KNX
Product documentation

GIRA

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RF/TP media coupler/repeater

Order no. 5110 00

Table of Contents

1 Information on the product

1.1 Product catalogue

Product name:	RF/TP media coupler/repeater
Use:	System device
Design:	Installation
Art.-no.	5110 00

1.2 Function

Media and segment couplers are the link between a specific KNX RF environment (RF = Radio Frequency) and a wired KNX TP installation (TP = Twisted Pair).

With regard to the routing property of telegrams, media and segment couplers function like standard TP backbone/line couplers. This means that RF devices can communicate with TP devices via a media and segment coupler or (with additional IP backbone couplers) with IP devices and vice versa. Media couplers possess filter settings and filter tables. The exact function of the device is determined by the selected parameterization and by the physical address.

Optionally, the device can additionally or alternatively work as a repeater. A repeater repeats the radio telegrams received in its RF line by retransmitting them immediately. This allows an extension of the range of a KNX RF installation, meaning that it is possible to position RF devices as required in a building, even in the case of difficult transmission and reception conditions.

The media and segment coupler is a device which allows the media type RF on the lower-level line and the media type TP on the higher-level line. The media and segment coupler can be configured and commissioned with the ETS version 5 or higher. The segment coupler functionality is supported from ETS version 6.0.5. The device is powered via a KNX TP bus connection (KNX voltage supply unit) or alternatively, via a suitable external DC voltage supply unit in repeater operation.

1.3 Device components

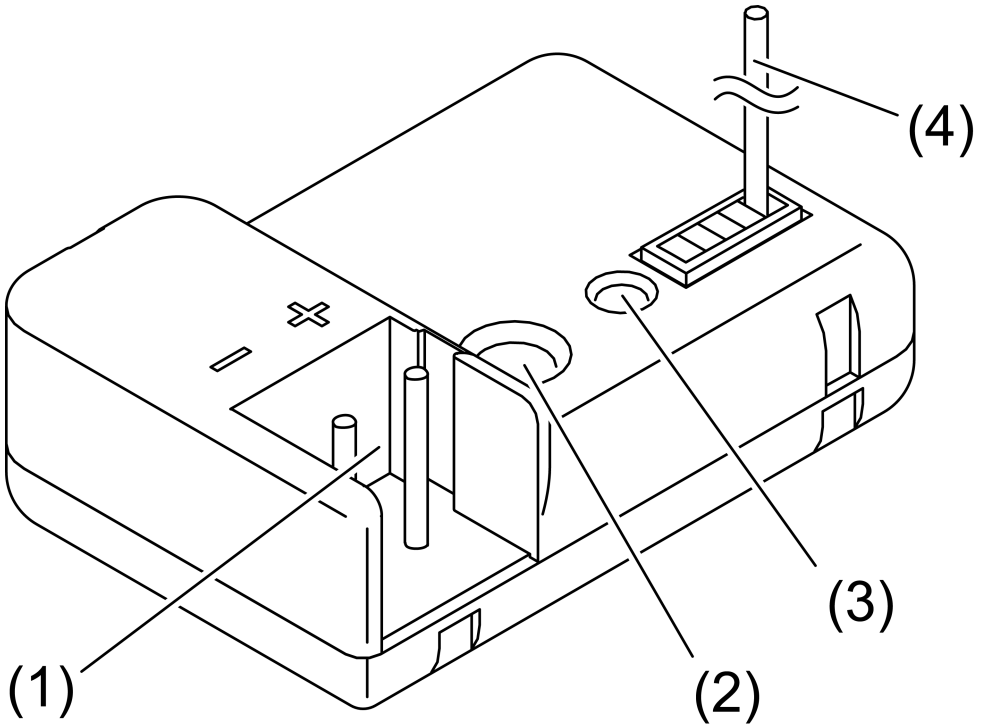

Image 1: Device components

(1) KNX connection (TP)
(2) Programming button
(3) Status LED
Red lit up: Prog. mode
Red flashing quickly: Filter function deactivated
Red flashing slowly: Safe-state mode active
Yellow flashing: telegram traffic
Yellow lit up: Repeater prog. mode (for devices with marking "I02" or higher)
(4) Antenna (RF)

1.4 Device generations

Devices marked "I00": No KNX Data Secure compatibility. Secure commissioning of other devices via media coupler is not possible with this device version.

Devices with marking "I01": The device is KNX Data Secure-compatible with ETS5.7.3 or higher. Secure commissioning of other devices via media coupler is possible without restrictions from this device version onwards. KNX Data Secure offers protection against manipulation in building automation and can be configured in the ETS project. Detailed specialist knowledge is required.

Devices with marking "I04" or higher: use as segment coupler possible for commissioning with ETS version 6.0.5 or higher.

1.5 Update capability

The device can be updated. Firmware updates (e.g. from device version I00 to I04) can be performed in existing installations with the ETS and a special update application program.

It is recommended to update media couplers individually and sequentially.

1.6 Technical data

KNX RF

KNX medium	RF1.R
Commissioning mode	S-mode
Radio frequency	868.0 ... 868.6 MHz
Transmission capacity	max. 20 mW
Transmitting range in free field	typ. 100 m
Receiver category (Data according to EN 300220)	2

KNX TP (media coupler/segment coupler operation)

KNX medium	TP256
Commissioning mode	S-mode
Rated voltage KNX	DC 21 ... 32 V SELV
Current consumption KNX	3.9 ... 5.1 mA

Repeater operation

Rated voltage	DC 24 V SELV

Degree of protection	IP20
Protection class	III
Ambient temperature	-20 ... +45 °C
Storage temperature	-25 ... +55 °C
Transport temperature	-25 ... +70 °C
Relative humidity	10 ... 100 % (no moisture condensation)
Dimensions L×W×H	44x29x16 mm

1.7 Accessories

Power supply 24 V DC 300 mA	Order no. 1296 00

2 Safety instructions

Electrical devices may only be mounted and connected by electrically skilled persons.

Serious injuries, fire or property damage possible. Please read and follow manual fully.

The radio communication takes place via a non-exclusively available transmission path, and is therefore not suitable for safety-related applications, such as emergency stop and emergency call.

This manual is an integral part of the product, and must remain with the end customer.

3 Mounting and electrical connection

General

Mount in suitable flush-mounted or surface appliance boxes.

i In outdoor installations: Use appliance box IP55.

i Do not place the device in metallic small distribution boards or appliance boxes.

Do not lead any wire or sheathed cables from other power circuits through the appliance box.

Precondition: To ensure good transmission quality, keep a sufficient distance from possible interference sources, e.g. metallic surfaces, microwave ovens, hi-fi and TV sets, ballasts or transformers.

Connect the device and mount it for use as media/segment coupler

The device is connected to and supplied by a KNX bus cable (TP).

Precondition: Ideally, the media coupler is positioned in the centre of an RF installation (domain), to allow low-loss and thus interference-free communication with all the associated RF devices.

- Connect device to a KNX bus cable. For this, use a KNX device connection terminal. Ensure correct polarity.

i If the media coupler is used as a line coupler, the KNX bus cable must be the main line of a TP area. If the media coupler is used as a backbone coupler, the KNX bus cable must be the TP area line (Backbone) of the KNX installation. If the media coupler is used as a segment coupler, the KNX bus cable must be the first segment of the line.

- Place the device in the appliance box.
- When laying the antenna, extend the antenna extended as much as possible. If this is not possible, position the antenna behind the device in a circular arrangement.

i When using blank covers, make sure the antenna does not lie directly behind the metal supporting frame.

Connect the device and mount it for use as a repeater only (no media/segment coupler function)

If needed, the repeater can be connected to a KNX bus cable (TP) via which it is supplied, as long as the bus cable is the TP line of the associated media coupler. Thus the use of the repeater is especially relevant for retroactive solutions in existing TP systems.

Alternatively, a repeater can also be supplied via a separate DC voltage supply, even without KNX bus voltage.

Use purely as an RF repeater is only possible in RF lines, but not in lower-level RF segments.

Precondition: The repeater is positioned within radio range of the media coupler and ideally within radio range of another repeater of the same RF domain, to allow low-loss and thus interference-free communication with all the associated RF devices.

- Connect the device to a KNX bus cable or, alternatively, to a separate DC voltage supply. For this, use a KNX device connection terminal. Ensure correct polarity.

Do not use the unchoked 30 V output of a KNX voltage supply! The media coupler may heat up to an impermissible temperature.

In the case of a device with the marking "I04" or higher, the "Repeater-Prog-mode" of the device must be activated before the physical address is programmed.

In the case of connection to a TP bus cable, direct ETS program access to the device via the TP side during repeater operation is no longer possible after commissioning. Consequently, the repeater can only be programmed and diagnosed (e.g. with the use of suitable KNX RF USB data interfaces or via another media coupler of the same RF domain) via the RF side.

- Place the device in the appliance box.
- When laying the antenna, extend the antenna extended as much as possible. If this is not possible, position the antenna behind the device in a circular arrangement.

When using blank covers, make sure the antenna does not lie directly behind the metal supporting frame.

4 Commissioning

General

The device can be inserted and commissioned as either a media coupler or a segment coupler (segment coupler only from ETS6.0.5 onwards with an application program intended for this purpose). In RF lines, use purely as an RF repeater is also possible.

The device operates as a media coupler when it is given a physical address in the form x.y.0 (line coupler) or x.0.0 (backbone coupler) (x = area address, y = line address).

The device operates as a segment coupler or as a repeater in RF lines when it is assigned a physical address in the form x.y.1...255.

In an RF domain, always commission the media coupler first! Only then should any optional additional repeaters and all other participants of the RF installation be programmed. Ideally, install and connect the repeater after the media coupler has been completely commissioned.

Precondition: An appropriate device must be created and configured in the ETS project. Device has been connected and the power is switched on.

i Project design and commissioning with ETS5 or a more recent version.

i Project design and commissioning as segment coupler with ETS from version 6.0.5 onwards.

i Programming mode is deactivated after the physical address has been successfully programmed, or is generally deactivated by a device test (power failure, ETS programming process of the application program). Programming mode is also deactivated automatically after 4 minutes if none of the above events occurs.

Commissioning the device as media coupler or segment coupler

As delivered, the device can be programmed and commissioned via the TP side (e.g. with the use of suitable USB or IP data interfaces) or via the RF side (e.g. with a KNX RF USB data interface).

After a successful initial commissioning, access to the device for programming may be restricted because of an active configuration lock (see chapter "Configuration lock" ▸ Page 28).

- Press the programming button (2) (see figure 1).

  The status LED (3) lights up red. Programming mode is activated.

- Load the physical address into the device. The ETS also automatically loads the domain address of the RF line into the device.

  The red status LED goes out.

i When programming the media coupler via RF: For the programming of the physical address and the domain address to be carried out and completed correctly, the domain address of the RF line must match the domain address of the RF communication interface (e.g. KNX RF USB data interface)! Otherwise, communication errors can be expected. The domain address of the KNX RF USB data interface used is configured in the general connection settings of the ETS. In an ETS project, the domain address of an RF line or a media/segment coupler is configured in the line properties (separate for each RF line).

- Load the application program into the device using the ETS.

i The filter table is automatically loaded to the device together with the application program via the ETS. Whether or not the filter table is used for routing group telegrams in media coupler operation is defined by the device parameters. In pure repeater operation, the filter table has no function.

Commissioning the device as a repeater

The device can be programmed and commissioned purely as a repeater in RF lines (no media coupler function) via the TP side only to a limited extent (e.g. with the aid of suitable USB or IP data interfaces insofar as the device is connected to the TP line of the associated media coupler). Programming access to the device via the RF side is always possible with no limitation (e.g. with a KNX RF USB data interface or via a media coupler).

After commissioning, a repeater can no longer be reached directly via the TP side. As a result, further programming operations using the ETS can no longer be executed on the TP side without the media coupler. Direct access to the device via the TP side is only possible again when the device is reset to delivery state (see chapter "As-delivered state" ▸ Page 40).

Program the physical address and the application program always separately.

The procedure for commissioning as a repeater depends on the version of the internal device software.

Commissioning a device with a marking from "I04" onwards

i In the case of a device with the marking "I04" or higher, the "Repeater-Prog-mode" of the device must be activated before the physical address is programmed.

- Disconnect the device connection terminal.
- Hold down the programming button (2) (see figure 1).
- Reconnect the device connection terminal.

  The device restarts. The status LED (3) briefly lights up red and then yellow.
- Release the programming button as soon as the status LED starts flashing red slowly.

  Safe-state mode is active.

- Press programming button again and hold about 2 seconds until status LED lights up yellow.

  The device is in "Repeater prog. mode".

- Release the programming button.
- Commission the device with a physical address **x.y.z** (z≠0).
- Load the Physical Address to the device via the TP side (if the device is connected to the TP line of the associated media coupler) or the RF side. The ETS also automatically loads the domain address of the RF line into the device.

  The status LED goes out.

i After the physical address has been successfully programmed, the device can no longer be reached with the ETS via the TP side, because the device's TP transponder is switched off! This feature is necessary because from a topological standpoint, a repeater (without media coupler function) is exclusively assigned to the RF line, and no longer to a TP line. Consequently, afterwards the application program can only be programmed separately via the RF side. To do so, either a programming connection via the media coupler of the RF domain can be used (TP -> RF) or alternatively, a KNX RF USB data interface.

Where necessary, the TP line of the media coupler can be used for voltage supply to the repeater (see chapter "Mounting and electrical connection" ▸ Page 8).

i When programming the repeater via RF: For the programming of the physical address and the domain address to be carried out and completed correctly, the domain address of the RF line must match the domain address of the RF communication interface (e.g. KNX USB RF data interface)! Otherwise, communication errors can be expected. The domain address of the KNX RF USB data interface used is configured in the general connection settings of the ETS. In an ETS project, the domain address of an RF line or a repeater is configured in the line properties (separate for each RF line).

- Load the application program into the device using the ETS.

i In pure repeater operation, the filter table has no function.

Commissioning a device with a marking up to "I01"

- Press the programming button.

  The status LED lights up red. Programming mode is activated.

- Load the Physical Address to the device via the TP side (if the device is connected to the TP line of the associated media coupler) or the RF side. The ETS also automatically loads the domain address of the RF line into the device.

  The red status LED goes out.

After the physical address has been successfully programmed, the device can no longer be reached with the ETS via the TP side, because the device's TP transponder is switched off! This feature is necessary because from a topological standpoint, a repeater (without media coupler function) is exclusively assigned to the RF line, and no longer to a TP line. Consequently, afterwards the application program can only be programmed separately via the RF side. To do so, either a programming connection via the media coupler of the RF domain can be used (TP -> RF) or alternatively, a KNX RF USB data interface.

Where necessary, the TP line of the media coupler can be used for voltage supply to the repeater (see chapter "Mounting and electrical connection" ▸ Page 8).

When programming the repeater via RF: For the programming of the physical address and the domain address to be carried out and completed correctly, the domain address of the RF line must match the domain address of the RF communication interface (e.g. KNX USB RF data interface)! Otherwise, communication errors can be expected. The domain address of the KNX RF USB data interface used is configured in the general connection settings of the ETS. In an ETS project, the domain address of an RF line or a repeater is configured in the line properties (separate for each RF line).

- Load the application program into the device using the ETS.

In pure repeater operation, the filter table has no function.

5 Application programs

ETS search path:	Radio / System components / RF/TP media coupler or RF repeater
Name	Media coupler / repeater 902011
Version	1.1 for ETS5 from Version 5.7.3 onwards and ETS6
from mask version	2920
Summarized description	Use as media coupler in the function of area or line coupler (depending on the physical address and configuration). Use as KNX RF repeater possible.
Name	Media coupler / repeater 902211
Version	1.1 for ETS version 6.0.5 onwards
from mask version	2920
Summarized description	Use as media coupler in the function of area or line coupler (depending on the physical address and configuration). Use as KNX RF segment coupler possible. Use as KNX RF repeater not possible.

6 Scope of functions

- Use as media coupler in the function of area or line coupler (depending on the physical address)
- Use as a segment coupler (ETS 6.0.5 or higher) with ETS application program "Media coupler / repeater 902211".
- Use as KNX RF repeater possible in RF lines with ETS application program "Media coupler / repeater 902011".
- Influence on forwarding of group telegrams (routing) by filter function in media and segment coupler operation.
- Support of the full address range (groups 0-31) for filter function
- Forwarding of group telegrams (TP -> RF, RF -> TP) parameterizable
- Forwarding of physically addressed telegrams (TP -> RF, RF -> TP) parameterizable
- Forwarding of broadcast telegrams (TP -> RF, RF -> TP) parameterizable
- Telegram repetitions in case of transmission errors for group, broadcast and physically addressed telegrams can be set on the TP side
- Telegram confirmation for group and physically addressed telegrams can be separately configured on the TP side
- Configuration lock can be set (programming only via TP or RF)
- Status LED to display device statuses
- Conversion and generation of RF system broadcast telegrams
- Support of extended frames
- Safe-state mode to stop the application program (e.g. if the device does not function properly due to errors in the project design or during commissioning)
- Function for reset to delivery state

7 Notes on software

Restricted ETS programming access in repeater operation

If the device is used as a repeater in RF lines with the ETS application program "Media coupler / repeater 902011" (physical address = x.y.1...255 / no media coupler function), note that after the physical address has been programmed, the repeater can no longer be reached directly via the TP side. As a result, further programming operations using the ETS (e.g. programming the application program) can no longer be executed on the TP side without the media coupler.

Direct access to the device via the TP side is only possible again when the device is reset to delivery state (see chapter "As-delivered state" ▸ Page 40).

8 Function

8.1 Function as media coupler

Backbone coupler, line coupler or segment coupler

A media coupler, depending on the physical address, can either be added to the KNX topology as a backbone coupler, as a line coupler or, alternatively, as a segment coupler. The segment coupler functionality is supported from ETS version 6.0.5. With KNX RF, there is generally no physical limitation of the number of possible bus subscribers as in a TP line (e.g. 64). With KNX RF, the number of subscribers is only limited by the physical addresses assigned in the ETS.

Media coupler as backbone coupler

The media coupler has a physical address in the form x.0.0 (x = TP area address / e.g. "1.0.0").
If a media coupler is used as a backbone coupler, then a total of up to 4,081 RF devices (including media couplers) can be integrated into the appropriate area. The RF devices must then divide themselves up on the backbone line itself and on up to 15 additional subordinate RF lines (see figure 2). In the ETS, a maximum of 255 subscribers may exist for each area or line. If the media coupler is a backbone coupler, then the backbone must possess the media type "TP". A KNX IP environment cannot then be implemented (the ETS prevents such a topology)!

Even in an RF area, there may only be one media coupler (subordinate RF lines do not possess their own media coupler).

Subordinate RF lines of an RF area always have the same domain address as the area itself.

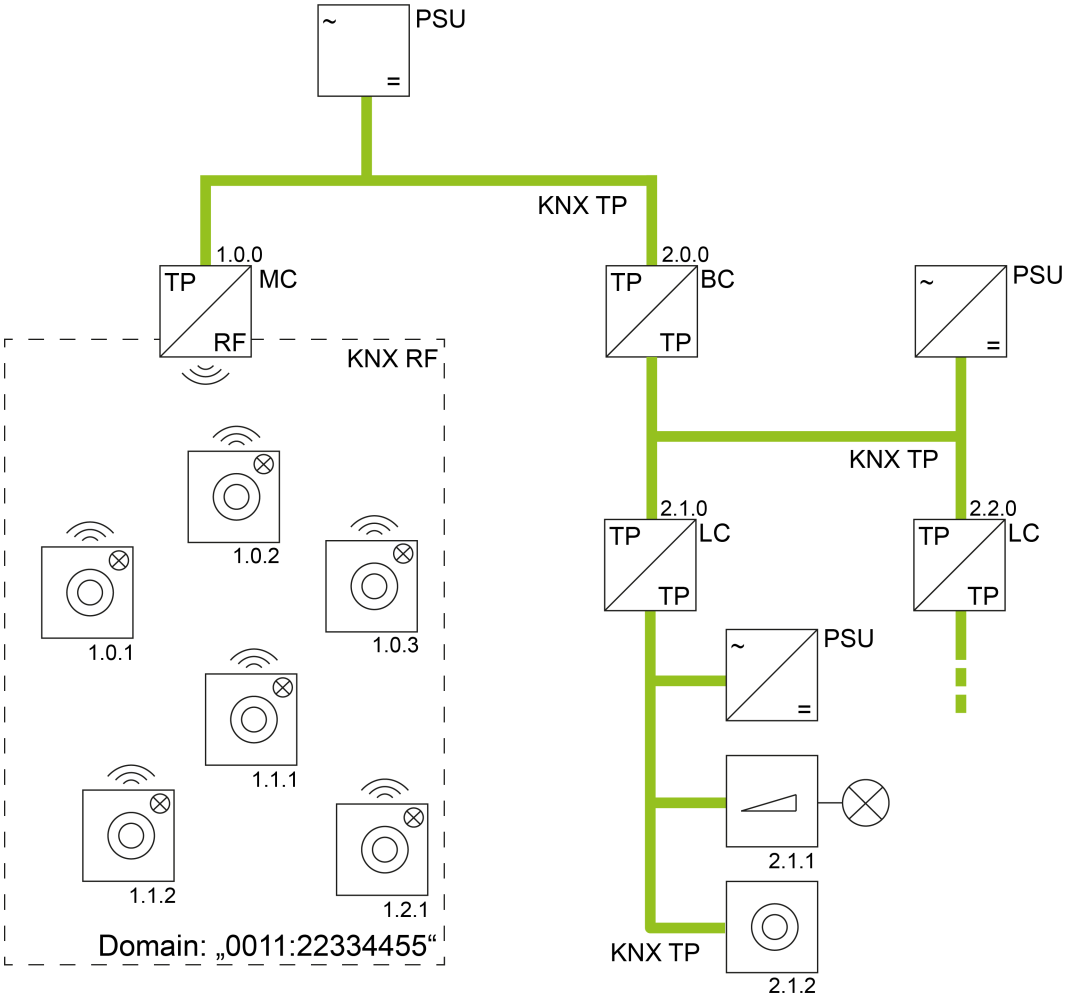

Image 2: Example of a possible KNX topology with RF and TP lines
Media coupler as backbone coupler

MC	Media coupler as backbone coupler (TP, RF)
LC	Line coupler (TP)
BC	Backbone coupler (TP)
PSU	Voltage supply (TP)

Media coupler as line coupler

The media coupler has a physical address in the form x.y.0 (x = TP area address, y = TP line address / e.g. "1.1.0").
A KNX RF line can contain up to 256 devices (including media coupler) (see figure 3). The media coupler is connected to the main TP line of an area. Additional TP lines can be set up using additional TP line couplers.

There may only ever be one media coupler in an RF line. Multiple repeaters can be added to an RF line.

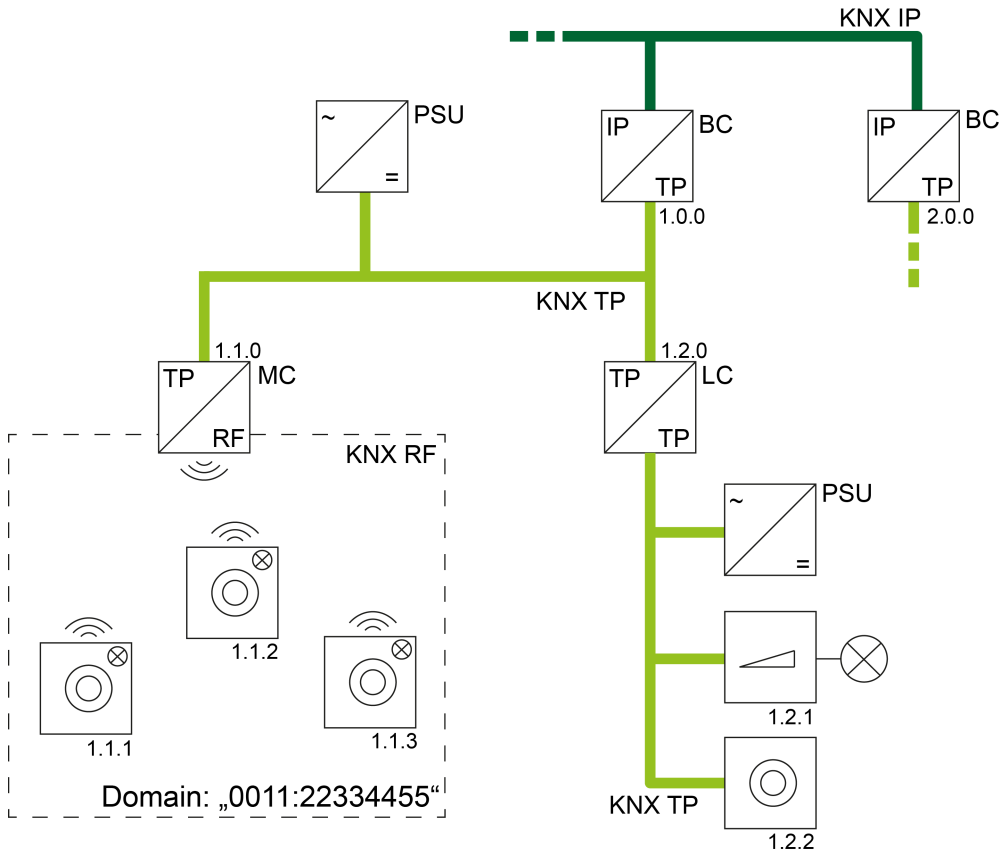

Image 3: Example of a possible KNX topology with RF, TP and IP lines
Media coupler as line coupler

MC	Media coupler as line coupler (TP, RF)
LC	Line coupler (TP)
BC	Backbone coupler (as IP router / TP, IP)
PSU	Voltage supply (TP)

Media coupler as segment coupler

The segment coupler has a physical address in the form x.y.1...255 (x = TP area address, y = TP line address / e.g. "1.1.47").
A KNX RF segment can contain up to 256 devices (including segment coupler) (see figure 4). The segment coupler is connected to the first TP segment of the line.

There may only ever be one segment coupler in an RF segment.

With ETS version 6.0.5 or higher, the device can be used as a segment coupler with the application program "Media coupler / repeater 902211".

It is not possible to create manual filter table entries in the ETS for RF segments. This means that no additional group addresses can be added to the automatically calculated filter tables for lower-level segments. If devices for which group addresses cannot be assigned with the ETS are used in the KNX installation, dummy applications must therefore be used in the ETS project in higher-level areas or lines. If dummy applications are used, the ETS can automatically calculate the filter tables correctly.

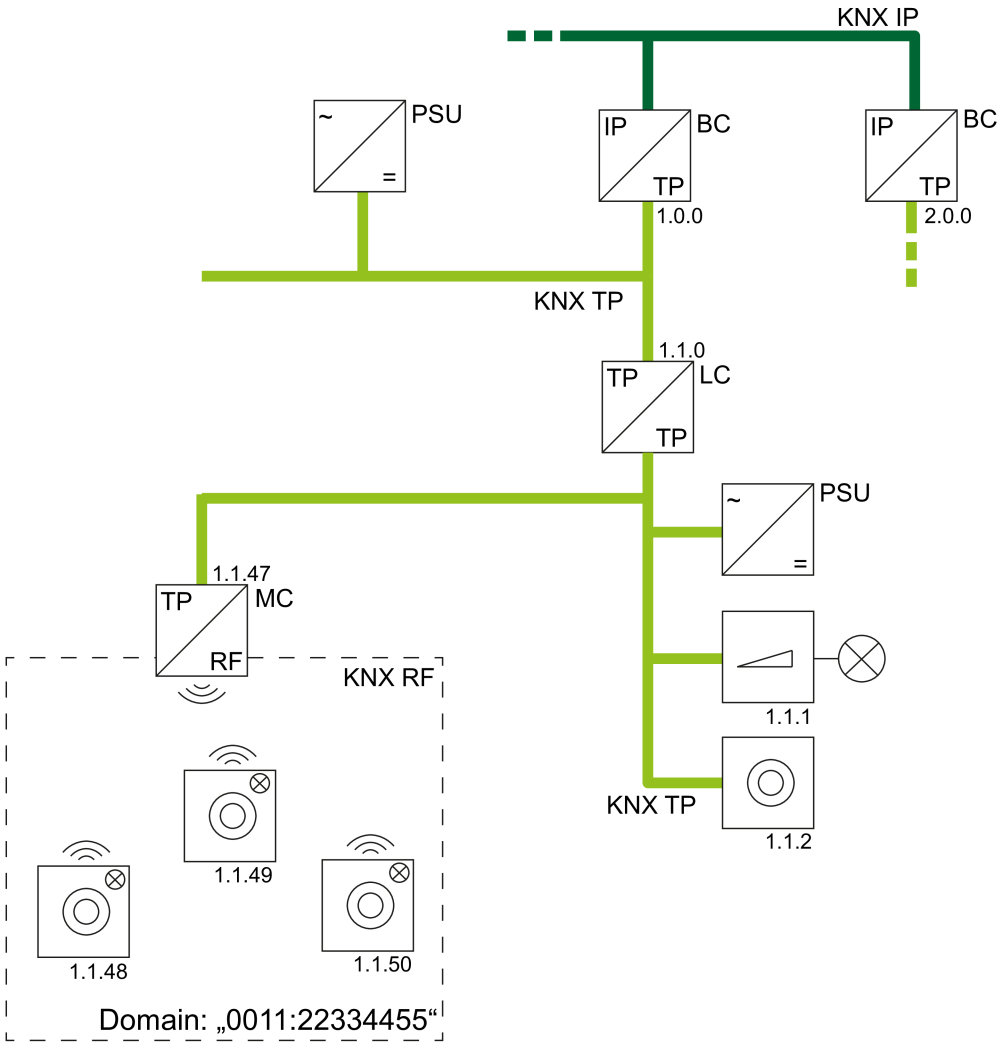

Image 4: Example of a possible KNX topology with RF and TP segments
Media coupler as segment coupler

MC	Media coupler as segment coupler (TP, RF)
LC	Line coupler (TP)
BC	Backbone coupler (as IP router / TP, IP)
PSU	Voltage supply (TP)

Different RF domains in one KNX installation

Devices in different RF domains must be topologically divided into two different lines or areas or segments, each with their own domain addresses. These different areas or lines must also contain their own media couplers for the devices to be able to communicate with one another, irrespective of the line. The logical connection between two or more KNX RF environments is thus always made via media couplers and higher-level TP or IP lines (see figure 5).

KNX RF USB data interfaces, as used in the ETS, are also assigned to a domain address. In consequence, only RF devices of the same domain can be commissioned directly by radio telegram. Only group telegrams and physically addressed telegrams

of the appropriate RF domain are recorded in the group monitor of the ETS (exception: System broadcast telegrams). If other RF devices of another domain are to be contacted with an RF data interface, then communication via media couplers is necessary. If the KNX topology is set up correctly, then such communication takes place automatically via the KNX routing (precondition: media and backbone/line couplers forward the telegrams according to their filter property).

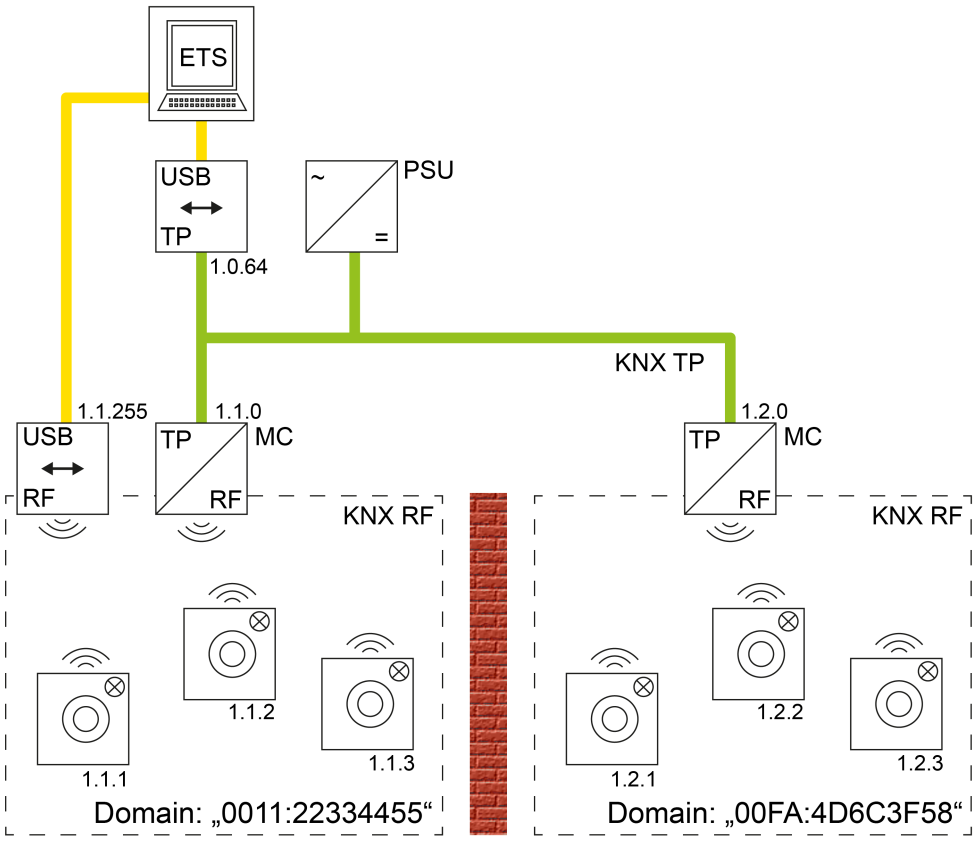

Image 5: Example of a possible KNX topology with two RF lines and coupling via a main TP line

In general, multiple media couplers can be used in various lines and areas of a KNX topology. The ETS permits such a configuration. However, media couplers in a shared KNX system can influence each other unfavourably. In particular, during the commissioning of various bus devices using the ETS, radio telegrams may be superimposed, meaning that radio communication is poor or even impossible. Suitable precautions can be taken to avoid such a situation (spatial separation of the RF environments, logical filtering of specific telegrams).

Media couplers cannot be used to network two or more KNX installations via RF (no proxy function)!

RF areas or lines of a joint KNX installation or of directly adjacent KNX installations in radio range may never have an identical domain address! The ETS offers a function for random assignment of a domain address for RF lines, in order to avoid this improper situation. When the random function is used, the

probability of multiple assignment of an identical address is more or less non-existent. A domain address automatically generated by the ETS is characterised by the hexadecimal characters "00FA..." (e.g. "00FA:4D6C3F58").

Routing counter and telegram repeat counter (expert knowledge)

In a TP telegram, the routing counter identifies how often the telegram has already been forwarded by the area or line coupler, or the TP line amplifier. The routing counter is a 3-bit counted measurand (values 0...7) which is reduced by "1" for every forwarding process via the coupler or line amplifier. As soon as a bus device sends out a new telegram, the routing counter is given the value "6". Through the permissible KNX topology with backbone couplers, line couplers and line amplifiers can, and are permitted to, forward the telegram a maximum of 6 times. Telegrams for which the routing counter is given the value "0" are no longer forwarded via the coupler or TP line amplifier.

The routing counter value "7" is a special case which is not used by normal bus devices. Telegrams with this value are always forwarded. The value is not reduced thereby.

With the KNX RF, the routing counter is replaced by the telegram repeat counter ("RF repeat counter"). When a transmitter sends a new telegram for the first time, it is given the repeat value "6". As soon as a repeater receives this telegram and forwards it, the value is reduced by "1". For each additional repetition process via another repeater in the same RF domain, the repeat value is again reduced by "1". Once the value is "0", the telegram is no longer repeated. With this process, an RF telegram can be forwarded through a maximum 6 repeaters in one domain. Only repeaters are permitted to influence the telegram repeat counter.

During forwarding on the RF side, a media/segment coupler always replaces the routing counter of a received TP telegram with the telegram repeat counter and the value "6". It is irrelevant which value the routing counter has.

Likewise, during forwarding on the TP side, the media/segment coupler always replaces the telegram repeat counter of received RF telegrams with a routing counter and the value "6", regardless of which value the telegram repeat counter had before.

Telegrams that are forwarded via a media/segment coupler via the TP side to the RF side cannot be returned to the TP side by any other media/segment coupler. This is prevented by the "Route-Last" flag, which is set during the forwarding process and forwarded in the RF telegram.

This limitation is important for system broadcast telegrams which are not dependent on any domain. Therefore a system broadcast generated by a media/segment coupler cannot be mistakenly returned to the TP side by other media/segment couplers.

8.2 Function as repeater

Media/segment coupler with repeater or repeater alone

The media/segment coupler can work as a repeater (also "retransmitter") in addition to its function as a coupler. A repeater repeats the radio telegrams received in its RF line by retransmitting them immediately. This allows an extension of the range of a KNX RF installation, meaning that it is possible to position RF devices as required in a building, even in the case of difficult transmission and reception conditions.

The device can only work as a media coupler (see chapter "Function as media coupler" ▸ Page 17), as a media coupler and repeater, or - depending on the application program used - as a repeater alone. The operating mode is defined by the parameter setting and the physical address.

i Only when using the ETS application program "Media coupler / repeater 902011" in RF lines:
The device works purely as an RF repeater if it has a physical address which corresponds to a normal participant address of the RF line (e.g. x.y.1 or x.y.200 / x = area address, y = line address) and the parameter "Physical address" is also set accordingly.

– Function as media/segment coupler with repeater:
The device has a physical address in the form x.y.0 and works as a coupler (see chapter "Function as media coupler" ▸ Page 17). In addition, the repeater function can be released with the setting "activated" for the parameter "Repeater function ...". The parameter "Physical address of the device" must be configured to "x.y.0 (media coupler)".
Combined operation of the media coupler and repeater function is helpful if, within a radio domain, all the RF subscribers are within radio range of the coupler but are not however in the radio ranges of other RF subscribers. Here, the repeater integrated in the central media/segment coupler ensures that telegrams from RF subscribers also actually reach all the other RF subscribers of the radio domain.
Application example (see figure 6): Because of the spatial distance, no direct communication between the two RF devices (1.) is possible. The communication route via the media coupler with repeater function (2.), however, enables communication between the two devices without interference.

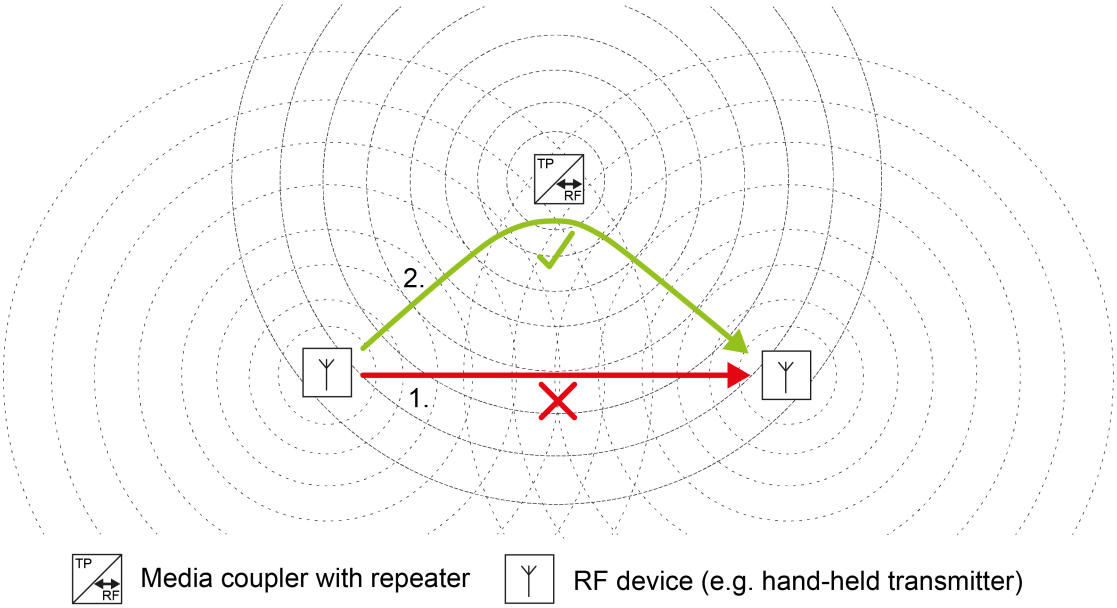

Image 6: Application example of a media coupler with repeater function

In combined operation, the repeater function is executed parallel to the media coupler function (routing). The device acts as if the media coupler and the repeater were two separate devices in the same housing and shared the same RF transmitter.

The integrated repeater does not repeat telegrams which are forwarded to the RF side by the media coupler function and transmitted there.

– Function as repeater alone (only when using the ETS application program "Media coupler / repeater 902011" in RF lines):
The device has a physical address in the form x.y.1...255. In this case, the media coupler function is completely switched off. The device does not perform any routing and thus does not have any parameters for configuring filter properties. The parameter "Physical address of the device" must be configured to "x.y.1...255 (RF repeater)".
The operation of one or more repeaters is recommended when the range of the RF domain should be deliberately extended in one or more directions (e.g. in trans-property communication), or when a part of a building (e.g. ceilings, walls, metal constructions) which weakens the signal need to be overcome. Repeaters can be positioned around the media coupler in a star configuration (see figure 7), ideally within the radio ranges of other/adjacent repeaters of the same RF domain, or also oriented in a strand configuration (see figure 8), e.g. to cover greater distances in a specific direction.

Using a maximum 2 repeaters in one RF domain (see application examples) is recommended to prevent communication problems due to forwarded telegrams. Communication problems due to forwarded telegrams can occur when repeaters are not positioned to each other within their own reception area, but still affect identical devices (e.g. hand-held transmitters) in the same RF domain independently of each other. In this case, therefore, the radio ranges of the repeaters overlap for some RF devices, but not at the installation location

of the repeater. If only two repeaters are used in one RF domain, the likelihood of communication problems due to repeated telegrams is reduced.
The ETS permits integration of up to 255 repeaters in one domain. Nonetheless, because of the RF data protocol, one RF telegram can only be forwarded a maximum of six times. Thus, use of more than 2 repeaters in one RF domain would be possible in principle.

After commissioning with the ETS, a repeater can no longer be reached directly via the TP side because the TP transceiver of the device is switched off. This feature is necessary because from a topological standpoint, a repeater (without media coupler function) is exclusively assigned to the RF line, and no longer to a TP line. As a result, further programming operations using the ETS can no longer be executed on the TP side without the media coupler. Direct access to the device via the TP side is only possible again when the device is reset to delivery state (see chapter "As-delivered state" ▸ Page 40).
Further information on commissioning is available in the chapter "Commissioning" in this documentation (see chapter "Commissioning" ▸ Page 10).

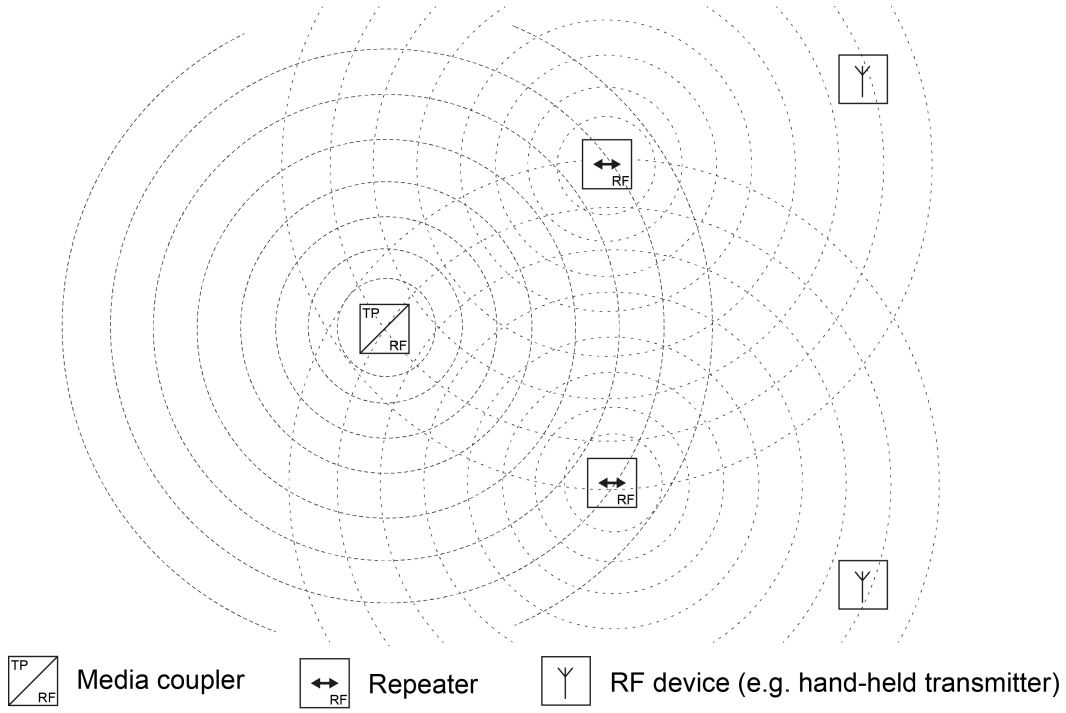

Image 7: Application example 1: two repeaters in a star configuration

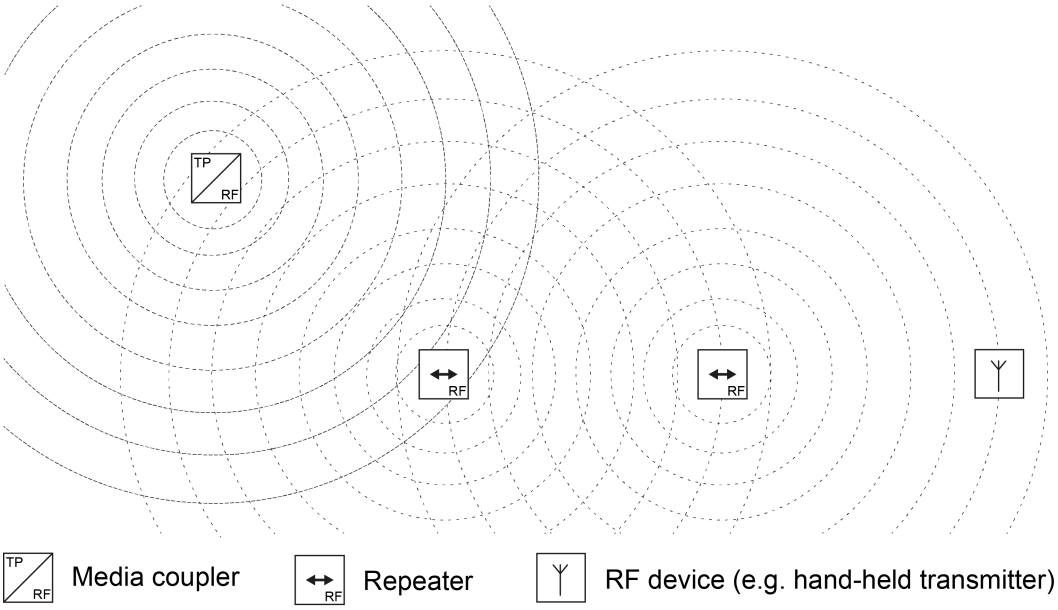

Image 8: Application example 2: two repeaters in a strand configuration

Function in detail (expert knowledge)

To prevent radio collisions, according to applicable KNX specifications, after an RF telegram has been received repeaters are permitted to retransmit more quickly than normal RF devices without repeater function (telegram pause time of the repeater = 5...15 ms, normal RF device = 15...30 ms). As a result, repeated telegrams from repeaters persist temporally in the RF medium (as a result, they have a higher transmission priority). Because of the listen-before-talk function, normal RF devices can recognize that repeaters are transmitting repeated telegrams and delay their own transmission requests until the radio channel is free again.

In addition, like all other RF devices, a repeater waits for a short random interval at each transmission request before a radio telegram is actually transmitted and thereby repeated. This random time is of different length for each transmission operation. Consequently, radio collisions in combination with listen-before-talk are largely suppressed to accommodate the possibility that there are several repeaters in one RF domain which, so to speak, want to transmit at the same time. The principle of this collision avoidance is only expedient when all repeaters in one RF domain are positioned within radio range of each other.

One repeater essentially repeats all RF telegrams from its own domain which it has not already transmitted itself, in addition to always repeating all system broadcast telegrams. Telegram repetitions are not forwarded to the TP side via a media coupler if the coupler has already forwarded the original telegram previously. Moreover, repeated telegrams also do not appear in the group or bus monitor of the ETS when telegram recording with a KNX RF USB data interface takes place. These specific modes of action are made possible by extending the RF telegram structure and evaluating special telegram characteristics, as explained in the following:

On a KNX RF, in addition to the physical and domain addresses of the transmitter, a telegram is also given an LFN (Line layer Frame Number). This LFN is a 3-bit counted measurand (value 0...7) which, starting at "0" for each new telegram, is counted up with value overrun by "1" by each transmitter (example, hand-held transmitter: press ON button -> LFN = 0, press ON button again -> LFN = 1, press OFF button -> LFN = 2 etc.). Repeaters do not change the LFN value when repeating telegrams.

In addition, an RF telegram is also given a telegram repeat counter (similar to the routing counter for a TP telegram / also"RF repeat counter"). When a transmitter sends a new telegram for the first time, it is given the repeat value "6". As soon as a repeater receives this telegram and forwards it, the value is reduced by "1". For each additional repetition process via another repeater in the same RF domain, the repeat value is again reduced by "1". Once the value is "0", the telegram is no longer repeated. With this process, an RF telegram can be forwarded through a maximum 6 repeaters in one domain. Only repeaters are permitted to influence the telegram repeat counter.

Because the last received telegrams and the evaluations of the LFN and the telegram repeat counter for newly received telegrams are saved internally, media couplers and all other RF devices can recognize whether a telegram has already been received and processed or not, despite of its identical user data content. This internal saving also permits repeaters to recognize whether they themselves have already forwarded the received telegram and therefore do not need to do so again.

The domain address of an RF telegram and the LFN can be displayed in ETS group or bus monitors under "Medium Info".

8.3 LED display

The device has a two-colour status LED. This LED displays device statuses in normal operation and during commissioning or maintenance.

The following display functions have been implemented:

- LED lights red:
  Programming mode is active. Programming mode is activated by pressing the programming button or by using the ETS. Programming mode is deactivated after the physical address has been successfully programmed, or is generally deactivated by a device test (power failure, ETS programming process of the application program). Programming mode is also deactivated automatically after 4 minutes if none of the above events occurs.
- LED flashes slowly red:
  Safe-state mode is active (see chapter "Safe-state mode" ▸ Page 38).
- LED flashes red quickly (only in operation as media/segment coupler):
  Filter function has not been configured (filter table has no function). This display is dependent on the parameter settings of the coupler. If the parameter "Telegrams TP -> RF group telegrams" and/or "Telegrams RF -> TP group telegrams" is configured to "forward unfiltered" and the device is started up with this parameter setting, the status LED flashes red quickly. This is a sign that the filter table has no function.

This state should only be configured in a KNX installation within the context of system commissioning. During normal operation of a KNX system after commissioning, it is always recommended to activate the filter function of the group telegrams in both communication directions. This is realised by the parameter settings "filter" (default setting) or "lock".

– LED flashes yellow:
  This display function also depends on the parameter settings. The parameter "Function of the yellow status LEDs" defines how the display acts .
– LED briefly changes between red and yellow:
  Device test at a device restart after power is restored or after an ETS programming process.
– LED lights up yellow:
  Repeater prog. mode active for devices with marking "I02" or higher.

The priority of the described display functions is fixed. Programming mode has the highest display priority. As a result, when programming mode is active, the red lighting of the status LED overrides all other display functions. Safe-state mode has the second-highest display priority. The slow red flashing of the safe-state mode overrides the quick red flashing of the filter function display (third display priority) and this, in turn, overrides the yellow status function (fourth display priority).

8.4 Configuration lock

Function of the configuration lock

By using the ETS, the device can be programmed and commissioned either via the TP side (e.g. with a suitable KNX TP USB or IP data interface) or as an alternative, via the RF side (e.g. with a KNX RF USB data interface). As needed, it is also possible to prevent programming access to the device depending on the medium and so prevent changes to the configuration. This allows unwanted programming attempts (e.g. for unauthorised manipulation) to be suppressed to a great extent.

Locking or forwarding group telegrams, physically addressed telegrams and broadcast telegrams (routing) are not affected by the configuration lock. With the safe-state mode, the configuration lock can be temporarily cancelled in media/segment coupler operation (see chapter "Safe-state mode" ▸ Page 38).

If the device is working exclusively as a repeater (physical address x.y.1...255), it is only possible to program the application program and read out device information via the RF side! Thus, the configuration lock is always active on the TP side. In this case, the lock cannot even be released in safe-state mode.
Only changing the physical address back to x.y.0 ends the pure repeater operation and makes the device a media coupler again, whereupon the configuration lock can be configured.

The configuration lock is deactivated on the device in delivery state.

Setting up the configuration lock

The parameter "Configuration via" determines whether the configuration lock is active and to which media it applies.

- Set the parameter to "TP and RF".

  The media coupler can be programmed and read out for diagnostic purposes from the TP or RF side with no limitation.

- Set the parameter to "only TP".

  The device can only be programmed and read out via the TP side. Physically addressed connections reaching the device via the RF side are not responded to. Nor does the device respond to RF broadcast telegrams.

- Set the parameter to "only RF".

  The device can only be programmed and read out via the RF side. Physically addressed connections reaching the device via the TP side are not responded to. Nor does the device respond to TP broadcast telegrams.

8.5 Parameters for media coupler configuration

Configuration

Physical address of device x = area y = line	**x.y.0 (media coupler in RF line)** x.y.1...255 (segment coupler in RF segment)

i This parameter is only available in the ETS application program "Media coupler / repeater 902211".

Depending on the physical address the device can be inserted either as a media coupler or, alternatively, as a segment coupler in the KNX topology. Already the physical address assignment and programming define the device function. The following parameter must also be configured for the appropriate use.

x.y.0 (media coupler in RF line)
The device works as media coupler. Depending on the allocated physical address, the media coupler operates as either an area or a line coupler. The device operates as a line coupler when it has a physical address in the form x.y.0 (x = TP area address, y = RF line address / e.g. "1.1.0"). Then the media coupler is connected to the main TP line of an area. The device operates as a backbone coupler when it has a physical address in the form x.0.0 (x = TP area address, e.g. "1.0.0"). In this case, the backbone must be media type "TP".

i There may only ever be one media coupler in an RF line.

x.y.1...255 (segment coupler in RF segment)
The device operates as a segment coupler when it has a physical address in the form x.y.1...255 (x = TP area address, y = TP line address / e.g. "1.1.78"). The segment coupler is then connected to the higher-level TP segment of the line. The segment coupler functionality is supported from ETS version 6.0.5.

i There may only ever be one segment coupler in an RF segment.

Physical address of device x = area y = line	**x.y.0 (media coupler)** x.y.1...255 (RF repeater)

i This parameter is only available in the ETS application program "Media coupler / repeater 902011".

Depending on the physical address the device can be inserted either as a media coupler or, alternatively, as a repeater in the KNX topology. Already the physical address assignment and programming define the device function. The following parameter must also be configured for the appropriate use.

x.y.0 (media coupler)
The device works as media coupler. Depending on the allocated physical address, the media coupler operates as either an area or a line coupler. The device operates as a line coupler when it has a physical address in the form x.y.0 (x = TP area address, y = TP line address / e.g. "1.1.0"). Then the media coupler is connected to the main TP line of an area. The device operates as a backbone coupler when it has a physical address in the form x.0.0 (x = TP area address, e.g. "1.0.0"). In this case, the backbone must be media type "TP".

i There may only ever be one media coupler in an RF line.

x.y.1...255 (RF repeater)
The device operates exclusively as a repeater, without media coupler function. A repeater repeats the radio telegrams received in its RF line by retransmitting them immediately. This allows an extension of the range of a KNX RF installation, meaning that it is possible to position RF devices as required in a building, even in the case of difficult transmission and reception conditions.

i Repeaters working in an identical RF domain must have the same area address (x) and line address (y). Multiple repeaters can be added to an RF line.

Repeater function when used as media coupler	**deactivated** activated

In media coupler function mode, the device can also repeat telegrams from its own RF domain. Like in an independent repeater mode, this allows the range of a KNX RF installation to be extended, meaning that it is possible to position RF devices as required in a building even in the case of difficult transmission and reception conditions.

Repeater function when used as segment coupler	**deactivated** activated

In segment coupler function mode, the device can also repeat telegrams from its own RF domain. Like in an independent repeater mode, this allows the range of a KNX RF installation to be extended, meaning that it is possible to position RF devices as required in a building even in the case of difficult transmission and reception conditions.

Function of yellow status LED	**deactivated** flashes on telegram forwarding TP <-> RF flashes on telegram reception at TP flashes on telegram reception at RF (own domain) flashes on telegram reception at RF (all domains)

deactivated
The yellow status function is permanently deactivated.

flashes on telegram forwarding TP <-> RF
The status LED lights up yellow briefly for each forwarded telegram.

flashes on telegram reception at TP
The status LED only lights up yellow briefly when a group telegram, broadcast telegram or physically addressed telegram is received on the TP side.

flashes on telegram reception at RF (own domain)
The status LED only lights up yellow briefly when a group telegram, broadcast telegram or physically addressed telegram with the domain name of the associated RF domain is received on the RF side.

flashes on telegram reception at RF (all domains)
The status LED only lights up yellow briefly when an arbitrary group telegram, broadcast telegram or physically addressed telegram is received on the RF side. In this case, telegrams of all KNX RF domains are displayed.

i With the settings "flashes for telegram reception on RF (own domain)" and "flashes for telegram reception on RF (all domains)", the status LED also lights up yellow briefly when system broadcast telegrams are received.

Configuration via	**TP and RF** only TP only RF

By using the ETS, the device can be programmed and commissioned either via the TP side (e.g. with a suitable KNX TP USB or IP data interface) or, as an alternative, via the RF side (e.g. with a KNX RF USB data interface). As needed, it is also possible using this parameter to prevent programming access to the device depending on the medium and so prevent changes to the configuration. This allows unwanted programming attempts (e.g. for unauthorised manipulation) to be suppressed to a great extent.

Locking or forwarding group telegrams, physically addressed telegrams and broadcast telegrams (routing) are not affected by the configuration lock. With the safe-state mode, the configuration lock can be temporarily cancelled in coupler operation (see chapter "Safe-state mode" ▸ Page 38).

TP and RF
The device can be programmed and read out for diagnostic purposes from the TP or RF side with no limitation.

only TP
The device can only be programmed and read out via the TP side. Physically addressed connections reaching the device via the RF side are not responded to. Nor does the device respond to RF broadcast telegrams.

only RF
The device can only be programmed and read out via the RF side. Physically addressed connections reaching the device via the TP side are not responded to. Nor does the device respond to TP broadcast telegrams.

Selection

Telegrams TP -> RF

Group telegrams	transmit unfiltered block **filter**

This parameter determines whether group telegrams are forwarded from the higher-level TP side to the lower-level RF side (routing TP -> RF).

transmit unfiltered
All group telegrams will be transmitted. The filter table will be disregarded. This setting influences the behaviour of the red status LED. As soon as this parameter is set to "forward unfiltered", the status LED flashes red quickly.

i This setting should only be selected in a KNX installation within the context of system commissioning. During normal operation of a KNX system after commissioning, it is always recommended to activate the filter function of the group telegrams in both communication directions. This is realised by the parameter setting "filter" (default setting).

block
All group telegrams will be blocked. No group telegram can pass the coupler from TP to RF.

filter
In accordance with the filter table generated and programmed in the ETS, group telegrams are either transmitted or blocked selectively.

Broadcast telegrams	**transmit unfiltered** block

This parameter determines whether broadcast telegrams are forwarded from the higher-level TP side to the lower-level RF side (routing TP -> RF).

transmit unfiltered
All broadcast telegrams are transmitted.

block
All broadcast telegrams are blocked. No broadcast telegram can pass the coupler from TP to RF.

physically addressed telegrams	transmit unfiltered block **filter (depending on target & coupler address)**
This parameter determines whether physically addressed telegrams are forwarded from the higher-level TP side to the lower-level RF side (routing TP -> RF). transmit unfiltered All physically addressed telegrams are transmitted. block All physically addressed telegrams are blocked. No physically addressed telegram can pass the coupler from TP to RF. This means that no RF devices can be programmed by TP in the domain of the device! filter (depending on target & coupler address) Only physically addressed telegrams with a target address matching the device area or line address are forwarded. All other physically addressed telegrams are blocked.	

Telegrams RF -> TP

Group telegrams	transmit unfiltered block **filter**
This parameter determines whether group telegrams are forwarded from the lower-level RF side to the higher-level TP side (routing RF -> TP). transmit unfiltered All group telegrams will be transmitted. The filter table will be disregarded. This setting influences the behaviour of the red status LED. As soon as this parameter is set to "forward unfiltered", the status LED flashes red quickly. i This setting should only be selected in a KNX installation within the context of system commissioning. During normal operation of a KNX system after commissioning, it is always recommended to activate the filter function of the group telegrams in both communication directions. This is realised by the parameter setting "filter" (default setting). block All group telegrams will be blocked. No group telegram can pass the coupler from RF to TP. filter In accordance with the filter table generated and programmed in the ETS, group telegrams are either transmitted or blocked selectively.	

Broadcast telegrams	**transmit unfiltered** block
This parameter determines whether broadcast telegrams are forwarded from the lower-level RF side to the higher-level TP side (routing RF -> TP). transmit unfiltered All broadcast telegrams are transmitted. block All broadcast telegrams are blocked. No broadcast telegram can pass the coupler from RF to TP.	

physically addressed telegrams	transmit unfiltered block **filter (depending on target & coupler address)**
This parameter determines whether physically addressed telegrams are forwarded from the lower-level RF side to the higher-level TP side (routing RF -> TP). transmit unfiltered All physically addressed telegrams are transmitted. block All physically addressed telegrams are blocked. No physically addressed telegram can pass the coupler from RF to TP. This means no TP or IP devices can be programmed via the RF side (device domain)! filter (depending on target & coupler address) Only physically addressed telegrams with a target address which does not match the coupler area or line address are forwarded. Physically addressed telegrams with a target address matching the coupler area or line address are blocked.	

Repetitions in case of TP transmission errors

Group telegrams	no **yes**
A group telegram transmitted by the device on the TP side is checked for transmission errors. This parameter determines whether the forwarded telegram is to be repeated up to three times when a BUSY or a NACK confirmation signal is received, or when there is no ACK confirmation signal on the higher-level TP line.	

Broadcast telegrams	no **yes**
A broadcast telegram transmitted by the device on the TP side is checked for transmission errors. This parameter determines whether the forwarded telegram is to be repeated up to three times when a BUSY or a NACK confirmation signal is received, or when there is no ACK confirmation signal on the higher-level TP line.	

physically addressed telegrams	no **yes**
A physically addressed telegram transmitted by the device on the TP side is checked for transmission errors. This parameter determines whether the forwarded telegram is to be repeated up to three times when a BUSY or a NACK confirmation signal is received, or when there is no ACK confirmation signal on the higher-level TP line. i Deactivating the telegram repetition if there are transmission errors reduces the bus load, but also reduces the transmission security!	

Telegram confirmation on TP line

Group telegrams	always **only if transmitted**
At this point, it is possible to define when the device confirms the group telegrams received on the higher-level TP line. always The device always confirms on the higher-order TP line every group telegram received. only if transmitted The device confirms, on the higher-level TP line, only those group telegrams forwarded on the lower-level RF line.	

physically addressed telegrams	always **only if transmitted**
At this point, it is possible to define when the device confirms the physically addressed telegrams received on the higher-level TP line. always The device always confirms, on the higher-level TP line, every physically addressed telegram received. only if transmitted The device confirms, on the higher-level TP line, only the physically addressed telegrams forwarded on the lower-level RF line. i Broadcast telegrams are always confirmed on the TP line by the device when they are received.	

9 Safe-state mode

Function of the safe-state mode

If the device does not work as intended, e.g. as a result of errors in the project design or during commissioning, the execution of the loaded application program can be halted by activating the safe-state mode. In safe-state mode, essential functions of the device are deactivated. Only the ETS diagnosis function can be executed, and it is still possible to program the device.

When safe-state mode is active, the device acts as follows:

- No group telegrams, physically addressed telegrams or broadcast telegrams are forwarded (the routing is inactive).
- The repeater function is inactive (no RF telegrams are repeated).
- The configuration lock is inactive.
- The status LED flashes red slowly.

If the device is working exclusively as a repeater (physical address x.y.1...255), it is only possible to program the application program and read out device information via the RF side! Thus, the configuration lock is always active on the TP side. In this case, the lock cannot even be released in safe-state mode.

Activating the safe-state mode

- Disconnect the device connection terminal.
- Hold down the programming button.
- Reconnect the device connection terminal.

  The device restarts. The status LED briefly lights up red and then yellow.
- Release the programming button as soon as the status LED starts flashing red slowly.

  Safe-state mode is active.

Deactivating safe-state mode

Safe-state mode is deactivated via the ETS or by disconnecting and reconnecting the device voltage supply.

Precondition: Safe-state mode is active.

- Reset the device via the ETS (restart).

  or
- Program the physical address with the help of the ETS.

  or
- Disconnect the device connection terminals or switch off the voltage supply.
- Wait about 3 s.

- Reconnect the device connection terminals or switch the voltage supply back on.

  Safe-state mode is deactivated.

i A programming process of the application program via the ETS does not end the safe-state mode, because there is no automatic restart.

10 As-delivered state

Function in delivery state

In delivery state, the device is ready for operation as a media coupler. The device works as follows with the configurations below:

- Physical address: 15.15.0
- Domain address: $FF FF FF FF FF FF
- Configuration lock: inactive
- Repeater function during use as media coupler: deactivated
- Configurable function of yellow status LED: deactivated
- Filtering group telegrams (TP -> RF, RF -> TP): Filter (because no filter table has been loaded, group telegrams are not forwarded)
- Filtering broadcast telegrams (TP -> RF, RF -> TP): Forward unfiltered
- Filtering physically addressed telegrams (TP -> RF, RF -> TP): Filter (TP-> RF forwarding physical addresses of line 15.15)
- Repetitions in case of TP transmission errors: yes
- Telegram confirmation on TP line: only if transmitted

In the case of devices with marking "I04" or higher, the yellow status LED indicates repeater prog. mode.

Reset delivery state (master reset)

The device can be reset to delivery state at any time, even without using the ETS.

i A reset to delivery state is useful when, for example, the device was mistakenly commissioned with the incorrect physical address x.y.1...255, so the repeater is active. In pure repeater operation, the device can no longer be programmed via the TP side. In this case, a reset to delivery state is helpful in allowing the TP to be reprogrammed.

- Disconnect the device connection terminals or switch off the voltage supply.

  The device does not function.

- Press and hold down the programming button.
- Reconnect the device connection terminals or switch the voltage supply back on.

  The device restarts. The status LED briefly lights up red and then yellow. Then the status LED flashes red slowly.

- Release the programming button as soon as the status LED starts flashing red slowly.

  Safe-state mode is active .

- Press and hold down the programming button again until the status LED goes out.

The device resets to delivery state.

- Release the programming button.

  The status LED lights red-> yellow briefly. The device is in delivery state.

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