	0096	Reserved	

Example:

Read 1CH (decimal 28) coils of starting address 0000H.

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

Table 3 Master Request Command

Slave Address	Function Code	Starting Address (0000)		Request Data Qty. (28)		CRC 16 Calibration	
		MSB	LSB	MSB	LSB	LSB	MSB
01	01	00	00	00	1C	3D	C3

The slave response command is as following:

Table 4 Slave Response Command

Slave Address	Function Code	Data Qty. (Bytes)	Data				CRC 16 Calibration	
			Content of Address 07-00	Content of Address 0F-08	Content of Address 17-10	Content of Address 1C-18	LSB	MSB
01	01	04	30	00	93	0A	18	26

Coil 07-00 expressed as 30H of hex and 00110000 of binary, coil 07 is high bit and 00 is low bit.

Coil 07-00 status is: OFF-OFF-ON-ON-OFF-OFF-OFF-OFF.

3.2 FUNCTION CODE 03H MAPPING DATA FIELD

Table 5 Value Data Field

Modbus Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0000	40001	Mains UA	0~65535	1	V	Unsigned	2Bytes
0001	40002	Mains UB	0~65535	1	V	Unsigned	2Bytes
0002	40003	Mains UC	0~65535	1	V	Unsigned	2Bytes
0003	40004	Mains UAB	0~65535	1	V	Unsigned	2Bytes
0004	40005	Mains UBC	0~65535	1	V	Unsigned	2Bytes
0005	40006	Mains UCA	0~65535	1	V	Unsigned	2Bytes
0006	40007	Mains Freq.	0~100.0	0.1	Hz	Unsigned	2Bytes
0007	40008	Gen UA	0~65535	1	V	Unsigned	2Bytes
0008	40009	Gen UB	0~65535	1	V	Unsigned	2Bytes
0009	40010	Gen UC	0~65535	1	V	Unsigned	2Bytes
0010	40011	Gen UAB	0~65535	1	V	Unsigned	2Bytes
0011	40012	Gen UBC	0~65535	1	V	Unsigned	2Bytes
0012	40013	Gen UCA	0~65535	1	V	Unsigned	2Bytes
0013	40014	Gen Freq.	0~100.0	0.1	Hz	Unsigned	2Bytes
0014	40015	A Phase Current	0~65535	0.1	A	Unsigned	2Bytes
0015	40016	B Phase Current	0~65535	0.1	A	Unsigned	2Bytes
0016	40017	C Phase Current	0~65535	0.1	A	Unsigned	2Bytes
0017	40018	Water Temp. Value	0~65535	1	°C	Unsigned	2Bytes NOTE 1
0018	40019	Water Temp. Resist. Value	0~65535	0.1	Ω	Unsigned	2Bytes
0019	40020	OP Value	0~65535			Unsigned	2Bytes NOTE 1
0020	40021	OP Resist. Value	0~65535	0.1	Ω	Unsigned	2Bytes
0021	40022	Level Value	0~65535			Unsigned	2Bytes NOTE 1
0022	40023	Level Resist. Value	0~65535	0.1	Ω	Unsigned	2Bytes
0023	40024	Speed	0~65535	1	RPM	Unsigned	2Bytes
0024	40025	Battery Voltage	0~65535	0.1	V	Unsigned	2Bytes
0025	40026	D+ Voltage	0~65535	0.1	V	Unsigned	2Bytes
0026	40027	Active Power	0~65535	0.1	kW	Unsigned	2Bytes
0027	40028	Reactive Power	0~65535	0.1	kvar	Unsigned	2Bytes
0028	40029	Apparent	0~65535	0.1	kVA	Unsigned	2Bytes

Modbus Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
		Power					
0029	40030	Power Factor		0.01	CosΦ	Unsigned	2Bytes
0030	40031	Aux. Sensor Value				Unsigned	2Bytes NOTE 1
0031	40032	Aux. Sensor Resist. Value			Ω	Unsigned	2Bytes
0032	40033	Maintenance Countdown h	0~5000	1	h	Unsigned	2Bytes
0033	40034	Maintenance Countdown min	0~59	1	min	Unsigned	2Bytes
0034	40035	Controller Running Table: Controller Running Status				Unsigned	2Bytes
0035	40036	Delay	0~3600	1	s	Unsigned	2Bytes
0036	40037	Auto Running Status 0 Start 1 Stop 2 No Delay				Unsigned	2Bytes
0037	40038	Delay				Unsigned	2Bytes
0038	40039	ATS Running Status 0 No Delay 1 Transfer Rest				Unsigned	2Bytes
0039	40040	Delay				Unsigned	2Bytes
0040	40041	Mains Status 0 Normal 1 Abnormal 2 No Delay				Unsigned	2Bytes
0041	40042	Delay	0~3600	1	s	Unsigned	2Bytes
0042	40043	Accum. Oil Engine Running Time (h) MSB	0~9000	1	h	Unsigned	2Bytes
0043	40044	Accum. Oil Engine Running	0~9999	1	h	Unsigned	2Bytes

Modbus Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark	
		Time (h) LSB						
0044	40045	Accum. Oil Engine Running Time (min)	0~59	1	min	Unsigned	2Bytes	
0045	40046	Accum. Oil Engine Running Time (s)	0~59	1	s	Unsigned	2Bytes	
0046	40047	Accum. Start Times MSB	0~9000	1	time	Unsigned	2Bytes	
0047	40048	Accum. Start Times LSB	0~9999	1	time	Unsigned	2Bytes	
0048	40049	Accum. Energy MSB	0~9000	1	kWh	Unsigned	2Bytes	
0049	40050	Accum. Energy LSB	0~9999	1	kWh	Unsigned	2Bytes	
0050	40051	SW				Unsigned	2Bytes	
0051	40052	HW				Signed	2Bytes	
0052	40053	A Phase Active Power	0~65535	0.1	kW	Unsigned	2Bytes	
0053	40054	B Phase Active Power	0~65535	0.1	kW	Unsigned	2Bytes	
0054	40055	C Phase Active Power	0~65535	0.1	kW	Unsigned	2Bytes	
0055	40056	Load Output Percentage	-100~100	1	%	Unsigned	2Bytes	
0056	40057	Reserved						
0057	40058	Reserved						
0058	40059	Coolant Level			%	Unsigned	2Bytes	NOTE 1
0059	40060	Oil Temp.	0~65535	1	°C	Unsigned	2Bytes	
0060	40061	Coolant Pressure	0~65535	1	kPa	Unsigned	2Bytes	
0061	40062	Fuel Pressure	0~65535	1	kPa	Unsigned	2Bytes	
0062	40063	Fuel Temp.	0~65535	1	°C	Unsigned	2Bytes	
0063	40064	Inlet Temp.	0~65535	1	°C	Unsigned	2Bytes	
0064	40065	Exhaust Temp.	0~65535	1	°C	Unsigned	2Bytes	
0065	40066	Turbo Pressure	0~65535	1	kPa	Unsigned	2Bytes	
0066	40067	Fuel	0~65535	0.1	L	Unsigned	2Bytes	

Modbus Address	PLC Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark	
		Consump.						
0067	40068	Reserved						
0068	40069	Accum. Fuel Consump.	0~4294967295	0.1	L	Unsigned	4Bytes	NOTE
0069	40070							1
0070	40071	SCM Internal Temp.	0~65535	0.1	°C	Unsigned		
0071	40072	Controller Model				Unsigned		
0072	40073	Controller Time: Year	0~99	1	year	Unsigned	2Bytes	
0073	40074	Controller Time: Month	1~12	1	month	Unsigned	2Bytes	
0074	40075	Controller Time: Day	1~31	1	day	Unsigned	2Bytes	
0075	40076	Controller Time: Week	0~6	1	week	Unsigned	2Bytes	
0076	40077	Controller Time: h	0~23	1	h	Unsigned	2Bytes	
0077	40078	Controller Time: min	0~59	1	min	Unsigned	2Bytes	
0078	40079	Controller Time: s	0~59	1	s	Unsigned	2Bytes	
0079	40080	Release Year	0~99	1	year	Unsigned	2Bytes	
0080	40081	Release Month	1~12	1	month	Unsigned	2Bytes	
0081	40082	Release Day	1~31	1	day	Unsigned	2Bytes	
0082	40083	Reserved						
0083	40084	Reserved						
0084	40085	Reserved						
0085	40086	Reserved						
0086	40087	Reserved						

NOTE1: When controller detects sensor is open, data will be 32766, “+++” will be displayed; if ECU doesn’t receive sensor information, data will be 32767, “####” will be displayed; the unit of aux. sensor is defined by corresponding sensor type;

NOTE2: Actual value=received data*ratio. Take the frequency as the example, if the received data is 5000 (1388H), ratio is 0.01Hz, then the actual frequency value is 50.00Hz (5000*0.01Hz);

NOTE2: Definition of signed number. Take received data 8000H as the example, transfer it to binary 1000 0000 0000 0000b, the MSB is 1, which is a negative number. One’s complement is obtained by subtracting 1 from it, which is inverted to obtain the absolute value of the negative number. Then transfer it to -32768 in decimal.

Example:

Read “Accum. Fuel Consump. (current is 123456)”, firstly get its address is 0068 and 0069 by checking the table, then it is known that you need to read 2 bytes’ data.

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

Table 6 Master Request Command

Slave Address	Function Code	Starting Address (0068)		Request Data Qty. (2)		CRC 16 Calibration	
		MSB	LSB	MSB	LSB	LSB	MSB
01	03	00	44	00	02	84	1E

The slave response command is as following:

Table 7 Slave Response Command

Slave Address	Function Code	Data Qty. (Bytes)	Data				CRC 16 Calibration	
			Data MSB of Address 0068	Data LSB of Address 0068	Data MSB of Address 0069	Data LSB of Address 0069	LSB	MSB
01	03	04	E2	40	00	01	0C	5F

Fill the received data into the corresponding address, as shown in the table below:

Table 8 Data Analysis

Address	Received Data (Hex)	After Combination (Hex)	Accum. Fuel Consump. (Decimal)
0103	E240H	0001E240H	123456
0104	0001H		

3.3 FUNCTION CODE 05H MAPPING COIL FIELD

Table 9 Remote Coil Field

Modbus Address	PLC Address	Item	Description
0000	0001	Remote Oil Engine in Start Status	1 for active (e.g. 0xFF00 for active)
0001	0002	Remote Oil Engine in Stop Status	1 for active (e.g. 0xFF00 for active)
0002	0003	Remote Oil Engine in Test Status	1 for active (e.g. 0xFF00 for active)
0003	0004	Remote Oil Engine in Auto Status	1 for active (e.g. 0xFF00 for active)
0004	0005	Remote Oil Engine in Manual Status	1 for active (e.g. 0xFF00 for active)
0005	0006	Remote Gen Close/Open Key (HGM4020N) Remote Gen Open Key (HGM4010N)	1 for active (e.g. 0xFF00 for active)
0006	0007	Remote Mains Close/Open Key (HGM4020N) Remote Gen Close Key (HGM4010N)	1 for active (e.g. 0xFF00 for active)

NOTE: The above remote command only can be sent once only.

Example:

Remote control controller to work in manual mode, firstly get its remote address is 0004.

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

Table 10 Master Request Command

Slave Address	Function Code	Remote Address (0004)		Remote Data		CRC 16 Calibration	
		MSB	LSB	MSB	LSB	LSB	MSB
01	05	00	04	FF	00	CD	FB

The slave response command is as following:

Table 11 Slave Response Command

Slave Address	Function Code	Remote Address (0004)		Remote Data		CRC 16 Calibration	
		MSB	LSB	MSB	LSB	LSB	MSB
01	05	00	04	FF	00	CD	FB

3.4 CONTROLLER RUNNING STATUS

Table 12 Controller Running Status

No.	Item & Description
0	Standby
1	Preheat
2	Fuel
3	Crank
4	Crank Rest
5	Safety Run
6	Start Idle
7	High Speed Warming Up
8	On-load
9	Normal Running
10	High Speed Cooling
11	Stop Idle
12	ETS
13	Wait for Stop
14	Stop Failure

4. COMMUNICATION PARAMETER VIEWING AND CONFIGURATION

- 1) In the homepage of main interface, press  key to enter menu interface;
- 2) Press Down key to select "Parameter Setting", then press  key to enter parameter password interface;
- 3) Input correct password (default 0318), press  key to enter the main interface of parameter;
- 4) Select "Controller Address" via  ,  key, Press  key to enter parameter edit function, corresponding parameters will be in the selected status;
- 5) Set the current selected content via  ,  key, then press  key to confirm, after editing, then the selected status will disappear;
- 6) Long press STOP key to return the main interface.

NOTE: After parameter setting is completed, the configuration takes effect.

5. FAQ

5.1 COMMUNICATION LINE SHIELDING LAYER GROUNDED

In order to prevent coupled interference signal on communication line, its single end needs to be grounded.

5.2 TERMINAL RESISTOR

At both ends of the linear network (on the two communication ports furthest apart), it is necessary to connect 120Ω terminal resistor in parallel on a pair of communication lines. According to the transmission line theory, the terminal resistor can absorb reflected waves on the network, effectively enhancing the signal strength. The value of two terminal resistors in parallel should be approximately equal to the characteristic impedance of the transmission line at the communication frequency.

A regular RS485 network usually uses terminal resistor. It can also be not used in the case of network connection line is very short, temporary or laboratory test.

5.3 RS485 TO USB COMMUNICATION ADAPTOR

PC can communicate with SG72A module produced by our company.

5.4 EXTENDED COMMUNICATION DISTANCE

Long distance (up to 10km) communication can be realized by a pair of SGCAN300 fiber optical relay modules.

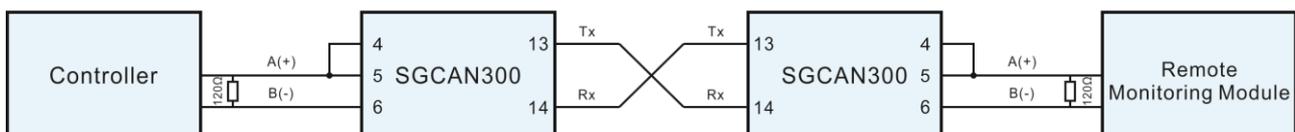


Fig.3 SGCAN300 Application Diagram

5.5 COMMON SOLUTIONS OF COMMUNICATION FAILURE

- 1) Check whether the positive and negative of RS485 is correctly connected;
- 2) Check whether the communication parameter in parameter setting is correct;
- 3) Check whether the RS485 converter (if configured) is normal;
- 4) Check whether the terminal resistor is correctly connected;
- 5) Disconnect the connection line of controller's RS485, measure the voltage difference of RS485's A and B terminal. If the difference is between $\pm 200\text{mV}$, it means communication port has abnormal situation;
- 6) It is recommended to download third-party communication software such as modscan32, modbus poll to check whether communication is normal.

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