Project planning and design guidance

Project planning

To benefit from all of the advantages of a under floor heating system, careful design is required. The following project planning instruction is intended as an aid to project planning of LK Under Floor Heating systems. Naturally, there can be differences between buildings, constructions and interacting heating, water and sanitation systems, so do not hesitate to contact LK Technical Support when help is needed.

Heat requirement

Use building drawings and calculate the heat losses for the selected areas at lowest required outside design temperature. Also take account of downward heat losses through the floor construction. When calculating floor transmission consideration must be taken to the increased floor temperature – on the average, assume a floor temperature of 24-25 °C. Also add ventilation losses and other variables that can affect heat requirement. The client's consultant or architect is responsible for the heat requirement estimate. LK cannot accurately calculate heat losses as there are many unknown variables.

The effect supplied to the room can be controlled with the aid of different pipe spacing, flows, Δt and feed temperatures. A normal mean requirement for new residences is 50 W/m^2.

Low-energy buildings

”Low-energy buildings” is a generic name for buildings which consume less energy than required by the Swedish Board of Housing, Building and Planning's Building Regulations. Low-energy buildings are normally divided into mini-energy buildings, passive buildings, zero-energy buildings, near zero-energy buildings (NNE buildings) and plus-energy buildings.

- Mini-energy buildings are buildings with lower energy requirements than demanded by the Swedish Board of Housing, Building and Planning's Building Regulations. These buildings need a traditional heating system in some form.
- Passive buildings – passive buildings are so energy-efficient that they can be heated using waste heat from living, solar gain, lighting and the devices in the building. Additional heat is provided in the colder months via the ventilation system or via an underfloor heating system, for example.
- Near zero-energy buildings (NNE buildings) are low-energy buildings with a climate shell similar to a passive building, but with self-produced energy. These buildings produce almost as much energy as they consume during the year. Additional heat is provided in the colder months via the ventilation system or via an underfloor heating system, for example. However, there is currently no officially clarified definition of an NNE building.
- Zero-energy buildings are low-energy buildings with a climate shell similar to a passive building, but with self-produced energy. These buildings should produce at least as much energy as they consume during the year. Additional heat is provided in the colder months via the ventilation system or via an underfloor heating system, for example.
- Plus energy buildings are buildings which produce more energy than they consume during the year. These buildings are normally fitted with solar cells. The surplus energy is exported to the external grid.

Depending on the type of low-energy building, underfloor heating can be installed either as a heating system or just as comfort heating.

Mini-energy buildings

In buildings of this type, underfloor heating is installed as a heating system in the conventional manner. The power output is adapted by selecting appropriate pipe spacing, flow and supply temperature. The underfloor heating is zoned by room and provided with control equipment with self-modulation technology and designed for underfloor heating.

Passive buildings, zero-energy buildings, near zero-energy buildings (NNE buildings) and plus energy buildings.

In these building types, it is possible to meet the need for heating by laying underfloor heating in edge zones/smaller areas. However, LK recommends that the entire floor area should be fitted with underfloor heating to provide satisfactory comfort. Otherwise residents may feel the floor areas not fitted with underfloor heating to be cold. The power output is adapted by selecting appropriate pipe spacing, flow and supply temperature. The underfloor heating is zoned by room and provided with control equipment with self-modulation technology and designed for underfloor heating.

Self-regulating underfloor heating in apartment buildings

In apartment buildings with particularly low heating needs there is today an opportunity to simplify the building's heating system using underfloor heating

Instead of traditional radiator installations the property is fitted with embedded underfloor heating in joists/intermediate joists. Self-regulating underfloor heating systems are not fitted with room controls, but instead it is the self-regulating properties of the underfloor heating that maintain room temperature and comfort.

Principles of self-regulation

The principle for a self-regulating underfloor heating system is a low supply temperature, only a few degrees above room temperature. When the room temperature exceeds the temperature of the joist then the underfloor heating/joist stops providing heat. And vice versa i.e. when the room temperature is lower than the temperature of the joist then heat emission increases.

To some extent it is also possible to move/redistribute surplus heat due to the self-regulating function. When room temperature exceeds the joist temperature e.g. from solar gain, then the underfloor heating will redistribute heat to other parts of the building with a heat deficit, such as the north side of the building.

Requirements

One requirement to use self-regulating underfloor heating is that the heating needs of the building do not exceed 30W/m2. In addition the heating needs of the building should not vary to any great extent between different storeys, rooms or zones as the same supply temperature is used for the entire underfloor heating installation.

The supply temperature in these energy-efficient buildings is generally between 21-25°C depending on the current outdoor temperature. The regulating curve for supply temperature in relation to outdoor temperature is therefore very flat.

Underfloor heating is installed in intermediate concrete joists with insulation. The pipe is placed towards the bottom of the joist.
This will provide a larger share of ceiling heating in the apartment under and a lesser share of underfloor heating in the apartment above. The ground floor is fitted with underfloor heating with underlying insulation. The top floor is fitted with ceiling heating with overlying insulation.

Underfloor heating is fitted normally without taking into account the room layout. The same pipe spacing is usually used through the installation. Pipes can be fitted closer together in exposed areas, such as corner rooms with two, cold outer walls.

Advantages and disadvantages of a self-regulating underfloor heating system.

Advantages

- A robust system
- Easy/fast installation
- Low investment costs
- Low operating costs, particularly in combination with a heat pump.

Disadvantages

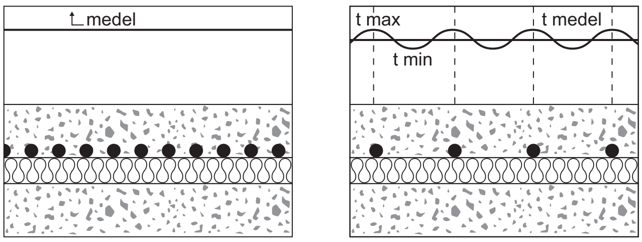
- Everyone has the same room temperature, residents cannot influence this.
- Difficult to design if there is a great variation in the heating requirements between zones/storeys as the same supply temperature is provided to the entire underfloor heating system.
- Requires careful adjustment.
- Restrictions in the use of ceiling attachments, important to inform residents and maintenance personnel about this.

Heat emission from the floor surface

For every degree of temperature above mean temperature the floor surface has in relation to room temperature, 11 W/m² are emitted. (The definition of mean temperature is explained in the illustrations below.) The demand on room temperature can vary in different rooms and types of premises. When planning for residential spaces, 20°C is normally accepted for (comfort setting) room temperature dimensioning, in parallel with a maximum floor surface temperature of 26 °C for the occupied zone. (See local building regulations.)

Example: A mean floor surface temperature of 26 °C gives a maximum heating effect of 11 x (26-20) = 66 W/m², which normally is quite sufficient for residences constructed to modern building regulations.

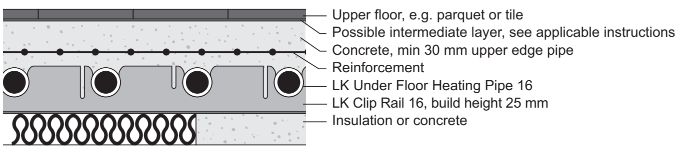
Premises such as shopping centers, atria, storerooms, etc., are allowed to have higher floor surface temperatures. Consideration must, however, be taken to the floor surface finish.



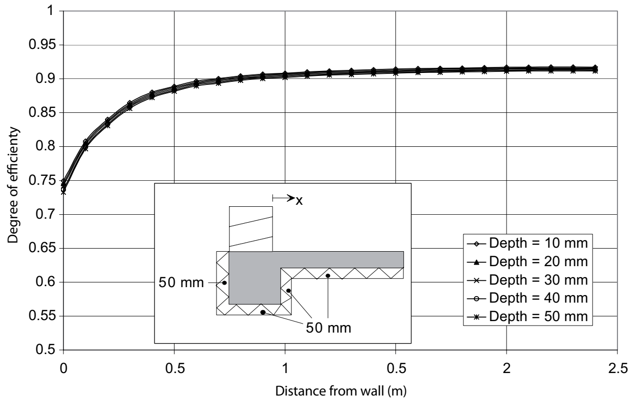
Left: Densely laid pipe with high effect emission per m².
Right: Sparsely laid pipe with lower effect emission per m².

The effect of heat flow on pipe depth at installation

Installation depth has little significance for heat flow to the room when installing on a normal concrete slab of 100 mm. This is due to the fact that the concrete offers little heat resistance. With LK System Plate or LK Clip Rail to position the pipe, the pipe's level in the concrete (or screed) slab is secure and ensures full encapsulation.



The graph below shows how so-called global insulating efficiency (portion of supplied heat utilised by the room) varies with the assembly depth of the pipe in the concrete.The graph shows that the difference is so small that the lines for the assembly depths are barely separable. The study was carried out with an underlying floor insulation of 50 mm.



The importance of floor covering

All floor coverings have some insulating effect. Floor coverings with the lowest insulating resistance are ceramics and fully glued vinyl coverings. Wood floors, laminated floors and wall-to-wall carpeting have a higher insulating effect. When planning for under floor heating, consideration should be given to floor type and its thickness, since this affects the effective emission of the under floor heating.

When laying floor coverings no air pockets should be allowed between the floor covering and the sub-floor, since air is a poor heat conductor.

Manifold location

The heat circuit manifold should be located as centrally as possible in the area it serves so as to minimize the length of the supply and return pipes to each room. For residences, of about 100-120 m^2 of floor surface per heat circuit manifold a maximum 8-10 circuits are recommended. Long flow runs and large flow surfaces cause involuntary and uncontrollable heat emission and can in extreme cases require additional floor surface insulation or other solution. The floor surfaces over the flow runs must be taken into account, since they can partly or entirely cover the heat requirement in the space they pass through.

The under floor heating manifold should be placed where it´s easily accessible to facilitate inspection and maintenance. For air bleeding the system, the manifold must always be installed higher than the under floor heating pipes.

Assembly on the wall

The heating circuit distributor can be fitted on the outside of a wall provided that the distributor is visible and accessible, and where any water from leaks can be detected quickly.

The manifold can be placed in LK Manifold Cabinet WP RF if you wish to hide the installation. Complete with accessory LK Base WP RF, which then conceals the pipe installation when mounted on the wall. LK Manifold Cabinet WP RF has a rigid base and drainage to ensure that any leaks can be lead to the optional inspection point. The maximum recommended length for the drainage pipe is 1,5 m.

Assembly built in wall

Assembly of manifold built into a wall must always be carried out using LK Manifold Cabinet WP RF. LK Manifold Cabinet WP RF has a rigid base and drainage to ensure that any leaks can be lead to the optional inspection point. The maximum recommended length for the drainage pipe is 1,5 m.

LK Manifold RF assembled in LK Manifold Cabinet WP RF .

Division into circuits

The size of a under floor heating circuit is directly dependent on feed temperature, pipe spacing, type of floor covering, allowable pressure drop, temperature drop and water flow.

As a rule the design should lay the circuit's supply flow pipe along an outer wall, where the heat requirement is greatest.

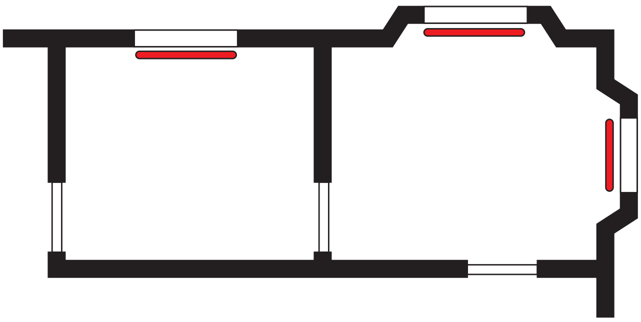
In order to obtain individual control, each room/zone is given its own under floor heating circuit. In larger rooms and rooms with a large heat requirement, the number of under floor heating circuits must be increased. Within the LK Calculation Program, the variables of the system are optimised, taking into consideration the given heat requirement. Contact LK Technical Support for help in calculating.

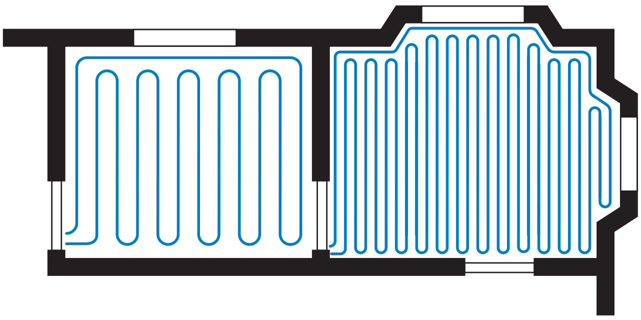
Pipe spacing

For a given heating effect from the floor surface, the feed temperature may be decreased with closer spacing of the pipes. If a system is being planned where low feed temperature is desirable, e.g. when a heat pump is to be installed, it is recommended to select closer pipe spacing. If the feed temperature is to be higher, wider pipe spacing can be chosen, thus reducing initial material and laying costs.

Correctly calculated heat requirements result in pleasantly comfortable rooms and floor surface temperatures throughout the entire building and, where room control is used, an even work rate for thermostats and actuators. Compare two rooms of the same size, one with two outer walls and the other with only one outer wall. With a radiator system, larger (or more) radiators would be selected for the room with the two outer walls.

Similarly, more capacity is added to under floor circuits by varying pipe spacing (see diagram below). To be able to offer varied pipe spacing ensures that the room with the greatest heat requirement/m^2 is not dimensioning the whole system, relative to feed temperature, flow rate and pump capacity.

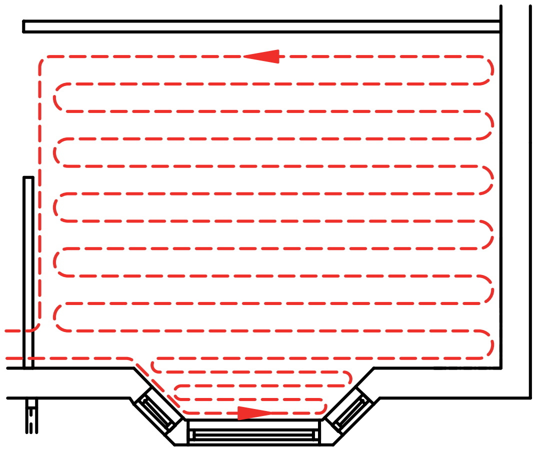




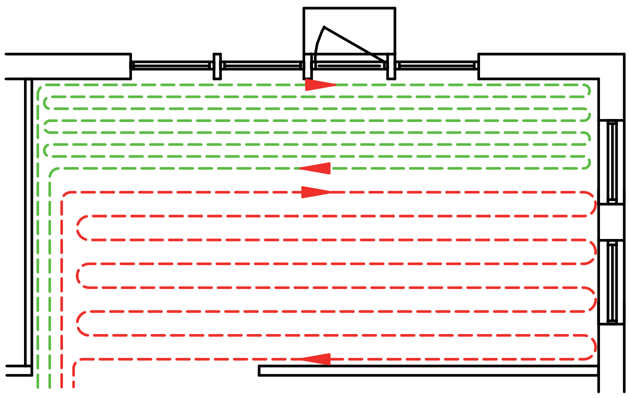
In larger systems where heat requirements do not exceed 25-30 W/m^2 due to additional heating or lower demands on floor surface temperature (e.g. shopping centres, storerooms, sports halls, etc.) wider pipe spacing and longer circuits than normal are allowable. Contact LK Technical Support for advice.

Edge zone

Large window areas and poorly insulated walls result in excessive heat transmission losses and the risk of cold downdrafts. Supplemantary heating is often required. In such cases circuits with close pipe spacing can be laid in so-called "edge zones", leading to higher heat emission. Under floor heating for edge zones can be calculated in the LK Calculation program. The edge zone can be designed and laid both as part of a under floor heating loop or as a separate circuit only for the edge zone.



Integrated edge zone.



Separate edge zone.

Laying patterns

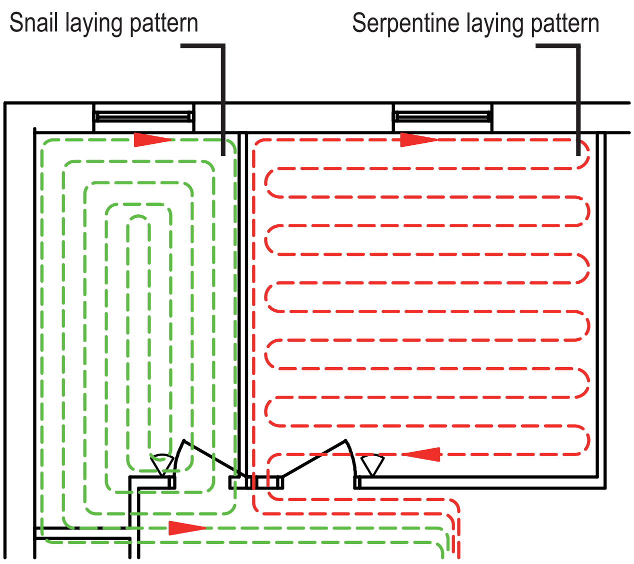
Concrete and Screed

Under floor heating circuits can be embedded in concrete/screed in two different patterns, snail or serpentine. Snail laying offers more even temperature over the surface of the floor. This is because the warmer "flow" pipe parallels the cooler return, thus providing an absolutely even floor surface temperature. When laid in this way, a relatively large drop in temperature (Δt) in the circuit loop can be accepted without affecting the comfort of the floor. Thus, larger circuits can be laid. For this type of system use LK System Plate 30, made of 30 mm EPS with integrated pipe holders, or LK Foil Board 30 Silent where the pipes are fixed in a grid pattern foil board with staples. (For more information, see the assembly instructions and the product range list).

Traditional serpentine laying reduces the floor surface temperature progressively from the supply manifold towards the return manifold as the water temperature drops. To maintain comfort, the temperature drop (Δt) over the circuit must be kept as low as possible.

Other systems

Other laying types, on wooden joists and floating floors, are always serpentine pattern type.

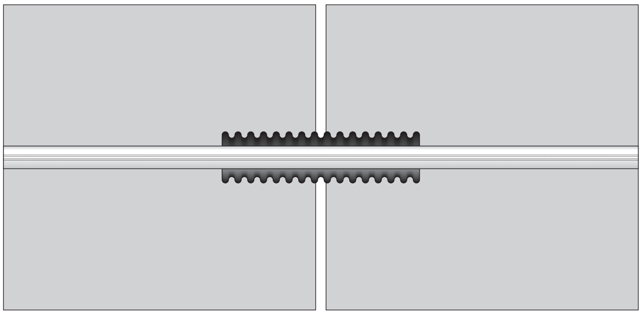


Supply pipe laid along outer wall in snail and serpentine laying pattern.

Expansion joints

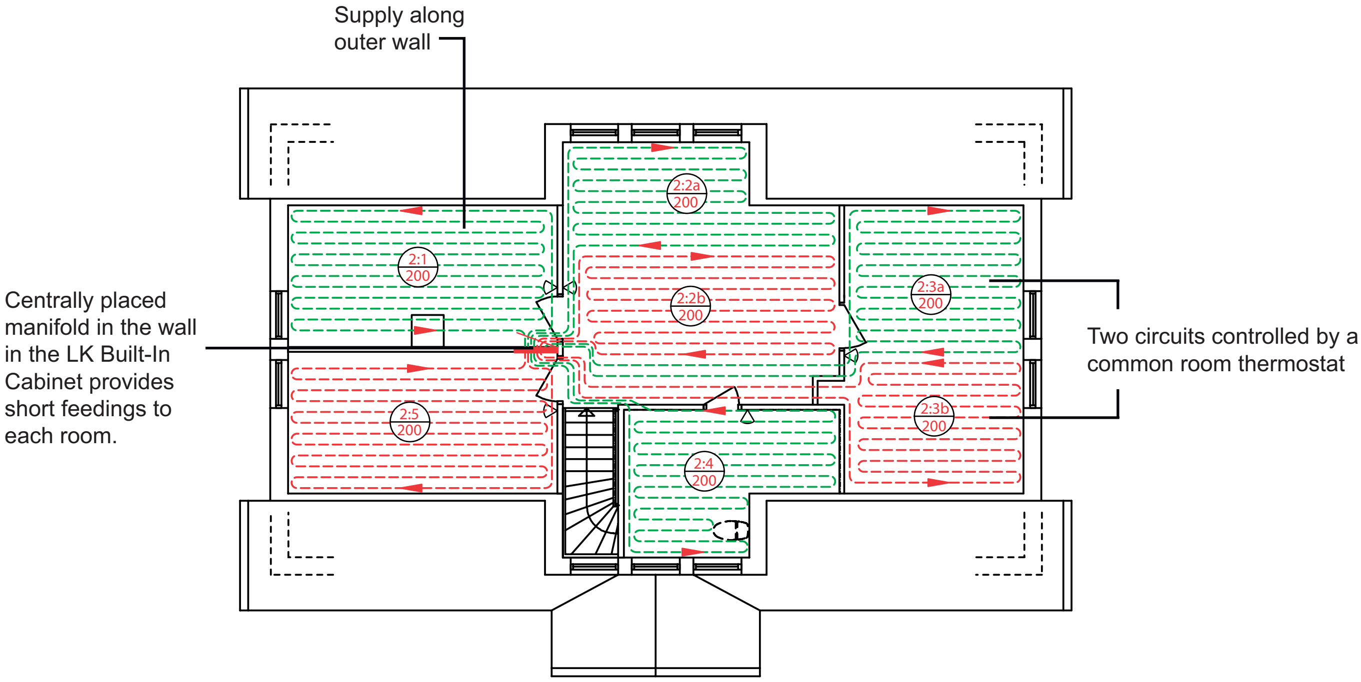
Large surface areas must be cast in so-called 'expansion zones'. Under floor heating circuits should be laid wholly within an expansion area. Only the supply and return pipes, suitably protected by LK Conduit Sleeve, should pass through an expansion joint. The conduit eliminates risk of damage that can occur by friction from expansion movements between concrete/screed slabs. The conduit is pulled out 10-15 cm on each side of the mould joint.

The total length of the protective pipe must be at least approx, 400 mm, and it must be positioned centrically, i.e. with 200 mm of protective pipe on either side of the expansion joint. This will eliminate the risk of damage which may occur due to expansion movements between the concrete slabs.

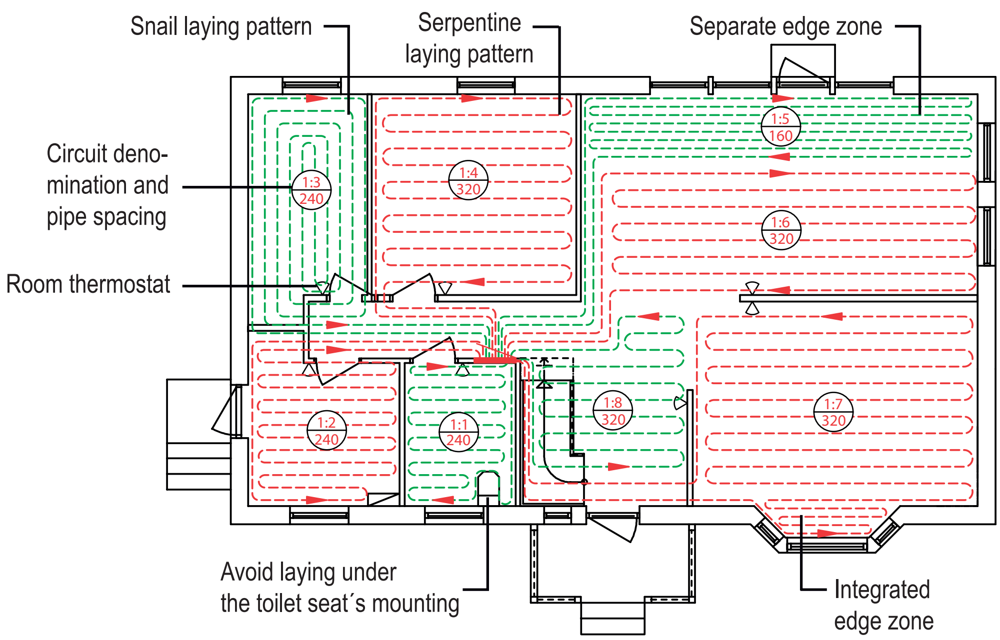


Mould joint with protective conduit.

Drawing example



Under floor heating on wooden joists.

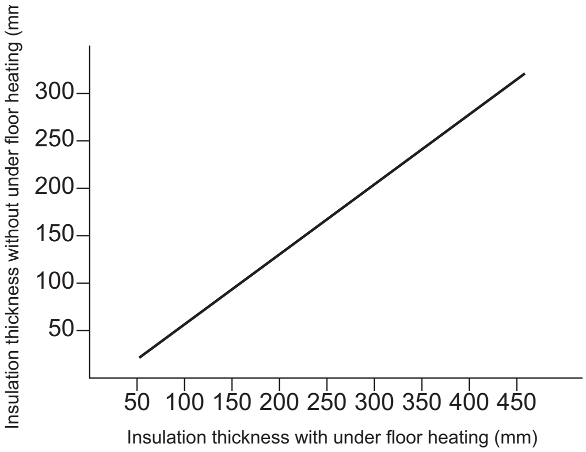


Under floor heating in concrete/screed.

Insulation

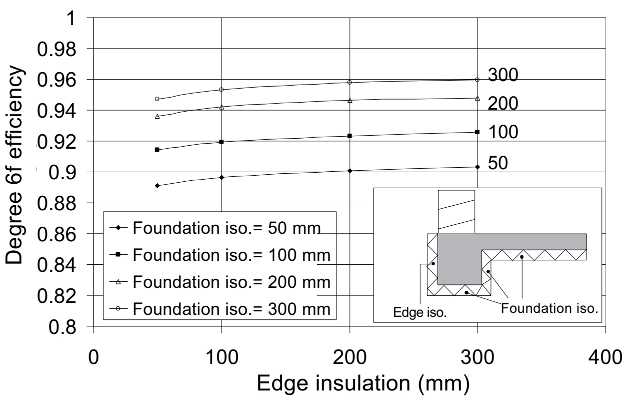
Under floor heating gives higher temperatures in floors and concrete slabs compared to a heating installation done with, for example, radiators. The increased temperatures entail higher heat losses that must be countered by insulation.

The need for insulation to equalise transmission losses in a ground slab with under floor heating installations compared to radiators is explained below.



The thickness of insulation of the foundation in a under floor heating installation compared to radiators. (The illustration above applies to a house of average size.)

The most important consideration in the distribution of insulation in the foundation is the total ground insulation. It is usually not the edge beam that causes the greatest loss in heat. This is because the outside surface portion of the total insulation surface of the concrete slab is small.



Degree of efficiency as a function of edge insulation with different foundation insulations. (The graph applies to a house of average size.)

Frost penetration

Frost penetration and frost heave should be taken into consideration with today's well-insulated foundations and ground slabs. In very cold regions excessively thick ground and edge beam insulation increases the risk of frost penetration beneath the building. To reduce the risk of frost penetration, the width of the ground insulation can be increased so that it extends outside the house foundation.

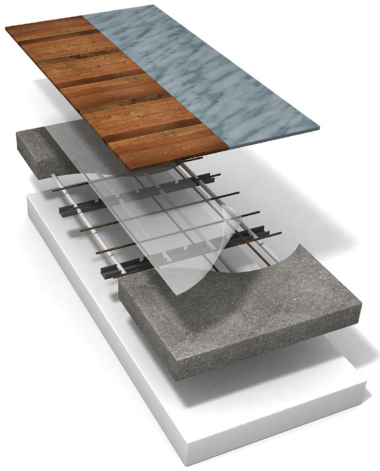
Intermediate floors of concrete

When under floor heating is to be laid in intermediate floors of concrete (and other constructions) in, for example, apartment buildings, floor joists and cavities must be insulated to avoid downward heat losses and "ceiling heat" in the room below.

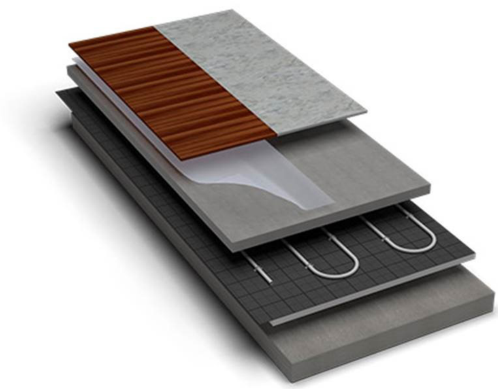
One solution is to lay insulation, fix LK Clip Rail and pipe, then encapsulate in screed or use LK Foil Board 30 Silent. A second solution is to lay under floor heating in pre-routed insulation boards (e.g. LK EPS) on the concrete.

In a residential house with identical heating and temperature requirements for both upper and lower floors, 50 mm insulation is the recommended minimum.

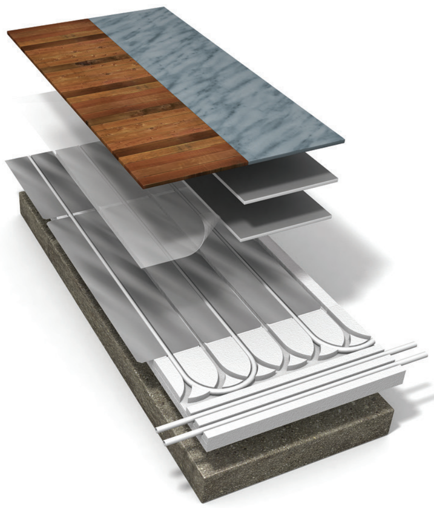
See assembly instructions and product range for further information on LK Clip Rail, LK Foil Board 30 Silent and LK EPS.



LK Clip Rail 16

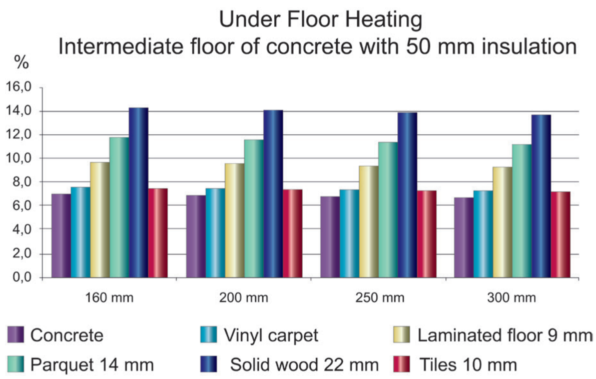


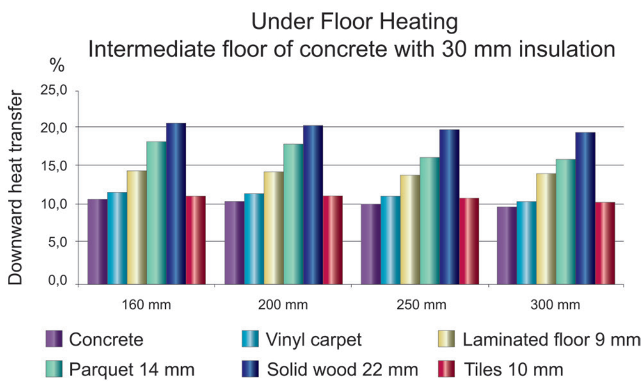
LK Folieskiva 30 Silent

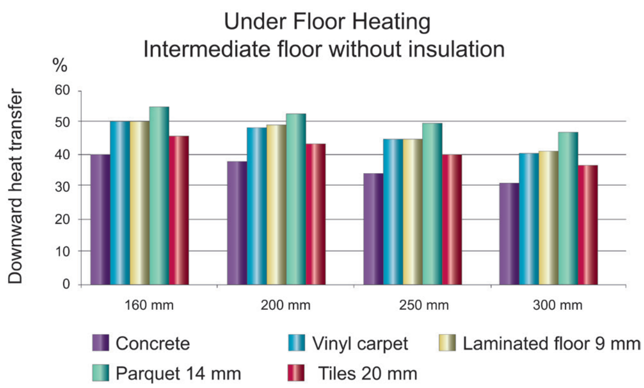


LK EPS.

The bar charts below shows how great a proportion of heat is transferred downwards in various floor thicknesses in different floor types. Thick wooden floors produce increased downward heat transfer, while tiles, which have low heat resistance, produce less downward heat transfer. The thickness of concrete floors has little effect on heat transfer, as concrete is a relatively good heat conductor. The calculation is for a construction with the same heat and temperature requirements above and below the floor.







LK Systems

Under floor heating on wooden joists

There are several different solutions for under floor heating on wooden joists, such as pre-routed chipboards, floor joist plates and secondary spaced boarding . Generally speaking the joist cavities should be fully insulated and air-tight, so that heat will not be "ventilated" away. It is important that the insulation fits snugly against the underside of the under floor heating installation.

Movement / Drying out of timber & joist systems

Construction timber with high moisture content used for floors and joists may, due to drying-out, cause movement, in turn causing cracks or gaps between floor and wall. Studies have shown that the degree of timber drying in a building with floor heating differs little from that of a building with radiators. However, floor heating speeds up the drying process and may, therefore, be perceived as if the drying has been greater. In order to avoid excessive movement (irrespective of the heating system used) the construction timber should be dried down to at most 12 % moisture content (standard construction timber normally has a moisture content of 18 %). Depending on the floor heating solution selected, the floor heating may help dry the timber, a process that takes some 3-4 weeks. A dehumidifier may be used to assist. As an alternative to standard construction timber, light or engineered joists may be used; alternatively ready dried timber may be purchased.

Humidity

There has been much discussion about humidity, or moisture content, in so-called ground slab installations. Below are explanations of the different concepts and the possible effect of under floor heating. Three different categories are usually mentioned: capillary suction, building damp and diffusion. In general, relative humidity may not exceed 75 % in a building construction, since organic material such as wooden studs, hard-board flooring etc. can be damaged.

Capillary suction

Capillary suction is caused by the surface tension of water sucking water from a free water surface, e.g. ground water. Problems with capillary suction arise if there is no capillary breaking layer, e.g. washed crushed stone and a good quality Damp Proof Membrane, or if water rises into the foundations, due to inadequate or faulty drainage.

Building damp

Newly cast concrete contains a good deal of water, so-called building damp. During construction rain and snow can also cause building damp. This moisture must always be given time to dry. With under floor heating embedded in concrete drying can be accelerated to half the time. Before the floor covering is laid, the relative humidity of the concrete slab must be checked and may not exceed applicable norms. See general material and work description for house construction work (refer to local building regulations).

Diffusion

Nature strives for equilibrium. Just as heat flows through a wall from the warm side to the cold, water vapour molecules move in the direction where there is the smallest number of molecules; this is called diffusion.

The air in a room normally has a higher moisture content than the outside air so moisture is transported from inside to out. When the air meets the external walls, it is cooled and its relative humidity increases, which can cause moisture problems in, for example, the joists. To prevent this, diffusion barriers are placed on the inside of the insulation, which is to say the warm side. The foundations beneath a concrete slab on the ground normally have lower moisture content than the air in the room so moisture is transported down into the foundations.

Insufficient insulation in combination with under floor heating increases the risk of the foundations being heated up and drying out. During winter months, when the heating is on, the drying of foundations and underlying earth extends downward. During summer months, the concrete slab cools and then, with insufficient thickness of insulation, the opposite can occur, which is to say moisture is transported from the foundations to the concrete slab. To prevent this, the insulation must be increased to decrease heat transfer to the foundations. A difference of minimally 4-5 °C is recommended between the inside air temperature and that at the underside of the insulation when dimensioning the thickness of the insulation. Each degree of difference reduces relative humidity by about 5 %. The risk for permafrost should be taken into account if still thicker insulation is being considered. It is also important to ensure that the heating control system is correctly adjusted to prevent unnecessarily high mean temperatures in the floor.

Design parameters

When designing under floor heating system there are a number of variables to be considered. Based on these variables, the design is set so that optimal operating economy and comfort are achieved.

Temperature drop (Δt) over the under floor heating circuit pipe loop

To achieve optimal comfort with a under floor heating system, a circuit's Δt is dimensioned to about 5-7 ºC in residential spaces. This is done to make the floor surface temperature as even as possible over the entire floor surface. Higher Δt can be allowed in spaces where there are no demands on comfort in the floor surface, e.g. storerooms, etc.

Pressure drop

An under floor heating system designed with a low Δt, will achieve higher flow rates than e.g. radiator systems, which are dimensioned with a higher Δt. The higher flow rate in under floor heating also entails greater drops in pressure in the heating loops. In the LK Calculation program pressure losses in pipes, including heat circuit manifolds, are calculated. Maximum pressure drop in a "normal" under floor heating circuit is about 20-25kPa.

Feed temperature

The under floor heating systems design feed temperature can vary depending on pipe spacing, heat requirement, floor covering and maximum floor surface temperature.

Pipes

The LK range includes various polyethylene-based pipe types designed for heating / underfloor heating systems as described below. Experience, calculations and accelerated ageing tests indicate that the service life of the pipes is well in excess of 50 years at a load corresponding to the maximum permitted continuous pressure and temperature of the pipes.

During normal operation, the system pressure and system temperature are considerably lower, so resulting in a considerably extended pipe service life. The pipes are fitted with oxygen diffusion barriers by EVOH, which prevents oxygenation of the water. Test results show that the oxygen permeability of LK pipes is more than three times better than the requirements specified in accordance with the applicable DIN standard 4726.

Because of LK's unique process, LK PE-X pipes benefit from consistent high flexibility (suppleness) combined with enhanced toughness. These features offer the benefits of fast and easy installations for the installer and greater security for the end user.

LK Underfloor Heating Pipes/Heating Pipes are designed for distribution of heat or cooling. These pipes are manufactured in accordance with pressure class PN 6, i.e. 0.6 MPa.

LK universal pipes have been developed and adapted for use for heating/cooling or tapwater systems. The pipes are dimensioned for pressure class PN10, i.e. in accordance with the requirements specified in the Swedish Board of Housing, Building and Planning's Building Regulations for pipes designed for tapwater. Hence any surplus piping/waste piping from underfloor heating installation can be used for tapwater installation.

LK heating pipes of dimension 25 or 32 are normally used as supply pipes for LK underfloor heating. These heating pipes are supplied as pipe in pipe solutions, with a corrugated protective pipe outside the PE-X pipe.

UV light

PE-X must not be exposed to direct sunlight for prolonged periods. UV adversely affects long-term performance characteristics. The pipes must be covered if there is any risk of them being exposed to direct sunlight for any length of time. Maximum length of exposion allowed is three months.

Pipe Overwiew

Pipe name	Pipe dimension	Pipe material	Pressure class	Max. cont. temperature	Max. momentary temperature	Standard
LK Under Floor Heating Pipe	8 x 1,0 mm	PE-Xa	PN6	70°C	95°C	EN ISO 15875 (DIN16892/3)
LK Under Floor Heating Pipe	12 x 2,0 mm	PE-Xa	PN6	70°C	95°C	EN ISO 15875 (DIN16892/3)
LK Under Floor Heating Pipe	16 x 2,0 mm	PE-RT	PN6	60°C	70°C	EN ISO 22391 (DIN16833/4)
LK Universal Pipe	16 x 2,0 mm	PE-Xa	PN10	70°C	95°C	EN ISO 15875 (DIN16892/3)
LK Under Floor Heating Pipe	20 x 2,0 mm	PE-RT	PN6	60°C	70°C	EN ISO 22391 (DIN16833/4)
LK Heating Pipe	25 x 2,3 mm	PE-Xa	PN6	70°C	95°C	EN ISO 15875 (DIN16892/3)
LK Heating Pipe	32 x 2,9 mm	PE-Xa	PN6	70°C	95°C	EN ISO 15875 (DIN16892/3)

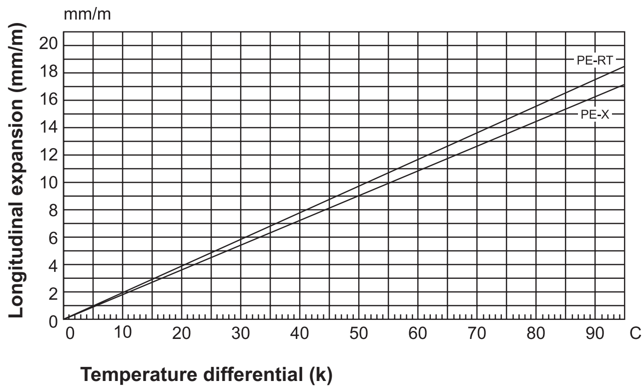
Material properties

Material properties, LK PE-Xa pipe			
Characteristics	**Value**	**Unit**	**Standard**
Degree of cross linking	>70	%	DIN 16892
Density	approx. 0,93	g/cm^3	DIN 53479
Tensile strength	approx. 20	N/mm^2	DIN 53455
Oxygen diffusion at 40 °C	<0,1	mg/l x d	DIN 4726
Ultimate stress	>500	%	DIN 53455
Thermal expansion coefficient	$1,8 \times 10^{-4}$	1/K	DIN 52328
Thermal conductivity	approx. 0,4	W/mK	DIN 52612

Material properties, LK PE-RT pipe			
Characteristics	**Value**	**Unit**	**Standard**
Density	0,93-0,94	g/cm^3	ISO 1872
Tensile strength	17	Mpa	ISO 527-2
Oxygen diffusion at 40 °C	≤ 0,32 / ≤ 0,10	mg/l x d / g/(m3 • d)	DIN 4726
Ultimate stress	>500	%	ISO 527-2
Thermal expansion coefficient	$1,95 \times 10^{-4}$	1/K	DIN 53752 A (20°C to 70°C)
Thermal conductivity (at 60°C)	ca 0,4	W/mK	DIN 52612-1

Longitudinal expansion

Changes in the length of a pipe due to temperature changes can be found in the graph below.



Longitudinal expansion for PE-Xa pipes.

Pressure loss in piping

The data in the graph is based on roughness coefficient 0.0005 and water temperature 40 °C. For other temperatures the values in the graph are to be converted using a factor from the table below.

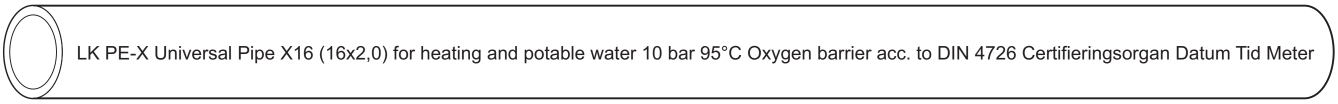
Water temperature (°C)	20	30	40	50	60
Conversion factor	1,09	1,05	1,00	0,95	0,93

LK Systems

EN.33.B.1.1912

Marking and identification

LK PE-Xa pipes are identified by pipe markings at 1 metre intervals.

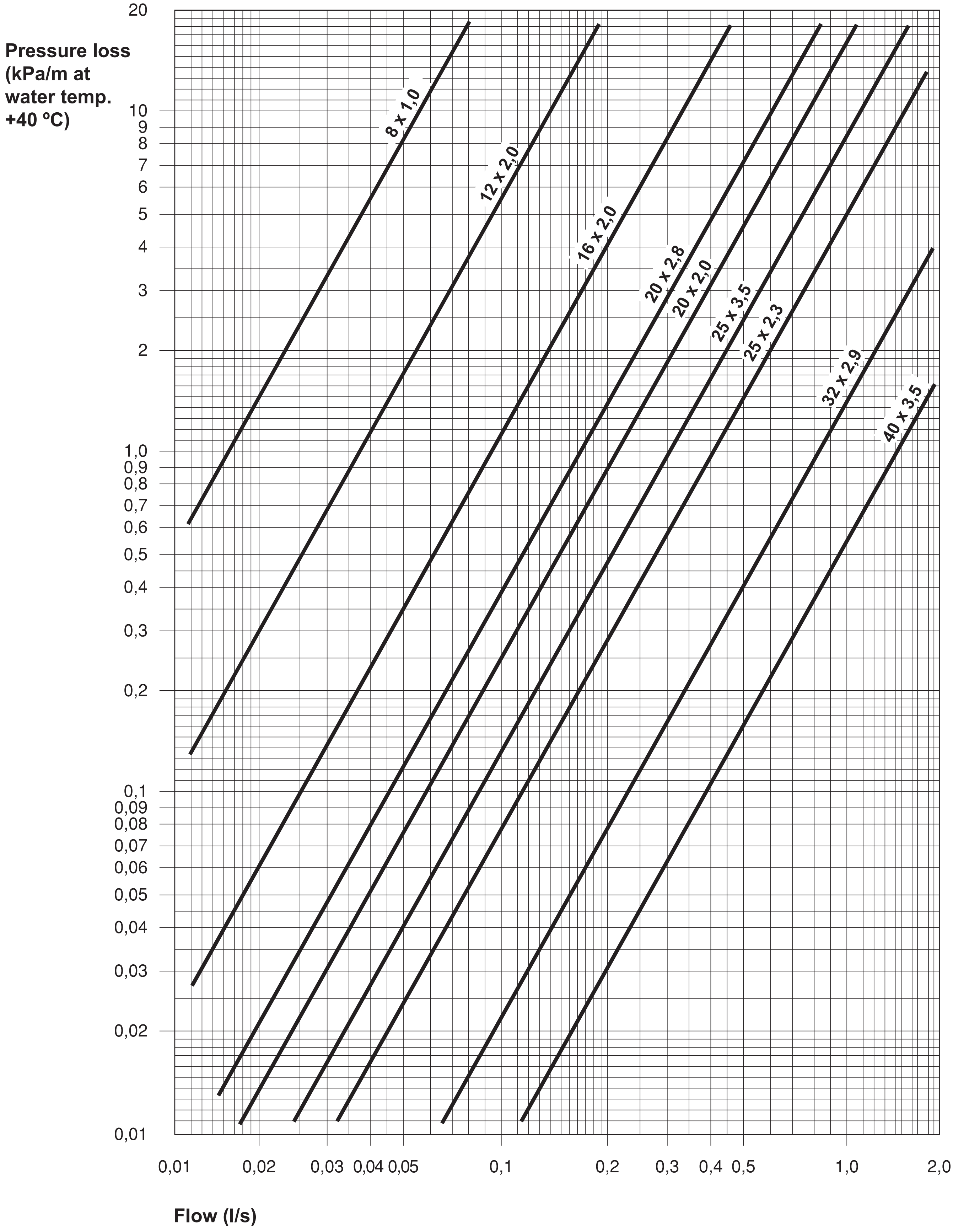


When anti-freeze is added the heat conductivity of the heat-carrying medium is reduced, for which reason, flow rates must be increased to generate the original design output.

Water volume by dimension and meters of pipe

Dimension	Volume l/m
8x1,0	0,028
12x2,0	0,053
16x2,0	0,113
20x2,0	0,201
25x2,3	0,327
25x2,5	0,311
32x2,9	0,539
32x3,0	0,523
40x3,5	0,845

Pressure loss graph LK PE-X pipe



LK Systems

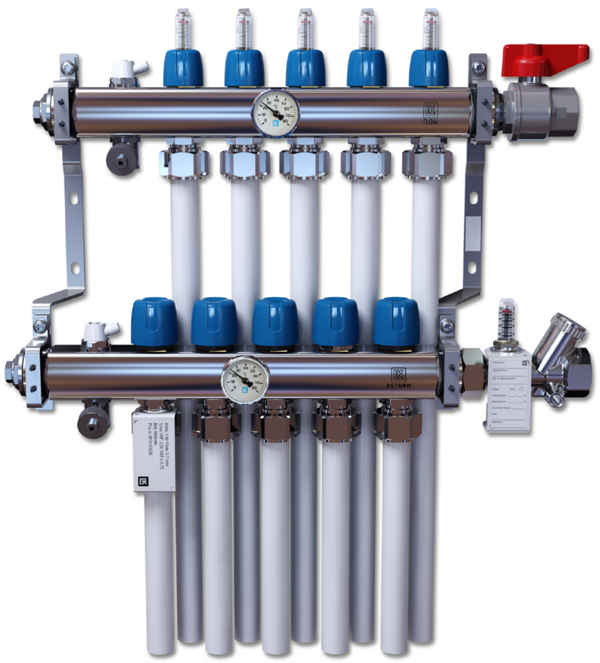
Manifolds

LK Manifold RF is made of stainless steel and is available with 2 to 12 floor heating circuits. The manifold has thermometers on the supply and return, manual air-bleed valves and filling/drain valves.

The upper manifold marked FLOW (supply) is fitted with flow indicators and adjustment valves for the adjustment of individual circuit flows. The flow indicators are made of temperature and impact resistant plastic. The plastic is resistant to anti-freeze, as well as glycol and ethanol with up to 50 % mix.

The lower manifold marked RETURN has hand actuators for shutting off individual circuits.The hand actuators are normally replaced with thermoelectric actuators controlled by LK Room thermostat.

For information about manifold location, see section *Manifold Location*.



LK Manifold RF with integrated flow indicator, ball valve and adjustment valve type LK OptiFlow EVO II attached.

Marking plates for identifying individual floor heating circuits are included. A protective bag used to protect the manifold from e.g. splashes of concrete during the assembly period is enclosed.

The following pipe dimensions can be connected to LK Manifolds.

LK PE-X pipes	LK PAL Universal Pipes	Copper pipes
8 x 1,0	16 x 2,0	Cu 12 x 1,0*
12 x 2,0	20 x 2,8 *	Cu 15 x 1,0*
16 x 2,0		
20 x 2,0		
20 x 2,8*		

** Cannot be calculated with the LK Calculation program.*

Temperature and flow adjustment

To ensure proper functioning of the under floor heating system, weather-controlled regulation (weather compensation) of the feed (supply) temperature is recommended. Balancing of the primary and secondary flow are essential.

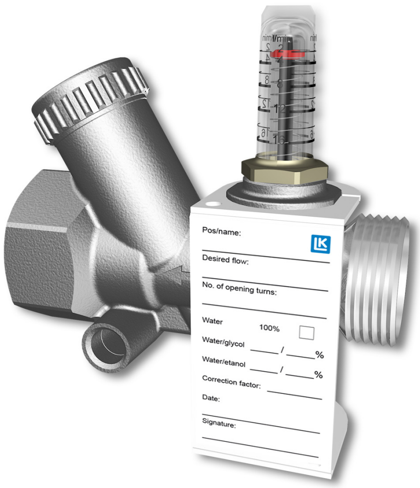
The printout from the LK Calculation program indicates each under floor heating valve setting value expressed in the number of opening revolutions from closed. The calculation also indicates the manifolds' total flow, pressure drop, temperature drop, etc.

Number of opening revolutions	Kv value
0,5	0,27
1,0	0,38
1,5	0,50
2,0	0,65
2,5	0,75
3,0	0,80
3,5	0,85
4,0	0,95
4,5 (Fully open)	1,15

Conversion table valve adjustment, LK Manifold RF.

Set values are to be recorded in the self-test protocol, which is attached to documents for operation and maintenance. Among the system documentation delivered by LK is the self-test form.

Supply and return pipes must be fitted to the manifolds with isolating ball valves. When two or more manifolds are used, the return pipe should be fitted with an adjustment valve (e.g. LK OptiFlow EVO II), so that each manifolds' total flow can be adjusted. In systems with one manifold, adjustment too, will be made easier if OptiFlow valves are fitted.



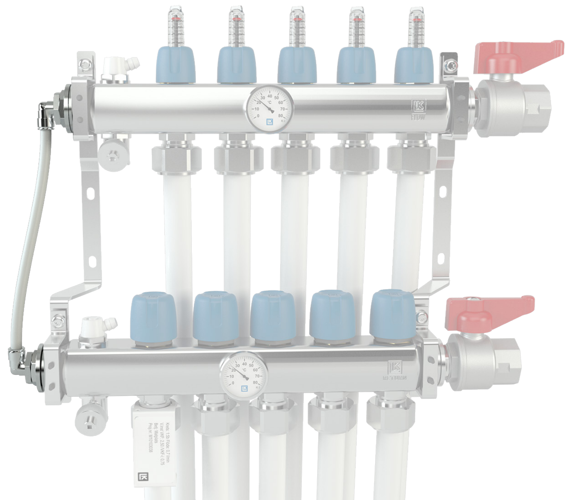
LK OptiFlow EVO II.

Accessories for LK Manifold

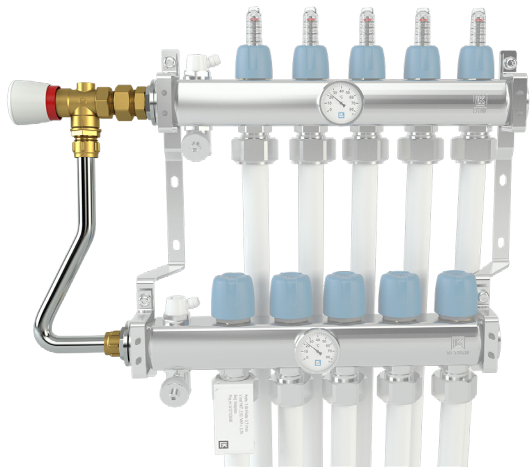
LK By-pass RF

When circuits, fitted with electrically operated actuators, are all closed, a low flow rate is desirable to limit damage to the circulation pump. LK Manifolds must then be fitted with a by-pass. There are two types, LK By-Pass RF and LK By-Pass Delta P RF. LK By-Pass RF allows a small continuous "leak flow" via a fixed throttle, of Kvs 0,05, through the manifold. The other, LK By-Pass Delta P RF, has an adjustable differential pressure valve. When the manifold valve actuators (one or more) close the return valves, differential pressure will increase. The differential pressure valve in the by-pass will then open and the pressure difference over the valves will then decrease correspondingly. As an alternative solution a circuit may be left uncontrolled (open), e.g. to a bathroom, to ensure "leak flow" without the need for a by-pass.

In systems where an LK Connection Box NO or LK Receiver Unit ICS.2 has been fitted (see section on ***Room Temperature Control***) with pump logic connected, there is no need for a By-pass flow. LK Connection Box then controls the circulation pump so that it gets switched off when the valves are closed.
If any of LK's shunt groups are mounted where no By-Pass is needed since they are equipped with an automatic speed-controlled pump. The pump adjusts the flow to the requirement of the system. Read more in the assembly instruction for each. shunt group.



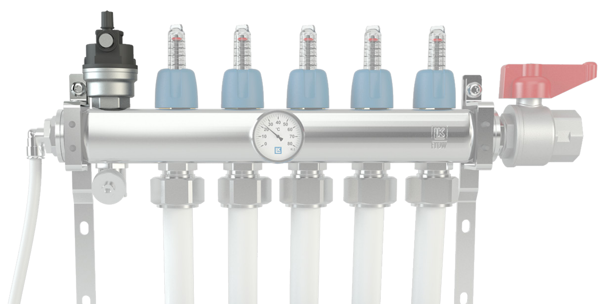
LK By-Pass RF assembled on a LK Manifold RF.



LK By-Pass Delta P RF mounted on LK Manifold RF.

LK Air Vent RF

To facilitate venting when the system is started up, the manual vent can be replaced by an automatic one.



LK Air Vent. RF.

LK Systems

Hidden placement of LK Manifold RF

LK Manifold may well be placed in LK Manifold Cabinet UFH or LK Shunt Cabinet VS2. LK Shunt Cabinet VS2 is used if LK Manifold Shunt VS is to be installed directly to LK Manifold RF. Cabinets has water proof pipe entry-holes and drainage to fulfil Swedens´s plumbing safety regulations. The cabinets can be built into a wall or assembled onto existing wall. For on wall assembly the cabinet must be supplemented with LK Base UFH for concealing of pipes under cabinets.

LK Manifold Cabinet UFH and LK Base UFH.

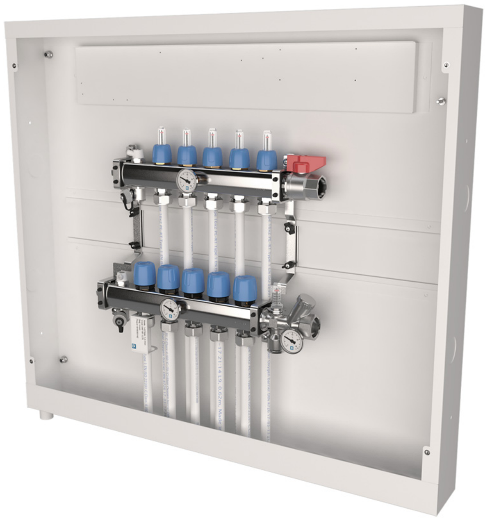
LK Manifold Cabinet UFH

LK Shunt Cabinet UFH is designed for assembly of LK Manifold RF. The cabinet is available in three sizes for assembly into wall. Using the accessory LK Base UFH the cabinet can also be mounted onto a wall.

The cabinet has a rigid base with drainage to ensure that any leaks can be lead to the optional point. The hatch of the cabinet is delivered with a screwdriver latch, keylocks are available as accessories. The back of the cabinet has attachments for the manifold´s brackets and designated location for installation of equipment for room temperature control.

LK Manifold Cabinet UFH -Prefab

LK Manifold Cabinet UFH -Prefab is a pre-assembled unit with LK Manifold RF assembled in a LK Manifold Cabinet UFH. Manifold Cabinet UFH-Prefab is available for manifold with 2 up to 12 circuits. The manifold has mounted ball valve, OptiFlow and assembled connection couplings dim 16. Frame and hatch are delivered as a separate article.



LK Manifold Cabinet UFH-Prefab with LK Manifold RF.

LK Shunt Cabinet VS2

LK Shunt Cabinet VS2 is designed for assembly of LK Manifold Shunt VS2 and LK Manifold RF. The cabinet is available in two sizes for assembly into wall. Using the accessory LK Base UFH the cabinet can also be mounted onto a wall.

The cabinet has a rigid base with drainage to ensure that any leaks can be lead to the optional point. The hatch of the cabinet is delivered with a screwdriver latch, keylocks are available as accessories. The back of the cabinet has attachments for the manifold´s brackets and LK Manifold Shunt VS2. In the back cover there is also designated location for installation of equipment for room temperature control. The cabinet fulfills Sweden's plumbing safety regulations.

LK Shunt Cabinet VS2 Prefab

LK Shunt Cabinet VS2 Prefab is a pre-assembled unit with LK Manifold RF and LK Manifold Shunt VS2 assembled in a LK Shunt Cabinet VS2 mounted in LK Shunt Cabinet VS2. Shunt Cabinet VS2 Prefab is available for manifold with 2 up to 12 circuits. The manifold has assembled connection couplings dim 16. The cabinet fulfills Sweden's plumbing safety regulations. Frame and hatch are delivered as a separate article.

LK Shunt Cabinet VS2 -Prefab.

LK Manifold Cabinet

The cabinets come in two models and three sizes, to be built in or for wall mounting. The cabinets are delivered with frame and hatch.

The cabinets are fitted with screwdriver catch, key locks is available as an accessory. The cabinet has assembly rails that are adjustable vertically and horizontally.

LK Manifold Cabinet, to be built in or for wall mounting

To avoid damage on the cabinet during the construction time, the cabinets can be mounted at a later time without having to dismount the manifold.

NB! This cabinet type does not fulful Swedens´s plumbing safety regulations and therefore do not normally sold on the Swedish market.

Room temperature regulation

LK Under Floor Heating can be equipped with individual room regulation and functions as follows: LK Room Thermostat regulates the temperature in each zone (e.g. a room) and controls one or more actuators on the distributor, which open and close the water flow in the under floor heating circuits. Several actuators – and thus, circuits – can be controlled by the same room thermostat. The aim of the room thermostats is to limit surplus heat, for examplebody heat, lighting, solar gain, etc. Room thermostats and actuators are switched on via an LK Connection Box or LK receiver unit, depending on the type of room control selected. LK Room Control units are available in wired and wireless versions as described below.

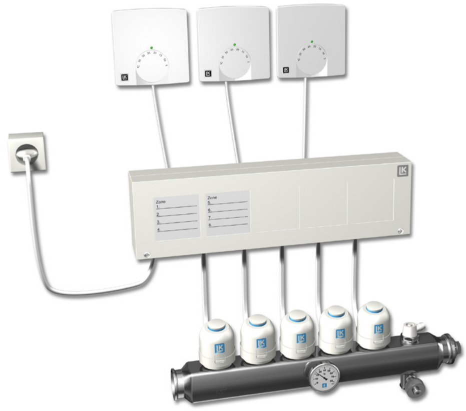
LK Room Control BAS, wired communication

LK Room Control BAS controls the temperature in each zone (e.g. a room) by transferring a wired signal from the room thermostat to the LK Connection Box. The connection box is positioned together with the heating circuit distributor. The actuators for each control zone are operated via the connection box. A maximum of five actuators can be connected to a shared zone/room thermostat. The LK Connection Box has built-in pump and valve motion logic. The circulation pump in the system can be controlled via the potential-free relay of the connection box if so required. The circulation pump will stop when all actuators in the system are closed. The room thermostats are mounted on an inner wall approx. 1.5 m above the floor. Avoid positioning them anywhere which may affect their operation (e.g. where there is solar gain, near ventilation etc.).

LK Room Control BAS Room Thermostats include two modern design models.
The Room Thermostat S1 model is of traditional design but still has a modern look to it, with a high-gloss white polished surface. The room thermostat is extremely thin and blends easily into the room surroundings. Available in models S1, S1 EXT and S1 Dti.

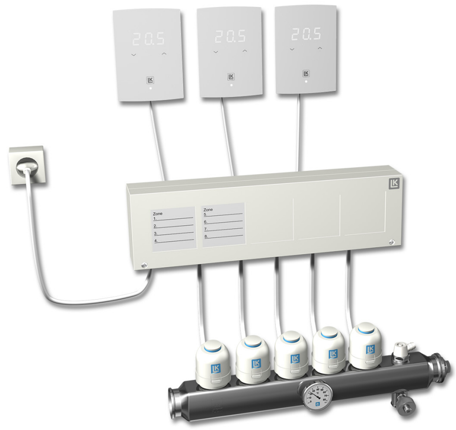
LK Systems

Thermostat models S1 EXT and S1 Dti offer options for connection of LK External Sensor S1 for controlling floor temperature, for example. The S1 Dti has hidden temperature setting suitable for public areas. Room thermostats and actuators are connected to the LK Connection Box.



LK Room Thermostat S1

Room Thermostat S2 is of new modern design with polished vitreous surface and touch temperature setting. The temperature setting is visible via the diode digits behind the glass. LK Room Thermostat S2 is available in two models, S2 and S2 EXT, where S2 EXT can be connected to LK Remote Sensor ICS/S2 for controlling e.g. floor temperature. For public environments, the temperature setting of the room thermostat can be locked by pressing buttons in combination. Room thermostats and actuators are connected to the LK Connection Box.



LK Room Thermostat S2

LK Room Control ICS.2

The LK Room Control ICS.2 system is available in a wireless version which allows communication between the room thermostat and receiver unit to take place wirelessly. This system is also available in a wired version, where communication between the room thermostat and receiver unit takes place via a cable. It is also possible to combine both wired and wireless communication in one and the same receiver unit.

LK Room Control ICS.2 controls the temperature in each zone (e.g. a room) by transferring a wired or wireless signal from the thermostat to the LK Receiver Unit. The receiver unit is positioned together with the heating circuit distributor. The actuators for each control zone are operated via the receiver unit. The room thermostat is fitted with a backlit display and is available in gloss white, gloss black and silver grey.

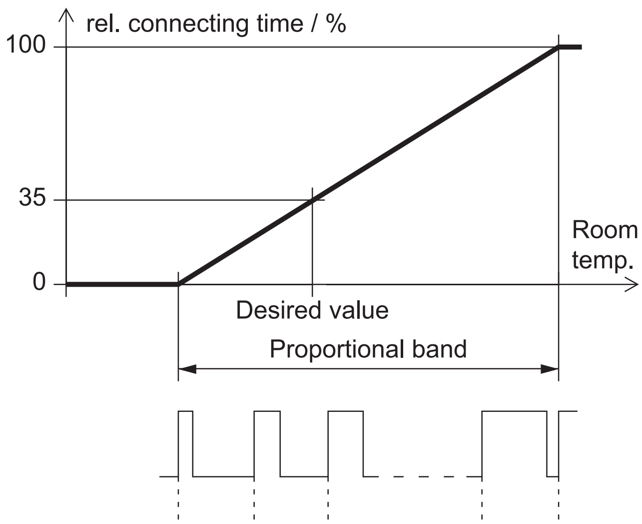
The system includes a range of smart functions such as an adaptive week programming, holiday function, woodburning stove function, the option of connecting an external sensor, By-pass function, logging/analysis function, valve and pump logic, boiler control, etc.

By using the LK Webserver accessory, you can control your heating system via the Internet from a mobile phone, tablet or computer. LK ICS.2 can communicate using the Modbus protocol RS485/ RTU for connection to the general building automatics.

General

Common to teh room regulation systems is that the room thermostats work with so-called self-modulation technique. Self-modulation technique ensures that the flow in the floor heating circuits is continuously optimized based on the room's needs. Thereby giving rise to better comfort and a more energy efficient and environmentally smarter floor heating system than a system that uses traditional ON-OFF technology.

The connection box and the receivers are fitted with light diodes, which show which circuits are open and which are closed. A built-in valve exercise program in the connection box and receivers minimize the risk of the under floor heating manifold seizing during the heating system's summer break.



Pulse characteristics as a function of temperature.

Remote control of LK Receiver 8 ICS.2

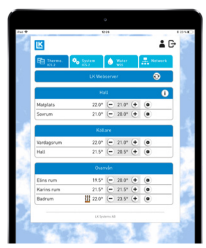
There are various solutions for remote control of LK Room Control ICS.2. The options that are available for remote control of LK Room Control ICS.2 are described below.

Simple remote control of LK ICS.2

Simple remote control of LK Receiver Unit 8 ICS.2 is implemented by closing its two-pole setback contact. The simplest way to close the setback contact is via a circuit breaker/relay, or alternatively via a GSM module which is controlled by a mobile phone. When the setback contact is closed, the room control reduces the room temperature for all room thermostats to a lower temperature, to the so-called setback temperature. The preset setback temperature is 12°C, but this can be changed in the respective room thermostat.

Remote control with LK Webserver

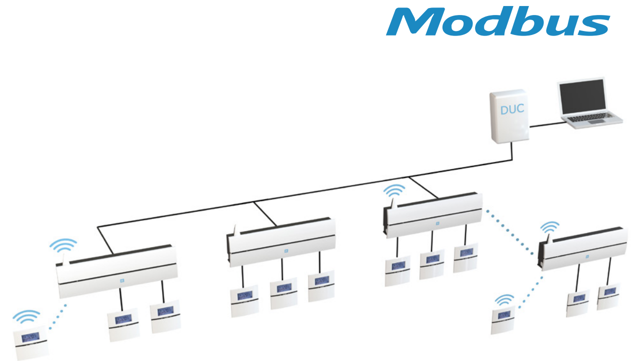
For a more extended control LK Webserver may be connected. Connection is made to the contact marked BUS in LK Receiver Unit 8 ICS.2



Using LK Webserver you can easily control your heating system remotely via a mobile phone, tablet or computer. The webserver's user interface is easy to manage and provides a good overview of the underfloor heating system. It is easy to make all the system settings using the user interface. Any alarms are displayed via the alarm icon and you receive information about the alarm in clear text.

LK Webserver can also be used as a wireless communications bridge. This function is used when the Internet is unavailable in the property at the underfloor heating installation's receiver. A wireless communication can then be established between two LK Webservers. The first web server is installed at the underfloor heating installation's receiver and the other at the building's Internet connection. The web server located at the receiver will now operate as a wireless communications bridge to the Webserver with an Internet connection.

Building automatics/Modbus



LK Room Temperature Control ICS.2 can be integrated into a building's general building automatics. LK ICS.2 communicates via the Modbus protocol RS485/RTU. LK Room Temperature Control ICS.2 communicates with the general control system's BMS.

LK Systems provide communications protocol when LK ICS.2 is to be connected to the general control system.

Room control in demanding environments

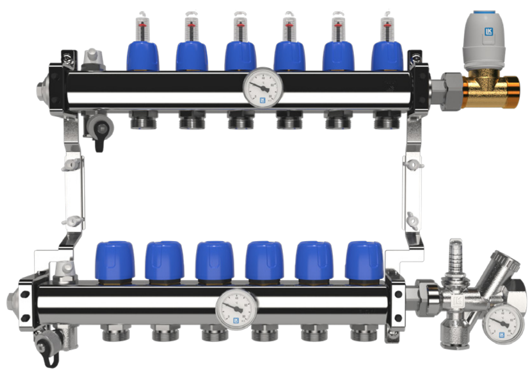
The LK TR 26 Electronic Thermostat is designed for under floor heating installations in particularly demanding environments such as car washes and stables, etc. The thermostat must be supplemented by sensors for regulating floor or room temperature. If average temperature regulation is required, several sensors can be connected together in a specific pattern. For further information, see the installation instructions for TR 26. The thermostat must be fitted in an enclosure with a DIN bracket. The enclosure is normally positioned next to the under floor heating manifold, but also be located close to the heating zone.

LK TR 26 Electronic Thermostat with related LK Enclosure, LK Room Temperature Sensor and cable sensor.

LK Single Zone Manifold Control

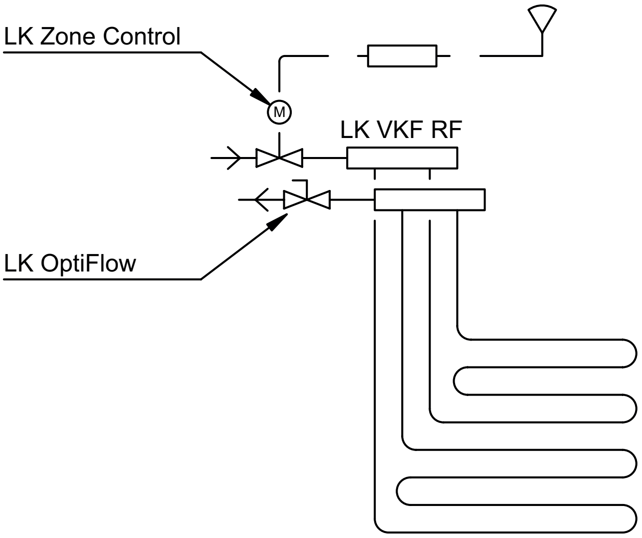
LK Zone Control 2-way (Kvs 4,5)

In buildings with large open areas and only one heating zone, such as storerooms, shopping centres, open-plan offices etc., each circuit does not need to be controlled individually. Here LK Single Zone Manifold Control can be used, which means that one and the same room thermostat controls the entire water flow to one or more (max 5) manifolds, each with 2 to 12 circuits. An actuator mounted on a seat valve at the SZMC controls, via the room thermostat, flow through the distributor so that desired room temperature is achieved. If more distributors from the same shunt group are installed, flow to each individual manifold must be adjusted separately.



LK Zone Control mounted on LK Manifold RF.

Circuit diagram connection LK Zone Control



Circuit diagram connection LK Zone Control 2-way. (Adjustment valves are not incl. in LK Zone Control product.)

Shunt groups

The LK Shunt model line up consists of preassembled shunt groups that, dependent on size, cover under floor heating surfaces up to about 1000 m^2 at 50W/m^2.The shunt groups are primarily intended for under floor heating but can also be used in other types of system solutions, for example radiators, ventilation and cooling systems etc. For further technical information, dimension sketches etc; see the assembly instructions for each shunt group.

Shunt group for smaller under floor heating areas

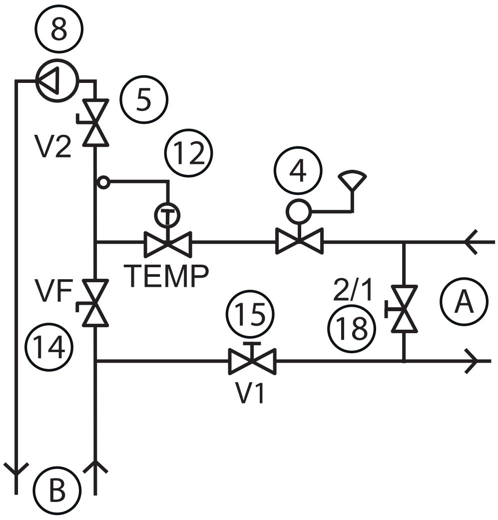
LK Minishunt M60n

This shunt group has variable flow on the primary side and a constant flow on the secondary side. This compact unit is for connection of smaller under floor heating areas to existing radiator systems.

- Can be connected for left or right hand operation.
- Can be connected to series or parallel radiator systems.
- Can be supplemented with the LK Mini Manifold for 2 – 4 circuits.
- Delivered with 2 m capillary-bound thermostat.
- Can be supplemented with electronic room temperature control (wired or wireless operation).
- Control valve Kvs 1.05 and with mounted thermostat Kv 0.9.
- Temperature limit 22-55 °C.
- Circulation pump, Wilo Yonos Para RSB15/6-RKA with automatic speed control.
- Max under floor heating surface about 60 m^2.*

* Given max floor surface is based on an energy requirement of 50 W/m^2 and a primary feed temperature at 55 °C.

LK Minishunt M60n



Flow diagram: LK Minishunt M60n

A. Primary side with main pump.
B. Secondary side underfloor heating system.
18. Switching from twin to single pipe system (2/1).
4. Control valve with thermostat and room sensor.
15. Isolation valve (V1) primary return.
12. Temperature limiter (TEMP). Max. limit for feed temperature to underfloor heating.
5. Supply valve (V2) for shutting off/adjusting feed/flow of underfloor heating.
8. Circulation pump.
14. VF Valve.

Manifold Shunt with two way control valves in systems with main pump

LK Manifold Shunt is primarily designed to be mounted directly on LK Manifold RF. The Manifold Shunt is equipped with a two way control valve with gives a variable flow on the primary circuit and a constant flow on the secondary circuit. 2-way operation provides variable flow on the primary side and is used when connecting to a district heating system.

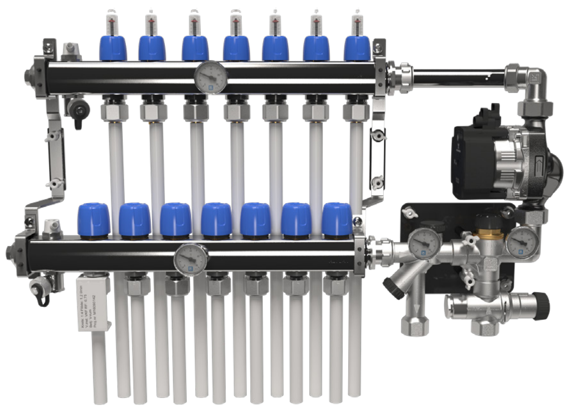
The shunt group is delivered with manually operated control valves, which can be replaced by an automatic actuator, part of the LK Control regulation equipment (see below). If the shunt group is to be controlled via C.S.C. (computerised sub centre) a valve actuator with 0-10 V control signal can be obtained.

LK Manifold Shunt VS2

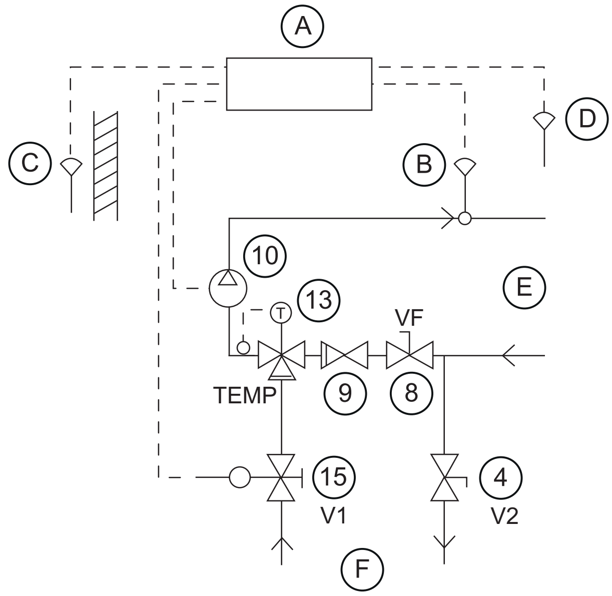
Compact shunt unit at angle, to be mounter directly on to LK Manifold RF.

- Right or left mounting.
- Control valve = seat valve Kvs 2.2.
- Temperature limiter 22–65 °C.
- Automatic variable speed circulation pump, Grundfos UPM3 AutoL 15-70.
- Bracket included.
- Max. under floor heating surface approx. 200 m²*.

* Given max floor surface is based on an energy requirement of 50 W/m² and a primary feed temperature at 55 °C.



LK Manifold Shunt VS2 mounted with LK Manifold RF.



Flow diagram: LK Manifold Shunt VS2

15. *Control valve (V1).*
4. *Isolation/flow control valve primary return (V2).*
13. *Temperature limiter (TEMP).*
12. *Circulation pump.*
9. *Built-in check valve.*
8. *VF Valve (VF).*

A. *Control unit (LK Control v.3) accessory.*
B. *Supply flow sensor (LK Control v.3) accessory.*
C. *Outdoor sensor (LK Control v.3) accessory.*
D. *Room unit (LK Control v.3) accessory.*
E. *Secondary side underfloor heating system.*
F. *Primary side, system with main pump.*

Shunt units with 3-way och 2-way valves in systems with main pump

These shunt groups have constant flow on the primary and secondary sides. They are also reversible between 2 and 3-way operation. 2-way operation provides variable flow on the primary side and is used when connecting to a district heating system. The shunt groups are delivered with manually operated control valves, which can be replaced by an automatic actuator, part of the LK Control v.3 regulation equipment (see below). If the shunt groups are to be controlled via C.S.C. (computerised sub centre) a valve actuator with 0-10 V control signal can be obtained. Model and size of the shunt group range is shown below.

LK Shunt 2/3-2.5

Complete straight shunt group.

- Can be connected for left or right hand operation.
- Bracket included.
- Adjustment valve LK OptiFlow EVO II mounted on primary side return.
- Control valve = seat valve Kvs 2.5.
- Circulation pump with fixed pump speed, Grundfos UPS 16-60.
- Max under floor heating surface about 300 m^2*

* Given max floor surface is based on an energy requirement of 50 W/m^2 and a primary feed temperature at 55 °C.

LK Shunt 2/3-2,5.

LK Shunt 2/3-4.0

Complete straight shunt group.

- Can be connected for left or right hand operation.
- Bracket included.
- Adjustment valve TA STA-D conn. 20 mounted on primary side return.
- Control valve = seat valve Kvs 4.0.
- Circulation pump Wilo Stratos Para 25/1-8, with automatic speed control.
- Must be supplemented by LK Control or other regulating equipment.
- Max under floor heating surface about 700 m^2.*

* Given max floor surface is based on an energy requirement of 50 W/m^2 and a primary feed temperature at 55 °C.

LK Shunt 2/3-4,0.

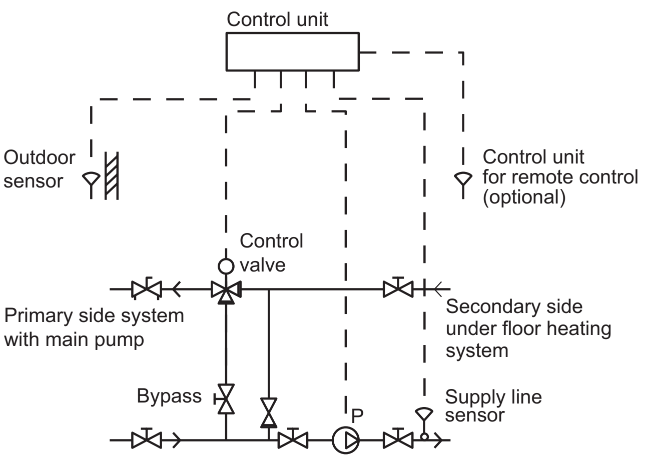
LK Shunt 2/3-6.3

Complete straight shunt group.

- Can be connected for left or right hand operation.
- Bracket included.
- Adjustment valve TA STA-D conn. 25 mounted on primary side return.
- Must be supplemented by LK Control or other regulating equipment.
- Control valve = seat valve Kvs 6.3.
- Circulation pump Wilo Stratos Para 25/1-8, with automatic speed control.
- Max under floor heating surface about 1000 m^2.*

* Given max floor surface is based on an energy requirement of 50 W/m^2 and a primary feed temperature at 55 °C.

LK Shunt 2/3-6,3.



Flow diagram: LK Manifold shunt with LK Control.

Shunt groups in systems without main pump

LK Shunt UHP-6.3

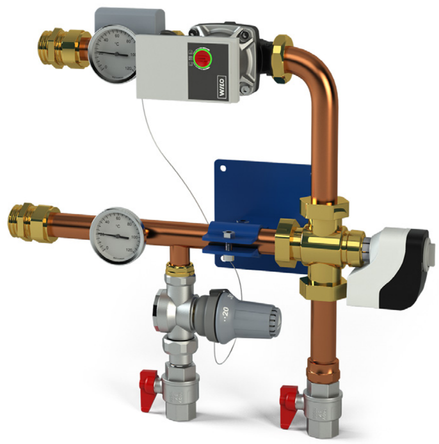
The shunt group has variable flow on the primary and secondary side and is primarily intended for systems without a main pump but can also be installed for systems with a main pump. Since the shunt group always delivers cooled water at the primary side return, it can be installed in district heating systems.

The shunt groups are delivered with manual control valves, which can be replaced by automatic actuators, which are part of the LK Control product range (see below). If the shunt groups are to be controlled by C.S.C. a valve actuator with 0-10 V control signal can be obtained.

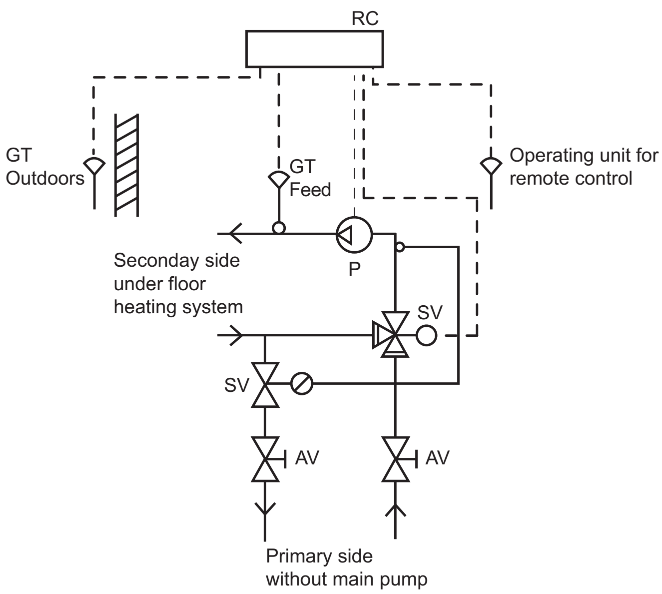
LK Shunt UHP-6.3 is a compact angled shunt group that can be mounted directly to LK Manifold.

- Can be connected for left or right hand operation.
- Bracket included.
- Max limitation thermostat.
- Control valve = seat valve Kvs 6.3.
- Wilo Yonos Para RS 25/6-RKA, with automatic speed control.
- Max under floor heating surface about 240 m².*

* Given max floor surface is based on an energy requirement of 50 W/m² and a primary feed temperature at 55 °C.



LK Shunt UHP-6,3.

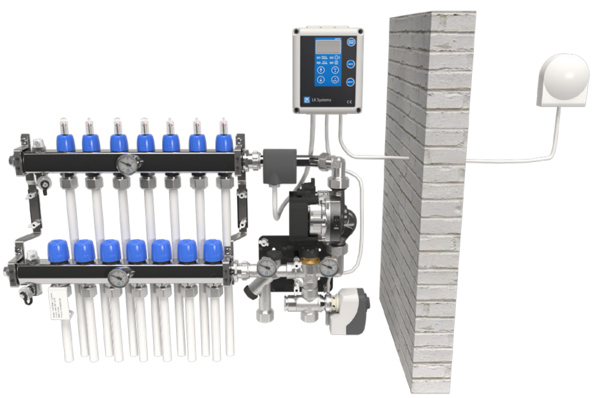


Flow diagram: LK Shunt UHP.

LK Control v.3

LK Control is a complete unit for weather-controlled heat regulation and is adapted to LK's shunt groups (except LK Minishunt M60). LK Control consists of a central regulator, valve actuators and temperature sensors on the feed-line and outdoors. The central regulator is equipped withan ECO function, automatic disconnection for the heating system during the summer period. LK Control can be manoeuvred by for example a mobile phone or other external equiptment. For more information contact LK Technical Support.

LK Control v.3



Examle installation of LK Control v.3 mounted on LK Manifold Shunt VS2

LK Room Unit v.3

LK Control v.3 can as an option, be supplemented with a room unit for room temperature control on the central regulators heat curve. The RCU operates in a similar way to a room thermostat.

LK Room Unit v.3.

Design example – shunt groups for systems with main pump

A under floor heating system with an estimated heat requirement of 25 kW is to be integrated into a heating system dimensioned for 55/45 °C.

From the LK Calculation program the following values for a under floor heating system (secondary side) have been taken:

Feed temperature	40 °C
Return temperature	33 °C
Water flow (Q)	3.079 l/h
Pressure drop sec.	24 kPa

1. First the primary flow is calculated using the formula below.

Supply temperature on the primary side at L.O.D.T.	55 °C
Return temperature on the primary side	33 °C

Return temperature on the primary side is the same as the return temperature from the under floor heating system when the control valve is full open at L.O.D.T. This means that no mixing takes place between primary and secondary return.

$$Q\ (l/h) = \frac{P\ (\text{heat requirement in W})}{\Delta t\ (\text{primary supply °C - primary return °C}) \times 1{,}16}$$

$$Q = \frac{25000}{(55\ °C - 33\ °C) \times 1{,}16} = 979$$

Q primary = 979 l/h (is adjusted using the regulation valve on the shunt group's primary side).

2. Select appropriate control valve from the valve diagram below.

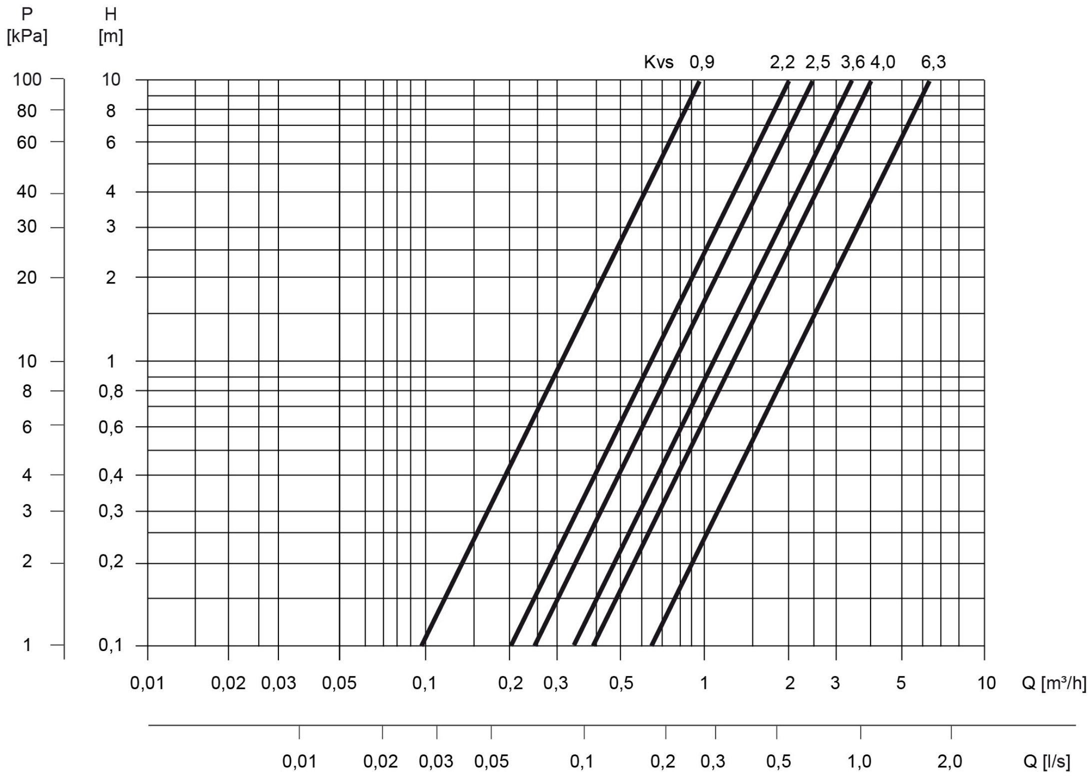
3. LK Shunt 2/3-4,0 with kvs 4,0 is best suited with regard to control valve. (Gives ab. 6,0 kPa pressure drop over the control valve).

4. Finally, check using a pump diagram that the shunt group's pump capacity for the secondary side is sufficient. Ensure also that each regulation device is equipped with a regulation valve on the return pipe for adjustment of the secondary flow.

LK Minishunt M60n

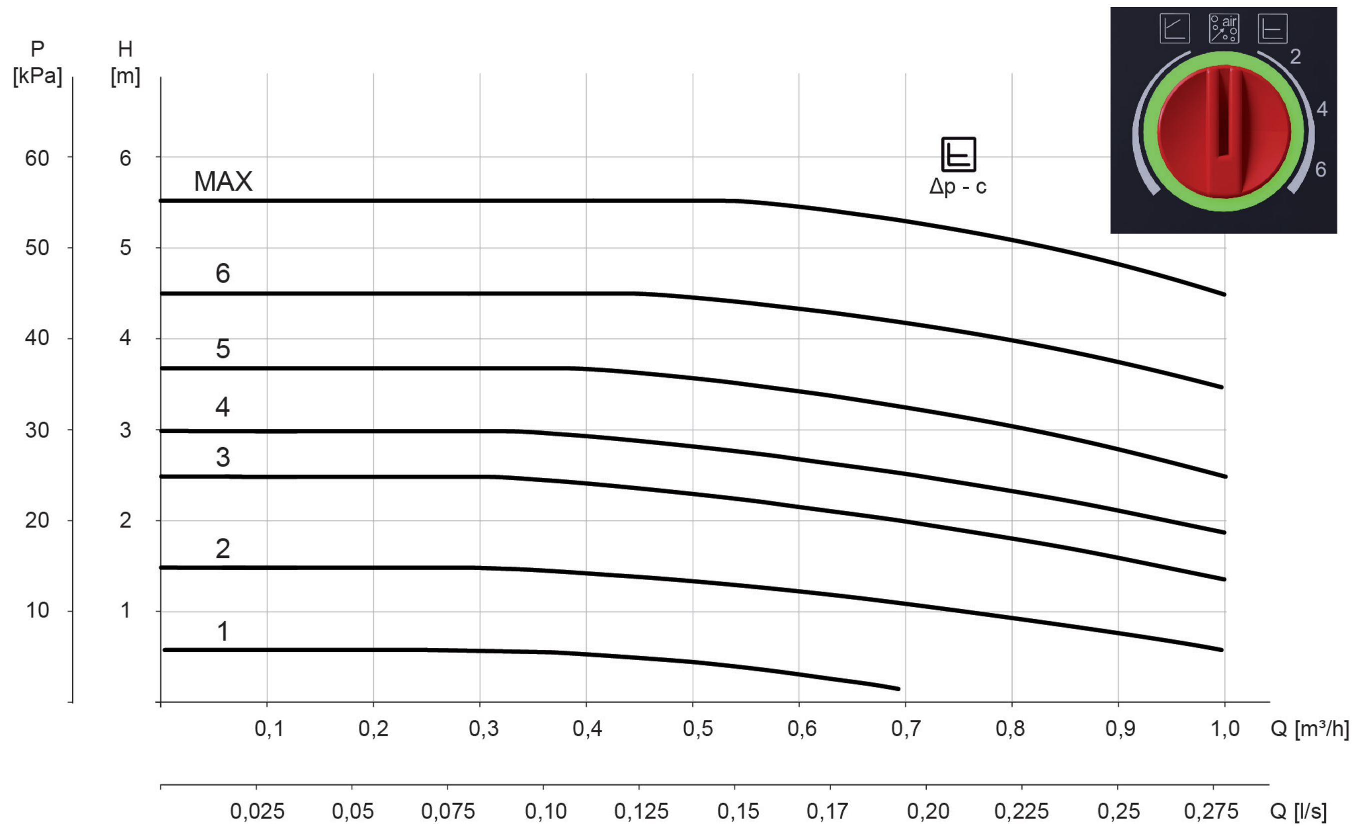
LK Minishunt M60n is dimensioned as outlined above. The Minishunt is also equipped with a throttle valve on the secondary side's return. For setting value, see below.

Valve diagram

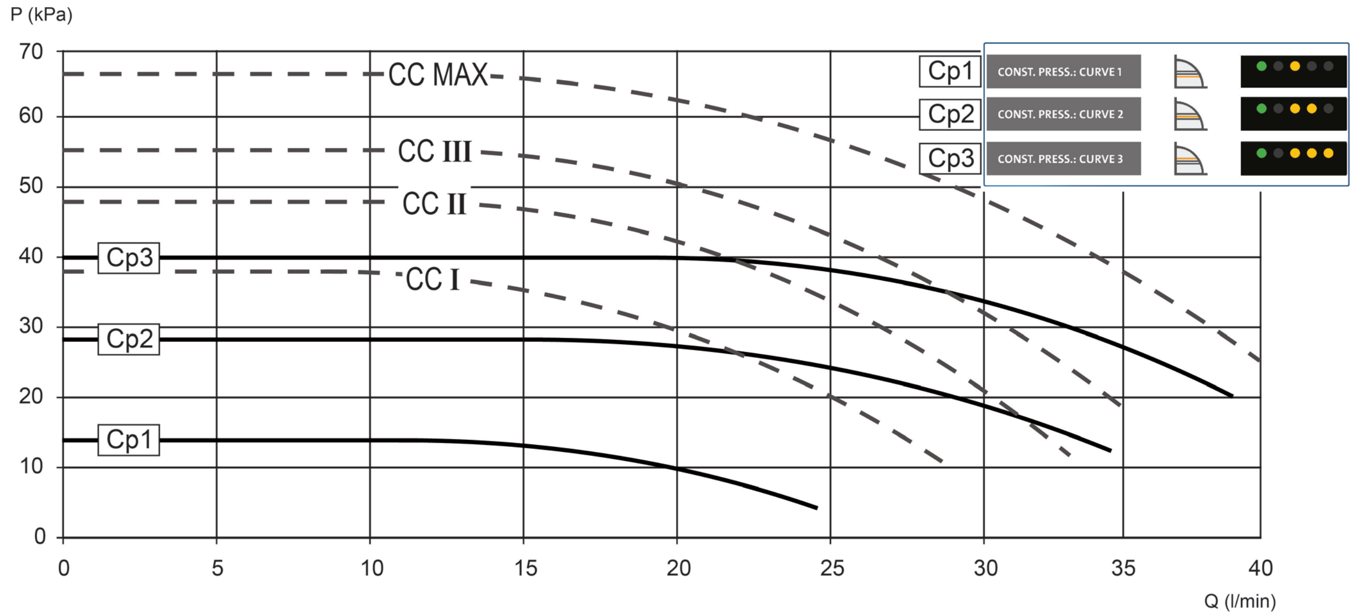


Valve diagram for LK Shunt groups.

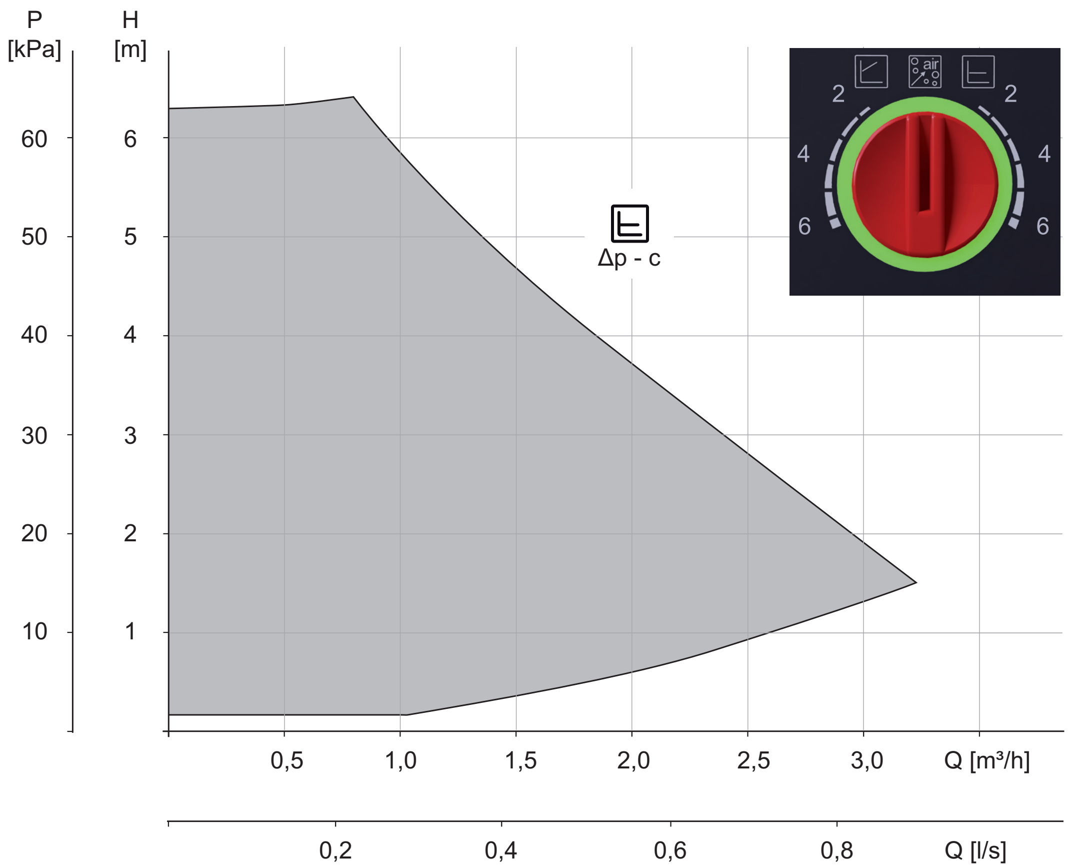
Pump curves



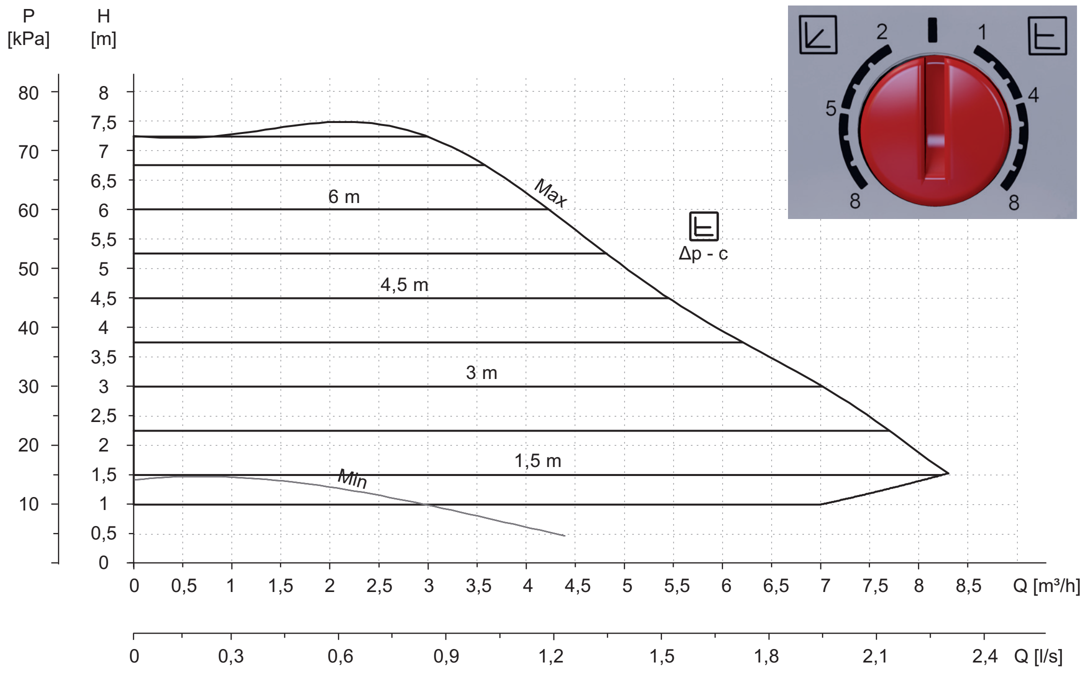
LK Minishunt M60n.



LK Manifold Shunt VS2.

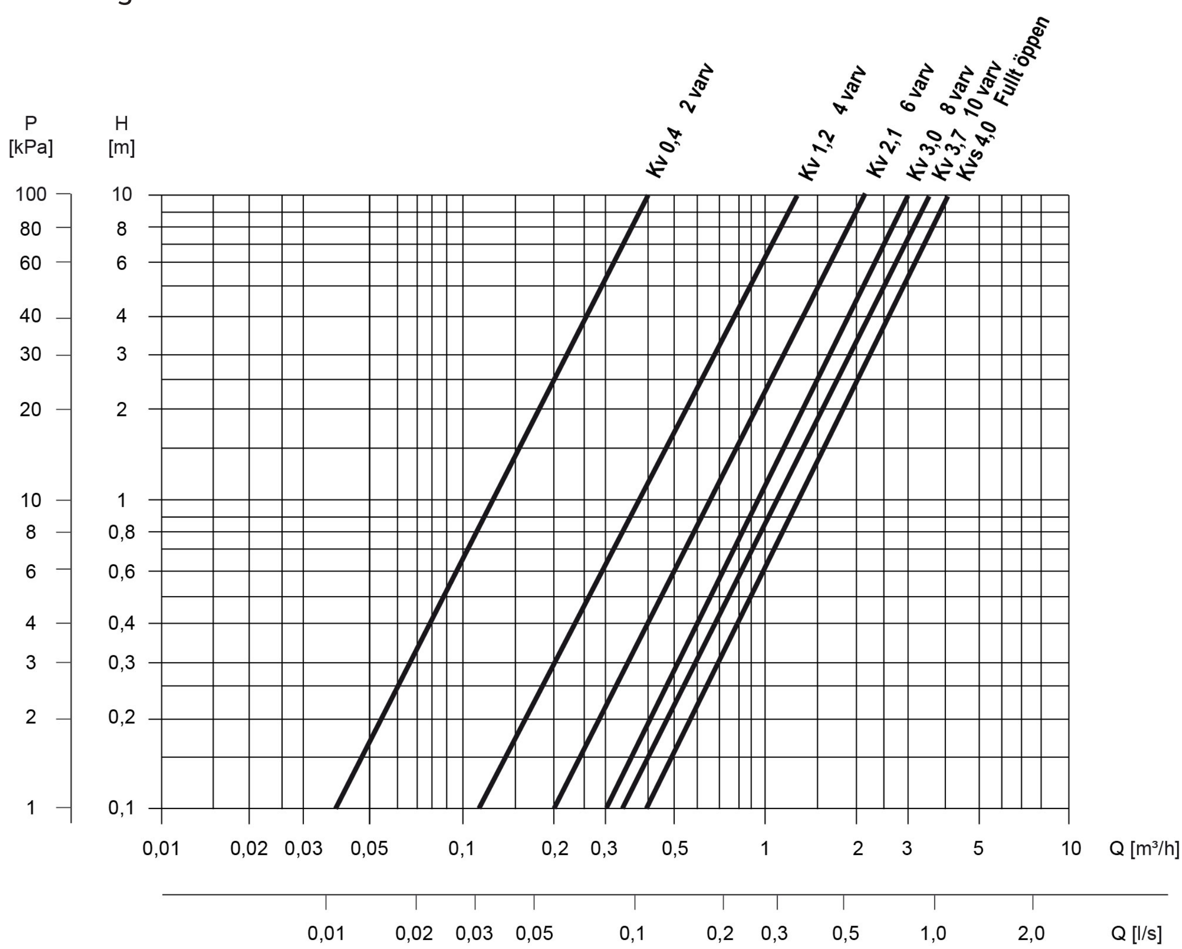


LK Shunt 2/3-2,5 and LK Shunt UHP-6,3.



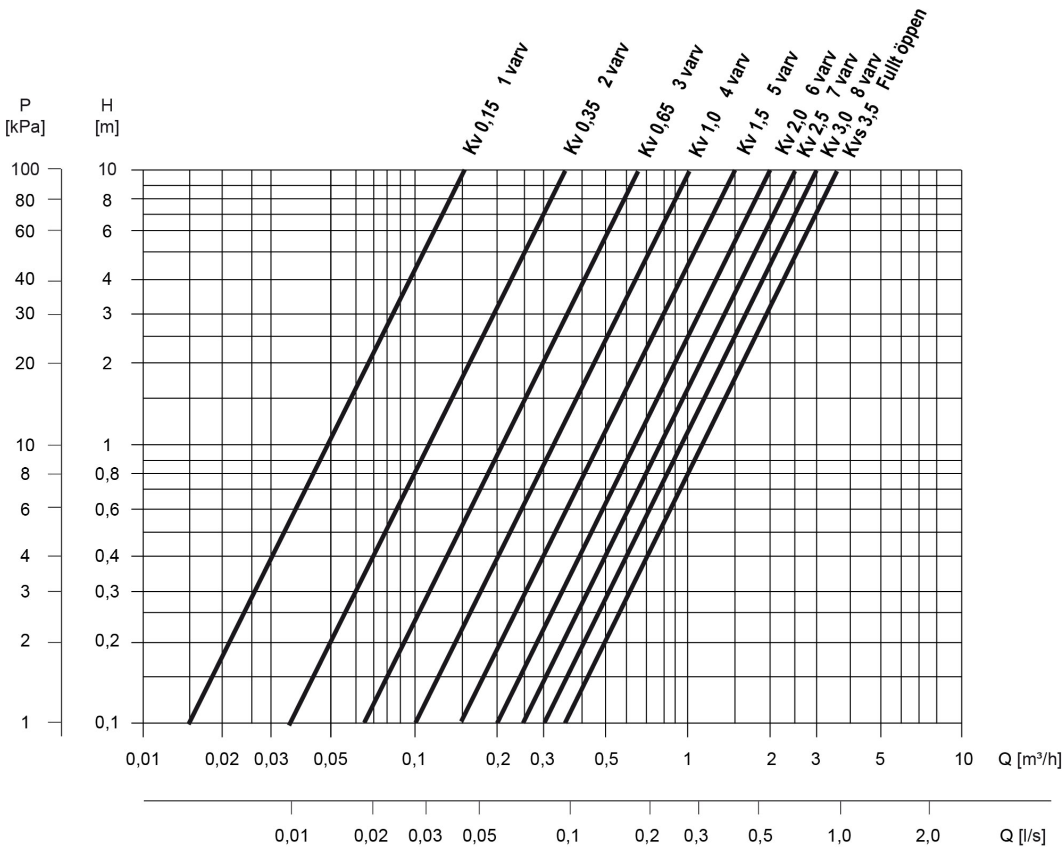
LK Shunt 2/3-4,0 and 6,3.

Adjustment diagram



Adjustment of primary flow LK Manifold Shunt VS2.

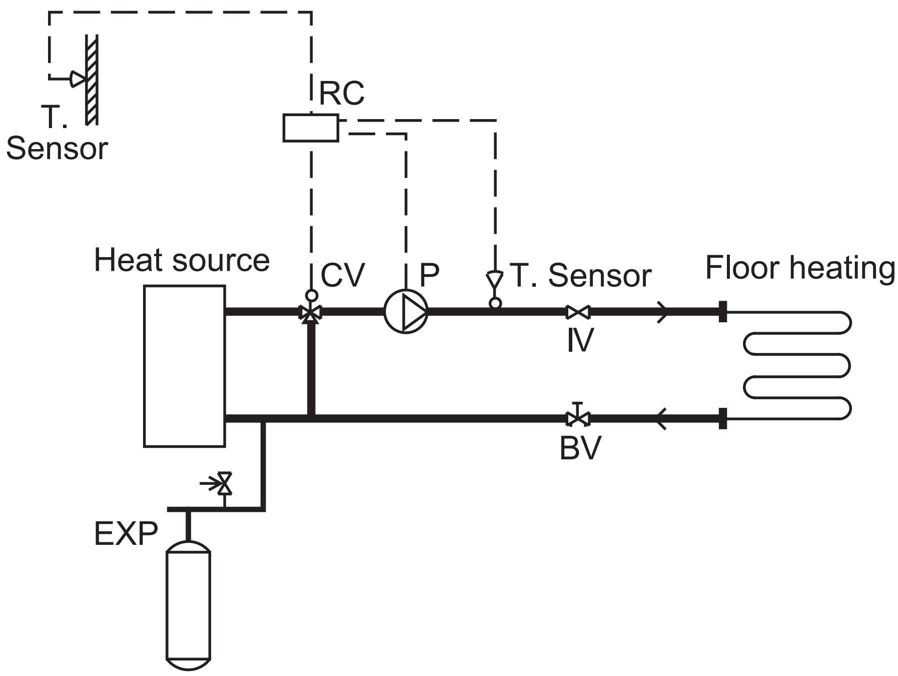
LK Systems



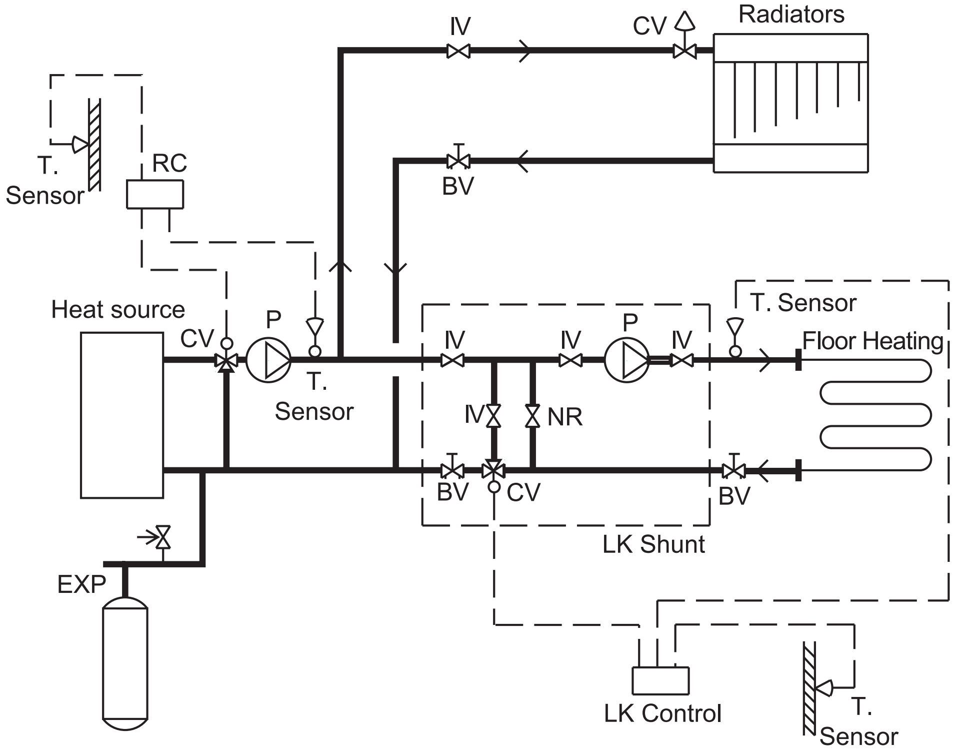
Adjustment of secondary flow LK Minishunt M60n.

Connection examples

1. Under floor heating connected to heat source with outdoor compensated feed temperature.

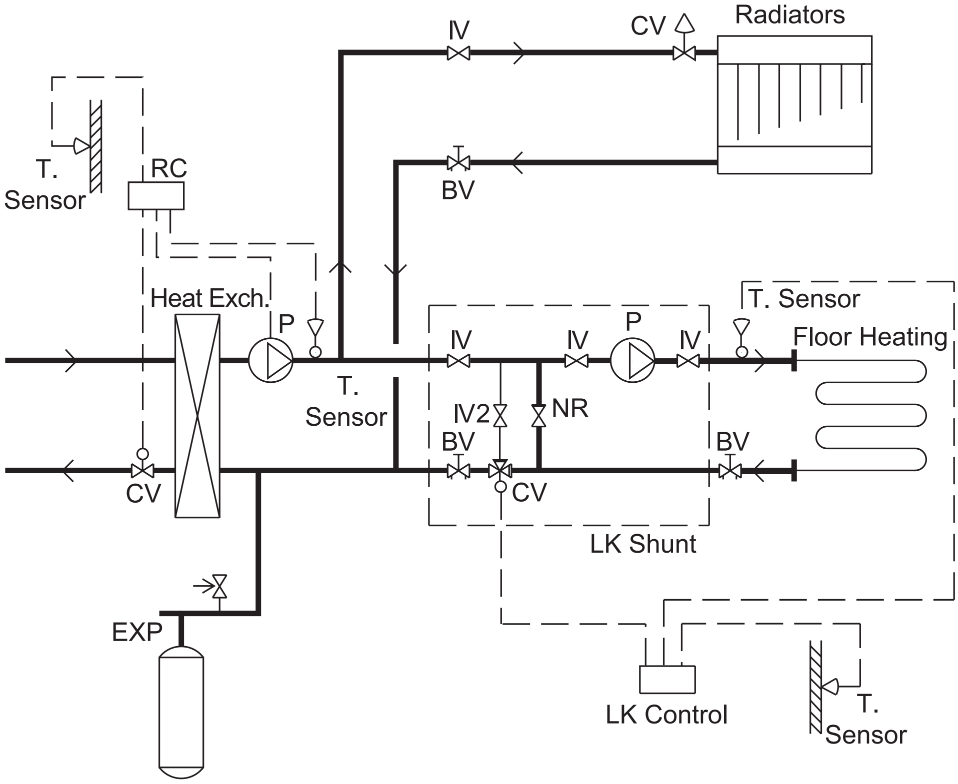


2. Under floor heating combined with radiators.



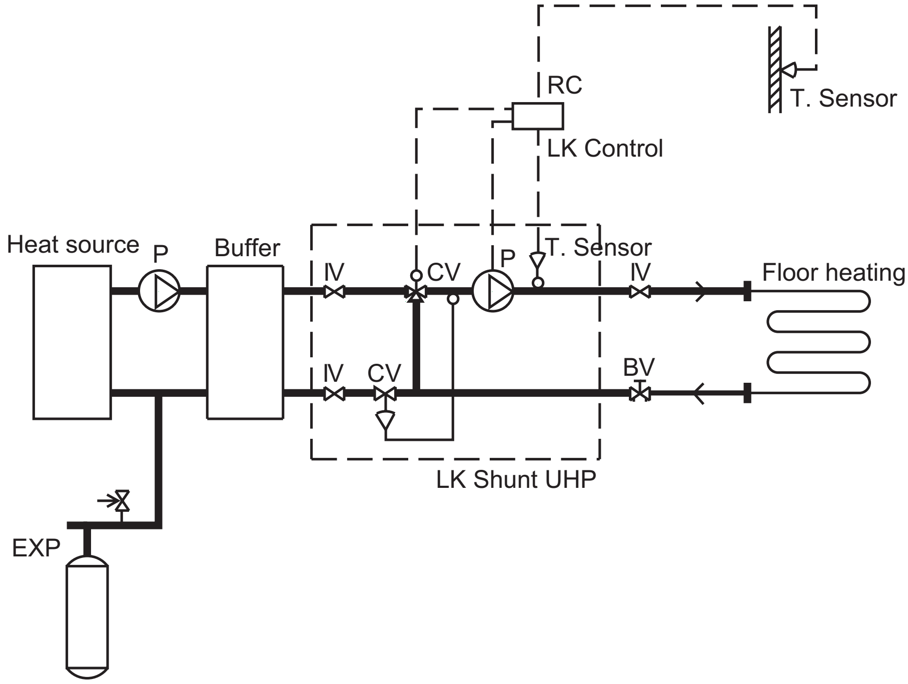
LK Shunt supplemented with LK Control.

3. Under floor heating connected to district heating system and in combination with radiators.



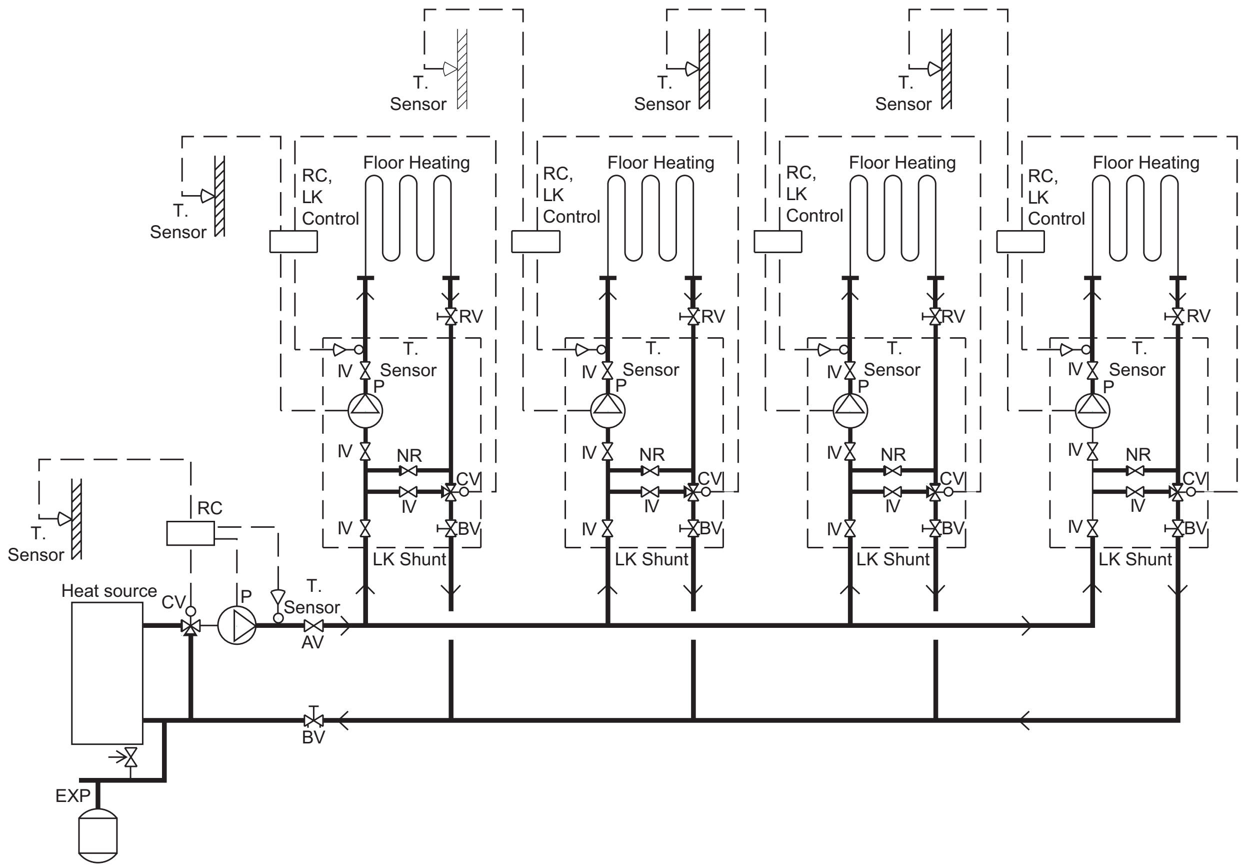
LK Shunt supplemented with LK Control. LK Shunt is set in 2-way performance by closing IV2.

4. Under floor heating connected to heat source with accumulator tank.

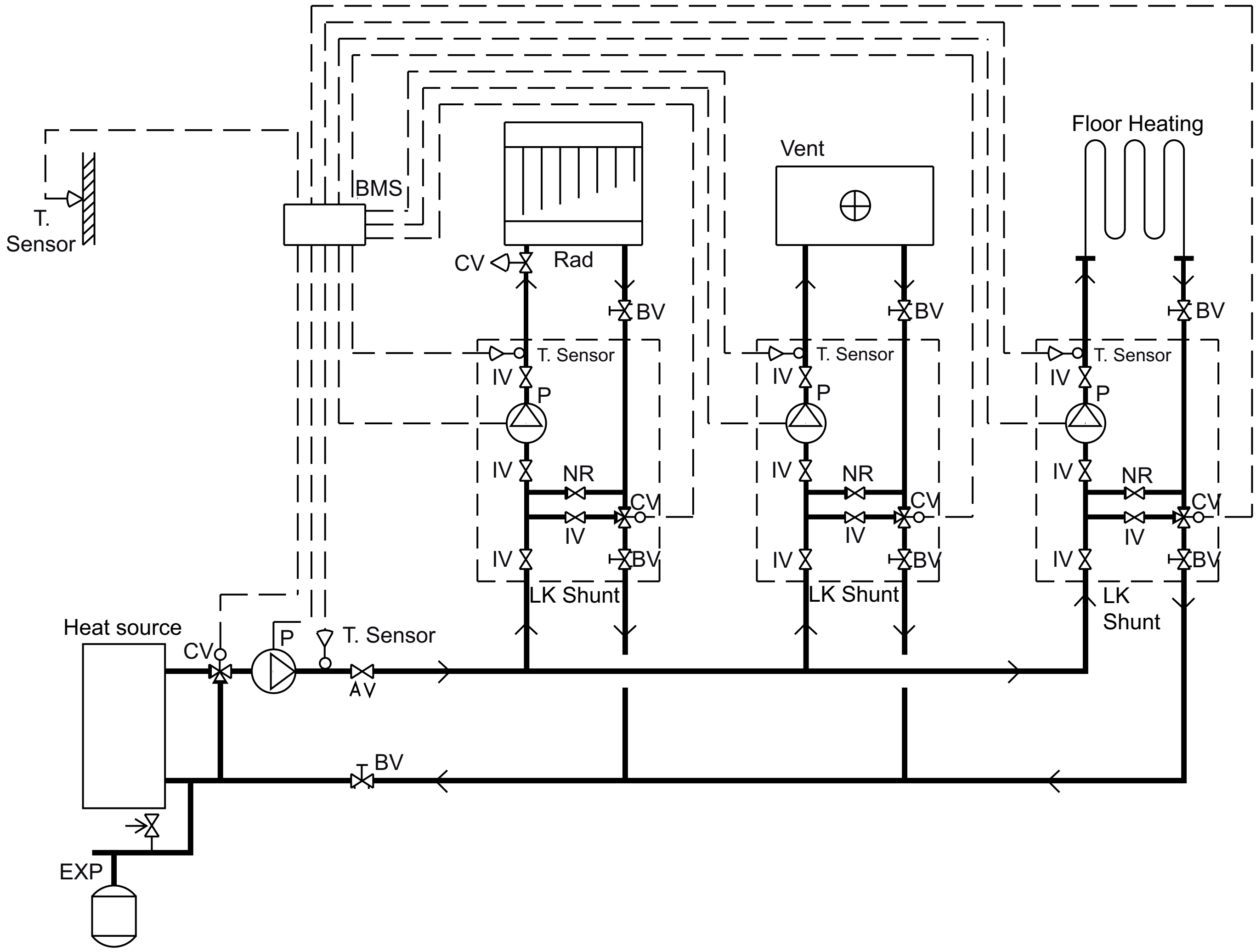


LK Shunt UHP is connected to systems without a main pump. The shunt group is supplemented with LK Control.

5. Block heating (For example heat supply to several houses/users from central boiler).



6. Heating systems with Computerized Sub Central (C.S.C.) (In UK also known as BMS.)



LK Systems
LK Systems AB, Box 66, 161 26 Bromma, Sweden | www.lksystems.se