

# Battery-Free Wireless Pushbutton

## Useful Tips for Reliable Range Planning



## 1. INTRODUCTION

Compared to wireline systems, wireless solutions enable convenient installation and greatest flexibility. Based on the physics of radio wave propagation, certain basic conditions must be observed. The straightforward recommendations in this guide apply to our battery-free radio bus system based on the ENOcean technology and shall ensure correct installation and reliable operation of the system.

## 2. PRINCIPLES OF WIRELESS SIGNALS IN BUILDINGS

The radio transmitters send event-triggered telegrams to the radio receiver. The receiver, also known as actuator, checks the incoming telegrams and thus controls its outputs. Since the radio signals are electromagnetic waves, the signal is attenuated on its way from the transmitter to the receiver. That means, the field strength decreases with increasing distance between transmitter and receiver, so, the transmission range is limited.

The fact that certain materials are affecting the transmission range must also be taken into consideration.

It is true that radio waves can penetrate walls, but thereby the attenuation increases even more than by a propagation in the free field. Here are some examples of different wall types :

<b>Material</b>	<b>Attenuation</b>
Wood, plaster, uncoated glass	0...10%
Brick, pressboard	5...35%
Ferro concrete	10...90%
Glass with metal coating	60...90%
Metal, aluminium coating	90...100%

Moreover, the way of installing the transmitter and especially the receiver is of great importance. It should definitely be avoided to mount them e.g. in electrical distributors made of steel, behind metal covers or in lights.

In practice that means that the materials used in buildings are of paramount importance for the evaluation of the transmission range.

Here are some guiding values to facilitate the evaluation of the environment:

**Lines of sight:** typical: 30 m range in corridors, up to 100 m in halls

**Plaster walls / dry wood:** typical: 30 m range through max. 5 walls

**Brick walls / aerated concrete:** typical: 20 m range through max. 3 walls

**Ferro-concrete walls / ceilings:** typical: 10 m range through max. 1 ceiling

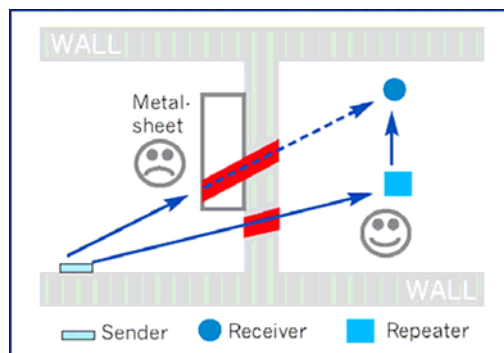
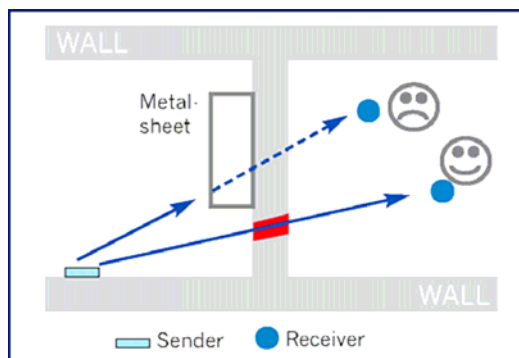
### 3. Screening

Metallic parts, such as reinforcements in walls, metallic foils of thermal insulations or metalised heat-absorbing glass, reflect electromagnetic waves. Thus, a so-called radio shadow is built up behind these parts, an area that cannot be reached by the radio transmitters.

Some major conditions that can restrict the transmission range:

- **Installation of switch on a metal wall** (typical loss of range 30%)
- **Use of metallic switch frames** (typical loss of range 30%)
- **Hollow lightweight walls filled with insulating wool on metal foil**
- **Inserted ceilings with panels of metal or carbon fibre**
- **Lead glass or glass with metal coating, steel furniture**
- **Installation of actuators in lights**
- **Installation of actuators in blind boxes**
- **Installation of actuators in concrete floor junction boxes**
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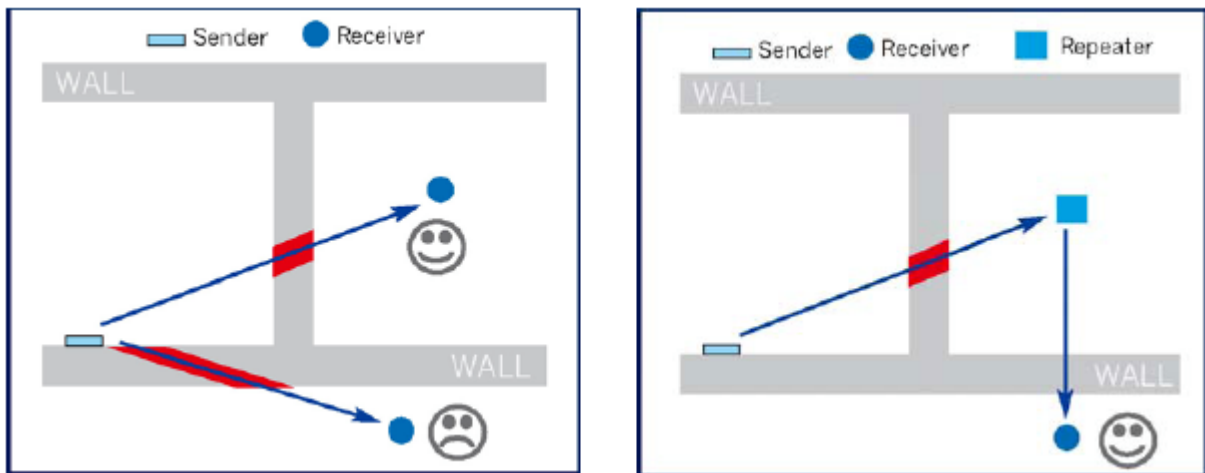
**Tip 1** Fire-safety walls, lift shafts, staircases and service areas should be considered as screening areas.



**Tip 2** Avoid screening by repositioning the transmitting and/or receiving antenna away from the radio shadow, or by using a repeater.

#### 4. PENETRATION ANGLE

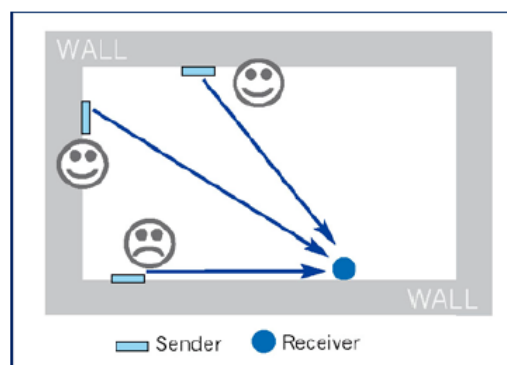
The angle at which the transmitted signal hits the wall is very important. Depending on this angle, the effective wall thickness and thus the signal attenuation varies. If possible, the signals should run vertically through the walling. Walling recesses should be avoided.



**Tip 3** Remedy an unfavourable penetration angle by repositioning the transmitting and/or receiving antenna, or by using a repeater.

#### 5. ANTENNA INSTALLATION

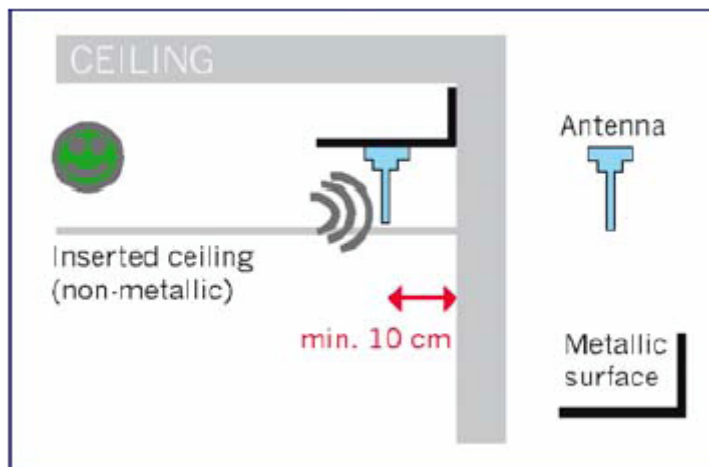
Radio receivers with internal receiving antenna should not be installed on the same side of the wall as the transmitter. In the wall area, radio waves are rather subject to an interfering scattering or reflection. Hence, the antenna should be mounted on the opposite side or adjacent.



**Tip 4** Avoid radio propagation along a wall area.

When using devices with external antenna, the ideal place to install it is in the center of the room. As far as possible, the antenna should be at least 10 cm away from the wall or concrete ceiling.

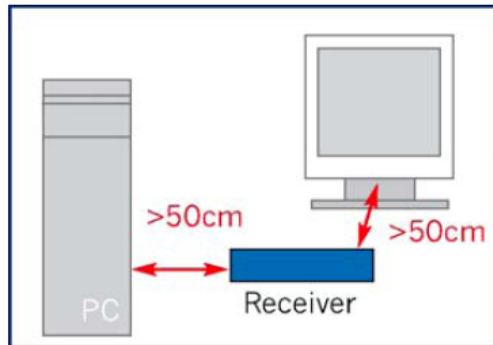
A magnetic base antenna must be attached onto a large metal surface in order to create an adequate antipole. Due to the polarisation of the radio waves, the magnetic base antenna should be aligned vertically. When installing the antenna cable make sure not to bend it as this may cause an irreparable damage (performance reduction through change of characteristic wave impedance).



**Tip 5** A so-called „active antenna“ is a radio receiver with attached antenna, which communicates with the actuator e.g. via a shielded cable. The cable should not be bent during installation and preferably not be extended, because the signal degrades with increasing length. All receivers of the type S\_789-601, S\_789-602 and S\_8003-001 can use the external receiving antenna S\_758-910. Hence, the receivers can also be installed in steel cabinets and the like.

## 6. DISTANCE BETWEEN RECEIVERS AND OTHER SOURCES OF INTERFERENCE

Radio transmitters can be mounted to any other transmitters without problems. However, the distance between the radio receivers and other transmitters (e.g. GSM / DECT / Wireless LAN) and high-frequency sources of interference (lights, transformers, computers, audio and video equipments) should be at least 50 cm.



**Tip 6** The distance between the radio receiver and other high-frequency transmitters should be at least 50 cm, the transmitter position is not critical.

## 7. USE OF REPEATERS

In case of poor reception quality it may be helpful to use a repeater. Repeaters mostly do not require any configuration (e.g. programming) and are simply put into operation by connecting them to the supply voltage. Possible applications are shown in the illustrations of the chapters „Screening“ und „Penetration“.

**Tip 7** In the preliminary planning stage, it may be worth to consider a retrofitting of the system with radio repeaters.

Some radio repeaters cannot be cascaded in their basic function; already repeated telegrams are not repeated again („1-level“ repeater). Repeaters which can be switched to 2-level function permit cascading of two repeaters but which are rarely required in the building technology.

**Tip 8** The use of too many repeaters is counterproductive (higher costs, telegram collisions).

## 8. FIELD INTENSITY METER

The EPM100 is a mobile field intensity meter enabling the installer to easily determine the optimal mounting positions for sensors and receivers. Furthermore, it can be used for checking faulty connections of already installed devices. The meter indicates the field intensities of received radio telegrams and any interfering radio signals in the 868MHz range:

The lighting-up of the GREEN LED signalises that the received field strength has sufficient power reserve for a reliable installation. So, any later changes of the ambient conditions (additional attenuation due to the installation of lightweight walls, shadowing by people in the room, etc.) will not affect this reserve. To distinguish a possible interfering transmitter the YELLOW LED simultaneously signalises a valid radio telegram.

How to use the field intensity meter and determine the mounting positions of sensors and receivers: Person 1 operates the radio sensor and generates radio telegrams by pressing the button. Person 2 checks on the meter the received field intensity and thus determines the ideal mounting position.



Field intensity meter EPM100 and field intensity testing set EPM200

**Tip 9** The field intensity meter EPM100 permits on-site determination of the ideal mounting position as well as identification of an interfering transmitter.

**Tip 10** Even after careful planning, the EPM100 should be used during installation to verify proper reception at the receiver position.

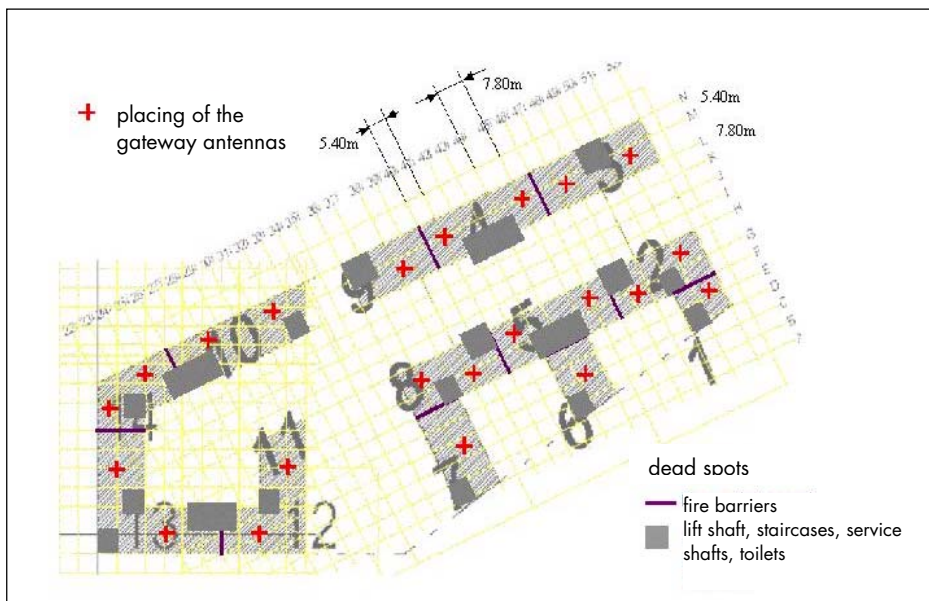
## 9. PLANNING GUIDE FOR COMMERCIAL BUILDINGS

Wireless coverage in commercial buildings is usually restricted by fire-safety walls that must be considered as screening. Inside the fire-protection zones lightweight or glass partition walls are generally used as featuring good radio propagation properties (except for metal reinforcements or metalised walls!). The two common installation architectures are:

- **Automation Systems (e.g. TCP/IP, LON, EIB)**  
To ensure complete coverage 1 to 2 wireless gateways placed centrally to the automation bus are sufficient per fire-protection zone (see illustr. under Tip 12)
- **Direct Control of the Actuators**  
Typically, the wireless paths to be covered are not very long ("cubicle installation")

Unfavourable conditions can be improved by an appropriate repositioning of the devices (or antennas), or by using a repeater. In the latter case, please observe the application and installation instructions in chapter 7 „Use of Repeaters“.

**Tip 11** For a highly robust wireless transmission system it is advisable to implement a redundant radio receiver path. For this purpose, programme two gateways for parallel reception of one radio transmitter or install one repeater per radio cell.



**Tip 12** Position the wireless gateways in a way to ensure that no screening blocks the connection to any corner inside the fire-protection zone (potential sensor positions).

## 10. PLANNING GUIDE FOR RESIDENTIAL BUILDINGS



For applications restricted to one or two rooms (e.g. when retrofitting a switch or an awning), the direct transmission range is usually adequate. For applications „throughout“ the building, one needs to differentiate as follows:

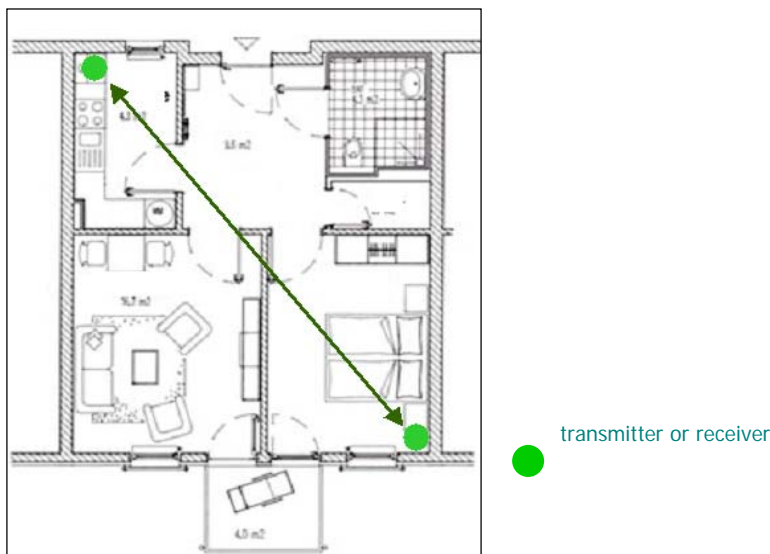
### **Flats, terraced or single-family detached houses up to 400 sqm**

- Larger residential units up to 3 rooms (living and bedroom) should be equipped with a radio repeater. The local position of the repeater is not critical, but should be placed centrally in the residential unit (e.g. in the center of the middle floor).
- The radio repeaters are designed in a way that a second repeater can be added in case of heavy ceiling reinforcement or other screening.
- Note: The use of too many repeaters is contraproductive (higher costs, telegram collisions).

### **Multi-family Residences and Multi-storey Buildings**

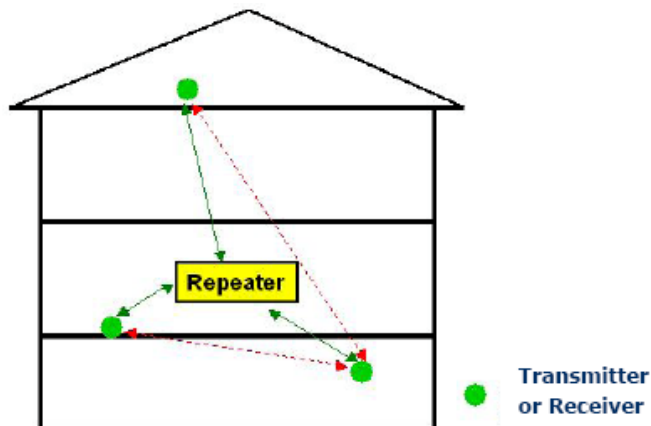
- Use separate radio systems for each flat.
- One radio gateway per flat can be used for cross-property connection via an established automation system (e.g. EIB, LON, TCP/IP, usw.) eingesetzt werden.

### **Small Residential Unit** (up to 3 walls and 1 ceiling)



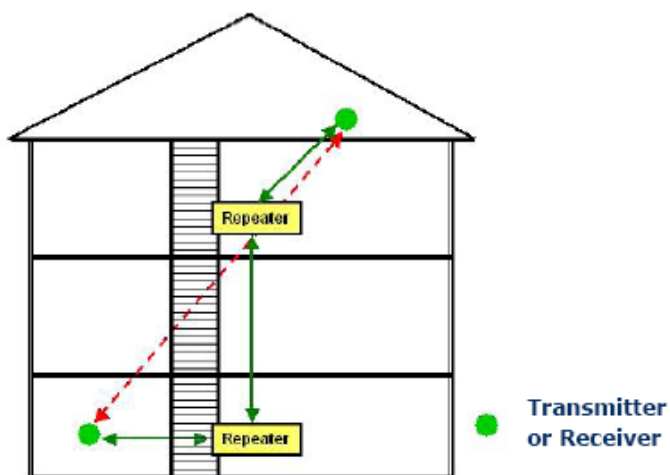
**Tip 13:** For a studio apartment or 2 floors of a town house, the direct transmission range is usually adequate.

**Multi-room flat and single-family detached house**  
(more than 3 walls, more than 1 ceiling)



**Tip 14** In a larger residential unit, it is generally advisable to install a central repeater to ensure wireless coverage.

**Extreme example in a single-family detached house**



**Tip 15** In rare cases of heavily reinforced concrete ceilings or thick basement walls, a second repeater may be necessary to ensure full coverage (both repeaters must be switched to 2-level function, see information in chapter 7).

## 11. WIRELESS SYSTEM DEBUGGING

Check-up with the EPM 100

The EPM 100 has 4 LED's in the upper part 4.

no radio signal	border area	good reception	telegram
○	○	○	○
red	yellow	green	yellow

When observing the above information on selecting the ideal mounting place for transmitters and receivers, a smooth operation of the devices should be ensured. Nevertheless, should you encounter any wireless transmission problems, the following debugging table may be a useful tool:

Fault	Possible Cause	Checking and Remedy
<b>Transmitter received not at all</b>	Transmitter fails to send	<p><b>Place the EPM100 near to the sender (distance abt. 20-50cm).</b>  <b>Activate a transmission telegram – both, the green LED and the yellow one for telegram fail to light up. If only the green LED lights up no telegram will be transmitted.</b></p> <p>→ Check the transmitter. When operating in both directions, a distinct click should be heard; when you hear the clicking but the transmitter fails to send properly, it must be replaced.</p>
	Transmitter is installed outside the receiver range	<p><b>Near the receiver (distance abt. 20-50 cm) the EPM100 does not receive a transmission telegram:</b>            Activate a transmission telegram - only the red LED of the EPM lights up.</p> <p>→ Reposition the transmitter or receiver by observing the hints for range planning and mounting.</p>
	Transmitter was removed (or possibly exchanged)	Program new transmitter into the receiver

	Receiver does not receive	<p><b>Near the receiver (distance abt. 20-50cm) the EPM 100 has good reception of the transmission telegram. Both, the green LED and the yellow one for telegram are lighting up.</b></p> <p>→ Check the receiver and the receiving antenna. If only the yellow LED for the border area and the yellow one for the telegram light up, it may happen that the receiver does not respond because it has been installed e.g. in the wall.</p>
	Transmitter not programmed	Reprogram the transmitter into the receiver
	Antenna not correctly installed	Check antenna connection

	Interfering transmitter existent	<p><b>At least one of the GREEN LED's of the EPM100 lights up occasionally but none of the YELLOW ones:</b> Invalid telegrams are occasionally received</p> <p>→ Remove source of interference</p>
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<b>Fault</b>	<b>Possible Cause</b>	<b>Checking and Remedy</b>
	Interfering transmitter permanently existent	<p><b>Near the receiver either the yellow LED (for border area) of the EPM100 or the green LED lights up.</b></p> <p>→ Remove source of interference</p>
	High-frequency source of interference near the receiver	Remove the source of interference (telephone, PC, etc.), distance at least 50 cm to the ENOcean receiver
<b>Transmitter is intermittently not received</b>	Transmitter is placed in the border area of receiver's range	<p><b>Near the receiver (distance abt. 20-50 cm) the EPM100 receives transmission telegrams only in the border area:</b> Activate a transmission telegram – only the two yellow LED's are lighting up.</p> <p>→ Reposition the transmitter or receiving antenna or install a repeater.</p>
	Temporary change of ambient conditions (cabinet, door, plants, people, interfering transmitter)	Check distance to high-frequency sources of interference, at least 50cm. Otherwise refer to "Transmitter is placed in the border area of receiver's range"
	The mounting place of the transmitter changes	Reposition the transmitter within the reception range

	occasionally (e.g. transmitter mounted on a mobile object)	
	Interfering transmitter existent	<p><b>Near the receiver either the yellow LED (for border area) of the EPM100 lights up temporarily, or the green LED.</b></p> <p>→ Invalid telegrams are occasionally received.</p> <p>If the frequency of 868.3MHz is used by several systems, it may of course happen that two or more signals meet . In this case one has to accept the facts.</p>

## DISCLAIMER

The information provided in this document serves to describe typical features of the radio bus system and are not to be understood as specified operating characteristics. No liability is assumed for any errors or omissions. We reserve the right to make changes without prior notice.