Reliable Range Planning

1. INTRODUCTION

Compared to installing wired systems, wireless systems provide much simpler installation as well as the flexibility to relocate or add to a system. Based on the physical principle of the propagation of radio waves, certain basic conditions should be observed. The following simple recommendations are provided to ensure successful installation and reliable operation of a robust radio network.

2. PRINCIPLES OF RADIO SIGNALS IN BUILDINGS

The EnOcean radio transmitters send wireless transmissions to the EnOcean radio receivers. The receiver checks the incoming telegrams for accuracy and uses the data to control outputs. Radio signals are electromagnetic waves, hence the signal becomes weaker the further it travels.
Please note that the coverage is decreased by specific materials found in the direction of the propagation. While radio waves can penetrate a wall, they are dampened more than on a direct line-of-sight path. Examples of different types of wall:

Material	***Attenuation***
Wood, plaster, glass uncoated, without metal	0...10%
Brick, press board	5...35%
Ferroconcrete	10...90%
Metal, aluminium lining	90...100%

In practice, this means that the material used in buildings play an important role in assessing the radio coverage.

Here are some typical guideline figures:

Line-of-sight connections: typ. 30m range in corridors, up to 100m in halls
Plasterboard walls / dry wood: typ. 30m range, through 5 walls
Brick walls / aerated concrete: typ. 20m range, through 3 walls
Ferroconcrete walls / ceilings: typ. 10m range, through 1 ceiling

3. SCREENING

Objects made of metal, such as wall reinforcements, the metal foil of heat insulations or metallised heat protection glass, reflect electromagnetic waves and thus create what is known as radio shadow

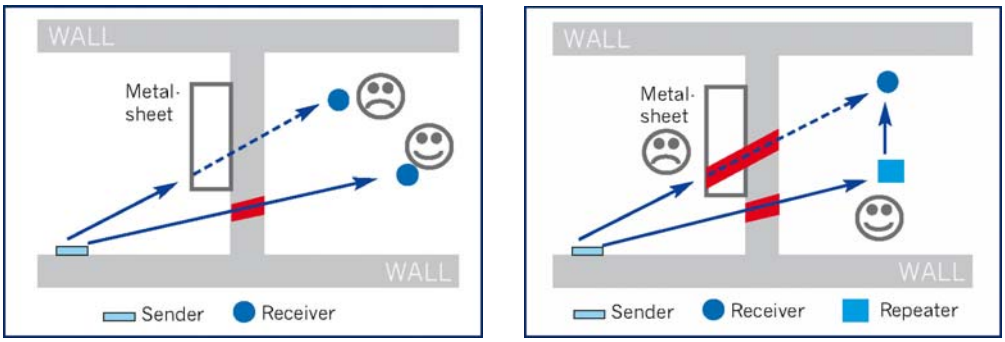
The main factors decreasing coverage include:

- ***Switch mounted on metal surfaces*** (typically 30% loss of range)
- ***Use of metallic switch frames*** (typically 30% loss of range)
- ***Hollow lightweight walls filled with insulating wool on metal foil***
- ***Inserted ceilings with panels made of metal or carbon fibre***
- ***Lead glass or glass with metal coating, steel furniture***

EnOcean GmbH
Kolpingring 18a
82041 Oberhaching
Germany

Phone +49.89.67 34 689-0
Fax +49.89.67 34 689-50
info@enocean.com
www.enocean.com

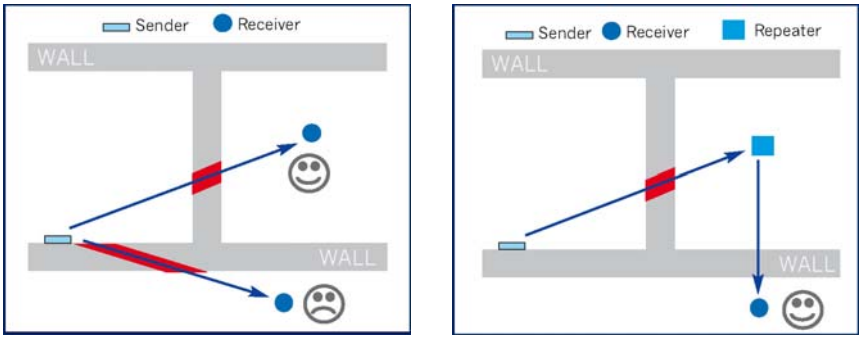
Tip 1 Fire-safety walls, elevator shafts, staircases and supply areas should be considered as screening.



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

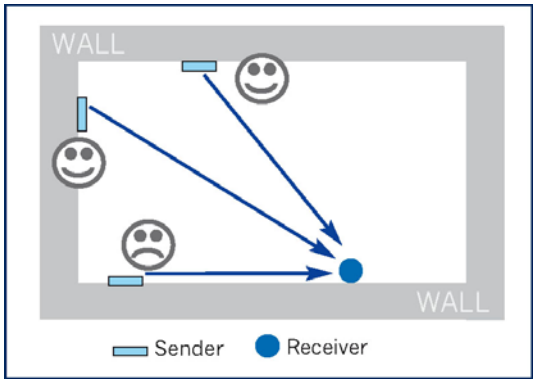
The angle at which the transmitted signal hits the wall is very important. The effective wall thickness – and with it the signal attenuation – varies according to this angle. Signals should be transmitted as directly as possible through the wall. Wall niches should be avoided.



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

5. ANTENNA INSTALLATION

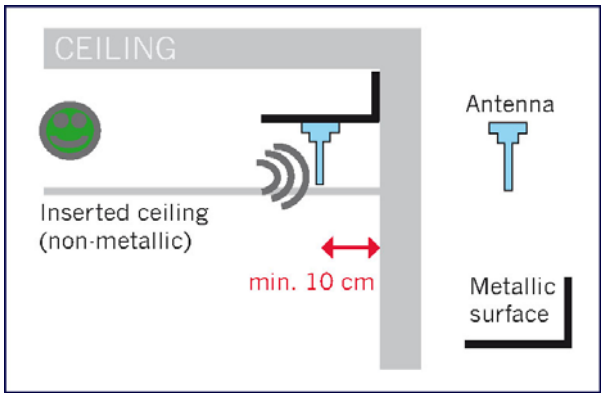
When using devices with an internal receiving antenna, the device should not be installed on the same side of the wall as the transmitter. Near a wall, the radio waves are likely to be subject to interfering dispersions or reflections. Consequently, position the antenna on the opposite or connecting wall.



Tip 4 Avoid radio propagation along a wall.

When using devices with an external antenna, the antenna should be mounted in a central location in the room. Where possible, the antenna should be at least 10cm away from the wall or concrete ceiling.

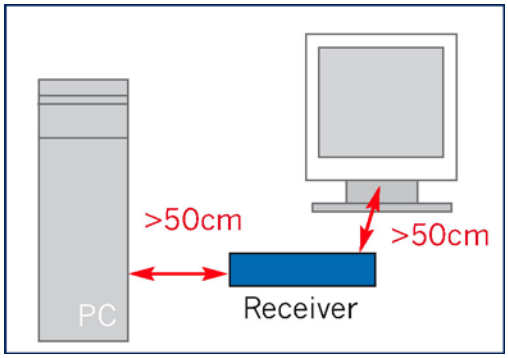
A magnetic antenna needs to be placed on a large metallic surface to create an adequate antipole. Due to the polarisation of the radio waves, a magnetic base antenna should be placed vertically. Flexing the antenna cable during installation can result in irreparable damage (performance reduction through change of impedance level).



Tip 5 A so-called “active antenna” is a radio receiver with integrated antenna. It communicates with the actuator unit via a RS485 cable for example (“RS485 gateway”). Thus a shielded antenna cable, which would loose performance with increasing length and could be folded during installation, can be avoided.

6. DISTANCE BETWEEN RECEIVER AND SOURCES OF INTERFERENCE

The distance between **EnOcean receivers** and other transmitters (e.g. GSM / DECT / wireless LAN) or high-frequency sources of interference (computers, audio and video equipment) should be at least 50cm. However, **EnOcean transmitters** can be installed next to any other high-frequency transmitters without any problem.



Tip 6 The distance of the EnOcean receiver to different high-frequency transmitters should be at least 50cm, the transmitter position is not critical.

7. USE OF REPEATERS

In case of poor reception, it may be helpful to use a repeater. EnOcean repeaters do not require any configuration (e.g. programming) and are put into operation simply by connecting them to the supply voltage. The various possibilities of use are shown by the illustrations in the chapters “Screening” and “Penetration”.

Tip 7 While planning, it may be worth considering retrofitting the system with a repeater.

In their basic function, EnOcean repeaters cannot be cascaded, telegrams already repeated are not repeated again (“1-level” repeater). Repeaters which can be switched to 2-level function are currently in preparation. This extended function will allow two repeaters to be cascaded which is required only in rare cases in the building industry.

Tip 8 Do not use too many repeaters as this is counterproductive (higher costs, telegram collisions)

8. FIELD INTENSITY METER

The EPM 100 is a mobile field intensity meter enabling the installer to determine the ideal mounting positions for sensors and receivers. Furthermore, faulty connections of devices already installed can be checked. The meter shows the field intensities of radio telegrams received and any interfering radio signals in the 868MHz range:

The flashing of one of the two GREEN light emitting diodes signals that the receiving field force possesses sufficient power reserve for a reliable installation. There will be generous provision for subsequently changing conditions of the surroundings (i.e. additional screening caused by lightweight walls, shadowing by people etc.). For differentiation from a jammer the YELLOW light emitting diode simultaneously signals a valid EnOcean telegram. For further information, refer to the operating instructions provided with the EPM 100.

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

Field intensity meter EPM 100 and test set EPM 200

Tip 9 The EPM 100 field intensity meter can be used for on-site determination of the ideal mounting position and for identification of an interfering transmitter.

Tip 10 Even after careful planning, the EPM 100 should be used to verify proper reception at the receiver position during installation.

9. PLANNING INFORMATION FOR COMMERCIAL BUILDINGS

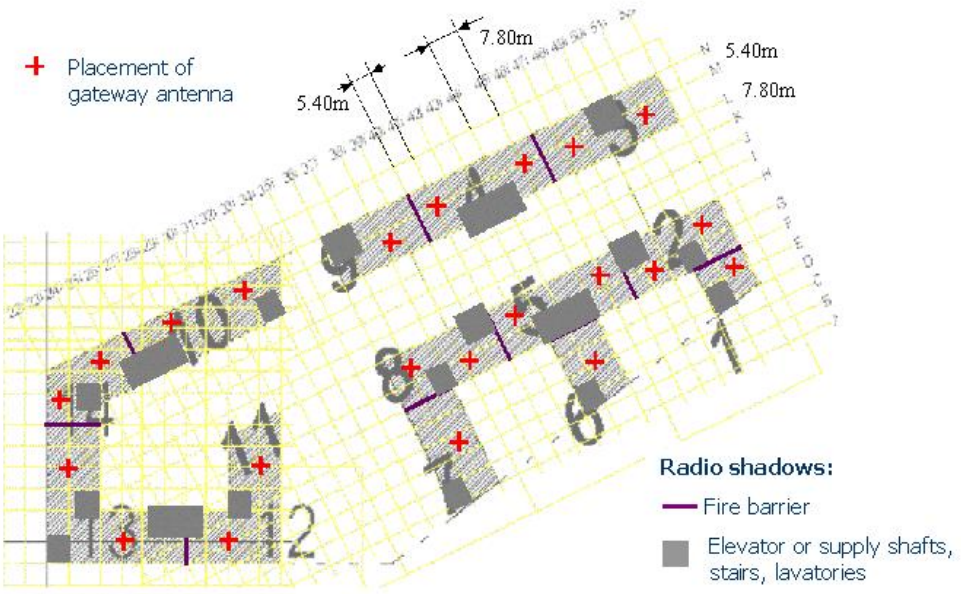
The radio coverage in commercial buildings is usually restricted by fire safety walls, which must be considered as screening. Inside the fire protected sections lightweight or glass partition walls are used with excellent radio wave propagation properties (except for metal reinforcements or metalised walls!).
The following are two common installation architectures:

- ***Automation system (e.g. TCP/IP, LON, EIB)***
  For complete coverage, each fire safety section usually requires 1 or 2 central radio gateways to the automation bus (see picture relating to Tip 12)

- ***Direct activation of the actuators***
  Usually, the radio paths to be covered are not very long ("cubicle installation")

Unfavourable conditions can be improved by appropriately repositioning the devices (antennae) or by using a repeater. In regard to the latter, please read the information on use and installation provided in chapter 7 "Use of Repeaters".

Tip 11 For a highly robust radio transmission system it is advisable to implement a redundant radio receiver path. To do so, either program two gateways for parallel reception of a radio transmitter or install one repeater per radio cell.



Tip 12 Position the radio gateways in such a way that no screens block the connection to any corner inside the fire safety section (potential sensor positions).

10. PLANNING INFORMATION 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 always adequate. For applications “throughout” a building, the following differentiations must be made:

Flats and terraced houses and single-family houses of up to 400sqm

- Larger residential units with 3 rooms or more (living room and bedrooms) should be fitted with a repeater. The repeater should be centrally placed (e.g. in the centre of the middle floor).
- EnOcean repeaters are designed in such a way that a second repeater can be added in case of heavy ceiling reinforcement or other screening.
- Note: Using too many repeaters is counterproductive (higher costs, telegram collisions).

Multifamily units and high-rise buildings

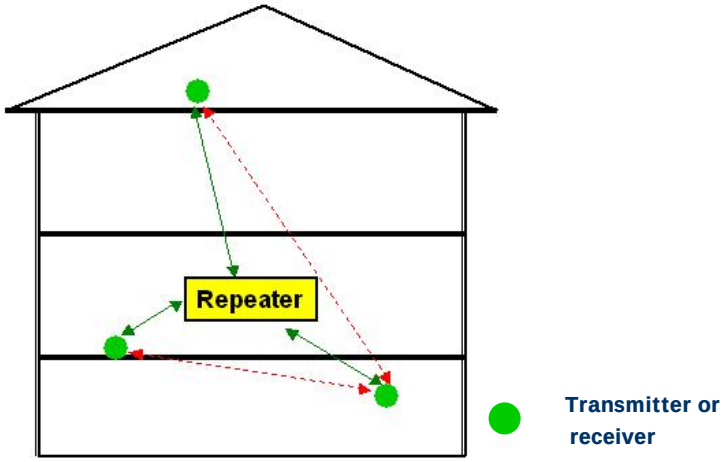
- Use separate radio systems for each flat.
- One radio gateway per flat can be used for cross-property connection via an established automation system (e.g. EIB, LON, TCP/IP, etc.)

Small residential unit

(up to 3 walls and 1 ceiling)

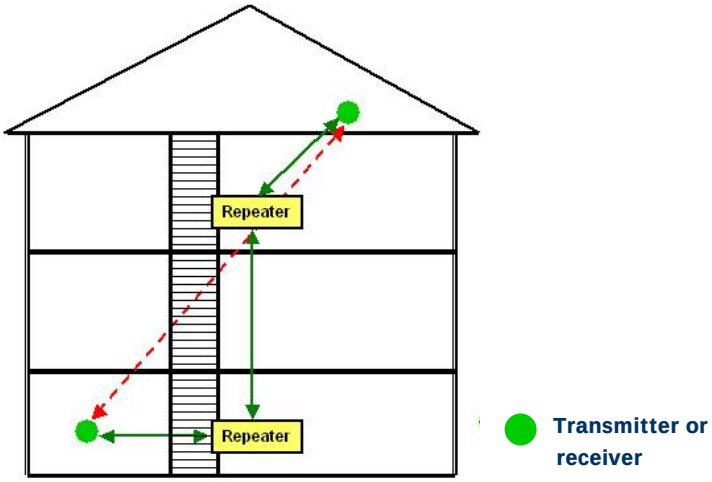
Tip 13: Bedsit or up to 2 floors in a townhouse: the direct transmission range is usually adequate

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



Tip 14 To ensure radio coverage in a larger residential unit, it is generally advisable to install a central repeater.

Extreme example in a one-family house



Tip 15 Heavily reinforced concrete ceilings, thick basement walls: in rare cases a second repeater may be necessary to ensure full coverage (both switched to 2-level function, see information in chapter 7)

11. TROUBLESHOOTING

The foregoing information on selecting the ideal place of installation for transmitters and receivers has been provided to ensure a smooth operation of the devices. If, however, you still experience radio transmission problems, please refer first to the following table for troubleshooting:

Fault	Possible cause	Checking and potential remedy
Transmitter not received	Transmitter fails to send	**Near the transmitter (distance of around 20-50cm), the EPM 100 does not receive a transmission telegram:** Activate a transmission telegram, the right GREEN light emitting diode of the EPM fails to light up → Check the transmitter. Where necessary, ensure sufficient light for solar-operated transmitters (for a quick functional test, briefly expose to daylight or place under a bright lamp).
	Transmitter installed outside the receiver range	**Near the receiver (distance of around 20-50cm), the EPM 100 does not receive a transmission telegram:** activate transmission telegram, the GREEN light emitting diodes of the EPM fail to light up → Reposition transmitter or receiver and follow the information on coverage and installation.
	Transmitter was removed (or maybe exchanged)	Program new transmitter into the receiver
	Receiver does not receive	**Near receiver antenna the EPM 100 has good reception of transmission telegrams:** activate transmission telegram, one GREEN light emitting diode of the EPM lights up → Check the receiver and/or the antenna
	Transmitter not programmed (or wrong transmitter programmed)	Reprogram transmitter into the receiver
	Antenna not connected correctly	Check installation of the antenna cable

Fault	Possible cause	Checking and potential remedy
	Jammer present	**At least one GREEN, but no YELLOW light emitting diode of the EPM 100 signals constantly:** no valid EnOcean telegram are received permanently → remove jammer
	High-frequency jammer near receiver	Move jammer (telephone, PC etc.) at least 50cm away from EnOcean receiver
Transmitter intermittently not received	Receiver is placed at the limit of the transmitter's range	**Near receiver antenna (distance of around 20-50cm) the EPM 100 receives transmission telegrams only marginally:** activate transmission telegram, none of the GREEN light emitting diodes of the EPM light up, but the YELLOW one → Reposition transmitter or receiver antenna, or use repeater
	Occasional change in environmental conditions (cupboard, door, plants, people, interfering transmitters)	Check distance to high-frequency sources of interference, at least 50cm. Or the receiver is placed at the limit of the transmitter's range
	The place of installation of the transmitter changes occasionally (e.g. transmitter fitted to a mobile object)	Choose a place of installation for the transmitter within the range of reception
	Jammer present	At least one GREEN light emitting diode signals intermittently, but not the YELLOW one of the EPM 100 (no valid EnOcean telegrams) → remove jammer

12. DISCLAIMER

The information provided in this document describes typical features of the EnOcean radio transmission system and should not be misunderstood as specified operating characteristics. No liability is assumed for errors and / or omissions. We reserve the right to make changes without prior notice. For the latest documentation visit the EnOcean website at www.enocean.com.