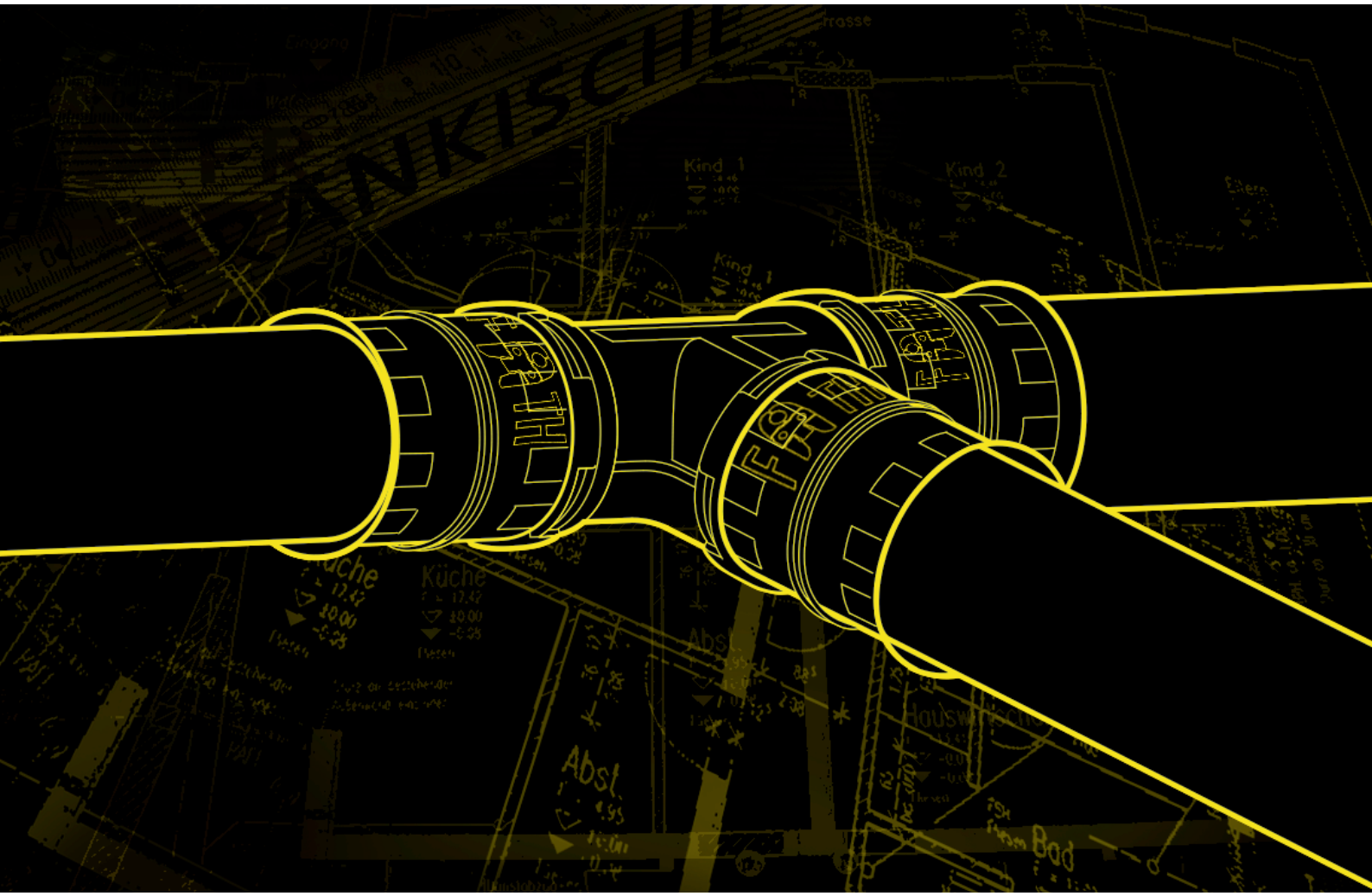
FRÄNKISCHE

Technical Information

alpex-duo® XS



Drinking water and heating installations

Building technology
www.fraenkische.com

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1. System description

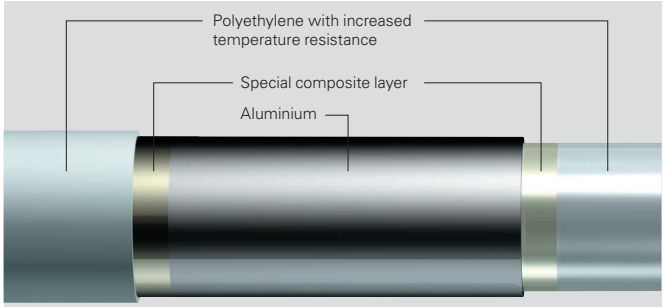
alpex – high-quality multilayer composite pipes

The high-quality alpex multilayer composite pipe for drinking water and heating installations consists of three layers: inside and outside layers of polyethylene and a core of flexible butt-welded aluminium. The three layers are connected with special composite layers to form a single durable product that satisfies highest demands and offers outstanding functionality and extreme durability. The butt-welding production process ensures that the aluminium layer has a consistent thickness across the entire pipe, meaning that the same forces apply everywhere upon bending of the pipe and the seam holds perfectly even under high stresses.

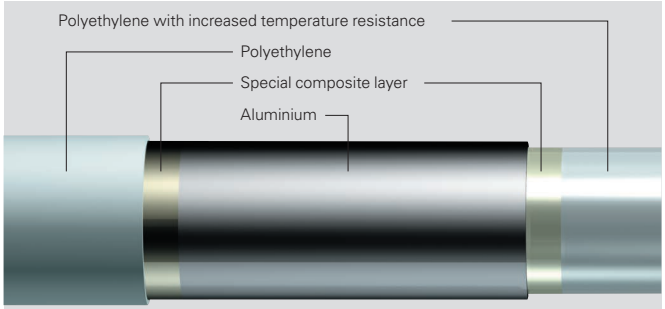
Clean and correct planning and installation of the pipes is of utmost importance for drinking water hygiene. The pipes are delivered with end caps to protect against bacteria and other contamination and to ensure safe use in drinking water installations. All alpex multilayer composite pipes are food-safe and completely free of physiological risks, in other words, the material has no effect whatsoever on the human body.

In addition, all alpex multilayer composite pipes are 100 % impermeable to oxygen, which is particularly important for heating pipe installations.

alpex multilayer composite pipes can be delivered as coiled or straight pipes. The coiled pipe is available in various lengths from 50 to 600 m. The alpex multilayer composite pipe for drinking water installations complies with the requirements and operating conditions according to DIN EN ISO 21003 and is certified according to DVGW.



turatec 16 – 32 mm

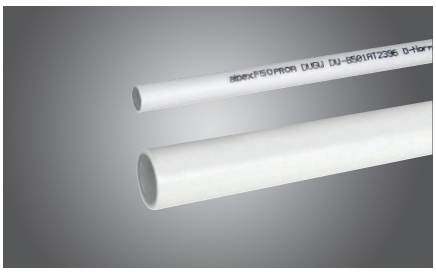


alpex-duo XS 16 – 32 mm
alpex L 40 – 75 mm

alpex-duo XS / turatec multi pipes

The various alpex-duo XS composite pipe designs with internally cross-linked materials and a butt-welded aluminium core (PE-X/AL/PE-RT) as well as turatec multi with materials heat-stabilised and a butt-welded aluminium core (PE-RT/AL/PE-RT) are of utmost quality, flexible and practice-oriented. A combination that ensures ideal processing and superior operational reliability. Whether as flexible coiled pipes, robust straight lengths, pre-insulated composite pipes, or pipes in conduits – installation is easy and time-saving!

- Corrosion resistance
- Good compatibility with other materials
- High chemical resistance
- 100 % impermeable to oxygen
- Favourable flow properties
- Low thermal linear expansion, comparable with copper



alpex L pipe

The high-quality composite pipe consists of a cross-linked polyethylene inside, a butt-welded aluminium core, and a heat-stabilised polyethylene outside. The three layers are connected with a special adhesion agent to form a single durable product.

- Good compatibility with other materials
- High chemical resistance
- 100 % impermeable to oxygen
- Low thermal linear expansion, comparable with copper
- Impervious to encrustation and sediment

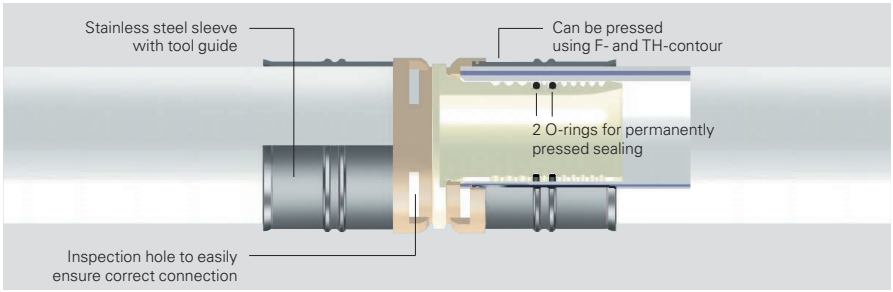
1. System description

alpex – high-quality fittings

alpex-duo XS fitting

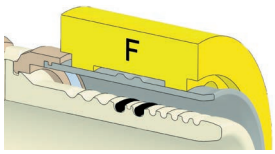
alpex-duo XS fittings provide specialists with a suitable solution for every installation situation. The ingenious fitting design and comprehensive selection in dimensions between 16 and 32 mm ensure highest flexibility in terms of processing options.

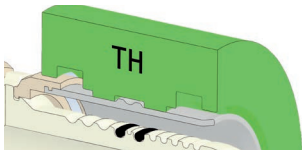
- Flow-optimised: 30 per cent larger cross-sectional surface
- Press jaw flexibility: 1 fitting – 2 possible crimping contours
- Leak function
- Superior materials:
- Fittings manufactured from high-performance PPSU plastic or dezincification-resistant lead-free brass CW724R
- Large inspection holes for verifying correct positioning

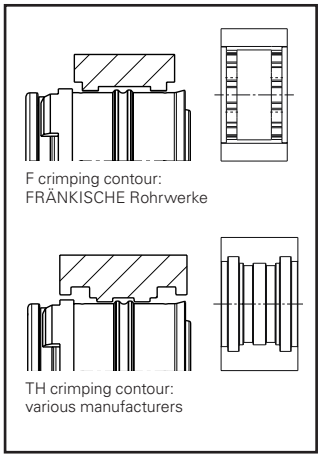


Your press jaw fits

With alpex-duo XS, FRÄNKISCHE offers the innovative advantage of 2 possible crimping contours. All alpex-duo XS fittings can be pressed using the F-contour and the TH-contour – using all common and approved pressing tools. A clear advantage for the installer, who, in most cases, does not need to purchase new tools.







Easy installation

1. Cut the pipe to length using a pipe cutter to ensure a cut at a right angle.

2. If required, deburr the pipe end using the alpex installation aid.

3. Fix the fitting by inserting the base body into the pipe end. Verify through the inspection hole in the fixation ring.

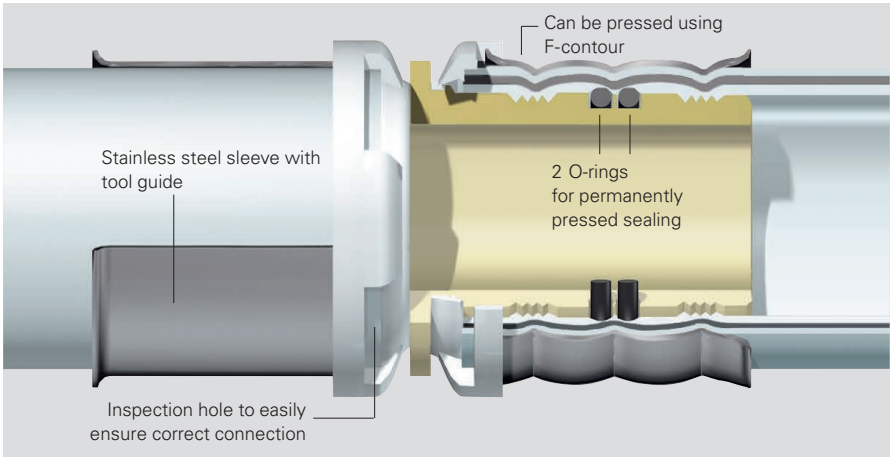
4. Press pipe and fitting using the pressing tool.

1. System description

alpex L fitting

alpex L fittings are made of high-performance PPSU or dezincification-resistant brass and are equipped with pre-assembled stainless steel sleeves. The four dimensions from 40 to 75 mm can be pressed quickly and easily using the alpex press jaw with F-contour.

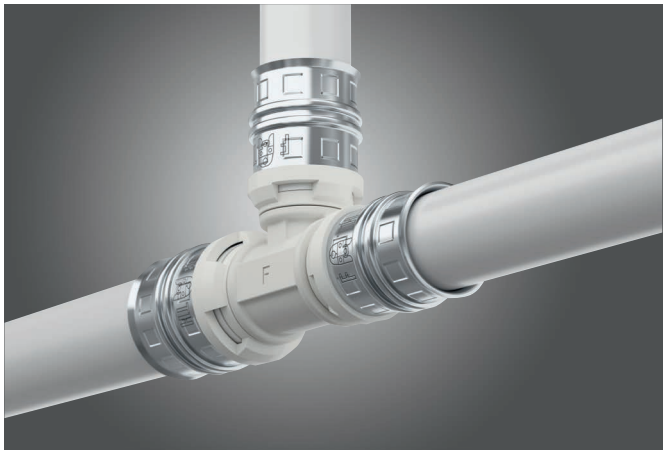
- Flow-optimised
- Fittings made of PPSU and dezincification-resistant brass
- Twice the safety due to two O-rings
- Easy visual inspection of the insertion depth due to extra-large inspection holes
- Leak function according to DIN EN ISO 21003



Controlled safety with leak function of 16–75 mm

In addition to the high-quality materials, both alpex-duo XS and alpex L fittings are even more reliable thanks to their smart processing. Thanks to the required pressure test after installation, due to the leak function, the user can immediately determine where a fitting has not been pressed, and subsequently fix the leak.

The press connectors are leaking if left unpressed according to DIN EN ISO 21003. The pressure test can be carried out using water or compressed air and is a two-step process for all alpex connectors. Firstly, the installation is tested for leak-tightness and secondly for strength.



1. System description

alpex range of fittings – hygienically impeccable drinking water installations

To ensure the best conditions for hygienically impeccable drinking water installations, FRÄNKISCHE offers looping options for serial and loop connections with its proven double wall mount elbows and the F-dual connections.

alpex double wall mount elbow

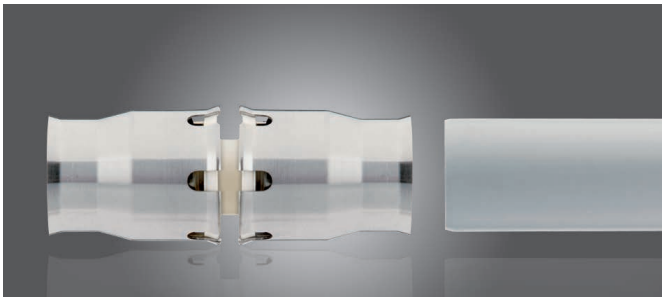
alpex F-dual connection

alpex-plus fitting – superior quality

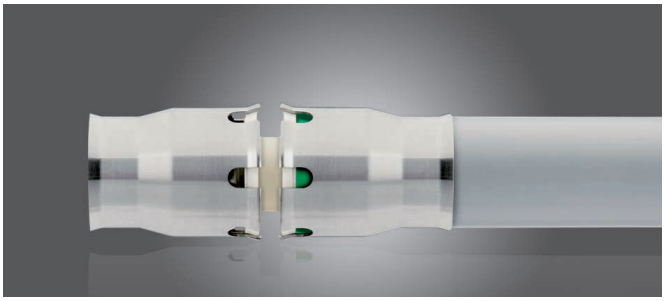
The base body of the alpex-plus fittings is made of high-performance PPSU (polyphenylsulphone), a material which has been tested in space and offers extremely good impact strength while being entirely non-toxic.

Threaded adapters with base bodies made of dezincification-resistant brass complete the product range. FRÄNKISCHE uses stainless steel for the sleeve and the fastening element, which makes alpex-plus particularly suited for heavy-duty applications.

- Ideal for narrow and confined construction site situations
- Green indicator for verifying correct positioning
- Time- and cost-saving due to fewer processing steps
- Easy to insulate due to its slim design
- Universal fittings for drinking water and heating installations
- 16 mm and 20 mm dimensions can be released prior to pressure testing and can be reused



The innovative indicator allows …



…to verify whether the pipe has been completely inserted.

1. System description

Controlled safety

In addition to the DVGW approval, all FRÄNKISCHE alpex system components, of course, feature a 10-year certificate.

Advantages of alpex at a glance:

HYGIENIC SAFETY

DURABILITY

SUPERIOR MATERIAL QUALITY

WIDE RANGE OF PRODUCTS

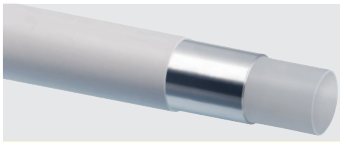
SYSTEM COMPATIBILITY

IMPERVIOUS TO ENCRUSTATION

COMPLIANCE WITH GERMAN ENVIRONMENT AGENCY / DRINKING WATER ORDINANCE

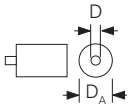
2. Technical data

Multilayer composite pipe



Type		alpex-duo XS				alpex L				turatec			
DN		12	15	20	25	32	40	50	65	12	15	20	25
Dimension [mm]		16x2.0	20x2.0	26x3.0	32x3.0	40x3.5	50x4.0	63x4.5	75x5.0	16x2.0	20x2.0	26x3.0	32x3.0
Inside diameter [mm]		12	16	20	26	33	42	54	65	12	16	20	26
Pipe weight [g/m]		112	154	294	404	583	879	1321	1600	112	154	294	404
Water content [litres/m]		0.113	0.201	0.314	0.531	0.855	1.385	2.29	3.316	0.113	0.201	0.314	0.531
Material		PE-X/AL/PE-RT								PE-RT / AL / PE-RT			
Pipe roughness [mm]		0.007											
Permanent operating temperature [°C]		Max. 95								Max. 70			
Operating pressure [bar]		Max. 10											
Material class DIN EN 13501-1		E											
Thermal conductivity [W/(m·K)]		0.45											
Expansion [mm/m·K]		0.026											
Min. bend radius [mm]	– without bending tool	80	100							80	100		
	– with bending spring	32	60							32	60		
	– with bending tool	55	79	88	128	160	200	252	–	55	79	88	128
	– with bending tool 79100630	32	40							32	40		

Pre-insulated



Dim	D_o	D	h	Material	Weight	Thermal conductivity	Material class DIN EN 13501-1
	[mm]	[mm]	[mm]		[g/m]	[W/(m·K)]	
16×2 9 mm insulation	36	16		Flexible PE foam with high-resistance protective film	151	0.040	E
20×2 9 mm insulation	40	20			201	0.040	E
16×2 13 mm insulation - 50 %	44	16			161	0.040	E
20×2 13 mm insulation - 50 %	48	20			214	0.040	E
26×3 13 mm insulation - 50 %	54	26			345	0.040	E

Conduit

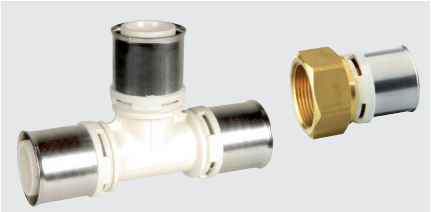
DN	19	23	28
Outside diameter/inside diameter [mm]	24/19	28/23	35/28
Material	PE-HD		
Thermal conductivity [W/(m·K)]	0.45		

2. Technical data

alpex-duo XS – connectors

DN		12	15	20	25
Dimension [mm]		16×2.0	20×2.0	26×3.0	32×3.0
Threadless connector material		Polyphenylsulphone (PPSU)			
Threaded connector material		Dezincification-resistant brass CW 724R			
Material class		E acc. to DIN EN 13501-1			
Pressing sleeve / sealing element		Stainless steel / EPDM			
Crimping contour		F – TH			
Leak function acc. to DIN EN ISO 21003		Yes			
Female thread / male thread	R / Rp	DIN EN 10226-1			
Connection thread	G	DIN EN ISO 228-1			

alpex L – connectors



DN		32	40	50	65
Dimension [mm]		40×3.5	50×4.0	63×4.5	75×5.0
Threadless connector material		Polyphenylsulphone (PPSU) Dezincification-resistant brass (dim. 75 mm)			
Threaded connector material		Dezincification-resistant brass CC 770S			
Material class		E acc. to DIN EN 13501-1			
Pressing sleeve / sealing element		Stainless steel / EPDM			
Crimping contour		F			
Leak function acc. to DIN EN ISO 21003		Yes			
Female thread / male thread	R / Rp	DIN EN 10226-1			
Connection thread	G	DIN EN ISO 228-1			

alpex-plus – connectors

DN		12	15	20
Dimension [mm]		16×2.0	20×2.0	26×3.0
Threadless connector material		Polyphenylsulphone (PPSU)		
Threaded connector material		Dezincification-resistant brass CW 724R / CC 770S		
Material class		E acc. to DIN EN 13501-1		
Sleeve / fastening element / sealing element		Stainless steel / EPDM		
Leak function acc. to DIN EN ISO 21003		No/green indicator as insertion check		
Speciality		Can be easily removed during installation 16×2.0 and 20×2.0 mm without being damaged; fitting can be reused		
Female thread / male thread	R / Rp	DIN EN 10226-1		
Connection thread	G	DIN EN ISO 228-1		

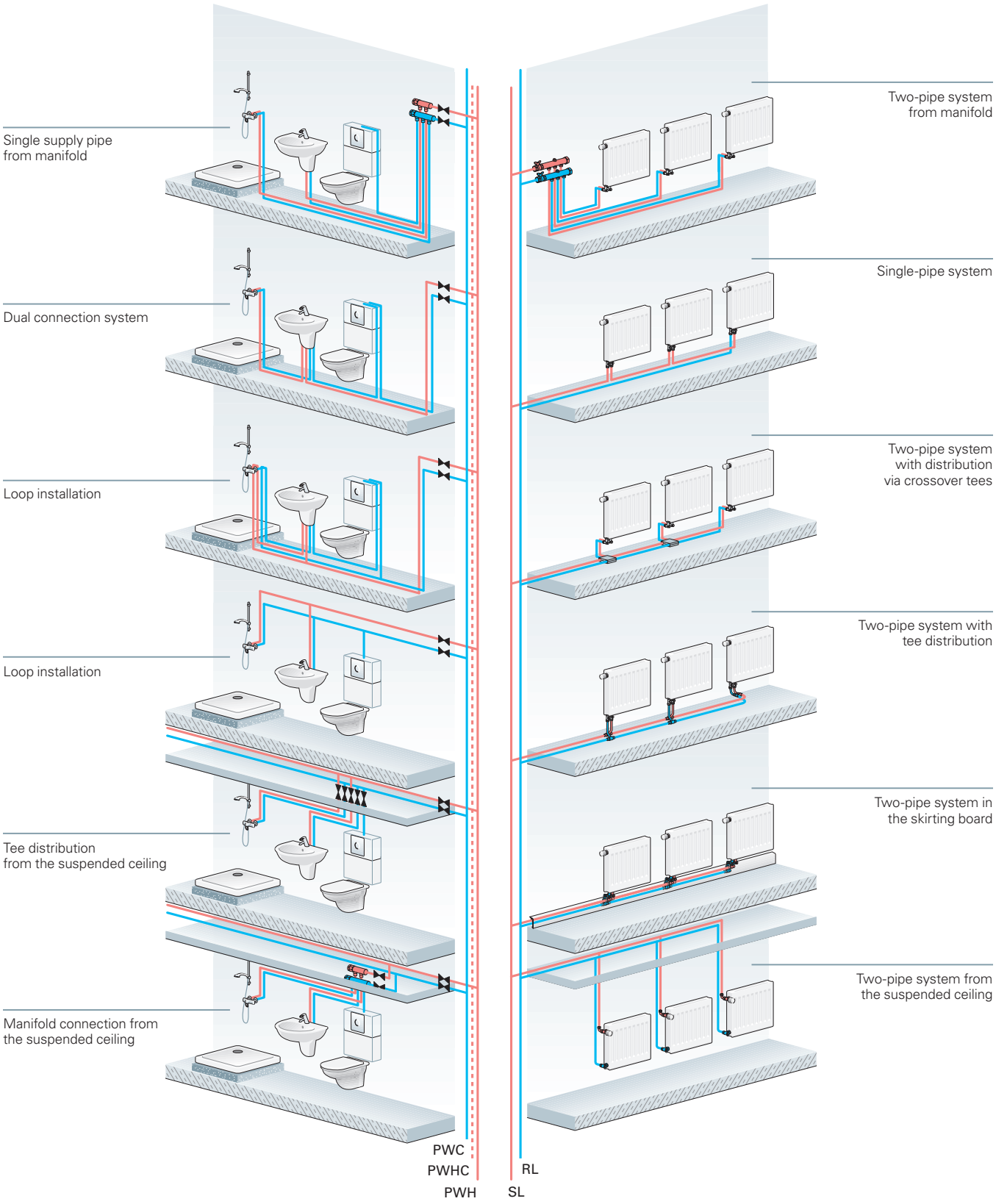
3. Application

Areas	Building technologies as well as industrial applications
Dimensions	alpex-duo XS: 16×2; 20×2; 26×3; 32×3 alpex-plus: 16×2; 20×2; 26×3 alpex L: 40×3.5; 50×4; 63×4.5; 75×5
Pipe structure	Polyethylene multilayer composite pipes with butt-welded aluminium layer alpex-duo XS made of PE-X/AL/PE-RT, turatec multi made of PE-RT/AL/PE-RT alpex L made of PE-X/AL/PE-RT
Drinking water	As drinking water pipe for cold and hot water, alpex satisfies all requirements for drinking water installations according to application class 2 pursuant to DIN EN ISO 21003 for hot water applications. The drinking water must comply with the currently valid limit values of the following regulations: DIN 2000 – German Drinking Water Ordinance – European Drinking Water Directive. Max. constant operating pressure is 10 bar at 95 °C operating temperature.*
Heating system	The alpex system can be used without limitations in heating applications as a heating pipe within the given capacity ratings. It is also suitable for radiant heating for heating installations according to application class 5 pursuant to DIN EN ISO 21003 for high-temperature applications and the aluminium core makes it absolutely oxygen-tight. System separation is required for district heating. Hot water according to VDI 2035. 95 °C max. temperature.
Stormwater	As a stormwater pipe up to the tapping point within buildings if the stormwater complies with the drinking water standard. Stormwater pH of larger than 6.
Compressed air	As a compressed air pipe in systems with upstream oil filter (oil-free) up to 12 bar operating pressure and max. 40 °C operating temperature, including for vacuum systems/suction pipes up to -0.8 bar.
Media	Anti-freeze agents without explosive properties as water glycol mixture with at least 35 per cent by volume, e.g., with Antifrogen N/L; Tyfocor N/L or Nalco 77336 provide frost protection up to approx. -20 °C. (see manufacturer's data sheet). Other media and applications upon request (e.g., disinfectant).
Installation in buildings	Suitable for installations within buildings as surface installation, concealed installation, riser and distribution pipe system, as well as for installation in pre-walls with prefabricated fixing devices or in concrete building elements. The fittings must be protected against ammonia or chloride compounds. alpex connections exhibit permanent seals and are therefore approved for concealed installations.
Installation outside buildings	The alpex system (pipes and fittings) must be protected against sustained, direct UV exposure (sunlight).
Installation	The optimal ambient temperature for proper installation is above 0 °C; however, installation is possible down to -20 °C. For installation temperatures below -10 °C, specific manufacturer instructions for pressing machines must be observed.
Threaded connections	The thread sealants used for the alpex system must be tested and approved for the respective application (e.g., DVGW-certified sealants). They must be used according to the specifications of the sealant manufacturer. Excessive use of hemp and excessive tightening of the threaded connection can lead to damage to the fittings.*
Material class	The alpex system corresponds to material class E according to DIN EN 13501-1.
Approval	alpex-duo XS/alpex-plus/alpex L: DVGW DW-8501BP0387 and DVGW DW-8501BP0388
Mixed installations	All FRÄNKISCHE alpex system components have been DVGW-certified and are perfectly matched. alpex system components must not be mixed in installations with system components by third-party manufacturers, i.e., alpex pipes must not be installed with third-party fittings and alpex fittings must not be installed with third-party pipes! Any claims based on the 10-year certificate can only be asserted if solely alpex components were used in the system during installation.

* for further information, please see page 14

4. General installation instructions

Overview



4. General installation instructions

Processing and installation is to be effected observing the applicable standards and directives as well as the manufacturer's installation instructions, and must generally be carried out by recognised experts. The alpex systems must be installed in compliance with the technical parameters and specifications for connection in accordance with our product descriptions and the instruction leaflet. Remove damaged areas and dents. Due to the variety of valid regulations, only the most important ones are listed here. The person carrying out the work must make sure that he/she is installing a system that complies at least with the valid accepted technical practices.

Accepted technical practices: In the Drinking Water Ordinance as well as in other laws and ordinances, reference is often made to the "accepted technical practices" (*allgemein anerkannte Regeln der Technik (a.a.R.d.T.)*). These include national standards and guidelines (DIN, DVGW, VDI) or international standards (EN, ISO) and leaflets of the relevant associations. When it comes to drinking water, high hygienic standards must be met in order to comply with the requirements of the Drinking Water Ordinance. The foodstuff drinking water must arrive at the points of consumption free of pathogens, fit for consumption and pure.

Laws and ordinances

- Buildings Energy Act (GEG)
- Building Products Act
- Accepted technical practices (a.a.R.d.T.)
- AVBWasserV – Ordinance on General Conditions for the Supply of Water
- Model Building Ordinance (MBO)

Standards and provisions

- DIN 1988 Drinking water supply systems
- DIN 4102 Fire protection
- DIN 4108 Thermal insulation
- DIN 4109 Sound insulation
- DIN EN 12502 Protection of metallic materials against corrosion
- DIN EN 13501 Fire classification of construction products and building elements
- DIN 4807 Expansion vessels
- DIN 50930 Requirements on metal materials
- DIN 18195 Water-proofing buildings
- DIN VDE 0100 Part 701 "Equipotential bonding"
- VDI 4100 Noise control in dwellings – Criteria for planning and assessment
- DIN EN 1717 Protection against pollution of potable water installations and general requirements of devices to prevent pollution by backflow
- VDI 6023 Hygiene for drinking water supply systems – Requirements for planning, design, operation and maintenance
- UBA Evaluation Criteria and Guidelines
- DIN EN 806 Specifications for installations inside buildings conveying water for human consumption (applies in parallel with DIN 1988)

Advisory leaflets and worksheets

- ZVSHK advisory leaflet "Rinsing drinking water installations"
- DVGW worksheet W551 "Drinking water heating and drinking water pipe installations" and W553 "Dimensioning of circulation systems in central drinking water heating systems"
- ZVSHK advisory leaflet "Leak Testing for Drinking Water Installations with Compressed Air, Inert Gas or Water"

Drinking Water Ordinance (TrinkwV) 2020 – important amendment/alterations

The updated Drinking Water Ordinance (TrinkwV) has been in force since 01 January 2020.

Reasons for the update are, for instance:
- Consideration of new scientific findings
- More precise adaptation to the EU directives
- Changes to regulations that have not proven themselves in practice

Excerpts of the most important amendments and alterations with regard to drinking water testing are listed below:

- § 6 Chemical limit values
- § 11 Treatment substances and disinfection procedures
- § 13 Obligation of the water supply system of large-scale systems for heating of drinking water to notify the competent health authority
- § 14 Obligation to examine large-scale systems for heating of drinking water in public and commercial buildings
- § 17 Requirements on systems for the production, treatment or distribution of drinking water

Note

For further information, the current Drinking Water Ordinance 2020 can be downloaded from the internet:
www.dvgw.de/wasser/recht-trinkwasserverordnung

4. General installation instructions

Limits of use of the alpex system

This ordinance transposes the European Drinking Water Directive into German law. This directive results in fundamental requirements for installation materials and the responsibility of the specialist trade and the specialist planner. The Drinking Water Ordinance, connected DIN 50930 Part 6 "Influencing the quality of drinking water", defines, among other things, the material and alloy components that can be used without restrictions in drinking water installations.

Requirements

Drinking water must be free of pathogens, fit for human consumption and pure. If this is not the case, a ban on the distribution of water can be imposed by the competent health authority. It is specifically defined that the limit values and requirements must be complied with at the consumer's tapping point.

Drinking water installations can be operated safely and hygienically over a long period of time if they are planned, built and operated at least in accordance with the accepted technical practices. However, it is a prerequisite that installers also know and observe these.

The most important European and national standards are DIN EN 806, DIN EN 1717, DIN 1988 and the accepted technical practices for planning and operation. The drinking water must comply with the currently valid limit values of the following regulations: DIN 2000, German Drinking Water Ordinance and European Drinking Water Directive.

The materials approved and used for drinking water installations comply with the current status of the UBA guidelines and standards and are particularly corrosion-resistant. DIN EN 12502-1 describes these factors that can influence corrosion behaviour. Nevertheless, regardless of the material used, it is possible that corrosion occurs in a drinking water installation in individual cases, even with permissible water qualities, due to different influencing factors.

During planning, execution and operation, care must be taken to ensure that corrosion is not promoted when the system is used properly. If water treatments are used, you must check whether this changes the corrosion-chemical behaviour of the water to such an extent that corrosion problems can occur with the installation materials used.

An assessment of the likelihood of corrosion due to water treatment should be checked in advance by the customer and the manufacturer of the water treatment system.

Limit values

The permissible limit values for all metals have changed with this new directive and have essentially been lowered again. In order to be able to exclude long-term impairments of the drinking water quality in the case of regionally varying water conditions, reductions in the alloy components were included in DIN 50930 Part 6 for fittings and pipe connectors, among other things.

Material selection

Plastics in the sense of the Foodstuffs and Consumer Goods Law can be used without restrictions. This is confirmed by the KTW recommendation of the Federal Ministry of Health. The KTW recommendation is part of a DVGW approval for drinking water installation systems. Brass, as a material which meets the requirements of DIN 50930 Part 6, can be used without restrictions in all drinking water systems.

Threaded connections

The thread sealants used for the alpex system must be tested and approved for the respective application (e.g., DVGW-certified sealants). They must be used according to the specifications of the sealant manufacturer. Threaded fittings may only be combined with matching standardised threads (e.g., DIN EN 10226-1 and ISO 7-1).
The threaded connection must be established before the press or push-fit connection so as to not stress the pipe connection. The threaded connections must be made professionally in accordance with the recognised rules of technology. Generally, no force may be used when processing alpex threaded fittings.

The following points must also be observed:

- Do not overpack the threaded connections (e.g., excessive use of hemp).
- Thread tips must still be visible.
- Avoid overtightening the threaded connection.
- Do not extend the lever arm of system tools, e.g., with pipes.
- Screw threaded connections together so that the end of the thread remains visible.
- Sealing materials must be free of media that cause stress corrosion cracking (e.g., compounds containing ammonia or chloride).

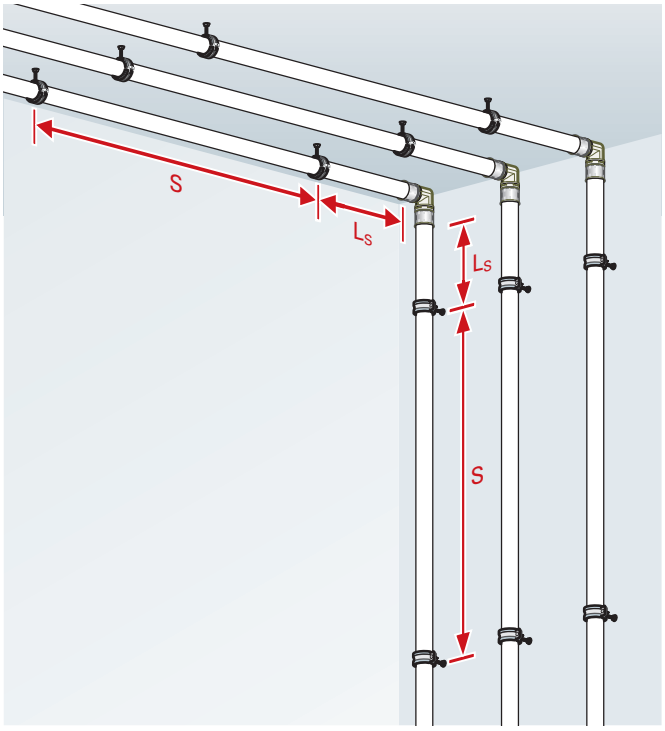
4.1 Spacing of fasteners and bend radii

Spacing of fasteners

Maximum spacing of fasteners "S" for surface installed alpex pipes:

DN	Pipe dimension [mm]	Maximum spacing of fasteners "S" [cm] horizontal	vertical	Pipe weight with water [kg/m]
12	16×2.0	120	150	0.225
15	20×2.0	135	150	0.355
20	26×3.0	150	175	0.608
25	32×3.0	165	200	0.935
32	40×3.5	200	200	1.438
40	50×4.0	250	250	2.264
50	63×4.5	250	250	3.611
63	75×5.0	250	250	4.916

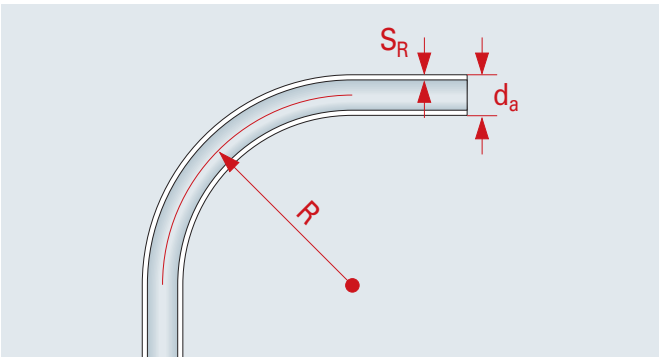
alpex pipes that are installed on a supporting substrate (bare concrete) must be fastened every 1.0 m. Pipe brackets, including sound insulation layer, must be used for the installation of alpex pipes on walls. The material of the sound insulation layer must be suitable for contact with plastic. For pre-wall installation, alpex pipes must be fastened to the appropriate support systems using the above pipe brackets. No binding wire or perforated tape must be used for fastening. **alpex connectors may only be used in straight pipe sections and must generally be installed stress-free.**



All pipes must be installed such that the change in length due to thermal influences is not impeded; see "Linear expansion".

Bend radii

The bending process must not result in indentations or deformation on the inside of the pipe bend. The PE outer layer of the alpex pipes must not be damaged.

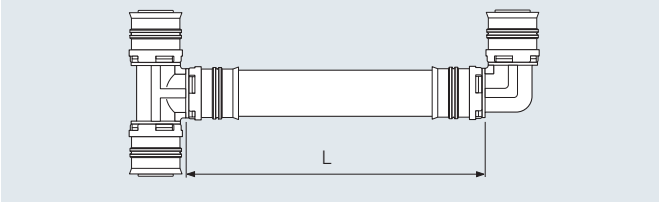


The minimum bend radii R (see figure on the left and table below) must be complied with. alpex connectors must not be used for pipe bending and must only be installed on the finished pipe bend.

Nominal width d_o × s [mm]	Bend radius R without aid [mm]	Bend radius R with bending spring [mm]	Bend radius R with bending tool [mm]
16×2.0	5×d_o - 80	3×d_o - 48	55
20×2.0	5×d_o - 100	3×d_o - 60	79
26×3.0			88
32×3.0			128
40×3.5			4.0×d_o - 160
50×4.0			4.0×d_o - 200
63×4.5			4.0×d_o - 252

Minimal installation lengths

alpex connectors may only be used in straight pipe sections and must generally be installed stress-free.

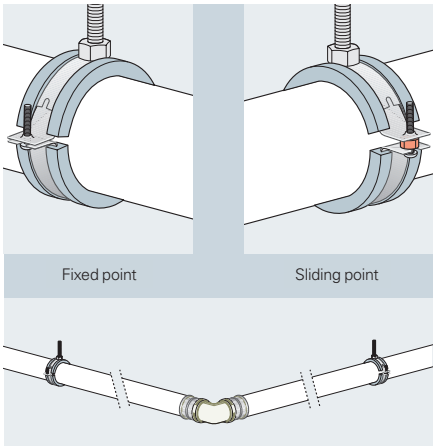


alpex pipe dimensions	Length L (mm)
16×2.0	60 mm
20×2.0	60 mm
26×3.0	70 mm
32×3.0	80 mm
40×3.5	100 mm
50×4.0	110 mm
63×4.5	120 mm
75×5.0	150 mm

4.2 Linear expansion and expansion bends

Linear expansion

Pipe fasteners both support the pipe network and accommodate temperature-related changes in length during operation. There are two types of pipe fasteners: fixed points (rigid fasteners) and sliding points that permit axial movements of the pipe. Pipes must be routed such that changes in length are not impaired. Sliding points must be located in such a way that they do not become fixed points during operation. Fixed points should not be located at press connections. In the case of long pipe sections, fixed points should be located in the middle of the pipe section in order to direct the expansion in two directions. It must be ensured that pipes in feed-throughs in walls and floors can expand as well. This can be provided through convenient placement of the riser pipes in the shaft, through a correspondingly large supply pipe, e.g., for the pipe branching off onto the floor, or through installation of an expansion bend.



Thermal linear expansion

Changes in pipe length result from warming and cooling. The coefficient of expansion for all alpex multilayer composite pipes is 0.026 mm/(m · K).

Example ~~Accessories~~

Temperature difference ΔT	50 K
Pipe length L	5 m
Coefficient of expansion α	0.026 mm/m · K
Linear expansion ΔL	6.5 mm

ΔL = α · L · ΔT
= 0.026 mm/m · K · 5 m · 50 K
= 6.5 mm

Pipe length L	Temperature difference ΔT [K]						
[m]	10	20	30	40	50	60	70
0.1	0.026	0.052	0.078	0.104	0.130	0.156	0.182
0.2	0.052	0.104	0.156	0.208	0.260	0.312	0.364
0.3	0.078	0.156	0.234	0.312	0.390	0.468	0.546
0.4	0.104	0.208	0.312	0.416	0.520	0.624	0.728
0.5	0.130	0.260	0.390	0.520	0.650	0.780	0.910
0.6	0.156	0.312	0.468	0.624	0.780	0.936	1.092
0.7	0.182	0.364	0.546	0.728	0.910	1.092	1.274
0.8	0.208	0.416	0.624	0.832	1.040	1.248	1.456
0.9	0.234	0.468	0.702	0.936	1.170	1.404	1.638
1.0	0.260	0.520	0.780	1.040	1.300	1.560	1.820
2.0	0.520	1.040	1.560	2.080	2.600	3.120	3.640
3.0	0.780	1.560	2.340	3.120	3.900	4.680	5.460
4.0	1.040	2.080	3.120	4.160	5.200	6.240	7.280
5.0	1.300	2.600	3.900	5.200	6.500	7.800	9.100
6.0	1.560	3.120	4.680	6.240	7.800	9.360	10.920
7.0	1.820	3.640	5.460	7.280	9.100	10.920	12.740
8.0	2.080	4.160	6.240	8.830	10.400	12.480	14.560
9.0	2.340	4.680	7.020	9.360	11.700	14.040	16.380
10.0	2.600	5.200	7.800	10.400	13.000	15.600	18.200

4.2 Linear expansion and expansion bends

Dimensioning of expansion bends

The vertical routing of alpex pipes in shafts and ducts depends on the available open space.

Expansion bends that are adapted to the various installation situations can compensate for thermal linear expansion.

Calculation formulas

Linear expansion

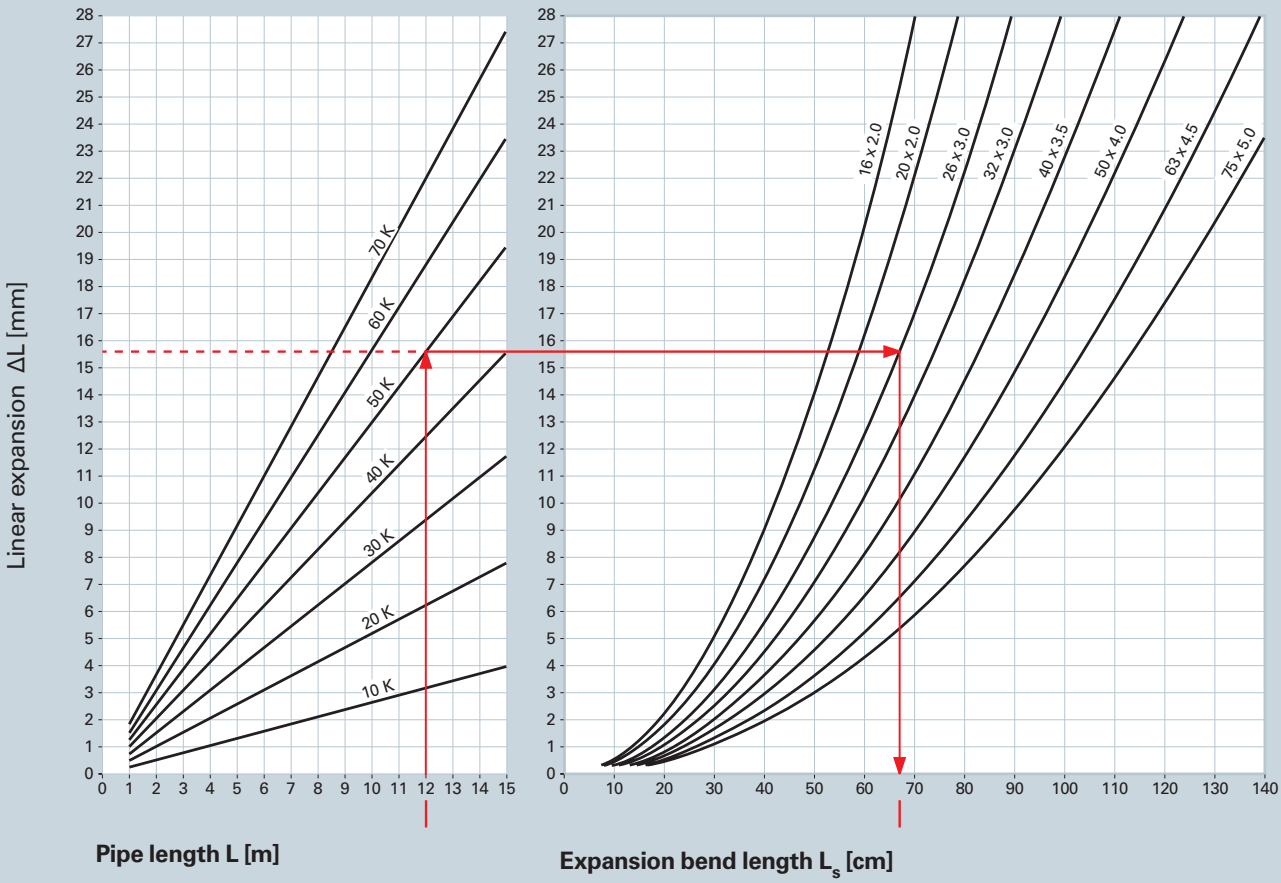
$$\Delta L = \alpha \cdot L \cdot \Delta T \quad [mm]$$

Length of the expansion bend

$$L_s = C \cdot \sqrt{d_o \cdot \Delta L} \quad [mm]$$

Legend

α	coefficient of expansion	[mm/m · K]
C	material-dependent constant for alpex pipes	[= 33]
d_o	pipe outside diameter	[mm]
L	pipe length	[m]
ΔL	linear expansion	[mm]
L_s	expansion bend length	[mm]
ΔT	temperature difference	[K]



Example

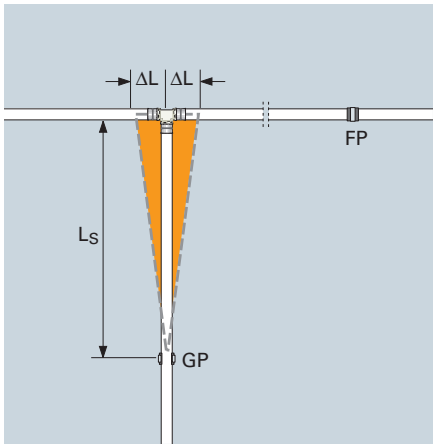
Pipe length L	12 m
Temperature difference ΔT	50 K
Pipe outside diameter d_o	26 mm

Solution

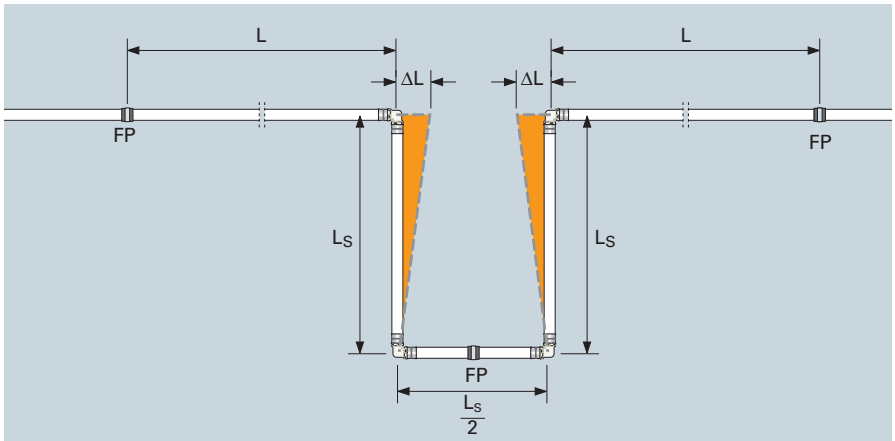
Linear expansion ΔL	15.6 mm
Expansion bend length L_s	66.5 cm

4.2 Linear expansion and expansion bends

Application examples



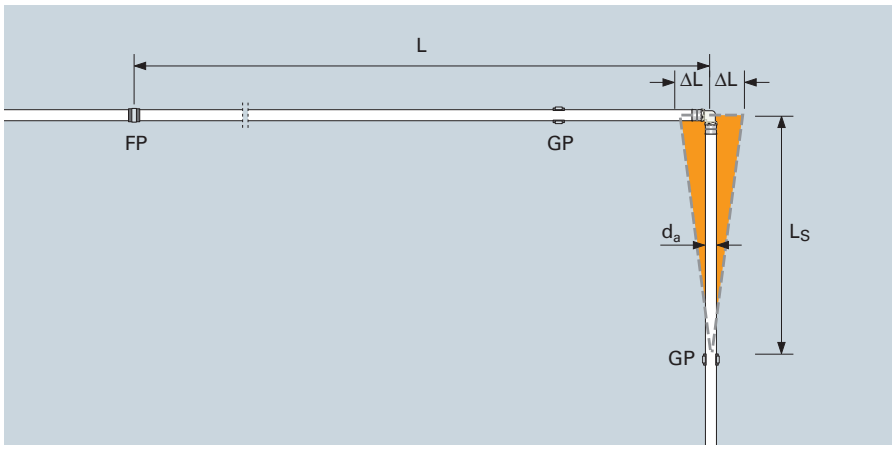
Compensation for length change with an expansion bend "L_S"



Compensation for length change using a U-shaped expansion bend

Legend

d_o	pipe outside diameter
FP	fixed point
GP	sliding point
L	pipe length
ΔL	linear expansion
L_s	expansion bend length

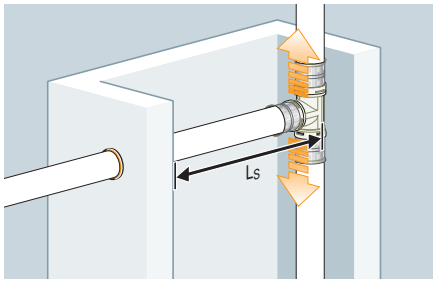


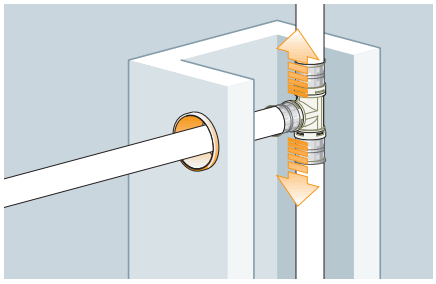
Compensation for length change using an expansion bend "L_S"

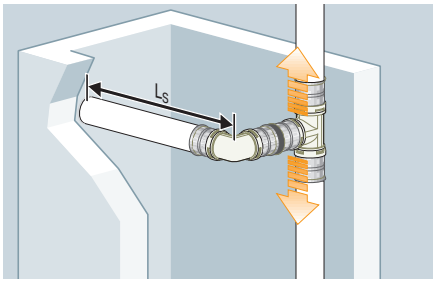
NB

alpex connectors must be installed without tension!

Compensation for length change using an expansion bend "L_S" in the riser pipe area





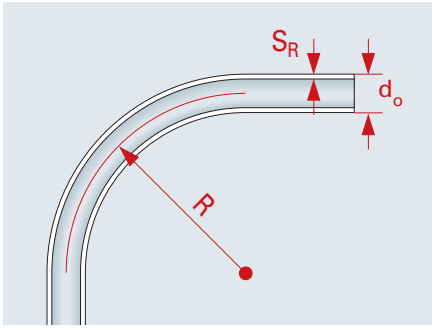


4.3 Pipe routing and installation

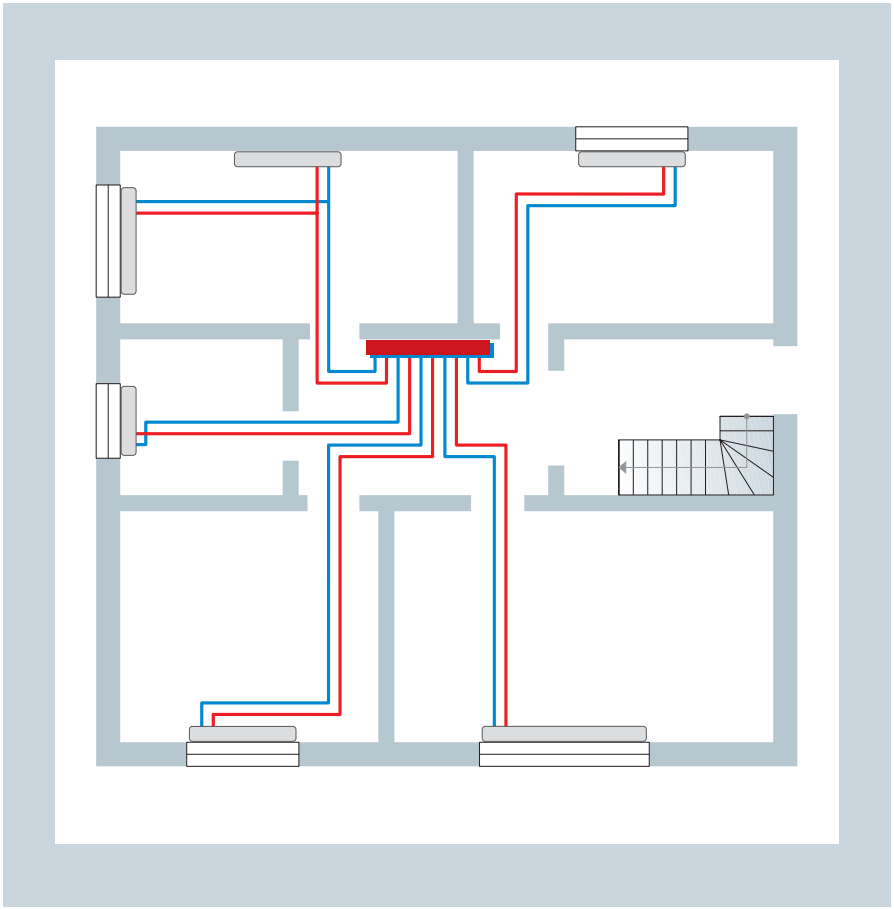
Pipe routing

Pipe routing on bare concrete

If possible, the pipes should be installed without crossovers, in straight lines as well as parallel to each other and the wall in accordance with the layout of the rooms. Any wall penetrations should be avoided when installing manifold connection pipes. It makes sense to plan the pipe routing through existing door openings depending on the layout of the rooms. This results in 90° angles for the installation of the pipe bends.
The bend radius of 5 × outside diameter must be observed when installing alpex pipes with appropriate sheathing and/or pre-insulated. Pipes shall be installed such that intersections in structural joints are avoided.



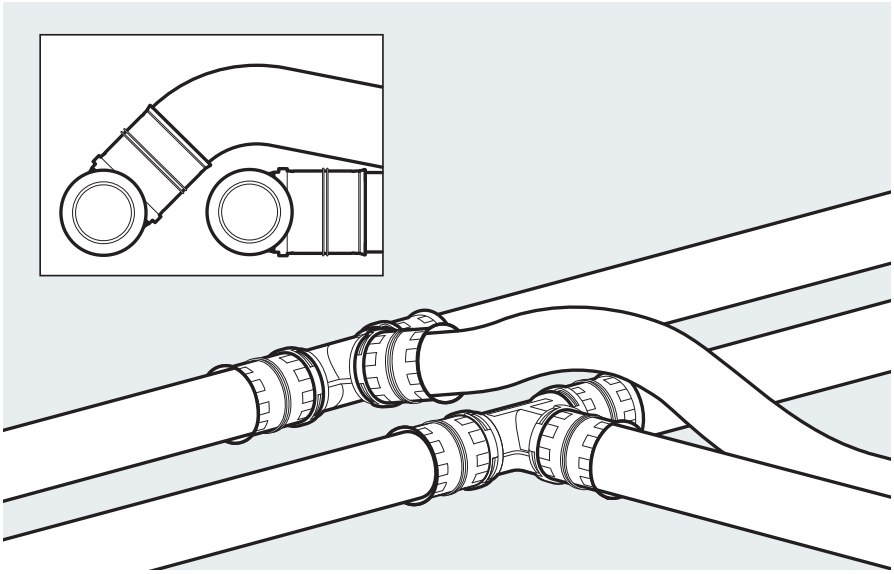
alpex bend radii



Floor plan with heating circuit routing

Pipe routing with pipe bridge

Particularly when routing pipes with pipe bridge, proper installation without tension is important. Pipe fastening must not impede thermal linear expansion.



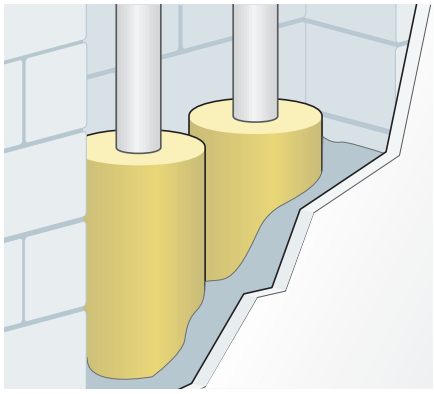
Tee installation with pipe bridge using alpex systems

4.3 Pipe routing and installation

Pipe installation

Pipes in walls

The DIN 1053 masonry standard must be observed when installing pipes in walls. The design of the pipe channels including the pipes with the respective insulation thickness affects the structural properties of the wall and is therefore crucial.
The GEG as amended must be complied with when installing pipes.



Pipes in the exterior wall

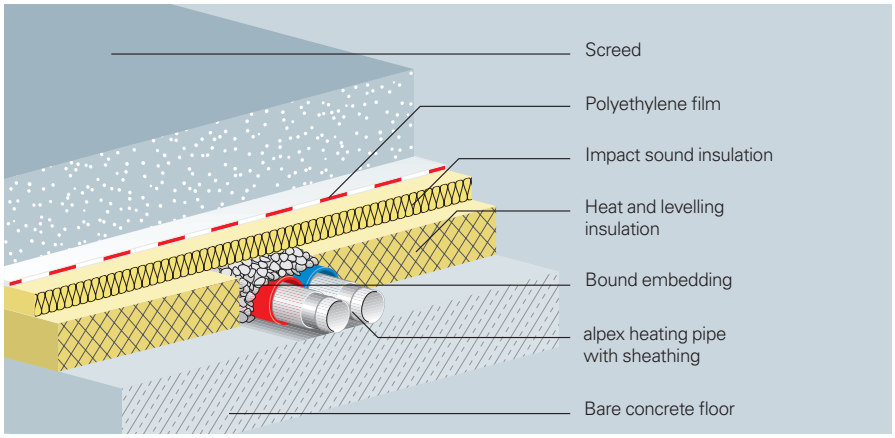
Pipes in concrete

When installing alpex pipes directly in screed or concrete, suitable measures (e.g., KEBU or DENSO) must be taken to protect the alpex fittings made of PPSU or dezincification-resistant brass against corrosion. The GEG as amended must be observed for the installation.

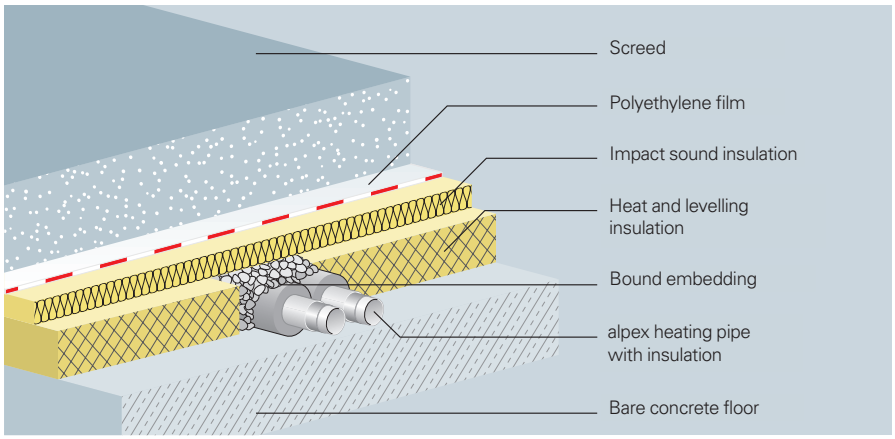
Pipes on the bare concrete floor under the screed

The supporting substructure for floating screeds must be sufficiently dry and have a level surface. There must not be any raised points or the like that could lead to acoustic bridges and/or differences in the screed thickness. The tolerances for the height and the incline of the supporting substructure must satisfy DIN 18202.

The provisions of the current GEG regarding pipe insulation must be observed. The height of the floor structure is based on this. Except for insulation requirements, alpex pipes must be installed inside appropriate sheathing. The installation of pipes on the bare concrete floor requires observing the accepted technical practices.



Floor structure under screed with alpex pipe and appropriate sheathing



Floor structure under screed with pre-insulated alpex pipe

4.3 Pipe routing and installation

In the event of corresponding insulation requirements, alpex pipes must be provided with the respective pipe insulation.

The pipes must be routed on and firmly attached to the supporting substructure. Plastic dowel hooks for single or double pipes must be used for this.

The levelling layer is applied with thermal insulation up to at least the height of the pipe section of the laid pipe. When using insulated pipes, the top edge of the pipe insulation is the minimum height.

The levelling layer must be installed all the way to where it makes contact with the pipes. The open space in the levelling layer created by the pipes must be filled with a bound embedding up to the top edge of the levelling layer.

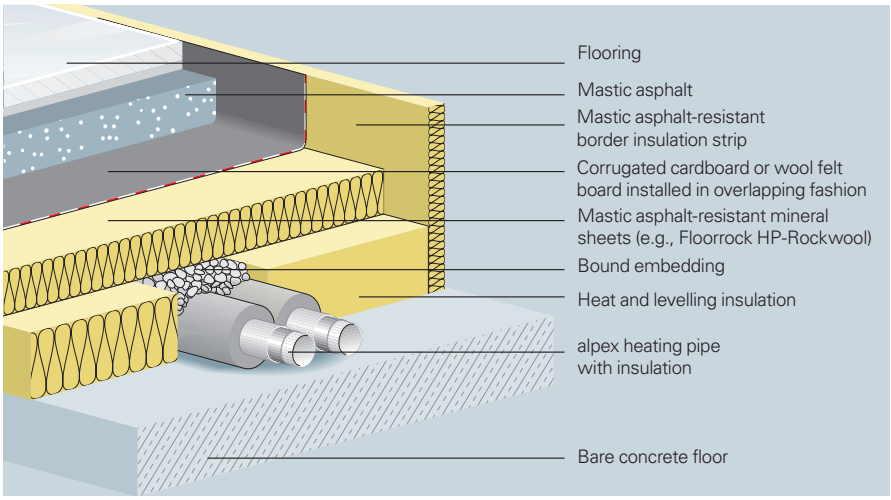
This ensures level, consistent contact with the uninterrupted impact sound insulation to be installed over the entire floor structure (see DIN 18560 Part 2 Section 4.1). Unbound embedding of natural or crushed sand, perlites must not be used. The lining (moisture barrier) of the impact sound insulation must consist of at least 0.1 mm thick PE or equivalent film, whereby the joints must overlap by at least 80 mm (see DIN 18560 Part 2 Section 6.1.2).

The joints must be taped when using liquid screed. Correct lining of the impact sound insulation in connection with the border insulation strips prevents the screed or its mixing water from penetrating into the insulation.

Pipes under mastic asphalt

Mastic asphalt (aka hot screed) must not be directly poured on alpex pipes and other plastic parts or radiator connection elements. Mastic asphalt has application temperatures up to 230 °C, which will damage pipes and accessories. It must be ensured that alpex pipes do not come into contact with mastic asphalt at any point. If the installation instructions below are observed, there will be no problem with installing alpex pipes underneath mastic asphalt in the levelling layer.

After installing alpex pipes in conduits or pre-insulated alpex pipes on the bare concrete floor, installing the levelling layer (e.g., bound embedding) up to the top edge of the pipe or pipe insulation, a layer of rock wool compatible with mastic asphalt with a minimum thickness of 20 mm (thermal conductivity group WLG 040) and fire safety class A1 (non-flammable) must be installed over the entire surface and sealed according to DIN 4102. Corrugated cardboard or the like must be installed in overlapping fashion over the rock wool layers in order to protect the floor structure beneath the mastic asphalt from any penetrations of the mastic asphalt into the insulation layer. Pipes and fitting penetrations through the insulation layers such as for radiator connections or tapping points in sanitary installations must also be sheathed with these rock wool sheets and taped for a tight seal. In addition to possibly damaging the alpex pipes, the reason for this is to conduct the high temperatures into the press connection when using metal fittings. After setting and cooling of the mastic asphalt, the mineral wool in the area of the protruding pipe or fitting connections is removed and covered with floor cover.



Floor structure under mastic asphalt

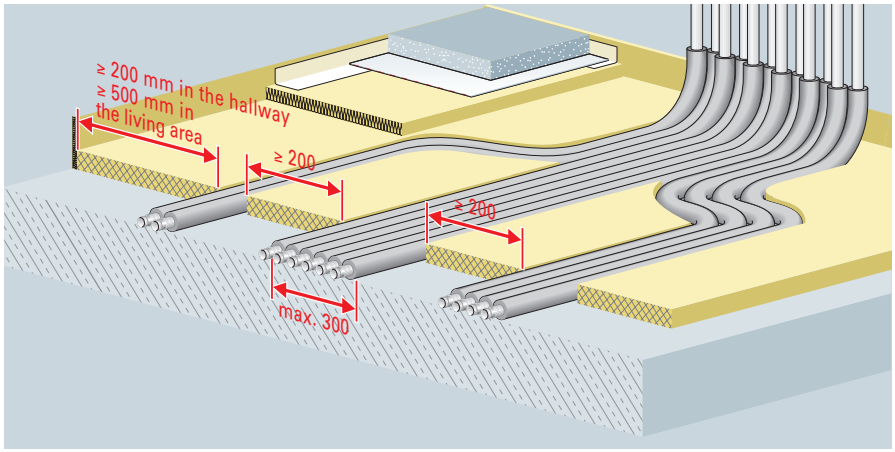
4.3 Pipe routing and installation

Routing of pipes on bare concrete

To prevent any problems from loads on the screed layer that could lead to reduced stability, it is necessary to separate pipe runs to provide a supporting area between them. When installing alpex pipes (in accordance with the applicable GEG) in parallel routes, particularly next to heating pipe manifolds, the following pipe run dimensions and spacings must be observed:

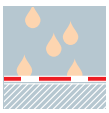
- Max. run width for parallel pipes is 300 mm
- Width of the levelling layer next to or between pipe runs larger than or equal to 200 mm
- Width of the spacing between walls and pipes or pipe runs in rooms other than hallways larger than or equal to 500 mm and in hallways larger than or equal to 200 mm.

When following the above recommendations, it is possible to route up to five heating circuits in two-pipe systems as a single pipe run in the heating area (without interruption by the levelling layer). The number of five heating circuits also includes the insulation thickness of 9 mm pipe insulation which is wrapped around the alpex pipe. If five heating circuits are not sufficient for a manifold connection, a tee distribution can be integrated into the individual heating circuits. In individual cases, a tee distribution directly connected to the riser pipe represents another alternative. The requirements of the Energy Conservation Ordinance must be observed for the respective width of the pipe run and the height of the floor structure. Pre-insulated alpex pipes can be installed in case of higher insulation requirements. This can lead to a reduction in the pipe run width, meaning that fewer pipes can be installed. Open spaces that arise due to the spacing between the pipes must be filled up to the top edge of the levelling layer with bound filler.



Pipe run widths and supporting area widths

Moisture barriers



The seal against ground moisture and non-pressurized water must be defined in the planning stage (DIN 18195) and installed before installation of the floor structure (cf. DIN 18560 Parts 4 and 5). If necessary, the insulation layer must be protected against moisture with suitable measures, e.g., with moisture barriers. If bituminous moisture barrier layers are used, an additional separating layer of PE film shall be installed against PS high-resistance foams. In the case of PVC moisture barrier layers, a layer of bogus paper must be installed underneath.

Thermal and sound insulation

Even for floor structures without pipe routing on any insulation or on the bare concrete floor, insulation measures are still required for thermal and impact sound insulation. Pouring “floating screed” on corresponding insulation material, along with a border insulation strip, is the ideal technique for such cases. The border insulation strip allows movement of the screed on all sides and prevents acoustic bridges to the building structure. The compressibility of the insulation material under loads from unheated screeds must not exceed 5 mm; when laying mastic asphalt screed, it must not exceed 3 mm. According to DIN 18560, insulation materials that comply with DIN 18164 Part 1 or DIN 18165 Part 1 or Part 2 must be used.
The necessary traffic loads must be considered when planning the insulation. The supporting substructure for screeds must be sufficiently dry and have a surface free of raised points that could lead to acoustic bridges.

4.3 Pipe routing and installation

UV resistance

alpex pipes and fittings must be protected from direct sunlight and UV exposure and covered during transport and storage if they have been removed from the original packaging. If alpex pipes with conduits are used, sufficient UV protection must be ensured during the installation phase. In addition, the insulating sheaths of alpex pipes also provide UV protection.

Chemical resistance

Cross-linking significantly improves the chemical properties of polyethylene. For this reason, Supplement 1 to DIN 8075, which lists the media to which non-cross-linked polyethylene is resistant, can be used as a guide for evaluating the chemical resistance of alpex pipes.

alpex pipes are resistant to the following media:

- Concrete, gypsum, mortar and cement
- Disinfectants and cleansers according to DVGW worksheet W 291 and DIN 2000
- All natural ingredients of drinking water according to the German Drinking Water Ordinance
- Anti-corrosion agents according to DIN 1988 Part 400

The alpex system must be protected against direct contact with bitumen or bitumen sheeting. In addition, alpex pipes must be protected against greases, solvents and oils. If the alpex installation system is used in areas with corrosive gases, ammonia or chloride compounds or constant exposure to moisture, the fittings must be protected with a suitable covering (e.g., KEBU or DENSO). This also applies to contact with screed, concrete, mortar or plaster.

Applications of the alpex installation system other than listed in Chapter 3 can be approved upon request.

Equipotential bonding

All connections between alpex fittings and pipes have an isolator in the form of a fixation ring. This prevents creation of a conductive metallic pipe system. For this reason, the alpex installation system cannot be used for equipotential bonding and does not have to be grounded.

VDE 0190 Parts 410 and 540 requires equipotential bonding between all types of protective conductors and existing "conductive" water and heating pipes. It states that the connection with a protective conductor may be established in one of the following ways:

a) in a central location, e.g., in the subcircuit distribution board of the residence or

b) at the equipotential bus bar of the main equipotential bonding conductor or

c) via a metal water pipe that has an uninterrupted connection with the main equipotential bonding conductor.

With the alpex installation system, equipotential bonding may only be established through one of the first two options a) or b) for connection with the protective conductor. This also applies to renovation work in which metal pipes are replaced by alpex pipes.

NB

The plumber/installer or construction supervisor must inform the customer or the customer's representative that a certified electrical technician must inspect whether existing electrical protection and grounding measures will be impaired by the installation of alpex systems (VOB Part C, General Technical Contract Conditions [ATV]).

Anti-freeze and trace heating

When filled with water, the alpex installation system must be protected against freezing in areas at risk of freezing. Due to reasons of corrosion protection, an application concentration of 25 per cent by volume should not be exceeded or fallen below 75 per cent by volume. The manufacturer's instructions must be observed.
If trace heating is used, the operating temperature of the drinking water must not exceed 60 °C (short-term max. 70 °C, e.g., for thermal disinfection).

The alpex installation pipe is suitable for use in combination with trace heating. The aluminium core pipe ensures even heat distribution over the entire pipe circumference.
At normal indoor temperatures, trace heating can be attached to the pipe using cable ties or tape. The manufacturer's instructions must be observed. During repair and maintenance work, trace heating must be switched off for pipes without circulating water.

4.4 Sound insulation

Sound insulation in buildings

DIN 4109 "Sound insulation in buildings" with supplementary table A1.

DIN 4109 with the supplementary table A1 regulates the minimum sound insulation requirements in buildings with different requirements as well as with respect to the noise source. The following maximum noise levels in db(A) are permitted:

NB

The maximum installation noise level Lin ≤ 30 dB(A) in residential buildings currently corresponds to the accepted technical practices and the applicable statutory requirements.

The purpose of all sound insulation measures is to protect against unreasonable disturbances due to sound transmission in rooms that are generally occupied. According to DIN 4109 with supplementary table A1, "rooms requiring protection" are defined as follows:

- Living rooms, including occupied halls,
- Bedrooms, including overnight rooms in hotels and bedrooms in hospitals and sanatoriums,
- Classrooms in schools, universities and similar institutions,
- Offices (except for open plan offices), clinical practice rooms, meeting rooms and similar work rooms.

Excerpt from DIN 4109 supplementary table A1:

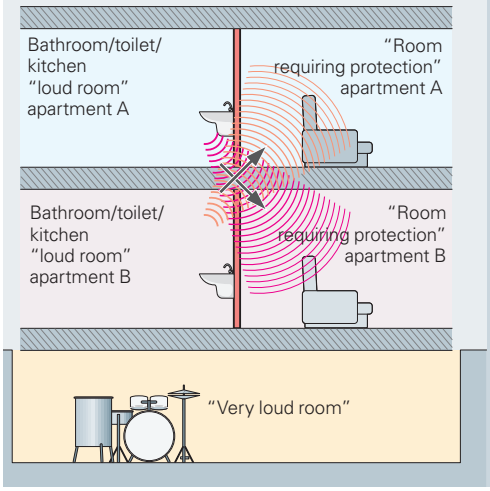
Noise source	Designated noise Level [dB(A)] by type of room requiring protection	
	Living and bedrooms	Classrooms and work rooms
Water installations (both water supply and wastewater systems)	≤ 30 [1) 2)]	≤ 35 [1) 2)]
Other building systems	≤ 30 [3)]	≤ 35 [3)]

1) Individual, short-term peaks that occur when operating valves and activating devices according to Table 6 (opening, closing, switching, interrupting, etc.) can currently be disregarded.

2) Requirements for satisfying the permissible installation sound level applicable to contract work:
   - The design documents must consider the requirements of sound insulation, i.e., the required verifications of sound insulation for, among others, the components must exist.
   - In addition, the party responsible for the construction work must be named and must participate in a preliminary acceptance inspection before sealing or covering the installation.

3) Values up to 5 dB(A) higher are permitted for ventilation systems, as long as the noise produced is continuous and does not contain apparent individual tones. In accordance with footnote 2), verifications of sound insulation must be included with the planning/design. Heating systems, including heat distribution, fall under the category of "other building systems".

4.4 Sound insulation



Goals of protection of DIN 4109 against installations noises

Example: The room requiring protection in apartment B should be protected against noises from the "loud room" of apartment A and vice versa.

- Apartment-separating floor m'> 410 kg/m²
- Single shell installation wall within one's own living area, m' ≥ 220 kg/m²
- Wall and floor masses are specified by DIN 4109; deviations are only permitted if proper sound insulation has been verified.

DIN 4109-10 "Improved sound insulation for residential buildings"

The current VDI directive 4100 and Supplement 2 to DIN 4109 will soon be replaced by a final version of DIN 4109-10. This standard defines improved sound insulation in residential buildings as follows:

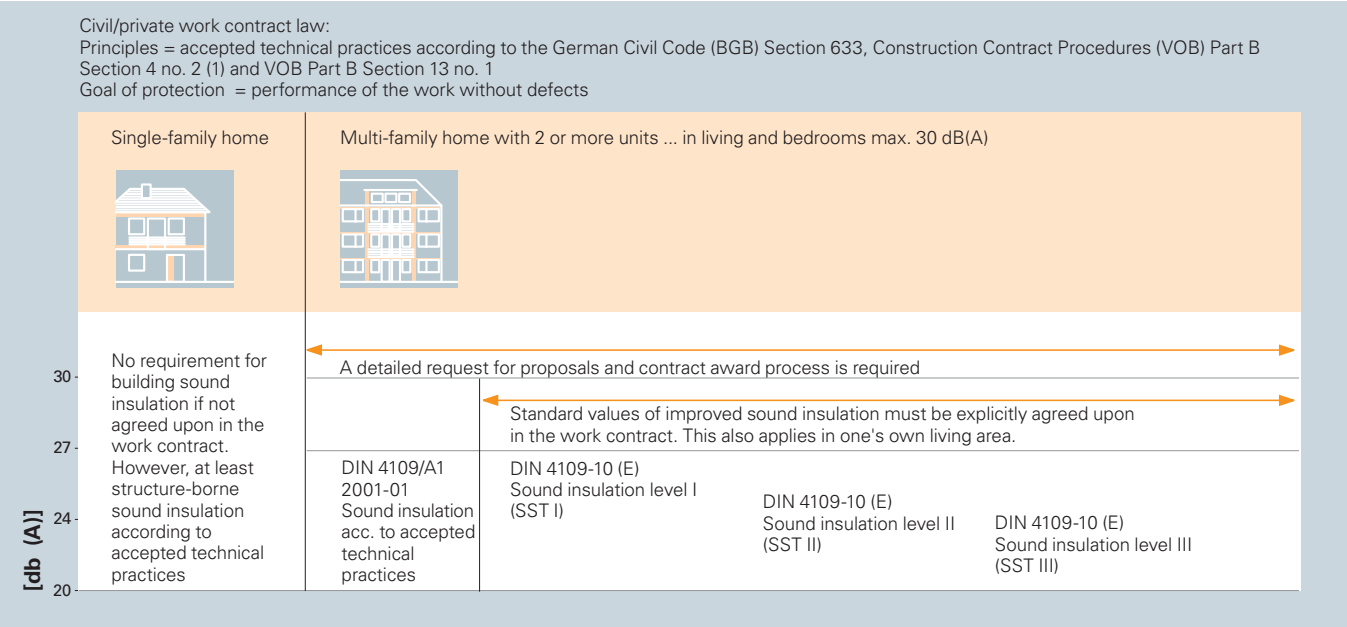
- 30 db(A) standard sound insulation level SST I in residential buildings
- 27 db(A) increased sound insulation level SST II in residential buildings
- 24 db(A) increased sound insulation level SST III in residential buildings

In addition, a maximum sound level of 35 db(A) can be agreed for "one's own living area" for the sound insulation levels SST I to SST III.

The sound insulation levels SST I to SST III represent guiding values that must be explicitly agreed upon in the work contract. This also applies for the sound insulation in "one's own living area".

NB

The standard values of sound insulation level SST III should not be agreed upon without consulting an acoustic engineer.



4.4 Sound insulation

Requirements for walls for the installation of feed and return pipes

According to DIN 4109, the following requirements apply to walls to which feed and return pipes, fittings or sanitary objects will be fastened:

- Single shell walls must have a mass per unit area of at least 220 kg/m^2.
- Walls that have a mass per unit area of less than 220 kg/m^2 may be used if it has been verified by inspection that they offer at least equivalent protection with regard to the transmission of installation noise.

The masonry properties must always be inspected for fulfilment of the requirements prior to installation. Metal-framed walls may only be used if it has been verified that they satisfy the requirements. The current industrial solution for minimising installation noise is pre-wall installation. Since the introduction of DIN 1053 "Masonry of simplified design", horizontal and vertical recesses and channels are no longer possible for installation pipes in load-bearing and reinforcing walls without a certified structural analysis.

An analysis of the channel sizes permitted without a certified structural calculation yields the following conclusions:

- Pipes in vertical channels are generally only possible in walls with a thickness of more than 24 cm and then only with restrictions.
- Pipes in horizontal channels are no longer possible.

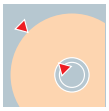
According to the Construction Contract Procedures (VOB), Part C, DIN 18381:2000-12, Section 3.1.14, chiselling, cutting and drilling work may only be performed on the structure if the customer has agreed to this. DIN 1053-1 "Masonry – design and construction" *(Mauerwerk – Berechnung und Ausführung)* must be observed for such work. As an alternative to common channel installation, pre-wall installation is generally used in residential construction today.

This provides the following advantages:

- Clean and rapid construction
- Elimination of construction waste and noise as no chiselling or cutting is required
- Walls are not weakened by recesses; the full wall thickness guarantees stability as well as better sound insulation and fire safety
- Improved sound insulation; no acoustic bridges to adjacent rooms
- No interruption of the thermal insulation or fire protection in walls with these functions
- Repair, replacement and modernization can be performed without interfering with the building structure
- Installations can be grouped together

4.5 Insulation of drinking water and heating pipes

Insulation of drinking water and heating pipes



The insulation of heat distribution and hot water pipes must be carried out according to the applicable GEG. This applies to new constructions, renovations and modernisations.
The insulation/sheathing material must be selected according to the respective application and must not cause contact corrosion or chemical corrosion at the pipe materials.

The provided insulation variant and insulation thickness must be agreed upon with the client and the other trades prior to starting the work. Even if there is no obligation to insulate pipes, sound insulation might lead to insulation of the pipes being required.

GEG

Appendix 8 (to Section 69, Section 70, Section 71 Para. 1)
Requirements for the insulation of pipes and fittings

Table 1 | Thermal insulation of heat distribution and hot water pipes and fittings in the cases of Section 69 and Section 71 Para. 1

Line	Type of pipe/fitting	Minimum thickness of the insulation layer with respect to a thermal conductivity of 0.035 W/(m·K)
aa	Inside diameter up to 22 mm	20 mm
bb	Inside diameter over 22 mm up to 35 mm	30 mm
cc	Inside diameter over 35 mm up to 100 mm	Equals inside diameter
dd	Inside diameter over 100 mm	100 mm
ee	Heat distribution pipes according to lines aa to dd in wall and floor penetrations, at pipe crossovers, at pipe connection points, at central network manifolds.	1/2 of the requirements of lines aa to dd
ff	Pipes of central heating installations according to lines aa to dd that are installed in building elements between heated rooms of different users after 31 January 2002.	1/2 of the requirements of lines aa to dd
gg	Pipes according to line ff in the floor structure.	6 mm
hh	If, in cases of Section 69 Para. 5, heat distribution and hot water pipes border on outside air, they must be insulated with twice the minimum thickness according to lines aa to dd.	Twice the requirements of lines aa to dd

1. In cases of Section 69, (a) is not applicable if heat distribution pipes according to lines aa to dd are located in heated rooms or building elements between heated rooms of a user and their heat emission can be influenced by openly accessible shut-off mechanisms.
   In cases of Section 69, (a) is not applicable to hot water pipes with a water content of up to 3 litres that are neither part of the circulation circuit nor equipped with electric trace heating (branch pipes) and are located in heated rooms.
2. In case of materials that exhibit another thermal conductivity than 0.035 W/(m·K), the minimum thicknesses of the insulation layers must be recalculated accordingly. The calculation rules and values according to the accepted technical practices must be used for the recalculation and the thermal conductivity of the insulation material.
3. For heat distribution and hot water pipes as well as cold distribution and cold water pipes, the minimum thicknesses of the insulation layers according to Table 1 and No. 1 can be reduced insofar as an equivalent restriction of their heat emission or heat absorption can be ensured using different pipe insulation arrangements and in consideration of the insulating effect of the pipe walls.

4.5 Insulation of drinking water and heating pipes

Table 2 shows the heating pipes and insulation layer thicknesses required according to GEG for various installation situations.

Table 2 | Explanations/examples heating system, GEG, Appendix 8 (to Section 69, Section 71 Para. 1)

Heating system	Multi-family home/ non-residential building several users	Single-family home/ non-residential building 1 user
Pipes in unheated rooms and basement rooms	100 %	100 %
Pipes in exterior walls, in exterior components, between an unheated and a heated room, in shafts and installation ducts	100 %	100 %
Distribution pipes to supply several different users	100 %	no requirement
Pipes installed in the floor, also radiator connection pipes to ground / unheated rooms [3)]	100 %	100 %
Pipes and fittings in wall and floor penetrations, at pipe crossovers, at pipe connection points, at central network manifolds	50 %	50 %
Pipes in building elements, between heated rooms of different users	50 %	no requirement
Pipes installed in the floor structure, between heated rooms of different users [3)]	see GEG, Appendix 8.1. a, line gg	no requirement
Heating pipes in heated rooms or in building elements between heated rooms of a single user and with shut-off mechanism	. / .	no requirement [1)]
Heat distribution pipes installed directly bordering on outside air [2)]	200 %	200 %

1) Although there are no legal requirements, insulation is required for the following reasons: corrosion protection, prevention of cracking and flowing noise, damping of structure-borne noise, reduction of thermal stress. In order to maintain the comfort of use, these hot water pipes should also be insulated to prevent unwanted cooling from building elements.

2) If pipes are installed in areas at risk of freezing, even insulation cannot provide permanent protection against freezing in case of longer downtimes. They must be emptied or protected in another way (e.g., by way of trace heating). For particulars, please refer to the VDI directives VDI 2055 and VDI 2069 respectively.

3) Eccentric/asymmetric tubular hoses are permissible to limit heat emission. The nominal thickness is to be applied to the cold side. For details, please refer to the required General Building Authority Approval *(Allgemeine bauaufsichtliche Zulassung – ABZ)* of the respective manufacturer.

Table 3 | Minimum thickness of the insulation layer referring to a thermal conductivity at 40 °C

0.035 W/(m · K) for concentric insulation	0.040 W/(m · K) for concentric insulation	0.040 W/(m · K) for eccentric/asymmetrical insulation
≥ 6 mm	≥ 9 mm	see General Building Authority Approval (AbZ) of the respective manufacturer

Pursuant to the GEG, drinking water pipes (cold) must be insulated according to the requirements of DIN 1988-200.

4.5 Insulation of drinking water and heating pipes

Insulation of drinking water systems – cold according to DIN 1988-200

According to the provisions, drinking water pipes must be installed in such a way that the temperature of the cold drinking water may not exceed 25 °C max. 30 seconds after opening a tapping point during intended operation and that the hot drinking water temperature must have reached at least 55 °C.

The insulation materials used must be protected against moisture since water in the insulation material reduces the insulating effect and may lead to corrosion damage at the insulated pipe materials and parts. Insulating materials must be installed and fastened joint-tight to minimise heat bridges.

Insulations reduce the heat loss of the medium (heat insulation) or the heat flow to the medium (cold insulation). Sheathings also perform other tasks beyond that such as sound insulation requirements, corrosion protection, integration of length changes, avoiding contacts between pipes and building.

The insulation or sheathing must be selected according to the respective application.

Pipes must be insulated such that, depending on temperature and moisture of the ambient air, condensation is avoided.

Pipes with contact to the building (e.g., concealed installations, installations in screed constructions or pre-wall installations) must at least feature sheathing (e.g., pipe-in-pipe routing) according to 14.2.1. Additional protection against condensation by insulation is not required.

The values for the minimum insulation layer thicknesses according to Table 8 apply as benchmark values for usual operating conditions and pipe routing in residential construction. Even insulation cannot provide permanent protection against heating in case of longer downtimes.

The provisions according to Table 8 can also be applied assuming a drinking water temperature of 10 °C for protection against condensation on the outside of the insulating material.

Table 8 | Benchmark values for layer thickness to insulate pipes for drinking water – cold (Tab. 8 - DIN 1988-200)

Line	Installation situation	Insulation layer thickness for $\lambda = 0.040$ W/(m·K)[a]
1	Pipes that are installed at the surface in unheated rooms, ambient temperature smaller than or equal to 20 °C (condensation protection only)	9 mm
2	Pipes in shafts, floor ducts and suspended ceilings, ambient temperature smaller than or equal to 25 °C	13 mm
3	Pipes installed in, e.g., building control systems or media channels and shafts, with heat loads and ambient temperatures larger than or equal to 25 °C	Insulation like hot water pipes (see Table 1, installation situations 1 to 5)
4	Storey pipes and single supply pipes in pre-wall installations	Pipe-in-pipe or 4 mm
5	Storey pipes and single supply pipes in the floor structure (also next to non-circulating hot drinking water pipes)[b]	Pipe-in-pipe or 4 mm
6	Storey pipes and single supply pipes in the floor structure next to hot-water circulating pipes[b]	13 mm

a) The insulation layer thicknesses must be recalculated for other thermal conductivities; benchmark temperature for the stated thermal conductivity: 10 °C.

b) In connection with underfloor heating, cold drinking water pipes must be installed such that the requirements according to 3 and 6 are compiled with.

4.5 Insulation of drinking water and heating pipes

Insulation of drinking water systems – hot according to DIN 1988-200

Hot drinking water pipes which are either included in the circulation system or feature a pipe heating tape must be insulated with insulation layer thicknesses according to Table 9 to limit heat emission. The minimum insulation layer thicknesses refer to the inside diameters of the pipes.

The insulation layer thicknesses listed in Table 9 (minimum insulation layer thicknesses for the heat insulation of hot drinking water pipes) according to DIN 1988-200 are guided by the legal provisions of the applicable GEG.

Table 9 | Minimum insulation layer thicknesses for the heat insulation of drinking water pipes – hot (Tab. 9 - DIN 1988-200)

Line	Installation situation	Insulation layer thickness for λ = 0.035 W/(m·K) [a]
1	Inside diameter ≤ 22 mm	20 mm
2	Inside diameter > 22–35 mm	30 mm
3	Inside diameter > 35–100 mm	Equals inside diameter
4	Inside diameter > 100 mm	100 mm
5	Pipes and fittings according to lines 1 to 4 in wall and floor penetrations, at pipe crossovers, at pipe connection points, at central network manifolds	Half (50 %) of the required minimum insulation layer thicknesses for installation situations 1 to 4
6	Hot drinking water pipes that are neither part of the circulation circuit nor equipped with pipe heating tape, e.g., storey pipes and single supply pipes with a water content smaller than or equal to 3 litres	No insulation requirements against heat emission [b]

a) The insulation layer thicknesses must be recalculated for other thermal conductivities; benchmark temperature for the stated thermal conductivity: 10 °C.

b) Concealed installations require insulation (e.g., pipe-in-pipe or 4 mm as mechanical protection or corrosion protection).

Note on the table

Heat distribution and circulation pipes installed directly bordering on outside air must be insulated with twice the minimum thickness of Table 9 lines 1 – 4.

Insulation is required for the following reasons even if no insulation requirements apply:

- Reduction in heat emission
- Prevention of cracking and flowing noise, damping of structure-borne noise
- Protection of pipes and general protection against corrosion
- If pipes are installed in areas at risk of freezing, they may require trace heating!

The minimum insulation layer thicknesses according to Table 9 may be reduced if equal limitation of heat emission is ensured with other types of insulation. Equality must be verified by the manufacturer with a General Building Authority Approval (AbZ).

4.5 Insulation of drinking water and heating pipes

Pipes in floors separating apartments

Pipes within heated rooms for which the user has control of the heat emission (e.g., with a thermostat valve) can be installed without insulation, as before. In particular, this includes radiator connection pipes routed on the wall. The same shall apply to pipes installed in building elements between heated rooms in the future. These may remain uninsulated if they belong to the same usage and metering unit. This means that radiator connection pipes with shut-off mechanisms installed in the skirting board in apartments can also be left uninsulated according to the GEG, because the heat emission benefits the respective heated room.

In the future, pipes installed in building elements between heated rooms of multiple users must be insulated. We recommend always installing alpex pipes in conduits even if no insulation requirements apply.

Exception: Pipes installed in the floor structure with a common outside diameter of 16 and 20 mm require an insulation layer with a minimum thickness of 6 mm (except in case of single-family homes).[2)]

Pipes in basement floors adjacent to unheated rooms, soil, outside air

Pipes no longer require insulation against heat loss, but rather against heat emission. The requirements are defined such that designs other than the common concentric pipe insulation structure are also permitted if, for example, increased insulation on the cold side achieves the same insulating effect as a concentric design. Verification by the manufacturer is required for this.

Pipes as riser pipes

Heating pipes and their fittings in wall and floor penetrations, near pipe crossovers, at pipe connection points and in the case of central network manifolds must be sheathed with 50 % insulation (Tab. 1). The GEG further regulates the insulation requirements for riser pipes of central heating systems, which must be insulated according to the following table based on the installation situation and the building type:

Installation situation		Insulation requirement
Riser pipes in or between heated rooms	Single-family home	none [1) 2)]
Riser pipes in a shaft or in a wall between rooms of different users	Multi-family home	50 % (Tab. 1, line ff) – GEG
Riser pipes that are installed at the surface, in a shaft, in or on a wall in unheated rooms	Single and multi-family home	100 % (Tab. 1, lines aa to dd) – GEG
Riser pipes that are installed at the surface or on a wall	Multi-family home	100 % (Tab. 1, lines aa to dd – GEG

1) There are no requirements for the minimum thickness of the insulation layer if the heat emission of the pipes can be influenced by openly accessible shut-off mechanisms.

2) **Attention** This type of installation does not satisfy any sound insulation requirements. It is generally recommended as good construction practice to observe the insulation requirements (e.g., 50 % insulation) even in a single-family home in order to avoid flowing or cracking sounds, although this is not required according to the GEG.

4.5 Insulation of drinking water and heating pipes

Hot water pipes

Hot water pipes with a water content up to 3 litres that are neither part of the circulation circuit nor equipped with electric trace heating (branch pipes) and are located in heated rooms do not need to be insulated according to GeG, Appendix 8.

NB

100 per cent insulation for routing against unheated rooms, soil and 200 per cent insulation in case of outside air.

Attention

The GEG assumes insulation with a thermal conductivity of 0.035 W/(m·K). Since common commercially available pipe insulation has a thermal conductivity of 0.040 W/(m·K), the insulation layer thicknesses must be recalculated accordingly.

Cold water pipes

Benchmark values for minimum insulation thicknesses of cold water pipes according to DIN 1988, Part 200, Table 8.

Pipe installation situation	Insulation layer thickness in [mm] for $\lambda = 0.040$ W/(m·K) [a]	FRÄNKISCHE recommends	
Storey pipes and single supply pipes in pre-wall installations	4		alpex-duo XS or turatec multi pre-insulated 6 mm multilayer composite pipe dim 16, 20 mm or multilayer composite pipe with on-site insulation
Storey pipes and single supply pipes in the floor structure (also next to non-circulating hot drinking water pipes)[b]	4		
Pipes that are installed at the surface in unheated rooms, ambient temperature smaller than or equal to 20 °C (condensation protection only)	9		alpex-duo XS or turatec multi pre-insulated 9 mm multilayer composite pipe dim 16, 20 mm
Pipes in shafts, floor ducts and suspended ceilings, ambient temperature smaller than or equal to 25 °C	13		alpex-duo XS pre-insulated 13 mm multilayer composite pipe dim 16, 20 + 26 mm
Storey pipes and single supply pipes in the floor structure next to circulating hot water pipes [b]	13		
Pipes installed in, e.g., building control systems or media channels and shafts, with heat loads and ambient temperatures larger than or equal to 25 °C	Insulation like hot water pipes Table 1, lines aa to ee acc. to GEG		alpex-duo XS or turatec multi multilayer composite pipe with on-site insulation

a) The insulation layer thicknesses must be recalculated for other thermal conductivities; benchmark temperature for the stated thermal conductivity: 40 °C.

b) Insulation as mechanical or corrosion protection is required for concealed installations.

NB

Protection against condensation is not required if the pipe has a suitable sheathing (e.g., pipe in pipe). If there is no risk of legionella due to warming of the cold water, the insulation requirement according to DIN 1988-200 is sufficient.

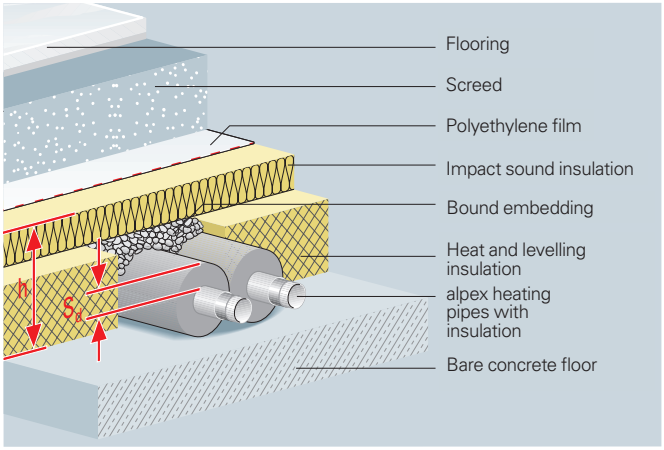
4.5 Insulation of drinking water and heating pipes

Pipe insulation variants with alpex according to GEG

Structure heights with thermal conductivity group 040 (λ = 0.040 W/(m · K)

alpex-duo XS	Insulation requirement	Insulation layer thickness s^d [mm]	Impact sound insulation [mm]	Structure height h to lower edge of impact sound insulation [mm]	FRÄNKISCHE solutions with alpex-duo XS
16×2.0	see table 1, line gg - GeG	9	20	36	83716214
20×2.0	see table 1, line gg - GeG	9	20	40	83720214
16×2.0	50 %	13	20	44	83716217
20×2.0	50 %	13	20	48	83720217
26×3.0	50 %	13	20	54	83726117
16×2.0	100 % warm water	26	20	68	on site
20×2.0	100 % warm water	26	20	72	on site

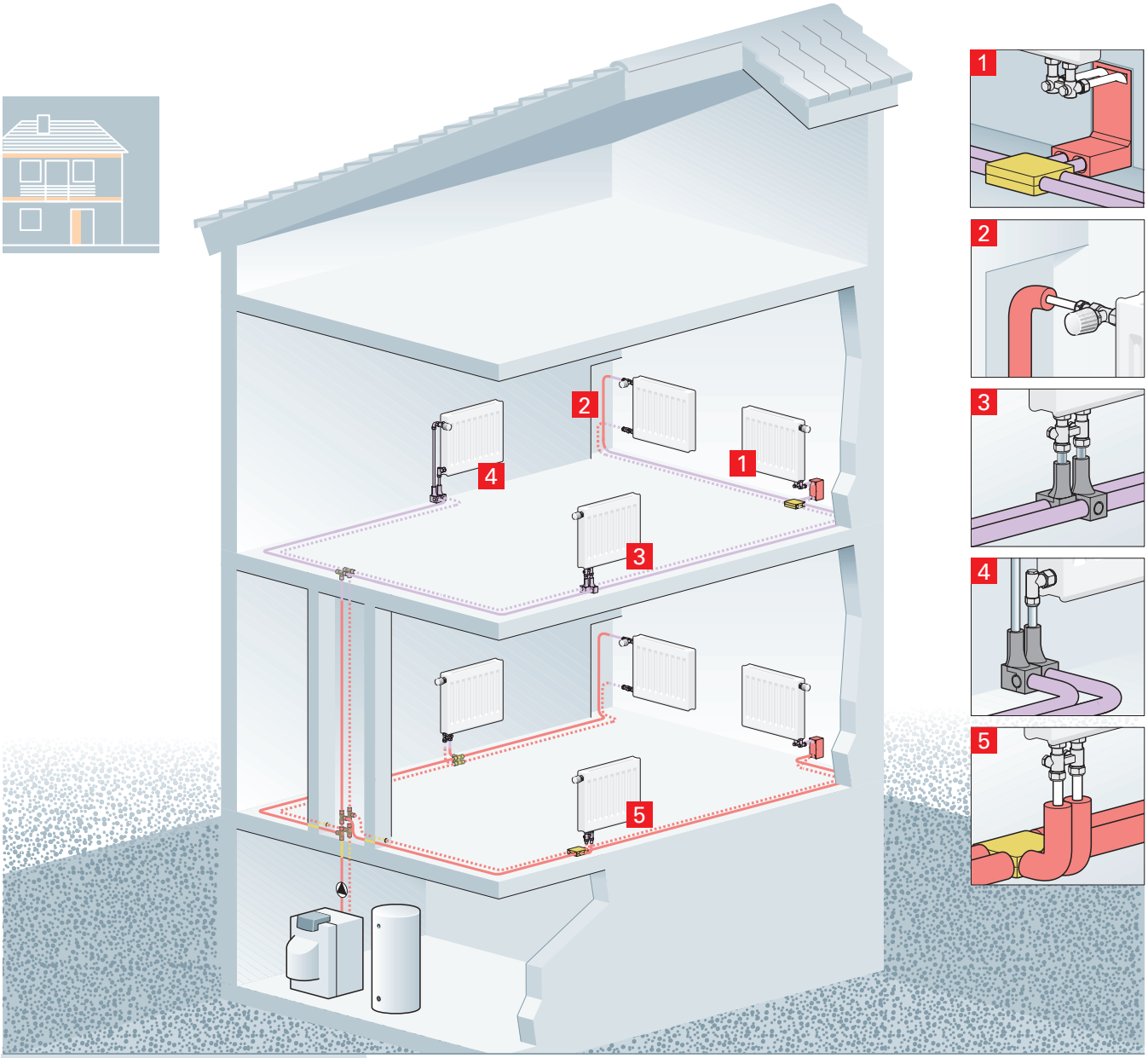
* Only applicable for installations in the floor structure



Floor structure with pipe insulation

4.5 Insulation of drinking water and heating pipes

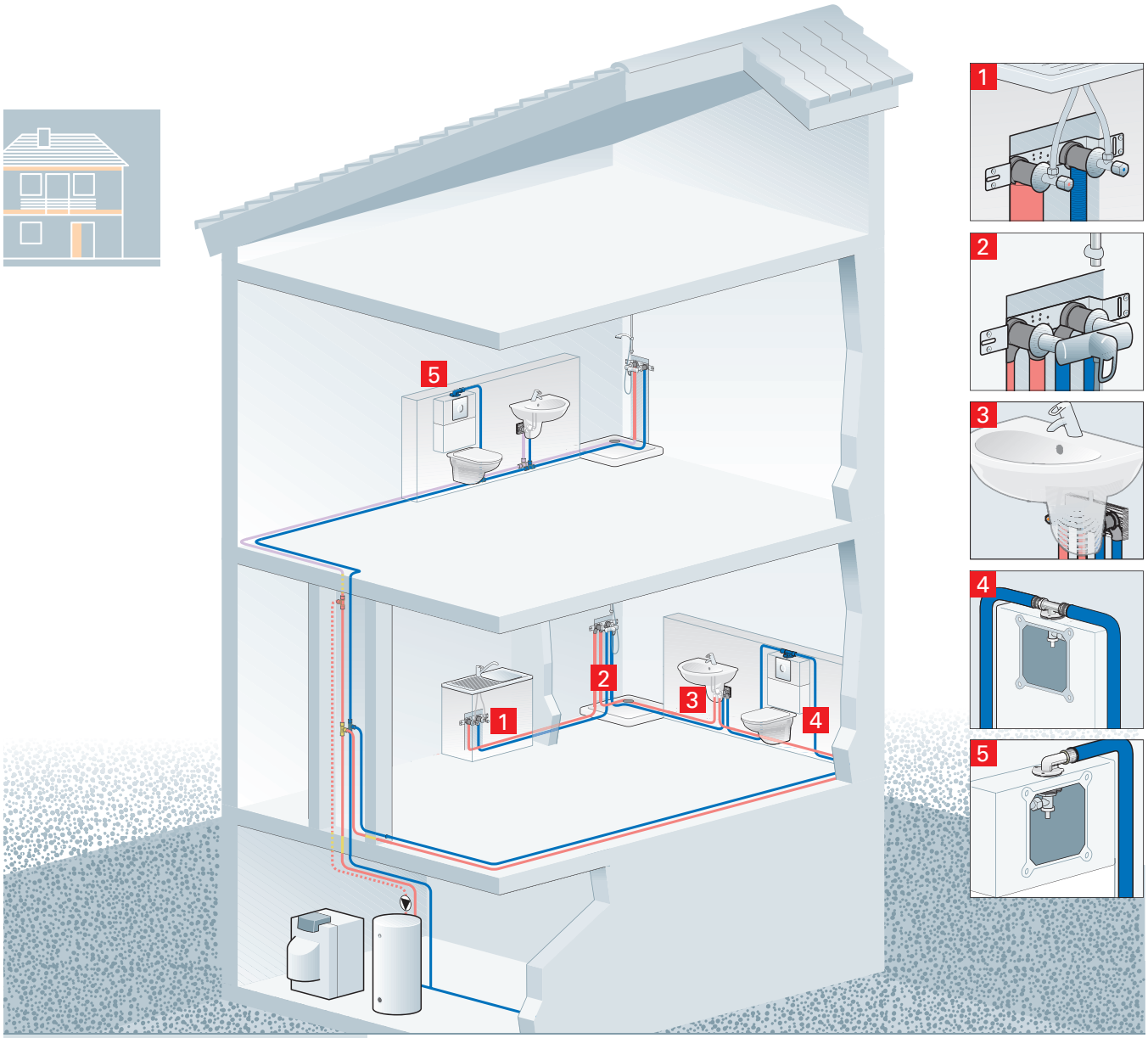
Heating system for single-family home



0 %	VL RL no requirement	■ Heating pipes and fittings in heated rooms or in building elements between heated rooms of a single user for which heat emission can be controlled by openly accessible shut-off mechanisms. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pipe with appropriate sheathing or pre-insulated 6 mm or 9 mm; dim. 16/20 mm.**
50 %	VL RL 50 % minimum insulation requirement (Table 1, line ee) - GEG	■ Heating pipes and fittings in wall and floor penetrations, at pipe crossovers, at pipe connection points, for central network manifolds. **FRÄNKISCHE solutions: alpex-duo XS pre-insulated pipe 13 mm, dim. 16/20/26 mm.**
100 %	VL RL 100 % minimum insulation requirement (Table 1, lines aa to dd) - GEG	■ Heating pipes and fittings in unheated rooms (e.g., basement). ■ Heating pipes and fittings in building elements adjacent to unheated rooms, soil or outside air.

4.5 Insulation of drinking water and heating pipes

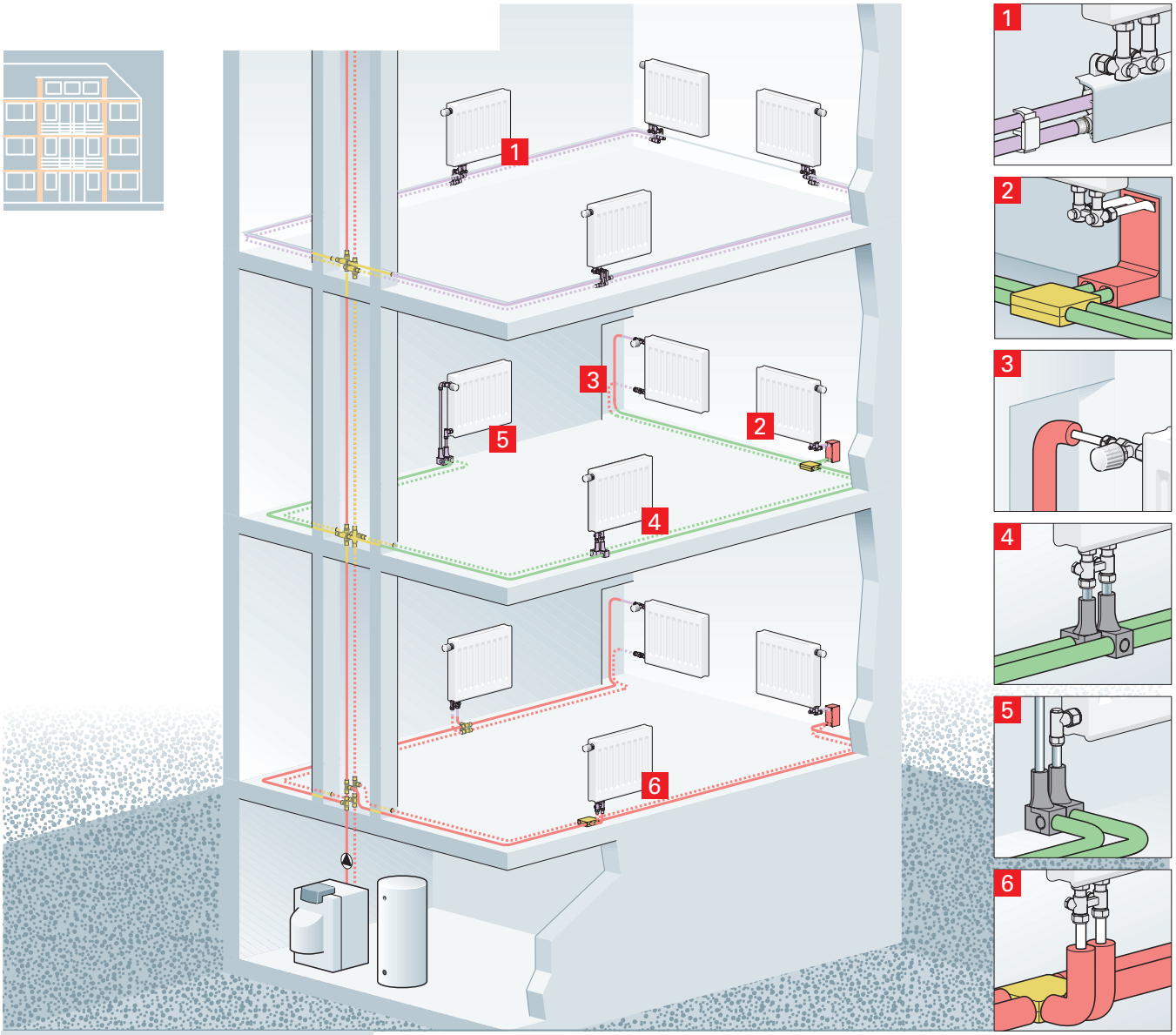
Drinking water system for single-family home



0 %	no requirement	■ Hot water pipes with a water content up to 3 litres that are neither part of the circulation circuit nor equipped with electric trace heating, see p. 34 Tab. 9. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pipe with appropriate sheathing or pre-insulated 6 mm or 9 mm, dim. 16/20/26 mm.**
50 %	50 % minimum insulation requirement (Table 1, line ee) - GEG	■ Hot water pipes and fittings in wall and floor penetrations, at pipe crossovers, at pipe connection points, for central network manifolds. **FRÄNKISCHE solutions: alpex-duo XS pre-insulated pipe 13 mm, dim. 16/20/26 mm.**
100 %	100 % minimum insulation requirement (Table 1, lines aa to dd) - GEG	■ Hot water pipes and fittings in unheated rooms (e.g., basement). ■ Hot water pipes and fittings in building elements adjacent to unheated rooms, soil or outside air. ■ Hot water pipes and fittings that are part of the circulation circuit or are equipped with electric trace heating. ■ Hot water pipes with a water content of more than 3 litres and fittings, see GEG, Appendix 8.
	Minimum insulation requirement (acc. to DIN 1988-200)	■ Cold water pipes (see "Insulation of drinking water and heating pipes", p. 33 Tab. 8) if there is no risk of legionella due to heating of the cold water. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pipe with appropriate sheathing or pre-insulated 9 mm, dim. 16/20/26 mm.**

4.5 Insulation of drinking water and heating pipes

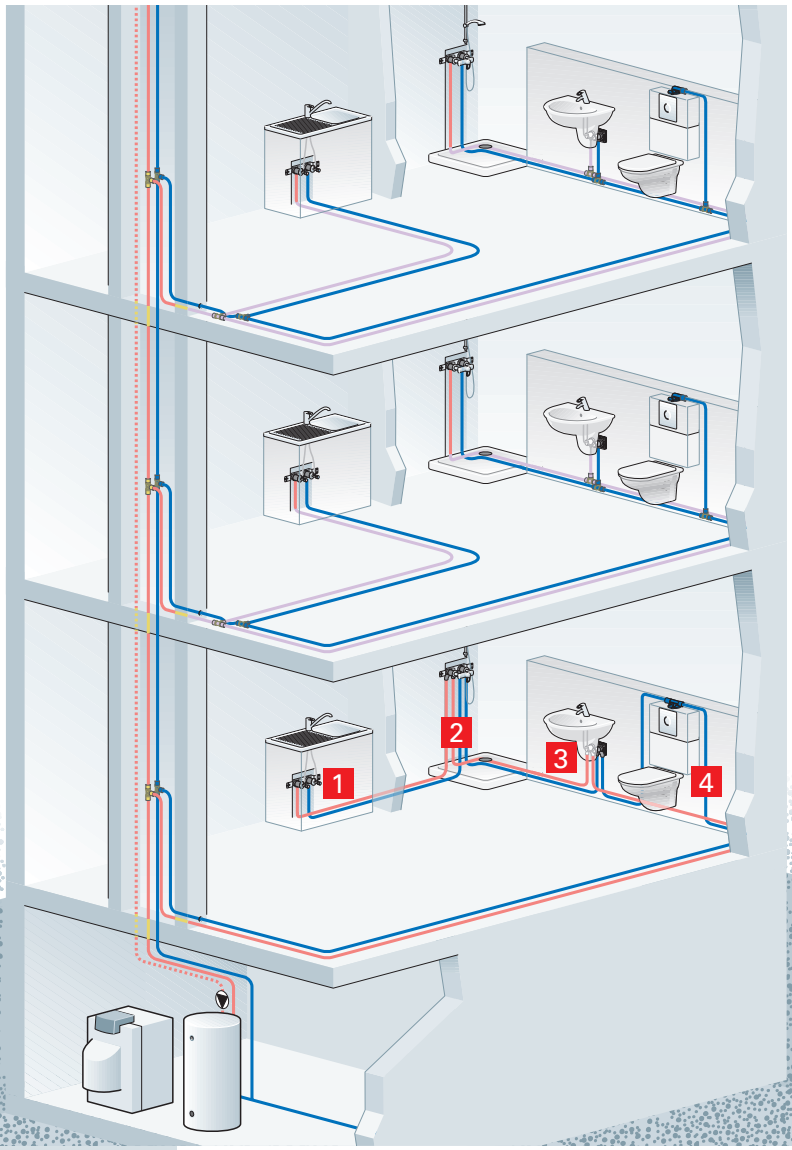
Heating system for multi-family home

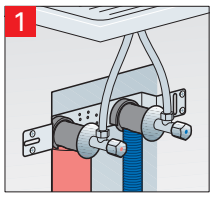


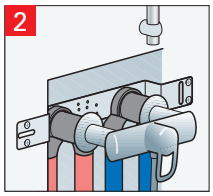
0 %	VL RL	no requirement	■ Heating pipes and fittings in heated rooms or in building elements between heated rooms of a single user for which the heat emission can be controlled by openly accessible shut-off mechanisms. ■ Heating pipes in the skirting board of heated rooms with shut-off mechanism. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pipe with appropriate sheathing or pre-insulated 6 mm or 9 mm, dim. 16/20/26 mm.**
50 %	VL RL	50 % minimum insulation requirement (Table 1, lines ee to ff) - GEG	■ Heating pipes and fittings in wall and floor penetrations, at pipe crossovers, at pipe connection points, for central network manifolds. ■ Heating pipes in building elements, between heated rooms of different users. **FRÄNKISCHE solutions: alpex-duo XS pre-insulated pipe 13 mm, dim. 16/20/26 mm.**
100 %	VL RL	100 % minimum insulation requirement (Table 1, lines aa to dd) - GEG	■ Heating pipes and fittings in unheated rooms (e.g., basement). ■ Heating pipes and fittings in building elements adjacent to unheated rooms, soil or outside air.
6 mm	VL RL	6 mm insulation requirement (Table 1, line gg) - GEG	■ Heating pipes in the floor structure between different users. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pre-insulated pipe 9 mm, dim. 16/20/26 mm.**

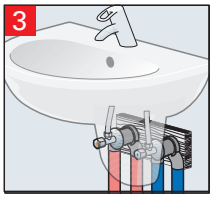
4.5 Insulation of drinking water and heating pipes

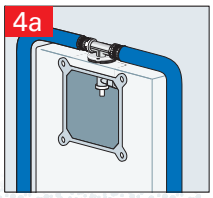
Drinking water system for multi-family home

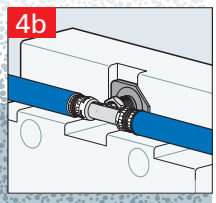












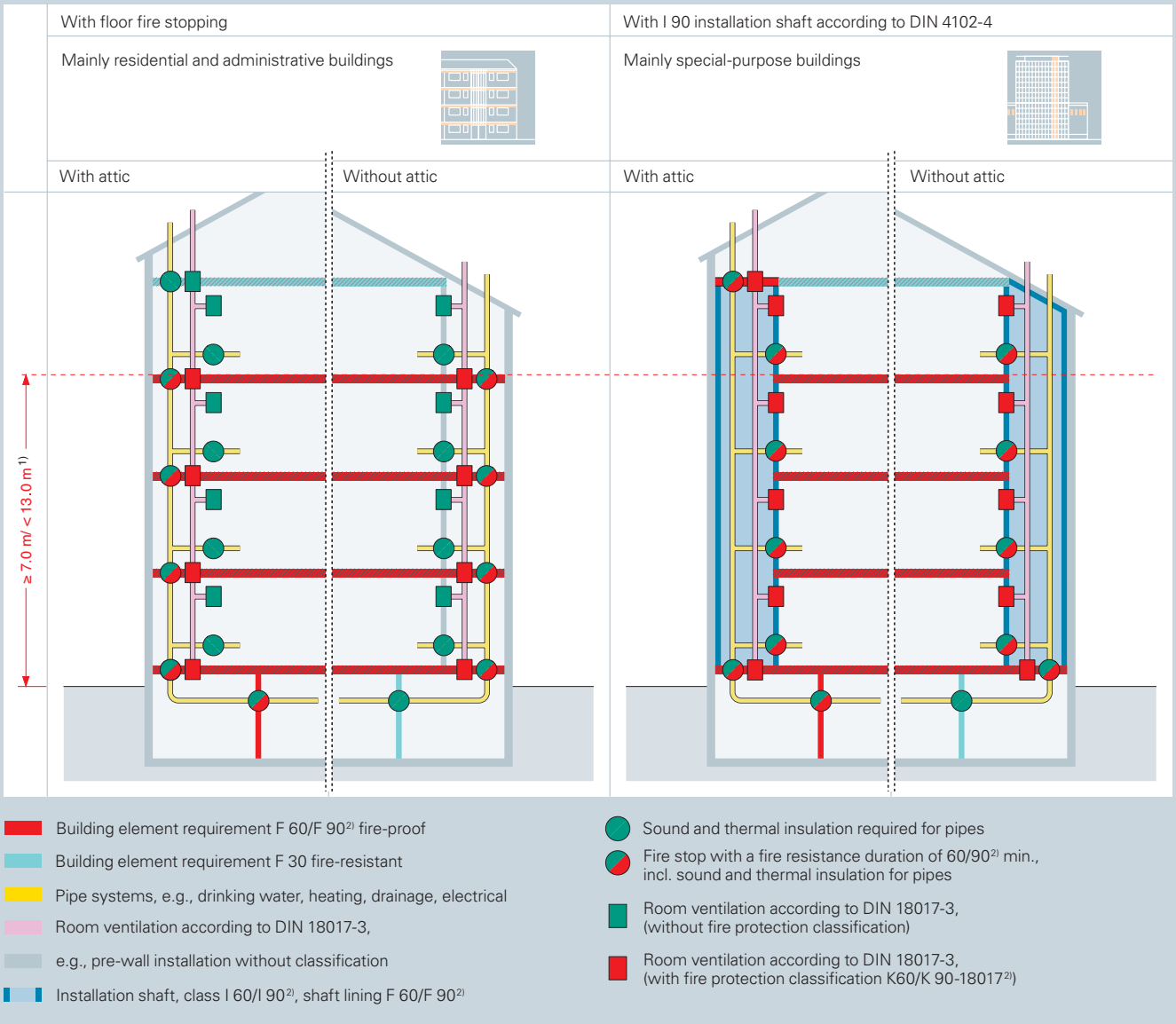
0 %	no requirement	■ Hot water pipes with a water content up to 3 litres that are neither part of the circulation circuit nor equipped with electric trace heating. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pipe with appropriate sheathing or pre-insulated 6 mm and 9 mm dim. 16/20/26 mm.**
50 %	50 % minimum insulation requirement (Table 1, line ee) - GEG	■ Hot water pipes and fittings in wall and floor penetrations, at pipe crossovers, at pipe connection points, for central network manifolds. **FRÄNKISCHE solutions: alpex-duo XS pre-insulated pipe 13 mm, dim. 16/20/26 mm.**
100 %	100 % minimum insulation requirement (Table 1, lines aa to dd) - GEG	■ Hot water pipes and fittings in unheated rooms (e.g., basement). ■ Hot water pipes and fittings in building elements adjacent to unheated rooms, soil or outside air. ■ Hot water pipes and fittings that are part of the circulation circuit or are equipped with electric trace heating. ■ Hot water pipes with a water content of more than 3 litres and fittings, see DIN 1988-200 Tab. 9.
	Minimum insulation requirement (acc. to DIN 1988-200)	■ Cold water pipes (see "Insulation of drinking water and heating pipes", p. 33 Tab. 8) if there is no risk of legionella due to warming of the cold water. **FRÄNKISCHE solutions: alpex-duo XS or turatec multi pipe with appropriate sheathing or pre-insulated 9 mm and 13 mm, dim. 16/20/26 mm.**

4.6 Fire protection

Preventive fire protection in home and building installations

Preventive fire protection in home and building installations is critical to save lives and protect property. The requirements of preventive fire protection in pipe systems within buildings are specified in the construction ordinances introduced to building law by the German federal states and in pipe system directives of the federal states. Fire stops for installation pipes generally follow one of two principles:

Example: class 4 building



1) Top edge of finished floor of the uppermost living room

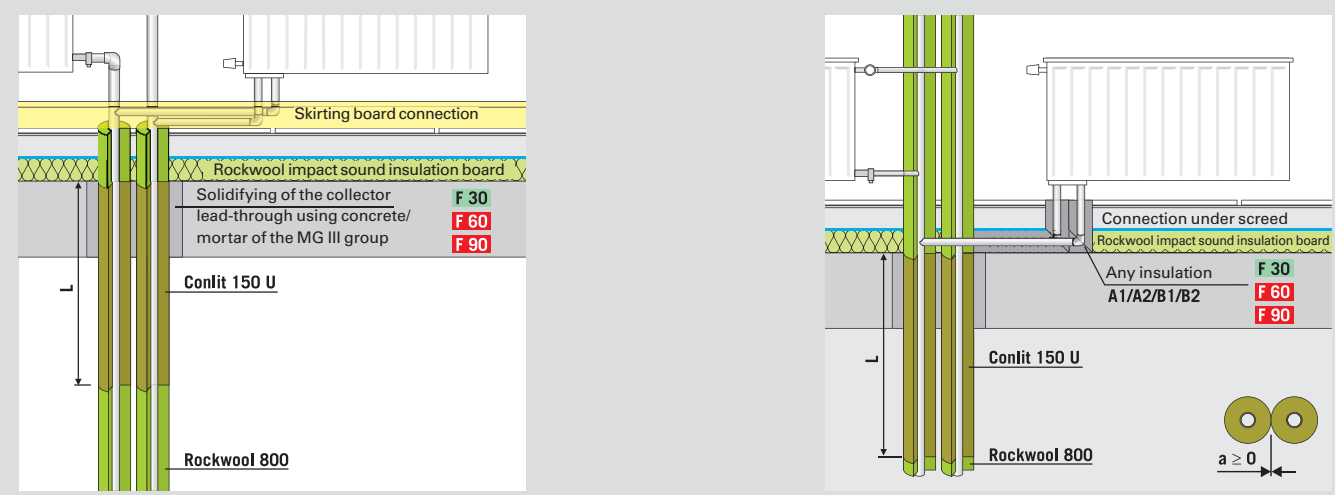
2) According to the requirements of the respective German federal state

In case of non-accessible installation shafts, the floor fire stopping principle should be preferred. If the installation shaft principle is applied, there is a risk that it may not be possible to properly close off the inner fire stops when creating wall feed-throughs connecting to the shaft.

4.6 Fire protection

Fire stopping of pipe systems with branching pipes in the area of the R 30 – R 90 stop according to Rockwool ABP P-3726/4140 MPAGS*)

Fire stopping in solid floors for alpex heating pipes

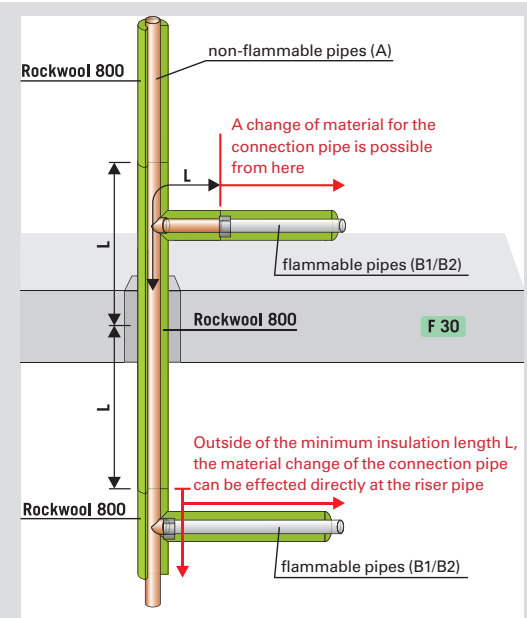


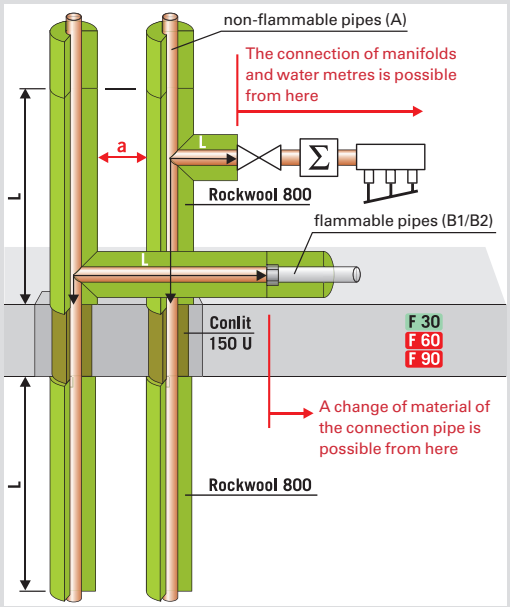
R 30 to R 90 fire stops for radiator connection pipes of metal composite pipe d ≤ 63 mm, maintaining a minimum insulation length L on one side of the feed-through (L ≥ 1,000 mm).

Fire stopping in solid floors for metal riser pipes and side branching pipes with alpex pipes

For pipes branching off within the minimum insulation lengths, these lengths must also be observed on the outgoing pipes.

Water metres and manifolds can be installed without difficulty beyond the end of the minimum insulation length L.





Connection pipes in riser pipes with feed-through insulation R 30, maintaining a minimum insulation length L on both sides of the feed-through (L ≥ 500 mm).

Connection pipes and manifolds on riser pipes with feed-through insulation R 60 to R 90, maintaining a minimum insulation length L on both sides of the feed-through (L ≥ 1,000 mm).

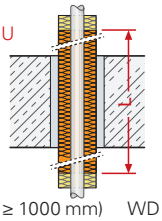
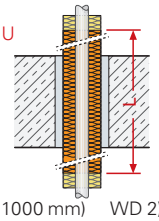
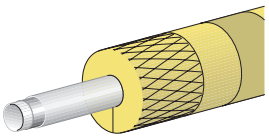
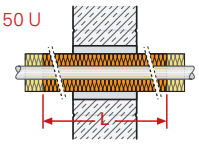
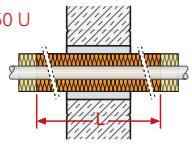
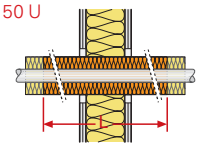
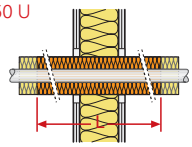
NB

*) The requirements of the general building authority Rockwool **AbP P-3726/4140 MPA GS** testing certificate must be met.

4.7 Fire protection solutions

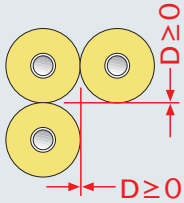
R 30 to R 90 pipe feed-throughs for the alpex installation system with Conlit 150 U for non-flammable media, e g., drinking water and heating

Possible designs according to Rockwool ABP P-3726/4140-MPA BS

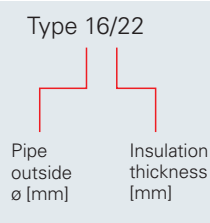
F 30 to F 90 building elements	R 30	R 60 bis R 90	
	For requirements based on building classes, see pages 42/43		
Solid floor thickness at least 150 mm	Conlit 150 U  (L ≥ 1000 mm) WD 2)	Conlit 150 U  (L ≥ 1000 mm) WD 2)	RS 800 minimum thickness 30 mm 
Solid wall thickness at least 100 mm	Conlit 150 U  (L ≥ 1000 mm) WD 2)	Conlit 150 U  (L ≥ 1000 mm) WD 2)	
Light-weight separating wall thickness at least 100 mm	Conlit 150 U  (L ≥ 1000 mm) WD 2)	Conlit 150 U  (L ≥ 1000 mm) WD 2)	

Pipe dimension outside ø Do [mm]	Conlit 150 U		Rockwool 800 [1) 2) 3)]			
	Type [mm]	Insulation thickness[3] s [mm]	Drill hole diameter s [mm]	(GEG) 100 % hot, type	(GEG) 50 % hot, type	DIN 1988 cold, type [4]
alpex-duo XS						
16.0	16/22	22.0	60	18/20	18/20	18/20
20.0	20/20	20.0	60	22/20	22/20	22/20
26.0	26/17	17.0	60	28/20	28/20	28/20
32.0	32/24	24.0	80	35/30	35/20	35/20
alpex L						
40.0	40/20	20.0	80	42/40	42/20	42/20
50.0	50/25	25.0	100	54/50	54/30	54/30
63.0	63/33.5	33.5	130	64/60	64/30	64/30
75.0	75/52.5	52.5	180	76/70	76/40	76/30

Spacing rule



Type designation



Notes / special installation conditions:

1) In some cases, the minimum available insulation thickness is indicated.
2) Rockwool 800 insulation jacket can be used as continuing insulation.
3) Insulation thickness acc. to GEG 50 per cent and acc. to DIN 1988-200 matching the drill hole diameter.
4) According to DIN 1988-200, there must be a vapour barrier for cold pipes, i.e., Conlit fire stop pipe jacket 150U/ insulation jacket 800 must be used. If necessary, pipe jackets without protective film should be wrapped in aluminium foil at the construction site.

All installation conditions specified in the general building authority testing certificates (AbP) or the general building authority approval (AbZ) must be observed.

4.7 Fire protection solutions

R 30 to R 90 or R 120 pipe fire stopping "FRÄNKISCHE alpex multilayer composite pipes" with Rockwool 800 for alpex installation system for non-flammable media, e g., drinking water and heating

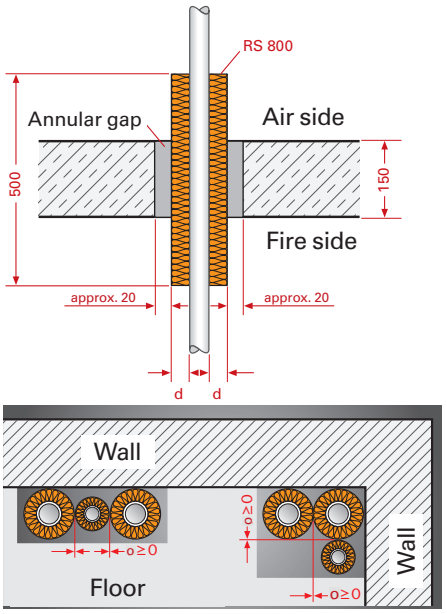
Possible designs according to FRÄNKISCHE AbP-P 3147/584/11-MPA BS

Please refer to the following table for the required lengths and minimum thicknesses of the RS 800 pipe fire stopping for the flammable alpex pipes.

Solid floor ≤ 150 mm

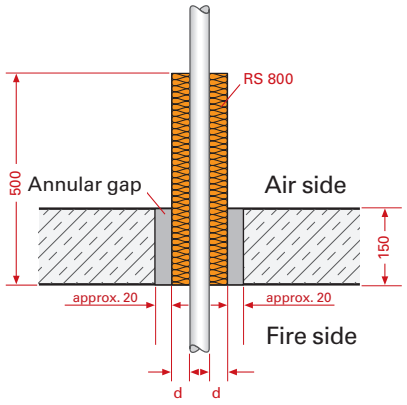
alpex multilayer composite pipe (PEX/AL/PE-RT) with Rockwool pipe jacket 800
Lead-through of single pipes and pipe pairs with 0 distance with symmetrical arrangement

Outside diameter [mm]	Wall thickness [mm]	Length of the insulation [mm]	Minimum insulation thickness [mm]	Description	Classification
≤ 50	2–4	≥ 500	≥ 20 ≤ 70	Rockwool 800	R 30–120
> 63 ≤ 75	4.5–5	≥ 500	≥ 30 ≤ 70	Rockwool 800	R 30–90



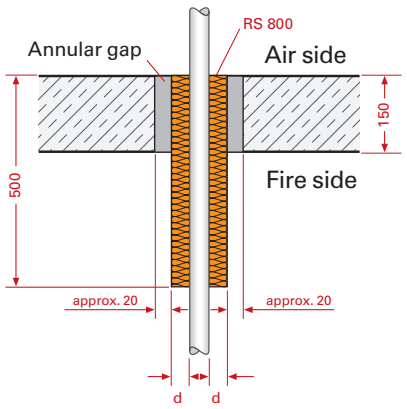
alpex multilayer composite pipe (PEX/AL/PE-RT) with Rockwool pipe jacket 800
Lead-through of single pipes with asymmetric arrangement with a spacing of a ≥ 100 mm

Outside diameter [mm]	Wall thickness [mm]	Length of the insulation [mm]	Minimum insulation thickness [mm]	Description	Classification
16 – 75 mm	2–5	≥ 500	≥ 20 ≤ 70	Rockwool 800	R 30–120



alpex multilayer composite pipe (PEX/AL/PE-RT) with Rockwool pipe jacket 800
Lead-through of single pipes with asymmetric arrangement with a spacing of a ≥ 100 mm

Outside diameter [mm]	Wall thickness [mm]	Length of the insulation [mm]	Minimum insulation thickness [mm]	Description	Classification
≤ 50	2–4	≥ 500	≥ 20 ≤ 70	Rockwool 800	R 30–120
> 63 ≤ 75	4.5–5	≥ 500	≥ 30 ≤ 70	Rockwool 800	R 30-60



NB All installation conditions specified in the general building authority testing certificates (AbP) FRÄNKISCHE AbP-P 3147/584/11-MPA BS must be observed.

4.7 Fire protection solutions

DOYMA fire protection systems

Curaflam collar XS Pro

Clasping collar for fire stopping (R 30, R 60, R 90) of:

- alpex-duo XS multilayer composite pipes in dimensions 16 – 63 mm, also available with insulation made of synthetic rubber

Applications / installation (F 30, F 60 and F 90 building elements):

- Solid floors from 150 mm, installation: open collar only from the bottom side of the floor
- Solid walls and light-weight separating walls from 100 mm, installation: collars opened on both sides on the wall (connected with threaded bars for light-weight separating walls

The Curaflam XS Pro collar has been certified by the German Institute for Building Technology (DIBt) according to Z-19.17-1983. Zero clearances between Curaflam XS Pro for drains to the alpex-duo XS fire protection system have been tested positively. Extended approval / extension of the general building authority testing certificate (AbP-P 3147/584/11) have been applied for.

Curaflam collar SM Pro

Fire protection collar system made of segments, can be adapted flexibly to different pipe diameters, for fire stopping (R 30, R 60, R 90) of:

- alpex-duo XS multilayer composite pipes in dimensions 16 – 75 mm, also available with insulation made of synthetic rubber or PE foam

Applications / installation (F 30, F 60 and F 90 building elements):

- Solid floors from 150 mm, installation: open collar only from the bottom side of the floor, alternative installation: flushly cemented in floor
- Solid walls and light-weight separating walls from 100 mm, installation: collars opened on both sides on the wall (connected with threaded bars for light-weight separating walls)

The Curaflam SM Pro collar has been certified by the German Institute for Building Technology (DIBt) according to Z-19.17-2067. Zero clearances within the system possible.

NB For further information, please see www.doyma.com

ARMACELL fire protection systems

ARMACELL PROTECT R-90

With the new ARMACELL PROTECT R-90, flammable pipelines can be fire-protected more easily than ever before Whether in floors, solid walls or light-weight walls. ARMACELL PROTECT R-90 ensures reliable fire protection in all building elements without any complicated extra measures. Armacell Protect R-90 has been designed for the remaining opening to be sealed with common mortar/filling compound. This removes all obstacles to a smooth construction process. ARMACELL PROTECT R-90 has been tested and certified according to the P-MPA-E-07-009 general building authority testing certificate of MPA NRW.

NB For further information, please see www.armacell.com

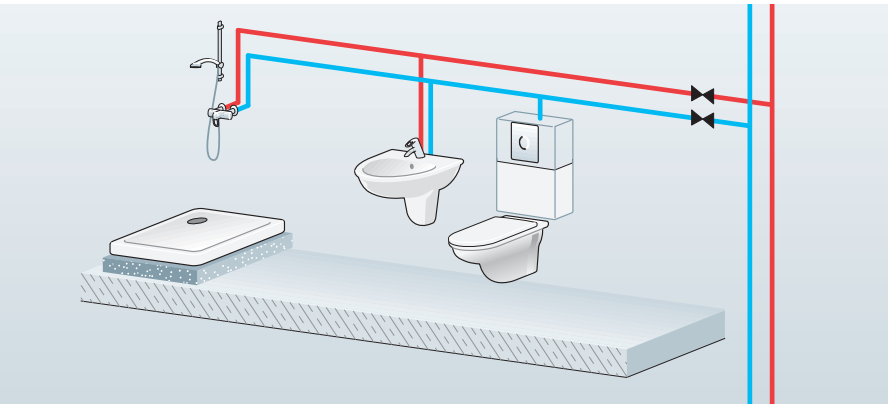
The options described are only a selection of the fire protection solutions for flammable pipes available on the market. However, we ask you to only use system solutions approved by the German Institute for Building Technology (DIBt) and to install them according to the instructions of the general building authority testing certificates. Fire protection solutions for pipe dimensions 75 × 5 available upon request: Technical hotline: 0 80 00 / 101 40 79

5.1 Drinking water systems – application examples

Tee installation

In conventional tee installations, individual consumers on a floor or in a utilisation unit are supplied via single pipes which are connected to a supply pipe/ storey pipe using tee fittings. This conventional and proven type of installation is used particularly to connect consumers with regular and frequent use, since this would otherwise lead to water stagnation.

By using larger pipe dimensions at the beginning of the pipe, this type of installation mostly features small pressure losses which benefits small supply pressures.
However, larger pipe dimensions contain more water which should not only be exchanged regularly but may also require circulation in the hot water pipe (> 3 litre rule).



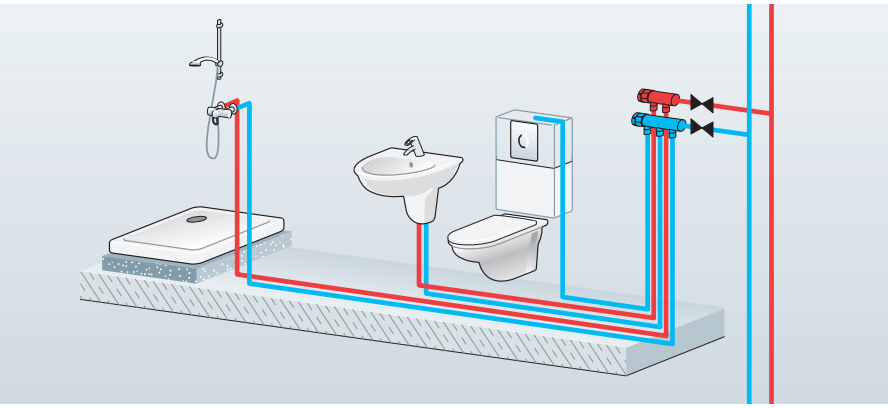
Tee installation characteristics

- Easy planning
- Easy routing
- Quick installation
- Little material consumption
- Little space required

Manifold installation

Via central or decentralised drinking water manifolds in a floor or a utilisation unit, single connections can be installed up to the respective tapping point. When connecting the alpex connection pipes to the drinking water manifold, these must be provided with the corresponding insulation according to the GEG. The pipe spacings for pipe runs must be observed (see Section 4.3).

The alpex pipe of the single-connection pipes is connected to the manifold with the alpex manifold connections with press connections in dimensions 16 × 2.0 and 20 × 2.0. The manifold bodies with 2-fold or 3-fold branches can be combined as desired depending on the size of the manifold cabinets.
If sporadically used tapping points with especially long pipe routing are connected to the manifold, this will lead to an increased risk of stagnation.



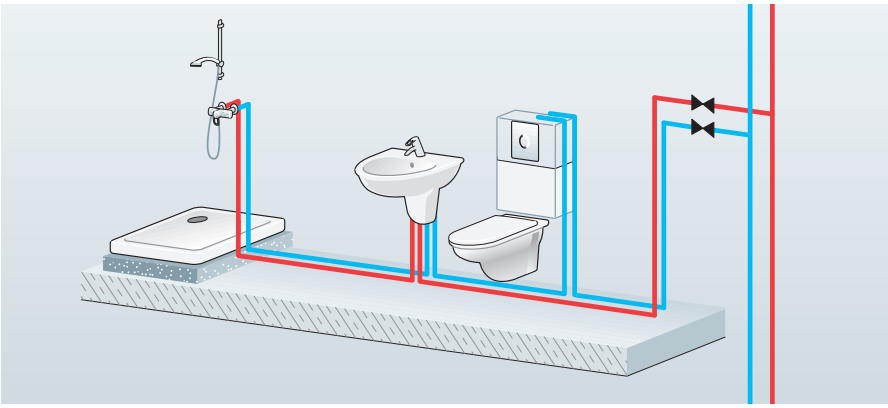
Manifold installation characteristics

- Easy planning
- Easy routing
- Quick installation
- Little material consumption
- Little space required
- Small water contents

5.1 Drinking water systems – application examples

Serial installation

In serial or looped installations, the first consumer is connected via fittings specifically developed for this type of installation from the riser pipe or storey pipes. The next consumer will then be connected directly from this consumer. This is repeated for each tapping point. When planning, it should be observed that the least commonly used consumers come first in the serial installation and the most frequently used consumer comes last. It is also beneficial to include less frequently used consumers with a high cumulative flow at the beginning of the pipe, since otherwise the necessary large pipe dimension must be installed from the pipe run branch across all upstream consumers. Due to this routing, there is only a small risk of stagnation.



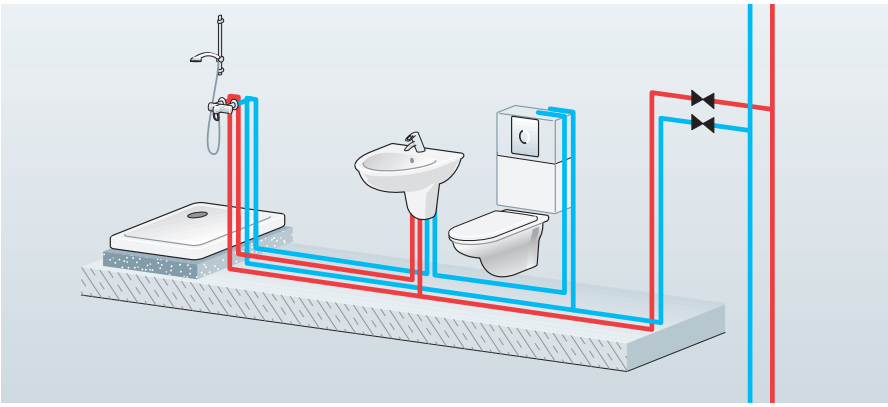
Serial installation characteristics

- Easy planning
- Routing in a meandering pattern
- Quick and time-saving installation
- Regular water exchange in the pipe routing
- No connections in the floor structure

Loop installation

The loop installation follows the same example as the serial installation by routing the pipe from one consumer to the next one. Since in this type of installation a pipe is routed from the last consumer to the starting point of the circle, each consumer within a circle is connected equally hygienically. You also do not have to consider a special arrangement of the consumers in the planning or their cumulative volume flow, since they are supplied with the required volume flow from both sides.

Due to the supply of the consumers from both sides, also the pressure loss in the pipe is reduced and noise generation is prevented as well due to the small volume flow per side. Due to a longer pipe section, loop installations with PWH can often lead to longer output times than required in the standard (DIN 1988-200 or VDI 6003). In this case the hot water pipe should be installed as serial installation.



Loop installation characteristics

- Calculation only possible using software
- Only one pipe dimension required
- No connections in the floor structure
- Regular water exchange in the pipe routing already when using one consumer

NB When using double wall mount elbows or F-dual connections in the hot water pipe and/or in combination with circulation pipes, serial and loop installation systems may lead to a risk of burning and damage of the fittings due to fittings becoming hot! FRÄNKISCHE therefore recommends connecting fittings via a cooling section of 10 × DN.

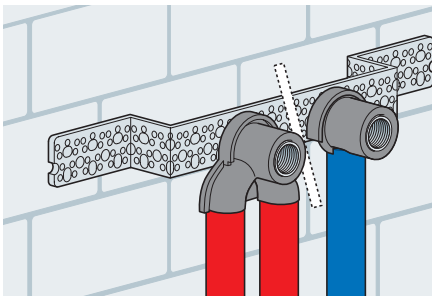
5.1 Drinking water systems – application examples

The following advantages of the individual systems should be considered when selecting the pipe distribution system. For example, extensive planning work is not required for a single feed pipe from the drinking water manifold, because usually only one pipe dimension is used. The pipe distribution system including double wall mount elbow or loop pipe distribution offers even pressure and temperature distribution as well as optimal water exchange thus reducing stagnation times. The insulation regulations of the GEG and DIN 1988 must be observed when installing pipes. If no insulation requirements are available, the alpex pipe must be installed in appropriate sheathing. Corresponding acoustic insulation is also available for the fitting connections such as the alpex wall mount elbow, double wall mount elbow and concealed toilet cistern elbow, which reduce the transmission of sound between the building structure or elements and the pipe system.

NB When using double wall mount elbows in the hot water pipe and/or in combination with circulation pipes, serial and loop installation systems may lead to a risk of burning due to fittings becoming hot!

Surface fitting connection

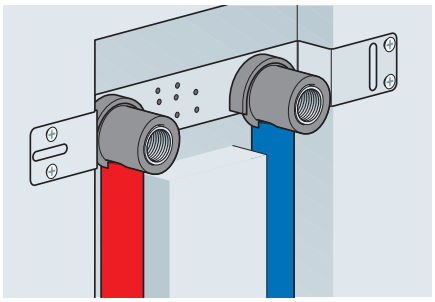
The alpex surface fitting connection is established with a pre-bent alpex wall mount plate fastened to the masonry or individually bendable alpex wall mount plates, including the alpex wall mount elbow. The alpex supply pipe is routed along the masonry to the alpex wall mount elbow or alpex double wall mount elbow. The alpex pipe distribution can be established as a single feed pipe from the drinking water manifold or via tee distribution.



Surface design

Concealed fitting connection

The alpex concealed fitting connection is established with a pre-bent alpex wall mount plate fastened in the masonry or individually bendable wall mount plate, including the alpex wall mount elbow. The alpex feed pipe is routed in a channel in the masonry to the alpex wall mount elbow.
The alpex pipe distribution can be established as a single feed pipe from the drinking water manifold or via tee distribution. When installing connection pipes in masonry or in walls, DIN 1053 “Masonry – Creation of channels” must be observed.

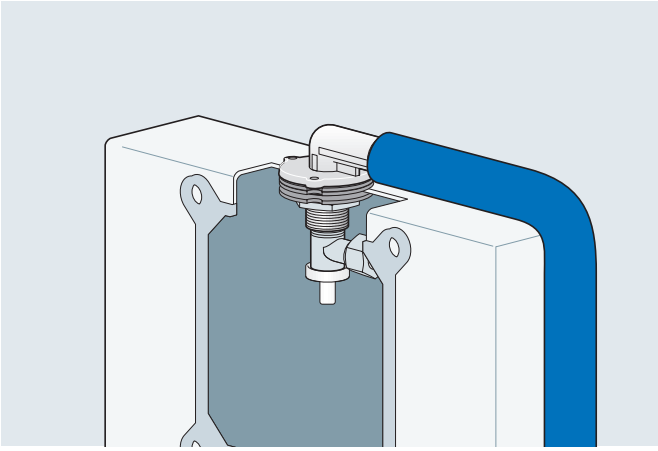


Concealed design

5.1 Drinking water systems – application examples

Toilet cistern connection

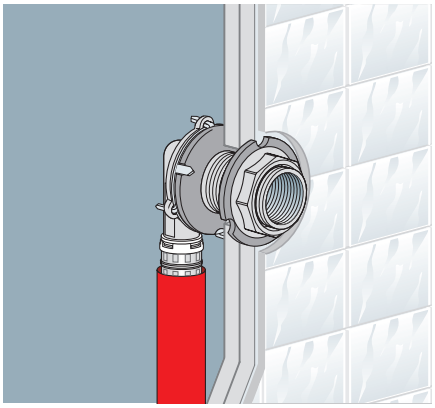
The toilet cistern connection is established using the alpex adapter elbow with female thread for toilet cisterns with existing threaded connection or using the alpex concealed toilet cistern elbow. For Geberit concealed toilet cisterns as of 2002, direct connections to Geberit concealed toilet cisterns are possible using alpex adapter elbows. The alpex pipe distribution can be established as a single feed pipe from the drinking water manifold, via tee distribution or loop pipe distribution including double wall mount elbow. For loop pipe distribution systems, an alpex pipe piece must be placed between the double wall mount elbow and the toilet cistern connection elbow or the alpex adapter.



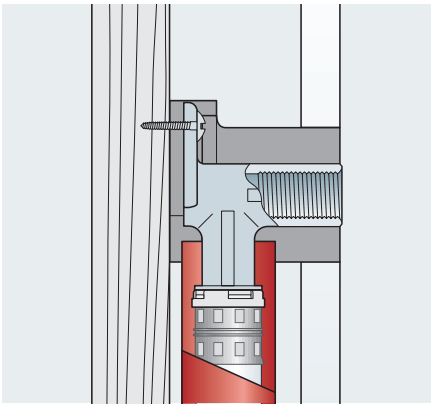
alpex concealed toilet cistern elbow

Pre-wall installation

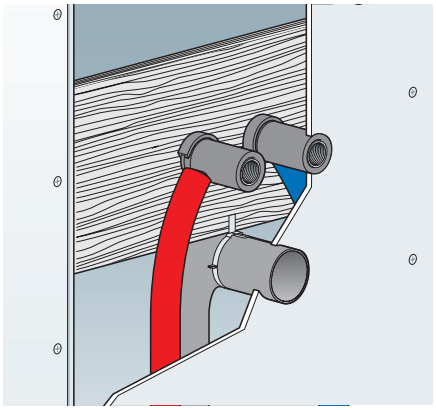
Drinking water installations in dry construction with the alpex installation system can be done as a single feed pipe system via the drinking water manifold, as loop pipe system or tee distribution from the riser pipe. Depending on the distribution form, the fitting connections may be the alpex wall feed-through for light-weight construction, the alpex wall mount elbow or the alpex double wall mount elbow. Ensure moisture protection in the area of sanitary fittings and feed-throughs. The sealing against the plasterboard should be accomplished according to the accepted technical practices, e.g., with a sealing collar or seals by standard manufacturers (Knauf, Rigips, Schönox, Sopro, etc.).



alpex wall feed-through in light-weight construction



alpex wall mount elbow



alpex wall mount elbow

5.1 Drinking water systems – application examples

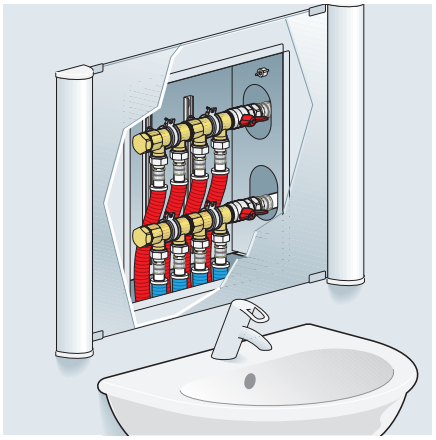
Connection to manifold

Individual connections and tee distributions can be established from the central drinking water manifold to the respective tapping points. Connection options include an assembly kit, wall mount elbow and the alpex pipe with alpex compression fittings, compression adapters or manifold connections with press connection. When connecting the alpex connection pipes to the drinking water manifold, these must be provided with the corresponding insulation according to the GEG. The pipe spacings for pipe runs must be observed. The alpex pipe is also connected to the manifold with pressed alpex manifold connections in dimensions 16×2.0 and 20×2.0. The manifold bodies can be combined together for up to 2 to 10 manifold connections each, depending on the size of the manifold cabinets. Cold and hot water connection pipes must be connected to the manifold without tension. The connection of the manifold to the cold and hot water riser pipes is established directly via the manifold ball valves and any hot water metering device installed, including its shut-off valve.

Manifold locations

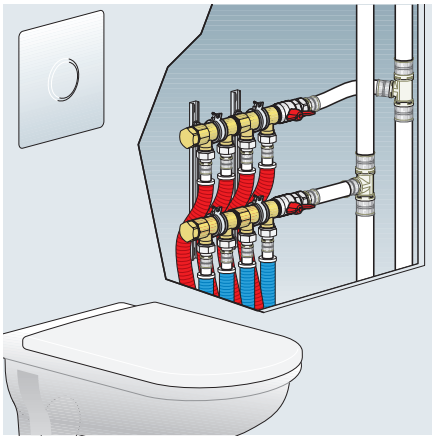
alpex manifolds can be located in various ways depending on the installation conditions. Thanks to the reliable, unremovable press connection with longitudinal friction locking, floor manifolds can be installed in inaccessible locations according to DIN 1988, Part 200. They do not require an inspection opening.

The following examples show common possible installations of alpex manifolds:



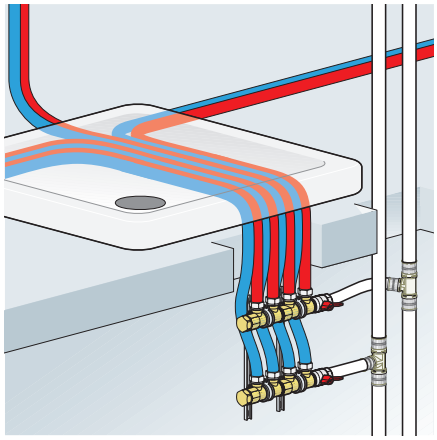
Manifold in concealed housing

Manifold located behind a mirror. In this case, the manifold is easily accessible, which is particularly important for decentralised metering.



Manifold in the pre-wall

Manifold in the pre-wall with direct connection to the alpex riser pipe. The open area of the pre-wall is used here for housing of the manifold.



Manifold beneath the basement floor

Manifold situated beneath the basement floor with central hot water supply, e.g., in a single-family home.

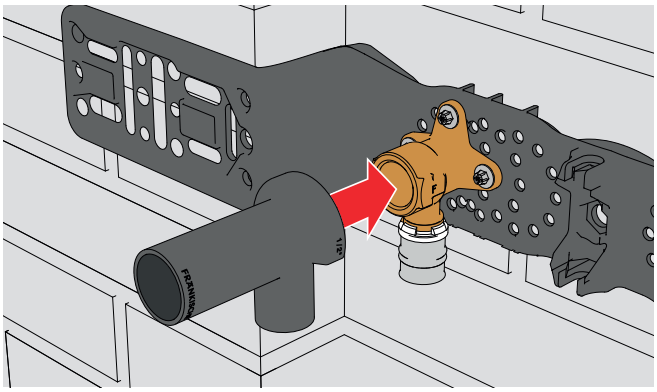
alpex drinking water manifold

Manifold connections	2	3	4	5	6	7	8	9	10
Number of double manifold bodies	1	–	2	1	–	2	1	–	2
Number of triple manifold bodies	–	1	–	1	2	1	2	3	2
Total manifold length [mm]	130	185	234	289	344	393	448	503	552

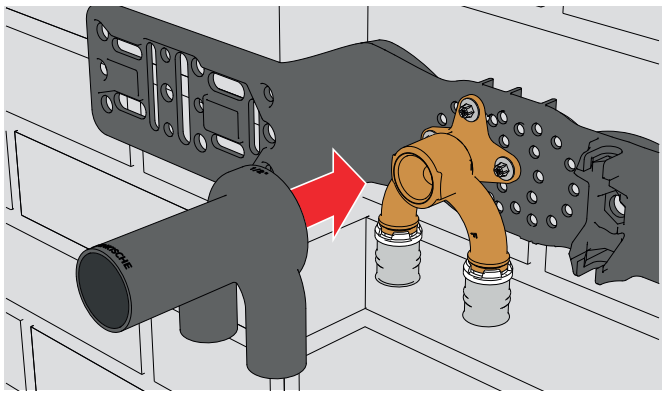
5.2 Drinking water systems – sound insulation and water heaters

Sound insulation

DIN 4109 specifies the conditions for sound insulation in buildings. All installation and system components must be properly isolated from the building structure during installation of the pipe systems. In addition, single shell walls must have a mass per unit area of at least 220 kg/m² for installations in order to sufficiently dampen structure-borne sound transmission. The most effective and cost-efficient sound insulation measure is a carefully planned installation. It should absolutely be considered during planning that resting and living rooms should, where possible, not border on walls in which sanitary fittings and equipment as well as pipes are installed. Sound transmission in the area of sanitary installations is primarily caused by structure-borne noise. In addition to low-noise fittings of fitting group I and the use of sound-insulated pipe brackets, alpex isolation measures in the form of two-part noise absorption kits for fastening of elbow fittings should be included in the planning. Pipe connectors that are installed directly into masonry or screed must be wrapped in insulation material. Structure-borne sound transmission depends on the sound transmission properties of the respective pipe material. The density and modulus of elasticity of the pipe material are the decisive parameters for the sound velocity. This sound velocity is very low in cross-linked polyethylene, giving alpex pipes excellent sound insulation properties.



alpex sealing for wall mount elbows



alpex sealing for double wall mount elbows

Water heaters

alpex multilayer composite pipes can always be connected to water heaters without metallic tie-in section if the water heaters do not generate water temperatures higher than 70 °C in accordance with the standards (DIN 4753, DIN VDE 0700, DIN 1988). For older hydraulically controlled, electric and gas-fired continuous-flow heaters, which can result in temperatures over 95 °C, we recommend a metallic tie-in section of 1 m. Continuous-flow water heaters can only be approved directly by the heater manufacturer. When using electronically controlled drinking water heating devices, the manufacturer's specifications must be observed.

5.3 Drinking water systems – hygiene

Planning, design, operation – prevention of legionella

Drinking water installations must be planned, designed and operated with particular accuracy according to DIN EN 806 and DIN 1988. VDI 6023 applies in addition. Measures for reduction in legionella growth are specified in DVGW worksheet W 551.

Among others, the following criteria should be observed when planning drinking water installations:

- Minimising stagnation – e.g., avoiding bypass and drainage pipes and designing rarely used tapping points as serial or loop pipes
- Separating pipe sections that are not needed or in operation right at the branch
- Enabling rapid water exchange by correct dimensioning
- Avoiding non-circulating storey or single pipes without trace heating
- Keeping the storage water volume as low as possible
- Preferring dry leak testing
- Planning and design according to the accepted technical practices
- Using products with accepted approval marks such as DIN DVGW
- Material selection according to DIN 1988, DIN 50930-6 and DIN EN 12502
- Ensuring hydraulic balancing in the circulation system
- Including sampling valves in public buildings
- Avoiding aerosol formation at tapping fittings
- Selecting single backflow protection systems
- Avoiding diaphragm type expansion tanks in TWW systems if possible
- Separating fire mains from drinking water pipes

Temperatures between 30 °C and 45 °C encourage legionella growth, i.e., the elevated infection risk is directly related to the temperature of the drinking water installation system. The following points are therefore also important:

- Planning the maximum possible clearing from drinking water pipes (cold) to heat sources
- Providing sufficient insulation of drinking water pipes (cold and hot) in shafts and suspended ceilings
- No more cooling of the circulating water temperature than 5 kelvin in hot water and circulation pipes
- Min. 60 °C drinking water reservoir temperature
- Max. ≤ 25 °C cold water temperature

The smooth pipe surface and the cross-linked polyethylene layer applied to the inside of the alpex multilayer composite pipe help reduce encrustation.

NB More information can be found at: https://ecdc.europa.eu/en/legionnaires-disease

Transport, storage and installation

Aside from planning, design and operation, also transport, storage and installation play an important role for impeccable drinking water quality. In order to avoid contamination of the surfaces coming into contact with water already before installation, the building elements must be stored and transported properly.

- alpex press connectors should only be unpacked right before installation to avoid contamination.
- All alpex F50 PROFI and alpex L pipes are provided with end plugs ex-factory to prevent contamination. Therefore, all pipes should be stored in their original packaging until installation.
- Pipe ends should be resealed with the end plugs after installation.
- All system components must be protected against dirt, dust, chemicals, solvents, paints, oils, greases, PU foam, etc.
- The pipes must not be pulled over sharp edges or concrete surfaces and must always be stored on level ground.
- The system components must be protected from contact with chemicals and damage (e.g., during storage and transport, in the vicinity of vehicles, machines or livestock, browsing by animals).
- Damaged components must not be repaired but replaced.
- Dirty pipes, fittings and accessories must not be installed.

5.4 Drinking water systems – pressure testing

Pressure testing of drinking water pipes

Pressure testing using compressed air and inert gas

If the pressure test with drinking water falls within a period with freezing temperatures or if an extended period of time is expected between the pressure test and operation of the pipe, we do not recommend performing the pressure test with water. In addition to freezing damage, failure to completely empty the pipes in particular may impair the hygienic condition of all system parts. For this reason, we recommend performing the pressure test with compressed air or inert gases in such cases. Due to the compressibility of gases, different requirements must be considered for physical and safety reasons when performing the pressure test with compressed air or inert gas as opposed to water. The procedures described in the ZVSHK advisory leaflet "Leak testing of drinking water installations with compressed air, inert gases or water" should be followed.

Leak test
The leak test is performed at a test pressure of 150 mbar before the strength test. The manometer used must have an indication precision of 1 mbar (10 mm water column) for the pressures to be measured. The U-pipe manometers familiar from the TRGI test or the standpipes can be used for this. Components in the pipe system must be rated for the test pressures or removed before the test. After application of the test pressure, the test time for up to **100 litres** of pipeline volume must be at least **120 minutes**. The **test time must be increased by 20 minutes** for every 100 litres of pipeline volume. The leak test starts upon reaching the test pressure, in consideration of the temperature equalization.

Strength test
The strength test is combined with a visual inspection of all pipe connections to check whether the compression and screwed connections were established with a proper seal. Subjecting the system to increased pressure is limited to a maximum of 3 bar for nominal widths smaller than or equal to 63×4.5 and maximum 1 bar for nominal widths larger than 63×4.5 for a test period of **10 minutes.**

The following media can be used for the leak and load tests:
- Oil-free compressed air
- Inert gases, e.g., nitrogen and carbon dioxide
- Forming gas with 5 % hydrogen in nitrogen (used to locate leaks)

Safety equipment such as pressure reducers on compressors must ensure that the planned test pressure is not exceeded within the pipe system.

For pressure test reports, see Section 11.4 or download area at www.fraenkische.com

Pressure testing using water

DIN EN 806-4 Section 6 requires pressure testing of drinking water pipes with filtered water after completion of installation but while still not covered. The pressure gauge must be connected to the lowest point in the system. Gauges that indicate a pressure difference of 0.1 bar may be used only.
Temperature equalization is required for a temperature difference of larger than 10 K. For this reason, the temperature of the installation should match that of the test medium. In addition, every connection point must be visually inspected for correct pressing.

Conducting the pressure test
The pressure test is performed as a leak and strength test, whereby the leak test is sufficient for smaller system components such as connection and distribution pipes within wet rooms.

Leak test
After having filled the system with water, the alpex connectors are visibly leaky when implementing the leak test in the range from **1 to 6.5 bar** in the unpressed state in accordance with the ZVSHK advisory leaflet "Leak Testing for Drinking Water Installations". Visual inspection required.

Strength test
The strength test is performed immediately after a successful leak test with **min. 11 bar** and lasts for **30 minutes**. The test pressure indicated during the strength test must not drop during this time. There must be no leaks anywhere within the tested system.

For pressure test reports, see Section 11.4 or download area at www.fraenkische.com

5.5 Drinking water systems – rinsing and commissioning

Rinsing of drinking water pipes

General information

Drinking water pipes must be rinsed with drinking water as soon as possible after installation and pressure testing and immediately before commissioning. Drinking water must be used for rinsing.

A mechanic filter according to EN 13443-1 must be used, since particles in the water may damage the installation.

Rinsing with water

When rinsing with water, the pipe is rinsed with normal supply pressure. The minimum flow velocity when rinsing the installation must be 2 m/s. Rinsing should achieve a water exchange of at least 20 times the system volume.

- Maintenance fittings (shut-off devices, stop valve) must be completely open.
- Sensitive fittings and devices must be removed or replaced or bridged with adapters.
- Aerators, tap aerators, restrictors must be removed.
- Installed strainers and dirt traps upstream of fittings must be cleaned after rinsing with water.

DIN EN 806-4 describes this procedure in detail.

- Rinsing starts at the main isolation valve in the rinsing process by sections to the most remote tapping point or in the lowest floor of the building and upwards floor by floor.
- Each tapping point must be completely opened starting with the one most remote from the riser.
- After riser, all tapping points are closed starting with the one closest to the riser.

Rinsing procedure with a water/air mixture

This rinsing procedure is an alternative to rinsing with water and should be used if this did not lead to sufficient rinsing, e.g., with mixed installations of metal and alpex.

The procedure is based on a pulsing stream of water and air and is described in more detail in DIN EN 806-4.

Commissioning of drinking water pipes

The following must be observed when commissioning drinking water installations:

- The prerequisite for proper and hygienic commissioning is correct planning and execution as well as proper transportation and storage before and during installation.
- Commissioning should take place right before permanent operation.
- The system should be rinsed right before commissioning.
- The operator must ensure that, after commissioning, drinking water is regularly extracted from the tapping points to avoid stagnation.

According to the Drinking Water Ordinance (TrinkwV 2001), the operator of a system is responsible for proper expansion, changes and maintenance of the drinking water installation starting from the building connection (with the exception of the water meter) incl. regular water extraction.

When handing over an object, the operator must be informed in particular that he/she is responsible for the regular and complete exchange of the drinking water and proper operation of all tapping points from then on.

- The customer should be informed about his/her operator duties according to DIN 1988-8 during approval/instruction
- The planning basics and all records, e.g., of leak test and strength test, rinsing and instruction must be handed over to the operator together with the operating manuals. The ZVSHK drinking water installations manual includes these documents which can be handed over to the operator upon approval.

For rinsing protocol / commissioning report, see Section 11.5 or download at: www.fraenkische.com.

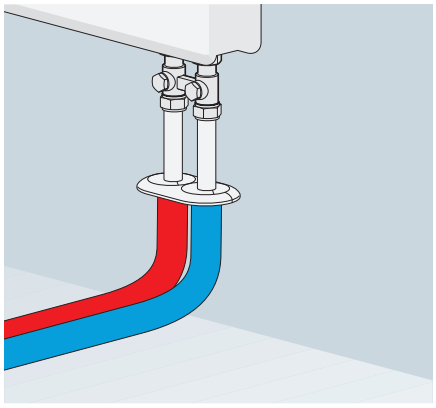
6.1 Heating systems – application examples

The insulation regulations according to the GEG must be observed when installing pipes. According to these regulations, alpex pipes must be installed with sheathing if no insulation requirements are available and with insulation if this is required. Installation of pipes in the skirting board represents an exception, since the alpex pipe can, in this case, be installed without insulation.

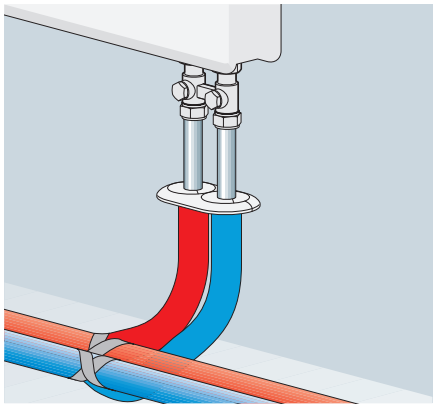
The use of double covers for two-pipe systems or single covers for one-pipe systems ensures clean ends of the visible radiator connection pipes on the floor or wall surfaces. alpex radiator compression fittings must be connected with "euro-cone" openings standardised in DIN EN 16313:2013-08.

alpex pipe connection to the radiator from the floor

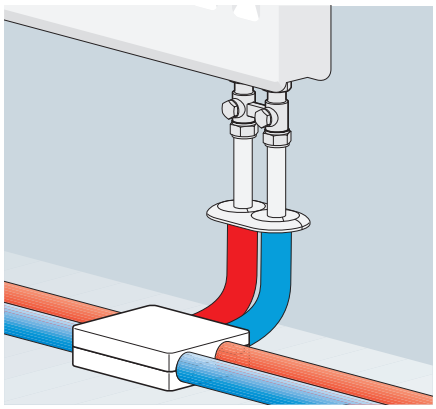
The radiator connection from the floor can most easily be established directly with the insulated alpex pipe via the radiator compression fitting. This option is used for one- or two-pipe systems via the individual feed pipe from the manifold and for distribution using normal tees or crossover tees in the floor structure. The excellent dimensional stability of alpex pipes is an advantage, since no subsequent bending of the pipes occurs after the bending of 90° bends. Insulation measures such as wrapping of the tees with suitable insulation material and embedding of the crossover tee in the specifically matching noise absorption kit must be observed. alpex pipe feed-throughs through the screed slab must be executed either with pipe insulation or sheathing.



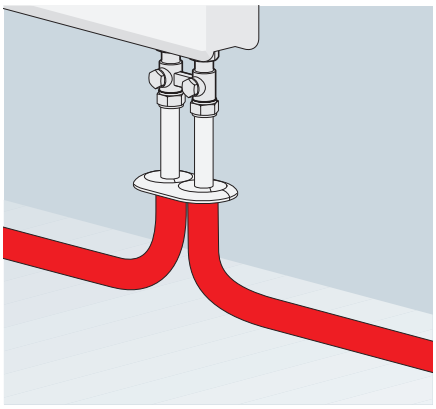
alpex single-connection from manifold



alpex tee distribution



alpex connection via crossover tee



alpex single pipe system

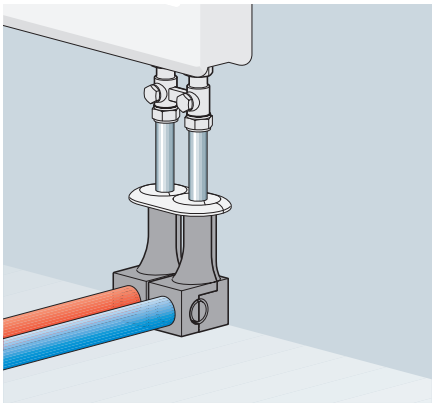
6.1 Heating systems – application examples

Fitting connection to radiator from the floor

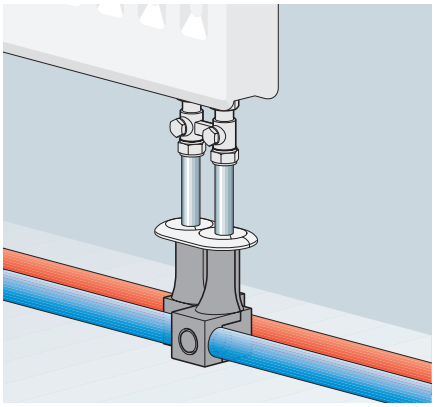
The radiator connection from the floor is established with alpex fittings such as radiator connection bends or tees in nickel-plated design via the radiator valve compression fitting. The radiator connection bends are used in one- or two-pipe systems via the individual supply pipe from the manifold and for distribution using normal tees or crossover tees in the floor structure. The radiator connection tee allows efficient installations of two-pipe loop pipes without additional fittings. Insulation measures such as wrapping of the normal tees with suitable insulation material and embedding of the crossover tee in the specifically matching noise absorption kit must be observed.

Sound insulation is used for both acoustic isolation between the bare concrete floor and the screed slab and for the alpex radiator connection bend and the alpex radiator connection tee.

This sheathing also provides thermal insulation around the screed feed-through.



alpex single connection from manifold with radiator connection bend

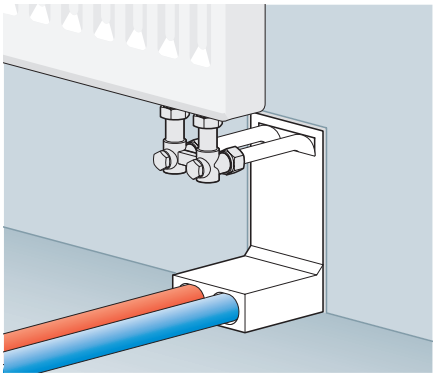


alpex loop pipe with radiator connection tee

6.1 Heating systems – application examples

Radiator connection from the wall

For reasons of hygiene, radiator connections coming out of the wall are becoming more common than those coming out of the floor. The alpex system offers two radiator connection blocks, each with integrated alpex pipe 16×2 mm. The radiator connection block is available 260 mm high for floor structures up to 100 mm and 310 mm high for floor structures up to 150 mm. The radiator connection block allows for pipe distribution within the floor structure, an individual supply pipe directly from the manifold and a tee distribution with normal tees or crossover tees. For two-pipe installations with an individual feed pipe from the manifold, the pipe is connected directly to the radiator connection block mounted to the wall via a fitting within the floor structure. The connection of the alpex pipe to the radiator takes place using the respective alpex compression fittings 16×2.

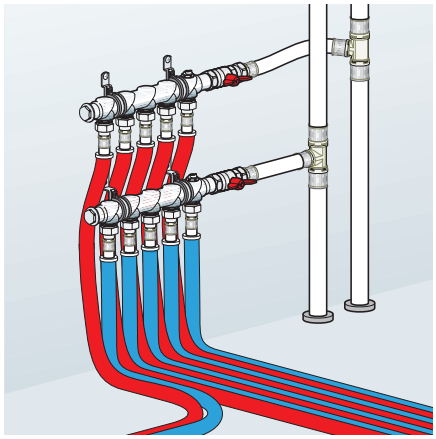


alpex single connection from manifold with radiator connection block

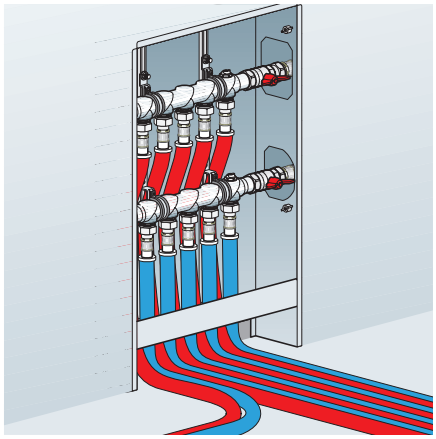
Possible connection to manifold

Individual connections and tee distributions can be installed from the central heating pipe manifold to the respective radiator connections. Radiator connection options include radiator connection bends, a wall connection block or the alpex pipe itself with alpex compression fittings or alpex manifold connections with press connection. According to the applicable GeG, the radiator connection pipes routed to the radiator manifold must either be completely wrapped with the corresponding insulation or, if no requirements are available, installed in protective sheathing. The pipe spacings for pipe runs must be observed.

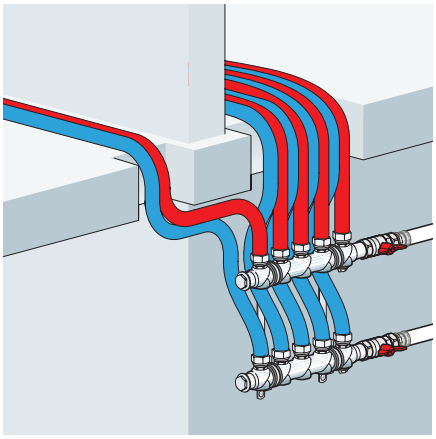
The alpex pipe is also connected to the manifold with alpex compression fittings or the pressed alpex manifold connections in the dimensions 16×2.0 and 20×2.0. Depending on the size, the heating manifolds can be mounted with 2 to 12 feed and return connections each. The feed and return connection pipes must be connected to the manifold without tension. The manifold connection to the riser feed and return pipes takes place directly via the manifold ball valves (3/4" or 1" with female thread) and any installed hot water meter including its shut-off valve.



Mounting of the manifold to the building structure



Mounting of the manifold in the manifold cabinet

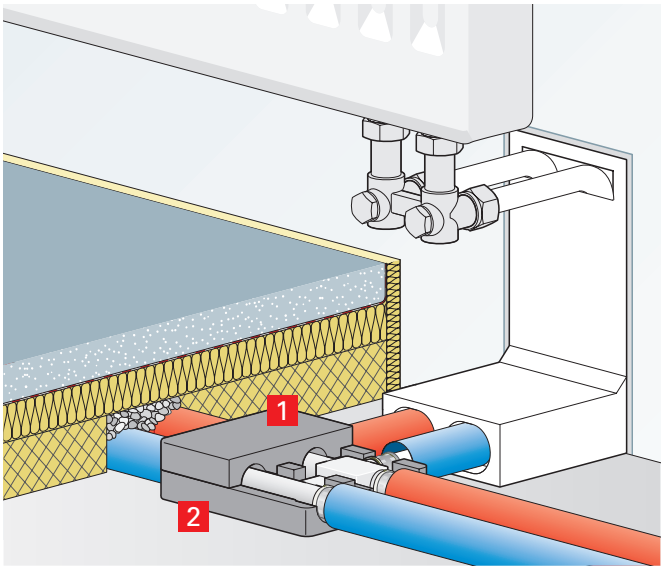


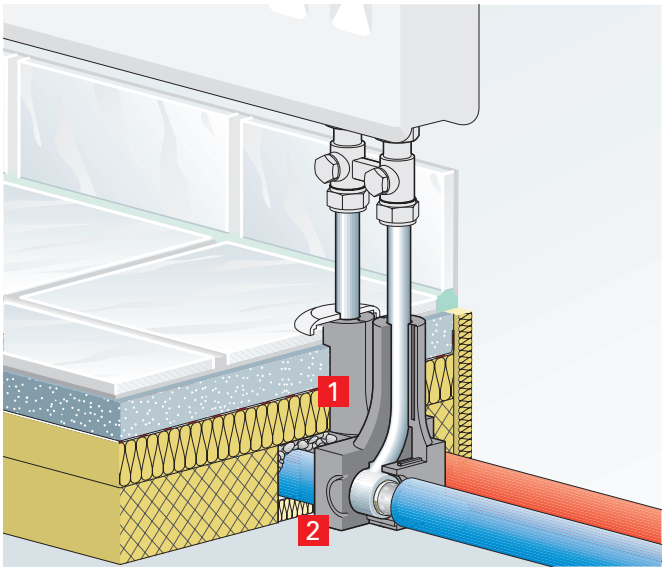
Mounting of the manifold beneath the basement floor

6.2 Heating systems – sound insulation and pressure testing

Sound insulation

alpex sound insulation must be installed to achieve acoustic isolation of the alpex radiator connection fittings. The sound insulation element can be used for both the radiator connection bend and radiator connection tees. This insulating sheathing and decoupling prevents contact and therefore structure-borne acoustic bridges between the metallic connection fittings and the bare concrete floor as well as between the connection fittings and the screed slab. The sound insulation sheathing protects the screed against corrosive influences that would result from the feed-through of the radiator connection fittings through the screed slab. Sound insulation can be mounted with the respective radiator connection fittings for either a radiator connection from the floor or from the wall.





1 acoustic isolation from the screed slab

2 acoustic isolation from the bare concrete

The isolation of the crossover tee is achieved by the noise absorption kit. This involves embedding of the metal body of the crossover tee into the two-part noise absorption kit.

The sheathing provided by the noise absorption kit acoustically isolates the crossover tee from the bare concrete floor below and the screed slab above.

Pressure testing of the heating system

The leak test must be performed according to DIN 18380. The plumber/installer must pressure test the system after installation and before closing the masonry channels, wall and floor penetrations. Prior to this, a visual inspection must be performed to verify correct and complete pressing of the joints. The contractor must issue a pressure test certificate and provide the customer with a copy. Hot water heating systems must be tested with a pressure that is 1.3 times the total pressure at every point in the system, however, no less than 1 bar of excess pressure.

After reaching the test pressure, it is necessary to wait for the ambient temperature and the water temperatures to equalize. It may be necessary to restore the test pressure after the waiting period. The pressure must not fall below the test pressure during the subsequent 60-minute test duration. Pressure gauges with an indication precision of 0.1 bar may be used only.

Upon completion of the cold water test, the system must be leak tested at the maximum temperature by heating to the highest hot water temperature used in the calculation.

For pressure test report, see Section 11.4 or download area at www.fraenkische.com.

7. Stormwater

General information

Identification/risk of confusion

Water-carrying pipes of stormwater utilisation systems must be designated as such by colour in order to prevent confusion between the drinking water supply system and other supply systems. All tapping points that are supplied with stormwater must be labelled with the words "No drinking water" or with an equivalent symbol.

Quality of collected stormwater

Various comprehensive scientific studies have shown that stormwater collected from thoroughly planned and built stormwater systems should satisfy the following quality requirements:

- Colourless, clear, without odour
- Free of turbid and fatty substances
- Less than 1 dH degree hardness, i.e., very soft
- Within the physiologically neutral range (pH between 6.2–8.7)

If these requirements are met, no increased corrosion is expected.

Requirements

DIN 1988 "Drinking water supply systems" must be complied with when installing a stormwater distribution network and the tapping points.

- Dimensioning of pipe diameter according to DIN 1988
- Pipes made of corrosion-resistant material
- Long life of pipes
- No connection between the stormwater and drinking water networks

The stormwater distribution network must be strictly separated from the drinking water network. The pipes of these two networks must not be directly connected. The stormwater network only supplies tapping points at which water of drinking quality is not required.

Distribution network

Two different installation systems must be used for the drinking water and the stormwater networks in the building in order to prevent confusion or connections between the networks during subsequent repair, modification and expansion work. Plastic (PE or PP) or multilayer composite pipes are preferred for stormwater pipes.

Information material

- The DVGW advisory leaflet twin 5 provides general information on stormwater utilisation systems, the ZVSHK advisory leaflet "Stormwater utilisation systems" includes concrete information regarding planning, construction, operation and maintenance of such systems.
- DVGW worksheet W 555 "Stormwater utilisation systems in private homes"

8. Compressed air

General information

alpex pipes can be used in compressed air systems with operating pressures up to 12 bar and up to quality class 1–3 (see table to the right). Respective filters are required in the system to reach class 1–3.

Compressed air quality by quality class acc. to ISO 8573.1

Quality class ISO 8573.1	Max. particle size [µm]	Max. particle density [mg/m³]	Max. dew point under pressure [°C]	Max. oil concentration [mg/m³]
1	0.1	0.1	-70	0.01
2	1	1	-40	0.1
3	5	5.1	-20	1.0
4	40	10	+3	5
5	–	–	+10	25

Compressed air installation

Pressure loss Δp dimensioning sizes

Compressed air installations with a maximum pressure p_{max} of 8 bar or more should not exceed a total pressure loss across the pipe network up to the consumer of Δp = 0.1 bar. FRÄNKISCHE recommends the following values for the individual pipe types:

- Main pipe Δp ≤ 0.04 bar
- Distribution pipe Δp ≤ 0.04 bar
- Connection pipe Δp ≤ 0.03 bar

The following applies to pipe networks with maximum pressures smaller than or equal to 8 bar:
Pressure loss pipe network Δp ≤ 1.5 bar of p_{max}.

Compressed air pipes

A compressed air pipe is generally divided in three pipe types:

- Main pipe
- Distribution pipe
- Connection pipe

The main pipe

The main pipe connects the compressors with the distribution pipes. The compressed air conditioning and the compressed air reservoir are generally connected to the main pipe, which transports the total delivery volume of the compressor. The pressure drop in the main pipe should not exceed 0.04 bar.

Distribution pipe as loop pipe

Distribution pipes should be designed as loop pipes if possible. This significantly increases the efficiency of the system. A loop pipe forms a closed distribution circle. This allows blocking individual sections of the network without interrupting the compressed air supply of the other areas. Compressed air has a shorter route here as compared to branch distribution pipes. When dimensioning the loop pipe, half the pipe length in terms of air flow and half the volume flow can be assumed.

Distribution pipe as branch pipe

The branch pipes connect the main pipe with the connection pipes. Branch pipes are often used to supply remote consumers. Frequently, branch pipes are used to save pipe material. This advantage is, however, most of the times eaten up because they need to be dimensioned larger than loop pipes. The pressure loss of branch pipes may not exceed 0.3 mbar.

Connection pipes

Connection pipes connect the consumers with the supply pipe. Generally, compressed air consumers are operated at different pressures. Therefore, most of the times a pressure controller is installed at the end of the connection pipe. Connection pipes are always connected from above and then routed down since, otherwise, larger amounts of condensed water or compressor oil accumulate in the connection pipe. FRÄNKISCHE recommends connection pipes for the industrial field to be in dimension 32. This dimension is only slightly more expensive as compared to smaller dimensions and generally ensures reliable compressed air supply. Consumers with a compressed air requirement of up to 1,800 litres per minute can be reliably connected to a connection length of up to 10 meters. The pressure drop in a connection pipe should not exceed 0.3 bar.

Collector pipe

We speak of a collector pipe if several compressors are connected to one pipe. The following must be observed for these pipes:

- Collector pipe with gradient:
- The collector pipe must be installed in flow direction with a gradient of approx. 1.5 to 2 per cent. The connection pipe must be connected to the collector pipe from above.
- A water separator with automatic drainage must be connected downstream of the compressor for longer riser pipes to the collector pipe to collect the backflowing condensate.

9. Radiant heating

General information

A few important, specific parameters are required for the planning of hot water underfloor heating in order to ensure that the design of the heating surfaces complies with DIN EN 1264, Part 3. Performance values can be estimated using performance tables or calculated more precisely with a computer design. A calculation of the standard heat load of buildings according to DIN EN 12831 is required to design the heating surface.
The heat distribution is dimensioned and the heating surface is designed according to these requirements, technical regulations and applicable standards.

Checklist

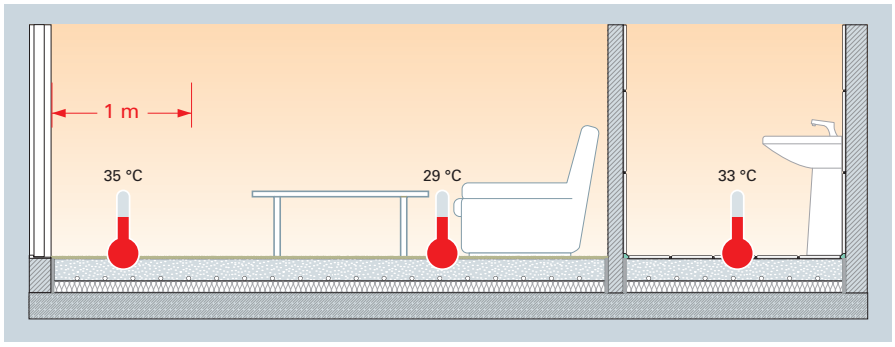
- Type of building (residential building, office, workshop, etc.)
- Layout of the building
- Construction plans (horizontal projections, cross-sections)
- Wall and floor structures
- Target room temperature requirements
- Planned flooring types
- Desired flow temperature
- Manifold/control technology

Surface temperature

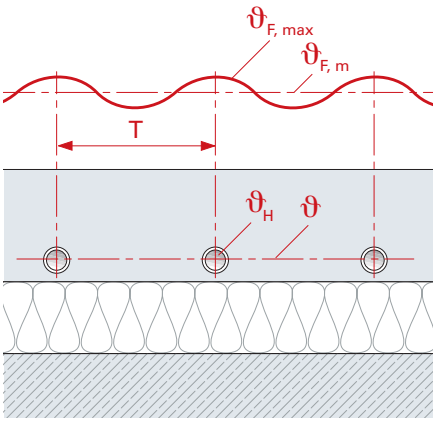
The floor surface temperature depends on several factors such as heat output, installation spacing and heat loss from the room. Concerning medical and physiological aspects, underfloor heating ensures both optimal heat distribution and a comfortable room climate.

The difference between the average floor surface temperature and the room temperature together with the basic characteristic curve form the basis for the output of the heating floor surface. The maximum surface temperature is defined by the "threshold heat flow density" that is specified in DIN EN 1264 and that in the design tables and diagrams as the theoretical threshold value.

The surface temperature of heated floors is decisive for the heat output of an underfloor heating system. The difference between the surface temperature and the ambient air temperature in the room influences the heat supply from the heated floor into the room. The maximum permissible floor surface temperature is specified in DIN EN 1264 based on physiologically sustainable values and must be complied with.



Max. surface temperature in rooms with heated floors



Max. surface temperatures according to DIN EN 1264:

- 29 °C in the living zone
- 35 °C in the adjoining area
- 33 °C in bathrooms

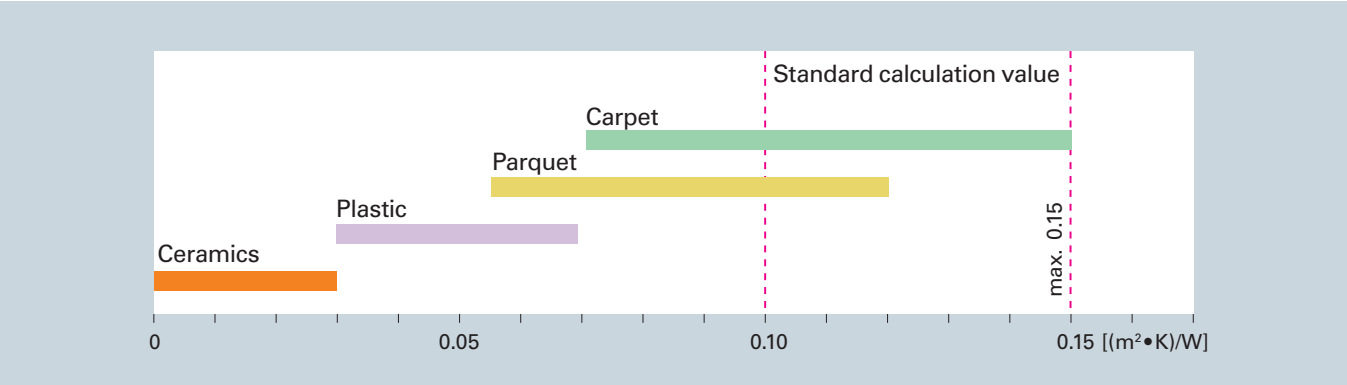
9. Radiant heating

Flooring types

Floors with a thermal insulation resistance of smaller than or equal to 0.15 ($m^2 \cdot K$)/W are ideal for underfloor heating:

- Textile and elastic floors
- Parquet, laminate or cork floors
- Natural or artificial stone, tiles or panels

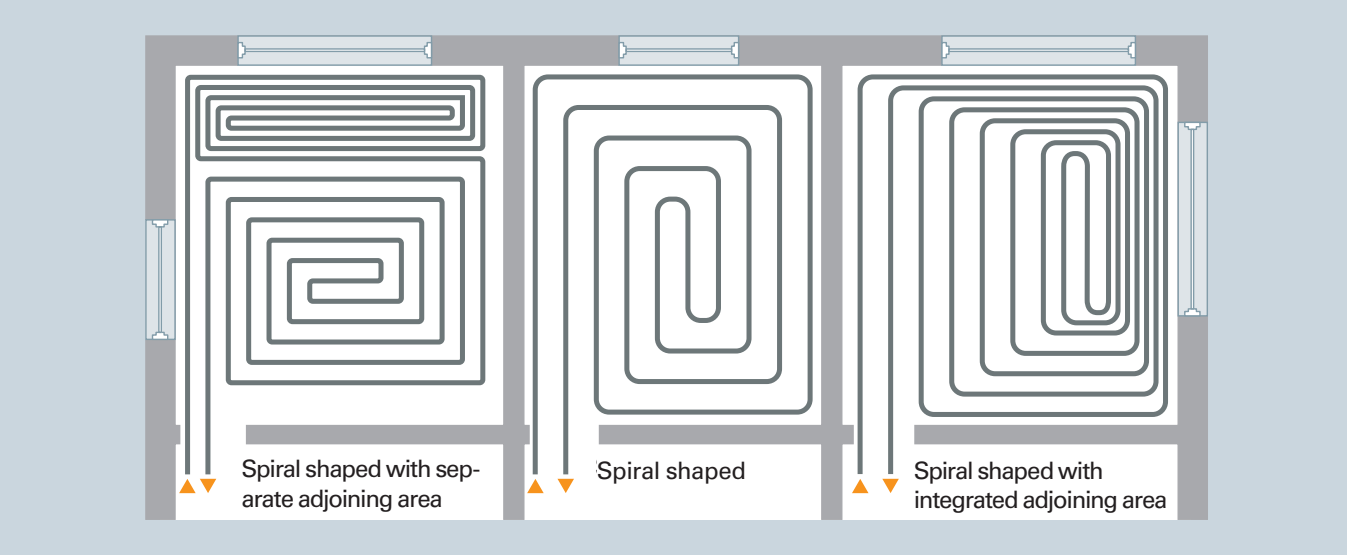
Brand products with explicit manufacturer confirmation regarding suitability for underfloor heating should be preferred. Also natural materials such as cork and wood are suited for underfloor heating when glued completely. Refer to the manufacturer in case of the wood types beech, maple and ash in solid wood due to their considerable material expansion and shrinkage. Floating parquet or laminate floors with a thickness of 10–22 mm are not suited in terms of thermal performance, since they are additionally fitted on a layer of 2 – 5 mm Etafoam. In this case, the thermal insulation resistance is way beyond 0.15 ($m^2 \cdot K$)/W and thus outside the values appropriate for underfloor heating. Please observe the maximum floor surface temperature, in particular in adjoining areas, as provided by the floor manufacturer. Wooden and cork floors should generally be glued completely. The necessary foundations, fillers and glues must resist permanent temperatures of 50 °C (DIN EN 1264-T4).



Overview of thermal resistances

Installation types

The following figure shows the different installation types of the pipes with and without adjoining area in the individual rooms. Adjoining area max. 1 m wide.



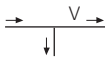
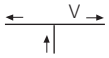
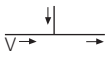
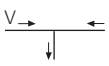
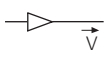
10.1 Individual resistances

Individual resistances – zeta values

Pressure losses due to individual resistances can be calculated based on the loss coefficients ζ of the individual resistances. These equivalents are then added to the pipe lengths of the respective pipe sections.

Loss coefficients due to individual resistances of alpex-plus / alpex-duo XS / alpex L fittings

A flow rate of 2 m/s was assumed to calculate the equivalent pipe lengths.

			Resistance coefficient ζ							
Individual resistance [b]	**Abbreviation according to DVGW**	**Graphic symbol** [a] **simplified representation**	**DN 12**	**DN 15**	**DN 20**	**DN 25**	**DN 32**	**DN 40**	**DN 50**	**DN 65**
			Pipe outside diameter d_o [mm]							
			16	**20**	**26**	**32**	**40**	**50**	**63**	**75**
Tee, branch Flow separation	TA [b]		10.1	5.1	3.8	3.2	3.4	4.2	2.3	1.9
Tee, transition Flow separation	TA [b]		4.1	1.9	1.1	0.7	1.4	0.8	0.9	0.5
Tee, transition Flow separation	TG [b]		10.1	5.1	3.8	3.2	3.4	4.2	2.3	1.9
Tee, branch Flow merging	TVA [b]		17.0	10.0	8.0	5.0	5.5	4.5	4.0	3.5
Tee, transition Flow merging	TVD [b]		35.0	23.0	16.0	11.0	10.0	9.0	8.0	7.0
Tee, counter direction Flow merging	TVG [b]		27.0	17.0	12.0	9.0	8.0	7.0	6.0	5.0
Bend 90°	B90		3.1	1.2	1.1	1.0	––	––	––	––
Elbow 90°	W90		11.2	5.9	4.2	3.2	3.5	3.9	2.0	2.0
Elbow 45°	W45		––	––	3.2	2.0	1.9	1.6	0.6	0.6
Reducer	RED		––	5.3	2.7	2.2	3.1	3.2	2.5	1.2
Wall plate	WS		7.4	5.5	4.9	––	––	––	––	––
Manifold	STV		4.5	3.0	––	––	––	––	––	––
Coupling	K		3.6	1.6	0.7	0.5	1.0	0.5	0.3	0.3

a) The symbol v for flow velocity defines the location of the proper reference velocity in the fitting and connecting piece.

b) For reduced tees, the resistance value of the similar tee is assumed with the smallest dimension of the reduced tee for the flow path to be calculated.

General: The loss coefficient ζ is assigned in each case to the volume flow (partial flow), which is indicated in the diagram with the symbol "V".
The indicated loss coefficients refer to alpex-duo XS / alpex L fittings pressed with F-contour.

10.2 Basis for calculation of drinking water systems

Basis for calculation of drinking water systems

Drinking water installations are calculated according to the basis for calculation of DIN 1988-300 "Codes of practice for drinking water installations – Pipe sizing".
The goal for the calculation of the drinking water supply is to function properly with an economic pipe diameter. Hygienic conditions of the drinking water installation are improved by the lower water content of the pipes, short dwell times and the associated rapid water exchange.
The circulation systems are calculated according to DVGW worksheet W553 "Dimensioning of circulation systems in central drinking water heating systems".

Dimensioning

Dimensioning and planning of the alpex multilayer composite pipes is based on DIN 1988-300 "Codes of practice for drinking water installations – Pipe sizing".

The following values can be assumed as roughness for commercially available pipes:

k = 0.0015 mm	for copper pipes and pipes made of stainless steel
k = 0.007 mm	for plastic pipes and structured-wall pipes
k = 0.015 mm	for galvanised threaded pipes

alpex dimensions comparison
alpex pipes can be assigned in their pipe dimension to the pipe materials copper/stainless steel and galvanised steel as follows:

alpex pipe	Stainless steel pipe/ copper pipe	Galvanised steel pipe		Nominal width
16×2	15×1	R 3/8	(17.2×2.35)	DN 10 / DN 12
20×2	18×1	R 1/2	(21.3×2.65)	DN 15
26×3	22×1	R 3/4	(26.9×2.65)	DN 20
32×3	28×1.5	R 1	(33.7×3.25)	DN 25
40×3.5	35×1.5	R 1 1/4	(42.4×3.25)	DN 32
50×4	42×1.5	R 1 1/2	(48.3×3.25)	DN 40
63×4.5	54×2	R 2	(60.3×3.65)	DN 50
75×5	64×2	R 2 1/2	(75.5×3.75)	DN 65

Hydraulic calculations are required to dimension entire systems.

Maximum calculated flow velocity with the associated top velocity

Pipe section	Maximum calculated flow velocity with flow rate m/s	
	< 15 min	≥ 15 min
Connection pipes	2	2
Supply pipes: Sections with low pressure loss individual resistances ($\zeta < 2.5$) [a]	5	2
Sections with higher loss coefficients for the individual resistances ($\zeta \geq 2.5$) [b]	2.5	2
Circulation pipes [c]	0.3 to 0.7	

a) E.g., piston valve, ball valve, slanted seat valves, fittings
b) E.g., straight seat valve, fittings
c) Indication of the recommended flow velocity. This may be 1.0 m/s max. at any rate.

10.2 Basis for calculation of drinking water systems

Design flow rates and flow pressure

Generally, the information provided by the manufacturer regarding the design flow rates and minimum flow pressures (required for the determination of the available pressure gradients for pipe friction R_v) of the tapping fittings must be considered for dimensioning pipe diameters. The reference values listed in the table may only be used under the conditions listed there (see important notes).

If an individual drinking water heater is installed right upstream of the tapping fitting, then this pressure loss must be recorded as device pressure loss. It can be ignored for reservoirs (individual drinking water heaters); for continuous-flow water heaters (individual drinking water heaters), the pressure losses according to the information provided by the manufacturer must be observed.

Minimum flow pressure and design flow rates according to DIN 1988-300

Minimum flow pressure min FL bar	**Type of drinking water tapping point**			**Calculation flow for tapping of only cold or heated drinking water mixed water***		
				$\dot{V}_R$ cold [l/s]	**$\dot{V}_R$ hot [l/s]**	**$\dot{V}_R$ [l/s]**
0.5	Taps without aerators [a]		DN 15	–	–	0.30
0.5	Taps without aerators [a]		DN 20	–	–	0.50
0.5	Taps without aerators [a]		DN 25	–	–	1.00
1.0	Taps with aerators		DN 10	–	–	0.15
1.0	Taps with aerators		DN 15	–	–	0.15
0.5	Flushing cistern filling valve (DIN EN 14124)		DN 15	–	–	0.13
1.2	Flush valve acc. to DIN 3265 Part 1		DN 20	–	–	1.00
1.0	Flush valve for urinals – electronic		DN 15	–	–	0.30
1.0	Flush valve for urinals – manual		DN 15	–	–	0.30
0.5	Household dishwasher (DIN EN 50242)		DN 15	–	–	0.07
0.5	Household washing machine (DIN EN 60456)		DN 15	–	–	0.15
1.0	Mixing taps for	showers [b),c)]	DN 15	0.15	0.15	–
1.0	Mixing taps for	bathtubs [b),c)]	DN 15	0.15	0.15	–
1.0	Mixing taps for	kitchen sinks [b),c)]	DN 15	0.07	0.07	–
1.0	Mixing taps for	washbasins [b),c)]	DN 15	0.07	0.07	–
1.0	Mixing taps for	bidets [b),c)]	DN 15	0.07	0.07	–
1.0	Mixing taps		DN 20	0.30	0.30	–

Important notes

Manufacturers must indicate the minimum flow pressure and the design flow rates on the cold and hot water side (with mixer taps). Generally, manufacturers' specifications, which can deviate significantly from the values indicated in the table, must be observed when dimensioning pipe diameters. Proceed as follows:

There are two options if the manufacturer's specifications regarding minimum flow pressure and design flow rate are below those specified in the table:
- If the drinking water installation is designed for lower values due to reasons of hygiene or efficiency, this procedure must be agreed with the owner and the design conditions for the tapping points (minimum flow rate, design flow rate) must be included in the calculation.
- If the drinking water installation is not dimensioned for lower values, the values specified in the table must be considered.

If the manufacturer's specifications are above the values specified in the table:
- The drinking water installation must be dimensioned according to the manufacturer's specifications.

a) Without connected appliances (e.g., lawn sprinkler).
b) The design flow rate must be calculated for the cold and hot water connection.
c) Angle valves, e.g., for basin fittings and S connections for, e.g., shower and bathtub fittings must be considered as individual resistances or in the minimum flow pressure of the tapping fitting.

Tapping fittings not included in the table and appliances of the same type with larger fitting flow rates or minimum flow pressures than indicated must be considered according to the manufacturer's specifications when determining the pipe diameters.

10.2 Basis for calculation of drinking water systems

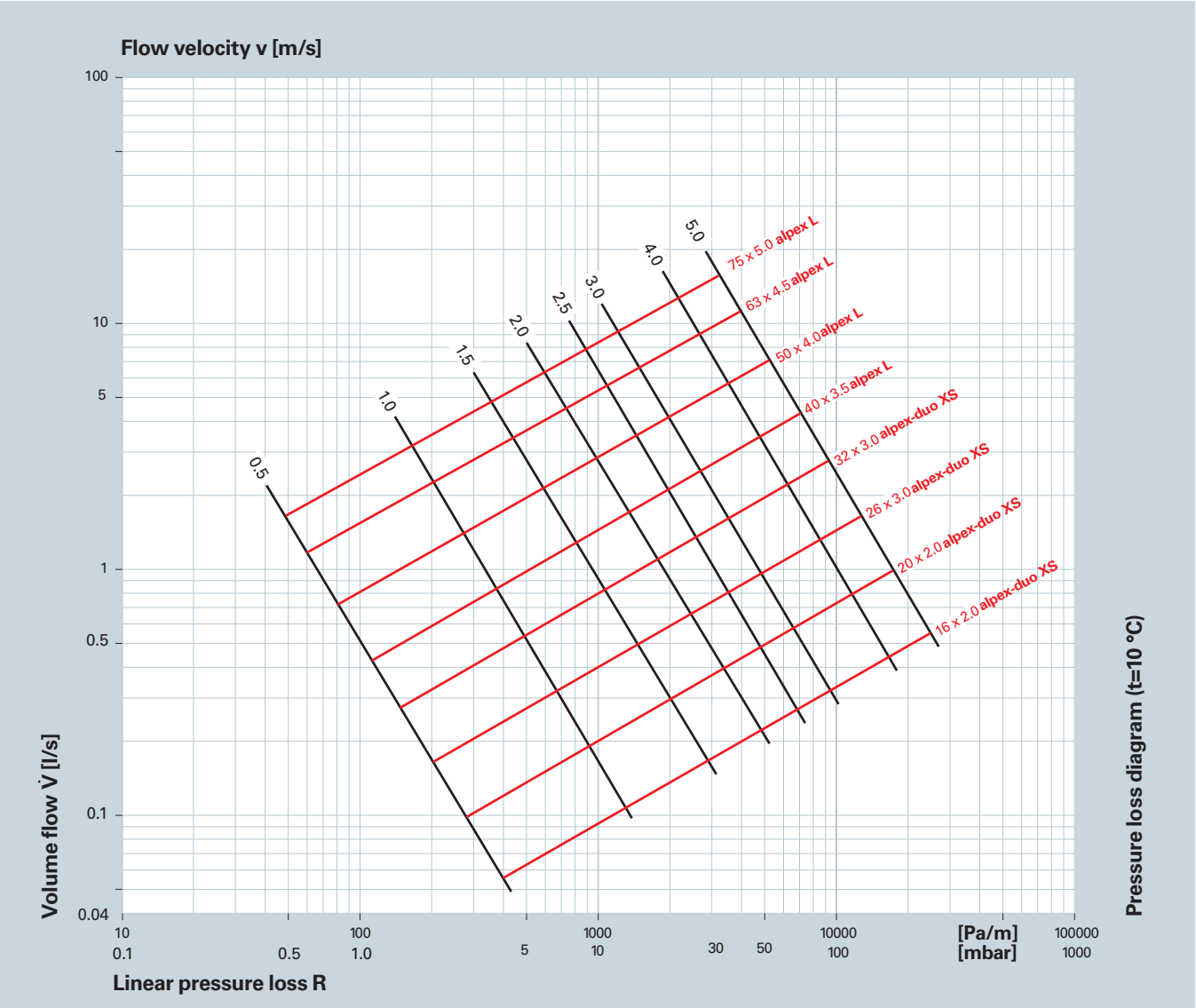
Pressure loss table for drinking water

Pressure loss table for alpex pipes at a medium temperature of 10 °C								
Pipe dimension	**16×2.0**		**20×2.0**		**26×3.0**		**32×3.0**	
Flow rate	**Volume flow**	**Pressure loss**	**Volume flow**	**Pressure loss**	**Volume flow**	**Pressure loss**	**Volume flow**	**Pressure loss**
v	**$\dot{V}$**	**R**	**$\dot{V}$**	**R**	**$\dot{V}$**	**R**	**$\dot{V}$**	**R**
[m/s]	**[l/s]**	**[mbar/m]**	**[l/s]**	**[mbar/m]**	**[l/s]**	**[mbar/m]**	**[l/s]**	**[mbar/m]**
0.5	0.06	4.13	0.10	2.83	0.16	2.12	0.27	1.47
0.5	0.06	4.13	0.10	2.83	0.16	2.12	0.27	1.47
0.6	0.07	5.62	0.12	3.88	0.19	2.89	0.32	2.05
0.7	0.08	7.31	0.14	5.07	0.22	3.78	0.37	2.69
0.8	0.09	9.17	0.16	6.42	0.25	4.78	0.42	3.42
0.9	0.10	11.30	0.18	7.79	0.28	5.91	0.48	4.16
1.0	0.11	13.54	0.20	9.34	0.31	7.12	0.53	5.00
1.2	0.14	18.66	0.24	13.05	0.38	9.75	0.64	6.95
1.4	0.16	24.58	0.28	17.09	0.44	12.79	0.74	9.12
1.6	0.18	31.25	0.32	21.60	0.50	16.19	0.85	11.71
1.8	0.20	38.87	0.36	26.42	0.57	19.92	0.96	14.45
2.0	0.23	46.49	0.40	32.12	0.63	24.00	1.06	17.46
2.5	0.28	67.69	0.50	47.45	0.79	35.93	1.33	26.08
3.0	0.34	93.73	0.60	66.08	0.94	49.27	1.59	36.51
3.5	0.40	127.58	0.70	88.03	1.10	66.44	1.86	48.99
4.0	0.45	159.30	0.80	110.98	1.26	83.98	2.12	62.14
4.5	0.51	200.77	0.90	137.93	1.41	105.28	2.39	77.09
5.0	0.57	239.54	1.01	167.94	1.57	127.47	2.65	93.25

Pressure loss table for alpex pipes at a medium temperature of 10 °C								
Pipe dimension	**40×3.5**		**50×4.0**		**63×4.5**		**75×5.0**	
Flow rate	**Volume flow**	**Pressure loss**	**Volume flow**	**Pressure loss**	**Volume flow**	**Pressure loss**	**Volume flow**	**Pressure loss**
v	**$\dot{V}$**	**R**	**$\dot{V}$**	**R**	**$\dot{V}$**	**R**	**$\dot{V}$**	**R**
[m/s]	**[l/s]**	**[mbar/m]**	**[l/s]**	**[mbar/m]**	**[l/s]**	**[mbar/m]**	**[l/s]**	**[mbar/m]**
0.5	0.43	1.09	0.69	0.80	1.15	0.59	1.67	0.48
0.6	0.51	1.51	0.83	1.11	1.37	0.81	1.99	0.66
0.7	0.60	1.95	0.97	1.46	1.60	1.08	2.33	0.87
0.8	0.68	2.50	1.11	1.86	1.83	1.37	2.66	1.10
0.9	0.77	3.07	1.25	2.30	2.06	1.66	2.99	1.37
1.0	0.88	3.71	1.39	2.80	2.29	2.04	3.34	1.65
1.2	1.03	5.17	1.66	3.82	2.75	2.83	3.98	2.28
1.4	1.20	6.83	1.94	5.09	3.21	3.76	4.66	3.01
1.6	1.37	8.57	2.22	6.52	3.66	4.86	5.31	3.81
1.8	1.54	10.70	2.49	8.10	4.12	5.91	5.98	4.73
2.0	1.71	13.03	2.77	9.90	4.58	7.15	6.64	5.72
2.5	2.14	19.69	3.46	14.80	5.73	10.70	8.30	8.58
3.0	2.57	27.54	4.16	20.46	6.87	14.91	9.96	11.97
3.5	2.99	36.37	4.85	27.27	8.02	19.85	11.62	15.87
4.0	3.42	46.05	5.54	35.04	9.16	25.48	13.30	20.35
4.5	3.85	57.67	6.23	43.14	10.31	31.49	14.95	25.25
5.0	4.28	69.68	6.93	52.67	11.45	38.19	16.65	30.85

10.2 Basis for calculation of drinking water systems

Pressure loss diagram for drinking water



Temperature correction factor

Flow rate	Correction factor φ depending on the temperature								
v [m/s]	10 °C	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C	90 °C
0.5	1.0	0.93	0.88	0.83	0.79	0.76	0.73	0.71	0.68
1.0	1.0	0.94	0.89	0.84	0.81	0.78	0.76	0.73	0.71
2.0	1.0	0.94	0.90	0.86	0.84	0.81	0.81	0.77	0.75
3.0	1.0	0.95	0.91	0.88	0.86	0.83	0.81	0.80	0.78
4.0	1.0	0.95	0.92	0.89	0.87	0.85	0.83	0.82	0.80
5.0	1.0	0.96	0.93	0.90	0.88	0.86	0.84	0.83	0.82
6.0	1.0	0.96	0.93	0.91	0.88	0.87	0.86	0.84	0.83

10.3 Basis for calculation of heating systems

Performance values

We recommend that the following standard flow values are not exceeded when designing the pipe network:

Radiator connection pipe ≤ 0.3 m/s
Heating distribution pipes ≤ 0.5 m/s
Heating riser and basement pipes ≤ 1.0 m/s.

The pipe network must be designed such that the flow rate declines evenly from the boiler to the radiator that is located farthest away. The standard values for the flow rate must be complied with.

The maximum heat transfer performance Q_N is given in the following table, taking into account the maximum flow rate depending on the pipe type, the temperature difference ΔT and the pipe size d_o x s.

Radiator connection pipe	**≤ 0.3 m/s**			
Pipe $d_o \times s$ [mm]	16×2	20×2	26×3	32×3
Mass flow $\dot{m}$ [kg/h]	120	214	335	559
Heat performance Q_N (W) at ΔT = 5 K	700	1250	1950	3250
Heat performance Q_N (W) at ΔT = 10 K	1400	2500	3900	6500
Heat performance Q_N (W) at ΔT = 15 K	2100	3750	5850	9750
Heat performance Q_N (W) at ΔT = 20 K	2800	5000	7800	13000

Radiator distribution pipes	**≤ 0.5 m/s**			
Pipe $d_o \times s$ [mm]	16×2	20×2	26×3	32×3
Mass flow $\dot{m}$ [kg/h]	206	361	559	946
Heat performance Q_N (W) at ΔT = 5 K	1200	2100	3250	5500
Heat performance Q_N (W) at ΔT = 10 K	2400	4200	6500	11000
Heat performance Q_N (W) at ΔT = 15 K	3600	6300	9750	16500
Heat performance Q_N (W) at ΔT = 20 K	4800	8400	13000	22000

Heating riser and basement pipes	**≤ 1.0 m/s**			
Pipe $d_o \times s$ [mm]	16×2	20×2	26×3	32×3
Mass flow $\dot{m}$ [kg/h]	404	710	1118	1892
Heat performance Q_N (W) at ΔT = 5 K	2350	4150	6500	11000
Heat performance Q_N (W) at ΔT = 10 K	4700	8300	13000	22000
Heat performance Q_N (W) at ΔT = 15 K	7150	12450	19500	33000
Heat performance Q_N (W) at ΔT = 20 K	9400	16500	26000	44000

Calculation formulas

Mass flow in heating circuit

$$\dot{m}_H = \frac{\dot{Q}_{HK}}{(\vartheta_V - \vartheta_R) \cdot C} \qquad (C = 1{,}163\ \text{Wh/(kg·K)}) \qquad [\text{kg/h}]$$

Total pressure loss in heating circuit

$$\Delta p_g = R \cdot l + Z + \Delta p_v \qquad [\text{Pa}]$$

Temperature difference between supply and return

$$\Delta \vartheta = \vartheta_V - \vartheta_R \qquad [\text{K}]$$

Sum of the individual resistances

$$Z = \sum \zeta \cdot (v^2 \cdot \rho)/2 \qquad [\text{Pa}]$$

$$Z = \sum \zeta \cdot v^2 \cdot 5 \qquad [\text{mbar}]$$

10.3 Basis for calculation of heating systems

Pressure loss table for alpex pipes at different temperature differences (t_m = 60 °C)

Connection pipe (W)				Mass flow	16×2.0		20×2.0		26×3.0		32×3.0	
Temperature difference				$\dot{m}$	v	R	v	R	v	R	v	R
20 K	15 K	10 K	5 K	[kg/h]	[m/s]	[mbar/m]	[m/s]	[mbar/m]	[m/s]	[mbar/m]	[m/s]	[mbar/m]
1000	750	500	250	43	0.11	0.24	-	-	-	-	-	-
1200	900	600	300	51.6	0.13	0.33	-	-	-	-	-	-
1400	1050	700	350	60.2	0.15	0.42	-	-	-	-	-	-
1600	1200	800	400	68.8	0.17	0.52	-	-	-	-	-	-
1800	1350	900	450	77.4	0.19	0.63	0.11	0.17	-	-	-	-
2000	1500	1000	500	86	0.21	0.74	0.12	0.2	-	-	-	-
2400	1800	1200	600	103.2	0.26	1.02	0.14	0.27	-	-	-	-
2800	2100	1400	700	120.4	0.3	1.32	0.17	0.34	0.11	0.12	-	-
3200	2400	1600	800	137.6	0.34	1.64	0.19	0.42	0.12	0.15	-	-
3600	2700	1800	900	154.8	0.38	2.06	0.22	0.52	0.14	0.18	-	-
4000	3000	2000	1000	172	0.43	2.39	0.24	0.62	0.15	0.21	-	-
4400	3300	2200	1100	189.2	0.47	2.85	0.26	0.72	0.17	0.25	0.1	0.07
4800	3600	2400	1200	206.4	0.51	3.36	0.29	0.84	0.18	0.29	0.11	0.08
5200	3900	2600	1300	223.6	0.56	3.88	0.31	0.97	0.2	0.33	0.12	0.1
5600	4200	2800	1400	240.8	0.6	4.47	0.34	1.1	0.22	0.38	0.13	0.11
6000	4500	3000	1500	258	0.64	5.1	0.36	1.25	0.23	0.43	0.14	0.12
6400	4800	3200	1600	275.2	0.68	5.74	0.38	1.4	0.25	0.48	0.15	0.14
6800	5100	3400	1700	292.4	0.73	6.31	0.41	1.56	0.26	0.53	0.15	0.15
7200	5400	3600	1800	309.6	0.77	6.93	0.43	1.74	0.28	0.58	0.16	0.17
7600	5700	3800	1900	326.8	0.81	7.63	0.46	1.92	0.29	0.64	0.17	0.18
8000	6000	4000	2000	344	0.86	8.4	0.48	2.11	0.31	0.7	0.18	0.2
8400	6300	4200	2100	361.2	0.9	9.19	0.51	2.24	0.32	0.77	0.19	0.22
8800	6600	4400	2200	378.4	0.94	10.02	0.53	2.45	0.34	0.84	0.2	0.24
9200	6900	4600	2300	395.6	0.98	10.83	0.55	2.65	0.35	0.91	0.21	0.28
9600	7200	4800	2400	412.8	1.03	11.66	0.58	2.87	0.37	0.98	0.22	0.28
10000	7500	5000	2500	430	-	-	0.6	3.07	0.38	1.06	0.23	0.3
10500	7875	5250	2625	451.5	-	-	0.63	3.32	0.4	1.14	0.24	0.33
11000	8250	5500	2750	473	-	-	0.66	3.61	0.42	1.24	0.25	0.36
11500	8625	5750	2875	494.5	-	-	0.69	3.91	0.44	1.35	0.26	0.39
12000	9000	6000	3000	516	-	-	0.72	4.23	0.46	1.45	0.27	0.42
12500	9375	6250	3125	537.5	-	-	0.75	4.53	0.48	1.55	0.28	0.45
13000	9750	6500	3250	559	-	-	0.78	4.87	0.5	1.66	0.3	0.48
14000	10500	7000	3500	602	-	-	0.84	5.49	0.54	1.89	0.32	0.54
15000	11250	7500	3750	645	-	-	0.9	6.25	0.58	2.15	0.34	0.61
16000	12000	8000	4000	688	-	-	0.96	7	0.62	2.42	0.36	0.68
17000	12750	8500	4250	731	-	-	1.02	7.84	0.65	2.65	0.39	0.75
18000	13500	9000	4500	774	-	-	-	-	0.69	2.95	0.41	0.84
19000	14250	9500	4750	817	-	-	-	-	0.73	3.26	0.43	0.92
20000	15000	10000	5000	860	-	-	-	-	0.77	3.58	0.46	1.02
22000	16500	11000	5500	946	-	-	-	-	0.85	4.27	0.5	1.21
24000	18000	12000	6000	1032	-	-	-	-	0.92	4.97	0.56	1.41
26000	19500	13000	6500	1118	-	-	-	-	1	5.71	0.59	1.62
28000	21000	14000	7000	1204	-	-	-	-	-	-	0.64	1.86
30000	22500	15000	7500	1290	-	-	-	-	-	-	0.68	2.12
32000	24000	16000	8000	1376	-	-	-	-	-	-	0.73	2.39
34000	25500	17000	8500	1462	-	-	-	-	-	-	0.77	2.65
36000	27000	18000	9000	1548	-	-	-	-	-	-	0.82	2.92
38000	28500	19000	9500	1634	-	-	-	-	-	-	0.87	3.21
40000	30000	20000	10000	1720	-	-	-	-	-	-	0.91	3.53
42000	31500	21000	10500	1806	-	-	-	-	-	-	0.96	3.86
44000	33000	22000	11000	1892	-	-	-	-	-	-	1	4.18

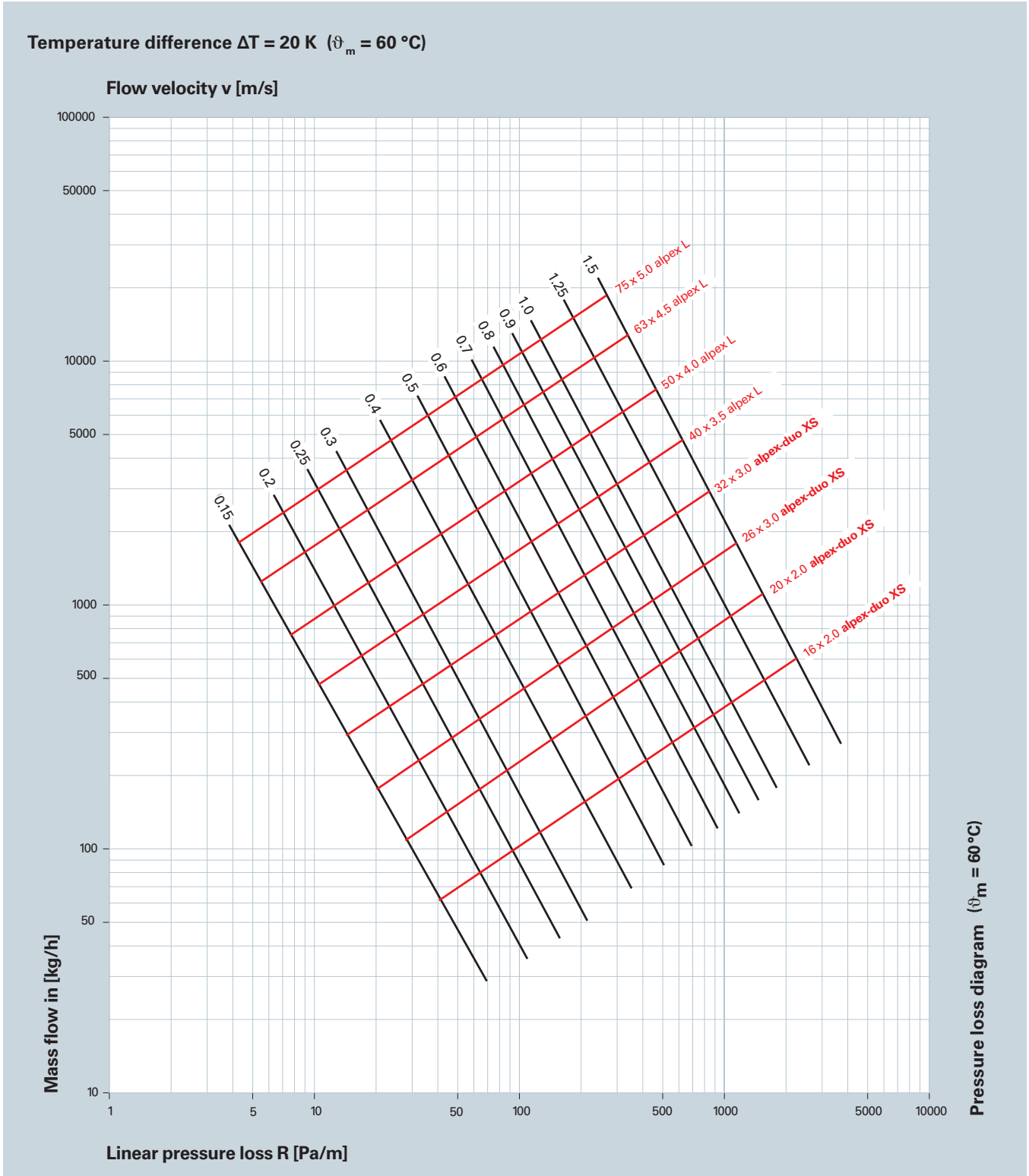
10.3 Basis for calculation of heating systems

Pressure loss table for alpex pipes at different temperature differences (t_m = 60 °C)

Connection pipe (W)				Mass flow	40×3.5		50×4.0		63×4.5		75×5.0	
Temperature difference				$\dot{m}$	v	R	v	R	v	R	v	R
20 K	15 K	10 K	5 K	[kg/h]	[m/s]	[mbar/m]	[m/s]	[mbar/m]	[m/s]	[mbar/m]	[m/s]	[mbar/m]
20000	15000	10000	5000	860	0.28	0.32	0.17	0.1	0.11	0.03		
22000	16500	11000	5500	946	0.31	0.38	0.19	0.12	0.12	0.04		
24000	18000	12000	6000	1032	0.34	0.45	0.21	0.14	0.13	0.04		
26000	19500	13000	6500	1118	0.37	0.52	0.23	0.16	0.14	0.05		
28000	21000	14000	7000	1204	0.4	0.59	0.24	0.18	0.15	0.06		
30000	22500	15000	7500	1290	0.42	0.67	0.26	0.21	0.16	0.06		
32000	24000	16000	8000	1376	0.45	0.75	0.28	0.24	0.17	0.07		
34000	25500	17000	8500	1462	0.48	0.84	0.3	0.26	0.18	0.08		
36000	27000	18000	9000	1548	0.51	0.93	0.31	0.29	0.19	0.09		
38000	28500	19000	9500	1634	0.54	1.02	0.33	0.32	0.2	0.09		
40000	30000	20000	10000	1720	0.57	1.11	0.35	0.35	0.21	0.1		
42000	31500	21000	10500	1806	0.59	1.21	0.37	0.38	0.22	0.11		
44000	33000	22000	11000	1892	0.62	1.32	0.38	0.41	0.23	0.12		
46000	34500	23000	11500	1978	0.65	1.43	0.4	0.45	0.24	0.13		
48000	36000	24000	12000	2064	0.68	1.54	0.42	0.48	0.25	0.14		
50000	37500	25000	12500	2150	0.71	1.66	0.44	0.52	0.26	0.15		
52000	39000	26000	13000	2236	0.74	1.78	0.45	0.56	0.27	0.16		
54000	40500	27000	13500	2322	0.76	1.91	0.47	0.6	0.29	0.18		
56000	42000	28000	14000	2408	0.79	2.04	0.49	0.63	0.3	0.19		
58000	43500	29000	14500	2494	0.82	2.16	0.51	0.67	0.31	0.2		
60000	45000	30000	15000	2580	0.85	2.29	0.52	0.72	0.32	0.21		
62000	46500	31000	15500	2666	0.88	2.43	0.54	0.76	0.33	0.23		
64000	48000	32000	16000	2752	0.9	2.46	0.56	0.81	0.34	0.24		
66000	49500	33000	16500	2838	0.93	2.61	0.58	0.85	0.35	0.25		
68000	51000	34000	17000	2924	0.96	2.77	0.59	0.9	0.36	0.27		
70000	52500	35000	17500	3010	0.99	2.94	0.61	0.95	0.37	0.28		
72000	54000	36000	18000	3096	1.02	3.11	0.63	1.01	0.38	0.29		
76000	57000	38000	19000	3268	-	-	0.66	1.11	0.4	0.33		
80000	60000	40000	20000	3440	-	-	0.7	1.23	0.42	0.36		
84000	63000	42000	21000	3612	-	-	0.73	1.35	0.44	0.4		
88000	66000	44000	22000	3784	-	-	0.77	1.47	0.46	0.44		
92000	69000	46000	23000	3956	-	-	0.8	1.59	0.49	0.47		
96000	72000	48000	24000	4128	-	-	0.84	1.72	0.51	0.51		
100000	75000	50000	25000	4300	-	-	0.87	1.84	0.53	0.55		
104000	78000	52000	26000	4472	-	-	0.91	1.98	0.55	0.59		
108000	81000	54000	27000	4644	-	-	0.94	2.11	0.57	0.63		
112000	84000	56000	28000	4816	-	-	0.98	2.25	0.59	0.67		
116000	87000	58000	29000	4988	-	-	1.01	2.39	0.61	0.71	0.41	0.27
120000	90000	60000	30000	5160	-	-	-	-	0.63	0.73	0.43	0.29
130000	97500	65000	32500	5590	-	-	-	-	0.69	0.86	0.47	0.33
140000	105000	70000	35000	6020	-	-	-	-	0.74	0.98	0.50	0.38
150000	112500	75000	37500	6450	-	-	-	-	0.79	1.12	0.54	0.43
160000	120000	80000	40000	6880	-	-	-	-	0.84	1.27	0.58	0.49
170000	127500	85000	42500	7310	-	-	-	-	0.89	1.41	0.61	0.54
180000	135000	90000	45000	7740	-	-	-	-	0.95	1.55	0.65	0.60
190000	142500	95000	47500	8170	-	-	-	-	1.00	1.72	0.68	0.66
200000	150000	100000	50000	8600	-	-	-	-	1.05	1.85	0.72	0.73
220000	165000	110000	55000	9460	-	-	-	-	1.15	2.2	0.79	0.87
240000	180000	120000	60000	10320	-	-	-	-	1.25	2.58	0.86	1.02
260000	195000	130000	65000	11180	-	-	-	-	1.35	2.98	0.94	1.18
280000	210000	140000	70000	12040	-	-	-	-	1.46	3.42	1.01	1.34
320000	240000	160000	80000	13760	-	-	-	-	-	-	1.15	1.72
360000	270000	180000	90000	15480	-	-	-	-	-	-	1.29	2.13
400000	300000	200000	100000	17200	-	-	-	-	-	-	1.44	2.59
440000	330000	220000	110000	18920	-	-	-	-	-	-	1.58	3.09
480000	360000	240000	120000	20640	-	-	-	-	-	-	1.73	3.62
520000	390000	260000	130000	22360	-	-	-	-	-	-	1.87	4.19
560000	420000	280000	140000	24080	-	-	-	-	-	-	2.02	4.82

10.3 Basis for calculation of heating systems

Pressure loss diagram for heating



10.4 Basis for calculation of radiant heating systems

Design

The radiant heating system is dimensioned based on the basic characteristic curve according to DIN EN 1264 Part 2 and the standard heating demand calculation of the design heat load according to DIN EN 12831. For the design, the statutory insulation requirements of the EnEV and EN 1264 must be observed. For floors bordering on outside air up to –15°, the minimum thermal insulation is $R_{\lambda,B}$ = 2.00 (m² · K)/W.
For basement floors, floors bordering on unheated or irregularly heated rooms and floors adjacent to soil, the minimum thermal insulation is $R_{\lambda,B}$ = 1.25 (m² · K)/W. For floors that separate apartments and border on heated rooms, the minimum downward thermal resistance of the thermal insulation is $R_{\lambda,B}$ = 0.75 (m² · K)/W.

Underfloor heating for residential buildings is designed for the least favourable but still permissible upper soil of $R_{\lambda,B}$ = 0.10 (m² · K)/W. We have no influence on the flooring of the rooms and their later use. If a carpet or parquet floor is installed later, sufficient heating is only possible with increasing the heating water temperature. Since the efficiency of low-temperature heaters is lower, a design using a thermal resistance of $R_{\lambda,B}$ = 0.15 (m² · K)/W must be evaluated and applied if necessary.

NB

Recommended installation spacings (in mm):
Bathroom or toilet with shower and 24 °C – VA 100; kitchen, children's room, living room, etc. 20 °C – VA 150/200

Installation spacings should not exceed VA 250 and only be used in exceptional cases in order to prevent noticeable cold zones on the surface. In kitchens, VA 150/200 should also be installed underneath the kitchen elements.

The heating circuit manifold should be located as centrally as possible within the building level/area in order to keep the connection pipes short. With high pipe density next to the manifold, a PE fleece should be installed as a cover to prevent exceeding of the desired surface temperature.

Note for rapid design:

- Select the heating requirement of the least favourable room
- Select pipe dimension 14 × 2; 16 × 2
- $p_{max.}$ = 250 mbar as max. pressure loss per heating circuit, incl. connection pipes (10 m)
- Max. length of heating circuit = 120 m, incl. connection pipes (2 × 5 m)
- 45 mm screed pipe covering – standard
- 0.75 (m² · K)/W is the minimum requirement for the insulation with the same type of heating
- R = 0.10 (m² · K)/W for 6 mm carpet
- Select 45 °C as design temperature

Pipe requirement in m/m²

Grid (VA)	[mm]	50	100	150	200	250	300
Pipe requirement	[m/m²]	20	10	6.7	5	4	3.4

10.4 Basis for calculation of radiant heating systems

Performance table with 14 x 2 mm pipe – cement screed: 45 mm covering – thermal conductivity 1.2 W/(m · K)

$R_{\lambda,B}$ = 0.00 (m² · K)/W		Ceramic floors – tiles, natural stone									
Heating fluid temperature	Room temperature	Heat flux q and maximum floor surface temperature υFm max. at									
		T = 300 mm		T = 250 mm		T = 200 mm		T = 150 mm		T = 100 mm	
[°C]	[°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]
30	15	53	20	61	21	71	22	82	23	95	24
	20	35	23	40	24	47	25	54	25	62	26
	24	20	26	23	26	27	27	31	27	37	28
35	15	71	22	82	23	94	24	110	25	127	26
	20	53	25	62	26	71	27	82	28	95	29
	24	39	28	45	28	52	29	60	30	70	31
40	15	90	23	103	24	118	25	137	27	160	29
	20	71	27	82	28	94	29	110	30	128	31
	24	57	30	66	30	76	31	88	32	102	33
45	15	107	25	123	26	142	27	164	29	192	31
	20	90	28	103	29	118	30	137	32	160	34
	24	75	31	86	32	99	33	115	34	134	36
50	15	125	26	144	28	165	29	192	31	224	34
	20	107	30	123	31	142	32	164	34	192	36
	24	93	33	107	34	123	35	142	36	166	38
55	15	143	28	164	29	189	31	219	33	256	36
	20	125	31	144	33	165	34	192	36	224	39
	24	111	34	127	35	146	37	170	39	198	41

$R_{\lambda,B}$ = 0.10 (m² · K)/W		6 mm carpet or 10 mm parquet									
Heating fluid temperature	Room temperature	Heat flux q and maximum floor surface temperature υFm max. at									
		T = 300 mm		T = 250 mm		T = 200 mm		T = 150 mm		T = 100 mm	
[°C]	[°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]
30	15	37	19	40	19	45	19	50	20	55	20
	20	24	23	26	23	29	23	33	23	36	24
	24	14	26	15	26	17	26	19	26	21	26
35	15	49	20	54	20	60	21	66	21	74	22
	20	36	24	40	24	45	24	50	25	55	25
	24	26	27	30	27	32	27	36	28	40	28
40	15	61	21	68	21	75	22	83	23	92	24
	20	49	25	54	25	60	26	66	26	74	27
	24	39	28	43	28	48	29	53	29	59	30
45	15	73	22	82	23	90	23	100	24	111	25
	20	61	26	68	26	75	27	83	28	92	29
	24	51	29	57	30	63	30	70	31	77	31
50	15	86	23	95	24	105	25	117	26	130	27
	20	73	27	81	28	90	28	100	29	111	30
	24	63	30	71	31	78	31	87	32	96	33
55	15	98	24	109	25	120	26	134	27	148	28
	20	86	28	95	29	104	30	116	31	130	32
	24	76	31	84	32	92	33	102	33	114	34

10.4 Basis for calculation of radiant heating systems

Performance table with 16 x 2 mm pipe – cement screed: 45 mm covering – thermal conductivity 1.2 W/(m · K)

$R_{\lambda,B}$ = 0.00 (m² · K)/W		Ceramic floors – tiles, natural stone									
Heating fluid temperature	Room temperature	Heat flux q and maximum floor surface temperature υFm max. at									
		T = 300 mm		T = 250 mm		T = 200 mm		T = 150 mm		T = 100 mm	
[°C]	[°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]
30	15	54	20	62	21	72	22	83	23	96	24
	20	36	24	42	24	48	25	55	25	64	26
	24	22	26	25	27	29	27	33	27	39	28
35	15	72	22	83	23	96	24	111	25	129	26
	20	54	25	62	26	72	27	83	28	96	29
	24	40	28	46	28	53	29	61	30	71	31
40	15	91	23	104	24	120	26	139	27	161	29
	20	72	27	83	28	96	29	111	30	129	31
	24	58	29	67	30	77	31	89	32	103	33
45	15	109	25	125	26	144	28	166	29	193	31
	20	91	28	104	29	120	31	139	32	161	34
	24	76	31	87	32	101	33	116	34	135	36
50	15	127	26	146	28	168	29	194	31	225	34
	20	109	30	125	31	144	33	166	34	193	36
	24	94	33	108	34	125	35	144	37	167	38
55	15	145	28	166	29	192	31	222	34	257	36
	20	127	31	146	33	168	34	194	36	225	39
	24	112	34	129	35	149	37	172	39	199	41

$R_{\lambda,B}$ = 0.10 (m² · K)/W		6 mm carpet or 10 mm parquet									
Heating fluid temperature	Room temperature	Heat flux q and maximum floor surface temperature υFm max. at									
		T = 300 mm		T = 250 mm		T = 200 mm		T = 150 mm		T = 100 mm	
[°C]	[°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]	q [W/m²]	υF [°C]
30	15	37	19	41	19	46	19	51	20	56	20
	20	25	23	28	23	30	23	34	23	37	24
	24	15	26	17	26	18	26	20	26	22	26
35	15	50	20	55	20	61	21	67	21	75	22
	20	37	24	41	24	46	24	51	25	56	25
	24	27	27	30	27	33	27	37	28	41	28
40	15	62	21	69	21	76	22	84	23	94	23
	20	50	25	55	25	61	26	67	26	75	27
	24	40	28	44	28	49	29	54	29	60	30
45	15	74	22	83	23	91	23	101	24	112	25
	20	62	26	69	26	76	27	84	28	94	28
	24	52	29	58	29	64	30	71	31	79	31
50	15	87	23	96	24	106	25	118	25	131	26
	20	74	27	83	28	91	28	101	29	112	30
	24	64	30	72	31	79	31	88	32	97	33
55	15	99	24	110	25	122	26	135	27	150	28
	20	87	28	96	29	106	30	118	30	131	31
	24	77	31	85	32	94	33	104	33	116	34

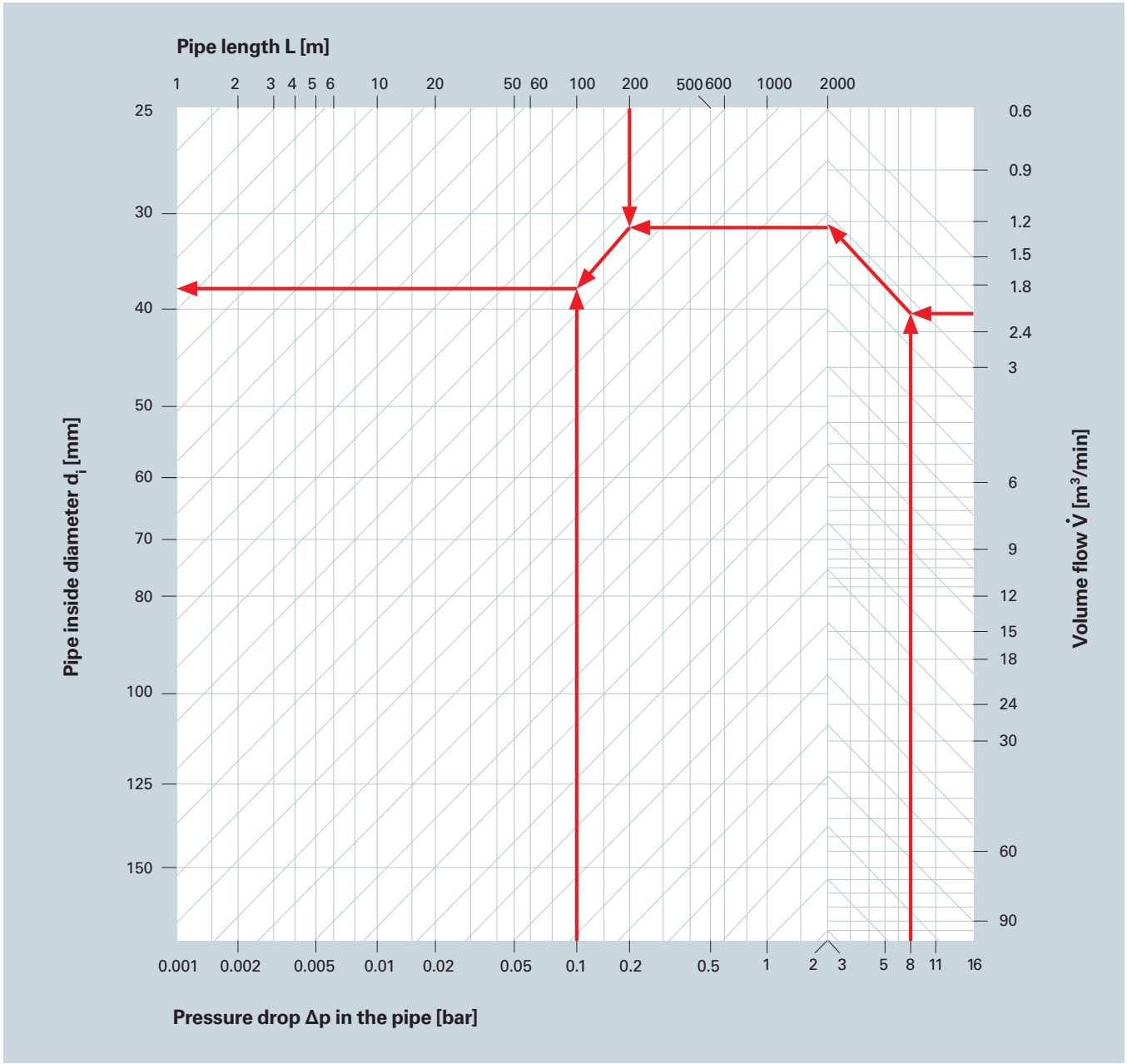
10.5 Basis for calculation of compressed air systems

The compressed air network

Graphical determination of the pipe inside diameter d_i

The pipe inside diameter $\mathbf{d_i}$ can be determined more easily and quickly using the graphical method of a nomogram instead of a calculation. The significant parameters are the same for the graphical and calculation method.

When taking readings you start with the intersection of volume flow $\dot{\mathbf{V}}$ and operating pressure $\mathbf{p_{max}}$. Further steps arise when following the bold lines of the example in direction of the arrow.



Example: The selected nominal diameter of the pipe is DN 40 ≙ 50 × 4

Volume flow	$\dot{V}$	=	2	m³/min
Pipe length in terms of air flow	L	=	200	m
Pressure drop	Δp	=	0.1	bar
Operating pressure	p_{max}	=	8	bar_{abs}
Pipe inside diameter	d_i	=	approx. 38	mm

10.5 Basis for calculation of compressed air systems

Calculated determination of the pipe inside diameter d_i

The pipe inside diameter can be dimensioned using the following approximation formula. The maximum operating pressure $\mathbf{p_{max}}$ (compressor shut-off pressure), the maximum volume flow $\dot{\mathbf{V}}$(required supply volume LB) and the pipe length in terms of air flow $\mathbf{L_a}$ are taken as the basis. **Δp** is the target pressure loss.

$$d_i = \sqrt[5]{\frac{1.6 \cdot 10^3 \cdot \dot{V}^{1,85} \cdot L}{10^{10} \cdot \Delta p \cdot p_{max}}}$$

d_i	=	pipe inside diameter	[m]
$\dot{V}$	=	total volume flow	[m^3/s]
L	=	pipe length in terms of air flow	[m]
Δp	=	target pressure drop	[bar]
p_{max}	=	compressor shut-off pressure	[bar_{abs}]

Example:
The pipe inside diameter $\mathbf{d_i}$ of a compressed air pipe with a target pressure drop **Δp** of 0.1 bar is to be determined using an approximation formula. The maximum operating pressure p_{max} (compressor shut-off pressure) is 8 bar_{abs}. A pipe of approx. 200 m has a volume flow $\dot{\mathbf{V}}$ of 2 m^3/min.

$$d_i = \sqrt[5]{\frac{1.6 \cdot 10^3 \cdot 0.033^{1,85} \cdot 200}{10^{10} \cdot 0.1 \cdot 8}}$$

d_i = 0.037 m = 37 mm

Selected nominal diameter: DN 40 ≙ 50×4

$\dot{V}$	=	2	m^3/min	=	0.033 m^3/s
L	=	200	m		
Δp	=	0,1	bar		
p_{max}	=	8	bar_{abs}		

The pipe inside diameters are standardised in specific stages. A standardised nominal diameter equalling the calculated inside diameter is rare. In these cases, the next biggest, standardised nominal diameter is selected.

10.6 Installation times

Installation times of heating and drinking water pipes

The following listed installation times for the alpex-duo XS and alpex L pipe systems apply as benchmark values for the preparation of an estimation and cost determination of installation pipes. The basic requirements for an estimation can be obtained in detail from the current VOB Part C (DIN 18381).

The indicated time values refer to the minutes per person and for the most part include the following services:

- Provision of tools/equipment and material at the place of installation
- Reading plans
- Measuring the pipe routing
- Measuring, marking, cutting, deburring, calibrating and cleaning pipes
- Installing and adjusting pipes
- Installing and pressing fitting

Additional ancillary services such as

- Construction site setup
- Preparing installation plans
- Chiselling operations for channels/penetrations
- Pressure test
- Insulation work
- Site measuring
- Clearing of the construction site

must be specified as separate items in a tender/quotation according to VOB. When estimating ancillary services, among others, the time and effort required referring to the construction site situation, weather conditions of the current season and journeys must be considered.

NB

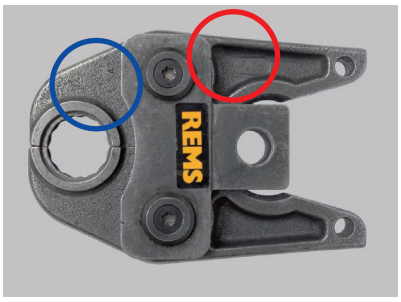
The determined time values per person refer to installers accustomed to working with alpex-duo XS and alpex L systems and apply per running metre and per fitting. These must be checked for accuracy and corrected, if required, by the planning installer/engineer before putting on the market.

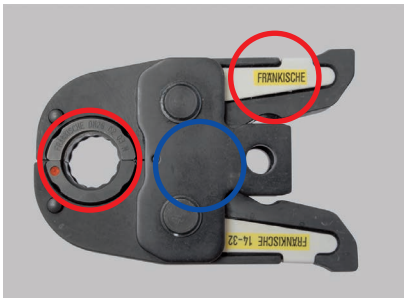
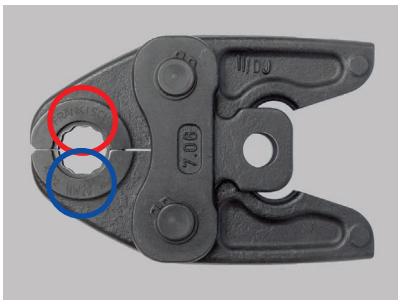
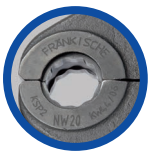
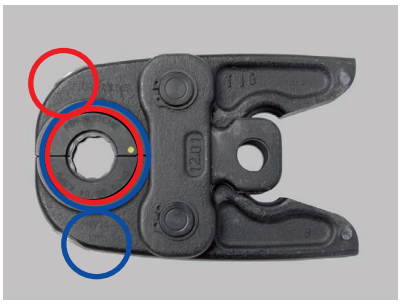
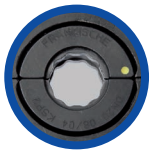
FRÄNKISCHE Rohrwerke (per installer)

	Installation times in minutes per person							
Dimension	**16**	**20**	**26**	**32**	**40**	**50**	**63**	**75**
Straight length pipes	10	11	12	14	16	18	21	23
Coiled pipes	8	9	10	11				
Elbow, bend, coupling	1.5	1.5	2	2.5	3	3.5	4	5
Tee	2	2	2.5	3	3.5	4	4.5	5.5
Reducer	1.5	1.5	2	2.5	3	3.5	4	5
Threaded adapter	3	3	3	3.5	4	4.5	5	6.5
Fitting connections	4	4	4					
Threaded connector with press nipple	1.5	2	2	2	2.5	3	3.5	
Flat-sealing threaded connector	1.5	1.5	2	2	2.5	3	3.5	
Transition coupling	1.5	1.5	2	2.5	3	3.5	4	
Radiator tee connection	3	3						
Radiator connection elbow	2.5	2.5						
Bending in pipes	1	1	1.5	2	3.5	4	4.5	
alpex connection set with wall mount elbow	5	5	5					

11.1 Press jaw overview

The age of the applicable press jaw makes can be ascertained as follows:

Manufactured as of 2005		Distinctive feature		Date of manufacture
REMS			REMS F20, F26 or F32 engraved inside the leg		2-digit or 3-digit engraving on upper press jaw. Before 2008: Digit 1 ≙ quarter before or after 2000 (1–4 before 2000; 5–8 after 2000) Digit 2 ≙ year e.g., 86 ≙ 4th quarter in the year 2006 After 2008: Digit 1 ≙ quarter Digits 2 and 3 ≙ year

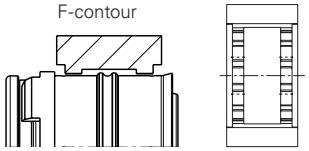
Manufactured up to 2005		Distinctive feature		Date of manufacture
NOVO-PRESS		 	NOVOPRESS FRÄNKISCHE inscription on lug FRÄNKISCHE inscription on insert tray plus identification N or NP		4-digit engraving on the insert tray and lug Digits 1+2 ≙ year Digits 3+4 ≙ calendar week e.g., 0247 ≙ CW 47 in the year 2002
KLAUKE			KLAUKE FRÄNKISCHE and KSP2 inscription close to the contour		4-digit engraving close to the contour Digits 1+2 ≙ calendar week Digits 3+4 ≙ year e.g., CW 44/06 ≙ CW 44 in the year 2006
KLAUKE		 	KLAUKE Disk for changing the insert trays FRÄNKISCHE and KSP2 inscription on the insert tray	 	4-digit engraving on the insert tray and on the adapter of the insert tray Digits 1+2 ≙ calendar week Digits 3+4 ≙ year e.g., CW44/06 ≙ CW 44 in the year 2006

Attention Press jaw products with manufacturing date older than 2002 must not be used for alpex-duo XS / alpex L!

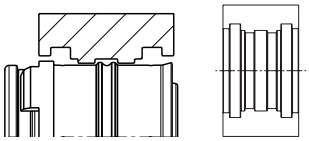
11.2 Contour overview

alpex-duo XS – possible jaw contours F and TH

F-contour



TH-contour



Company	Pressing systems	
F crimping contour	**Dim. 16, 20, 26, 32**	
FRÄNKISCHE Rohrwerke	alpex-duo XS	
CONEL	CONNECT MULTI	
Pfeiffer & May	XtraConnect	
TH crimping contour	**only dim. 16, 20, 26, 32**	
FRÄNKISCHE Rohrwerke	alpex-duo XS	
Comap	Florys, Sudopress Skin	(up to dim 26!)
Comisa	COMISA-PRESS	
Empur	PEXPRESS	
CONEL	CONNECT MULTI	
DIWAFLEX	Pressing system	
Gabo Systemtechnik	Pressing systems	
Giacomini	GiacoFlex, GiacoTherm	
Henco	Pressing systems	(up to dim 26!)
HERZ	Pipefix	
Lavagrund	Lavapress	
Multitherm	Pressing system	
Pfeiffer & May	XtraConnect	
Polysan	Pressing systems	
Praski	Bavaria-Press	
Purmo	HKS Sitec Press	
Schütz EHT	Ropress	
Schlösser	Europress-System	
Simplex	SiRoCon Installationssystem	
Viessmann	Pressing systems	
ZEWOTHERM	Pressing system	
More systems upon request!	E-mail: haustechnik@fraenkische.de www.fraenkische.com	

11.3 Tool compatibility list

Compatibility list of approved hydraulic pressing tools

Manufacturer or brand	Type/designation/year	Press jaw	Press jaw	Press jaw
		16 - 20 - 26 - 32	40 - 50 - 63	75
		F-, TH-contour	F-contour	F-contour
CONEL	PM 2 / PM 2 BT / PM 2 E	X	X	X
Novopress	ACO 1 / ECO 1 / EFP 1 / EFP 2 from ser. no. 30.001 - 1996 ACO 201 / AFP 201 / EFP 201 ACO 202 / AFP 202 ACO 203 ECO 201 / ECO 202 / EFP 201	X X X X X	X X X X X	NO X X NO X
Viega or Nussbaum	Pressgun 4 B / Pressgun 5 Pressgun 4 E PT3 - AH / EH Type 2 ser. no. 96509001 - 1996	X X X X	X X X X	X X X NO
REMS	Akku Press ACC Power Press E*/ Power Press 2000* Power Press ACC / Power Press / Power Press SE	X X X	X X X	X X X
Roller	Multi Press / Multi Press ACC Uni Press / Uni Press ACC Uni Press E* / Uni Press 2000*	X X X	X X X	X X X
Klauke	UAP2 (UP75) / UP 110 UAP3L / UAP4L UNP2 / UP 75 EL UP2 EL 14 HPU 2 (hydr.)	X X X X X	X X X X X	X X X NO X
Hilti	NPR 032 IE-A22 NPR 032 PE-A22	X X	X X	X X
Rothenberger	Romax Pressliner / Pressliner ECO Romax 3000 Romax AC ECO	X X X	X X X	X X X
RIDGID	Pressing tool RP 300-B / RP 340-B Pressing tool RP 300-C / RP 340-C	X X	X X	X X
Klauke mini	MAP1 / MAP2L / MAP2L19 HPU 32	Attention! Special press jaws required!	NO NO	NO NO
Hilti	NPR 019 IE-A22	"	NO	NO
Novopress	ACO 102	"	NO	NO
RIDGID	RP 100-B Compact RP 210-B	"	NO NO	NO NO
REMS	Mini Press ACC	"	40	NO
ROLLER	Multi Press Mini ACC	"	40	NO
Rothenberger	Compact / Compact TT	"	40 (only TT)	NO
CONEL	PM 1 / PM 1 BT	X	NO	NO

Status 03/24

***Attention** Press jaws and pressing tools with manufacturing date from 2002 must be subject to regular manufacturer maintenance.
Pressing machines must only be used with REMS / ROLLER press jaws and FRÄNKISCHE press jaws (alpex) as of 2007.

Use alpex press jaws dim. 40 - 50 - 63 - 75 mm with F-contour for pressing the FRÄNKISCHE alpex L installation system only.

A constant shearing force of 32 kN is required to establish a firm connection and achieve proper pressing. Pressing tools and press jaws must be regularly maintained by an authorised dealer or directly by the manufacturer according to the manufacturer's specifications.

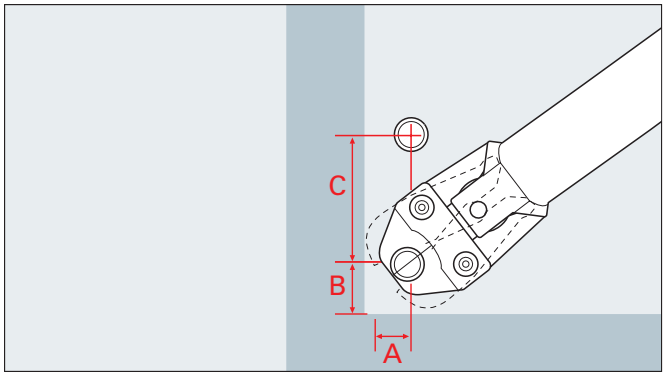
Attention For the purpose of liability security, we recommend only using pressing machines and tools approved by FRÄNKISCHE in the compatibility list of released hydraulic pressing tools or approved by a respective suitability verification in writing.
Please obtain the current versions of the lists "11.2 Contour overview" and "11.3 Tool compatibility overview" from the download section of www.fraenkische.com.

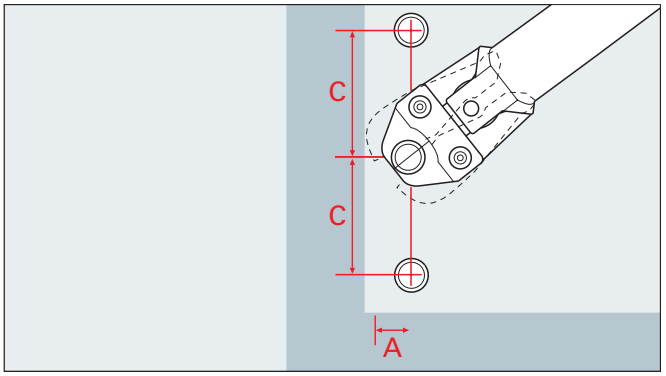
If it is verified in case of a complaint that a damage occurred due to pressing tools not tested and approved by FRÄNKISCHE, FRÄNKISCHE reserves the right to object to complaints.

Subject to change without notice.

11.4 Installation of drinking water and heating systems

Pressing with press jaws 16–32 mm

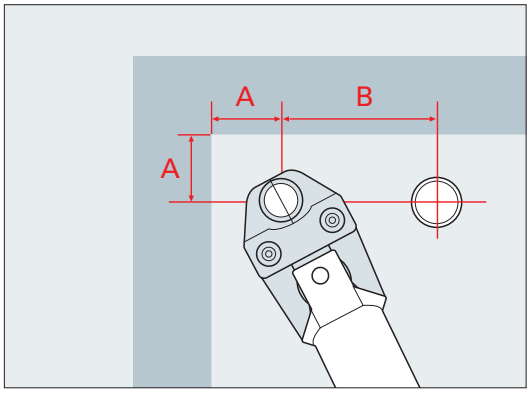


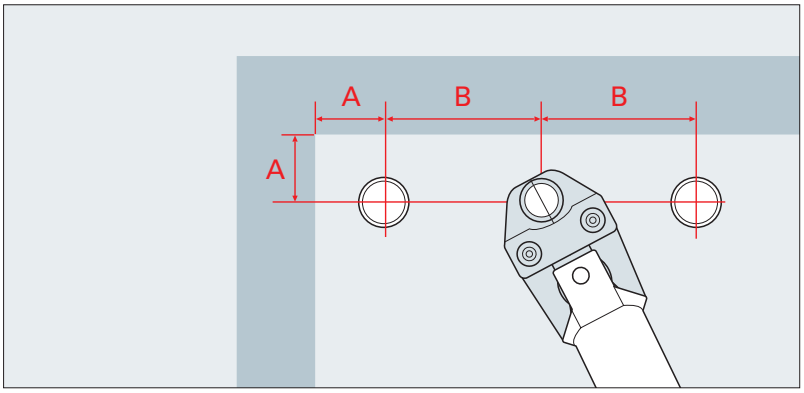


Pipe dimension [mm]	A [mm]	B [mm]	C [mm]
16×2,0	31	30	77
20×2,0	31	30	77
26×3,0	31	34	90
32×3,0	31	52	90

Pipe dimension [mm]	A [mm]	B [mm]
16×2,0	21	48
20×2,0	21	50
26×3,0	26	77
32×3,0	28	77

Pressing with alpex press jaws 40–75 mm





Pipe dimension [mm]	A [mm]	B [mm]
40×3,5	80	130
50×4,0	90	140
63×4,5	110	160
75×5,0	170	230

11.5 Pressure test/reports

Pressure test using water or compressed air

alpex-duo XS and alpex L press fittings as well as alpex-plus push-fit fittings made of PPSU/brass must be pressure-tested after installation and before plastering or screed work.

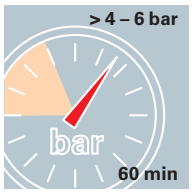
Testing can be carried out using water or compressed air and is generally a two-step process for all alpex connectors. Firstly, the installation is tested for leak-tightness (leak function) and secondly for strength.

1. Leak test and visual inspection

Water
ZVSHK advisory leaflet

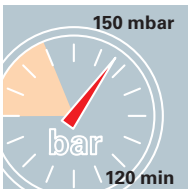
2. Strength test for drinking water and heating installations

Water
DIN EN 806-4



Water
DIN 18380

1. Leak test and visual inspection



Air
ZVSHK advisory leaflet

2. Strength test for drinking water and heating installations

Air
ZVSHK advisory leaflet

Pressure testing with water:

1. After having filled the system with water, the alpex-duo XS/alpex L connectors are visibly leaky when implementing the leak test in the range from **1 to 6.5 bar** in the unpressed state in accordance with the ZVSHK advisory leaflet. Visual inspection required! With the alpex-plus push-fit fitting, the green indicator shows the correct installation depth. Visual inspection required!

2. A successful leak test is followed by a strength test using water for drinking water installations according to DIN 806-4 at min. 11 bar for 30 min. and for heating systems according to DIN 18380 at 4 to max. 6 bar for 60 min.

   VDI directive 6023 specifies that drinking water systems should be put into operation immediately after water pressure testing and subsequent flushing, i.e., without downtime, for reasons of hygiene! We recommend a pressure test using compressed air if installations are started later.

Pressure test using compressed air

1. **Leak testing is carried out at** 150 mbar according to the ZVSHK advisory leaflet. The test time for 100 litres of pipeline volume is at least **120 minutes**. Increase the test time by **20 minutes** for every additional **100 litres**.

2. A successful leak test without pressure drop is followed by a **strength test** according to the ZVSHK advisory leaflet for drinking water installations and heating systems at **max. 3 bar** smaller than or equal to 63× 4.5 mm and at **max. 1 bar** larger than 63×4.5 mm at a test time of **10 min**.

NB

ZVSHK advisory leaflet "Leak Testing for Drinking Water Installations with Compressed Air, Inert Gas or Water".

Attention Only use leak detection systems certified by the DVGW and released by the respective manufacturers for use with the material PPSU.

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PRESSURE TEST REPORT using water as test medium for heating and drinking water

for the alpex-duo XS and alpex L systems with press fittings (alpex-duo XS dim. 16, 20, 26, 32; alpex L dim. 40, 50, 63, 75) or push-fit fittings alpex-plus (dim. 16, 20, 26)

Construction project _____

Building phase _____

Customer represented by _____

Supplier represented by _____

System pressure: ____ bar Water temperature: ____ °C Difference: ____ °C

The system has been tested as ☐ an entire system ☐ in sections

Metal plugs, caps, blanking plates or blind flanges must be used to seal all pipes. Apparatuses, pressure tanks or water heaters for drinking water must be disconnected from the pipes. **The system or pipeline section to be tested must be filled with filtered water, rinsed and completely bleeded.** Visually check that all pipe connections are properly connected. **The ZVSHK advisory leaflet "Leak Testing of Drinking Water Installations with Compressed Air or Inert Gas" and VDI 6023 Sheet 1 "Hygiene for Drinking Water Supply Systems" must be observed.**

1. Leak test according to the ZVSHK advisory leaflet

A large temperature difference (at least 10 K) between the ambient temperature and the water temperature requires a 30-minute waiting period to allow the temperature to equalize.
The pressure corresponds to the available supply pressure of _____ bar, but at least **1 bar and max. 6.5 bar!**

☐ The visual inspection of the system has been completed.

☐ A manometer was used for the test.*

☐ No leaks were found during the test period.

☐ No pressure drop* was observed during the test period.

2. Strength test

☐ **Drinking water according to DIN EN 806-4**

- ☐ The drinking water system has been pressure tested **at a minimum pressure of 11 bar**; the test was performed over a **30-minute period**.
- ☐ No leaks were found during the test period.
- ☐ No pressure drop was observed during the test period.*

The pipe system has been proven to be leak-tight.

☐ **Heating system according to DIN 18380**

- ☐ The heating system has been pressure tested using cold water **at a minimum pressure of 4 bar to a maximum pressure of 6 bar**; the test was performed over a **60-minute period**.
- ☐ No leaks were found during the test period.
- ☐ No pressure drop was observed during the test period.*

Place, date _____

Customer signature/customer representative signature

Supplier signature/supplier representative signature

* Manometers must be capable of accurately measuring the pressure to the nearest 0.1 bar.

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PRESSURE TEST REPORT using compressed air as test medium or inert gases as test medium for heating and drinking water

for the alpex-duo XS and alpex L systems with press fittings (alpex-duo XS dim. 16, 20, 26, 32; alpex L dim. 40, 50, 63, 75) or push-fit fittings alpex-plus (dim. 16, 20, 26)

Construction project _____

Building phase _____

Customer represented by _____

Supplier represented by _____

System pressure: ____ bar Water temperature: ____ °C Difference: ____ °C

The system has been tested as ☐ an entire system ☐ in sections

Metal plugs, caps, blanking plates or blind flanges must be used to seal all pipes. Apparatuses, pressure tanks or water heaters for drinking water must be disconnected from the pipes. Visually check that all pipe connections are properly connected. Only use leak detection systems certified by the DVGW and released by the respective manufacturers for use with the material PPSU.
The ZVSHK advisory leaflet "Leak Testing of Drinking Water Installations with Compressed Air or Inert Gas" and VDI 6023 Sheet 1 "Hygiene for Drinking Water Supply Systems" must be observed.

1. Leak test according to the ZVSHK advisory leaflet

Test pressure 150 mbar: The test time for up to **100 litres** of pipeline volume is at least **120 minutes**. Increase the test time by **20 minutes** for every additional **100 litres**.

Pipeline volume: _____ Litres Test time: _____ Minutes

The test period will begin only after thermal equilibrium and steady state condition has been achieved.

☐ The visual inspection of the system has been completed.

☐ A manometer/U pipe was used for the test.*

☐ No pressure drop was observed during the test period.

2. Strength test

The test period will begin only after thermal equilibrium and steady state condition has been achieved.

Test pressure max. 3 bar ** ≤ 63 × 4.5 mm Test period: 10 minutes
Test pressure max. 1 bar ** > 63 × 4.5 mm Test period: 10 minutes

☐ **The pipe system has been proven to be leak-tight.**

Place, date _____

Customer signature/customer representative signature

Supplier signature/supplier representative signature

* Manometers must be capable of accurately measuring the pressure to the nearest 1 mbar.

** Manometers must be capable of accurately measuring the pressure to the nearest 0.1 bar.

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RINSING REPORT for drinking water systems

Rinsing process: rinsing with water according to DIN 1988-200 and VDI 6023

Construction project _____

Building phase _____

Customer represented by _____

Supplier represented by _____

Pipe system material _____

The pressure test was performed on _____

Guiding values for the minimum number of tapping points to open based on the largest widths of the distribution pipe

Largest nominal width of the distribution pipe DN in current rinsing section	25	32	40	50	65	80	100
Minimum number of DN 15 tapping points to open	2	4	6	8	12	18	28

Throughout the entire floor/level, the tapping points are opened completely, starting with the tapping point farthest away from the riser pipe!
After a rinsing time of 5 minutes at the last opened rinsing point, the tapping points are closed in reverse order.

The drinking water used for rinsing is filtered, the static pressure Pw = _____ bar;

Maintenance fittings (shut-off valves, upstream shut-off valves) are completely opened;

Sensitive fittings and appliances are removed or replaced or bridged over with adapters;

Aerators, perlators, flow restrictors are removed;

Built-in strainers and dirt traps upstream of fittings must be cleaned after rinsing with water;

Rinsing takes place starting with the main shut-off fitting in the rinsing sequence by sections up to the tapping point that is located farthest away.

Rinsing of the drinking water system was completed properly!

Place, date _____

Customer signature/customer representative signature

Supplier signature/supplier representative signature

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COMMISSIONING REPORT for drinking water systems

Construction project _____

Building phase _____

Customer represented by _____

Supplier represented by _____

Commissioning took place on _____

System components commissioned	Tick as appropriate	Remarks
Building connection	☐	
Main shut-off fitting	☐	
Backflow preventer	☐	
Pipe separator	☐	
Filters	☐	
Pressure reducer	☐	
Distribution pipes	☐	
Riser pipes/shut-off fitting	☐	
Storey pipes/shut-off fittings	☐	
Tapping points with single backflow protection system	☐	
Water heating/ drinking water heater	☐	
Safety valves/pressure relief pipes	☐	
Circulation pipe/circulation pump	☐	
Batcher	☐	
Softening installation	☐	
Booster station/ drinking water reservoir	☐	
Swimming pool inlet	☐	
Other system components	☐	

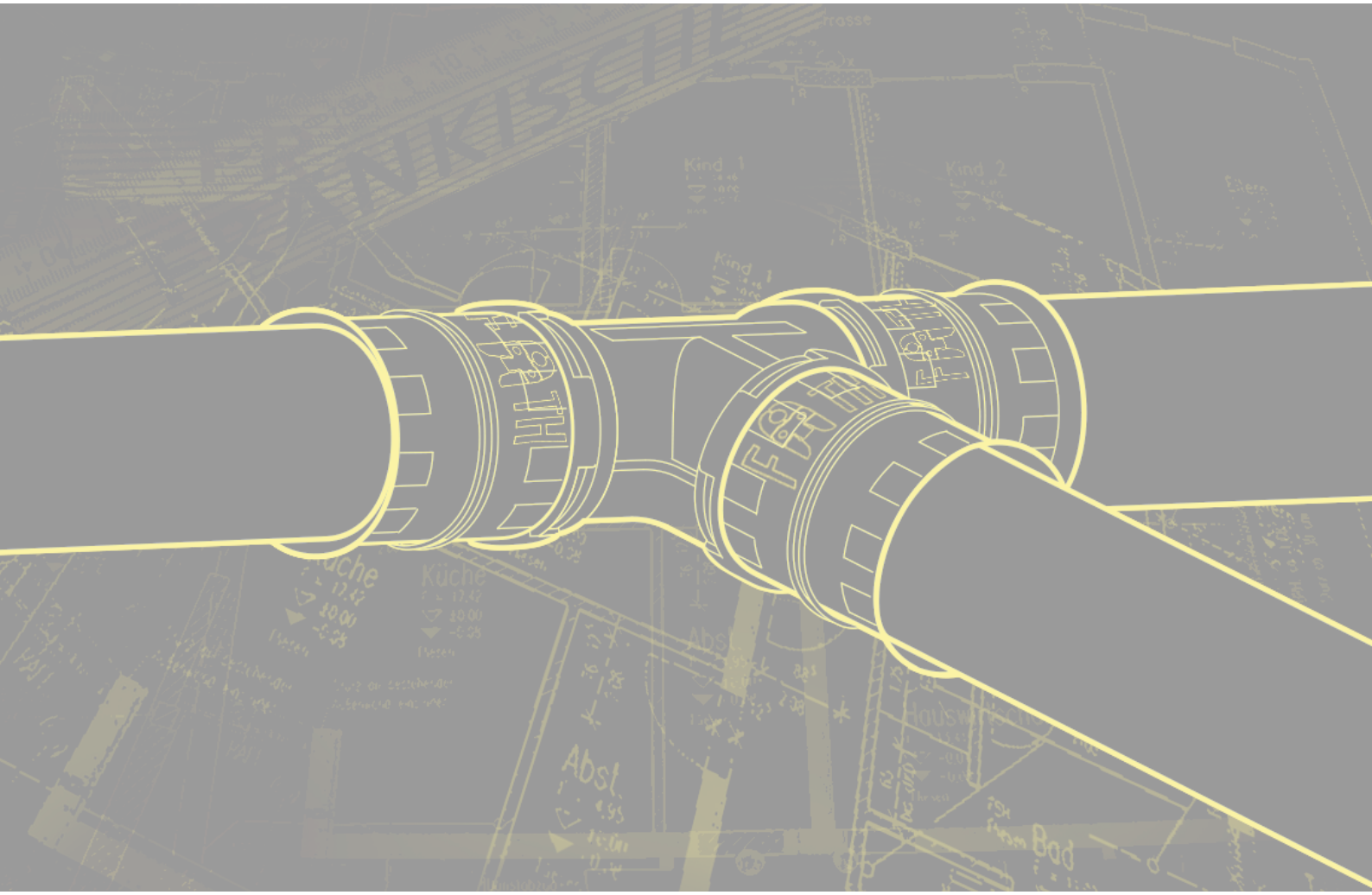
Instruction/document transfer

- Information for operating the system and apparatuses has been provided – the required operating documents and the existing operating and maintenance manuals for the system components mentioned above have been handed over.
- Information has been provided that despite careful planning and execution of the installation, drinking water of excellent quality can only be available from all tapping points if regular water exchange in all areas of the installatiois ensured.
- The temperature at the hot water outlet of large-scale systems must always be larger than or equal to 60 °C. This temperature may be fallen below by max. 5 K in the circulation system. For small-scale systems, the risk at temperatures smaller than 50 °C must be observed.

Place, date _____

Customer signature/customer representative signature

Supplier signature/supplier representative signature



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FRÄNKISCHE Rohrwerke Gebr. Kirchner GmbH & Co. KG | Hellinger Str. 1 | 97486 Königsberg/Germany
Phone +49 9525 88-0 | Fax +49 9525 88-2413 | marketing@fraenkische.de | www.fraenkische.com

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