Wireless Accelerometer and Surface Temperature Sensor

R718EC User Manual

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1. Introduction

The R718EC is identified as a LoRaWAN ClassA device with three-axis acceleration, temperature and is compatible with the LoRaWAN protocol.

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

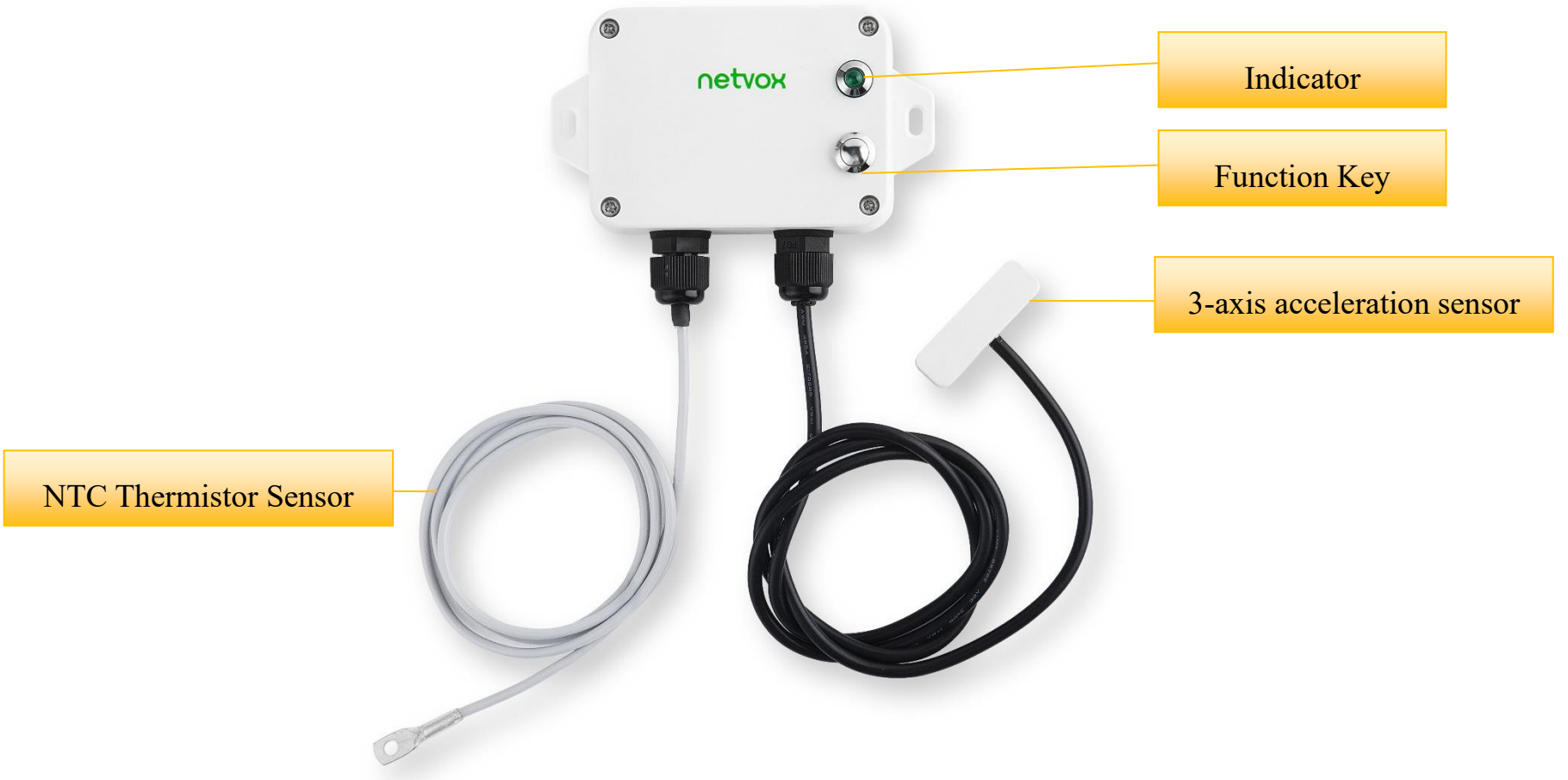
LoRa Wireless Technology:

LoRa is a wireless communication technology dedicated to long-distance and low power consumption. Compared with other communication methods, the 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, and 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 platforms: Actility / ThingPark, TTN, MyDevices/Cayenne
- Low power consumption and long battery life

Battery Life:

- Please refer to the web: http://www.netvox.com.tw/electric/electric_calc.html
- On this website, users can find battery lifetime for various models at different configurations.

1. Actual range may vary depending on the 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, and the 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. The first 5 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

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: the green indicator remains off

Sleeping Mode

The device is on and in the network	Sleeping period: Min Interval. When the reportchange exceeds the 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 device sends data in the default configuration before any configuration is done.

Default setting:

MaxTime: 0x0E10 (3600s)

MinTime: 0x0E10 (3600s)

BatteryChange: 0x01 (0.1v)

AccelerationChange: 0x0003

ActiveThreshold = 0x0003

InActiveThreshold = 0x0002

RestoreReportSet = 0x00 (DO NOT report when sensor restore)

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.

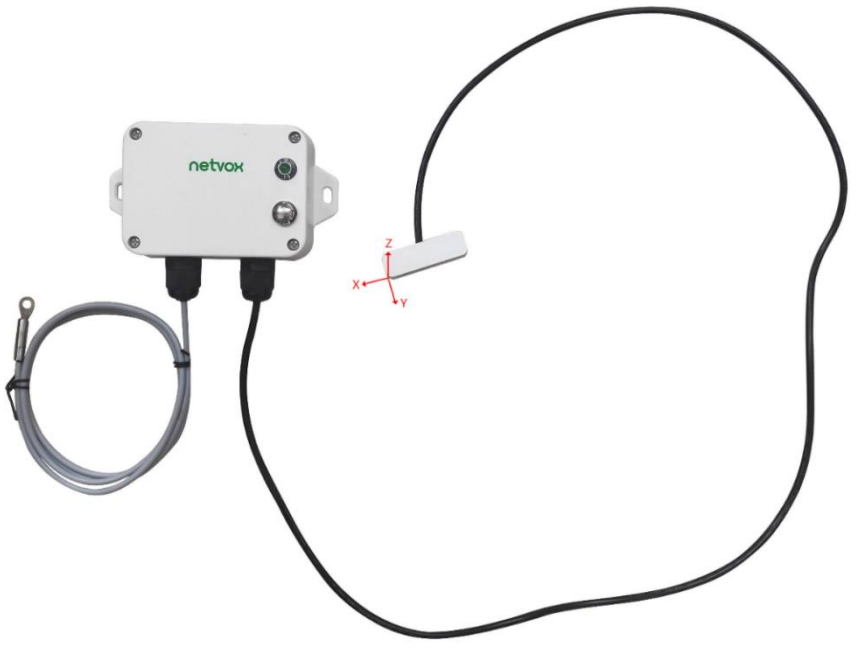
Users would need to install and turn on R718E first. 1 minute after joining the network, the R718EC would automatically deviate from the calibration. The data reported before deviation calibration could be neglected.

If users would like to adjust the device's position, it shall be disconnected from the power supply for 1 minute and turn it on to automatically deviate from the calibration.

After deviating from calibration, the reported three-axis acceleration value will be within 1m/s^2, which means the device remains still. (If the value exceeds 1m/s^2, users need to repeat the above instructions until the value is within 1m/s^2.)

To have the correct reported value, the position of the sensor shall be fixed after deviating from calibration.

5.3 The X,Y,Z axis Direction of R718EC



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. R718EC value uses big-endian computing.

   c. Because of the length limitation of R718EC 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**				
R718EC	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 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	CmdID	Device Type	NetvoxPayLoadData				
Config ReportReq	R718EC	0x01	0x1C	MinTime (2bytes Unit:s)	MaxTime (2bytes Unit:s)	BatteryChange (1byte Unit:0.1v)	AccelerationChange (2byte Unit:m/s^2)	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/s^2)	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/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.

Assuming that the InActive Threshold is set to 8m/s^2, 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)

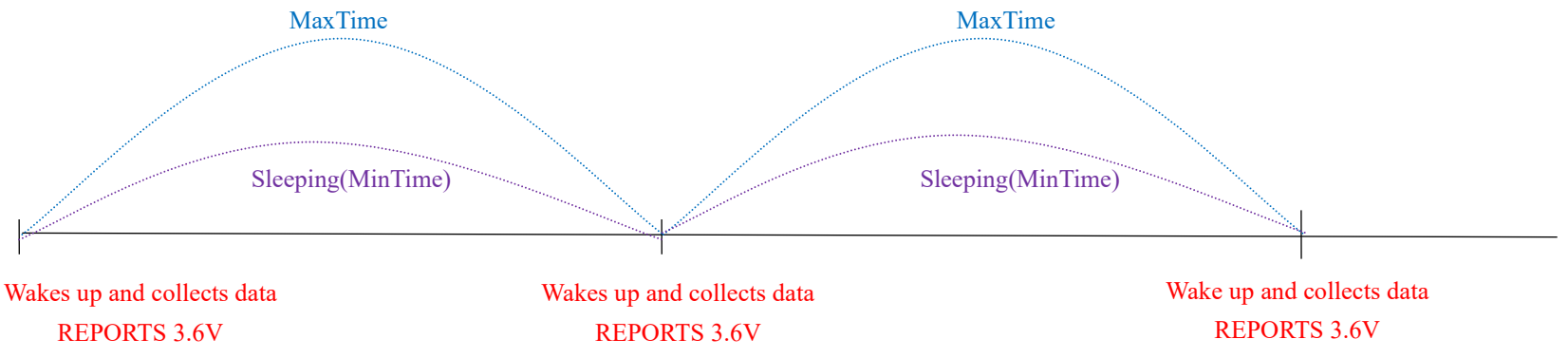
Read device parameters

Downlink: 041C000000000000000000

Device returns: 841C0010000D0000000000 (device current parameter)

5.6 Example for MinTime/MaxTime logic

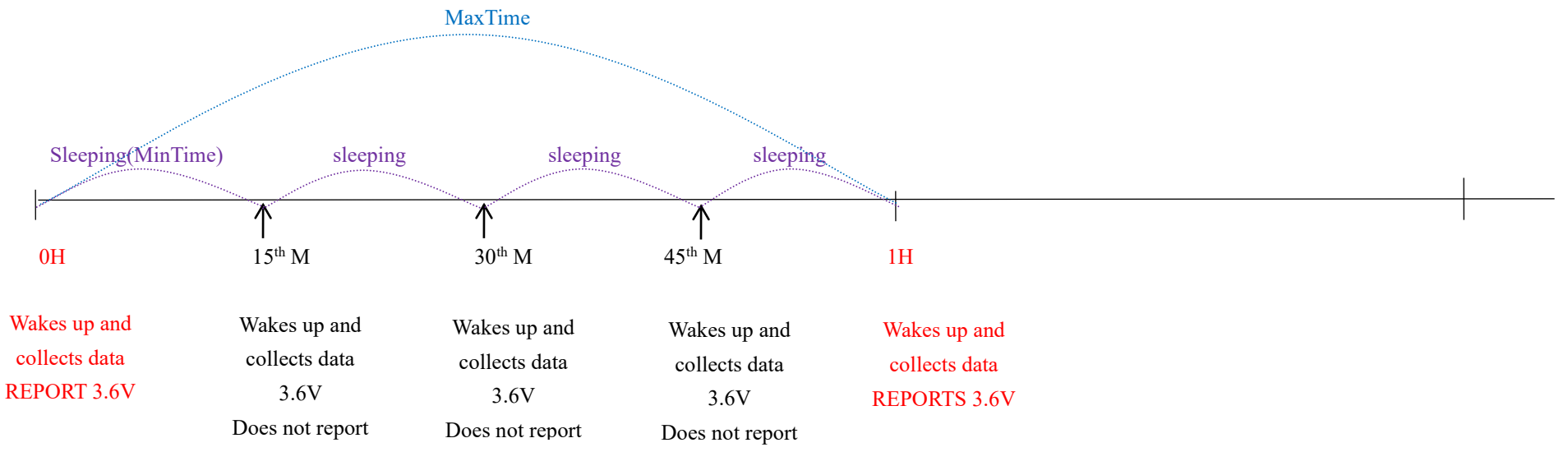
Example#1 based on MinTime = 1 Hour, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange=0.1V



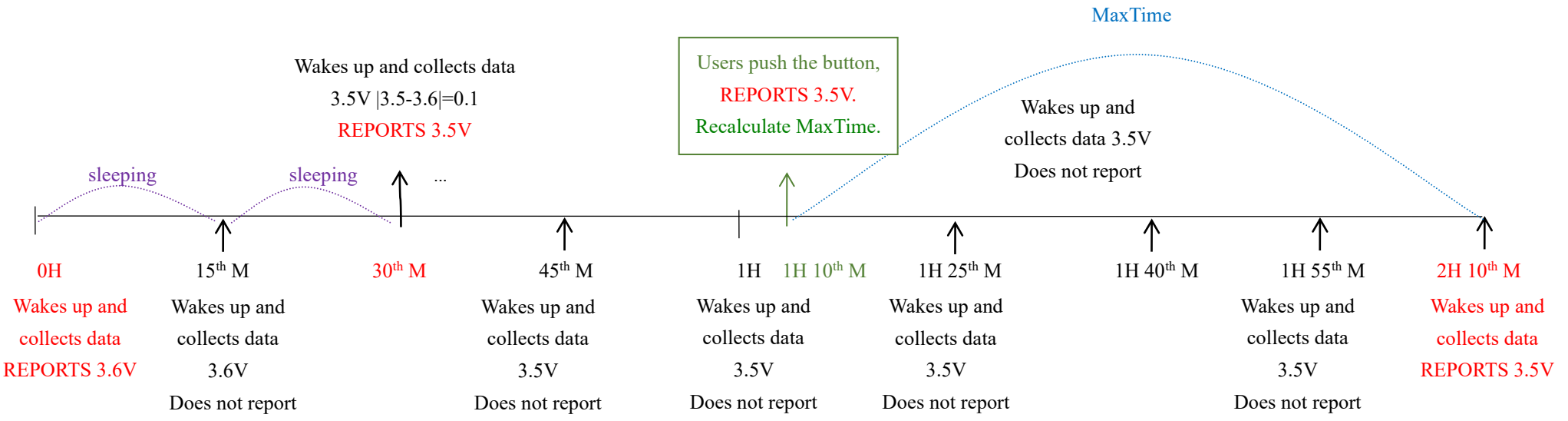
Note:

MaxTime=MinTime. Data will only be reported 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 the MinTime interval. If the data variation is not greater than the last data reported, the device reports according to the MaxTime interval.
3) We do not recommend setting 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 R718EC horizontal while the generator is power-off and in static status. After installing and fixing R718EC, please turn on the device. After the device is joined, one minute later, R718EC 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).
R718EC would need some time to gather the data of the 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.

Note:

Please do not disassemble the device unless it is required to replace the batteries.
Do not touch the waterproof gasket, LED indicator light, or function keys when replacing the batteries. Please use a 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. Installation

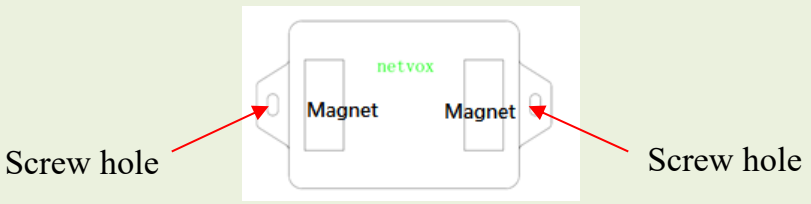
1. The R718EC main body has a built-in magnet (as shown in the figure below). During installation, the main body can be attached to the surface of the object with iron. In order to make the installation more secure, if possible, please use screws (to be purchased) to fix the device to the motor surface.

2. Before installing the three-axis accelerator, tear off the 3M adhesive on the back and paste it on the motor plane.

3. When installing NTC, lock it on the motor with appropriate screws. The contact surface shall be cleaned and coated with thermal conductive adhesive before locking.

Notes:

Do not install the device in a metal shielding box or in an environment with other electrical device around, so as to avoid affecting the wireless transmission signal of the device.



R718EC is applicable to the following scenarios:

- Industrial device
- Mechanical device

And other occasions where it is necessary to detect whether the motor operates normally.

4. Installation precautions:

During installation, the device shall be installed when the device is powered off and the motor is stationary. It is recommended to install it horizontally. Power on the device after fixing. The offset calibration of the device shall be carried out one minute after the network is added (the device cannot be moved after the offset calibration. If it needs to be moved, the device needs to be powered off for 1 minute and then re offset calibrated). The device needs a period of time to collect the three-axis acceleration and temperature of the motor under normal operation, so as to make reference for the setting of static threshold and motion threshold and whether the motor works abnormally.

Assume that the collected Z-axis acceleration is stable at 100m/s², the error is ± 2m/s ², the activity threshold can be set to 110m/s², static threshold is 104m/s². The specific configuration shall be based on the actual situation.

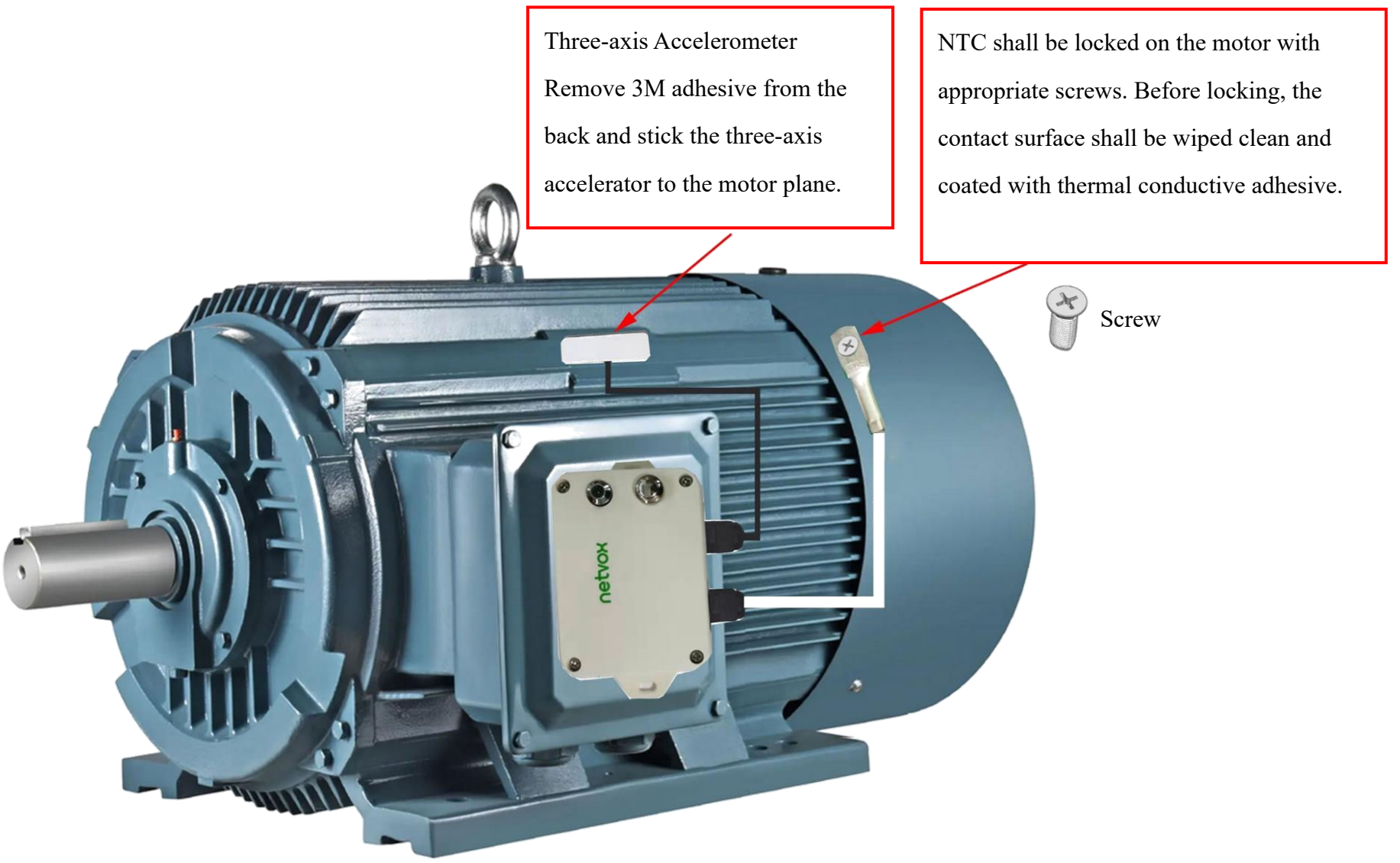
For the configuration of active threshold and static threshold, please refer to the command document.

5. When the device detects that the three-axis acceleration exceeds the set activity threshold, it immediately sends the currently detected value. After sending the three-axis acceleration and speed, the next detection can be carried out only after the triaxial acceleration of the device is lower than the set static threshold and lasts for more than 5 seconds (not modifiable).

Notes:

- When the three-axis acceleration of the device is lower than the set static threshold and the duration is less than 5 seconds, if vibration continues to occur (the three-axis acceleration is higher than the set static threshold), it will be postponed for 5 seconds. Until the three-axis acceleration is lower than the static threshold and lasts for more than 5 seconds.

- The device will send two data packets. One is the three-axis acceleration. After 10 seconds, it will send the three-axis speed and temperature.



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 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 a dusty or dirty environment. It might damage its detachable parts and electronic components.
- Do not store the device under excessive heat conditions. 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 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.