Wireless Accelerometer and Surface Temperature Sensor

R718E User Manual

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1. Introduction

The R718E is identified as a LoRaWAN Class A device with three-axis acceleration, temperature and compatible with LoRaWAN protocol.

When the device moves or vibrates over threshold value, it immediately reports the temperature, acceleration and velocity of the X, Y, and Z axes.

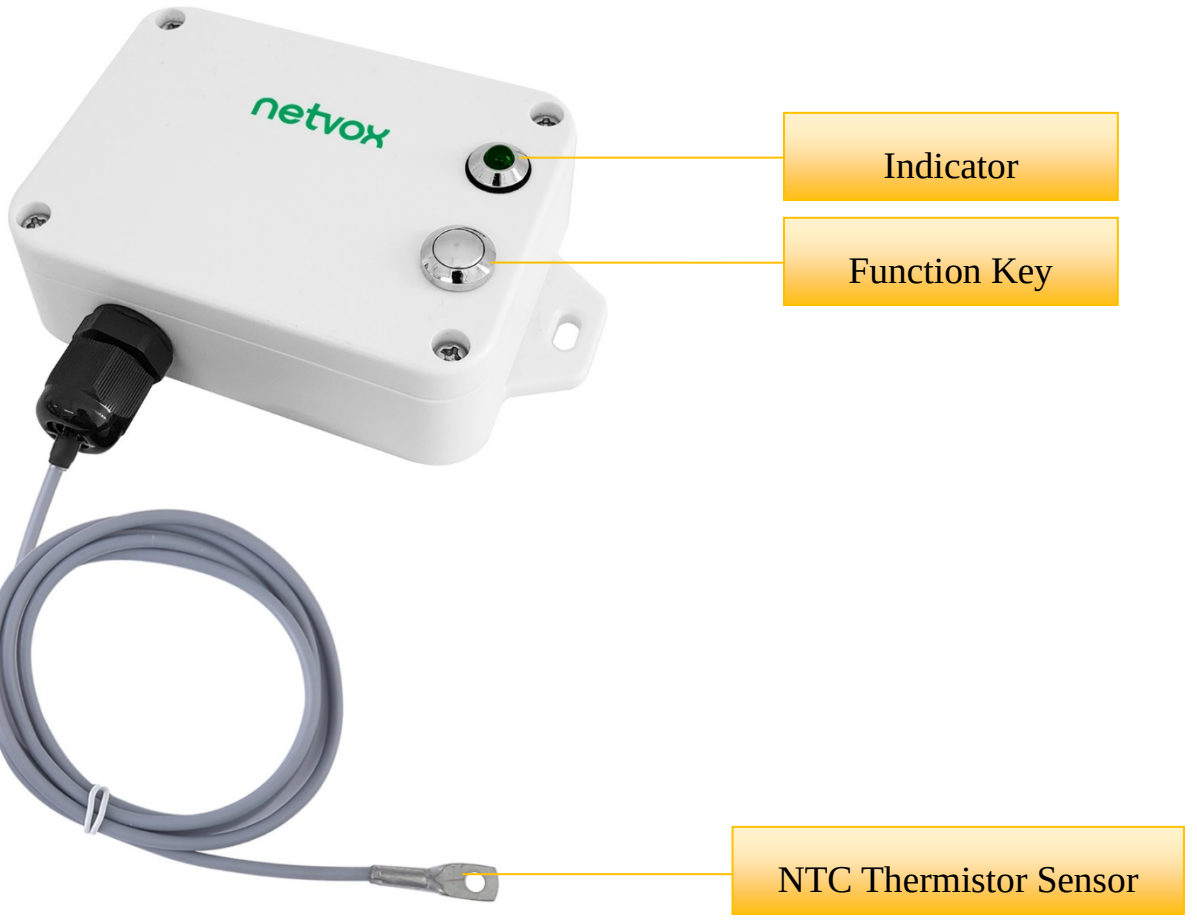
LoRa Wireless Technology:

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



3. Main Features

- Apply SX1276 wireless communication module
- 2 sections ER14505 3.6V Lithium AA size battery
- Detect the acceleration and velocity 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™ 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 life time 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 for 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. At 1st -5th second 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 to join. 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 to join. 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 registration 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 for 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 immediately send a version packet report along with two uplink packets including temperature, battery voltage, acceleration and velocity of the X, Y, and Z axes.

The interval between these two packets will be 10 seconds.

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)

Acceleration Change: 0x0003

ActiveThreshold: 0x0003

InActiveThreshold: 0x0002

Restore Report Set: 0x00

Three-axis acceleration and velocity:

If the three-axis acceleration of the device exceeds ActiveThreshold, a report will be sent immediately. After the three-axis acceleration and speed are reported, the three-axis acceleration of the device needs to be lower than InActiveThreshold, the duration is greater than 5s (cannot be modified), and the vibration stops completely, the next detection will start. If the vibration continues during this process after the report is sent, the timing will restart.

The device sends two packets of data. One is the acceleration of the three axes, and the other is the speed of the three axes and temperature. The interval between the two packets is 10s.

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 (or 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);
InActive Threshold	InActive Threshold can be changed by ConfigureCmd InActive Threshold range is **0x0002-0x00FF** (default is 0x0002)
Example	Assuming that the critical value is set to 10m/s^2, the Active Threshold (or InActive Threshold) to be set is 10/9.8/0.0625=16.32 Active Threshold (or InActiveThreshold) to be set integer as 16. Note: When configuration, ensure that the Active Threshold must be greater than the InActive Threshold.

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 R718E, 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 speed is within 160mm/s, it can be judged that the device is stationary.

5.3 The X, Y, Z axis direction of R718E

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 011C000A0B202005200000, the firmware version is 2020.05.20

3. **Data Packet:**

   a. When Report Type=0x01 is data packet. If the device data exceeds 11 bytes or there are shared data packets, the Report Type will have different values.

   b. R718E value uses big-endian computing.

   c. Because of the length limitation of R718E instruction. Therefore, R718E sends out 2 bytes and adds 0 to the data to form 4 bytes of float32.

Device	**Device Type**	**Report Type**	**NetvoxPayLoadData**				
R718E	0x1C	0x00	SoftwareVersion (1Byte) Eg.0x0A—V1.0	HardwareVersion (1Byte)	DateCode (4Bytes,eg0x20170503)	Reserved (2Bytes,fixed 0x00)	
		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)	Temperature (Signed2Bytes,unit:0.1°C)	

Example of uplink:

Packet 1: 011C01246A3E883E1F4100

1st byte (01): Version

2nd byte (1C): DeviceType 0x1C － R718E

3rd byte (01): ReportType

4th byte (24): Battery－3.6v , 24 Hex=36 Dec 36*0.1v=3.6v

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: 011C0212422B42C7440107

1st byte (01): Version

2nd byte (1C): DeviceType 0x1C － R718E

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 (0107): Temperature－26.3°C, 0107(HEX)=263(DEC),263*0.1°C =26.3°C

5.5 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				
ConfigReport Req	R718E	0x01	0x1C	MinTime (2bytes Unit:s)	MaxTime (2bytes Unit:s)	BatteryChange (1byte Unit:0.1v)	Acceleration Change (2byte Unit:m/s2)	Reserved (2Bytes,Fixed 0x00)
ConfigReport Rsp		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)	Acceleration Change (2byte Unit:m/s2)	Reserved (2Bytes,Fixed 0x00)

SetActive ThresholdReq		0x03		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)

(1) Configure device parameters MinTime = 1min, MaxTime = 1min, BatteryChange = 0.1v, Acceleratedvelocitychange = 1m/s^2

Downlink: 011C003C003C0100010000 003C($H_{ex)}$ = 60($D_{ec)}$

Device returns:

811C000000000000000000 (configuration is successful)

811C010000000000000000 (configuration failed)

(2) Read device parameters

Downlink: 021C000000000000000000

Device returns:

821C003C003C0100010000 (current device parameters)

(3) Assuming that the Active Threshold 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 InActive Threshold 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.

Configure device parameters ActiveThreshold=16, InActiveThreshold=13

Downlink: 031C0010000D0000000000

Device returns:

831C000000000000000000 (configuration is successful)

831C010000000000000000 (configuration failed)

Read device parameters

Downlink: 041C000000000000000000

Device returns:

841C0010000D0000000000 (device current parameter)

5.6 Example of Restore Report

SetRestore ReportReq	R718E	0x07	0x1C	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)

0x00: Only report when the device detects vibration. (Default)

0x01: A report is sent when the device vibrates, and a report is also sent when the vibration stops.

(The function of *Restore* is supported by the firmware version after 20200518 version)

(1) Configure DO report when sensor restore (When the vibration stops, R718E will report an uplink package)

Downlink: 071C010000000000000000

Device return:

871C000000000000000000 (configuration success)

871C010000000000000000 (configuration failure)

(2) Read device parameters

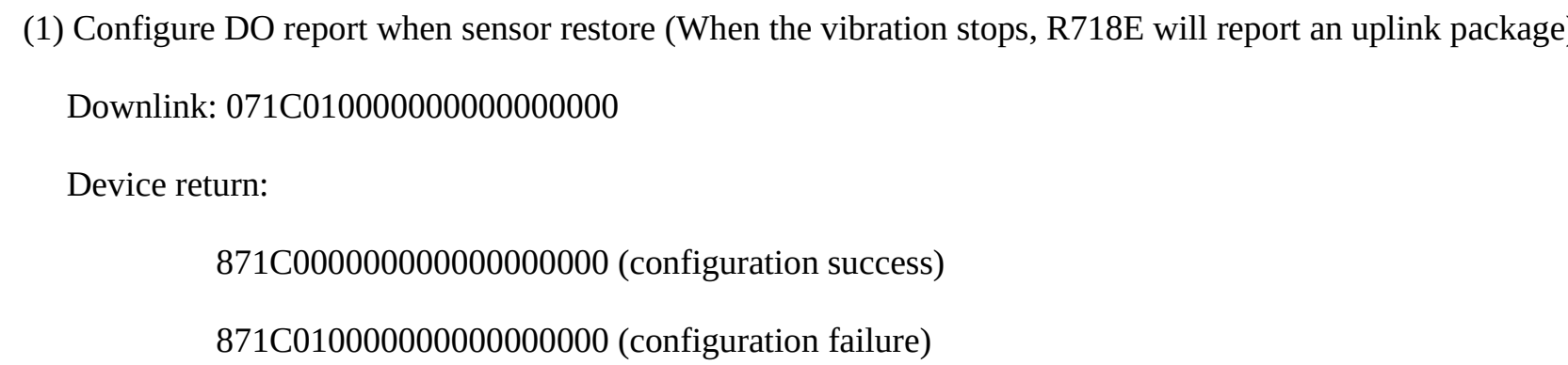
Downlink: 081C000000000000000000

Device return:

881C010000000000000000 (device current parameter)

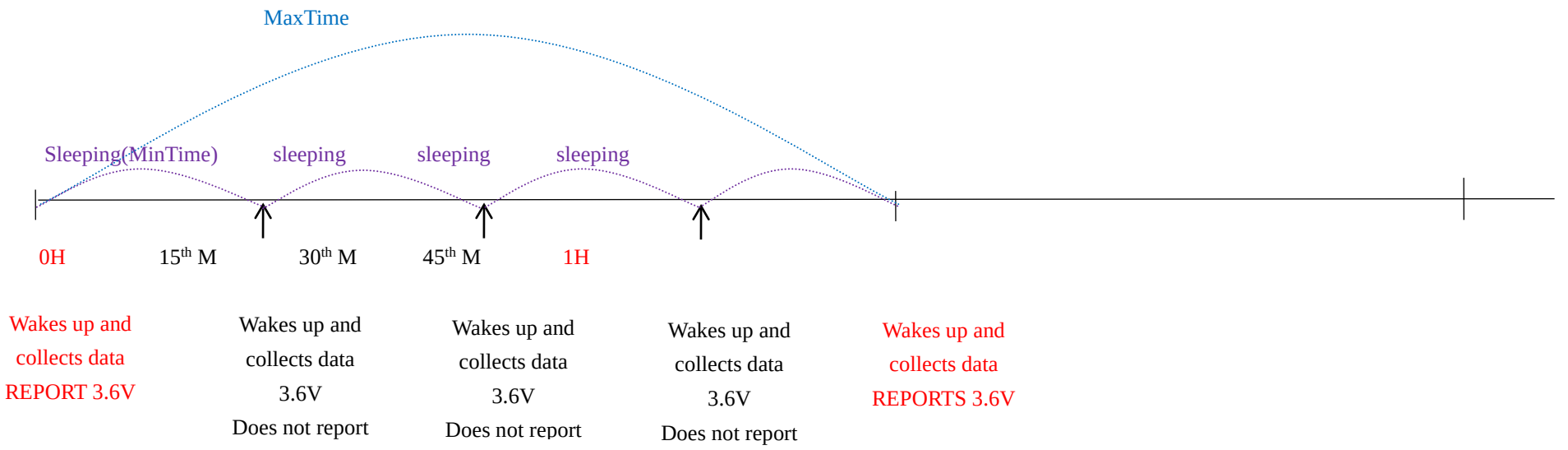
5.7 Example for MinTime/MaxTime logic

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

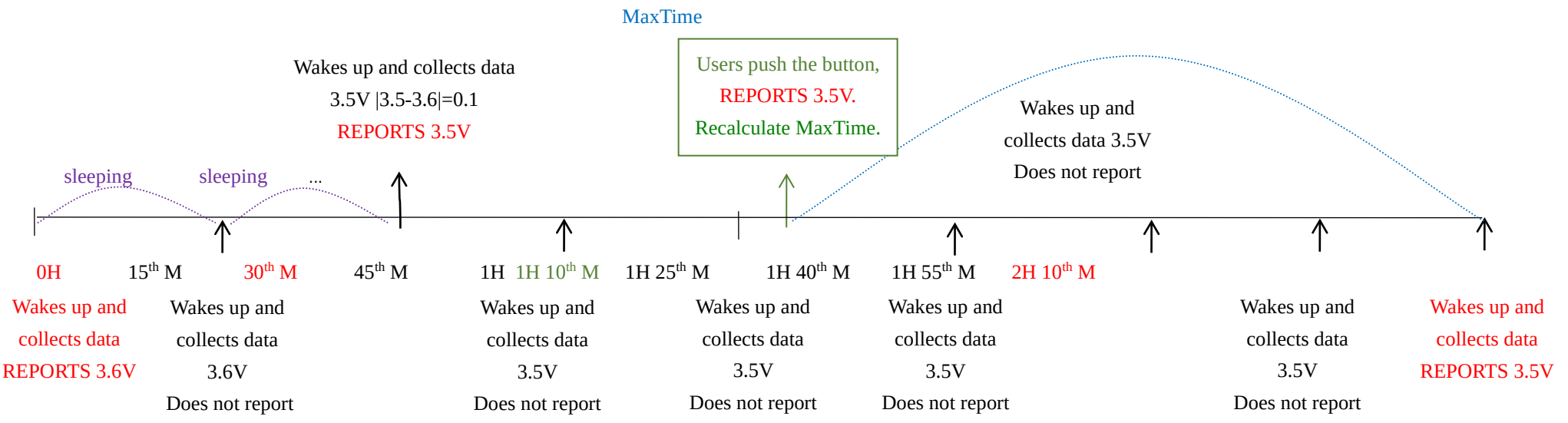


Note: MaxTime=MinTime. Data will only be report according to MaxTime (MinTime) duration regardless BatteryVoltageChange value.

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 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. Example Application

In the case of detecting if the generator is working normally, it is recommended to install R718E horizontal while the generator is power-off and in static status. After installing and fixing R718E, please turn on the device. After the device is joined, one minute later, R718E 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). R718E 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.

Assuming that the collected Z Axis Accelerometer data is stable at 100m/s², the error is ±2m/s², the ActiveThreshold can be set to 110m/s², and the InActiveThreshold is 104m/s².

7. Installation

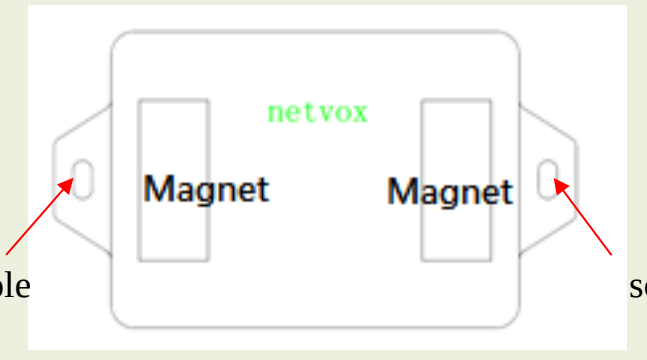
1. The Wireless Accelerometer and Surface Temperature Sensor(R718E) has a built-in magnet

   When installed, it can be attached to the surface of an object with iron which is convenient and quick.

   To make the installation more secure, use screws (purchased) to secure the unit to a surface.

Note:

Do not install the device in a metal shielded box or in an environment with other electrical equipment around it to avoid affecting the wireless transmission of the device.



screw hole screw hole

2. Installation Precautions：

While installing, it is recommended to install R718E horizontal while the generator is power-off and in static status. After installing and fixing R718E, please turn on the device. After the device is joined, one minute later, R718E 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). R718E 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 R718E detects the data of three-axis accelerometer exceed ActiveThreshold, R718E 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：

(1) 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.

(2) R718E 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 the speed of three-axis & the temperature.

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.

8. 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:

8.1 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.

8.2 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.

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.