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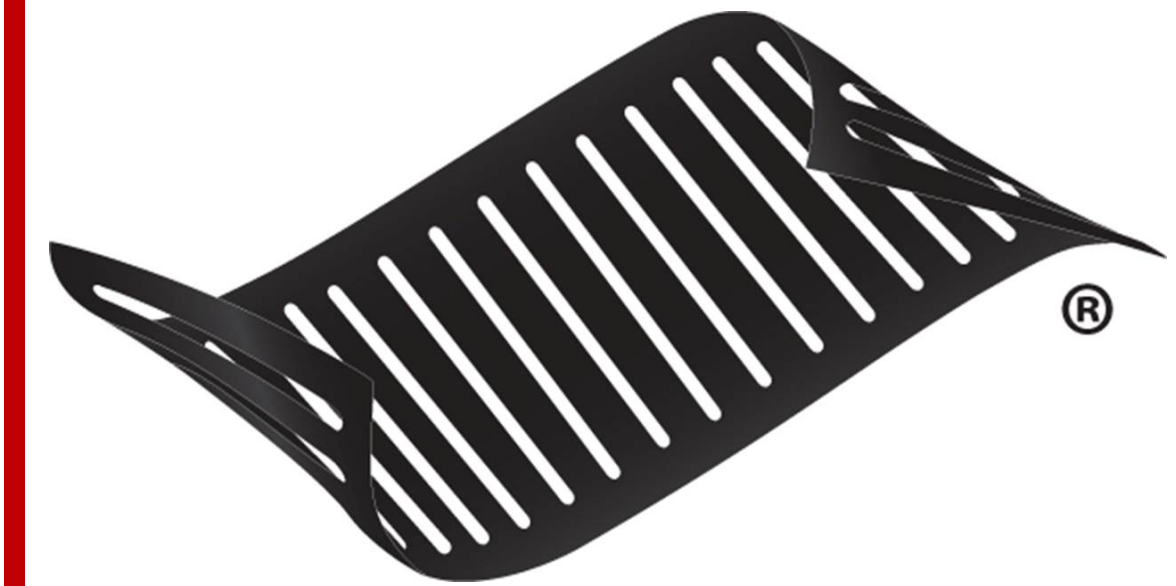
Floor Warming, Primary Heating, Snow Melting, & Roof De-Icing with PTC Heaters



Floor Warming, Primary Heating, Snow Melting, & Roof De-Icing with PTC Heaters

Presented by: Electro Plastics, Inc.
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Description: Provides an overview of self-regulating polymer technology and the performance benefits of using PTC (positive temperature coefficient) heaters for energy efficient floor warming, primary heating, snow melting, and roof de-icing.

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REGISTERED CONTINUING EDUCATION PROGRAM

Purpose and Learning Objectives

Purpose: Provides an overview of self-regulating polymer technology and the performance benefits of using PTC (positive temperature coefficient) heaters for energy efficient floor warming, primary heating, snow melting, and roof de-icing.

Learning Objectives:

At the end of this program, participants will be able to:

- discuss the underlying principles of heat transfer and the advantages of radiant heat
- compare the operation and installation of radiant heating systems
- explain how self-regulating polymer technology works, and identify specific applications across a variety of construction sectors
- discuss the energy efficiency and performance of PTC (positive temperature coefficient) heaters, and
- discuss the advantages of using PTC heaters for floor warming, primary heating, snow melting, and roof de-icing.

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Radiant Heating Options

Heat Transfer

Hot air rises, but heat can travel in any direction. Heat flows from a hot object to a cold object until an equilibrium is established and both objects are the same temperature. Heat is transferred from one point to another by:

- **conduction**
  (the transfer of heat between two parts of a stationary system caused by a temperature difference between the parts)

- **convection**
  (the transfer of heat by circulation or movement of the heated parts of liquid or gas), and

- **radiation**
  (the process by which energy is emitted, as particles or waves, by one body and transmitted through an intervening medium or space, then absorbed by another body).

Convection Heating

A convection heating system, like forced-air, relies on blowing warm air into the interior. Since air does not maintain heat, the room temperature fluctuates as the system goes on and off.

Do you know that if your feet are warm and your head is cool, you will feel perfectly comfortable?

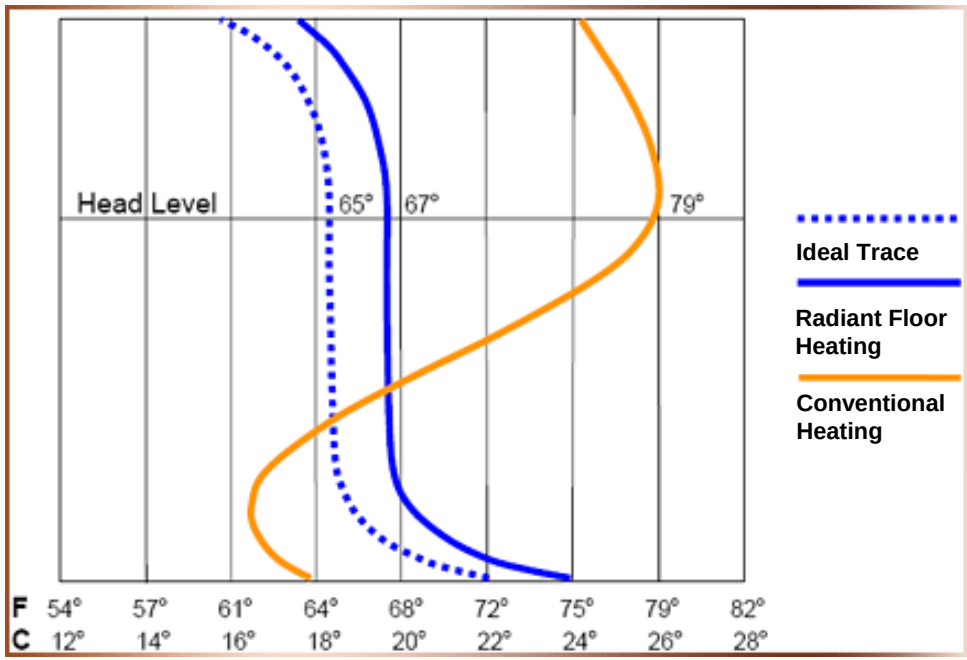
If you look at forced-air heating systems, we are actually heating our living spaces from the ceiling down to the floor because warm air rises. This means to get our feet moderately comfortable, the temperature at the ceiling may wind up being very high. It takes a significant amount of energy to create and maintain an even and comfortable temperature at our feet in a forced-air heating system.

Radiant Heating

With a radiant heat system, the temperature profile associated with a forced-air system is switched around, and the entire floor becomes the radiator. The temperature at the floor level is at that comfortable range, while the temperature at our heads is lower but still at a very comfortable temperature. The heat radiates from the floor, warming all of the objects in the room, and everything in the room gains a warm, comfortable feel to it. The amount of energy required to create and maintain this comfortable temperature at our feet is significantly less than compared to that of a forced-air system.

Radiant Heating

A large area of mild surface temperatures, such as a warm floor, is capable of transferring as much heat as a small surface area, such as a radiator with a high surface temperature. The even distribution of heat eliminates drafts and gives a pleasant comfort at a lower temperature, making the system more cost-effective.



Heat distribution in a room is optimal when the temperature is higher at the feet than at the head level.

Types of Radiant Floor Heating Systems

Commonly used radiant floor heating systems are: hot water systems (hydronic systems) and electric systems (heating cables, flexible heating films, and self-regulating heating elements).

Hydronic systems pump heated water from a boiler through tubing laid in a pattern underneath the floor. The water supplied to the system generally ranges from 85°F (29°C) to 140°F (60°C) and is controlled by thermostats to moderate the floor temperature. A cementitious material or an air gap is required to evenly distribute the heat.

Electric cables and flexible heating films convert electrical power into heat and require a thermal mass or an air gap to spread out the heat. Since the power generated is fixed, temperatures are controlled by on/off thermostats and floor sensors, creating differential temperature changes in the floor.

Self-regulating elements are made of a semi-conductive material, which acts as a sensor; the heat output increases as the temperature decreases and conversely, the heat output decreases as the temperature increases. The self-regulating element comes as a mat and can be placed directly under the floor covering because it cannot overheat.

Self-Regulating Elements

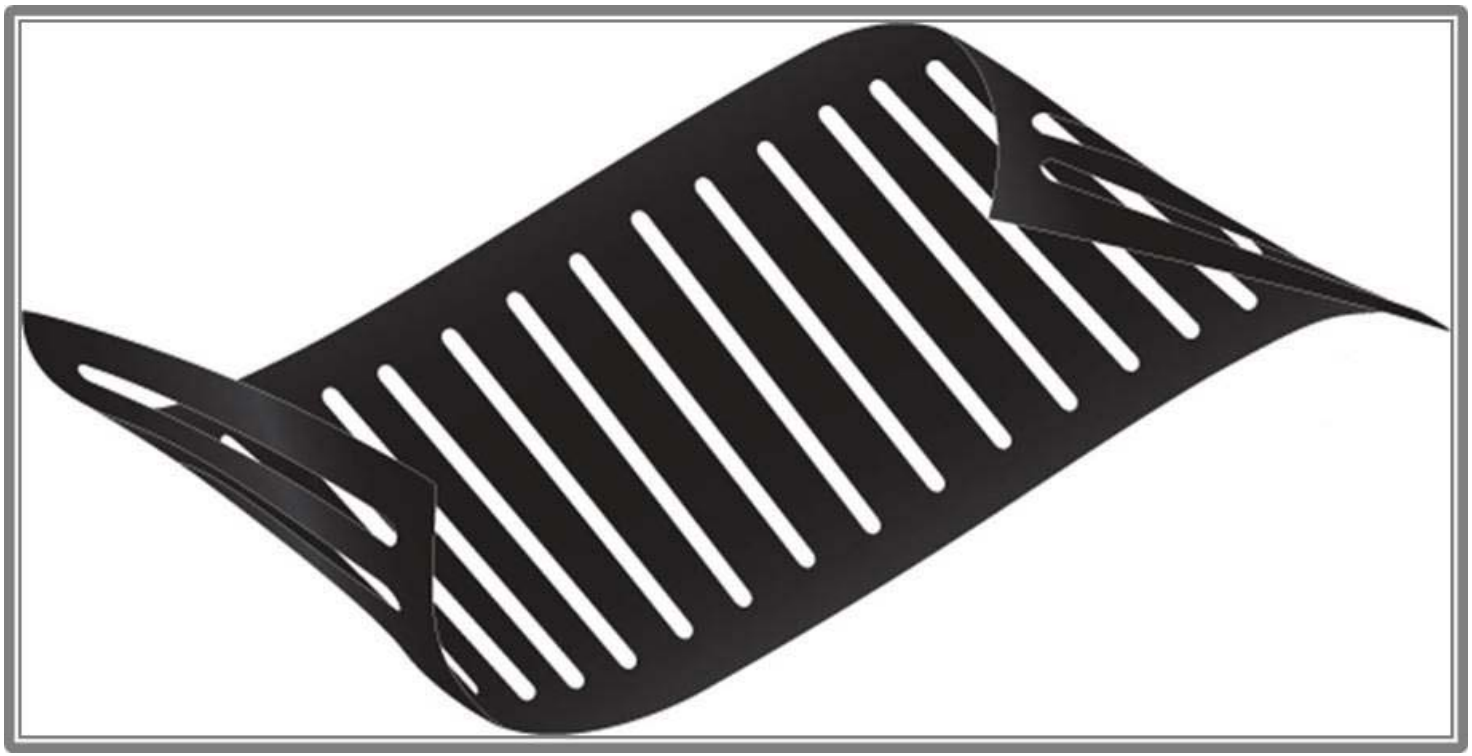
The remainder of this course focuses on a radiant heating system that utilizes a strong, homogeneous, self-regulating heating element made of a positive temperature coefficient (PTC) semi-conductive polymer. It may be used for a variety of applications from residential and commercial heating, to snow, roof, and gutter melting systems. It is versatile enough to go under virtually all types of floor coverings, and can be used as the primary heat source for an entire building, or just to take the chill out of the floor in a small area.

Residential

Snow melting

Commercial

Roof de-icing



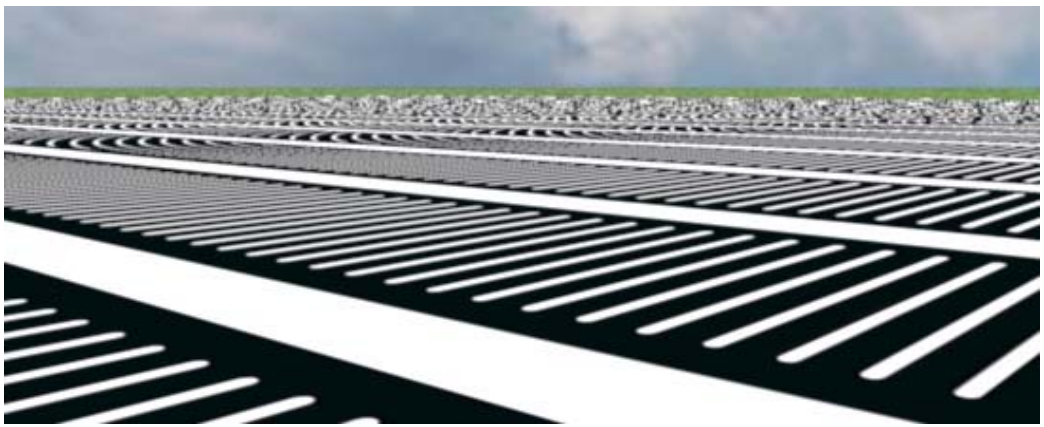
PTC Heating Elements

What Is a PTC Heater?

Self-regulating polymer technology was developed in 1981 and first used to provide heated seats for automobiles. Since then, the technology has been used in a variety of applications, including the floor covering area.

A PTC (positive temperature coefficient) heater is a homogeneous, flat, thin (3/64"/1.2mm), strong, flexible mat made of a unique polymer blend that heats when electricity passes through it. The polymer is extremely durable and can be used to generate heat continuously up to 140ºF (60ºC) without being mechanically affected; however, it will melt above 248ºF (120ºC).

The mat comes in a roll, in different widths (3", 6", 9", and 12"), and can be cut to the desired length and field-wired onsite.



Recyclable & Non-Hazardous

A PTC heating element is made of recyclable non-hazardous materials, and the product complies with LEED®, LEED® for Homes™, and NAHB standards, and as such, may earn credits that contribute to a project's certification under a green building rating system. Polyethylene does not produce hazardous gases and is biodegradable in sunlight.

Under the LEED (Leadership in Energy and Environmental Design) green building program, PTC heating elements may contribute to earning credits in the following categories:

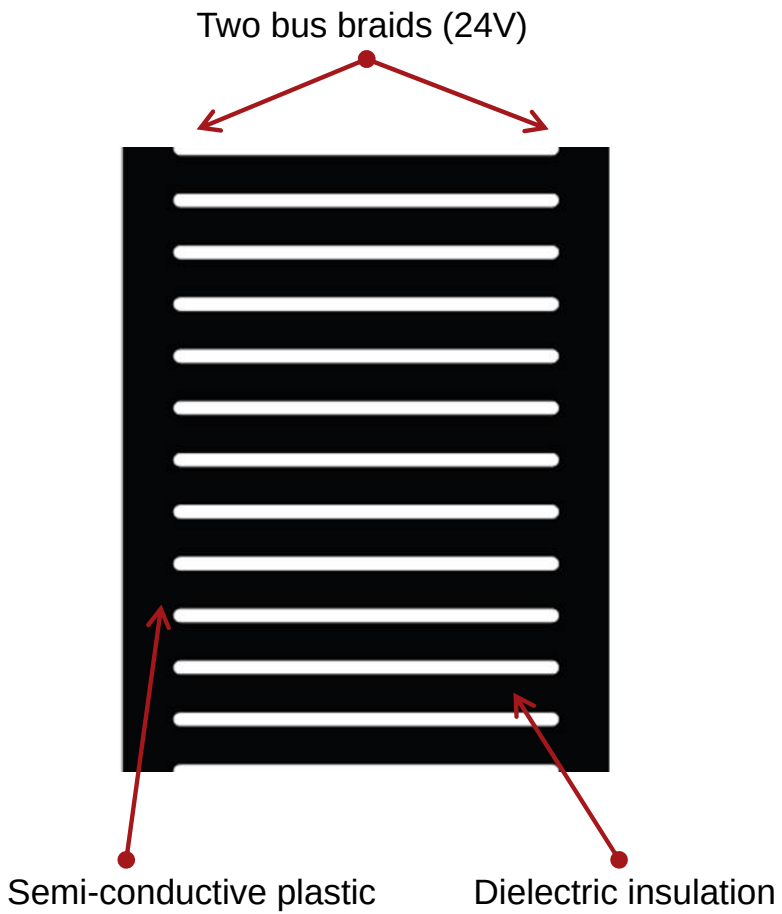
- Energy and Atmosphere
- Indoor Environmental Quality, and
- Materials and Resources.

How a PTC Heater Works

The PTC heater has two or more conductors (flat bus braids) embedded along each side of the material. Their sole purpose is to bring in the low-voltage current; they do not heat.

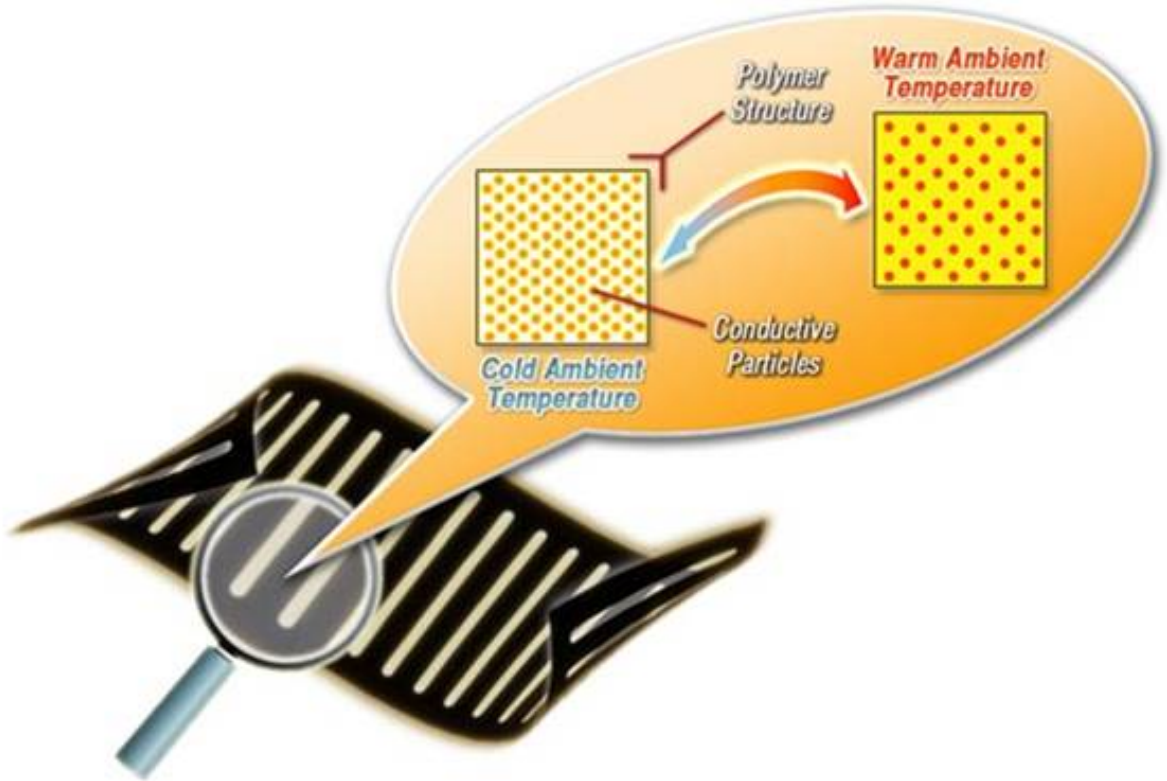
The heating element is protected with a pair of layers of a chemical-resistant and a water-resistant insulation.

The heat transfer occurs through the polymer material (a semi-conductive plastic).



How a PTC Heater Works: Self-Regulating

The polymer constitutive of the heating elements has in its composition molecular particles distributed in a homogeneous manner that when in contact with one another, permits the passage of electrical current due to its semi-conductive configurations.

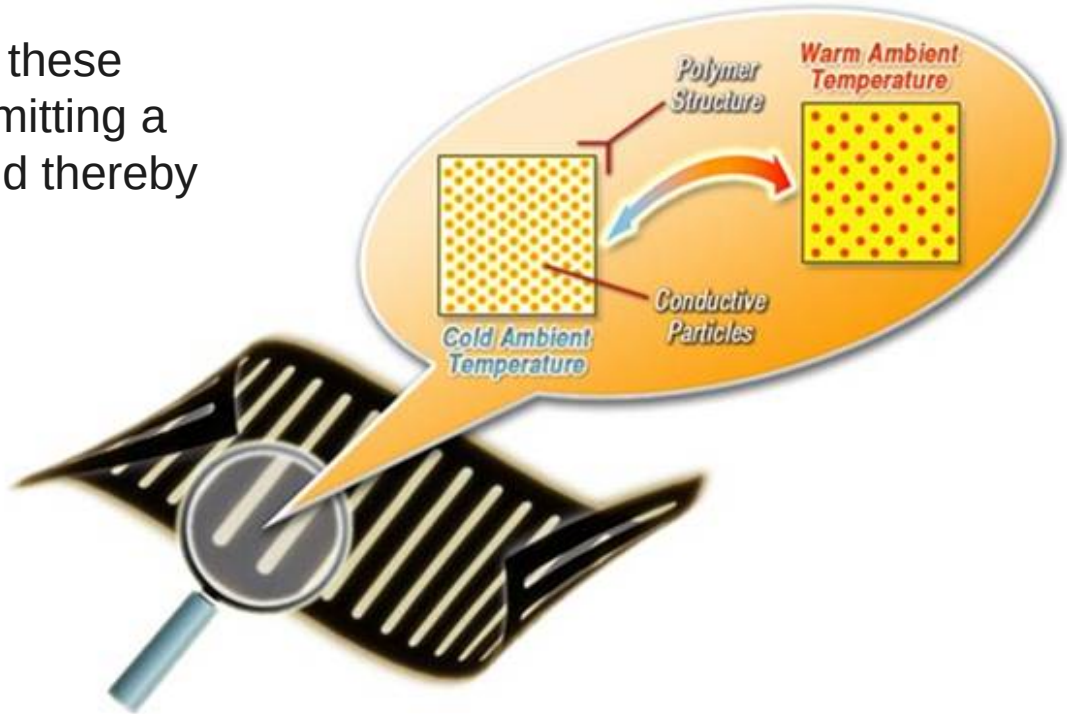


How a PTC Heater Works: Self-Regulating

When the ambient temperature increases, the morphology of the polymer structure changes and the particles separate, reducing the points of contact between each other. As the electrical resistance increases, less current can circulate and the emission of heat decreases.

When the ambient temperature is cold, these particles are closer to one another, permitting a greater passage of electrical current and thereby generating more calorific power.

The self-regulating property of the material means it cannot overheat.



How a PTC Heater Works: A Floor Sensor

The self-regulating elements act as a floor sensor, supplying more wattage when cold, and less wattage as they warm up. Maintaining a continuous, even temperature is more efficient than an on/off heating system—the heating elements use only the energy necessary to maintain an even temperature.

Depending on the thermal insulation and the floor covering, the floor surface temperature with the residential elements will not rise above 78–82°F, which is more than sufficient to heat most rooms. Actually, a floor temperature over 82°F is not recommended for health considerations in Europe. In the U.S., the maximum floor temperature is 85°F.

Most manufacturers of building materials limit floor temperatures to 85°F to increase the longevity of the building materials. For hardwood floors, the maximum temperature is normally between 78–82°F, just within the temperature range of the PTC residential elements.

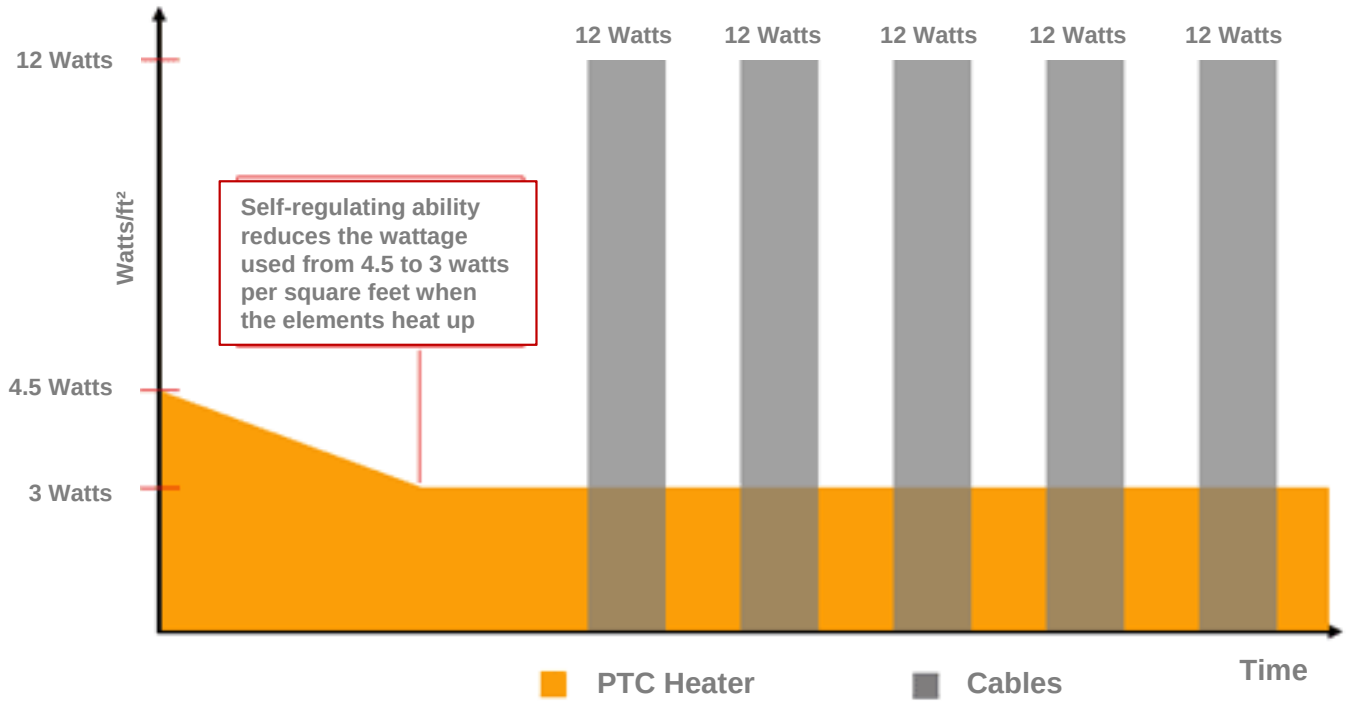
How a PTC Heater Works: A Floor Sensor

Typically, a heating system with cables is installed with 12 watts per square foot. To achieve the same heat output, a PTC flat heater is typically installed with only 4.5 watts per square foot.

Cable heating systems require a floor sensor, and most manufacturers recommend the use of a thermostat. The PTC heater does not require a floor sensor due to the self-regulating ability of the element, but a thermostat is recommended to control the desired temperature. The thermostat is used to measure the ambient temperature for primary heating or can be used with an external sensor for floor warming or complementary heat. For complete energy efficiency, it is necessary to take into consideration the location and type of construction, including thermal insulation and flooring installed.

How a PTC Heater Works: A Floor Sensor

As seen in this graph, a PTC heater is installed with 4.5 watts per square foot, but as the element heats up, the self-regulating ability reduces the wattage used to approximately 3 watts per square foot. The cable system relies on the on/off functionality of the thermostat to reduce the floor temperature, making it less energy efficient.

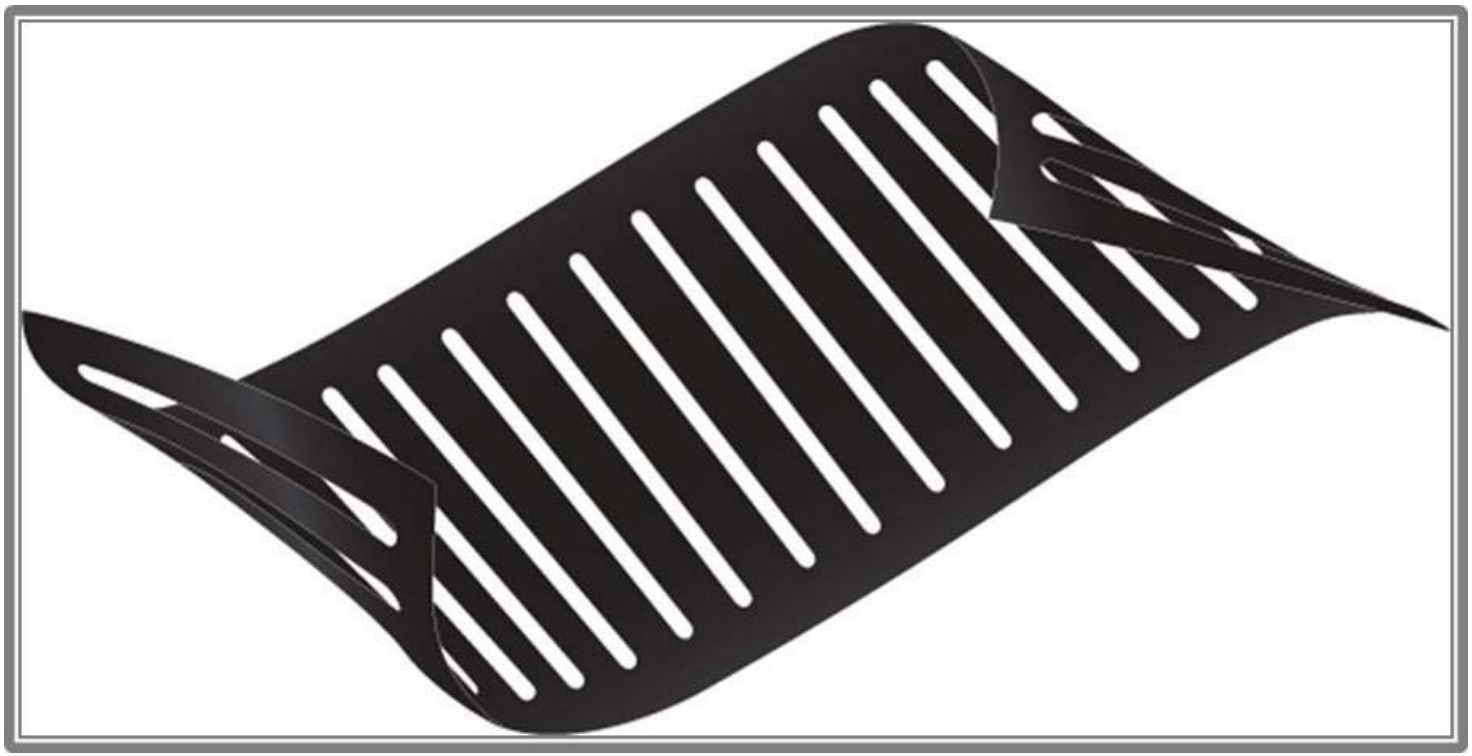


How a PTC Heater Works: Safe Extra Low Voltage

PTC heating elements operate on low-voltage, AC or DC (alternating current or direct current) and do not require a ground fault switch. The polymer will not give rise to sparks or ignite (it is inherently safe).

As a safe extra-low voltage product, it is ideally suited for bathrooms and other wet environments. Because it is mainly a polymer, it is unaffected by moisture.

The heating elements can be connected to an AC power supply or to a DC distribution grid. Additionally, the elements can run on solar panels, a generator, or batteries.



Power Supply & Thermostat

Power Supply

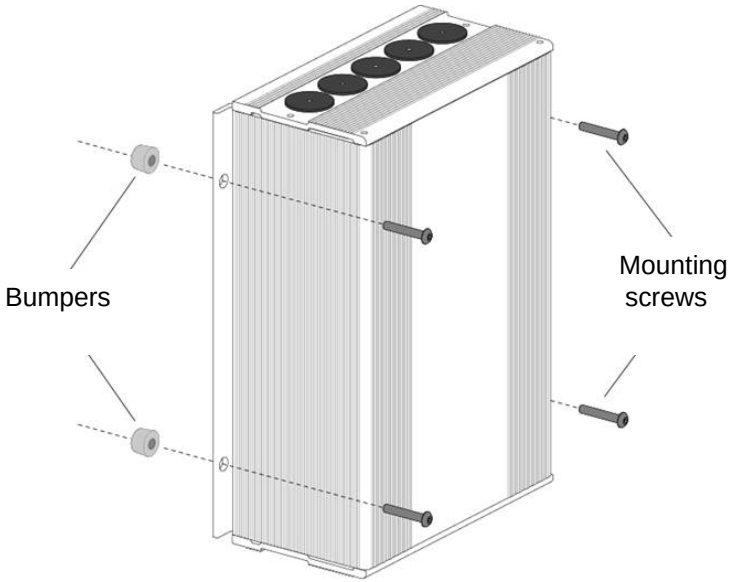
The heating elements operate on low voltage and are normally connected to the accompanying 24 V AC power supply. The transformers use safety extra-low voltage (SELV), one of several means to protect against electrical shock. Since the radiant heating elements operate on low voltage, they do not require a ground fault switch. The safety of a SELV circuit lacks a return path through a ground source, so that an electric current cannot come in contact with a human body.

The primary voltage is 120, 208, or 230 V AC 50/60 Hz, and the secondary voltage is normally 24 V, but the system is approved for 30 V or less. The transformer has circuit breakers on the primary and on the secondary, and each secondary circuit is rated not to exceed 25 amperes, having a maximum output of 500 VA.

Power Supply

The mechanical design of the power supply is both functional and installation-friendly. Fabricated from extruded aluminum, its slim design means it fits inside a wall, and the aluminum profile provides a high-performance cooling structure, as well as an enclosure which eliminates air sound.

Sound is also reduced by the winding of the energy efficient toroidal coils, making the power supply essentially silent. All vibrating parts are isolated, thereby eliminating the transmission of noise through a building structure.



Load & Ambient Temperature

The rated power of the transformer relates to its maximum ambient temperature, and it must have specific characteristics to supply the specified power.

The specified power of a transformer is normally quoted for an ambient temperature of 104°–113°F (40°–45°C). If the temperature is higher, the load must be reduced. It is therefore important to take into account where the transformer is to be installed: for example, in a sealed cabinet, with other heat-generating equipment, with little or good ventilation, etc.

It is completely normal for transformers in operation to have a surface temperature between 158°–185°F (70°–85°C). The heat produced by the transformer is partly stored in its mass and partly dissipated into the environment. When used with the self-regulating heating elements, the load on the transformer will be lower as the PTC elements get warmer.

Power Output

Different applications require a different power output to heat the required space to a desired temperature.

- Interior applications – from 2 W/ft^2–10 W/ft^2
- Exterior applications – up to 30 W/ft^2

There are several factors that influence the PTC element's power output. The heat generated by the PTC heater is obtained by altering either the voltage, composition of the conductive compound, thickness, or width (distance between the bus braids).

The default heating element for most residential interior heating projects is:

- 12" wide, cut to size (maximum 57 ft. length) per circuit of 450 W
- 7.8 W/ft @68°F
- 6.8 W/ft @86°F

Installing PTC heating elements with a substantially higher wattage than needed will make the system more reliant on a thermostat and thereby decrease the energy efficiency of the system. It is important to choose the appropriate heating element and power supply according to the heating needs, available open floor space to be heated, and floor covering.

Power Output: Design & Calculation

To avoid uneven temperatures (e.g., cold spots) there is a maximum recommended spacing between the strips of elements depending on the type of floor covering installed:

- ceramic tile, natural stone, resilient - 2"–3"
- hardwood, laminate - 2"–5"
- carpet - 2"–8"

Element Data at 24 volts @ 68°F					Installation Data					
Element Width	Element Type	Linear W/ft.	Density W/sq.ft.	Max. length (ft.) @ 450 W	Element spacing and wattage per sq.ft. 2"	3"	4"	5"	8"	12"
9"	Narrow areas (e.g., residential bathrooms)	6.8	9.0	66	7.7	7.2	6.8	6.3	5.4	4.5
12"	Residential (homes, kitchens, bathroom floors)	7.8	7.8	57	6.6	6.2	5.9	5.5	4.7	3.9
12"	Joists (retrofit floor heating under existing floors)	9.0	9.0	50	7.7	7.2	6.8	6.3	5.4	4.5
12"	RVs and motorhomes, boats, etc. Sunrooms, decks, conservatories	11.0	11.0	41	9.4	8.8	8.3	7.7	6.6	5.5

Power supply units for residential applications consist of one to three 500-watt circuits. The designed wattage is 90% or 450 watts. Do not exceed the maximum length @ 450 W for the selected element in the above table, and combine the element strips from a layout design to optimize the distribution for each 450-watt circuit in the power supply.

Thermostat

Although the heating system does not require a control unit, except for an on/off switch, the homeowner may want to install a controller or regulator for the following reasons:

- the system can be turned on as desired
- not everyone has the same temperature comfort needs
- some rooms may need to be kept warmer than others
- some owners may want to keep the floors warm and not rely on the ambient temperature
- when the house is not in use, not as much heat may be required, but in colder climates, the risk of the water tubing becoming frozen can be avoided, and
- while the system is energy efficient, the controller offers an opportunity to further reduce heating costs.

Thermostat

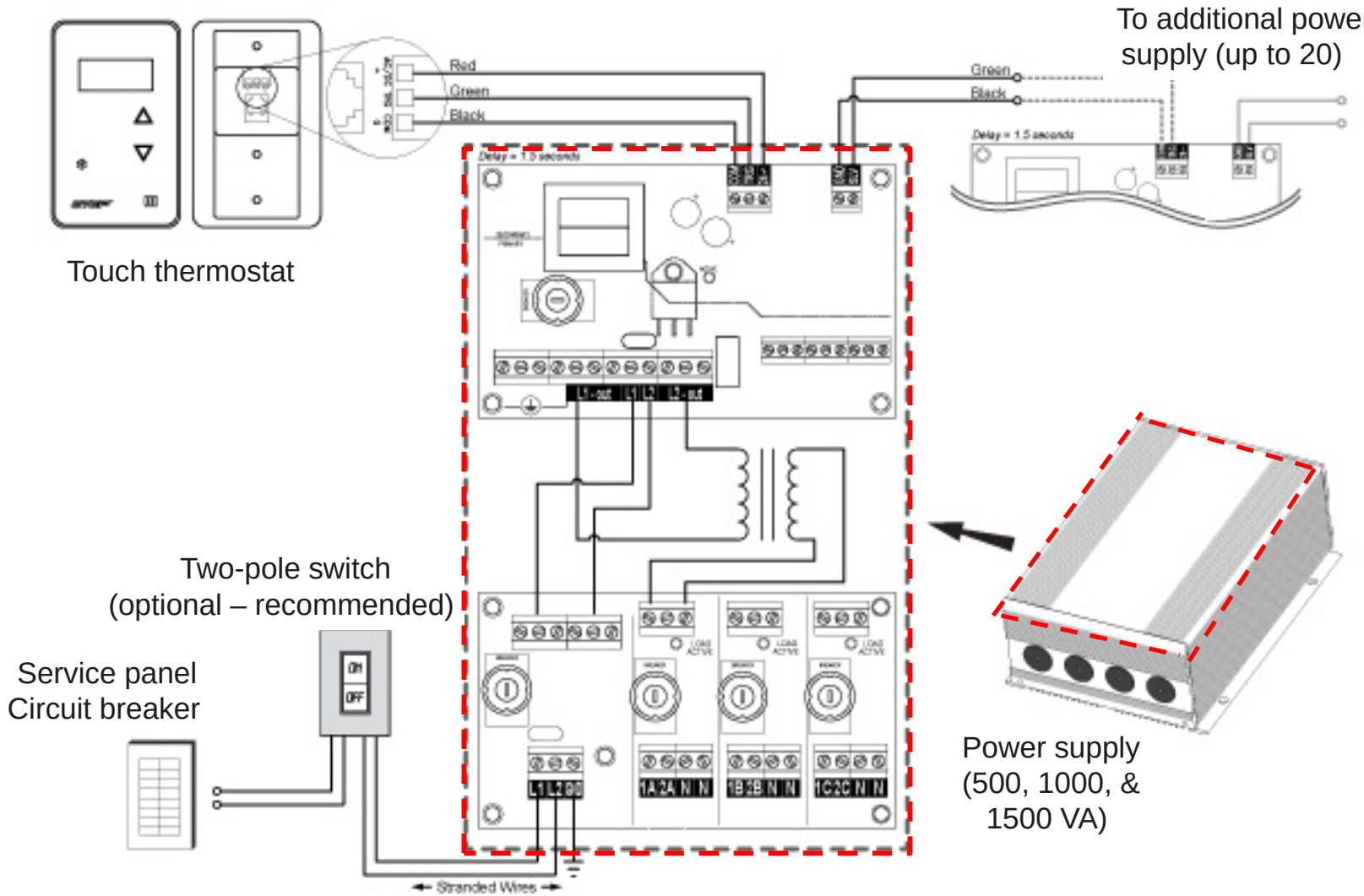
The low-voltage (24 V) thermostat can control up to 20 power supplies or 20 DC controllers; there is a delay of 1.5 seconds between each power supply to avoid a massive, combined startup draw.

The thermostat measures and keeps the ambient temperature at +/- 0.5 degrees Fahrenheit and has the option to measure the floor temperature using an external sensor. The thermostat is operated by two touch buttons only; press up or press down to add or reduce heat, or press both buttons simultaneously to switch the system on or off.

The thermostat has four settings:

- Position 1 – °C or °F (the temperature is displayed in Celsius or Fahrenheit)
- Position 2 – DIM (the display is lit or dimmed)
- Position 3 – EXT (displays the ambient or floor temperature using a sensor)
- Position 4 – SM (interior or snowmelt with remote external sensor)

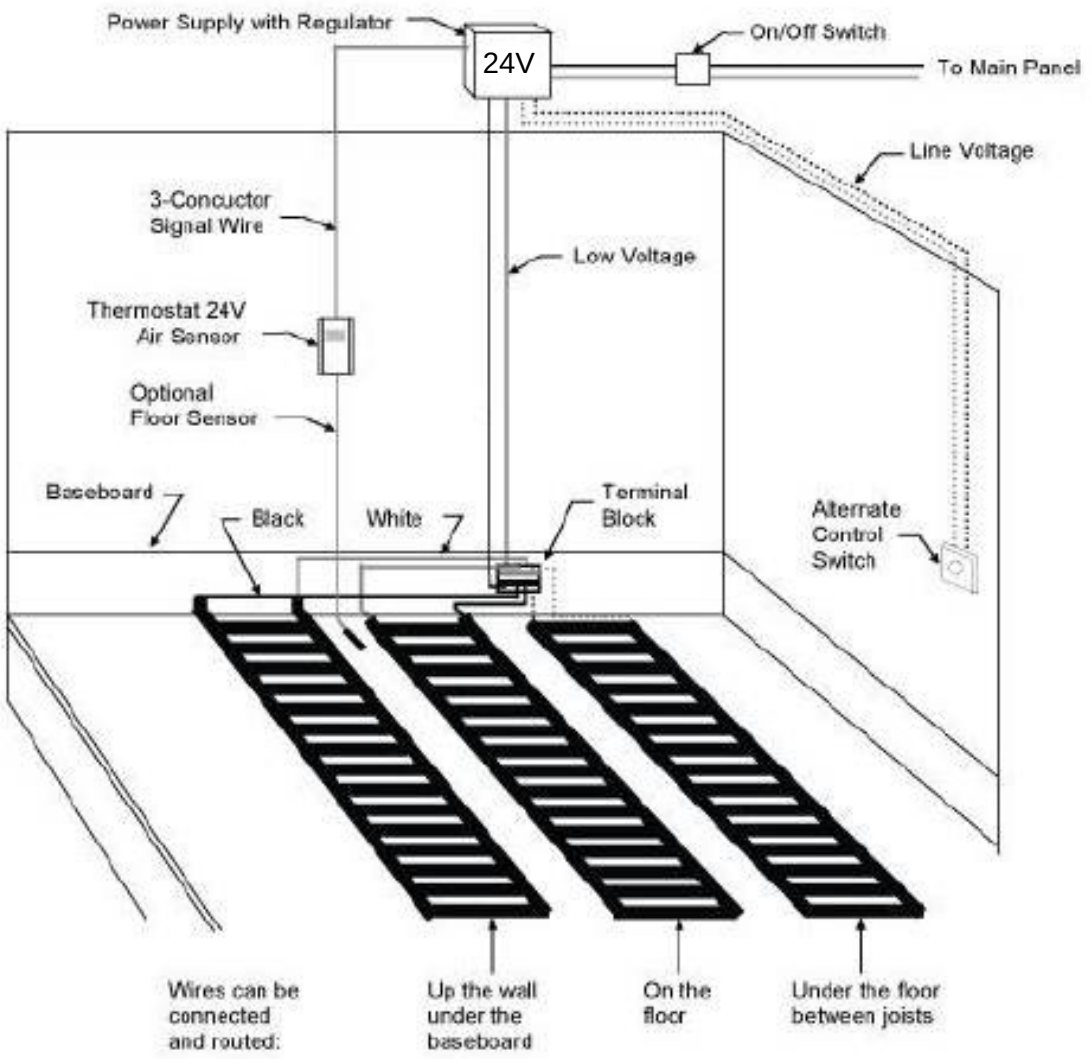
Example: Power Supply & Controls

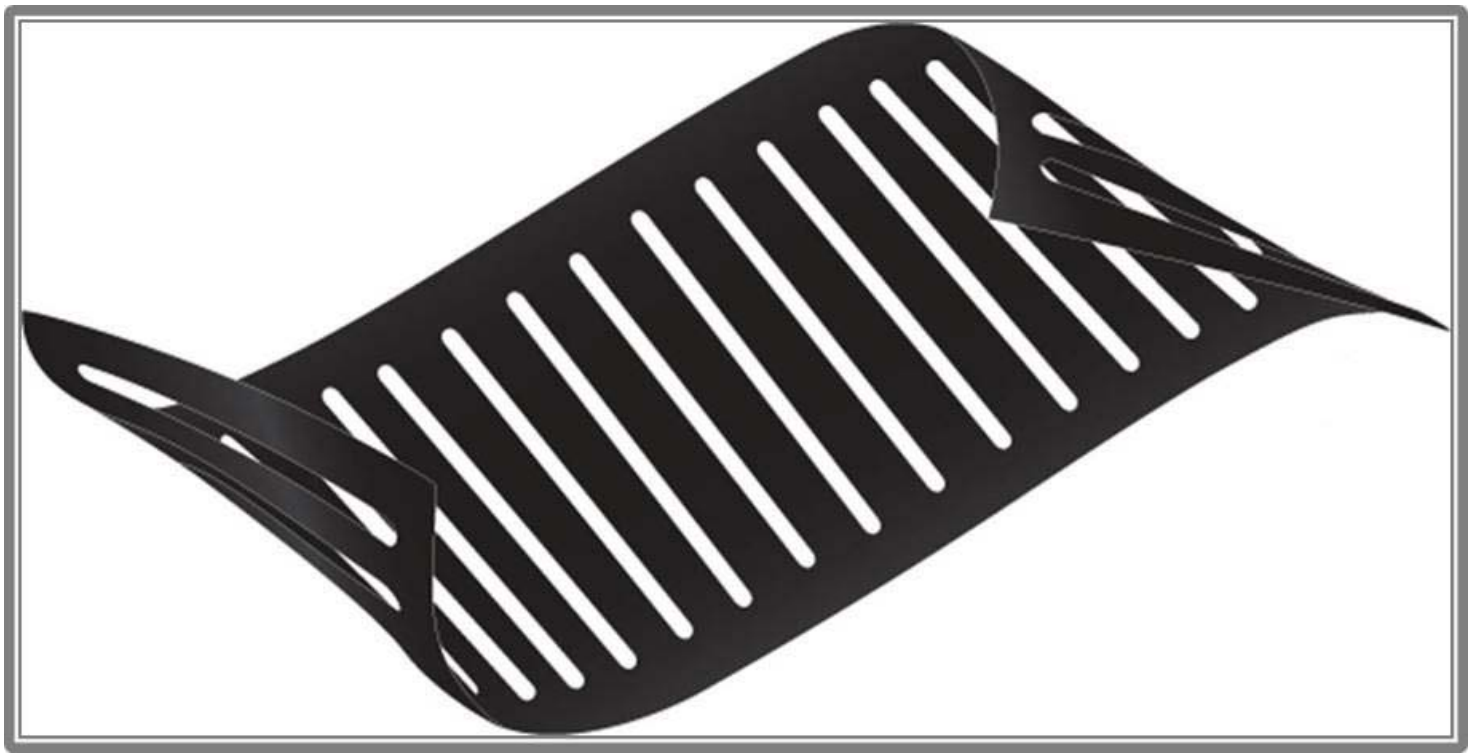


Example: Routing the Wires

The installation shall be made in accordance to local codes and ordinances. Codes may require special wiring and/or a conduit (plastic or metal) in the walls.

The circuit supply should be planned from the main panel to the on/off switch, control, power supply, terminal block (if needed), and heating elements. The power supply should be placed vertically on a wall, in the ceiling, under the floor, or in a closet, according to NEC code in such a way that heat is dissipated effectively.

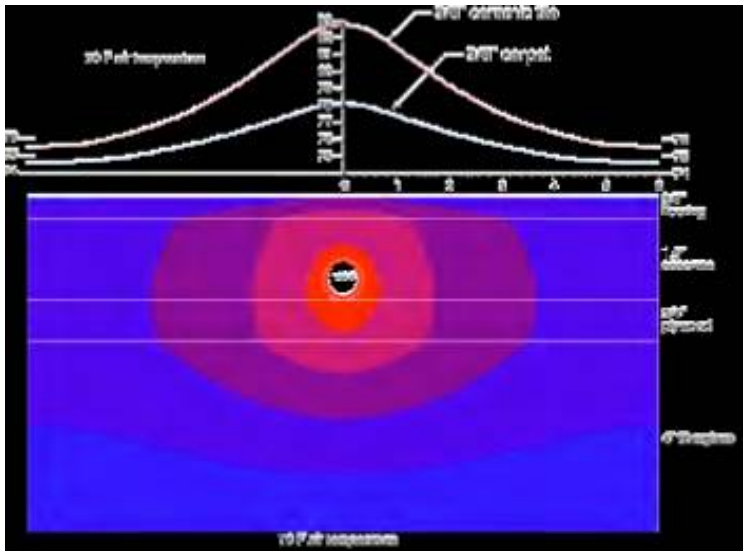




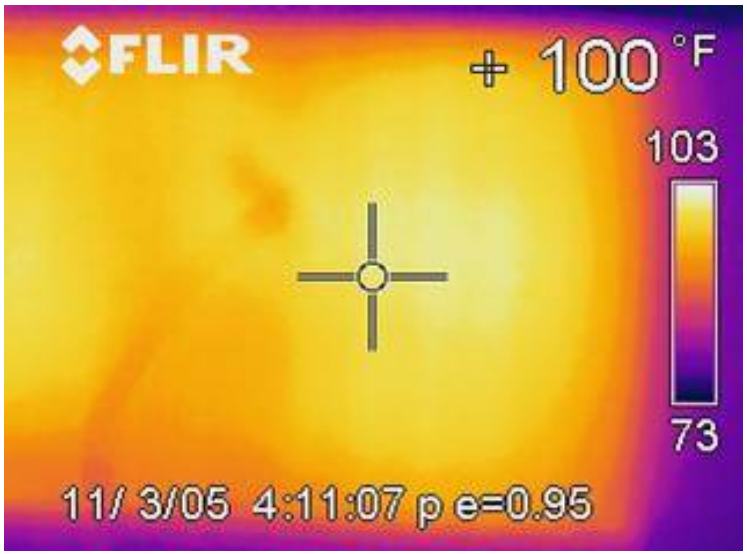
Energy Efficiency & Performance

PTC Performance

The heat distribution with electric cable or water tubing differs substantially from a PTC flat heater.



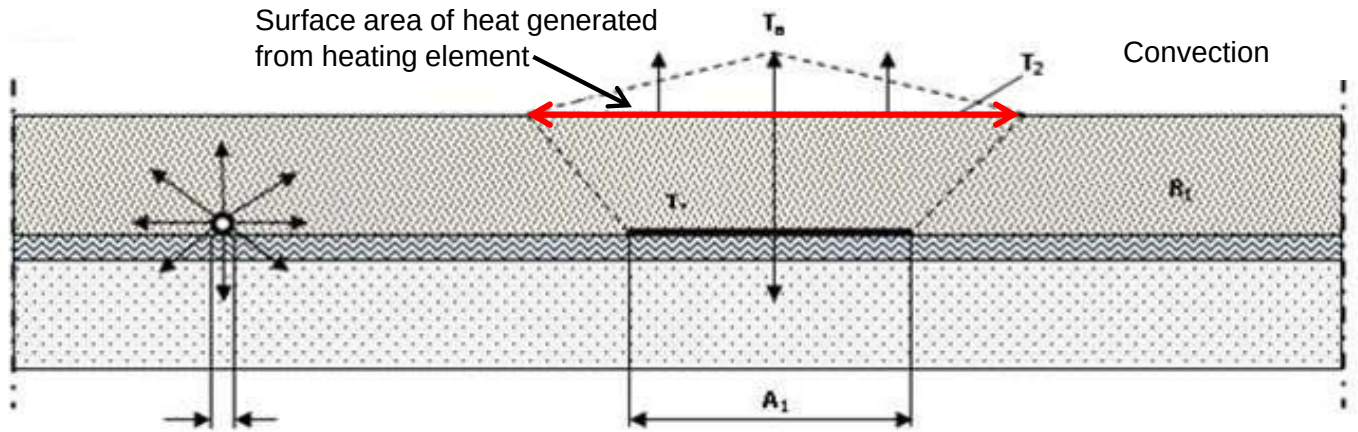
Electric cable or water tubing in section



PTC flat heating elements in plan

When installed, the 12"-wide PTC heating elements are designed to cover a large surface (60–70%), and consequently, this even heat distribution makes it 2.5 times more efficient than electric cables and 2.08 times more efficient than hydronic/water tubing (½") systems.

PTC Performance



Cross-sectional area of a floor with a cable or tubing and PTC flat heating element

A typical total heating installation with the PTC heating element system requires **4.5 W/ft^2**.

To provide the same heat output over the same size surface area:

- an electric cable system with 3" spacing requires 2.5 times more wattage, which is 4.5 W/ft^2 x 2.5 = **11.25 W/ft^2**, and
- a water tubing system with 6" spacing requires 2.08 times more wattage, which is 4.5 W/ft^2 x 2.08 = **9.36 W/ft^2**.

PTC Performance: How Is This Possible?

The results on the previous slide are from a study in which PTC heating elements were found to be significantly more efficient than other heating systems. Francesco Schiavone, PhD (PhD, BEng (Mech) – University of Florence, Italy; Senior Research Associate – Royal Melbourne Institute of Technology, Australia), compared the heat transmission from a PTC self-regulating heating element with electric cable systems and water tubing systems.

There is no discussion that an equal amount of wattage will generate the same energy output. So how is it possible that PTC elements require less wattage?

Let's take an example from the kitchen that most people are familiar with; you want to boil water using two, large, identical pots, 10 cups of water in each.

- You place pot (A) on a large cooking plate, which has the same diameter as the pot, and you place identical pot (B) on a smaller cooking plate.
- If the same amount of energy (1000 watts) is used, in which pot will the water boil faster?
- As most of us have experienced, the water will boil faster in pot (A), the one on the larger cooking plate.

PTC Performance: Distribution & Transmission of Heat

It is all about distribution and transmission of heat. If you compare the surface area of cable or water tubing with that of a PTC flat heating element, it is a similar comparison to that of the different sized cooking plates. While cables and tubing cover only a fraction of the floor area, an installation of PTC flat heating elements will cover more than 60% of the total surface.

The challenge lies in changing the thought process from an efficient component to an efficient system. To have an efficient heating system, it is not sufficient that the heating product is good; it is as important that the heat distribution is designed properly. For efficiency, it will also be necessary to take into consideration the location and type of construction, including thermal insulation and floor covering installed.

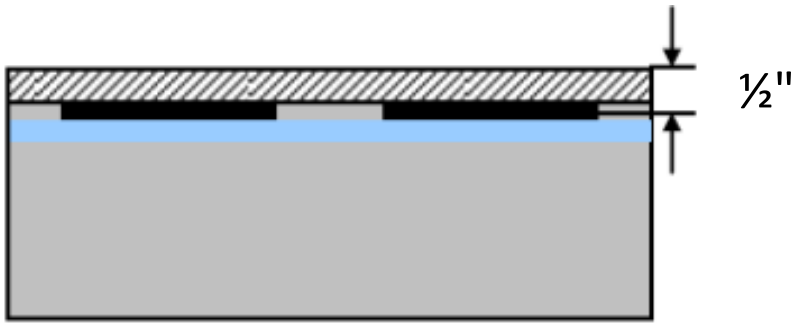
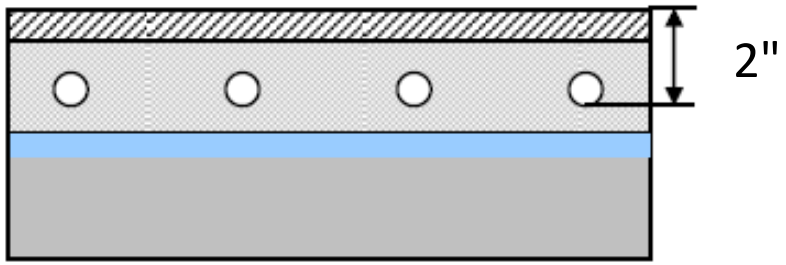
Francesco Schiavone based his calculations on Newton's law. According to Newton's law, the rate of heat transfer to the surrounding air is proportional to the floor exposed area and to the difference between the floor temperature and the air temperature.

To view or download Francesco Schiavone's calculations, please use the link in the list of resources on slide 69.

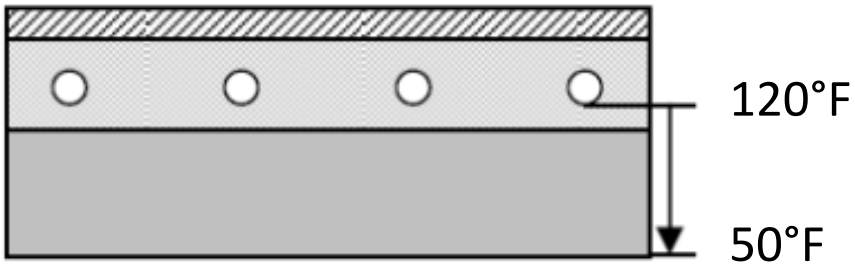
PTC Performance: Distribution & Transmission of Heat

The low-voltage, self-regulating system also means that the mat can be placed safely closer to the floor surface than any other type of heating system. With less mass to heat, the system reacts quickly to its regulated temperature. This eliminates the disadvantage of a large thermal bed heating the house when the ambient temperature does not require additional heat.

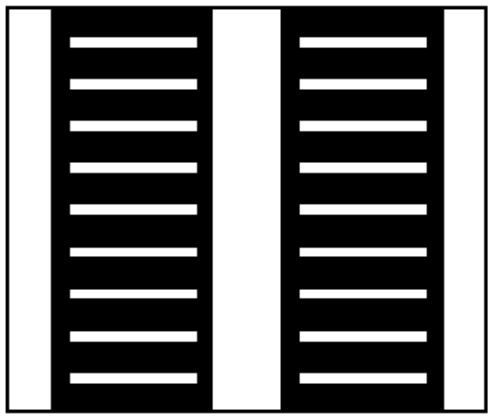
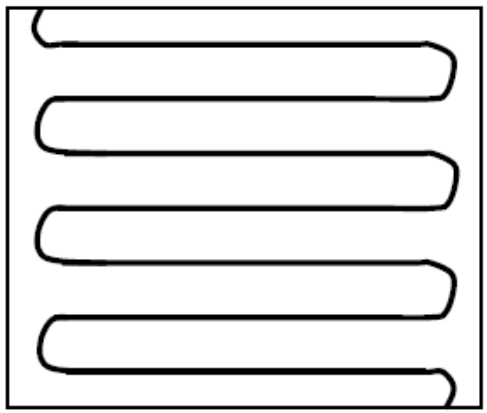
Overall Savings with PTC Elements

Reaction to temperature fluctuations	
PTC elements are installed right under the floor covering and react quickly to any temperature changes.	A hot water system needs to heat a thermal mass, which takes a long time to heat up and to cool off.
	
Self-regulating elements act as a floor sensor, supplying more wattage when cold and less wattage as they warm up.	Hot water systems require four times more energy or four times more time for the heat to reach the surface.

Overall Savings with PTC Elements

Temperature loss to the ground	
The temperature difference between the PTC heating element and the ground is minimal, giving less heat loss.	The temperature difference between the hot water tubing and the ground gives considerable heat loss.
	
Heat loss through the subfloor: 10 sq.ft x 1/R-20 (84-50)°F = 5 W	Heat loss through the subfloor: 10 sq.ft. x 1/R-20 (120-50)°F = 10 W

Overall Savings with PTC Elements

Heat distribution	
PTC elements cover a much larger area, thereby warming the floor evenly with a lower temperature.  Floor area covered by elements: 2 x 3 ft. long x 1 ft. wide/10 sq.ft. x 100% = 60% coverage	Thin heating cables need more power to warm a floor due to the small area they cover.  Floor area covered by cables: 20 ft. long x 0.01ft. dia./10 sq.ft. x 100% = 2% coverage

Costs

To estimate the energy consumption, a heat loss calculation is necessary; this is even more important when an entire building is to be heated with self-regulating PTC heating elements. The more energy efficient a building is, the more efficient the heating system will be. This is because when there is less heat loss, the heating elements, being self-regulating, can maintain the ambient temperature with less power. Knowing the total cost of ownership and the cost of energy will also provide the payoff time or ROI compared to other heating systems.

The actual cost of any heating system will depend on a variety of factors:

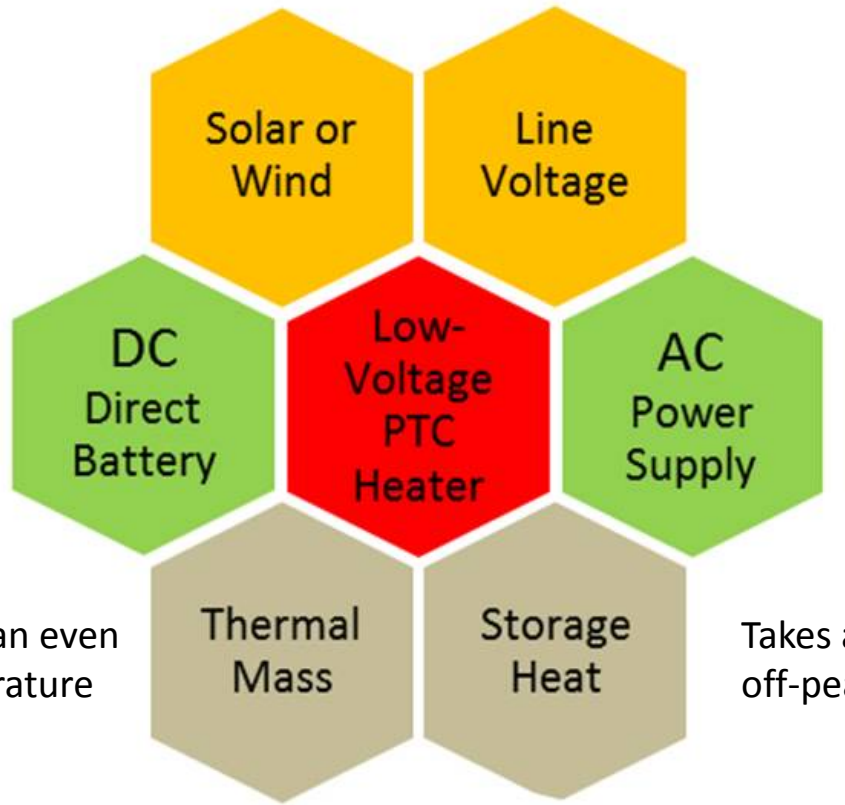
- how well insulated the area is
- heat loss by infiltration and by transmission
- the outdoor temperature
- the preferred indoor temperature
- size of the area to be heated
- number of exterior walls and window areas
- geographic location and altitude
- price of the energy used, and
- maintenance requirements, if applicable.

Alternative Energy Sources

Since PTC heaters can operate using DC power, they are capable of using alternative energy sources such as wind turbine and solar panel power. Onsite alternative power generation and use reduces the need for onsite AC/DC conversions and can reduce energy costs. DC power is a key component for zero net energy buildings.

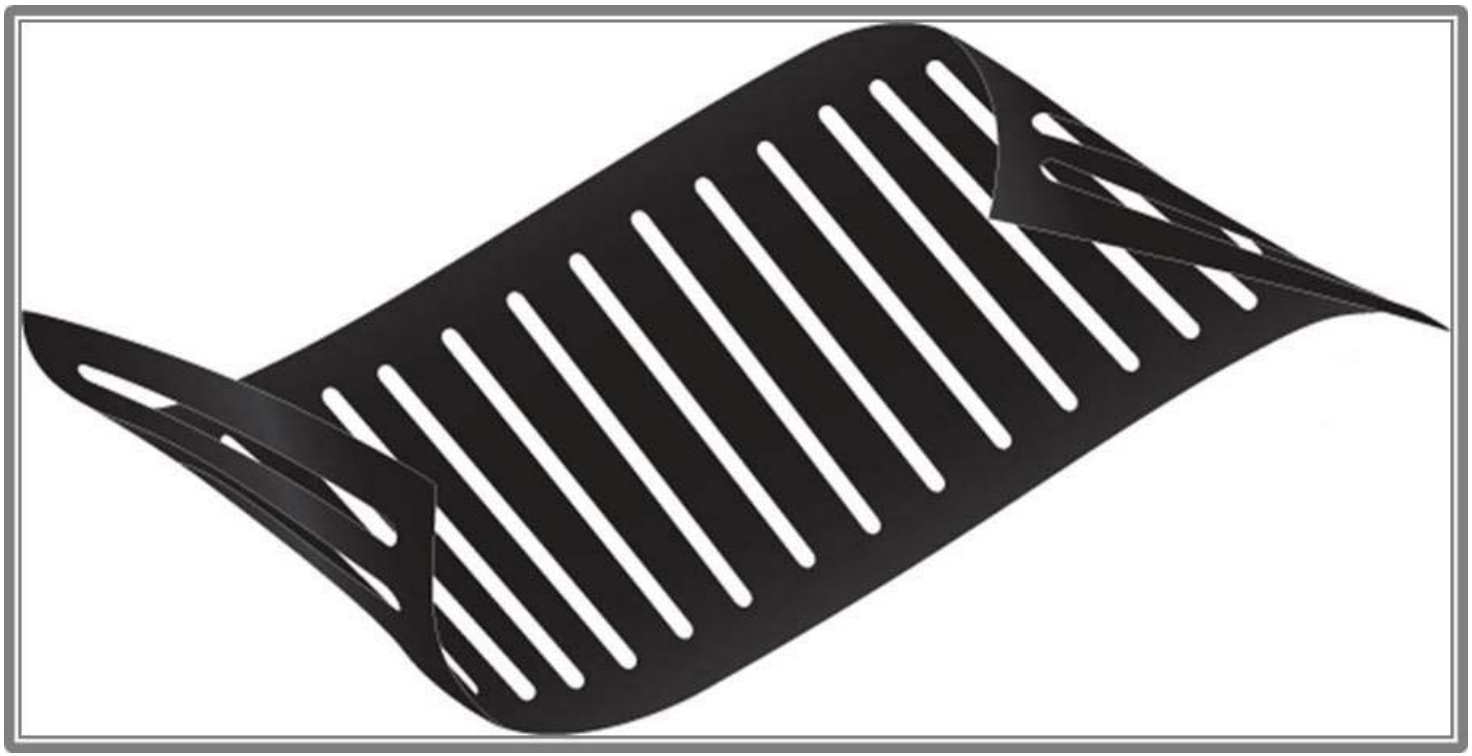
Alternative Energy Sources

Multiple options are available when using low-voltage PTC heating elements with DC or AC power.



Maintains an even low temperature

Takes advantage of off-peak electric rates



Applications & Installation

Floor Warming, Complementary or Primary Heating

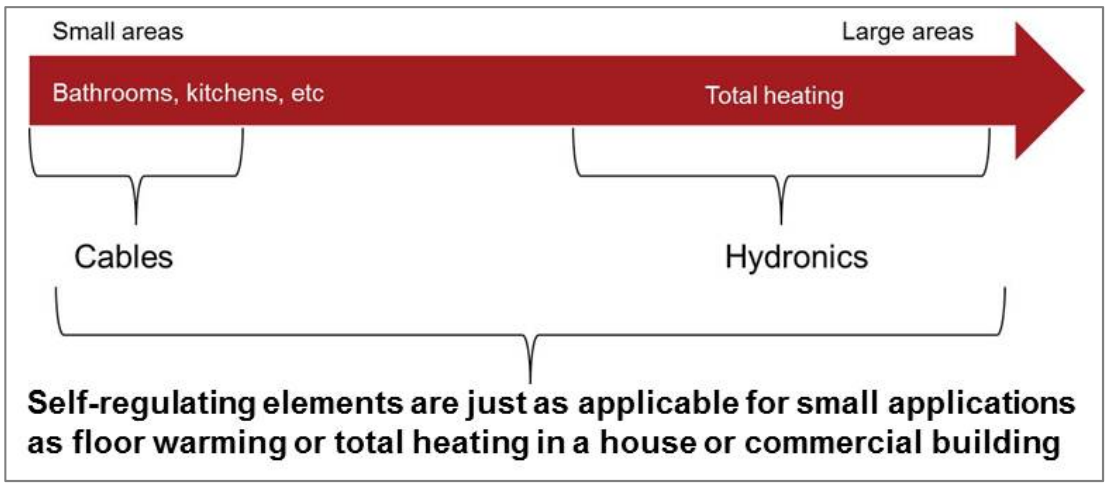
Typically, a radiant floor warming system is installed in a bathroom, underneath tiles in the kitchen or hallways, or any other area where the comfort of underfloor radiant heating is desired. Many floor warming systems are designed to take the chill out of cold floors, but may not be designed to be the primary heat source.

As a complementary heat source, radiant heating provides a gentle and even underfloor heating experience in addition to the existing heating system already installed in the house.

Floor Warming, Complementary or Primary Heating

A PTC electric radiant heating system is just as suitable for:

- large commercial or industrial installations
- whole houses, or
- small areas such as bathrooms.



Additional Residential Applications

Where else in the house can a PTC heating element be used?

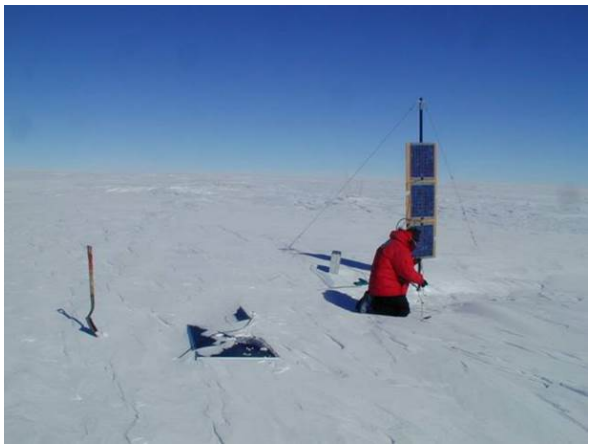
It can be:

- used to heat places such as basements, sunrooms, and living spaces above garages
- used to take away the chill of cold walls
- placed behind mirrors to prevent them from fogging up
- used under shower seats and around tubs, and
- placed under stone counter tops.

Additional Applications

PTC technology has been used in a variety of areas:

- under sidewalks and driveways to prevent snow and ice buildup—no more shoveling walkways or using salt to melt the ice
- for roofs and gutters to solve problems of snow buildup, ice damming, and the creation of icicles
- on Alaskan tug boat decks to prevent ice and snow buildup in minus 40-degree weather
- in the North Sea to keep living areas on oil platforms (100 feet above the ice-cold ocean) warm and comfortable
- in the Antarctic to help keep delicate electronics working
- by veterinarians to keep animals warm, and
- in greenhouses to help plants grow.



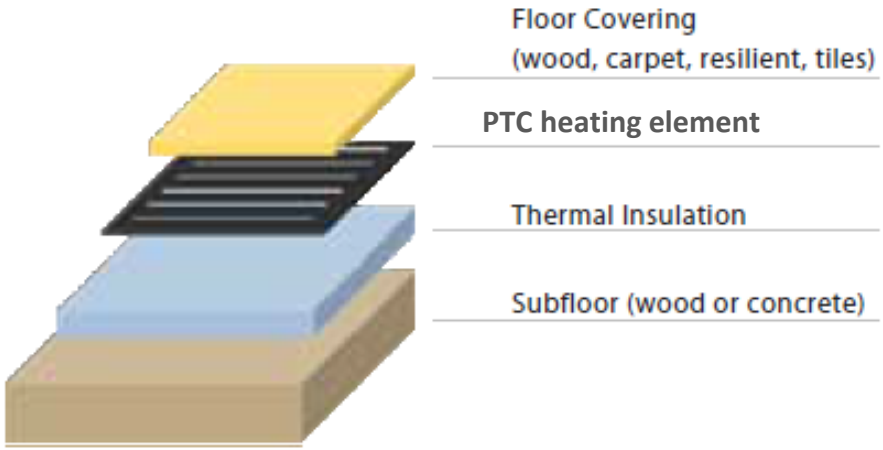
Warming the batteries for NASA's GPS and all seismic sensors on the South Pole

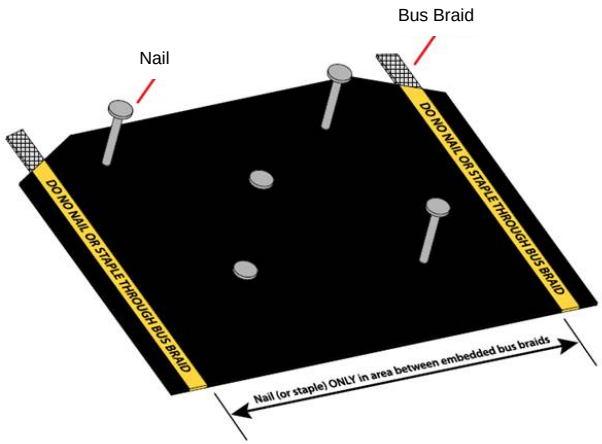
De-icing on NOAA research vessels to avoid ice accumulation on decks, bulkhead, and walls

Installation

The PTC heating elements can be:

- installed under, in, or on the concrete slab
- sandwiched between the insulation and the floor covering
- stapled/nailed without affecting the conductivity (note, do not penetrate the two conductors on each side)
- cut to length at the jobsite
- easily bent 90 degrees to fit any contour, and
- installed without changing the height of molding, doors, or cabinets.





Installation: Under Most Flooring

The PTC heating elements can be used under almost any flooring including tile, stone, hardwood, engineered wood, laminate, and carpet.

Installation: Under Tile

Out of all the common finished floor materials, tile and natural stone produce the coldest sensations. A radiant heating system under the tile will greatly enhance the comfort of the home. The PTC heating elements can be covered using mortar bed, thin-set or cementitious backer board. The elements are rolled out, cut to the desired length on the jobsite, and secured to the sub-floor with staples, approved tape, or directly to the mortar, under the tile and stone.

In wet areas, the heating elements have to be properly installed under a waterproof membrane to avoid risks of sneak current and/or short circuit. Although the elements use a low-voltage (24 V) system and cannot harm you, it is unpleasant to feel a tingling sensation on the floor. It is also necessary to ensure that the plumbing and drain have the same potential, i.e., common ground.

Installation: Under Hardwood, Engineered Wood, & Laminate

Plank style finished floors come in many shapes, sizes, and colors. For a wood floor, it is very important to have a low and stable temperature on the whole floor surface. For heated floors under hardwood, it is essential that the temperature stay below 82°F. In addition, radiant heat should not be turned on and off abruptly because this repeated action will traumatize the wood fibers, causing stress fractures, gaps, and twisting.

With a PTC heating element, the heating level is by nature low and can be adjusted to attain the ideal constant temperature by using the accompanying thermostat.

The heating elements should not be in direct contact with any conductive material, i.e., metal mesh, aluminum foil, etc., or aggressive adhesives. Always check with the manufacturer, and use only approved products.

Installation: Under Carpet

Out of all the commonly used finished floor materials, carpet provides the warmest sensation on the floor. Even though this is the case, many carpet installations can benefit from the use of a radiant floor warming system, especially if the floor is over a basement slab or an unheated space.

Since the PTC heating element is capable of self-regulating its output and does not reach temperatures above 82°F, it can be installed under the carpet pad. This helps to spread the radiant heating between the designed spacing of the element strips laid down on the floor. The pad acts as a radiant heat sink to absorb and spread the heat through the carpet. The carpet pad acts as a cushion so the wires or crimp connectors are not felt underfoot. It is best to use a quality firm pad for use with radiant heat as recommended by the manufacturer.

Installation: Residential, Commercial, & Industrial

The PTC heating elements can be used in renovation and new construction in residential, commercial, and industrial applications.

Residential

Commercial and industrial

Retrofit Installation

A PTC heating element is designed to provide radiant heat to existing floors by accessing the floor joists from below. This type of element can be ordered without slots and can be stapled or nailed through for easy installation. After stapling the radiant heating elements between the floor joists and making the electrical connections, insulation is installed snug underneath the heating element with no air gap.

Please remember the **exam password STAPLE.** You will be required to enter it in order to proceed with the online examination.

Thermal Insulation

Thermal insulation decreases energy costs and increases the building's comfort level in winter and summer. Insulation should be placed between any area that separates a heated space from an unheated space; this includes all exterior walls, attics, and floors over unheated areas.

It is highly recommended to place insulation under the PTC heating elements. It is also important to know the thermal transmission properties of the floor covering. When higher thermal resistance is applied on the radiant floor, compensate by placing higher R-value insulation under the heating elements with a ratio of 4 to 1. Limit the R-value over the heating elements to R-2.5 to avoid trapping the heat.

Insulation on floors must be strong and stiff. Consult the manufacturer for deflection/load characteristics and for maximum allowable live and dead load limits. Check that the product and installation procedure is approved by code for the application. Since the elements must not be in direct contact with any conductive material, when an insulation with reflective aluminum foil is used, a one-sided aluminum backing should be specified and the aluminum foil placed facing downwards.

Snowmelt Systems

The PTC snowmelt system is designed to melt snow and ice on entrances, walkways, driveways, ramps, patios, etc. It eliminates the need to shovel snow and protects pedestrians from slippery ice or snow covered driveways and sidewalks. The self-regulating PTC technology allows the elements to heat with maximum power in cold environments and use less electricity as they warm up.

Snowmelt Systems: Design Considerations

When designing a snowmelt system, it is essential to know the: area conditions and temperatures, number of snowfall days, surface type, heat loss to ground, atmospheric loss, and perimeter insulations.

Before starting, it is also necessary to define the snow-free area ratio, according to ASHRAE:

- 0: designed not to melt snow while it is falling, but afterwards
- 0.5: 50% of snow is melted while falling, the rest afterwards
- 1: all snow is melted while falling

Snowmelt Systems: Design Considerations

To start melting ice or snow after everything is frozen requires a lot of power. The design data differs throughout the United States and has to be calculated for each location according to: freezing index of the area, soil type, and loading conditions.

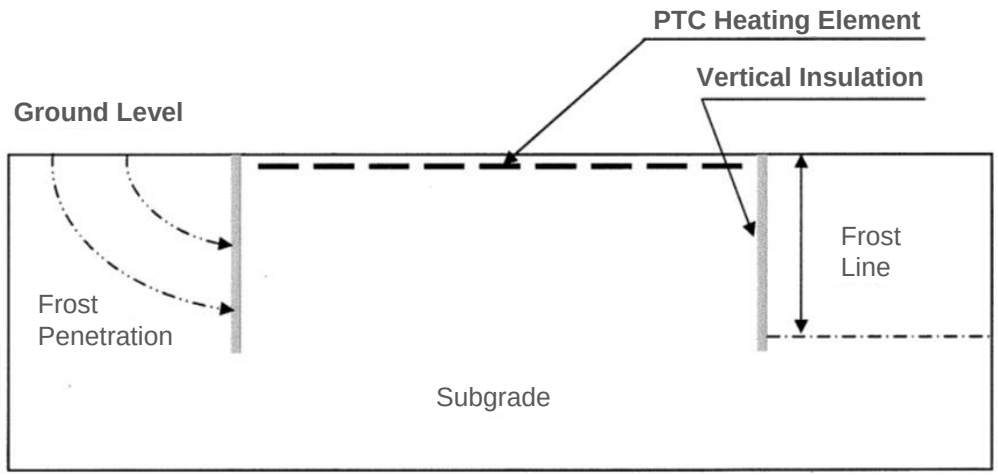
The climate of a location will determine which of the following two snowmelt systems will be selected:

- an on-demand snowmelt system may be favorable in places with few snowfall days, while
- the thermal bed concept is used in areas with frequent snowfall; it is a low-power system that is switched on prior to seasonal frost and kept energized all winter.

Snowmelt Systems: Thermal Bed Concept

The thermal bed concept relies on maintaining a frost-free area under the protected surface to allow the earth's stored energy to provide the bulk heat required for the snow or ice event. The design and installation of this type of system is very heater-dependent and involves calculations to ensure the correct application and sizing of the system.

A vertical and wing configuration allows placement of insulation that will reduce frost penetration and reduce excavating and backfilling. It is recommended that the perimeter insulation strip be placed on a slight slope grading away from the structure to encourage drainage.



De-icing Systems

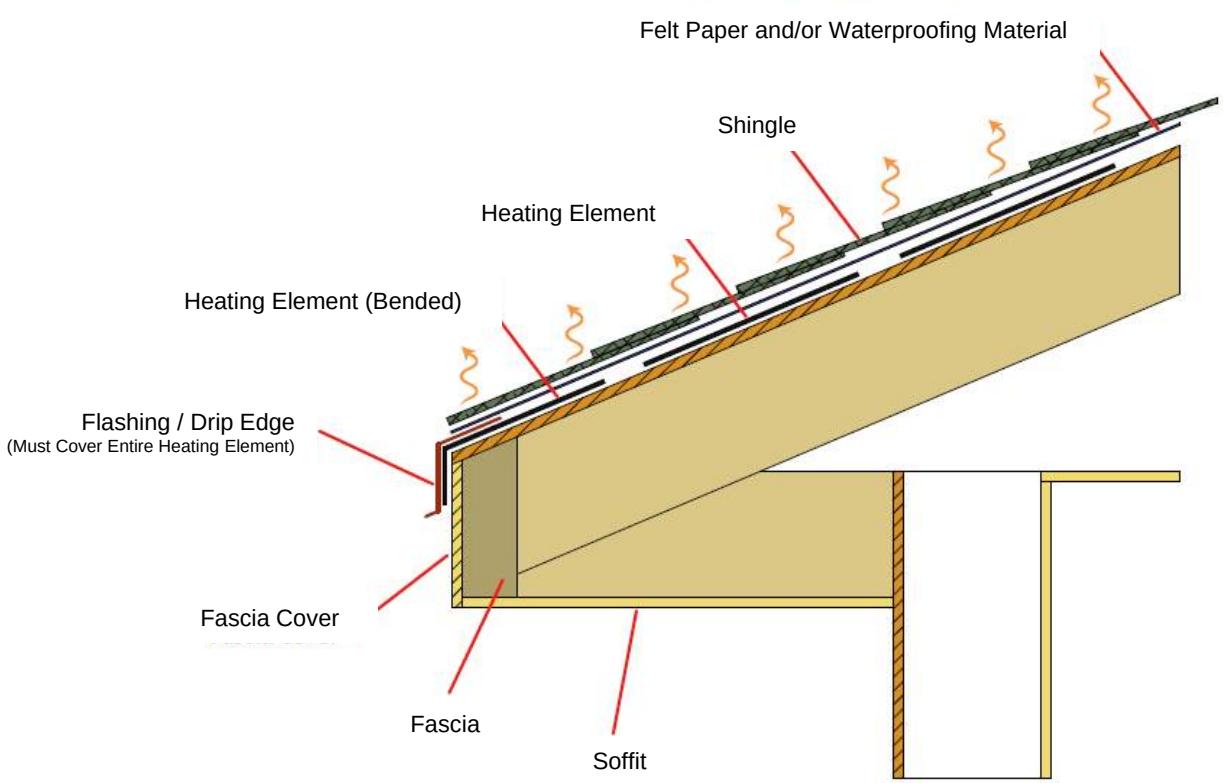
De-icing systems are designed to solve problems with snow buildup and ice damming on roofs, valleys, eaves, and gutters.

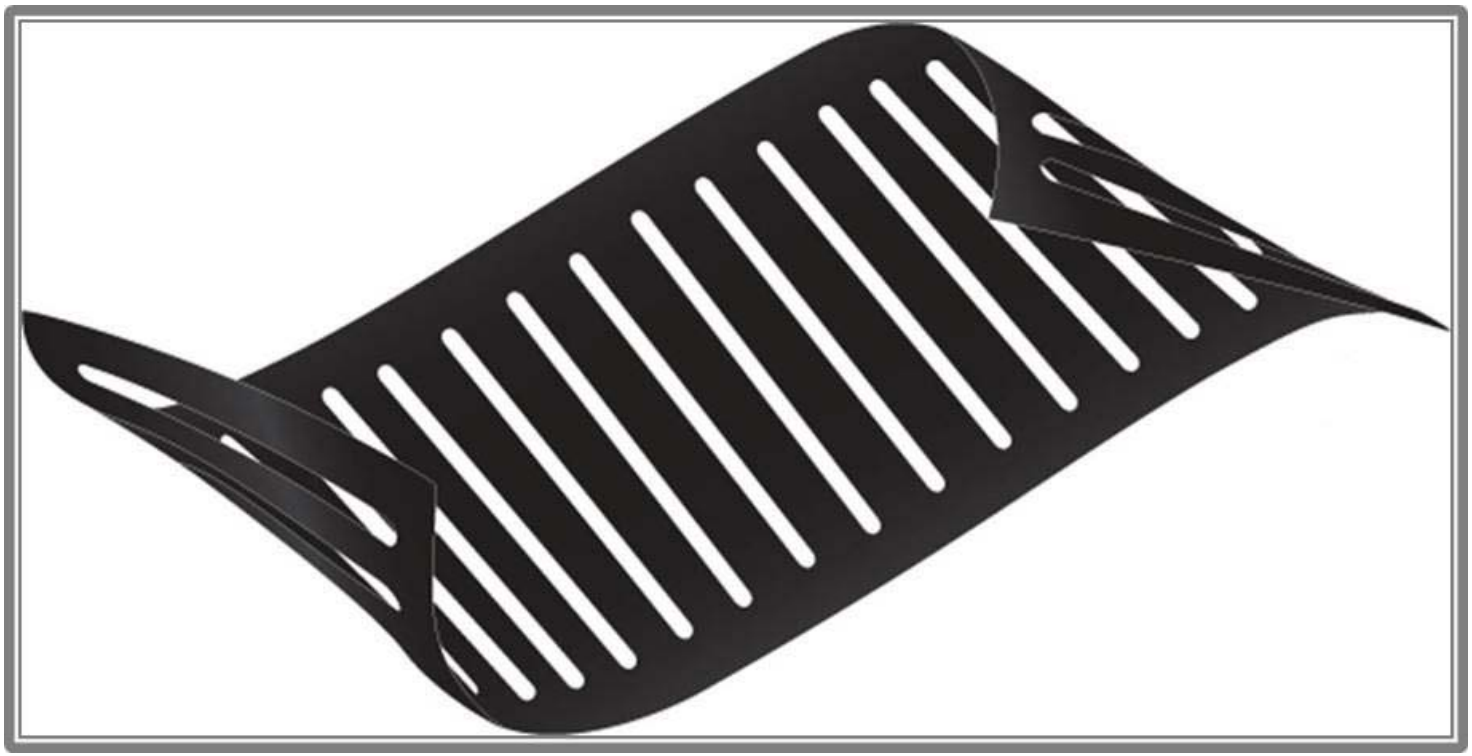
Ice dams are formed due to the interaction between the amount of heat loss from a house, snow cover, outside temperatures, and the effects of solar energy. The water that accumulates behind an ice dam can cause moisture to seep through the roof, resulting in damaged ceilings, walls, and floors and eventually mold growth. Ice dams and their accompanying icicles are also heavy objects that can cause severe damage or even death when they slide or fall off a roof.

Rooftop and ice buildup can lead to dangerous conditions resulting in personal injury as well as serious structural damage.

De-icing Systems

PTC heating elements may be installed under any rooftop and configuration: new construction, remodeling, and existing roofs as well as gutters.





Summary & Resources

Why Radiant Heat Flooring?

Increases Comfort

- When your feet are warm, you feel warmer—the heat distribution in a room is optimal when the temperature is higher at the feet than at the head level.

Improves Indoor Air Quality

- Radiant heat does not blow allergens; it helps those with allergies and asthma find dramatic improvement to their symptoms.

Safe and Aesthetically Pleasing

- Completely invisible, electric radiant floor heating is concealed in the floor without the need for heat pumps, baseboard heaters, and vents; there is no risk of direct contact with the heating element, avoiding any risk of burns and electrical shock.

Radiant Heating Reduces Energy Costs

- You are more comfortable at a lower air temperature. This lower air temperature will save you money on your energy bills.

Easy to Zone

- Heat where and when you want it.

Why PTC Heating Elements?

- The PTC elements are used for primary heating, floor warming, snow melting, and roof de-icing. They use safety extra low voltage (approved for 30 V or less) and can operate using AC or DC power.
- When installed, the 12"-wide elements cover over 60% of the floor, thereby warming the floor evenly with a lower temperature. With a reduced operating temperature, there is less heat loss to the ground.
- The PTC elements act like a floor sensor. The heating element is self-regulating so when the ambient temperature increases, the electrical resistance increases and the consumption of electricity decreases.
- Approved to be installed under any floor covering, the elements can be stapled onto the subfloor or up between the joists, or set in mortar. They are suitable for both retrofit and new construction projects.
- The polymer mats are made of recyclable, non-hazardous materials and comply with LEED®, LEED® for Homes™, and NAHB standards.

Additional Resources

- ARCAT – Specs/CAD/BIM modeling, www.arcat.com (accessed March 1, 2014)
- ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers, www.ashrae.org (accessed March 1, 2014)
- Emerge Alliance, www.emergealliance.org (accessed March 1, 2014)
- NWFA – National Wood Flooring Association, www.nwfa.org (accessed March 1, 2014)
- RPA - Radiant Professionals Alliance, www.radiantprofessionalsalliance.org (accessed March 1, 2014)
- Francesco Schiavone's calculations may be viewed and downloaded here: www.warmfloor.com/images/stories/pdf/efficiency/Efficiency_(Imperial).pdf (accessed March 1, 2014)

Conclusion

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