USER MANUAL V1.0

Pushbutton Transmitter Device
PTM 215 ZGPGP

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US 7,019,241
Further patents pending

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REVISION HISTORY

The following major modifications and improvements have been made to the first version of this document:

No	Major Changes
1.0	Initial Release

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Important!

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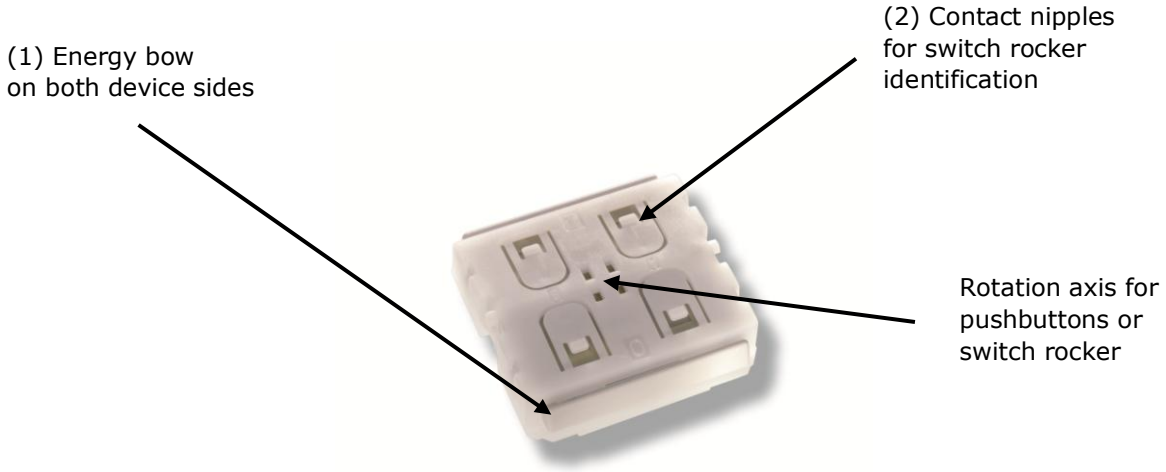
The devices must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.
Components of the devices are considered and should be disposed of as hazardous waste. Local government regulations are to be observed.
Packing: Please use the recycling operators known to you. By agreement we will take packing material back if it is sorted. You must bear the costs of transport. For packing material that is returned to us unsorted or that we are not obliged to accept, we shall have to invoice you for any costs incurred.

TABLE OF CONTENT

1 GENERAL DESCRIPTION

The radio transmitter device PTM 215ZGP from EnOcean enables the implementation of wireless remote controls without batteries. Power is provided by a built-in electro-dynamic power generator. The PTM 215ZGP device transmits data based on the 2.4GHz ZigBee Green Power standard.

The outer appearance of PTM 215ZGP is shown on the picture below.



Electro-dynamic powered radio transmitter device PTM 215ZGP

1.1 Basic Functionality

PTM 215ZGP devices contain an electro-dynamic energy transducer which is actuated by a bow (1). This bow is pushed by an appropriate push button, switch rocker or a similar construction mounted onto the device. An internal spring will release the energy bow as soon as it is not pushed down anymore.

When the energy bow is pushed down, electrical energy is created and a ZigBee Green Power radio telegram is transmitted. Releasing the energy bow similarly generates energy which is used to transmit a different ZigBee Green Power radio telegram. It is therefore possible to distinguish between radio telegrams sent when the energy bar was pushed and radio telegrams sent when the energy bar was released.

By identifying these different telegrams types and measuring the time between pushing and releasing of the energy bar, it is possible to distinguish between "Long" and "Short" push button presses. This enables simple implementation of applications such as dimming control or blinds control including slat action.

The PTM 215ZGP radio telegram identifies the status (pressed or not pressed) of the four contact nipples (2) when the energy bow was pushed or released. This enables the implementation of up to two switch rockers or up to four push buttons.

1.2 Typical Applications

Typical applications are found in the following areas:

- Building installation
- Consumer electronics
- Light and door switches

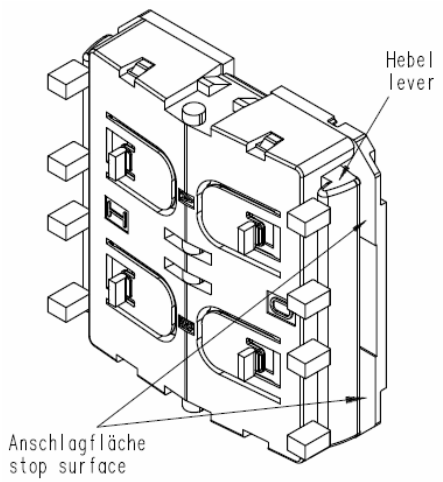
Key products include wall-mounted switches and handheld remote controls supporting up to two rockers or up to four pushbuttons.
PTM 215ZGP pushbutton transmitters are self-powered (no batteries) and therefore maintenance-free. They can be used in hermetically sealed systems or in remote (not easily accessible) locations.

1.3 Technical Data

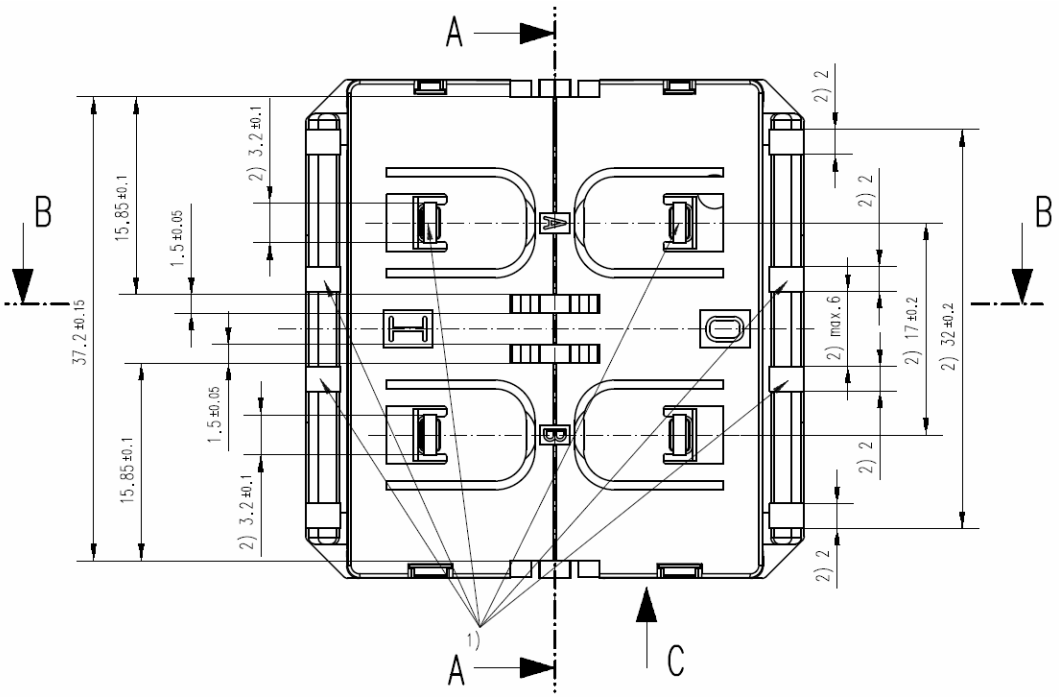
Power supply	Internal electro-dynamic power generator actuated by the energy bow
Antenna	Internal PCB antenna
Frequency	2.4GHz / IEEE 802.15.4 channels 11 … 26 (User selectable during commissioning)
Data rate	250 kbps (according to IEEE 802.15.4 standard)
Conducted output power	typ. 0dBm
Button inputs	Up to four buttons
ZigBee Device ID	0x02 (ZigBee on / off switch)
Security mode	Unique device security key
Transmission range	typ. 175 m free field / 20 m indoor
Device identifier	Individual 32-bit ZGPD SrcId (factory programmed)

1.4 Mechanical Interface

Device dimensions (inclusive rotation axis and energy bow)	40.0 x 40.0 x 11.2 mm
Device weight	20 g ± 1 g
Energy bow travel / operating force	1.8 mm / typ. 8 N At room temperature Only one of the two energy bows may be actuated at the same time!
Restoring force at energy bow	typ. 0.7 N to 4 N Minimum restoring force of 0.5 N is required for correct operation
Number of operations at 25°C	typ. 100.000 actuations tested according to VDE 0632 / EN 60669
Cover material	Hostaform (POM)
Energy bow material	PBT (50% GV)

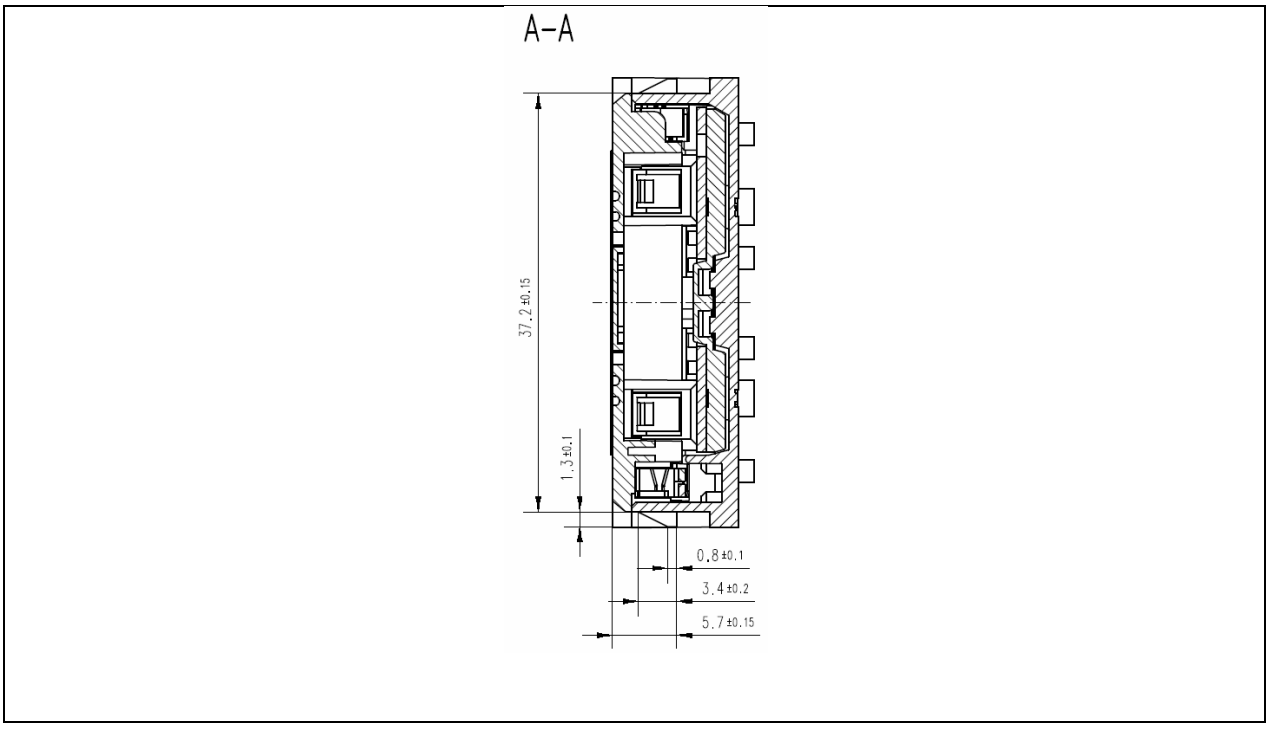


PTM 215ZGP without antenna, tilted view (including rocker catwalks)

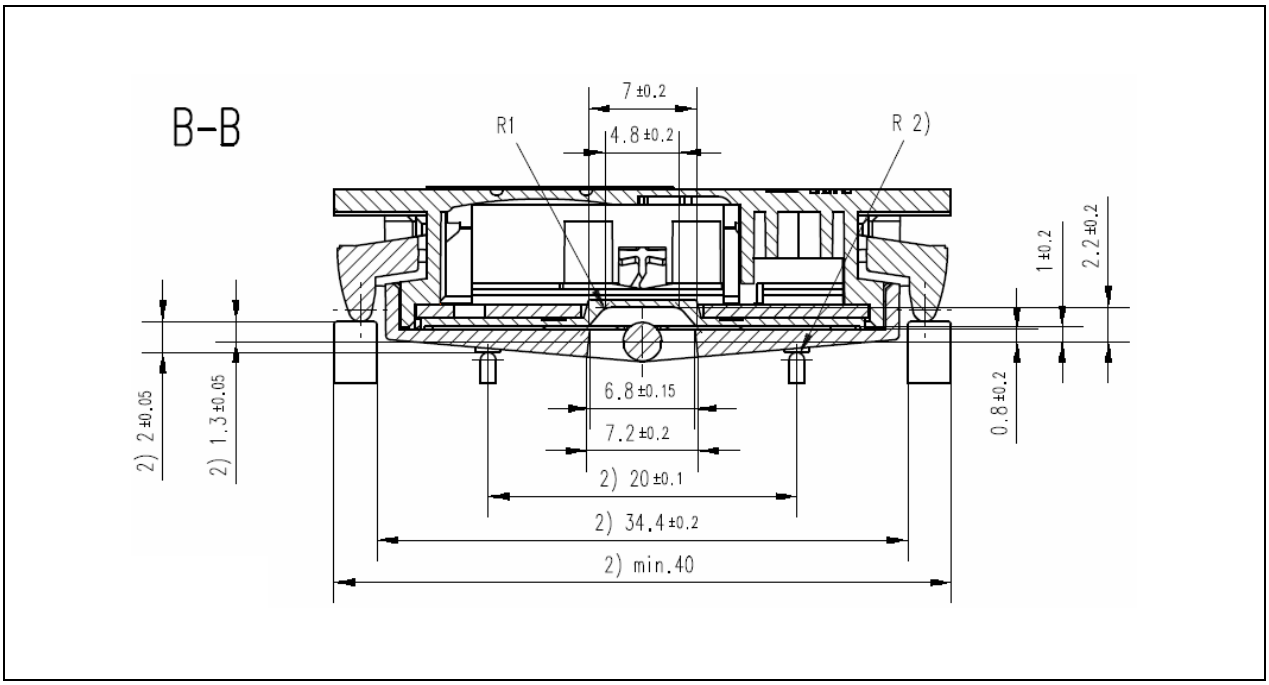


1) these catwalks are not needed when using one single rocker only 2) dimensions of rocker part

PTM 215ZGP, top view (note cut A, B and C marking)

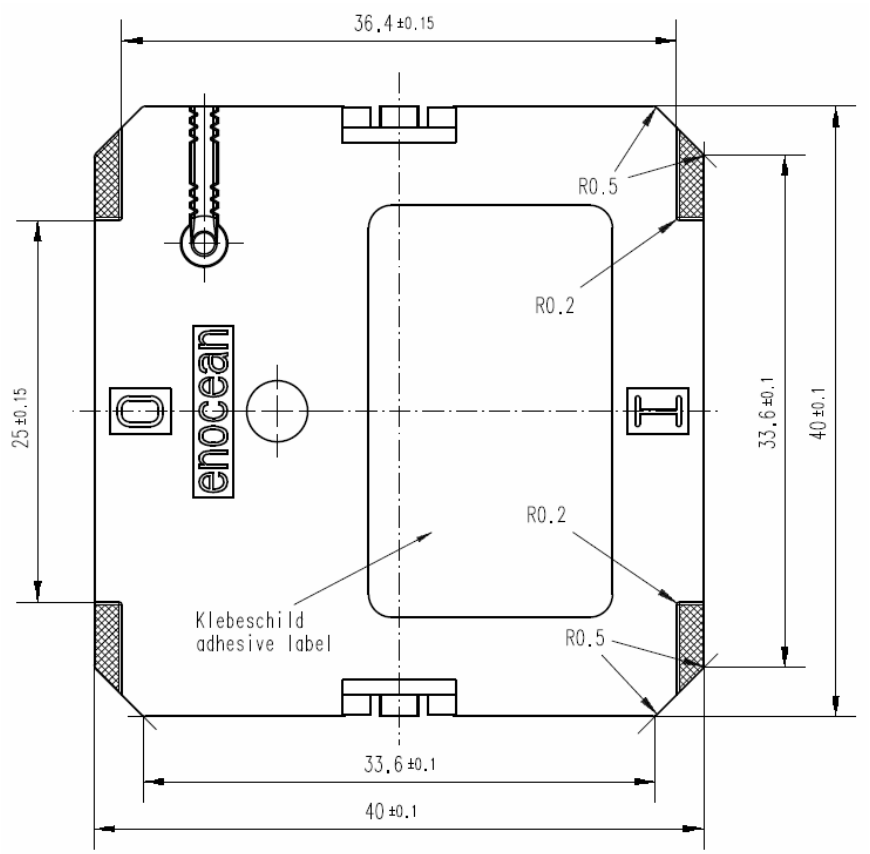


PTM 215ZGP, cut A



2) dimensions of rocker part

PTM 215ZGP, cut B and C



Hatched areas: support planes

PTM 215ZGP rear view

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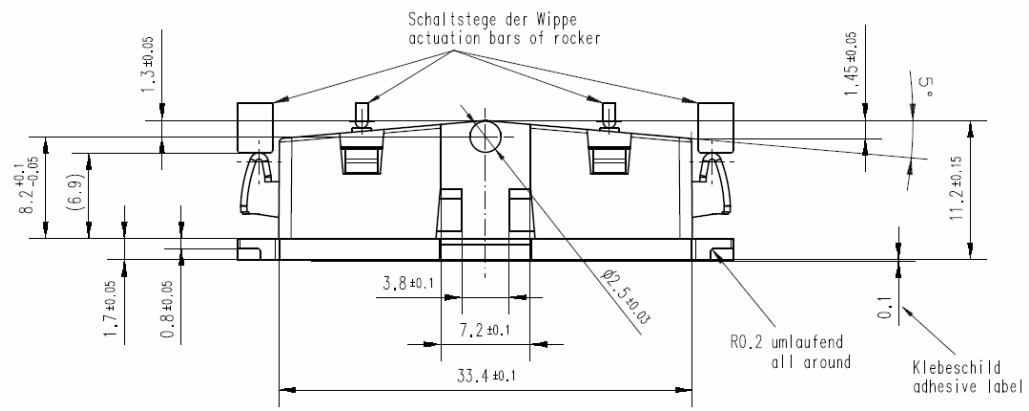

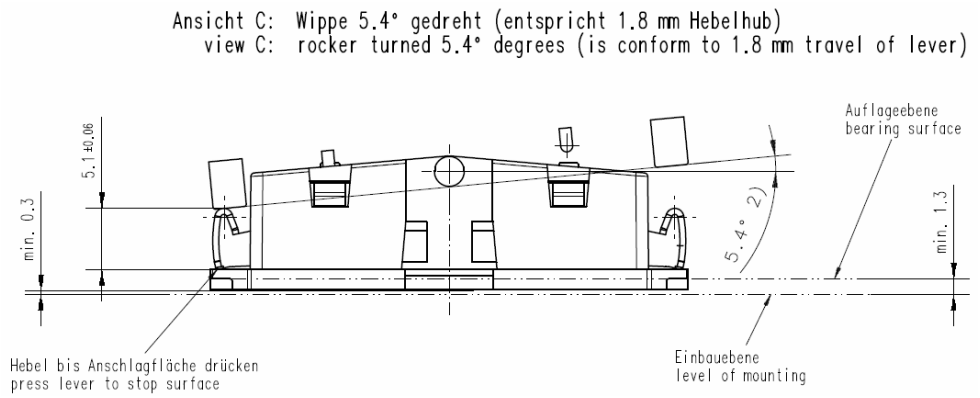

2) dimensions of rocker part

PTM 215ZGP, side view

If the rocker is not mounted on the rotation axis of PTM 215 ZGP several tolerances have to be considered! The measure from support plane to top of the energy bow is 7.70 mm +/- 0.3 mm!

The movement of the energy bow must not be limited by mounted rockers!

Catwalks of the switch rocker must not exert continuous forces on contact nipples!

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1.5 Environmental Conditions

Operating temperature	-5 °C up to +45 °C
Storage temperature	-25 °C up to +65 °C
Humidity	0% to 95% r.h., non-condensing

1.6 Ordering Information

Type	Ordering Code
PTM 215ZGP	**S3171-A215**

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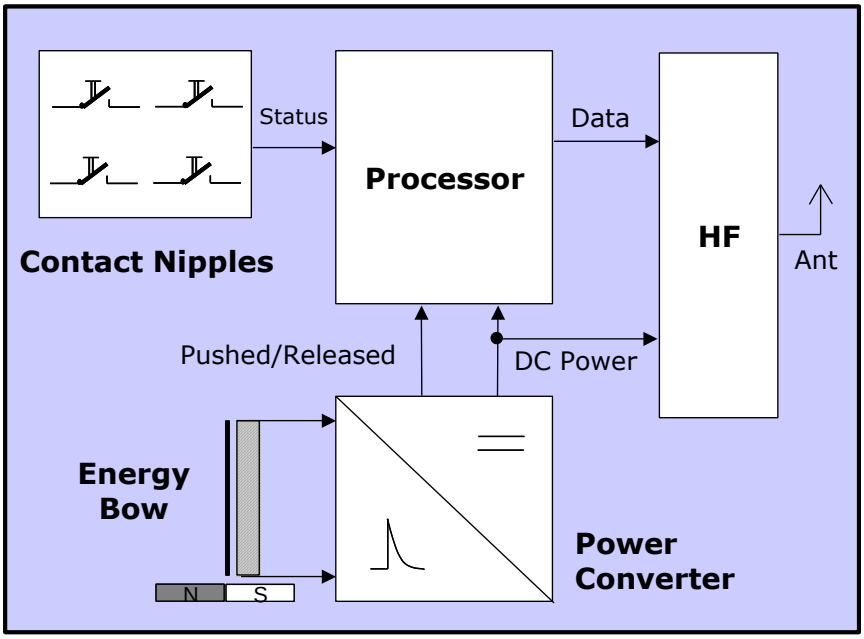
2 FUNCTIONAL DESCRIPTION

2.1 Block Diagram



Block diagram of PTM 215ZGP

Energy Bow / Power Generator
Converts the motion of the energy bow into electrical energy.

Power Converter
Converts the energy of the power generator into a stable DC supply voltage for the device electronics.

Processor
Determines the status of the contact nipples and the energy bow, encodes this status into a data word, generates the proper radio telegram structure and sends it to the radio transmitter.

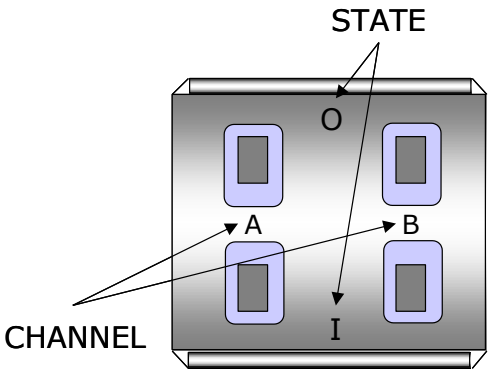
Radio transmitter
Transmits the data in the form of a series of short ZigBee Green Power radio telegrams.

2.2 Contact Nipples Designation

PTM 215ZGP devices provide four contact nipples. They are grouped into two channels (Channel A and Channel B) each containing two contact nipples (State O and State I).

The state of all four contact nipples (pressed or not pressed) is transmitted together with a unique device identification (fixed 32-bit ZGPD SrcId) whenever the energy bow is pushed or released.

The picture below shows the arrangement of the four nipples and their designation:



Contact nipple designation

2.3 Operating modes

PTM 215ZGP supports three operating modes:

- Out of the box mode
  This is the initial operation mode before PTM 215ZGP has sent a commissioning telegram.

- Normal mode
  This is the normal operation mode of PTM 215ZGP.
  In this mode, data telegrams are sent according to the button(s) pressed.
  The data telegrams are authenticated using the device security key.

- Commissioning mode
  In this mode, the Radio channel can be changed according to user input and a "Commissioning" telegram is transmitted in order to commission PTM 215ZGP into an existing network.

These three operation modes are outlined in more detail in the following chapters.

2.3.1 Out of the Box Mode

PTM 215ZGP operates in "Out of the Box" mode before it has joined an existing network for the first time via the transmission of a Join request. In this mode, PTM 215ZGP can therefore only communicate without security measures.

The following correspondence between button event and data payload is implemented:

Button Event	Event Type	Command
NONE	Energy Bar only	-
A0	Press Long release (>8s) Release	0x10 (SCENE 0) Decommissioning 0x14 (SCENE 4)
A1	Press Long release (>8s) Release	0x12 (SCENE 2) Commissioning 0x16 (SCENE 6)
B0	Press Release	0x11 (SCENE 1) 0x15 (SCENE 5)
B1	Press Release	0x13 (SCENE 3) 0x17 (SCENE 7)
A0 and B0	Press Release	0x21 (ON) -
A1 and B1	Press Release	0x20 (OFF) -

2.3.1.1 Security Parameters

In Out of the Box mode, PTM 215ZGP transmits data without specific security mechanisms. The Auto-Commissioning flag is set to 0b1 in this mode for all button actions except the press of button A1 where it is set to 0b0.

2.3.2 Normal Mode

In normal mode, PTM 215ZGP transmits secure data telegrams reflecting the state of the four device buttons whenever the energy bar is pressed or released. The state of the four buttons is encoded in one data byte of payload.

The data telegrams sent when the energy bar is pressed are different from the ones sent when the energy bar is released.

The following correspondence between button event and data payload is implemented:

Button Event	Event Type	Command
NONE	Energy Bar only	-
A0	Press Long release (>8s) Release	0x10 (SCENE 0) Decommissioning 0x14 (SCENE 4)
A1	Press Long release (>8s) Release	0x12 (SCENE 2) Commissioning 0x16 (SCENE 6)
B0	Press Release	0x11 (SCENE 1) 0x15 (SCENE 5)
B1	Press Release	0x13 (SCENE 3) 0x17 (SCENE 7)
A0 and B0	Press Release	0x21 (ON) -
A1 and B1	Press Release	0x20 (OFF) -

2.3.2.1 Security Parameters

In normal mode, PTM 215ZGP transmits data in secured format in accordance with the ZigBee Green Power Specification Revision 23, Version 1.0 using the following security parameters:

- *zgpSecurityLevel* is 0b10
  Full 4Byte frame counter and full 4Byte MIC

- *zgpSecurityKeyType* is 0b100
  Out of the box ZGPD Key

Each PTM 215ZGP device contains its own unique and random security key. This key will be transmitted to the host system in the Commissioning request which is described in the following chapter.

2.3.3 Commissioning Mode

In order to join an existing ZigBee Green Power compliant network, PTM 215ZGP devices need to be configured for the correct radio channel and subsequently issue a properly formatted Commissioning Request outlining its device and security parameters. The combination of these tasks is referred to as "Commissioning".

2.3.3.1 Radio Channel Selection

PTM 215 ZGP devices support sixteen radio channels in the 2.4GHz according to the IEEE 802.15.4 standard. These radio channels are referred to as channels 11 … 26, with the default radio channel of PTM 215ZGP being channel 15.

The radio channel can be changed and a Join request can be sent using a dedicated mode, the so-called "Commissioning Mode".

Entry into Commissioning Mode is triggered by pressing and holding button A1 for more than 8 seconds before releasing it. Upon detecting such event, PTM 215ZGP will enter Commissioning Mode and send a Commissioning request on the current radio channel.

The radio channel can be incremented by the user by pressing button A1 until the right radio channel has been reached. If the current radio channel is channel 26, then pressing button A1 will update the radio channel to channel 11.

PTM 215ZGP will send a Commissioning request every time the radio channel is incremented.

The Commissioning mode can be exit by the user once the correct radio channel has been reached and the Commissioning request was accepted. Exit from Commissioning mode is triggered by pressing button A0.

2.3.3.2 Commissioning Request

Whenever a radio channel is selected in accordance to 2.3.3.1, PTM 215ZGP will issue a Commissioning request. This Commissioning request will be sent as broadcast (destination ID 0xFFFF) on the selected channel.

The Commissioning request will identify the PTM 215ZGP device as ZigBee on / off switch (device ID 0x02) and contain the unique ZGPD SrcId as well as the unique device security key encoded with the ZigBee Trust Center Link Key.

2.4 Construction of application specific Switch Rockers

For CAD system development support, 3D construction data is available from EnOcean (IGS data). Using this data, the mechanical interface is fixed, and the shape and surface of the rocker(s) can be changed according to requirements.
Polycarbonate is recommended as rocker material since it is both buckling resistant and wear-proof. It is also recommended to apply Teflon varnish in the areas of actuation.

It is recommended using non-conductive material for the rockers to ensure best transmission range. Avoid if possible metallic materials or plastics with conducting ingredients such as graphite.

2.5 Device Mounting

For mounting the PTM 215ZGP device into an application specific case, the package outline drawings of the device are given in chapter 1.4.
More detailed 3D construction data is available from EnOcean in IGS format.

It is recommended not to mount the device directly onto metal surfaces or into metal frames since this can lead to significant loss of transmission range.

2.6 Regulatory Notes

PTM 215ZGP has been certified according to applicable regulations.
Changes or modifications not expressly approved by EnOcean could void the user's authority to operate the equipment.

2.6.1 FCC (United States) Regulatory Statement

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.

2.6.2 IC (Industry Canada) Regulatory Statement

This device complies with Industry Canada licence-exempt RSS standard(s).
Operation is subject to the following two conditions:

(1) this device may not cause interference, and

(2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.
L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.”

3 Transmission Range

The main factors that influence the system transmission range are:

- Type and location of the antennas of receiver and transmitter
- Type of terrain and degree of obstruction of the link path
- Sources of interference affecting the receiver
- "Dead spots" caused by signal reflections from nearby conductive objects.

Since the expected transmission range strongly depends on this system conditions, range tests should always be performed to determine the reliably achievable range under the given conditions.

The following figures should be treated as a rough guide only:

- Line-of-sight connections
  Typically 20 m range in corridors, up to 75 m in halls

- Plasterboard walls / dry wood
  Typically 20 m range, through max. 3 walls

- Ferro concrete walls / ceilings
  Typically 7 m range, through max. 1 ceiling

- Fire-safety walls, elevator shafts, staircases and similar areas should be considered as shielded

The angle at which the transmitted signal hits the wall is very important. The effective wall thickness – and with it the signal attenuation – varies according to this angle. Signals should be transmitted as directly as possible through the wall. Wall niches should be avoided.

Other factors restricting transmission range include:

- Switch mounting on metal surfaces (up to 30% loss of transmission range)
- Hollow lightweight walls filled with insulating wool on metal foil
- False ceilings with panels of metal or carbon fibre
- Lead glass or glass with metal coating, steel furniture

The distance between the receiver and other transmitting devices such as computers, audio and video equipment that also emit high-frequency signals should be at least 0.5 m.