

MEMS Inclinometer Sensor Analog Output User Manual

I. Product Characterization

LVT418T is a low-cost single-axis current output inclination sensor, the output current 4-20mA, 0-20mA optional, can be at the same time TTL serial communication, the user can independently set the range output range.

Products built-in inclination unit, small size, low power consumption, and MEMS microelectromechanical process consistency and stability is very high, the operating temperature to industrial -40-85 °C, long-distance transmission up to 2500 meters or more, real-time output of the current attitude inclination, easy to use, without the need to retrieve the relative change of the two surfaces of the installation. Strong resistance to external electromagnetic interference, can be adapted to work in harsh industrial environments for a long time, is the ideal choice for industrial equipment, platforms to measure the attitude!

II. Product Performance

Single-axis inclination monitoring

Range $\pm 0 \sim \pm 180^\circ$ (0-360°) optional

Output mode 4~20mA, 0-20mA, 0-24mA selectable

Voltage input DC 9~36V

Small size (44*44*30mm) (customizable)

High vibration resistance >3000g

Accuracy 0.2°, high resolution 0.05°

Relative/absolute zero point can be set

New magnet self-priming mounting

IP67 rated (IP68 customizable)

III. Product Applications



Product Performance Indicator

Parameter	Condition	LVT418T-10	LVT418T-30	LVT418T-60	LVT418T-90	unit
Measuring range		±10	±30	±60	±90	°
Measuring Axis	Y-axis selectable	X-axis	X-axis	X-axis	X-axis	
Zero temperature drift	-40 to 85°	±0.05	±0.05	±0.05	±0.05	°/°C
Sensitivity temperature coefficient	-40 to 85°	≤200	≤200	≤200	≤200	ppm/°C
Zero offset	0° output	4-20mA output 12mA 0-20mA output 10mA 0-24mA output 12mA				mA
Frequency Response	DC response	100	100	100	100	Hz
Frequency Response	Bandwidth 5Hz	0.05	0.05	0.05	0.05	°
Accuracy	-40 ~ 85°C	0.2				°
Long-term stability	-40 ~ 85°C	<0.3				°
Power-up time		0.2	0.2	0.2	0.2	s
Response Time		0.01	0.01	0.01	0.01	s
Average operating time		≥55000 Hour/times				
Output Mode		4-20mA, 0-20mA, 0-24mA (selectable)				
Anti-shock		3000g,0.5ms,3 Times/axis				
Anti-vibration		10grms, 10 ~ 1000Hz				
Insulation Resistance		≥100MΩ				
Waterproof rating		IP67				
Cable		Comes standard with a 1.5 meter length of abrasion-, oil-, and temperature-resistant, shielded cable. 4*0.3mm ²				
Weight		60g (without box)				

* The performance parameters are listed as ±10°, ±30°, ±60°, and ±90° for reference only; for other measurement ranges, please refer to the most neighboring parameter.

Electrical Indicator

Parameter	Condition	Minimum value	Typical value	maximum value	Unit
Supply Voltage		9	12	36	V
Working current			40		mA
Output Load	Resistive	0		500	k Ω
Operating Temperature		-40		+85	$^{\circ}$ C
Storage Temperature		-55		+100	$^{\circ}$ C

Noun Explanation:

Resolution: refers to the sensor in the measuring range can detect and distinguish the smallest change in the measured value.

Precision: Absolute accuracy refers to the sensor at room temperature conditions, the absolute linearity, repeatability, hysteresis, zero deviation, and cross-axis error of the combined error.

Long-term stability: long-term stability refers to the sensor at room temperature, after a year of long-term work under the maximum value and the minimum value of the deviation.

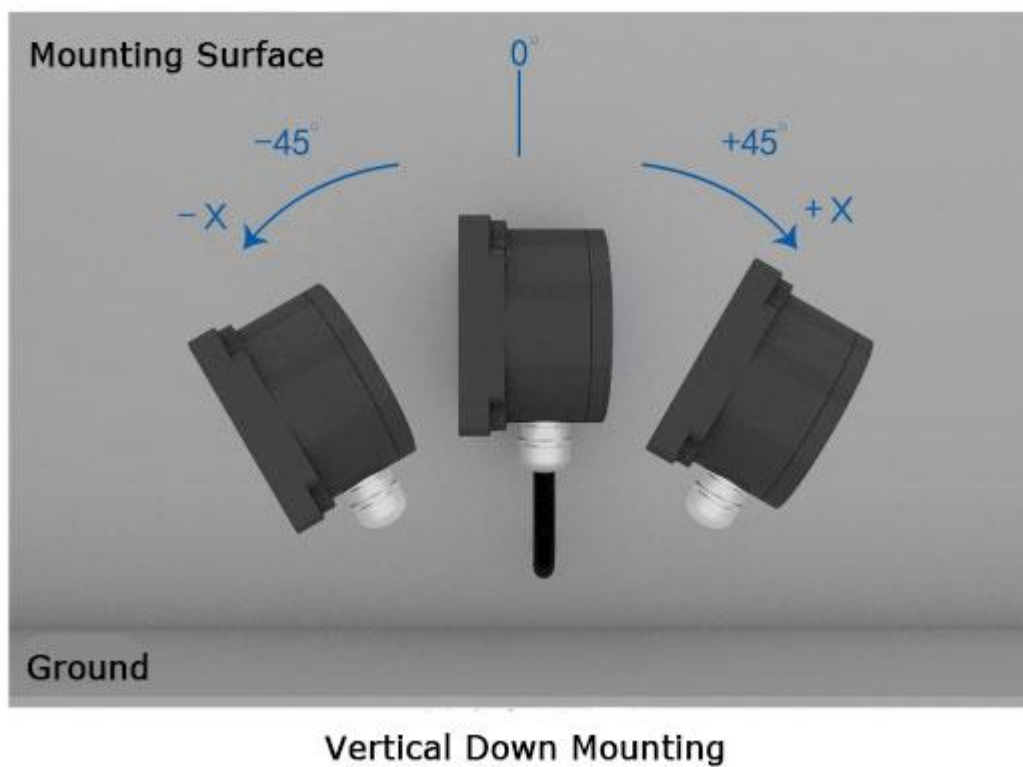
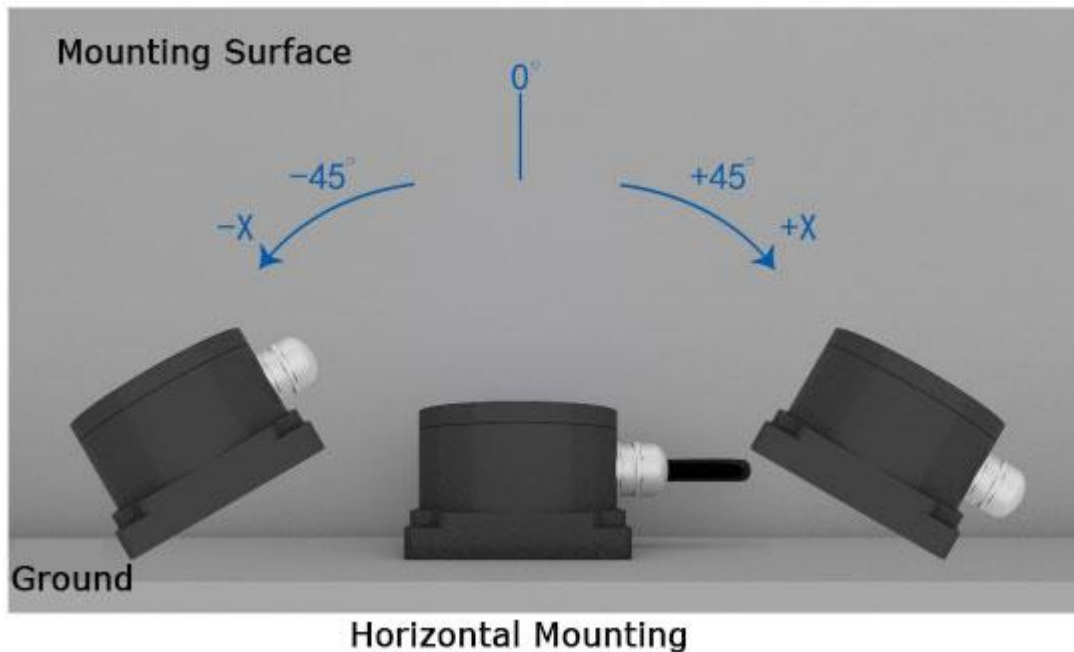
Response time: Response time is the time required for the sensor output to reach the standard value when the sensor angle changes at one time.

Mechanical Properties

Connector	Lead wire (1.5m) or waterproof aviation socket (customized)
Protection class	IP67
Housing Material	Aluminum alloy sandblasted
Mounting	<ol style="list-style-type: none">1. Four M4 screws2. Magnetic mounting (optional when ordering) 

Measuring Direction & Installation

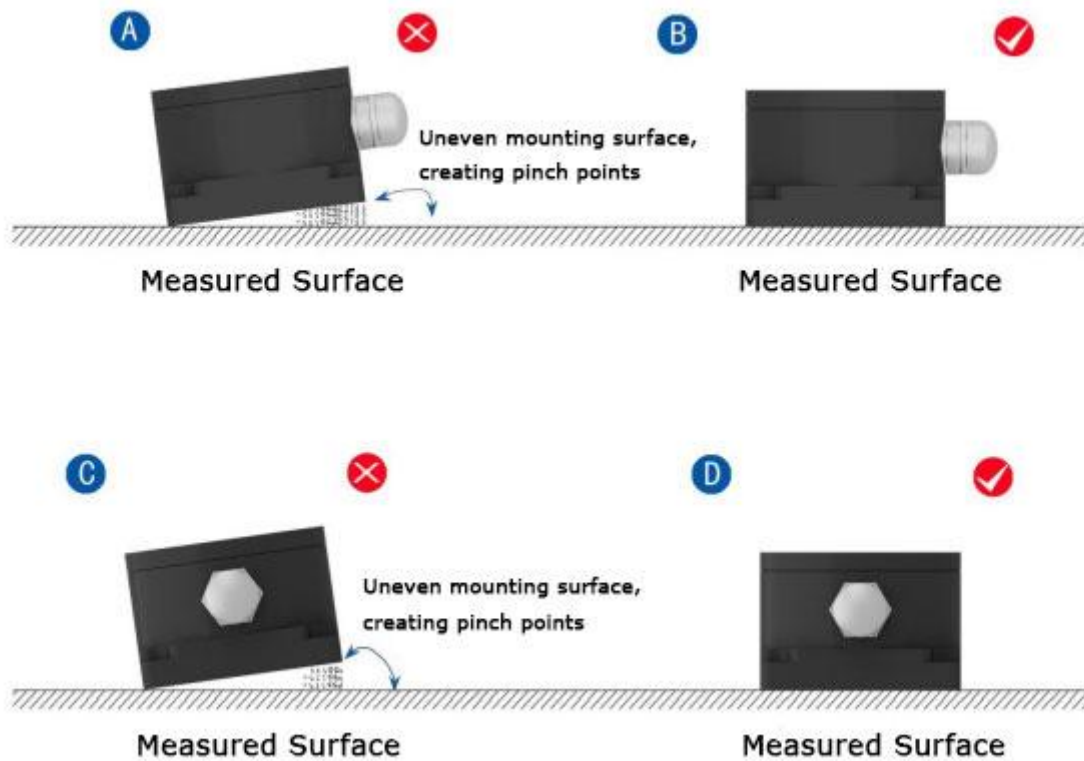
The sensor should be installed parallel to the target surface; it can be installed horizontally or vertically, please refer to the diagram below.



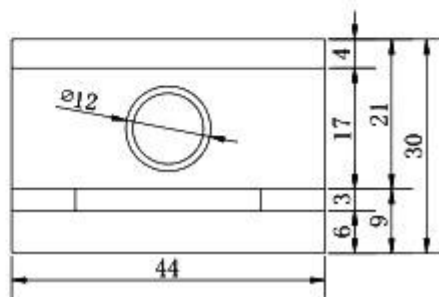
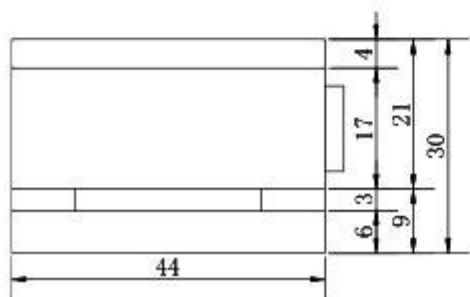
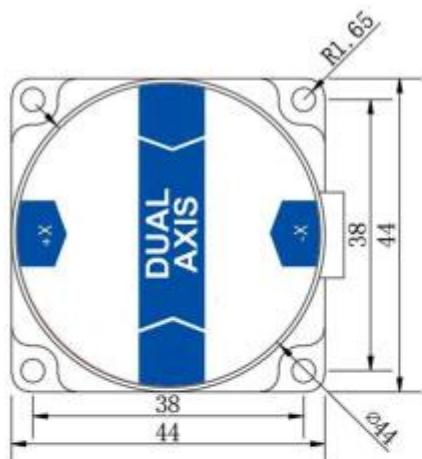
Product Installation Precautions

Please install the inclination sensor in accordance with the correct method, incorrect installation will lead to measurement errors, in particular, pay attention to a "surface", two "line": (1) the sensor's mounting surface and the measured surface must be fixed tightly, flat, stable, if the mounting surface is uneven, it will easily cause the sensor to measure the angle error. If the mounting surface is uneven, it is easy to cause the sensor to measure the angle error. See Figure A, B

2) The sensor axis and the measured axis must be parallel, the two axes as far as possible not to produce the angle. See Figure C, D



Product Dimension



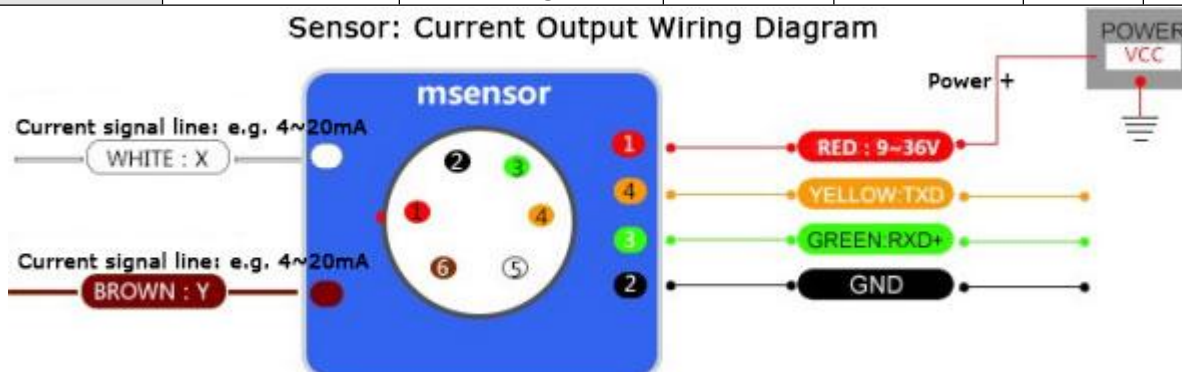
Product size: L44*W44*H30MM

Default horizontal upward installation: the installation should keep the sensor mounting surface parallel to the target surface to be measured; please refer to the rotating schematic for the installation method. For other mounting methods, please refer to the "Product Mounting Methods" diagram, and make a note when ordering.

Product Electrical Connection

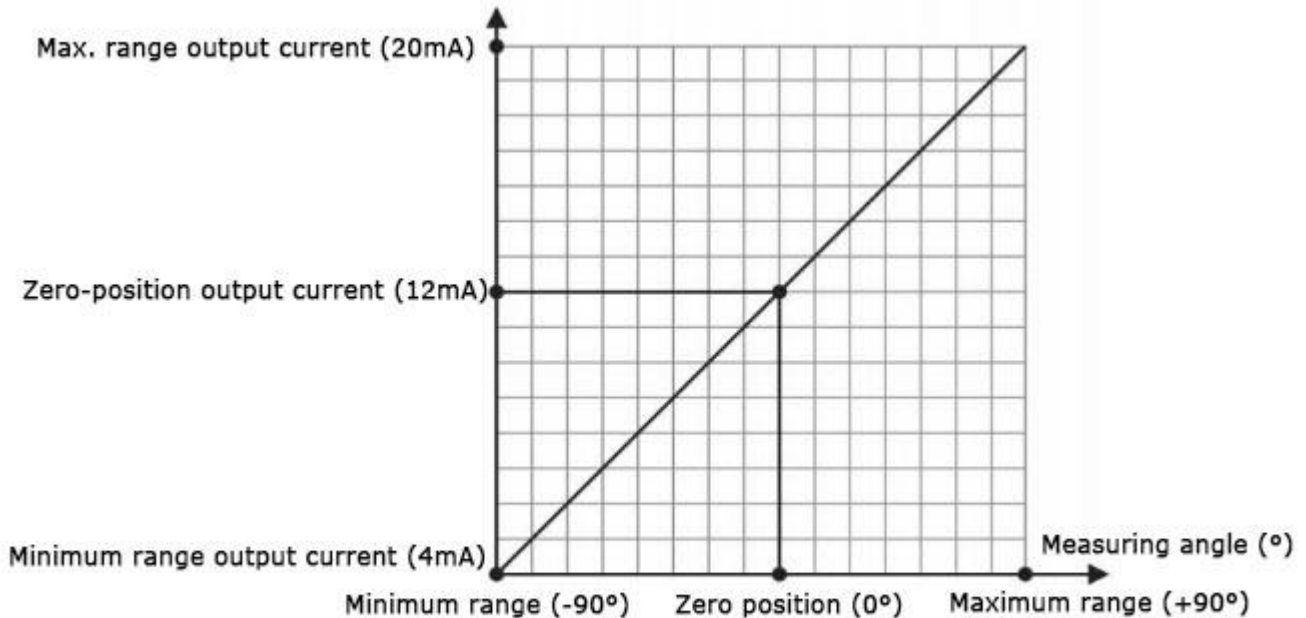
Line Color	RED	BLACK	GREEN	YELLOW	WH	BR
Function	1	2	3	4	5	6
	VCC Power Positive	GND Power Negative	TTL RXD	TTL TXD	Out X	Out Y

Sensor: Current Output Wiring Diagram



LVT418T output is standard current 4-20mA, 0-20mA, corresponding to the minimum range and maximum range of angle measurement; when calculating the angle, just press the ratio to get the corresponding angle value:

For example: LVT418T-90 (4~20mA): indicates $\pm 90^\circ$ measuring range, 4~20mA output current.



Current Output and Angle Calculation Formulas

Current output and angle conversion equations:

$$\text{Inclination angle} = \text{Sensitivity} * (I_{out} - I_{offset})$$

Current tilt angle

I_{out}: Current value of the sensor output, unit mA

I_{offset}: Sensor zero position output current value (typically 12mA)

Sensitivity: Sensor sensitivity is the proportion of the change in current corresponding to a change in the inclination of the sensor, e.g., if the range of the sensor is $\pm 90^\circ$, and the corresponding change in current is 4-20 mA, then the sensor sensitivity is 11.25.

$$90 - (-90) = \text{sensitivity} * (20 - 4)$$

If the current output current is 16mA, the corresponding tilt angle is 45 degrees:

$$45 = 11.25 * (16 - 12)$$

For example, if the range of the sensor is $\pm 30^\circ$ and the corresponding current variation is 4-20mA, the sensitivity of the sensor is 3.75.

$$30 - (-30) = \text{sensitivity} * (20 - 4)$$

If the current output current is 16mA, the corresponding tilt angle is 15 degrees:

$$15 = 3.75 * (16 - 12)$$

Communication Protocols

1 Data Frame Formatting: 1 (8 data bits, 1 stop bit, no parity, default rate 9600)

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)		(1byte)
0x68					

Data format: hexadecimal

Marker: Fixed to 0x68

Data length: length from data length to checksum (including checksum)

Address code: address of acquisition module, default is 0x00.

Data field: the content and length change according to the command word.

Checksum: the sum of data length, address code, command word and data field, not considering rounding (Note: when the command word or data field changes, the checksum will change. When you change the data field, please change the checksum accordingly).

2 Command Format

2.1 Reading the X-axis angle

Send command: 68 04 00 01 05

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(0byte)	(1byte)
0x68			0x01		

Response

command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(3byte)	(1byte)
0x68			0x81	SXXX.YY	

Note: The data field is a 3-byte return angle value, compressed BCD code, S is the sign bit (0 positive, 1 negative), XXX is a three-digit integer value, and YY is a decimal value. Other axis data are the same as this one. For example, 102680 means -26.8°.

2.2 Setting Relative/Absolute Zero

Send command: 68 05 00 05 00 0A

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x05	0x00: Absolute zero 0x01: Relative zero	

Response

command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x85	0x00: Successful setup 0xFF: Setup failure	

Note: If absolute zero is set, the measurement angle will be based on the zero point set by the factory. If it is set as relative zero point, the measuring angle will be based on the current position as the zero point. This function is the same as grounding the gray output line.

2.3 Query Relative/Absolute Zero

Send command: 68 04 00 0D 11

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(0byte)	(1byte)
0x68			0x0D		

Response

command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x8D	0x00: Absolute zero 0xFF: Relative zero	

2.4 Setting Communication Rate

Send command: 68 05 00 0B 03 13

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x0B		

Response

command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x8B	0x00: Successful setup 0xFF: Setup failure	

Note: 0x00 means 2400, 0x01 means 4800, 0x02 means 9600, 0x03 means 19200, 0x04 means 115200, 0x05 means 14400, 0x06 means 38400, 0x07 means 57600, and the default value is 0x02:9600. If you set the baud rate to 19200, the command will be 68 05 00, where 13 = 05+ 00+ 0B+ 03, and so on when setting other baud rates. 0B 03 13, where 13 = 05+ 00+ 0B+ 03, and so on when setting other baud rates. Each time when the baud rate is successfully changed, the response command will be sent back at the original baud rate, and then the baud rate of the device will be changed immediately.

Note: If you need high frequency output, please set the baud rate to 115200.

2.5 Setting the Angle Mode

Send command: 68 05 00 0C 00 11

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x0C	0x00: question-and-answer style 0x01: 5Hz Data Rate 0x02: 15Hz Data Rate 0x03: 25Hz Data Rate 0x04: 35Hz Data Rate 0x05: 50Hz Data Rate	

*The default output mode is 00; if the device is in non-answer mode, there will be 10s of idle time without sending data after each power restart, and after 10s, it will start to output data continuously.

Response command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x8C	0x00: Successful setup 0xFF: Setup failure	

Note: 5Hz Data Rate means that data is automatically output 5 times per second, and so on. When you are using the product with RS485 interface, because the 485 interface works in half-duplex, the product may not be able to receive the incoming commands efficiently when it automatically outputs data to the outside. In this case, you may need to repeat the command several times before the product receives it. Therefore, if you need to send commands to interact with the product while using the 485 interface, it is recommended that you set the product to work in the Question and Answer mode. In addition, when the product is set to Auto Output Mode, there will be no output for 10 seconds after the product is powered on, and then the product can effectively receive external setup commands.

2.6 Setting Module Address

Send command: 68 05 00 0F 01 15

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x0F	XX module address	

Note: The default address of the sensor is 00.

Response command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x8F	0x00: Successful setup 0xFF: Setup failure	

1. If more than one sensor is connected to a bus at the same time, for example, RS485, it is necessary to set each sensor to a different address to achieve separate control and response speed.
2. If you successfully change the new address, all subsequent commands and response packets in the address code to change the new address code in order to take effect, otherwise the sensor will not respond to the command.

3.XX module address from 00 to EF range.

2.7 Query Module Addresses

Send command: 68 04 00 1F

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(0byte)	(0byte)
68	04	00	1F		

Note: The query module address does not take into account the parity bit

Response command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x1F		

2.10 update flash (Save Settings)

Send command: 68 04 00 0A 0E

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(0byte)	(1byte)
0x68			0x0A		

Response command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x8A	0x00: Successful setup 0xFF: Setup failure	

*If the save setting command is not sent after the setting is completed, the settings will be lost when the power is turned off.

2.11 Restore Factory Setting

Send command: 68 04 00 0E 12

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(0byte)	(1byte)
0x68			0x0E		

Response command:

Identifier	Data Length	Address Code	Command Word	Data Field	Checksum
(1byte)	(1byte)	(1byte)	(1byte)	(1byte)	(1byte)
0x68			0x8E	0x00: Successful setup 0xFF: Setup failure	