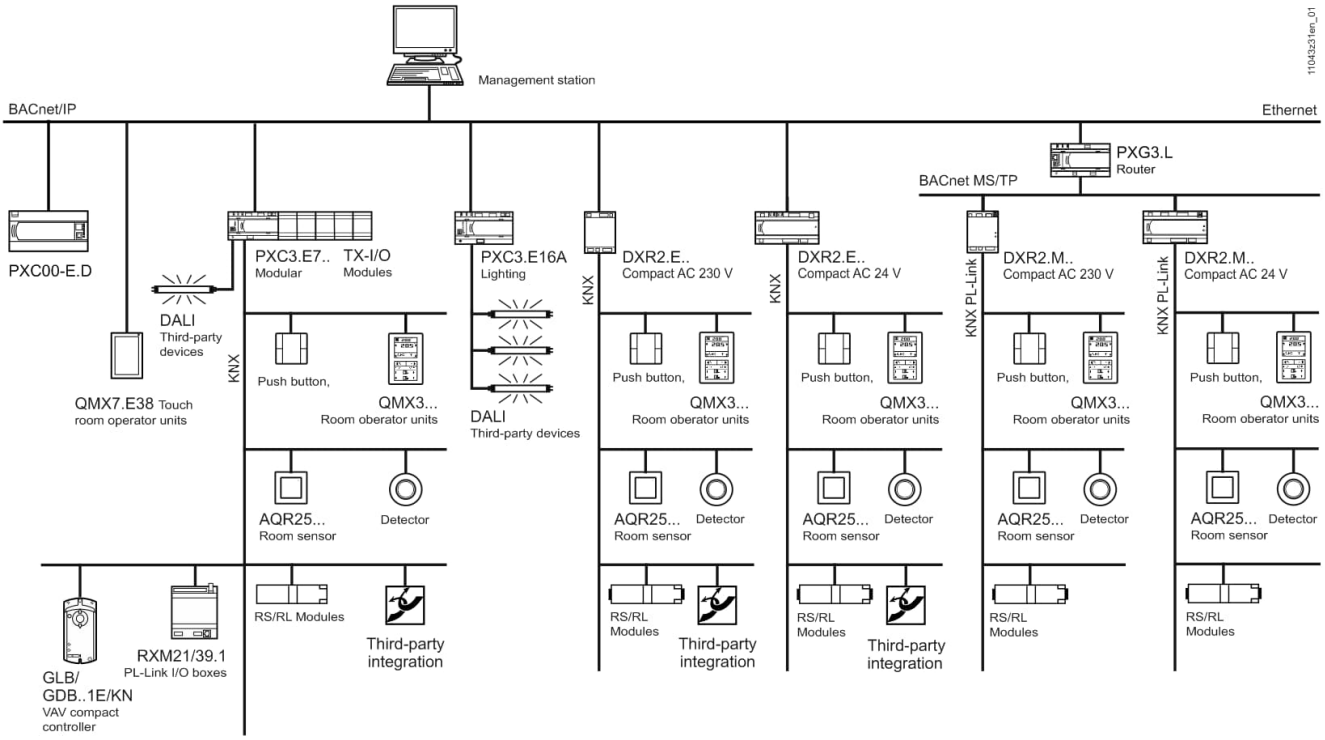
SIEMENS



Desigo™ Room automation
Engineering, mounting and installation
Manual

CM111043en_15
2023-01-20

Smart Infrastructure

Contents

1 About this document 4
1.1 Revision history 4
1.2 Reference documents 4
1.3 Before you start 6
1.4 Document validity 7

2 Introduction 8
2.1 About this document 8
2.2 What does this document describe? 9

3 Important information on safety 11
3.1 System-specific regulations 11
3.2 Device-specific regulations 13
3.3 Cyber security Disclaimer 14

4 Installation – overview 15
4.1 PXC3 15
4.2 DXR2 16

5 Installation box / panel for DRA 17
5.1 Requirements 17
5.2 Layout 18
5.3 Geometric design 19
5.3.1 Mounting position 19
5.3.2 Space requirements 19
5.4 EMC compliant installation box / panel 21
5.5 EMC compliant wiring 22

6 Wiring of power lines 24
6.1 Supplemental notes on safety 24
6.2 AC 230 V power lines 25
6.2.1 DXR2, RXM 25
6.2.2 AC 230 V power line cables 26
6.3 AC 24 V power lines 27
6.3.1 PXC3 (power and island bus lines) 27
6.3.2 DXR2 / DXR1 29
6.3.3 AC 24 V Transformer sizing 30
6.3.4 AC 24 V power line cable lengths 33
6.4 Power supply for field devices 34

7 Wiring of field devices (without bus) 35
7.1 Signal wiring 35
7.1.1 Digital inputs 36
7.1.2 Passive resistance sensors and resistance transmitters 36
7.1.3 Active sensors and actuators DC 0 … 10 V 39
7.2 Wiring for Triac outputs AC 24 V 41
7.3 Wiring for Relay outputs 42
7.4 Connecting the differential pressure sensor 42

8 Electrical features of inputs & outputs 43

8.1 Digital inputs 43
8.2 Analog inputs 43
8.2.1 Passive resistance sensors 43
8.2.2 Active sensors DC 0 … 10 V 44
8.2.3 Technical data for the analog inputs 45
8.3 Digital outputs (relays, triacs) 46
8.3.1 Admissible relay load 46
8.3.2 Admissible triac load 46
8.3.3 Triacs and AO 0-10V on DXR2 AC 230 V: engineering 47
8.4 Analog outputs DC 0...10 V 49
9 Ethernet network 50
9.1 IT security 50
9.2 Network topologies 50
9.3 Cables 51
9.4 Power over Ethernet (PoE) 51
10 MS/TP networks 53
10.1 Network requirements 53
10.2 Technical data BACnet MS/TP 56
11 SCOM sensor bus 58
12 Island bus 59
13 KNX PL-Link room bus 60
13.1 Bus power supply 60
13.1.1 Internal KNX PL-Link power supply 60
13.1.2 External bus supply 61
13.2 Bus topologies 62
13.3 Cables 63
13.4 Commissioning notes 64
13.5 Technical data KNX PL-Link 65
14 DALI network 66
14.1 Bus power supply 66
14.2 Bus topologies 67
14.3 Cables 67
14.4 Technical data DALI 68
15 EnOcean RF networks 69
15.1 Technology 69
15.2 Lighting conditions at mounting location 71
15.3 Battery operation 74
15.4 RF link properties 74
15.5 Planning RF networks 76
15.6 Range planning 81
15.7 Troubleshooting 83
15.8 Commissioning RF link 85
15.9 Gateways 85
16 Disposal 86

1 About this document

1.1 Revision history

Revision	Date	Changes	Section
_15	**01.2023**	• **Adapted specification for AC 24 V transformers**	**6.3.3**
_14	10.2020	• Added PXC3.ExxA-200A and DALI-2	Various
_13	04.2020	• Added DXR1 and SCOM bus	Various
_12	10.2018	• Note DALI bus	14.1
_11	June 2017	• Note on faulty wiring AC 24 V	6.4
_10	Feb 2016	• Deleted condensation monitor • Deleted AI NTC 3K • Additional example • Number of MS/TP devices	6.4 8.2.1 8.3.3 10
_09	Feb 2016	• Number of MS/TP devices	10
_08	Nov 2015	• Temperature range DXR2	7.1, 8.2
_07	Oct 2015	• Added DXR2... and PXC3E.16A • Added techn. data of inputs and outputs • Added Cyber security • Added MS/TP network • Added USB not working • Various corrections	Various 8 3.3, 9.1 10 6.3 Various
_05	Nov 2013	• Power over Ethernet	9.4
_04	May 2013	• Designation KNX PL-Link • Wiring	All 6
_02	Nov 2012	• Gamma Instabus Documentation • External bus supply types	1.2 13.1.2
_01	Mar 2012	First edition	All

1.2 Reference documents

Ref.	Document title	Document number
[1]	Desigo Technical principles manual, Section 21.	CM110664
[2]	Data sheet PXC3... Room automation station	CM1N9203
[3]	Data sheets DXR2...	CM1N9204...7
[6]	Onboard-I/O functions of DXR2 Room automation stations	CM110589
[7]	TX-I/O™ Product range overview.	CM2N8170
[8]	TX-I/O™ Engineering and installation manual.	CM110562
[9]	Desigo PX Mounting and installation guide	CA110396
[10]	Ethernet, TCP/IP as well as BACnet on Ethernet/IP principles	CM110666
[11]	Application Guide for IP Networks in Building Automation Systems	CM110668
[12]	Desigo Cybersecurity Guidelines Application Guide	A6V14142297
[13]	Apogee Wiring Guidelines	125-3002
[14]	BACnet Network Setup and Troubleshooting Manual	125-5103
[15]	DALI: www.dali-alliance.org	
[16]	EnOcean: www.enocean.com	

1.3 Before you start

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KNX®	KNX Association, B - 1831 Brussels-Diegem Belgium http://www.knx.org/
EnOcean®	EnOcean LLC, Germany 82041 Oberhaching www.enocean.com
DALI ™	c/o IEEE-ISTO 445 Hoes Lane Piscataway, NJ 08854, USA www.dali-alliance.org

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1.4 Document validity

Desigo V6 and later

2 Introduction

2.1 About this document

Main target audience

The mounting and installation guide is targeted at

- **Engineers**
- **Panel builders and factory installers**
- **Electricians**
- **Engineers**

Purpose

The mounting and installation guide provides all the information needed by the aforementioned personnel for:

The proper mounting and wiring of Desigo DRA in the cabinet / in the installation box and connections to the plant.

An overview of the room automation station product range and its design is provided for general understanding.

Additional use

The mounting and installation guide is provided to internal engineering personnel at Siemens Building Technologies and system houses with information on the following topics:

– Transformer sizing
– Wiring topology and sizing
– Installation variants for room automation station.
– Regulations and notes.

Restrictions

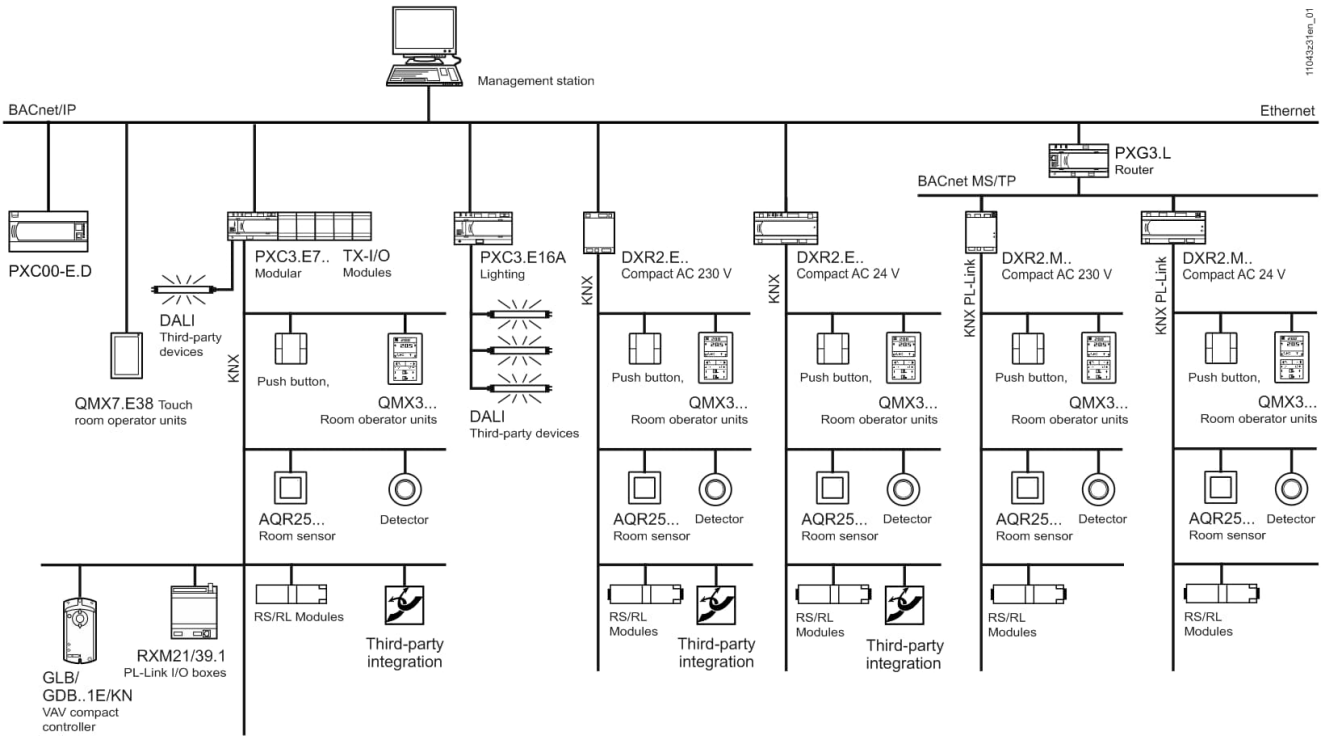
The mounting and installation guide includes all documentation in the form of text and images required fort he aforementioned target groups and intended use.
It does not include information of plant-specific mounting and wiring work. This information is available in the appropriate project documentation.

2.2 What does this document describe?

Overview

The document describes proper engineering, mounting and wiring for
- the room automation stations.
- the TX-I/O modules.
- for peripheral devices connected to the TX-I/O modules or DXR2 room automation stations.
- for peripheral devices connected via KNX PL-Link, DALI and EnOcean.

Topology



The areas indicated above can be briefly described as follows:

Range	Brief description
Installation box or panel	The following devices are installed in the installation box / in the panel: – PXC3... or DXR... room automation station. – TX-I/O modules connected to the room automation station via the island bus. Other ways of installation: – Directly in the fan coil. – In the VAV box (with terminal covers). – In a raised floor / suspended ceiling (with terminal covers). – in a parapet channel (with terminal covers).
Building services equipment	Connected plants and systems, including: Heating, ventilation and air conditioning plants, electrical systems, etc., as well as electrical areas (switches, buttons, lighting groups, blinds).

Note KNX S-Mode is not supported by MS/TP devices

Connections

In general the following connections exist from and to the installation box:

- **BACnet/Ethernet**
  Room automation stations, the primary plant level PX and the management station are connected via Ethernet cables and switches.
- **BACnet MS/TP**
  Room automation stations and the primary plant level are connected via twisted pair cables.
  The connection to the management station is done via IP.
- **Island bus / island bus expansion**
  A bus cable runs from the room automation station to the external I/O modules.
- **Wiring of the field devices** (sensors, switches/buttons, control values, motors, etc).
- **KNX PL-Link**
  A bus cable runs from the automation station to the KNX devices.
- **DALI**
  A bus cable runs from the automation station to DALI devices.
- **USB:**
  The room automation station includes an USB Device interface. It serves for commissioning and service.
- **Wireless connections:**
  A KNX gateway integrates wireless EnOcean devices (room units, sensors, buttons).

3 Important information on safety

Please comply with these notes

This section deals with general and system-specific regulations. It includes important information for your safety and the safety of the entire plant.

Safety notes

Sections flagged with the warning symbol to the left contain safety-related requirements and restrictions that must be adhered to at all times to prevent physical injury and equipment damage.

General Regulations

Please comply with the following general regulations during engineering and execution:

- Electrical and mains power ordinances for the given country.
- Other applicable, national regulations.
- Building installation regulations for the given country.
- Regulations of the facility supplying electricity.
- Diagrams, cable lists, dispositions, specifications and orders by the customer or authorized engineering office.
- Third-party regulations, e.g. by the general contractor or building owner.

As a rule, comply with local regulations for electrical installations. These take precedence over any notes in this document.

3.1 System-specific regulations

Safety

The electrical safety for building automation and control systems by Siemens Building Technologies is essentially based on **safely separating low voltage from mains voltage.**

IEC (SELV, PELV) (worldwide)

Application as per SELV or PELV pursuant to IEC 60364-4-41 "Low-voltage electrical installations" depending on the grounding (⊥ AC24V) of the low voltage:
Ungrounded = Safety Extra-Low Voltage (SELV).
Grounded = Protection by Extra Low Voltage (PELV).

NEC (North America)

- Using an energy limited Class 2 transformer with max. 100 VA OR

Class 2 circuits with max. 100 VA each, using a non energy limiting transformer with max. 400VA, combined with over-current protective devices (T 4 A fuses) for each room automation station. Multiple fuses per transformer may be used to provide multiple isolated secondary circuits, see 6.3.2.

Device safety

Device-related safety is guaranteed, among others, by
– Low-voltage power supply AC 24 V
– Double insulation between mains voltage AC 230 V, AC 24 V circuits and housing.

Comply with specific regulations for electrical wiring per the following sections.

⚠ Grounding of ⊥ (System neutral AC 24 V)

Observe the following points when grounding ⊥ AC 24 V (system neutral):

- **As a principle**, operating voltage of AC 24 V is permitted in principle for both grounded (PELV) as well as non-grounded (SELV) system neutral. Local regulations and customers apply accordingly.
  Grounding may be required or not allowed for functional reasons.
- **Recommendation: PELV installation. AC 24 V systems are grounded** unless disadvised by any of the field device manufacturers.
- System neutral ⊥ must be grounded at a single point at the primary transformer.
- Where AC 24V power for field devices is not distributed by the TX-I/O terminals, all secondary transformers powering the field devices must be star grounded to the single point at the primary transformer.
- **Caution**: where AC 24V system neutral ⊥ is **not grounded**, all connected devices using ⊥ must be capable of accepting AC 24V on their ⊥ terminal.
  This means they must be SELV-compatible.
- **Caution**: where AC 24V system neutral ⊥ is **not grounded**, USB must be isolated from laptop using an USB isolator.
- In order to avoid ground loops, connect systems with **PELV** to the ground at one location only (especially for transformers), if no other indication exists.

⚠ Grounding of AC 230 V

- **AC 230 V devices and AC 230 V field devices must not be grounded.**

⚠ Mains and operating voltage

Operating voltage AC 24 V	It must meet requirements for SELV or PELV. Permitted deviation for nominal voltage • At the transformer: AC 24 V -10 - + 20%. • At the room automation station: AC 24 V -12 - + 20%. • At the field devices: AC 24 V -20 - + 20%. Do not interchange the conductors V~ and ⊥ (system neutral), otherwise island bus and USB communications will not work properly.
Transformer specification AC 24 V	• IEC: Use safety insulating transformers as per IEC 61558 with double insulation designed for 100% duty to supply SELV or PELV circuits. • USA: Class 2 circuits to UL 5085-3. • Power taken from the transformer should be at least 50% of nominal load for efficiency reasons (effectiveness). • Transformer nominal power should be at least 25 VA. For smaller transformers, the ratio of open circuit voltage to full load is unfavorable (> + 20%).
Operational voltage fuse AC 24 V	Transformers on the secondary side correspond to the actual load of all connected devices as per transformer sizing: • AC 24 V line (system potential) must always be fused. • Where required, also line ⊥ (system neutral).
Mains fuse	Transformer, primary side: Installation box fuse (control circuit fuse).
Operating voltage AC 230 V	For devices with AC 230 V supply: • The sizing and fuse protection of the supply cables depends on the total load and on local regulations. • Supply cables must be secured with cable restraints on the room automation station.

⚠ Caution with regard to foreign voltages!

Any insertion or drawing of dangerous voltages to the system's low-voltage circuit, e.g. caused by improper wiring directly places people at risk and may result in the partial or complete destruction of the building automation and control system!

Mains filter

Spikes and high-frequency interference may occur in areas with high levels of interference. The disturbances not only impact the transformer on the primary side, but may also influence secondary connected components.

A mains filter should be attached on the primary transformer if such interference is anticipated. Mains filters should be installed as close to the network transformer as possible and grounded.

Emergency intervention of power components

Peak loads occur when switching inductive loads that may cause faults to the system. In addition, sparks may damage switching contacts. Power components must include effective protection against disturbances to prevent such faults. Inductivity (transformers, fuses, relays) are wired directly at the terminals using transzorbs, MOVs (metalloxyd varistors) or RC elements. The breakdown voltage of the transzorbs or MOVs must equate to the 1.7 to 2 times the applicable nominal voltage.

Inductive DC consumers can also be suppressed using diodes or RC elements.

The transzorbs, MOVs, diodes or RC elements must be optimally matched to the power components and mounted using short wiring.

3.2 Device-specific regulations

⚠ Field device connection

Devices using different power circuits

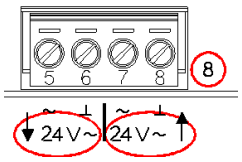
Devices must have the required insulation of the power circuits from each other to be able to connect them directly without additional insulation.

Interfaces for different voltage circuits

Connections via interfaces increase the risk of distributing dangerous voltage through the building. Ensure that the required insulation is available at all times and installed per applicable regulations.

PXC3...
supply AC 24 V

The terminals for the supply of additional devices (terminals 7 and 8) bare a max current of 6 A.
An external T 10 A fuse is compulsory



TX-I/O modules: island bus conductor V~ (AC 24 V)

The island bus conductor V~ is fused with the M 10 A fuse in the PXC3 / the power supply module. The cross section of the field device cables must therefore be designed for 10 A.

DXR2... with supply AC 24 V *(see 6.3.2)*

- IEC: Fusing with max. 10 A
- NEC: A class 2 transformer or an external T 4 A fuse is compulsory
  Max. 100 VA per transformer / per fuse circuit

DXR2.**M**... with supply AC 24 V *(see 6.3.2)*

- System neutral (⊥) must always be grounded at the transformer.

DXR2... with supply AC 230 V

- Max. load. 6 A for the supply lines (protection of the PCB tracks to the load circuits / relays).

3.3 Cyber security Disclaimer

Siemens provides a portfolio of products, solutions, systems and services that includes security functions that support the secure operation of plants, systems, machines and networks. In the field of Building Technologies, this includes building automation and control, fire safety, security management as well as physical security systems.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art security concept. Siemens' portfolio only forms one element of such a concept.

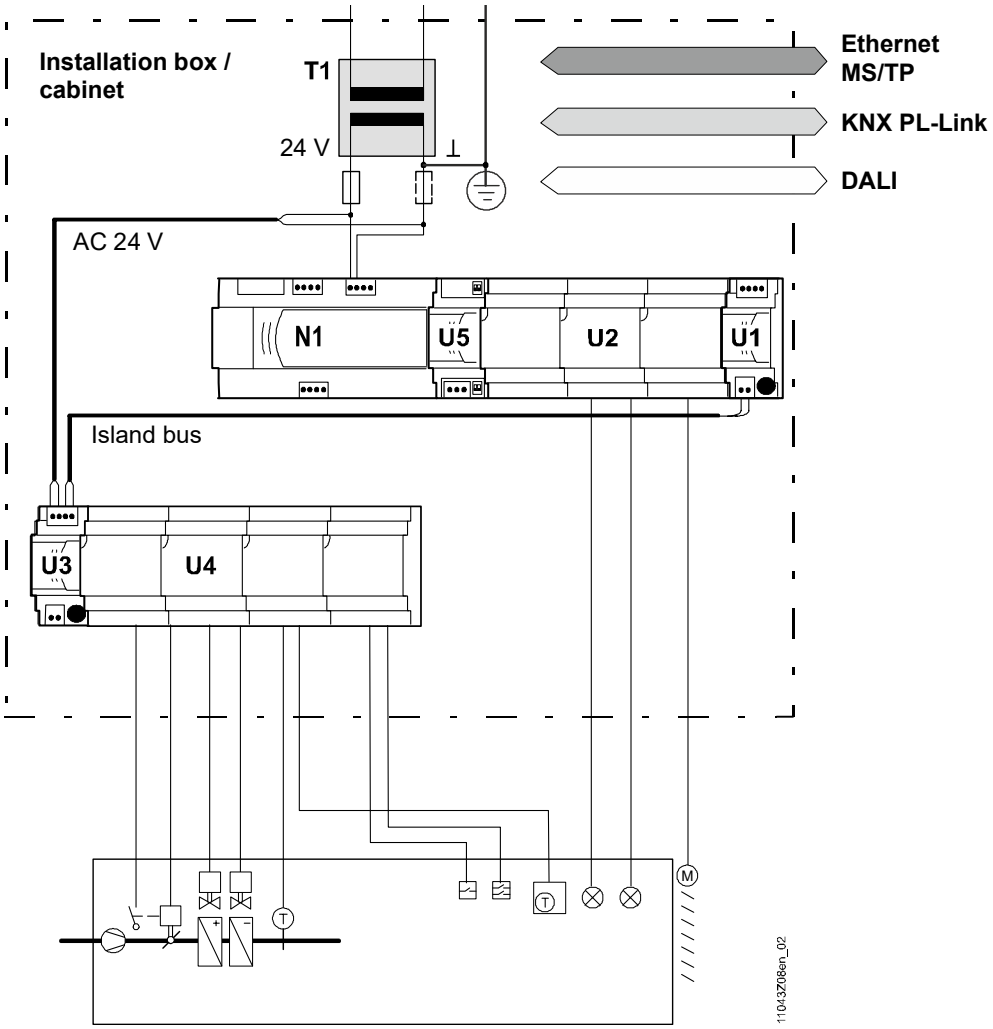
You are responsible for preventing unauthorized access to your plants, systems, machines and networks which should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place. Additionally, Siemens' guidance on appropriate security measures should be taken into account. For additional information, please contact your Siemens sales representative or visit https://www.siemens.com/global/en/home/company/topic-areas/future-of-manufacturing/industrial-security.html.

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4 Installation – overview

4.1 PXC3...

The illustration is a diagram of a PXC3 room automation station in an installation box / panel, the TX-I/O modules, connections to the field devices as well as bus connections (Ethernet, KNX, DALI).. Insert

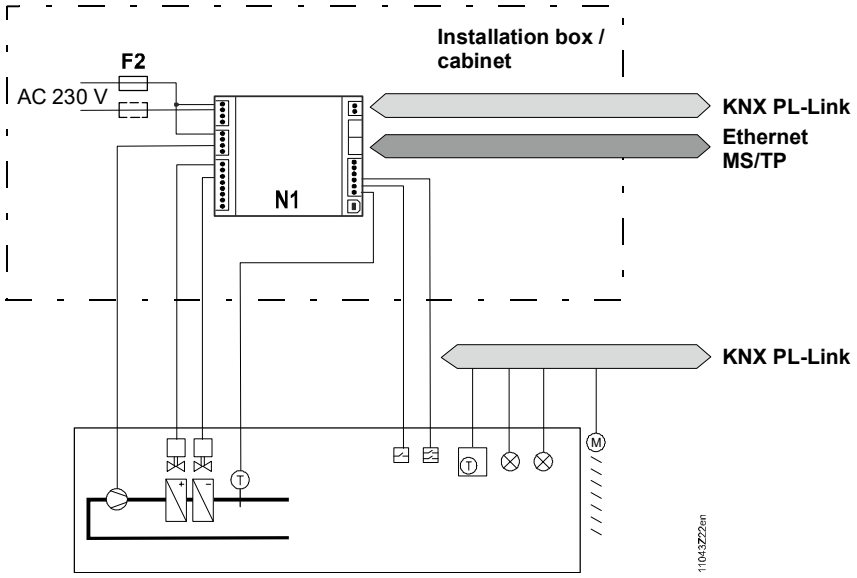


Element	Description	Details see section / document
T1	Transformer AC 24 V → transformer sizing	6.3.3
AC 24 V	Wiring of power lines and island bus	6.3.1
N1	PXC3... room automation station.	[8]
U1, U3	TXS1.EF10Bus connection modules	[8]
U2	I/O row, supplied by the PXC3...	[8]
U4	I/O row supplied by a TXS1.EF10Bus connection module	[8]
U5	TXA1.IBE Island bus expansion module (optional)	[8]
--	Electrical properties of inputs and outputs	8
--	Power supply for field devices	6.4
--	Wiring of field devices	7
Ethernet		9
KNX PL-Link		13
DALI		14

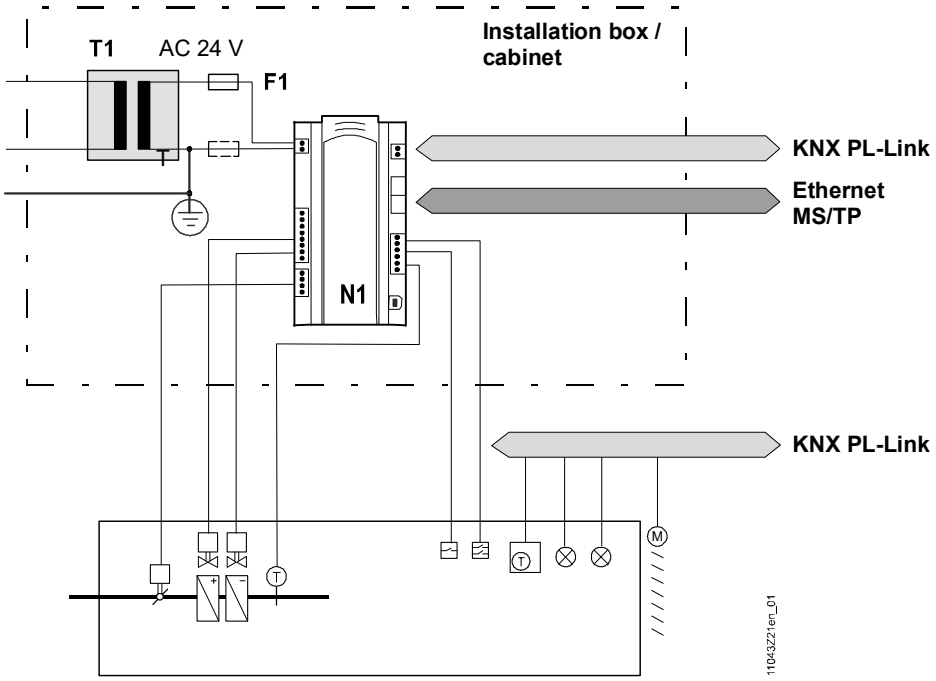
4.2 DXR2...

The illustrations are diagrams of DXR2 room automation stations in an installation box / panel, the connections to the field devices as well as bus connections (Ethernet, MS/TP, KNX, DALI)..

DXR2 AC 230 V



DXR2 AC 24 V
DXR1 AC 24 V



Element	Description	Details see section
T1	Transformer AC 24 V → transformer sizing	6.3.3
AC 230 V, F2	Wiring of power lines	6.2
AC 24 V, F1	Wiring of power lines	6.3.2
N1	DXR2... room automation station	
--	Electrical properties of inputs and outputs	8
--	Power supply for field devices	6.4
--	Wiring of field devices	7
Ethernet		9
MS/TP		10
KNX PL-Link		13

5 Installation box / panel for DRA

5.1 Requirements

Systems with TX-I/O modules

Please read Sections 5.1 "Panel requirements" and 5.3 "EMC compliant panel" in the TX-I/O engineering and installation guide [8] prior to engineering and executing the installation box.

Space requirements

Observer the following for mounting and installation.

- Installation depth
- Maintain sufficient cable distance to be able to easily snap on and remove the screw terminal blocks, even if the automation stations are mounted.
- Room automation stations can be mounted directly next to one another; a distance of ca. 2 cm is recommended, however, for facilitate access.
- Reserve sufficient free space for subsequent extensions.

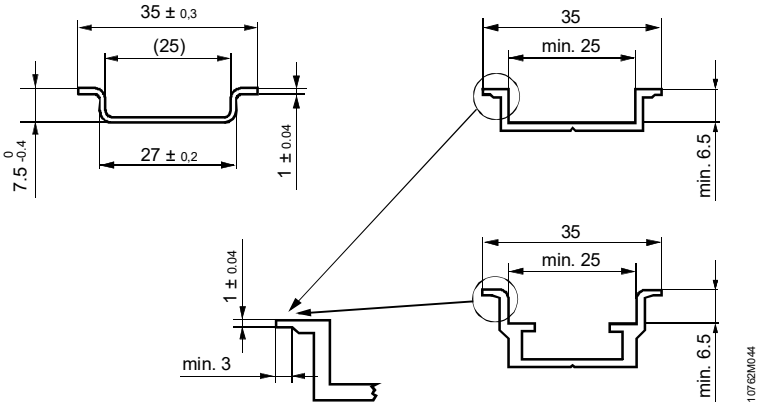
Installation mode

Standard rails

The room automation stations and TX-I/O modules are designed for installation on standard rails (prerequisite to establishing the island bus connection using TX-I/O modules).

Permissible standard rails:

- Top hat rails TH35-7.5 as per EN60715 (35 x 7.5 mm).
- Other top hat rails that meet the following conditions:
  - Material thickness exterior max. 1 mm, min. 3 mm in depth
  - Internal opening at least 25 mm.



Wall mounting

The room automation station may also be attached to a wall if used without TX-I/O modules.

5.2 Layout

Requirements

The table below provides information on general installation box / panel requirements. Check to ensure the individual requirements are met.

Bullet	Requirements	OK
Mechanical execution	Construction, stability and sealing meet applicable regulations at the plant's location.	
Ambient conditions	• Desigo DRA is designed for an ambient temperature of -5 - 50°C / 23...122 °F. PXC3.E7x and DXR2...: 45°C / 113 °F for certain mounting positions, see below. Make sure that the installation box / panel is sufficiently ventilated to ensure compliance with the ambient temperature for all devices. • For devices, the permissible values as per the data in "Technical data" in the datasheet must be observed with regard to: – Humidity, vibration. – Device IP class and device protective type.	
EMC compliant installation box	The installation box / panel corresponds to the rules described in Section 5.4.	

Mechanical dimensions

The following help to determine the required dimensions:

– Data on placement in this section.
– Device dimensions in the data sheets.

5.3 Geometric design

5.3.1 Mounting position

The mounting position is equivalent to the direction of the device labeling.

TX-I/O devices and **PXC3.E16A** can be mounted in any position:

Recommended	Permissible
• Wall, horizontal from left to right or from right to left • Wall, vertical from top to bottom or from bottom to top.	• Over head. • On a horizontal surface.
Ambient temperature -5...50 °C / 23...122 °F	**Ambient temperature -5...50 °C / 23...122 °F**

For the **PXC3.x.7x** types and **DXR...**, the following **restrictions** apply:

Recommended	With restrictions *)
• Wall, horizontal from left to right or from right to left	• Wall, vertical from top to bottom or from bottom to top. • Overhead. • On a horizontal surface.
Ambient temperature -5...50 °C / 23...122 °F	**Ambient temperature -5...45 °C / 23...113 °F *)**

*) **PXC3.x.7x:** 50°C / 122 °F is admissible if the bus supplies use max. 2/3 of the specified load:
KNX PL-Link 105mA, DALI 85mA and island bus 400mA.

Note

- **You must ensure, however, that sufficient ventilation is available to maintain the permissible ambient temperature for the devices (inside the cabinet / installation box).**
  Outside the installation box / panel temperature must be 10 K lower.
- **In case of vertical mounting on a mounting rail, a stopper clamp is required to prevent the devices from sliding off.**

5.3.2 Space requirements

Number of devices

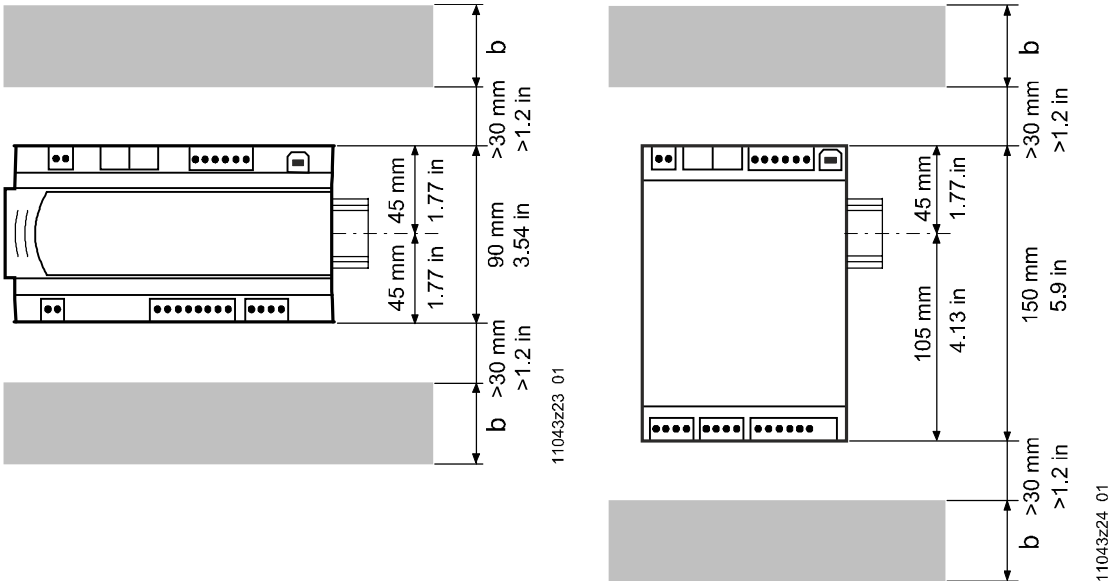
Space requirements in the installation box / panel can be calculated as follows:

- Number of I/O modules x 64 mm / 2.52 in.
- Number of power supply modules x 96 mm / 3.78 in.
- Number of bus connection modules x 32 mm / 1.26 in.
- PXC3 room automation station x 162 mm / 6.38 in.
- DXR2 room automation station (24 V) x 180mm / 7.09 in.
- DXR2 room automation station (230 V) x 112mm / 4.41 in.
- Transformers
- Terminal strips.

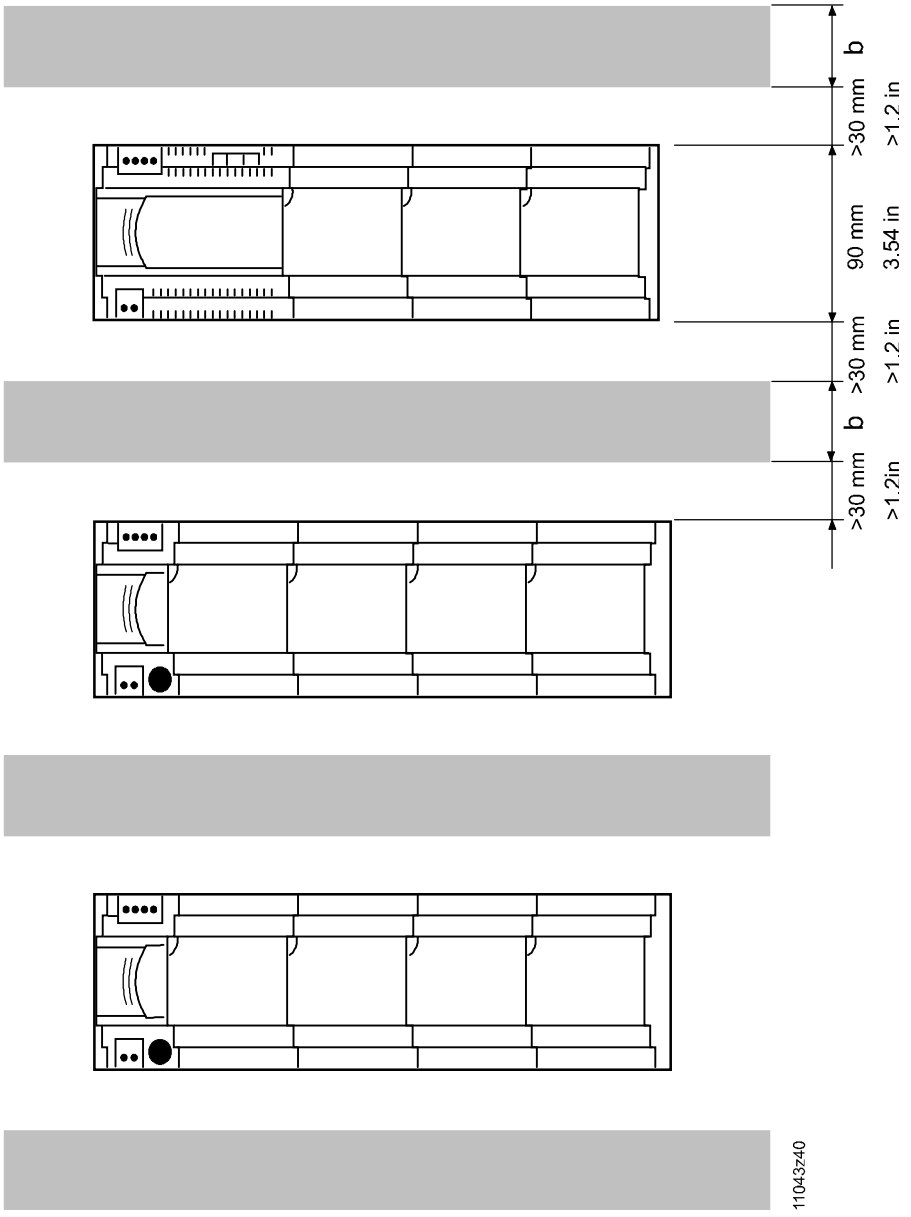
Observe free space!

All connection terminals must be connected unhindered and inspected. We recommend at least 30 mm / 1.2 in between the devices and the cable ducts. This results in the following distance of the standard rails/cable ducts:
90 mm / 3.54 in (device width) + (b = cable duct width) + 2 x ≥30 mm / 2 x 1.2 in (available space for wiring).

DXR2...


b
>30 mm
>1.2 in
45 mm
1.77 in
90 mm
3.54 in
105 mm
4.13 in
150 mm
5.9 in
11043z23 01
11043z24 01

PXC3...


b
>30 mm
>1.2 in
90 mm
3.54 in
>1.2in
11043z40

5.4 EMC compliant installation box / panel

Below only installation boxes are mentioned. Panels are included.

Introduction

One purpose of the installation box is to reduces electromagnetic interference. The influence depends on the **internal** and/or **external** EMC interference.

The internal EMC disturbance can be, for example, an inverter in the same installation box; an external disturbance a nearby RF transmitter.
The installation boxes are the reference point for shielding cables and housings. They must reduce interferences and short-circuit surges.

General rules

The following generally applicable rules apply to an EMC compliant installation box:

Installation box mechanical design

- Interior walls cannot be painted if difficult EMC conditions prevail.
- Grates and rails must be conductive and may not be painted.
- Screws are attached directly on blank areas in the installation box.
- Grounding connections with doors through flat copper banks (eventually including a connection to normal protective grounds).

Device order

Strongly disruptive devices (devices that generate strong EMC interference) must be separated as far as possible from DRA devices when setting up the installation box. Special attention must be paid to the connections between the two device groups as follows:

- Use separate installation boxes for strong strongly disruptive devices and DRA devices.
- Place strongly disruptive devices outside the installation box.
  Do not violate safety requirements.
- Separate the device groups within the installation box with a separating plate.

Screens

- Cable screens must be installed as close as possible to the installation box insert on its metal structure and connected to the building's potential equalization.
- Screen/shield connection terminals must be used and suitable installation space be provided to this end
  (see drawing on Page 23).

Exception

Using screens/shields to power the TX-I/O modules: See TX-I/O engineering and installation, CM110562.

5.5 EMC compliant wiring

Below only installation boxes are mentioned. Panels are included.

Wiring rules

If heavy EMC disturbance is expected in an installation box or in the building, the following wiring rules can better protect DRA devices:

Installation box wiring

- In the installation box, separate unshielded lines from shielded lines at the terminal connections and cable ducts.
- Avoid cable loops.
- Plan sufficient space to correctly connect the cable screens.
- Connect cable screens to the installation box directly at the inlet to the installation box. Leave screen intact to the module.
- The installation box must be grounded/bonded to the building's ground system..

Building wiring

Different types of cable in one cable duct.

When setting up cable ducts, separate strongly disruptive cables from victims.

Cable types

- Disruptive cable: Motor cables, energy cables.
- DRA devices: Control cables, low-voltage cables, interface cables, LAN cables, digital and analog signal cables.

Separate cables

- Both types of cables may be in the same cable duct, but should be place is separate compartments.
- If not three-sided duct with separating wall is available, the disruptive cables must be separated by at least 150 mm / 6 in from the others or placed in separate ducts.
- The crossing of strongly disruptive cables should be at a right angle to DRA cables.

Shielded cables

- Comply with the manufacturer's installation recommendations for the selection of shielded or unshielded cables. In general, **unshielded twisted pair cables** have sufficient EMC properties for building-technical applications (including data applications.
- Unshielded round wires can also be used for the **island bus** (wire CS, CD).
- Benefit: Unscreened/unshielded cables do not need to be coupled to the surrounding ground.

Screened cable

Screening/shielding improves EMC properties. Please note the following, however:

- The grounding (common reference point), is tasked with diverting and short-circuiting existing interference voltage.
- Special emphasis must be placed on the grounding concept to prevent grounding loops or differences in potential○.
- Against low-frequency interference: Ground the screen/shield on one side only.
- Screens/shields must be connected on both sides with the ground against high frequencies. Grounding must never take place via the cable screens/shields.
  A separate ground must be installed when missing.
  Alternative: hard wired earthing on one side, via a capacitor on the other side.
- The cable screens/shields must be properly connected to the ground to achieve a solid level of screening/shielding (see below).
- Island bus extension, see: TX-I/O engineering and installation, CM110562)

Attaching cables to the installation box

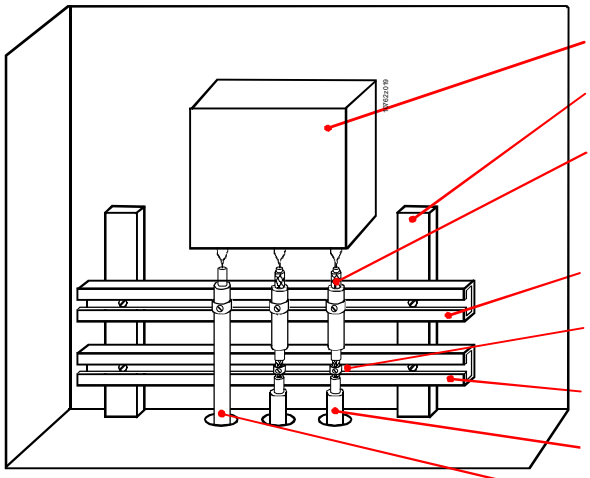
Strain relief of cables is done on the outside of the installation box.

Attaching cables in the cabinet

Cable screens for screened/shielded wiring must be installed as close as possible to the cabinet inlet on its metal structure and connected to the building's ground system.

The following illustrations display the correct connections for shielded and unshielded cables to the screen and cable fastening rails.
Use only off-the-shelf screen terminal connections for trouble-free screen/shield connections.

Attaching cables in the cabinet



I/O module

Support rail

Run screen/shield to the module, but do not connect it to the module!

Cable fastening rails

Screen/shield connection

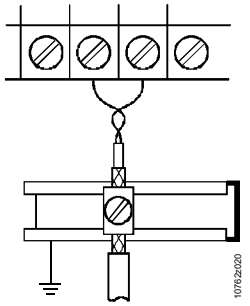
Screen/shield rail

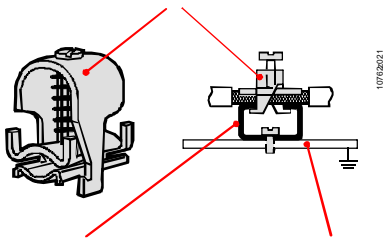
Cable screened/shielded

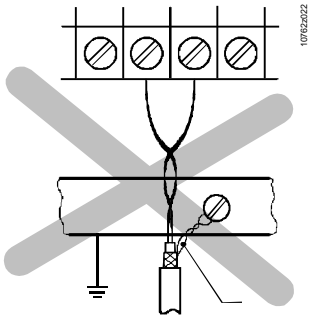
Cable unscreened/ unshielded

The screen rail cannot be used to relieve cable strain.

Screen/shield connection with screen connection terminals







Avoid screen/shield braid.

6 Wiring of power lines

This section describes the wiring between the transformer and power point(s) (Room automation station, power supply module, bus connection module).

Note Detailed information on wiring for AC24V and island bus is available in the TX-I/O engineering and installation guide CM110562 [8].

6.1 Supplemental notes on safety



Safety notes Before starting the wiring, please comply with "Important information on safety" in Section 3. The following notes are closely related to Section 3.2 “Device-specific regulations“and must be observed accordingly.

Cabling, duct cross-section Wire the devices in the standard manner in the cable ducts.
Recommendation: Design the duct cross-section with at least 30% in reserve.

Wiring and connection terminals Use wiring types and diameters as per the specifications below:

Cabling Use standard stranded cable and wiring. The ends can be connected directly or strengthen with conductor sleeves or pin connectors.

⚠.**Important**: If **low-voltage wiring** runs alongside **mains voltage**, it must have the **same level of insulation** as wiring for mains voltage.

Device connection terminals The device connection terminals are designed for wiring for:

- min. 0.5 mm ∅ / AWG24.
- max. 2 x 1.5 mm^2 / AWG16 or 1 x 2.5 mm^2 / AWG13

Connection terminals are lifting clams; the contact plate between the wire end and screw end is easy on the wiring.

⚠.**Important:** Only the **original pluggable connection terminals** may be used as the connection facility.

Tightening torque Set the torque to 0.5-0.6 Nm or 50-60 Ncm (4.4...5.3 in*lbf) when using electrical screwdriver on the connection terminals.

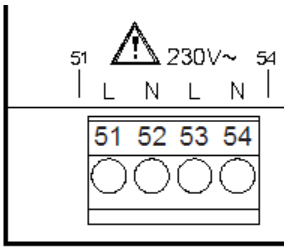
6.2 AC 230 V power lines

6.2.1 DXR2, RXM

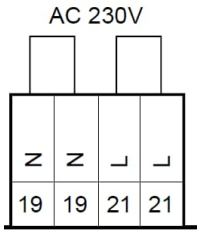
⚠

- **The sizing and fusing of the power lines are oriented to overall load and local regulations.**
- Devices with AC 230 V supply can be wired in line topology.
  However, the next device has no AC 230 V power when a room automation station is removed. The connection exists only on the board, but not on the terminal block.

DXR2



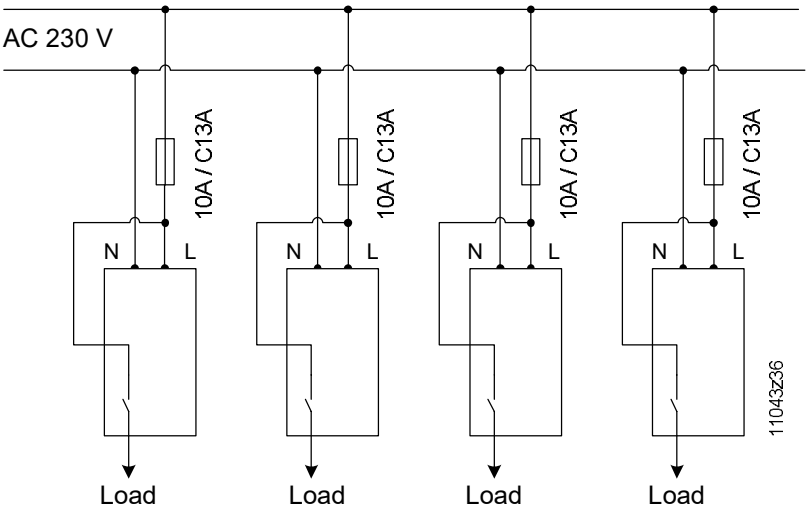
RXM...



- External fuse max. T 10 A (protection of the PCB tracks to the load circuits / relays). Max. load of the lines: 6 A.

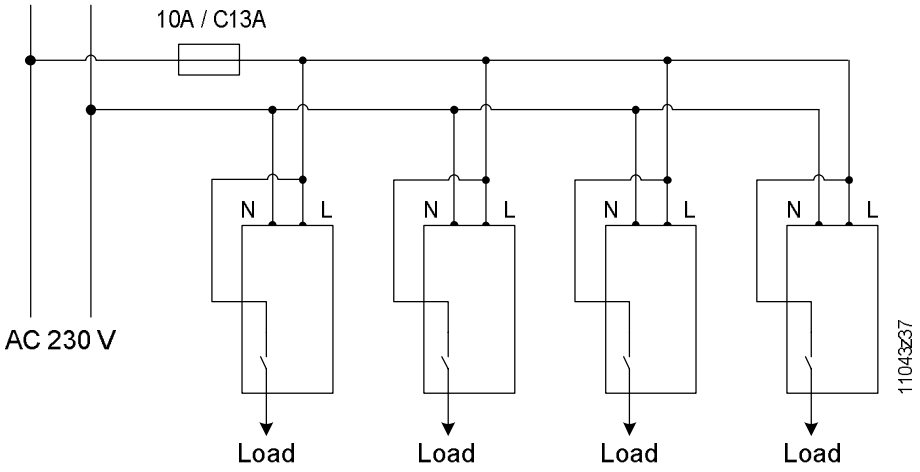
Each device fused separately

Each fuse max. T 10 A



A group of devices fused by one fuse

Common fuse max. T 10 A



6.2.2 AC 230 V power line cables

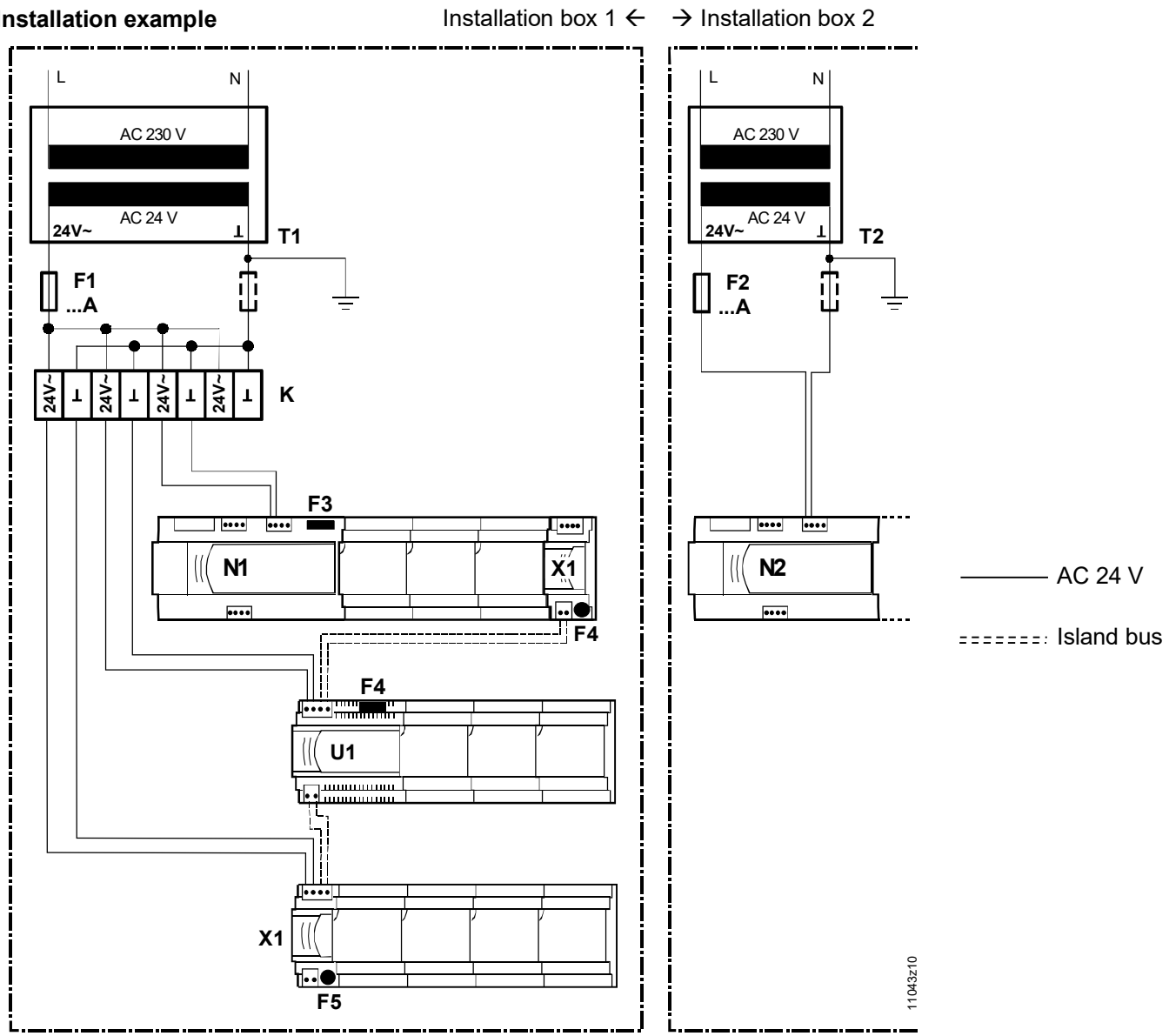
- **The sizing and fusing of the power lines are oriented to overall load and local regulations.**
- Fuse max. T 10 A (protection of the PCB tracks to the load circuits / relays).
- Supply cables must be secured with cable restraints.
- The AC 230 V installation must guarantee that the voltage is at least 230 V -15% = 196 V at the location of the room automation station.
- Each supply point (room automation station) is either connected separately (star topology) or looped via the neighboring room automation station.

6.3 AC 24 V power lines

6.3.1 PXC3 (power and island bus lines)

The following diagram illustrates basic wiring for power lines for modular room automation stations using AC 24 V operating voltage as per PELV (Grounding of ⊥ near the transformer). SELV without grounding is also admitted.

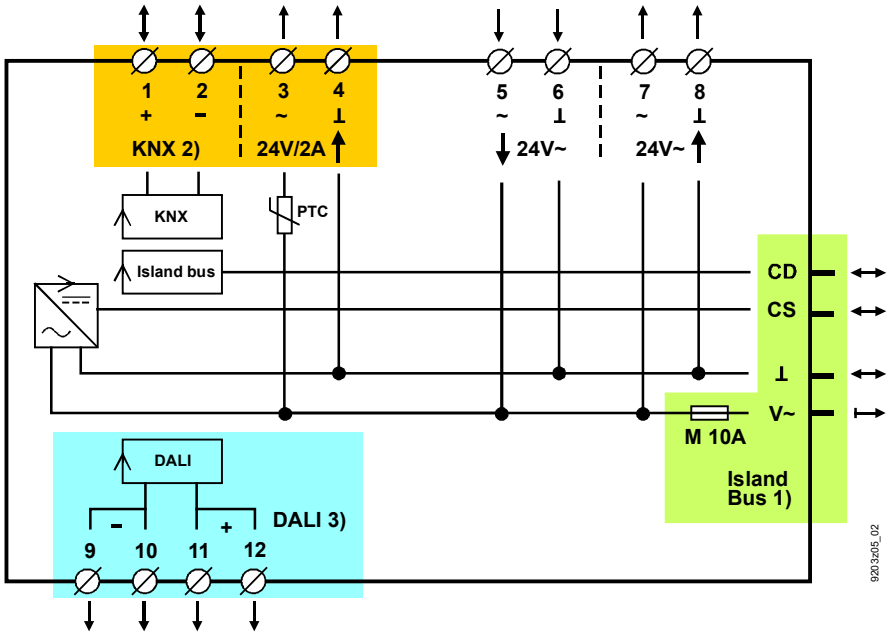
Installation example



Key

T, T2	Safety transformer AC 230 V / AC 24 V as per EN 61 558.
K	Terminal block for star distribution of AC 24 V and ⊥.
N1	PXC3 room automation station.
N2	PXC3 room automation station, with separate power AC 24 V (looped power from T1 admitted but not recommended).
U1	Power supply module TXS1.12F10
X1	Bus connection module TXS1.EF10
F1, F2	Low-voltage fuse, for max. power with AC 24 V. **Max. T 10 A**
F3	M 10 A fuse in the PXC3
F4	M 10 A fuse in power supply module.
F5	M 10 A fuse in the bus connection module.

Basic circuit diagram
(connections AC 24 V, fusing)

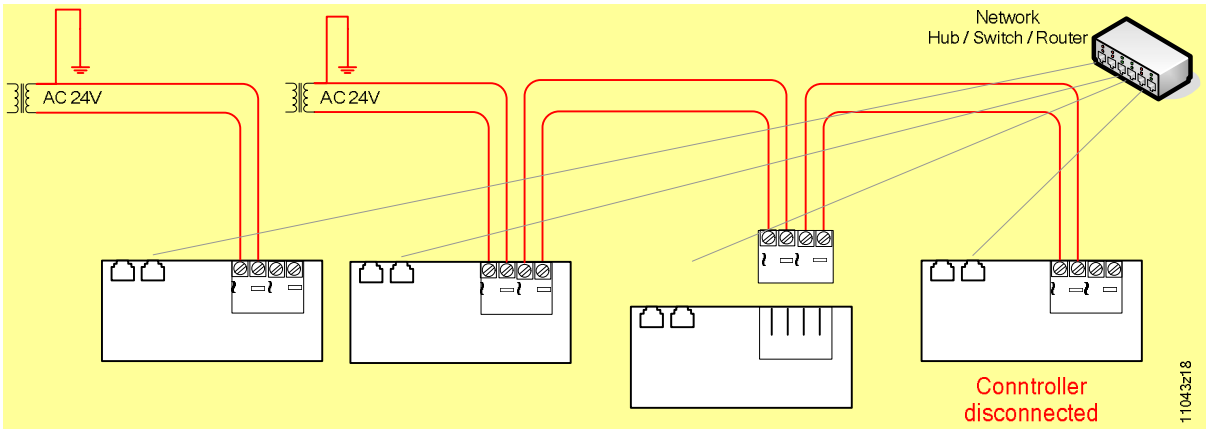


1), 2) Not with PXC3.E16A-100A, PXC3.E16A-200A
3) Only with PXC3.E...A... types

Secure operation

- The next device has no AC 24 V power when a room automation station is removed. The connection exists only on the board, but not on the terminal block.
- Without AC 24 V, the internal Ethernet switch of the room automation station is inactive. The next devices, if in line topology, are disconnected from the network. **For secure operation of the system it is recommended to supply each room automation station separately with AC 24 V.**

Note!



Communications

Note!

- **Island bus:** If a TXS1.12F10 supply module is connected to output ↑ 24 V (terminals 7 and 8), do not invert ~ and ⊥.
  The devices are not damaged, but island bus communications will not work.
- **USB:** If USB communications do not work, this is an indicator that the AC 24 V operating voltage is incorrectly wired (conductors ~ and ⊥, terminals 5 and 6 inverted).

6.3.2 DXR2 / DXR1

- **Topology**: DXR2... room automation stations with AC 24 V supply can only be wired in star topology or with stubs (no daisy chain wiring).
- **DXR2.E... / DXR1.E… :** AC 24 V grounded or not grounded
- **DXR2.M... / DXR1.M… :** AC 24 V ⊥ must always be earthed at the transformer.
- **Consumption**: DXR2... room automation stations with AC 24 V supply are limited to a consumption of 4 A / 100 VA.
- The devices have an **internal 4 A fuse** which CANNOT be replaced.
- An **external power supply** for field devices should be fused separately for secure operation. It must **NOT be grounded**.
  The external power supply must NOT be used to supply the triacs.

IEC installation (International Electrotechnical Commission / International Installation Standards)

SELV / PELV
Class II



Transformer with unlimited power
The over-current protective device limits the energy in the secondary circuit.

DXR1.M… : SELV or PELV. ***DXR2.M...****: PELV only!*
⊥ must always be **grounded** at the transformer.

NEC Class 2 installation (National Electric Code for North America)

A

Using an energy limited transformer with **max. 100 VA**

DXRx.**M**...: ⊥ must always be **grounded** at the transformer.

B

Using a non energy limiting transformer (**max. 400VA**)

The over-current protective devices (T 4 A fuses) limit the energy to 100VA or less. Multiple fuses per transformer may be used to provide multiple isolated secondary circuits.

DXRx.**M**...: ⊥ must always be **grounded** at the transformer.

Communications

Note!

If USB communications do not work, this is an indicator that the AC 24 V operating voltage is incorrectly wired (conductors V~ and ⊥ inverted).

6.3.3 AC 24 V Transformer sizing

The engineering responsibility includes transformer sizing.

The selected transformer rating is based on the total power consumption of the automation station, the I/O modules and the connected field devices.

Operating voltage

- The operating voltage is AC 24 V. It must comply with SELV or PELV to HD 60364-4-41 (2007-01-01) requirements.
  NEC: Class 2 transformers or Class 2 circuits.
- The acceptable deviation of the AC 24 V nominal voltage connected to the **transformer** is +20%/–10%. This means that after taking account of the cable and contact resistances, a tolerance of +/- 20 % can be guaranteed for the **field devices**.

Specification for AC 24 V transformers

- **IEC:** Double-insulated safety transformers to EN 61558, designed for continuous operation, to supply SELV or PELV circuits.
- **NEC:** Class 2 transformers.
- The rated transformer output must be at least 25 VA and maximum of 250 VA.
- For reasons of power efficiency, the rated transformer output should not exceed 200 % of the maximum load.

Power consumption PXC3

Terminals see page 28

Max. permissible input current AC 24 V (through terminals 5 and 6)	Total max. 10 A (Ext. fusing compulsory: max. T 10 A melting fuse or max.C 10 A circuit breaker)
Base load (without loading by modules and field devices)	8 VA / 0.33 A
Island bus supply *) DC 24 V / max. 600 mA	30 VA / 1.25 A
KNX PL-Link supply *) **) DC 29 V / max. 160 mA	12 VA / 0.50 A
DALI supply *)	
DC 16 V / max. 128 mA	9 VA / 0.37 A (PXC3.E…A-100A)
DC 16 V / max. 230 mA	16 VA / 0.61 A (PXC3.E…A-200A)

*) The bus supplies can be switched off via tool if not used.

**) The KNX PL-Link supply MUST be switched off via tool if an external bus supply is used.

Supply for field devices (Transit power AC 24 V)	
TX-IO: AC 24V (island bus)	Max. 144 VA / 6 A
KNX PL-Link: AC 24V (terminals 3 and 4)	Max. 48 VA / 2 A
AC 24 V (terminals 7 and 8, for additional AC 24 V consumers)	Max. 144 VA / 6 A (only if the sum of 10 A at terminals 5 and 6 is not exceeded)

Power consumption TX-I/O: Consumption data DC 24 V per I/O point
Values in mA, for **DC 24 V** supply sizing (max. 600 mA from the PXC3, otherwise separate power supply module(s), for details see [7]).

Type	TXM1.8D	TXM1.16D	TXM1.8U	TXM1.6R	TXM1.6RL	TXM1.8RB	TXM1.8T
Intrinsic consumption [1]	**25**	**25**	**35**	**20**	**25**	**25**	**10**
Digital input [2] (contact closed)	**3.5**	**2.5**	**3**				
Analog input [3] (Temp. sensors Ni, PT, T1)			**0**				
Analog input [3] (Temperature sensor NTC)			**0**				
Analog input [3] (Resistance)			**1**				
Analog input (10 V) [2]			**1**				
Digital output (relay active) [2]				**8**	**12**	**8**	
Digital output (triac active) [2] [5]							**4**
Analog output (10 V) [2]			**3**				
Unconfigured I/O point (Reserve for later configuration)	**3.5**	**2.5**	**3**	**8**	**12**	**8**	**4**

[1] Including module status LED; includes LCD and all override LEDs if applicable
[2] Including I/O status LED
[3] Included in intrinsic consumption (no I/O status LED for temperature inputs)
[5] The triacs have a switch capacity of ***AC*** 24 V, 125 / 250 mA (max 500 mA for 90 s). This power is supplied by the 24 V ~ conductor, not by the DC 24 V power supply.

Power consumption DXR2 AC 24 V DXR1 AC 24 V

Base load (without loading by field devices and triacs)	
DXR2.M11	6 VA / 250 mA
DXR2.M12P	6 VA/ 250 mA
DXR2.E12P	8 VA/ 250 mA
DXR2.M18	6 VA/ 250 mA
DXR2.E18	8 VA/ 333 mA
KNX PL-Link supply	
DC 29 V / max. 50 mA	Max. 4 VA/ 167 mA
The bus supply can be switched off via tool if not used.	
Field supply AC 24 V	
DXR2.M11	Max. 12 VA / 500 mA
DXR2.M12P	Max. 12 VA / 500 mA
DXR2.E12P	Max. 12 VA / 500 mA
DXR2.M18	Max. 18 VA / 750 mA
DXR2.E18	Max. 18 VA / 750 mA
Field supply DC 24 V max. 100 mA (DXR2.E18 only)	Max. 6 VA/ 250 mA
Basic Load including damper actuator	
DXR1.E02…	Max. 6.5 VA/ 270 mA
DXR1.E09…	Max. 7 VA/ 291 mA
DXR1.E10…	Max. 12 VA/ 500 mA
DXR1.M09…	Max. 5 VA/ 208 mA

Power consumption of the triacs on DXR2 AC 24 V

Per triac	6 VA / 250 mA
Unconfigured triac (Reserve for later configuration)	6 VA / 250 mA

Thermal actuators with a starting power of 6 VA (not pre-heated):
If driven by a 5...50% PWM signal, they only count for 3 VA.

Power consumption of the triacs on DXR1 AC 24 V

Per triac	12 VA / 500 mA
Unconfigured triac (Reserve for later configuration)	12 VA / 500 mA

Max. power consumption of DXR2 / DXR1 AC 24 V

Due to internal heat dissipation, the max. power consumption of the devices is limited (sum of base load, KNX supply, field supply, and triacs):

Device	Max. power	Max. power with cold thermal actuators
DXR2.M11	58 VA / 2.416 A	94 VA / 3.917 A
DXR2.M12P	58 VA / 2.417 A	94 VA / 3.917 A
DXR2.E12P	60 VA / 2.5 A	96 VA / 4 A
DXR2.M18	82 VA / 3.42 A	96 VA / 4 A
DXR2.E18	84 VA / 3.5 A	96 VA / 4 A
DXR1.E02…	6.5 VA/ 270 mA	n.a.
DXR1.E09…	55 VA/ 2.29 A	103 VA/ 4.29 A
DXR1.E10…	60 VA/ 2.50 A	108 VA/ 4.50 A
DXR1.M09…	53 VA/ 2.21 A	101 VA/ 4.21 A

6.3.4 AC 24 V power line cable lengths

The permissible voltage drop of 0.48 V (2%) on the power wire between the transformer and the most distant power point (room automation station, power supply module, bus connection module) is the basis for calculations.

The table below provides cable lengths and cable cross sections based on load.

Cable cross-section	**Cable length**					
Power	5 VA	10 VA	20 VA	50 VA	100 VA	200 VA
2.50 mm² / AWG14	135 m 440 ft	70 m 220 ft	35 m 110 ft	13 m 44 ft	7 m 22 ft	3 m 11 ft
1.50 mm² / AWG16	85 m 280 ft	42 m 140 ft	21 m 70 ft	8 m 30 ft	4 m 15 ft	2 m 7 ft
1.00 mm² / AWG18	55 m 180 ft	27 m 90 ft	13 m 45 ft	5 m 17 ft	3 m 9 ft	1 m 4 ft

Notes

- The supply (AC 24 V) and return lines (⊥) can each have the indicated lengths.
- Each supply point (room automation stations/power supply module/bus connection module) is either connected separately to the transformer's terminal block (star wiring) or looped via the room automation station.
- Power is added together for multiple back-to-back looped devices ("daisy chain") which reduces the cable length accordingly.
- Cables **may** be wired in parallel to increase the cross section.
- **In practice, the small level of permissible voltage drop-off means that the transformer must always be installed in close proximity to the DRA devices and that any cascading powering of room automation stations is only possible over short distances or at small outputs.**

6.4 Power supply for field devices

Most of the DRA devices have a built-in power supply for field devices

Type	TXM1.8U	DXR2.x09 AC 230 V	DXR2... AC 24 V	DXR2.x18	PXC3	RXM39.1
Data sheet	N8173	N9204 N9206	N9205 N9207	N9205 N9207	N9203	N3836
AC 24 V Fusing	..4 A [5] 10 A [4]	4 VA [2] [3] [1]	12 VA [1]	18 VA [1]	144 VA 10 A [4]	6 VA [1]
DC 24 V Fusing				2.4 W [1]		
KNX field supply (terminals 3 and 4) Fusing					48 VA [1]	

[1] Short circuit proof.

[2] Sum of all triacs plus field supply

Note!

[3] **Air quality sensors (QPA.., AQR..):**
These devices require an external / local transformer.
Reason: Although the documented continuous load is only 0.5 VA, high peak currents occur at switch on and during measurement operations.

[4] M 10 A fuse in the PXC3 / in the power supply module / in the bus connection module.

Caution!

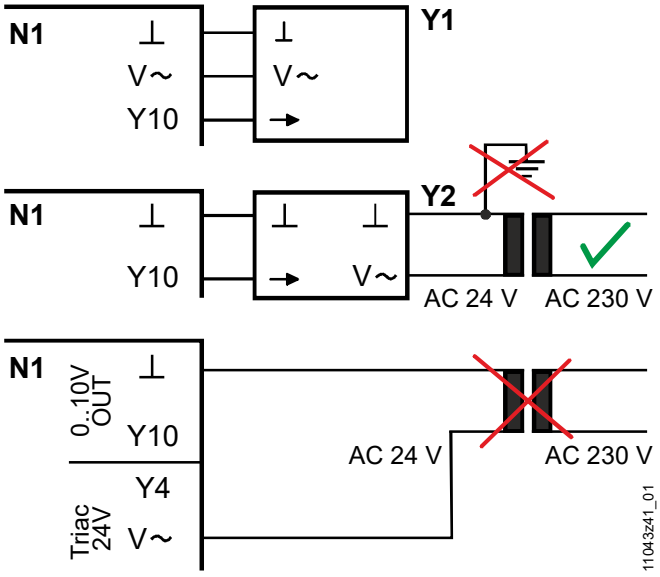
Use cable cross section suited for **10 A** according to local regulations!

Note!

[5] TXM1.8U: max, admissible current is 4 A.
Supply voltage from the PXC3 / from the power supply module is AC 24 V.
But the bus connection module may feed any supply voltage.

Powering field devices with external transformer

Field devices may be powered using an external / local transformer.
The external transformer must NOT be grounded (earth loops).
The external power supply must NOT be used to supply the triacs.



N1 Room automation station
Y1 General device with input DC 0...10 V, supplied by room automation station

Y2 General device with input DC 0...10 V, supplied externally
External supply must NOT be earthed (earth loop)

***External supply** must NOT be used to supply the triacs.*
Connecting it to V~ will destroy the room automation station

7 Wiring of field devices (without bus)

This section describes the wiring between the room automation station / the TX-I/O module and the field devices.

7.1 Signal wiring

The following applies in common for signal wiring of field devices such as temperature sensors, window switches, presence detectors, dew point sensors or electrical buttons, as well as DC 0...10 V devices:

Cable material

- Use stranded, 2 or multiple core round cables, without screen (standard off-the-shelf installation cable).
- Single wires or ribbon cables may not be used.

Cable laying

- Signal wiring may be laid together with power lines (AC 230 V).
  They must be isolated from the power lines per regulations. Isolation must meet PELV requirements.
- Signal wiring can *not be led in the same cable* as the power lines.

Cable length

- The length must not exceed the following values (measuring errors, EM interference):
  – PXC3... , RXM... 300 m / 1000 ft
  – DXR2 80 m / 260 ft
  Exceptions (hum injection) see page 37.

Cable cross section

- Min. 0.5 mm^2 / AWG 24

System neutral terminals (⊥, M, GND, G0):

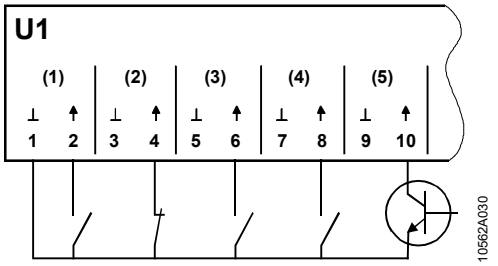
- All system neutral terminals of a device are interconnected.
  TX-I/O: The connection is *not* in the terminal base but in the plug-in module. When this unit is unplugged there is no connection.
- The system neutral of a **digital input** can be connected to any signal neutral terminal of the device.
- It is also permissible to combine the system neutral conductors of several digital inputs in order to save wire.
  TX-I/O: However, system ground must be connected at least once per module.
- With **analog inputs and outputs**, the measuring neutral must always be connected to the terminal associated with that specific I/O point to avoid possible measurement errors.
- **DC 0…10 V actuators with DC 0…10 V feedback:**
  System neutral of output and feedback may be in the same conductor due to the small current of the AO 0-10V und AI 0-10V signals. However, output and feedback must be on the same device and there is no DC 24 V supply current admissible on the system neutral conductor.

7.1.1 Digital inputs

Common ⊥ conductor with multiple contacts

When several status or counter contacts are to be connected, a common ⊥ conductor may be used. This saves wiring.
However, system ground must be connected at least once per room automation station / per TX-I/O module.

Connection diagram (Example)



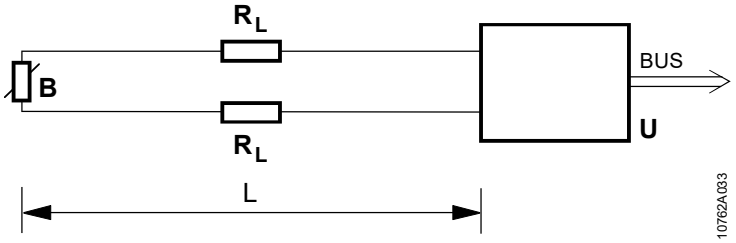
In principle, the number of contacts that can be connected via a common ⊥ conductor depends on the length and cross section of the conductor.
However, the measuring current (1...2 mA) is so small that up to 16 inputs (TXM1.16D) can be connected with the minimum cross section 0.28 mm^2 (0.6 mm diameter) and with the maximum cable length of 300 m / 1000 ft.

7.1.2 Passive resistance sensors and resistance transmitters

Line resistance

The maximum permissible cable length for passive resistance sensors and transmitters depends on the permissible measuring error due to the **line resistance** (see the graphs below).

The maximum cable length is 300 m / 1000 ft for TX-I/O and 80m / 260 ft for DXR2.



Key

	B	LG-Ni resistance sensor or resistance transmitter
	L	Cable length
	R_L	Line resistance
	U	Measured value input of I/O module

Hum injection

Another limiting factor for cable length is **hum injection** for certain sensitive signal types:

	Signal type	Normal hum		Reduced hum	
		mA_{eff}	Can be maintained with cable length	mA_{eff}	Can be maintained with cable length / shield
TXM1.8U	AI NTC100K	--	--	0.05	30 m / 100 ft (80 m with shield *)
	AI NTC10K	--	--	0.05	30 m / 100 ft (80 m with shield *)
	All other signal types	0.5	300 m / 1000 ft	0.05	300 m / 10000 ft
DXR2...	AI NTC100K	--	--	0.05	30 m / 100 ft (80 m / 260 ft with shield *)
	AI NTC10K	--	--	0.05	30 m / 100 ft (80 m / 260 ft with shield *)
	AI NTC3K	--	--	0.05	30 m / 100 ft (80 m / 260 ft with shield *)
	AI R100K	--	--	0.05	30 m / 100 ft (80 m / 260 ft with shield *)
	All other signal types	0.13	80 m / 260 ft	0.05	80 m / 260 ft

*) Connect the shield to system neutral ⊥ on one end.

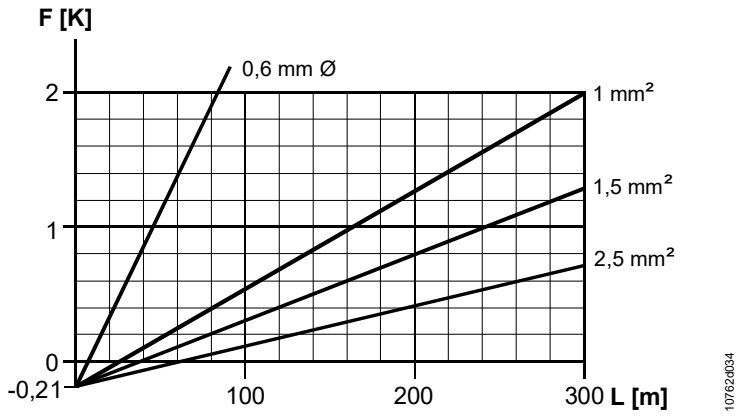
Line resistance compensation ("Sensor calibration")

The measured value functions are already adjusted with a line resistance of 1 ohm and the graphs below take account of this.
Exception: NTC3K, NTC10K and NTC100K.

Measured value error LG-Ni 1000

The graphs below are for copper cable.

Measured value error due to line resistance

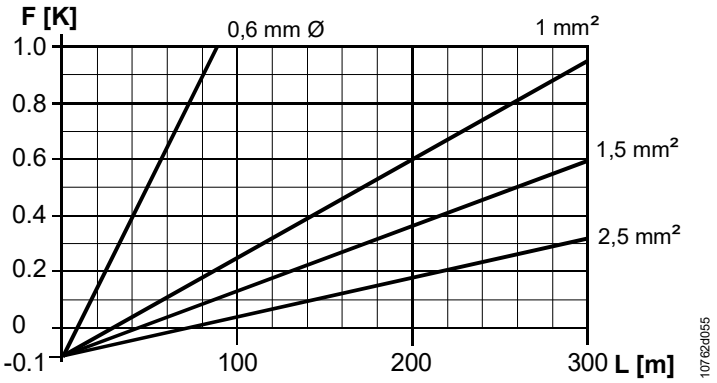


Formula: $F = \frac{\frac{2 \bullet L}{57 \bullet A} - 1}{4.7}$

Key
- A Cable cross-section in mm^2
- F Measured temperature error in K
- L Cable length in m

Measured value error T1 sensors

T1 sensors: Measured value error due to line resistance:



Formula: $F = \frac{\frac{2 \bullet L}{57 \bullet A} - 1}{10}$

Key
- A Cable cross-section in mm²
- F Measured temperature error in K
- L Cable length in m

Measured value error NTC sensor

Measured value error of **NTC sensors** due to line resistance:
The sensors are highly non-linear. But thanks to the high sensor resistance the errors are very small.

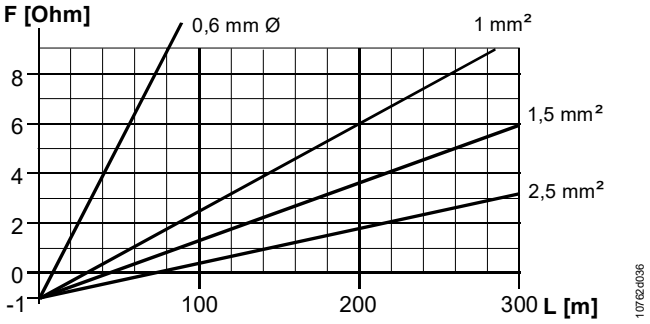
Error compared to T1:

	NTC 100K	NTC10K	NTC3K
20°C	x 0.01	x 0.1	x 0.3
100°C	x 0.1	x 1 (~ equal)	- -

Measured value error Resistance transmitters

Resistance transmitters (potentiometers):

Measured value error due to line resistance



Formula: $F = \frac{2 \bullet L}{57 \bullet A} - 1$

Key
- A Cable cross-section in mm²
- F Measurement error in ohms, due to line resistance (2RL for supply and return conductor)
- L Cable length in m

7.1.3 Active sensors and actuators DC 0 … 10 V

The permissible length of DC 10 V cables for signals, and of the cables to supply the devices, have to be calculated on the following basis for each device (see also the relevant device data sheets):

– Max. 7 % voltage drop (1.68 V) on the cables due to the sensor supply current. Reason: to ensure sufficient voltage for the device supply.
– **Active sensors**: Measuring error of max. 0.5 % due to line resistance on the measuring conductor (not critical, as the measuring current is only 0.1 mA)
– **Active actuators**: control signal error of max. 1 % due to line resistance on the measuring conductor (not critical, as the measuring current is only 0.1 mA)

Notes

- Longer cables are permissible provided larger measuring errors are acceptable.
- If the device is supplied locally from a transformer, the signal cable can be up to 300 m / 1000 ft long (DXR2: 80 m / 260 ft) with a wire diameter of ≥ 0.6 mm.
  → The local transformer MUST NOT be earthed (earth loop)!
- **DC 0…10 V actuators with DC 0…10 V feedback:**
  System neutral of output and feedback may be in the same conductor due to the small current. However, output and feedback must be on the same device.

Caution!
PXC3 with TX-I/O modules

- In case of active sensors with AC 24 V supply, use cable cross section suited for 10 A according to local regulations (M 10 A fuse in the power supply module / room automation station).

Cable length for devices with AC 24 V

The maximum cable length is 300 m / 1000 ft (DXR2: 80 m / 260 ft).

The permissible length of the cables is calculated as follows: Voltage drop of max. **7 %** (1.68 V) on the AC 24 V operating voltage for the sensor / actuator.

Cable cross section	**Cable length**				
Power	2 VA	5 VA	10 VA	20 VA	50 VA
2.50 mm² / AWG14	300 m 1000 ft	300 m 1000 ft	235 m 770 ft	120 m 390 ft	47 m 150 ft
1.50 mm² / AWG16	300 m 1000 ft	300 m 1000 ft	150 m 500 ft	75 m 250 ft	30 m 100 ft
1.00 mm² / AWG18	300 m 1000 ft	185 m 600 ft	95 m 300 ft	50 m 150 ft	20 m 60 ft
0.75 mm² / AWG20	290 m 960 ft	120 m 380 ft	60 m 190 ft	30 m 95 ft	12 m 40 ft

Note The outgoing and return cables may **each** have the indicated length.

Cable length for devices with AC/DC 24 V

These devices have an internal rectifier, to convert AC 24 V to DC 24 V. This causes a DC current to flow in the system neutral conductor (⊥) which causes a voltage drop over the line resistance. This voltage drop falsifies the DC 0...10 V signal value.

The cable length must be reduced to limit the signal error (0.5% for sensors, 1% for actuators).

Sensors

Cable cross section	**Cable length**				
Power	1 VA	2 VA	5 VA	10 VA	20 VA
2.50 mm² / AWG14	140 m 460 ft	70 m 230 ft	30 m 90 ft	15 m 45 ft	8 m 25 ft
1.50 mm² / AWG16	90 m 290 ft	45 m 145 ft	20 m 60 ft	10 m 30 ft	5 m 15 ft
1.00 mm² / AWG18	55 m 180 ft	30 m 90 ft	12 m 35 ft	6 m 20 ft	3 m 10 ft
0.75 mm² / AWG20	35 m 110 ft	17 m 55 ft	7 m 25 ft	3 m 12 ft	2 m 6 ft

Actuators

Cable cross section	**Cable length**				
Power	1 VA	2 VA	5 VA	10 VA	20 VA
2.50 mm² / AWG14	280 m 920 ft	140 m 460 ft	60 m 200 ft	30 m 90 ft	15 m 45 ft
1.50 mm² / AWG16	180 m 580 ft	90 m 290 ft	40 m 120 ft	20 m 60 ft	10 m 30 ft
1.00 mm² / AWG18	110 m 360 ft	55 m 180 ft	20 m 70 ft	12 m 35 ft	6 m 20 ft
0.75 mm² / AWG20	70 m 220 ft	35 m 110 ft	15 m 50 ft	7 m 25 ft	3 m 12 ft

Note The outgoing and return cables may each have the indicated length.

7.2 Wiring for Triac outputs AC 24 V

The following applies for wiring to actuating devices such as valves, damper actuators or protection connected to the Triac outputs:

Cable material

- Use stranded, 2 or multiple core round cables, screened (standard off-the-shelf installation cable).
- Single wires may not be used.

Cable laying

- Wiring may be laid together with power lines (AC 230 V).
  They must be isolated from the power lines per regulations. Isolation must meet PELV requirements.
- Wiring cannot be led in the same cable as the power lines.

Cable length and cross section

DXR2... room automation stations

- Triacs are protected against overload.
- **Cable cross section** >= AWG20 / 0.75 mm^2.
- **Cable length** <= 80 m / 260 ft (EM interference).

PXC3 with TX-I/O triac modules: ⚠ **Caution!**

- Use **cable cross section** suited for **10 A** according to local regulations (M 10 A fuse in the power supply module / room automation station).
- **Cable length** <= 300 m / 1000 ft (EM interference).

Cable length

Calculation is based on a voltage drop of 0.48 V = 2% of 24 V (the triac and the PTC protection resistor have a voltage drop of 6%).

Cable cross section	**Cable length**				
Power	1 VA	2 VA	5 VA	10 VA	20 VA
2.50 mm^2 / AWG14	300 m 1000 ft	300 m 1000 ft	140 m 440 ft	70 m 220 ft	35 m 110 ft
1.50 mm^2 / AWG16	300 m 1000 ft	210 m 700 ft	85 m 280 ft	42 m 140 ft	21 m 70 ft
1.00 mm^2 / AWG18	270 m 880 ft	135 m 440 ft	50 m 180 ft	25 m 90 ft	13 m 45 ft
0.75 mm^2 / AWG20	170 m 550 ft	85 m 275 ft	33 m 110 ft	16 m 55 ft	8 m 27 ft

Notes

- The outgoing and return cables may **each** have the indicated length.
- Power = permanent load. The higher starting current of thermal or motorized actuators is admissible.

7.3 Wiring for Relay outputs

- External fuse of max. T 10 A for protection of the PCB tracks.
- The maximum load of the relay contracts must be observed (see data sheets for the corresponding devices). It may require a fusing <10 A.
- Relays have volt-free relay contacts.
  The mains voltage / switching voltage (AC 230 V / AC/DC 24 V) must be supplied as an external voltage to the terminals.
- The lines must be secured on the device with strain relief.
- ⚠ The sizing and fusing of the lines are oriented to overall load and local regulations.

Cable length AC 230 V ⚠

Actuators up to 100 VA: Lengths of up to 300 m / 1000 ft are admissible.
Wiring must comply with local regulations.

Cable length AC 24 V

Taking account of the permissible voltage drop, the cable between the switching outputs and the equipment to be switched may be up to 300 m / 1000 ft long (DXR2: 80 m / 260 ft).

The permissible lengths are calculated as follows:
Voltage drop of max. **7 %** (1.68 V) on the AC 24 V operating voltage for the actuator.

Cable cross section	**Cable length for AC 24 V**				
Power	2 VA	5 VA	10 VA	20 VA	50 VA
2.50 mm² / AWG14	300 m 1000 ft	300 m 1000 ft	235 m 770 ft	120 m 390 ft	47 m 150 ft
1.50 mm² / AWG16	300 m 1000 ft	300 m 1000 ft	150 m 500 ft	75 m 250 ft	30 m 100 ft
1.00 mm² / AWG18	300 m 1000 ft	185 m 600 ft	95 m 300 ft	50 m 150 ft	20 m 60 ft
0.75 mm² / AWG20	290 m 960 ft	120 m 380 ft	60 m 190 ft	30 m 95 ft	12 m 40 ft

Note The outgoing and return cables may **each** have the indicated length.

Cable cross sectio

Use cable cross section suited for **10 A** according to local regulation.

7.4 Connecting the differential pressure sensor

- Avoid bends and pressure when attaching the tube.
- Connect the "+" connection on the side with the higher pressure and the "–" connection on the side with the lower pressure.
- A tube length of 2 m (6 ft) is recommended.

8 Electrical features of inputs & outputs

8.1 Digital inputs

Digital inputs are not electrically isolated from the system electronics.
Mechanical contacts must be volt-free.
Electronic switches must comply with SELV or PELV standards.

Technical data

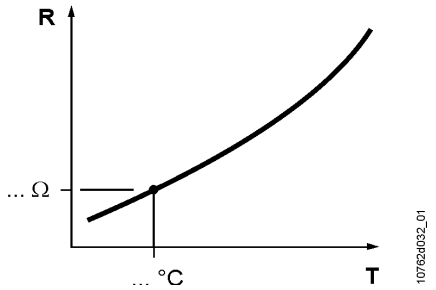
Contact sensing voltage	DC 17...25 V
Contact sensing current	1.0...1.6 mA (initial current 6...10 mA)
Insulation resistance with	Max. 200 Ohm (TX-I/O)
contacts closed	Max. 100 Ohm (DXR2)
Contact resistance with contacts open	Min. 50kΩ

8.2 Analog inputs

8.2.1 Passive resistance sensors

Measured value acquisition and measured signal

The temperature sensors register the temperature by means of a nickel or platinum wire or a semiconductor which change their resistance in relation to the temperature.



Key:
R Sensor signal (resistance)
T Actual temperature

Resistance table

The table below shows the resistance of the supported sensor elements as a function of the temperature.

Temp		AI Ni1000	AI Ni1000	AI Pt1K375	AI Pt1K385	AI T1	AI NTC100K	AI NTC10K
		TCR 5000 (LG-Ni 1000)	DIN	TCR 3750 (USA)	TCR 3850 (Europe) EN60751	(PTC)	Beta 3891 Ratio 9.062	Beta 3890 Ratio 9.065
°C	°F	Ohm		Ohm	Ohm	Ohm *)	kOhm	kOhm
-40	-40	830.8	791.3	846.6	842.7	1'840.4		336.487
-30	-22	871.7	841.5	885.1	882.2	1'934.6		176.974
-20	-4	913.5	893.0	923.5	921.6	2'030.3		97.080
-10	14	956.2	945.8	961.8	960.9	2'127.6	552.830	55.332
0	32	1'000.0	1'000.0	1'000.0	1'000.0	2'226.4	326.329	32.650
10	50	1'044.8	1'056.0	1'038.0	1'039.0	2'326.9	198.958	19.904
20	68	1'090.7	1'112.0	1'076.0	1'077.9	2'429.1	124.920	12.494
30	86	1'137.6	1'171.0	1'113.8	1'116.7	2'532.9	80.567	8.057
40	104	1'185.7	1'230.0	1'151.4	1'155.4	2'638.5	53.256	5.326
50	122	1'235.0	1'291.0	1'189.0	1'194.0	2'745.9	36.010	3.602
60	140	1'285.4	1353.4	1'226.4	1'232.4	2'855.1	24.864	2.488
70	158	1'337.2	1417.2	1'263.8	1'270.8	2'966.2	17.505	1.752
Typical sensing current		1.1	1.1	1.1	1.1	1.1	0.16	0.7

*) Not measurable with ohm meter
Supported only with reduced hum injection (details see 7.1.2)

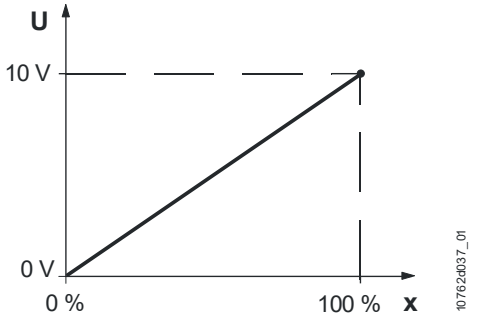
8.2.2 Active sensors DC 0 … 10 V

Measured value acquisition and measured signal

The active sensors use a signal amplifier which emits a standard DC 0...10 V signal. This voltage range is proportional to the application range of the sensor.

Active sensors are available for:

- Relative humidity
- Pressure in liquid and gaseous media
- Differential pressure in liquid and gaseous media
- Air quality
- Air velocity



Key
U Sensor signal (voltage)
x Measured value
(0…100% = application range)

Note When the process value is outside -1.5...11.5 V, a fault message will be sent. For a workaround (Zener diode), see CM110563.

8.2.3 Technical data for the analog inputs

Compensation of the line resistance	1 Ohm, calibrated in the module, (except for NTC3K, NTC10K, and NTC100K)

Signal type	***TX-I/O***		***DXR2***	
	Range (Under / over range) [3]	Resolution	Range (Under / over range) [3]	Resolution
Resistance AI 1000 Ohm	0...2500 Ohm (0...2650 Ohm)	100 mOhm	0...1000 Ohm (0...1050 Ohm)	1 Ohm
Resistance AI 2500 Ohm	0...2500 Ohm (0...2650 Ohm)	100 mOhm	0...2500 Ohm (0...2625 Ohm)	2.5 Ohm
Resistance AI 10 kOhm			0...10 kOhm (0...10.5 kOhm)	10 Ohm
Resistance AI 100 kOhm			0...100 kOhm (0...105 kOhm)	100 Ohm
Temperature AI PT1K 375	-50…150 °C (-52.5 ...185.0 °C)	10 mK 0.018 °F	-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	25 mK 0.045 °F
Temperature AI PT1K 385	-50...400 °C (-52.5...610°C)	20 mK 0.036 °F	-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	25 mK 0.045 °F
Temperature AI Ni1000 LG-Ni 1000)	-50...150°C (-52.5...155.0 °C)	10 mK 0.018 °F	-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	25 mK 0.045 °F
Temperature AI Ni1000 DIN			-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	25 mK 0.045 °F
Temperature AI T1 (PTC)	-50...130 °C (-52.5...155.0 °C)	10 mK 0.018 °F	-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	100 mK 0.18 °F
Temperature AI NTC 3K			-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	25 mK (25 °C) 0.045 °F (77 °F)
Temperature AI NTC 10K	-40...115 °C [1] (-52.5...155°C)	10 mK 0.018 °F (25°C)	-40...70 °C (-45...75 °C) -40...158 °F (-49...167 °F)	25 mK (25 °C) 0.045 °F (77 °F)
Temperature AI NTC 100K	-40 ...125 °C [1] (-52.5...155°C)	10 mK 0.018 °F (25°C)	-10...70 °C (-15...75 °C) 14...158 °F (5...167 °F)	25 mK (25 °C) 0.045 °F (77 °F)
Voltage measuring AI 0-10V [2]	0 ... 10 V [2] (-1.5...11.5 V)	1 mV	0 ... 10 V [2] (-1.0...11.0 V)	2 mV
Voltage measuring AI 0-10V norm [2]			0...100% (-10...110%)	2 mV

[1] Only with reduced hum injection (details see 7.1.2)

Caution!

[2] Range monitoring of signal type AI 0-10V:
– TX-I/O: short NEGATIVE signal –3.1 V (open circuit), 0.05 mA (shorted)
– DXR: permanently -1.5 V, 0.008 mA.
If a field device has no power supply, the negative voltage can damage any polarized components (e.g. capacitors) in the field device.

[3] When the process value is outside the range, a fault message is issued.

8.3 Digital outputs (relays, triacs)

8.3.1 Admissible relay load

Type	TXM1.6R...	TXM1.6RL	TXM1.8RB	DXR2...	RXM21.1	RXM39.1
Data sheet	N8175	N8177	N8178	N9204ff	N3835	N3836
General use	4 (3) A			4 (3) A		
Fan stages	4 (3) A			4 (3) A	5 (4)	
Fan release	4 (3) A			4 (3) A		5 (4) (Q34)
Electric reheater	(4 (3) A)			(4 (3) A)		1,8 kW ohm load (Q14)
Light		10 A				
Blinds			3 A			

8.3.2 Admissible triac load

Type		TXM1.8T	DXR2... AC 230 V	DXR2... AC 24 V [4]	RXM21.1 AC 230 V	DXR1... AC 24 V [5]
Data sheet	Signal type	N8179	N9204, N9206	N9205, N9207	N3835	A6V11393931 A6V11393933 A6V11393929
Max. continuous load	BO, MO	8 x 3 VA [3] 4 x 6 VA	4 VA [1]	6 VA	2 x 4.5 VA	12 VA
	3-position	4 x 6 VA [3]	4 VA [1]	6 VA	2 x 4.5 VA	12 VA
	PWM 0...100%, Spring return	8 x 3 VA [3] 4 x 6 VA	4 VA [1]	6 VA	2 x 4.5 VA	12 VA
	PWM 5...50%	8 x 3 VA [3] 4 x 6 VA	2 x 4 VA [1]	2 x 6VA [2]	2 x 4.5 VA	2 x 12VA [6]
Short time load per triac for starting power in cold condition		12 VA [2] max.90s	6 VA [2] max.300s	6 VA [2]	12 VA [2]	24 VA [5]
Field supply AC 24 V		240 VA [3]	4 VA [1]	6 VA	--	--
Field supply DC 24 V		--	--	xx12P -- xx18 2.4 W	--	--
Sum for device		24 VA without field supply	4 VA [1]	xx12P 72 VA xx18 88 VA	9 VA	DXR1. E09 55 VA E10 60 VA M09 53 VA

[1] By choosing appropriate signal types, multiple actuators can be run at the same time because of staggered activation of the triacs. Details see below.

[2] Thermal actuators with a starting power of 6 VA in cold condition:
If driven by a 5...50% PWM signal, they only count for 3 VA.

[3] M 10 A fuse in the PXC3 / the power supply module / the bus connection module.
⚠ **Caution!** Use cable cross section suited for 10 A according to local regulations.

[4] Each of the 6 / 8 triacs has a current limitation.
No fault messages in case of overload or short circuit.

[5] Two triacs share one resetting thermal fuse of 2 A. Therefore, thermal actuators may use 1 A per triac for heat-up from cold condition.

[6] Thermal actuators with a starting power of 12 VA in cold condition:
If driven by a 5...50% PWM signal, they only count for 6 VA.

8.3.3 Triacs and AO 0-10V on DXR2 AC 230 V: engineering

Firmware functions

AC 24 V is produced internally. **The max. admissible continuous load for triacs and field supply is 4 VA** (6 VA during 300 s for the starting load of thermal actuators in cold condition).

The firmware features the following mechanisms to avoid overload:

- **Internal prioritization** of commands "AO 3-position", "AO PWM Const. period" and "AO PWM Thermal" so that only one triac is active at a time. Thus, **two actuators on two different triacs can be driven simultaneously under certain conditions.**
  Alarm "Triac overload" appears in the output object if a 3-position command is delayed by more than 15 minutes by the prioritization.
  The alarm disappears 15 minutes after the problem ends.
- **No prioritization** for binary and multistate outputs (BO and MO).
- **The power supply switches off for 2 s** and on again if the max. load (6 VA) is exceeded. **Alarm "Current overload"** appears in the triac module device object and disappears 10 minutes after the overload ends.

Engineering rules

The following rules are independent of the source of the input / output command (the application or an external BACnet reference).

1. **The sum of all simultaneous loads must not exceed 4 VA:**
   – loads on triacs
   – Binary and multistate outputs
   – loads on the field supply
   A higher field supply load may be covered by an external AC 24 V transformer. For triacs this solution is not admissible.
2. **2 thermal actuators** (AO PWM thermal 5...50%) may be driven at the same time with one triac each. In this case the two triacs are activated round robin.
3. **2 motorized actuators** (AO 3-position) may be driven at the same time with two triacs each. The pulses for the second actuator are delayed.
   If the motor power is very small, up to 4 actuators can be driven with the same two triacs (see examples on next page).
4. **Max. 1 actuator** with function **AO PWM spring return or AO PWM constant period**. These signals have highest priority. They would delay other commands much too long.
5. **Multiple motorized actuators (AO 0-10V) on one output** are admissible if
   – The sum of the loads on the 0...10 V inputs is <= 1 mA.
   – The sum of the max. power of the actuators (delivered by the field supply) is <= 4 VA (the motor pulses are not staggered).
6. "Max. 4 VA" applies for **heating and cooling devices separately**, if the application EITHER heats OR cools.
7. "Max. 4 VA" applies for **the sum of heating and cooling devices**, if the application heats AND cools simultaneously (downdraft compensation).
8. **Binary and multistate outputs** (BO Triac, MO Triac) are not subject to prioritization. The load must be considered in addition and must be added to the load of the actuators.

Overall load: Summary: The maximum overall load is calculated as follows:

Highest load at one of the Triacs with motorized or thermal actuator
\+ Load at digital outputs
\+ Load a field supply [1)]

Examples Triac

Example 1: DXR2x10.., 09T				Example 2: DXR2.x10.., 09T			
Use	**Type**	**Signal**	**Load**	**Use**	**Type**	**Signal**	**Load** [4)]
Fan coil heating	STP73	PWM	2,5 W / (6 VA)	**Radiator 1** [2)]	STP73	PWM 5...50%	2,5 W / (6 VA)
Chilled ceiling	STP73	PWM	2,5 W / (6 VA)	**Radiator 2** [2)]	STP73	PWM 5...50%	2,5 W / (6 VA)
Outside air damper	GEB131.1E	3-Punkt	**4 VA**	**Chilled ceiling 1** [3)]	STP73	PWM 5...50%	2,5 W / (6 VA)
				Chilled ceiling 2 [3)]	STP73	PWM 5...50%	2,5 W / (6 VA)
Overall load			**4 VA / (6 VA)**				**2,5 W / (6 VA)**

Example 3: DXR2.x09			
Use	**Type**	**Signal**	**Load**
Radiator	4 x SSA81	3-Pt	4 x 0.8 VA
Chilled ceiling	4 x SSA81	3-Pt	**4 x 0.8 VA**
Overall load			**3.2 VA**

Example 4: DXR2.x09			
Use Chilled/heated ceiling	**Type**	**Signal**	**Load**
6-port control ball valve	GDB116.9E	0…10 V	**3 VA**
Condensation monitor	QXA2100	DI	**1 VA**
Overall load			**4 VA**

Examples DC 0…10 V

Example 5: DXR2x09				Example 6: DXR2.x09			
Use	**Type**	**Signal**	**Load**	**Use**	**Type**	**Signal**	**Load** [5)]
Fan coil heating	SSB61	DC 0...10 V	2,5 VA	**Radiator**	STP63	DC 0...10 V	2,5 W / (6 VA)
Outside air damper	GLB161.1E	DC 0...10 V	**3 VA**	**Chilled ceiling**	STP63	DC 0...10 V	2,5 W / (6 VA)
Digital output	Relay	BO	0,5 VA				
Overall load			**3,5 VA**				**2,5 W / (6 VA)**

[1)] Field supply:
– DXR2.x09: Terminal 73 (on the output's side)
– DXR2.x09T: Terminal 72 + 75 (on the output's side)
A higher field supply load may be covered by an external AC 24 V transformer. For triacs this solution is not admissible.

[2)] Radiator: Note! In the case of downdraft compensation, the application may cool and heat at the same time (cooling because of high internal load, heating to stop cold air from falling down along the cold window). PWM 5-50 only is admissible.

[3)] In this case downdraft compensation is not admissible, because 2 thermal actuators are already used for chilled ceiling OR radiator.
Note! The I/O choice does not prevent such a choice.

[4)] Short time load 6 VA for cold thermal actuators.

[5)] Short time load 6 VA for synchronization run at startup.

8.4 Analog outputs DC 0...10 V

Technical data

	Signal type	Range (under / over range)	Resolution
Output voltage			
TX-I/O	AO 0-10V	0 … 10 V (-0.05...10.6 V)	1 mV
DXR2	AO 0-10V	0 … 10 V (0...10.5 V)	2 mV
	AO 0-10 V norm	0...100% (0...10,5 V) 0% = 0 V, 100% = 10 V	2 mV
Output current		max. 1 mA	

9 Ethernet network

9.1 IT security

- Building automation and control systems must use a separate technical network with very restricted and selective connection to the rest of the intranet and no connection at all to the internet. This can be done using a VLAN or a separate subnet.
- If access from the rest of the intranet is required: Use a router with very selective bridging.
- Prevent unauthorized access to any infrastructure (e.g. cables, LAN ports, IT devices as routers, building automation devices) with appropriate measures, e.g. lockable cabinets / panels.

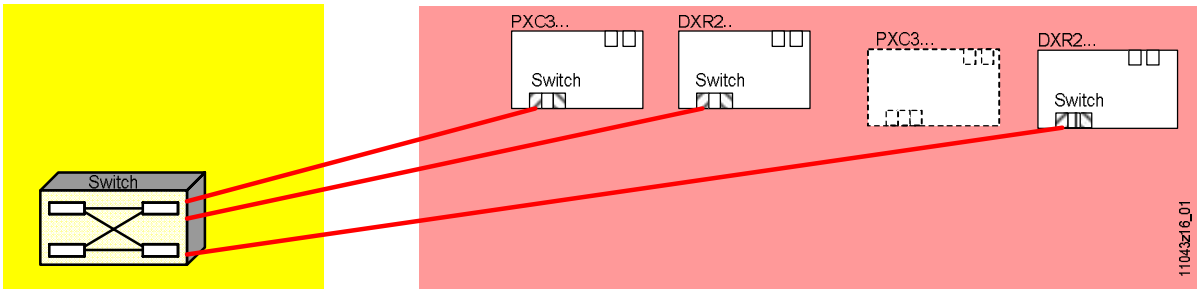
See documents [10], [11], [12] for detailed information.

9.2 Network topologies

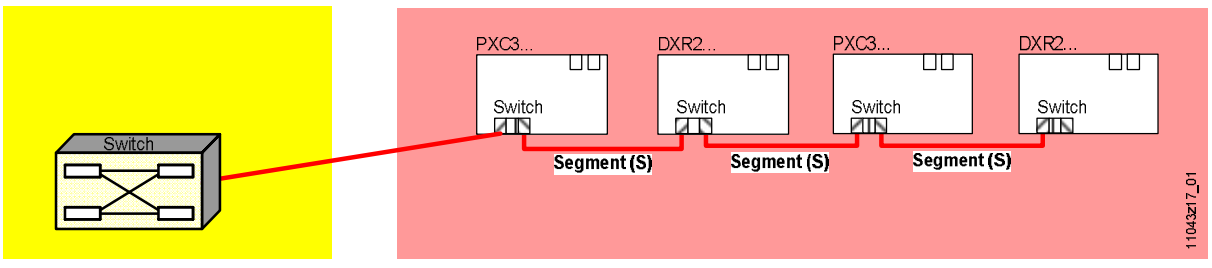
Topologies

You can use the following bus topologies:
- Star topology (general).
- Line topology (for room automation).
- DXR2... and PXC3... can be mixed.

Star topology



Line topology



Notes
- The number of room automation stations is limited to 20 for a line topology (daisy chain).

Note!
Availability / reliability

- The next device has no AC 24 V power when a room automation station is removed. The connection exists only on the board, but not on the terminal block.
- The Ethernet switch is inactive when a room automation station has no AC 24 V power. The next devices, if in line topology, are disconnected from the network. For secure operation of the system it is recommended to supply each room automation station separately with AC 24 V.

9.3 Cables

Room automation stations are connected to one another via switches and Ethernet cables with RJ45 connectors.
The following conditions must be met:

Bus cable and length

- Standard Ethernet cable — min. category 5
- Shielded or unshielded
  STP (**S**hielded **T**wisted **P**air) or UTP (**U**nshielded **T**wisted **P**air).
- Length between switch and Room automation station — max. 100 m / 328 ft.
- Length between Room automation stations — Max. 100 m / 328 ft.
- Number of devices under a line topology — max. 20.

Switch

- Standard IT product at 100 MB or 1 GB.

Reference documents

Additional information:

- Desigo Technical principles manual [1], Section 3 (overview), 16 (network view) and 18 (system limits).
- Ethernet, TCP/IP as well as BACnet on Ethernet/IP principles [6].
- Practitioner's guide IP networks for building automation [10]
- IT Security in Desigo Installations [11]

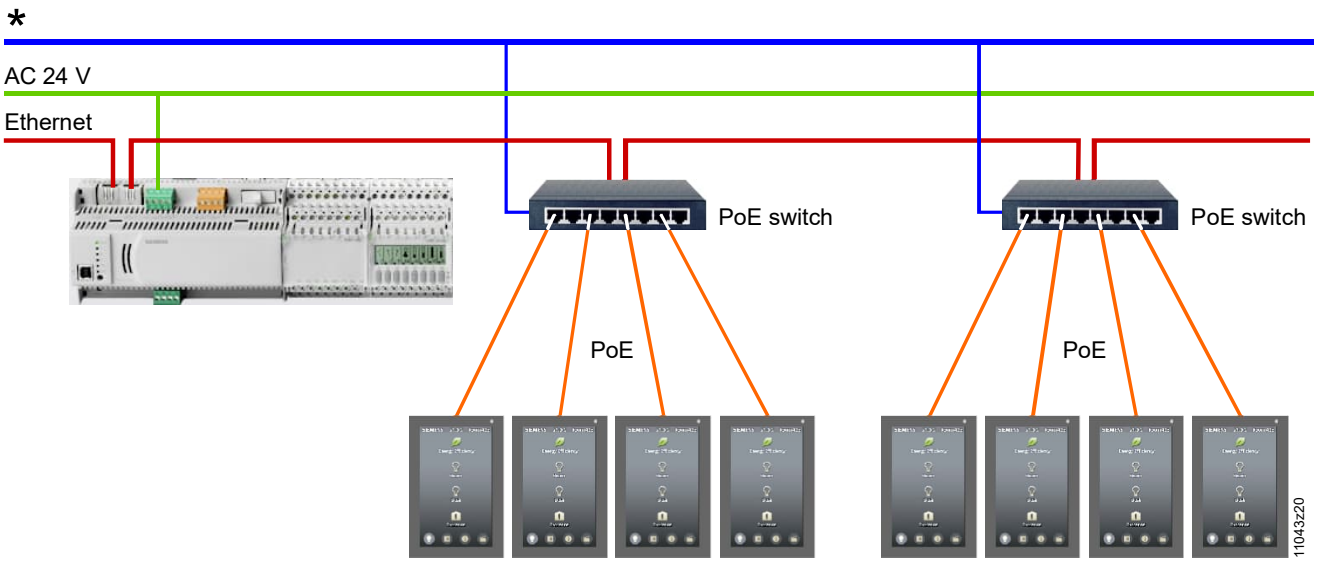
9.4 Power over Ethernet (PoE)

"Effective signal and power supply on same cable".

Benefits

Power over Ethernet (PoE) is a simple solution to supply power to room operator units consuming only little power. This saves a power cable and associated installation costs. PoE allows for installing Ethernet devices also in hard-to-access locations or areas where too many cables are an issue.

For more information on Power over Ethernet (PoE), see also [10], CM110666, Section 3.6.1, Power over Ethernet.



* Supply voltage and power depend on the type of PoE switch used and the number of connected room operator units.

Function

In PoE, power sourcing equipment (PSE) supplies power to powered devices (PD, here: end devices). Voltage is supplied via the RJ45 plugs and a twisted-pair cable (TP) to the devices either:
1. Via data transmission lines
2. Or via unused lines of the RJ45 connection.

PoE topologies

PoE requires a star topology. Standard PoE switches have between 4 and 16 outputs. In large plants (e.g. different rooms in a hotel) require use of multiple switches in a line topology.

Further topologies:

- Some switches (mostly industrial types) feature an uplink, i.e. multiple switches can be switched in series.
- A single consumer can be supplied via PoE injector, a midspan power source, contrary to direct sourcing (endspan) via PoE switch.

Specifications

• Standard Ethernet cable	min. category 5
• Screened or unscreened STP (**S**hielded **T**wisted **P**air) or UTP (**U**nshielded **T**wisted **P**air)	STP / UTP
• Distance between switch and room automation station	max. 100 m
• Distance between switch and end unit	max. 100 m

Suppliers

Always use switches designed for industrial environment.
Speed 100 Mbit/s or 1 Gbit/s.
Suppliers: e.g. Siemens Scalance, Siemens Ruggedcom.

Selection criteria

- Required number of outputs
- Required power
- Operating voltage for switch
  (DC 48 V is required for PoE; various switches, however, can be operated on e.g. DC 18…24 V or AC 230 V
- Mounting location (protection class)

10 MS/TP networks

10.1 Network requirements

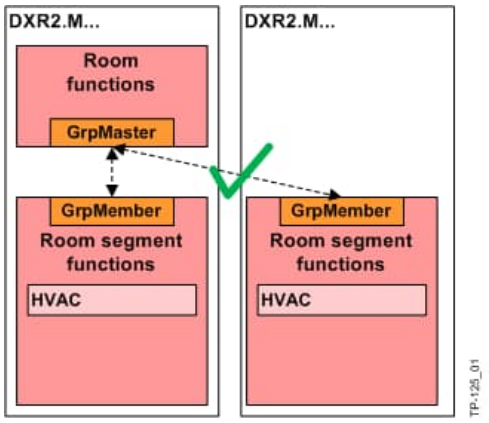
Topology

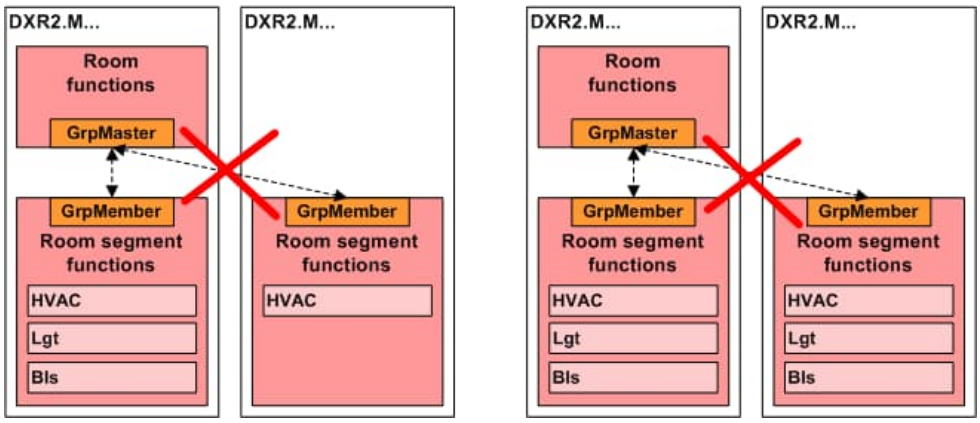
- **The MS/TP network must be inside the building.**
  The cables must never leave the building.
- BACnet MS/TP networks for Desigo DRA can only be wired in line topology. T-taps (T-junctions) are not allowed, except for stubs (max. 30 m).

Restrictions for DXR2.M...

Whereas HVAC functions are not time-critical, lighting and blinds require a visible response within 0.25 s.
For response time reasons, and because the number of commandable group objects is limited, DXR2.M... room automation stations with MS/TP communications are subject to the following restrictions:

– Switches / pushbuttons and actuators for Lighting and blinds must operate on KNX PL-Link, and they must be connected to the same DXR2.M.. .
– No combination with PXC3 (via MS TP to IP router).
  As a consequence, no combination with DALI lighting control via a PXC3.
– Room-segment relations only allowed in the same MS/TP network.
– Grouping of several room segments is only allowed for HVAC functions.
  The maximum of 32 DXRs can be used as follows:
  2 rooms with 16 segments each or 16 rooms with 2 segments each
  or any intermediate values. *Desigo V6.1: max. 64 DXR2.*
– If lighting and/or blinds are present, only one DXR2.M... room automation station per room is allowed.
– No central functions.
– No KNX S-Mode device integration, only KNX PL-Link.
– Connecting the room automation stations to a management station via an MS/TP to IP router is admitted.





Network settings

- The Desigo DRA devices communicate with up to 115,200 bps.
- All devices must be set to the same speed. Otherwise, no communication is possible.
- APDU timeout and APDU segment timeout recommendation:
  16 devices: 6 sec 32 devices: 10 sec.
- Set Max Master for all devices.
- Set router address to 0.
- Set Max Info Frame to 50 in the router.
- Set Max Info Frame to 10 in the DXRs (default).
- In case of communication problems, the speed can be reduced via tool.

Note!

- The "Set Baud rate" function in ABT is only supported by Desigo DRA devices. If a third-party device stays at another speed, the whole MS/TP communication may break down.

Number of devices

- As Desigo DRA creates much bus traffic, the number of devices in an MS/TP network must not exceed the following values:

Baud rate	9,600	19,200	38,400	**76,800**	**115,200**
Number of devices	*Not recommended*			**Max. 32**	**Max. 32**
	- -	(Max. 16)	(Max. 16)		
Number of devices V6.1 and later	*Not recommended*			**Max. 64**	**Max. 64**
	- -	(Max. 16)	(Max. 16)		

  Ignoring these values may cause communications to break down and block for all participants in the MS/TP bus segment.

- The electrical capacity of 256 devices cannot be used, although Desigo DRA devices have 1/8 load interfaces (32 loads * 8 = 256).

Addressing

- As all Desigo DRA devices are operated as masters, the max. address range is 0...127.

Third-party devices

Siemens does not assume any responsibility for correct operation of third-party devices in conjunction with Desigo DRA. Test such devices before using them in a project.

- The maximum of 32 loads must not be exceeded when using third-party devices. Check the manufacturer's literature for network loading information.
- For more than 32 loads use a repeater.
  Max. 2 repeaters in series are admissible.

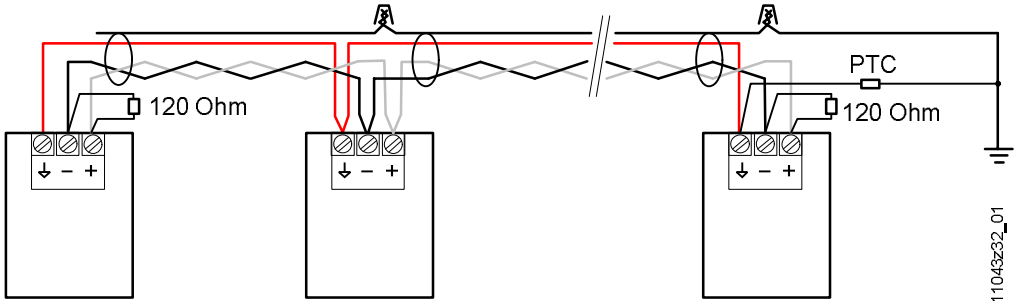
Network distances

- Max. length between two room automation stations 500 m / 1650 ft
- Max length for stubs 30 m / 100 ft
- Max. cable length of an MS/TP segment (including stubs) 1000 m / 3300 ft
- Length can be extended using one or two repeaters.
  Creating network sections using a repeater may also help in case of communication problems.
- It is also possible to span long distances using routers and BACnet/IP.

Bus terminating resistors

- Two resistors 120 Ohm (5% ½ W) **between + and –** at BOTH ends of the network segment.
- One PTC thermistor (TRF250-120) **between Reference (⏚) and earth** at ONE end of the network segment. This prevents the cable from being damaged by high ground currents that may occur if the reference wire is accidentally grounded to earth ground at a second location.
  Before installing the PTC thermistor, use a DMM to ensure that the reference wire is not already connected to earth ground.

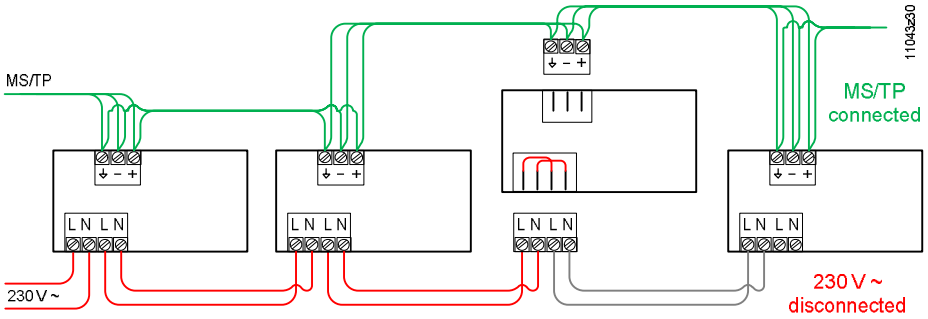
- Grounding of the **shield** at ONE end of the network segment.

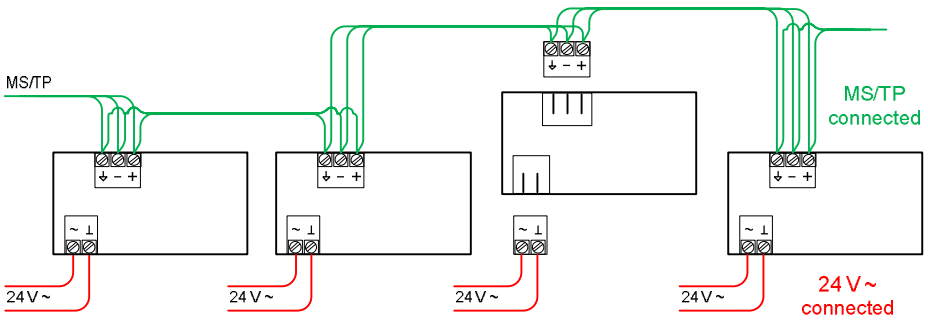


Key				
	+, –	Twisted pair	120 Ohm	Bus terminating resistor (½ W 5%) at BOTH ends
	⏚	Reference wire	PTC	Special-thermistor (TRF250-120) at ONE end
	⬯	Shield		

Note!
Availability

- The next device has no **power (AC 230 V)** when a room automation station is removed. The connection exists only on the board, but not on the terminal block.
- The **BACnet MS/TP terminal block** is not affected when a room automation station has no power (AC 230 V or AC 24 V).





Additional information

For more detailed information, see documents [10], [13] and [14] as well as Knowledge base article 2556.

10.2 Technical data BACnet MS/TP

Communications on BACnet MS/TP networks take place over EIA-485 physical media.

3-wire RS-485 network interface

- Desigo DRA devices use the 3-wire interface without noise suppression. Therefore, the cables must provide noise protection. This is guaranteed by the reference wire and the shielding.
- The interface is protected against short circuit, wrong polarity and faulty wiring with AC 24 V. However, communications do not work with wrong polarity.

Cable specifications

	Transmission medium	1.5-Pair (1 TP & 1 conductor)
	(bus cable)	with overall Shield and drain wire
	Pair	
1)	Gauge	Min. 0.2 mm^2 (24 AWG) stranded or solid
2)	Capacitance	
	conductor to	Max. 41 pF/m / 12.5 pF/ft
	conductor	Max. 79 pF/m / 24 pF/ft
	conductor to shield	
	Twists	Min. 13/m / 4/ ft
	Reference wire ($\triangledown$)	
	Gauge	Min. 0.2 mm^2 / 24 AWG stranded, or solid
	Twists with pair	Min. 13/m / 4/ ft
	Shield	100% overall foil with drain wire
3)	Voltage rating	300 V
4)	Temperature rating	75°C / 167 °F or higher
	Standards	EU CE Mark 2011/65/EU (ROHS II) 2002/96/EC (WEE) 2003/11/EC (BFR) MII Order #39 (China RoHS)

1) Stranded conductors are easier to connect in narrow places.
Less risk of breaking in case of vibrations

2) Higher capacitance must be compensated by
– smaller network length or
– smaller number of devices or
– smaller Baud rate.

3) Infrastructure network cabling is normally separated from mains cables, 30 V would be sufficient. But in cabinets, very small distance to main cables, therefore 300 V or even 600 V is required.
National standards may also require 300 V.

4) As the room automation stations require less than 50 °C, cabling in the cabinet can have the same rating. But outside the cabinet, avoid hot places like lighting troughs.

Examples of recommended cable types

Belden Type	Capacitance	Non-halogen	Shield [1]	Tempe-rature	Pairs	Color [3]
9925	39 pF/m 12 pF/ft		Foil + Braid	80	1.5	Black Red White
8102NH	41 pF/m 12.5 pF/ft	NH	Foil + Braid	80	2 [2]	Blue White / White Blue Orange White / White Orange
1419A	43 pF/m 13.1 pF/ft		Foil	80	2 [2]	Blue White / White Blue Orange White / White Orange

[1] Foil + Braid is recommended for harsh environment (mechanical and electromagnetic interference, e.g. variable speed drives).

[2] 2-pair cable to be used with care because of different color scheme. The two conductors of the second pair must be wired in parallel to the Reference terminal to prevent a floating conductor.

[3] Recommended color scheme for wiring.
Observe these rules to prevent communications problems.

3-wire		**2 pairs**	
+	White	+	White/blue
–	Black	–	Blue/White
Reference	Red	Reference	2 Orange conductors, parallel
Shield	Drain wire (bare)	Shield	Drain wire (bare)

11 SCOM sensor bus

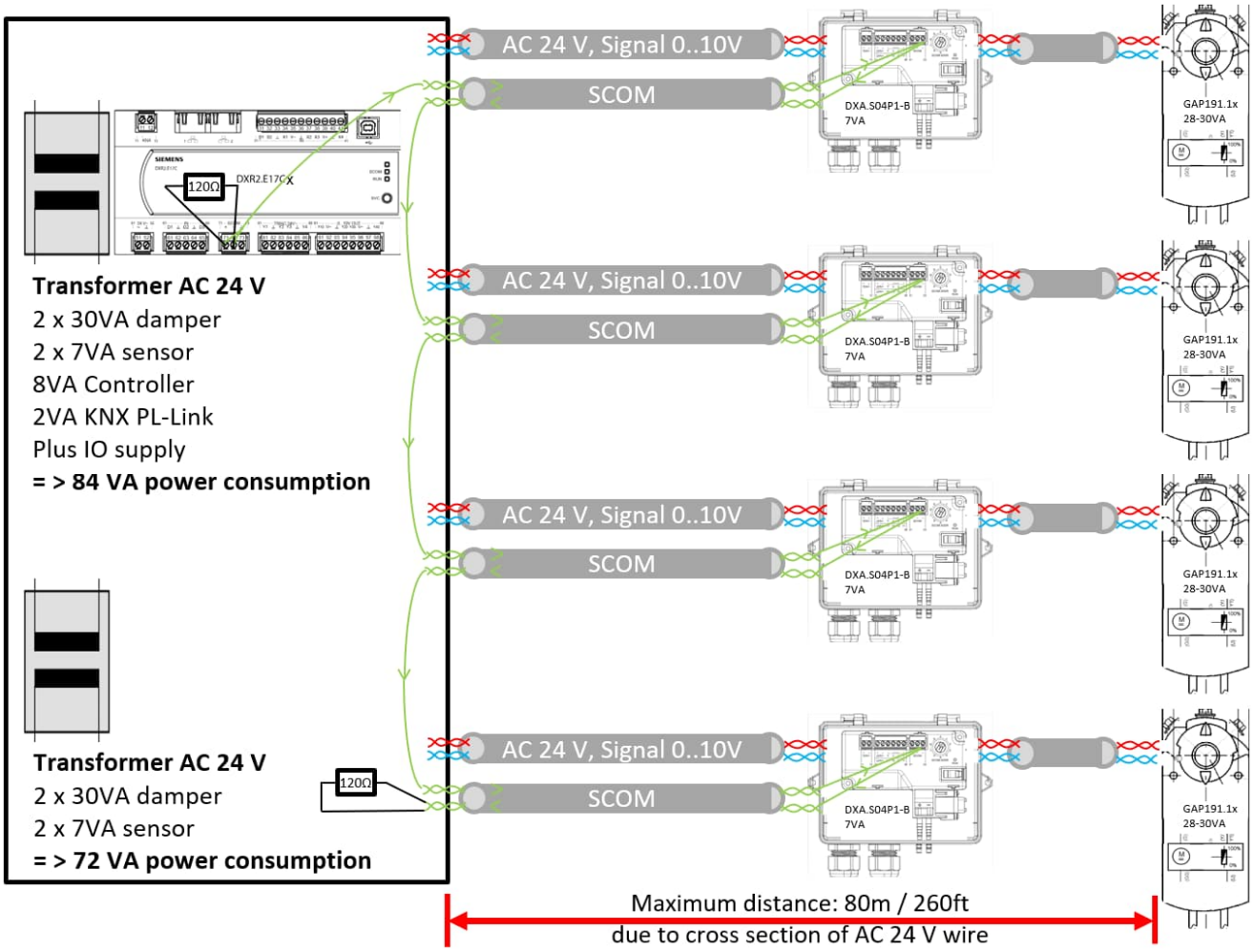
Use

SCOM provides dedicated digital sensor communication:

- Interface type RS485 – non-insulated (reference wire ⏚ is connected to system neutral ⊥)
- Baud rate 115200
- Cable type KNX or BACnet MS/TP cable, e.g. Belden 9925
- Max. cable length 800 m (2600 ft)
- Topology Line
- Network terminators (120 Ohm, 0.5 W) are recommended at the ends of the network between + and – if the total network length exceeds 30 m (100 ft)
- Short-circuit proof and protection against faulty wiring at max. AC 24V
- Polarity + / - must be observed

Connection of SCOM devices

As an example, a system with sensors and damper actuators is shown.



- AC 24 V and signal cable: star topology.
  Current and cable cross section limit the total distance to max. 80 m (260 ft), see chapter 7.1.3
- SCOM: Line topology: Using 2 x twisted pair cable allows forth and back cabling in the same cable - for cable saving purposes and for placing the network terminators in the enclosure / installation box
- Additional terminals are needed in the controller enclosure for SCOM daisy chain and AC 24 V wiring

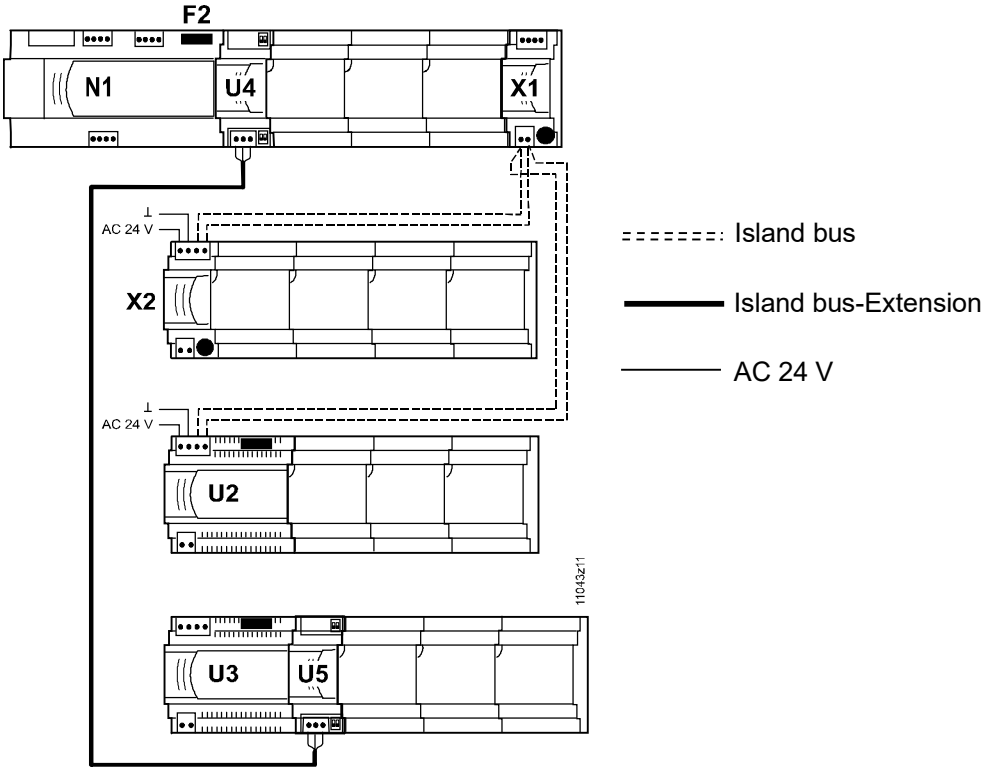
12 Island bus

This chapter is only a brief overview of the island bus installation.
The TX-I/O engineering and installation guide 10562 [7] includes detailed information on island bus wiring and island bus extension for PXC3 room automation stations and TX-I/O modules.

- Island bus and island bus expansion are designed for indoor use in one building only.
- PXC3 room automation stations each have switchable TX-I/O DC 24 V / 600 mA module power supply. They are switched on at the factory.

The following diagram displays basic wiring variants of the island bus together with the room automation station:

– TX-I/O modules on the **same standard rail as the PXC3**.
– TX-I/O modules on a different standard rail, connected via an additional **bus connection modules X1, X2**.
– TX-I/O modules on a different standard rail, connected via an additional **power supply module U2**.
– TX-I/O modules in an offset installation box; connected via **island bus extension modules U4, U5**.



Key

N1	PXC3 room automation station.
X1, X2	TXS1.EF10 Bus connection modules
U2, U3	TXS1.12F1 0Power supply modules
U4, U5	TXA1.IBE Island bus extension modules

Notes

- The **bus connection module** (X1) must be placed at the end of the TX-I/O row. Modules to the right side of the bus connection module would otherwise have no supply of AC 24 V.
- The **island bus extension modules** (U4, U5) may be anyplace in their TX-I/O row. For signal quality reasons, however, the best place is directly after the power supplying device

13 KNX PL-Link room bus

- **The KNX PL-Link bus must be inside the building.**
  The cables must never leave the building.
- The KNX PL-Link bus facilities communications from the PXC3 room automation station to a maximum 64 devices on the KNX bus devices for various manufacturers.
- Note: The number of devices is also limited by the number of data points and the available bus power.
  Bus power is incremented during engineering with the ABT tool.
- The KNX PL-Link bus basic version comprises one cable and two stranded bus wires.
- The PXC3 has one internal bus power supply of 160mA.
- The DXR2 has one internal bus power supply of 50mA.
- The PXC3 also includes an AC 24 V / 2A output for devices with increased power consumption that is supplied via AC 24 V rather than via the KNX PL-Link bus.
- The KNX PL-Link is physically based on the KNX bus (Konnex).
- In KNX networks area/line couplers and IP routers are not allowed.
- Interconnection of room automation stations via KNX PL-Link is not admissible; the connection is done exclusively via Ethernet switches (Section 9) or MS/TP section 10).
- The polarity of the KNX PL-Link bus conductors must be correct.
  (KNX terminals + and –).

In most countries, specific /KNX know-how is transmitted through training centers certified by the EIBA / KNX association (see www.eiba.com or www.knx.org)

13.1 Bus power supply

A bus power supply is required for KNX bus communications. Throttled voltage DC 29 V is used.

13.1.1 Internal KNX PL-Link power supply

The room automation stations have an internal bus power supply, which is switched on by default.
DXR2: 50 mA to supply approx. 5 KNX PL-Link devices
PXC3: 160 mA to supply approx. 16 KNX PL-Link devices

If an external supply is used, the internal supply must be switched off manually via tool, as parallel operation is not permitted.

DXR2: If **third-party KNX devices** are integrated, we recommend switching off the internal bus power supply via tool and using an external bus power supply.

13.1.2 External bus supply

If the 160mA of the PXC3 / the 50 mA of the DXR2 are insufficient to cover the power demand of the connected devices, the internal bus power supply must be switched off via tool and replaced by an external bus power supply unit (PSU).

Power supply units for **80,160, 320** and **640 mA** available in specialty stores. The total power supply for the devices must be calculated to determine the appropriate size. Comply with the corresponding details in the datasheet.

A 640 mA power supply unit suffices for a line featuring 64 devices on the KNX bus with an average power demand of 10 mA each.

Parallel operation

- Parallel operation of external bus supplies with the **internal** bus supply of a room automation station is NOT allowed.
- In principle, parallel operation of external bus supplies **among themselves** is possible. However, check if the specific PSU is allowed to be operated in parallel with other PSUs. Refer to the technical specifications.
- Depending on the type, a minimum cable distance is required between two PSU, see section 13.3. Siemens PSU may be placed without a distance

Siemens power supply units

We recommend the following Siemens power supply units for KNX networks (see links below).

Ordering

- 5WG1 125-4AB23, short designation RL125/23 **80mA**
  (with integrated throttle) Parallel operation with other PSUs is allowed
- 5WG1 125-4CB23, short designation JB 125C23 **80mA**
  (with integrated throttle) Parallel operation with other PSUs is allowed
- 5WG1 125-1AB02, short designation N125/**02** **160 mA**
  (with integrated throttle). Parallel operation with other PSUs is allowed
- 5WG1 125-1AB12, short designation N125/**12** **320 mA**
  (with integrated throttle). Parallel operation with other PSUs is allowed
- 5WG1 125-1AB22, short designation N125/**22** **640 mA**
  (with integrated throttle). Parallel operation with other PSUs is allowed

Data

- Operating voltage AC 120…230 V, 50…60 Hz
- Bus supply output DC 29 V (21…30 V, throttled)

Additional information

- Product and function description (inserted with each device).
- Technical product information:
  https://www.hqs.sbt.siemens.com/cps_product_data/data/search_find_en.htm?te1=5WG1

13.2 Bus topologies

64 devices on one line

Up to 64 devices with KNX PL-Link can be installed on one line (main line as well). No restrictions apply to the type mix.

Notes

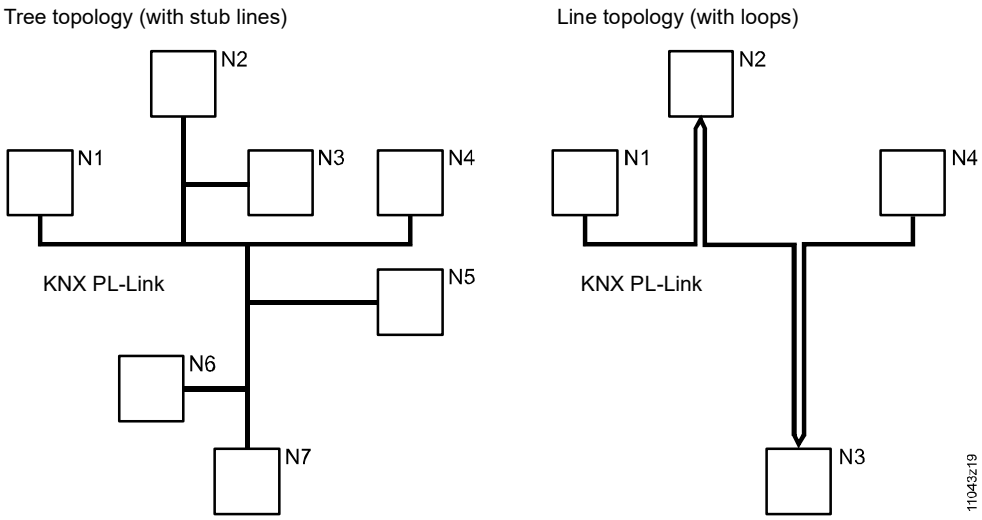
- There is no need to calculate the bus load number E for up to 64 devices.
- A maximum of 64 devices may be installed even if devices requiring less power are used.

Permissible bus topologies

Permissible bus topologies are: Tree, line, and star topologies. These topologies can be mixed as needed. However, ring topologies are not allowed.

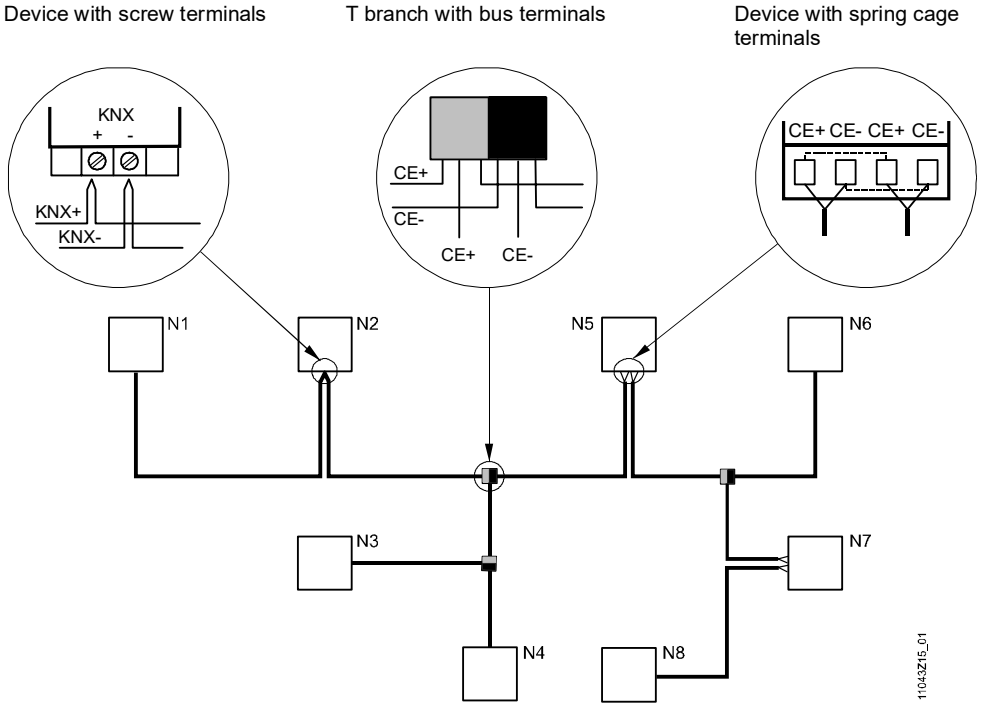
Advantage: Tree topology

The tree topology is advantageous if a large network must be created.



N1 .. N7 Devices

Branching and connection variants

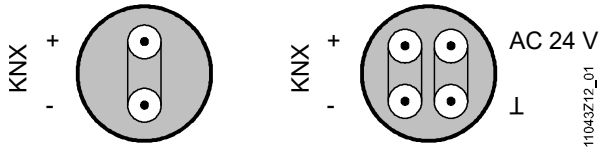


N1 .. N8 Devices

13.3 Cables

Bus lines

The bus lines (= twisted pair) are connected via PL+ (red) and PL– (black).



Bus cable selection

Choose the bus cable as per country-specific offerings. Comply with values indicated in this document under "Technical data KNX PL-Link".

AC24V for field supply can be provided in the same (2 x 2 stands) or in a separate cable.

Recommended bus cable are available on the KNX homepage under Downloads / Support – 06 KNX Certification – 02 KNX Certified Products – Cable: http://www.knx.org/downloads-support/downloads/:

Recommended cable types

– 1 x 2 x 0.8 mm (e.g. Belden YE00819 or YE00905 - non-halogen).
– 2 x 2 x 0.8 mm (e.g. Belden YE00820 or YE00906 - non-halogen).

Bus cable screening

In DRA plants, bus cables **without screen** are permitted. The screens available for bus cables do not need to be connected.

If interference is expected on the KNX bus, use a cable **with screen**. Connect the screen as per standard installation rules.

Bus cable: KNX specified.

The indications for distances and line lengths in a network are designed for bus cables specified by KNX.

Admissible cable lengths

Comply with the following distances :

Network with internal power supply from the room automation station

	DXR2	PXC3
• Distance between device and internal supply	max. 80 m / 260 ft	Max. 350 m / 1150 ft
• Distance between devices	max. 80 m / 260 ft	Max. 350 m / 1150 ft
• Total length of all lines on one line	max. 80 m / 260 ft	Max. 350 m / 1150 ft

Network with external power supply (PSU) (see section 13.1.2)

• Distance PSU to PXC3 with switched off internal supply	Min. 0 m
• Distance device to next PSU	Max. 350 m / 1150 ft
• Distance between two PSU operated in parallel	Min. 200 m / 650 ft
Min. 0 m for the new Siemens power supply modules recommended in section 13.1.2.	
• Distance between devices	Max. 700 m / 2300 ft
• Total length of all lines on one line	Max.1000 m / 3280 ft

Polarity

Important: The bus conductors must NOT be inverted.
(KNX terminals + and –).

Notes

- At least one supply (internal or external) is required for each line, and max. two supplies (external) are allowed per line.
- Install the power supply unit as close to the network center as possible to achieve maximum line size.
- The distance between the device and the next neighboring PSU may not exceed 350 m / 1100 ft. As a result:
  Even if the power demand from the devices does not require it, two power units must be used depending on the line length.

Power supply AC 24 V
PXC3 only

The PXC3 room automation station also includes an AC24V / 2 A / 48 VA output for devices with increased power consumption that is supplied via AC 24V rather than via the KNX bus.

Voltage drop off between the room automation station and devices with KNX is maximum -7 % (-1.7 V).

The table below provides permissible loads based on cable lengths and cable cross sections.

Permissible load [VA]

	Cable length for AC 24 V				
AWG NO. Cable cross section (diameter)	**10 m 33 ft**	**20 m 65 ft**	**50 m 165 ft**	**100 m 330 ft**	**200 m 650 ft**
AWG20 0.5 mm² (0.8mm)	**48 VA**	**30 VA**	**12 VA**	**6 VA**	**3 VA**
AWG18 0.8 mm² (1.0mm)	**48 VA**	**48 VA**	**20 VA**	**10 VA**	**5 VA**
AWG16 1.3 mm² (1.3 mm)	**48 VA**	**48 VA**	**32 VA**	**16 VA**	**8 VA**
AWG14 2.1 mm² (1.6mm)	**48 VA**	**48 VA**	**48 VA**	**24 VA**	**12 VA**

13.4 Commissioning notes

Observer the following commissioning aspects to commission a KNX network as intended.

Wiring KNX bus Polarity

Check the bus wiring prior to commissioning, and make sure that the bus line polarity is not interchanged (KNX terminals + and –).

Operating voltage

Check the operating voltage wiring to make sure that the devices are connected to AC 24 V or AC 230 V (as per the technical device information). Apply operating voltage only after this check.

Bus power supply

After switching on operating voltage, you must check whether bus power from the room automation station or the PSU is available.

13.5 Technical data KNX PL-Link

KNX bus	Transmission medium (bus cable)	TP (twisted pair)
	Baud rate	9.6 kbps (fixed for TP)
	Bus line polarity	PL+, PL– (not interchangeable)
	Bus terminating resistor	Not required
Communication signal	The communication signal (information) is transferred symmetrically, i.e., as voltage difference between the two bus lines (and not as a voltage difference to the earthing potential). The sign preceding the voltage between PL+ and PL– determines signal values 0 and 1.	
KNX bus cable	Cable type	2-wire, stranded (one wire pair) or 2x2-wire, stranded or spiral quad
	Wire diameter	Min. 0.8 mm (AWG20) Max. 1.0 mm (AWG18)
	Line resistance	20 … 75 Ω/km
	Specific capacity	10 …100 nF/km at 10 kHz
	Specific inductivity	450 …850 µH/km at 10 kHz
	Screens	Not required
Note	PXC3 devices do not have a connection for bus cable screens	
Bus power supply	Internal bus power from room automation station PXC3... DC 30 V, 160 mA for max. 16 KNX devices with 10 mA each DXR2... DC 30 V, 50 mA for max. 5 KNX devices with 10 mA each If the consumption is more than 160 / 50 mA (more than 16 / 5 devices or more than 10 mA per device), one or two external bus power supplies are required. In this case the internal bus power supply must be disabled via tool, as parallel operation of the internal supply with external supplies is not admissible.	
Max. number of devices	64 devices in a KNX PL-Link network.	

14 DALI network

- The DALI network allows the PXC3 room automation station to communicate with DALI ballasts and sensors.
- DALI is a two wire bus. The signal conductors can be in the same cable as the AC 230 V power for the lights, or in a separate bus cable.
- The PXC3 possesses a DALI bus supply to power DALI devices.

Additional information

Detailed information is available on the DALI homepage at www.dali-alliance.org.

14.1 Bus power supply

Supply is compulsory

A bus power supply is required for bus communications.

Bus power supply

PXC3 room automation stations each have switchable (via the ABT) bus supply. They are switched on at the factory.

Notes

- **Operation with an external power supply is NOT possible.**
- An external power supply cannot be connected even if the internal power supply is switched off.
- When the internal DALI bus power supply is switched off, the DALI interface of the PXC3 is off too.
- DALI-2 ballasts may have an integrated bus power supply, which is enabled by factory default. → Make sure to disable the integrated bus power supply of such ballasts before connecting them to a PXC3.

Number of devices PXC3.ExxA-100A

- Guaranteed supply current 128 mA
- 64 addresses are supported for commercially available DALI ballasts
- As one ballast uses typically 2 mA, 64 ballasts can be connected
- Max. 16 lighting groups
- Input devices like sensors are not supported

Number of devices PXC3.ExxA-200A (DALI-2)

- Guaranteed supply current 230 mA
  Usable supply power: 190 mA (20% reserve for dynamic events!)
- 64 addresses are supported for commercially available DALI **ballasts**
- 63 addresses are supported for commercially available DALI-2 **sensors**
- **As sensors use typically 5…15 mA, the power consumption of all connected devices (incl. ballasts) may limit the max. number of devices on a DALI line**
- Max. 16 lighting groups

Examples for the number of admissible DALI-2 devices:

- 64 lights, no input devices
  64 x 2 mA = 128 mA
- 14 groups of 4 lights each, each with 1 sensor
  14 x (8mA + **5 mA**) = 182 mA
- 10 groups of 4 lights each, each with 1 sensor
  10 x (8mA + **10 mA**) = 180 mA

NOT admissible:

- 28 lights with onboard sensor
  28 x (2mA + **5 mA**) = 196 mA
- 50 lights, 1 sensor per 2 lights
  50 x 2 mA + 25 x **5 mA** = 225 mA

14.2 Bus topologies

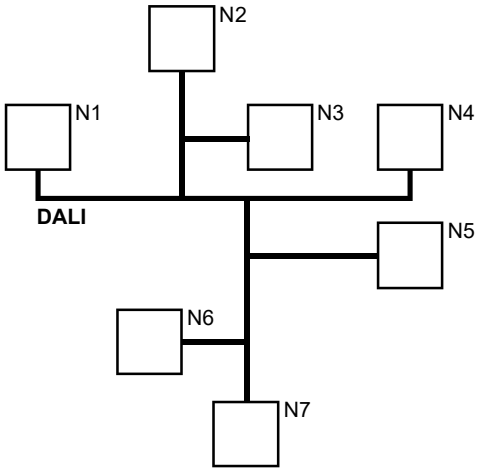
DALI devices in a circuit

Up to 64 DALI ballasts and 63 DALI-2 sensors may be installed on one DALI circuit. No restrictions apply to the type mix.

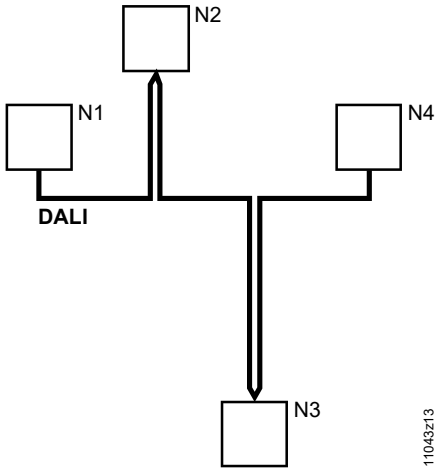
Permissible bus topologies

Permissible bus topologies are: Tree, line, and star topologies. These topologies can be mixed as needed. However, ring topologies are not allowed.

Tree topology (with stub lines)



Line topology (with loops)



N1 .. N7 DALI devices

14.3 Cables

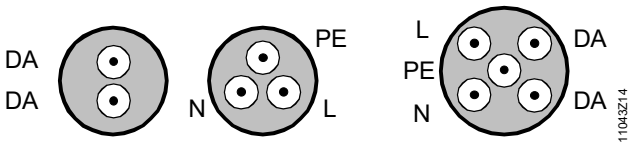
Bus lines

The bus lines (= wired pair) are connected via DALI (DA).
Observe polarity.

Bus cable selection

Use standard off-the-shelf installation materials to wiring mains power. You must observe the values indicated in this document under "Technical data DALI".

AC 230 V and the bus signal can be provided in separate cables (2 + 3 stands) or in the same cable (5-wire).



Commonly used cable sizes (as per DIN VDE 0100/T520/Section 6):

– NYM 5 x 1.5 mm^2
– NYM 7 x 1.5 mm^2
– NYM 2 x 1.5 mm^2 and 3 x 1.5 mm^2
– NYM 2 x 1.5 mm^2 and 5 x 1.5 mm^2

A 1.5 mm^2 cable corresponds to AWG15...16.

Admissible cable lengths

The overall length is 300 m / 1000 ft for a wiring cross-section of at least 1.5 mm^2.

Note

The permissible voltage drop off over the DALI line and the terminals is a maximum of 2 V. The voltage drop off over the DALI line is typically 90% of 2V (1.8V) and via the terminals 10% of 2V (0.2V).

⚠. Regulations

Must comply with low-voltage installation regulations since the DALI signal is not SELV.

Faulty wiring

NO protection against miswiring with AC 24 V or AC 230 V:
Applying a voltage between DA+ / DA+ or between DA– / DA– will destroy the device!
This is particularly the case when the AC 24 V supply plug is connected to the DALI socket.

14.4 Technical data DALI

DALI bus	Transmission medium (bus cable)		TP (twisted pair)
	Baud rate		1.2 kbps
	Bus line polarity		DA+, DA- (interchangeable)
	Bus terminating resistor		Not required
DALI bus cable	Cable type		2-wire (one wire pair)
		or	5-wire
		or	7-wire
	Wiring cross section		Min. 1.5 mm^2 (AWG16).
	Distance (sum of all bus sections)		Max. 300 m / 1000 ft
	Screens		Not required
Note	PXC3… devices do not have a connection for bus cable screens.		
Bus power supply by room automation station PXC3	Nominal voltage		DC 16 V
	Guaranteed supply current		128 mA (PXC3.E…A-100A) 230 mA (PXC3.E…A-200A)
	Maximum supply current		250 mA
	Shutdown mechanism		PXC3.E…A-200A only:
	Shutdown delay time		700 ms
	Restart period		10 s
	Protection		Short-circuit proof Upon power-on, AC 230 V bus voltage is recognized on terminals DA+ and DA–.

Operation with an external power supply is NOT possible!
NO protection against miswiring with AC 24 V or AC 230 V:
Voltage between DA+ / DA+ or between DA- / DA- will destroy the device!

15 EnOcean RF networks

15.1 Technology

(This section is based on the document "EnOcean Range planning" by Engineer Armin Anders, EnOcean LLC).

The patented EnOcean RF technology creates a surprisingly far-reaching signal with remarkably little energy. So that devices can be operated trouble-free without solar cells, Piezo elements or thermocouples.

The patented EnOcean RF technology creates a surprisingly far-reaching signal with remarkably little energy. So that devices can be operated trouble-free without solar cells (for room temperature sensors) or Piezo elements (switches/buttons).

At just 50 µWs, a standard EnOcean RF modules can transmit a signal over a distance of 300 m / 1000 ft (in a free field). The secret is the signal duration is just one thousandth of a second and triggers, executes and concludes the entire process.

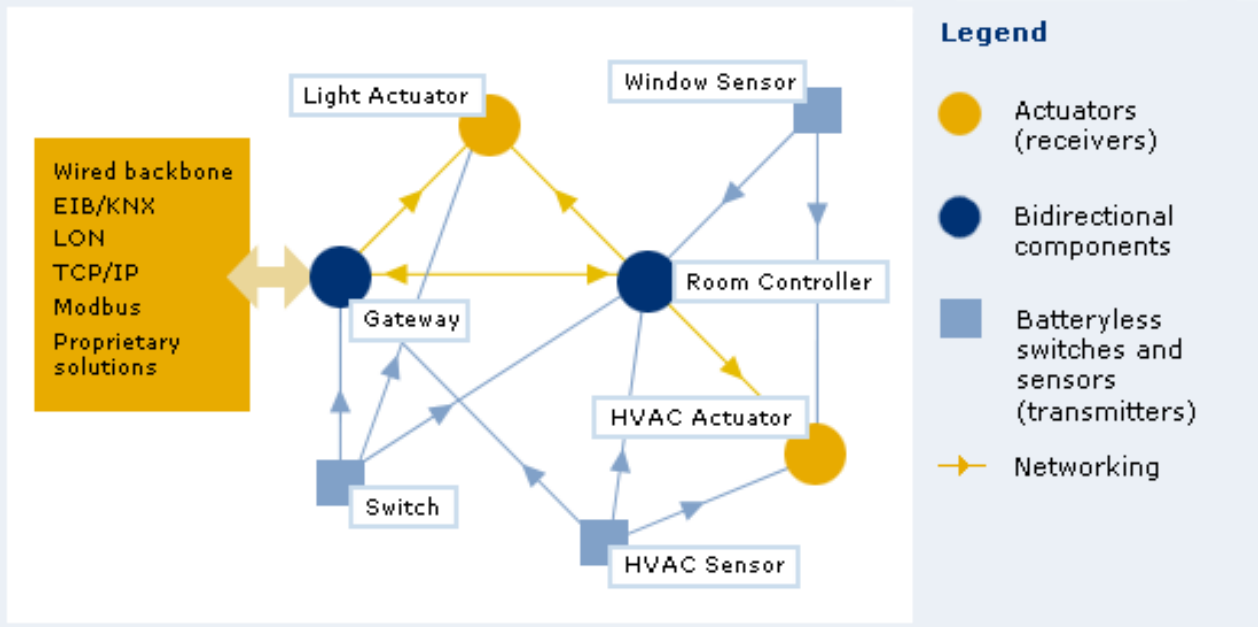


Figure: EnOcean technology uses

Summary of EnOcean RF standards (http://www.enocean-alliance.org/en/enocean_standard/)

High reliability

- License-free frequency ranges 868 MHz or 315MHz at 1% duty cycle (comply with local law/releases).
- Multiple telegram transmission with checksum.
- Short telegrams (ca. 1ms) results in a low probability of collisions.
- High range: 30 m / 100 ft in buildings & 300 m / 1000 ft unhindered.
- Repeater available for extensions.
- Uni and bidirectional communications.

Low energy demand.

- High data transmission rate of 125 kbps.
- Low "data overhead".
- ASK modulation.

Interoperability

- RF protocol is defined and integrated in the modules.
- Sensor profiles are established and followed by users.
- Unique transmission ID (32 bit).

Coexistence with other RF systems

- No interference with DECT, WLAN, PMR systems, etc.
- System design verified in an industrial environment.

Specially suited for

- Renovation projects (old buildings, museums, churches, historical buildings, etc.).
- Rooms where wall reworking is difficult or even impossible (sandstone, glass, metal)
- Spaces requiring adjustable room division (open plan offices, museums, TV studios)
- Rooms with flexible furnishing or frequently changing decor
- System extensions

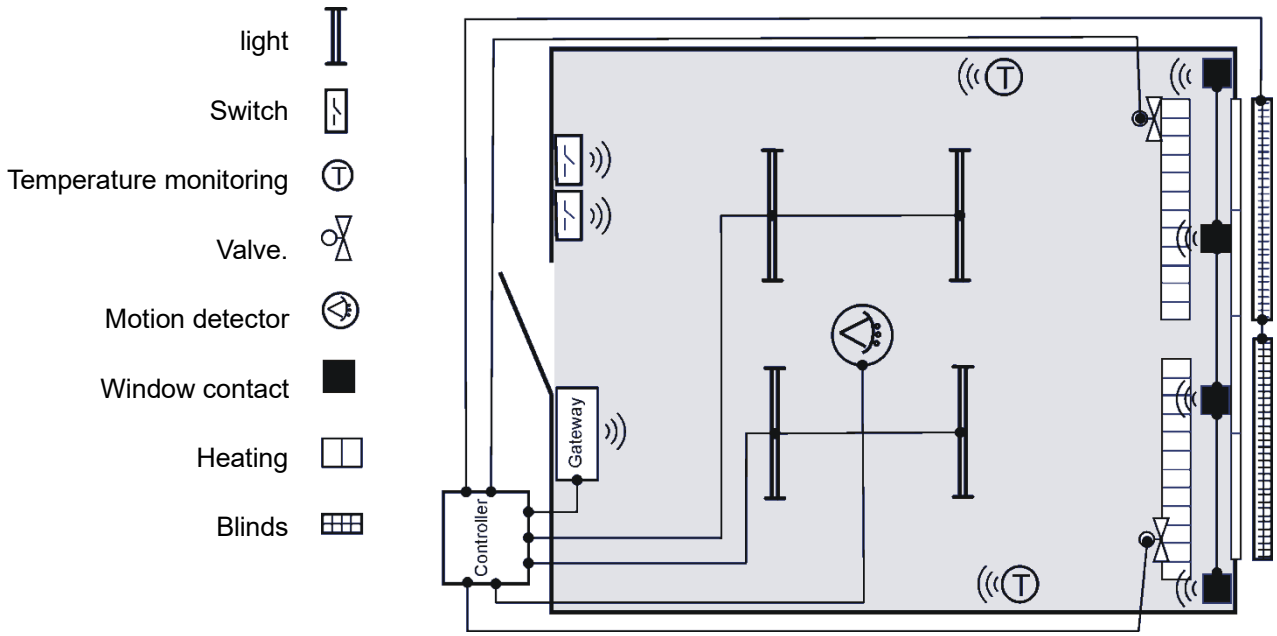
Use

Switches, sensors and actuators in building technology.

Wireless range in building is ca. 30 m.

For operation with a control unit, the connection to the gateway must first be set up. See data sheet N1661 (Gateway EnOcean/LonWorks) or N1662 (Gateway EnOcean/KNX).

Typical application
(example with additional third-party components)



Function

Data telegrams from EnOcean devices are received by the receiver (e.g. EnOcean / KNX Gateway) and forwarded as communications objects to the control unit.

This type of cooperation requires that the receiver "trained" the sender. See data sheet N1662 (Gateway EnOcean/KNX).

Current room device data are sent only every ca. 15 minutes to consume as little energy as possible. However, this signal, a so-called presence signal, is always

sent. Moreover, some events are sent with a ca. 2-minute delay or immediately. For details, see the technical data "Frequency of transmission".

The room device stops transmitting if the energy store is not charged sufficiently and/or the battery is empty.

100% functionality cannot be guaranteed under all circumstances. There are simply too many possible sources of interference, both legal and illegal, impacting range tremendously. This includes radio applications using the same frequency for transmission, e.g. other control systems with wireless connection. In addition, reflection based on room design or interior décor impacts signal quality and transmission security.

Additional information

Detailed information is available on the EnOcean homepage at: www.enocean.com.
The EnOcean Alliance homepage includes a list of all manufacturers offering compatible devices: www.enocean-alliance.org.

15.2 Lighting conditions at mounting location

This section refers to room units equipped with solar cells. The data provided below is based on QAX9x.4 room units.

For guaranteed operation (without battery), at least 200 Lux illuminance must be present for at least 3 to 4 hours daily. Avoid direct exposure to the sun, as this results in fault temperature readings. Avoid also shading by furniture as well as mounting in wall recesses without sufficient lighting.

Startup time at empty energy store:	Approx. 1 min. at 400 lx
Illumination time required to charge the empty energy store for 14 hours operation in total darkness:	Approx. 6 h at 400 lx 1), 2)
Illumination time to recharge a working energy store for 14 hours operation in total darkness:	Approx. 2 h at 200 lx 1), 2)
Maximum operating time at 100% charge and total darkness:	Approx. 4 days

1) Sending a radio signal ca. every 15 minutes (average).
2) Typical value depending on prior charging of energy cell.

As brightness is hard to evaluate, we recommend control measurements using a device to measure illuminance.

Definition: Illuminance

Brightness refers to how the human eye perceives the intensity of a light source. Brightness is measured in Lux [lx]. The human eye can perceive various light sources with the same brightness. Depending on the technology, solar cells have varying degrees of efficiency for daylight and artificial light. Fluorescent lights require at least 30% greater brightness to generate the same level of charging as daylight.

The value of the product light (Lux) and duration (h) are referred to as Lux h.

The amount of available daylight in the winter is minimal. Winter must be used for calculations if the intent is to guarantee functionality. Of further note is that illuminance differs on horizontal versus vertical surfaces. As a matter of principle, horizontal surfaces are better than vertical, of course with the exception of roofs.

Minimum room conditions

The following minimum conditions must be guaranteed for the mounting location of STM solar cells:

- Check the STM initialization parameters as described in the user's guide.
- Check light sources (daylight or artificial light). Assume a worst case involving fluorescent lamps if the light source cannot be clearly defined.
- Define minimum brightness and duration of illuminance required to ensure operation.
- Check lighting conditions on the planned mounting location for the module assuming the least favorable conditions (e.g. in winter).

Note

The energy cell drains too much if the average illuminance drops below the defined, indicated values and transmission ceases. Transmissions resumes automatically as soon as the energy cell is sufficiently charged.

The list provides typical illuminance values. Please use a Lux meter to measure actual values.
A satisfactory Luxmeter is available as of EUR 30.

Building type	Room type	Typical brightness
Apartments	Normally	100 - 500 lx
Schools	Hallway	100 - 300 lx.
	Class rooms in general	300 - 750 lx.
	Reading rooms, labs	500 - 1500 lx.
Offices	PC rooms, working on PCs	200 - 500 lx.
	Meeting rooms	300 - 700 lx.
	Cafeteria	150 - 300 lx.
	Hallways	50 - 100 lx.
	Reception area	300 - 700 lx.
	Bathrooms	100 - 300 lx.
production	Manufacturing halls	500 - 1500 lx.
	Development, office	300 - 750 lx.
	Design CAD	500 - 1500 lx.
	Labs and inspections	750 - 1500 lx.
	Product packaging	150 - 500 lx.
	Storage	100 - 300 lx.
Hospitals	Visitor rooms	300 - 500 lx.
	First aide, surgery	500 - 1500 lx.
	Patient rooms	100 - 300 lx.
	Pharmacies	500 - 1000 lx.
	Laundry rooms	150 - 300 lx.
Hotels	Reception area	200 - 500 lx.
	Reception areas	100 - 300 lx.

	Restaurant	150 - 300 lx.
	Bathrooms	100 - 300 lx.
	Bars	50 - 150 lx.
	Hallways	50 - 100 lx.
	Stairwells	50 - 150 lx.
Business	Sales room	300 - 1000 lx.
	Showroom	500 - 1500 lx.
	Packaging area	200 - 300 lx.
	Break room	300 - 500 lx.
	Conference room	300 - 700 lx.
Showroom	Both	300 - 500 lx.
Sports facility	Interior	200 - 500 lx.

Notes on mounting location of room units

- Select the best compromise between Illuminance, ventilation locations and aesthetic requirements.
- Where possible, install room units opposite windows with the longest daylight exposure.
- Avoid recesses without sufficient daylight.
- With regard to future room use: Select a mounting location where the room unit is not shaded by users (e.g. by moving around furniture).

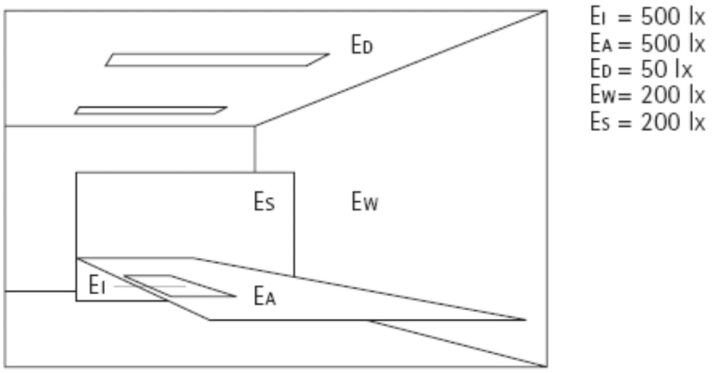


Fig.: Examples for brightness on various locations in a typical office (desk EA = 500 lx) Whether illuminance on the wall is actually 200 lx, depends in large measure on local conditions. We recommend conducting reference measurements using a luxmeter. A device with battery backup can be used is illuminance is insufficient (see Section 15.3).

Prior to commissioning

Solar energy cells must be charged prior to commissioning (especially after storage for long periods in darkness prior to initial installation). This occurs automatically as soon as the solar cell is exposed to light.

The device is fully operational after 3 to 4 days if the initial charge is not enough.

The energy is now sufficient to ensure full functionality even after darkness (even at night or on weekends for up to 90 hours).

15.3 Battery operation

This section refers to room units equipped with solar cells.

Normally, ambient light suffices to charge the energy store required to operate the room device. If, however, lighting conditions at the mounting location are insufficient to meet guide values provided in Section 15.2 "Lighting conditions at mounting location", insert a battery in the battery holder. This ensures device operation even under unfavorable lighting conditions.

Use a lithium button cell battery (type CR2032).
It is widely available in electrical supply shops.
A battery can have a typical battery life of up to 5 years.
The battery will be emptied sooner if the device is operated in total darkness and radio telegrams are transmitted frequently.

Battery-supported operation is neither necessary nor recommended if there is sufficient light!

15.4 RF link properties

General information on "radio signals"

In Europe, room devices use frequency 868.3 MHz and 315 Mhz reserved for this purpose. This frequency may be used for various applications (ISM) with some limitations.

If radio signals on this frequency overlap and interfere, data transmission from a room device to a receiver module may temporarily be impaired. The distance of sender and receiver to various interference sources (e.g. audio/video systems, computer) should at least be 50 cm.



Caution!

Check sensitive medical devices using this frequency range in a case-by-case basis.

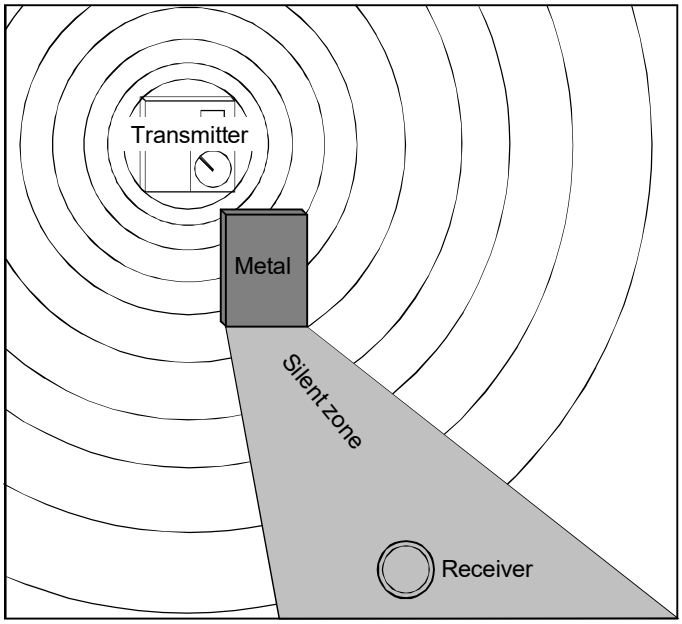
Used together with third-party receivers

For detailed information, see the description of the radio signal modules available for download at: http://www.enocean-alliance.org/de/home.

Radio signal range

A radio signal's strength decreases with distance as it is sent in all directions. In addition, other factors influence the radio signal strength.

Below are a few examples of interference and attenuating impact of different materials.

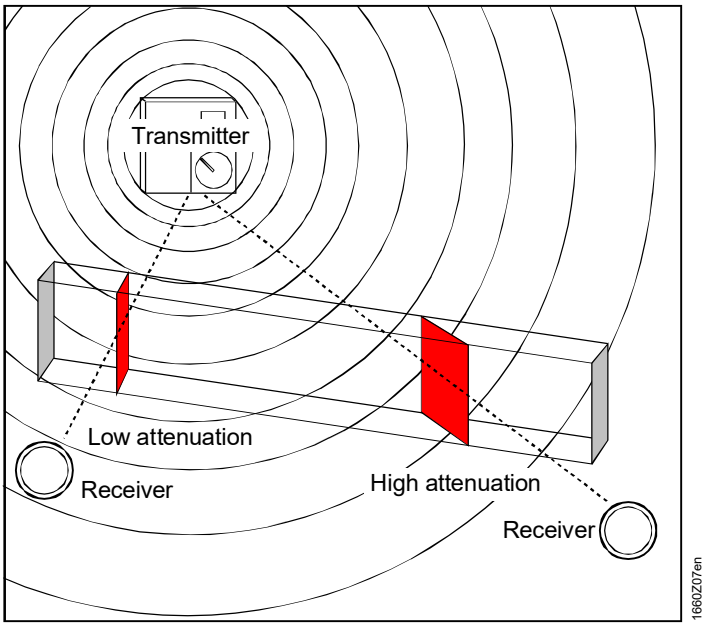


Material:	Passage of radio signals
Wood, gypsum, uncoated glass	90...100 %
Brick, pressboards	65...95 %
Reinforced concrete	10...90 %
Metal, aluminum lamination	0...10 %

Avoid under all circumstances to **metallically screen** a room device.

Building materials as well as wall angles in particular influence the radio signal range with the radio link. The greater the angle at which electromagnetic waves hit a wall, the greater signal attenuation.

As a result, avoid flat angles and wall niches.



Examples:	Radio signal range	Passage
Visual contact:		
In hallways	Up to 30 m	
In halls	Up to 100 m	
RIGIPS walls, dry wood	Ca. 27 m up to 30 m	Max. 5 walls
Brick walls, aerated concrete	Ca. 19 m	Max. 3 walls
Reinforced concrete walls	Ca. 10 m	Max. 1 wall
Fire protection walls, elevator shafts, stairwells, supply areas	The radio signal is isolated	

15.5 Planning RF networks

RF signal range

Since RF signals are electromagnetic waves, the field strength at the receiver decreases as the distance to the transmitter increases, in other words, the RF range is limited. Any materials in the transmission field reduces the range accordingly. RF waves do penetrate walls, but dampen the strength versus pure line of sight.

Reduction in range from walls versus a free field of view:

Material	**Reduction in range versus a free field of view**
Wood, gypsum, uncoated glass, without metal	0...10%
Brick, pressboards	5...35%
Reinforced cement	10...90%
Metal, aluminum lamination	see Section 15.4

The **geometric shape of the room** determines the RF range, since transmission is not in the form of rays, but rather requires a certain room volume (ellipsoid with sender Tx and receiver Rx in both focal points). At 30 meter in range, the ellipsoid center diameter is theoretically around 10 m / 33 ft (868 MHz). Narrow hallways with large walls are unfavorable.

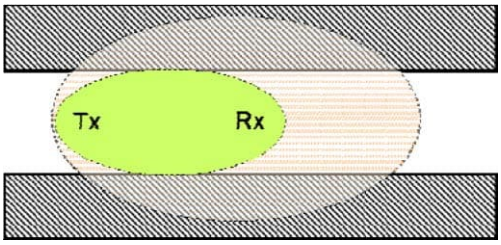


Fig: Narrow hallways with large walls.

The **antenna setup** and the **distance from ceilings, floors and walls** plays an important role. Internal antennas typically have better RF properties versus flush-mount receivers. People and objects in the room also reduce range. The generally standard range of "30 m / 100 ft in buildings" should be viewed in a differential manner dues to the numerous influences. Planning for reserves in the range is necessary to achieve a reliable function of the RF system, even under unfavorable conditions.

Robust and reliable installation in buildings is achieved by ensuring sufficient range reserves.

Practical hints

- **> 30 meter** for very good conditions: Large free space, optimum antenna installation and placement.
- **Planning security** with furniture and people in the room, through up to 5 gypsum drywall or 2 brick/aerated concrete:
  - **> 20 m / 66 ft** for transmitters and receivers with solid antenna execution and positioning.
  - **> 10 m / 33 ft** for received installed in the room wall or corner. Or small receives with internal antennas. Also together with switches on or wire antenna near metal. Or narrow hallway.
- Vertical through 1-2 room corners depending on fixtures and antenna execution.
- Learning by EnOcean devices can greatly increase availability. A receiver can work with multiple, received signals.

RF signal shielding

Metal surfaces reflect electromagnetic waves, e.g. metal partitions and metal ceilings, massive steel reinforcement in the concrete walls and metal foils from insulation. Creating RF shading in a "silent zone". Individual, thin metal strips have little impact, for example, strips in a gypsum drywall.

Metal surfaces

Mounting a transmitter directly on a metal surface (e.g. panel doors, steel door frames) prevent the free transmission of the RF signal. This may impact RF connection or even cause a loss of connection. Functions are only possible as an exception for a device mounted in this manner and cannot be guaranteed accordingly.

Metal partitions

Sometimes, RF technology does work with metal room partitions. The signals are reflected: Metal and concrete walls reflect RF waves. RF waves penetrate to neighboring hallways or rooms through opening, e.g. a wood door or glass partition. The range can be significantly reduced based on the specific local conditions. An additional repeater in the right place is an easy way to provide and alternative RF path.
An EnOcean RF signal can be amplified at most two times by a repeater.

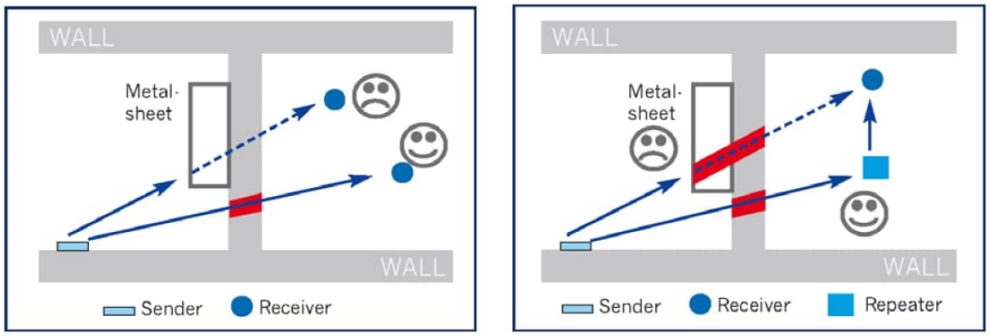
Factors reducing range

- Metal partitions or hallow walls with insulation on metal foil.
- Suspending ceilings with panels made of metal or carbon fibers.
- Steel furniture or glass with metal coating.
- Mounting the switch on a metal wall (typically results in a loss of 30% in range).
- User of metal switch frames (typically results in a loss of 30% in range).

Fire protection walls, elevator shafts, stairwells and supply areas should be considered shielding.

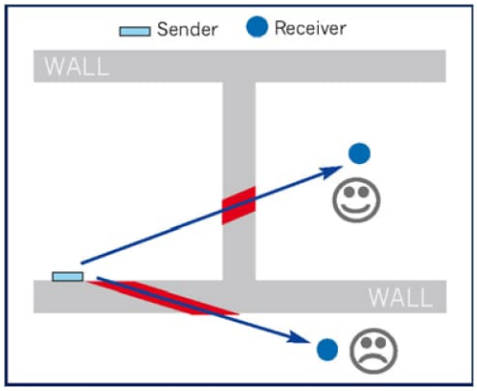
Solution

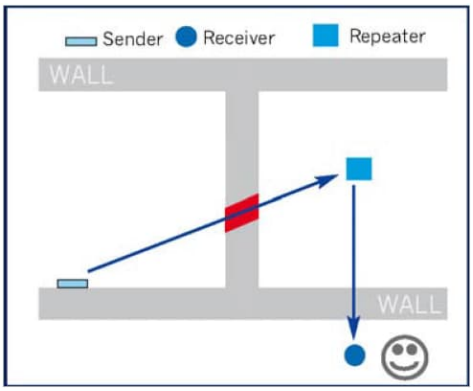
You can eliminate shielding by repositioning the transmitter and/or receiver antenna from the silent zone or using a repeater.



Penetration angle

The angle at which a transmitted signal hits the wall plays an important role. The effective wall strength and thus the dampening of the signal depends on the angle. The signals should run vertical to the walls as much as possible. Avoid wall recesses as much as possible.



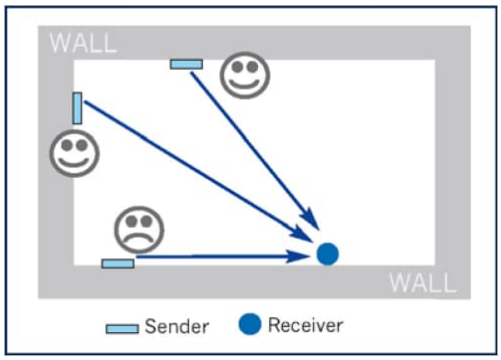


Solution

Eliminate excessively flat penetration angles by repositioning the transmitter and/or receiver antenna or use a repeater.

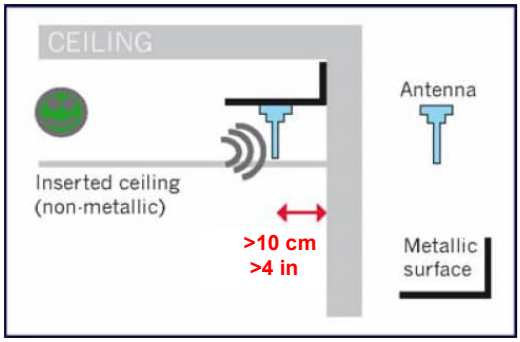
Mounting the antenna

Do not mount the receiver antenna or a receiver with internal antenna on the same wall as the transmitter. RF waves are subject to disruptive refraction or reflection near walls. It is better to mount the receiver on the next or opposite wall. The antenna for devices with featuring external antennas should be mounted in a centralized location in the room. Where possible, the antenna should be at least 10 cm from corners or cement ceilings.



Tip Avoid RF transmission along wall surfaces (e.g. in a long hallway as well).

The ideal mounting location of the receiver's antenna is a central location in the room. "Magnetic foot antenna" (e.g. Hirschmann MCA 1890 MH) must attach to a large a metal surface as possible to provide a sufficient counter polarity. For example, mounting the antenna on a ventilation duct. Conversely, a "patch antenna" (surface antenna, e.g. HAMA MiniPlanar 38499) must be mounted in a non-metal ceiling or drywall, for example, in a cavity wall socket of the right size (see image below). A patch antenna cannot normally be mounted directly in cement or in direct proximity to metal. One exception is the "metal patch antenna MCA 1890MP“ by the Hirschmann company. The flat antenna can be attached discretely and directly to a metal ceiling.
For additional details on selected suitable plugs, please refer to the application note "AN103 External Antennas" by EnOcean.



Mounting magnetic foot antenna



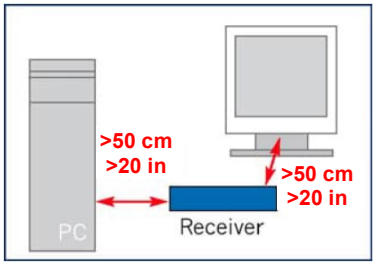
Mounting patch antenna

Tip When laying the antenna cable it is important not to bend the cable, causing irreparable damage (reduction in performance caused by a change to wave resistance).

A "active antenna" is a RF receiver with integrated antenna. It communicates with an actuator unit, for example, via a simply RS485 cable (RS485 Gateway). So that no shielded antenna is required that suffers from reduced performance as the length increases and that can be bent during installation.

Distances from receive to other sources of interference

EnOcean **transmitters** can be placed next to any transmitter without a problem. Conversely, the distance from the EnOcean **receiver** to other transmitters (e.g. GSM / DECT / Wireless LAN) and high frequency sources of interference (computer, audio and video systems) must be at least 50 cm.



The distance of the EnOcean receiver to other high frequency transmitters should be at least 50 cm / 20 in.

The transmitter position is non-critical.

Repeaters

Repeaters (i.e. amplifiers) can help overcome problems with reception quality. The EnOcean repeater requires no configuring (e.g. self-learning). Simply connect to the supply voltage to commission. The Sections on "Shielding" and "Penetration" include illustration on possible deployment.

Tip Post-installation of repeaters should be considered (electrical connection) during planning for unfavorable situations. Too many repeaters is counter-productive (higher costs, collision of telegrams).

EnOcean repeaters cannot be cascaded in their "1-level" basic function, previously repeated telegrams will not be repeated again. Repeaters switchable to 2-level function do allow for cascading via two repeaters. But it should only be used under exceptional building-technical cases.

Field strength measuring equipment

Off-the-shelf field strength measures devices that easily find the best mounting locations for transmitter and receiver. Faulty connection from previously installed devices can also be reviewed. The RF telegrams and disruptive RF signals are displayed in the relevant frequency range.

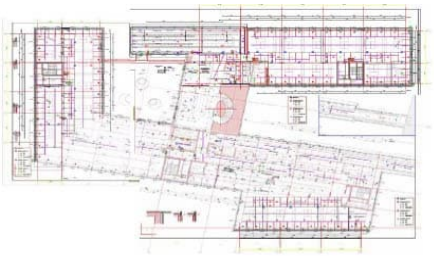
Additional information available at: http://www.enocean-alliance.org/de/home.

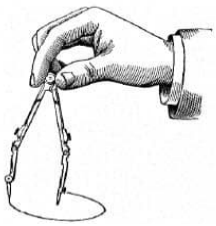
15.6 Range planning

RF range is typically limited by fire protection walls that are considered shielding. Within fire protection areas, light walls or glass partitions with solid RF properties are often used. Avoid metal reinforcement or metalized glass!.

The following diagrams illustrate how to implement a reliable RF plan in three steps.

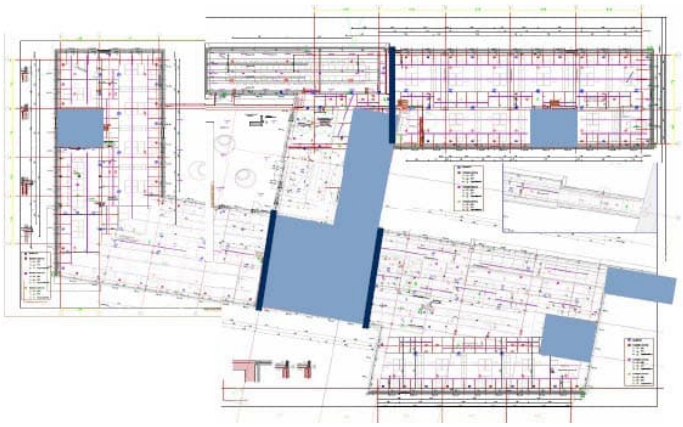
STEP 1: Floor plan and compass





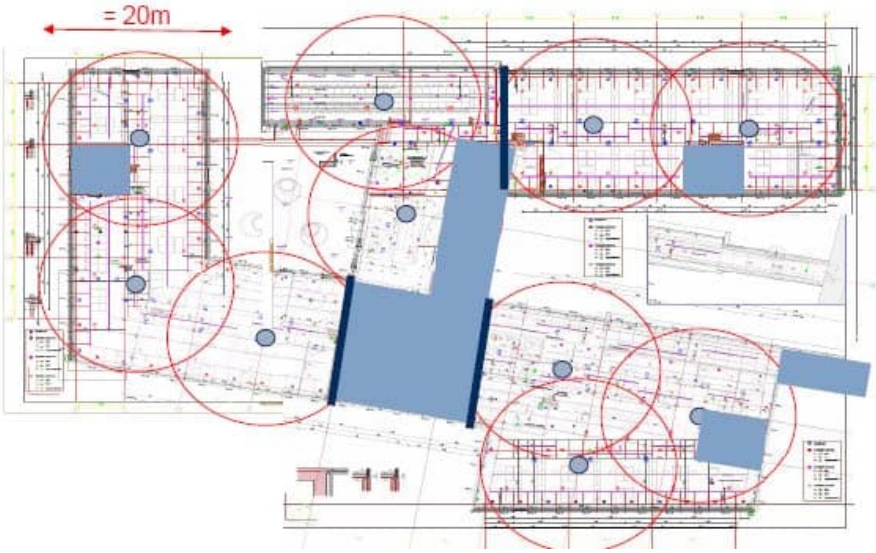
STEP 2: Draw relevant RF shielding on the floor plan

- Fire protection walls
- Elevator shafts, stairwells and other supply areas



STEP 3:
Draw range circles

- The center of the circle represents the ideal position for RF gateways.
- This allows for a shield-free connection in all corners of the fire protection section (possible sensor positions).



Real-world experience suggests that unfavorable conditions and shortcomings are commonplace. Planning at 10-12 meter radiuses provide a high level of security; against future changes to environmental changes as well (light walls, furniture, personnel in the room, etc.). One meter either way for the gateway position is not an issue due to reserves, even later.

A very robust RF system can be achieved by implementing a redundant RF reception path. This can be accomplished by programming neighboring RF gateways for parallel reception of the RF transmitter.

Even if carefully planned, the field strength measuring device should be used on site to test ranges. Unfavorable conditions can be improved through more suitable re-positioning of the devices or through the use of a repeater.

15.7 Troubleshooting

Trouble free operation of the devices is normally guaranteed if you follow all the notes on the selection of mounting locations for transmitters and receivers. The following overview of potential problems may help should problems nevertheless arise:

Transmitter is not received

Check with EPM100	Possible cause and solution
In close proximity to the transmitter (distance approx. 20-50 cm / 10-20 in), the EPM 100 does not receive any transmission telegrams. Trigger transmission telegram, the LED HI is unlit on the EPM.	**Transmitter is not transmitting.** Check transmitter: Solar-powered transmitter is supplied with sufficient light as applicable (for quick function test, briefly expose the device to daylight or under a bright lamp).
In close proximity to the receiver (approx. 20-50 cm / 10-20 in), the EPM 100 does not receive any transmission telegrams. Trigger transmitter telegram, the corresponding LO/HI LED is unlit on EPM (HI for flush-mounted receiver, LO for receiver with external antenna).	**Transmitter mounted beyond the receiver range (or the transmitter was removed in the meantime).** Change the mounting location for the transmitter or receiver, or use repeater. Comply with notes in Section 1.
In close proximity to the receiver (approx. 20-50 cm / 10-20 in), the EPM 100 has solid reception of the transmitter telegram. Trigger transmission telegram, the LED HI is lit on the EPM.	**a) Transmitter did not learn or incorrectly learned.** Have receiver self-learn the transmitter. **b) Receiver is not receiving.** Check receiver, as needed, the receiver antenna and cabling for antenna cable as well.
Invalid EnOcean telegrams are permanently received. One of the two LO/HI LEDs is continuously lit on EPM 100, but not the VALID LED.	**a) High-frequency disruptions in the vicinity of the receiver.** Remove sources of interference (PC, wireless phone, etc., at least 50 cm from EnOcean receiver). **b) Jammer (continuous transmission).** Eliminate jammer.

	Check with EPM100	Possible cause and solution
Transmitter is occasionally not received	**In close proximity to the receiver antenna (distance approx. 20-50 cm / 10-20 in), the EPM 100 receives transmitter telegram at the limits.** Trigger transmission telegram, the corresponding LO/HI LED is unlit on the EPM. (HI for flush-mount receiver; LO for receiver with external antenna).	**a) Transmitter is within the limits of the transmitter.** Move the transmitter or receiver antenna or use a repeater. Comply with notes in Section 1. **b) Transmitter not installed where expected (or incorrectly assigned transmitter/receiver).** Properly assign transmitter. **c) Transmitter mounting location changes on occasion (e.g. not tightly attached).** Move the mounting location of the transmitter within the receiver range.
	In close proximity to the receiver antenna (distance approx. 20-50 cm / 10-20 in), the EPM 100 has solid reception of the transmitter telegram.	**Receiver is not receiving.** Check receiver, as needed, the receiver antenna and cabling for antenna cable as well.
	Invalid EnOcean telegrams are occasionally received. One of the two LO/HI LEDs is occasionally lit on EPM 100, but not the VALID LED.	**Jammer exists.** Eliminate jammer.

15.8 Commissioning RF link

For operation, the connection to the gateway must first be set up. See data sheet N1661 (Gateway EnOcean/LonWorks) or N1662 (Gateway EnOcean/KNX).

Send "Init" telegrams

The LEARN button is located on the lower section of the housing below the battery. Press this button to create and immediately send a complete learning telegram. The current switching status of LEARN – pressed – is also transmitted.

If the corresponding receiver is being configured, the information helps assign a specific output channel to the sender.



LEARN button

This procedure is referred to as "learning". A normal telegram does not initiate this procedure.

Repeat the procedure if you want to assign **several output channels** to one sender.

Simple function check

The LEARN button allows for a simple function and range test. **Make sure the room device was charged sufficiently prior to testing.**

Depending on receiver type and configuration, an LED indicates if the receiver finds the LEARN button was pressed on a learned room device. No acknowledgement occurs if the telegram is not received completely. Possible causes: Distance too great or unfavorable mounting location with too many interference sources within the radio link.

Off-the-shelf field strength measures devices that easily find the best mounting locations for transmitter and receiver.

Additional information available at: http://www.enocean-alliance.org/de/home.

15.9 Gateways

Wireless room units together with a gateway (EnOcean/KNX) can be used with all controllers on a KNX network.

EnOcean gateways

Type	Stock number	Name
RXZ97.1/KNX	S55842-Z101	Gateway EnOcean/KNX

Engineering KNX LONWORKS page

See description of the gateway datasheet.

16 Disposal



The device is considered an electronic device for disposal in accordance with the European Guidelines and may not be disposed of as domestic garbage.

- Dispose of the device through channels provided for this purpose.
- Comply with all local and currently applicable laws and regulations.

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