DEVI by Danfoss

Domestic Hot Water

Application manual

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Let DEVI do the work

DEVI - an abbreviation of Dansk El-Varme Industri - 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.

DEVI is Europe’s leading brand of electrical cable heating systems and electric pipe heating systems with over 70 years of experience. The development of electric floor heating system takes place in Denmark, where the head office is situated while heating elements (cables and mats) are manufactured by Danfoss in EU (in France and Poland).

Domestic Hot Water temperature maintenance system

This design guide presents DEVI’s recommendations for design and installation of Domestic Hot Water system. It provides guidance for a heating cable layout, electrical data and system configurations.

Following DEVI’s recommendations will ensure energy efficient, reliable and maintenance free solution for constant wattage heating cables with 20 year warranty, self-limiting heating cables with 5 years of warranty.

Our quality management system **certifications and compliances**

- ISO 9001
- TS 16949
- ISO 14001
- PED

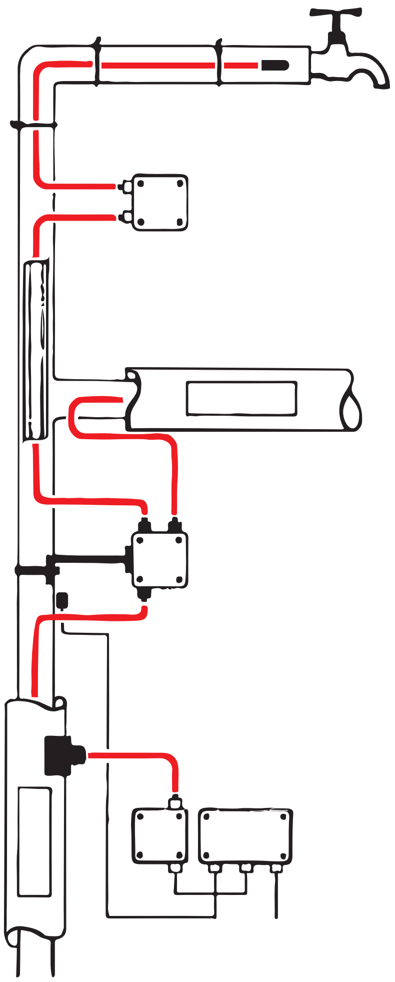
Along with full compliance with EU directives and product approvals

1. Application briefing

Modern living requires buildings to have hot water available whenever and wherever needed – and preferably immediately. The latest building regulations (ASHRE 188-2015) demand domestic hot water systems to ensure best comfort and efficiency as well as the Legionella control measures.

DEVI Electric heat tracing systems ensure instant and reliable supply of the Legionella-free domestic hot water (DHW). DEVIhotwatt™ is a self-limiting heating cable that is used for temperature control of hot water supply.

DEVIhotwatt™ is mainly used in the DHW system without circulation ("One pipe system"). The heat tracing complies with IEC 62395-2, CIBSE TM13 and ASHRE 188-2015.



Benefits

- DEVI pipe tracing systems **ensure hot water** in all taps and savings when a circulating pipe system is unnecessary.
- DEVI heating cable **reduces water waste** as you can get hot water immediately.
- **High protection against the Legionella –** DEVI system maintains water supply at the required temperature level and provides appropriate disinfection to suppress the Legionella bacteria.
- Perfect partner system to be used in domestic hot water (DHW) systems supplied by the Low-temperature district heating (LTDH), which is a **cost and energy efficient** way of building water supply in urban areas.
- **Lower initial investment** of DHW system without circulation – appx. 50% less pipes, insulation, valves, and pumps to be installed as no return pipes and insulation are required.
- **Space saving** – no need for return pipe gives more room in service ducts.
- **Energy efficient** - heating cables provide power only where needed adapting output according to the ambient temperature. Also, less pipes and smaller boilers requirements for the DHW means less heat losses in the system.
- The heating cable is **flexible and easy to install** as it can be cut to length right on site and installed directly on the pipe system.
- **Long lifetime** – with over 70 year experience in the field, the lifetime of DEVI pipe tracing cables is exceeding twenty years.

2. System Description

Since 1998 the EU Drinking Water Directive (98/83/EG) in EN 806-2 has established standards for hot water in pipes that should not drop below 50 °C. The latest building regulations (IEC 62395-2:2013 and ASHRAE 188-2015) as well as global trends are demanding domestic hot water (DHW) systems to provide the best comfort, energy efficiency and the Legionella mitigation measures.

General design principles aim to provide uniform water temperature, which should also avoid temperatures enabling the Legionella growth. The general recommendation for DHW is to maintain the heat source temperature between 50-60 °C (IEC 62395-2:2013).

Recommendations for hot water services and water temperature regulation (IEC 62395-2:2013)

Application	Temperature, °C
Safety showers and eyewashes	16 to 35
Hot service without mixing valves	40
Nursing homes and hospitals	40 to 46
General purpose	49 to 60
Laundry service	71
Kitchen sanitization	82

Water heating is often provided by means of centralized or decentralized installations with a large distribution network. To avoid the Legionella formation and unnecessary water loss the DHW circulation should be operated at 55 °C. According to IEC 62395-2:2013 guidelines: "For disinfection purposes min 55 °C is typically required for hot water installations fitted with mixing valves".

However, the temperature of domestic hot water cannot achieve the recommended level if the supply temperature from the source is lower than that. Considering the above there is a concern about occurrence of possible water waste or hygiene problems (Legionella) therefore a supplementary electrical tracing system is recommended.

The reason behind the required disinfection is the Legionella bacteria, which is commonly found in many types of water worldwide and creates potentially a fatal type of pneumonia for people.

The Legionella bacteria multiply best where temperatures are between 20-45 °C and nutrients are available. The bacteria are dormant below 20 °C and don't survive above 65 °C. The primary method used, to reduce the risk from the Legionella, is water temperature control, which is easy to do with help of DEVIhotwatt™ system.

The DEVI pipe heating system for domestic hot water (DHW) replaces the heat lost on hot water supply pipes, to maintain the water at the desired nominal temperatures when needed.

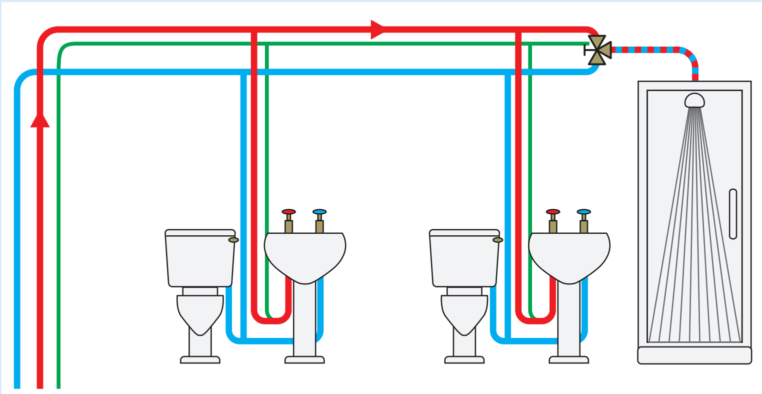
Usually the DHW pipe tracing will be required in the following cases:

- Low-temperature district heating, heat pump or another source is supplying DHW at around 55 °C
- DHW system without circulation used
- The ambient temperature variation is greater than 3 °C
- DHW tap is located further than 8 m from circulation loop

Heat tracing in DHW system

DHW system without circulation (a single pipe) - the temperature of the cable adjusts, at any point along the pipe, dependent upon the local conditions on the pipe network. This means that the DHW pipe is heated everywhere in proportion to how much it cools down.

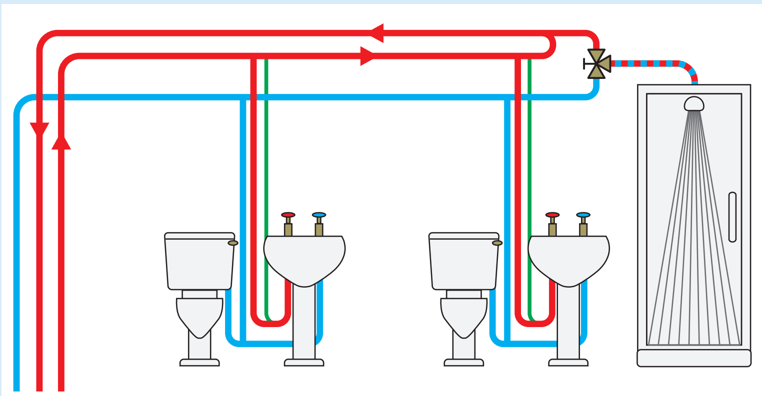
The more often the hot water tap is turned on, the less the hot water temperature maintenance system needs to be activated.



Self-limiting heating cable

DHW system with circulation - continuous circulation of hot water to insure that hot water is available at any of the taps.

In case of DHW with circulation - the use of pipe tracing can only be required if the DHW tap is located farther than 8 m from the circulation loop



Self-limiting heating cable

The electric pipe tracing in DHW system without circulation requires less pipes, less valves, less pumps and installation labor compared to the Recirculating system.

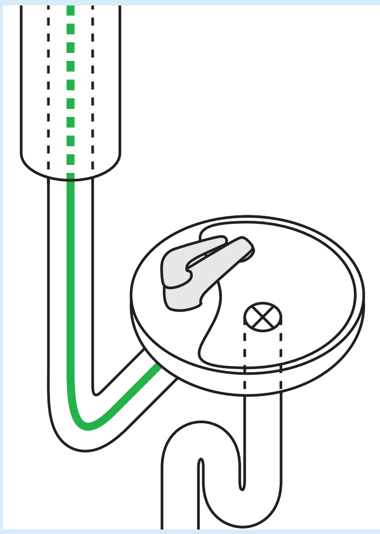
- Appx. 50% less pipes – less water volume in the pipes, so smaller boiler can be used.
- Energy consumption reduction, as heat losses from the pipes will be reduced by min 50%.
- Less maintenance cost, as less mechanical parts and pumps.
- Energy consumption reduction during the night time, with help of intelligent controls.
- Saving water – DEVI tracing system attached to the pipes keeps water at the desired temperature along the whole pipe system, so hot water is immediately provided, when demanded, and with minimum water loss.

The DEVIhotwatt™ system insures that domestic hot water is supplied, independent of the pipes length, and reduces the risk of localized temperature fluctuations.

DEVI pipe heating system is insuring automatic maintenance of the required temperature 24/7.

Area of Use

- Hospitals & Nursing homes
- Hotels & Prisons
- Schools & Universities
- Multi-store buildings
- Residential building
- Sports facilities



3. System Design

Linear output of a heating cable (W/m), which is installed on hot water pipe, should be at least the same as heat loss (Q, W/m) of this insulated pipe. Heat loss depends on the following: pipe diameter, insulation thickness and temperatures inside pipe and outside insulation.

Calculated heat losses for pipes, with insulation thickness equal to pipe diameter, are presented on the diagram.

One line of the heating cable installed along the water pipe is preferred. The table and the graph show the calculated heat losses for corresponding heating cables.

If technical conditions for hot water pipe differ from the mentioned above, the heat loss should to be calculated using the formula below. Increased heat loss will lead to the necessitation of installation of 2 or more lines of heating cable along 1 pipe length.

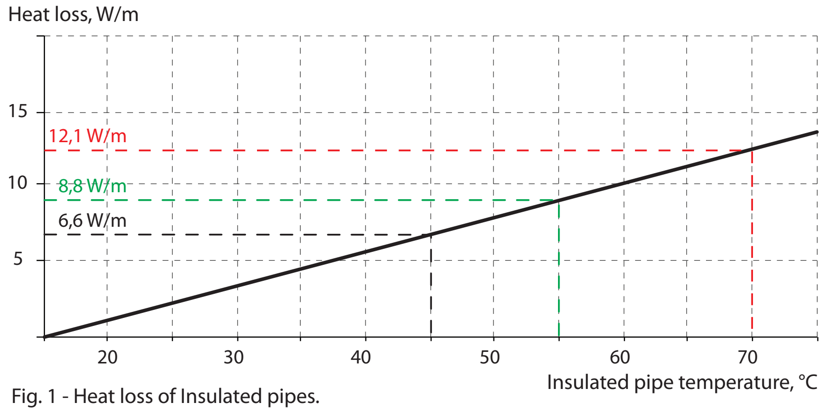
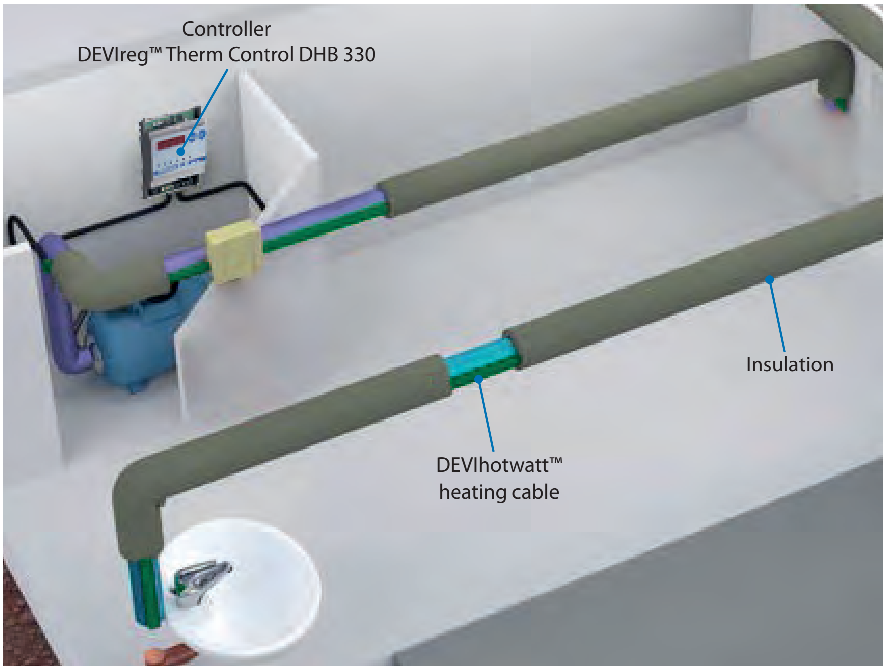


Fig. 1 - Heat loss of Insulated pipes.
* Calculation conditions: insulation thickness equal to pipe diameter, insulation λ = 0,035 W/m·K, ambient temperature 15°C, safety factor 1,1.

Maintain temperature	Calculated heat loss*	DEVIhotwatt™ nominal output
45 °C	6,6 W/m	7 W/m @ 45 °C, DEVIhotwatt™ 45
55 °C	8,8 W/m	9 W/m @ 55 °C, DEVIhotwatt™ 55
70 °C	12,1 W/m	12 W/m @ 70 °C, DEVIhotwatt™ 70

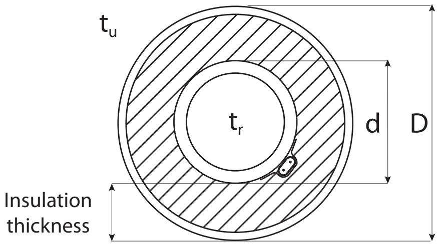


Heat loss calculation for pipe heating
The formula below is an approximation of heat loss calculation and should only be used as a reference. Pipe dimensions, insulation thickness, and the ambient temperature are crucial for the dimensional output.

Heat loss calculation formula:

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

where
D - Insulation outer diameter, [m];
d - Pipe outer diameter, [m];
π - Pi (3,14);
t_r - Temperature of the liquid inside the pipe, [°C];
t_u - Ambient temperature, [°C];
λ - Thermal conductivity for insulating material, [W/m·K];
1,3 - Safety factor.



Example
A ¾" (outer Ø 27 mm) water pipe with 50 mm insulation and λ = 0,04 W/m·K.
The pipe length is 15 m.
d = 27 mm;
D = 27 + 50 + 50 = 127 mm;
t_r = 70 °C;
t_u = 15 °C.

The temperature inside the pipe may drop down to 35 °C, but needs to be maintained at min. 55 °C. Once per week, the temperature rise up to 70 °C is required.

The ambient temperature can drop down to 15 °C, resulting max. Δt is Δt = 70 – 15 = 55 °C .

The heat loss is calculated as follows:

$$Q = \frac{2 \cdot \pi \cdot 0{,}04 \cdot 55}{\ln (0{,}127 / 0{,}027)} \cdot 1{,}3 = 11{,}6\ W/m$$

In this example a 15 m self-limiting DEVIhotwatt™ 70 cable with an output of 12 W/m @ 70 °C is chosen.

Output for 15 m pipe:
11,6 · 15 = 174 W.

4. Product Selection

The pipe tracing system consists of a self-limiting heating cable (SLC), installed straight on a pipe along its whole length, and providing hot water instantly, even at faucets placed far away from pipe draw off.

The system is controlled by an electronic regulator to maintain the temperature and to run disinfection insuring safe and Legionella-free water supply.

The DEVIhotwatt™ is a self-limiting heating cable that is used for temperature maintenance of hot water and other fluids which require certain temperature levels.

The self-limiting capability of the cable ensures cable output regulation according to water temperature in the pipes and the ambient temperature, hence the self-limiting effect.

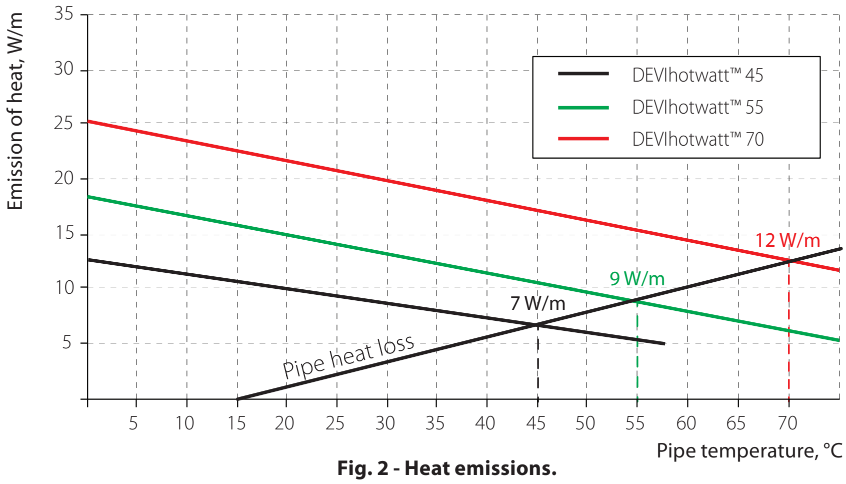


Fig. 2 - Heat emissions.
Curve on Fig. 2 represents Pipe heat loss, the same as Fig. 1 on previous page.

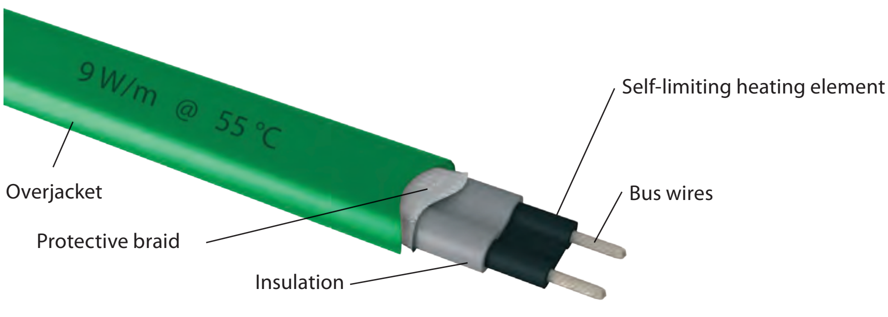


Fig. 3 - SLC construction

- 1,3 mm^2 nickel plated cooper bus wires
- Radiation Cross-linked Semiconductive Heating Matrix
- Radiation Cross-linked Primary Dielectric insulation
- Tinned copper braid
- Polyolefin overjacket

Type	Value
Operation voltage:	230 V AC
Output, color:	7 W/m @ 45 °C, black (DEVIhotwatt™ 45) 9 W/m @ 55 °C, green (DEVIhotwatt™ 55) 12 W/m @ 70 °C, red (DEVIhotwatt™ 70)
Maximum permissible use temperature	65 °C, powered 100 °C, unpowered
Minimum use temperature	- 30 °C
Cable dimensions	11,8 × 5,8 mm
Outer sheath	TPE
Minimum braid coverage	70%
Maximum resistance protective braid	18,2 Ω/Km
Bending radius	25 mm (radius to the inside of the tape)
Max. length, with 10 A circuit breaker:	55 m (DEVIhotwatt™ 45) 40 m (DEVIhotwatt™ 55) 35 m (DEVIhotwatt™ 70)
Warranty	5 years

Benefits

- The cables can be cut to length on site providing quick installation.
- Automatic compensation for heat loss along the pipe
- Economical, self-limitting
- PVC free
- Limitted pre-planing of the installation

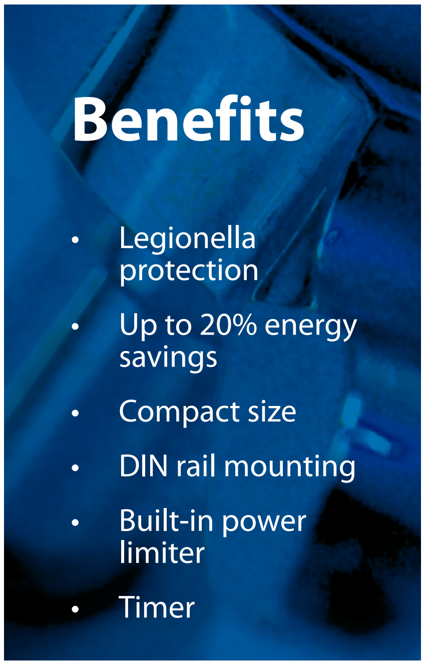
The DEVIreg™ Therm Control DHB 330

The DEVIreg™ Therm Control DHB 330 is designed for controlling DEVIhotwatt™ self-limiting heating cables used for temperature maintenance inside pipes. The temperature can be regulated within a range of 35 to 70 °C.

Due to the built-in timer it is possible to switch the system off once every 24 hours e.g. at night as usually there is not a great demand for hot water, however this will of course affect the comfort. The system can be set up to operate at max. temperature once a week to run disinfection and suppress the Legionella bacteria. Compared to the control method without timer, smart control is helping to save up to 20% of the total electricity consumption.

A power limiter has been built-in in order not to overload the fuse. After switching the system on it will slowly start up (about 8 min.).

Type	Value
Adjustment range	Hb 09: 45 to 60 °C = Typ 1 (factory adjustment) - DEVIhotwatt 55 Hb 12: 45 to 70 °C = Typ 2 - DEVIhotwatt 70
Operating voltage	230 V~ +10 to -15%
Breaking capacity	16 A
Clock operating reserve	12 h
Protection class	IP 20
Permissible ambient temperature	-10 to 50 °C
Maximum cable length	DEVIhotwatt™ 55: 88 m @ 16 A DEVIhotwatt™ 70: 70 m @ 16 A
Size	90 x 71 x 58 mm
Weight	0,30 kg
Attachment	on DIN rail



Alutape

Glued aluminum tape, 38 mm x 50 m

19805076

DEVIconnecto™

Item code	Type	Description
19808360	DEVIconnecto B-A	Connection to supply cable
19808361	DEVIconnecto B-C	Heating tape connection
19808362	DEVIconnecto B-E	End termination
19808363	DEVIconnecto B-S	Connection to supply cable and end termination as set
19808364	DEVIconnecto B-T	T-branch for 3 x heating tape 1 I/O
19808365	DEVIconnecto B-TE2	T-branch with power connection and 2 x heating tape 2 I/O
19808366	DEVIconnecto B-TE3	T-branch with power connection and 3 x heating tape 3 I/O
19808367	DEVIconnecto B-X	X-branch for 4 x heating tape 2 I/O

5. Installation

Calculation of cable length

Heating cable length is calculated as minimum pipe length plus extra length for some pipe system construction elements, if any.

Calculation formula:

Heated pipe length
\+ Number of connections x 0,3 m heating cable
\+ Number of specials x 0,5 m heating cable
\+ Number of T-junctions x 1 m heating cable
\+ Heating cable length for flanges, fittings and measured pipe extensions

The cable installed throughout the pipe length needs to be covered along its whole length with aluminum tape to ensure good contact with the pipe.

All cables must be installed in parallel passes; no spiral wrapping is allowed. Hot water pipes shall be pressure tested prior to installation of heating cable and thermal insulation. Thermal insulation shall not be installed until heating cable installation is complete and tested.

Pipe diameter, mm	Recommended number of cable lines
Ø 20 – 100	1
Ø 125 – 200	2
Ø 250 – 400	3
Ø 450 – 600	4

Aluminum tape is recommended. When using aluminum tape the heat transfer is improved.

Straight cables must be fitted as shown at 5 or 7 o'clock positions.

When the heating cable is installed on pipes, the insulation should be clearly marked with a warning sign, e.g. **"WARNING: 230 VOLT HEATING CABLES".**

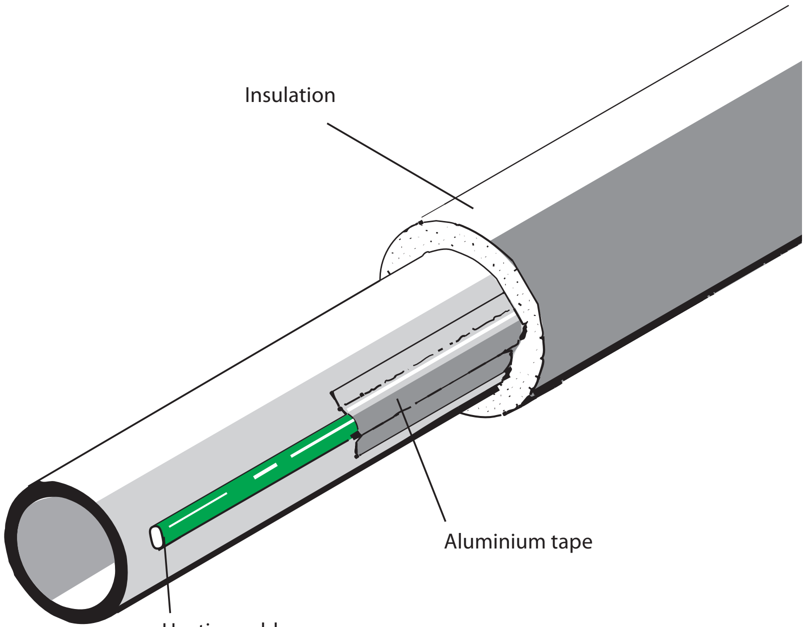
Pipe diameter and recommended insulation

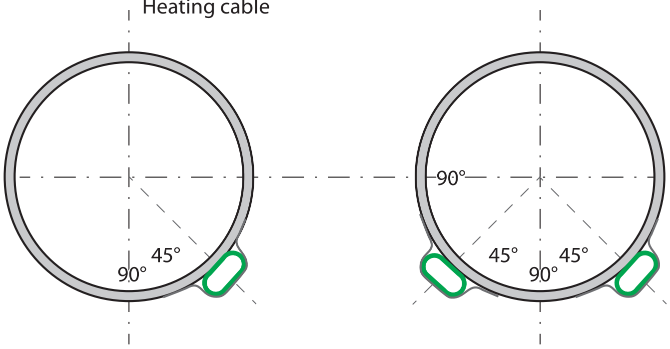
mm	15	20	25	32	40	50	65
inch	½"	¼"	1"	1¼"	1½"	2"	2½"
Advised minimum insulation thickness							
mm	20	20	30	30	40	50	65

Conditions for table:
Ambient temperature = min. 18 °C,
Insulation = min. 0,035 W/m²·K.

DEVIhotwatt™ heating cable maximum length

Temperature	DEVIhotwatt™ 55			DEVIhotwatt™ 70		
	Fuse					
	10 A	16 A	20 A	10 A	16 A	20 A
10 °C	70 m	88 m	117 m	56 m	70 m	90 m





The recommended ways to mount the cable lines on the pipe

Notes

6. Cases

0809XXXX &VGLUA102

SU ZHOU CENTER
Su Zhou, China

Project scale: 2 apartment buildings.

Apartment quantity: 600.

Product: DEVIhotwatt™ 55.

Total length: 10,000 m.

Thermostat: 600 pcs.

Project finished : 2016.

The Main DHW system is a circulating system, but the decision was made for all the branch pipes indoor to use pipe tracing by self-limiting cables, about 20 meters for each apartment.

PROMENADA SHOPPING CENTRE
Warsaw, Poland

Project scale: shopping center.

Product: DEVIhotwatt™ 55.

Total length: 150 m.

Project finished: 1996.

DHW system without circulation.