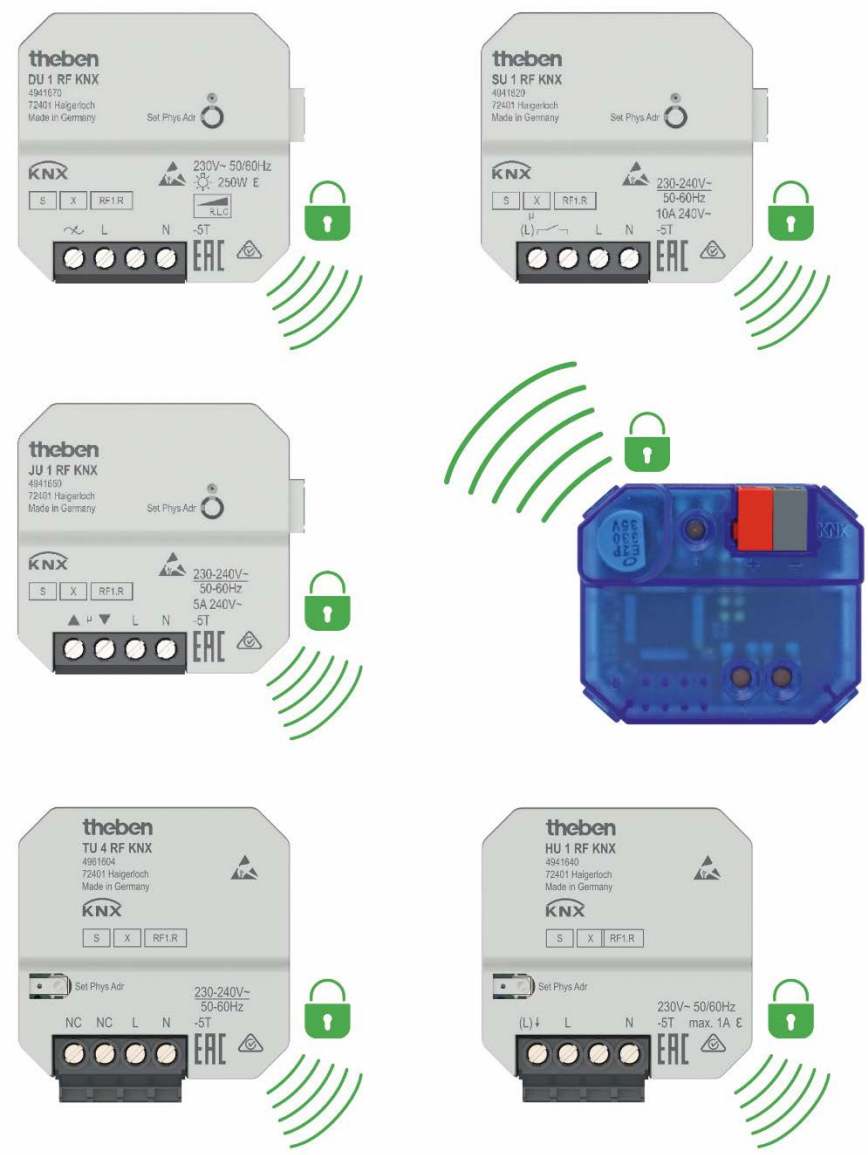
KNX RF
System Manual



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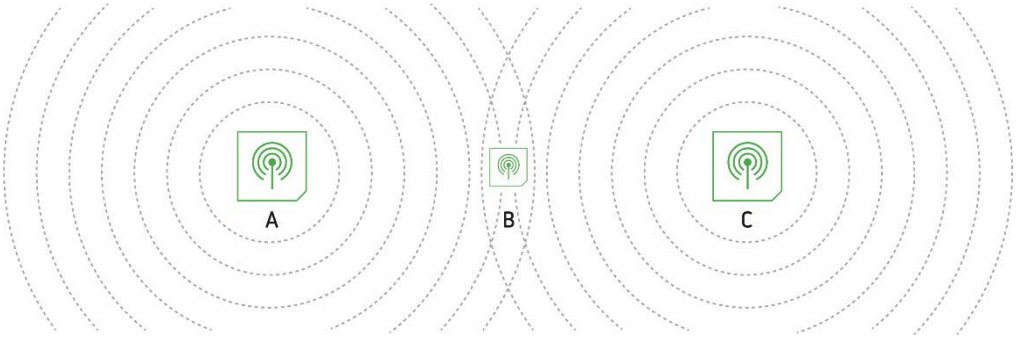
1 KNX RF system description

The KNX RF system (→ Radio Frequency) is a manufacturer-independent KNX radio standard operating in the 868 MHz frequency range. The transmittable data rate is 16 KBit/s. The packet size is in the range of 8 bytes – 23 bytes. The latency times are low enough not to be noticed by humans, even when using relatively time-critical sensors such as buttons.
The maximum range in buildings is approx. 30 m. KNX RF devices can be used to extend existing KNX installations without a bus line. A wide range of flush-mounted devices such as switching, dimming, blind or heating actuators is available for this purpose. There is also an RF button interface for the integration of buttons or temperature sensors.
In addition, each Theben RF actuator also has 2 binary inputs for connecting switches, buttons, temperature sensors or signal contacts. This range will be further extended, while all Theben KNX RF components support secure communication on RF as well as on TP (media coupler) according to the KNX Data Secure standard. The media coupler is used to connect or extend wire-bound systems with the RF devices. KNX RF is a bidirectional radio system, so the devices can receive as well as send information. As with TP devices (→ Twisted Pair), start-up is also carried out by the ETS.

1.1 Technical features

The KNX RF radio standard uses a frequency from the SRD frequency band (Short Range Device), which also has a relatively small range due to its particularly low output power. It therefore has a high electromagnetic compatibility and does not interfere with other systems. It is a licence-free frequency range for low power and can therefore generally be used in all states that recognise European Union standards and directives. However, the 868 MHz frequency range used is not reserved exclusively for KNX RF, but is also used by various other devices/systems, e.g. gate drives, radio alarm systems and various other building automation systems.

KNX RF has a transmission power of 0.5-25 mW, and the medium frequency is fixed at 868.3 MHz. Each transmitter has the LBT function (→ Listen Before Talk). This means that each transmitter, before sending anything, first listens to see if the radio channel is free. In addition, each transmitter waits for a random, ever-changing time before actually transmitting. This avoids radio collisions as far as possible.
Also, in the following constellation, it could lead to device A and C transmitting at the same time, as they are not in the reception range to one another. This causes a radio collision at device B and the telegrams might not be processed.


A
B
C

2 Radio characteristics

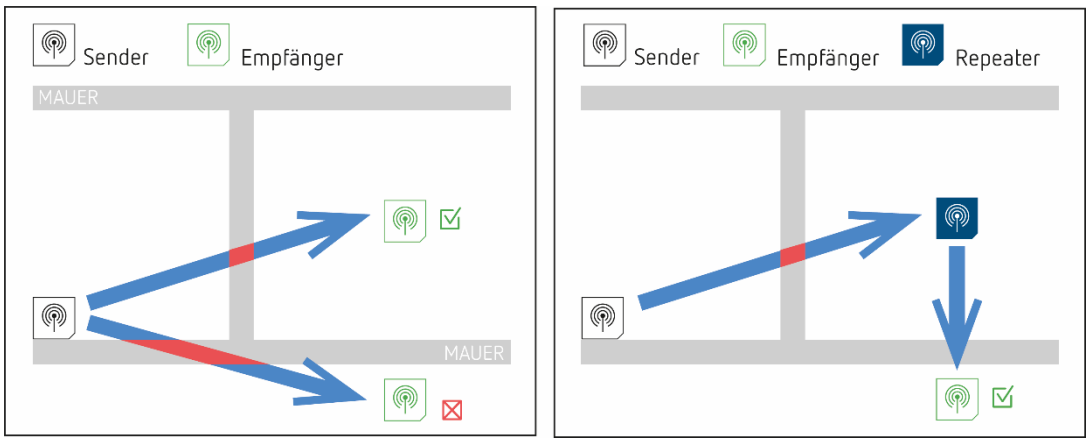
2.1 Attenuation of radio waves

Material	Attenuation	Examples
Wood	low	Furniture, ceilings, partition walls
Plaster	low	Partition walls without metal mesh
Glass	low	Window panes
Water	average	Humans, wet materials, aquarium
Bricks	average	Walls, ceilings
Concrete	high	solid walls, steel-reinforced concrete walls
Coated glass	high	Glasses coated with metal
Plaster	high	Partition walls with metal mesh
Metal	very high	Reinforced concrete structures, fire doors, lift shaft

The attenuation also depends on the thickness of the material

During radio transmission, the following negative effects occur:

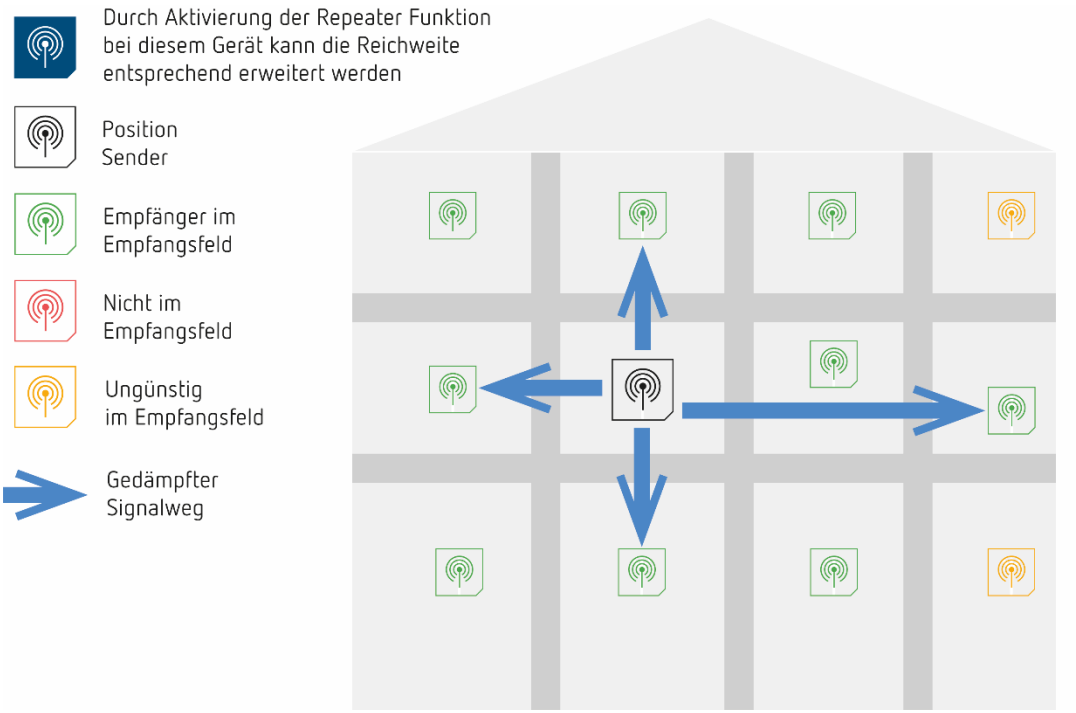
- Attenuation/absorption: Signal is swallowed
- Reflection: Signal is reflected
- Refraction: Signal is deflected into another direction
- Scattering: Signal multiplication



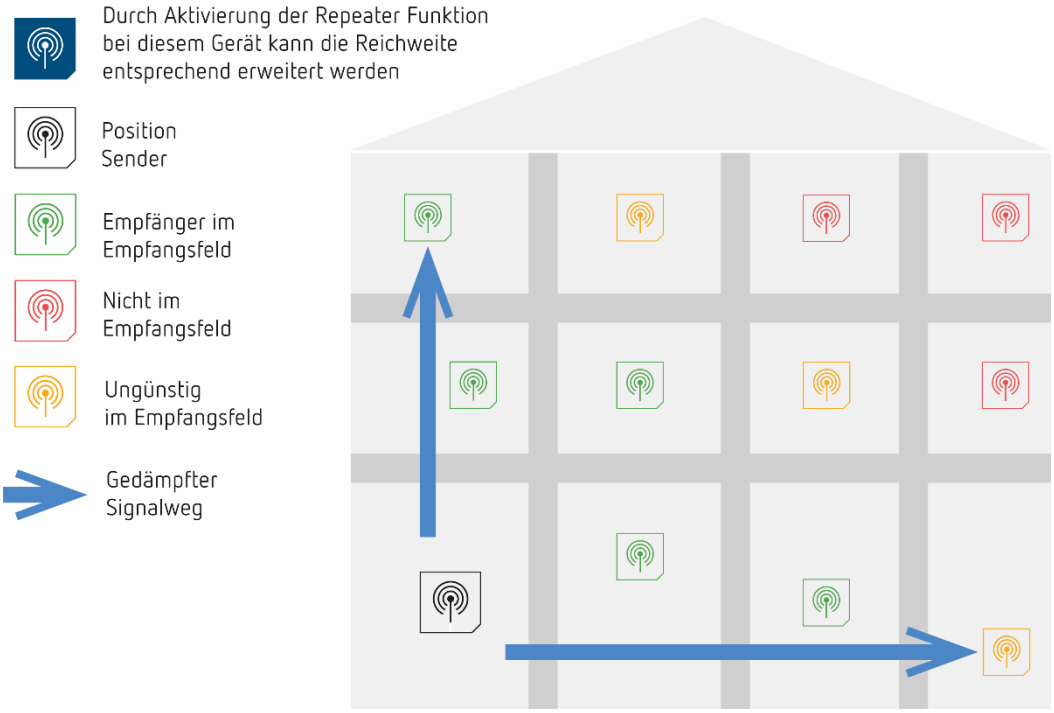
Wall or ceiling thickness effective for attenuation

2.2 Selecting the installation location for RF devices

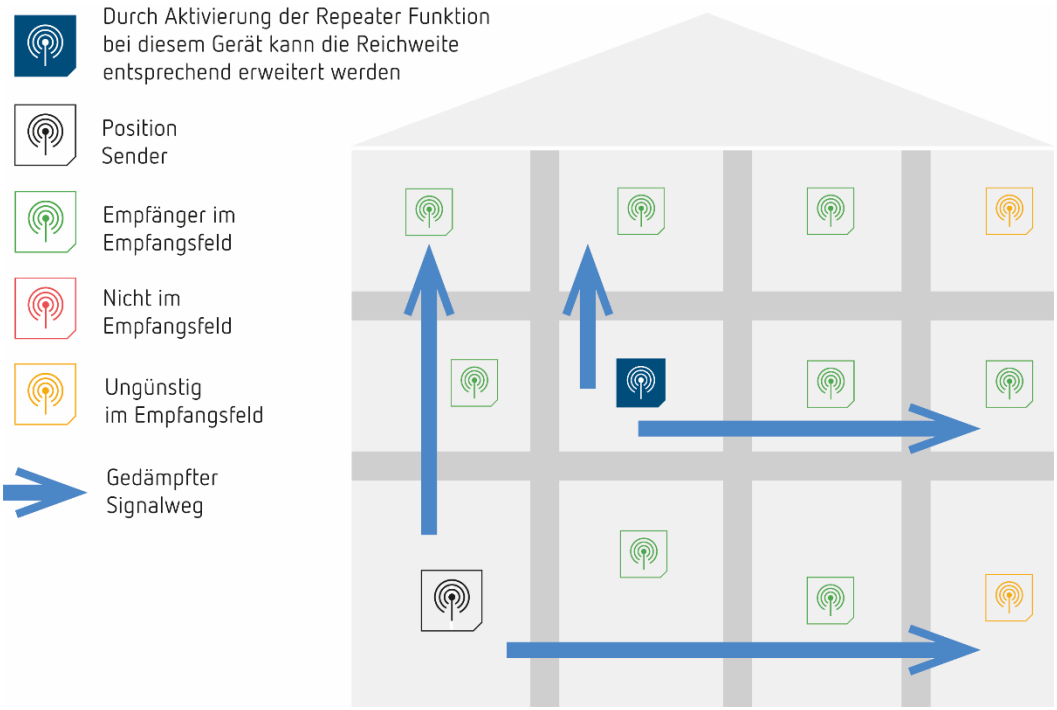
Example of good central placement of the TP-RF media coupler



Example of poor non-central placement of the TP-RF media coupler



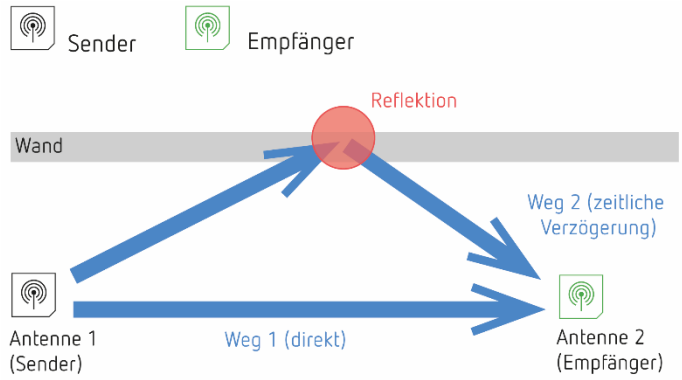
Example with activated repeater function with a Theben KNX-RF actuator



Repeater function

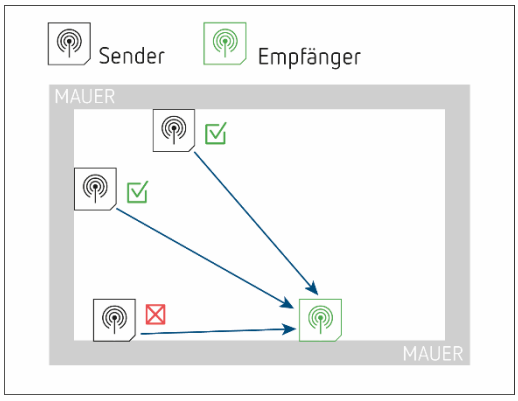
It is possible to use each Theben RF device additionally as a repeater, to amplify the RF signal in the system. This repeater function can be activated in the ETS in the properties of the device under **Settings**.
However, it is not advisable to activate the function on each or many devices in the system. The picture above shows which device is suitable to be configured as a repeater in the system. It is therefore imperative to know the spatial arrangement of the devices and to use the "Retransmitter" function in a targeted manner. The media coupler can also be configured as a retransmitter. This can be useful if the media coupler is placed centrally and RF devices need to receive telegrams from other devices placed on the opposite side of the media coupler.

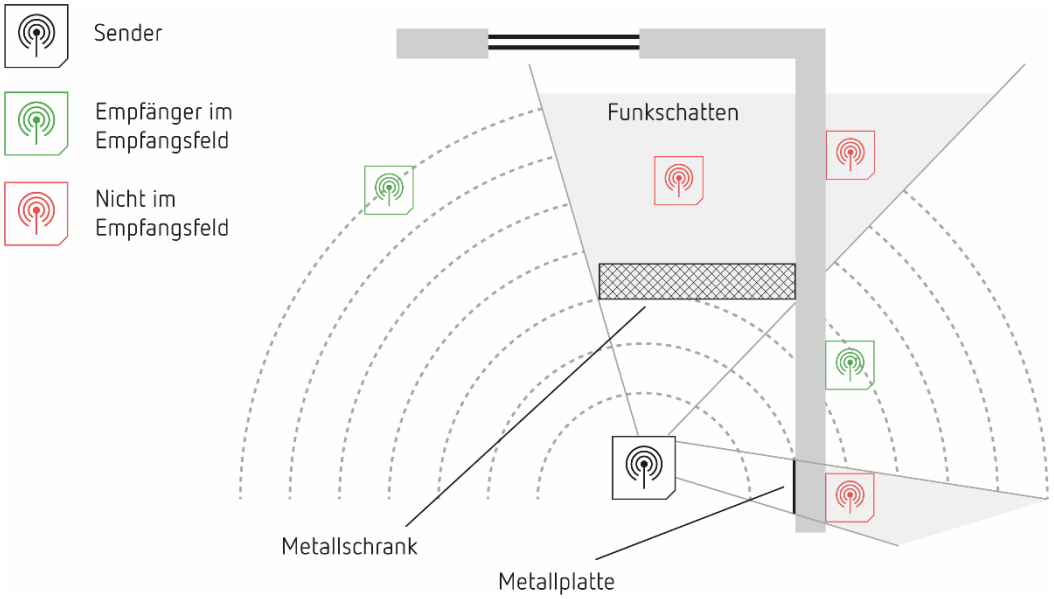
2.3 Other negative influences on reception



Reflections can be interference factors for radio transmission. They occur when radio signals hit obstacles and are reflected from there into a different direction. In the worst case, however, the waves received directly and via the reflection overlap unfavourably at the target location, resulting in a signal that receivers can no longer reliably evaluate.

The positive and negative superposition of radio waves directed in the same direction is also called interference. This can distort or even completely erase the signal.
Also, avoid spreading along a long wall, e.g. in a long corridor. The devices that need to communicate with each other should already be taken into account during the planning stage.





Radio shadow e.g. due to metal parts

2.4 Installation location

The following aspects must be considered when planning KNX RF installations with regard to the installation locations:

- For fixed installations, align all RF devices in the same way → identical polarisation of the antenna
- Observe structural conditions with regard to shading, reflections, attenuation, absorption, refraction and scattering
- Keep as wide a distance as possible from larger metal surfaces, e.g. doors, frames, distribution cabinets, aluminium roller shutters ...
- Penetrate walls and ceilings over the shortest possible distance (beeline)
- Keep as much distance as possible from the following devices: Electronic transformers, electronic ballasts, microwaves, motors, cordless telephones, WLAN devices ...
- If possible, do not install RF devices close to the ground
- Do not install RF devices in metal enclosures, e.g. control cabinets

2.5 Range

Under favourable conditions, the range inside buildings can be up to 30 m. In unfavourable cases, however, it can be only a few metres. In the open field, ranges of up to 100 m are possible. When planning, consider the radio range critically, in order to ensure functional reliability.

3 KNX RF topology

The KNX RF media coupler is the interface between wired and radio-based (RF) communication. The media coupler works like a conventional range/line coupler and also has filter settings. The corresponding filter tables are loaded by the ETS when programming the application. In this way, the media coupler forwards only the required telegrams between TP-RF and vice versa. This is also important with regard to the telegram traffic on the RF side. It is important to keep this as low as possible in order to minimise problems caused by telegram collisions.

3.1 Differences between TP and RF

When communicating via TP, CSMA/CA (→ Carrier Sense Multiple Access/Collision Avoidance) prevents several devices from sending simultaneously before each individual participant has access to the bus. Thus, this procedure checks the bus at any time to see if it is occupied. Data will only be sent when it is free. In addition, with TP, the telegrams of each participant addressed are acknowledged with Ack, Nack or Busy. This means that after sending a telegram, each device receives feedback as to whether at least 1 device has received and understood the telegram. If the sent telegram is not acknowledged with Ack, it can be repeated up to 3 times by the transmitter. For KNX RF communication according to RF1.R standard, there is only the LBT method (→ Listen Before Talk). This means that each transmitter, before sending anything, first listens to see if the radio channel is free. In addition, each transmitter then waits for a random, ever-changing time before actually transmitting. This avoids radio collisions as far as possible. An acknowledgement of the telegrams and a repetition in case of a non-acknowledged telegram do not exist in the RF1.R standard. Thus, a telegram that has not arrived, due to whatever circumstances, will not be repeated. However, the media coupler acknowledges on the TP side, like any other TP device, its telegrams received and forwarded to the RF side.

3.2 Domain address

Since radio signals can also cross room, flat or even property boundaries, each RF line receives its own domain address from the ETS. Should the area line be configured as RF media type, all sub-lines also receive the same domain address as the area line.

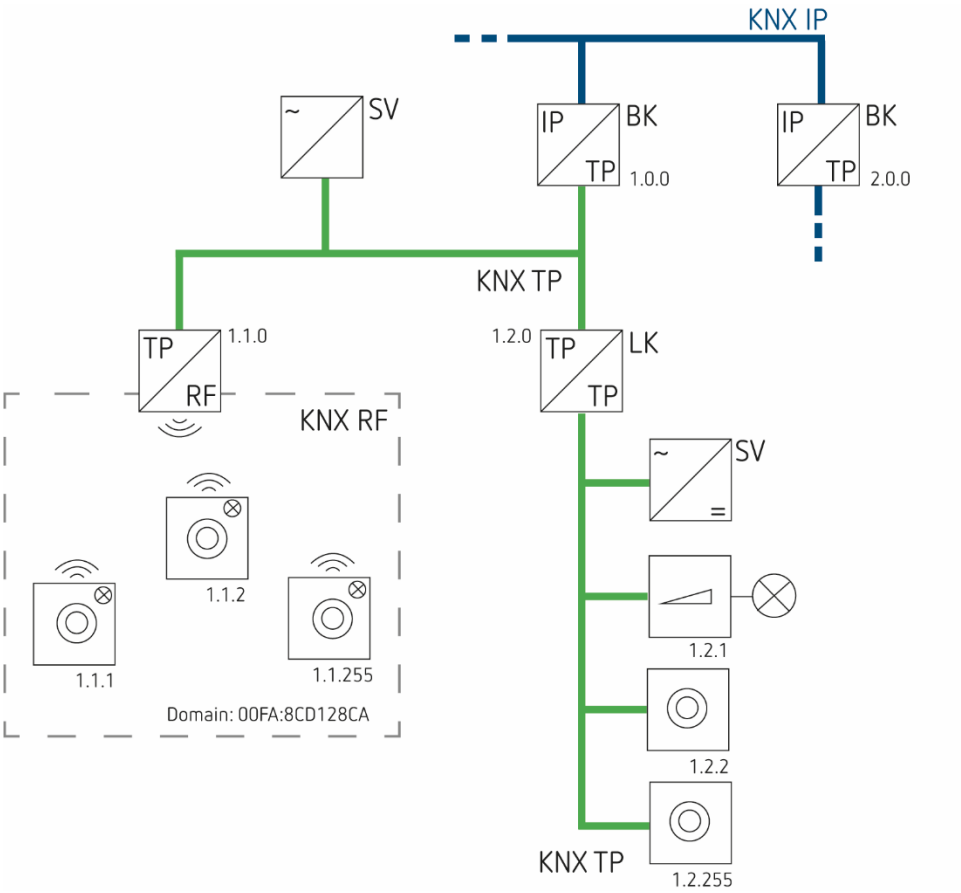
KNX RF devices can only communicate with each other if they have the same domain address. The domain address assigned by the ETS can also be changed manually in the ETS if another KNX installation were to accidentally use the same one. The domain address is automatically programmed into the KNX RF devices together with the physical address.

A physical interference of different KNX RF systems or KNX RF lines that are spatially within the radio range cannot be completely excluded by the LBT method (→ Listen Before Talk). Different RF telegrams sent almost simultaneously can overlap each other and can therefore no longer be evaluated. However, due to the unique domain address contained in each radio telegram, no external interference can occur.
Example of a domain address: 00FA:8CD128CA

3.3 Media coupler in the line

Media coupler as line coupler

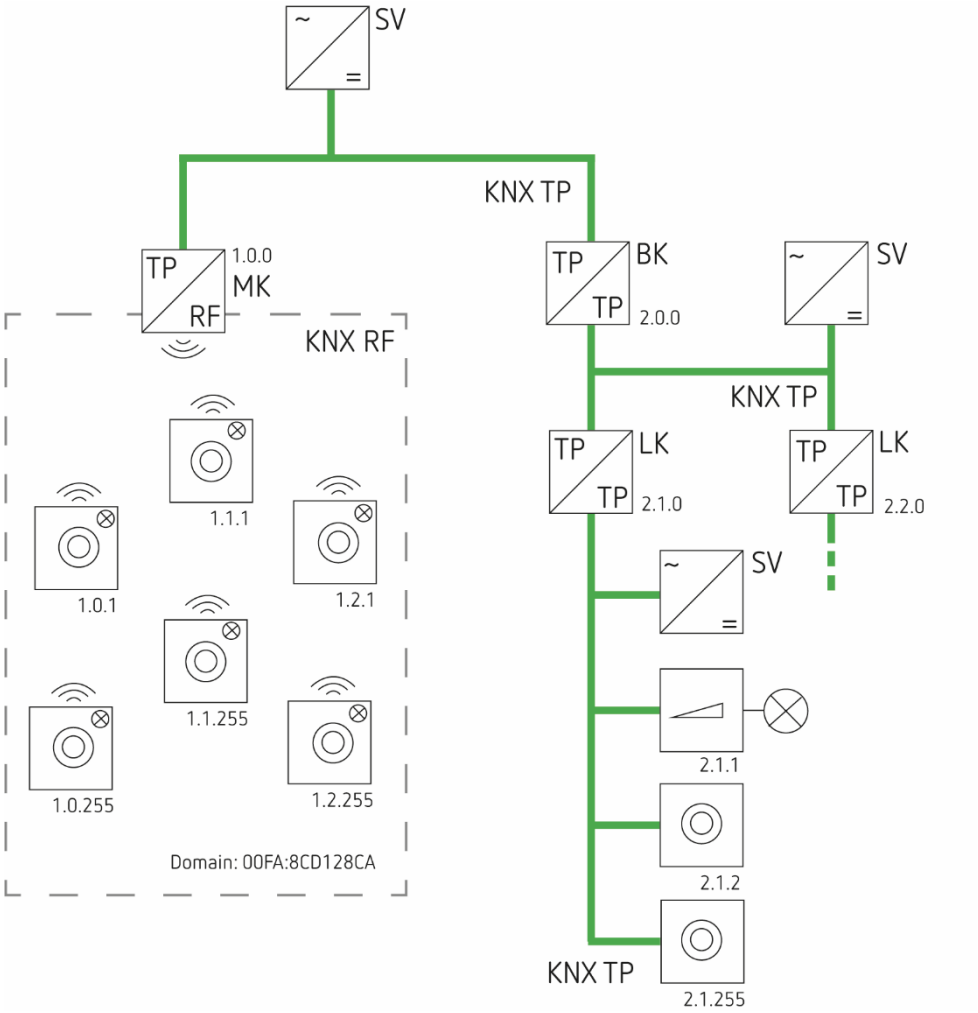
- Further lines can be set up with TP line couplers or RF media couplers
- Each line may only contain 1 media coupler (unless the media coupler is configured as a repeater)



3.4 Media coupler in the area

Media coupler as area coupler

- If the media coupler is to work as an area coupler, a backbone with media type TP is absolutely necessary
- Each area may only contain 1 media coupler (unless the media coupler is configured as a repeater)



3.5 General recommendations

- Place the media coupler as centrally as possible in the reception area of all RF participants
- In smaller RF installations, RF devices as repeaters are preferable to several media couplers. Repeaters should be located in the reception area of each other. The repeater mode should only be activated for needed devices in order to keep the number of repeated RF telegrams as low as possible
- Multiple media couplers or RF lines should only be used if the radio ranges are congruent with each other or strictly separated. If the different RF lines are only in intersections with each other in the reception area, communication problems due to overlapping telegrams may occur.
- Due to the nature of the protocol (LBT and lack of acknowledgement of receipt), we recommend using KNX RF as a supplement to TP systems for setting up room, island and extension solutions. The practical maximum size depends on the building condition, the placement of the devices as well as the telegram volume.
- Since the media coupler has the filter characteristics of a line coupler, the media coupler must usually also be reprogrammed after changes to other RF devices.

4 Secure devices in new installation

KNX RF devices which have already been safely started up in a project cannot simply be used in a new project. Since the FDSK is replaced by a toolkey during programming, it is necessary to reset the devices. A master reset restores the device to its original FDSK. The device can then be transferred to a new project.

4.1 Master reset via ETS

Via a right click on the device in the ETS, the device can be unloaded. Selection: "Unload physical address and application"

4.2 Master reset at the device

On Theben RF actuators and sensors:

De-energise the device. - Press and hold the Phys. address button on the device. - While the button is held, switch on the power again. After approx. 2 s the button can be released. The physical LED goes out.

On Theben TP-RF media coupler:

De-energise the device. - Press and hold the Phys. address button on the device. - While the button is held, switch on the power again. Only release the button when the reception LED starts to light up.