ENGINEERING
TOMORROW

Application manual | Roof application. Frost protection

# Roof application. Frost protection

## 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.

## The value of experience

We have installed literally thousands of systems across the globe, in every conceivable setting. This experience means that we can offer you practical advice about precisely which components you need to get the best results at the lowest cost.

## Roof application. Frost protection

This design guide presents Danfoss's recommendations for design and installation of ice and snow melting systems for roofs application.
It provides guidance for heating cable positioning, 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**

# Index

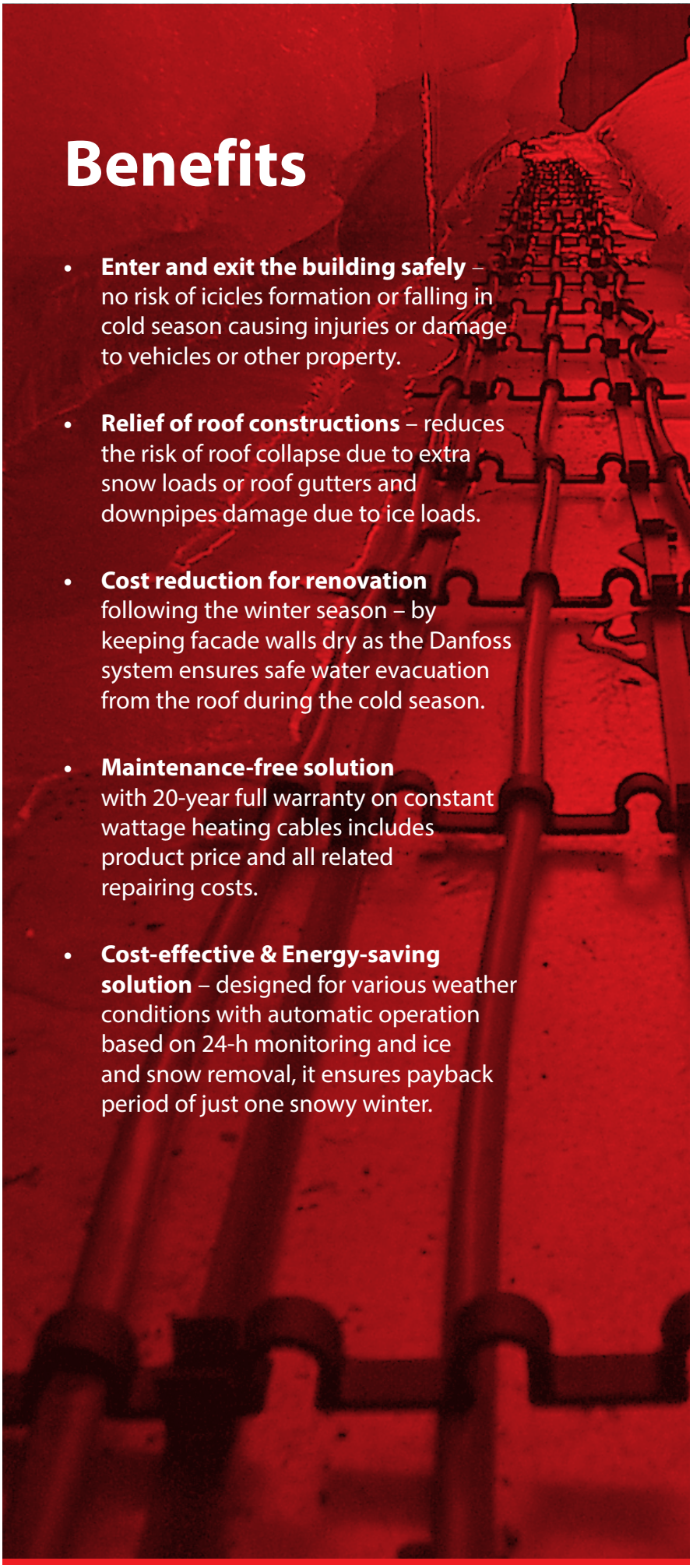
# 1. General information

Danfoss's ice and snow melting system for roofs and roof gutters can be applied for virtually any type of roof constructions to prevent meltwater accumulation in roof gutters and to reduce damage to constructions like frozen facades and roofs.

The ice and snow melting system should be installed along the roof edge or where there is a risk of ice and snow formation. Damage prevention in roof gutters and downpipes is achieved by efficient and free meltwater draining, which typically proves satisfactory operation of the system.

Electronic ECtemp thermostats ensure that optimal results are achieved with the least possible energy consumption. These results are ensured by highly precise readings of weather sensors and thermostats providing automatic on/off heating control at the right time.

The typical applications are roof constructions, roof gutters, downpipes, flat roofs and valley gutters.



## Benefits

- **Enter and exit the building safely** – no risk of icicles formation or falling in cold season causing injuries or damage to vehicles or other property.
- **Relief of roof constructions** – reduces the risk of roof collapse due to extra snow loads or roof gutters and downpipes damage due to ice loads.
- **Cost reduction for renovation** following the winter season – by keeping facade walls dry as the Danfoss system ensures safe water evacuation from the roof during the cold season.
- **Maintenance-free solution** with 20-year full warranty on constant wattage heating cables includes product price and all related repairing costs.
- **Cost-effective & Energy-saving solution** – designed for various weather conditions with automatic operation based on 24-h monitoring and ice and snow removal, it ensures payback period of just one snowy winter.

# 2. System Description

When winter sun melts snow and ice, it starts forming icicles on cold roof edges and gutters which over time can cause serious damage to the building and constitute a danger for vehicles and passerby.

First of all, in order to avoid all above and manual ice removal heating cables should be installed in all drains such as gutter valleys, gutters and downpipes.

Frost protection of the roof itself is required where such problems can exist, e.g:

- on south-faced eaves
- under skylights/roof windows
- 1-1,5 m lower the roof for older houses, e.g. with heated attics and
- on roofs where snow loads typically exceed the capacity of the existing roof construction.

In harsh water or water and sludge environment ECsnow cables provide constant wattage when appropriate, whereas ECiceguard self-limiting cables represent flexible small scale installation.

**Opportunities**

- No winter damage costs
- Discreet UV resistant cables
- Automatic control
- Priority zones with limited power supply

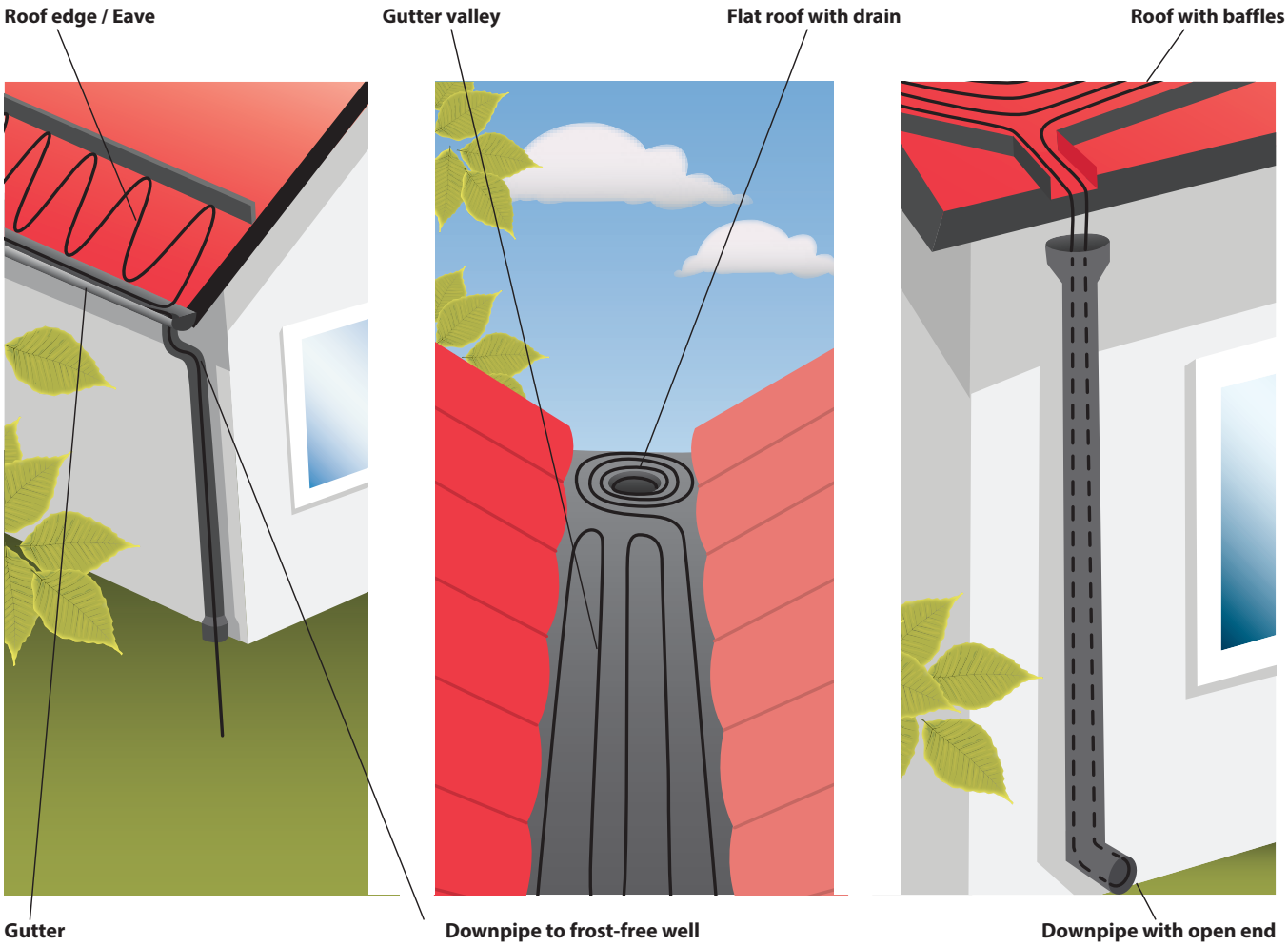
**Installation**

ECsnow 20,
ECsnow 30,
ECiceguard 18,
ECfast fitting band.

**Performance**

Save 50-80% with control by smart ECtemp 850.

Thermostat improves ECiceguard performance with regard to energy consumption.



# 3. Product Selection

## 3.1 Heating elements

**Heating cables ECsafe 20T and ECsnow 30T:**

Heating cable ECsafe 20T/ ECsnow 30T – a twin conductor resistive heating cable complies with IEC 60800:2009 and provides high UV resistance. Ready-made set with a connection box and 2,5 m cold lead. Cable design provides for 230 V and 400 V power supply and ensures installation in a safe, efficient and cost-saving manner.

ECsafe 20T/ECsnow 30T

**Heating cable ECiceguard 18:**

Heating cable ECiceguard 18 is a self-limiting heating cable (SLC) with high UV resistance. The cable can be cut to the required length from drum or ready made (RM) version.

The self-limiting capability of the cable ensures that the output of the cable increase or decrease according to the ambient temperature.

The heating cable is flexible and easy to install as it can be cut to length on site and can be installed directly on the roof or in the gutter system.

**Important:** Always install thermostat over 3 m far from the self-limiting cables, this will help to prolong cable lifetime and minimize energy consumption in a standby mode.

ECiceguard 18

## 3.2. Control

Frost protection systems are different and require different thermostat types.

ECtemp thermostats are fitted with a complete set of control functions for heating systems for ice and snow melting of any type and allow attaching external measuring sensors for air or ground temperature measuring as well as control of moisture conditions.

Electronic thermostats feature high-speed operation and good repeatability. Correctness of thermostat selection and control accuracy impact significantly on reliability and power consumption of the heating system.

ECtemp 850

The thermostat product range is designed for external systems including the following: ECtemp 316, ECtemp 330, ECtemp 610 and ECtemp 850.

**ECtemp 850 electronic controller**

Two-zone controller is recommended for the installation protection against frost.

It has external 24 V DC power supply. Four integrated roof moisture and temperature sensors can be connected to the controller providing optimal control of the heating system. Comparing to installations with typical temperature measuring this thermostat allows reducing energy consumption costs of up to 75% (see 3.2.1).

**Moisture and temperature roof sensor**

Moisture and temperature measuring sensor with a built-in heating element for snow melting. All measured values are highly accurate, which is provided by an integrated processor of the sensor as well as digital, not analogous, measurment and set-point calculation. The sensor is equipped with a 15 m cable for connection to the controller.

Moisture roof sensor

ECtemp 316, ECtemp 610

### 3.2.1 ECtemp 850 detailed description

ECtemp 850 microprocessor controller is fully automatic, digital electronic device. Its operation is based on complex digital measurements provided by temperature and humidity measuring sensors. Simultaneous moisture and temperature measuring allows controller to save up to 75% energy comparing with systems that provide temperature measurements only.

Digital sensors provide much higher accuracy than analog ones. As a result frost protection system operated by ECtemp 850 provides higher level of functionality and lower operating costs. Therefore we recommend using this type of thermostat for installations with output capacity exceeding 5 kW or for any smaller installations where optimum power use is a preference.

### Configuration options

ECtemp 850 can control two independent installations with maximum 4 sensors connected in various configurations, i.e. two independent systems or two zones in one system with separate outputs.

In addition, priority setting for both zones is possible. You can set one zone for the higher priority and another for the lower priority.

The zone with lower priority will be activated following switching off the zone with higher priority. In this way you can reduce demand of the available power for the frost protection system.

Intuitive menu of the thermostat allows simple settings. For detailed instructions and data specifications please refer to the safety data catalog and installation manuals for corresponding sensors and controllers.

**Note:** When connecting more than two sensors additional power supply is required.

### Energy consumption

Control of several parameters has an effect on energy consumption.
**No energy is consumed in cold dry weather** – usage of moisture sensors is important and enables switching the system off in cold dry days, so no excessive energy is consumed.

**Less energy consumption in case of system splitting into zones with different weather impact** – splitting area into 2 zones, e.g. North and South, allows saving energy when the southern side is free of ice and snow melting runs faster by the sun heat.

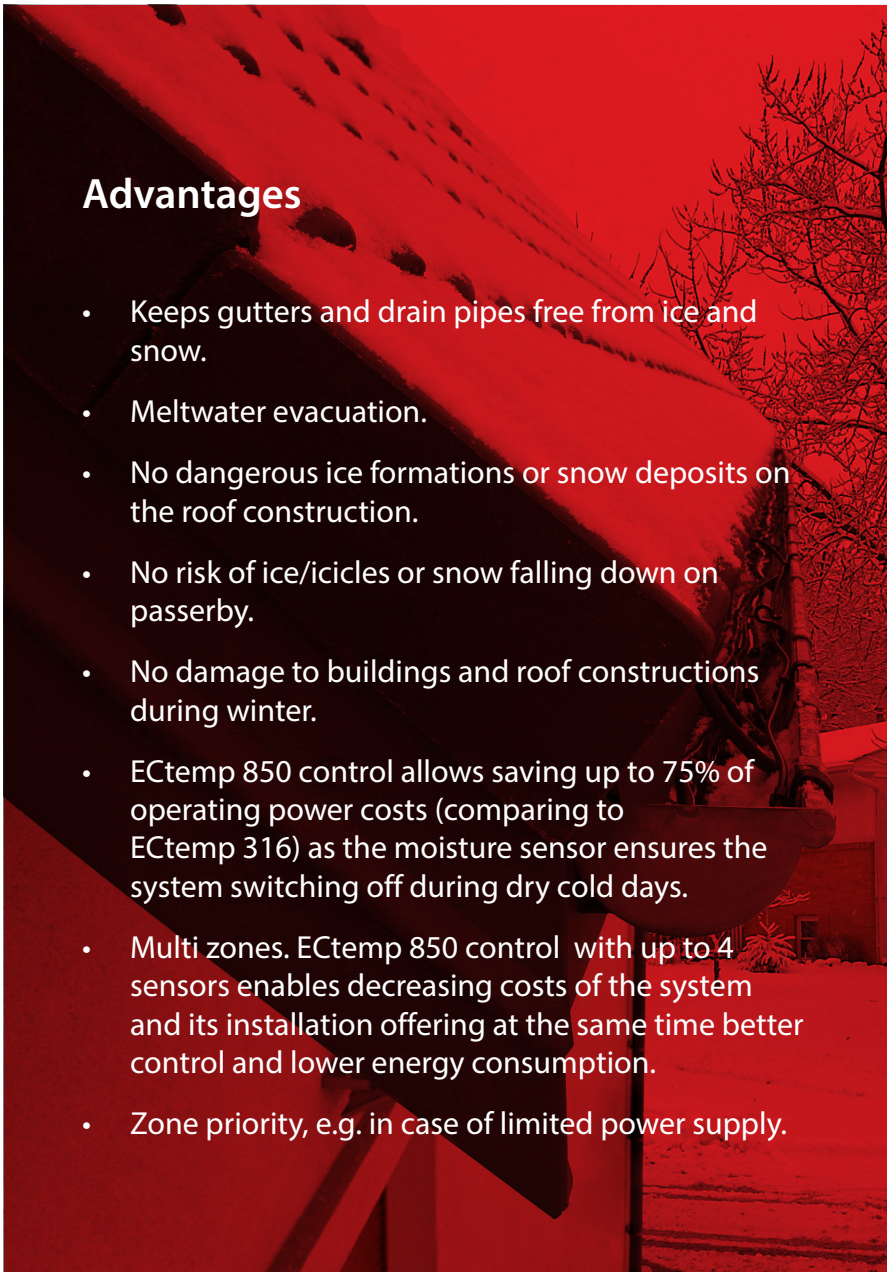
**Running hours for different control systems - Example from Salzburg, Austria, winter 2005/2006.**

| Controller | Sensor parameters | Origin of data | Hours | Index |
|---|---|---|---|---|
| ECtemp 850 | Air temperature below +3 °C and moisture | Meter reading | 535 | 1 |
| ECtemp 316 | Air temperature between +3 °C and -7 °C | Weather data | 2309 | 4 |
| ECtemp 330 | Air temperature below +3 °C | Weather data | 2737 | 5 |
| None | Constant from November to March | | 3624 | 7 |

* ECtemp 850 is a highly efficient multizone thermostat which is equipped with a multilingual menu enabling both temperature and humidity measuring as well as zone prioritization in case of limited power.

## 3.3 Product selection general overview table

| Product | Options | Description |
|---|---|---|
| ECsnow<br>Constant wattage | ECsnow 20T,<br>ECsnow 30T<br>230 & 400 V program | Twin conductor cable, 100% screen, UV stabilized, black, DIN IEC 60800: 2009 M2 |
| ECsafe<br>Constant wattage | ECsafe 20T<br>230 & 400 V program | Twin conductor cable, 100% screen, UV stabilized, black, DIN IEC 60800: 2009 M2 |
| ECiceguard<br>Self-limiting cable | ECiceguard 18T<br>Drum program | Twin conductor cable, wire screen, UV stabilized black<br>DIN VDE 0254 |
| Thermostats | ECtemp 850 with air & moisture sensor<br>ECtemp 316 with min/max temp. setting<br>ECtemp 330, max. temp. setting<br>ECtemp 610, max. temp. setting | 2x15 A, 24 V PSU, DIN rail<br>-10...50 °C, 16 A, DIN rail<br>-10...10 °C, 16 A, DIN rail<br>-10...50 °C, 10 A, wall installation |
| Sensor | Roof sensor for ECtemp 850 | IP67 with 15 m sensor cable |
| Accessories | ECfast Metal | C-C steps 2,5 cm |
| For self-limiting cables | Connection box<br>Connection box kit<br>Cold tail connection kit<br>End termination<br>Connectors | |



## Advantages

- Keeps gutters and drain pipes free from ice and snow.
- Meltwater evacuation.
- No dangerous ice formations or snow deposits on the roof construction.
- No risk of ice/icicles or snow falling down on passerby.
- No damage to buildings and roof constructions during winter.
- ECtemp 850 control allows saving up to 75% of operating power costs (comparing to ECtemp 316) as the moisture sensor ensures the system switching off during dry cold days.
- Multi zones. ECtemp 850 control with up to 4 sensors enables decreasing costs of the system and its installation offering at the same time better control and lower energy consumption.
- Zone priority, e.g. in case of limited power supply.

# 4. System Design

**Required output**

To determine the required output ($W/m^2$) of the roof ice and snow melting system it is important to take into account the type of roof construction and local weather conditions.

Generally all roofs can be divided into two categories:

1. **Cold roofs.** These are well-insulated roofs with low upward heat losses. Typically they are subject to ice formations during periods of snow melting under the sunlight on the roof surface.

2. **Hot roofs.** These are not properly insulated roofs and/or buildings with habitable attics. Hot roofs provide snow melting to a certain extent followed by meltwater moving to the roof edge where it freezes up.

The rated output in gutters should therefore be higher for hot roofs than for cold ones. This will ensure proper efficiency even at low temperatures.

## 4.1. Roof and down pipe

For roof applications should be used cables of 20-30 W/m output. In case of cable installation on the roof top by means of meltable materials (like bitumen) the heating cable rating must not exceed 20 W/m.

All heating cables with PVC other sheath (ECsafe, ECsnow) should not be in direct contact with bitumen roofs. PE-foil can be used as an intermediate layer between bitumen and heating cables.

Gutters running along the cold roof edge generally require 30-40 W/m. As a reference the required rating for the hot roof is 40-50 W/m. In this case in order to provide adequate output per meter, 2 or 3 ECsnow cables are required and in some cases even more.

For further information, please refer to the table below:

| Area | Cold roof | Hot roof | Max. rating | Cable rating |
|---|---|---|---|---|
| Valley gutter, roof surface | 200-300 $W/m^2$ | 250-350 $W/m^2$ | 400 $W/m^2$ | 20-30 W/m |
| Downpipes, plastic roof gutters | 30-60 W/m | 40-60 W/m | 60 W/m* | 20-30 W/m |
| Downpipes, metal roof gutters | 30-60 W/m | 40-60 W/m | 100 W/m* | 20-30 W/m |
| Downpipes, wooden roof gutters | 30-40 W/m | 40 W/m | 40 W/m | 20 W/m |

* We recommend 2 x 30 W/m cable lines or 3 x 20 W/m cable lines in downpipes with diameter of Ø120 mm and above.

The same as for frost protection when installing the system on flat roofs or in gutter valleys follow the ratings recommended for your geographic location (between 250 – 400 W/m$^2$).

## Down pipes

### Calculation

Recommended heat density for roofs and gutters depends on local climatic conditions.

Refer to the table below to select an appropriate cable output $q_{cable}$ applicable for both pipes (n) and areas (C-C).

**C-C** – Average cable distance in cm in gutter valleys and on roof areas

**n –** Number of cable lines in gutters and down pipes.

| Design temperature °C | City e.g. | Heat density (W/m$^2$) | ECiceguard SLC | | ECsnow resistive | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 18 W/m | | 20 W/m | | 30 W/m | |
| | | | n | C-C (cm) | n | C-C (cm) | n | C-C (cm) |
| 0 to -5 | London | 250-250 | 1-2 | 8 | 1 | 9 | – | – |
| -6 to -15 | Vienna, Beijing | 250-300 | 2 | 7 | 2 | 7-8 | 1 | 12 |
| -16 to -25 | Oslo, Kiev | 300-350 | 2-3 | 6 | 2 | 6 | 2* | 10 |
| -26 to -35 | Moscow | 350-400 | 3 | 5 | 3 | 5 | 2* | 8 |

* 2 lines of 30 W/m (60 W/m) require minimum Ø120 mm downpipe and a moisture sensitive controller e.g. ECtemp 850.

Ensure that the number of cable lines *n* complies with the gutter/pipe diameter from the table below.

If not applicable, you can choose cables for roofs and gutters separately.

| Gutter/pipe diameter | No. of cable lines, n |
|---|---|
| Ø75-120 mm | 1 |
| Ø120-150 mm | 2* |
| Ø150-200 mm | 3 |

| Design temperature, °C | 20 W/m, n | 30 W/m, n |
|---|---|---|
| 0 to -5 | 1 | - |
| -6 to -15 | 2 | 1 |
| -16 to -25 | 2 | 2* |
| -26 to -35 | 3 | 2* |

* 2 lines of 30 W/m (60 W/m) cable require minimum Ø120 mm downpipe and a controller with a moisture sensor, e.g. ECtemp 850.

$P_{cable} \geq P_{roof} + P_{gutter}$

$P_{roof} = q_{roof} \cdot (A_{valley} + A_{roof})$

$P_{gutter} = q_{cable} \cdot n \cdot (L_{gutter} + L_{pipe}) + 0.5 \cdot C$

$P_{cable}$ power required by cable (see Product Sheet), W;

$P_{roof}$ power required on roofs and gutter valleys, W;

$q_{roof}$ heat density on roofs and gutter valleys, W/m$^2$;

$A_{valley}$ gutter valley area to be heated, m$^2$;

$A_{roof}$ roof area to be heated, m$^2$;

$P_{gutter}$ power required in gutters and downpipes, W;

$q_{cable}$ cable output = 18, 20 or 30 W/m, W/m;

n number of lines in gutters and downpipes;

$L_{gutter}$ length of gutters to be heated, m;

$L_{pipe}$ length of down pipes to be heated + 1 m, m;

C number of Self Limiting Cable connections (0,5 m cable each).

Observe max length for ECiceguard 18 (see Data Sheet or Product Catalogue)

### 4.1.1 Example

**Example from Oslo (design temperature -21°C)**

3,5 m$^2$ roof tiles, 5 m gutter and 3 m Ø120 mm downpipe to frost-free depth (+1 m) needs frost protection.

Since roofing is tiled, all cable types can be used. ECsnow 30T is preferred.

According to the calculation table above, the roof heat loss is:

$q_{roof}$ = 300 W/m$^2$ which means that 2 cable lines should be used in the gutter and downpipe.

The power required is now found by:

$P_{roof}$ = 300 · 3,5 = 1050 W.

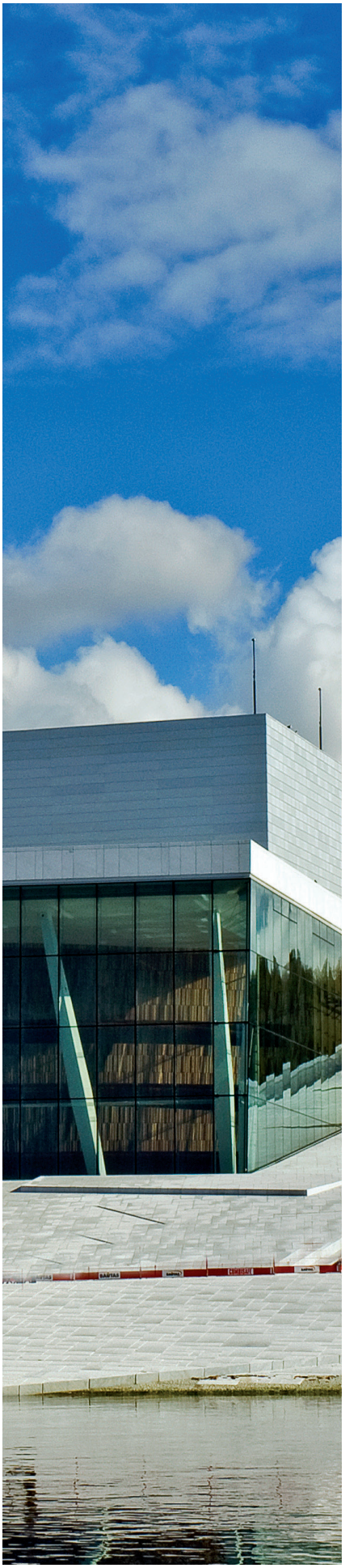
$P_{gutter}$ = 2 · (5+3+1) · 30 = 540 W,

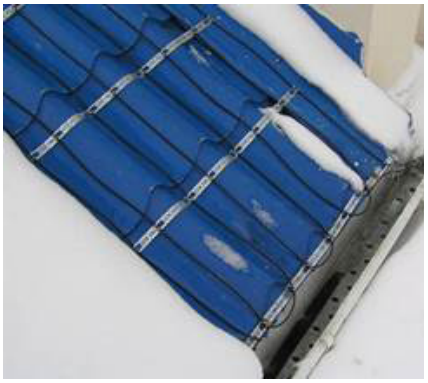
$P_{roof} + P_{gutter}$ = 1050 + 540 = 1590 W.

From the ECsnow 30T product sheet 1700 W, 55 m cable is chosen.

C-C on roof = 9,5 cm.
Optionally a C-C distance of 10 cm is chosen, and the 2 m cable left is fixed to an unheated area.

As a controller the moisture sensitive ECtemp 850 is chosen, since it is required with 2 lines of ECsnow 30T in a Ø120 mm downpipe.





# 5. Installation

For the roof installation it is recommended to use ECsafe, ECiceguard 18 or ECsnow cables due to their increased UV resistance. The cable must be laid along the gutter in both directions to provide required thermal power.

Usually two lines of heating cable are sufficient. The exact number of cable lines (n) to ensure proper heating in gutters and downpipes depends mainly on two factors:

- design temperature,
- diameter of the gutter/downpipe.

The tables on p. 10 list the recommended amount of heating cable sections in typical gutters and downpipes, according to the above parameter.

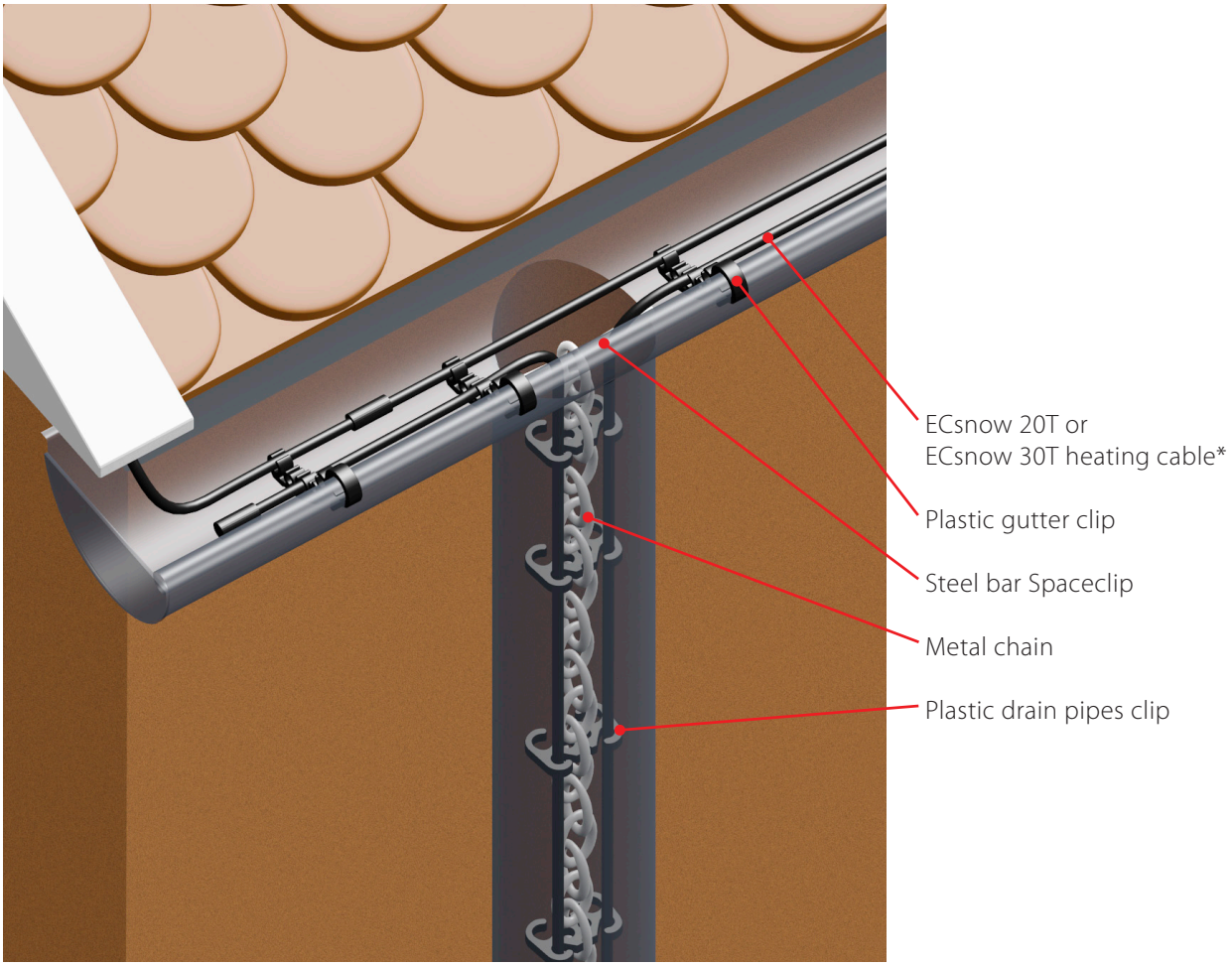
Installations in downpipes made with self-limiting heating cables ECiceguard doesn't require the use of metal chain. However the cable must be protected against cuts that can occur, e.g. on the sharp edges of the metal down pipes.
To do this, a set for mounting of self-limiting cables Spaceclip is used, to protects cables at the transition from the gutter into the drain pipe.

For controlling the roof gutter installation, it is recommended to use ECtemp 850 combined with gutter sensor (integrated temperature and moisture sensor). ECtemp 316 with air temperature measure, can also be used.

## 5.1. Safety Instructions/precautions

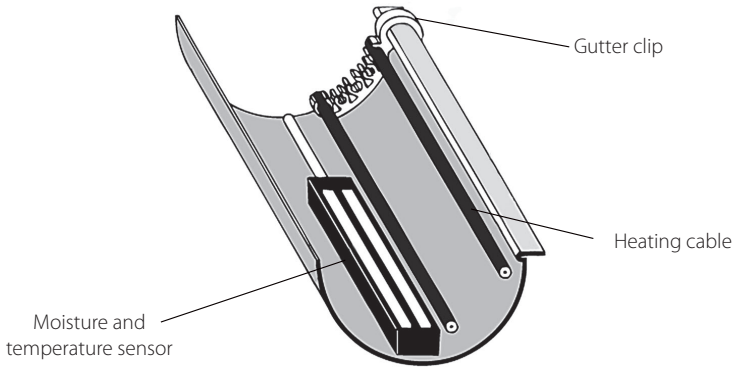
### 5.1.1. Roof gutter and down pipe

Heating cable installation in gutter and drain pipe



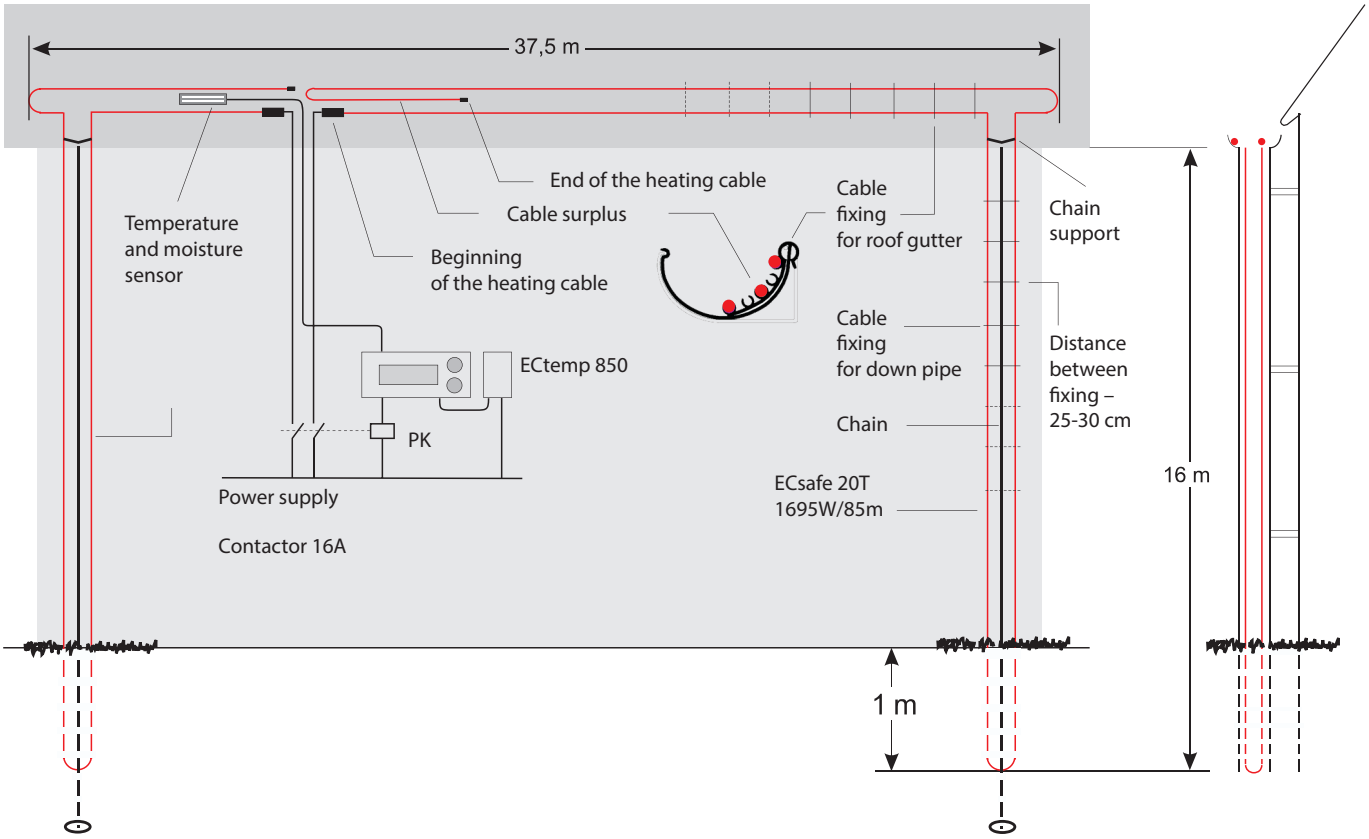

* For drain pipes with diameter 120 mm or more, two lines of 30 W/m heating cable should be placed. For diameters to 120 mm two lines of 20 W/m heating cable will be enough.

**Installation in gutter, heating cable and sensor placing**




The heating system will be placed in a standard plastic gutter length 37,5 m combined with two drainpipes, with a length of 15 m each. These pipes enter the system sewerage placed approx. 1 m beneath the ground surface.

**Example. Frost protection system in roof gutter and down pipe**




**1. Required cable length:**
2 · (37,5 m + 2 · (15 m + 1 m)) = 139 m.
In the calculation following was taken into account:
necessity to extend the heating system in downpipes, to make water frost protection in drainpipe and under ground.

**2. Choice of heating cable:**
We choose two heating cables:
ECsafe 20T with a length of 85 m and an output of 1695 W and ECsafe 20T with a length of 60 m and a output of 1200 W. (See Danfoss catalogue)

The cables will be arranged, as shown below, in the gutter and downpipe in the form of two parallel sections which will provide 40 W/m output.

Surplus cable: 85 m + 60 m =
= 145 m - 139 m = 6 m
is placed in the middle part of clip hook between the cables already installed in the gutter. In order to keep the cables in the right position, roof gutter clips should be mounted at approx. 25-30 cm intervals. The cable in the downpipe must be fixed by some extra chain.

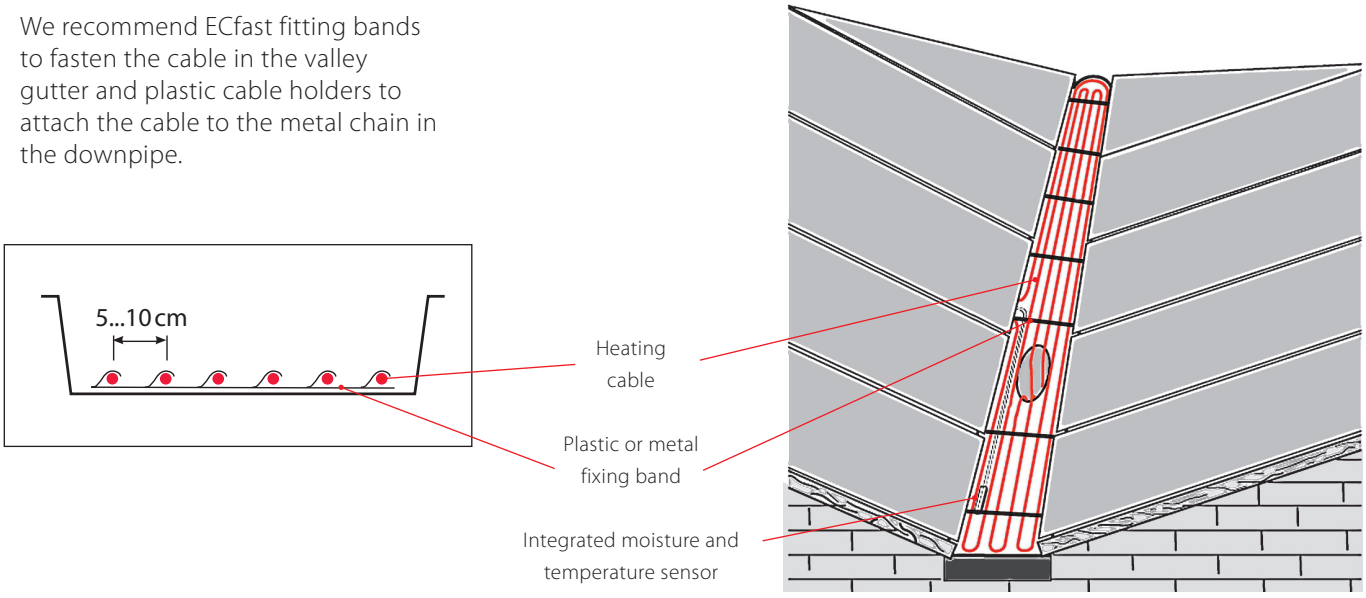
### 5.1.1 Gutter valley and drain pipe

The installation of heating cables in valley gutters typically concerns larger buildings. The heating cable is led backwards and forwards along the gutter so the correct output per $m^2$ is achieved, see table in 4.1.

We recommend ECfast fitting bands to fasten the cable in the valley gutter and plastic cable holders to attach the cable to the metal chain in the downpipe.

The ECfast is fixed by means of hotmelt, silicone, etc., but the best decision would be by screws or rivets.

Typically downpipes are connected to roof drains to ensure adequate water evacuation. Even if there is no need to protect downpipe along its full length, e.g. in case of installation in continuously heated building, arrangement of a 1 m cable loop is required. Otherwise a standard installation method by means of chain and fixing accessories should be used along the full length of the drain pipe.




Gutter valley heating cable installation

**Example**

The frost protection heating system will be placed in the gutter valley of 0,5 m x 11m connected to 4 m drain pipe.

Select ECsnow 30T cable assuming that the necessary output is 300 $W/m^2$ (C-C = 10 cm).

1. The heated area is:
   11 m · 0,5 m = 5,5 $m^2$.

2. The total installed capacity of the roof drain:
   300 $W/m^2$ · 5,5 $m^2$ = 1650 W.

   The installed output in the gutter valley of 150 mm diameter:
   2 · 4 m · 30 W/m = 240 W.

   Total installed heating power:
   1650 + 240 = 1890 W.

3. Find an appropriate position in the product list for ECsnow 30T heating cables. The item with 2060 W output and 70 m length meets our requirements.

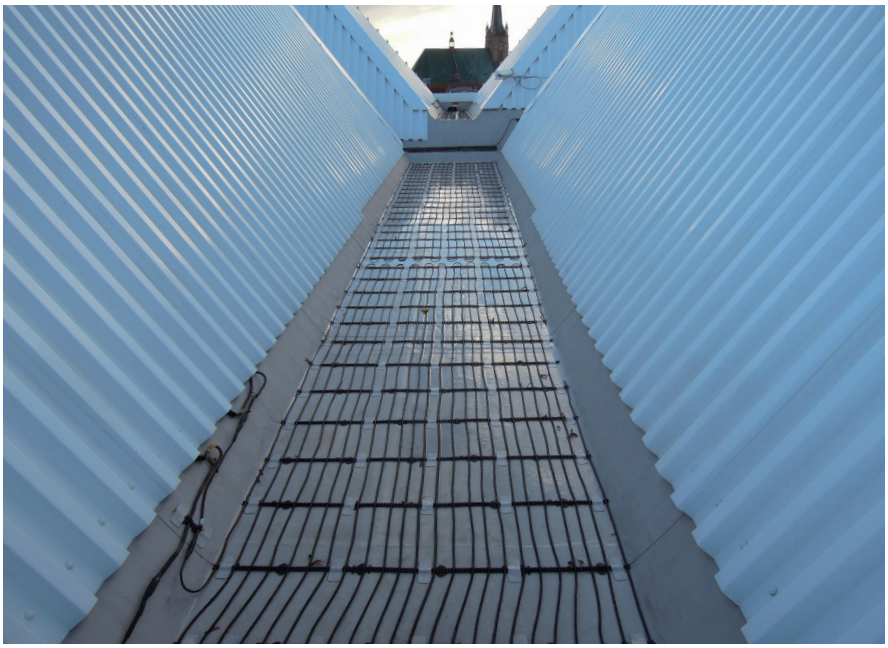
4. C-C distance:

$$C\text{-}C = \frac{5{,}5\ m^2 \cdot 100\ cm/m}{70\ m - 8\ m} = 9\ cm$$

   To fix cables in the roof drain use ECfast fitting bands (C-C = 10 cm) or plastic installation tapes, downpipe chains and appropriate fixing clips.

5. To control the installation select ECtemp 850 controller with integrated moistrue and temperature sensor.

**Note.** Two lines of ECsnow 30T (30 W/m) can be used in drain pipes with diameter of 120 mm or more.



### 5.1.2 Roof edges

Often lower unheated parts of roofs (especially hot roofs) are subject to accumulation of large amount of snow and ice. This will slowly transform into large and heavy overhang.

During thaw periods it may break down leading nearly always to gutter destruction and contributing serious danger for passerby.

To prevent overhang formation lower parts of the roof should be equipped with a heating system. Usually the roof heating system uses special fencing (as shown in the picture) to avoid snow slides.

This snow fence is typically installed at a distance of 50 cm from the roof edge at the same level with upper ends of the heating cables.

The cable must be arranged in a loop running up and down and covering area of about 50 cm in direction from the roof edge (refer to the picture below).

**Example**

The installation will be laid on the "cold" (well insulated) roof of 8 m length. The installed output of the roof surface is 300 W/m² according to weather conditions.

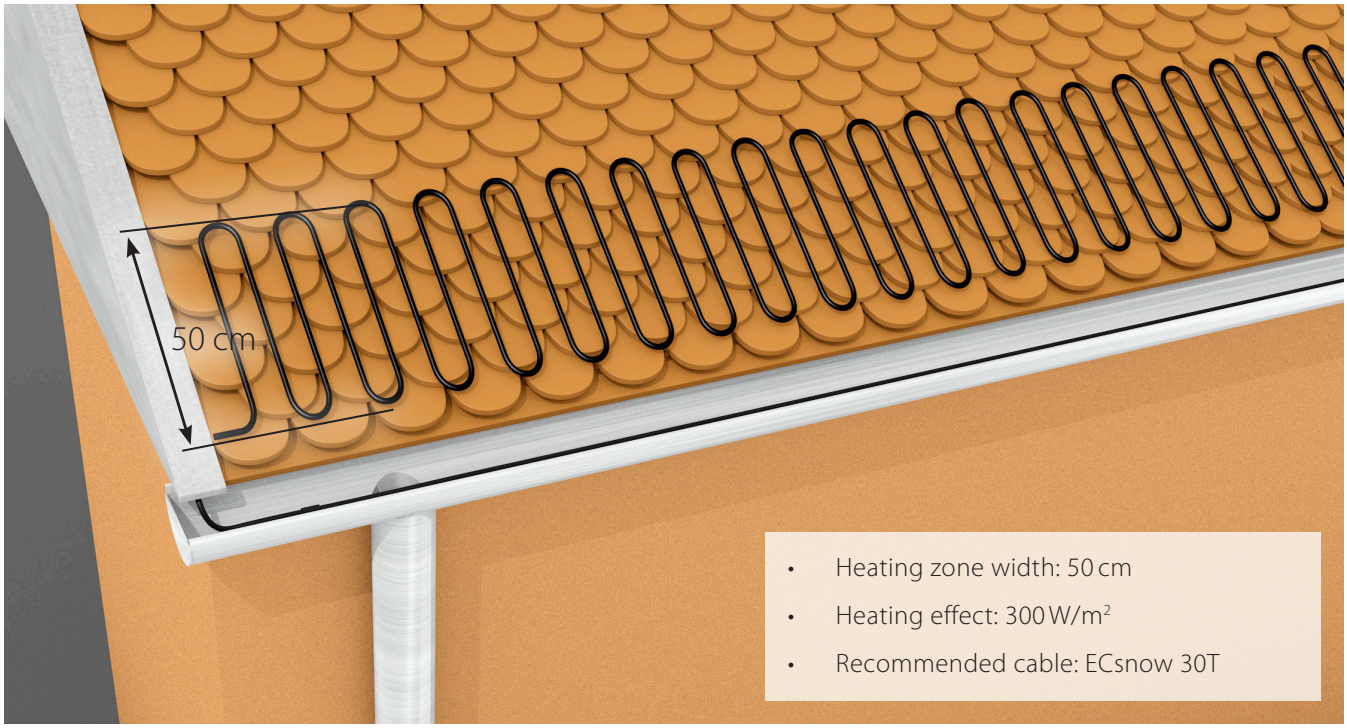
The cable will be laid in loops covering area of 50 cm in direction from the roof edge.

1. Heated area:
   8 m · 0,5 m = 4 m².
2. Installation total power:

   4 m² x 300 W/m² = 1200 W.
3. Select ECsnow 30T cable with 40 m length and1250 W output (see Danfoss Catalogue or Data sheet).
4. C-C distance between lines of the cable is calculated with help of:

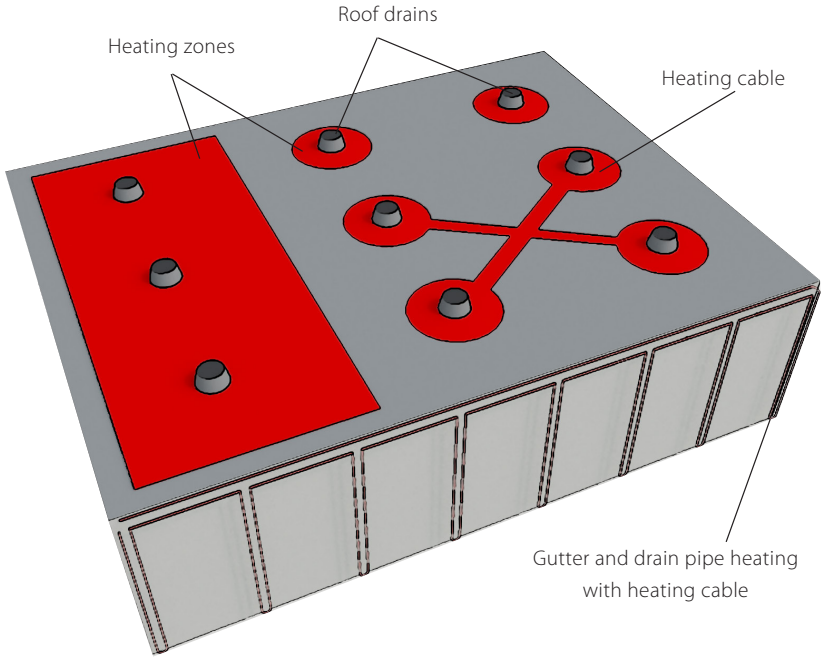
$$\text{C-C} = \frac{4\ \text{m}^2 \cdot 100\ \text{cm/m}}{40\ \text{m}} = 10\ \text{cm}.$$

5. The selected cable should work as integrated part of an installation in the gutter and drain pipe, so connect it to the same control, e.g. ECtemp 850.




Roof edges and gutter with heating installation.

### 5.1.3 Flat roofs & internal roof drains




When planning frost protection on flat roofs, protection of the following building elements should be taken into account:

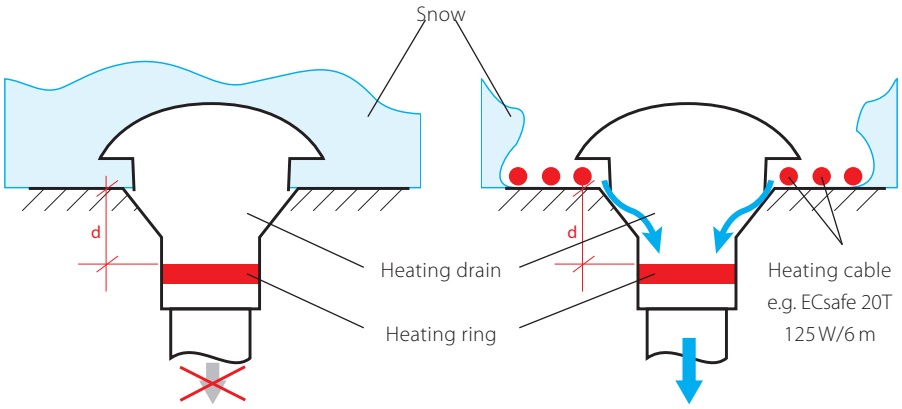
- gutters and downspouts (downpipes) located along the roof edge (1). These elements are protected according to principles described in section of this Application manual about Gutters and downpipes heating;
- internal roof drains (2) which can be protected by short pieces of heating cables laid spirally around the inlet (see picture below);
- roof cavity and grooves between internal roof drains (3). Use a separate set of heating cables for each groove or a set of heating cables for connection of several grooves or inlets at once. To provide route between grooves use min. 2-3 length of ECsafe 20T, ECsnow 30T, or ECiceguard 18 self-limiting heating cable;
- protection of flat roof areas (4). This is the most effective way to protect the roof against snow, however it requires larger installation in terms of of heating output than any described above.

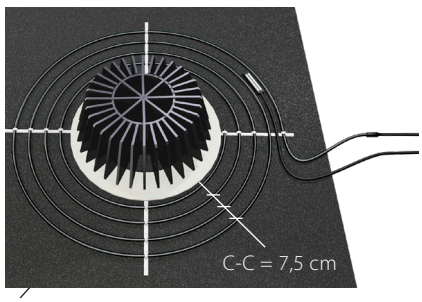
**Internal roof drains.**
Implementation of the heating cable helps to avoid snow or ice formation around the drain and ensure free water evacuation.

Recommended heating power: 250-300 W/m$^2$ output density per 1 m$^2$ for each drain.
E.g. ECsafe 20T, ECsnow 30T heating cable or ECiceguard 18 self-limiting heating cable.

Recommended surface efficiency for this type of installation is 350-400 W/m$^2$ for roofs covered with sheet metal and 250-300 W/m$^2$ for roofs covered with bitumen sheet or similar materials.

**Note:** If you use ECsnow 30T cable on the roofs covered with bitumen sheet or similar materials, please consult Danfoss's technical service.




ECsafe 20T/30T heating cable
or ECiceguard 18 with same length

During heavy snowfalls heating ring which is used in the heated roof drains will not fulfill its function due to overlong distance from the roof plane.

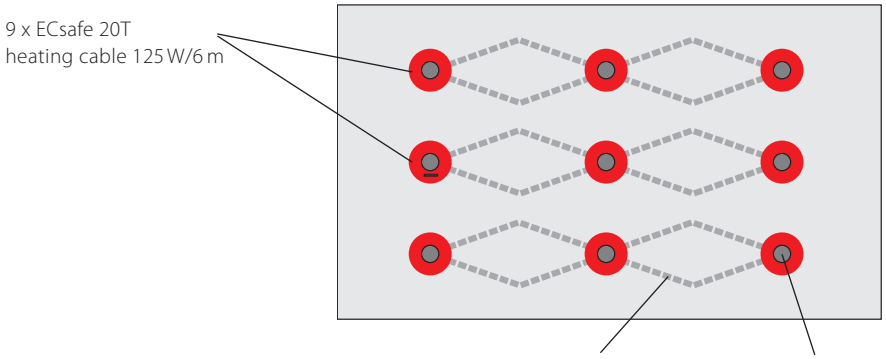
**Frost protection system for flat roofs calculations examples**

**Assumptions:**
- Roof dimension: 40 m x 20 m
- 9 roof drains
- No roof gutters and downpipes

**Example 1**

Heating of only drain inlets.

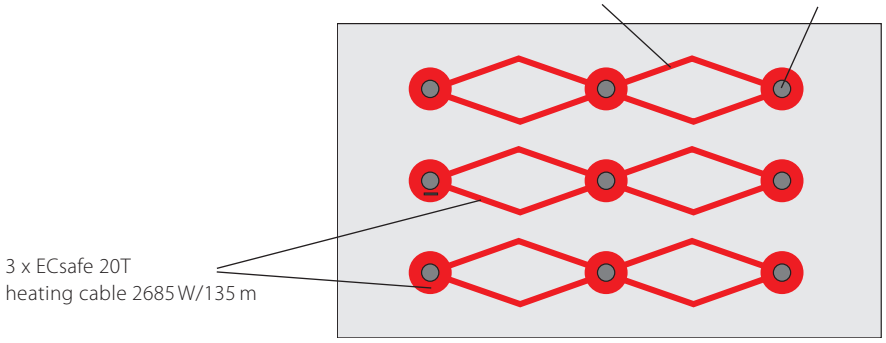
Installed power: 9 x 125 W = 1125 W




**Example 2**

Heating drains and roof drainage (depressions).

Installed power:
3 x 2685 W = 8055 kW

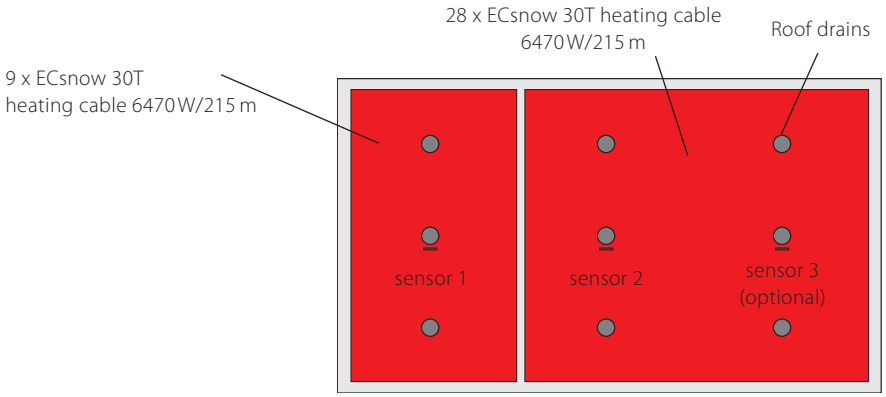


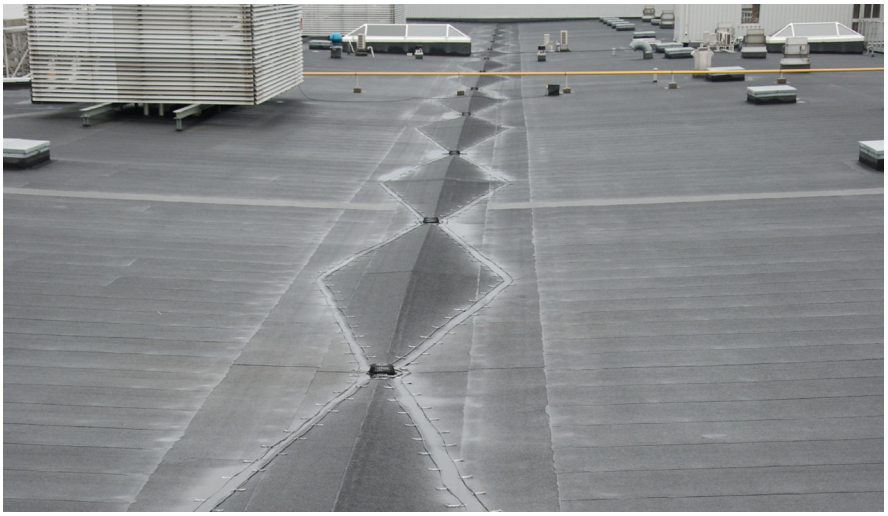

**Example 3**

Heating the entire roof surface.

Heated area: 20 m x 40 m = 800 $m^2$.

Installed power:
800 $m^2$ · 300 W/$m^2$ = 240 kW.



### 5.1.4 Self-limiting cables installation

These cables are suitable for systems with a large number of short cables located in different parts of the protected roof, e.g. single-family house with multi-surface roof including a large number of dormers and balconies.

In such cases, it is advisable to use ECiceguard™ 18 self-limiting cable of increased UV resistance.

Self-limiting cable can be cut to any desired length depending on the gutter or drain pipe size and assembled into the installation using a connecting set.

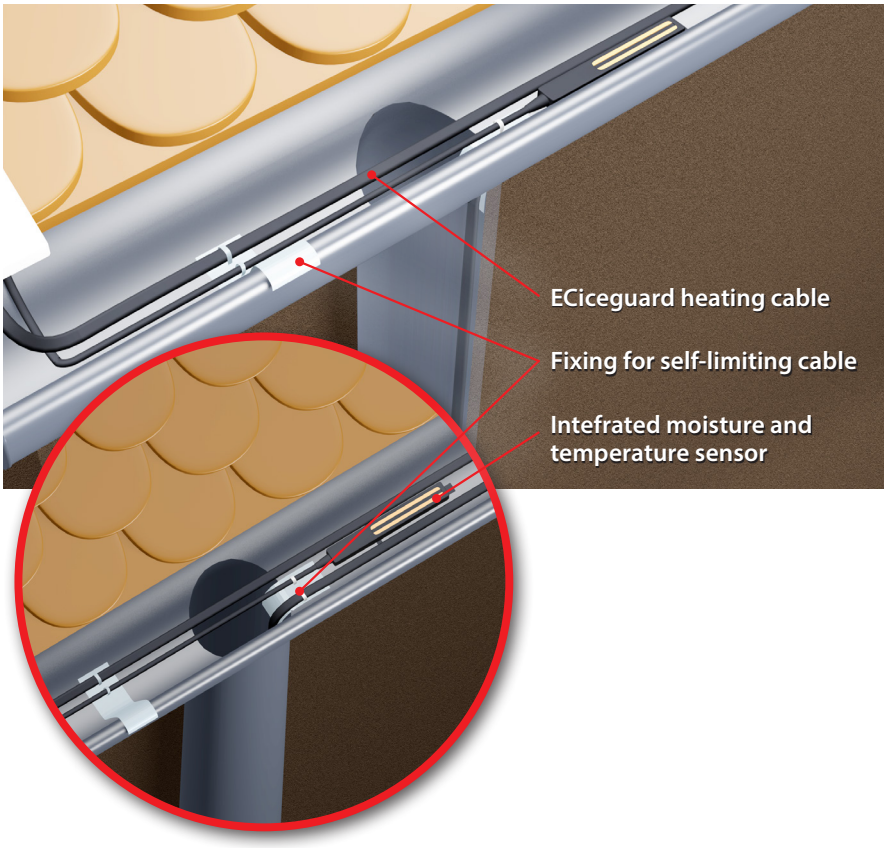
For more complex circuits (e.g. the gutter edge with several downpipes) different junction boxes can be used to connect separate sections in one circuit. For details on self-limiting heating cables refer to the Danfoss Catalogue.

The specific feature of ECiceguard 18 self-limiting heating cable is nearly twice increased heat output (from 20 W/m to 36 W/m) under the so-called intensive cooling (cable covered with wet snow or ice).

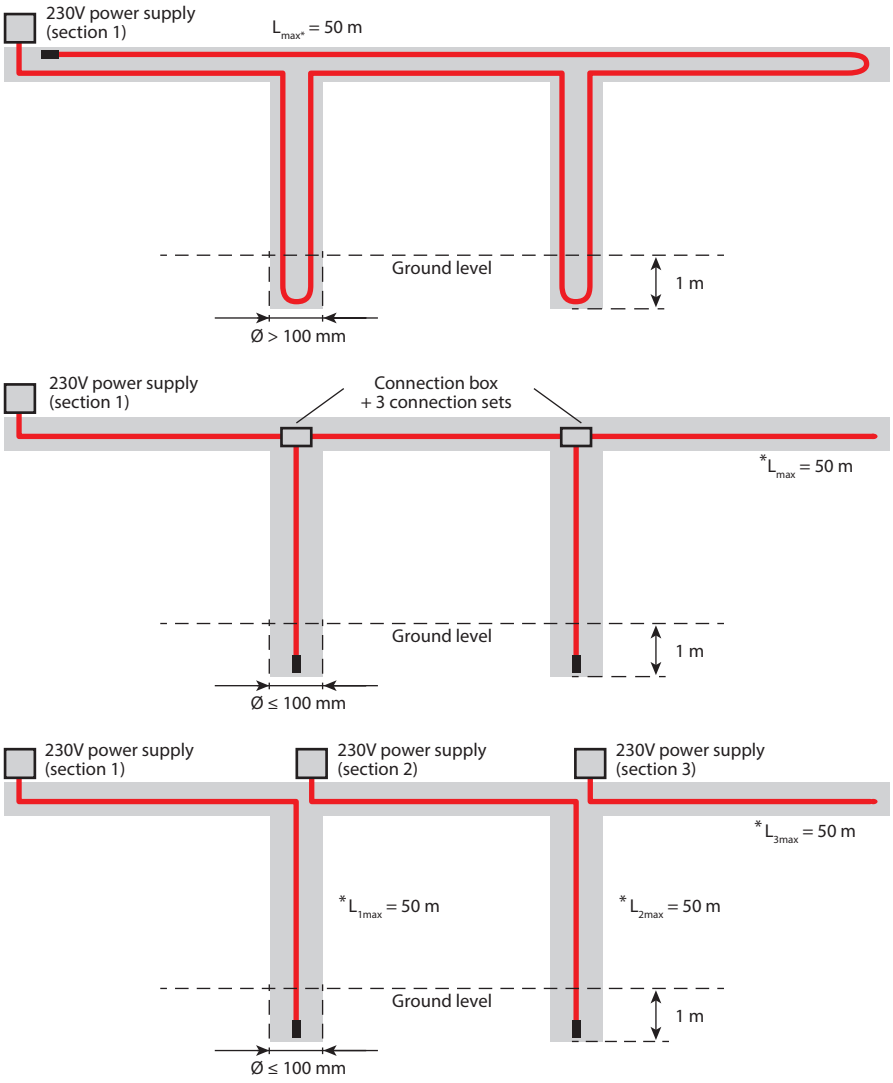
Increased output improves the system performance right after its start, especially during the initial period.

Due to greater resistance to tensile pull (especially when heated) as compared to the constant wattage heating cables, self-limiting cables avoid the need of chain implementation in downpipes up to 33 m height.

Selection rules (output per meter or area and thermostat type) are the same as described above for ECsafe 20T and ECsnow 30T constant wattage cables.




**Example. Three possible types of self-limiting cable installation**



**Note!**
For gutters and downpipes with more than 100 mm diameter we recommend using two lines of heating cables.

The maximum length of the heating circuit ($L_{max}$) for ECiceguard 18 for de-icing installations in roof gutters depends on the ambient temperature and the selected fuse type. A detailed list of max. circuit length is shown in a table.

| | Fuse (with C characteristic) | | | |
|---|---|---|---|---|
| | 16 A | 20 A | 25 A | 32 A |
| | Maximum length of ECiceguard 18 | | | |
| In gutters, downpipes, etc. | 65 | 80 | 80 | 80 |

A comprehensive range of accessories for self-limiting cables is available. Contact your local representative for details.

| Type | |
|---|---|
| Alutape<br>Tape aluminum, 38 mm x 50 m, for cables |  |
| Connecto B-A<br>Connection |  |
| Connecto B-C<br>Heating cable connection |  |
| Connecto B-E<br>End termination |  |
| Connecto B-S<br>Connection termination |  |

| Type | |
|---|---|
| Connecto B-T<br>T-Junction + End termination |  |
| Connecto B-TE2<br>Junction + 2 End termination |  |
| Connecto B-TE3<br>Junction + 3 End termination |  |
| Connecto B-X<br>X-Junction + 2 End termination |  |
| Connecto B-E<br>Bracket |  |

## 5.2 Important

Ensure training of end users on daily monitoring, operation and maintenance of the frost protection system. At the beginning of each season check and remove any sharp edges, leaves and mud from the roof and gutter systems. Also inspect switchboards, thermostats and sensors for any damage.

Sometimes self-limiting cables create a heated tunnel under the snow that results in heat blockage due to its self-limiting characteristics. This can be avoided with constant wattage cables.

2 x 30 W/m is the minimum required for downpipe ø120 mm or more and with a moisture sensitive controller, e.g. ECtemp 850.

Do not install cables in temperatures below -5° C.

Do not cut or cross ECsnow and ECsafe constant wattage cables.

Do not connect self-limiting cables with constant wattage cables in series.

Do not interconnect two conductors in a self-limiting cable.

Observe maximum length for self-limiting cables (ref. to Product Data sheet).

Self-limiting cables must be stored in a dry place after being cut to size.

Do not use PVC tape to attach self-limiting cables as it contains plasticizers which can interact with outer sheet of the self-limiting heating cable.

Check Ohm rating (ECsnow and ECsafe constant wattage only) and insulation resistance of the cable before and after installation. All electrical works should be performed by authorized personnel in compliance with applicable local regulations.

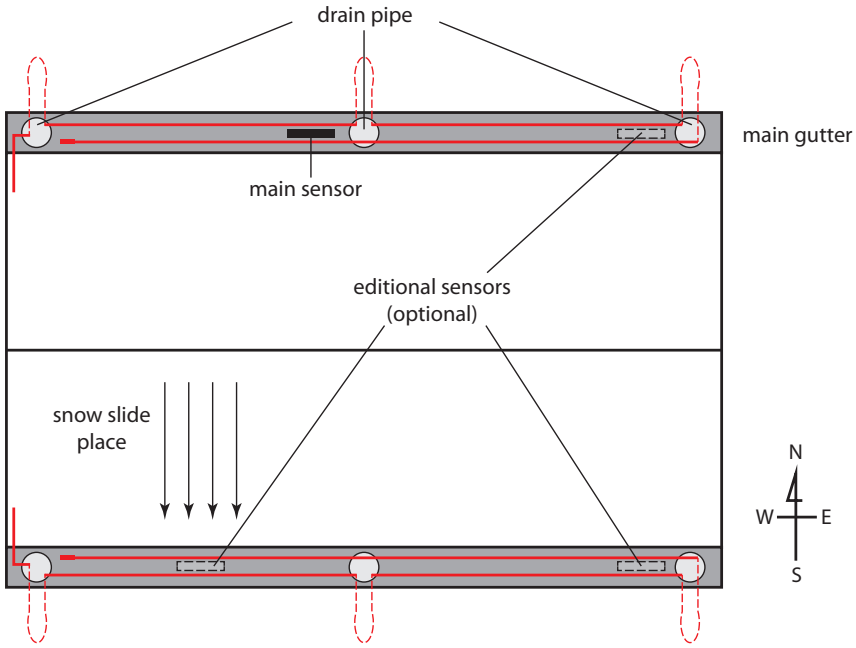
# 5.3. Commissioning of thermostats

### 5.3.1 Roof sensor location

**Location of main roof sensors**
The first ECtemp 850 roof sensor should be located where snow and ice accumulation causes the biggest problem. If such information for the building is unavailable try to obtain it from the residents. The following locations within the heated area can be used for sensor installation:

- shaded places or locations facing the north-west,
- in the main gutter close to vertical drain pipe.

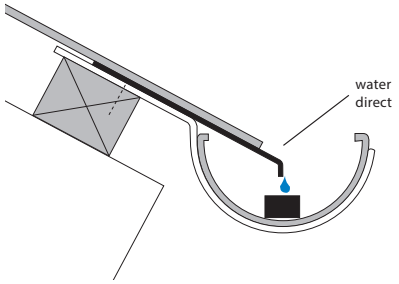
In the dual system, that comprises of two zones, criteria for the first sensor location are the same for both zones.




**Location of additional roof sensors**
Additional roof sensors should be installed in places where the roof surface dries at the latest. You can also use the following locations within the heated area:

- places where snow does not slide down into the gutter or the roof slope edge on its own,
- next to other drain pipes,
- at least 1 meter away from other sensors.

Picture shows an example of moisture sensors location on the pent roof, where gutters and drain pipes are protected by the same system/zone for the installation equipped with one sensor (main sensor). To increase the system accuracy additional sensors and cables can be installed adjacent to the roof gutters.




Steep roofs facing south may be exposed to the strong sunlight and as a result fast water dry out. In such cases it may be required to install some additional means to direct water towards a moisture detecting sensor.

To ensure optimal moisture detection it may need several attempts to direct water flow in the right direction.

In case of any doubts concerning the location of the sensor, it is recommended to consider several alternative sites for different configurations.

The sensors are equipped with 15 m connection cable. It enables the sensor connection even if the mounting location is relatively far from the thermostat. In case of longer distance the sensor cable can be extended. An extension cable must comply with the requirements listed in corresponding tables of the Installation guide.

| | 1 PSU (24 V / 24 W) | | 2 PSUs (24 V /48 W) | |
|---|---|---|---|---|
| Number of sensors | 1 | 2 | 3 | 4 |
| Connection cable dimension (mm²) | | | | |
| 1 | 400 | 100 | 130 | 75 |
| 1,5 | 600 | 150 | 200 | 110 |
| 2,5 | 1000 | 250 | 330 | 190 |
| 4 | 1600 | 400 | 525 | 300 |

### 5.3.2 ECtemp 850 control system

Find detailed information in ECtemp 850 Installation and User manuals.

### 5.3.3 ECtemp 316

To control a small frost protection system ECtemp 330 can be used. For small roof installations an advanced ECtemp 316 version can be applied. ECtemp 316 can run differential mode (described below).

Since first two thermostats operate based on temperature measurements only, it is expected higher running costs comparing with ECtemp 850.

Example of ECtemp 316 operation in differential mode: the thermostat switches ON the heating cable only if temperature is in the range from -8 °C to +2 °C.

It is assumed that it snows only when the temperature is about 0 °C and snowfalls outside this temperature range happen rearly. This is applicable for certain weather conditions only.

ECtemp 316

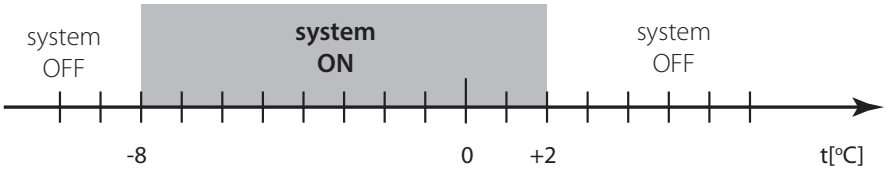



**Table 7. Recommended settings of ECtemp 316 and ECtemp 850**

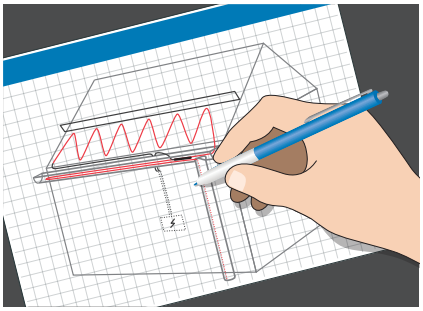
| Thermostat | Parameter | Recommended settings |
|---|---|---|
| ECtemp 316 | Low temperature | -8...-6 °C |
| | High temperature | 3...5 °C |
| ECtemp 850 | Melting temperature | 1...2 °C |
| | Post Heat | 1-3 hours |

## 5.4 Installations summary

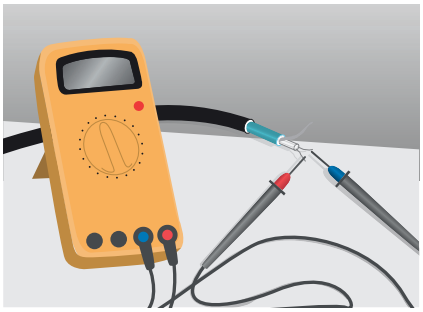
**Required tools:**

- Hammer
- Chisel
- Glue gun
- Scissor
- Installation manuals

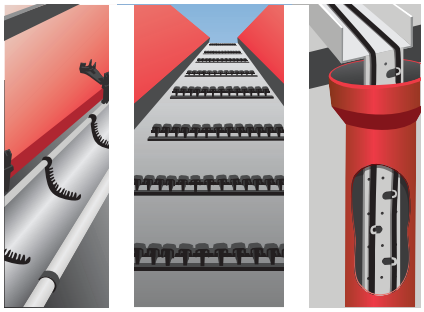
1. Ensure that the roof and the gutter system are heated and remove sharp edges, leaves and mud. Check and prepare the switchboard.



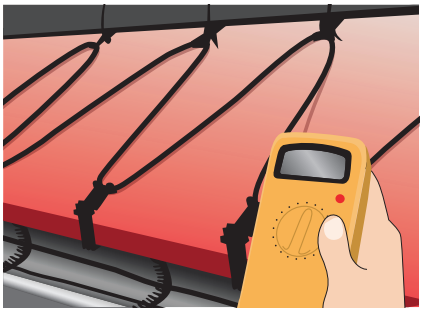
2. Develop the layout plan for cable(s), sensors and thermostats, cable connections/cold tails, connection box, cable paths and a switchboard.
Refer to ECtemp 850 manual for location.



3. Check the insulation resistance and also Ohm rating for constant wattage cables. Install the cable(s) on the roof, in gutters and downpipes.

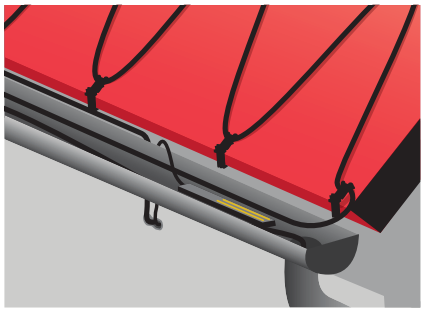


4. Install the connection box and fixing accessories in the gutters, gutter valleys, on the roof and/or the cable.

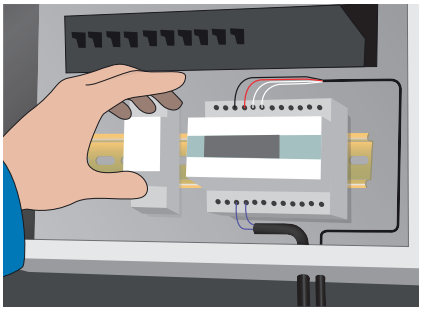


5. Install the cable(s) on the roof, in gutters and downpipes. Check once again and compare the insulation resistance and Ohm rating for constant wattage cables.

6. Install ECtemp 850 external sensor, if any, in the gutter according to the sensor manual.



7. Extend sensor cables, cold tails/terminate cables and place connections dry. Seal all penetrations, e.g. through roofs and walls.



8. Check once again and compare the insulation resistance and Ohm rating for cables.
Install ECtemp thermostat and connect cables to the connection boxes and to the switchboard.

# Notes

# 6. Cases

**THE ÖREBRO CASTLE,**
**Örebro, Sweden**

The Örebro Castle is a medieval castle fortification situated in the scenic region of Närke, in Sweden.

For the Örebro Castle renovation project the heating cable ECiceguard, Danfoss Connecto and control system ECtemp 850 with humidity and temperature sensors were chosen.

Products:
- ECiceguard 18 – 1000 m;
- Danfoss Connecto;
- ECtemp 850.

**DAHLSKE HIGH SCHOOL,**
**Grimstad, Norway**

Originally the builder planned to strengthen the old building with new pillars in order to meet the new building regulations which demand that the roof has a carrying capacity on 400 kg per $m^2$. When Dahlske High School was build the carrying capacity was only 250 kg per $m^2$.

Instead the builder was convinced that it was a much better solution to install an ice and snow melting system, and Danfoss's new twin conductor outdoor heating cable ECsnow 30T was chosen.

Project size:
- 600 $m^2$.

Products:
- ECsnow 30T.

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