



Commissioning of the EP5000-L (LoRa) probe

Ver	Date	Modification / Update
V1	04/01/2020	Initial Version
V2	20/01/2020	Flickering added
V3	01/6/2020	Dimming LEDs removed, Byte numbering corrected, Lux range extended
V4	01/03/2021	New organization of the telegram with index, NOx and O3
V5	15/04/2021	Number of bits reduction for noise
V6	19/11/2021	BITE reduced to 1 byte
V7	21/03/2022	Outdoor air quality downlink added
V8	10/06/2022	Corrections
V9	22/06/2022	Return BITE to 2 bytes

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1. Overview

The EP5000L (powered) and E5000AL (autonomous with indoor light supply) probe communicates by radio in LoRaWAN. This document describes how to commission the probe on the LoRaWAN network and describes the content of the telegrams.

2. Memory security accessible by NFC

The NFC chip has a password to protect it in read and / or write.

Thus the serial number, radio ID and other parameters to be secured cannot be modified by a third party.

The settable data (parameters) can only be accessed from the manufacturer's Android Application containing the passwords to avoid any hacking or corruption of data by people using standard NFC chip reading and writing software.

3. Download the setting application

The setting of parameters and the reading of data is compatible with Android smartphones (not IOS because Apple does not allow the use of the on-board NFC of their smartphone for purposes other than payment). You can go to the Google store and search for NanoSense. You will see a list of applications: Select the application corresponding to the IAQ probe model and download it.

4. Smartphone type and settings

Make sure your Android smartphone has an integrated NFC function.

Activate NFC in the settings section.

5. Reading the LoRa Keys with the NFC application

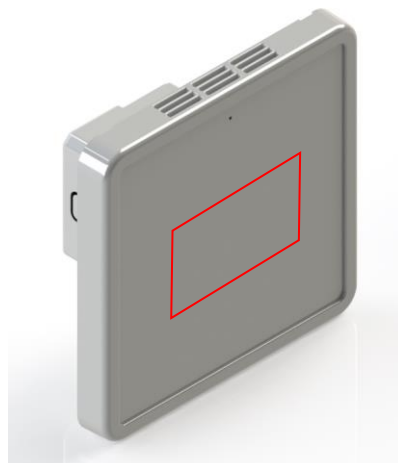
Open the NFC configuration App and approach the back of the smartphone from the center of the front face of the probe (the antenna is located in the middle).

Reading by NFC does not require the unit to be powered or even mounted. It is even possible to read the NFC memory through the cover of the box (a marking on the box indicates the location of the NFC antenna)

The power supply for the front panel comes from the smartphone via NFC. When the NFC antenna on the probe responds, you should hear a Beep on the phone.

You can read the unique LoRa keys. To do this, click on the "Read" button in the application.

The keys can now be copied for recording in the network or sent by Email.



NFC antenna location



6. Join a network

By default, the probe is in public mode. For private mode, you must use the dedicated smartphone application and activate this function by NFC. Do not confuse private mode and private network. Private mode exchanges longer keys.

Select OTAA mode in the web page of the LoRaWAN network or of the gateway used.

Enter the following keys:

Key	Bits	Byte	Contend	Contend in hexadecimal for input
Device EUI	64	8	“Unique”	Contained in the NFC chip
Application EUI	64	8	EP5000-L	Contained in the NFC chip (45 50 35 30 30 30 2D 4C)
Application Key	128	16	“Unique”	Contained in the NFC chip

Keys are confidential and readable on smartphone via the App and NFC

Keys can then be protected by password or even be erased (Bur DevEUI). Refer to the App manual for details

Copy the keys on the LoRa platform of an operator or a gateway.

At startup, the radio module will be automatically recognized by the LoRa or LoRaWAN network.

When the radio module is connected to the LoRaWAN network, The Joined green LED in the upper part of the front panel remains on.



Joined LED

Be careful, recording on an operated network may require several radio transmission cycles.

The management of this LED is settable by NFC:

- Always ON
- On for one hour after connection to the network
- Disabled if no downlink in the last 8 hours
- Disabled if no downlink in the last 12 hours
- Disabled if no downlink in the last 24 hours

7. Setting the LoRa emission rate

The transmission rate depends mainly on the operator and the contract with him. It is generally allowed to transmit on average at most every 10 minutes in an operated network. In a private network, the rate may be faster.

By default, the cadence of the Radio LoRa module is 10 minutes.

The transmission rate can be configured by NFC and by the downlink for powered EP5000L.

The following command must be sent:

0x01 0xdd 0xdd

0x01: command number for time cycling change. (See chapter 2.2.2)

0xdd 0xdd is the delay between two frames in minutes, it will be taken into account after the next emission.

8. LoRaWAN Payload

8.1. Contend of LoRaWAN Payload

Regularly, the LoRa module sends a set of measurements distributed over its emission rate. This message can be timestamped on receipt. It belongs to a gateway or the database that archives the recordings to time stamp the data.

8.2. LoRa messages format

8.2.1. Uplink

EP5000 LoRa Telegram:

Presence sensor	Probe Frm	LoRa Module Frm	BITE	Autonomy	Emission rate	RH	T°	PM	Noise	CO2	TCOV	Formaldehyde	Benzene	Sulphurous odors
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	2 Bytes	1 Byte	9 bits	27 bits	14 bits	13 bits	2 Bytes	2 Bytes	2 Bytes	1 Byte

NOx	Ozone	Atmospheric pressure	Lux	Color T°	Flickering	Health index	Cognitivity index	Quality of sleep index	Throat irritation index	Virus spreading risk index	Building health index
1 Byte	1 Byte	14 bits	10 bits	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte

Total 37 Bytes

Please note that the standard authorizes 51 bytes (from SF12 to SF10, the longest ranges at 125Khz) in most regions and particularly in Europe, but only 11 in DR0 and 53 in DR1 in North America. So the radio stack for North America starts at DR1 which limits the range a little bit.

Detail of the sensor presence byte (byte 1)

Byte 1							
Presence sensors							
7	6	5	4	3	2	1	0

Bit	
0	1 = T°, RH active
1	1 = PM active
2	1 = Bruit active
3	1 = CO2 active
4	1 = TCOV, sulfurous odors active
5	1 = NOx, O3 active
6	1 = Benzene, Formaldehyde active
7	1 = Lux & light T° active

Detail of EP5000L probe Firmware version and LoRa stack software bytes

Byte 2							
Probe Firmware Version							
7	6	5	4	3	2	1	0

Byte 3							
LoRa Stack Firmware Version							
7	6	5	4	3	2	1	0

Bits 4 to 7: integer

Bits 0 to 3: tenths

Valid range: 1.0 to 15.15

Detail of BITE (Built In Test Equipment) bytes

The 2 bytes of the BITE identify the FRU (Filed Replaceable Unit) to be changed.

Bit	
0	LoRa front panel board.
1	Single band CO2 sensor module.
2	Dual band CO2 sensor module
3	VOC/odors/NOx/O3 sensors module
4	Motherboard.
5	Interconnection board.
6	Particles sensor board
7	Radio version power supply board.
8	Multiple failures.
9	Perishable sensor arrived at end of life.
10 to 16	Reserved

Detail Autonomy byte

Byte 6							
Autonomy							
7	6	5	4	3	2	1	0

Used for indoor solar stand-alone version only.
 Valid range from 0 to 100%
 Resolution 1% by LSB

Detail of the Transmission rate bytes

Byte 7								Byte 8							
Emission rate															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Unit: Minutes
 Useful to verify that the cadence command has been received.
 By default, the value is zero which corresponds to an emission rate of 10 minutes. Note that values greater than 720 also correspond to the default value of 10 minutes.
 Therefore, the range goes from 1 minute to 12h.
 Valid range: 0-720 minutes (12 hours)

Detail of the RH byte

Byte 9							
RH							
7	6	5	4	3	2	1	0

Valid range: 0/200 LSB
 Range of measurement: 0 to 100% RH
 Resolution: 0.5%/LSB

Detail of Temperature

Byte 10								Byte 11							
Temperature															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Valid range: 0/511 LSB
 Range of measurement: 0 to +51°C
 Resolution: 0.1°C/LSB

Detail of PM

Byte 11								Byte 12								Byte 13								Byte 14							
PM 10								PM 2.5								PM 1															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Valid range: 0/511 LSB
 Range of measurement: 0 to 511 µg/m³
 Resolution: 1 µg/m³/LSB

Detail of Noise

Byte 14								Byte 15								Byte 16							
Average Noise								Pic Noise															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

valid Range pic & average: 0/103 LSB
 Range of measurement: 17 to 120 dB
 Resolution: 1 dB

Detail of CO2

Byte 16								Byte 17							
CO2															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Concentration:
 Valid Range: 0/5000 LSB
 Range of measurement: 0 to 5000ppm
 Resolution: 1ppm / LSB

Detail of TVOC

Byte 18								Byte 19							
TVOC Concentration															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Concentration:
 Valid Range: 0/65 535 LSB
 Range of measurement: 0 to 65535 µg/m³
 Resolution: 1 µg/m³ / LSB

Detail Formaldehyde:

Byte 20								Byte 21							
Formaldehyde Concentration															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Concentration:
 Valid Range: 0/65 535 LSB
 Range of measurement: 0 to 655.35 µg/m³
 Resolution: 0.01 µg/m³ / LSB

Detail Benzene:

Byte 22								Byte 23							
Benzene Concentration															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Concentration:
 Valid Range: 0/65 535 LSB
 Range of measurement: 0 to 655.35 µg/m³
 Resolution: 0.01 µg/m³ / LSB

Detail Sulphurous Odors

Octet 24							
Sulphurous Odors							
7	6	5	4	3	2	1	0

Concentration:

Valid Range: 0/100 LSB

Range of measurement: 0 to 100 OU (Odor Units)

Resolution: 1 OU / LSB

Detail NOx:

Octet 25							
NOx							
7	6	5	4	3	2	1	0

Concentration:

Valid Range: 0/250 LSB

Range of measurement: 0 to 500 ppb

Resolution: 2 ppb / LSB

Detail Ozone:

Octet 26							
Ozone							
7	6	5	4	3	2	1	0

Concentration:

Valid Range: 0/250 LSB

Range of measurement: 0 to 500 ppb

Resolution: 2 ppb / LSB

Detail of Atmospheric Pressure:

Byte 27								Byte 28							
mbar / hPa															
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Atmospheric Pressure:

Valid Range: 0/1638.3 LSB

Range of measurement: 0 to 1638.3 mbar

Resolution: 0.1 mbar / LSB

Detail Lux:

Byte 28						Byte 29									
Lux															
7	6	5	4	3	2	1	0	6	5	4	3	2	1	0	

Luminosity:

Valid Range: 0/1023 LSB

Range of measurement: 0 to 4092 Lux

Resolution: 4 lux / LSB

Detail Light color Temperature:

Byte 30							
Light color T° in Kelvin							
7	6	5	4	3	2	1	0

light color Temperature:
 Valid Range: 0/255 LSB
 Range of measurement: 1 635°K to 7 500°K
 Resolution: 23°K / LSB

Detail Light flickering:

Byte 31							
Flickering in %							
7	6	5	4	3	2	1	0

Flickering of the light:
 Valid Range: 0/100 LSB
 Range of measurement: 0 to 100%
 Resolution: 1% / LSB

Physiological Effects

Octet 32	Octet 33	Octet 34	Octet 35
Health Index	Cognitivity Index	Sleeping Index	Throat irritation index

Valid Range: 0/100 LSB
 Range of measurement: 0 à 100%
 Resolution: 1% / LSB

Detail Building Health

Byte 36
Building Index

Valid Range: 0/100 LSB
 Range of measurement: 0 à 100%
 Resolution: 1% / LSB

Detail virus spreading risk index

Octet 37
Virus spreading risk index

Valid Range: 0/100 LSB
 Range of measurement: 0 à 100%
 Resolution: 1% / LSB

Conversion of physical values:

Parameters measured	Size	Range	Resolution	Physical Values
CO2	13 bits	0...5000	1 LSB = 1 ppm	0...5000 ppm
Humidity	1 Byte	0...200	1 LSB = 0.5%	0...100 %RH
Temperature	1 Byte	0...255	1 LSB = 0.2°C	0...+51 °C
VOC	2 Bytes	0...65535	1 LSB = 1 µg/m ³	0...65535 µg/m ³
Formaldehyde	2 Bytes	0...65535	1 LSB = 0.01 µg/m ³	0...655.35 µg/m ³
Benzene	2 Bytes	0...65535	1 LSB = 0.01 µg/m ³	0...655.35 µg/m ³
PM10, PM2.5, PM1	9 bits per value	0...511	1 LSB = 1 µg/m ³	0...511 µg/m ³
Sulphurous Odors	1 Byte	0...100	1 LSB = 1 OU	0...100 OU
NOx	1 Byte	0...250	1 LSB = 2ppb	0...500 ppb
Ozone	1 Byte	0...250	1 LSB = 2ppb	0... 500 ppb
Average and pic Noise	2 x 7 bits	0...103	1 LSB = 1dBA	17...120dB
Atmospheric Pressure	14 bits	0...16384	1 LSB = 0.1 mBar	0...1638.4 mBar
Lux	10 bits	0...1023	1 LSB = 4 Lux	0...4092 lux
Color T°	1 Byte	0...255	1 LSB = 2°K	1 635°K to 7 500°K
Flickering	1 Byte	0...200	1 LSB = 0.5%	0...100 %
Health Index	1 Byte	0...100	1 LSB = 1%	0...100 %
Cognitivity Index	1 Byte	0...100	1 LSB = 1%	0...100 %
Sleeping Index	1 Byte	0...100	1 LSB = 1%	0...100 %
Irritation index	1 Byte	0...100	1 LSB = 1%	0...100 %
Building Index	1 Byte	0...100	1 LSB = 1%	0...100 %
Virus spreading index	1 Byte	0...100	1 LSB = 1%	0...100 %

8.2.1.1. Time stamp

It is up to the gateway or the operator which receives the telegram to time stamp the measurements.

8.2.2. Down Link

The transmission of the configuration data is done on port 2.

Byte 1 Command Code	Byte 2	Byte 3
0x01	Emission rate in minutes	

Total 3 Bytes

Emission rate command 0x01

This command is used to set the transmission rate.

The two Bytes of rate are a delay between two frames expressed in minutes, it will be taken into account after the next transmission.

By default, the value is at zero which corresponds to a transmission rate of 10 minutes. Note that values greater than 720 also correspond to the default value of 10 minutes.

The range goes from 1 minute to 12 hours.

Outdoor air quality data:

Byte 1 command Code
0x03

Present sensors 1	RH1	T°1	Particles1	Noise1	NOx1	Ozone1
1 Byte	1 Byte	9 bits	27 bits	14 bits	1 Byte	1 Byte

Present sensors 2	RH2	T°2	Particles2	Noise2	NOx2	Ozone2
1 Byte	1 Byte	9 bits	27 bits	14 bits	1 Byte	1 Byte

Total 23 Bytes.

Detail of the Present sensors byte

Byte 2 & 9							
Present sensors							
7	6	5	4	3	2	1	0

Bit	
0	1 = T°, RH active
1	1 = PM active
2	1 = Noise active
3	1 = NOx active
4	1 = Ozone active
5	Reserved
6	Reserved
7	Reserved

Humidity, T°, Particles, noise, NOx and Ozone coded identically to the uplink of the EP5000

9. CODEC example of uplink payload (Objenious)

```
{  
"attributes": {  
  
"sensor_Light" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_Benzene_Formaldehyde" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_NOx_O3" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_VOC_Odor" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_CO2" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_Noise" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_PM" : {  
"type": "bool",  
"length": 1  
},  
  
"sensor_Temp_RH" :  
{  
"type": "bool",  
"length": 1  
},  
  
"Firmware_E5000": {  
"type": "uint",  
"length": 8
```

```
},  
  
"Firmware_Lora": {  
  "type": "uint",  
  "length": 8  
},  
  
"BITE_FrontLoRa" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_CO2_1B" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_CO2_2B" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_VOC_NOx_O3" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_LoRa" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_InterBoard" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_PM" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_PowerLoRa" : {  
  "type": "bool",  
  "length": 1  
},  
  
"BITE_MultipleFailure" : {  
  "type": "bool",
```

```
"length": 1  
},
```

```
"BITE_EndOfLife_Sensor" : {  
"type": "bool",  
"length": 1  
},
```

```
"BITE_dummy" : {  
"type": "uint",  
"length": 6  
},
```

```
"Autonomy" : {  
"type": "uint",  
"length": 8  
},
```

```
"Emission_Rate": {  
"type": "uint",  
"length": 16  
},
```

```
"humidity": {  
"type": "uint",  
"length": 8,  
"divide": 2  
},
```

```
"temperature": {  
"type": "uint",  
"length": 9,  
"divide": 10  
},
```

```
"PM10_Value": {  
"type": "uint",  
"length": 9  
},
```

```
"PM2_5_Value": {  
"type": "uint",  
"length": 9  
},
```

```
"PM1_Value": {  
"type": "uint",  
"length": 9  
},
```



```
"Noise_Avg": {  
  "type": "uint",  
  "length": 7  
},
```

```
"Noise_Peak": {  
  "type": "uint",  
  "length": 7  
},
```

```
"Dummy1": {  
  "type": "uint",  
  "length": 1,  
  "hidden": true  
},
```

```
"CO2": {  
  "type": "uint",  
  "length": 13  
},
```

```
"VOct": {  
  "type": "uint",  
  "length": 16  
},
```

```
"Formaldehyde": {  
  "type": "uint",  
  "length": 16  
},
```

```
"Benzen": {  
  "type": "uint",  
  "length": 16  
},
```

```
"Odor": {  
  "type": "uint",  
  "length": 8  
},
```

```
"NOx": {  
  "type": "uint",  
  "length": 8,  
  "multiply" : 2  
},
```

```
"Ozone": {  
  "type": "uint",  
  "length": 8,  
  "multiply" : 2  
},
```

```
"AtmoPressure": {  
  "type": "uint",  
  "length": 14,  
  "divide": 10  
},
```

```
"LightLux": {  
  "type": "uint",  
  "length": 10,  
  "multiply": 4  
},
```

```
"LightTemp": {  
  "type": "uint",  
  "length": 8,  
  "multiply": 23  
},
```

```
"LightFlickering": {  
  "type": "uint",  
  "length": 8  
},
```

```
"PhysioHealth": {  
  "type": "uint",  
  "length": 8  
},
```

```
"PhysioCognitivity": {  
  "type": "uint",  
  "length": 8  
},
```

```
"PhysioSleep": {  
  "type": "uint",  
  "length": 8  
},
```

```
"PhysioRespiratory": {  
  "type": "uint",  
  "length": 8  
},
```

```
"VirusRisk": {  
  "type": "uint",  
  "length": 8  
},
```

```
"BuildingIndex": {  
  "type": "uint",  
  "length": 8  
}
```

```
},
```

```
"format":[  
  {"attributes":["sensor_Temp_RH","sensor_PM","sensor_Noise","sensor_CO2","sensor_VOC_Odor"  
  ,"sensor_NOx_O3","sensor_Benzene_Formaldehyde","sensor_Light","Firmware_E5000","Firmware_Lora"  
  ,"BITE_FrontLoRa","BITE_CO2_1B","BITE_CO2_2B","BITE_VOC_NOx_O3","BITE_LoRa","BITE_I  
  nterBoard","BITE_PM","BITE_PowerLoRa","BITE_MultipleFailure","BITE_EndOfLife_Sensor","BITE_  
  dummy","Autonomy","Emission_Rate","humidity","temperature","PM10_Value","PM2_5_Value","PM1_  
  Value","Noise_Avg","Noise_Peak","Dummy1","CO2","VOct","Formaldehyde","Benzen","Odor","NOx",  
  "Ozone","AtmoPressure","LightLux","LightTemp","LightFlickering","PhysioHealth","PhysioCognition",  
  "PhysioSleep","PhysioRespiratory","VirusRisk","BuildingIndex"]  
  }  
]  
}
```