Roof and Gutter De-Icing

IceStop System

This step-by-step design guide provides the tools necessary to design a Raychem IceStop roof and gutter de-icing system. For other applications or for design assistance, contact your Tyco Thermal Controls representative or phone Tyco Thermal Controls at (800) 545-6258. Also, visit our web site at www.tycothermal.com.

Contents

Introduction

Raychem IceStop is a roof and gutter de-icing system that provides drain paths for the following applications:

- Roofs made from standard roofing materials, including shake, shingle, rubber, tar, wood, metal, and plastic.
- Gutters made from standard materials, including metal, plastic, and wood.
- Downspouts made from standard materials, including metal and plastic.

The guide does **not** cover applications in which any of the following conditions exist:

- Preventing snow movement on roofs — IceStop will not keep snow or ice from falling off the roof. IceStop is designed to remove melt water, not accumulated snow. Snow fences or snow guards should be used to eliminate snow movement.

  For the names of manufacturers of snow guards or snow fences, contact your Tyco Thermal Controls representative, or contact Tyco Thermal Controls directly at (800) 545-6258.
- Melting snow on a roof and/or reduction of snow load — IceStop is designed to remove melt water, not accumulated snow.

If your application conditions are different, or if you have any questions, contact your Tyco Thermal Controls representative, or contact Tyco Thermal Controls directly at (800) 545-6258.

How to Use this Guide

This design guide presents Tyco Thermal Controls' recommendations for designing an IceStop roof and gutter de-icing system. It provides design and performance data, electrical sizing information, and heating-cable layout suggestions. Following these recommendations will result in a reliable, energy-efficient system.

OTHER REQUIRED DOCUMENTS

This guide is not intended to provide comprehensive installation instructions. For complete IceStop roof and gutter de-icing system installation instructions, please refer to the following additional required documents:

- *IceStop System Installation and Operation Manual* (H58067)
- Additional installation instructions that are included with the connection kits, thermostats, controllers, and accessories

If you do not have these documents, you can obtain them from the Tyco Thermal Controls web site at www.tycothermal.com.

For products and applications not covered by this design guide, please contact your Tyco Thermal Controls representative or call Tyco Thermal Controls directly at (800) 545-6258.

Safety Guidelines

As with any electrical equipment, the safety and reliability of any system depends on the quality of the products selected and the manner in which they are installed and maintained. Incorrect design, handling, installation, or maintenance of any of the system components could damage the system and may result in inadequate performance, overheating, electric shock, or fire. To minimize these risks and to ensure that the system performs reliably, read and carefully follow the information, warnings, and instructions in this guide.

This symbol identifies important instructions or information.

⚠ This symbol identifies particularly important safety warnings that must be followed.

⚠ **WARNING**: To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of Tyco Thermal Controls, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

Warranty

Tyco Thermal Controls' standard limited warranty applies to Raychem Roof and Gutter De-icing Systems.

An extension of the limited warranty period to ten (10) years from the date of installation is available, except for the control and distribution systems, if a properly completed online warranty form is submitted within thirty (30) days from the date of installation. You can access the complete warranty on our web site at www.tycothermal.com.

System Overview

The Raychem IceStop system can prevent ice dams and icicles by maintaining a continuous path for melt water to drain from the roof. The IceStop system uses a self-regulating heating cable which reduces heat output automatically as the cable warms to above freezing, resulting in lower energy use, and eliminating the possibility of overheating. A typical roof and gutter de-icing system includes the IceStop self-regulating heating cables, connection kits, control system and power distribution.

Typical System

A typical system includes the following:

- IceStop self-regulating heating cable
- Connection kits and accessories
- Control system
- Power distribution

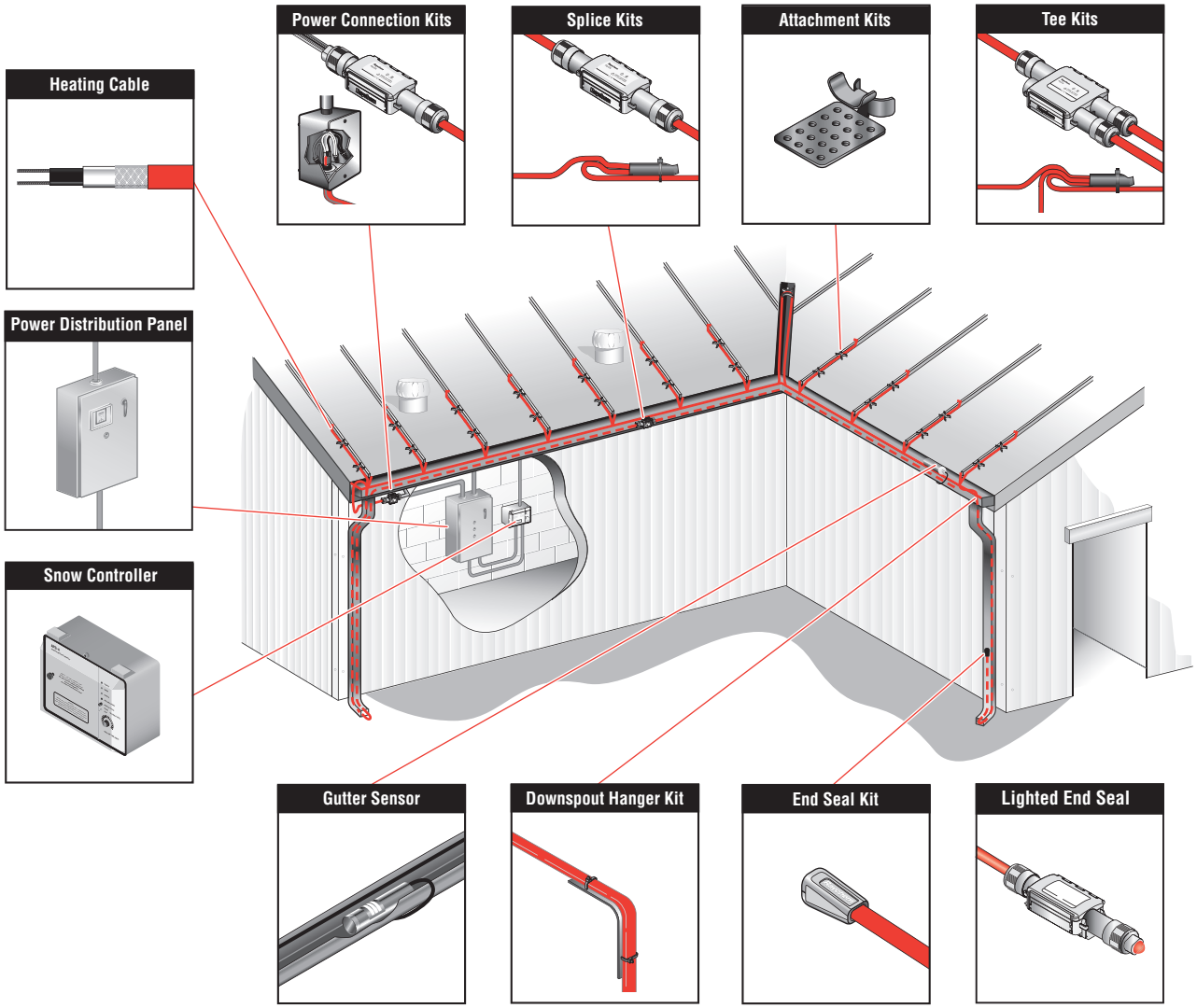

Fig. 1 Typical IceStop roof and gutter de-icing system

Self-Regulating Heating Cable Construction

Raychem IceStop self-regulating heating cables are comprised of two parallel nickel-coated bus wires in a cross-linked polymer core, a tinned copper braid and a fluoropolymer or polyolefin outer jacket. These cables are cut to length simplifying the application design and installation.

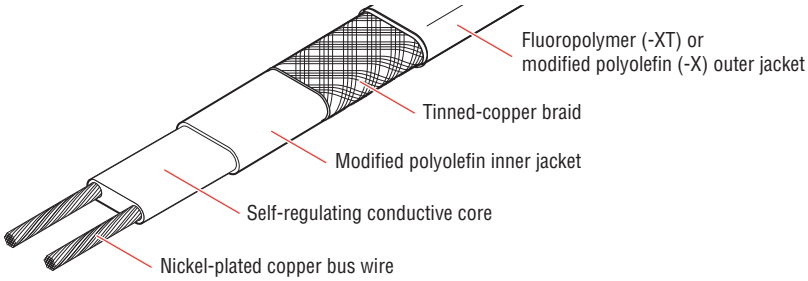

Fig. 2 IceStop heating cable construction

With self-regulating technology, the number of electrical paths between bus wires changes in response to temperature fluctuations. As the temperature surrounding the heater decreases, the conductive core contracts microscopically. This contraction decreases electrical resistance and creates numerous electrical paths between the bus wires. Current flows across these paths to warm the core.

As the temperature rises, the core expands microscopically. This expansion increases electrical resistance and the number of electrical paths decreases. The heating cable automatically begins to reduce its output.

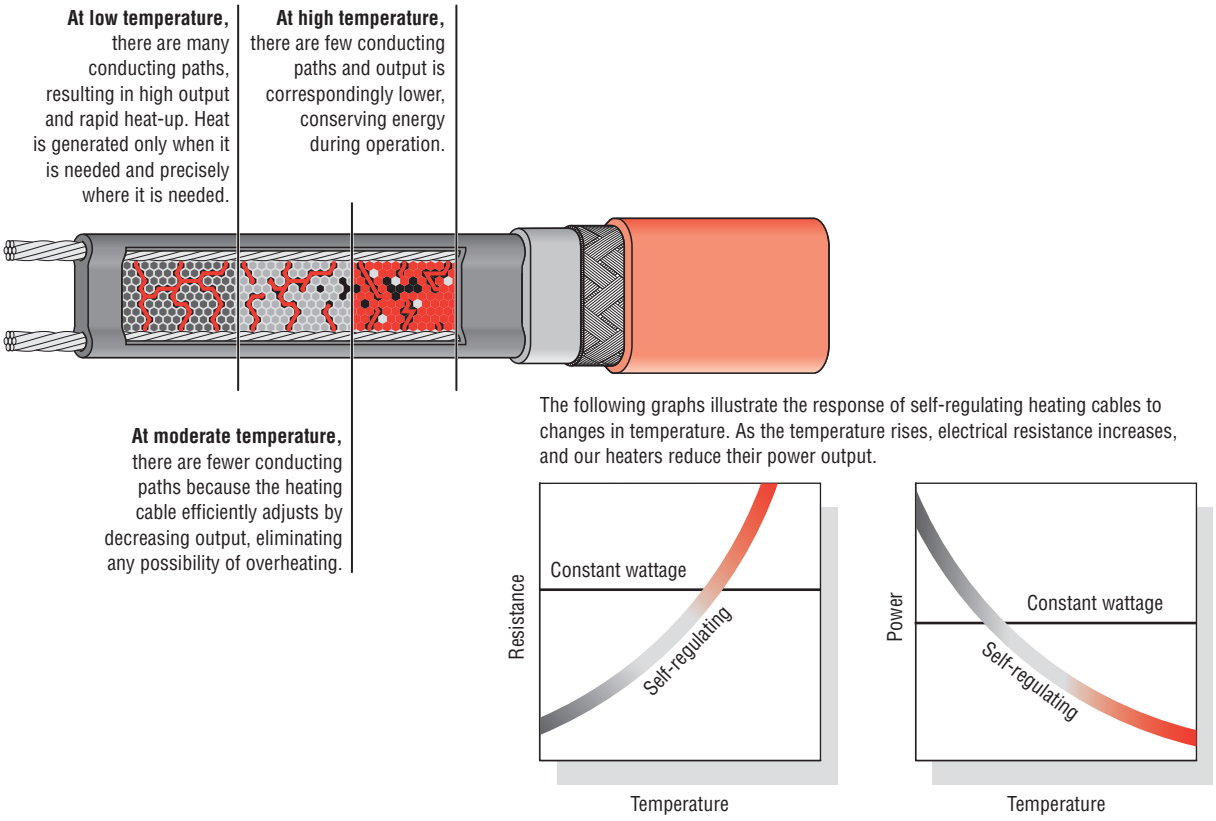

Fig. 3 Self-regulating heating cable technology

Approvals

The IceStop roof and gutter de-icing system is UL Listed, CSA Certified, and FM Approved for use in nonhazardous locations. GM-1XT and GM-2XT are FM Approved for use in Class I, Division 2 hazardous locations.

Roof and Gutter De-Icing Design

This section details the design steps necessary to design your application. The example provided in each step is intended to incrementally illustrate the project parameter output for a sample design from start to finish. As you go through each step, use the "IceStop System Roof and Gutter De-Icing Design Worksheet," page 34, to document your project parameters, so that by the end of this section, you will have the information you need for your Bill of Materials.

Design Step by Step

1. Determine design conditions
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits
6. Select attachment accessories and method
7. Select the control system and power distribution
8. Complete the Bill of Materials

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Step 1 Determine design conditions

Collect the following information to determine your design conditions:

- Type of roof
- Layout
  - Roof edge
  - Eave overhang
  - Gutters
    - Length
    - Depth
    - Width
  - Roof valley
  - Roof/wall intersections
  - Downspouts
- Supply voltage
- Minimum start-up temperature
- Control method

PREPARE SCALE DRAWING

Draw to scale the roof of the building noting roof valleys, different roof levels and gutter and downspout locations. Note rating and location of voltage supply. Measurements for each distinct section of the roof system, the gutters and the downspouts, will allow for an accurate systems design, including control configuration.

Example: Roof and Gutter De-Icing System

Type of roof	Sloped roof – standard with wood shingles and gutters
Layout	
Roof edge	50 ft (15.2m) x 2 roof edges = 100 ft (30.5 m)
Eave overhang	24 inch (60 cm)
Gutters	2 gutters
Length	50 ft (15.2m) x 2 roof edges = 100 ft (30.5 m)
Depth	6 in (15 cm)
Width	4 in (11 cm)
Roof valley	20 ft (6.1 m)
Downspouts	12 ft (3.7 m) x 2 downspouts = 24 ft (7.4 m)
Supply voltage	208 V
Minimum start-up temperature	20°F (–7°C)
Control method	Automatic controller

Step 2 Select the heating cable

To select the appropriate IceStop heating cable for your application, use the supply voltage from Step 1, and select the appropriate outer jacket material. Once you select these, you will be able to determine the catalog number for your cable.

HEATING CABLE CATALOG NUMBER

Before beginning, take a moment to understand the structure underlying the heating cable catalog numbers. You will refer to this numbering convention throughout the product selection process. Select the appropriate heating cable catalog number based on the voltage and outer jacket, as indicated below.

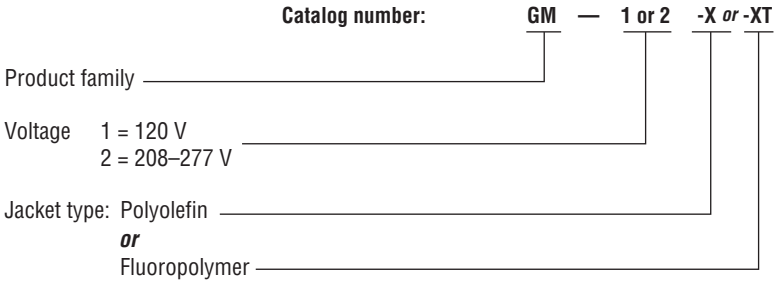


Fig. 4 Heating cable catalog number

SELECT HEATING CABLE SUPPLY VOLTAGE

Select the heating cable supply voltage. Note that a higher supply voltage will allow for longer circuit lengths. Supply voltage options include:

1 = 120 V
2 = 208–277 V

EVALUATE HEATING CABLE SPECIFICATIONS

Use the following table to evaluate heating cable specifications that describe some important aspects of the heating cable.

Table 1 IceStop Self-Regulating Heating Cable Specifications

Power output (nominal)	12 W/ft (39 W/m) in ice or snow
Minimum installation temperature	0°F (–18°C)
Minimum bend radius	5/8 in (16 mm)

SELECT OUTER JACKET

Select the appropriate heating cable outer jacket for the application. Jacket options include:

-X A polyolefin outer jacket (-X) is more economical for less demanding applications.
-XT A fluoropolymer outer jacket (-XT) provides maximum abrasion, chemical, and mechanical resistance.

Example: Roof and Gutter De-Icing System

Supply voltage	208 V *(from Step 1)*
Catalog number	**GM-2XT**

Step 3 Determine the heating cable length

To determine the required heating cable length for your application, you will need to determine the heating cable layout for each roof and gutter section that requires ice protection. Detailed sketches of the building from Step 1 can ensure each area and level is accounted for. The following guide will help determine length of cable required for a variety of roof types and sections. For applications not covered in this section, please contact Tyco Thermal Controls for assistance.

Heating cable layout depends primarily on the roof type and its related roof features. The following sections show typical layouts on standard roof types

Table 2 Roof Types and Areas

Important: For optimum performance, the heating cable should be in contact with snow or ice. Installing the heating cable under the roofing or the roofing materials will reduce the efficiency of the heating system. Please contact Tyco Thermal Controls for assistance.

Figure 5 and Figure 6 below illustrate several important terms:

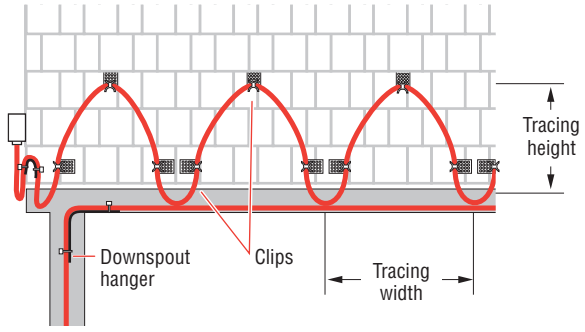


Fig. 5 Front view of roof with IceStop system

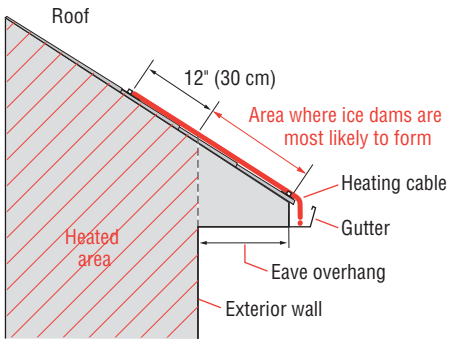


Fig. 6 Side view of roof with IceStop system

SLOPED ROOF — STANDARD

For sloped roofs, ice dams may form at the roof edge. To maintain a continuous path for melt water runoff, route the heating cable in a zig-zag pattern as shown in Figure 7 and follow the appropriate attachment recommendations in “Step 6 Select attachment accessories and method,” page 21. Additional heating cable may be needed for other gutters, downspouts, and valleys.

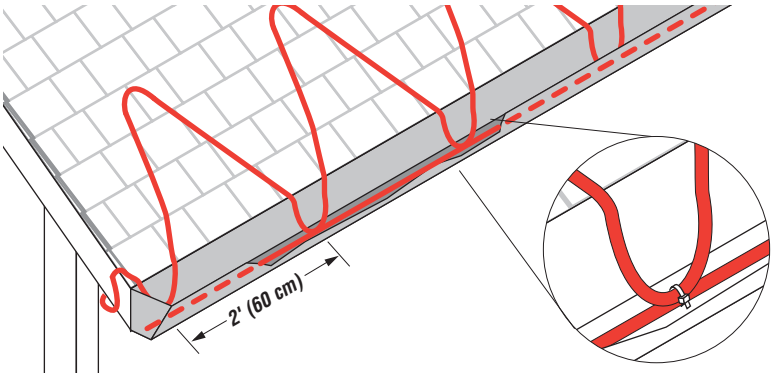


Fig. 7 Layout in a zig-zag pattern

- Install the heating cable on the roof in a zig-zag pattern as shown in Figure 7.
- Run heating cable up the roof until it is 12 inches (30 cm) past the exterior wall into the heated area (see Figure 6 on page 8).
- Use Table 3 to determine how much heating cable to use per foot of roof edge. This will determine how much heating cable you need to trace on the roof. Additional heating cable will be needed for gutters, downspouts, and component connections.

Table 3 IceStop Heating Cable Length for Sloped Roof – Standard

Eave overhang distance	Tracing width	Tracing height	Feet of heating cable per foot of roof edge	Meters of heating cable per meter of roof edge
0	2 ft (60 cm)	12 in (30 cm)	2.5 ft	2.5 m
12 in (30 cm)	2 ft (60 cm)	24 in (60 cm)	3.1 ft	3.1 m
24 in (60 cm)	2 ft (60 cm)	36 in (90 cm)	4.2 ft	4.2 m
36 in (90 cm)	2 ft (60 cm)	48 in (120 cm)	5.2 ft	5.2 m

For roofs without gutters, add 6 inches of heating cable per foot of roof edge (0.5 meters of heating cable per meter of roof edge) to allow for a 2-3 inch (5-8 cm) drip loop to hang off the roof edge as shown in Figure 10 on page 12.

For roofs with gutters, heating cable must be run to the bottom of the gutter. You can determine the amount of extra heating cable required by adding twice the gutter depth per foot of roof edge to the amount determined in Table 3.

For example, for a 6 inch deep gutter, add 1 foot of heating cable per foot of roof edge to the amount determined using Table 3.

Additional heating cable must be run along the bottom of the gutter. See “Gutters,” page 14.

Note: Attachment methods are not shown in Figure 7. For attachment methods, proceed to “Step 6 Select attachment accessories and method,” page 21.

SLOPED ROOF — STANDING SEAM

For sloped standing-seam metal roofs, ice dams may form at the roof edge. To maintain a continuous path for melt water to run off, route the heating cable along the seams as shown

in Figure 8 and follow the attachment recommendations in "Step 6 Select attachment accessories and method," page 21. Additional heating cable may be needed for gutters, downspouts, and valleys.

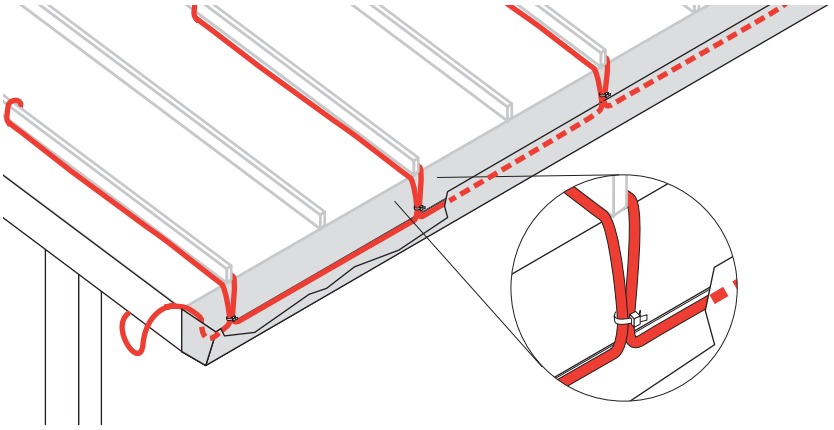


Fig. 8 Layout on a standing seam roof

- Run the heating cable up one side of the seam, loop it over to the other side, and return it to the bottom of the gutter. Continue along the bottom of the gutter to the third seam and repeat the process (Figure 8 on page 10). If the seams are more than 24 inches (60 cm) apart, trace every seam.
- Run the heating cable up the seam until it is 12 inches (30 cm) past the exterior wall and into a heated area, Figure 6 on page 8.
- If the roofing materials continue down the fascia, contact your local Tyco Thermal Controls representative or Tyco Thermal Controls directly for design assistance.
- If there are no gutters, refer to "Heated Drip Edges," page 26, for information on how to install heating cable for this application.

Table 4 IceStop Heating Cable Length for Sloped Roof – Standing Seam

Eave overhang distance	Standing seam spacing	Tracing height	Feet of heating cable per foot of roof edge	Meters of heating cable per meter of roof edge
12 in (30 cm)	18 in (45 cm)	24 in (60 cm)	2.8 ft	2.8 m
24 in (60 cm)	18 in (45 cm)	36 in (90 cm)	3.6 ft	3.6 m
36 in (90 cm)	18 in (45 cm)	48 in (120 cm)	4.3 ft	4.3 m
12 in (30 cm)	24 in (60 cm)	24 in (60 cm)	2.4 ft	2.4 m
24 in (60 cm)	24 in (60 cm)	36 in (90 cm)	2.9 ft	2.9 m
36 in (90 cm)	24 in (60 cm)	48 in (120 cm)	3.6 ft	3.6 m

For standing seam roofs without gutters, add 6 inches (0.1 meter) of heating cable for each seam traced to allow for a 2-3 inch (5-8 cm) drip loop to hang off the roof edge as shown in Figure 10.

For standing seam roofs with gutters, heating cable must be run to the bottom of the gutter. You can determine the amount of extra heating cable required by adding twice the gutter depth per seam traced to the amount determined in Table 4.

Additional heating cable will be needed for component connections and downspouts.

Note: Attachment methods are not shown in Figure 8. For attachment methods, proceed to "Step 6 Select attachment accessories and method," page 21.

FLAT ROOF

Ice dams may occur on flat roofs at the edge flashing and at drains. Flat roofs are typically pitched toward drains and these paths often become obstructed by snow and ice. To maintain a continuous path for melt water to run off, route the heating cable as shown in Figure 9 and follow the appropriate attachment recommendations in "Step 6 Select attachment accessories and method," page 21. Additional heating cable may be needed for downspouts.

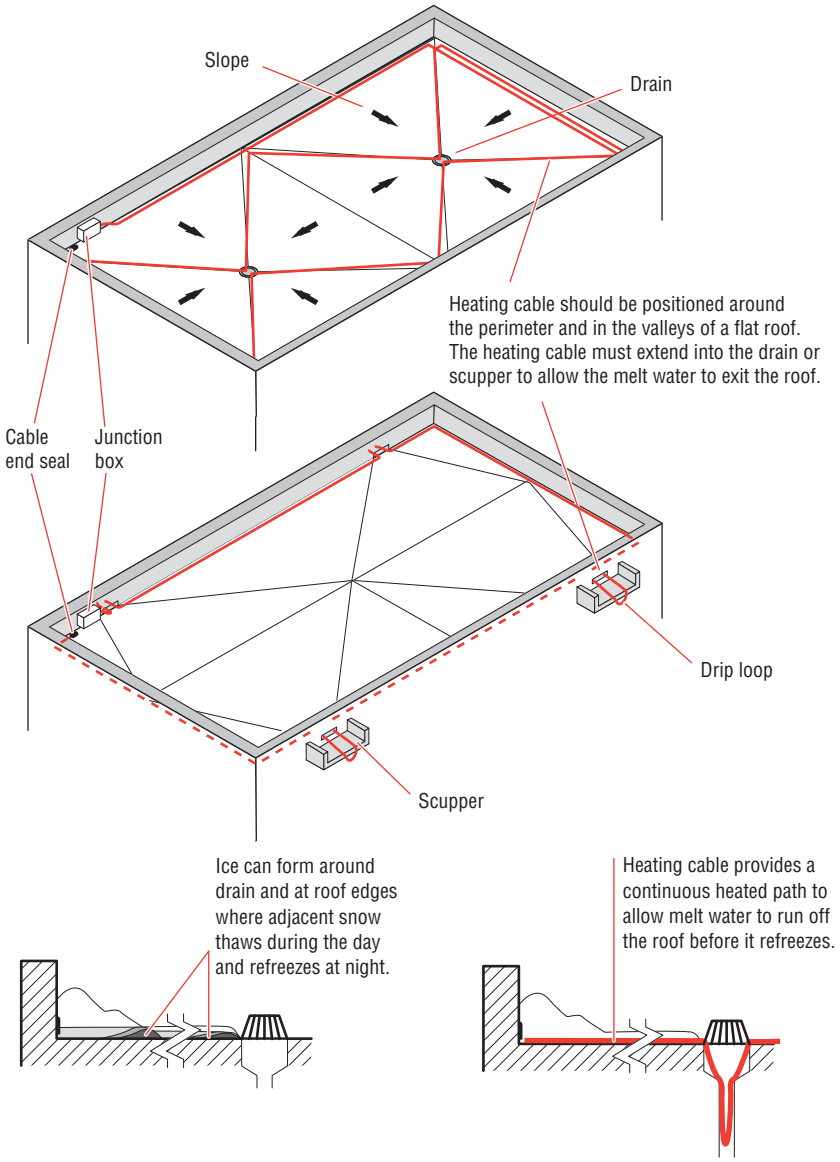


Fig. 9 Layout on a flat roof

- Place heating cable around perimeter.
- Trace valleys from perimeter to drain.
- Extend heating cable into internal downspouts at least 12 inches (30 cm) into heated space.
- External downspouts and scuppers must be treated carefully. A path must be provided for the valley/perimeter heating cable to the point of discharge (see Figure 17 on page 15).
- To avoid damage, do not walk on the heating cable.

SLOPED ROOF WITHOUT GUTTERS

When gutters are not used on a building, ice dams may form at the roof edge. To maintain a continuous path for melt water to run off, a drip loop or heated drip edge may be used. Drip loops and drip edges allow water to drip free of the roof edge.

Route the heating cable as shown in Figure 10 or Figure 11 below and follow the appropriate attachment recommendations in "Step 4 Determine the electrical parameters," page 16. Additional heating cable may be needed for valleys.

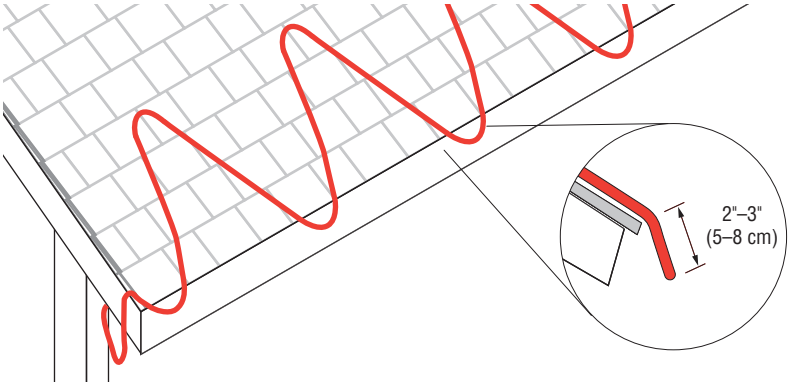


Fig. 10 Layout for heated drip loops

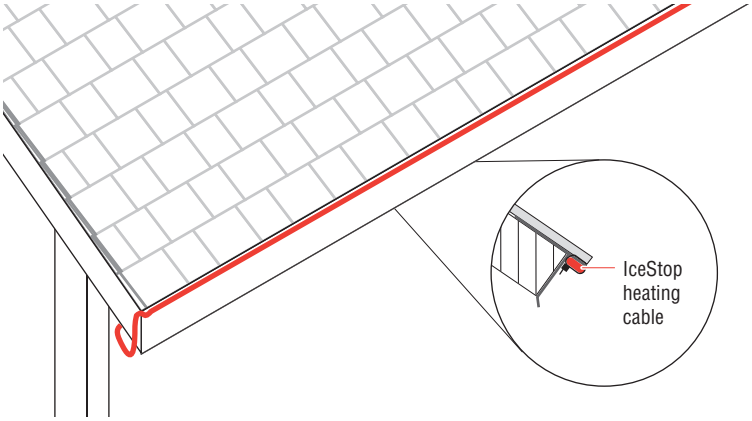


Fig. 11 Layout for heated drip edge

Note: Attachment methods are not shown in the above illustrations. For attachment methods, proceed to "Step 6 Select attachment accessories and method," page 21.

OTHER CONSIDERATIONS

- Ice will build up on the surfaces below the drip loop or drip edge if gutters are not used.
- Ice may also build up on the vertical surfaces if there isn't a sufficient overhang or if there is a strong wind. Using a gutter system will prevent this ice buildup.

ROOF VALLEYS

Ice dams may form at the valley on a roof where two different slopes meet. To maintain a continuous path for melt water, run the heating cable up and down the valley as shown in Figure 12 and follow the appropriate attachment recommendations in “Step 6 Select attachment accessories and method,” page 21. Additional heating cable may be needed for the roof surface, gutters, and downspouts.

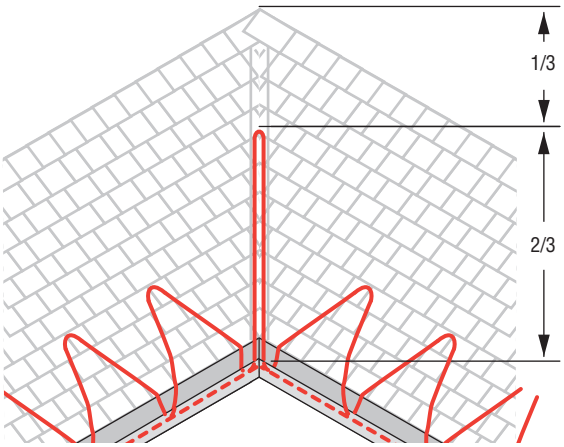


Fig. 12 Layout for a roof valley

- Trace two-thirds of the way up each valley with a double run of heating cable (loop up and back once).
- The heating cable must extend into the gutter. If you don’t have gutters, the heating cable should extend over the edge 2 to 3 inches (5 to 8 cm) to form a drip loop.
- For attachment methods, proceed to “Step 6 Select attachment accessories and method,” page 21.

ROOF/WALL INTERSECTIONS

Roof/wall intersections can be treated in the same manner as valleys. Snow has a tendency to collect at this interface. Providing a loop of heating cable two-thirds of the way up the slope will provide a path for the extra melt water in this area to escape.

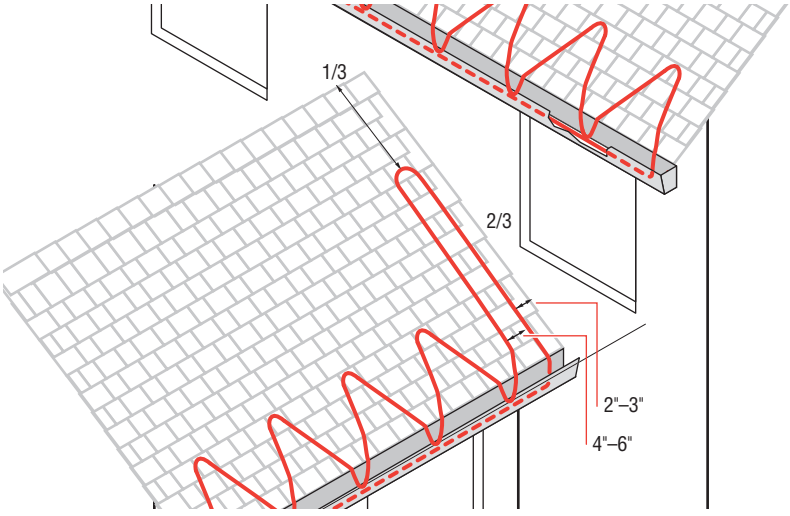


Fig. 13 Layout for a roof/wall intersection.

- Extend a loop of heating cable two-thirds of the way up the slope adjacent to the wall.
- Position the closest heating cable approximately 2 to 3 inches (5 to 8 cm) from the wall. Position the second heating cable 4 to 6 inches (10 to 16 cm) from the first.

GUTTERS

Ice may accumulate in gutters and at the roof edge. To maintain a continuous path for melt water to run off, route the heating cable as shown in Figure 14 below. Additional heating cable may be needed for the roof surface, downspouts, and valleys.

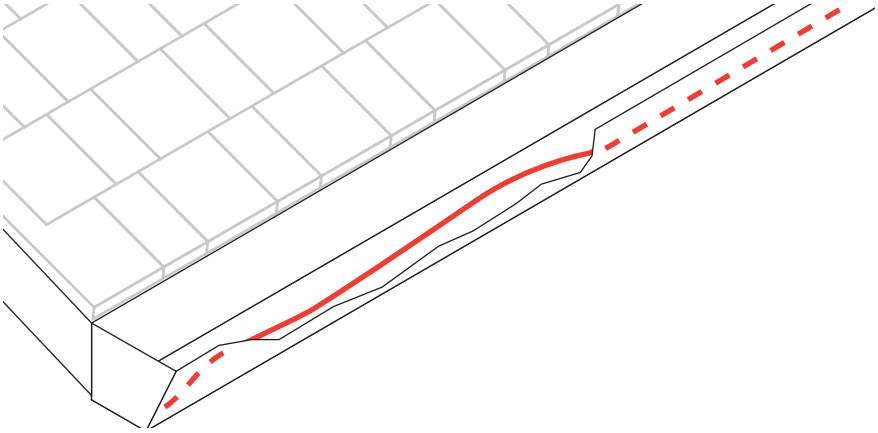


Fig. 14 Layout in standard gutters — up to 6" (16 cm) wide

- Use one run of heating cable in the gutter.
- No attachment to gutter is normally required. If attachment is desired, use a roof clip such as a Raychem GMK-RC clip.
- Continue heating cable down the inside of the downspout. See Downspouts page 15, for more information.

In wide gutters, snow and ice can bridge over the tunnel created by a single heating cable and prevent melt water from getting into the gutter and downspouts. To maintain a continuous path for melt water to run off, run the heating cable in the gutter as shown in Figure 15 below and follow the appropriate attachment recommendations in "Step 6 Select attachment accessories and method," page 21. Additional heating cable may be needed for the roof surface, downspouts, and valleys.

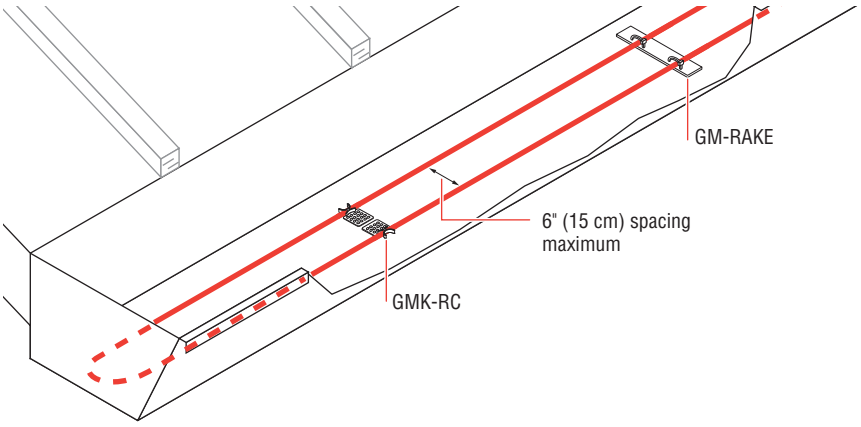


Fig. 15 Layout in wide gutters — 6" to 12" (16 to 31 cm) wide

- Use two parallel runs of heating cable. Separate the two runs of heating cable with a pair of GMK-RC clips or a single GM-RAKE downspout hanger bracket.
- No attachment to the gutter is normally required. If attachment is desired, use a GMK-RC with appropriate adhesive.
- Continue heating cable down the inside of the downspout. See Downspouts page 15 for more information.

DOWNSPOUTS

Ice may form in downspouts and prevent melt water from escaping from the roof. To maintain a continuous path for melt water to run off, run the heating cable inside the downspout to the end as shown in Figure 16 and Figure 17 below. Follow the appropriate attachment recommendations in "Step 6 Select attachment accessories and method," page 21. Additional heating cable may be needed for the roof surface, gutters, and valleys.

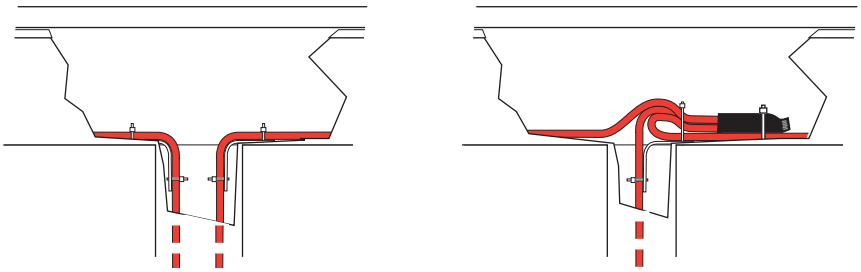


Fig. 16 Heating cable at top of downspout

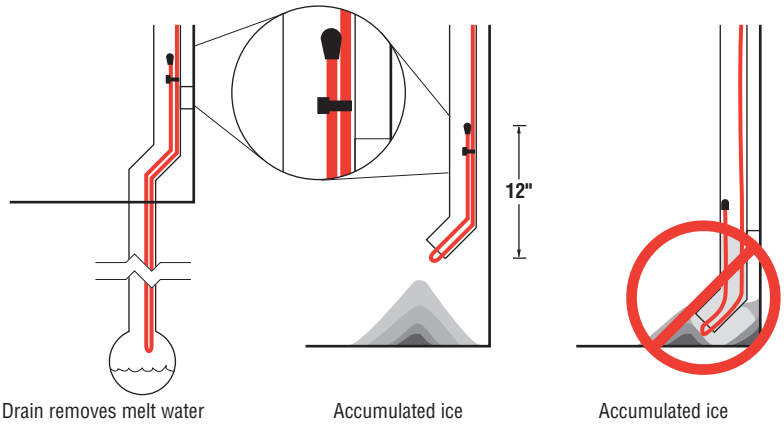


Fig. 17 Heating cable at bottom of downspout

- If the downspout ends underground, the heating cable should extend into a heated area or below the frost line.
- For low water-flow situations, teeing the heating cable so that a single run goes down the downspout is usually sufficient. For high water-flow situations, where ambient temperatures often fall below –10°F (–23°C), or where it isn't convenient to tee the heating cable, use two runs by running the heating cable down to the bottom and then back to the top.
- Leave drip loops below the downspout at bottom.
- If a single run of heating cable is used, the end seal should be looped back up at least 12 inches (30 cm) inside the downspout.
- If the downspout ends near the ground, water will refreeze on the ground and build up around the downspout, eventually blocking the opening.

⚠ **WARNING:** To prevent mechanical damage, do not leave the end seal exposed at the end of the downspout.

Example: Roof and Gutter De-Icing System

Type of roof	Sloped roof – standard with wood shingles and gutters *(from Step 1)*
Layout	
Roof edge	100 ft (30.5 m) *(from Step 1)*
Eave overhang	24 inch (60 cm) *(from Step 1)* Requires 4.2 ft of heating cable per foot of roof edge (4.2 m per meter of roof edge). See Table 2.
Gutters	
Length	100 ft (30.5 m) *(from Step 1)* = **100 ft (30.5 m)** heating cable
Depth	6 in (11cm) x 2 *(from Step 1)* = 1 foot of additional heating cable 4.2 ft + 1 ft = 5.2 ft x 100 ft = **520 ft (158.5 m)** heating cable
Width	4 in *(from Step 1)* therefore single run of heating cable at indicated gutter length
Roof valley	20 ft (6.1 m) *(from Step 1)* x 1.33 = 26.6 = rounded to **27 ft (8.3 m)** heating cable
Downspouts	Two 12 ft (3.7 m) *(from Step 1)* = **26 ft (8.0 m)** heating cable (Single runs in each downspout with 1 ft (0.3 m) loop back from bottom)
Total heating cable length	**673 ft (205.2 m)**

Additional heating cable will be required for connection kits. After determining kit requirements, heating cable allowances for each will be added to total heating cable length for Bill of Materials.

Roof and Gutter De-Icing
1. Determine design conditions
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits
6. Select attachment accessories and method
7. Select the control system and power distribution
8. Complete the Bill of Materials

Step 4 Determine the electrical parameters

This section will help you determine the electrical parameters for an IceStop system including circuit breaker sizing and maximum circuit length. Total required heating cable length divided by maximum heating cable circuit length will determine the number of circuits required for your snow melting solution.

DETERMINE MAXIMUM CIRCUIT LENGTH

To determine maximum circuit length, it is important to establish a minimum startup temperature for the system. The Table 5 provides maximum circuit lengths based on minimum startup temperature, circuit breaker rating and supply voltage. Colder temperature startup requires shorter maximum circuit lengths. The use of an automatic system, which energizes the system above 20°F (–7°C), ensures that you can use maximum circuit lengths. Manual control systems may require you to use shorter circuit lengths to compensate for startup below 20°F (–7°C).

Select the smallest appropriate circuit breaker size. A 30-mA ground-fault protection device (GFPD) must be used to provide protection from arcing or fire, and to comply with warranty requirements, agency certifications, and national electrical codes. If the heating cable is improperly installed, or physically damaged, sustained arcing or fire could result. If arcing does occur, the fault current may be too low to trip conventional circuit breakers.

Table 5 Maximum Circuit Length in Feet (Meters)

Heating cable	Start-up temperature	Circuit breaker size 15 A	20 A	30 A	40 A [1]	Max. A/ft	Max. (A/m)
GM-1X and -1XT at 120 V	32°F (0°C)	100 (30)	135 (41)	200 (61)	—	0.120	(0.394)
	20°F (–7°C)	95 (29)	125 (38)	185 (56)	200 (61)	0.126	(0.414)
	0°F (–18°C)	80 (24)	100 (30)	155 (47)	200 (61)	0.150	(0.492)
GM-2X and -2XT at 208 V	32°F (0°C)	190 (58)	250 (76)	380 (116)	—	0.063	(0.207)
	20°F (–7°C)	180 (55)	235 (72)	355 (108)	380 (116)	0.067	(0.220)
	0°F (–18°C)	145 (44)	195 (59)	290 (88)	380 (116)	0.083	(0.272)
GM-2X and -2XT at 240 V	32°F (0°C)	200 (61)	265 (81)	400 (122)	—	0.060	(0.197)
	20°F (–7°C)	190 (58)	250 (76)	370 (113)	400 (122)	0.063	(0.207)
	0°F (–18°C)	155 (47)	205 (62)	305 (93)	400 (122)	0.077	(0.253)
GM-2X and -2XT at 277 V	32°F (0°C)	215 (66)	290 (88)	415 (126)	—	0.056	(0.184)
	20°F (–7°C)	200 (61)	265 (81)	400 (122)	415 (126)	0.060	(0.197)
	0°F (–18°C)	165 (50)	225 (69)	330 (101)	415 (126)	0.073	(0.240)

[1] Only FTC-P power connection, FTC-HST splice/tee, and RayClic-E end kits may be used with 40-A circuits.

⚠ **WARNING**: To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with the requirements of Tyco Thermal Controls, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit protection.

Example: Roof and Gutter De-Icing System

Startup temperature	20°F (–7°C) *(from Step 1)*
Circuit breakers	30 A
Supply voltage	208 V *(from Step 1)*
Maximum circuit length	**355 ft (108 m)** *(from Table 5)*

DETERMINE NUMBER OF CIRCUITS

Use the following formula to determine number of circuits for the system:

$$\text{Number of circuits} = \frac{\text{Heating cable length required}}{\text{Maximum heating cable circuit length}}$$

Example: Roof and Gutter De-Icing System

Total heating cable length	673 ft (205.2 m) *(from Step 3)*
Maximum circuit length	355 ft (108 m) *(from above)*
Number of circuits	673 ft / 355 ft = 1.9 rounded to **2 circuits**

DETERMINE TRANSFORMER LOAD

The total transformer load is the sum of load on all the circuit breakers in the system.

Calculate the Circuit Breaker Load (CBL) as:

$$\text{CBL (kW)} = \frac{\text{Circuit breaker rating (A)} \times 0.8 \times \text{Supply voltage}}{1000}$$

If the CBL is equal on all circuit breakers, calculate the Total Transformer Load as follows:

Total Transformer Load (kW) = CBL x Number of circuits

*If the CBL is **not** equal on all circuit breakers, calculate the Total Transformer Load as follows:*

Total Transformer Load (kW) = $CBL_1 + CBL_2 + CBL_3 ... + CBL_N$

Example: Roof and Gutter De-Icing System

Circuit breaker load (CBL) = (30 A x 0.8 x 208 V) / 1000 = 5 kW

Total transformer load = 5 kW x 2 circuits = **10 kW**

Roof and Gutter De-Icing
1. Determine design conditions
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits
6. Select attachment accessories and method
7. Select the control system and power distribution
8. Complete the Bill of Materials

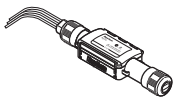
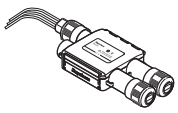
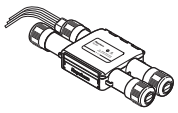
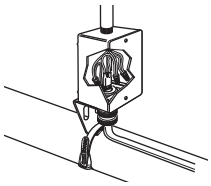
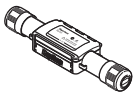
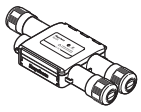
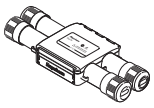
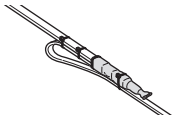
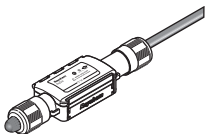
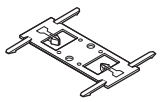
Step 5 Select the connection kits

A typical IceStop system may have several connection kits to seal and power the heating cable. The connection kits work together with the IceStop heating cable to provide a safe and reliable de-icing system that is easy to install and maintain. The available accessories are listed in Table 6. A complete IceStop system also consists of attachment accessories and adhesives which we discuss later in “Step 6 Select attachment accessories and method,” page 21.

The self-regulating IceStop heating cable is cut to length at the job site. In order to seal the heating cable from the environment and provide power, Tyco Thermal Controls approved connection kits must be used. A power connection kit is required to attach power to one end of the heating cable. An end seal is required, and is provided with each power connection to seal the other end. Splice and tee kits are also available to connect two or three heating cables together.

RayClic and FTC connection kits are available for the IceStop system. The RayClic connection kits are insulation-displacement quick connect systems. The FTC connection kits use heat-shrinkable tubing and crimp barrels. All of these connection kits are outlined in Table 6 below. Additional heating cable will be required to allow for connection kit assembly and drip loops.

Table 6 Connection Kits

	Catalog number	Description	Standard packaging	Usage	Heating cable allowance [1]
Connection kits					
	RayClic-PC	Power connection and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	2 ft (0.6 m)
	RayClic-PS	Powered splice and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	4 ft (1.2 m)
	RayClic-PT	Powered tee and end seal (RayClic-SB-04 pipe mounting bracket included)	1	1 per circuit	6 ft (1.8 m)
	FTC-P[2]	Power connection and end seal **Note:** FTC-P is required for circuits requiring 40 A circuit breakers.	1	1 per circuit	2 ft (0.6 m)
	RayClic-S	Splice	1	As required	2 ft (0.6 m)
	RayClic-T	Tee kit with end seal	1	As required	3 ft (0.9 m)
	RayClic-X	Cross connection to connect four heating cables	1	As required	8 ft (2.4 m)
	FTC-HST[3]	Low-profile splice/tee	2	As required	2 ft (0.6 m)
	RayClic-LE	Lighted end seal (RayClic-SB-04 pipe mounting bracket included)	1	Alternate end seal	2 ft (0.6 m)
	RayClic-E	Extra end seal	1	Additional end seal	0.3 ft (0.1 m)
Accessories					
	RayClic-SB-02	Wall mounting bracket	1	Required for every RayClic connection kit	–

[1] Additional heating cable required for connection kit assembly and drip loops.

[2] Junction box not included.

[3] One RayClic-E end seal is required for each FTC-HST used as a tee kit.

Example: Roof and Gutter De-Icing System

Connection kit	Quantity	Heating cable allowance
RayClic-PC	2	4 ft (1.2 m)
RayClic-PS	2	8 ft (2.4 m)
RayClic-SB-02	4	NA

Determine how much additional heating cable you need for the connection kits.

Example: Roof and Gutter De-Icing System

Sloped roof – standard	520 ft (158.5 m)
Gutters	100 ft (30.5 m)
Roof valley	27 ft (8.3 m)
Downspouts	26 ft (8.0 m)
Total heating cable allowance for connection kits	12 ft (4.0 m)
Total heating cable length required	**685 ft (208.8 m)**

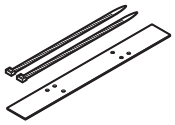
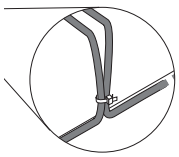
Roof and Gutter De-Icing
1. Determine design conditions
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits
6. Select attachment accessories and method
7. Select the control system and power distribution
8. Complete the Bill of Materials

Step 6 Select attachment accessories and method

A typical IceStop system also consists of various attachment accessories and adhesives for attaching the heating cable to the roof. The available accessories are listed in Table 7, the adhesives in Table 9. The type of attachment accessories you need will depend on the type of roof you have. See Table 8 for details.

Always check with the roofing manufacturer for recommendations on how to attaching heating cables to their roofing material.

Table 7 Attachment Accessories

	Catalog number	Description	Standard packaging	Usage	Heating cable allowance
	GMK-RC	Roof clips	50/box	1 box per 35' of roof edge when zig-zag layout is used. See Table 8 for other layout options.	–
	GMK-RAKE	Hanger bracket	1	1 hanger per cable in downspout or as required for mechanical protection. See Table 8 for other layout options.	–
	CT-CABLE-TIE	UV-resistant cable tie	100/box	As required.	–

Heating cable attachment depends primarily upon the roof type. The following table shows the recommended attachment methods for typical roof materials and roof areas.

Table 8 Attachment Methods for Typical Roofs

Roof material	Recommended attachment method	Alternate attachment method
Shake/shingle	Mechanical Attachment, page 23	
Rubber/membrane	Belt Loop Approach, page 24	Adhesive Attachment, page 23
Metal	Mechanical Attachment, page 23	Adhesive Attachment, page 23 Belt Loop Approach page 24
Wood	Mechanical Attachment, page 23	
Other	Attachment Methods for Other Areas, page 25	
Area	**Attachment method**	
Gutters	Recommend using hanger clips glued to gutter for security if possible (see page 25)	
Downspouts	Downspout hangers (page 25)	
Drip edges	Attached to a flat sheet or standard drip edge, or installed informed sheet metal (see page 26)	
Component locations	Drip loops	
Roof edges with no gutter	Drip loops	

Note: Do not use adhesives on slate or tile roofs. Please contact roofing manufacturer for a recommended attachment method or contact your Tyco Thermal Controls representative.

Adhesive is not supplied by Tyco Thermal Controls. Follow manufacturer's instructions for surface preparation and installation.

Table 9 Adhesives

Adhesive	Description	Color	Approximate tooling time	Cure time	Dispensing equipment
Momentive Performance Materials, Inc. RTV167	Neutral-cure silicone adhesive	Gray	20 minutes	48 hours	Caulking gun
SpeedBonder® H3300	Methacrylate adhesive	Tan	15 minutes	24 hours	2 part mixing dispenser
SpeedBonder H4800	Methacrylate adhesive	Light yellow	45 minutes	24 hours	2 part mixing dispenser
Plexus® MA300	Methacrylate adhesive	Yellow	15 minutes	16 hours	2 part mixing dispenser
Plexus MA310	Methacrylate adhesive	Yellow	30 minutes	16 hours	2 part mixing dispenser

Note: Before using adhesives on metal roofs check with the roofing manufacturer. Trademarks are the property of their respective owners.

ROOF ATTACHMENT METHODS

Mechanical Attachment

One of the most common attachment methods is to use Raychem GMK-RC roof clips. It can be used on all surfaces where nails or screws are acceptable.

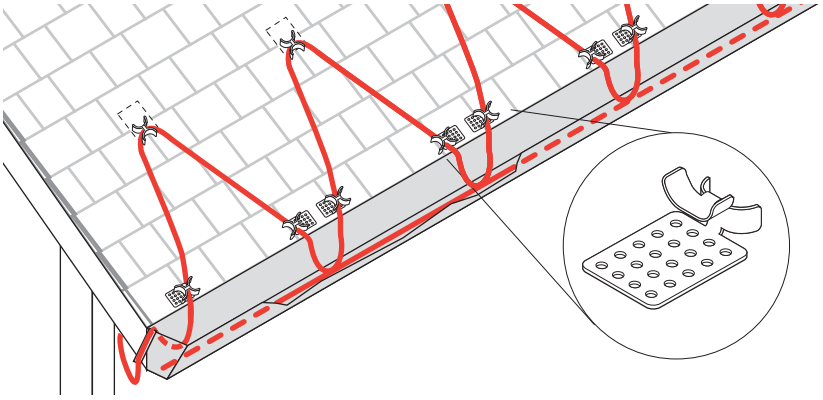


Fig. 18 GMK-RC clip attachment

- The GMK-RC roof clips are used to secure IceStop heating cable. This multipurpose bracket attaches with a screw, nail, or adhesive to many types of roofs and gutters.
- One box of 50 GMK-RC roof clips is sufficient to attach the heating cable on 30 feet (9.1 m) of roof edge using a zig-zag layout. Your layout may require additional clips.
- For layouts other than the standard zig-zag, use one clip for each 5 to 10 feet (1.5 to 3 m) of unsupported heating cable and at every change of heating cable direction.
- For standard sloped roofs, the loops of heating cable being zig-zag on the roof should be attached using a UV-resistant cable tie to the heating cable run in the gutter.
- For standing-seam roofs, the heating cable should be cable-tied together at the bottom of the seam.
- For high wind areas, it is recommended to use a UV resistant cable tie to further secure the heating cable to the attachment clip.

Adhesive Attachment

For roofs where penetrating attachments are not desired, use the GMK-RC roof clip attached by adhesive.

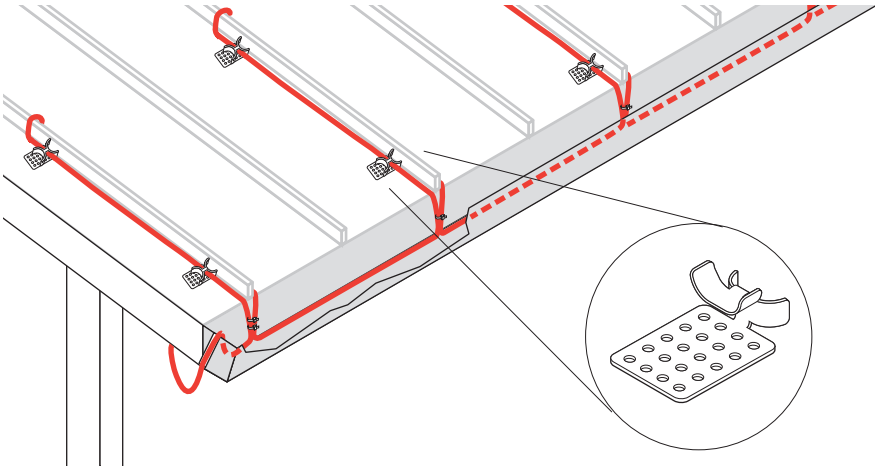


Fig. 19 GMK-RC clip on standing-seam roof

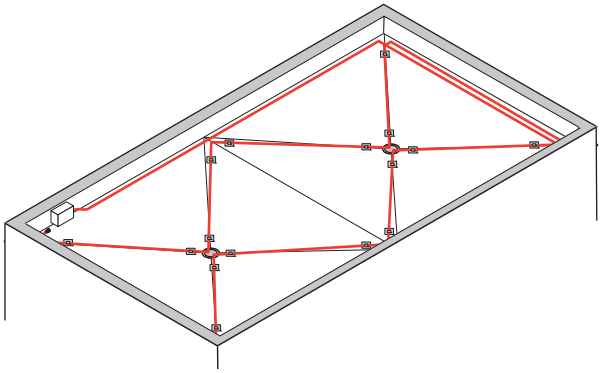


Fig. 20 GMK-RC clip on flat roof

- The GMK-RC roof clips are used to secure IceStop heating cable. The clip attaches with adhesive (not supplied by Tyco Thermal Controls) to many types of roofs and gutters.
- Several different adhesives are recommended by Tyco Thermal Controls. See Table 9 on page 22 or contact Tyco Thermal Controls for alternatives.
- On a standing seam roof, use four clips on each seam being traced. On a flat surface, use one clip for every 5 to 10 feet (1.5 to 3 m) of unsupported heating cable and at every change of direction.
- Follow all recommendations from the adhesive manufacturer with regard to cleaning and preparing the roof surface for the adhesive.

Belt Loop Approach

With the belt loop approach, strips of roofing materials are fastened to the roof using standard means for that particular type of roof. The heating cable is attached with a UV-resistant cable tie to the loop formed by this material.

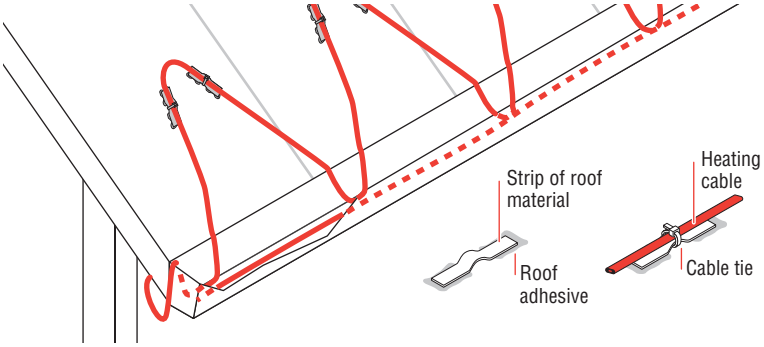


Fig. 21 Belt loop approach on a sloped roof

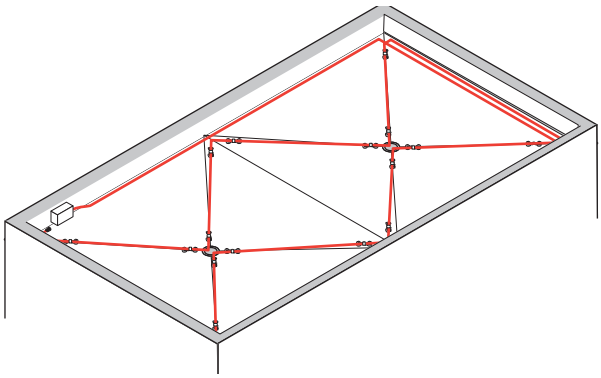


Fig. 22 Belt loop approach on a flat roof

- The belt loop method of securing the IceStop heating cable involves using a small piece of roofing material to form a “belt loop.”
- Use at least one belt loop for every 5 to 10 feet (1.5 to 3 m) of unsupported heating cable and at every heating cable change of direction.

ATTACHMENT METHODS FOR OTHER AREAS

Gutters

Attachment is not generally required for standard gutters. If attachment is desired, such as in high-wind areas, use GMK-RC adhesive-mounted attachment clips. Several different adhesives are recommended by Tyco Thermal Controls. See Table 9 on page 22.

For large gutters (6 to 12 inches wide [15 cm to 30 cm]), use two runs of heating cable separated by GMK-RC roof clips. It is not necessary to attach the clips to the gutter. Use one pair of GMK-RC roof clips for every 10 feet (3 m).

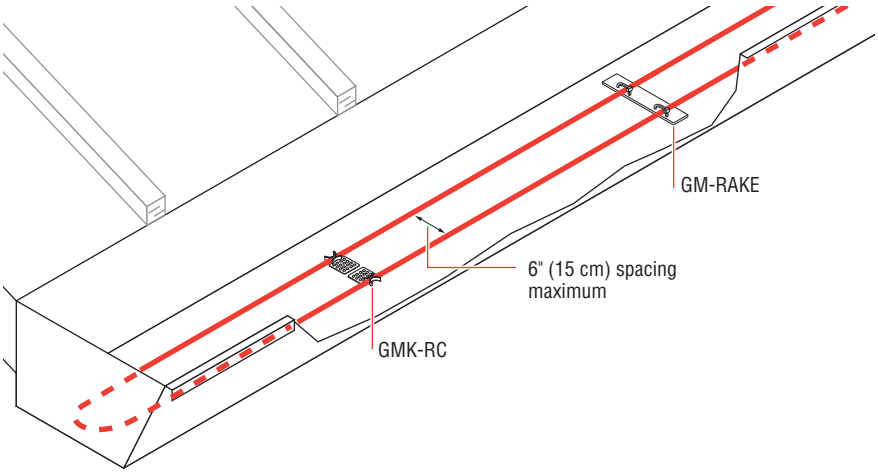


Fig. 23 GMK-RC clip in a gutter

Downspouts

The IceStop heating cable needs to be attached at the top of each downspout, using one GM-RAKE downspout hanger per heating cable. The GM-RAKE downspout hanger clamps around the heating cable and attaches to the fascia with a screw or nail.

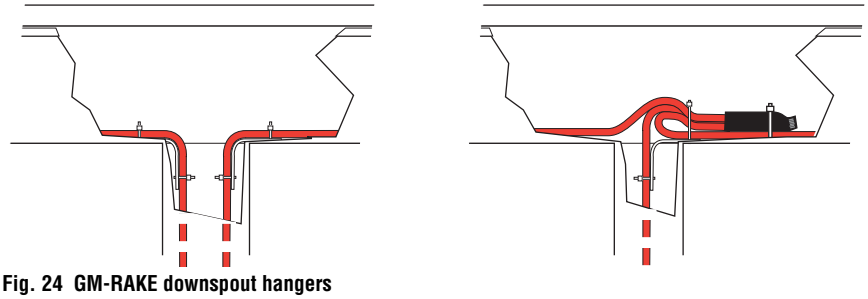


Fig. 24 GM-RAKE downspout hangers

- GM-RAKE downspout hangers protect the heating cable from damage from sharp edges and also provide support for the weight of the heating cable.
- Use two GM-RAKE downspout hangers for double-traced downspouts.
- Attach the GM-RAKE downspout hangers to the structure with a nail or other suitable method.

Heated Drip Edges

When installing a heated drip edge, you can attach the heating cable to the roof's drip edge or to a flat sheet of sheet metal with a UV-resistant cable tie, or place the heating cable in a formed (J-channel) piece of sheet metal.

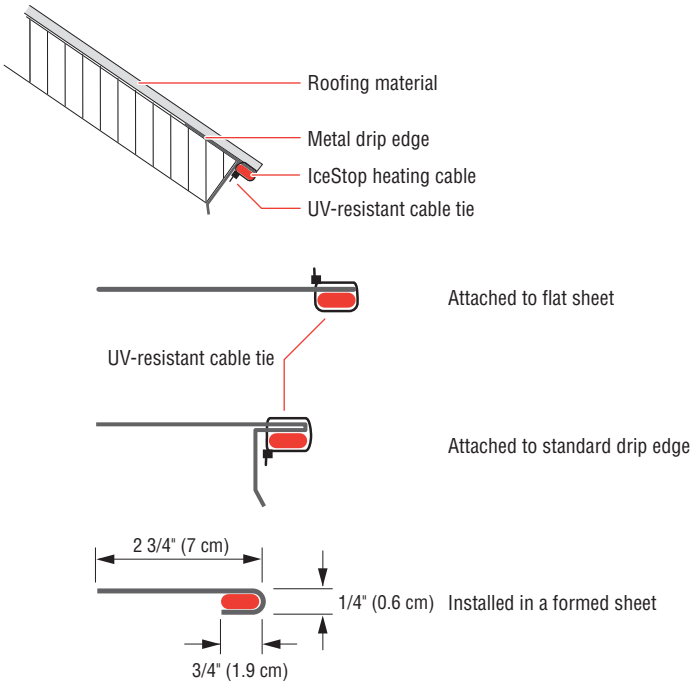


Fig. 25 Heated drip edge attachment guidelines

- The illustrations above are guidelines for heating cable attachment in a heated drip edge application. Tyco Thermal Controls does not manufacture drip edge attachment clips.
- Use 20-gauge or thicker corrosion-resistant sheet metal.
- Contact your Tyco Thermal Controls representative or Tyco Thermal Controls directly for specific recommendations.

Example: Roof and Gutter De-Icing System

100 ft (30.5 m) roof edge and 2 gutters

GMK-RC	3 boxes of 50
GM-RAKE	2

Step 7 Select the control system and power distribution

CONTROL SYSTEMS

Three control methods are commonly used with roof de-icing systems:

- Manual on/off control
- Ambient thermostat
- Automatic moisture/temperature controller

All three methods require contactors if any significant length of heating cable is being used. The contactor must be sized to carry the load. Each method offers a trade-off of initial cost versus energy efficiency and ability to provide effective de-icing. If the system is not energized when needed, ice will form. If the system is energized when de-icing is not needed, there will be unnecessary power consumption. Choose the control method that best meets the project performance requirements. Contact your Tyco Thermal Controls representative for details.

For Class I, Division 2 hazardous locations, use an agency-approved controller or thermostat suitable for the same area use.

Manual On/Off Control

A manually controlled system is operated by a switch that controls the system power contactor. This method requires constant supervision to work effectively. A manual system can be controlled by a building management system.

Ambient Thermostat

When an ambient sensing thermostat is used, the roof and gutter system will be energized when the ambient temperature is below freezing. This will ensure the heating cable is energized any time the water might freeze.

Table 10 Thermostats

	EC-TS
Type of sensing	Ambient
Sensor	Thermistor
Set point range	30°F to 110°F (–1°C to 43°C)
Enclosure	NEMA 4X
Differential	3°F (1.7°C)
Set point repeatability	3°F (1.7°C)
Enclosure limits	–40°F to 140°F (–40°C to 60°C)
Electrical rating	30 A, 100 to 277 V
Approvals	c-UL-us Listed

Automatic Moisture/Temperature Controller

The most conservative approach from an energy-consumption point of view is an automatic moisture/temperature sensor. Tyco Thermal Controls supplies an automatic moisture/temperature sensor, which consists of a control panel, one or more gutter sensors, and one or more aerial snow sensors. Table 11 outlines the options for this approach.

The gutter sensor should be mounted in gutters near downspouts. It senses the actual environmental conditions, such as temperature and moisture. A gutter sensor is recommended for each critical area that needs to be monitored for icing conditions (such as when one side of a building gets sun in the morning and the other side gets sun in the afternoon, or one side gets the prevailing winds and the other side is protected). An aerial-mounted snow sensor is also recommended. Having both gutter and snow sensors allows for snow to begin melting in the gutters at the onset of any snow or ice condition.

For areas where a large number of circuits are required, the DigiTrace ACCS-30 can be used. The Roof & Gutter De-icing control mode in the ACCS-30 includes an External Device control option. This option allows a Snow/Moisture sensing controller (from Table 11) to be integrated into the ACCS-30 system. Note that sensors (snow or gutter) cannot be directly connected to the ACCS-30 system. Refer to the ACCS-30 Programming Guide (H58692) for more information on system setup.

Table 11 Automatic Controllers

Application	APS-3C	APS-4C	SC-40C	GIT-3	GIT-4
	Snow controller	Snow controller with ground-fault protection	Satellite contactor	Gutter de-icing controller	Gutter de-icing controller with ground-fault protection
Number of sensors	1 to 6	1 to 6	1 to 6	1	1
Set point	38°F (3°C) and moisture	38°F (3°C) and moisture	38°F (3°C) and moisture	38°F (3°C) and moisture	38°F (3°C) and moisture
High limit temperature set point	40°F to 90°F (4°C to 32°C) adjustable	40°F to 90°F (4°C to 32°C) adjustable	40°F to 90°F (4°C to 32°C) adjustable	NA	NA
Enclosure	NEMA 3R	NEMA 3R	NEMA 3R	NEMA 3R	NEMA 3R
Temperature operating limits	–40°F to 160°F (–40°C to 71°C)	–40°F to 160°F (–40°C to 71°C)	–40°F to 160°F (–40°C to 71°C)	–40°F to 160°F (–40°C to 71°C)	–40°F to 160°F (–40°C to 71°C)
Electrical Rating	24 A, 120 V 24 A, 208–240 V	50 A, 208–240 V 40 A, 277 V 50 A, 277–480 V 50 A, 600 V	50 A, 208/240 V 40 A, 277 V 50 A, 277–480 V 50 A, 600 V	26 A, 120 V 26 A, 208-240 V 26 A, 277 V	26 A, 120 V 26 A, 208-240 V 26 A, 277 V
Approvals	c-UL-us Listed	c-UL-us Listed	c-UL-us Listed	c-UL-us Listed	c-UL-us Listed
Ground-fault protection	Not included	30 mA	30 mA, 60 mA and 120 mA	Not included	30 mA

Table 12 Moisture/Temperature Sensors

Application	GIT-1	CIT-1
	Gutter-mounted moisture/temperature	Aerial-mounted moisture/temperature
Set point	38°F (3°C)	38°F (3°C)

Table 13 Control Systems

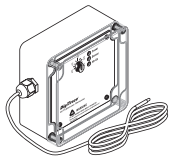
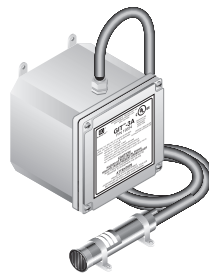
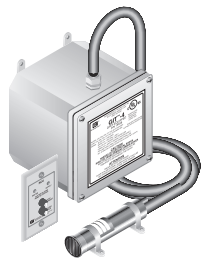
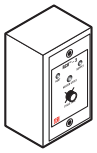
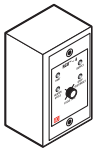
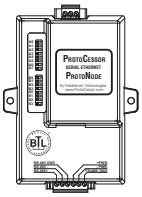
	Catalog number	Description
Electronic Thermostats and Accessories		
	EC-TS	Electronic thermostat for snow melting applications housed in a NEMA 4X enclosure with 2 x 1/2 in conduit entries for power and 1 gland entry for the sensor. The temperature set point and LED indicators for alarm, power, and heating cable status can be visually checked through the clear lid. Electrical rating is 30 A at 100–277 V, 50–60 Hz, SPST switch. The EC-TS includes a 25 ft (7.6 m) sensor.
Snow Melting Controllers		
	APS-3C	Automatic snow melting controller housed in a NEMA 3R enclosure provides effective, economical automatic control of all snow melting applications. Features include: 120 V or 208–240 V models, 24-A DPDT output relay and an adjustable hold-on timer. Enclosure dimensions: 11-1/2 in x 9-1/8 in x 6-9/16 in (292 mm x 232 mm x 167 mm)
	APS-4C	Automatic snow melting controller housed in a NEMA 3R enclosure provides effective, economical automatic control of all snow melting applications. The APS-4C can operate with any number of SC-40C satellite contactors for larger loads. Features include: 277 V single-phase or 208–240, 277/480, and 600 V three-phase models, built-in 3-pole contactor, integral 30 mA ground-fault circuit interrupter and an adjustable hold-on timer. Enclosure dimensions: 11-1/2 in x 9-1/8 in x 6-9/16 in (292 mm x 232 mm x 167 mm)
	SC-40C	Satellite contactor power control peripheral for an APS-4C snow melting controller, housed in a NEMA 3R enclosure. Features include: 277 V single-phase or 208–240, 277/480 and 600 V three-phase models, built-in 3-pole contactor and integral 30 mA ground-fault circuit interrupter. Enclosure dimensions: 11-1/2 in x 9-1/8 in x 6 in (292 mm x 232 mm x 152 mm)
Gutter De-Icing Controllers		
	GIT-3A	Gutter de-icing controller consists of a gutter-mounted computerized sensor and a controller in a NEMA 3R enclosure connected by a 12 ft 6 in (3.8 m) cable. Features include: 120, 208–240 or 277 V single-phase operating voltage and a SPST 26-A contactor. Enclosure dimensions: 6 in x 6 in x 4.4 in (152 mm x 152 mm x 112 mm) Sensor dimensions: 5.6 in x 1.5 in (141 mm x 38 mm)
	GIT-4	Gutter de-icing controller with ground-fault sensor consists of a gutter-mounted computerized sensor and a control enclosure connected by a 12 ft 6 in (3.8 m) cable. Features include: Remote Control Unit (RCU-2),120, 208–240 or 277 V single-phase operating voltage, a SPST 26-A contactor and an integral 30 mA ground-fault equipmentprotection. Enclosure dimensions: 6 in x 6 in x 4.4 in (152 mm x 152 mm x 112 mm) Sensor dimensions: 5.6 in x 1.5 in (141 mm x 38 mm)

Table 13 Control Systems (Continued)

	Catalog number	Description
Snow Melting and Gutter De-Icing Sensors and Accessories		
	CIT-1	Overhead snow sensor that detects precipitation or blowing snow at ambient temperatures below 38°F (3.3°C). For use with an APS-3C or APS-4C automatic snow controller, or an SC-40C satellite contactor.
	GIT-1	Gutter sensor that detects moisture at ambient temperatures below 38°F (3.3°C). For use with an APS-3C or APS-4C automatic snow controller, or a SC-40C satellite contactor.
	RCU-3	The RCU–3 provides control and status display to the APS–3C controller from a remote location. It has a 2, 4, 6 or 8 hour CYCLE TIME adjustment, independent of APS-3C setting.
	RCU-4	The RCU–4 provides control and status display to the APS–4C controller and SC-40C Satellite Contactor from a remote location. It has a 2, 4, 6 or 8 hour CYCLE TIME adjustment, independent of the APS-4C or SC-40C setting.
Electronic Controllers		
	ACCS-UIT2 ACCS-PCM2-5	The DigiTrace ACCS-30 Advanced Commercial Control System is a multipoint electronic control and monitoring system for heat-tracing used in various commercial applications such as pipe freeze protection, roof and gutter de-icing, surface snow melting, hot water temperature maintenance and floor heating. The DigiTrace ACCS-30 system can control up to 260 circuits with multiple networked ACCS-PCM2-5 panels, with a single ACCS-UIT2 user interface terminal. The ACCS-PCM2-5 panel can directly control up to 5 individual heat-tracing circuits using electromechanical relays rated at 30 A up to 277 V.
	ProtoNode-LER ProtoNode-RER	The DigiTrace ProtoNode is an external, high performance multi-protocol gateway for customers needing protocol translation between Building Management Systems (BMS) and the DigiTrace ACCS-30 or C910-485 controllers. The ProtoNode-LER is for LonWorks® systems; and the ProtoNode-RER is for BACnet® or Metasys® N2 systems.

Example: Roof and Gutter De-Icing System

208 V system with 2 circuits

APS-4C	1
SC-40C	1
GIT-1	2 (one for each gutter section)
CIT-1	1

POWER DISTRIBUTION

Once the heating cable circuits and control have been defined, you must select how to provide power to them. Power to the IceStop heating cables can be provided in several ways: directly through the controller, through external contactors, or through SMPG or HTPG power distribution panels.

Single circuit control

Heating cable circuits that do not exceed the current rating of the selected control device shown in Table 11 can be switched directly (see Figure 26).

Group control

If the current draw exceeds the switch rating, or if the controller will activate more than one circuit (group control), an external contactor must be used.

Note: Large systems with many circuits should use an SMPG power distribution panel. The SMPG is a dedicated power-distribution, control, ground-fault protection, monitoring, and alarm panel for roof and gutter de-icing applications. This enclosure contains an assembled circuit-breaker panelboard. Panels are equipped with ground-fault circuit breakers with or without alarm contacts. The group control package allows the system to operate automatically in conjunction with an ambient-sensing thermostat, individual electronic, or duty cycle controller.

Table 14 Power Distribution Panels

Application	SMPG1	HTPG
	Control panel	Control panel
Controller	EUR-5A included	APS-3C required for control
Number of sensors	Up to 6	see APS-3C
Enclosure	NEMA 1/12, NEMA 3R/4	NEMA 12,NEMA 4 and NEMA 4X
Temperature operating limits	Without space heater 14°F to 122°F (–10°C to 50°C) With a space heater –40°F to 122°F (–40°C to 50°C)	Without space heater 32°F to 122°F (0°C to 50°C) With a space heater –40°F to 122°F (–40°C to 50°C)
Supply voltage	208 V, 277 V	120 V, 208 V, 240 V, 277 V
Circuit breaker rating	15 A, 20 A, 30 A, 40 A, 50 A	20 A, 30 A, 40 A, 50 A
Approvals	c-UL-us	ETL, c-ETL
Ground-fault protection	Yes	Yes

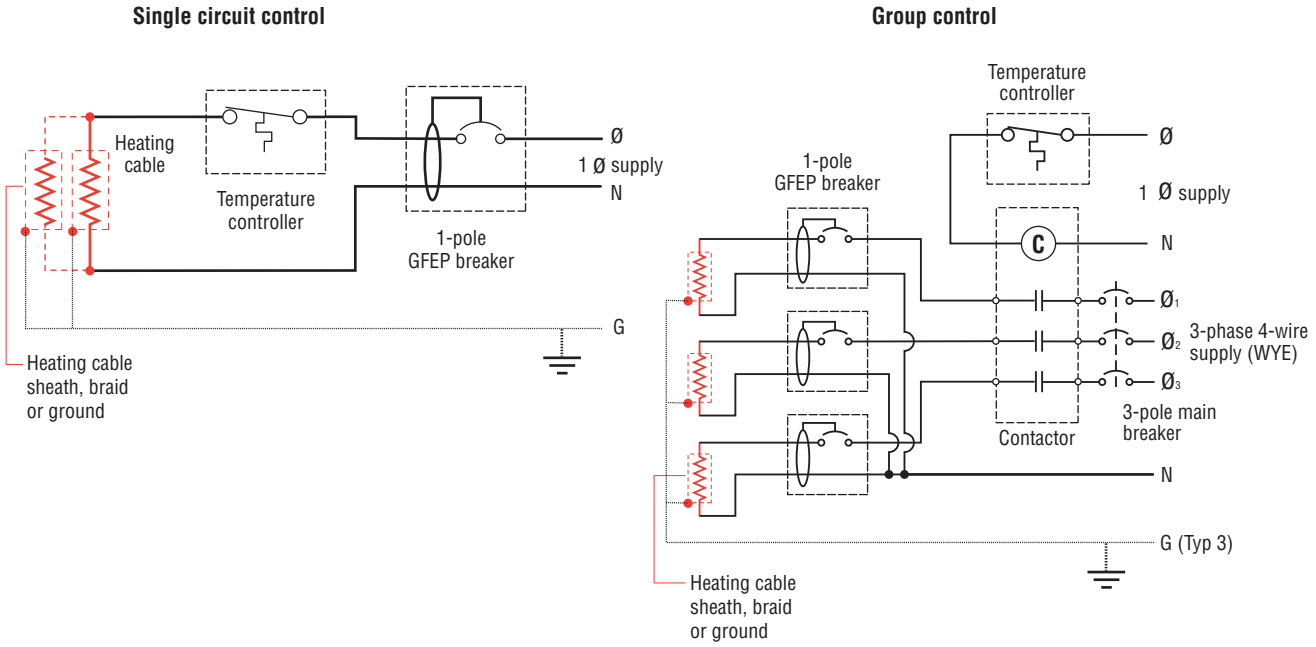


Fig. 26 Single circuit and group control

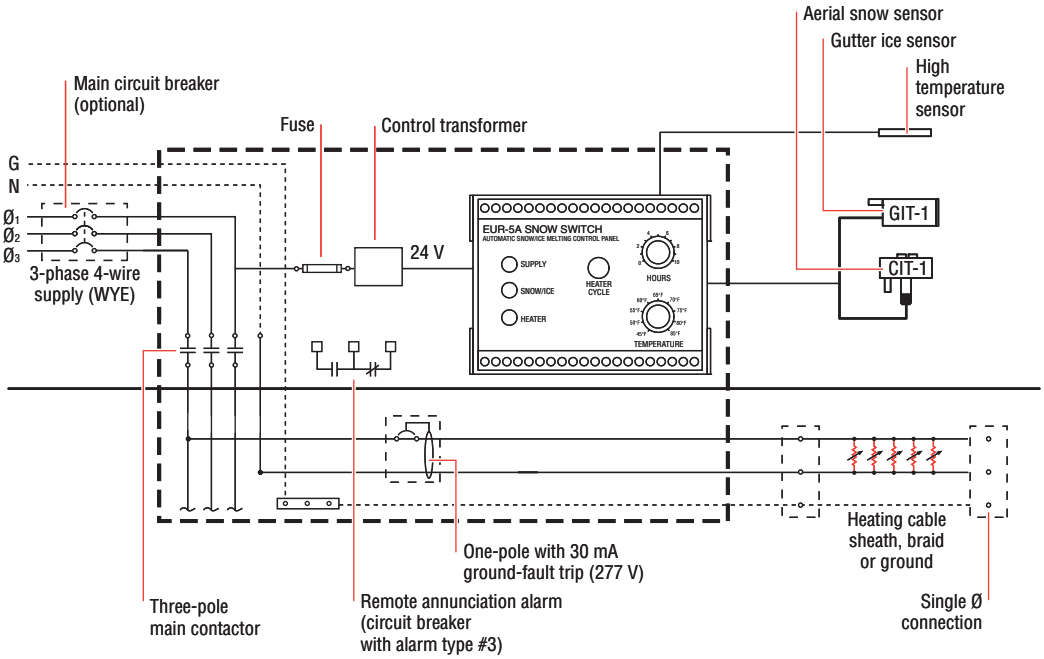
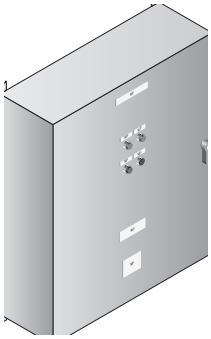
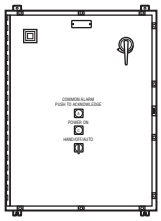
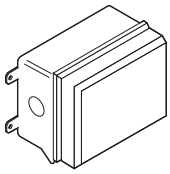
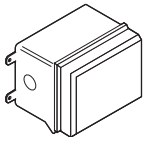


Fig. 27 Typical wiring diagram of group control with SMPG1

Table 15 Power Distribution

	Catalog number	Description
Power Distribution and Control Panels		
	SMPG1	Single-phase power distribution panel that includes ground-fault protection, monitoring, and control for snow melting systems. Single-phase voltages include 208 and 277 V.
	HTPG	Heat-tracing power distribution panel with ground-fault and monitoring for group control.
Contactors & Junction Boxes		
	E104	Three-pole, 100 A per pole, 600 V maximum contactor housed in UL Listed, CSA Certified, NEMA 4X enclosure with two 1-inch conduit entries. When ordering, select coil voltage (110–120, 208–240, 277 V). Enclosure dimensions: 13-1/2 in x 9-1/5 in x 6-11/16 in (343 mm x 234 mm x 170 mm).
	E304	Three-pole, 40 A per pole, 600 V maximum contactor housed in UL Listed, CSA Certified NEMA 4X enclosure with two 1-inch conduit entries. When ordering, select coil voltage (110–120, 208–240, 277 V). Enclosure dimensions: 9-1/2 in x 7-1/5 in x 6-11/16 in (241 mm x 183 mm x 170 mm).

Roof and Gutter De-Icing
1. Determine design conditions
2. Select the heating cable
3. Determine the heating cable length
4. Determine the electrical parameters
5. Select the connection kits
6. Select attachment accessories and method
7. Select the control system and power distribution
8. Complete the Bill of Materials

Step 8 Complete the Bill of Materials

If you used the Design Worksheet to document all your project parameters, you should have all the details you need to complete your Bill of Materials.

IceStop System Roof and Gutter De-Icing Design Worksheet

Step 1 Determine design conditions

Type of roof	Layout	Supply voltage	Min. start-up temperature	Control method
❑ Sloped roof – standard ❑ Sloped roof – standing seam ❑ Flat roof **Roof material** ❑ Shake/shingle ❑ Rubber membrane ❑ Metal ❑ Wood ❑ Other: _____	Roof edge Length of roof edge (ft/m) _____ Number of edges _____ Eave overhang Distance of overhang (in/cm) _____ Gutters Length of gutters (ft/m) _____ Number of gutters _____ Depth of gutters (in/cm) _____ Width of gutters (in/cm) _____ Roof valley Height of roof valley (ft/m) _____ Number of roof valleys _____ Roof/wall intersection Height of intersection (ft/m) _____ Number of intersections _____ Downspouts Downspout height (ft/m) _____ Number of downspouts _____	❑ 120 V ❑ 208–277 V	_____ (°F/°C)	❑ Manual on/off control ❑ Ambient thermostat ❑ Automatic controller

Example

✓ **Sloped roof – standard with wood shingles and gutters**

Roof edge: 50 ft (Length of roof edge) x 2 (Number of edges) → = 100 ft (Total length of roof edges)

Eave overhang: 24 in

Gutters: 50 ft (Length of gutter) x 2 (Number of gutters) → = 100 ft (Total length of gutters)

6 in (Depth of gutter)

4 in (Width of gutter)

Roof valley: 20 ft (Height of roof valley) 1 (Number of roof valleys)

Downspouts: 12 ft (Downspout height) x 2 (Number of downspouts) → = 24 ft (Total downspout height)

Supply voltage: 208 V

Minimum start-up temperature: 20°F

Control method: Automatic controller

Step 2 Select the heating cable

See Figure 4.

	Product family	Supply voltage		Outer jacket		Catalog number
		❑ **1** = 120 V		❑ **-X** polyolefin		
		❑ **2** = 208, 240, 277 V		❑ **-XT** fluoropolymer		
Use catalog number:	**GM**		—		→	
	Product family	Supply voltage		Outer jacket		**Catalog number**
Example catalog number:	**GM**	**2**	—	**XT**	→	**GM-2XT**
	Product family	Supply voltage		Outer jacket		Catalog number

Step 3 Determine the heating cable length

Sloped roof – standard

_____ Roof edge (ft/m) with _____ Eave overhang (in/cm) requires → _____ Heating cable per foot of roof edge (ft/m)

Sloped roof – standing seam

_____ Roof edge (ft/m) with _____ Eave overhang (in/cm) requires → _____ Heating cable per foot of roof edge (ft/m)

Flat roof

_____ Roof perimeter (ft/m) x _____ From perimeter to drains (ft/m) x _____ Into internal downspouts (ft/m) = _____ Heating cable for flat roof (ft/m)

Gutters

_____ Gutter depth (ft/m) x 2 = _____ Additional heating cable (ft/m) + _____ Heating cable per foot of roof edge (ft/m) = _____ Heating cable with gutter depth allowance (ft/m)

_____ Roof edge (ft/m) x Heating cable with gutter depth allowance (ft/m) = _____ Total heating cable for roof edge (ft/m)

_____ Gutter length (ft/m) x _____ Gutter width multiplier → = _____ Heating cable for gutters (ft/m)

No gutters – heated drip edge

_____ Roof edge (ft/m) x 1 → = _____ Heating cable for heated drip edge (ft/m

Roof valleys

_____ Height of roof valley (ft/m) x 1.33 x _____ Number of roof valleys → = _____ Heating cable for roof valleys (ft/m)

Roof/wall intersection

_____ Height of intersection (ft/m) x 1.33 _____ Number of intersections → = _____ Heating cable for roof/wall intersections (ft/m)

Downspouts

_____ Height of downspouts (ft/m) x _____ Number of downspouts x _____ Runs of heating cable per downspout = _____ Heating cable per downspout (ft/m)

_____ Total heating cable length

Example: Sloped roof – standard with eave overhang and gutters

100 ft Feet of roof edge (ft/m) with 24 in Eave overhang (in/cm) requires → 4.2 ft Heating cable per foot of roof edge (ft/m)

6 in Gutter depth (ft/m) x 2 = 1 ft Additional heating cable (ft/m) + 4.2 ft Heating cable per foot of roof edge (ft/m) = 5.2 ft Heating cable with gutter depth allowance (ft/m)

100 ft Roof edge (ft/m) x 5.2 ft Heating cable with gutter depth allowance (ft/m) → = 520 ft * Total heating cable for roof edge (ft/m)

100 ft Gutter length (ft/m) x 1 Gutter width multiplier → = 100 ft * Heating cable for gutters (ft/m)

20 ft Height of roof valley (ft/m) x 1.33 x 1 Number of roof valleys → = 26.6 ft rounded to 27 ft * Heating cable for roof valleys (ft/m)

12 ft Height of downspouts (ft/m) x 2 Number of downspouts x 1 Runs of heating cable per downspout = 24 ft Heating cable per downspouts (ft/m)

\+ 2 Drip loop allowance (1 ft with loopback) = 26 ft * Feet heating cable for downspouts

= 673 ft * Total heating cable length

Step 4 Determine the electrical parameters

Determine maximum circuit length and number of circuits (See Table 5)

Total heating cable length required: _____

Supply voltage: ❑ 120 V ❑ 208 V ❑ 240 V ❑ 277 V

Start-up temperature: _____

Circuit breaker size: ❑ 15 A ❑ 20 A ❑ 30 A ❑ 40 A

Maximum circuit length: _____

_____ (Total heating cable length required) / _____ (Maximum heating cable circuit length) = _____ **Number of circuits**

Determine transformer load

Calculate the circuit breaker load (CBL)

(_____ (Circuit breaker rating) x **0.8** x _____ (Supply voltage)) / **1000** → = _____ **Circuit breaker load (kW)**

If the CBL is equal on all circuits, calculate the transformer load as:

_____ (Circuit breaker load (kW)) x _____ (Number of breakers) → = _____ **Total transformer load (kW)**

If the CBL is NOT equal on all circuits, calculate the transformer load as:

$\overline{CBL_1} + \overline{CBL_2} + \overline{CBL_3}... + \overline{CBL_N}$ = _____ **Total transformer load (kW)**

Example:

Determine the maximum circuit length and number of circuits

Total heating cable length required: **673 ft of GM-2XT**

Supply voltage: ❑ 120 V ☑ 208 V ❑ 240 V ❑ 277 V

Start-up temperature: **20°F**

Circuit breaker size: ❑ 15 A ❑ 20 A ☑ 30 A ❑ 40 A

Maximum circuit length: **355 ft**

673 ft (Total heating cable length required) / **355 ft** (Maximum heating cable circuit length) = **1.9 circuits, round up to 2** **Number of circuits**

Determine transformer load

(**30 A** (Circuit breaker rating) x **0.8** x **208 V** (Supply voltage)) / **1000** → = **4.99 kW rounded to 5 kW** **Circuit breaker load (kW)**

5 kW (Circuit breaker load (kW)) x **2** (Number of breakers) → = **10 kW** **Total transformer load (kW)**

Step 5 Select the connection kits (See Table 6)

Connection kits and accessories	Description	Quantity	Heating cable allowance
❑ RayClic-PC	Power connection and end seal	_____	_____
❑ RayClic-PS	Power splice and end seal	_____	_____
❑ RayClic-PT	Powered tee and end seal	_____	_____
❑ FTC-P	Power connection and end seal	_____	_____
❑ RayClic-S	Splice	_____	_____
❑ RayClic-T	Tee kit with end seal	_____	_____
❑ RayClic-X	Cross connection	_____	_____
❑ FTC-HST	Low-profile splice/tee	_____	_____
❑ RayClic-LE	Lighted end seal	_____	_____
❑ RayClic-E	Extra end seal	_____	_____
❑ RayClic-SB-02	Wall mounting bracket	_____	_____

_____
Total heating cable allowance for connection kits

_____ + _____ = _____

Total heating cable length | Total heating cable allowance for connection kits | **Total heating cable length required**

Example:

Connection kit catalog number	Quantity	Heating cable allowance
✓ **RayClic-PC**	2	**4 ft**
✓ **RayClic-PS**	2	**8 ft**
✓ **RayClic-SB-02**	4	**NA**

12 ft
Total heating cable allowance for connection kits

673 ft + **12 ft** = **685 ft**

Total heating cable length | Total heating cable allowance for connection kits | **Total heating cable length required**

Step 6 Select attachment accessories and method

See Table 7 Attachment Accessories, Table 8 Attachment Methods for Typical Roofs, and Table 9 Adhesives.
Adhesive is not supplied by Tyco Thermal Controls

Attachment accessories	Description	Quantity
❑ GMK-RC	Roof clips	_____
❑ GMK-RAKE	Hanger bracket	_____
❑ CT-CABLE-TIE	UV-resistant cable tie	_____

Example:

100 ft roof edge and 2 gutters	
✓ **GMK-RC**	**3 boxes of 50 (from Table 7)**
✓ **GM-RAKE**	**2 (from Table 7)**

Step 7 Select the control system and power distribution

Control Systems
See Table 10 Thermostats, Table 11 Automatic Controllers, Table 12 Moisture/Temperature Sensors, Table 13 Control Systems.

Thermostats, controllers and accessories	Description	Quantity
❑ EC-TS	Electronic thermostat with 25-ft sensor	_____
❑ APS-3C	Automatic snow melting controller	_____
❑ APS-4C	Automatic snow melting controller	_____
❑ SC-40C	Satellite contactor	_____
❑ GIT-3A	Gutter de-icing controller	_____
❑ GIT-4	Gutter de-icing controller	_____
❑ CIT-1	Overhead snow sensor	_____
❑ GIT-1	Gutter sensor	_____
❑ RCU-3	Remote control unit for APS-3C	_____
❑ RCU-4	Remote control unit for APS-4C	_____
❑ ACCS-UIT2	ACCS-30 user interface terminal	_____
❑ ACCS-PCM2-5	ACCS-30 power control panel	_____
❑ ProtoNode-LER	Multi-protocol gateway	_____
❑ ProtoNode-RER	Multi-protocol gateway	_____
❑ RTD3CS	Resistance temperature device for DigiTrace ACCS-30	_____
❑ RTD10CS	Resistance temperature device for DigiTrace ACCS-30	_____
❑ RTD200	Resistance temperature device for DigiTrace ACCS-30	_____

Example:		
Supply voltage	208 V *(from Step 1)*	
Controller(s)	✓ **APS-4C**	**1**
	✓ **SC-40C**	**1**
Snow melting and gutter de-icing sensors and accessories	✓ **GIT-1**	**2 (one for each gutter section)**
	✓ **CIT-1**	**1**

Power distribution
See Table 14 Power Distribution Panels and Table 15 Power Distribution.

Power distribution and control panels	Description	Quantity
❑ SMPG1	Single-phase power distribution panel	_____
❑ HTPG	Heat-tracing power distribution panel for group control	_____

Contactors	Description	Quantity
❑ E104	Three-pole, 100 A per pole contactor	_____
❑ E304	Three-pole, 40 A per pole contactor	_____

Step 8 Complete the Bill of Materials

Use the information recorded in this worksheet to complete the Bill of Materials.

Worldwide Headquarters
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Thermal Controls