Technical Information

Sushi Sensor System
LoRaWAN Installation Guide

Sushi Sensor
LoRaWAN™

TI 01W06A51-10EN

Contents

Introduction

This document provides guidance on how to install devices so that the Sushi Sensor system using LoRaWAN operates in a stable manner. For details on how to install devices, e.g., how to secure a sensor and a gateway, refer to the relevant manuals.

The Sushi Sensor can be installed in various site environments. In most cases, by installing devices as described in this guide, you will be able to use sensors without the need to carry out any prior investigations.

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1.   About LoRaWAN

The Sushi Sensor adopts the LoRaWAN communication system that has high-level receiving sensitivity and resistance to radio-frequency interference, and that offers a communication distance of 10 km or more in an ideal communication environment.

The LoRaWAN communication system is specifically designed for IoT (Internet of Things) applications and provides power-saving and long-distance communication features standardized by LoRa Alliance. Low power consumption contributes to a battery service life of several years, and the long-distance communication feature expands the area that can be covered by a single gateway and enables communications regardless of the location of the Sushi Sensor, thereby simplifying installation and maintenance procedures.

The Sushi Sensor creates a simple star-type network in which sensors directly connect to the gateway. The Sushi Sensor sends sensed data to the gateway. When receiving data from the Sushi Sensor, the gateway transfers it to the pre-specified application.

LoRaWAN does not support the data relay function. If there are any Sushi Sensors that cannot directly connect to the gateway, you will need to add a gateway in the vicinity of the sensors.
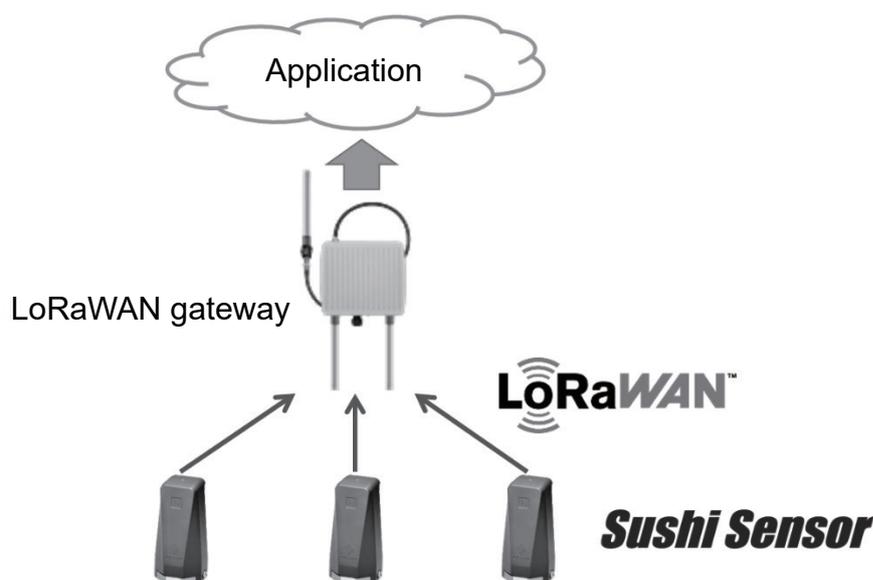
LoRaWAN uses Sub-GHz radio frequency bands. The communication data rate is variable and automatically optimized depending on communication conditions. LoRaWAN communications are protected by AES128 encryption in both the network and application.

LoRaWAN provides three communication classes. To establish communications, the Sushi Sensor uses the simplest and power-saving communication class that is referred to as "class A".

2.   Installation Guide

2.1   Gateway Installation Guide

This section describes how to install a gateway.

LoRaWAN only supports star-type networks. In general, the installation location of the Sushi Sensor is determined by the location of the measuring target. For this reason, the manner of installing the Sushi Sensor is restricted. Therefore, in order to achieve stable LoRaWAN communication, it is essential that the gateway is appropriately installed.

1.   Install the gateway in a location that is as high as possible.
2.   Install the antenna perpendicular to the ground.
3.   Install the LoRaWAN antenna above the gateway installation pole.
4.   Install the gateway in a location where there are as few obstacles as possible.
5.   Install the gateway in a location where there are no other wireless system devices that use the same frequency band in its vicinity.

1.   Install the gateway in a location that is as high as possible.

Install the gateway in an elevated location such as a building rooftop from which the Sushi Sensor installation area can be seen. The higher the location the gateway is installed in, the less wireless communications will be interfered with by structures in surrounding areas. This will lead to improved reception. When you want to achieve a communication distance of one kilometer, you should install the gateway 20 meters or more above the ground. However, when the gateway is installed in an elevated location, lightning-related risks will increase. To avoid such risks, install the gateway within the protective range of a lightning rod. In addition, ground the gateway in accordance with its instruction manual.

2.   Install the antenna perpendicular to the ground.

The antenna of a general LoRaWAN gateway used in the Sushi Sensor system is designed so that the quality of wireless communications reaches the utmost level when the antenna is installed perpendicular to the ground.

3.   Install the LoRaWAN antenna above the gateway installation pole.

Metallic structures close to the antenna may have significant effects on LoRaWAN communication. When installing the gateway on a metallic pole, set up the pole at a lower position than the LoRaWAN antenna of the gateway.

4.   Install the gateway in a location where there are as few obstacles as possible.

If there are any structures near the gateway, wireless signal waves sent from the gateway may reflect off the structures and may interfere with a different stream of the sent waves. To avoid this problem, install the gateway in a location where there are no structures in a horizontal orientation within its vicinity. Note that even an obstacle opposite the sensor may cause interference.

5. Install the gateway in a location where there are no other wireless system devices that use the same frequency band in its vicinity.

   If the antenna of another wireless system is near the gateway, LoRaWAN communication characteristics may be negatively impacted. LoRaWAN uses the 800 MHz frequency band. To minimize the influence, install the gateway as far away as possible from any wireless systems and mobile phone base stations that use the same frequency band.

Installed within the protective range of the lightning rod.

Install the antenna perpendicular to the ground

There must be no surrounding obstacles.

Installed in an elevated location such as a building rooftop

Installed to prevent the antenna from being interfered with by the gateway installation pole.

2.2   Sushi Sensor Installation Guide

This section describes how to install the Sushi Sensor.

As with the case of the gateway, wireless communications can be available at satisfactory quality levels by installing the Sushi Sensor in a location where there are no structures or other obstacles around. However, unlike the gateway, the installation location of the Sushi Sensor is often restricted. The installation location of the Sushi Sensor depends on the location of the measuring target; therefore, in some cases, it is difficult to raise communication quality by making any improvements to the installation of the Sushi Sensor.

When there are flexible options as to how to install the Sushi Sensor, improvement in the communication distance and/or quality can be expected by considering the following points.

1.   Installing Sushi Sensor in a location where there are no surrounding obstacles
2.   Avoiding locations near the ground
3.   Installing the Sushi Sensor perpendicular to the ground

1. Installing Sushi Sensor in a location where there are no surrounding obstacles

   In general, the more vacant space there is around the Sushi Sensor, the more stable communications will be.

2. Avoiding locations near the ground

    When it comes to establishing wireless communication, the ground is an enormous obstacle. Stable communications can be possible by installing the sensor far above the ground.

3. Installing the Sushi Sensor perpendicular to the ground

    Install the Sushi Sensor perpendicular to the ground whenever possible. The Sushi Sensor is designed so that the quality of wireless communication reaches the utmost level when it is installed perpendicular to the ground.

2.3 Influence on Existing Devices

This section describes influences the Sushi Sensor and the gateway (LoRaWAN device) may have on existing devices.

As a prerequisite for evaluation of influences, it is assumed that general industrial equipment satisfies the IEC standards or equivalent requirements related to immunity levels shown below.

The table below shows the offset distance in which the electric field intensity generated from the LoRaWAN device installed near an existing device falls below the required level.

Devices	Standards to comply with	Required immunity level	Offset distance
Devices for heavy industrial environments Measuring instruments for industrial environments	• IEC 61000-6-2 • IEC 61326-1: Industrial Electromagnetic Environment	10V/m	8cm
Devices for residential and commercial environments Information technology equipment Measuring instruments for general environments	• IEC 61000-6-1 • CISPR 24 • IEC 61326-1: Basic Electromagnetic Environment	3V/m	26cm

For devices such as motors and compressors classified as devices for heavy industrial environments used in plants, providing an offset distance of eight centimeters or more between the electronic circuit that controls the industrial device and the antenna of the LoRaWAN device reduces the electrical field intensity generated from the LoRaWAN device below the required immunity level. For devices for residential and commercial environments and general information technology equipment, an offset distance of 26 centimeters or more is required to ensure electrical field intensity below the required immunity level.

3. Maximum Communication Distance

When the gateway is installed as instructed in this guide, typical maximum communication distances between the Sushi Sensor and the gateway are as shown below. The actual maximum communication distance is affected not only by the visibility level but also by the environment of the installation location.

Case	Visibility level	Installation environment example	Typical maximum communication distance [*1]
I	A sufficient level of visibility is ensured between the gateway and the Sushi Sensor.	Along a large river or coast Oil drilling well, pipeline	Up to 7 km
II	Outdoor locations where a sufficient level of visibility cannot be ensured between the gateway and the Sushi Sensor	Various plant environments (Tank yard, pipe jungle)	1km
III	Installations in environments where the sensor is completely surrounded by structures (including indoor installations)	Installations in a complete "shield" such as the inside of an enclosure, indoor production facility, and the inside of a building	Varies depending on installation conditions.

[*1]   This table shows the maximum communication distance values when Yokogawa Wireless Vibration Sensor (XS770A) is used as a Sushi Sensor.

If long-distance communication cannot be established between the Sushi Sensor and the gateway, no communications can be established because the Sushi Sensor is installed indoors, or communications are consistently unstable, consider installing an additional gateway.

Examples of case I	
Riverside or seashore	Oil drilling well
Pipeline	Broad flat area

Examples of case II	
Outdoor plant environment, pipe jungle	Tank yard
Mine, raw materials storage yard	Belt conveyor

Examples of case III	
Indoor production site	Building

4. Evaluation of Communication Stability

The RSSI, SNR, and PER values that can be viewed in the Application, on Sushi Sensor APP, or on the gateway management screen are important indexes used to evaluate communication stability. In a future revision of this document, specific thresholds for evaluating communication status will be included as guidelines.

For details on how to evaluate communication stability before the threshold guidelines are provided, contact our Sushi Sensor Information Service.

5.　Glossary

- RSSI (Received Signal Strength Indicator)

Indicates the strength of wireless signals received by a wireless communication device in dBm units. The RSSI is an important value required to confirm communication quality. In general, the stronger the signal is, the more stable communications will be. On the other hand, if high-level noises exist in the same communication bandwidth, it may be difficult to establish communications even if the RSSI is high. In such a case, check the communication environment together with the SNR value described later.

You can check two RSSI values in the Sushi Sensor system.

	RSSI measuring device	Checking method
RSSI from gateway to Sushi Sensor communication	Sushi Sensor	• Sushi Sensor App (Android device tool) • Health report the application is periodically notified of by the sensor
RSSI from Sushi Sensor to gateway communication	Gateway	• Gateway management screen

For details on the checking method, refer to the instruction manual of the Application, each sensor or gateway.

- SNR (Signal Noise Ratio)

Indicates the ratio of the strength of wireless signals for LoRaWAN communication to that of other ambient noise signals. The higher the SNR value is, the more stable LoRaWAN communication will be. When the SNR value is low, communication errors may occur even if the RSSI value is high. The LoRa modulation used in LoRaWAN communication has the advantage of enabling communications even if the communication signal level is lower than the ambient noise level. In such an environment, the SNR may be a negative value.

You can check two SNR values in the Sushi Sensor system.

	SNR measuring device	Checking method
SNR from gateway to Sushi Sensor communication	Sushi Sensor	• Health report the application is periodically notified of by the Sushi Sensor
SNR from Sushi Sensor to gateway communication	Gateway	• Gateway management screen

For details on the checking method, refer to the instruction manuals of the Application, the Sushi Sensor and the gateway.

- PER (Packet Error Rate)

Indicates the communication failure rate when wireless communication is established actually. The PER value is calculated as shown below.

PER (%) = Number of packets that were not sent correctly ÷ Total number of sent packets x 100 (%)

When packets sent from the Sushi Sensor did not arrive at the gateway, or the system failed toreceive the delivery acknowledgment packet (ACK) from the gateway although it received the sent packets, it is judged that sending has failed.

The Sushi Sensor resends the packets when sending has failed. When the PER value is low, it is judged that the communication is successful with fewer number of data transmission. When the PER value continues to be high, affects the battery life due to the number of retransmission.

In the Sushi Sensor system, check the PER value using the following method.

	PER measuring device	Checking method
PER from Sushi Sensor to gateway communication	Sensor	• Health report the application is periodically notified of by the sensor

For details on the checking method, refer to the instruction manual of the Application and each sensor.

Revision Information

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