

**ZCT330Mx-xWP-xN-YKx NB-IoT Tiltmeter
Datasheet**



4010 Foothills Blvd. Suite 103/194
Roseville, CA 95747, USA

www.quakelogic.net

+1-916-899-0391

sales@quakelogic.net

ZCT330Mx-xWP-xN-YKx NB-IoT Tiltmeter

Datasheet



I. Overview

CT330Mx-xWP-xN-YKx is a high-accuracy dual-axis tiltmeter made by Shanghai Zhichuan Electronic Tech Co., Ltd. using the latest NB-IoT technology for communication. The maximum measurement range is ± 30 degrees, with alarm function, and the default protocol is CTIOT (based on China Telecom platform), with MQTT (connectable to Onenet platform) and CoAP as optional. The product can be widely used in geotechnical and structural health monitoring, municipal administration, telecommunications, public utility and many other areas.

II. Applications

Safety control
Monitoring
Alarming

III. Features

Made using industrial class components
Stable and reliable performance
Ultra-low power consumption

IV. Specifications

(Unless otherwise noted, the following parameters are typical values at 25°C)

1. Working parameters:

Item	Conditions	Min	Typical	Max	Unit
Power Source	3.6V C-size Lithium Thionyl Chloride battery with hybrid pulse capacitor ⁽¹⁾	2.7	3.6	3.8	VDC
Quiescent Current (Standby)	Alarm Enabled		210	220	uA
	Alarm Cancelled		1.5	5	

Peak Current			300	1,000	mA
Working Temperature		-40		+85	°C
Stocking Temperature ⁽²⁾	Battery not included	-40		+85	°C
	Battery included	25		30	°C

Note 1: Lithium Thionyl Chloride batteries should never be recharged, otherwise they may explode. When a battery is out of power, please replace it in time, do not charge it!

Note 2: The self-discharge rate of the battery is less than 3% a year, if it is stocked at room temperature (25°C). The self-discharge rate becomes higher if the battery is stocked at a higher temperature.

2. Performance:

Item	Testing Conditions	Min	Typical	Max	Unit
Measuring Range	Two Axis	-30		30	degree
Resolution ⁽¹⁾			0.001		degree
Accuracy	-15 ~ +15°C		±0.005	±0.01	degree
	-15 ~ +15°C		±0.01	±0.02	degree
Zero Point Temperature Drift	-40°C ~ +85°C		±0.002		degree/°C
				±0.2	degree
Zero Point Deviation			±0.05		degree
Heartbeat Interval ⁽²⁾		60	86,400 (default)	131,071	second
Alarm Angle	same for X and Y axis		3		degree
Alarm Accuracy ⁽³⁾	-5° ~ +5°		±0.01	±0.03	degree
	-15° ~ +15°		±0.03	±0.1	degree
	-30° ~ +30°		±0.1	±0.3	degree
Alarm Delay Time ⁽⁴⁾		0.3	2 (default)	25.5	second
Battery Working Time ⁽⁵⁾			3		year
IP level	housed		IP65		
Weight	plastic housing	229	249	269	g
	metal housing	456	476	496	g

Note 1: Resolution refers to the minimum variation that can be detected by the sensor while working in its valid range.

Note 2: Heartbeat interval refers to the time interval at which the device periodically

uploads data to the server.

- Note 3: Alarm accuracy refers to the angular error when the product triggers an alarm. Suppose the alarm angle is 3 degree and the alarm accuracy is 0.03 degree, if X and Y axis angle are smaller than 2.97 degree, alarm will not be triggered, if X or Y axis angle is between 2.97 and 3.03 degree, alarm may or may not be triggered, if X or Y axis angle is larger than 3.03 degree, the alarm will be triggered for sure.
- Note 4: Alarm delay time refers to the time when the product continues to tilt beyond the alarm angle to trigger an alarm.
- Note 5: Estimation is based on such conditions: at an ambient temperature of 25°C, the capacity of the battery is 8,500mAh, the battery loss factor is 0.7, and the heartbeat rate is 24 hours. Average current for transmitting data $\approx 31\text{mA}$, time for single transmission $\approx 22\text{s}$, battery working time = $8500 \times 0.7 / 24 / 365 / ((0.21 \times (24 - 22 / 3600) + 31 \times 22 / 3600) / 24) \approx 3$ years.

V. Instructions for Use

1. Instructions on Installation

- 2.1 The product measures absolute angle, and should be installed on the measured object horizontally.
- 2.2 Set parameters of the product on the platform, otherwise it will work according to the default parameters.
- 2.3 Plug in the battery, the product will start to work, and the indicator light will flash. If the indicator light does not flash, unplug the battery and wait for about 1 minute for the product to discharge completely, or tilt the product to make it alarm and discharge completely. In about 30 ~ 120 seconds, the telecom platform or the broker server will receive a frame of data, so the installation is successful.
- 2.4 If the platform or broker server does not receive data in 5 minutes, please confirm that the product is in an area covered by the NB network, reboot the product, and wait for the data to upload again.

2. Heartbeat

From the time the product is powered on, the product will upload a heartbeat frame every heartbeat period (settable). After the product receives the command to modify the heartbeat time, the period in which the product uploads the heartbeat frame will change. After the heartbeat frame is sent successfully, the device waits for 5 seconds before entering standby mode, if no command is received from the server.

3. Alarm

When the tiltmeter tilts beyond the alarm angle, alarm will be triggered and the tiltmeter will upload the alarm frame every 60 minutes. The first detected alarm angle value will be used as the angle value in the alarm frame. The tiltmeter detects itself every 60 seconds until its tilt angle is smaller than the alarm angle again, then the alarm function is automatically restored.

If the alarm frame is not successfully uploaded, the tiltmeter will upload it at intervals of 5 minutes, 15 minutes, 30 minutes and 60 minutes until the alarm frame is sent successfully. After the alarm frame is sent successfully, the device waits for 5 seconds before entering standby mode, if no command is received from the server.

The data ID's sent with the heartbeat frame and the alarm frame include 0x01, 0x02, 0x03, 0x04, 0x0C, 0x0D, 0x11, 0x17, 0x18, and 0x19, representing product P/N, product model, X-axis angle, Y-axis angle, sensor temperature, power supply voltage, enable/disable status, signal strength, work mode and alarm axis respectively.

4. Reset

When the product is working, the indicator light flashes. If we press and hold the reset key for 3 seconds, the red and green lights of the tiltmeter will flash synchronously at the frequency of 4Hz, and then both stop flashing but keep shining. At this time, release the reset button and wait for about 3 seconds, the device will reboot and the parameters of the tiltmeter will be reset to the default values. The IP and port of the server using CTIOT protocol will be reset to 117.60.157.137, 5683, the IP and port of the broker server will be reset to mqtt.zc-sensor.com, 1883, while the IP and port of the server using CoAP protocol will be reset to 101.132.187.83, 5683.

5. LED Description

Green LED	Red LED	Descriptions
Off	Off	standby mode
Flash, 1Hz	Off	upload heartbeat frame
Off	Flash	upload alarm frame and tilt angle
Flash synchronously, 4Hz		reset button pushed
On		reset to default settings

6. Protocol Format

The protocol format blow (IoT Tilt Sensing Devices Communication Protocol of Shanghai Zhichuan Electronic Tech Co., Ltd. Version 1.1) applies to CTIOT protocol and MQTT protocol

only.

Valid data ID and parameter range supported by the product						
Data ID	ID Descriptions	Data Type (Data Length)	R/W	Range	Default	Remark
0x00 ⁽¹⁾	Sequence No.	DWord(4)	R	/	0	The ID can be carried when platform downstream reads device and sets device parameters. The device returns the same data. Refer to examples in Appendix.
0x01	P/N	DWord(4)	R	/	/	/
0x02	Model	Byte(1)	R	32	32	Factory code:32
0x03	X-axis angle	Float(4)	R	-90°~90°	/	X-axis angle
0x04	Y-axis angle	Float(4)	R	-90°~90°	/	Y-axis angle
0x09	X-axis relative angle	Float(4)	R	-90°~90°	0	Return the X-axis angle value when relative zero point is set
0x0A	Y axis relative angle	Float(4)	R	-90°~90°	0	Return the Y-axis angle value when relative zero point is set
0x0C	Sensor temperature	Word(2)	R	-32768~32767	/	sensor temperature=data/100 unit: °C
0x0D	Power supply voltage	Word(2)	R	0~65535	/	voltage=data/100 unit: V
0x11	Enable/disable	Byte(1)	R/W	0~255	1	0=disable, non-zero= enable
0x12	Alarm delay time	Byte(1)	R/W	3~255	20	The device waits for a certain period of time, after the tilt exceeds the alarm angle, before alarming. unit: 0.1 second
0x13 ⁽²⁾	Restore factory settings	Byte(1)	R/W	0~255	0	0=do nothing non-zero=restore non-network-related parameters of the device
0x14	Server IP and port	4*Byte(1)+Word(2)	R/W	/	CTIOT: 117.60.157. 137, 5683 MQTT: 0.0.0.0, 0	/
0x17	Signal strength	Byte(1)	R	10~34	/	A larger value indicates a stronger signal.
0x18	Sensor work mode	Byte(1)	R/W	0	0	The sensor can only work in absolute measurement mode.
0x19	Alarm axis	Byte(1)	R	0~3	/	0=no alarm; 1=X-axis alarm; 2=Y-axis alarm; 3=X/Y axis alarm at the same time
0x1A	SIM card ID	QWord(8)	R	0~184467	/	Take the first 19 bits and discard the last bit

				44073709 551615		(check bit)
0x21	Heartbeat interval	DWord(4)	R/W	60~ 131071	86400	interval at which the device periodically uploads data to the server
0x22	IMEI of the device	QWord(8)	R	0~184467 44073709 551615	/	IMEI of the NB-IoT module inside the device
0x23	Backup server IP and port	4*Byte(1) +Word(2)	R/W	/	CTIOT: 117.60.157. 137, 5683 MQTT: 0.0.0.0, 0	/
0x24	Backup server enable	Byte(1)	R/W	0~255	0	0=off; non-zero=on
0x33	DNS IP address	4*Byte(1)	R/W	/	208.67.222. 222	/
0x34	Domain name and port	64*Byte(1)	R/W	/	mqtt.zc-sensor. com,1883	CTIOT and MQTT protocol are supported. IP address (Data ID 0x14) has priority over domain name. Domain name and port should be separated with comma, length <=64
0x35	MQTT ClientID	32*Byte(1)	R/W	/	Device IMEI	Length <=32, subject to MQTT protocol
0x36	MQTT Username	32*Byte(1)	R/W	/	empty	Length <=32, subject to MQTT protocol
0x37	MQTT Password	32*Byte(1)	R/W	/	empty	Length <=32, subject to MQTT protocol
0x38 ⁽³⁾	MQTT publishing topic name	128* Byte(1)	R/W	/	Inclinometer/Z CT330Mx_SWP _N_YK/IMEI/up	Length <=128, subject to MQTT protocol
0x39	MQTT subscription topic name	128* Byte(1)	R/W	/	Inclinometer/Z CT330Mx_SWP _N_YK/IMEI/do wn	Length <=128, subject to MQTT protocol
0x3A	Set relative zero command	Byte(1)	R/W	0~255	0	0=absolute angle mode; 1=set the current position to zero, relative angle mode (0x09 and 0x0A are current angle values); Other values are invalid.
0x3B	Backup server domain name and port	64*Byte(1)	R/W	/	mqtt.zc-sensor. com, 1883	CTIOT and MQTT protocol are supported. Backup IP address (Data ID 0x23) has priority over backup domain name. Domain

						name and port should be separated with comma, length <=64
0x3D ⁽⁴⁾	Protocol type	Byte(1)	R/W	0~255	CTIOT	0=CTIOT 1=MQTT Other values are invalid.
0x44	Alarm angle	Float(4)	R/W	-90°~90°	3°	Alarm angle for X-axis and Y-axis are the same.

- A single data ID or a combination of data ID's can be sent to the device according to the protocol format.

Note 1: When carrying a sequence number, the data packet must contain 1 byte of data ID, 1 byte of data length, and 4 bytes of data content. Please refer to Appendix.

Note 2: When the device is reset to default factory settings, the heartbeat interval, alarm angle, alarm delay time, relative angle and enable/disable status will be restored to the default values, while the other parameters will remain unchanged.

Note 3: About format of publishing topic and subscription topic, find below an example.

IMEI is 869858031635304, then

default publishing topic is Inclinometer/ZCT330Mx_SWP_N_YK/869858031635304/up,

default subscription topic is Inclinometer/ZCT330Mx_SWP_N_YK/869858031635304/down.

Note:

- The first character of "Inclinometer" should be capitalized, product model ZCT330Mx_SWP_N_YK should be capitalized, up/down should be in lower case.
- Replace crossbar "-" with underscore "_" in the product number.
- The topic applied to OneNet platform must be a combination of numbers, English characters, underscores (_), backslashes (/), and must be in compliance with OneNet's rules on MQTT protocol.
- Because the NB-IoT network is designed for application scenarios with less data, the maximum data length of read/write parameter is 512 bytes, and it is better if the length is less than 300 bytes, otherwise the device may not return data (depending on the parameters of different protocols).

Note 4: When changing the protocol type remotely, one should also modify the server IP address. Otherwise, the device may not connect to the server.

7. Upstream parameter setting result code

Result code	Analysis
1	Set successfully
2	Parameter length incorrect (handled as protocol error if no return from device)
3	Incorrect parameter range
4	Data ID not writable

8. Note on backup server IP

When backup server is not set, if the device fails to upload data to the server, it will lose the data and enter standby mode. When backup server is enabled, if the device fails to upload data to the server, it will re-send the same data to the backup server; if it fails to upload data to the backup server, it will lose the data and enter standby mode.

9. CoAP protocol

9.1 In case of obtaining real-time data of the device via telemetry messages, the default URI is /api/v1/ZCIMEI/telemetry, where IMEI refers to IMEI of the device. For example, IMEI is 864823042076612, the telemetry message URI of the device is /api/v1/ZC8648823042076612/telemetry. The device sends data to the server through POST requests.

The data type of the telemetry messages is json, and the format is as follows:

```
{
  "msgType": "heartbeat",
  "rssi": 35,
  "rsrq": 24,
  "battery": 3.52,
  "xAngle": -0.1379,
  "yAngle": -0.0206,
  "xAlarm": false,
  "yAlarm": false,
  "temperature": 31.96
}
```

Key	Value	Value Type	Description
msgType	Heartbeat or alarm	character string	Heartbeat: heartbeat frame data Alarm: alarm frame data
rssi	0~99	numerical value	RSSI signal level: 0 = -110dbm or less 1 = -110dBm<=RSSI<=-109dBm 62 = -49dBm<=RSSI<=-48dBm 63 = -48dBm<=RSSI 99 = unknown or undetectable

rsrq	0~255	numerical value	Signal strength of RSRQ 0 = -19.5dB or less 1 = -19.5dB<=RSRQ<=-19dB 2 = -19dB<=RSRQ<=-18.5dB 33 = -3.5dB<=RSRQ<=-3dB 34 = -3dB<=RSRQ 255 = unknown or undetectable.
battery	2.0~3.8	double decimal	Battery voltage, less than 3.2V means that the battery is running out of power Unit: V
xAngle	-90.0~+90.0	double decimal	Real-time angle of the X-axis Unit: degree
yAngle	-90.0~+90.0	double decimal	Real-time angle of Y-axis Unit: degree
xAlarm	true or false	Boolean type	true: X-axis alarming false: X-axis not alarming
yAlarm	true or false	Boolean type	true:Y-axis alarming false: Y-axis not alarming
temperature	-40.0~85.0	double decimal	Sensor temperature Unit: ℃

9.2 Client attributes

The default URI of client attributes is /api/v1/ZCIMEI/attributes, where IMEI refers to IMEI of the device. For example, if IMEI is 864823042076612, the client attributes URI of the device is /api/v1/ZC864823042076612/attributes. The device sends data to the server through POST requests.

The data type of client attributes messages is json, and the format is as follows:

```
{
  "pn":1901016001,
  "mode":32,
  "sim":8986111828300029268,
  "imei":864823042076612
}
```

Key	Value	Value Type	Description
pn	0~4294967296	numerical value	P/N of the product
mode	32	numerical value	Fixed to 32 for the product
sim	/	numerical value	Nano SIM card number
imei	/	numerical value	IMEI of the device

9.3 Share attributes

The default URI of share attributes is `/api/v1/ZCIMEI/attributes`, where IMEI refers to IMEI of the device. For example, if IMEI is 864823042076612, the share attributes URI of the device is `/api/v1/ZC864823042076612/attributes`. The device requests the server to send data through GET.

The data type of share attributes messages is json. Please follow below format:

```
{
  "alarmEnable":true,
  "alarmAngle":3,
  "alarmDelayTime":20,
  "relativexAngle":0,
  "relativeyAngle":0,
  "heartbeatTime":3600
}
```

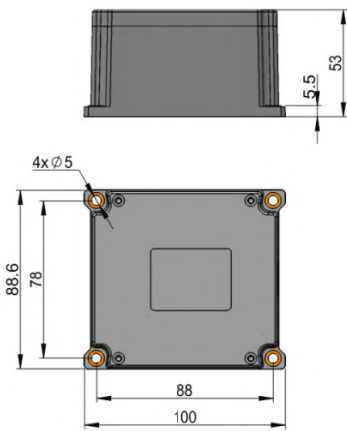
Key	Value	Default	Value Type	Description
alarmEnable	true or false	true	Boolean type	True = enable alarm mode False = disable alarm mode
alarmAngle	0.0~90.0	3.0	double decimal	Alarm angle Unit: degree
alarmDelayTime	3~255	20	numerical value	Alarm delay time Unit: 0.1s
relativexAngle	0.0~90.0	0	double decimal	Set the relative angle of X-axis Unit: degree For example, if the current relativexAngle = 0 and the telemetry message shows xAngle = 1.0, then xRealAngle = 0 + 1.0 = 1.0 degree; if the current position is set as relative zero point, xAngle = 0, relativexAngle = xRealAngle = 1.0, after successful setting, the next telemetry message will display xAngle = 0. ⁽¹⁾
relativeyAngle	0.0~90.0	0	double decimal	Set the relative angle of Y-axis Unit: degree For example, if the current relativeyAngle = -1.2 and the telemetry message shows yAngle = 1.0, then yRealAngle = 1.0 + (- 1.2) = -0.2 degree; if the current position is set as relative zero point, yAngle = 0, relativeyAngle = yRealAngle = -0.2, after successful setting, the next telemetry message will display yAngle = 0.

heartbeatTime	0~131071	86400	numerical value	Set the heartbeat interval Unit: second
---------------	----------	-------	-----------------	--

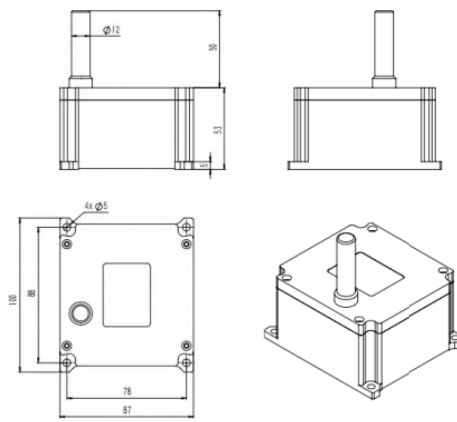
Note 1: Telemetry message output angle $xAngle = xRealAngle - relativexAngle$, so the actual angle of current axis $xRealAngle = xAngle + relativexAngle$.

VI. Product size and measurement directions

1. Size (length of the external antenna is 5cm)

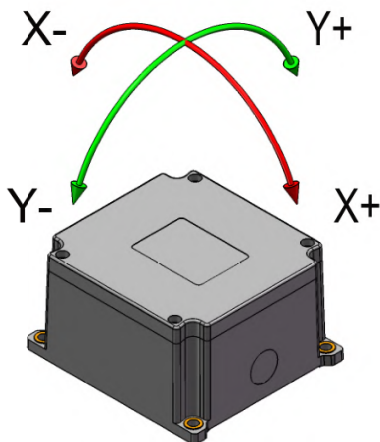


ZCT330M-SWP-N-YK

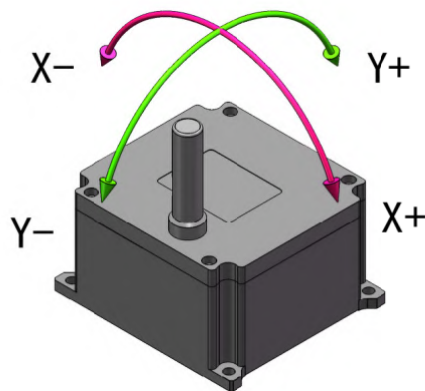


ZCT330M1-LWP-AN-YKG

2. Measurement directions



ZCT330M-SWP-N-YK



ZCT330M1-LWP-AN-YKG

VII. Ordering Information: ZCT330Mx-xWP-xN-YKx

1. Default battery capacity (customizable) is 8,500mAh.
2. Default product model is ZCT330M-SWP-N-YK, with internal antenna:

Product Model	Antenna Type	Housing Type
ZCT330M-SWP-N-YK	Internal	Plastic
ZCT330M1-LWP-AN-YKG	External	Metal (Aluminum alloy)

3. The gravity acceleration value adopted for the product is of Shanghai area by default. If more accurate output is required, please provide us with your local gravity acceleration value. Some examples:

Region	Shanghai	Guangzhou	Beijing	Moscow	Tokyo	New York
Gravity acceleration (g) value (m/s ²)	9.794	9.788	9.801	9.816	9.798	9.803

4. CTIOT is the default protocol and China Telecom is the default SIM card provider. If MQTT protocol, CoAP protocol, third-party server or non-default SIM card provider is needed, please advise in advance.

Protocol	Default SIM card provider	Default server
CTIOT	China Telecom	117.60.157.137, 5683
MQTT	China Mobile or China Unicom	mqtt.zc-sensor.com, 1883
CoAP	China Telecom	101.132.187.82, 5683

This information in this datasheet is for reference only. Shanghai Zhichuan Electronic Tech Co., Ltd. has the right to amend it without notice.

Appendix I

(Applicable for CTIOT and MQTT protocol only, not applicable for CoAP protocol)

Chapter One Basic Agreement

1.1 Basic Protocol

The protocol uses small-end mode network bytes to transfer bytes, words, double words, quadruple words and floats.

- Bytes are transmitted in a byte stream;
- Words are transmitted by sending the lower 8 bits first and then the upper 8 bits;
- Double words (DWords) are transmitted by sending the lower 8 bits first, then the upper 8 bits, then the upper 16 bits, and finally the high 24 bits.
- Quadruple words (Qwords) are transmitted by sending the lower 8 bits first, then the upper 8 bits, then the upper 16 bits, and so on, and finally the upper 56 bits;
- Floats are transmitted by sending the lower 8 bits first, then the upper 8 bits, then the upper 16 bits, and finally the high 24 bits.

1.2 Upstream

Refers to the direction the IoT device (tiltmeter) uploads data to the server platform (device → platform).

1.3 Downstream

Refers to the direction the server platform downloads data to the IoT device (tiltmeter) (platform → device).

1.4 Protocol Format

Frame Data Format					
Frame Header	Protocol Version	Function Code	Data Length	Data Packet	Check Bits
1 byte	1 byte	1 byte	2 byte	N byte	CRC

Frame header: 0x5A;

Protocol version: 0x0A for V1.0, 0x0B for V1.1, and so on, protocol version = version number *10;

Function code: 0x03, 0x06, 0x07, 0x08, see Chapter 2 for details;

Data length: the length of the packet content (n), low byte first, high byte follows;

Packet: See Chapter 2 for details. Data transmission follows the rule that low byte first and high byte follows.

Check bits: The length of the checked data is from the first byte to the byte before the check bits. Modbus CRC16 method is applied. Low byte first, high byte follows.

Chapter Two Protocol Format

2.1 Upstream data format

Frame Content						Description
Frame Header	Protocol Version	Function Code	Data Length	Data Packet	Check Bits	
0x5A	0x0B	0x07	length	...	Modbus CRC16	Upstream heartbeat frame
		0x08				Upstream alarm frame
		0x03				Upstream return read parameter frame
		0x06				Upstream return write parameter frame

2.2 Downstream data format

Frame Content						Description
Frame Header	Protocol Version	Function Code	Data Length	Data Packet	Check Bits	
0x5A	0x0B	0x03	length	...	Modbus CRC16	Downstream read parameter frame
		0x06				Downstream write parameter frame

- When the downstream data includes frame header error, function code error or CRC error, the device does not respond.

2.3 Data Packet Structure

Type A:

Data ID
1 byte

- Applied to the frame structure of downstream read parameters. The data packet needs to include Data ID only, except for Data ID-00 (sequence number). Refer to the data structure table for data ID.

Type B:

Data ID	Data Length	Data Range
1 byte	1 byte	n bytes (determined by data length)

- Applied to the frame structure of upstream heartbeat frame, upstream alarm frame, upstream return read parameter frame and downstream write parameter frame. Refer to the data structure table for data ID, data length and data range.

Type C:

Data ID	Set Result
1 BYTE	1 BYTE

- Applied to the upstream return write parameter frame. Refer to the data structure table for data ID, refer to the setting result table for setting result.

Note:

1. If the downstream read parameter contains sequence number, the packet must be formed according to Type B;
2. If the protocol does not support the data ID, the returned data length is 0.

Chapter Three Examples

3.1 Upstream heartbeat frame

Frame Header	Protocol Version	Function Code	Data Length	Data Packet 1	Data Packet 2	Data Packet 3	Data Packet 4
5A	0B	07	29	00 01 04 C1 33 4F 71	02 01 20	03 04 3C BD 52 3E	04 04 3C BD 52 BE
Data Packet 5	Data Packet 6	Data Packet 7	Data Packet 8	Data Packet 9	Data Packet 10	Check Bits	
0C	02 82 09 0D 02 68 01 11 01 01	17 01 19	18 01 00	19 01 00	50	2B	

Analysis:

- Data Packet 1: product serial number 1901016001;
- Data Packet 2: product model is 0x20;
- Data Packet 3: X-axis angle, 0.2058 degree;

- Data Packet 4: Y-axis angle, -0.2058 degree;
- Data Packet 5: sensor temperature, 24.34°C;
- Data Packet 6: power supply voltage, 3.6V;
- Data Packet 7: alarm function enabled;
- Data Packet 8: signal strength is 25;
- Data Packet 9: absolute angle mode;
- Data Packet 10: alarm not triggered

3.2 Upstream alarm frame

Frame Header	Protocol Version	Function Code	Data Length	Data Packet 1								Data Packet 2			Data Packet 3				Data Packet 4						
5A	0B	08	29	00	01	04	C1	33	4F	71	02	01	01	03	04	00	00	B0	C0	04	04	3C	BD	52	BE
Data Packet 5				Data Packet 6				Data Packet 7			Data Packet 8			Data Packet 9		Data Packet 10		Check Bits							
0C	02	82	09	0D	02	68	01	11	01	01	17	01	19	18	01	00	19	01	01	BC	79				

Analysis:

- Data Packet 1: product serial number 1901016001;
- Data Packet 2: product model is 1;
- Data Packet 3: X-axis angle, -5.5°;
- Data Packet 4: Y-axis angle, -0.2058°;
- Data Packet 5: sensor temperature, 24.34°C;
- Data Packet 6: power supply voltage, 3.6V;
- Data Packet 7: alarm function enabled;
- Data Packet 8: signal strength is 25;
- Data Packet 9: absolute angle mode;
- Data Packet 10: X-axis alarm triggered

3.3 Read parameter frame

Downstream:

Frame Header	Protocol Version	Function Code	Data Length		Data Packet 1							Data Packet 2	Data Packet 3	Data Packet 4	Check Bits	
5A	0B	03	09	00	00	04	E8	03	00	00	21	44	AA	4B	F3	

Analysis:

- Data Packet 1: the sequence number, which is dispensable. When it exists, it must contain a data length of 1 byte and a data content of 4 bytes. The same sequence number is returned in the upstream;
- Data Packet 2: read data ID-0x21 (heartbeat interval);
- Data Packet 3: read data ID-0x44 (alarm angle);

Data Packet 4: read data ID-0xAA, no this ID for the current version

Upstream:

Frame Header	Protocol Version	Function Code	Data Length	Data Packet 1	Data Packet 2	Data Packet 3	Data Packet 4	Check Bits
5A	0B	03	14 00	00 04 E8 03 00 00	21 04 80 51 01 00	44 04 00 00 40 40	AA 00	91 55

Analysis:

Data Packet 1: upstream returns the same sequence number;

Data Packet 2: heartbeat interval is 86,400 seconds;

Data Packet 3: returned alarm angle is 3 degree;

Data Packet 4: invalid ID, returned data length is 0.

3.4 Setting parameters

Downstream:

Frame Header	Protocol Version	Function Code	Data Length	Data Packet 1	Data Packet 2	Data Packet 3	Data Packet 4	Check Bits
5A	0B	06	15 00	00 04 E9 03 00 00	21 04 10 0E 00 00	3A 01 01 44	04 00 00 80 3F	48 D3

Analysis:

Data Packet 1: the sequence number, which is dispensable. When it exists, it must contain a data length of 1 byte and a data content of 4 bytes. The same sequence number is returned in the upstream;

Data Packet 2: set the heartbeat interval to 3,600 seconds;

Data Packet 3: set current position as zero point;

Data Packet 4: set alarm angle to 1 degree.

Upstream:

Frame Header	Protocol Version	Function Code	Data Length	Data Packet 1	Data Packet 2	Data Packet 3	Data Packet 4	Check Bits
5A	0B	06	0F 00	00 04 E9 03 00 00	21 01 01 3A	01 01 44 01 01	9D A5	

Analysis:

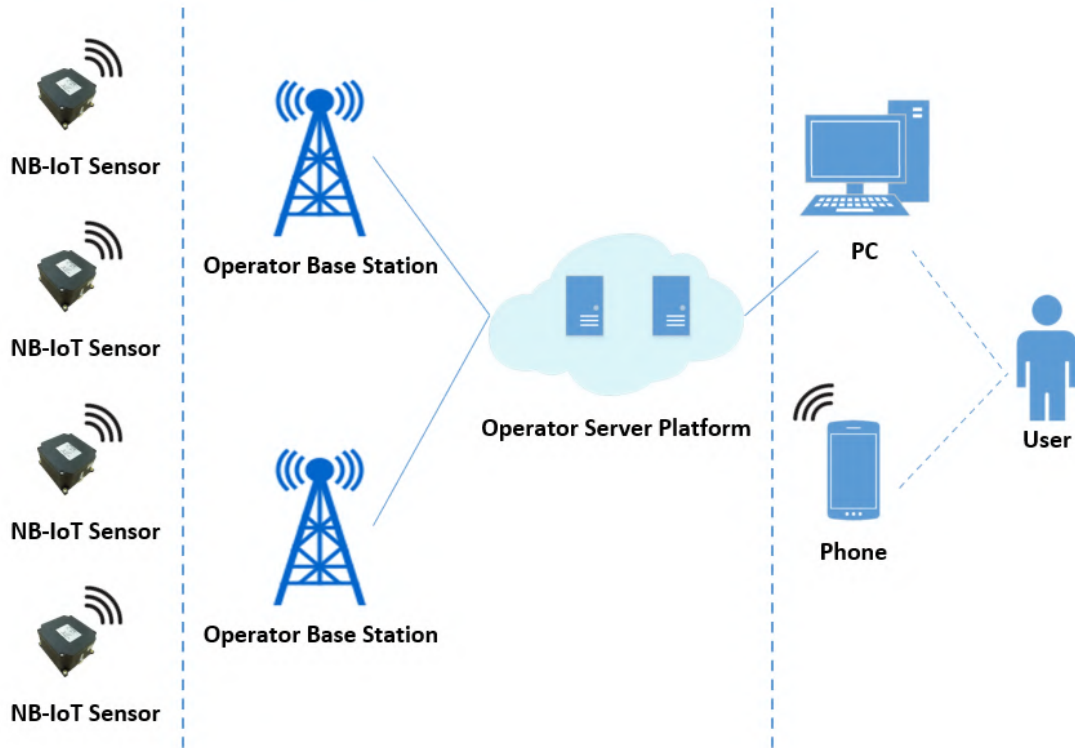
Data Packet 1: upstream returns the same sequence number;

Data Packet 2: heartbeat interval setting OK;

Data Packet 3: relative zero point setting OK;

Data Packet 4: alarm angle setting OK.

Appendix II



NB-IoT System Drawing