Milesight

Insertion Temperature Sensor

TS101

User Guide

Contents

Chapter 1. Preface

Copyright Statement

Safety Instruction

These instructions are intended to ensure that user can use the product correctly to avoid danger or property loss. Milesight will not shoulder responsibility for any loss or damage resulting from not following the instructions of this operating guide.

CAUTION:
Injury or equipment damage may be caused if any of these cautions are neglected.

- The probe has a sharp point. Please be careful and keep the edges and points away from human body.
- The device must not be disassembled or remodeled in any way.
- To ensure the security of your device, please change the device password during the initial configuration. The default password is 123456.
- Do not place the device close to objects with naked flames.
- Do not place the device where the temperature is below/above the operating range.
- Make sure electronic components do not drop out of the enclosure while opening.
- When installing the battery, please install it accurately, and do not install the inverse or wrong model.
- The device must never be subjected to shocks or impacts.

Revision History

Release Date	Version	Description
April 10, 2023	V1.0	Initial version

Release Date	Version	Description
Feb. 20, 2024	V 1.1	Add temperature calibration downlink command

Chapter 2. Product Introduction

Overview

Milesight TS101 is an all-in-one insertion temperature sensor with an integrated transmitter. It is equipped with an advanced measuring unit that provides a wide temperature measuring range.

With IP67 and IK10 ratings, the exquisite TS101 sensor is suitable for monitoring the inner temperature of Tobacco or grain stacks. It can also be applied in other warehousing scenarios which require inner temperature detection with high efficiency.

TS101 is compatible with Milesight LoRaWAN® gateway and mainstream LoRaWAN® network servers. With this low power consumption technology, TS101 can work for up to 10 years with a 4,000mAh battery. Combining with Milesight LoRaWAN® gateway and Milesight Development Platform solution, users can manage all sensor data remotely.

TS101 can be used to monitor the temperature of tobacco warehouses, farm haystacks, compost piles and other applications.

Features

- Equipped with highly accurate and stable DS18B20 temperature sensor chip with high resolution
- Adopt food-grade stainless-steel probe and shell material for efficient and safe detection
- Store locally historical records and support retransmission to prevent data loss
- IP67 and IK10 rated and phosphine corrosion-resistant for harsh environment
- Built-in 4000 mAh replaceable battery and works for up to 10 years without replacement
- Integrated and compact design for wireless deployment
- Built-in NFC for easy configuration
- Compatible with standard LoRaWAN® gateways and network servers
- Quick and easy management with Milesight IoT Cloud solution and Milesight Development Platform

Chapter 3. Hardware Introduction

Packing List

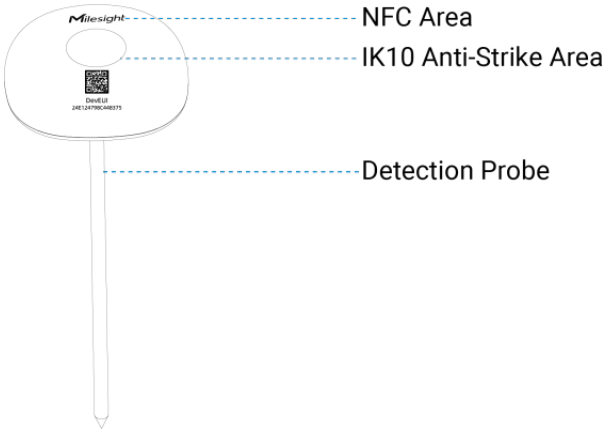
1 × TS101 Device

1 × Quick Guide

1 × Warranty Card

Note:
If any of the above items is missing or damaged, please contact your sales Representative.

Hardware Overview



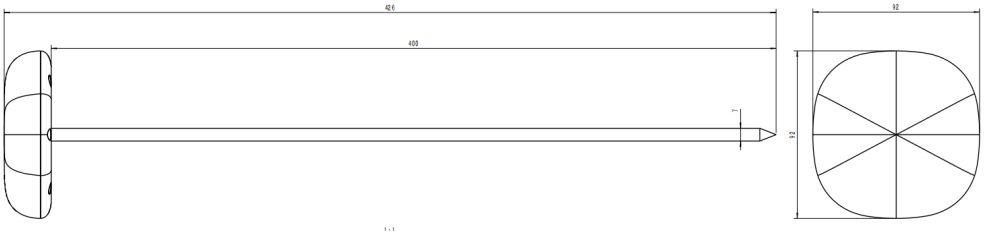
Button and LED Indicator

TS101 sensor equips with a reset button and a LED indicator inside the device, please remove the cover for emergency reset or reboot. Usually, users can use NFC to complete all steps.

Function	Action	LED Indicator
Power On	Press and hold the button for more than 3 seconds.	Off → On
Power Off		On → Off
Reset to Factory Default	Press and hold the button for more than 10 seconds.	Blinks quickly

Function	Action	LED Indicator
Check On/Off Status	Quickly press the power button once.	Light On: device is on.
		Light Off: device is off.

Dimensions(mm)



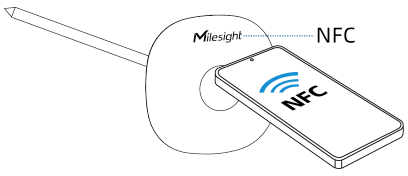
Chapter 4. Quick Start

Access the Sensor via NFC

1. Download and install “Milesight ToolBox” App from Google Play or Apple Store on an NFC-supported smartphone.
2. Enable NFC function on the smartphone.
3. Launch Milesight ToolBox, and select the default mode as NFC.
4. Attach the smart phone with NFC area to the device and click to read device information. Basic information, data, and settings of the device will be shown on the Milesight ToolBox App if it’s recognized successfully.
5. Adjust the settings on the App, then attach the smartphone with NFC area to the device and click **Write** to write the settings. After writing, reread the device to check if the configuration is written well.

Note:

- Ensure the location of smartphone NFC area and it’s recommended to take off phone case.
- If the smart phone fails to read/write configurations via NFC, keep the phone away and back to try again.
- The default device password is 123456. Please change a new password for security.



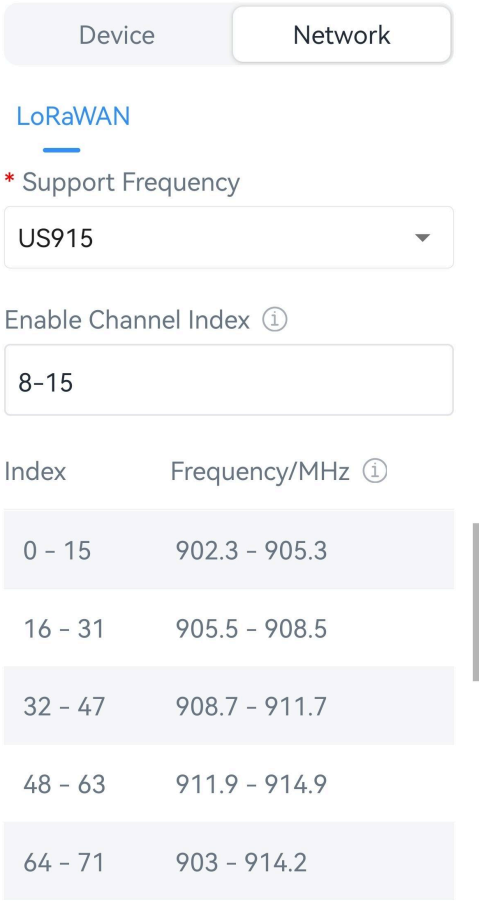
Configure the Network Setting

1. Go to **Network** settings page, select the join type as OTAA or ABP as required.

Note:
OTAA mode is required if you connect device to Milesight IoT Cloud or Milesight Development Platform.

2. Select supported frequency the same as LoRaWAN® gateway.

Note:
Set the channel index as 8-15 for US915 or AU915 if using default settings of Milesight gateways.



3. Keep other settings by default and click **Write** to save the settings.

Chapter 5. Operation Guide

LoRaWAN Settings

This chapter describes the LoRaWAN® network settings of device.

Parameter	Description
Device EUI	Unique ID of the device which can be found on the device. **Note:** please contact sales for device EUI list if you have many units.
App EUI	The default App EUI (join EUI) is 24E124C0002A0001.
Application Port	The port used for sending and receiving data, the default port is 85.
LoRaWAN® Version	V1.0.2 and V1.0.3 are available.
Work Mode	It's fixed as Class A.
Confirmed Mode	If the device does not receive ACK packet from network server, it will re-send data once.
Join Type	OTAA and ABP mode are available. **Note:** it's necessary to select OTAA mode if connecting device to Milesight IoT Cloud or Milesight Development Platform.
Application Key	Appkey for OTAA mode, default value: "Device EUI" + "Device EUI" (since Q4 of 2025). Example: 24e124123456789024e1241234567890 **Note:** • The default value of earlier devices is 5572404C696E6B4C6F52613230313823. • Please contact sales before purchase if you require random App Keys.

Parameter	Description
Network Session Key	Nwkskey for ABP mode, the default is 5572404C696E6B4C6F52613230313823.
Application Session Key	Appskey for ABP mode, the default is 5572404C696E6B4C6F52613230313823.
Device Address	DevAddr for ABP mode, default is the 5th to 12th digits of SN.
Rejoin Mode	Reporting interval≤35 mins: the device will send a specific number of LinkCheckReq MAC packets to the network server every reporting interval or every double reporting interval to validate connectivity; If there is no response, the device will re-join the network. Reporting interval > 35 mins: the device will send a specific number of LinkCheckReq MAC packets to the network server every reporting interval to validate connectivity; If there is no response, the device will re-join the network. **Note:** 1. Only OTAA mode supports rejoin mode. 2. The actual sending number is **Set the number of packets sent** +1.
Supported Frequency	Enable or disable the frequency to send uplinks. If frequency is one of CN470/AU915/US915, enter the index of the channel to enable in the input box, making them separated by commas. **Examples:** 1, 40: Enabling Channel 1 and Channel 40 1-40: Enabling Channel 1 to Channel 40 1-40, 60: Enabling Channel 1 to Channel 40 and Channel 60 All: Enabling all channels Null: Indicate that all channels are disabled

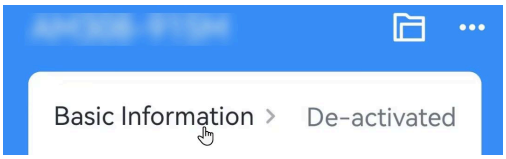
Parameter	Description
ADR Mode	Enable or disable network server to adjust Spreading Factor, Bandwidth an Tx Power to optimize data rates, airtime and energy consumption in the network.
Spreading Factor	If ADR mode is disabled, the device will send uplink data following this SF parameter. The higher the spreading factor, the longer the transmission distance, the slower the transmission speed and the more the consumption.
Tx Power	Tx power (transmit power) refers to the strength of the outgoing signal transmitted by the device. This is defined by LoRa alliance.
RX2 Data Rate	RX2 data rate to receive downlinks.
RX2 Frequency	RX2 frequency to receive downlinks. Unit: Hz

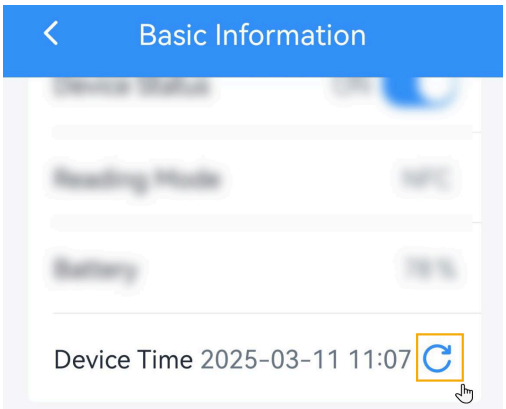
Time Synchronization

This section describes how to sync the time of the device.

Sync via ToolBox App

After reading the device via Milesight ToolBox App, sync the device time with time zone from the smart phone.





Sync via Network Server

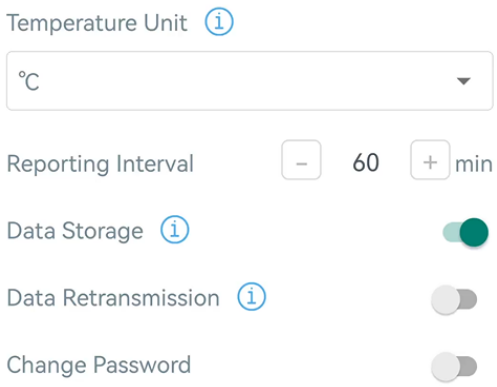
This requires to ensure the LoRaWAN® network server supports device time synchronization feature. Example: Milesight gateway embedded NS.

1. Set the LoRaWAN® version of the device to V1.0.3.
2. Connect the device to the network server. After joining the network, the device will send a DeviceTimeReq MAC command to enquire the time from network server.

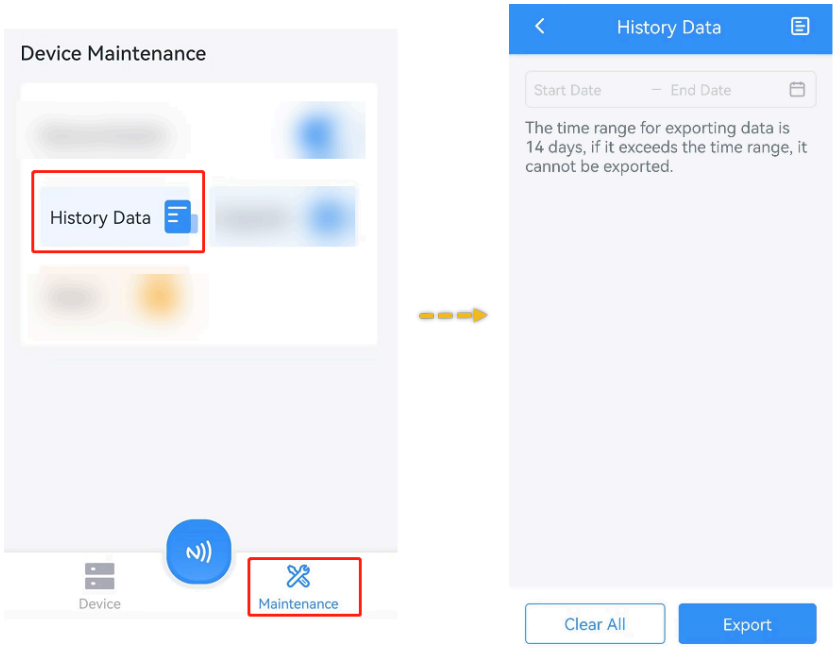
Note:

- This only supports to get the time but not time zone. The time zone can be configured by ToolBox App or downlink command.
- The device will send the DeviceTimeReq command every 5 days since the last sync.

General Settings



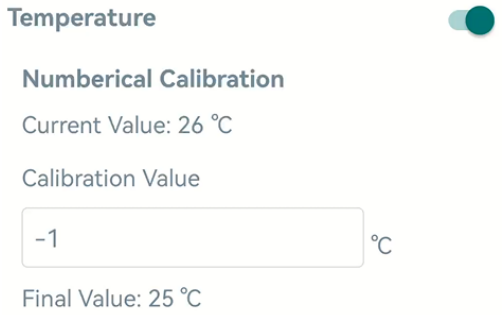
Parameter	Description
Temperature Unit	Change the temperature unit displayed on the ToolBox.

Parameter	Description
	Note: 1. The temperature unit in the reporting package is fixed as Celsius(°C). 2. Please modify the threshold settings if the unit is changed.
Reporting Interval	Reporting interval of transmitting current sensor values to network server. Default: 60 mins, Range: 1-1080 mins.
Data Storage	Disable or enable to store **periodic report** data locally. The stored data can be exported as CSV format file and saved to smartphone via Tool-Box. 

Parameter	Description
	Note: 1. It is necessary to sync the time to ensure the data is stored in correct time. 2. The device will still store the data even the network status is de-activated. 3. ToolBox App can only export the last 14 days' data at most.
Data Retransmission	Disable or enable data retransmssion. When the device detects the network status is de-activated via Rejoin Mode, the device will record a data lost time point and re-transmit the lost data after device re-connects to the network. **Note:** 1. This setting only takes effect when Data Storage is enabled. 2. If the device is rebooted or re-power when data retransmission is not completed, the device will re-send all retransmission data again after device is reconnected to the network. 3. If the network is disconnected again during data retransmission, it will only send the latest disconnected data. 4. The default report data retransmission interval is 600s, this can be changed via downlink command. 5. The reported format of retransmission data will include timestamps and is different from periodic report data. 6. This setting will increase the uplink frequencies and shorten the battery life.
Change Password	Change the password for ToolBox App to write this device.

Calibration Settings

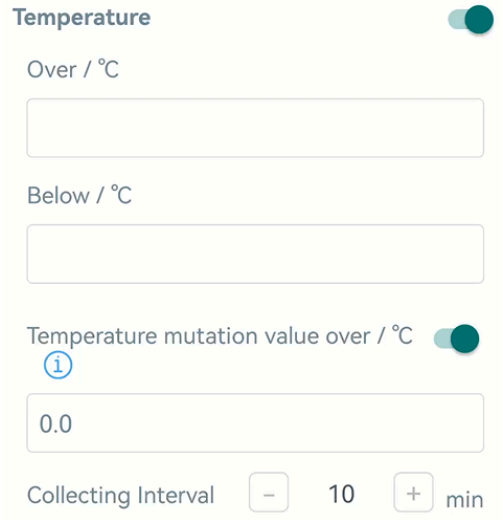
Set the calibration value, the device will add calibration value to the current temperature value, then display and report the final value.



Threshold Setting

When the temperature threshold is triggered, the device will upload the current data once instantly. Only when the threshold alarm is re-triggered, the device will send the threshold alarm again.

Note:
when you change the temperature unit, please re-configure the threshold.



Parameters	Description
Temperature Threshold	When the temperature is over or below the threshold value, the device will report an alarm packet.
Temperature Mutation Value	When the temperature mutation value is over the threshold value, the device will report an alarm packet. **Temperature Mutation Value** = |Current temperature - Last temperature |.
Collecting Interval	Collecting interval for detecting the temperature. Default: 10min; Range: 1~1080min

Maintenance

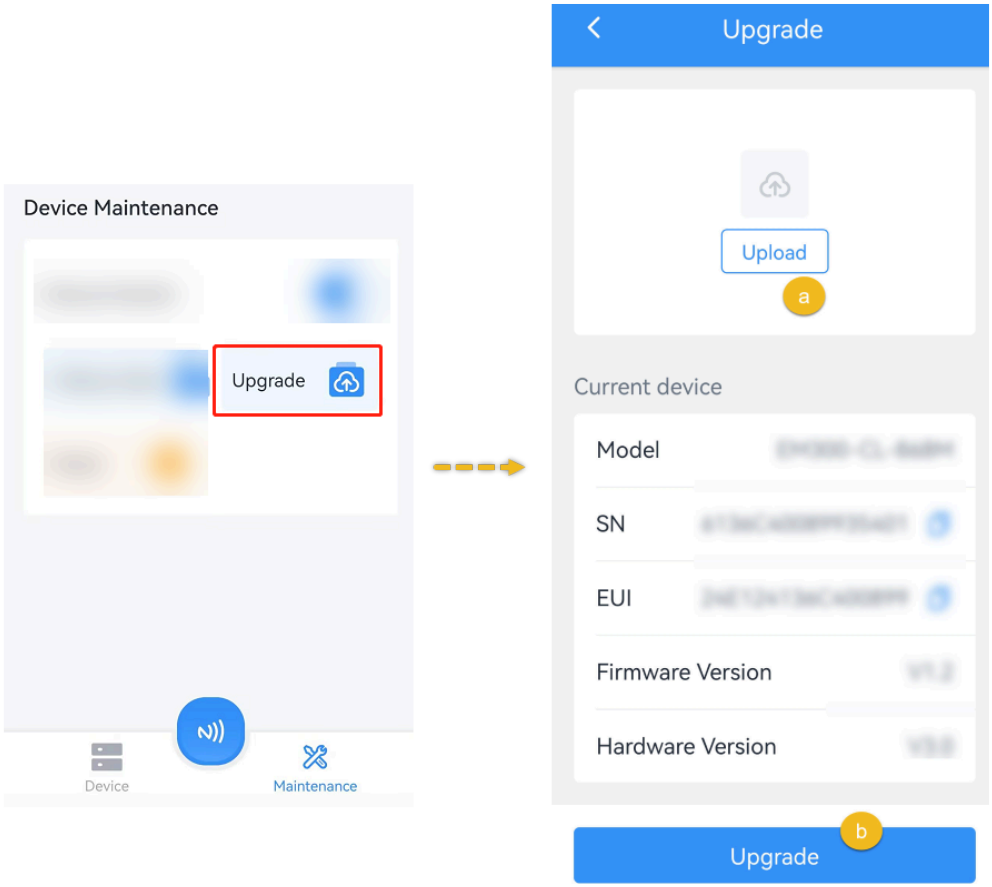
Upgrade

This chapter describes the steps to upgrade the device via ToolBox App.

1. Download firmware from Milesight official website to your smartphone.
2. Read the target device via ToolBox App, click **Upgrade** to upload the firmware file.
3. Click **Upgrade** to upgrade the device.

Note:

- Operation on ToolBox is not supported during an upgrade.
- Only Android version ToolBox supports the upgrade feature.

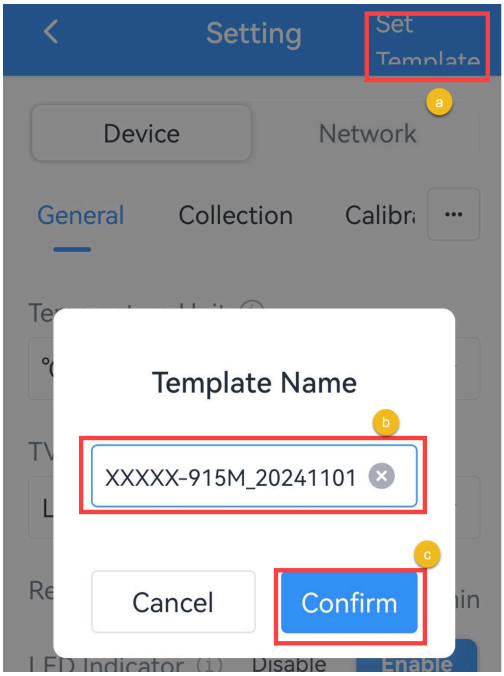


Backup and Restore

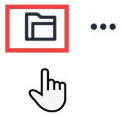
This device supports configuration backup for easy and quick device configuration in bulks. Backup and restore is allowed only for devices with the same model and frequency band.

Backup and Restore

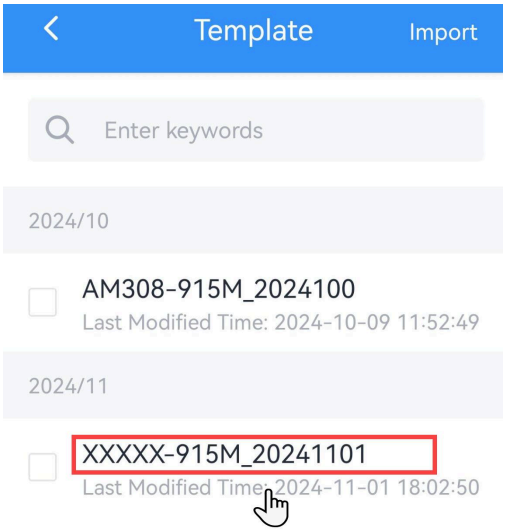
1. Launch ToolBox App, attach the NFC area of smartphone to the device to read the configuration.
2. Edit the configuration as required, click **Set Template** to save current configuration as a template to the ToolBox App.



3. Go to **Device >Template** page.

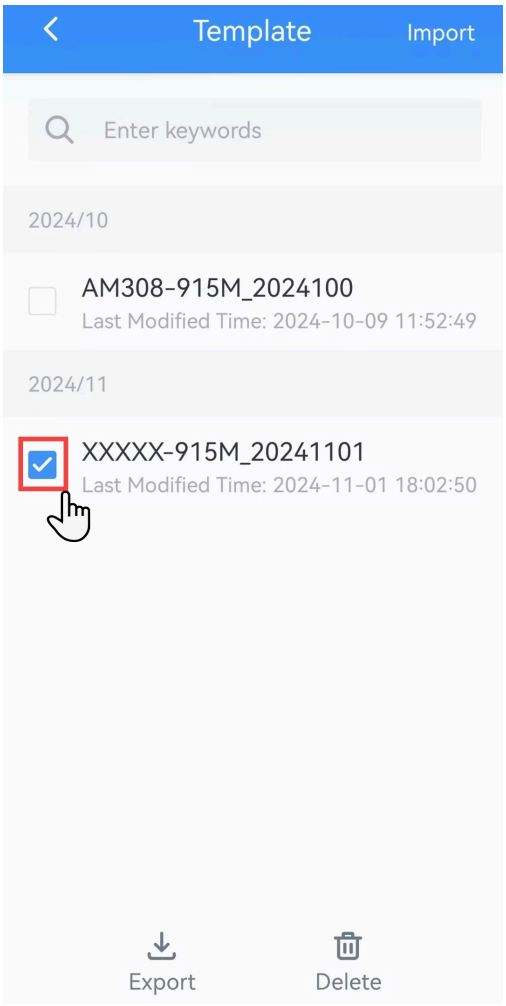


4. Select and click the target template, click **Write** to import the configuration to target devices.



Export and Delete Template

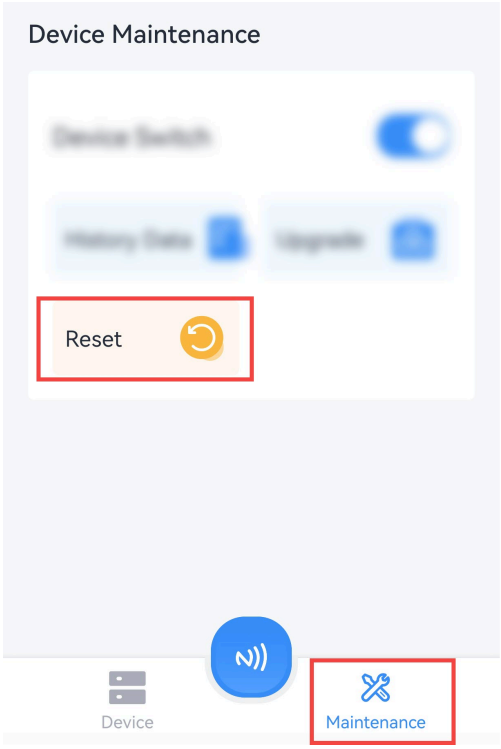
1. Check the box of the target template.
2. Click **Export** to export this template as JSON format file and save it to the smartphone, click **Delete** to delete this template from your ToolBox App.



Reset to Factory Default

Via Hardware: Hold on the reset button for more than 10s until the LED indicator quickly blinks.

Via ToolBox App: Click **Reset** and attach the smartphone to device to reset the device.

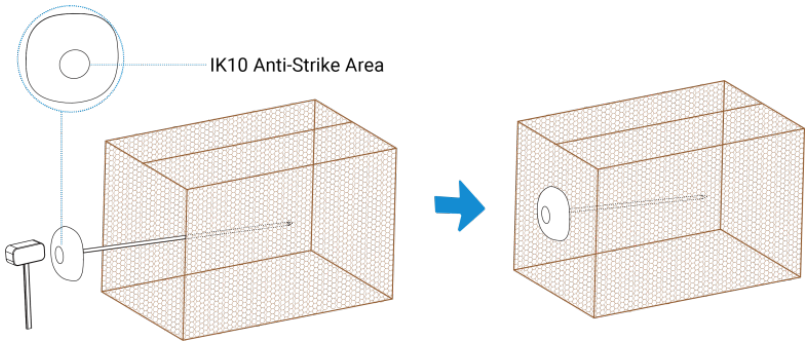

Device Maintenance
Reset
Device
Maintenance

Chapter 6. Installation

Insert the probe into the measured object directly.

Note:

If the density of the measured object is too high to insert the probe directly (such as haystack), please use rubber hammer to strike the anti-strike area of TS101 until the probe is completely inserted into the measured object.



Chapter 7. Uplink and Downlink

Overview

All messages are based on following format (HEX), the Data field should follow little-endian:

Channel1	Type1	Data1	Channel2	Type2	Data2	Channel3	...
1 Byte	1 Byte	N Bytes	1 Byte	1 Byte	N Bytes	1 Byte	...

For decoder examples please find files on https://github.com/Milesight-IoT/SensorDecoders.

Uplink Data

Item	Channel	Type	Byte	Description
Power On	ff	0b	1	Device is on
Protocol Version	ff	01	1	Example: 01=V1
Hardware Version	ff	09	2	Example: 03 10 = V3.1
Software Version	ff	0a	2	Example: 03 01 = V3.1
Device Type	ff	0f	1	00: Class A, 01: Class B, 02: Class C, 03: Class C to B
Serial Number	ff	16	8	16 digits
Battery Level	01	75	1	UINT8, Unit: %
Temperature	03	67	2	INT16/10, Unit: °C
Threshold Alarm	83	67	3	**Byte 1-2**: Temperature, INT16/10, Unit: °C **Byte 3**: 01
Mutation Threshold Alarm	93	d7	5	**Byte 1-2**: Temperature, INT16/10, Unit: °C **Byte 3-4**: Mutation Temperature, INT16/100, Unit: °C **Byte 5**: 02
Historical Data	20	ce	6	**Byte 1-4**: Data unix timestamp, UINT32, Unit: s **Byte 5-6**: Temperature, INT16/10, Unit: °C

Basic Information

The device will report a basic information packet whenever joining the network.

Example:

ff0bff ff0101 ff166732d07453450005 ff090100 ff0a0101 ff0f00		
Channel	**Type**	**Value**
ff	0b	Power On: ff
ff	01	Protocol Version: 01=V1
ff	16	Serial Number: 6732d07453450005
ff	09	Hardware: 0100=V1.0
ff	0a	Software: 0101=V1.1
ff	0f	00: Class A

Periodic Report

The device supports the sensor data according to reporting interval (60 min by default).

Example:

017564 0367f900		
Channel	**Type**	**Value**
01	75	Battery Level: 64 => 100%
03	67	Temperature: f9 00 => 00 f9 =>249/10=24.9°C

Alarm Report

The device supports to report below types of alarm report packets.

1. Temperature threshold alarm: report when threshold alarm is enabled.

83675201 01		
Channel	**Type**	**Value**
83	67	52 01 => 01 52 => 338/10 = 33.8°C

2. Temperature mutation alarm: report when mutation alarm is enabled.

93d74e01 c602 02		
Channel	**Type**	**Value**
93	d7	Temperature: 4e 01 => 01 4e => 334/10 = 33.4°C Mutation Value: c6 02 => 02 c6 => 710/100=7.1°C 02 => Mutation Alarm

Historical Data

The device will report retransmission data or stored data as below example.

20ce 0d755b63 0401			
Channel	**Type**	**Time Stamp**	**Value**
20	ce	0d 75 5b 63 => 63 5b 75 0d=1666938125s	Temperature: 04 01=>01 04 =26°C

Downlink Command

This device supports downlink commands for configuration and control. The downlink application port is 85 by default.

General Settings

Item	Channel	Type	Byte	Description
Reboot	ff	10	1	ff
Report Interval	ff	03	2	UINT16, Unit: s
Collect Interval	ff	02	2	UINT16, Unit: s
UTC Time Zone	ff	17	2	INT16/10
Data Storage	ff	68	1	00: Disable, 01: Enable
Data Re-transmission	ff	69	1	00: Disable, 01: Enable
Data Retrans-mission Interval	ff	6a	3	**Byte 1**: 00 **Byte 2-3**: UINT16, Unit: s, Range: 30~1200, Default: 600

Example:

1. Reboot the device.

ff10ff

2. Set report interval as 20 minutes.

ff03b004		
Channel	**Type**	**Value**
ff	03	b004=>04b0=1200s=20 minutes

3. Set time zone as UTC-2.

ff17ecff		
Channel	**Type**	**Value**
ff	17	ecff=>ff ec=-20/10=-2

Temperature Calibration Settings

Channel	Type	Byte	Description
ff	ab	3	**Byte 1:** 00: disable, 01: enable **Byte 2-3:** Calibration value, INT16/10, unit: °C

Example:

Enable temperature calibration and set calibration value.

ffab01fdff		
Channel	**Type**	**Value**
ff	ab	01=Enable fdff=>fffd=-3/10=-0.3 °C

Temperature Threshold Settings

Channel	Type	Byte	Description
ff	06	9	CTRL(1B)+Min(2B)+Max(2B)+00000000(4B)

Channel	Type	Byte	Description
			CTRL: Bit2~Bit0: 000=disable 001=below 010=above 011=within 100=below or above Bit5~Bit3: ID 001=Temperature Threshold 010=Temperature Mutation Threshold Bit6: 0=disable the Alarm Threshold 1=enable the Alarm Threshold Bit7: Reserved **Max/Min**: INT16/10, Unit: °C

Example:

1. Enable temperature threshold and configure the alarm when the temperature exceeds 30°C.

ff06 ca 0000 2c01 00000000		
Channel	**Type**	**Value**
ff	06	CTRL: ca =11 001 010 010 = above 001 = Temperature Threshold 1 = enable the Threshold Alarm Max: 2c 01 => 01 2c => 300/10 = 30°C

2. Disable mutation threshold and configure the alarm when the mutation value exceeds 5°C.

ff06 10 0000 3200 00000000		
Channel	**Type**	**Value**
ff	06	CTRL: 10 = 00 010 000 010 = Temperature Mutation Threshold 0 = disable the Threshold Alarm Max: 32 00 => 00 32 => 50/10 = 5°C

Historical Data Enquiry

The device supports data retrievability feature to send downlink command to enquire the historical data stored in the device. Before that, ensure the device time is correct and data storage feature was enabled to store data.

Command Format:

Item	Channel	Type	Byte	Description
Enquire Data in Time Point	fd	6b	4	Unix timestamp, Unit: s
Enquire Data in Time Range	fd	6c	8	Byte 1-4: Start timestamp, Unit: s Byte 5-8: End timestamp, Unit: s
Stop Query Data Report	fd	6d	1	ff
Data Retriev-ability Interval	ff	6a	3	Byte 1: 01 Byte 2-3: UINT16, Unit: s, Range: 30~1200, Default: 60

Reply Format:

Item	Channel	Type	Byte	Description
Enquiry Result	fc	6b/6c	1	00: Enquiry success. The device will report the historical data according to data retrievability interval.

Item	Channel	Type	Byte	Description
				01: Time point or time range invalid 02: No data in this time or time range

Note:

1. Use Unix Timestamp Converter to calculate the time.
2. The device only uploads no more than 300 data records per range enquiry.
3. When enquiring the data in time point, it will upload the data which is closest to the search point within the reporting interval range. For example, if the device's reporting interval is 10 minutes and users send command to search for 17:00's data, if the device find there is data stored in 17:00, it will upload this data; if not, it will search for data between 16:50 to 17:10 and upload the data which is closest to 17:00.

Example:

Enquire the historical data in a time range.

fd6c 64735b63 7c885b63		
Channel	**Type**	**Value**
fd	6c	Start time: 64 73 5b 63 => 63 5b 73 64 = 1666937700s End time: 7c 88 5b 63 => 63 5b 88 7c = 1666943100s

Reply:

fc6c00		
Channel	**Type**	**Value**
fc	6c	00: Enquiry success

20ce 0d755b63 0401			
Channel	**Type**	**Time Stamp**	**Value**
20	ce	0d 75 5b 63 => 63 5b 75 0d=1666938125s	Temperature: 04 01=>01 04 =26°C

Chapter 8. Services

Milesight provides customers with timely and comprehensive technical support services. End-users can contact your local dealer to obtain technical support. Distributors and resellers can contact directly with Milesight for technical support.

Technical Support Mailbox: iot.support@milesight.com

Online Support Portal: https://support.milesight-iot.com

Resource Download Center: https://www.milesight.com/iot/resources/download-center/

MILESIGHT CHINA

TEL: +86-592-5085280

FAX: +86-592-5023065

Add: Building C09, Software Park Phase III, Xiamen 361024, Fujian, China