HAT553V

DUAL POWER ATS CONTROLLER

COMMUNICATION PROTOCOL

SMARTGEN (ZHENGZHOU) TECHNOLOGY CO., LTD.

Chinese trademark

English trademark

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Table 1 - Software Version

Date	Version	Note
2020-10-23	1.0	Original release.

CONTENT

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 etc.), and DCS or third-party monitoring system which is compatible with MODBUS. The monitoring system can be set up if a central PC (or IPC)-based communication master software is added (such as Kingview, Intouch, FIX, Synall etc.).

2. MODBUS BASIC RULES

— All communication loops should follow the master-slave mode. In this way, data can be transferred between a master (e.g. PC) and 32 slaves.
— No communication can start from slaves.
— In communication loop, all communication should be transmitted in “information frame”.
— If master or slave receives information frame with unknown command, no response will be given.

3. DATA FRAME FORMAT

Communication is asynchronously transferred by the unit of byte (data frame). Each data frame is a serial data stream of 10 bits (stop bit: 1) or 11 bits (stop bit: 2) between master and slave.

Table 2 - Data Frame Format

Item	Description
Start bit	1-bit
Data bit	8-bit
Parity bit	Odd/Even/No parity
Stop bit	1-bit, 2-bit can be set.
Baud rate	9600bps (2400/4800/9600/19200bps can be set)

4. COMMUNICATION PROTOCOL

4.1 ILLUSTRATION

When communication command is sent to the instrument, device who accords with the address code receives the communication command, and removes the address code to read information. If nothing goes wrong, it shall conduct the task, and then send implementation result to the sender. The returned information includes address code, function code of implemented action, data after implemented action, and CRC. If an error occurs, then nothing shall be sent.

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, which means that slave device whose address code is defined by users will receive the information sent by the master. Each slave has a unique address code, and each response begins with its address code. The address code issued by the master means the slave address to be sent to, while address code issued by slave means the responded slave address.

4.4 FUNCTION CODE

Function code is the second data of each communication transmission. ModBus communication protocol defines function code as 1-255 (01H-0FFH). HAT553V controller uses a part of it. By master request master can tell slave to conduct certain action. By slave response slave can show that it has responded to the master and conducted the action as the function code issued by the slave is the same as the one issued by the master. If the function code MSB is 1 (function code>127), it means slave does not respond, or response has an error.

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

Table 4 - ModBus Partial Function Codes

Function code	Definition	Operation
03H	Read Registers	Reads single or multiple register data
05H	Place Single Coil	Place single coil
06H	Write Single Register	Write a 16-bit binary number to register

4.4.1 03H READ REGISTERS

With communication command of function code 03H, master can read the numerical registers (all kinds of collected analogue and parameter setting values are stored in the register) inside the device. Input register value of 03H mapping data field is 16-bit (2 bytes). So register values read from the device are 2 bytes. For each time maximum readable register values are 125.

Command format of slave response is slave address, function code, data field, and CRC code. Data in data field are double bytes in a group of 2 bytes and high byte is in the front.

4.4.2 05H PLACE SINGLE COIL

With this command master can store single coil data to bit registers (e.g. ATS transfer control). Slave also can respond information to the master with this command.

4.4.3 06H WRITE SINGLE REGISTER

With this command master can store single data to bit registers in the device. Register in ModBus communication protocol refers to 16-bit (2 bytes) and high byte is in the front. In this way all points in the device are 2 bytes. Command format is slave address, function code, data field and CRC code.

4.5 DATA FIELD

Data field varies with different function codes.

4.5.1 CORRESPONDING DATA FIELD FORMAT TO FUNCTION CODE 03H

Table 5 Master Request

Data Sequence	Data Signification	Byte Count
1	Starting address	2
2	Read register numbers	2

Table 6 Slave Response

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

4.5.2 CORRESPONDING DATA FIELD FORMAT TO FUNCTION CODE 05H

Table 7 Master Request

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

Table 8 Slave Response

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

4.5.3 CORRESPONDING DATA FIELD FORMAT TO FUNCTION CODE 06H

Table 9 Master Request

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

Table 10 Slave Response

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

4.6 ERROR CHECK CODE (CRC)

Master or slave can detect whether the received information is wrong or not with CRC. Sometimes due to electric noise or other interference, information will have imperceptible changes in the transmission process. CRC ensures master or slave does not respond to the wrong information in the transmission process. In this way system safety and efficiency are guaranteed. CRC applies CRC-16 calibration method.

For 2 bytes CRC, low byte is in the front and high byte is in the back.

NOTE: All information frame format are same: address code, function code, data field and CRC code.

CRC includes 2 bytes, which is 16-bit binary number. CRC is counted by the sender and placed at the end of the transmitted information. Responded device will recalculate whether the CRC code of the received information is the same as that received. If they are different, then it means there is an error.

CRC counting method: first place 16-bit register as 1. Then gradually tackle with 8-bit data information. Only 8-bit of data is used in the process of CRC counting. Start bit and stop bit are not included.

In the process of CRC counting, 8-bit data is Exclusive OR with the register data. The obtained result moves 1 bit to the low byte direction and fill MSB with 0. Check LSB again and if LSB is 1, then make register contents Exclusive OR with the preset values. If LSB is 0, then do not do Exclusive OR counting.

This process is repeated for many times. After the eighth bit move, the next 8-bit shall Exclusive OR with the current register contents. This also repeated for 8 times as the last one. Until all data information is handled, the last register contents are CRC code value.

CRC-16 Code Calculation Procedure:

— Place a 16–bit CRC register as FFFF hex;
— Make the first 8–bit data Exclusive OR with the low 8-bit of the CRC register, and put the result in the CRC register;
— Shift the CRC register one bit to the right, and fill MSB with 0. Examine the moved-out bit.
— If LSB was 0: repeat Step 3 (another shift).
— If LSB was 1: Exclusive OR the CRC register with A001 hex;
— Repeat Step 3 and 4 until 8 shifts have been performed. When this is done, a complete 8–bit data are processed.
— Repeat Step 2 to 5 for the next data processing.
— The final CRC register value is the CRC code. Low-order 8-bit data is transmitted first and high-order 8-bit data is at the last.

NOTE：The calculation 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 03H

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

Table 11 Data Address Example

Address	Data(Hex)
0026	0014
0028	0014
002A	0005

Table 12 Function Code 03H Master Request Example

Request	Bytes	Example (Hex)
Slave address	1	01 Send to slave 01
Function code	1	03 Read point registers
Starting address	2	00 Starting address is 0026H 26
Count number	2	00 Read 3 data (total 6 bytes) 03
CRC code	2	E4 CRC code which calculated by PC 00

Table 13 Function Code 03H Slave Response Example

Response	Bytes	Example (Hex)
Slave address	1	01 Respond slave address 01
Function code	1	03 Read point registers
Read count	1	06 3 data (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

4.7.2 FUNCTION CODE 05H

Slave address is 01 and starting address is 1 coil of 0002H, place 0002H unit as 1.

Table 14 Coil Data Address Example

Address	Data(Hex)
0000	0
0001	1
0002	0

Illustration: FF00 hex coil is forced to 1 and 0000H is forced to 0. Other values are illegal and will not affect the coil.

Table 15 Function Code 05H Master Request Example

Request	Bytes	Example (Hex)
Slave address	1	01 Send slave address 01
Function code	1	05 Forced coil
Starting address	2	00 Starting address is 0000H 00
Data	2	FF Set coil as 1 00
CRC code	2	04 CRC code which calculated by PC. 3A

Table 16 Function Code 05H Slave Response Example

Slave Response	Bytes	Example (Hex)
Slave address	1	01 Respond slave address 01
Function code	1	05 Forced coil
Starting address	2	00 Starting address is 0000H 00
Data	2	FF Set coil as 1 00
CRC code	2	04 CRC code which calculated by slave. 3A

4.7.3 FUNCTION CODE 06H

Slave address is 01 and place the 1 point content with starting address of 00E3H as 0002H.

Table 17 Function Code 06H Master Request Example

Request	Bytes	Example (Hex)
Slave address	1	01 Send slave address 01
Function code	1	06 Write single register
Starting address	2	00 Starting address is 0026H 26
Data	2	00 Place 1 point data (2 bytes in total) 14
CRC code	2	68 CRC code which calculated by PC. 0E

Table 18 Function Code 06H Slave Response Example

Slave Response	Bytes	Example (Hex)
Slave address	1	01 Respond slave address 01
Function code	1	06 Write single register
Starting address	2	00 Starting address is 0026H 26
Data	2	00 Place 1 point data (2 bytes in total) 14
CRC code	2	68 CRC code which calculated by slave. 0E

4.8 ERROR HANDLING

When device detects 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 sent by the master. The following codes show that unexpected errors have occurred.

If CRC error occurs for the information received by the slave, then the device will ignore.

Table 19 Error Code Format of Slave Response (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. ATTACHMENT: ADDRESS AND DATA

5.1 FUNCTION CODE 03H MAPPING DATA FIELD

Table 20 Function Code 03H Mapping Data Field

Address (decimal)	Item	Description	Byte
00	Common Alarm	1 for active(LSB)	1bit
	Common Warning Alarm	1 for active	1bit
	Common Fault Alarm	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Audible Alarm	1 for active	1bit
	Transfer Output	1 for active	1bit
	Auto Mode	1 for active	1bit
	Reserved	1 for active	1bit
	A Power Master	1 for active	1bit
	B Power Master	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for manual	1bit
	Reserved	1 for active	1bit
	Genset Start Output	1 for active(MSB)	1bit
01	A Power Voltage Normal	1 for active(LSB)	1bit
	A Power Voltage Abnormal	1 for active	1bit
	A Power Voltage Transient Abnormal	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
	A Power No Voltage	1 for active	1bit
	A Power High Voltage	1 for active	1bit
	A Power Low Voltage	1 for active	1bit
	A Power High Frequency	1 for active	1bit
	A Power Low Frequency	1 for active	1bit
	A Power Loss of Phase	1 for active	1bit
	A Power Reverse Phase Sequence	1 for active	1bit
	Reserved	1 for active(MSB)	1bit
02	B Power Voltage Normal	1 for active(LSB)	1bit
	B Power Voltage Abnormal	1 for active	1bit
	B Power Voltage Transient Abnormal	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit

Address (decimal)	Item	Description	Byte
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	B Power No Voltage	1 for active	1bit
	B Power High Voltage	1 for active	1bit
	B Power Low Voltage	1 for active	1bit
	B Power High Frequency	1 for active	1bit
	B Power Low Frequency	1 for active	1bit
	B Power Loss of Phase	1 for active	1bit
	B Power Reverse Phase Sequence	1 for active	1bit
	Reserved	1 for active (MSB)	1bit
03	Switch Transfer Failure	1 for active (LSB)	1bit
	A Power Close Failure	1 for active	1bit
	A Power Open Failure	1 for active	1bit
	B Power Close Failure	1 for active	1bit
	B Power Open Failure	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
	Force to Open Fault Alarm	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Switch Trip Alarm	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active (MSB)	1bit
04	Reserved	1 for active (LSB)	1bit
	Reserved	1 for active	1bit
	Force to Open 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
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active (MSB)	1bit

Address (decimal)	Item	Description	Byte
05	Digital Input Port 1 Status	1 for active (LSB)	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
	A Power Closed Status	1 for active	1bit
	B Power Closed Status	1 for active	1bit
	Open Status	1 for active (MSB)	1bit
06	Digital Output Port 1 Status	1 for active (LSB)	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
	A Power Close Control Output	1 for active	1bit
	A Power Open Control Output	1 for active	1bit
	B Power Close Control Output	1 for active	1bit
	B Power Open Control Output	1 for active (MSB)	1bit
07	Reserved	1 for active (LSB)	1bit
	Reserved	1 for active	1bit
	Remote Start Input	1 for active	1bit
	A Power Master Input	1 for active	1bit
	B Power Master Input	1 for active	1bit
	Force to Open Input	1 for active	1bit
	Remote Start On Load	1 for active	1bit
	Remote Start Off Load	1 for active	1bit
	Mains Abnormal Start	1 for active	1bit
	Scheduled Run	1 for active	1bit
	Reserved	1 for active	1bit

Address (decimal)	Item	Description	Byte
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Reserved	1 for active	1bit
	Auto Transfer, Auto Restore	1 for active (MSB)	1bit
1000	UAB1	Unsigned	2Bytes
1001	UBC1	Unsigned	2Bytes
1002	UCA1	Unsigned	2Bytes
1003	UA1	Unsigned	2Bytes
1004	UB1	Unsigned	2Bytes
1005	UC1	Unsigned	2Bytes
1006	UA1 Phase	Signed(*10)	2Bytes
1007	UB1 Phase	Signed(*10)	2Bytes
1008	UC1 Phase	Signed(*10)	2Bytes
1009	Frequency 1	Signed(*100)	2Bytes
1010	UAB2	Unsigned	2Bytes
1011	UBC2	Unsigned	2Bytes
1012	UCA2	Unsigned	2Bytes
1013	UA2	Unsigned	2Bytes
1014	UB2	Unsigned	2Bytes
1015	UC2	Unsigned	2Bytes
1016	UA2 Phase	Signed(*10)	2Bytes
1017	UB2 Phase	Signed(*10)	2Bytes
1018	UC2 Phase	Signed(*10)	2Bytes
1019	Frequency 2	Signed(*100)	2Bytes
1020	Reserved		2Bytes
1021	Reserved		2Bytes
1022	Reserved		2Bytes
1023	Reserved		2Bytes
1024	Reserved		2Bytes
1025	Reserved		2Bytes
1026	Reserved		2Bytes
1027	Reserved		2Bytes
1028	Reserved		2Bytes
1029	Reserved		2Bytes
1030	Reserved		2Bytes
1031	Reserved		2Bytes
1032	Reserved		2Bytes
1033	Reserved		2Bytes
1034	A Power Voltage Status	See voltage status description;	2Bytes
1035	A Power Voltage Status Delay		2Bytes
1036	B Power Voltage Status	See voltage status description;	2Bytes
1037	B Power Voltage Status Delay		2Bytes

Address (decimal)	Item	Description	Byte
1038	Genset Status	See genset status description;	2Bytes
1039	Genset Status Delay		2Bytes
1040	ATS Status	See ATS status description;	2Bytes
1041	ATS Status Delay		2Bytes
1042	Reserved		2Bytes
1043	Controller Time: Year	Unsigned	2Bytes
1044	Controller Time: Month	Unsigned	2Bytes
1045	Controller Time: Day	Unsigned	2Bytes
1046	Controller Time: Week	Unsigned	2Bytes
1047	Controller Time: Hour	Unsigned	2Bytes
1048	Controller Time: Minute	Unsigned	2Bytes
1049	Controller Time: Second	Unsigned	2Bytes
1050	Reserved		2Bytes
1051	Reserved		2Bytes
1052	Reserved		2Bytes
1053	Reserved		2Bytes
1054	Continuous Supply Time (Hours)	Unsigned	2Bytes
1055	Continuous Supply Time (Minutes)	Unsigned	2Bytes
1056	Continuous Supply Time (Seconds)	Unsigned	2Bytes
1057	Last Continuous Supply Time (Hours)	Unsigned	2Bytes
1058	Last Continuous Supply Time (Minutes)	Unsigned	2Bytes
1059	Last Continuous Supply Time (Seconds)	Unsigned	2Bytes
1060	A Power Total Supply Time (Hours) (LSB)	Unsigned	2Bytes
1061	A Power Total Supply Time (Hours) (MSB)		2Bytes
1062	A Power Total Supply Time (Minutes)	Unsigned	2Bytes
1063	A Power Total Supply Time (Seconds)	Unsigned	2Bytes
1064	B Power Total Supply Time (Hours) (LSB)	Unsigned	2Bytes
1065	B Power Total Supply Time (Hours) (MSB)		2Bytes
1066	B Power Total Supply Time (Minutes)	Unsigned	2Bytes
1067	B Power Total Supply Time (Seconds)	Unsigned	2Bytes
1068	A Power Total Close Times (LSB)	Unsigned	2Bytes
1069	A Power Total Close Times (MSB)	Unsigned	2Bytes
1070	B Power Total Close Times (LSB)	Unsigned	2Bytes
1071	B Power Total Close Times (MSB)	Unsigned	2Bytes
1072	Battery Voltage	Unsigned	2Bytes
1073	SCM Temperature	Signed	2Bytes
1074	Liquid Crystal Temperature	Signed	2Bytes
1075	Reserved		2Bytes

5.2 FUNCTION CODE 05H MAPPING DATA FIELD

Table 21 Function Code 05H Mapping Data Field

Address	Item	Description
15000	Remote Close A Power	1 for active
15001	Remote Open	1 for active
15002	Remote Close B Power	1 for active
15003	Remote Open (Same as 15001)	1 for active
15004	Auto/Manual	1 for active
15005	A Power Master Status Set	1 for active
15006	B Power Master Status Set	1 for active
15007	Alarm Reset	1 for active
15008	Remote Start Genset	1 for active
15009	Remote Stop Genset	1 for active
15010	Reserved	1 for active
15011	Reserved	1 for active
15012	Remote Output Port 1 Output	1 for active
15013	Reserved	1 for active
15014	Reserved	1 for active
15015	Reserved	1 for active

5.3 A POWER VOLTAGE STATUS DESCRIPTION

Table 22 A Power Voltage Status Description

Count	Status	Delay	Description
0	A Power Normal Identify	Delay (Unit: s)	
1	A Power Abnormal Identify	Delay (Unit: s)	
2	A Power Voltage Normal	No Delay	
3	A Power No Voltage	No Delay	
4	A Power High Voltage	No Delay	
5	A Power Low Voltage	No Delay	
6	A Power High Frequency	No Delay	
7	A Power Low Frequency	No Delay	
8	A Power Loss of Phase	No Delay	
9	A Power Reverse Phase Sequence	No Delay	

5.4 B POWER VOLTAGE STATUS DESCRIPTION

Table 23 B Power Voltage Status Description

Count	Status	Delay	Description
0	B Power Normal Identify	Delay (Unit: s)	
1	B Power Abnormal Identify	Delay (Unit: s)	
2	B Power Voltage Normal	No Delay	
3	B Power No Voltage	No Delay	
4	B Power High Voltage	No Delay	
5	B Power Low Voltage	No Delay	
6	B Power High Frequency	No Delay	
7	B Power Low Frequency	No Delay	
8	B Power Loss of Phase	No Delay	
9	B Power Reverse Phase Sequence	No Delay	

5.5 GENSET STATUS DESCRIPTION

Table 24 Genset Status Description

Count	Status	Delay	Description
0	Start Delay	Delay (Unit: s)	
1	Stop Delay	Delay (Unit: s)	
2	Scheduled Run	Delay (Unit: s)	
3	Genset Start	No Delay	
4	Genset Standby	No Delay	

5.6 SWITCH STATUS DESCRIPTION

Table 25 Switch Status Description

Count	Status	Delay	Description
0	Ready to Transfer	No Delay	
1	A Power Closing	Delay (Unit: s)	
2	A Power Opening	Delay (Unit: s)	
3	B Power Closing	Delay (Unit: s)	
4	B Power Opening	Delay (Unit: s)	
5	Transfer Rest Time	Delay (Unit: s)	
6	A Power Re-close	Delay (Unit: s)	
7	A Power Re-close	Delay (Unit: s)	
8	B Power Re-close	Delay (Unit: s)	
9	B Power Re-close	Delay (Unit: s)	
10-15	Reserved		
16	A Power Loading Supply	No Delay	
17	B Power Loading Supply	No Delay	
18	Load disconnect	No Delay	