

Tilt Angle Sensor APPdata format

-Based on LORAWAN protocol

Uplink data packet:

1. Heartbeat data packet

Function	Type of device	Data type	Status bits			Battery Power	Label temperature		Tilt angle
Byte sample	Byt00001	Byt0101	Byt02(Bit7~Bit3 not used)			Byt03 50	Byt04 09	Byt05 ab	Byt0620
			Bit2	Bit1	Bit0				
Corresponding value	Manhole cover label	Heartbeat	low voltage	Displacement	Manhole cover state	80%	24.75		32°

2. Alarm data packet

Function	Type of device	Data type	Status bits			Battery Power	Label temperature		Tilt angle
Byte sample	Byt00001	Byt0102	Byt02(Bit7~Bit3 not used)			Byt03 50	Byt04 09	Byt05 ab	Byt0620
			Bit2	Bit1	Bit0				
Corresponding value	Manhole cover label	Alarm	low voltage	Displacement	Manhole cover state	80%	24.75		32°

3. User APPdata

Byte00: type of device. To distinguish different types of labels. 01: tilt angel label. Specific device type code will be given in the form of document latter.

Byte01: type of data, it's used to distinguish different data packets.

01: Heartbeat data packet, as a periodic reporting data packet, which contains a variety of status information, the main purpose is to tell the background label status as well as to determine which label is offline.

02: Alarm packets, as real-time alarm packets, which contains real-time status information, this packet will be sent when the cover has abnormal action

Byte02: Manhole cover status byte

Bit0: Manhole sensor status, 1 means the manhole cover is open, when this bit is 0, the manhole cover is normal.

Bit1: Displacement state.1 means manhole covers take place displacement, 0 means Manhole cover is normal.

Bit2: Battery low voltage condition. 1 means the battery voltage is too low.0 means normal.

Bit3~Bit7: Not used.

Byte03: The battery voltage percentage is displayed. $50 \text{ (16)} = 80 \text{ (10)}$, ->80%, means that the remaining battery power is 80%

Byte04 -Byte05: temperature value $09ab \text{ (16)} = 2475 \text{ (10)}$ -> 24.75°C, which indicates the internal temperature of the label

Byte06: Inclination tilt angle of manhole cover, $20 \text{ (16)} = 32 \text{ (10)}$ -> means the tilt angle of manhole cover is 32°

LoRaWan Protocol part of the data format, refer to the CLASSA protocol type, which is defined in the LORAWAN protocol. We are going to use port 2. for application data.