Intens’O

User Guide

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Embedded software is based on Nke Watteco proprietary drivers and applicative code and operates on the Contiki kernel from the SICS (Swedish Institute of Computer Science).

http://www.nke-watteco.com/

DOCUMENT HISTORY

Date	Revision	Modification Description
November 2017	1.0	First revision
23/11/2017	1.1	Add reference to LoRaWAN_Sensors_Application_Layer_Addon_001_V1_~~5~~0.pdf

CONTENTS

1 INTRODUCTION

This document describes the installation and operation of the Intens'O sensor. Please refer to the website http://support.nke-watteco.com/ for all general information about LoRaWAN or the standard nke Watteco application layer and more.

1.1 GENERAL DESCRIPTION

1.1.1 FUNCTIONAL DESCRIPTION

Intens'O allows the detection of AC current intensity passing through a simple conductor. In its standard configuration the sensor is not intended to provide a precise measurement over its full range. Its standard application is the detection of correct behaviour of industrial appliances such as street lighting, escalator, elevator…
The following table shows the main precision values according to the current measured:

Current range	Precision	Notes
0.0 - 0.5A	_*	In standard configuration measuring current less than 500 mA is not possible. Then 0 A is returned. In that case user should multply wire turns in curent transformer.
0.5 - 1A	30%	
1 - 3A	10%	
3 - 17A	2%	
17 - 18A	10%	
18 - 20A	20%	
20 - 30A	30%	
30+ A	_*	

** Upon specific request, the current transformer and standard electronic input can be changed to cope with specific use cases*

Sensor casing is an IP55 box compliant with UL94-V2 flammability standard.

Different functions are available in Intens'O:

Data logger: measures and records at a specific resolution the current measured on periodicity and/ or on variation. Sends all recorded measurements on periodicity in a "batch" report. *By default batch reporting is not set.*

Alarm: possibility to set an alarm on thresholds or variation of current. The measurement is made according to the default reporting configuration. The "standard" report is used for this feature. The **resolution** is **0.1A**. *By default the alarm is set on threshold of crossing threshold rising and falling at 1 ± 0.5 Amps.*

1.1.2 MAIN CHARACTERISTICS

Out of the factory, the sensor works in EU bands (863 to 870 MHz), but it can be configured for other ISM frequency bands (US or others) upon customer demand.

For the EU case, the default radio Tx power is 14 dBm.

The Intens'O sensor is a Class A LoRaWAN sensor. It is powered by a 3.6Ah A-type battery that can only be replaced in factory.

The current transformer is delivered with a 3-metre cable, which allows the sensor casing to be moved in the most efficient radio position around the measurement position.

1.2 INSTALLATION

1.2.1 CURRENT TRANFORMER SETUP

The user must open the current transformer to clip it around a single wire: Phase OR Neutral. Both wires MUST NOT be placed together in the current transformer.

Even if an arrow is present on the current transformer, no particular direction has to be observed.

Make sure the clip firmly grips the wire. A slight "click" must be heard.

1.2.2 CASING FIXATION

At the factory, the casing is fitted with a "dual lock adhesive strip" that makes the sensor easily removable from its support. After sticking the adhesive part to the support, the sticker should not be removed for approximately 48hrs to achieve the best resistance.

Alternatively the casing may be screwed to the support. However, this implies opening the casing and carefully screwing the casing without damaging the electronics inside.

Important: to get the best radio coverage, the box should be fixed to the support in such a way that the stickers are can be read normally/horizontally.

1.2.3 CURRENT TRANSFORMER CONNECTION

The current transformer cable is connected to the sensor through a black connector. It must be simply pushed inward after aligning both white strips. There is no need for rotation.

The installator should take care of fixing the wire of current transformer to avoid any subsequent grabbing.

1.2.4 DEVICE STARTUP

Out of the factory, the sensor is in a special "blocked/deep sleep" mode to reduce battery consumption as much as possible. Hence the operator must wake up the device using a magnet.

The operator must pass the magnet in front of the receptive position for about 3 seconds. During magnet application, the sensor emits a continuous "beep" to signal to the operator that he is in the correct position. After 3 seconds, the sensor will emit a specific "beep sequence" signalling the sensor is awake: two short tones, first low then high pitched.

Then the device emits single beeps at approximately 2-second intervals to signal it is trying to pair with a LoRaWAN infrastructure.

Once paired, the device emits 2 "low then high pitched" tones twice to signal that pairing is complete.

For more information about possible local actions on the sensor, please see §1.3.

IMPORTANT: for successful pairing on a local or global LoRaWAN network, please ensure the device was correctly and effectively charged beforehand. If it is not the case the sensor will stay in pairing mode until it discovers its network. But to save the battery, the pairing attempts will progressively reduce to one every 24 hours.

1.3 MAIN IHM FEATURES

Different actions can be initiated with the magnet or monitored with an audio signal locally on the sensor. The following table is a reminder of the main IHM functionalities.

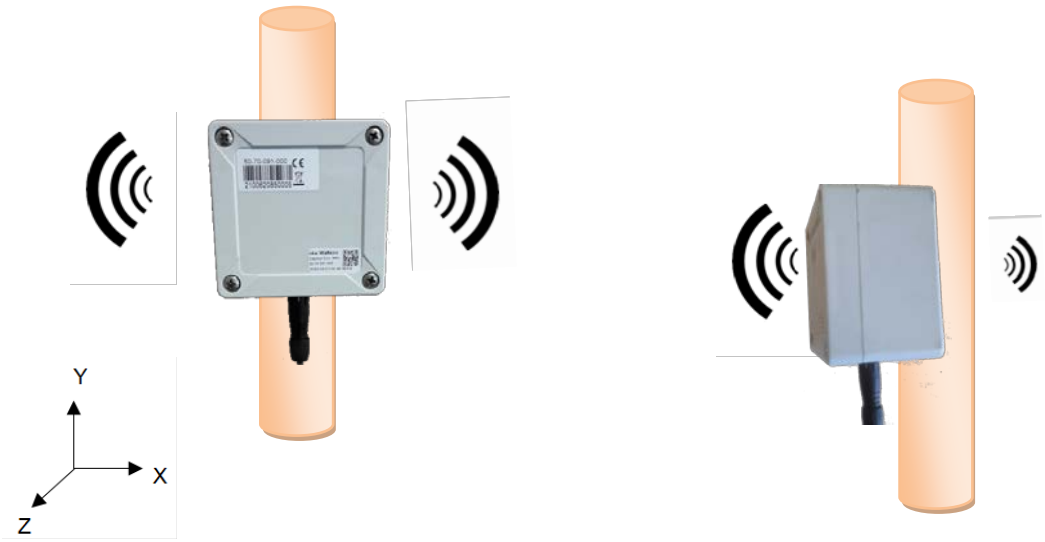
Action	Magnet	Resulting signal	Remarks
Switch ON	2 seconds	2 tones, low then high	Association process starts
Switch OFF	5 seconds	2 tones, high then low	When sensor must be stopped to save battery
New Association	3 times		Association restarts. Allowing to change from ABP to OTAA connection or the opposite
Association ongoing	-	Periodic beeps at 2-second intervals	When pairing is in progress
Association complete	-	Twice 2 tones, low then high	After correct association the sensor does not emit any more sounds
Set or Unset configuration mode	Once short when ON	Periodic beeps at 2-second intervals	Configuration mode started for 10 minutes
Configuration mode	-	Dual beeps at 2-second intervals	Configuration mode running, one uplink sent every minute to allow downlink communication
Factory reset of the sensor	2 short passes + one 7-second stay	3 times 3 beeps	The sensor resets all its current parameters (LoRaWAN and applicative configurations) to the default factory status. Then the sensor restarts its association.
Magnet passes	During pass	Continuous fast beeps	

Make sure you always have a magnet at hand when installing this kind of device. The magnet is the main tool to interact localy with the sensor.

The sensitive part of the sensor is below the cable connector, normally labelled with the name "ILS".

1.4 RADIO PROPAGATION

In order for the sensor to operate correctly, the number of obstacles should be limited in order to avoid excessive radio wave attenuation. It is also important to place the sensor as high as possible. The Intens'O device should be positioned as below to achieve the best radio propagation:



2 APPLICATIVE LAYER

2.1 REFERENCES

It is important to note that the software part of the sensor follows LoRaWAN specifications and nke Watteco Application Layer as described here: http://support.nke-watteco.com. The main Intens'O functionality is decribed at http://support.nke-watteco.com/analog-input-cluster/.

This sensor supports some **new applicative functionalities** that are reminded in chapter §2.3~~2.2.1~~ and fully described in **"LoRaWAN_Sensors_Application_Layer_Addon_001_V1_~~5~~0.pdf"**.

2.2 SUPPORTED CLUSTERS

The Intens'O device is a Class A device. It integrates the following clusters:

Cluster	Endpoint	Cluster name	Managed attributes
0x0000	1 (0x11)	Basic	All
0x0050	1 (0x11)	Configuration	All
0x8004	1 (0x11)	LoRaWAN	All
0x000C	2 (0x31)	Analog Input	All

Notice that only Endpoint No. 2 (0x31) for cluster "Analog Input" is available and manages the current measurement in Amps.

2.3 NEW APPLICATIVE LAYER FUNCTIONALITIES SINCE NOVEMBER 2017

The document **"LoRaWAN_Sensors_Application_Layer_Addon_001_V1_~~5~~0.pdf"** describes complementary functions that are available in the Intens'O sensor.

As a summary here is a list of functions that extend what was available in the "analog" cluster (0x000C), attribute "Present value"(0x0055) since November 2017.

1) Allow management of "thresholds" as standard report trigger; the usual capability of reports triggered by "variation level" remains available

2) Up to 7 distinct criteria can be programmed on a single attribute to trigger a report.

3) Possibility to define a trigger to set an alarm flag on the report.

4) All these triggers can be factory configured or set via downlink frames.

5) Associated to each "Threshold" criteria, it is possible to set a "Gap" around the thresholds to manage "hysteresis". It is also possible to define a number of occurrences for the criteria before they trigger an alarm.

6) It is possible to require that a report contains the "reason(s)" for the report.

7) It is now possible to set the LoRaWAN "confirmed" or "not confirmed" property of the report associated with certain criteria. For example, it allows the transmission of a specific alarm to be secured, even if the global LoRaWAN status is to send only "unconfirmed" frames.

8) Allows the amount of data sent for each standard report to be compressed by configuring a LoRaWAN port different from 125 during report configuration. If done, the report will be sent without the usual mandatory header fully defining the report. I.e. the first 7 bytes of the frame (`<EP>(0x0A|0x8A)<CID><AID><Type>`) will not be sent.

9) Lastly, this version also adds a slight modification to "Batch report" management. The maximum number of bytes used in a batch is now dynamically calculated according to the recommended payload size compared to the currently used LoRa spreading factor.

Please refer to the **"LoRaWAN_Sensors_Application_Layer_Addon_001_V1_~~0~~5.pdf"** for a more detailed description of these new functionalities.

2.4 DEFAULT PARAMETERS

Since November 2017 and as the first use cases was the detection of malfunction of a specific appliance, the default parameters are set this way for the Current value of Analog cluster:

General report configuration

Parameter	Value	Note
Min Report	1 Minute	This will set the measurement period of current
Max Report	2 Hours	Kind of "heartbeat", this parameter forces at least one report every 2 hours
All report secured	No	Any "no alarm" report is sent "unconfirmed"
Secured frame if declared as alarm	Yes	Each time a report is defined as alarm, it is sent "confirmed"
Report cause	Yes	Any triggered criteria is sent with report

A single trigger criteria is programmed this way

Parameter	ID	Value	Note
Threshold	0	1.5A	This threshold is characteristic of a malfunction in the appliance in question
Gap	0	0.5 A	Define an hysteresis between 1 and 2 Amps
Occ	0	3	Number of values over the threshold before triggering a report
Exceed	0	Yes	Report required on rising crossing threshold
Fall	0	Yes	Report required on fallling crossing threshold
Is alarm	0	Yes	This criteria is defined as an alarm

As an example, the corresponding configuration frame is the following one:

```
31 06 000C E8 0055 39 8001 8078 F0 3fc00000 3f000000 03
```

2.5 EXAMPLES

2.5.1 CONFIGURING AN ALARM REPORT

In this example, the user requires the following characteristics:

- Report on standard nke Watteco ZCL port 125 (containing ZCL header)
- Report secured if alarm
- Display short cause as report suffix

- Periodic Min: 5 seconds (this represents the measurement period)
- Periodic Max: 2 minutes (this is a kind of Heartbeat for the cluster, at least one report every 2 minutes)

First criteria slot (No. 0):

- Report with flag alarm on falling threshold: Threshold 2A, Gap 0.5A, 3 Occurences
  In that case the minimum delay after crossing threshold is: 3 * 5s = 15s

Second criteria slot (No. 1):

- Report with flag alarm on rising threshold: Threshold 4A, Gap 0.5A, 4 Occurences
  In that case the minimum delay after crossing threshold is: 4 * 5s = 20s

Resulting configuration frame:

31 06 000c d8 0055 39 0005 8002 b0 40000000 3f000000 03 d1 40800000 3f000000 04

Description:

General frame format: <Ep><Cmd><CID><RP><AID><Type>
<MinR><MaxR><CSD><Val><Gap><Occ><CSD><Val><Gap><Occ>

<EP>: ZCL Endpoint
0x31: Current measurement for Intens'O

<Cmd>: Command
0x06: Configure report

<CID>: Cluster ID
0x000C: Analog input cluster

<RP>: Report params
b0: 0 Not a batch
b1: 0 Normal, on prot 125 using ZCL header
b2: 0 General report not secured "confirmed"
b3: 1 Confirmed if alarm
b5-4: 01 Request short cause
b6: 1 Reserved
b7: 1 New ZCL format
==> 1110 1000 = 0xD8

<AID>: Attribute ID
0x0055: Present value

<Type>: Type of value

0x39: Float Single

<MinR>: Min report
0x0005: 5 seconds

<MaxR>: Max report
0x8002: 2 minutes

<CSD>: Criteria slot descriptor
b2-0: 000 Slot 0
b4-3: 10 on threshold
b5: 1 On fall
b6: 0 Not on exceed
b7: 1 Alarm
==> 1111 0000 = 0xb0

<Val>: Threshold value
0x40000000: 2A (float Single IEE754)

<Gap>: Hysteresis around threshold value (Threshold +/- GAP)
0x3f000000: 0.5 A en (float Single IEE754)

<Occ>: Number of consecutive occurrences before triggering report
0x03: 3 occurrences

<CSD>: Criteria slot descriptor
b2-0: 001 Slot 1
b4-3: 10 On threshold
b5: 0 Not on fall
b6: 1 On exceed
b7: 1 Alarm
==> 1101 0001 = 0xd1

<Val>: Threshold value
0x40000000: 2A (float Single IEE754)

<Gap>: Hysteresis around threshold value (Threshold +/- GAP)
0x3f000000: 0.5A (float single precision IEE754)

<Occ>: Number of consecutive occurrences before triggering report
0x04: 4 occurrences

2.5.2 DECODING A RECEIVED REPORT WITH NEW FUNCTIONNALITIES

Received frame: 31 8A 000C 0055 39 412487D2 D8 D1

General frame format: <EP>(0x0A|0x8A)<CID><AID><Type><Value><RP><CSD>

Decoded reporting frame is:

```
<EP>: Endpoint
  0x31: Intens'O Analog Input endpoint used for current measurement

<Cmd>: Command
  0x8A: The report is an alarm (either it would be 0x0A)

<CID>: Cluster ID
  0x000C: Analog input cluster

<AID>: Attribute ID
  0x0055: Present value

<Type>: Type of value
  0x39: Float single precision

<Value>: Value when report triggered
  0x412487d2 ➔ 10.283159 A

<RP>: Report params:  0xD8: 1110 1000
  b0:   0  Not a batch
  b1:   0  Normal, On port 125 et with header
  b2:   0  Not alarm reports are not secured
  b3:   1  Secured if criteria is an alarm
  b5-4: 01 Request short cause
  b6:   1  Reserved
  b7:   1  New ZCL format

<CSD>: Criteria slot descriptor: 0xD1: 1101 0001
  b2-0: 001 Slot 1
  b4-3: 10  On threshold
  b5:   0   Has not fall
  b6:   1   Has exceed
  b7:   1   Is Alarm
```

3 CONSUMPTION AND AUTONOMY

Transmission periodicity	Measurement periodicity	Battery life*
30 minutes	60 seconds	10 years

* measured at 20°C in SF12