03905

Two-Rocker-Buttons flat device with radio frequency transmitter 2.4 GHz standard 802.15.4 no battery, powered by built-in electrodynamich generator, to complete with dedicate 20506 Eikon, 19506 Arké or 14506 Plana buttons.

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Contents

1. General description

1.1 Basic functionality

03905 enables the realization of energy harvesting wireless switches for ZigBee systems communicating based on the 2.4 GHz IEEE 802.15.4 radio standard.

03905 is mechanically compatible with the established PTM 21x form factor enabling quick integration into a wide range of designs. Key applications are wall-mounted or portable switches either with up to two rockers or up to four push buttons.

03905 pushbutton transmitters are self-powered (no batteries) and fully maintenancefree.
They can therefore be used in all environments including locations that are difficult to reach or within hermetically sealed housings. The required energy is generated by an electro- dynamic energy transducer actuated by an energy bow located on the left and right of the module. This energy bow which can be pushed from outside the module by an appropriate pushbutton or switch rocker.

When the energy bow is pushed down or released, electrical energy is created and a 2.4GHz radio telegram according to the IEEE 802.15.4 standard is transmitted. This radio telegram transmits the operating status of all four contact nipples at the moment when the energy bow was pushed down or released.

03905 telegram format has been defined to maximize compatibility with a wide range of devices including such supporting the ZigBee Green Power standard.
03905 radio telegrams are protected with AES-128 security based on a device-unique private key.
Figure 1 below shows 03905.

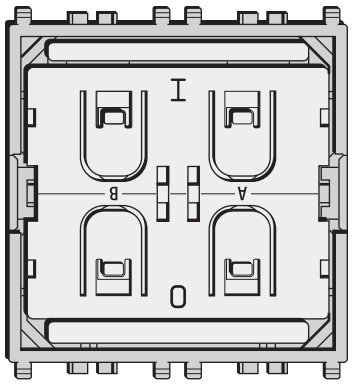

Fig. 1: 03905

1.2 Technical data

Antenna	Integrated antenna
Radio Transmission Power (typ. at 25°C)	+2 dBm
Radio Standard	IEEE 802.15.4 using 2.4 GHz radio channels 11 … 26
Default Radio Channel	IEEE 802.15.4 radio channel 11
Radio Channel Selection	User-selectable (Commissioning)
Device Identification	Individual 32 Bit Device ID (factory programmed)
Security	AES128 (CBC Mode) with Sequence Code
Power Supply	Integrated Kinetic Energy Harvester
Button Inputs	Up to four buttons or two rockers

1.3 Environmental conditions

Operating Temperature	-25°C ... 65°C
Storage Temperature	-25°C ... 65°C
Humidity	0% to 95% r.h. (non-condensing)

2. Functional information

2.1 03905 Device Overview

The pushbutton transmitter module 03905 from ZigBee enables the implementation of wireless remote controls without batteries. Power is provided by a built-in electrodynamic power generator. 03905 device transmits data based on the 2.4GHz IEEE 802.15.4 standard.

The outer appearance of 03905 is shown in Figure 2 below.

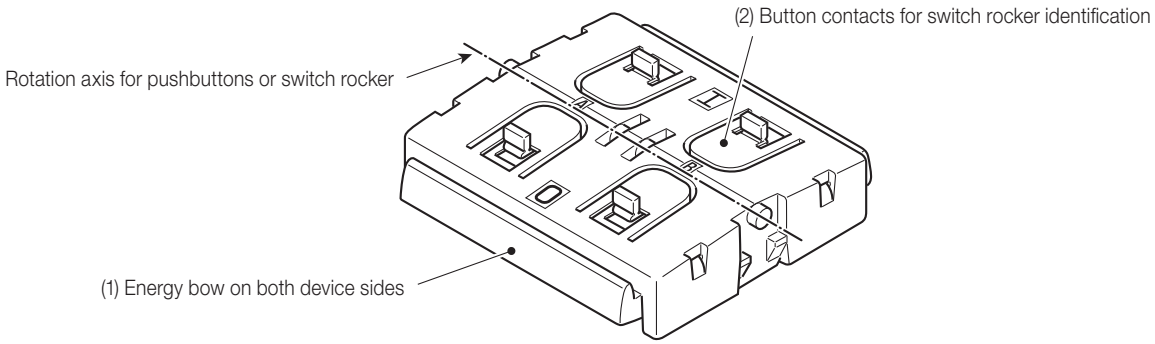

Fig. 2: Electro-dynamic powered pushbutton transmitter module 03905

2.2 Basic Functionality

03905 devices contain an electro-dynamic energy transducer which is actuated by an energy 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 a soon as it is not pushed down anymore.

When the energy bow is pushed down, electrical energy is created and an IEEE 802.15.4 radio telegram is transmitted which identifies the status (pressed or not pressed) of the four button contacts (2). Releasing the energy bow similarly generates energy which is used to transmit a different 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” button contact presses. This enables simple implementation of applications such as dimming control or blinds control including slat action.

2.3 User Interface

03905 devices provide four button contacts. They are grouped into two channels (Channel A and Channel B) each containing two button contacts (State O and State I).

The state of all four button contacts (pressed or not pressed) is transmitted together with a unique device identification (32 Bit device ID) whenever the energy bow is pushed or released.

Figure 3 below shows the arrangement of the four button contacts and their designation:

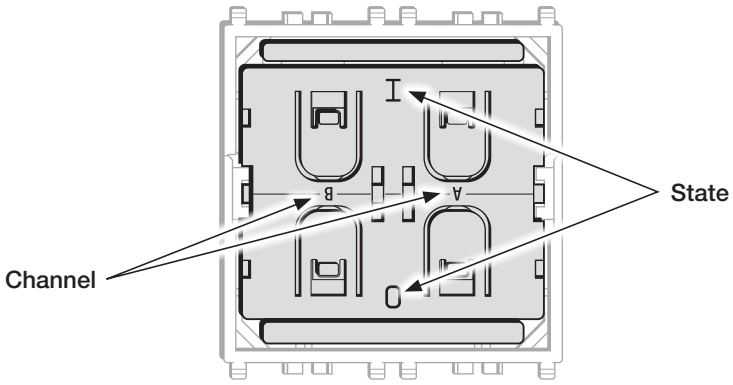

Fig. 3: Button contact designation

2.4 03905 radio channel parameters

03905 supports all sixteen IEEE 802.15.4 radio channels in the 2.4 GHz band (channels 11 … 26 according to IEEE 802.15.4 notation).

2.5 Operation modes

03905 can operate in two modes:

- Data mode
  Data mode is used to transmit data telegrams reporting the status of 03905 button inputs.
- Commissioning mode
  Commissioning mode is used to commission (teach-in) 03905 into a specific receiver or network. To do so, 03905 will identify its capabilities and its security parameters and – if required – change the radio channel it uses for telegram transmission.

2.5.1 Data mode

Data mode is the standard mode of operation. In this mode, 03905 will transmit data telegrams identifying the status of its four button contacts and the energy bar.

03905 supports both single button actions (one button contact or only the energy bar being actuated) and dual button actions (two button contacts being actuated at the same time).

03905 uses the following sequence to identify and transmit button contact status:

1. Determine direction of the energy bar movement (push or release).
2. Read status of all button contacts.
3. Calculate telegram payload.
4. Calculate security signature.
5. Format IEEE 802.15.4 radio telegram.
6. Transmit radio telegram.

2.5.2 Commissioning mode

Commissioning mode is used to configure 03905 and learn it into an existing network.

To do so, it provides two key functions:

- Transmission of a commissioning telegram in order to learn-in 03905 into a network.
- Radio channel selection in order to set the radio channel of 03905 to that used by the network.

These functions are described subsequently in more detail.

2.5.2.1 Commissioning mode entry

Commissioning mode is entered using a special button contact sequence. This is illustrated in Figure 4 below.

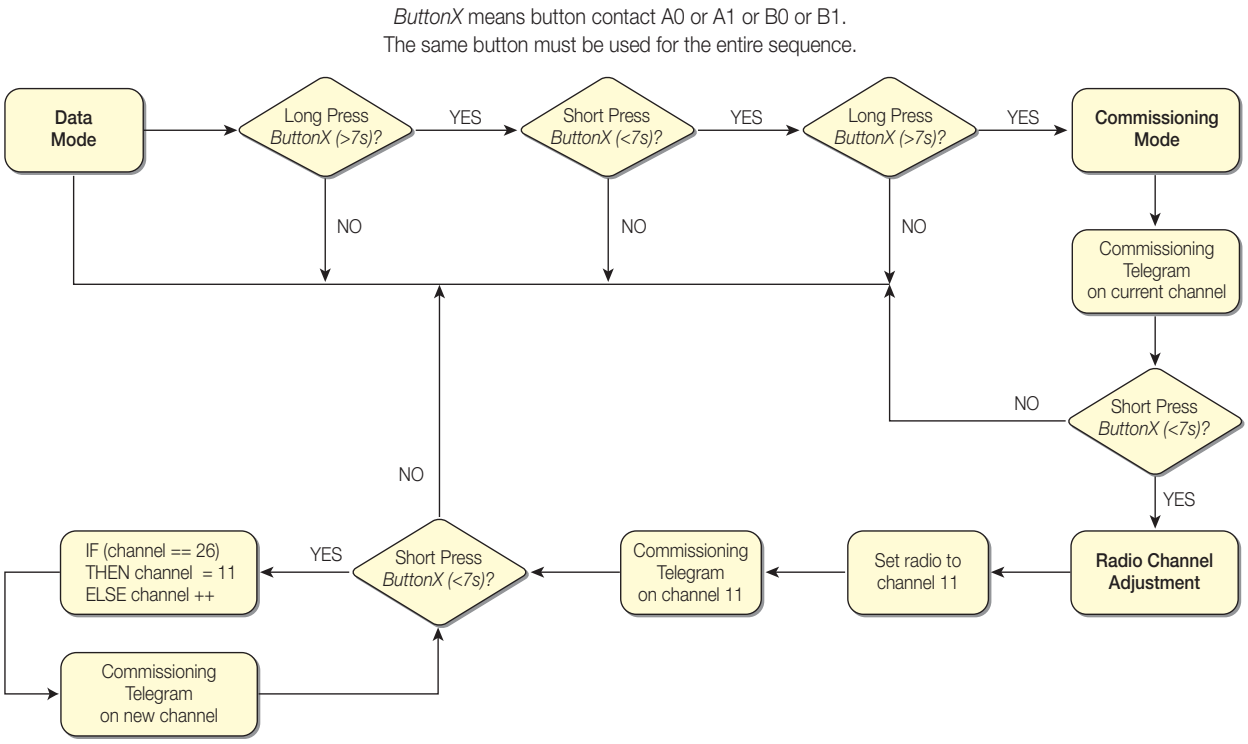

Fig. 4: Button sequence for commissioning mode

To enter commissioning mode, start by selecting one button contact of 03905. Any contact of 03905 (A0, A1, B0, B1) can be used. This contact is referred to as *ButtonX* in Figure 4 above.

Next, execute the following long-short-long sequence:

1. Press and hold the selected button contact together with the energy bar for more than 7 seconds before releasing it.
2. Press the selected button contact together with the energy bar quickly (hold for less than 2 seconds).
3. Press and hold the selected button contact together with the energy bar again for more than 7 seconds before releasing it.

Upon detection of this sequence, 03905 will enter commissioning mode and transmit a commissioning telegram on the current radio channel.

2.5.2.2 Commissioning telegram transmission

03905 will transmit a commissioning telegram on the current radio channel immediately upon entering commissioning mode. This allows teach-in into additional devices without changing the currently used radio channel.

The default radio channel used by 03905 is channel 11. It can be subsequently adjusted as described in the following chapter.

Whenever a new radio channel is selected, 03905 will transmit a commissioning telegram on the new radio channel. This enables the receiver to provide feedback to the user to indicate when 03905 has reached the correct radio channel (i.e. when the receiver receives a commissioning telegram from 03905 on the radio channel the receiver is using). See chapter 2.5.2.5 for a discussion of feedback mechanisms.

2.5.2.3 Radio channel adjustment

The radio channel used by 03905 can be changed whenever 03905 is in commissioning mode.

In order to change the radio channel, press the selected button contact shortly (< 7s) once after entry into commissioning mode. This will reset the radio channel used by 03905 to channel 11 and enable subsequent channel adjustment.

If 03905 was already operating on channel 11 (default condition) then the radio channel will remain unchanged. This ensures that 03905 will always use channel 11 as starting point for the radio channel adjustment.

The radio channel can now be incremented by continuing to press the selected button contact shortly (< 7s). For each such button press, the radio channel is incremented. If channel 26 has been reached then channel 11 will be used next.

2.5.2.4 Radio channel adjustment examples

Example 1: 03905 operating on channel 11 (out of the box condition)

In this case, 03905 would send a commissioning telegram on channel 11 immediately after detecting the long-short-long sequence.

After that, it would for each additional short button press send commissioning telegrams on incrementing radio channels starting with channel 11.

This means that the channel sequence would be:
11 (current channel) - 11 – 12 – 13 … 25 – 26 – 11 – 12 and so on

Example 2: 03905 operating on channel 15

In this case, 03905 would send a commissioning telegram on channel 15 immediately after detecting the long-short-long sequence.

After that, it would for each additional button press send commissioning telegrams on incrementing radio channels starting with channel 11.

This means that the channel sequence would be:
15 (current channel) - 11 – 12 – 13 … 25 – 26 – 11 – 12 and so on

2.5.2.5 Determining the correct radio channel

The user requires system feedback to determine if the correct radio channel has been reached.

Several methods are possible for that, including:

- Feedback from the device into which 03905 is learned in E.g. blinking a status light, toggling a connected load, moving a motor etc.
- Feedback from a dedicated user interface This could for instance instruct the user on the required key sequence and confirm correct execution

It is the responsibility of the system designer to define a suitable feedback mechanism.

2.5.2.6 Storing the new radio channel and return to data mode

If 03905 has been successfully set to the desired radio channel then this radio channel has to be stored and operation should return to data mode.

This is achieved by pressing any button contact other than the one used for entry into commissioning mode (and channel change). So if button contact A0 was used to enter commissioning mode then pressing button contact A1, B0 or B1 will cause storing of the current radio channel and return to data mode.

Failure to store the selected radio channel and to return to data mode could cause accidental reconfiguration of 03905.

2.5.2.7 Setting 03905 to a defined state (data mode)

Sometimes the user might be unsure if 03905 is operating in data mode, in commissioning mode or if part of the entry sequence into commissioning mode has already been executed.

03905 can always be set into a defined state (data mode) by shortly (< 7s) pressing two different buttons one after another. After that, 03905 will operate in data mode and the full sequence for commissioning mode entry (long-sort-long) would have to be executed to enter commissioning mode.

3. Application information

3.1 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 15 m range in corridors, up to 50 m in halls.
- Plasterboard walls / dry wood
  Typically 15 m range, through max. 2 walls.
- Ferro concrete walls / ceilings
  Maximum 1 wall or ceiling, depending on thickness and material.
- Fire-safety walls, elevator shafts, staircases and similar areas should be consideredas 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.

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