HSC941
GENSET CONTROLLER
COMMUNICATION PROTOCOL

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Table 1 Software Version

Date	Version	Content
2024-1-20	V1.0	Original release.

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CONTENT

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1. DESCRIPTION

This protocol describes the controller serial ports' read and write command format, 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, and DCS of international brands (such as Schneider, Siemens, and Modicon), or the third-party supervisory control system compatible with MODBUS. The system can be set up by installing the central communication master control software (such as KingView, Intouch, FIX, Synall, etc.) on PC (or IPC).

MODBUS BASIC RULES:
——All communication transmission should follow the master-slave mode. Data can be transmitted between a master (e.g. PC) and 32 slaves by this mode.
——No communication can be sent from slave.
——All communication should be transmitted in "frame".
——If master or slave receives frame which contains unknown command, no response will be sent.

FRAME FORMAT:

Communication transmission is in asynchronously way, which uses byte (or frame) as data unit. Every frame will be 11-bit (1 stop bit) or 11-bit (2 stop bits) serial data when it is transmitted between master and slave.

Table 2 Frame Format

Item	Bits
Start	1 bit
Data	8 bits
Parity	None
Stop	1 bit
Transmission baudrate	9600bps

Error Check Code:

The Error Check Code allows the master or slave to detect if the packet has errors. Sometimes, the information occurs imperceptible changes due to electronic noise and other interference when transmitted, and the error check code ensures the error information does not work to increase the system's reliability and efficiency. Error check code adapts CRC-16 method.

The CRC code is formed with 2 bytes, and the LSB is followed by the MSB.

Note: All frame format is same: address code, function code, data field and CRC code.

The CRC code contains two bytes, which is a 16-bit binary value. The CRC code is calculated by the transmitting terminal, and follows the data/message. The receiving device recalculates a CRC code during receipt of the message, and compares it to the actual value that received in the CRC field. If the two values are not equal, an error occurs.

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 1, the register is then exclusive OR with a preset, fixed value. If the LSB was 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.

CRC-16 CALCULATION PROCEDURE:

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 LSB 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).
   If the LSB was 1: Exclusive OR the CRC register with the hexadecimal A001.
5) Repeat Step 3 and Step 4 until 8 shifts have been performed. When this is done, a complete 8–bit byte has been processed.
6) Repeat Step 2 to Step 5 for the next 8–bit byte of the message. Continue repeating this procedure until all bytes have been processed.
7) The final contents of the CRC register are the CRC value. When the 16–bit CRC (two 8–bit bytes) is transmitted in the message, the LSB will be transmitted first, followed by the MSB.

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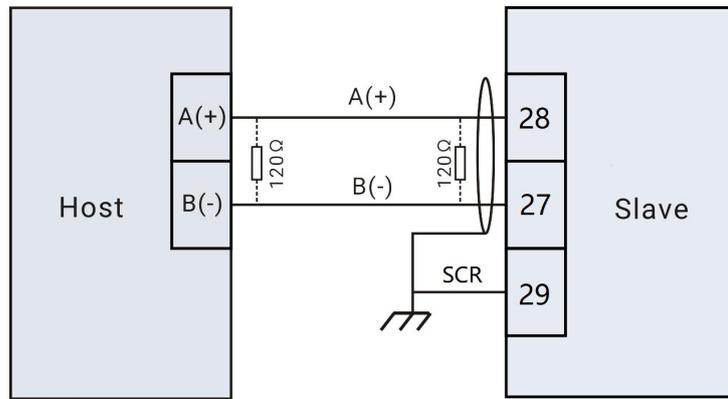
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2. WIRING DIAGRAM

Figure 1 Single Unit Communication Wiring Diagram

Note: Two 120-ohm resistors can be put in the line according to the site's requirement.

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3. CONTROLLER INTERNAL REGISTER ADDRESS AND DATA

3.1 FUNCTION CODE 01H MAPPING ALARM AND STATUS OF READ COILS

Table 3 Alarm and Status of Read Coils

Address	Item	Description	Bytes
0000	Common Alarm	1 as active	1 bit
0001	Common Warning	1 as active	1 bit
0002	Common Shutdown	1 as active	1 bit
0003	Reserved	1 as active	1 bit
0004	Reserved	1 as active	1 bit
0005	Reserved	1 as active	1 bit
0006	Reserved	1 as active	1 bit
0007	Gen. On-load	1 as active	1 bit
0008	Emergency Stop	1 as active	1 bit
0009	Overspeed Shutdown	1 as active	1 bit
0010	Underspeed Shutdown	1 as active	1 bit
0011	Loss of Speed Signal Shutdown	1 as active	1 bit
0012	Gen. Overfrequency Shutdown	1 as active	1 bit
0013	Gen. Underfrequency Shutdown	1 as active	1 bit
0014	Gen. Overvoltage Shutdown	1 as active	1 bit
0015	Gen. Undervoltage Shutdown	1 as active	1 bit
0016	Gen. Overcurrent Shutdown	1 as active	1 bit
0017	Crank Failure Shutdown	1 as active	1 bit
0018	High Temp. Shutdown(IN)	1 as active	1 bit
0019	Low OP Shutdown(IN)	1 as active	1 bit
0020	No Gen. Shutdown	1 as active	1 bit
0021	External Shutdown Input	1 as active	1 bit
0022	Low Fuel Level Shutdown(IN)	1 as active	1 bit
0023	Low Coolant Level Shutdown(IN)	1 as active	1 bit
0024	High Temp. Warning(IN)	1 as active	1 bit
0025	Low OP Warning(IN)	1 as active	1 bit
0026	Reserved	1 as active	1 bit
0027	Stop Failure Warning	1 as active	1 bit
0028	Low Fuel Level Warning(IN)	1 as active	1 bit
0029	Charging Failure Warning	1 as active	1 bit
0030	Battery Undervoltage Warning	1 as active	1 bit
0031	Battery Overvoltage Warning	1 as active	1 bit
0032	External Warning Input	1 as active	1 bit
0033	Loss of Speed Signal Warning	1 as active	1 bit
0034	Low Coolant Level Warning(IN)	1 as active	1 bit
0035	Temp. Sensor Open Warning	1 as active	1 bit

Address	Item	Description	Bytes
0036	OP Sensor Open Warning	1 as active	1 bit
0037	Aux. Sensor Open Warning	1 as active	1 bit
0038	Aux. Sensor Warning	1 as active	1 bit
0039	Reserved	1 as active	1 bit
0040	Aux. Sensor Shutdown	1 as active	1 bit
0041	In Auto Mode	1 as active	1 bit
0042	In Manual Mode	1 as active	1 bit
0043	In Stop Mode	1 as active	1 bit
0044	Temp. Sensor Open Shutdown	1 as active	1 bit
0045	OP Sensor Open Shutdown	1 as active	1 bit
0046	Low Engine Oil Level Shutdown(IN)	1 as active	1 bit
0047	Aux. Sensor Open Shutdown	1 as active	1 bit
0048	Emergency Stop Input	1 as active	1 bit
0049	Aux. Input 1	1 as active	1 bit
0050	Aux. Input 2	1 as active	1 bit
0051	Aux. Input 3	1 as active	1 bit
0052	Aux. Input 4	1 as active	1 bit
0053	Aux. Input 5	1 as active	1 bit
0054	Aux. Input 6	1 as active	1 bit
0055	Reserved	1 as active	1 bit
0056	Start Relay Output	1 as active	1 bit
0057	Fuel Relay Output	1 as active	1 bit
0058	Aux. Output 1	1 as active	1 bit
0059	Aux. Output 2	1 as active	1 bit
0060	Aux. Output 3	1 as active	1 bit
0061	Aux. Output 4	1 as active	1 bit
0062	Reserved	1 as active	1 bit
0063	Reserved	1 as active	1 bit
0064	High Temp. Shutdown	1 as active	1 bit
0065	Low OP Shutdown	1 as active	1 bit
0066	Reserved	1 as active	1 bit
0067	Reserved	1 as active	1 bit
0068	Reserved	1 as active	1 bit
0069	Reserved	1 as active	1 bit
0070	Reserved	1 as active	1 bit
0071	Reserved	1 as active	1 bit
0072	Reserved	1 as active	1 bit
0073	Reserved	1 as active	1 bit
0074	Reserved	1 as active	1 bit
0075	Reserved	1 as active	1 bit
0076	Reserved	1 as active	1 bit
0077	Reserved	1 as active	1 bit

Address	Item	Description	Bytes
0078	Reserved	1 as active	1 bit
0079	Reserved	1 as active	1 bit
0080	High Temp. Warning	1 as active	1 bit
0081	Low OP Warning	1 as active	1 bit
0082	Reserved	1 as active	1 bit
0083	Reserved	1 as active	1 bit
0084	Reserved	1 as active	1 bit
0085	Reserved	1 as active	1 bit
0086	Reserved	1 as active	1 bit
0087	Reserved	1 as active	1 bit

Example：

If "High Temp. Warning (IN)" need to be read, check the table above and find its coil address is 0024, so it needs to read one data address.

Assuming the slave address is 01, the master (could be PC) request command is as following:

Table 4 Master (PC) Request Frame

Slave Address	Function Code	Start Address(0024)		Request Data Length(1)		CRC 16	
		MSB	LSB	MSB	LSB	LSB	MSB
01	**01**	**00**	**18**	**00**	**01**	**7D**	**CD**

The slave response is as following:

Table 5 Slave (Controller) Response Frame

Slave Address	Function Code	Data Length (Bytes)	Data of Address 0024	CRC 16	
				LSB	MSB
01	**01**	**01**	**01**	**90**	**48**

Table 6 Data Analysis

Address	Data Received(Hex)	Convert to Binary	Meaning
0024	01H	0000 0001 (Mapping to 0031, 0030, ..., 0024 respectively)	The rightmost bit of the data is 1, which means there is high temperature warning from input port.

3.2 FUNCTION CODE 03H MAPPING DATA FIELD

Table 7 Data Field

Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0000	Reserved					
0001	Reserved					
0002	Reserved					

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Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0003	Reserved					
0004	Reserved					
0005	Reserved					
0006	Reserved					
0007	Gen. UA	0~65535	1	V	16-bit Unsigned	
0008	Gen. UB	0~65535	1	V	16-bit Unsigned	
0009	Gen. UC	0~65535	1	V	16-bit Unsigned	
0010	Gen. UAB	0~65535	1	V	16-bit Unsigned	
0011	Gen. UBC	0~65535	1	V	16-bit Unsigned	
0012	Gen. UCA	0~65535	1	V	16-bit Unsigned	
0013	Gen. Frequency	0~100.00	0.01	Hz	16-bit Unsigned	
0014	Phase A Current	0~65535	0.1	A	16-bit Unsigned	
0015	Phase B Current	0~65535	0.1	A	16-bit Unsigned	
0016	Phase C Current	0~65535	0.1	A	16-bit Unsigned	
0017	Water Temp. Value		1	°C	16-bit Unsigned	
0018	Water Temp. Resistance Value		0.1	Ω		
0019	Oil Pressure Value		1	kPa	16-bit Unsigned	
0020	OP Resistance Value		0.1	Ω		
0021	Aux. Sensor 1		1	°C / kPa /%	16-bit Unsigned	
0022	Aux. Sensor 1 Resistance		0.1	Ω		
0023	Speed		1	r/min	16-bit Unsigned	
0024	Battery Voltage	0~65535	0.1	V	16-bit Unsigned	
0025	D+ Voltage	0~65535	0.1	V	16-bit Unsigned	
0026	Controller Date: Year	0~99	1	Year	16-bit Unsigned	

Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0027	Controller Date: Month	1~12	1	Month	16-bit Unsigned	
0028	Controller Date: Day	1~31	1	Day	16-bit Unsigned	
0029	Controller Date: Week	0~6	/		16-bit Unsigned	0: Sunday 1~6: Monday to Saturday
0030	Controller Time: Hour	0~23	1	Hour	16-bit Unsigned	
0031	Controller Time: Minute	0~59	1	Minute	16-bit Unsigned	
0032	Controller Time: Second	0~59	1	Second	16-bit Unsigned	
0033	Reserved					
0034	Engine Running Status	0~14	No.		16-bit Unsigned	See detail in Table 14
0035	Delay	0~65535	1	s	16-bit Unsigned	
0036	Auto Running Status: 0 Start 1 Stop 2 No Delay		No.		16-bit Unsigned	
0037	Delay	0~65535	1	s	16-bit Unsigned	
0038	Reserved					
0039	Reserved					
0040	Reserved					
0041	Reserved					
0042	Engine Accumulated Running Time (h) MSB	0~99	1	Hour	16-bit Unsigned	
0043	Engine Accumulated Running Time (h) LSB	0~9999	1	Hour	16-bit Unsigned	
0044	Engine Accumulated Running Time (min)	0~59	1	Minute	16-bit Unsigned	
0045	Engine Accumulated Running Time (sec)	0~59	1	Second	16-bit Unsigned	

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Address	Item	Range (Decimal)	Ratio	Unit	Description	Remark
0046	Accumulated Start Times MSB	0~99	1	Time	16-bit Unsigned	
0047	Accumulated Start Times LSB	0~9999	1	Time	16-bit Unsigned	
0048	Accumulated Electric Energy MSB	0~9999	1	kWh	16-bit Unsigned	
0049	Accumulated Electric Energy LSB	0~9999	1	kWh	16-bit Unsigned	
0050	Software Version				16-bit Unsigned	
0051	Hardware Version				16-bit Unsigned	
0052	Phase A Angle	0~359	1	°	16-bit Signed	
0053	Phase B Angle	0~359	1	°	16-bit Signed	
0054	Phase C Angle	0~359	1	°	16-bit Signed	
0055	Phase A Active Power	-32768~32767	0.1	kW	16-bit Signed	
0056	Phase B Active Power	-32768~32767	0.1	kW	16-bit Signed	
0057	Phase C Active Power	-32768~32767	0.1	kW	16-bit Signed	
0058	Active Power	-32768~32767	0.1	kW	16-bit Signed	
0059	Reactive Power	-32768~32767	0.1	kW	16-bit Signed	
0060	Apparent Power	-32768~32767	0.1	kW	16-bit Signed	
0061	Power Factor	0~1	0.1		16-bit Unsigned	
0062	Output Load Percentage	0~100	1	%	16-bit Unsigned	
0063	Release Year	0~99	1	Year	16-bit Unsigned	
0064	Release Month	1~12	1	Month	16-bit Unsigned	
0065	Released Day	1~31	1	Day	16-bit Unsigned	

Note 1: 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);

Note 2: For 4 bytes data, the actual value = received data MSB * 65536 + received data LSB.

Note 3: If received data is 32766, it means no normal data, and "###" will be shown.

Note 4: Definition of signed number: Take the received data "8000H" as the example, convert it to binary number "1000 0000 0000 0000b". The MSB is 1, which means it is negative. The number minus 1 will get its 1's complement, then inverting it will get the absolute value of the negative number. Finally convert the absolute value to demical number of -32768.

Example:

If "Accumulated Electric Energy" (current value is 123456 kWh) need to be read, check the table above and find its coil address is 0048 and 0049, so it needs to read two data addresses.

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

Table 8 Master Request Frame

Slave Address	Function Code	Start Address(0048)		Request Data Length(2)		CRC 16	
		MSB	LSB	MSB	LSB	LSB	MSB
01	**03**	**00**	**30**	**00**	**02**	**C4**	**04**

The slave response is as following:

Table 9 Slave Response Frame

Slave Address	Function Code	Data Length (Bytes)	Data				CRC 16	
			Data of Address 0048 MSB	Data of Address 0048 LSB	Data of Address 0049 MSB	Data of Address 0049 LSB	LSB	MSB
01	**03**	**04**	**E2**	**40**	**00**	**01**	**0C**	**5F**

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

Table 10 Data Analysis

Address	Data Received(Hex)	Data Combined(Hex)	Accumulated Electric Energy(Decimal)
0048	E240H	0001E240H	123456
0049	0001H		

3.3 FUNCTION CODE 05H MAPPING REMOTE COIL FIELD

Table 11 Remote Coil Field

Address	Item	Description
0000	Engine in Start Status	Active only when sending FFFFH
0001	Engine in Stop Status	Active only when sending FFFFH
0002	Reserved	Active only when sending FFFFH
0003	Engine in Auto Status	Active only when sending FFFFH
0004	Engine in Manual Status	Active only when sending FFFFH
0005	Engine Gen. Switch off	Active only when sending FFFFH
0006	Engine Gen. Switch on	Active only when sending FFFFH

Note 1: The remote command in the table above only need to be sent once.

Note 2: When using Modbus address to communicate: it needs to send FFFFH to load corresponding address as 1, and send 0000H to load corresponding address as 0.

Example:

If remote controller is in auto mode, check the table first and find its address is 0003. Assuming the slave address is 01, the master request command is as following:

Table 12 Master Request Frame

Slave Address	Function Code	Remote Address(0003)		Remote Data		CRC 16	
		MSB	LSB	MSB	LSB	LSB	MSB
01	**05**	**00**	**03**	**FF**	**FF**	**7C**	**3A**

The slave response is as following:

Table 13 Slave Response Frame

Slave Address	Function Code	Remote Address(0003)		Remote Data		CRC 16	
		MSB	LSB	MSB	LSB	LSB	MSB
01	**05**	**00**	**03**	**FF**	**FF**	**7C**	**3A**

Whether the remote command is active can be checked by sending function code 01H to read auto mode status of address 0041.

3.4 ENGINE RUNNING STATUS

Table 14 Engine Running Status

No.	Item	Description
0	Standby	No delay value in the status
1	Preheat	
2	Fuel Output	No delay value in the status
3	Crank	
4	Crank Rest	
5	Safety on Delay	
6	Start Idle	
7	Warming up	
8	Wait for On-load	No delay value in the status
9	Normal Running	No delay value in the status
10	Cooling	
11	Stop Idle	
12	ETS	
13	Wait for Stop	
14	Stop Failure	No delay value in the status

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