



## Installation Guide

# Indoor Heating Applications Mats and cables



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## 1 Introduction

In this installation manual, the word “element” refers to both heating cables and heating mats.

If the words “heating cable” or “heating mat” are used, the instruction in question applies only to this type of element.

All dimensioning, product selection, installation and commissioning of any given application are the responsibility of an authorized installer.

Any application using heating elements or thermostats purchased by end user must be approved by an authorized electrician prior to commissioning.

- Including type, size, installation and connection of the heating element.
- Including type, size, connection and settings of the thermostat controlling the heating element.
- Children shall not play with the heating element.
- This heating element can be used by children aged from 8 years and above and

persons with reduced physical, sensory or mental capabilities or lack of experience and knowledge if they have been given supervision or instruction concerning use of the appliance in a safe way and understand the hazards involved.

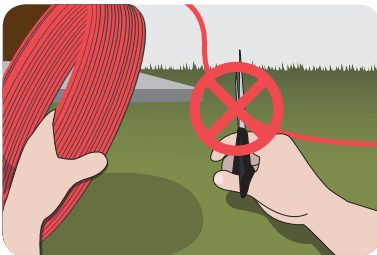
- Cleaning and user maintenance shall not be made by children without supervision.

The intended use of the heating elements covered by this installation manual is floor heating, only.

- According to IEC 60335 the mats may not be installed in a metallic floor or storage heating application.
- Mats shall be fully embedded in at least 5 mm concrete, screed, tile adhesive or similar. incl. tiles



### 1.1 Safety Instructions



#### Never cut or shorten the heating element

- Cutting the heating element will void the warranty.
- Cold leads can be shortened to suit requirements.

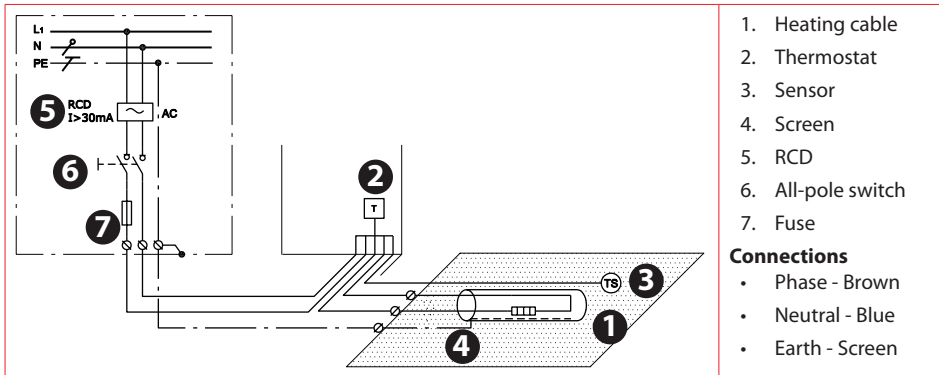


**Elements must always be installed according to local building regulations and wiring rules as well as the guidelines in this installation manual.**

- Any other installation may hamper element functionality or constitute a safety risk, and will void the warranty.

**Elements must always be connected by an authorised electrician using a fixed connection.**

- De-energize all power circuits before installation and service.
- Each heating element screen must be earthed in accordance with local electricity regulations and connected to a residual current device (RCD).
- RCD trip rating is max. 30 mA.
- Heating elements must be connected via a switch providing all pole disconnection.
- The element must be equipped with a correctly sized fuse or circuit breaker according to local regulations.



**The presence of a heating mat must**

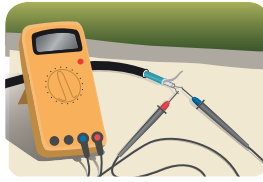
- be made evident by affixing caution signs or markings at the power connection fittings and/or frequently along the circuit line where clearly visible
- be stated in any electrical documentation following the installation.

**Never exceed the maximum heat density ( $W/m^2$ ) for the actual application.**

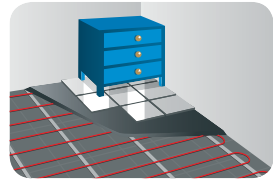
## 1.2 Installation guidelines



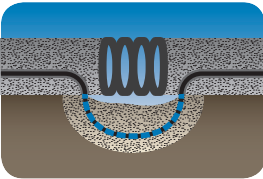
Prepare the installation site properly by removing sharp objects, dirt, etc.



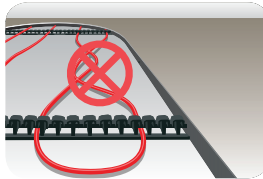
Regularly measure ohmic resistance and insulation resistance before and during installation



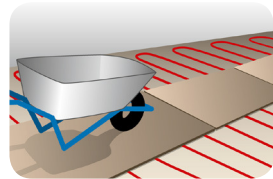
Do not lay heating elements under walls and fixed obstacles. Min. 6 cm air is required



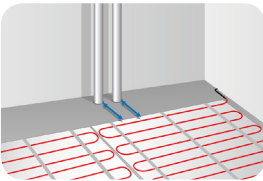
Keep elements clear of insulation material, other heating sources and expansion joints



Elements may not touch or cross themselves or other elements and must be evenly distributed on areas.



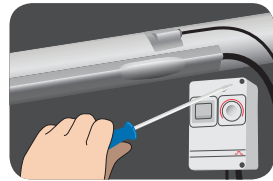
The elements and especially the connection must be protected from stress and strain.



The elements and sensors shall be installed minimum 30 mm away from conductive parts of the building, e.g. water pipes.



A floor sensor is mandatory and must be connected to a thermostat limiting the floor temperature to maximum 35°C.



The element should be temperature controlled and not operate at ambient temperature higher than 10°C in outdoor applications.

- Caution! Do not use M1 classified elements in areas subject to high mechanical loads or impact, see section 1.3 for classification.

- Store in a dry, warm place at temperatures between +5 °C to +30 °C.

## 1.3 System overview

Standards	ECcomfort (LXmat)	ECbasic (EFSIC)	ECflex (EFTPC)	EHeat (EFSM)	ECmat (EFTM)	ECaqua (EFTWC)
60800:2009 (cable)	-	+ (M1)	+ (M2)	-	-	+ (M1)
60335-2-96 (mat)	+	-	-	+	+	-

**M1**

For use in applications with **low risk of mechanical damage**, e.g. installed on even surfaces and embedded in screeds with no sharp objects.

**M2**

For use in applications with **high risk of mechanical damage**.

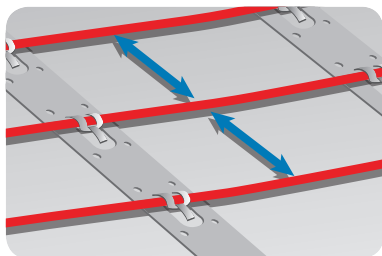
Floor heating in:	ECcomfort (LXmat)	ECbasic (EFSIC)	ECflex (EFTPC)	ECheat (EFSM)	ECmat (EFTM)	ECaqua (EFTWC)
Thin Beddings (< 3 cm)	+	+	-	+	+	-
Joist Floor Constructions	+	-	+	-	-	-
Danfoss Reflect	(+)	-	+	-	-	-
Concrete Floors (> 3 cm)	(+)	+	+	(+)	(+)	-
Frost protection of pipes	-	(+)	+	-	-	+

## 2 Installation step by step

### 2.1 Calculating C-C distance for heating cables

The C-C distance is the distance in centimetres from the centre of one cable to the centre of the next.

For heating of pipes, please refer to the number of cables per metre, see section 4.5.



$$C - C [cm] = \frac{\text{Area [m}^2\text{]}}{\text{Cable length [m]}} \times 100 \text{ cm}$$

or

$$C - C [cm] = \frac{\text{Cable output [W/m]}}{\text{Heat density [W/m}^2\text{]}} \times 100 \text{ cm}$$

**Max. C-C distance**

Thin beddings (<3 cm)	10 cm
Joist floor constructions	20 cm
Danfoss Reflect	20 cm
Concrete floors (>3 cm)	15 cm

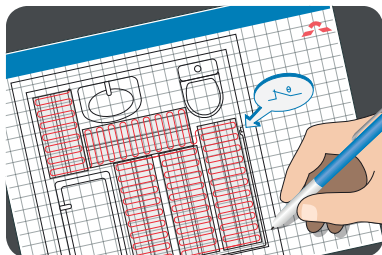
- Heating cable bending diameter must be at least 6 times cable diameter.
- The actual cable length may vary +/- 2 %.

230V/400V				
C-C [cm]	W/m <sup>2</sup> @ 6 W/m	W/m <sup>2</sup> @ 10 W/m	W/m <sup>2</sup> @ 18 W/m	W/m <sup>2</sup> @ 20 W/m
5	120	200	-	-
7,5	80	133	-	-
10	60	100	180	200
12,5	48	80	144	160
15	40	67	120	133

## 2.2 Planning the installation

### Draw a sketch of the installation showing

- element layout
- cold leads and connections
- junction box/cable well (if applicable)
- sensor
- connection box
- thermostat



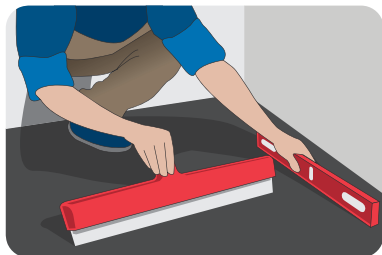
### Save the sketch

- Knowing the exact location of these components makes subsequent troubleshooting and repair of faulty elements easier.

### Please the following:

- Observe all guidelines - see section 1.2 .
- Observe correct C-C distance (heating cables only) - see section 2.1.
- Observe required installation depth and possible mechanical protection of cold leads according to local regulations.
- When installing more than one element, never wire elements in series but route all cold leads in parallel to the connection box.
- Two or more elements may be installed in the same room but a single element is not to be installed across two or more rooms.
- All heating elements in the same room must have the same heat density ( $W/m^2$ ) unless they are connected to separate floor sensors and thermostats.
- For single conductor cables, both cold leads must be connected to the connection box.

## 2.3 Preparing the installation area



- Remove all traces of old installations, if applicable.
- Ensure that the installation surface is even, stable, smooth, dry and clean.
- If necessary, fill out gaps around pipes, drains and walls.
- There must be no sharp edges, dirt or foreign objects.

## 3 Installing elements

It is not recommended to install elements at temperatures below  $-5^{\circ}\text{C}$ .

At low temperatures, heating cables can become rigid. After rolling out the element, briefly connect

it to the mains supply to soften the cable before fastening.

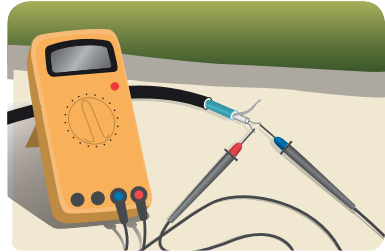
### Measuring Resistance

Measure, verify and record element resistance during installation.

- After unpacking
- After fastening the elements
- After the installation is finalized

If ohmic resistance and insulation resistance are not as labelled, the element must be replaced.

- The ohmic resistance must be within -5 to +10 % of the value labelled.
- The insulation resistance should read >20 MΩ after one minute at min. 500V DC.

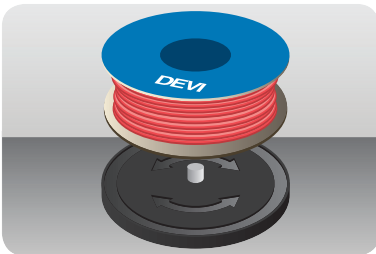


## 3.1 Installing heating elements

Observe all instructions and guidelines in section 1.1 and 1.2.

### Heating elements

- Position the heating element so that it is at least half the C-C distance from obstacles.
- Elements must always be in good contact with the heat distributor (e.g. concrete), see section 4 for details.



### Heating mats

- Always roll out heating mats with the heating cables facing up.
- When the heating mat reaches the area boundary, cut the liner/net and turn the mat before rolling it back.

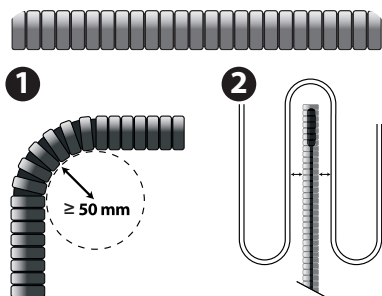
### Extending cold leads

- Avoid extending cold leads if possible. Wire cold leads to e.g. junction boxes or cable wells.
- Be aware of power loss in the cable according to local regulations.

## 3.2 Sensor Installation


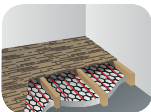
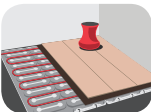
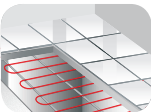
- Mandatory under wooden floors and on wooden sub floors.
- The floor sensor should be mounted in an insulating conduit, sealed at the floor end, for easy replacement of the sensor if required.
- The floor sensor must be considered a LIVE cable; therefore any extension made to the sensor wiring should be treated in the same way as normal mains voltage cabling.
- The sensor can be extended up to a total of 50 m using 1.5 mm<sup>2</sup> installation cable.
- The minimum bending radius for the pipe is 50 mm (1).
- The sensor cable must be placed between two loops of the heating cable (2).
- To avoid cracks in the concrete floor do not switch on the heat until the floor has completely hardened.





- Shall be placed in an appropriate place, where not exposed to sunlight or draft from door openings.
- The conduit should be flush with the sub floor.
- Route the conduit to the connection box.

#### 4 Indoor applications

				
<b>Sub floor</b>	Thin beddings* (<3 cm)	Joist floor constructions	Danfoss Reflect	Concrete floors* (>3 cm)
Wood	-	Max. 10 W/m and 80 W/m <sup>2</sup>	Max. 10 W/m and 100 W/m <sup>2</sup>	-
Concrete	Max. 200 W/m <sup>2</sup>	-	Max. 10 W/m and 100 W/m <sup>2</sup>	Max. 20 W/m and 225 W/m <sup>2</sup>
<b>Floor type</b>				
Wood, parquet, laminate	Max. 100 W/m <sup>2</sup>	Max. 80 W/m <sup>2</sup>	Max. 100 W/m <sup>2</sup>	Max. 150 W/m <sup>2</sup>
Carpet, vinyl, linoleum, etc.	Max. 100 W/m <sup>2</sup>	-	-	Max. 150 W/m <sup>2</sup>
Tiled floors in bathrooms conservatories cellars, etc.	100 - 200 W/m <sup>2</sup>	-	-	100 - 200 W/m <sup>2</sup>
Tiled floors in kitchens living rooms halls, etc.	100 - 150 W/m <sup>2</sup>	-	-	100 - 150 W/m <sup>2</sup>

\* May be up to 225 W/m<sup>2</sup> in rim zones e.g. under large windows.

- On concrete sub floors and under tiles, only.
- If connected to a separate floor sensor and thermostat.

#### Wooden floor coverings

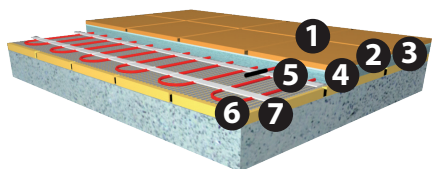
Wood shrinks and swells naturally depending on the relative humidity (RH) in the room.

- Avoid beech and maple in multilayered floor coverings unless press dried.
- Install a vapour barrier for sub floors <95% RH and a damp proof membrane >95%.

- Ensure 100% contact between the element and the embedding material above (no air pockets).
- Install the heating system in the whole floor area at 15°C surface temperature.
- Always install a floor sensor to limit the max. floor temperature.

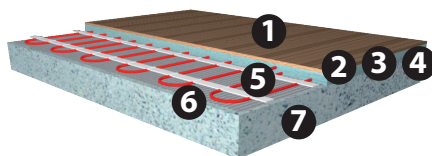
### 4.1 Floor heating in thin beddings (< 3 cm)

#### New tiles on existing tiles, concrete floors or wooden floors



1. New tiles.
2. Tile adhesive.
3. Vapour barrier.
4. Self-levelling compound.
5. Heating element.
6. Primer (on concrete) or screed (on wood).
7. Existing tiles, concrete or wooden floor.

#### New floor covering on existing tiles, concrete floors or wooden floors



1. Wooden floor, laminate or carpet.
2. Noise absorption mat.
3. Vapour barrier.
4. Self-levelling compound.
5. Heating mat or heating cable.
6. Primer (on concrete) or screed (on wood).
7. Existing tiles, concrete or wooden floor.

#### Wooden sub floors must be properly anchored

- Apply screed before laying the heating element.

#### Vapour barrier

- Apply only if not already installed in existing floor.
- In wet rooms apply only above the heating elements.

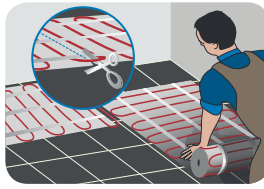
#### Tile adhesive or self-levelling compound

- Prime the sub floor as specified by the supplier.
- The heating element should be securely fastened before applying.
- The heating element must be fully embedded and at least 5 mm.

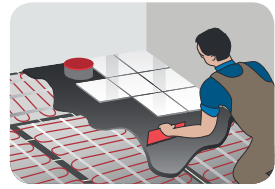
### Installation summary



Cut out a wall groove and fix cable ducts and connection box. Chisel off a groove for the sensor conduit and cold cable. Fix the sensor conduit e.g. with a glue gun.



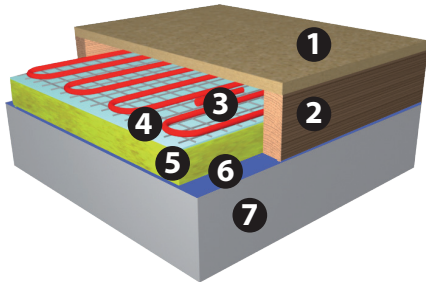
Roll out the element. Attach it to the sub floor. Cut and turn the mat mesh when meeting walls or obstacles. Do NOT cut the heating elements.



Apply flexible self-levelling compound, vapour barrier, and tile adhesive, depending on the floor finish.

## 4.2 Floor heating in joist floor constructions

### Wooden floor on joist constructions



1. Wooden floor covering.
2. Floor joists.
3. Heating Cable.
4. Mesh (reinforced or fine) or aluminium foil.
5. Insulation.
6. Vapour barrier.
7. Sub floor construction.

### The sub floor construction must be well insulated

- Insulate thermal bridges and close vents, e.g. between the floor construction and walls/ roofs.

### The heating cables may not touch the insulation or woodwork

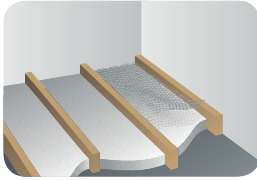
- Fine mesh or foil can be laid directly onto the insulation, reinforced mesh should be raised 10 mm from the insulation (e.g. use fillets).
- The distance between the heating cable and the joists should be at least 30 mm.

- The optimal distance between the heating cables and the underside of the floor covering is 3-5 cm.
- The heating cable must be fastened to the mesh or foil at max. 25 cm intervals.

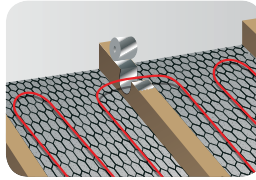
### Heating cables may cross a joist

- Through a 30 mm x 60 mm (h x w) recess lined with aluminium tape.
- Make sure the cable is never in contact with bare wood.
- Only one cable in each recess.

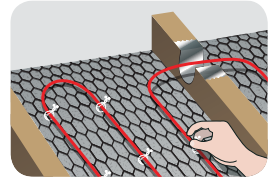
**Installation summary**



Apply mesh or similar onto the insulation.



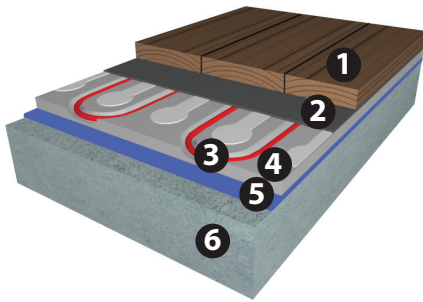
Cut a 30 mm x 60 mm recess and cover with aluminium tape where cables cross a joist.



Attach the cable and sensor properly.

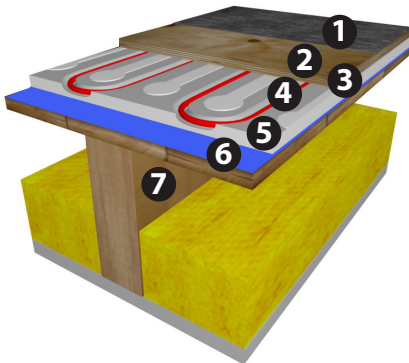
**4.3 Floor heating with Danfoss Reflect**

**On Concrete floors**



1. Wooden floor, parquet or laminate.
2. Noise absorption mat / rag felt.
3. Heating cable.
4. Danfoss Reflect.
5. Vapour barrier.
6. Existing floor construction (e.g. concrete, gypsum, polystyrene)

**On existing wooden floors**

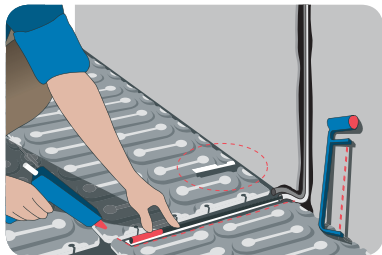


1. Linoleum or vinyl or carpet.
2. Pressure distribution board, min. 5 mm.
3. Noise absorption mat / rag felt.
4. Heating cable.
5. Danfoss Reflect.
6. Vapour barrier.
7. Existing wooden floor construction.

### Installation under carpets, linoleum or vinyl

- Must be separated from cables by at least 5 mm of pressure distribution board.
- Observe the total insulation value above the pressure distribution board.
- $R < 0.10 \text{ m}^2\text{K/W}$  corresponding 1 Tog or a thin carpet.

### Installation summary



Cut out a hole for the connection and the floor sensor conduit and remove any sharp edges. Fix the conduit to the sub floor e.g. with glue.

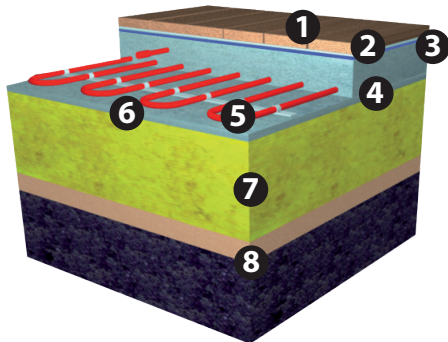


Install the heating cable. Make sure that the cable, end termination, and connection are in contact with the aluminium plate or surrounded by aluminium.

See the installation manual for the Danfoss Reflect product for further information.

### 4.4 Floor heating in concrete floors (> 3 cm)

#### Wooden floors (example with concrete slab)



1. Top flooring.
2. Noise absorption mat/rag felt, tile adhesive depending on top flooring.
3. Vapour barrier.
4. Concrete.
5. Heating cable.
6. Concrete slab or reinforced mesh.
7. Insulation.
8. Capillary-breaking layer, concrete, etc..

Other combinations of floor covering and existing floor construction are also possible.

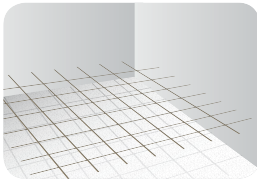
#### The heating cables may not touch the insulation

- The heating cable must be separated by reinforced mesh or concrete slab.

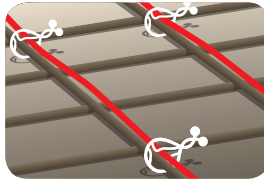
### Embedding in concrete or screed

- The bedding must not contain sharp stones.
- Must be sufficiently wet, homogeneous, free of air voids.
- Pour at a moderate delivery speed to avoid displacement of the element
- Avoid damaging the cable with any tools.
- The heating element must be fully embedded and at least 5 mm
- Allow a drying time of approximately 30 days for concrete and 7 days for moulding compounds.

### Installation summary



Apply reinforced mesh or concrete slab onto the insulation.



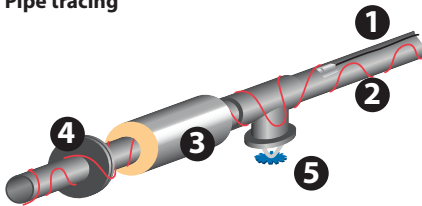
Roll out the cable and attach it to the sub floor or mesh reinforcement by means of Danfoss CLIP fastening accessories or similar.



Pour at a moderate delivery speed to avoid displacement of the element.

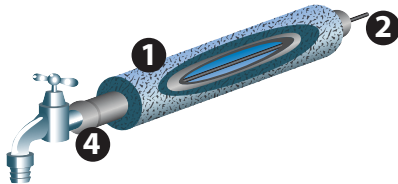
## 4.5 Frost protection of pipe systems

### Pipe tracing



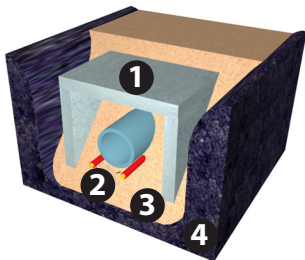
1. Sensor.
2. Heating cable.
3. Insulation.
4. Fitting.
5. Valve.

### In-pipe frost protection



1. Insulation.
2. Heating cable.
3. Sensor (not shown).
4. Fitting.

**Subsurface pipe tracing**



1. Concrete breeze block (optional) and / or insulation (optional).
2. Heating cable.
3. Sand bed.
4. Soil.
5. Sensor (not shown).

$\lambda$	W/mK	Thermal conductivity for insulation $\approx 0.04$ used in table
$\Delta t$	K	Temp. diff. between media/surroundings
D	mm	Outer insulation diameter
d	mm	Outer pipe diameter

**The number of cables n**

- Relation between required output and cable output.
- Number of cables per metre in the length direction.
- Min. 2 for DN125-200.
- Integer = straight cables (easier installation).
- Decimal = wrapped around pipe.

- Apply aluminium tape below and on top on the whole length of the cable.

$$n = \frac{Q_{\text{pipe}}}{Q_{\text{cable}}}$$

Observe the following heat densities ( $\text{W/m}^2$ ) for the actual application.

$$Q_{\text{pipe}} = 1.3 * \frac{2\pi * \lambda * \Delta t}{\ln \frac{D}{d}}$$

**For plastic pipes:**

- Cable output max. 10 W/m.

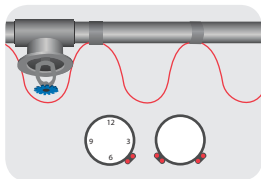
**For in-pipe installation:**

- Do not pull cable through valves.
- The heating cable may in exceptional cases be cut max 10 % and reworked outside the pipe and next to the compression gland.

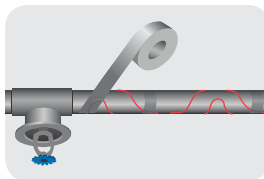
Never switch on power, before the pipe is filled.

$\Delta t$ [K]	Insulation [mm]	Pipe diameter DN [mm]											
		15	20	25	32	40	50	65	80	100	125	150	200
20°	10	8	9	11	14	16	19	24	29	36	44	-	-
	20	5	6	7	8	9	11	14	16	19	24	28	36
	30	4	5	5	6	7	8	10	12	14	17	19	25
	40	4	4	5	5	6	7	8	9	11	13	15	19
	50	3	4	4	5	5	6	7	8	9	11	13	16
30°	10	12	14	17	20	24	29	37	44	-	-	-	-
	20	8	9	10	12	14	17	20	24	29	35	42	-
	30	6	7	8	9	11	12	15	18	21	25	29	37
	40	5	6	7	8	9	10	12	14	17	20	23	29
	50	5	6	6	7	8	9	11	12	14	17	19	24
40°	10	15	19	22	27	32	39	49	-	-	-	-	-
	20	10	12	14	16	19	22	27	32	39	47	-	-
	30	8	9	11	12	14	17	20	23	28	33	39	50
	40	7	8	9	10	12	14	16	19	22	26	31	39
	50	6	7	8	9	10	12	14	16	19	22	26	32

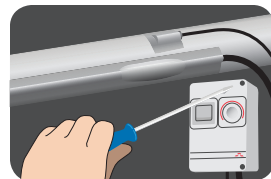
### Installation summary



Cables wrapped around pipes are attached as shown for every 20-30 cm of pipe with aluminium tape. Straight cables must be fitted as shown at 5 or 7 o'clock. In-pipe cables are fitted directly in the pipe with compression gland.



Apply aluminium tape below (mandatory for plastic pipes) and on top of pipe for the whole length of cable.



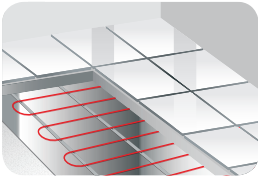
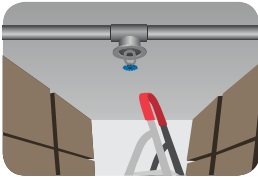
Extend cold leads/terminate cables, and place connections in a dry place. Mount connection box on or close to pipe, and install thermostat next to pipe.



5 Optional settings

If the element is connected to a thermostat such as a ECtemp, configure basic settings according to the table below and as described in the thermostat installation manual.

If applicable, adjust the temperature limit in accordance with the manufacturer's recommendations in order to prevent damage to e.g. the floor or the pipe.

			
Thermostat	Max. load	Floor heating in general	Frost protection of pipe systems
ECtemp 13x	16A	Room temp. 20-22° C.	-
ECtemp 330	16A		On < +5° C
ECtemp 53x	15A		-
ECtemp 610	10A		On < +5° C
ECtemp Touch	16A		-
Danfoss link CC	15A (FT)		-





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