ENSTO

Frost Protection Systems

Don’t let safety slip away

Better life.
With electricity.

Frost protection ensures that passages, piping and rainwater systems that are important to a property are always kept functional and safe.

ensto.com

Frost protection systems

- a workable whole

Our frost protection system has been developed for the demanding climatic conditions of northern Europe. Frost protection ensures that passages and piping systems that are important to a property are always kept functional and safe. The ease of use as well as the dependable operation of our products are also vital to us. The high quality of our products guarantee reliable performance for years to come.

Contents

Frost protection cables

For water and drain pipes as well as outdoor areas

By means of self-regulating heating cables, heat-resistant cables and ready-made heating mats, it is easy to plan and realize functional frost protection solutions for water and drain pipes important to a property, as well as for outdoor areas.

Series-resistant cables

Tash series-resistant cables represent an economical frost protection solution for outdoor areas, pipes and tanks. Ensto's ULLA300 frost protection mats are ideally suited for the frost protection of vehicle access ramps, entrances and pavements. Series-resistant are ready-assembled in the mat.

Tash cable

Self-regulating cables

The Optiheat cable is specially designed for frost protection of water and drain pipes as well as roofs and stairways. The self-regulating power output of the cable changes with any change in environmental temperature, and the cable's own temperature remains stable. The power consumed by the cable varies in accordance with the properties of its location.

Optiheat cables

Plug'n Heat cable

The Plug'n Heat frost protection cable is fitted with a schuko-plug, and it's designed for keeping piping and water meters ice-free. It can also be installed as a retrofit solution. The cabling is made of food provision-tested materials to ensure that it is also appropriate for use inside drinking water pipes.

Plug'n Heat

Sizing and selection

A workable solution for outdoor areas can be achieved either with Tash-series-resitant cables or by self-regulating Optiheat-cables.

Sizing and selection

See the table for a summary of the sizing of frost protection solutions and the selection of a control thermostat. For sizing instructions, see the system-specific descriptions.

	Maximum power per meter W/m	Installation power W/m or W/m²	Cables					Control			
			OPTIHEAT 10	OPTIHEAT 20/40	OPTIHEAT RAMP	TASH	PLUG'N HEAT	ECO500	ECO900*	ECO910	ECO920
Water Pipes		**> 1.3 x HEAT LOSS**									
Plastic pipe	10		*				*	*			
Plastic, instalallation inside pipe	10		*				*	*			
Metal pipe	20		*	*		*	*	*			
Drain Pipes		**> 1.3 x HEAT LOSS**									
Plastic pipe	10		*				*	*			
Metal pipe	20		*	*		*	*	*			
Rain Water Systems											
Plastic gutter	10	20–60 W/m				*			*	*	*
Metal gutter	20	20–60 W/m		*		*			*	*	*
Roof valley > 300 mm	20	200 W/m²		*		*			*	*	*
Outdoor Areas											
Covered outdoor area		200 W/m²			*	*			*	*	*
Other outdoor areas		300 W/m²			*	*			*	*	*
Heavy traffic		400 W/m²			*	*			*	*	*

* ECO900 THERMOSTAT REQUIRES ALWAYS A SENSOR PAIR (ECOA901 + ECOA902 OR ECOA903 + ECOA904).

Outdoor systems

To keep outdoor areas such as vehicle access ramps, pavements, loading platforms or entrances ice-free, the heating cables are installed into the sand or concrete beneath the surface layer. Melting efficiency is maximized when the area to be kept ice-free is insulated from below.

When installing heating cables into sand, the granular size of the sand must be 0.063–2 mm. It is important in installation that the cable sheath is not damaged and that the cable does not shift during levelling. A surface layer of slabs, concrete or asphalt is placed on top of the sand.

When installing heating cables in concrete they are fixed to the reinforcement mesh with, e.g. cable ties. Care should be taken not to damage the cables.

Tash-series-resistant cables or self-regulating Optiheat-cables are suited for frost protection of outdoor areas.

Tash series-resistant cable suited for installation in areas of different forms and also for large outdoor areas. With singleconductor cables, a loop is formed during installation so that both cold cables are connected to the junction box. (PICTURE PROVIDED FOR GUIDANCE ONLY)

Tash series-resistant cables

The planning stages for the frost protection solution implemented using Tash series-resistant cables are as follows:

1. the installation power output is specified
2. maximum loading of the cable is inspected
3. the cable is selected based on the power and the length
4. the required cable length is calculated
5. the installation spacing is determined
6. total output, power per square meter out put and cable power per meter output are inspected

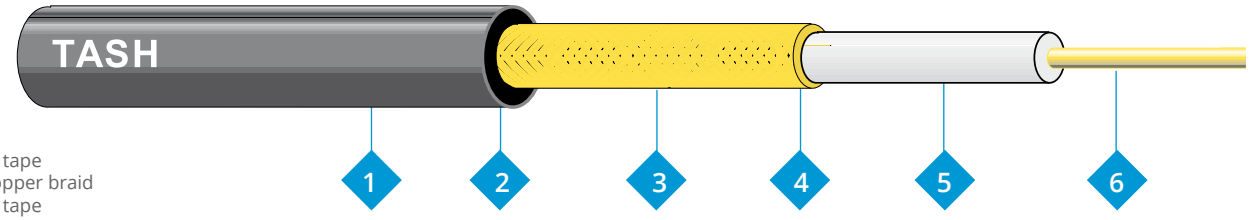
Maximum loadings for Tash-cables	P_{MAX}
Concrete	30 W/m
Sand	25 W/m
On the surface of a metal pipe	20 W/m
On the surface of a plastic pipe	10 W/m
Metal gutters	20 W/m
Plastic gutters	10 W/m

Cable installation

Tash series-resistant cables are of single conductor type. The heating cable cannot be connected directly to a junction box: instead, a separate connecting lead is used, i.e., a cold lead. With single-conductor cables, a loop is formed during installation so that both cold cables are connected to the junction box.

Cable thermal efficiency

Cable thermal efficiency is inversely proportional to its length, i.e., with increase in length, output power declines and correspondingly increases as the length shortens. Cable manufacturers state the highest permitted temperature and maximum metric output, i.e., the minimum permitted length for cables.

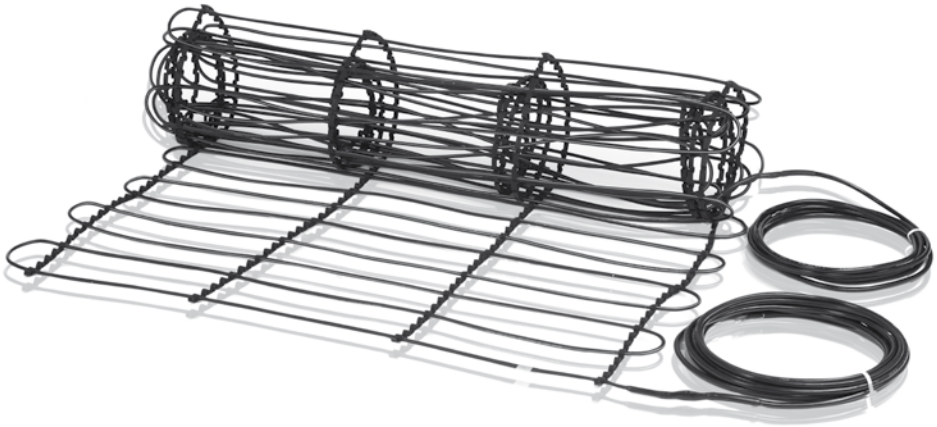


1. Sheath
2. Polyester tape
3. Tinned copper braid
4. Polyester tape
5. Insulation
6. Tinned conductor

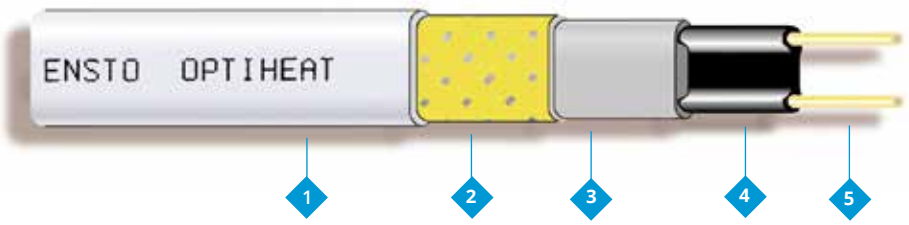
ULLA300-frost protection mats

Factory manufactured and tested, ULLA300 frost protection mats can be used for keeping vehicle entrance ramps, entrances and pavements ice-free. They can be installed quickly and easily in both concrete and sand. The ready-made mat is easily installed and the installation spacing is always correct.

The mat is easy to shape by cutting the installation strips. The output is 300 W/m^2 and the nominal voltage is 230 V. The standard width of the frost protection mats is 0.95 m and the length can be from 2–12 m. One cold cable end is 5 meters and the other is mat length + 5 meters.



1. Outer jacket
2. Tinned copper braid (Not Optiheat10 which has alufoil with earth wire)
3. Insulation
4. Self-regulating heating element
5. Nickel plated bus wire



Self-regulating Optiheat cable

The core of the cable is formed by two tinned copper braid conductors coated with semiconducting material. The current passes between the tinned conductors through the heat-resistant material. The resistivity of the conductors declines with a drop in temperature and increases with a rise in temperature.

The current and the cable power depends on the temperature. A self-regulating cable is used to keep the temperature stable, regardless of what the temperature is. The cable parts can be used in various environments, so their metric efficiencies may vary.

The purchase costs for self-regulating heating cables are higher than for series-resistant cable, but in overall costs it is highly competitive. It is well suited for use in small heating spaces as well as in pipework.

Self-regulating cable can be cut to the desired length. The maximum length for installation is determined on the basis of the protective, devicebased design current protecting the cable.

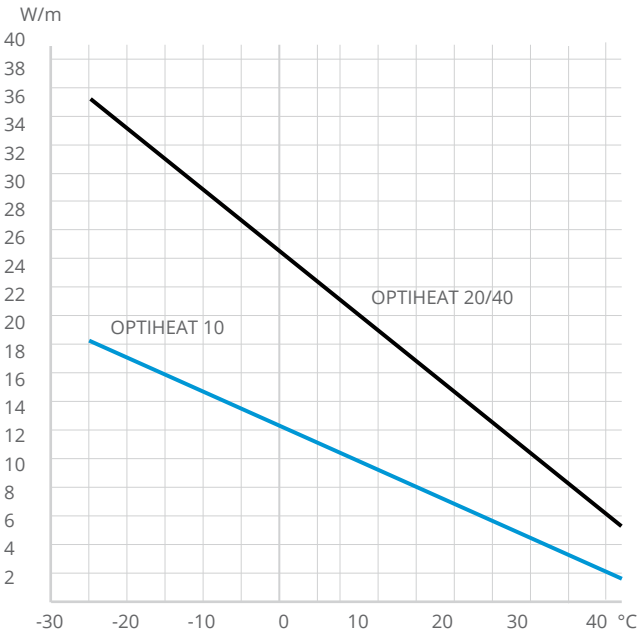
Cable resistance is small when a self-regulating cable is cold. For this reason, the voltage causes a power peak of approximately 2-3 times in comparison to the nominal current when connected to the cable. The protective device must be measured in accordance with the operating temperature. The Miniature Circuit Breaker (MCB) must be type C.

Maximum installation lengths

Optiheat 10	**10 A**	**16 A**	**32 A**
On pipe surface +10 °C	74 m	89 m	-
On pipe surface ±0 °C	61 m	89 m	-
On pipe surface –30 °C	61m	89 m	-
Optiheat 20/40			
On pipe surface +10 °C	68 m	109 m	129 m
On pipe surface ±0 °C	57 m	92 m	119 m
On pipe surface –10 °C	50 m	79 m	111 m
On pipe surface –20 °C	44 m	70 m	104 m
Optiheat RAMP			
On concrete -10 °C	18 m	28 m	55 m

Maximum cable installation lengths for certain switch-on temperatures when the cable surface and surrounding temperatures are the same.

Temperature/power output curves and maximum installation lengths for Optiheat-cables



Alteration of Optiheat 10 and Optiheat 20/40 heating power output when the surrounding temperature changes. Optiheat RAMP is ~50 W/m/10 ° C (110 W/m in concrete 5° C)

By using ECO control equipment, frost protection always functions as required while at the same time saving energy. Our control equipment is appropriate not only for pipes and outdoor areas but also for demanding frost protection control systems.

Frost protection control

Energy-saving control units for various requirements

The ECO500 controls the frost protection of pipes

The ECO500 thermostat controls the frost protection of pipes. The sensor is installed on top surface of the pipe when the heating cable is used inside the pipe. When the cable is used on the outside of the pipe, the sensor must be installed on the opposite side in the coldest spot.The adjustment range of temperature is +2 °C ... +35 °C.

Thermostat for frost protection of pipes

The ECO910 controls the frost protection of outdoor areas and rainwater systems

There are two sensors in the ECO910 thermostat: a ground sensor and one measuring the temperature of the air. Both sensors are used in the frost protection control of outdoor areas. In maintaining ice-free conditions in rainwater systems, one sensor measures air temperature. The thermostat is mounted on a DIN rail, and the adjustment range of temperature is –30 °C ... +15 °C.

DIN rail mounted thermostat with two sensors

The ECO920 controls the frost protection of outdoor areas and rainwater systems

The ECO920 controls the frost protection for outdoor areas and rainwater systems. In outdoor area frost protection, ECOA908 ground sensor is used for measuring the humidity and temperature.

In rainwater systems, the ECO920 thermostats floor sensor is used for measuring the air temperature and the ECOA907 sensor for measuring the humidity of a gutter. The thermostat is mounted on a DIN rail, and the adjustment range of temperature is -20 °C...+10 °C.

DIN rail mounted thermostat with display

The ECO900 is suitable for demanding frost protection control solutions

The ECO900 is a fully-automatic control unit ensuring frost protection for outdoor areas and rainwater systems. The equipment sensors identify ice, moisture and temperature, so the device is ideally suited for frost protection control solutions in varying freezing conditions. The control equipment is mounted in the distribution board. The unit's LCD display continuously displays the temperature and moisture information. Various sensors must be connected to the unit, depending on the required application. **Thermostat requires always a sensor pair** (ECOA901+ECOA902 or ECOA903+ECOA904).

DIN rail mounted fully-automatic control unit

Tash and Optiheat make up an easily assembled and reliable whole.

Mounting and installation accessories

– Assure safe assembly and practical use

Tash and Optiheat connection supplies and other accessories for heating cables and heating mats make up an easily assembled and reliable whole.

Tash-connection kit

Tash connection accessories

Tash connection kit includes shrink joints, branch joints, extensions and joints for cold cables. Connection cables must be in accordance with the installation environment.

Optiheat-connection kit

Optiheat connection accessories

With the Optiheat connection supply series, shrink joints, branch joints, extensions and cold cable joints as well as other joints can be connected directly to the junction box. The cable is led from the point of installation to the junction box either as it is or in a protective tube. A pressure resistance lead-through is also provided in the connection accessories for laying the cables inside a water pipe.

Strain relief

Fixing strip

Mounting accessories and strain reliefs

Mounting accessories also include heat-resistant tape and galvanised mesh, by which the heating cable is attached to the surface of the pipe or valve in order to achieve favourable thermal transfer. By means of a plastic mounting strip, the correct gaps are maintained throughout all stages of the work. A strain relief is used for installing the heating cables to the downpipe.

PPN10

PPN12

Selection of accessories

This table will provide help in selecting heating cable accessories. The selection of right accessories will ensure the proper functioning of frost protection solutions in given conditions.

Water Pipe Frost Protection	Accessories	OPTIHEAT 10	OPTIHEAT 20/40	TASH	PLUG'N HEAT
Plastic pipe	LT20 Fibreglass tape	*			*
	EFPLP1 Connection kit	*			
	EFPLP2 Connection kit	*			
Plastic, installed in pipe	EFPLV1 Pressure resistance lead-through	*			*
	EFPLP1 Connection kit	*			
	EFPLP2 Connection kit	*			
Metal pipe	LT20 Fibreglass tape	*	*	*	*
	SV10 Galvanised mesh	*	*	*	
	ALU50 Aluminum tape	*	*	*	
	EFPLP1 Connection kit	*	*		
	EFPLP2 Connection kit	*	*		
	EFPLP4 Connection kit			*	
Drain Pipe Frost Protection					
Plastic pipe	LT20 Fibreglass tape	*			*
	SV10 Galvanised mesh	*			*
	EFPLP1 Connection kit	*			
	EFPLP2 Connection kit	*			
Metal pipe	LT20 Fibreglass tape	*	*	*	*
	SV10 Galvanised mesh	*	*	*	*
	ALU50 Aluminum tape	*	*	*	*
	EFPLP1 Connection kit	*	*		
	EFPLP2 Connection kit	*	*		
	EFPLP4 Connection kit			*	

Rainwater system	Accessories	OPTIHEAT 20/40	OPTIHEAT RAMP	TASH
Plastic gutter	PPN6/8 mounting strip			*
	PPN10 downpipe spacing clip	*		*
	PPN12 gutter holder	*		*
	VP300 strain relief	*		*
	EFPLP1 connection kit	*		
	EFPLP2 connection kit	*		
	EFPLP4 connection kit	*		*
	SJGEL0.27 gel filled joint kit	*		*
	SJGEL1 gel filled joint kit	*		*
	RTS199 support chain for down pipe	*		*
Metal gutter	PPN6/8 mounting strip			*
	PPN10 downpipe spacing clip	*		*
	PPN12 gutter holder	*		*
	VP300 strain relief	*		*
	EFPLP1 connection kit	*		
	EFPLP2 connection kit	*		
	EFPLP4 connection kit			*
	SJGEL0.27 gel filled joint kit	*		*
	SJGEL1 gel filled joint kit	*		*
	RTS199 support chain for down pipe	*		*
	RXBC1230 fixing strip	*		*
Roof valleys	PPN6/8 mounting strip			*
	EFPLP1 connection kit	*		
	EFPLP2 connection kit	*		
	EFPLP4 connection kit			*
	PPM13 clip for seam metal roofs	*		*
Outdoor Areas				
Installation in sand	PPN6/8 mounting strip	*		*
	EFPLP1 connection kit	*		
	EFPLP2 connection kit	*		
	EFPLP4 connection kit			*
Installation in concrete	PPN6/8 mounting strip	*		*
	XBC1230 fixing strip	*	*	*
	EFPLP1 connection kit	*		
	EFPLP2 connection kit	*		
	EFPLP4 connection kit			*
Installation on top of concrete	PPN6/8 mounting strip	*		*
	XBC1230 fixing strip	*		*
	EFPLP1 connection kit	*		
	EFPLP2 connection kit	*		
	EFPLP5 connection kit		*	
	EFPLP4 connection kit			*

Quick and effective frost protection

Electric frost protection

Simple structural applications

The electrical control of frost protection is quick and effective. This energy-efficient solution requires the correct power sizing and heating control in accordance with requirements.

Frost protection for water and drain pipes

Frost protection control prevents frozen pipes from causing water damage. Primary place for the heating cable is on the surface of a water pipe, but a cable may also be installed inside the water pipe as required.

Frost protection for rainwater systems

By means of frost protection control over rainwater systems, water-freezing in connection with temperature changes in rainwater gutters and roof structures is prevented. Heavy ice masses damage structures and can be dangerous for those walking in the vicinity. The melt waters route must be looked after all the way to the rainwater drains.

Frost protection for ramps and other demanding areas

Optiheat RAMP is intended for demanding frost-protection applications, such as vehicle ramps, helipads, and other frost-protection needs requiring high power per meter. In addition to ice-free maintenance, run-off route planning for melt waters must also be kept in mind.

Frost protection for outdoor areas

By using frost protection for outdoor area, the pavements of a property are kept safe to walk on. Planning begins from the clarification of installation site conditions and the structure of the area to be heated. In addition to ice-free maintenance, run-off route planning for melt waters must also be kept in mind.

Sizing frost protection of pipework

In planning the heating of pipes, we proceed as follows:

1. Thermal losses in the pipe are determined (table or by calculation)
2. Heating power is dimensioned: 1.3–1.5 x thermal loss
3. L ength of the heating cable is calculated.
4. On the basis of the cable tables, the appropriate specific resistance of the cable is specified.
5. The type of cable is chosen that achieves sufficient installation output.
6. Check that the total output is adequat and that the highest permitted metric output is not exceeded.
7. If the power per meter output exceeds what is permitted, the length of the heating cable is extended with several cable loops heating the pipe.

The thermal efficiency and cable type for the piping system are determined in accordance with material, size and thermal losses.

The following should be noted with Tash series-resitant cables:

- highest permitted power per meter output (plastic pipe 10 W/m, metal pipe 20 W/m)
- the cable does not criss-cross
- the heating cable is generally installed along the pipe
- the cabling is always installed as loops, two heating cables go to the pipe

Water pipe material	Maximum cable power/m output	Heating cable
Plastic	10	Optiheat 10 Plug´n Heat Tash
Metal	20	Optiheat 10 Optiheat 20/40 Plug´n Heat Tash
Plastic/metal, heating cable inside pipe	10	Plug´n Heat

Optiheat 10 heating cable for heating plastic and metal pipes. Take sensor position into account. An aluminium tape divides heat more evenly and a galvanised mesh is also used here. The pipe must be insulated. (PICTURE PROVIDED FOR GUIDANCE ONLY)

Thermal loss table for pipe

(W/meter of pipe)

Instructions for reading the table

Thermal loss table for pipe

An uncertainty factor of 1.3 to 1.5 should be applied to the values in the table. The thermal loss table for pipes is used for determining how much power per meter of pipe is required for keeping the pipe water unfrozen.

1. The first column shows the outer pipe diameter.
2. The second column gives the insulation thickness.
3. In the next columns, the values 20 °C to 60 °C refer to the temperature difference between the pipe and environment. When you want to keep the pipe unfrozen in an environment where the temperature can get as low as –30 °C, you should select the 40 °C column for perusal. With regard to dimensioning, the insulation's thermal conductivity is 0.035 W/m^2. (Mineral wool: +10 °C.)

N.B. Holder rings (brackets) and valves have not been taken into consideration regarding sizing.

Example

A plastic pipe's outer diameter is 48 mm, insulation thickness 50 mm, and temperature difference 35 °C. This translates into a heat loss of 7.8 W/m. Here, 1.4 is selected as the uncertainty factor, for a design power of 7.8 x 1.4 = 10.92 W/m. Since the maximum metric load on the surface of the plastic pipe is 10 W/m, Optiheat 10 is selected as the heating cable. Same issue can be also calculated:

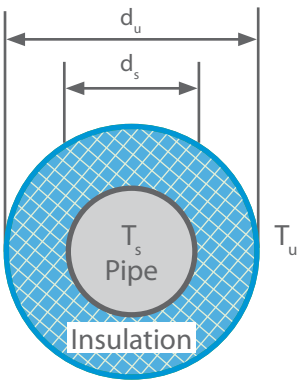
Thermal loss of a pipe

$$\Phi = \frac{2\,\pi\,\lambda_{insulation}}{\ln \frac{d_u}{d_s}} * (T_s - T_u)$$

Φ	Thermal loss of a pipe (W)
$\lambda_{insulation}$	Thermal conductivity of insulation (W/mK)
d_u	Pipe overall diameter with insulation (m)
d_s	Pipe diameter (m)
T_s	Inside temperature in pipe (°C)
T_u	Outside temperature (°C)

Insulation

Insulation is the factor that affect heat loss most. Properly covered pipe with thermal insulation to retain heat losses. You need less heating power per meter if you use more insulation.



Temperature difference $T_s - T_u$

OUTER DIAMETER of PIPE Ø/mm	INSULATION THICKNESS mm	20 °c	30 °c	40 °c	50 °c	60 °c
14	20	3.3	4.9	6.5	8.1	9.8
	30	2.6	4.0	5.3	6.6	7.9
	40	2.3	3.5	4.6	5.8	6.9
	50	2.1	3.1	4.2	5.2	6.3
21	20	4.1	6.2	8.2	10.3	12.4
	30	3.3	4.9	6.5	8.1	9.8
	40	2.8	4.2	5.6	7.0	8.4
	50	2.5	3.8	5.0	6.3	7.5
27	20	4.8	7.3	9.7	12.1	14.5
	30	3.8	5.6	7.5	9.4	11.3
	40	3.2	4.8	6.4	8.0	9.6
	50	2.8	4.3	5.7	7.1	8.5
	80	2.3	3.4	4.5	5.7	6.8
34	20	5.7	8.5	11.3	14.1	17.0
	30	4.3	6.5	8.6	10.8	13.0
	40	3.6	5.5	7.3	9.1	10.9
	50	3.2	4.8	6.4	8.0	9.6
	80	2.5	3.8	5.1	6.3	7.6
42	30	5.0	7.4	9.9	12.4	14.9
	40	4.1	6.2	8.2	10.3	12.4
	50	3.6	5.4	7.2	9.0	10.8
	80	2.8	4.2	5.6	7.0	8.4
48	30	5.4	8.1	10.8	13.6	16.3
	40	4.5	6.7	9.0	11.2	13.5
	50	**3.9**	**5.9**	**7.8**	**9.8**	**11.7**
	80	3.0	4.5	6.0	7.5	9.0
60	30	6.3	9.5	12.7	15.9	19.0
	40	5.2	7.8	10.4	13.0	15.6
	50	4.5	6.7	9.0	11.2	13.5
	80	3.4	5.1	6.8	8.5	10.2
76	30	7.6	11.3	15.1	18.9	22.7
	40	6.1	9.2	12.2	15.3	18.3
	50	5.2	7.9	10.5	13.1	15.7
	80	3.9	5.8	7.8	9.7	11.6
	100	3.4	5.1	6.8	8.5	10.2
89	30	8.5	12.8	17.1	21.3	25.6
	40	6.9	10.3	13.7	17.1	20.6
	50	5.8	8.8	11.7	14.6	17.5
	80	4.3	6.4	8.6	10.7	12.8
	100	3.7	5.6	7.5	9.3	11.2
114	30	10.4	15.6	20.8	26.0	31.2
	40	8.3	12.4	16.5	20.7	24.8
	50	7.0	10.5	14.0	17.5	21.0
	80	5.0	7.5	10.0	12.5	15.0
	100	4.3	6.5	8.7	10.9	13.0
168	40	11.3	16.9	22.6	28.2	33.9
	50	9.4	14.1	18.8	23.5	28.3
	80	6.6	9.9	13.1	16.4	19.7
	100	5.6	8.4	11.2	14.0	16.8
	120	5.0	7.4	9.9	12.4	14.9
219	40	14.1	21.2	28.3	35.3	42.4
	50	11.7	17.5	23.4	29.2	35.1
	80	8.0	12.0	16.0	20.0	24.1
	100	6.8	10.2	13.6	16.9	20.3
	120	5.9	8.9	11.9	14.9	17.8
273	40	17.1	25.7	34.2	42.8	51.3
	50	14.1	21.1	28.2	35.2	42.3
	80	9.5	14.3	19.1	23.8	28.6
	100	8.0	12.0	16.0	20.0	24.0
	120	7.0	10.5	13.9	17.4	20.9

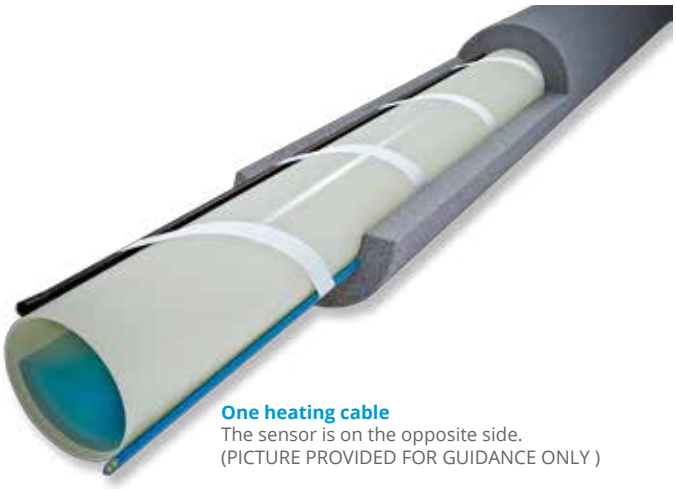
Installation for pipework

Heating cable external to the pipe

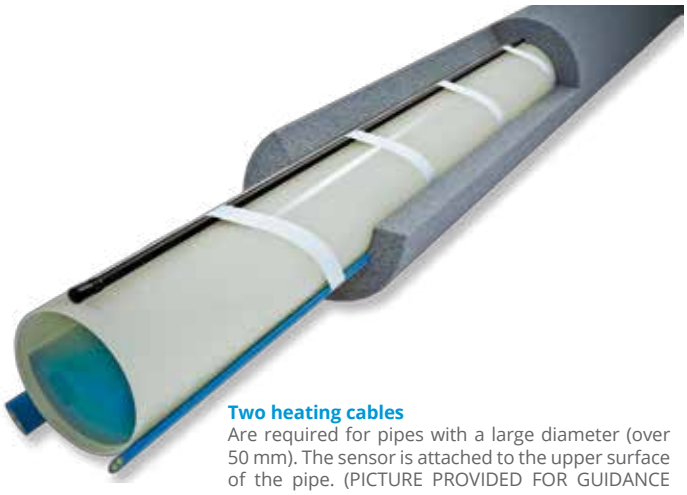
The heating cable is installed horizontally next to the pipe (5 o'clock). When two heating cables are used, the cables are installed on the bottom edge (at 5 and 7 o'clock). The heating cable is attached to the pipe so that the cable is fixed closely to the surface of the pipe. The thermostat sensor controlling the heating is placed on the opposite side from the heating cable.

The following may be used for mounting:

- heat-resistant fiberglass tape (LT20)
- heat-compensating aluminium tape (ALU50) applied along the pipe
- galvanised mesh (SV10)



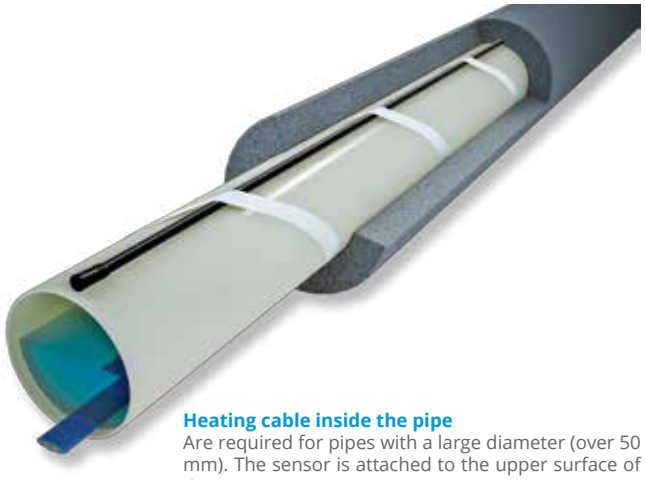
One heating cable
The sensor is on the opposite side.
(PICTURE PROVIDED FOR GUIDANCE ONLY)



Two heating cables
Are required for pipes with a large diameter (over 50 mm). The sensor is attached to the upper surface of the pipe. (PICTURE PROVIDED FOR GUIDANCE ONLY)

Heating cable inside the pipe

The heating cabling inside the water pipe is conveyed to the pipe by a pressure resistant lead-through (EFPLV1). In the installation the cable is horizontal at the lower edge of the pipe. The thermostat sensor is mounted on top of the pipe.



Heating cable inside the pipe
Are required for pipes with a large diameter (over 50 mm). The sensor is attached to the upper surface of the pipe. (PICTURE PROVIDED FOR GUIDANCE ONLY)

EFPLV1 lead-in
Lead-in for Optiheat 10 cable for water pipes.

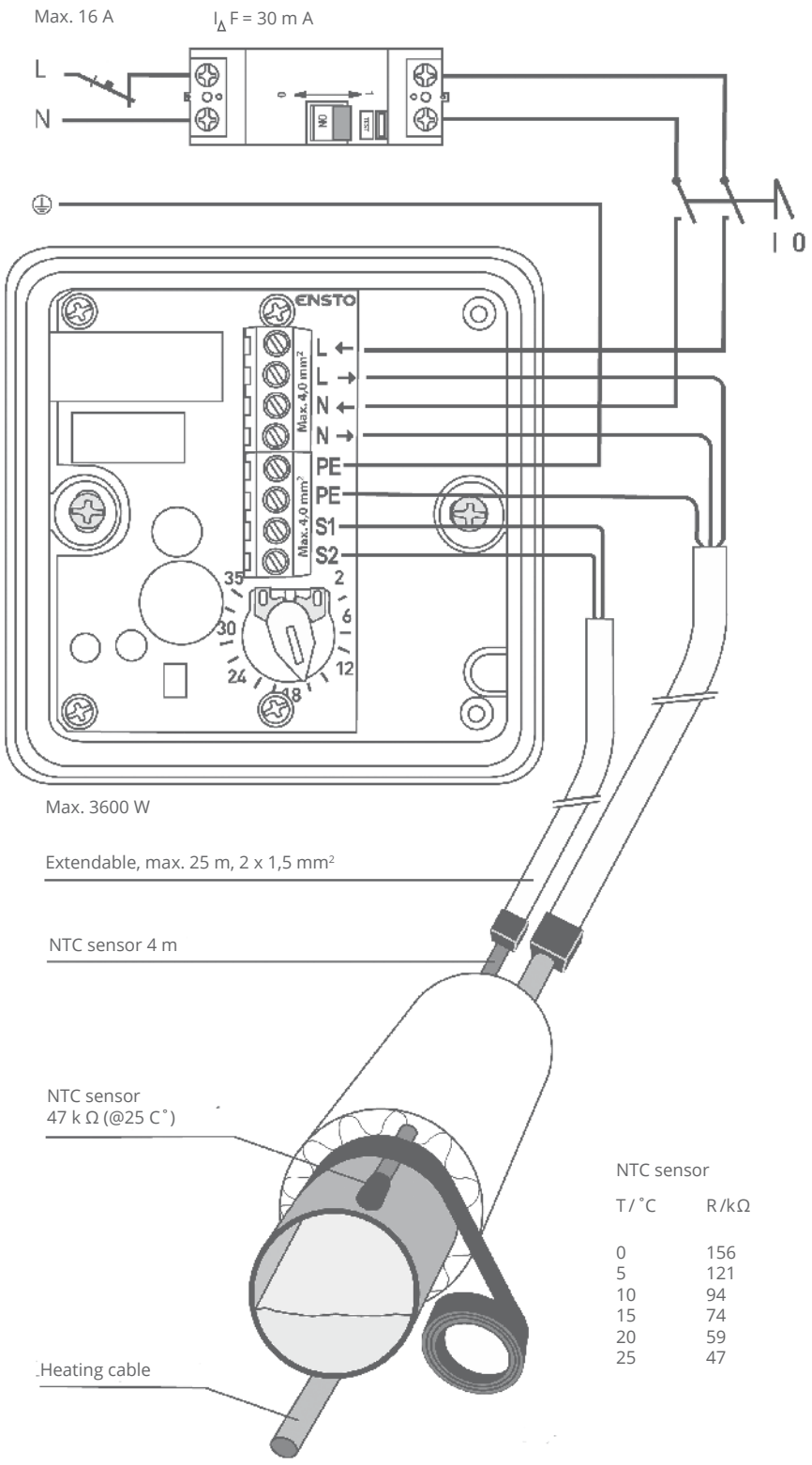
Controlling pipeline

By using ECO500 thermostat

A pipeline frost protection system must always be controlled with an operating switch. A thermostat is recommended to be used to activate heating only when necessary, thus avoiding the unnecessary waste of energy. Without a thermostat control the self-regulating cable's lifetime is shorter because it is activate all the time.

Ready-made Plug'n Heat cables can be directly connected to the socket outlet when heating is required.

Heating implemented with series-resistant cables (Tash) is always controlled with a thermostat. The thermostat sensor is mounted on top of the pipe.



NTC sensor

T / ˚C	R / kΩ
0	156
5	121
10	94
15	74
20	59
25	47

Frost protection of water pipes

Heating cables can be used for preventing water pipes that are vital to a property from being frozen, and for preventing water damage. Near outer walls, the impact of cold bridges is prevented by heating and insulating water pipes and their shutoff valves.

The heating power and cable type of pipes are determined on the basis of the pipe material and size as well as thermal loss. Pipe size, installation environment, and insulation are the factors that affect heat loss most.

Heat loss calculation is based on the principle that the insulation remains dry and does not have cracks etc.. A tolerance factor of 1.3–1.5 x the heat loss value is used in the design (see table on page 19).

Self-regulating cables (Optiheat) and series-resistant cables (Tash) are suitable for frost protection of pipes. The maximum metric outputs of heating cables can be found in the table on page 18.

The heating cable is usually installed on the pipe surface, but it can also be installed inside pipes if so required. In these cases, a heating cable, tested for compliance with regulations for operations involving foodstuffs and designed for drinking-water pipes, must be used.

Near the outer wall, the creation of cold bridges is prevented by heating and insulating the water pipe, water gauge, and shutoff valve. (PICTURE PROVIDED FOR GUIDANCE ONLY)

The heating cable in a water pipe is inserted into the pipe via a pressure resistant lead-through (EFPLV1). (PICTURE PROVIDED FOR GUIDANCE ONLY)

Plug'n Heat

Factory made Plug'n Heat cables are equipped with a plug. The cables have polyethylene sheaths and they're tested for compliance with regulations on use with foodstuffs, meaning that they can be installed in drinking-water pipes too. The heating cables are directly inserted into the pipes via a pressure resistent lead-through EFPLV1. Thanks to the plug, the cables can be plugged directly into a socket outlet, for use whenever heating is required. Additional protection for heating cables must always be provided by means of a residual-current device that is either in the distribution board or integrated with the socket outlet.

Frost protection of valves
(also applicable for brackets)

The pipe's normal frost protection sizing is sufficient. At the valve, an extra cable loop is made in order to offset heat loss through the valve shaft to outside the insulation. The valve and pipe must be insulated. The extra cable loop also provides flexibility for cases in which the valve has to be replaced.

Rain water system
Sizing and Designing

For narrow gutters, the design and power for keeping a rainwater system ice-free is sufficient if it is approx. 20 W/m, i.e., one Tash cable per gutter is adequate. Greater heating power requires installation of more than one heating cable in the gutter.

In large-scale applications is recommended to use the TASH cable and a temperature control system. Using self-regulating cables the control system shall be to keep the starting peaks lower and to ensure the long life time of the cables.

	Gutter width mm	Insta llatio n output per e.g. gutter meter W/m	Installation output per surface to be heated W/m²
Rain water gutter			
Horizontal / vertical	< 150	20–60	
Rain water gutter			
Horizontal	> 150		200
Roof valley	> 150		200

Installation

A rain water system consists of a heating cable as well as mounting accessories and control device.

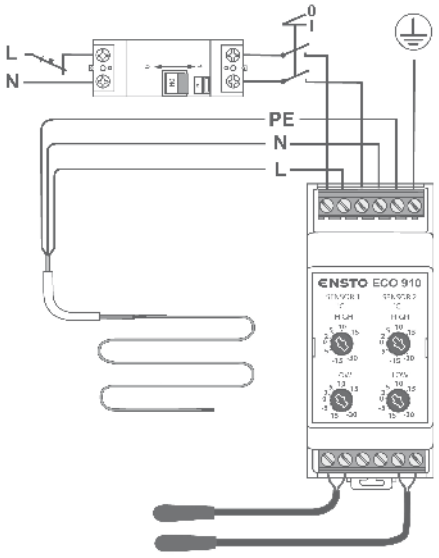
A cable is fastened to the top ends of the vertical gutters with cable clamps. In long vertical gutters (>10m), support cable wire is also used. Cable clamps are mounted, if required, on the horizontal gutters.

Optiheat cables can live freely along the gutters but they're recommended to set to the gutters.

Tash series-resistant cables are fixed to the gutters. Plastic mounting strips, plastic-coated cable clamps or cable wire supports combinations are used on horizontal sections.

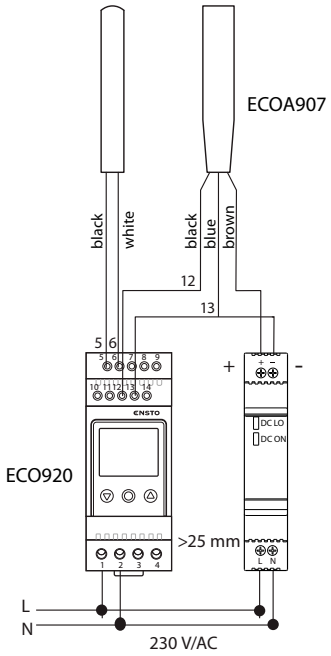
Rain water wells on the roof must be protected from freezing in order to prevent ice damage to the wells and roof structures. In rain water well heating applications, the cable should extend for quite a distance into a warm area, since otherwise downspouts cool across a fairly long distance downwards. Roof wells usually include a factory-installed heating cable to which the supply voltage is connected.

Heating cable	Thermostat	Sensor	Connection accessories	Mounting accessories
Optiheat 20/40	ECO900	ECOA903 + ECOA904	EFPLP1 EFPLP2 EFPLP3	VP300 PPN13 RXBC1230
	ECO910			
	ECO920	ECOA907		
TASH	ECO900	ECOA903 + ECOA904	EFPLP4	VP300 PPN8 PPN6 PPN13 XBC1230
	ECO910			
	ECO920	ECOA907		



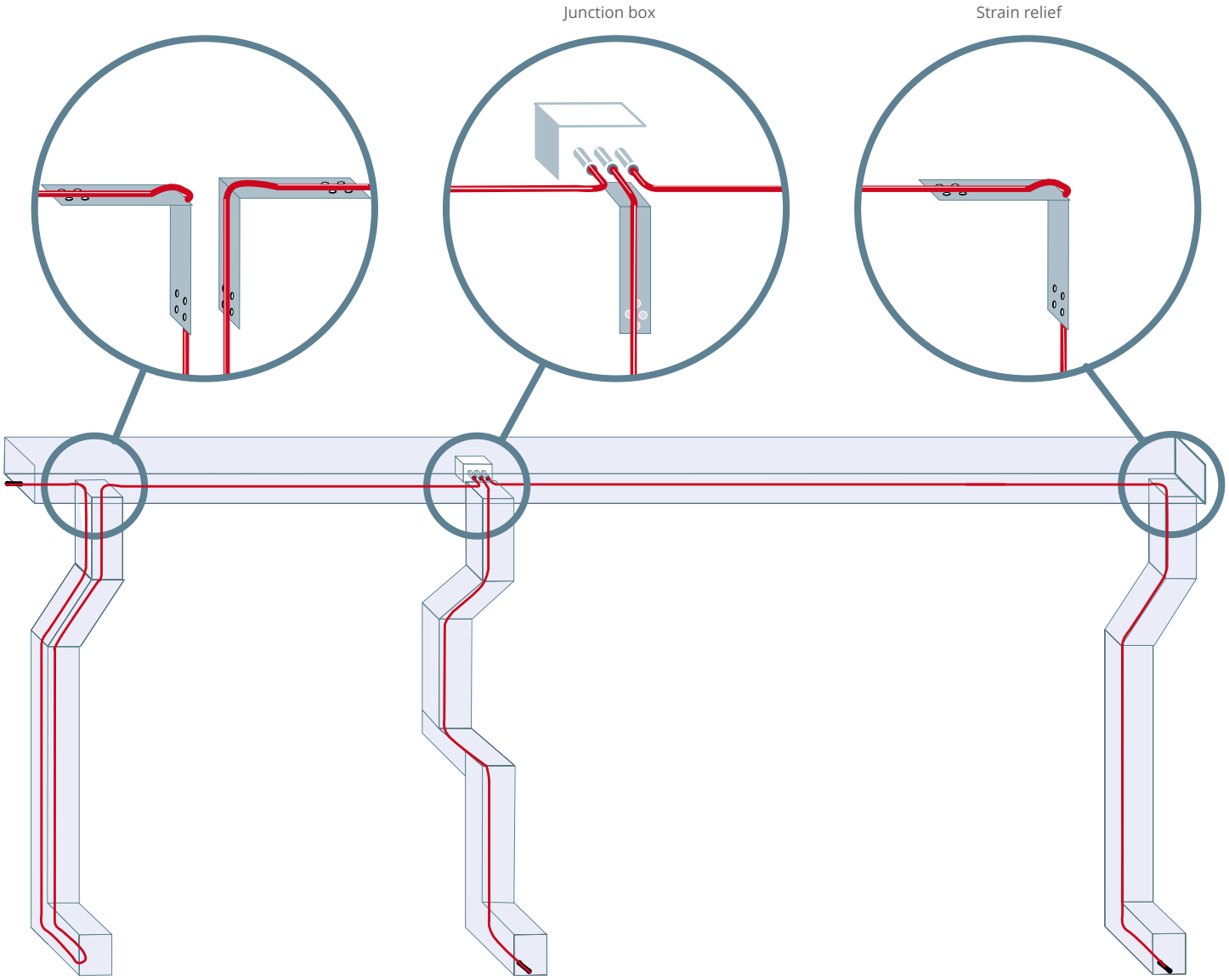
NTC sensor

T / ˚C	R / k Ω
0	156
5	121
10	94
15	74
20	59
25	47



NTC sensor

T / ˚C	R / k Ω
0	32.6
10	18
15	14.7
20	12.1
25	10.0



The frost protection cable and the sensors are attached by using a PPN6/8 mounting strip. The top end of the downpipe is equipped with a VP300 strain relief unit. In long downpipes (>10 m long) a wire is needed for holding the weight of the cable. The rain water system must be kept free of leaves. (PICTURE PROVIDED FOR GUIDANCE ONLY)

Frost protection of rainwater systems in a detached house

Applying Optiheat heating cabling

Design and installation of frost protection for rainwater gutters

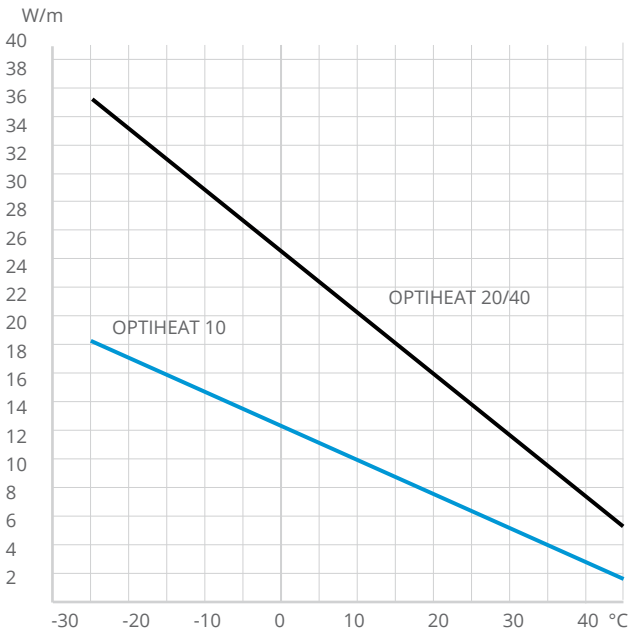
The metric output of the Optiheat 20/40 heating cable is 28W/m–24W/m in an environment with a temperature of –5 °C...+5 °C. In ice water, its metric power output is around 40 W/m.

One or more heating cables are installed in the horizontal sections and downpipe of the rainwater gutter in order to achieve the desired installation output. In the southernmost parts of Finland, one cable is sufficient for narrow gutters; more cables are required in other parts of Finland and for wider gutters (i.e., those with a diameter of over 150 mm).

The heating cable is installed as a loop in horizontal gutters, with the cable ending at the bottom end of the downpipe. Optiheat cables can be left free or inserted into an aluminium pipe. The cable is mounted using a strain relief (VP300) at the top end of a downpipe and, if required, a plastic-coated cable clamp at the bottom end.

Heating cables are connected to junction boxes. If required, a cold lead that is connected to the heating cable by a cable joint e.g. connection kit EFPLP2 can be used. The termination kit has to be used in the other end of the cable.

In Optiheat cables, the switching current is around 1.5 x the operating current. Since around 60 meters of heating cable in ice water can be installed in a group protected with a 10 A circuit breaker, heating is connected to a single group. The heating is controlled via an ECO910, ECO920 or ECO900 thermostat. See the wiring diagram on pages 24 and 29.



Alteration of Optiheat 10 and Optiheat 20/40 heating cables' power output as the ambient temperature changes.

Optiheat heating cables' temperature/power output curves and maximum installation lengths

Maximum installation lengths

Optiheat 10	10 A	16 A	32 A
On pipe surface +10 °C	74 m	89 m	-
On pipe surface ±0 °C	61 m	89 m	-
On pipe surface –30 °C	61m	89 m	-
Optiheat 20/40			
On pipe surface +10 °C	68 m	109 m	129 m
On pipe surface ±0 °C	57 m	92 m	119 m
On pipe surface –10 °C	50 m	79 m	111 m
On pipe surface –20 °C	44 m	70 m	104 m
Optiheat RAMP			
On concrete -10 °C	18 m	28 m	55 m

Maximum cable installation lengths with certain switching temperatures at which the cable's surface temperature is still the same as the ambient temperature.

Example:
Residential house

Frost protection of roof valleys

With heating that has been installed in the roof valleys, ice that has possibly accumulated in the eaves of the roof can be melted. As installation output, approx. 200 W/m² is used, which is approx. 60 W/m in the example site. The amount of installed cable to roof valley is 16m of Optiheat 20/40 cable (point 37 in picture below). Cable length is compared to the Optiheat 20/40 cable's maximum installation length for creation of an installation.

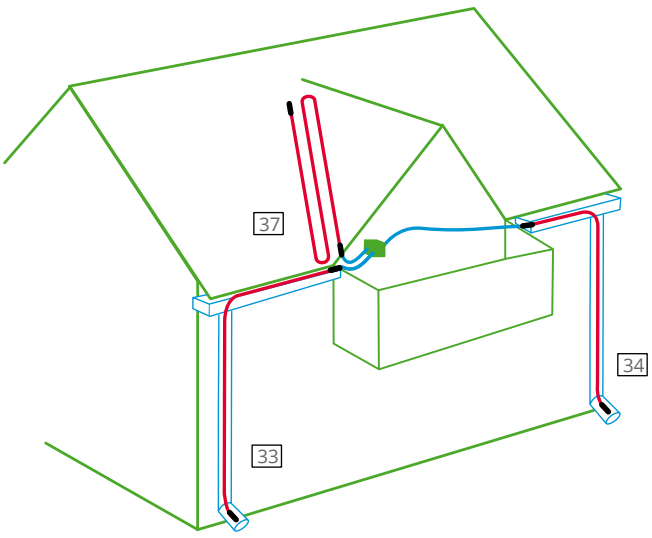
Example calculation:

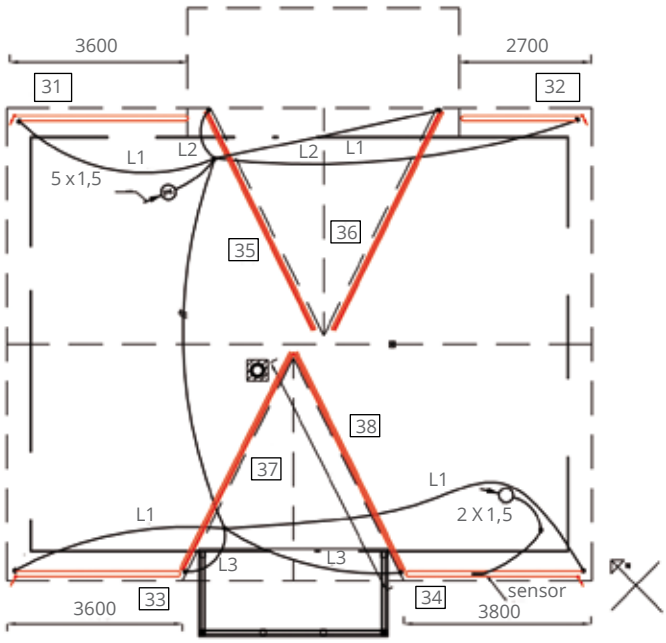
Roof Valley: 5,2m x 0,3m = 1,6m2

Needed heating power: 1,6m2 x 200W/m2 = 320W

Lenght of heating cable: 320W / 20W/m = 16m
Intallation space: 6m2 / 16m = 0,1m = 10cm

	Output/gutter length W/m		Optiheat 20/40, total number of cables
Horizontal gutter	40		2
Vertical gutter	20		1
Roof valley	60		3
Pos.	**Horizontal gutter, m**	**Vertical gutter, m**	**Length of heating cable**
31	3,6	5,8	(2 x 3,6 + 5,8) = 13,0
32	2,7	5,8	(2 x 2,7 + 5,8) = 11,2
33	3,6	5,8	(2 x 3,6 + 5,8) = 13,0
34	3,8	5,8	(2 x 3,8 + 5,8) = 13,4
Total			50,6
Pos.	**Roof VALLEY length, m**	**Roof VALLEY width, m**	**Lämmityskaapelin pituus, m**
35	5,2	0,3	320W / 20W/m = 16m
36	5,2	0,3	320W / 20W/m = 16m
37	5,2	0,3	320W / 20W/m = 16m
38	5,2	0,3	320W / 20W/m = 16m
Total			64

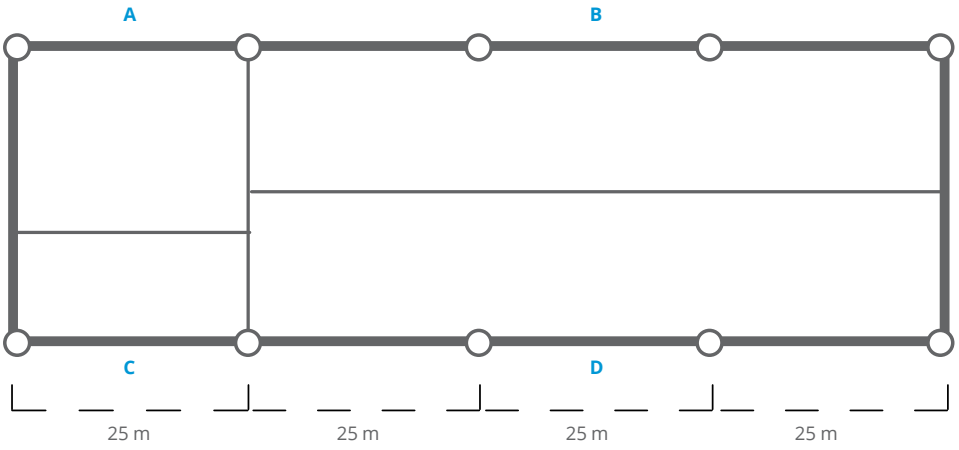




A rainwater system in an industrial hall

Using Tash series-resistant cabling

If the design power in the gutter is 20–60 W/m, 30 W/m is selected. The installation output of the Tash cable can be maximum 20 W/m in a metal gutter, so it is installed as loops, approx. 15 W/m.



Example

Rain water gutter length (A + B):
4 x 25 m + 2 x 5.8 m + 3 x 6.7 m
≈ 132 m

Heating cable (A + B):
length 2 x 132 m = 264 m

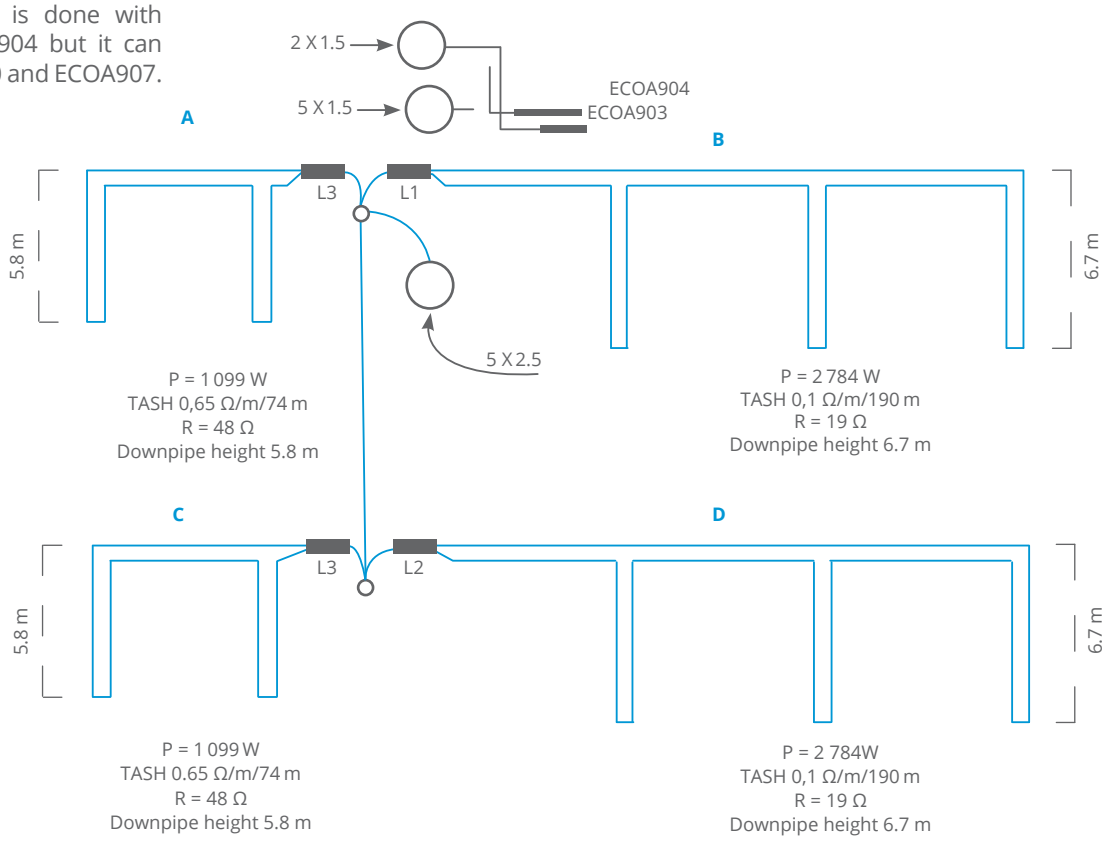
Heating output P1
= 15 W/m x 264 m = 3 960 W

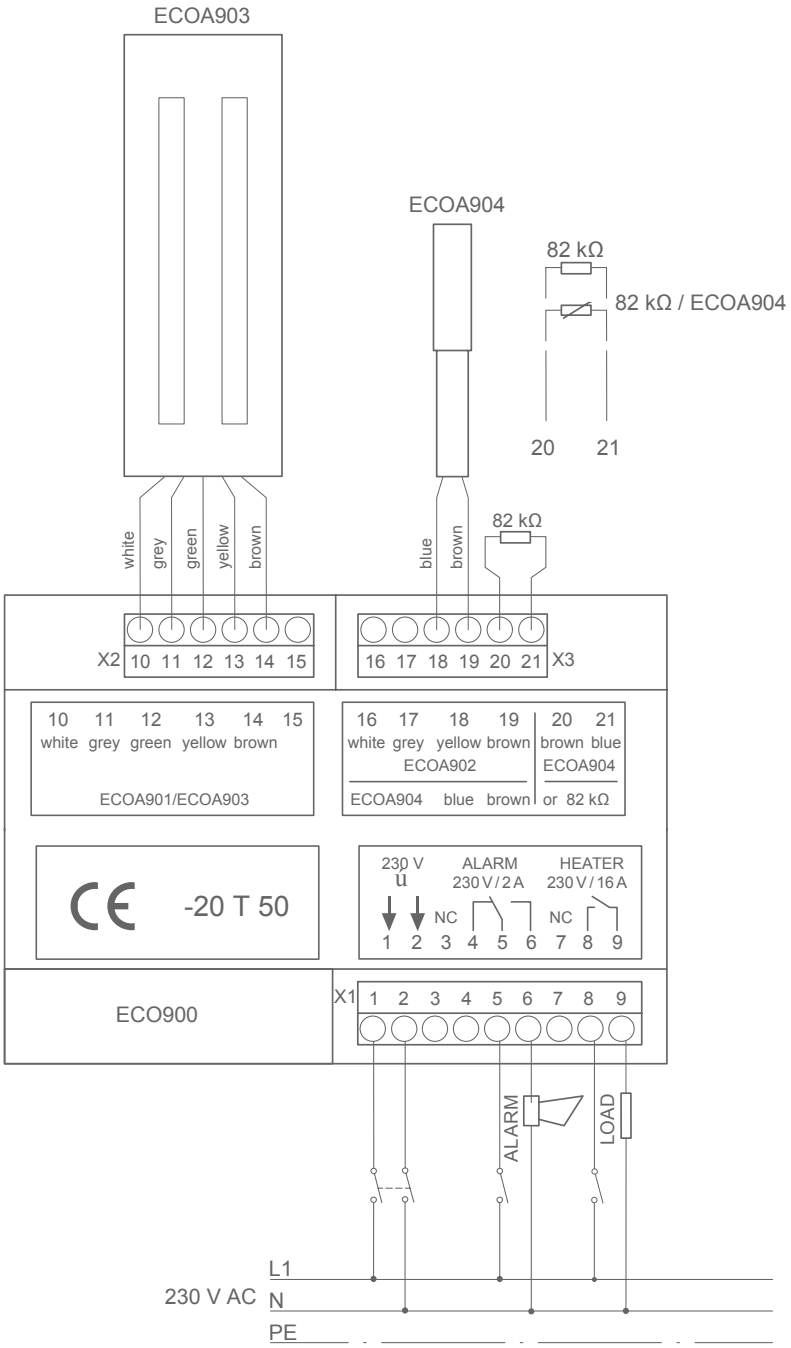
To be connected either to the principal voltage or distributed to two links.

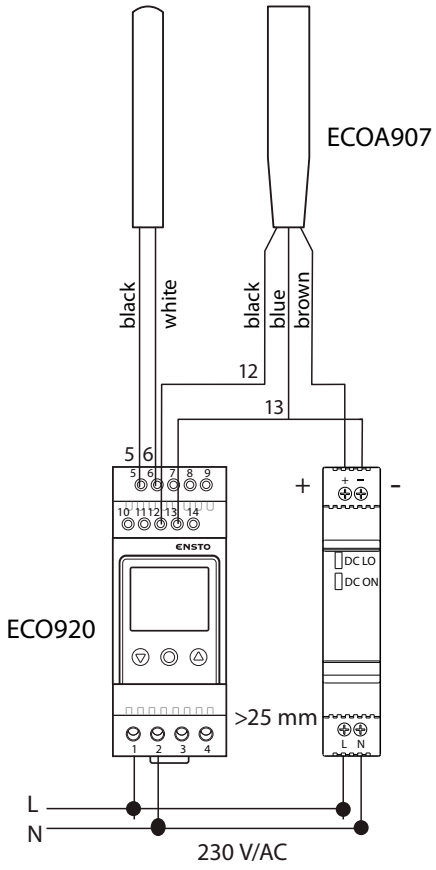
Total output
(A + B + C + D) = 7 920 W

Heating is connected to
a 3 x16 A group.

Control in the example is done with ECO900+ECOA903+ECOA904 but it can be also done with ECO920 and ECOA907.







EXAMPLE	LOOP A (=LOOP C)	LOOP B (=LOOP D)
Gutter length + downpipe length	25 m + 2 x 5.8 m ≈ 37 m	3 x 25 + 3 x 6.7 m ≈ 95 m
Required power output 30 W/m	1 110 W	2 850 W
Heating cable length	2 x 37 m = 74 m	2 x 95 m = 190 m
Heating cable resistance	$(230V)^2$ / (1 110 W x 74 m) ≈ 0,64 Ω/m	$(230V)^2$ / (2 850 W x 190 m) ≈0,1 Ω/m
Selecting heating cable	Tash 0,65 Ω/m	Tash 0.1 Ω/m
Installation power	1 099 W	2 784 W
Total power (A+B+C+D)	2 x (1 099 W + 2 784 W) = 7 766 W	

Outdoor areas
Sizing and planning

The power per square meter used in a frost protection solution for an outdoor area depends on factors including the purpose of use and structures.

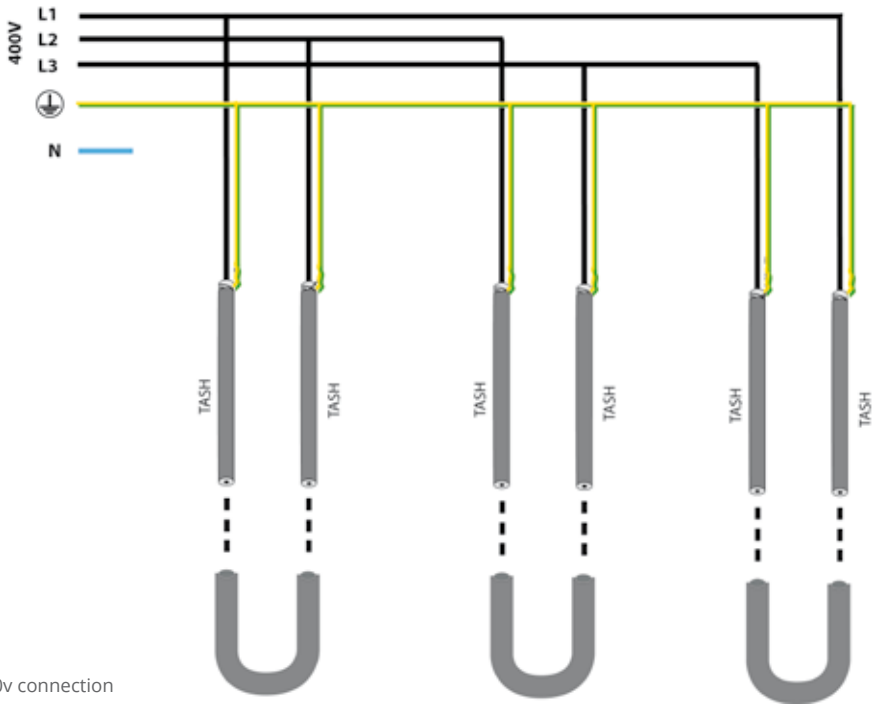
Installation site conditions and the structure of the areas to be heated are always the starting points in the design and implementation of frost protection. The melt water route must be designed in co-operation with other designers in order to prevent melt water from causing problems elsewhere on the site.

The heating cable is selected on the basis of the area and the heating output required. The cables used are self-regulating (Optiheat) and series-resistant cables (Tash) as well as ready-made mats.

The process of designing a frost protection system:

- select the cable type
- select the suitable power per meter output or specific resistance
- determine the installation spacing
- select the control system

Installation Site		Installation Power, W/m²
Pavements (protected from wind)		150–200
Pavements (unprotected)		200–250
Outdoor steps and areas in front of doors		200–300
Parking areas and roadways		250–300
Loading areas (insulated)		250–300
Loading areas (uninsulated)		300–400
Heating Cable Type	**Characteristic**	**Use**
Self-regulating cable (Optiheat)	Easy to design and install. High cable cost	Small areas. Concrete structures, steps, etc.
Frost protection mat (ULLA300)	Quick to install. Stable installation power. Only one power per square meter output	Suited to areas of all sizes. Concrete and sand
Series-resistant cable (Tash)	Low cable cost. Requires careful planning	Versatile areas. Large areas. Concrete and sand.



Tash 400v connection

10 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	30	176	52	308
8	26	203	45	356
10	23	230	40	400
12	21	252	37	432
14	19	278	34	471
16	18	294	32	500
18	17	311	30	533
20	16	331	28	571
22	16	331	27	593
24	15	353	26	615
26	14	378	25	640
28	14	378	24	667
30	13	407	23	696

6 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	38	232	67	398
8	33	267	58	460
10	30	294	52	513
12	27	327	47	567
14	25	353	44	606
16	23	383	41	650
18	22	401	38	702
20	21	420	37	721
22	20	441	35	762
24	19	464	33	808
26	18	490	32	833
28	18	490	31	860
30	17	519	30	889

Tash cable tables

The tables show cable-specific maximum installation lengths with certain metric loads. The tables also indicate outputs in relation to lengths. The values are measured with both 230 V and 400 V switching voltage.

3 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	54	327	94	567
8	47	375	82	650
10	42	420	73	731
12	38	464	67	796
14	35	504	62	860
16	33	534	58	920
18	31	569	54	988
20	30	588	52	1026
22	28	630	49	1088
24	27	653	47	1135
26	26	678	45	1185
28	25	705	44	1212
30	24	735	42	1270

1.5 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	77	458	133	802
8	66	534	115	928
10	59	598	103	1036
12	54	653	94	1135
14	50	705	87	1226
16	47	750	82	1301
18	44	802	77	1385
20	42	840	73	1461
22	40	882	70	1524
24	38	928	67	1592
26	37	953	64	1667
28	35	1008	62	1720
30	34	1037	60	1778

1 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	94	563	163	982
8	81	653	141	1135
10	73	725	126	1270
12	66	802	115	1391
14	61	867	107	1495
16	58	912	100	1600
18	54	980	94	1702
20	51	1037	89	1798
22	49	1080	85	1882
24	47	1126	82	1951
26	45	1176	78	2051
28	43	1230	76	2105
30	42	1260	73	2192

0.82 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	104	620	180	1084
8	90	717	156	1251
10	80	806	140	1394
12	73	884	128	1524
14	68	949	118	1654
16	63	1024	110	1774
18	60	1075	104	1876
20	57	1132	99	1971
22	54	1195	94	2076
24	52	1241	90	2168
26	50	1290	87	2243
28	48	1344	83	2351
30	46	1402	81	2409

0.65 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	117	696	203	1213
8	101	806	176	1399
10	90	904	157	1568
12	83	981	143	1721
14	76	1071	133	1851
16	71	1146	124	1985
18	67	1215	117	2104
20	64	1272	111	2218
22	61	1334	106	2322
24	58	1403	101	2437
26	56	1453	97	2538
28	54	1507	94	2619
30	52	1565	91	2705

0.45 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	140	840	243	1463
8	121	972	211	1685
10	108	1088	189	1881
12	99	1187	172	2067
14	92	1278	159	2236
16	86	1367	149	2386
18	81	1451	141	2522
20	77	1527	133	2673
22	73	1610	127	2800
24	70	1679	122	2914
26	67	1755	117	3039
28	65	1809	113	3147
30	63	1866	109	3262

0.32 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	166	996	289	1730
8	144	1148	250	2000
10	80	806	40	2283
12	117	1413	204	2451
14	109	1517	189	2646
16	102	1621	177	2825
18	96	1722	167	2994
20	91	1817	158	3165
22	87	1900	151	3311
24	83	1992	144	3472
26	80	2066	139	3597
28	77	2147	124	3759
30	74	2234	129	3876

0.21 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	205	1229	356	2140
8	177	1423	309	2466
10	159	1584	276	2761
12	145	1737	252	3023
14	124	1880	233	3270
16	125	2015	218	3495
18	118	2135	206	3699
20	112	2249	195	3907
22	107	2354	186	4096
24	102	2470	178	4280
26	98	2570	171	4456
28	95	2652	165	4618
30	92	2738	159	4792

0.17 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	228	1365	396	2377
8	197	1580	343	2744
10	176	1768	307	3066
12	161	1933	280	3361
14	149	2088	259	3634
16	139	2239	243	3873
18	131	2375	229	4110
20	125	2489	217	4337
22	119	2615	207	4547
24	114	2730	198	4753
26	109	2855	190	4954
28	105	2964	183	5143
30	102	3151	177	5317

0.1 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	297	1781	516	3101
8	257	2058	447	3579
10	230	2300	400	4000
12	210	2519	365	4384
14	194	2727	338	4734
16	182	2907	316	5063
18	171	3094	298	5369
20	163	3245	283	5654
22	155	3413	270	5926
24	148	3574	258	6202
26	80	2066	139	6452
28	77	2147	124	6695
30	74	2234	129	6926

0.05 Ω/m

W/m	230 V length/m	Output /W	400 V length/m	Output /W
6	420	2519	730	4384
8	364	2907	632	5063
10	325	3255	566	5654
12	297	3562	516	6202

Vehicle access ramps

If the traffic using the vehicle access ramp is light, the frost protection control cables are installed on the ramp only at the location of the wheels. When heavy traffic uses the ramp or it is steep, the frost protection heating cables are installed throughout the entire area. If the area has slopes, the route for melting water must also be protected from freezing.

Example 1 Light vehicle access ramp frost protection can be maintained with an ULLA300 frost protection mat (300 W/m^2). In this case, 10 meters long and 4 meters wide, two ULLA300 mats (300.10) are chosen at the location of the wheels, producing a total frost protection output of 6 kW. Heating is regulated either with the ECO900 control system or the ECO910 frost protection control thermostat.

Example 2 An alternative is to install Tash cabling to a strip 0.5 meters wide at the location of the wheels. The cabling is installed into the concrete with maximum load of the cable at 30 W/m. The heating cable must not be installed across the movement joint.

Total output forms 3 kW (1 500 W/ strip). A suitable Tash cable can be chosen from the sizing tables. The load output is 1 500 W and maximum load 30 W/m, i.e., cable type Tash 0.65 Ω is chosen.

Since the total output is rather small (3.1 kW), an ECO 910 frost protection control thermostat is selected for control purposes. The two sensors in the thermostat enable both ground and air temperature measurement.

Frost protection of entrance area

The self-regulating cable is selected according to the size of the area and the required output. The metric output of the Optiheat 20/40 cable varies with the temperature.

Outdoor heating is usually required with an outdoor temperature of –5 °C to 5 °C. In these cases, the cable's metric output (P metric) is around 28W/m–24W/m.

The required cable length is calculated on the basis of the cable's metric output $l_{cable} = P_{length} / P_{metric}$

The cable installation spacing is calculated by dividing the installation area (A installation) by the heating cable length (l_{cable}). $d = A_{installation} / l_{cable}$

Heating is controlled by ECO910, ECO920 or ECO900 frost protection thermostat installed in the panel board or by an operating switch.

Example 1.

With light traffic, it suffices to install frost protection cables only on the wheel routes on the ramp (installation in concrete). In the inclined area, freezing of melt water must be prevented also. (PICTURE PROVIDED FOR GUIDANCE ONLY)

Example 2.

Heavy traffic requires frost protection cables to be installed throughout the ramp area (installation in concrete). In the inclined area, freezing of melt water must be prevented also. (PICTURE PROVIDED FOR GUIDANCE ONLY)

Designing and installing of loading area

Example 1:

The loading area is 24 m long and 4 m wide 300 W/m^2 is used as the installation output, since the underlay of the installation site is insulated. A 300 m^2 ULLA300 frost protection mat is selected, with six mats chosen for the area, four for the large turnaround area and two underneath the wheels.

The total frost protection output comes to 6 x 3.6 kW = 21.6 kW. Frost protection is controlled by means of the ECO900 control system. The ECOA901 snow and ice sensor is installed outside the heated area, with the temperature and humidity sensor, ECOA902, installed in the heated area. Frost protection mats are installed in the sand or concrete located underneath the heated layers (in this case, the asphalt) surface layer.

Heating cable is installed around the rainwater well in order to prevent melt water from freezing, and around the drain output pipe below the ground frost level.

Example 2:

Frost protection of the inclined area, designed for heavy traffic, is implemented with Tash cables throughout the area. There is no insulation underneath the sand, yielding a 400 m^2 design power. The total frost protection output is 24 m x 4 m x 400 m^2 = 38.4 kW, controlled by the ECO900 control system.

A Tash cable with a max. 25 W/m load output is selected from the tables. The Tash 0.45 cable fulfils these requirements with a 400 V voltage. In total, 12 cables are required (supply of 16 A). The length is 122 m and output 2 921 W. Cable connections are shown on page 30.

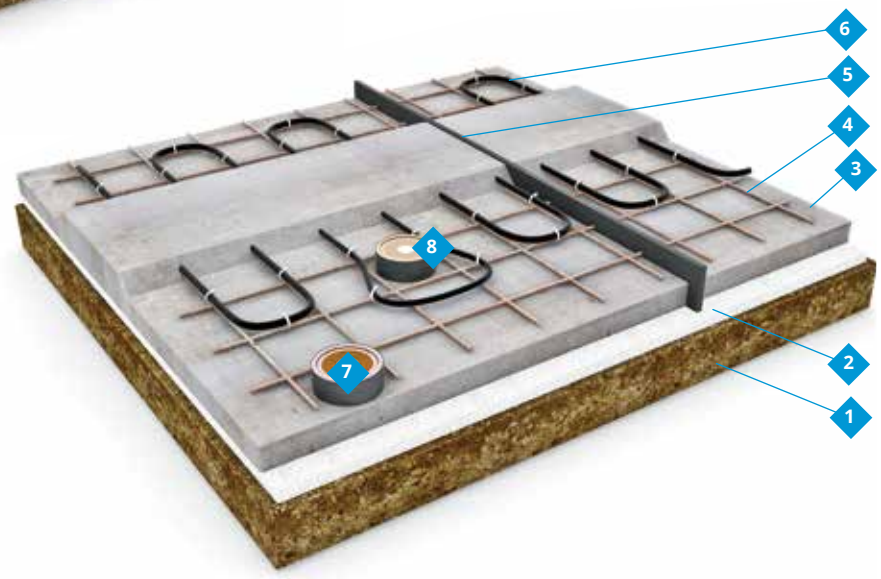
The total output is 12 x 2 921 W = 35.05 kW, the output per square meter 35.05 W/96 m^2 = 365 m^2, and the installation spacing 8 m^2/122 m = 6.5 cm. The cables are installed in the sand or concrete that is under the heated layer (usually tile or asphalt).

Installation examples

Installation of an ULLA300 frost protection mat in the sand underneath the asphalt. There is insulation underneath the sand.

1. Soil / gravel
2. Insulation
3. Sand or concrete
4. ULLA300 frost protection mat
5. Snow and ice sensor
6. Temperature and humidity sensor
7. Asphalt

(PICTURE PROVIDED FOR GUIDANCE ONLY)



Installation of a Tash heating cable in concrete with an expansion joint. No insulation underneath the concrete.

1. Soil / gravel
2. Sand
3. Concrete
4. Reinforcement mesh
5. Expansion joint
6. Tash heating cable
7. Snow and ice sensor
8. Temperature and humidity sensor

(PICTURE PROVIDED FOR GUIDANCE ONLY)

Installation in outdoor areas

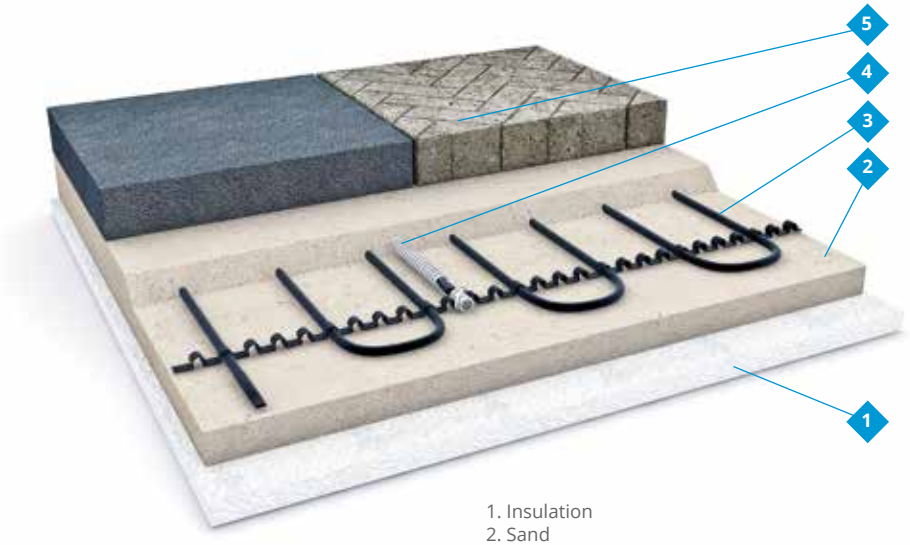
Heating cables are usually installed in the sand or concrete (N.B. not in asphalt!) underneath the heated layer's surface layer. Optimal frost protection efficiency is achieved by insulating the frost-protected area from underneath.

The heating cable is installed at a minimum depth of 5 cm in order to prevent, for instance, traffic from damaging it. The heating cable may not be installed across movement joints. Installation areas are designed in such a manner that only connecting leads (cold leads) cross movement joints.

Installation in sand

In a paved or asphalted area, the heating cable is installed in the installation sand underneath the surface layer. The grain size of installation
sand is 0.063 to 2 mm. There should be around 3 cm of sand between the insulation and the heating cable. Either an ULLA300 frost protection mat or a series-resistant Tash cable is used as the heating cable.

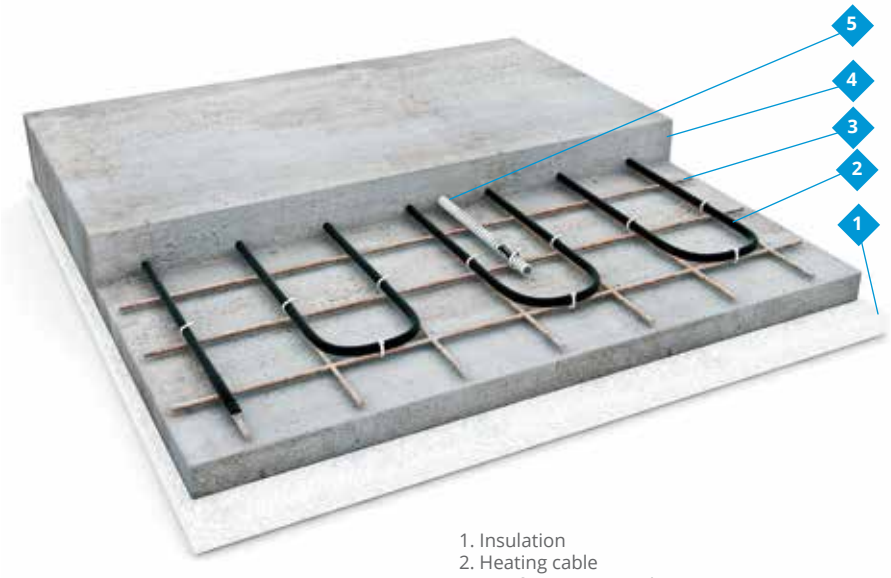
A thin layer of sand is spread over the installed cable and manually leveled using a long-handled leveler with an edge that is either rounded or protected with a strip of felt. The cable's outer sheath must not be damaged and the cable must not come loose from its fastenings. A surface layer is laid over the sand, for example tiles, concrete or asphalt.



1. Insulation
2. Sand
3. ULLA300 frost protection mat
4. Sensor
5. Pavement, asphalt, or concrete
(PICTURE PROVIDED FOR GUIDANCE ONLY)

Installation in concrete

The heating cable is loosely attached to the reinforcement mesh (with, for example, a cable tie) without damaging the cable's outer sheath. In order to aid in any later troubleshooting and repairs, the cable is laid on top of the reinforcement mesh.



1. Insulation
2. Heating cable
3. Reinforcement mesh
4. Concrete
5. Sensor
(PICTURE PROVIDED FOR GUIDANCE ONLY)

Heating of cold room floor

Cold rooms and refrigerated warehouses where the temperature is continuously below –20 °C cool the surrounding floor even when there is good floor insulation. Due to this, all structures connected to the ground/soil, such as foundations and floors, conduct heat away from the ground, causing the ground/soil to freeze. Frost in the ground will then cause damage.

An installed power of around 15–20 W/m^2 is sufficient for the floor structure of a cold room, with a maximum installation spacing of 50 cm.

The amount of thermal loss directed downwards is affected by the U-value of the floor structure, desired ground temperature and the temperature of the cold room.

Example

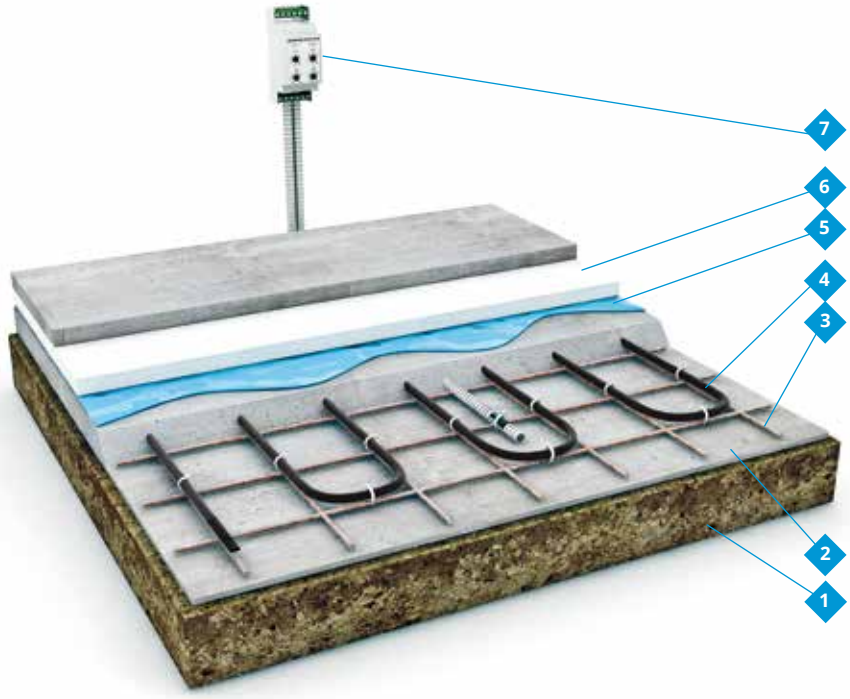
Cold room indoor temperature –25 °C
Ground temperature +4 °C
Floor structure U value 0,1 W/m^2 °C

Thermal loss of the floor:
Φ/A = 29 °C x 0,1 W/m^2 °C = 2,9 W/m^2

Φ/A=dt*U
dT= dT= difference between the temperatures of the cold room and the floor
U= thermal conductance of the floor structure

The cables are installed in the floor in the same way as in normal concrete structures. For safety reasons, two parallel loops and two floor thermostats are recommended. The cables are installed underneath minimum of 5 cm of insulation in the area because the aim is to keep the ground under the insulation free of ice. If there are movement joints, the installation areas of the heating cables are distributed into sections in the room, so that only cold cables are installed across the movement joints.

Doors and doorways are also subject to freezing, so their structures must be protected from freezing with heating cables. This prevents structural damage and the doors can be operated flawlessly and will close properly.



1. Soil/gravel
2. Concrete
3. Reinforcement mesh
4. Tash or Tassu heating cable
5. Moisture barrier
6. Insulation
7. Thermostat

(PICTURE PROVIDED FOR GUIDANCE ONLY)

Frost protection of parking area

By using Tash series-resistant cables

Example

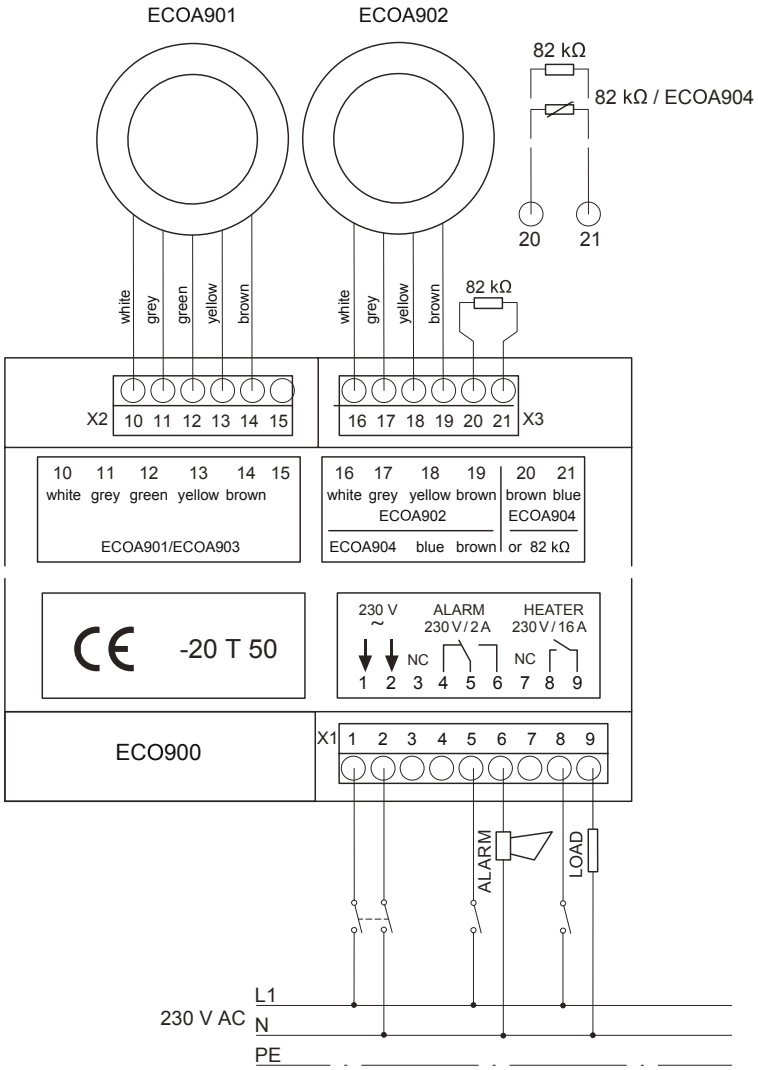
Outdoor area 155 m²
installation in concrete

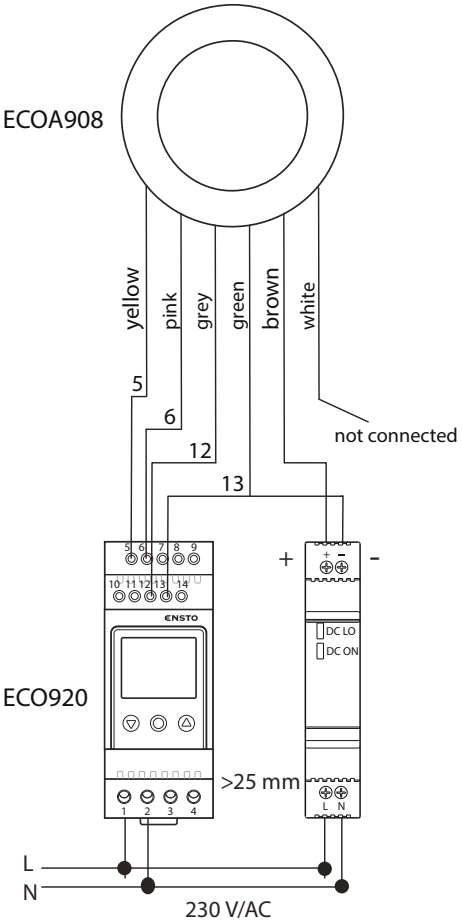
Surface area to be heated 155 m², installation output selected: 300 W/m². Design power achieved: 155 m² x 300 W/m² = 46.5 kW.

The highest permitted power per meter output for Tash cable as installed in concrete is 30 W/m. The installation spacing for the cable comes to = (30 W/m)/(300 W/ m²), i.e., 0.10 m. The total length of the thermal cable is, at minimum, 155 m²/0.1 m = 1 550 m.

When the installation is distributed to three three-phase groups, the output of each group comes to 15.5 kW and the output and length of each individual cable is 5.16 kW and 172 m. The installation area of one cable is thus A = 155 m/9 meaning 17.2 m². After this, the cable can be selected from the Tash cables sizing table. Heating is regulated by the ECO900 control system.

The snow and ice sensor is installed external to the area to be heated, and the temperature and moisture sensor to the area to be heated. (PICTURE PROVIDED FOR GUIDANCE ONLY)





Frost protection of outdoor steps

By using Tash cables

Example

10 steps, installation width 0.9 meters, step advance 0.5 meters.

Surface area to be heated: 10 x 0.9 m x 0,5 m = 4.5 m^2. Installation power output selected: 300 W/m^2. Design power achieved: 4.5 m^2 x 300 W/m^2 = 1 350 W.

The highest permitted power per meter output for Tash cable when installed in concrete is 30 W/m. The installation spacing for the cable comes to = (30 W/m)/(300 W/m^2), i.e., 0.10 m.

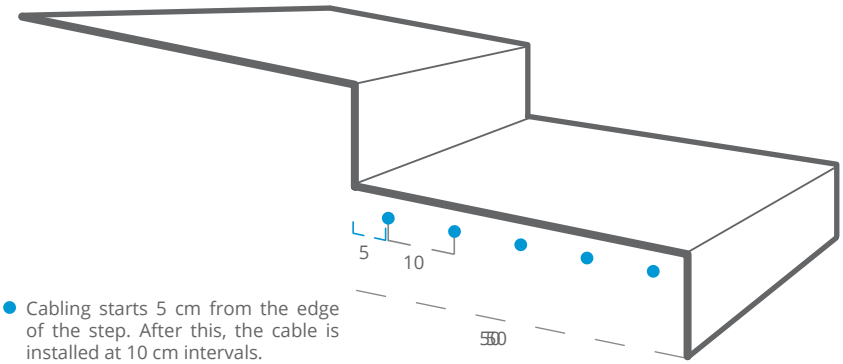
Five cables are installed to one step. Per step, the amount of cabling required is 5 x 0.9 m, i.e., 4.5 m.

The total length of the heating cable is:

- steps 10 x 4.5 m = 45 m
- step ascent 9 x 0.15 m = 1.35 m
- return to connection point
- 9 x 0.5 + 9 x 0.15 = 5.8 m total: 52 meters.

The specific resistance of the cable is 0.75 Ω/m, and Tash cable 0.82 Ω/m is selected from the sizing tables (page 30-31). Installation power output is to 1 240 W, heating cable power per meter output is 24 W and installation power per square meters output is 275 W/m^2. Heating is controlled by installing an ECO900, ECO910 or ECO920 frost protection control thermostat to the panel board.

Series-resistant Tash cables are always installed as loops, with the cold leads led back to the connection box. (PICTURE PROVIDED FOR GUIDANCE ONLY)



● Cabling starts 5 cm from the edge of the step. After this, the cable is installed at 10 cm intervals.

Maintaining the temperature in tanks

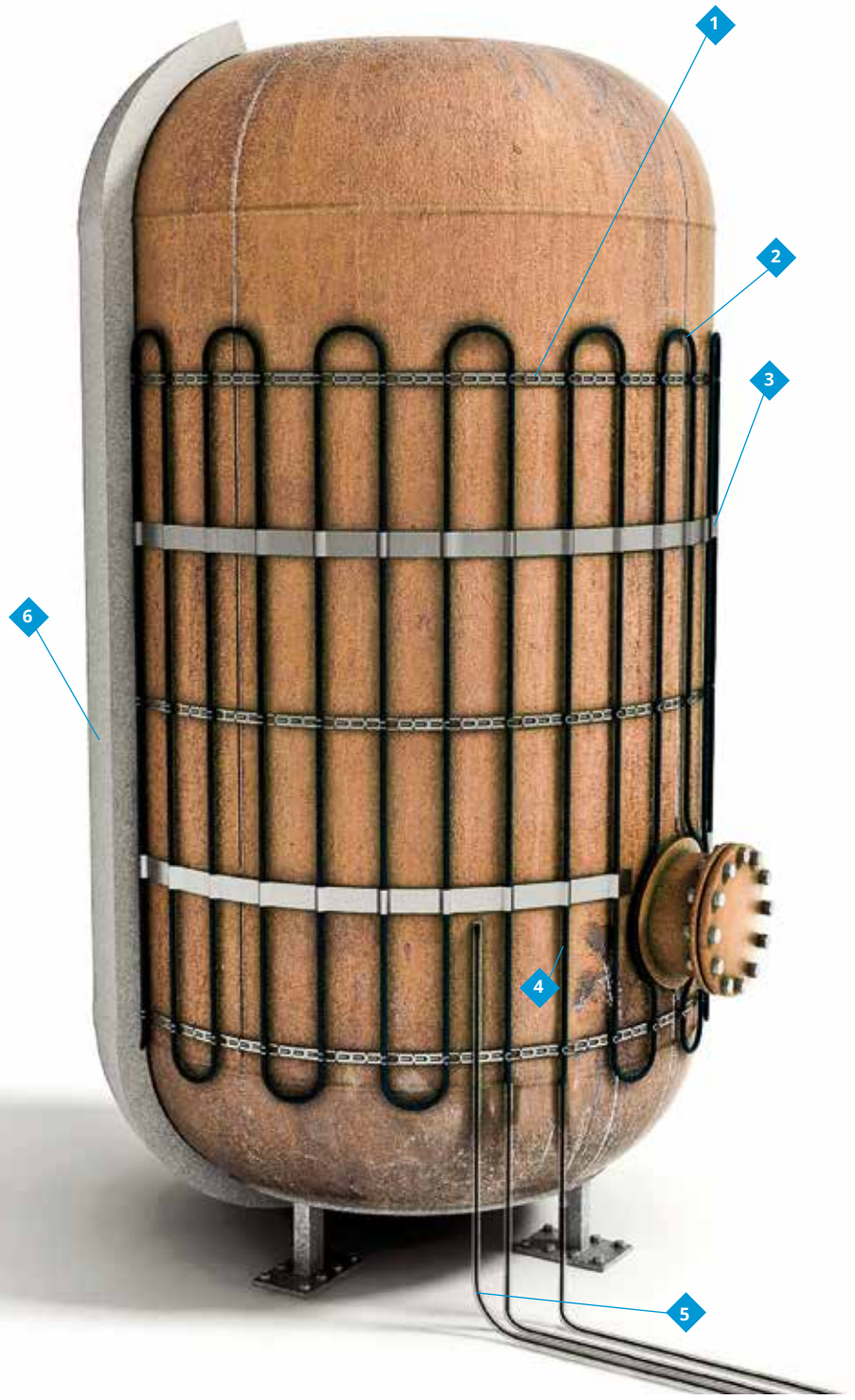
Heating cables can be used to maintain the required temperature of various tanks in order to prevent excessive increases in the viscosity of the liquids within. Heating also prevents freezing damage to the structures.

When choosing the heating cable, all possible thermal losses in the tank and its base must be taken into account. These thermal losses are dependent on the tank's shape, size, understructure type (foundation or stand), the insulation thickness used, the required temperature and the surrounding temperature.

The tank pipes must also be protected from freezing and insulated. Around one third of the tank's top section can be left uncabled, but the entire tank must be carefully insulated.

The appropriate control units are ECO500 , ECO910 or ECO920 thermostats.

Stored liquids have a tendency to somehow escape their container. Thus, it is recommended to check whether the liquid in question can cause cable corrosion, and select the correct cable type for the application. Similarly, easily evaporating liquids may result in an environment classification that requires special solutions.



1. Fixing ribbon
2. Tash heating cable
3. Aluminium tape
4. Heating cable / cold lead joint
5. Sensor
6. Insulation

(PICTURE PROVIDED FOR GUIDANCE ONLY)

Frost Protection

Products

The high quality of our products guarantees reliable performance for years to come.

Frost protection systems

ULLA300 -cable heating mat

Factory-made and tested ULLA300-cable heating mats for preventing vehicle access ramps, entrances and pavements from freezing. Can be rapidly and easily laid in concrete, sand and asphalt. A ready-to-connect mat is easy to install, the gaps always being correct. It can be shaped without cutting the installations strips. The output is 300 W/m². Nominal voltage 230 V. Standard width of mats are 0.95 m, and lengths at 1 m intervals from 2 to 12 m. Cold ends MCMK 5 meter and length of mat + 5 m.

Type	GTIN -code	Description	Pack.qty
ULLA300.2	64 100 81 688 020	0.95 x 2 m, 2 m², 600 W	1/6
ULLA300.3	64 100 81 688 037	0.95 x 3 m, 3 m², 900 W	1/6
ULLA300.4	64 100 81 688 044	0.95 x 4 m, 4 m², 1200 W	1/6
ULLA300.5	64 100 81 688 051	0.95 x 5 m, 5 m², 1400 W	1/6
ULLA300.6	64 100 81 688 068	0.95 x 6 m, 6 m², 1800 W	1/6
ULLA300.7	64 100 81 688 075	0.95 x 7 m, 7 m², 1900 W	1/6
ULLA300.8	64 100 81 688 082	0.95 x 8 m, 8 m², 2500 W	1/6
ULLA300.9	64 100 81 688 099	0.95 x 9 m, 9 m², 2800 W	1/6
ULLA300.10	64 100 81 688 105	0.95 x 10 m, 10 m², 3000 W	1/6
ULLA300.11	64 100 81 688 112	0.95 x 11 m, 11 m², 3100 W	1/6
ULLA300.12	64 100 81 688 129	0.95 x 12 m, 12 m², 3600 W	1/6

Plug'n Heat -heating cable

A cable, fitted with a plug, for keeping piping, water meters and other frost-prone places ice-free. The heating cable is a self-regulating cable, making a thermostat unnecessary. It can also be installed inside drinking water pipes. Length of connection leads 2.5 m. Power rating 10 W/m. Voltage 230 V. IP68. Plug'n Heat frost protection cable is suitable for use inside drinking water pipes, EFPLV1 lead-in is recommended.

Type	GTIN -code	Description	Pack.qty
EFPPH2	64 100 81 684 220	Frost protection cable 2 m, 20 W	1/24
EFPPH3	64 186 77 638 671	Frost protection cable 3 m, 30 W	1/24
EFPPH4	64 100 81 684 244	Frost protection cable 4 m, 40 W	1/24
EFPPH5	64 186 77 638 688	Frost protection cable 5 m, 50 W	1/24
EFPPH6	64 100 81 684 268	Frost protection cable 6 m, 60 W	1/24
EFPPH8	64 186 77 638 695	Frost protection cable 8 m, 80 W	1/24
EFPPH10	64 100 81 684 305	Frost protection cable 10 m, 100 W	1/24
EFPPH12	64 186 77 638 701	Frost protection cable 12 m, 120 W	1/24
EFPPH15	64 100 81 684 350	Frost protection cable 15 m, 150 W	1/24
EFPPH20	64 100 81 684 404	Frost protection cable 20 m, 200 W	1/24

Frost protection systems

Tash single-conductor heating cables

The TASH single-conductor series resistant cables are designed for keeping outdoor areas, pipes and containers ice-free. Outer sheet of cross linkable HFFR compound. Max loading 30 W/m (concrete), 25 W/m (sand), 20 W/m (pipe surface). Operating temperature under current 80 ºC, momentarily 160 ºC. Max voltage 500 V. Min. bending radius 5x outside diameter of cable.

Type	GTIN -code	Description	Pack.qty
TASH0.05	64 100 04 301 555	Tash-series resistant cable. 0.05 ohm/m	1/2000
TASH0.1	64 100 04 301 500	Tash-series resistant cable. 0.1 ohm/m	1/2000
TASH0.17	64 100 04 301 562	Tash-series resistant cable. 0.17 ohm/m	1/2000
TASH0.21	64 100 04 301 517	Tash-series resistant cable. 0.21 ohm/m	1/2000
TASH0.32	64 100 04 301 326	Tash-series resistant cable. 0.32 ohm/m	1/2000
TASH0.45	64 100 04 301 579	Tash-series resistant cable. 0.45 ohm/m	1/2000
TASH0.65	64 100 04 301 593	Tash-series resistant cable. 0.65 ohm/m	1/2000
TASH0.82	64 100 04 301 586	Tash-series resistant cable. 0.82 ohm/m	1/2000
TASH1	64 100 04 301 661	Tash-series resistant cable. 1.0 ohm/m	1/2000
TASH1.5	64 100 04 301 609	Tash-series resistant cable. 1.5 ohm/m	1/2000
TASH3	64 100 04 301 616	Tash-series resistant cable. 3 ohm/m	1/2000
TASH6	64 100 04 301 630	Tash-series resistant cable. 6.0 ohm/m	1/2000
TASH10	64 100 04 301 647	Tash-series resistant cable. 10 ohm/m	1/2000

Optiheat self-regulating cables

Ensto Optiheat self-regulating frost protection cables are energy-efficient solutions for rainwater systems, roofs, stairs, ramps and outdoor areas.

Type	GTIN -code	Description	Pack.qty
EFPO10	64 100 04 313 107	Optiheat 10, power 10 W/m, blue	1/1000
EFPO20	64 186 77 639 180	Optiheat 20/40, power 20 W/m, black	1/1000
EFPO20.250	64 186 77 639 197	Optiheat 20/40, power 20 W/m, black	1/250
EFPORAMP	64 186 77 639 159	Optiheat Ramp, power 50 W/m, yellow	1/250

Tash accessories

By using EFPLP4 connection kit a single or a twin-conductor heating cable can be connected to a cold cable or another heating cable. The kit can also be used for connecting cold cables to both ends of a single conductor cable.

Type	GTIN -code	Description	Pack.qty
EFPLP4	64 186 77 630 767	Jointing kit for single conductor Tash- and Lask heating cables	1/50

Optiheat accessories

EFPLP1 jointing kit containing joint and shrink accessories for the watertight extension of a cable by means of a connector cable (MMJ or MMCK) and a termination accessory. EFPLP2 jointing kit for connecting a heating cable to a junction box or a termiantion accessory. The cable is laid from the point of installation to the box either as it is or in a protective tube. The kit includes a cable-shaped rubber seal. EFPLV1 pressure resistant lead-through for installing Optiheat 10 and Plug'n Heat cables inside a water pipe.

Type	GTIN -code	Description	Pack.qty
EFPLP1	64 186 77 630 002	Extension sleeve + termination accessory	1/20
EFPLP2	64 186 77 630 019	Junction box + termination accessory	1/20
EFPLP3	64 186 77 630 026	Optiheat – Optiheat extension	1/20
EFPLP5	64 186 77 639 333	Splice package Optiheat Ramp	1/20
EFPLV1	64 186 77 630 033	Lead-in for Optiheat 10-cable for water pipes	1/12

Heating cable attachment accessories

LT20 heat resistant tape for attaching a heating cable for piping. ALU50 aluminium tape, which is attached to the surface of the pipe in the same direction as the cable. SV10 is used for improving heat exchange to the pipe surface or valve. XBC1230 fixing strip, to which the heating cable is attached to ensure the correct gaps. PPN6 plastic mounting strip for attachment of Tash heating cable and assurance of correct gaps. PPN8 plastic mounting cable fixing strip for 2-conductor Tash heating cable attachment and to ensure correct gap. VP300 cable strain reliever for use when laying a heating cable in a drainpipe.

Type	GTIN -code	Description	Pack.qty
LT20	64 186 77 631 764	Heat resistant tape, 12 mm x 20 m	1/16
ALU50	64 186 77 631 702	Aluminium tape, 50 mm x 50 m	1/10
SV10	64 186 77 631 795	Galvanized mesh, 50 mm x 10 m	1/10
XBC1230	64 100 13 290 024	Galvanised attachment ribbon 20 m, installation gap 30 mm	1/10
PPN6	64 186 77 631 771	Plastic mounting, 5.5 mm	1/100
PPN8	64 100 13 290 611	Plastic mounting, 6.5 mm	1/100
PPN10	64 186 77 637 766	Kaapelikiinnike syöksytorveen (25kpl)	25/300
PPN12	64 186 77 637 773	Kaapelikiinnike räystäskouruun tai katolle (25kpl)	25/100
VP300	64 186 77 632 082	Strain relief	1/20

ECO500-thermostat

For frost protection control of pipes. Nominal voltage 230 V. Nominal current 16 A res. Max load 3600 W. Adjustment range +2 ... +35 °C. Sensor 4 m, extendable up to 25 m with 2 x 1.5 mm². Sensor 47 kohm / 25 °C. Box AP9. IP55. The sensor is installed to the top surface of the pipe when the cable is used inside the pipe. When using the cable outside the pipe, the sensor must be installed opposite of the heating cable, to the presumably coldest spot.

Type	GTIN -code	Description	Pack.qty
ECO500	64 186 77 635 830	Electronic thermostat, 3600 W, for frost protection of drain pipes	1/12

ECO910-thermostat

DIN rail mounted frost protection thermostat with two sensors. Frost protection thermostat suits for the control of frost protection in outdoor areas, ramps, roofs and rainwater systems. Both two sensors are used for frost protection in outdoor areas and one sensor for frost protection in rainwater systems. Adjustment range of thermostat is –30 ... +15 °C, IP20. Operating voltage 230 V. Maximum load 16 A. Sensor 47 kohm / 25°C. Length of sensor cable 4 m (extendable up to 25 m).

Type	GTIN -code	Description	Pack.qty
ECO910	64 186 77 636 141	Frost protection thermostat, DIN-rail mounted	1/12

ECO920-thermostat

Frost protection thermostat with LCD LCD-display. Frost protection thermostat suits for the control of outdoor areas and rainwater systems. The thermostat is mounted on a DIN rail, and the adjustment range of temperature is -20 °C...+10 °C.

Type	GTIN -code	Description	Pack.qty
ECO920	64 186 77 639 227	Frost protection thermostat, LCD	1/10
ECOA907	64 186 77 639 234	Roof sensor, humidity	1/12
ECOA908	64 186 77 639 241	Ground sensor, humidity and heat	1/10
ECOA909	64 186 77 639 302	ECO920 NTC-sensor, 10kohm 6 m	1/10

ECO900-thermostat

Fully automatic snow- and ice melting control unit. Heat- and humidity informations. LCD-display with continuousinformation of temperature and humidity. Available versions in Finnish, Swedish, German, English, Czech and French. Diagnosis of faults and potential-free information in case of fault situation. Possibility of manual steering. DIN-rail mounting. 230 V.

Type	GTIN -code	Description	Pack.qty
ECO900	64 186 77 630 866	Control device of frost protection in outdoor areas, ramps and roofs	1/180
ECOA901	64 186 77 630 873	Heated snow and ice sensor for ground installation	1/128
ECOA902	64 186 77 630 880	Humidity and temperature sensor for ground installation	1/128
ECOA903	64 186 77 630 897	Heated snow and ice sensor for rainwater guttering	1/180
ECOA904	64 186 77 630 903	Sensor for temperature measurement in gutters	1/180

Index of product types

Index of SSTL-codes

Index of GTIN -codes

EL10EN/5/2017/1000

ENSTO

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