netvox™

Wireless Tilt Angle
and
Surface Temperature Sensor

R718EA
User Manual

Table of Content

1. Introduction

The R718EA is a LoRaWAN ClassA device, it detects the angle of three-axis tilt and surface temperature of the detected object, and it is compatible with LoRaWAN protocol.

When the device moves or vibrates over threshold value, it immediately reports the data of temperature and the tilt angle.

LoRa Wireless Technology:

LoRa is a wireless communication technology dedicated to long distance and low power consumption. Compared with other communication methods, LoRa spread spectrum modulation method greatly increases to expand the communication distance. Widely used in long-distance, low-data wireless communications. For example, automatic meter reading, building automation equipment, wireless security systems, industrial monitoring. Main features include small size, low power consumption, transmission distance, 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

Indicator

Function Key

NTC Thermistor Sensor

3. Main Features

- Apply SX1276 wireless communication module.

- 2 sections ER14505 3.6V Lithium AA size battery

- Detect tilt angle of the X, Y, and Z axes.

- The base is attached with a magnet that can be attached to a ferromagnetic material object.

- Protection level IP65/IP67 (optional)

- Compatible with LoRaWAN^{TM} Class A

- Frequency hopping spread spectrum technology

- Available third-party platform: Actility / ThingPark, TTN, MyDevices/Cayenne

- Low power consumption and long battery life

    Battery Life:

    ⁻ Please refer to web: http://www.netvox.com.tw/electric/electric_calc.html

    ⁻ At this website, users can find battery lifetime for variety models at different configurations.

        1. Actual range may vary depending on environment.

        2. Battery life is determined by sensor reporting frequency and other variables.

4. Set up Instruction

On/Off

Power on	Insert batteries. (Users may need a screwdriver to open)
Turn on	Press and hold the function key for 3 seconds till the green indicator flashes once.
Turn off (Restore to factory setting)	Press and hold the function key for 5 seconds till green indicator flashes 20 times.
Power off	Remove Batteries.
Note:	1. Remove and insert the battery; the device is at 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. Five seconds after power on, the device will be in engineering test 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 (when the device is on)	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: send a data report according to Min Interval.

Low Voltage Warning

Low Voltage	3.2V

5. Data Report

The device will send a version package report immediately after power-on. After it is powered on, and the auto-calibration is executed for one minute (Do not move the device), the device will report the attribute data.

The device sends data in the default configuration before any configuration is done.

Default Setting:

MaxTime: 0x0E10 (3600s)

MinTime: 0x0E10 (3600s)

BatteryChange: 0x01 (0.1v)

AngleChange: 0x14 (20°)

TemperatureChange: 0x0A (1°C)

ActiveThreshold: 0x0003   // Range:0x0003-0x00FF

Inactivetime: 0x05 (5s)   // Range:0x03-0xFF

R718EA Reporting Requirements:

When the vibration of the device exceeds the value of ActiveThreshold (the default value is 3, which can be modified), it will start to detect, and when the angle of any axis is greater than or equal to AngleChange, the three-axis tilt angle, battery voltage, and temperature will be reported after the device stops vibrating for 5 seconds.

To detect the next vibration, InActiveTime needs to be longer than 5 seconds (the number of seconds can be modified)

If the vibration continues during the process, the timing will restart.

Calibration:

1. The device **must be placed horizontally** during automatic calibration.

2. After calibration, the angles of X, Y, Z axes are about **0°, 0°, -90°** when the device is placed horizontally.

3. There will be no operation when pressing the button before the automatic calibration is completed.

Note:

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

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

Please refer Netvox LoRaWAN Application Command document and Netvox Lora Command Resolver

http://cmddoc.netvoxcloud.com/cmddoc to resolve uplink data.

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= 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);
Inactive time	Inactivetime can be changed by ConfigureCmd. Inactivetime means that the acceleration variation during the stationary time is less than the set Inactivetime Threshold to declare stationary. Inactivetime range is **0x03-0xFF** (default is 0x05)
Example	Assuming that the critical value is set to 10m/s^2, the Active Threshold to be set is 10/9.8/0.0625=16.32 Active Threshold to 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 or offset is an important accelerometer indicator because it defines the baseline used to measure acceleration.

After installing R718EA, turn on the device and wait for the device join the network 1 minute, the device will automatically offset the calibration.

If the device installation position moves, you need to power off the device 1 minute and restart turn on.

5.3 The X, Y, Z axis direction of R718EA

5.4 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)

Tips

1. **Battery Voltage:**

   The voltage value is bit 0 ~ bit 6, bit 7=0 is normal voltage, and bit 7=1 is low voltage.

   Battery=0xA0, binary=1010 0000, if bit 7= 1, it means low voltage.

   The actual voltage is 0010 0000 = 0x20 = 32, 32*0.1v =3.2v

2. **Version Packet:**

   When Report Type=0x00 is the version packet, such as 019A000A0B202005200000, the firmware version is 2020.05.20

3. **Data Packet:**

   When Report Type=0x01 is data packet.

4. **Signed Value:**

   When the value is negative, 2's complement should be calculated.

Device	Device Type	Report Type	NetvoxPayLoadData					
R718EA	0x9A	0x00	SoftwareVersion(1Byte) Eg.0x0A—V1.0	HardwareVersion (1Byte)		DateCode (4Bytes,eg 0x20170503)		Reserved (2Bytes,fixed 0x00)
		0x01	Battery (1Byte, unit:0.1V)	AngleX (1Byte Signed Value,Unit:1°)	AngleY (1Byte, Signed Value ,Unit:1°)	AngleZ (1Byte, Signed Value ,Unit:1°)	Temperature (Signed2Bytes, unit:0.1℃)	Reserved (2Bytes,fixed 0x00)

Example of Uplink: 019A01240A36E701070000

1st byte (01): Version

2nd byte (9A): DeviceType 0x9A- R718EA

3rd byte (01): ReportType

4th byte (24): Battery－3.6v , 24 H$_{ex}$=36 D$_{ec}$ 36*0.1v=3.6v

5th byte (0A): AngleX－10°, 0A H$_{ex}$=10 D$_{ec}$ 10*1°=10°

6th byte (36): AngleY－54° ,36 H$_{ex}$=54 D$_{ec}$　　54*1°=54°

7th byte (E7): AngleZ－-25°, 0x100 H$_{ex}$ -0xE7 H$_{ex}$ = 19 H$_{ex}$,　　19 H$_{ex}$=25 D$_{ec}$　　-25*1°= -25°

8th 9th byte (0107): Temperature－26.3°C , 107 Hex= 263 Dec　　263*0.1°C=26.3°

10th 11th byte (0000): Reserved

5.5 Example of data configuration

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					
ConfigReportReq		0x01		MinTime (2bytes Unit:s)	MaxTime (2bytes Unit:s)	BatteryChange (1byte Unit:0.1v)	AngleChange (1byte Unit:1˚)	Temperature Change (1byte Unit:0.1˚C)	Reserved (2Bytes,Fixed 0x00)
ConfigReportRsp		0x81		Status(0x00_success)			Reserved (8Bytes,Fixed 0x00)		
ReadConfigReportReq		0x02		Reserved (9Bytes,Fixed 0x00)					
ReadConfigReportRsp	R718EA	0x82	0x9A	MinTime (2bytes Unit:s)	MaxTime (2bytes Unit:s)	BatteryChange (1byte Unit:0.1v)	AngleChange (1byte Unit:1˚)	Temperature Change (1byte Unit:0.1˚C)	Reserved (2Bytes,Fixed 0x00)
SetActiveThresholdReq		0x03		Threshold (2Bytes)		Inactivetime (1Byte,Unit:1s)		Reserved (6Bytes,Fixed 0x00)	
SetActiveThresholdRsp		0x83		Status (0x00_success)			Reserved (8Bytes,Fixed 0x00)		
GetActiveThresholdReq		0x04		Reserved (9Bytes,Fixed 0x00)					
GetActiveThresholdRsp		0x84		Threshold (2Bytes)		Inactivetime (1Byte,Unit:1s)		Reserved (6Bytes,Fixed 0x00)	

(1) Configure device parameters MinTime = 1min, MaxTime = 1min, BatteryChange = 0.1v, AngleChange =5°,

　　TemperatureChange=1°C

　　Downlink: 019A003C003C01050A0000　　　　003C(H$_{ex)}$ = 60(D$_{ec}$)

　Device returns:

　　　　　819A000000000000000000 (Configuration is successful)

　　　　　819A010000000000000000 (Configuration failed)

(2) Read device parameters

Downlink: 029A000000000000000000

Device returns:

829A003C003C01050A0000 (current device parameters)

(3) Configure device parameters ActiveThreshold=16, Inactivetime =5 seconds

Assuming that the Active Threshold is set to 10m/s^2, 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.

Downlink: 039A001005000000000000

Device returns:

839A000000000000000000 (Configuration is successful)

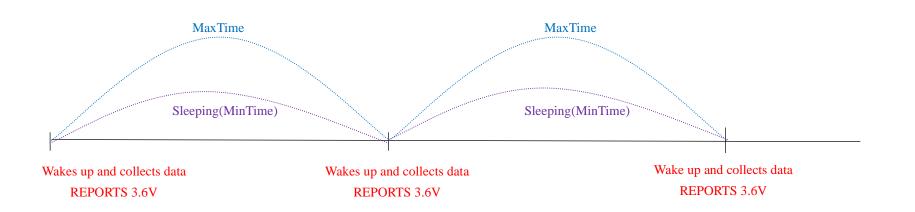839A010000000000000000 (Configuration failed)

(4) Read device parameters

Downlink: 049A000000000000000000

Device returns:

849A001005000000000000　(Device current parameter)
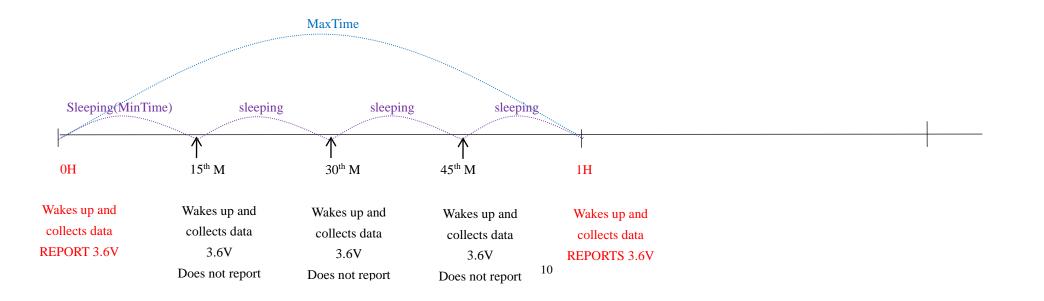
5.6 Example for MinTime/MaxTime logic

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

MaxTime　　　　　　　　　　　　MaxTime

Sleeping(MinTime)　　　　　　Sleeping(MinTime)

Wakes up and collects data　　Wakes up and collects data　　Wake up and collects data
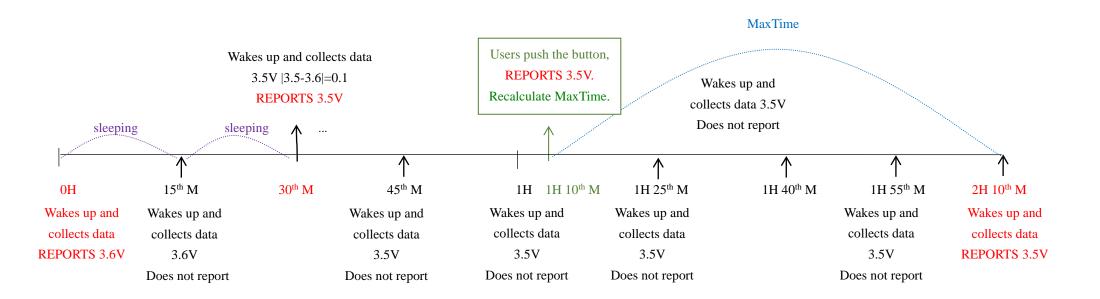REPORTS 3.6V　　　　　　REPORTS 3.6V　　　　　　REPORTS 3.6V

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.

MaxTime

Sleeping(MinTime)　　sleeping　　sleeping　　sleeping

0H　　　　15th M　　　30th M　　　45th M　　　1H

Wakes up and　　Wakes up and　　Wakes up and　　Wakes up and　　Wakes up and
collects data　　collects data　　collects data　　collects data　　collects data
REPORT 3.6V　　3.6V　　　3.6V　　　3.6V　　　REPORTS 3.6V
　　　　　Does not report　Does not report　Does not report

10

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 <u>reported</u>. If the data variation 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.

6. Installation

While installing, it is recommended to install R718EA while the device is power-off, and be installed horizontal at a stationary place. After installing and fixing R718EA, please turn on the device. After the device is joined, one minute later, R718EA would perform the offset calibration of the device.

R718EA would need some time to gather the data of three-axis tilt angle, the voltage of battery and the surface temperature for reference.

The specific configuration depends on the actual situation.

Note:

Please do not disassemble the device unless it is required to replace the batteries. Do not touch the waterproof gasket, LED indicator light, function keys when replacing the batteries. Please use suitable screwdriver to tighten the screws (if using an electric screwdriver, it is recommended to set the torque as 4kgf) to ensure the device is impermeable.

7. Information about Battery Passivation

Many of Netvox devices are powered by 3.6V ER14505 Li-SOCl2 (lithium-thionyl chloride) batteries that offer many advantages including low self-discharge rate and high energy density.

However, primary lithium batteries like Li-SOCl2 batteries will form a passivation layer as a reaction between the lithium anode and thionyl chloride if they are in storage for a long time or if the storage temperature is too high. This lithium chloride layer prevents rapid self-discharge caused by continuous reaction between lithium and thionyl chloride, but battery passivation may also lead to voltage delay when the batteries are put into operation, and our devices may not work correctly in this situation.

As a result, please make sure to source batteries from reliable vendors, and it is suggested that if the storage period is more than one month from the date of battery production, all the batteries should be activated.

If encountering the situation of battery passivation, users can activate the battery to eliminate the battery hysteresis.

ER14505 Battery Passivation:

7.1 To determine whether a battery requires activation

Connect a new ER14505 battery to a resistor in parallel, and check the voltage of the circuit.

If the voltage is below 3.3V, it means the battery requires activation.

7.2 How to activate the battery

a. Connect a battery to a resistor in parallel

b. Keep the connection for 5~8 minutes

c. The voltage of the circuit should be ≧3.3, indicating successful activation.

Brand	Load Resistance	Activation Time	Activation Current
NHTONE	165 Ω	5 minutes	20mA
RAMWAY	67 Ω	8 minutes	50mA
EVE	67 Ω	8 minutes	50mA
SAFT	67 Ω	8 minutes	50mA

Note:

If you buy batteries from other than the above four manufacturers, then the battery activation time, activation current, and required load resistance shall be mainly subject to the announcement of each manufacturer.

8. Description of Waterproof Grade

1: According to Enclosure Protection Class

This standard is equivalent to IEC 60529:2001 Degrees of Protection Provided by Enclosures (IP Code) (English version)

2: The test method of IP65 waterproof grade is:

Spray the device in all directions under 12.5L/min water flow for 3min, and the internal electronic function is normal.
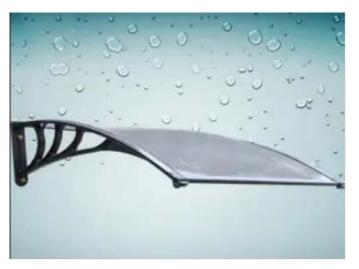
The test method of IP67 waterproof grade is:

The device is immersed in 1m deep water for 30min, and the internal electronic function is normal.

IP65, dust-proof and to prevent damage caused by water from nozzles in all directions from invading electrical appliances. It can be used in general indoor environment and sheltered outdoor environment. It is not suitable for use in environments with high water pressure, high temperature and high humidity, such as long time direct sunlight outdoors and possible direct exposure to rainstorm. If it is really necessary to install in harsh environments, it is recommended to add sunscreen and rainproof shields when installing.

Case I (face down with LED and buttons)   Case II (installed under the rain shield)

9. 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.