3.1 General information

DEVI's pipe tracing systems consist of deviflex™ heating cables, devireg™ thermostats and installation accessories. The devireg™ thermostats with sensors ensure that optimal results are achieved with the least possible amount of energy.

DEVI's pipe tracing systems may be used for two main purposes:

1. Frost protection of pipes.
2. Maintenance of the required temperature in pipes.

Frost protection systems are installed where there is a need to prevent water and sanitary pipes from freezing and becoming ice-damaged.

Temperature maintenance systems ensure that hot water or fluid pipes maintain the required temperature.

DEVI's pipe tracing systems may be used on the inside and outside of pipes, for indoor and outdoor pipe networks as well as for pipes above and below the ground.

The advantages of the pipe tracing systems are:

- Ice-free pipes
- Constant flow in pipes
- Depth reduction for underground pipes
- No repair costs after a hard winter
- No hardening of fatty products in pipe systems
- Efficient hot water supply

3.2 Heating cables on pipes

Heating cables can be installed on pipes above and below the ground.

Installing the cable on outdoor pipes above the ground

Outdoor pipes above the ground are especially exposed to cold and consequently, good insulation is necessary.

There are several ways in which the cable may be attached to the pipe:

1. One or more cables are led in a straight line along the side of the pipe, see fig. 1+2.
2. The cable is attached to the pipe in waves, see fig. 3.
3. The cable is wrapped in a spiral around the pipe, see fig. 4+5.

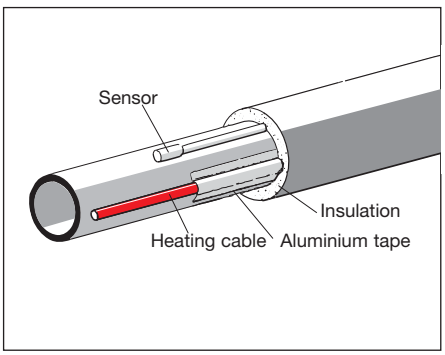


Fig. 1

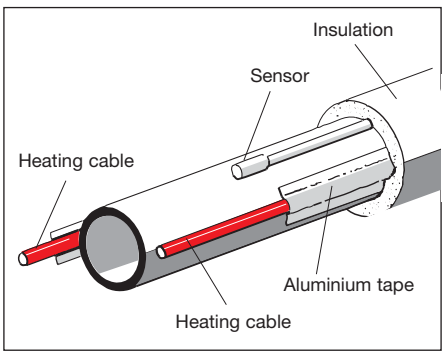


Fig. 2

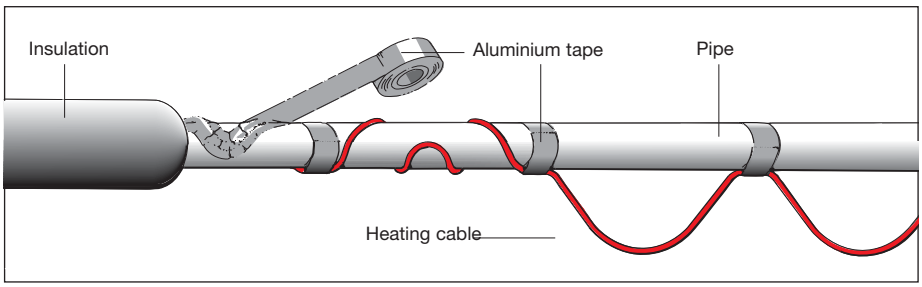


Fig. 3

Pipes are usually insulated with plastic foam, mineral wool or another kind of insulation, which can range in thickness, typically from 10-50 mm. The insulation should be protected against damp and moisture that could damage the insulation and reduce its efficiency.

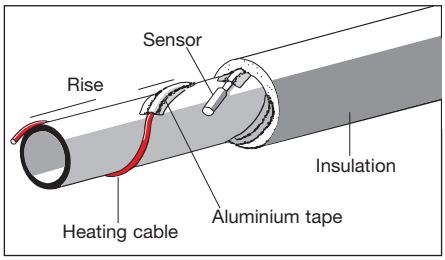


Fig. 4

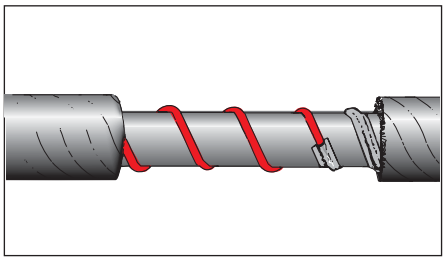


Fig. 5

If the cables are installed above the ground in a case, the case must be safe and solid. It should also be marked with a distinct warning sign, i.e.

"WARNING: 230 VOLT HEATING CABLES".

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

- the outdoor pipe is not more than 50 mm in diameter,
- the insulation is not less than 50 mm,
- the outdoor temperature does not fall below -30°C.

Installing the cable on outdoor pipes below the ground
When pipes with frost protection systems are installed below ground level, they need not be buried as deeply as if there had not been any pipe tracing.

The heating cable is mounted directly on the pipe and secured with aluminium tape ensuring an optimal contact between the cable and the pipe.

All pipe trenches should be distinctly marked to indicate that electric heating cables have been installed on/in them. This can be done by laying a plastic tape (red, yellow etc.) over the area or on the outer pipe in which the cables are installed. It should also be marked with a distinct warning sign, i.e. " **WARNING: 230 VOLT HEATING CABLES".**

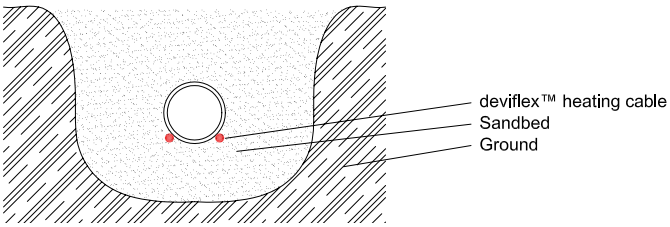
The following examples are designed to assist in the choice of frost protection systems and show some of the common installation possibilities.

Plastic pipe with heating cables installed in a larger plastic pipe
This installation method is often used in connection with under water pipes. It can protect the pipes to a certain extent against mechanical influences and help reduce the cooling output of the surrounding water.

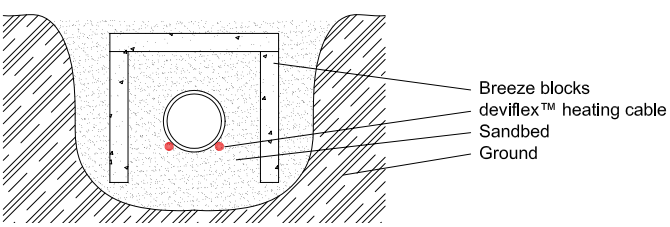
Pipe with heating cables installed in breeze blocks
Breeze blocks offer a solid protection for the pipes and the cables. The breeze blocks should be placed on a stable foundation of stones.

Pipe with heating cables installed for frost protection
The top of the pipe is placed at least 50 cm below ground level and protected by concrete tiles. The cable is surrounded by sand. A plastic tape (red, yellow etc) is laid on top of the concrete to indicate that heating cables are placed just below.

Pipe installed with heating cable

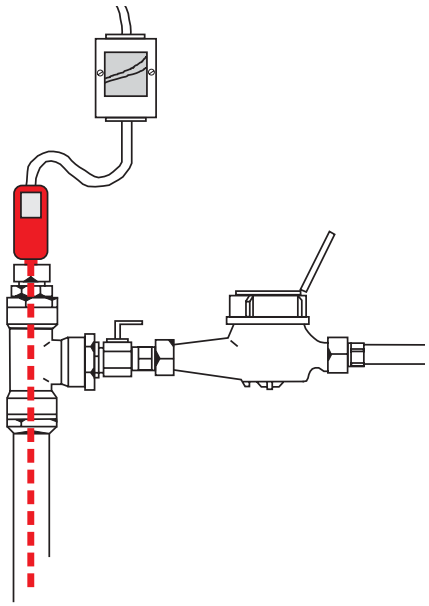


Pipe installed with heating cable in breeze blocks

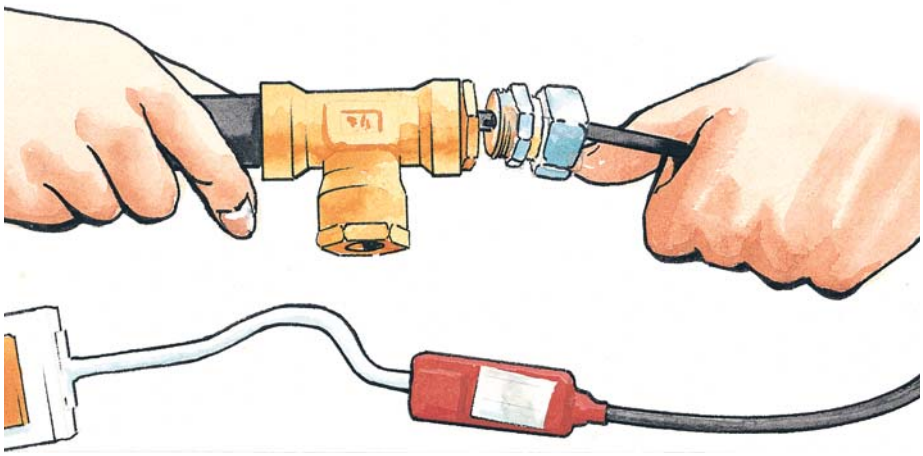


3.3 Heating cables inside pipes

It is appropriate to install the heating cable inside the pipe. For this installation method one can choose between the deviflex™



DTIV-9 (230 V, 9 W/m) and the devi-pipeheat™ 10. The method is very efficient as the cable gets into direct contact with the substance to be heated.



The deviflex™ DTIV-9 is designed to be installed inside pipes.

The heating cable is relatively stiff, which makes the installation easier. The polyethylene coating prevents any output or alteration in the taste of the drinking water.

This fact together with the fact that the heating cable is inside the pipe are great advantages for farmers and gardeners, who need a frost free water supply in their outdoor systems.

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

Heating cables for drinking water pipes must be connected via a RCD relay. It should also be marked with a distinct warning sign, i.e. **“WARNING: 230 VOLT HEATING CABLES“.**

3.4 Self-limiting heating cables

DEVI’s self-limiting heating cables are used for ice and snow melting in roof gutters and downpipes, for frost protection of pipes, and for temperature maintenance of the hot-water supply.

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

This autonomous output regulation takes place on the entire cable according to the actual ambient temperature. If the ambient temperature rises, the heating output of the cable is reduced. Due to this self-limiting capability, overheating of the cable can be avoided, also if two heating cables are touching or crossing.

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

The maximum output for the different installations and the operating outputs must be observed.

The bending diameter of the heating cables must not be less than 50 mm. The cable must only be bent on the flat side.

In order to limit the power consumption the heating cable should be switched off if it is longer than approx. 3 m, i.e. by using a devireg™ thermostat.

IMPORTANT!
DO NOT interconnect the two conductors of the self-limiting cable as this may cause a short circuit!

There are several different types of self-limiting cables:

1. The devi-iceguard™ is used for ice and snow melting in roof gutters and down pipes.
2. The devi-pipeguard™ is used for all types of cold pipes/installation for frost protection and to avoid the hardening of fatty products in the pipe system.
3. The devi-hotwatt™ is used in tracing systems to maintain the required temperature of hot water or other fluids in all hot pipes.

Specifications of the self-limiting cables

Cable	Colour	Application	Output	Dimension	Sheath
devi-iceguard™ 18	Black	Roof and gutter	18W/m at 0˚C*	6 x 12 mm	Polyolefin
devi-pipeguard™ 10	Blue	On pipes	10 W/m at 10˚C	6 x 12 mm	Polyolefin
devi-pipeguard™ 15	Black	On pipes	15 W/m at 10˚C	6 x 12 mm	Polyolefin
devi-pipeguard™ 25	Red	On pipes	25 W/m at 10˚C	6 x 12 mm	Polyolefin
devi-pipeheat™ 10	Blue	On/in pipes	10 W/m at 10˚C	6 x 8 mm	Helar
devi-hotwatt™ 55	Green	On pipes	8 W/m at 55˚C	6 x 12 mm	Polyolefin

*Output in ice approx. 30 W/m
Voltage 230 V AC
Max. temperature ON = 65˚C, max. temperature (accumulative) OFF = 85˚C
However, for devi-hotwatt™ 55 ON = 80°C, max. temperature (accumulative over 1000 hours) = 100°C

The considerations and calculations which should be made before installing a tracing system consisting of self-limiting cables are similar to those for deviflex™. Unlike deviflex™ cables, however, self-limiting cables can quite simply be cut or extended to the appropriate length.

The maximum lengths of self-limiting cables are presented in the table below.

Max. cable length at different ambient temperatures

	Blue (10 W/m)					Black (15/18 W/m)					Red (25 W/m)				
	Fuse*					Fuse*					Fuse*				
	10A	16A	20A	32A	40A	10A	16A	20A	32A	40A	10A	16A	20A	32A	40A
Ambient temperature	Max. heating cable length at 230 V														
	m	m	m	m		m	m	m	m	m	m	m	m	m	m
-20˚C	87	133	167			64	87	109	160		51	53	66	105	
-10˚C	102	143	186			71	100	125	160		57	59	74	118	
0˚C	116	167	208			83	111	139			66	67	83	133	
+10˚C	125	205				96	133	167			77	80	100	160	

*Fuses with C-characteristic

The stated maximum lengths for self-limiting heating cables are determined not only by the power consumption of the cable under normal circumstances but also – and mainly – by the power consumption during start-up, which can be up to 1.8-2.3 times as high.

3.5 Silicone heating cables

Thanks to their silicone insulation the silicone heating cables are very flexible and can be used under very cold or very hot conditions.

The maximum allowed surface temperature for silicone cables is 170˚C. The maximum allowed rating for silicone cables is 40 W/m.

Silicone heating cables are used on pipes where a high temperature (over 40˚C) or a high output (up to 40 W/m) is needed.

Silicone heating cables are installed in the same way as deviflex™ or devi-iceguard™ heating cables.

Silicone heating cables must not get into contact with oils or animal fat.

Silicone cables must be controlled by devireg™ thermostats. Depending on the application, the thermostats which can provide exactly the right control and regulation are the devireg™ 330's with a temperature range from -10 …+10˚C to +60…+160˚C.

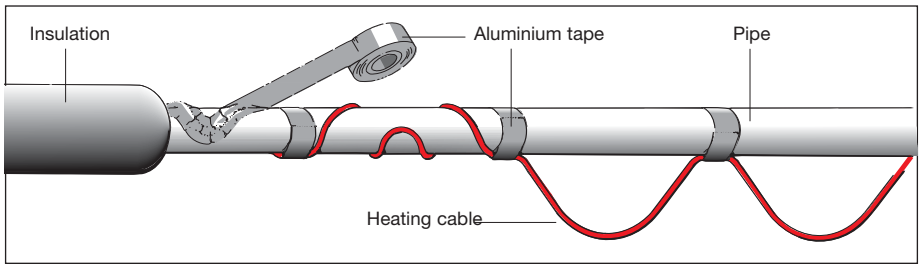
3.6 Installation

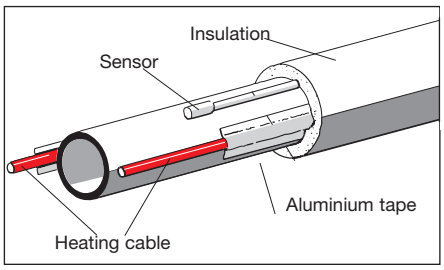
Calculation of cable length

In most cases frost protection for pipes requires an output of 10 W/m if the pipe has a diameter of less than 50 mm and the insulation is not less than 50 mm.

If this is the case a deviflex™ with a max. output of 10 W/m is an appropriate choice for cables installed on the outside of the pipe and a deviflex™ DTIV-9 for cables installed inside.

In order to find the appropriate length of deviflex™ cable to be installed per metre pipe, the required output per metre pipe is divided by the cable output per metre.





Example 1

If the required output is 10 W/m and the cable is a DTIP-8, the installed cable length per meter pipe is:

$$\frac{10\ \text{W/m}}{8\ \text{W/m}} = 1.25\ \text{m}$$

Example 2

If the required output is 15 W/m and the cable is a DTIP-10, the installed cable length per meter pipe is:

$$\frac{15\ \text{W/m}}{10\ \text{W/m}} = 1.5\ \text{m}$$

When the length is calculated for devi-iceguard™ or devi-hotwatt™, the following things have to be considered:

- Length of heated pipe
- Number of connections, specials, multiplied with 0.3 m heating cable
- Heating cable length for flanges, fittings
- Measured pipe extensions

The sum of the measurements will give the needed length of the devi-iceguard™ or devi-hotwatt™ heating cable.

Calculation of C-C distance

The table is a guide in finding the approximate C-C distance after the needed length of the cable per 1 m pipe has been calculated.

Outside pipe dimension (mm)	Inside pipe dimension (mm)	Inside pipe dimension (“)	C-C distance (mm) m of cable per m of pipe				
			1.1	1.2	1.3	1.4	1.5
34	25	1	250	170	140	110	100
42	32	1¼	310	210	170	140	130
48	40	1½	350	240	190	160	140
60	50	2	430	300	240	200	180
76	65	2½	520	360	290	240	210
89	80	3	630	430	350	290	260
102	90	3½	720	490	390	330	290
114	100	4	800	560	440	370	330
141	125	5	990	680	550	460	400
168	150	6	1180	810	650	550	480
219	200	8	1520	1050	840	710	620

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

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

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

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

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

When heating cables are installed below the ground, a plastic tape (red, yellow etc) is laid on top of the pipes/installation to indicate that cables are placed just below. Insulated pipes must be marked with a warning sign placed on the outside of the insulation material.

If the pipes with cables are installed in a case above the ground, the case must be safe and solid. It should also be marked with a distinct warning sign.

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

If the cable becomes stiff and difficult to bend due to the cold, it can be rolled out and connected to the mains for a short period, until it becomes flexible again. The cable must always be rolled out during this process.

The cables should not be installed at temperatures less than -5°C.

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

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

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

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

The bending diameter of the cable must not be less than 6 times the cable diameter.

The cable must not be subject to stress greater than 25 kg.

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

3.7 Product choice

The deviflex™ with a max. output of 10W/m and the devi-pipeguard™ 10/15/25 heating cables are suitable for frost protection systems on pipes in applications where the temperature of the pipe does not exceed 40°C.

For frost protection of plastic pipes the output of the cable should not exceed 10 W/m. For metal pipes the output may be higher.

The deviflex™ DTIV-9 and the devi-pipeheat™ DPH-10 are used inside drinking water pipes.

The devi-hotwatt™ 55 is used in tracing systems to maintain the required temperature of hot water or other fluids in hot pipes (up to 85°C).

Silicone cables are used in tracing systems where a high temperature (up to 170°C) or a high output (up to 40 W/m) is needed.

DEVI's frost protection and temperature maintenance systems should be controlled by devireg™ 316, devireg™ 330 or devireg™ 610 thermostats. All devireg™ thermostats are equipped with a relay and are able to control an external contactor.

3.8 Heat loss calculation

To calculate the heat loss the formula or table below may be useful.

The formula below is not an exactly documented heat loss calculation and therefore, it should only be used as a guide.

The pipe dimension, the insulation thickness, and the ambient temperature are decisive for the dimensional output.

To calculate the heat loss for a pipe with a given insulation this simplified formula can be used as a guide:

Heat loss:

$$Q\ [W] = \frac{2 \times \pi \times \lambda \times l \times (t_r - t_u)}{\ln\ D/d} \times 1{,}3$$

Where

D [m]	=	Outer diameter, insulation
d [m]	=	Outer diameter of the pipe
π	=	Pi (3,14)
l [m]	=	Pipe length
t_r [°C]	=	Temperature of the liquid inside the pipe
t_u [°C]	=	Ambient temperature
λ [W/m°C]	=	Thermal conductivity for insulating material
1,3	=	Safety factor

λ - value for the insulation material (mineral wool and styrophor) – typically 0.04 W/m°C.

Below a logarithmic table is presented showing the lnX value.

(X = D/d)

Example

A 1" outdoor water pipe with an insulation of 30 mm is to be frost protected with heating cables. For outdoor installations a Δt of minimum 30° C is required. The pipe is 15 m long.

The heat loss is calculated in the following way:

D = 86 mm
d = 26 mm
l = 16 m
t_r = 0 °C
t_u = -30°C
λ = 0.04 W/m°C

$$Q = \frac{2 \times \pi \times 0.04\ W/m°C \times 15\ m \times 30\ °C \times 1.3}{\ln\ (0.086m/0.026m)} = 123\ W$$

In this example a 15 m deviflex™ DTIV-9 cable with an output of 135 W is chosen.

X	lnX
1.0	0.0
1.5	0.4
2.0	0.7
2.5	0.9
3.0	1.1
3.5	1.3
4.0	1.4
4.5	1.5
5.0	1.6
6.0	1.8
7.0	2.0
8.0	2.1
9.0	2.2
10.0	2.3
15.0	2.7
20.0	3.0
25.0	3.2