3M™ Self-Regulating Heat Tracing Cables

Application Guide

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To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

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Introduction

3M Canada and Thermon Manufacturing Company have entered into a strategic alliance to market the commercial line of heat tracing products manufactured by Thermon. The alliance agreement provides 3M exclusive rights within Canada to sell and market two distinct products: TTS™ and KSR™ Self-Regulating Heating Cables and Accessories.

Note: The agreement with the KSR™ Self-Regulating Heating Cables and Accessories is within commercial markets only.

Properties

TTS™ and KSR™ Self-Regulating Heating Cables consist of a conductive-polymer heating matrix extruded between two parallel copper bus conductors. Heat is generated in the conductive polymer matrix when energized. The bus conductors provide uniform voltage across the heating matrix by providing current down the entire length of the cable. The conductive polymer matrix is irradiated with an electron beam to provide cross-linking and "lock in" performance properties.

As the temperature increases, the electrical paths in the carbon-polymer heating matrix become longer and the resistance of the heating element increases. This causes the heat output of the cable to decrease. As the temperature of the heating matrix increases, the resistance of the heating matrix increases. **This is a self-regulating effect.**

TTS™ and KSR™ Self-Regulating Heating Cables can adjust their output to the surrounding temperature down the cable length. This adaptability to individual thermal conditions provides more heat where needed and can also reduce energy consumption as the ambient temperature increases, reducing heating costs.

Advantages

- Self-regulating heat output at any point
- Cut to length at any point down the cable
- Energy saving
- Can overlap heating cable
- Easy to install
- Multi-use
- Low investment
- Reliable, long-term performance

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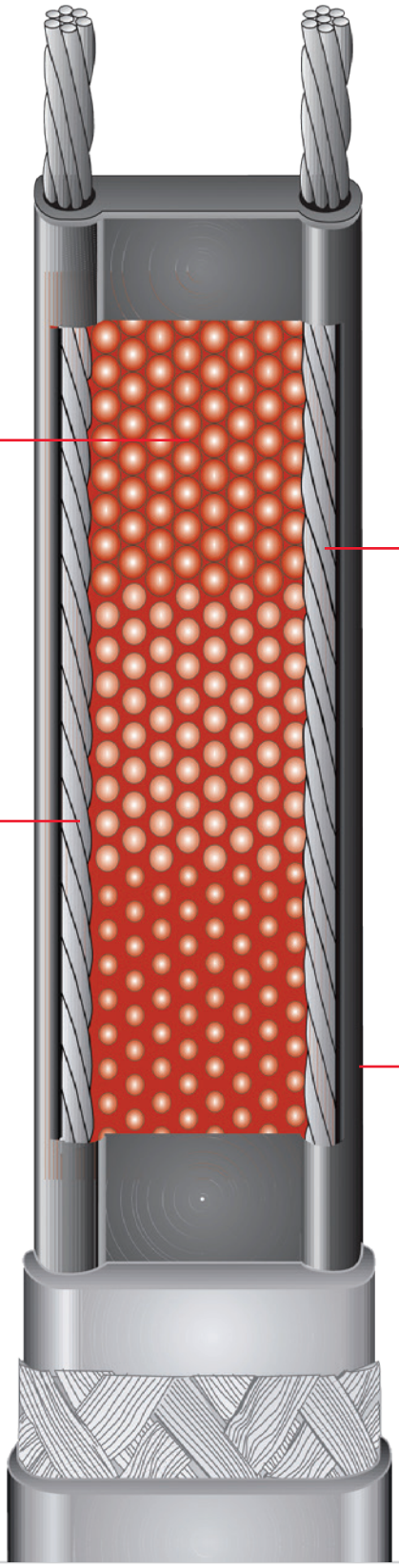
Construction

TTS™ and KSR™ Self-Regulating Heating Cables consist of a conductive-polymer heating matrix between two parallel bus conductors.

Benefit: the cable can be cut to any desired length without changing TTS™ and KSR™ Self-Regulating Heating Cable properties.



The heating matrix provides an infinite number of parallel resistances.

Benefit: the cable can respond to the temperature conditions and adjust the heat output at any point of the cable.

Copper grounding braid serves as a safety conductor.

Benefit: provides a continuous ground path.

The cable is quipped with an outer protective jacket.

Benefit: helps to protect against corrosion, chemicals, and adverse environmental conditions.

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Pipe Freeze Protection

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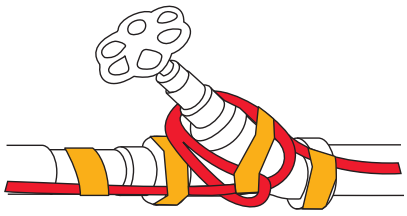
TTS™ Self-Regulating Heating Cable for Pipe Freeze Protection

Certifications/Approvals



Canadian Standards Association
Ordinary (Non-Classified) Locations
Hazardous (Classified) Locations
Class I, Division 2, Groups A, B, C and D
Class II, Division 2, Groups F and G
Meets or exceeds - IEEE 515, 515.1 - UL 1588
CSA 130-16

Description

Cut-to-length TTS™ Self-Regulating Heating Cables are designed to help provide freeze protection to metallic and non-metallic piping. Whether the application is a small project or a complex network, designing an electric heat trace system is easy with TTS™ Self-Regulating Heating Cable.

Please refer to the TTS™ Self-Regulating Heating Cables materials guide for Pipe Freeze Protection on pages 10-11 of this catalogue for full details.

TTS™ Self-Regulating Heating Cables are approved for use in ordinary (non-classified) and hazardous (classified) areas.

Areas of Application

- Freeze protection or low-temperature maintenance
- Metallic or non-metallic piping tanks and equipment
- Sewage pipes, intake and drain lines (external tracing only)
- Water meters and outside pipes/taps
- Water pipes in unheated areas
- Sprinkler systems
- Refrigeration

* For a complete installation, add thermal insulation in pipe freeze applications.

Ratings

Available watt densities	16, 26, 33 w/m @ 10°C (5, 8, 10 w/ft @50°F)
Supply voltages	110-120 or 208-240 vac
Max. Maintenance temperature	65°C (150°F)
Max. Continuous exposure temperature power off	85°C (185°F) minimum
Minimum installation temperature	-51°C (-60°F)
Minimum bend radius	32 mm (1.25")
T-rating	T6 85°C (185°F)

Basic Components

A pipe freeze protection system that uses TTS™ Self-Regulating Heating Cable will typically include heating cable and components shown in the illustration (page 11) and TTS™ Self-Regulating Heating Cable ordering information table below.

Ref #	Part #	Description
	Cable	
1	TTS-5-1-OJ	5 W/FT @ 120 V
1	TTS-8-1-OJ	8 W/FT @ 120 V
1	TTS-10-1-OJ	10 W/FT @ 120 V
1	TTS-5-2-OJ	5 W/FT @ 240 V
1	TTS-8-2-OJ	8 W/FT @ 240 V
1	TTS-10-2-OJ	10 W/FT @ 240 V
	Termination kits	
2	18-SXG-KIT[1]	Power connection gland kit w/o junction box
2	ECA-1-SR-SP	Power connection kit with metallic junction box
2	PCA-1-SR	Power connection kit with non-metallic junction box
4	PCS-1-SR	T-splice kit with non-metallic junction box[1]
8	HS-PBSK	Inline heat shrink splice kit (under insulation)
4	HS-TBSK	T-splice heat shrink kit (under insulation)
5	ET-6C	End-termination kit (ordinary and div 2 approved)
	Installation accessories	
6	BTape	Binding/attachment tape (1/2 ft X 180 ft)
7	CL	Caution labels (25 per pack)
9	AL TAPE	3M™ Aluminum Foil Tape (2 ft X 150 ft) for non-metallic pipe
	Controls	
3	R1-050-DP	Indoor thermostat
3	R3C-0120-DP	Weatherproof indoor/outdoor thermostat

[1] Junction box appropriate for the application to be supplied by the installer.

Note: More power connection/end termination, and control options available – see the Alternative Accessories section.

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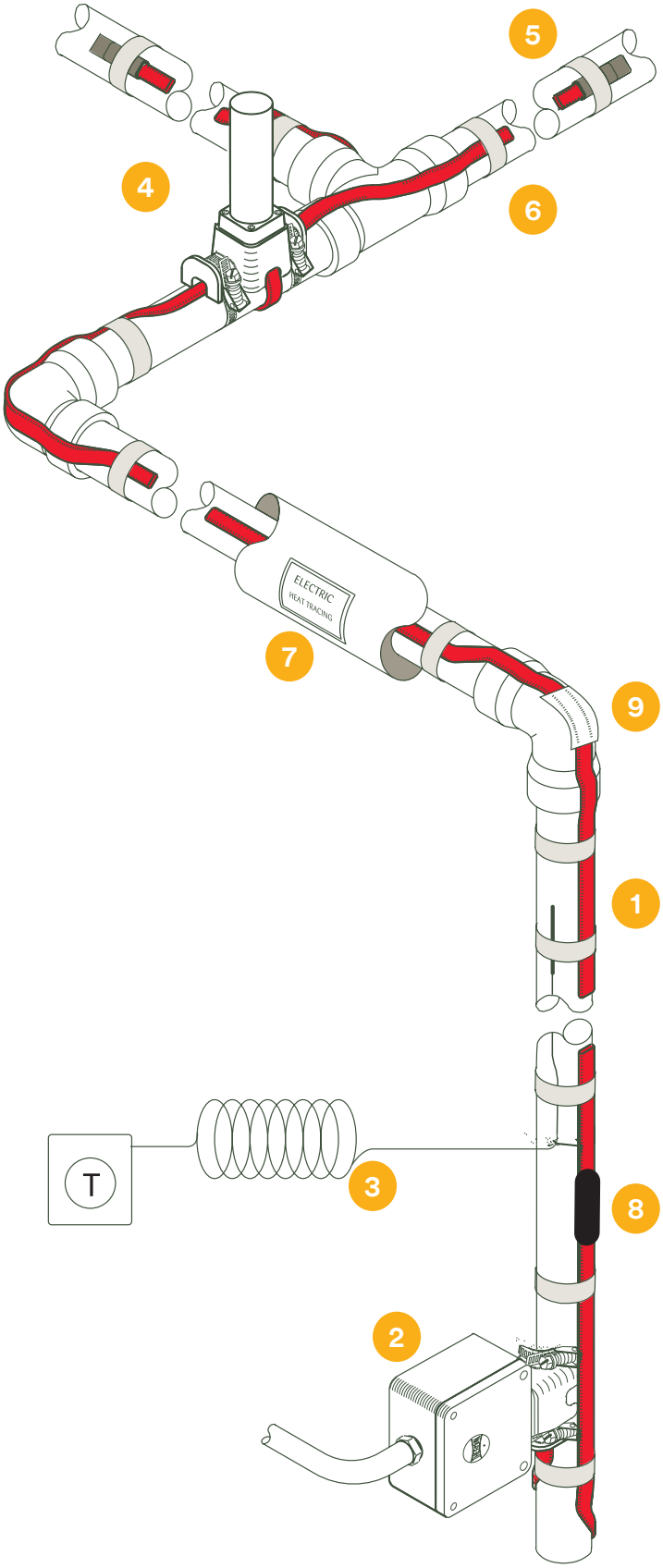
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Application overview

While an insulated pipe can withstand cold temperatures longer than an uninsulated pipe, it's still affected by the temperature of the surrounding environment. An ambient temperature below freezing can cause insulated pipes to burst, which can be costly and inconvenient. TTS™ Self-Regulating Heating Cable is designed to help provide freeze protection of metallic and non-metallic pipes by replacing the heat lost through the thermal insulation into the air.

Whether the application is a small project or a complex network of piping and equipment, designing an electric heat-traced freeze protection system is easy with TTS™ Self-Regulating Heating Cable. The information contained in this materials guide will take you through a step-by-step procedure to make proper heating cable selections based on:

- Minimum ambient temperature
- Thermal insulation type and thickness
- Heating cable start-up temperature
- Available power supply
- Pipe size

If higher maintain temperatures are required, contact us at **3Menergysolutions@mmm.com**

Safety first.

The safety and performance of electric heat tracing depends on how the cable was selected, installed and maintained. Improper handling, installation or maintenance of the cable can result in electrical shock, fire or cable failure. The information, instructions, testing procedures and warnings addressed in this guide are important. To minimize these risks, read this guide prior to starting any heating cable or component installation and follow the instructions carefully.

The Canadian Electrical Code requires that all heat tracing applications utilize ground-fault protection. This protection requirement can be achieved through ground-fault branch circuit breakers supplying power to the heating cable.

Creating a materials list

To create your materials list online, visit 3M.ca/HeatTrace.

The generally accepted maintenance temperature for freeze protection is 5°C (40°F). This application guide is based on maintaining 5°C (40°F) temperature and provides a safety factor to protect the piping and the contents from freezing.

To become familiar with the requirements of a properly designed electric heat tracing freeze protection system, use the five design steps detailed here and on the following pages.

Step 1: Establish parameters.

Collect information relative to the following design parameters:

Application Information:

- Pipe sizes or tubing diameters
- Pipe lengths
- Pipe material (metallic or non-metallic)
- Type and number of valves, pumps, or other equipment
- Type and number of pipe supports

Expected Minimum Ambient Temperature

Generally, this number is obtained from weather data compiled for an area and is based on recorded historical data. There are times, however, when the minimum ambient will be a number other than the minimum outside air temperature. Piping located inside of unheated buildings or in unconditioned attics may be subject to freezing, but may have different minimum ambient.

Minimum Start-Up Temperature

This temperature differs from the minimum expected ambient in that the heating cable will typically be energized at a higher ambient temperature. This temperature will have an effect on the maximum circuit length and circuit breaker sizing for a given application.

Insulation Material and Thickness

The selection charts in this guide (see pages 14-15) are based on fibreglass insulation. These charts may also be used with polyisocyanurate or mineral wool insulations of the same thickness. If insulation materials other than these are used, contact 3M (**3Menergysolutions@mmm.com)** for a selection chart supplement that corresponds with the insulation material.

Supply Voltage

TTS™ Self-Regulating Heating Cables are designed in two voltage groups:
1. 110-120 Vac
2. 208-240 Vac
Determine what voltage(s) are available at a facility for use with heat tracing.

Step 2: Select the proper TTS™ Self-Regulating Heating Cable.

Using the pipe diameter, insulation thickness and minimum expected ambient, find the recommended heating cable using **Selection Chart 1.2.1 Metallic Piping** on page 14, or **Selection Chart 1.2.2 Non-metallic Piping** on page 15. If the pipe size or insulation information does not appear, contact 3M at **3Menergysolutions@mmm.com.**

1. Select the vertical column headed by a low ambient temperature that is equal to or lower than that expected in your area.
2. Use the table section which corresponds to the insulation thickness shown in the left-hand column.
3. Based on the pipe diameter(s) of the application, read across the table to the low ambient temperature and note the TTS™ Self-Regulating Heating Cable recommended for that set of conditions.
4. Note that larger pipe sizes and lower ambient temperatures may require multiple passes of heating cable.
5. On piping 1-1/4" (25.4 mm - 6.4 mm) in diameter and smaller, the insulation must be one pipe size larger to accommodate the heating cable [i.e., use insulation sized for a 1" (25.4 mm) diameter pipe if the pipe to be insulated is 3/4" (19.1 mm) diameter].
6. For pipe sizes larger than listed or for maintain temperatures other than 5°C (40°F), contact 3M at **3Menergysolutions@mmm.com**

Note: Heat loss calculations are based on IEEE Std 515-1997, Equation A.1, with the following provisions:
- Piping insulated with glass fibre in accordance with ASTM Std C547
- Pipes located outdoors in the noted ambient with a 40 km/h (25 mph) wind
- A 10% safety factor has been included

Note: Chart may also be used with polyisocyanurates or mineral wool of the same thickness.

Selection Chart 1.2.1: Metallic Piping

Metallic Piping						
Insulation Thickness (Fibreglass)	NPS Pipe Size	Low Ambient Temperature				
		-12°C (10°F)	-18°C (0°F)	-23°C (-10°F)	-29°C (-20°F)	-40°C (-40°F)
0.5"	1/2", 3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3"	One Pass TTS-5		One Pass TTS-8		1X TTS-10
	4"			1X TTS-10		
	6"	1X TTS-10	Two Passes TTS-8			Contact 3M
1"	1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4"	One Pass TTS-5				
	6"		One Pass TTS-8			1X TTS-10
	8"				1X TTS-10	Contact 3M
	10"			1X TTS-10		
	12", 14"		1X TTS-10		Two Passes TTS-10	Contact 3M
			Two Passes TTS-8			
1.5"	1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4"	One Pass TTS-5				
	6"		One Pass TTS-8			1X TTS-10
	8", 10"			One Pass TTS-10		
	12", 14"				Two Passes TTS-8	
			1X TTS-10			2X TTS-10
2"	1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4", 6"	One Pass TTS-5				
	8", 10"			One Pass TTS-8		1X TTS-10
	12", 14"				1X TTS-10	
				1X TTS-10		Two Passes TTS-8

Example on how to read the Metallic piping chart

Example: A 4" diameter metallic pipe that will be insulated with 1" fibreglass must not freeze even with a minimum expected ambient temperature of -12°C (10°F). Refer to **chart 1.2.1**.

Using the column for the -12°C (10°F) ambient temperature, the section of the table that corresponds to 1" thick insulation and the row indicated for a 4" diameter pipe in **chart 1.2.1** identifies 1 pass of TTS™ Self-Regulating Heating Cable-5 as the proper cable to use.

Note: Chart may also be used with polyisocyanurates or mineral wool of the same thickness.

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Selection Chart 1.2.2: Non-metallic Piping

Non-metallic Piping						
Insulation Thickness (Fibreglass)	NPS Pipe Size	Low Ambient Temperature				
		-12°C (10°F)	-18°C (0°F)	-23°C (-10°F)	-29°C (-20°F)	-40°C (-40°F)
0.5"	1/2", 3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4", 6"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	1X TTS-10	1X TTS-10
			1X TTS-10	Two Passes TTS-8	Two Passes TTS-8	Two Passes TTS-8
1"	1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4", 6", 8", 10", 12", 14"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	1X TTS-10	1X TTS-10
				1X TTS-10	1X TTS-10	Two Passes TTS-10
			1X TTS-10	Two Passes TTS-8	Two Passes TTS-8	Two Passes TTS-10
1.5"	1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4", 6", 8", 10", 12", 14"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	1X TTS-10
					1X TTS-10	Two Passes TTS-8
				1X TTS-10	Two Passes TTS-8	Two Passes TTS-8
2"	1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4", 6", 8", 10", 12", 14"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-10
					One Pass TTS-8	2 X TTS-8
				One Pass TTS-8	1X TTS-10	2 X TTS-8

Additional considerations for non-metallic piping

For freeze-protecting non-metallic pipes, TTS™ Self-Regulating Heating Cable is to be installed with a continuous covering of 3M™ Aluminum Foil Tape. The data in **selection chart 1.2.2** is based on this installation method.

Heat loss characteristics of non-metallic pipes are similar to metal pipes, but the TTS™ Self-Regulating Heating Cable output is lower because of the insulating properties of the pipewall material. Design **selection chart 1.2.2** reflects these values.

Note: Chart may also be used with polyisocyanurates or mineral wool of the same thickness.

Step 3: Determine how much cable you will require.

Heat tracing circuit lengths are based on several conditions that must be simultaneously taken into account and include:

- Length of piping (including extra allowances)
- Operating voltage
- Available branch circuit breaker sizes
- Expected start-up temperature
- Maximum allowable circuit lengths

Every heat tracing circuit will require some additional heating cable to make the various splices and terminations.

Additional cable will also be needed to provide extra heat at valves, pumps, miscellaneous equipment and pipe supports. Use the following guidelines to determine the amount of extra cable required:

- Valves and pumps: use allowances from **Table 1.3.1**
- Miscellaneous equipment and pipe supports: use allowances from **Table 1.3.1 A**

To determine circuit lengths, a voltage selection must be made from the available voltages gathered as part of Step 1.

- TTS™ Self-Regulating Heating Cable intended for use on 110-120 Vac will have a catalogue number followed by a 1 (i.e., TTS-X-1)
- TTS™ Self-Regulating Heating Cable intended for use on 208-240 Vac will have a catalogue number followed by a 2 (i.e., TTS-X-2)

In Step 2, the proper TTS™ Self-Regulating Heating Cable (5, 8 or 10) was selected from **selection chart 1.2.1** or **1.2.2.** Using voltage and cable selections plus information from **Table 1.3.2** or **1.3.3,** the maximum heating cable lengths and branch circuit breaker requirements can be determined.

- If a branch circuit breaker of a known amperage will be used, match this rating with the cable selection and the temperature at which the cable will be energized
- If no circuit breaker sizing has been established, find the maximum circuit length that meets or exceeds the length of the appropriate TTS™ Self-Regulating Heating Cable at the start-up temperature of the cable and determine what amperage branch circuit breaker will be required

⚠ **Remember the start-up temperature does not necessarily match the expected low ambient temperature.**

Table 1.3.1: Valve and Pump Allowances

	Valve Allowance			Pump Allowance	
Pipe Size	Screwed	Flanged	Welded	Screwed	Flanged
1/2"	6"	1'	0	1'	2'
3/4"	9"	1' 6"	0	1' 6"	3'
1"	1'	2'	1'	2'	4'
1-1/4"	1' 6"	2'	1'	3'	4' 6"
1-1/2"	1' 6"	2' 6"	1' 6"	3'	5'
2"	2'	2' 6"	2'	4'	5' 6"
3"	2' 6"	3' 6"	2' 6"	5'	7'
4"	4'	5'	3'	8'	10'
6"	7'	8'	3' 6"	14'	16'
8"	9' 6"	11'	4'	19'	22'
10"	12' 6"	14'	4'	25'	28'
12"	15'	16' 6"	5'	30'	33'
14"	18'	19' 6"	5' 6"	36'	39'

Table 1.3.1 A: Other Allowances

Description	Allowance
Power Connections	1 foot of TTS™ Self-Regulating Heating Cable for each heating circuit
Splices	2 feet of TTS™ Self-Regulating Heating Cable for each splice kit 3 feet of TTS™ Self-Regulating Heating Cable for each TSplice kit
Insulated Pipe Supports	Require no additional heating cable
Uninsulated Pipe Supports	Allow 2 times the length of the pipe support plus an additional foot of heating cable for each support

Example: Continuing with the first example from page 10, the 4" diameter metallic pipe is 60' long, has one screwed valve and is supported by 6 metal pipe hangers. The heating cable allowances for the circuit would be as follows:

Pipe Length: 60'
1 power connection: 1'
1 valve: 4'
6 pipe supports: 4' (4" dia. x 2 = 8"/hanger)
Total circuit length: 69'

Table 1.3.2

Maximum Circuit Length vs. Breaker Size – 120 Vac Service Voltage feet (meters)

Cable Type	Start-Up Temp. °C (°F)	Circuit Breaker Size 15 A	20 A	30 A	40 A
TTS 5-1	10 (50) -18 (0) -29 (-20) -40 (-40)	180 (55) 155 (47) 140 (43) 125 (38)	240 (73) 205 (62) 185 (56) 165 (50)	285 (87) 285 (87) 275 (84) 250 (76)	285 (87) 285 (87) 285 (87) 265 (81)
TTS 8-1	10 (50) -18 (0) -29 (-20) -40 (-40)	145 (44) 115 (35) 100 (31) 90 (27)	195 (59) 150 (46) 135 (41) 120 (37)	240 (73) 225 (69) 200 (61) 180 (55)	240 (73) 240 (73) 240 (73) 215 (66)
TTS 10-1	10 (50) -18 (0) -29 (-20) -40 (-40)	120 (37) 85 (26) 75 (23) 70 (21)	160 (49) 115 (35) 100 (30) 90 (27)	200 (61) 170 (52) 150 (46) 135 (41)	200 (61) 200 (61) 200 (61) 180 (56)

Table 1.3.3

Maximum Circuit Length vs. Breaker Size – 240 Vac Service Voltage feet (meters)

Cable Type	Start-Up Temp. °C (°F)	Circuit Breaker Size 15 A	20 A	30 A	40 A
TTS 5-2	10 (50) -18 (0) -29 (-20) -40 (-40)	365 (111) 295 (90) 260 (79) 240 (73)	485 (148) 395 (120) 350 (107) 315 (96)	585 (178) 585 (178) 525 (160) 475 (145)	585 (178) 585 (178) 585 (178) 535 (163)
TTS 8-2	10 (50) -18 (0) -29 (-20) -40 (-40)	290 (88) 215 (66) 190 (58) 170 (52)	385 (117) 285 (87) 255 (78) 230 (70)	485 (148) 430 (131) 380 (116) 345 (105)	485 (148) 485 (148) 480 (147) 480 (147)
TTS 10-2	10 (50) -18 (0) -29 (-20) -40 (-40)	240 (73) 170 (52) 150 (46) 135 (41)	320 (98) 225 (69) 200 (61) 180 (55)	405 (123) 340 (104) 305 (93) 275 (84)	405 (123) 405 (123) 405 (123) 365 (111)

Step 4: Choose TTS™ Self-Regulating Heating Cable installation accessories.

A TTS™ Self-Regulating Heating Cable Self-Regulating Freeze Protection Heat Tracing System will typically include the following components:

1. TTS™ Self-Regulating Heating Cable (refer to **Selection Charts 1.2.1** and **1.2.2** for proper cable)
2. Power connection / circuit fabrication kits
3. Thermostats
4. T-splice kit
5. End termination kit
6. BTape attachment tape (1/2" X 60 yd) secures cable to pipe; use on 12" intervals or as required by code or specification. Use **Table 1.5.1. Attachment Tape Allowance** on page 18 to determine tape requirements.
7. CL "Electric Heat Tracing" label (peel and stick label attaches to insulation vapor barrier on 10' intervals or as required by code or specification.
8. Inline splice kit
9. Aluminum tape to hold down cable and disperse heat as required

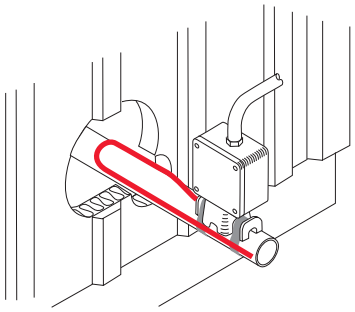
Table 1.5.1: Attachment Tape Allowance (BTape)

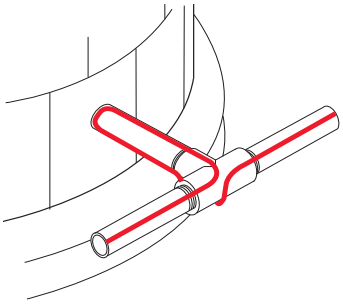
Pipe Size	½"-1"	1¼"	1½"	2"	3"	4"	6"	8"	10"	12"	14"
Feet of Pipe/Roll of Tape – 180' roll of tape	360'	260'	220'	180'	150'	120'	90'	70'	60'	50'	40'

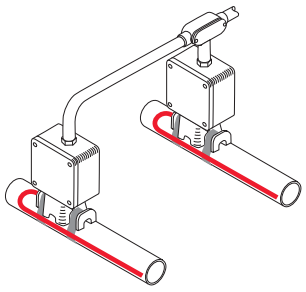
Installation Tips

To help ensure a properly operating heat tracing system and avoid the common mistakes made by first-time users, we have compiled the following tips:

1. **What to do when you have heat-trace pipe entering a facility:**
   The heating cable should extend into the building approximately 12" (305 mm) to ensure the pipe temperature is maintained. This prevents temperature drops due to air gaps or compression of the thermal insulation.
2. **What to do when an above ground pipe goes underground:**
   While the pipe may eventually travel below the frost line and therefore be protected from freezing, the distance between the surface (grade) and the frost line must be protected. This can be accomplished by creating a loop with the heating cable end terminated above the normal water line. If the application is temperature maintenance, the above-grade and below-grade portions should be controlled as separate circuits due to the differing surrounding environments.
3. **What to do when a freeze protection application has a main line with a short branch line connected to it:**
   The heating cable installed on the main line can be looped (double passed) on the branch line. This eliminates the need to install a T-splice kit.
4. **What to do when all heating cable power connection points need to be secured to the piping:**
   Heating cable should not pass through the air to travel to an adjoining pipe. Instead, use multiple circuit fabrication kits interconnected with conduit and field wiring as shown.







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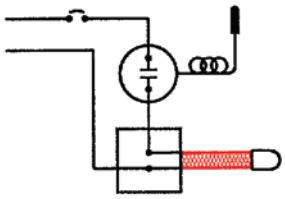
Thermostatic Control

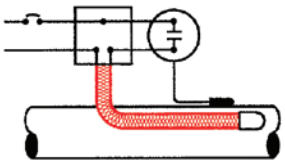
While these four steps provide the considerations required to plan the materials list and/or specify a TTS™ Self-Regulating Heating Cable Self-Regulating Heat Tracing System, some type of control will typically be needed. The type of control and level of sophistication needed will depend entirely on the application of the piping being heat-traced.



Self-regulating heating cables can, under some design conditions, be operated without the use of any temperature control. However, some method of control is generally used and the two most common methods are **ambient sensing** and **pipewall sensing**. Each method has its own benefits, and various options are available within each method.

Ambient Sensing: An adjustable thermostat, designed for mounting in an exposed environment, senses the outside air temperature. When this temperature falls below the setpoint, a set of contacts close and energize the heating cable(s).

Should the electrical load of the heating circuit exceed the rating of the thermostat switch, a mechanical contractor can be used. An entire power distribution panel, feeding dozens of heat tracing circuits, can be energized through an ambient sensing thermostat. The primary application for ambient sensing control of electric heat tracing is freeze protection (winterization) of water and water-based solutions. **A benefit of ambient sensing control for freeze protection is that pipes of varying diameters and insulation thicknesses can be controlled as a single circuit.**



By controlling heat tracing with ambient sensing control, the status (flowing or non-flowing) of the heated pipe needs no consideration.

Pipewall Sensing: While a self-regulating cable adjusts TTS™ Self-Regulating Heating Cable heat output to accommodate the surrounding conditions, **the most energy-efficient method for controlling heat tracing is a pipewall-sensing thermostat.**

This is because a flowing pipe will typically not need any additional heat to keep it at the proper temperature. Where a piping system has tees and therefore multiple flow paths, more than one thermostat may be required. Examples of situations where more than one thermostat could be necessary:

- Pipes of varying diameters or insulation thicknesses
- Varying ambient conditions such as above/below ground transitions and indoor/outdoor transitions
- Flowing versus non-flowing conditions within the interconnected piping
- Applications involving temperature-sensitive products

Note: Pipewall sensing is required for non-metallic piping.

Data Sheet — TTS™ Self-Regulating Heating Cable for Pipe Freeze Protection

Product Specifications

Construction

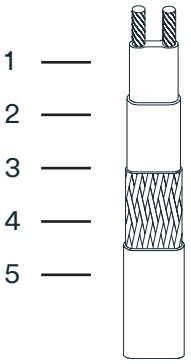
1 Nickel-Plated Copper Bus Wires (16 AWG)

2 Radiation Cross-Linked Semiconductive Heating Matrix

3 Radiation Cross Linked Dielectric Insulation

4 Tinned Copper Braid (BC)

5 Polyolefin Overjacket



Ratings

Available watt densities	16, 26, 33 w/m @10° C (5,8,10 w/ft @50° F)
Supply voltages	110-120 or 208-240 vac
Max. Maintenance temperature	65°C (150°F)
Max. Continuous exposure temperature power off	85°C (185°F)
Minimum installation temperature	-51°C (-60°F)
Minimum bend radius	32 mm (1.25")
T-rating	T6 85°C (185°F)

Basic Accessories

Power Connection: All TTS™ Self-Regulating Heating Cables require an ECA, PCA or 18-SXG-KIT power connection kit for terminating the circuit before connecting to power.

End-of-Circuit Termination: TTS™ Self-Regulating Heating Cables require the ET-6C end cap for terminating the end of the circuit.

Note: T-rating per the 1996 NEC, Tables 500-3(d), 505-10(b) and as verified by Factory Mutual Research and the Canadian Standards Association.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

Certifications/Approvals

Canadian Standards Association
Ordinary (Non-Classified) Locations
Hazardous (Classified) Locations
Class I, Division 2, Groups A, B, C and D
Class II, Division 2, Groups F and G
Meets or exceeds - IEEE 515, 515.1 – UL 1588
CSA 130-16

Circuit Breaker Sizing

Maximum circuit lengths for various circuit breaker amperages are shown below. Circuit breaker sizing should be based on the local or applicable code.

Ground fault protection equipment is required for each branch circuit supplying electrical heating equipment. Consult local authority for ground fault circuit protection.

Table 1.3.2

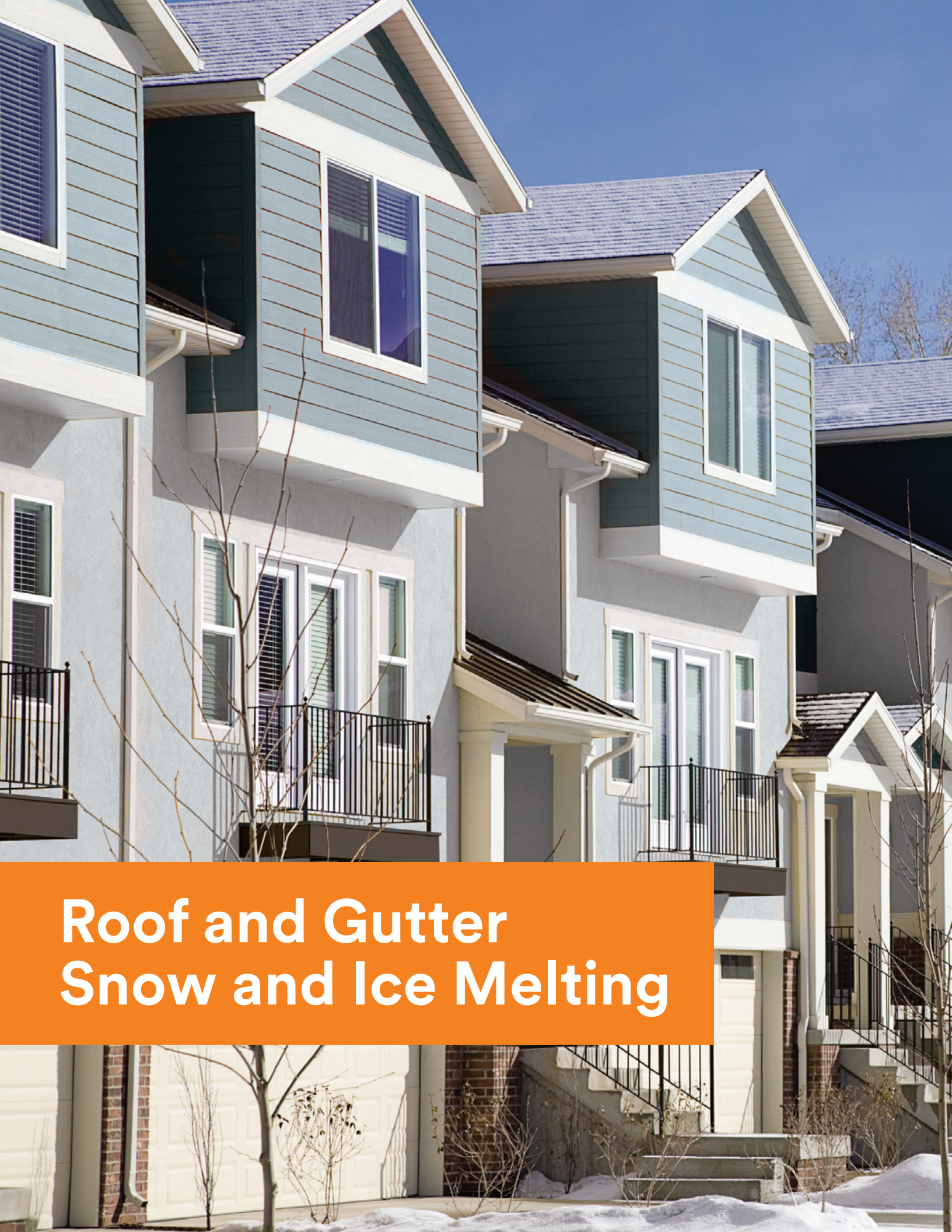
Maximum Circuit Length vs. Breaker Size – 120 Vac Service Voltage feet (meters)

Cable Type	Start-Up Temp. °C (°F)	Circuit Breaker Size 15 A	20 A	30 A	40 A
TTS 5-1	10 (50) -18 (0) -29 (-20) -40 (-40)	180 (55) 155 (47) 140 (43) 125 (38)	240 (73) 205 (62) 185 (56) 165 (50)	285 (87) 285 (87) 275 (84) 250 (76)	285 (87) 285 (87) 285 (87) 265 (81)
TTS 8-1	10 (50) -18 (0) -29 (-20) -40 (-40)	145 (44) 115 (35) 100 (31) 90 (27)	195 (59) 150 (46) 135 (41) 120 (37)	240 (73) 225 (69) 200 (61) 180 (55)	240 (73) 240 (73) 240 (73) 215 (66)
TTS 10-1	10 (50) -18 (0) -29 (-20) -40 (-40)	120 (37) 85 (26) 75 (23) 70 (21)	160 (49) 115 (35) 100 (30) 90 (27)	200 (61) 170 (52) 150 (46) 135 (41)	200 (61) 200 (61) 200 (61) 180 (56)

Table 1.3.3

Maximum Circuit Length vs. Breaker Size – 240 Vac Service Voltage feet (meters)

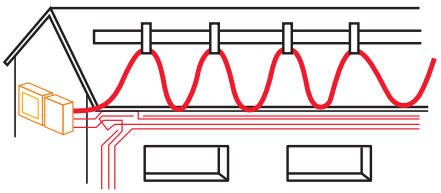
Cable Type	Start-Up Temp. °C (°F)	Circuit Breaker Size 15 A	20 A	30 A	40 A
TTS Cable 5-2	10 (50) -18 (0) -29 (-20) -40 (-40)	365 (111) 295 (90) 260 (79) 240 (73)	485 (148) 395 (120) 350 (107) 315 (96)	585 (178) 585 (178) 525 (160) 475 (145)	585 (178) 585 (178) 585 (178) 535 (163)
TTS 8-2	10 (50) -18 (0) -29 (-20) -40 (-40)	290 (88) 215 (66) 190 (58) 170 (52)	385 (117) 285 (87) 255 (78) 230 (70)	485 (148) 430 (131) 380 (116) 345 (105)	485 (148) 485 (148) 480 (147) 480 (147)
TTS 10-2	10 (50) -18 (0) -29 (-20) -40 (-40)	240 (73) 170 (52) 150 (46) 135 (41)	320 (98) 225 (69) 200 (61) 180 (55)	405 (123) 340 (104) 305 (93) 275 (84)	405 (123) 405 (123) 405 (123) 365 (111)



Roof and Gutter Snow and Ice Melting

2 3M Self-Regulating Heating Cables Ordering Information and Materials Guide

Certifications/Approvals



Canadian Standards Association
Ordinary (Non-Classified) Locations
Hazardous (Classified) Locations
Class I, Division 2, Groups A, B, C and D
Class II, Division 2, Groups F and G
Meets or exceeds - IEEE 515.1 – UL 1588
CSA 130-16

Diagram shown above is for illustration purposes only; it is not to scale.

Description

Cut-to-length TTS™ Self-Regulating Heating Cables are designed to provide snow and ice melting for roof and gutter applications. Whether the application is a small project or a complex network, designing an electric heat trace system is easy with TTS™ Self-Regulating Heating Cables. Please refer to the basic components section for roof and gutter snow and ice melting on page 24 of this guide for full details.

TTS™ Self-Regulating Heating Cables are approved for use in ordinary (non-classified) and hazardous (classified) areas.

Areas of Application

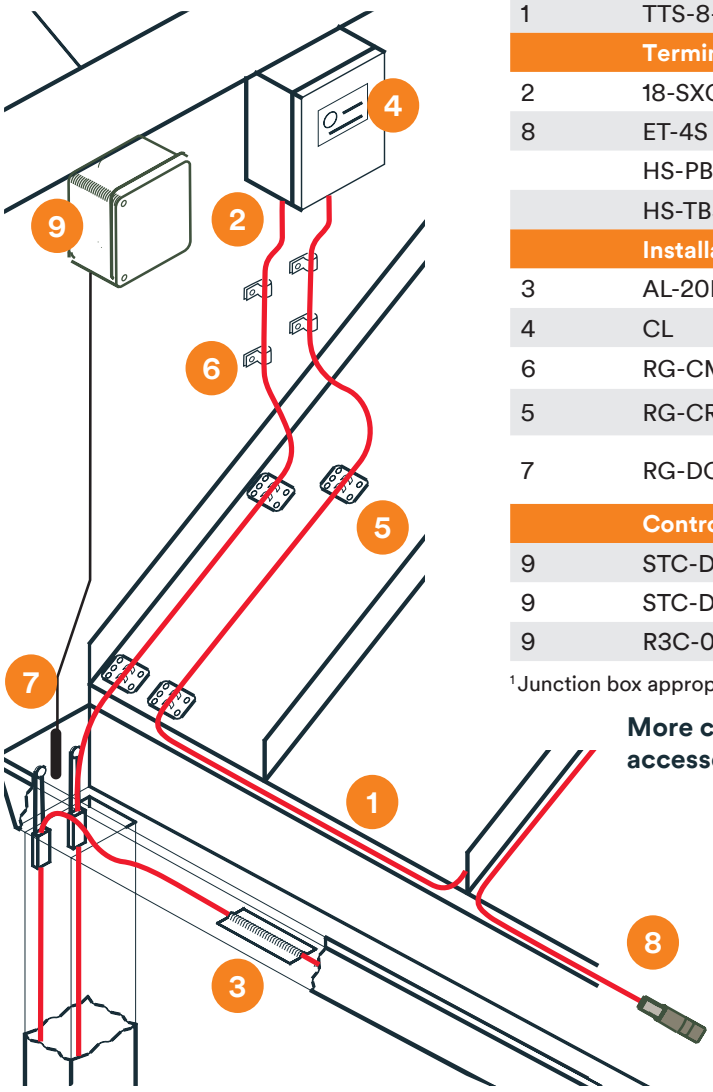
- Roof surfaces: asphalt, shingle, or metal
- Gutters and downspouts: metal or plastic

Ratings

Heating cable output	In snow and ice	39 W/m @ 0°C (12 W/ft @ 32°F)
	In dry air	20 W/m @ 0°C (6 W/ft @ 32°F)
Supply voltages		110-120 or 208-240 V
Minimum installation temperature		-51°C (-60°F)
Minimum bend radius		32 mm (1.25in)
T-rating		T6 85°C (185°F)

Basic Components

A TTS™ Self-Regulating Heating Cable roof and gutter snow and ice melting heat tracing system will typically include heating cable and components shown in the illustration below and TTS™ Self-Regulating Heating Cable ordering information below.



Ref #	Part #	Description
	Cable	
1	TTS-8-1-OJ	8 W/FT @ 120 V
1	TTS-8-2-OJ	8 W/FT @ 240 V
	Termination kits	
2	18-SXG-KIT[1]	Power connection gland kit w/o junction box
8	ET-4S	End termination kit
	HS-PBSK	Inline splice with heat shrink
	HS-TBSK	T-splice with heat shrink
	Installation accessories	
3	AL-20L	3M™ Aluminum Tape (2" X 150') in gutter
4	CL	Caution labels (25 per pack)
6	RG-CMC	"P" style roof, cable mounting clips (100/bag)
5	RG-CRF	Roof clips, cable roof fastener (25/bag)
7	RG-DCH	Downspout cable hanger (2 hangers needed per downspout)
	Controls	
9	STC-DS2C	Snow and ice sensor, pole mounted
9	STC-DS-8	Snow and ice sensor, gutter mounted
9	R3C-0120-DP	Weatherproof indoor/outdoor thermostat

[1] Junction box appropriate for the application to be supplied by the installer.

More control options are available – see the Alternative accessories on page 39.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

Introduction

This guide provides a basis for a roof and gutter snow and ice melting system. The amount of heating cable required and the performance of the system is highly dependent upon the following parameters:

- Geographical location of project
- Building and construction
- Orientation of building to prevailing wind and weather
- Degree of protection required[1]

[1]While entire roof areas can be electrically heat traced for snow and ice removal, this guide addresses only roof overhangs, gutters and downspouts. Should your application require more area to be protected, contact 3M at **3Menergysolutions@mmm.com.**

Creating a Materials List

To create your materials list online, visit 3M.ca/HeatTrace.

The area that will require heat tracing is based somewhat on the size and shape of the building. A building with no overhangs, for example, may only need gutter and downspout protection while an overhang covering a building entrance that is subject to drifting may need complete coverage. Typically the areas susceptible to snow and ice dams consist of:

- Roof overhangs without gutters
- Roof overhangs with gutters and downspouts
- Gutters and downspouts only

Step 1: Identify the area requiring snow and ice melting and determine level of protection required.

Review the plans and/or design of the facility to identify the areas that will require roof and gutter snow and ice melting. To establish the level of protection necessary, decide if the climate/installation conditions fall into the moderate or heavy levels based on the variables below:

Snowfall Rate	Moderate (≤1"/hr)	Heavy (1-2"/hr)
Eave-to-ridge distance	≤20'	20-40'
Size (width) of gutter	≤6"	6-12"

If any variable falls into the heavy category, plan the system for heavy accumulation to ensure adequate protection for the building. Should weather conditions, the building's design/orientation or the expected usage of the facility dictate, increase the amount of cable to be installed.

Step 2: Select proper heating cables and lengths.

The following three considerations are used to help determine heating cables and lengths:

1. *Operating voltage:* TTS™ Self-Regulating Heating Cables are available in two voltage groups: 110-120 Vac and 208-240 Vac. **Determine what voltage is available for use with heat tracing.**

2. *Branch circuit breakers:* Use **Table 2.1**, Cable Selection, to match the TTS™ Self-Regulating Heating Cables circuit length with the available branch circuit breaker size. If a known branch circuit breaker size is being used, match this value with the corresponding TTS™ Self-Regulating Heating Cables circuit length. If breaker size will be dictated by heating cable requirements, determine the optimal TTS™ Self-Regulating Heating Cables circuit lengths based on the project size and cable layout.

3. *x:* The maximum circuit lengths shown in **Table 2.1** are based on TTS™ Self-Regulating Heating Cables start-up at an ambient temperature of 7° C (20° F). Because the power output of TTS™ Self-Regulating Heating Cables will vary to meet the needs of the surrounding environment, the operating load will vary.

Don't forget: To aid in planning, TTS™ Self-Regulating Heating Cable multipliers are given for the most common roofing material types. Use these multipliers, shown in **Tables 2.2.1** and **2.2.2**, to determine the footage of TTS™ Self-Regulating Heating Cable required based on the variables indicated. Be sure to add extra cable to get from the heat-traced area back to the power connection point.

Table 2.1 Cable Selection

Start up temperature 20°F -7°C			
	Voltage	Max Circuit Length (feet)	Max Ckt Length (meters)
15A Breaker	120 V 208 V 240 V	100 185 190	31 57 58
20A Breaker	120 V 208 V 240 V	135 245 250	42 75 77
30A Breaker	120 V 208 V 240 V	175 350 350	54 107 107
40A Breaker	120 V 208 V 240 V	175 350 350	54 107 107

Start up temperature 0°F -18°C			
	Voltage	Max Circuit Length (feet)	Max Ckt Length (meters)
15A Breaker	120 V 208 V 240 V	80 145 150	25 45 46
20A Breaker	120 V 208 V 240 V	105 190 200	33 58 61
30A Breaker	120 V 208 V 240 V	155 290 295	48 89 90
40A Breaker	120 V 208 V 240 V	175 350 350	54 107 107

Note: Due to TTS™ Self-Regulating Heating Cable self-regulating feature, TTS™ Self-Regulating Heating Cable will increase power when exposed to ice and snow. When the cable has cleared the area, the power output will decrease, reducing energy consumption.

Step 3: Cable layout - specify power connection locations.

1. The junction boxes used for connecting the heating cable to power should, whenever possible, be located under a roof overhang or similar area to avoid direct exposure. Provide drip loops where the power feed and heating cable enter the junction box.
2. On larger projects with multiple circuits or where the design layout permits, locate the power connection points for two circuits in the same location to reduce power feed conduits.

Step 4: choose TTS™ Self-Regulating Heating Cable installation accessories.

A TTS™ Self-Regulating Heating Cable Roof and Gutter Heat Tracing System will require the following components:

- 18-SXG kit
- ET-4S

Additional installation accessories are detailed on page 41-47.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

Step 5: Establish control method needed to operate system.

All roof and gutter snow and ice melting systems should be controlled to turn the heating cable on and off as conditions warrant. There are three easy ways to activate a roof and gutter system:

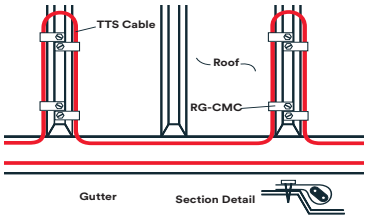
1. **Manual On/Off Switch with Timer:** Economical and simple to install; requires diligence on the part of the operator.
2. **Ambient Sensing Control:** Turns system on and off based on ambient temperature. Heating cable will frequently be energized during non-required times.
3. **Automatic Control:** Roof- or gutter-mounted ice sensor turns system on when moisture is detected and temperatures are in the range when freezing can occur on roof overhangs or in gutters.

Attention: The Canadian Electrical Code requires ground-fault protection of equipment to be provided for branch circuits supplying fixed outdoor electric snow-melting equipment.

Heating Cable Length Multipliers

Select a multiplier from the examples shown based on the type of roofing material utilized. If gutters and downspouts will also require protection, be sure to add the cable requirements (see **Table 2.2.3**) to the roof overhang footages.

Metal Roofs



Metal roofing materials such as standing seam or corrugated, as well as tile/concrete roofing materials that have distinct ridges or grooves, must be properly addressed when installing heat tracing. Metal roofs in particular pose an avalanche potential that could damage the heating cable if it were installed in a serpentine pattern. To combat this, the cable is installed parallel to the standing seams or along the length of a corrugation. This partial sketch depicts TTS™ Self-Regulating Heating Cable as it would be installed on a standing seam metal roof.

To help determine the layout pattern for TTS™ Self-Regulating Heating Cable on metal roofs, use **Table 2.2.1** in conjunction with measurements of the spacing of the seams, corrugations or ridges in the roofing material. This spacing, combined with the desired level of protection, will determine what multiplier to use to determine the footage of cable required (heating cable does not have to be installed on every seam, corrugation, etc). Be sure to add extra cable to reach the power connection point for each circuit.

To help determine the amount of cable required, select the overhang distance that fits the application and follow this row across to the spacing pitch column that corresponds to the roofing material. **The number where the row and column intersect is the multiplier for that application.** You then need to multiply this number by the number of linear feet of roof eave to be protected and add sufficient cable to reach the power supply junction box plus any additional cable to allow for on-site variations.

Table 2.2.1: Metal Roofs

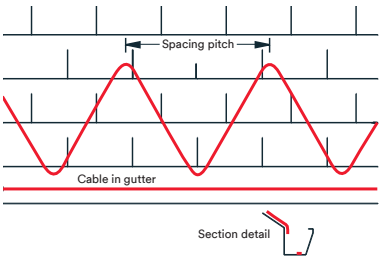
Overhang Distance	Spacing Pitch 10"	12"	14"	16"	18"	20"	22"	24"
12"	4.2	3.7	3.3	3.0	2.8	2.6	2.5	2.4
18"	5.4	4.7	4.2	3.8	3.5	3.2	3.0	2.9
24"	6.6	5.7	5.0	4.5	4.1	3.8	3.6	3.4
30"	7.8	6.7	5.9	5.3	4.8	4.4	4.1	3.9
36"	9.0	7.7	6.7	6.0	5.5	5.0	4.7	4.4

Heavy Condition Multipliers Moderate Condition Multipliers

Determining how far up the roof the heating cable should travel

The heating cable should loop past the point where an imaginary line extending up from the inside wall would pass through the roof.

Shingle Roofs



All shingle roofs (fibreglass, flat tile or concrete shingle) can utilize heating cable installed in a serpentine pattern as detailed in the partial sketch to the left.

To establish the amount of cable required, select the row with the corresponding overhang distance and follow across to the multiplier that matches the level of protection desired. After selecting a multiplier, read the corresponding spacing pitch value at the top of the column.

Multiply this number by the number of linear feet of roof eave to be protected and add sufficient cable to reach the power supply junction box.

The heating cable may be attached to the roof and fascia with cable fasteners (Catalogue No. RG-CRF) or similar devices held in place with suitable fasteners or adhesives. Care should be exercised to maintain the integrity of the roof.

To determine the layout pattern for TTS™ Self-Regulating Heating Cable on shingle-style roofs, use **Table 2.2.2**. Recommended moderate and heavy conditions multipliers have been shaded for each overhang distance. Should conditions dictate a specific pitch, multipliers for additional spacings have been included. Be sure to add sufficient extra cable to reach the power connection point for each circuit.

Table 2.2.2: Shingle Roofs

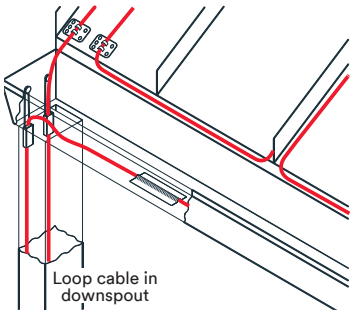
Overhang Distance	Spacing Pitch							
	10"	16"	18"	20"	22"	24"	26"	28"
18"	3.3	3.0	2.7	2.4	2.3	2.1	NR	NR
24"	4.2	3.7	3.3	3.0	2.8	2.6	2.4	2.3
30"	5.0	4.4	3.9	3.6	3.3	3.0	2.8	2.7
36"	5.8	5.1	4.6	4.1	3.8	3.5	3.3	3.1
42"	6.7	5.9	5.2	4.7	4.3	4.0	3.7	3.5

Heavy Condition Multipliers Rate of Snow Fall (2"/hr)

Moderate Condition Multipliers Rate of Snow Fall (1"/hr)

Attention: Where conditions dictate (heavy snow loads, steep roof slopes, smooth roofing materials or long eave-to-ridge distances), snow fences and/or snow brakes should be considered to prevent/reduce the potential for damage to the cable and/or facility.

Gutters and Downspouts



TTS™ Self-Regulating Heating Cable can be utilized in gutters and downspouts regardless of whether heating cable has been installed on the roof. The amount of cable required is based on the width of the gutters, the level of protection desired and the linear footage of gutters and downspouts. A typical layout is shown to the left.

As stated in the IEEE Standard 515.1, it is recommended practice for the testing, design, installation and maintenance of electrica-resistance heat tracing for commercial applications that the use of in-line splices and T-splices be avoided. This will require that heating cable in downspouts be looped (also an IEEE 515.1 recommendation) to eliminate splicing the cable. Additionally, the heating cable end termination should not be located in the lowest portion of the downspout.

1. Select the level of protection required (based on the size of the gutter) from **Table 2.2.3**.
2. Choose the multiplier which corresponds to the application and apply this multiplier to the footage of gutters and the number and footage of downspouts to be heat traced.
3. Add sufficient heating cable (including a drip loop) to reach the power connection junction box.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

Table 2.2.3: Gutters and Downspouts

Gutter width	Gutter allowance	Downspout allowance
<6"	1X gutter length	2X downspout length
6-12"	2X gutter length	2X downspout length

Example

To determine the recommended amount of cable for a standing seam metal roof under a heavy snowfall rate with 12" seams and a 24" overhang use **Table 2.2.1.**

Using the column for 12" seams and the row for a 24" overhang indicates the application would require 5.7 feet of cable per linear foot of roof. Therefore, if the length of roof is 100', you would multiply by 5.7' (100' x 5.7' = 570') which would tell you that you need 570' of cable for the roof surface. (Additional cable will be required for power connection, see complete calculations below.)

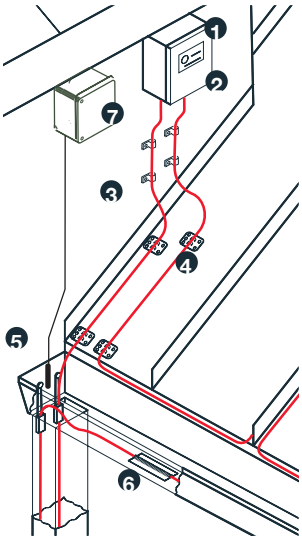
Continuing with the example, refer to **Table 2.2.3** to determine the amount of cable required for a 12" gutter with 3 downspouts that are 15' in length.

Using the row for 12" gutter widths indicates that a 2X multiplier should be used for the total gutter length and downspout length. Therefore the total length of roof 100' x 2 = 200' for the gutters. Additionally, each downspout (15' in length) would require 30' of cable (15'x 2 = 30'). For the three downspouts, you would need to multiple this total three times (30' x 3 = 90') which would calculate to 90' of cable for three downspouts

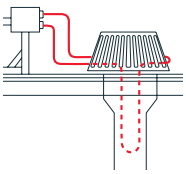
Roof Length	100' x 5.7 = 570'
Gutter Length	100' x 2 = 200'
3 Downspouts	3 x (15' x 2) = 90'
3 Power Connections	3 x 2' = 6'
	866

Installation Accessories

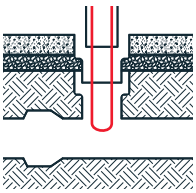
1. 18-SXG-KIT and ET-4S circuit fabrication kits are designed to terminate one circuit for both power connection and end termination. Junction boxes will be supplied by installer.
2. CL “Electric Heat Tracing” caution labels peel and stick to junction boxes, breaker panels and control panel(s), or as required by code or specification.
3. RG-CMC cable mounting clips secure TTS™ Self-Regulating Heating Cable to the roof utilizing screws and a waterproof cover material.
4. RG-CRF cable roof fasteners attach TTS™ Self-Regulating Heating Cable to roof or fascia materials. The can be secured with fasteners or adhesives compatible with roofing material.
5. RG-DCH downspout cable hanger secures heating cable at downspouts to remove strain at lip of downspout/gutter contact point.
6. AL-20L aluminum tape secures heating cable to bottom of clean gutter to keep cable in place during rain.
7. Snow sensor/controller



Tips



1. **Roof drains**
Roof drains may require heat tracing to prevent blockage caused by ice buildup. Heating cable should extend a minimum of 12" into the heated portion of the building. If building is unheated, extend heat tracing down to the storm sewer.



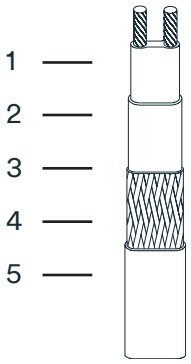
2. **Downspouts to underground storm sewers**
When downspouts are routed to storm sewers located below the frost line, extend the TTS™ Self-Regulating Heating Cable down to the point where the vertical drain meets the horizontal drain. The cable should not extend into the horizontal drain line.

Data sheet — TTS™ Self-Regulating Heating Cable for Roof and Gutter Snow and Ice Melting

Product Specifications

Construction

1. Nickel-Plated Copper Bus Wires (16 AWG)
2. Radiation Cross-Linked Semiconductive Heating Matrix
3. Radiation Cross Linked Dielectric Insulation
4. Tinned Copper Braid (BC)
5. Polyolefin Overjacket



Ratings

Heating cable output	In snow and ice	39 W/m @ 0°C (12 W/ft @ 32°F)
	In dry air	20 W/m @ 0°C (6 W/ft @ 32°F)
Supply voltages		110-120 or 208-240 V
Minimum installation temperature		-51°C (-60°F)
Minimum bend radius		32 mm (1.25 in)
T-rating		T6 85°C (185°F)

Basic Accessories

Power Connection: All TTS™ Self-Regulating Heating Cables require an 18-SXG-KIT power connection kit for terminating the circuit before connecting to power.

End-of-Circuit Termination: TTS™ Self-Regulating Heating Cables require the ET-4S end cap for terminating the end of the circuit.

Note: T-rating is per the 1996 NEC, Tables 500-3(d), 505-10(b) and as verified by Factory Mutual Research and the Canadian Standards Association.

Certifications/Approvals

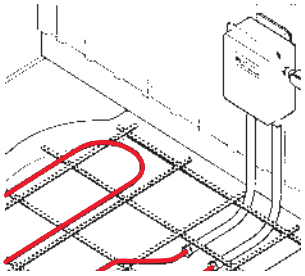
Canadian Standards Association
Ordinary (Non-Classified) Locations
Hazardous (Classified) Locations
Class I, Division 2, Groups A, B, C and D – Class II, Division 2, Groups F and G
Meets or exceeds - IEEE 515, IEEE 515.1 – UL 1588
CSA 130-16

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

Surface Snow and Ice Melting

2 3M Self-Regulating Heating Cables Ordering Information and Materials Guide

Certifications/Approvals



Canadian Standards Association
Ordinary (Non-Classified) Locations
Meets or exceeds - IEEE 515.1 –UL 1588
CSA 130-16

Description

Cut-to-length KSR™ Self-Regulating Heating Cables are designed to provide snow and ice protection in concrete and asphalt applications. Designed and specifically approved for direct burial, KSR™ Self-Regulating Heating Cables withstand harsh installation environments.

Areas of Application

- Building entrance and exit locations
- Ramps and accessibility routes
- Stairs and footpaths
- Loading docks
- Driveways and garage entrances
- Critical access routes

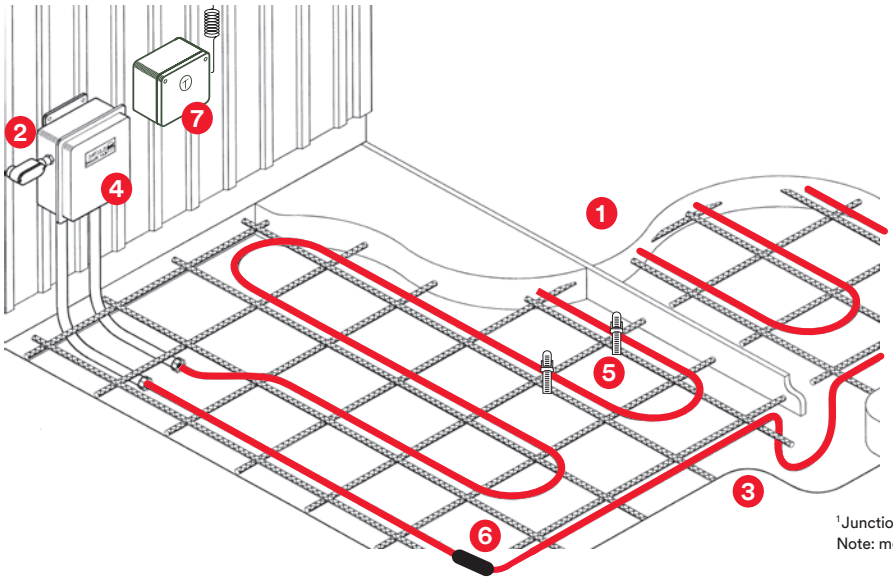
Ratings

Available watt densities	88 w/m @ 0°C (27 w/ft @32°F in concrete)
Supply voltages	208-240 Vac
Minimum installation temperature	-40°C (-40°F)
Minimum bend radius	32 mm (1.25 in)

Basic Components

A KSR™ Self-Regulating Heating Cable Self-Regulating Surface Snow and Ice Melting System will typically include heating cable and components shown in the illustration and KSR™ Self-Regulating Heating Cable ordering information on page 33.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**



[1] Junction box appropriate for the application to be supplied by the installer.
Note: more control options in Alternative Accessories section starting on page 39.

Ref #	Part #	Description
	Cable	
1	KSR-2-OJ	208 - 240 Vac
	Termination kits	
2	KSR-CFK[1]	Power connection/end termination kit w/o junction box
3	KSR-EJK	Expansion joint kit
6	KSR-SK-DB	Splice kit
	Installation accessories	
4	CL	Caution labels (25 per pack)
5	CT8BK50-C	3M™ Weather Resistant Cable Ties (100 per Pack)
	Controls	
7	STC-DS2C	Snow and ice sensor, pole mounted
7	R3C-0120-DP	Weatherproof indoor/outdoor thermostat

Introduction

Snow melting systems have been steadily increasing in popularity during the last few years. This is due in part to the risk management demands placed on building owners and occupants to provide clear and safe access to the facilities even during inclement weather. The intent of this guide is to simplify the design and installation of an electrical snow and ice melting system.

While there are many methods for determining the heating requirements of a snow and ice melting system, the goal is to keep the protected area safe and accessible. The severity of weather in which the system must perform is of primary significance. Therefore, it is important to establish a performance level[1] as the amount of materials and power requirements are directly related to the weather conditions.

Establishing a proper sequence of planning, procurement, installation and performance expectations before each function occurs will ensure successful installation of a heat tracing system. To facilitate this interaction, this guide[2] has been assembled to assist engineers and contractors.

Notes:
1. The examples and descriptions contained in this guide are based on structurally sound, steel-reinforced slab-on-grade concrete 4 to 6 inches thick. The amounts of heat provided in the design tables are for snow and ice melting at the rates indicated. Preventing accumulation from drifting snow or runoff from other sources may require additional heating cable. Should design conditions vary from those shown, please contact a 3M representative for assistance.

2. The formulas, calculations, charts, tables and layout information presented have been researched for accuracy; however, the design and selection of a snow and ice melting system are ultimately the responsibility of the user.

The following five steps outline the selection process for a snow melting system using KSR™ Self-Regulating Heating Cable.

Following each design step is an example that illustrates the process of evaluating, planning and specifying a snow melting system.

While the example shown is small, the process would be the same regardless of the area to be protected. The design examples include flat surfaces, stairs, a ramp, expansion joints in the concrete, and the need to bring power from a specific location.

Step 1: Identify area requiring snow and ice melting.

Determining the area that will require heat tracing is based somewhat on the traffic expected during snow and ice accumulation periods, as well as the layout of the area and TTS™ Self-Regulating Heating Cables location relevant to prevailing winds and susceptibility to drifting.

Then you must identify the existence of electric snow and ice melting heat tracing cable in the concrete curbs, walkways, and paving portions of the project specification. In addition, the project drawings (both electrical and site work) should include reference to the existence of electric heat tracing.

For example, the public/employee entrance to a facility is exposed to weather with only the area directly in front of the entry doors covered by a roof. The building is adjacent to the concrete on two sides with the accessibility ramp (which has a retaining wall) located on the third side. Snow removal can only be accomplished at the curb and parking area, a choice found undesirable for various reasons.

To maintain a clear entrance, the landing, stairs, ramp and approach area will require snow melting. The area in front of the doors will be heat traced to also prevent accumulation from drifting and tracking.

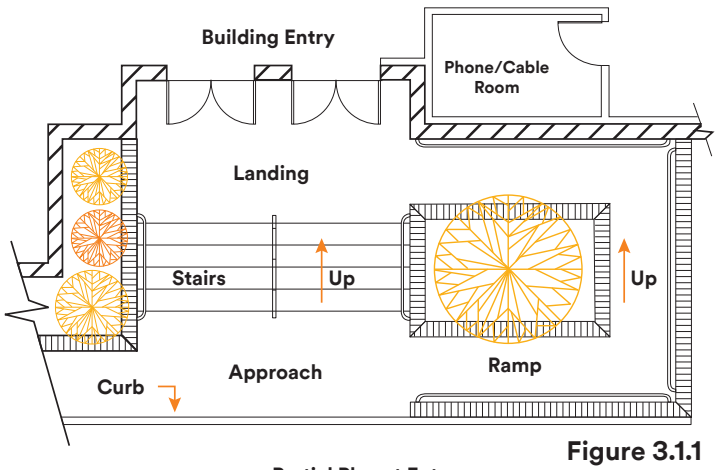
Step 2: Determine level of protection.

Regardless of geographical location or size of area to be protected, the heating requirements for snow melting are affected by four primary factors:

- Rate of snowfall
- Ambient temperature
- Wind velocity
- Humidity

Establishing the level of protection required for a facility requires an understanding of the type of service the area will encounter and under what type of weather conditions the snow and ice melting system must perform.[1] 3M developed **Table 3.2.1** KSR™ Self-Regulating Heating Cable spacing (using information from IEEE Standard 515.1-1995 and ASHRAE) to simplify determining and selecting the level of protection required. An additional table can be found in the Cable Spacing Selection Guide on page 37.

Information from IEEE Standard 515.1-1995 and ASHRAE) to simplify the selection process for determining the level of protection required. An additional table can be found in the Cable Spacing Selection Guide on page 39.



Partial Plan at Entry

Figure 3.1.1

Since the example shown is a public/employee entrance, it would be considered a non-critical area (**Table 3.2.1**) where snow removal is convenient but not essential. Additionally, if the example is located in Vancouver, BC, where the snowfall severity would fall into the "moderate" category of 1 inch per hour, the heating cable should be installed on 9-inch, centre-to-centre spacing.

If the system is to meet ASHRAE requirements, refer to the Cable Spacing Selection Guide on page 39. Based on this data for Vancouver, 9-inch, centre-to-centre spacing of KSR™ Self-Regulating Heating Cable indicates that for approximately 84% of snowfall hours the surface will remain clear.

Applications where snow removal is a convenience but not essential:

- Building entrances
- Loading docks
- Parking garage ramps

Applications where safe access is essential:

- Hospital emergency entrances
- Train loading platforms
- Fire station driveways

Table 3.2.1: KSR™ Self-Regulating Heating Cable Spacing[2]

Snowfall Severity		KSR™ Self-Regulating Heating Cable Spacing	
Category	Rate of snowfall	Non-critical	Critical
Light	½"/hour	12" O.C.	7½" O.C
Moderate	1"/hour	9" O.C.	6" O.C.
Heavy	2"/hour	6" O.C.	5" O.C.

O.C. = on-centre

Notes:
1. Additional heat may be needed if the area will be subject to drifting or moisture run-off from another source. No allowance has been made for back or edge loss. Both back and edge loss will occur to varying degrees on every application. The amount and extent of loss is affected by soil types, frost line depth, shape and size of the area, plus the location of the area as it relates to other structures and wind.

2. Spacing as shown in Table 3.2.1 will provide a completely melted surface for the concrete area under typical snowfall weather conditions: ambient temperatures between -6°C (20°F) and 1°C (34°F) with wind speeds of 5 to 24 km/h (15 mph). Should the ambient temperature fall below -6°C (20°F) during the snowstorm, some snow accumulation could occur but will be melted at the rate of fall.

Step 3: Determine length of cable required and circuit lengths.

Most snow melting applications will utilize a 208, 220, or 240 Vac power supply. To ensure maximum snow melting potential, KSR™ Self-Regulating Heating Cable is for 208/240 Vac. **Table 3.3.1**, Cable Selection, shows the circuit lengths possible with KSR™ Self-Regulating Heating Cable at each voltage. For a specific system, match the branch circuit breaker size to the KSR™ Self-Regulating Heating Cable circuit length based on:

- The maximum circuit length shown in **Table 3.3.1**
- The maximum circuit length required for a given heating cable layout
- The maximum circuit length for a predetermined branch circuit breaker size

Estimating the amount of KSR™ Self-Regulating Heating Cable required, number of circuits needed and the total power requirements can be accomplished with **Formulas 3.1** and **3.2**. These estimates will be useful for coordinating the material and power requirements of the cable.

Dividing the total KSR™ Self-Regulating Heating Cable estimate by the circuit length shown in **Table 3.3.1** will indicate how many circuits will be needed for a given branch circuit breaker size.

Formula 3.1: Estimating Quantity of KSR™ Self-Regulating Heating Cable Required

Total KSR™ Self-Regulating Heating Cable required = area in square feet x (12 ÷ S)
Where: S = KSR™ Self-Regulating Heating Cable spacing in inches

Formula 3.2: Total Heat Output / Operating Load

$$P_1 = L_1 \times I_1 \times E$$

Where:
P_1 = Total heat output (in watts) for system
L_1 = Total installed length of KSR cable
I_1 = Amps per foot multiplier for voltage used
E = Operating voltage

Table 3.3.1: Cable Selection

Catalogue Number	Start-Up Temperature	Operating Voltage	Installation Method	Maximum Circuit Length vs. Breaker Size			
				15 Amp	20 Amp	30 Amp	40 Amp
KSR-2	-18°C (0°F)	208 Vac	Direct burial	80 ft (24 m)	105 ft (32 m)	160 ft (49 m)	210 ft (64 m)
KSR-2	-18°C (0°F)	240 Vac	Direct burial	85 ft (26 m)	110 ft (34 m)	170 ft (52 m)	225 ft (69 m)
KSR-2	-7°C (20°F)	208 Vac	Direct burial	85 ft (26 m)	110 ft (34 m)	165 ft (50 m)	220 ft (67 m)
KSR-2	-7°C (20°F)	240 Vac	Direct burial	90 ft (27 m)	120 ft (37 m)	180 ft (55 m)	225 ft (69 m)

The total operating load of a KSR™ Self-Regulating Heating Cable Snow and Ice Melting System is dependent on the supply voltage and the total footage of cable which will be energized. To determine the total operating load, use the following amps per foot multipliers:

KSR-2 @ 208-240 Vac draws 0.12 amps/foot

By inserting the appropriate values into the following formula, the total load of the snow and ice melting system can be determined.

As the example facility will have 208 Vac, single-phase, four-wire available, KSR-2 cable is selected. To optimize the circuit length potential, the branch circuit breakers will be sized to reflect the layout of the cable (see Step 4 for cable layout).

Using Formula 3.1: Putting the Formula to Work

Total KSR™ Self-Regulating Heating Cable required for area in ft² x (12 ÷ S)

and substituting values for the design example:

Total KSR™ Self-Regulating Heating Cable required = 600 ft² x (12 ÷ 9)

the total footage of cable can be estimated:

Total KSR™ Self-Regulating Heating Cable required = 800 linear feet (plus allowance from Note 2)

Using Formula 3.2:

Pt = Lt x If x E

and substituting values for the design example:

Pt = 840 ft x 0.12 amps/ft x 208 Vac

the total kilowatt demand for the system can be estimated:

Pt = 21 kw

Note: When calculating the amount of KSR™ Self-Regulating Heating Cable required based on the square footage of the area, allowances should be included for making connections within junction boxes and for any expansion joint kits necessary to complete the layout.

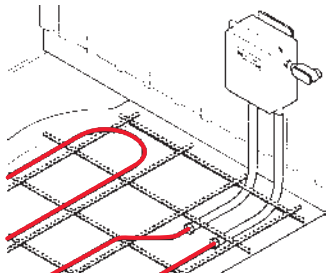
Design step 4: specify locations for power connections/end terminations and layout cable on scaled drawing

Junction boxes: KSR™ Self-Regulating Heating Cable power connection and end termination points must be located inside suitable junction boxes located above the moisture line. Depending on the size of the junction box, several power connections and/or end terminations can be located within the same box.

- Protect heating cable with rigid metallic conduit (one cable per conduit) between junction box and area being heated
- Extend conduit (equipped with bushings on each end) a minimum of 12" into slab

A typical junction box and conduit assembly is shown in **Figure 3.4.1**.

Figure 3.4.1: Junction Box/Conduit

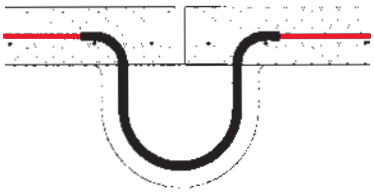


KSR™ Self-Regulating Heating Cable Layout: When the location of the junction boxes for power connections and end terminations has been established, lay out the heating cable.

- Use a scaled drawing or sketch to simplify the process.
- Base layout on centre-to-centre spacing selected in Step 1.
- Do not exceed circuit lengths shown in **Table 3.3.1**.
- Locate cable 2" to 4" below finished concrete surface.

- For standard slab (4" to 6" thick), place KSR™ Self-Regulating Heating Cable directly on top of reinforcing steel.
- Attach to steel with nylon tie wraps on 24" (minimum) intervals.

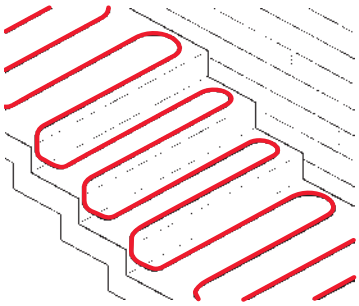
Figure 3.4.2: Expansion Joint Kit Section



Expansion Joints: Unless the slab is of monolithic construction, there will be expansion or construction joints that must be taken into account to prevent damage to the cable (**Figure 3.4.2**).

- Keep expansion joint kit use to a minimum by utilizing proper layout techniques.
- Mark drawings with locations of expansion and construction joints.
- Allow an extra 3' of KSR™ Self-Regulating Heating Cable for each expansion joint kit.

Figure 3.4.3: Detail at Steps



Stair Steps: Because of the rugged yet flexible nature of KSR™ Self-Regulating Heating Cable and the centre-to-centre spacing typical to most applications, difficult areas such as steps can be easily accommodated.

- Tie KSR™ Self-Regulating Heating Cable to reinforcing steel in same manner as open areas.
- Serpentine across each tread; route up riser to next tread.
- Concrete can be placed in single pour.

Example: Heat Tracing for Building Entry

Determine a suitable location for the power connection and end termination junction boxes. Considerations should be given to aesthetics, obstructions, routing of power supply wiring and the space required for the junction boxes.

Several locations could be utilized in the example shown. These include either side of the entrance doors, the building wall where it meets the planter or the wall along the accessibility ramp.

The area located to the right of the entrance doors was ultimately selected because the room located behind it would make an excellent location for the snow melting power distribution and control panel.

When finished, the system layout will be as shown at right in **Figure 3.4.5**. Note how the heating cable has been routed to minimize the number of crossings at expansion joints. Additionally, all power connections and end terminations originate from the same area. This minimizes the power feed requirements and provides a clean installation. The layout shows that three circuits are required on 240 Vac to cover the area, based on the spacing selected. Since each of the three circuits is less than the 40 amp branch circuit breaker limit of 225 feet (refer to **Table 3.3.1**), power distribution can be accomplished through three 40 amp breakers with 30 mA ground-fault protection.

Figure 3.4.4

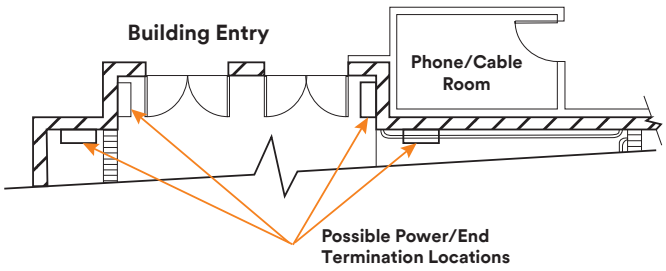
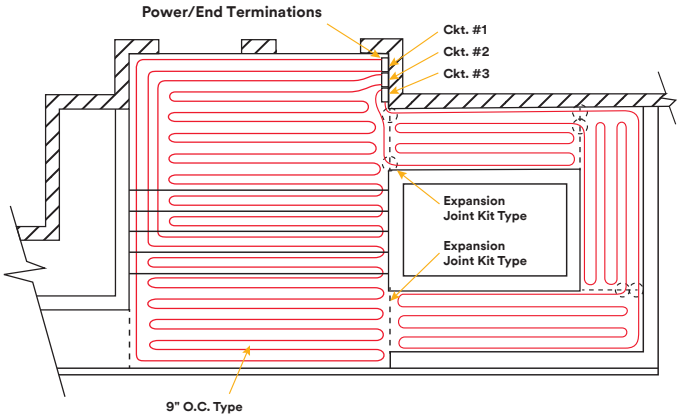


Figure 3.4.5



Step 5: Establish control method needed to operate the system.

Energizing the Heating Cable

All snow melting systems should be controlled to turn the heating cable on and off as conditions warrant. There are three basic means to activate a snow melting system:

A. Manual

- On/off switch — simple to install and economical to purchase; requires diligence on the part of the operator.

B. Automatic

- Ambient sensing control — turns system on and off based on ambient temperature. Heating cable will frequently be energized during non required times.
- Automatic control — turns system on when precipitation is detected and temperatures are in the range where snow or freezing rain is likely.

Some applications, such as truck scales and loading zones, are subject to freezing water or slush accumulation even though no precipitation is falling. To properly deal with these conditions, a custom-designed control system is typically required and the designer should contact 3M for assistance at **3Menergysolutions@mmm.com**.

Example: Because the facility will be occupied during normal business hours, the system is to be controlled automatically. To accomplish this, an STC-DS-2C snow and ice sensor will be utilized.

A power distribution and contactor panel would consist of a main three-pole breaker, a three-pole contactor and three 40 amp branch circuit breakers equipped with 30 mA ground-fault protection. The panel would also be equipped with a hands-off/auto switch plus lights to indicate system status.

Because the panel will be located indoors, a NEMA 12 enclosure is suitable for the panel. If the panel was to be installed outside, a NEMA 4 or 4X enclosure would be required.

Providing power distribution and contactors: When a snow melting system requires four or more heat tracing circuits, it is recommended that a dedicated power distribution and contactor panel be utilized. By keeping the snow melting circuit breakers in a dedicated panel, several design and operation advantages will occur:

- The panel can utilize a main circuit breaker and contactor, which permits a complete shutdown of the system for out-of-season times as well as routine maintenance checks.
- A dedicated snow melting panel will reduce the potential of non-authorized access.
- A dedicated snow melting panel can be located close to the point of use and reduce power feed wiring and conduit necessary to energize the system.
- In critical snow melting applications, the panel can be equipped with a monitor and alarm feature that will verify the integrity of the circuit and the status of the ground-fault branch circuit breakers.

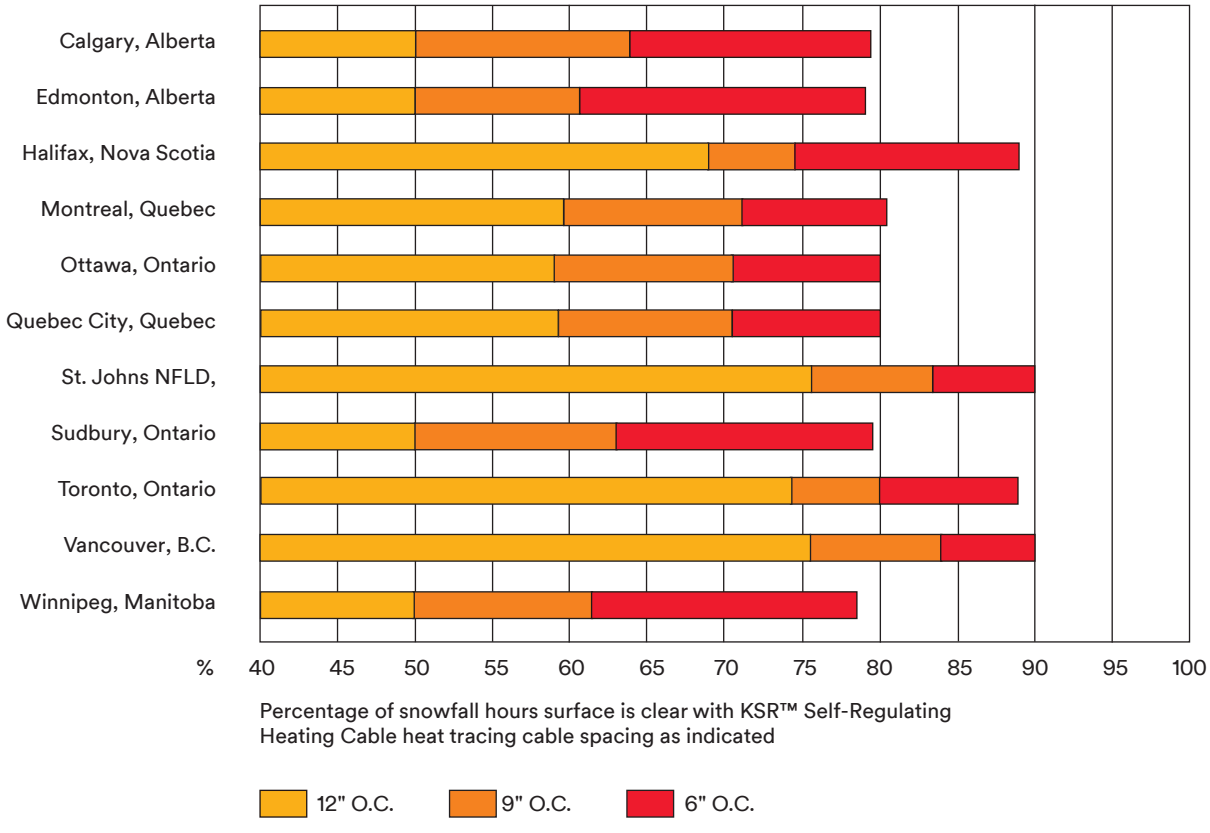
Cable Spacing Selection Guide

As an alternate to the KSR™ Self-Regulating Heating Cable spacing selection chart shown in Step 2 (page 34-35), a snow and ice melting system can be designed using the information presented in Chapter 45 of the ASHRAE Applications Handbook. In their tutorial on snow and ice melting, ASHRAE compiled a list of 33 Canadian cities with weather data for each. Using this information, 3M developed the table below to show the effect of various power (heat) outputs.

The values presented in Table 1, Data for Determining Operating Characteristic of Snow Melting Systems (ASHRAE 1991 Applications Handbook, Chapter 45), and detailed below in the **Cable Spacing Selection Guide chart,** show the calculated percentage of snowfall hours that a surface will remain clear of snow when a predetermined level of heating is installed. This method is useful when comparing what additional benefit, in terms of keeping an area clear, is obtained when the watts/ft² are increased.

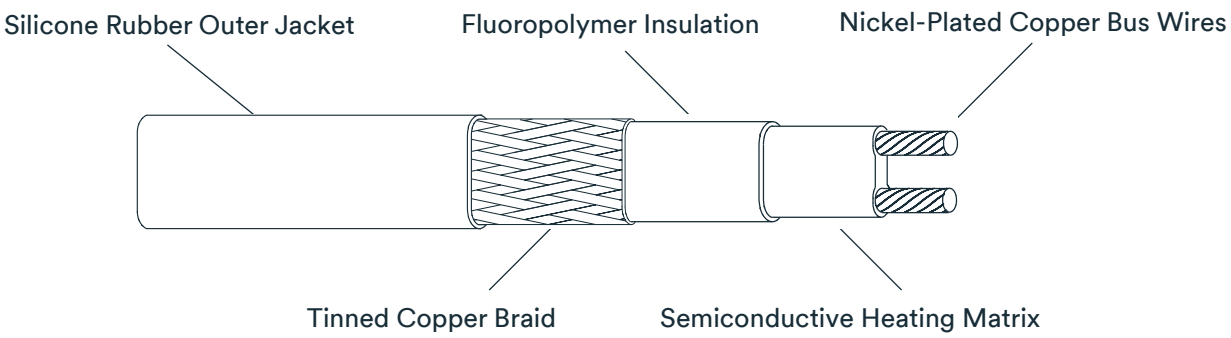
While it is necessary to have weather data to establish values for temperature, wind, humidity and snowfall, ASHRAE cautions that a snow melting system should not be designed based on the annual averages or worst weather conditions encountered. Doing so will result in a system unnecessarily over-designed for a majority of applications.

Cable Spacing Selection Guide



Percentage of snowfall hours surface is clear with KSR™ Self-Regulating Heating Cable heat tracing cable spacing as indicated

Construction



Ratings

Bus wire	16 Awg nickel-plated copper
Heating core	Semiconductive heating matrix
Primary dielectric insulation	High-performance fluoropolymer
Metallic braid	Tinned copper
Outer jacket	Silicone rubber
Minimum bend radius	1.25 in (32 mm)
Supply voltage	208-240 Vac
Circuit protection	30 mA ground-fault protection required

Cable Selection

Catalogue Number	Start-Up Temperature	Operating Voltage	Installation Method	Maximum Circuit Length vs. Breaker Size			
				15 Amp	20 Amp	30 Amp	40 Amp
KSR-2	-18°C (0°F)	208 Vac	Direct burial	80 ft (24 m)	105 ft (32 m)	160 ft (49 m)	210 ft (64 m)
KSR-2	-18°C (0°F)	240 Vac	Direct burial	85 ft (26 m)	110 ft (34 m)	170 ft (52 m)	225 ft (69 m)
KSR-2	-7°C (20°F)	208 Vac	Direct burial	85 ft (26 m)	110 ft (34 m)	165 ft (50 m)	220 ft (67 m)
KSR-2	-7°C (20°F)	240 Vac	Direct burial	90 ft (27 m)	120 ft (37 m)	180 ft (55 m)	225 ft (69 m)

Certifications/approvals

Canadian Standards Association

LISTED

Note: Consult your local or applicable electrical code regarding ground-fault protection.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

3 Alternative Accessories

Power Connection, Splice, and End-Termination Kits

Metallic Power Connection Kit with Junction Box, ECA-1-SR-SP

Designed for connecting one or two heating cables to power or for splicing two cables together. The ECA-1-SR KIT components include
- NEMA 7 junction box
- Pipe-mounted expediter
- 2 stainless steel pipe attachment bands
- Heater cable grommet
- 2 power connection boots (TBX-3L)
- RTV adhesive
- Wire fasteners and grounding splice lug

Metallic T-Splice Kit with Junction Box, ECT-2-SR

Designed for connecting two heating cables to power or for splicing three cables together. The ECT-2-SR KIT components include
- NEMA 7 junction box
- Pipe-mounted expediter
- Third-cable entry assembly
- 2 stainless steel pipe attachment bands
- Heater cable grommets
- 3 power connection boots (TBX-3L)
- RTV adhesive
- Wire fasteners and grounding splice lug

3M™ Non-Metallic Power Connection Kit, PCA-1-SR

Designed for connecting up to three heating cables to power. The PCA-1-SR may also be used as an in-line or T-splice connection kit. The PCA-1-SR kit components include
- NEMA 4X junction box
- Pipe-mounted expediter
- 2 stainless steel pipe attachment bands
- Heater cable grommet
- 3 power connection boots (TBX-3L)
- RTV adhesive
- Ground wire extension lead with lug
- Wire fasteners

3M™ Non-Metallic T-Splice Kit with Splice Cover, PCS-1-SR

Re-enterable in-line or T-splice kit is designed to fabricate outside-the-insulation splices of TTS™ Self-Regulating Heat Tracing Cables. The PCS-1-SR kit components include
- NEMA 4X pipe-mounted expediter with splice cover
- 2 stainless steel pipe attachment bands
- Heater cable grommet
- 3 power connection boots (TBX-3L)
- RTV adhesive
- Wire fasteners and grounding splice lug

Power Connection, Splice, and End-Termination Kits

Non-Metallic Power Connection Kit with Junction Box, Dp-Kit

Designed to fabricate power connections, in-line/T-splice connections or for making end terminations. Electrical connections are made in terminal blocks utilizing nickel-plated copper terminals to ensure corrosion-free electrical integrity. (PETK kit required, order separately.)

Power Connection Gland Kit w/o Junction Box, 18-SXG-KIT

Non-hazardous power connection kit includes rubber boot, RTV adhesive, grommet and gland connector. Junction box not included.

End-Of-Circuit Light Kit with Junction Box, De-B

Designed to provide visual indication of an energized heating circuit. The DE-B utilizes a high-intensity green LED assembly for superior day or night visibility. Type 4X pipe-mounted fitting with locking splice cover, stainless steel pipe attachment band for piping 10” or less. (SCTK termination kit required, order separately.)

3M™ End Termination Kit, ET-6C

End termination kits are designed to properly terminate the end (away from power) of an SX heat tracing circuit. Each kit includes two rubber end caps plus RTV adhesive.

3M™ End Termination Kit, ET-4S

End termination kits are specifically designed for roof and gutter applications. Each kit contains one UV-resistant heat shrink end cap

Power and End termination Kit for DP Kit, PETK-1D

Power and End Termination Kit, PETK-1D, is designed for use with TTS™ Heating Cable. This kit includes one power connection boot, one end cap, RTV sealant, and one caution label.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

End Boot for DE-B, SCTK-1D

Splice connection/termination kit includes power boots, wire spring connectors, RTV adhesive.

3M™ T-Splice Kit, HS-TBSK

3M™ Heat Shrink T-Splice kits designed to join three heater cables together. Kit components include one heat shrink tube, one heat shrink tee, two silicone tubes, two parallel connectors, one butt connector, one tie wrap, and one caution label. Use in ordinary, non-hazardous locations.

3M™ In-Line Splice Kit, HS-PBSK

Heat shrink inline splice kit designed to join two heater cables together. Kit components include a heat shrink sleeve, two silicone sleeves, two butt connectors, and a caution label. Used in ordinary, non-hazardous locations.

KRS™ Power Connection and End Termination Kit w/o Junction Box, KSR-CFK

Circuit fabrication kit is designed to fabricate a KSR™ Self-Regulating Heating Cable circuit with one power connection boot and one end cap. Both power and end terminations must be made in UL-listed or CSA-Approved junction boxes.

3M™ Cable Splice, KSR™, SK-DB

This cable splice kit is designed to fabricate an in-line splice between two pieces of overjacketed cable. The kit allows for field fabrication of heating cable should the cable become damaged during installation. Easy-to-use kit includes splice lugs, self-vulcanizing tape, and heat shrink tubing.

Snow/Ice Sensor

Snow and Ice Sensor/Controller, STC-DS-8

Gutter snow and ice sensor/controller that can be used in ordinary, non-hazardous locations. This unit includes remote sensor capabilities with a 10-foot lead wire, which allows sensor placement directly in gutters or downspouts. Controller includes an adjustable temperature trigger set point from 1°C to 7°C (34°F to 44°F) with manual on/off, automatic and standby switching functions. The STC-DS-8 operates on a 120 Vac or 208-240 Vac power source, providing a single 30-amp normally open load contact set rated to 277 Vac. Contactor may be required. Not included in kit.

Snow/Ice Sensor

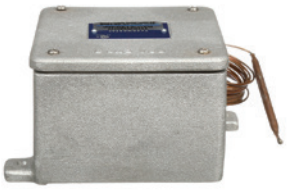
Snow and Ice Sensor/Controller Pole Mount, STC-DS-2C

Stand-alone snow and ice sensor/controller that can be used in ordinary, non-hazardous locations. This compact unit provides an adjustable temperature trigger set point from 1°C to 7°C (34°F to 44°F) with manual on/off, automatic and standby switching functions. The STC-DS-2C operates on a 120 Vac or 208-240 Vac power source, providing a single 30-amp normally open load contact set rated to 277 Vac. Contactor may be required. Not included in kit.

Indoor

Indoor Thermostat, R1-050-DP

This cost-effective thermostat, designed for use in indoor/protected locations, utilizes a painted steel NEMA 1 enclosure to house the thermostat switch while permitting temperature adjustments without removing any cover.



Indoor/Outdoor

Weatherproof Indoor/Outdoor Thermostat, R3C-0120-DP

A gasketed cast aluminum enclosure provides weatherproof protection to the thermostat switch and internal setpoint dial.

Application: electric heat tracing control

The R1 and R3, equipped with double-pole switches, are designed for use as adjustable control thermostats for freeze protection and temperature maintenance applications requiring pipewall or tankwall sensing.

The R1 thermostat is approved for indoor/protected use in ordinary (non-classified) locations. The R3 is approved for indoor/outdoor use in ordinary (non-classified) locations.

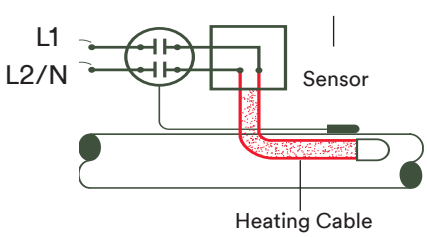
Voltage rating	240 Vac
Switch rating	25 amps
Switch type	DPST
Electrical connection	
R1[1]	Screw terminals on switch
R3[2]	12 AWG leads
Adjustable control range	
R1	0°C to 50°C (32°F to 122°F)
R3	0°C to 120°C (32°F to 248°F)
Maximum control differential	
R1	1.8°C (32°F)
R3	4.3°C (7.7°F)
Setpoint repeatability	
R1	±0.4°C (0.7°F)
R3	±1.1°C (2.0°F)
Maximum bulb exposure temperature	
R1	68°C (154°F)
R3	200°C (392°F)
Bulb dimensions	
R1	6 × 300 mm (1/4" x 12")
R3	6 × 140 mm (1/4" x 5-1/2")
Bulb material	Copper
Capillary length	300 cm (10')
Capillary material	Copper

Notes:
1. The R1 includes two ½" or ¾" conduit knockouts with an internal grounding terminal.
2. The R3 includes two ½" NPT conduit hubs with an internal grounding terminal.

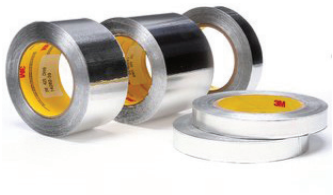
R1-050-DP

R3C-0120-DP

Typical wiring diagram



Installation Accessories Designed to Complement 3M Heating Cables



3M™ Aluminum Foil Tape, AL-20L

Aluminum tape for securing cable in the bottom of a gutter or on a non-metallic pipe. This tape is designed to hold cable in place and prevent movement. Allow one foot of tape for each foot of heating cable. Tape is 2 in (51 mm) wide x 150 in (55 m) long.

3M™ Fibreglass Cloth Tape, B-Tape

Fibreglass cloth tape for circumferential banding cable to piping every 12 in (30 cm) or as required by code or specification. Tape is 1/2 in (13 mm) wide x 180 in (55 m) long.

- Max. exposure temp 150°C (300°F)
- Min. installation temp 0°C (32°F)
- Min. operating temp -40°C (-40°F)

3M™ Caution Labels, Bilingual

These caution labels are vinyl-based peel and stick with black letters on a yellow background and are intended for direct exposure to harsh environments. In accordance with the CEC (62-316), electrically heated pipelines and vessels are to be suitably marked.

Caution labels should be placed at 3 m (10') intervals or as required by code or specification.
25 labels per pack.

3M™ Expansion Joint Kit, KSR™-EJK

Expansion joint kit is designed to allow KSR™ Self-Regulating Heating Cable Self-Regulating Heat Tracing Cables to cross a concrete expansion or construction joint. When installed, the kit will allow normal expansion and contraction of the substrate without straining or damaging the heating circuit. Easy-to-use kit includes reinforced flexible sleeve and RTV sealant.

To use the 3M Heat Trace Bill of Materials Tool, visit **3M.ca/HeatTrace**

Cable Roof Fastener, RG-CRF

Cable roof fastener is designed to hold heating cable in place and is suitable for most types of roof surfaces. The fastener can be secured to the roof with screws (a waterproof cover material is recommended) or adhesive. (Screws, waterproofing and adhesive are not included.) (25/bag)

Cable Mounting Clip, RG-CMC

Cable mounting clip is designed to hold heating cable in place on standing seam roof surfaces. The P-shaped fastener can be secured to the roof with screws using a waterproof cover material. (Screws and waterproofing are not included.) (100/bag)

Downspout Cable Hanger, RG-DCH

Downspout cable hanger is designed to secure the cable when entering long downspouts, to prevent abrasion of the cable by the edge of the gutter/downspout. Hanger is to be secured to the building fascia in a similar manner to the gutters.

3M™ Performance Plus™ Wire Connectors (B/G+, O/B+, R/Y+, T/R+ and T/Y+)

3M™ Performance Plus™ Wire Connectors are used to connect the conductor ends inside metallic or non-metallic junction boxes. They combine a very small shell with an increased wire range. The spring bites wire quickly with less effort, and the small shell fits easily into tight spaces. 3M™ Performance Plus™ Wire Connectors can withstand temperatures up to 105°C (221°F).

Please note:
The diagrams and instructions outlined in this guide are for illustration purposes only. They are not necessarily to scale and do not necessarily represent exact real-world heat tracing systems. In addition, they are not meant or implied to be a replacement for the services of a licensed professional. Any use of 3M Self-Regulating Heating Cables must be in accordance with all local regulations and/or building codes. Please consult your local authority.

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