

EnOcean switch mesh proxy server

Application note

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1. Introduction

The EnOcean switch is an energy harvesting wireless switch that communicates using the Bluetooth Low Energy (BLE) radio standard.

The EnOcean switch mesh proxy server is a software that translates the proprietary EnOcean's protocol to standardized Bluetooth mesh messages.

For EnOcean switch details, see the [EnOcean PTM 216B Bluetooth® Pushbutton Transmitter Module user manual](#).

2. Definition

The EnOcean switch proxy server translates the EnOcean switch data telegrams to Bluetooth mesh messages.

2.1 Model state

The EnOcean switch mesh proxy server model uses the Configuration state.

2.1.1 Configuration state

This state has two substates.

2.1.1.1 Security key state

The Security Key state is a 16-octet-long AES key used in AES-CCM computation.

The 0x00000000000000000000000000000000 and the 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF values are not allowed and setting them results in Status 0x01 (Configuration not set).

2.1.1.2 Source address state

The Source Address state is the Bluetooth device (BD) address of the EnOcean switch (it is called Static Source Address in EnOcean's documentation).

The default value is unset.

2.2 Model messages

EnOcean switch mesh proxy server model messages are used to configure the behavior of an EnOcean switch mesh proxy server node.

The following table lists the OpCodes and SubOpCodes of the EnOcean switch proxy server mesh model messages:

Message	OpCode	SubOpCode
ENOCEAN_PROXY_CONFIGURATION_GET	0xF43601	0x00
ENOCEAN_PROXY_CONFIGURATION_SET	0xF43601	0x01
ENOCEAN_PROXY_CONFIGURATION_DELETE	0xF43601	0x02
ENOCEAN_PROXY_CONFIGURATION_STATUS	0xF43601	0x03

2.2.1 ENOCEAN_PROXY_CONFIGURATION_GET

ENOCEAN_PROXY_CONFIGURATION_GET is a reliable message used to report the current Configuration state.

The response to the ENOCEAN_PROXY_CONFIGURATION_GET message is an

ENOCEAN_PROXY_CONFIGURATION_STATUS message. This message has no parameters.

2.2.2 ENOCEAN_PROXY_CONFIGURATION_SET

ENOCEAN_PROXY_CONFIGURATION_SET is a reliable message used to set the Configuration state. The response to the ENOCEAN_PROXY_CONFIGURATION_SET message is an ENOCEAN_PROXY_CONFIGURATION_STATUS message.

Field	Size	Description
Security Key	16	New value of the Security Key state.
Source Address	6	New value of the Source Address state.

2.2.3 ENOCEAN_PROXY_CONFIGURATION_DELETE

ENOCEAN_PROXY_CONFIGURATION_DELETE is a reliable message used to clear the current Configuration state. The response to the ENOCEAN_PROXY_CONFIGURATION_DELETE message is an ENOCEAN_PROXY_CONFIGURATION_STATUS message. This message has no parameters.

2.2.4 ENOCEAN_PROXY_CONFIGURATION_STATUS

ENOCEAN_PROXY_CONFIGURATION_STATUS is an unreliable message used to report the status of the operation on the Configuration state.

Field	Size	Description
Status	1	Status code for the requesting message.
Source Address	6	Current value of the Source Address state (optional).

The Status field reports the current EnOcean switch mesh proxy server Status code of the node as defined in the following table:

Value	Description
0x00	Success.
0x01	Configuration not set.
0x02	Unspecified error.
0x03 – 0xFF	Reserved for future use.

The Source Address field is present in the message when the Source Address state is set and the Status field is equal to Success; otherwise the Source Address field is not present.

2.3 Model description

This model is a root model.

The application-layer security on the model uses application keys.

This model shall support model subscription defined in Section 4.2.3 of the Mesh Profile specification.

The Model ID is a Vendor Model ID: Company ID is 0x0136 and vendor-assigned Model identifier is 0x0001.

2.3.1 Behavior

The specific behaviors are defined in the following sections.

When an Element receives a message with a parameter set to the value described as “Not allowed” it shall ignore the message.

When an Element receives a message with a bit set to one in the fields described as RFU, it shall process the message ignoring the value of the field described as RFU.

When an Element receives a message with parameters length set to different than specified size it shall ignore the message.

2.3.2 Configuration state

When an Element receives an ENOCEAN_PROXY_CONFIGURATION_GET message it shall respond with an ENOCEAN_PROXY_CONFIGURATION_STATUS message. If the Source Address state is set, the Source Address field shall be set to the current Source Address state and the Status field shall be set to 0x00 (Success). If the Source Address state is not set, the Source Address field shall be omitted and the Status field shall be set to 0x01 (Configuration not set).

When an Element receives an ENOCEAN_PROXY_CONFIGURATION_SET message that is successfully processed (i.e., it does not result in any error conditions listed in the following table), it shall set the Source Address state to the Source Address field, the Security Key state to the value of Security Key field, and respond with an ENOCEAN_PROXY_CONFIGURATION_STATUS message with the Source Address field set to the current Source Address state and the Status field set to 0x00 (Success).

When an Element receives an ENOCEAN_PROXY_CONFIGURATION_SET message that is not successfully processed (i.e., it results in any error conditions listed in the following table), it shall respond with an ENOCEAN_PROXY_CONFIGURATION_STATUS message with the Status field set to Status code value. If the Source Address state is set, the Source Address field shall be set to the current Source Address state; otherwise the Source Address field shall be omitted.

Error condition	Status code
The Security Key field value is not allowed	Configuration not set
The Security Key state and the Source Address state is not set	Configuration not set
The new state values cannot be stored or any other internal error	Unspecified error

When an Element receives an ENOCEAN_PROXY_CONFIGURATION_DELETE message, it shall unset the Security Key state and Source Address states and respond with an ENOCEAN_PROXY_CONFIGURATION_STATUS message with Status field set to 0x01 (Configuration not set) and omit the Source Address field.

3. Behavior

The EnOcean Switch Mesh Proxy Server model uses two elements – element A and element B. Each element handles a pair of buttons. Each element has a Generic OnOff Client and a Generic Level Client. Each Generic OnOff Client or Generic Level Client can be configured independently to publish messages. Element B has a mesh element address that is one bigger than the mesh address of element A.

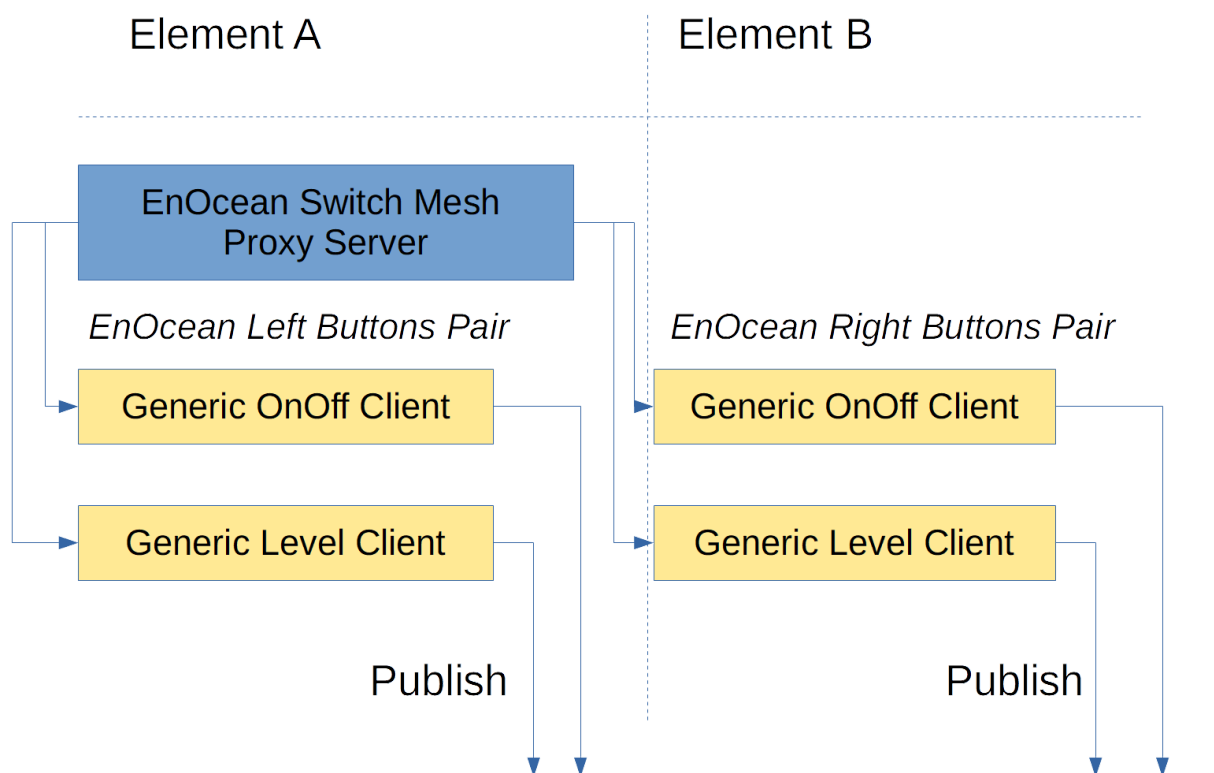


Fig. 1. EnOcean switch mesh proxy server elements and models mapping

3.1 EnOcean data telegrams processing

Each message that contains a Manufacturer specific AD Type is processed:

1. The BD_ADDRESS is checked against the configured Source Address.
2. The size of the message is checked versus expected EnOcean data telegram size.
3. The EnOcean data telegram's authentication is checked using the Security Key state as described in the [EnOcean PTM 216B user manual](#).
4. The EnOcean data telegram sequence field is checked against the stored sequence to prevent replay attacks. Each processed EnOcean data telegram sequence is persistently stored to prevent replay attacks.
5. When all checks are passed, the Switch Status field of the EnOcean data telegram is parsed and events are generated for the state machines. The following mapping is used:
 - a. State machine used by element A:
 - i. EnOcean ON event – State I of the channel B – B1 bit is set to Action, B0 bit is set to No Action
 - ii. EnOcean OFF event – State O of the channel B – B0 bit is set to Action, B1 bit is set to No Action
 - b. State machine used by element B:
 - i. EnOcean ON event – State I of the channel A – A1 bit is set to Action, A0 bit is set to No Action
 - ii. EnOcean OFF event – State O of the channel A – A0 bit is set to Action, A1 bit is set to No Action

! When both buttons on the same channel report Action in the same EnOcean data telegram, EnOcean ON and EnOcean OFF events are not generated.

i For more information on O/I States, A0, A1, B0, B1 bits, and Action / No Action values, refer to section 2.4 User Interface and section 4.6.2 Button action encoding in the [EnOcean PTM 216B user manual](#).

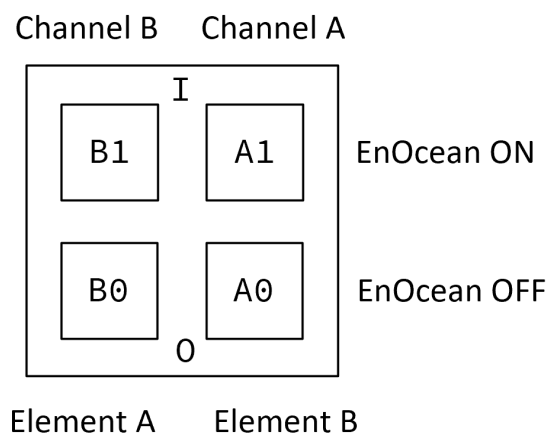


Fig. 2. EnOcean switch mesh proxy server elements, channels, and events mapping

3.2 State machine

EnOcean channel B is mapped to a state machine and a pair of Generic OnOff Client and Generic Level Client models on element A. EnOcean channel A is mapped to a state machine and a pair of Generic OnOff Client and Generic Level Client models on element B. The state machine is described as follows.

Triggers are **Bold** e.g. **ON Released**
 Action are *Italic* e.g. *Send Generic ON*

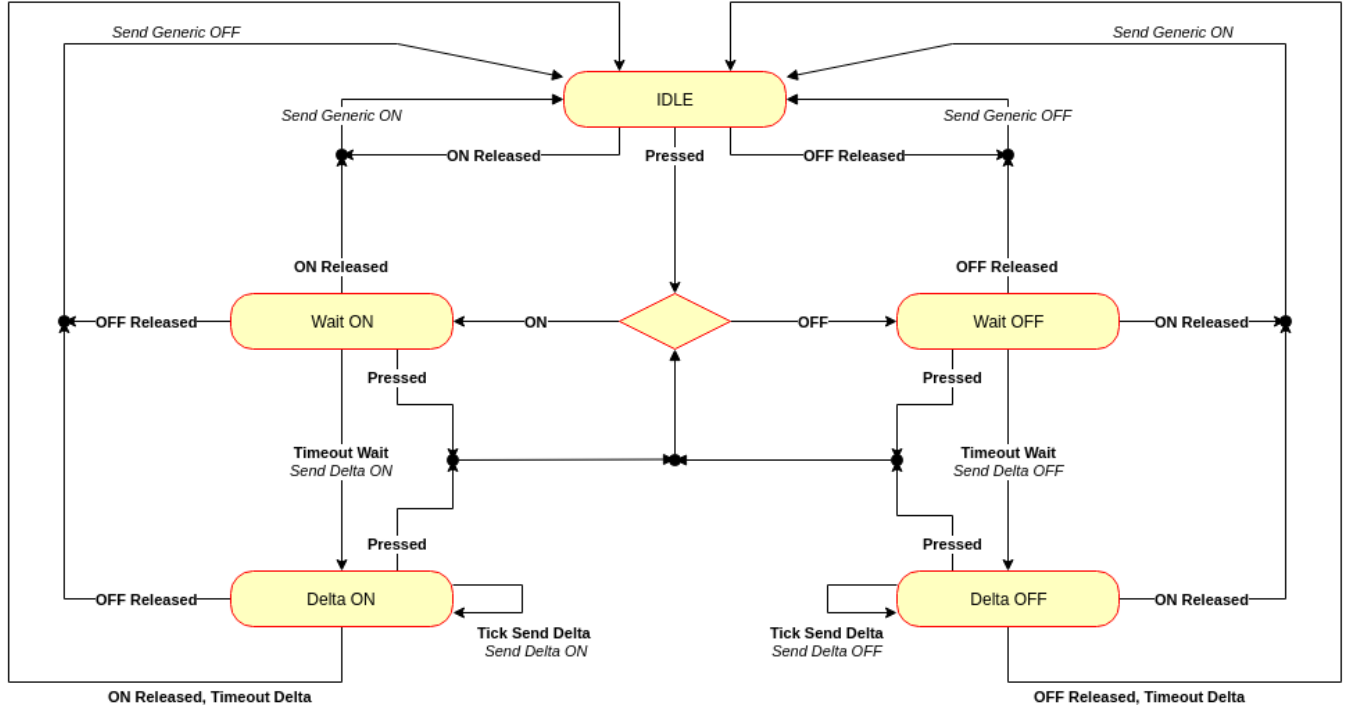


Fig. 3. EnOcean switch mesh proxy server state machine

States:

- IDLE: no message received
- Wait ON: EnOcean ON press received, timer started to detect short/long press
- Delta ON: Long press timeout elapsed, Increasing Generic Delta messages are sent
- Wait OFF: EnOcean OFF press received, timer started to detect short/long press
- Delta OFF: Long press timeout elapsed, Decreasing Generic Delta messages are sent

Events:

- ON Pressed: EnOcean ON press received
- ON Released: EnOcean ON release received
- OFF Pressed: EnOcean OFF press received
- OFF Released: EnOcean OFF release received
- Timeout Wait: Long press detection timeout elapsed
- Timeout Delta: Timeout for sending Generic Delta messages
- Tick Send Delta: Periodic sending of Generic Delta messages

Actions:

- Send Generic ON: Send Generic OnOff messages with value 1 using the short press message sequence
- Send Generic OFF: Send Generic OnOff messages with value 0 using the short press message sequence
- Send Delta ON: Send Generic Delta message with the incremented value using the long press message sequence
- Send Delta OFF: Send Generic Delta message with the decremented value using the long press message sequence

3.3 Message sequences

Depending on the time between pressing and releasing the EnOcean switch rocker, a long press or a short press messages sequence is triggered. The state machine is controlling which message sequence is used. The short press message sequence has one phase and once started it is always fully executed. The long press message sequence has three phases and the state machine controls transitions between phases.

3.3.1 Short press message sequence

Short press action is started when the button is released before the long press timeout elapses. The resulting action is a sequence of messages (phase A) that contain the same value (On or Off) but with a decreasing Delay parameter. This helps reduce the popcorn effect on message receivers.

Generic OnOff Set Unacknowledged messages are used.

The short press message sequence is shown in the following figure. The red arrows represent the value of the Transition Time field of the message, the black arrows represent the value of the Delay field.

- There are 4 messages, 50 ms apart from each other
- The messages have the same Generic OnOff state value equal to 1 (Send Generic ON action) or to 0 (Send Generic OFF action)
- Transition Time is set to the Generic Default Transition Time state value
- The messages have a decremting Delay parameter value in 50 ms steps

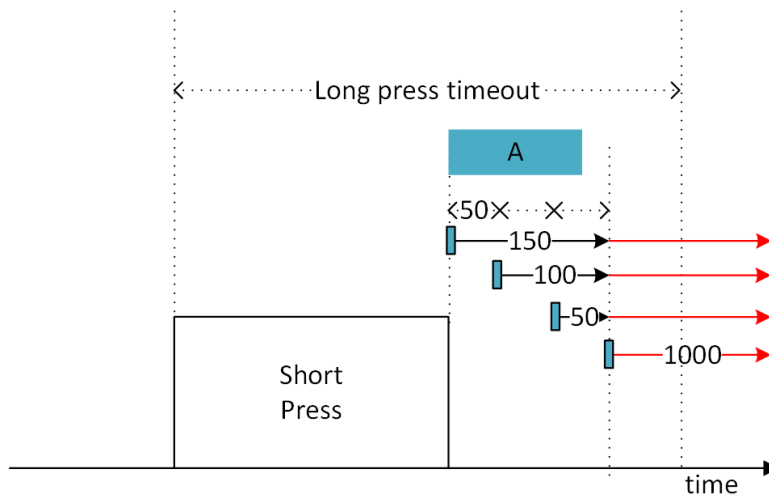


Fig. 4. Example of a short press message sequence for default Transition Time set to 1000 ms

3.3.2 Long press message sequence

Long press message sequence is started when the button is still pressed when long press timeout expires. The resulting action is three sequences of messages (phase B, phase C, and phase D). In each phase, message parameters are different, but each phase shares the same TID.

Generic Delta Set Unacknowledged messages are used for each phase.

When the state machine enters the Delta ON or Delta OFF states, phase B is started. When phase B is completed, phase C is started. When the state machine leaves the Delta ON or Delta OFF states, phase D is run. Phase B is always 150 ms long, phase D is always 200 ms long. The phase C length depends on the state machine events.

The long press message sequence is shown in the following figure. The red arrows represent the value of the Transition Time field of the message and the black arrows represent the value of the Delay field.

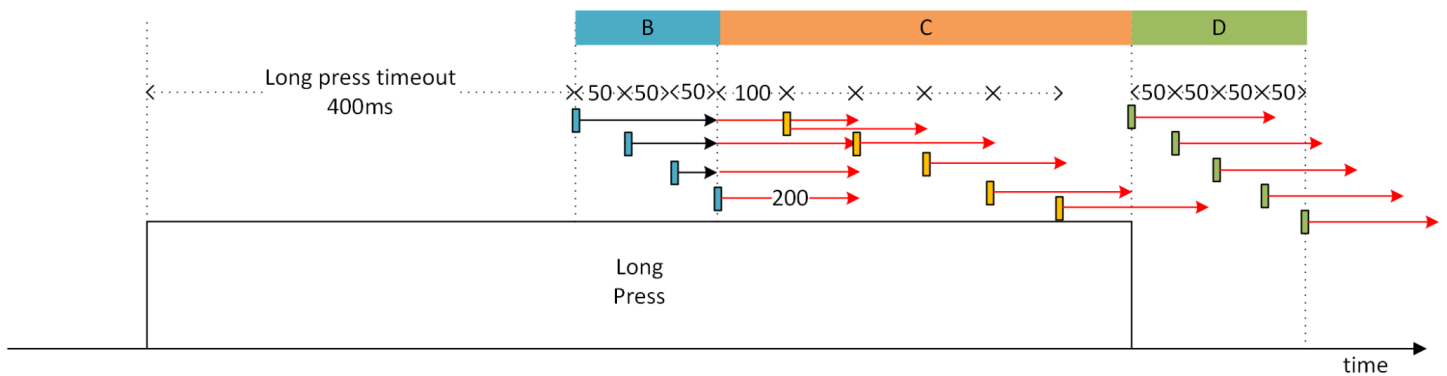


Fig. 5. Example of a long press message sequence

The B phase is similar to phase A of the short press message sequence:

- There are 4 messages, 50 ms apart from each other
- The messages have the same Delta Level value equal to 2520 (Send Delta ON action) or to -2520 (Send Delta OFF action)
- Transition Time is set to 200 ms
- The messages have a decremting Delay parameter value in 50 ms steps

The C phase is started after the B phase is over and the button is still pressed:

- Each 100 ms a message is transmitted
- Each message has a different Delta Level value (linear increasing in time by 2520 when the Send Delta ON action is run or linear decreasing in time by -2520 when the Send Delta OFF action is run)
- Transition Time is set to 200 ms
- Delay is set to 0

When the button is released, the sequence D is started:

- There are 5 messages, 50 ms apart from each other
- The messages have the same Delta Level value (final Delta Level value)
- Transition Time is set to 200 ms
- Delay is set to 0

3.3.3 Examples

Screens provided in this section are taken using the Wireshark® packet analyzer.

3.3.3.1 OnOff

The following screen shows actual messages from a short press event.

SRC	SEQ	DST	TTL	Info	OnOff	TID	Delay	Transition Time
1031	40517	49154	5	Generic OnOff Set Unacknowledged	Off	3	150 ms	1000 ms
1031	40519	49154	5	Generic OnOff Set Unacknowledged	Off	3	100 ms	1000 ms
1031	40521	49154	5	Generic OnOff Set Unacknowledged	Off	3	50 ms	1000 ms
1031	40523	49154	5	Generic OnOff Set Unacknowledged	Off	3	0 ms	1000 ms

Fig. 6. Example of short press event messages

3.3.3.2 Dimming

The following screen shows actual messages from a long press event. Phase B and phase D are highlighted with a blue background, whereas phase C has a white background.

Time	SRC	SEQ	DST	TTL	Info	Delta Level	TID	Transition Time	Delay
0.000	1031	38235	49156	8	Generic Delta Set Unacknowledged	2520	11	200 ms	150 ms
0.049	1031	38236	49156	8	Generic Delta Set Unacknowledged	2520	11	200 ms	100 ms
0.048	1031	38237	49156	8	Generic Delta Set Unacknowledged	2520	11	200 ms	50 ms
0.050	1031	38238	49156	8	Generic Delta Set Unacknowledged	2520	11	200 ms	0 ms
0.100	1031	38240	49156	8	Generic Delta Set Unacknowledged	5040	11	200 ms	0 ms
0.100	1031	38241	49156	8	Generic Delta Set Unacknowledged	7560	11	200 ms	0 ms
0.099	1031	38242	49156	8	Generic Delta Set Unacknowledged	10080	11	200 ms	0 ms
0.099	1031	38243	49156	8	Generic Delta Set Unacknowledged	12600	11	200 ms	0 ms
0.100	1031	38244	49156	8	Generic Delta Set Unacknowledged	15120	11	200 ms	0 ms
0.100	1031	38245	49156	8	Generic Delta Set Unacknowledged	17640	11	200 ms	0 ms
0.098	1031	38246	49156	8	Generic Delta Set Unacknowledged	20160	11	200 ms	0 ms
0.100	1031	38247	49156	8	Generic Delta Set Unacknowledged	22680	11	200 ms	0 ms
0.100	1031	38248	49156	8	Generic Delta Set Unacknowledged	25200	11	200 ms	0 ms
0.098	1031	38249	49156	8	Generic Delta Set Unacknowledged	27720	11	200 ms	0 ms
0.100	1031	38251	49156	8	Generic Delta Set Unacknowledged	30240	11	200 ms	0 ms
0.099	1031	38252	49156	8	Generic Delta Set Unacknowledged	32760	11	200 ms	0 ms
0.101	1031	38253	49156	8	Generic Delta Set Unacknowledged	35280	11	200 ms	0 ms
0.098	1031	38254	49156	8	Generic Delta Set Unacknowledged	37800	11	200 ms	0 ms
0.100	1031	38255	49156	8	Generic Delta Set Unacknowledged	40320	11	200 ms	0 ms
0.099	1031	38256	49156	8	Generic Delta Set Unacknowledged	42840	11	200 ms	0 ms
0.102	1031	38257	49156	8	Generic Delta Set Unacknowledged	45360	11	200 ms	0 ms
0.044	1031	38258	49156	8	Generic Delta Set Unacknowledged	45360	11	200 ms	0 ms
0.043	1031	38259	49156	8	Generic Delta Set Unacknowledged	45360	11	200 ms	0 ms
0.026	1031	38260	49156	8	Generic Delta Set Unacknowledged	45360	11	200 ms	0 ms
0.050	1031	38261	49156	8	Generic Delta Set Unacknowledged	45360	11	200 ms	0 ms

Fig. 7. Example of long press event messages

 The Time column shows the number of seconds since the previous displayed message.

3.3.3.3 Delta timeout behavior

When a button is pressed for a long time (over 6 seconds), the Generic Delta Set Unacknowledged messages are not sent anymore.

When the button is released, the Generic OnOff Set Unacknowledged is sent.

Time	SRC	SEQ	DST	TTL	Info	Parameters	Delta Level	Scene Number
0.000	1032	41129	49157	8	Generic Delta Set Unacknowledged		138600	
0.100	1032	41130	49157	8	Generic Delta Set Unacknowledged		141120	
0.113	1032	41131	49157	8	Generic Delta Set Unacknowledged		143640	
0.084	1032	41132	49157	8	Generic Delta Set Unacknowledged		146160	
0.101	1032	41133	49157	8	Generic Delta Set Unacknowledged		148680	
0.099	1032	41134	49157	8	Generic Delta Set Unacknowledged		151200	
0.100	1032	41135	49157	8	Generic Delta Set Unacknowledged		153720	

Fig. 8. Example of Generic Delta Set Unacknowledged messages

4. Document revisions

Revision	Date	Editor	Changes
1.4	1 August 2023	GM	Added links to the new PTM 216B user manual.
1.3	18 May 2023	GM	Corrected the links to the EnOcean PTM 215B user manual. Corrected figure numbers. Implemented template v. 1.2. Minor corrections.
1.2	21 September 2021	AS	Corrected the 3.3.2 Long press message sequence section.
1.1	9 July 2021	PW	Updated the 2.3 Model description and 3.1 EnOcean data telegrams processing sections and added figure descriptions.
1.0	23 June 2021	PW	Initial version of the document.

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