

Wireless Tilt Angle Sensor

R718EB

User Manual

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1. Introduction

R718EB is the Class A device based on the LoRaWAN™ protocol of Netvox. The device detects the tilt angle of three axes. When the device moves or vibrates beyond the set threshold value, and after the device is stationary, if the angle variation of any one of the three axes is greater or equal to than the AngleChange, it will immediately report the current tilt angle of the X, Y, and Z axes and the battery voltage. The device is compatible with LoRaWAN protocol.

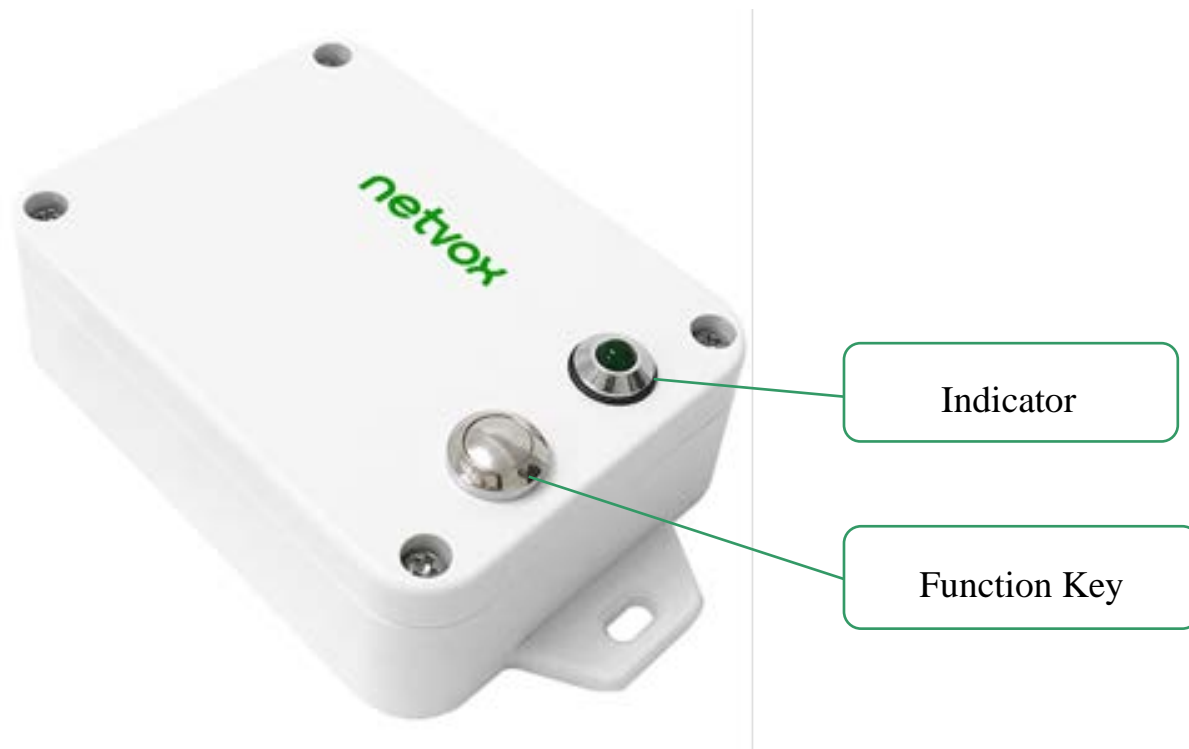
LoRa Wireless Technology:

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. Features

- SX1276 wireless communication module
- 2 sections ER14505 3.6V Lithium AA size battery in parallel
- Built-in tilt measurement chip
- Magnetic base
- 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*

Note: 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. Applications

- Pillars, telegraph poles and other applications such as tilt sensing, angle detection, direction identification, etc.
- Industrial equipment
- Others

5. 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 second, and the green indicator flashes 20 times.
Power off	Remove Batteries.
Note:	<ol style="list-style-type: none"> 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	<p>Turn on the device to search the network.</p> <p>The green indicator stays on for 5 seconds: success</p> <p>The green indicator remains off: fail</p>
Had joined the network	<p>Turn on the device to search the previous network.</p> <p>The green indicator stays on for 5 seconds: success</p> <p>The green indicator remains off: fail</p>

Function Key

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

Sleeping Mode

The device is on and in the network	<p>Sleeping period: Min Interval.</p> <p>When the reportchange exceeds setting value or the state changes: send a data report according to Min Interval.</p>
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Low Voltage Warning

Low Voltage	3.2V
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6. Function Description

6.1 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.

6.2 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 R718EB, 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.

6.3 The X, Y, Z axis direction of R718EB



7. 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) // It is recommended that MinTime is not less than 1min.

//By default, the current voltage and three-axis tilt value are detected once every Min Interval.)

Battery Change: 0x01 (0.1v)

Angle Change: 0x00C8 (20°, Unit: 0.1°) / 0x0FA0(20°, Unit: 0.005°)

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

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

R718EB 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 and battery voltage 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

7.1 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 01C8000A0B202005200000, 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				
R718EB	0xC8	0x00	SoftwareVersion(1Byte) Eg.0x0A—V1.0	HardwareVersion (1Byte)	DateCode (4Bytes,eg0x20170503)	Reserved (2Bytes, fixed 0x00)	
		0x01	Battery (1Byte,unit:0.1V)	AngleX (2Bytes, SignedValue) Unit: according unit type	AngleY (2Bytes, SignedValue) Unit: according unit type	AngleZ (2Bytes, SignedValue) Unit: according unit type	UnitType (1Byte, 0x00_0.1° 0x01_0.005°) *2023/2/17 starts to support
		0x02	Battery (1Byte, unit:0.1V)	ThresholdAlarm (1Byte) Bit0_LowAngleXAlarm, Bit1_HighAngleXAlarm, Bit2_LowAngleYAlarm, Bit3_HighAngleYAlarm, Bit4_LowAngleZAlarm, Bit5_HighAngleAlarm, Bit6-7:Reserved		Reserved (6Bytes, fixed 0x00)	

*The unit cannot be changed through the configuration of commands. It shall be set before the shipment.

Example 1 of Uplink: 01C8012400020003FC8100 (Unit:0.1°)

1st byte (01): Version

2nd byte (C8): DeviceType 0xC8 — R718EB

3rd byte (01): ReportType

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

5th 6th byte (0002): Angle X -0.2° , $2*0.1^\circ=0.2^\circ$

7th 8th byte (0003): Angle Y -0.3° , $3*0.1^\circ=0.3^\circ$

9th 10th byte (FC81): Angle Z -89.5° , $0x10000\text{Hex} -0xFC81\text{Hex} = 37F\text{Hex}$, $37F\text{Hex}=895\text{Dec}$ $-895*0.1^\circ = -89.5^\circ$

11th byte (00): Unit Type — 0.1°

Example 2 of Uplink:

#1 01C80124010C0000BAB401 (Unit:0.005°)

1st byte (01): Version

2nd byte (C8): DeviceType 0xC8 — R718EB

3rd byte (01): ReportType

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

5th 6th byte (010C): Angle X -1.34° , $010C(\text{Hex})=268(\text{Dec})$, $268*0.005^\circ=1.34^\circ$

7th 8th byte (0000): Angle Y -0°

9th 10th byte (BAB4): Angle Z -88.7° , $BAB4(\text{Hex})=-17740$, $-17740*0.005^\circ = -88.7^\circ$

11th byte (01): Unit Type — 0.005°

#2 01C8022401000000000000 // The second data package will only be reported if the set alarm threshold is reached.

1st byte (01): Version

2nd byte (C8): DeviceType 0xC8 — R718EB

3rd byte (02): ReportType

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

5th byte (01): Threshold Alarm—01(Hex) = 0000 0001(Bin), bit 0=1 (Low AngleX Alarm)

6th-11th byte (000000000000): Reserved

7.2 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	R718 EB	0x01	0xC8	MinTime (2bytes, Unit: s)	MaxTime (2bytes, Unit: s)	BatteryChange (1byte, Unit: 0.1v)	AngleChange (2byte, Unit: 0.1°)	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)	AngleChange (2byte, Unit: 0.1°)	Reserved (2Bytes, Fixed 0x00)	
SetActive ThresholdReq		0x03		Threshold (2Bytes)		InActivetime (1Bytes, Unit: 1s)		Reserved (5Bytes, Fixed 0x00)	
SetActive ThresholdRsp		0x83		Status (0x00_success)			Reserved (8Bytes, Fixed 0x00)		
GetActive ThresholdReq		0x04		Reserved (9Bytes, Fixed 0x00)					
GetActive ThresholdRsp		0x84		Threshold (2Bytes)		InActivetime (1Bytes, Unit: 1s)		Reserved (5Bytes, Fixed 0x00)	

Example 1. Configure device parameters MinTime = 2 min, MaxTime = 2 min, BatteryChange = 0.1v, AngleChange = 5°

(unit:0.1°)

Downlink: 01C8007800780100320000 78(H_{ex}) = 120(D_{ec}); 0032(H_{ex}) = 50(D_{ec})

Device returns:

81C80000000000000000 (configuration is successful)

81C80100000000000000 (configuration failed)

Example 2. Read device parameters

Downlink: 02C800000000000000000000

Device returns:82C8007800780100320000 (current device parameters)

Example 3. Configure device parameters ActiveThreshold=16, InActiveTime=5

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: 03C800100500000000000000 0010(H_{ex}) = 16(D_{ec})

Device returns:83C800000000000000000000 (configuration is successful)

83C801000000000000000000 (configuration failed)

Example 4. Read device parameters

Downlink: 04C800000000000000000000

Device returns:84C800100500000000000000 (device current parameter)

7.3 Example of GlobalCalibrateCmd

FPort: 0x0E

Remain the last configuraton when the device is reset back to factory setting.

Description	Cmd ID	Sensor Type	PayLoad(Fix =9 Bytes)				
			Channel(1Byte) 0_Channel1, 1_Channel2,etc	Multiplier (2bytes) Unsigned	Divisor (2bytes) Unsigned	DeltValue (2bytes) Signed	Reserved (2Bytes) Fixed 0x00
SetGlobal CalibrateReq	0x01	0x37 (Angle Sensor)	Channel(1Byte) 0_Channel1, 1_Channel2,etc	Multiplier (2bytes) Unsigned	Divisor (2bytes) Unsigned	DeltValue (2bytes) Signed	Reserved (2Bytes) Fixed 0x00
SetGlobal CalibrateRsp	0x81		Channel(1Byte) 0_Channel1, 1_Channel2,etc	Status (1Byte,0x00_success)		Reserved (7Bytes,Fixed 0x00)	
GetGlobal CalibrateReq	0x02		Channel (1Byte,0_Channel1,1_Channel2,etc)		Reserved (8Bytes,Fixed 0x00)		
GetGlobal CalibrateRsp	0x82		Channel(1Byte) 0_Channel1, 1_Channel2,etc	Multiplier (2bytes) Unsigned	Divisor (2bytes) Unsigned	DeltValue (2bytes) Signed	Reserved (2Bytes) Fixed 0x00
ClearGlobal CalibrateReq	0x03		Reserved (10Bytes,Fixed 0x00)				
ClearGlobal CalibrateRsp	0x83	Status (1Byte,0x00_success)			Reserved (9Bytes,Fixed 0x00)		

R718EB angle unit: 0.1°

The calibration channel corresponding to each angle: AngleX = 00, AngleY= 01, AngleZ = 02

Example 1. Sensor detects Angle X value = 0° > Actual = 1° // +1°

Downlink: 01370000010001000A0000

Cmd ID (01) –SetGlobal CalibrateReq

Sensor type (37) – Angle sensor

Channel (00) – Channel 1

Multiplier (0001) – not used in this case, fill in ‘0001’

Divisor (0001) – not used in this case, fill in ‘0001’

Delt Value (000A) – 1°, 000A Hex = 10 Dec, 10*0.1°= 1°

Example 2. Sensor detects Angle Y value = 0° > Actual = -1° // -1°

Downlink: 01370100010001FFF60000

Cmd ID (01) –SetGlobal CalibrateReq

Sensor type (37) – Angle sensor

Channel (01) – Channel 2

Multiplier (0001) – not used in this case, fill in ‘0001’

Divisor (0001) – not used in this case, fill in ‘0001’

Delt Value FFF6) – -1°, FFF6 Hex = -10 Dec, -10*0.1°= -1°

Example 3. Clear Global Calibrate

Downlink: 0300000000000000000000

7.4 Example of AlarmThresholdCmd

Fport:0x10

Remain last config when reset to factory.

CmdDescriptor	CmdID (1 byte)	NetvoxPayLoadData (10 bytes)			
		SetSensor AlarmThresholdReq	0x01	Channel (1Byte) 0x00_Channel 1 0x01_Channel 2 0x02_Channel 3,etc	SensorType (1Byte) 0x00_Disable ALL SensorthresholdSet 0x0E_Angle
SetSensor AlarmThresholdRsp	0x81	Status (0x00_success)		Reserved (9Bytes,Fixed 0x00)	
GetSensor AlarmThresholdReq	0x02	Channel (1Byte) 0x00_Channel 1 0x01_Channel 2 0x02_Channel 3,etc	SensorType (1Byte) 0x00_Disable ALL SensorthresholdSet 0x0E_Angle	Reserved (8Bytes,Fixed 0x00)	
GetSensor AlarmThresholdRsp	0x82	Channel (1Byte) 0x00_Channel 1 0x01_Channel 2 0x02_Channel 3 ,etc	SensorType (1Byte) 0x00_Disable ALL SensorthresholdSet 0x0E_Angle	SensorHighThreshold (4Bytes)	SensorLowThreshold (4Bytes)

- SensorHighThreshold / SensorLowThreshold =0xFFFFFFFF indicates that the threshold alarm is disabled.
- The calibration channel corresponding to each angle: AngleX = 00, AngleY= 01, AngleZ = 02

Example 1. Set the AngleX HighThreshold to 0° and LowThreshold to -88°. (Unit: 0.005°)

Downlink: 01000E00000000000000BB40

Device returns: 81000E00000000000000000000

1st byte (01): Cmd ID – SetSensorAlarmThresholdReq

2nd byte (00): Channel – Channel 1

3rd byte (0E): Sensor Type – Angle Sensor

4th – 7th byte (00000000): Sensor High Threshold – 0°

8th -11th byte (0000BB40): Sensor Low Threshold – -88°, BB40(Hex)=-17600(Dec), -17600*0.005°=-88°

Example 2. Get the AngleX AlarmThresholdReq

Downlink: 02000E000000000000000000

Device returns: 81000E000000000000000000

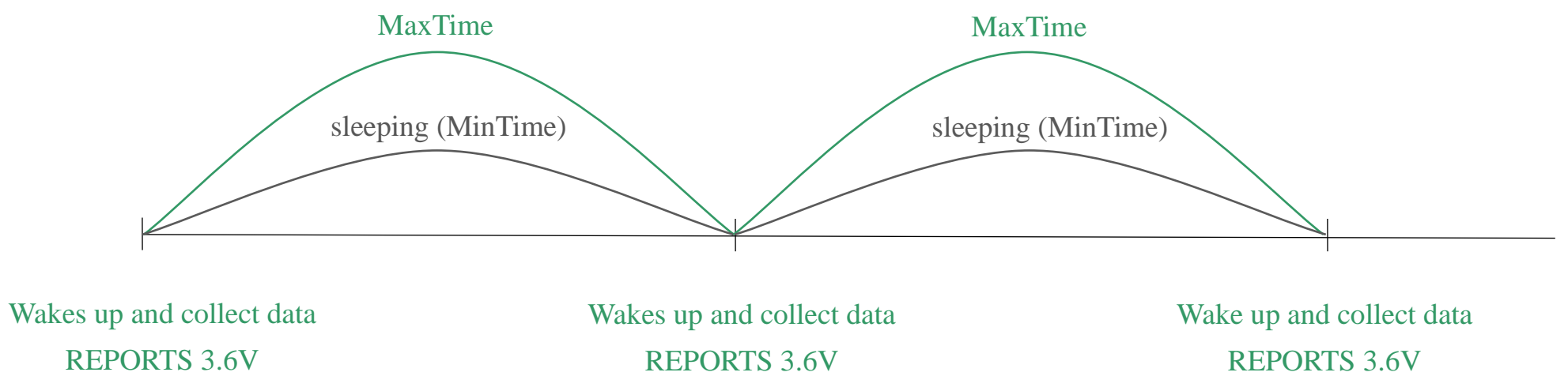
Example 3. Clear AlarmThresholdReq

Downlink: 010000000000000000000000 // Sensor Type =0x00, Disable all sensor threshold settings.

Device returns: 810000000000000000000000

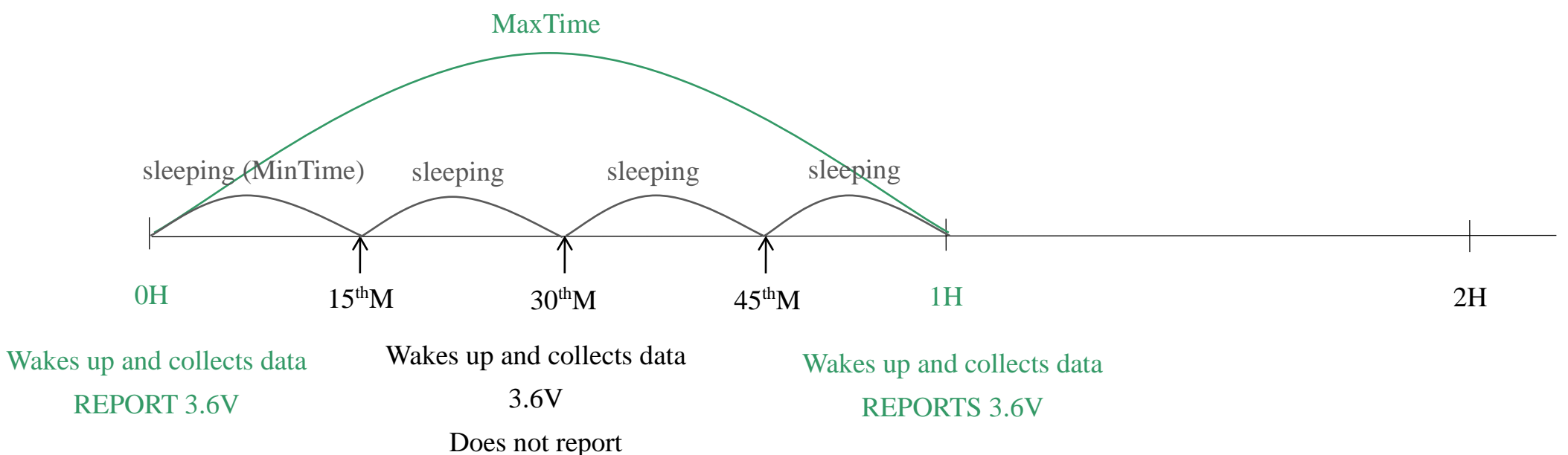
7.5 Example for MinTime/MaxTime logic

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

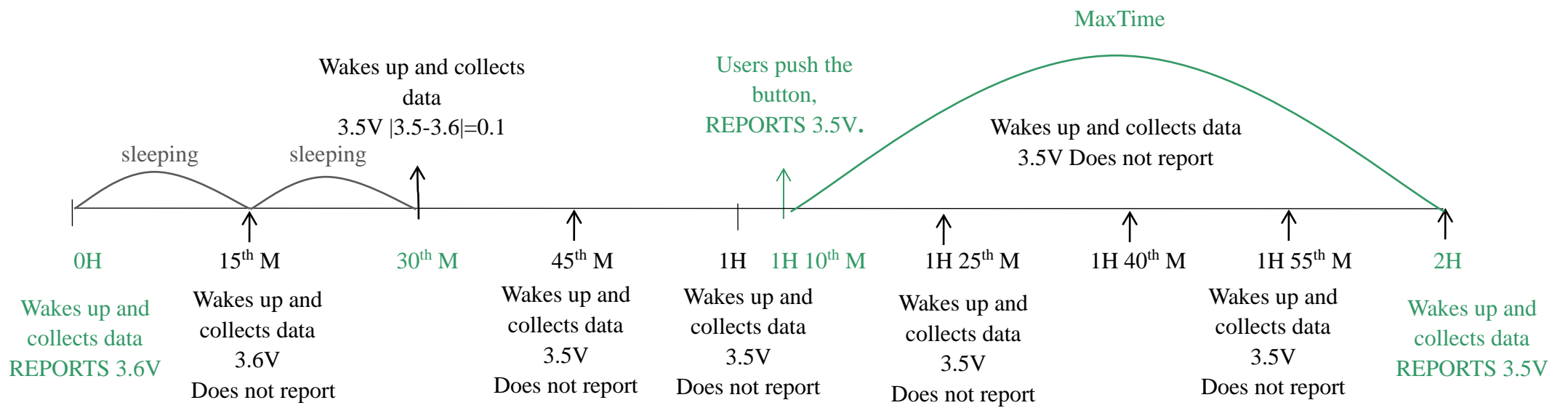


Note: MaxTime=MinTime. Data will only be reported according to MaxTime (MinTime) duration regardless BatteryVoltageChange value.

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 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.

8. Installation

The device needs to be installed when it is powered off and the detected building/pole is in static status. It is recommended to install the device horizontally. After the fixation is completed, please power on the device. The device performs offset calibration after it has joined the network for one minute. The device needs a period of time to collect the three-axis tilt angle and battery voltage of the detected building/telephone pole, and to make reference for the activity threshold, the inactive time, and whether the building/telephone pole is tilted. The specific configuration depends on the actual situation.

Note: After the device is turned on, it must be placed horizontally for one minute before using.

(The purpose is that the device will automatically perform the offset calibration to reduce the error of the detection result.)

9. 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:

9.1 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.

9.2 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.

10. Description of Waterproof Grade

According to Enclosure Protection Class, this standard is equivalent to IEC 60529:2001 Degrees of Protection Provided by Enclosures (IP Code).

2: The test method of IP65 waterproof grade:

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:

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)

11. 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.