A16 Module Output Interface

01 — Pulse Width Output(PWM)

02 — UART Auto output

03 — UART Controlled output

04 — Switch

05 — RS232 and RS485 output

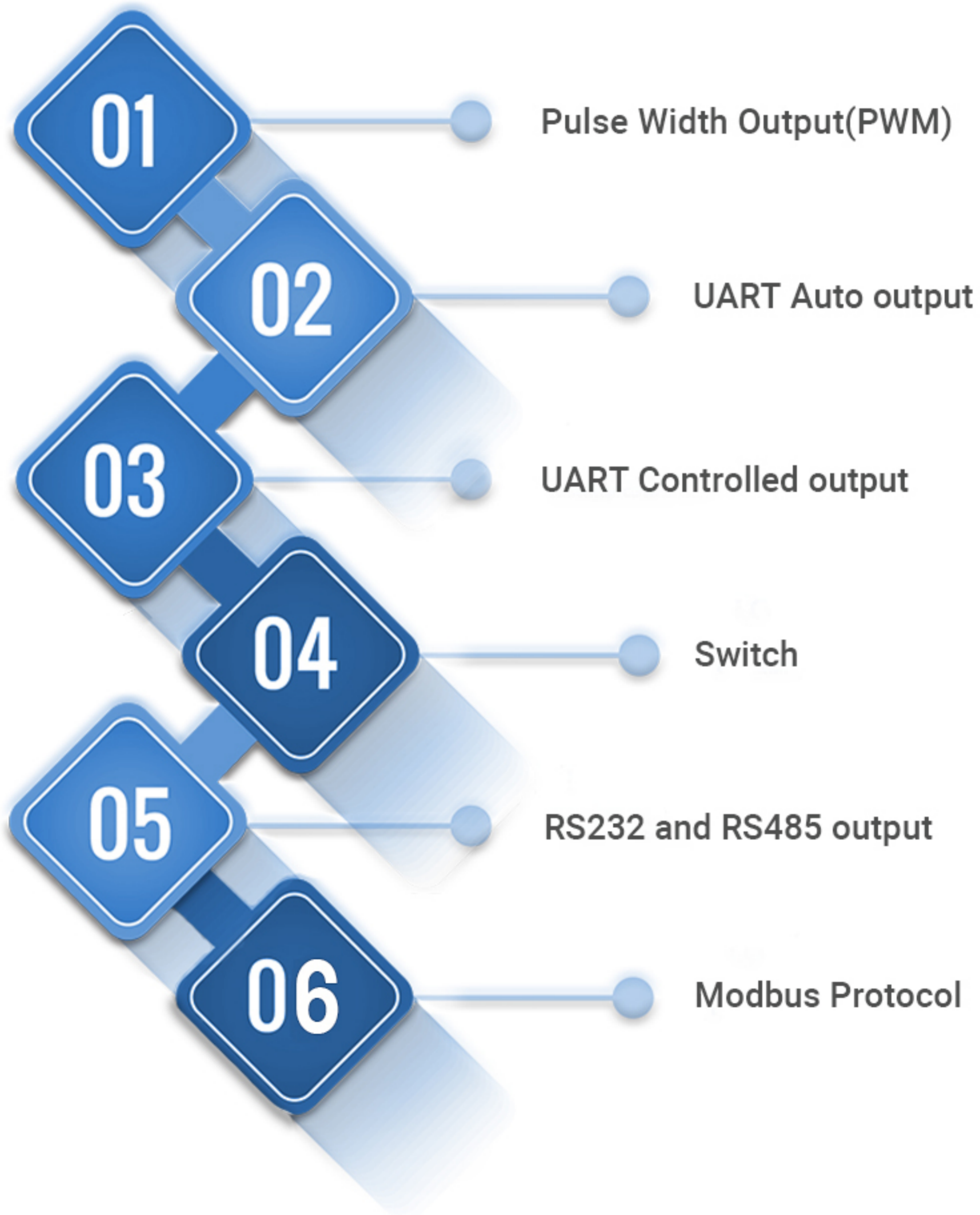**06** — Modbus Protocol

1. PWM output

PWM output interface with simple connector, flexible connect to analog or digital circuit.

(1) Pin definition

Pin No.	Mark	Pin Description	Remark
③	RX	Signal input	

Remark: The output high-level voltage of RX TX is 3V,the max allowable input voltage is 5V.

(2) Instruction

The module responds to the signal and outputs a high-level pulse width signal on the PIN(TX) after Pin(RX) receives a falling edge pulse, starts detection at the same time. the Pin(TX) will be set to low level after the target signal is detected, The high level duration of the pin(TX) corresponds to the distance between the detection target and the module. This cycle period of the module must be greater than 220ms. If the module does not detect an object, the pin(TX) will output a fixed pulse width of about 94ms.

(3) Timing Diagram
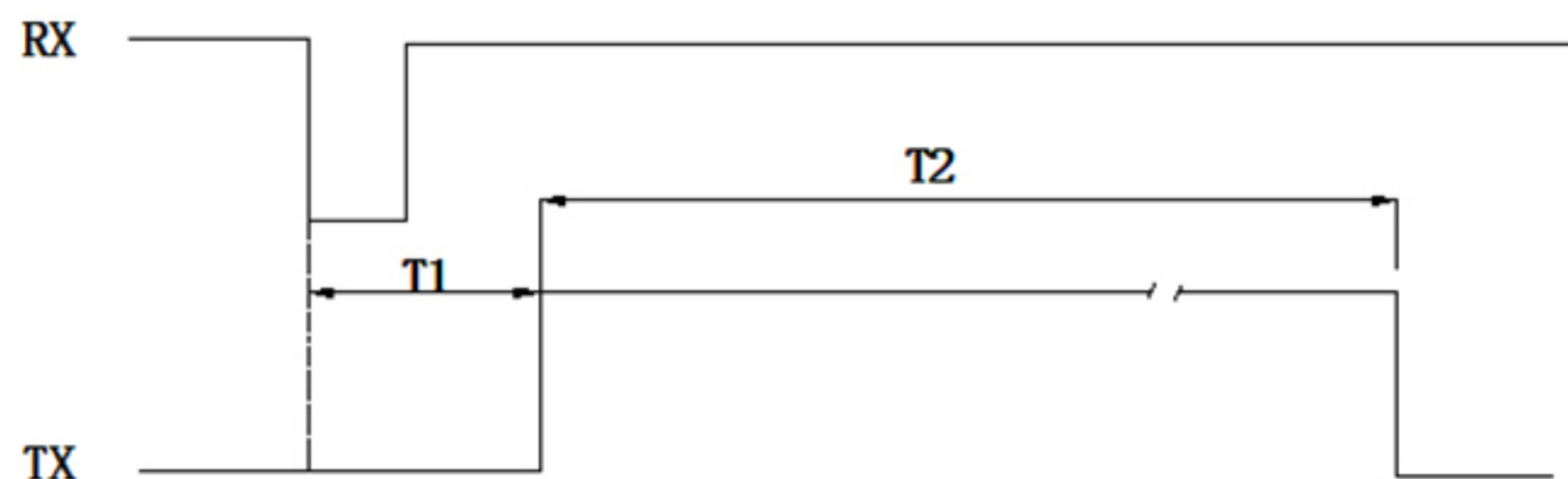
Remark: T1≈110ms T2=3～94ms（Timing of PWM High-level pulse width）

(4) Formula

Formula: $S=T*V/2$ (S is the distance value, T is duration time of PWM high-level pulse width, the V is sound travel speed in the air). V is directly calculated at speed of 348m/S at room temperature. The simplified formula is $S= T/57.5$ (unit of S in centimeters and us of time T)

For example: The duration time(T3) of PWM high-level pulse width is 10000us, the $S= T/57.5=10000/57.5≈173.9$(cm), means 173.9cm distance value.

2. UART Auto Output

UART auto output mode outputs measured distance value(Hexadecimal) according to UART communication format. This mode does not require an external trigger signal, only one I/O port is needed.

(1) Pin definition

Pin No.	Mark	Pin Description	Remark
③	RX	Processing value and Real time value output	
④	TX	UART output	

Remark: The output high-level voltage of RX TX is 3V,the max allowable input voltage is 5V.

(2) UART Instruction

When the Pin(RX) is disconnect or input high-level, the module outputs according to the processed value, the data is more stable, and the response time is 2.5~7.5s. Module outputs real-time value when Pin(RX)input low level, the response time is about 500ms.

Interface	Data Bit	Stop Bit	Parity Bit	Baud Rate
TTL level	8	1	No	9600bps

(3) UART Output format

Data Frame	Description	Byte
Start Bit	0XFF 0XFF	1byte
Data_H	High8 distance value	1byte
Data_L	Low8 distance value	1byte
SUM	Parity sum	1byte

(4) Example

Start Bit	Data_H	Data_L	SUM
0XFF	0X07	0XA1	0XA7

Remark: Parity sum only remain low8 value.

SUM =(start bit+ Data_H+ Data_L)&0x00FF

=(0XFF + 0X07 + 0XA1)&0x00FF

=0XA7

Distance value= Data_H*256+ Data_L=0X07A1；

Convert to decimal equal to 1953

Means current measurement distance value is 1953mm

3. UART Controlled Output

UART controlled mode outputs measured distance value(Hexadecimal) according to UART communication format.When pin(RX) receives a falling edge pulse, the module will perform a measurement, measured distance value output through pin(TX) after completed. Such output method can set measuring cycle to drop power consumption.

(1) Pin Definition

| Pin No.	Mark	Pin Description	Remark
③	RX	Trigger Signal input	
④	TX	UART output	

Remark: The output high-level voltage of RX TX is 3V,the max allowable input voltage is 5V.

(2) UART Instruction

The module will perform a distance detection after Pin(RX) receives a falling edge pulse. Pin(TX) will output a TTL level after detection is completed. The trigger period of the module must be greater than 120ms.

Interface	Data Bit	Stop Bit	Parity Bit	Baud Rate
TTL level	8	1	No	9600bps

(3) Timing Diagram
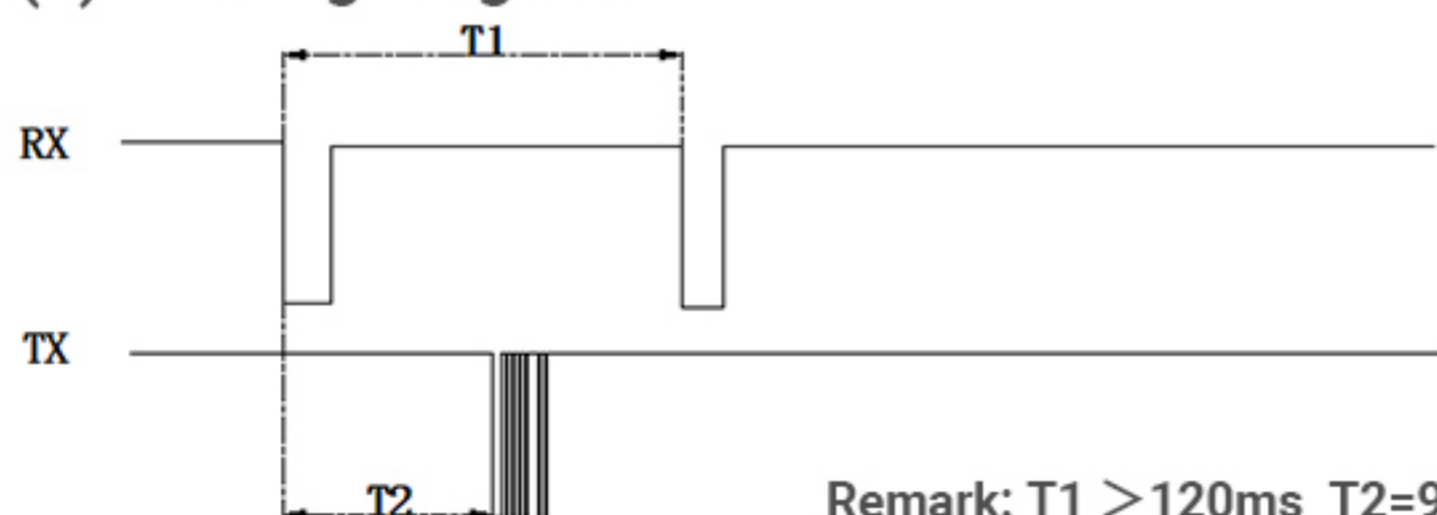
Remark: T1 ＞120ms T2=90～110ms

(4) UART Output Format

Data Frame	Description	Byte
Start Bit	0XFF 0XFF	1byte
Data_H	High8 distance value	1byte
Data_L	Low8 distance value	1byte
SUM	Parity sum	1byte

(5) Example

Start Bit	Data_H	Data_L	SUM
0XFF	0X07	0XA1	0XA7

Remark: Parity sum only remain low8 value.

SUM =(Start bit+ Data_H+ Data_L)&0x00FF

=(0XFF + 0X07 + 0XA1)&0x00FF

=0XA7

Distance value= Data_H*256+ Data_L=0X07A1

Convert to decimal equal to 1953

Means current measurement distance value is 1953mm

4. Switch

The switch output interface is simple, and the distance can be judged only by simple analog or digital.s

(1) Pin Definition

Pin No.	Mark	Pin Description	Remark
③	RX	UART receiving	
④	TX	Switch output/UART output	

Remark: The output high-level voltage of RX TX is 3V,the max allowable input voltage is 5V.

(2) Interface specification

Factory setting a thresholds of 1 meter as default of this module. The module performs distance measurement every 500ms. When the distance value less than 1 meter, the Pin(TX) output high level, the current detected distance value is greater than 1 meter, pin(TX) output low level.

In order to improve stability, the factory defaults that when the distance value of the target is detected 3 times in a row is less than the set thresholds, it is determined that the detected target distance is less than the set thresholds. The distance value of the target detected 5 times in a row is greater than the set thresholds. It is determined that the detected target distance is greater than the set threshold value. The Pin(TX) of the module only outputs high and low level signals without driving capability.

(3) Automatic output instructions

UART	Data Bit	Stop Bit	Parity Bit	Baud Rate
TTL level	8	1	NO	9600bps

5. RS232 and RS485 Output

Use RS232 interface for data communication. It can work in two modes: automatic output mode and MODBUS mode (see 6.MODBUS protocol description for details) (default is automatic output mode, when using MODBUS mode, send MODBUS command to automatically switch to MODBUS model). Use RS485 interface for data communication, only MODBUS mode.

(1) Pin Definition

Pin No.	Mark	Pin Description	Remark
③	RX	RS232-RX/RS485 terminal invert (B)	
④	TX	RS232-TX/RS485 terminal non-invert (A)	

Note: The pin function setting followed customer's order, can't coexist with other output modes.

(2) Interface specification

Interface	Baud Rate	Data Bit	Stop Bit	Parity Bit
RS232/RS485	9600 bit/S	8	1	NO

(3) Automatic output instruction

Data Frame	Description	Byte
Start Bit	0XFF 0XFF	1byte
Data_H	High8 distance value	1byte
Data_L	Low8 distance value	1byte
SUM	Parity sum	1byte

(4) For Example

Start Bit	Data_H	Data_L	SUM
0XFF	0X07	0XA1	0XA7

Remark: Parity sum only remain low8 value.

SUM =(Start Bit+ Data_H+ Data_L)&0x00FF

=(0XFF + 0X07 + 0XA1)&0x00FF

=0XA7

Distance Value== Data_H*256+ Data_L=0X07A1

Convert to decimal equal to 1953

Means current measurement distance value is1953mm

6. Modbus Protocol

(1) Modbus protocol specification

Mode	Parity	Sensor Address	Read function code	Write function code
Modbus-RTU	CRC-16/MODBUS	Settable, default 0x01	0x03	0x06

(2)　Modbus protocol format

Sensor module as slave. Customer device as master.

Master request(Read):

Name	Device Addres	Function code 0x03	Register address	Registers qty	CRC16 Parity
(Byte) Length(Byte)	1	1	2	2	2

Slave response(Read):

Name	Address	Function code 0x03	Response byte	Data zone	CRC16 Parity
(Byte) Length(Byte)	1	1	1	N	2

Master request(write):

Name	Device Address	Function code 0x06	Register address	Data zone	CRC16 Parity
(Byte) Length(Byte)	1	1	2	2	2

Slave response(write):

Name	Address	Function code 0x06	Register address	Data zone	CRC16 Parity
(Byte) Length(Byte)	1	1	2	2	2

(3)　Modbus Register

Status	Register Address	Register Function	Type of Data	Description	Remark
Read-only	0x0100	Processing value	Unsigned, 16bit	Processing value in mm unit	

Read-only	0x0101	Real-time value	Unsigned, 16bit	Real-time value, mm unit	
Read-write	0x0200	Slave address	Unsigned, 16bit	Range: 0x00~0xFE, Default is 0x01,0xFF is broadcast address	
Write-only	0x0202	Operating mode	Unsigned, 16bit	0x00-controlled mode, 0x01-automatic mode, do not save when power off	
Read-write	0x0207	Set the data type of the automatic output mode	Unsigned, 16bit	0x00-processing value, 0x01 real-time value, Only valid for RS23 mode	
Read-write	0x0205	Switch output polarity	Unsigned, 16bit	Set switch output polarity 0x00-negative output, 0x01-positive output Only valid for switch output	
Read-write	0x0206	Set thresholds of Switch	Unsigned, 16bit	Set the thresholds of the switch value, unit: mm Only valid for switch output	

(1) Remark:Register data is high byte first and low byte last.

(4) Example

Example 1:Read process value data

Master:01 03 01 00 00 01 85 F6

Slave=:01 03 02 02 F2 38 A1

Instruction: Sensor address is 0x01, process distance value is 0x02F2, convert to decimal is 754mm.

Example 2: Read real time data

Master： 01 03 01 01 00 01 D4 36

Slave=： 01 03 02 02 EF F8 A8

Instruction： Sensor address is0x01， real time distance value is 0x02EF,convert to decimal is 751mm

Example 3: Modify slave address

Master:01 06 02 00 00 05 48 71

Slave:01 06 02 00 00 05 48 71

Instruction: Sensor address changed from 0x01 to 0x05.

Example 4: Set operating modes

Master:01 06 02 02 00 01 E8 72

Slave: 01 06 02 02 00 01 E8 72

Instruction: Change the sensor from controlled mode to automatic mode. This register is only for the case that changed from automatic mode to controlled mode by reception of the modbus protocol, and the purpose is to exit the controlled mode and return to the original automatic mode.

Example 5: Set the type of data output in automatic mode

Master: 01 06 02 07 00 01 F8 73

Slave: 01 06 02 07 00 01 F8 73

Instruction: Set the sensor to real-time value output, which is only valid for RS232 mode.

Example6: Modify switch polarity

Master: 01 06 02 05 00 00 98 73

Slave: 01 06 02 05 00 00 98 73

Instruction: Change the positive output of the sensor to negative output.

Example: Modify Switch thresholds

Master:01 06 02 06 07 D0 6B DF

Slave:01 06 02 06 07 D0 6B DF

Instruction: Modify thresholds to 2000mm.