Wireless TVOC / Temperature / Humidity Sensor

R720E
User Manual

Table of Contents

1. Introduction

R720E is the temperature, humility and TVOC detection device which is Class A device of NETVOX based on 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

Indicator

Function Key

Built-in TVOC Sensor

3. Features

- Adopt SX1276 wireless communication module

- 2 ER14505 lithium batteries AA size (3.6V / section) in parallel

- TVOC concentration, temperature, and humidity detection

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

- Protection class IP65

- Compatible with LoRaWAN^{TM} Class A

- Frequency hopping spread spectrum

- Configuration parameters can be configured via a third-party software platform, data can be read and alerts can be set via SMS text and email (optional)

- Applicable to third-party platforms: 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 battery cover.)
Turn on	Press and hold the function key for 3 seconds until 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. Press and hold the function key for 3 seconds until the green indicator flashes once to turn on the device. 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 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 |
|---|---|
| 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: 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 and a data report including voltage of the battery and TVOC value.

The device sends data according to the default configuration before any other configuring.

Default Setting:

        Maximum time: Max Interval = 15 min

        Minimum time: Min Interval = 15 min   * Minimum time should <u>not be less than 4min</u>.(Maxtime ≥ Mintime)

        Battery Change = 0x01 (0.1V)

        TVOC Change = 0x012C (300 ppb)

TVOC Measurement Range: 0 ppb to 60000 ppb

Excellent	0 to 65 ppb
Good	65 to 220 ppb
Moderate	220 to 660 ppb
Poor	660 to 2200 ppb
Unhealthy	2200 to 60000 ppb

Note:

1. R720E needs to **work for 13 hours after the first power-on**.

   (The sensor needs to be calibrated automatically during the 13 hours, and the data will be biased during this period. The accurate data shall prevail after 13 hours. At present, <u>this step has been completed before the shipment.</u>)

2. On the condition that the sensor can operate normally, the read data is valid after the device is powered off and has been turned on again for **20 minutes**. (The 20 minutes is the time for the sensor to enter a stable state.)

3. The device will report **0xFFFF** when the sensor is damaged, the initiation fails, and the device fails to read the data three times continuously after warming up.

   (The above process will be completed automatically after the device is turned on; therefore, users do not need to operate by themselves.)

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 ≥ 240	Any number between 240~65535	Can not be 0	Report per Min Interval	Report per Max Interval

5.1 Example of ReportDataCmd

Bytes	1 Byte	1 Byte	1 Byte	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

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 01A5000A01202109180000, the firmware version is 2021.09.18

3. Data Packet:

When Report Type=0x01 is data packet.

4. Signed Value:

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

Device	Device Type	Report Type	NetvoxPayLoadData				
			Battery (1Byte, Unit: 0.1V)	TVOC (2Bytes, 1ppb)	Temperature (Signed2Bytes, Unit: 0.01℃)	Humidity (2Bytes, Unit: 0.01%)	Reserved (1Byte, fixed 0x00)
R720E	0xA5	0x01					

Example of Uplink: 01A5019F00290A4B11B400

1st byte (01): Version

2nd byte (A5): DeviceType   0xA5 – R720E

3rd byte (01): ReportType

4th byte (9F): Battery – 3.1V   Low battery   9F(Hex)=31(Dec), 31*0.1v=3.1V

5th 6th byte (0029): TVOC – 41ppb   29(Hex) = 41 (Dec)   41*1ppb = 41ppb

7th 8th byte (0A4B): Temperature – 26.35°C   0A4B (Hex) = 2635 (Dec)   2635*0.01°C = 26.35°C

9th 10th byte (11B4): Humidity – 45.32%   11B4 (Hex) = 4532 (Dec)   4532*0.01% = 45.32%

11th byte (00): Reserved

5.2 Example of ConfigureCmd

FPort: 0x07

Bytes	1 Byte	1 Byte	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				
ConfigReportReq	R720E	0x01	0xA5	MinTime (2bytes, Unit: s)	MaxTime (2bytes, Unit: s)	BatteryChange (1byte, Unit:0.1v)	TVOC Change (2bytes, Unit: 1ppb)	Reserved (2Bytes, Fixed 0x00)
ConfigReportRsp		0x81		Status (0x00_success)		Reserved (8Bytes, Fixed 0x00)		
ReadConfigReportReq		0x02		Reserved (9Bytes, Fixed 0x00)				
ReadConfigReportRsp		0x82		MinTime (2bytes, Unit: s)	MaxTime (2bytes, Unit: s)	BatteryChange (1byte, Unit: 0.1v)	TVOC Change (2bytes, Unit: 1ppb)	Reserved (Bytes, Fixed 0x00)
ResetTVOCBaseLineReq		0x03		Reserved (9Bytes, Fixed 0x00)				
ResetTVOCBaseLineRsp		0x83		Status (0x00_success)		Reserved (8Bytes, Fixed 0x00)		

(1) Command Configuration:

MinTime = 5min (012C), MaxTime = 5min (012C), BatteryChange = 0.1v (0x01), TVOC Change=100ppb (0x64)

Downlink: 01A5012C012C0100640000

Response:

81A5000000000000000000 (Configuration success)

81A5010000000000000000 (Configuration failure)　　* When min time < 4min, Configuration fails

(2) Read Configuration:

Downlink: 02A5000000000000000000

Response:

82A5012C012C0100640000 (Current configuration)

(3) Calibrate the baseline:

After the configuration is successful, users can re-acquire and set the baseline value after 13 hours.

Downlink: 03A5000000000000000000

Response:

83A5000000000000000000 (Configuration success)

83A5010000000000000000 (Configuration failure)

Note:

R720E needs to work for 13 hours after the first power-on. (The sensor needs to be calibrated automatically during the 13 hours, and the data will be biased during this period. The accurate data shall prevail after 13 hours. At present, this step has been completed before the shipment.) The device needs 10 minutes to correct long-term sensor drift every week.

Please refer to the below pictures for detailed information of TVOC auto-calibration.

Initial Start-up and Baseline Correction

Warm-up Phase (15s)
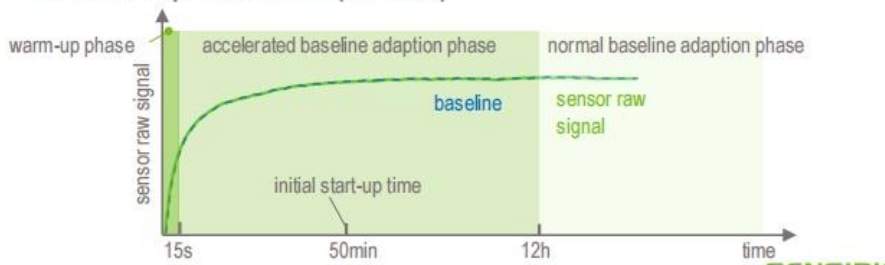- TVOC and CO2eq output fixed at 0ppb and 400 ppm, respectively

Accelerated Baseline Adaption Phase (12h)
- Fast baseline adapation to enable fast baseline initialization at first start-up

Normal Baseline Adaption Phase
- Slow baseline adaption to correct longterm sensor drift

Initial Start-up Time: 50 min (soldered)

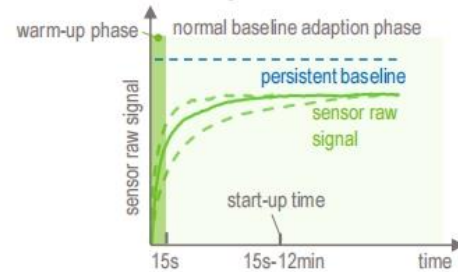## Start-up and Persistent Baseline

Warm-up Phase (15s)
- TVOC and CO2eq output fixed at 0ppb and 400 ppm, respectively

Normal Baseline Adaption Phase
- Slow baseline adaption to correct longterm sensor drift

Start-up Time
- Time the sensor signal needs to stabilize after start-up (see table).

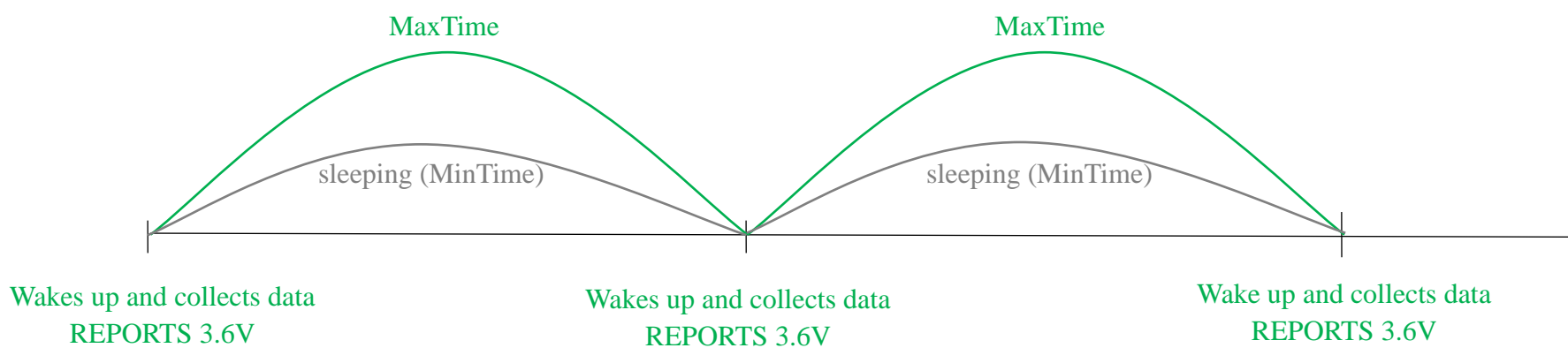| Off time	SGP30 typical switch-on time
1 min	15 s
5 min	30 s
1 h	90 s
12 h	6 min
48h	12 min

Baseline – Correction of Longterm Drift

Correction of longterm drift
- Drift of sensor raw signal over several weeks or months.
- Exposure to clean air adjusts the baseline and thereby corrects the longterm drift
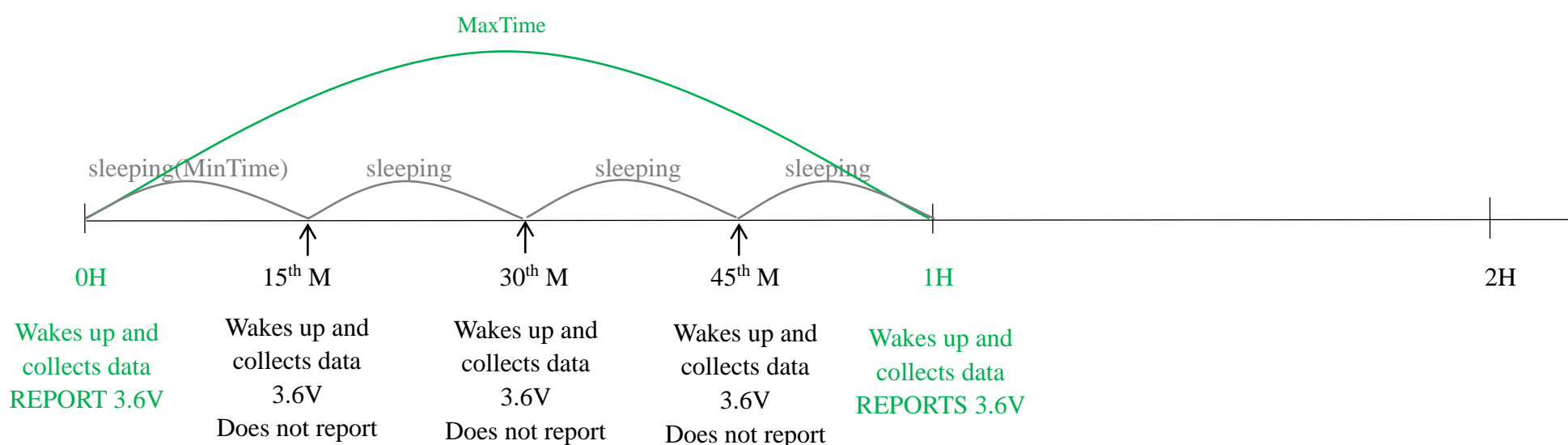- Clean air exposure for only 10 min per week is sufficient
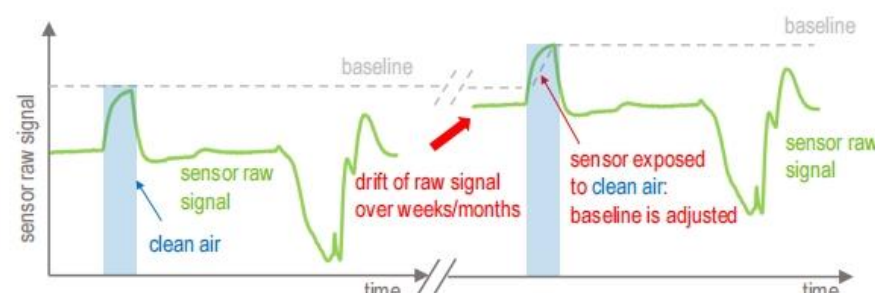
5.3 Example for MinTime/MaxTime logic:

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
REPORTS 3.6V

Wakes up and collects data
REPORTS 3.6V

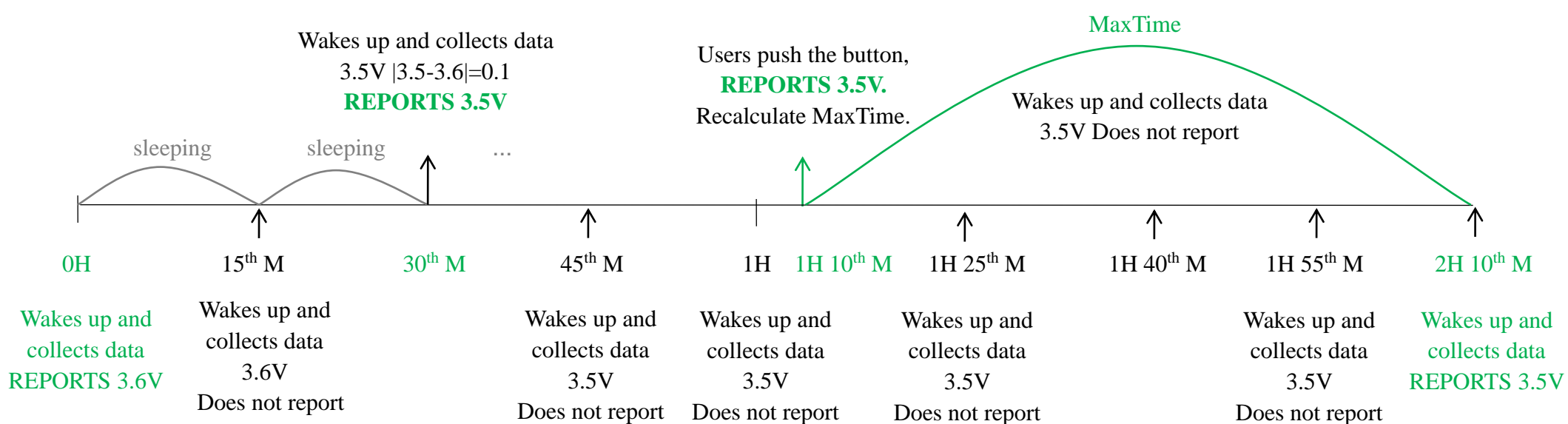Wake up and collects data
REPORTS 3.6V

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   2H

Wakes up and
collects data
REPORT 3.6V

Wakes up and
collects data
3.6V
Does not report

Wakes up and
collects data
3.6V
Does not report

Wakes up and
collects data
3.6V
Does not report

Wakes up and
collects data
REPORTS 3.6V

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

MaxTime

Wakes up and collects data
3.5V |3.5-3.6|=0.1
REPORTS 3.5V

Users push the button,
REPORTS 3.5V.
Recalculate MaxTime.

Wakes up and collects data
3.5V Does not report

sleeping   sleeping   ...

0H   15th M   30th M   45th M   1H   1H 10th M   1H 25th M   1H 40th M   1H 55th M   2H 10th M

Wakes up and
collects data
REPORTS 3.6V

Wakes up and
collects data
3.6V
Does not report

Wakes up and
collects data
3.5V
Does not report

Wakes up and
collects data
3.5V
Does not report

Wakes up and
collects data
3.5V
Does not report

Wakes up and
collects data
3.5V
Does not report

Wakes up and
collects data
REPORTS 3.5V

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. Installation

1. R720E has a built-in magnet (the dotted line in the figure below). When installing, the sensor can be attached to the surface of iron objects.

2. If it is installed on a wall or other object without iron, users can install another piece of iron on the wall or other object, and then attach the sensor to the iron.

   Note: Do not install the device in a metal shielded box or an environment with other electrical equipment around to avoid affecting the wireless transmission signal of the device.
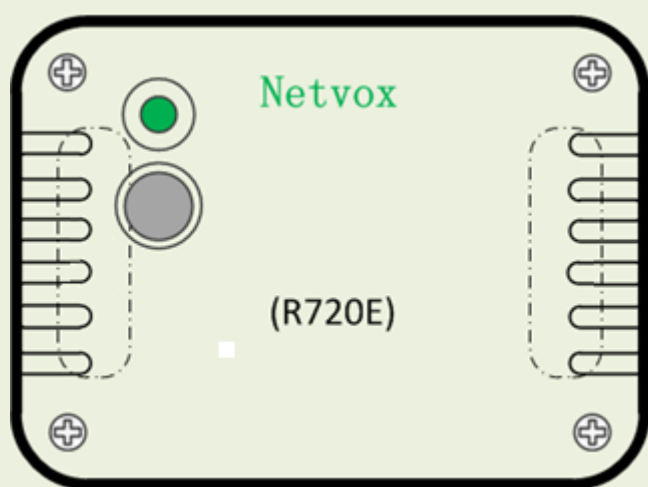
4. R720E detects according to Min Time. When the detected TVOC value or battery voltage is compared with the last report, the value exceeds the set value. (Default TVOC Value: 300ppb; Default Battery Voltage: 0.1V) If the TVOC concentration exceeds 300ppb or the battery voltage exceeds 0.1V, the currently detected TVOC, temperature, and humidity will be sent.
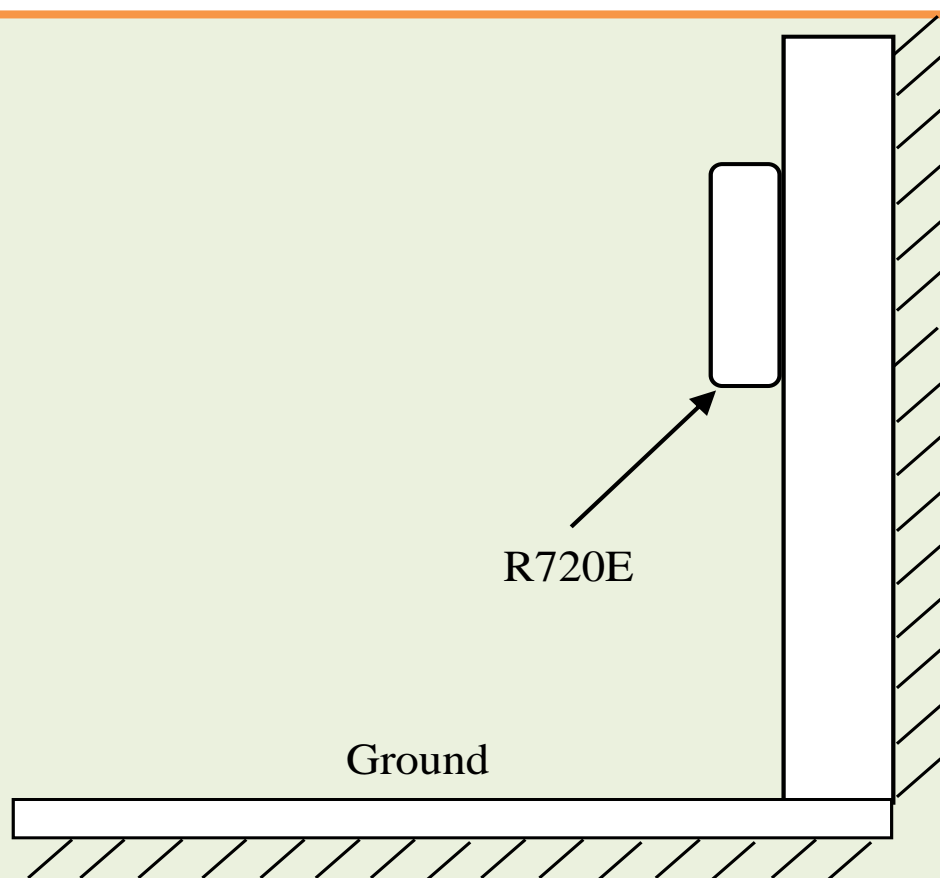
5. If the variation of TVOC concentration or battery voltage does not exceed the set value, the data is reported regularly according to the Max Time.

   Note: Min Time and Max Time defaults 15 minutes.

R720E is suitable below scenarios:

- Residential
- Shopping mall
- Station
- School
- Airport
- Construction site

The place needs to detect the TVOC, temperature, or humidity.

Installation Diagram

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. Important Maintenance Instruction

The device is a product with superior design and craftsmanship and should be used with care. The following suggestions will help you use the warranty service effectively.

• Keep the equipment dry. Rain, moisture and various liquids or water may contain minerals that can corrode electronic circuits. In case the device is wet, please dry it completely.

• Do not use or store in dusty or dirty areas. This way can damage its detachable parts and electronic components.

• Do not store in excessive heat place. High temperatures can shorten the life of electronic devices, destroy batteries, and deform or melt some plastic parts.

• Do not store in excessive cold place. 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. Treating equipment roughly can destroy internal circuit boards and delicate   structures.

• Do not wash with strong chemicals, detergents, or strong detergents.

• Do not paint the device. Smudges can make debris block detachable parts up and affect normal operation.

• Do not throw the battery into the fire to prevent the battery from exploding. Damaged batteries may also explode.

All the above suggestions apply equally to your device, batteries, and accessories. If any device is not operating properly, please take it to the nearest authorized service facility for repairing.

9. Outdoor Installation

1. 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. (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 environments and sheltered outdoor environments. 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 rainstorms. If it is really necessary to install in harsh environments, it is recommended to add sunscreen and rainproof shields when installing.)

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.

3. Installation examples

Figure 1. Install the R720E upside down

Figure 2. Installed the R720E under the rain shield