



SmartGen
ideas for power

APC615
PUMP UNIT CONTROLLER
COMMUNICATION PROTOCOL

SmartGen

SMARTGEN (ZHENGZHOU) TECHNOLOGY CO., LTD.



Chinese trademark

SmartGen English trademark

SmartGen — make your generator *smart*

SmartGen Technology Co., Ltd.

No.28 Jinsuo Road

Zhengzhou

Henan Province

P. R. China

Tel: 0086-371-67988888/67981888

0086-371-67991553/67992951

0086-371-67981000(overseas)

Fax: 0086-371-67992952

Web: www.smartgen.com.cn

www.smartgen.cn

Email: sales@smartgen.cn

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Table 1 - Software Version

Date	Version	Note
2017-12-20	1.0	Original release.

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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

- All RS232 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 messages sent from RS232 communication coil of the device.
- No communication can start from slaves.
- In RS232 communication loop, all communication should be transmitted in “information frame”.
- 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 11-bit serial data stream.

Table 2 - Data frame format

Item	Description
Start bit	1-bit
Data bit	8-bit
Parity bit	No parity
Stop bit	2-bit can be set.

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

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	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 (from 0-255). Single device address range is 1–247; 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). APC615 controller uses 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.

Table 4 - ModBus Partial Function Codes

Function code	Definition	Operation
01H	Read Coils	Reads the contents of coils
03H	Read Holding Registers	Reads the contents of holding registers
05H	Force Single Coil	Forces a single coil to either ON or OFF.

4.4.2 01H READ COILS

Master can read all coils (like switch on/off, fault information, auto or manual status and so on) of the device via function code 01 communication command.

4.4.3 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.

4.4.4 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.

4.5 DATA FIELD

4.5.1 ILLUSTRATION

Data field varies with different function codes.

4.5.2 FUNCTION 01H –READ COILS

Request:

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

Response:

Data Sequence	Data Signification	Byte Count
1	Loopback byte count	1
2	N – coil data	1

4.5.3 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

4.5.4 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

4.6 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. CRC adapts CRC-16 method of calibration.

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.

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).
(If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
- 5) Repeat Steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
- 6) Repeat Steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
- 7) 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>.

4.7 EXAMPLES OF INFORMATION FRAME FORMAT

4.7.1 FUNCTION CODE 01H

Slave address is 00 and read starting address is 20H of 0000H (decimal 32).

Request

Request	Bytes	Example (Hex)
Slave address	1	01 Send to the slave 01
Function code	1	01 Read coils
Starting address	2	00 Starting address is 0000 00
No. of Points	2	00 Read 28 coils 1C
CRC code	2	3D CRC code which calculated by PC. C3

Response

Response	Bytes	Example (Hex)
Slave address	1	01 Respond to the slave 01
Function code	1	01 Read coils
Read count	1	04 Respond coils: 28 coils (total 4bytes)
Data 1	1	30 The content of address 07-00
Data 2	1	00 The content of address 0F-08
Data 3	1	93 The content of address 17-10
Data 4	1	0A The content of address 1C-18
CRC code	2	18 CRC code which calculated by slave. 26

Switch value 07-00 expressed as 30H of hexadecimal and 00110000 of binary, 07 is in MSB and 00 is in LSB. 07-00 switch value status are: OFF – OFF – ON – ON – OFF – OFF – OFF – OFF.

4.7.2 FUNCTION CODE 03H

Slave address is 01 and starting address is 3 data of 0026H.

Address	Data(Hex)
0026	0014
0027	0014
0028	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 0026 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 0026 14
Data 2	2	00 The content of address 0027 14
Data 3	2	00 The content of address 0028 05
CRC code	2	91 CRC code which calculated by slave. 71

4.7.3 FUNCTION CODE 05H

Read coil for slave address is 01 and starting address is 1 switch value of 0002H. 0002 unit is 1.

Address	Data(Hex)
0000	0
0001	1
0002	0

▲ Note: A value of 00FF hex requests the coil to be ON. A value of 00 0H 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 0000 00
Data	2	00 Set coil as 1 FF
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 0000 00
Data	2	00 Set coil as 1 FF
CRC code	2	CD CRC code which calculated by slave. FB

4.8 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.

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5. ATTACHMENT: ADDRESS AND DATA
5.1 FUNCTION CODE 03H MAP DATA FIELD

Address	Item	Description	Bytes
0000	Common Alarm	1 for active (LSB)	1bit
	Common Shutdown Alarm	1 for active	1bit
	Common Warning Alarm	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	System In Auto Mode	1 for active	1bit
	System In Manual Mode	1 for active	1bit
	System In Stop Mode	1 for active	1bit
	System In Adjust Speed Mode	1 for active	1bit
	System In Auto/Manual Adjust Speed Mode	1 for manual; 0 for auto	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active (MSB)	1bit
0001	Emergency Stop Alarm	1 for active	1bit
	Engine Over Speed Shutdown	1 for active	1bit
	Engine Underspeed Shutdown	1 for active	1bit
	Loss of Speed Signal Alarm	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Failed to Start Alarm	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	ECU Alarm Shutdown	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	High Temp. Input Alarm Shutdown	1 for active	1bit
	Low Oil Pressure Input Alarm Shutdown	1 for active	1bit
0002	ECU COM Fail Alarm Shutdown	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit

Address	Item	Description	Bytes
0005	Reserved	2Bytes	2Bytes
0006	Reserved	2Bytes	2Bytes
0007	Reserved	2Bytes	2Bytes
0008	Input 1 Shutdown	1 for active	1bit
	Input 2 Shutdown	1 for active	1bit
	Input 3 Shutdown	1 for active	1bit
	Input 4 Shutdown	1 for active	1bit
	Input 5 Shutdown	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0009	Overflow Alarm Shutdown	1 for active	1bit
	Maintenance 1 Alarm Shutdown	1 for active	1bit
	Maintenance 2 Alarm Shutdown	1 for active	1bit
	Maintenance 3 Alarm Shutdown	1 for active	1bit
	Maintenance 4 Alarm Shutdown	1 for active	1bit
	Maintenance 5 Alarm Shutdown	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
Reserved	1 for active	1bit	
0010	Reserved	2Bytes	2Bytes
0011	Reserved	2Bytes	2Bytes
0012	Reserved	2Bytes	2Bytes
0013	Reserved	2Bytes	2Bytes
0014	Reserved	2Bytes	2Bytes
0015	Reserved	2Bytes	2Bytes
0016	Reserved	2Bytes	2Bytes
0017	Reserved	2Bytes	2Bytes

Address	Item	Description	Bytes
0018	Reserved	2Bytes	2Bytes
0019	Reserved	2Bytes	2Bytes
0020	Engine Overspeed Warning	1 for active	1bit
	Engine Underspeed Warning	1 for active	1bit
	Loss of Speed Signal Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Failed to Stop Warning	1 for active	1bit
	Failed to Charge Warning	1 for active	1bit
	Battery Overvoltage Warning	1 for active	1bit
	Battery Undervoltage Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
ECU Warning	1 for active	1bit	
0021	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Engine Temp. Sensor Open Circuit Warning	1 for active	1bit
	Engine Temp. High Warning	1 for active	1bit
	Engine Temp. Low Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Engine Fuel Level Sensor Open Circuit Warning	1 for active	1bit
	Engine Fuel Level High Warning	1 for active	1bit
	Engine Fuel Level Low Warning	1 for active	1bit
Reserved	1 for active	1bit	
0022	Engine Oil Pressure Sensor Open Circuit Warning	1 for active	1bit
	Engine Oil Pressure High Warning	1 for active	1bit
	Engine Oil Pressure Low Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Outlet Pressure Open Circuit Warning	1 for active	1bit
	Outlet Pressure High Warning	1 for active	1bit
	Outlet Pressure Low Warning	1 for active	1bit

Address	Item	Description	Bytes
	Reserved	1 for active	1bit
	Flexible Sensor 1 Open Circuit Warning	1 for active	1bit
	Flexible Sensor 1 High Warning	1 for active	1bit
	Flexible Sensor 1 Low Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Flexible Sensor 2 Open Circuit Warning	1 for active	1bit
	Flexible Sensor 2 High Warning	1 for active	1bit
	Flexible Sensor 2 Low Warning	1 for active	1bit
Reserved	1 for active	1bit	
0023	Reserved	2Bytes	2Bytes
0024	Reserved	2Bytes	2Bytes
0025	Reserved	2Bytes	2Bytes
0026	Reserved	2Bytes	2Bytes
0027	Reserved	2Bytes	2Bytes
0028	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Overflow Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Authorization time Due warning	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
Reserved	1 for active	1bit	
0029	Input 1 Warning	1 for active	1bit
	Input 2 Warning	1 for active	1bit
	Input 3 Warning	1 for active	1bit
	Input 4 Warning	1 for active	1bit
	Input 5 Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit

Address	Item	Description	Bytes
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0030	Maintenance 1 Warning	1 for active	1bit
	Maintenance 2 Warning	1 for active	1bit
	Maintenance 3 Warning	1 for active	1bit
	Maintenance 4 Warning	1 for active	1bit
	Maintenance 5 Warning	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0031	Reserved	2Bytes	2Bytes
0032	Reserved	2Bytes	2Bytes
0033	Input 1 Indication	1 for active	1bit
	Input 2 Indication	1 for active	1bit
	Input 3 Indication	1 for active	1bit
	Input 4 Indication	1 for active	1bit
	Input 5 Indication	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0034	Maintenance 1 Indication	1 for active	1bit
	Maintenance 2 Indication	1 for active	1bit
	Maintenance 3 Indication	1 for active	1bit
	Maintenance 4 Indication	1 for active	1bit
	Maintenance 5 Indication	1 for active	1bit
	Reserved	1 for active	1bit

Address	Item	Description	Bytes
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0035	Emergency Input Port Status	1 for active	1bit
	Input 1 Status	1 for active	1bit
	Input 2 Status	1 for active	1bit
	Input 3 Status	1 for active	1bit
	Input 4 Status	1 for active	1bit
	Input 5 Status	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
Reserved	1 for active	1bit	
0036	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0037	Fuel Relay Output Status	1 for active	1bit

Address	Item	Description	Bytes
	Start Relay Output Status	1 for active	1bit
	Relay Output 1 Status	1 for active	1bit
	Relay Output 2 Status	1 for active	1bit
	Relay Output 3 Status	1 for active	1bit
	Relay Output 4 Status	1 for active	1bit
	Relay Output 5 Status	1 for active	1bit
	Relay Output 6 Status	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0038	Reserved	2Bytes	2Bytes
0039	Reserved	2Bytes	2Bytes
0040	Reserved	2Bytes	2Bytes
0041	Reserved	2Bytes	2Bytes
0042	Reserved	2Bytes	2Bytes
0043	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Running Status Lamp	1 for active	1bit
	Buzzer Indicator	1 for active	1bit
	Idle Button Indicator	1 for active	1bit
	Reserved	1 for active	1bit
	Idle Running Status	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0044	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit

Address	Item	Description	Bytes
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0045	Input 1 Active	1 for active	1bit
	Input 2 Active	1 for active	1bit
	Input 3 Active	1 for active	1bit
	Input 4 Active	1 for active	1bit
	Input 5 Active	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
0046	Reserved	2Bytes	2Bytes
0047	Reserved	2Bytes	2Bytes
0048-139	Reserved		
0140	Head	Unsigned	2Bytes
0141	Engine Speed	Unsigned	2Bytes
0142	Battery Voltage	Signed(*10)	2Bytes
0143	Charger Voltage	Signed (*10)	2Bytes
0144	Reserved		2Bytes
0145	Reserved		2Bytes
0146	Pump Flow (m3/h)	Unsigned (*10)	2Bytes
0147	Adjust Speed Output Percentage	Unsigned (*10)	2Bytes
0148	Sensor 1 Resistance/Current	Unsigned (*10)	2Bytes
0149	Sensor 1 Value (Water Temp.)	Signed	2Bytes
0150	Sensor 2 Resistance/Current	Unsigned (*10)	2Bytes
0151	Sensor 2 Value (Fuel Level)	Signed	2Bytes
0152	Sensor 3 Resistance/Current/Voltage	Unsigned (*10)	2Bytes
0153	Sensor 3 Value (Oil Pressure)	Signed	2Bytes
0154	Sensor 4 Resistance/Current/Voltage	Unsigned (*10)	2Bytes

Address	Item	Description	Bytes
0155	Sensor 4 Value (Outlet Water Pressure)	Signed	2Bytes
0156	Sensor 5 Resistance/Current/Voltage	Unsigned (*10)	2Bytes
0157	Sensor 5 Value (Flexible Sensor1)	Signed	2Bytes
0158	Sensor 6 Resistance/Current/Voltage	Unsigned (*10)	2Bytes
0159	Sensor 6 Value (Flexible Sensor 2)	Signed	2Bytes
0160	Reserved		2Bytes
0161	Reserved		2Bytes
0162	Coolant Pressure	Signed	2Bytes
0163	Coolant Level	Signed	2Bytes
0164	Fuel Pressure	Signed	2Bytes
0165	Fuel Temperature	Signed	2Bytes
0166	Oil Temperature	Signed	2Bytes
0167	Inlet Temperature	Signed	2Bytes
0168	Turbine Pressure	Signed	2Bytes
0169	Outlet Temperature	Signed	2Bytes
0170	Fuel Consumption	Signed (*10)	2Bytes
0171	Total Fuel Consumption (LSB)	Signed	4Bytes
0172	Total Fuel Consumption (MSB)		
0173	Reserved		2Bytes
0174	Reserved		2Bytes
0175	Reserved		2Bytes
0176	Reserved		2Bytes
0177	Reserved		2Bytes
0178	Reserved		2Bytes
0179	Reserved		2Bytes
0180	Reserved		2Bytes
0181	Reserved		2Bytes
0182	Reserved		2Bytes
0183	Reserved		2Bytes
0184	Reserved		2Bytes
0185	Reserved		2Bytes
0186	Reserved		2Bytes
0187	Reserved		2Bytes
0188	Reserved		2Bytes
0189	Engine Status	Please to see <u>CONTROLLER</u> <u>RUNNING STATUS</u> <u>TABLE</u>	2Bytes
0190	Engine Delay	Unsigned	2Bytes
0191	Remote Start Status	Please to see <u>REMOTE</u> <u>START STATUS TABLE</u>	2Bytes
0192	Remote Start Delay	Unsigned	2Bytes
0193	Remote Start Type	Please to see <u>REMOTE</u>	2Bytes

Address	Item	Description	Bytes
		<u>START TYPE TABLE</u>	
0194	Reserved		2Bytes
0195	Reserved		2Bytes
0196	Reserved		2Bytes
0197	Reserved		2Bytes
0198	Reserved		2Bytes
0199	Total Running Hours	Unsigned	2Bytes
0200	Total Running Minutes	Unsigned	2Bytes
0201	Total Running Seconds	Unsigned	2Bytes
0202	Total Start Times	Unsigned	2Bytes
0203	Total Flow m ³	Unsigned	4Bytes
0204			
0205	Current Total Flow	Unsigned	4Bytes
0206			
0207	Reserved		4Bytes
0208			
0209	Reserved		4Bytes
0210			
0211	Reserved		2Bytes
0212	Reserved		2Bytes
0213	Reserved		2Bytes
0214	Reserved		2Bytes
0215	Reserved		2Bytes
0216	Reserved		2Bytes
0217	Controller Model	Unsigned	2Bytes
0218	Controller Software Version	Unsigned (*10)	2Bytes
0219	Controller Hardware Version	Unsigned (*10)	2Bytes
0220	Release Time (YY)	Only reserve last two numbers of the year.	2Bytes
0221	Release Time (MM)	Unsigned	2Bytes
0222	Release Time (DD)	Unsigned	2Bytes
0223	Reserved		2Bytes
0224	Number of Event Log	Unsigned	2Bytes
0225	Controller Time: Year	Only reserve last two numbers of the year.	2Bytes
0226	Controller Time: Month	Unsigned	2Bytes
0227	Controller Time: Day	Unsigned	2Bytes
0228	Controller Time: Week	Unsigned	2Bytes
0229	Controller Time: Hour	Unsigned	2Bytes
0230	Controller Time: Minute	Unsigned	2Bytes
0231	Controller Time: Second	Unsigned	2Bytes
0232	Current Running Hours	Unsigned	2Bytes
0233	Current Running Minutes	Unsigned	2Bytes

Address	Item	Description	Bytes
0234	Current Running Seconds	Unsigned	2Bytes
0235	Reserved		2Bytes
0236			2Bytes
0237	Reserved		2Bytes
0238	Reserved		2Bytes
0239	Reserved		2Bytes
0240	Reserved		4Bytes
0241			
0242	Reserved		4Bytes
0243			
0244	Reserved		4Bytes
0245			
0246	Reserved		4Bytes
0247			
0248	Reserved		4Bytes
0249			
0250	Reserved		4Bytes
0251			
0252	Reserved		4Bytes
0253			
0254	Reserved		2Bytes
0255	Maintenance 1 Remaining Time (Hour)	Unsigned	2Bytes
0256	Maintenance 1 Remaining Time (Minute)	Unsigned	2Bytes
0257	Maintenance 1 Remaining Time (Second)	Unsigned	2Bytes
0258	Maintenance 2 Remaining Time (Hour)	Unsigned	2Bytes
0259	Maintenance 2 Remaining Time (Minute)	Unsigned	2Bytes
0260	Maintenance 2 Remaining Time (Second)	Unsigned	2Bytes
0261	Maintenance 3 Remaining Time (Hour)	Unsigned	2Bytes
0262	Maintenance 3 Remaining Time (Minute)	Unsigned	2Bytes
0263	Maintenance 3 Remaining Time (Second)	Unsigned	2Bytes
0264	Maintenance 4 Remaining Time (Hour)	Unsigned	2Bytes
0265	Maintenance 4 Remaining Time (Minute)	Unsigned	2Bytes
0266	Maintenance 4 Remaining Time (Second)	Unsigned	2Bytes
0267	Maintenance 5 Remaining Time (Hour)	Unsigned	2Bytes
0268	Maintenance 5 Remaining Time (Minute)	Unsigned	2Bytes
0269	Maintenance 5 Remaining Time (Second)	Unsigned	2Bytes
0270	Reserved		2Bytes

5.2 FUNCTION CODE 05H MAP DATA FIELD

Discrete Values		
Address	Item	Description
0000	Remote Start Key	1 for active
0001	Remote Stop Key	1 for active
0002	Reserved	

0003	Remote Auto Key	1 for active
0004	Remote Manual Key	1 for active
0005	Remote Idle Key	1 for active
0006	Reserved	
0007	Remote Up Key	1 for active
0008	Remote Down Key	1 for active
0009	Remote Raise Speed Key	1 for active
0010	Remote Drop Speed Key	1 for active
0011	Remote Confirm Key	1 for active
0012	Remote Mute Key	1 for active
0013	Reserved	
0014	Reserved	
0015	Remote Immediately Stop	1 for active
0016	Reserved	
0017	Reserved	
0018	Reserved	
0019	Reserved	
0020	Remote Output Port 1 Output	1 for active, 0 for inactive
0021	Remote Output Port 2 Output	1 for active, 0 for inactive
0022	Remote Output Port 3 Output	1 for active, 0 for inactive
0023	Remote Output Port 4 Output	1 for active, 0 for inactive
0024	Remote Output Port 5 Output	1 for active, 0 for inactive
0025	Remote Output Port 6 Output	1 for active, 0 for inactive
0026-0033	Reserved	
0034	Raise SpeedX1	1 for active
0035	Drop SpeedX1	1 for active
0036	Raise SpeedX10	1 for active
0037	Drop SpeedX10	1 for active

5.3 CONTROLLER RUNNING STATUS

No.	Item	Range	Description
0	Standby		No delay value displayed in this status
1	Preheat		
2	Diesel-driven Pump Started		
3	Suction Pump Crank Rest		
4	Waiting Suction Pump Pressure to		
5	Fuel Output		
6	Start Delay		
7	Start Interval		
8	Safety On		
9	Start Idle		
10	Hi-speed Warming Up		
11	Waiting for Load		No delay value displayed in this status
12	Normal Running		No delay value displayed in this status
13	Hi-speed Cooling		
14	Stop Idle		
15	Energize to Stop		
16	Wait Stop Time		
17	Failed to Stop		No delay value displayed in this status
18	After Stop Time		

5.4 REMOTE START STATUS

No.	Item & Description
0	Without delay
1	Start delay
2	Stop delay

5.5 REMOTE START TYPE

No.	Item & Description
0	Inactive
1	Remote Start
2	High Water Level Start
3	Low Pipe Pressure Start
4	Scheduled Run