**Series TUF Modbus Communication Variables Table**

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Communication  protocol | Modbus |  |
| 2 | Communication  cable | 2-core shielded double-twisted wire | Shield needs to be grounded |
| 3 | Hardware  interface | RS-485 |  |
| 4 | Baud rate | Default:  9600 bps | It can be modified according  customer’s requirements; Max Value is 38400bps |
| 5 | Byte format | Default:  1 start bit,8 data bits,1 even parity bit,1  stop bit | It can be modified according  customer’s requirements |
| 6 | Transmission  mode | RTU mode |  |
| 7 | MDU Address | 1~247 |  |
| 8 | Function codes  (hexadecimal) | 02H 03H 06H 10H |  |
| 9 | Error Checking  Methods | CRC-16 |  |

1. **Communication protocol parameters**
2. **Modbus RTU communication register table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 02H: Read Input Status [Address range: 0x1000-0x17D0] | | | | |
| Function  code | Register  address | Discrete input | Description | Remarks |
| **02H** | 1000H | Input 1 | Valve Open | 0: Normal  1: Open |
| **02H** | 1001H | Input 2 | Valve Close | 0: Normal  1: Close |
| **02H** | 1002H | Input 3 | Valve Abnormal | 0: Normal  1: Abnormal |
| **02H** | 1003H | Input 4 | Fan status | 0: Run  1: Stop |
| **02H** | 1004H | Input 5 | Fan in low speed | 0: OFF  1: ON |
| **02H** | 1005H | Input 6 | Fan in medial speed | 0: OFF  1: ON |
| **02H** | 1006H | Input 7 | Fan in high speed | 0: OFF  1: ON |
| **02H** | 1007H | Input 8 | Status of the second valve | 0: OFF  1: ON |
| **02H** | 1008H | Input 9 | Low power | 0: Normal  1: Under-voltage |
| **02H** | 1009H | Input 10 | EEPROM alarm | 0: Normal  1: Abnormal |
| **02H** | 100AH | Input 11 | RAM alarm | 0: Normal  1: Abnormal |
| **02H** | 100BH | Input 12 | Communication status of  output module | 0: Normal  1: Failure |
| **02H** | 100CH | Input 13 | Undefined | 0 |
| **02H** | 100DH | Input 14 | Undefined | 0 |
| **02H** | 100EH | Input 15 | Undefined | 0 |
| **02H** | 100FH | Input 16 | Undefined | 0 |
| **02H** | 1010H | Input 17 | Inlet platinum resistance of water  inflow short circuit | 0: Normal  1: Alarm |
| **02H** | 1011H | Input 18 | Inlet platinum resistance of water  inflow in open circuit | 0: Normal  1: Alarm |
| **02H** | 1012H | Input 19 | Outlet platinum resistance of water  outflow in short circuit | 0: Normal  1: Alarm |
| **02H** | 1013H | Input 20 | Outlet platinum resistance of water  outflow in open circuit | 0: Normal  1: Alarm |
| **02H** | 1014H | Input 21 | Flow sensor short circuit | 0: Normal  1: Alarm |
| **02H** | 1015H | Input 22 | Flow sensor open circuit | 0: Normal  1: Alarm |
| **02H** | 1016H | Input 23 | Strong magnetic | 0: Normal  1: Alarm |
| **02H** | 1017H | Input 24 | Hall | 0: Normal  1: Alarm |
| **02H** | 1018H | Input 25 | Gas leakage | 0: Normal  1: Alarm |
| **02H** | 1019H | Input 26 | Emergency input | 0: Normal  1: Alarm |
| **02H** | 101AH | Input 27 | Alarm against burglary | 0: Normal  1: Alarm |
| **02H** | 101BH | Input 28 | Overload alarm | 0: Normal  1: Alarm |
| **02H** | 101CH | Input 29 | Undefined | 0 |
| **02H** | 101DH | Input 30 | Undefined | 0 |
| **02H** | 101EH | Input 31 | Undefined | 0 |
| **02H** | 101FH | Input 32 | Undefined | 0 |
|  |  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| 03H: Read Holding Registers  06H: Preset Single Register  10H:Preset Multiple Registers  [Address range: 0x4000-0x4FFF] | | | |
| Function  code | Register  address | Description | Remarks |
| 03H/06H/10H | 4000H | Week | 0000H Range (0~6) 0 indicates Sunday, 1  indicates Monday, ... |
| 4001H | Year (High byte) | 0014H Range (0~99) |
| 4002H | Year (Low byte) | 000BH Range (0~99) |
| 4003H | Month | 0008H Range (1~12) |
| 4004H | Date | 001DH Range (1~31) |
| 4005H | Hour | 000DH Range (0~23) |
| 4006H | Minute | 002EH Range (0~59) |
| 4007H | Second | 0005H Range (0~59) |
| It indicates the time: 46 minutes and 05 seconds past 13 o’clock on 29 August 2011, Thursday. The time is the time collected from the current calibration, the deviation with the actual time of the meter is 0~4 T [Note 2] | | | |
| 03H/06H/10H | 4009H | Date of backup (BCD code) | 0012H(12) Range(1~31) |
| 03H/06H/10H | 400AH | METER Address | 0012H(12) Range(1~247) |
| 03H/06H/10H | 400BH | Four-bytes data upload format | 1（default)：Two-high-bytes is in low address  register and two-low-bytes is in high  address register；  0： High-bytes is in high address  register and low-bytes is in low  address register。 |
| 03H | 400CH | METER Type | High-bytes：Meter type； low-bytes：Pipe type  For example:4006, 40 stands for meter  type, 6 stands for pipe type |
| 03H | 400DH | Forward flow temperature  （ Temp. forward） | Enlarge 10times /enlarge 100 times，  operating method [Note 9] °C |
| 03H | 400EH | Return flow temperature  （ Temp. return） | Enlarge 10times /enlarge 100 times, operating method [Note 9] °C |
| Register 4000H~402FH can read continuously. Writing to other registers not listed in variables table is not allowed, otherwise the normal operation of meter will be affected | | | |
| 03H/10H | 4022H | Accumulative flow(2 low bytes) | Enlarge 100 times (4 Bytes) |
| 4023H | Accumulative flow(2 high bytes) |
| 03H/10H | 4024H | Total cool energy(2 low bytes) | Enlarge 100 times (4 Bytes) |
| 4025H | Total cool energy (2 high bytes) |
| 03H/10H | 4026H | Total heat energy (2 low bytes) | Enlarge 100 times (4 Bytes) |
| 4027H | Total heat energy (2 high bytes) |
| 03H | 4028H | Power (2 low bytes) | Enlarge 100 times (4 Bytes) |
| 4029H | Power (2 high bytes) |
| 03H | 402AH | Volume Flow (2 low bytes) | Enlarge 1000 times (4 Bytes) |
| 402BH | Volume Flow (2 high bytes) |
| 03H | 402EH | Meter ID (2 low bytes) | (4 Bytes) |
| 402FH | Meter ID (2 high bytes) |
| 03H | 4030H | Software version and Hardware  version | High-byte: Software version of Meter  Low-byte: Hardware version of Meter |
| 4031H | Protocol version and Reset times | High-byte: Protocol version of Meter  Low-byte: the number of Restart |
| Register 4114H~4155H can read continuously. Writing to other registers not listed in variables table is not allowed, otherwise the normal operation of Meter will be affected | | | |

Note:

1. TUF indicates the Series TUF thermal energy meter

2. T indicates the interval of visit to TUF from communication. If ultrasonic heat meter requires time calibration, it is feasible to continuously enter the current time to communication.

3. Two flow rates exist in variables table, one is that has been enlarged by 100 times and the other is that has been enlarged by 1,000 times. The one that has been enlarged by 1,000 times are mainly applied in ultrasonic heat meter. The one that has been enlarged by 100 times are mainly applied in ACM meter;

4. The flow valve value in the instruction of ultrasonic heat meter is the same variable of the minimum flow in the variables table;

5. In discrete reading input status, variables related to ultrasonic heat meter include: 1000H~1002H valve status, 1008H battery under-voltage alarm, 100BH is mainly applied to indicate whether the meter communicate normally and 1010H~1015H is mainly applied to indicate platinum resistance status of the meter;

6. Some parameters in the variables table are the configuration parameters of ultrasonic heat meter, which are mainly intended for maintenance and commissioning by professionals. The users shall never causally modify them. Otherwise, the ultrasonic heat meter may fail to work normally. If the parameters are required to be modified, please contact the working personnel of our company;

7. The cold and heat mode of ultrasonic heat meter shall be set according to actual situation, for when it is in cold, only the cold quantity shall be updated. When it is in heat, only the heat quantity shall be updated.

8. The valve control of ultrasonic heat meter shall be matched with valve module. Therefore, valve control in variables table is the reserved function;

9. The temperature schemes are available: one is one decimal transmission and the other is two decimal transmission; when one decimal transmission is available, if the read-out data is 0x0123, then, it indicates the temperature is 29.1 ℃; if the highest order of the data transmitted is 1, then, it indicates the temperature is two decimals, for example 0x8B5F, then, the temperature is 29.11 ℃, the digit on the highest order indicates the decimal of the transmitted data is of one decimal or two decimals.

1. **Exception codes**

|  |  |  |
| --- | --- | --- |
| Code | Name | Meaning |
| 01 | ILLEGAL FUNCTION | The function code received in the query is not an allowable action for the slave. If a Poll Program Complete command was iTUFed, this code indicates that no program function preceded it. |
| 02 | ILLEGAL DATA  ADDRESS | The data address received in the query is not an allowed address for the slave. |
| 03 | ILLEGAL DATA  VALUE | A value contained in the query data field is not an allowable value for the slave. |
| 04 | SLAVE DEVICE  FAILURE | An unrecoverable error occurred while the slave was attempting to perform the requested  action. |
| 05 | ACKNOWLEDGE | The slave has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the master. The master can next iTUFe a Poll Program Complete message to determine if processing is completed. |
| 06 | SLAVE DEVICE BUSY | The slave is engaged in processing a long-duration program command. The master should  retransmit the message later when the slave is free. |
| 07 | NEGATIVE  ACKNOWLEDGE | The slave cannot perform the program function received in the query. This code is returned for an unsuccessful programming request using function code 13 or 14 decimal. The master should request diagnostic or error information from the slave. |
| 08 | MEMORY PARITY  ERROR | The slave attempted to read extended memory, but detected a parity error in the memory. The  master can retry the request, but service may be required on the slave device. |

1. **Communication example**

1 .Read single register or Read multiple registers:

QUERY:

Slave address + Function code (03H) + Starting Address Hi + Starting Address Lo + No. of Points Hi +

No. of Points Lo + Error Check(CRC)

RESPONSE:

Slave address + Function code (03H) + Btye Count + Data Hi + Data Lo + Data Hi + Data Lo + Data Hi+ Data Lo + Error Check(CRC)

EXCEPTION RESPONSE:

Slave address + 83H + Exception code + Error Check(CRC)

EXAMPLE:

1.1 Visit data of 16 Bit:

Transmit: 01 03 40 00 00 02 D1 CB

Correct Receive: 01 03 04 00 01 00 14 AB FC

It visits two registers: Register 4000H, Data 0x0001; Register 4001H, Data 0x0014

1.2 Visit data of 32 Bit:

Transmit: 01 03 41 15 00 02 C1 F3

Correct Receive: 01 03 04 C3 50 00 00 C6 66

The data visited is data of 4 bytes: The value of the data is 0x0000C350;

Note: The data of 32 bit is dislocated and regrouped. This is because application of dislocated regrouping in PLC is abundant. Therefore, the data transmission shall also adopt this method, high byte is in high address register and low byte is in low address register;

2. Write single register:

QUERY:

Slave address + Function code (06H) + Register Address Hi + Register Address Lo + Preset Data Hi +

Preset Data Lo + Error Check(CRC)

RESPONSE:

Slave address + Function code (06H) + Register Address Hi + Register Address Lo + Preset Data Hi +

Preset Data Lo + Error Check(CRC)

EXCEPTION RESPONSE:

Slave address + 86H + Exception code + Error Check(CRC)

EXAMPLE:

Transmit: 01 06 40 97 00 01 EC 26

Correct Receive: 01 06 40 97 00 01 EC 26

Error Receive: 01 86 03 FD 9E

Correct return indicates correct operation and error return indicates data error;

3. Write multiple registers

QUERY:

Slave address + Function code (10H) + Starting Address Hi + Starting Address Lo + No. of Registers Hi

+ No. of Registers Lo + Byte Count + Data Hi + Data Lo + Data Hi + Data Lo + Error Check(CRC)

RESPONSE:

Slave address + Function code (10H) + Starting Address Hi + Starting Address Lo + No. of Registers Hi

+ No. of Registers Lo + Error Check(CRC)

EXCEPTION RESPONSE:

Slave address + 90H + Exception code + Error Check(CRC)

EXAMPLE:

Transmit: 01 10 40 01 00 0A 14 00 14 00 0B 00 0A 00 18 00 0D 00 0B 00 10 00 00 00 00 00 00 CB FD

Receive: 01 90 05 73 FC

Returned data indicates the unit correctly receives data sent by upper computer, however, the operation shall be executed for long time;

If the unit is executing the writing, the upper computer will continue to communicate and will return the command of subordinate equipment busy;

The current unit still has not finished the writing and the upper computer sends command to read the data

Transmit: 01 03 41 15 00 02 C1 F3

Receive: 01 83 06 C1 32