

# SMARTPLUG

# **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).

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# **DOCUMENT HISTORY**

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# 1 INTRODUCTION

This document describes the usage of the SmartPlug device. It is necessary to read the "LoRaWAN Sensors Application Layer Description" for the applicative layer presentation and the "LoRaWAN Sensors Behavior on Public LoRaWAN Networks" for the network layer in prerequisite for all generic information.

# 2 START-UP

The SmartPlug uses the main voltage as a power supply. In order to switch it on, plug it into a wall socket. The SmartPlug will automatically start.

Here below can be seen illustrations of the SmartPlug in the Europe version and in the US version.



FIGURE 1 - SMARTPLUG IN EU VERSION (LEFT) AND US VERSION (RIGHT)

**<u>CAUTION</u>**: This is a device connected to the mains power source, do not open the boxing while the device is running

The SmartPlug remote is not waterproof. Thus, it has to be protected from the water splash and cannot be used in bathrooms.



# 3 USE CASES

### 3.1 FIRST USE: CONTROLLING ELECTRIC DEVICES IN ON/OFF

The direct application for the SmartPlug is to control electrical devices thanks to their electric supplies. Indeed the SmartPlug is plugged inside a wall socket. Then the device to control has to be plugged on the SmartPlug's socket, as it can be seen on the picture here below.



FIGURE 2 - SMARTPLUG IN OFF AND ON STATE WITH AN ELECTRIC DEVICE

Once this quick installation is done, the electric device can be controlled through the LoRaWAN network to be either powered or not. This control is done thanks to the ZCL: the nke Watteco's application layer. More precisely, thanks to the On/Off cluster (*cf. "LoRaWAN Sensors Application Layer Description" document p.22*). The exact frame to send can be found in the paragraph §5.

#### 3.2 SECOND USE: WATCHING THE CONSUMPTION OF ELECTRIC DEVICES

Controlling an electric device in On/Off is, of course, not the only application for the SmartPlug. Indeed, this latter integrate the necessary electronic to measure the power consumption of the electric device plugged on it.

All the measured value can be found iniside the Simple-Metering Like Cluster (*cf. "LoRaWAN Sensors Application Layer Description" document p.29 and 30*). Here below can be seen a table summarizing all the value measured along with their unit.

Measure	Unit
Active Energy	W.h
Reactive Energy	VAR.h
Accumulation duration	Number of sample
Active Power	W
Reactive Power	VAR

**<u>CAUTION</u>**: The maximum power that the SmartPlug can commute is 16 A for the European version and 15 A for the US version. Please be careful to not exceed these limits.

#### 3.3 THIRD USE: WATCHING THE QUALITY OF THE ELECTRICAL MAIN

Finally, the SmartPlug integrates as well the electronic necessary to measure and evaluate the quality of the electrical main where it is plugged to.

In the array here below, are listed the available indicators provided by the SmartPlug to evaluate the quality of the main. These measures are located inside the Power Quality cluster (*cf. "LoRaWAN Sensors Application Layer Description" document p.31 and 32*).

Measure	Measure Description	
Frequency	Current frequency seen by the SmartPlug	(x+22232)(Hz/1000)
Frequency min.	Minimum frequency seen by the SmartPlug	(x+22232)(Hz/1000)
Frequency max.	Maximum frequency seen by the SmartPlug	(x+22232)(Hz/1000)
V <sub>RMS</sub>	Current Root Mean Square Voltage of the main signal (V/10) seen by the SmartPlug	
V <sub>RMS</sub> min.	Minimum Root Mean Square Voltage of the main signal (V/10) seen by the SmartPlug	
V <sub>RMS</sub> max.	Maximum Root Mean Square Voltage of the main signal (V/10) seen by the SmartPlug	
OverVoltageNumber	Counter incremented by the SmartPlug each time a Counter voltage peak exceed the value set by the "Over voltage Threshold" in the Power Quality Cluster	
agNumber Counter incremented by the SmartPlug each time the main voltage is lower than the value set by the "Sag voltage Threshold" for at least the number of half cycle defined by the "Sag cycle Threshold" attribute in the Power Quality Cluster		Counter
BrownoutNumber	nber Counter incremented by the SmartPlug each time this Counter   latter reboot Counter Counter	

# 4 HUMAN MACHINE INTERFACE

One led can be seen on the device (cf. picture in §2). This led can have 3 different colors

- Green: blinking until the association to a network is done.
- Red: *not used for the moment*
- Orange: blinking 3 time on a reset factory

A user button can be seen as well on the picture in the paragraph §2. When the utton is pressed for a long time (7 to 8 second, until the orange led blink), the orange led will blink 3 times and a "Reset Factory" is done. To complete the "Reset Factory" the device needs to be reboot (unplug and plug the SmartPlug will do a correct reboot).

A "Reset Factory" allows to delete all the applicative configurations saved in the device (report configuration, batch configuration, etc.) and to delete some LoRaWAN configurations as the channel masks or the channels added thanks to the NewChannelsReq Mac command.

# 5 APPLICATIVE LAYER

The SmartPlug device is an awake device. It implements the "On/Off" cluster associated with the output controlled by relay, the "Power Quality" cluster and the "Simple-Metering-Like" cluster.

SmartPlug integrated clusters:

Cluster	Cluster name	Managed attributes
0x0000	Basic	All
0x0050	Configuration	All
0x0006	On/Off	All
0x0052	Simple Metering Like	All
0x8052	Power Quality	All

#### 5.1 EXAMPLES

Herebelow are some examples of sending an On/Off order to the SmartPlug or configuring a report or a batch on either the "Simple Metering" Cluster or on the "Power Quality" cluster. If you want more informations about the applicative layer, please refer to the "LoRaWAN Sensors Application Layer Description" document.

In the following examples, the 6lowpan header has been removed for an easier understanding. See 6LOWPAN LAYER OVER LORAWAN<sup>™</sup> in the LoRaWAN Sensors Behavior on Public LoRaWAN Networks guide, for more details.

#### 5.1.1 ON/OFF COMMAND

<u>Specification:</u> Supply or unsupply the electric device plugged on the SmartPlug in electricity.

<u>Solution:</u> As there is only one On/Off output, the End Point is 0 and Cluster "On/Off" is 0x0006. The frame to send to apply the On or the Off is a cluster command from the On/Off cluster.

#### Applicative payload are:

1150000600 Command OFF 1150000601 Command ON 1150000602 Command TOGGLE

#### 5.1.2 CONFIGURE A STANDARD REPORT ON THE POWER QUALITY CLUSTER

<u>Specification:</u> Report all the measures allowing to evaluate the Power Quality (F, Fmin, Fmax, Vrms, Vrms min., Vrms max., Vpeak, Vpeak min., Vpeak max., Over-Voltage Number, Sag. Number and Brownout Number). These values has to be reported at less each 20 minutes and a minimum timing of 1 minute between 2 reports has to be setted. Finally, an increase or a decrease of 10Vrms has to trigger a report. All other delta on the values should not trigger a report.

Solution: As there is only one measurement input, the End Point is 0, cluster "Power Quality" is 0x8052 and attribut "Current" is 0x0000. The maximum field has to be 0x8014 to have a report all 20 minutes and the minimum field has to be 0x8001 to have a minimal timing of 1 min between two reports. All the 0xpppp fields have to be configured to 0x00 in order to not trigger a report except for the Vrms measure, where a delta of 10V should trigger a report, thus the value for dVrms will be 0x0064 (because the unit is V/10).

Applicative payload is:

#### 5.1.3 CONFIGURE A BATCH REPORT ON THE SIMPLE METERING LIKE CLUSTER

<u>Specification:</u> Timestamp and record the Active Energy and the Active Power each time it decrease or increase of respectively 10 W.h and 100 W. A batch has to be sent at least every 3h and at maximum every 10 min. The resolution needed for both of the measure is 1 W.h and 1 W.

Solution: As there is only one measurement input, the End Point is 0, cluster "Simple Metering-Like" is 0x0052 and attribut "Current Metering" is 0x0000. Here, there are two values to record in the batch, the tag size can be 1 (label 0 and label 1 available). For the Active Energy, the delta will be 0x00000A and resolution will be 0x000001. For the Active Power, the delta will be 0x0064 and resolution will be 0x0001.

For both of the measure, the maximum field has to be 0x80B4 to have a report at least every 3 hours and the minimum field has to be 0x800A to have a minimal timing of 10 min between two reports.

Applicative payload is: 110600522D00000800A80B400000A0000010103800A80B40064000109

# 6 APPENDIX

## 6.1 SMARTPLUG FCC LABEL

#### FCC ID: 2AGTV50-70-022

#### SmartPlug SENSOR

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

▲ *Caution:* Changes or modifications not expressly approved by the party responsible for FCC compliance could void the user authority to operate the device. (Cf. FCC Part 15.21).