ENERGY HARVESTING FAQS

What form of energy does the generator produce?
The inductive generator transforms mechanical force into electrical energy in the form of an inductive voltage pulse. The energy management unit on the PCB converts this voltage pulse to a constant operating voltage for the RF chip through rectification and buffering.

Is the energy from the inductive generator stored?
The electrical energy generated is not stored. The energy is buffered with the aid of a condenser to ensure that the RF chip remains available for operation for as long as possible. All the energy is used for transmitting RF telegrams.

Has ZF filed a patent application for its wireless switch?
ZF has applied for several patents relating to energy harvesting. These patents cover the technology, design, and structure of the products as well as applications. You can download details about the registered patents from ZF's website.

What should I take into account when installing the generator?
The energy converter must be securely seated throughout the lifetime of the product. When installing the generator in a housing, note the relevant specifications for the press-fit positions to avoid possible damage to the energy converter. In addition, avoid distorting the energy converter during installation. The moving parts must not be pinched or hindered in their movement. The specified lifetime and energy generated are guaranteed only if the exact operating point is observed. All important information is contained in the technical specifications.

What is unique about the energy converter?
Its compact, miniature construction and its high energy output, which allows it to be integrated into industrial switching applications as well as building automation systems.

KNX PUSHBUTTON MODULE FAQS

What are the benefits of using the ZF KNX light switch module?
ZF's self-powered light switch module directly supports the KNX RF Ready protocol, thus permitting direct wireless communication with KNX RF receivers and KNX media couplers. No gateway is needed to convert another RF protocol on the wired KNX bus. Both the ZF light switch module and the KNX media coupler can be configured directly via the ETS5 software. The parameters can then be loaded wirelessly to the devices.

Which plastic frames, panels, and rocker switches are used for the KNX light switch module?
The ZF light switch module can be installed with a commercially available plastic frame that is designed for use with energy harvesting modules. Many well-known manufacturers offer these components, including Gira, Jung, BuschJäger, Legrand, and Schneider.

How is the KNX light switch module configured via ETS?
The ZF KNX light switch module can be configured directly via ETS5. For this purpose, ZF provides a corresponding catalog file for downloading. Functions can be assigned for lights on/off, dimming, and blinds up/down. The parameters can then be loaded wirelessly to the device.

During the loading process – which may take several seconds – the ZF light switch module is powered by a battery adapter.

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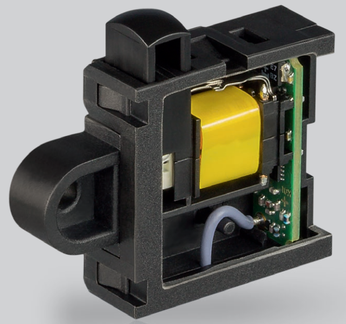
ENERGY HARVESTING WIRELESS SWITCH



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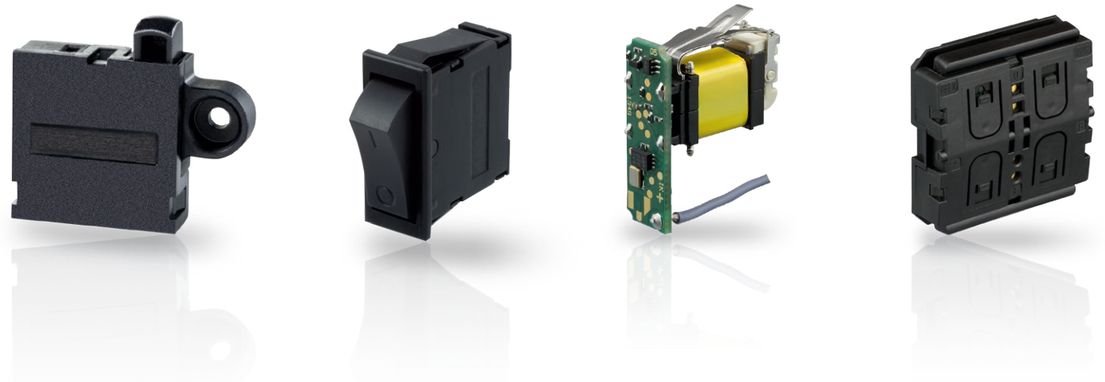
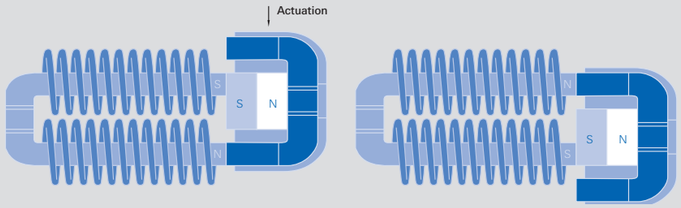
ENERGY HARVESTING WIRELESS SWITCH

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.



ENERGY HARVESTING WITH THE ENERGY HARVESTING WIRELESS SWITCH



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.

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 pushbutton module from ZF applies this principle of energy conversion.

Energy harvesting with an inductive generator

ZF’s energy harvesting wireless pushbutton 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 pushbutton 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, from ZF proprietary to ZigBee GreenPower, right up to customer-specific requirements. An excellent option for integration into building automation is provided by the worldwide bus standard KNX. This standard was developed in recent 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 pushbutton module, which integrates the energy harvesting aspect: Operating the pushbutton 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 because 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 micro-switches

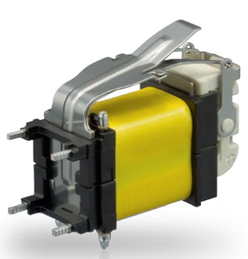
STANDARD TRANSMITTER – COMPONENTS

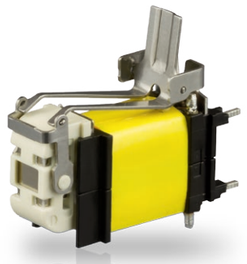
Generators – Features

- 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” allows the operation of several receivers with one switch (and vice versa)
- “Unique ID” ensures unambiguous identification when operating multiple switches





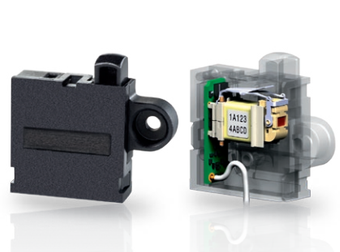
Technical data

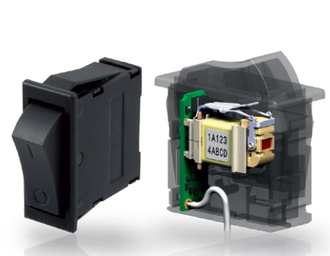
Series	Generator – momentary	Generator – maintained	Generator with PCB
Part no.	AFIG-0007	AFIG-0010	AFIM-1001 (868.3 MHz) / AFIM-5002 (915 MHz)
Dimensions	20.1 x 7.3 x 14.3 mm	20.1 x 7.3 x 19.3 mm	21.7 x 7.3 x 23.3 mm
Energy generated	2x min. 0.33 mWs	1x min. 0.33 mWs	–
Lifetime	min. 1,000,000 operations	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 or 915.0 MHz
RF protocol	–	–	ZF proprietary

STANDARD TRANSMITTER – WIRELESS SWITCH WITH HOUSING

Energy harvesting wireless snap and rocker switches – Features

- Energy harvesting, wireless system
- Miniature design combined with extremely high energy output
- Wireless data transfer via RF technology
  - Saves on plug connections
  - Easy to install in virtually inaccessible areas
  - No complex wire assembly
- Energy harvester without a battery: The RF energy required is created by the mechanical actuation of the switch
- Availability of multiple frequency bands allows use worldwide in a range of applications
- Maintenance-free – no batteries to replace
- Long mechanical life
- Flexible “pairing” allows the operation of several switches with one receiver (and vice versa)
- “Unique ID” ensures unambiguous identification when operating multiple switches
- Compatible RF receiver available
- Protocols are sent multiple times and delayed to ensure a robust data transmission
- Snap switch also available with auxiliary actuator options





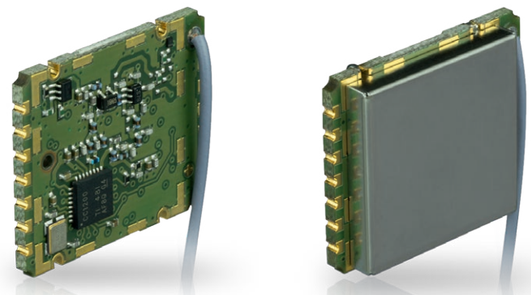
Technical data

Series	Energy harvesting wireless snap switch	Energy harvesting wireless rocker switch
Part no.	AFIS-1002 (868.3 MHz) / AFIS-5002 (915 MHz)	AFIS-1003 (868.3 MHz) / AFIS-5003 (915 MHz)
Dimensions	36.7 x 27 x 9.8 mm	27 x 27 x 11.85 mm
Design	Snap switch, momentary	Rocker switch, momentary
Temperature range	–40 to +85 °C	–40 to +85 °C
Lifetime	min. 1,000,000 operations	min. 100,000 operations
Frequency bands	868.3 MHz or 915.0 MHz	868.3 MHz or 915.0 MHz
RF protocol	ZF proprietary	ZF proprietary
RF distance (open area)	up to 300 m	up to 300 m
RF distance (in buildings)	up to 30 m	up to 30 m
Operating force	max. 15 N	max. 8 N
Operating speed	0.1 m / s	0.1 m / s
Housing protection class	IP40	IP40

RECEIVER PCB

Receiver only – Features

- PCB as standalone product for energy harvesting wireless switches
- Designed for frequency bands in Europe and China (868.3 MHz) or North America (915.0 MHz)
- Flexible “pairing” allows the operation of several wireless switches with one receiver (and vice versa)
- Unambiguous identification of each wireless switch by means of a hard-coded “unique ID”
- Compatible wireless switches (snap switch, rocker switch) available
- Reflow can be soldered
- Repeater function possible for greater distances
- Proprietary ZF RF protocol
- Various operating modes for interface and direct control transmission



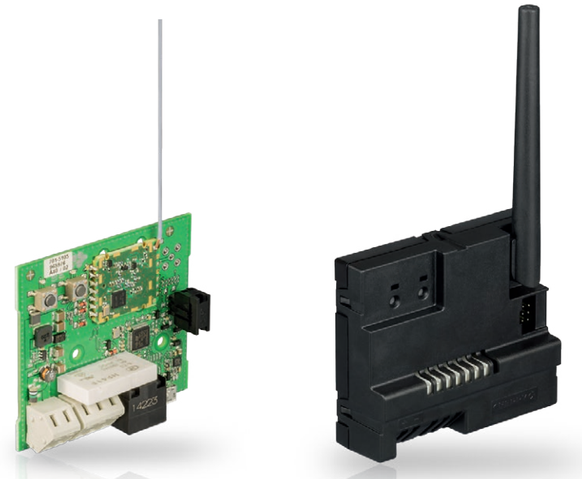
Technical data

Series	Receiver PCB
Part no.	AFZE-1005 (868.3 MHz, IFM) / AFZE-5004 (915 MHz, IFM) AFZE-1007 (868.3 MHz, DCM) / AFZE-5007 (915 MHz, DCM)
Dimensions	26 x 23 x 1.3 mm
Temperature range	–40 to +85 °C
Receiver sensitivity	typ. –98 dBm
Receiver class	Class 2
Supply voltage	5 V DC stabilized
Output interfaces **Operating modes**	Interface Mode (IFM): In interface mode, the RF telegrams received are combined in one UART telegram and transmitted. Direct Control Mode (DCM): In direct control mode, the telegrams received are evaluated and four output channels are switched directly.
Frequency bands	868.3 MHz or 915.0 MHz
Antennas	Wire antenna or 50 ohm output
RF protocol	ZF proprietary

RECEIVER WITH HOUSING

Receiver with housing – Features

- Standard receiver module for energy harvesting wireless switches
- Various connection options
- Suitable for wall or rail installation
- Designed for frequency bands in Europe and China (868.3 MHz) or North America (915.0 MHz)
- Flexible “pairing” allows the operation of several wireless switches with one receiver (and vice versa)
- “Unique ID” ensures the unambiguous identification of multiple switches
- Compatible wireless switches (snap switch, rocker switch) available
- Repeater function possible for greater distances
- Proprietary ZF radio protocol



Technical data

Series	Receiver PCB
Part no.	AFZE-1003 (868.3 MHz) / AFZE-5003 (915 MHz)
Dimensions	77 x 65.7 x 30.5 mm
Temperature range	–40 to +85 °C
Receiver sensitivity	typ. –98 dBm
Receiver class	–40 to +85 °C
Supply voltage	5 V DC stabilized or 7 V to 24 V DC unstable, 5 V USB
Output interfaces	Low-voltage relay 48 V or 230 V; TTL, RS232 or RS485 bus; digital output (high / low) or SPI; USB 2.0
Frequency bands	868.3 MHz or 915.0 MHz
Antennas	Wire antenna with plastic sleeve or 50 ohm output

Wireless pushbuttons

FOR BUILDINGS. Transmits its signal without batteries or wires, even through ceilings, floors, and walls.

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 multi-pushbutton module from ZF, you're finally entering the "smart" age. Connect your high-tech product comfortably and conveniently. ZF's energy harvesting multi-pushbutton 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 multi-pushbutton module, ZF declares war on cable slots and batteries. ZF's "energy harvesting" portfolio stands for easy installation and handling.

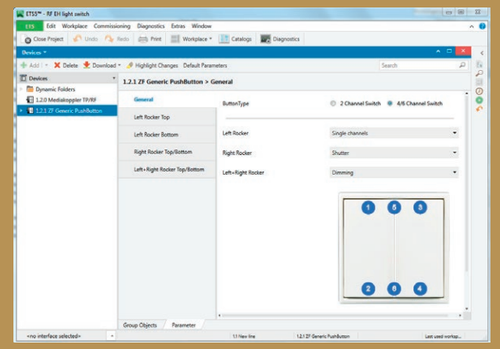
Flexible and uncomplicated

The multi-pushbutton 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 cozy with a preconfigured 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 our top sellers (e.g. KNX and ZigBee) to our customized RF solution. Every aspect of your application benefits from ZF's typically excellent service while we accompany you every step of the way. With the KNX multi-pushbutton 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 multi-pushbutton module from ZF be your next step toward a "smarter world".

KNX WIRELESS PUSHBUTTON MODULE: ONE SWITCH, SIX COMMANDS



WHETHER ZF OR ZIGBEE – LIGHT SWITCH MODULES SET YOU FREE

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.

Light switch modules from ZF speak your customers' language and support communication based on different RF protocols.

KNX RF
- See right-hand page

ZigBee GreenPower
- Integration in standard solutions
- Control of lighting / mood schemes, shutters, or blinds

ZF protocol, proprietary
- High energy efficiency
- For customer-specific solutions

Other
- EnOcean RF protocol

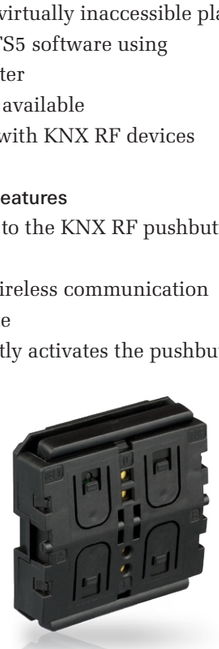
Over 500 of the company's own pushbutton modules ensure optimal working conditions in the ZF Forum.

KNX PUSHBUTTON MODULE WITH PROGRAMMING ADAPTER AND MEDIA COUPLER

Pushbutton module – Features
- Self-powered, wireless pushbutton 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 via the ETS5 software using of a programming adapter
- ETS5 product database available
- Direct communication with KNX RF devices

Programming adapter – Features
- Supplies battery power to the KNX RF pushbutton module
- Permits bidirectional wireless communication with pushbutton module
- When plugged in, directly activates the pushbutton module's pairing mode

Media coupler
- Connects a KNX TP (twisted-pair) line to a KNX RF (radio) line
- Receiver for KNX RF pushbutton module and other KNX RF devices
- Configurable via the ETS5 software using of a programming adapter
- ETS5 product database available
- Powered via TP KNX bus, so no external AC or DC power supply unit is required



Technical data

Series	KNX RF pushbutton 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)

RF TECHNOLOGY FAQS

What is pairing and how does it work?
To set up a connection between an RF transmitter and an RF receiver, the transmitter and receiver must be interconnected. The technical term for this is “pairing”. The RF receiver is switched to pairing mode with the press of a button. If one or more RF transmitters now emit a signal, all these transmitters are connected to the receiver.

What factors affect reception and transmission security?
The reception and transmission security of an RF system depends on various factors. In addition to technical variables such as the RF transmitter’s transmitting power, the most important factor is the ambient conditions. Barriers such as walls, floors, and ceilings suppress or reflect radio waves in buildings and can interfere with transmission security. RF transmission can also be disrupted by other RF devices if they use RF frequencies in the same range. See the relevant Application Note for instructions on how to operate and install our RF system.

How can reception and transmission security be guaranteed?
Barriers such as walls, floors, and ceilings suppress or reflect radio waves in buildings. Therefore, you should make sure that there are as few walls, floors, and ceilings as possible between RF transmitters and receivers when installing. Multiple RF telegrams are transmitted to minimize interference from other RF devices. See the relevant Application Note for instructions on how to operate and install our RF system.

How many transmitters can be linked to one receiver?
For products using a ZF protocol, up to 32 RF transmitters can be linked to one RF receiver in standard applications. For special applications, the number can be increased to a maximum of 256 RF transmitters.

How many RF telegrams are sent per actuation?
For products using a ZF protocol in standard applications, three redundant RF telegrams are sent per actuation to increase transmission security. For special applications, the number can be increased to a maximum of seven RF telegrams.

Can an RF signal from another RF receiver be intercepted?
Each ZF RF product transmits at a specific RF frequency. Only RF receivers that use the same frequency can receive and evaluate these RF signals. Each ZF RF telegram starts with a defined sequence of data bits called a “preamble”. Only RF receivers that know this preamble respond to the ZF RF signal. This means that RF signals can be evaluated only by receivers that operate on the same frequency and know the ZF RF protocol. See the relevant Application Note for details on the structure of the ZF RF protocol.

How does the receiver know which transmitter sent a signal it has received?
Each ZF RF transmitter is programmed with a unique 32-bit identifier (UID). Each RF telegram that the transmitter sends to the receiver contains this UID. When the RF transmitter is paired with the RF receiver, the receiver stores this UID. The receiver evaluates only RF signals from RF transmitters whose UIDs it has stored. See the relevant Application Note for details on the structure of the ZF RF protocol.

RF TECHNOLOGY FAQS

How many receivers can be paired with one transmitter?
For products using a ZF protocol, there is no limit to the number of RF receivers that can be paired with one RF transmitter.

Is transmission using ZF protocols encrypted?
Currently, transmission using a ZF protocol is not encrypted.

What receivers can be paired with energy harvesting RF transmitters?
To pair an RF transmitter with an RF receiver, the two devices must “speak the same language”. In the world of RF technology, this means that they must both use the exact same frequency and understand the RF protocol. That’s why RF telegrams from ZF products that use a ZF protocol understand and evaluate only those RF receivers that have implemented the ZF RF protocol, such as the ZF RF receiver.

Receiver	AFZE-1003 AFZE-1005 AFZE 1007	AFZE-5003 AFZE-5004 AFZE 5007
Transmitter		
AFIM-1001 AFIS-1002 AFIS-1003	●	–
AFIM-5002 AFIS-5002 AFIS-5003	–	●

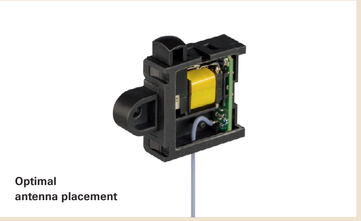
Why do energy harvesting RF products use different RF frequencies?
Two factors are key when selecting a frequency band: the technical propagation characteristics and regulatory or statutory applicability. Regarding the technical propagation characteristics, it is generally the case that lower frequencies have a greater transmission range. Furthermore, transmission characteristics in buildings are better at lower frequencies. This makes sub-GHz frequencies (i.e. frequencies below 1 GHz) especially attractive. Due to international and national provisions, however, not all frequencies can be used in all locations. Only the 2.4 GHz band, known as the ISM band, can be used worldwide in accordance with the international definition of the ITU (International Telecommunication Union). The 868 MHz frequency band is used only in Europe and China. This band may not be used in the U.S. or Canada. There it is necessary to use 915 MHz.

Region	Europe	China	U.S. / Canada
Frequency	–	–	–
868 MHz	●	●	–
915 MHz	–	–	●
2.4 GHz	●	●	●

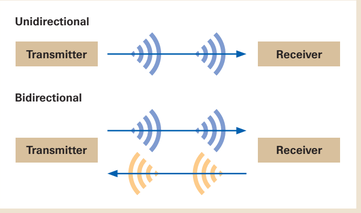
What do I need to know about antenna placement?
Because the task of an antenna is to emit the generated transmitting power at minimal loss (transmitter antenna) or to receive as much transmitting power as possible (receiver antenna), the placement of the antenna can significantly affect RF characteristics. ZF RF products come with either a wire antenna or a PCB antenna. If a wire antenna is used, this insulated wire must run to the outside of the housing. To guarantee optimal emission, the antenna must not be sharply bent or twisted. Nor should it come into direct contact with or be indirectly shielded by metallic surfaces. This applies to products with an antenna integrated directly onto the PCB as a printed conductor. See the relevant Application Note for instructions on how to install this product.

RF TECHNOLOGY FAQS

Can the wire antenna be shortened?
“Resonance frequency” is an important factor in antenna construction. At this frequency, antenna losses are at a minimum. The resonance frequency is generally the preferred communication frequency and preset in the RF chip. The antenna was designed to use precisely this frequency. This means that the length of the wire antenna exactly corresponds to its design. Shortening the wire interferes with transmission and should never be done.



What’s the difference between unidirectional and bidirectional communication?
RF communication can flow either exclusively from the transmitter to the receiver (unidirectional) or can flow from the transmitter to the receiver and vice versa (bidirectional). Bidirectional communication makes sense when the transmitter continues to emit its signal until it receives an acknowledgement from the receiver.



Can the ZF wireless switch also communicate bidirectionally?
The wireless switch supplies electrical energy when the induction generator is actuated or released. All the electrical energy generated is used for transmitting one or more RF telegrams. No energy is stored. No energy from generator actuation is available for receiving RF telegrams. The ZF wireless switch can communicate unidirectionally only.

Which RF protocols are supported?
ZF wireless switch products for industrial applications as well as the generator module support the ZF proprietary RF protocol. Light switch products support the KNX RF, ZigBee GreenPower, and EnOcean standard protocols. Bluetooth, ZWave, and WiFi are not currently supported.

Product	ZF proprietary	KNX RF	ZigBee Greenpower	EnOcean
	●	–	–	–
	●	–	–	–
	●	–	–	–
	●	–	–	–
	–	●	●	●
	–	●	–	–