ENGINEERING
TOMORROW

Electrical Heating

Cold Store Protection Systems
Application manual

Let Danfoss do the work

Danfoss Group is Denmark's largest industrial group. It is one of the world's leading companies within heating, cooling and air-conditioning. The Danfoss Group has more than 23000 employees and serves customers in more than 100 countries.

Danfoss is Europe's leading brand of electrical cable heating systems and electric pipe heating systems with over 70 years of experience. The production of heating cables takes place in France and Poland while the head office is situated in Denmark.

Cold stores, Ice stadiums and alike

This design guide presents Danfoss's recommendations for design and installation of frost heave prevention systems and frost protection for cold room doors, drain lines, and fire protection sprinklers and pipes. It provides guidance for a heating cable layout, electrical data and system configurations.

Following Danfoss's recommendations will ensure energy efficient, reliable and maintenance free solution for constant wattage heating cables with 20 year warranty.

Our quality management system **certifications and compliances**

✓ ISO 9001 ✓ TS 16949

✓ ISO 14001

Along with full compliance with EU directives and product approvals

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General information

In cold stores, ice stadiums, etc. the temperature is always within the range of –20 and –30 °C, however cold leak occurs even if the floor is insulated properly. This means that materials which are in contact with the soil, such as foundation and floor areas, will absorb the cold and let the ground freeze. Water, contained in the soil, will change volume when turning into ice and can cause substantial damage due to frost erosion.

Furthermore, in areas where very cold dry air meets warm moist air, the moisture contained in the warm air flow may settle on the cold surface and turn into ice. Ice conduces unwanted freezing of elements such as cold store doors/gates or door frames and can cause: damage to the door structure, weather stripping, disabling closing the door tightly and leading to increased energy consumption, etc.

Another problem, that occurs in a drainage system of refrigeration equipment, is condensation freezing and inability of free water flow.

Danfoss offers reliable and energy efficient cable heating systems to prevent frost heave and ensure frost protection of doors drain lines and firefighting piping. Danfoss has supplied various range of such systems to 5 continents over many years.

Benefits

- **Eliminate risk of foundation damage** – ice buildup in the foundation, which can result in problems such as: uncontrolled movement or elevation of the building foundation causing damage to the construction. Danfoss Electric heating systems prevents frost heaving damage in commercial freezers & ice stadiums by eliminating the possibility of such ice buildup.
- **Investment safety** – reduces the possibility of cold storage stock loss or destruction of the building due to the damaged foundation.
- **Reduced energy loss** - smooth operation of doors, protects the construction and prevents energy loss through untightly closed doors.
- **Safety of working environment** - prevents slippery floors and ensures frost protection of firefighting pipes and sprinklers.
- **Power saving solution** – Danfoss uses Advanced Controls to ensure power saving by: minimizing running time of the system, while maintaining the appropriate foundation temperature to prevent its freezing.
- **Space saving** – as compared to alternative solutions, Danfoss Electric heating system is less complicated, easier for planning & installation and requires no extra space.
- **Lower initial costs** – competitive solution with over 50% lower cost of the system, comparing to Pumped Fluid solution (Glycol) in pipes built into the foundation.
- **No Environmental Concerns** – Danfoss electric heating systems do not pose any environmental hazards, e.g. glycol leak into the soil. Danfoss systems use electric heating cables instead of glycol-water mixture.
- **Lowest ownership costs** - 20 years of full warranty from Danfoss Group and 50 years of expected lifetime for all Danfoss serial resistive heating cables.

1. Frost heave prevention system

1.2. System Description

The main object of heating, in the Frost Heave Prevention System, is to provide frost protection of foundation in premises where temperature is constantly maintained below zero (cold storages, ice stadiums, etc.).

Installation of an indoor frost protection system is required and electrical heating cables embedded in concrete is a solution to prevent frost heaving. Frost heave can cause floor slab cracking, damage to support structures and foundations. In such cases underfloor heating is needed in order to avoid freezing or other related problems and prevent destruction of foundation structures.

The heating cable in this case is located below the main floor insulation of the cold storage, typically in the sand backfill or in concrete screed.

For safety reasons: two identical parallel heating systems should be installed (main and reserve).

Frost Heaving

As the soil temperature under a freezer drops below zero, the moisture contained in the soil freezes up and expands significantly.

This ice formation results in floor cracking and its change of elevation or "heaving".

Ice formation can lift up columns, push over foundation walls and rip open roofs. Almost all components of the cold store can be repaired, whilst the major part of space is still used for storage, but this doesn't apply to the floor.

The problem cannot be solved by insulation alone.

1.2. Products

Heating cables

To prevent ground freezing the heating system may include the following resistive (constant wattage) heating cables:

ECflex 10T, ECflex 18T;
ECbasic 20S.

Danfoss resistive heating cables allow safe, efficient and economical cold store installation.

ECflex is a twin conductor heating cable for installation in concrete floors, pipe heating etc. The cable complies with IEC 60800:2009 class M2, and is designed for applications with the high risk of mechanical damage. It is supplied in readymade sets with 2,3 m cold lead (supply cable), sealed joints and end muff.

Cable diameter is Ø 6,9 mm.

The cable is available for 230 V power supply.

Cables of 10 or 18 W/m (230 V) linear output are available.

Available cable length:
ECflex 10T: from 10 m to 140 m;
ECflex 18T: from 7,3 m to 155 m.

ECflex

ECbasic is a single conductor heating cable complying with IEC 60800:1992 and intended for installation in concrete floors, for pipe heating etc. It is supplied on drum.

Cable diameter is Ø 5,5 mm.

ECbasic is available for 230 V power supply voltage.

Cable of 20 W/m (230 V) linear output is availible.

Available cable length:
ECbasic 20S from 9 m to 228 m.

ECbasic

Fixing

In case of heating cables application, it is recommended to use fitting bands to fix the cable to the floor, e.g. ECfast (cable strapping) metal galvanized fitting band. It should be attached to the floor (e.g. nailed down) in parallel lines usually at intervals of 100 cm or using one meter of fitting band per each square meter of cable installation. The same applies to plastic bands – Installation rail.

For cable fixing to metal columns etc. adhesive "tape aluminum" is recommended.

Thermostats

For control of Frost Heave Prevention System the EFET 330 (-10…+10 °C) thermostat with DIN rail attachement is recommended. Additionally a wall mounted EFET 610, IP44 can be used.

All thermostats are equipped with wire temperature sensors –
NTC 15 kOhm @ 25 °C with 3 meter long cable.

To provide correct temperature measuring the sensor cable should be of e.g. 10 m, to measure the temperature in the heated area (depends on the local conditions). 10 m long sensor is available, but needs to be ordered separately.

Note! For safety reasons: installations in cold storages should contain two independent circuits (main and reserve) controlled by separate thermostats.

EFET 330

EFET 610

Products - general overview of Frost Heave Prevention Systems

Product	Options	Description
Resistive heating cable ECflex	ECflex 10T, 230 V	Twin conductor, 100% screen. 10 W/m (230 V). DIN IEC 60800:2009 M2
Resistive heating cable ECbasic	ECbasic (DEVIbasic) 20S, 230 V	Single conductor, wire screen. 20 W/m (230 V). DIN IEC 60800:1992
EFET thermostat	EFET 330 (-10…+10 °C)	-10…+10 °C, 16 A, IP20, DIN rail
EFET thermostat	EFET 610	-30…+50 °C, 10 A, IP44, on wall/pipe installation
Fixing	ECfast Metal (Cable strapping) Installation rail, plastic, TYPE MS	25 m pack; galvanized metal, fixings every 2,5 cm. 1 m; plastic, fixes cable Ø 6,6-8 mm every 2,5 cm
Fixing	Tape aluminum	Glued aluminium tape 38 mm x 50 m; 0,06 mm; max. 75 °C

For details please refer to the Danfoss Catalogue.

1.3. System design

The heating cable for the Frost Heave Prevention System is located under the main floor insulation of the cooling facility, typically into sand backfill or concrete screed (fig. 1 and fig. 2).

Heating cable should be placed under the insulation layer of the floor to offer frost protection. Cables should be placed directly on top of the hardened concrete only, as an option can also be separated from the floor surface with the damp proof membrane. The cables should be installed at least 5 cm below the insulation. The floor construction must comply with local norms and regulations.

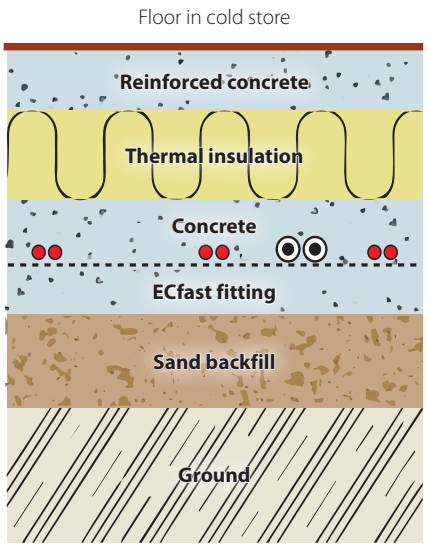


Fig. 1 – Heating cable in in the concrete screed

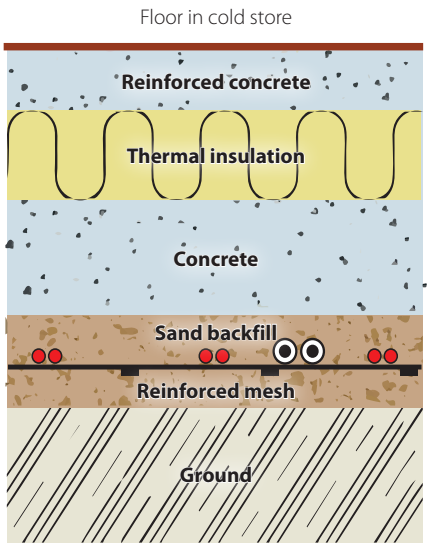


Fig. 2 – Heating cable in the sand backfill

Installed output

Under normal conditions calculated values of heat loss aren't very high, e.g. 3-8 W/m^2 only. However it is recommended to use 15-30 W/m^2 as a standard value or at least 15 W/m^2 for frost protection installations. In any case an output value should be calculated and correspond to downward heat loss.

The foundation cooling rate depends on:

- the rate of heat/cold emission through the floor;
- soil/ground temperature;
- interior temperature of the cold room or surface temperature of ice stadiums etc.

To estimate the required power density in [W/m^2] of the freeze protection system, the thermal resistance of multilayer floor construction should be calculated. While comparing actual values of all layers the thermal resistance of each layer, except the insulation layer, should be neglected.

Heating system output can be determined from the following formula:

$P = \Delta t \cdot U \cdot 1{,}3$ [W/m^2],

where
Δt – the temperature difference between ground/soil and cold store interior [°C];
U – the floor heat transfer factor, typically for insulation only [W/m^2·°C];
1,3 – safety factor.

For insulation U value can be determined as follows:
$U = \lambda/\delta$ = (thermal conductivity coefficient [W/m·K]) / (thickness [m])

Calculation example

A cold store has the following parameters:

Cold store temperature: -25 °C.

Ground temperature: +5 °C.

Insulation: 0,2 m thick,
λ = 0,04 W/m·°C.

The U-value of the insulation:
U = 0,04 / 0,2 = 0,2 W/(m^2·°C).

Δt = +5 °C - (-25 °C) = 30 °C.

Calculation of heating system output per square meter:

P = 30 °C · 0,2 W/(m^2·°C) · 1,3 =
= 6 W/m^2 · 1,3 = 7,8 W/m^2.

Output calculation is 7,8 W/m^2, but as per recommendations, the installed minimum should be 15 W/m^2!

For example, three lines of ECbasic 20S of 6,6 W per m^2 will provide 19,8 W/m^2 output and ensure cold store protection against frost heaving.

C-C distance

There must not be any subzero temperature gaps between the heating cable lines! Otherwise it will not prevent frost heave!

The temperature distribution in geometry of cold store floor has to be evaluated. The result depends on a number of parameters, the main are the following:

- thermal conductivity of the ground;
- linear output of the heating cable;
- C-C distance.

The thermal conductivity of the soil may vary significantly during operation, hence in practice following simplification rule is often used:

to ensure even heat distribution with no cold gaps the maximum central-central distance (C-C distance) between the heating cables should not exceed 50 cm (fig. 3). In other words, an installation of minimum 2 meter heating cable per m^2, is necessary.

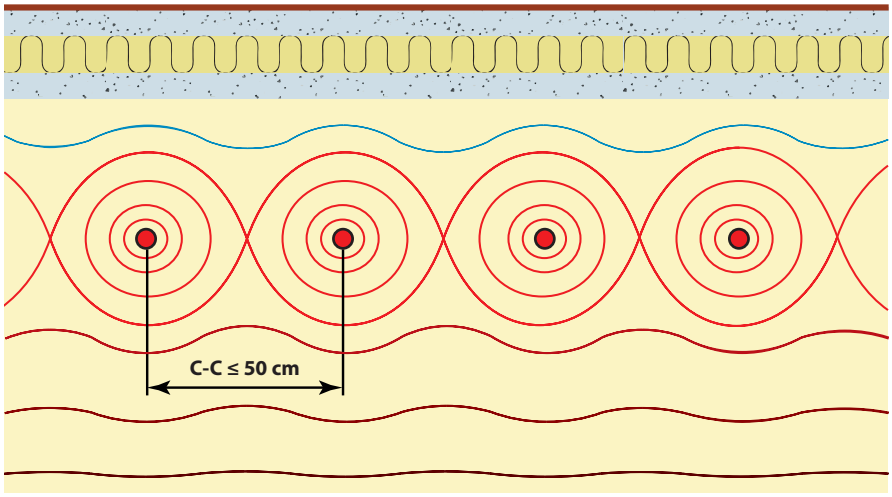


Fig. 3 – Heat/cold distribution and max C-C without cold gaps

It's very strongly advisable to always place a second supplementary cable loop with the same C-C distance.

For installations with max. C-C distance of 50 cm power output per $1m^2$ for some cable types is the following:

ECflex 10T – 20 W/m^2;
ECbasic 20S, 230 V – 40 W/m^2.

Recommendations: the preferred C-C distance between cable lines is 33 cm. It allows implementation of a simple rule for cable length calculation – 3 m of cable per 1 m^2.

For example three lines of ECflex 10T per 1 m^2 provides 30 W/m^2 (230 V) output. It is applicable for almost all types of cold stores, ice stadiums etc.

Minimum requirement: 10 W/m cable should be installed with a C-C distance of maximum 50 cm.

Safety

For safety reasons two identical heating systems should be installed in parallel – the main and the reserve one.

Elements for such system are following:

- two identical parallel circuits of heating cable (main and reserve);
- two identical thermostats with temperature sensors for each cable;
- alarm signals in case of reserve cables operation – light and acoustic alarm;
- two separate power supply lines;
- separate fuses, RCD relays, contactors, etc.

Please note that the reserve cable system is obligatory for this type of installations. Reserve cables are usually mounted in parallel to the main cable with a distance of
2,5-5 cm, to the primary system.

The C-C distance is determined as a median line between the main and reserved cable, see fig. 4.

Note! One thermostat per heating cable should be installed.

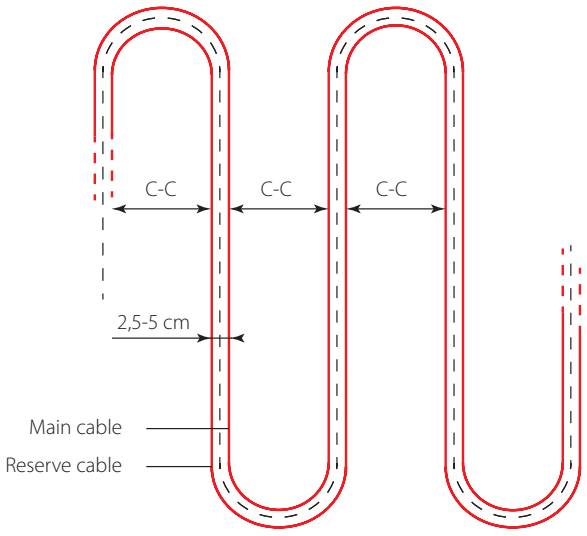


Fig. 4 – Main and reserve heating cables

Control

The most commonly used thermostat for Frost Heave Prevention System is EFET 330 (-10…+10 °C) with DIN rail attachment.

Two identical thermostats, with separate temperature sensors, should be used.

The thermostat which controls the main circuit should be set to a temperature of +5 °C. It provides adequate protection against the ground freezing.

The thermostat which controls the reserve circuit should be set to a temperature +3 °C. Additionally it should be connected to an alarm system (acoustic and light).

In case of failure of the main heating circuit the reserve circuit, with lower temperature settings, is switched ON and the alarm system is activated.

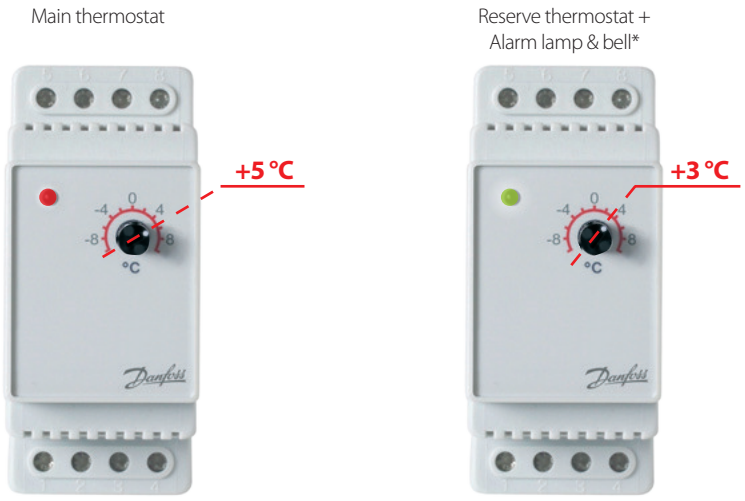


Fig. 5 – Main and reserve thermostats with settings

Alternatively current flow control devices can be recommended for use. This is required for each main and reserve heating cables.

Flow control devices should be connected to special control system ensuring alarm activation if any cable fails to heat (no current flow).

Special heated zones

For large rooms, the system should be divided into zones, ensuring protection by separate heating circuits. An individual thermostat is required for control of each zone.

Columns, concrete walls, etc. inside a cold store call for special attention. They can cause cold bridges with downward cold flows, that may provoke soil freezing around its base. In any case, we recommend arrangement of thermal insulation over the entire height of the columns. However, extra heating of the column base is required, either by the same heating cable installed in the floor or an individual one.

Ensure proper thermal contact between the heating cable and a column. For concrete columns it is recommended to cover the cable with a plaster layer, tile glue, concrete, etc. For metal columns the heating cable should be attached to the surface by adhesive aluminum tape along the entire length.

In order to calculate the required heating power thermal insulation parameters and the column design data are needed. Heat/cold loss calculation is the same as described above in "Installed output".

Extra heating along the outside wall perimeter of the cold room is recommended – directly nearby outside walls.

The floor surface along the perimeter gets in contact with the ground outside the facility and during winter period freezing is possible.
Two additional cable lines with C-C = 5…7,5 cm are recommended in such cases.

1.4. Installation

As mentioned above (ref. to 1.3) there are two variants of cable installation:

- in the concrete screed of base floor structure;
- in the sand backfill below all building structures.

The cable should be spread evenly on the floor of the cold store and securely attached, usually by means of ECfast fitting band. Installation in the concrete screed is virtually the same as installation of the underfloor heating. When cable is mounted in sandy backfill it is important to fix it securely to a metal or plastic mesh.

As an example the Frost Heave Prevention System with 3 heating zones and with 3 pairs of heating cables is shown in fig. 6.

Note. In case cold leads are all bundled in the same cable channel, each of them will add some heat to the bundle and in the end it might overheat and be damaged. Please be aware of maximum current in cables and local wiring rules in case of bundling.

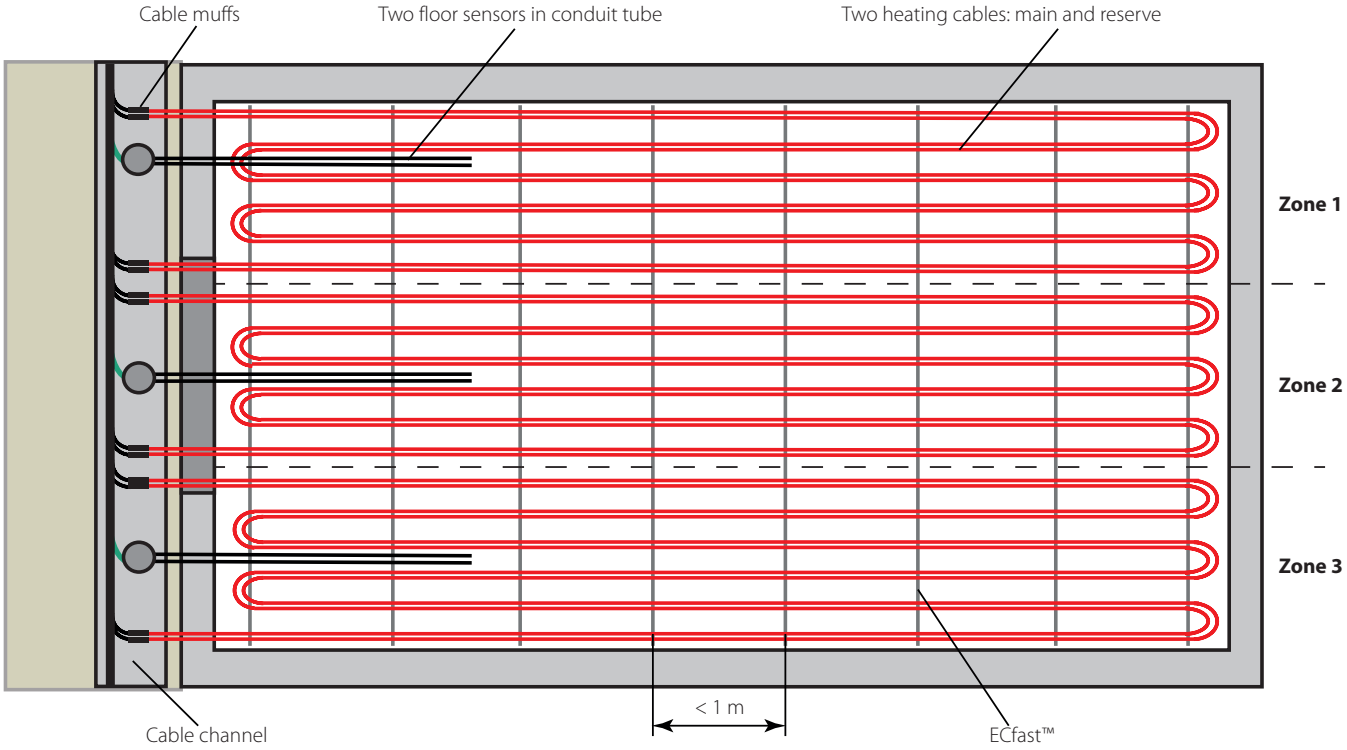


Fig. 6 – Heating system with 3 zones. There are pairs of heating cables and sensors (main and reserve)

Temperature sensor

The temperature sensor (wire sensor) should be installed in a conduit pipe of 14-20 mm diameter. The pipe should provide free access to the wire sensor for replacement (remove-insert) through a hole in the mounting box. Large bending radius is recommended where the pipe is bent between the floor and the wall. The pipe end should be sealed to avoid concrete from entering.

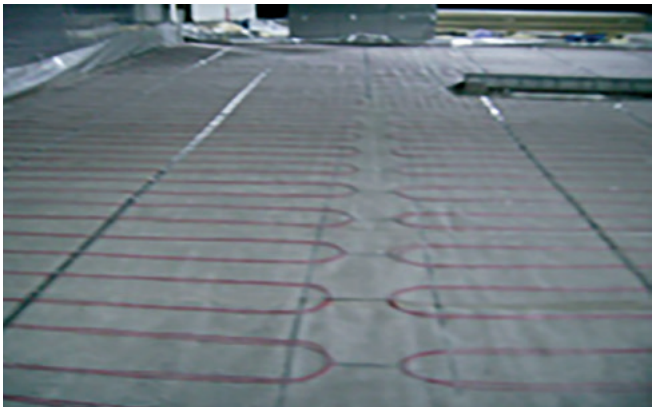
The pipe/sensor must be positioned in the center at an open end of a cable loop and usually at the same level or a little above.

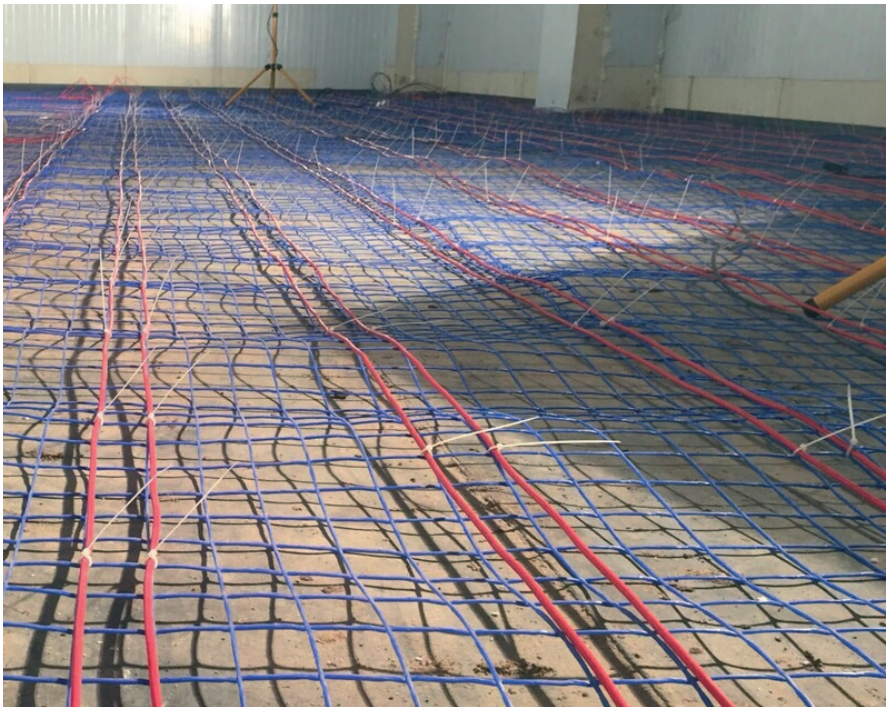
For sensors to measure correct temperature, avoid placement of sensor(s) near walls where extra heating from outside is possible. The recommended distance of the sensor is approx. 5-10 m from the wall. A wire sensor with a dedicated long connecting cable, e.g. 10 m, is required.

The sensor cable can be extended to any reasonable length (e.g. 100 m) using a cable of min. 2 x 0,75 mm^2. It is important to place the sensor (sensor tube), in the middle, between the heating cables.

As an option the sensor can be placed in the center of a heated zone. Considering that the heated zone center is located far from the service access point. It is recommended to install the sensor by means of U-tube accompanied by U-shaped wire hawser/rope. This helps to avoid possible problems with the sensor replacement.

Some examples with heating cables installed on the base of cold store floors.





2. Protection against condensation on floors

2.1 Systems description

Cold rooms suffer from one more problem related to floor areas nearby doors and doorframes – slippery floor. In the areas where very cold dry air meets warm moist air, the moisture from the warm air flow may settle on the cold surface and turn into ice. To prevent this, an anti-slippery heating system should be installed.

Floor heating systems are necessary for anti-slippery and frost protection. Electrical heating cable, embedded in concrete, is a solution for small floor areas nearby doors.

In doorways between cold stores and heated rooms condensed water may form on the floor: opening and closing of doors causes the constant shifts between cold and warm air. This can result in dangerous and operation-limiting ice formations on the floor or in the door opening and therefore, the floor in these areas must be heated.

As an extra comfort, it will also limit the flow of cold air to the heated area.

2.2 Products

Heating cables

For a heating system to prevent freezing of the ground following resistive heating cables and mats can be used:

ECflex 18T (230 V);
ECbasic 20S (230 V and 400 V);
ECsnow 30T (230 V and 400 V).

Note. The number at the end of the cable's name refers to its specific output – W/m, at voltage of 230 V or 400 V. Letter "T" means twin conductor cable/mat (Twin), letter "S" – single-conductor cable (Single).

Fixing

For cable fixing to the floor basement it is typically used ECfast metal galvanized fitting band with fixing elements at intervals of 2,5 cm. It is attached to the floor (nailed) in parallel lines usually at 25 cm intervals or 4 meter fitting band per each square meter of a cable installation. The same applies to plastic bands – Installation rail, plastic.

Thermostats

To control floor heating system EFET 330 (5…45 °C) thermostat with DIN rail attachment is recommended as a standard solution.

Wall mounted EFET 610 (IP44), can also be used.
All thermostats are equipped with wire temperature sensors as a set – NTC 15 kOhm @ 25 °C, 3 m.

Find thermostat pictures in chapter 1.2.

Products - general overview of Protection against condensation on floor

Product	Options	Description
Resistive heating cable ECflex	ECflex 18T, 230 V	Twin conductor, 100% screen. 18 W/m (230 V). DIN IEC 60800:2009 M2
Resistive heating cable ECbasic	ECbasic 20S, 230 V	Single conductor, wire screen. 20 W/m (230 V) DIN IEC 60800:1992
Resistive heating cable ECsnow	ECsnow 30T (230 V; 400 V)	Twin conductor, 100% screen, UV stabilized. 30 W/m (230 V/400 V). DIN IEC 60800:2009 M2
EFET thermostat	EFET 330 (5…45 °C)	5…45 °C, 16 A, IP20, DIN rail mounting
EFET thermostat	EFET 610	-30…+50 °C, 10 A, IP44, wall/pipe installation
Fixing	ECfast Metal	25 m pack; galvanized metal, fixings every 2,5 cm.

For details please refer to the Danfoss Catalogue.

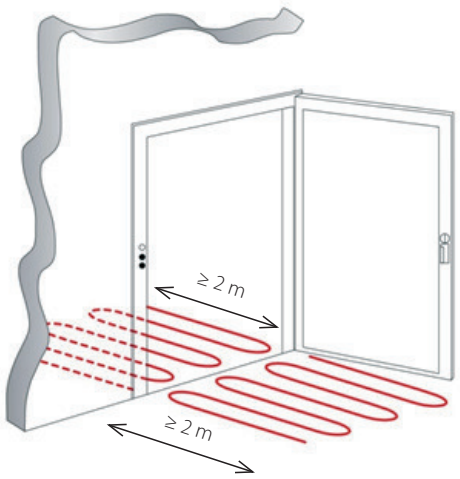
2.3 System design

The heating cable and mats for protection against condensation around doorways are located typically in concrete screed just below the floor surface.

Heating cables/mats must be planned at both sides of the doorway, but they should not be laid across expansion joints. This means that it is better to use separate heating elements for installation inside and outside doorways.

The system should cover an area of min. 2 meters from each side of the door.

Cable and mats are usually installed in the same way as for ordinary concrete floors.



Installed output

The installed output for condensation protection of floors is normally 250-300 W/m^2 per each side of the doorway.

C-C distance

For standard heating cables the C-C distance should be 7,5 cm, which ensures output of 240 W/m^2 for ECflex 18T and 265 W/m^2 for ECbasic 20S.

Note. C-C = 7,5 cm is relevant to a cable length as follows: 1 m^2 of heated area requires 13 m cable.

Control

Thermostats with floor temperature sensors should be used.

The temperature of the thermostat must be set to ensure that the floor surface is kept frost-free, so at least at +5 °C. However to ensure water drying up from the floor surface the temperature can be much higher and should be determined by an experiment.

The most commonly used thermostat for Protection against condensation on doors floor is EFET 330 (-10…+10 °C) with DIN rail attachment. Also it can be used a wall/pipe mounted EFET 610.

As an option EFET 130 is the only Comfort Floor Heating thermostat that can be used for protection against condensation on floor. Ensure the correct thermostat location, taking into account that its protection class is IP20.

2.4 Installation

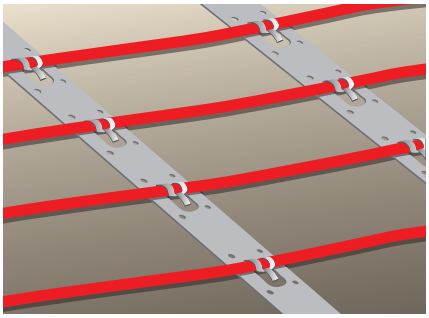
Cables and mats installation in the concrete screed is almost the same as installation of the underfloor heating.

The cable is mounted in the floor basement and usually attached by ECfast metal fitting band. Recommended distance between fitting bands is 25 cm. In case of cable fixing to a metal mesh ensure that it is attached securely. The heating cable should be covered by 5 cm of concrete.

Temperature sensors (wire sensor) should be installed in a conduit pipe of 14-20 mm diameter. The pipe should provide free access to wire sensors for replacement (remove-insert) through a hole in the mounting box. The pipe end should be sealed to avoid concrete from entering. The minimum bending radius is 6 cm.

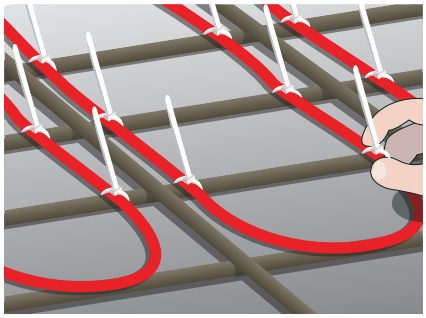
The pipe/sensor must be positioned in the center at an open end of a cable loop and usually at the same level.

The temperature of the thermostat must be set to ensure that the floor surface is kept frost-free (min. +5 °C), evenly over the whole heated surface.



ECfast

For keeping exact C-C distance (2,5 cm steps) on even surfaces.



Cable ties

For use on reinforcement mesh.
Do NOT fix the loop.
The cable must be able to move.

3. Freeze protection of doors and gates

3.1 Systems description

In the areas where very cold dry air meets warm and moist air, moisture from the warm air flow may settle on the cold surface and turn into ice. In cold stores there is permanent frost influence, which means that the door can easily freeze. Apart from the obvious damage to the door sealing strip, frozen weather stripping may also prevent the door from shutting tightly leading also to increased energy consumption in the cold room due to big temperature differences.

Typically frost protection systems are used for: sliding doors, swing doors, gates in car washes, doors in cold stores, roller edges in water treatment plants etc.

For sliding doors and swing doors, etc. the frost can also be a problem for slide bars.

This does not apply only to cold stores but also to gates and doors of car washes, etc. where there is a potential frost risk during winter.

In this case the problem can also be solved by means of heating cables.

3.2 Products

Heating cables

For outside doorframes and doors, any cable with linear output of 15-20 W/m is applicable. The cable should be fixed to the doorframe by means of adhesive aluminum tape or embedded in concrete connected to the doorframe.
The following resistive heating cables are recommended:
ECflex 18T (230 V);
ECbasic 20S (230 V.

Fixing

Attachment of cable lines to metal doors and doorframes is usually performed by adhesive aluminum tape, e.g. Alutape.

For cable fixing to concrete the most commonly used fitting band is ECfast – a metal band with fixing elements at 2,5 cm intervals. ECfast can be attached to concrete by means of nails, screws, glue etc. at approx. 25 cm intervals.

Thermostats

Such applications usually don't require a thermostat, but for limitting of running cost, it is advisable to install one.

Like option for high output heating systems can be used DIN rail thermostat EFET 330 (5…45 °C) or wall mounted EFET 610.

Products - general overview of Freeze protection doors and gates

Product	Options	Description
Resistive heating cable ECflex	ECflex 18T, 230 V	Twin conductor, 100% screen. 18 W/m (230 V). DIN IEC 60800:2009 M2
Resistive heating cable ECbasic	ECbasic 20S, 230 V	Single conductor, wire screen. 20 W/m (230 V) DIN IEC 60800:1992
Fixing	ECfast Metal	25 m pack; galvanized metal, fixings every 2,5 cm.
Fixing	Tape aluminum (Alutape)	Glued aluminium tape 38 mm x 50 m; 0,06 mm; max. 75 °C

For details please refer to the Danfoss Catalogue.

3.3 System design

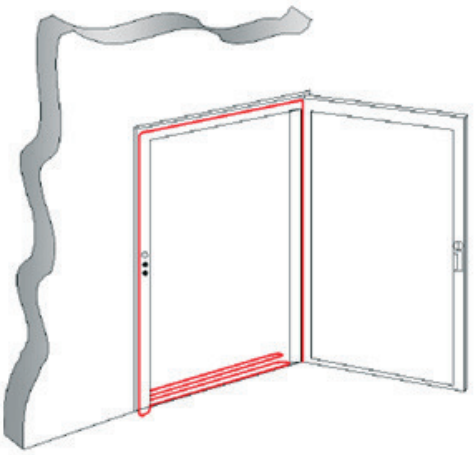
For outside doorframes and along the door/gate perimeter, heating cables used for floor heating, are installed.

In case of cable installation on outside doorframes, it should be fixed to the frame by adhesive aluminum tape or embedded in concrete, in the close vicinity to the frame, to ensure appropriate heat transferring and prevent the cable overheating.

In case of installation inside doors/ gates it is recommended to fix the cable by adhesive aluminum tape. Special flexible connection for power supply is required due to doors/frames rotation and movement.

Installation on door seal around gates and doors, etc., is performed by attaching a cable with aluminum tape at the back of door seal before it is secured.

For the purpose of frost protection of floor slide bars the cable must be placed in concrete directly under the slide bar. It is important that the cable is placed in such a manner to prevent its damage during the bar mounting and movement.



Installed output

The installed output for gates and doors of cold rooms is typically 15-20 W/m per each door seal.

For swing doors and slide bars of outside gates, the installed output must correspond to the output used for ice and snow melting systems, e.g. typically 250-350 W/m^2 (C-C = 7,5 cm).

The recommended linear output for PVC heating cables is 15-20 W/m.

C-C distance

For cables installed in concrete (slide bars, doorframes, etc.) it is common to use 2 cable lines with C-C distance of 5 or 7,5 cm.

Virtually the same should apply for cables installed along the inside perimeter of doors etc.

For standard heating cables the C-C = 7,5 cm provides output of 240 W/m^2 for ECflex 18T and 265 W/m^2 for ECbasic™20S .

Control

For limitting of running cost, it is advisable to install a thermostat.

As an option for high output heating systems it can be used EFET 330 thermostat (5…45 °C) with DIN rail attachment or wall mounted EFET 610.

Safety

For safety reasons, door heating applications can be powered by low voltage power supply, e.g. 12 V.

3.4 Installation

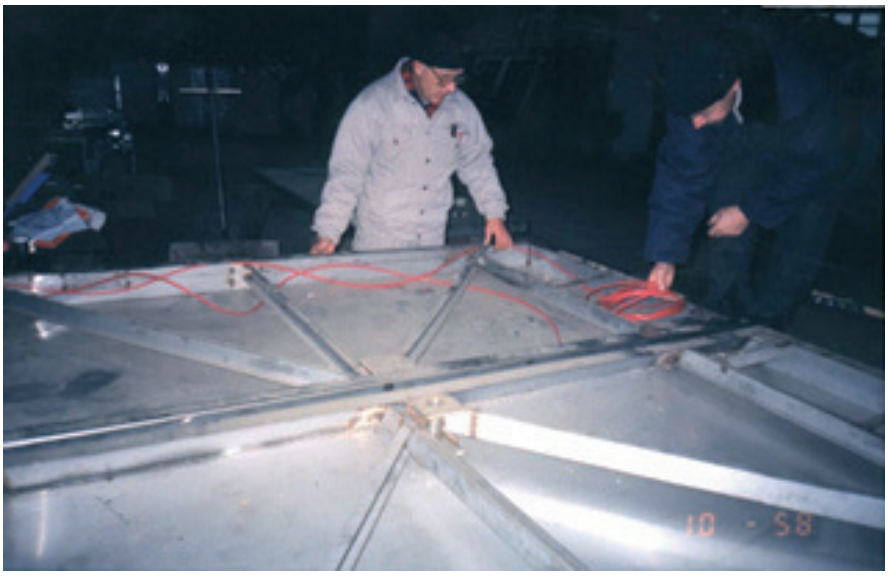
For outside doorframes and along the door/gate perimeter, it is usual to use serial resistive heating cables applied for the floor heating.

In case of cable installation on outside doorframes it is used two types of cable fixing:

- by means of adhesive aluminum tape, right to the frame back;
- by embedding in concrete in the close vicinity to the doorframe concrete construction.

In case of cable installation inside along the door/gate perimeter, it is recommended to fix the cable by adhesive aluminum tape.

Special flexible connection for power supply is required due to doors/frames rotation and movement.



Installation on weather stripping around gates and doors, etc. is performed by attaching a cable with adhesive aluminum tape to the weather stripping back before it is secured.

For the purpose of frost protection of floor slide bars, the cable must be placed in concrete directly under the slide bar. It is important that the cable is placed in such a manner to prevent its damage during the bar mounting.

4. Frost protection of pipes in cold stores

4.1 Systems description

Inside cold stores/rooms the negative temperature is maintained all the time. Process pipelines are usually installed. Additionally firefighting pipelines and sprinklers should be ready for water supply in cold stores.
Frost protection is typically used for heating pipelines with liquids inside as well as fire pipelines and sprinklers. Danfoss pipe heating systems can be installed both inside and outside the pipes.

Benefits

- Frost protection of pipes - eliminating costly repairs and replacement
- Secures constant flow in pipes
- Any installation areas

4.2 Products

Heating cables

The following heating cables can be used for the pipe heating system:

Resistive (constant wattage):
ECflex 10T, ECflex 18T;
ECbasic 10S, ECbasic 20S.

Self-limiting cables (SLC):
ECpipeguard 10,
ECpipeguard 25,
ECpipeguard 33;
ECiceguard 18.

Heating cable for installation inside water pipes:
self-limiting ECpipeheat 10
This cable is approved for use in contact with drinking water.

Self-limiting heating cables are equipped with a temperature dependent resistant element between two parallel copper conductors. When the connecting conductors are connected to the mains, a current goes through the temperature dependent resistant element, which then starts heating. As the element is heated, the resistance value rises causing the current to decline and the heating is then reduced. This explains the self-limiting output.

Due to the parallel power supply the self-limiting heating cable can be shortened or extended anywhere. This simplifies the planning and installation.

Fixing

Cable lines attaching to metal or plastic pipes is recommended by means of Alutape adhesive aluminum tape.

Thermostats

To control a pipe heating system EFET 330 (5…45 °C) thermostat with DIN rail attachment and pipe or wall mounted EFET 610, IP44 are recommended.
All thermostats are equipped with wire temperature sensors in set – NTC 15 kOhm @ 25 °C, 3 m.

Find the thermostat pictures in chapter 1.2.

Product overview for Frost Protection of Pipes

Product	Options	Description
ECflex Resistive heating cable	ECflex 10T, 230 V; ECflex 18T, 230 V	Twin conductor, 100% screen. 10 or 18 W/m (230 V); Ø 6,9 mm. DIN IEC 60800:2009 M2
ECiceguard Self-limiting heating cable	ECiceguard 18, on drum	18 W/m @ 10 °C. 11,8 x 5,8 mm.
ECpipeheat Self-limiting heating cable inside pipe	ECpipeheat 10 with plug, 2-25 m. 3/4"+1" Pipe fitting (13 bar @ 22 °C)	10 W/m @ 10 °C, 100% screen. 7,7 mm × 5,3 mm. Approved for use in drinking water.
Assembly kit	Danfoss Connecto	Connection accessories kits for self-limiting cables
EFET thermostat	EFET 330 (5…45 °C)	5…45 °C, 16 A, IP20, DIN rail
EFET thermostat	EFET 610	-30…+50 °C, 10 A, IP44, wall/pipe installation
Fixing	Tape aluminum (Alutape)	Glued aluminium tape 38 mm x 50 m; 0,06 mm; max. 75 °C

For details please refer to the Danfoss Catalogue.

4.3 System design

Output of the heating cables installed on pipe should not be less than the calculated heat loss from pipe surface multiplied by 1,3 safety factor.

In most cases 10 W/m output is enough if:

- the pipe diameter does not exceed 50 mm,
- the insulation thickness is at least the same as the pipe diameter,
- the temperature of cold store does not fall below -30 °C.
- the required temperature inside the pipe is 5 °C.

In other words, for the above conditions, the only one 10 W/m cable line (ECflex 10T, etc.) is required. Cable should be laid in a straight line along the pipe, i.e. the selected cable length is the same as the pipe length or the next value in a row.

Some extra length of the heating cable is required for valves, joints, control devices, etc.

For more details on frost protection of pipes and heat loss calculation please refer to the Danfoss Pipe heating application. Minimum ambient temperature to be considered should be the cold store temperature.

Note. For plastic pipes the linear output of resistive heating cables should not exceed 10 W/m. This restriction does not apply to self-limiting cables (SLC).

There are several ways of the cable attachment to the pipe:

1. One or more cables are led in a straight line along the side of the pipe, see fig. 7 and fig. 8.

2. The cable is attached to the pipe in waves or spiral, see fig. 9.

The heating cable is mounted directly on the pipe and secured with aluminum tape ensuring optimal contact (heat transfer) between the cable and the pipe. The same applies for wire sensors.

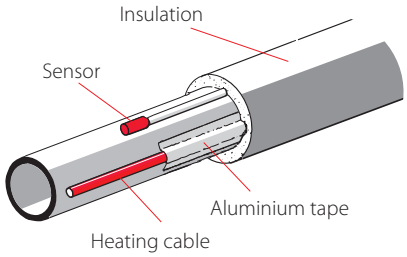


Fig. 7

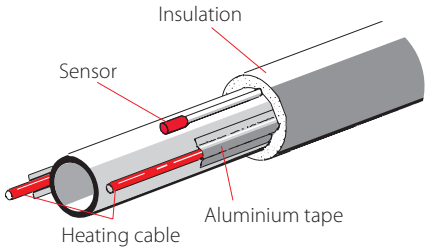


Fig. 8

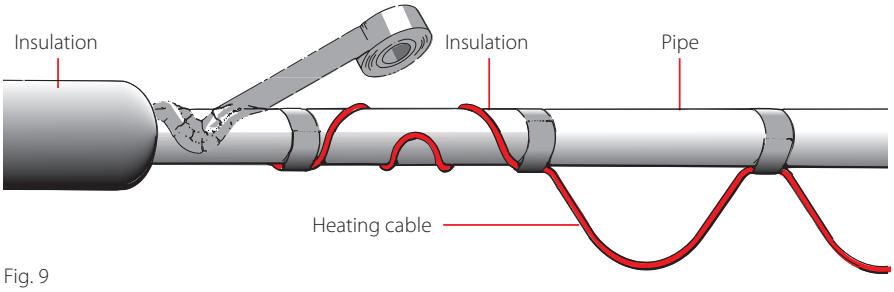


Fig. 9

Before the heating cable is attached to the plastic pipe, a full lane of aluminum tape should be applied to the pipe for the cable to lie on.

Fig. 10 shows the recommended ways to mount the cable lines depending on the amount of heating cables to place on the pipe. The temperature sensor should be mounted at 90 degrees from the heating cable counting around the perimeter of the pipe or at least 5 cm away from it.
But preferably at the opposite side of the pipe, compared to placement of the heating cable.

Pipes are usually insulated with plastic foam, mineral wool or another kind of insulation, which can range in thickness, typically not less than the pipe diameter.
The insulation should be protected against damp and moisture that could damage the insulation and reduce its efficiency.

Ensure that insulation with bigger inner diameter is chosen, taking into account that the pipe diameter is increased due to heating cable installation.

Connection to electricity (power supply) must be performed by an authorized and qualified electrician and in accordance with the local electrical regulations.

If cables are installed above the ground in trays, it should be safe and solid.
It should be marked with a distinct warning sign, e.g.
“WARNING: 230 VOLT HEATING CABLES“.

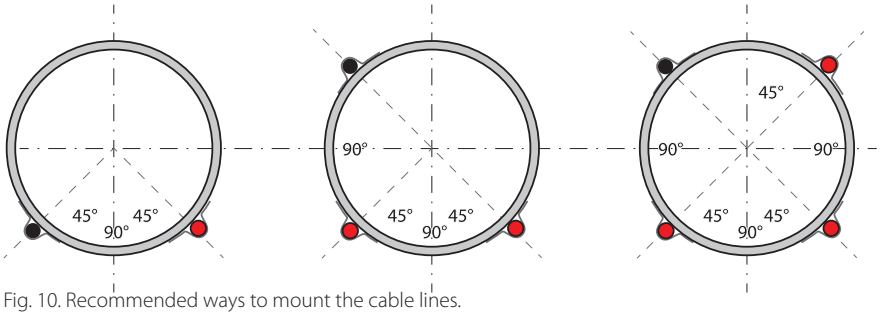


Fig. 10. Recommended ways to mount the cable lines.

Heating cables for drinking water pipes must be connected via RCD relay. It should also be marked with a distinct warning sign.

For this type of installation it is necessary to measure the required pipe run precisely, as the cable cannot be cut or bent in a loop. The heating cable must not be led through valves. The heating cable is relatively stiff that makes the installation easier.

The sensor cable can be extended to any reasonable length using a cable of min. 2 x 0,75 mm^2.

You will need an appropriate DEVIcrimp assembly kit to perform cold tail connections and end muff of heating cables on drums. For instance, DEVIcrimp assembly/repair kit 2-cond. CS2A/CS2B (product number: 18055350).

4.4 Installation

Before installing the heating cables it is important to check the pipe for any signs of damage or leakage.

Besides, the pipes should be insulated as this reduces the heat loss from the pipe considerably. This goes for all pipes whether they are below or above the ground.

The cable should be attached to the pipe gently, so it does not get damaged. The entire length of the cable should be attached to the pipe with aluminum tape and NOT plastic tape.

The cable should not be laid on the sharp edges of the pipe. Treading on the cables should be avoided and the cables should be treated carefully at all times.

All pipe trenches should be distinctly marked to indicate that heating cables have been installed on/in them. It should also be marked with a distinct warning sign, e.g.
"WARNING: 230 VOLT HEATING CABLES".

When heating cables are installed below the ground, a plastic tape (red, yellow etc.) is laid on top of the pipes/ installation to indicate that cables are placed just below.

Insulated pipes must be marked with a warning sign placed on the outside of the insulation material.

The screen of the heating cables must be earthed in accordance with the local electricity laws.

The resistance and the insulating resistance of the heating cable must be checked before and after installation. The resistance value must be as indicated on the label of the connection box.

The cable is attached to the pipe with strips of aluminum tape placed at intervals of approx. 25-30 cm. When the heating cable has been attached to the pipe, the entire length of the heating cable must be covered with lanes of aluminum tape. This prevents the heating cable from getting into direct contact with the insulation material and ensures a tight fit between the pipe surface and the heating cable.

Before the heating cable is attached to the plastic pipe, a full lane of aluminum tape should be applied to the pipe for the cable to lie on. This ensures a better heat distribution to the pipe. Cables should be attached at the lower part of the pipe or/and symmetrically around the pipe.

The connection box between the heating cable and the cold tail should also be fixed with aluminum tape. The sensor cable is attached to the pipe in the same way as the heating cable. The tip at the end of the sensor should be covered with aluminum tape and be positioned centrally between the cable lines and on top of the pipe, if possible.

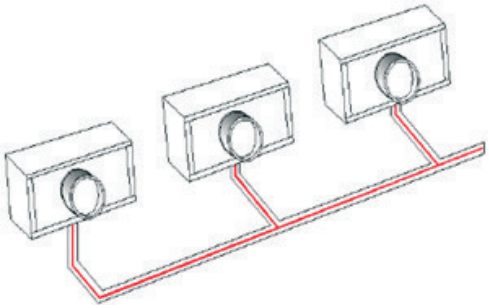
The cable must be evenly spread and the crossing of resistive cables must be avoided.

5. Frost protection of drain lines of cooling equipment

5.1 Systems description

Ice leads to unwanted freezing of elements such as drainage of cold store refrigeration equipment. Condensate water can freeze up into pipes, water trays, etc. disabling free water flow , and damage the cooling equipment.

Danfoss product choice is: self-limiting heating cables connected to power/control system of chilling/refrigerating equipment.



5.2 Products

Heating cables
The following self-limiting heating cables (SLC) can be used for Frost protection of drain lines:
ECpipeguard 25,
ECpipeguard 33;
ECiceguard 18.

Fixing
Inside pipes the SLC typically is not fixed.
Fixing cable lines to metal surface of water trays, etc. is recommended by adhesive aluminum tape, e.g. Alutape.

Thermostats
Such applications typically do not require thermostat. Heating cables are usually connected to power/control system of chilling/refrigerating equipment.

Product overview for Frost protection of drain lines

Product	Options	Description
Self-limiting heating cable ECpipeguard	ECpipeguard 25, on drum ECpipeguard 33, on drum	25 W/m @ 10° C. 33 W/m @ 10 °C. 11,8 x 5,5 mm.
Self-limiting heating cable ECiceguard	ECiceguard 18, on drum	18 W/m @ 10 °C. 11,8 x 5,8 mm.
Assembly kit	Danfoss Connecto	Connection accessories kits for self-limiting cables
Fixing	Tape aluminum (Alutape)	Glued aluminium tape 38 mm x 50 m; 0,06 mm; max. 75 °C

For details please refer to the Danfoss Catalogue.

5.3 System design

Self-limiting heating cable is usually used, for this type of application. This is due to the fact, that heating cables aren't operated by thermostat and/or power/control system of chilling/refrigerating equipment is used.

SLCs with the output of at least 18 W/m @ 10 °C is recommended.

If any part of self-limiting cable is subjected to the sun, UV-stable cable (e.g. ECiguard 18), or UV-stable shrink tube, shdould be used. If cable is designed for installation in pipes for condensate water, the cable length should not be less than the total pipe length.

Due to the parallel power supply the self-limiting heating cable can be shortened or extended into desired length. This simplifies the planning and installation.

If cable is designed for installation in water trays etc. it should be fixed to metal surface by adhesive aluminum tape.

Cold tails for self-limiting cables must be performed by an authorized and qualified electrician and in accordance with the local electrical regulations.

An appropriate assembly kit is needed to perform cold tail connections and end muff for heating cables on drums, e.g. Danfoss Connecto assembly kits.

For more details on frost protection of pipes please refer to chapter 4 and the Danfoss Pipe heating application.

5.4 Installation

For details on installation please refer to chapter 4.4 and the Danfoss Pipe heating application.

6. General installation guide

The installation of heating cables and thermostats should comply with general and local regulations. The cables and the thermostats should only be connected by an authorized electrician.

The foundation must be clean and free of sharp objects.

The cables must never get into contact with the insulation material or become enveloped by it in any way.

The cables must be evenly spread on the available floor.

The cables must be gently attached so they are not damaged.

To ensure an accurate and easy installation of the cables, ECfast fitting bands can be used.

The concrete around the cables must not contain sharp stones and should have a consistency enabling it to surround the cable completely without leaving air pockets.

The concrete should be applied very carefully in order not to damage the heating cables!

If the floor is built on the ground, a damp proof membrane is needed to prevent moisture from moving upwards and into the floor construction.

The wire of the floor sensor must be protected by a plastic pipe.

The sensor must be positioned in the center at an open end of a cable loop. Where the pipe is bent between the floor and the wall, the minimum bending radius is 6 cm.

The pipe must be sealed at the end to prevent concrete from entering.

Should the cable become damaged while being laid out or later during the building process, it is a great advantage in the fault finding process to know the exact positioning of the connection box between the heating cable and the cold cable as well the end of the cable end, as the cable layout. It is therefore important to make a sketch showing the positioning of these things in the room.

The heating cable and the connection muff between the heating cable and the cold cable must both be cast in concrete. If the cable is pushed down into the insulation material or covered by it in any other way, the surface temperature can become too high, which might result in cable defects at worst.

It is not recommended to lay cables at temperatures below -5 °C.
At low temperatures (below 5 °C) the cable can become difficult to handle due to the plastic sheath. This problem can be overcome by connecting the cables to power supply for a short period of time.
For this purpose THE CABLE MUST BE ROLLED OUT! When the cable has become flexible again, the electrical flow should be disconnected.

Heating must not be turned on before the concrete has fully set. It takes approximately 30 days for concrete.
It is important to carefully followed to the manufacturer's recommendations and instructions carefully.

The resistance and insulation values of the heating cables should always be measured before and after the concrete, etc. is applied.

7. Case story

Danfoss has been chosen to protect the biggest cold store built on the Middle East.

The biggest Middle Eastern cold store belonging to a supermarket in the popular Arabian chain "Panda", located in Jeddah, Saudi Arabia, will be equipped with Danfoss. The construction has been finished by the end of Q3, 2015.

Danfoss electrical heating solutions is used for the protection of thresholds and floor of the biggest Middle Eastern cold store. The total size of the project is 8000 m^2 and total installed power is approximately 160 kW.

"The constant temperature in average cold room is even up to -30 °C, which may impact a building construction and surroundings, even though the floor is well insulated. – Serhan Ozten Ismail from Danfoss Dubai said. – Without an additional protection such cold can cause serious damages due to frost erosion. The best solution to avoid them is installation of electrical heating cables during a cold room construction. We are glad that Danfoss, as the reliable partner, was chosen for the biggest Middle Eastern cold sore. It has been the biggest cold store project for us so far, but we strongly believe that Danfoss meets all expectations and demands required by such huge constructions."

The project was completed by YMCO at the end of September 2015 and, to meet all needs of such huge cold store construction, following products were chosen:

ECbasic 192 m – 14 pcs;
ECbasic 229 m – 73 pcs;
ECsnow 63 m – 13 pcs ;
ECsnow 140 m – 18 pcs ;
ECfast – 982 pcs;
EFET 330 (-10...+10 °C) – 30 pcs.

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