RADIO SYSTEM INSTALLATION AND SIGNAL PENETRATION

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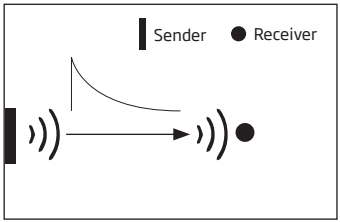
1. RADIO SIGNALS IN BUILDINGS

Radio signals are electromagnetic waves, hence the signal becomes weaker the further it travels, the range is limited.



1.1. Reflection and Transmission

Beside these natural transmission range limits, further interferences have to be considered: metallic parts, e.g. reinforcements in walls, metallized foils of thermal insulations or metallized heat-absorbing glass, reflecting electromagnetic waves. Thus, a so-called radio shadow is produced behind.

It is true, that radio waves can penetrate walls, but thereby the damping attenuation is even more increased than by a propogation in the free field.

The radio coverage is further decreased by specific materials

In the following please find some examples of different types of wall:

Material	**Range reduction vs LoS**
Wood, plaster, glass uncoated, without metal	0 - 10 %
Brick, press board	5 - 35 %
Ferro concrete	10 - 90 %
Metal, aluminium lining	see **1.2. Screening**

At 30 m range the theoretical diameter of the ellipsoid is around 10 m at 868 Mhz system frequency. So narrow floors with thick walls are unfavourable:

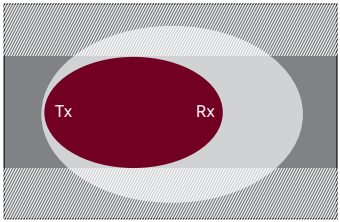


Fig. 1: Radio transmission shapes an ellipsoid

Kind of antenna mounting and antenna distance from ceiling, floor and walls are a major influence for coverage. External antennas typically do have a better radio performance than internal antennas from in-wall receivers. People and other objects within a room also can reduce the radio range. Because of the big amount of different impacts, in practice the common specification of "30 m in-door range" should be considered more precisely. Reserve in the range planning is needed to achieve reliability of the radio system, even in case of several unfavourable conditions combined.

Radio signal range variation depends on the building. Reliable and robust in-door installation can be achieved through sufficient reserve in coverage. Recommendations from practice to provide this are:

Visual contacts: Typical 30m range in passages, corridors, up to 100m in halls

- **> 30 m:** under ideal conditions – broad room, no obstacles, and good antenna positions.
- **> 20 m:** building is filled with furniture and people. And penetration through up to 5 dry walls or up to 2 brick walls or up to 2 aero concrete walls, if transmitter and receiver do have good antenna positions.
- **> 10 m:** if receiver is mounted on a massive wall. Or receiver is placed next to a room corner. And switch or whip antenna is mounted on metal. Or range along a narrow floor.

1-2 metal-reinforced ceilings at upright penetration angle (in strong dependence of reinforcement density and antenna positions).

1.2. Screening

Massive objects made of metal, such as metallic separation walls and metal inserted ceilings, massive wall reinforcements and the metal foil of heat insulations, reflect electromagnetic waves and thus create what is known as radio shadow. However singularized small metal studs, e.g. the metal studs of a gypsum dry wall, don't show a recognizable screening.

- Switch mounted on metal surfaces (typically 30% loss of range)
- Use of metallic switch frames (typically 30% loss of range)

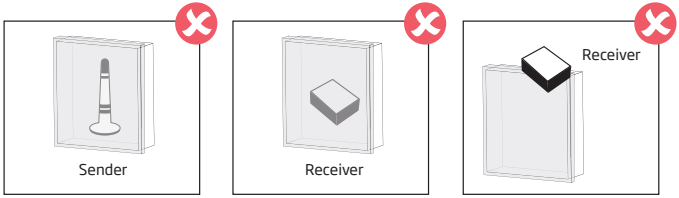


Fig. 2: Wrong sender and receiver placement

Metal separation walls: It can be noticed that radio transmission even works with metal indoor separation walls. This happens through reflections: Walls made of metal or concrete reflect the electromagnetic waves. The radio waves reach the next room or floor via a non metallic opening.

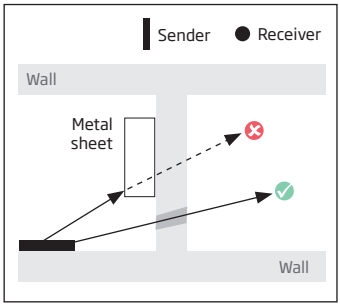


Fig. 3: Screening of radio signal in premises

1.3. 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.

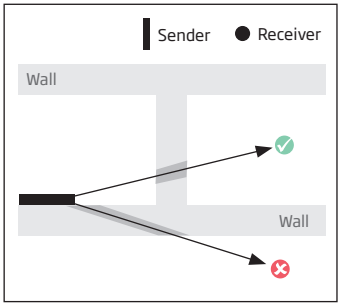


Fig. 4: Penetration of radio signal in premises

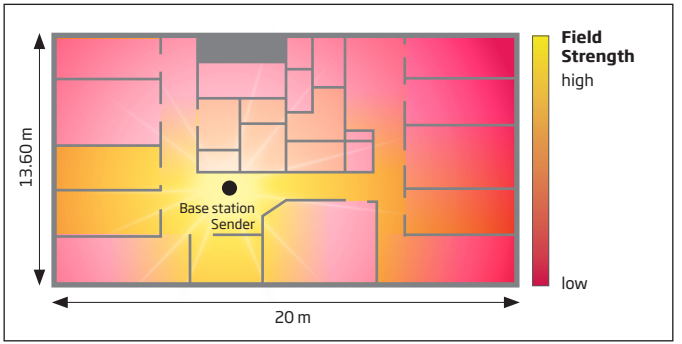


Fig.5: Spread of radio signal within a building

2. 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, the position of the antenna has to be on the opposite or connecting wall. When using devices with an external antenna, the ideal antenna installation place is a central location in the room. Where possible the antenna should be at least 10 – 15 cm away from the wall corner or concrete ceiling.

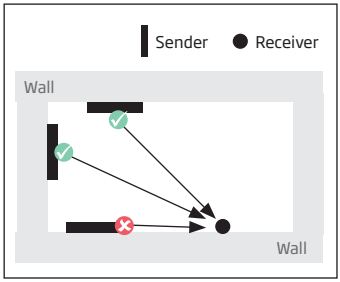


Fig. 6: Antenna installation aspects

2.1. Mounting a Magnetic Antenna of the Alarm Panel

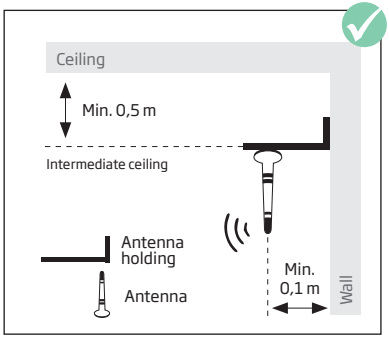


Fig. 7: Right antenna mounting by the ceiling

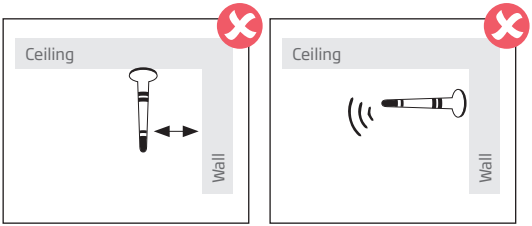


Fig. 8: Wrong antenna mounting by the ceiling

2.2. Distance To Other Interference Sources

The distance to other transmitters (e.g. GSM / DECT / Wireless LAN / EnOceanTransmitters) shall at least amount to 2m.

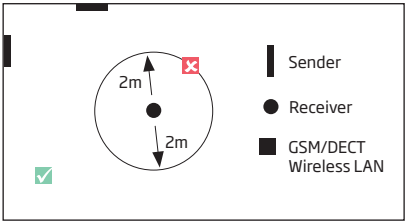


Fig.9: Right and wrong receiver and sender placement next to sources of signal interference

2.3. Performing Distance Tests

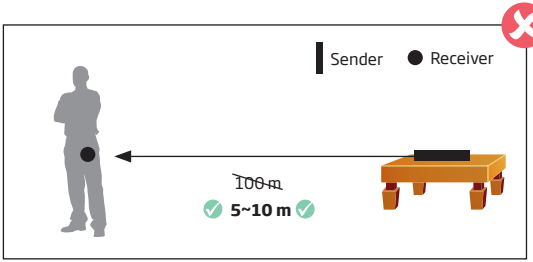


Fig. 10: User holding the receiver in his hand against the sender

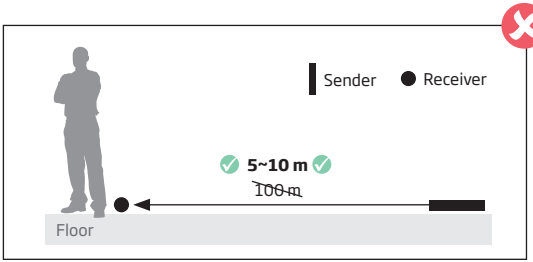


Fig. 11: Sender and receiver placed on the floor against each other

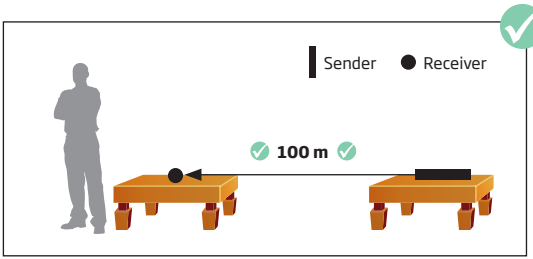


Fig. 12: Sender and receiver placed on wooden surface against each other