

## 4-NOKS ZIGBEE HOME-AUTOMATION SMART SWITCH DEVICE (Remote Controlled Switch & Energy meter)

products code:  
ZR-SWITCH-HA

Document Version	Compiling Date	Related Firmware Revision	Author
V2.1	15 April 2015	V1b159_20150130	Franco Pierazzoli

## 1) GENERAL CHARACTERISTICS

ZR-SWITCH-HA is a ZigBee Home Automation compliant wall mounted radio controlled switch with mono-phase energy meter (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-SWITCH-HA may also be controlled by using the On/Off Cluster.

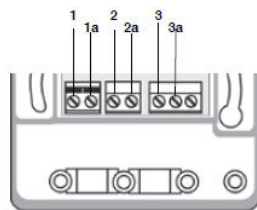
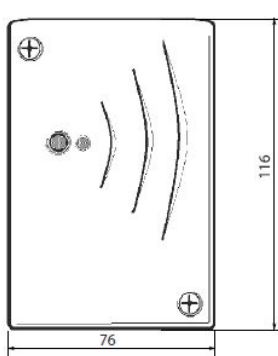
Moreover it has some Manufacturer-Specific extensions of the the Simple Metering Cluster that allow to set a Power threshold below which the device automatically turns off the load (Stand-by-killer function).

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).

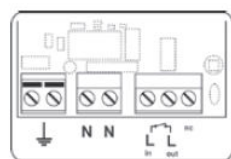
## 2) ELECTRICAL CHARACTERISTICS

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
CONNECTIONS	Terminal Blocks
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

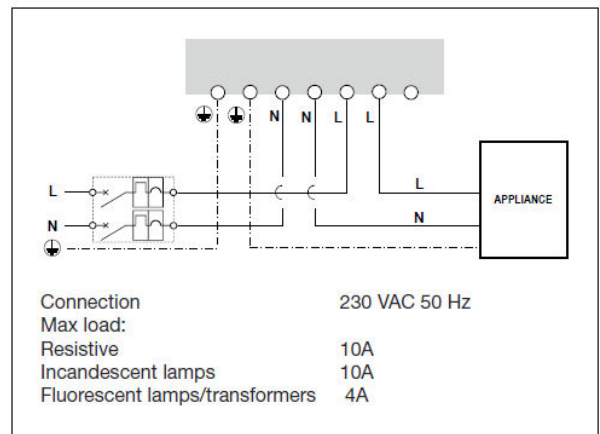
## 3) DEVICE VIEW



Connection  
1 GROUND  
2 NEUTRAL (N)  
3 LINE (L)



Load Connection  
1a GROUND  
2a NEUTRAL (N)  
3a LINE (L)



**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-SWITCH-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 BEHAVIOUR**Led 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-SWITCH-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-SWITCH-HA" "ZR-SWITCH-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: "V1b159-20150130"

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 <b>(Active Energy Counter)</b>	0x25 (int48u)	0 ÷ 2 <sup>48</sup> -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 <sup>24</sup> -1	R-	1
0x0302	Divisor	0x22 (int24u)	0 ÷ 2 <sup>24</sup> -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 <b>(Active Power)</b>	0x2A (int24s)	-(2 <sup>23</sup> -1) ÷ +(2 <sup>23</sup> -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.

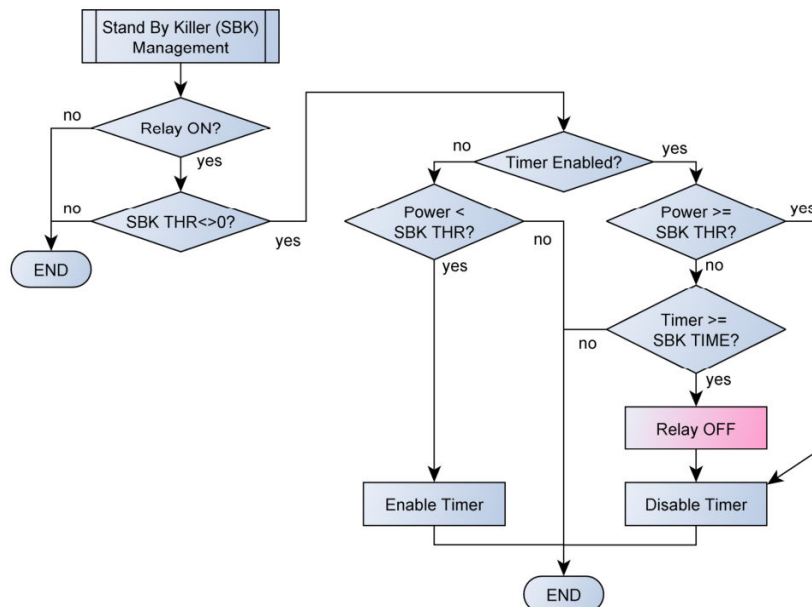
Attribute-ID 0xFC01 Values	Output (Relay) changing source
0	Remote
1	Button
2	Stand-By-Killer

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.