ENERGY HARVESTING WIRELESS SWITCH

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In a world where the number of networks is increasing, requirements for information transmission are also changing. Transmission must be mobile and flexible, while using as little energy as possible. The solution is energy harvesting wireless switches from ZF. They're easy and effective to use, without any cables or batteries.
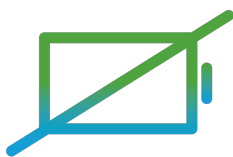
battery-free   **maintenance-free**   **wireless**

https://switches-sensors.com/energy-harvesting/

ENERGY HARVESTING WITH THE
ENERGY HARVESTING WIRELESS SWITCH

For many years, electromechanical switches have been a technical constant offering few surprises – until the day that ZF added "energy harvesting solutions" and "wireless" to the mix.

Breaking new ground means using intelligent technologies: Energy harvesting makes use of energy that is already available. Instead of generating auxiliary energy through an integrated energy source or adding it via an external energy supply, it converts energy that is available in the surrounding environment or that is acting on the system. The energy harvesting wireless switch module from ZF applies this principle of energy conversion.

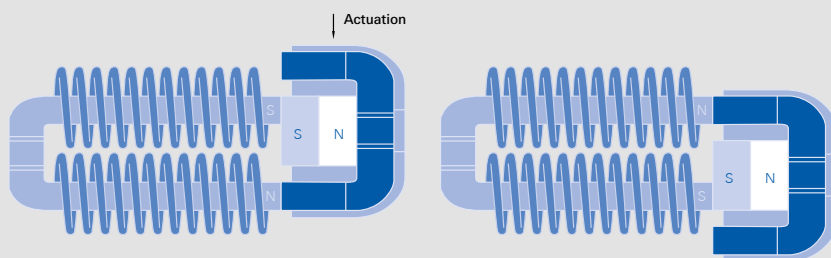### Energy harvesting with an inductive generator
ZF's energy harvesting wireless switch module works on an inductive basis. It transforms energy created by mechanical actuation into an electrical energy pulse. When the generator is activated, the magnetic flux in a coil system is suddenly reversed, thus generating the required electrical energy. This energy pulse is then transformed and spread over time into a constant supply voltage by the energy management components.

Thus, it supplies the consumer – in this case RF electronics with transmitting antenna – with the energy required for transmitting the RF signal.

This offers a tremendous advantage: Due to its miniature construction, the high efficiency in the functional chain, and its long life expectancy of up to 1,000,000 switching cycles, the ZF wireless switch module needs only a small amount of power for operation with no maintenance required – and can be installed in a tight space.

Best connections – for industry and building technology
Various RF standards can be used for transmission, such as Bluetooth® Low Energy, right up to customer-specific requirements. Via Bluetooth® Low Energy, batteryfree IoT applications that enable an easy connection to mobile applications (IOS®, Android™) can be realized for numerous projects. Another excellent option for integration into building automation is provided by the worldwide bus standard KNX®. This standard was developed in recent

Intelligent energy converter: The inductive generator converts mechanical energy into an electrical energy pulse by continuously changing the direction of the magnetic field.
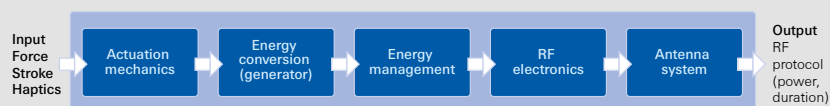
Energy harvesting with the self-powered functional switch: It converts the incoming mechanical energy from operating the switch into electrical energy that sends pulses to an RF receiver via RF electronics.

years, starting from a purely cabled approach, moving on to wireless technology, and then to fully integrated wireless technology with central configuration via the ETS software tool. It is now being expanded with the new wireless switch module, which integrates the energy harvesting aspect: Operating the switch module generates enough electrical energy to send a complete KNX-RF® protocol directly to a KNX® receiver of your choice. A gateway is not required. The transmitter range is up to 30 meters in buildings (868.3 MHz band).

One advantage after another

This environmentally friendly system has numerous advantages: You have the flexibility to install a switch without cabling in any location you want, where it will fulfill its function over the entire length of its service life without any maintenance or battery changes. In contrast to information transmission via cables, the self-powered wireless switch is also attractive for building services be-cause it's easy to retrofit. For example, you can install new light switches in a

freshly decorated room without having to cut any holes in the wall.

There are also numerous possibilities for use in industrial automation, particularly when the time it takes to lay cables is disproportionate to the application. Here again, the energy harvesting wireless switch serves as a cost-effective, battery-less alternative to cable-based microswitches.
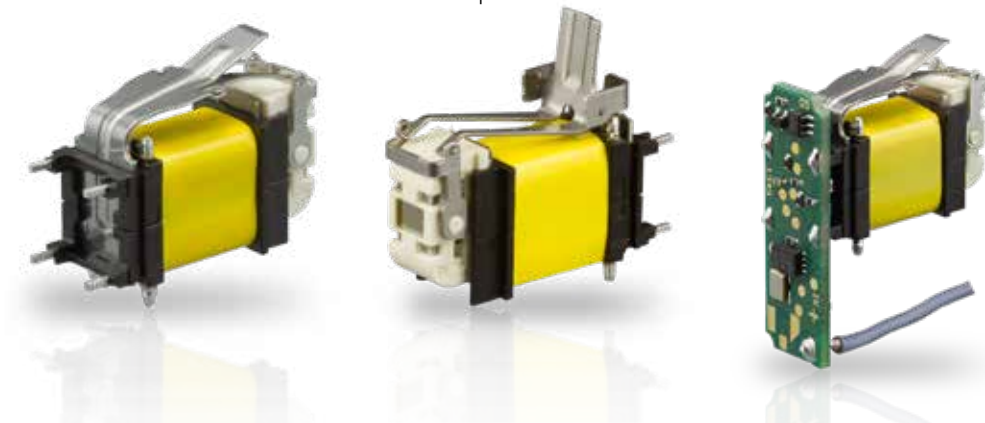
GENERATORS
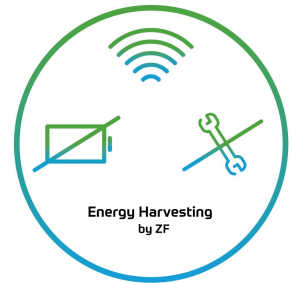
Generators – Features

- Inductive generator: The energy required for data transmission is created by the mechanical actuation of the switch
- Miniature design combined with extremely high energy output
- Long mechanical life
- Momentary design: Switching mechanism returns to starting position after release (pushbutton)
- Maintained design: Switching mechanism with two rest positions (e.g. On/Off switch)

Generators with PCB – Features

- Energy harvesting system with no wires, consisting of generator and transmission electronics
- Wireless data transfer via RF technology
  - Saves on plug connections
  - Easy to install in virtually inaccessible areas
  - No complex wire assembly
- Availability of multiple frequency bands allows use worldwide in a range of applications
- Maintenance-free – no batteries to replace
- Flexible "pairing" (for BLE also via NFC) allows the operation of several receivers with one switch (and vice versa)
- "Unique ID" ensures unambiguous identification when operating multiple switches
- Realization with Bluetooth® Low Energy protocol & EnOcean® possible. Further RF protocols available on request

Technical data

Series	Generator – momentary	Generator – maintained	Generator with PCB
Part no.	AFIG-0007	AFIG-0010	Transmitter module on request
Dimensions	20.1 x 7.3 x 14.3 mm	20.1 x 7.3 x 19.3 mm	21.7 x 7.3 x 23.3 mm
Energy generated	2x min. 0.33 mWs	1x min. 0.33 mWs	–
Lifetime	min. 1,000,000 operations	min. 100,000 operations	min. 1,000,000 operations
Operating force	approx. 13 N	5 – 16 N (depending on lever length)	–
Temperature range	−40 to +85 °C	−40 to +85 °C	−40 to +85 °C
Frequency bands	–	–	868.3 MHz, 915.0 MHz, 2.4 GHz
RF protocol	–	–	Bluetooth® Low Energy, EnOcean® Further protocols available on request

WHETHER KNX-RF®, BLUETOOTH® OR ENOCEAN® – LIGHT SWITCH MODULES SET YOU FREE

Light Switch Modules from ZF support the communication based on different RF protocols

The ZF Forum in Friedrichshafen. A new office concept promotes efficient and variable work for over 600 employees. One feature contributing to the flexible use of rooms is the energy harvesting light switch module.

KNX-RF®

The KNX® standard is a manufacturer independent bus system for building automation applications. The RF version of KNX®, KNX-RF®, communicates in the 868 MHz frequency band and can be connected to an existing bus system or operate individually.

EnOcean®

The EnOcean® RF protocol is mainly used for building automation applications with the focus of energy harvesting technologies.

Bluetooth® Low Energy

Bluetooth® Low Energy or Bluetooth® 5.0 is a RF protocol for the 2.4 GHz frequency band that is used for Internet of Things applications with low power consumption.

Over 500 of the company's own switch modules ensure optimal working conditions in the ZF Forum.

Wireless Switch Module

SMART HOME

Today this term covers a variety of solutions that make living and working in buildings more efficient and comfortable. In this arena, ZF represents independence and flexibility: flexibly switching and controlling the building environment, independently of cables and batteries.

Easy installation and handling

In new buildings, old buildings, renovated properties, or even in an industrial application – with the energy harvesting switch module from ZF, you're finally entering the "smart" age. Connect your high-tech product comfortably and conveniently. ZF's energy harvesting switch module works without batteries or wires, allowing you to install it anywhere without going to the trouble of laying cables. This means that there's no longer any problem with installing it on design surfaces such as glass, wood, or concrete. With the switch module, ZF declares war on cable slots and batteries. ZF's "energy harvesting" portfolio stands for easy installation and handling.

Flexible and uncomplicated

The switch module is as flexible as its user, adapting to any living situation. Thanks to the simple configuration of ZF products, your switch can turn a light on and off today and function as a door opener tomorrow. You can comfortably decide what function your switch will perform and where it will be positioned in your building, and then change it later on without a lot of trouble. Plan your home decor without worrying about where to position the switches, because they can be subsequently moved to wherever they're actually needed. Dim your lights, control your blinds, or make your living room cosy with a pre-configured scheme that sets the lights exactly as you like when you want to relax – all with a single switch, from your seat on the couch.

„Smart" and independent

Stay independent and take advantage of the various RF standards in our program. From the RF standards like KNX-RF® and Bluetooth® Low Energy, to customer-specific RF solutions. Every aspect of your application benefits from ZF's typically excellent service while we accompany you every step of the way. With the KNX® switch module, you can execute up to six commands with a single switch. You have the usual left rocker top / bottom and right rocker top / bottom settings, with the additional option of switching the right and left rocker switches top / bottom simultaneously to generate a fifth and sixth command (see right). This is only one innovation in energy harvesting wireless communication. Learn about others and immerse yourself in the world of RF technologies. Let the battery-less, wireless switch module from ZF be your next step toward a "smarter world".

KNX WIRELESS SWITCH MODULE: ONE SWITCH, SIX COMMANDS
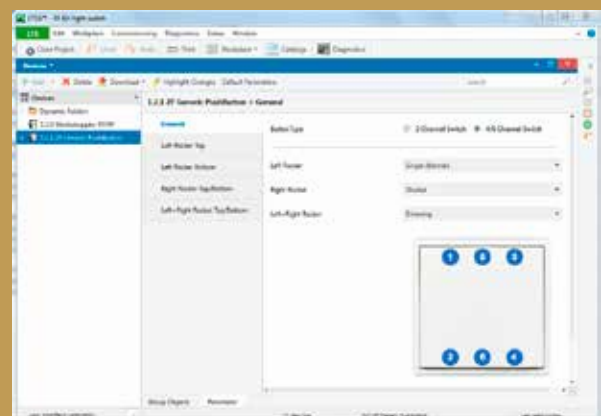
KNX SWITCH MODULE WITH PROGRAMMING ADAPTER AND MEDIA COUPLER

Energy Harvesting by ZF
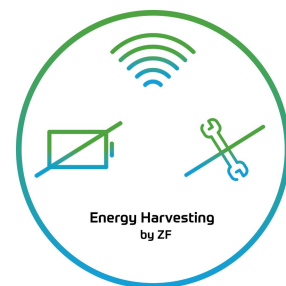
Switch module – Features

- Self-powered, wireless switch module for building automation (e. g. for controlling lights or blinds)
- Can be universally adapted for customer-specific design parts
- Maintenance-free – no batteries to replace
- Easy to install, even in virtually inaccessible places
- Configurable without gateway via the ETS software (from ETS 5) using a programming adapter
- Product included in ETS catalogue from ETS 5
- Direct communication with KNX-RF® devices

Programming adapter – Features

- Supplies battery power to the KNX-RF® switch module
- Permits bidirectional wireless communication with switch module
- When plugged in, directly activates the switch module's pairing mode

Media coupler

- Connects a KNX-TP® (twisted-pair) line to a KNX-RF® (radio) line
- Receiver for KNX-RF® switch module and other KNX-RF® devices
- Configurable via the ETS software (from ETS5) using a programming adapter
- Product included in ETS catalogue (from ETS5)
- Powered via TP KNX® bus, so no external AC or DC power supply unit is required

Technical data

Series	KNX-RF® switch module	Programming adapter	Media coupler
Part no.	AFIM-1010	AFZM-0001	AFZE-1008
Dimensions	40 x 40 x 11.2 mm	42.1 x 58.1 x 30.4 mm	37 x 37 x 9 mm
Frequency band	868.3 MHz	–	868.3 MHz
Temperature range	−20 °C to +45 °C	−20 °C to +45 °C	−5 °C to +45 °C
RF distance (in buildings)	up to 30 m	–	up to 30 m
RF protocol	KNX RF1.R	–	KNX RF1.R
Modulation	FSK	–	FSK
Power supply	Self-powered	2 x AAA batteries (1.2 V or 1.5 V)	KNX line, 21 to 30 V DC (SELV)

ENERGY HARVESTING BLUETOOTH® LOW ENERGY SWITCH MODULE
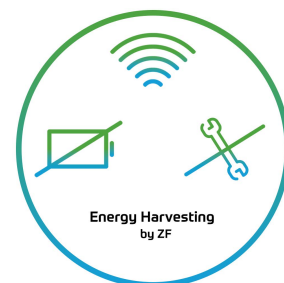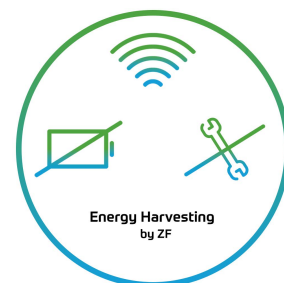
Switch module – Features

- Flexibility in application design and easy to install – no cables necessary
- Batteryfree = Maintenance-free
- Long lifetime (100,000 switching cycles at room temperature)
- Suitable for a wide range of 55 x 55 / 45 x 45 design parts
- Compatible to Bluetooth® mesh systems (e.g. Silvair)

Technical data

Series	**Bluetooth® low energy switch module**
Dimensions	40 x 40 x 11.2 mm
Frequency band	2.4 GHz
RF distance	up to 10m in buildings
RF protocol	Bluetooth® Low Energy Advertising
Power supply	Energy harvesting (Generator designed for 1 million switching cycles)
Actuation force	Typ. 11N
Device Identification	Factory preset individual 48 Bit Bluetooth® MAC address
Data packages	Typ. 10 telegrams per push and release
RF channels	BLE Advertising channels 37, 38, and 39
Security	Factory preset individual AES128 - key
Configuration	QR-Code (camera-based commissioning), optional NFC
Compatibility	Silvair Wireless Lighting Ecosystem (Bluetooth Mesh)
Operating temperature	-20°C up to +65°C
Radio Certifications	Europe (RED), USA (FCC), Japan (ARIB)

ENERGY HARVESTING ENOCEAN SWITCH MODULE

Switch module – Features

- Flexibility in application design and easy to install – no cables necessary
- Long lifetime (100,000 switching cycles) and no batteries – maintenance-free
- Suitable for all Energy Harvesting switch series
- Completely compatible with existing EnOcean® RF-Systems
- ZF as member of the EnOcean® Alliance enables customer specific RF solutions

Technical data

Series	EnOcean Switch module
Dimensions	40 x 40 x 11.2 mm
Frequency bands	868 MHz (EU/Asia) / 915 MHz (US) on request
RF protocol	EnOcean® Alliance Radio Standard ERP1 (ISO/IEC 14543-3-10)
RF distance	Up to 30m (in buildings at 0dBm)
Certification	EnOcean® 3.0, Certified Platform 3.0
Power supply	Self-powered
Actuation force	Typ. 11N
Device identification	Individual 32 bit ID
Data packages	Typ. 10 telegrams per push and release
EnOcean Equipment Profiles	TX-EEP F6-01-01, F6-02-01, F6-02-02, F6-02-03, F6-04-01, D2-03-00
Security	Rolling code with AES128 on request
Configuration	Pairing over market available EnOcean® receivers, NFC on request
Operating temperature	-20°C up to +65°C

WIRELESS TECHNOLOGY FAQ'S

What is the meaning of pairing and how does it work?
To connect a wireless transmitter and a receiver, they have to be coupled. This is called pairing. The receiver is switched to pairing-mode by pressing a push button. If a signal is triggered with one or more wireless transmitters, all the transmitters will pair with the one receiver.

Which factors affect the transmitting and receiving reliability?
Transmitting and receiving reliability of wireless signals depends on various factors. In addition to technical values, e.g. transmission power of the wireless transmitter and sensitivity of radio receivers, environmental conditions are essential. Barriers - like walls and ceilings in buildings - dampen and reflect radio waves affecting the transmission reliability. Interference of radio transmission can be caused by other radio participants when they are using the same frequency bands. Instructions for operation and installation of our wireless technology can be found in the application notes.

How can the transmitting and receiving reliability be ensured?
Barriers - like walls and ceilings in buildings - damp and reflect radio waves. Therefore it is important to ensure that as few walls and ceilings are between the wireless transmitters and receivers, as possible. To minimize the disturbance caused by other radio participants, the radio telegrams should be transmitted several times. Instructions for operation and installation of our wireless technology can be found in the application notes.

What is the difference between unidirectional and bidirectional communication?
The radio communication could either work from transmitter to the receiver (unidirectional) or from the transmitter to the receiver and reversed (bidirectional). A bidirectional communication is useful if the transmitter sends, providing that it receives an acknowledgement from the receiver.
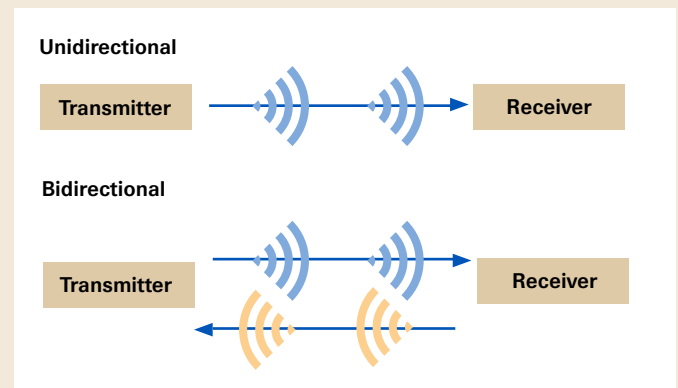
Is it possible to use ZF wireless switches for bidirectional communication?
The wireless switch produces electrical energy through the actuation or release of the inductive generator. The entire electrical energy produced is required for the transmission of one or more radio telegrams. No energy remains. There is no energy left for the receiving of radio telegrams. The ZF wireless switch is only capable of unidirectional communication.

WIRELESS TECHNOLOGY FAQ'S

Why do the energy harvesting wireless products use different frequencies?

Basically two factors are important for selecting a frequency: the technical propagation characteristics and regularity and legal aspects. Regarding the technical propagation characteristics, it is generally correct that lower frequencies have a greater transmission range.
In addition, the propagation characteristics in buildings get better with lower frequencies. These so-called Sub-GHz-Frequencies, which means below 1 GHz, become therefore very attractive.
Due to national and international regulations not all frequencies can be used everywhere. Only the 2.4 GHz band is based on the definition of the ITU (International Telecommunication Union), a so-called ISM Band. It is applicable all over the world. The 868 MHz frequency band is just applicable in Europe and China. In USA and Canada this band cannot be used. In this case it is necessary to use the 915 MHz band.

Area	Europe	China	USA / Kanada
Frequency	–	–	–
868 MHz	●	●	–
915 MHz	–	–	●
2,4 GHz	●	●	●

How to get best results with the antenna set up?

The task of the antenna is to radiate the produced transmission power with minimal losses into the surrounding environment (transmitting antenna) or to capture maximum transmission power (receiving antenna). Consequently, the orientation of the antenna can have a critical effect on the radio characteristics. ZF wireless products use a wire antenna or a PCB antenna. In the case of a wire antenna, the insulated wire leads out of the switch housing. To ensure an optimal radiation it is important that the antenna is not twisted. Direct contact or indirect shielding through metal surfaces should also be avoided. This also applies for products with an integrated antenna that is directly implemented into the conducting path on the electronic board. For these products you will find information with regard to the installation in the respective application notes.

Is it possible to reduce the length of the wire antenna?

The so-called resonance frequency is a very important factor of the antenna construction. At this resonance frequency the losses from the antenna are minimal. The resonance frequency is usually the requested communication frequency and confirmed in the settings by the radio chip. The antenna was precisely designed for this frequency which means the length of the wire antenna corresponds exactly to the constructive design. Therefore, reducing the length of the antenna will lead to transmission losses and should be avoided.

ENERGY HARVESTING FAQ'S

KNX® SWITCH FAQ'S

Which form of energy does the generator produce?
The inductive generator transforms mechanical force into electrical energy in the form of inductive voltage pulses. The energy management of the soldered electronics changes this voltage pulse through rectification and intermediate buffering into a constant operating voltage for the radio chip.

Is the produced energy from the inductive generator saved?
The produced electrical energy is not saved. The energy is buffered using a capacitor to ensure the availability of the radio chip for as long as possible. All available energy is used to transmit the radio telegrams.

Has the wireless switch been filed for patent?
ZF has various patents filed for Energy Harvesting. These patents include technology, design and structure of the products, as well as applications. Details of the filed patents can be downloaded from the ZF website.

What is important for the installation of the generator?
A tight fit of the Energy Harvester has to be ensured over the whole life time. During the assembly of the Energy Harvester in the application you must consider the guidelines for the "press-in position" to avoid possible damage, as the functionality of the Energy Harvester could be affected. During assembly the mechanical parts should not be be pinched or their movement impeded. The specified lifetime and energy yield are only ensured if the exact actuation point is observed. All relevant information is detailed in our technical specification.

Which unique selling points distinguish the energy generator?
The unique characteristics of the ZF energy generator are the compact size and high energy yield. The generator is therefore suitable for installation in industrial switch applications and integration for building automation applications.

Which advantages are there for using the ZF KNX® switch module?
The energy harvesting pushbutton module from ZF directly supports the KNX-RF® radio protocol. Communication can be made with KNX® radio receivers or KNX® media coupler via the KNX-RF® protocol. There is no 'Gateway' necessary, to translate another radio protocol into a wired KNX® Bus. Also, the ZF pushbutton module and KNX® media coupler can be configured via the ETS software (from ETS5). Parameters can be loaded via radio into the devices.

Which housing, panels or rockers can be used for the KNX® light switch module?
The ZF pushbutton module is compatible with all switch series designed for energy harvesting pushbuttons. If there are questions regarding the selection and procurement, please contact ZF.

How could the KNX® pushbutton module be configured via ETS?
You can configure the ZF KNX® light switch module via ETS (from ETS5). The product can be selected via the ETS catalogue. In addition, ZF offers a catalogue file for download. There is the option to assign functions for light on/off, dim or shutter up/down. Parameters can be loaded via radio into the devices. During the charging process – which takes a few seconds – the required energy is supplied by the specified battery adapter. Watch this video for more information - https://youtu.be/uXeKGPCi_yM

How many KNX® devices can be connected?
Due to the KNX® topology, one line can combine 255 switches and one media coupler.

Where can electricians and system integrators purchase the ZF KNX® components?
For information on KNX® distributors and partners, please visit the ZF Switches & Sensors Website: https://switches-sensors.zf.com/location-cat/knx-partner/

BLUETOOTH®
FAQ'S

How does the pairing of the ZF Bluetooth® Low Energy components work?
Pairing of wireless device via pre-programmed MAC addresses, a dynamic list of connected switches or via a mobile app. According to the version pairing can also be realized via NFC.

Which smartphone app can be used to display the Bluetooth® Low Energy telegrams of a ZF Bluetooth® Low Energy Switch?
The telegrams can be displayed via IOS® Bluetooth® Smart Scanner or Android™ Bluetooth® Low Energy Analyzer.

Which housing, panels or rockers can be used for Bluetooth switch module?
The ZF pushbutton module is compatible with all switch series designed for energy harvesting pushbuttons. If there are questions regarding the selection and procurement, please contact ZF.

For more information on BLE solutions and devices please visit the ZF Switches & Sensors Website:
https://switches-sensors.zf.com/bluetooth-low-energy-5-0/

ENOCEAN®
FAQ'S

Which housing, panels or rockers can be used for EnOcean switch module?
The ZF pushbutton module is compatible with all switch series designed for energy harvesting pushbuttons. If there are questions regarding the selection and procurement, please contact ZF.

How does the pairing of the ZF EnOcean switch module work?
Pairing of the EnOcean switch module from ZF is depending on the receiver. Also, remote commissioning is possible (also via NFC).

Is the ZF switch module with EnOcean protocol compatible with existing EnOcean systems?
The switch module from ZF is completely compatible with existing EnOcean® RF-systems. ZF fulfills the EnOcean® Alliance Radio Standard ERP1 (ISO/IEC 14543-3-10).

Is the ZF switch module with EnOcean protocol certified by the EnOcean Alliance?
Yes, ZF is a member of the EnOcean alliance and the switch module is certified by the alliance.

For more information on EnOcean solutions and devices please visit the ZF Switches & Sensors Website:
https://switches-sensors.zf.com/enocean-3-0/

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