2.1 General information

DEVI's ice and snow melting system consists of deviflex™ or devi-iceguard™ heating cables or devimat™ heating mats, devireg™ thermostats, and installation accessories. DEVI's ice and snow melting systems are applied for roof construcions and ground areas.

Provides safety
DEVI's ice and snow melting system is designed to provide safety for people, vehicles, and buildings safety through safe walking and driving during winter and safety in terms of less damage to buildings.

The system is flexible
DEVI's ice and snow melting system works well with most common surface covering materials such as asphalt, concrete, and tiles. Besides, it can clear ice and snow from all types of roof constructions, roof gutters, downpipes, and valley gutters.

Works automatically
DEVI's ice and snow melting system operates fully automatically. It automatically registers the need for ice and snow melting and it switches the heat on and off as required.

An economical alternative
The devireg™ thermostats with advanced moisture sensors ensure that optimal results are achieved with the least possible amount of energy. The costs of installing and running DEVI's ice and snow melting system are low when the preventive advantages of the system are taken into consideration, i.e. snow shovelling and salting becomes unnecessary. Furthermore, the repairing costs caused by ice, snow and salt are saved.

Provides comfort
With DEVI's ice and snow melting system the area is kept free from ice and snow at all times so heavy salting, snow shovelling or frost damages are avoided.

2.2 Ground applications

The most common DEVI ice and snow melting applications on ground are car parks, driveways, pavements, outdoor steps, loading platforms, and bridges.

Installed output

When the required W/m² of an ice and snow melting system is to be determined, there are several considerations to be made:

1. The place where the system it is to be installed – geographical location and specific application.
2. The requirements the system is to meet, e.g. the time of ice and snow melting.

The installed rating for Denmark is 200-250 W/m². In comparison the corresponding rating for Russia is 250-500 W/m².

In places such as bridges and loading platforms the cables are also susceptible to the influence of cold weather and wind from both above and below. In these places the output should be increased by up to 50% to compensate for the extra amount of cold. Therefore, it is advisable to use an appropriate insulation material below the cables in order to minimise the downward heat loss. Where it is not possible to insulate below the heating cables, we recommend an output of 300-500 W/m².

Typical installed ratings of various ground applications are shown in the table below.

Area	Output in Denmark	Output in Russia
Car parks	200-250 W/m²	250-300 W/m²
Driveways	200-250 W/m²	250-300 W/m²
Pavements	200-250 W/m²	250-300 W/m²
Outdoor steps, insulated	200-250 W/m²	250-300 W/m²
Loading ramps, insulated	200-250 W/m²	250-300 W/m²
Bridges, insulated	200-250 W/m²	250-300 W/m²
Outdoor steps, not insulated	300-375 W/m²	300-400 W/m²
Loading ramps, not insulated	300-375 W/m²	300-400 W/m²
Bridges, not insulated	300-375 W/m²	300-400 W/m²

The general guidelines for choosing the output for the installation are presented below.

Outdoor dimensioning temperature	Output on ground	Output on ramps, bridges (not insulated)
-10°C	200 W/m²	250 W/m²
-15°C	250 W/m²	300 W/m²
-20°C	300 W/m²	350 W/m²
-25°C	350 W/m²	400 W/m²
-30°C	400 W/m²	450 W/m²
-35°C	450 W/m²	500 W/m²
-40°C	500 W/m²	550 W/m²

The installed output should be higher if:

1. The installation is placed in an area with frequent wind during winter. A wind speed of 10 m/s results in an additional relative temperature drop of approx. 5°C. The higher the wind speed, the bigger the temperature drop.

2. The installation is placed on a high geographical location. We recommend adding 50 W/m² per every 1000 m for locations over 1000 m above sea level.

3. Significant snowfalls are observed in the area. If there is more snow than what equates to 6.3 mm of water every 6 hours, 50 W/m² should be added.

Products for ground applications
For ice and snow melting applications the deviflex™ heating cables with a minimum output of 17 W/m or devimat™ cable mats with a minimum output of 200 W/m² can be used. For applications in asphalt we recommend deviflex™/devimat™ DSVK.

To control the system the devireg™ 850, 610, 330, or 316 with a ground and/or air sensor should be used.

Installation under asphalt
There are two main installation methods for asphalt:

1. Cables are covered with sand or concrete before the asphalt is applied.
   Before the asphalt is applied, a thin layer of sand or concrete (at least 2 cm) should be used to cover the top of the cables to protect them from the heat of the asphalt. Allow the asphalt to cool to a temperature of 130°C-140°C before it is applied.

For this installation method we recommend a deviflex™ cable such as the DSIA or the DSIG.

2. Asphalt is applied directly onto the cables or mats.

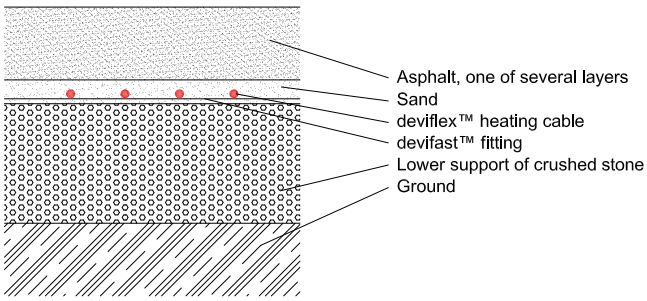
DEVI recommends the deviflex™ or devimat™ DSVK for asphalt installations as it can resist 240°C for a short time. With this type of cable it

is not necessary to cover the cable with sand. This reduces the time and installation costs. In order not to damage the cables, heavy machinery (rollers or asphalt laying machines) should not be used on the cables.

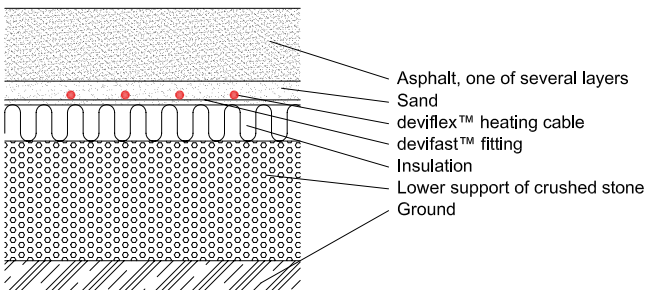
The asphalt should have a minimum thickness of 5 cm measured from the top of the deviflex™ heating cables.

An electrician should measure the cable resistance and the insulation resistance before and after the asphalt is applied.

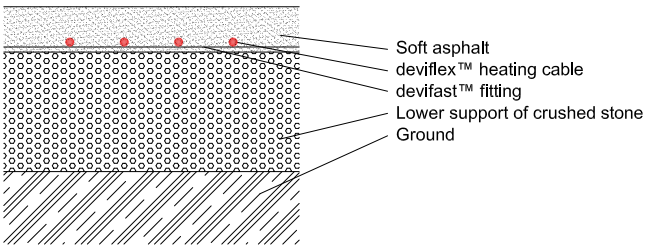
Asphalt



Asphalt (with insulation)



Soft asphalt



Installation under concrete tiles
Special care must be taken not to damage the heating cables when they are installed under tiles.

The area must be completely level, free of stones or other sharp objects and all holes should be filled.

The heating cables must be installed close to the tiles, typically in a layer of sand (2-3 cm).

Installation under concrete
Installing deviflex™ cables or devimat™ mats in concrete is similar to the procedure for tiles or asphalt.

The cables should be well secured with devifast™ fitting bands (which may be fastened to the metal armouring) so they are not dislodged when the concrete is applied. The concrete must cover the cables completely without leaving any air pockets.

The concrete mixture must not contain sharp stones as these may damage the cables.

The concrete should be allowed to set for 30 days before the heating system is turned on.

An electrician should measure the cable resistance and insulation resistance before and after the concrete is applied.

In places where the heating cables are to cross expansion joints, the cables must not be subject to mechanical strain in connection with movements in the construction.

Car parks
Normally, a car park is a large area where fast ice and snow melting is required. There are a number of advantages to be gained from installing an ice and snow melting system. It reacts quickly and efficiently against snow and appears to be an excellent preventive feature against ice. The problem of removing snow from occupied parking bays is eliminated and as an extra advantage the car park may be used to the full.

For this kind of ice and snow melting system to work efficiently it should incorporate the devireg™ 850 with star/delta function and a deviflex™ cable or a devimat™ heating mat.

Example
An ice and snow melting system has to be installed in a 150 m² car park in Denmark.

For that application we choose a deviflex™ DSIG-20 and an installed output of 250 W/m², which is sufficient for Danish climate conditions.

1) Calculation of total required output: 150 m² x 250 W/m² = 37.5 kW

2) Choice of nearest DSIG cable(s): for this purpose it will be 12 deviflex™ DSIG-20 heating cables with 3175 W, 158 m, 400 V. The total effect will be 38.1 kW.

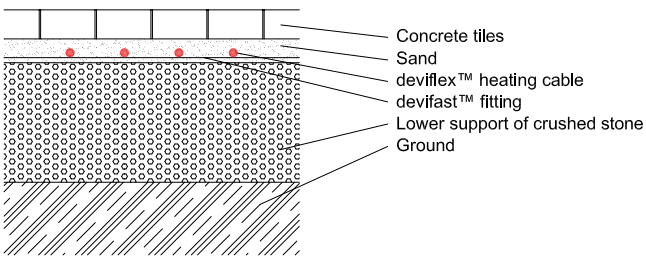
If the installation is equipped with a star/delta switch, the number of cables must be dividable by 3 or the load should be evenly distributed on 3 phases. This ensures a steady load of the phases.

3) Calculation of C-C distance:

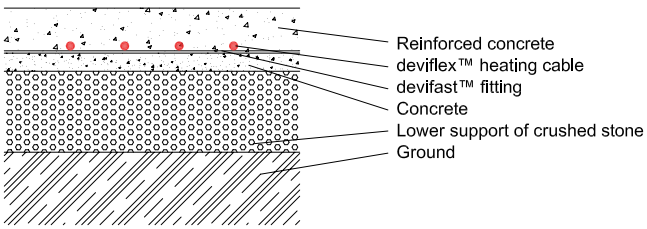
$$\text{C-C} = \frac{20\ \text{W/m} \times 100\ \text{cm/m}}{250\ \text{W/m}^2} = 8\ \text{cm}$$

4) Choice of thermostat:
We choose the devireg™ 850 because of the size of the area.

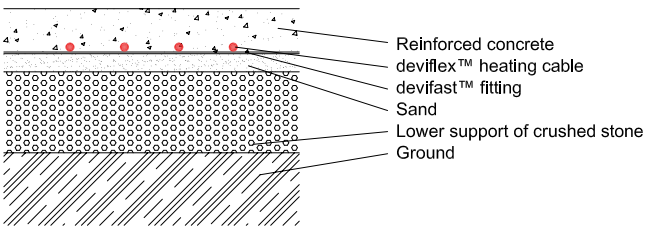
Concrete tiles



Concrete (cables on concrete)



Concrete (cables on sand)



Driveways
One of the great advantages of an ice and snow melting system is the automatic clearing of driveways keeping them passable at all times - night and day. This is especially important in specific situations where a free passage is needed for ambulances or other types of vehicles.

There are two options when an ice and snow melting system is installed in a driveway:

1. Covering the entire area with heating cables or mats.
2. Covering just the area affected by car tyres.

We recommend the first option for all major driving areas with heavy traffic. The cleaning of snow and ice formations, which can occur with the second option, will be complicated.

The second option is recommended for minor areas, like driveways to private garages. If the driving area has a slope, we recommend the entire area be covered with heating cables or mats.

When installing ice and snow melting systems on steep slopes it may be necessary to provide some form of drainage for the melted water at the bottom of the slope. The drain system should also be protected against ice formations.

Example
In this example we have chosen a medium-sized driveway with a length of 10 m and a width of 2 m. The cables are to be installed in the two tyre tracks with a width of 0.5 metre each.

For this application the installed output is 250 W/m² and the chosen cable is the deviflex™ DSIG-20.

1) Calculation of the area where the cable is to be installed:
10 m x 0.5 m x 2 = 10 m²

2) Calculation of the total output for the area: 10 m² x 250 W/m² = 2500 W.

3) Choice of cable: The deviflex™ DSIG-20, 2520 W, 126 m heating cable.

4) Calculation of C-C distance:

$$\frac{10\ m^2 \times 100\ cm/m}{126\ m} = 7.9\ cm$$

5) Choice of thermostat: Since the area is rather small, we choose the devireg™ 330 with a temperature sensor.

Pavements
An ice and snow melting system can ensure a safe walking area for pedestrians. Apart from keeping pedestrian streets free from snow the snow melting system provides clean entrances for all shops.

Outdoor steps
An ice and snow melting system may be used as an efficient preventive feature against slippery and dangerous steps.

We recommend that outdoor steps are insulated if they are open underneath and susceptible to cold. If, on the other hand, the steps are solid, they need not to be insulated.

The output/m^2 in the steps should always be higher than the output/m^2 in the area immediately before the steps. If this is not observed, accidents may occur if the area before the steps is free of ice while the steps are slippery.

When calculating the cable length for a step application, remember to take into account the extra piece of cable which is led down the front of each step.

The cables are laid backwards and forwards in evenly spaced loops along the step.

As the heating cables are not installed on the vertical part of the steps, the steps, the first cable loop should be laid as close as possible to the edge of each step (5 cm) to ensure an efficient melting of ice.

When the cables are installed all stones or sharp objects should be removed from the surface as they may damage the cables.

The cables are installed directly on the concrete and must be covered with 3-5 cm of concrete.

Example
We have an example of steps:
12 steps with a depth of 0,32 m, a height of 0,17 m and a stair width of 1,00 m.

With a DTIP - 18 heating cable and a required output of 250 W/m^2 the C-C distance will be:

$$\text{C-C} = \frac{18\text{W/m} \times 100\text{cm/m}}{250\ \text{W/m}^2} = 7.2\ \text{cm}$$

As each step is 0,32 m deep, there is room for 4 cable runs on each step amounting to 4 m of cable per step.

4 m of cable x 12 (steps) = 48 m of cable plus the cable running down the front of each step: 12 x 0.17 m = 2 m.

This gives a total of 50 m cable and therefore, a deviflex™ DTIP-18 cable, 935 W and 52 m, is appropriate.

The total area of the steps is:
12 x 1 m x 0,32 m = 3.84 m^2

And therefore, the installed rating is:
935 W/3.84 m^2 = 244 W/m^2

If there is any cable left, it should be installed in the area in front of the steps.

Loading areas
Loading areas must be safe to work on and therefore, they should be kept free of ice and snow. DEVI's ice and snow melting system reduces the risk of accidents and ensures that the work can be done at all times.

Loading ramps are generally open and consequently, they are more susceptible to the cold weather. We recommend that all loading areas and loading platforms are well insulated to avoid heat loss downwards. Where it is not possible to insulate below a loading area, the output per m^2 must be increased to 300-400 W/m^2.

Example – loading areas
DEVI's ice and snow melting system has to be installed in a 2.5 m x 15 m non-insulated loading area.

1) Choice of product and required output per m^2: the cable to be used is a deviflex™ DSIG-20 and the installed rating is 350 W/m^2.

2) Calculation of area: 2.5 m x 15 m = 37.5 m^2

3) Calculation of total required output: 37.5 m^2 x 350 W/m^2 = 13125 W.

4) Choice of cable: three deviflex™ DSIG-20 cables, 4575 W, 229 m, 400 V are chosen for this installation.

5) Calculation of the total length of the cable to be installed: 3 x 229 m = 687 m.

6) Calculation of C-C distance:

$$\text{C-C} = \frac{37.5\ m^2 \times 100\ cm/m}{687\ m} = 5.5\ cm$$

Bridges
Bridges are even more susceptible to cold weather than loading areas as they are almost always completely open. This reduces the effect of the heating cables considerably and therefore, the under side of bridges should be well insulated. Where this is not possible, the output per m^2 should be increased to 300-400 m^2.

The devireg™ 850 with star delta function and the deviflex™ 400 V heating cable will in most cases be the most appropriate ice and snow melting system for bridges.

The heating cables should never be laid across the section joining of a bridge.

2.3 Roof applications

DEVI's ice and snow melting system for roofs and roof gutters can be installed in virtually any type of roof construction where there is a need to prevent melt water deposits in roof gutters and reduce damages to constructions like frozen facades and roofs.

The ice and snow melting system should be installed along the edge of the roof or in places where there is a risk of ice and snow formations. In roof gutters and downpipes damage is prevented by an efficient and free draining of melt water, which naturally ensures that the system functions satisfactorily.

Electronic devireg™ thermostats ensure that optimal results are achieved with the least possible amount of energy. In order to achieve these results sensors and thermostats read the weather with total accuracy, automatically switching the heating on and off at exactly the right moment.

The typical areas of use are roof constructions, roof gutters, downpipes, and valley gutters.

Required output

To determine the required output (W/m^2) of an ice and snow melting system for a roof it is important to consider the type of roof construction in question and the local weather conditions.

In general, all roofs fall into two categories:

1. A cold roof. A cold roof is a well-insulated roof with a low upward heat loss. A cold roof will typically cause ice formations in those periods when the sun melts snow formations on the roof.

2. A hot roof. A hot roof is not well insulated or/and the attic is used as a living area. Hot roofs melt the snow to a certain extent and the water from the melted snow then moves downwards to the edge of the roof where it freezes.

The installed rating in gutters should therefore be higher in hot roofs than in cold roofs. This will ensure efficiency, even at low temperatures.

For roof applications cables with 15-25 W/m are used. If the cables are installed on top of a roof by means of a meltable material, the maximum rating of the heating cable must not exceed 20 W/m.

The required output per m^2 will be similar to that of ground applications.

Gutters running along the edge of a cold roof, generally require 30-40 W/m. In comparison the required rating for hot roofs is 40-50 W/m. For these applications 2 or 3 deviflex™ cables can be chosen in order to obtain the necessary output per m, and in some cases even more.

For further information, please refer to the diagram below:

Area	Cold roof	Hot roof	Max. rating	Cable rating
Valley gutter, roof surface	200-250 W/m^2	250-300 W/m^2	300 W/m^2	15-25 W/m
Downpipes, plastic roof gutters	30-40 W/m	40-50 W/m	50 W/m	15-25 W/m
Downpipes, metal roof gutters	30-40 W/m	40-50 W/m	100 W/m	15-25 W/m
Downpipes, wooden roof gutters	30-40 W/m	40 W/m	40 W/m	15-25 W/m

Roof gutters and downpipes
The cable is led back and forth along the gutter as many times as necessary in order to achieve the needed output. Two lengths of cable (back and forth) is usually adequate.

In general, if the dimensioning outdoor temperature is above -20°C, you need:

- 2 lengths of cable in a gutter connected to a cold roof;
- 3 lengths of cable in a gutter connected to a hot roof.

If the dimensioning temperature is below -20°C, you need:

- 3 lengths of cable in a gutter connected to a cold roof;
- 4 lengths of cable in a gutter connected to a hot roof.

The heating cables can be installed in different ways in roof gutters and downpipes but in most cases the same cable is used for both roof gutters and downpipes.

In roof gutters the heating cables are fixed at the correct distance (C-C distance) by devifast™ spacing clips. In downpipes a metal chain is hung inside the pipe to which the devifast™ spacing clips are then attached. If the cable length does not exceed 50 cm, a metal chain is not needed but spacing clips are still necessary.

Alternatively, a rope can be used for installations in downpipes. In this case the cable is fixed with special metal clips.

If a self-regulating heating cable (the devi-iceguard™) is used for roof applications, it is usually enough to use 1 m of cable per 1 m of roof gutter and downpipe. With self-regulating heating cables it is not necessary to use a metal chain in the downpipe. The cable has to be protected from the sharp edges of the downpipe.

Example
The following example is intended for a plastic gutter with a length of 13 m and a 5 m long downpipe at the end.

1) Calculation of necessary cable length: two cable lengths in the gutter will require:

   2 x (13 m + 5 m) =
   36 m of cable.

2) Choice of cable: we have chosen a deviflex™ DTIP 18, 680 W, 37 m and by folding the cable, we are able to cover both the gutter and the downpipe with an installed output of 36 W/m.

In order to keep the cable in the correct position in the gutter, devifast™ spacing clips should be used. The cable in the downpipe should be attached to a metal chain.

3) Choice of thermostat:
   a devireg™ 316 with an outdoor sensor is suitable for this installation.

Valley gutters
The installation of heating cables in valley gutters typically concerns larger buildings. The heating cable is led backwards and forwards along the the gutter so the correct output per m^2 is achieved, similar to ground applications.

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

The devifast™ is fixed by means of hotmelt or silicone.

Often several downpipes are placed in the middle of the valley gutter. If only a short length of the cable is led down the pipe devifast™ spacing clips should be used in order to avoid crossing cables.

If the cable is led all the way down the pipe, it must be supported by a chain hanging down from the top of the downpipe.

The hook or supporter bar of the chain must by no means be placed on top of the cables in the gutter.

Example
The following example is intended for a valley gutter with an area of 10 m x 0,30 m and a 3 m long plastic downpipe at the end.

We have chosen a deviflex™ DTIP-18 heating cable and would like an installed rating of 250 W/m^2.

1) Calculation of installation area:
   The installation area of the cable is:

   10 m x 30 cm = 3 m^2

2) Calculation of total required output:

   250 W/m^2 x 3 m^2 = 750 W

Remember the heating cable for the downpipe:

2 x 3 m = 6 m, 6 m x 18 W/m = 108 W

This gives the following total output:

750 W + 108 W = 858 W

3) Choice of cable: in DEVI's cable programme we find the deviflex™ DTIP-18, 935 W, 52 m to be the most appropriate cable for this example.

4) Calculation of C-C distance: the distance between the cables for the valley gutter is calculated as follows:

$$\text{C-C} = \frac{3\ \text{m}^2 \times 100\ \text{cm/m}}{52\ \text{m} - 6\ \text{m}} = 6.5\ \text{cm}$$

In order to keep the cable in the correct position in the gutter, devifast™ fitting bands and spacing clips should be used.

5) Choice of thermostat: a moisture sensor is chosen for the registration of ice and snow and therefore, a devireg™ 850 thermostat with a set of sensors for the roof and gutter system is chosen.

Roof constructions
During winter the following unpleasant phenomenon may appear (especially with hot roofs):
A large quantity of snow and ice accumulates on the unheated lower part of the roof. It gradually condenses and converts into a big massif of ice. In the spring or when the weather gets mild during winter, this massif can roll down the roof, damaging roof gutters and other roof constructions and creating a serious threat to everything or everybody standing next to the house.

A typical output for a roof is 250 W/m².

To prevent the accumulation of ice, heating cables should be installed in the lower part of the roof. When heating cables are installed on roofs, the installation is often combined with a snow-stopping unit to prevent snow sliding. This snow-stopping unit is typically installed 50-100 cm from the edge of the roof.

The heating cable is installed in cable loops which are placed from the edge of the roof and 50-100 cm up the roof towards the snow-stopping unit. It is important that the cable is installed in cable loops up and down the roof and not as a straight line along the roof.
The cable must be secured at suitable intervals as the installation is exposed to harsh weather conditions.

In some cases the cable may also be covered by shielding sheets in the same metal material as that of the main roofing. This protects the cable from mechanical damage, direct sunrays, and fallen leaves, seeds etc.

Example
The following example is intended for a cold roof. The roof is 8 m long and the cable is installed in loops from the edge and 0,5 m up the roof. The installed rating on the roof must be 250 W/m².

1) Calculation of installation area: The installation area is:

8 m x 0.5 m = 4 m²

2) Calculation of total required output:

4 m² x 250 W/m² = 1000 W

3) Choice of products: in this example the installation can be carried out with a deviflex™ DTIP-18, 1075 W, 59 m and a devireg™ 316 with an outdoor sensor.

4) Calculation of C-C distance: The C-C distance between the cable loops is:

$$\text{C-C} = \frac{4\ \text{m}^2 \times 100\ \text{cm/m}}{59\ \text{m}} = 6.8\ \text{cm}$$

2.4 Product choice

The product choice depends on the area of use and the output. For an overview, please refer to the table bellow.

Area of use	Choice of rating		Product choice		
	Normal	Maximum	deviflex™ min. 17W/m	devimat™ 300	devi-iceguard™
Car parks	200-300 W/m²	300 W/m²	X	X	
Driveways	200-300 W/m²	300 W/m²	X	X	
Pavements	200-300 W/m²	300 W/m²	X	X	
Insulated:					
Steps	200-300 W/m²	300 W/m²	X		
Loading platforms	200-300 W/m²	300 W/m²	X	X	
Bridges	200-300 W/m²	300 W/m²	X	X	
Non-insulated:					
Steps	300-375 W/m²	400 W/m²	X		
Loading platforms	300-375 W/m²	400 W/m²	X	X	
Bridges	300-375 W/m²	400 W/m²	X	X	
Roof; tiles, metal	300-375 W/m²	350 W/m²	X		X
Roof; tar paper	150-300 W/m²	20 W/m cable	X		X
Cold roof					
Roof gutter/downpipe:					
Metal	30-40 W/m	50 W/m	X		X
Plastic	30-40 W/m	40 W/m	X		X
Wood	30-40 W/m	40 W/m	X		X
Hot roof					
Roof gutter/downpipe:					
Metal	40-50 W/m	50 W/m	X		X
Plastic	40-50 W/m	40 W/m	X		X
Wood	40 W/m	40 W/m	X		X

Choice of devireg™ thermostat
DEVI has developed a variety of devireg™ electronic thermostats for controlling the outdoor applications to meet the various frost, ice and snow problems. Electronic thermostats regulate the temperature quickly and precisely, and by choosing the optimal thermostat both safety and financial benefits may be achieved.

The DEVI outdoor thermostat programme includes the following items: the devireg™ 316, the devireg™ 330, the devireg™ 610, and the devireg™ 850. Depending on your requirements and the situation of the installation, the type of ice and snow melting thermostat will vary.

In order to ensure economic running costs and exploit the optimal comfort of the ice and snow melting system we recommend that the devireg™ 850 be used. This is especially relevant for applications where the total output exceeds 6 kW.

Thanks to its intelligent, digital sensors the devireg™ 850 system works with an incredible accuracy enabling a reduction of the energy consumption to the lowest possible level without compromising safety.