

SUBJECT : User guide

PRODUCT : 50-70-064(101)-000 LoRaWAN Ventil'0


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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:

50-70-064_SPG_Capteur_VMC_Gaz_outdoor_LoRaWAN ICT_V0_X_Y.pdf

LoRaWAN_Sensors_Application_Layer_Addon_001_V1_X.pdf

You will find more support at:

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

For example, detailed documentation on the Differential pressure measurement cluster:

<http://support.nke-watteco.com/differential-pressure-measurement-cluster/>

3. DEVICE CHARACTERISTICS

This sensor is designed to monitor CMV (Controlled Mechanical Ventilation). Main features are:

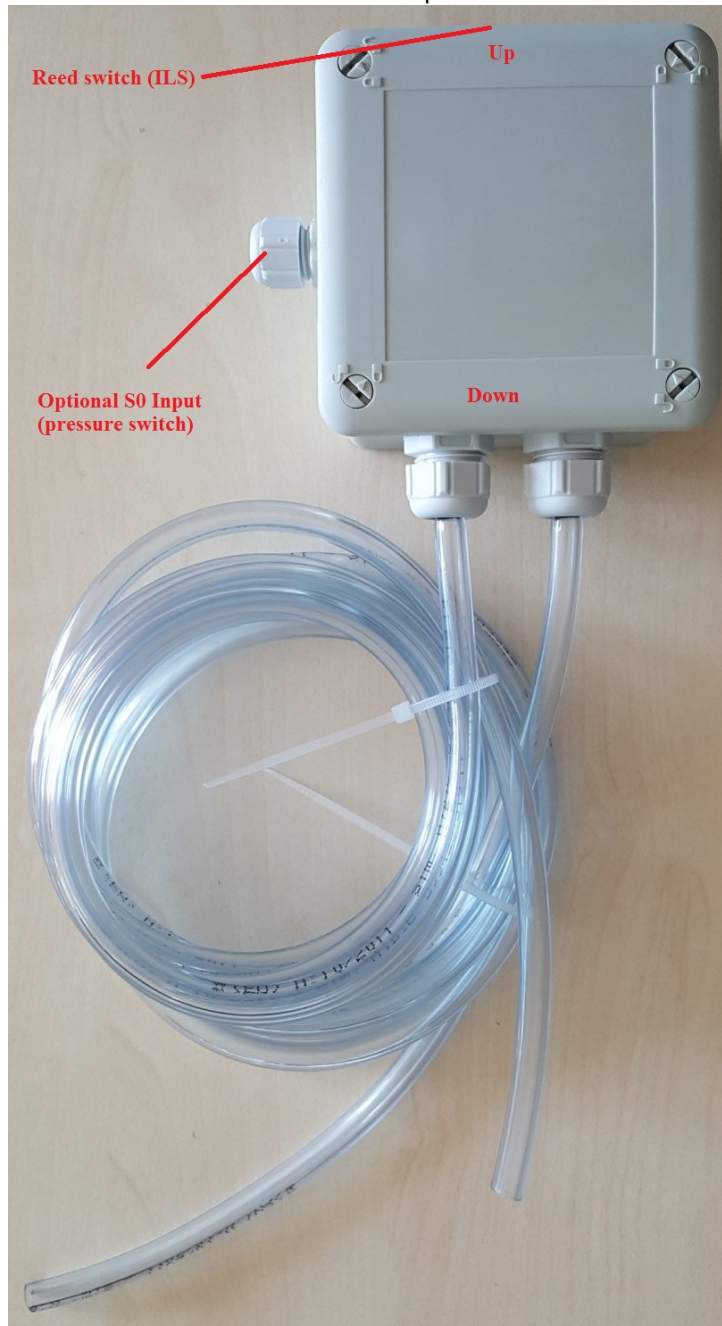
- Measurement of differential pressure. Calculation of mean, minimum and maximum values. These 3 values are reset each time they are read. All of these values are reportable and can be configured.
- Reports on thresholds of differential pressure or [Option]temperature.
- [Option] Monitoring of a pressure switch (via a digital input), that measures and sends the differential pressure when triggered. Only available on model 50-70-064-000.
- [Option] Measurement of ambient temperature. Reports can be configured.

Note: the digital input of this sensor is exclusively designed to be used with a pressure switch to trigger a differential pressure measurement and report. It is not designed for any other purposes.

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 Ventil'O sensor is illustrated in the picture below:

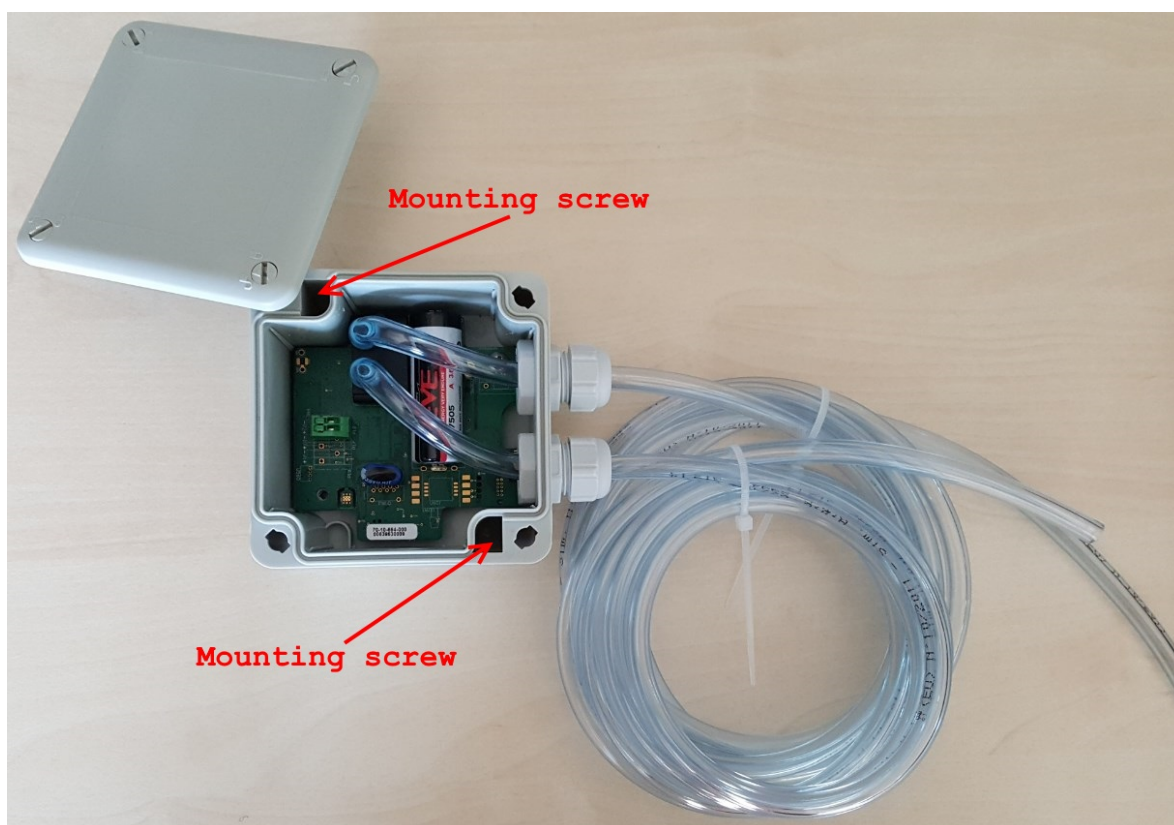


Picture 1 - General view of the sensor

The 2 hoses for the differential pressure measurement are preinstalled on the sensor. You must not alter the connection between these 2 hoses and the sensor. If you purchased a sensor with an S0 input (to monitor a pressure switch), you will have to set up the connection between your cable and the sensor, through the gland at the bottom on the sensor.

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.).

The sensor SHALL be set up under shelter to avoid excessively fast temperature changes (direct sunlight, wind, rainfall, etc.) that may impair the measurement. Fix the sensor using 2 screws (not provided - the 2 holes for the mounting screws are shown in picture 2) on a non-metallic vertical wall. The sensor SHALL be set up vertically with the two hose glands on the right side, as shown in picture 1. This is important because the radiofrequency antenna is optimised to achieve the best performance in that position. The sensor SHALL be kept away from any metallic surface/object, in particular from the ventilation's metal box, which may disrupt the radiofrequency signals.



Picture 2 - Shows the 2 holes for the mounting screws (not provided)

Now, use the mounting kit supplied and shown in picture 3 to set up the 2 hoses.



Picture 3 - Hoses mounting kit: 2 connectors, 2 hose clamps, 4 screws

Plug each hose on the short tip of one connector, secure it with a hose clamp.

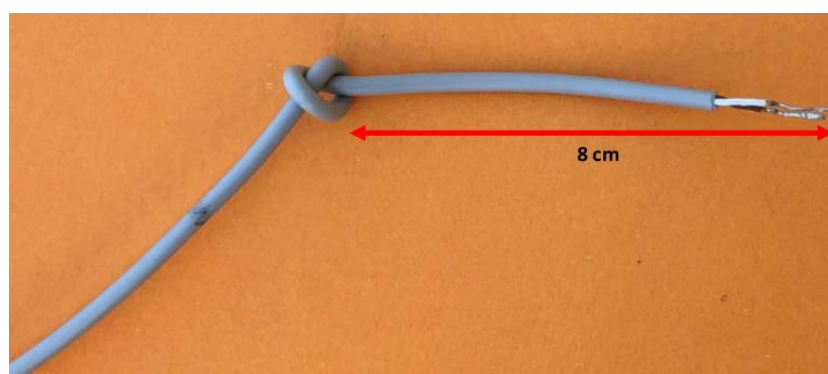
The hoses SHALL go up all the way, from the mounting point to the sensor, and NEVER back down. Otherwise, water condensation might impair the measurement. The hoses SHALL be shorter than 3 metres (the hoses supplied are approximately 2 metres). Cut off any surplus hose.

Drill an 8mm-hole in the upper part of the depressed ventilation pipe (the one to be monitored). Take one of the two connectors and slide its longest part at least 50mm into the hole you have just drilled. Fix it with 2 screws. The hose MUST NOT be pinched or crushed. The finished assembly SHALL be sealed.

Following the same steps, set up the other connector on a case, into the ventilation box, so that it is exposed to atmospheric pressure but in a draft-free location.

[Option 50-70-064-000 Ventil'O sensor with a pulse S0 input]

The cable is not supplied. We recommend using a moulded (to ensure waterproofing) 2-single-wire-threads AWG20 to AWG26 cable, like the one shown in picture 4.



Picture 4 - Example of cable to be used with the S0 input

The cable SHALL be shorter than 3 metres. Connect one end of your cable to the pressure switch to be monitored. At the other end of the cable, we recommend stripping each thread 5mm to 6mm to ensure a good contact. Pass the cable through the M12-gland located at the bottom of the sensor's case. Make a knot 8cm from the end of the cable as shown in picture 4. Connect the 2 stripped threads to the green connector. You should obtain an assembly as shown in picture 5.



Picture 5 - The sensor with an S0 cable set up

Close the lid of the sensor box and lock the 4 quarter turn screws. Their indicator MUST face the locked padlock.

5. OPERATION

5.1. UI components

This sensor includes the following UI components:

- Reed switch (ILS).
- Buzzer.

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 top 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 buzzer emits a short beep every 2 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, a tune is played for approximately 1 second: 2 short tones, the first one is low-pitched and the second middle-pitched, played twice in a row. Then, the sensor is in working mode. The buzzer stays mute.

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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.

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:

Very short, less than one second, 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
- Differential pressure measurement
- Temperature measurement
- Binary input (for the pressure switch input)

Here is an example of how to reconfigure the sensor:

ZCL-like command	Description
115000500203	Configuration cluster: completely removes the existing configuration.
1106800800000029803C803C0000	Differential pressure measurement cluster: reports the Measured value attribute every hour.
1106040200000029803C803C0000	Temperature measurement cluster: reports the Measured value attribute every hour.
1106000F000055108001000001	Binary input: reports the Present value attribute when its value change (boolean) and at a maximum of once every minute.
1106040298000029800A0000B10000003201	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. <ul style="list-style-type: none"> • Threshold: 0x0000 = 0 degree Celsius • Hysteresis: 0x0032 = 50 = 0.5 degree Celsius • Send 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	Temperature measurements cluster: sends a high threshold report when the Measured value exceeds the threshold, and at a maximum of once every 10 minutes. <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.
--	---

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

The measurements of the sensor are transmitted through an applicative communication protocol. The LoRaWAN nke Watteco sensors incorporate two different applicative communication protocols, the “Batch” and the “ZCL-like”. The “Batch” is a nke Watteco proprietary protocol that features compression and aggregation. It is useful if you want the sensor to wait until it has several measurements before transmitting them all together, or if you want to transmit different kinds measurements all together - depending on the sensor’s capabilities/options. The compression algorithm makes it very hard to directly understand the frame’s content. Please refer to “DATA PROCESSING > Decompress Batch reports with br_uncompress”. The “ZCL-like” is a protocol based on the ZCL standard, but with some proprietary differences. Contrary to the Batch, it is much easier to directly read the report frames in order to extract the transmitted data. But each measurement is transmitted separately. Please refer to our documents and website listed in the “REFERENCE DOCUMENTS” section for more information. On this sensor, the default report configuration is described below:

	Reported value (unit)	Report kind (details)
1	Mean differential pressure since last value (Pascal)	Batch (1 record/6hrs, 1 transmission/6hrs)
2	Minimal differential pressure since last value (Pa)	Batch (1 record/6hrs, 1 transmission/6hrs)
3	Maximal differential pressure since last value (Pa)	Batch (1 record/6hrs, 1 transmission/6hrs)
4	Battery voltage (mV)	Batch (1 record/7d, 1 transmission/7d)
5	Differential pressure (Pa)	ZCL-like low/high threshold report when the value falls under/exceeds 90Pa, with a hysteresis of - /+10Pa
6	Differential pressure (Pa)	ZCL-like low/high threshold report when the value falls under/exceeds 400Pa, with a hysteresis of - /+10Pa
7	Battery voltage (mV)	Batch record when the value falls under (low threshold) 3000mV, with a hysteresis of -/+100mV. Does not trigger the transmission of the current Batch. The Batch will be sent as usual and will carry this record, in addition to usual records.

Note: a record corresponds to a measurement of the physical value, temporarily saved for later transmission. It can also be called a sample.

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To summarise the table shown above, the sensor transmits a Batch frame every 6 hours containing 1, 2 and 3. Once a week, the transmitted Batch frame contains also 4 in addition. If the low threshold of the battery voltage is reached, the 12h-transmitted Batch frame will also contain 7. **The first Batch frame is sent 6 hours after the sensor successfully paired with a network.** When the sensor executes a measurement, if a threshold is reached, then a ZCL-like threshold report is immediately transmitted. In addition to these applicative-Batch or ZCL-like frames, the sensor can send void frames. These frames are beacons / heartbeats useful to the network.

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.

Another example with differential pressure: 110A80080000290190

- 0x0A: This is a ZCL-like report
- 0x8008: Differential pressure measurement cluster
- 0x0000: Measured value attribute
- 0x0190: The value of the measurement when the frame was issued. 0x190 = 400Pa.

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 below.

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 (the default configuration does not include a configuration that triggers this kind of frame, but you could configure it yourself): 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)

Another example with differential pressure: 118A8008000029009A98B2

- 0x8A: This is a ZCL-like threshold report
- 0x8008: Differential pressure measurement cluster
- 0x0000: Measured value attribute
- 0x009A: The value of the differential pressure when the frame was issued. 0x9A = 154Pa.

- **0xB2**: This allows this threshold report to be linked to one of the threshold report configurations of the sensor. Here, this is the low threshold report configured on the second slot: this report is sent when the Measured value falls under the Threshold (400Pa) - Hysteresis (10Pa). This byte allows the frame to be construed as an end of alarm of the default's high threshold (400Pa) configuration.

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:

When the sensor is configured with a Batch report, a label is assigned to each Batch report configured. This label is used to identify each value carried in a Batch frame. When building a sensor's configuration from scratch, the labels can be arbitrarily assigned to each measured value to be reported. However, since the sensor has a factory default configuration, and also to enable the sensor to work quickly with public networks (and to avoid having to make some additional configurations on the network interface before the whole installation works), we strongly recommend using the labels defined here:

For this sensor, these parameters are: "3 0, 1, 7 1, 1, 7 2, 1, 7 3, 1, 6 4, 10, 7 5, 1, 7 6, 1, 10 7, 1, 1"

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

Label	Corresponding measured value
0	Mean_differential_pressure_since_last_report
1	Minimum_differential_pressure_since_last_report
2	Maximum_differential_pressure_since_last_report
3	BatteryLevel
4	Temperature
5	Differential_pressure
6	S0_Counter
7	S0_State

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: the 6hr periodic Batch frame of a 50-70-064(101)-000

Here, the frame contains measured values that correspond to what the default configuration would produce. However, for the example, the measurement and transmission frequencies have been reduced. This explains why the timestamps below have low values.

```
$ echo "3607008000f780c3ec01d8b517105900" | ./br_uncompress.exe -a 3 0, 1, 7 1, 1, 7 2, 1, 7 3, 1, 6 4, 10, 7 5, 1, 7 6, 1, 10 7, 1, 1
Scan args:
S00: 0, 1. 000000, 7
```

```

Scan args:
S01: 1, 1.000000, 7
Scan args:
S02: 2, 1.000000, 7
Scan args:
S03: 3, 1.000000, 6
Scan args:
S04: 4, 1.000000, 7
Scan args:
S05: 5, 1.000000, 7
nb_of_type_measure: 3
batch requested: 0
no sample: 1
cnt: 7
tag: 0, index 0 timestamp: 494 Measurement: 391
tag: 1, index 1 bi: 0 sz: 7 timestamp: 494 Measurement: 236
tag: 2, index 2 bi: 0 sz: 7 timestamp: 494 Measurement: 546
TimeStamp of the sending
bi: 1 sz: 5 raw: 0 timestamp: 495

```

DECOMPRESSION SERIES

```

cnt: 7
495
494 0 391

494 1 236

494 2 546

```

In this example, the frame to be decompressed is: 3607008000f780c3ec01d8b517105900

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

```
$ echo "3607008000f780c3ec01d8b517105900" | ./br_uncompress.exe -a 3 0, 1, 7 1, 1, 7 2, 1, 7 3, 1, 6 4, 10, 7 5, 1, 7 6, 1, 10 7, 1, 1
```

The next lines are the result of the frame decompression.

In the last lines, we can observe:

DECOMPRESSION SERIES

```

cnt: 7 Sequence number of this batch (cyclic, form 0 to 7)
495 Timestamp of when the frame was sent
494 0 391 Timestamp, label and value for the sole record for mean differential pressure. P = 391Pa

494 1 236 Timestamp, label and value for the sole record for minimum differential pressure. P = 236Pa

494 2 546 Timestamp, label and value for the sole record for maximum differential pressure. P = 546Pa

```

Timestamps are given in seconds from the start-up of the sensor (timestamp = 0 seconds when the sensor starts up). Each timestamp gives a relative date for an event, like, in the above example, for when the frame was sent or for each record. This is especially useful to give an absolute date to each record when the Batch frame holds several records of the same measured value (depending on the configuration of the sensor).

Here, the timestamp of the frame (when the frame was sent) is 495 seconds. If we make the hypothesis the frame has been immediately received by the network (no disruption), then this timestamp can be linked with the absolute date of reception of the frame (for example, 07/18/2017-17h31m0s corresponds to 495s). Then we can determine an absolute date for every other timestamp (then, for example, 07/18/2017-17h30m59s corresponds to 494s). Furthermore, the timestamp is not reset from one Batch to another, so we could determine an absolute date for previous or subsequent Batch frames (and their included records).

Note that in the case of this default configuration, the relative timestamp is not essential to use the values: there is only one record of each value in one Batch frame, and as the measurements had been completed one second (timestamp = 494 seconds) before the frame was sent, then it is easier to use the (absolute) date of reception of the frame to date each record.

The label (also named tag) identifies the type of measured value. E.g. label 0 identifies the Mean differential pressure.

6.3.4. Example 2: 6hr periodic Batch frame of a 50-70-064(101)-000 including weekly battery voltage

In that example, the Batch frame contains the measured physical values of the 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 "4631000001b30648ec0138b20720d01ea06601" | ./br_uncompress.exe -a 3 0, 1, 7 1, 1, 7 2, 1, 7 3, 1, 6 4, 10, 7
5, 1, 7 6, 1, 10 7, 1, 1
Scan args:
S00: 0, 1.000000, 7
Scan args:
S01: 1, 1.000000, 7
Scan args:
S02: 2, 1.000000, 7
Scan args:
S03: 3, 1.000000, 6
Scan args:
S04: 4, 1.000000, 7
Scan args:
S05: 5, 1.000000, 7
nb_of_type_measure: 4
batch requested: 0
no sample: 1
cnt: 1
tag: 3, index 3 timestamp: 614 Measurement: 3472
tag: 0, index 0 bi: 0 sz: 7 timestamp: 614 Measurement: 28
tag: 1, index 1 bi: 0 sz: 7 timestamp: 614 Measurement: 4
tag: 2, index 2 bi: 0 sz: 7 timestamp: 614 Measurement: 53
TimeStamp of the sending
bi: 1 sz: 5 raw: 0 timestamp: 615

DECOMPRESSION SERIES
cnt: 1
615
614 0 28

614 1 4

614 2 53

614 3 3472
```

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

```
614 3 3472 Timestamp, label and value for the unique record of battery voltage. Up = 3,472V
```