Lidar Material Level Detection Sensor

R718PE02D
User Manual

Table of Contents

1. Introduction

R718PE02D is a wireless communication device for Netvox Class C device based on LoRaWAN open protocol. It is a wireless communication device for the material level detection industry that uses LiDAR radar for single-point ranging. Based on the ToF (Time of Flight) schematic, the R718PE02D provides stable, accurate, and reliable ranging performance by optimizing the optical system and built-in algorithms. It is not easily affected by the surface state of the detected object, and the ranging performance can reach up to 25m. The product is equipped with a unique dust-removal wiper structure. The radar-driven dust-removal wiper can complete the dust removal operation of the optical mirror, so it can maintain the accuracy of distance measurement in an environment with severe dust pollution and dust accumulation. The R718PE02D body and the LiDAR sensor communicate through the UART serial communication and transmit the detected data to other devices for display through the wireless network. It adopts a wireless communication method that conforms to the LoRaTM protocol standard.

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, and industrial monitoring. The 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

LiDAR Sensor

Dust-Removal Wiper

Indicator

Function Key

3. Features

- SX1276 wireless communication module

- Powered by 5V DC

- IP30 rating

- Lidar material level detection with dust removal wiper

- Compatible with LoRaWAN^{TM} Class C device

- Frequency hopping spread spectrum technology

- Configuration parameters can be configured through third-party software platforms, data can be read and alarms can be set via SMS text and email (optional)

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

4. Setup Instructions

4.1 On/Off

Power on	5V DC power supply
Turn on	Connect the power supply
Turn off	Disconnect the power supply
Restart	Press the function key for 5 seconds until the green indicator flashes once. Release the function key and the indicator will flash 10 times.
Factory Resetting	Press the function key for 10 seconds until the green indicator flashes 20 times
Note	1. When user disconnects the power supply; the device should be off 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. 5 seconds after power on, the device will be in engineering test mode.

4.2 Network Joining

Never joined the network	Turn on the device to search the network to join. The green indicator remains on for 5 seconds: Success The green indicator remains off: Fail
Had joined the network (without factory resetting)	Turn on the device to search the previous network to join. The green indicator remains on for 5 seconds: Success The green indicator remains off: Fail
Fail to join the Network	Please check the device verification information on the gateway or consult your platform server provider.

4.3 Function Key

Press and hold for 5 seconds	Restart The green indicator flashes 10 times: Success The green indicator remains off: Fail
Press and hold for 10 seconds	Factory resetting and restart 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

4.4 Sleeping Mode

The device is on and in the network	Sleeping period: Min Interval When the report change exceeds setting value or the state changes, the device would send a data report according to Min Interval.
The device is on but not in the network	Disconnect the power supply when the device is not in use. Check the device verification information on the gateway

5. Data Report

After powering on, the device will immediately send a version packet report and an attribute packet report.

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

Default:

Max Interval = 0x0384 (900s)

Min Interval = 0x0384 (900s) (detect the material level and voltage at every Min Interval)

reportchange: batteryvoltagechange ---- 0x01 (0.1V)

distancechange ---- 0x012C (300mm)

WiperPeriod = 0x05A0 (1440 min)

WipeCnt = 0x01 (1 time)

Note: a. The interval of the data reports might vary due to the firmware.

b. The dust removal wiper will automatically wipe once after powering on.

c. Minimum WiperPeriod = 0x0001 (1 min); maximum WipeCnt = 0x0A

The last configuration would be kept if the device is factory reset.

d. The blind zone distance of the sensor ≤ 0.1m.

e. Please refer to the Netvox LoRaWAN Application Command and http://www.netvox.com.cn:8888/cmddoc for devices' data

analysis.

Tips

1. **Battery Voltage:**

If the battery is equal to 0x00, it means that the device is powered by a DC power supply.

2. **Version Packet:**

When Report Type=0x00 is the version packet, such as 01D5000A02202305250000, the firmware version is 2023.05.25.

3. **Data Packet:**

When Report Type=0x01 is the data packet; If the device data exceeds 11 bytes or there are shared data packets, the Report

Type will have different values.

5.1 Example of ReportDataCmd

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 – DeviceType of Device

        The DeviceType is listed in Netvox LoRaWAN Application DeviceType doc

ReportType – 1 Byte –the presentation of the NetvoxPayLoadData, according the DeviceType

NetvoxPayLoadData– Var (Fixed =8bytes)

Device	Devive Type	Report Type	NetvoxPayloadData					
R718PE02D	0xD5	0x00	SoftwareVersion (1 Byte) Eg.0x0A-V1.0	HardwareVersion (1 Byte)	DateCode(4 Bytes) e.g. 0x20170503		Reserved (2 Bytes)	
		0x01	Battery (1Byte, unit: 0.1V)	Status (1 Byte, 0x01_On 0x00_Off)	Distance (2 Bytes, unit: 1mm)	FillLevel (1Byte, unit: 1%)	SensorStrength (2 Bytes)	CapBattery (1 Byte, unit: 0.1V) Only the battery version is supported)
		0x02	Battery (1 Byte, unit: 0.1V)	ThresholdAlarm (1 Byte, Bit0_Low Distance Alarm, Bit1_High Distance Alarm, Bit2_ Low FillLevel Alarm, Bit3_ High FillLevel Alarm, Bit4-7: Reserved)	Reserved (6 Bytes, fixed 0x00)			

Example of Uplink1: 01D50100000C1226105700 (FillMaxDistance: 5000mm, DeadZoneDistance: 0mm)

1st byte (01): Version

2nd byte (D5): DeviceType 0xD5 － R718PE02D

3rd byte (01): ReportType

4th byte (00): DC power supply

5th byte (00): Status － OFF

6th-7th byte (0C12): Distance – 3090mm   0C12(Hex) = 3090(Dec), 3090*1mm = 3090mm

8th byte (26): FillLevel – 38%   26(Hex) = 38 (Dec), 38*1% = 38%

9th – 10th byte (1057): SensorStrength – 1057(Hex) = 4183 (Dec)

11th byte (00): CapBattery – 0V 00(Hex)=0(Dec), 0*0.1V=0V

1st byte (01): Version

2nd byte (D5): DeviceType 0xD5 － R718PE02D

3rd byte (02): ReportType

4th byte (00): DC power supply

5th byte (01): ThresholdAlarm   3090mm < 4000mm (LowThreshold)   //0x01 = 0000 0001 (bin)

6th-11th byte (000000000000): Reserved   └─ Bit 0 = 1

5.2 Example of ConfigureCmd

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 (2 Bytes, unit: s)	MaxTime (2 Bytes, unit: s)	BatteryChange (1 byte, unit: 0.1v)	DistanceChange (2 Bytes, unit:1mm)	Reserved (2 Bytes, fixed 0x00)
ConfigReportRsp		0x81		Status (0x00_success)			Reserved (8 Bytes, fixed 0x00)	
ReadConfigReportReq		0x02		Reserved (9 Bytes, fixed 0x00)				
ReadConfigReportRsp		0x82		MinTime (2 Bytes, unit: s)	MaxTime (2 Bytes, unit: s)	BatteryChange (1 Byte, unit: 0.1v)	DistanceChange (2 Bytes, unit: 1mm)	Reserved (2 Bytes, fixed 0x00)
SetOnDistanceThresholdRreq		0x03		OnDistanceThreshold (2 Bytes, unit: 1mm)			Reserved (7 Bytes, fixed 0x00)	
SetOnDistanceThresholdRrsp	R718PE02D	0x83	0xD5	Status (0x00_success)			Reserved (8 Bytes, fixed 0x00)	
GetOnDistanceThresholdRreq		0x04		Reserved (9 Bytes, fixed 0x00)				
GetOnDistanceThresholdRrsp		0x84		OnDistanceThreshold (2 Bytes, unit: 1mm)			Reserved (7 Bytes, fixed 0x00)	
SetFillMaxDistanceReq		0x05		FillMaxDistance (2 Bytes, unit: 1mm)			Reserved (7 Bytes, fixed 0x00)	
SetFillMaxDistanceRsp		0x85		Status (0x00_success)			Reserved (8 Bytes, fixed 0x00)	
GetFillMaxDistanceReq		0x06		Reserved (9 Bytes, fixed 0x00)				
GetFillMaxDistanceRsp		0x86		FillMaxDistance (2 Bytes, unit: 1mm)			Reserved (7 Bytes, fixed 0x00)	

SetDeadZoneDistanceReq(REMAIN Lastconfig when resetfac)		0x0B		DeadZoneDistance (2 Bytes, unit: 1mm)		Reserved (7 Bytes, fixed 0x00)
SetDeadZoneDistanceRsp(REMAIN Lastconfig when resetfac)		0x8B		Status (0x00_success)		
GetDeadZoneDistanceReq		0x0C		Reserved (9 Bytes, fixed 0x00)		
GetDeadZoneDistanceRsp		0x8C		DeadZoneDistance (2 Bytes, unit: 1mm)		Reserved (7 Bytes, fixed 0x00)
SetWiperPeriodReq (REMAIN Lastconfig when resetfac)		0x0D		WiperPeriod (2 Bytes, unit:1 min)	WipeCnt (1 Byte)	Reserved (6 Bytes, fixed 0x00)
SetWiperPeriodRsp		0x8D		Status (0x00_success)		Reserved (8 Bytes, fixed 0x00)
GetWiperPeriodReq		0x0E		Reserved (9 Bytes, fixed 0x00)		
GetWiperPeriodRsp		0x8E		WiperPeriod (2 Bytes, unit: 1 min)	WipeCnt (1 Byte)	Reserved (6 Bytes, fixed 0x00)

(1) Configure R718PE02D report parameters:

MinTime = 1h (3600s, 0x0E10), MaxTime = 1h (3600s, 0x0E10), BatteryChange = 0V (0x00),

DistanceChange = 500mm (0x01F4)

Downlink: 01D50E100E100001F40000

Response: 81D5000000000000000000 (configuration success)

81D5010000000000000000 (configuration failure)

(2) Read Configuration:

Downlink: 02D5000000000000000000

Response: 82D50E100E100001F40000 (device current parameter)

(3) Configure R718PE02D report parameter:

FillMaxDistance = 5000mm (0x1388)

Downlink: 05D513880000000000000

Response: 85D50000000000000000000

(4) Read device parameter:

FillMaxDistance = 5000mm (0x1388)

Downlink: 06D50000000000000000000

Response: 86D513880000000000000

(5) SetDeadZoneDistance: //When restoring factory settings, the last set value will be retained.

Downlink: 0BD5006400000000000000   // Set the device detection dead zone distance to 100mm (0x64).

Response: 8BD500000000000000000000

(6) GetDeadZoneDistance:

Downlink: 0CD50000000000000000000

Response: 8CD5006400000000000000   // Get the device detection dead zone distance of 100mm (0x64).

(7) SetWiperPeriodReq:

WiperPeriod= 4 hours (0x00F0); WipeCnt = 1 time (0x01)

Downlink: 0DD500F001000000000000

Response: 8DD50000000000000000000 (configuration success)

    8DD5010000000000000000 (configuration failure)

(8) GetWiperPeriodReq:

Downlink: 0ED50000000000000000000

Response: 8ED500F001000000000000

5.3 Example of General Calibration Configuration

FPort: 0x0E

Description	CmdID	SensorType	PayLoad(Fix =9 Bytes)				
SetGlobalCalibrate Req	0x01	See below	Channel (1Byte) 0_Channel1 1_Channel2,etc	Multiplier (2bytes, Unsigned)	Divisor (2bytes, Unsigned)	DeltValue (2bytes, Signed)	Reserved (2Bytes, Fixed 0x00)
SetGlobalCalibrate Rsp	0x81		Channel (1Byte) 0_Channel1 1_Channel2,etc	Status(1Byte,0x00_success)			Reserved (7Bytes, Fixed 0x00)
GetGlobalCalibrate Req	0x02		Channel (1Byte) 0_Channel1 1_Channel2,etc				Reserved (8Bytes, Fixed 0x00)
GetGlobalCalibrate Rsp	0x82		Channel (1Byte) 0_Channel1 1_Channel2,etc	Multiplier (2bytes, Unsigned)	Divisor (2bytes, Unsigned)	DeltValue (2bytes, Signed)	Reserved (2Bytes, Fixed 0x00)
ClearGlobalCalibrateReq	0x03	Reserved 10Bytes,Fixed 0x00)					
ClearGlobalCalibrateRsp	0x83	Status(1Byte,0x00_success)	Reserved (9Bytes,Fixed 0x00)				

SensorType = 0x36   Channel = 0x00   // The distance sensor channel fixed value of the device is 00

(When restoring factory settings, the last set value will be retained.)

Multiplier =0x0001   Divisor = 0x0001   DeltValue = 0x0064

Assuming that the original value of the uploaded Distance is 1000mm, and the calibration is increased by 100mm, the uploaded value is 1100mm.

(1) SetGlobalCalibrateReq:

Downlink: 0136000001000100640000

Response: 8136000000000000000000

(2) GetGlobalCalibrateReq：

Downlink: 0236000000000000000000

Response: 8236000001000100640000

Assuming that the original value of the uploaded Distance is 1000mm, and the calibration is reduced by 100mm, the uploaded value is 900mm.

(3) SetGlobalCalibrateReq: Calibration reduced by 100mm, Multiplier =0x0001, Divisor = 0x0001, DeltValue = 0xFF9C

Downlink: 01360000010001FF9C0000

Response: 8136000000000000000000

(4) GetGlobalCalibrateReq：

Downlink: 0236000000000000000000

Response: 82360000010001FF9C0000

(5) Clear the calibration value: The uploaded value is back to 1000mm.

ClearGlobalCalibrateReq：

Downlink: 0300000000000000000000

Response: 8300000000000000000000

5.4 Set/GetSensorAlarmThresholdCmd

Fport:0x10

CmdDescriptor	CmdID (1 Byte)	Payload (10 Bytes)			
SetSensorAlarm ThresholdReq	0x01	Channel (1 Byte, 0x00_Channel1, 0x01_Chanel2, 0x02_Channel3, etc.)	SensorType (1 Byte, 0x00_Disable ALL SensorthresholdSet 0x2F_ Distance, 0x30_ FillLevel,	SensorHighThreshold (4 Bytes, unit: same as reportdata in fport6, 0Xffffffff_DISALBLEr HighThreshold)	SensorLowThreshold (4 Bytes, unit: same as reportdata in fport6, 0Xffffffff_DISALBLErHi ghThreshold)
SetSensorAlarm ThresholdRsp	0x81	Status (0x00_success)	Reserved (9 Bytes, fixed 0x00)		
GetSensorAlarm ThresholdReq	0x02	Channel (1 Byte, 0x00_Channel1, 0x01_Chanel2, 0x02_Channel3, etc.)	SensorType (1 Byte, Same as the SetSensorAlarmThresh oldReq's SensorType)	Reserved (8 Bytes, fixed 0x00)	
GetSensorAlarm ThresholdRsp	0x82	Channel (1 Byte, 0x00_Channel1, 0x01_Chanel2, 0x02_Channel3, etc.)	SensorType (1 Byte, Same as the SetSensorAlarmThresh oldReq's SensorType)	SensorHighThreshold (4 Bytes, unit: same as reportdata in fport6, 0Xffffffff_DISALBLEr HighThreshold)	SensorLowThreshold (4 Bytes, unit: same as reportdata in fport6, 0Xffffffff_DISALBLErHi ghThreshold)

Channel - 1 byte; 0x00_Distance

0x01_FillLevel   // When restoring factory settings, the last set value will be retained.

(1) SetSensorAlarmThresholdReq: (Set the Distance high threshold to 5m and the low threshold to 4m)

    Downlink: 01002F0000138800000FA0   //1388Hex = 5000Dec, 5000*0.001m = 5m; FA0Hex = 4000Dec 4000*0.001m = 4m

    Response: 810000000000000000000000

(2) GetSensorAlarmThresholdReq：

    Downlink: 02002F0000000000000000

    Response: 82002F0000138800000FA0

(3) Clear all sensor thresholds. (Configure the Sensor Type to 0)

    Downlink: 010000000000000000000000

    Response: 810000000000000000000000

5.5 Example of NetvoxLoRaWANRejoin

(NetvoxLoRaWANRejoin command is to check if the device is still in the network. If the device is disconnected, it will automatically rejoin back to the network.)

Fport: 0x20

CmdDescriptor	CmdID	Payload						
SetNetvoxLoRaWAN RejoinReq	0x01	RejoinCheckPeriod (4 Bytes, unit: 1s 0XFFFFFFFF Disable NetvoxLoRaWANRejoinFunction)				RejoinThreshold (1 Byte)		
SetNetvoxLoRaWAN RejoinRsp	0x81	Status (1 Byte, 0x00_success)				Reserved (4 Bytes, fixed 0x00)		
GetNetvoxLoRaWAN RejoinReq	0x02	Reserved (5 Bytes, fixed 0x00)						
GetNetvoxLoRaWAN RejoinRsp	0x82	RejoinCheckPeriod (4 Bytes, unit:1s)				RejoinThreshold (1 Byte)		
SetNetvoxLoRaWAN RejoinTimeReq	0x03	1st Rejoin Time (2 Bytes unit: min)	2nd Rejoin Time (2 Bytes unit: min)	3rdRejoin Time (2 Bytes unit: min)	4th Rejoin Time (2 Bytes unit: min)	5th Rejoin Time (2 Bytes unit: min)	6th Rejoin Time (2 Bytes unit: min)	7th Rejoin Time (2 Bytes unit: min)
SetNetvoxLoRaWAN RejoinTimeRsp	0x83	Status (1Byte, 0x00_success)				Reserved (13 Bytes, fixed 0x00)		
GetNetvoxLoRaWAN RejoinTimeReq	0x04	Reserved (15 Bytes, fixed 0x00)						
GetNetvoxLoRaWAN RejoinTimeRsp	0x84	1st Rejoin Time (2 Bytes unit: min)	2nd Rejoin Time (2 Bytes unit: min)	3rd Rejoin Time (2 Bytes unit: min)	4th Rejoin Time (2 Bytes unit: min)	5th Rejoin Time (2 Bytes unit: min)	6th Rejoin Time (2 Bytes unit: min)	7th Rejoin Time (2 Bytes unit: min)

(1) Configure parameters

RejoinCheckPeriod = 0x00000E10 (60 min); RejoinThreshold = 0x03 (3 times)

Downlink: 0100000E1003

Response: 810000000000 (configuration succeed)

810100000000 (configuration fail)

(2) Read configuration

Downlink: 020000000000

Response: 8200000E1003

(3) SetNetvoxLoRaWANRejoinTimeReq

1st Rejoin Time = 1 min; 2nd Rejoin Time = 2 mins; 3rd Rejoin Time = 3 mins; 4th Rejoin Time = 4 mins;

5th Rejoin Time = 5 mins; 6th Rejoin Time =6 mins; 7th Rejoin Time = 7 mins

Downlink: 030001000200030004000500060007

Response: 8300000000000000000000000000000 (configuration succeed)

83010000000000000000000000000000 (configuration fail)

(4) GetNetvoxLoRaWANRejoinTimeRsp

Downlink: 040000000000000000000000000000000

Response: 840001000200030004000500060007

Note: a. Set RejoinCheckThreshold as 0xFFFFFFFF to stop the device from rejoining the network.

b. The last configuration would be kept as user reset the device back to the factory setting.

c. Default setting: RejoinCheckPeriod = 2 (hr) and RejoinThreshold = 3 (times)

1st Rejoin Time = 2 mins; 2nd Rejoin Time = 2 mins; 3rd Rejoin Time = 3 mins; 4th Rejoin Time = 4 mins;

5th Rejoin Time = 60 mins; 6th Rejoin Time =360 mins; 7th Rejoin Time = 1440 mins

5.6 Example for MinTime/MaxTime logic

Example#1 based on MinTime = 1 Hour, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange=0.1V
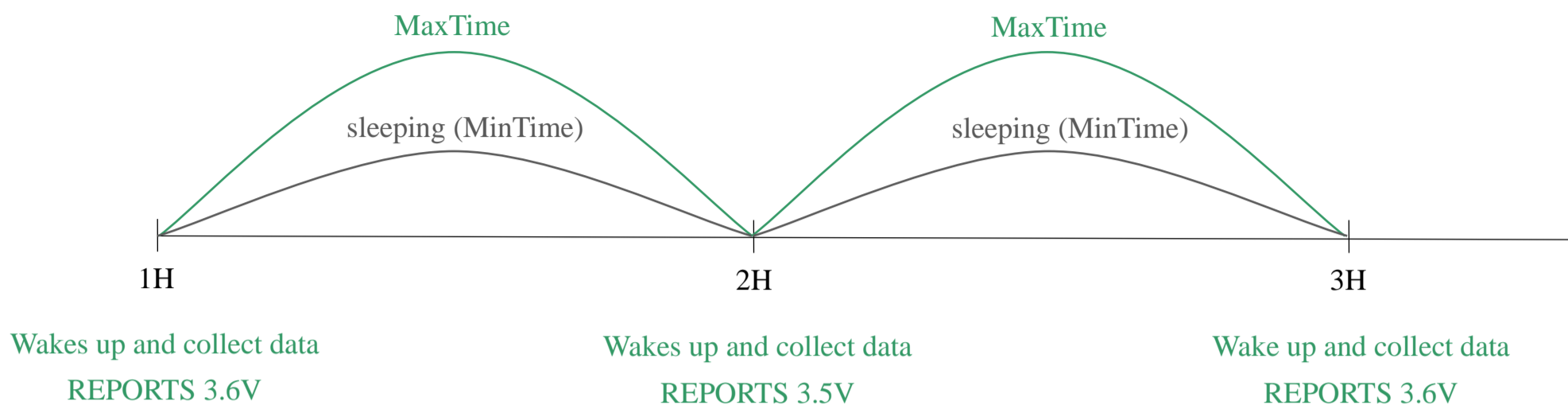
Note: MaxTime = MinTime. Data will only be reported according to MaxTime (MinTime) duration regardless BatteryVoltageChange value.

Example#2 based on MinTime = 15 Minutes, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange= 0.1V.
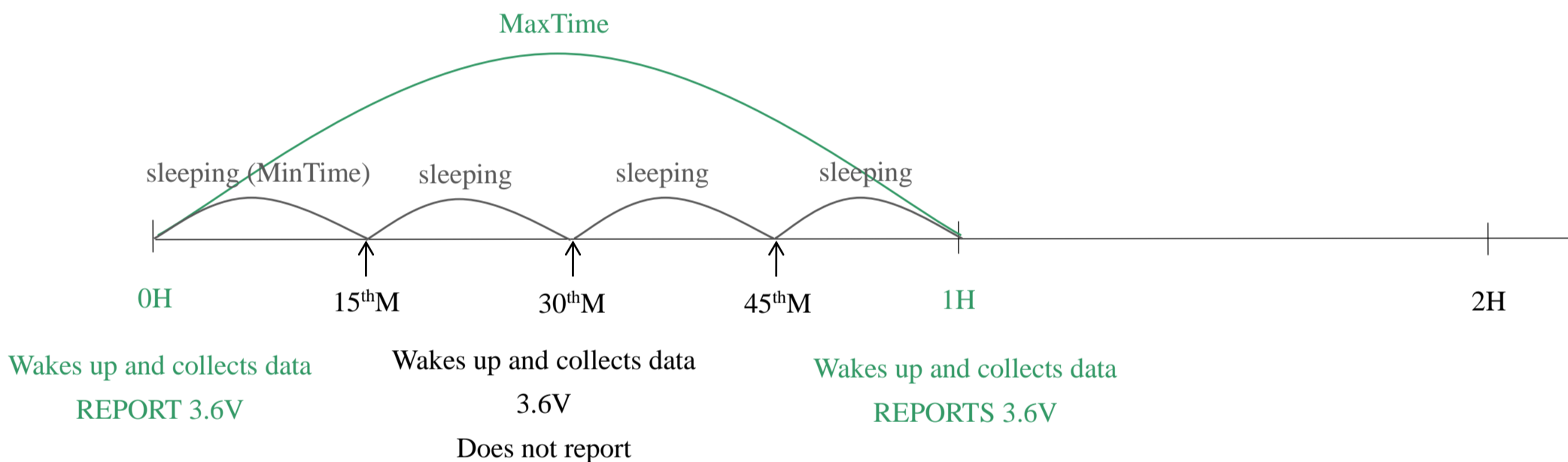
Example#3 based on MinTime = 15 Minutes, MaxTime= 1 Hour, Reportable Change i.e. BatteryVoltageChange= 0.1V.
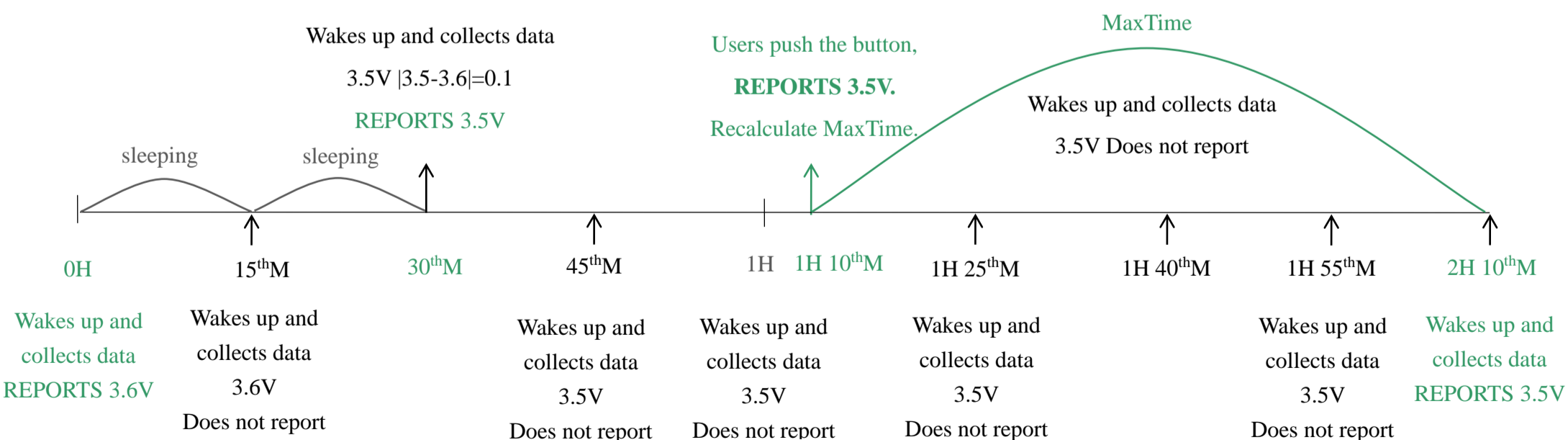
Notes:

(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 <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. Application

In the case of detecting the material level of the barn, the device is installed on the top of the barn, and the device is powered on after fixing. The device collects the distance between the material level and the sensor and the percentage of the material level in the barn at regular intervals.

H: The height of the barn (this value can be set with the payload command; the "fillmaxdistance" in payload means H)

D: The distance between the device and the material (this value is "distance" in uplinks)

L: The material level (this value can be calculated by the "distance" in uplink and "fillmaxdistance" in payload)

Calculation: L = fillmaxdistacnce – distance

d: The DeadZoneDeistance set by the device (the distance that cannot be detected by the actual device)

FillLevel: The percentage of the material level in the barn. (Status = 0)

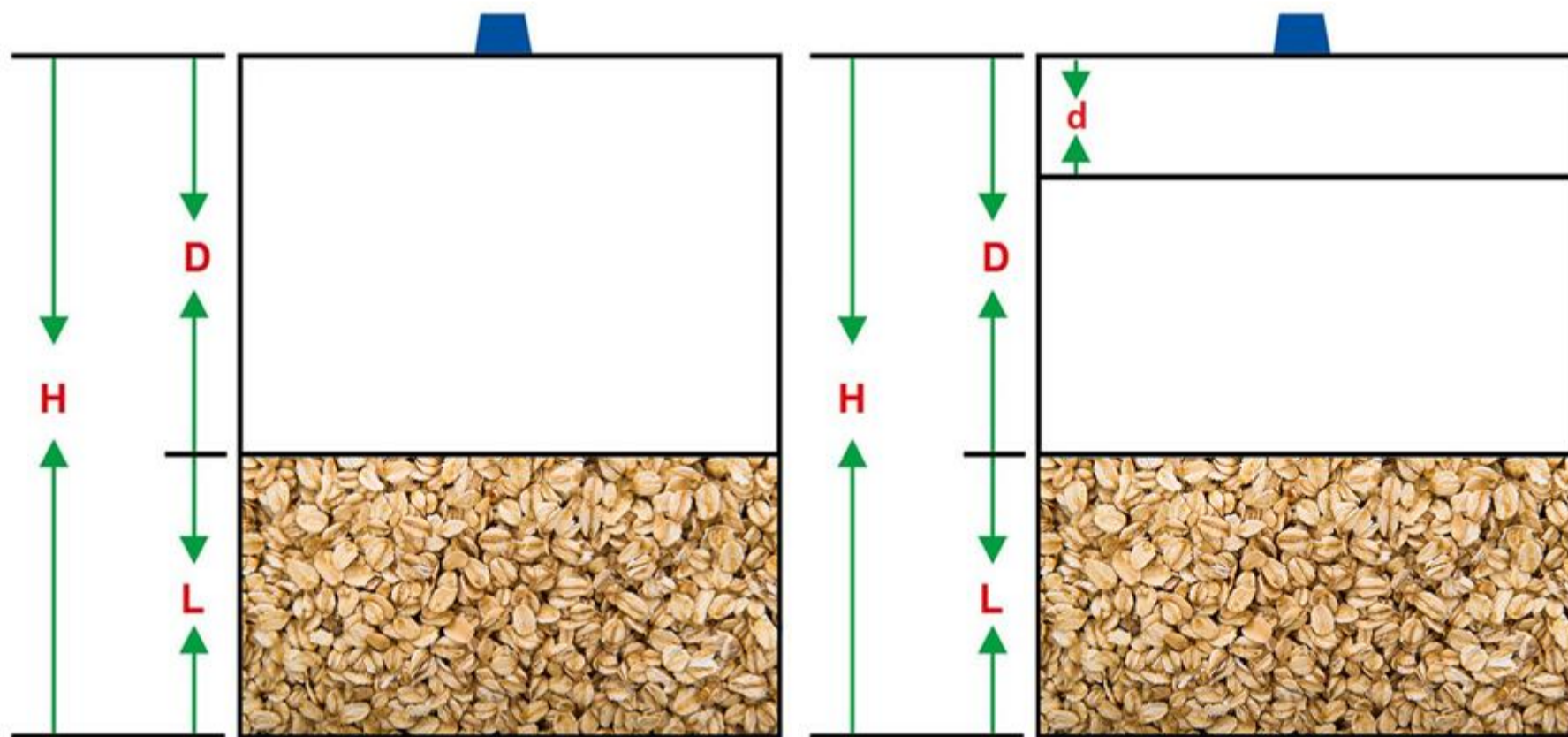The value of the total height of the barn can be set through commands according to the specific scene.

Illustration 1	**Illustration 2**
FillLevel = ((H - D) / H) * 100%	FillLevel = ((H - D) / H-d) * 100%
	The calculate method of material level percentage of DeadZoneDistance can be set.

Note:

The ranging range of the device is:

90% reflectivity, 0Klux 0.1m~25m;   10% reflectivity, 0Klux 0.1m~12m;

90% reflectivity, 100Klux 0.1m~25m;   10% reflectivity, 100Klux 0.1m~12m

7. Installation

Precautions for sensor:

A. When installing the sensor, it is recommended to use M2.5 round head Phillips screws for installation.

Please remove the protective film of the optical lens before use. The lens of front panel of LiDAR cannot be covered. Please keep it clean. The surface of optical lens is the ranging zero of LiDAR.

B. The detection angle of the sensor is 3°. At different distances, the size of light spot, namely the edge length of the detection range, is different.
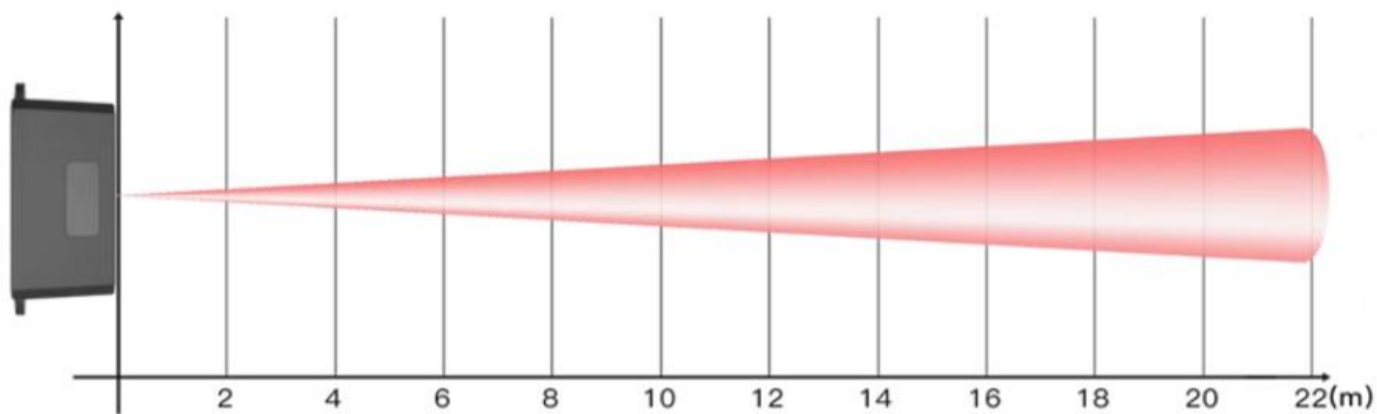
The spot size at different distances

C. Side length of the detection range at different distances (the detection range is a square)

Distance (m)	1	2	3	4	5	6	7	8	9	10	15	20	22
Spot Size (cm)	5	10	16	21	26	31	37	42	47	52	79	105	115

Spot Size at Different Distances

Note: The side length of the detected target object should be greater than the side length of the detection range of the sensor. When the side length of the detected object is smaller than the side length of the detection range, the effective range of the radar will be reduced. When detecting a slope, the sensor can be placed in the middle of the slope.

D. Maintenance and Cleaning

● Before/after turning on the device, please check the exposed window mirror and check whether the optical components are dirty, if dirty, please clean it in time.

● The optical components should be cleaned regularly because the device will be placed and operated in a harsh environment.

● Before cleaning, please turn off the device first, and use a soft cloth to gently wipe the window in the same direction, avoiding repeated wiping back and forth, which may cause damage to the window mirror.

- Do not use alcohol to clean the window mirror as it may be damaged.

- Do not disassemble the dust-removal wiper, which may easily cause device failure.

- When the steering gear shaft is blocked by dust, the steering gear may be damaged due to increased resistance. It is recommended to clean the shaft regularly.

E. Storage of Sensor

- The sensor shall be stored in an environment without exposure to corrosive gas or exceeding the storage temperature range (-30°C to 80°C) and humidity (≤60%).

- Before storing the sensor, all switches and dust covers should be plugged or closed.

- The device should be tested before operation if it has been stored for over 3 months.

- Installation, connection, or maintenance without following the instructions could cause the malfunction of the device.

F. Reflectivity

- Detecting transparent objects like water would cause incorrect results.

- Detecting dark objects requires a closer distance, but the accuracy remains the same. The reflectivity of different dark objects is as follows:

	Materials	Reflectivity
1	Black foam rubber	2.4%
2	Black cloth	3%
3	Black rubber	4%
4	Coal (varies from coal to coal)	4–8%
5	Black car paint	5%
6	Black paper	10%
7	Opaque black plastic	14%
8	Clean rough board	20%
9	Translucent plastic bottles	62%
10	Packing case cardboard	68%
11	Clean pine	70%
12	Opaque white plastic	87%
13	White card	90%
14	Kodak standard whiteboard	100%
15	Unpolished white metal surface	130%
16	Shiny light metal surface	150%
17	Stainless steel	200%
18	Reflective board, reflective adhesive tape	>300%

8. Important Maintenance Instructions

Kindly pay attention to the following to achieve the best maintenance of the product:

• 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 extremely hot conditions. High temperatures 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, moisture that forms inside the device will damage 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 operating properly, please take it to the nearest authorized service facility for repair.