

4-NOKS ZIGBEE HOME-AUTOMATION SMART PLUG DEVICE (Remote Controlled Socket & Energy meter)

products code:

ZR-PLUG-EU-HA (Schuko plug)
ZR-PLUG-IT-HA (Italian 10/16Amp plug)
ZR-PLUG-UK-HA (UK plug)
ZR-PLUG-FR-HA (French plug)

| Document Version | Compiling Date | Related Firmware Revision | Author |
|------------------|------------------|---------------------------|-------------------|
| V2.1 | 17 February 2015 | V1b159_20150130 | Franco Pierazzoli |

1) GENERAL CHARACTERISTICS

ZR-PLUG-HA is a ZigBee Home Automation compliant SmartPlug (not yet formally certified). It may provide information about the real time active power and the related amount of active energy using the Simple Metering Cluster; ZR-PLUG-HA may also be controlled by using the On/Off Cluster.

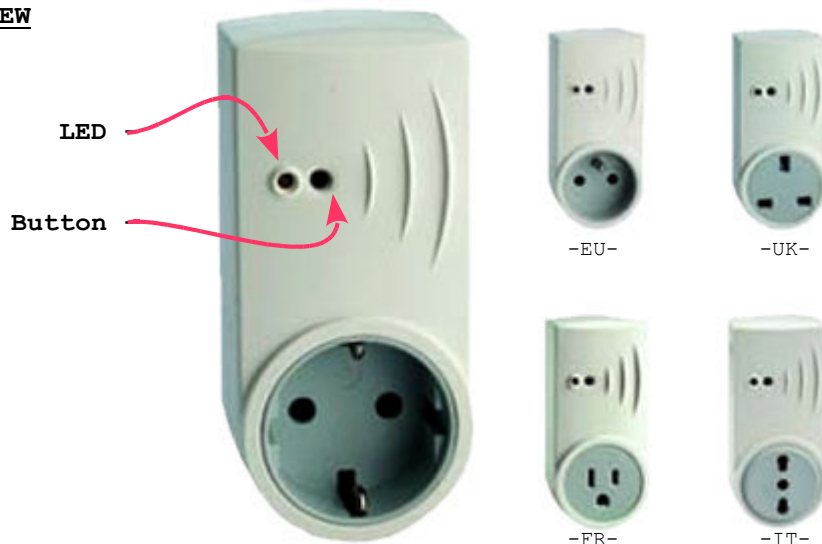
Moreover it has some Manufacturer-Specific extensions of the the Simple Metering Cluster that allow to set a Power threshold below which the device automatically turns off the load (Stand-by-killer function).

The device is a ZigBee Router; it extends the range and the strengthens of its ZigBee network and it can be parent for battery-powered ZigBee HA devices (sleepy-end-devices). The device has a pass-through socket for different country standards (EU, IT, UK, US).

2) ELECTRICAL CHARACTERISTICS

| | |
|--------------------------|--|
| POWER SUPPLY | 90÷250Vac; 50÷60Hz |
| POWER CONSUMPTION | <1W |
| WIRELESS CHARACTERISTICS | 2405 MHz ÷ 2480 MHz DSSS Modulation Nominal transmission Power +3dBm Internal PCB Antenna Chipset Ember/SiliconLabs EM250 Stack EmberZNet5.0.1 IEEE 802.15.4 compliant |
| ZIGBEE PROFILE | Home Automation Profile (HA1.2) Profile ID: 0x0104 End-Point: 1 (=1) Device ID: 0x0051 (Smart Plug) In-Cluster List: 0x0000, 0x0003, 0x0006, 0x0702 Binding Table Size: 10 Reporting Table Size: 10 Child Table Size: 8 |
| MEASURES | Active Energy [Wh] Active Power [W] |
| METERING ACCURACY | <2% 20W ÷ 2500W |
| MAX LOAD CURRENT | - Pure Resistive Load: 10A - Medium Reactive Load: 4A Expected life: 100.000 cycles with resistive load |
| OUTLET | Schuko Plug, French Plug, UK Plug, Italian Plug Schuko Socket, French Socket, UK Socket, Italian Socket |
| OPERATING CONDITIONS | Operating temperature: 0 ÷ +50°C; <80% U.R. not condensing Storage temperature: -20 ÷ +70°C; <80% U.R. not condensing |
| PROTECTION CLASS | IP30 |

3) DEVICE VIEW



4) JOINING NETWORK

If the device is not part of a ZigBee Network (device not joined), a simple press of the device button starts the Joining process (Network Steering).

The Joining process consists in the search for a suitable open network through all the sixteen ZigBee channels; this process lasts less than ten seconds during which the device led blinks green.

If no open ZigBee HA network is found, ZR-PLUG-HA comes back to the not joined state (led blinks red), until another press of the device button restarts the joining process.

If the device finds a proper open network it joins to it; from that moment on, the device will keep being part of that network unless further command to quit the network is performed.

5) LEAVING NETWORK

If the device is part of a ZigBee Network (device joined), press the button for more than ten seconds to quit the network.

6) COMMISSIONING

If device is joined to a network, pressing the button for 3 to 10 seconds will start the EZ-Mode Finding and Binding commissioning process.

During this process, the device activates its own identify state, opens the network and searches for matching end-point in remote identifying nodes.

This process lasts maximum 3 minutes during which the device led blinks alternately red and green.

The process ends earlier if a matching end-point is found, or if another commissioning process is performed through the press of the button.

7) BUTTON INTERFACE

Pressing the button when the device is not Joined:

If the device is not joined, a simple press of the button starts the Joining process.

Pressing the button when the device is Joined:

If the device is joined to a ZigBee Network, the Button press has several effects, depending on the duration of the pressure (the action is performed after leaving the button).

| Network State | Button Pressing Time (seconds) | Led Feedback | Performed Action after button release |
|---------------|--------------------------------|--------------|--|
| Not Joined | Any | Off | Network Joining Attempt |
| Joined | < 3 | Off | Relay Toggle (Behaviour changeable through custom attribute) |
| | 3 ÷ 10 | Green | EZ-Mode Finding and Binding Commissioning Device in Identifying State |
| | 10 ÷ 20 | Red | Network Leave + Restore attribute default + Erase Bindings + Initialize Reports |
| | 20 ÷ 30 | Yellow | As above + Erase energy counters |
| | > 30 | Off | None |

8) LED BEHAVIOURLed Behaviour at Power-Cycle/Reset:

At reset, the Led stays on with yellow light for two seconds, then it blinks yellow for another 2 seconds.

After these first four seconds the Led behaviour depends on the network join state.

Led Behaviour when device is not Joined:

If the device is not joined it blinks red.

During the joining process, the led blinks green.







Led Behaviour when device is Joined:

If the device is joined to a ZigBee Network the Led is steady on and its colour reflects the Relay state.

If the Relay is switched-off (socket unpowered) the Led is steady red.

If the Relay is switched-on (socket powered) the Led is steady green.

During "EZ-Mode Finding and Binding" process the Led blinks red/green.

| Led State | | Device State |
|--|---|---|
| Steady Yellow (for 2 sec.) Flashing Yellow (for 2 sec.) |  | Device Reset (Power-Cycle) |
| Flashing Red |  | Device not Joined |
| Flashing Green |  | Device is searching for a Network (ongoing Joining process) |
| Steady Red |  | Device is part of a ZigBee Network Relay Off - Socket Unpowered |
| Steady Green |  | Device is part of a ZigBee Network Relay On - Socket Powered |
| Flashing Red/Green |  | Device is part of a ZigBee Network EZ-Mode Finding and Binding Commissioning |

9) POWER AND ENERGY MEASUREMENTS

The device measures the real time active power that flows through its socket and the related amount of active energy. This is done only if the Relay is switched-on.

The power measure is issued on attribute "Instantaneous Demand" (Cluster-ID=0x0702, Attribute-ID=0x0400).

The energy amount is issued on attribute "Current Summation Delivered" (Cluster-ID=0x0702, Attribute-ID=0x0000).

The energy amount is stored in non-volatile memory every four hours.

Note that, if the device is in not joined state, its relay is switched-off and, as a consequence, the power/energy measurements are disabled.

10) ZIGBEE DATA AND REFERENCES

The following sections describes some ZigBee characteristics of the device.

More detailed information can be found in the ZigBee Alliance documents quoted in the references.

REFERENCES:

[R1] ZigBee Document 075123r04ZB - ZigBee Cluster Library

[R2] ZigBee Document 05-3520-29 - ZigBee Home Automation Public Application Profile

[R3] ZigBee Document 075356r16ZB - ZigBee Smart Energy Profile Specification

HA.1) END-POINT

The Device has one End-Point (=1).
The Related Device-Id is 0x0051 (SmartPlug).

| Device Name | ZigBee Node Type | End-Point | Device ID | Main Function |
|-------------|------------------|-----------|-----------|---------------|
| ZR-PLUG-HA | Router | 1 | 0x0051 | HA SmartPlug |

HA.2) CLUSTER LIST

The Device has 6 In-Clusters (Server-Side Clusters).
The Device has 1 Out-Cluster (Client-Side Cluster).

| Cluster Name | End-Point | Cluster-ID | Client/Server |
|-----------------|-----------|------------|---------------|
| Basic | 1 | 0x0000 | Server |
| Identify | 1 | 0x0003 | Client/Server |
| On/Off | 1 | 0x0006 | Server |
| Simple Metering | 1 | 0x0702 | Server |

HA.3) DEFAULT REPORTS

The Device has one report set by default.

| Default Reported Attribute | End-Point | Min Interval (seconds) | Max Interval (seconds) | Change Value |
|--|-----------|------------------------|------------------------|--------------|
| Current Summation delivered (Cluster-ID=0x0702, Attribute-ID=0x0000) | 1 | 5 | 60 | 100 Wh |

HA.4) BINDING TABLE SIZE

The Device's Binding Table (non-volatile) has room for 10 entries

HA.5) REPORTING TABLE SIZE

The Device's Reporting Table (non-volatile) has room for 10 entries

HA.6) CHILD TABLE SIZE

The Device can be parent for maximum 8 end-devices.

HA.7) EZ-MODE COMMISSIONING

The Device acts as an EZ-Mode Initiator.

When the EZ-Mode is invoked (by pressing device button for a time between 3 and 10 seconds) it broadcasts to all nodes in the network the Identify Query commands. If it receives an Identify Query response, then it attempts to discover clusters on the responding node.

If it finds a cluster match with Cluster-ID=0x0702, client-side, then it creates a source binding with the corresponding end-point.

See specification [R2]

CL.1) SERVER SIDE CLUSTER DESCRIPTION - BASIC CLUSTER (CLUSTER-ID=0x0000)

Implemented Attributes:

| Attribute-ID | Name | Attribute Type | Range | Access | Attribute Default Value |
|--------------|---------------------|----------------|------------|--------|---|
| 0x0000 | ZCL Version | 0x20 (int8u) | 0x00÷0xFF | R- | 1 |
| 0x0001 | Application Version | 0x20 (int8u) | 0x00÷0xFF | R- | 1 |
| 0x0002 | Stack Version | 0x20 (int8u) | 0x00÷0xFF | R- | 2 (ZigBee Pro) |
| 0x0003 | HW Version | 0x20 (int8u) | 0x00÷0xFF | R- | 1 |
| 0x0004 | Manufacturer Name | 0x42 (String) | 0÷32 bytes | R- | "4-noks s.r.l." |
| 0x0005 | Model Identifier | 0x42 (String) | 0÷32 bytes | R- | "ZR-PLUG-HA" "ZR-PLUG-RB-HA" |
| 0x0006 | Date Code | 0x42 (String) | 0÷16 bytes | R- | Serial number like: "2014111900000123" |
| 0x0007 | Power Source | 0x30 (enum8) | 0x00÷0xFF | R- | 0x01 (Mains) |
| 0x4000 | SW Build ID | 0x42 (String) | 0÷32 bytes | R- | Firmware build like: "V1b151-20141202" |

Commands Received (Client to Server):

| Command-ID | Name |
|------------|---------------------------|
| 0x00 | Reset to Factory Defaults |

CL.2) SERVER SIDE CLUSTER DESCRIPTION - IDENTIFY CLUSTER (CLUSTER-ID=0x0003)

Implemented Attributes:

| Attribute-ID | Name | Attribute Type | Range | Access | Attribute Default Value |
|--------------|---------------|----------------|---------------|--------|-------------------------|
| 0x0000 | Identify Time | 0x21 (int16u) | 0x0000÷0xFFFF | RW | 0 |

Commands Received (Client to Server):

| Command-ID | Name |
|------------|----------------|
| 0x00 | Identify |
| 0x01 | Identify Query |

Commands Generated (Server to Client):

| Command-ID | Name |
|------------|-------------------------|
| 0x00 | Identify Query Response |

See specification [R1]

CL.3) SERVER SIDE CLUSTER DESCRIPTION - ON/OFF CLUSTER (CLUSTER-ID=0x0006)

Implemented Attributes:

| Attribute-ID | Name | Attribute Type | Range | Access | Attribute Default Value |
|--------------|--------|-------------------|-----------|--------|-------------------------|
| 0x0000 | On/Off | 0x10 (boolean) | 0x00÷0x01 | R- | 0 |

Commands Received (Client to Server):

| Command-ID | Name |
|------------|--------|
| 0x00 | Off |
| 0x01 | On |
| 0x02 | Toggle |

See specification [R1]

CL.4) SERVER SIDE CLUSTER DESCRIPTION - SIMPLE METERING CLUSTER (CLUSTER-ID=0x0702)

Implemented Attributes:

| Attribute-ID | Name | Attribute Type | Range | Access | Attribute Default Value |
|--------------|---|-------------------|--|--------|--------------------------|
| 0x0000 | Current Summation Delivered (Active Energy Counter) | 0x25 (int48u) | 0 ÷ 2 ⁴⁸ -1 | R- | 0,000 [KWh] |
| 0x000A | Default Update Period | 0x20 (int8u) | 0x00÷0xFF | R- | 2 Sec |
| 0x0200 | Status | 0x18 (bitmap8) | 0x00÷0xFF | R- | 0 |
| 0x0300 | Unit of Measure | 0x30 (enum8) | 0x00÷0xFF | R- | 0 (KW/KWh) |
| 0x0301 | Multiplier | 0x22 (int24u) | 0 ÷ 2 ²⁴ -1 | R- | 1 |
| 0x0302 | Divisor | 0x22 (int24u) | 0 ÷ 2 ²⁴ -1 | R- | 1000 |
| 0x0303 | Summation Formatting | 0x18 (bitmap8) | 0x00÷0xFF | R- | 227 (=1'1100'011) |
| 0x0304 | Demand Formatting | 0x18 (bitmap8) | 0x00÷0xFF | R- | 227 (=1'1100'011) |
| 0x0306 | Metering Device Type | 0x18 (bitmap8) | 0x00÷0xFF | R- | 0 (Electric Metering) |
| 0x0400 | Instantaneous Demand (Active Power) | 0x2A (int24s) | -(2 ²³ -1) ÷ +(2 ²³ -1) | R- | 0,000 [KW] |

Commands Received (Client to Server): None

See specification [R3]

CC.1) 4-NOKS MANUFACTURER SPECIFIC EXTENSIONS

The device has some manufacturer specific extensions added to the standard ZigBee Clusters by using Manufacturer Specific Commands and Manufacturer Specific Attributes. These functionalities are accessible by using the 4-Noks's Manufacturer Code 0x1071.

CC.2) 4-NOKS SPECIFIC EXTENSIONS - BASIC CLUSTER (CLUSTER-ID=0x0000)

4-Noks Specific Commands Received (Client to Server):

| Command-ID | Name | Payload Size | Payload |
|------------|----------------|--------------|--------------------------|
| 0xFC | 4-NOKS COMMAND | 2 | 1° int16u: Command value |

List of 4-NOKS COMMAND values and their action:

| 4-NOKS COMMAND value | Command Issued |
|----------------------|---|
| 0x1968 | Activate Bootloader (for OTA firmware upgrade) |
| 0x196E | Reload Default Parameters |
| 0x196F | non-volatile memory total initialize |
| 0x1970 | Reset |
| 0x1971 | Disassociation |
| 0x1972 | Disassociation with reload default parameters |
| 0x1973 | Disassociation with non-volatile memory total initialize |
| 0x1975 | Rejoin |
| 0x2100 :- 0x21FF | Change Transmission Power (value in the low byte, from -30 to 8) |

CC.3) 4-NOKS SPECIFIC EXTENSIONS - SIMPLE METERING CLUSTER (CLUSTER-ID=0x0702)

4-Noks Specific Implemented Attributes:

| Attribute-ID | Name | Attribute Type | Range | Access | Attribute Default Value |
|--------------|---------------------------------|------------------|-------------------|--------|-------------------------|
| 0xFC00 | Button Behaviour | 0x20 (int8u) | 0x00÷0xFF | RW | 0 |
| 0xFC01 | Output Change Source | 0x20 (int8u) | 0x00÷0xFF | R- | 0 |
| 0xFC10 | Stand-By-Killer Power Threshold | 0x21 (int16u) | 0x0000÷ 0xFFFF | RW | 0 [W] |
| 0xFC11 | Stand-By-Killer Time | 0x21 (int16u) | 0x0000÷ 0xFFFF | RW | 60 [seconds] |
| 0xFC30 | Calibration Value | 0x21 (int16u) | 0x0000÷ 0xFFFF | R- | ---- |

4-Noks Specific Commands Received (Client to Server):

| Command-ID | Name | Payload Size | Payload |
|------------|--------------------------|--------------|--|
| 0xFC | Set Energy Counter | 7 | 1° int8u: Counter Index = 0x00 then the Energy Counter (int48u) |
| 0xFD | Change Calibration Value | 4 | 1° int16u: Current Calibration Value 2° int16u: New Calibration Value |

Description of Attribute-ID 0xFC00 (Button Behaviour):

This attribute oversees the behaviour of the relays in relation to the pressure of the device's button.

| Attribute-ID 0xFC00 Valid Values | Behaviour of Relay after button pressing |
|-------------------------------------|---|
| 0 | Relay Toggle |
| 1 | Relay switched Off (if on) |
| 2 | Relay switched On (if off) |
| 3 | No action |

Description of Attribute-ID 0xFC01 (Output Change Source):

This attribute gives information about the last Output (Relay) Changing Source.

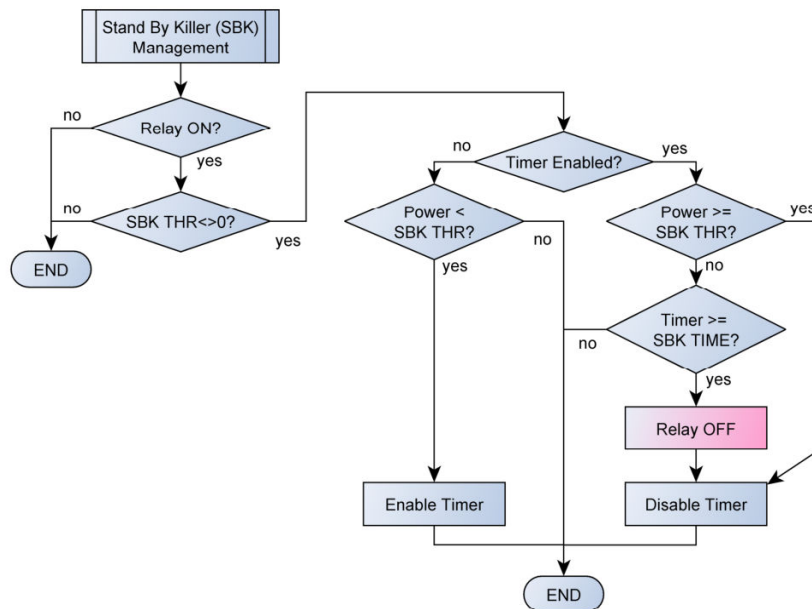
| Attribute-ID 0xFC01 Values | Output (Relay) changing source |
|-------------------------------|-----------------------------------|
| 0 | Remote |
| 1 | Button |
| 2 | Stand-By-Killer |

Stand-By-Killer Management

If attribute 0xFC10 (SBK Threshold) is not zero (zero is the default value) the Stand-By-Killer management is enabled.

In this case, if the Relay is switched on and the power measured by device is under the threshold, after the delay set by the attribute 0xFC11 (SBK Time) the Relay is automatically switched off

If the Relay has been switched-on by button pressing, the operation delay of SBK is instead fixed to 900 seconds (15 minutes).



Stand-By-Killer management flowchart

Description of Attribute-ID 0xFC30 (Calibration Value):

This attribute represent the internal calibration value, set during factory testing.