PRINETO®

Technical Documentation

IVT
MEMBER OF THE WÜRTH GROUP

Contents

Subject to error and alterations.

General information

IVT – a Würth Group company

As a partner company within the globally successful Würth Group, we have made a name for ourselves internationally with our innovative solutions for plumbing and heating systems as well as solar heating. IVT has modern production facilities at its plant in Rohr near Nuremberg and implements national and international projects ranging from single family houses to large buildings. Our philosophy is to achieve innovations at a high technical level – for the benefit and satisfaction of our customers.

Our brands:

PRINETO The plastic pipe system for drinking water, heating and surface heating

NANOTEC The world innovation in the plastic pipe sector –100 % oxygen diffusion-tight

PRIPRESS radial-press installation system - fast, direct, safe.

LATENTO All-year solar systems for heating mains water and backing up heating systems

IVT – at a glance

- subsidiary of the global Würth Group
- modern production facilities in Germany
- direct sales without intermediate retailer
- 24h delivery service (DE, AT)
- competent specialists on site
- construction site instructions and support
- planning assistance with larger projects
- numerous patents and new developments
- individual logistics solutions for every application

LATENTO solar system

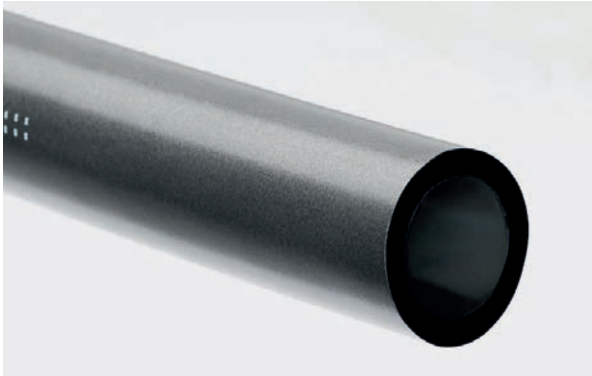
Delivery service
"Ordered in the evening, delivered the next morning!" Your urgent orders are delivered during the night – direct to the building site, if required. Our 24-hour service guarantees delivery within 24 hours or sooner, according to your individual needs. Our 99.5 % service level guarantees that almost all items can be supplied immediately.

Quality assurance
Quality is our top priority. Our high level of quality is ensured by stringent quality monitoring in our own laboratory, as well as regular checks by recognised European testing organisations. More than 100 million connections worldwide and over 5,000 satisfied customers are our best recommendation.

Customer service
Customer support is our priority. Our own specialist planners are there to help you with the planning of your projects. Our skilled specialist advisers are available at any time to answer your questions concerning ***PRINETO***, ***NANOTEC*** and ***LATENTO*** – on site, by phone, fax, or e-mail. Try us!

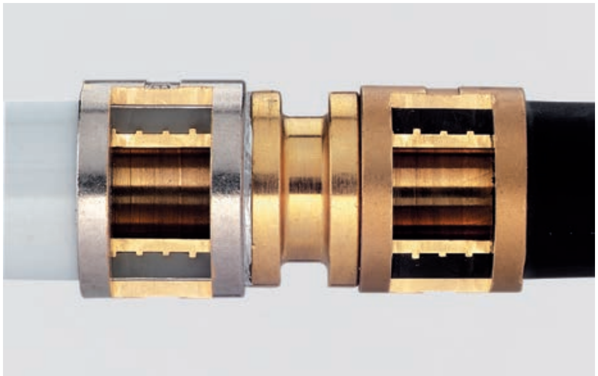
Würth
IVT is a subsidiary of Adolf Würth GmbH & Co. KG, a group which enjoys success worldwide in assembly and fixing technology; Würth has its registered head office in Künzelsau, Germany. More than three million customers from trade and industry trust the products, the quality and the service provided by Würth.

NANOTEC PE-X pipe – 100 % oxygen-tight
Through the patented IVT-**NANOTEC** process a metallic coating of nanoparticles is applied to the IVT PE-X pipe in the two-stage system and is sealed with a transparent ultra-thin protective layer. So, for the first time a PE-X pipe is as oxygen-tight as a metal pipe, whilst all the PE-X pipe characteristics are still preserved. The metallic coating can withstand even the most extreme stretching and gives the pipe an outstanding look. It is lightfast, colour-fast and UV resistant.

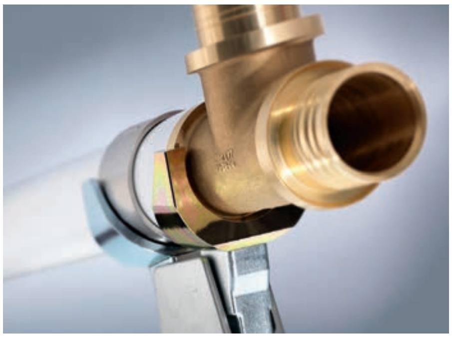


PRINETO® – one fitting for heating and plumbing
PRINETO – The universal pipe system for drinking water, heating and surface heating installations and for compressed air systems from 12 to 63 mm outer diameter. All types of application can be covered with just one pipe and one fitting – saving storage space and costs. The patented **PRINETO** sliding sleeve connection guarantees straightforward and safe installation and ensures perfect drinking water hygiene and safety – for life.

PRINETO – no O-ring – 100 % safe
The patented **PRINETO** connection technique does not require an O-ring and has a sealing surface that is many times larger than that of conventional connections. This means 100% safety and perfect hygiene. In addition, the **PRINETO** connection technology also allows a high rate of flow, as the pipe diameter remains almost unchanged inside the fitting (widening technique).



PRINETO Tools – simple, suitable for building site use and safe.
Our tools, developed in cooperation with users, guarantee maximum manageability and speed on the building site. Thanks to clear visual monitoring whilst making the joint, the quality of the connection can be checked at any time. The end stops of all ***PRINETO*** tools are designed in such a way that it is impossible to over-compress the connection.

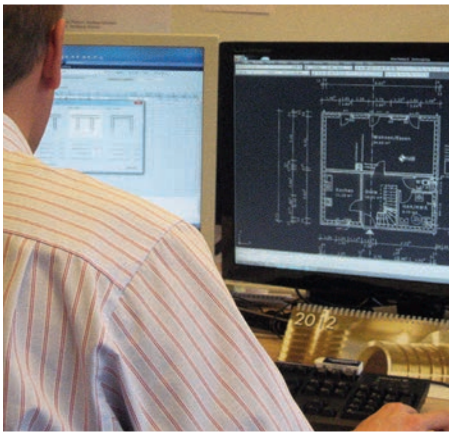


PRINETO Surface heating – modular, convenient, universal.
PRINETO surface heating systems offer you the choice of various wet laying systems for residential and industrial buildings, and a dry laying system for floor and wall heating/cooling. The ***PRINETO*** thin-bed system allows underfloor heating with a particularly low installed height to be laid directly on an existing floor covering – ideal for renovation work.

PRINETO Planning assistance
Our own planning support and expert planners can assist you with the overall conception and implementation of your projects with ***PRINETO***.
The technical planning for buildings e.g. fast design of the underfloor heating and pipeline network dimensioning with the preparation of ***PRINETO*** bills of quantities is done using liNear planning software.
Further information:
LiNear GmbH, Kackerstr. 7–11, D-52072 Aachen,
Tel. +49 (0)241-889800
Prices and invitation to tender wordings for the complete ***PRINETO*** product range are available in datanorm 4.0 format at www.ivt-rohr.de (application software with datanorm interface required).

PRINETO quick online draft
The IVT online web application runs independently of permanently installed software and offers fast and straightforward planning of underfloor heating for quotation calculation.

www.ivt-flaechenheizung-schnellauslegung.de/?locale=en



References

PRINETO has been installed in almost all kinds of buildings for more than 20 years now. More than 100 million ***PRINETO*** connections worldwide are in continuous operation in plumbing and heating installations, surface heating and cooling systems, sprung floor heating systems, compressed air installations and other industrial areas, such as shipbuilding, railway rolling stock and prefabricated housing. These are constantly being added to by further major national and international projects. Well-known property developers and building concerns as well as more than 5,000 installation and industrial companies that value quality and service have put their trust in ***PRINETO***.

- single family homes and apartment buildings
- small and large industrial properties
- banks
- businesses and shops
- hotels
- residential homes for the elderly
- workshops for the disabled
- administrative buildings
- shipyards
- sports and multi-purpose halls
- radio and TV stations
- football stadiums
- churches
- motorway tunnels
- etc.

2
Pipes

2. Planning notes & technical data

Contents

2

Pipes

PRINETO pipes

PRINETO

Properties

Standards

PRINETO pipes are compliant with the applicable standards for the respective fields of application, e.g. DIN EN ISO 15875, Plastic piping systems for hot and cold water installation – cross-linked polyethylene PE-X, DIN EN ISO 21003 Multilayer compound piping systems for hot and cold water installation within buildings, or the worksheets of the DVGW ("Deutscher Verein des Gas- und Wasserfaches e.V. Eschborn"), respectively; e.g. worksheet W270 concerning suitability in respect of drinking water from a microbiological point of view. The standards relevant to the respective pipe types are shown separately in the corresponding chapters, e.g. the chapter on the surface heating system.

Raw material

High-molecular polyethylene of high density is used as a raw material (surface heating pipes also available as polyethylene of high temperature resistance PE-RT, which is amalgamated with thermo-stabilising additives against thermal degradation.

Pipe production

The pipes are extrusion products manufactured on modern extruding machines which have been optimised for processing high-molecular polyethylene material.

Cross-linking

Cross-linking, i.e. the linking of the molecular chains of the polyethylene to make a "macromolecule" with a three-dimensional network, has the effect that pipes made of thermoplastic materials no longer experience the usual steep decline of internal pressure over a long-period, particularly at higher temperatures.

Quality assurance through external monitoring

The plumbing pipes bear the DVGW mark of conformity, registration no. DW 8306BN0286. The heating pipes are oxygen diffusion-tight in accordance with DIN 4726 and DIN 4724 respectively. The most important characteristic values are continually checked within the scope of monitoring contracts with the Austrian Research Centre (OFI), Vienna, and the Southern German Plastics Centre (SKZ).

Sound insulation

Compared with metal pipes PE-X pipes have a dampening effect on structure-borne noise. PE-X pipes are therefore particularly suitable for low-noise drinking water systems and heating installation.

Chemical resistance

There are more than 1,000 substances which ***PRINETO*** pipes are known to be resistant to. ***PRINETO*** pipes do not tend to form sludge.

Storage

PRINETO pipes are light-protected and must be stored in their original packaging until used.

Water hammer

PE-X pipes have a dampening effect on water hammer. Prolonged water hammer can damage the multilayer composite pipes and should thus be avoided.

Deposits

PE-X pipes have a more repellent effect on water ingredients. There is no tendency to form deposits.

Filling quantities

Nanoflex, plumbing and heating pipe

PE-X 16	16 x 2.2:	0.11 l/lfdm
PE-X 20	20 x 2.8:	0.16 l/lfdm
PE-X 25	25 x 3.5:	0.25 l/lfdm
PE-X 32	32 x 4.4:	0.42 l/lfdm

Surface heating pipe

Fhr 12	12 x 2.0:	0.05 l/lfdm
Fhr 14	14 x 2.0:	0.08 l/lfdm
Fhr 16	16 x 2.0:	0.11 l/lfdm
Fhr 17	17 x 2.0:	0.13 l/lfdm
Fhr 20	20 x 2.0:	0.20 l/lfdm
Fhr 25	25 x 2.3:	0.33 l/lfdm

Multilayer composite pipe

Stabil 14	14 x 2.3:	0.07 l/lfdm
Stabil 16	17 x 2.8:	0.11 l/lfdm
Stabil 20	21 x 3.4:	0.16 l/lfdm
Stabil 25	26 x 4.0:	0.25 l/lfdm
Stabil 32	33 x 4.9:	0.42 l/lfdm
Stabil 40	42 x 4.6:	0.86 l/lfdm
Stabil 50	52 x 5.65:	1.31 l/lfdm
Stabil 63	63 x 6.0:	2.04 l/lfdm

Properties

Material properties PE-X

	PE-X (HD)	Norm
Degree of cross-linking (%)	≥ 65	DIN 16892
Density (g/cm³)	approx. 0.94	DIN EN ISO 1183
Tensile strength (N/mm²)	approx. 23	DIN EN ISO 527
Elongation at tear (%)	approx. 400	DIN EN ISO 527
Secant elasticity modulus (N/mm²)	approx. 600	DIN EN ISO 527
Impact resistance at –20°C	no fracture	DIN EN ISO 179/180
Notch impact resistance at –20°C	no fracture	DIN EN ISO 179/180
Stress cracking resistance 8 bar, 80°C	no crack	ISO 16770
Thermal conductivity (W/mK)	0.35	DIN 52612
Linear expansion coefficient (per Kelvin)	0.00015	DIN 53752
Pipe internal surface finish (mm)	0.007	DIN 1988
Material class	B2	DIN 4102

Operating conditions

The operating conditions for PE-X piping systems are described and defined in DIN EN ISO 15875, for multilayer compound pipe systems in DIN EN ISO 21003, and for the PE-RT surface heating system in DIN 4724. The pipe systems are subdivided into application classes.

There the maximum operating temperatures are given for a defined period of time (in relation to a service life of 50 years). The respective permissible operating pressures depend on the pipe material and the pipe dimension and application class and are stated in the following tables.

Application class 1 = plumbing hot-water supply 60°C (for Germany) **Nanoflex, plumbing and multilayer composite pipes**	
Operating temperature:	60 °C for 49 years
Maximum operating temperature:	80 °C for 1 year
Failure temperature:	95 °C up 100 hours

Application class 2 = plumbing hot water supply 70°C (not for Germany) **Nanoflex, plumbing and multilayer composite pipes**	
Operating temperature:	70 °C for 49 years
Maximum operating temperature:	80 °C for 1 year
Failure temperature:	95 °C up 100 hours

Application class 4 = surface heating, low-temperature radiator heating **Nanoflex, surface heating, heating and multilayer composite pipes**	
Operating temperatures:	20 °C for 2.5 years
+	40 °C for 20 years
+	60 °C for 25 years
Maximum operating temperature:	70 °C for 2.5 years
Failure temperature:	100 °C up 100 hours

Properties

Application class 5 = high-temperature radiator heating Nanoflex, heating and multilayer composite pipes	
Operating temperatures:	20 °C for 14 years
+	60 °C for 25 years
+	80 °C for 10 years
Maximum operating temperature:	90 °C for 1 year
Failure temperature:	100°C up to 100 hours

Permissible operating pressures for multilayer composite pipes acc. to DIN EN ISO 21003-2

Pipe dimension	Operating pressure in bar for application class 1	Operating pressure in bar for application class 4	Operating pressure in bar for application class 5
Stabil 14 (14 x 2.3)	10.0	10.0	10.0
Stabil 16 (17 x 2.8)	10.0	10.0	10.0
Stabil 20 (21 x 3.4)	10.0	10.0	10.0
Stabil 25 (26 x 4.0)	10.0	10.0	10.0
Stabil 32 (33 x 4.9)	10.0	10.0	10.0
Stabil 40 (42 x 4.6)	10.0	10.0	10.0
Stabil 50 (52 x 5.65)	10.0	10.0	10.0
Stabil 63 (63 x 6.0)	10.0	10.0	10.0

Permissible operating pressures for PE-X pipes acc. to DIN EN ISO 15875-2

Pipe dimension	Operating pressure in bar for application class 1	Operating pressure in bar for application class 4	Operating pressure in bar for application class 5
12 x 2.0		10.0	10.0
14 x 2.0		10.0	10.0
16 x 2.2	10.0	10.0	10.0
17 x 2.0		10.0	
20 x 2.0		8.0	
20 x 2.8	10.0	10.0	10.0
25 x 2.3		8.0	
25 x 3.5	10.0	10.0	10.0
32 x 4.4	10.0	10.0	10.0

Permissible operating pressures for PE-RT type II pipes acc. to DIN 4724

Pipe dimension	Operating pressure in bar for application class 4
17 x 2.0	8.0

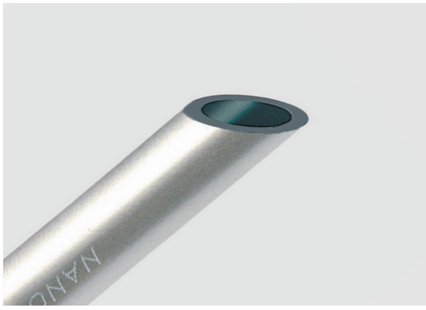
Properties

Pipe dimensions in comparison (acc. to DIN 1988 part 3)

DN	Threaded pipe	Stainless steel pipe	Copper pipe	PE-X pipe	Multilayer composite pipe
10	3/8"	12 x 1 mm	12 x 1 mm	14 x 2.0 mm	14 (14 x 2.3 mm)
12		15 x 1 mm	15 x 1 mm	16 x 2.2 mm	16 (17 x 2.8 mm)
15	½"	18 x 1 mm	18 x 1 mm	20 x 2.8 mm	20 (21 x 3.4 mm)
20	¾"	22 x 1.2 mm	22 x 1 mm	25 x 3.5 mm	25 (26 x 4.0 mm)
25	1"	28 x 1.2 mm	28 x 1.5 mm	32 x 4.4 mm	32 (33 x 4.9 mm)
32	1 ¼"	35 x 1.5 mm	35 x 1.5 mm		40 (42 x 4.6 mm)
40	1 ½"	42 x 1.5 mm	42 x 1.5 mm		50 (52 x 5.6 mm)
50	2"	54 x 1.5 mm	54 x 2 mm		63 (63 x 6.0 mm)

DIN 2440	for medium-weight threaded pipes
DIN (1786) EN 1057	for copper pipes
EN ISO 1127	for precision steel pipes made of stainless steel
DIN EN ISO 15875	for cross-linked polyethylene pipes of high density (PE-X and Stabil 16–32)
DVGW worksheet 542	for compound pipes (all multilayer composite pipes)
DIN EN ISO 21003	for multilayer compound pipes (all multilayer composite pipes)

Nanoflex pipe



Colour: stainless steel

Description:
Nanoflex universal pipe, stainless steel coloured, DIN 16892/93, pipe series S 3.2. DVGW DW-8306BNO286.

Marking:
Runn. metre info., manufacturer info, designation, DVGW reg. no., material, dimension, DIN, pressure info., testing laboratory, other approvals, prod. no.

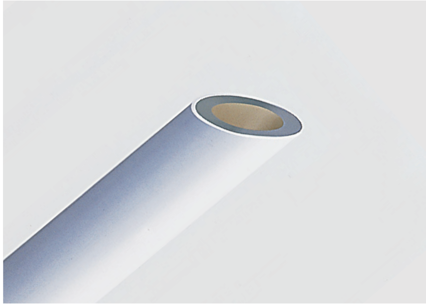
Example:
(8453m) IVT Nanoflex pipe 16 DVGW DW-8306BN0286 ÖVGW W1.369 PE-Xb 16 x 2.2 DIN 16892/93 S 3.2 OFI (20 bar/20°C–10 bar/70°C) 100 % oxygen-tight acc. to DIN 4726 ÖVGW 2616073302

Properties:
Linear expansion coefficient acc. to DIN 53752 1.60 x 10-4 K-1 Nanoflex pipes are flexible. The Nano-metal surface makes the pipe 100 % oxygen diffusion-tight and UV-resistant and gives the pipe a stainless steel look.

Application:
- In drinking water installations acc. to DIN 1988
- In heating installations acc. to DIN EN 12831
- In surface heating (underfloor heating) acc. to DIN EN 1264 and DIN 18560.

Properties

Multilayer composite pipe



Colour: white

Description:
Multilayer composite pipe = PE-X pipe, natural-coloured, DIN 16892/93, pipe series S 3.2 DVGW plus anchoring agent plus aluminium foil, butt welded, 0.2 – 0.8 mm thick plus anchoring agent plus top layer of PE-MD, colour: white, oxygen-tight

Marking:
Runn. metre info., manufacturer info., designation, DVGW reg. no., material, dimension, DIN, pressure info., testing laboratory, prod. no.

Example:
(0343m) IVT multilayer composite pipe 20 Y (basic pipe DVGW DW-8311 AW 2193 PE-Xc 20 x 2.8 acc. to DIN 16892/93 S 3.2 EN 15875 –A– S 3.2 class 1+2/10 bar MPA DA) (20 bar/20 °C–10 bar/70 °C) ATG 2284 KIWA/KOMO CV 26160733021

Properties:
Linear expansion coefficient: 0.30 x 10-4 K-1
The aluminium foil/plastic sheathing gives the PE-X pipe stability, acts as a diffusion barrier to prevent the ingress of air and oxygen into the heating water, reduces linear expansion to approx. 1/5 of the basic pipe.

Application:
- In drinking water installations acc. to DIN 1988.
- In heating installations acc. to DIN EN 12831
- In surface heating (underfloor heating) acc. to DIN EN 1264 and DIN 18560.

Properties

PE-X plumbing pipe

Colour: black

Description:
PE-X plumbing pipe, black ("flex pipe"), DIN 16892/93, pipe series S 3.2. DVGW DW 8306BN0286

Marking:
Serial. meter info, manufacturer info, designation, DVGW reg. no., material, dimension, DIN, testing laboratory, pressure info, other approvals, prod. no.

Example:
(8453m) IVT PE-X pipe 20 DVGW DW 8306BN0286 ÖVGW W.1.369 PE-Xb 20 x 2.8 DIN 16892/93 S 3.2 + EN 15875 –A– S 3.2 class 1+2/10 bar OFI (20 bar/20 °C–10 bar/70 °C) KIWA VC 26160733021

Properties:
Linear expansion coefficient acc. to DIN 53752 1.60 x 10-4 K-1 plumbing pipes are flexible and coloured black for UV stabilisation.

Application:
In drinking water installations acc. to DIN 1988.

PE-X heating pipe

Colour: red

Description:
PE-X heating pipe, red, DIN 16892/93, pipe series S 3.2, oxygen-tight acc. to DIN 4726 plus anchoring agent plus 0.1 mm EVOH sheathing (ethylene vinyl alcohol)

Marking:
Serial meter info, manufacturer info, designation, material, dimension, DIN, application class, testing laboratory, prod. no.

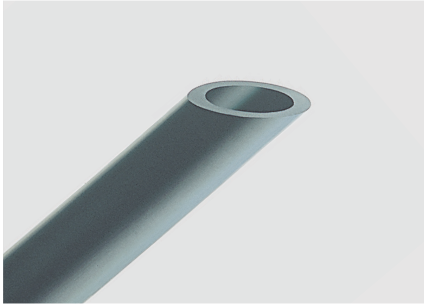
Example:
(0121m) IVT heating pipe 20 PE-Xb 20 x 2.8 DIN 16892 + EVOH oxygen-tight acc. to DIN 4726 + EN 15875 –A– S 3.2 class 4+5/10 bar OFI (KOMO CV 6 bar) 27230436201

Properties:
Linear expansion coefficient acc. to DIN 53752 1.60 x 10-4 K-1
PE-X heating pipes are flexible. The EVOH sheathing acts as a diffusion barrier to prevent air and oxygen entering the heating water.

Application:
- In heating installations acc. to DIN EN 12831
- In surface heating (underfloor heating) acc. to DIN EN 1264 and DIN 18560.

Properties

Surface heating pipe



Colour: grey

Description:
PE-X surface heating pipe, grey, DIN 16892, oxygen-tight acc. to DIN 4726 plus anchoring agent plus 0.1 mm EVOH sheathing (ethylene vinyl alcohol).

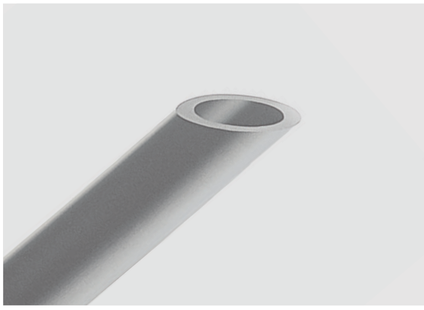
Marking:
Serial meter info., manufacturer info., designation, material, dimension, DIN, testing laboratory, prod. no.

Example:
(0121m) IVT surface heating pipe 17 PE-Xb 17 x 2 DIN 16892 + EVOH oxygen-tight acc. to DIN 4726 + EN 15875 –C– class 4/10 bar
OFI 110207080301

Properties:
Linear expansion coefficient acc. to DIN 53752 1.60 x 10-4 K-1 PE-X surface heating pipes are flexible. The EVOH sheathing acts as a diffusion barrier to prevent air and oxygen entering the heating water.

Application:
In surface heating (underfloor heating) acc. to DIN 4726, DIN 18560 and EN 1264.

Surface heating pipe PE-RT



Colour: light grey

Description:
PE-RT surface heating pipe, high flexibility, light grey, DIN 16894, oxygen-tight acc. to DIN 4724 plus anchoring agent plus 0.1 mm EVOH sheathing (ethylene vinyl alcohol).

Marking:
Serial meter info., manufacturer info., designation, material, dimension, DIN, testing laboratory, prod. no.

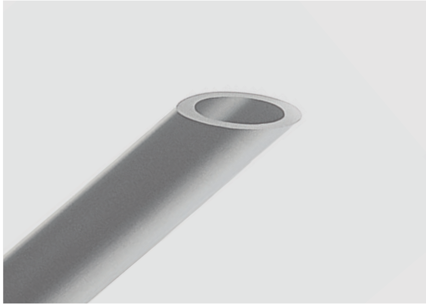
Example:
(0121m) IVT surface heating pipe, highly flexible, 17 PE-RT (type II) 17 x 2, DIN 16894 + EVOH oxygen-tight acc. to DIN 4724 –C– class 4/4 bar
OFI 110207080301

Properties:
Linear expansion coefficient acc. to DIN 53752 1,60 x 10-4 K-1 surface heating pipes PE-RT are highly flexible. The EVOH sheathing acts as a barrier to prevent air and oxygen entering the heating water.

Application:
In surface heating (underfloor heating) acc. to DIN 4724, DIN 18560 and EN 1264.

Properties

■ ***PRINETO*** surface heating pipe PE-MDS (HD-Xb S) self-cross-linking



Colour: light grey

Description:
PE-HD S (HD-Xb S) self-cross-linking surface heating pipe, highly flexible, light grey, in line with DIN 16894, oxygen-tight in line with DIN 4724 plus anchoring agent plus 0.1 mm EVOH sheathing (ethyl vinyl alcohol)

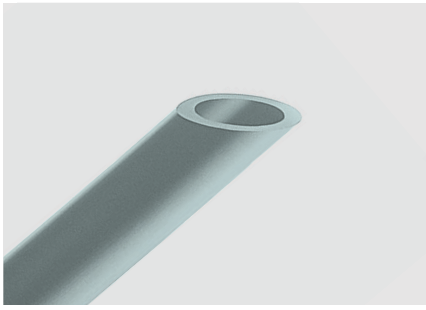
Marking:
Serial meter info., designation, manufacturer info., material, dimension, DIN, prod. no.

Example:
(0121m) IVT surface heating pipe, highly flexible 17 PRINETO PE-HDS (HD-Xb S – self-cross-linking) 17 x 2 in line with DIN 16892 + EVOH oxygen-tight in line with DIN 4726 + in line with EN 15875–C– class 4/10 bar 11020708030

Properties:
Linear expansion coefficient acc. to DIN 53752 1.60 x 10-4 K-1
PE-HDS-(HD-Xb S) surface heating pipes are highly flexible and cross-link themselves during operation. The EVOH sheathing acts as a diffusion barrier to prevent air and oxygen entering the heating water.

Application:
In surface heating (underfloor heating) acc. to DIN 18560 and in line with DIN 4724 and EN 1264.

■ Stabil surface heating pipe



Colour: Blue-grey

Description:
Stabil surface heating pipe, multilayer PE-S/AL/PE-RT composite pipe which is oxygen-tight due to its aluminium sheathing

Marking:
Serial meterage info., manufacturer info., designation, material, dimension, prod. no.

Example:
(0121m) IVT Stabil surface heating pipe 16x2.0 ***PRINETO*** composite pipe PE-S/AL/PE-RT (PE-S - self-cross-linking) 110207080301

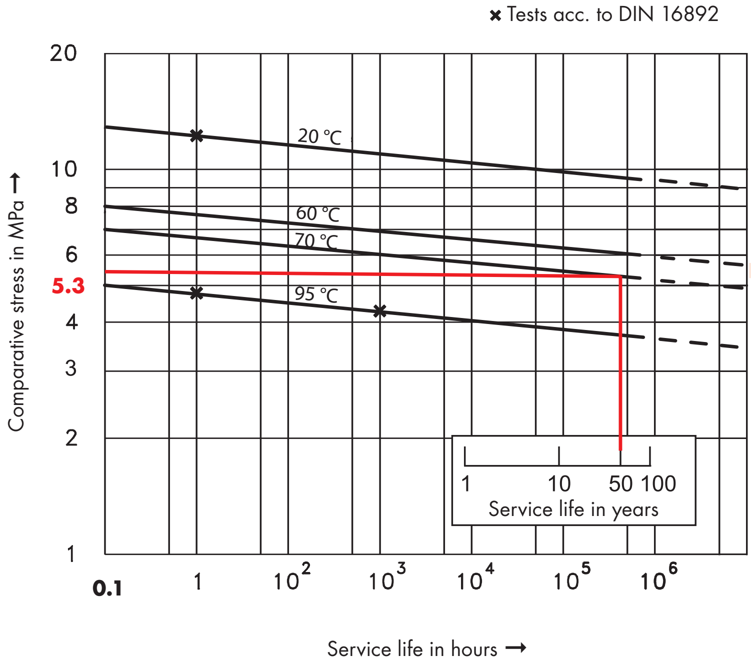
Properties:
Linear expansion coefficient: 0.30 x 10-4 K-1
The aluminium foil / plastic sheathing gives the PE-S pipe stability, acts as a diffusion barrier to prevent the ingress of air and oxygen into the heating water, and reduces linear expansion to approx. 1/5 of the basic pipe.

Application:
In surface heating (underfloor heating) acc. to DIN 4724, DIN 18560 and EN 1264

Properties

Creep behaviour

The long-period internal pressure resistance of PE-X acc. to DIN 16892 reflects the pressure load carrying power of PE-X pipes depending on the temperature of the media carried and the length of operation.



Permissible operating pressures for water as the flow medium acc. to DIN 16893, safety factor 1.5, pipe series S 3.2

Temperature	Operating years	Permissible operating pressure
20°C	10	20.4
	25	20.1
	50	20.0
	100	19.8
30°C	10	18.1
	25	17.9
	50	17.7
	100	17.6
40°C	10	16.1
	25	15.9
	50	15.7
	100	15.6
50°C	10	14.3
	25	14.1
	50	14.0
	100	13.9
60°C	10	12.8
	25	12.6
	50	12.5
70°C	10	11.4
	25	11.3
	50	11.2
80°C	5	10.3
	10	10.2
	25	10.1
90°C	1	9.5
	5	9.3
	10	9.2

Depending on pipe dimension the permissible operating pressure can be calculated using the following equation:

$$\text{Internal pressure (bar)} = \frac{\text{Comparative stress (MP) x 10 x 2 x wall thickness (mm)}}{\text{pipe diameter (mm) - wall thickness (mm)}}$$

Example:
Pipe 16 x 2.2, minimum operating period 50 years, operating temperature 70°C
→ acc. to curve 5.3 MPa

$$\text{p in bar} = \frac{5.3 \times 2 \times 2.2 \times 10}{(16 - 2.2)} = 16.9 \text{ bar}$$

→ acc. to DIN 16893, table 5, with safety factor 1.5, 11.2 bar operating pressure is permissible (16.9 : 1.5)

Length change and bending legs

Temperature changes cause length changes within the piping system. Synthetic materials have a higher linear expansion coefficient than metals. Depending on the ambient temperature during installation the temperature differences between installation and the maximum and minimum operating temperature of the piping system have to be considered:

- In the case of installation at 5°C, the expansion of a hot-water pipe up to 60°C is greater than in the case of installation at 25°C.
- Cold-media piping installed at 30°C will become shorter when carrying cold water at 10°C in winter.

The temperature-related linear expansion is calculated according to the following equation:

$$\Delta L = \alpha_i \cdot L_S \cdot \Delta\theta$$

Linear expansion: ΔL (mm)
Temperature difference: $\Delta\theta$ (K)
Pushing pipe length: L_S (m)
Linear expansion coefficient:

α_i (mm/m · K)
$\alpha_{PE\text{-}X} = 0.20$ mm/m · K
$\alpha_{STABIL} = 0.025$ mm/m · K

The length changes caused during operation and the resulting forces lead to mechanical stress on the connections. These have to be eliminated by the installation of fixed points and bending legs (cushioning capability of pipe) in the lengths specified. Non-observance can lead to damage to pipes, connections and fittings.

The required length of the bending leg is calculated as follows:

$$L_B = C \cdot \sqrt{(\Delta L \cdot d_{pipe})}$$

Length bending leg: L_B (mm)
Linear expansion: ΔL (mm)
External pipe diameter: d_{pipe}
Material constant: C
$C_{PE\text{-}X} \approx 27.5$
$C_{Stabil} \approx 36.5$

The temperature-related length changes and the required minimum bending leg lengths for flexible PE-X pipes (Nanoflex, heating and plumbing pipe) and multilayer composite pipes can be determined from the following tables.

This is based upon the expected difference in temperature (in Kelvin) and the changing pipe length. The respective length changes in millimetres are given in the two larger tables in relation to the material of the pipes (flexible or rigid).

Using the calculated value (rounded), the minimum length of the required bending leg can be determined depending on the raw material (flexible or rigid) and the respective pipe dimension.

Installation advice

Example:
A hot water riser, maximum operating temperature 60°C, is installed at +10°C. The ***PRINETO*** pipe has a length of 6 m from the lower fixed point in the cellar to the attic and could be made either of flexible PE-X pipe or multilayer composite pipe. The pipe dimension is not important at this point.

The difference in temperature is:

$\Delta\theta$ (60 °C – 10 °C)	= 50 K

Depending on the raw material, there is a change in length for the riser pipe of:

$\Delta L_{PE\text{-}X}$ (50 K, 6 m)	= 60.0 mm

or

ΔL_{STABIL} (50 K, 6 m)	= 7.5 mm (rounded to 10 mm)

For calculation of the bending leg length, the dimension and raw material of the bending leg pipe must now be taken into account. If the riser pipe is installed with multilayer composite pipe, the following bending legs result for a branching PE-X or multilayer composite pipe of dimension 25:

$L_{B,\ PE\text{-}X\ 25}$	= 435 mm

resp.

$L_{B,\ Stabil\ 25}$	= 589 mm

If the riser pipe is installed with PE-X pipe, the following bending legs result for a branching PE-X or multilayer composite pipe of dimension 25:

$L_{B,\ PE\text{-}X\ 25}$	= 1065 mm

resp.

$L_{B,\ Stabil\ 25}$	= 1442 mm

Installation advice

Temperature-dependent length change and bending leg lengths

Change in length in mm for flexible PE-X pipes of medium linear expansion coefficient 0.200 (mm per m pipe and K)

Example:
If the pipe wall temperature changes by **50 K**, a **6 m** long ***PRINETO*** Nanoflex pipe is shortened or expanded by **60 mm**.

Pipe length in m	10 K	20 K	30 K	40 K	50 K	60 K	70 K
1	2.0	4.0	6.0	8.0	10.0	12.0	14.0
2	4.0	8.0	12.0	16.0	20.0	24.0	28.0
3	6.0	12.0	18.0	24.0	30.0	36.0	42.0
4	8.0	16.0	24.0	32.0	40.0	48.0	56.0
5	10.0	20.0	30.0	40.0	50.0	60.0	70.0
6	12.0	24.0	36.0	48.0	60.0	72.0	84.0
7	14.0	28.0	42.0	56.0	70.0	84.0	98.0
8	16.0	32.0	48.0	64.0	80.0	96.0	112.0
9	18.0	36.0	54.0	72.0	90.0	108.0	126.0
10	20.0	40.0	60.0	80.0	100.0	120.0	140.0

Change in length in mm for multilayer composite pipes of medium linear expansion coefficient 0.025 (mm per m pipe and K)

Example:
If the pipe wall temperature changes by **50 K**, a **6 m** long ***PRINETO*** multilayer composite pipe is shortened or expanded by **7.5 mm**.

Pipe length in m	10 K	20 K	30 K	40 K	50 K	60 K	70 K
1	0.3	0.5	0.8	1.0	1.3	1.5	1.8
2	0.5	1.0	1.5	2.0	2.5	3.0	3.5
3	0.8	1.5	2.3	3.0	3.8	4.5	5.3
4	1.0	2.0	3.0	4.0	5.0	6.0	7.0
5	1.3	2.5	3.8	5.0	6.3	7.5	8.8
6	1.5	3.0	4.5	6.0	7.5	9.0	10.5
7	1.8	3.5	5.3	7.0	8.8	10.5	12.3
8	2.0	4.0	6.0	8.0	10.0	12.0	14.0
9	2.3	4.5	6.8	9.0	11.3	13.5	15.8
10	2.5	5.0	7.5	10.0	12.5	15.0	17.5

Installation advice

Bending leg lengths in mm for PE-X-pipes

Pipe dimension	5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	50 mm	55 mm	60 mm	65 mm	70 mm	75 mm	80 mm	85 mm	90 mm	95 mm	100 mm
14	230	325	399	460	514	564	609	651	690	728	763	797	830	861	891	920	949	976	1003	1029
16	246	348	426	492	550	602	651	696	738	778	816	852	887	920	953	984	1014	1044	1072	1100
20	275	389	476	550	615	674	728	778	825	870	912	953	992	1029	1065	1100	1134	1167	1199	1230
25	307	435	533	615	688	753	813	870	922	972	1020	1065	1109	1150	1191	1230	1268	1304	1340	1375
32	348	492	602	696	778	852	920	984	1044	1100	1154	1205	1254	1302	1347	1391	1434	1476	1516	1556

Bending leg lengths in mm for multilayer composite pipes

Pipe dimension	5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	50 mm	55 mm	60 mm	65 mm	70 mm	75 mm	80 mm	85 mm	90 mm	95 mm	100 mm
14	305	432	529	611	683	748	808	864	916	966	1013	1058	1101	1143	1183	1222	1259	1296	1331	1366
16	337	476	583	673	752	824	890	952	1010	1064	1116	1166	1213	1259	1303	1346	1387	1428	1467	1505
20	374	529	648	748	836	916	990	1058	1122	1183	1240	1296	1349	1399	1449	1496	1542	1587	1630	1673
25	416	589	721	832	931	1019	1101	1177	1248	1316	1380	1442	1501	1557	1612	1665	1716	1766	1814	1861
32	469	663	812	938	1048	1148	1240	1326	1407	1483	1555	1624	1690	1754	1816	1875	1933	1989	2044	2097
40	529	748	916	1058	1183	1296	1399	1496	1587	1673	1754	1832	1907	1979	2049	2116	2181	2244	2306	2365
50	589	832	1019	1177	1316	1442	1557	1665	1766	1861	1952	2039	2122	2202	2279	2354	2427	2497	2565	2632
63	648	916	1122	1296	1449	1587	1714	1832	1943	2049	2149	2244	2336	2424	2509	2591	2671	2748	2824	2897

Depending on the pipe dimension and pipe material, the length of the bending leg results from the extent of the length change. In the above example of linear expansion of a PE-X pipe dimension 25, a bending leg of 1065 mm is required.

If a multilayer composite pipe is used, the required bending leg in the above example is 1442 mm.

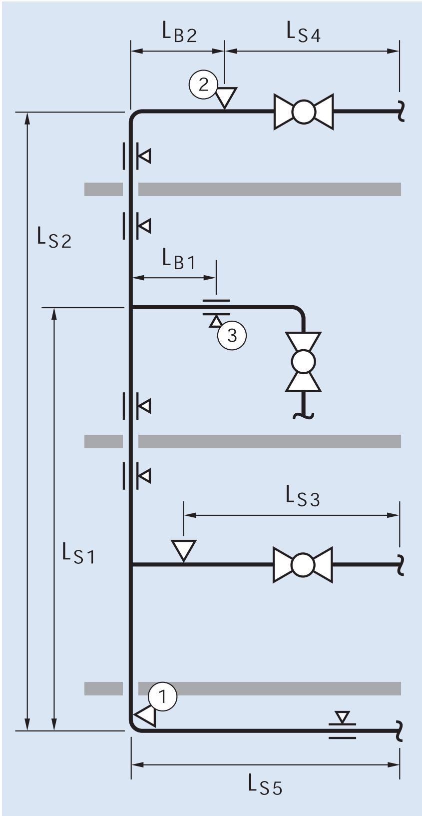
Installation advice

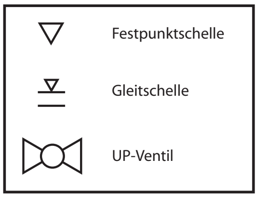
The bending legs are positioned at a right angle to the expanding pipe length, absorbing the expansion forces of the pipe.

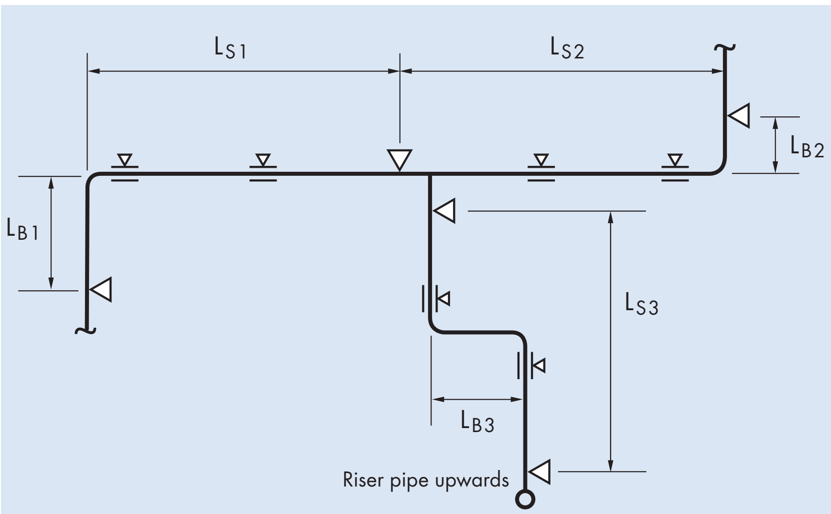
The diagram shows the (vertical section) of the hot water installation in a house with 3 accommodation units. To cushion the weight of the riser pipe a fixed-point clamp (1) is installed at the bottom of the riser shaft. The thrust of the entire riser pipe length L_{S2} is off-set by the bending leg L_{B2} on the 2nd floor. For this, it is necessary to mount the fixed-point clamp (2) in the horizontal part of the pipe on the 2nd floor at a distance of the length of bending leg L_{B2} to the riser pipe.

On the 1st floor the clamp (3) has to be mounted at a distance of the length of bending leg L_{B1} to the riser pipe, in order to take up the expansion of pipe section L_{S1} and to eliminate the mechanical stress on the tee piece. Only sliding clamps may be used on the riser pipe to guarantee unhindered upward movement.

The installation of more bending legs may have to be taken into account for expanding pipe sections L_{S3}, L_{S4} and L_{S5} depending on the further course of the pipe.

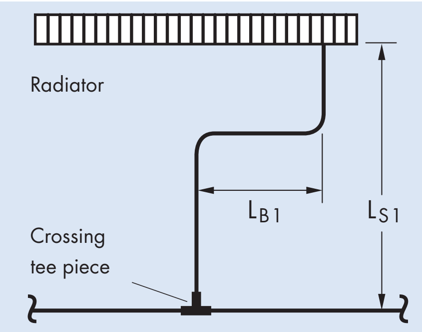






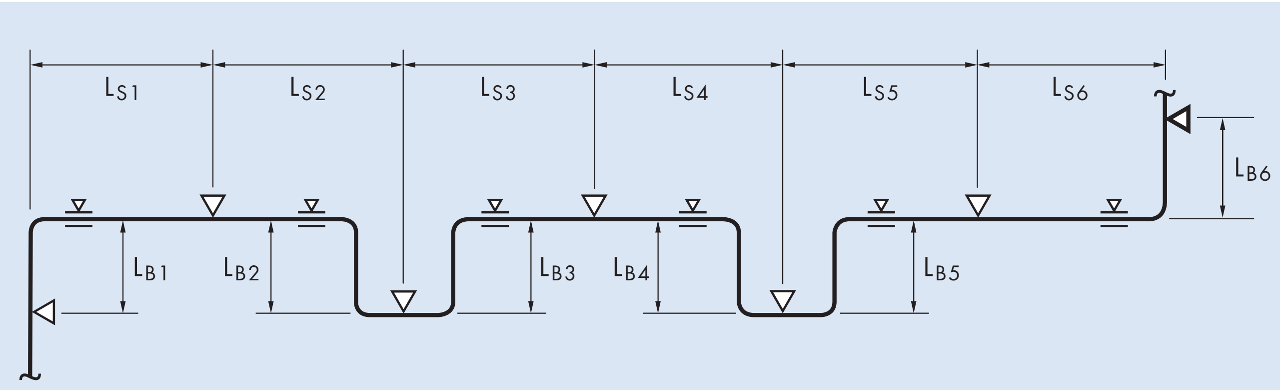
If due to structural conditions the beginning (e.g. point of intersection of the main pipe) and the end (riser pipe guided upwards) of a section is executed as a fixed point, the resultant forces have to be off-set via a S-shaped bending leg. This is shown in the top view (horizontal section) on the left.

Installation advice



A comparable situation occurs with long floor-laid radiator connection pipes. The mechanical stresses on the threaded connectors at the valve block must be avoided by laying the pipes in the form of an S or by securing them by means of a fixed-point clamp in front of the radiator.

We recommend this if the connection length L_{S1} exceeds 4 m.




Fixed-point clamp

If off-setting of the entire expansion forces at both ends is not possible in the case of straight pipeline routing, e.g. because of a 90° change in the direction of the pipes, additional expansion bends have to be installed. The position of the fixed-point clamps should be determined in such a way that the entire length of the pipe is divided up into sections of as equal a length as possible in order to get bending legs of the same size, corresponding to the equal length.

The example could be a 60 m distribution pipe in the cellar, which is divided up in such a way that each part of the expansion length is 10 m long. For this purpose fixed-point clamps are mounted in the centre of the expansion bend and the straight piping. No further clamps may be mounted in the expansion bend. Here, too, sliding clamps are used to guide the pipe.

Installation advice

2

Pipes

Fixed points and sliding clamps

With all other dimensions rubber-lined fixed-point clamps have to be used to create fixed points.

Sliding clamps must not obstruct changes in length of the pipes. Spacers must be used with the screws in order to prevent excessive tightening with these clamps. The linings of such clamps are either made of plastic material or of special rubber and are without profile.

Maximum fixing point intervals in m for horizontally laid ***PRINETO*** pipes

Pipe dimension	14	16	20	25	32	40	50	63
PE-X + Nanoflex cold media		0.70	0.75	0.80	0.90			
PE-X + Nanoflex hot media (> 40 °C)		0.60	0.65	0.75	0.85			
Multilayer composite pipe cold media	0.80	1.00	1.00	1.25	1.50	1.50	1.75	1.80
Multilayer composite pipe hot media (> 40 °C)	0.70	0.80	0.90	1.00	1.10	1.30	1.45	1.50

Sagging of flexible PE-X pipes

Horizontally laid pipes tend to sag between the clamps. In case of cold-media piping ∅ 25 and 32 sagging will hardly be observed. In the case of hot-media piping in particular, the change in length as the pipe heats up may result in noticeable sagging between the clamps. This sagging can be consciously taken into consideration when planning piping routing. Firmly tightened rubber-lined clamps can ensure uniform sagging between the fasteners.

In the case of a PE-X pipe a linear expansion of 10 mm is to be expected with a clamp interval of 1 m and a temperature increase of 50 K; this will result in sagging by approx. 4 cm.

If sagging is not acceptable for reasons of appearance, multilayer composite pipes must be used. Where PE-X piping size 16 and 20 which is 100% thermally insulated is laid in the screed or under plasterwork, measures are not generally required to compensate for changes in length. Where piping is laid in exposed areas (cellar distribution, piping routes etc.) multilayer composite pipes are more suitable than PE-X pipes since they have better dimensional stability and less linear expansion when heated.

Installation at below-zero temperature

PRINETO pipes should preferably not be laid at below-zero temperatures (preheat location of installation, if necessary). The pipe material is heavily stressed during widening and when bending narrow radii. The expandability of the pipe material decreases as temperature decreases. For this reason, work must be done slowly and evenly. In cold conditions, the widened pipe sockets and pipe bends must be checked for damage (e.g. overstraining or bend).

The following temperature data refer to the pipe material near the processing area. Ambient temperatures can also be lower. Do not widen or bend heating pipes and surface heating pipes at temperatures under 0°C. Work slowly and evenly at temperatures < 20°C. Do not widen or bend multilayer composite pipes 40 and 63 at temperatures under 0°C. Do not widen or bend plumbing or Nanoflex pipes or any multilayer composite pipes 14 and 32 – at temperatures under –5°C.

Installation advice

Potential equalisation

PRINETO pipes are made of electrically non-conducting plastic material. Therefore these pipes cannot be used for electrical potential equalisation. In the case of repair work on metal piping, e.g. in old buildings, it is important to re-establish the electrical potential equalisation which originally existed across the "old" metal water pipes. In this case, the newly fitted ***PRINETO*** pipes must be bridged in an electrically conducting manner.

Bending

PE-X-/PE-RT pipes:
Minimum bending radius (freely bent, referenced to pipe centre) = 8 x external pipe diameter
(8 x 16 mm = 128 mm/8 x 20 mm = 160 mm etc.)

Minimum bending radius in curved pipe guide = 5 x external pipe diameter (5 x 16 mm = 80 mm etc.) Secure bending radius by means of guide elbow or fixing of legs on the surface. Use of plastic dowel hooks is recommended. Install pipes in such a way as to prevent them collapsing in bending zones due to linear expansion.

Multilayer composite pipe:
Minimum bending radius for multilayer composite pipes (freely bent, referenced to pipe centre) = 5 x external pipe diameter
(5 x 17 mm = 85 mm/5 x 21 mm = 105 mm etc.)

The pipe dimensions 40 to 63 can only be bent with suitable matrices (42, 52 and 63 mm). We recom-mendenlarging the bending radius since the pipes tend to become slightly oval at 5 x d. multilayer composite pipes tend to spring back after bending. For this reason, the bending angle of the multilayer composite pipe must be exceeded by about 15°.

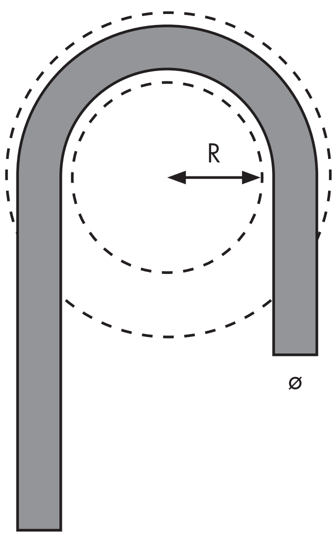


Fig.: bending radius

Minimum bending radius for multilayer composite pipe 16 and 20 (referenced to pipe centre) = 4.5 x external pipe diameter, can be obtained with bending spring or bending device with lateral guide. Hot bending is not advisable. The material would have to be heated to the crystallite melting point at 135°C to achieve permanent deformation. In addition, damage to the structure can-not be excluded if an air heater is used.

NOTE

Do not bend pipes directly next to pressed connections!

Installation advice

Minimum distance between the fittings

Due to structural conditions it may be necessary to install fittings as close as possible to each other (e.g. branch out of riser pipe). The bigger the pipe dimensions, the larger the distances between the axes of the fittings.

The minimum distance between the fittings depends on the z measures of the two fitting ends to be connected (z measure for each fitting in chapters 3 and 5 and in the price list) and the minimum pipe length required for making the connection. In turn, this minimum pipe length L_{pipe}, min, i depends on the length of the sliding sleeve used L_{sleeve}, i plus the space needed for placing the sliding jaw behind the sliding sleeve:

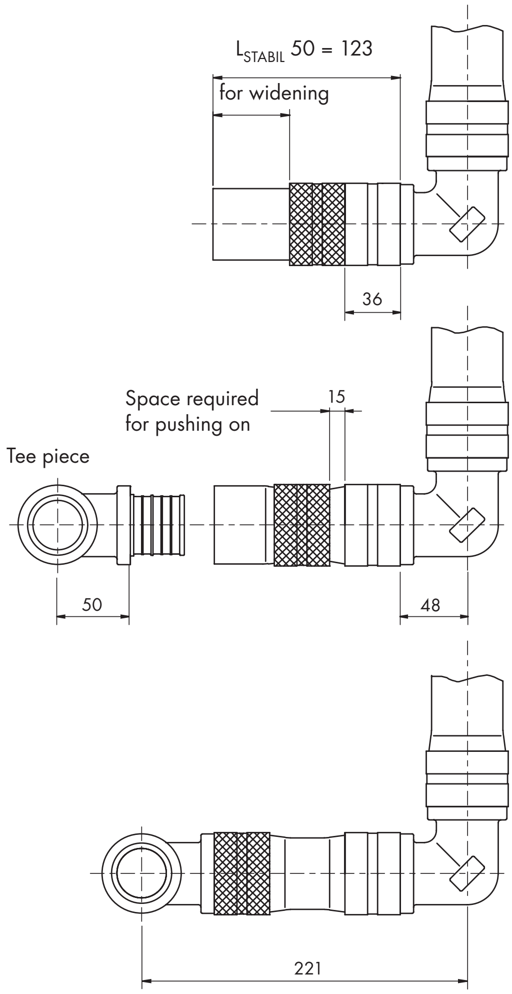
$$L_{pipe,\ min,\ i} = 3 \cdot L_{sleeve,\ i} + X_i$$

Example multilayer composite pipe 50:

$L_{sleeve\ 50}$ = 36 mm
$X_{Stabil\ 50}$ = 15 mm

$$L_{Stabil\ 50} = 3 \cdot 36 + 15 = 123 \text{ mm}$$

The required minimum pipe lengths for effecting a ***PRINETO*** connection can be taken from the following table:



Pipe dimension	14	16	20	25	32	40	50	63
Minimum pipe length L_{pipe}, min, i (mm)	48	66	75	93	106	111	123	130

For calculating the minimum distances between the fittings the two z-values of the fittings have to be added to the minimum pipe length:

$$L_{tot} = L_{pipe,\ min,\ i} + z_a + z_b$$

Example multilayer composite pipe 50 with angle and tee piece 50 (pressed on outlet = z_2 – value!):

$L_{Stabil\ 50}$ = 123 mm
$z_{angle\ 50}$ = 48 mm
$z_{2,\ Tee\ 50}$ = 50 mm

$$L_{tot\ 50} = 123 + 48 + 50 = 221 \text{ mm}$$

The minimum fitting distance (distance between pipe axes) in the above example would be 221 mm.

This value can be reduced only by combining a tee piece with internal thread and an angle transition with external thread. This may be necessary for the cross-over from a cellar distribution pipe if dropping below the permissible doorway height is to be avoided.

Fire protection insulation

As a rule, fire protection insulation is always required where fire-resistant walls and ceilings are breached by building piping systems. In this case measures have to be taken to prevent the spreading of fire and smoke in accordance with protection objectives in building regulations. These measures are classified according to the type or use of buildings and their respective materials.

These are based on the Model Building Regulations (MBO 2002-11) which are precisely defined in the state building regulations of the Federal states. The model piping directive (MLAR 2005-11) describes the requirements made of piping systems in escape and rescue routes and where they pass through walls and ceilings with fire protection requirements.

Material classes

A distinction is made between combustible and incombustible materials. Incombustible materials are subdivided into A1 and A2:

- A1 would be e.g. concrete or a pipe shell made of stone wool
- A2 would be e.g. pipe shells of stone wool with aluminium lamination (a very low percentage of combustible adhesive and fabric)

Combustible materials are subdivided into B1, B2 and B3:

- B1 are flame-resistant materials, e.g. plasterboards (these products keep on burning only with supporting fire and are self-extinguishing).
- B2 are normally flammable materials, e.g. polyethylene (these products keep on burning also without supporting fire, do not extinguish fire themselves).
- B3 are highly flammable materials (these must not be used in buildings according to the state building regulations).

Fire resistance classes

Classification of resistance times (in minutes) of the various building components against the effects of flames. 30 minutes – flame-retardant, 60 minutes – highly flame-retardant, 90 minutes – fire-resistant, 120 minutes – highly fire-resistant. Depending on the building component different code letters are used:

Selected building components	**Classified acc. to DIN 4102**	**Duration of fire resistance in minutes**				
		≥ 30	**≥ 60**	**≥ 90**	**≥ 120**	**≥ 180**
Walls, ceilings, supports, beams, staircases	Part 2	F 30	F 60	F 90	F 120	F 180
Non-supporting external walls	Part 3	W 30	W 60	W 90	W 120	W180
Fire protection closures (doors, gates, flaps)	Part 5	T 30	T 60	T 90	T 120	T 180
Pipes and fittings for ventilation systems	Part 6	L 30	L 60	L 90	L 120	
Cable isolation	Part 9	S 30	S 60	S 90	S 120	S 180
Installation shafts and channels	Part 11	I 30	I 60	I 90	I 120	
Pipe ducts	Part 11	R 30	R 60	R 90	R 120	
Continued function of electric installations	Part 12	E 30	E 60	E 90		

Fire protection insulation

The ***PRINETO*** PE-X and multilayer composite pipes are classified in material class B2 as combustible construction materials. They are normally flammable and keep on burning even without a supporting fire. In each case it must be checked whether the details of the model piping directive correspond to the respective state building regulations. In accordance with MLAR 2005, the following requirements are made of combustible piping systems carrying non-combustible media.

Piping systems of all diameters

PRINETO pipes with and without insulation are allowed to be laid through walls and ceilings between separate fire compartments, either in common or separate openings and drilling openings, if the following requirements are met:

- Tested or approved systems with general official building test certificates (ABP) or certificates issued by the building authorities (ABZ) must be used which have at least the same fire resistance power as the space-enclosing components.
- The minimum distance between bulkheads and installation shafts or channels and the required distance to other ducts (e.g. ventilation pipes) or other opening closures (e.g. fire doors) is determined by the conditions of the respective test or approval.
- If no relevant specifications are given, a distance (measured between the insulating layer surfaces near the bushings) of at least 50 mm is required.
- Detailed installation requirements, such as insulation material lengths and thicknesses or the filling of residual openings can also be found in the respective ABP or ABZ.

There are no special fire protection requirements for the piping area outside the bushings. The low-cost ***PRINETO*** pipe shell Rockwool 800 can be used for our multilayer composite pipes (Rockwool 800, ABZ Z-23.14-1114 in conjunction with ABZ Z-19.17-2009).

Pipe bushing for wall acc. to ABZ Z-19.17-2009

Single pipe	**Pair of pipes with zero distance**	**Pipe type**	**Insulation layout**	**Rockwool RS 800**		**Fire protection**		**Filling material**
				Length	Thickness	Class	Back-up	
x	x	Stabil 14	symmetrical	≥ 250 mm	≥ 20 mm	R 90	Binding wire at least every 20 cm. Non-combustible holder at a distance of ≥ 50 cm away from the wall.	Non-combustible materials which retain their shape (acc. to DIN 4102-A) e.g. concrete, cement or plaster mortar. Filling up to component thickness
x	x	Stabil 16 to 32	symmetrical	≥ 250 mm	≥ 20 mm	R 90		
x	x	Stabil 40 to 63	symmetrical	≥ 500 mm	≥ 20 mm	R 90		
x	x	Stabil 14	asym. away from dir. of fire	≥ 500 mm	≥ 20 mm	R 90		
x	x	Stabil 16 to 63	asym. away from dir. of fire	≥ 500 mm	≥ 30 mm	R 60		
x	x	Stabil 14	asym. towards fire	≥ 500 mm	≥ 20 mm	R 90		
x		Stabil 16 to 63	asym. towards fire	≥ 500 mm	≥ 30 mm	R 60		
	x	Stabil 16 to 63	asym. towards fire	≥ 500 mm	≥ 30 mm	R 60		

Fire protection insulation

Pipe bushing for ceiling acc. to ABZ Z-19.17-2009

Single pipe	Pair of pies with zero distance	Pipe type	Insulation layout	Rockwool RS 800		Fire protection		Filling material
				Length	Thickness	Class	Back-up	See wall. Joints up to 30 mm wide may be stuffed with mineral wool, melting point at least 1000°C according to DIN 4102-17.
x	x	Stabil 14 to 32	symmetrical	≥ 1000 mm	≥ 20 mm	R 120	Binding wire at least every 20 cm.	
x	x	Stabil 40 to 63	symmetrical	≥ 1000 mm	≥ 30 mm	R 120		
x	x	Stabil 14	symmetrical	≥ 1000 mm	≥ 20 mm	R 120		
x	x	Stabil 16 to 63	asymmetrical downwards, level to the ground on top	≥ 1000 mm	≥ 30 mm	R 120		

Our fire protection insulation shells Conlit 150 U can be used for all ***PRINETO*** pipes (Rockwool Conlit U, ABP P-3726/4140-MPA BS).

Simplification rules for *PRINETO* pipes ≤ 32 mm external diameter

Non-insulated pipes

... are allowed to be laid through walls and ceilings between separate fire compartments in common openings and drilling openings, if the following requirements are met:

- The wall or ceiling must have the following thickness, depending on the FR class: F 90 ≥ 80 mm, F 60 ≥ 70 mm, F 30 ≥ 60 mm.
- The clear distance of the pipes near the ducts must correspond at least to five times the largest pipe diameter.
- The space between the pipes and the surrounding components must be completely filled with cement mortar or cement to the minimum structural component thickness.

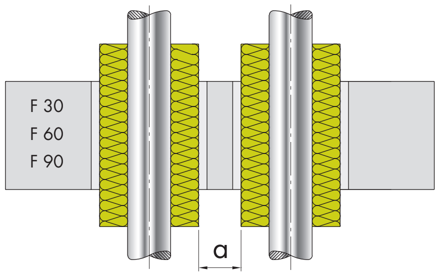
... are allowed to be laid through walls and ceilings between separate fire compartments in their own openings and drilling openings in each case, if the following requirements are met:

- Requirements as for common openings and drilling openings, with the following supplement.
- The space (gap) between the pipes and the surrounding structural components can also be filled completely with non-combustible mineral fibres (melting temperature > 1000°C, gap width max. 50 mm) or with materials which are intumescent in the event of fire (gap width max. 15 mm).

Insulated pipes

... are allowed to be laid through walls and ceilings between separate fire compartments, either in common or separate openings and drilling openings, if the following requirements are met:

- The wall or ceiling must have the following thickness, depending on the FR class: F 90 ≥ 80 mm, F 60 ≥ 70 mm, F 30 ≥ 60 mm.
- The space between the pipes and the surrounding components must be dimensioned according to non-insulated pipes and sealed.
- The insulation in the area of the pipe duct must consist of incombustible materials with a melting temperature of at least 1000°C.
- They can have a sheathing of combustible materials of up to 0.5 mm thickness.
- Their length must be at least equal to the thickness of the wall or ceiling.
- The clear distance "a" of the pipes measured between the insulating layer surfaces near the ducts, must be at least 50 mm.
- In case of continuative insulations (outside the fire wall or ceiling) made of combustible materials, sheathing made of steel sheet or insulation made of non-combustible materials must be provided on both sides of the duct over a length of 500 mm.



R90-duct without ABP

Fire protection insulation

Piping systems in escape and rescue routes

Necessary stairwells, corridors and exits to the outside, as well as rooms between these: Here, only piping systems which are exclusively used for directly supplying these rooms or for fire-fighting purposes are permitted. Piping installations with combustible pipes can be laid through such areas, if the following requirements are met:

- They must be routed in slits in solid walls which are sealed by mineral plaster at least 15 mm thick on non-combustible plaster bases, or by panels at least 15 mm thick made of mineral materials.
- They must be routed in installation shafts, channels or suspended ceilings. They must – including the covers over the openings – be made of non-combustible materials and have fire-resistance properties which correspond to the maximum necessary fire resistance classes of the enclosing components that they breach. The openings must be sealed airtight all the way round. Attachment of the installation shafts and channels must be carried out with non-combustible means of attachment.

NOTE

Single lines with ***PRINETO*** pipes laid in exposed areas are only permissible if an exemption or exception has been granted by the building authorities responsible. Such an application is possible for ***PRINETO*** fire protection and thermal insulation shells with insulation thickness 30 mm; the expert reference no. is 3335/1111 MIC.

These piping systems can also have insulation of combustible materials. There are simplified regulations for corridors in building class 1 to 3 with less than 200 m^2 useful area which are not special buildings.

Cold-media piping systems

It must be noted that cold-media pipes produce condensation and therefore require a steam brake in accordance with DIN 1988-1 to prevent the insulating mineral wool becoming soaked. Condensation-proof insulation systems must be used for these pipes. In the case of these insulations the outer skin has a sandwich-like structure of alu – PE – alu. This compound is also resistant to chemical attacks by concrete or mortar. If required, unclad pipe shells must be sheathed on site with resistant aluminium foil.

The fire loads of the pipes are:

14 x 2.0 = 1.01 kWh/m
16 x 2.2 = 1.22 kWh/m
20 x 2.8 = 1.71 kWh/m
25 x 3.5 = 2.89 kWh/m
32 x 4.4 = 4.57 kWh/m
42 x 4.5 = 4.89 kWh/m
52 x 5.6 = 7.79 kWh/m
63 x 6.0 = 11.37 kWh/m

Pipe insulation

Insulation for the purpose of obligatory defect-free performance not only serves to limit heat loss or to prevent the unacceptable increase in temperature of the medium but, even more, to fulfil important contractual targets (e.g. unhampered mobility for linear expansion, reduced transmission of structure-borne sound, mechanical protection etc.). Further requirements, defined and described by the customer (e.g. in a contract for services), can also be of relevance. Insulation execution is described in DIN 4140.

Insulation of cold drinking water

The insulation of cold- and hot-media drinking water piping is regulated in Part 200 of DIN 1988. DIN EN 806-2 does not supplement it in this regard. Installed cold drinking water piping must be protected against warming and condensation. Pipes must at least be installed with protection (e.g. pipe-in-pipe) if they are in contact with the structure (e.g. under plaster or in pre-wall installation systems). For residential buildings, standard values for the minimum thickness of insulation layers are stated in DIN 1988 (see following table), and these apply under normal operating conditions. If the water does not circulate for lengthy periods, warming cannot be prevented despite insulation. The chosen routing of the pipe must ensure that the water temperature does not exceed 25°C at the latest 30 s after a fitting is opened.

Standard values for the minimum thickness of insulation coatings for the insulation of drinking water piping (cold), acc. to DIN 1988 part 2, part 200, table 8.

Installation situation	**thickness of insulation layer if thermal conductivity equals 0.040 W/mK***
Piping laid exposed in unheated rooms, ambient temperature <20°C (condensation protection only)	9 mm
Piping laid in pipe shafts, floor ducts and suspended ceilings, ambient temperature < 25°C	13 mm
Piping laid in, for example, technical services rooms or service ducts and shafts with thermal loads and ambient temperatures >25°C	insulation as for hot water pipes, Table 9, installation situations 1 to 5
Pipes for individual storeys and individual supply pipes in pre-wall installations	pipe-pipe or 4 mm
Pipes for individual storeys and individual supply pipes in floor structures (including next to hot non-circulating drinking water pipes)**	pipe-in-pipe or 4 mm
Pipes for individual storeys and individual supply pipes in floor structures next to hot-media circulating pipes)**	13 mm

*) For other thermal conductivity values the thicknesses of the respective insulation layers must be converted accordingly for a diameter of d = 20 mm. Reference temperature for the stated thermal conductivity: 10°C

**) In conjunction with underfloor heating systems, pipes for cold drinking water must be installed so that the water temperature does not exceed 25°C at the latest 30 s after a fitting is opened.

Pipe insulation

Insulation of hot drinking water and heating

Insulation of hot drinking water and heating
For hot water pipes the same requirements are stated in DIN 1988-200 as in EnEV 2014 Appendix 5 Table 1. DIN 1988-200 and EnEV contain the minimum requirements under public law for the reduction of heat dissipation. The pipe insulating regulations of the EnEV are applicable to heating and sanitary installations, but not to solar systems.

Acc. to EnEV, annex 5, table 1, heat distribution and hot water piping systems and fittings have to be 100 % insulated (lines 1 to 4) or, e.g. in areas of crossings or wall or ceiling breakthroughs, 50 % insulated (line 5). The percentage values given for the thickness of insulation materials with a thermal conductivity of 0.035 W/mK relate to the respective internal pipe diameter.

NOTE

Corrugated pipe or protective pipe does not constitute insulation within the meaning of EnEV. As already indicated by its name, the protective pipe is only a mechanical protection for the interior pipe against damage or to prevent condensation forming in the case of cold water pipes acc. to DIN 1988. The pipes laid in the protective pipe must therefore be classified as non-insulated pipes. Pipe-in-pipe piping may therefore be laid only in places where insulation acc. to EnEV is not required.

Heat insulation of heat distribution and hot water piping system and fittings acc. to EnEV annex 5 table 1

Line	Kind of pipe/faucet	Minimum thickness of insulation at thermal conductivity 0.035 W/mK *
1	Internal diameter up to 22 mm (***PRINETO*** 14 to 25)	20 mm
2	Internal diameter from 22 mm up to 35 mm (***PRINETO*** 32 to 40)	30 mm
3	Internal diameter from 35 mm up to 100 mm (***PRINETO*** 50 to 63)	same internal diameter
4	Internal diameter more than 100 mm	100 mm
5	Piping and fittings acc. to lines 1 to 4 in wall and ceiling breakthroughs, in the area of crossings of pipes, at pipe connections, in central distribution pipe networks	½ of requirements of lines 1 to 4
6	Pipes of central heating systems acc. to lines 1 to 4 which are laid in building components between heated rooms of different users after 31st January 2002	½ of requirements of lines 1 to 4
7	Piping in floor structure acc. to line 6	6 mm
8	Cold distribution and cold water pipes as well as fittings of room ventilation and air conditioning cooling systems.	6 mm
9	Piping and fittings according to lines 1 to 4 which are adjacent to fresh air.	double the requirements of lines 1 to 4
10	Central heating pipes according to line 1 to 4 in heated rooms or in components between the rooms of the same user, the exposed shut-off fittings which influence heat emission	no requirements
11	Hot water branch pipes up to 4 metres in length which are not integrated in the circulation circuit or are equipped with electric trace heating.	no requirements

* For other conductivity values the insulation layer thicknesses must be determined according to DIN V 4108-4 tables 15 and 16.

Pipe insulation

Example multilayer composite pipe 25

Internal pipe diameter 18 mm (< internal diameter 22 mm)	
Insulation thickness 100 %	= 20 mm for WLG 035 or 26 mm for WLG 040
Insulation thickness 50 %	= 10 mm for WLG 035 or 13 mm for WLG 040

Example Nanoflex pipe 32

Internal pipe diameter 23.2 mm (internal diameter between 22 mm and 35 mm)	
Insulation thickness 100 %	= 30 mm for WLG 035 or 38 mm for WLG 040
Insulation thickness 50 %	= 15 mm for WLG 035 or 19 mm for WLG 040

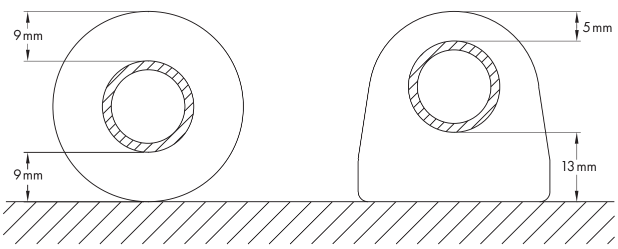
Piping for central heating systems which is laid in building components between heated rooms for different users (e.g. in separating wall between living room of family C and children's room of family B), must also be only 50% insulated (line 6). Hot water piping is excepted from this.

Line 7 refers to line 6. Accordingly, pipes for central heating systems laid in the floor structure have to be provided with concentric insulation 6 mm WLG 035 (corresponds to 9 mm for WLG 040) in building components between heated rooms for different users (e.g. in a floor between living room of family A and living room of family C).

Eccentric insulation of 13 mm thickness is equivalent to concentric insulation of 9 mm thickness (corresponds to 6 mm WLG 035, line 7) and complies with the approved regulations of this technology (official explanation to annex 5: "Apart from that, the requirements are formulated in such a way that other versions than the usually concentric structure of pipe insulation are also permissible, if for instance the same overall insulating effect can be achieved with reinforced insulation towards the cold side as that achieved with concentric insulation.").

In accordance with the specifications of the expert commission for building engineering of the Federal Building Ministers conference, other thermally insulating layers of the building structure must not be used and offset as pipe insulation. According to the test certificate, all eccentric insulation may only be installed between the heated rooms of one or different users. In other words, an eccentric 100 % insulation must never be installed on a floor slab adjacent to ground or above an unheated room. It can only replace a concentric 100 % insulation in exceptional cases if there is a heated room underneath and the pipe insulation is embedded in the floor insulation layers on both sides (limiting of the uncontrolled heat emission for at least one user).

No requirements for minimum insulation material thickness are made in respect of pipes in central heating systems which are located in heated rooms or in structural components between heated rooms of the same user, and whose heat emission can be influenced by exposed shut-off devices (e.g. thermostat valves for heating systems). This applies also to hot water branch pipes up to 4 metres long which are neither included in the circulation circuit, nor provided with electric trace heating.



Section comparison concentric – eccentric, 9+9 = 13+5

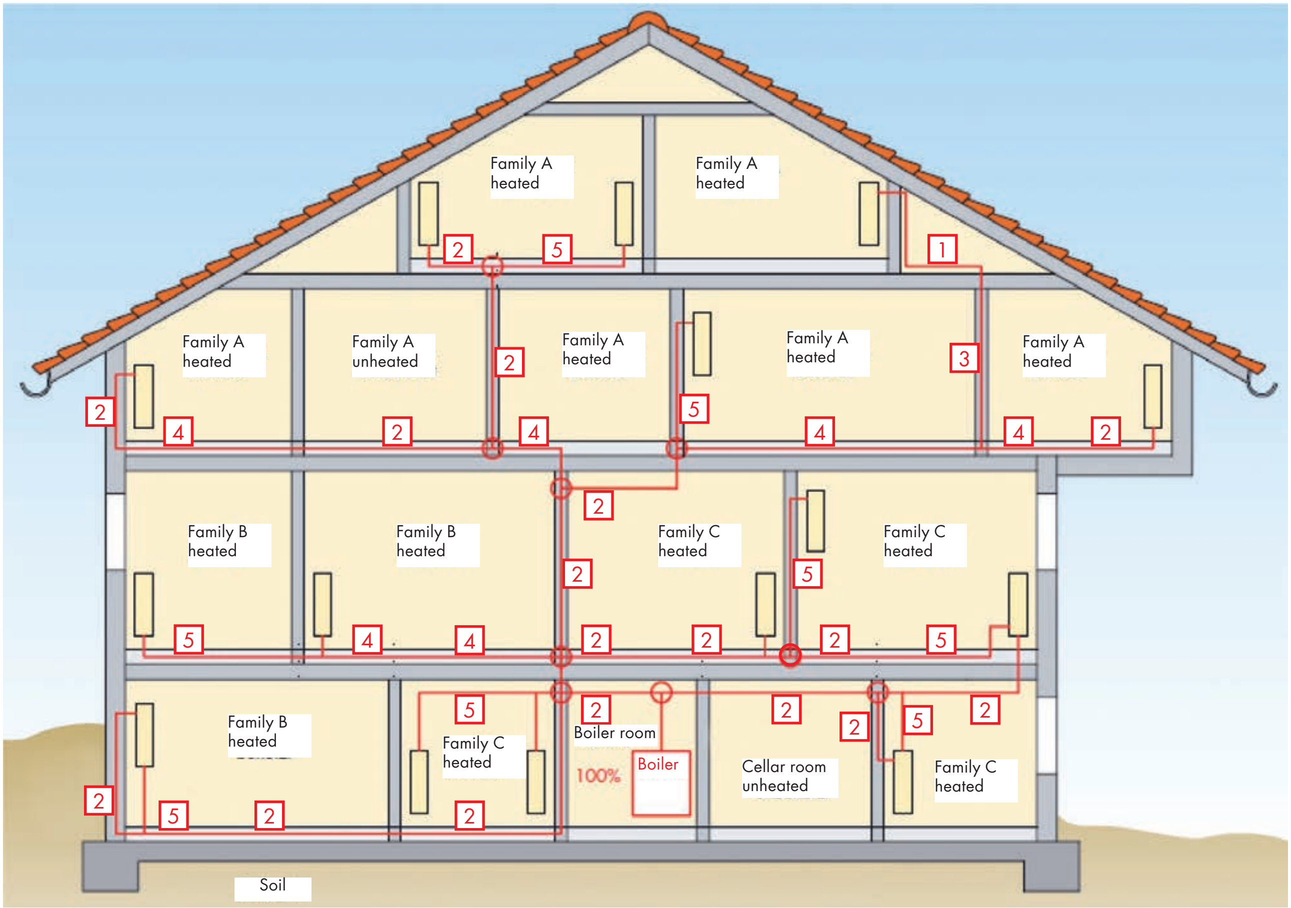
TIP

Sheathing of pipes and connections with corrugated pipe or thin insulation is also recommended for reasons of corrosion protection or prevention of creaking and flow noises, unhampered linear expansion or sound insulation, even if the EnEV does not make any specific requirement for the respective pipe section.

Pipe insulation

Insulation examples for heating pipes according to EnEV

In the house sections insulation examples for various components, users and room temperatures are depicted. The pipe routing is only for demonstration and does not represent an applicable piping diagram!



1 = concentric 200 %

2 = concentric 100 %

3 = concentric 50 %

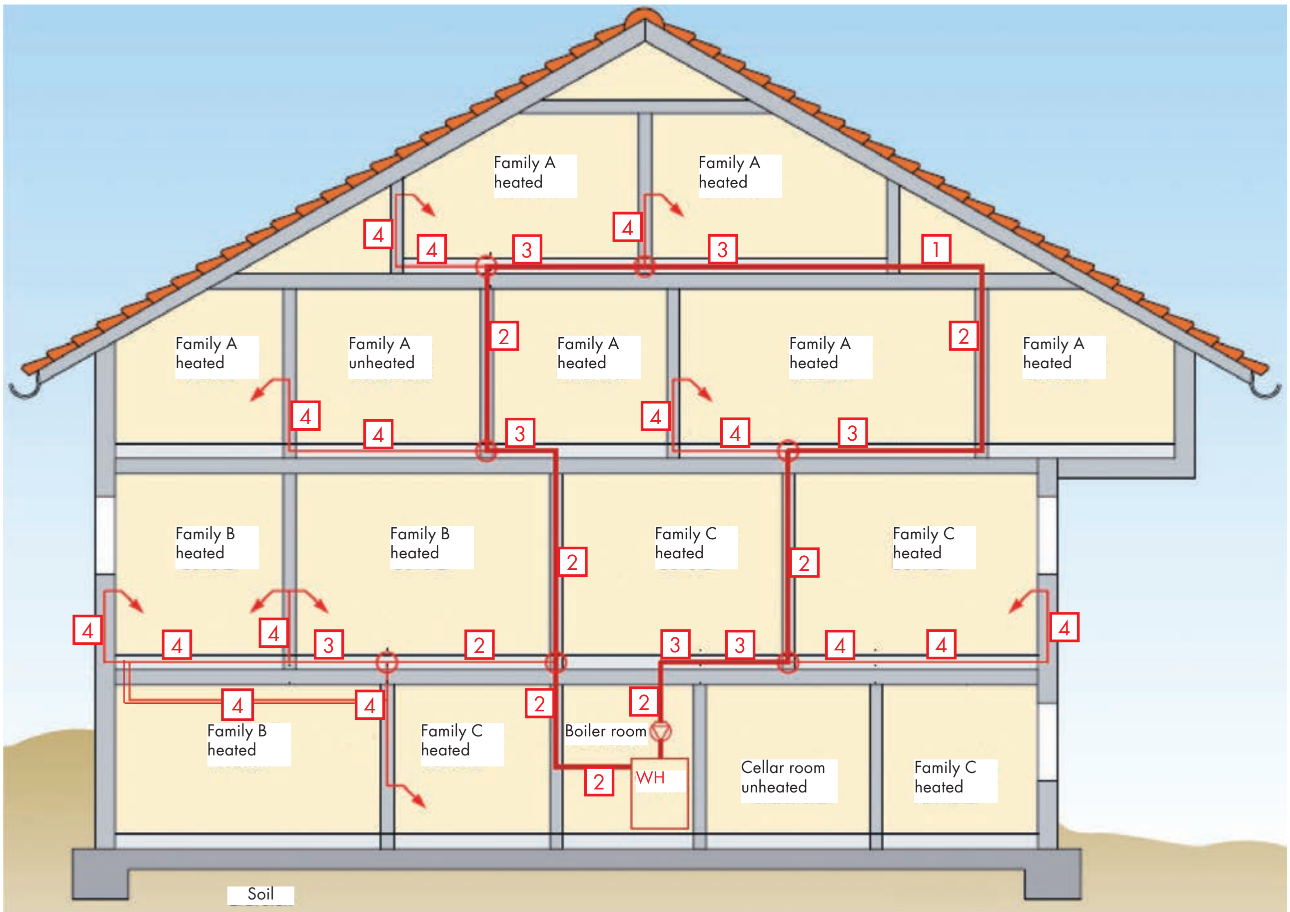
4 = concentric 9 mm or eccentric 50 % or Quadro 7 mm

5 = no requirement

○ = 50 %

Pipe insulation

Insulation examples for hot water piping systems according to EnEV



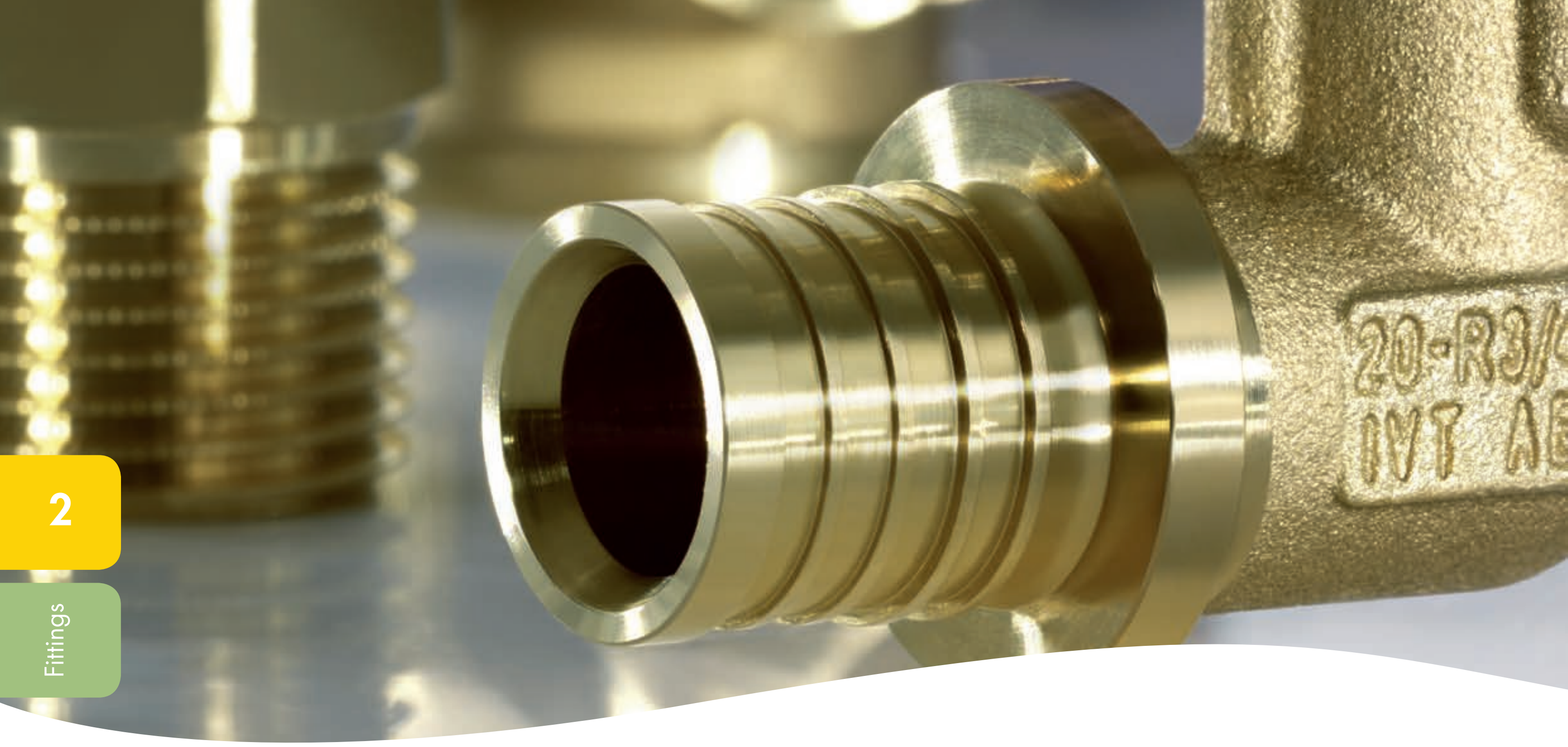
1 = concentric 200 %

2 = concentric 100 %

3 = concentric 100 %, eccentric 100 % also possible if embedded in floor insulation

4 = no requirement unless water content < 3 l

○ = 50 %



PRINETO Fittings

General basics

Material

PRINETO fittings can be used universally with all ***PRINETO*** pipes (exception: fittings for surface heating system). All standard fittings (e.g. tee pieces, angles or transitions) can be used for both plumbing and heating installations.

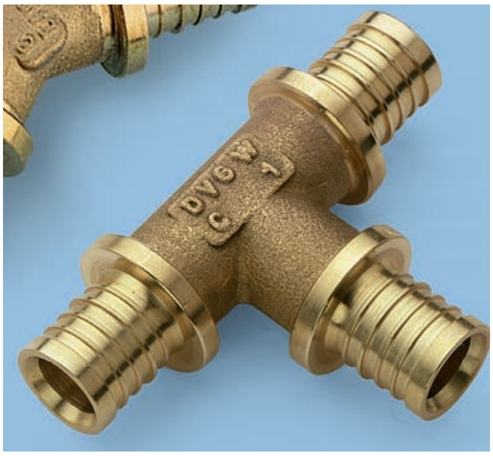
The fittings are made of tin-plated brass CW617N. This material provides good resistance against neutral, alkaline and organic liquids. The material is approved as per DVGW certificate 8501AT2606 as pipe connection material in drinking water installations.

Special fittings made of ***Cuphin*** supplement the standard fittings range. Cuphin is a new type of lead-free, dezincification-resistant installation material made of the special brass CuZn21Si3 and is insensitive to tension cracks. It is particularly suitable for use in areas with drinking water qualities where tension cracks have occurred in brass fittings of smaller dimensions in the past. The ***Cuphin*** fittings have a rectangular marking, distinguishing them from our standard fittings.

Fittings made of the high-performance plastic PPSU offer a durable and economic alternative. The machining can be done using the same sleeves and tools. PPSU has excellent hygiene properties and is particularly suitable for a durable, corrosion-resistant and lead-free drinking water installation.

The sleeves are made of brass CuZn39Pb3 (CW 614 N acc. to DIN EN 1254-3) and then heat-treated. Due to their material properties they cannot crack either during pressing or in their installed position.

Fittings which have been designed specially for the connection of heating radiators are made of brass CuZn38Pb1.5.



PRINETO special fittings CUPHIN

- Special brass CuZn21Si3
- Lead-free
- Insensitive to tension cracks
- Has a similar material strength to steel
- Material treatment like standard brass

PRINETO special fitting PPSUs

- Hygienic (corrosion-resistant and lead-free)
- Robust and durable
- Low weight for easy handling
- No costs for new tools
- Can be used with the usual sliding sleeves
- Can be combined with all ***PRINETO*** pipe types and ***PRINETO*** metal fittings

General basics

Threaded fittings

The corresponding threaded fittings made of dezincification-resistant special brass or red brass are suitable for the corrosion-resistant ***PRINETO*** system.

Outer corrosion

PRINETO fittings may have to be protected against corrosion on the outside (e.g. installations in stables – air containing ammonia!). Ammonia, amines, ammonium salts or sulphur dioxide etc. may lead to tension crack corrosion. Therefore, insulation materials must be free from nitrite and must not exceed a percentage of 0.2% by mass of ammonia. This is guaranteed if our pre-insulated pipes are used. If the fittings may come into contact with moisture over a long time (e.g. buried pipes) they have to be insulated against water.

PRINETO PPSU fittings

PPSU is a corrosion-free and impact-resistant high-performance material. Nevertheless, components in cleaning agents, paints or foams can have a harmful effect on the properties. For this reason, only foams or other auxiliary materials that have been approved by their respective manufacturer for use with PPSU may come into contact with the fittings. In case of doubt, suitable measures must be taken to protect the fitting from the substances in question. Suitable products from Denso or KEBU can be used here, for example.

Soldering transition fittings

All fittings for the transition to soldered copper systems may only be soft-soldered (soldering transition nipple and sockets). These transitions may only be pressed with the ***PRINETO*** pipes once the soldered connection has been made and has cooled to the point where it can be touched. Soldering transition nipples made of brass cannot be used for radial pressing. Stainless steel transitions are available in the product range for this purpose.

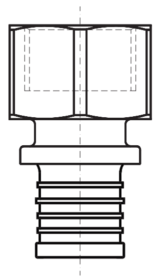
Threads

The threads comply with DIN 10226 Part 1 – cylindrical internal thread (Rp), tapered external thread (R); sealing in thread.
This does not include valve extensions with cylindrical internal and external threads, screw-in parts and union nuts (G). These threads comply with DIN ISO 228.
Only materials which do not trigger tension cracks are to be used as thread sealants. The product description should contain information such as "suitable for plastic pipes" and the DVGW mark of conformity (e.g. for Teflon strip).

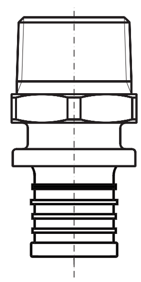
Transition to other threads

The following fittings from other piping systems can also be used in the ***PRINETO*** installation system:

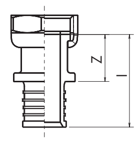
- Transition with internal Rp or external R thread (e.g. transition 25 - R 3/4 art.-no. 878 641 360)
- Transition with soldering socket (for soft soldering to copper pipes e.g. 25 - M 22, art.-no. 878 343 390)
- Transition with soldering nipple (for soft soldering in copper fittings; e.g. 25 - S 22, art.-no. 878 343 391)
- Flat-sealing screw-in connections as screw-in part or transition with union nut (e.g. transition with union nut 25 – G 3⁄4, , art-no. 878 640 040)
- Transition with radial pressing nipple (for radial pressing in fittings; e.g. 25 - P 22, art.-no. 878 643 390)



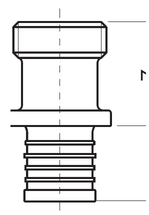
Rp
Cylindrical internal thread,
sealing in thread



R
Tapered external thread,
sealing in thread



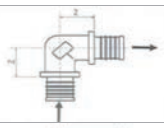
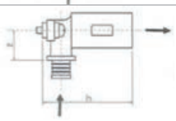
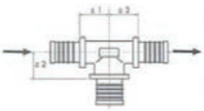
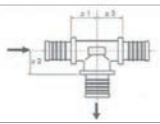
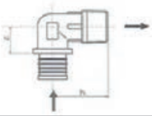
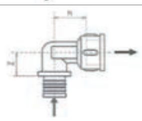
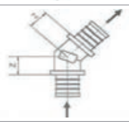
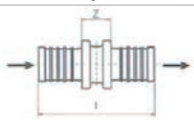
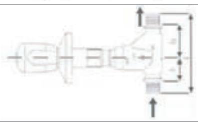
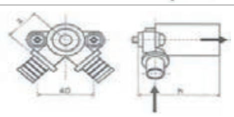
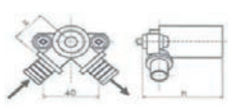
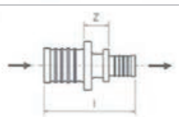
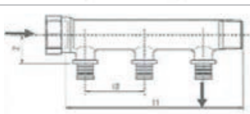
G
Cylindrical internal thread,
(movement thread)
here flat-sealing

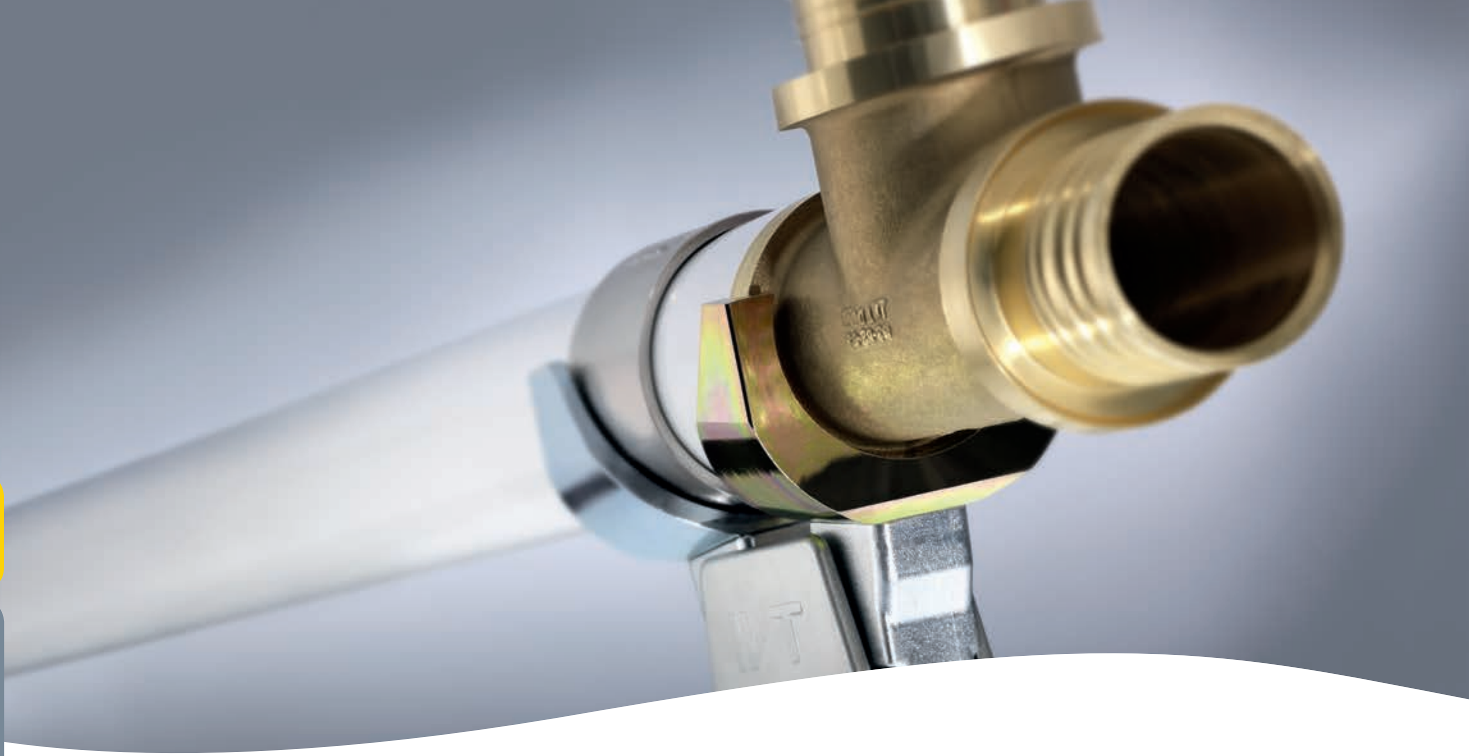


G
Cylindrical external thread,
(movement thread)
here flat-sealing

Pressure loss coefficients

Pressure loss values of selected *PRINETO* fittings

Article	Fitting	Dimension			
		16	20	25	32
	Angle	4,2	3,9	3,1	2,7
	Wall angle Rp 1/2	7,9	7,2	5	
	Tee passage	1,1	0,9	0,7	0,6
	Tee brunch	4,4	3,9	3	2,9
	Angle transition R	6,3	5,8	4,8	3,7
	Angle transition Rp	6,9	5,9	5	
	Angle 45°	2,2	1,4	1,1	0,9
	Coupling	1,1	0,7	0,4	0,5
	Ball-valve UP	9,9	7,2	8	
	Wall angle with V-passage	5,1	4,5		
	Wall angle with V-passage	5,7	4,3		
	Coupler reduced by one dimension		0,6	0,3	0,2
	Manifold R/Rp 3/4	4,7	3,5		



2

Clamping joints

PRINETO Clamping joints

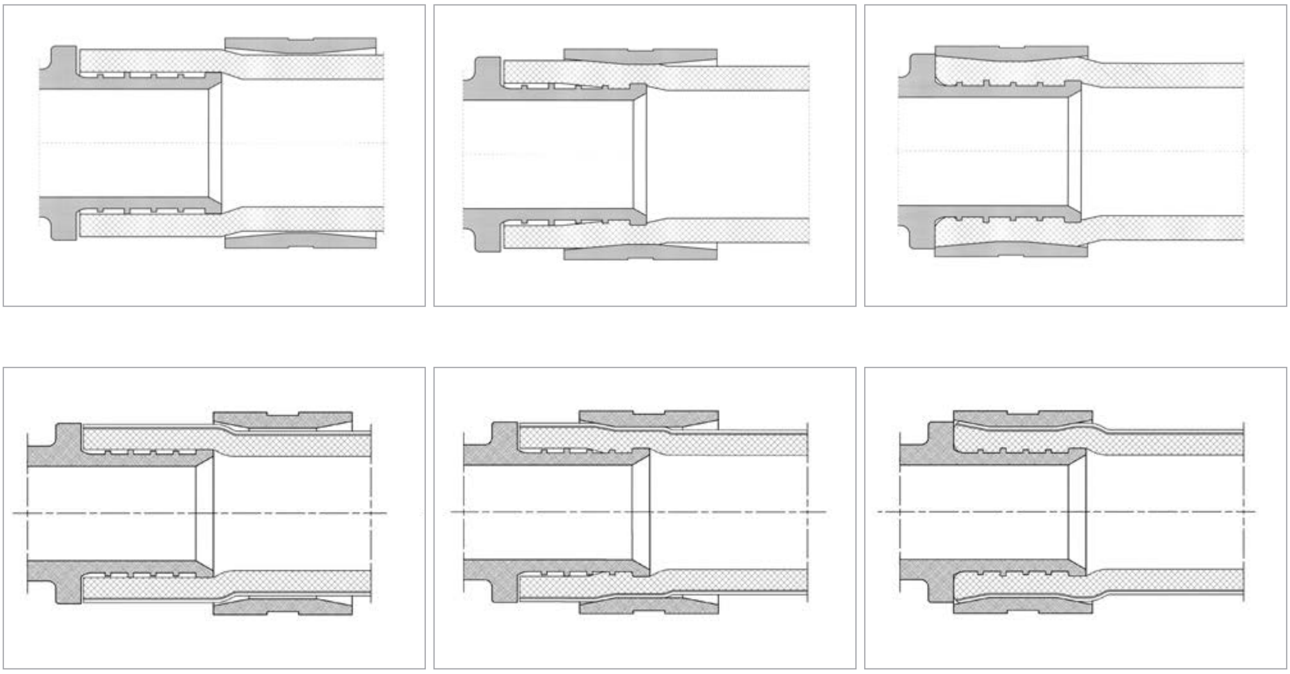
Properties

The axial ***PRINETO*** clamping joints have been tested acc. to DVGW worksheet W 534 in combination with all ***PRINETO*** pipes. They are permanently airtight and may be installed under plaster or screed without inspection opening.
A monitoring contract with Süddeutsches Kunststoffzentrum, Würzburg (SKZ), and OFI research institute, Vienna, ensures their consistently high quality. DVGW worksheet W 534: Pipe connectors and connections for pipes in drinking water installations; requirements and testing.

For the ***PRINETO*** clamping joints the DVGW marks of conformity with the registration numbers DW8501AT2149 and DW8501AT2606 have been awarded. For avoiding errors when making the ***PRINETO*** connection, the sliding sleeves are supplied with different "colours". The sleeves for the PE-X pipes 16, 20, 25 and 32 as well as for PE-MDX surface heating pipes, highly flexible, 12, 14, 16, 20 and 25 are non-treated, brass coloured. The sleeves for the white multilayer composite pipes (except for multilayer composite pipe 14)
and all surface heating pipes 17 are nickel-plated (see colour guiding system from page 163).

ADVANTAGES

- No O-ring
- Large sealing surface
- High flow rate due to widening of the pipes
- Connection can be turned and aligned afterwards
- Cavity-free hygienic connection without stagnant water



Sealing and longitudinal frictional connection between fitting and pipe are ensured by pressing the PE-X/PE-MDX material onto the fitting body by means of the sliding sleeve without any additional sealant.

The pipe end is widened first for accepting the fitting first. The finished joints can immediately be subjected to pressure and temperature.

Summary of tools

Pipe shears

For cutting the pipes to length up to dimension 32, pipe cutter for all pipes 14 to 63 (right).

PRINETO Installation case MAZ, manual widening pliers

For shortening and widening pipes, incl. expander heads 16, 20, 25 and 32.

PRINETO Cordless compact widening pliers AKA

For widening pipes 12 to 32
(expander heads required!).

**_PRINETO_ Installation case
MSP Manual sliding pliers**

For pushing on sleeves up to dimension 32 incl. sliding jaws 16, 20, 25 and 32.

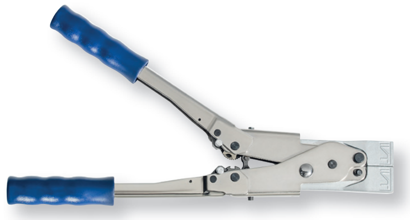
PRINETO Installation case KSZ, toggle-lever sliding pliers

For shortening pipes and pushing on sleeves for measurements up to 20, incl. sliding jaws 16 and 20.

Summary of tools

PRINETO Ratchet sliding pliers RSZ

For pushing on sleeves for the dimensions 12 to 25; use of a lubricant is necessary for dimension 32 (adapter jaws and sliding jaws required).



PRINETO Manual widening and sliding pliers MASZ

For widening pipes and pressing the sleeves in place for dimensions 16 to 20.

PRINETO Cordless compact sliding pliers AKSZ

For sliding on sleeves for dimensions 12 to 32 (sliding jaws required!).

PRINETO Installation case ESZ 2/ASZ, (cordless) electric sliding pliers

For widening with expander bits and for pushing on sleeves up to dimension 63 (supplementary tool required!).

Summary of tools

PRINETO Installation case for ASZ and ESZ 2 drives (supplementary tool)

For widening with expander bits and pushing on sleeves up to dimension 63 incl. adapter A, sliding jaws 16, 20, 25 and 32.

Expander bit 40 – 63 (16-32 not shown) (supplementary tool)

For widening pipes using an electrical tool, adapter A and expander head 40, 50 or 63.

Expander head 40, 50 or 63 (supplementary tool)

For widening pipes using an electrical tool, adapter A and expander bit 40 to 63.

Sliding jaws 40, 50 or 63 (supplementary tool)

For pushing on sleeves 40, 50 and 63 using electrical tool and adapter A.

Colour guiding system

The various *PRINETO* joints can easily be produced with the assistance of the colour guiding system.

Colour guiding system

Pipe dimension	Pipe type	Widening	Sliding sleeve	Expander head	Sliding jaws
12 x 2.0	Surface heating pipe	twice	Bright brass	12 x 2.0	FS 12 black (two)
14 x 2.0	Surface heating pipe, Nanoflex pipe	twice	Bright brass	14 x 2.0	F 14 Brass + S 14 Black
16 x 2.0	Surface heating pipe	twice	Bright brass	16	F 16 Brass + S 16 Black
PE-S/AL/PE-RT (16 x 2.0)	Stabil surface heating pipe	once	Bright brass	16	F 16 Brass + S 16 Black
17 x 2.0	Surface heating pipe	twice	nickel plated, silver-coloured	17 x 2.0	F 16 Brass + SS 16 silver
20 x 2.0	Surface heating pipe	twice	Bright brass	20 x 2.0	F 20 Brass + S 20 Black
25 x 2.3	Surface heating pipe	twice	Bright brass	25 x 2.3	F 25 Brass + S 25 Black
16 x 2.2	Heating pipe, plumbing pipe, Nanoflex pipe	twice	Bright brass	16	F 16 Brass + S 16 Black
20 x 2.8	Heating pipe, plumbing pipe, Nanoflex pipe	twice	Bright brass	20	F 20 Brass + S 20 Black
25 x 3.5	Heating pipe, plumbing pipe, Nanoflex pipe	twice	Bright brass	25	F 25 Brass + S 25 Black
32 x 4.4	Heating pipe, plumbing pipe, Nanoflex pipe	twice	Bright brass	32	F 32 Brass + S 32 Black
Stabil 14 (14 x 2.0)	Multilayer composite pipe	once	Bright brass	14 x 2.0	F 14 Brass + S 14 Black
Stabil 16 (17 x 2.8)	Multilayer composite pipe	once	Bright brass	16	F 16 Brass + S 16 Black
Stabil 20 (21 x 3.4)	Multilayer composite pipe	once	nickel plated, silver-coloured	20	F 20 Brass + SS 20 silver
Stabil 25 (26 x 4.0)	Multilayer composite pipe	once	nickel plated, silver-coloured	25	F 25 Brass + SS 25 silver
Stabil 32 (33 x 4.9)	Multilayer composite pipe	once	nickel plated, silver-coloured	32	F 32 Brass + SS 32 silver
Stabil 40 (42 x 4.6)	Multilayer composite pipe	twice	nickel plated, silver-coloured	40	F 40 Brass + SS 40 silver
Stabil 50 (52 x 5.65)	Multilayer composite pipe	twice	nickel plated, silver-coloured	50	F 50 Brass + SS 50 silver
Stabil 63 (63 x 6.0)	Multilayer composite pipe	three times	nickel plated, silver-coloured	63	F 63 Brass + SS 63 silver

Pipes and sliding sleeves

Sleeve, brass

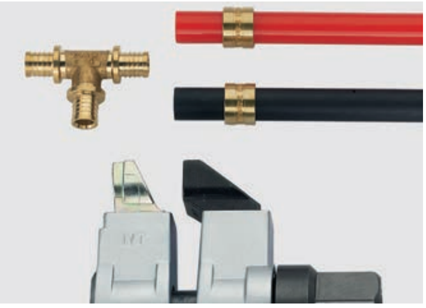
PE-X pipes (black, red and stainless steel coloured), surface heating pipes (grey) 12, 14, 20, 25 and multilayer composite pipe 14.

Sleeve, nickel-plated silver colour

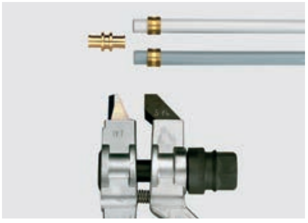
Multilayer composite pipes (white) and surface heating pipes 17 (grey, stainless steel coloured).

Prepare connection

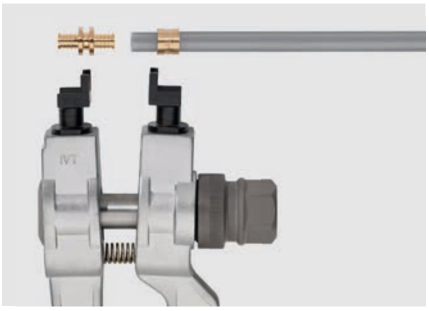
Sliding jaws



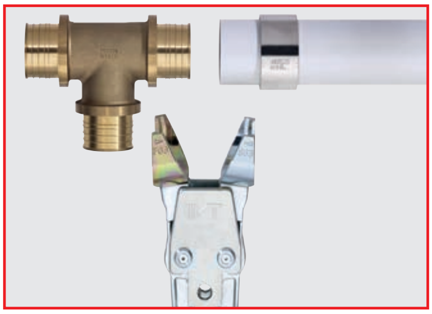
Jaws F yellow for fitting jaws S black for sliding sleeve PE-X pipes/Nanoflex pipes and surface heating pipes 12, 14, 20, 2 and multilayer composite pipe 14.



Jaws F yellow for fitting
Jaws S Stabil, silver-coloured for sliding sleeve multilayer composite pipe 16, 20, 25, 32 and surface heating pipes 17.



Jaw F/S for fitting and sliding sleeve surface heating pipe 12.



Jaws F yellow for fitting
Jaws S Stabil, silver-coloured, for sliding sleeve multilayer composite pipe 40, 50, 63.

CAUTION

Pipes, fittings and sleeves should be used straight from the original packaging if possible. Soiled fittings must be cleaned, damaged fittings sorted out and rejected. Only use original ***PRINETO*** tools. Do not use faulty tools e.g. with damaged expander head jaws. Keep installation tools clean. All moving parts of the manual tools must be cleaned and lubricated regularly. Follow the installation and operating instructions. Read the operating instructions first before using the power tools. Pay attention to the notes, including those on safety.

ADVANTAGES

The front sides of the sliding jaws must always be put into the pliers parallel to each other (exception Stabil multilayer pipe 40/50/63).

Expander heads

63
50
40
32
25
20
16

40
25
20
17
14
12

Widening pliers equipped with special expander heads for surface heating pipes and for multilayer composite pipe 40.

PRINETO®

Prepare connection

Cut the pipe to length with a 90° cut using the pipe shears or pipe cutter. Select the sliding sleeve to match the pipe dimension and pipe type (see colour guiding system on page 47) and push the sleeve onto the pipe in such a way that it is not in the widening zone during widening. Lightly spray the inner surfaces of size 63 sliding sleeves with ***PRINETO*** glide spray (art.-no. 878 503 998) before fitting in order to reduce the pressing force required to produce the connection.

In the case of pre-insulated pipe or pipe enclosed in corrugated pipe, first push the sheathing back or shorten it (e.g. using ***PRINETO*** pipe shears with corrugated pipe cutter, art.-no. 878 800 150) without damaging the inner pipe.

Have a suitable fitting ready for pushing directly into the pipe socket after the widening of the pipe has been completed.

CAUTION

Pipes, fittings and sleeves should be used straight from the original packaging if possible. Soiled fittings must be cleaned, damaged fittings sorted out and rejected. Only use original ***PRINETO*** tools. Do not use faulty tools e.g. with damaged expander head jaws. Keep installation tools clean: All moving parts of the hand-tools must be cleaned and lubricated regularly. Follow the installation and operating instructions. Read the operating instructions first before using the power tools. Pay attention to the safety instructions.

CAUTION

Read the operating instructions first before using the tools. Pay attention to the safety notes.

CAUTION

For smooth processing of the PPSU fittings we recommend the use of ***PRINETO*** lubricant (art. no. 878 530 998). For processing ***PRINETO*** heating pipe 32 and with Stabil multilayer pipe 25 or larger, the use of lubricant is necessary. Lubricant is also necessary for processing dimension 63.

2

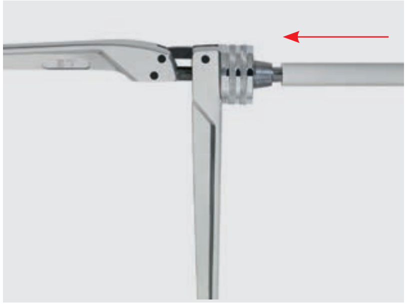
Clamping joint

Widen pipe

Select the expander head to match the pipe dimensions (see colour guiding system on p. 47) and screw as far as possible onto the relaxed widening pliers, the compact widener or the expander bit. All the segments of the expander head must be in a good condition.

The widening process is made easier and wear reduced if the sliding cone of the widening tool is regularly cleaned and greased lightly with tool grease (e.g. grease for MSZ, art-no. 878 800 203). Do not use oil. Grease must not be allowed to get into the pipe during widening.

Widen pipe

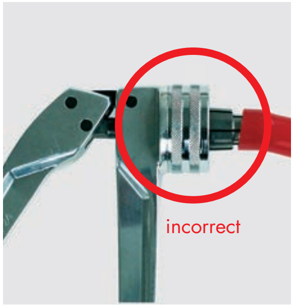


CAUTION

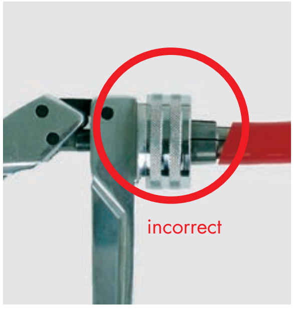
Do not pull, do not pump! Do not bend the pipe out of line when widening or widen under bending stress. Do not widen the sliding sleeve as well. The expander bit must not slip out of adapter A during widening.

When widening using the ASZ or ESZ 2 insert the expander bit into adapter A until it locks into place, then insert this into the holder on the electric tool and lock in place.

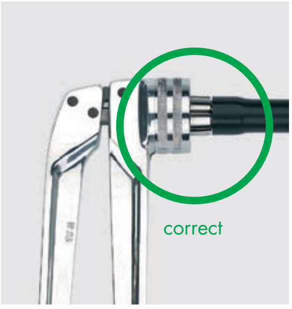
Push the expander head straight into the pipe until it stops. Completely close the manual widening pliers slowly and evenly in one smooth movement.

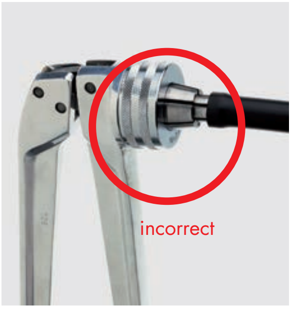


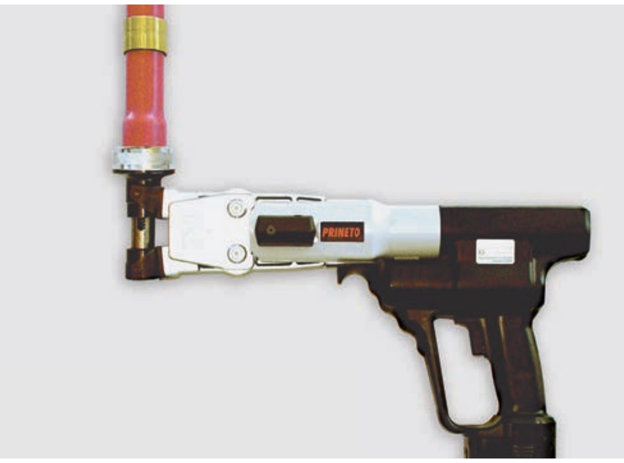
Widening under bending stress



Skew pipe cut







Widening process with CSP

CAUTION

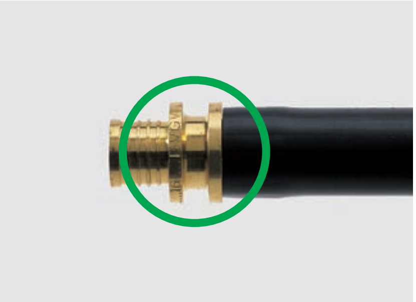
Only widen multilayer composite pipes 14 to 32 once, in order to prevent the pipe socket becoming too big.

When widening using the cordless compact widening pliers AKA or the cordless sliding pliers ASZ keep the manual control switch pressed until the tool slackens again automatically after a 'clicking sound' is heard.

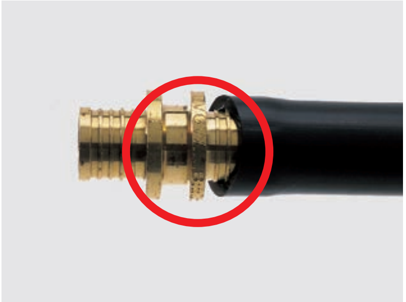
When widening using the electric sliding pliers ESZ 2 set the directional switch to the 'V' position and keep the manual control switch pressed until you hear that the push-rod has reached the front point of return. Then set the directional switch to the 'R' position and keep the manual control switch for slackening the tool pressed until you hear that the push-rod has reached the rear point of return.

Depending on pipe dimension and pipe type, widening has to be carried out a differing number of times (see colour guiding system on page 47). If widening is to be done more than once, turn the widening tool or the pipe through about 30° before the second widening process.

Insert fitting



Correctly pushed-on fitting



Fitting pushed on askew

Gap in the case of pipe diameter 32

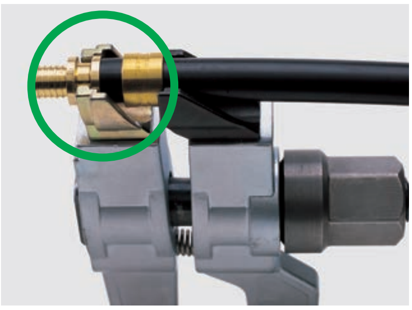
After widening the pipe, insert the fitting into the pipe socket and align it straight. The pipe socket must touch the fitting collar (exception: pipes 20, 25 and 32, see table of gap widths). With flexible pipes time is limited, as the widened pipe socket will begin to shrink again. In this case widen the pipe again.

TIP

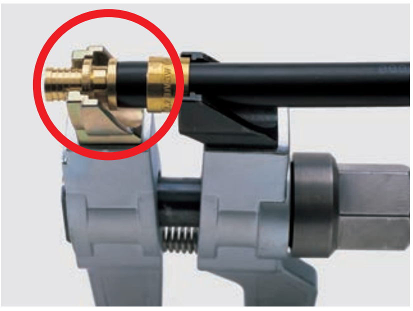
With pipe dimensions 20, 25 and 32 the widening length is determined by the expander head in such a way that a gap remains between the end of pipe and fitting collar after full insertion of the fitting.

Gap widths between fitting collar and end of pipe:

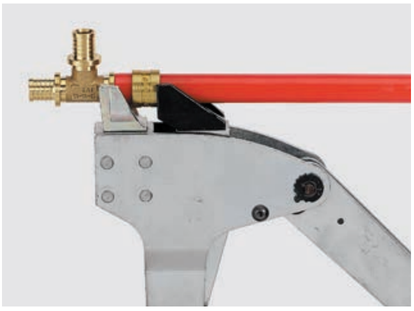
Pipe type and dimension	Gap width
Surface heating pipe 12	0 mm
Surface heating and multilayer composite pipe 14	0 mm
Nanoflex, heating, plumbing and multilayer composite pipe 16 x 2.0	0 mm
Surface heating pipe 17	0 mm
Nanoflex, heating, plumbing and multilayer composite pipe 20	**1.0 mm**
Nanoflex, heating, plumbing and multilayer composite pipe 25	**2.0 mm**
Surface heating pipe 25	0 mm
Nanoflex, heating, plumbing and multilayer composite pipe 32	**3.0 mm**
Multilayer composite pipe 40	0 mm
Multilayer composite pipe 50	0 mm
Multilayer composite pipe 63	0 mm



Correctly aligned in MSZ sliding jaw F.



Sliding jaw F applied at wrong fitting collar. Connection is thus overstrained.



Manual push-on connection process with KSZ.

Push sliding sleeve on

2

Clamping joint

Slide the sliding sleeve up to the pipe socket by hand. Equip sliding pliers or adapter A with suitable sliding jaws in accordance with pipe dimension and type (see colour guiding system on p. 47). Always only apply the yellow F sliding jaw on the fitting. Place the sliding jaws on both sides of the prepared connection.

Make sure the fitting collar and sliding sleeve are resting correctly in the centres of the sliding jaws, do not twist them. Slide the sliding sleeve up to the fitting collar.

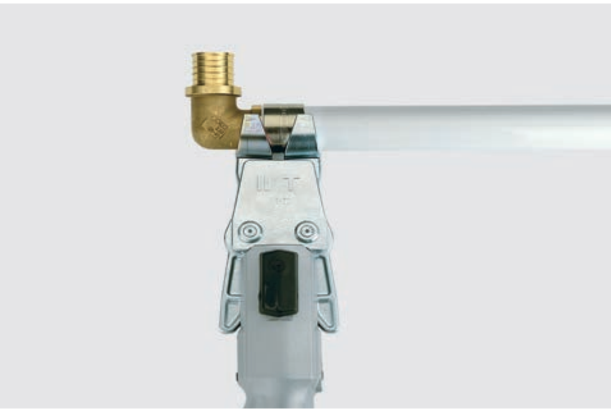
CAUTION

The connection must remain deep in the sliding jaws until pressing has been completed. The sliding jaws must not slip out of the tool during pressing. Keep the tool pressed against the connection to prevent this.

With KSZ (diameter 12 - 20) the push-on process is to be executed in one continuous action by complete closing of the levers.

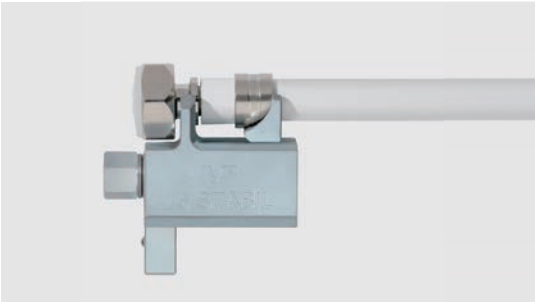
With AKSZ (diameter 12 - 32) pre-select the dimension to be pressed by attaching the slide adapter (1) to the bolt (2) in one of two different positions. One bore hole (3) is used for pressing pipe dimensions 25 and 32, the other bore hole (4) is used for pipe dimensions 12 to 20. Keep the manual control switch pressed until the tool automatically slackens and releases the connection.

With ASZ (diameter 14 - 63) keep the manual control switch pressed until the tool slackens again automatically after a 'clicking sound' is heard.



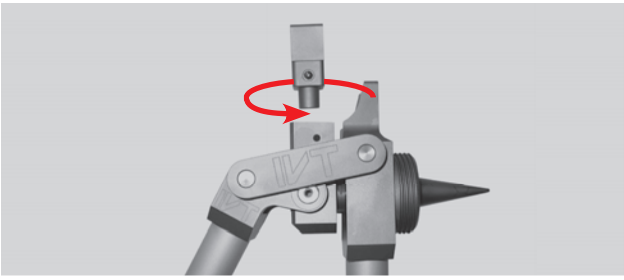
With ESZ 2 (diameter 14 - 63) set the directional switch to the 'V' position and keep the manual control switch pressed until you hear that the push-rod has reached the front point of return. Then set the directional switch to the 'R' position and keep the manual control switch for slackening the tool pressed until you hear that the push-rod has reached the rear point of return and the connection is released.

Push sliding sleeve on



Electrical connection with ESP 2 in operation.

With PSZ (diameter 16) turn the spindle drive (1) clockwise as far as it will go, at first by hand and then with the aid of any tool with spanner width 17 mm. Then loosen the spindle drive again by turning it in the opposite direction.

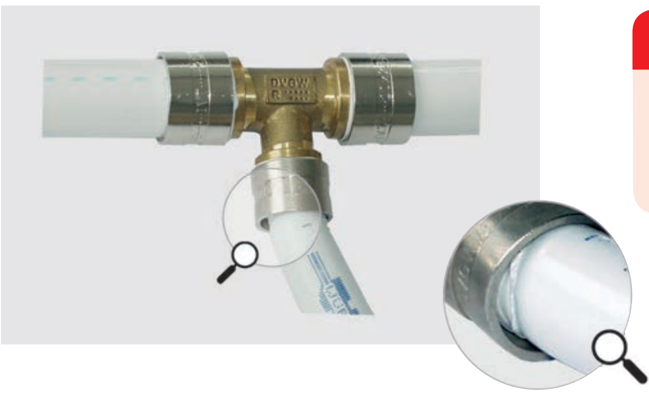


MWSP combination expander head 16-20
Two sides: for multilayer & PE-X pipes

With MASZ (16 – 20) the sliding sleeve jaw can be adapted between Stabil and PE-X. For this purpose, the sliding jaw must be removed, turned and then inserted again.

TIP

Regularly clean the MSP spindle of dust and dirt and then grease it. During assembly it is important to make sure that the pressure bearings are assembled again in correct sequence.



CAUTION

Bending directly at the clamped spot causes cracks in the wall of the pipe.

Note: First bend, then make the connection!

2

Drinking water installations

PRINETO Drinking water installations

General basics

The ***PRINETO*** drinking water installation system has been tested and approved by the DVGW, reference numbers are DW-8501AT2606 and DW-8501AT2149. It can be used with all waters which comply with the 2001 Drinking Water Ordinance. Water qualities deviating from this must be approved by the IVT Engineering department.
The following standards and regulations amongst others have to be observed during the planning, installation and operation of drinking water piping systems in buildings:

- DIN 1988, Technical rules for drinking water installations (TRWI)
- DIN EN 806, Technical rules for drinking water installations (TRWI)
- DIN EN 1717 (partly replacing part 4 of DIN 1988), Protection of drinking water against polluting substances in drinking water installations and general requirements for safety installations for the prevention of drinking water contamination by backflow,
- Drinking Water Ordinance (TrinkwV) 2001, regulation on the quality of water for human use
- KTW recommendation, recommendation by the Federal Health Office concerning plastic materials for drinking water
- Model piping directive (MLAR), model directive on fire protection requirements for piping systems
- DIN 4109 Sound insulation in structural engineering
- DIN EN 1254, Copper and copper alloys – fittings
- DIN 50930, Corrosion of metal materials in the interior of piping systems, containers and apparatuses under corrosion stress due to water
- VDI 6023, Hygiene in drinking water installations
- DVGW W 551, Technical measures for reducing the growth of legionnaire bacteria
- DIN 18381, VOB Part C, General technical contractual conditions for construction work

The following demands, among others, are made of a drinking water installation:

1. Prevention of deterioration of drinking water quality within building installation.
2. Compliance with the physical, chemical and microbiological water quality described in TrinkwV at the tapping points.
3. Functional protection throughout whole service life.
4. Guarantee of required operating values for pressure and flow rate to user.
5. Compliance with the permissible limit parameters regarding flow sounds.
6. Avoidance of contamination of drinking water from the public supply network.

Professional planning of the system with regard to function and materials used is critical for compliance with the above-mentioned standards.

Installation materials

All plastic and non-metallic materials in contact with the drinking water in ***PRINETO*** installation systems are compliant with the KTW recommendations of the German Federal Health Office and the Law on food requirements. ***PRINETO*** pipes have been microbiologically tested acc. to DVGW worksheet W 270 and approved. They are toxicologically and physiologically safe. The alloy components of all metallic materials in contact with the drinking water used in the ***PRINETO*** installation system comply with DIN 50930 - 6 and thus ensure compliance with the Drinking Water Ordinance (TrinkwV) 2001. The fitting material used is dezincification-resistant special brass (CW 617 N acc. to DIN EN 1254 - 3 and CUPHIN CW724R).

The installation components of drinking water installations have to be designed for a permissible operating excess pressure of 10 bar. With cold water pipes a water temperature of 25°C must not be exceeded when the stagnant water has flown out. The hot water temperature must not exceed 60°C as a rule (exception e.g. thermal disinfection). Pipes and pipe connectors have to be designed for a service life of at least 50 years.

Risers must able to be shut off and emptied separately by shut-off valves that are always accessible. In larger buildings such as multiple-family homes, storey conduits for each storey and supply pipes for self-contained apartments must also be able to be individually shut off. ***PRINETO*** valves for concealed installation can be used for this.

Linear expansion caused during operation and the resulting forces have to be taken into account by the installation of bending legs and fixed points (see linear expansion and and bending legs, page 20). Niches and slots in the masonry are permissible only if they do not impair stability. Therefore, wall surface installation is acceptable by reason of technical rules. Cold-media drinking water piping must be protected against a rise in temperature and condensation. For limiting heat losses from hot water pipes the Energy-saving Ordinance (EnEV) in its respective applicable version must be observed (see Pipe insulation, page 33 onwards).

General basics

Water filters

When solids such as rust particles and sand get into the domestic water supply, this can lead to corrosion damage and pitting. The drinking water can become soiled, fittings blocked, and domestic appliances soiled. For this reason, a certified water filter must be installed downstream from the domestic water meter.

Low-stagnation installation

The piping routing and layout of the tapping points must be planned in such a way that maximum possible water exchange is guaranteed. The smallest possible simultaneity factor should be chosen in order to achieve small nominal widths. Single supply pipes should be as short as possible.

Circulation

According to DVGW worksheet W 551 circulation pipes are required in pipe sections containing more than 3 litres of water. The water temperature in the system must not drop in circulation operation by more than 5 K compared with the hot water outlet temperature of the drinking water heater. The circulation pump or electric trace heating can be switched off for up to 8 hours a day in perfect hygienic conditions in order to save energy. Care must be taken that a flow velocity of a maximum of 0.5 m/s is not exceeded.

Corrosion probability

In order to prevent later impairment of the drinking water properties caused by corrosion and any related damage to the piping system, VDI 6023 specifies that a current water analysis must be carried out according to DIN 50930-6 and DIN EN 12502-2 to check the corrosion probability. The local water supplier provides the data required on request. A water analysis must be prepared if there is a separate water supply (e.g. well water). If in doubt, you must obtain approval for the use of our pipe system from the IVT Engineering department.

Pressure testing and flushing

For reasons of hygiene, the piping system must be subjected to pressure testing with oil-free compressed air or inert gases (nitrogen) in accordance with VDI 6023 (pressure testing protocol on page 59). Testing with drinking water in accordance with DIN 1988 is permitted if the intended operation takes place directly afterwards (pressure testing protocol on page 61). The ***PRINETO*** drinking water installation must be flushed with freshly filtered water (no particles 150 µm) with at least 20 times the water replacement at a flow rate of at least 2 m/s directly before it is put into operation. The flushing and initial operation of the piping system as well as operator instructions must be documented. Thereafter, the operator is responsible for operation and maintenance repairs. The intermittent flushing with an air/water mixture described in DIN 1988 or EN 806 is an alternative to flushing with pure drinking water. It is left to the plumber's own discretion whether this relatively time-consuming procedure is also appropriate in case of a new ***PRINETO*** piping system which is free from any coarser soiling and installation remnants. But thorough flushing of the drinking water piping is always required!

Outer corrosion

PRINETO fittings may have to be protected against corrosion on the outside (e.g. installations in stables – air containing ammonia!). Ammonia, amines, ammonium salts or sulphur dioxide etc. may lead to tension crack corrosion. Therefore, insulation materials must be nitrite-free and must not exceed a percentage of 0.2% by mass of ammonia. This is guaranteed if our pre-insulated pipes are used. If the fittings may come into contact with moisture over a lengthy period (e.g. buried pipes) they have to be insulated against water.

Operation with continuous-flow heaters

Some manufacturers of electric continuous-flow heaters advise against using plastic pipes in combination with their products. This usually concerns the older lines of products and also some hydraulically controlled continuous-flow heaters. In this case a flow sensor controls heating of the flowing water, depending on whether a hot water tap is opened or closed. With these units very small switch-off delays of the heating process can lead to after-heating, causing extreme pressure and temperature increases for short periods which exceed the allowed operating parameters of the ***PRINETO*** pipes. Therefore we suggest not using these heating units in conjunction with ***PRINETO*** pipes. It is recommended that electronically controlled units which are suitable for use in combination with plastic pipes should primarily be used.

General basics

Operation with electric trace heating

PRINETO pipes are suitable for use in combination with electric trace heating. The maximum temperature of the heater band must not exceed 90°C. The information published by the heater band manufacturer should be observed. For optimum heat transfer we recommend attaching the heater band to the pipe over its full surface using aluminium adhesive tape.

Flow rule with combined installation

The flow rule says that base metals have to be installed upstream from more noble metals in the direction of drinking water flow. This prevents destruction of the base metals by electrochemical corrosion. If, for example, components of an existing drinking water system that are made of galvanised steel, which is a base metal, are replaced by ***PRINETO*** pipes and fittings of special brass, a noble metal, a combined installation results. This is permissible acc. to DIN 1988 part 7 and EN 806-4 and complies with the approved technological rules. We recommend keeping the amount of fittings in these installation components as low as possible and avoiding unnecessary circulation of the hot water.

Disinfection

In accordance with DVGW worksheet W 551 we recommend thermal disinfection at temperatures above 70° to decontaminate ***PRINETO*** drinking water systems. Continuous disinfection of ***PRINETO*** drinking water systems with chlorine according to W 551 is possible only in compliance with the valid Drinking Water Ordinance 2001. According to this, the amount of free chlorine must not exceed the maximum value of 0.3 mg/l after completion of drinking water purification.
A one-off disinfection of a ***PRINETO*** drinking water system with chlorine dioxide which is prepared on site and exactly dosed is possible in accordance with the DVGW worksheets W 291 and W 224 in agreement with the IVT Engineering department. This method is to be preferred over disinfection with free chlorine since it is less corrosive.

Rain water

The quality and chemical composition of rain water is subject to regional and industrial influences and may therefore vary greatly. We recommend using the ***PRINETO*** piping system with a pH value of 6.5 or higher only. The evaluation of the parameters of corrosion-promoting ingredients, like chloride, nitrate, sulphate, nitrite, ammonia, and the acidity, is required.

Softening/demineralisation

When water is softened by an ion exchanger, the cations Ca^{2+} and Mg^{2+} are eliminated from the water and replaced by Na^{+} ions. This method is permissible for ***PRINETO*** systems providing the water output is compliant with the Drinking Water Ordinance. Water softened by reverse osmosis must not be used. Fully demineralised water (demin. water) is water that has had salt (sodium) removed by reverse osmosis in a softening system; the water is practically free of salts but still contains soluble gases. The lack of mineral substances prevents a protective layer being formed on the inside of the fitting, which leads to the material being eroded. This water must not be used in ***PRINETO*** systems.

Filling quantities of ***PRINETO*** pipes

Nanoflex and plumbing pipe

PE-X 16 16 x 2.2:	0.11 l/lfdm
PE-X 20 20 x 2.0:	0.16 l/lfdm
PE-X 25 25 x 3.5:	0.25 l/lfdm
PE-X 32 32 x 4.4:	0.42 l/lfdm

Multilayer composite pipe

Stabil 14 14 x 2.0:	0.08 l/lfdm
Stabil 16 17 x 2.8:	0.11 l/lfdm
Stabil 20 21 x 3.4:	0.16 l/lfdm
Stabil 25 26 x 4.0:	0.25 l/lfdm
Stabil 32 33 x 4.9:	0.42 l/lfdm
Stabil 40 42 x 4.6:	0.86 l/lfdm
Stabil 50 52 x 5.6:	1.31 l/lfdm
Stabil 63 63 x 6.0:	2.04 l/lfdm

Pressure testing of ***PRINETO*** drinking water systems

Testing with oil-free compressed air or inert gases

According to VDI 6023 Sheet 1 Sec. 4.9.1, drinking water systems must be subjected to pressure testing with oil-free compressed air or inert gases and according to DIN 1988 Part 2 Sect. 11.1 to a pressure test with drinking water. Both tests check leakage and permeability and are carried out on exposed pipes. The test must be documented and signed by the client and tester. Both pressure tests are secondary services and should not be tendered separately and stipulated as a service contract (see DIN 18381). A test with drinking water is only permissible if the drinking water system is to be put into proper operation directly after the test.

The pressure test comprises a separate leakage and permeability test with different test pressures. The leakage test is to be carried out as follows:

1. Divide the pipe installation into smaller test sections.
2. Carry out a visual inspection of the pipe connections.
3. Drinking water heaters, fittings, appliances and pressure tanks must be isolated before testing the pipe-work.
4. The pipe openings are directly sealed off using metal plugs or blank flanges, PN 3.
5. Closed shut-off installations are not regarded as a watertight seal.
6. An expert conducts the test on site and is responsible for it.
7. The testing pressure for the leakage test is 150 mbar.
8. The precision of the pressure gauge must be 1 mbar on the display, this corresponds to a 10 mm head of water (e.g U-pipe manometer).
9. The test period for up to 100 litres output volume is 120 minutes. For each additional 100 litres the test period is lengthened by 20 minutes.
10. Water tightness is indicated when the start and end pressure correlate, taking the normal variations resulting from media temperature and pressure at the manometer into consideration.
11. The permeability test is carried out after the leakage test.

During this, a visual inspection of the individual connections must also be carried out.

The objective of the permeability test is to find any faults which can lead to connections splitting or coming apart by applying a max. pressure of 3 bar to the system. A visual inspection of the individual connections must be made during this test.

1. Up to and including DN 50, the test pressure is max. 3 bar, over DN 50 max. 1 bar.
2. The test period is at least 10 minutes.
3. Build up the test pressure in the drinking water installation slowly, wait for temperature adjustment and steady state to be reached and re-establish the test pressure if necessary after the pressure has stabilised.
4. The precision of the manometer must be 0.1 bar on the display.
5. If there is a loss of pressure during the testing period, the system is not leakproof. The pressure must be maintained and the leaking spot found. After the fault has been eliminated, the leak test must be repeated.
6. If no leaks are found, note the visual inspection and leak-proofness of the drinking water installation in the pressure test log.

NOTE

The test pressure and the pressure curve during the test do not allow reliable conclusions regarding the system tightness. For this reason, the tightness of the complete drinking water installation must be checked, as required in the standards, with a leak indicator medium and a visual inspection.

CAUTION

Use a leak indicator medium with current DVGW certificate only (e.g. foaming agents). For PPSU fittings, the leak indicator medium must additionally have a manufacturer release for the material "PPSU".

Pressure testing of ***PRINETO*** drinking water systems

Pressure testing protocol in accordance with VDI 6023 for ***PRINETO*** drinking water systems

Object: ______________________________

Owner: ______________________________

Inspector: ______________________________

Description test stage

Material of pipe system ______________________________

Connection type ______________ Ambient temperature ______________ °C

Equipment pressure ______________ bar Test medium temperature ______________ °C

Test medium ☐ Oil-free compressed air ☐ Nitrogen ☐ Co2 ☐ ______________

Equipment tested ☐ the entire system ☐ in ____ sections

☐ All pipes are to be shut off with metal plugs, caps, blanking plates or blank flanges. Appliances, pressure tanks or drinking water heaters are to be isolated from the pipe work. A visual check of all pipe connections is to be carried out by a skilled out professionally.

Leakage test

☐ Testing pressure 150 hPa (150 mbar), test duration up to 100 liter pipe volume min. 120 minutes. The test duration must be extendes by 20 minutes for each further 100 liters.

Pipe volume: ____ liters Test duration: ____ min.

Temperature adjustment and static condition pipes is to be observed before starting the test period.

☐ No drop in pressure detected during the test period

Bearing test with raised pressure

Testing pressure ≤ 50 DN max. 0,3 MPa (3 bar)
Testing pressure > 50 DN max. 0,1 MPa (1 bar), test duration 10 minutes temperature adjustment and static condition of the PE-X pipes observed before starting the test period

☐ No drop in pressure detected during the test period

Results of the testing

☐ Visual inspection passed.

☐ Leakage test passed no drop in pressure detected.

______________ ______________ ______________

Place, Date | Signature Inspector | Signatureowner or representative

Pressure testing of ***PRINETO*** drinking water systems

Testing with drinking water

The material characteristics of the synthetic pipes lead to an expansion of the pipe during the pressure testing, which causes the pressure to drop. Changes in temperature also distort the test result. Therefore, during pressure testing as constant a temperature as possible should be aimed at for the test medium, and the initial pressure must be restored several times after the pipe expansion.

The pressure test with drinking water is to be carried out as follows:

1. The piping system is filled with fresh drinking water. Care must be taken to ensure that there is no air in the pipes.
2. Prepare for the preliminary test by feeding water into the entire system at a test pressure of 1.1 x permitted operating pressure (normally 11 bar). The initial pressure is re-established after 10 minutes and 20 minutes. After a further 10 minutes (30 minutes from the start of the test) the preliminary test begins (without establishing the initial pressure again!). The equipment is considered watertight if within 30 minutes the pressure drop is less than 0.6 bar and no leaks are detected.
3. Directly after the preliminary test the main test is carried out (without establishing the initial pressure again!). For this the main testing pressure corresponds to the end pressure of the preliminary testing. The pipe system is considered watertight if after 2 hours the pressure drop is less than 0.2 bar and no leaks are detected in the pipe system.

During the main test, visual checks of the connections must be carried out continually.

NOTE

For reasons of hygiene and to avoid corrosion damage, the drinking water installation must be put into operation directly after completion of the pressure testing with drinking water. Otherwise pressure testing must be carried out with oil-free compressed air or inert gases.

NOTE

The test pressure and the pressure curve during the test do not allow reliable conclusions regarding the system tightness. For this reason, the tightness of the complete drinking water installation must be checked, as required in the standards, with a leak indicator medium and a visual inspection.

Pressure testing of ***PRINETO*** drinking water systems

Pressure testing protocol in accordance with DIN EN 806-4 for ***PRINETO*** drinking water systems

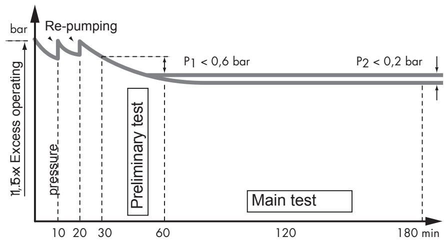
Object: ______________________________

Owner: ______________________________

Inspector: ______________________________

Description test stage

Stabil 14	____________	m
16 x 2.2	____________	m
20 x 2.8	____________	m
25 x 3.5	____________	m
32 x 4.4	____________	m
Stabil 40	____________	m
Stabil 50	____________	m
Stabil 63	____________	m



Preliminary test (duration 30 minutes)

Start ____ : ____ End ____ : ____

Testing pressure (1.1 x operating pressure)	____________	bar
Pressure after 30 minutes	____________	bar
Pressure after 60 minutes (End of preliminary test)	____________	bar
Pressure drop (max. 0.6 bar):	____________	bar

NOTE

The temperature of the test medium should be kept as constant as possible. Fill pipes with water. Vent pipes completely.

Main test (duration 2 hours)

Start ____ : ____ End ____ : ____

Testing pressure, end of preliminary test	____________	bar
Testing pressure after 2 hours	____________	bar
Pressure drop (max. 0.2 bar)	____________	bar

Results of preliminary and main test

Pressure testing passed ☐ yes ☐ no

Visual inspection passed ☐ yes ☐ no

Place, Date

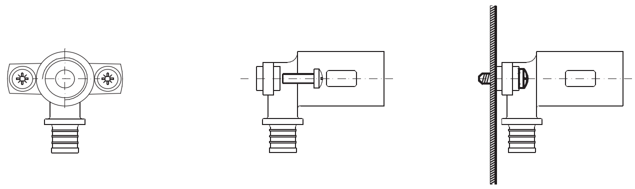
Signature inspector

Signature owner or representative

Notes for pipe laying and installation

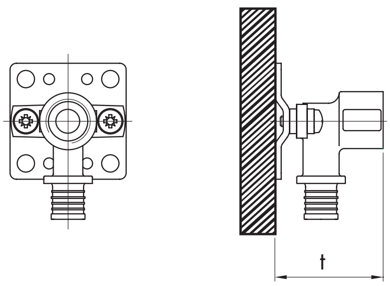
Fastening plate for wall angle

The wall angles are fitted with surface-mounted head screws M5 with cross slot and sound/heat insulation. The screws can be pushed out and replaced by a fastener that is appropriate for the mounting surface. For wall angle 'short' the dimension (t) is changed by the corresponding difference in length from the standard wall angle.



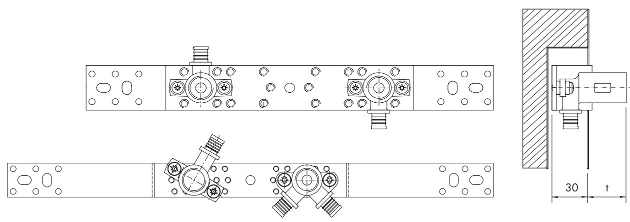
Fastening plate for wall angle

Wall angle 16-Rp 1/2	t = 64
Wall angle 20-Rp 1/2	t = 64
Wall angle passage 16-Rp 1/2	t = 64
Wall angle passage 20-Rp 1/2	t = 64
Wall angle 16-Rp 1/2 short	t = 52
Wall angle 20-Rp 1/2 short	t = 53
Wall angle 20-Rp 3/4	t = 54
Wall angle 25-Rp 3/4	t = 59



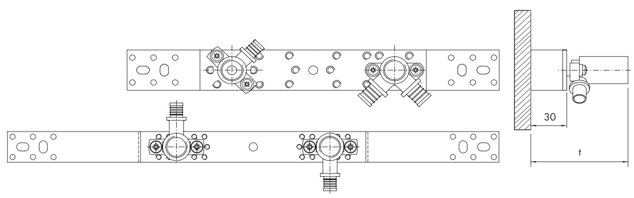
Slot/Niche installation with holders stepped
Holder 70/150, holder 80/100, holder 120/150

Wall angle 16-Rp 1/2	t = 27
Wall angle 20-Rp 1/2	t = 27
Wall angle passage 16-Rp 1/2	t = 27
Wall angle passage 20-Rp 1/2	t = 27
Wall angle 16-Rp 1/2 short	t = 15
Wall angle 20-Rp 1/2 short	t = 16
Wall angle 20-Rp 3/4	t = 17
Wall angle 25-Rp 3/4	t = 21



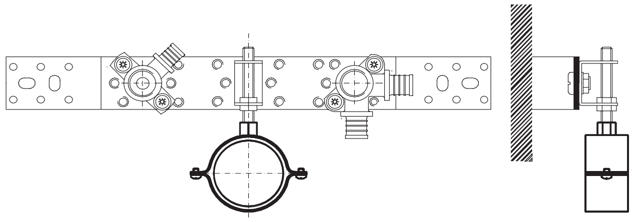
Fastening plate for wall angle

Wall angle 16-Rp 1/2	t = 90
Wall angle 20-Rp 1/2	t = 90
Wall angle passage 16-Rp 1/2	t = 90
Wall angle passage 20-Rp 1/2	t = 90
Wall angle 16-Rp 1/2 short	t = 78
Wall angle 20-Rp 1/2 short	t = 79
Wall angle 20-Rp 3/4	t = 80
Wall angle 25-Rp 3/4	t = 85



Notes for pipe laying and installation

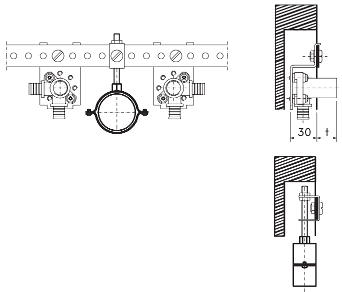
Holder 70/150 with U-component for pipe clamp drain



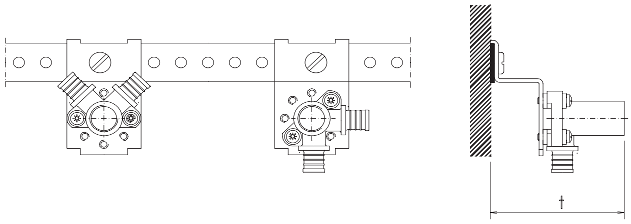
Holder 80/400

Wall angle 16-Rp 1/2	t = 27
Wall angle 20-Rp 1/2	t = 27
Wall angle passage 16-Rp 1/2	t = 27
Wall angle passage 20-Rp 1/2	t = 27
Wall angle 16-Rp 1/2 short	t = 15
Wall angle 20-Rp 1/2 short	t = 16
Wall angle 20-Rp 3/4	t = 17
Wall angle 25-Rp 3/4	t = 22

U-component for pipe clamp drain

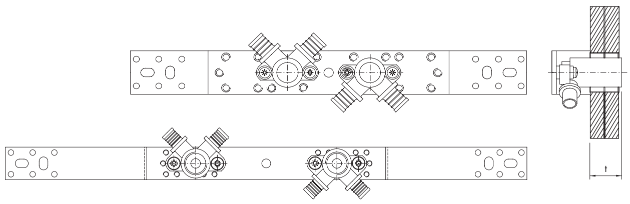


Holder 80/400
without U-component for pipe clamp drain



Wall angle 16-Rp 1/2	t = 27
Wall angle 20-Rp 1/2	t = 27
Wall angle passage 16-Rp 1/2	t = 27
Wall angle passage 20-Rp 1/2	t = 27
Wall angle 16-Rp 1/2 short	t = 15
Wall angle 20-Rp 1/2 short	t = 16
Wall angle 20-Rp 3/4	t = 17
Wall angle 25-Rp 3/4	t = 22

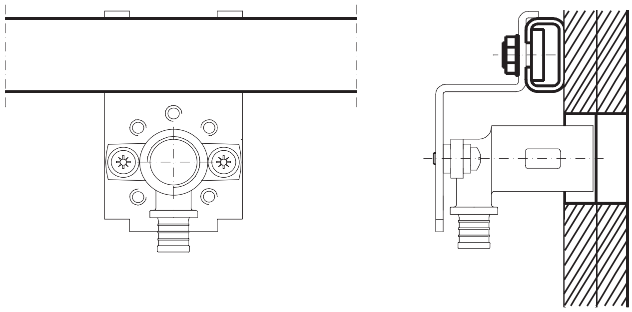
Lightweight wall installation with holders, holder 70/150



Wall angle 16-Rp 1/2	t = 27
Wall angle 20-Rp 1/2	t = 27
Wall angle passage 16-Rp 1/2	t = 27
Wall angle passage 20-Rp 1/2	t = 27
Wall angle 16-Rp 1/2 short	t = 15
Wall angle 20-Rp 1/2 short	t = 16
Wall angle 20-Rp 3/4	t = 17
Wall angle 25-Rp 3/4	t = 22

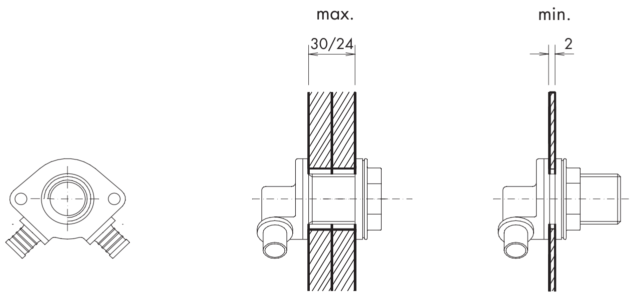
Holder Z-part

Separate part of holder 80/400
in lightweight wall carrier rack



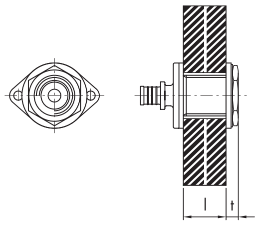
Notes for pipe laying and installation

Lightweight wall/Carrier rack installation with wall angles with flange



Wall bushing with hexagon nut flat

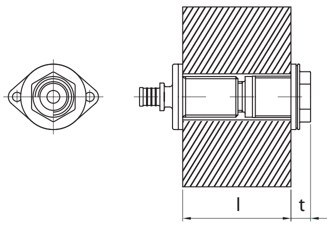
t = 10



Wall bushing with extensions

with extension short
878 641 251 l = 50-75/43-68

with extension long
878 641 252 l = 74-108/65-100
t = 13



Wall bushing with mounted locking washer

Notes for pipe laying and installation

PRINETO Holder with wall angle and insulating cover

The ***PRINETO*** insulating cover for wall angles (art.-no. 878 659 030) is suitable for all Rp ½ wall angles and prevents heat emission and structure-borne sound transmission

PRINETO Distribution manifold connection

5-fold distribution manifold mounted in ***PRINETO*** manifold holder (art.-no. 878 669 240) for separate connection without tee pieces.

PRINETO Connection angle for concealed toilet cistern

After mounting the angle valve on the workbench, the ***PRINETO*** connection angle (art.-no. 878 650 130) is fixed in the cistern by using the special recession nut.

Notes for pipe laying and installation

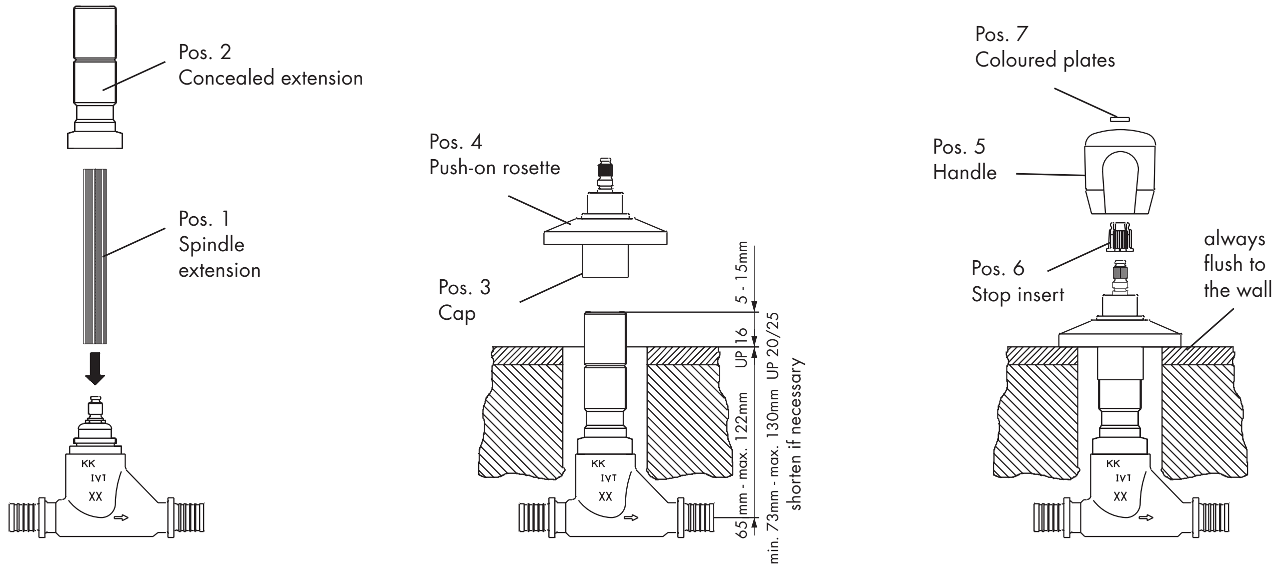
PRINETO Valve for concealed installation

The ***PRINETO*** valve for concealed installation is a straight seat valve used as a pipe fitting (e.g. in storey piping) with fixed ***PRINETO*** connection profile for the direct connection of Nanoflex, plumbing, heating or multilayer composite pipes without additional transitions. The ***PRINETO*** valve for concealed installation is DVGW-approved and suitable for concealed plumbing and heating installations up to a maximum of 90° C (pressure level PN 10). The valve core can be replaced subsequently.

Scope of delivery:
Main body with valve core, protective cap, concealed extension for variable depth of installation, chromium rosette, chromium-plated plastic handle with small coloured red and blue plates.

Material basic body:
Dezincification-resistant brass

Material valve core:
Brass, stainless steel, EPDM



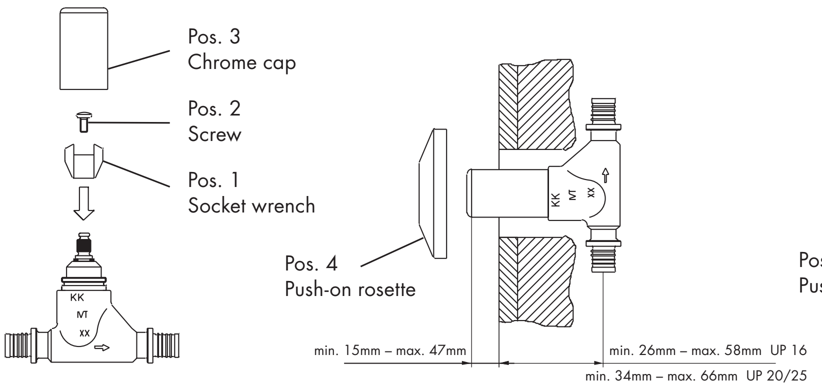
Installation in building shell
After installing concealed valve, fit protective cap.

Final installation:
- Remove protective cap
- Put spindle extension (pos. 1) with internal corrugation on upper part of valve.
- Screw on concealed extension (pos. 2) and cut to length together with the spindle extension (pos. 1) approx. 5–15 mm before wall.
- The push-on rosette (pos. 4) has to be pushed onto the pre-installed cap until the stop is felt (pos. 3) and has to be mounted together with the concealed extension flush to the wall.
- Put stop insert (pos. 6) on spindle of the cap.
- Put handle (pos. 5) on stop insert (pos. 6)

Notes for pipe laying and installation

PRINETO Valve for concealed installation, design for public buildings

The ***PRINETO*** valve for concealed installation for public buildings is used wherever use should be restricted (e.g. in nursery schools, schools, etc.). Instead of the handle, a cover cap is screwed on. Below this cap there is a small wing handle for operation. If the maximum standard depth of installation of 58 mm (UP 16), or 66 mm (UP 20/25) respectively, is exceeded, the depth of installation can be extended up to 153 mm (UP 16), or 161 mm (UP 20/25) respectively, by the concealed extension for public buildings (art.-no. 878 680 037). Then, operation of the valve is effected by a broad pan head screw with cross recession (on site) in the rotation adapter. The socket wrench is not needed in this case.



Concealed valve, design for public buildings

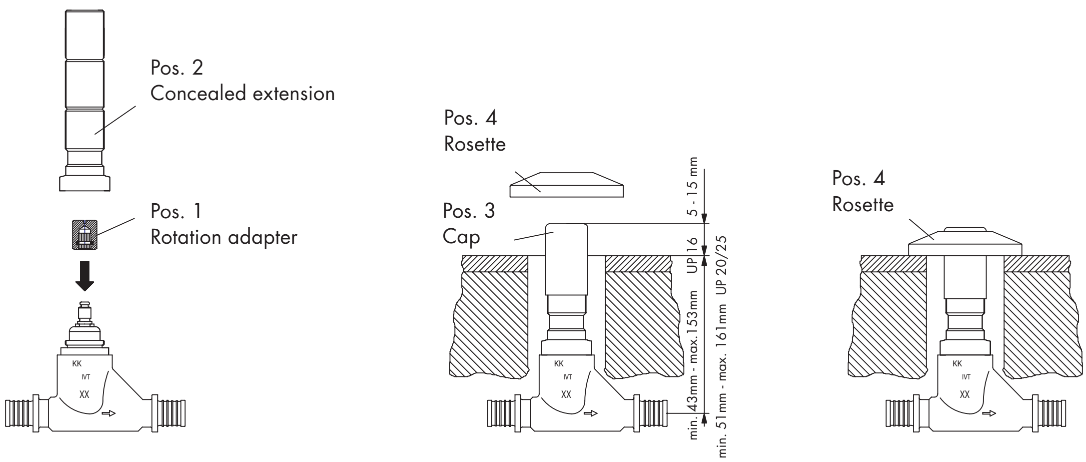
Installation in building shell
- After installing concealed valve, fit protective cap.

Final installation:
- Remove protective cap
- Place socket wrench (pos. 1) with internal corrugation on upper part of valve.
- Tighten screw (pos. 2), and screw cap (pos. 3) onto the upper part.
- Slide push-on rosette (pos. 4) onto the already installed cap (pos. 3) until stop is felt.

Concealed extension designed for public buildings

Installation in building shell
- After installing concealed valve, fit protective cap.

Final installation:
- Remove protective cap
- Place rotation adapter (pos. 1) with internal corrugation on upper part of valve.
- Screw concealed extension (pos. 2) onto upper part and cut to length if necessary
- Screw cap on (pos. 3) and slide push-on rosette (pos. 4) until it is on the wall.



Planning and dimensioning of the drinking water system

The planning and dimensioning of the drinking water system is based on DIN 1988 technical regulations for drinking water installations (TRWI) as well as for determining the pipe diameter for hot and cold water pipes, DIN 1988-300 and DIN EN 806 part 1 to 5. DIN EN 806 parts 1 to 5 is available. DIN EN 1717 partly replaces DIN 1988 part 4.

The benchmark for the dimensioning is the minimum supply pressure of the water supply company (WVU), which has to be obtained before planning is started.

Nowadays, the exact calculation and dimensioning with mass determination is normally done using buildings engineering planning software. For the ***PRINETO*** system the data of Messrs. LiNear and Dendrit can be used.

Approximate determination of quantities for a small building project of up to 6 residential units without sophisticated planning software is possible according to DIN 1988-300 and also EN 806-3 although the use of this method is not generally accepted.

The determining of the pipe diameter is based on the calculation of the pressure loss which occurs in the pipe system at peak flow and/or the flow volume for circulation. The pipe diameters of all part-sections of the drinking water system are determined according to DIN 1988-300, mainly by using the following procedure.

1. Ascertain the calculation flows of the draw-off fittings, and from this ascertain the cumulative flows for each part-section.
2. Ascertain the peak flow
3. Calculate the available pipe friction pressure gradient for all the flow paths
4. Choose pipe diameter for the most unfavourable flow path
5. Calculate the pressure gradient that is now available for the remaining flow paths, and then choose the pipe diameter for the next least favourable flow path until all the part-sections have been dimensioned

When selecting the pipe diameter, the maximum calculated flow velocities must not be exceeded at the peak flows stated in Table 1.

Tabelle 1: Maximum calculated flow velocities based on table 5, DIN 1988-300

Pipe section	Maximum calculated flow velocity for given flow duration	
	≤ 15 min	> 15 min
Connection pipes	2 m/s	2 m/s
Consumption pipes		
Part-sections with two-way valves with little pressure loss ($\zeta < 2.5$) *)	5 m/s	2 m/s
Part-sections with two-way valves with little pressure loss ($\zeta < 2.5$) **)	2.5 m/s	2 m/s
Circulation pipes **)	0.2 - 0.5 m/s	

*) e.g. piston valve acc. to DIN 3500, ball valve, angle seat valve acc. to DIN 3502 (from DN 20 onwards)

) e.g. straight seat valve acc. to DIN 3512 (*PRINETO*** concealed valves)

**) Stated recommended flow velocity. This may be limited to a maximum of 1.0 m/s.

Planning and dimensioning of the drinking water system

Step 1: Calculation flow and cumulative flow Calculation flow

The calculation flow is the rated design flow for the draw-off fitting. A minimum flow pressure is required in this regard. The manufacturer's stipulations regarding the calculation flows and the minimum flow pressures of the draw-off fittings must always be followed when calculating the pipe diameters.

If there are not yet any known values for the corresponding fittings, the values shown in Table 2 for commonly used drinking water draw-off points can be used for the dimensioning if the important notes are heeded.

Table 2: minimum flow pressure and minimum values for the calculation flow for commonly used drinking water draw-off points

Type of draw-off point	DN	Minimum flow pressure	Calculation flow
		p_{minFl} [MPa]	V_R [l/s]
Outlet valves [a] without aerator	15	0,05	0,30
	20	0,05	0,50
	25	0,05	1,00
with aerator	10	0,10	0,15
	15	0,10	0,15
Mixer taps [b, c] **for** shower tray	15	0,10	0,15
Bath tub	15	0,10	0,15
Kitchen sink	15	0,10	0,07
Wash basin	15	0,10	0,07
Bidet	15	0,10	0,07
Domestic appliances Washing machine (acc. to DIN EN 60456)	15	0,05	0,15
Dish washer (acc. to DIN EN 50242)	15	0,05	0,07
Toilet bowls and urinals Filler valve for flush cistern (acc. to DIN EN 14124)	15	0,05	0,13
Pressure flush valve for urinal (acc. to DIN EN 12541)	15	0,10	0,30
Pressure flush valve (electronic) for urinal (acc. to DIN EN 15091)	15	0,10	0,30
Pressure flush valve for toilet	20	0,12	1,00

a Without connected appliances (e.g. lawn sprinklers).

b The stated calculation flow is to be calculated for the cold and hot water connection.

c Angle valves for wash-stand fittings etc., and S-connections for shower tray and bath tub fittings etc. must be taken into account as individual resistance values or within the minimum flow pressure of the draw-off fitting.

IMPORTANT NOTES:

The manufacturers must state the minimum flow pressure and the calculation flow rates for the cold and the hot water sides (in the case of mixer taps). The manufacturer's stipulations must always be followed when calculating the pipe diameters, which may differ considerably from the values stated in this table. The following procedure should be adopted:

If the manufacturer's stipulations regarding the minimum flow pressure and the calculation flow are **lower than the values stated in the table**, there are two options

If the calculation for drinking water installation is to be carried out based on the lower values for hygienic or economic reasons, this procedure must be agreed with the owner, and the design requirements for the draw-off points (minimum flow pressure and calculation flow) must be incorporated into the calculation.

If the calculation for drinking water installation is not to be carried out based on the lower values, the table values must be adhered to. The manufacturer's stipulations are higher than the values stated in the table, the drinking water installation must be calculated using the manufacturer's values.

Cumulative flow

The cumulative flow represents the total of the calculation flows for the relevant part-sections. In order to calculate the cumulative flow, the calculation flows against the flow direction are added together, beginning at the most distant draw-off point and up to the relevant part-section. This process usually ends at the domestic water meter. The respective part-section begins at the pipe fitting at which the cumulative flow, the diameter, or the pipe material changes.

When undertaking the calculation, all the draw-off points and their calculation flows must always be taken into account. However, in this instance certain usage points are excluded, such as a second washbasin or a shower tray in addition to a bath tub, a bidet next to a urinal, or tap fittings in the vestibules of toilet facilities.

NOTE:

At the branch-off point from the cold water pipe to the drinking water heater, the cumulative cold and the hot water flows are added together.

CAUTION!

Continuous flows lasting for more than 15 minutes must be separately listed. These fittings, such as garden outlet fittings for example, must not be included in the calculation of the peak flow. A lawn-sprinkler may be in operation for hours.

Step 2: Peak flow

Since it is very unlikely that all the draw-off fittings will be open at the same time, so-called peak flows which take account of the usage-dependent simultaneity of the drawing off of water are formed from the cumulative flows for hot and cold water. For calculation flows of up to 500 l/s, the peak flow is calculated as follows:

$$\dot{V}_S = a\,(\Sigma\,\dot{V}_R)^b - c$$

Equation 1

where V_S is the peak flow, V_R the previously ascertained calculation flow, and a, b, and c are constants for taking account of differing usages. These constants are listed in Table 3.

Table 3: Constants for determining peak flow according to DIN 1988-300

Building type	Constant		
	a	b	c
Residential building	1,48	0,19	0,94
Ward block in hospital	0,75	0,44	0,18
Hotel	0,70	0,48	0,13
School	0,91	0,31	0,38
Administration building	0,91	0,31	0,38
Assisted living facility, old people's home	1,48	0,19	0,94
Care home	1,40	0,14	0,92

NOTE

A usage unit is defined as a room for a residential type of use, and it is characterised by the fact that a maximum of two draw-off points are open at the same time. The peak flow in each part-section within a usage unit is therefore no greater than the total of the two largest consumption points. The connecting up of further usage units entails adding the corresponding peak flows, provided that the result of the peak flow calculation according to the equation shown above is not lower.

As well as the exception relating to long-term usage points, further exceptions are defined for large-scale installations and special structures such as commercial and industrial facilities. In these cases, the simultaneity of the draw-off of water must be determined in conjunction with the operator, and it must be calculated based on the cumulative flow. The peak flows of other sub-areas must be added together if they may coincide.

Step 3: Available pipe friction pressure gradients

As a general rule, the calculation of the pressure gradient for each flow path begins immediately after the domestic water meter, and it takes account of the distance to the respective draw-off point. In principle it is The pipe friction pressure gradient R_V is calculated as follows:

$$R_V = \frac{\left(1 - \frac{a}{100}\right)}{l_{ges}} \Delta p_{ges.v}$$

Equation 2

where a is the individual resistance proportion which, based on experience, is between 40 % and 60 % in residential buildings. l_{ges} is the respective overall length of the flow path between the domestic water meter and the draw-off fitting. $\Delta p_{ges.v}$ is the available pressure difference, which is made up as follows

$$\Delta p_{ges.v} = p_{minWZ} - \Delta p_{geo} - \Sigma \Delta p_{Ap} - \Sigma \Delta p_{RV} - p_{minFl}$$

Equation 3

based on the following definitions:

p_{minWZ}	the minimum pressure after the domestic watermeter
Δp_{geo}	the pressure loss due to the difference in geodetic height
Δp_{Ap}	the pressure loss in an appliance
Δp_{RV}	the pressure loss in the backflow preventer
p_{minFl}	the minimum flow pressure of the fitting at the corresponding flow rate

The minimum pressure after the domestic water meter is based on the minimum supply pressure that is to be specified by the water supply company. As a general rule, the applicable pressure loss is 200 hPa in the domestic mains, and 650 hPa for the water meter. In this case the minimum supply pressure can consequently be reduced by 850 hPa when calculating the minimum pressure.

Step 4: Choose pipe diameter for the most unfavourable flow path

The most unfavourable flow path is the one with the lowest pipe friction pressure gradient. In the case of this flow path, the pipe diameter is to be determined accordingly for each part-section taking account of the previously calculated peak flow rates. The resulting pressure gradient should be as close as possible to the value of the pipe friction pressure gradient, but not exceed it. Furthermore, the pressure loss caused by fittings must also be taken into account. When determining the pipe diameter, the maximum arithmetical flow velocities shown in table 1 must be adhered to.

Individual resistance values for frequently used fittings are listed on page 41. Pipe friction resistance values for the individual dimensions are listed on the following pages according to flow volume and flow velocity. Separate resistance values must be used at 10°C for cold water pipes, and at 60°C.

Planning and dimensioning of the drinking water system

Step 5: Choose pipe diameter for further part-sections

For the more hydraulically favourable flow paths (with a higher pipe friction pressure gradient), the already determined pipe dimensions still apply. The further part-sections are similarly dimensioned using the pressure gradients that are still available. This enables the amount of water in the pipe system to be minimised while ensuring supply pressure.

NOTE:

In order to achieve a hygienic flow of water through a ring pipe system which is as even as possible, a nominal width must be chosen for the ring. In order to determine the available pressure difference for this, the simultaneous draw-off by the two largest usage points in the ring is taken into account. In this case equation 3 is supplemented by the pressure loss in the ring pipe system: Δp_{Ring}.

Pipe friction resistance values

Pipe friction resistances for dimension 16 x 2.2
[Nanoflex 16, plumbing pipe 16, multilayer composite pipe 16]

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0.01	0.09	0.23	0.17
0.02	0.19	0.76	0.58
0.03	0.28	1.55	1.18
0.04	0.38	2.57	1.96
0.05	0.47	3.79	2.89
0.06	0.57	5.22	3.98
0.07	0.66	6.83	5.22
0.08	0.76	8.63	6.59
0.09	0.85	10.61	8.01
0.10	0.95	12.75	9.74
0.11	1.04	15.07	11.50
0.12	1.14	17.55	13.40
0.13	1.23	20.18	15.41
0.14	1.32	22.98	17.55
0.15	1.42	25.93	19.80
0.16	1.51	29.03	22.16
0.17	1.61	32.28	24.64
0.18	1.70	35.67	27.24
0.19	1.80	39.21	29.94
0.20	1.89	42.89	32.75
0.21	1.99	46.72	35.67
0.22	2.08	50.68	38.70
0.23	2.18	54.78	41.83
0.24	2.27	59.02	45.06
0.25	2.37	63.39	48.40
0.26	2.46	67.89	51.84
0.27	2.55	72.52	55.38

Pipe friction resistances for dimension 20 x 2.8
[Nanoflex 20, plumbing pipe 20, multilayer composite pipe 20]

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0.01	0.06	0.08	0.06
0.02	0.12	0.27	0.21
0.03	0.18	0.56	0.42
0.04	0.25	0.92	0.70
0.05	0.31	1.36	1.04
0.06	0.37	1.87	1.43
0.07	0.43	2.45	1.87
0.08	0.49	3.09	2.36
0.09	0.55	3.80	2.90
0.10	0.61	4.57	3.49
0.11	0.68	5.40	4.12
0.12	0.74	6.28	4.80
0.13	0.80	7.23	5.52
0.14	0.86	8.23	6.28
0.15	0.92	9.28	7.09
0.16	0.98	10.39	7.94
0.17	1.04	11.56	8.82
0.18	1.11	12.77	9.75
0.19	1.17	14.04	10.72
0.20	1.23	15.36	11.73
0.21	1.29	16.73	12.77
0.22	1.35	18.15	13.86
0.23	1.41	19.61	14.98
0.24	1.47	21.13	16.13
0.25	1.54	22.70	17.33
0.26	1.60	24.31	18.56
0.27	1.66	25.97	19.83
0.28	1.72	27.67	21.13
0.29	1.78	29.43	22.47
0.30	1.84	31.23	23.84
0.31	1.90	33.07	25.25
0.32	1.96	34.96	26.69
0.33	2.03	36.89	28.17
0.34	2.09	38.87	29.68
0.35	2.15	40.89	31.23
0.36	2.21	42.96	32.80
0.37	2.27	45.07	34.41
0.38	2.33	47.22	36.06
0.39	2.39	49.42	37.74
0.40	2.46	51.66	39.45
0.41	2.52	53.94	41.19

Pipe friction resistance values

Pipe friction resistance values for dimension 25 x 3.5 [Nanoflex 25, plumbing pipe 25, multilayer composite pipe 25]

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0.01	0.039	0.028	0.021
0.02	0.079	0.095	0.072
0.03	0.118	0.192	0.147
0.04	0.157	0.318	0.243
0.05	0.196	0.470	0.359
0.06	0.236	0.647	0.494
0.07	0.275	0.848	0.647
0.08	0.314	1.071	0.817
0.09	0.354	1.316	1.005
0.10	0.393	1.582	1.208
0.11	0.432	1.869	1.427
0.12	0.472	2.177	1.662
0.13	0.511	2.504	1.912
0.14	0.550	2.851	2.177
0.15	0.589	3.217	2.456
0.16	0.629	3.601	2.750
0.17	0.668	4.004	3.057
0.18	0.707	4.425	3.379
0.19	0.747	4.865	3.714
0.20	0.786	5.321	4.063
0.21	0.825	5.796	4.425
0.22	0.865	6.287	4.801
0.23	0.904	6.796	5.189
0.24	0.943	7.321	5.590
0.25	0.982	7.864	6.004
0.26	1.022	8.422	6.431
0.27	1.061	8.997	6.870
0.28	1.100	9.589	7.321
0.29	1.140	10.196	7.785
0.30	1.179	10.819	8.261
0.31	1.218	11.458	8.749
0.32	1.258	12.113	9.249
0.33	1.297	12.783	9.760
0.34	1.336	13.468	10.284
0.35	1.375	14.169	10.819
0.36	1.415	14.885	11.366
0.37	1.454	15.616	11.924
0.38	1.493	16.362	12.494
0.39	1.533	17.123	13.075
0.40	1.572	17.899	13.667
0.41	1.611	18.690	14.270
0.42	1.650	19.495	14.885
0.43	1.690	20.314	15.511
0.44	1.729	21.148	16.148
0.45	1.768	21.996	16.795

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0.46	1.808	22.859	17.454
0.47	1.847	23.735	18.123
0.48	1.886	24.626	18.803
0.49	1.926	25.531	19.494
0.50	1.965	26.450	20.196
0.51	2.004	27.383	20.908
0.52	2.043	28.329	21.631
0.53	2.083	29.289	22.364
0.54	2.122	30.263	23.108
0.55	2.161	31.251	23.862
0.56	2.201	32.252	24.626
0.57	2.240	33.266	25.401
0.58	2.279	34.295	26.186
0.59	2.319	35.336	26.981
0.60	2.358	36.391	27.786
0.61	2.397	37.459	28.602
0.62	2.436	38.540	29.427
0.63	2.476	39.634	30.263
0.64	2.515	40.742	31.109

Pipe friction resistance values

Pipe friction resistance values for dimension 32 x 4.4 [Nanoflex 32, plumbing pipe 32, multilayer composite pipe 32]

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0.10	0.237	0.474	0.362
0.20	0.473	1.594	1.217
0.21	0.497	1.736	1.326
0.22	0.520	1.883	1.438
0.23	0.544	2.036	1.554
0.24	0.568	2.193	1.675
0.25	0.591	2.356	1.799
0.26	0.615	2.523	1.926
0.27	0.639	2.695	2.058
0.28	0.662	2.872	2.193
0.29	0.686	3.054	2.332
0.30	0.710	3.241	2.475
0.31	0.733	3.432	2.621
0.32	0.757	3.628	2.770
0.33	0.781	3.829	2.924
0.34	0.804	4.035	3.081
0.35	0.828	4.244	3.241
0.36	0.852	4.459	3.405
0.37	0.875	4.678	3.572
0.38	0.899	4.901	3.743
0.39	0.923	5.129	3.917
0.40	0.946	5.362	4.094
0.41	0.970	5.599	4.275
0.42	0.994	5.840	4.459
0.43	1.017	6.085	4.646
0.44	1.041	6.335	4.837
0.45	1.065	6.589	5.031
0.46	1.088	6.847	5.228
0.47	1.112	7.110	5.429
0.48	1.135	7.377	5.633
0.49	1.159	7.648	5.840
0.50	1.183	7.923	6.050
0.51	1.206	8.203	6.263
0.52	1.230	8.486	6.480
0.53	1.254	8.774	6.699
0.54	1.277	9.065	6.922
0.55	1.301	9.361	7.148
0.56	1.325	9.661	7.377
0.57	1.348	9.965	7.609
0.58	1.372	10.273	7.844
0.59	1.396	10.585	8.082
0.60	1.419	10.901	8.324
0.61	1.443	11.221	8.568
0.62	1.467	11.545	8.815
0.63	1.490	11.873	9.065
0.64	1.514	12.204	9.319
0.65	1.538	12.540	9.575
0.66	1.561	12.880	9.834
0.67	1.585	13.223	10.097
0.68	1.609	13.570	10.362
0.69	1.632	13.922	10.630
0.70	1.656	14.277	10.901
0.71	1.680	14.635	11.175
0.72	1.703	14.998	11.452
0.73	1.727	15.364	11.732
0.74	1.751	15.735	12.014
0.75	1.774	16.109	12.300
0.76	1.798	16.486	12.588
0.77	1.821	16.868	12.880
0.78	1.845	17.253	13.174
0.79	1.869	17.642	13.471
0.80	1.892	18.035	13.770
0.81	1.916	18.431	14.073
0.82	1.940	18.831	14.379
0.83	1.963	19.235	14.687
0.84	1.987	19.642	14.998
0.85	2.011	20.053	15.312
0.86	2.034	20.468	15.628
0.87	2.058	20.886	15.948
0.88	2.082	21.308	16.270
0.89	2.105	21.734	16.595
0.90	2.129	22.163	16.923
0.91	2.153	22.596	17.253
0.92	2.176	23.032	17.586
0.93	2.200	23.472	17.922
0.94	2.224	23.915	18.261
0.95	2.247	24.362	18.602
0.96	2.271	24.813	18.946
0.97	2.295	25.267	19.293
0.98	2.318	25.725	19.642
0.99	2.342	26.186	19.994
1.00	2.366	26.650	20.349
1.01	2.389	27.118	20.706
1.02	2.413	27.590	21.066
1.03	2.437	28.065	21.429
1.04	2.460	28.544	21.795
1.05	2.484	29.026	22.163
1.06	2.507	29.511	22.533

Pipe friction resistance values

Pipe friction resistance values for dimension 42 x 4.6 [multilayer composite pipe 40]

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0.10	0.117	0.089	0.068
0.20	0.234	0.299	0.228
0.25	0.292	0.442	0.337
0.30	0.351	0.608	0.464
0.35	0.409	0.796	0.608
0.40	0.468	1.006	0.768
0.45	0.526	1.236	0.944
0.50	0.585	1.486	1.135
0.55	0.643	1.756	1.341
0.60	0.702	2.045	1.561
0.65	0.760	2.352	1.796
0.70	0.818	2.678	2.045
0.75	0.877	3.021	2.307
0.80	0.935	3.382	2.583
0.85	0.994	3.761	2.872
0.90	1.052	4.157	3.174
0.95	1.111	4.569	3.489
1.00	1.169	4.998	3.817
1.02	1.193	5.175	3.951
1.04	1.216	5.353	4.088
1.06	1.239	5.535	4.226
1.08	1.263	5.719	4.367
1.10	1.286	5.906	4.509
1.12	1.309	6.095	4.654
1.14	1.333	6.287	4.800
1.16	1.356	6.481	4.948
1.18	1.380	6.678	5.099
1.20	1.403	6.877	5.251
1.22	1.426	7.079	5.405
1.24	1.450	7.283	5.561
1.26	1.473	7.490	5.719
1.28	1.497	7.699	5.879
1.30	1.520	7.911	6.040
1.32	1.543	8.125	6.204
1.34	1.567	8.342	6.369
1.36	1.590	8.561	6.537
1.38	1.613	8.782	6.706
1.40	1.637	9.006	6.877
1.42	1.660	9.233	7.050
1.44	1.684	9.462	7.224
1.46	1.707	9.693	7.401
1.48	1.730	9.926	7.579

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
1.50	1.754	10.162	7.759
1.52	1.777	10.401	7.941
1.54	1.801	10.641	8.125
1.56	1.824	10.884	8.311
1.58	1.847	11.130	8.498
1.60	1.871	11.377	8.687
1.62	1.894	11.627	8.878
1.64	1.917	11.880	9.071
1.66	1.941	12.134	9.265
1.68	1.964	12.391	9.461
1.70	1.988	12.651	9.659
1.72	2.011	12.912	9.859
1.74	2.034	13.176	10.061
1.76	2.058	13.442	10.264
1.78	2.081	13.711	10.469
1.80	2.105	13.982	10.676
1.82	2.128	14.255	10.884
1.84	2.151	14.530	11.094
1.86	2.175	14.807	11.306
1.88	2.198	15.087	11.520
1.90	2.221	15.369	11.735
1.92	2.245	15.653	11.952
1.94	2.268	15.940	12.171
1.96	2.292	16.228	12.391
1.98	2.315	16.519	12.613
2.00	2.338	16.812	12.837
2.02	2.362	17.108	13.063
2.04	2.385	17.405	13.290
2.06	2.409	17.705	13.519
2.08	2.432	18.007	13.749
2.10	2.455	18.311	13.981
2.12	2.479	18.617	14.215
2.14	2.502	18.926	14.451

Pipe friction resistance values

Pipe friction resistance values for dimension 52 x 5.65 [multilayer composite pipe 50]

V [l/s]	v [m/s]	R [mbar/m]		V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C			10 °C	60 °C
0.10	0.076	0.032	0.024	2.46	1.872	8.714	6.654
0.20	0.152	0.108	0.082	2.48	1.888	8.838	6.749
0.30	0.228	0.219	0.167	2.50	1.903	8.964	6.844
0.40	0.304	0.363	0.277	2.52	1.918	9.089	6.940
0.50	0.381	0.536	0.409	2.54	1.933	9.216	7.037
0.60	0.457	0.738	0.563	2.56	1.949	9.343	7.134
0.70	0.533	0.966	0.738	2.58	1.964	9.472	7.232
0.80	0.609	1.220	0.932	2.60	1.979	9.600	7.330
0.90	0.685	1.500	1.145	2.62	1.994	9.730	7.429
1.00	0.761	1.803	1.377	2.64	2.009	9.860	7.529
1.05	0.799	1.964	1.500	2.66	2.025	9.991	7.629
1.10	0.837	2.131	1.627	2.68	2.040	10.123	7.730
1.15	0.875	2.303	1.759	2.70	2.055	10.256	7.831
1.20	0.913	2.481	1.894	2.72	2.070	10.389	7.933
1.25	0.951	2.665	2.035	2.74	2.086	10.523	8.035
1.30	0.989	2.854	2.179	2.76	2.101	10.658	8.138
1.35	1.028	3.049	2.328	2.78	2.116	10.794	8.241
1.40	1.066	3.249	2.481	2.80	2.131	10.930	8.345
1.45	1.104	3.455	2.638	2.82	2.146	11.067	8.450
1.50	1.142	3.666	2.800	2.84	2.162	11.204	8.555
1.55	1.180	3.883	2.965	2.86	2.177	11.343	8.661
1.60	1.218	4.105	3.134	2.88	2.192	11.482	8.767
1.65	1.256	4.332	3.308	2.90	2.207	11.622	8.874
1.70	1.294	4.564	3.485	2.92	2.223	11.763	8.981
1.75	1.332	4.802	3.666	2.94	2.238	11.904	9.089
1.80	1.370	5.044	3.852	2.96	2.253	12.046	9.198
1.85	1.408	5.292	4.041	2.98	2.268	12.189	9.307
1.90	1.446	5.545	4.234	3.00	2.283	12.332	9.416
1.95	1.484	5.803	4.431	3.02	2.299	12.477	9.527
2.00	1.522	6.066	4.632	3.04	2.314	12.622	9.637
2.05	1.560	6.334	4.836	3.06	2.329	12.767	9.748
2.10	1.598	6.606	5.044	3.08	2.344	12.914	9.860
2.15	1.636	6.884	5.256	3.10	2.360	13.061	9.973
2.20	1.675	7.167	5.472	3.12	2.375	13.209	10.085
2.25	1.713	7.454	5.692	3.14	2.390	13.357	10.199
2.30	1.751	7.747	5.915	3.16	2.405	13.506	10.313
2.32	1.766	7.865	6.005	3.18	2.420	13.656	10.427
2.34	1.781	7.984	6.096	3.20	2.436	13.807	10.542
2.36	1.796	8.104	6.188	3.22	2.451	13.958	10.658
2.38	1.812	8.224	6.280	3.24	2.466	14.110	10.774
2.40	1.827	8.346	6.372	3.26	2.481	14.263	10.891
2.42	1.842	8.468	6.465	3.28	2.497	14.417	11.008
2.44	1.857	8.590	6.559	3.30	2.512	14.571	11.126

Pipe friction resistance values

Pipe friction resistance values for dimension 63 x 6,0 [multilayer composite pipe 63]

V [l/s]	v [m/s]	R [mbar/m]	
		10 °C	60 °C
0,10	0,049	0,011	0,009
0,20	0,098	0,038	0,029
0,30	0,147	0,077	0,059
0,40	0,196	0,127	0,097
0,50	0,245	0,188	0,143
0,60	0,294	0,259	0,197
0,70	0,343	0,339	0,259
0,80	0,392	0,428	0,327
0,90	0,441	0,526	0,401
1,00	0,490	0,632	0,483
1,10	0,538	0,747	0,570
1,20	0,587	0,870	0,664
1,30	0,636	1,000	0,764
1,40	0,685	1,139	0,870
1,50	0,734	1,285	0,981
1,60	0,783	1,439	1,099
1,70	0,832	1,600	1,222
1,80	0,881	1,768	1,350
1,90	0,930	1,944	1,484
2,00	0,979	2,126	1,624
2,05	1,004	2,220	1,695
2,10	1,028	2,316	1,768
2,15	1,052	2,413	1,843
2,20	1,077	2,512	1,918
2,25	1,101	2,613	1,995
2,30	1,126	2,715	2,073
2,35	1,150	2,820	2,153
2,40	1,175	2,925	2,234
2,45	1,199	3,033	2,316
2,50	1,224	3,142	2,399
2,55	1,248	3,253	2,484
2,60	1,273	3,365	2,570
2,65	1,297	3,479	2,657
2,70	1,322	3,595	2,745
2,75	1,346	3,712	2,835
2,80	1,371	3,831	2,925
2,85	1,395	3,952	3,017
2,90	1,420	4,074	3,111
2,95	1,444	4,198	3,205
3,00	1,469	4,323	3,301
3,05	1,493	4,450	3,398
3,10	1,518	4,578	3,496
3,15	1,542	4,708	3,595
3,20	1,566	4,840	3,695
3,25	1,591	4,973	3,797
3,30	1,615	5,108	3,900
3,35	1,640	5,244	4,004
3,40	1,664	5,381	4,109
3,45	1,689	5,521	4,215
3,50	1,713	5,661	4,323
3,55	1,738	5,804	4,432
3,60	1,762	5,948	4,541
3,65	1,787	6,093	4,652
3,70	1,811	6,240	4,764
3,75	1,836	6,388	4,878
3,80	1,860	6,538	4,992
3,85	1,885	6,689	5,107
3,90	1,909	6,842	5,224
3,95	1,934	6,996	5,342
4,00	1,958	7,152	5,461
4,05	1,983	7,309	5,581
4,10	2,007	7,468	5,702
4,15	2,032	7,628	5,824
4,20	2,056	7,789	5,948
4,25	2,080	7,952	6,072
4,30	2,105	8,117	6,198
4,35	2,129	8,283	6,324
4,40	2,154	8,450	6,452
4,45	2,178	8,619	6,581
4,50	2,203	8,789	6,711
4,55	2,227	8,960	6,842
4,60	2,252	9,134	6,974
4,65	2,276	9,308	7,107
4,70	2,301	9,484	7,241
4,75	2,325	9,661	7,377
4,80	2,350	9,840	7,513
4,85	2,374	10,020	7,651
4,90	2,399	10,201	7,789
4,95	2,423	10,384	7,929
5,00	2,448	10,568	8,070
5,05	2,472	10,754	8,211
5,10	2,497	10,941	8,354
5,15	2,521	11,129	8,498

2

Heating installations

PRINETO Heating installations

General basics

The following standards and regulations amongst others have to be observed during the planning, installation and operation of heating systems in buildings:

- DIN 4726 Piping systems made of synthetic materials
- DIN EN 1254 Copper and copper alloy fittings
- DIN EN 12831 Methods for the calculation of the standard heating load of buildings
- DIN EN 12828 Heating systems in buildings – planning of hot water heating systems
- DIN EN 14336 Heating systems in buildings – installation and inspection of hot water heating systems
- DIN 18380 Heating systems and central water-heating systems
- DIN V 4701-10 Energy evaluation of heating, ventilation and air technology systems
- EnEV Energy-saving Ordinance
- DIN 4102 Fire behaviour of construction materials and construction components
- Model piping directive (MLAR), model directive on fire protection requirements for piping systems
- DIN 4108 Heat insulation and energy saving in buildings
- DIN 4109 Sound insulation in structural engineering
- VDI 2035 Avoidance of damage in hot water heating systems

The ***PRINETO*** piping system can be used for radiator connection during the renovation of old houses as well as for installation in new buildings. In general, all types of laying are possible. The installation of piping systems can be effected in the form of a one-pipe system (valve blocks with bypass required, not in IVT range), or as a two-pipe system, as ring piping, a manifold system, or a system of shortest laying distances. If the unfinished floor is not available for pipe laying in the renovation of old buildings, laying in the skirting board is recommended.

All plastic pipes used in the field of heating have to be oxygen diffusion-tight according to DIN 4726.
The standard requires an area-related limiting value for oxygen diffusion of 0.32 mg per m^2 and per day at 40°C (application class 4) or 3.6 mg per m^2 and per day at 80°C (application class 5).
PRINETO heating pipes fall well below this value.
The Nanoflex and multilayer composite pipes are 100% oxygen diffusion-tight acc. to DIN 4726 (oxygen entry Nanoflex pipe <0.0005 cm^3/Package.d.0.21 bar).

All fittings of the drinking water piping system can also be used for heating installations (e.g. tee pieces, angles, etc.). In addition, a whole range of special fittings is available. These are made of high-grade brass and are suitable only for heating installations. Crossing tee pieces, for example, would act as a heat exchanger in drinking water installations and would cause inadmissible heating of the cold water. Nickel-plated fittings are no longer permitted for drinking water installations either acc. to the DVGW requirements, but can be used for heating systems. For the transition to Eurocone components (e.g. valve blocks) the following components are available:

- Clamp/screw-in connections for multilayer composite pipes (e.g. extremely short radiator connection type 12 from the wall to corner valve block, no room for sliding sleeve and tool).
- Soft-sealing threaded connector for metal pipes (e.g. for all connection elbows).
- Transition screw connections V-Euro (pipe with sliding sleeve connection pressed onto fitting).

TIP

We recommend using V-Euro transition screw connections wherever possible, since these are resistant to temperature fluctuation during heating operation. The pipe material in clamp/screw-in connections may relax under certain circumstances and lead to the union nut becoming loose. This is impossible in the case of properly installed V-Euro transitions. Later "tightening" as required with clamp/screw-in connections is not necessary with V-Euro transition screw connections.

General basics

Installation

Linear expansion caused during operation and the resulting forces have to be dealt with by the installation of bending legs and fixed points (see length change and bending legs, p. 20). Niches and slots in the masonry are permissible only if they do not impair stability. In general, static proof is required.

Due to their reduced linear expansion during heating we recommend the use of ***PRINETO*** multilayer composite pipes for surface-mounted distribution pipes or in riser shafts. For this purpose pipes up to dimension 63 are available (128 kV at 15 K temperature difference and 1.0 m/s), which can be used for the installation of everything, directly from the boiler to the heating surface.

Heating water additives

PRINETO pipes and fitting parts in contact with water are resistant to heating water and any additives.

The ***PRINETO*** piping system is suitable for the flow media ethylene (ethanediol) and propylene glycol. As anti-corrosion and anti-freeze agent we recommend:

- Antifrogen N (ethylene glycol, material class 3 acc. to DIN 1988-4) or
- Antifrogen L (propylene glycol, material class 3 acc. to DIN 1988-4, suitable for the foodstuffs sector).

The manufacturer's recommendations in respect of the intended application and the correct dosage must be followed (Clariant GmbH, 65926 Frankfurt am Main, Germany).

Outer corrosion

PRINETO fittings may have to be protected from outer corrosion under certain circumstances. Ammonia, amines, ammonium salts or sulphur dioxide etc. may lead to tension crack corrosion. Therefore, insulation materials must be nitrite-free and must not exceed a percentage of 0.2% by mass of ammonia. This is guaranteed if our pre-insulated pipes are used. If the fittings may come into contact with moisture over a lengthy period (e.g. buried pipes) they have to be insulated against water.

Following installation the piping system has to be subjected to pressure testing acc. to DIN 18380 or DIN EN 14336.

NOTE

When ***PRINETO*** crossing tee pieces are used, care must be taken that supply and return of the pipes are clamped at the same time.

PRINETO radiator connections

Pipe laying

PRINETO Branch line
Separate connection from the manifold.

Properties: small number of fittings, lots of pipe, each supply line can be shut off separately.

NOTE

Connection elbows must be fixed with ***PRINETO*** fixed-point clamps. If connection pipes are longer than 4 m, a bending leg must be placed directly ahead of the radiator connection.

PRINETO Ring line
Pipe laid along the edges of the room below the radiator.

Properties: little pipe, connection with ***PRINETO*** crossing tee pieces U or L with integrated connection elbows.

NOTE

Connection elbows must always be fixed on the rough floor using the fastening material supplied with the delivery.

PRINETO System of the shortest laying distance
Piping laid straight through the room to the radiators.

Properties: little pipe, connection via ***PRINETO*** crossing tee pieces with ***PRINETO*** connection elbows or multilayer composite pipe.

NOTE

The connection elbows must be fixed with ***PRINETO*** fixed-point clamps.

PRINETO One-pipe system
Return from the preceding radiator is flow for the next radiator.

Properties: extremely little pipe and fittings, unfavourable hydraulics. The pipes are fixed on the rough floor with dowel hooks.

PRINETO radiator connections

Radiator connections from the floor

PRINETO Multilayer composite pipe as supply pipe and connection to valve block, passage

The valve block connection is made with a ***PRINETO*** transition with screw connection Eurocone, the ***PRINETO*** clamp/screw-in connection for multi-layer composite pipe or the Eurocone transition with threaded connector, soft-sealing. Fixing of the pipeline near the connection is made with dowel hooks or U-type clamp within the bending leg.

PRINETO Nanoflex pipe as supply line and connection to valve block, passage

The connection to the valve block is made with the ***PRINETO*** transition with Euro-one screw connection or Eurocone transition with threaded connector, soft-sealing. Fixing of the pipeline near the connection is made with dowel hooks or U-type clamp.

PRINETO connection bend L for connection to the valve block, passage, ***PRINETO*** heating pipe as supply pipe

PRINETO threaded connector, soft-sealing. Fixing of the connection is made with the ***PRINETO*** fixed-point clamp behind the fitting collar. The piping is fastened by means of dowel hooks.

PRINETO Multilayer composite pipe, ***PRINETO*** Nanoflex pipe or ***PRINETO*** heating pipe for feeding and ***PRINETO*** crossing tee piece with L-type connection elbow for connection to valve block, passage

The connection to the valve block is made with the ***PRINETO*** connection union piece, soft-sealing. Fixing of the connection on the rough floor is made with the fastening material supplied with the delivery. The piping is fastened by means of dowel hooks.

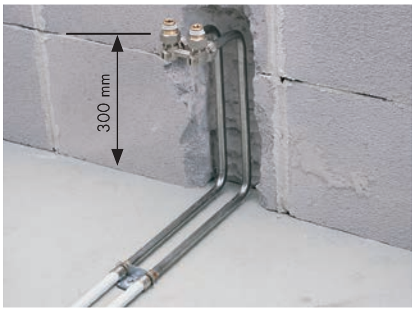
PRINETO radiator connections

Radiator connections from the wall

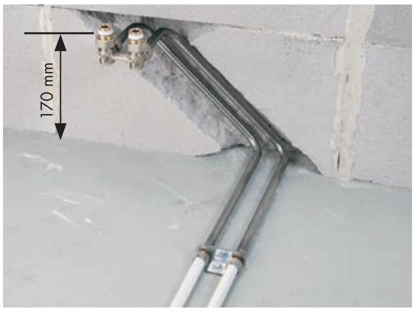
PRINETO U-type connection bend for connection to valve block, ***PRINETO*** Stabil pipe or Nanoflex pipe (alternatively heating pipe) for supply line.

The connection to the valve block is made with the ***PRINETO*** threaded connector, soft-sealing. Fixing of the connection is made with the ***PRINETO*** fixed-point clamp on the fitting collar. The piping is fastened by means of dowel hooks. By parallel rotation of the connection elbows in the masonry it is possible to achieve differing installation heights of the radiator.

The concealed U-type connection can also be bent using ***PRINETO*** multilayer composite pipe. The connection to the valve block is made with ***PRINETO*** transition with Eurocone screw connection or clamp/screw-in connection Stabil 16. Fixing of the connection is made with ***PRINETO*** fixed-point clamp on the coupler.



Concealed connection with ***PRINETO*** U-type connection elbow.



The height can be altered by angular positioning.


PRINETO Multilayer composite pipe for connection to valve block, ***PRINETO*** heating pipe or Nanoflex pipe for supply line.

The connection to the valve block, corner type, is made with the ***PRINETO*** threaded connector, soft-sealing.


PRINETO radiator connection box double, height of radiator fixed.

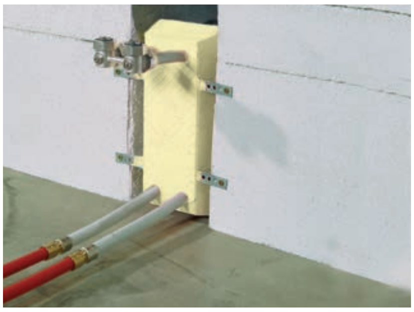

PRINETO radiator connection box variable double, height of radiator variable.


PRINETO radiator connection box variable single, height of radiator variable

PRINETO radiator connections

PRINETO crossing tee piece with soldered U-type connection elbows. The connection to the valve block is made with the ***PRINETO*** threaded connector, soft-sealing. Fixing of the connection on the rough floor is made with the fastening material supplied with the delivery. The piping is fastened by means of dowel hooks.

PRINETO Multilayer composite pipe, Nanoflex pipe or ***PRINETO*** heating pipe for supply line and ***PRINETO*** crossing tee piece with U-type connection elbow for connection to valve block, corner-type



PRINETO radiator connection box Stabil 16 double. The connection to the valve block is either made with transition 16 V Euro or the clamp/screw-in connection Stabil 16 V-Euro.

The photo illustrates the tightest distance for direct connection of a radiator with corner-type valve block and V-Euro with sliding sleeve. If the distance between the wall and the centre of the radiator connection is 75 mm or more, this is possible using the parallel sliding pliers. Depending on the wall brackets used, this distance (75 mm) occurs on compact radiators of the types 21 and 22. The KSZ can be used from 105 mm. If the distance is smaller than 75 mm, clamp/screw-in connections still have to be used (radiator types 10, 11 and 12).

When the parallel sliding pliers are used, many radiators which have until now had to be connected by clamp/ screw-in connections for space reasons can now be connected using sliding sleeve connection and V-Euro transition. Clamp/screw-in connections work loose during fluctuations in temperature during operation and thus need re-tightening. The sliding sleeve connection combined with the V-Euro transition is a much more reliable connection for this purpose and it is permanently leak-tight as soon as it has been installed (see also General basics – Tip).

Radiator connections from the skirting board

For the renovation of living rooms without any screed or plaster work in old buildings the ***PRINETO*** skirting board system is the given choice.

In the case of the skirting board system the radiator connection is made with the ***PRINETO*** tee piece for skirting board (see p. 88), the crossing tee for skirting board with S- or L-type connection elbow (see p. 87), or the ***PRINETO*** crossing tee piece with L-type connection elbow (see p. 87).

All radiator connections must be fixed as fixed points using the fastening material supplied with the delivery.

The ***PRINETO*** multilayer composite pipes 16 and 20 and the ***PRINETO*** skirting board fittings can be used inside all normal skirting boards. The distance between skirting board fixing points is 0.5 m.

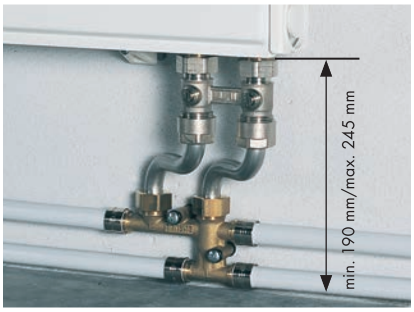
PRINETO radiator connections

Piping layout for the ***PRINETO*** skirting board system.

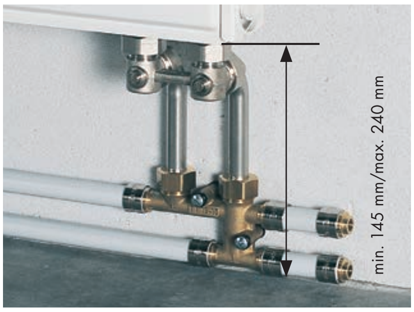
NOTE

For the skirting board system only ***PRINETO*** multi-layer composite pipe should be used, because of its significantly lower linear expansion when heated.

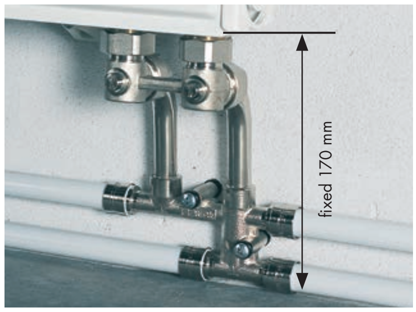
Connection with crossing tee piece or crossing tee piece 16 L



Connection situation in the skirting board with two ***PRINETO*** S-type connection elbows. ***PRINETO*** crossing tee piece for skirting board with two S-type elbows made of stainless steel, different radiator construction depths are compensated through angular positioning of the connection elbows. Maximum distance between finished wall and centre: 245 mm. Radiator connection: 90 mm.



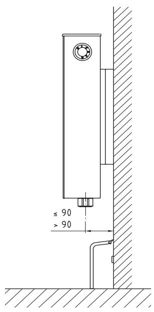
Connection situation in the skirting board with two ***PRINETO*** L-type connection elbows. ***PRINETO*** crossing tee piece for skirting board with two L-type elbows made of stainless steel for the skirting board connection at a distance from centre of radiator – wall of > 90 mm.



Connection situation in the skirting board with the ***PRINETO*** crossing tee piece L. Here, a valve radiator with corner-type valve block is connected to the piping system (minimum distance wall – radiator 90 mm).

Connection situation in the skirting board with ***PRINETO*** crossing tee piece with angle connection and shut-off angle valves. ***PRINETO*** crossing tee piece for skirting board with two angle connections and two lockable angle valves. The connections are made of chrome-plated copper and are connected by means of soft-sealing threaded connectors. A valve block is no longer required.

Connection situation in the skirting board with ***PRINETO*** crossing tee piece with angle connection ***PRINETO*** crossing tee piece for skirting board with two angle connections and two L-type elbows made of stainless steel for connection to the skirting board.



≤ 90 mm connection with S-type elbows or angle connection with L-type elbows/shut-off angle valves
> 90 mm connection with L-type elbows.
Wall distances radiator

After the last radiator connection the pipeline is continued for approx. 10 cm and closed with blind plug.

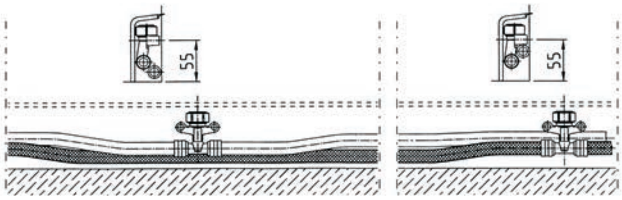
The connection to the valve block is made in all cases by ***PRINETO*** threaded connector, soft-sealing.

PRINETO radiator connections

Connection alternately with tee piece V15 for skirting board

When installing the ***PRINETO*** tee piece T-16-V15-16 care must be taken that the ***PRINETO*** skirting board covers the complete assembly.

Installation T 16-V15-16



Piping layout in the case of alternating radiator connection with ***PRINETO*** skirting board tee piece; upper pipe behind tee piece, lower pipe below tee piece.

Connection with crossing tee piece V15 for skirting board installation

When installing the crossing tee piece in the skirting board the following sequence must be observed. The connection with ***PRINETO*** S-type connection elbows is shown.

Adapting the ***PRINETO*** stainless steel S-type connection elbow to the construction depth.

Different radiator connection depths are to be offset by angular positioning of the connection elbows. The distance of the lower leg to the wall must be 16 mm.

Marking of drill hole

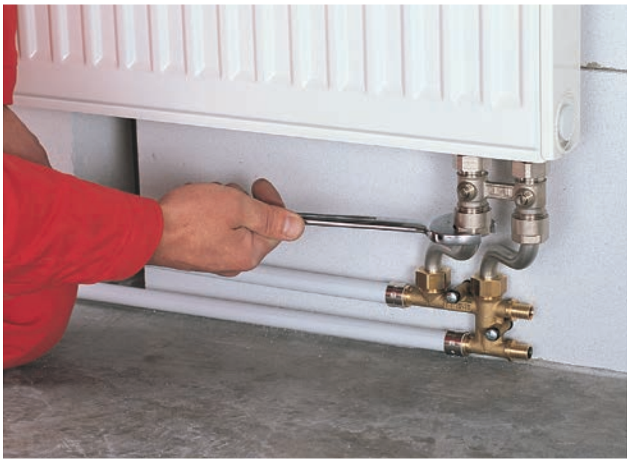
The necessary leg length must be determined carefully. The ends of the connection elbows must be deburred. The legs must touch the bottom of the screw connection bores of the crossing tee piece and the valve block. The legs have to be cut to length with the metal cutting saw, and then deburred. The ***PRINETO*** stainless steel connection elbows S-type do not require support tubes.

PRINETO radiator connections

Installation of the crossing tee piece

Initially fix the position of the crossing tee piece using dowels. For this purpose attach the plastic washers on both sides.

Tightening of connection elbows S-type



Release the screws at crossing tee piece, moisten leg end of connection elbow with water and press against the slight resistance of the O-ring sealing element into the bore of the crossing tee piece. Tighten nut manually. Slip parts of the valve block screw connection over the leg end, push leg end into the bore of the connection, install screw connection, tighten nut manually. Then tighten up nut of screw connection at crossing tee piece, after manual tightening, with spanner by 3/4 rotation. Tighten nut of valve block connection as specified (tightening torque: 40 Nm).

Pressure testing of ***PRINETO*** heating systems

General basics

Upon completion and before closing of the slots, wall and ceiling breakthroughs, and – if applicable – before application of the screed or another cover, hot water heating systems have to be pressure tested with water for leak tightness and solidity. The test is to be recorded and signed by the client and the test operative.

In accordance with DIN 18380 (published 12/2002) all system components have to be tested with a pressure which corresponds to the threshold pressure of the safety valve.

In accordance with DIN EN 14336 (published 01/2005) the system is tested with 1.3 times the value of the operating pressure. System components which do not withstand this pressure, must be detached from the testing network before the test. Acc. to DIN EN 14336 testing with air or inert gases is also permissible. The testing pressure is max. 0.5 bar. The performance of the individual tests is described in detail in the standard.

The owner has to determine which regulations are to be used as a basis for the test.

NOTE

If ***PRINETO*** crossing tee pieces are used care must be taken that supply and return of the pipes are clamped at the same time! If there is danger of freezing, appropriate measures, like the use of antifreeze agents or heating of the building, have to be taken (see Heating water additives, p. 82).

The material characteristics of the synthetic pipes lead to an expansion of the pipe during the pressure testing, which causes the pressure to fall. Changes in temperature also distort the test result. Therefore, with pressure testing, as constant a pressure as possible should be maintained for the test medium, and the initial pressure should be restored several times after the pipe expansion. The pressure test with water is to be implemented as follows:

1. Starting at the lowest point, the piping system is gradually filled with water, until all pipes are free from air.
2. A visual check of the pipe connections is to be carried out.
3. As soon as the system is filled, the connection to the filling appliance (e.g. water supply network) has to be severed acc. to DIN 1717.
4. Preparation of the test by subjecting the whole system to the testing pressure specified by the owner (see standard value references on the left). The initial pressure should be restored again after half an hour, and again after a further half hour.
   After another half hour (1.5 hours after the start) testing can begin (without restoring the initial pressure again!).
5. The test is regarded as passed, if the pressure drop within 24 hours is less than 1 bar, if no leaks have been detected, and no component has suffered permanent distortion.

TIP

(In compliance with the "old" DIN 18380 of 12/2002) we recommend heating the system after cold-water pressure testing and testing for leak-tightness at the highest permissible operating pressure.

NOTE

The test pressure and the pressure curve during the test do not allow reliable conclusions regarding the system tightness. For this reason, the tightness of the complete drinking water installation must be checked, as required in the standards, with a leak indicator medium and a visual inspection.

PRINETO®

Pressure testing of ***PRINETO*** heating systems

Pressure testing protocol for ***PRINETO*** heating systems

Performed ☐ acc. to DIN 18380 (threshold pressure, safety valve) ☐ acc. to DIN 14336 (operating pressure x 1.3)

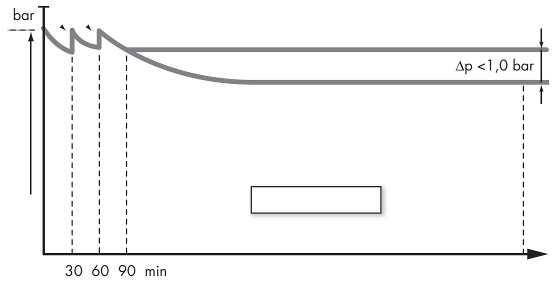
Object: ____________________

Owner: ____________________

Inspector: ____________________

Description test stage

16 ______ m
20 ______ m
25 ______ m
32 ______ m
Stabil 14 ______ m
Stabil 40 ______ m
Stabil 50 ______ m
Stabil 63 ______ m



Preparation (duration 90 minutes)

Start ____ : ____ h End ____ : ____ h

Testing pressure at beginning of test ______ bar
Testing pressure after 24 hours ______ bar
Pressure after 90 minutes ______ bar

NOTE

The temperature of the test medium should be kept as constant as possible. Fill pipes with water. Vent pipes completely.

Test (duration 24 hours)

Start ____ : ____ h End ____ : ____ h

Testing pressure at beginning of test ______ bar
Testing pressure after 24 hours ______ bar
Pressure after 90 minutes ______ bar

Results of the testing

Pressure testing passed ☐ yes ☐ no

Leaks detected ☐ yes ☐ no

Changes in shape detected ☐ yes ☐ no

Visual inspection passed ☐ yes ☐ no

Place, Date ______ Signature inspector ______ Signature owner or representative ______

2

Heating installations

Planning and dimensioning of the heating system

The planning and dimensioning of the heating system is based on the calculation of the heating load of the building acc. to DIN EN 12831.

Nowadays, the exact calculation and dimensioning with mass determination is normally done with planning software for domestic engineering.

For the ***PRINETO*** system the data of Messrs. LiNear and Dendrit can be used.

General basics

Recommended maximum flow velocities:
Radiator connection pipes: up to 0.5 m/s
Heating distribution pipes: up to 1.0 m/s

Recommended maximum pressure losses:
Static heating systems: 100 – 200 Pa/m
(Overall pressure loss for one 6 m pump approx. 300 - 400 hPa)

Surface heating supply pipes: 100 – 200 Pa/m
(Overall pressure loss for one 6 m pump approx. 100 - 200 hPa)

Individual surface heating circuits: 200 – 250 Pa/m

Maximum heating power of the pipes:
Dimensioning data for ***PRINETO*** heating, multilayer composite and Nanoflex pipes with differing temperature differences and flow velocities, with regard to straight pipe sections (pressure losses of fittings and valves not taken into consideration, heating water temperature 60°C).

Conversion of pressure units:
1 bar = 100 kPa = 1000 hPa = 10 mWS
100 Pa (1.0 hPa) = 1.0 mbar (0.001 bar) = 10 mmWS

Limited to maximum pressure loss of 200 Pa/m

Temperature difference	**5 K**	**10 K**	**15 K**	**20 K**	**m**	**R**	**w**	
Pipe dimension	Max. heating power Q [KW]				[kg/h]	[Pa/m]	[m/s]	
14 x 2.0 (Stabil)	0.57	1.13	1.70	2.27	97	200	0.34	Connection pipes
16 x 2.2 (Nanoflex, PE-X & Stabil)	0.85	1.69	2.54	3.39	146	200	0.38	
20 x 2.8 (Nanoflex, PE-X & Stabil)	1.52	3.05	4.57	6.10	262	200	0.45	
25 x 3.5 (Nanoflex, PE-X & Stabil)	2.79	5.59	8.38	11.17	480	200	0.52	Distribution pipes
32 x 4.4 (Nanoflex, PE-X & Stabil)	5.56	11.12	16.68	22.24	956	200	0.63	
42 x 4.6 (Stabil)	14.47	28.94	43.41	57.88	2.488	200	0.81	
52 x 5.6 (Stabil)	25.91	51.82	77.73	103.64	4.456	200	0.94	
63 x 6.0 (Stabil)	47.17	94.34	141.51	188.68	8.112	200	1.00	

Limited to maximum flow velocity (0.5 or 1.0 m/s)

Temperature difference	**10 K**	**15 K**	**20 K**	**25 K**	**m**	**R**	**w**	
Pipe dimension	Max. heating power Q [KW]				[kg/h]	[Pa/m]	[m/s]	
14 x 2.0 (Stabil)	1.1	1.7	2.3	2.8	97	200	0.34	Connection pipes
16 x 2.2 (Nanoflex, PE-X & Stabil)	1.7	2.6	3.4	4.3	146	201	0.38	
20 x 2.8 (Nanoflex, PE-X & Stabil)	3.1	4.6	6.1	7.6	262	200	0.45	
25 x 3.5 (Nanoflex, PE-X & Stabil)	5.6	8.4	11.2	14.0	481	201	0.53	Distribution pipes
32 x 4.4 (Nanoflex, PE-X & Stabil)	11.1	16.7	22.2	27.8	955	200	0.63	
42 x 4.6 (Stabil)	29.0	43.5	58.0	72.5	2.493	200	0.81	
52 x 5.6 (Stabil)	51.8	77.7	103.6	129.5	4.454	200	0.94	
63 x 6.0 (Stabil)	86.0	129.0	172.0	215.0	7.395	170	1.00	

Planning and dimensioning of the heating system

Rough heating demand

Building quality	Heat quantity [kWh/m²a]	Spec. heat demand [W/m²]
Old buildings – single-glazed windows	340–400	170–200
Old buildings – double-glazed windows	260–320	130–160
Buildings acc. to WSTO 1977	180–240	90–120
Buildings acc. to WSVO 1982	140–160	70–80
Buildings acc. to WSVO 1995	100–120	50–60
Buildings acc. to EnEV 2002	70–80	35–40
Buildings acc. to EnEV 2009	50–60	25–30
Buildings acc. to EnEV 2012	30–40	15–20

Simplified method of piping dimensioning

The approximate mass determination for a small building project without expensive planning software is described below. Pressure losses of the fittings and the pipe lengths are not taken into consideration. The limiting values for the approximate dimensioning are the pressure loss or the flow velocity. It must be established for each room how many radiators are to be installed at which location in the room. Accordingly, the planned piping layout has to be entered in the ground plan, or – if there are several storeys – a piping diagram (vertical section of system) has to be drawn.

The following characteristic values for the dimensioning of the piping network are required:

- Surface heat flux q [W/m²] of the building, The respective room surface is required for calculating the heating power for each room.
- Room surface A_{Room} [m²] of each individual room to be heated, The dimensioning heating power of the room is established by multiplying the surface heat flux by the respective room surface:

$$Q_{Room} = q \cdot A_{Room}$$

TIP

In the bathroom the surface heat flux should be slightly surface-mounted because of the higher internal room temperature.

Dimensioning heating power for each individual room

Q_{room} [W] is determined by means of heat load calculation acc. to DIN EN 12831 (standard heating Φ_{HL}). If there is only one radiator in the room, the dimensioning power room [Q_{room}] is equal to the dimensioning power radiator [Q_{HK}]. If several radiators are installed in the room the dimensioning power room is distributed appropriately between the respective number of radiators.

Supply and return temperature

θ_V and θ_R [°C], is defined by the architect or planner, the difference results in the

- Temperature difference σ [K]:

$$\theta_V - \theta_R = \sigma \text{ [K]},$$

Max. permissible pressure loss

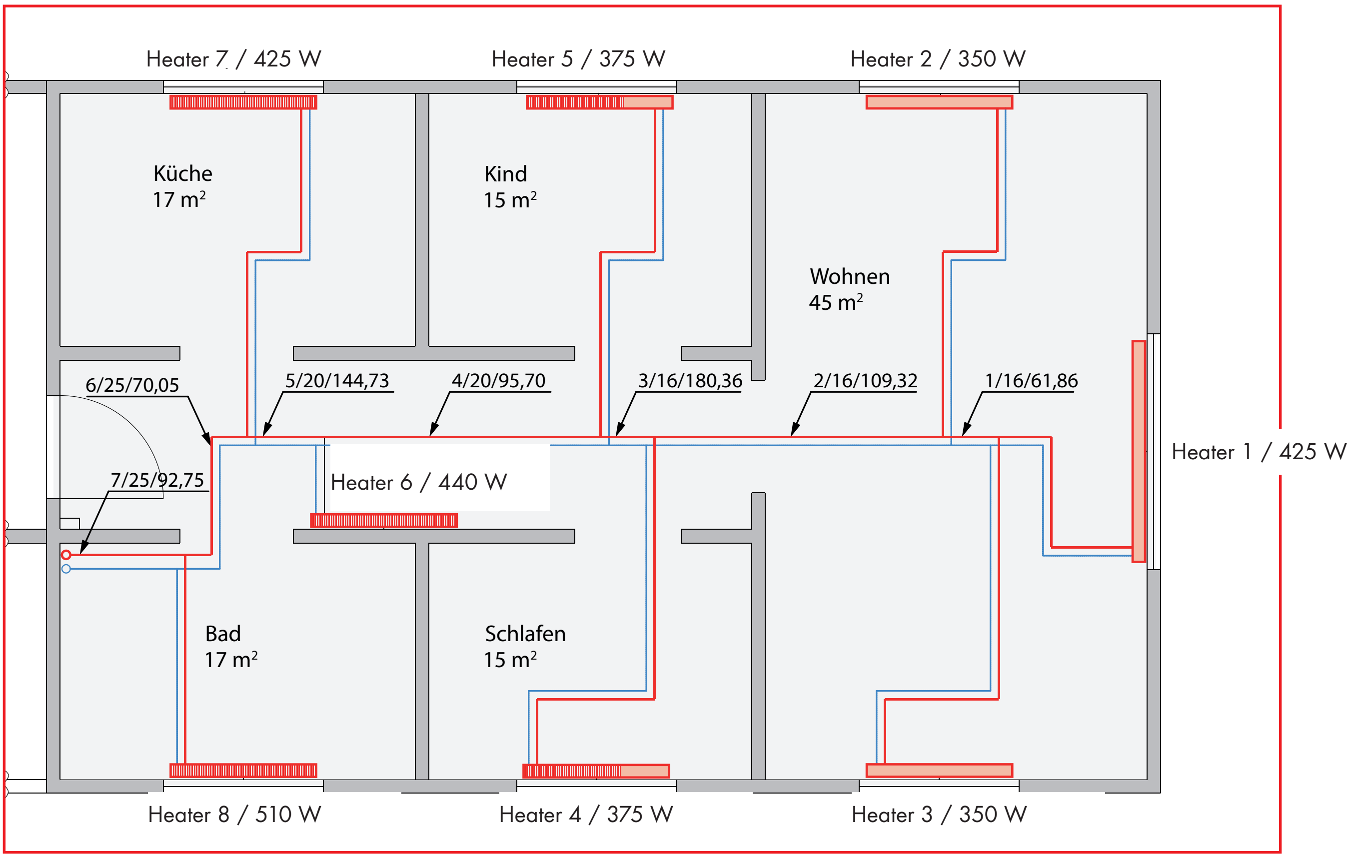
R [Pa/m], is defined depending on the size of the system.

If the dimensioning heating power is not yet known, the specific heat demand (surface heat flux q) can be estimated and taken as a basis by means of the construction year and the size of the building (see table).

Planning and dimensioning of the heating system

Example with single apartment, multiple-family dwelling

- Surface heat flux: 25 W/m² (hallway 20 W/m², bathroom 30 W/m²)
- Flow temperature: 55 °C
- Return temperature: 45 °C
- Max. pressure loss: 200 Pa/m



Calculation children's room:

Rated heating power Q_{HK} = surface heat flux q · room surface A_{Room}
= 25 W/m² · 15 m²
= 375 W

Temperature difference σ = flow temperature θ_V – return temperature θ_R
= 55 °C – 45 °C
= 10 K

Planning and dimensioning of the heating system

The pipe dimensions are determined on the basis of the pressure loss tables; the dimensioning capacities are rounded up to the next respective table value (see p. 98-121). The resulting temperature difference of 10 K determines the column in which the pressure loss has to be compared. The aim is to use as small a pipe dimension as possible. If one of the limiting values, pressure loss (200 Pa/m) or flow velocity (0.5 or 1.0 m/s depending on the piping section), is exceeded, the next larger dimension has to be used.

With pipe dimension 14 the calculated value for the children's room is therefore 32.35 Pa/m at 0.12 m/s (375 W at 10 K, rounded up to 400 W) or with pipe dimension 16 only 15.99 Pa/m at 0.09 m/s (rounded up to 400 W). This means the radiator could be connected to both dimensions. The dimension chosen depends on the kind of connection. The dimension 14 pipe could be used to connect the radiator from a distribution manifold (e.g. art.-no. 878 669 030) directly or using an L-type connection elbow (art.-no. 878 312 010). The dimension 16 pipe could be used for crossing tee pieces (e.g. art.-no. 878 370 030) for example.
For each part-section the connected power (sum of all the radiators connected) is calculated, and based on this the pipe dimension. A total of 3250 W is connected to the apartment supply line (part-section 7).

- Kitchen = 425 W
- Child's room = 375 W
- Living room = 1125 W
- Bedroom = 375 W
- Hallway = 440 W
- Bathroom = 510 W

If pipe dimension 20 were used here, the pressure loss would be 224 Pa/m. Using 25-dimension pipes the resulting pressure loss is only 84 Pa/m at 0.32 m/s (rounded up to 3400 W). Section 7 is therefore designed with pipe dimension 25. The section descriptions, the pipe dimension and the pipe friction pressure loss are entered in the ground plan or piping diagram. Pipe dimensioning for the risers and the cellar distribution is also performed according to the procedure described. All the data could also be summarised in one table.

Example calculation for 1st storey

Part-section	Heating power [W]	Mass flow rate [kg/h]	Flow velocity [m/s]	Pressure loss [Pa/m]	Dimension PRINETO
HK 1	425	42.99	0.11	23.62	16
HK 2	350	34.39	0.09	15.99	16
TS 1	775	68.79	0.18	53.77	16
HK 3	350	34.39	0.09	15.99	16
TS 2	1125	103.18	0.27	109.32	16
HK 4	375	34.39	0.09	15.99	16
TS 3	1500	128.98	0.34	161.55	16
HK 5	375	34.39	0.09	15.99	16
TS 4	3000	163.37	0.28	87.48	20
HK 6	440	42.99	0.11	23.62	16
TS 5	2315	206.36	0.35	131.66	20
HK 7	425	42.99	0.11	23.62	16
TS 6	2740	240.76	0.41	172.43	20
HK 8	510	51.59	0.14	32.5	16
TS 7	3250	292.35	0.32	83.92	25

NOTE

The simple method of calculation presented here is only an aid to providing easy mass determination for the purpose of a non-binding quotation and it does not discharge the technician or planner from his duty to plan and dimension the heating system correctly (also basis for hydraulic equalisation) according to the approved technological rules!

If higher pump pressures are available the flow velocity may also be the limiting criterion. However, the recommended max. pressure losses can be exceeded in certain circumstances. More electrical drive energy is then consumed to circulate the water. Therefore we advise against it for the purposes of approximate calculation.

Calculation of pressure loss in piping network

Based on the calculated heating load acc. to DIN EN 12831 the following form can be used for planning the piping network of a heating system. The pressure losses in the piping are taken from the pressure loss tables for ***PRINETO*** pipes (see p. 98-121).

Fill out the form in the attachment (master copy):

Columns 1/2/3:
Entry of storey description, room number and room description as planned.

Column 4:
Subdivision of piping system into part-sections (sections of equal mass flow) and numbering of part-sections acc. to plan.

Column 5:
Entry of heat quantity Q_{HK} in Watt for each radiator, which is required to ensure the stated room temperature. The calculation of the standard heating load Φ_{HL} is done according to DIN EN 12831. The heating load is distributed to several radiators depending on the size of the respective room.

Column 6:
Determination of the pipe dimension of the radiator connection pipes or part-sections by means of the pressure loss tables (limiting criteria flow velocity and pressure loss, see Planning and dimensioning of heating system).

Column 7:
Determination of the required mass flow in kg per hour for the respective radiator by means of pressure loss tables (for temperature differences 10, 15, 20 K) or according to the following formula:

$$m_{HK} = Q_{HK} : [1{,}163 \cdot (\theta_V - \theta_R)]$$

m_H = mass flow rate [kg/h]
Q_{HK} = heat quantity radiator [W]
θ_V = flow temperature [°C]
θ_R = return temperature [°C]

Column 8:
Determination of the length of the radiator connection l_{HK} or the part-section l_{TS} in metres. The whole length of the pipe for supply and return to each radiator for which the mass flow rate is constant is counted as connection or part-section length of the heating circuit.

Column 9:
Entry of pressure losses R of the piping in Pascal per metre from the pressure loss tables (pressure loss related to temperature difference is determined by pipe dimension and mass flow rate).

Column 10:
Calculation of the overall pressure loss Δp pipe of the pipe section by multiplying column 8 by column 9, acc. to equation:

$$\Delta p_{pipe}\ [Pa] = l_{HK}\ [m] \cdot R\ [Pa/m]$$

Column 11:
Determination of flow velocity w (m/s) for pipe section from the pressure loss tables.

Column 12:
The total of the resistance coefficients Σζ is composed of the individual resistance coefficients for the fittings, shut-off valves and radiator. The ζ-values of the individual components are taken from DIN 1988 or other specialist literature.

Column 13:
The pressure loss of the individual resistances is calculated as follows:

$$Z\ [Pa] = \frac{\zeta \cdot \rho \cdot w^2}{2}$$

ρ = density of water (kg/m³)
w = flow velocity (m/s)
ζ = resistance coefficient

Simplified:

$$Z\ [Pa] = \zeta \cdot w^2 \cdot 500$$

Column 14:
The overall pressure loss Δp total of the heating circuit is calculated by adding the pressure loss of the connection pipes or part-sections Δp pipe (column 10) and the pressure loss of the individual resistance values Z (column 13).

$$\Delta p_{tot.}\ [Pa] = \Delta p_{pipe} + Z$$

Column 15:
From column 14 the greatest pressure loss Δp total max. of the most unfavourable heating circuit is deducted from the total pressure loss of all other heating circuits. The difference is the pressure difference Δp to be throttled.

$$\Delta p_{dr}\ [Pa] = \Delta p_{tot.,max.} - \Delta p_{tot.}$$

Planning and dimensioning of the heating system

Owner / building ______________________________

Person in charge ______________________________

θ_{flow} _______ °C θ_{return} _______ °C

Sheet no. _______ of _______ dated ________________

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Storey	**Room no.**	**Room**	**Part-section no. Section no.**	**Heat demand**	**Internal pipe diameter**	**Mass flow rate**	**Radiator connection length**	**Pressure drop**	**Pipe pressure loss**	**Flow velocity**	**Sum of resistance coefficients**	**Pressure loss of individual resistances**	**Overall pressure loss**	**Pressure difference to be throttled**	**Valve presetting**
				Q_{HK} [W]	d_i [mm]	m_{HK} [kg/h]	l_{HK} [m]	R [Pa/m]	Δp_{PIPE} [Pa]	w [m/s]	$\Sigma\zeta$	Z [Pa]	$\Delta p_{tot.}$ [Pa]	Δp_{ar} [Pa]	turns

Pressure losses of dimension 14 x 2.0 (Nanoflex, Stabil) at 60°C (Stabil pipe 14)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
200	34.39	0.12	32.35	17.20	0.06	9.62	11.46	0.04	4.73	8.60	0.03	2.86
300	51.59	0.18	65.78	25.80	0.09	19.56	17.20	0.06	9.62	12.90	0.05	5.81
400	68.79	0.24	108.82	34.39	0.12	32.35	22.93	0.08	15.91	17.20	0.06	9.62
500	85.98	0.30	160.81	42.99	0.15	47.81	28.66	0.10	23.52	21.50	0.08	14.21
600	103.18	0.36	221.25	51.59	0.18	65.78	34.39	0.12	32.35	25.80	0.09	19.56
700	120.38	0.43	289.76	60.19	0.21	86.15	40.13	0.14	42.37	30.09	0.11	25.61
800	137.58	0.49	366.04	68.79	0.24	108.82	45.86	0.16	53.53	34.39	0.12	32.35
900	154.77	0.55	449.82	77.39	0.27	133.73	51.59	0.18	65.78	38.69	0.14	39.76
1,000	171.97	0.61	540.90	85.98	0.30	160.81	57.32	0.20	79.10	42.99	0.15	47.81
1,100	189.17	0.67	639.08	94.58	0.33	190.00	63.06	0.22	93.45	47.29	0.17	56.49
1,200	206.36	0.73	744.19	103.18	0.36	221.25	68.79	0.24	108.82	51.59	0.18	65.78
1,300	223.56	0.79	856.09	111.78	0.40	254.52	74.52	0.26	125.19	55.89	0.20	75.67
1,400	240.76	0.85	974.64	120.38	0.43	289.76	80.25	0.28	142.52	60.19	0.21	86.15
1,500	257.95	0.91	1099.71	128.98	0.46	326.95	85.98	0.30	160.81	64.49	0.23	97.20
1,600	275.15	0.97	1231.20	137.58	0.49	366.04	91.72	0.32	180.04	68.79	0.24	108.82
1,700	292.35	1.03	1369.00	146.17	0.52	407.01	97.45	0.34	200.19	73.09	0.26	121.00
1,800				154.77	0.55	449.82	103.18	0.36	221.25	77.39	0.27	133.73
1,900				163.37	0.58	494.46	108.91	0.39	243.21	81.69	0.29	147.01
2,000				171.97	0.61	540.90	114.65	0.41	266.05	85.98	0.30	160.81
2,100				180.57	0.64	589.11	120.38	0.43	289.76	90.28	0.32	175.14
2,200				189.17	0.67	639.08	126.11	0.45	314.34	94.58	0.33	190.00
2,300				197.76	0.70	690.78	131.84	0.47	339.77	98.88	0.35	205.37
2,400				206.36	0.73	744.19	137.58	0.49	366.04	103.18	0.36	221.25
2,500				214.96	0.76	799.30	143.31	0.51	393.14	107.48	0.38	237.63
2,600				223.56	0.79	856.09	149.04	0.53	421.08	111.78	0.40	254.52
2,700				232.16	0.82	914.54	154.77	0.55	449.82	116.08	0.41	271.89
2,800				240.76	0.85	974.64	160.50	0.57	479.38	120.38	0.43	289.76

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Pressure losses of dimension 14 x 2.0 at 60°C (Nanoflex 14, Stabil pipe 14)

Temperature difference in K	**5**			**10**			**15**			**20**		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
3,200				275.15	0.97	1231.20	183.43	0.65	605.58	137.58	0.49	366.04
3,400				292.35	1.03	1369.00	194.90	0.69	673.36	146.17	0.52	407.01
3,600							206.36	0.73	744.19	154.77	0.55	449.82
3,800							217.83	0.77	818.05	163.37	0.58	494.46
4,000							229.29	0.81	894.87	171.97	0.61	540.90
4,200							240.76	0.85	974.64	180.57	0.64	589.11
4,400							252.22	0.89	1057.30	189.17	0.67	639.08
4,600							263.69	0.93	1142.83	197.76	0.70	690.78
4,800							275.15	0.97	1231.20	206.36	0.73	744.19
5,000							286.62	1.01	1322.37	214.96	0.76	799.30
5,200										223.56	0.79	856.09
5,400										232.16	0.82	914.54
5,600										240.76	0.85	974.64
5,800										249.36	0.88	1036.36
6,000										257.95	0.91	1099.71
6,200										266.55	0.94	1164.66
6,400										275.15	0.97	1231.20
6,600										283.75	1.00	1299.32

Pressure losses of dimension 16 x 2.2 at 60°C (Nanoflex 16, heating pipe 16, Stabil pipe 16)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
100	17.20	0.05	4.75	8.60	0.02	1.41	5.73	0.02	0.69	4.30	0.01	0.42
200	34.39	0.09	15.99	17.20	0.05	4.75	11.46	0.03	2.34	8.60	0.02	1.41
300	51.59	0.14	32.50	25.80	0.07	9.66	17.20	0.05	4.75	12.90	0.03	2.87
400	68.79	0.18	53.77	34.39	0.09	15.99	22.93	0.06	7.86	17.20	0.05	4.75
500	85.98	0.23	79.46	42.99	0.11	23.62	28.66	0.08	11.62	21.50	0.06	7.02
600	103.18	0.27	109.32	51.59	0.14	32.50	34.39	0.09	15.99	25.80	0.07	9.66
700	120.38	0.32	143.17	60.19	0.16	42.57	40.13	0.11	20.94	30.09	0.08	12.65
800	137.58	0.36	180.86	68.79	0.18	53.77	45.86	0.12	26.45	34.39	0.09	15.99
900	154.77	0.41	222.26	77.39	0.20	66.08	51.59	0.14	32.50	38.69	0.10	19.65
1,000	171.97	0.45	267.27	85.98	0.23	79.46	57.32	0.15	39.08	42.99	0.11	23.62
1,100	189.17	0.50	315.78	94.58	0.25	93.88	63.06	0.17	46.18	47.29	0.12	27.91
1,200	206.36	0.54	367.71	103.18	0.27	109.32	68.79	0.18	53.77	51.59	0.14	32.50
1,300	223.56	0.59	423.00	111.78	0.29	125.76	74.52	0.20	61.86	55.89	0.15	37.39
1,400	240.76	0.63	481.58	120.38	0.32	143.17	80.25	0.21	70.42	60.19	0.16	42.57
1,500	257.95	0.68	543.38	128.98	0.34	161.55	85.98	0.23	79.46	64.49	0.17	48.03
1,600	275.15	0.72	608.35	137.58	0.36	180.86	91.72	0.24	88.96	68.79	0.18	53.77
1,700	292.35	0.77	676.44	146.17	0.38	201.11	97.45	0.26	98.92	73.09	0.19	59.79
1,800	309.54	0.81	747.60	154.77	0.41	222.26	103.18	0.27	109.32	77.39	0.20	66.08
1,900	326.74	0.86	821.79	163.37	0.43	244.32	108.91	0.29	120.17	81.69	0.21	72.64
2,000	343.94	0.90	898.97	171.97	0.45	267.27	114.65	0.30	131.46	85.98	0.23	79.46
2,100	361.13	0.95	979.10	180.57	0.47	291.09	120.38	0.32	143.17	90.28	0.24	86.54
2,200	378.33	0.99	1062.14	189.17	0.50	315.78	126.11	0.33	155.32	94.58	0.25	93.88
2,300	395.53	1.04	1148.07	197.76	0.52	341.32	131.84	0.35	167.88	98.88	0.26	101.48
2,400				206.36	0.54	367.71	137.58	0.36	180.86	103.18	0.27	109.32
2,500				214.96	0.57	394.94	143.31	0.38	194.26	107.48	0.28	117.42
2,600				223.56	0.59	423.00	149.04	0.39	208.06	111.78	0.29	125.76
2,700				232.16	0.61	451.88	154.77	0.41	222.26	116.08	0.31	134.35
2,800				240.76	0.63	481.58	160.50	0.42	236.87	120.38	0.32	143.17
2,900				249.36	0.66	512.08	166.24	0.44	251.87	124.68	0.33	152.24
3,000				257.95	0.68	543.38	171.97	0.45	267.27	128.98	0.34	161.55

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Pressure losses of dimension 16 x 2.2 at 60°C (Nanoflex 16, heating pipe 16, Stabil pipe 16)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
3,300				283.75	0.75	642.01	189.17	0.50	315.78	141.87	0.37	190.87
3,400				292.35	0.77	676.44	194.90	0.51	332.71	146.17	0.38	201.11
3,500				300.95	0.79	711.64	200.63	0.53	350.03	150.47	0.40	211.57
3,600				309.54	0.81	747.60	206.36	0.54	367.71	154.77	0.41	222.26
3,700				318.14	0.84	784.32	212.10	0.56	385.77	159.07	0.42	233.18
3,800				326.74	0.86	821.79	217.83	0.57	404.21	163.37	0.43	244.32
3,900				335.34	0.88	860.01	223.56	0.59	423.00	167.67	0.44	255.68
4,000				343.94	0.90	898.97	229.29	0.60	442.17	171.97	0.45	267.27
4,100				352.54	0.93	938.67	235.02	0.62	461.69	176.27	0.46	279.07
4,200				361.13	0.95	979.10	240.76	0.63	481.58	180.57	0.47	291.09
4,300				369.73	0.97	1020.26	246.49	0.65	501.82	184.87	0.49	303.32
4,400				378.33	0.99	1062.14	252.22	0.66	522.42	189.17	0.50	315.78
4,500				386.93	1.02	1104.75	257.95	0.68	543.38	193.47	0.51	328.44
4,600							263.69	0.69	564.69	197.76	0.52	341.32
4,700							269.42	0.71	586.34	202.06	0.53	354.41
4,800							275.15	0.72	608.35	206.36	0.54	367.71
4,900							280.88	0.74	630.70	210.66	0.55	381.22
5,000							286.62	0.75	653.40	214.96	0.57	394.94
5,100							292.35	0.77	676.44	219.26	0.58	408.87
5,200							298.08	0.78	699.82	223.56	0.59	423.00
5,300							303.81	0.80	723.54	227.86	0.60	437.34
5,400							309.54	0.81	747.60	232.16	0.61	451.88
5,500							315.28	0.83	772.00	236.46	0.62	466.63
5,600							321.01	0.84	796.73	240.76	0.63	481.58
5,700							326.74	0.86	821.79	245.06	0.64	496.73
5,800							332.47	0.87	847.19	249.36	0.66	512.08
5,900							338.21	0.89	872.91	253.65	0.67	527.63
6,000							343.94	0.90	898.97	257.95	0.68	543.38
6,100							349.67	0.92	925.35	262.25	0.69	559.33
6,200							355.40	0.93	952.06	266.55	0.70	575.47

Pressure losses of dimension 16 x 2.2 at 60°C (Nanoflex 16, heating pipe 16, Stabil pipe 16)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
6,500							372.60	0.98	1034.14	279.45	0.73	625.08
6,600							378.33	0.99	1062.14	283.75	0.75	642.01
6,700							384.06	1.01	1090.46	288.05	0.76	659.13
6,800										292.35	0.77	676.44
6,900										296.65	0.78	693.94
7,000										300.95	0.79	711.64
7,100										305.25	0.80	729.52
7,200										309.54	0.81	747.60
7,300										313.84	0.82	765.87
7,400										318.14	0.84	784.32
7,500										322.44	0.85	802.96
7,600										326.74	0.86	821.79
7,700										331.04	0.87	840.81
7,800										335.34	0.88	860.01
7,900										339.64	0.89	879.40
8,000										343.94	0.90	898.97
8,100										348.24	0.92	918.73
8,200										352.54	0.93	938.67
8,300										356.84	0.94	958.79
8,400										361.13	0.95	979.10
8,500										365.43	0.96	999.59
8,600										369.73	0.97	1020.26
8,700										374.03	0.98	1041.11
8,800										378.33	0.99	1062.14
8,900										382.63	1.01	1083.35

PRINETO

Pressure losses of dimension 20 x 2.8 at 60°C (Nanoflex 20, heating pipe 20, Stabil pipe 20)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
1,000	171.97	0.29	95.70	85.98	0.15	28.45	57.32	0.10	13.99	42.99	0.07	8.46
1,150	197.76	0.34	122.21	98.88	0.17	36.33	65.92	0.11	17.87	49.44	0.08	10.80
1,300	223.56	0.38	151.46	111.78	0.19	45.03	74.52	0.13	22.15	55.89	0.10	13.39
1,450	249.36	0.43	183.35	124.68	0.21	54.51	83.12	0.14	26.81	62.34	0.11	16.21
1,600	275.15	0.47	217.82	137.58	0.23	64.76	91.72	0.16	31.85	68.79	0.12	19.25
1,750	300.95	0.51	254.81	150.47	0.26	75.75	100.32	0.17	37.26	75.24	0.13	22.52
1,900	326.74	0.56	294.25	163.37	0.28	87.48	108.91	0.19	43.03	81.69	0.14	26.01
2,050	352.54	0.60	336.10	176.27	0.30	99.92	117.51	0.20	49.15	88.13	0.15	29.71
2,200	378.33	0.65	380.31	189.17	0.32	113.07	126.11	0.22	55.61	94.58	0.16	33.61
2,350	404.13	0.69	426.84	202.06	0.34	126.90	134.71	0.23	62.42	101.03	0.17	37.73
2,500	429.92	0.73	475.65	214.96	0.37	141.41	143.31	0.24	69.56	107.48	0.18	42.04
2,650	455.72	0.78	526.72	227.86	0.39	156.59	151.91	0.26	77.02	113.93	0.19	46.56
2,800	481.51	0.82	579.99	240.76	0.41	172.43	160.50	0.27	84.81	120.38	0.21	51.26
2,950	507.31	0.87	635.46	253.65	0.43	188.92	169.10	0.29	92.92	126.83	0.22	56.17
3,100	533.10	0.91	693.07	266.55	0.45	206.05	177.70	0.30	101.35	133.28	0.23	61.26
3,250	558.90	0.95	752.82	279.45	0.48	223.82	186.30	0.32	110.09	139.72	0.24	66.54
3,400	584.69	1.00	814.68	292.35	0.50	242.20	194.90	0.33	119.13	146.17	0.25	72.01
3,550				305.25	0.52	261.21	203.50	0.35	128.48	152.62	0.26	77.66
3,700				318.14	0.54	280.83	212.10	0.36	138.13	159.07	0.27	83.49
3,850				331.04	0.56	301.06	220.69	0.38	148.08	165.52	0.28	89.51
4,000				343.94	0.59	321.88	229.29	0.39	158.32	171.97	0.29	95.70
4,150				356.84	0.61	343.30	237.89	0.41	168.86	178.42	0.30	102.06
4,300				369.73	0.63	365.31	246.49	0.42	179.68	184.87	0.32	108.61
4,450				382.63	0.65	387.90	255.09	0.44	190.79	191.32	0.33	115.32
4,600				395.53	0.67	411.07	263.69	0.45	202.19	197.76	0.34	122.21
4,750				408.43	0.70	434.82	272.28	0.46	213.87	204.21	0.35	129.27
4,900				421.32	0.72	459.13	280.88	0.48	225.83	210.66	0.36	136.50
5,050				434.22	0.74	484.01	289.48	0.49	238.06	217.11	0.37	143.90
5,200				447.12	0.76	509.45	298.08	0.51	250.58	223.56	0.38	151.46
5,350				460.02	0.78	535.44	306.68	0.52	263.36	230.01	0.39	159.19

Pressure losses of dimension 20 x 2.8 at 60°C (Nanoflex 20, heating pipe 20, Stabil pipe 20)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
5,800				498.71	0.85	616.73	332.47	0.57	303.34	249.36	0.43	183.35
5,950				511.61	0.87	644.91	341.07	0.58	317.20	255.80	0.44	191.73
6,100				524.51	0.89	673.63	349.67	0.60	331.33	262.25	0.45	200.27
6,250				537.40	0.92	702.88	358.27	0.61	345.72	268.70	0.46	208.97
6,400				550.30	0.94	732.67	366.87	0.63	360.37	275.15	0.47	217.82
6,550				563.20	0.96	762.99	375.47	0.64	375.28	281.60	0.48	226.84
6,700				576.10	0.98	793.83	384.06	0.66	390.45	288.05	0.49	236.01
6,850				588.99	1.00	825.19	392.66	0.67	405.88	294.50	0.50	245.33
7,000							401.26	0.68	421.56	300.95	0.51	254.81
7,150							409.86	0.70	437.49	307.39	0.52	264.44
7,300							418.46	0.71	453.68	313.84	0.54	274.22
7,450							427.06	0.73	470.12	320.29	0.55	284.16
7,600							435.65	0.74	486.81	326.74	0.56	294.25
7,750							444.25	0.76	503.75	333.19	0.57	304.49
7,900							452.85	0.77	520.93	339.64	0.58	314.88
8,050							461.45	0.79	538.37	346.09	0.59	325.41
8,200							470.05	0.80	556.04	352.54	0.60	336.10
8,350							478.65	0.82	573.97	358.99	0.61	346.93
8,500							487.25	0.83	592.13	365.43	0.62	357.91
8,650							495.84	0.85	610.54	371.88	0.63	369.04
8,800							504.44	0.86	629.19	378.33	0.65	380.31
8,950							513.04	0.88	648.07	384.78	0.66	391.73
9,100							521.64	0.89	667.20	391.23	0.67	403.29
9,250							530.24	0.90	686.57	397.68	0.68	414.99
9,400							538.84	0.92	706.17	404.13	0.69	426.84
9,550							547.43	0.93	726.01	410.58	0.70	438.83
9,700							556.03	0.95	746.08	417.02	0.71	450.96
9,850							564.63	0.96	766.39	423.47	0.72	463.24
10,000							573.23	0.98	786.93	429.92	0.73	475.65
10,150							581.83	0.99	807.70	436.37	0.74	488.21

Pressure losses of dimension 20 x 2.8 at 60°C (Nanoflex 20, heating pipe 20, Stabil pipe 20)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
10,600										455.72	0.78	526.72
10,750										462.17	0.79	539.83
10,900										468.62	0.80	553.08
11,050										475.06	0.81	566.47
11,200										481.51	0.82	579.99
11,350										487.96	0.83	593.66
11,500										494.41	0.84	607.45
11,650										500.86	0.85	621.39
11,800										507.31	0.87	635.46
11,950										513.76	0.88	649.66
12,100										520.21	0.89	664.00
12,250										526.66	0.90	678.47
12,400										533.10	0.91	693.07
12,550										539.55	0.92	707.81
12,700										546.00	0.93	722.68
12,850										552.45	0.94	737.69
13,000										558.90	0.95	752.82
13,150										565.35	0.96	768.09
13,300										571.80	0.98	783.49
13,450										578.25	0.99	799.02
13,600										584.69	1.00	814.68

Pressure losses of dimension 25 x 3.5 at 60°C (Nanoflex 25, heating pipe 25, Stabil pipe 25)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
2,000	343.94	0.38	111.53	171.97	0.19	33.16	114.65	0.13	16.31	85.98	0.09	9.86
2,200	378.33	0.41	131.77	189.17	0.21	39.18	126.11	0.14	19.27	94.58	0.10	11.65
2,400	412.73	0.45	153.44	206.36	0.23	45.62	137.58	0.15	22.44	103.18	0.11	13.56
2,600	447.12	0.49	176.51	223.56	0.24	52.48	149.04	0.16	25.81	111.78	0.12	15.60
2,800	481.51	0.53	200.96	240.76	0.26	59.74	160.50	0.18	29.39	120.38	0.13	17.76
3,000	515.91	0.56	226.74	257.95	0.28	67.41	171.97	0.19	33.16	128.98	0.14	20.04
3,200	550.30	0.60	253.86	275.15	0.30	75.47	183.43	0.20	37.12	137.58	0.15	22.44
3,400	584.69	0.64	282.27	292.35	0.32	83.92	194.90	0.21	41.28	146.17	0.16	24.95
3,600	619.09	0.68	311.96	309.54	0.34	92.75	206.36	0.23	45.62	154.77	0.17	27.57
3,800	653.48	0.71	342.92	326.74	0.36	101.95	217.83	0.24	50.15	163.37	0.18	30.31
4,000	687.88	0.75	375.13	343.94	0.38	111.53	229.29	0.25	54.86	171.97	0.19	33.16
4,200	722.27	0.79	408.56	361.13	0.39	121.47	240.76	0.26	59.74	180.57	0.20	36.11
4,400	756.66	0.83	443.22	378.33	0.41	131.77	252.22	0.28	64.81	189.17	0.21	39.18
4,600	791.06	0.86	479.07	395.53	0.43	142.43	263.69	0.29	70.05	197.76	0.22	42.34
4,800	825.45	0.90	516.11	412.73	0.45	153.44	275.15	0.30	75.47	206.36	0.23	45.62
5,000	859.85	0.94	554.33	429.92	0.47	164.80	286.62	0.31	81.06	214.96	0.23	49.00
5,200	894.24	0.98	593.72	447.12	0.49	176.51	298.08	0.33	86.82	223.56	0.24	52.48
5,400	928.63	1.01	634.25	464.32	0.51	188.56	309.54	0.34	92.75	232.16	0.25	56.06
5,600				481.51	0.53	200.96	321.01	0.35	98.84	240.76	0.26	59.74
5,800				498.71	0.54	213.68	332.47	0.36	105.10	249.36	0.27	63.53
6,000				515.91	0.56	226.74	343.94	0.38	111.53	257.95	0.28	67.41
6,200				533.10	0.58	240.14	355.40	0.39	118.11	266.55	0.29	71.39
6,400				550.30	0.60	253.86	366.87	0.40	124.86	275.15	0.30	75.47
6,600				567.50	0.62	267.90	378.33	0.41	131.77	283.75	0.31	79.65
6,800				584.69	0.64	282.27	389.80	0.43	138.84	292.35	0.32	83.92
7,000				601.89	0.66	296.96	401.26	0.44	146.06	300.95	0.33	88.29
7,200				619.09	0.68	311.96	412.73	0.45	153.44	309.54	0.34	92.75
7,400				636.29	0.69	327.29	424.19	0.46	160.98	318.14	0.35	97.30
7,600				653.48	0.71	342.92	435.65	0.48	168.67	326.74	0.36	101.95
7,800				670.68	0.73	358.87	447.12	0.49	176.51	335.34	0.37	106.69

Pressure losses of dimension 25 x 3.5 at 60°C (Nanoflex 25, heating pipe 25, Stabil pipe 25)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
8,400				722.27	0.79	408.56	481.51	0.53	200.96	361.13	0.39	121.47
8,600				739.47	0.81	425.74	492.98	0.54	209.40	369.73	0.40	126.57
8,800				756.66	0.83	443.22	504.44	0.55	218.00	378.33	0.41	131.77
9,000				773.86	0.84	460.99	515.91	0.56	226.74	386.93	0.42	137.05
9,200				791.06	0.86	479.07	527.37	0.58	235.64	395.53	0.43	142.43
9,400				808.25	0.88	497.45	538.84	0.59	244.67	404.13	0.44	147.89
9,600				825.45	0.90	516.11	550.30	0.60	253.86	412.73	0.45	153.44
9,800				842.65	0.92	535.08	561.77	0.61	263.18	421.32	0.46	159.08
10,000				859.85	0.94	554.33	573.23	0.63	272.65	429.92	0.47	164.80
10,200				877.04	0.96	573.88	584.69	0.64	282.27	438.52	0.48	170.62
10,400				894.24	0.98	593.72	596.16	0.65	292.03	447.12	0.49	176.51
10,600				911.44	0.99	613.84	607.62	0.66	301.92	455.72	0.50	182.50
10,800				928.63	1.01	634.25	619.09	0.68	311.96	464.32	0.51	188.56
11,000							630.55	0.69	322.14	472.91	0.52	194.72
11,200							642.02	0.70	332.46	481.51	0.53	200.96
11,400							653.48	0.71	342.92	490.11	0.54	207.28
11,600							664.95	0.73	353.52	498.71	0.54	213.68
11,800							676.41	0.74	364.25	507.31	0.55	220.17
12,000							687.88	0.75	375.13	515.91	0.56	226.74
12,200							699.34	0.76	386.14	524.51	0.57	233.40
12,400							710.81	0.78	397.28	533.10	0.58	240.14
12,600							722.27	0.79	408.56	541.70	0.59	246.95
12,800							733.73	0.80	419.98	550.30	0.60	253.86
13,000							745.20	0.81	431.53	558.90	0.61	260.84
13,200							756.66	0.83	443.22	567.50	0.62	267.90
13,400							768.13	0.84	455.04	576.10	0.63	275.04
13,600							779.59	0.85	466.99	584.69	0.64	282.27
13,800							791.06	0.86	479.07	593.29	0.65	289.57
14,000							802.52	0.88	491.29	601.89	0.66	296.96
14,200							813.99	0.89	503.64	610.49	0.67	304.42

Pressure losses of dimension 25 x 3.5 at 60°C (Nanoflex 25, heating pipe 25, Stabil pipe 25)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
14,800							848.38	0.93	541.46	636.29	0.69	327.29
15,000							859.85	0.94	554.33	644.88	0.70	335.06
15,200							871.31	0.95	567.33	653.48	0.71	342.92
15,400							882.77	0.96	580.46	662.08	0.72	350.86
15,600							894.24	0.98	593.72	670.68	0.73	358.87
15,800							905.70	0.99	607.10	679.28	0.74	366.96
16,000							917.17	1.00	620.61	687.88	0.75	375.13
16,200										696.47	0.76	383.37
16,400										705.07	0.77	391.69
16,600										713.67	0.78	400.09
16,800										722.27	0.79	408.56
17,000										730.87	0.80	417.11
17,200										739.47	0.81	425.74
17,400										748.07	0.82	434.44
17,600										756.66	0.83	443.22
17,800										765.26	0.84	452.07
18,000										773.86	0.84	460.99
18,200										782.46	0.85	470.00
18,400										791.06	0.86	479.07
18,600										799.66	0.87	488.22
18,800										808.25	0.88	497.45
19,000										816.85	0.89	506.74
19,200										825.45	0.90	516.11
19,400										834.05	0.91	525.56
19,600										842.65	0.92	535.08
19,800										851.25	0.93	544.67
20,000										859.85	0.94	554.33
20,200										868.44	0.95	564.07
20,400										877.04	0.96	573.88
20,600										885.64	0.97	583.76

Pressure losses of dimension 32 x 4.4 at 60°C (Nanoflex 32, heating pipe 32, Stabil pipe 32)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
3,000	515.91	0.34	67.92	257.95	0.17	20.19	171.97	0.11	9.93	128.98	0.08	6.00
3,350	576.10	0.38	82.39	288.05	0.19	24.49	192.03	0.13	12.05	144.02	0.09	7.28
3,700	636.29	0.42	98.04	318.14	0.21	29.15	212.10	0.14	14.34	159.07	0.10	8.67
4,050	696.47	0.46	114.84	348.24	0.23	34.14	232.16	0.15	16.79	174.12	0.11	10.15
4,400	756.66	0.50	132.77	378.33	0.25	39.47	252.22	0.17	19.41	189.17	0.12	11.74
4,750	816.85	0.54	151.80	408.43	0.27	45.13	272.28	0.18	22.20	204.21	0.13	13.42
5,100	877.04	0.58	171.91	438.52	0.29	51.11	292.35	0.19	25.14	219.26	0.14	15.19
5,450	937.23	0.62	193.08	468.62	0.31	57.40	312.41	0.21	28.23	234.31	0.15	17.07
5,800	997.42	0.66	215.30	498.71	0.33	64.01	332.47	0.22	31.48	249.36	0.16	19.03
6,150	1057.61	0.69	238.55	528.80	0.35	70.92	352.54	0.23	34.88	264.40	0.17	21.09
6,500	1117.80	0.73	262.81	558.90	0.37	78.14	372.60	0.24	38.43	279.45	0.18	23.23
6,850	1177.99	0.77	288.08	588.99	0.39	85.65	392.66	0.26	42.13	294.50	0.19	25.46
7,200	1238.18	0.81	314.33	619.09	0.41	93.45	412.73	0.27	45.96	309.54	0.20	27.78
7,550	1298.37	0.85	341.55	649.18	0.43	101.54	432.79	0.28	49.95	324.59	0.21	30.19
7,900	1358.56	0.89	369.74	679.28	0.45	109.92	452.85	0.30	54.07	339.64	0.22	32.68
8,250	1418.74	0.93	398.88	709.37	0.47	118.59	472.91	0.31	58.33	354.69	0.23	35.26
8,600	1478.93	0.97	428.97	739.47	0.49	127.53	492.98	0.32	62.73	369.73	0.24	37.92
8,950	1539.12	1.01	459.98	769.56	0.51	136.75	513.04	0.34	67.26	384.78	0.25	40.66
9,300				799.66	0.53	146.25	533.10	0.35	71.93	399.83	0.26	43.48
9,650				829.75	0.55	156.02	553.17	0.36	76.74	414.88	0.27	46.38
10,000				859.85	0.57	166.05	573.23	0.38	81.67	429.92	0.28	49.37
10,350				889.94	0.58	176.36	593.29	0.39	86.74	444.97	0.29	52.43
10,700				920.03	0.60	186.93	613.36	0.40	91.94	460.02	0.30	55.57
11,050				950.13	0.62	197.76	633.42	0.42	97.27	475.06	0.31	58.79
11,400				980.22	0.64	208.85	653.48	0.43	102.72	490.11	0.32	62.09
11,750				1010.32	0.66	220.20	673.55	0.44	108.31	505.16	0.33	65.47
12,100				1040.41	0.68	231.80	693.61	0.46	114.02	520.21	0.34	68.92
12,450				1070.51	0.70	243.67	713.67	0.47	119.85	535.25	0.35	72.44
12,800				1100.60	0.72	255.78	733.73	0.48	125.81	550.30	0.36	76.04
13,150				1130.70	0.74	268.14	753.80	0.50	131.89	565.35	0.37	79.72

Pressure losses of dimension 32 x 4.4 at 60°C (Nanoflex 32, heating pipe 32, Stabil pipe 32)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
14,200				1220.98	0.80	306.73	813.99	0.53	150.87	610.49	0.40	91.19
14,550				1251.07	0.82	320.08	834.05	0.55	157.43	625.54	0.41	95.16
14,900				1281.17	0.84	333.68	854.11	0.56	164.12	640.58	0.42	99.20
15,250				1311.26	0.86	347.51	874.18	0.57	170.93	655.63	0.43	103.32
15,600				1341.36	0.88	361.59	894.24	0.59	177.85	670.68	0.44	107.50
15,950				1371.45	0.90	375.91	914.30	0.60	184.89	685.73	0.45	111.76
16,300				1401.55	0.92	390.46	934.37	0.61	192.05	700.77	0.46	116.08
16,650				1431.64	0.94	405.25	954.43	0.63	199.33	715.82	0.47	120.48
17,000				1461.74	0.96	420.28	974.49	0.64	206.72	730.87	0.48	124.95
17,350				1491.83	0.98	435.53	994.55	0.65	214.22	745.92	0.49	129.49
17,700				1521.93	1.00	451.03	1014.62	0.67	221.84	760.96	0.50	134.09
18,050							1034.68	0.68	229.57	776.01	0.51	138.77
18,400							1054.74	0.69	237.42	791.06	0.52	143.51
18,750							1074.81	0.71	245.38	806.10	0.53	148.32
19,100							1094.87	0.72	253.45	821.15	0.54	153.20
19,450							1114.93	0.73	261.64	836.20	0.55	158.14
19,800							1135.00	0.75	269.93	851.25	0.56	163.16
20,150							1155.06	0.76	278.34	866.29	0.57	168.24
20,500							1175.12	0.77	286.85	881.34	0.58	173.39
20,850							1195.18	0.79	295.48	896.39	0.59	178.60
21,200							1215.25	0.80	304.21	911.44	0.60	183.88
21,550							1235.31	0.81	313.06	926.48	0.61	189.22
21,900							1255.37	0.82	322.01	941.53	0.62	194.64
22,250							1275.44	0.84	331.07	956.58	0.63	200.11
22,600							1295.50	0.85	340.23	971.63	0.64	205.65
22,950							1315.56	0.86	349.51	986.67	0.65	211.26
23,300							1335.63	0.88	358.89	1001.72	0.66	216.93
23,650							1355.69	0.89	368.38	1016.77	0.67	222.66
24,000							1375.75	0.90	377.97	1031.81	0.68	228.46
24,350							1395.82	0.92	387.67	1046.86	0.69	234.33

Pressure losses of dimension 32 x 4.4 at 60°C (Nanoflex 32, heating pipe 32, Stabil pipe 32)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
25,400							1456.00	0.96	417.40	1092.00	0.72	252.29
25,750							1476.07	0.97	427.51	1107.05	0.73	258.41
26,100							1496.13	0.98	437.73	1122.10	0.74	264.59
26,450							1516.19	1.00	448.06	1137.15	0.75	270.83
26,800										1152.19	0.76	277.13
27,150										1167.24	0.77	283.49
27,500										1182.29	0.78	289.92
27,850										1197.33	0.79	296.41
28,200										1212.38	0.80	302.96
28,550										1227.43	0.81	309.57
28,900										1242.48	0.82	316.24
29,250										1257.52	0.83	322.97
29,600										1272.57	0.84	329.77
29,950										1287.62	0.85	336.62
30,300										1302.67	0.86	343.53
30,650										1317.71	0.87	350.51
31,000										1332.76	0.88	357.54
31,350										1347.81	0.89	364.64
31,700										1362.85	0.90	371.79
32,050										1377.90	0.91	379.00
32,400										1392.95	0.92	386.28
32,750										1408.00	0.93	393.61
33,100										1423.04	0.94	401.00
33,450										1438.09	0.94	408.45
33,800										1453.14	0.95	415.96
34,150										1468.19	0.96	423.53
34,500										1483.23	0.97	431.15
34,850										1498.28	0.98	438.83
35,200										1513.33	0.99	446.58
35,550										1528.37	1.00	454.38

Pressure losses of dimension 42.2 x 4.6 at 60°C (Stabil pipe 40)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
5,000	859.85	0.28	31.14	429.92	0.14	9.26	286.62	0.09	4.55	214.96	0.07	2.75
5,600	963.03	0.31	37.98	481.51	0.16	11.29	321.01	0.10	5.55	240.76	0.08	3.36
6,200	1066.21	0.35	45.38	533.10	0.17	13.49	355.40	0.12	6.64	266.55	0.09	4.01
6,800	1169.39	0.38	53.34	584.69	0.19	15.86	389.80	0.13	7.80	292.35	0.09	4.71
7,400	1272.57	0.41	61.85	636.29	0.21	18.39	424.19	0.14	9.04	318.14	0.10	5.47
8,000	1375.75	0.45	70.89	687.88	0.22	21.08	458.58	0.15	10.37	343.94	0.11	6.27
8,600	1478.93	0.48	80.45	739.47	0.24	23.92	492.98	0.16	11.76	369.73	0.12	7.11
9,200	1582.12	0.51	90.53	791.06	0.26	26.92	527.37	0.17	13.24	395.53	0.13	8.00
9,800	1685.30	0.55	101.12	842.65	0.27	30.06	561.77	0.18	14.79	421.32	0.14	8.94
10,400	1788.48	0.58	112.20	894.24	0.29	33.36	596.16	0.19	16.41	447.12	0.15	9.92
11,000	1891.66	0.61	123.77	945.83	0.31	36.80	630.55	0.20	18.10	472.91	0.15	10.94
11,600	1994.84	0.65	135.82	997.42	0.32	40.38	664.95	0.22	19.86	498.71	0.16	12.01
12,200	2098.02	0.68	148.36	1049.01	0.34	44.11	699.34	0.23	21.69	524.51	0.17	13.11
12,800	2201.20	0.71	161.36	1100.60	0.36	47.97	733.73	0.24	23.60	550.30	0.18	14.26
13,400	2304.39	0.75	174.83	1152.19	0.37	51.98	768.13	0.25	25.57	576.10	0.19	15.45
14,000	2407.57	0.78	188.76	1203.78	0.39	56.12	802.52	0.26	27.60	601.89	0.20	16.68
14,600	2510.75	0.82	203.14	1255.37	0.41	60.39	836.92	0.27	29.71	627.69	0.20	17.96
15,200	2613.93	0.85	217.97	1306.96	0.42	64.80	871.31	0.28	31.87	653.48	0.21	19.27
15,800	2717.11	0.88	233.25	1358.56	0.44	69.35	905.70	0.29	34.11	679.28	0.22	20.62
16,400	2820.29	0.92	248.97	1410.15	0.46	74.02	940.10	0.31	36.41	705.07	0.23	22.01
17,000	2923.47	0.95	265.13	1461.74	0.47	78.82	974.49	0.32	38.77	730.87	0.24	23.43
17,600	3026.66	0.98	281.72	1513.33	0.49	83.76	1008.89	0.33	41.20	756.66	0.25	24.90
18,200	3129.84	1.02	298.75	1564.92	0.51	88.82	1043.28	0.34	43.69	782.46	0.25	26.41
18,800				1616.51	0.52	94.01	1077.67	0.35	46.24	808.25	0.26	27.95
19,400				1668.10	0.54	99.32	1112.07	0.36	48.85	834.05	0.27	29.53
20,000				1719.69	0.56	104.76	1146.46	0.37	51.52	859.85	0.28	31.14
20,600				1771.28	0.58	110.32	1180.85	0.38	54.26	885.64	0.29	32.80
21,200				1822.87	0.59	116.00	1215.25	0.39	57.06	911.44	0.30	34.49
21,800				1874.46	0.61	121.81	1249.64	0.41	59.91	937.23	0.30	36.21
22,400				1926.05	0.63	127.73	1284.04	0.42	62.83	963.03	0.31	37.98

PRINETO®

Pressure losses of dimension 42.2 x 4.6 at 60°C (Stabil pipe 40)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
24,200				2080.83	0.68	146.24	1387.22	0.45	71.93	1040.41	0.34	43.48
24,800				2132.42	0.69	152.64	1421.61	0.46	75.08	1066.21	0.35	45.38
25,400				2184.01	0.71	159.16	1456.00	0.47	78.28	1092.00	0.35	47.32
26,000				2235.60	0.73	165.80	1490.40	0.48	81.55	1117.80	0.36	49.29
26,600				2287.19	0.74	172.55	1524.79	0.50	84.87	1143.59	0.37	51.30
27,200				2338.78	0.76	179.42	1559.19	0.51	88.25	1169.39	0.38	53.34
27,800				2390.37	0.78	186.40	1593.58	0.52	91.68	1195.18	0.39	55.42
28,400				2441.96	0.79	193.50	1627.97	0.53	95.17	1220.98	0.40	57.53
29,000				2493.55	0.81	200.71	1662.37	0.54	98.72	1246.78	0.40	59.67
29,600				2545.14	0.83	208.03	1696.76	0.55	102.32	1272.57	0.41	61.85
30,200				2596.73	0.84	215.47	1731.16	0.56	105.98	1298.37	0.42	64.06
30,800				2648.32	0.86	223.02	1765.55	0.57	109.69	1324.16	0.43	66.30
31,400				2699.91	0.88	230.68	1799.94	0.58	113.46	1349.96	0.44	68.58
32,000				2751.50	0.89	238.44	1834.34	0.60	117.28	1375.75	0.45	70.89
32,600				2803.10	0.91	246.32	1868.73	0.61	121.16	1401.55	0.46	73.23
33,200				2854.69	0.93	254.31	1903.12	0.62	125.09	1427.34	0.46	75.61
33,800				2906.28	0.94	262.41	1937.52	0.63	129.07	1453.14	0.47	78.01
34,400				2957.87	0.96	270.62	1971.91	0.64	133.10	1478.93	0.48	80.45
35,000				3009.46	0.98	278.93	2006.31	0.65	137.19	1504.73	0.49	82.93
35,600				3061.05	0.99	287.35	2040.70	0.66	141.34	1530.52	0.50	85.43
36,200				3112.64	1.01	295.88	2075.09	0.67	145.53	1556.32	0.51	87.97
36,800							2109.49	0.69	149.78	1582.12	0.51	90.53
37,400							2143.88	0.70	154.08	1607.91	0.52	93.13
38,000							2178.27	0.71	158.43	1633.71	0.53	95.76
38,600							2212.67	0.72	162.83	1659.50	0.54	98.42
39,200							2247.06	0.73	167.29	1685.30	0.55	101.12
39,800							2281.46	0.74	171.79	1711.09	0.56	103.84
40,400							2315.85	0.75	176.35	1736.89	0.56	106.60
41,000							2350.24	0.76	180.96	1762.68	0.57	109.38
41,600							2384.64	0.77	185.62	1788.48	0.58	112.20

Pressure losses of dimension 42.2 x 4.6 at 60°C (Stabil pipe 40)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
43,400							2487.82	0.81	199.90	1865.86	0.61	120.83
44,000							2522.21	0.82	204.77	1891.66	0.61	123.77
44,600							2556.61	0.83	209.68	1917.45	0.62	126.74
45,200							2591.00	0.84	214.64	1943.25	0.63	129.74
45,800							2625.39	0.85	219.65	1969.05	0.64	132.77
46,400							2659.79	0.86	224.71	1994.84	0.65	135.82
47,000							2694.18	0.87	229.82	2020.64	0.66	138.91
47,600							2728.58	0.89	234.98	2046.43	0.66	142.03
48,200							2762.97	0.90	240.19	2072.23	0.67	145.18
48,800							2797.36	0.91	245.44	2098.02	0.68	148.36
49,400							2831.76	0.92	250.75	2123.82	0.69	151.56
50,000							2866.15	0.93	256.10	2149.61	0.70	154.80
50,600							2900.54	0.94	261.50	2175.41	0.71	158.06
51,200							2934.94	0.95	266.95	2201.20	0.71	161.36
51,800							2969.33	0.96	272.45	2227.00	0.72	164.68
52,400							3003.73	0.98	278.00	2252.79	0.73	168.04
53,000							3038.12	0.99	283.59	2278.59	0.74	171.42
53,600							3072.51	1.00	289.24	2304.39	0.75	174.83
54,200										2330.18	0.76	178.27
54,800										2355.98	0.77	181.73
55,400										2381.77	0.77	185.23
56,000										2407.57	0.78	188.76
56,600										2433.36	0.79	192.31

Pressure losses of dimension 52.2 x 5.65 at 60°C (Stabil pipe 50)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
57,800										2484.95	0.81	199.50
58,400										2510.75	0.82	203.14
59,000										2536.54	0.82	206.81
59,600										2562.34	0.83	210.50
60,200										2588.13	0.84	214.22
60,800										2613.93	0.85	217.97
7,000	1203.78	0.25	20.25	601.89	0.13	6.02	401.26	0.08	2.96	300.95	0.06	1.79
8,000	1375.75	0.29	25.58	687.88	0.15	7.60	458.58	0.10	3.74	343.94	0.07	2.26
9,000	1547.72	0.33	31.43	773.86	0.16	9.34	515.91	0.11	4.60	386.93	0.08	2.78
10,000	1719.69	0.36	37.79	859.85	0.18	11.24	573.23	0.12	5.53	429.92	0.09	3.34
11,000	1891.66	0.40	44.65	945.83	0.20	13.28	630.55	0.13	6.53	472.91	0.10	3.95
12,000	2063.63	0.44	52.00	1031.81	0.22	15.46	687.88	0.15	7.60	515.91	0.11	4.60
13,000	2235.60	0.47	59.82	1117.80	0.24	17.78	745.20	0.16	8.75	558.90	0.12	5.29
14,000	2407.57	0.51	68.10	1203.78	0.25	20.25	802.52	0.17	9.96	601.89	0.13	6.02
15,000	2579.54	0.55	76.84	1289.77	0.27	22.84	859.85	0.18	11.24	644.88	0.14	6.79
16,000	2751.50	0.58	86.03	1375.75	0.29	25.58	917.17	0.19	12.58	687.88	0.15	7.60
17,000	2923.47	0.62	95.66	1461.74	0.31	28.44	974.49	0.21	13.99	730.87	0.15	8.45
18,000	3095.44	0.65	105.72	1547.72	0.33	31.43	1031.81	0.22	15.46	773.86	0.16	9.34
19,000	3267.41	0.69	116.21	1633.71	0.35	34.55	1089.14	0.23	16.99	816.85	0.17	10.27
20,000	3439.38	0.73	127.13	1719.69	0.36	37.79	1146.46	0.24	18.59	859.85	0.18	11.24
21,000	3611.35	0.76	138.46	1805.67	0.38	41.16	1203.78	0.25	20.25	902.84	0.19	12.24
22,000	3783.32	0.80	150.20	1891.66	0.40	44.65	1261.11	0.27	21.96	945.83	0.20	13.28
23,000	3955.29	0.84	162.35	1977.64	0.42	48.27	1318.43	0.28	23.74	988.82	0.21	14.35
24,000	4127.26	0.87	174.91	2063.63	0.44	52.00	1375.75	0.29	25.58	1031.81	0.22	15.46
25,000	4299.23	0.91	187.86	2149.61	0.45	55.85	1433.08	0.30	27.47	1074.81	0.23	16.60
26,000	4471.20	0.95	201.20	2235.60	0.47	59.82	1490.40	0.32	29.42	1117.80	0.24	17.78
27,000	4643.16	0.98	214.94	2321.58	0.49	63.90	1547.72	0.33	31.43	1160.79	0.25	19.00
28,000	4815.13	1.02	229.07	2407.57	0.51	68.10	1605.04	0.34	33.50	1203.78	0.25	20.25
29,000				2493.55	0.53	72.41	1662.37	0.35	35.62	1246.78	0.26	21.53

Pressure losses of dimension 52.2 x 5.65 at 60°C (Stabil pipe 50)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
31,000				2665.52	0.56	81.38	1777.01	0.38	40.03	1332.76	0.28	24.19
7,000	1203.78	0.25	20.25	601.89	0.13	6.02	401.26	0.08	2.96	300.95	0.06	1.79
8,000	1375.75	0.29	25.58	687.88	0.15	7.60	458.58	0.10	3.74	343.94	0.07	2.26
9,000	1547.72	0.33	31.43	773.86	0.16	9.34	515.91	0.11	4.60	386.93	0.08	2.78
10,000	1719.69	0.36	37.79	859.85	0.18	11.24	573.23	0.12	5.53	429.92	0.09	3.34
11,000	1891.66	0.40	44.65	945.83	0.20	13.28	630.55	0.13	6.53	472.91	0.10	3.95
12,000	2063.63	0.44	52.00	1031.81	0.22	15.46	687.88	0.15	7.60	515.91	0.11	4.60
13,000	2235.60	0.47	59.82	1117.80	0.24	17.78	745.20	0.16	8.75	558.90	0.12	5.29
14,000	2407.57	0.51	68.10	1203.78	0.25	20.25	802.52	0.17	9.96	601.89	0.13	6.02
15,000	2579.54	0.55	76.84	1289.77	0.27	22.84	859.85	0.18	11.24	644.88	0.14	6.79
16,000	2751.50	0.58	86.03	1375.75	0.29	25.58	917.17	0.19	12.58	687.88	0.15	7.60
17,000	2923.47	0.62	95.66	1461.74	0.31	28.44	974.49	0.21	13.99	730.87	0.15	8.45
18,000	3095.44	0.65	105.72	1547.72	0.33	31.43	1031.81	0.22	15.46	773.86	0.16	9.34
19,000	3267.41	0.69	116.21	1633.71	0.35	34.55	1089.14	0.23	16.99	816.85	0.17	10.27
20,000	3439.38	0.73	127.13	1719.69	0.36	37.79	1146.46	0.24	18.59	859.85	0.18	11.24
21,000	3611.35	0.76	138.46	1805.67	0.38	41.16	1203.78	0.25	20.25	902.84	0.19	12.24
22,000	3783.32	0.80	150.20	1891.66	0.40	44.65	1261.11	0.27	21.96	945.83	0.20	13.28
23,000	3955.29	0.84	162.35	1977.64	0.42	48.27	1318.43	0.28	23.74	988.82	0.21	14.35
24,000	4127.26	0.87	174.91	2063.63	0.44	52.00	1375.75	0.29	25.58	1031.81	0.22	15.46
25,000	4299.23	0.91	187.86	2149.61	0.45	55.85	1433.08	0.30	27.47	1074.81	0.23	16.60
26,000	4471.20	0.95	201.20	2235.60	0.47	59.82	1490.40	0.32	29.42	1117.80	0.24	17.78
27,000	4643.16	0.98	214.94	2321.58	0.49	63.90	1547.72	0.33	31.43	1160.79	0.25	19.00
28,000	4815.13	1.02	229.07	2407.57	0.51	68.10	1605.04	0.34	33.50	1203.78	0.25	20.25
29,000				2493.55	0.53	72.41	1662.37	0.35	35.62	1246.78	0.26	21.53
30,000				2579.54	0.55	76.84	1719.69	0.36	37.79	1289.77	0.27	22.84
31,000				2665.52	0.56	81.38	1777.01	0.38	40.03	1332.76	0.28	24.19
32,000				2751.50	0.58	86.03	1834.34	0.39	42.31	1375.75	0.29	25.58
33,000				2837.49	0.60	90.79	1891.66	0.40	44.65	1418.74	0.30	26.99
34,000				2923.47	0.62	95.66	1948.98	0.41	47.05	1461.74	0.31	28.44
35,000				3009.46	0.64	100.64	2006.31	0.42	49.50	1504.73	0.32	29.92

Pressure losses of dimension 52.2 x 5.65 at 60°C (Stabil pipe 50)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
37,000				3181.43	0.67	110.91	2120.95	0.45	54.55	1590.71	0.34	32.97
38,000				3267.41	0.69	116.21	2178.27	0.46	57.16	1633.71	0.35	34.55
39,000				3353.40	0.71	121.62	2235.60	0.47	59.82	1676.70	0.35	36.16
40,000				3439.38	0.73	127.13	2292.92	0.48	62.53	1719.69	0.36	37.79
41,000				3525.37	0.75	132.74	2350.24	0.50	65.29	1762.68	0.37	39.46
42,000				3611.35	0.76	138.46	2407.57	0.51	68.10	1805.67	0.38	41.16
43,000				3697.33	0.78	144.28	2464.89	0.52	70.96	1848.67	0.39	42.89
44,000				3783.32	0.80	150.20	2522.21	0.53	73.88	1891.66	0.40	44.65
45,000				3869.30	0.82	156.23	2579.54	0.55	76.84	1934.65	0.41	46.45
46,000				3955.29	0.84	162.35	2636.86	0.56	79.85	1977.64	0.42	48.27
47,000				4041.27	0.85	168.58	2694.18	0.57	82.92	2020.64	0.43	50.12
48,000				4127.26	0.87	174.91	2751.50	0.58	86.03	2063.63	0.44	52.00
49,000				4213.24	0.89	181.33	2808.83	0.59	89.19	2106.62	0.45	53.91
50,000				4299.23	0.91	187.86	2866.15	0.61	92.40	2149.61	0.45	55.85
51,000				4385.21	0.93	194.48	2923.47	0.62	95.66	2192.61	0.46	57.82
52,000				4471.20	0.95	201.20	2980.80	0.63	98.96	2235.60	0.47	59.82
53,000				4557.18	0.96	208.02	3038.12	0.64	102.32	2278.59	0.48	61.85
54,000				4643.16	0.98	214.94	3095.44	0.65	105.72	2321.58	0.49	63.90
55,000				4729.15	1.00	221.95	3152.77	0.67	109.17	2364.57	0.50	65.99
56,000							3210.09	0.68	112.67	2407.57	0.51	68.10
57,000							3267.41	0.69	116.21	2450.56	0.52	70.24
58,000							3324.73	0.70	119.80	2493.55	0.53	72.41
59,000							3382.06	0.72	123.44	2536.54	0.54	74.61
60,000							3439.38	0.73	127.13	2579.54	0.55	76.84
61,000							3496.70	0.74	130.86	2622.53	0.55	79.10
62,000							3554.03	0.75	134.63	2665.52	0.56	81.38
63,000							3611.35	0.76	138.46	2708.51	0.57	83.69
64,000							3668.67	0.78	142.33	2751.50	0.58	86.03
65,000							3726.00	0.79	146.24	2794.50	0.59	88.39
66,000							3783.32	0.80	150.20	2837.49	0.60	90.79

Pressure losses of dimension 63 x 6.0 at 60°C (Stabil pipe 63)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
67,000							3840.64	0.81	154.21	2880.48	0.61	93.21
15,000	2579.54	0.35	26.94	1289.77	0.18	8.01	859.85	0.12	3.94	644.88	0.09	2.38
16,500	2837.49	0.39	31.82	1418.74	0.19	9.46	945.83	0.13	4.65	709.37	0.10	2.81
18,000	3095.44	0.42	37.06	1547.72	0.21	11.02	1031.81	0.14	5.42	773.86	0.11	3.28
19,500	3353.40	0.46	42.63	1676.70	0.23	12.67	1117.80	0.15	6.23	838.35	0.11	3.77
21,000	3611.35	0.49	48.53	1805.67	0.25	14.43	1203.78	0.16	7.10	902.84	0.12	4.29
22,500	3869.30	0.53	54.76	1934.65	0.26	16.28	1289.77	0.18	8.01	967.33	0.13	4.84
24,000	4127.26	0.56	61.31	2063.63	0.28	18.23	1375.75	0.19	8.97	1031.81	0.14	5.42
25,500	4385.21	0.60	68.17	2192.61	0.30	20.27	1461.74	0.20	9.97	1096.30	0.15	6.03
27,000	4643.16	0.63	75.34	2321.58	0.32	22.40	1547.72	0.21	11.02	1160.79	0.16	6.66
28,500	4901.12	0.67	82.82	2450.56	0.33	24.62	1633.71	0.22	12.11	1225.28	0.17	7.32
30,000	5159.07	0.70	90.60	2579.54	0.35	26.94	1719.69	0.23	13.25	1289.77	0.18	8.01
31,500	5417.02	0.74	98.67	2708.51	0.37	29.34	1805.67	0.25	14.43	1354.26	0.18	8.72
33,000	5674.98	0.77	107.04	2837.49	0.39	31.82	1891.66	0.26	15.65	1418.74	0.19	9.46
34,500	5932.93	0.81	115.70	2966.47	0.40	34.40	1977.64	0.27	16.92	1483.23	0.20	10.23
36,000	6190.89	0.84	124.65	3095.44	0.42	37.06	2063.63	0.28	18.23	1547.72	0.21	11.02
37,500	6448.84	0.88	133.88	3224.42	0.44	39.80	2149.61	0.29	19.58	1612.21	0.22	11.83
39,000	6706.79	0.91	143.39	3353.40	0.46	42.63	2235.60	0.30	20.97	1676.70	0.23	12.67
40,500	6964.75	0.95	153.18	3482.37	0.47	45.54	2321.58	0.32	22.40	1741.19	0.24	13.54
42,000	7222.70	0.98	163.25	3611.35	0.49	48.53	2407.57	0.33	23.87	1805.67	0.25	14.43
43,500	7480.65	1.02	173.59	3740.33	0.51	51.61	2493.55	0.34	25.38	1870.16	0.25	15.34
45,000				3869.30	0.53	54.76	2579.54	0.35	26.94	1934.65	0.26	16.28
46,500				3998.28	0.54	58.00	2665.52	0.36	28.53	1999.14	0.27	17.24
48,000				4127.26	0.56	61.31	2751.50	0.37	30.16	2063.63	0.28	18.23
49,500				4256.23	0.58	64.70	2837.49	0.39	31.82	2128.12	0.29	19.24
51,000				4385.21	0.60	68.17	2923.47	0.40	33.53	2192.61	0.30	20.27
52,500				4514.19	0.61	71.72	3009.46	0.41	35.28	2257.09	0.31	21.32
54,000				4643.16	0.63	75.34	3095.44	0.42	37.06	2321.58	0.32	22.40
55,500				4772.14	0.65	79.04	3181.43	0.43	38.88	2386.07	0.32	23.50
57,000				4901.12	0.67	82.82	3267.41	0.44	40.74	2450.56	0.33	24.62

Pressure losses of dimension 63 x 6.0 at 60°C (Stabil pipe 63)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
61,500				5288.05	0.72	94.60	3525.37	0.48	46.53	2644.02	0.36	28.12
63,000				5417.02	0.74	98.67	3611.35	0.49	48.53	2708.51	0.37	29.34
64,500				5546.00	0.75	102.82	3697.33	0.50	50.57	2773.00	0.38	30.57
66,000				5674.98	0.77	107.04	3783.32	0.51	52.65	2837.49	0.39	31.82
67,500				5803.96	0.79	111.34	3869.30	0.53	54.76	2901.98	0.39	33.10
69,000				5932.93	0.81	115.70	3955.29	0.54	56.91	2966.47	0.40	34.40
70,500				6061.91	0.82	120.14	4041.27	0.55	59.09	3030.95	0.41	35.72
72,000				6190.89	0.84	124.65	4127.26	0.56	61.31	3095.44	0.42	37.06
73,500				6319.86	0.86	129.23	4213.24	0.57	63.56	3159.93	0.43	38.42
75,000				6448.84	0.88	133.88	4299.23	0.58	65.85	3224.42	0.44	39.80
76,500				6577.82	0.89	138.60	4385.21	0.60	68.17	3288.91	0.45	41.21
78,000				6706.79	0.91	143.39	4471.20	0.61	70.53	3353.40	0.46	42.63
79,500				6835.77	0.93	148.25	4557.18	0.62	72.92	3417.88	0.46	44.08
81,000				6964.75	0.95	153.18	4643.16	0.63	75.34	3482.37	0.47	45.54
82,500				7093.72	0.96	158.18	4729.15	0.64	77.80	3546.86	0.48	47.03
84,000				7222.70	0.98	163.25	4815.13	0.65	80.29	3611.35	0.49	48.53
85,500				7351.68	1.00	168.38	4901.12	0.67	82.82	3675.84	0.50	50.06
87,000							4987.10	0.68	85.38	3740.33	0.51	51.61
88,500							5073.09	0.69	87.97	3804.82	0.52	53.17
90,000							5159.07	0.70	90.60	3869.30	0.53	54.76
91,500							5245.06	0.71	93.26	3933.79	0.53	56.37
93,000							5331.04	0.72	95.95	3998.28	0.54	58.00
94,500							5417.02	0.74	98.67	4062.77	0.55	59.64
96,000							5503.01	0.75	101.43	4127.26	0.56	61.31
97,500							5588.99	0.76	104.22	4191.75	0.57	63.00
99,000							5674.98	0.77	107.04	4256.23	0.58	64.70
100,500							5760.96	0.78	109.90	4320.72	0.59	66.43
102,000							5846.95	0.80	112.78	4385.21	0.60	68.17
103,500							5932.93	0.81	115.70	4449.70	0.61	69.94
105,000							6018.92	0.82	118.65	4514.19	0.61	71.72

Pressure losses of dimension 63 x 6.0 at 60°C (Stabil pipe 63)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
108,000							6190.89	0.84	124.65	4643.16	0.63	75.34
109,500							6276.87	0.85	127.69	4707.65	0.64	77.18
111,000							6362.85	0.87	130.77	4772.14	0.65	79.04
112,500							6448.84	0.88	133.88	4836.63	0.66	80.92
114,000							6534.82	0.89	137.02	4901.12	0.67	82.82
115,500							6620.81	0.90	140.19	4965.61	0.68	84.74
117,000							6706.79	0.91	143.39	5030.09	0.68	86.67
118,500							6792.78	0.92	146.62	5094.58	0.69	88.63
120,000							6878.76	0.94	149.89	5159.07	0.70	90.60
121,500							6964.75	0.95	153.18	5223.56	0.71	92.59
123,000							7050.73	0.96	156.51	5288.05	0.72	94.60
124,500							7136.72	0.97	159.86	5352.54	0.73	96.63
126,000							7222.70	0.98	163.25	5417.02	0.74	98.67
127,500							7308.68	0.99	166.66	5481.51	0.75	100.74
129,000							7394.67	1.01	170.11	5546.00	0.75	102.82
130,500										5610.49	0.76	104.92
132,000										5674.98	0.77	107.04
133,500										5739.47	0.78	109.18
135,000										5803.96	0.79	111.34
136,500										5868.44	0.80	113.51
138,000										5932.93	0.81	115.70
139,500										5997.42	0.82	117.91
141,000										6061.91	0.82	120.14
142,500										6126.40	0.83	122.39
144,000										6190.89	0.84	124.65
145,500										6255.37	0.85	126.93
147,000										6319.86	0.86	129.23
148,500										6384.35	0.87	131.55
150,000										6448.84	0.88	133.88
151,500										6513.33	0.89	136.23

Pressure losses of dimension 63 x 6.0 at 60°C (Stabil pipe 63)

Temperature difference in K	5			10			15			20		
Q [W]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]	m [kg/h]	w [m/s]	R [Pa/m]
153,000										6577.82	0.89	138.60
154,500										6642.30	0.90	140.99

2

Underfloor heating

PRINETO Underfloor heating

PRINETO®

2

Underfloor heating

General basics

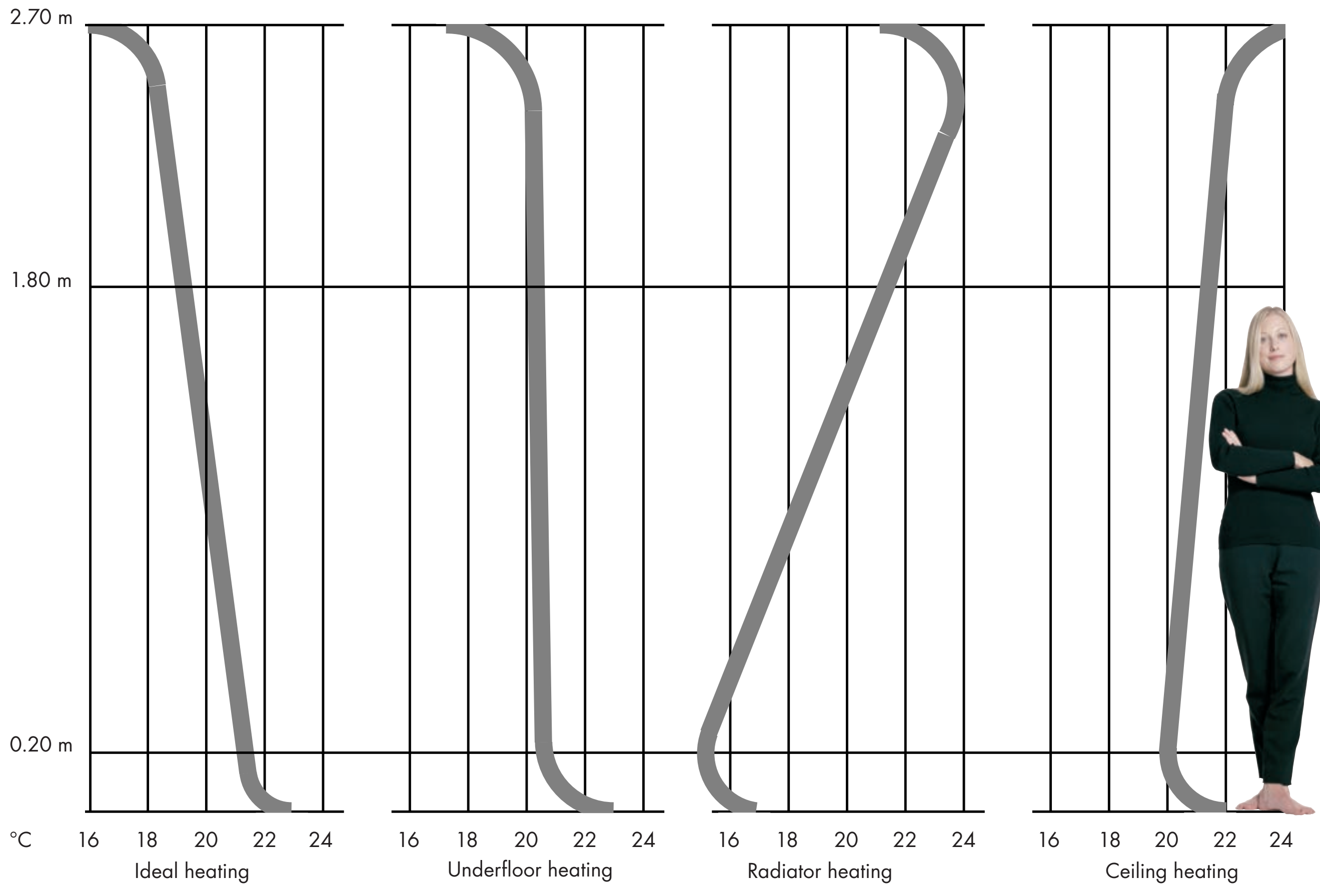
A surface heating system is a low-temperature heating system, in which the heat is provided to the rooms via heated room surfaces such as floors. The heat can be sourced from any regulated low-temperature hot water heating system. Because surface heating systems provide a large part of the heat by radiation, the system temperatures can be kept very low. This reduces energy consumption, leading to lower emissions and hence less environmental impact. Combined with modern heating technology, this lead to greater energy efficiency and thus lower running costs.

The key advantage of surface heating systems is the so-called self-regulation effect. This occurs independently of the individual-room controllers required by law on each individual surface heating system. The amount of energy released is determined by the temperature difference between the heating surface and room air. As the temperature of the room air rises towards that of the heating surface, e.g. as a result of sunshine, less heat is released. The self-regulation effect comes into play.

PRINETO Underfloor heating

Comfort means physical well-being. It depends on the room temperature and its even distribution in the room as well as the air speed, moisture and the temperature of the surrounding room surfaces. The balance between convection and radiation in heat emission influences most of these factors. The radiation component of the underfloor heating is about 50%. The average temperature of floor and wall surfaces in the room is thus higher than the room air temperature. Compared with static heating systems, the room air temperature can be kept about 1 – 2°C lower without any loss of comfort.

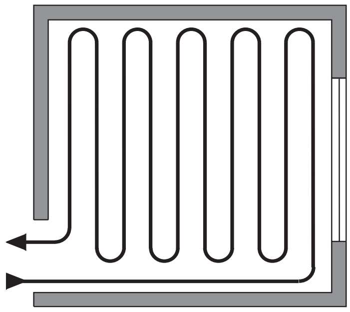
An underfloor heating system provides heating that is perceived as being especially pleasant. Since underfloor heating has a large-area heating source, the low heating medium temperatures generate a comfortable room climate. Studies carried out have enabled ideal heat physiology curves to be developed. The temperature profile of underfloor heating comes closest to the ideal curve.



General basics

Advantages of surface heating systems

- Low running costs – energy saving through lower room air temperature
- Thermal comfort through high radiation heat component
- Minimum distribution losses through lower heating medium temperatures
- Open room layouts possible without intrusive heating units
- Very low system temperatures possible, ideal in combination with condensing boiler systems, heat pumps and solar systems
- No dust transport or dust eddies due to air circulation
- Building component damage due to air condensation is prevented
- Self-regulation effect

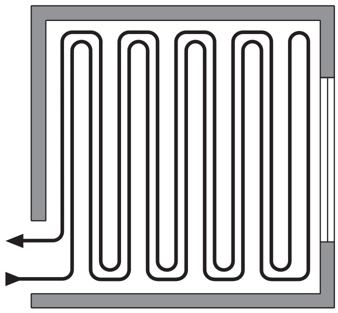


Meandering pipe laying

When the meandering pattern is used, the large temperature gradient in the floor surface between flow and return has to be taken into consideration. If the flow is laid where the greatest heat demand is to be expected – normally the exterior wall – this effect can be put to good use.

Oxygen diffusion

All synthetic pipes used for heating must be oxygen diffusion-tight, in compliance with DIN 4726. The standard requires an area-related limiting value for oxygen diffusion of 0.32 mg per m^2 and per day at 40°C (application class 4) or 3.6 mg per m^2 and per day at 80°C (application class 5). ***PRINETO*** heating pipes fall well below this value. All three types of pipes are suitable for the installation of hot water underfloor heating systems without system separation.



Double meandering pipe laying

The double meandering pattern balances the unfavourable temperature gradient that may exist in the room, since supply and return alternate in heating the floor. The heat flow is increased as the pipes can be laid with smaller distances between them than the ones permitted by the bending radius with normal meandering laying.

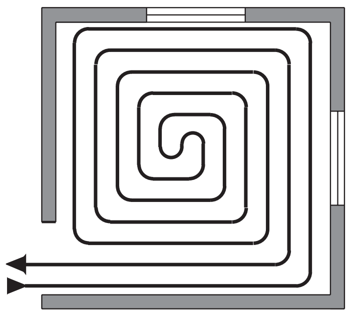
Types of laying

There are two general ways to lay heating pipes:

- In a meandering or snaked pattern
- In a bifilar or snail pattern

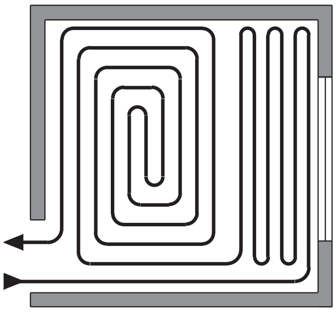
NOTE

To avoid opening a new pipe bundle for every heating circuit, the surface heating pipes can be connected using couplers. However, just like other brass fittings and sliding sleeves, the couplers must be protected from corrosion by the screed before they are laid. This can be done by wrapping suitable material around the connection, for example.



Bifilar pipe laying

The bifilar method of laying ensures an even floor surface temperature because supply and return are alternated and create a balance accordingly. In general, the bifilar pipe layout with its 90° bends is easier to lay than the meander layout with 180° bends.

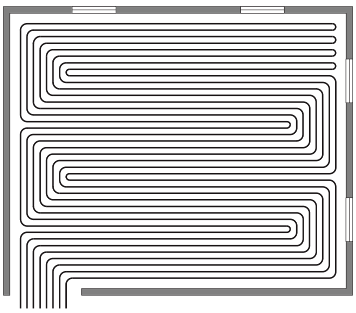


Combined pipe layout

In addition to the basic types, a combination of the two is also possible. For example, the meandering pattern can be used for less frequented marginal areas and the bifilar pattern for the central area.

The term 'edge zone' is used to describe a strip of a maximum of 1 m in width, e.g. in front of glass surfaces or outer doors, where people do not usually spend much time. The maximum floor surface temperature must not exceed 35°C.
The term 'central area' describes the area of the heated floor surface where people usually spend most of their time. Here, the maximum floor surface temperature must not exceed 29°C.

The increased floor surface temperatures which are sometimes required for different areas of rooms can be achieved by reducing the distance between lines of pipes in the respective areas. It has to be taken into consideration, however, that with a laying interval of less than 100 mm the number of pipes required is disproportionately high in relation to the slight increase in the surface heat flux achieved. A laying interval of more than 250 mm is not recommended because of the temperature differences on the screed surface.



Large-area heating system

For the laying of large areas (e.g. sports halls) all the heating circuits are laid in a meandering pattern next to each other. This ensures even heat distribution and makes hydraulic equalisation unnecessary, as all the heating circuits are of exactly the same length.

Surface cooling

If a room becomes over-heated, people's comfort is reduced and they lose their ability to concentrate.
The human body perspires in order to try and reduce its core temperature. Therefore more and more surface heating systems are also being used for room cooling in summer. However, this should always be combined with an appropriate shading system because otherwise the cooling power will probably not be adequate to eliminate the simultaneous warming by the sunlight.

Often, air conditioning units which are comparatively cheap and easy to install are used for room cooling. However, these units only cool the room air by means of a fan and a heat exchanger, causing a draught and removing the water vapour from the room (condensation on the heat exchanger), which in turn results in extremely dry room air. The air conditioning in a car operates on the same principle. This dry, cool air does not agree with everybody because it dries out the nasal mucous membrane and increases the risk of catching a cold.

Surface cooling works according to a different principle: without any movement of air, the cooled surfaces largely absorb the infrared radiation (heat radiation) from all the objects and surfaces in their surroundings: ceilings, walls, furniture, the skin of the occupants. Because of this, these objects lose their heat energy, and cool down. The cooling of the air in the room is the logical consequence. Even if the room temperature is still high, the cooler surrounding surfaces will make you feel comfortable. This type of cooling is therefore physiologically more comfortable and healthier.

Because the cooling also works during the night, the solid components of the building will lose a part of their heat energy during this time, which they can re-absorb during the day and store without warming up the air in the room too quickly

General basics

The most effective surface cooling works on the ceiling. Therefore the heating power is at its lowest on the ceiling. If the system is on the floor, the exact opposite is the case. If however, the installation of underfloor heating is planned, the heating pipes installed in the floor can also carry cold water in the summer, and thus be used for cooling. In addition, it would be necessary to extend the room temperature regulation slightly and to add a corresponding cooling unit (e.g. a combination heating pump with a cooling function).

Since the ***PRINETO*** regulator components do not include a room humidity sensor, the minimum cooling medium temperature in the cooling appliance must be strictly limited depending on the installation system, floor covering and heating pipes interval, so that for physiological reasons the floor surface does not cool down to lower than 20°C, and also to prevent condensation forming (if the temperature falls below the dew point) on the cooled surfaces. For information, please refer to the tables at the end of this chapter.

NOTE

The warmer the air is, the more water it can absorb. If the air cools down too much on the floor, the water vapour will condense onto the floor once the temperature falls below the dew point. The result can be damage to the floor covering or to the screed itself.

NOTE

Because all the pipes carrying the cold water are colder than the cooled floor surfaces, these must be insulated with a suitable insulating water vapour diffusion layer.

Dew point temperatures in °C
The dew point table indicates the surface temperatures at which condensation will occur.

Air temperature in °C	Relative air humidity in %										
	45	50	55	60	65	70	75	80	85	90	95
30	16.8	18.4	20.0	21.4	23.7	23.9	25.1				
29	15.9	17.6	19.0	20.5	21.8	23.0	24.2	25.2	26.2	27.3	28.2
28	15.0	16.6	18.1	19.4	20.9	22.1					
27	14.1	15.7	17.2	18.6	19.8	21.1	22.2	23.3	24.3	25.2	26.1
26	13.2	14.8	16.3	17.7	18.9	20.1	21.3	21.3	23.3	24.3	25.2
25	12.2	13.8	15.4	16.7	18.0	19.1	20.2	21.4	22.3	23.3	24.2
24	11.3	12.9	14.4	15.7	17.1	18.2	19.2	20.3	21.4	22.3	23.2
23	10.4	12.0	13.5	14.9	16.0	17.3	18.4	19.4	20.4	21.3	22.2
22	9.5	11.1	12.5	13.9	15.2	16.3	17.4	18.4	19.4	20.3	21.2
21	8.6	10.2	11.6	12.9	14.2	15.4	16.4	17.4	18.4	19.3	20.2
20	7.7	9.3	10.7	12.0	13.2	14.4	15.5	16.5	17.4	18.4	19.2

Dew point curve 20°C

Table according to VDI 2055-1 Annex 16

Short description of the ***PRINETO*** underfloor heating systems

Because the cooling power essentially depends upon the temperature difference between the cooling surface and the actual room temperature, and for each m² of floor surface and for each Kelvin of temperature difference and only about 6.5 Watt cooling load is achieved for each m² of floor surface and each Kelvin of temperature difference, the heating power of the surfaces (about 10.8 Watt heating power for each m² of floor surface and each Kelvin of temperature difference) is considerably greater than the comparable cooling power.

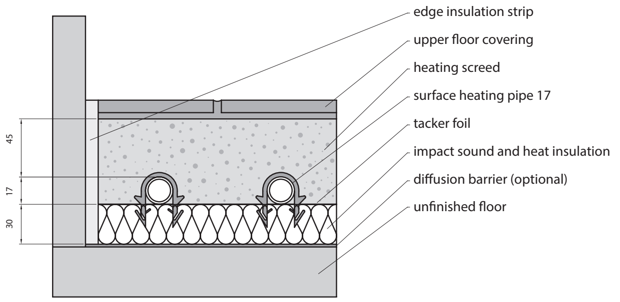
Example:
Cooling: 20°C floor and 26°C room = 6 Kelvin difference x 6.5 Watt = 39 Watt/m² cooling power.
Heating: 29°C floor and 20°C room = 9 Kelvin difference x 10.8 Watt = 99 Watt/m² heating power.

		α in W/m² K		Surface temperature in°C		Maximum power in W/m²	
		Heating	**Cooling**	**Max. heating**	**Min. cooling**	**Heating**	**Cooling**
Floor	Edge zone	10.8	6.5	35	20	162	39
	Central area	10.8	6.5	29	20	97.2	39
Wall		8	8	~40	20	160	48
Ceiling		6.5	10.8	~27	20	45.5	63

Inner heat transfer coefficient α, maximum and minimum surface temperatures and maximum power at 20°C room temperature for heating and 26°C room temperature for cooling in wall, ceiling and floor surface systems (source: DIN EN 1264-5)

PRINETO Tacker system

The heating pipes are fastened to the cover foil of the insulation with ***PRINETO*** tacker needles, and are completely surrounded by the wet-laid heating screed. The structure thus corresponds to construction type A as per DIN 18560-2. With the ***PRINETO*** tacker tool the tacker needles are positioned above the pipes and hook under the cover foil of the insulation boards. Either individual heat and impact sound insulation boards of polystyrene, onto which the self-adhesive ***PRINETO*** tacker foil is fixed, or the ***PRINETO*** system roll, can be used for insulation.



Cross-section tacker system

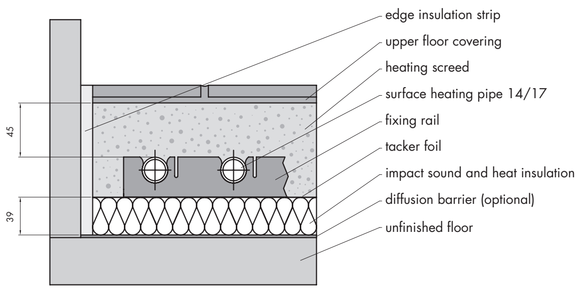
- Laying type, laying distance and pipe layout can be selected freely
- High heating power through heating pipes completely surrounded by wet-laid screed
- Especially suited for complicated and small ground-plans with little cutting loss during insulation laying (only approx. 3% cutting loss)
- Max. heating circuit areas larger than with knobbed board 14 – therefore, depending on distribution, smaller heating circuit manifolds are possible (fewer actuators etc.)
- Job separation possible: Owner or screed layer lays insulation – the heating engineer lays tacker foil and installs the heating pipes
- 2 high live loads possible on the floor

Short description of the ***PRINETO*** underfloor heating systems

PRINETO fixing rail system

The heating pipes are attached to the cover foil of the insulation by means of a self-adhesive grooved rail and are completely surrounded by the wet-laid heating screed. The structure thus corresponds to construction type A as per DIN 18560-2. The heating pipes are fixed by being pressed into the grooves at the required intervals. In the area of bends the pipes can be additionally fastened with tacker needles in some places. Either individual heat and impact sound insulation boards of polystyrene onto which the self-adhesive ***PRINETO*** tacker foil is fixed, or the ***PRINETO*** system roll, can be used for insulation.

- Snake-like laying of the heating pipes (complicated snail pattern)
- High heating power through heating pipes completely surrounded by wet-laid screed
- Especially suitable for large areas with insulation laying with little cutting loss (only approx. 3% cutting loss)
- Easy and quick fastening of pipes can be performed by one person
- Job separation possible: Owner or screed layer lays insulation – the heating engineer lays tacker foil and installs the heating pipes
- High live loads on the floor possible

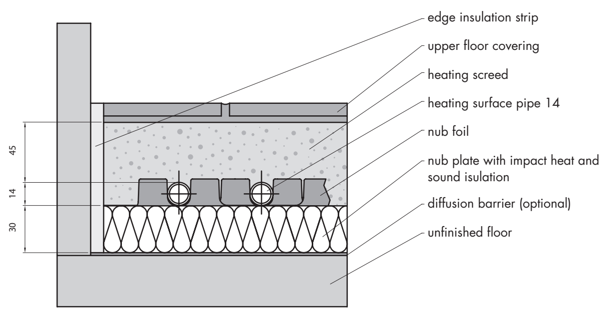


Cross-section fixing rail system

PRINETO Knobbed board 14 system

The heating pipes are clamped in the rigid, knobbed cover foil of the insulation without using any tools, and they are completely surrounded by the wet-laid heating screed. The structure thus corresponds to construction type A as per DIN 18560-2. The profiled foil overlap connects the knobbed boards and seals the insulation edges.

- The knobbed board is insulation, covering foil and pipe fastener combined together and laid in one step
- Easy and quick fastening of pipes can be performed by one person
- Impact-resistant knobbed foil screed-tight without additional sealing
- High heating power through heating pipes completely surrounded by wet-laid screed
- Defined distances between pipes in the grid 50 mm if laid straight, or 75 mm if laid diagonally
- Extremely low installed height possible through use of heating pipe 14 with 11 mm knobbed board (without impact sound insulation)
- Straight and precise laying of pipes
- High live loads on the floor possible



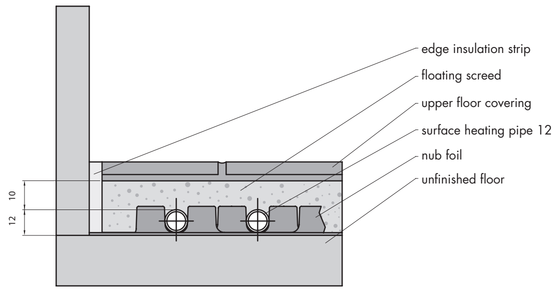
Cross-section knobbed board 14 system

Short description of the ***PRINETO*** underfloor heating systems

PRINETO Thin-bed system

The thin-bed system 12 is a special system for laying water-carrying underfloor heating with minimum floor structure. Since no heat and impact sound insulation is laid under the special screed, this system does not meet the requirements of DIN EN 1264-4 with regard to the thermal conductivity resistance of the insulation. The heating pipes are clamped between the knobs in the knobbed foil without any tools being necessary, and are completely surrounded by the wet-laid heating screed.

The profiled foil overlap connects the knobbed foils to one another.

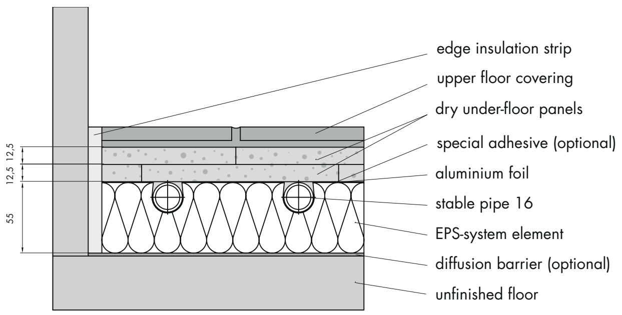


Cross-section thin-bed system

- For modernisation work incorporating low-temperature surface heating in existing buildings.
- Extremely flat floor structure: approx. 22 mm overall height from lower edge of knobbed foil with 10 mm pipe covering (20 mm is required with insulation underneath with max. 20 mm EPS and 100 kPa)
- With 12 x 2.0 mm heating pipe – so smaller maximum heating circuit areas are required
- Lower weight per square metre than classic heating screed: approx. 40 kg/m^2 with 22 mm height (classic systems approx. 120 kg/m^2 with 65 mm height)
- Fast setting and drying thanks to special levelling screed e.g. Knauf 425; can be walked on after 5 hours, is ready for load power after 2 days, covering can be laid after a further 5 days of dry heating
- Short reaction times of 30 minutes for room temperature control
- High thermal conductivity of levelling screed with 1.4 W/mK
- Large specific heating capacities at minimum heating medium temperatures: room 20°C, parquet floor, flow 33°C/ return 28°C, VA 15 cm = 48 W/m^2
- High level of comfort and even heating of the floor thanks to small laying distances from 5 cm
- Suitable for use in residential rooms and similar, maximum live load 3 kN/m^2

PRINETO Dry system

The multilayer composite pipe 16 is inserted in the grooves in the aluminium-coated insulation elements. The aluminium foil conducts the heat from the multilayer composite pipe directly to the insulation surface, where it is distributed to the dry-laid screed. The structure therefore corresponds to construction type B as per DIN 18560-2.



Cross-section dry system

- The system elements are insulation, heat manifold and pipe fastener at the same time – laying in one work step
- Snake-like laying with defined distances between the pipes of 12 or 24 cm
- Quick and easy installation not dependent on the weather
- Very well suited for wooden joist ceilings due to low system weight
- No moisture in the building
- Reduction of construction time compared to wet-laying systems, since no drying time is required
- Laying of upper floor covering possible shortly after dry screed laying
- Very pressure-resistant floor (depending on dry screed, approx. 3 kN/m^2)
- Very low installed height compared to wet systems
- Laying of heat insulation and heat conducting elements in one work step
- Little cutting loss of system elements (approx. 3% cutting loss only)

Installation and laying

Standard reference

For the planning, installation and operation of underfloor heating systems in buildings the following standards and regulations have to be observed:

- DIN 1055 Loads assumed for buildings
- DIN 4102 Fire behaviour of construction materials and construction components
- DIN 4108 Heat insulation and energy saving in buildings
- DIN 4109 Sound insulation in structural engineering
- DIN V 4701-10 Energy evaluation of heating, ventilation and air technology systems
- DIN 4724 Plastic piping systems for hot water underfloor heating systems and radiator connection (PE-MDX)
- DIN 4725 Part 200 Hot water underfloor heating systems – determination of heating power with pipe covering greater than 65 mm
- DIN 4726 Piping systems of synthetic materials
- DIN EN 1254 Copper and copper alloy fittings
- DIN EN 1264 Underfloor heating systems and components
- DIN EN 12831 Methods for the calculation of the standard heating load of buildings
- EnEV Energy-saving Ordinance
- DIN EN 12828 Heating systems in buildings – planning of hot water heating systems
- DIN EN 13163 Manufactured products made of expanded polystyrene (EPS)
- DIN EN 13165 Manufactured products made of polyurethane (PUR)
- DIN 18195 Sealing of buildings
- DIN 18202 Tolerances in structural engineering
- DIN 18333 VOB part C, Concrete block construction work
- DIN 18336 VOB part C, Sealing work
- DIN EN 832 Thermal behaviour of buildings
- DIN 18353 VOB part C, Screed work
- DIN 18380 VOB part C, Heating systems and central water heating systems
- DIN 18560 Screeds in the field of construction

Building condition

The building should be leak-proof, and windows and outside doors must be built-in in order to protect the surface heating system and the heating screed against moisture and temperature fluctuations. All rising building components which are intended for wall plastering must be plastered down to the bearing structure, and all the building components adjacent to the floor must be in place. Any required shell constructions in front of shafts or staircase penetrations must be finished.

In all the rooms where the laying has to be done there should be a level mark plaquette to mark the reference height. For filling and purging the heating circuits a water main connection and a 230 V construction power connector are required on site. The system planning documents (e.g.: laying system, arrangement of heating circuits, laying distance, insulation materials and thickness, hydraulic data of the manifolds) and the joint plan have to be coordinated and have to be available. Sealing against rising ground moisture and water acc. DIN 18195, or DIN 18336 respectively has to be completed before laying of the underfloor heating system is started.

Acc. to DIN 18560 the bearing substrate has to be sufficiently strong and dry for the insulation and the screed to be laid, and it must have an even surface. Where heating screeds of ready-made components (dry screed slabs) are used, the manufacturer's requirements regarding the evenness of the bearing structure have to be observed.

If the required evenness tolerances acc. to DIN 18202 are not complied with, level equalisation by means of an equalising layer has to be performed. The equalising layers have to have a firm structure when installed. Fillings may be used if their suitability is proven. Pressure-resistant insulation material may also be used as equalising layers.

The substrate must not contain any pipelines or elevations which can produce sound bridges or variations in the thickness of the screed. Pipes laid must be fastened, and – by means of equalisation – an even surface has to be created that is suitable for the insulation layer or at least the impact sound insulation.

If the surface of the floating screed is to be at an angle, this must be taken into consideration when planning the bearing substrate, so that the screed can be produced with an even thickness. Joints in the insulation layer and in the screed have to be arranged over building joints.

NOTE

If there is doubt as to whether all the requirements have been met, the client must be informed. In this case laying should not be started. In order to protect the underfloor heating, the heating engineer should be the only trade working in the rooms.

Installation and laying

2

Underfloor heating

Heat and impact sound insulation

Before the insulation layers or the screed are installed, a sound-insulating perimeter strip must be laid along the walls and all rising building components (e.g. pillars or staircases) as an expansion joint. It prevents tension in the heating screed during linear expansion and avoids sound propagation to the surrounding building.

In the case of multiple insulation layers the perimeter strip must be laid before laying the impact sound insulation. The perimeter strip must be secured against changes in its position when the screed is applied.

The insulation layers must be arranged in blocks and abut each other tightly. When laying several layers, a cross joint must be provided.

Only two layers may consist of impact sound insulation material. The insulation layer must have full contact with the bearing substrate. No cavities are permitted.

The insulation layer must be suitable for the prescribed live load (cf. insulation below underfloor heating systems, p. 134 onwards). Before the screed is laid the insulation layer must be covered with a PE foil which is at least 0.15 mm thick or with a product with an equivalent function (e.g. tape webbing, system roll or PS grid foil). Loosely laid lengths must overlap at the edges by at least 80 mm (the tacker foil is fixed overlapping by at least 50 mm!). Where floating screed is used, the coating must be moisture-tight until the screed has hardened (e.g. protect system roll overlap and foil bottom of the perimeter strip by attaching adhesive tape).

TIP

Only tack the perimeter strip to the wall in the lower area of the future insulation layer. If the tacker needles are in the screed layer, they will form impact sound bridges to the wall. If they are positioned above the screed, the finished wall plastering will be damaged when the overlapping perimeter strip is cut and detached.

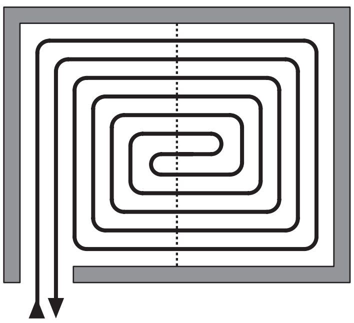
NOTE

Installation without sound bridges is required in order to improve impact sound insulation! Therefore impact sound insulation has to be laid carefully. Not all insulation materials have impact sound insulating properties (see insulation below underfloor heating systems). All insulation materials have to be protected against damage (e.g. cracking, tearing) until the screed is finished.

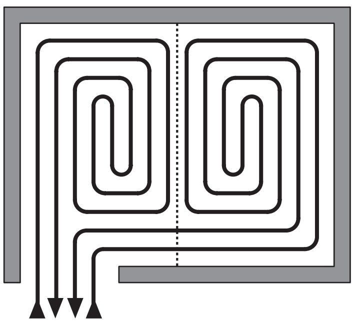
Expansion joints

To avoid damage caused by contraction during drying out, thermal expansion of the heating screed and propagation of impact sound, it is necessary to locate expansion joints at the edge of the screed (perimeter strip) and maybe also in the screed and the floor covering.

In the case of heating screeds, expansion joints have to be installed generally for highly dispersing surfaces, in doorways and within a heating area with differently heated heating circuits. Heating circuits must not be laid through expansion joints. In doorways the expansion joints should be positioned below the leaf. Connection pipes which are routed through an expansion joint must be protected by pipe sleeves (e.g. corrugated pipe) around 300 mm long.



Wrong layout of the heating circuit

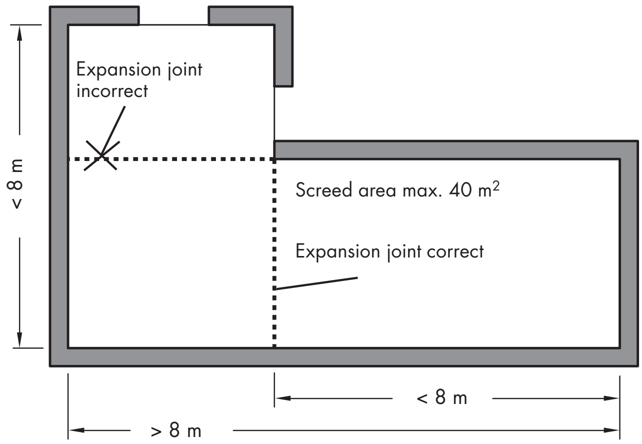


Correct layout of the heating circuit

Installation and laying

TIP

In accordance with DIN EN 1264-4 we recommend that a screed area of 40 m² and a side length of 8 m should not be exceeded. If the rooms are larger, expansion joints have to be positioned within the screed slab as well, so that there are smaller areas with the above mentioned maximum dimensions (side ratio 1:2). Screed joints must also be located above building joints. The information provided by the screed manufacturer manufacturer must be heeded.



Heating screed

Depending on the layout of the pipes the heating screed can be subdivided in several construction types:

- Construction type A with pipes within the screed (tacker system, knobbed system)
- Construction type B with pipes below the screed (dry-laid underfloor heating)

In the area of heating pipes for hot water underfloor heating systems the medium temperature in cement and calcium sulphate screeds must not permanently exceed 55°C. The thickness of the screed depends on the solidity class (resistance to bending and stretching) and the live load acc. to DIN 18560-2. For the determination of the nominal thickness of screeds according to construction type A the external pipe diameter of the surface heating pipe also has to be included in the calculation. The pipe covering (actual nominal thickness of screed) must be 45 mm for screeds of the lowest solidity class F4, and 40 mm for floating screeds.

For other solidity classes differing thicknesses, at least 30 mm, are possible. With these screeds a test for bearing power, and also for bending in the case of stone and ceramic coverings, has to be performed.

If heating screeds of ready-made components are laid, the manufacturer's instructions have to be observed.

TIP

For treating cement screeds (30% higher compressibility and bending resistance, decreased cracking, and improved workability of screed mortar with less mixing water being required) we recommend the use of ***PRINETO*** screed agent ZE 30 (art.-no. 878 386 040).

Insulation below underfloor heating systems

General requirements

In order to exploit the full heating power of an underfloor heating system, downward heat losses must be kept to a minimum. Depending on the temperature of the room or building component below the underfloor heating system, this can be achieved by different insulation materials or insulation thicknesses. DIN EN 1264 (Underfloor heating; systems and components), DIN 4108 (Heat insulation and energy saving in buildings) and the Energy saving Ordinance (EnEV) are based on this requirement.

Acc. to DIN 4109 (Sound protection in structural engineering) these insulation materials must also reduce propagation of the impact sound of the heated floor structure to the room below, depending on the purposes for which the building is used.

The ***PRINETO*** insulation materials comply with the following standards and regulations:

- DIN EN 13163 (Heat insulation materials for buildings, manufactured products of expanded polystyrene EPS),
- DIN EN 13165 (Heat insulation materials for buildings, manufactured products of polyurethane rigid foam PUR),
- DIN V 4108-10 (Heat insulation and energy saving in buildings, application-related requirements for heat insulation materials – manufactured heat insulation materials).

If other insulation materials are used their compliance with the regulations of the building authorities has to be proved accordingly (e.g. by a General Approval by the Building Authorities ABZ).

Buildings to be constructed

The minimum thermotechnical requirements for insulation materials below floor heating systems for buildings to be erected are described in DIN EN 1264-4.

There, the respective thermal resistances R_λ of the insulation layers below the underfloor heating system are given in relation to the room below and its temperature.

- Adjacent to heated room:
  ≥ 0.75 m²K/W
  (e.g. EPS 30 mm with 0.040 W/mK).

- Adjacent to unheated room or ground:
  ≥ 1.25 m²K/W
  (e.g. EPS 50 mm with 0.040 W/mK),
  at a groundwater level of ≤ 5 m this value should be increased.

- Adjacent to outside air temperature down to -15° C:
  ≥ 2.00 m²K/W
  (e.g. EPS 20 mm with 0.040 W/mK and PUR 40 mm with 0.025 W/mK).

If the required thermal resistance R_λ is multiplied by the value of the thermal conductivity λ of an insulation material, the required thickness of this material d (in metres) is obtained:

$$d\,[m] = R_\lambda\,[m^2K/W] \cdot \lambda\,[W/mK]$$
$$0.03\ m = 0.75\ m^2K/W \cdot 0.040\ W/mK$$

If the thickness of the insulation material d (in metres) is divided by the value of the thermal conductivity λ of this insulation, the result is its thermal resistance R_λ:

$$R_\lambda\,[m^2K/W] = d\,[m] : \lambda\,[W/mK]$$
$$1.25\ m^2K/W = 0.05\ m : 0.040\ W/mK$$

These values represent the minimum requirements. In order to improve the energy balance of the building (DIN V 4108-6 and DIN V 4701-10) higher thermal resistances may be required.

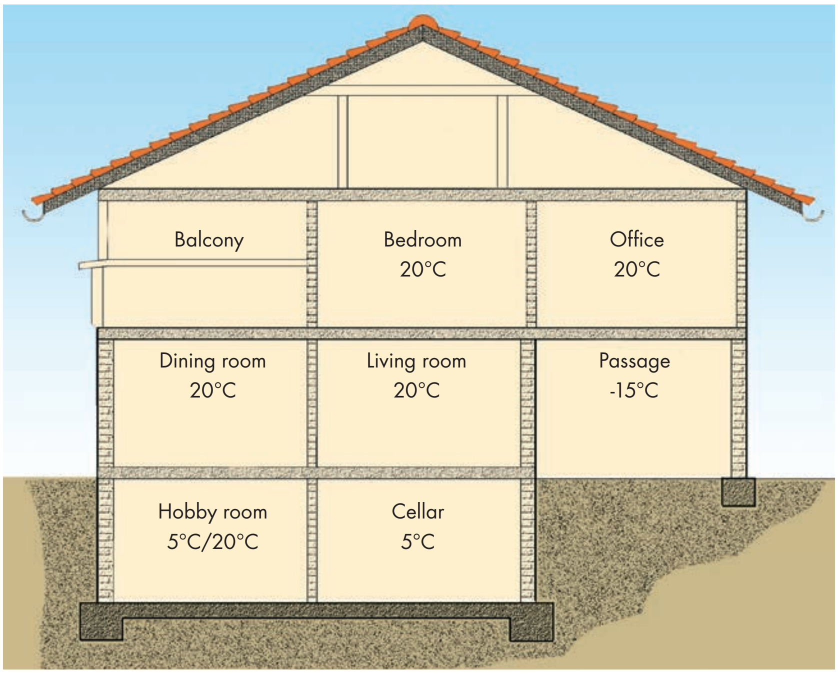
NOTE

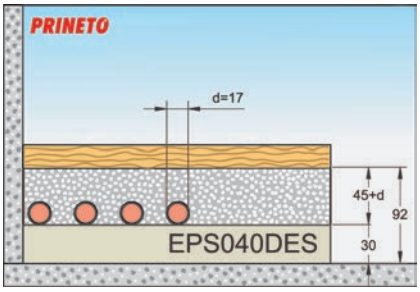
A higher thermal resistance between the heating surface and the ceiling surface also increases the possibility of lowering temperatures in the room below (e.g. bedroom). For this reason, it is recommended particularly in multiple-family buildings to choose a higher thermal resistance than the one stated in DIN 1264.

Insulation below underfloor heating systems

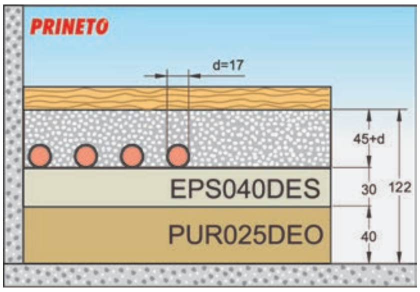
Examples of insulation layout acc. to DIN EN 1264

PRINETO tacker system or fixing rail system

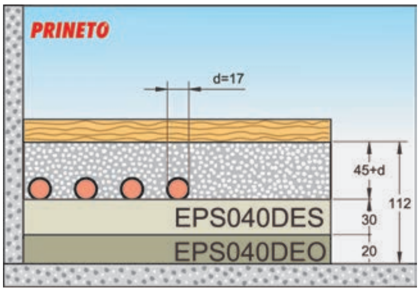




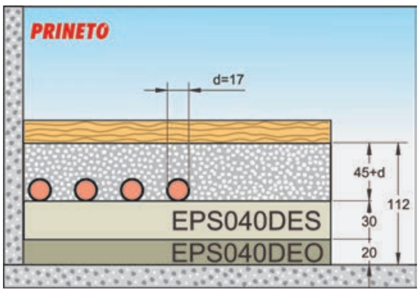
Bedroom:
Adjacent to heated room



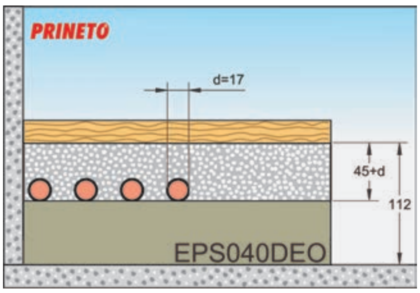
Office:
Adjacent to outside temperature down to -15°C



Living room:
Adjacent to unheated room



Dining room:
Adjacent to room heated at intervals



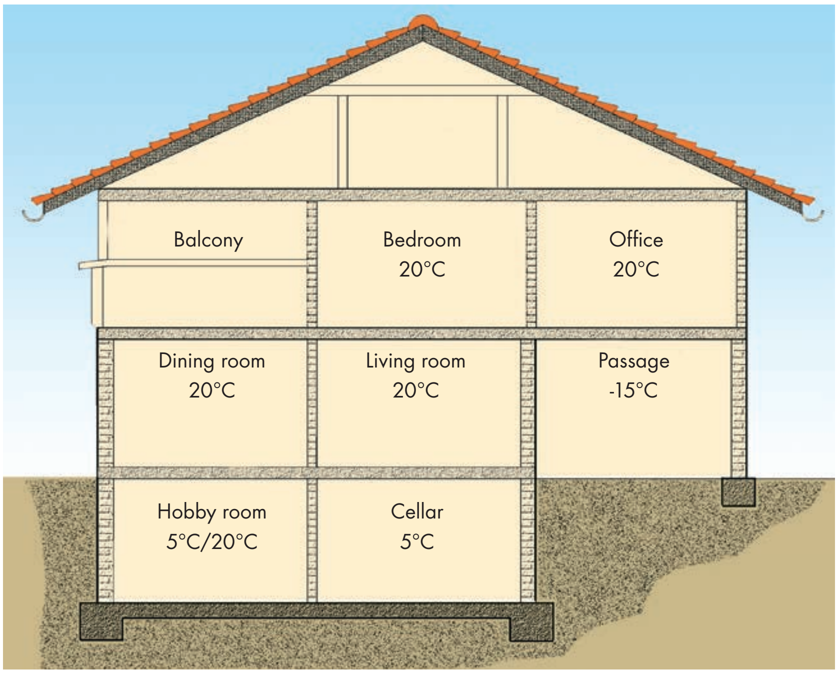
Hobby room:
Adjacent to ground

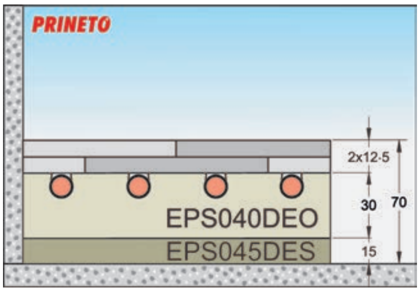
EPS: Expanded polystyrene
PUR: Polyurethane rigid foam
DEO: Internal insulation of ceiling or floor slab (upper side) below screed without sound insulation requirements
DES: Internal insulation of ceiling or floor slab (upper side) below screed with sound insulation requirements 040: thermal conductivity 0.040 W/mK

Insulation below underfloor heating systems

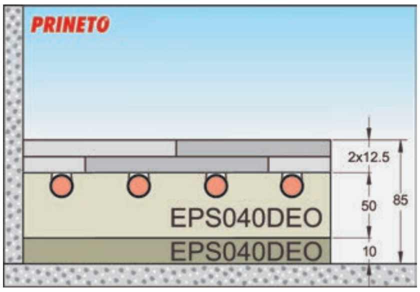
Examples of insulation layout acc. to DIN EN 1264

PRINETO Dry-laid underfloor heating system 30 mm

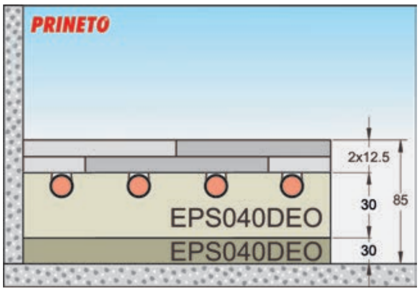




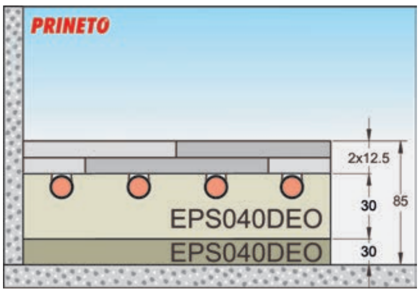
Bedroom:
Adjacent to heated room



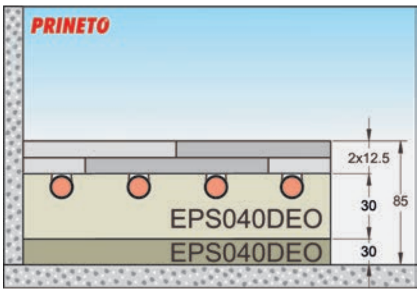
Office:
Adjacent to outside temperature down to -15°C



Living room:
Adjacent to unheated room



Dining room:
Adjacent to room heated at intervals



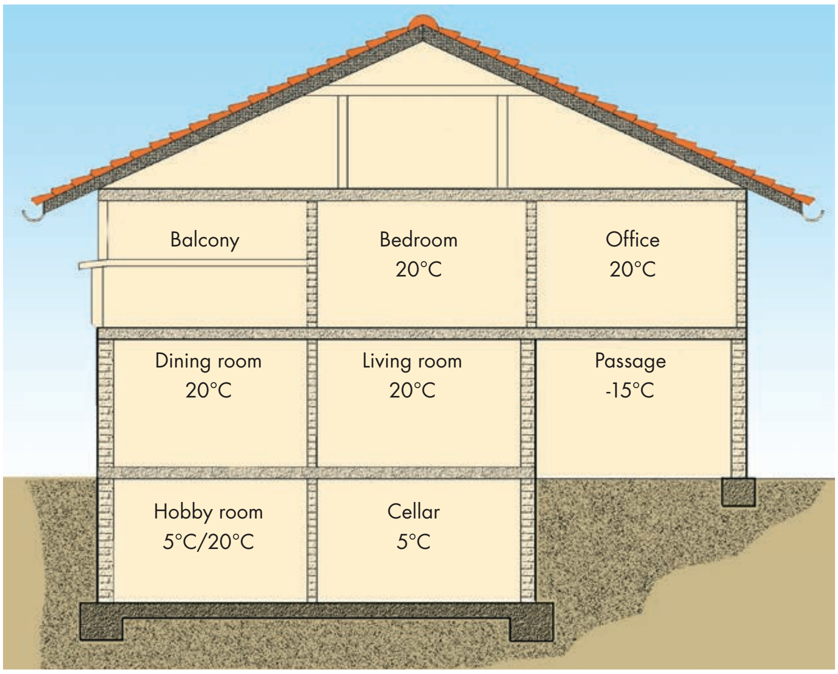
Hobby room:
Adjacent to ground

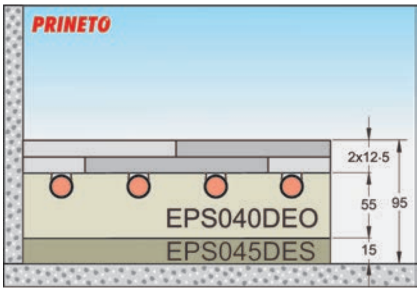
EPS: Expanded polystyrene
PUR: Polyurethane rigid foam
DEO: Internal insulation of ceiling or floor slab (upper side) below screed without sound insulation requirements
DES: Internal insulation of ceiling or floor slab (upper side) below screed with sound insulation requirements 040: thermal conductivity 0.040 W/mK

Insulation below underfloor heating systems

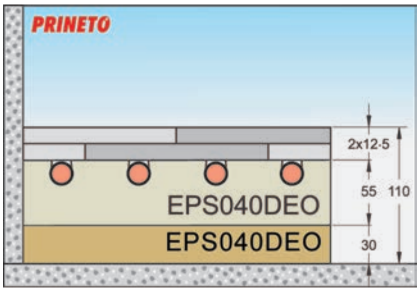
Examples of insulation layout acc. to DIN EN 1264

PRINETO Dry-laid underfloor heating system 55 mm

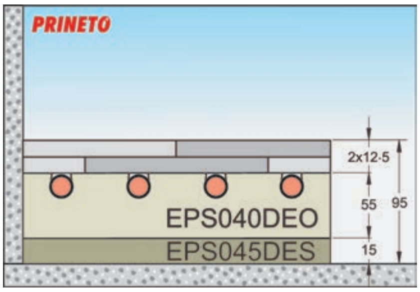




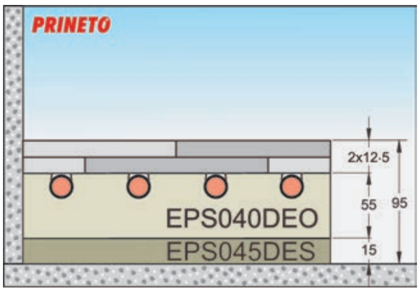
Bedroom:
Adjacent to heated room



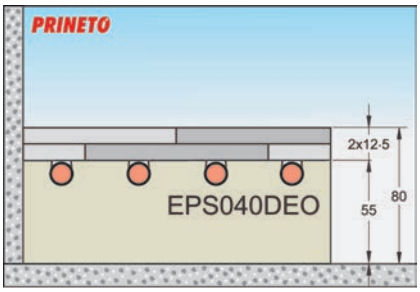
Office:
Adjacent to outside temperature down to -15°C



Living room:
Adjacent to unheated room



Dining room:
Adjacent to room heated at intervals



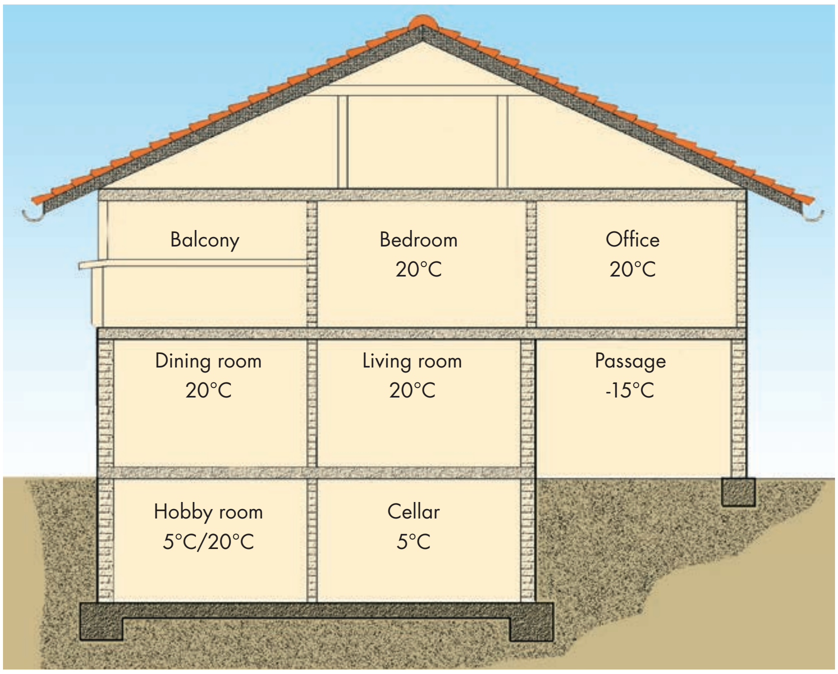
Hobby room:
Adjacent to ground

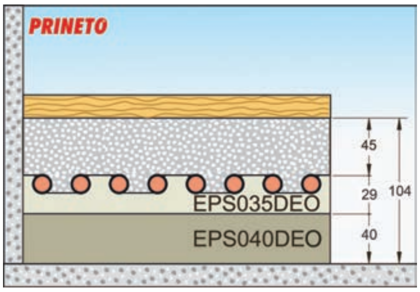
EPS: Expanded polystyrene
PUR: Polyurethane rigid foam
DEO: Internal insulation of ceiling or floor slab (upper side) below screed without sound insulation requirements
DES: Internal insulation of ceiling or floor slab (upper side) below screed with sound insulation requirements 040: thermal conductivity 0.040 W/mK

Insulation below underfloor heating systems

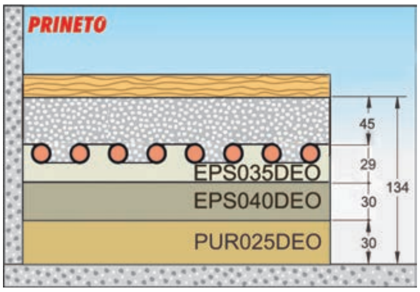
Examples of insulation layout acc. to DIN EN 1264

PRINETO Knobbed system 14 with thermal insulating board 10 mm

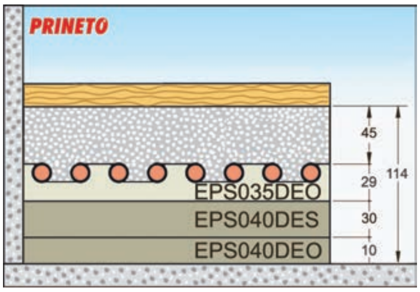




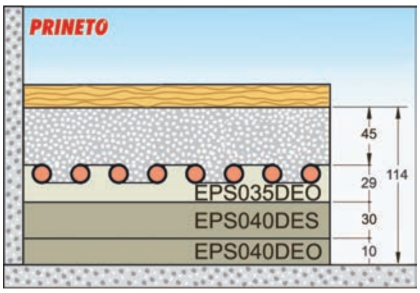
Bedroom:
Adjacent to heated room



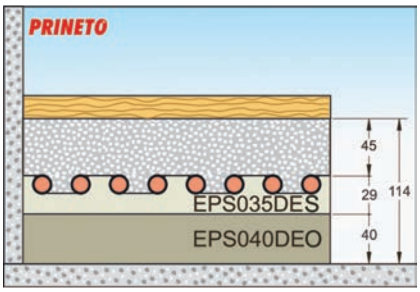
Office:
Adjacent to outside temperature down to -15°C



Living room:
Adjacent to unheated room



Dining room:
Adjacent to room heated at intervals



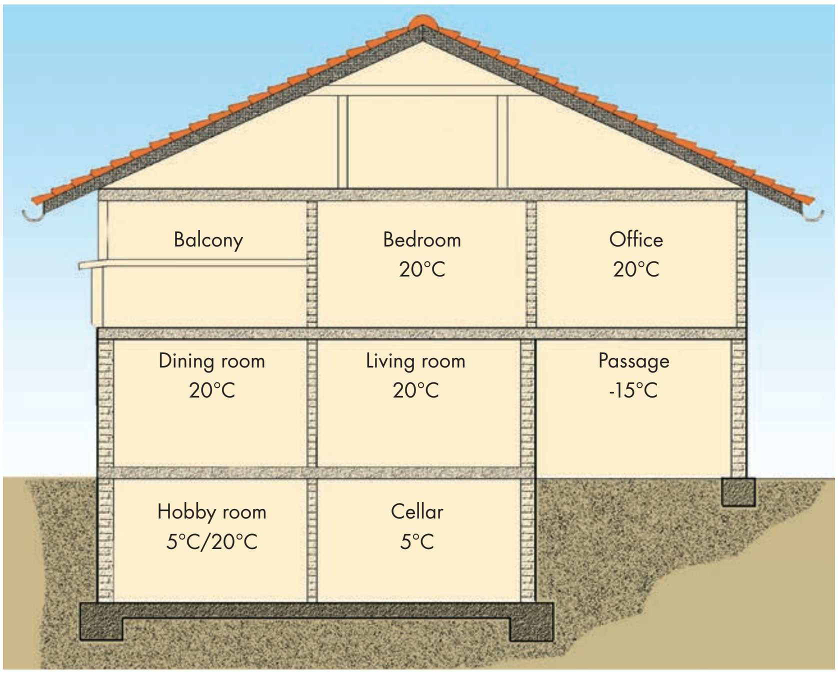
Hobby room:
Adjacent to ground

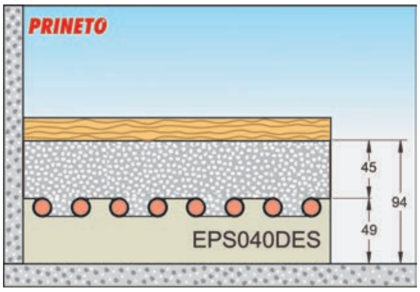
EPS: Expanded polystyrene
PUR: Polyurethane rigid foam
DEO: Internal insulation of ceiling or floor slab (upper side) below screed without sound insulation requirements
DES: Internal insulation of ceiling or floor slab (upper side) below screed with sound insulation requirements 040: thermal conductivity 0.040 W/mK

Insulation below underfloor heating systems

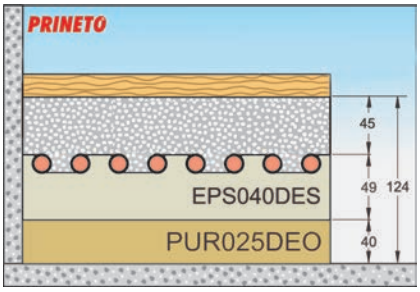
Examples of insulation layout acc. to DIN EN 1264

PRINETO Knobbed system 14 with thermal and impact sound insulation board 30 mm

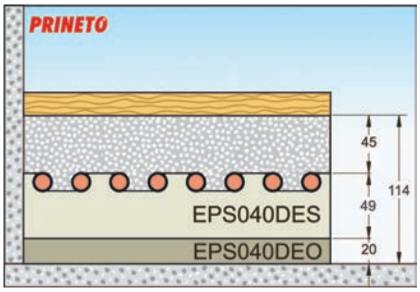




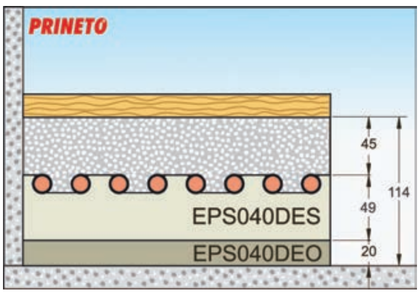
Bedroom:
Adjacent to heated room



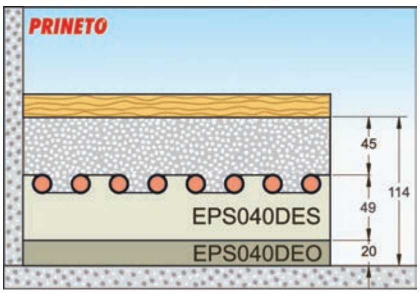
Office:
Adjacent to outside temperature down to -15°C



Living room:
Adjacent to unheated room



Dining room:
Adjacent to room heated at intervals



Hobby room:
Adjacent to ground

EPS: Expanded polystyrene
PUR: Polyurethane rigid foam
DEO: Internal insulation of ceiling or floor slab (upper side) below screed without sound insulation requirements
DES: Internal insulation of ceiling or floor slab (upper side) below screed with sound insulation requirements 040: thermal conductivity 0.040 W/mK

Insulation below underfloor heating systems

2

Underfloor heating

Existing buildings or small buildings (< 50 m² floor space)

The minimum thermotechnical requirements for insulation materials below underfloor heating systems acc. to DIN EN 1264-4 also basically apply to these buildings. Additionally, the Energy-saving Ordinance of 18.03.2009, in table 3, annex 1, line 5b, prescribes a higher thermal resistance for insulation adjacent to unheated rooms and the ground for these buildings: Maximum heat transmission coefficient Umax. adjacent to unheated room or the ground 0.50 m^2K/W (corresponds to a thermal resistance of 2.00 m^2K/W).

The layout of the insulation materials and the floor structure heights to provide protection from an unheated room or the ground then correspond to the insulation against outside temperature down to -15° C.

Application restrictions:
If ceilings in existing buildings are changed, this value can only be kept if the change affects more than 10% of the total surface of the building component (EnEV 2009 – section 9, subsection 3).

If floor structures on the heated side are built or renovated in existing buildings, the requirements are regarded as being complied with if a floor structure is executed with the thickest insulation layer possible – without adaptation of door heights – (at a thermal conductivity design value of 0.040 W/mK) (EnEV 2009 – annex 3, item 5).

Impact sound insulation

The values for the maximum permissible impact sound insulation measures (TSM) for protection against sound transmission from a third party living or working area are mentioned in DIN 4109 and are for the most part 10 dB.

The equivalent impact sound insulation measure (TSMeq, R) of a rough ceiling is determined in relation to its material, mass and construction. The difference between the equivalent impact sound insulation measure of this ceiling and the max. permissible impact sound insulation measure is the required impact sound improvement measure (VMR). 2 dB (so-called lead measure) is added to this.

$TSM_{eq, R}$	= –8 dB
erf. TSM	= 10 dB
$VM_{R, min}$ [dB]	= erf. TSM [dB] – $TSM_{eq. R}$ [dB] + 2 dB
	= 10 dB – (–8)dB + 2dB + 2 dB
	= 20 dB

For compliance with the max. permissible impact sound insulation measure this rough concrete ceiling has to be covered with a ceiling covering with a minimum impact sound improvement measure of 20 dB (e.g. system roll with 28 dB).

Live load and compressibility

In order to prevent the finished floor from sinking (e.g. torn-off expansion joints) the insulation layer must be suitable for the predetermined live load. Compressibility of the insulation is determined by the difference between supply thickness (nominal thickness) and the thickness under load. It can be seen from the identifying marking of the insulation material (see Identification of insulation material, p. 141). If there are several layers, the compressibility values of the individual layers have to be added up.

In the case of cement and calcium sulphate screeds, the compressibility of the overall insulation layer according to DIN 18560-2 must be:

- max. 5 mm with a surface load of ≤ 3.0 kN/m^2
- max. 3 mm with surface loads of 4.0 to 5.0 kN/m^2
- and max. 3 mm with cast asphalt screeds.

If impact sound and heat insulation materials are combined in one insulation layer, the material with the lower compressibility (normally pure heat insulation boards) should be placed on top. This does not apply to impact sound insulation heating system boards, nor to cases of pipe equalisation with heat insulation boards.

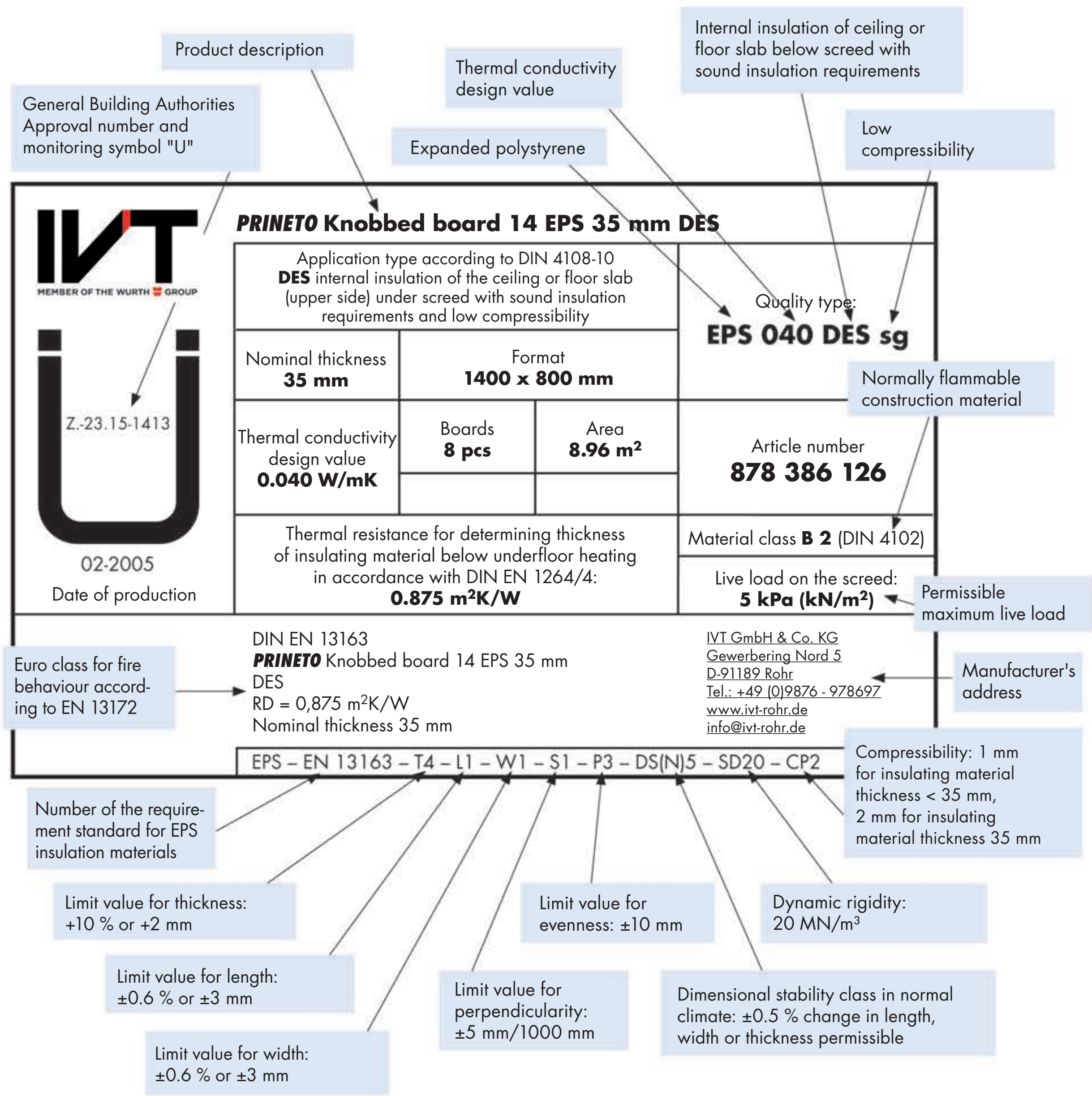
NOTE

In combination with certain construction materials (e.g. bitumen welding lengths or synthetic resin screeds), the insulation materials can be damaged by binder components or solvents. Appropriate protection measures have to be taken to prevent this.

Insulation below underfloor heating systems

Identification of insulation materials

Within the scope of free transfer of goods in Europe the regulations applicable to insulation materials were also standardised. All insulation materials were provided with a description code, which is on the packaging label and which contains all the relevant product data. The most important data are explained by means of the following label:



Insulation below underfloor heating systems

NOTE

The nominal value of the thermal resistance is the value actually determined by the manufacturer (e.g. 0.038 W/mK).

With CE marking the design value of the thermal resistance is calculated from the nominal value multiplied by 1.20 (e.g. 0.038 W/mK • 1.2 = 0.045 W/mK).

If there is an ABZ (Ü) marking the design value of the thermal resistance can be calculated from the nominal value multiplied by 1.05 (e.g. 0.038 W/mK • 1.05 = 0.040 W/mK).

Source: Forschungsinstitut für Wärmeschutz e.V., Munich (FIW Munich)

The individual fields of application and the technical minimum requirements for the insulation materials are described in DIN 4108 10 (06/2008). There too, code letters are used for distinction and marking. Some examples are given below:

Field of application ceiling or roof:

- DEO = internal insulation of ceiling or floor slab (upper side) below screed, without impact sound insulation requirements (pure heat insulation),
- DES = internal insulation of ceiling or floor slab (upper side) below screed, with impact sound insulation requirements (heat and impact sound insulation).

Compressive strength:

- dg = low compressive strength (living and office area below screed)
- dm = medium compressive strength (unused roof with sealing)
- dh = high compressive strength (used roof surfaces or terraces, with PUR insulation material CS (10/Y) 100 = pressure resistance ≥ 100 kPa),
- ds = very high compressive strength (industrial floors or parking decks, with PUR insulation material CS (10/Y) 150 = pressure resistance ≥ 150 kPa)

Sound-related properties:

- sg = impact sound insulation, increased compressibility (below floating screed)
  With EPS insulation materials CP2:

Requirement	≤ 2 mm
Limit value	≤ 1 mm with insulation thickness < 35 mm
	≤ 2 mm with insulation thickness ≥ 35 mm
Screed live load	≤ 5 kPa [kN/m²]

- sm = impact sound insulation, increased compressibility (below floating screed)
  With EPS insulation materials CP3:

Requirement	≤ 3 mm limit value
	≤ 2 mm with insulation thickness < 35 mm
	≤ 3 mm with insulation thickness ≥ 35 mm
Screed live load	≤ 4 kPa [kN/m²]

- sh = impact sound insulation, increased compressibility (below floating screed)
  With EPS insulation materials CP5:

Requirement	≤ 5 mm
Limit value	≤ 2 mm with insulation thickness < 35 mm
	≤ 3 mm with insulation thickness ≥ 35 mm
Screed live load	≤ 2 kPa [kN/m²]

Insulation of passing supply lines

The connection lines between the manifold and the heating areas are passing supply lines which are not part of the "manifold equipment..." in the sense of EnEV 2014 (§ 14) but rather belong to heat transfer. This means the passing supply lines are not subject to compulsory insulation in accordance with EnEV.**

** Source: BVF position paper

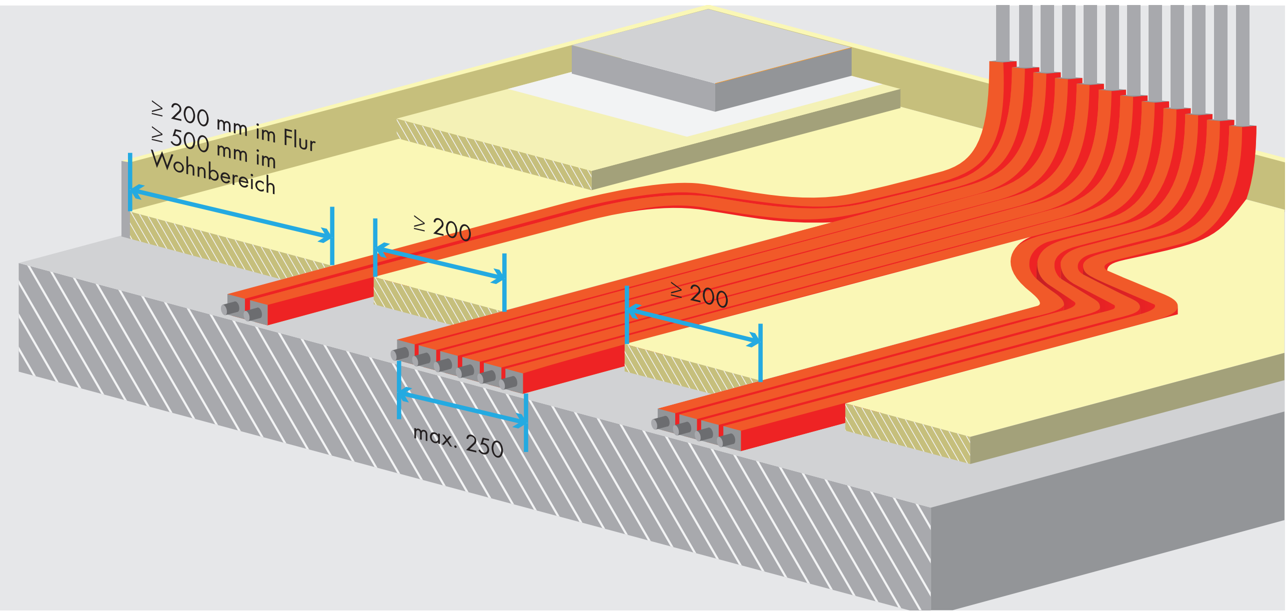
In accordance with ENEV § 14 section two, "heating systems with water as the heat carrier in buildings must be equipped with automatic equipment for the room-by-room regulation of room temperature; an exception to this compulsory rule are underfloor heating systems in rooms with less than six square metres of floor space.

According to this, the room temperature must be controllable. However, even in rooms smaller than 6 m^2 an impermissible increase in temperature caused by passing supply lines must be avoided. The following rule of thumb can be applied for controllability: the total supply line length with supply and return is less than 1/3 of the total pipe lengths in the respective room. This may need to be checked by calculation in order to exclude an undesirable increase in temperature. Planning of the manifold location is crucial here.

If constructional modifications cannot assure that there is no impermissible heating of the room, heat emission to the passing supply lines must be restricted.

PRINETO surface heating pipes, pre-insulated with square material, can be used for this purpose. This also promotes living comfort since the floor is not heated irregularly but by the respective heating circuit. Thanks to the square shape and design height of 34 mm, the passing supply lines can be laid without the insulation having to be cut up too much.

Using ***PRINETO*** pipe insulating material tape (878 681 900) to glue the attachments of the pre-insulated pipes prevents impact sound being transmitted to the building.



Width of pipeline alignments and installations face

Installation instructions

Heating circuit manifold cabinets

In the heating circuit manifold cabinets, surface-mounted or flush-mounted, the heating manifolds with the required control and measurement technology can be fixed and connected in a tidy and easily accessible way. All the visible surfaces of the cabinets are white powder-coated (RAL 9010 gloss). For operation of the control components a 230 V alternating voltage connection is required in the manifold cabinet.

Surface-mounted cabinet

For mounting, the cabinet is screwed onto the plastered wall through the two bore holes (Ø 8 mm) in the back, and the legs are screwed on the rough floor (through 4 Ø 8 mm bores holes). The legs are fastened within the interior of the cabinet with butterfly screws and can be pulled out to a length of 170 mm. The maximum realisable distance between the upper edge of the rough floor and the lower edge of the screed baffle plate (corresponds to upper edge of surface heating pipe) is therefore 170 mm. Thus a maximum of 140 mm insulation can be laid, since the pipe thickness must be taken into consideration in the insulation. If higher floor structures are required the difference has to be equalised on site. The two holders of the heating circuit manifold and the top-hat rail of the terminal strip are fastened to the sliding rails on the back of the cabinet. This is done using 5 screws with cap nuts on each of the rails. We recommend mounting the terminal strip above the return bar to make clear wiring possible. For the connection of the surface heating pipes to the manifold the screed baffle plate can be taken off by loosening the two sheet metal screws.

The supply and the return pipe to the manifold connection can only be laid into the cabinet from below. If angle transitions are used for connection to the ball valve, the pipes have to be laid in a staggered way behind each other. Laying pipes alongside each other is possible using the special angle of the vertical heat meter WMZ (special part, to be ordered separately). Then the pipes can also be connected through the rear hole, as is the case if they emerge from the wall.

After completion of all the installation work and before the screed is applied, the screed baffle plate must be refitted and the door of the cabinet must be attached. To avoid damaging or soiling during the construction period the cabinet surface should be sealed with adhesive foil.

Dimensions of surface-mounted cabinets

Size	Article number	Width (mm)	Height (mm)	Depth (mm)	Weight (kg)
1	878 386 030	442	623-795	126	9.0
2	878 386 031	496	623-795	126	9.5
3	878 386 032	581	623-795	126	10.5
4	878 386 033	731	623-795	126	13.0
5	878 386 034	881	623-795	126	14.5
6	878 386 035	1031	623-795	126	17.0

Dimensions of flush-mounted cabinets

Size	Article number	Width (mm) outer	Width (mm) inner	Width with frame	Height (mm)	Depth (mm)	Weight (kg)
1	878 386 022	435	400	455	655-820	110	9.5
2	878 386 023	485	455	510	665-820	110	10.5
3	878 386 024	570	540	595	665-820	110	11.5
4	878 386 025	720	690	745	665-820	110	14.0
5	878 386 026	875	845	900	665-820	110	16.0
6	878 386 027	1020	990	1045	665-820	110	18.5
7	878 386 028	1170	1140	1195	665-820	110	21.0

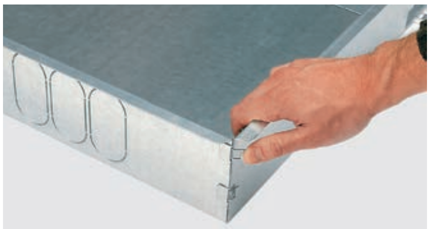
Installation instructions

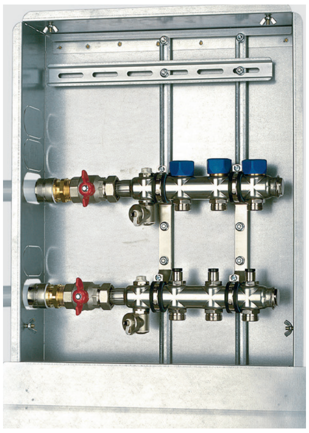
Flush-mounted cabinet

The fitting body is made of galvanised steel sheet. To save packing materials and storage room, the cabinet is supplied "flat". The cabinet can be put together in no time, with no tools required.

- Set the cabinet down so that the interior is on top (4 butterfly screws for fixing the lid are visible).
- Bend the two side parts upwards at right angles along the edge of the longitudinal punched area.
- Bend the upper part of the cabinet upwards at a right angle along the edge of the punched area, and slide the 4 small holder plates of the side parts into the 4 holder plates of the upper part of the cabinet.
- Bend the holder plates onto the side parts.
- Bend the two sheet metal strips of the screed baffle plate at right angles.
- Slide pipe baffle strip and screed baffle plate into the guides of the side parts.

For the cabinet to be mounted, the legs are screwed on the rough floor through the 4 bore holes (Ø 8 mm).





CAUTION

The pipe baffle strip or/and the screed baffle plate must be mounted before the flush-mounted cabinet is fastened onto the rough floor.

The size of the required niche in the wall depends on the size of the cabinet used (see table). The legs are fastened to the outside of the cabinet with butterfly screws and can be pulled out to a length of 165 mm. Up to 160 mm heat insulation can be installed when the flush-mounted cabinet is used. On account of the higher lower edge rebate, only 5 mm must be taken into consideration for the pipe thickness. If higher floor structures are required the difference has to be equalised on site.

The two holders of the heating circuit manifold and the top-hat rail of the terminal strip are fastened to the sliding rails on the back of the cabinet. This is done using the 5 screws with cap nuts on each of the rails. We recommend mounting the terminal strip above the return bar to make clear wiring possible. The connection pipes to the manifolds can be laid through the side wall either coming from the floor below or from the left or right. For this purpose the already the pre-punched oval sheet metal plates have to be broken out. When plastering the wall the painted screed baffle plate should not be mounted, and the cardboard splash guard supplied as part of the delivery should be used to protect the inside of the cabinet.

After connection of the surface heating pipes to the manifold and before applying the screed, the screed baffle plate is mounted flush against the wall. When the screed is laid the cardboard splash guard should again be used to protect the inside of the cabinet.

For final mounting the separately packed door frame with door is fastened flush against the wall through the 4 holder plates on the butterfly screws within the cabinet. Beforehand, the individual holder plates are inserted into the respective holes of the door frame until they can be felt to lock in place. They enable equalisation of a varying thickness of the plaster to a maximum of 40 mm.

Heating circuit manifolds

Heating circuit manifold with flow meter
The heating circuit manifold is used for the distribution, shutting off and control of the heating water flows of individual low-temperature heating circuits of surface heating systems. Integrated flow meters make hydraulic equalisation easier and enable visual control of the mass flow (for procedures and pressure loss diagrams see "Hydraulic equalisation" in the ***PRINETO*** catalogue, p. 195).

- Made of high-quality stainless steel 1.4301 (stainless steel pipe 35 x 1.5 mm)
- High material strength (bursting pressure 349 bar, MPA Stuttgart) and low weight
- Heating circuit connections G ¾ and eurocone external thread acc. to DIN V 3838 with a spacing distance of 50 mm in each case
- Flow bar with integrated flow meters 0.5 - 5 litres/minute for controlling the mass flow rates of the individual heating circuits (kvs = 1.12 m^3/h)
- Return bar with Oventrop thermostat valve inserts (thread 30 x 1.5; closing measure 11.8 mm, kvs = 2.56 m^3/h) and manual control caps for future fitting of actuators
- Turnable filling and draining valve 3/4" eurocone   3/4" male
- All manifolds are 100% tested for leak-tightness and function at a pressure of 6 bar
- Primary side manifold connection via flat-sealing union nut G 1
- Low pressure losses, very good kv- and kvs-values
- Galvanised wall holder with sound insulation insert (complete with screws and dowels for direct wall mounting)
- Max. operating temperature 70°C, max. operating pressure: 4 bar, max. test pressure: 6 bar

The heating circuit manifold consists of high-quality and carefully matched components. It is fastened in the surface-mounted or flush-mounted cabinets. The return bar should be mounted on top of the holder in order to provide for short cable distances between the actuators that have been fitted and the terminal strip on the one hand. On the other hand, if a heat meter is mounted in the return, this can also be housed in the manifold cabinet, where it is accessible. The surface heating pipes to the return are laid upwards behind the flow bar.

Depending on the number of heating circuits to be connected (overall mass flow) ball valves Rp ¾ (art.-no. 878 386 132) or Rp 1 (art.-no. 878 386 105) can be connected to the G1 manifold union nut using flat seals. The ball valves have to be ordered separately.

Heating circuit manifold with Regolux Memory

Installation instructions

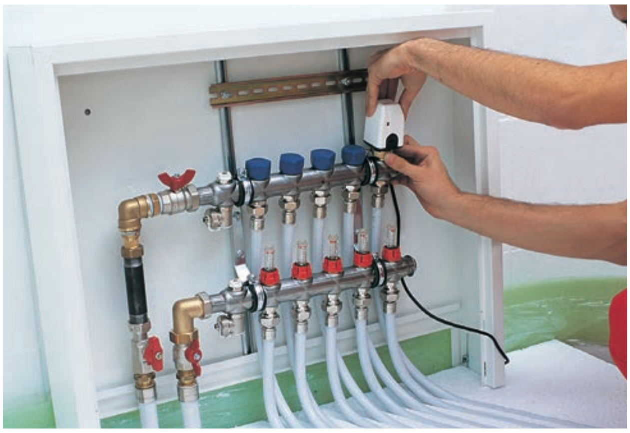
Heating circuit manifold with control valves
The heating circuit manifold is used for the distribution, shutting off and control of the heating water flows of individual low-temperature heating circuits of surface heating systems (for procedures and pressure loss diagrams see "Hydraulic equalisation" in the ***PRINETO*** catalogue, p. 195).

- Made of high-quality stainless steel 1.4301 (stainless steel pipe 35 x 1.5 mm)
- High material strength (bursting pressure 349 bar, MPA Stuttgart) and low weight
- Heating circuit connections G ¾ and eurocone external thread acc. to DIN V 3838 with a spacing distance of 50 mm in each case
- Flow bar with integrated shut-off and control valves for controlling the mass flow rates of the individual heating circuits (kvs = 2.88 m^3/h)
- Return bar with Oventrop thermostat valve inserts (thread 30 x 1.5; closing measure 11.8 mm, kvs = 2.56 m^3/h) and manual control caps for future fitting of actuators
- Turnable filling and draining valve 3/4" eurocone 3/4" male
- All manifolds are 100% tested for leak-tightness and function
- Primary side manifold connection via G1 flat-sealing union nut
- Low pressure losses, very good kv- and kvs-values
- Galvanised wall holder with sound insulation insert (complete with screws and dowels for direct wall mounting)
- Max. operating temperature 80°C, max. operating pressure 10 bar

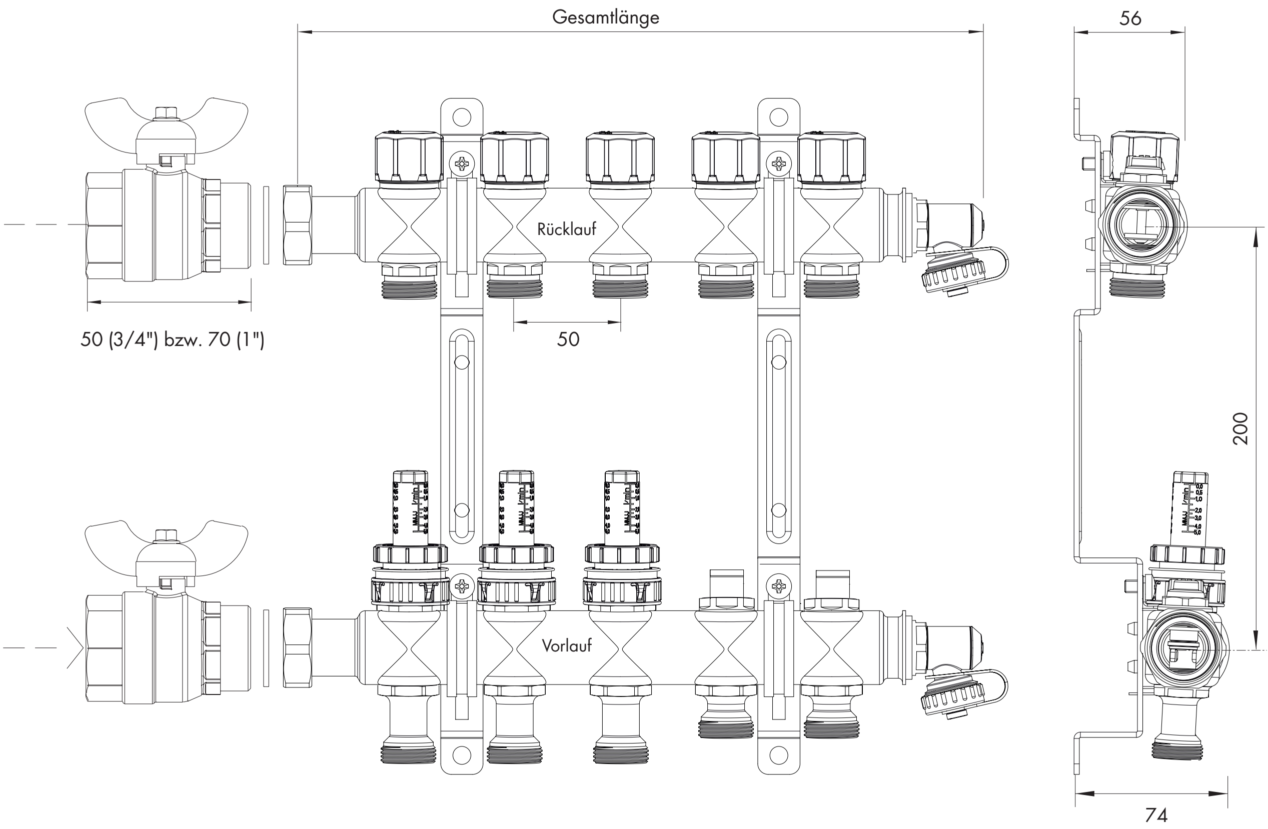
The heating circuit manifold consists of high-quality and carefully matched components. It is fastened in the surface-mounted or flush-mounted cabinets. The return bar should be mounted on top of the holder in order to provide for short cable distances between the actuators that have been fitted and the terminal strip on the one hand. On the other hand, if a heat meter is mounted in the return, this can also be housed in the manifold cabinet, where it is accessible. The surface heating pipes to the return are laid upwards behind the flow bar. Depending on the number of the heating circuits to be connected (overall mass flow) the ball valves Rp 3⁄4 (art.-no. 878 386 132) or Rp 1 (art.-no. 878 386 105) can be connected to the G1 manifold union nut with gasket seal. The ball valves have to be ordered separately.

TIP

For flushing and venting of the individual heating circuits the respective black adjusting screw and the valve spindle have to be screwed upwards as far as possible and thus be fully opened.



Setting of ***PRINETO*** actuators



Dimensions of heating circuit manifolds

Number of heating circuits	Overall length
3	240 mm
4	290 mm
5	340 mm
6	390 mm
7	440 mm
8	490 mm
9	540 mm
10	590 mm
11	640 mm
12	690 mm

Manifold cabinets for heating circuit manifolds

Assembly	Flush-mounted cabinet	Surface-mounted cabinet
Heating circuit manifold 3-fold	Size 1 (2)*	Size 1 (2)*
Heating circuit manifold 4-fold	Size 2 (3)*	Size 2 (3)*
Heating circuit manifold 5-fold	Size 3 (4)*	Size 3 (4)*
Heating circuit manifold 6-fold	Size 4	Size 3
Heating circuit manifold 7-fold	Size 4	Size 4
Heating circuit manifold 8-fold	Size 4 (5)*	Size 4
Heating circuit manifold 9-fold	Size 5	Size 4 (5)*
Heating circuit manifold 10-fold	Size 5	Size 5
Heating circuit manifold 11-fold	Size 5	Size 5
Heating circuit manifold 12-fold	Size 6	Size 6

* Use size of cabinet in brackets for ***PRINETO*** heating circuit with flowmeter (878 386 001 - 878 386 010)

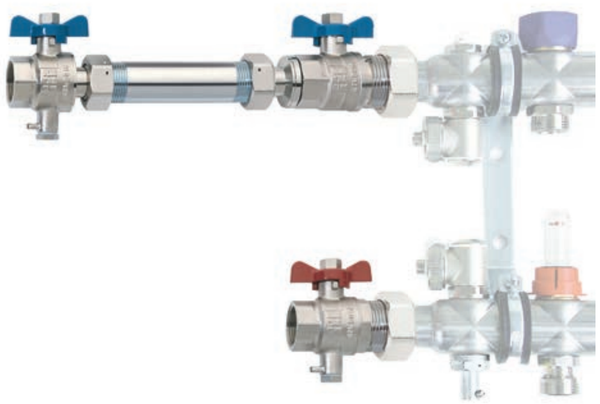
Installation instructions

Heat meter connection assemblies

Heat meters (WMZ) are required for recording heating costs in buildings with several tenants. The heat meter connection assembly prepares the installation of a G ¾ heat meter of an installation size of 110 m up to 1.5 m³/h at the return of the heating circuit manifold of the underfloor heating system. The manifold cabinets necessary for the horizontal heat meter are bigger than the ones for the vertical heat meter.

In place of the heat meter, a double nipple is provided as an adapter. The assembly unit is screwed directly into the flat-sealing union nuts of the heating circuit manifold bar. The temperature sensors can be fitted directly into the medium in the middle of the flow on the connecting pieces of the ball valves in the flow and return (in accordance with the MID (EU Measuring Instruments Directive). If a 6 mm temperature sensor is used, an adapter (Art. no.: 878 386 278) is necessary. This is not required in the case of most heat meters.

The black steel adapter is unscrewed and removed for subsequent installation of the heat meter main body. When installing the heat meter, make sure that the direction of flow is correct. The adapter seals should then be replaced by new ones. The ball valve union nut to the heat meter and the fixing screw on the immersion sleeve have bore holes for sealing, thus protecting against unauthorised removal of the meter.



Horizontal heat meter

- Flow: Ball valve G 1-Rp ¾ with sensor stem with red handle
- Return: Ball valve Rp ¾ – G ¾ union nut with seal, sensor stem with blue handle, double nipple 110 mm R ¾, transition G ¾ self-sealing on G ¾ union nut with seal, ball valve Rp ¾ - G 1 with blue handle
- 2 flat seals 30/22 for G 1.

Vertical heat meter

- Flow: elbow 90° G 1 male self-sealing, ball valve G 1-Rp ¾ with sensor nipple and red handle
- Return: Ball valve Rp ¾ – G ¾ union nut with seal, sensor stem with blue handle, double nipple 110 mm R ¾, transition G ¾ self-sealing on G ¾ union nut with seal, ball valve Rp ¾ - G 1 with blue handle
- 2 flat seals 30/22 for G 1.

Installation instructions

Manifold cabinets for heating circuit manifolds with vertical heat meter

Assembly	Flush-mounted cabinet	Surface-mounted cabinet
Heating circuit manifold 3-fold with heat meter 110 mm ¾" vertical	Size 2	Size 1 (2)*
Heating circuit manifold 4-fold with heat meter 110 mm ¾" vertical	Size 3	Size 2 (3)*
Heating circuit manifold 5-fold with heat meter 110 mm ¾" vertical	Size 3 (4)*	Size 3
Heating circuit manifold 6-fold with heat meter 110 mm ¾" vertical	Size 4	Size 4
Heating circuit manifold 7-fold with heat meter 110 mm ¾" vertical	Size 4	Size 4
Heating circuit manifold 8-fold with heat meter 110 mm ¾" vertical	Size 4 (5)*	Size 4
Heating circuit manifold 9-fold with heat meter 110 mm ¾" vertical	Size 5	Size 5
Heating circuit manifold 10-fold with heat meter 110 mm ¾" vertical	Size 5	Size 5
Heating circuit manifold 11-fold with heat meter 110 mm ¾" vertical	Size 5 (6)*	Size 6
Heating circuit manifold 12-fold with heat meter 110 mm ¾" vertical	Size 6	Size 6

* Für ***PRINETO*** Heizkreisverteiler mit Flowmeter (878 386 001 – 878 386 010) Schrankgröße in der Klammer verwenden.

Manifold cabinets for heating circuit manifolds with horizontal heat meter

Assembly	Flush-mounted cabinet	Surface-mounted cabinet
Heating circuit manifold 3-fold with heat meter 110 mm ¾" horizontal	Size 4	not possible
Heating circuit manifold 4-fold with heat meter 110 mm ¾" horizontal	Size 4	
Heating circuit manifold 5-fold with heat meter 110 mm ¾" horizontal	Size 4	
Heating circuit manifold 6-fold with heat meter 110 mm ¾" horizontal	Size 5	
Heating circuit manifold 7-fold with heat meter 110 mm ¾" horizontal	Size 5	
Heating circuit manifold 8-fold with heat meter 110 mm ¾" horizontal	Size 5	
Heating circuit manifold 9-fold with heat meter 110 mm ¾" horizontal	Size 6	
Heating circuit manifold 10-fold with heat meter 110 mm ¾" horizontal	Size 6	
Heating circuit manifold 11-fold with heat meter 110 mm ¾" horizontal	Size 7	
Heating circuit manifold 12-fold with heat meter 110 mm ¾" horizontal	Size 7	

2

Underfloor heating

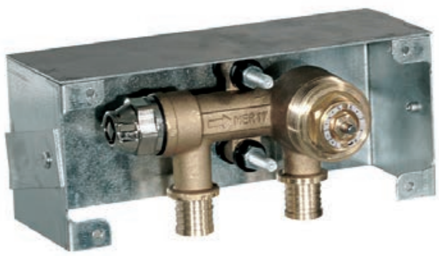
Mechanical individual-room controller MIC

To ensure disturbance-free functioning the MIC should not be exposed to direct sunshine or other heat or cold source. The ambient room air must be able to circulate unhindered around the controller.

NOTE

The thermostat can only be connected to a low-temperature heating circuit (flow max. 50°C), it is not a return temperature controller.

The MIC must be installed in the required room between 800 mm and 1500 mm over the finished floor. For this purpose provision has to be made for a vertical wall niche for the supply line to the surface heating pipes 17, insulated acc. to EnEV, and an installation opening for the main body (component dimensions: approx. 14 cm long, 6 cm high, 5.5 cm deep).



The housing with the previously fitted thermostat valve fitting is fitted into the wall with the open side facing downwards. The mounting plates attached on both sides are fixed to the wall with screws after the housing has been aligned. Depending on the intended final thickness of the plaster the main body must be mounted so that it projects slightly from the rough wall. The covering plate can compensate only approx. 5 to 10 mm difference between height of plaster and main body afterwards.

The surface heating pipe 17 is joined directly to the MIC by means of the ***PRINETO*** sliding sleeve connection. The flow, which comes from the manifold conduit, has to be connected on the left (observe direction of arrow on the fitting). The floor heating circuit is fixed to the outlet of the MIC and connected to the return of the manifold conduit. Connection of the floor heating circuit to the manifold conduit is made with the tee pieces 20-17-20 (art.-no. 878 360 757) or the reduction couplers 20-17 (art.-no. 878 340 750), see connection example on page 153.

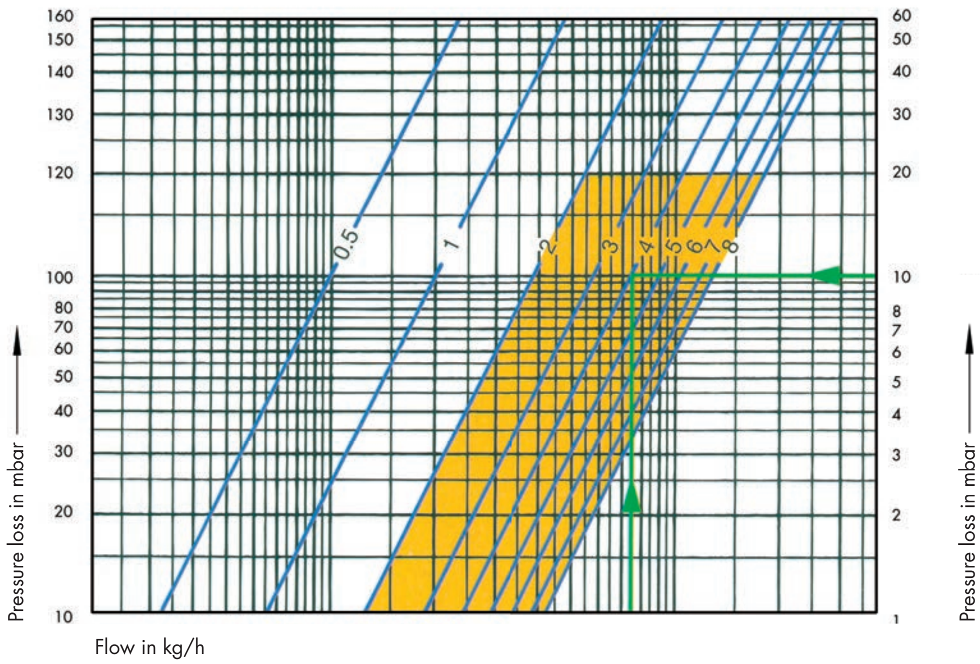
Filling and flushing of the heating circuits with water has to be done separately. The thermostat valves must be opened and shut individually. The integrated venting plug can be used for air bleeding at any time. The heating circuits then have to be tested for leak tightness. The MIC has to be protected against dirt as long as the slots in the walls have not been closed.

NOTE

If no further wall slots must be made when the underfloor heating is laid, the MIC must be mounted before the walls are plastered. To do this, connect all MICs to sufficiently long surface heating pipe 17 and pressure test them together. Then cut the heating pipes to length, insulate them acc. to EnEV and install the MICs in the wall slots in such a way that the surface heating pipes project from the wall to the level of the future insulation (mark flow and return, close and protect). After the walls have been plastered the MICs can be connected to the heating circuits as the underfloor heating system is laid.

Installation instructions

Pressure loss diagram MIC

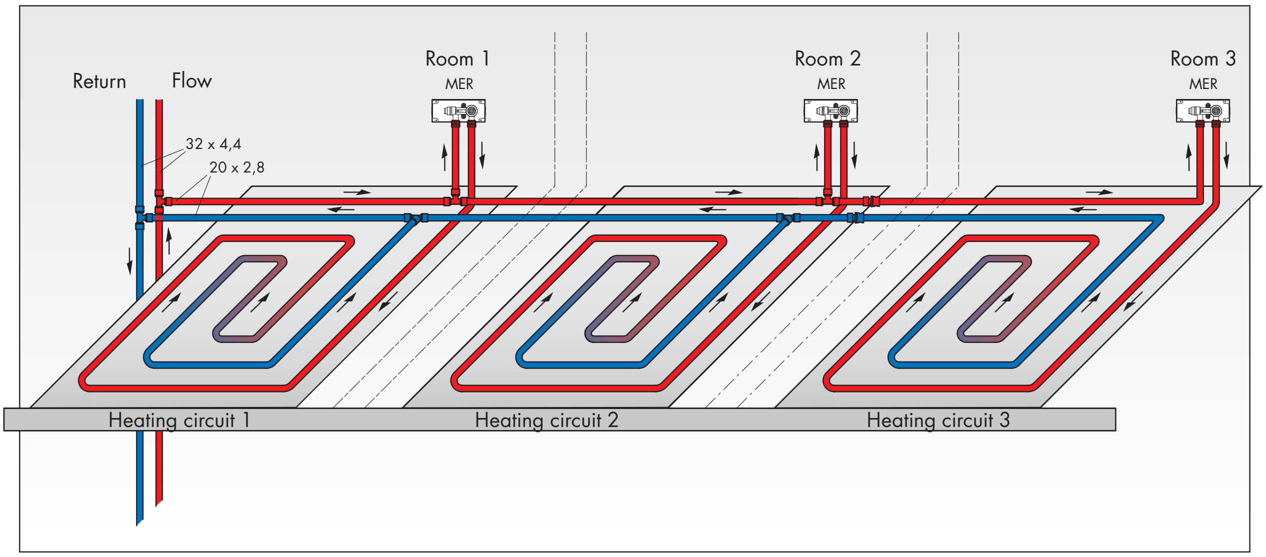


Hydraulic equalisation of the individual heating circuits in accordance with the pressure loss diagram is effected via the MIC's pre-set valve inserts. A curb in the brass ring beside the numbers marks the point of reference.

For final installation the thermostat head (art.-no. 878 386 043) is screwed onto the thermostat valve fitting and the white cover plate is slid over it so that it is clamped flush against the wall.

TIP

If heating is interrupted for a longer period (e.g. during summer) the MIC should be opened completely to prevent the valve plate becoming stuck.



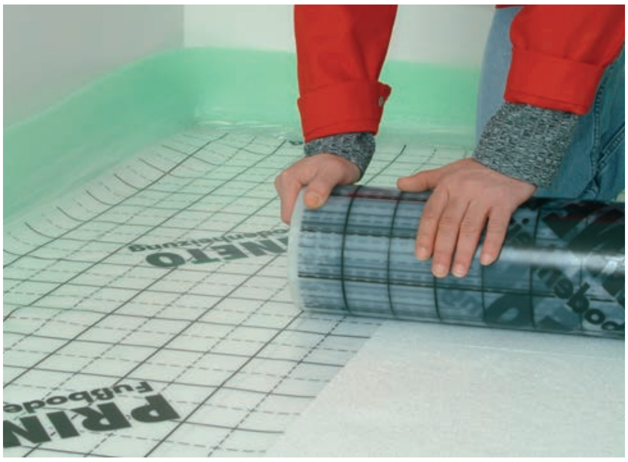
Installation instructions

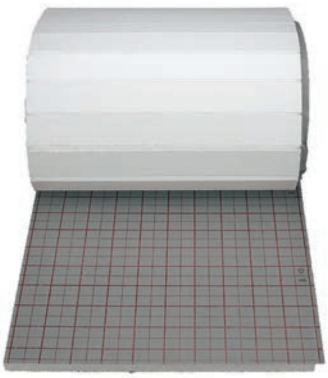
Tacker system

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of underfloor heating systems, and the descriptions for insulation below underfloor heating systems have to be observed!

After laying the ***PRINETO*** perimeter strip (art.-no. 878 386 039), the system roll or the heat and impact sound insulation respectively is laid in all the rooms in such a way that the foil leg of the perimeter strip is on top of the insulation. When the insulation is cut to size attention has to be paid to perpendicularity and accuracy to avoid sound and heat bridges. Cutting of the polystyrene insulation material can be effected with a sharp knife.

If loose ***PRINETO*** heat and impact sound insulation boards (e.g. art.-no. 878 386 063) are used, the upper insulation layer must be free from dust and dry in order to ensure optimum adhesion of the self-adhesive ***PRINETO*** tacker foil (art.-no. 878 386 041). This is rolled out at right angles to the laying direction of the insulation boards and pressed into place. When the first roll is laid the foil leg of the perimeter strip is glued to the tacker foil in such a way that no air pockets are produced near the wall. All other foil abutments are glued in the grid overlapping each other by 50 mm until a liquid-tight surface has been achieved.





PRINETO System roll

When the ***PRINETO*** system roll with grid foil (art.-no. 878 386 059) is used, the first roll is laid with the foil overlap facing the wall. Each subsequent roll covers the preceding one with an overlap. The foil leg of the perimeter strip is laid on top of the insulation and held in place with ***PRINETO*** adhesive tape (art.-no. 878 386 068) in such a way that there are no air pockets under the foil near the wall. All cutting edges of the insulation and all the overlaps must be protected by applying adhesive tape in order to prevent penetration of screed mixing water.

Expansion joints are positioned in the doorways and between the heating circuits' expansion joints in compliance with the joint plan. In these places the self-adhesive ***PRINETO*** expansion joint profile (art.-no. 878 386 233) is glued onto the insulation surface.

Installation instructions

Laying of the ***PRINETO*** pipe is started at the upper heating circuit manifold bar, or at the MIC (MIC only pipe 17) respectively. At the ducts into the manifold cabinet the pipes have to be protected with protective pipe or curved pipe guides. Connection to the manifold is carried out according to the type of pipe, with ***PRINETO*** V-Euro transitions (e.g. art.-no. 878 343 590) or with ***PRINETO*** clamp/screw-in V-euro-cones (e.g. art.-no. 878 386 011).

Near expansion joints the supply pipes are to be protected with the slit ***PRINETO*** protective pipe (art.-no. 878 386 103). Subsequently, the ***PRINETO*** expansion strip (art.-no. 878 386 233) is cut to the required length, the pipe ducts are cut in, and the self-adhesive underside of them is attached firmly to the floor. If fittings (e.g. couplers) are to be integrated in the underfloor heating, they must be protected from corrosion from the outside. The fittings and sliding sleeves must be sheathed with suitable materials for this purpose.

The following ***PRINETO*** pipes can be used for installation:

- Surface heating pipe 17 (art.-no. 878 311 151)
- Multilayer composite pipe 16 (art.-no. 878 520 100)
- Heating pipe 16 (art.-no. 878 310 100)

A foldable ***PRINETO*** pipe reel (art. no. 878 386 071) is available as laying aid. Depending on the type and distance of laying selected, the pipe is fixed onto the insulation layer using ***PRINETO*** tacker needles (art.-no. 878 386 038). The tacker needles are applied at intervals of approx. 0.5 m using the ***PRINETO*** tacker tool (art.-no. 878 386 037). At the pipe bends tighter fastening is required to observe the bending radii.

Subsequently each heating circuit must be flushed through with water and vented. All the heating circuits connected to the manifold must undergo pressure testing (pressure testing protocol on p. 194). The pressure should be maintained while the screed is being laid.

CAUTION

If there is danger of freezing, appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

After the screed has been laid, the hydraulic equalisation of the heating circuits (see p. 195) and function heating (s. page 198) is performed.

Installation instructions

Fixing rail system

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of underfloor heating systems, and the descriptions for insulation below underfloor heating systems have to be observed!

After the laying of the ***PRINETO*** perimeter strip (art.-no. 878 386 039), the system roll or the heat and impact sound insulation respectively is laid in all the rooms in such a way that the foil leg of the perimeter strip is on top of the insulation. When the insulation is cut to size attention has to be paid to perpendicularity and accuracy to avoid sound and heat bridges. Cutting of the polystyrene insulation material can be effected with a sharp knife.

When the ***PRINETO*** system roll with grid foil (art.-no. 878 386 059) is used, the first roll is laid with the foil overlap facing the wall. Each subsequent roll covers the preceding one with its overlap. The foil leg of the perimeter strip is laid on top of the insulation and held in place with ***PRINETO*** adhesive tape (art.-no. 878 386 068) in such a way that there are no air pockets under the foil near the wall. All cutting edges of the insulation and all the overlaps must be protected by applying adhesive tape in order to prevent penetration of screed mixing water.

If loose ***PRINETO*** heat and impact sound insulation boards (e.g. art.-no. 878 386 063) are used, the upper insulation layer must be free from dust and dry in order to ensure optimum adhesion of the self-adhesive ***PRINETO*** tacker foil (art.-no. 878 386 041). This is rolled out at right angles to the laying direction of the insulation boards and pressed into place. When the first roll is laid the foil leg of the perimeter strip is glued to the tacker foil in such a way that no air pockets are produced near the wall. All other foil abutments are glued in the grid overlapping each other by 50 mm until a liquid-tight surface has been achieved.

Expansion joints are positioned in the doorways and between the heating circuits expansion joints in compliance with the joint plan. In these places the self-adhesive ***PRINETO*** expansion joint profile (art.-no. 878 386 233) is glued onto the insulation surface.

The self-adhesive ***PRINETO*** fixing rails (e.g. art.-no. 878 386 074), which are 1 metre long, are shortened without tools at the breaking points (each 10 cm), depending on laying direction and laying type of pipe, and glued onto the insulation surface. The distance between the fixing rails should not exceed 1 m.

Laying of the ***PRINETO*** pipe is started at the upper heating circuit manifold bar, or at the MIC (MIC only pipe 17) respectively. At the ducts into the manifold cabinet the pipes have to be protected with protective pipe or curved pipe guides. The connection to the manifold is carried out according to the type of pipe, with ***PRINETO*** V-Euro transitions (e.g. art.-no. 878 343 590) or with ***PRINETO*** clamp/screw-in V-euro-cones (e.g. art.-no. 878 386 011).

Installation instructions

A foldable ***PRINETO*** pipe reel (art. no. 878 386 071) is available as laying aid. Depending on the type and distance of laying chosen the pipe is pressed into the fixing rail by treading on it. The pipe bends are fastened with short pieces of fixing rails or with individual ***PRINETO*** tacker needles. The bending radii have to be observed.

The following ***PRINETO*** pipes can be used for installation:

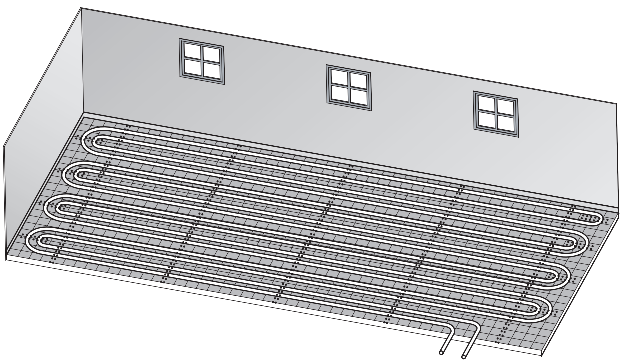
- Nanoflex surface heating pipe, high flexibility 17 (art.-no. 878 111 250)
- Surface heating pipe, high flexibility 17 (art.-no. 878 311 250)
- Surface heating pipe 17 (art.-no. 878 311 150)
- Multilayer composite pipe 16 (art.-no. 878 520 100)

Near expansion joints the supply pipes are to be protected with the slit ***PRINETO*** protective pipe (art.-no. 878 386 103). Subsequently, the ***PRINETO*** expansion strip (art.-no. 878 386 233) is cut to the required length, and the pipe ducts are cut in and pressed into the expansion joint profile.

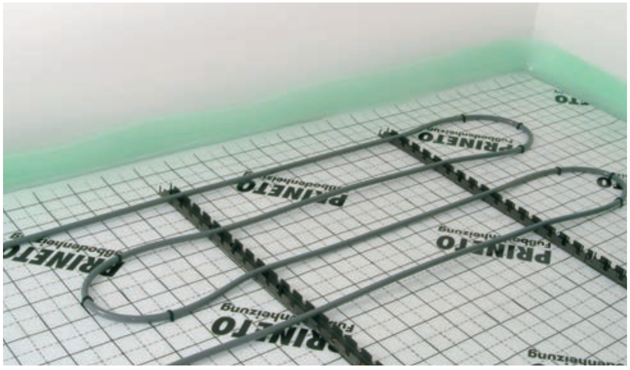
If fittings (e.g. couplers) are to be integrated in the underfloor heating, they must be protected from corrosion from the outside. The fittings and sliding sleeves must be sheathed with suitable materials for this purpose.

The fittings and sliding sleeves must be sheathed with suitable materials for this purpose. The connector positions must be marked on the service documents in compliance with EN 1264-4.

Subsequently, each heating circuit must be flushed through with water and vented. All the heating circuits connected to the manifold must undergo pressure testing (pressure testing protocol on p. 194). The pressure should be maintained while the screed is being laid.



Laying pattern double meander fixing rail



After the screed has been laid, the hydraulic equalisation of the heating circuits (see p. 195) and function heating (s. page 198) is performed.

CAUTION

If there is danger of freezing, appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

TIP

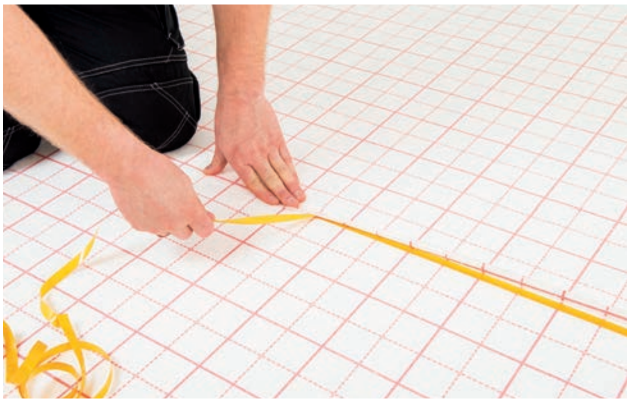
We recommend a double meandering (snake-like) laying pattern, e.g. 10 cm and 15 cm alternately.

Installation instructions

Velcro system

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of underfloor heating systems, and the descriptions for insulation in the underfloor heating systems chapter must be heeded.

After the laying of the insulation base and the ***PRINETO*** perimeter strip (art.-no. 878 386 039), the system roll or the heat and impact sound insulation respectively is laid in all the rooms in such a way that the foil leg of the perimeter strip is on top of the insulation. When the insulation is cut to size attention has to be paid to perpendicularity and accuracy in order to avoid sound and thermal bridges. The polystyrene insulation material can be cut with a sharp knife.



When the ***PRINETO*** velcro system roll with grid foil is used, the first roll is laid with the foil overlap facing the wall. Each subsequent roll covers the preceding one with its overlap. There is a self-adhesive strip on the opposite side of the foil overlap. To connect the velcro system roll, the protective backing must be removed from the self-adhesive strip and the pressed onto the overlap of the adjacent board.

The foil leg of the perimeter strip is laid on top of the insulation and held in place with adhesive tape such as ***PRINETO*** adhesive tape (art.-no. 878 386 068) in such a way that there are no air pockets under the foil near the wall. All cutting edges of the insulation and all the overlaps must be protected by applying adhesive tape in order to prevent penetration of screed mixing water.

TIP

If possible, the perimeter strip can also be fastened in place using a self-adhesive strip.

Laying of the ***PRINETO*** velcro surface heating pipe is started at the upper heating circuit manifold bar, or at the MIC. At the ducts in the manifold cabinet the pipes have to be protected with protective pipe or curved pipe guides. The connection to the manifold is carried out depending on the type of pipe either using ***PRINETO*** V-Euro transitions (e.g. art. no. 878 343 590) or ***PRINETO*** clamp/screw-in V-Euro cones (e.g. art. no. 878 386 011).

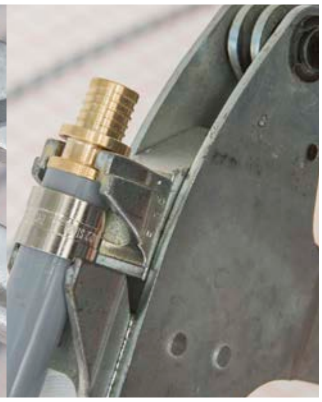
Installation instructions

TIP

The velcro becomes statically charged under friction and the influence of wide range of factors. To dissipate the charge after laying, the surface can be moistened with a plant spray or wet cloth.

The velcro surface heating pipe (e.g. art. no. 878 311 551) has a hook strip wound around it. The hooks in this strip make it stick to the fleece coating of the velcro system roll. The surface of the hook strip is rough. For this reason, we recommend the use of ***PRINETO*** velcro installation gloves (art. no. 878 386 076) for hand protection.

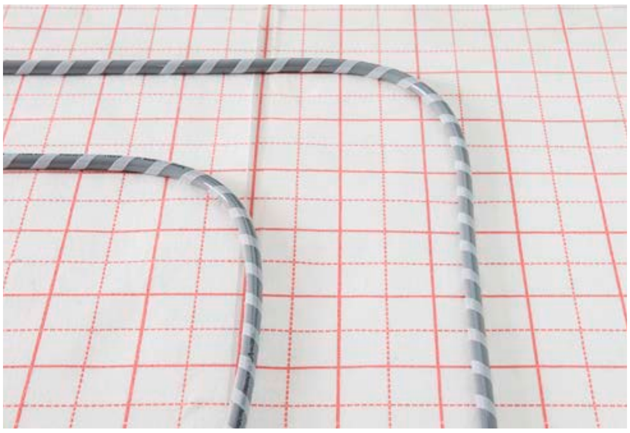
The pipe is fixed to the insulation layer according to the type and distance of laying chosen. The bending radii must be observed. A clearance of 50 mm must be maintained from vertical structures (e.g. walls), and of 200 mm from chimneys and open fireplaces and shafts.



NOTE

For joining a ***PRINETO*** velcro surface heating pipe to a terminal screw or other fitting, the Velcro strip wound around the pipe must be stripped to such an extent that the joint can be made.

If fittings (e.g. couplers) are to be integrated in the underfloor heating, they must be protected from direct contact. The fittings and sliding sleeves must be sheathed with suitable materials for this purpose. The connector positions must be marked on the service documents in compliance with EN 1264-4.



Rohrverlegung auf der Überlappung ist zu vermeiden.

NOTE

If in the area of fleece coating overlap the ***PRINETO*** velcro surface heating pipe is laid in such a way that the pipe is strained in relation to the overlapped velcro system roll, the pipe should be attached to the velcro system roll underneath.

Installation instructions

Help with laying is provided by the foldable ***PRINETO*** pipe reel carrier (art.-no. 878 386 071). In connection with the ***PRINETO*** velcro guide eyelet for pipe reel carrier (art. no. 878 386 072), this reduces unwanted contact between the pipe and the velcro system roll. The ***PRINETO*** velcro pipe guide for doorways (art. no. 878 386 075) helps with this, too. It can be attached flexibly to different projections.

Expansion joints are positioned in the doorways and between the heating circuits' expansion joints in compliance with the joint plan. In these places the self-adhesive ***PRINETO*** expansion joint profile (art.-no. 878 386 233) is glued onto the insulation surface. Near the expansion joints the supply pipes are to be protected with the slit ***PRINETO*** protective pipe (art.-no. 878 386 103). The expansion joint profile is cut from below at the duct point.

Each heating circuit must subsequently be individually flushed through with water and vented. All the heating circuits connected to the manifold must undergo pressure testing. The pressure should be maintained while the screed is being laid.

CAUTION

If there is a risk of freezing, appropriate measures must be taken e.g. use of antifreeze agents or heating of the building. After the screed has been laid, the hydraulic equalisation of the heating circuits and function heating are carried out.

Installation instructions

Knobbed board system 14

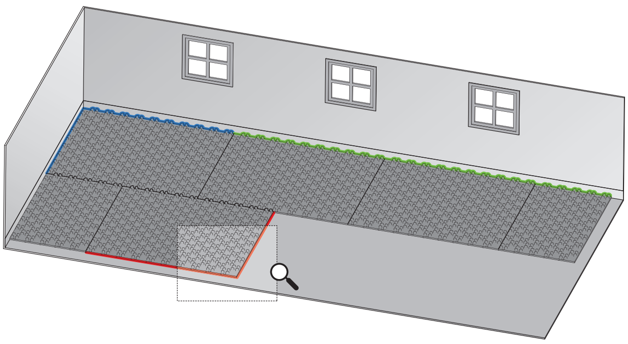
The general instructions in the **PRINETO** catalogue concerning the installation and laying of underfloor heating systems, and the descriptions for insulation below underfloor heating systems have to be observed!

After the **PRINETO** permiter strip (art.-no 878 386 039) has been laid, the knobbed boards are laid in all the rooms in such a manner that the foil leg of the perimeter strip is on top of the knobs. When the insulation is cut to size attention has to be paid to perpendicularity and accuracy in order to avoid sound and heat bridges. We recommend the use of a straight edge as a cutting aid. Cutting of the polystyrene insulation material can be effected with a sharp knife.

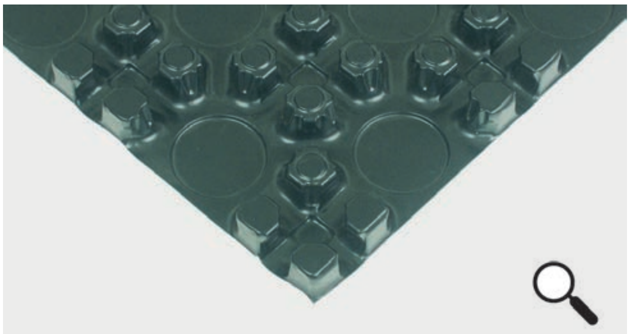
Depending on the required insulation material thickness and requirements the choice is between **PRINETO** knobbed boards 14 with a thickness of 30 mm (art.-no. 878 386 086, heat and impact sound insulation) or a thickness of 10 mm (art.-no. 878 386 085, heat insulation). If laying is started with an uncut board from a new package the overlap of the knobbed foil has to be cut off on both sides first!

These two "cut" sides must face the walls of the starting corner. Thus, depending on room geometry, laying is always started in the far left-hand corner if the boards are laid cross-wise (see laying pattern, blue edges).

The next board is laid to the right of the starting board. Only the (upper) foil overlap of this knobbed board which is facing the wall must be cut off first (green edges). The left-hand knobbed foil overlap (with circularly marked knobs) of the right board is pressed over the knobs (without circular knob marking) of the board on the left. Thus, a solid and liquid-tight unit of boards is produced.



Laying pattern knobbed board



NOTE

Even when starting with residual boards from another room laid previously, the two knobbed board edges without circular knob marking (red edges) always face towards the open centre of the room.

Installation instructions

Laying is continued this way right up to the wall of the room. The last knobbed board is cut to the respective size. The remaining piece is the starting piece for the next row of knobbed boards, which is again laid from left to right.

TIP

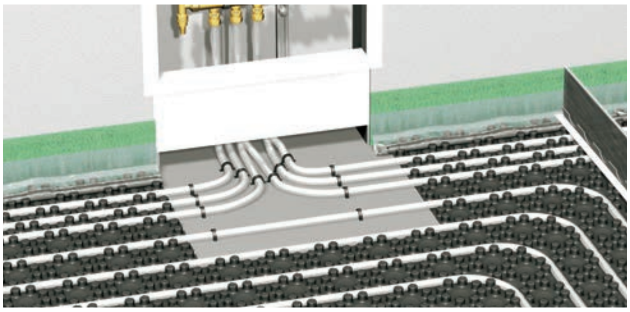
It is only after the board has been cut to size that you should cut off the (upper) knobbed foil overlap of the last board facing the wall according to the difference in distance to the right wall! The residual board can only be used as the starting piece of the next row if the upper foil overlap is still there.

Thus it is possible to lay with little cutting loss and without crossing joints. The respective overlapping foils (with circularly marked knobs) are pressed over the knobs (without circular knob marking) of the neighbouring boards already laid.

TIP

The foils which are left over when the "bottom" wall of the room is reached are used as starting pieces in the next room. If new boards are used the foil overlap facing towards the wall has already been cut off the residual boards.

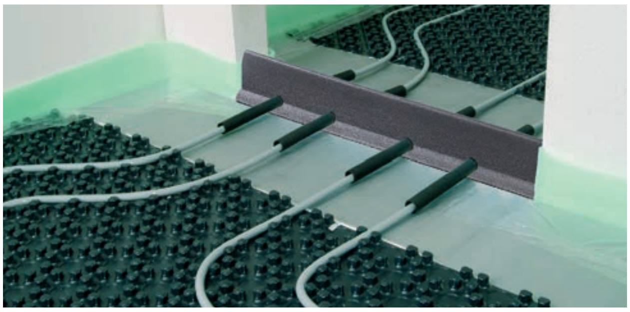
PRINETO non-profiled compensation boards, which are either 30 mm thick (art.-no. 878 386 128) or 10 mm thick (art.-no. 878 386 129) depending on the thickness of the insulation material, must be laid instead of the knobbed boards in front of the heating circuit manifold and near all expansion joints that are crossed by heating circuit feeder pipes.



The adjoining cutting edges between knobbed board and levelling board must be cut 100% straight and parallel. The self-adhesive ***PRINETO*** foam tape (art.-no. 878 386 131) has to be fixed to the cutting edges on the sides.

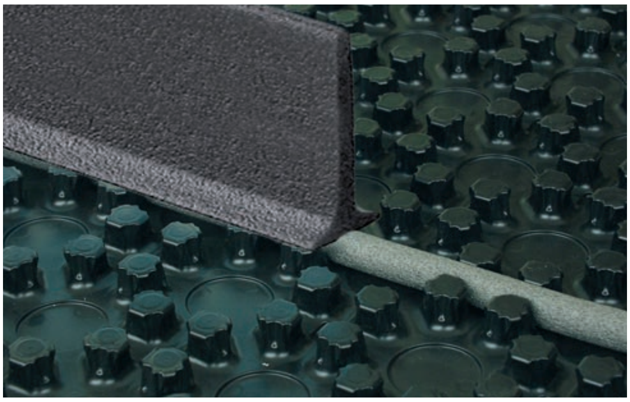
During laying of the insulation the adjoining cutting edges must be pressed towards each other to ensure liquid-tightness of the gap. Expansion joints are positioned in the doorways and between the heating circuits' expansion joints in compliance with the joint plan. In these places the self-adhesive ***PRINETO*** expansion joint profile (art.-no. 878 386 233) is fixed to the surface of the levelling board.

PRINETO connection strips lengthwise and across (art. no. 878 386 080 and 878 386 081) must be used to connect butt-jointed knobbed boards. A screed-moisture-proof transition to the levelling board can be created using ***PRINETO*** transition strips lengthwise and across (art. 878 386 082 and 878 386 083).



Installation instructions

Here, the ***PRINETO*** sealing strip 16 (art.-no. 878 386 130) is laid along the expansion joint between the knobs, and above it the self-adhesive ***PRINETO*** expansion joint profile is glued onto the knobs.



With the heating pipe next to the wall, the foil leg of the perimeter strip is clamped between the knobs in such a way that there are no air pockets near the wall.
A clearance of 50 mm must be maintained from vertical structures (e.g. walls) and of 200 mm from chimneys and open fireplaces and shafts. Sealing strip 16 can be used instead of the pipe for this.

In the area of levelling board the foil leg is fixed onto the surface of the insulation material with ***PRINETO*** adhesive tape (art.-no. 878 386 068).

Laying of the ***PRINETO*** pipe 14 is started at the upper heating circuit manifold bar, or at the MIC respectively (with MIC only pipe 17 is possible, otherwise it has to be connected using 17-16 reduction couplers, art.-no. 878 340 540, and 16–14, art.-no. 878 340 130). At the ducts into the manifold cabinet the pipes have to be protected with protective pipe or curved pipe guides. Connection to the manifold is made with ***PRINETO*** transitions 14 V-Euro (art.-no. 878 343 320) or ***PRINETO*** clamp/ screw-in 14 V-Euro cone (art.-no. 878 386 017).

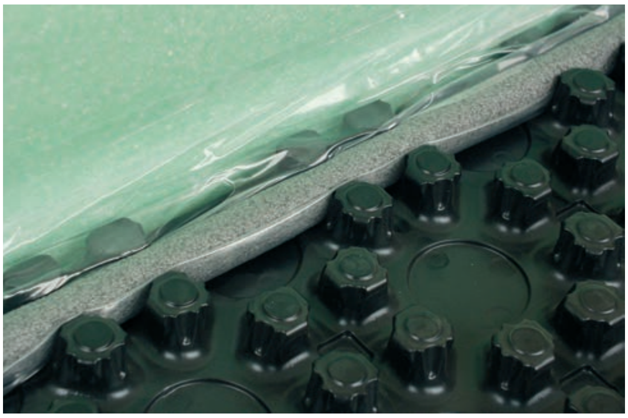
Help with laying is provided by the foldable ***PRINETO*** pipe reel carrier (art.-no. 878 386 071). Depending on the type and distance of laying chosen, the pipe is pressed between the knobs by treading on it. The bending radii must be observed.

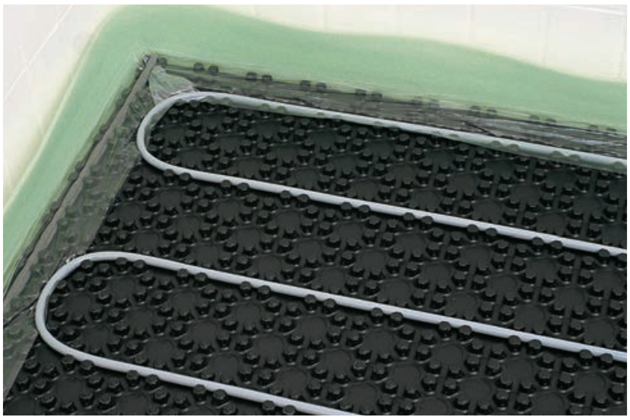
The following ***PRINETO*** pipes can be used for installation:
- Surface heating pipe, high flexibility 14 (art. no. 878 311 331)
- Stabil multilayer pipe 14 (art. no. 878 520 080)

Near the expansion joints the supply pipes are to be protected with the slit ***PRINETO*** protective pipe (art.-no. 878 386 103). Subsequently, the ***PRINETO*** expansion strip (art.-no. 878 386 233) is cut to the required length, and the pipe ducts are cut in and pressed into the expansion joint profile.

If fittings (e.g. couplers) are to be integrated in the underfloor heating, they must be protected from direct contact.

The fittings and sliding sleeves must be sheathed with suitable materials for this purpose. The connector positions must be marked on the service documents in compliance with EN 1264-4.





CAUTION

If there is danger of freezing, appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

Subsequently each heating circuit must be flushed through with water and vented. All the heating circuits connected to the manifold must undergo pressure testing (pressure testing protocol on p. 194). The pressure should be maintained while the screed is being laid.

After the screed has been laid, the hydraulic equalisation of the heating circuits (see p. 195) and function heating (s. page 198) is carried out.

Knobbed board without insulation

The knobbed board without insulation (art.-no. 878 386 084) has been designed for special applications that require a minimal floor structure, sometimes even without insulation underneath. To guarantee that the boards are fitted in place securely, they must be glued over their full surface to the base surface using a solvent-free adhesive. If the board is to be laid directly onto a rough concrete floor, we recommend using ***PRINETO*** plate-head plugs (art.-no. 878 386 042) to fix it in place. PE-X pipes push the knobs apart very easily, which is why only use with multilayer composite pipe 14 (art.-no. 878 520 080) is recommended.

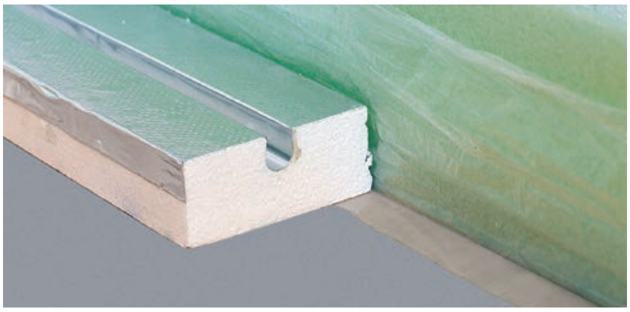
Installation instructions

Dry system

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of underfloor heating systems, and the descriptions for insulation below underfloor heating systems have to be observed!

The insulation elements must be transported without damage, and in addition they must be stored in dry conditions and protected from the effects of the weather. The aluminium and polystyrene surfaces, and the groove contours must not be deformed. Heavily frequented areas (e.g. at entrance doors) must therefore be covered with dry underfloor boards or other suitable materials. Ladders or similar objects must not be placed directly on the insulation boards.

After the ***PRINETO*** perimeter strip (art.-no. 878 386 039) has been laid, the system elements are laid in all the rooms in such a way that the foil leg of the perimeter strip is clamped in on the sides. It is not required for the dry-laid underfloor heating system. Laying is started in the room which is farthest from the heating circuit manifold.



TIP

For thermotechnical reasons the exclusively meandering (snake-like) pipe laying pattern should be parallel to the outside wall with the largest glass façade. Laying of the flow of the heating circuit is started directly in front of the glass façade.

For guiding the flow along the wall towards the glass façade a ***PRINETO*** grooved element (art.-no. 878 386 133) 48 cm wide is cut into 4 equal strips each 12 cm wide, and laid along the wall of the room in such a way that a continuous groove is produced. It is important to cut the insulation at right angles, and with fitting accuracy. We recommend the use of a straight edge or the side of a long spirit level as a cutting aid. The cutting of the polystyrene insulating material can be carried out with a sharp and sturdy knife.

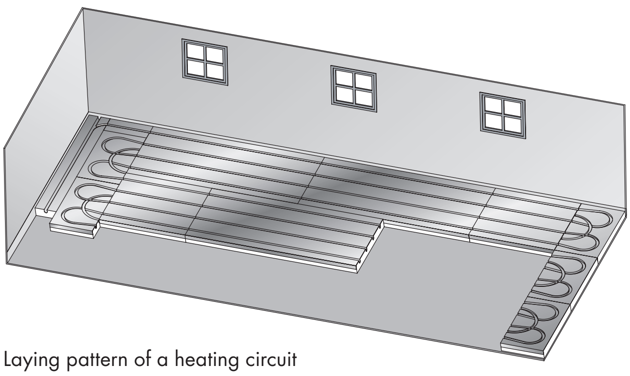
CAUTION

The cut edges of aluminium foil are sharp! Suitable gloves should be worn as protection against skin injuries.

TIP

The system elements have measurements which can be divided by the smallest pipe gap of 12 cm, in other words 96 cm, 48 cm and 24 cm. This guarantees that the cut-off pieces can almost always be used again. For this purpose, the floor layout should be at right angles. 5% cutting loss usually has to be taken into consideration in the calculation.

After this, the ***PRINETO*** U-turn elements (art.-no. 878 386 134) are laid in front of the grooved strips and along the opposite wall of the room. The U-turn elements opposite each other are staggered in such a way that pipe laying in a snake-like pattern in the grooves is possible.



Laying pattern of a heating circuit

Installation instructions

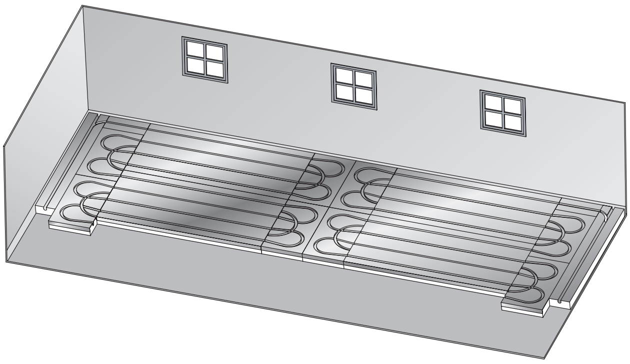
If the pipes are to be laid at a distance of 24 cm to each other, a U-turn element has to be shortened accordingly.

Laying of the grooved elements is started at the glass façade. The U-turn elements are laid next to each other so that a continuous "groove snake" is produced. The respective last grooved element in a row is cut at right angles to the required remaining length. The remaining part of this grooved element can be used at the beginning of the next row. This way there is only little cutting loss when elements are installed. The residual elements left over when the "bottom" wall of the room is reached are used as starting pieces for the next room.

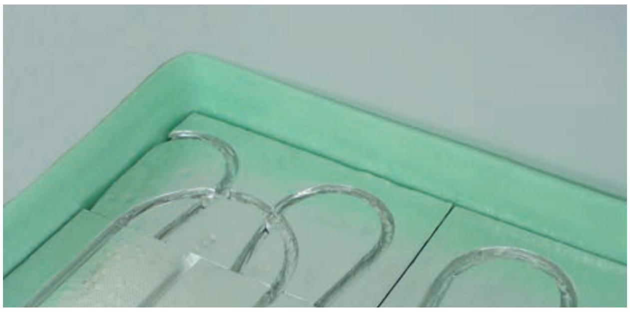
If one room is subdivided into several heating circuits the U-turn elements are laid opposite each other along the border between the heating circuits.

PRINETO compensation elements (art.-no. 878 386 135) are only laid in areas where pipe laying is difficult or the pipes are very close to each other (e.g. directly in front of the heating circuit manifold), or in doorways. The later distance between the grooves depends on the numbers of the heating pipes to be laid and the available space. It has to be distributed equally. When laying the insulation elements increasing allowance has to be made for heating circuit feeder pipes near manifolds.

The connection grooves to be cut are marked with a felt tip pen on the aluminium or polystyrene surfaces, so that continuous heating circuits will result in each case. Near pipe bends the radius must be at least 85 mm (180° U-turn = 170 mm pipe centre distance).



Laying pattern for several heating circuits



TIP

Pre-cutting should be done in rooms that are not yet equipped with insulation so that no polystyrene residues will contaminate the grooved elements.
If necessary, the grooved elements can be cleaned with a vacuum cleaner.

NOTE

The insulation elements must be laid full-surface, adjoining each other and tension-free. To achieve maximum heat flow full-surface aluminium-coated insulation elements should be used.

Installation instructions

The arrangement of the grooves in doorways should ensure heating of the passage area.

If the whole heating surface is laid with system elements the previously marked connections of the grooves are realised. For this the aluminium foil must be cut with a knife and removed at the marked areas, also in the grooves and at the edge of the elements. The cut should only separate the aluminium foil and must not go into the polystyrene too deeply.

Afterwards the required pipe grooves are cut manually using the ***PRINETO*** heat-cutter 230 V (art.-no. 878 386 136) (max. length 3 m). The cuts must be made quickly to avoid fusion of the polystyrene.

CAUTION

The cutting tip of the heat-cutter heats up to 600°C. It must not be touched when heated and must not be placed on flammable surfaces!

TIP

The cutting of pipe grooves at very small distances from each other (connection to manifold) is done immediately before the laying of every single pipe. If all the pipe grooves are cut at one time the remaining thin polystyrene bridges between the grooves can be broken out as the pipes are laid, which may make the proper laying and fixing of the pipes difficult.

Laying of the ***PRINETO*** multilayer composite pipe 16 is started at the upper heating circuit manifold bar, or at the MIC respectively (with MIC only pipe 17 is possible, must be connected with ***PRINETO*** 17–16 reduction coupler, art.-no. 878 340 540). For this purpose the pipe is rolled out by hand and pressed into the grooves completely by treading on it. The pipe must not jut out at any point across the insulation surface. Near the U-turn elements the pipe must be bent manually according to the predetermined radius. The pipe bends which stand slightly upwards after this are bent downwards to prevent rising of the U-turn elements.

Installation instructions

The connection of the pipes to the manifold is carried out with ***PRINETO*** transition 16 V-Euro (art.-no. 878 343 120) or with ***PRINETO*** clamp/screw-in multilayer composite pipe 16 V-Euro cone (art.-no. 878 386 092).

TIP

Only insert pipe connectors in straight running grooves. This involves the aluminium foil at the base of the groove being incised with a knife for a length of about 10 cm and the joined coupler being pushed into the polystyrene. After insertion the coupler must not jut out above the surface of the insulation.

Subsequently, each heating circuit must be flushed through with water and vented. All the heating circuits connected to the manifold must undergo pressure testing (pressure testing protocol on p. 194). The pressure should be maintained while the screed is being laid.

CAUTION

If there is danger of freezing appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

For laying the precast screed components the instructions of the respective manufacturer have to be followed.

After the screed has been laid, the hydraulic equalisation of the heating circuits (see page 195) and function heating are performed.

Thin-bed system

NOTE

The thin-bed system 12 is a special system for laying water-carrying underfloor heating with minimal floor structure. Since no heat and impact sound insulation is laid under the special screed, this system does not meet the requirements of DIN EN 1264-4 with regard to the thermal conductivity resistance of the insulation. The downward heat loss of the underfloor heating cannot be influenced with this system. The client must be informed in good time.

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of underfloor heating systems, and the special installation and laying instructions for thin-bed screed have to be observed!

For optimum laying, the base must be capable of bearing a load, be crack-free and have a firm, level and clean surface (free of grease and cleaning agents). Any cracks must be gummed up. The type of priming or pre-treatment depends on the material the old base is made of. Expansion joints in the old base must be matched by the self-adhesive expansion joint profiles in the thin-bed screed. Screed fields with several heating circuits must be heated evenly or separated from one another by expansion joints.

In order to fix the ***PRINETO*** perimeter strip 50 x 5 (art.-no. 878 386 232) in place, remove the protective film from the backing and press this self-adhesive side onto the wall. The perimeter strip has no foil leg since the intention is to connect the screed directly with the base. It has to be attached to all rising components.

Laying of the self-adhesive ***PRINETO*** knobbed foil 12 (art.-no. 878 386 231) is always started in the far left-hand corner of the room opposite the door. The first two sides are laid with the "half" notches in the starting corner. The knobs in the first row of these two sides are larger than the other knobs on the foil so that they can be pushed over one another later on.

Installation instructions

Once the foil has been adjusted properly, pull the protective film off and press the knobbed foil with the self-adhesive side facing downwards firmly onto the floor. The next board is laid on the right, also with the half notches at the top and left. Stick the left-hand side of the foil over the respective row of the starting board, this will result in a firm film composite.

In this way the laying is continued to the right to the right-hand wall of the room. The last knobbed foil is cut to the respective size. The remaining piece is the starting piece for the next row of knobbed foils, which is again laid from left to right. The foils which are left over when the "bottom" wall of the room is reached are used as starting pieces in the next room.

TIP

The foil only needs to be laid in the areas to be heated. There is no need to carry out any complex cutting in difficult edge areas.

TIP

Do not remove the white protective film on the adhesive before you have finished adjusting the knobbed foils. Once the protective film has been removed, the knobbed foil can no longer be moved on the floor.

CAUTION

If there is danger of freezing appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

Start laying the ***PRINETO*** heating pipe 12 (art.-no. 878 311 320) at the top heating circuit manifold box or at the mechanical individual-room controller (MIC).Protect the pipes at the ducts to the manifold cabinet with protective pipes or curved pipe guides. Use ***PRINETO*** clamp/screw-in 12-V eurocones (art-no. 878 386 234) to fix the pipes to the manifold.The surface heating pipe can be connected using the ***PRINETO*** coupler 12 (art.-no. 878 340 220) in conjunction with the ***PRINETO*** sliding sleeve 12 (art.-no. 878 530 080). This saves on expensive pipe cut waste. A foldable ***PRINETO*** pipe reel (art. no. 878 386 071) is available as laying aid.

Tread the pipe between the knobs, depending on the type of laying and the laying distance. The smallest bending radius is 75 mm. Then flush and vent each heating circuit individually, and perform pressure testing on all the heating circuits connected to the manifold (see pressure testing protocol on p.194). The pressure should be maintained while the screed is being laid. Screed is laid on site. We recommend the use of the special screed KNAUF, WEBER, MAXIT or PCI. Mounting and laying instructions of manufacturers must always be followed.

Installation instructions

Following approval for the use of thin-bed underfloor heating by the screed manufacturer, other special screeds can also be used. The surface heating pipes must be under pressure during screed laying.

Subsequently the hydraulic equalisation of the heating circuits and operational heating is carried out (cf. from p.195 or see screed manufacturer's instructions).

NOTE

When couplers or other fittings are used that are to be cast in the screed, suitable measures must be taken to protect them from corrosion from the outside. The fittings and sliding sleeves must be sheathed with suitable materials for this purpose. The connector positions must be marked on the service documents in compliance with EN 1264-4.

Room temperature control

Acc. to the Energy-saving Ordinance (EnEV) all heating systems have to be provided with a self-activating device for individual temperature regulation in dry and closed rooms such as flats, schools, halls, workshops etc. in a usual environment.

In the case of ***PRINETO*** underfloor heating systems mechanical, electromechanical and electronic control components are available for this. To ensure disturbance-free functioning the controllers should not be exposed to direct sunlight or other sources of heat or cold. The ambient room air must be able to circulate unhindered around the controller.

CAUTION

The electrical devices must only be connected by an expert in compliance with the terminal inscriptions. The existing safety regulations of the VDE and the local power supply company must be observed! The components always have to be de-energised before opening!

Mechanical individual-room controller

The most economical device to be had: The mechanical individual-room controller MIC regulates the room temperature of a single heating circuit by means of a thermostat valve to which the surface heating pipes 17 are connected directly via the sliding sleeve connection. The controller housing with the thermostat valve insert is mounted concealed in the wall of the room, only the thermostat head juts out.

The MIC is an economical alternative to electronic room temperature regulation as no electrical installation work has to be performed and neither heating circuit manifolds with a manifold cabinet nor actuators are required.

Hydraulic equalisation of the individual heating circuits is effected via a pre-set valve core (pressure loss diagram with installation instructions MIC on p.153).

CAUTION

The thermostat can only be connected to a low-temperature heating circuit (flow max. 50°C), it is not a return temperature controller.

Room temperature control

Room temperature controller, surface-mounted

The room temperature controller is an electromechanical contact opener with thermal feedback and heat sink resistance. If the desired room temperature is exceeded the controller contact interrupts the circuit to the actuator. If the room temperature controller is intended to control several heating circuits for one room at the same time, the control current can be distributed to several actuators via the terminal strip (art.-no. 878 386 094).

The resistance of the thermal feedback in the heating circuit is activated in order to reduce the room temperature control tolerance to approx. 0.5 K.

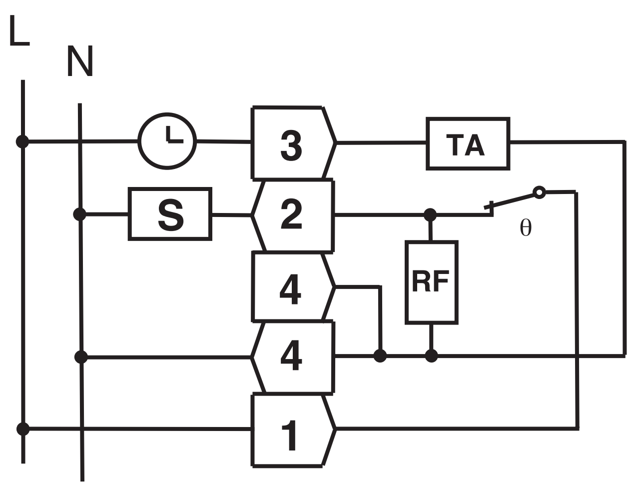
When the heat sink resistance is wired with power supply, the room temperature selected on the handwheel decreases automatically by 3K.

This can be done via a cover with pilot timer (art.-no. 878 386 154) for example. For all functions to be able to be used, a cable with at least four live conductors must be laid between the manifold cabinet and the room temperature controller.

The room temperature controller is suppressed in accordance with VDE 0875 or EN 55014 and operates according to operating mode 1c (bi-metal). The permissible relative humidity of max. 95 % must not be exceeded. Condensation must be avoided.

TECHNICAL DATA

Operating voltage:	AC 230 V/50/60 Hz
Temperature range:	+5°C to +30°C
Switching difference:	Approx.0.5 K, thermal feedback
Protection class:	IP 30 according to EN 60 529
Solid conductor cross-section:	0.75–1.5 mm^2, no earth conductor required
Number of actuators:	Max. 10
Housing colour:	Pure white (similar to RAL 9010)
Installation height:	Approx. 1.5 m above floor
Contact:	Opener 2 (1) A/230 V AC
Night-time reduction:	Via heat sink resistance -3 K against pre-set desired day-time value (only with external pilot timer)
Housing size:	78 x 78 x 14 mm
Installation:	Surface-mounted or directly on flush-mounted socket (distance between screws 60 mm)



Terminal configuration:

3	Additional conductor for night-time reduction
2	Control conductor to actuator
4	Neutral conductor N (both terminals are bridged)
1	Outer conductor L (phase)
🕒	Pilot timer
S	Actuator, closed with power off
RF	Resistance for thermal feedback
TA	Resistance for temperature reduction

Room temperature control

Room temperature controller for heating/cooling, flush-mounted

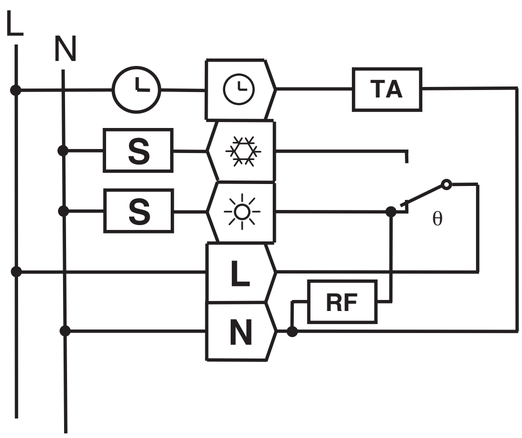
The room temperature controller is an electromechanical contact changer with thermal feedback and heat sink resistance. The controller contact switches on the circuit to the control conductor for cooling when the selected room temperature is exceeded, and the circuit to the control conductor for heating when the temperature drops below the selected room temperature. Depending on the regulator state of the heating / cooling terminal strip (art.-no. 878 386 150), the connected actuators will open to allow the flow of either warm water for heating or cold water for cooling. The controller measuring 50 x 50 mm can be integrated in almost all commercially available switch ranges using a separate intermediate frame. It is delivered with a white standard frame for individual installation.

If the room controller is intended only for heating, the control current can be distributed to several actuators via the terminal strip (art.-no. 878 386 094).Terminal strip heating/cooling (art.-no. 878 386 150) must be used for heating and cooling. Room temperature is automatically reduced by 4 K for size reduction.This can be done via a cover with pilot timer for the terminal strips (art.-no. 878 386 154 for heating, please request special articles for heating/cooling separately).

For all heating operation functions to be able to be used, a cable with at least four live conductors must be laid between the manifold cabinet and the room temperature controller. Five live conductors are required for heating and cooling. The room temperature controller is suppressed in accordance with VDE 0875 or EN 55014 and operates according to operating mode 1c (bi-metal). The permissible relative humidity of max. 95 % must not be exceeded. Condensation must be avoided.

TECHNICAL DATA

Operating voltage:	AC 230 V/50/60 Hz
Temperature range:	+5°C to +30°C
Switching difference:	Approx. 0.5 K, thermal feedback
Protection class:	IP 30 according to EN 60 529
Solid conductor cross-section:	0.75–1.5 mm^2, no earth conductor required
Housing colour:	Pure white (similar to RAL 9010)
Number of actuators:	Heating max. 10, cooling max. 5
Installation height:	Approx. 1.5 m above floor
Contact:	Changer 5 (2) A/230 V AC
Night-time reduction:	Via heat sink resistance – 4 K against pre-set desired day-time value (only with external pilot timer)
Dimensions:	Controller 50 x 50 x 16 mm With frame 81 x 85 x 16 mm
Installation:	In flush-mounted socket, distance between screws 60 mm



Terminal configuration:

(clock symbol)	Additional conductor for night-time reduction
(snowflake symbol)	Cooling control wire to the actuator
(sun symbol)	Heating control conductor to the actuator
L	Outer conductor L (phase)
N	Neutral conductor N
(clock symbol)	Pilot timer
S	Actuator, closed with power off
RF	Resistance for thermal feedback
TA	Resistance for temperature reduction

Room temperature control

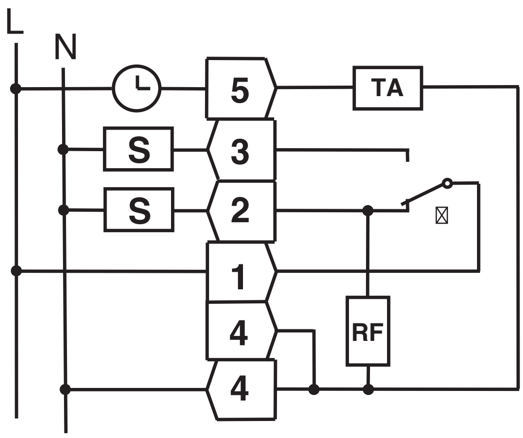
Room temperature controller for heating/cooling, surface-mounted

The room temperature controller is an electromechanical contact changer with thermal feedback and heat sink resistance. The controller contact switches on the circuit to the control conductor for cooling when the selected room temperature is exceeded, and the circuit to the control conductor for heating when the temperature drops below the selected room temperature. Depending on the regulator state of the terminal strip heating/cooling (art.-no. 878 386 150) the connected actuators will open to allow the flow, either to heat warm water or to cool cold water. The resistance of the thermal feedback in the heating circuit is activated in order to reduce the room temperature control tolerance to approx. 0.5 K. If a voltage is connected to the heat sink resistance, the room temperature selected on the handwheel is automatically reduced by 3 K. This can be done via a cover with pilot timer for the heating/cooling terminal strip (special article, please request separately). For all functions to be able to be used, a cable with at least five live conductors must be laid between the manifold cabinet and the room temperature controller.

The room temperature controller is suppressed in accordance with VDE 0875 or EN 55014 and operates according to operating mode 1c (bi-metal). The permissible relative humidity of max. 95 % must not be exceeded. Condensation must be avoided.

TECHNICAL DATA

Operating voltage:	AC 230 V/50/60 Hz
Temperature range:	+5°C to +30°C
Switching difference:	Approx. 0.5 K, thermal feedback
Protection class:	IP 30 according to EN 60 529
Solid conductor cross-section:	0.75–1.5 mm^2, no earth conductor required
Housing colour:	Pure white (similar to RAL 9010)
Number of actuators:	Heating max. 10, cooling max. 5
Installation height:	Approx. 1.5 m above floor
Contact:	Changer 2 (1) A/230 V AC
Night-time reduction:	Via heat sink resistance – 3 K against pre-set desired day-time value (only with external pilot timer)
Dimensions:	78 x 78 x 14 mm
Installation:	Surface-mounted or directly on flush-mounted socket (distance between screws 60 mm)



Terminal configuration:

1	Outer conductor L (phase)
2	Heating control conductor to the actuator
3	Cooling control conductor to the actuator
4	Neutral conductor N (both terminals are bridged)
5	Additional conductor for night-time reduction
🕒	Pilot timer
S	Actuator, closed with power off
RF	Resistance for thermal feedback
TA	Resistance for temperature reduction

Room temperature control

Wireless control systems

Wireless control systems are ideal for upgrading existing heating systems, because they do not require any electrical connection cables from the room temperature controller to the manifold cabinet with all the chiselling, laying, plastering and painting work this would entail. They can be used for heating or cooling and can be switched manually according to needs.

The ready-to-use transmitter is a surface-mounted room temperature controller without timer which transmits the control signals wirelessly to the receiver installed in the manifold cabinet. It is equipped with an LED heating display, a sliding switch for changing from heating to cooling, and a mode selector switch which must be at the ☼ symbol during normal operation.

The receiver transforms the radio signals of the transmitter into control signals for electrical consumers (e.g. actuators). The actuators of the individual heating circuits are connected to the receiver and controlled by it. Depending on the design type, either one or up to four or six room temperature controller transmitters can be assigned to the receivers.

The transmitter changes learning mode when the ⧗ key is kept pressed and the 'Reset' key is pressed at the same time. The LED lights up permanently, the ⧗ key can be released again. Now the receiver channel can be assigned on the receiver (cf. receiver description). Following successful assignment, press the 'Reset' key briefly to end learning mode, the LED will go out.

TECHNICAL DATA

Functions:	Heating or cooling (can be changed manually by a sliding switch)
Control behaviour:	Variable impulse/pause ratio or 2-point control
Operating voltage:	DC 3 V (2 batteries AAA)
Carrier frequency:	868.95 MHz
Range:	1 ceiling or 3 walls
Protection class:	IP 30.
Mode of operation:	4 (automatic time switch ◷), heating (☼), reduction (☾), off (○)
Temperature range:	5°C – 30°C
Temperature reduction:	4 K (heating) or 2 K (cooling)
Colour:	White (similar to RAL 9010)
Installation:	Surface-mounted or directly on flush-mounted socket (distance between screws 60 mm)
Dimensions:	74 x 74 x 28 mm

Wireless control system transmitter

Room temperature control

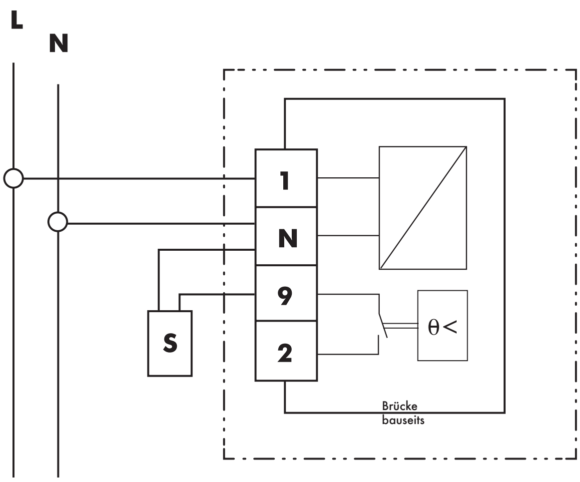
Receiver 1 can only receive control signals from one transmitter. An actuator can be connected directly to the receiver. Terminals 1 and 2 must be bridged on site for this (cf. terminal configuration plan). If several heating circuits in one room need to be controlled at the same time, the control current (9) can be distributed to up to 20 actuators. The receiver can be switched from heating to cooling by opening the bridge J1 (jumper).

To establish wireless contact with a transmitter (this must be in the learning mode), press '! ' key briefly. A signal will be sounded and the LED lights up while the connection is being made. Following successful assignment at the transmitter, press the 'Reset' key briefly to end learning mode, the LED will go out.

TECHNICAL DATA

Operating voltage:	AC 230 V/50 Hz
Power consumption:	< 1.5 W
Load switching:	1 relay, closer 16 (2) A potential-free (terminals 2 and 9)
Carrier frequency:	868.95 MHz
Operating temperature:	0°C–40°C
Protection class:	IP 30.
Colour:	Pure white (similar to RAL 9010)
Installation:	Surface-mounted or on flush-mounted socket (distance between screws 60 mm)
Dimensions:	75 x 75 x 28 mm

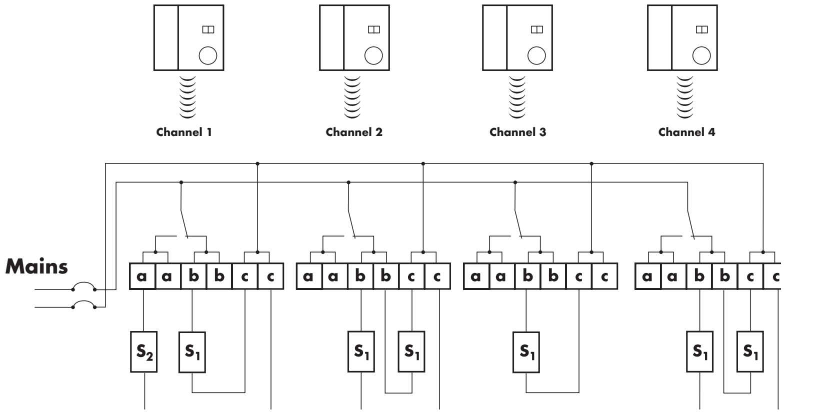
Wireless control system receiver 1



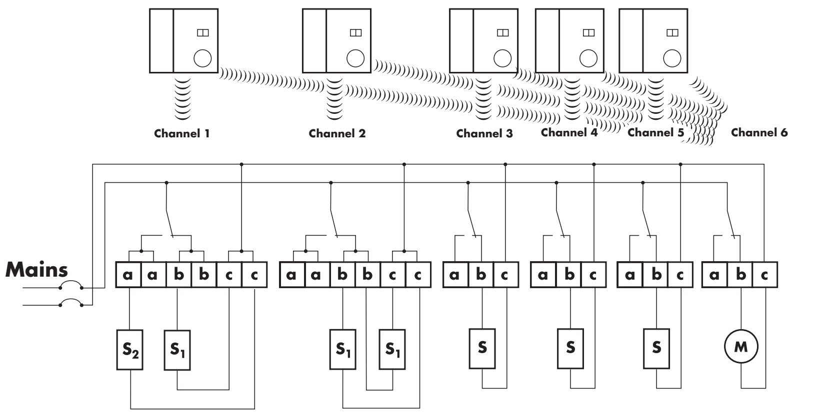
Terminal configuration:

1	Outer conductor L (phase)
N	Neutral conductor N
9	Load circuit potential-free e.g. control conductor to the actuator
2	Load circuit potential-free e.g. outer conductor L (phase)
S	***PRINETO*** actuator, closed with power off

Room temperature control



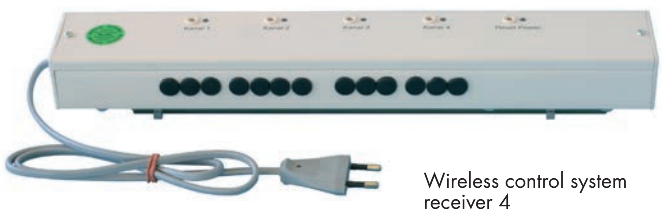
Circuit diagram Receiver 4



Circuit diagram Receiver 6 with pump logic

Terminal configuration:

b–c To the actuator, closed with power off (***PRINETO***)
a–c To the actuator, open with power off
S1 ***PRINETO*** actuator, closed with power off
S2 Actuator, open with power off
Ⓜ Heating circuit pump



Wireless control system receiver 4

Receivers 4 and 6 can receive the signals of 4 or 6 transmitters and transform them into control signals for electrical consumers. In case of double occupancy of the terminal positions a maximum of 4 actuators per receiver channel can be connected directly (no terminal strip required).

In the case of receiver 6, only 2 actuators can be directly connected to each of channels 3 to 6. If several heating circuits in one room are to be controlled at the same time, the control current (on terminal positions b) can be distributed to up to 10 actuators per channel via the terminal strip (art.-no. 878 386 094).

If no room temperature controller transmitter is assigned to channels 4 or 6, and a heating circuit pump is connected to terminal b, this pump is switched off if none of the 3 or 5 transmitters demands heat (pump logic).

The receiver can be switched from heating to cooling by pressing the 'Channel 3' and 'Reset' keys at the same time. Pressing 'Channel 4' and 'Reset' changes back to heating. To establish wireless contact with a transmitter (this must already be in the learning mode), briefly press the key of each respective receiver channel. A signal will be sounded and the LED of the selected channel lights up while the connection is being made. Following successful assignment at the transmitter, press the 'Reset' key briefly to end learning mode, the LED will go out. Now the next transmitter can be assigned.

TECHNICAL DATA

Operating voltage:	AC 230 V/50 Hz	Protection class:	IP 40
Power consumption:	3 W	Colour:	Pure white (similar to RAL 9010)
Load switching:	4 or 6 relays, 8 (2) A changers potential-free	Installation:	on top-hat rail for fast mounting in manifold cabinet
Carrier frequency:	868.95 MHz	Connection cable:	0.9 m long, 2-wire with plug
Operating temperature:	0°C–50°C	Dimensions:	375 (453) x 60 x 52 mm (incl. top-hat rail)

Room temperature control

Terminal strip 230 V (art.-no. 878 386 094)

The terminal strip is a current manifold and is used for the tidy and space-saving wiring of up to six room temperature controllers with up to 14 thermoelectric actuators (e.g. individual-room controllers for surface heating systems). The cable terminal blocks are arranged in six zones; each zone can be controlled via a separate room temperature controller. Through bridging of the control circuit terminals the zones can be combined and thus the number of the actuators switched increased (at the expense of the number of zones).

Zone R1 and R2 for the connection of 4 actuators each

Zone R3 and R4 for the connection of 2 actuators each

Zone R5 and R6 for the connection of 1 actuator each

TECHNICAL DATA

Operating voltage:	AC 230 V – 50/60 Hz
Amperage:	max. 4 A
Protection class:	IP 43, protection class II
Connection cable:	1.4 m long, 2-wire with plug
Housing size:	305 x 100 x 60 mm

The optional cover with 6-channel pilot timer and pump logic (art.-no. 878 386 154) allows the heat sink resistance of the connected room temperature controllers to be activated according to the timer (night-time reduction of the rooms connected). For this purpose the terminal of the heat sink resistance of the room temperature controller must be connected to the respective terminal of the time channel (🕒 CH1 to 🕒 CH6) (see examples in terminal plan).

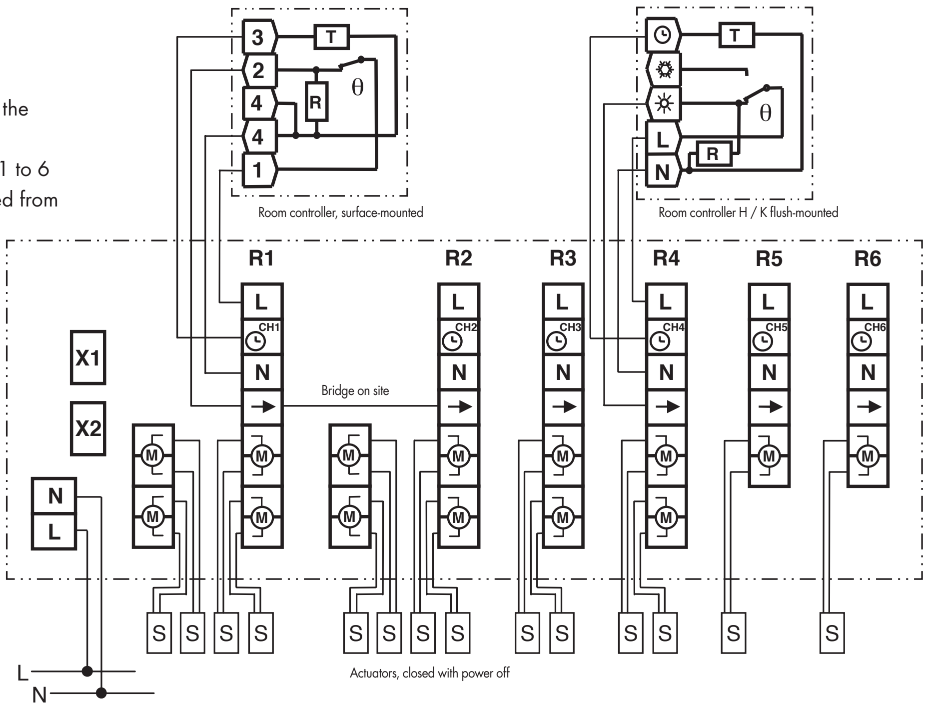
For all functions to be able to be used, the room temperature controller must be connected using a cable with at least four live conductors.

Examples terminal plan:

- The surface-mounted room temperature controller switches a total of eight actuators via zones R1 and R2 and receives a time signal for room temperature reduction via channel 1. The control terminals of zones R1 and R2 are bridged.
- The flush-mounted room temperature controller heating/cooling switches two actuators via zone 4 and receives a time signal for room temperature reduction via channel 4. The cooling output of the controller is not connected

Terminal configuration:

L	Outer conductor L (phase)
N	Neutral conductor N
➔	Control conductor coming from the room temperature controller
CH1–6	Additional conductor channels 1 to 6 for night-time reduction (switched from optional pilot timer art.-no. 878 386 154)
Ⓜ	Connections for actuators
X1 + X2	Slots for signals reduction time and pump logic (for optional pilot timer art.-no. 878 386 154)
X2	Slot for signal pump logic (for optional pump logic art.-no. 878 386 155)



Room temperature control

Terminal strip 230 V heating/cooling (art.-no. 878 386 150)

The 230 V heating/cooling terminal strip provides tidy and space-saving wiring for up to six heating/cooling room temperature controllers with up to 12 230 V self-shut-off thermo-electric actuators. The cable terminal blocks are arranged in six zones R1 to R6, each of which can be controlled via a separate room temperature controller. Up to two actuators can be connected to each zone. Through bridging of the control circuit terminals the zones can be combined and thus the number of the actuators switched increased (at the expense of the number of zones).

The room temperature controllers are connected to terminals 2 to 5 of each of the controller zones. These regulate the connected actuators through terminals 6 to 9. The external switching signal from heating to cooling operation is laid to the potential-free terminals e and f. If 230 V voltage is applied to the changeover contact, the terminal strip works in cooling mode; only the control current coming via terminal 3 from the room temperature controller can flow to the actuators and open these. If terminals e and f are voltage-free, the terminal strip works in heating mode; only the control current coming via terminal 4 from the room temperature controller can flow to the actuators and open these. The function mode can be inverted through jumper J1.

If the conductor current for a heating circuit pump is routed via terminals c and d, the pump is switched off when all the actuators are without power and close (pump logic). The mains connection for this pump must not be via the terminal strip since this only has 4 A fuse protection, there has to be a separate external supply. With an optional cover with 6-channel pilot timer (special article please request separately) the heat sink resistances of the room temperature controllers connected can be activated according to a timer (night-time reduction of the rooms connected). The activation of the room temperature controller heat sink resistance is via terminal 1 of the respective zone. For all functions to be able to be used, the room temperature controller must be connected using a cable with at least five live conductors.

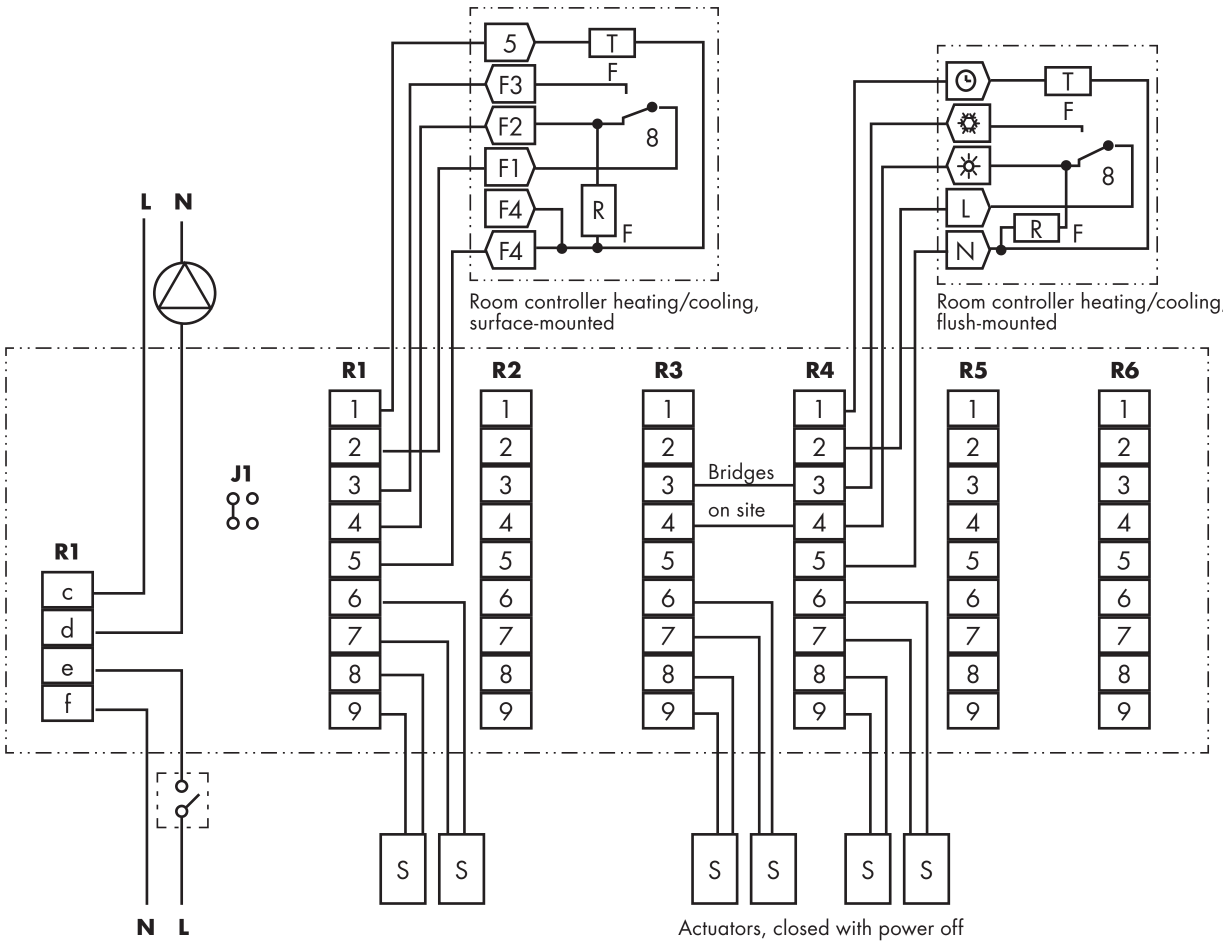
This apparatus is suppressed in accordance with VDE 0875 T.14 or EN 55014 and operates according to operating mode 1c (EN 60730).

TECHNICAL DATA

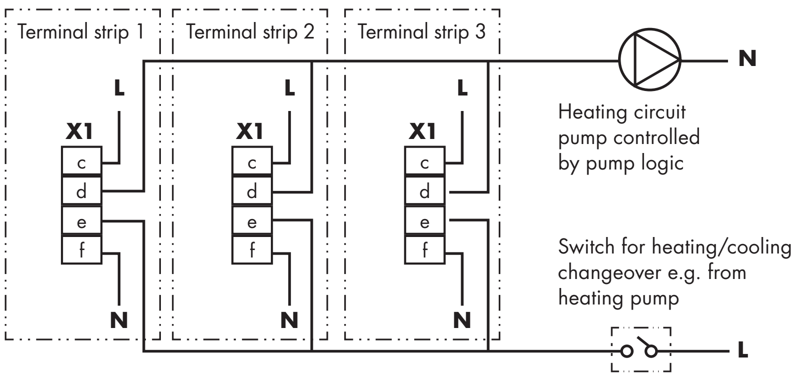
Operating voltage:	AC 230 V/50 Hz
Power consumption:	3 W
Amperage:	max. 4 A
Ambient temperature:	0 to 50°C
Load circuits:	6 x ~4 (2) A (total of all currents ≤ 4 A)
Number of actuators:	
3 W per controller zone:	Max. 10 (a maximum of 16 actuators can be controlled by one unit)
Protection class:	IP 54, protection insulated
Protection class:	II
Colour:	White (similar to RAL 9010)
Connection cable:	1.4 m long, 2-wire with plug
Weight:	Approx. 700 g
Dimensions:	305 x 100 x 60 mm

Room temperature control

Electrical wiring diagram



Combination of several terminal strips



Terminal configuration:

L	Outer conductor L (phase)
N	Neutral conductor N
c, d	Heating circuit pump (pump logic)
e, f	Switching signal 230 V for heating/cooling
2	Outer conductor L (phase)
3	Control conductor cooling
4	Control conductor heating
5	Neutral connector N, to the RTR
6, 7, 8, 9	Actuators

If individual rooms are not to be cooled, the control conductor cooling (3) is not occupied in the respective zone. Surface-mounted room temperature controllers (art.-no. 878 386 096) can be installed in these rooms.

Room temperature control

Cover pump logic and pump protection (art.-no. 878 386 155)

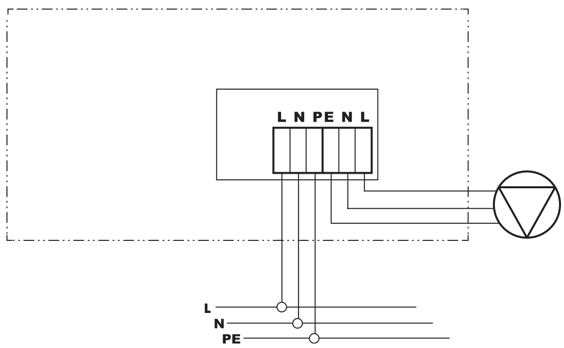
The cover is installed in place of the standard cover on the 230 V terminal block (art.-no. 878 386 094) and is connected to slot X2 of the terminal strip by a twist-proof plug. It switches the heating circuit pump that has been connected (e.g. from the thermostat set art.-no. 878 386 230) after a delay of about five minutes if all actuators are closed. This saves electrical energy, protects the heating circuit pump from overheating and prevents pump noise.

The pump protection prevents the pump shaft seizing up in summer. The pump is activated for about 5 minutes every day. The pump is switched on 24 hours after it was last switched off.

The pump to be controlled is connected on the right side of the black terminal block of the cover (PE', N', L'). The power supply cable is clamped on the left side. The mains connection for the pump must not be via the terminal strip since this only has 4 A fuse protection, there has to be a separate external supply.

TECHNICAL DATA

Protection class:	IP 40.
Colour:	White (similar to RAL 9010)
Power consumption:	3 W
Protection class:	II
Load circuits:	Relay closer, potential-free 4 (2) A; 24 ...230 V
Dimensions:	305 x 95 x 20 mm



Room temperature control

Cover with 6-channel pilot timer and pump logic (art.-no. 878 386 154)

The cover incorporating a 6-channel pilot timer and pump logic is a supplementary device for the 230 V terminal strip, art.-no. 878 386 094 (please order special article for terminal strip heating/cooling) which enables the time programming reduction of room temperature from the terminal strip, surface-mounted or flush-mounted. This makes it a cost-effective alternative to digital room temperature controllers, saving electricity with its integrated pump logic and protecting the pump from overheating. The cover is mounted in place of the standard cover on the terminal strip and is connected to slots X1 and X2 by two twist-proof plugs.

The 6-channel digital timer allows an individual heating program to be assigned to each of the room temperature controllers connected to the terminal strip. This allows individual days or blocks of days to be selected in combination with six different timing profiles. The sixth profile can be individually altered. The timer can be set up to prevent unintentional adjustment.

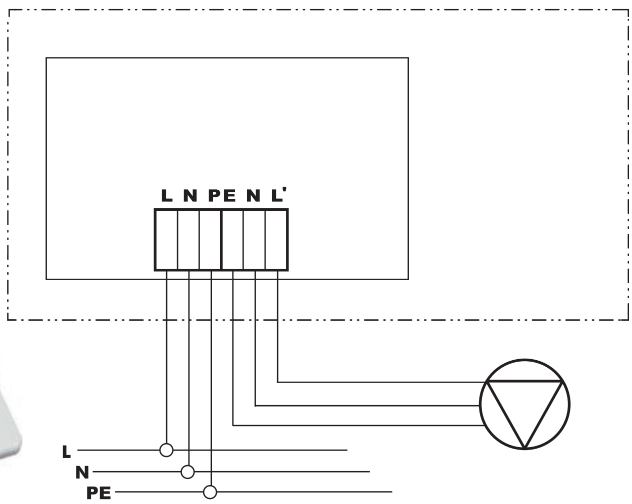
The integrated pump logic function ensures the heating circuit pump switches off when no there is no heating required in the rooms and all the actuators are closed (or during night-time reduction with thermostat set and room controllers). The pump protection prevents the pump shaft seizing up in summer. The pump is activated for about ten minutes every day. The switch-on time is the time the cover is put into operation for the first time.

NOTE

The current flow at terminals CH1 to CH6 of the terminal strip is enabled during the preset heat reduction times in order to activate the heat sink resistance of the room temperature controller.

Profile 1	Heat reduction time from 10 pm to 6 am
Profile 2	Heat reduction time from 10 pm to 6 am, 10 am to 12 pm, 3 pm to 6 pm
Profile 3	Heat reduction time from 5 pm to 6 am
Profile 4	Heat reduction time from 10 pm 6 am, 10 am to 7 pm
Profile 5	Heat reduction time from 11 pm to 6 am, 11 am to 7 pm
Profile 6	Heat reduction time from 11 pm to 5 am, 9 am to 4 pm

The pump to be controlled is connected on the right side of the black terminal block of the cover (PE', N', L'). The power supply cable is clamped on the left side. The mains connection must not be via the terminal strip since this only has 4 A fuse protection, there has to be a separate external supply.



TECHNICAL DATA

Operating voltage:	AC 230 V/50 Hz
Amperage:	4 A
Protection class:	IP 40.
Switched power:	6 A / AC 250 V, not potential-free,
Shifting link:	6 electronic switches
Power reserve storage:	Lithium battery 3 V
Power reserve:	Approx. 4 years
Housing size:	305 x 95 x 20 mm
Data storage:	EEPROM
Precision:	1 second
Settings:	6 pre-programmed cycles 1 cycle with 2 heating times per day freely programmable
Shortest settings gap:	10 Min.
Clock functions:	Automatic summer/winter time changeover and leap year correction pump logic
Temperature range:	+10°C to +50°C
Colour:	White (similar to RAL 9010)
Power consumption pump logic:	3 W
Load circuits pump logic:	Relay closer, potential-free 4 (2) A; 24 ...230 V
Weight:	Approx. 250 g

Actuator 230 V closed with power off (art.-no. 878 386 018)

The electrical actuator is used to control valves with M 30 x 1.5 connection threads on heating circuit manifolds. Triggering is by means of a 2-point room temperature controller or pulse width modulation. The actuating mechanism of the drive works with a heated expanding material element and a compression spring. The expanding element is heated by application of the operating voltage and then moves the integrated slide. This makes the valve open. The round functional display on the drive now projects by 4 mm, the blue ring is visible. After the operating voltage has been switched off, the valve is closed again slowly and evenly by the closing force of the compression spring. The round functional display projects by about 0.5 mm.

On delivery, the actuator is slightly opened without power on account of the first-open function, the round function display on the drive projects by about 1–2 mm. This allows the drive to be fitted onto the adapter more easily and permits heating operation during the preliminary building work when the electrical wiring of the individual room controllers has not been completed. During initial operation (> 6 minutes voltage) the actuator then opens completely and closes completely after it has been cleared of voltage.

- Compact design, small measurements
- Patented protection with leaking valves
- All-round function display
- Maintenance-free
- Silent
- Low power consumption
- 360° installation position
- Push-on installation with valve adapter
- First-open function
- 100% waterproof

Room temperature control

TECHNICAL DATA

Operating voltage:	230 V AC, +10 % ...–10 %, 50/60 Hz
Switch-on current, max.:	< 550 mA for max. 100 ms
Service output:	1 W
Displacement:	4.0/5.0 mm
Actuating force:	100 N +– 5 %
Media temperature:	0 to +100°C
Storage temperature:	-25°C to +60°C
Ambient temperature:	0 to +60°C
Degree of protection/protection class:	IP 54.
CE conformity in accordance with:	EN 60730
Housing material/colour:	Polyamide/light grey (RAL 7035)
Connection cable/colour:	2 x 0.75 mm PVC/light grey (RAL 7035)
Cable length:	Weight with connection cable (1 metre)
Overvoltage protection according to EN 60730-1	min. 2.5 kV

Installation

The actuator has a white valve adapter which is screwed hand-tight to the connection thread of the thermostat valve cores of the ***PRINETO*** heating circuit manifolds. The actuator can now be pushed on and connected to the terminal strip. To loosen the actuator from the adapter, the small plastic spring on the front is pushed in and the actuator lifted off. If the ***PRINETO*** actuator is to be used on heating circuit manifolds made by other manufacturers, the valve adapter may need replacing. The suitable adapter depends on the thermostat valve insert installed. In this case, please contact the IVT technical department.

Room temperature control

Individual room control ***WEB***

The individual room control system ***WEB*** is an intelligent wireless control for maximum comfort and energy efficiency for surface temperature control.

The individual room control system comprises three different room consoles as well as the base station. The room consoles are the system's operating and control unit. They are used for interaction between the user and the base station. An energy-saving bi-directional data exchange of room and operating status data is guaranteed by 868 MHz wireless technology
.

The actuators are connected at the base station in order to control the heating agent flows for the heating circuits.

There is a dedicated web server on the base station. The Ethernet connection of the base station not only makes control of the ***PRINETO*** wireless RTR ***WEB*** possible locally via a home network but also globally via the internet.

Smart Home ready

Thanks to Smart Home ready, the system can also be integrated in existing home automation systems via an open XML interface. In this case, control takes place discreetly via the home automation. Existing components such as door/window contacts can be used to control the ***WEB*** system.

Digital room console

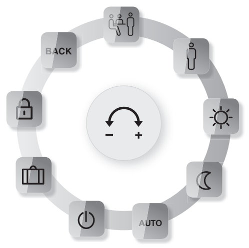
The ***PRINETO*** digital room console is used for the independent room-by-room control of room temperature by means of a wireless signal. With comprehensive functionality for access to all room- and system-specific parameters as well as precise temperature recording, it makes the set-up of a perfectly harmonised individual room control possible for maximum user convenience. In addition, it guarantees bi-directional data exchange with the wireless base station for the retrieval of numerous status messages as well as their indication on the large, clear display. Operation is by means of a rotary button with turn/push mechanism and fine detent, as well as the always clear, language-neutral display. With options for connecting an external sensor as well as a control option via the home network or internet by means of the base station with Ethernet connection

For the wireless connection to be set up, the rotary button must be pressed for approx. 3 seconds until SEE appears on the display.

Characteristics

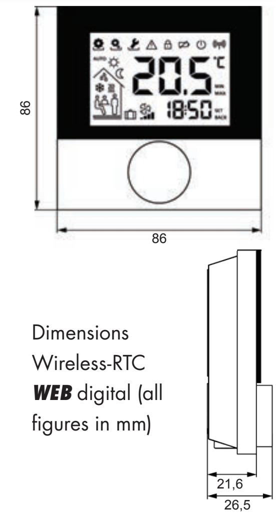
- Self-explanatory, language-neutral operation and user guidance
- LC display (60mmx40mm) made of scratch-resistant plastic
- Permanent display of room temperature, system time and operating status
- 868 MHz wireless technology for positioning without cabling effort
- 3 menu levels (lifestyle functions, parameters and service)
- Limitation of the room temperature setting range
- Operation using a rotary button (turn-push mechanism with fine, dynamic detent)
- Setting range 5°C - 30°C

Room temperature control

Lifestyle-Funktions	Parameter	Service
 Party - deactivates the temperature setback for XX hours Presence - weekend heating times are also used for working day Default settings - day, night, atomatic Switching off - deactivates the room control unit, the temperature is still displayed. anti-freeze operation is activated Holiday mode - the temperature is set back automatically to the set holiday temperature Child safety lock - locks the room operating unit	 Selection of predefined lifestyle settings (individually changeable via online-tool) Activate and set desired temperature day/ Night, ECO and holiday Activate and select the desired floor heating minimum temperature Date & time for the complete system Display of software versions of room controller, base station and web-system of base station Setback parameters	Protected by a PIN code against unauthorized access Individual and optimum adjustment of the system using system parameters such as: • Setting of the heating system used for each zone (e.g. floor heating, radiator, convector, etc.) • Blocking of switching outputs of a zone depending on the activated operation mode (heating/cooling) • Active switchover heating/cooling • Activation/deactivation Smart-Start technology • Definition of operation locks / PIN • Setting a correction of actual values • Global switchover of the direction of action of the system (de-energized open) • Setting of the frost protection temperature • Blocking of heating/cooling for individual zones • Switchover Fahrenheit/Celsius • Setting of various pump/vessel parameters

TECHNICAL DATA

Voltage supply	2 x LR03/AAA (micro) alkaline battery
Battery life	> 2 years
Polarity protection	electronic via MOSFET switch
Wireless technology	radio, 868 MHz SRD band
Protective rating/protection class	IP 20/III
Permissible ambient temperature	0 °C bis 50 °C
Permissible ambient humidity	5 % bis 80 %, non-condensing
Storage/transport temperature	–10 °C bis +50 °C
Standards and regulations	EN60730-1/EN60730-2-9/Electrical and Electron. Equipment Act or RoHS-conform
Material	ABS (housing, base, rotary button) PMMA (screen)
Colour	RAL9010 (pure white)
Outer dimensions	86 x 86 x 21,6 mm/26,5 mm
Weight	115 g
Visible display area	40 x 60 mm
Encoder	30 detents over 360°
Setting range setpoint temperature spec	5 °C bis 30 °C
Resolution setpoint temperature spec	0,2 K
Measuring range ACTUAL temp. recording	0 °C – 40 °C
Measuring accuracy of internal NTC	±0,3 K



Dimensions Wireless-RTC ***WEB*** digital (all figures in mm)

Room temperature control

Analogue room console

The ***PRINETO*** analogue room console is used for the independent room-by-room control of room temperature by means of a wireless signal. With precise temperature recording, it makes the set-up of a harmonised individual room control possible for maximum user convenience. The desired room temperature is set in the assigned zone by using a rotary button with fine detent and the always clearly legible scale. The possible setting range is limited using tabs underneath the rotary button, and the value is compared with the setpoint value. Setting range 10 – 28°C, using a base station with Ethernet connection this can also be retrieved via the home network or the internet.

The set button under the setting wheel must be pressed for a maximum of 1 second to build up the wireless connection.

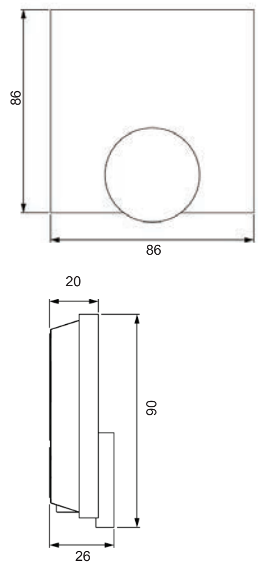
Operation of the room console is convenient via the rotary button, with the temperature scale always easily legible. The user simply turns the button to the desired temperature comfort level.

Characteristics

- Setpoint comparison
- Setting range 10 °C – 28 °C
- 868-MHz-wireless technology for positioning without cabling effort or tethered with 24 V BUS-connection
- Rotary button with ¼ -degree soft detent
- Setting wheel with degree markings, can be adjusted in ¼ -degree stages

TECHNICAL DATA

Voltage supply	2 x LR03/AAA (Micro) Alkaline Batterie
Battery life	> 2 years
Polarity protection	electronic via MOSFET switch
Wireless technology	funk, 868 MHz SRD
Protective rating/protection class	IP 20/III
Permissible ambient temperature	0 °C bis 50 °C
Permissible ambient humidity	5 % to 80 % non-condensing
Lager-/Transporttemperatur	–10 °C – +50 °C
Standards and regulations	EN60730-1/EN60730-2-9/Electrical and Electronic Equip. Act or RoHS-conform
Material	ABS (housing, base, rotary button)
Colour	RAL9010 (pure white)
Outer dimensions	86 x 86 x 20 mm/25,5 mm
Weight	90 g
Potentiometer	47 K/260° setting range
Pairing key	under rotary button
Setting range setpoint temperature spec	10 °C – 28 °C
Resolution setpoint temperature spec	0,25 K
Measuring range ACTUAL temp. recording (int. sensor)	0 °C bis 40 °C
Measuring accuracy of internal NTC	±0,3 K



Dimensions Wireless RTC ***WEB*** analogue (all figures in mm)

Room temperature control

Sensor room console

The ***PRINETO*** sensor room console is used for the independent room-by-room control of room temperature by means of a wireless signal with inner setting. With precise temperature recording, it makes the set-up of a harmonised individual room control possible for maximum user convenience. The desired room temperature is set in the assigned zone by using a rotary button under the cover in order to avoid unwanted adjustment. Setting range 10 – 28°C, using a base station with Ethernet connection this can also be operated via the home network or the internet.

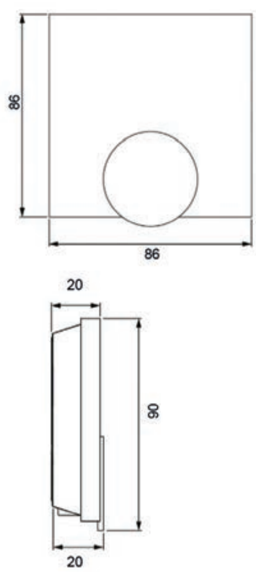
The set button under the setting wheel must be pressed for a maximum of 1 second to build up the wireless connection.

Characteristics

- Setpoint comparison
- Setting range 10 – 28°C
- 868-MHz-wireless technology for positioning without cabling effort oder kabelgebunden mittels 24 V Bus-Verbindung
- Rotary button with ¼ -degree soft detent
- Setting wheel with degree markings, can be adjusted in ¼ -degree stages

TECHNICAL DATA

Voltage supply	2 x LR03/AAA (micro) alkaline batterie
Battery life	> 2 years
Polarity protection	electronic via MOSFET switch
Wireless technology	radio, 868 MHz SRD band
Protective rating/protection class	IP 20/III
Permissible ambient temperature	0 °C to 50 °C
Permissible ambient humidity	5 % to 80 % non-condensing
Storage/transport temperature	–10 °C – +50 °C
Standards and regulations	EN60730-1/EN60730-2-9/Electrical and Electronic Equip. Act or RoHS-conform
Material	ABS (housing, base, rotary button)
Colour	RAL9010 (pure white)
Outer dimensions	86 x 86 x 20 mm
Weight	90 g
Potentiometer	47 K/260° setting range
Pairing key	under rotary button
Setting range setpoint temperature spec	10 °C – 28 °C
Resolution setpoint temperature spec	0,25 K
Measuring range ACTUAL temp. recording (int. sensor)	0 °C bis 40 °C
Measuring accuracy of internal NTC	±0,3 K



Dimensions Wireless-RTC ***WEB*** sensor (all figures in mm)

Room temperature control

Base station

The wireless RTR ***WEB*** base station 230V with 4 and 8 zones are the system's intelligent control and connection units for central information processing and communication with all system components. They record and evaluate numerous measuring data for individual, energy-efficient temperature control in each room and maximum user convenience. The 868 MHz wireless technology guarantees safe, bi-directional communication of the assigned room consoles, base stations and connected drives while keeping radio load to a minimum. The system software fulfils all requirements of current and future systems even in its standard version – adaptations and updates for a technologically changing environment are carried out conveniently by means of a MicroSD card slot.

There is one outlet each for pump logic and boiler control on the base station which can close the circuit if no heat is required. For several base stations to be taken into consideration, they can be linked. The room console can use the heating and cooling pilot function to switch the entire heating system over via the boiler output.

The base station learns the heat-up times through the Smart Start function and can adapt to user habits. Since the pattern over several days is taken into consideration, the base station can also react to changes.

The XML interface permits straightforward integration in higher-order systems. The Ethernet version also permits integration into the home network. The integrated Web application offers convenient control of the individual room control by PC and/or smartphone as well as via the internet.

Characteristics
- Versions in 4 or 8 zones
- All-in-one – complete equipment for heating and/or cooling systems
- Coupling of up to 7 base stations via radio
- Output status NC or NO can be selected
- Tried-and-trusted cable routing and strain relief
- Screwless plug-type/clamp connection technique
- MicroSD card slot for individual adaptation
- Perfect interaction of several base stations via bus
- Integrated system clock
- Integration in the home network
- Web-based application software for convenient control by PC, smartphone and via the internet
- Smart Start function for even more energy-efficient operation

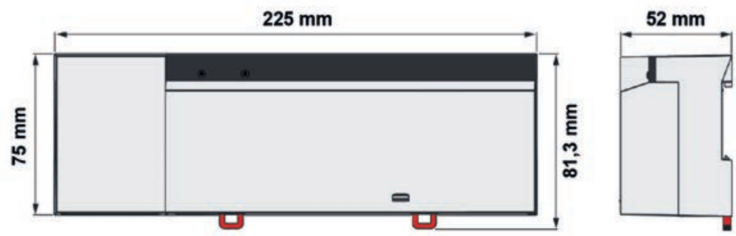
Technical data

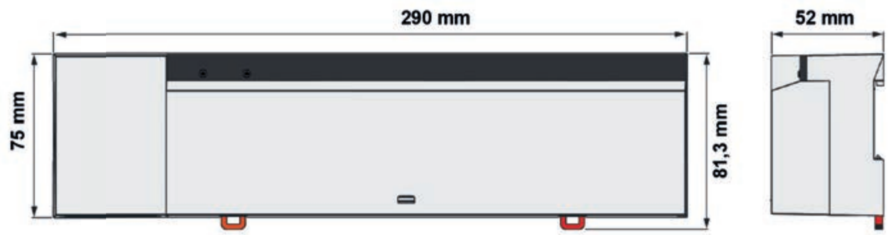
	4-channel	8-channel
Max. number of heating zones	4	8
Power consumption when idling	2,4 W	
Max. power consumption (without pump)	50 W	
Fuse protection	5 x 20mm, T4AH	
Protection class	II	
Protective rating	IP 20	
Wireless technology	radio, 868 MHz SRD-band	
Max. number of drives	2 x 2 + 2 x 1	4 x 2 + 4 x 1
Max. nominal load of all drives	24 W (12 x 2 W or 8 x 3 W resp. 18 x 1 W)	
Switching element version	Relay	
Switching capacity per heating zone	max. 1 A permissible	
Overload protection	Current limitation through device fuse	
Pump connection	Contact: 1C (single pole switching/direct pump supply)/ no through-wiring option	
Pre-/post-run time	configurable	

Room temperature control

	4-channel	8-channel
High-efficiency pump	configurable	
Switched power	8A bei cosj = 1/inductiv max. 200 VA	
Boiler connection/CO output	Contact 1 A (single pole, closer)/can be inverted	
Pre-/post-run time	configurable	
Switched power	1A bei cosj = 1/inductive max. 200 VA	
System bus connection	RS485 with GND and 24 V for supplying ext. components max. 2 W power drain possible	
Ethernet connection	RJ45	
Connection terminals		
Wire cross-section: solid	0,2 bis 1,5 mm²	
Wire cross-section: fine-wired with ADH without plastic sleeve	max. 1,0 mm²	
Wire cross-section: fine-wired with ADH with plastic sleeve	max. 0,75 mm²	
Stripped length	8 to 9 mm	
Type of control	PI / 2-point adjustable	
Control accuracy of the setpoint value set	±1 K	
Control instability	±0,2 K	
Permissible ambient temperature	0 °C to 60 °C	
Permissible ambient humidity	5 % to 80 % non-condensing	
Storage/transport temperature	–25 °C to +70 °C	
Mains connection version	Terminals NYM connection 3 x 1.5 mm²	
Material	PC + ABS	
Colour	RAL7035 (light grey)	
Outer dimensions	225x52x75 mm	290x52x75 mm
Weight	500 g	650 g
Gewicht Trafo (BUS-Version)	-	600 g

Dimensions





Room temperature control

Thermostat set

Application
If several rooms in a building with a high-temperature heating system are to be heated by means of an underfloor heating system, the heating media temperature has to be lowered to prevent the surface temperatures of the floors becoming too high. With the ***PRINETO*** thermostat set the temperature is reduced directly at the heating circuit manifolds near the rooms. The installation of an additional pump assembly at the boiler and the laying of additional risers through the building are not necessary.

Controlling of the temperatures of the individual rooms can be done by room temperature controllers and actuators. For easier hydraulic equalisation we recommend the use of manifolds with Regolux Memory flow meters. In order to save electrical energy an electronic pump logic
(art. no. 878 386 154 or 155) is recommended.

NOTE

The thermostat set is a complementary assembly unit and is delivered without heating circuit manifold. It is suitable for the ***PRINETO*** heating circuit manifolds with 200 mm bar gap. Separate ball valves for sealing the manifold are not necessary but are possible with our ball valve sets (878 386 132). The thermostat set includes an electronically controlled high-efficiency heating circuit pump which causes unavoidable running noises during operation. With low-noise installation in mind, care must be taken that the power level is set according to the actual amount of water required (cf. pump characteristic) and that structure-borne noise from the running pump cannot be transmitted to the surrounding components, and/or that a suitable installation location is chosen.

Function
By using the thermostat set the desired flow temperature of underfloor heating is set at a thermostat head (temperature control independent of the weather). If the underfloor heating temperature falls below the desired value (freely selectable from 20°C to 50°C) the thermostat head gradually opens the thermostat valve on the return manifold bar and allows warmer flow water from the high-temperature heating circuit to flow into the underfloor heating circuits (admixture).

In the heating circuit pump the cool return water of the heating circuits is mixed with the following flow water. The mixing temperature can be read from and controlled at the thermometer. The heated mixed water flows into the underfloor heating circuits as flow. An immersion sensor is installed downstream from the heat circuit pump which closes the thermostat valve on the return manifold bar once the desired underfloor heating temperature is reached. The heating circuit pump allows the heated mixed water to flow through the heating circuits until the temperature falls again due to heat emission into the connected rooms and the admixing sets in.

To prevent inadmissible exceeding of flow temperature (e.g. because of defective thermostat head) a temperature sensor is integrated in the pump. Its stops the pump when the temperature exceeds 55°C.

Installation
The thermostat set, comprising a circulation pump with two stainless steel bars, is delivered pre-assembled. It is screwed directly to the flat-sealing G 1" union nut screw connections of the ***PRINETO*** heating circuit manifolds. The return manifold bar (1) must be mounted on top for this! The thermostat head (2) is screwed hand-tight to the thermostat valve (3) and the immersion sensor (capillary sensor) is pushed as far as it will go into the immersion sleeve (4) and fixed in place using a black cap. Do not bend the capillary tube (5) of the immersion sensor as you do this.

The flow of the high-temperature heating circuit system is connected to (6), the return to (7). There is a control valve (8) in the return which allows the flow to be preset (default setting corresponds to graph 2.0 of the pressure loss diagram). Connections to the HT-system can be horizontal through the brackets (9). If vertical installation is required, the brackets can be removed or both brackets can be screwed together on the flow bar to achieve parallel displacement to the vertical return.

The thermostat set includes a safety temperature limiter (STB) with a fixed preset. This is screwed to the flow bar (12). If the flow temperature exceeds a maximum permissible value of 55°C, the STB switches the power supply to the circulation pump off. The necessary wiring is done on-site.

Room temperature control

CAUTION!

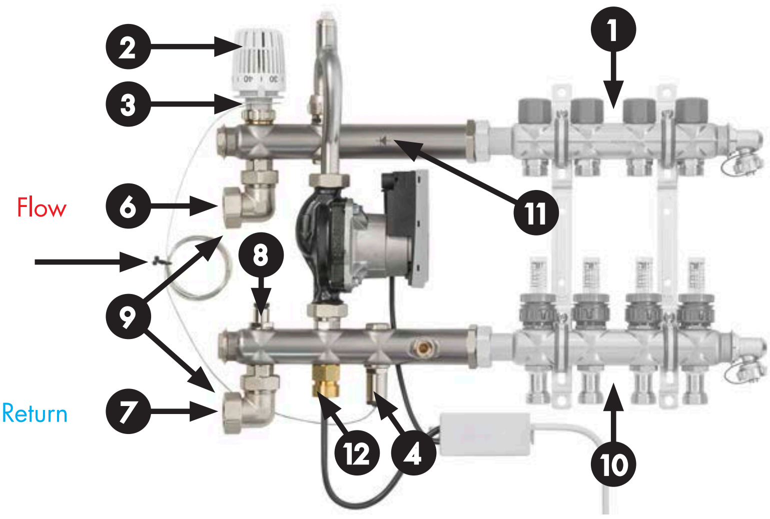
The electrical devices may only be connected by an expert in compliance with the terminal inscriptions. The existing safety regulations of the VDE and the local power supply company must be observed! The components always have to be de-energised before opening!

NOTE

Filling of the heating circuits for venting must be done via the flow manifold bar to (4). The return preventer in the flow pipe (10) prevents incorrect flow via the heating circuit pump to the return manifold bar.

When Regolux Memory manifolds are used, the connection to the high-temperature heating circuit must be closed during hydraulic equalisation of all heating circuits, the heating circuit pump must be running and the valves in the return must be opened.

All screw connections have to be retested for a firm fit before filling. The tigh tening torque of the G1 union nuts must not exceed 40 Nm (reference value: nut tightened hand-tight + approx. ¼ turn).



Heating circuit pump Yonos Para RS 15/6

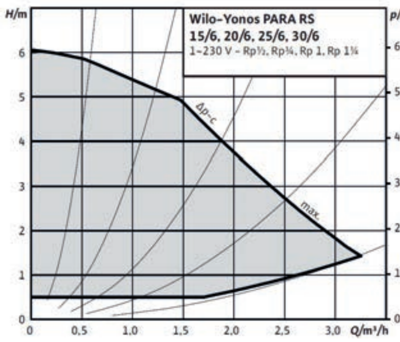
Type of motor	Automatically controlled high-efficiency pump with volume-flow-dependent differential pressure regulation, with start-up current limitation and LED display
Methods of regulation	Constant differential pressure or proportional pressure
Operating voltage	230 Volt, 50/60 Hz
Energy class	High-efficiency A
EE-Index	< 0,20
Permissible pumping media	Heating water in accordance with VDI 2035, glycol-water mixture*
Mediums to be pumped	6.2 m
Power consumption	4 – 45 W
Permissible temperature range of the pumped liquid	–10 °C** to +110 °C
Motor protection class	IP 4D
Insulation class	F
Weight	2370 g
Connection	1" AG flat-sealing

* Pump capacity changes considerably when water-glycol mixtures with concentrations greater than 20% are pumped.
** Protect from frost. In order to avoid condensation the liquid temperature must be higher than the room temperature.

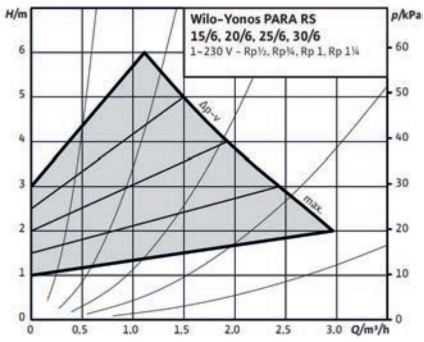
Room temperature control

Curve family

Δp-c (constant)



Δp-v (variable)

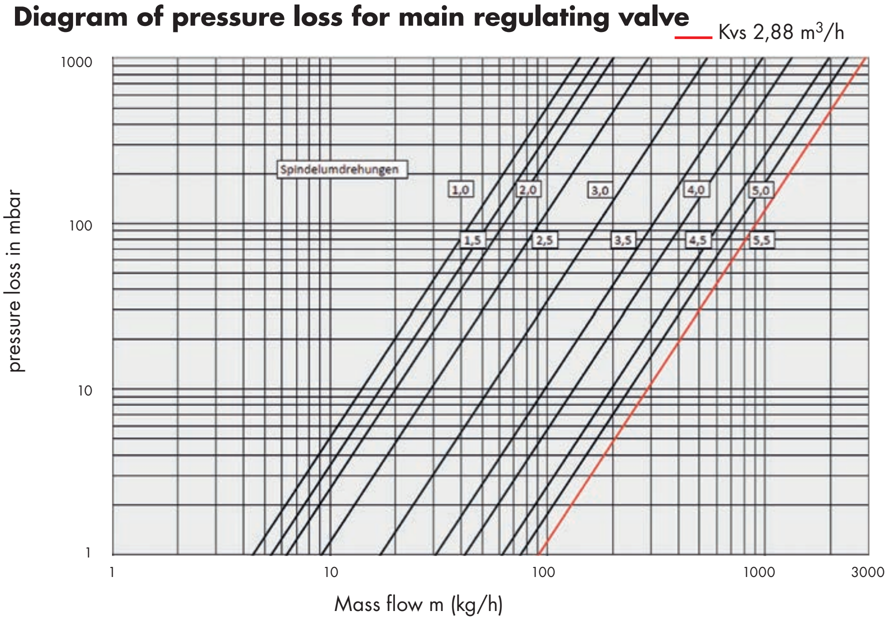


Für den Einsatz von Flächenheizungen ist die Einstellung Δp-c zu bevorzugen.

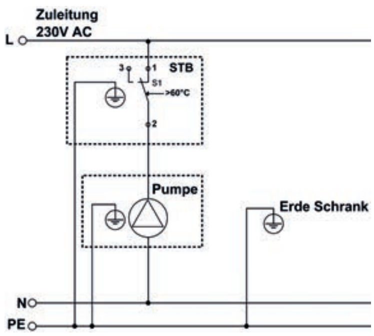
Armatures

Heimeier thermostat head K
• -Liquid sensor as immersion sensor with 2 m capillary tube • -Setting number 20 - 30 - 40 - 50 Setpoint range 20°C - 50°C • -Connection thread M 30 x 1.5

Diagram of pressure loss for main regulating valve



STB (Jumo)



Manifold cabinets for heating circuit manifolds with thermostat set

Assembly	flush-m. cabinet	surface-m. cabinet
Heating circuit manifold 3-fold with thermostat set	Size 4	Size 4
Heating circuit manifold 4-fold with thermostat set	Size 4	Size 4
Heating circuit manifold 5-fold with thermostat set	Size 5	Size 5
Heating circuit manifold 6-fold with thermostat set	Size 5	Size 5
Heating circuit manifold 7-fold with thermostat set	Size 5	Size 5
Heating circuit manifold 8-fold with thermostat set	Size 6	Size 6
Heating circuit manifold 9-fold with thermostat set	Size 6	Size 6
Heating circuit manifold 10-fold with thermostat set	Size 6	Size 6
Heating circuit manifold 11-fold with thermostat set	Size 7	on request
Heating circuit manifold 12-fold with thermostat set	Size 7	on request

Installation testing of ***PRINETO*** underfloor heating system

Pressure testing acc. to DIN 1264/-4

After completion and before the screed or another covering is applied, the heating circuits of hot-water underfloor heating systems have to be pressure tested with water as per **DIN EN 1264 part 4** for leak-tightness. The test is to be recorded and signed by the client and the test operative.

With standard systems, the testing pressure must not be lower than 4 bar or higher than 6 bar. This pressure on the pipes must be maintained when the screed is applied. In the case of cast asphalt, the pipes must be pressureless during application of the asphalt (when cast asphalt is used a compensation filling with at least 10 mm pipe cover and an insulating plate (e.g. Knauf Fasoperl A8) must be laid).

The material characteristics of the synthetic pipes lead to an expansion of the pipe during the pressure testing, which causes the pressure to fall. Changes in temperature also distort the test result. Therefore as constant a temperature as possible should be maintained for the test medium during pressure testing, and the initial pressure should be restored several times after the pipe expansion. The pressure test with water is to be implemented as follows:

1. The heating circuit manifolds are disconnected from the rest of the heating system by closing the isolating equipment.
2. Each heating circuit is individually filled with water through the flow manifold bar until it is absolutely free of air. For this purpose the thermostat valves and control valves or top meters must be separately fully opened and closed.
3. When all the heating circuits have been filled the connection to the filling device (e.g. water supply network) must be interrupted as per DIN 1717.
4. All thermostat valves and control valves or top meters are opened.
5. The test is prepared by applying the testing pressure to the entire system. The initial pressure should be restored again after half an hour, and again after a further half hour. After another half hour (1.5 hours after the start) testing can begin (without restoring the initial pressure again!).
7. Visual inspection of all connections
8. The testing is considered successful if after 24 hours the pressure drop is less than 1.5 bar and no leaks have been detected.

NOTE

If manifolds are fitted with flow meters, a testing pressure of 6 bar must not be exceeded! Manifolds with control valves can withstand a pressure of up to 10 bar!

TIP

(In compliance with the “old” DIN 18380 of 12 - 2002) we recommend heating the system after cold-water pressure testing and testing for leak-tightness at the highest permissible operating pressure. Heating of the pipes relieves laying tensions. For laying the screed the testing pressure has to be restored again.

NOTE

If there is danger of freezing, appropriate measures such as the use of antifreeze agents or heating of the building, have to be taken. If no further frost protection is required for the normal operation of the installation, the antifreeze agents must be removed by draining and flushing out with at least three water changes.

Installation testing of ***PRINETO*** underfloor heating system

Pressure testing protocol for floor heating systems as per DIN EN 1264-4

Object: ______________________

Owner: ______________________

Inspector: ______________________

Description of heating circuit manifold

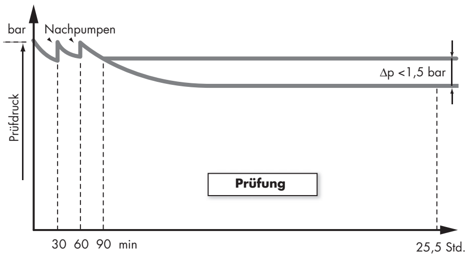
14 ______________________

16 ______________________

17 ______________________

20 ______________________

25 ______________________



Preparation (duration 90 minutes)

Start ______________ h

End ______________ h

Testing pressure ______________ bar
(min. 4 bar, max. 6 bar)

Pressure after 90 minutes ______________ bar
(start of test)

NOTE

The temperature of the test medium should be kept as constant as possible. Fill pipes with water. Vent pipes completely.

Test (duration 24 hours)

Start ______________ h

End ______________ h

Testing pressure at start of testing ______________ bar

Testing pressure after 24 hours ______________ bar

Pressure drop (max. 1.5 bar) ______________ bar

Results of the testing

Pressure testing passed ☐ yes ☐ no

Visual inspection passed ☐ yes ☐ no

Leaks detected ☐ yes ☐ no

Place, Date

Signature inspector

Signature owner or representative

Installation testing of ***PRINETO*** underfloor heating system

Hydraulic equalisation

The client must adjust the system parts in such a way that the planned functions and capacities can be achieved and the legal requirements are met.

In order to achieve the most equal distribution of water quantities in heating circuits with differing total pressure losses, hydraulic equalisation of the heating circuits of the individual manifolds among each other must be effected. This is based on the mass flow rates and pressure losses of heating circuits calculated by means of planning software for domestic technology (liNear or Dendrit). Equalisation must be done in such a way that all heat consumers are supplied with hot water according to their heat requirements even during room temperature reduction or breaks in operation. Hydraulic equalisation is performed after all the heating circuits have been filled and vented.

If the heating circuits of a manifold are coordinated with each other the manifolds of larger buildings have to be included in an overall piping network. For this purpose additional piping control valves must be installed.

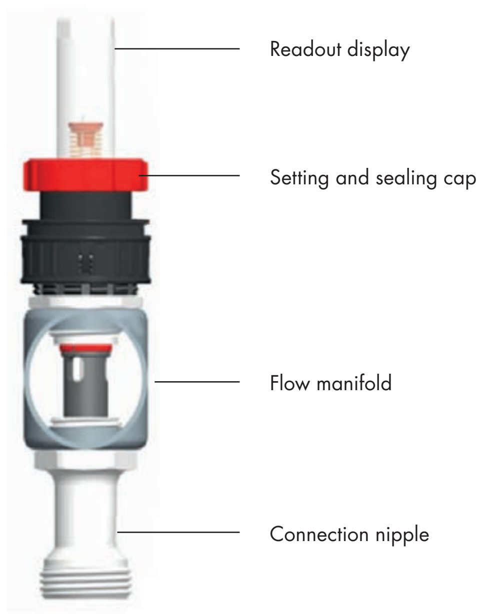
Subsidies can be granted for modernisation work if hydraulic equalisation is confirmed, for example. Visit www.intelligent-heizen.info to view an appropriate form.

Equalisation at heating circuit manifold with flow meter

Where manifolds with a flow meter or control valve with flow volume display are concerned, the data for mass flow rates in litres per hour is sufficient. The values are divided by 60 to get the flow volume in litres per minute. The flow meter of the heating circuit in question is adjusted to the respective value.

Hydraulic equalisation or the regulation of the heating water quantity (mass flow rate) respectively, is performed by turning the red setting and sealing cap on the flow meter. For this purpose, all the thermostat valves in the return must be fully opened and the heating circuit pump must be put into operation.

Adjustment of the respective flow volume (value to be taken from underfloor heating design) in litres per minute is directly dependent on the degree of opening of the valve, and is done by rotating the setting and sealing cap with the circulation pump in operation. The value set can be read immediately from the sight glass. After adjustment of all the heating circuits, it may be that the initial settings have to be corrected. If all flow meters show the flow value calculated for the respective heating circuit, the flow meter is protected against unauthorised or inadvertent incorrect setting by depressing the red sealing cap.



1. Pull safety sliding ring upwards and turn safety cap upwards with the safety sliding ring

2. Set flow value by turning the hand wheel

3. Turn safety cap with safety sliding ring downwards to end stop position

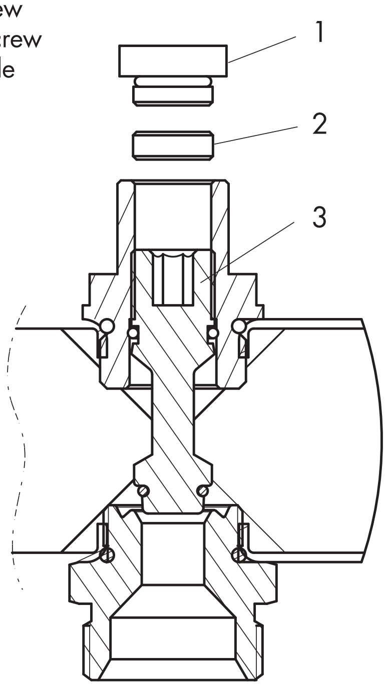
4. Depress safety sliding ring

Equalisation at heating circuit manifold with control valve

Hydraulic equalisation, or adjustment of heating water quantity (pressure loss difference and mass flow rate) respectively, is performed at the control valves in the flow. By rotating the valve spindle the pressure loss Δp of the heating circuit in question is adjusted to the pressure loss of the most unfavourable (highest pressure loss) heating circuit Δp_{max} of this manifold. The required mass flow rate of the respective heating circuit has to be taken into consideration.

Kv = m : √(10 x Δp)
m in [kg/h]; Δp in [Pa]

(1) Closing screw
(2) Adjusting screw
(3) Valve spindle



- Open closing screw (1) with spanner for 5 mm hexagon nuts
- Close valve spindle (3) clockwise with spanner for 5 mm hexagon nuts
- Close adjusting screw (2) clockwise using spanner for 6 mm hexagon nuts until screw touches the valve spindle = zero position
- Open adjusting screw (2) anticlockwise using spanner for 6 mm hexagon nuts according to calculated number of spindle turns (this value is to be taken from the pressure loss diagram, determined by pressure loss difference and mass flow rate acc. to underfloor heating design).
- Thus the setting value is fixed, even if the valve is closed again.
- Open valve spindle (3) by turning it anticlockwise using the 5 mm spanner for hexagon nuts until the spindle touches adjusting screw (2),
- Close closing screw (1) using spanner for hexagon nuts 5 mm

The throttling pressure difference Δp at the new flow meter is determined mathematically by required mass flow. The required Kv value at the valve results from these two values.

The number of spindle turns can be read from the diagram.

Example for a heating circuit:

Pressure loss of the most unfavourable heating circuit
Δp, max. = 200 hPa (= 20 kPa)

Pressure loss heating circuit to be equalised
Δp = 125 hPa (= 12.5 kPa)

Mass flow rate of the heating circuit to be equalised

m = 95 kg/h

Difference in pressure to be equalised

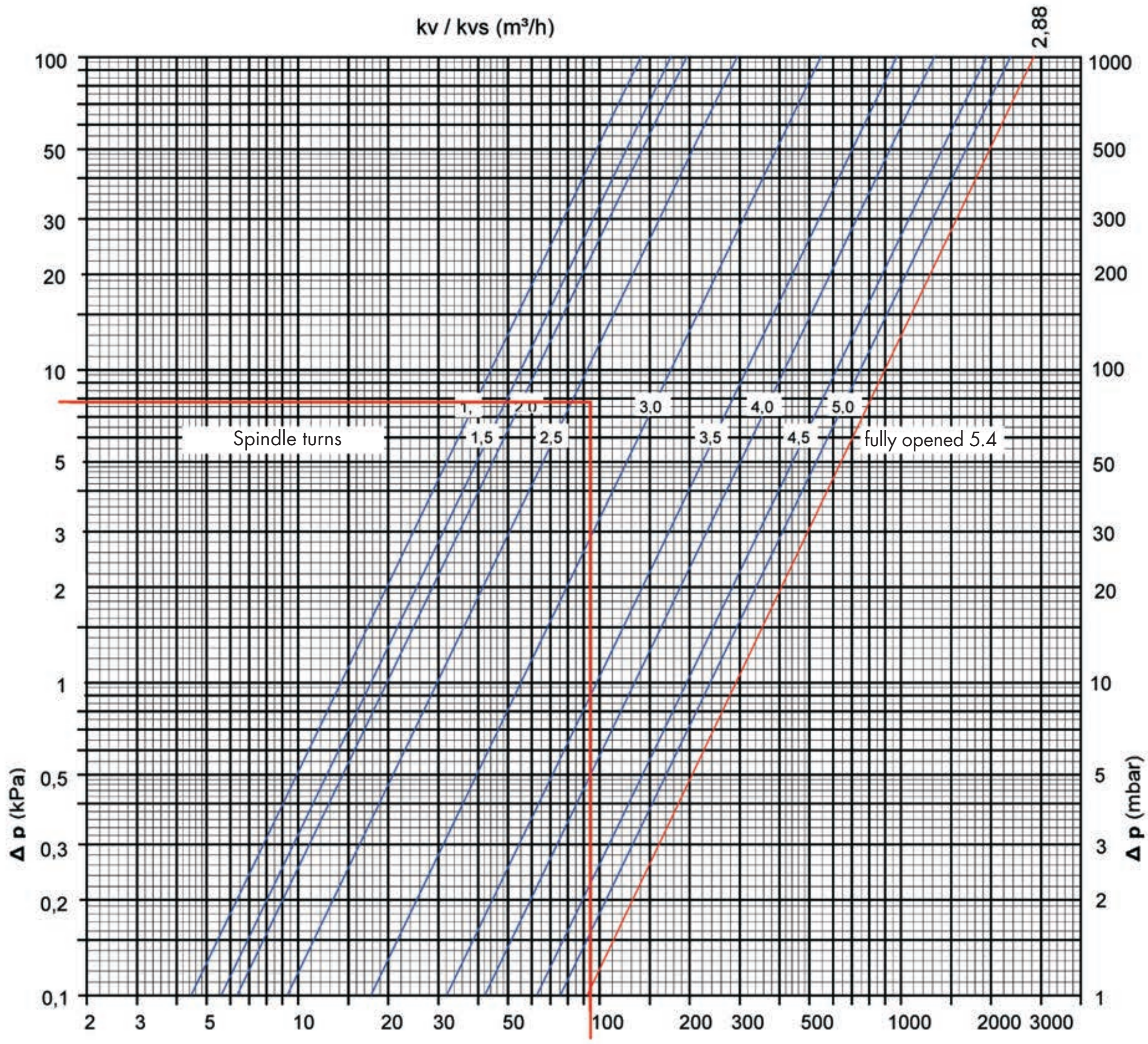
Δp, diff.= 75 hPa (= 7.5 kPa) at 95 kg/h mass flow rate

Kv = 95 kg/h: √ (10 · 7500 Pa) = 0.35
(corresponding to about 2.75 turns, see diagram)

It should be noted that the pressure loss at the valve must not exceed 20 kPa (sound barrier). Valve authority at the thermostat valves Pv (Δp, diff: Δp, max.) should be between 0.3 – 0.7.

Installation testing of ***PRINETO*** underfloor heating system

Pressure loss diagram for mechanical control valves (in flow)



Reading example:
Mass flow rate m = 95 kg/h and Δp, diff.= 7.5 kPa → Open valve by approx. 2.75 spindle turns

Function heating of **PRINETO** underfloor heating installations

In the case of cement screeds operational heating as per DIN EN 1264-4 must not be performed earlier than 21 days after the application of the screed, or according to the manufacturer's instructions, or not earlier than 7 days in the case of calcium sulphate screeds. Operational heating begins with a flow temperature of between 20° C and 25° C, which is to be maintained for a minimum of 3 days. Afterwards the maximum design temperature has to be set and this value has to be maintained for at least 4 days.

Heating up should not take place faster than 5 K temperature increase per day.

This procedure must be recorded in a protocol, which is to be handed to the customer.

Installation testing of PRINETO underfloor heating system

Operational heating protocol as per DIN EN 1264-4 for wet-laid underfloor heating systems of type A (DIN 18560)

Object: ______________________________

Owner: ______________________________

Heating engineer: ______________________________

Screed layer: ______________________________

Type of screed ______ ☐ Calcium sulphate screed (CA) ☐ Cement screed (CT) ☐ Calcium sulphate wet-laid screed CAF

Screed additive ______________ Bending tearing strength class or hardness class (DIN EN 13813) ______________

Overall thickness of screed (incl. pipe diameter) ______________ mm

Screed work finished on ______________

Resting period of the cement screed 21 days   Resting period of the calcium sulphate screed 7 days

	Start date	Target flow temp. (°C)	Actual flow temp. (°C)	Minimum period	End date
Heat up	→	20	→		
		25	→	Maintained 3 days	→
Heat up	→	30	→		
		35	→		
		40	→		
		45	→		→
Max. heating	→	Maximum design temperature	→	Maintained 4 days	→
Cool-down	→	45	→		
		40	→		
		35	→		
		30	→		
		25	→		
		20	→	Completion	→

Handover for further construction work

Outside temperature: ________ °C System in operation: ☐ yes ☐ no Flow temperature: ______________ °C

Remarks: ______________________________

____

______________ Place, Date

______________ Signature inspector

______________ Signature owner or representative

Heat load tables for detrmination and design

Based on the diagrams of the heat engineering test results (starting on p. 221) of the ***PRINETO*** surface heating systems, tables have been produced for the approximate designing of an underfloor heating system and for mass determination. They are subdivided according to the respective underfloor heating system and the thermal resistances of the floor coverings. The tables relate to a temperature difference of 5 K, the maximum pressure loss was limited to 250 hPa. However, for execution – the heat load tables for mass determination and design of the hydraulic equalisation – more detailed calculations (liNear or Dendrit) must be carried out. From these tables the surface heat flux, the mean floor surface temperature and the maximum heating circuit area can be derived in relation to floor covering, internal room temperature, pipe laying distance and mean heating water temperature. We recommend keeping the heating circuit area smaller than 40 m^2.

If the permissible average floor surface temperature of 29°C (33°C in bathrooms) is exceeded, the respective fields are marked red. These must not be used for designing.

Heat load table thin-bed system 12 x 2.0 (10 mm pipe cover with KNAUF 425 with 1.40 W/mK, direct floor contact without insulation against heated room, Rλ underfloor 0.75 m²K/W)
Temperature difference: 5.0 K; Δp: 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.0 m²*K/W** (without covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 27°C			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 33°C			Mean heating water temperature $\theta_{H\mu}$ = 36°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	5	20.0	114	25.1	3.4	142	27.4	2.9	170	29.6	2.6	199	31.8	2.3
	10	10.0	95	23.6	4.8	118	25.5	4.2	142	27.4	3.7	166	29.2	3.3
	15	6.7	79	22.3	6.2	99	23.9	5.3	119	25.5	4.7	139	27.1	4.3
	20	5.0	67	21.2	7.6	83	22.6	6.5	100	24.0	5.8	117	25.4	5.2
	25	4.0	57	20.4	9.0	72	21.7	7.7	86	22.9	6.8	101	24.0	6.1
`= 18°C	5	20.0	85	25.8	4.0	114	28.1	3.3	142	30.4	2.9	170	32.6	2.6
	10	10.0	71	24.6	5.7	95	26.6	4.7	118	28.5	4.1	142	30.4	3.6
	15	6.7	59	23.6	7.3	79	25.3	6.0	99	26.9	5.2	119	28.5	4.6
	20	5.0	50	22.8	8.9	67	24.2	7.4	83	25.6	6.4	100	27.0	5.6
	25	4.0	43	22.2	10.5	57	23.4	8.6	72	24.7	7.5	86	25.9	6.6
`= 20°C	5	20.0	66	26.2	4.6	95	28.6	3.7	123	30.9	3.1	151	33.1	2.7
	10	10.0	55	25.2	6.6	79	27.3	5.2	103	29.2	4.4	126	31.1	3.9
	15	6.7	46	24.5	8.4	66	26.2	6.7	86	27.8	5.6	106	29.5	4.9
	20	5.0	39	23.8	10.2	56	25.3	8.1	72	26.7	6.9	89	28.1	6.0
	25	4.0	34	23.3	11.9	48	24.6	9.5	62	25.8	8.0	77	27.1	7.0
`= 22°C	5	20.0	47	26.6	5.5	76	29.0	4.2	104	31.3	3.4	132	33.6	2.9
	10	10.0	39	25.9	7.8	63	27.9	5.9	87	29.9	4.8	110	31.8	4.2
	15	6.7	33	25.3	9.9	53	27.0	7.5	73	28.7	6.2	92	30.4	5.3
	20	5.0	28	24.8	12.0	44	26.3	9.1	61	27.8	7.5	78	29.2	6.4
	25	4.0	24	24.5	14.0	38	25.8	10.6	53	27.0	8.7	67	28.3	7.5
`= 24°C	5	20.0	28	26.9	7.2	57	29.4	4.8	85	31.8	3.8	114	34.1	3.2
	10	10.0	24	26.4	10.1	47	28.6	6.8	71	30.6	5.4	95	32.6	4.5
	15	6.7	20	26.1	12.6	40	27.9	8.6	59	29.6	6.8	79	31.3	5.7
	20	5.0	17	25.8	15.1	33	27.3	10.4	50	28.8	8.2	67	30.2	6.9
	25	4.0	14	25.5	17.3	29	26.9	12.0	43	28.2	9.5	57	29.4	8.1

θ floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

for bathrooms θ_{FB} > 33°C

Heat load table thin-bed system 12 x 2.0 (10 mm pipe cover with KNAUF 425 with 1.40 W/mK, direct floor contact without insulation against heated room, Rλ underfloor 0.75 m²K/W)
Temperature difference: 5.0 K; Δp: 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.015 m²*K/W** (natural stone, tiles, composite stone tiles)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 27°C			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 33°C			Mean heating water temperature $\theta_{H\mu}$ = 36°C		
Internal tempera-ture	Laying dis-tance VA	Pipe re-quirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	5	20.0	114	25.1	3.4	142	27.4	2.9	152	28.2	2.8	177	30.1	2.5
	10	10.0	95	23.6	4.8	118	25.5	4.2	129	26.3	3.9	150	28.0	3.5
	15	6.7	79	22.3	6.2	99	23.9	5.3	109	24.7	5.0	127	26.2	4.5
	20	5.0	67	21.2	7.6	83	22.6	6.5	91	23.3	6.1	106	24.5	5.5
	25	4.0	57	20.4	9.0	72	21.7	7.7	79	22.3	7.1	92	23.4	6.4
`= 18°C	5	20.0	85	25.8	4.0	114	28.1	3.3	127	29.2	3.1	152	31.2	2.7
	10	10.0	71	24.6	5.7	95	26.6	4.7	107	27.6	4.3	129	29.3	3.8
	15	6.7	59	23.6	7.3	79	25.3	6.0	91	26.3	5.5	109	27.7	4.9
	20	5.0	50	22.8	8.9	67	24.2	7.4	76	25.0	6.7	91	26.3	5.9
	25	4.0	43	22.2	10.5	57	23.4	8.6	66	24.2	7.8	79	25.3	6.9
`= 20°C	5	20.0	66	26.2	4.6	95	28.6	3.7	110	29.8	3.3	135	31.8	2.9
	10	10.0	55	25.2	6.6	79	27.3	5.2	93	28.4	4.7	114	30.2	4.1
	15	6.7	46	24.5	8.4	66	26.2	6.7	79	27.2	5.9	97	28.8	5.2
	20	5.0	39	23.8	10.2	56	25.3	8.1	66	26.2	7.2	81	27.4	6.3
	25	4.0	34	23.3	11.9	48	24.6	9.5	57	25.4	8.4	70	26.5	7.3
`= 22°C	5	20.0	47	26.6	5.5	76	29.0	4.2	93	30.4	3.6	118	32.5	3.1
	10	10.0	39	25.9	7.8	63	27.9	5.9	79	29.2	5.1	100	31.0	4.4
	15	6.7	33	25.3	9.9	53	27.0	7.5	67	28.2	6.4	85	29.8	5.5
	20	5.0	28	24.8	12.0	44	26.3	9.1	56	27.3	7.8	71	28.6	6.7
	25	4.0	24	24.5	14.0	38	25.8	10.6	48	26.6	9.1	62	27.8	7.8
`= 24°C	5	20.0	28	26.9	7.2	57	29.4	4.8	76	31.0	4.0	101	33.1	3.4
	10	10.0	24	26.4	10.1	47	28.6	6.8	64	30.0	5.7	86	31.8	4.8
	15	6.7	20	26.1	12.6	40	27.9	8.6	55	29.2	7.1	73	30.7	6.0
	20	5.0	17	25.8	15.1	33	27.3	10.4	46	28.4	8.6	61	29.7	7.2
	25	4.0	14	25.5	17.3	29	26.9	12.0	40	27.9	9.9	53	29.0	8.4

θ Floor temperature – θ Internal temperature > 9 K, or θ_{FB} > 29°C

for bathrooms θ_{FB} > 33°C

Heat load table thin-bed system 12 x 2.0 (10 mm pipe cover with KNAUF 425 with 1.40 W/mK, direct floor contact without insulation against heated room, Rλ underfloor 0.75 m²K/W)

Temperature difference: 5.0 K; Δp: 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.05 m²*K/W** (parquet floor, needle felt, synthetic fibre)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 27°C			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 33°C			Mean heating water temperature $\theta_{H\mu}$ = 36°C		
Internal tempera-ture	Laying dis-tance VA	Pipe re-quirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	5	20.0	78	22.2	4.2	97	23.8	3.6	117	25.3	3.2	136	26.9	2.9
	10	10.0	66	21.2	5.9	83	22.6	5.1	99	23.9	4.5	116	25.3	4.1
	15	6.7	57	20.4	7.4	72	21.7	6.4	86	22.9	5.6	100	24.0	5.1
	20	5.0	50	19.8	8.9	62	20.8	7.6	75	21.9	6.7	87	22.9	6.1
	25	4.0	43	19.2	10.4	54	20.2	8.9	65	21.1	7.8	76	22.0	7.1
`= 18°C	5	20.0	58	23.5	5.0	78	25.2	4.1	97	26.8	3.5	117	28.3	3.1
	10	10.0	50	22.7	7.0	66	24.2	5.8	83	25.6	5.0	99	26.9	4.4
	15	6.7	43	22.2	8.7	57	23.4	7.2	72	24.7	6.2	86	25.9	5.5
	20	5.0	37	21.7	10.4	50	22.8	8.6	62	23.8	7.4	75	24.9	6.6
	25	4.0	33	21.2	12.1	43	22.2	9.9	54	23.2	8.6	65	24.1	7.6
`= 20°C	5	20.0	45	24.4	5.7	65	26.1	4.5	84	27.7	3.8	104	29.3	3.3
	10	10.0	39	23.8	7.9	55	25.2	6.3	72	26.6	5.4	88	28.0	4.7
	15	6.7	33	23.3	9.9	48	24.6	7.9	62	25.8	6.7	77	27.1	5.8
	20	5.0	29	22.9	11.8	41	24.0	9.4	54	25.1	7.9	66	26.2	7.0
	25	4.0	25	22.6	13.6	36	23.6	10.8	47	24.5	9.2	58	25.5	8.0
`= 22°C	5	20.0	32	25.2	6.7	52	26.9	5.1	71	28.6	4.2	91	30.2	3.6
	10	10.0	28	24.8	9.4	44	26.3	7.1	61	27.7	5.8	77	29.1	5.0
	15	6.7	24	24.5	11.6	38	25.8	8.8	53	27.0	7.2	67	28.2	6.2
	20	5.0	21	24.2	13.7	33	25.3	10.4	46	26.4	8.6	58	27.5	7.4
	25	4.0	18	23.9	15.8	29	24.9	12.0	40	25.9	9.9	51	26.8	8.5
`= 24°C	5	20.0	19	26.0	8.5	39	27.8	5.8	58	29.5	4.6	78	31.2	3.9
	10	10.0	17	25.7	11.8	33	27.3	8.1	50	28.7	6.4	66	30.2	5.4
	15	6.7	14	25.5	14.4	29	26.9	10.0	43	28.2	7.9	57	29.4	6.7
	20	5.0	12	25.4	16.9	25	26.5	11.8	37	27.7	9.4	50	28.8	7.9
	25	4.0	11	25.2	19.2	22	26.2	13.5	33	27.2	10.8	43	28.2	9.1

θ Floor temperature – θ Internal temperature > 9 K, or θ_{FB} > 29°C

Heat load table thin-bed system 12 x 2.0 (10 mm pipe cover with KNAUF 425 with 1.40 W/mK, direct floor contact without insulation against heated room, Rλ underfloor 0.75 m²K/W)
Temperature difference: 5.0 K; Δp: 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.10 m²*K/W** (fitted carpet, loop pile carpet)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 27°C			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 33°C			Mean heating water temperature $\theta_{H\mu}$ = 36°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	5	20.0	57	20.4	5.0	72	21.7	4.3	86	22.9	3.8	101	24.0	3.4
	10	10.0	50	19.8	6.9	63	20.9	5.9	76	22.0	5.2	88	23.0	4.7
	15	6.7	45	19.3	8.5	56	20.3	7.3	67	21.3	6.4	78	22.2	5.8
	20	5.0	40	18.9	10.0	50	19.8	8.6	60	20.6	7.5	70	21.5	6.8
	25	4.0	35	18.5	11.6	44	19.3	9.8	53	20.1	8.7	62	20.8	7.8
`= 18°C	5	20.0	43	22.2	5.8	57	23.4	4.8	72	24.7	4.2	86	25.9	3.7
	10	10.0	38	21.7	8.0	50	22.8	6.6	63	23.9	5.7	76	25.0	5.1
	15	6.7	33	21.3	9.9	45	22.3	8.1	56	23.3	7.0	67	24.3	6.2
	20	5.0	30	21.0	11.6	40	21.9	9.6	50	22.8	8.2	60	23.6	7.3
	25	4.0	27	20.7	13.3	35	21.5	10.9	44	22.3	9.4	53	23.1	8.4
`= 20°C	5	20.0	34	23.3	6.6	48	24.6	5.3	62	25.8	4.5	77	27.1	3.9
	10	10.0	29	23.0	9.1	42	24.1	7.2	55	25.2	6.1	67	26.3	5.4
	15	6.7	26	22.6	11.1	37	23.7	8.9	48	24.7	7.5	60	25.6	6.6
	20	5.0	23	22.4	13.1	33	23.3	10.4	43	24.2	8.8	53	25.1	7.7
	25	4.0	21	22.1	14.9	29	23.0	11.9	38	23.8	10.1	47	24.5	8.8
`= 22°C	5	20.0	24	24.5	7.8	38	25.8	5.9	53	27.0	4.8	67	28.3	4.2
	10	10.0	21	24.2	10.6	34	25.3	8.0	46	26.5	6.6	59	27.6	5.7
	15	6.7	19	24.0	13.0	30	25.0	9.8	41	26.0	8.1	52	27.0	7.0
	20	5.0	17	23.8	15.1	27	24.7	11.5	36	25.6	9.5	46	26.5	8.2
	25	4.0	15	23.6	17.1	24	24.4	13.1	32	25.2	10.8	41	26.0	9.3
`= 24°C	5	20.0	14	25.5	9.6	29	26.9	6.7	43	28.2	5.3	57	29.4	4.5
	10	10.0	13	25.4	13.0	25	26.6	9.1	38	27.7	7.2	50	28.8	6.1
	15	6.7	11	25.2	15.8	22	26.3	11.1	33	27.3	8.9	45	28.3	7.5
	20	5.0	10	25.1	18.2	20	26.1	12.9	30	27.0	10.3	40	27.9	8.7
	25	4.0	9	25.0	20.5	18	25.9	14.6	27	26.7	11.7	35	27.5	9.9

θ Floor temperature – θ Internal temperature > 9 K, or θ_{FB} > 29°C

Heat load table thin-bed system 12 x 2.0 (10 mm pipe cover with KNAUF 425 with 1.40 W/mK, direct floor contact without insulation against heated room, Rλ underfloor 0.75 m²K/W)
Temperature difference: 5.0 K; Δp: 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.15 m²*K/W** (fitted carpet, velour)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 27°C			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 33°C			Mean heating water temperature $\theta_{H\mu}$ = 36°C		
Internal tempera-ture	Laying dis-tance VA	Pipe re-quirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	5	20.0	46	19.4	5.6	57	20.4	4.8	69	21.4	4.2	80	22.4	3.8
	10	10.0	41	19.0	7.7	52	19.9	6.5	62	20.8	5.8	72	21.7	5.2
	15	6.7	37	18.7	9.3	47	19.5	8.0	56	20.3	7.0	65	21.1	6.3
	20	5.0	33	18.3	11.0	42	19.1	9.3	50	19.8	8.2	58	20.5	7.4
	25	4.0	30	18.0	12.5	38	18.7	10.6	46	19.4	9.3	53	20.1	8.4
`= 18°C	5	20.0	34	21.4	6.5	46	22.4	5.4	57	23.4	4.7	69	24.4	4.1
	10	10.0	31	21.1	8.9	41	22.0	7.3	52	22.9	6.3	62	23.8	5.6
	15	6.7	28	20.8	10.8	37	21.7	8.9	47	22.5	7.6	56	23.3	6.8
	20	5.0	25	20.6	12.6	33	21.3	10.4	42	22.1	8.9	50	22.8	7.9
	25	4.0	23	20.3	14.3	30	21.0	11.7	38	21.7	10.1	46	22.4	9.0
`= 20°C	5	20.0	27	22.7	7.4	38	23.7	5.9	50	24.8	5.0	61	25.7	4.4
	10	10.0	24	22.5	10.0	34	23.4	8.0	45	24.3	6.7	55	25.2	5.9
	15	6.7	22	22.3	12.1	31	23.1	9.6	40	24.0	8.2	50	24.8	7.1
	20	5.0	19	22.0	14.1	28	22.8	11.2	36	23.6	9.5	44	24.3	8.3
	25	4.0	18	21.9	15.9	25	22.6	12.7	33	23.3	10.7	40	24.0	9.4
`= 22°C	5	20.0	19	24.0	8.6	31	25.1	6.5	42	26.1	5.4	53	27.1	4.6
	10	10.0	17	23.8	11.6	27	24.8	8.8	38	25.7	7.3	48	26.6	6.3
	15	6.7	16	23.7	13.9	25	24.5	10.6	34	25.4	8.8	44	26.2	7.6
	20	5.0	14	23.5	16.2	22	24.3	12.3	31	25.1	10.2	39	25.8	8.8
	25	4.0	13	23.4	18.2	20	24.1	13.9	28	24.8	11.5	35	25.5	9.9
`= 24°C	5	20.0	11	25.3	10.5	23	26.4	7.4	34	27.4	5.9	46	28.4	5.0
	10	10.0	10	25.1	14.0	21	26.1	9.9	31	27.1	7.9	41	28.0	6.7
	15	6.7	9	25.0	16.7	19	26.0	11.9	28	26.8	9.5	37	27.7	8.1
	20	5.0	8	24.9	19.2	17	25.8	13.7	25	26.6	11.0	33	27.3	9.4
	25	4.0	8	24.9	21.5	15	25.6	15.4	23	26.3	12.4	30	27.0	10.5

Heat load table tacker system

Temperature difference 5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.015 m²K/W** (tiles, stone)

Planning data				Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal tempera-ture	Laying distance VA	Pipe re-quirements l_R	Bedarf Tacker-nadeln T	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	St/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	20	88	23.0	11.5	117	25.4	9.6	147	27.8	8.3	176	30.1	7.4
	15	6.7	14	78	22.2	14.3	104	24.3	11.9	130	26.4	10.3	156	28.5	9.2
	20	5.0	10	67	21.3	17.2	90	23.2	14.4	112	25.0	12.5	135	26.8	11.1
	25	4.0	8	59	20.6	20.1	78	22.2	16.8	98	23.8	14.5	118	25.4	12.9
	30	3.3	7	51	19.8	23.3	67	21.3	19.4	84	22.7	16.8	101	24.1	15.0
`= 18°C	10	10.0	20	70	24.5	13.1	100	27.0	10.5	129	29.4	9.0	159	31.7	7.9
	15	6.7	14	62	23.9	16.2	88	26.1	13.0	115	28.2	11.1	141	30.3	9.8
	20	5.0	10	54	23.1	19.4	76	25.0	15.7	99	26.9	13.3	121	28.7	11.7
	25	4.0	8	47	22.5	22.6	67	24.2	18.3	86	25.9	15.6	106	27.5	13.7
	30	3.3	7	40	21.9	26.1	57	23.4	21.1	74	24.9	18.0	91	26.3	15.8
`= 20°C	10	10.0	20	59	25.5	14.4	88	28.0	11.3	117	30.4	9.4	147	32.8	8.2
	15	6.7	14	52	25.0	17.8	78	27.2	14.0	104	29.3	11.7	130	31.4	10.2
	20	5.0	10	45	24.3	21.4	67	26.3	16.7	90	28.2	14.0	112	30.0	12.2
	25	4.0	8	39	23.8	24.8	59	25.6	19.5	78	27.2	16.3	98	28.8	14.3
	30	3.3	7	34	23.3	28.6	51	24.8	22.5	67	26.3	18.9	84	27.7	16.5
`= 22°C	10	10.0	20	47	26.5	16.2	76	29.0	12.2	106	31.5	10.0	135	33.8	8.6
	15	6.7	14	42	26.1	20.0	68	28.3	15.0	94	30.5	12.4	120	32.6	10.7
	20	5.0	10	36	25.6	23.9	58	27.5	18.0	81	29.4	14.8	103	31.3	12.8
	25	4.0	8	31	25.1	27.6	51	26.9	20.9	71	28.6	17.2	90	30.2	14.9
	30	3.3	7	27	24.7	31.7	44	26.2	24.1	61	27.7	19.9	77	29.1	17.2
`= 24°C	10	10.0	20	35	27.5	18.7	65	30.0	13.3	94	32.5	10.7	123	34.9	9.0
	15	6.7	14	31	27.1	23.0	57	29.4	16.4	83	31.6	13.2	109	33.8	11.2
	20	5.0	10	27	26.7	27.3	49	28.7	19.6	72	30.7	15.8	94	32.5	13.4
	25	4.0	8	24	26.4	31.5	43	28.2	22.7	63	29.9	18.3	82	31.5	15.6
	30	3.3	7	20	26.1	35.9	37	27.6	26.0	54	29.1	21.0	71	30.6	17.9

θ Floor temperature – θ Internal temperature > 9 K, or θ_{FB} > 29°C

for bathrooms θ_{FB} > 33°C

DIN geprüft

Test report no. HB00P065,
DIN- CERTCO 7F101

Planning and design of the underfloor heating system

Heat load table tacker system

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.05 m²K/W** (parquet floor, needle felt, synthetic fibres)

Planning data				Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal tempera-ture	Laying distance VA	Pipe re-quirements l_R	Bedarf Tacker-nadeln T	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	St/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	20	71	21.6	13.0	95	23.6	10.8	118	25.5	9.4	142	27.4	8.4
	15	6.7	14	63	20.9	16.1	84	22.7	13.4	105	24.4	11.6	126	26.1	10.4
	20	5.0	10	56	20.3	19.0	75	21.9	15.8	94	23.5	13.7	112	25.0	12.2
	25	4.0	8	50	19.8	22.0	66	21.2	18.3	83	22.6	15.9	100	24.0	14.1
	30	3.3	7	44	19.3	25.0	59	20.6	20.8	74	21.8	18.0	88	23.0	16.1
`= 18°C	10	10.0	20	57	23.4	14.7	81	25.4	11.8	104	27.3	10.1	128	29.3	8.9
	15	6.7	14	50	22.8	18.1	71	24.6	14.6	92	26.4	12.5	113	28.1	11.0
	20	5.0	10	45	22.4	21.4	64	24.0	17.2	82	25.5	14.7	101	27.1	12.9
	25	4.0	8	40	21.9	24.6	56	23.4	19.9	73	24.8	17.0	90	26.1	14.9
	30	3.3	7	35	21.5	27.9	50	22.8	22.6	65	24.1	19.2	79	25.3	16.9
`= 20°C	10	10.0	20	47	24.6	16.2	71	26.6	12.7	95	28.6	10.6	118	30.5	9.2
	15	6.7	14	42	24.1	19.9	63	25.9	15.6	84	27.7	13.1	105	29.4	11.4
	20	5.0	10	37	23.7	23.4	56	25.3	18.4	75	26.9	15.4	94	28.5	13.5
	25	4.0	8	33	23.3	26.9	50	24.8	21.2	66	26.2	17.8	83	27.6	15.5
	30	3.3	7	29	23.0	30.4	44	24.3	24.0	59	25.6	20.2	74	26.8	17.6
`= 22°C	10	10.0	20	38	25.7	18.1	62	27.8	13.6	85	29.8	11.2	109	31.7	9.7
	15	6.7	14	34	25.3	22.2	55	27.2	16.8	76	29.0	13.8	97	30.7	11.9
	20	5.0	10	30	25.0	26.0	49	26.7	19.7	67	28.3	16.3	86	29.9	14.0
	25	4.0	8	27	24.7	29.8	43	26.2	22.7	60	27.6	18.7	76	29.0	16.2
	30	3.3	7	24	24.4	33.6	38	25.8	25.6	53	27.1	21.2	68	28.3	18.3
`= 24°C	10	10.0	20	28	26.9	20.7	52	29.0	14.8	76	31.0	11.9	100	33.0	10.1
	15	6.7	14	25	26.6	25.4	46	28.5	18.2	67	30.3	14.7	88	32.0	12.5
	20	5.0	10	22	26.3	29.6	41	28.0	21.4	60	29.7	17.2	79	31.2	14.7
	25	4.0	8	20	26.1	33.8	37	27.6	24.5	53	29.1	19.8	70	30.5	16.9
	30	3.3	7	18	25.9	37.8	32	27.2	27.6	47	28.5	22.4	62	29.8	19.1

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

for bathrooms θ_{FB} > 33°C

geprüft

Test report no. HB00P065,
DIN- CERTCO 7F101

Heat load table tacker system

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.10 m²K/W** (fitted carpet, loop pile carpet)

Planning data				Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Bedarf Tackernadeln T	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	St/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	20	56	20.3	14.8	75	21.9	12.3	94	23.5	10.7	113	25.0	9.5
	15	6.7	14	51	19.9	18.0	68	21.3	15.0	85	22.8	13.0	102	24.2	11.6
	20	5.0	10	46	19.4	21.1	61	20.8	17.6	76	22.1	15.3	92	23.3	13.6
	25	4.0	8	41	19.0	24.2	55	20.2	20.1	69	21.4	17.4	83	22.6	15.5
	30	3.3	7	38	18.7	27.1	50	19.8	22.5	63	20.9	19.5	75	22.0	17.4
`= 18°C	10	10.0	20	45	22.4	16.6	64	24.0	13.4	83	25.6	11.4	101	27.1	10.0
	15	6.7	14	41	22.0	20.2	58	23.5	16.3	75	24.9	13.9	92	26.3	12.3
	20	5.0	10	37	21.6	23.6	52	23.0	19.1	67	24.3	16.3	83	25.6	14.3
	25	4.0	8	33	21.3	26.9	47	22.5	21.8	61	23.7	18.6	75	24.9	16.4
	30	3.3	7	30	21.0	30.1	43	22.1	24.4	55	23.2	20.8	68	24.3	18.3
`= 20°C	10	10.0	20	38	23.7	18.2	56	25.3	14.3	75	26.9	12.0	94	28.5	10.5
	15	6.7	14	34	23.4	22.1	51	24.9	17.4	68	26.3	14.6	85	27.8	12.7
	20	5.0	10	31	23.1	25.8	46	24.4	20.3	61	25.8	17.1	76	27.1	14.9
	25	4.0	8	28	22.8	29.3	41	24.0	23.1	55	25.2	19.5	69	26.4	17.0
	30	3.3	7	25	22.6	32.7	38	23.7	25.8	50	24.8	21.7	63	25.9	19.0
`= 22°C	10	10.0	20	30	25.0	20.2	49	26.7	15.3	68	28.3	12.6	86	29.9	10.9
	15	6.7	14	27	24.8	24.5	44	26.3	18.6	61	27.8	15.4	78	29.2	13.3
	20	5.0	10	24	24.5	28.5	40	25.9	21.7	55	27.2	18.0	70	28.5	15.5
	25	4.0	8	22	24.3	32.3	36	25.5	24.7	50	26.8	20.4	63	28.0	17.7
	30	3.3	7	20	24.1	36.0	33	25.3	27.5	45	26.4	22.8	58	27.5	19.8
`= 24°C	10	10.0	20	23	26.3	23.0	41	28.0	16.6	60	29.7	13.4	79	31.2	11.4
	15	6.7	14	20	26.1	27.8	37	27.7	20.1	54	29.2	16.3	71	30.6	13.9
	20	5.0	10	18	25.9	32.2	34	27.3	23.4	49	28.7	19.0	64	30.0	16.2
	25	4.0	8	17	25.8	36.3	30	27.0	26.6	44	28.3	21.6	58	29.5	18.4
	30	3.3	7	15	25.6	40.0	28	26.8	29.6	40	27.9	24.0	53	29.0	20.6

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

DIN geprüft

Test report no. HB00P065, DIN- CERTCO 7F101

Heat load table tacker system

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.15 m²K/W** (fitted carpet, velour)

Planning data				Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal tempera-ture	Laying distance VA	Pipe re-quirements l_R	Bedarf Tacker-nadeln T	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area AHK	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area AHK	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area AHK	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area AHK
	cm	m/m²	St/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	20	47	19.5	16.3	62	20.8	13.6	78	22.2	11.8	93	23.5	10.5
	15	6.7	14	43	19.2	19.7	57	20.4	16.4	71	21.6	14.2	86	22.8	12.7
	20	5.0	10	39	18.8	22.9	52	20.0	19.1	65	21.1	16.5	78	22.2	14.7
	25	4.0	8	36	18.5	25.9	48	19.6	21.6	60	20.6	18.7	72	21.6	16.7
	30	3.3	7	33	18.3	28.9	44	19.3	24.0	55	20.2	20.9	66	21.2	18.6
`= 18°C	10	10.0	20	37	21.7	18.2	53	23.0	14.7	68	24.4	12.6	84	25.7	11.1
	15	6.7	14	34	21.4	22.0	49	22.7	17.8	63	23.9	15.2	77	25.1	13.4
	20	5.0	10	31	21.1	25.5	44	22.3	20.6	58	23.4	17.6	71	24.6	15.5
	25	4.0	8	29	20.9	28.8	41	22.0	23.3	53	23.0	19.9	64	24.0	17.6
	30	3.3	7	26	20.7	32.0	37	21.7	25.9	48	22.6	22.1	59	23.6	19.5
`= 20°C	10	10.0	20	31	23.1	19.9	47	24.5	15.7	62	25.8	13.2	78	27.2	11.5
	15	6.7	14	29	22.9	24.0	43	24.2	18.9	57	25.4	15.9	71	26.6	13.9
	20	5.0	10	26	22.7	27.7	39	23.8	21.9	52	25.0	18.4	65	26.1	16.1
	25	4.0	8	24	22.4	31.3	36	23.5	24.7	48	24.6	20.8	60	25.6	18.2
	30	3.3	7	22	22.3	34.6	33	23.3	27.4	44	24.3	23.1	55	25.2	20.2
`= 22°C	10	10.0	20	25	24.5	22.0	40	26.0	16.8	56	27.3	13.9	72	28.6	12.0
	15	6.7	14	23	24.4	26.5	37	25.7	20.2	51	26.9	16.7	66	28.1	14.4
	20	5.0	10	21	24.2	30.5	34	25.4	23.3	47	26.5	19.3	60	27.7	16.7
	25	4.0	8	19	24.0	34.3	31	25.1	26.3	43	26.2	21.8	55	27.2	18.9
	30	3.3	7	18	23.9	37.9	29	24.9	29.2	40	25.9	24.2	50	26.8	21.0
`= 24°C	10	10.0	20	19	26.0	24.8	34	27.4	18.1	50	28.8	14.6	65	30.1	12.5
	15	6.7	14	17	25.8	29.7	31	27.1	21.7	46	28.4	17.6	60	29.7	15.1
	20	5.0	10	16	25.7	34.2	29	26.9	25.1	42	28.1	20.4	55	29.2	17.4
	25	4.0	8	14	25.5	38.3	26	26.7	28.2	38	27.8	23.0	50	28.8	19.7
	30	3.3	7	13	25.4	40.0	24	26.5	31.2	35	27.5	25.5	46	28.5	21.8

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

DIN geprüft

Test report no. HB00P065, DIN- CERTCO 7F101

Heat load table knobbed board system 14

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.015 m²K/W** (tiles, stone)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	84	22.6	7.6	111	24.9	6.3	139	27.2	5.5	167	29.4	4.9
	15	6.7	72	21.7	9.5	96	23.7	7.9	120	25.6	6.9	144	27.5	6.1
	20	5.0	63	20.9	11.4	84	22.7	9.5	105	24.4	8.2	126	26.1	7.3
	25	4.0	55	20.2	13.3	73	21.8	11.0	92	23.3	9.6	110	24.8	8.5
	30	3.3	48	19.6	15.2	64	21.0	12.7	80	22.3	11.0	96	23.7	9.8
`= 18°C	10	10.0	67	24.2	8.6	95	26.6	6.9	123	28.8	5.9	150	31.0	5.2
	15	6.7	58	23.5	10.7	82	25.5	8.7	106	27.5	7.4	130	29.4	6.5
	20	5.0	50	22.8	12.8	71	24.6	10.3	92	26.4	8.8	113	28.1	7.7
	25	4.0	44	22.3	14.9	62	23.9	12.0	81	25.4	10.2	99	26.9	9.0
	30	3.3	38	21.8	17.0	54	23.2	13.8	70	24.5	11.7	86	25.9	10.3
`= 20°C	10	10.0	56	25.3	9.4	84	27.6	7.4	111	29.9	6.2	139	32.2	5.4
	15	6.7	48	24.6	11.8	72	26.7	9.3	96	28.7	7.8	120	30.6	6.8
	20	5.0	42	24.1	14.1	63	25.9	11.0	84	27.7	9.2	105	29.4	8.1
	25	4.0	37	23.6	16.3	55	25.2	12.8	73	26.8	10.8	92	28.3	9.4
	30	3.3	32	23.2	18.6	48	24.6	14.6	64	26.0	12.3	80	27.3	10.7
`= 22°C	10	10.0	45	26.3	10.6	72	28.7	8.0	100	31.0	6.5	128	33.3	5.6
	15	6.7	38	25.8	13.2	62	27.9	10.0	86	29.9	8.2	111	31.9	7.1
	20	5.0	34	25.3	15.7	55	27.2	11.9	76	29.0	9.8	97	30.7	8.4
	25	4.0	29	25.0	18.1	48	26.6	13.7	66	28.2	11.3	84	29.7	9.8
	30	3.3	26	24.6	20.6	42	26.1	15.7	58	27.4	13.0	74	28.8	11.2
`= 24°C	10	10.0	33	27.3	12.2	61	29.8	8.7	89	32.1	7.0	117	34.4	5.9
	15	6.7	29	26.9	15.2	53	29.0	10.8	77	31.1	8.7	101	33.1	7.4
	20	5.0	25	26.6	17.9	46	28.5	12.9	67	30.3	10.4	88	32.0	8.8
	25	4.0	22	26.3	20.6	40	27.9	14.9	59	29.5	12.0	77	31.1	10.2
	30	3.3	19	26.0	23.3	35	27.5	16.9	51	28.9	13.7	67	30.3	11.7

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

for bathrooms θ_{FB} > 33°C

Heat load table knobbed board system 14

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.05 m²K/W** (parquet floor, needle felt, synthetic fibres)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	69	21.4	8.4	91	23.3	7.0	114	25.2	6.1	137	27.0	5.4
	15	6.7	61	20.7	10.4	81	22.4	8.7	101	24.1	7.5	121	25.7	6.7
	20	5.0	53	20.1	12.4	71	21.6	10.3	89	23.1	9.0	107	24.6	8.0
	25	4.0	47	19.6	14.3	63	20.9	11.9	79	22.3	10.4	95	23.6	9.2
	30	3.3	42	19.1	16.3	56	20.3	13.6	70	21.5	11.8	84	22.7	10.5
`= 18°C	10	10.0	55	23.2	9.5	78	25.2	7.7	101	27.0	6.5	123	28.9	5.7
	15	6.7	49	22.7	11.8	69	24.4	9.5	89	26.1	8.1	109	27.7	7.1
	20	5.0	43	22.2	13.9	61	23.7	11.2	78	25.2	9.6	96	26.7	8.4
	25	4.0	38	21.7	16.0	54	23.1	13.0	70	24.5	11.0	85	25.8	9.7
	30	3.3	34	21.3	18.2	48	22.6	14.7	62	23.8	12.5	76	25.0	11.0
`= 20°C	10	10.0	46	24.4	10.5	69	26.4	8.2	91	28.3	6.9	114	30.2	6.0
	15	6.7	40	24.0	12.9	61	25.7	10.1	81	27.4	8.5	101	29.1	7.4
	20	5.0	36	23.5	15.2	53	25.1	12.0	71	26.6	10.1	89	28.1	8.8
	25	4.0	32	23.2	17.5	47	24.6	13.8	63	25.9	11.6	79	27.3	10.1
	30	3.3	28	22.8	19.8	42	24.1	15.6	56	25.3	13.1	70	26.5	11.5
`= 22°C	10	10.0	37	25.6	11.7	59	27.6	8.8	82	29.5	7.3	105	31.4	6.3
	15	6.7	32	25.2	14.4	53	27.0	10.9	73	28.7	9.0	93	30.4	7.7
	20	5.0	28	24.9	16.9	46	26.5	12.9	64	28.0	10.6	82	29.5	9.2
	25	4.0	25	24.6	19.4	41	26.0	14.8	57	27.4	12.2	73	28.7	10.5
	30	3.3	22	24.3	21.8	36	25.6	16.7	50	26.8	13.8	64	28.0	11.9
`= 24°C	10	10.0	27	26.8	13.4	50	28.8	9.6	73	30.8	7.7	96	32.7	6.6
	15	6.7	24	26.5	16.4	44	28.3	11.8	65	30.1	9.5	85	31.8	8.1
	20	5.0	21	26.2	19.2	39	27.8	13.9	57	29.4	11.2	75	30.9	9.6
	25	4.0	19	26.0	21.9	35	27.4	15.9	51	28.8	12.9	66	30.2	11.0
	30	3.3	17	25.8	24.5	31	27.1	17.9	45	28.3	14.6	59	29.6	12.4

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

for bathrooms θ_{FB} > 33°C

Heat load table knobbed board system 14

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.10 m²K/W** (fitted carpet, loop pile carpet)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	55	20.2	9.5	73	21.8	7.9	92	23.3	6.9	110	24.8	6.1
	15	6.7	49	19.7	11.7	66	21.1	9.7	82	22.5	8.4	99	23.9	7.5
	20	5.0	44	19.3	13.7	59	20.6	11.4	74	21.8	9.9	89	23.1	8.8
	25	4.0	40	18.9	15.6	53	20.1	13.0	66	21.2	11.3	80	22.3	10.1
	30	3.3	36	18.6	17.5	48	19.6	14.6	60	20.7	12.7	72	21.7	11.3
`= 18°C	10	10.0	44	22.3	10.7	62	23.9	8.6	81	25.4	7.3	99	26.9	6.5
	15	6.7	39	21.9	13.1	56	23.3	10.6	72	24.7	9.0	89	26.1	7.9
	20	5.0	36	21.5	15.3	50	22.8	12.3	65	24.1	10.5	80	25.3	9.3
	25	4.0	32	21.2	17.4	45	22.4	14.1	58	23.5	12.0	72	24.7	10.6
	30	3.3	29	20.9	19.5	41	22.0	15.8	53	23.1	13.5	65	24.1	11.9
`= 20°C	10	10.0	37	23.6	11.7	55	25.2	9.2	73	26.8	7.7	92	28.3	6.7
	15	6.7	33	23.3	14.3	49	24.7	11.2	66	26.1	9.4	82	27.5	8.2
	20	5.0	30	23.0	16.6	44	24.3	13.1	59	25.6	11.0	74	26.8	9.6
	25	4.0	27	22.7	19.0	40	23.9	15.0	53	25.1	12.6	66	26.2	11.0
	30	3.3	24	22.5	21.1	36	23.6	16.7	48	24.6	14.1	60	25.7	12.3
`= 22°C	10	10.0	29	24.9	13.0	48	26.6	9.9	66	28.2	8.1	84	29.7	7.0
	15	6.7	26	24.7	15.8	43	26.2	12.0	59	27.6	9.9	76	29.0	8.6
	20	5.0	24	24.4	18.4	38	25.8	14.0	53	27.1	11.6	68	28.3	10.0
	25	4.0	21	24.2	20.9	35	25.4	16.0	48	26.6	13.2	61	27.8	11.4
	30	3.3	19	24.0	23.2	31	25.1	17.8	43	26.2	14.8	55	27.3	12.8
`= 24°C	10	10.0	22	26.3	14.8	40	27.9	10.7	59	29.5	8.6	77	31.1	7.3
	15	6.7	20	26.1	17.9	36	27.6	13.0	53	29.0	10.5	69	30.4	9.0
	20	5.0	18	25.9	20.7	33	27.2	15.1	47	28.6	12.3	62	29.8	10.5
	25	4.0	16	25.7	23.4	29	26.9	17.2	43	28.1	13.9	56	29.3	11.9
	30	3.3	14	25.6	25.9	27	26.7	19.1	39	27.8	15.6	51	28.8	13.3

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

Heat load table knobbed board system 14

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.15 m²K/W** (fitted carpet, velour)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal tempera-ture	Laying distance VA	Pipe require-ments l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	10	10.0	46	19.4	10.5	61	20.7	8.7	76	22.0	7.6	91	23.3	6.7
	15	6.7	42	19.0	12.7	55	20.3	10.6	69	21.4	9.2	83	22.6	8.2
	20	5.0	38	18.7	14.8	51	19.8	12.3	63	20.9	10.7	76	22.0	9.5
	25	4.0	35	18.4	16.8	46	19.4	14.0	58	20.4	12.1	69	21.4	10.8
	30	3.3	32	18.2	18.7	42	19.1	15.6	53	20.0	13.5	63	20.9	12.0
`= 18°C	10	10.0	37	21.6	11.7	52	23.0	9.5	67	24.3	8.1	82	25.5	7.1
	15	6.7	33	21.3	14.2	47	22.5	11.5	61	23.7	9.8	75	24.9	8.6
	20	5.0	30	21.0	16.4	43	22.2	13.3	56	23.3	11.4	68	24.4	10.0
	25	4.0	28	20.8	18.6	39	21.8	15.1	51	22.8	12.9	62	23.8	11.4
	30	3.3	25	20.6	20.7	36	21.5	16.8	46	22.5	14.3	57	23.4	12.6
`= 20°C	10	10.0	30	23.1	12.8	46	24.4	10.0	61	25.7	8.4	76	27.0	7.4
	15	6.7	28	22.8	15.5	42	24.0	12.2	55	25.3	10.3	69	26.4	9.0
	20	5.0	25	22.6	17.9	38	23.7	14.1	51	24.8	11.9	63	25.9	10.4
	25	4.0	23	22.4	20.2	35	23.4	16.0	46	24.4	13.5	58	25.4	11.8
	30	3.3	21	22.2	22.4	32	23.2	17.7	42	24.1	15.0	53	25.0	13.1
`= 22°C	10	10.0	24	24.5	14.1	40	25.9	10.8	55	27.2	8.9	70	28.5	7.7
	15	6.7	22	24.3	17.1	36	25.6	13.0	50	26.8	10.8	64	28.0	9.3
	20	5.0	20	24.1	19.6	33	25.3	15.0	46	26.4	12.5	58	27.5	10.8
	25	4.0	18	23.9	22.1	30	25.0	17.0	41	26.0	14.1	53	27.0	12.2
	30	3.3	17	23.8	24.5	27	24.8	18.8	38	25.7	15.7	49	26.7	13.6
`= 24°C	10	10.0	18	25.9	15.9	34	27.3	11.6	49	28.7	9.4	64	30.0	8.0
	15	6.7	17	25.8	19.1	30	27.1	14.0	44	28.3	11.4	58	29.5	9.7
	20	5.0	15	25.6	22.0	28	26.8	16.2	41	28.0	13.1	53	29.1	11.2
	25	4.0	14	25.5	24.7	25	26.6	18.2	37	27.6	14.8	48	28.6	12.7
	30	3.3	13	25.4	27.2	23	26.4	20.1	34	27.4	16.5	44	28.3	14.1

θ Floor temperature – θ internal temperature > 9 K, or θ_{FB} > 29°C

Heat load tables dry-laid underfloor heating

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.015 m²K/W** (tiles, stone)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	12	8.3	30	18.0	17.7	40	18.9	14.8	50	19.8	12.8	60	20.7	11.4
	24	4.2	21	17.2	26.5	29	17.9	22.0	36	18.5	19.1	43	19.2	17.0
`= 18°C	12	8.3	24	20.5	19.6	34	21.4	15.9	44	22.3	13.6	54	23.1	12.0
	24	4.2	17	19.8	29.0	24	20.5	23.6	31	21.1	20.2	39	21.8	17.8
`= 20°C	12	8.3	20	22.1	21.2	30	23.0	16.8	40	23.9	14.2	50	24.8	12.4
	24	4.2	14	21.5	31.0	21	22.2	24.7	29	22.9	20.9	36	23.5	18.3
`= 22°C	12	8.3	16	23.7	23.1	26	24.6	17.8	36	25.6	14.8	46	26.5	12.8
	24	4.2	11	23.3	33.5	19	24.0	26.1	26	24.6	21.8	33	25.3	18.9
`= 24°C	12	8.3	12	25.3	25.6	22	26.3	19.0	32	27.2	15.6	42	28.1	13.4
	24	4.2	9	25.0	36.5	16	25.7	27.6	23	26.4	22.7	30	27.0	19.6

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.05 m²K/W** (parquet floor, needle felt, synthetic fibres)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal temperature	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	12	8.3	39	18.8	15.6	52	20.0	13.0	65	21.1	11.3	78	22.2	10.1
	24	4.2	26	17.6	24.4	35	18.4	20.3	43	19.2	17.6	52	19.9	15.7
`= 18°C	12	8.3	31	21.1	17.4	44	22.3	14.1	57	23.4	12.0	70	24.5	10.6
	24	4.2	21	20.2	26.9	29	21.0	21.8	38	21.7	18.7	47	22.5	16.5
`= 20°C	12	8.3	26	22.6	18.9	39	23.8	15.0	52	25.0	12.6	65	26.1	11.0
	24	4.2	17	21.8	28.9	26	22.6	23.0	35	23.4	19.4	43	24.2	17.0
`= 22°C	12	8.3	21	24.2	20.9	34	25.4	16.0	47	26.5	13.2	60	27.6	11.4
	24	4.2	14	23.5	31.4	22	24.3	24.3	31	25.1	20.3	40	25.9	17.6
`= 24°C	12	8.3	16	25.7	23.4	29	26.9	17.1	42	28.1	13.9	55	29.2	11.9
	24	4.2	10	25.1	34.5	19	26.0	25.9	28	26.8	21.2	36	27.6	18.3

θ Floor temperature – θ Internal temperature > 9 K, or θ_{FB} > 29°C

Heat load table dry-laid underfloor heating

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.10 m²K/W** (fitted carpet, loop pile carpet)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal tempera-ture	Laying distance VA	Pipe require-ments l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	12	8.3	34	18.4	16.7	45	19.4	13.9	57	20.4	12.1	68	21.3	10.8
	24	4.2	24	17.4	25.5	31	18.1	21.2	39	18.8	18.4	47	19.5	16.4
`= 18°C	12	8.3	27	20.8	18.6	39	21.8	15.0	50	22.8	12.8	61	23.8	11.3
	24	4.2	19	20.0	28.0	27	20.7	22.7	34	21.4	19.4	42	22.1	17.1
`= 20°C	12	8.3	23	22.3	20.1	34	23.4	15.9	45	24.4	13.4	57	25.4	11.7
	24	4.2	16	21.7	30.0	24	22.4	23.9	31	23.1	20.2	39	23.8	17.7
`= 22°C	12	8.3	18	23.9	22.0	29	25.0	16.9	41	26.0	14.1	52	27.0	12.2
	24	4.2	13	23.4	32.5	20	24.1	25.2	28	24.8	21.1	36	25.6	18.3
`= 24°C	12	8.3	14	25.5	24.5	25	26.5	18.1	36	27.6	14.8	48	28.6	12.7
	24	4.2	9	25.0	35.5	17	25.8	26.8	25	26.6	22.0	33	27.3	18.9

Temperature difference 7.5 K; Δp = 250 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.15 m²K/W** (fitted carpet, velour)

Planning data			Mean heating water temperature $\theta_{H\mu}$ = 30°C			Mean heating water temperature $\theta_{H\mu}$ = 35°C			Mean heating water temperature $\theta_{H\mu}$ = 40°C			Mean heating water temperature $\theta_{H\mu}$ = 45°C		
Internal tempera-ture	Laying distance VA	Pipe require-ments l_R	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. θ_{Fm}	Max. heating circuit area A_{HK}
	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
`= 15°C	12	8.3	30	18.0	17.7	40	18.9	14.8	50	19.8	12.8	60	20.7	11.4
	24	4.2	21	17.2	26.5	29	17.9	22.0	36	18.5	19.1	43	19.2	17.0
`= 18°C	12	8.3	24	20.5	19.6	34	21.4	15.9	44	22.3	13.6	54	23.1	12.0
	24	4.2	17	19.8	29.0	24	20.5	23.6	31	21.1	20.2	39	21.8	17.8
`= 20°C	12	8.3	20	22.1	21.2	30	23.0	16.8	40	23.9	14.2	50	24.8	12.4
	24	4.2	14	21.5	31.0	21	22.2	24.7	29	22.9	20.9	36	23.5	18.3
`= 22°C	12	8.3	16	23.7	23.1	26	24.6	17.8	36	25.6	14.8	46	26.5	12.8
	24	4.2	11	23.3	33.5	19	24.0	26.1	26	24.6	21.8	33	25.3	18.9
`= 24°C	12	8.3	12	25.3	25.6	22	26.3	19.0	32	27.2	15.6	42	28.1	13.4
	24	4.2	9	25.0	36.5	16	25.7	27.6	23	26.4	22.7	30	27.0	19.6

Planning and design of the underfloor heating system

Cooling medium tables

In order to achieve a high cooling power, it is necessary to install the heating pipes as close as possible. This has the advantage during heating, that the temperature of the heating medium can be kept very low, and heat pumps or calorific value appliances can work very effectively. The laying distances, maximum heating circuit length and surfaces, and the hydraulic settings determine the floor heating rating. The floor surface covering should preferably be ceramic and very thermo-conductive. Carpeting is unsuitable.

To ascertain the minimum cooling medium temperature in the building project, the following tables should be referred to. Surface coverings with high heat-permeability resistance require considerably lower operating temperatures, which increases the danger of condensation forming. Therefore the highest cooling medium temperature reached in one room becomes the reference value for the settings in the whole building!

CAUTION

The values for relative room air humidity given in the tables with relation to room air temperature must not be exceeded as otherwise the dew point will increase to over 20 °C. For this reason, damp rooms such as bathrooms should not be cooled. We recommend you control this in a reference room using a hygrometer.

Minimum cooling medium temperatures in°C for tacker system
Heat transfer coefficient 6.5 W/m^2 K, floor surface temperature 20°C;

Floor covering resistance m^{2}K/W	Room temperature°C	23	24	25	26	27	28	29	30
	Cooling power W/m^2	19.5	26	32.5	39	45.5	52	58.5	65
	Max. relative humidity %	83	78	74	70	66	62	58	55
0.000	Laying distance 10 cm	18.6	18.2	17.7	17.3	16.8	16.4	15.9	15.5
0.015		18.4	17.8	17.3	16.7	16.2	15.6	15.1	14.6
0.050		17.6	16.8	15.9	15.1	14.3	13.5	12.7	11.9
0.100		16.5	15.3	14.2	13.0	11.8	10.7	9.5	
0.150		15.5	13.9	12.4	10.9	9.4	7.9		
0.000	Laying distance 15 cm	18.1	17.5	16.8	16.2	15.6	15.0	14.3	13.7
0.015		17.8	17.1	16.4	15.6	14.9	14.2	13.5	12.7
0.050		17.0	16.0	15.0	14.0	13.0	12.0	11.0	10.0
0.100		15.9	14.6	13.2	11.8	10.5	9.1		
0.150		14.9	13.2	11.5	9.8	8.1			
0.000	Laying distance 20 cm	17.5	16.7	15.9	15.0	14.2	13.4	12.5	11.7
0.015		17.2	16.3	15.4	14.4	13.5	12.6	11.7	10.7
0.050		16.4	15.2	14.0	12.8	11.6	10.4	9.2	
0.100		15.3	13.7	12.1	10.6	9.0			
0.150		14.3	12.3	10.4	8.5				

- very well suited for cooling
- well suited for cooling
- badly suited for cooling
- not suitable for cooling

Planning and design of the underfloor heating system

Minimum cooling medium temperatures in°C for knobbed board systems
Heat transfer coefficient 6 W/m² K, floor surface temperature 20°C;

Floor covering resistance m²K/W	Room temperature°C	23	24	25	26	27	28	29	30
	Cooling power W/m²	19.5	26	32.5	39	45.5	52	58.5	65
	Max. relative humidity %	83	78	74	70	66	62	58	55
0.000	Laying distance 10 cm	18.5	18.0	17.5	17.0	16.5	16.0	15.5	15.0
0.015		18.2	17.6	17.0	16.5	15.9	15.3	14.7	14.1
0.050		17.4	16.6	15.7	14.8	14.0	13.1	12.3	11.4
0.100		16.4	15.1	13.9	12.7	11.5	10.3	9.1	
0.150		15.3	13.8	12.2	10.6	9.1			
0.000	Laying distance 15 cm	17.9	17.2	16.5	15.8	15.1	14.4	13.8	13.1
0.015		17.6	16.8	16.0	15.3	14.5	13.7	12.9	12.1
0.050		16.8	15.7	14.7	13.6	12.6	11.5	10.4	
0.100		15.7	14.3	12.9	11.5	10.0	8.6		
0.150		14.7	12.9	11.2	9.4	7.7			
0.000	Laying distance 20 cm	17.3	16.4	15.5	14.6	13.6	12.7	11.8	10.9
0.015		17.0	16.0	15.0	14.0	13.0	11.9	10.9	
0.050		16.1	14.9	13.6	12.3	11.0	9.7		
0.100		15.1	13.4	11.8	10.1	8.5			
0.150		14.0	12.0	10.1	8.1				

Minimum cooling medium temperatures in°C for dry systems
Heat transfer coefficient 6.5 W/m² K, floor surface temperature 20°C;

Floor covering resistance m²K/W	Room temperature°C	23	24	25	26	27	28	29	30
	Cooling power W/m²	19.5	26	32.5	39	45.5	52	58.5	65
	Max. relative humidity %	83	78	74	70	66	62	58	55
0.000	Laying distance 10 cm	15.3	13.7	12.1	10.5	8.9	7.3		
0.015		14.9	13.3	11.6	9.9	8.2			
0.050		14.1	12.2	10.2	8.3				
0.100		13.0	10.7	8.4	6.1				
0.150		11.9	9.2	6.5					
0.000	Laying distance 15 cm	11.5	8.6	5.8					
0.015		11.1	8.2	5.2					
0.050		10.3	7.1						
0.100		9.1	5.5						
0.150		8.0	4.0						

very well suited for cooling
well suited for cooling
badly suited for cooling
not suitable for cooling

Planning and design of the underfloor heating system

The more rigorous requirements regarding heat conservation and improved heat insulation have led to a drastic reduction of heat losses in buildings. The resultant lower heating load can generally be met by a surface heating system.

Nowadays, the exact calculation and dimensioning with mass determination is normally carried out using planning software for domestic engineering. For the ***PRINETO*** system the data of Messrs. liNear and Dendrit can be used.

The planning programs also take into account the influence of insulation and the conditions under the floor. Heat emission downwards influences the heating water mass flow rate in particular.

The following characteristic values are required for designing an underfloor heating system:

Dimensioning heating power Q_H (W), is – acc. to DIN 1264-3 the heating load Q_{Nf}, that is determined by the heat load calculation acc. to DIN EN 12831 (standard heating load Φ_H),

Heating surface AF (m^2), the room area that can actually be used for pipe laying.

Standard internal room temperature θ_i [°C], acc. to DIN EN 12831 supplementary sheet 1, includes the air temperature and the average temperature of the areas surrounding the room.

- Maximum floor surface temperature$\theta_{F, max.}$ [° C], acc. to DIN EN 1264 -2, is limited for physiological and medical reasons:

Central areas:
29°C (+9 K above standard inside temperature of a room at 20°C) 33°C (+9 K above standard inside temperature of a bathroom at 24°C)
Edge zones:
35° C (+15 K above the standard internal temperature of a room at 20° C)

The design flow temperature Φ_{HL} has to be chosen such that these temperatures are not exceeded in the room. For a previously chosen heating medium excess temperature the temperature difference is chosen such that this is guaranteed (see example diagram, p. 221).

Mean heating water temperature $\theta_{H,m}$ [°C], average value of flow and return temperature, takes temperature difference into consideration

$$\theta_{H,m} = (\theta_V - \theta_R) : 2 + \theta_R$$

- Temperature difference σ [K],
  Difference in temperature between supply and return $(\theta_V - \theta_R)$

Thermal resistance of floor covering
$R_{\lambda,B}$ [m^2K/W], influences thermal transfer of heating screed to room and is dependent on the materials concerned.

These must be supplied with a certificate of suitability from the manufacturer. Textiles and other elastic floor coverings have a special marking.

Floor covering	Thermal resistance
Natural stone, tiles < 15 mm	0.015
Natural stone, tiles < 25 mm	0.025
Parquet floor, needled felt, man-made fibre	0.050
Fitted carpet, loop pile carpet	0.100
Velour, carpet	0.150

Planning and design of the underfloor heating system

The following parameters can be calculated from this:

- Heating medium excess temperature $\Delta\theta_H$ [K], the difference between the mean heating water temperature $\theta_{H,m}$ and standard internal room temperature θ_i

$$\Delta\theta_H = \theta_{H,m} - \theta_i$$

- Flow excess temperature $\Delta\theta_V$, difference between flow temperature θ_V and standard internal room temperature θ_i

$$\Delta\theta_V = \theta_V - \theta_i$$

NOTE:
For heating medium excess temperature, flow excess temperature and temperature difference the following preconditions must be fulfilled:

$$\Delta\theta_V = \Delta\theta_H + 0{,}5 \cdot \sigma$$
(if $\sigma : \Delta\theta_H > 0{,}5$)

$$\Delta\theta_V = \Delta\theta_H + 0{,}5 \cdot \sigma + \sigma \cdot \sigma : 12 \cdot \Delta\theta_H$$
(if $\sigma : \Delta\theta_H < 0{,}5$)

- Surface heat flux q [W/m^2], ratio of the dimensioning heating power Q_H and the actual heating surface A_F available for use

$$q = Q_H : A_F$$

- Laying distance VA [cm] is determined depending on the surface heat flux, heating medium excess temperature and possible thermal resistance of the floor covering (see diagrams of heat-related tests, from p. 221).

- Maximum pipe length to be laid $l_{R,max}$ [m], the total pressure loss of a heating circuit should not exceed 250 hPa – the required mass flow rate and the pipe dimension therefore limit the pipe length to be laid (see pressure loss tables for pipes, from page 227)

- Pipe demand l_R [m], the laying distance VA and the heating area A_F determine the pipe demand per m^2 floor:

$$l_R = [1 : VA \text{ (in m)}] \times A_F$$

- Maximum heating circuit area $A_{HK,max}$ [m^2] is determined by the geometry of the room and the maximum pipe length to be laid on the basis of the pipe demand (see heat load tables, from page 200).

- Mass flow rate m [kg/h], is to be determined as design heating medium flow mH acc. to DIN 1264-3.

$$m = Q_H : [1{,}163 \times (\theta_V - \theta_R)]$$

- The normal mass flow rate calculation for radiator heating systems has to be corrected by the mass flow rate which results from the heat loss to the room below. For this purpose the part heat transition resistance upwards (R_o) and downwards (R_u, sum of all individual thermal resistances of insulation boards and floor construction) has to be determined. R_o can be calculated by using the diagrams or the heat load tables according to the following equation:

$$R_o = \Delta\theta_H : q$$

This results in:

$$m = K \cdot Q_H : [1{,}163 \times (\theta_V - \theta_R)]$$
$$K = 1 + R_o : R_u + (\theta_i - \theta_u) : (q \times R_u)$$

θ_u is the room temperature of the room below.

Examples for the determination of the laying distance

- Tacker system, central area
- Heating surface: 30 m²
- Internal room temperature: 20°C
- Mean heating water temperature: 40°C
- Parquet floor: 0.050 m²K/W
- Dimensioning heating power: 2000 W

These values are carried over to the axes of the diagrams for the tacker system. The largest laying distance VA 25 cm is started with. The point of intersection of both values in the diagram should be on straight line 0.05 or slightly below, in no case above the black limit curves for the floor surface temperatures.

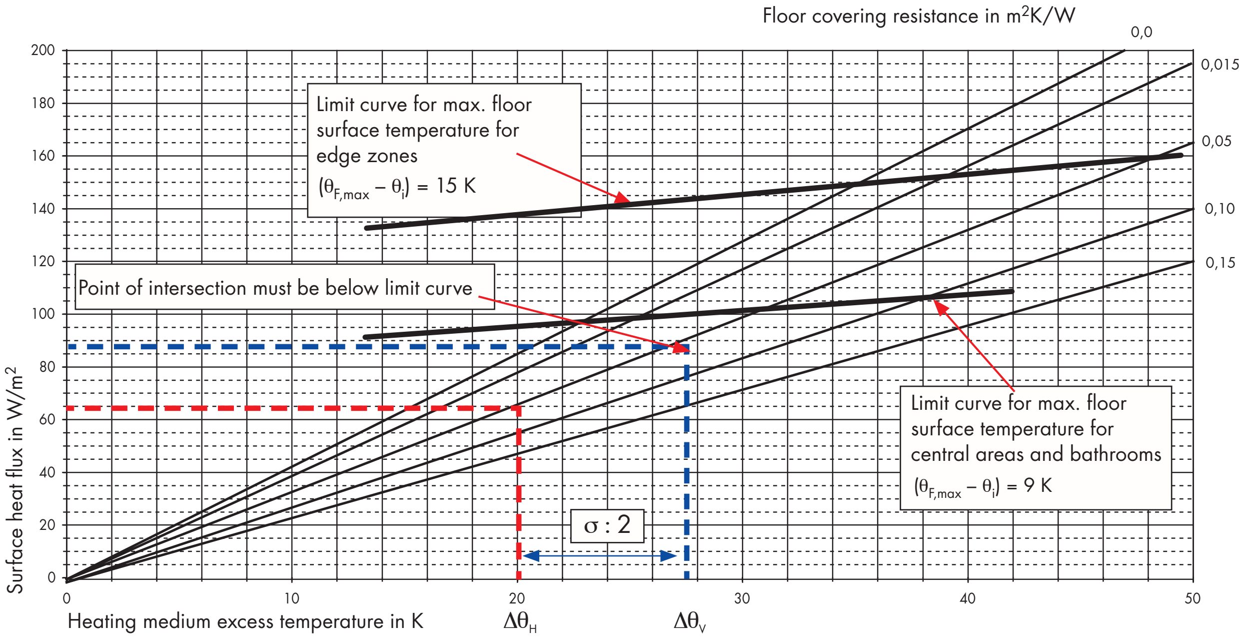
Heating medium excess temperature $\Delta\theta_H$
= mean heating water temperature $\theta_{H,m}$ – room temperature θ_i
= 40°C – 20°C
= 20 K

Surface heat flux q
= design power Q_H : Heating surface A_F
= 2000 W : 30 m²
= 67 W/m²

Example:

$\Delta\theta_H$ = 20 K; $\Delta\theta_V$ = 26.25 K;
σ = 12.5 K; q = 67 W/m²

Example diagram tacker system laying distance 25 cm



In the example diagram the point of intersection is found exactly on the 0.05 line. At a laying distance of 25 cm the required surface heat flux of 67 W/m² is achieved with a heating medium excess temperature of 20°C.

With a temperature difference of 12.5 K this results in a flow temperature of 46.25°C. The point of intersection with the straight line 0.05 is below the black limit curve for limiting the surface temperature of the floor (central area or edge zone). In the case of parquet floor the maximum permissible surface temperature of 29°C is not exceeded with a flow temperature of 46.25°C.

Planning and design of the underfloor heating system

Now the laying distances are calculated for all rooms of a house in relation to floor covering and surface heat flux on the basis of the previously selected heating medium excess temperature and the flow temperature.

If the division is reduced the surface heat flux is increased for the same floor covering and the same heating medium excess temperature. If the heating medium excess temperature is increased the laying distance can be reduced for the same floor covering and the same surface heat flux.

Finally
The determination of the mass flow rates according to DIN EN 1264-3 and the resulting pressure losses for hydraulic equalisation takes a lot of time. We therefore recommend the use of domestic engineering planning software (Dendrit or liNear). For this purpose the heat losses downwards have to be taken into consideration.

These result from the room temperature differences and the respective insulation thicknesses and floor constructions.

If the heating pipes are laid on the basis of manual calculation, a maximum pipe length of 120 m per heating circuit should not be exceeded. The values of the maximum heating circuit areas can be taken from the heat load tables.

TIP

A reduction of system temperatures is thus possible where a smaller division is used. For reasons of comfort we recommend not using laying distances of more than 20 cm, as the floor would not be heated evenly.

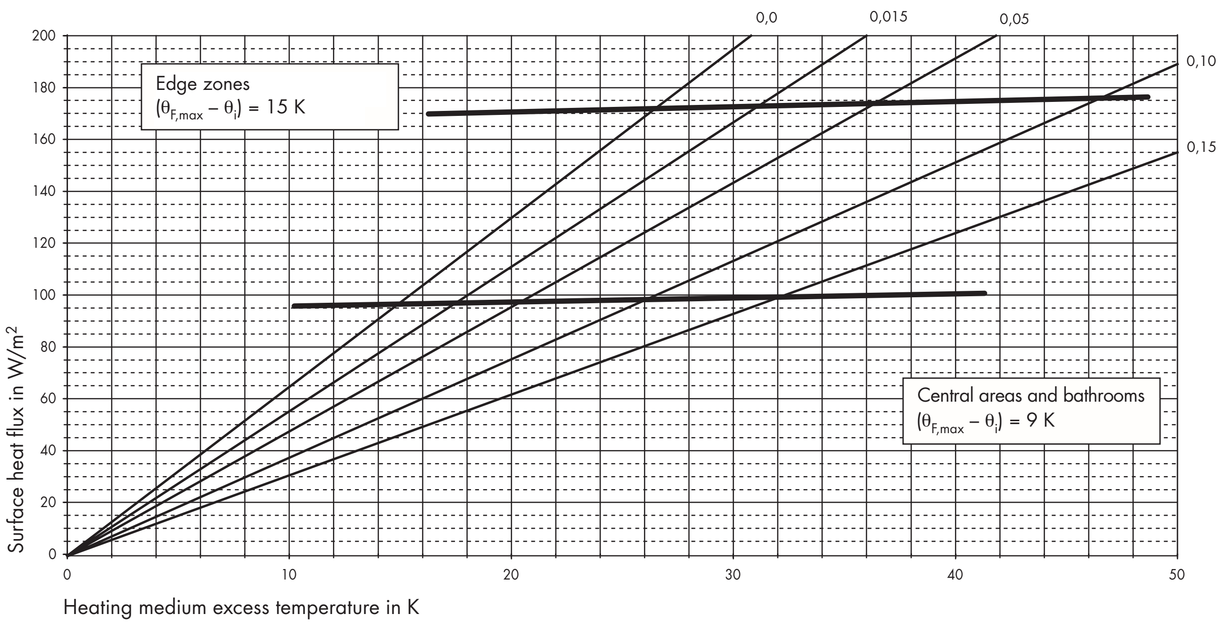
Diagrams of the heat-related tests

The ***PRINETO*** surface heating systems – tacker system, knobbed board system 14 and dry-laid floor heating system – are thermotechnically tested as per DIN EN 1264-2. The test numbers are furnished for the respective system on the following pages.

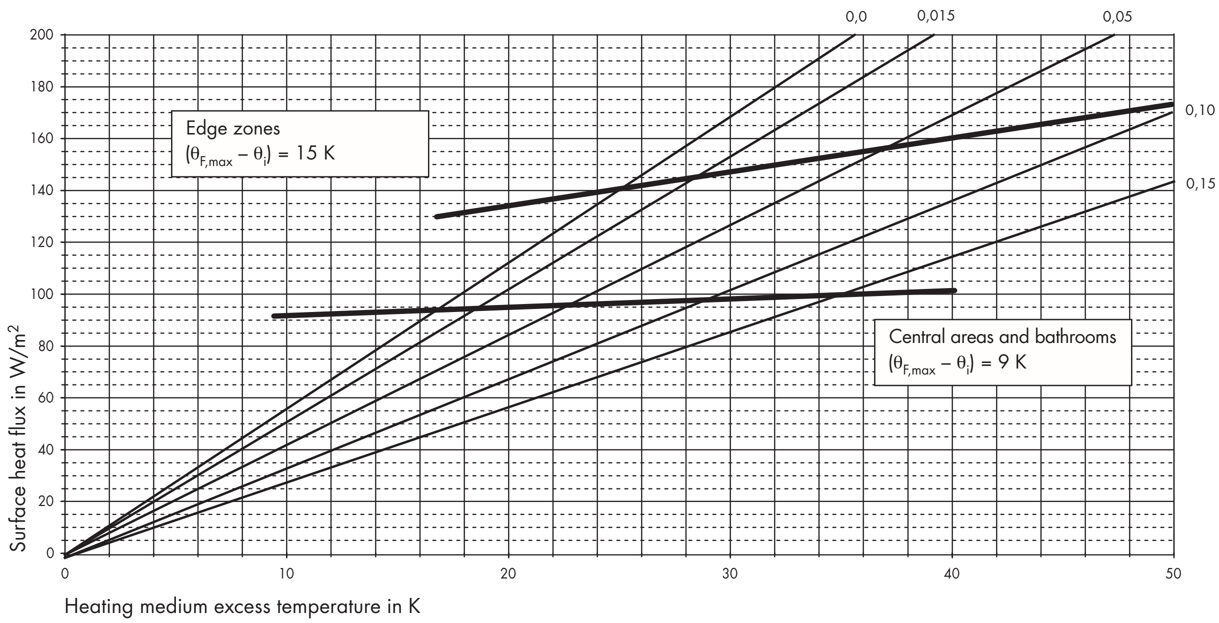
In the following diagrams the system-specific realisable surface heat fluxes of the various systems are depicted in relation to laying distance, floor covering resistance and heating medium excess temperature.

PRINETO tacker system

Laying distance 10 cm



Laying distance 15 cm

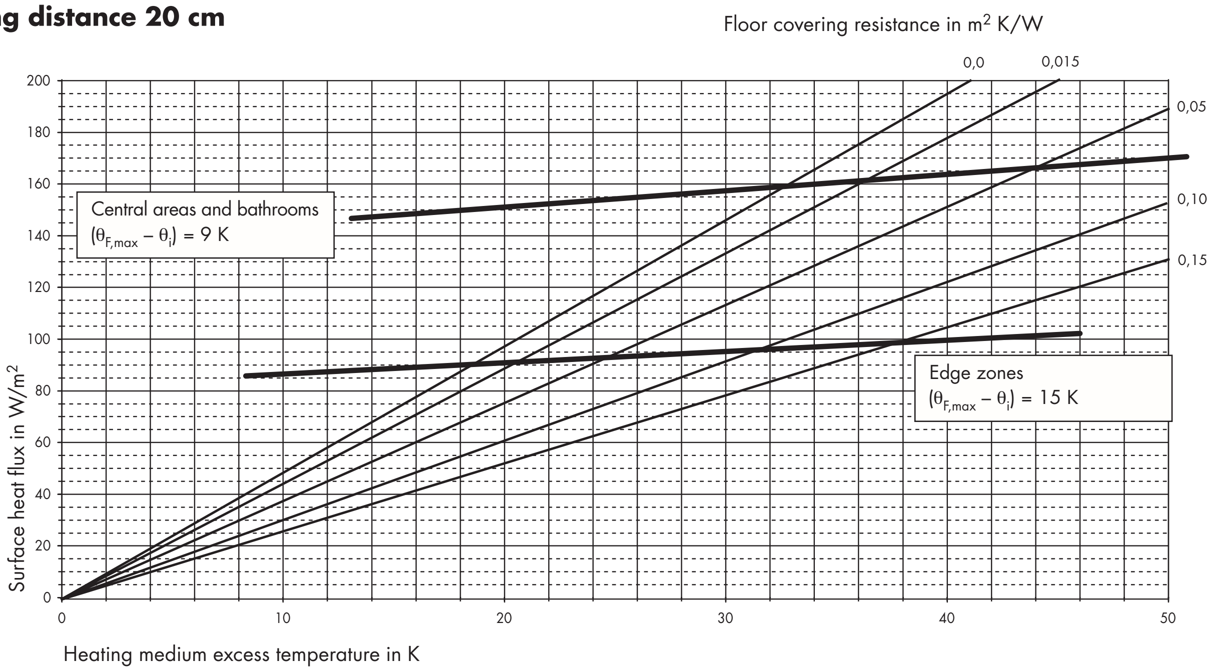


DIN geprüft Test report no. HB00P065, DIN- CERTCO 7F101

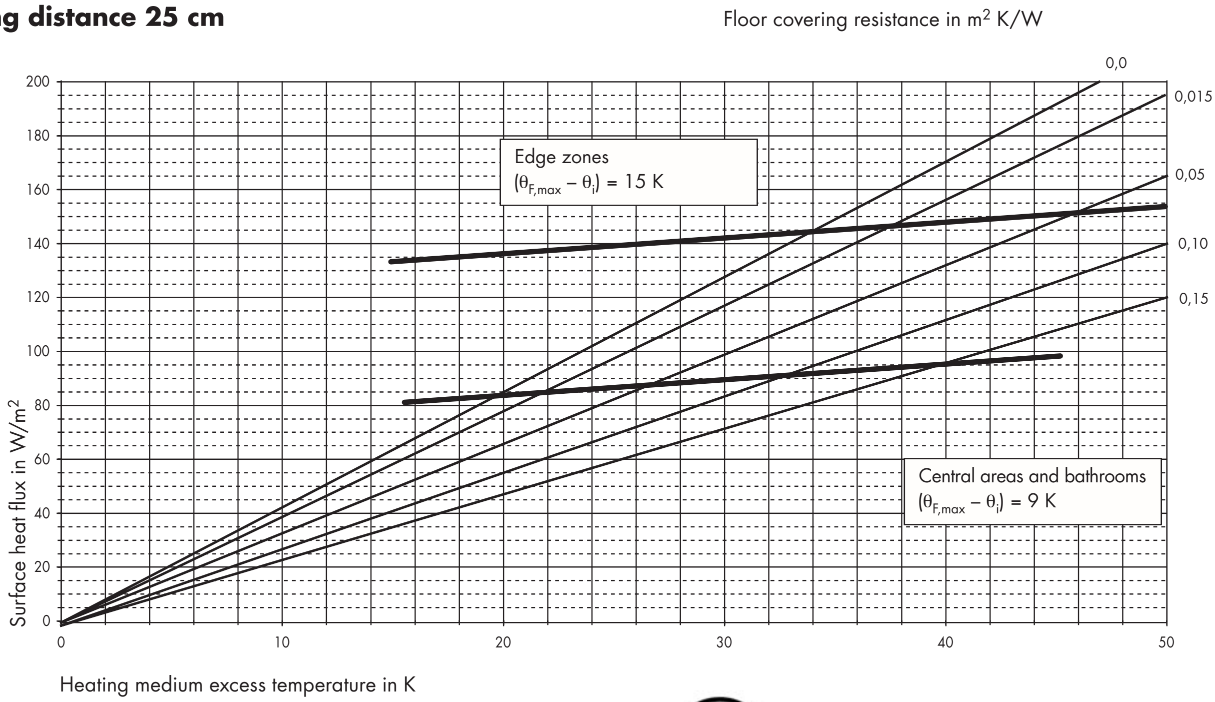
Planning and design of the underfloor heating system

PRINETO tacker system

Laying distance 20 cm



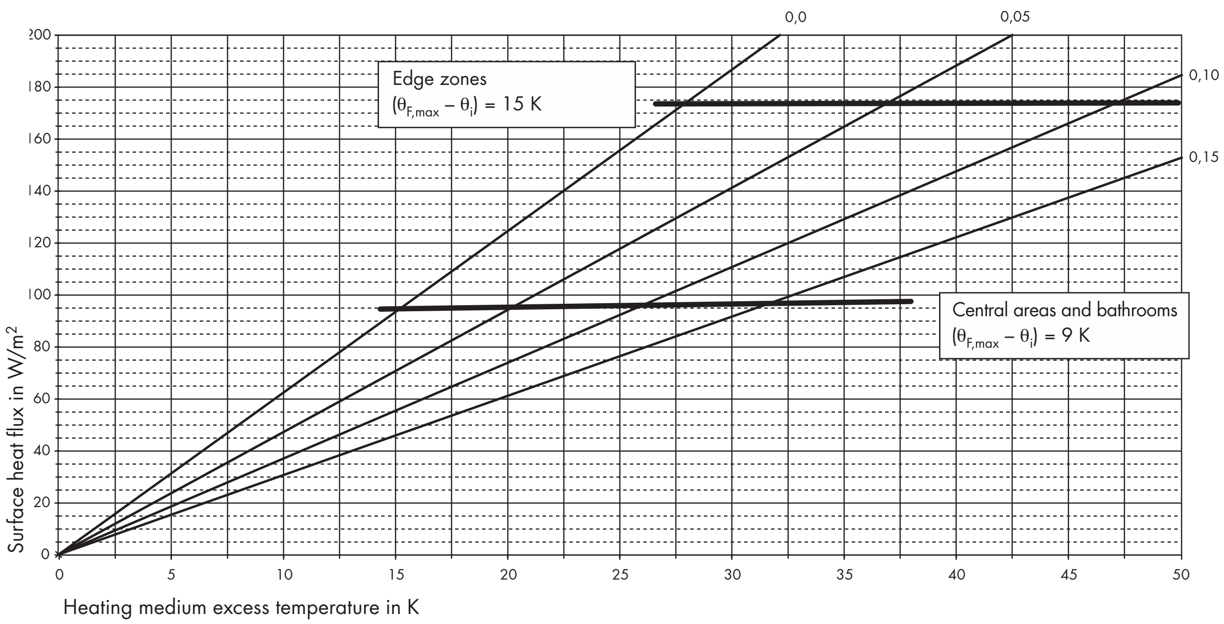
Laying distance 25 cm



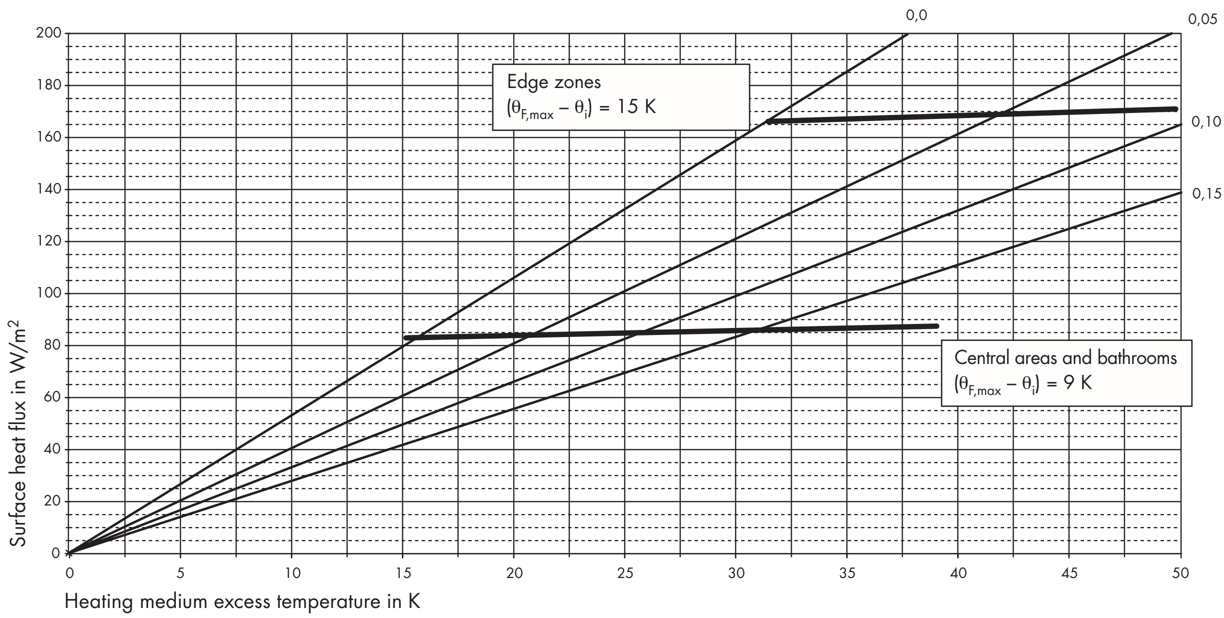
DIN geprüft Test report no. HB00P065, DIN- CERTCO 7F101

PRINETO knobbed board system

Laying distance 10 cm



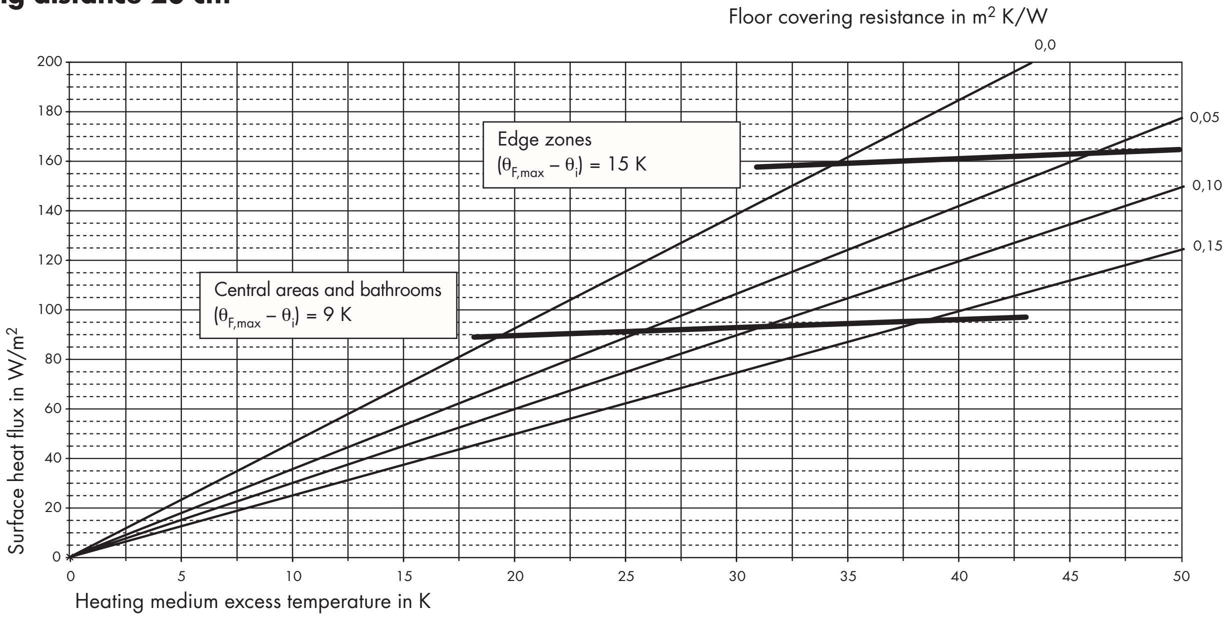
Laying distance 15 cm



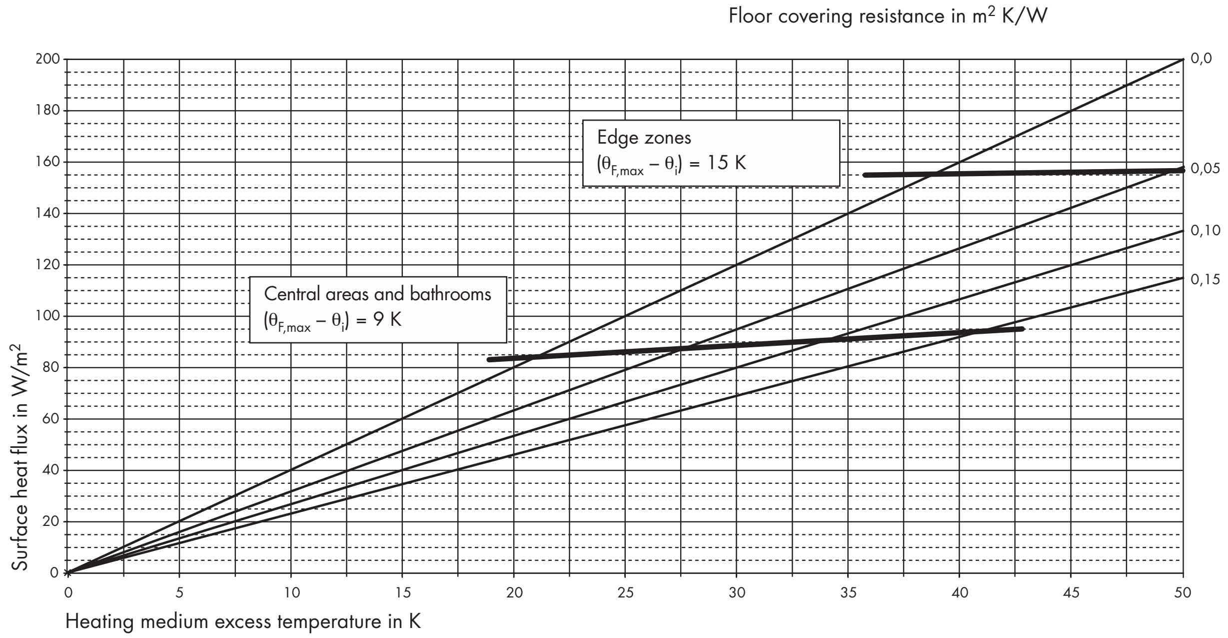
Planning and design of the underfloor heating system

PRINETO knobbed board system

Laying distance 20 cm

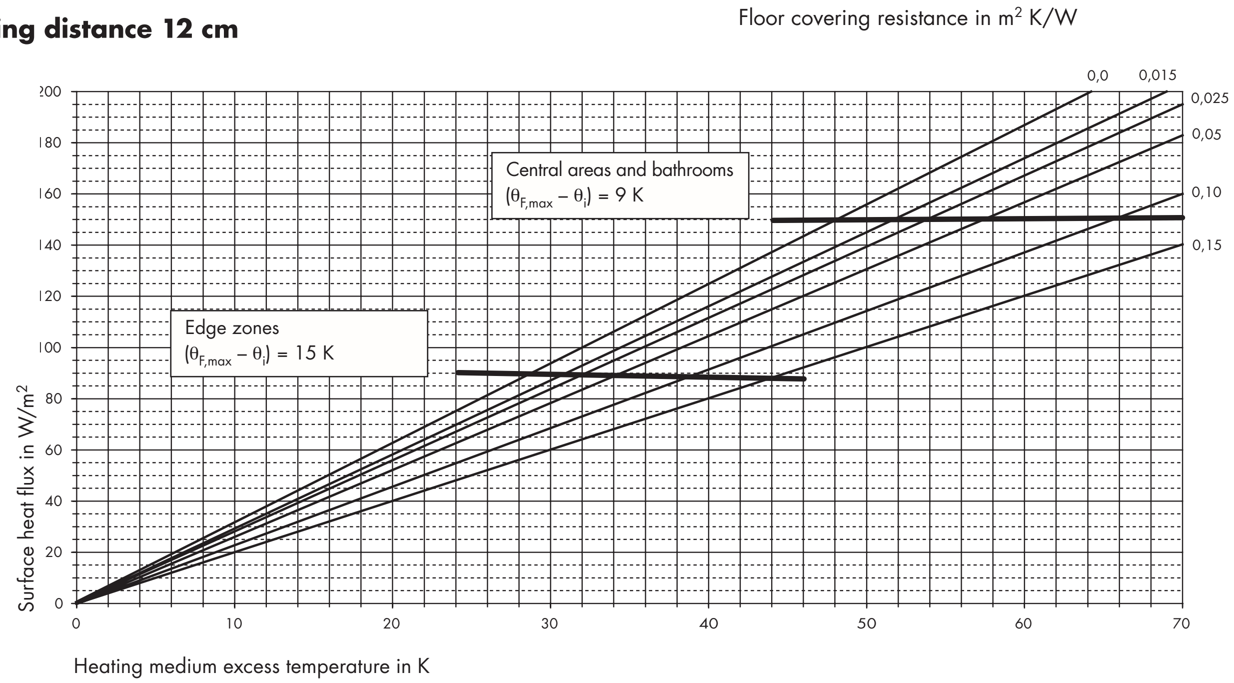


Laying distance 25 cm

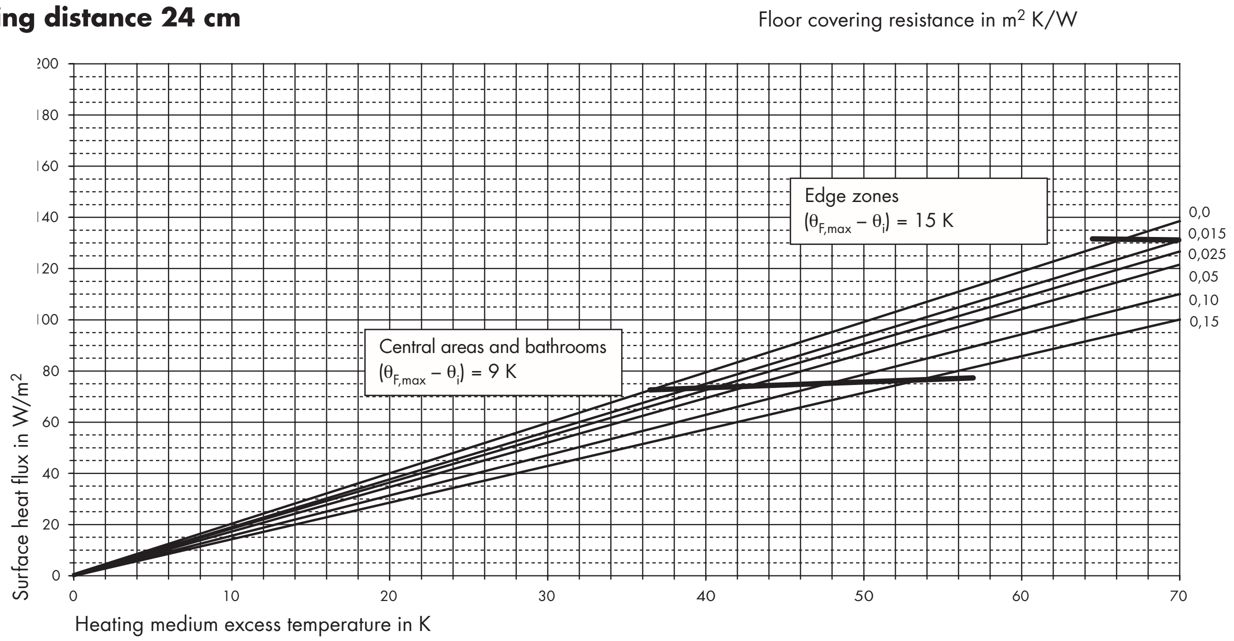


PRINETO dry system

Laying distance 12 cm



Laying distance 24 cm



Pressure loss tables

Pressure losses for dimension 12 x 2.0 [SH]

Temperature difference	3 K				5 K				7 K			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
20	5.73	0.03	4.45	5.13	3.44	0.02	1.82	2.10	2.46	0.01	1.01	1.17
40	11.46	0.06	14.95	17.27	6.88	0.04	6.12	7.06	4.91	0.03	3.39	3.92
60	17.20	0.10	30.40	35.12	10.32	0.06	12.43	14.36	7.37	0.04	6.90	7.97
80	22.93	0.13	50.29	58.10	13.76	0.08	20.57	23.76	9.83	0.05	11.42	13.19
100	28.66	0.16	74.31	85.85	17.20	0.10	30.40	35.12	12.28	0.07	16.87	19.49
120	34.39	0.19	102.25	118.11	20.64	0.11	41.82	48.31	14.74	0.08	23.21	26.81
140	40.13	0.22	133.91	154.69	24.08	0.13	54.77	63.27	17.20	0.10	30.40	35.12
160	45.86	0.25	169.16	195.41	27.52	0.15	69.19	79.93	19.65	0.11	38.40	44.36
180	51.59	0.29	207.88	240.14	30.95	0.17	85.03	98.23	22.11	0.12	47.19	54.51
200	57.32	0.32	249.96	288.76	34.39	0.19	102.25	118.11	24.57	0.14	56.74	65.55
220	63.06	0.35	295.34	341.17	37.83	0.21	120.80	139.55	27.02	0.15	67.04	77.45
240	68.79	0.38	343.91	397.29	41.27	0.23	140.67	162.51	29.48	0.16	78.07	90.19
260	74.52	0.41	395.62	457.02	44.71	0.25	161.82	186.94	31.94	0.18	89.81	103.75
280	80.25	0.44	450.40	520.31	48.15	0.27	184.23	212.83	34.39	0.19	102.25	118.11
300	85.98	0.48	508.20	587.08	51.59	0.29	207.88	240.14	36.85	0.20	115.37	133.27
320	91.72	0.51	568.97	657.27	55.03	0.30	232.73	268.85	39.31	0.22	129.16	149.21
340					58.47	0.32	258.78	298.94	41.76	0.23	143.62	165.91
360					61.91	0.34	286.00	330.39	44.22	0.24	158.73	183.36
380					65.35	0.36	314.39	363.18	46.68	0.26	174.48	201.56
400					68.79	0.38	343.91	397.29	49.13	0.27	190.86	220.48
420					72.23	0.40	374.56	432.70	51.59	0.29	207.88	240.14
440					75.67	0.42	406.33	469.40	54.05	0.30	225.51	260.50
460					79.11	0.44	439.20	507.37	56.50	0.31	243.75	281.58
480					82.55	0.46	473.17	546.60	58.96	0.33	262.60	303.35
500					85.98	0.48	508.20	587.08	61.42	0.34	282.04	325.81
520					89.42	0.49	544.31	628.79	63.87	0.35	302.08	348.96
540					92.86	0.51	581.47	671.72	66.33	0.37	322.71	372.79
560									68.79	0.38	343.91	397.29
580									71.24	0.39	365.69	422.45
600									73.70	0.41	388.04	448.27
620									76.16	0.42	410.96	474.74
640									78.61	0.43	434.44	501.87
660									81.07	0.45	458.48	529.63
680									83.53	0.46	483.07	558.04
700									85.98	0.48	508.20	587.08
720									88.44	0.49	533.89	616.74
740									90.90	0.50	560.11	647.04

Pressure losses for dimension 14 x 2.0 [multilayer composite pipe and SH]

Temperature difference	3 K				5 K				7 K			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
100	28.66	0.10	25.75	29.74	17.20	0.06	10.53	12.17	12.28	0.04	5.85	6.75
120	34.39	0.12	35.43	40.92	20.64	0.07	14.49	16.74	14.74	0.05	8.04	9.29
140	40.13	0.14	46.40	53.60	24.08	0.09	18.98	21.92	17.20	0.06	10.53	12.17
160	45.86	0.16	58.61	67.70	27.52	0.10	23.97	27.69	19.65	0.07	13.30	15.37
180	51.59	0.18	72.02	83.20	30.95	0.11	29.46	34.03	22.11	0.08	16.35	18.89
200	57.32	0.20	86.61	100.05	34.39	0.12	35.43	40.92	24.57	0.09	19.66	22.71
220	63.06	0.22	102.33	118.21	37.83	0.13	41.86	48.35	27.02	0.10	23.23	26.83
240	68.79	0.24	119.16	137.65	41.27	0.15	48.74	56.30	29.48	0.10	27.05	31.25
260	74.52	0.26	137.07	158.35	44.71	0.16	56.07	64.77	31.94	0.11	31.12	35.95
280	80.25	0.28	156.06	180.28	48.15	0.17	63.83	73.74	34.39	0.12	35.43	40.92
300	85.98	0.30	176.08	203.41	51.59	0.18	72.02	83.20	36.85	0.13	39.97	46.18
320	91.72	0.32	197.14	227.73	55.03	0.19	80.64	93.15	39.31	0.14	44.75	51.70
340	97.45	0.34	219.20	253.22	58.47	0.21	89.66	103.58	41.76	0.15	49.76	57.48
360	103.18	0.36	242.26	279.86	61.91	0.22	99.09	114.47	44.22	0.16	55.00	63.53
380	108.91	0.39	266.30	307.63	65.35	0.23	108.93	125.83	46.68	0.17	60.45	69.83
400	114.65	0.41	291.31	336.52	68.79	0.24	119.16	137.65	49.13	0.17	66.13	76.39
420	120.38	0.43	317.28	366.52	72.23	0.26	129.78	149.92	51.59	0.18	72.02	83.20
440	126.11	0.45	344.19	397.61	75.67	0.27	140.79	162.64	54.05	0.19	78.13	90.26
460	131.84	0.47	372.03	429.77	79.11	0.28	152.18	175.79	56.50	0.20	84.45	97.56
480	137.58	0.49	400.80	463.00	82.55	0.29	163.94	189.39	58.96	0.21	90.98	105.10
500	143.31	0.51	430.48	497.29	85.98	0.30	176.08	203.41	61.42	0.22	97.72	112.89
520					89.42	0.32	188.59	217.86	63.87	0.23	104.66	120.91
540					92.86	0.33	201.47	232.74	66.33	0.23	111.81	129.16
560					96.30	0.34	214.71	248.03	68.79	0.24	119.16	137.65
580					99.74	0.35	228.31	263.74	71.24	0.25	126.70	146.37
600					103.18	0.36	242.26	279.86	73.70	0.26	134.45	155.32
620					106.62	0.38	256.57	296.39	76.16	0.27	142.39	164.49
640					110.06	0.39	271.23	313.32	78.61	0.28	150.53	173.89
660					113.50	0.40	286.23	330.66	81.07	0.29	158.85	183.51
680					116.94	0.41	301.58	348.39	83.53	0.30	167.37	193.35
700					120.38	0.43	317.28	366.52	85.98	0.30	176.08	203.41
720					123.82	0.44	333.31	385.04	88.44	0.31	184.98	213.69
740					127.26	0.45	349.68	403.95	90.90	0.32	194.07	224.18
760					130.70	0.46	366.39	423.25	93.35	0.33	203.34	234.90
780					134.14	0.47	383.43	442.94	95.81	0.34	212.79	245.82
800					137.58	0.49	400.80	463.00	98.27	0.35	222.43	256.96
820					141.01	0.50	418.50	483.45	100.72	0.36	232.26	268.30

Pressure losses for dimension 14 x 2.0 [surface heating pipe stabil and SH] continued

Temperature difference	3 K				5 K				7 K			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
840									103.18	0.36	242.26	279.86
860									105.64	0.37	252.44	291.62
880									108.09	0.38	262.81	303.60
900									110.55	0.39	273.35	315.77
920									113.01	0.40	284.07	328.16
940									115.46	0.41	294.96	340.74
960									117.92	0.42	306.03	353.53
980									120.38	0.43	317.28	366.52
1,000									122.84	0.43	328.70	379.71
1,020									125.29	0.44	340.29	393.10

Pressure losses for dimension 16 x 2.0 [surface heating pipe stabil]

Temperature difference	3				5				7				
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C		R [Pa/m] at 15°C
200	57.32	0.14	36.43	42.08	34.39	0.08	14.90	17.21	24.57	0.06	8.27	1100.29	9.55
230	65.92	0.16	46.52	53.74	39.55	0.10	19.03	21.98	28.25	0.07	10.56	1265.34	12.20
260	74.52	0.18	57.66	66.60	44.71	0.11	23.58	27.24	31.94	0.08	13.09	1430.38	15.12
290	83.12	0.20	69.80	80.63	49.87	0.12	28.55	32.98	35.62	0.09	15.84	1595.43	18.30
320	91.72	0.23	82.92	95.79	55.03	0.14	33.92	39.18	39.31	0.10	18.82	1760.47	21.74
350	100.32	0.25	97.00	112.05	60.19	0.15	39.68	45.83	42.99	0.11	22.02	1925.51	25.44
380	108.91	0.27	112.01	129.40	65.35	0.16	45.82	52.93	46.68	0.11	25.43	2090.56	29.37
410	117.51	0.29	127.94	147.80	70.51	0.17	52.33	60.46	50.36	0.12	29.04	2255.60	33.55
440	126.11	0.31	144.77	167.24	75.67	0.19	59.22	68.41	54.05	0.13	32.86	2420.65	37.96
470	134.71	0.33	162.49	187.70	80.83	0.20	66.46	76.78	57.73	0.14	36.89	2585.69	42.61
500	143.31	0.35	181.07	209.17	85.98	0.21	74.06	85.56	61.42	0.15	41.10	2750.73	47.48
530	151.91	0.37	200.51	231.62	91.14	0.22	82.01	94.74	65.10	0.16	45.52	2915.78	52.58
560	160.50	0.39	220.79	255.05	96.30	0.24	90.31	104.33	68.79	0.17	50.12	3080.82	57.90
590	169.10	0.42	241.90	279.44	101.46	0.25	98.95	114.30	72.47	0.18	54.91	3245.86	63.44
620	177.70	0.44	263.83	304.78	106.62	0.26	107.92	124.67	76.16	0.19	59.89	3410.91	69.19
650	186.30	0.46	286.58	331.05	111.78	0.27	117.22	135.41	79.84	0.20	65.06	3575.95	75.15
680	194.90	0.48	310.12	358.25	116.94	0.29	126.85	146.54	83.53	0.21	70.40	3741.00	81.33
710	203.50	0.50	334.46	386.37	122.10	0.30	136.81	158.04	87.21	0.21	75.93	3906.04	87.71
740					127.26	0.31	147.08	169.91	90.90	0.22	81.63	4071.08	94.30
770					132.42	0.33	157.68	182.15	94.58	0.23	87.51	4236.13	101.09
800					137.58	0.34	168.58	194.75	98.27	0.24	93.56	4401.17	108.08
830					142.73	0.35	179.80	207.71	101.95	0.25	99.79	4566.22	115.27
860					147.89	0.36	191.33	221.02	105.64	0.26	106.18	4731.26	122.66

Pressure losses for dimension 16 x 2.0 [underfloor heating pipe stabil] continued

Temperature difference	3				5				7				
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C		R [Pa/m] at 15°C
890					153,05	0,38	203,16	234,69	109,32	0,27	112,75	4896,30	130,25
920					158,21	0,39	215,30	248,71	113,01	0,28	119,48	5061,35	138,03
950					163,37	0,40	227,73	263,08	116,69	0,29	126,39	5226,39	146,00
980					168,53	0,41	240,47	277,79	120,38	0,30	133,45	5391,44	154,16
1.010					173,69	0,43	253,50	292,84	124,06	0,30	140,68	5556,48	162,52
1.040					178,85	0,44	266,82	308,23	127,75	0,31	148,08	5721,52	171,06
1.070					184,01	0,45	280,43	323,96	131,43	0,32	155,63	5886,57	179,79
1.100					189,17	0,46	294,34	340,02	135,12	0,33	163,35	6051,61	188,70
1.130					194,33	0,48	308,53	356,41	138,80	0,34	171,23	6216,66	197,80
1.160					199,48	0,49	323,00	373,13	142,49	0,35	179,26	6381,70	207,08
1.190					204,64	0,50	337,76	390,19	146,17	0,36	187,45	6546,74	216,54
1.220									149,86	0,37	195,80	6711,79	226,19
1.220									149,86	0,37	195,80	6711,79	226,19
1.250									153,54	0,38	204,30	6876,83	236,01
1.280									157,23	0,39	212,96	7041,88	246,01
1.310									160,91	0,40	221,77	7206,92	256,19
1.340									164,60	0,40	230,74	7371,96	266,55
1.370									168,28	0,41	239,85	7537,01	277,08
1.400									171,97	0,42	249,12	7702,05	287,78
1.430									175,65	0,43	258,54	7867,10	298,66
1.460									179,34	0,44	268,10	8032,14	309,71
1.490									183,02	0,45	277,82	8197,18	320,93
1.520									186,71	0,46	287,68	8362,23	332,33
1.550									190,39	0,47	297,69	8527,27	343,89
1.580									194,08	0,48	307,85	8692,32	355,62

Planning and design of the underfloor heating system

Pressure losses for dimension 16 x 2.2 [Nanoflex, heating, multilayer composite pipe]

Temperature difference	3 K				5 K				7 K			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
200	57.32	0.15	42.79	49.44	34.39	0.09	17.50	20.22	24.57	0.06	9.71	11.22
230	65.92	0.17	54.65	63.13	39.55	0.10	22.35	25.82	28.25	0.07	12.41	14.33
260	74.52	0.20	67.73	78.24	44.71	0.12	27.70	32.00	31.94	0.08	15.38	17.76
290	83.12	0.22	81.99	94.72	49.87	0.13	33.54	38.74	35.62	0.09	18.61	21.50
320	91.72	0.24	97.41	112.52	55.03	0.14	39.84	46.03	39.31	0.10	22.11	25.54
350	100.32	0.26	113.95	131.63	60.19	0.16	46.61	53.84	42.99	0.11	25.87	29.88
380	108.91	0.29	131.58	152.00	65.35	0.17	53.82	62.18	46.68	0.12	29.87	34.51
410	117.51	0.31	150.30	173.62	70.51	0.19	61.48	71.02	50.36	0.13	34.12	39.41
440	126.11	0.33	170.07	196.46	75.67	0.20	69.56	80.36	54.05	0.14	38.61	44.60
470	134.71	0.35	190.88	220.50	80.83	0.21	78.08	90.19	57.73	0.15	43.33	50.05
500	143.31	0.38	212.70	245.72	85.98	0.23	87.00	100.51	61.42	0.16	48.29	55.78
530	151.91	0.40	235.54	272.09	91.14	0.24	96.34	111.30	65.10	0.17	53.47	61.77
560	160.50	0.42	259.36	299.62	96.30	0.25	106.09	122.55	68.79	0.18	58.88	68.01
590	169.10	0.44	284.16	328.27	101.46	0.27	116.23	134.27	72.47	0.19	64.51	74.52
620	177.70	0.47	309.93	358.03	106.62	0.28	126.77	146.45	76.16	0.20	70.36	81.28
650	186.30	0.49	336.65	388.90	111.78	0.29	137.70	159.07	79.84	0.21	76.42	88.28
680	194.90	0.51	364.31	420.85	116.94	0.31	149.02	172.14	83.53	0.22	82.70	95.54
710					122.10	0.32	160.71	185.65	87.21	0.23	89.19	103.03
740					127.26	0.33	172.78	199.60	90.90	0.24	95.89	110.77
770					132.42	0.35	185.23	213.97	94.58	0.25	102.80	118.75
800					137.58	0.36	198.04	228.77	98.27	0.26	109.91	126.96
830					142.73	0.38	211.22	244.00	101.95	0.27	117.22	135.41
860					147.89	0.39	224.76	259.64	105.64	0.28	124.74	144.09
890					153.05	0.40	238.66	275.70	109.32	0.29	132.45	153.01
920					158.21	0.42	252.91	292.16	113.01	0.30	140.36	162.15
950					163.37	0.43	267.52	309.04	116.69	0.31	148.47	171.51
980					168.53	0.44	282.48	326.32	120.38	0.32	156.77	181.10
1,010					173.69	0.46	297.79	344.00	124.06	0.33	165.27	190.91
1,040					178.85	0.47	313.44	362.08	127.75	0.34	173.95	200.95
1,070					184.01	0.48	329.43	380.56	131.43	0.35	182.83	211.20
1,100					189.17	0.50	345.76	399.43	135.12	0.36	191.89	221.67
1,130									138.80	0.36	201.14	232.36
1,160									142.49	0.37	210.58	243.26
1,190									146.17	0.38	220.20	254.38
1,220									149.86	0.39	230.01	265.71
1,250									153.54	0.40	240.00	277.25
1,280									157.23	0.41	250.17	289.00

Pressure losses for dimension 16 x 2.2 [Nanoflex, heating, multilayer composite pipe] continued

Temperature difference	3 K				5 K				7 K			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
1.310									160,91	0,42	260,52	300,95
1.340									164,60	0,43	271,05	313,12
1.370									168,28	0,44	281,76	325,49
1.400									171,97	0,45	292,65	338,06
1.430									175,65	0,46	303,71	350,84
1.460									179,34	0,47	314,95	363,83
1.490									183,02	0,48	326,36	377,01
1.520									186,71	0,49	337,94	390,39
1.550									190,39	0,50	349,70	403,98
1.580									194,08	0,51	361,63	417,76

Planning and design of the underfloor heating system

Pressure losses for dimension 17 x 2.0 [SH]

Temperature difference	3				5				7			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
200	57.32	0.12	24.91	28.77	34.39	0.07	10.19	11.77	24.57	0.05	5.65	6.53
240	68.79	0.14	34.27	39.59	41.27	0.09	14.02	16.19	29.48	0.06	7.78	8.99
280	80.25	0.17	44.88	51.84	48.15	0.10	18.36	21.21	34.39	0.07	10.19	11.77
320	91.72	0.19	56.69	65.49	55.03	0.12	23.19	26.79	39.31	0.08	12.87	14.87
360	103.18	0.22	69.67	80.48	61.91	0.13	28.50	32.92	44.22	0.09	15.82	18.27
400	114.65	0.24	83.78	96.78	68.79	0.14	34.27	39.59	49.13	0.10	19.02	21.97
440	126.11	0.26	98.98	114.35	75.67	0.16	40.49	46.77	54.05	0.11	22.47	25.96
480	137.58	0.29	115.26	133.15	82.55	0.17	47.15	54.46	58.96	0.12	26.17	30.23
520	149.04	0.31	132.60	153.17	89.42	0.19	54.24	62.65	63.87	0.13	30.10	34.77
560	160.50	0.34	150.96	174.38	96.30	0.20	61.75	71.33	68.79	0.14	34.27	39.59
600	171.97	0.36	170.33	196.76	103.18	0.22	69.67	80.48	73.70	0.15	38.67	44.67
640	183.43	0.38	190.69	220.29	110.06	0.23	78.00	90.11	78.61	0.16	43.29	50.01
680	194.90	0.41	212.04	244.95	116.94	0.24	86.73	100.19	83.53	0.17	48.13	55.60
720	206.36	0.43	234.34	270.71	123.82	0.26	95.86	110.73	88.44	0.19	53.20	61.45
760	217.83	0.46	257.60	297.58	130.70	0.27	105.37	121.72	93.35	0.20	58.48	67.55
800	229.29	0.48	281.79	325.53	137.58	0.29	115.26	133.15	98.27	0.21	63.97	73.90
840	240.76	0.50	306.91	354.54	144.45	0.30	125.54	145.02	103.18	0.22	69.67	80.48
880					151.33	0.32	136.19	157.32	108.09	0.23	75.58	87.31
920					158.21	0.33	147.20	170.05	113.01	0.24	81.69	94.37
960					165.09	0.35	158.58	183.20	117.92	0.25	88.01	101.67
1,000					171.97	0.36	170.33	196.76	122.84	0.26	94.53	109.20
1,040					178.85	0.37	182.43	210.74	127.75	0.27	101.24	116.96
1,080					185.73	0.39	194.89	225.13	132.66	0.28	108.16	124.94
1,120					192.61	0.40	207.69	239.92	137.58	0.29	115.26	133.15
1,160					199.48	0.42	220.85	255.12	142.49	0.30	122.56	141.59
1,200					206.36	0.43	234.34	270.71	147.40	0.31	130.06	150.24
1,240					213.24	0.45	248.18	286.70	152.32	0.32	137.74	159.11
1,280					220.12	0.46	262.36	303.08	157.23	0.33	145.61	168.20
1,320					227.00	0.48	276.88	319.85	162.14	0.34	153.66	177.51
1,360					233.88	0.49	291.73	337.01	167.06	0.35	161.90	187.03
1,400					240.76	0.50	306.91	354.54	171.97	0.36	170.33	196.76
1,440									176.88	0.37	178.94	206.71
1,480									181.80	0.38	187.72	216.86
1,520									186.71	0.39	196.69	227.22

Pressure losses for dimension 17 x 2.0 [SH] continued

Temperature difference	3				5				7			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
1,600									196.54	0.41	215.17	248.56
1,640									201.45	0.42	224.67	259.54
1,680									206.36	0.43	234.34	270.71
1,720									211.28	0.44	244.20	282.09
1,760									216.19	0.45	254.22	293.67
1,800									221.10	0.46	264.42	305.45
1,840									226.02	0.47	274.79	317.43
1,880									230.93	0.48	285.32	329.61
1,920									235.84	0.49	296.03	341.98
1,960									240.76	0.50	306.91	354.54

2

Underfloor heating

Pressure losses for dimension 20 x 2.0 [SH]

Temperature difference	3				5				7			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
500	143.31	0.20	46.17	53.34	85.98	0.12	18.89	21.82	61.42	0.08	10.48	12.11
550	157.64	0.22	54.55	63.02	94.58	0.13	22.31	25.78	67.56	0.09	12.38	14.31
600	171.97	0.24	63.53	73.38	103.18	0.14	25.98	30.02	73.70	0.10	14.42	16.66
650	186.30	0.26	73.08	84.42	111.78	0.15	29.89	34.53	79.84	0.11	16.59	19.16
700	200.63	0.28	83.20	96.11	120.38	0.17	34.03	39.31	85.98	0.12	18.89	21.82
750	214.96	0.30	93.87	108.44	128.98	0.18	38.40	44.36	92.13	0.13	21.31	24.62
800	229.29	0.32	105.10	121.41	137.58	0.19	42.99	49.66	98.27	0.14	23.86	27.56
850	243.62	0.34	116.86	135.00	146.17	0.20	47.80	55.22	104.41	0.14	26.53	30.65
900	257.95	0.36	129.15	149.20	154.77	0.21	52.83	61.03	110.55	0.15	29.32	33.87
950	272.28	0.38	141.97	164.00	163.37	0.23	58.07	67.08	116.69	0.16	32.23	37.23
1,000	286.62	0.40	155.30	179.41	171.97	0.24	63.53	73.38	122.84	0.17	35.26	40.73
1,050	300.95	0.42	169.15	195.40	180.57	0.25	69.19	79.93	128.98	0.18	38.40	44.36
1,100	315.28	0.44	183.49	211.97	189.17	0.26	75.06	86.70	135.12	0.19	41.65	48.12
1,150	329.61	0.46	198.34	229.12	197.76	0.27	81.13	93.72	141.26	0.20	45.02	52.01
1,200	343.94	0.48	213.67	246.84	206.36	0.29	87.40	100.97	147.40	0.20	48.51	56.03
1,250	358.27	0.49	229.50	265.11	214.96	0.30	93.87	108.44	153.54	0.21	52.10	60.18
1,300	372.60	0.51	245.80	283.95	223.56	0.31	100.54	116.15	159.69	0.22	55.80	64.46
1,350					232.16	0.32	107.41	124.08	165.83	0.23	59.61	68.86
1,400					240.76	0.33	114.46	132.23	171.97	0.24	63.53	73.38
1,450					249.36	0.34	121.71	140.60	178.11	0.25	67.55	78.03
1,500					257.95	0.36	129.15	149.20	184.25	0.25	71.68	82.80
1,550					266.55	0.37	136.78	158.01	190.39	0.26	75.91	87.69
1,600					275.15	0.38	144.60	167.04	196.54	0.27	80.25	92.70
1,650					283.75	0.39	152.60	176.28	202.68	0.28	84.69	97.83
1,700					292.35	0.40	160.78	185.73	208.82	0.29	89.23	103.08
1,750					300.95	0.42	169.15	195.40	214.96	0.30	93.87	108.44
1,800					309.54	0.43	177.70	205.27	221.10	0.31	98.62	113.92
1,850					318.14	0.44	186.42	215.36	227.24	0.31	103.46	119.52
1,900					326.74	0.45	195.33	225.64	233.39	0.32	108.40	125.23
1,950					335.34	0.46	204.41	236.14	239.53	0.33	113.44	131.05
2,000					343.94	0.48	213.67	246.84	245.67	0.34	118.58	136.99
2,050					352.54	0.49	223.11	257.74	251.81	0.35	123.82	143.04
2,100					361.13	0.50	232.72	268.84	257.95	0.36	129.15	149.20
2,150									264.10	0.36	134.58	155.47

Pressure losses for dimension 20 x 2.0 [SH] continued

Temperature difference	3				5				7			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
2,200									270.24	0.37	140.11	161.85
2,250									276.38	0.38	145.73	168.34
2,300									282.52	0.39	151.44	174.95
2,350									288.66	0.40	157.25	181.66
2,400									294.80	0.41	163.15	188.47
2,450									300.95	0.42	169.15	195.40
2,500									307.09	0.42	175.23	202.43
2,550									313.23	0.43	181.41	209.57
2,600									319.37	0.44	187.68	216.81
2,650									325.51	0.45	194.05	224.16
2,700									331.65	0.46	200.50	231.62
2,750									337.80	0.47	207.04	239.17
2,800									343.94	0.48	213.67	246.84

Planning and design of the underfloor heating system

Pressure losses for dimension 25 x 2.3 [SH]

Temperature difference	3				5				7			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
1,000	286.62	0.24	48.98	56.58	171.97	0.15	20.03	23.14	122.84	0.10	11.12	12.84
1,080	309.54	0.26	56.04	64.74	185.73	0.16	22.92	26.48	132.66	0.11	12.72	14.70
1,160	332.47	0.28	63.51	73.36	199.48	0.17	25.98	30.01	142.49	0.12	14.42	16.65
1,240	355.40	0.30	71.37	82.44	213.24	0.18	29.19	33.72	152.32	0.13	16.20	18.72
1,320	378.33	0.32	79.62	91.98	227.00	0.19	32.57	37.62	162.14	0.14	18.07	20.88
1,400	401.26	0.34	88.25	101.95	240.76	0.20	36.10	41.70	171.97	0.15	20.03	23.14
1,480	424.19	0.36	97.27	112.36	254.51	0.22	39.79	45.96	181.80	0.15	22.08	25.51
1,560	447.12	0.38	106.65	123.21	268.27	0.23	43.63	50.40	191.62	0.16	24.21	27.97
1,640	470.05	0.40	116.41	134.48	282.03	0.24	47.62	55.01	201.45	0.17	26.43	30.53
1,720	492.98	0.42	126.53	146.16	295.79	0.25	51.75	59.79	211.28	0.18	28.72	33.18
1,800	515.91	0.44	137.01	158.27	309.54	0.26	56.04	64.74	221.10	0.19	31.10	35.93
1,880	538.84	0.46	147.84	170.78	323.30	0.27	60.47	69.86	230.93	0.20	33.56	38.77
1,960	561.77	0.48	159.02	183.70	337.06	0.29	65.05	75.14	240.76	0.20	36.10	41.70
2,040	584.69	0.50	170.55	197.02	350.82	0.30	69.76	80.59	250.58	0.21	38.72	44.73
2,120					364.57	0.31	74.62	86.20	260.41	0.22	41.41	47.84
2,200					378.33	0.32	79.62	91.98	270.24	0.23	44.19	51.04
2,280					392.09	0.33	84.75	97.91	280.06	0.24	47.04	54.34
2,360					405.85	0.34	90.03	104.00	289.89	0.25	49.96	57.72
2,440					419.60	0.36	95.43	110.25	299.72	0.25	52.96	61.18
2,520					433.36	0.37	100.98	116.65	309.54	0.26	56.04	64.74
2,600					447.12	0.38	106.65	123.21	319.37	0.27	59.19	68.38
2,680					460.88	0.39	112.46	129.92	329.20	0.28	62.41	72.10
2,760					474.63	0.40	118.40	136.78	339.02	0.29	65.71	75.91
2,840					488.39	0.42	124.48	143.79	348.85	0.30	69.08	79.80
2,920					502.15	0.43	130.68	150.96	358.68	0.30	72.52	83.78
3,000					515.91	0.44	137.01	158.27	368.51	0.31	76.03	87.84
3,080					529.66	0.45	143.46	165.73	378.33	0.32	79.62	91.98
3,160					543.42	0.46	150.05	173.33	388.16	0.33	83.27	96.20
3,240					557.18	0.47	156.76	181.09	397.99	0.34	87.00	100.50
3,320					570.94	0.49	163.59	188.98	407.81	0.35	90.79	104.88
3,400					584.69	0.50	170.55	197.02	417.64	0.35	94.65	109.34
3,480									427.47	0.36	98.59	113.89
3,560									437.29	0.37	102.59	118.51
3,640									447.12	0.38	106.65	123.21

Pressure losses for dimension 25 x 2.3 [SH] continued

Temperature difference	3				5				7			
Q [W]	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C	m [kg/h]	w [m/s]	R [Pa/m] at 40°C	R [Pa/m] at 15°C
3,720									456.95	0.39	110.79	127.98
3,800									466.77	0.40	114.99	132.84
3,880									476.60	0.41	119.26	137.77
3,960									486.43	0.41	123.60	142.78
4,040									496.25	0.42	128.00	147.87
4,120									506.08	0.43	132.47	153.03
4,200									515.91	0.44	137.01	158.27
4,280									525.73	0.45	141.60	163.58
4,360									535.56	0.46	146.27	168.97
4,440									545.39	0.46	151.00	174.43
4,520									555.21	0.47	155.79	179.97
4,600									565.04	0.48	160.65	185.58
4,680									574.87	0.49	165.57	191.27

Notes

2

Wall heating

PRINETO Wall heating

General basics

Wall heating is a low temperature surface heating system where the heat emission in the rooms takes place through heated wall surfaces. Due to its large radiant quotient it ensures that the heat feels especially pleasant. Because the heating source of wall heating has a large area, it can provide a comfortable room climate with low heating medium temperatures. For the regulation of the room temperature, the regulating components for underfloor heating systems are used.

The radiant quotient of wall heating is about 50%. The average temperature of the room surfaces therefore remains higher than the room air temperature. Compared with static heating systems, the room air temperature can be kept about 1 – 2°C lower without any loss of comfort. The energy consumption is reduced, which means heat cost savings, lower emissions and therefore less of a burden on the environment. Wall heating delivers about 8 Watts of heating power per square metre of free wall surface and per Kelvin of temperature difference between the wall surface and the air in the room. With a wall surface temperature of, for example, 35 °C, and an internal room temperature of 20°C, this corresponds to 120 Watts per square metre.

The heat supply can take place, for example, through heat pumps or calorific value appliances. It is also possible to combine them with solar-thermal ***LATENTO*** equipment. If sufficiently large wall surfaces are available, the system temperatures can be kept very low, with values of between 25 and 35 °C, and the rooms can be heated exclusively by means of the wall heating. Because – in contrast to underfloor heating – the surface temperature does not have to be limited to 29°C, small surface areas can also be heated using higher system temperatures of up to 50°C. The limiting factor with this is the heat compatibility of the wall plastering. Wall heating operates, depending on the use of each room, with wall surface temperatures of a maximum 35 or 40°C.

Wall heating can be combined excellently with underfloor heating, because it operates with the same low system temperatures. Examples of wall coatings that can be used are wallpaper or paint, textured wall coating, tiles or natural stone.

The size and number of the heated wall surfaces depends upon the heat demand of each room to be heated, and must be ascertained by taking the wall heating system, pipework spacing and system temperature into account (see heat load tables/planning and design of wall heating from page 260 onwards). In principle, all the internal and external walls that are available in a room can be used for heating. Depending on the wall material and strength, the heat loss to adjoining rooms/outdoor air can potentially be reduced by additional insulation.

With wet systems 14 or 17 the wall plaster completely overlays the heating pipes. Due to their very good thermal transfer, both these heating systems offer almost identical heating output data and are suitable for brick or concrete walls which are to be wet plastered. However, wall heating system 14, with approx. 35 mm plaster thickness, has a smaller installed height; with wall heating system 17 the installation of longer heating circuits up to 130 metres is possible because of the larger inner dimension of the pipes.

NOTE

Large items of furniture set against the heated wall, or wall hangings or pictures mounted on it significantly reduce the amount of heat emitted. For this reason, wall heating systems should be mounted on walls which are kept free whenever possible. The areas that are covered over should otherwise be deducted from the calculated area available for heating use and assigned to other free wall spaces or to underfloor heating.

TIP

We recommend installing the heating pipes at intervals of 10 cm (wet system) or 12 cm (dry system), because a uniform surface temperature and a very low heating medium temperature can then be achieved.

General basics

If there are shelves or pictures mounted on the heated walls, the position of the heating pipes can be made visible when the heating is operating with the help of thermal foil. If a heating pipe nevertheless becomes damaged, the plastering must be removed to a distance of approx. 20 cm around the pipe at the site of the damage.

The damaged section of pipe is cut out with pipe shears to a length of 12 mm. Both ends of the pipe are then re-connected with a sliding sleeve coupler. This should then be protected against outer corrosion with suitable adhesive tape before plastering.

Advantages of wall heating

- The use of basic components – heating circuit manifold and distribution box – heating pipe – fixing rail – system elements – regulation technology from ***PRINETO*** underfloor heating – no additional components are required,
- High heating capacities of up to 120 W/m² are possible,
- Low consumption costs – energy saving due to 1-2 °C lower room air temperature,
- High thermal comfort due to 50% radiated heat quotient
- Minimisation of distribution losses due to low heating medium temperatures
- Clear room layouts possible without intrusive heating elements
- System temperatures from 25°C are possible – optimal in combination with calorific value technology and renewable energies
- No dust transportation and turbulence caused by reduced air circulation
- No 'cold radiating' outer wall surfaces
- Building component damage through air condensation is prevented
- Can be installed in all private, public, commercial and industrial buildings
- Installation of low-energy heating technology is possible in existing buildings without changing the floor levels
- No static loading of the building's ceilings
- Combines very well with underfloor heating for the coverage of additional low-temperature heat loads
- Can also be combined with static heating systems in conjunction with constant regulation system.

Oxygen diffusion

All synthetic pipes used in the heating area must be oxygen diffusion-tight, in compliance with DIN 4726 (for PE-X pipes) or DIN 4724 (for PE-X-MD pipes). The standard requires a limit for oxygen diffusion of 0.1 g oxygen per m³ heating water per day, at a water temperature of 40 °C.

PRINETO heating pipes fall well below this value. The Nanoflex and multilayer composite pipes are 100% oxygen diffusion-tight as per DIN 4726. The Nanoflex pipe has an oxygen entry of less than 0.0005 cm³/package.d.0.21 bar. All three types of pipes are therefore suitable for the installation of hot water wall heating systems without system separation.

Heating water additives

PRINETO pipes and fitting parts in contact with water are resistant to heating water and any additives. The ***PRINETO*** piping system is suitable for the flow media ethylene (ethanediol) and propylene glycol. As anti-corrosion and anti-freeze agents we recommend:

- Antifrogen N (ethylene glycol, material class 3 acc. to DIN EN 1717) or
- Antifrogen L (propylene glycol, material class 3 acc. to DIN EN 1717, suitable for the foodstuffs sector)

The manufacturer's recommendations in respect of the intended application and the correct dosage must be followed (Clariant GmbH, 65926 Frankfurt am Main, Germany).

General basics

Wall heating - installation and ventilation types

Installing ***PRINETO*** wall heating wet

Installing ***PRINETO*** wall heating dry

To enable easy air-purging of the heating system a horizontal meandering or snake-shaped type of laying should always be used. This is to be installed starting with the supply pipe at the lower part of the wall. The air will be removed through careful flushing of the individual heating circuits, in the direction of the flow.

Should the integration of a separate air-purging facility at the highest point of the heating circuit be necessary, then R½ connectors to the heating pipes (art.-no. 878 341 350 for heating pipe 14, art.-no. 878 641 150 for multilayer composite pipe 16, art.-no. 878 341 150 for heating pipe 17) in combination with a brass tee piece ½" and a manual vent plug can be used.

Double meandering pipework laying is suitable for laying at 10 cm intervals because it allows the larger bending radius.

NOTE

It might be necessary to carry out a further bleeding/purging of the heating circuits, using a suitable purging device with an air extractor and the already filled heating water, in order to prevent the entry of air from fresh water into the system.

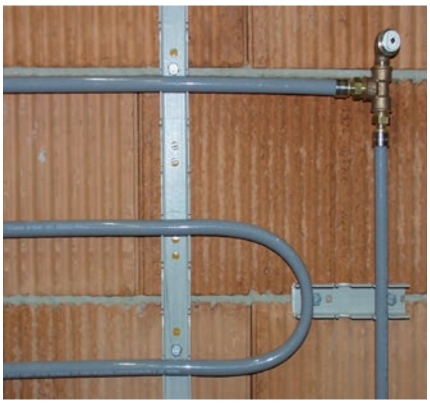
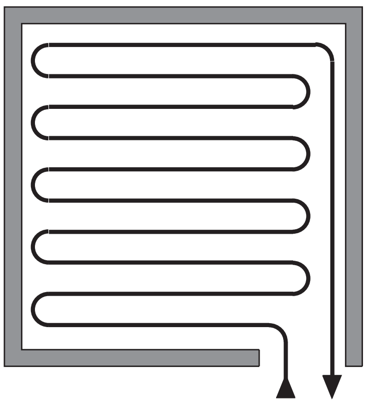
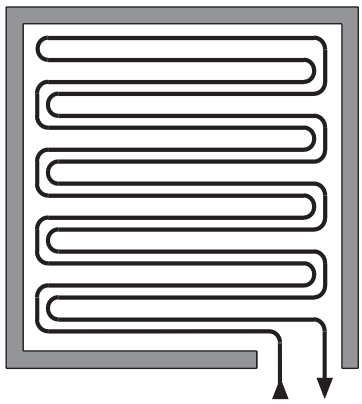


Photo of the air-purger



Meandering pipework

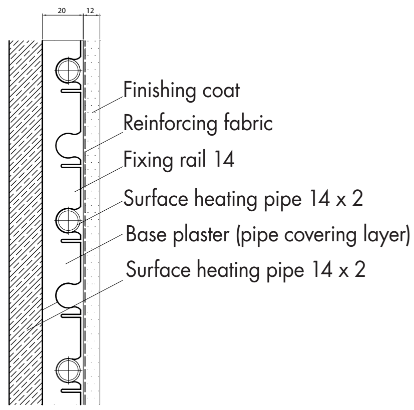


Double meandering pipe laying

General basics

Short description of ***PRINETO*** wall heating

Wet system 14

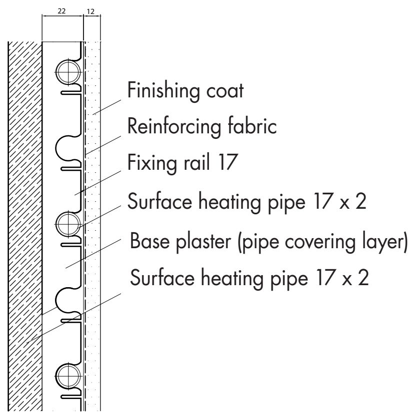


Test report no. H.0701.P.408.IVT

The surface heating pipes 14 are attached to the bare masonry or to the wall insulation using ***PRINETO*** fixing rails 14 (art.-no. 878 386 085) and are completely enclosed by wet-applied wall plastering. The design thus corresponds to construction type A. The heating pipes must be pressed firmly into the notches at the desired spacing interval so that they are securely attached. In the area of the bends, individual pipes can additionally be attached using synthetic dowel hooks or short fixing rail pieces.

- Easy and quick fastening of pipes, can be performed by one person
- High heating power due to heating pipes being completely enclosed by wet plastering,
- Defined pipe spacing in a 50 mm grid
- Low wall installation height through using heating pipe 14 and flat fixing rail
- Straightforward and precise pipe installation
- Well suited for masonry and concrete walls which are to be plastered

Wet system 17



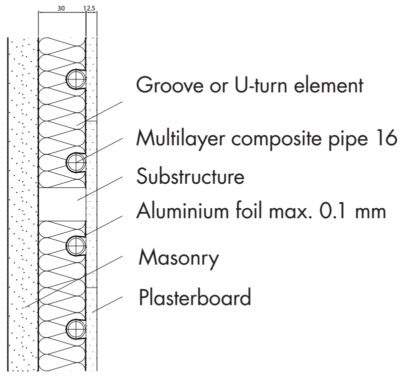
Test report no. H.0701.P.409.IVT

The surface heating pipes 17 are attached to the bare masonry or to the wall insulation using ***PRINETO*** fixing rails 17 (art.-no. 878 386 074) and are completely enclosed by wet-applied wall plastering. The design thus corresponds to construction type A. The heating pipes must be pressed firmly into the notches at the desired spacing intervals so that they are securely attached. In the area of the bends, individual pipes can additionally be attached using synthetic dowel hooks or short fixing rail pieces.

- Easy and quick fastening of pipes, can be performed by one person
- High heating power due to heating pipes being completely enclosed by wet plastering,
- Defined pipe spacing in a 50 mm grid
- Max. heating circuit surfaces greater than with wet system 14 – therefore smaller heating circuit manifolds are possible depending on the subdivision (fewer actuators etc.)
- Straightforward and precise pipe installation
- Well suited for masonry and concrete walls which are to be plastered

General basics

Dry system



The multilayer composite pipe 16 is inserted into the notches in the aluminium-coated insulation elements. The aluminium foil conducts the heat direct from the multilayer composite pipe to the insulation material surface and distributes it from there to the wall covering. The installation thus complies with construction type B.

- The system elements are insulation, heat manifold and pipe fastener all in one – laying in one work step
- Snake-like laying with defined distances between the pipes of 12 or 24 cm
- Installation independent of the weather
- No moisture brought into in the building
- Reduction of construction time compared to wet-laying systems, as there is no drying time
- Installation of wall covering possible shortly after wall encasement

Test report no. H.0701.P.406.IVT

General advice for the assembly and installation

Standard reference

In connection with the planning, installation and with the operation of wall heating equipment in buildings, the following standards and regulations are to be observed:

DIN 4102	Combustion properties of building materials and building components
DIN 4108	Thermal insulation and energy saving in buildings
DIN 4109	Soundproofing in building construction
DIN V 4701-10	Energy measuring for heating and indoor air technology equipment
DIN EN 832	Heat technology properties of buildings
DIN 4724	Synthetic piping systems for hot-water underfloor heating systems and radiator connections (PE-MDX)
DIN 4726	Piping made from synthetic material
DIN EN 1254	Copper and copper alloy fittings
DIN EN 1264	Underfloor heating systems and components
DIN EN 12831	Procedures for the calculation of the standard heating load of buildings
EnEV	Energy-saving Ordinance 2007
DIN EN 12828	Heating systems in buildings – Planning of hot water heating systems
DIN EN 13163	Factory-made products of expanded polystyrene (EPS)
DIN EN 13165	Factory-made products of polyurethane (PUR)
DIN 18180	Gypsum plasterboard, types and requirements
DIN 18181	Gypsum plasterboard in building construction, processing
DIN 18182	Accessories for the processing of gypsum plasterboard
DIN 18195	Building structure sealing
DIN 18202	Tolerances in building construction
DIN 18336	Sealing of buildings Part C, sealing work
DIN 18350	Sealing of buildings Part C, Plastering and rendering,
DIN V 18550	Plastering and rendering systems, procedures
DIN 18380	Sealing of buildings Part C Central heating systems and hot water supply systems

Condition of the building

Wall heating systems can be mounted on stonework walls, concrete walls, in wooden wall boarding or dry-wall constructed walls. These walls must be stable and capable of supporting the wall heating. Angle and flatness tolerances in accordance with DIN 18202 must be strictly adhered to. All exposed installation work in the wall from other services must be shut off, and cables and pipes must be secured in position.

The building should be leak-proof, and windows and outside doors must be fitted, or sealed with plastic sheeting, in order to protect the wall heating system and the plastering against moisture, temperature fluctuations and frost. The manufacturers' minimum temperatures for using wall plaster or fillers must be taken into consideration. In accordance with DIN V 18550 the air and building component temperature must not be below +5°C, and/or fall below that level until the plaster has hardened adequately.

A water connection for filling and pressurising the heating circuits, as well as a power supply of 230 V are required on site. The system planning documents (e.g.: laying system, arrangement of heating circuits, laying intervals, insulation materials and thicknesses, hydraulic data for the manifolds) and the joint plan have to be coordinated and to be available. Sealing of the structures (e.g. in the case of basement walls) must be completed before beginning the installation of the wall heating. The supporting substructure must be sufficiently stable, dry, frost-free and durable and provide a level outside surface for the installation of the insulation and the wall plaster. If surfaces which are not suitable (e.g. wooden and steel building components) are to be used as a plaster base, these must first be coated with a plaster sealant.

The special requirements of the manufacturer of the wall plaster or the wall cladding must be complied with.

NOTE

If there is doubt as to whether all the requirements have been met, the client must be informed. In this case laying should not be started.

Installation instructions

Heat and sound insulation

In the planning of wall heating it should be taken into consideration that the reverse side of the wall is also heated. The heat transfer depends, amongst other things, on the wall material and thickness, and the temperature of the reverse side of the wall. In order to keep the heat loss to the adjoining room to a minimum, additional insulation may be required. This is already integrated with the dry system and insulation, providing 1.18 m^2K/W at 50 mm thickness, or 0.68 m^2K/W at 30 mm thickness. With wet applied wall heating systems the insulation materials can be applied inside the wall or to the unheated side of the wall. Partition walls between areas of different use may require the application of sound protection technology. It is important to take this into consideration when choosing the insulating material. The system elements of the dry system have no sound protection improving properties.

Depending on the configuration and purpose of the insulation, the insulating materials are identified with the following short description, in accordance with DIN V 4108-10:

Wall	WAB	Outside insulation of the wall behind coating
	WAA	WAA Outside insulation of the wall behind sealing
	WAP	Outside insulation of the wall under plastering
	WZ	Insulation of double partition walls, core insulation
	WH	Insulation of timber frames and timber panel construction
	WI	Internal insulation of the wall
	WTH	Insulation between house partition walls with noise protection requirements
	WTR	Insulation of room partition walls
Perimeter	PW	Outside heat insulation of walls against the ground (outside the waterproofing)*
	PB	Outside laid heat insulation under the floor slab against the ground (outside the waterproofing)*

In buildings to be constructed with normal indoor temperatures, the heat transmission coefficient of the building component layers between the wall heating and the outside air or parts of the building with significantly lower indoor temperatures must be measured in accordance with the Energy-saving Ordinance 2007, depending on the annual primary energy requirement of the building. We recommend a value of $\leq$ 0.35 W/m^2K. With building work on existing or small buildings, the maximum heat transference coefficients are shown in EnEV 2007 Appendix 3, Table 1 and necessitate between 0.35 and 0.45 W/m^2K depending on the building project.

When heating systems are installed in the walls of heated rooms, the thermal resistance of the entire construction must not fall below the value of 0.75 m^2K/W according to DIN 1264-4 (walls adjacent to unheated rooms 1.25 m^2K/W). The calculation is made from the heating pipe level. For example, a plastered 12 cm thick vertical core lightweight brick wall already attains this required value.

Expansion joints

In order to make the linear expansion of the wall construction possible, expansion joints are to be made between abutting and penetrating components. The type and arrangement of these joints are to be determined by the planner.

Joints in the heating elements and in the plastering must also be arranged over structural joints. These expansion joints must not be crossed by heating circuits. If possible the individual heating surfaces should be separately connected from the floor. However, crossing supply pipes are to be protected with pipe sleeving (e.g. corrugated pipe) about 300 mm long.

Wall plastering – Wall covering

The wall plastering is constructed from the bonding agents gypsum, lime, clay, cement, or combinations according to DIN 18550. This serves as a heat dispersion layer. Depending on the raw wall material and its characteristics, a pre-treatment might be required for better adhesion. A plaster reinforcement increases the strength of the plaster and prevents the enlargement of possible fissures. Depending on the plastering system, it is applied between the pipe covering layer and the final rendering and is to be used with the wet systems.

With gypsum bonded wall plastering and dry construction boards a flow temperature of 50 °C must not be exceeded. In order to prevent fissures we recommend that this maximum flow temperature is not exceeded for lime-cement plastering and clay plastering either. Gypsum bonded wall plastering or clay plastering can be applied in dry rooms. Lime-cement plastering can be used in bathrooms or wet rooms with high air humidity. Heat insulating plastering is unsuitable for wall heating.

Wall coverings such as wallpaper or paint, tiles or natural stone can be used. Silicone and synthetic resin structured plastering are likewise suitable according to the manufacturer's recommendation.

With the installation of plasterboard the special instructions of the manufacturer in respect of use, required substructure and fixing must be taken into consideration. The appropriate plasterboard must be chosen for each application:

- Plasterboard (GKB), ... Plasterboard from 12.5 mm thickness upwards, with construction site processing for fixing to substructures for wall and ceiling covering in accordance with DIN 18181 ... as well as for the boarding of partition walls and facings according to DIN 18183 and of non-supporting inner partition walls, according to DIN 4103-4.
- Fire protection plasterboard (GKF), ... for applications such as GKB with requirements for the fire resistance duration of the components,
- Impregnated plasterboard (GKBI), ... for applications such as GKB with inhibited water absorption corresponding to H2 according to DIN EN 520.
- Impregnated fire protection plasterboard (GKFI), ... for applications such as GKF with inhibited water absorption corresponding to H2 according to DIN EN 520.

Assembly instructions for wall heating – Wet systems 14 and 17

Materials required for wall mounting:

- Fixing rails 14 or 17
- Surface heating pipe 14 or 17 or multilayer composite pipe 14 or 16
- Wall plugs and screws for the attachment of the fixing rails
- Primer coat or bonding layer
- Plastering
- Reinforcing fabric

Before starting the fasten the fixing rails onto the wall, the plastered surface should be tested. It must be flat and even, able to bear the load, sufficiently stable, dust-free and free from contaminants. For each plastering system and surface to be plastered one primer coat or adhesion improver is required.

NOTE

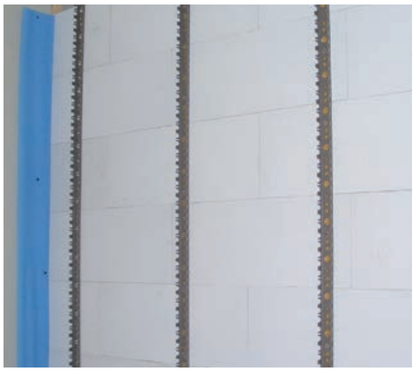
The general advice for mounting and installation of the wall heating systems must be followed!
In DIN V 18550 the procedure for plaster and plastering systems is described in detail.
The preparation of the walls and the plastering are to be carried out accordingly.

Installation instructions

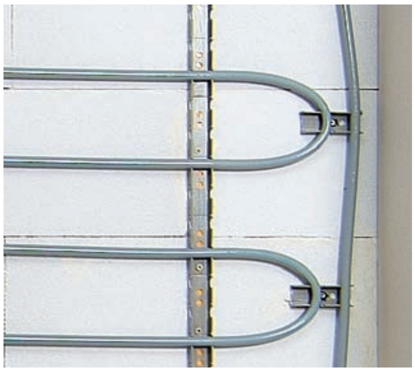
The choice of fixing rails depends on the chosen heating pipe. For surface heating pipe 17 or multilayer composite pipe 16 fixing rails 17 (art.-no. 878 386 074) should be used. For surface heating pipe 14 or multilayer composite pipe 14 fixing rails 14 (art.-no. 878 386 058) should be used. The fixing rails are 1 m long and must be fixed vertically throughout from the lower end to the upper end of the wall. For this, depending on the consistency and material of the surface to be plastered, wall plugs 6 to 8 mm with the appropriate screws can be used at intervals of between 200 and 300 mm.

NOTE

For the straight installation of the heating pipes the notches in the fixing rails must be mounted horizontally aligned.



For this, the fixing rails have 8 mm diameter drilled holes positioned every 50 mm. Washers may be required depending on the screws used. The gap between the fixing rails must not exceed 400 mm (fixing rail 14) or 600 mm (fixing rail 17). On smooth substructures the rails can be temporarily attached with the rear-sided adhesive tape until they are screwed down. In order to do this, remove the waxed paper and press the rails on firmly.



For the installation of the pipe turning bends or the return pipe, gaps of 200 to 300 mm between the fixing rails and the left and right heating surface edges are required. To allow for the later attachment of the pipe bends and the return pipe, approx. 100 to 200 mm long fixing rail pieces are attached horizontally along the edges of the heating surfaces. These are arranged in such a way that they are located horizontally, between the subsequent pipe installation notches. With pipework laid at 150 mm intervals, a horizontal offset of 75 mm will result.

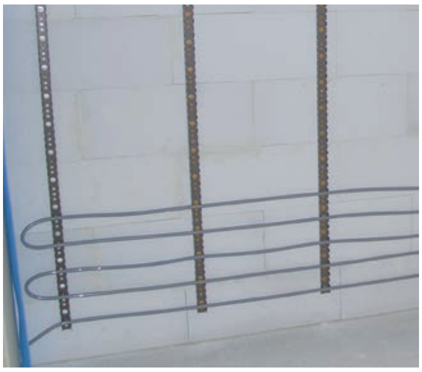
NOTE

For the straight installation of the return pipe and for the uniform assembly of the bends, the notches in the fixing rails must be mounted vertically aligned.

Installation instructions

Laying of the ***PRINETO*** pipe is started at the upper heating circuit manifold bar or at the MIC (at the MIC only pipe 17 is possible, and must be connected with ***PRINETO*** reducing couplers 17–16,art-no. 878 340 540, for multilayer composite pipe 16, with ***PRINETO*** reducing coupler 17–16, art.-no. 878 340 540 + ***PRINETO*** reducing couplers 16 –14, art.-no. 878 340 130, for heating and multilayer composite pipe 14). Heating circuit feeder pipes through neighbouring rooms must be insulated in accordance with EnEV 2007.

In front of the wall the pipe should be unrolled by hand and pushed into the notches of the fixing rail by hand according to the laying interval chosen. Help with laying is provided by the foldable ***PRINETO*** pipe reel carrier (art.-no. 878 386 071). The return pipe should thereby be installed starting from the bottom and vertically ascending to the upper end of the wall, where it is bent and routed horizontally, alternately from right to left. The pipe bends are fastened in the short fixing rail pieces, the bending radii are to be maintained. The laying finishes at the lower end of the wall with the flow pipe, which is again routed next to the return pipe to the heating circuit manifold.



TIP

We recommend that with a laying interval of 10 cm the returning bends are bent into an Omega shape in order to avoid kinking the pipes.

The connection to the manifold is carried out according to the type of pipe, with ***PRINETO*** V-Euro transitions (e.g. art.-no. 878 343 590) or with ***PRINETO*** clamp/screw-in V-Euro cones (e.g. art.-no. 878 386 011).

The following PRINETO pipes can be used for installation:

- Nanoflex surface heating pipe 14 (art.-no. 878 110 080)
- Nanoflex surface heating pipe, high flexibility 17 (art.-no. 878 111 250),
- Surface heating pipe, high flexibility 17 (art.-no. 878 311 250)
- Surface heating pipe 17 (art.-no. 878 311 150)
- Multilayer composite pipe 16 (art.-no. 878 520 100),
- Surface heating pipe, high flexibility 14 (art.-no. 878 311 231)
- Multilayer composite pipe 14 (art.-no. 878 520 080),
- Surface heating pipe 17, self-cross-linking (art.-no. 878 311 351)

TIP

Do not install the flow pipe closer than 100 mm from the upper edge of the finished flooring, in order to avoid damaging the pipes when fixing skirting boards in place later.

Joints in the heating elements and in the plastering are also to be arranged over structural joints. These expansion joints must not be crossed by the heating circuit. If possible the individual heating surfaces should be separately connected from the floor. However, crossing supply pipes must be fitted with slotted ***PRINETO*** protective pipe (art.-no. 878 386 103).

Each heating circuit must subsequently be individually flushed through with water and vented. All heating circuits connected to the manifold must undergo pressure testing (pressure testing protocol on page 205). The testing pressure must be maintained during the plastering process.

NOTE

For reasons of stability the heating pipes should be installed at a minimum distance of 150 mm from wall edges, window frames and door frames etc.

Installation instructions

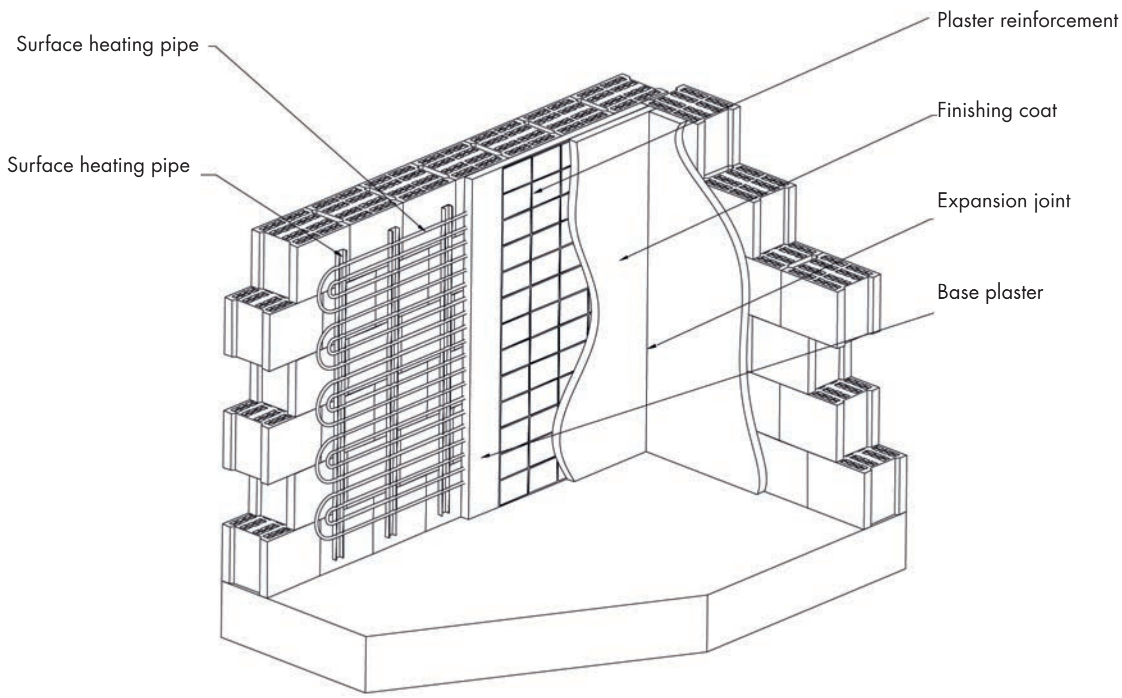
Regulations DIN V 18550 and VOB/C DIN 18350 are to be complied with for the necessary plastering work. The properties of the different plaster layers in a system must be so attuned with each other that any stresses in the contact surfaces of the individual plaster layers and of the plastering base arising through shrinkage or thermal expansion can be absorbed. A plastering operation in several layers is required because of the great thickness of the plaster (sub plaster approx. 22 to 27 mm, finishing coat 10 to 15 mm). The base plaster must completely cover the pipes and fixing rails. A plaster reinforcing agent is to be incorporated in the finishing layer. In the case of plasters containing gypsum, the plaster layer must be applied in two layers, wet on wet.

NOTE

For the regulation of the room temperature the underfloor heating components are used. The room temperature controllers must not be mounted on heated walls!

After the walls have been plastered, hydraulic equalisation of the individual heating circuits must be carried out. Operational heating should begin, depending on the plastering system, at the earliest after the complete drying out of the joint filling material (manufacturer's recommendations must be heeded! Initial start-up procedure protocol on page 259).

Wet system



Installation instructions

Installation instructions dry system

Materials required for wall mounting:

- Grooved elements 30 or 50 mm
- U-turn elements 30 or 50 mm
- Adhesive for polystyrene elements
- Hot cutter with cutting tip
- Multilayer composite pipe 16
- Substructure profiles 30 – 32 or 50 – 52 mm
- Plasterboard
- Fixing materials for profiles and plasterboard

Facing assembly

This is started with the horizontal attachment of the substructure to the clean and smooth wall. For this, timber studs of type class S 10 according to DIN EN 1912 with a residual moisture content of up to 20% can be used, or metal profiles. The depth of the substructure must be matched to the depth of the system elements including adhesives in order to ensure optimal thermal transfer to the wall covering. For the 30 mm groove and U-turn elements the timber studs or metal profiles must accordingly be 30 – 32 mm high (e.g. wooden studs 31 x 52 mm, type class S 10 according to DIN EN 1912).

The vertical intervals within the substructure should be ≤ 625 mm. Depending on the resilience of the substructure the distance between wall plugs for the fixing must be ≤ 800 mm.

The insulation elements must be transported without damage, and in addition they must be stored dry and protected from the effects of weather. The aluminium and polystyrene surfaces, and the groove contours must not be deformed.

NOTE

The special mounting and processing instructions of the plasterboard manufacturer must be followed.

The timber construction pieces or the construction profiles are installed on one side up to the edge of the wall. On the other side, a gap of 24 cm is required for the installation of both heating pipes. For the secure fixing of the plasterboard on this side, a vertical construction profile is mounted on the wall ending.

For guiding the return pipe along the wall to the floor a ***PRINETO*** grooved element 48 cm wide is cut into 4 equal 12 cm wide strips and installed on the vertical construction profile so that a continuous groove is produced. It is important to cut the insulation at right angles, and with fitting accuracy. We recommend the use of a straight edge or the side of a long spirit level as a cutting aid. The cutting of the polystyrene insulating material can be carried out with a sharp and sturdy knife.

TIP

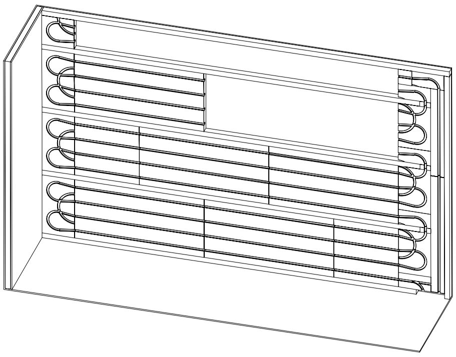
We recommend leaving a clear gap of 480 mm (tolerance up to + 5 mm) between the wooden lengths or profiles. Then the system elements can be laid between the substructure without width allowance.

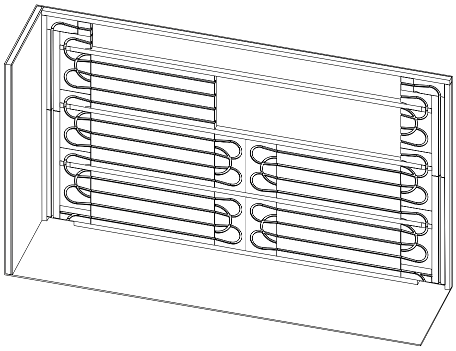
NOTE

The cut edges of aluminium foil are sharp! Suitable gloves should be worn for protection from cut injuries.

Installation instructions

The secure attachment of the polystyrene elements to the wall can be carried out using a gypsum-based adhesive (e.g. fixing bond) or other suitable adhesives. These must be thinly applied with a toothed spatula to the rear of the system elements, over their entire surface. With absorbent substructures, a sealing coat or dampening the wall with water may be required. The application instructions given by the adhesive manufacturers must be followed.





For the cutting and the alignment of the ***PRINETO*** U-turn elements on the left and right sides of the wall, several groove elements are mounted within the substructure, but not yet glued in place. The offset arranged U-turn elements must connect the grooved elements in such a way that a continuous 'groove snake' is formed. Depending on the spacing intervals chosen for laying the heating pipes, the U-turn elements must be shortened if necessary. The respective last grooved element in a row is cut at right angles to the required remaining length. The remaining part of this grooved element can be used to begin the next row. This ensures that there is little cutting loss when elements are installed.

In the area of the turn over the sub-structure, the U-turn elements are likewise cut flush. The spaces which arise in-between can be filled in with the remaining pieces of the system elements, into which individual grooves can subsequently be cut by using the hot cutter.

If one wall is divided into several heating circuits, the U-turn elements along the edges of the heating circuit are installed against each other.

The connection notches to be cut are marked with a felt tip pen on the aluminium or polystyrene surface so that continuous heating circuits will result in each case. In the area of the pipe bends the radius must be at least 85 mm (180° U-bend = 170 mm pipe axis gap).

If the entire wall heating surface is fitted with system elements, the previously marked connections will be made in the grooves. For this, the aluminium foil must be cut with a knife and removed in the marked area, and also in the grooves and at the edge of the elements. The incision should only divide the aluminium foil and must not go deeper than 5 mm into the polystyrene.

NOTE

The insulation elements must be laid across the entire surface, have flush abutting edges between them and be tension-free. To achieve max. heat flow full-surface aluminium-coated insulation elements should be used.

TIP

We recommend leaving a clear gap of 480 mm (tolerance up to + 5 mm) between the wooden lengths or profiles. Then the system elements can be laid between the substructure without width allowance.

Then the required pipe grooves are cut manually using the ***PRINETO*** heat-cutter 230 V (art.-no. 878 386 136).

The cuts must be made quickly in order to avoid melting or burning the polystyrene.

Installation instructions

The installation of the ***PRINETO*** multilayer composite pipe 16 can begin after the complete hardening of the adhesive in the system elements (the manufacturer's instructions for use must be followed!), on the upper heating circuit manifold return bar or at the MIC (at the MIC only pipe 17 is possible, and this must be connected using ***PRINETO*** reducing couplers 17–16, art-no. 878 340 540). Heating circuit feeder pipes through neighbouring rooms must be insulated in accordance with EnEV 2007.

In front of the wall the pipe should be unrolled by hand, straightened, and pushed completely into the grooves. The return pipe should be installed in the vertically ascending groove starting from the bottom and moving to the upper end of the wall, where it is bent and fed horizontally, alternately from right to left. The installation finishes at the lower end of the wall with the flow pipe, which is again routed next to the return pipe to the heating circuit manifold.

NOTE

For reasons of stability the heating pipes should be installed at a minimum distance of 150 mm from wall edges, window frames and door frames etc.

Next, each heating circuit must be individually flushed through using the flow, and the air purged. All the heating circuits connected to the manifold must undergo pressure testing (pressure testing protocol on p. 257). The testing pressure must be maintained during application of the wall covering.

The attachment of the plasterboard to the substructure is carried out using drywall screws with a maximum distance between fixings of 250 mm. We would not advise the use of staples or nails because of the thermal expansion of the plasterboard. The position of the substructure is to be marked on the plasterboard before it is mounted in order to prevent accidental damaging of the pipe when it is being screwed on. The minimum length, the nominal diameter and the penetration depth of the drywall screws are governed by the respective available covering thickness, and must be assessed according to DIN 18181.

The filling of the joints is carried out with gypsum-bonded materials according to DIN EN 13963 in an unheated state. Depending on whether or not the edges of the plasterboard have reinforcing strips, the joints are closed over with the appropriate filler.

NOTE

The cutting tip of the heat-cutter heats up to 600°C. It must not be touched when heated and must not be placed on flammable surfaces! There is a danger of fire!

The pipe must not jut out of the insulation surface at any point. In the area of the U-turn elements the pipe must be bent around the outside of the groove bends by hand, according to the predetermined radius. The pipe bends, which are then facing slightly upwards, must now be bent downwards again in order to remove the tension before they are pushed into the U-turn elements.

TIP

Do not install the flow pipe closer than 100 mm from the upper edge of the finished flooring, in order to avoid damaging the pipes when fixing skirting boards in place later.

NOTE

If there is a danger of freezing because of room temperatures which are too low, suitable measures must be taken, e.g. the use of antifreeze agents or heating of the building.

Plasterboard is to be separated from building components made of other materials by expansion joints. We recommend the use of expansion joints with all closed wall surfaces with side lengths of over 8 m.

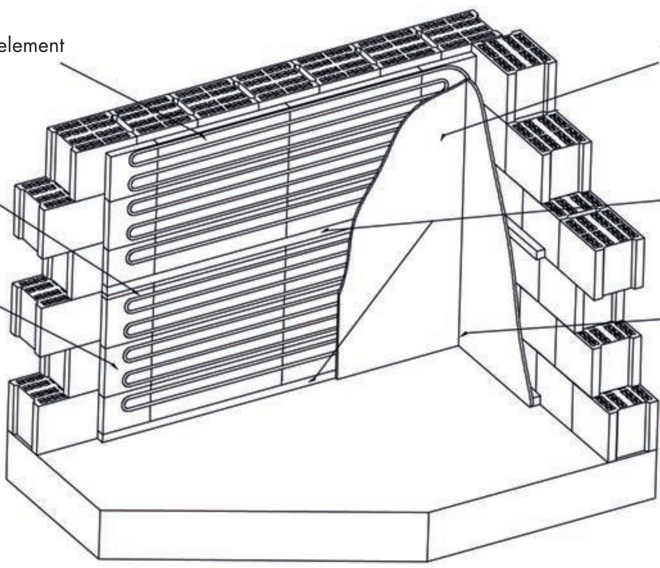
Installation instructions

Free-standing prefabricated walls

Should the dry system be integrated with free-standing prefabricated walls, then each heated wall side is to be implemented as a double column wall. At the lower planking position, as with the facing installation, the sub-structure profile and the system elements with the heating pipe are installed. The actual wall covering is attached over this. After the wall heating surfaces have been completed, hydraulic equalisation of the heating circuits must be carried out. The operational heating should begin at the earliest after the complete drying out of the joint filling material (heed manufacturer's recommendations! Operational heating protocol on p. 259).

NOTE

Underfloor heating components are used for the regulation of the room temperature. The room temperature controllers must not be mounted on heated walls!



Installation test ***PRINETO*** wall heating systems

Pressure testing of ***PRINETO*** wall heating systems

The heating circuits of hot-water wall heating must be tested for water-tightness after installation has been completed and before application of the plaster or the wall covering, by means a hydraulic test. The test is to be recorded and signed by the client and the test operative.

The testing pressure must be double the operating pressure, and must be at least 6 bar. This pressure must be maintained on the pipes during the plastering or the cladding of the wall.

NOTE

If manifolds are fitted with flow meters, a testing pressure of 6 bar must not be exceeded! If manifolds are fitted with control valves, a testing pressure of 10 bar must not be exceeded!

The pressure test with water is to be implemented as follows:

- The heating circuit manifold is disconnected from the remaining heating system by closing the isolating equipment.
- Each heating circuit is individually filled with water through the flow manifold bar until it is absolutely free of air. To do this, the thermostat valves and control valves or flow meters must be fully opened and then closed.
- Once all the heating circuits are filled, the connection to the filling device (e.g. water supply network) must be interrupted as per DIN 1717.
- All thermostat valves and control valves or flow meters are opened.
- Prepare for the test by subjecting the water of the entire system to the testing pressure (operating pressure x 2, minimum 6 bar). The initial pressure should be restored again after half an hour, and again after a further half hour. After another half hour (1.5 hours after the start) testing can begin (without restoring the initial pressure again!).
- The testing is considered successful if after 24 hours the pressure drop is less than 1.5 bar and no leaks have been detected.

The material characteristics of the synthetic pipes lead to an expansion of the pipe during the pressure testing, which causes the pressure to fall. Changes in temperature also distort the test result. Therefore, during pressure testing as constant a temperature as possible should be aimed at for the test medium, and the initial pressure should be restored several times after the pipe expansion.

NOTE

If there is a danger of freezing, appropriate measures must be taken such as use of antifreeze agents or heating of the building. If no further frost protection is required for the normal operation of the installation, the antifreeze agent must be removed by draining and flushing out with at least three water changes.

Installation test of ***PRINETO*** wall heating systems

Pressure testing protocol for wall heating systems

Performed ☐ acc. to DIN 18380 (threshold pressure, safety valve) ☐ acc. to DIN 14336 (operating pressure x 1.3)

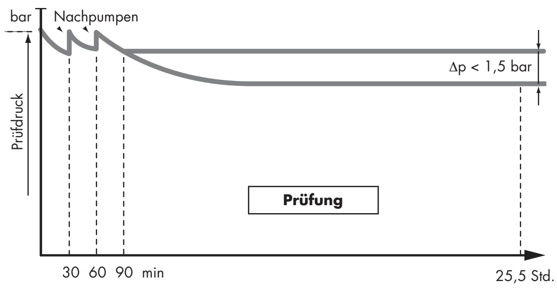
Object: ______________________________

Owner: ______________________________

Inspector: ______________________________

Description of heating circuit manifold

Surface heating pipe 14 ______________ m
Multilayer composite pipe 14 ______________ m
Multilayer composite pipe 16 ______________ m
Surface heating pipe 17 ______________ m



Preparation (duration 90 minutes)

Start ____ : ____ h End ____ : ____ h

Testing pressure (2 x operating pressure, min. 6 bar) ________ bar
Pressure after 90 minutes (start of test) ________ bar

NOTE

The temperature of the test medium should be kept as constant as possible. Fill pipes with water. Vent pipes completely.

Test (duration 24 hours)

Start ____ : ____ h End ____ : ____ h

Testing pressure at beginning of test ____________ bar
Testing pressure after 24 hours ____________ bar
Pressure drop (max. 1.5 bar) ____________ bar

Results of the testing

Pressure testing passed ☐ yes ☐ no

Leaks detected ☐ yes ☐ no

Place, Date ______________ Signature inspector ______________ Signature owner or representative ______________

Operational heating

Operational heating must not be performed earlier than 21 days after the application of lime-cement type plaster or earlier than 7 days after the application of gypsum or clay type plaster. The special recommendations of the plaster manufacturers must be followed. With dry walls the joint filling material must be completely dry.

Operational heating begins with a flow temperature of between 20° C and 25° C, which is to be maintained for a minimum of 3 days. Then, in stages, the maximum design temperature must be reached, and this value must be held for a minimum of 4 days.

The process is to be recorded in a report, which is then to be passed to the client.

Installation test of ***PRINETO*** wall heating systems

Operational heating protocol for wall heating systems

Object: ______________________________

Owner: ______________________________

Inspector: ______________________________

Heating engineer: ______________________________

Plasterer: ______________________________

Plaster ____________ ☐ Lime-cement ☐ Gypsum ☐ Clay ☐ Plasterboard

Overall thickness of plaster (incl. pipe diameter) ________ mm (with plasterboard: board thickness over pipe)

Plastering work finished on ____________

Resting period of the lime-cement plastering: 21 days

Resting period of the gypsum or clay plastering: 7 days

	Start date	**Target flow temp. (°C)**	**Actual flow temp. (°C)**	**Minimum period**	**End date**
Heat up		20			
		25		Maintained 3 days	
Heat up		30			
		35			
		40			
		45			
Max. heat-up		Maximum design temperature		Maintained 4 days	
Cool-down		45			
		40			
		35			
		30			
		25			
		20		Completion	

Handover for further construction work

Outside temperature: ____ °C System in operation: ☐ yes ☐ no Flow temperature: ________ °C

Remarks: ______________________________

____

Place, Date

Stamp and signature heating engineer

Stamp and signature client/planner

Planning of ***PRINETO*** wall heating

Heat load tables for measurement determination and rating

Based on the graphs of the thermo technical tests of ***PRINETO*** wall heating systems, tables have been compiled for the approximate rating of wall heating and for evaluating quantities. The tables are subdivided according to the respective wall heating system and according to the thermal resistances of the wall coverings. The tables relate to a temperature difference of 7.5 K, the maximum pressure loss was limited to 250 hPa.

From these tables, the surface heat flux, the average wall surface temperature and the maximum heating circuit area can be determined, depending on the internal room temperature, the laying interval and average heating water temperature.

PRINETO

Planning of PRINETO wall heating

Heat load table — Wall heating wet system 14

Temperature difference 7.5 K; Δp: 250 hPa — Thermal resistance of the wall coating RlB = 0.00 m²*K/W (without coating, i.e. moulded plaster, emulsion paint, wallpaper)

Planning data				Mean heating water temperature ΘHm in °C 30.0			Mean heating water temperature ΘHm in °C 35.0			Mean heating water temperature ΘHm in °C 40.0			Mean heating water temperature ΘHm in °C 45.0		
Internal room temperature Θ_i	Laying interval VA	Pipe requirements l_R	Fixing rail requirement l_{Fs}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}
in °C	cm	m/m²	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
15	10	10.0	2.5	55	22.4	12.4	74	24.6	10.3	92	26.8	9.0	110	28.9	8.0
	15	6.7	2.5	48	21.5	15.6	64	23.4	13.0	80	25.3	11.2	95	27.2	10.0
18	10	10.0	2.5	44	24.0	14.0	63	26.3	11.3	81	28.5	9.6	99	30.6	8.5
	15	6.7	2.5	38	23.3	17.5	54	25.3	14.1	70	27.2	12.0	86	29.1	10.6
20	10	10.0	2.5	37	25.1	15.3	55	27.4	12.0	74	29.6	10.1	92	31.8	8.8
	15	6.7	2.5	32	24.5	19.1	48	26.5	15.0	64	28.4	12.6	80	30.3	11.0
22	10	10.0	2.5	29	26.2	17.1	48	28.5	12.9	66	30.7	10.7	85	32.9	9.2
	15	6.7	2.5	25	25.7	21.2	41	27.7	16.1	57	29.7	13.3	73	31.6	11.5
24	10	10.0	2.5	22	27.2	19.5	40	29.6	14.0	59	31.9	11.3	77	34.1	9.6
	15	6.7	2.5	19	26.8	24.1	35	28.9	17.4	51	30.9	14.1	67	32.8	12.0

Heat load table — Wall heating wet system 14

Temperature difference 7.5 K; Δp: 250 hPa — Thermal resistance of the wall coating RlB = 0.015 m²*K/W (natural stone, tiles, composite stone tiles)

Planning data				Mean heating water temperature ΘHm in °C 30.0			Mean heating water temperature ΘHm in °C 35.0			Mean heating water temperature ΘHm in °C 40.0			Mean heating water temperature ΘHm in °C 45.0		
Internal room temperature Θ_i	Laying interval VA	Pipe requirements l_R	Fixing rail requirement l_{Fs}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}
in °C	cm	m/m²	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
15	10	10.0	2.5	55	22.4	12.4	74	24.6	10.3	92	26.8	9.0	110	28.9	8.0
	15	6.7	2.5	48	21.5	15.6	64	23.4	13.0	80	25.3	11.2	95	27.2	10.0
18	10	10.0	2.5	44	24.0	14.0	63	26.3	11.3	81	28.5	9.6	99	30.6	8.5
	15	6.7	2.5	38	23.3	17.5	54	25.3	14.1	70	27.2	12.0	86	29.1	10.6
20	10	10.0	2.5	37	25.1	15.3	55	27.4	12.0	74	29.6	10.1	92	31.8	8.8
	15	6.7	2.5	32	24.5	19.1	48	26.5	15.0	64	28.4	12.6	80	30.3	11.0
22	10	10.0	2.5	29	26.2	17.1	48	28.5	12.9	66	30.7	10.7	85	32.9	9.2
	15	6.7	2.5	25	25.7	21.2	41	27.7	16.1	57	29.7	13.3	73	31.6	11.5
24	10	10.0	2.5	22	27.2	19.5	40	29.6	14.0	59	31.9	11.3	77	34.1	9.6
	15	6.7	2.5	19	26.8	24.1	35	28.9	17.4	51	30.9	14.1	67	32.8	12.0

Planning of ***PRINETO*** wall heating

Heat load table — Wall heating wet system 17

Temperature difference 7.5 K; Δp: 250 hPa — Thermal resistance of the wall coating RlB = 0.00 m²*K/W (without coating, i.e. moulded plaster, emulsion paint, wallpaper)

Planning data				Mean heating water temperature ΘHm in °C 30.0			Mean heating water temperature ΘHm in °C 35.0			Mean heating water temperature ΘHm in °C 40.0			Mean heating water temperature ΘHm in °C 45.0		
Raum-innentem-peratur Θ_i	Laying interval VA	Pipe require-ments l_R	Fixing rail requi-rement l_{Fs}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}
in °C	cm	m/m²	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
15	10	10.0	2	60	23.0	18.7	80	25.4	15.6	100	27.7	13.5	120	30.0	12.0
	15	6.7	2	52	22.0	23.5	69	24.0	19.6	86	26.1	17.0	103	28.1	15.1
18	10	10.0	2	48	24.5	21.1	68	27.0	17.0	88	29.3	14.5	108	31.6	12.7
	15	6.7	2	41	23.7	26.4	58	25.8	21.3	76	27.9	18.2	93	29.9	16.0
20	10	10.0	2	40	25.5	23.2	60	28.0	18.1	80	30.4	15.2	100	32.7	13.3
	15	6.7	2	34	24.8	28.9	52	27.0	22.7	69	29.0	19.1	86	31.1	16.6
22	10	10.0	2	32	26.5	25.9	52	29.0	19.5	72	31.4	16.1	92	33.8	13.9
	15	6.7	2	28	25.9	32.2	45	28.1	24.4	62	30.2	20.1	79	32.3	17.4
24	10	10.0	2	24	27.5	29.6	44	30.0	21.2	64	32.5	17.1	84	34.8	14.5
	15	6.7	2	21	27.0	36.7	38	29.3	26.4	55	31.4	21.3	72	33.5	18.2

Heat load table — Wall heating wet system 17

Temperature difference 7.5 K; Δp: 250 hPa — Thermal resistance of the wall coating RlB = 0.015 m²*K/W (natural stone, tiles, composite stone tiles)

Planning data				Mean heating water temperature ΘHm in °C 30.0			Mean heating water temperature ΘHm in °C 35.0			Mean heating water temperature ΘHm in °C 40.0			Mean heating water temperature ΘHm in °C 45.0		
Raum-innentem-peratur Θ_i	Laying interval VA	Pipe require-ments l_R	Fixing rail requi-rement l_{Fs}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}	Max. sur-face heat flux q	Mean wall tempera-ture ΘFm	Max. hea-ting circuit area A_{HK}
in °C	cm	m/m²	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
15	10	10.0	2	56	22.4	19.5	74	24.7	16.2	93	26.8	14.1	111	29.0	12.5
	15	6.7	2	49	21.6	24.2	65	23.6	20.2	81	25.5	17.5	97	27.4	15.6
18	10	10.0	2	44	24.1	21.9	63	26.3	17.7	81	28.5	15.1	100	30.7	13.3
	15	6.7	2	39	23.4	27.2	55	25.4	22.0	71	27.3	18.7	87	29.3	16.5
20	10	10.0	2	37	25.1	24.1	56	27.4	18.9	74	29.7	15.8	93	31.8	13.8
	15	6.7	2	32	24.6	29.8	49	26.6	23.4	65	28.6	19.7	81	30.5	17.2
22	10	10.0	2	30	26.2	26.9	48	28.5	20.3	67	30.8	16.7	85	33.0	14.4
	15	6.7	2	26	25.7	33.1	42	27.8	25.1	58	29.8	20.7	75	31.7	17.9
24	10	10.0	2	22	27.2	30.7	41	29.6	22.0	59	31.9	17.8	78	34.1	15.1
	15	6.7	2	19	26.9	37.6	36	29.0	27.2	52	31.0	22.0	68	33.0	18.7

Planning of **PRINETO** wall heating

Heat load table — Wall heating dry system

Temperature difference 7.5 K; Δp: 250 hPa — Thermal resistance of the wall coating RlB = 0.00 m^2*K/W (without coating, i.e. moulded plaster, emulsion paint, wallpaper)

Planning data			Mean heating water temperature ΘHm in °C 30.0			Mean heating water temperature ΘHm in °C 35.0			Mean heating water temperature ΘHm in °C 40.0			Mean heating water temperature ΘHm in °C 45.0		
Internal room temperature $Θ_i$	Laying interval VA	Pipe requirements l_R	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}
in °C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
15	12	8.3	53	22.1	17.6	70	24.2	14.6	88	26.3	12.7	106	28.4	11.3
	24	4.2	34	19.8	28.3	46	21.2	23.6	57	22.6	20.4	68	24.0	18.2
18	12	8.3	42	23.8	19.8	60	26.0	15.9	77	28.1	13.6	95	30.1	12.0
	24	4.2	27	21.9	31.5	39	23.4	25.5	50	24.8	21.7	62	26.2	19.2
20	12	8.3	35	24.9	21.7	53	27.1	17.0	70	29.2	14.3	88	31.3	12.4
	24	4.2	23	23.3	34.2	34	24.8	27.0	46	26.2	22.7	57	27.6	19.9
22	12	8.3	28	26.0	24.1	46	28.2	18.3	63	30.4	15.1	81	32.5	13.0
	24	4.2	18	24.7	37.7	30	26.2	28.8	41	27.7	23.9	52	29.1	20.7
24	12	8.3	21	27.1	27.5	39	29.4	19.8	56	31.5	16.0	74	33.7	13.6
	24	4.2	14	26.1	40.0	25	27.6	31.0	36	29.1	25.2	48	30.5	21.5

Heat load table Wall heating dry system

Temperature difference 7.5 K; Δp: 250 hPa — Thermal resistance of the wall coating RlB = 0.015 m^2*K/W (natural stone, tiles, composite stone tiles)

Planning data			Mean heating water temperature ΘHm in °C 30.0			Mean heating water temperature ΘHm in °C 35.0			Mean heating water temperature ΘHm in °C 40.0			Mean heating water temperature ΘHm in °C 45.0		
Internal room temperature $Θ_i$	Laying interval VA	Pipe requirements l_R	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean wall temperature ΘFm	Max. heating circuit area A_{HK}
in °C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
15	12	8.3	50	21.7	18.2	66	23.7	15.1	83	25.7	13.1	99	27.6	11.7
	24	4.2	32	19.6	29.0	43	20.9	24.2	54	22.3	21.0	65	23.6	18.7
18	12	8.3	40	23.5	20.4	56	25.5	16.5	73	27.5	14.0	89	29.4	12.4
	24	4.2	26	21.7	32.3	37	23.1	26.1	48	24.5	22.3	58	25.8	19.7
20	12	8.3	33	24.6	22.4	50	26.7	17.6	66	28.7	14.8	83	30.7	12.9
	24	4.2	22	23.2	35.0	32	24.6	27.7	43	25.9	23.3	54	27.3	20.4
22	12	8.3	26	25.8	24.9	43	27.9	18.9	59	29.9	15.6	76	31.9	13.4
	24	4.2	17	24.6	38.5	28	26.0	29.5	39	27.4	24.5	50	28.7	21.2
24	12	8.3	20	26.9	28.3	36	29.1	20.4	53	31.1	16.5	69	33.1	14.1
	24	4.2	13	26.0	40.0	24	27.4	31.7	35	28.8	25.8	45	30.2	22.1

Planning of ***PRINETO*** wall heating

Planning and design of the wall heating

The more stringent thermal insulation requirements and improved heat insulation result in a drastic reduction in heat loss from buildings. The resultant lower heating load can generally be met by a surface heating system.

Nowadays, the exact calculation and dimensioning with mass determination is normally done with buildings technology planning software. The data records from Dendrit can be used for the ***PRINETO*** system.

The following characteristic values are required for designing of a wall heating system:

In accordance with DIN 1264-3, dimensioning heating power Q_H(W) is the heating load Q_{N},f determined by the heating load calculation in accordance with DIN EN 12831 (standard heating load Φ_{HL}), heating surface A_F (m²), the wall area that can actually be used for pipe laying, standard internal room temperature Θ_i (°C), in accordance with DIN EN 12831 supplementary sheet 1, comprises the air temperature and the mean temperature of the areas surrounding the room, maximum wall surface temperature Θ_{W}, max. (°C), is restricted to take account of comfort criteria:

Rooms used for short periods (e.g. bathrooms, therapy rooms): 40°C. Rooms used for longer periods (e.g. living rooms, offices): 35°C

The design flow temperature Θ_V must be selected such that these values are not exceeded on the wall.
With a pre-selected heating medium excess temperature the temperature difference is selected so as to guarantee this.

NOTE

Large items of furniture, wall hangings or pictures that are set against or mounted on the heated wall significantly reduce the amount of heat emitted. For this reason, wall heating systems should be mounted on walls which are kept free wherever possible. The areas covered over should otherwise be deducted from the calculated area available for heating use and redistributed to other free wall spaces or to underfloor heating for example.

Average heating water temperature $\Theta_{H,m}$ (°C), average value of flow and return temperature, takes account of temperature temperature difference,

$$\Theta_{H,m} = (\Theta_V - \Theta_R) : 2 + \Theta_R$$

Temperature difference σ (K), temperature difference between supply and return ($\Theta_V - \Theta_R$), thermal resistance of the wall covering $R_{\lambda,B}$ (m² K/W), influences the thermal transfer of the wall plaster to the room and depends on the material used. The value should not exceed 0.015 m²K/W (for example wall tiles)

The following parameters can be calculated from this

- Heating medium excess temperature $\Delta\Theta_H$ (K), the difference between the mean heating water temperature $\Theta_{iH,m}$ and standard internal room temperature Θ_{ii}

$$\Delta\Theta_H = \Theta_{H,m} - \Theta_i$$

- Flow excess temperature $\Delta\Theta_V$, difference between flow temperature Θ_V and standard internal room temperature Θ_i

$$\Delta\Theta_V = \Theta_V - \Theta_i$$

- Laying interval VA (cm), is determined depending on the surface heat flux, heating medium excess temperature and possible thermal resistance of the wall covering (see diagrams of thermotechnical tests, see page 267).
- Maximum pipe length to be laid $l_{R,max.}$ (m), the total pressure loss of a heating circuit should not exceed 250 hPa – the requisite mass flow rate and pipe dimension therefore restrict the installable pipe length (see pressure loss tables of pipes, from page 101 onwards).
- Pipe requirement l_R (m), the laying interval VA and the heating surface A_F determine the pipe requirement per m² of wall space:

$$l_R = [1 : \text{VA (in m)}] \times A_F$$

Planning of ***PRINETO*** wall heating

- Maximum heating circuit area AHK, max. (m^2), is determined by the geometry of the room and the maximum installable pipe length on the basis of the pipe requirement (see heat load tables, see page 260).
- Mass flow rate m (kg/h), should be calculated as the heating medium flow mH designed according to DIN 1264 – 3.

The normal mass flow rate calculation for radiator heating systems

$$m = QH : [1{,}163 \times (\Theta V - \Theta R)]$$

has to be corrected by the mass flow rate which results from the heat loss to the neighbouring room. For this, it is necessary to calculate the partial heat transmission resistance to the heated room (R_{bR}) and to the neighbouring room (R_{nR}, the sum of all individual heat conduction and transfer resistances of the wall construction and any insulating wall panels).

The R_{bR} can be calculated using the following equation with the aid of the diagrams or heat load tables:

$$R_{bR} = \Delta\Theta H : q$$

This results in:

$$m = K \cdot Q_H : [1{,}163 \times (\Theta_V - \Theta_R)]$$

$$K = 1 + R_{bR} : R_{nR} + (\Theta i - \Theta_{nR}) : (q \times R_{nR})$$

ΘnR is the room temperature of the neighbouring room.

Planning of ***PRINETO*** wall heating

Examples for the determination of the laying interval

Wet system 14

Heating surface:	20 m²
Internal room temperature:	20 °C
Mean heating water temperature:	38 °C
Structured ceiling plaster:	0,0 m² K/W
Dimensioning heat power:	1200 W

Heating medium excess temperature $\Delta\Theta_H$ = Mean heating water temperature $\Theta_{H'm}$ – Room temperature Θ_i

= 38 °C – 20 °C
= 18 K

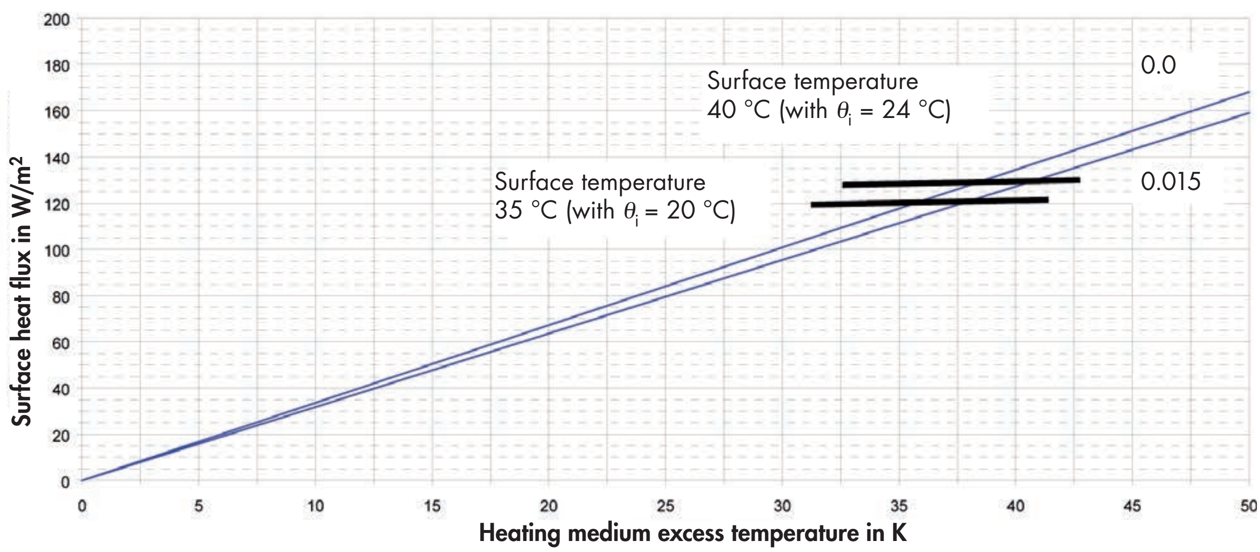
Surface heat flux q = Dimensioning power Q_H: Heating surface A_F

= 1200 W: 20 m²
= 60 W/m²

These values are carried over to the axes of the diagrams for the wet system 14. The starting point for this is the laying interval VA 15 cm. The point of intersection of the two values in the diagram should be on the 0.0 straight lines or just below.

Example: $\Delta\Theta_H$ = 18 K ; $\Delta\Theta_V$ = 22 K ; σ = 8 K ; q = 60 W/m²

Wall heating wet system 14 laying interval 15 cm



Planning of ***PRINETO*** wall heating

In the example diagram the point of intersection is exactly on straight lines 0.00. With a laying interval of 15 cm the required surface heat flux of 60 W/m² is achieved at a heating medium excess temperature of 18°C.

With a temperature difference of 8 K this results in a flow temperature of 42°C. The point of intersection with the straight line 0.00 is below the black limit curve for limiting the wall surface temperature (rooms used for longer periods). In the case of structured ceiling plaster the maximum permissible surface temperature of 35°C is not exceeded with a flow temperature of 42°C.

The laying intervals for all rooms of a house are now determined depending on the wall covering and surface heat flux of the heating materials excess temperature and flow temperature already selected.

If the spacing is reduced, the surface heat flux will increase given the same wall covering and same heating medium excess temperature. If the heating medium excess temperature is increased with the same wall covering and same surface heat flux, it is possible to reduce the laying interval. Shorter laying intervals therefore lead to lower system temperatures.

Diagrams of the thermotechnical tests

The ***PRINETO*** wall heating systems have been thermotechnically calculated in accordance with prEN 1264-5. The test report numbers are furnished for the respective system on the following pages.

The attainable system-specific heat flow densities of the various systems, depending on the laying intervals, wall covering resistance and heating medium excess temperature, are represented in the following diagrams.

Limit curve for maximum wall-surface temperature for rooms used for shorter periods.

It costs a lot of time to manually determine the mass flow rates according to DIN EN 1264 – 3 and the resultant pressure losses for the hydraulic equalisation; we therefore recommend using buildings technology planning software (Dentrit).

If the heating pipes are installed on the basis of a manual calculation, the overall pressure loss of each heating circuit should be under 250 hPa. This produces the maximum pipe length of a heating circuit depending on the velocity of flow (here at 0.4 m/s):

Surface heating pipe 14:	90 m
Multilayer composite pipe 14:	90 m
Multilayer composite pipe 16:	106 m
Surface heating pipe 17:	124 m

The values for the maximum heating circuit areas can be taken from the heat load tables.

$\Theta_{W,max}$ = 40 °C; Θ_i = 24 °C

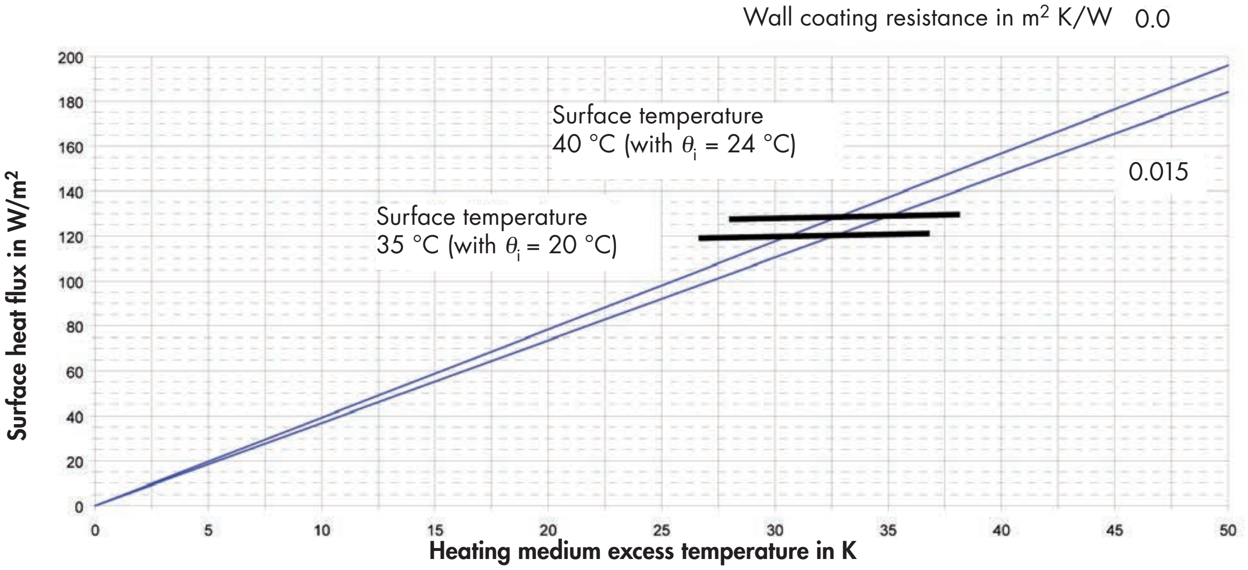
Limit curve for maximum wall-surface temperature for rooms used for longer periods.

$\Theta_{W,max}$ = 35 °C; Θ_i = 20 °C

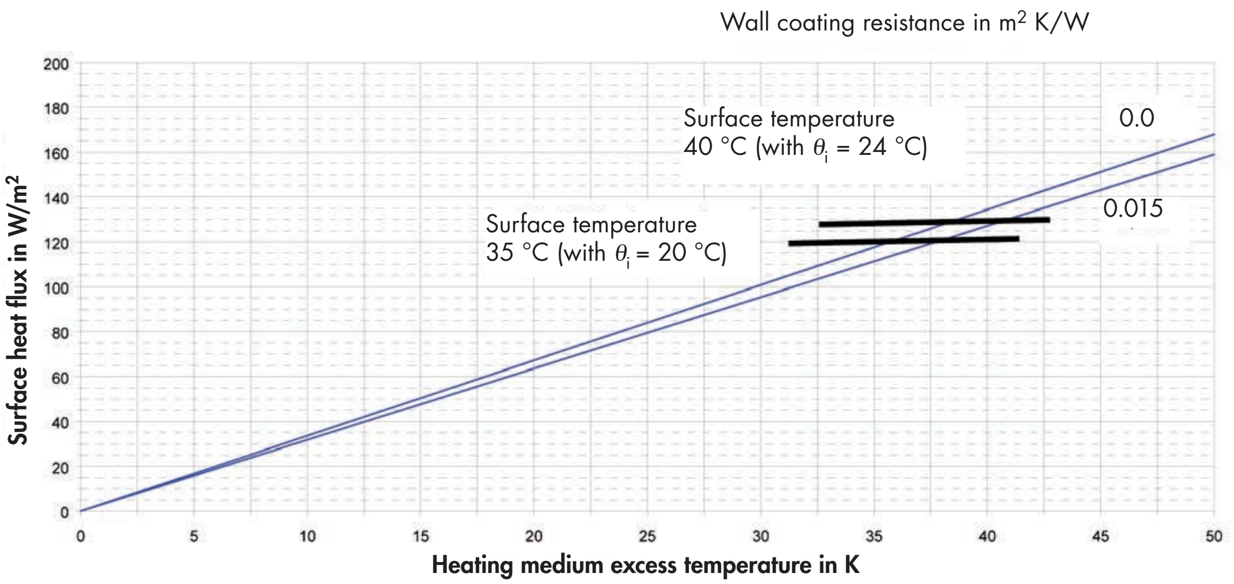
The point of intersection must be below the limit curve.

Planning of ***PRINETO*** wall heating

Wall heating wet system 14 laying interval 10 cm

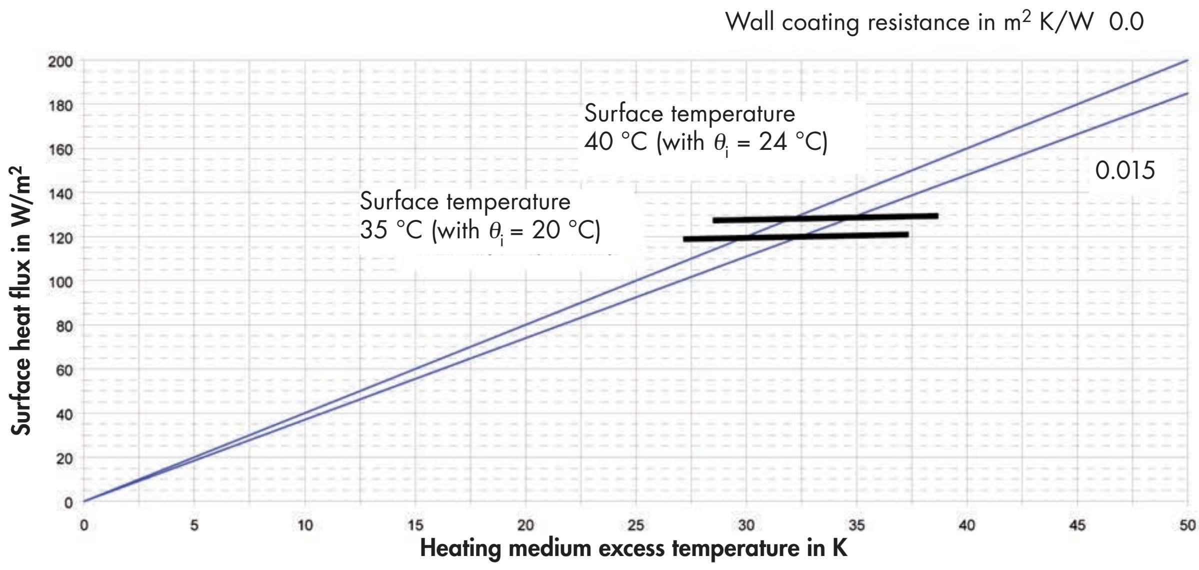


Wall heating wet system 14 laying interval 15 cm

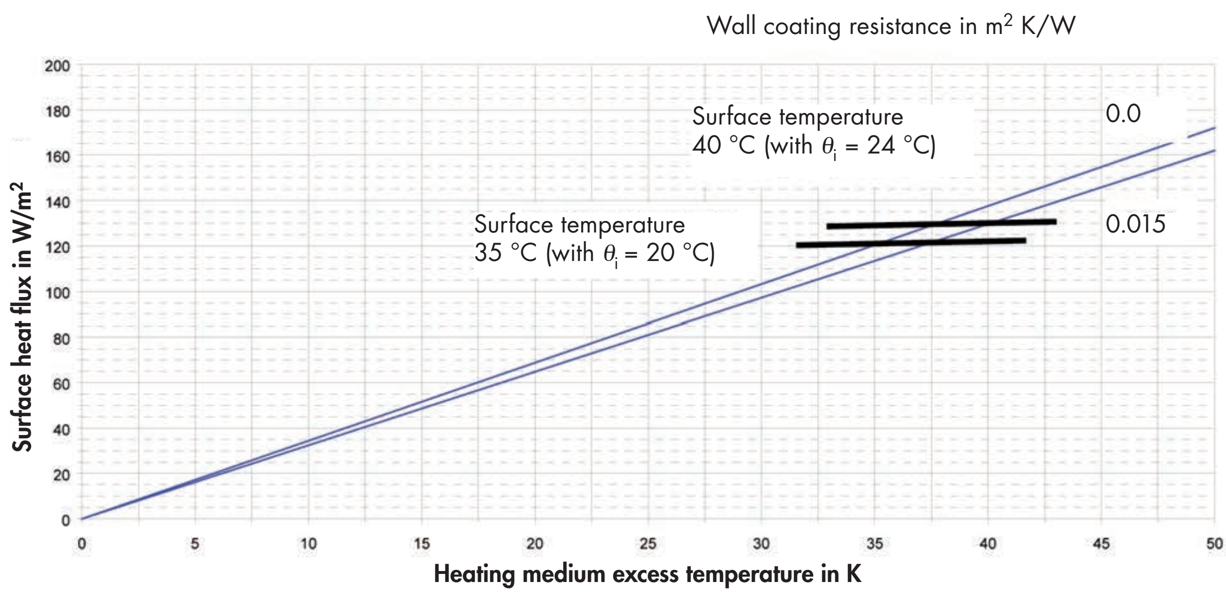


Planning of ***PRINETO*** wall heating

Wall heating wet system 17 laying interval 10 cm

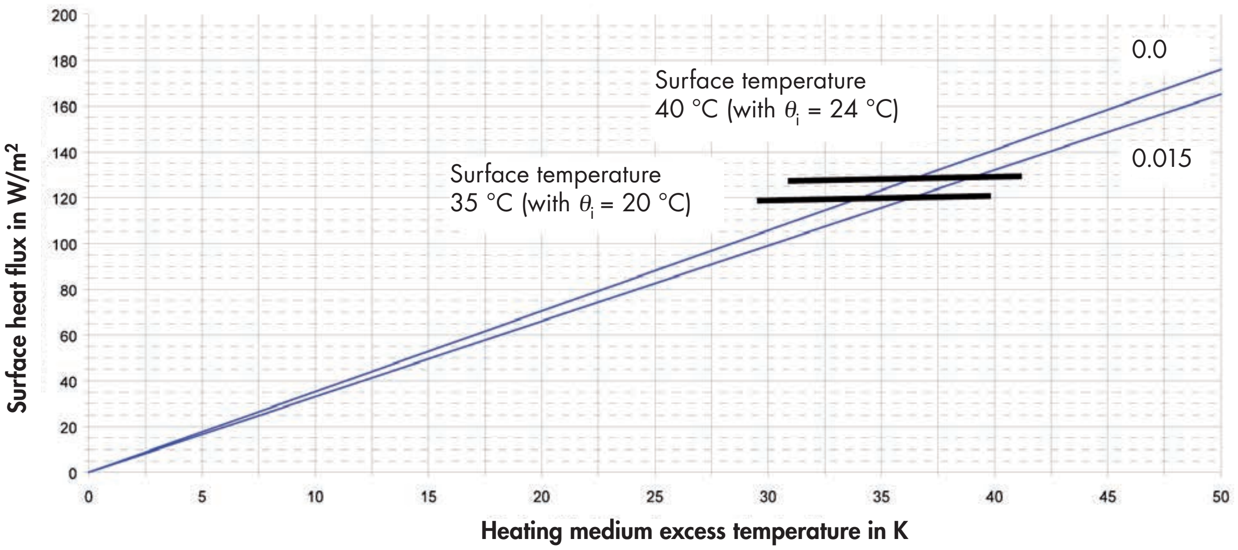


Wall heating wet system 17 laying interval 15 cm



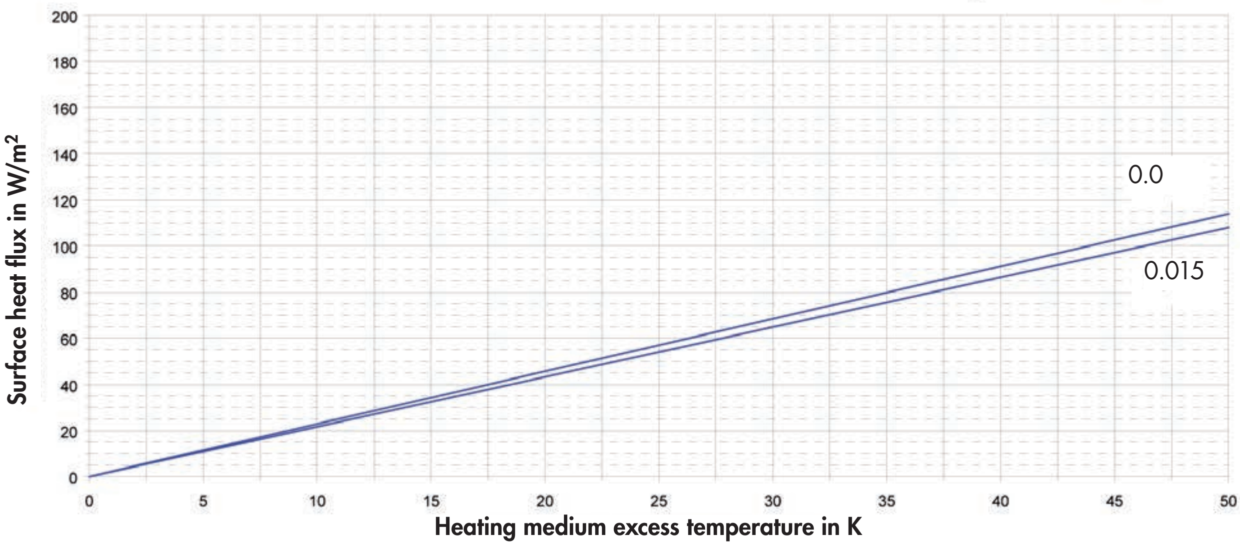
Planning of ***PRINETO*** wall heating

Wall heating dry system laying interval 12 cm



Wall heating dry system laying interval 24 cm

Wall coating resistance in m^2 K/W



Notes

2

Wall heating

2

Industrial surface heating

PRINETO Industrial surface heating

General basics

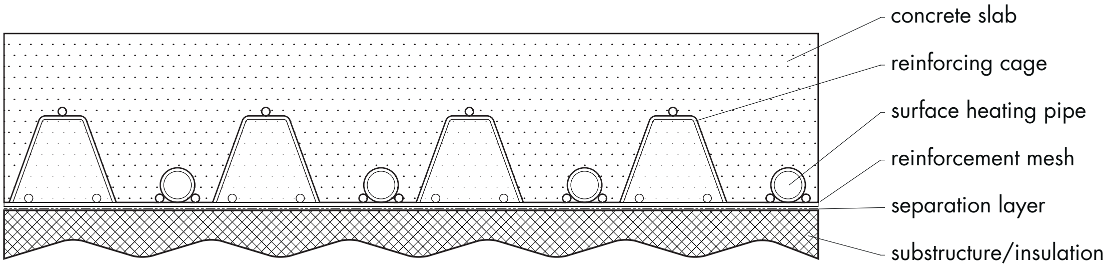
Surface heating is not only used for residential buildings, it is also used in warehouses, sales buildings and production halls, for example. The heating principle of industrial underfloor heating works in the same way as underfloor heating in a residential building. The maximum temperature occurs near the ground, in other words in an area where there are lots of people, and falls as height increases. This is a significant advantage compared with ceiling radiation, for example, particularly in halls with high roofs. A stable temperature profile is created without any draught.

Because the inner temperature is lower and the system itself is slower to react, the heating can be operated with an even lower flow temperature than with standard underfloor heating systems. In addition, the total mass of the concrete floor represents a very large heat storage unit, which allows longer heating downtimes to be compensated.

In the case of new halls, the necessary heating power may well be around 30 – 40 W/m². The heat load tables from page 277 onwards, where heating power can be read off depending on pipe covering and laying distance, provide an overview of the power of industrial underfloor heating systems.

Structure of industrial surface heating

The sub-structure is usually a packed bed or perimeter insulation. If no perimeter insulation is to be used, an application for exemption from the Energy-saving Ordinance (EnEV) must be made to the building authorities responsible. A separating layer, usually a diffusion-tight sheet, is placed on the sub-structure. The reinforcement mats are laid on this in the casing, with rails used if necessary. The heating pipe is fixed in place at the required height on the reinforcement mats. However, care must be taken that they are set deep enough in the concrete in case any holes need drilling. Once the concrete has been cast, it is very difficult to determine the position of the pipes in the concrete, and results are very unreliable. For this reason, we recommend a concrete covering at least 10 cm deep.



Section drawing of industrial surface heating (heating pipe on the lowest reinforcement mat).

- Suitable for heating industrial halls using buried concrete slabs
- Same advantages as underfloor heating with low flow temperature
- Suitable for continuous heat supply
- The pipe is surrounded by concrete, which permits good thermal transmission
- Laying distance and laying type can be selected freely
- Pipe covering can be selected freely
- Use of flexible heating pipes with internal diameter 16 mm and 20.4 mm to make the heating circuit areas as large as possible
- Heating pipes are oxygen diffusion-tight thanks to an EVOH layer in accordance with DIN 4726

Installation instructions

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of floor heating systems must be followed.

An insulating layer must be placed on the sub-structure (perimeter insulation, soil). Reinforcement mats are laid out on this insulating layer, depending on the building design. Alternatively, spacers and rails can be used to place the mats at a certain height above the separating layer. The ***PRINETO*** surface heating pipe is now laid at the required distance to the sub-structure. The pipe is fixed to the reinforcement mats using the ***PRINETO*** wire binder (art.-no. 878 386 215) and the ***PRINETO*** binding wire (art.-no. 878 386 216). It is also possible to fix the pipe using cable ties. The type of laying can be freely chosen, which means connection according to Tichelmann is also possible. The plan of the joints must be taken into consideration.

For installation, the following ***PRINETO*** pipes can be used:
- Surface heating pipe PE-MDX 20 (art.-no. 878 311 171)
- Surface heating pipe PE-MDX 25 (art.-no. 878 311 181)

Where pipes pass through expansion joints and enter the concrete slab, they must be sheathed by ***PRINETO*** slit protective pipe (for surface heating pipe 20 art.-no. 878 386 210, for surface heating pipe 25 art.-no. 878 386 211). The ends of the protective pipe must be protected before they enter the concrete.

CAUTION

Fittings that are to be enclosed in concrete must be sheathed by suitable means to prevent outer corrosion.

The distribution of heating circuits with dimension 20 pipes is connected to the industrial manifold 2" with flow meter. Connection is made with ***PRINETO*** transitions V-Euro (art.-no. 878 343 720) or ***PRINETO*** clamp/screw-in connections V-Euro (art.-no. 878 386 015).

The distribution of heating circuits with dimension 25 pipes is connected to the industrial manifold 2" with control valve. The transition is secured by a clamp screw connection on the manifold.

The ***PRINETO*** ball valve for industrial manifolds (art.-no. 878 386 179) is used to close the manifolds.

A foldable ***PRINETO*** pipe reel carrier (art.-no. 878 386 071) is available as a laying aid.

Before concreting work, each heating circuit must be individually flushed through with water and vented. Equally, pressure testing must be carried out before concreting work. A pressure testing protocol like the one shown on page 294 must be prepared.

CAUTION

The pipe must be pressurised during the concrete casting process. This can be achieved, for example, by connecting the heating circuits to a compressor or a water supply. This is necessary in order to detect any leaks in the pipes. For this reason, a fitter equipped with tools, couplers and sleeves should accompany the concreting work.

CAUTION

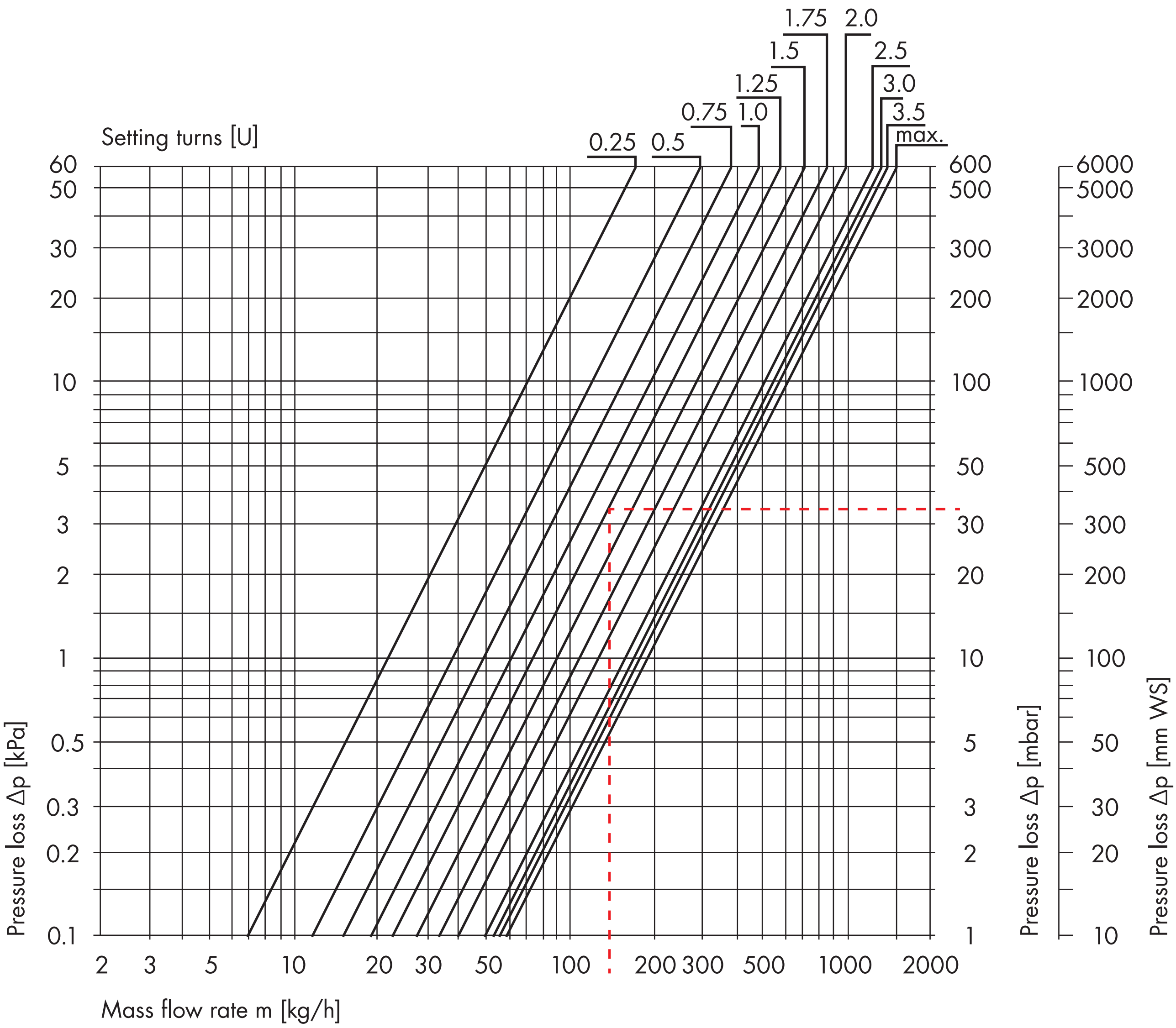
If there is danger of freezing, appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

Hydraulic equalisation

After the concrete has been cast, the hydraulic equalisation of the heating circuits is carried out. Where manifolds with a flow meter or a control valve with volume flow display are used, the data for volume flows in litre per minute are sufficient for equalisation. All the heating circuits must be opened during adjustment. Then the individual flow meters can be adjusted to the respective calculated value.

Where manifolds with control valves are used, the valve spindle is turned to adapt the pressure loss Δp of the current heating circuit to the least favourable (maximum pressure loss) $\Delta p_{max.}$ value. Knowledge of pressure losses in the heating circuits and the required mass flow rates is necessary for this. With the aid of the diagram below, the valve setting can be read off depending on the difference in pressure loss between the current heating circuit and the least favourable heating circuit and the mass flow rate of the current heating circuit. For setting, the valve must be closed completely, then opened again by the number of turns ascertained from the diagram.

Pressure loss diagram for mechanical control valves (in the flow) of industrial manifolds



Planning and design

Heat load tables

On the basis of calculations performed according to DIN EN 1264-2 and DIN EN 15377-1, heat load tables have been prepared in which the heating power transmitted to the room and maximum heating circuit length can be read off depending on the laying distance, pipe covering and mean heating water temperature. These values relate to a maximum pressure loss in the heating circuit of 300 mbar and a temperature difference of 5 K. However, for execution and hydraulic equalisation more exact calculations have to be made.

The heat load tables can be found on the following pages.

Heat load table industrial underfloor heating 20 x 2.0 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)

Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.1 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	74	22.8	20.4	100	25.0	16.9	126	27.1	14.6	153	29.2	12.9
	15	6.7	66	22.2	25.2	90	24.1	20.9	113	26.1	18.0	137	28.0	16.0
	20	5.0	59	21.6	29.8	80	23.4	24.7	102	25.1	21.3	123	26.8	18.9
	25	4.0	53	21.1	34.5	72	22.7	28.5	91	24.3	24.6	110	25.8	21.9
	30	3.3	48	20.6	39.2	65	22.1	32.4	82	23.5	28.0	99	24.9	24.9
17	10	10.0	68	23.4	21.3	95	25.6	17.4	121	27.7	14.9	147	29.8	13.2
	15	6.7	61	22.8	26.4	85	24.8	21.5	108	26.7	18.5	132	28.6	16.3
	20	5.0	55	22.2	31.2	76	24.0	25.5	97	25.8	21.9	119	27.5	19.3
	25	4.0	49	21.7	36.0	68	23.4	29.4	87	25.0	25.3	106	26.5	22.3
	30	3.3	44	21.3	40.9	61	22.8	33.4	79	24.2	28.7	96	25.6	25.4
18	10	10.0	63	23.9	22.4	89	26.1	18.0	116	28.3	15.3	142	30.4	13.5
	15	6.7	57	23.4	27.6	80	25.4	22.3	104	27.3	19.0	127	29.2	16.7
	20	5.0	51	22.9	32.6	72	24.7	26.3	93	26.4	22.4	114	28.2	19.7
	25	4.0	46	22.4	37.7	65	24.0	30.4	84	25.6	25.9	103	27.2	22.8
	30	3.3	41	22.0	42.7	58	23.5	34.6	75	24.9	29.5	92	26.4	25.9
19	10	10.0	58	24.5	23.5	84	26.7	18.7	110	28.9	15.8	137	31.0	13.8
	15	6.7	52	24.0	29.0	75	26.0	23.1	99	27.9	19.5	123	29.8	17.1
	20	5.0	47	23.5	34.3	68	25.3	27.3	89	27.1	23.1	110	28.8	20.2
	25	4.0	42	23.1	39.6	61	24.7	31.5	80	26.3	26.6	99	27.9	23.3
	30	3.3	38	22.7	44.9	55	24.2	35.8	72	25.7	30.3	89	27.1	26.5
20	10	10.0	53	25.0	24.9	79	27.3	19.4	105	29.4	16.2	132	31.5	14.1
	15	6.7	47	24.5	30.7	71	26.6	24.0	94	28.5	20.1	118	30.5	17.5
	20	5.0	42	24.1	36.2	63	26.0	28.3	85	27.7	23.7	106	29.5	20.7
	25	4.0	38	23.7	41.7	57	25.4	32.7	76	27.0	27.4	95	28.6	23.9
	30	3.3	34	23.4	47.3	51	24.9	37.1	68	26.4	31.1	85	27.8	27.1

Heat load table industrial underfloor heating 20 x 2.0 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)

Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.15 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	65	22.1	22.0	88	24.0	18.2	111	25.9	15.7	134	27.7	14.0
	15	6.7	59	21.5	27.0	80	23.3	22.3	101	25.1	19.3	122	26.8	17.1
	20	5.0	53	21.1	31.7	72	22.7	26.2	91	24.3	22.7	110	25.8	20.1
	25	4.0	46	20.4	37.6	62	21.8	31.1	78	23.2	26.9	95	24.6	23.9
	30	3.3	40	19.9	43.6	54	21.1	36.1	68	22.3	31.2	82	23.5	27.8
17	10	10.0	60	22.7	23.0	83	24.6	18.8	106	26.5	16.1	129	28.4	14.3
	15	6.7	55	22.2	28.2	76	24.0	23.1	97	25.7	19.8	117	27.4	17.5
	20	5.0	50	21.7	33.1	69	23.4	27.1	88	25.0	23.3	107	26.5	20.6
	25	4.0	42	21.1	39.2	59	22.5	32.1	75	23.9	27.6	91	25.3	24.4
	30	3.3	37	20.6	45.4	51	21.9	37.2	65	23.1	32.0	79	24.3	28.3
18	10	10.0	55	23.3	24.1	79	25.2	19.4	102	27.1	16.6	125	29.0	14.6
	15	6.7	50	22.8	29.5	71	24.6	23.8	92	26.4	20.3	113	28.1	17.9
	20	5.0	46	22.4	34.7	65	24.1	28.0	84	25.7	23.9	103	27.2	21.0
	25	4.0	39	21.8	41.0	55	23.3	33.2	72	24.7	28.3	88	26.0	24.9
	30	3.3	34	21.4	47.5	48	22.6	38.4	62	23.8	32.8	76	25.0	28.9
19	10	10.0	51	23.9	25.3	74	25.8	20.1	97	27.8	17.0	120	29.6	14.9
	15	6.7	46	23.5	31.0	67	25.3	24.7	88	27.0	20.9	109	28.7	18.3
	20	5.0	42	23.1	36.4	61	24.7	29.0	80	26.3	24.5	99	27.9	21.5
	25	4.0	36	22.5	43.1	52	24.0	34.3	68	25.4	29.1	85	26.7	25.5
	30	3.3	31	22.1	49.8	45	23.4	39.8	59	24.6	33.7	73	25.8	29.5
20	10	10.0	46	24.5	26.8	69	26.4	20.9	92	28.4	17.5	116	30.3	15.2
	15	6.7	42	24.1	32.8	63	25.9	25.6	84	27.7	21.5	105	29.4	18.7
	20	5.0	38	23.7	38.4	57	25.4	30.1	76	27.0	25.2	95	28.6	22.0
	25	4.0	33	23.2	45.4	49	24.7	35.6	65	26.1	29.9	82	27.5	26.0
	30	3.3	28	22.9	52.4	42	24.1	41.2	56	25.4	34.6	71	26.6	30.2

Heat load table industrial underfloor heating 20 x 2.0 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_{λ} 2 m loamy ground 1.38 m² K/W)

Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.2 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 45 °C		
Internal temper-ature θ	Laying distance VA	Pipe require-ments l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	58	21.5	23.6	78	23.2	19.5	99	24.9	16.8	119	26.6	14.9
	15	6.7	53	21.0	28.7	72	22.7	23.7	91	24.2	20.5	110	25.8	18.2
	20	5.0	48	20.7	33.5	66	22.1	27.7	83	23.6	24.0	100	25.0	21.3
	25	4.0	42	20.1	39.4	57	21.4	32.6	72	22.7	28.2	87	23.9	25.1
	30	3.3	37	19.6	45.3	50	20.8	37.6	63	21.9	32.5	76	23.0	28.9
17	10	10.0	54	22.1	24.6	74	23.9	20.1	95	25.6	17.3	115	27.2	15.3
	15	6.7	49	21.7	29.9	68	23.3	24.5	87	24.9	21.0	106	26.5	18.6
	20	5.0	45	21.4	34.9	62	22.9	28.6	80	24.3	24.6	97	25.7	21.7
	25	4.0	39	20.8	41.1	54	22.1	33.6	69	23.4	28.9	84	24.7	25.6
	30	3.3	34	20.4	47.2	47	21.6	38.7	60	22.7	33.3	74	23.8	29.5
18	10	10.0	49	22.7	25.7	70	24.5	20.8	91	26.2	17.7	111	27.9	15.6
	15	6.7	45	22.4	31.3	64	24.0	25.3	83	25.6	21.6	102	27.2	19.0
	20	5.0	42	22.0	36.6	59	23.6	29.6	76	25.0	25.2	93	26.5	22.2
	25	4.0	36	21.6	42.9	51	22.9	34.7	66	24.2	29.6	81	25.4	26.1
	30	3.3	32	21.2	49.3	45	22.3	40.0	58	23.5	34.1	71	24.6	30.1
19	10	10.0	45	23.4	27.1	66	25.2	21.5	86	26.9	18.2	107	28.6	15.9
	15	6.7	42	23.1	32.9	60	24.7	26.2	79	26.3	22.2	98	27.9	19.4
	20	5.0	38	22.7	38.4	55	24.3	30.6	73	25.7	25.9	90	27.2	22.7
	25	4.0	33	22.3	45.0	48	23.6	35.9	63	24.9	30.4	78	26.2	26.7
	30	3.3	29	21.9	51.7	42	23.1	41.3	55	24.2	35.0	68	25.4	30.7
20	10	10.0	41	24.0	28.6	62	25.8	22.3	82	27.5	18.7	103	29.2	16.3
	15	6.7	38	23.7	34.7	57	25.4	27.2	76	27.0	22.8	94	28.5	19.9
	20	5.0	35	23.4	40.5	52	25.0	31.7	69	26.4	26.6	87	27.9	23.2
	25	4.0	30	23.0	47.4	45	24.4	37.2	60	25.7	31.3	75	26.9	27.3
	30	3.3	26	22.7	54.4	39	23.9	42.8	53	25.0	36.0	66	26.1	31.4

Heat load table industrial underfloor heating 20 x 2.0 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)

Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.23 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	54	21.2	24.4	73	22.8	20.2	93	24.4	17.5	112	26.0	15.5
	15	6.7	50	20.8	29.7	68	22.3	24.5	86	23.8	21.2	103	25.3	18.8
	20	5.0	46	20.4	34.5	62	21.9	28.6	79	23.2	24.7	95	24.6	22.0
	25	4.0	40	19.9	40.4	54	21.2	33.5	69	22.4	29.0	83	23.6	25.7
	30	3.3	35	19.5	46.4	48	20.6	38.4	61	21.7	33.3	73	22.8	29.6
17	10	10.0	50	21.8	25.5	70	23.5	20.8	89	25.1	17.9	108	26.7	15.8
	15	6.7	46	21.5	30.9	64	23.0	25.3	82	24.5	21.7	100	26.0	19.2
	20	5.0	43	21.1	36.0	59	22.6	29.5	75	24.0	25.3	92	25.3	22.4
	25	4.0	37	20.7	42.1	52	21.9	34.5	66	23.2	29.7	80	24.4	26.3
	30	3.3	33	20.3	48.3	45	21.4	39.6	58	22.5	34.1	71	23.6	30.1
18	10	10.0	46	22.5	26.7	66	24.1	21.5	85	25.8	18.4	104	27.4	16.2
	15	6.7	43	22.2	32.4	61	23.7	26.2	78	25.2	22.3	96	26.7	19.6
	20	5.0	39	21.9	37.7	56	23.3	30.5	72	24.7	26.0	89	26.1	22.9
	25	4.0	34	21.4	44.0	49	22.7	35.6	63	23.9	30.4	77	25.1	26.8
	30	3.3	30	21.0	50.4	43	22.2	40.9	56	23.3	34.9	68	24.3	30.8
19	10	10.0	43	23.1	28.0	62	24.8	22.3	81	26.4	18.9	101	28.0	16.5
	15	6.7	39	22.8	34.0	57	24.4	27.1	75	25.9	22.9	93	27.4	20.1
	20	5.0	36	22.6	39.5	53	24.0	31.5	69	25.4	26.7	85	26.8	23.4
	25	4.0	32	22.2	46.2	46	23.4	36.9	60	24.7	31.2	75	25.9	27.4
	30	3.3	28	21.8	52.8	40	22.9	42.3	53	24.1	35.8	66	25.1	31.4
20	10	10.0	39	23.8	29.6	58	25.5	23.1	77	27.1	19.4	97	28.7	16.9
	15	6.7	36	23.5	35.8	53	25.1	28.1	71	26.6	23.6	89	28.1	20.5
	20	5.0	33	23.3	41.7	49	24.7	32.7	66	26.1	27.4	82	27.5	23.9
	25	4.0	29	22.9	48.6	43	24.2	38.2	57	25.4	32.1	72	26.6	28.0
	30	3.3	25	22.6	55.6	38	23.7	43.8	50	24.8	36.8	63	25.9	32.1

Heat load table industrial underfloor heating 25 x 2.3 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)

Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.1 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	76	23.0	30.5	103	25.2	25.2	130	27.4	21.8	157	29.6	19.3
	15	6.7	68	22.4	37.6	93	24.4	31.1	117	26.4	26.8	142	28.4	23.8
	20	5.0	62	21.8	44.3	84	23.7	36.6	106	25.5	31.7	128	27.3	28.1
	25	4.0	56	21.3	51.0	76	23.0	42.2	96	24.6	36.5	115	26.3	32.4
	30	3.3	50	20.8	57.9	68	22.4	47.9	86	23.9	41.4	104	25.3	36.8
17	10	10.0	70	23.5	31.9	97	25.8	26.1	124	28.0	22.4	151	30.1	19.8
	15	6.7	64	23.0	39.2	88	25.0	32.1	112	27.0	27.5	137	29.0	24.3
	20	5.0	57	22.4	46.3	79	24.3	37.8	101	26.1	32.5	124	27.9	28.7
	25	4.0	52	21.9	53.3	72	23.6	43.6	92	25.3	37.4	111	26.9	33.1
	30	3.3	47	21.5	60.4	65	23.0	49.4	83	24.6	42.5	100	26.0	37.5
18	10	10.0	65	24.1	33.5	92	26.3	27.0	119	28.5	23.0	146	30.7	20.2
	15	6.7	59	23.5	41.1	83	25.6	33.2	108	27.6	28.2	132	29.6	24.8
	20	5.0	53	23.0	48.5	75	24.9	39.1	97	26.8	33.3	119	28.6	29.3
	25	4.0	48	22.6	55.8	68	24.3	45.0	88	26.0	38.4	107	27.6	33.8
	30	3.3	43	22.2	63.2	61	23.7	51.1	79	25.3	43.6	97	26.7	38.3
19	10	10.0	60	24.6	35.2	87	26.9	27.9	114	29.1	23.6	141	31.3	20.6
	15	6.7	54	24.1	43.3	78	26.2	34.4	103	28.2	29.0	127	30.2	25.4
	20	5.0	49	23.7	51.0	71	25.6	40.5	93	27.4	34.2	115	29.2	30.0
	25	4.0	44	23.2	58.6	64	25.0	46.6	84	26.6	39.4	103	28.3	34.5
	30	3.3	39	22.9	66.4	57	24.4	52.9	75	26.0	44.7	93	27.4	39.2
20	10	10.0	54	25.1	37.2	81	27.4	29.0	108	29.7	24.3	135	31.8	21.1
	15	6.7	49	24.7	45.7	73	26.8	35.7	98	28.8	29.9	122	30.8	26.0
	20	5.0	44	24.3	53.8	66	26.2	42.1	88	28.0	35.2	110	29.8	30.7
	25	4.0	40	23.9	61.9	60	25.6	48.4	80	27.3	40.6	100	29.0	35.3
	30	3.3	36	23.5	70.0	54	25.1	54.9	72	26.7	46.0	90	28.2	40.1

Heat load table industrial underfloor heating 25 x 2.3 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)

Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.15 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιv ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	66	22.2	33.0	90	24.2	27.3	114	26.1	23.6	137	28.0	20.9
	15	6.7	61	21.7	40.3	82	23.5	33.3	104	25.3	28.8	126	27.1	25.6
	20	5.0	55	21.3	47.2	75	22.9	39.1	95	24.6	33.8	115	26.2	30.0
	25	4.0	48	20.6	55.7	65	22.1	46.1	82	23.5	39.9	99	24.9	35.4
	30	3.3	42	20.1	64.4	57	21.4	53.3	71	22.6	46.1	86	23.9	41.0
17	10	10.0	62	22.8	34.5	85	24.8	28.2	109	26.7	24.2	133	28.6	21.4
	15	6.7	56	22.3	42.1	78	24.2	34.4	100	26.0	29.5	121	27.7	26.1
	20	5.0	51	21.9	49.3	71	23.6	40.3	91	25.3	34.6	111	26.9	30.6
	25	4.0	44	21.3	58.2	61	22.8	47.6	78	24.2	40.9	96	25.6	36.2
	30	3.3	39	20.8	67.1	54	22.1	55.0	68	23.4	47.2	83	24.6	41.8
18	10	10.0	57	23.4	36.2	80	25.4	29.2	104	27.3	24.8	128	29.3	21.8
	15	6.7	52	23.0	44.1	74	24.8	35.6	95	26.6	30.3	117	28.4	26.7
	20	5.0	47	22.6	51.6	67	24.3	41.7	87	25.9	35.5	107	27.6	31.3
	25	4.0	41	22.0	60.8	58	23.5	49.2	75	24.9	41.9	92	26.4	36.9
	30	3.3	36	21.5	70.2	51	22.8	56.8	65	24.1	48.5	80	25.4	42.7
19	10	10.0	52	24.0	38.0	76	26.0	30.2	99	28.0	25.5	123	29.9	22.3
	15	6.7	48	23.6	46.4	69	25.5	36.9	91	27.3	31.2	113	29.0	27.3
	20	5.0	43	23.2	54.2	63	24.9	43.2	83	26.6	36.5	103	28.2	32.0
	25	4.0	38	22.7	63.9	55	24.2	50.9	72	25.6	43.1	89	27.1	37.7
	30	3.3	33	22.3	73.6	48	23.6	58.7	62	24.9	49.7	77	26.1	43.6
20	10	10.0	47	24.6	40.2	71	26.6	31.4	95	28.6	26.3	118	30.5	22.9
	15	6.7	43	24.2	48.9	65	26.1	38.3	87	27.9	32.1	108	29.7	27.9
	20	5.0	40	23.9	57.2	59	25.6	44.8	79	27.3	37.5	99	28.9	32.7
	25	4.0	34	23.4	67.3	51	24.9	52.8	68	26.4	44.3	85	27.8	38.6
	30	3.3	30	23.0	77.5	45	24.3	60.9	60	25.6	51.1	74	26.9	44.6

Heat load table industrial underfloor heating 25 x 2.3 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)
Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.2 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	59	21.6	35.4	80	23.3	29.2	101	25.1	25.3	122	26.8	22.4
	15	6.7	54	21.2	42.9	74	22.8	35.5	93	24.5	30.7	113	26.0	27.2
	20	5.0	50	20.8	50.0	68	22.3	41.4	86	23.8	35.8	104	25.3	31.8
	25	4.0	44	20.3	58.5	60	21.6	48.4	75	22.9	41.9	91	24.2	37.2
	30	3.3	39	19.8	67.1	52	21.0	55.6	66	22.2	48.1	80	23.4	42.8
17	10	10.0	55	22.2	36.9	76	24.0	30.2	97	25.7	25.9	118	27.5	22.9
	15	6.7	51	21.8	44.8	70	23.5	36.6	89	25.1	31.5	109	26.7	27.8
	20	5.0	47	21.5	52.2	64	23.0	42.7	82	24.5	36.6	100	26.0	32.4
	25	4.0	41	21.0	61.0	56	22.3	50.0	72	23.7	42.9	88	25.0	38.0
	30	3.3	36	20.5	70.0	50	21.8	57.3	63	23.0	49.3	77	24.1	43.6
18	10	10.0	51	22.8	38.7	72	24.6	31.2	93	26.4	26.6	114	28.1	23.4
	15	6.7	47	22.5	46.9	66	24.2	37.9	86	25.8	32.3	105	27.4	28.4
	20	5.0	43	22.2	54.6	61	23.7	44.1	79	25.2	37.6	97	26.7	33.1
	25	4.0	38	21.7	63.8	53	23.1	51.6	69	24.4	44.0	85	25.7	38.8
	30	3.3	33	21.3	73.1	47	22.5	59.2	61	23.7	50.5	75	24.9	44.5
19	10	10.0	46	23.5	40.6	67	25.3	32.3	88	27.0	27.3	109	28.8	23.9
	15	6.7	43	23.2	49.3	62	24.8	39.2	82	26.5	33.2	101	28.1	29.0
	20	5.0	39	22.9	57.3	57	24.4	45.6	75	25.9	38.6	93	27.4	33.8
	25	4.0	34	22.4	66.9	50	23.8	53.4	66	25.1	45.2	81	26.5	39.6
	30	3.3	30	22.0	76.6	44	23.3	61.2	58	24.5	51.9	72	25.7	45.5
20	10	10.0	42	24.1	42.9	63	25.9	33.6	84	27.7	28.1	105	29.4	24.5
	15	6.7	39	23.8	52.0	58	25.5	40.7	78	27.2	34.1	97	28.8	29.7
	20	5.0	36	23.5	60.4	54	25.1	47.3	72	26.6	39.7	90	28.1	34.6
	25	4.0	31	23.1	70.5	47	24.5	55.4	63	25.9	46.5	78	27.2	40.5
	30	3.3	28	22.8	80.7	41	24.0	63.4	55	25.2	53.3	69	26.4	46.5

Heat load table industrial underfloor heating 25 x 2.3 (reinforced concrete 1.9 W/mK, with 8 cm perimeter insulation (0.04 W/mK), R_λ 2 m loamy ground 1.38 m² K/W)
Temperature difference 5.0 K; Δp = 300 hPa; thermal resistance of the floor covering $R_{\lambda,B}$ = **0.00 m² K/W** (without covering or with 2 mm walkway layer; 0.225 m pipe covering)

Planning data			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 30 °C in			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 35 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 40 °C			Mean heating water temperature $\theta_{H\mu}$ ιν ° = 45 °C		
Internal temperature θ	Laying distance VA	Pipe requirements l_R	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}	Max. surface heat flux q	Mean floor temp. $\theta_{F\mu}$	Max. heating circuit area A_{HK}
in ° C	cm	m/m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²	W/m²	°C	m²
16	10	10.0	59	21.6	35.4	80	23.3	29.2	101	25.1	25.3	122	26.8	22.4
	15	6.7	54	21.2	42.9	74	22.8	35.5	93	24.5	30.7	113	26.0	27.2
	20	5.0	50	20.8	50.0	68	22.3	41.4	86	23.8	35.8	104	25.3	31.8
	25	4.0	44	20.3	58.5	60	21.6	48.4	75	22.9	41.9	91	24.2	37.2
	30	3.3	39	19.8	67.1	52	21.0	55.6	66	22.2	48.1	80	23.4	42.8
17	10	10.0	55	22.2	36.9	76	24.0	30.2	97	25.7	25.9	118	27.5	22.9
	15	6.7	51	21.8	44.8	70	23.5	36.6	89	25.1	31.5	109	26.7	27.8
	20	5.0	47	21.5	52.2	64	23.0	42.7	82	24.5	36.6	100	26.0	32.4
	25	4.0	41	21.0	61.0	56	22.3	50.0	72	23.7	42.9	88	25.0	38.0
	30	3.3	36	20.5	70.0	50	21.8	57.3	63	23.0	49.3	77	24.1	43.6
18	10	10.0	51	22.8	38.7	72	24.6	31.2	93	26.4	26.6	114	28.1	23.4
	15	6.7	47	22.5	46.9	66	24.2	37.9	86	25.8	32.3	105	27.4	28.4
	20	5.0	43	22.2	54.6	61	23.7	44.1	79	25.2	37.6	97	26.7	33.1
	25	4.0	38	21.7	63.8	53	23.1	51.6	69	24.4	44.0	85	25.7	38.8
	30	3.3	33	21.3	73.1	47	22.5	59.2	61	23.7	50.5	75	24.9	44.5
19	10	10.0	46	23.5	40.6	67	25.3	32.3	88	27.0	27.3	109	28.8	23.9
	15	6.7	43	23.2	49.3	62	24.8	39.2	82	26.5	33.2	101	28.1	29.0
	20	5.0	39	22.9	57.3	57	24.4	45.6	75	25.9	38.6	93	27.4	33.8
	25	4.0	34	22.4	66.9	50	23.8	53.4	66	25.1	45.2	81	26.5	39.6
	30	3.3	30	22.0	76.6	44	23.3	61.2	58	24.5	51.9	72	25.7	45.5
20	10	10.0	42	24.1	42.9	63	25.9	33.6	84	27.7	28.1	105	29.4	24.5
	15	6.7	39	23.8	52.0	58	25.5	40.7	78	27.2	34.1	97	28.8	29.7
	20	5.0	36	23.5	60.4	54	25.1	47.3	72	26.6	39.7	90	28.1	34.6
	25	4.0	31	23.1	70.5	47	24.5	55.4	63	25.9	46.5	78	27.2	40.5
	30	3.3	28	22.8	80.7	41	24.0	63.4	55	25.2	53.3	69	26.4	46.5

2

PRINETO Concrete core temperature control/thermal component activation

General basics

Concrete core temperature control/thermal component activation is used in large multi-storey buildings such as hotels, hospitals or office blocks.

With concrete core temperature control, the thermal storing power of the component (usually a concrete ceiling slab) is exploited for heating and cooling the enclosed rooms. Concrete core temperature control cannot meet the entire heating or cooling load requirements of the building, rather it produces a base load. The individual rooms must be heated or cooled to the required temperature using separate systems, but these can be designed significantly smaller than if they had to cope with the whole heating load. As far as cooling is concerned, it must be ensured that the surface temperature does not fall below the cooling limit temperature since otherwise condensation will form.

With correct design, concrete core temperature control is to a large extent self-regulating. On account of the usually small temperature difference between the flow temperature and room temperature, as well as the large storage mass of the concrete, the effect of self-regulation is distinct. It is very difficult to regulate individual rooms using concrete core temperature control, but it can be necessary to regulate specific zones depending on the position of the building in relation to the sun.

Structure

The storage power of the concrete structure is utilised by casting the heating/cooling pipes in the concrete. The storage power depends on the ceiling structure and position of the pipes. As with industrial underfloor heating, the pipes are attached to the reinforcement mats. There are no restrictions on the design of the floor structure on the concrete slab and the ceiling sub-structure, but the design has a significant influence on the storage power. An additionally suspended ceiling or excessive insulation in the floor structure considerably reduces power, for example.

Planning aid

Knowledge of the planned structure and general conditions is required when designing the concrete core temperature control. Since concrete core temperature control is mainly installed in ceiling structures, the ambient parameters both above and below the concrete ceiling are required. The activation of other components such as columns, for example, requires more comprehensive design planning.

The form "Performance determination for concrete core temperature control" lists the desired ambient parameters to be entered and illustrates the structure of a concrete ceiling as shown in the example. The result in accordance with DIN EN 15337-1 is the thermal power per square metre that can be made available through concrete core temperature control. These values are used to calculate the mass flow rate and maximum possible pipe length per heating circuit at maximum pressure loss.

An overview can be prepared for each manifold according to the planned heating circuits and the results of performance determination. This can be used as a basis to calculate pressure drop and flow rate of each circuit.

There are various planning programs available for designing and planning concrete core temperature control.

General basics

Performance determination

Project	
Component	Reinforced concrete ceiling 250 mm between heated rooms
Planner/processor	
Sales representative	

Operation mode	**Heating**	**Cooling**
Flow temperature in °C	30	16
Temperature difference in K	3.5	3.1
Air temperature above the ceiling in °C	20	26
Air temperature under the ceiling in °C	20	26
Pipework gap in m	0.15	
Outer pipe diameter in m	0.02	
Thickness of pipe wall in m	0.002	

Ceiling structure from top to bottom	**Thickness in m**	**λ in W/mK**
Cement screed	0.04	1.2
Insulation	0.02	0.04
Concrete cover to centre of pipe	0.125	1.9
Concrete gap to centre of pipe	0.125	1.9
Plaster	0.01	1.2

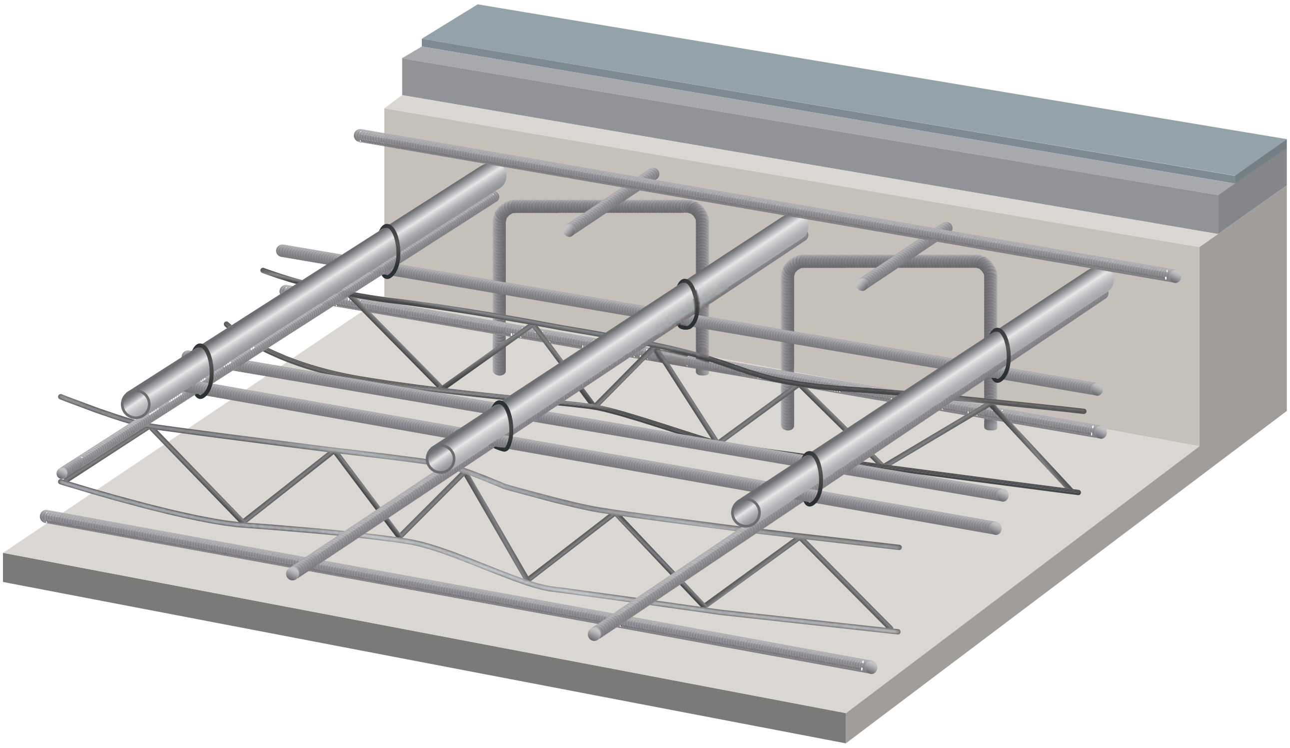
Operation mode	**Heating**		**Cooling**	
	Power in W/m²	**Surface temperature in °C**	**Power in W/m²**	**Surface temperature in °C**
Heat flow upwards	10.5	21.2	–9.8	24.5
Heat flow downwards	32.9	25.1	–39.8	21.5
Total heat flow	43.4		49.7	
Mass flow rate in kg/h*m²	10.66		13.78	

Max. pressure loss per heating circuit in Pa	30000
Max. heating circuit area in m²	22.4
Max. heating circuit length in m²	149.1

2

Concrete core temperature control/
Thermal component activation

General basics



Construction with thermal component activation (schematic)

Installation instructions

The general instructions in the ***PRINETO*** catalogue concerning the installation and laying of surface heating systems must be followed.

Concrete core temperature control can be designed in various ways.

After casing work has been completed, the ***PRINETO*** ceiling duct for surface heating pipes is fixed in a hole in the casing when heating circuit feeder pipes are laid beneath the concrete. An adapter (included in the scope of delivery) must be inserted in the ceiling duct for pipes of dim. 20. It is not needed for pipes of dim. 25. Then the reinforcement mats are laid out. The reinforcement mesh can also be laid on spacers and rails at a certain height above the casing.

Ideally, the surface heating pipes should be positioned in the centre of the concrete block. If this is not possible, the pipes can also be fixed to the lower reinforcement. The pipes are fixed in place using ***PRINETO*** binding wire (art. no.: 878 386 216) which is wound around the reinforcement and the pipe by using the cordless wire binder. Alternatively, cable ties or a fixing rail can also be used for the respective dimension.

For installation, the following ***PRINETO*** pipes can be used:
- Surface heating pipe PE-MDX 20 (art.-no. 878 311 171)
- Surface heating pipe PE-MDX 25 (art.-no. 878 311 181)

If the heating circuit feeder pipes are to be laid above the floor, then at the point of entry into the concrete slab or passage through the expansion joints the pipes must be sheathed with ***PRINETO*** slit protective pipe (for surface heating pipe 20 art.-no. 878 386 210, for surface heating pipe 25 art.-no. 878 386 211). The ends of the protective pipe must be protected before they enter the concrete.

CAUTION

Fittings that are to be enclosed in concrete must be sheathed by suitable means to prevent outer corrosion.

Once the pipes have been laid, reinforcement work can be continued.

The distribution of heating circuits with dimension 20 pipes is connected to the industrial manifold 2" with flow meter. Connection is made with ***PRINETO*** transitions V-Euro (art.-no. 878 343 720) or ***PRINETO*** clamp/screw-in Euro-cone (art.-no. 878 386 015).

The distribution of heating circuits with dimension 25 pipes is connected to the industrial manifold 2" with control valve. The transition is secured by a clamp screw connection on the manifold.

With large homogeneous heating areas it is also possible to connect the heating circuits using the Tichelmann system. There are numerous tee pieces and couplers available for the surface heating pipes 17 to 25 for this purpose.

The ***PRINETO*** ball valve for industrial manifolds (art.-no. 878 386 179) is used to shut off the manifolds.

Installation instructions

Laying according to the Tichelmann system is possible for every dimension using ***PRINETO*** tee pieces with internal threaded outlet and thread transitions.

A foldable ***PRINETO*** pipe reel is available as laying aid (art.-no. 878 386 071).

Before concreting work, each heating circuit must be individually flushed through with water and vented. Equally, pressure testing must be carried out before concreting work. A pressure testing protocol like the one shown on page 294 must be prepared.

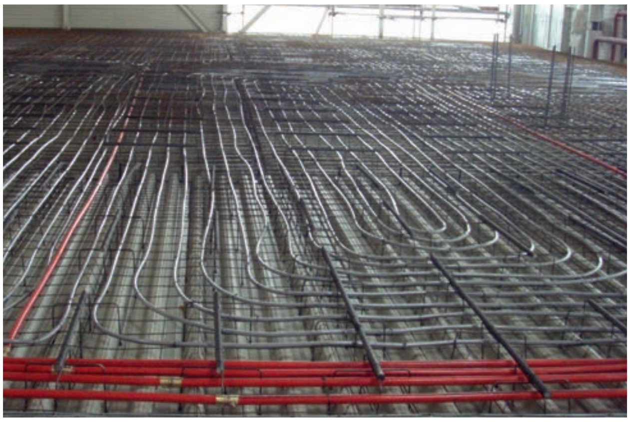
After pressure testing, the concrete can be cast. During casting the pressure should be maintained at the same level as during pressure testing.

CAUTION

The pipe must be pressurised during the concrete casting process. This can be achieved by connecting the heating circuits to a compressor or a water supply pipe. This is necessary in order to detect any leaks in the pipes. For this reason, a fitter equipped with tools, couplers and sleeves should accompany the concreting work.

CAUTION

If there is danger of freezing, appropriate measures must be taken, e.g. use of antifreeze agents or heating of the building.

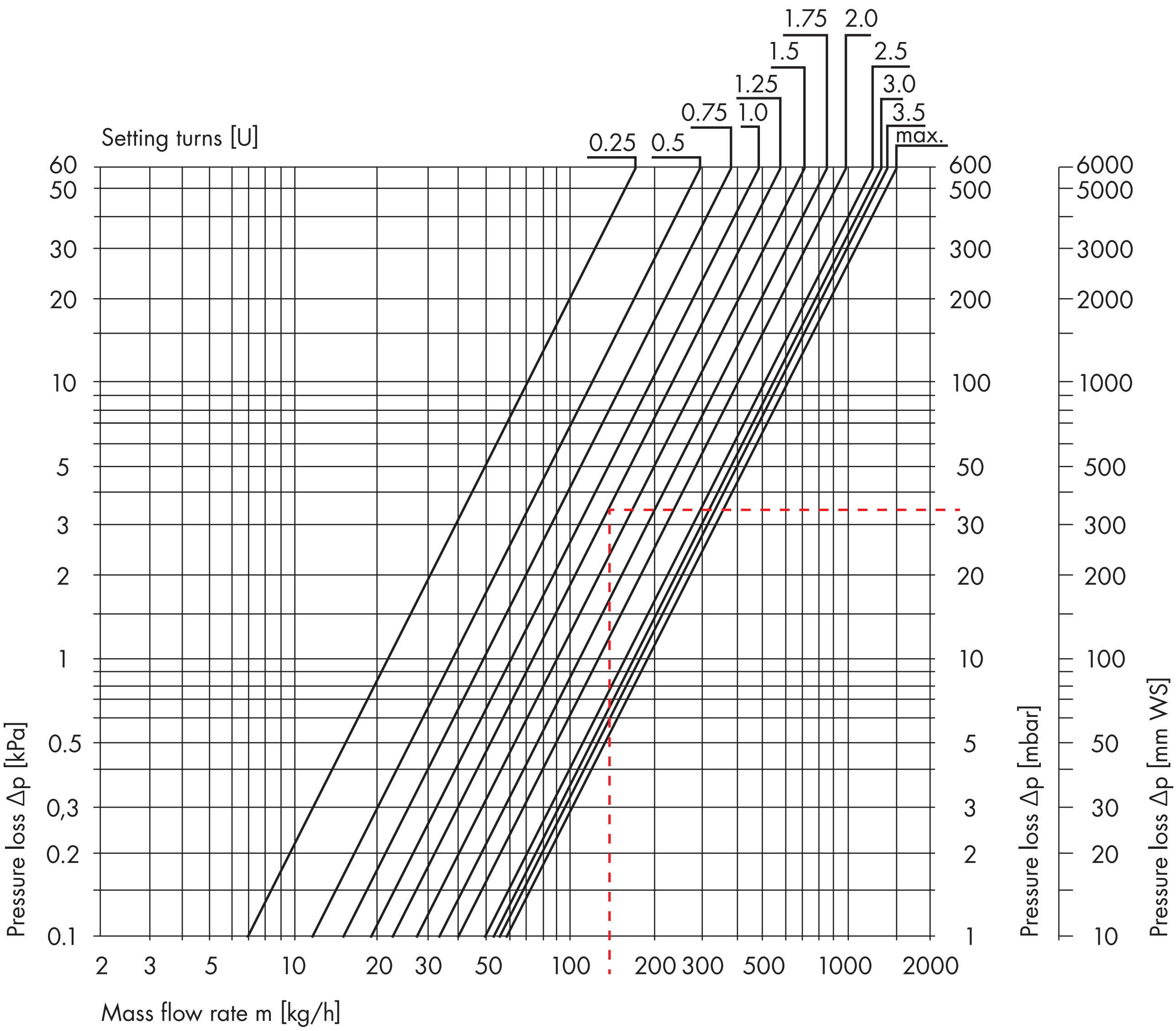


Hydraulic equalisation

After the concrete has been cast, the hydraulic equalisation of the heating circuits is carried out. For manifolds with flow meter control valve carrying display of the flow volume, the specification is sufficient for equalisation. All the heating circuits must be opened during adjustment. The individual flow meters can then be adjusted to the respective calculated value.

For manifolds only with control valves, the pressure drop of the current heating circuit is adjusted to the most unfavourable $\Delta p_{max.}$ value (maximum pressure drop) by turning the valve spindle. Knowledge of pressure losses in the heating circuits and the required mass flow rates is necessary for this. With the aid of the diagram below, the valve setting can be read off, depending on the difference in pressure loss between the current heating circuit and the least favourable heating circuit and the mass flow rate of the current heating circuit. The valve must be closed completely for adjustment and for reopening to the number of setting turns that has been determined on the basis of the diagram.

Pressure loss diagram for mechanical control valves (in the flow) of industrial manifolds



Pressure testing

After completion and before the concrete is applied, the heating circuits of the concrete core temperature control system must be pressure-tested with water as per DIN EN 1264 part 4 for leak-tightness. The test is to be recorded and signed by the client and the test operative.

The testing pressure must not be lower than 4 bar or higher than 6 bar. When the concrete is laid, the pipes must be pressurised again using a compressor or a "running" water supply so that any leaks under the wet concrete can be detected. A fitter equipped with tools and couplers must accompany the concreting work in order to repair any leaks.

NOTE

When manifolds for surface heating pipe 20 are used, the testing pressure must not exceed 6 bar.
If manifolds for surface heating pipe 25 are installed, the testing pressure must not exceed 10 bar.

The material characteristics of the synthetic pipes lead to an expansion of the pipe during the pressure testing, which causes the pressure to fall. Changes in temperature also distort the test result. Therefore, with pressure testing, as constant a temperature as possible should be maintained for the test medium, and the initial pressure should be restored several times after the pipe expansion.

The pressure test with water is to be carried out as follows:

- The heating circuit manifolds are disconnected from the rest of the heating system by closing the isolating equipment.
- Each heating circuit is individually filled with water through the flow manifold bar until it is absolutely free of air. In order for this to be done, all thermostat valves and control valves or flow meters are to be individually fully opened and then closed.
- Once all the heating circuits are filled, the connection to the filling facility (e.g. mains water supply) must be interrupted in accordance with DIN 1717.
- All thermostat valves and control valves or flow meters are opened.
- Preparing the test by applying the testing pressure to the entire system. The initial pressure should be restored again after half an hour, and again after a further half hour. After another half hour (1.5 hours after the start) testing can begin (without restoring the initial pressure again!).
- During and after the test, all connections and the pipe must be checked for leaks (visual inspection).
- The testing will count as successful if after 24 hours the pressure drop is less than 1.5 bars and no leaks have been detected.

CAUTION

If there is a danger of freezing, appropriate measures must be taken such as use of antifreeze agents or heating of the building. If no further frost protection is required for the normal operation of the installation, the antifreeze agent must be removed by draining and flushing out with at least three water changes.

Pressure testing

Pressure testing protocol for industrial underfloor heating/concrete core temperature control

Object: ______________________

Owner: ______________________

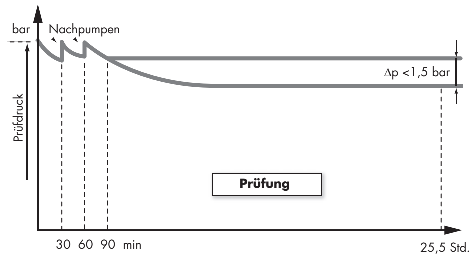
Inspector: ______________________

Description of heating circuit manifold

Surface heating pipe 17 ______________________

Surface heating pipe 20 ______________________

Surface heating pipe 25 ______________________



Preparation (duration 90 minutes)

Start ______________________ h

End ______________________ h

Test
(duration 24 hours) ______________________ bar

Pressure after 90 minutes
(start of the testing) ______________________ bar

NOTE

The temperature of the test medium should be kept as constant as possible. Fill pipes with water. Vent pipes completely.

Test (duration 24 hours)

Start ______________________ h

End ______________________ h

Testing pressure at start of testing ______________________ bar

Testing pressure after 24 hours ______________________ bar

Pressure drop (max. 1.5 bar) ______________________ bar

Results of the testing

Pressure testing passed ☐ yes ☐ no

Visual inspection passed ☐ yes ☐ no

Leaks detected ☐ yes ☐ no

Place, Date

Signature inspector

Signature owner or representative

Notes

2

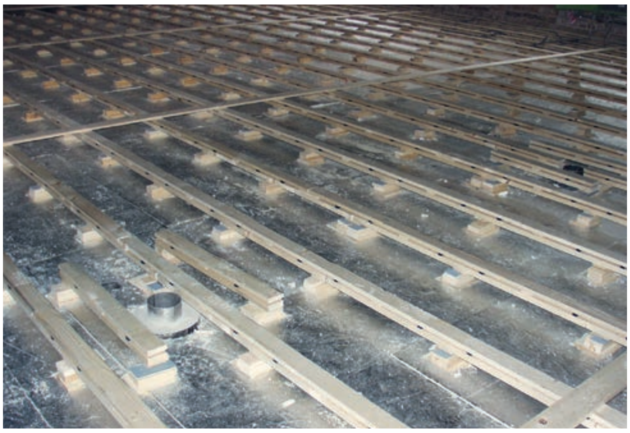
Sprung floor heating systems

PRINETO Sprung floor heating systems

Sprung floor heating systems

A sprung floor is often used in sports halls to guarantee an elastic floor structure which is easy on the joints. Underfloor heating can be installed for this type of floor too. This makes it possible to create a pleasant, draught-free climate in sports halls.

With a sprung floor, spacer blocks surrounded by insulation are set up at defined intervals. So-called elastic pads can be used to cushion the spacer blocks. Then a layer of battens is fixed in place on this as a double vibration carrier, then the so-called blind floor at right angles to this. The floor covering is laid on the chipboard panels placed on top of this. A cavity in which the heating pipes are laid out is produced between the insulation and the chipboard panels.



The ***PRINETO*** surface heating pipe can be used for heating over a sprung floor. However, a larger dimensioned pipe (surface heating pipe 20 and 25) should be used for this. But smaller dimensions are also possible.

Fixing rails are available for fixing the surface heating pipe. If a different fixing option is required, this is possible on request.

The ***PRINETO*** dry system can also be used for heating sports halls with elastic sports floors with a modular structure.

PRINETO industrial manifolds 2" with attached control valves or flow meters (depending on the pipe dimension) are used to distribute the heating circuits. The connection of the heating circuits according to Tichelmann is no problem either for all ***PRINETO*** dimensions of distribution pipe, using tee pieces with outlets with an internal thread and thread transitions.

Open space heating/frost inhibitor

Since ***PRINETO*** surface heating pipes can be installed in the ground, they are also suitable for heating the ground outdoors.

Thus the ***PRINETO*** system can keep drives, entrances, ramps or sports fields free of ice and snow. This means football pitches can be played on all year round, the risk of slipping accidents in entrance areas is reduced and the dirt brought into a building can be kept to a minimum.

Where open spaces are heated, a distinction is made between two modes of operation. On the one hand, it must be clarified whether the area is to be kept free of ice and snow permanently, or only at certain times when there is a need for heat. In addition, the question of the temperature down to which the ground is to remain ice-free and how much snow should if necessary be thawed has to be answered.

In the case of permanent freeing from ice and snow, the storage power of the ground helps to keep the temperature higher for short periods when there are extreme temperatures.

If an area is only to be kept free of ice at certain times, the power also depends on how long the ground is allowed to heat up and how much snow might have to be thawed. In order to take extreme cases into consideration, a power of more than 250 W/m^2 at times must be assumed.

It is often sufficient to consider snow clearance up to –7°C, since it seldom snows at temperatures lower than this. It is dangerous around car washes, though, since water flows onto the ground here at very low temperatures. Dimensioning should aim to achieve a surface temperature of around 3°C.

Draining should be taken into account with large surfaces in particular so as to enable the melted water to flow off better and not flow into the colder edge area. In addition, waterproof heat insulation under the pipes helps to minimise heat losses.

Pipes with larger diameters are particularly suitable for heating open spaces. This is due to the fact that a mixture of water and anti-freeze agent is routed through the pipes for safety reasons; this has a greater viscosity and lower thermal power. This leads to greater pressure loss in the pipe. For this reason, ***PRINETO*** surface heating pipes 20 x 2.0 and 25 x 2.3 are particularly suitable.

The pipes are laid in a layer of sand or fine soil. Any larger stones which could damage the pipe must be removed from the vicinity. The pipes are attached using the fixing rails in dimensions 20 or 25. Quite often, however, reinforcement mats are placed on a layer of sand, and the pipe is fixed to these using ***PRINETO*** binding wire (art.-no.: 878 386 216) and the ***PRINETO*** cordless wire binder (art.-no.: 878 386 215). To make installation easier, there is an extension available for the wire binder (art.-no.: 878 386 218).

The ***PRINETO*** industrial manifolds 2" with attached control valves or flow meters (depending on the pipe dimension) are used to distribute the heating circuits. The connection of the heating circuits according to Tichelmann is no problem either for all ***PRINETO*** dimensions of distribution pipe, using tee pieces with outlets with an internal thread and thread transitions.

A further application for ***PRINETO*** pipes outdoors is their use as solo pipes for heating with a heating pump. In contrast to heating open spaces, however, these should absorb heat. The same specifications apply for the application as solo pipe as for heating open spaces.

CAUTION

Suitable measures must be taken to protect the installed fittings from ground humidity.

It is necessary to separate the system from heat supply. All materials used outside should be as resistant as possible to corrosion.

Notes

PRINETO compressed air installations

General basics

The ***PRINETO*** pipe system is also suitable for conveying compressed air. When compressed air pipes are laid surface-mounted (and whenever vacuum pipes are required), multilayer composite pipes should be used, since they protect the PE-X inliners from damaging UV rays and are extremely dimensionally stable. The compressed air quality must correspond to quality class 1 to 4 according to BS ISO 8573. The quality class of the compressed air is not influenced by the pipe.

The permissible operating pressures for ***PRINETO*** PE-X or multilayer composite pipes for compressed air follow DIN 16893 Table 5 Pipe Series S 3.2 depending on operating temperature and service life. These values include a safety factor of 1.5 (pressure reserve up to maximum permissible operating pressure).

20°C – 50 years – 20 bar
50°C – 50 years – 14 bar
70°C – 50 years – 11 bar

The conveyance of inert gases such as nitrogen or argon is also possible.

Quality class ISO 8573.1	Solids		Water content max. dew point [°C]	Water content max. dew point [mg/m³]
	max. particle size [µm]	max. particle concentration [mg/m³]		
1	0.1	0.1	–70	0.01
2	1	1	–40	0.1
3	5	5	–20	1
4	15	8	3	5
5	40	10	10	25

Acc. to Ruppelt: Compressed air manual, 3rd edition, p. 169–171

Compressed air as an energy source

In industry and workshop applications, compressed air is used as an energy source for drive and control technologies as well as for cleaning purposes. Compressed air is generated by a central compressor and then distributed via a pipework system to the tapping points (e.g. blow and spray guns, impact screwdrivers, pneumatic cylinders, drilling and sanding machines...).

The air should be transported with as little loss as possible in order to avoid high energy costs. As little as 1 bar additional pressure loss increases the costs for installed electric power by approx. 10 %[1].

Pressure losses can be caused on the one hand by rough pipe inner walls. With a roughness of 0.007 m, the IVT PE-X multilayer composite pipe is considered a technically smooth pipe. On the other hand, pressure can drop due to leaks in the pipe. Even the tiniest of holes cause energy costs for the compressed air system to increase sharply. The IVT multilayer composite pipe is so tight that there will be no pressure loss.

[1] Acc. to Ruppelt: Compressed air manual, 3rd edition, p. 279

Dimensioning

The following data are required for the correct dimensioning of the system; they are described in more detail below: nominal length, air volume flow, operating pressure, pressure drop and pipe diameter.

Nominal length

The nominal length is of fundamental significance for dimensioning. It includes the length of the respective pipe, which in turn results from the geometry of the planned system, in other words the distance from the compressor to the consumer, for example.

Fittings such as angles or tee pieces cause additional resistance. In order to estimate the nominal length roughly, these fittings can be considered as 50% additional pipe length.[1] If the nominal length is to be calculated more exactly, these fittings are assigned substitute lengths which are then added to the pipe length in order to determine the nominal length.
The following table provides an overview of the most important fittings and their respective substitute lengths (in m). Since the pipe dimension is also required for calculation of the equivalent pipe lengths, the pipe diameter must be determined roughly without fittings first. Then the result is checked with substitute length and corrected if necessary.

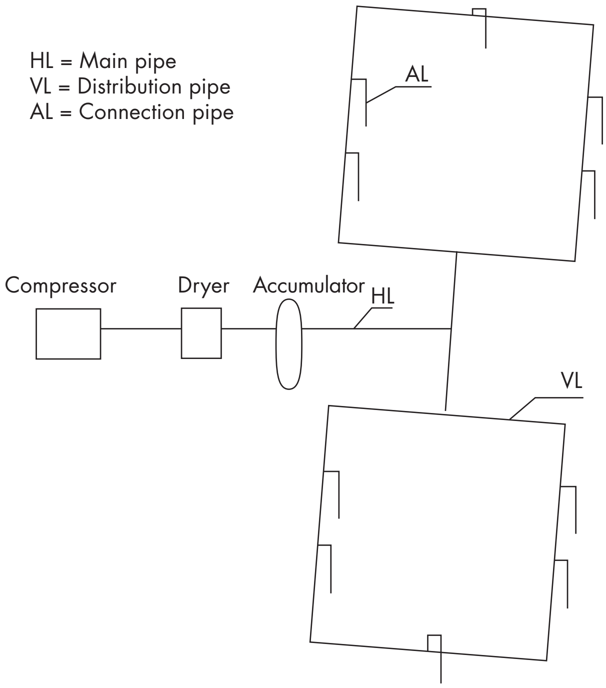


Fig. 1: Diagram showing the systematic laying of compressed air pipes

Multilayer composite pipe	Angle 90°	Angle 45°	Tee passage	Tee outlet	Reduction
16	0.4 m	0.2 m	0.2 m	0.5 m	0.2 m
20	0.6 m	0.3 m	0.2 m	0.7 m	0.3 m
25	0.7 m	0.4 m	0.3 m	0.9 m	0.4 m
32	1.0 m	0.6 m	0.4 m	1.3 m	0.6 m
40	1.5 m	0.9 m	0.7 m	2.0 m	0.9 m
50	2.0 m	1.2 m	0.9 m	2.6 m	1.2 m
63	2.7 m	1.5 m	1.2 m	3.5 m	1.5 m

Reference values for determining the equivalent pipe length

[1] Acc. to Ruppelt: Compressed air manual, 3rd edition, p. 287

Dimensioning

Volume flow

One crucial factor for the pipe diameter is air volume flow. This defines how many litres of air are available per second at the end of the pipe (under normal conditions, i.e. a pressure of 1013.25 hPa). The air requirements of some typical tools are listed in the adjacent table.

The volume flow required is calculated from the sum of the consumption values of all the connected devices.

Tool	Air consumption in l/s
Blow gun	2 – 5
Spray gun	2 – 7
Orbital sander	4 – 7
Drill	9 – 30
Impact screwdriver	2 – 35
Sanding machine	5 – 20

Operating pressure

The operating pressure chosen for the system should be as low as possible, depending on the pressure provided by the compressor or the pressure required by the devices. The normal value is between 6 and 8 bar. The IVT multilayer composite pipe has been tested up to 10 bar.

Pressure drop

Pressure in the pipes falls as the length of pipelines increases. Since the air – like water or other media – is conveyed at high speed through the pipe, it causes turbulence and corresponding friction inside. In principle, the higher the pressure and the smaller the internal diameter of the pipe are, the more the pressure drop per metre will be.

Dimensioning

Pipe diameter

A few basics must be considered when choosing the right pipe diameter.

The pressure per metre falls less quickly in a thick pipe, in other words a greater volume of air can be transported. However, the pipe should not be over-dimensioned either in order to avoid unnecessary material costs.

A pipeline network is divided into main pipes, distribution pipes, connection pipes and accessory parts. The pressure loss in the whole pipe should not exceed 0.1 bar. The pressure drop in the individual pipe sections should not for example exceed the following values:

Main pipes:	0.03 bar
Distribution pipes:	0.04 bar
Connection pipes	0.03 bar
Accessory parts:	0.03 to 0.9 bar

In total the pressure drop should not exceed 1 bar, particularly when energy costs are considered.

The internal diameter d can be calculated approximately as follows:

$$d\ [m] = \sqrt[5]{\frac{4.51 \cdot 10^{-13} \cdot \text{Volume flow}\ [l/s]^{1{,}85} \cdot \text{Nominal length}\ [m]}{\text{Pressure loss}\ [bar] \cdot \text{Operating pressure}\ [bar]}}$$

With ring piping (like the distribution pipes in Fig. 1 on p. 302), half the length of the ring system and half the volume flow of all consumers are used for the nominal length.

The tables on the following pages can be used for approximate pipe dimensioning (prepared by using the above equation).

Dimensioning

For main pipes:
Operating pressure 6 bar, pressure drop 0.03 bar

Volume flow in [l/s]	Nominal length in m													
	10	20	25	40	60	80	100	150	200	250	300	400	500	1000
5	20	25	25	32	32	32	32	40	40	40	40	40	40	50
10	25	32	32	40	40	40	40	40	40	50	50	50	50	63
20	32	40	40	40	40	50	50	50	63	63	63	63	63	>63
30	40	40	40	50	50	50	63	63	63	63	>63	>63	>63	>63
40	40	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63
50	40	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63
70	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
100	50	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
150	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
200	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
	Multilayer composite pipe size													

Operating pressure 8 bar, pressure drop 0.03 bar

Volume flow in [l/s]	Nominal length in m													
	10	20	25	40	60	80	100	150	200	250	300	400	500	1000
5	20	25	25	25	32	32	32	32	40	40	40	40	40	40
10	25	32	32	32	40	40	40	40	40	40	50	50	50	63
20	32	40	40	40	40	40	50	50	50	63	63	63	63	>63
30	40	40	40	50	50	50	50	63	63	63	63	>63	>63	>63
40	40	40	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63
50	40	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63
70	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63
100	50	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
150	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
200	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
	Multilayer composite pipe size													

Operating pressure 10 bar, pressure drop 0.03 bar

Volume flow in [l/s]	Nominal length in m													
	10	20	25	40	60	80	100	150	200	250	300	400	500	1000
5	20	20	25	25	25	32	32	32	32	40	40	40	40	40
10	25	32	32	32	32	40	40	40	40	40	40	50	50	50
20	32	40	40	40	40	40	40	50	50	50	63	63	63	>63
30	40	40	40	40	50	50	50	63	63	63	63	63	>63	>63
40	40	40	40	50	50	50	63	63	63	>63	>63	>63	>63	>63
50	40	50	50	50	63	63	63	63	>63	>63	>63	>63	>63	>63
70	40	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63
100	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
150	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
200	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
	Multilayer composite pipe size													

Dimensioning

For distribution pipes:
Operating pressure 6 bar, pressure drop 0.04 bar

Volume flow in [l/s]	Nominal length in m														
	10	15	20	25	40	60	80	100	150	200	250	300	400	500	1000
5	20	20	25	25	25	32	32	32	32	40	40	40	40	40	40
10	25	32	32	32	32	40	40	40	40	40	40	50	50	50	63
20	32	40	40	40	40	40	40	50	50	50	63	63	63	63	>63
30	40	40	40	40	50	50	50	50	63	63	63	63	>63	>63	>63
40	40	40	40	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63
50	40	50	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63
70	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63
100	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
150	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
200	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
	Multilayer composite pipe size														

Operating pressure 8 bar, pressure drop 0.04 bar

Volume flow in [l/s]	Nominal length in m														
	10	15	20	25	40	60	80	100	150	200	250	300	400	500	1000
5	20	20	20	25	25	25	32	32	32	32	40	40	40	40	40
10	25	25	32	32	32	32	40	40	40	40	40	40	50	50	50
20	32	32	40	40	40	40	40	40	50	50	50	50	63	63	>63
30	40	40	40	40	40	50	50	50	50	63	63	63	63	>63	>63
40	40	40	40	40	50	50	50	63	63	63	63	>63	>63	>63	>63
50	40	40	50	50	50	63	63	63	63	>63	>63	>63	>63	>63	>63
70	40	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63
100	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
150	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
200	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
	Multilayer composite pipe size														

Operating pressure 10 bar, pressure drop 0.04 bar

Volume flow in [l/s]	Nominal length in m														
	10	15	20	25	40	60	80	100	150	200	250	300	400	500	1000
5	20	20	20	20	25	25	25	32	32	32	32	32	40	40	40
10	25	25	25	32	32	32	32	40	40	40	40	40	40	50	50
20	32	32	32	40	40	40	40	40	50	50	50	50	63	63	63
30	32	40	40	40	40	40	50	50	50	63	63	63	63	63	>63
40	40	40	40	40	50	50	50	50	63	63	63	63	>63	>63	>63
50	40	40	40	50	50	50	63	63	63	63	>63	>63	>63	>63	>63
70	40	50	50	50	63	63	63	63	>63	>63	>63	>63	>63	>63	>63
100	50	50	50	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63
150	63	63	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
200	63	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
250	63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63	>63
	Multilayer composite pipe size														

Notes