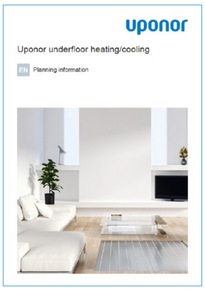
Uponor underfloor heating/cooling

EN Planning information

Technical information
Uponor floor systems

General information



Planning information for underfloor heating and cooling

Forms

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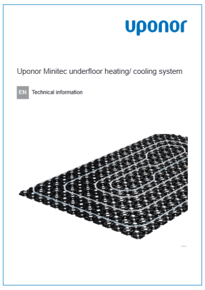
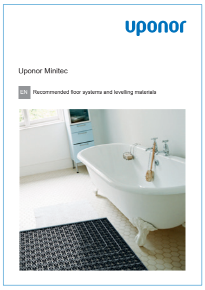
Uponor housing construction floor systems



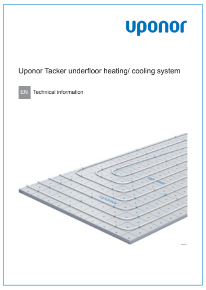
Uponor Minitec
Low profile system



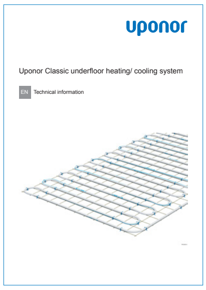
Uponor Minitec
Floor systems and levelling materials

Uponor Tecto
Wet installation system

Uponor Nubos
Wet installation system

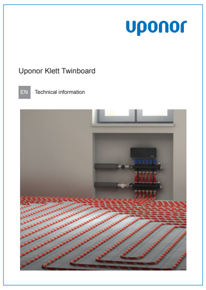


Uponor Tacker
Wet installation system

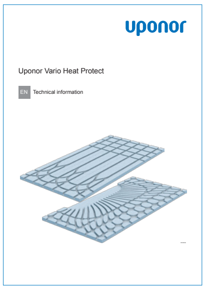


Uponor Classic
Wet installation system

Uponor Klett
Wet installation system



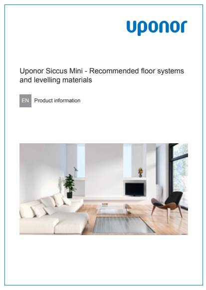
Uponor Klett Twinboard
Wet installation system



Uponor Vario Heat Protect
Wet installation system

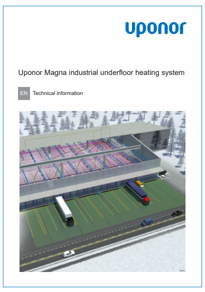
Uponor Siccus
Dry installation system

Uponor Siccus Mini
Dry installation system



Uponor Siccus Mini
Adhesive overview

Uponor floor systems special solutions



Uponor Magna
Industrial floor heating

Uponor Contec
Concrete core activation

Uponor solutions
Underfloor heating and cooling

	Installation type	System panel thickness [mm]	Mini-mum in-stallation height [mm]	**System name**	Description	**Corresponding system pipes**	Di-men-sion [mm]
WET INSTALLATION	Self-adhesive nub panel	—	**≥ 15 ****	**Uponor Minitec**	Very low construction height, directly on old substrate (screed, tiles, wood)	Comfort Pipe	9,9
	System panels for standard housing construction	DES 25-2 30-2 30-3 35-3 WLS032 25-2	**≥ 74**	**Uponor Klett**	Hook-and-loop connection of system panel and pipe. Fastest way to lay, no damage to the screed foil	Klett Comfort Pipe PLUS Klett MLCP RED	14, 16 16
	Hook-and-loop system on on-site insulation	3	**≥ 52**	**Uponor Klett Twinboard**	Hook-and-loop installation on existing insulation on site using 3 mm hollow-chamber panels	Klett Comfort Pipe PLUS Klett MLCP RED	14, 16 16
	Hook-and-loop system incl. mineral wool insulation	30	**≥ 79**	**Uponor Klett Silent**	Hook-and-loop installation on mineral wool panels	Klett Comfort Pipe PLUS Klett MLCP RED	14, 16 16
	System panel for underfloor heating connection pipes below the heat protec-tion layer	32	**≥ 74**	**Uponor Vario Heat Protect**	Covered with Klett Twinboard to prevent overheating in hallways	All piping to the manifold	
	Nub panel	11 or 30-2	**≥ 68**	**Uponor Tecto**	Quick pipe installation, system panels for floor parti-tions, secure grip	Comfort Pipe PLUS Blue Comfort Pipe PLUS MLCP RED	16 14, 17 14, 16
	Nub panel Nub foil	11 or 30-2 –	**≥ 64** **≥ 53**	**Uponor Nubos**	Easy to use, standard-compli-ant installation spacing, free choice of insulation layer (nub foil only)	Comfort Pipe PLUS Blue Comfort Pipe Comfort Pipe PLUS MLCP RED	16 16 14 14, 16
	Steel mesh with clip	—	**≥ 57**	**Uponor Classic**	Free choice of insulation layer. High impact sound improve-ment with mineral wool. Clear separation of trades between screed/heating	Comfort Pipe PLUS Blue Comfort Pipe PLUS Magna Pipe PLUS	16, 20 17 20
	Tacker and U-pro-files	EPS DEO 20, 30 DES 20-2, 30-2, 30-3, 35-3, 40-3	**≥ 69**	**Uponor Tacker**	The most economical solution. Various heat/impact sound insulation layers are available	Comfort Pipe PLUS Blue Comfort Pipe MLCP RED	16 16 14, 16
DRY INSTALLATION	Pre-formed EPS panels and aluminium heat emission plates	25	**≥ 43**	**Uponor Siccus 14**	Can be used immediately, fast installation progress	Comfort Pipe PLUS MLCP RED	14 14
	Pre-formed XPS panels with full-surface aluminium heat distribution layer	15	**≥ 15**	**Uponor Siccus Mini**	Low weight, usable immediate-ly, very low construction height	Comfort Pipe	9,9

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Planning information for warm water underfloor heating/cooling

Thermal insulation requirements for underfloor heating

The following regulations and standards must be applied with regard to the thermal insulation of surface heating:

- GEG – heat protection of surface heating in the building envelope or in components that are adjacent to rooms with significantly lower temperatures.
- DIN EN 1264 – heat protection of surface heating in general and as a supplement to the GEG of surface heating in components that separate rooms of approximately the same temperature.

The thermal insulation regulations for surface heating apply to floor, wall and ceiling heating.

Thermal insulation requirements obeying GEG

Thermal insulation requirements for building components apply independently of the heating system, so that surface heating does not require higher heat protection requirements.

Residential building (new construction)

The requirements for the structural heat protection of newly constructed residential buildings are regulated in Part 2, S 16 "Structural heat insulation" with reference to Appendix 1 (to S 15(1)) (see table extract below).

S 16 Structural heat insulation
(extract)
A residential building to be constructed shall be constructed in such a way that the maximum value of the specific transmission heat loss relating to the heat transmission area does not exceed 1,0 times the corresponding value of the respective reference building according to S 15, paragraph 1.

Technical design of the reference building (residential building)
Extract from Appendix 1 (to S 15 Paragraph 1)

Line	Components/systems	Reference version/value (unit of measure) Property (regarding points 1.1 to 1.3)	
1.1	Exterior wall (including fittings such as roller shutters), ceiling against outside air	Heat transfer coefficient	U = 0,28 W/(m² K)
1.2	Exterior wall against ground, floor slab, walls and ceilings to unheated rooms	Heat transfer coefficient	U = 0,35 W/(m² K)
1.3	Roof, top floor ceiling, walls to sides	Heat transfer coefficient	U = 0,20 W/(m² K)

Thermal insulation requirements obeying DIN EN 1264

Surface heating, which is neither integrated into the external envelope of the building nor into components between rooms of very different temperatures, is not subject to the GEG in terms of thermal insulation.

However, the "Underfloor heating standard" DIN EN 1264 contains information on the choice of thermal insulation for surface heating to achieve the greatest possible transmission heat flow to the room used.

DIN EN 1264 has been created based on considerations regarding the traditional underfloor heating system and contains in some cases limited correlation to a "Floor – heating system". However, the specified minimum thermal conductivity must also be applied to wall and ceiling heating.
The standard points out that national building regulations may require higher insulation values. In this context, the requirements of the GEG described above apply to rooms heated either without interruption or with interruptions, and rooms directly on the substrate.

Minimum thermal conductivity of the insulation layers (m^2K/W) under the underfloor heating obeying DIN EN 1264, Table 1

		Thermal conductivity [m^2K/W]
Heated room below or adjacent		0,75
Unheated or intermittently heated room below or directly located on the ground[1]		1,25
Ambient air temperature in the lower or adjacent area:		
Design outdoor temperature	$\delta_d \geq 0$ °C	1,25
Design outdoor temperature	0 °C $\geq \delta_d \geq$ -5 °C	1,50
Design outdoor temperature	-5 °C > $\delta_d \geq$ -15 °C	2,00

[1] For a groundwater level ≤ 5 m, a higher value should be applied.

For other heated or cooled areas, the minimum required insulation values must be the maximum energy losses, taking into account the type of adjacent room and the design temperature level.

Design variants of all Uponor floor heating systems at this value are shown throughout this document.

Non-residential buildings (new construction)

The requirements for structural heat protection in newly constructed non-residential buildings are regulated in the GEG, Part 2, S 19, "Structural heat protection" with reference to Appendix 3 (see table).

S 19 Structural heat protection
(extract)
A non-residential building is to be constructed in such a way that the maximum values of the average heat transfer coefficients of the heat-bearing surface of Appendix 3 are not exceeded.

Appendix 3 contains values for opaque (i.e. non-transparent) components in Line 1. This includes the base slab of non-residential buildings that borders the ground.

When calculating the average value of the component concerned, the components must be taken into account in accordance with their surface area. The heat transfer coefficients of components against unheated spaces (except roof rooms) or soil must also be weighted by a factor of 0,5.

When calculating the average value of the floor slabs adjacent to the ground, areas more than five metres from the outer edge of the building are not taken into account.

The calculation must be carried out separately for zones with different room target temperatures in the case of heating.

It is possible to provide a vertical perimeter insulation instead of an insulation which is located underneath the floor slab. In DIN V 18599-2, Table 5, an energy equivalence is approximate if a 2 m high, vertically arranged insulation with the same heat transfer resistance is installed instead of the 5 m horizontal arrangement of an insulation layer.

Maximum values of the average heat transfer coefficients of the heat transfer area (non-residential buildings) Appendix 3, Line 1 (to S 19)

Line	Components	Maximum values of the average values of the heat transfer coefficients	
		Zones with room target temperatures in case of heating ≥ 19 °C.	Zones with room target temperatures in case of heating from 12 to < 19 °C.
1	Opaque outer components, unless included in components of points 3 and 4	U = 0,28 W/(m² K)	0,50 W/(m² K)

Existing building (installation, renovation, modification)

The requirements for structural heat protection in the event of changes to existing buildings are regulated in GEG, Part 1, S 48, with reference to Appendix 7 (see table).

S 48 Requirement for an existing building upon modification (extract)
Where, in the case of heated or cooled rooms of a building, outer components (against ground) as defined in Appendix 7 are replaced or installed for the first time, these measures shall be carried out in such a way that the surfaces of the outer component concerned do not exceed the heat transfer coefficients of Appendix 7. Except for changes in outer components which do not affect more than 10 percent of the total area of the respective component group of the building.

Reduced insulation requirements for technical reasons

Technical reasons (e.g. floor construction height)

If measures are carried out in accordance with point 6c and the insulation layer thickness is limited for technical reasons within the scope of these measures, the requirements shall be deemed to be fulfilled if the maximum insulation layer thickness possible according to recognised rules of the technology is installed, whereby a rated value of the thermal conductivity of λ = 0,035 W/(m•K) must be observed.

Requirements for single-room control

S 63 Room-by-room temperature control
If a heating system with water as a heat transfer medium is installed in a building, the developer
or owner shall ensure that the heating system is a self-acting room temperature control device (this requirement is fulfilled, for example, by the Uponor Smatrix single room control).

Exceptions

1. For room utilisation areas < 6 m², room-by-room control can be omitted.
2. An underfloor heating system installed before 1 February, 2002 may be equipped with a device to adapt the heat output to the heat load in a room-by-room manner (possibly an Uponor zone valve).
3. In the case of heating systems built after 1 February, 2002 and which do not have a single-room control, this must be retrofitted.

Maximum heat transfer coefficients of external components when changing existing buildings (Residential building/non-residential building) Annex 7 (to S 48) (extract)

Point	Renewal, replacement or initial installation of outer components	Residential buildings and areas of non-residential buildings with room target temperatures of at least 19 °C	Zones of non-residential buildings with room target temperatures from 12 to < 19 °C.
		Maximum values of heat transfer coefficients $U_{max.}$	
	Component group: Walls against ground or unheated rooms (except roof rooms) and ceilings down against ground, outside air or unheated rooms		
6c	Ceilings that separate heated rooms down to ground, outside air or unheated rooms: - Construction or renovation of floor structures on the heated side	U = 0,50 W/(m² K)	No request

Architectural monuments
Particularly valuable building structures, such as architectural monuments, are excluded from the requirements of the GEG under certain conditions.

S 105 Architectural monuments and other particularly valuable building structure
(extract)
If, in the case of a building monument, in the case of building substance which is particularly protected under federal or state law or in the case of other particularly valuable building structures, the fulfilment of the requirements of this law affects the structure or appearance or other measures result in a disproportionate effort, it may be derogated from the requirements of this law.

S 102 Exemptions (extract)

(1) The authorities responsible under federal state law shall, at the request of the owner or developer, exempt the owner or developer from the requirements of this law, insofar as

1. the objectives of this law are achieved to the same extent by measures other than those provided for in this law or
2. the requirements in individual cases, due to special circumstances, result in undue effort or in any other way undue hardship.

In particular, there is undue hardship when the necessary expenditure cannot be balanced

- by the savings that occur within the normal useful life.
- if requirements relate to existing buildings, by the savings that occur within a reasonable period of time.

This means that the necessary investments are not proportionate to the return. There is also undue hardship when the necessary investments are not proportionate to the value of the building. In this respect, taking into account the objective of this law, the expected price developments for energy, including the prices for greenhouse gases under European and national emissions trading, must be taken into account. There is also undue hardship if due to special personal circumstances the fulfilment of the requirements of the law is not reasonable.

Economic inefficiency of GEG measures

For measures prescribed in the course of the renovation of an old building by GEG, an exemption of the implementation obligation may be obtained in individual cases in three ways.

1. Exemption, insofar as legal requirements lead to an undue hardship.
2. Exemption in the event that the objectives of the law are achieved to the same extent by measures other than those provided for in this law.
3. There is also undue hardship if due to special personal circumstances the fulfilment of the requirements of the law is not reasonable.

Legal basis of economic efficiency

Obeying S 5 of the GEG, the requirements and obligations laid down in this law and in the legal regulations adopted pursuant to this law shall be governed by the principle of economic efficiency.

S 5 Principle of economic efficiency (extract)

The requirements and obligations laid down in this law or in the legal regulations adopted pursuant to this law must be state-of-the-art and economically justifiable for buildings of the same type and use and for installations or facilities.

Requirements and obligations are considered economically justifiable if generally the necessary expenses can be generated within the normal useful life by the resulting savings. For existing buildings, equipment and facilities, the expected useful life must be taken into account.

Company declaration for measures implemented

Obeying S 96, those professionals who carry out business work on or in existing buildings must confirm in writing to the owner immediately after completion of the work that the construction or installation components they have modified or installed meet the requirements of the GEG (company declaration). With the company declaration, the experts concerned fulfil their obligation to provide evidence in accordance with the GEG.

The following work on the building requires this private proof (extract):

- Modification of outer components
- Insulation of top floor ceilings
- Installation of central heating systems
- Equipment of central heating systems with control equipment
- Installation of circulation pumps in central heating and circulation pumps in hot water systems
- First-time installation, replacement or thermal insulation of heat distribution piping and hot water pipes as well as cold distribution and cold water pipes.
- Installation of air conditioning and room air systems

The company declaration must be kept by the owner for at least ten years and must be submitted to the competent authority under federal state law on request.

Continuous heating circuit supply lines in corridors and through rooms

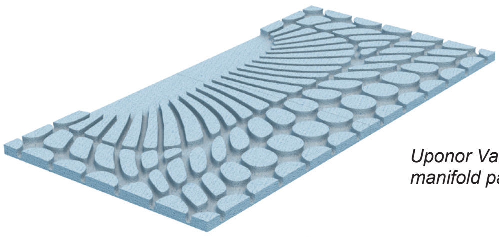
Uncontrolled heat output

Especially in the connection area in front of the manifold, the heat output of heating circuit supply lines is particularly high due to the tight installation distance. This concentration in a confined space leads to a higher surface temperature and, under certain circumstances, an unacceptable rise in the upper floor temperature or to high room temperatures in the affected room. However, supply lines that run through a hallway from the central heating circuit manifold to the connected heating circuits, for example, also contribute to an uncontrolled, non-controllable heat output to the respective room. This can cause the following problems:

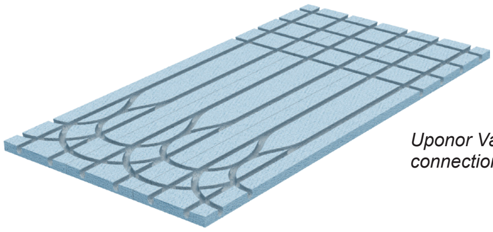
- The single-room control required in accordance with S 63 GEG for rooms > 6 m^2 cannot be implemented because there is no space for a separate heating circuit in the room.
- The room temperature in the affected room is either too high or too low.
- The permissible surface temperature is exceeded, which can lead to damage to the upper surface and physiological impairment of the room user.
- The affected room can become unusable due to the over-temperature for the intended use (e.g. storeroom).

Heat-insulated supply pipe guide with Uponor Vario Heat Protect

Uponor Vario Heat Protect is a laying system for underfloor heating connecting pipes to prevent uncontrolled overheated hallways and passages. It also ensures that the maximum surface temperatures in rooms where heating circuit distributors are installed are not exceeded. Two different insulation plates with integrated pipe guides are available for installation in front of the manifold and for the supply routing in the room. The elements are laid beneath the heating layer and covered with Uponor Klett Twinboard elements. The supply pipes are routed to the heating level in the transition area to the individual heating circuits in the adjacent rooms.



Uponor Vario Heat Protect manifold panel



Uponor Vario Heat Protect connection panel

Construction design planning (floor construction)

General

Uponor underfloor heating/cooling systems are designed for use in a wide variety of buildings and for different uses. In addition to the thermal insulation and noise protection requirements, the static requirements for floor construction must also be observed during planning. Depending on the type of use, the appropriate Uponor system must be selected. In addition, any additional insulating materials and screed thicknesses and qualities required must be planned for the respective type of use. The following table provides an overview of common payloads for different usage types.

When planning the floor construction of a surface heating system, the respective laws, regulations, guidelines, VOB (German Construction Contract Procedures) and standards must be observed.

Payloads on ceilings of different use for ceilings obeying DIN EN 1991-1-1

Category	Feature – example	Payload qk [kN/m²]	Single load Qk [kN]
A	**Living spaces**	2,0	2,0
	- Rooms in residential buildings and houses, ward and hospital rooms, rooms in hotels and hostels, kitchens, toilets.		
B	Office spaces	3,0	4,5
C	**Crowded areas**		
C1	- Areas with tables etc., e.g. in schools, cafés, restaurants, dining rooms, reading rooms, reception rooms.	3,0	4,0
C2	- Fixed seating areas, e.g. in churches, theatres, cinemas, conference rooms, lecturehalls , meeting halls, waiting rooms, station waiting rooms.	4,0	4,0
C3	- Areas without obstacles to the mobility of persons, e.g. in museums, exhibition rooms etc. as well as access areas in public buildings and administrative buildings, hotels, hospitals, railway station halls.	5,0	4,0
C4	- Areas with possible physical activities of persons, e.g. dance halls, gyms, stages.	5,0	7,0
C5	- Areas with possible crowds, e.g. in buildings with public events, such as concert halls, sports halls with stands, terraces and access areas and platforms.	5,0	4,5
D	**Sales areas**		
D1	- Areas in retail stores	4,0	4,0
D2	- Areas in department stores	5,0	7,0
	Areas with possible stacking of goods including access areas		
E1	- Storage areas including storage of books and files.	7,5	7,0

Note: For areas with industrial use E2 or storage use, see DIN EN 1991-1-1 Section 6.3.2

Installation conditions

Building condition

Before the floor construction is installed, windows and exterior doors should be installed, and wall plaster and the fitting of technical installations, as well as the installation of door frames and the plaster of pipe slots, should be completed. All components adjacent to the floor must be present. The requirements of DIN 18560, Part 2, Section 5 "Building requirements" must be taken into account. In particular: Surface-mounted components for which wall-mounting is provided must be plastered to lay the insulating layers of floating screeds. Structural joints in the load-bearing substrate must not be crossed by heating elements.

Supporting substrate

The supporting substrate must be sufficiently dry and have a flat surface to accommodate the floating screed. Flatness and angle tolerances must correspond to DIN 18202. It must not have point-shaped elevations, lines, pipes, ducts or other mounting parts that can cause sound bridges and/or fluctuations in the thickness of the screed.

Installation level

If lines, pipes, ducts or other installation parts are to be laid on the supporting substrate, a separate installation level must be defined, planned and taken into account in the construction height.

If pipes are laid on the supporting substrate, they must be securely fastened. Pipe jackets must be suitable for use in floor constructions and must be sufficiently resilient. This must be ensured by the construction planning.

The installation level must be filled by a levelling layer and a flat surface must be created again to accommodate the gap free insulation layer. The construction height required for this must be considered. Refer to DIN 18560-2 for further information.

Via the height reference point for each floor to be maintained on site, it must be checked whether the intended construction height is guaranteed throughout.

Slopes

If the surface of the floating screed is to be on a slope, this must already be present in the supporting substrate so that the screed can be produced in a uniform thickness.

Building waterproofing
Components that are adjacent to the ground, i.e. floors of buildings that are not built with a basement or basement floors, must be sealed obeying DIN 18533 depending on the load. The necessity and type of this work lies in the decision-making area of the construction-above-ground trade and is, in the case of use, a structural prerequisite before the surface heating is applied. As this building waterproofing can be made with plasticiser or solvent-separating materials, a layer of Uponor Multi PE foil must be laid before the polystyreneinsulation is applied.

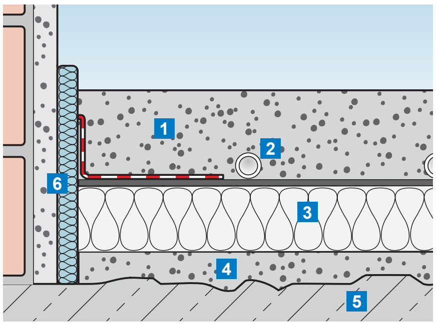
If sealing against surface water is provided on site in wet rooms (baths, showers etc.), the sealing must be carried out above the load distribution layer. This automatically protects the screed and ensures clear separation of the trades. Sealing above the screed can be done with a sealing adhesive system or a sealing coating.

Info:
Uponor Multi foil is not a seal obeying DIN 18533. However, it is a "moisture barrier with inhibiting effect". If there is a risk in a concrete ceiling of residual moisture from concrete with water diffusing, which could damage the upper surface, the Uponor PE foil may act as a diffusion inhibitor by laying it on the concrete ceiling in 2 layers to keep the remaining moisture from the floor construction to a significant extent.

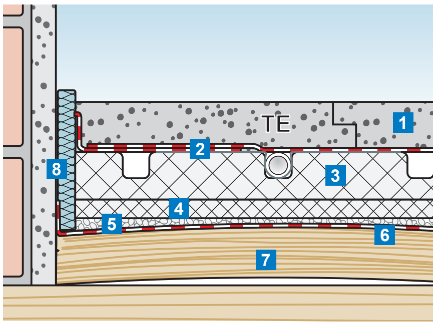
Levelling layers
If the supporting substrate does not meet the required flatness tolerances, level compensation using a suitable levelling layer is required. This requirement applies to wood and concrete ceilings in new and old buildings.

For this purpose, levelling compounds or high-speed, resin-enriched coatings are suitable on rough ceilings. The manufacturer's specifications regarding the laying readiness – residual moisture in the respective levelling layer – and information about the primers or adhesion bridges on the raw ceiling must be observed. The additional weight load must be taken into account for light ceiling constructions.

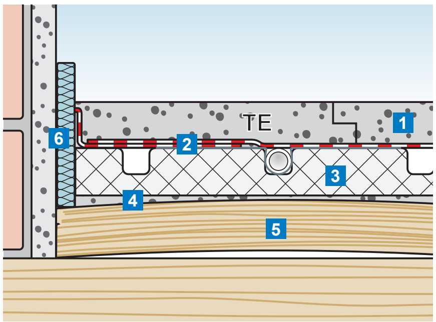
Damaged floorboards in old buildings must be repaired depending on the condition. To ensure a sufficiently stable substrate, the floorboards must be "sound", firmly fixed and capable of bearing the load. Some of the unevenness can be remedied by re-screwing the floorboards. Cracks or knot holes in the floorboards must be closed. Only then can the installation of the insulation layer or the surface heating begin. "Follow through" of the wooden floor cannot be eliminated by levelling layers or dry load distribution layers. Depending on the levelling height, the following levelling layers are possible:



Raw concrete ceiling with levelling screed (example: Uponor Klett)
1 *Load distribution layer*
2 *Uponor System pipe*
3 *Uponor Klett panel*
4 *Levelling screed*
5 *Raw concrete ceiling*
6 *Uponor Multi edging strip*



Wood ceiling with floorboards, dry insulation and cover plate (example: Uponor Siccus)
1 *Load distribution layer*
2 *PE cover foil*
3 *Uponor Siccus*
4 *Cover plate*
5 *Dry insulation*
6 *Trickle barrier*
7 *(Renovated) floorboards*
8 *Uponor Multi edging strip*



Wood ceiling with floorboards and levelling compound (example: Uponor Siccus)
1 *Load distribution layer*
2 *PE cover foil*
3 *Uponor Siccus*
4 *Levelling compound*
5 *(Renovated) floorboards*
6 *Uponor Multi edging strip*

Floor construction components

Foils

The Uponor Multi foil 0,1 mm must be used to separate the floor heating elements or additional insulation from structural seals. The 0,2 mm Uponor Multi foil is used to cover the insulation, e.g. for the Uponor Classic system.

Edging strips

Edging strips have an important function between the load distribution layer and ascending components. It forms the edge joint to ensure the following:

- Separation layer as impact sound insulation
- Absorb the thermal expansion of the load distribution layer
- Thermal insulation layer between load distribution layer and colder components

To obey DIN EN 1264-4, the edging strip must be secured against changing the position during installation. The edge joint prescribed in accordance with DIN 18560 must ensure a movement space of 5 mm for the load distribution layer. The Uponor edging strip made of polyethylene 8 mm or 10 mm with laminated foil provides this compressibility. The corresponding edging strip must be used during planning.

In the case of multi-layer insulation layers, the edging strip must be laid before the insulation layer for the sound insulation is applied, without sound insulation before the installation of the top insulation layer.
The edging strips must stand up on the supporting substrate for single-layer insulation layers.
The protruding parts of the edging strip and the raised cover may only be cut off after completion of the floor covering or, in the case of textile and elastic coverings, only after hardening of the adhesive.

Noise protection

Noise protection is calculated in accordance with DIN 4109. This also sets the minimum standard (health protection) with an $L'_{n,w,R}$ = 50 dB, which must be achieved. If comfort noise protection is to be achieved (by contractual agreement or by description of the building), DIN 4109-5, VDI 4100 level 2 or 3 or the DEGA recommendation 103 can be used as the basis for evaluation. The requirements differ depending on whether noise protection is considered in a multi-family house or in semi-detached houses or terraced houses where a higher protection requirement is assumed. Noise protection requirements can also be made in single-family houses, for example, if increased noise protection for a home office is desired.

The surface-related mass of the residential partition ceiling, the dynamic stiffness of the impact sound insulation, the thickness of the screed and the attenuation of flanking transmission by the mass of the partition walls have an influence on the calculated noise protection. A safety coefficient is added to the calculated value. The sum must not exceed the requirements specified by the standard or contract.

Thus, even when planning the building, it is necessary to coordinate the partners involved (developer, architect, planner, trade) to achieve the noise protection objectives.

For wooden construction, the component catalogue of DIN 4109 can be used.

Thermal/impact sound insulation

Compressibility/strength
In accordance with DIN 18560 Part 2, the maximum compressibility on the impact sound insulation (thickness difference) for heating screeds is 5 mm. For several layers, the compressibility of the individual layers must be summed. The compressibility of suitable, pressure-resistant thermal insulation materials must be set at the value 0 during addition. For example, for the Klett roller panel Extra, EPS DES 25-2 mm (nominal compression capacity 2 mm), the permissible payload is 5 kN/m², which means that the system can also be used for offices, treatment rooms, classrooms, exhibition and sales rooms, public houses and churches.

Arrangement of the insulation layers
If impact sound and thermal insulation materials are used together in an insulation layer, the insulation material with the lower compressibility should lie on top. If Uponor impact sound system panels are used, they can be laid throughout the entire surface above the installation level.
To produce the insulation layer, the insulation materials must be laid tightly edge to edge. Multi-layer insulation layers must be laid in such a way that the edge-to-edge joints are offset against one another. A maximum of two layers of impact sound insulation material may be used.

Important!

Only unbroken impact sound insulation can achieve a sound-absorbing effect.

Covers
Before applying the heating screed, insulation layers in accordance with DIN 18560 Part 2 shall be provided with a cover of at least 0,15 mm thick polyethylene film or another material proven to be equivalent. The individual tracks must overlap at least 80 mm at the joints, 100 mm with flow screed. Other substances or measures may also be used for coverage if a function of covering equivalent to those mentioned above is demonstrated. (e.g. Uponor Klett Twinboard).
The cover does not need to be pulled up at the edges when using the Uponor Multi edging strip, as the Uponor edging strip is covered with a laminated foil that overlaps the multi foil laid to the edge sufficiently.

In many surface systems from Uponor, such as Uponor Klett, functions for covering and sealing are already integrated into the laying panel so that additional covers are not required.

Load distribution layers

Screeds obeying DIN 18560
Screed as a load-absorbing and load-distributing panel is one of the most important components in the heated floor construction. It must have the following properties, amongst others:
- Good pipe containment for safe heat transfer
- Strength values according to DIN 18560 Part 2, Table 1 *"Nominal thickness and bending tensile strength of unheated screeds on insulating layers for various vertical payloads"*
- Adequate temperature resistance obeying DIN 18560, Part 2.

Only screeds obeying DIN 18560 are used as standard version for the Uponor surface heating, whereby the construction planning determines the respective strength class, e.g. CT F4 (cement screed) for residential and office construction at payloads up to 2 kN/m^2, with regard to subsequent use. For higher payloads, such as industrial construction, the type and strength of insulation and screed must be determined in accordance with the static requirements.

The technical information sheets "Interface coordination for surface heating and surface cooling systems in existing buildings" and "Interface coordination for surface heating and cooling systems in new buildings" are particularly helpful for coordination of the trades and offer various protocol templates.

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Cement screed (CT)
Cement screeds are screeds made from sand, water and the binder (cement) obeying the requirements of DIN 18560. Cement screeds are used in housing, industrial construction and commercial construction. They can withstand both high and low temperatures and are insensitive to moisture.

To achieve the required screed level, level using a hose level or laser. Additional processing guidelines from the respective manufacturers must be observed; this applies in particular to the planning of joint field sizes, application in damp and wet rooms and temperature resistance.

Obeying DIN EN 1264-4, functional heating is to take place at the earliest after 21 days. The setting times, drying times and heating regulations are therefore carried out obeying the manufacturer's instructions.

The screed covering above the system plate or heating pipe for a maximum surface load of ≤ 2 kN/m^2 (EL ≤ 1 kN) is only 45 mm in accordance with Table 1 of DIN 18560. With a surface load of ≤ 5 kN/m^2 (EL ≤ 4 kN), a pipe cover of 75 mm is usually specified.

Important!

During the installation of screed, the system pipes must be under operating pressure.

Anhydrite flow screed (CAF)

Anhydrite flow screeds are screeds made from anhydride binders and water, using aggregates and, if necessary, adding additives, obeying the requirements of DIN 18560. Anhydrite flow screeds are used in both residential and commercial construction. These screeds are not suitable for outdoor use.

Anhydrite flow screeds offer the advantages of quick and easy processing as well as self-levelling thanks to their high flowability. In this case, the flow screed is conveyed directly from the screed silo into the screed bay via a hose. To achieve the required screed level, level using a hose level or laser. After processing, the flow screed is processed with a buffing rod to achieve a flat surface and homogeneous screed.

Product advantage:
Due to the high thermal conductivity, optimal pipe contact and reduced pipe cover requirement, calcium sulphate flow screeds can be heated faster than conventional cement screeds. This increases living comfort and reduces energy consumption.

Additional processing guidelines from the respective manufacturers must be observed; this applies in particular to the planning of joint field sizes, application in damp and wet rooms and temperature resistance. Obeying DIN EN 1264-4, functional heating is to take place at the earliest after 7 days. However, there are already flow screeds which are heated immediately when the screed is laid. The setting times, drying times and heating regulations are therefore carried out obeying the manufacturer's instructions.

The screed covering above the system plate or heating pipe for a maximum surface load of ≤ 2 kN/m² (EL ≤ 1kN) is 35 mm in accordance with Table 1 of DIN 18560. With a surface load of ≤ 5 kN/m² (EL ≤ 4 kN), a pipe cover of 55 mm is usually specified. Depending on the strength quality, lower screed thicknesses are possible, but they must be agreed with the manufacturer (see tested Knauf/Uponor special designs).

Thin-layer heating screed systems

Tested system solutions with pipe coverings < 35 mm, e.g. with Uponor Minitec (covering min. 3 mm) and a Knauf levelling compound are not covered in DIN 18560 and thus represent a special design.
Special solutions outside DIN 18560 must be agreed separately with the developer.

Important!

- Contact the screed manufacturer for the bonding and function heating time, the thickness of the screed, the max. surface load and the joint arrangement
- Only levelling blocks that do not damage the cover foil may be used
- During the installation of screed, the system pipes must be under operating pressure.

Important!

The surface heating must be installed carefully, as even small joints allow the screed to flow through and may lead to the formation of sound bridges.

Cement-based flow screed
Cement flow screeds are cement-based. They are produced with the addition of water obeying the requirements of DIN 18560. Cement-based flow screeds are used in both residential and commercial construction. Thanks to the cement binder, they can also be used outdoors as well as in a permanent wet area.

> The surface heating must be installed carefully, as even small joints, damage or gaps in the cover foil allow the screed to flow through and thus sound bridges can form.

Similar to the anhydrides, cement-based flow screeds have the advantages of fast and easy processing as well as self-levelling. They are conveyed directly from the screed silo into the screed bay via a hose. To achieve the required screed level, level using a hose level or laser. After processing, the flow screed is processed with a buffing rod to achieve a flat surface and homogeneous screed.

Additional processing guidelines from the respective manufacturers must be observed, this applies in particular to the planning of the joint field sizes and temperature resistance. Functional heating starts at the earliest after 7 days (obeying DIN EN 1264-4). The nominal screed thickness for a maximum payload of 2 kN/m² is 45 mm in accordance with Table 1 of DIN 18560. Other screed thicknesses must be agreed with the respective cement-based flow screed manufacturer.

Dry screed
Floor panels for "dry installation" are referred to as dry screed. The panels must meet the following minimum requirements:

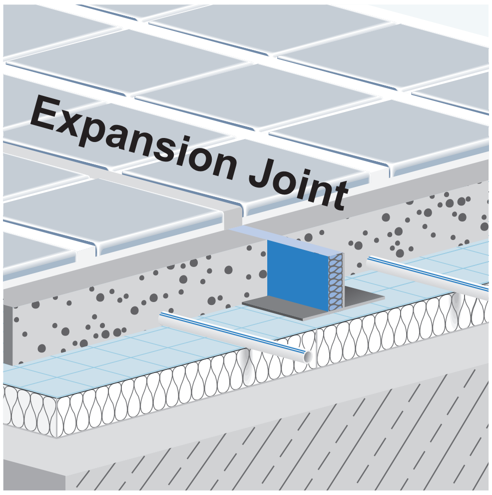
- Suitable for surface heating
- Good interconnectivity (groove and spring or rabbet edge).

If steel clips or screws are used to connect the dry screed panels, apart from bonding, care must be taken to ensure that the length of these fixing aids and the processing device are matched to the panel thickness. If the clips or screws are too long or the processing device cannot be fixed, the heating pipes could be damaged. During planning, observe the max. temperature load of the dry screed panel and ensure optimal flat support on the substructure. For example, for the Uponor Siccus dry system, pipe spacing must not exceed 50 mm for cut connecting pipes.

Joint technology

DIN 18560 "Screeds in building construction" distinguishes:

Expansion joints are joints in the screed that completely separate it up to the insulating layer. Expansion joints should only be crossed by heating circuit pipes in one level. At this point, the Uponor floor heating pipes must be fitted with a 300 mm long protection sleeve made of elastic material, which allows vertical movement of ± 3 mm (DIN EN 1264).



Form of an expansion joint (example: Uponor Klett).

Suitable expansion joint profiles must be used to ensure the functionality of the expansion joint. The joint width shall be determined by the construction planner together with the joint plan in accordance with DIN 18560 Part 2 and submitted to the contractor as part of the service description.

Normally, expansion joints must be arranged in door jambs and passageways. However, the arrangement of the expansion joint also depends on the geometric form of the space. The thermal elongation of a cement screed is approx. 0,012 mm/mK.

Info (DIN 18560-2):
A joint plan must be created using the arrangement of the joints, which can be used to determine the type and arrangement of the joints. The joint plan must be drawn up by the construction works planner and submitted to the contractor as part of the service description.

The general rules of technology and the technical information and leaflets of the trade associations must be taken into account when arranging the joints.

In the case of calcium sulphate screeds, the arrangement of expansion joints must be discussed with the manufacturer. With ceramic coverings, the expansion joints hold special importance. The decisive factor is that the expansion joints run the same way in all layers above the cover.

Edge joints are joints that separate the screed from the walls, columns, stairs etc. The edging strip must allow space for movement of 5 mm! All expansion and edge joints must be sealed with suitable elastic material after the floor covering work has been completed.

Dummy joints (furrow) for wet screeds can be arranged to further divide the screed bays divided by the expansion joints. They may not be cut more than one third of the thickness of the screed, avoiding damage to the heating pipes. The arrangement is usually carried out
wherever expansion joints are not required, but possible stresses in the installation plate are to be derived into these setpoint breakpoints. These joints and other possible cracks are closed after the curing phase and the initial heating of the screed, e.g. by filling with resin.

Screed humidity and measuring points for heating screeds obeying DIN 18560-2

The arrangement of the measuring points must be indicated by the heating planner in the plan. It depends on the largest thickness of the screed, the most unfavourable ventilation conditions in the room and the lowest surface power of the heating. Observing the conditions on site, the prescribed location must be checked by the installer of the insulation layer, marked by the installer of the heating and adopted by the installer of the screed. At least one measuring point must be marked for each room, with larger rooms (> 50 m²) correspondingly more. For larger areas, three measuring points must be provided for each 200 m². There must be no heating pipe around the measuring point at a distance of 10 cm (diameter 20 cm).

Prior to the definitive measurement of the screed moisture level with the CM device, we recommended that you check the humidity with a foil or electronic measuring device to avoid unnecessary CM measurements.

The measurements of the screed moisture with the CM device by the installer of the floor covering for determining the maturity for laying should only be carried out at the specified measuring points.

Functional heating

Calcium sulphate and cement screeds must be heated before laying the floor coverings in accordance with DIN EN 1264, Part 4. As with unheated screeds, it is the responsibility of the flooring company to check the maturity for laying as part of its test in accordance with VOB (German Construction Contract Procedures) Part C, DIN 18365 "Floor laying works" Section 3.1.1 before starting work. The start of the functional heating process depends on the load distribution layer used. In standard cases, the functional heating time is at least 7 days. Functional heating protocols and instructions are available online at the Uponor Download Centre.

Important!
The function heating process is used for the function test obeying VOB DIN 18380 and not for drying out the screed to maturity for laying!

If necessary, the ready-for-laying heating must be ordered separately.

Floor coverings

The following types of floor coverings can be laid on Uponor surface heating/cooling systems if a maximum thermal resistivity of $R_{\lambda,B} \leq 0{,}15$ m²K/W is observed and approved by the manufacturer (corresponding marking):

- Textile coverings (carpeted floor)
- Elastic coverings (PVC floor)
- Parquet and laminate flooring
- Ceramic tiles and panels
- Natural stone
- Concrete stone

A solid adhesive base on the surface of the screed is the prerequisite for a long-lasting function of the upper floors. Surface areas with sand-off or tail cracks must be renovated. Before laying the floor coverings, the special installation conditions for the coverings must be observed. The tile adhesives for stone and ceramic coverings, which are introduced in the thin bed method, must be suitable for surface heating and for the selected load distribution layer. In the thick bed method, the adhesive thickness must be selected depending on the covering. For floating parquet and laminate coverings, the surface, any air layers and additional carpets must be included for maximum thermal resistivity.
In principle, the screed must be heated up before the covering is laid ("Function and ready-for-laying heating"). Before starting the installation, switch off the heating or reduce the flow temperature so that the surface temperature of the screed does not exceed 15 to 18 °C.
Only materials designated by the manufacturer as "suitable for underfloor heating" and resistant to heat ageing may be used as base materials, putty and adhesives. These materials must be resistant to a continuous temperature load of 50 °C. If the screed is also to be used for cooling, the adhesives and floor covering must be suitable for the purpose.

Thermal resistivity of the floor covering
The thermal resistivity of the floor covering depends on the nature of the selected material and can be found in the manufacturer's documentation.

Reference values of some thermal conductivities	
Carpet	Approx. 0,06–0,15 m²K/W
Parquet	Approx. 0,04–0,11 m²K/W
PVC	Approx. 0,025 m²K/W
Tiles, marble	Approx. 0,01–0,02 m²K/W

If parquet, PVC or stone floors are partially covered with rugs, the average thermal resistivity $R_{\lambda,B}$ must be determined observing the area components:

$$\mathbf{R_{\lambda,B} = \frac{[(A_{Ges} - A_B) \cdot R_{\lambda,O} + A_B \cdot (R_{\lambda,O} + R_{\lambda,T})]}{A_{Ges}}}$$

$R_{\lambda,O}$ = thermal resistivity without carpet
$R_{\lambda,T}$ = thermal resistivity with carpet
$R_{\lambda,B}$ = average thermal resistivity
A_B = covering area
A_{Ges} = total area

Example:
25 m² tiles $R_{\lambda,O}$ = 0,02 m²K/W,
Covered with 8 m² of carpet.

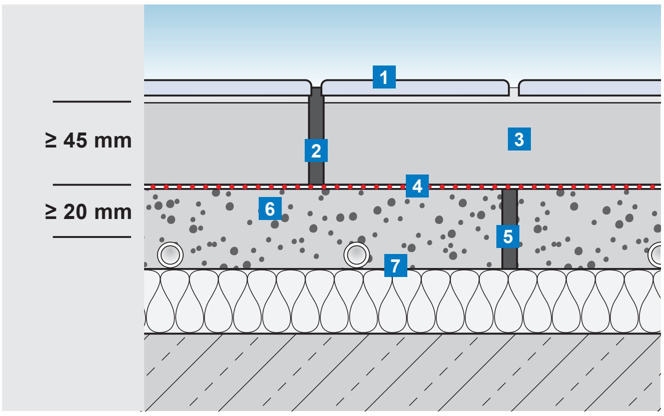
$R_{\lambda,T}$ = 0,15 m²K/W
$R_{\lambda,B}$ = [(25 - 8) · 0,02 + 8 · (0,02 + 0,15)] / 25
$R_{\lambda,B}$ = 0,07 m²K/W

Two-layer laying
A particularly variable laying of stone and ceramic coverings is made possible by a two-layer installation (type C in DIN 18560 or EN 1264-4).

The surface heating is initially covered with a levelling layer on which the screed or mortar layer is then created on a sliding foil layer to accommodate the floor covering. This technique allows a different joint arrangement in the upper surface than specified in the levelling screed, since the layer above the sliding foil can move independently of the elongation behaviour of the levelling screed.

The prerequisite is that the layer applied over the sliding foil is sufficiently stable, the levelling screed is smoothed accordingly and dried up to the permissible residual moisture.

Type C levelling screed with different joint arrangement (example: Uponor Klett)



1 *Tiling*
2 *Expansion joint*
3 *Screed*
4 *Two-layer separating/sliding foil*
5 *Expansion joint*
6 *Levelling screed*
7 *Uponor Klett panel*

Underfloor heating design

Design criteria

The detailed design of a underfloor heating/cooling system is essential for reliable operation and therefore for customer satisfaction. Proper hydraulic balancing obeying VOB (German Construction Contract Procedures) cannot be carried out, for example, without a project design. The design provides the necessary data, such as mass flows, pressure drops and water temperatures, which are required for planning the heat or cold generator and the distribution network.

In principle, the design of underfloor heating/cooling can lead to very different results, depending on the criteria (energy efficiency, comfort, investment costs, operating costs) which are the main focus. With the help of Uponor HSE design software, different requirements can be simulated simply by changing the parameters to obtain the ideal result. The basis for the design of the underfloor heating is DIN EN 1264, Part 3.

Room temperature, perceived temperature and average radiation temperature

In the case of radiation heating such as the Uponor surface heating, considerable energy savings can be assumed in comparison to other less favourable heating systems.

The energy-saving effect is mainly due to the lower room air temperature and the vertical temperature profile. In addition to the room air temperature ϑ_L, the average radiation temperature ϑ_S of the surrounding areas is also important for humans. This results in optimal perceived temperatures despite low air temperature.

The "perceived temperature" must be the same as the standard internal temperature ϑ_i from DIN EN 12831 and results from the average radiation temperature and room air temperature.

Important!
When determining the design flow temperature, it must be ensured that the permissible screed temperatures as defined in DIN 18560, Part 2, as well as the permissible temperatures for the floor coverings and adhesive layers are not exceeded.

Temperatures

Floor surface temperature

Special attention must be paid to the floor surface temperature, which must take into account the limits of the medical and physiologically justifiable floor surface temperature.

The difference between the average surface temperature of the floor and the standard internal temperature together with the base characteristic forms the basis for the performance of the floor heating area. The maximum surface temperatures are determined by the "Limit for heat flux density" defined in DIN EN 1264, which is taken into account as the theoretical design limit in the design tables and diagrams.

Max. surface temperatures in DIN EN 1264:

- 29 °C in the occupied area
- 35 °C in the edge zone
- 33 °C in bathrooms

Heating medium overtemperature

The heating medium overtemperature $\Delta\vartheta_H$ is calculated as a logarithmic average from the flow temperature, the return temperature and the standard internal temperature in DIN EN 1264. This determines the heat flux density when the construction is constant.

Equation (1)
In DIN EN 1264 Part 3:

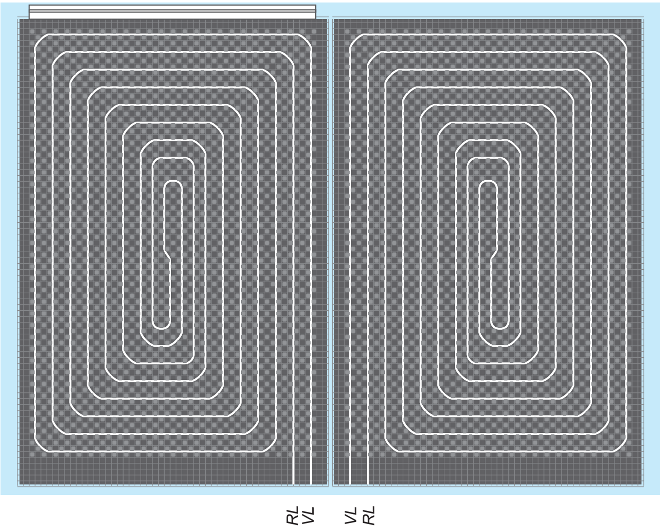
$$\Delta\vartheta_H = \frac{\vartheta_V - \vartheta_R}{\ln \dfrac{\vartheta_V - \vartheta_i}{\vartheta_R - \vartheta_i}}$$

Design flow temperature

The design flow temperature $\vartheta_{V,\,des}$ is the flow temperature determined by the design room, i.e. by the room/edge zone with the highest heat flux density or the highest required heating medium overtemperature (except baths). The design room is based on a temperature difference between flow and return (spread) of 2-5 K (edge zone 3 K). The spread in the other rooms/zones with lower heat flux density is correspondingly greater, since the design flow temperature is also specified for these heating surfaces.

Load Vz

The heating circuit size is limited by the total pressure drop resulting from the heat flux density or the mass flow rate and pipe length.
If two or more heating circuits are required for a room, they should be of similar length and installed with the same spacing. It is only necessary to split into a separate edge zone in old buildings, e.g. in front of old, poorly insulating windows.
Combination zones with different installation spacings are not recommended.



Utilisation of VZ for occupied areas.

Basis for calculation

Design
The calculation of the Uponor surface heating is based on the basic characteristic of DIN EN 1264 Part 2 and the standard heating load requirement calculation in DIN EN 12831.

The statutory insulation regulations in the GEG and DIN EN 1264 must be observed for the design. In the case of basement ceilings, ceilings against unheated or intermittently heated rooms and ceilings against ground, the minimum heat protection of insulation is R_λ = 1,25 m²K/W. In the case of residential ceilings against heated rooms, the minimum heat transfer resistance of the thermal insulation downwards is 0,75 m²K/W.

In residential buildings, the Uponor surface heating is designed for the most unfavourable but still permissible floor covering. One cannot assume that a room with a stone floor covering will be used as such even after years. If designed for stone and subsequently carpet or parquet floors are used, sufficient heating could only be achieved by increasing the heating water temperature, which has an unfavourable effect on the efficiency of the condensing units and heat pumps. The design must therefore be carried out with a thermal resistivity of $R_{\lambda,B}$ = 0,15 m²K/W.

The hydraulic balancing can be adapted to the actual floor covering and actual heating circuit length by a recalculation or, even more conveniently, by using the Uponor Smatrix control with auto balancing.

Pipe spacing

For comfort reasons, the pipe spacing for living and office rooms must be limited to a maximum of 30 cm (Minitec 15 cm).

Bathrooms: Direct foot contact with the floor covering is most common in swimming pools and sanitary rooms. For physiological reasons, the pipe spacing selected in the bathroom and toilet area as well as in the surrounding area of swimming pools must be as small as possible.

Kitchens: When planning, the area covered with built-in furniture is not always known, as such kitchen floors should be laid fully if possible. Since most kitchens use a hygienic floor covering (tiles), a smaller pipe spacing should also be selected. As far as possible, it is necessary to avoid recesses of the surface heating under installations (except under fireplaces) to ensure constant heat distribution.

If the underfloor heating system is also to be used for cooling, a minimum pipe spacing is recommended to obtain optimal cooling performance.

Manifold connection area
The pipes are often laid with very tight spacing in front of the heating circuit manifold/collector. These connecting pipes also release heat. If these connecting pipes result in excessive heat output or surface temperature for the room concerned, Uponor Vario Heat Protect panels can be used to reduce heat output and to limit surface temperatures. In principle, the pipe routing to the adjacent rooms must be planned in the shortest way possible.

Recommended spacing Vz in cm

System for area	Klett, Tecto, Classic, Tacker	Nub panel/ foil 14 – 16	Siccus	Minitec
Bathrooms, WC	10	11	15	5
Kitchens	20	16,5	15	10
Occupied areas (WZ, SZ, children's room)	20	22,5	15	10
Bedroom	25	22,5	22,5	15
Edge zones	10	11	15	10

Spacing

Installation specifications in DIN EN 1264-4

- **50 mm** from vertical construction parts and
- **200 mm** from chimneys and open fireplaces, open or brick shafts and flue spaces

Couplings

All couplings in the floor design must be precisely positioned and labelled in the revision drawing.

Pipe mounting

The pipes and their mounting systems must be secured in such a way that their planned horizontal and vertical position is maintained. The vertical deviation of the pipes upwards must not exceed 5 mm before and after adding the screed. The horizontal deviation of the specified pipe spacing in the heating circuit must not exceed ±10 mm at the mounting points.
The requirements do not apply in the area of bends and deflections. The mounting distance required to comply with these requirements depends on the pipe material, the pipe dimensions and the pipe systems.

Underfloor heating design

Technical information
for the individual Uponor surface heating/cooling systems include design tables, which enable a fast, generic estimate of the installation spacing and the max. heating circuit size.

However, the tables do not replace detailed planning and calculation. They are based on typical design criteria. If the basic data differs, the design and pressure drop diagrams must be used in conjunction with the calculation equations.

Application example (Klett)

1. Room temperature 20 °C
2. Required design heat flux density q_{des} = 50 W/m²
3. Design flow temperature $\vartheta_{V,des}$ = 45 °C
4. Cement screed, nominal thickness 45 mm
5. Thermal conductivity of the screed 1,2 W/m²
6. Selected system: Uponor Klett with heating pipe 16 x 2 mm

Result:
For the given general conditions, the maximum laying surface $A_{max.}$ = 28 m² at an installation spacing Vz 20. The maximum laying surface may be reduced by the length of the connecting pipes to the manifold (flow and return).

Solution:

1. For the "Klett" system, the design table for ϑ_i = 20 °C must be selected for the load distribution layer cement screed.
2. Select the line with the specified maximum design heat flux density q_{des} of your project (no bathrooms).
3. In this line, go to the right and select a design flow temperature $\vartheta_{V,des}$.
4. At the intersection, the necessary installation spacing Vz and the max. heating circuit size A_{Fmax} can then be read directly.
5. Then use design table ϑ_i = 24 °C for bathrooms.

Nominal thickness 45 mm, thermal conductivity 1,2 W/mK (pipe dimension 16 mm)

ϑi = 20 °C, Rλ,B = 0,15 m²K/W

		$\vartheta_{V,des}$ = 54,9 °C[1]		$\vartheta_{V,des}$ = 50 °C		$\vartheta_{V,des}$ = 45 °C	
$\vartheta_{F,m}$ (C)	q_{des} (W/m²)	T (cm)	$A_{F,max}$ (m²)	T (cm)	$A_{F,max}$ (m²)	T (cm)	$A_{F,max}$ (m²)
29	100	10	9				
28,6	95	10	13				
28,2	90	15	12,5				
27,8	85	15	17,5	10	10		
27,3	80	20	18	10	14		
26,9	75	20	21	15	15,5		
26,5	70	25	27	20	16	10	11
26,1	65	25	35	20	23,5	10	14
25,7	60	30	36	25	27,5	15	19
25,2	55	30	42	25	35	20	22
24,8	50	30	42	30	39,5	20	28

The specifications in these design tables are based on the following key data:
$R_{\lambda,ins}$ = 0,75 m²K/W, ϑ_u = 20 °C, concrete ceiling 130 mm,
Spread = 3 – 30K, max. heating circuit length = 150 m max.
Pressure drop per heating circuit incl. 2 x 5 m connecting pipe Δpmax = 250 mbar.
[1] At $\vartheta_{V,des}$ > 55,5 °C, the
limit heat flux density and thus the max. floor surface temperature of 29 °C or for the bathrooms design table 33 °C is exceeded.

Design diagrams for detailed calculation

The design diagrams, which are included in the technical information for the respective Uponor surface heating/cooling system, enable detailed manual heating surface planning using forms and also provide an overview of the following influencing variables and their relationship to one another:

1. Heat flux density of surface heating q_h in [W/m²]

2. Thermal resistivity of the floor covering $R_{\lambda,B}$ in [m²K/W]

3. Spacing Vz in [cm]

4. Heating medium overtemperature $\Delta\vartheta_H = \vartheta_H - \vartheta_l$ in [K]

5. Limit heat flux density – depiction of the boundary curve

If three influencing variables are specified, only one diagram can be used to determine the missing parameters.

Reading example

Determination of design flow temperature $\vartheta_{V,\,des}$

Specification:
q_H = 40 W/m²
ϑ_l = 20 °C.
$R_{\lambda,B}$ = 0,1 m² K/W

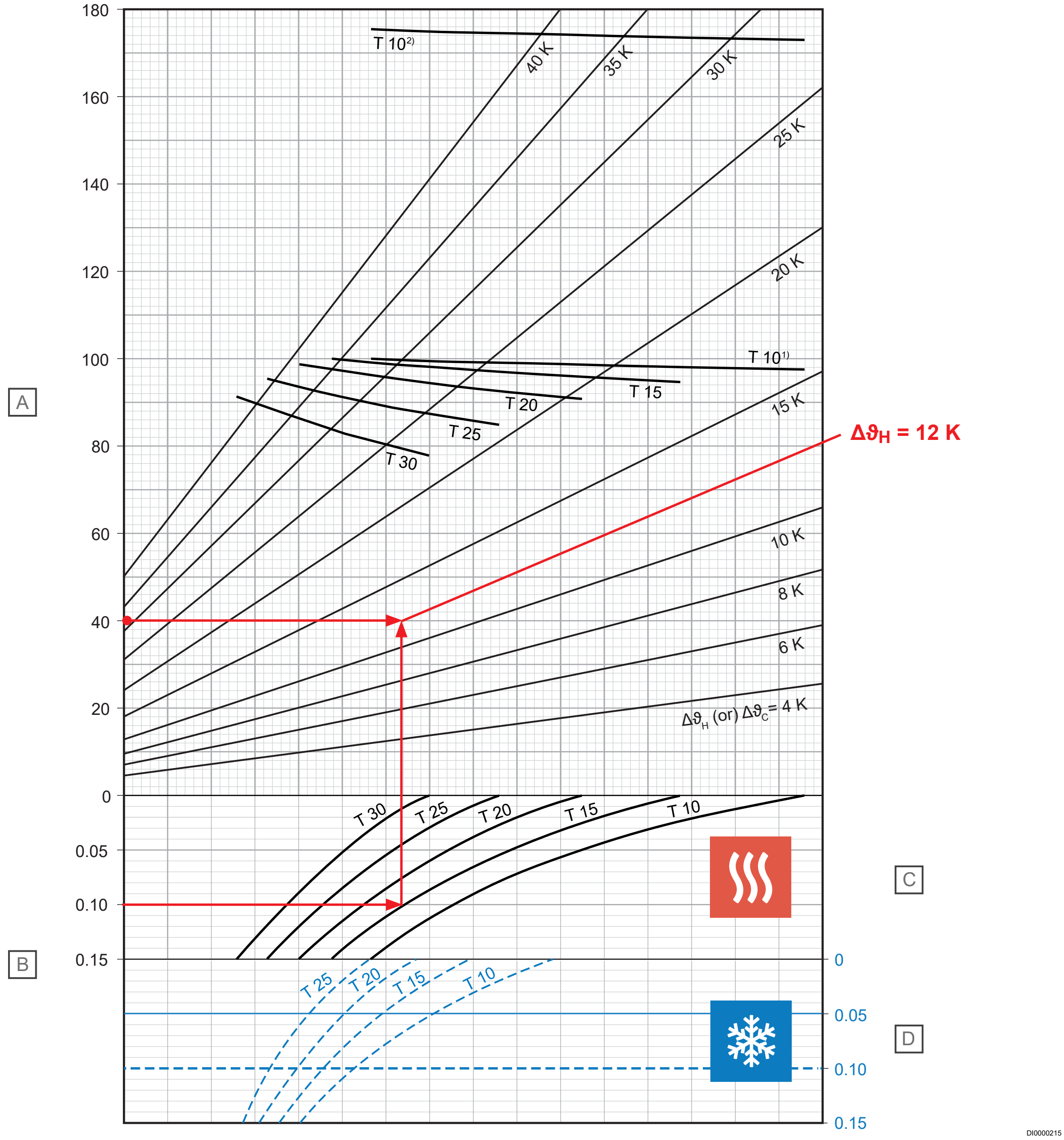
Selected:
Installation spacing = Vz 15

Reading:
$\Delta\vartheta_H$ = 12 K
(Below limit curve for Vz 15)

Spread:
5 K

Calculated:
$\vartheta_{V,\,des} = \vartheta_i + \Delta\vartheta_H + (\vartheta_V - \vartheta_R)/2$
$\vartheta_{V,\,des} = 20 + 12 + 5/2$
$\vartheta_{V,\,des} = 34{,}5$ °C

Uponor Klett Comfort Pipe PLUS 16 x 2,0 mm with screed load distribution layer (s_u = 45 mm with λ_u = 1,2 W/mK)



Item	Description
A	Specific thermal heating or cooling output [q_H or q_C] [W/m²]
B	Thermal resistance [$R_{\lambda,B}$] [m²K/W]

C - Heating

T [cm]	q_H [W/m²]	$\Delta\vartheta_{H,N}$ [K]
10	97,7	15,0
15	94,6	16,8
20	90,3	18,5
25	84,1	19,8
30	76,5	20,7

D - Cooling

T [cm]	q_C [W/m²]	$\Delta\vartheta_{C,N}$ [K]
10	36,0	8
15	32,2	8
20	28,8	8
25	25,8	8

1) Limit curve valid for ϑ_i 20 °C and $\vartheta_{F,\,max}$ 29 °C or ϑ_i 24 °C and $\vartheta_{F,\,max}$ 33 °C

2) Limit curve valid for ϑ_i 20 °C and $\vartheta_{F,\,max}$ 35 °C

Underfloor cooling design

In contrast to conventional radiators, which can only be used for heating in winter, underfloor heating/cooling systems offer double benefits. They can be used all year round – in winter for heating, in summer for cooling. The additional costs for the cooling function are low compared to conventional air cooling, especially when the required cooling water temperatures can be provided cost-effectively in combination with brine/water heat pumps or reversible air/water heat pumps.

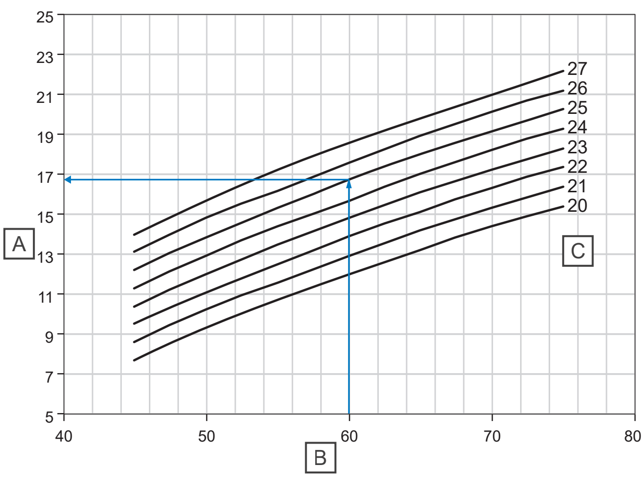
Design information

To be able to circulate sufficient quantities of water in the case of cooling, it is advisable to design the heating case which forms the basis for calculation with as little spread as possible (σ ≤ 5 K). The determination of the heating circuits should be as uniform as possible in the sense of the above requirement. Since the valve preset is not changed in the case of cooling, the design principles such as small spread and uniform heating circuit division are crucial for good cooling performance. Rooms that are not included in the cooling, such as the bathroom and kitchen, should be kept closed during cooling by the single room control, e.g. Uponor Smatrix.

To achieve the highest possible cooling performance with a heating/cooling surface, the following additional parameters are advantageous:

1. Small pipe spacing:
   ► Higher cooling performance at high flow temperature
2. Short heating/cooling circuit lengths:
   ► Lower pressure drops with small spread
3. Large pipe diameter:
   ► Lower pressure drops with small spread
4. Floor covering with good thermal conductivity:
   ► Better heat transfer
5. Low screed covering:
   ► Improved control capability when there is a risk of falling below the dew point
6. Automatic optimisation of the hydraulic system to cooling through the automatic balancing of the Uponor Smatrix control

It can be assumed that underfloor heating systems, which are efficiently designed for use with heat pumps, are also ideally suited to underfloor cooling.



Item	Description
A	Dew point temperature [°C]
B	Relative humidity [%]
C	Room air temperature [°C]

Dew point determination (example)
Room air temperature 25 °C,
relative humidity 60 %,
dew point temperature 16,8 °C

Cooling performance

The cooling performance that can be achieved depends on several factors. In addition to the design factors (such as pipe spacing, pipe cover, floor covering), which
also apply to the underfloor heating, the minimum permissible surface temperature of approx. 20 °C (for reasons of comfort) and the dew point of the room air have an effect on the cooling performance. In principle, cooling water flow temperatures of 15 – 16°C are not to be undercut in order to minimise the possibility of condensation forming (dew point undershoot) on system components.

Connecting pipes to the manifold are to be insulated to prevent vapour diffusion. The target temperature for floor system cooling is be the upper comfort limit at room temperature of 26 °C.

Basically, there are two different approaches to cooling with the underfloor heating, which are to be defined before the design starts. A distinction is made between cooling and full cooling:

Cooling

Cooling is used to define the cooling performance achieved when the underfloor heating has been designed for the heating load. Installation spacing, heating circuits etc. are planned obeying EN 1264 in accordance with the calculated heating load (DIN EN 12831). These parameters result in a limitation of the cooling performance. It is therefore referred to as cooling performance. In housing construction, this can compensate for the cooling load that is incurred, but it is not proven by calculations.

If higher performance than the expected cooling performance is desired, we recommend the design to be implemented as full cooling.

Full cooling

With this planning type, pipe spacings are reduced, the pipe diameter is selected larger and volume flows and hydraulics are adapted to the cooling case in such a way that the system achieves the cooling capacity expected in the VDI 2078. Optimal is a control system such as the Uponor Smatrix that automatically adjusts the hydraulic system from heating to cooling. The thermal resistivity of the floor covering is also to be taken into account. If the cooling load as in VDI 2078 cannot be covered by the floor alone, Uponor offers solutions for wall and ceiling (e.g. Uponor Thermatop M), which can more easily cover the required cooling load due to their higher cooling capacity.

Note!
The different mass flows between heating and cooling for hydraulic balancing must be taken into account.

Design diagrams for cooling performance design

The combined Uponor heating/cooling diagrams, which are located in the technical information for the respective Uponor surface heating/cooling system, enable detailed manual cooling area planning. The exact formulas of EN 1264-5 are used as the basis for the cooling performance calculation, so that no estimated values have to be used on the basis of the heat transfer coefficients.

Similar to the design of the heating surface, the following influencing variables and their relationship to each other apply:

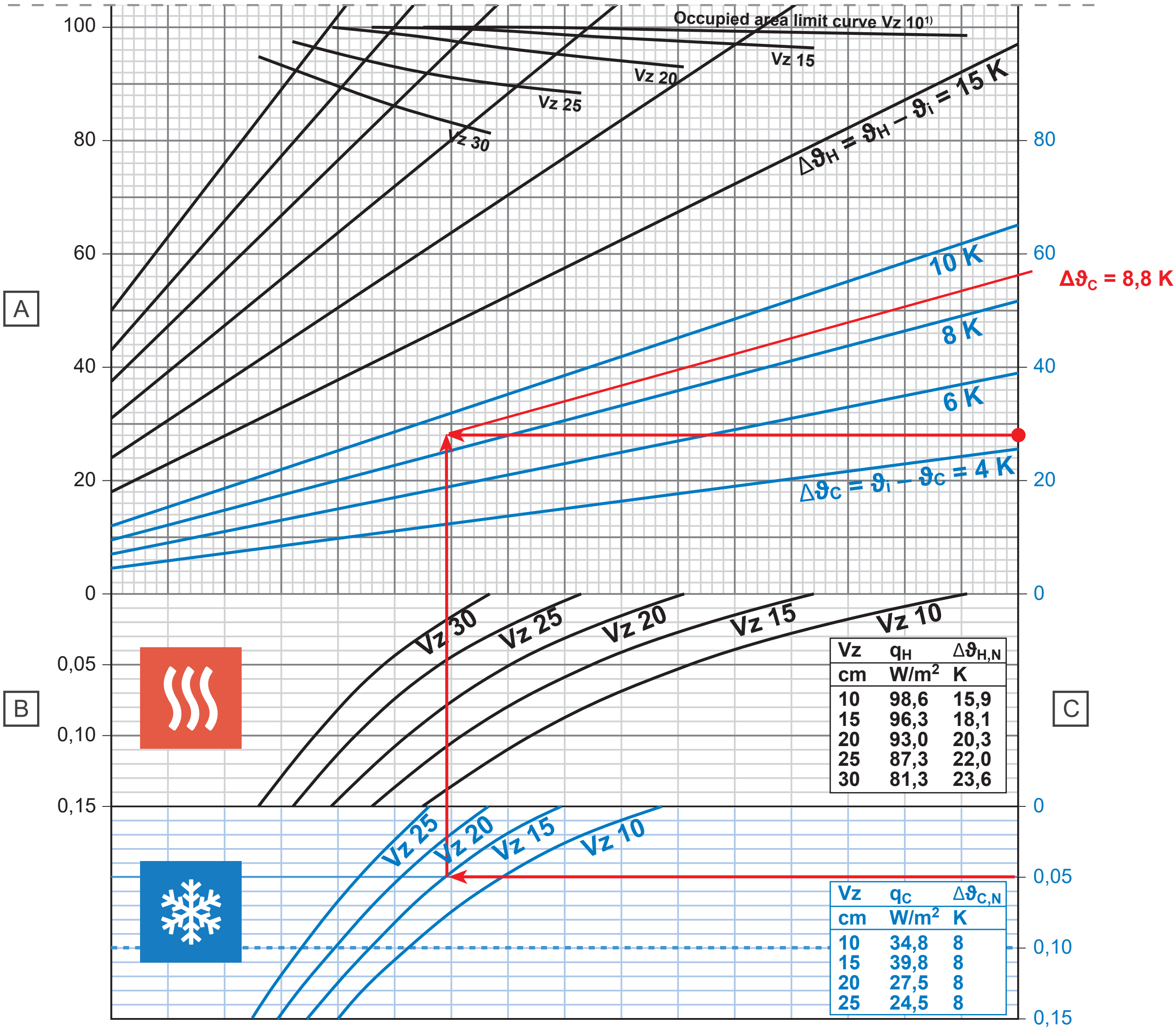
1. Floor area cooling performance q_C in [W/m²]

2. Thermal resistivity of the floor covering $R_{\lambda,B}$ in [m²K/W]

3. Spacing Vz in [cm]

4. Coolant undertemperature $\Delta\vartheta_C = \vartheta_i - \vartheta_C$ in [K]

If three influencing variables are specified, only one diagram can be used to determine the missing parameters.



Section of a design diagram.

Item	Description
A	Specific heat performance q_H [W/m²]
B	Thermal resistivity [m² K/W]
C	Specific cooling performance q_C [W/m²]

Note:
The desired cooling performance can only be achieved if both the average surface temperature and the design flow temperature are above the dew point temperature of the ambient air (h-x diagram).

To avoid the forming of condensation on system components, dew point-guided flow temperature control must be provided.

If the room sensors (such as the Uponor style T-169) also detect the relative humidity, a limit can also be implemented here via a limit value (typically 75 % rH).

Reading example cooling

Determination of design flow temperature $\vartheta_{V,\,des}$

Specification:
q_C = 29 W/m²
ϑ_I = 26 °C.
$R_{\lambda,B}$ = 0,05 m² K/W

Selected:
Installation spacing = Vz 15

Reading:
$\Delta\vartheta_C$ = 8,8 K

Design spread:
$\vartheta_V - \vartheta_R = 2$ K

Calculated:
$\vartheta_{V,\,des} = \vartheta_i + \Delta\vartheta_C + (\vartheta_V - \vartheta_R)/2$
$\vartheta_{V,\,out} = 26 - 9 - 2/2$
$\vartheta_{V,\,des} = 16$ °C

Hydraulics

Due to different performance requirements and heating circuit lengths in the rooms or heating zones, it is necessary to move precisely the required amount of water through the heating circuits, which is necessary to meet the heat demand. The intelligent Uponor control systems Smatrix and the new Base 230-V X-60 and X-80 controllers achieve this by means of demand-orientated and self-adapting cycles of the respective heating circuit-water quantity (auto-balancing), which generally makes static hydraulic balancing as required for conventional systems unnecessary.

The following specifications of the GEG must be complied with

Hydraulic balancing and further measures for heating optimisation

(1) A heating system with water as a heat transfer medium shall be hydraulically balanced after installation or assembly of a heating system for the purpose of commissioning in buildings with at least six flats or other independent use units.

(2) Implementation of the hydraulic balancing within the meaning of this regulation shall include at least the following planning and implementation services, taking into account all the essential components of the heating system:
A room-by-room heating load calculation, a test and, if necessary, optimisation of the heating surfaces with regard to the lowest flow temperature and the adaptation of flow temperature control.

The procedure provided in DIN EN 12831, Part 1, September 2017 edition, in connection with DIN/TS 12831, Part 1, April 2020,1 edition) must be used for the room-by-room heating load calculation.

(3) Hydraulic balancing must be carried out in accordance with procedure B of the ZVSHK technical rule "Optimierung von Heizungsanlagen im Bestand" (Optimisation of existing heating systems in stock), VdZ – Wirtschaftsvereinigung Gebäude und Energie e. V., 1. Updated edition April 2022, Point 4.2. or an equivalent procedure.

(4) Confirmation of the hydraulic balancing must be recorded in writing, including the setting values, the heating load of the building, the set power of the heat generators and the room-by-room heating load calculation, the design temperature, the setting of the control and the setting of the pressure in the expansion vessel and communicated to the person responsible. Confirmation in accordance with Sentence 1 must be presented to the tenant immediately upon request.
S 60a, paragraph 5, Sentence 4 must be applied accordingly.

Static hydraulic balancing

In the case of hydraulic balancing, all heating circuits on the manifold must be aligned to the most unfavourable heating circuit (greatest pressure drop). This so-called "static hydraulic balancing" is described in the following example:

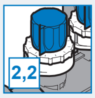
Heating circuit manifold (example)

Heating circuit	Heating circuit mass flow rate+ fully open valve/ flowmeter [kg/h]	Heating circuit pressure drop [mbar]	Differential pressure to be controlled at the flow valve [mbar]
HK 1	100	215	0
HK 2	90	140	215 – 140 = 75
HK 3	80	160	215 – 160 = 55
HK 4	90	195	215 – 195 = 20
HK 5	100	130	215 – 130 = 85

Manifold diagram example:
Uponor Vario PLUS manifold

m_{HK5} Heating circuit mass flow rate (here: heating circuit HK 5)

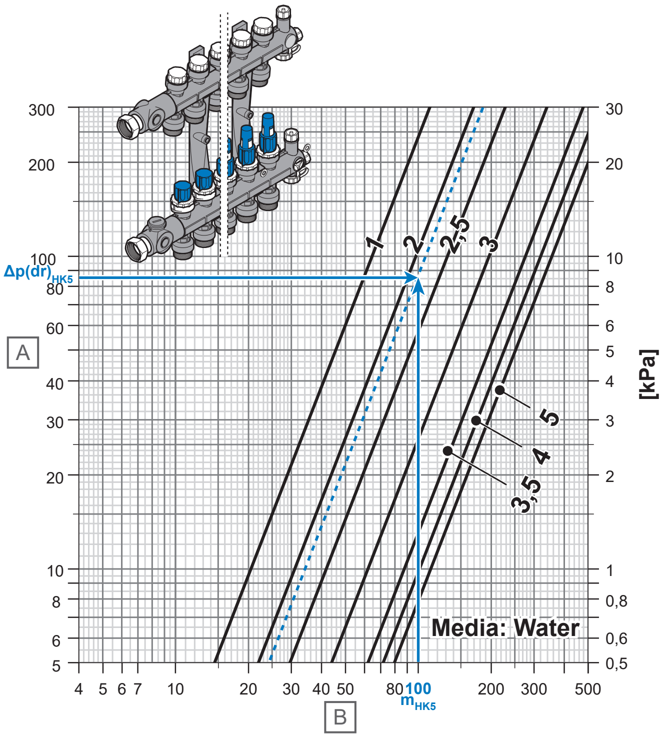
$\Delta p(dr)_{HK5}$ heating circuit differential pressure to be limited (here: heating circuit HK 5)



For this example, the pre-setting digit "2,2" on the flow valve must be set for the HK 5 heating circuit.

All other heating circuits must be balanced as described.

For more information, refer to the Uponor Vario PLUS manifold installation instructions.



Item	Description
A	Pressure drop, Δp [mbar]
B	Mass flow rate, m [kg/h]

Note:
In conjunction with an Uponor Smatrix single-room control with auto-balancing function, static hydraulic balancing can generally be omitted at the manifold.

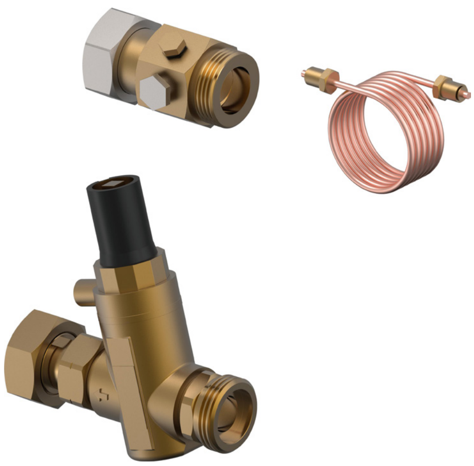
Dynamic hydraulic balancing

Uponor Vario differential pressure regulator

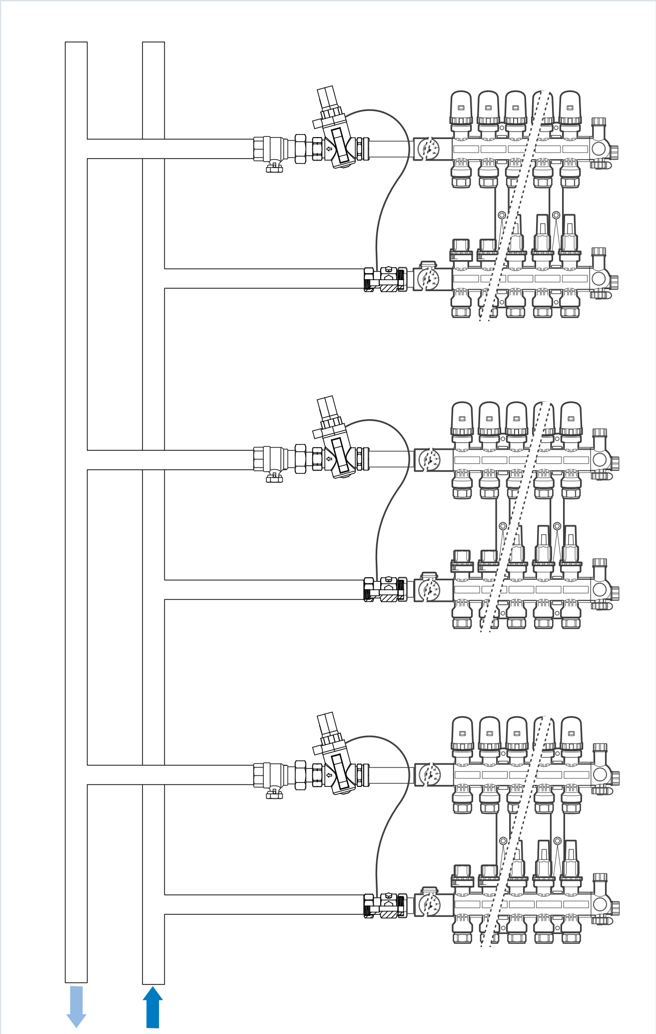
For larger objects with more than two manifolds, we recommend using the Uponor Vario differential pressure regulator. This is mounted upstream of the respective manifolds and keeps the differential pressure at the manifold constant within a proportional band even when operating conditions change (dynamic hydraulic balancing). The differential pressure regulator has no influence on temperature, heating medium flow and heating circuit design, but simplifies pressure calculations and pump design considerably.

For the pump design, only the mass flow rates of all manifolds must be summed up; the regulated differential pressure of the most unfavourable manifold (manifold with the highest differential pressure) is used to determine the required pump total head.

The Uponor Vario differential pressure regulator thus creates the best conditions for a hydraulically optimally balanced system, ideally in conjunction with Uponor single-room control with auto-balancing function.



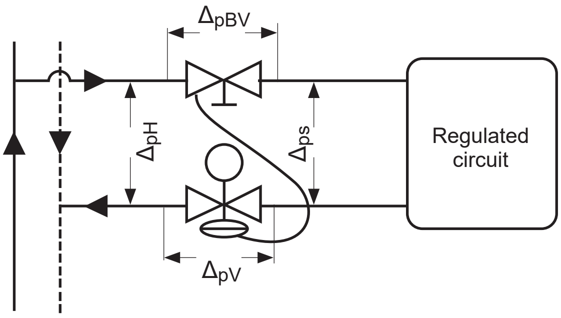
Uponor Vario differential pressure regulator Compact



Heating circuit manifold with 6 heating circuits

Heating circuit	Heating circuit mass flow rate [kg/h]	Pressure drop of heating circuit [mbar]	Differential pressure to be limited on the flow valve [mbar]
HK 1	100	215	0
HK 2	90	140	215 – 140 = 75
HK 3	80	160	215 – 160 = 55
HK 4	90	195	215 – 195 = 20
HK 5	100	130	215 – 130 = 85
HK 6	120	185	215 – 185 = 30

M_V = total HK = 580 kg/h, Δ_{ps}= 215 mbar



Operation of the Uponor Vario differential pressure regulator is described in the following example.

1. Calculation of pressure drop via differential pressure control valve (Δ_{PV}):

$$\Delta p_V = \left(\frac{m_V \text{ design}}{K_{vs}}\right)^2 \times 1000 \qquad 58 \text{ mbar} = \left(\frac{0{,}580 \text{ m}^3/\text{h}}{2{,}4 \text{ m}^3/\text{h}}\right)^2 \times 1000$$

2. Determine minimum pump total head:

$$\Delta p_H = \Delta p_{BV} + \Delta p_s + \Delta p_V \qquad 273 \text{ mbar} = 0 \text{ mbar (fitting)} + 215 \text{ mbar} + 58 \text{ mbar}$$

m_V Total manifold mass flow (total heating circuit mass flow)
Δp_s differential pressure to be kept constant upstream of the manifold
ΔP_V drop of regulator pressure
Δp_H total pressure drop for pump design

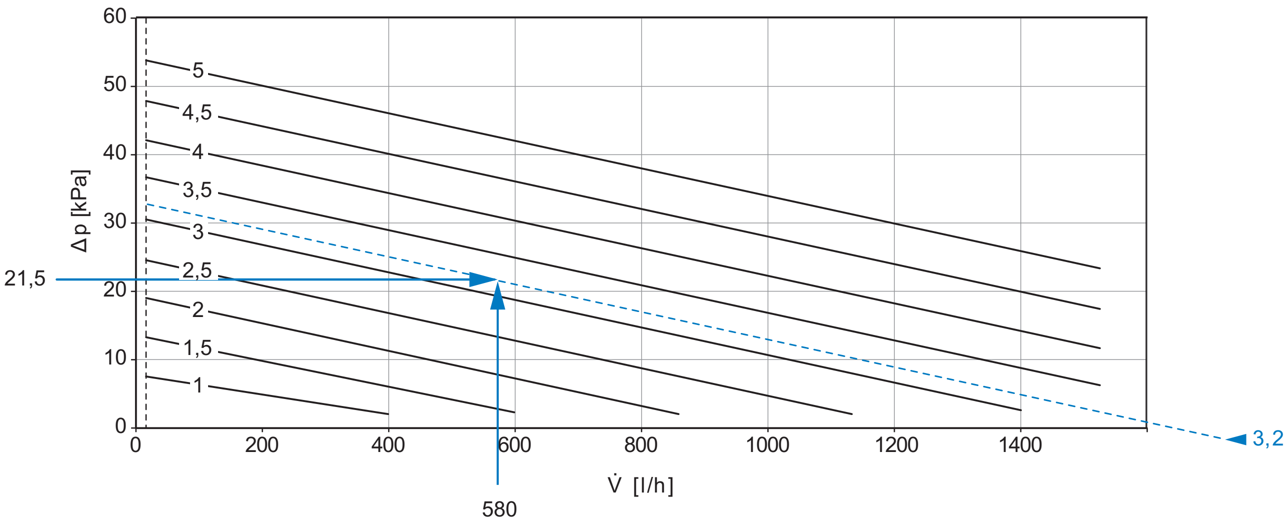
$$\boldsymbol{\Delta p_H = \Delta p_{BV} + \Delta p_s + \Delta p_V}$$

3. Heating circuit pump design
Now the pump can be selected taking into account a pressure drop of 273 mbar.

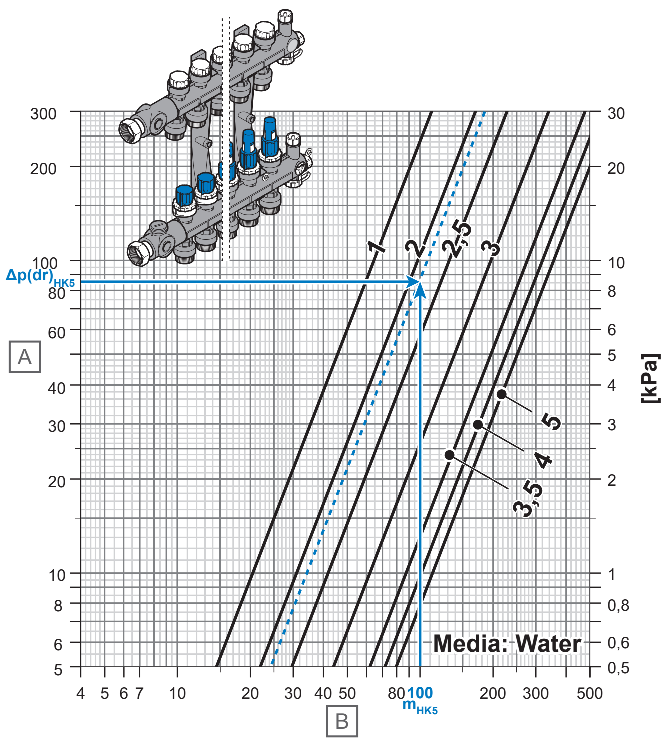
4. Differential pressure regulator setting
With a setting of 3,2, the regulator now ensures that the differential pressure Δp_s does not exceed 32 kPa at the specified volume flow range.

Note: The maximum volume flow values must be limited either by the partner valve Δp_{BV} or underfloor heating circuit valves.

Pre-installation diagram for Uponor Vario differential pressure regulator Compact DN25 5–50 kPa

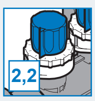


Balancing of the heating circuits on the manifold for heating circuit 5



Manifold diagram example:
Uponor Vario PLUS manifold

$\mathbf{m}_{HK5}$	Heating circuit mass flow rate (here: heating circuit HK 5)
$\Delta\mathbf{p(dr)}_{HK5}$	heating circuit differential pressure to be limited (here: heating circuit HK 5)



For this example, the pre-setting digit "2,2" on the flow valve must be set for the HK 5 heating circuit.

All other heating circuits must be balanced as described.

Item	Description
A	Pressure drop, Δ**p** [mbar]
B	Mass flow rate, m [kg/h]

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