Wireless 3-axis Accelerometer Sensor

R311FA1

User Manual

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1. Introduction

R311FA1 is the LoRaWAN™ Class A device which detects three-axis acceleration and is compatible with LoRaWAN protocol. When the device moves or vibrates over threshold value, it immediately reports the acceleration and velocity of the X, Y, and Z axes.

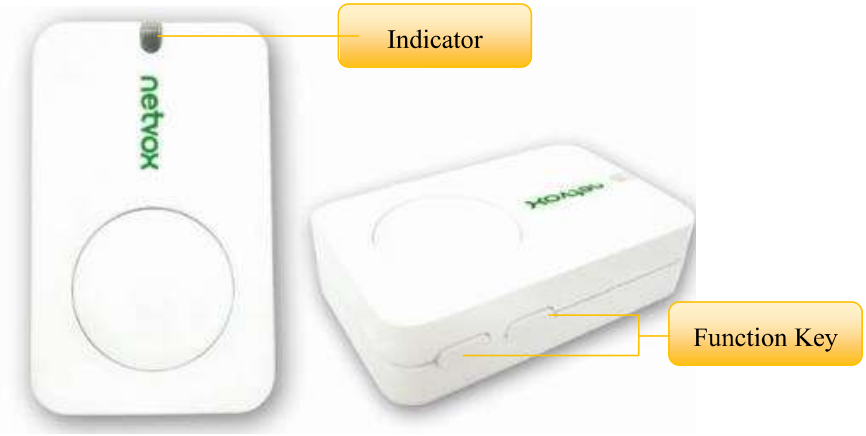
LoRa Wireless Technology:

LoRa is a wireless communication technology famous for its long-distance transmission and low power consumption. Compared with other communication methods, LoRa spread spectrum modulation technique greatly extend the communication distance. It can be widely used in any use case that requires long-distance and low-data wireless communications. For example, automatic meter reading, building automation equipment, wireless security systems, industrial monitoring. It has features like small size, low power consumption, long transmission distance, strong anti-interference ability and so on.

LoRaWAN:

LoRaWAN uses LoRa technology to define end-to-end standard specifications to ensure interoperability between devices and gateways from different manufacturers.

2. Appearance



3. Main Features

- Adopt SX1276 wireless communication module
- 2 sections 3.0V CR2450 button batteries
- Detect the three-axis acceleration and velocity of the device and the voltage
- Compatible with LoRaWAN™ Class A
- Frequency hopping spread spectrum technology
- Configuration parameters can be configured through third-party software platforms, data can be read and alarms can be set via SMS text and email (optional)
- Available third-party platform: Actility / ThingPark, TTN, MyDevices/Cayenne
- Low power consumption and long battery life

Note:

Battery life is determined by the sensor reporting frequency and other variables, please refer to http://www.netvox.com.tw/electric/electric_calc.html On this website, users can find battery life time for varied models at different configurations.

4.Set up Instruction

On/Off

Power on	Insert batteries. (users may need a screwdriver to open); (Insert two sections of 3V CR2450 button batteries and close the battery cover.)
Turn on	Press any function key, and the indicator flashes once.
Turn off (Restore to factory setting)	Press and hold the function key for 5 seconds, and the green indicator flashes 20 times.
Power off	Remove Batteries.
Note:	1. Remove and insert the battery; the device memorizes previous on/off state by default. 2. On/off interval is suggested to be about 10 seconds to avoid the interference of capacitor inductance and other energy storage components. 3. Press any function key and insert batteries at the same time; it will enter engineer testing mode.

Network Joining

Never joined the network	Turn on the device to search the network. The green indicator stays on for 5 seconds: success The green indicator remains off: fail
Had joined the network	Turn on the device to search the previous network. The green indicator stays on for 5 seconds: success The green indicator remains off: fail
Fail to join the network	Suggest to check the device verification information on the gateway or consult your platform server provider.

Function Key

Press and hold for 5 seconds	Restore to factory setting / Turn off The green indicator flashes 20 times: success The green indicator remains off: fail
Press once	The device is in the network: green indicator flashes once and sends a report The device is not in the network: green indicator remains off

Sleeping Mode

The device is on and in the network	Sleeping period: Min Interval. When the reportchange exceeds setting value or the state changes, a data report will be sent according to Min Interval.

Low Voltage Warning

Low Voltage	2.4V

5. Data Report

The device will immediately send a version packet report and two attribute data reports.

Data will be reported by default setting before any configuration.

Default setting:

Max Interval: 3600s

Min Interval: 3600s (The current voltage is detected every Min Interval by default.)

Battery Voltage Change: 0x01 (0.1V)

Acceleration Change: 0x03 (m/s^2)

R311FA1 Three-axis acceleration and velocity: s:

1. After the three-axis acceleration of the device **exceeds ActiveThreshold**, a report is sent immediately to report the three-axis acceleration and velocity.
2. After reporting, the three-axis acceleration of the device needs to be **lower than InActiveThreshold**, and the duration is greater than **5s** (cannot be modified). Then, the next detection will start. If the vibration continues during this process after the report is sent, the timing will restart.
3. The device sends two data packets, one is the acceleration of the three axes, and the other is the velocity of the three axes. The interval between the two packets is 10s.

Note:

(1) The device report interval will be programmed based on the default firmware.

(2) The interval between two reports must be the minimum time.

The reported data is decoded by the Netvox LoRaWAN Application Command document and

http://www.netvox.com.cn:8888/cmddoc

Data report configuration and sending period are as following:

Min Interval (Unit: second)	Max Interval (Unit: second)	Reportable Change	Current Change≥ Reportable Change	Current Change＜ Reportable Change
Any number between 1~65535	Any number between 1~65535	Can not be 0.	Report per Min Interval	Report per Max Interval

5.1 ActiveThreshold and InActiveThreshold

Formula	**Active Threshold/ InActiveThreshold = Critical value ÷ 9.8 ÷ 0.0625** * The gravitational acceleration at standard atmospheric pressure is 9.8 m/s^2 * The scale factor of the threshold is 62.5 mg
Active Threshold	Active Threshold can be changed by ConfigureCmd Active Threshold range is **0x0003-0x00FF** (default is 0x0003);
InActiveThreshold	InActiveThreshold can be changed by ConfigureCmd InActiveThreshold range is **0x0002-0x00FF** (default is 0x0002) * Active Threshold and InActiveThreshold can not be the same
Example	Assuming that the critical value is set to be 10m/s^2, the Active Threshold would be set 10/9.8/0.0625=16.32 Active Threshold would be set integer as 16.

5.2 Calibration

The accelerometer is a mechanical structure that contains components that can move freely.

These moving parts are very sensitive to mechanical stress, far beyond solid-state electronics.

The 0g offset is an important accelerometer indicator because it defines the baseline used to measure acceleration.

After installing R311FA1, users need to let the device rest for 1 minute, and then power on. Then, turn on the device and wait for the device taking 1 minute to join the network. After that, the device will automatically executes the calibration.

After calibration, the reported three-axis acceleration value will be within 1m/s^2.

When the acceleration is within 1m/s^2 and the velocity is within 160mm/s, it can be judged that the device is stationary.

5.3 Example of ReportDataCmd

FPort：0x06

Bytes	1	1	1	Var (Fix=8 Bytes)
	Version	DeviceType	ReportType	NetvoxPayLoadData

Version– 1 byte –0x01——the Version of NetvoxLoRaWAN Application Command Version

DeviceType– 1 byte – Device Type of Device

The devicetype is listed in Netvox LoRaWAN Application Devicetype doc

ReportType – 1 byte –the presentation of the NetvoxPayLoadData，according the devicetype

NetvoxPayLoadData– Fixed bytes (Fixed =8bytes)

Device	Device Type	Report Type	NetvoxPayLoadData				
R311FA1 (R311FD)	0xC7	0x01	Battery (1Byte, unit:0.1V)	AccelerationX (Float16_2Bytes, m/s^2)	AccelerationY (Float16_2Bytes, m/s^2)	AccelerationZ (Float16_2Bytes, m/s^2)	Reserved (1Byte,fixed 0x00)
		0x02	VelocityX (Float16_2Bytes, mm/s)	VelocityY (Float16_2Bytes, mm/s)	VelocityZ (Float16_2Bytes, mm/s)	Reserved (2Bytes,fixed 0x00)	

Example of uplink:

packet 1: 01C7011E6A3E883E1F4100

1st byte (01): Version

2nd byte (C7): DeviceType 0XC7 — R311FA1

3rd byte (01): ReportType

4th byte (1E): Battery—3v , 1E Hex=30 Dec 30*0.1v=3v

5th 6th byte (6A3E): Acceleration X, float32(3E6A0000) = 0.22851562 m/s^2

7th 8th byte (883E): Acceleration Y, float32(3E880000) = 0.265625 m/s^2

9th 10th byte (1F41): Acceleration Z, float32(411F0000) = 9.9375 m/s^2

11th byte (00): Reserved

packet 2: 01C70212422B42C7440000

1st byte (01): Version

2nd byte (C7): DeviceType 0XC7 — R311FA1

3rd byte (02): ReportType

4th 5th byte (1242): Acceleration X, float32(42120000) = 36.5 mm/s

6th 7th byte (2B42): Acceleration Y, float32(422B0000) = 42.75 mm/s

8th 9th byte (C744): Acceleration Z, float32(44C70000) = 1592.0 mm/s

10th ~11th byte (0000): Reserved

* R311FA1 value uses big-endian computing.

* Because of the length limitation of R311FA1 instruction. Therefore, R311FA1 sends out 2 bytes and adds 0 to the data to form 4 bytes of float32.

5.4 Example of ConfigureCmd

FPort：0x07

Bytes	1	1	Var (Fix =9 Bytes)
	CmdID	DeviceType	NetvoxPayLoadData

CmdID– 1 byte

DeviceType– 1 byte – Device Type of Device

NetvoxPayLoadData– var bytes (Max=9bytes)

Description	Device	Cmd ID	Device Type	NetvoxPayLoadData				
Config ReportReq	R311FA1	0x01	0xC7	MinTime (2bytes Unit:s)	MaxTime (2bytes Unit:s)	BatteryChange (1byte Unit:0.1v)	AccelerationChange (2byte Unit:m/s²)	Reserved (2Bytes,Fixed 0x00)
Config ReportRsp		0x81		Status (0x00_success)		Reserved (8Bytes,Fixed 0x00)		
ReadConfig ReportReq		0x02		Reserved (9Bytes,Fixed 0x00)				
ReadConfig ReportRsp		0x82		MinTime (2bytes Unit:s)	MaxTime (2bytes Unit:s)	BatteryChange (1byte Unit:0.1v)	AccelerationChange (2byte Unit:m/s²)	Reserved (2Bytes,Fixed 0x00)

(1)**Command Configuration:**

MinTime = 1min, MaxTime = 1min, BatteryChange = 0.1v, Acceleratedspeedchange = 1m/s²

Downlink： 01C7003C003C0100010000 003C($H_{ex)}$ = 60($D_{ec)}$

Response：

81C7000000000000000000（Configuration success）

81C7010000000000000000（Configuration failure）

(2)**Read Configuration:**

Downlink： 02C7000000000000000000

Response：

82C7003C003C0100010000（Current configuration）

Description	Device	Cmd ID	Device Type	NetvoxPayLoadData		
SetActive ThresholdReq	R311FA1	0x03	0xC7	ActiveThreshold (2Bytes)	InActiveThreshold (2Bytes)	Reserved (5Bytes,Fixed 0x00)
SetActive ThresholdRsp		0x83		Status (0x00_success)	Reserved (8Bytes,Fixed 0x00)	
GetActive ThresholdReq		0x04		Reserved (9Bytes,Fixed 0x00)		
GetActive ThresholdRsp		0x84		ActiveThreshold (2Bytes)	InActiveThreshold (2Bytes)	Reserved (5Bytes,Fixed 0x00)
SetRestore ReportReq		0x07		RestoreReportSet (1byte, 0x00_DO NOT report when sensor restore; 0x01_DO report when sensor restore)	Reserved (8Bytes, Fixed 0x00)	
SetRestore ReportRsp		0x87		Status (0x00_success)	Reserved (8Bytes, Fixed 0x00)	
GetRestore ReportReq		0x08		Reserved (9Bytes,Fixed 0x00)		
GetRestore ReportRsp		0x88		RestoreReportSet (1byte, 0x00_DO NOT report when sensor restore; 0x01_DO report when sensor restore)	Reserved (8Bytes, Fixed 0x00)	

Assuming that the ActiveThreshold is set to 10m/s2, the value to be set is 10/9.8/0.0625=16.32, and the last value obtained is an integer and is configured as 16.

Assuming that the InActiveThreshold is set to 8m/s2, the value to be set is 8/9.8/0.0625=13.06, and the last value obtained is an integer and is configured as 13.

(3) **Configure device parameters ActiveThreshold=16, InActiveThreshold=13**

Downlink: 03C70010000D0000000000 0010(H_{ex}) = 16(D_{ec}) , 000D(H_{ex}) = 13(D_{ec})

Response：

83C7000000000000000000 (configuration is successful)

83C7010000000000000000 (configuration failed)

(4) **Read device parameters**

Downlink: 04C7000000000000000000

Response: 84C70010000D0000000000 (device current parameter)

(5) **Configure DO report when sensor restore** (When the vibration stops, R311FA1 will report an uplink package)

Downlink: 07C7010000000000000000

Response：

87C7000000000000000000 (configuration success)

87C7010000000000000000 (configuration failure)

(6) Read device parameters

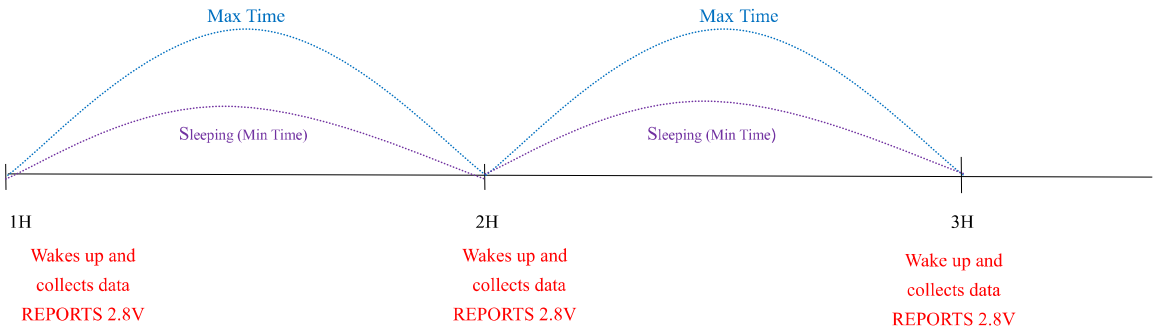
Downlink: 08C7000000000000000000

Response：

88C7010000000000000000 (device current parameter)

5.5 Example of MinTime/MaxTime logic

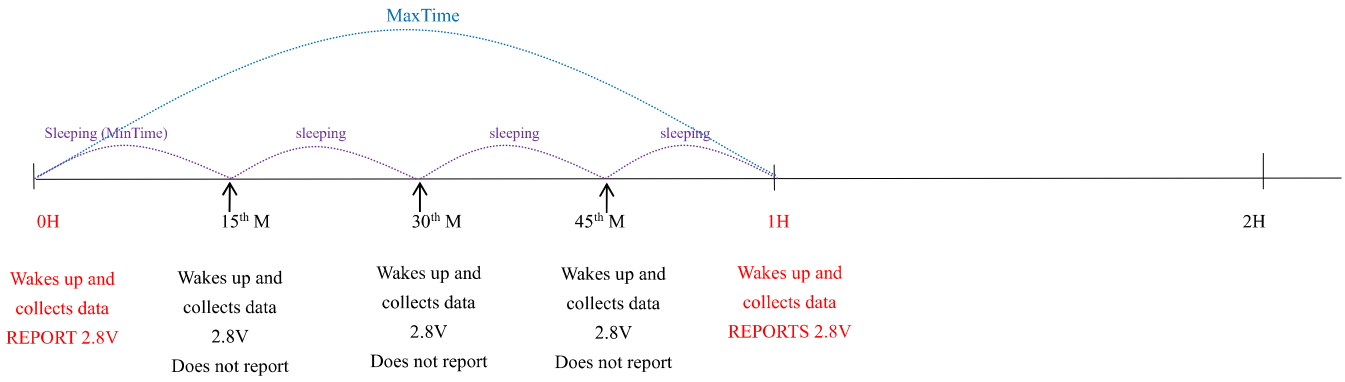
Example#1 based on MinTime = 1 Hour, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange=0.1V



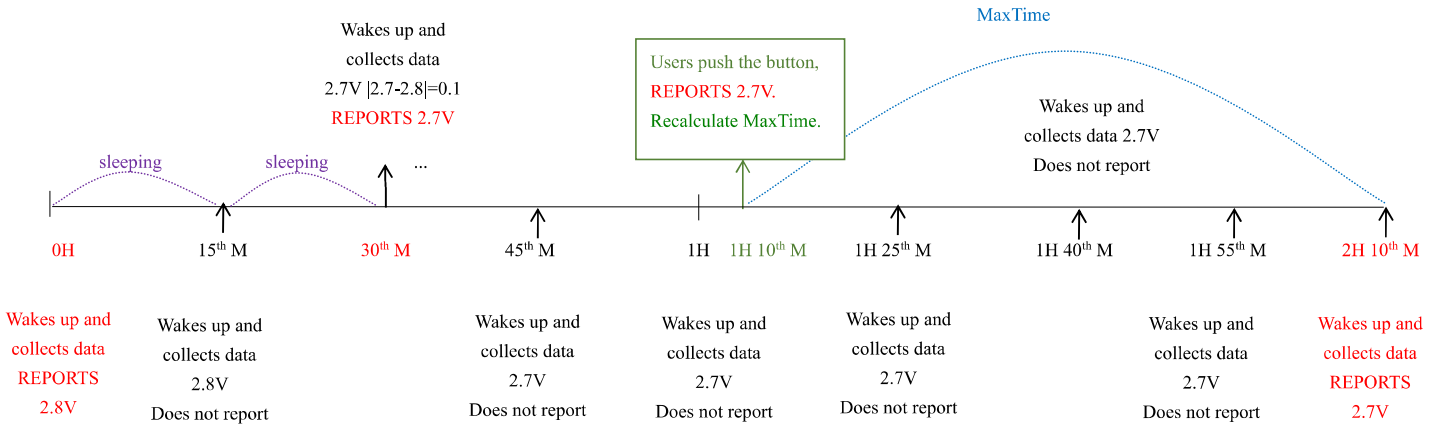
Note:

MaxTime=MinTime. Data will only be report according to MaxTime (MinTime) duration regardless BatteryVoltageChange value.

Example#2 based on MinTime = 15 Minutes, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange= 0.1V.



Example#3 based on MinTime = 15 Minutes, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange= 0.1V.



Notes:

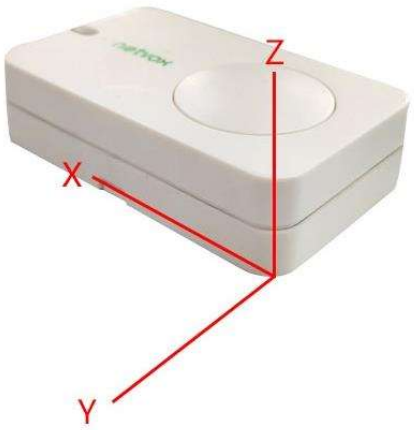
1) The device only wakes up and performs data sampling according to MinTime Interval. When it is sleeping, it does not collect data.

2) The data collected is compared with the last data reported. If the data change value is greater than the ReportableChange value, the device reports according to MinTime interval. If the data variation is not greater than the last data reported, the device reports according to MaxTime interval.

3)We do not recommend to set the MinTime Interval value too low. If the MinTime Interval is too low, the device wakes up frequently and the battery will be drained soon.

4) Whenever the device sends a report, no matter resulting from data variation, button pushed or MaxTime interval, another cycle of MinTime / MaxTime calculation is started.

5.6 The X, Y, Z axis direction of R311FA1



6. Installation

1. Remove the 3M adhesive on the back of the 3-axis Accelerometer Sensor and attach the body to the surface of a smooth object (please do not stick it to a rough surface to prevent the device from falling off after a long time use).

Note：

- Wipe the surface clean before installation to avoid dust on the surface to affect the adhesion of the device.
- Do not install the device in a metal shielded box or other electrical equipment around it to avoid affecting the wireless transmission of the device.

2. Installation Precautions：

While installing, it is recommended to install R311FA1 horizontal while the generator is power-off and in static status. After installing and fixing R311FA1, please turn on the device. After the device is joined, one minute later, R311FA1 would perform the calibration of the device (the device cannot be moved after the calibration. If it needs to be moved, the device needs to be turned off/powered off for 1 minute, and then the calibration would be performed again). R311FA1 would need some time to gather the data of three-axis accelerometer & the temperature of the generator while it is working normally. The data is a reference for the settings of ActiveThreshold & InActiveThreshold, it is also for checking if the generator is working abnormally.

3.When R311FA1 detects the data of three-axis accelerometer exceed ActiveThreshold, R311FA1 would report the data that detected. After sending the data of three-axis accelerometer, the data of three-axis accelerometer of the device needs to be lower than InActiveThreshold and the duration has to be more than 5 seconds (cannot be modified) before the next detection.

Note：

- While the data of three-axis accelerometer of the device is lower than InActiveThreshold and the duration has to be lesser than 5 seconds, at this time, if the vibration continues (the data of three-axis accelerometer is higher than InActiveThreshold), it will be delayed for 5 seconds. Until the data of three-axis accelerometer is lower than InActiveThreshold, and the duration is more than 5 seconds.
- R311FA1 would send two packets, one is the data of three-axis accelerometer, and the other would be sent after 10 seconds with the data of three-axis velocity.

3-axis Accelerometer Sensor (R311FA1) is suitable for the following scenarios:

- Industrial Equipment
- Industrial Instrument
- Medical Instruments

When it necessary to detect 3-axisthe acceleration and velocity

7. Important Maintenance Instruction

Kindly pay attention to the following in order to achieve the best maintenance of the product:

• Keep the device dry. Rain, moisture, or any liquid might contain minerals and thus corrode electronic circuits. If the device gets wet, please dry it completely.

• Do not use or store the device in dusty or dirty environment. It might damage its detachable parts and electronic components.

• Do not store the device under excessive heat condition. High temperature can shorten the life of electronic devices, destroy batteries, and deform or melt some plastic parts.

• Do not store the device in places that are too cold. Otherwise, when the temperature rises to normal temperature, moisture will form inside, which will destroy the board.

• Do not throw, knock or shake the device. Rough handling of equipment can destroy internal circuit boards and delicate structures.

• Do not clean the device with strong chemicals, detergents or strong detergents.

• Do not apply the device with paint. Smudges might block in the device and affect the operation.

• Do not throw the battery into the fire, or the battery will explode. Damaged batteries may also explode.

All of the above applies to your device, battery and accessories. If any device is not working properly, please take it to the nearest authorized service facility for repair.