

Electric Heating

Vineyards Frost Protection

Application guide





Solve the challenge of vine growers with an Electric Heating system

Electric Heating by Danfoss is a symbiosis of **long history** formed by 2 brands **DEVI** and **Danfoss** united under 1 company umbrella.

It derives from DEVI brand that was established in Copenhagen, Denmark, in 1942. As from January 1st 2003 DEVI has become a part of the Danfoss Group - Denmark's largest industrial Group.

Danfoss is one of the world's leading companies within heating, cooling and air conditioning. The Danfoss Group has more than 23.000 employees and serves customers in more than 100 countries. The development of electric heating systems takes place in Denmark, where the head office is situated while heating elements (cables and mats) are manufactured by Danfoss in EU.

Electric Heating is an energy efficient system using electric heating cables to protect vines against frost damage

This design guide presents our recommendations for design and installation of Vineyards Frost Protection system. It provides guidance for a heating cable layout, electric data and system configurations.

Following our 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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Application overview

Every year vine growers from different regions face a problem of late frosts. They often happen in April - May when buds start blossoming. Late spring frosts are one of the greatest challenges vine growers are facing. Non-heated vines can suffer considerable inflorescence damages (up to 50%), whilst heated vines will have dramatically improved protection of harvest loss or damage and reduce the losses to approximately 13-20%.

Worldwide, the grape and wine industry rely on three main alternatives for frost protection: frost fans, sprinklers, and candles.

Electric Heating solves the challenge with energy efficient systems using Electric Heating cables to protect vines against frost damage.

A green (without CO2 emissions) and sustainable lifetime solution. Highly economic due to low energy consumption during the frosts period.

- Protected against chemical fertilizers;
- Extremely-high pulling strength (special tractors cowerd the vineyards, while knocking the fruits);
- Accurate power design (W) according to requested needs;
- 5 or 20 years warranty.

Heating system can provide frost protection ONLY in spring season when the bud grows and NOT in wintertime!

Benefits

- An energy-efficient solution with electric heating cables.
- Easy, fast and reliable installation.
- A customized approach to meet client's needs, area of vinery and number of rows.
- Proven high saving compared to the existing methods.
- A sustainable solution for a green and clean future through low energy consumption during the frost period.
- Tough cable outer sheath (resistant to weather and UV)



System description

Electric Heating solves the challenge with energy efficient systems using Electric Heating cables to protect vines against spring frost damage. The heating cables by Danfoss are installed and fixed on metal wire along the grapes. The system is controlled automatically by temperature sensors connected to the controller.

Non-heated vines can suffer considerable inflorescence (bud) losses. Number of berries can decrease by 3 times or completely disappear!

Different grape varieties can withstand frosts different.

A dormant bud is reasonably frost hardy, it can survive frost down to $-3,5\text{ }^{\circ}\text{C}$ (Pinot Noir).

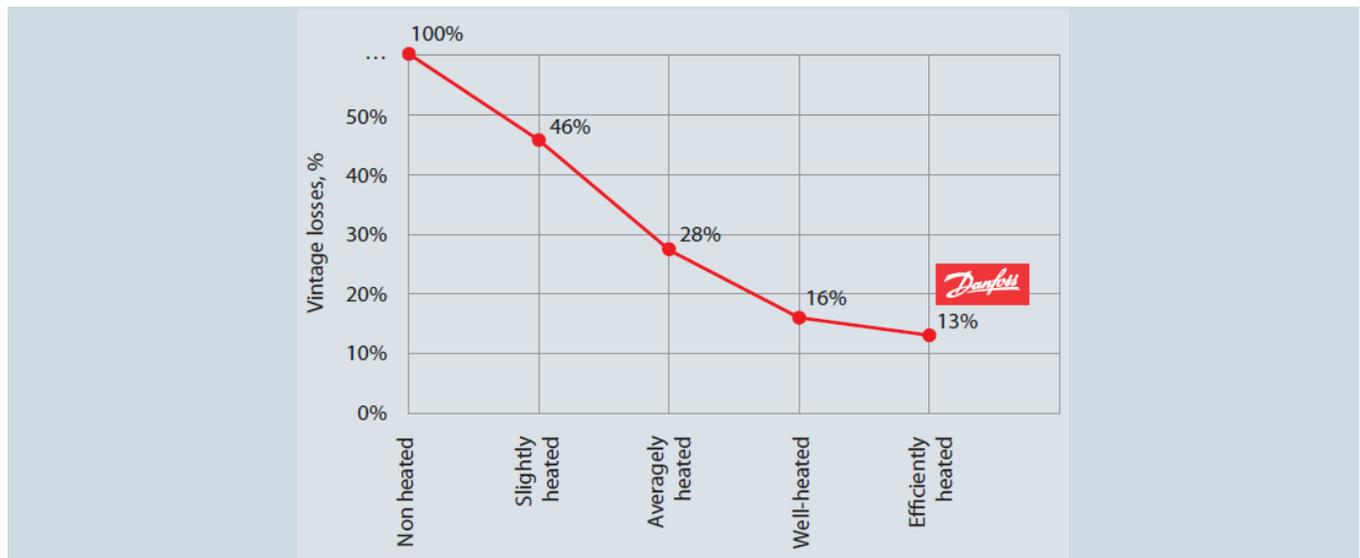
As the bud grows the water contents raise in the bud and it becomes more susceptible to frost $-1,1\text{ }^{\circ}\text{C}$ can damage it (Pinot Noir).

We offer an energy-efficient solution with our electric heating cables for frost protection of the vines.

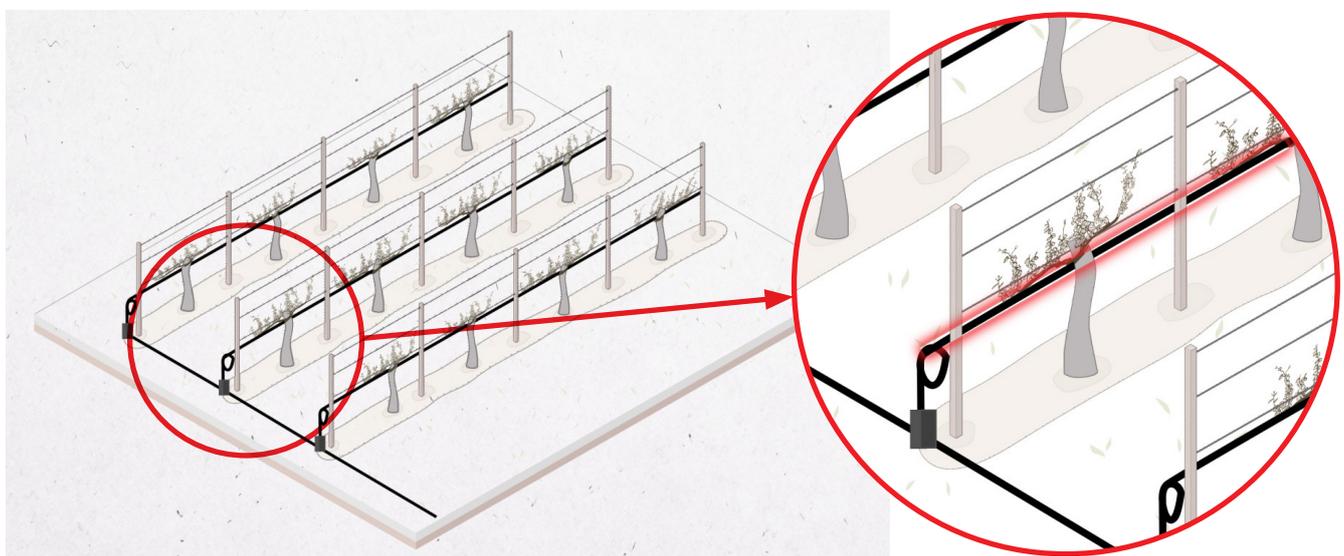
The concept involves installation of heating cable along the main trellising wire of grapevines.

- Frosts protection in spring time (from 2 up to 7 days)
- The ambient temperature is $-2\dots-8\text{ }^{\circ}\text{C}$
- Most susceptible to frost vineyards are located in the lowlands/valleys (low area of land)

Depending on heating level, vintage losses may be decreased



Common view of electric heating system for vineyards



System design

Following pages provide an easy design guide for selection of a Vineyards frost protection system. The recommendations are provided relates to heating cables, as well as thermostats and accessories.

3.1 Heat loss calculation

Linear output of a heating cable (W/m), which is installed for main vine branch, should be at least the same as heat loss (Q, W/m).

In order to calculate heat losses and design the system, we need to know:

- Minimum ambient temperature in spring frost period (**-2...-8 °C**);
- Grape sort. For different sorts we need to maintain different temperature (**+1...+5 °C**). The temperature must be checked with vineyard owner and specified for the project calculation;
- Length and numbers of vineyard rows;
- Available total load on site, kW;
- Voltage (230, 400 V).

For **medium weather conditions***, in order to increase temperature by **1 °C** needs power of approx. **1 Watt**.

** Medium conditions are the following: wind velocity is from 4-6 m/s. But it always depends on local weather conditions!*

In average can be installed from **10 up to 20 W/m** for each main branch of grapevine.

Example.

Location is France and ambient temperature during frosts period is -8 °C. Grape sort is Pinot Noir and we can maintain +2 °C near the main vine branch.

According to the data above:

$$q_{sys} = \Delta t_{main-amb} \cdot p$$

$$\Delta t_{main-amb} = t_{main} - t_{amb} = +2 - (-8) = 10 \text{ °C}$$

$$q_{sys} = 10 \cdot 1 = 10 \text{ W/m}$$

q_{sys} – heat loss of the system, W/m.

t_{main} – maintain temperature near the vines, °C.

t_{amb} – ambient temperature, °C.

p – output coefficient, W/(m · °C).



3.2 System output

The heat required for vineyards frost protection depends on the following main factors:

- Weather conditions (min. temperature, wind speed, humidity, altitude);
- Electrical data (voltage, power, control requirements);
- System performance expectations;
- Safety factor.

With data from previous example will calculate linear output of heating cable:

$$p_{sys} = q_{sys} \cdot 1,3$$

$$p_{sys} = 10 \cdot 1,3 = 13 \text{ W/m}$$

However, in some locations the **wind is present** at any time of the day. In such cases we need to add influences of wind velocity.

Heat transfer coefficient should be considered according to wind velocity.

Safety factor is very important and depends on the following parameters:

- Tolerance of heating cable resistance: +10%...-5%;
- Cable length tolerance: +2%...-2%;
- Supply voltage: +5%...-5%.

} **Totally can be up to 30%**

Average values of linier outputs depending on different wind velocity:

Wind velocity	2 m/s	3 m/s	4 m/s	5 m/s	6 m/s
Linear output*	10,2 W/m	11,4 W/m	14 W/m	16,6 W/m	19,2 W/m

** Note that values in the table above are calculated without influence of altitude, Nusselt and Prandtl criterions. For more info: EH@danfoss.com*

Total system output depends on numbers and length of vine rows and should be calculated in order to choose appropriate load equipment.

$$P_{tot} = p_{sys} \cdot n \cdot L_r$$

$$P_{tot} = 13 \cdot 10 \cdot 100 = 13000 \text{ Watts}$$

p_{tot} – total output of the system, W;

p_{sys} – linear output of the system, W/m;

n – vine row numbers;

L_r – vine rows length, m.

3.3 Product selection

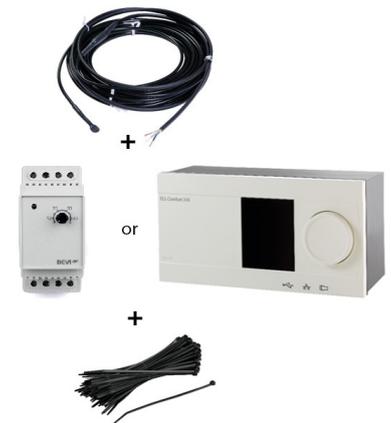
This section will show how to choose the correct heating element, control device and what accessories to use for the installation.

The electric heating system product portfolio for the Vineyards Frost protection consists of three major components:

- Heating element – heating cable with constant wattage ready-made units or drum goods;
- Controller with a temperature sensor or a controller with both temperature and moisture sensors;
- Fixing elements and accessories.

Danfoss frost protection systems can be fully automated which eliminates the need for field personnel during frost events.

Also, the prefabricated cold connections in Danfoss factories offer considerable time savings in the deployment of frost protection systems. Connection to the electrical cabinet is pretty easy due to DIN rail construction.



3.3.1 Heating cable selection

Most of cables are manufactured as ready-made heating elements with a specific length, with connecting power supply cable (cold lead or cold tail) and sealed joints (connection muffs or end terminals).

It is also possible to choose special drum goods which can be customized for the specific project.

Main rules how to choose suitable heating cable:

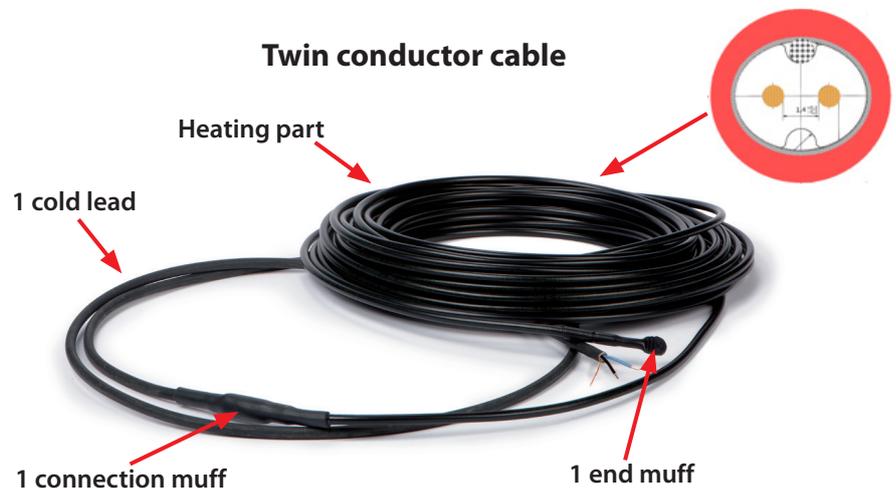
- Calculate heat loss;
- Add safety factor to heat loss (usually + 30% or 1,3);
- Outer sheath of heating cable MUST be UV protected;
- Check voltage supply and choose suitable heating cable: 230 V or 400 V;
- Choose product type: ready-made

units or drum goods (usually depends on specific row length and linear output).

Range of the heating cables linear output for vineyards frost protection is usually between 10 and 20 W/m (Watt per linear meter).

Ready-made heating cables

The heating cable offered for the application is constant wattage cable with an extremely high-quality. Its round profile and robust construction ensures a fast, simple and safe installation in multiple applications.



Product	Linear output, W/m	Type	Max. permissible use temp., °C	Cable dimensions, mm	Conductor insulation	Outer sheath	Cold lead	IP class
ECsafe 20T	20	Twin conductor	60	6,9	XLPE	PVC UV protected	One 2,3 m DTCL	IPX7
ECsnow 20T	20	Twin conductor	70	7	FEP	PVC UV protected	One 2,3 m DTCL	IPX7

3.3.2 Thermostats/controllers

Thermostats and controllers are fitted with a complete set of control functions for frost protection systems. It is a combination of multi functionality and temperature control.

The product range of controls is designed for frost protection systems including the following:

- **simple electronic thermostats;**
- **digital controllers.**

Line of **simple electronic thermostats** to be installed in electric cabinets with DIN rail attachment. To measure and control the desired temperature either a wire sensor (in the set) or an external indoor/outdoor air sensor must be used. The thermostat must be installed via an all-pole disconnection switch. It has a LED indicating standby (green light) and heating (red light) periods.

To control simple or low output (less than 3000 Watts) systems, simple thermostats are recommended as a standard solution.

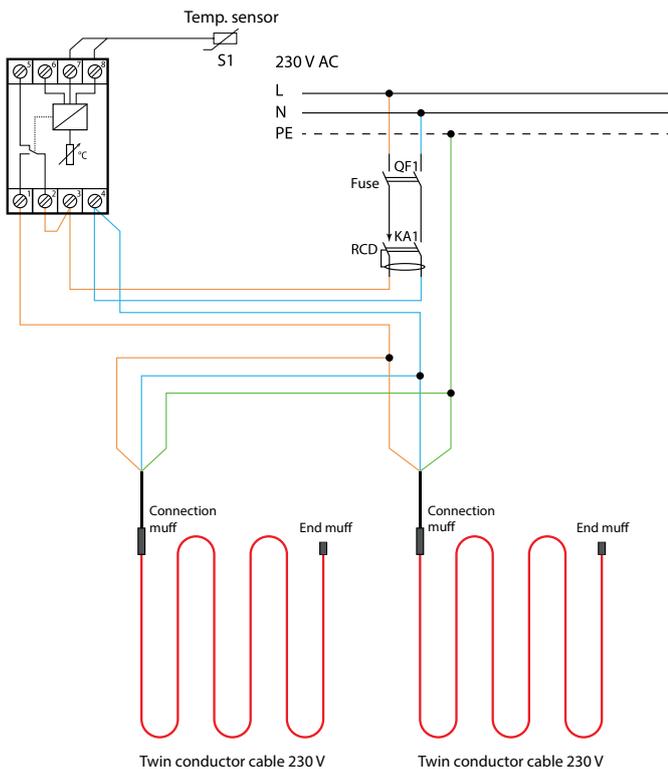
ECtemp 330 (+5...+45 °C) and ECtemp 330 (-10...+10 °C) can be used for such purposes.

Wire sensors should be installed according to specific project data. Minimum one sensor must be used for one heated zone (could be one vineyard row or few rows depending on field size and location). Always contact local sales representative or EH@danfoss.com in order to get technical help.

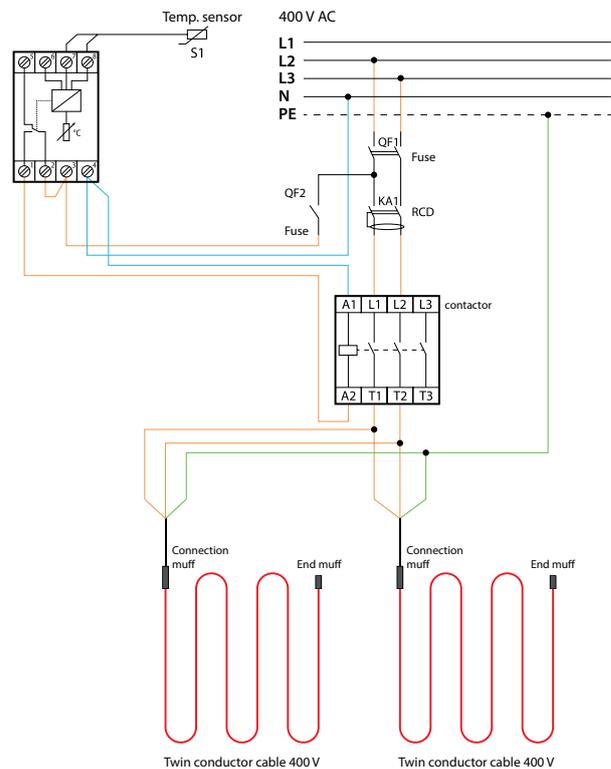


Find basic thermostat connections below.

Thermostat connection of twin conductor heating cables (max. 3680 Watts at 230 V).



Thermostats connections of twin conductor heating cables (400 V) via contactor.



For more connection schemes please contact EH@danfoss.com.

Line of **digital controllers** have special functions which can be programmed for different purposes.

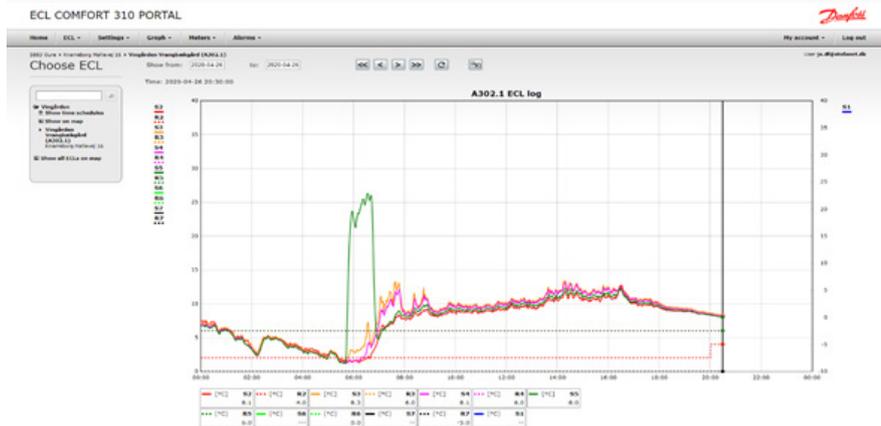
The ECL Comfort 310 is an electronic weather compensated temperature controller. The weather compensated heating system increases the comfort level and saves energy.

Main functions and benefits:

- Easy installation;
- Optimized performance;
- Easy modifications;
- Alarm function;
- Different configurations;
- 24/7 overview of the system;
- Ability to make log of the individual sensors
- Remote control;
- For mounting on wall and DIN rail.



Interface example:



Product	Resistive load, at 230V, Amps	Sensor type	Temperature range, °C	Hysteresis, °C	BMS	IP class	Installation
ECtemp 330 (-10...+10 °C)	16	Wire	-10...+10	±0,2	No	IP20	DIN rail
ECtemp 330 (+5...+45 °C)	16	Wire/Air optional	+5...+45	±0,2	No	IP20	DIN rail
ECL Comfort 310	4 (2 x CO and 2 x NC)	Wire	-50...+200		Yes		On wall

3.3.3 Accessories

Danfoss range has all necessary accessories for fixing, measurement and connection in order to provide full project specification.

In order to find all accessories please refer to Product Catalogue or visit www.devi.com.

<p>Cable ties</p> <p>Plastic ties for fixing heating cables.</p>	<p>Wire sensors</p> <p>Wire sensors for different temperature range.</p>	<p>Air sensor</p> <p>Outdoor air sensor with IP44</p>	<p>Plastic conduit pipe</p> <p>Plastic conduit pipe for wire sensors</p>	<p>DTCL Cold leads</p> <p>Different cold leads with different cross sections and construction are available for ordering</p>
<p>End termination repair set</p> <p>DEVICrimp™ CS-2C assembly kit dk 2-cond.</p>	<p>Heating cable to cold lead repair set</p> <p>DEVICrimp™ for DEVIsnow™</p>	<p>Heating cable to heating cable repair set</p> <p>DEVICrimp™ ass/repair kit 2-cond. CS-2A/CS-2B</p>	<p>Heating cable to cold lead/heating cable repair set</p> <p>Repair kit cables 2 cond. Concrete/støbesæt</p>	

Note: always use only authorized accessories!
For more details please use Product Catalogue or EH@danfoss.com.

3.4 Installation guide

After product selection proper installation should be done. Always use the following rules during the installation process:

- Heating cable should be installed on metal wire near the main branch of grapevines, the closer the cable is to the buds the more heat it will exert on the buds;
- One cable line for one row of vineyard. All cables should be connected in parallel;
- Heating cable can be fixed by plastic ties;
- Distance between cable and vines branch is maximum 0-4 cm;
- Control system should have temperature sensors (wire sensors);
- Install sensors where the temperature is estimated to be representative for the whole installation, where 2 sensors are needed for the thermostat/controller please install at the estimated extreme points (coldest and hottest);
- Wire sensors should be installed in plastic conduit pipe (avoid direct contact of sun rays) near the main branch of grapevines;
- Alarm should be installed in order to check all cables which can be damaged by grape secateurs, tractors, etc.

1. Fix one line of the heating cable to metal wire by plastic ties.



2. Heating cables should be connected to thermostat/controller according to local norms and regulations. Contact EH@danfoss.com for all technical information about connections.



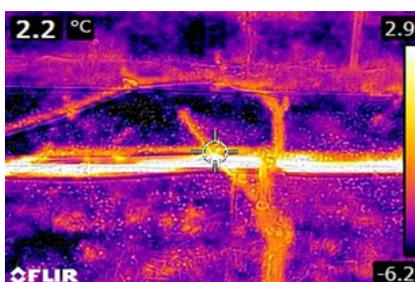
3. Install wire sensor in plastic conduit pipe and place it in coldest place near main branch of grapevines.



4. It is strongly recommended to install alarm system in order to check the integrity of the cables in real-time and before the frost season



As a result you will get reliable frost protection heating system providing a stable harvest.



Safety instruction

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

De-energize all power circuits before installation and service.

Residual current device (RCD) protection is required. RCD trip rating is max. 30 mA.

The screen from each heating cable must be connected to earthing terminal in accordance with local electricity regulations.

Heating cables must be connected via a switch providing all pole disconnection.

The heating cable must be equipped with a correctly sized fuse or circuit breaker according to local regulations.

Never exceed the maximum heat density (W/m or W/m²) for the actual application.

It is strongly recommended to use the heating cable together with an appropriate thermostat to secure against overheating.

The presence of a heating cable must be made evident by affixing caution signs in the fuse box and in the distribution board or markings at the power connection fittings and/or frequently along the circuit line where clearly visible (tracing) must be stated in any electrical documentation following the installation.

4.1 DO's

- For installation of cable and thermostat/controller, always refer to the local regulations/legislations and respective manuals;
- Remember to fill out the warranty certificate with the required information as this will not be valid otherwise;
- Carefully complete the installation, the cable can break when overloaded;
- If any doubt arises consult you manual or local Danfoss department;
- Ensure that the cable is sufficiently fixed and mounted according to the manual;
- Ensure that warning labels and stickers (potentially tape) with warning text is used to inform about the heat traced cable;
- Install sensors where the temperature is estimated to be representative for the whole installation, where 2 sensors are needed for the thermostat/controller please install at the estimated extreme points (coldest and hottest);
- To get the best performance of the system and avoid failures it is necessary to follow the installation descriptions;
- To get the best performance of the system it is strictly necessary to calculate the correct heat losses. Using this knowledge the cable with right output can be chosen;
- Plan every installation step and fixing point of the frost protection system ahead of time and ensure that the "run" is proper and possible;
- Ensure sensors are connected according to the applicable installation guide and/or application guide.

4.2 DON'Ts

- Never make an installation without thermostat/controller;
- Never install cables where the heat can't be dissipated, even with a self-limiting cable the output will never become zero and the cable can overheat;
- Never let unauthorized personnel install controllers/thermostats or heating elements;
- Never use unauthorized accessories;
- Never use our products (cables, controllers, sensors, etc.) outside provided temperature range.

Case stories

<https://devi.danfoss.com/en/case-stories/?page=1>



Technical support

The Electric Heating team is offering valuable support to professionals when it comes to preparing your new projects.

We offer support for:

- Calculation of Electric Heating system;
- Development of drawings for projects;
- Preparation of the BoM (Bill of Material);

- Recommendations for the installation and operation of the system;
- Technical trainings.

In order to clarify the project data for different applications use the following technical request forms, fill in with your specifications and send it to: **EH@danfoss.com**

<https://devi.danfoss.com/en/support/>



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