


SUBJECT : User guide for LoRaWAN indoor TH(Temperature) sensor
PRODUCT : 50-70-053(085)-000 LoRaWAN indoor TH(Temperature)
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History

DATE	REVISION	OBJET	AUTHOR
07/02/18	0	Creation	NJC
12/02/18	1	“Configuration of application layer” section added	NJC
18/05/18	2	Add information and examples for the Threshold report feature + some minor fixes.	NJC
15/06/18	3	Add the two options: 50-70-053 TH and 50-70-085 Temperature only	NJC
24/09/18	4	Add a Batch configuration example and the frames corresponding to the default configuration.	NJC
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1. ABOUT THIS DOCUMENT

This user guide contains some useful informations, characteristics about the device, and examples of use. The aim is to provide the new user with essential knowledge in order to make the device work quickly. This user guide is not exhaustive. Please refer to the reference documentation for more information. This user guide is provided for informational purposes only. It is not a contractual nor a technical reference. Characteristics and features of the device can change at any time without notice.

2. REFERENCE DOCUMENTS

Reference documentation for this device :
50-70-053_SPG_Capteur_TH_LoRaWAN ICT_V0_X_Y.pdf
LoRaWAN_Sensors_Application_Layer_Addon_001_V1_X.pdf

You can find more informations on the technical aspects of the device at:
<http://support.nke-watteco.com/>

3. DEVICE CHARACTERISTICS

Depending on the model you purchased, your device has the following features

The 50-70-053-000 LoRaWAN indoor TH sensor is designed to :

- measure ambient temperature
- measure hygrometry

The 50-70-085-000 LoRaWAN indoor Temperature sensor is designed to :

- measure ambient temperature

These sensors are designed for indoor use (e.g. private housing, offices...).

Therefore, the hygrometry measurement will be treated as an option below, and will be marked with the tag **[option]**.

4. INSTALLATION

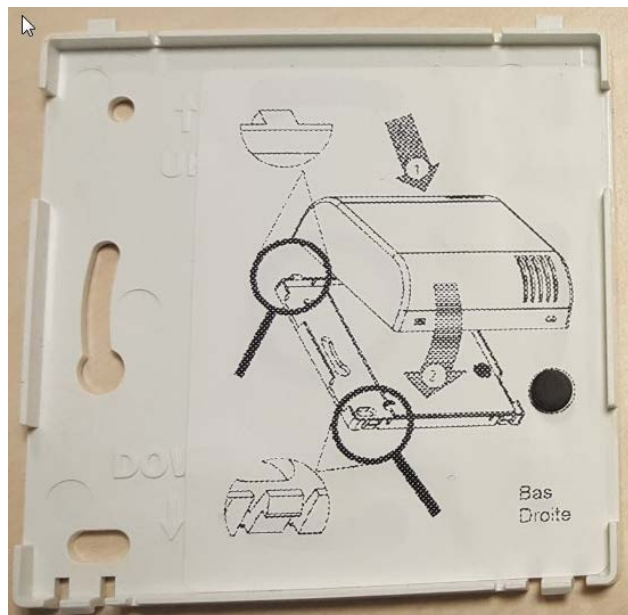
Metallic objects/surfaces are likely to reduce or disrupt radiofrequency signals. The sensor must be mounted at least one metre from any metallic object or surface.

The LoRaWAN indoor TH sensor is illustrated in the picture below:



Picture 1 - Sensor mounted on a vertical wall

First, fix the lid of the sensor to the wall using the screw kit provided. Then attach the case that contains the electronic board to the lid by following the instructions on the label inside the lid:



Picture 2 - Housing lid to be wall-mounted using the screw kit, with mounting instructions inside

Note: Check the radio coverage before installing the sensor. The radio coverage can be disrupted or reduced by various obstacles between the LoRa gateway and the sensor (buildings, embankments, hills, etc.).


5. OPERATION

5.1. UI components

This sensor includes the following UI components:

nke ☎(33).02.97.36.10.12 Fax (33).02.97.36.55.17

Fichier modèle : QPE.dot du 02/11/1999 (MAJ éditions normes)

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- Reed switch (ILS).
- Buzzer.
- Green LED, visible through the top-right opening.

When a magnet is placed in front of the “ILS” mark, the sensor produces a slightly intermittent feedback sound that signifies the reed switch is being activated. The location of the reed switch is identified by an “ILS” tag on the right of the sensor case.

5.2. Setting the sensor in working mode

If you are using a private network, you should start up your gateway first. If you don't know it, familiarise yourself with it before starting the sensor. We advise you to provide the network with the sensor's identification information before you start up the sensors. This aims to reduce the time taken by the pairing procedure.

5.2.1. Setting the sensor in working mode

Place a magnet in front of the reed switch for 1 second.

A tune is played for approximately 1 second: 2 short tones, the first one is low-pitched and the second high-pitched.

5.2.2. Pairing to a network

Then, the sensor launches the pairing process: the green LED blinks 250 milliseconds every 5 seconds until the end of the pairing process. The pairing process will not stop until the sensor is successfully paired to a network. When the sensor successfully pairs to a network, the green LED is switched on for 3 seconds to confirm the sensor has been successfully paired to a network. Then the sensor is in working mode. The green LED and the buzzer stay switched off.

Note 1: we use a green LED instead of the buzzer to signal a network pairing is in progress. This avoids noise disruption while this sensor is being set up in a occupied room.

See the “Test mode: check whether a sensor is switched on or off” section to determine if the sensor is in storage mode or in working mode.

5.3. Setting the sensor in storage mode

Place a magnet in front of the reed switch for 5 seconds.

A tune is played for approximately 1 second: 2 short tones, the first one is high-pitched and the second is low-pitched.


See the “Test mode: check whether a sensor is switched on or off” section to determine if the sensor is in storage mode or in working mode.

5.4. Factory reset

The reset factory feature resets the network and the application parameters to their initial value as defined by the manufacturer. E.g. data about the paired network are deleted and attribute values like counters are reset to 0.

Execute the following sequence by activating the reed switch with a magnet:
2 short activations + one long activation of 7 seconds (at least).

Note: perform these 3 activations (2 short + 1 long) without any pause during the entire sequence. If the sequence is fragmented, it will not work.

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The factory reset is confirmed by a tune: 3 tones, from low pitch to high pitch, played 3 times. Then the sensor reboots.

5.5. Pairing reset

The pairing reset feature resets the pairing state and launches a new pairing process. The application parameters are kept.

Execute the following sequence by activating the reed switch with a magnet:
3 short activations.

The sensor launches the network pairing process, like it does when it is set in working mode.

5.6. Test mode: check whether a sensor is in working or storage mode

You can check whether the sensor is in working or storage mode by activating the reed switch with a magnet, following this sequence:
One short activation.

If the sensor is in storage mode, nothing happens: the sensor stays in storage mode.

If the sensor is in working mode, it switches to test mode:

- The sensor sends one void frame (heartbeat) per minute.
- The reports are temporarily deactivated during the test mode. The next report is postponed while the test mode is activated.
- The buzzer sounds 2 relatively loud high-pitched tones (the second one lasts a little longer than the first) every 3 seconds.
- The first void frame (heartbeat) is sent 10 seconds after activating the test mode.
- The test mode automatically turns off after 10 minutes if it is not deactivated beforehand by the user.

The characteristic beeps emitted during this test mode only happen if the sensor is in working mode. This allows the current mode (working or storage) of the sensor to be checked directly.

To deactivate the test mode, repeat the same sequence used to activate it.

5.7. Configuration of the application layer

For instructions on how to use the sensor straight “out of the box”, see the “DATA PROCESSING > How reports work” section.

The application layer, and in particular the report configuration, can be modified through ZCL-like commands sent to the sensor. See the support website at:

<http://support.nke-watteco.com/>

This sensor integrates the following clusters:

- Basic
- Configuration
- LoRaWAN
- Relative humidity measurements
- Temperature measurements
- Binary input (for the open/close case alarm feature)

Here is an example of how to reconfigure the TH sensor:

ZCL-like command	Description
115000500203	Configuration cluster: completely removes the existing configuration
110604020000029803C803C0000	Temperature measurement cluster: reports the Measured value attribute every hour.
110604050000021803C803C0000	Relative humidity measurement cluster: reports the Measured value attribute every hour.
1106000F000055108001000001	Binary input: reports the Present value attribute when its value changes (boolean) and at a maximum of once every minute.
1106040515000000800A803C000000640A	<p>Relative humidity measurement cluster: reports the measured value in the Batch frame.</p> <ul style="list-style-type: none"> • A record of the value every 10 minutes, 0xA = 10 ; 8 signifies “minutes”. • A report of the values every hour, 0x3C = 60 ; 8 signifies “minutes”. • 0x0A: this is the tag value. There is only one Batch that contains all of the measurements reported by the Batch. The measurements are identified by a label, and the link between the measurement type and the label is done by the configuration ZCL-like command. So here we have: <ul style="list-style-type: none"> ◦ 0x0405 and 0x0000: This identifies respectively the cluster Relative humidity measurement and the attribute Measured Value. ◦ 0x0A=0b00001010. The label of this configuration command is 1. The maximum label size, in bits, is 2. <p>See http://support.nke-watteco.com/#BatchReport for more details.</p>
1106040298000029800A0000B10000003201	<p>Temperature measurements cluster: sends a low threshold report when the Measured value falls under the threshold, and at a maximum of once every 10 minutes.</p> <ul style="list-style-type: none"> • Threshold: 0x0000 = 0 degree Celsius • Hysteresis: 0x0032 = 50 = 0.5 degree Celsius • Sends a ZCL-like report only when a threshold is reached (alarm reports): 0x0000. • This threshold report is sent at a maximum of once every 10 minutes, 0xA = 10; 8 signifies “minutes”. • 0xB1: this is a low threshold. The report is sent when the Measured value falls under the Threshold - Hysteresis.
1106040298000029800A0000D20190003201	<p>Temperature measurements cluster: sends a high threshold report when the Measured value exceeds the threshold, and at a maximum of once every 10 minutes.</p> <ul style="list-style-type: none"> • Threshold: 0x0190 = 400 = 4 degrees Celsius • Hysteresis: 0x0032 = 50 = 0.5 degree Celsius • Sends a ZCL-like report only when a threshold is reached (alarm reports): 0x0000. • This threshold report is sent at a maximum of once every 10 minutes, 0xA = 10; 8 signifies

	<p>“minutes”.</p> <ul style="list-style-type: none"> • 0xD2: This is a high threshold. The report is sent when the Measured value exceeds Threshold + Hysteresis.
--	---

And here are the ZCL-like commands to use in order to obtain the default configuration:

```
11 50 00 50 02 03
11 06 04 02 15 00 00 00 80 1E 80 3C 00 00 00 0A 02
11 06 04 05 15 00 00 00 80 1E 80 3C 00 00 00 64 0A
11 06 00 50 15 00 06 04 A7 60 A7 60 00 00 00 01 12
11 06 00 0F 00 00 55 10 80 01 FF FF 01
11 06 04 02 90 00 00 29 80 1E FF FF B1 02 BC 00 64 01
11 06 04 02 90 00 00 29 80 1E FF FF D2 09 C4 00 64 01
11 06 04 05 90 00 00 21 80 1E FF FF B1 00 64 00 64 01
11 06 04 05 90 00 00 21 80 1E FF FF D2 1B 58 00 64 01
```

Every change made to the default configuration must comply with the legal duty cycle (for example, the most restrictive in the EU is 0.1%, which corresponds to approximately 1 frame per hour with SF12).

A factory reset removes any custom configuration and sets the default Batch configuration again.

Please note that this is a Class A LoRaWAN sensor. The command frames will be sent to the sensor only successively upon reception of a frame from the sensor. To speed up this process you can use the “test mode”.


6. DATA PROCESSING

6.1. How reports work

Depending on the kind of data to be reported, the nke Watteco LoRaWAN sensors use an nke Watteco proprietary compression and aggregation protocol named “Batch” or a ZCL-like protocol (based on the ZCL standard, but with some differences). On this sensor, the reports are described as follow:

Reported value (unit)	Report kind (details)
Ambient temperature (1/100 of degree Celsius)	Batch (1 record/30min, 1 transmission/hr)
[option] Hygrometry (1/100 of %)	Batch (1 record/30min, 1 transmission/hr)
Battery voltage (mV)	Batch (1 record/7d, 1 transmission/7d)
State of the opening/closing case detector (boolean)	ZCL-like (a transmission on event, and max once per minute)
Ambient temperature (1/100 of degree Celsius)	ZCL-like low threshold report when the temperature falls under 7°C, with an hysteresis of -/+1°C
Ambient temperature (1/100 of degree Celsius)	ZCL-like high threshold report when the temperature exceeds 25°C, with an hysteresis of -/+1°C
[option] Hygrometry (1/100 of %)	ZCL-like low threshold report when the hygrometry falls under 1%rH, with an hysteresis of -/+1%rH
[option] Hygrometry (1/100 of %)	ZCL-like high threshold report when the temperature falls under 70%rH, with an hysteresis of -/+1%rH

Note 1: to summarise the table shown above, the sensor transmits a Batch frame every hour. The first Batch frame is sent one hour after the pairing with the network is successfully completed. In case the sensor case is opened / closed by removing / putting back the lid, a

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ZCL-like frame (alarm) is sent. In addition to these Batch frames, the sensor can send void frames. These frames are beacons / heartbeats useful to the network.

Note 2: a record corresponds to a sample of the measured physical value. It can also be called a sample.

6.2. How to read the report frames

6.2.1. ZCL-like report

A ZCL-like report can be identified by the value of the second byte of the frame: 0x0A. Here is an example of such a report: 110A040200002907D0

- 0x0A: This is a ZCL-like report
- 0x0402: Temperature measurement cluster
- 0x0000: Measured value attribute
- 0x07D0: The value of the temperature when the frame was issued. 0x7D0 = 2000 = 20°C.

6.2.2. Batch report

Every single bit of a Batch report is optimized to get the best data size/frame size ratio. As a consequence, trying to parse or read the report directly is hardly feasible. Please refer to the “DATA PROCESSING > Uncompress Batch reports with br_uncompress” section.

6.2.3. ZCL-like threshold report (alarm)

A ZCL-like threshold report can be identified by the value of the second byte of the frame: 0x8A. Here is an example of such a report: 118A040200002901C298D2

- 0x8A: This is a ZCL-like threshold report
- 0x0402: Temperature measurement cluster
- 0x0000: Measured value attribute
- 0x01C2: The value of the temperature when the frame was issued. 0x1C2 = 450 = 4.50°C.
- 0xD2: This allows this threshold report to be linked to one of the threshold report configurations of the sensor. Here, this is the high threshold report configured on the second slot: this report is sent when the Measured value exceeds the Threshold (4°C) + Hysteresis (0.5°C)

6.3. Decompressing Batch reports with br_uncompress

6.3.1. Downloading the necessary piece of software

The br_uncompress piece of software is used to decompress Batch reports. It can be downloaded here:

<http://support.nke-watteco.com/downloads/>

The zip contains:

- br_uncompress-WIN.exe: a pre-compiled executable for Windows shell
- wtc-br_uncompress-aaaamdd.zip: the source code of the br_uncompress piece of software

If you want to use the piece of software on a system that is not compatible with the pre-compiled executable, you can compile your own executable from the source code. The necessary compilation line can be found in the header of the br_uncompress.c source file.

6.3.2. Using the br_uncompress piece of software

The br_uncompress piece of software is used to decompress the Batch frames sent by LoRaWAN nke Watteco sensors.

Note: this piece of software cannot decompress encrypted frames. The frames must be decrypted by the network before being decompressed by this piece of software.

Some parameters are needed to describe the content of the Batch frames that will be decompressed. In the case of the indoor TH sensor, these parameters are:

- For TH 50-70-053-000 : « -a 2 0,1,7 1,1,6 2,1,6 »
- For TH 50-70-053-001 : « -a 2 0,10,7 1,100,6 2,1,6 »
- For Temperature 50-70-085-000 : « -a 2 0,1,7 2,1,6 »
- For Temperature 50-70-085-001 : « -a 2 0,10,7 2,1,6 »

The first number of each triplet is the label of a corresponding measured value as described below:

Label	Corresponding measured value
0	Temperature
1	Hygrometry
2	Battery voltage

If there is no report configuration of some of these measured values on your sensor, or if a Batch frame does not contain any record for a configured value, the measured value and its corresponding label are simply ignored during decompression.

6.3.3. Example 1: hourly periodic Batch frame

Here, the frame contains measured values of the TH sensor.

```
$ echo "220000C081938297B457C0140108D009645E1968B707" | ./br_uncompress.exe -a 2 0, 1, 7 1, 1, 6 2, 1, 6
Scan args:
S00: 0, 1.000000, 7
Scan args:
S01: 1, 1.000000, 6
Scan args:
S02: 2, 1.000000, 6
nb_of_type_measure: 2
batch requested: 0
no sample: 0
cts: 1
cnt: 0
tag: 0, index 0 timestamp: 1870 Measurement: 2654 Coding type: 2, Coding table 0
tag: 1, index 1 bi: 0 sz: 7 timestamp: 1870 Measurement: 2712 Coding type: 2, Coding table 0
common timestamp
number of samples: 2
TimeStamp Coding(0-A/1-B/2-C): 0
bi: 0 sz: 2 timestamp: 1870
bi: 10 sz: 11 raw: 777 timestamp: 3670
tag: 0 index: 0
0. available: 1 coding table: 0 bi: 0 sz: 2
1. available: 1 coding table: 0 bi: 4 sz: 4 RawValue: 7 Value: 2632 TimeStamp: 3670
tag: 1 index: 1
0. available: 1 coding table: 0 bi: 0 sz: 2
1. available: 1 coding table: 0 bi: 8 sz: 8 RawValue: 118 Value: 2339 TimeStamp: 3670
TimeStamp of the sending
bi: 0 sz: 7 timestamp: 3670

DECOMPRESSION SERIES
cnt: 0
3670
1870 0 2654
3670 0 2632

1870 1 2712
3670 1 2339
```

In that example, the frame to be decompressed is: 220000C081938297B457C0140108D009645E1968B707

The command line used in the shell to decompress the frame is:


```
$ echo "220000C081938297B457C0140108D009645E1968B707" | ./br_uncompress-WIN.exe -a 2 0, 1, 7 1, 1, 6 2, 1, 6
```

The next lines are the result of the frame decompression.

In the last lines, we can observe:

```
DECOMPRESSION SERIES
cnt: 0      Sequence number of this batch (cyclic, form 0 to 7)
3670      Timestamp of the frame
1870 0 2654 Timestamp, tag and value for the 1st record of ambient temperature. T = 26,54C
3670 0 2632 Timestamp, tag and value for the 2nd record of ambient temperature. T = 26,32C

1870 1 2712 [option] Timestamp, tag and value for the 1st record of hygrometry. rH = 27,12%
3670 1 2339 [option] Timestamp, tag and value for the 2nd record of hygrometry. rH = 23,39%
```

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The timestamp corresponds to the relative date in seconds (0 corresponds to the start-up of the sensor) when the frame has been sent. If we make the hypothesis the frame has been immediately received by the network (no disruption), then the timestamp can be linked with the absolute date of reception of the frame. This allows an absolute date to be determined for each record of the Batch.

The timestamp of each record corresponds to the relative date in seconds when the record has been done, in the same way than for the timestamp of the frame.

For example, if we receive this frame on 07/18/2017-17h31, we can consider the relative clock of the sensor was 3670 (=timestamp of the frame).

If we take a closer look at the records of the ambient temperature:
The first record has been done at 1870. This timestamp is consistently lower than the timestamp of the frame as it has been done before the frame was sent. By computing the difference, we can determine the delay to be subtracted from the absolute date. This way, we obtain the absolute date of the record:
 $3670 - 1870 = 1800 \text{ seconds} = 30 \text{ minutes}$.
We deduce that the absolute date of the record is 07/18/2017-17h01.

The same calculation can be done with timestamps from different frames. For example, it is possible to compute the delay between the first record of this Batch frame and the last record of the previous Batch frame.


The tag identifies the type of value. e.g. tag 1 identifies a hygrometry value.

6.3.4. Example 2: hourly periodic Batch frame including weekly battery voltage

In that example, the Batch frame contains the measured physical values of the TH sensor we saw in "Example 1", and also the battery voltage that is transmitted weekly. We use the same parameters to decompress the frame. Indeed these parameters already include what is needed to decompress the battery voltage. The br_uncompress program just ignores the parameters for which there is no data to decompress, as is the case in "Example 1".

```
$ echo "320200004198C08DB457680EFF0E212100F9E496282B" | ./br_uncompress.exe -a 2 0,1,7 1,1,6 2,1,6
Scan args:
S00: 0,1.000000,7
Scan args:
S01: 1,1.000000,6
Scan args:
S02: 2,1.000000,6
nb_of_type_measure: 3
batch requested: 0
no sample: 0
cts: 1
cnt: 2
tag: 0, index 0 timestamp: 1121 Measurement: 567 Coding type: 2, Coding table 0
tag: 1, index 1 bi: 0 sz: 7 timestamp: 1121 Measurement: 2765 Coding type: 1, Coding table 0
tag: 2, index 2 bi: 4 sz: 3 raw: 15 timestamp: 1151 Measurement: 3617 Coding type: 1, Coding table 0
common timestamp
number of samples: 2
TimeStamp Coding(0-A/1-B/2-C): 0
bi: 0 sz: 2 timestamp: 1121
bi: 4 sz: 4 raw: 15 timestamp: 1151
tag: 0 index: 0
0. available: 1 coding table: 0 bi: 0 sz: 2
1. available: 1 coding table: 0 bi: 2 sz: 2 RawValue: 2 Value: 562 TimeStamp: 1151
tag: 1 index: 1
0. available: 1 coding table: 0 bi: 0 sz: 2
1. available: 1 coding table: 0 bi: 0 sz: 2 Value: 2765 TimeStamp: 1151
tag: 2 index: 2
0. available: 0
1. available: 1 coding table: 0 bi: 0 sz: 2
TimeStamp of the sending
bi: 1 sz: 5 raw: 1 timestamp: 1153

DECOMPRESSION SERIES
cnt: 2
1153
1121 0 567
```

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1151 0 562

1121 1 2765 [option]

1151 1 2765 [option]

1151 2 3617

The decompression result is very similar to what we saw in “Example 1”. There is just the battery voltage added in the last line:

1151 2 3617 *Timestamp, tag and value for the unique record of battery voltage. Up = 3,617V*