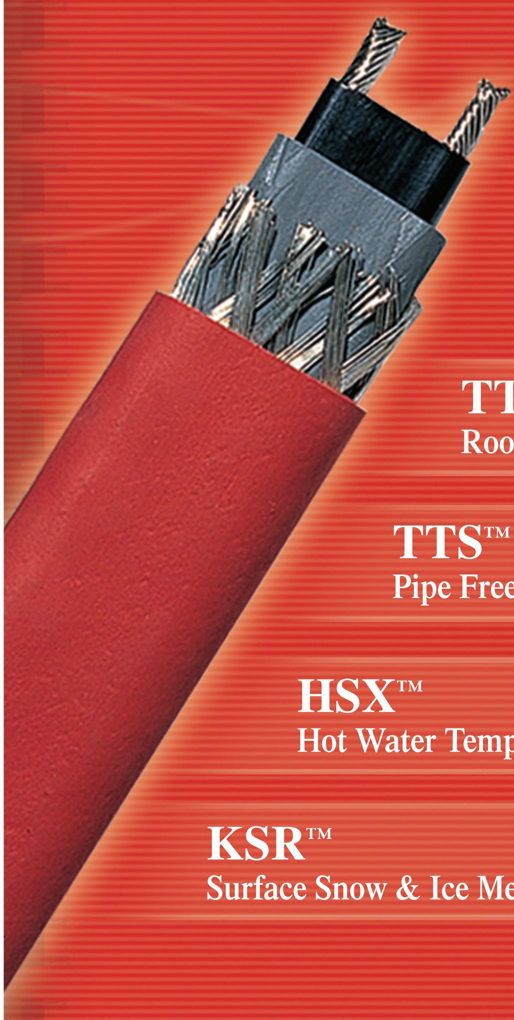
Self Regulating Heat Tracing Cables

For Industrial, Commercial & Residential Buildings



TTS™
Roof & Gutter Snow & Ice Melting Cable

TTS™
Pipe Freeze Protection Cable

HSX™
Hot Water Temperature Maintenance Cable

KSR™
Surface Snow & Ice Melting Cable

Contents

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3M™ Self-Regulating Heating Cables Ordering Information & Design Guides:

Data Sheets:

3M Innovation

3M™ Self Regulating Heating Cables

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 Canada exclusive rights within Canada to sell and market three distince products: TTS, KSR, and HSX heat tracing cable with accessories.

Properties:

The Heat Tracing Cable consists 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.

Self-regulating Heat Tracing 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
- No overheating
- Can overlap heating cable
- Economical, simple installation
- Safe assembly due to simple handling
- Low Investment
- Reliable, long term performance

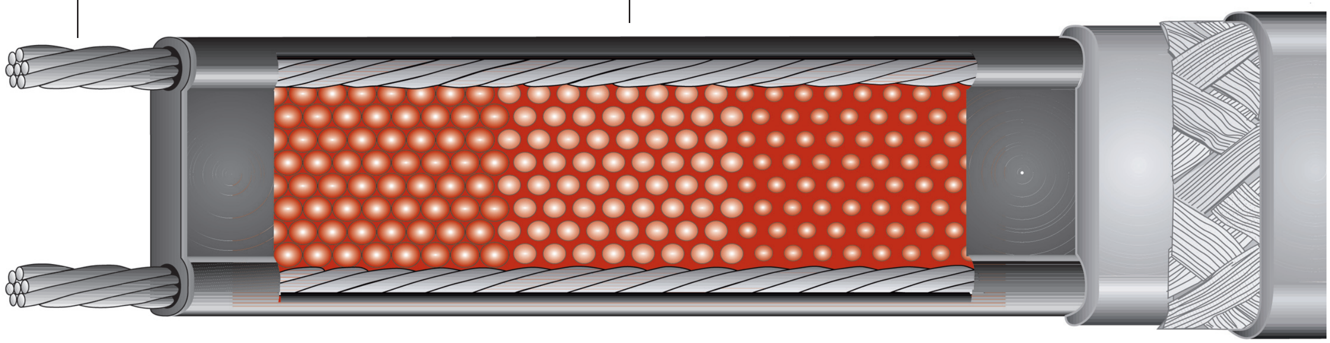
3M™ Self Regulating Heating Cables

Construction:

3M's self-regulating Heat Tracing Cables consist of a conductive-polymer heating matrix between two parallel bus conductors. Therefore the cable can be cut to any desired length without changing its properties.

The heating matrix provides an infinite number of parallel resistances. This provides the ability of the heating cable to respond to temperature conditions at any point down its length and adjust its heat output.

Copper grounding braid serves as a safety conductor and provides a continuous ground path.



The outer protective jacket protects against corrosion, chemicals, and adverse environmental conditions.

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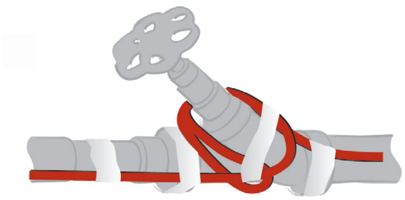
Self-Regulating Heating Cable for Pipe Freeze Protection



Certifications / Approvals:

Canadian Standards Association
Ordinary 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 130.1, CSA 130.2, CSA 138

Description:

TTS cut-to-length self-regulating heating cables are designed to 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 heater cable.

Please refer to the TTS design guide for Pipe Freeze Protection on page 12 of this catalogue for full details.

TTS 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 pipe freeze protection add thermal insulation for a complete installation

Ratings:

Available watt densities...16, 26, 33 w/m @ 10° C
(5, 8, 10 w/ft @50° F)
Supply Voltages...110-120 or 208-277 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)

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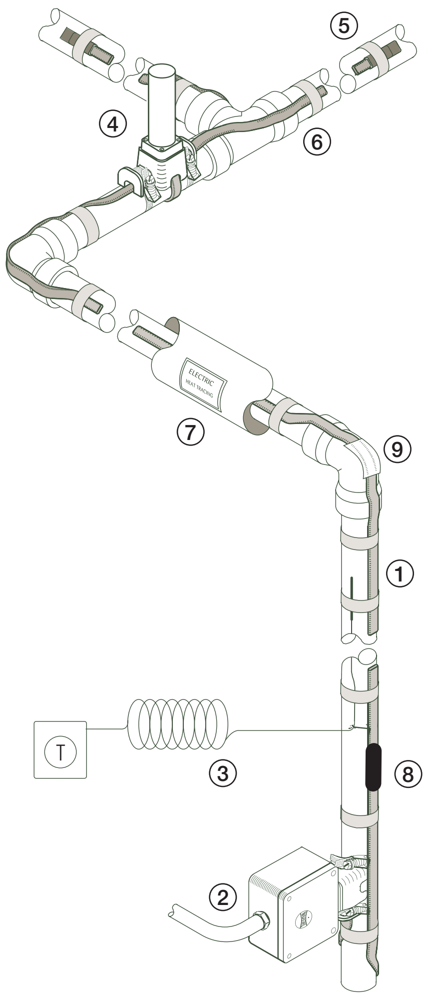
Self-Regulating Heating Cable for Pipe Freeze Protection

Basic Components:

A TTS freeze protection heat tracing system will typically include heating cable and components shown in the illustration and TTS ordering information table below. Please refer to page 54 for detailed accessory information.



Ref #	Part Number	Description
	Cable	
1	TTS-5-1-OJ	5 W/FT @ 120V (500 / 1000 foot spools)
1	TTS-8-1-OJ	8 W/FT @ 120V (500 / 1000 foot spools)
1	TTS-10-1-OJ	10 W/FT @ 120V (500 / 1000 foot spools)
1	TTS-5-2-OJ	5 W/FT @ 240V (500 / 1000 foot spools)
1	TTS-8-2-OJ	8 W/FT @ 240V (500 / 1000 foot spools)
1	TTS-10-2-OJ	10 W/FT @ 240V (500 / 1000 foot spools)
	Termination Kits	
2	18-SXG-KIT[1]	Power Connection Gland Kit w/o Junction Box
2	ECA-1-SR-SP	Metallic Power Connection Kit (Ordinary & Div 2 Approved) with Junction Box
4	ECT-2-SR	Metallic T-Splice Kit (Ordinary & Div 2 Approved) with Junction Box
2	PCA-1-SR	Non-metallic Power Connection Kit (Ordinary & Div 2 Approved) with Junction Box
4	PCS-1-SR	Non-metallic T-Splice Kit (Ordinary & Div 2 Approved) with Splice Cover
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 & Div 2 Approved)
	Installation Accessories	
6	BTape	Binding / Attachment Tape (1/2" X 60 yds)
7	CL	Caution Labels (25 Per Pack)
9	AL-20P	Aluminum Tape (2" X 150') for non-metallic pipe
	Controls	
3	R1-050-DP	Indoor Thermostat
3	R3C-0120-DP	Weatherproof Indoor / Outdoor Thermostat

1. Junction box supplied by installer

TTS™
Self-Regulating Heating Cable for Pipe Freeze Protection

Design Guide Contents

TTS™
Self-Regulating Heating Cable for Pipe Freeze Protection

Safety Comes First . . .

The safety and performance of electric heat tracing depends on how the cable was selected, installed and eventually maintained. Improper handling, installation or maintenance of the cable could 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.

Introduction:

While an insulated pipe can withstand cold temperatures longer than an uninsulated pipe, the contents of the pipe will cool to the temperature of the surrounding environment. When the ambient temperature is below freezing, the results can be both costly and inconvenient. TTS self-regulating heating cable is designed to 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. The information contained in this design guide will take the reader through a step-by-step procedure to make proper heating cable selections based on:

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

After following the prescribed steps in this design guide, the reader will be able to design, specify or establish a bill of materials for a freeze protection heat tracing system. If higher maintain temperatures are required (such as for fuel oil or caustic soda lines), contact 3M for additional information.

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Self-Regulating Heating Cable for Pipe Freeze Protection

Basis for a Good Design . . .

The generally accepted maintenance temperature for freeze protection is 5° C (40° F.) This design 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 Design Parameters

Collect information relative to the following design parameters:

Application Information . . .

- Pipe sizes or tubing diameters
- Pipe lengths
- Pipe material (metallic or nonmetallic)
- 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 ambients

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 design guide are based on fiberglass 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 your 3M representative for a design selection chart supplement that corresponds with the insulation material.

Supply Voltage . . .

TTS self-regulating cables are designed in two voltage groups: 110-120 Vac and 208-240 Vac. Determine what voltage(s) are available at a facility for use with heat tracing.

Step 2: Select the Proper TTS Heating Cable

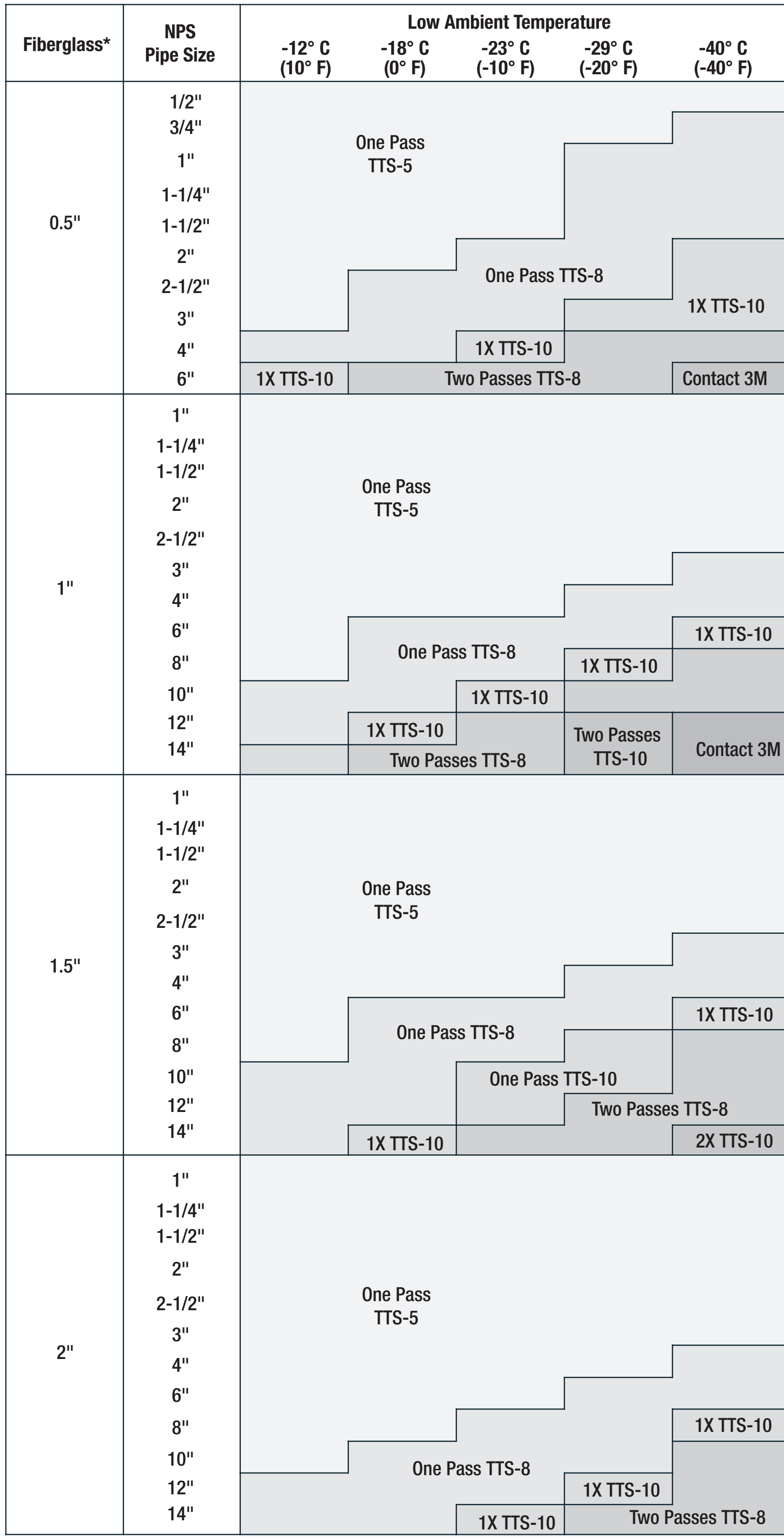
Using the pipe diameter, insulation thickness and minimum expected ambient, find the recommended heating cable using Design Selection Chart 1.2.1 Metallic Piping, at right, or Design Selection Chart 1.2.2 Non-metallic Piping on page 10. If the pipe size or insulation information does not appear, contact your 3M representative.

1. Select the vertical column headed by a low ambient temperature which 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 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" 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" diameter pipe if the pipe to be insulated is 3/4" diameter.
6. For pipe sizes larger than listed or for maintain temperatures other than 5° C (40° F), contact your local 3M representative.

Note . . . Heat loss calculations are based on IEEE Std 515-1997, Equation A.1, with the following provisions:

- Piping insulated with glass fiber in accordance with ASTM Std C547.
- Pipes located outdoors in the noted ambient with a 25 mph wind.
- A 10% safety factor has been included.

Design Selection Chart 1.2.1 Metallic Piping



* Charts may also be used for designs with Polyisocyanuate or mineral wool insulation of the same thickness.

Additional Considerations for Nonmetallic Piping . . . For freeze protecting nonmetallic pipes, TTS is to be installed with a continuous covering of AL-20P foil tape. The data in Design Selection Chart 1.2.2 is based on this installation method.

Heat loss characteristics are similar to metal pipes, but the TTS self-regulating cable output is lower because of the insulating properties of the pipewall material. Design Selection Chart 1.2.2 reflects these values.

Example . . . A 4" diameter metallic pipe that will be insulated with 1" fiberglass 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-5 as the proper cable to use.

Design Selection Chart 1.2.2 Nonmetallic Piping

Fiberglass*	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"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
0.5"	3/4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
0.5"	1"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
0.5"	1-1/4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
0.5"	1-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
0.5"	2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8
0.5"	2-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8
0.5"	3"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8	1X TTS-10
0.5"	4"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	1X TTS-10	Two Passes TTS-8
0.5"	6"	One Pass TTS-8	1X TTS-10	Two Passes TTS-8	Two Passes TTS-8	Two Passes TTS-8
1"	1"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1"	1-1/4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1"	1-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1"	2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1"	2-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
1"	3"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
1"	4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8
1"	6"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8	1X TTS-10
1"	8"	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8	1X TTS-10	Two Passes TTS-8
1"	10"	One Pass TTS-8	One Pass TTS-8	1X TTS-10	Two Passes TTS-8	Two Passes TTS-8
1"	12"	One Pass TTS-8	1X TTS-10	Two Passes TTS-8	Two Passes TTS-8	Two Passes TTS-10
1"	14"	One Pass TTS-8	1X TTS-10	Two Passes TTS-8	Two Passes TTS-8	Two Passes TTS-10
1.5"	1"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1.5"	1-1/4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1.5"	1-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1.5"	2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1.5"	2-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1.5"	3"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
1.5"	4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
1.5"	6"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8
1.5"	8"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	1X TTS-10
1.5"	10"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8	Two Passes TTS-8
1.5"	12"	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8	1X TTS-10	Two Passes TTS-8
1.5"	14"	One Pass TTS-8	One Pass TTS-8	1X TTS-10	Two Passes TTS-8	Two Passes TTS-8
2"	1"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	1-1/4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	1-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	2-1/2"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	3"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	4"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5
2"	6"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8
2"	8"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8
2"	10"	One Pass TTS-5	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-10
2"	12"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	One Pass TTS-8	One Pass TTS-10
2"	14"	One Pass TTS-5	One Pass TTS-8	One Pass TTS-8	1X TTS-10	2 X TTS-8

* Charts may also be used for designs with Polyisocyanuate or mineral wool insulation of the same thickness.

Step 3: Determine TTS Circuit Lengths

Heat tracing circuit lengths are based on several conditions which 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 1.3.1A

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

- TTS intended for use on 110-120 Vac will have a catalog number followed by a 1; i.e., TTS-X-1.
- TTS intended for use on 208-240 Vac will have a catalog number followed by a 2; i.e., TTS-X-2.

In Step 2 the proper TTS cable (5, 8 or 10) was selected from Design Selection Chart 1.2.1 or 1.2.2. Using voltage and cable selections plus 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 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.

Table 1.3.1 Valve and Pump Allowances

Pipe Size	Valve Allowance Screwed	Valve Allowance Flanged	Valve Allowance Welded	Pump Allowance Screwed	Pump Allowance 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 cable for each heating circuit
Splices	2 feet of TTS cable for each splice kit / 3 feet of TTS 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 and additional foot of heating cable for each support

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Example . . . Continuing with the first example from page 25, 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:

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

Step 4: Choose TTS Installation Accessories

A TTS self-regulating freeze protection heat tracing system will typically include the following components:

1. TTS self-regulating heating cable (refer to Design Selection Charts 1.2.1 and 1.2.2 for proper cable).
2. Power connection / circuit fabrication kits.
3. Thermostats.
4. T Splice kits.
5. End termination kit
6. BTape attachment tape (1/2" X 60 yds) 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 14 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.

Notes . . .
1. All heat-traced lines must be thermally insulated.
2. The 18SXG-Kit does not include electrical junction boxes.
3. 30 mA ground-fault equipment protection is to be used for all heat tracing circuits.

Table 1.3.2 110-120 Vac

120 Vac Service Voltage		Max. Circuit Length vs. Breaker Size Ft(m)			
Catalog Number	Start-Up Temp. ° C (° F)	15A	20A	30A	40A
TTS 5-1	10 (50)	190 (58)	270 (82)	275 (84)	275 (84)
	-18 (0)	125 (38)	170 (52)	275 (84)	275 (84)
	-29 (-20)	105 (32)	145 (44)	240 (73)	275 (84)
	-40 (-40)	95 (29)	130 (40)	210 (64)	275 (84)
TTS 8-1	10 (50)	150 (46)	205 (63)	220 (67)	220 (67)
	-18 (0)	100 (30)	140 (43)	220 (67)	220 (67)
	-29 (-20)	90 (27)	125 (38)	200 (61)	220 (67)
	-40 (-40)	85 (26)	115 (35)	180 (55)	220 (67)
TTS 10-1	10 (50)	115 (35)	160 (49)	195 (59)	195 (59)
	-18 (0)	80 (24)	115 (35)	180 (55)	195 (59)
	-29 (-20)	75 (23)	100 (30)	160 (49)	195 (59)
	-40 (-40)	70 (21)	95 (29)	145 (44)	195 (59)

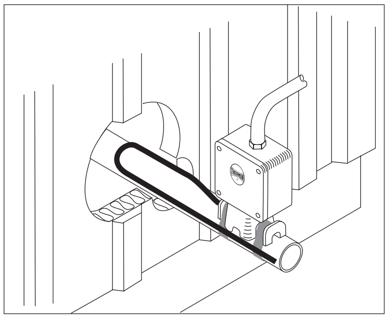
Table 1.3.3 208-240 Vac

240 Vac Service Voltage		Max. Circuit Length vs. Breaker Size Ft(m)			
Catalog Number	Start-Up Temp. ° C (° F)	15A	20A	30A	40A
TTS 5-2	10 (50)	380 (116)	530 (162)	550 (168)	550 (168)
	-18 (0)	245 (75)	335 (102)	550 (168)	550 (168)
	-29 (-20)	215 (66)	295 (90)	475 (145)	550 (168)
	-40 (-40)	195 (59)	265 (81)	420 (128)	550 (168)
TTS 8-2	10 (50)	295 (90)	410 (125)	435 (133)	435 (133)
	-18 (0)	205 (63)	280 (85)	435 (133)	435 (133)
	-29 (-20)	185 (56)	250 (76)	400 (122)	435 (133)
	-40 (-40)	165 (50)	225 (69)	360 (110)	435 (133)
TTS 10-2	10 (50)	230 (70)	320 (98)	390 (119)	390 (119)
	-18 (0)	165 (50)	225 (69)	360 (110)	390 (119)
	-29 (-20)	150 (46)	205 (63)	325 (99)	390 (119)
	-40 (-40)	140 (43)	190 (58)	295 (90)	390 (119)

Design Tips . . .

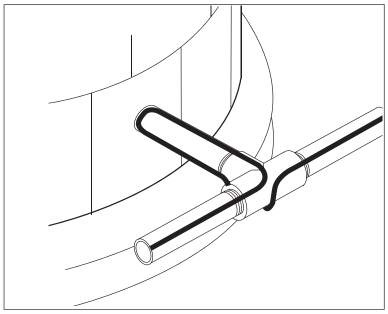
To ensure a properly operating heat tracing system and avoid the common mistakes made by first-time users, the following tips have been compiled:

1. When a heat-traced pipe enters a facility, the heating cable should extend into the building approximately 305 mm (12") to ensure the pipe temperature is maintained. This prevents temperature drops due to air gaps or compression of the thermal insulation.

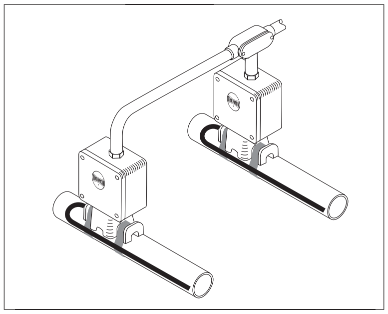


2. A similar situation exists when an above ground pipe goes underground. While the pipe may eventually travel below the frost line and therefore be protected from freezing, the distance between the surface (grade) and the frost line must be protected. This can be accomplished by creating a loop with 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. Where 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. All of the heating cable power connection points should 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.



TTS™
Self-Regulating Heating Cable for Pipe Freeze Protection

Thermostatic Control . . .

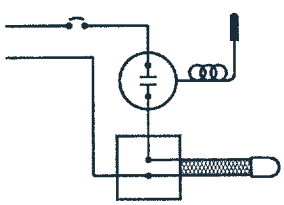
While the five steps in the design and selection process provide the detailed information required to design, select and/or specify a TTS self-regulating heat tracing system, some type of control will typically be needed. The type of control and level of sophistication needed will depend entirely on 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 set point, 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 contactor 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 nonflowing) of the heated pipe needs no consideration.



Pipewall Sensing . . . While a self-regulating cable adjusts its 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. Situations where more than one thermostat could be necessary include:

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

Note: Pipewall sensing required for non-metallic piping.

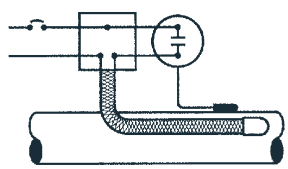
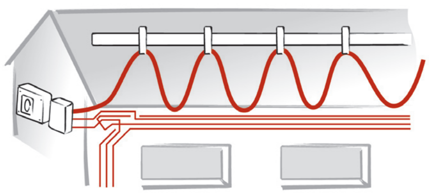


Table 1.5.1 Attachment Tape Allowance (BTape)

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'

TTS™
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting



Certifications / Approvals:

Canadian Standards Association
Ordinary 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 130.1, CSA 130.2, CSA 138

Description:

TTS cut-to-length 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. Please refer to the TTS design guide for Roof and Gutter on page 17 of this catalogue for full details.

TTS Cables are approved for use in ordinary (non-classified) and hazardous (classified) areas

Areas of Application:

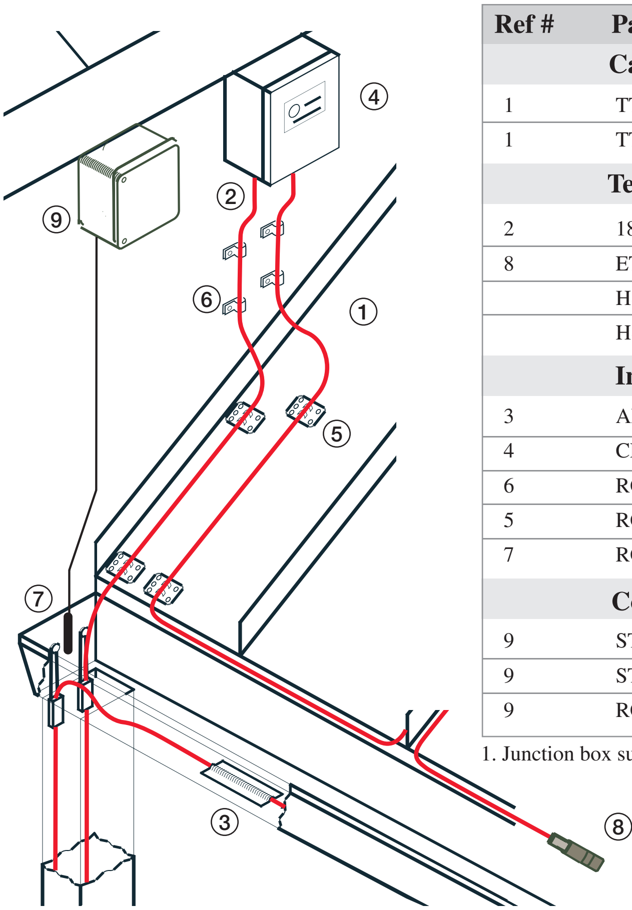
- Asphalt, shake, shingle, or metal roof surfaces
- Metal or plastic gutters and downspouts

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")
T-rating..T6 85° C (185° F)

TTS™

Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting



Basic Components:

A TTS self-regulating roof and gutter snow and ice melting heat tracing system will typically include heating cable and components shown in the illustration and TTS ordering information below. Please refer to page 54 for detailed accessory information.

Ref #	Part Number	Description
	Cable	
1	TTS-8-1-OJ	8 W/FT @ 120V (500 / 1000 Foot Spools)
1	TTS-8-2-OJ	8 W/FT @ 240V (500 / 1000 Foot Spools)
	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-20P	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
	Controls	
9	STC-DS2B	Snow and Ice Sensor, Pole Mounted
9	STC-DS-8	Snow and Ice Sensor with a 10' Remote Lead Wire
9	RC3-0120-DP	Weatherproof Indoor / Outdoor Thermostat

1. Junction box supplied by installer

Design Guide

TTS™
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting

Contents

3M Innovation

TTS™
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting

Introduction:

This design guide provides a basis for designing 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 design parameters:

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

Notes...
1. While entire roof areas can be electrically heat traced for snow and ice removal, this design guide addresses only roof overhangs, gutters and downspouts. Should your application require more area to be protected, contact a 3M factory representative.

Basis for a Good Design . . .

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 design variable falls into the heavy category, design 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 TTS Cable Based on:

Operating Voltage . . . TTS self-regulating cables are available in two voltage groups: 110-120 Vac and 208-240 Vac. Determine what voltage is available for use with heat tracing.

Branch Circuit Breakers . . . Use Table 2.1, Cable Selection, to match the TTS 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 circuit length. If breaker size will be dictated by heating cable requirements, determine the optimal TTS circuit lengths based on the project size and cable layout.

Maximum Circuit Lengths . . . The maximum circuit lengths shown in Table 2.1 are based on TTS cable start-up at an ambient temperature of 7° C (20° F). Because the power output of TTS will vary to meet the needs of the surrounding environment, the operating load will vary.

Step 3: Specify Locations for Power Connections; Lay Out Cable:

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.
3. To aid in design, TTS multipliers are given for the most common roofing material types. Use these multipliers, shown in Tables 2.2.1 through 2.2.2, to determine the footage of TTS cable required based on the variables indicated. Be sure to add sufficient extra cable to get from the heat-traced area back to the power connection point.

Step 4: Choose TTS Installation Accessories

A TTS roof and gutter system will typically use the installation accessories detailed on page 16. As a minimum, the heating cable must be terminated with an 18-SXG kit and ET-4S kit to properly terminate the ends of the cable.

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 basic means 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.

Table 2.1 Cable Selection

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

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

Notes…Due to its self-regulating feature, TTS 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.

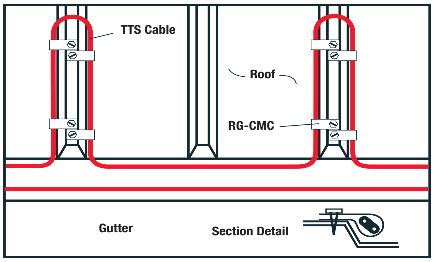
TTS™
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting

TTS 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/Tile 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. The partial sketch below depicts TTS cable as it would be installed on a standing seam metal roof. This method would also be used on corrugated or tile roofs.

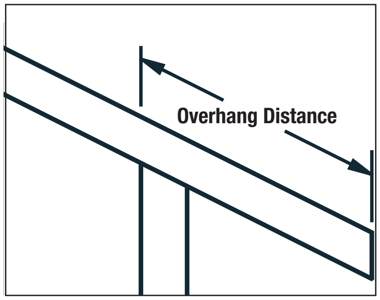
To determine the layout pattern for TTS heating cable on metal or tile roofs, use Table 2.2.1 in conjunction with measurements of the spacing of the seams, corrugations or ridges in the roofing material. This spacing, combined with the desired level of protection, will determine what multiplier to use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

To establish 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. 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/Tile 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

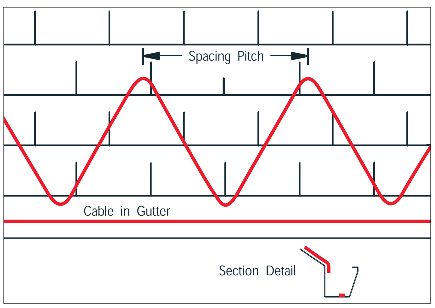
Heavy Conditions Multipliers   Moderate Conditions Multipliers



How far up the roof the heating cable should travel may be determined by measuring the distance as shown at left. 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 (fiberglass, cedar shake, flat tile or concrete shingle) can utilize heating cable installed in a serpentine pattern as detailed in the partial sketch below.



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 (Catalog 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 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 Conditions Multipliers
Rate of Snow Fall 2"/hr

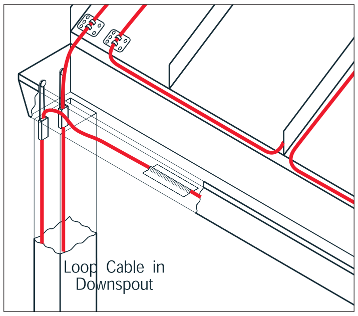
Moderate Conditions Multipliers
Rate of Snow Fall 1"/hr

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.

TTS™
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting

Gutters and Downspouts . . .

TTS 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 below.

As stated in IEEE Standard 515.1, Recommended Practice for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Commercial Applications, in-line and T-splice kits should 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.

Select the level of protection required (based on the size of the gutter) from Table 2.2.3. 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. Add sufficient heating cable (including a drip loop) to reach the power connection junction box.

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 the roof was 100' x 5.7 = 570 of cable for the roof surface.
(Additional cable 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 15' x2 = 30' of cable. Multiply this total times three downspouts 30' x 3 = 90' 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

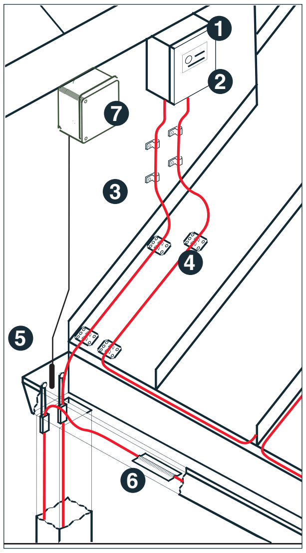
TTS™

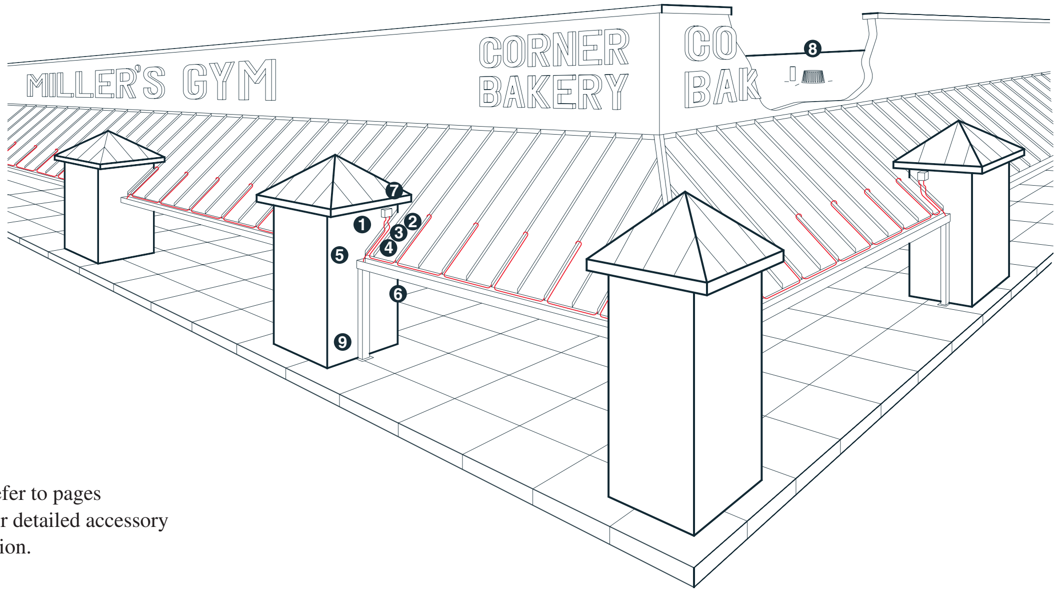
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting

Design Guide

Installation Accessories . . .

1. **18-SXG Kit & ET-4S** circuit fabrication kits are designed to terminate one circuit for both power connection and end termination. Junction boxes supplied by installer.
2. **CL-1** "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 heating cable to the roof utilizing screws and a waterproof cover material.
4. **RG-CRF** cable roof fasteners attach TTS heating cable to roof or fascia materials. 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-20P** aluminum tape secures heating cable to bottom of clean gutter to keep cable in place during rain.
7. **Snow Sensor / Controller**



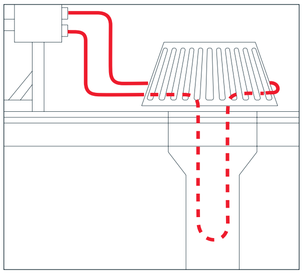


* Please refer to pages 54-59 for detailed accessory information.

Design Tips . . . (see diagram p.29)

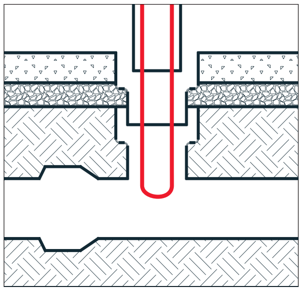
8. Roof Drains

Roof drains may require heat tracing to prevent blockage due to 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 (see 8. at right).



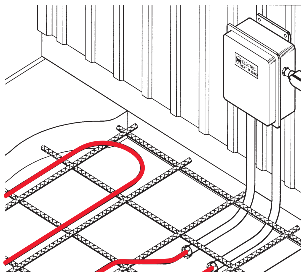
9. Downspouts to Underground Storm Sewers

When downspouts are routed to storm sewers located below the frost line, extend the TTS cable down to the point where the vertical drain meets the horizontal drain. The cable should not extend into the horizontal drain line.



KSR™

Self-Regulating Heating Cable for Surface Snow & Ice Melting



Certifications / Approvals:

Canadian Standards Association
Ordinary Locations
Meets or exceeds - IEEE 515.1 - UL 1588
CSA 130.2

Description:

KSR cut-to-length self-regulating heating cables are designed to provide snow and ice protection in concrete and asphalt applications. Designed and approved specifically for direct burial, KSR cable withstands the abuse encountered during installation.

Areas of Application:

- Business entrance and exit locations
- Ramps or Handicap Access routes
- Stairs and Footpaths
- Loading docks
- Driveways and garage entrances
- Critical access routes and helicopter pads

Ratings:

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

KSR™

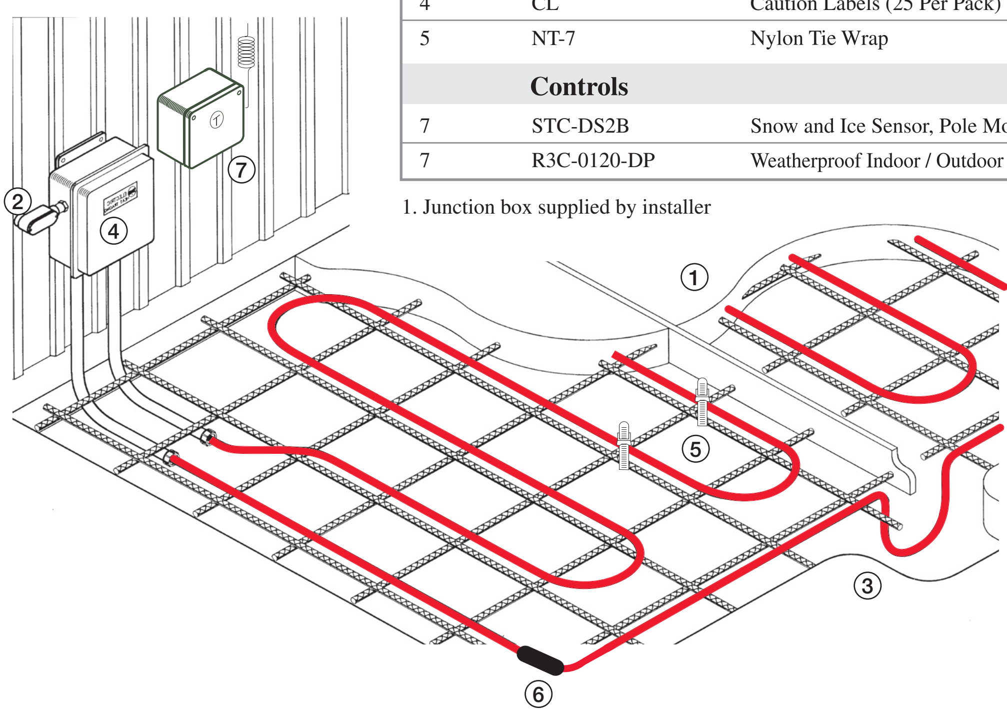
Self-Regulating Heating Cable for Surface Snow & Ice Melting

Basic Components:

A KSR self-regulating surface snow and ice melting system will typically include heating cable and components shown in the illustration and KSR ordering information below. Please refer to page 54 for detailed accessory information.

Ref #	Part Number	Description
	Cable	
1	KSR-2-OJ	208 - 240 Vac (500/1000 Foot Spools)
	Termination Kits	
2	KSR-CFK[1]	Power Connection / End Termination Kit w/o Junction Box
3	KSR-EJK	Expansion Joint Kit
6	KSR-SR-DB	Splice Kit
	Installation Accessories	
4	CL	Caution Labels (25 Per Pack)
5	NT-7	Nylon Tie Wrap
	Controls	
7	STC-DS2B	Snow and Ice Sensor, Pole Mounted
7	R3C-0120-DP	Weatherproof Indoor / Outdoor Thermostat

1. Junction box supplied by installer



Design Guide

KSR™

Self-Regulating Heating Cable for Surface Snow & Ice Melting

Contents

KSR™

Self-Regulating Heating Cable for Surface Snow & Ice Melting

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 exists a multitude of 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 design, procurement, installation and performance expectations before each function occurs will ensure successful installation of a heat tracing system. To facilitate this interaction, this design 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. Prevention of 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.
3. Refer to Canadian Electrical Code.

Basis for a Good Design . . .

The following five design steps outline the selection process for a KSR snow melting system.

An example following each design step will take the reader through the process of evaluating, designing 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 example includes flat surfaces, stairs, a ramp, expansion joints in the concrete and the need to bring power from a specific location.

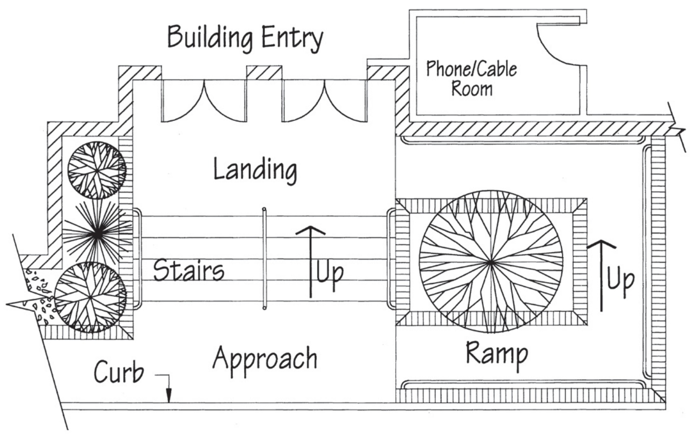
Step 1: Identify Area Requiring Snow and Ice Melting

Determining the area that will require heat tracing is based somewhat on the traffic expected during snow and ice accumulation periods plus the layout of the area and its location relevant to prevailing winds and susceptibility to drifting.

Identify the existence of electric snow and ice melting heat tracing cable in the Concrete Curbs, Walks 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.

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 handicap access ramp (which has a retaining wall) located on the third side. Snow removal could 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 prevent accumulation also from drifting and tracking.



PARTIAL PLAN AT ENTRY

Figure 3.1.1

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Step 2: Determine the Level of Protection Required

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 Cable Spacing (using information from IEEE Standard 515.1-1995 and ASHRAE) to simplify the selection process for determining the level of protection required. An additional design table can be found in Appendix A on page 35.

When an application requires an in-depth design review or does not conform to the "standard" design conditions stated, contact a 3M representative for additional design information. If required, a complete snow and ice melting review using finite element analysis (FEA) plus other computer-aided design programs to accurately assess your application can be provided.

Example . . . Since the example shown is a public / employee entrance it would be considered a noncritical 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" per hour, the heating cable should be installed on 9" center-to-center spacing.

If the design was to meet ASHRAE requirements, refer to Appendix A. Based on the data included in Appendix A on page 35, for Vancouver, 9" center-to-center spacing of KSR cable indicates that for approximately 84% of snowfall hours the surface will remain clear.

Noncritical: Applications where snow removal is a convenience but not essential. Examples include building entrances, loading docks and parking garage ramps.

Critical: Applications where safe access is essential. Examples include hospital emergency entrances, train loading platforms and fire station driveways.

Notes . . .

1. Additional heat may be needed if the area will be subject to drifting or moisture runoff 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 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.

Table 3.2.1 KSR Cable Spacing[2]

Snowfall Severity		KSR Cable Spacing	
Category	Rate of Snowfall	Noncritical	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.	6" O.C.

O.C. = On Centre

KSR™
Self-Regulating Heating Cable for Surface Snow & Ice Melting

Step 3: Select Operating Voltage, Size Circuit Breakers and Determine Power Requirements

Most snow melting applications will utilize a 208, 220, or 240 Vac power supply. To ensure maximum snow melting potential, KSR is rated for 208/240 Vac. Table 3.3.1, Cable Selection, shows the circuit lengths possible with KSR heating cable at each voltage. For a specific system, match the branch circuit breaker size to the KSR 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 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 cable estimate by the circuit length shown in Table 3.3.1 will give an indication as to how many circuits will be needed for a given branch circuit breaker size.

The total operating load of a KSR 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.

Formula 3.1 Estimating Quantity of KSR Required

Total KSR cable required = Area in square feet x (12 ÷ S)
Where: S = KSR 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 heating cable
I_1 = Amps per foot multiplier for voltage used
E = Operating Voltage

Table 3.3.1 Cable Selection

Catalog 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	24 m (80')	32 m (105')	49 m (160')	64 m (210')
KSR-2	-18° C (0° F)	240 Vac	Direct Burial	26 m (85')	34 m (110')	52 m (170')	69 m (225')
KSR-2	-7° C (20° F)	208 Vac	Direct Burial	26 m (85')	34 m (110')	50 m (165')	67 m (220')
KSR-2	-7° C (20° F)	240 Vac	Direct Burial	27 m (90')	37 m (120')	55 m (180')	69 m (225')

Example . . . 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 . . .

Total KSR cable required =
Area in ft^2 x (12 ÷ S)

and substituting values for the design example . . .

Total KSR cable required =
600 ft^2 x (12 ÷ 9)

the total footage of cable can be estimated . . .

Total KSR cable required = 800 linear feet (plus allowance from Note 2)

Using Formula 3.2 . . .

$$P_t = L_t \times I_f \times E$$

and substituting values for the design example . . .

$$P_t = 840 \text{ ft} \times 0.12 \text{ amps/ft} \times 208 \text{ Vac}$$

the total kilowatt demand for the system can be estimated . . .

$$P_t = 21 \text{ kw}$$

Notes . . .
1.When calculating the amount of KSR 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.

Step 4: Specify Locations for Power Connections /End Terminations and Lay Out Cable on Scaled Drawing

Junction Boxes . . . KSR 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.

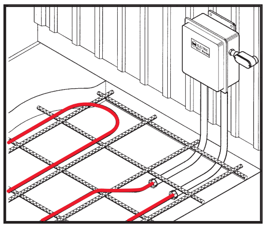

Figure 3.4.1 Junction Box/Conduit

KSR 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 center-to-center 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 directly on top of reinforcing steel.
- Attach to steel with nylon tie wraps on 24" (minimum) intervals.

Expansion Joints . . . Unless the slab is of monolithic construction, there will be expansion or construction joints which 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 for each expansion joint kit.

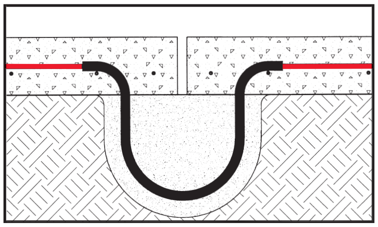

Figure 3.4.2 Expansion Joint Kit Section

Stair Steps . . . Because of the rugged yet flexible nature of KSR and the center-to-center spacing typical to most applications, difficult areas such as steps can be easily accommodated.

- Tie KSR 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.

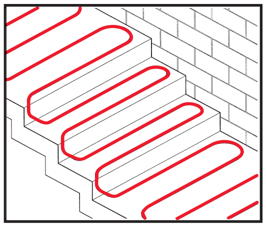

Figure 3.4.3 Detail at Steps

Example . . . 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 handicap access 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.

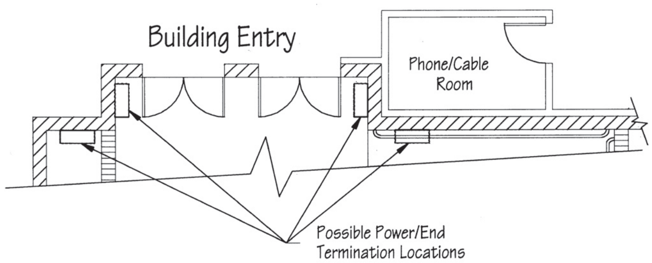

Figure 3.4.4

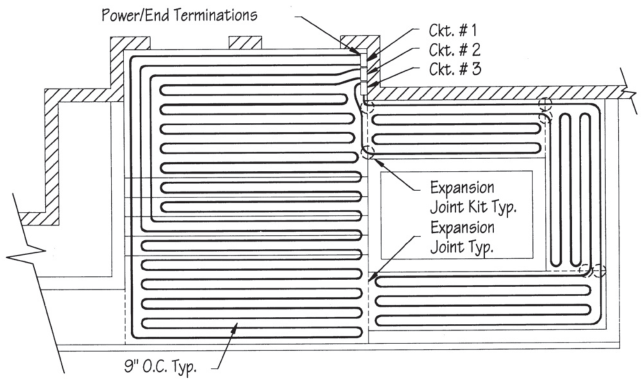

Figure 3.4.5

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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.

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

A power distribution and contactor panel would consist of a main 3 pole breaker, a 3 pole contactor and three 40 amp branch circuit breakers equipped with 30 mA ground-fault protection. The panel would also be equipped with a hand/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 shut-down 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.

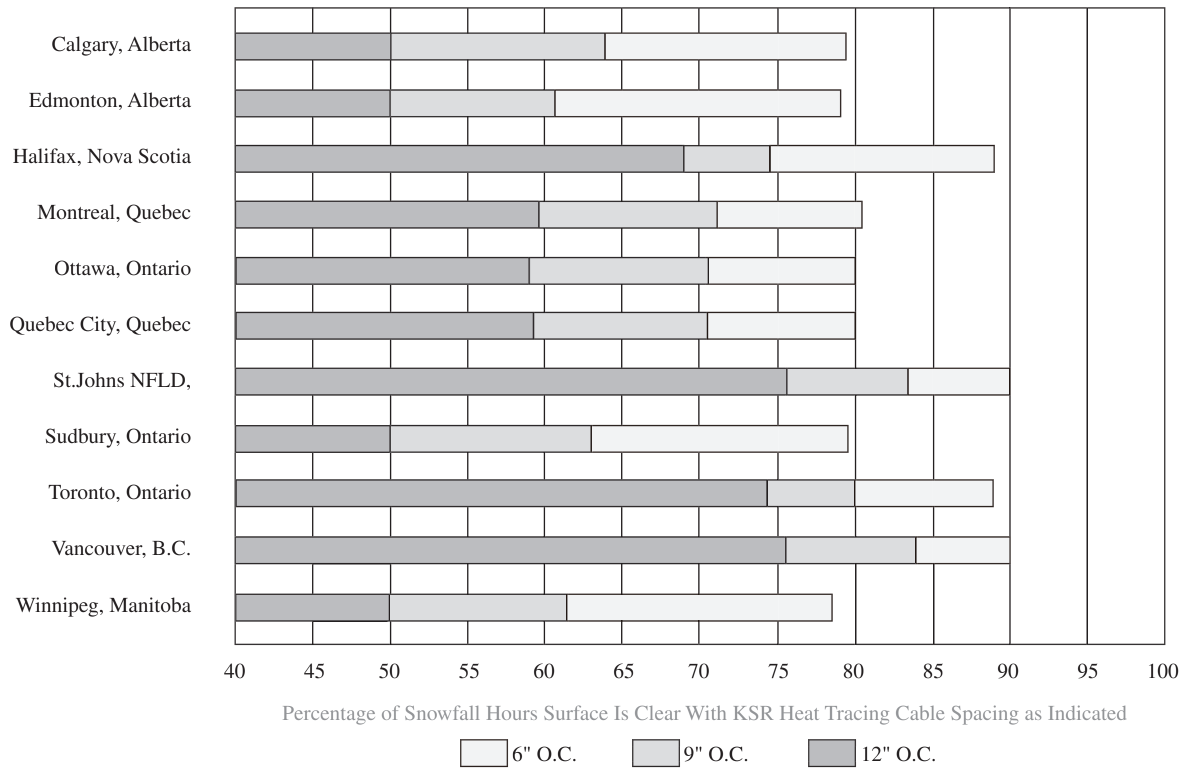
Appendix A . . .

As an alternate to the KSR cable spacing selection chart shown in Step 2, 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 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 Characteristics of Snow Melting Systems (ASHRAE 1991 Applications Handbook, Chapter 45), and detailed below show the calculated percentage of snowfall hours that a surface will remain clear of snow when a predetermined level of heat is installed. This method is very useful when comparing what additional benefit, in terms of keeping an area clear, is obtained when the watts/ft^2 is increased.

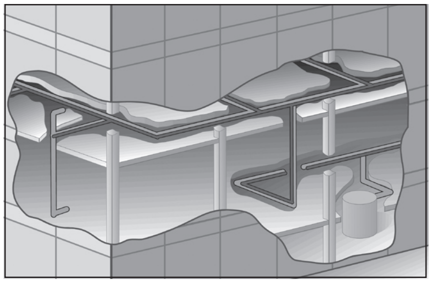
While it is necessary to have weather data to establish values for temperature, wind, humidity and snowfall, ASHRAE cautions that a snow melting system should not be designed based on the annual averages or worst weather conditions encountered. Doing so will result in a system unnecessarily over designed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

Cable Spacing Selection Guide



HSX™

Self-Regulating Heating Cable for Hot Water Temperature Maintenance



Certifications / Approvals:

Canadian Standards Association
Ordinary Locations
Meets or exceeds - IEEE 515.1 - UL 1588
CSA 130.2

Description:

HSX 2100 series cut to length self-regulating heating cables are specifically designed to maintain hot water supply piping at desired nominal maintenance temperatures. With 14 AWG bus wires, HSX 2100 series can reduce the number of circuits required to install an electric heat-traced system. Simply match the hot water maintenance temperature with the corresponding color-coded cable (Blue/Green/Red) and insulate per the design guide.

Application:

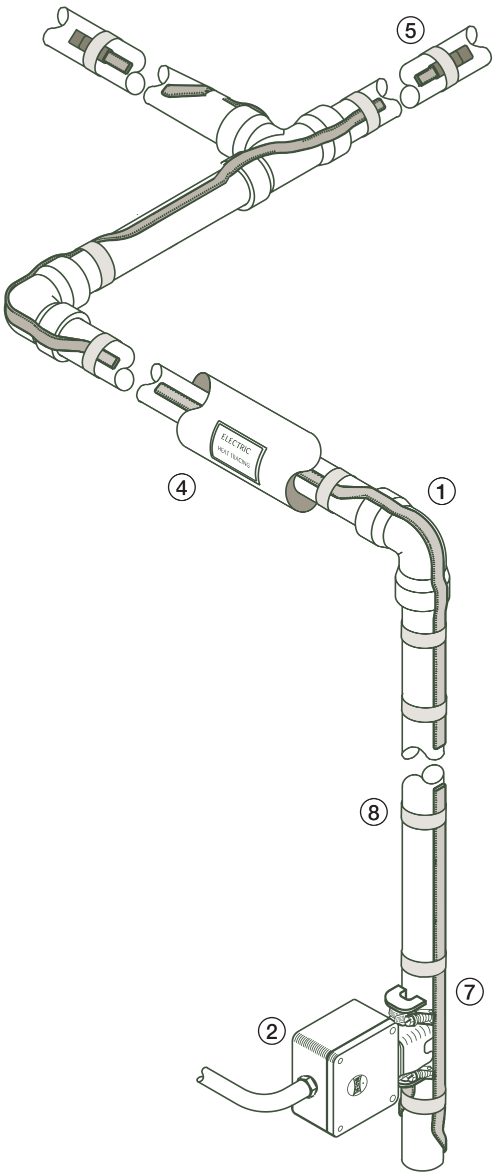
- Energy efficient alternate to recirculation pipe systems
- Ideal for installations with multiple maintain temperatures
- Maintain hot water at three temperature levels:
    - 40° C, ie Nursing Homes
    - 50° C, ie Hotels
    - 60° C, ie Kitchens

Ratings:

Maintain Temperatures.. 40, 50, or 60° C (104, 122, 140° F)
Supply Voltages..120, 208, 240 Vac
Minimum installation temperature.. -50° C (-40° F)
Minimum bend radius...13 mm (.5")

HSX™

Self-Regulating Heating Cable for Hot Water Temperature Maintenance



Basic Components:

An HSX self-regulating hot water temperature maintenance system will typically include heating cable and components shown in the illustration and HSX ordering information below. Please refer to page 54 for detailed accessory information.

Ref #	Part Number	Description
	Cable	
1	HSX-2105-1	40 C @ 120V Blue (500/1000 Foot Spools)
1	HSX-2120-1	50 C @ 120V Green (500/1000 Foot Spools)
1	HSX-2105-2	40 C @ 240V Blue (500/1000 Foot Spools)
1	HSX-2120-2	50 C @ 240V Green (500/1000 Foot Spools)
1	HSX-2140-2	60 C @ 240V Red (500/1000 Foot Spools)
	Termination Kits	
2	18-SXG-KIT	Power Connection Gland Kit w/o Junction Box
5	ET-6C	End Termination Kit
2	PCA-1-SR	Non Metallic Power Connection Kit with Junction Box
2	PCS-1-SR	Non Metallic Splice Kit with Splice Cover
	Installation Accessories	
4	CL	Caution Labels (25 Per Pack)
8	BTape	Binding / Attachment Tape (1/2" X 60 yds)

Notes . . .

1. 30 mA ground-fault equipment protection is required for all hot water temperature maintenance heat tracing circuits.
2. Circuit fabrication kits do not include electrical junction boxes.

HSX™
Self-Regulating Heating Cable for Hot Water Temperature Maintenance

Contents

HSX™

Self-Regulating Heating Cable for Hot Water Temperature Maintenance

Design Guide

Introduction . . .

A WarmTrace system replaces heat lost through the thermal insulation on hot water supply piping to maintain the water at desired nominal temperatures without the need for costly insulated recirculation lines, pumps and balancing valves. Preventing the hot water from cooling also ensures readily available hot water when needed.

Like many other systems installed in a facility, the successful installation of a heat tracing system for maintaining[1] hot water requires coordination among the various trades involved. Mechanical, electrical and insulation contractors must be made aware of the specific requirements each must provide.

The information contained in this design guide will take the reader through a step-by-step procedure[2] to:

- Identify the piping which requires heat tracing.
- Determine the maintain temperature and make the proper cable selection.
- Specify the electrical circuit breaker requirements based on the estimated heat tracing circuit lengths.
- Specify the thermal insulation type and thickness to complete the thermal design.
- Incorporate the design information provided into a complete package for a facility.

To further facilitate this interaction, an additional installation, operation and start-up guide has been prepared to provide trouble free installation of the heating cable and accessories.

Notes...

1. An electrical heat tracing system is not a substitute for a complete, efficient domestic hot water system: it does not replace the need for an efficient water heater.

2.The examples and descriptions contained in this guide are based on copper water pipe with fiberglass thermal insulation (ASTM Std C-547) and other design conditions typical of most applications. Should design conditions vary from those shown, contact 3M™.

HSX™
Self-Regulating Heating Cable for Hot Water Temperature Maintenance

Basis for a Good Design . . .

Step 1: Identify Piping Which Requires Heat Tracing

Typically, the main and branch lines 3/4" and larger are the primary applications for a hot water temperature maintenance system. Where a recirculation system would only be able to provide temperature maintenance within the recirculation loop, a heat-traced line can maintain hot water to every point of use. Systems which have different pressure or temperature zones can be easily accommodated in the design and layout of HSX 2100 heating circuits.

Determining the amount of piping that will require heat tracing is easy. The extent of the heat tracing is dictated by the layout of the building and the need for water conservation.

Deciding on how close to the point of use the heat tracing should be installed is dependent on the following conditions:

- The gallons per minute (GPM) of the fixture.
- The diameter of the "runout" line.
- The number of times per day the fixture will be used.
- Any acceptable time period waiting on water to get hot.
- Any acceptable level of water waste per fixture per use.
- Special requirements at the point of use.

A wait of 15 or 20 seconds for the water to get hot at a utility room mop sink may be acceptable; however, it would not be appropriate for a public washroom. Here the need to have water hot when the faucet is operated would dictate installing heating cable to the rough-in point.

Most new facilities require the use of lavatory and shower fixtures that have GPM flow limits. As a result, the length of piping not recirculated or heat traced has become increasingly important. Tables 4.1.1 and 4.1.2 show the time correlation between fixture flow rate and length of runout piping that is not temperature maintained. Table 4.1.3 shows the water wasted while waiting for temperatures to reach proper levels where low flow fixtures are used.

Fixture Flow Rate US GPM	Distance From End of Heat Tracing Circuit to Point of Use 15'	20'	25'	30'	40'
1	23	30	38	45	60
1.5	15	20	25	30	40
2	11	15	19	23	30
2.5	9	12	15	18	24
3	8	10	13	15	20
3.5	6	9	11	13	17
4	6	8	9	11	15
4.5	5	7	8	10	13
5	5	6	8	9	12

Table 4.1.1 Time Correlation for 3/4" Type L Copper Tubing (time in seconds for hot water to reach fixture)

Fixture Flow Rate US GPM	Distance From End of Heat Tracing Circuit to Point of Use 15'	20'	25'	30'	40'
1	39	51	64	77	103
1.5	26	34	43	51	69
2	19	26	32	39	51
2.5	15	21	26	31	41
3	13	17	21	26	34
3.5	11	15	18	22	29
4	10	13	16	19	26
4.5	9	11	14	17	23
5	8	10	13	15	21

Table 4.1.2 Time Correlation for 1" Type L Copper Tubing (time in seconds for hot water to reach fixture)

Type L Copper nom. dia.	Distance From End of Heat Tracing Circuit to Point of Use 15'	20'	25'	30'	40'
1/2"	23	31	39	47	62
3/4"	48	64	80	97	129
1"	82	110	137	164	219

Table 4.1.3 Water Wasted While Waiting for Hot Water[2] (in ounces and based on line diameter /distance from end of temperature maintenance)

Notes . . .

1. Based on flow rates, line diameter and distance from end of temperature maintenance to fixture.
2. Remember to add up all the fixtures throughout a facility and multiply by both the waste number shown plus the expected number of usages per day.

HSX™
Self-Regulating Heating Cable for Hot Water Temperature Maintenance

Unheated Water Cools Fast . . .

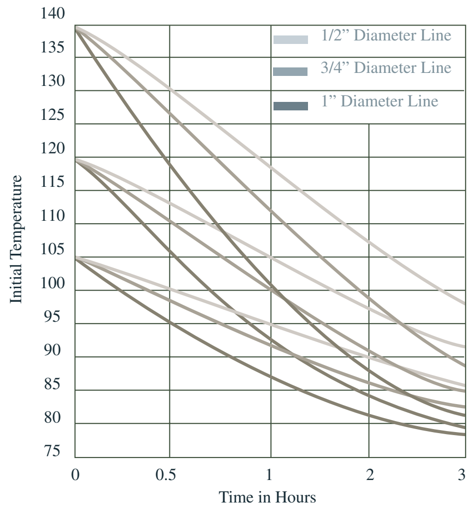
Although protected by means of the fiberglass thermal insulation, hot water lines will lose their heat to the surrounding ambient in a very short period of time.

While Tables 4.1.1, 4.1.2 and 4.1.3 identify the amount of time and/or water lost during the waiting process, Graph 4.1.4 demonstrates how quickly the cooling process occurs.

Coordinating Design Information . . .

To get the most from each heat tracing circuit, establish the maximum circuit length based on the available circuit breakers for the project. (Note that maximum circuit lengths will vary based on voltage and temperature selection.) Regardless of the shape and size of a building, it is recommended that the heat tracing circuits be organized to provide a means of recording the layout of the cable. For ease of identification during the layout process and for effective communication in the contract drawings, it is recommended that the pipes requiring heat tracing be identified. This is a simple process that can also include locating power connection points, end terminations and heating cable T-splice locations. The symbols that follow are routinely used to show the various components of a heat-traced hot water supply system.

Graph 4.1.4 1/2", 3/4" & 1" Diameter Lines with 1" Fiberglass Insulation



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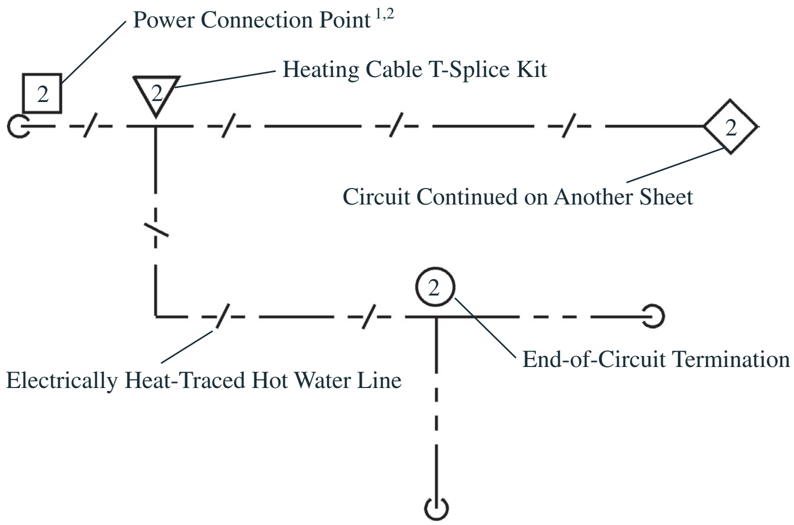


Example: A lavatory faucet located in a hospital patient room is used an average of six times per day with a minimum time between each use of one hour.

Design Parameters

Pipe..3/4" nominal diameter copper
Insulation...1" fiberglass
Maintain temperature.............................49° C (120° F)
Ambient temperature.............................24° C (75° F)
Fixture flow rate....................................1.5 US GPM
Uses per day...6 (average)
Time between uses..................................1 hour (minimum)
Unmaintained distance............................20'

After only one hour of non use, the water in the insulated (but not heat-traced) line will drop from the 49° C (120° F) initial temperature to just over 38° C (100° F). Additionally, each time the faucet is opened, 20 seconds will pass before the water gets hot. During this time approximately 1/2 gallon of water will be wasted. When these values are extended to every patient room for a 250 bed facility with a 75% occupancy rate, the annual water wasted is significant.

Notes . . .

1. Circuit number is shown inside symbol.

2. While the indication of heating cable, power connection, end termination and T-splice kits are shown on the plumbing drawings, only the power connection points will need referencing on the electrical drawings.

Heat Tracing Horizontal Mains . . .

Designing a heat tracing temperature maintenance system for horizontal mains and branch lines can be done on the plumbing plan drawings. By referring to the heating cable selection chart (see Table 4.2.1, page 52) for the desired maintain temperature, the maximum heating cable circuit length can be determined for different circuit breaker sizes (refer to Table 4.3.1, page 52). Coordinating the layout of the hot water lines with the heating cable circuit length information will allow optimum use of the extended circuit lengths possible with HSX 2100.

Note that the main and branch lines are heat traced and insulated while the short runouts are only insulated. (The runouts that feed the individual points of use would typically contain minimal amounts of water. If the faucet flow rate was above 1-1/2 gallons per minute, hot water would reach the point of use within ten seconds.) Should the distance between the branch line and the runout be much longer or the flow rate be lower, the amount of water potentially wasted and the time required for hot water to reach the point of use may be beyond the acceptable level for the facility. To remedy this condition, simply heat trace closer to the point of use.

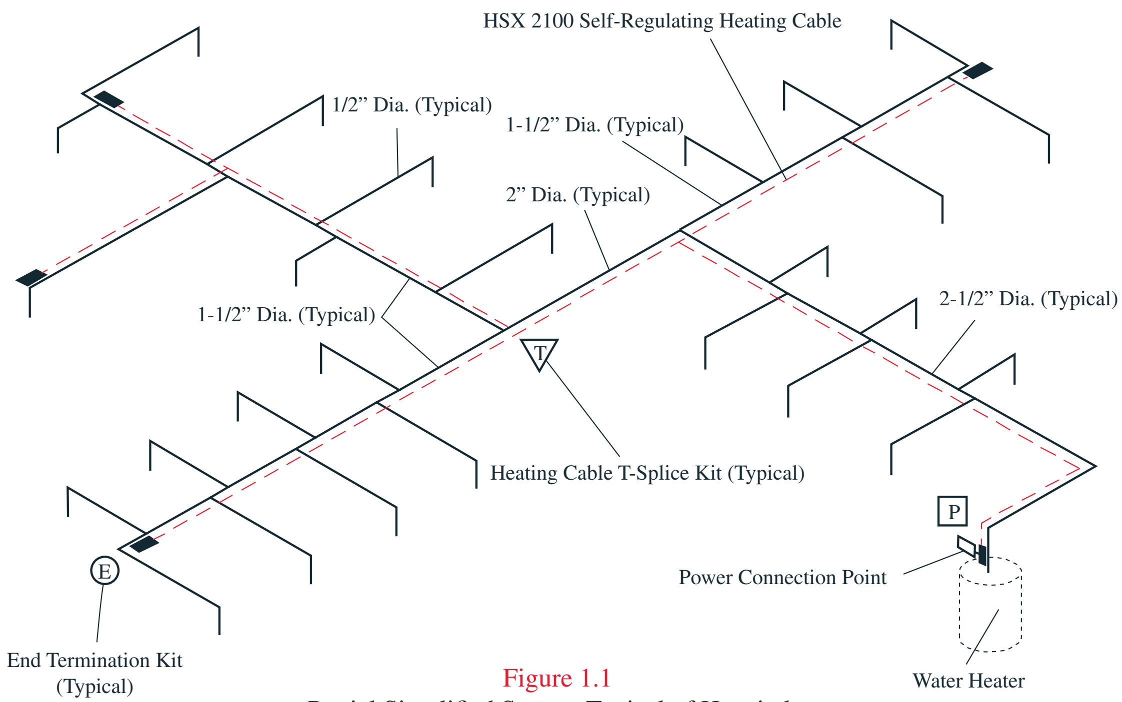


Figure 1.1
Partial Simplified System Typical of Hospitals, Correctional Facilities and Hotels

Heat Tracing Riser Lines . . .

Riser lines that extend three floors or less should be heat traced in the same manner as horizontal piping. In a facility where a riser extends beyond three floors, some additional design conditions should be considered.

When vertical piping extends more than 30 feet, heat migration (convective circulation) within the pipe and the air space between the pipe and thermal insulation (if oversized insulation is used) is possible. This condition, referred to as "chimney effect," can result in water temperatures above the desired temperature at the upper floors of the facility. To compensate for this (in the example shown), the heating cable installed on the horizontal piping located on the lower level has been extended to the vertical piping up to the fifth floor level and is intended to operate without the use of any control thermostat. On the vertical riser from the fifth floor level to the eighth floor level, a thermostatically controlled heat tracing circuit was installed. This controls the heat output of the cable in this area to reduce any possibility of overheating the water when additional heat from chimney effect is encountered. Because the vertical pipe diameters above the eighth floor are smaller and heat is migrating from lower levels, thermal insulation is needed, but heat tracing cable might not be required.

When the horizontal runouts from a riser are long enough to require temperature maintenance, each floor should be treated as a separate heat tracing circuit. This will simplify the layout and installation process plus facilitate future building renovations or expansions.

Because the riser configuration will vary with each facility, it is recommended that the designer/engineer responsible for the plumbing system contact 3M™.

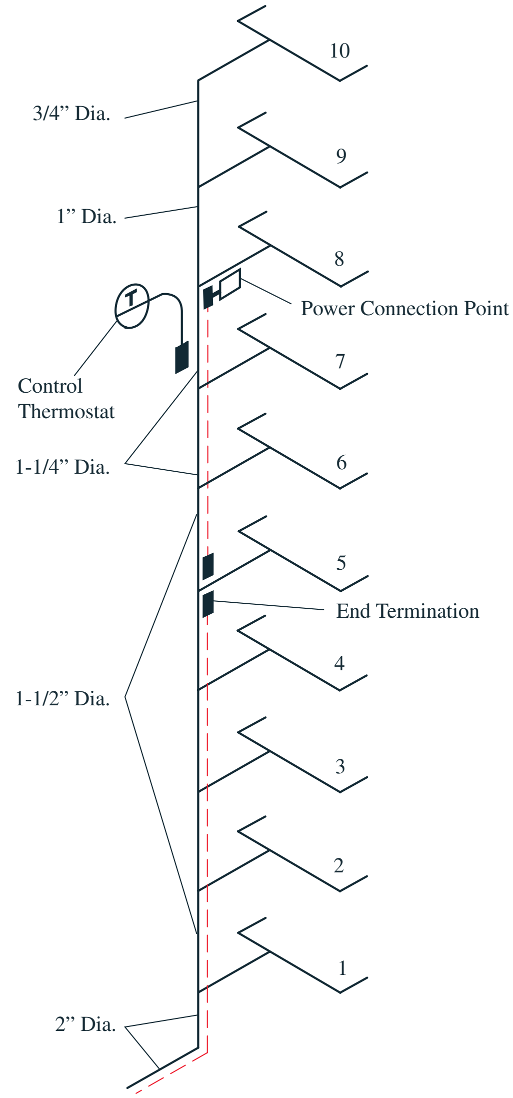


Figure 1.2
Partial Simplified System for
High-Rise Buildings

Combining Horizontal Mains with Supply Risers . . .

Many multilevel facilities duplicate floor plans over several levels. This practice simplifies the layout of electrical, HVAC and mechanical equipment. Hot water supply lines are no exception to this ease of layout unless a maze of recirculation piping and balancing valves are required. Figure 1.3 shows a typical layout found in two- to four-story facilities such as hospitals, research labs, correctional facilities and campus dormitories.

In this example, the supply main is located in the interstitial space between the first-floor ceiling and the second floor. Because each floor has roughly the same layout with water use points stacked, a riser and drop would supply water at each plumbing location. Electric heat tracing has been installed on the horizontal mains and risers. Since the distance between the horizontal piping and the first-floor runouts is minimal (less than 15 feet), it would typically not require heating cable beyond the horizontal line connecting the main to the riser. As the example shown is for a four-story facility, it is recommended that heating cable be installed up to the feed point for the third floor. The line feeding from level three to level four would again be within 15 feet and, under most conditions, would not require heat tracing. The untraced lines should be insulated to prevent rapid heat loss between usages.

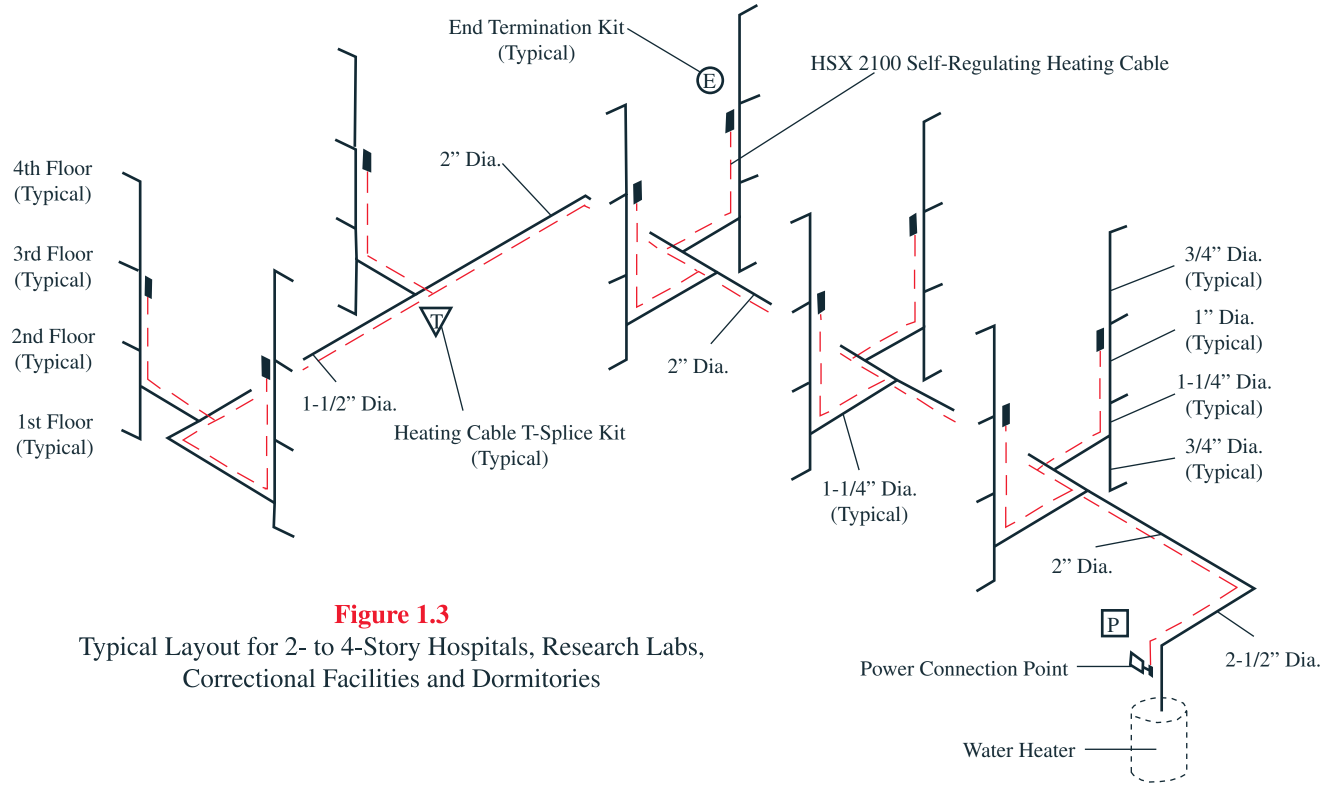


Figure 1.3
Typical Layout for 2- to 4-Story Hospitals, Research Labs, Correctional Facilities and Dormitories

HSX™
Self-Regulating Heating Cable for Hot Water Temperature Maintenance

Step 2: Determine the Maintain Temperature and Make Cable Selection

The desired maintenance temperatures for most applications are listed in Table 4.2.1. Based on the maintain temperature desired, choose the appropriate HSX 2100 self-regulating cable. For temperatures other than those shown below, contact 3M™.

Table 4.2.1 Nominal Maintain Temperature

	40° C (105° F)	**50° C (120° F)**	**60° C (140° F)**
	Hospitals, Nursing Homes, Correctional Facilities	Hospitals, Hotels, Condos, Correctional Facilities, Schools	Kitchens, Laundries
Ambient Range[1]	24° C - 27° C (75° F - 80° F)	22° C - 27° C (72° F - 80° F)	22° C - 27° C (72° F - 80° F)
Cable Jacket Color	Blue	Green	Red
240 Vac Power Supply	HSX 2105-2	HSX 2120-2	HSX 2140-2
120 Vac Power Supply	HSX 2105-1	HSX 2120-1	--

Note . . .

1. Ambient temperature ranges other than those listed are possible; contact 3M™.

Step 3: Specify Circuit Breaker Requirements Based on Heat Tracing Circuit Lengths

After determining the extent of the hot water supply piping to be heat traced, determine the quantities to be maintained at 40° C (105° F), 50° C (120° F) and/or 60° C (140° F). At this point, the total footage of each type of HSX 2100 self-regulating cable can be determined.

Because HSX 2100 is designed specifically for hot water temperature maintenance and is manufactured with 14 AWG nickel-plated copper bus wires, the maximum circuit length possible is far greater than any other product approved for hot water temperature maintenance. These maximum circuit lengths must be observed to prevent excessive electrical currents in the bus wires of the heating cable. The maximum circuit length is defined as total length of cable that can be fed from a single power connection point, inclusive of all splices and tees. Note that longer circuit lengths may require larger circuit breakers. Be sure to verify the available amperages of the branch circuit breakers supplying power to the heat tracing.

Table 4.3.1 outlines the maximum length possible with each type of HSX 2100 self-regulating cable.

Step 4: Specify Insulation Thickness

The following information should be made part of the thermal insulation specification. Variations to this insulation schedule may result in different maintain temperatures.

Table 4.1 Fiberglass Insulation Schedule[1] for HSX Systems

Insulation[2] Thickness	Nominal Pipe Size[3]	Nominal Insulation Size
1"	1/2"	3/4"
	3/4"	1"
	1"	1-1/4"
1-1/2"	1-1/4"	1-1/2"
	1-1/2"	1-1/2"
	2"	2"
2"	2-1/2"	2-1/2"
	3"	3"
	4"	4"

Notes . . .

1. This insulation schedule is applicable for 40° C (105° F), 50° C (120° F) and 60° C (140° F) HSX systems.
2. All selections are based on using fiberglass insulation with a kraft paper moisture vapor barrier. Before using other types of thermal insulation, consult 3M™.
3. To accommodate the heating cable on copper piping that is 1¼" or less in diameter, the thermal insulation will need to be one line size larger than the nominal pipe diameter.

Table 4.3.1 Maximum Circuit Length vs. Circuit Breaker Size

Catalog Number	Service Voltage (Vac)	15 Amp ft (m)	Breaker Size 20 Amp ft (m)
HSX 2105-2 (Blue)	240	1,295 (395)	1,720 (525)
HSX 2120-2 (Green)	240	685 (210)	915 (280)
HSX 2140-2 (Red)	240	360 (110)	490 (150)
HSX 2105-1 (Blue)	120	510 (155)	510 (155)
HSX 2120-1 (Green)	120	360 (110)	425 (130)

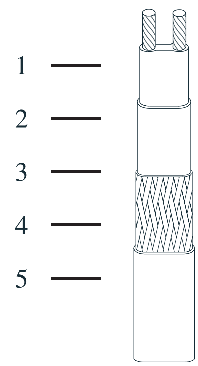
Note . . .

1. Steady-state current draw is defined as the theoretical current draw of the heating cable at the desired maintain temperature. Because temperature fluctuations will exist, this current should be used for reference purposes only. Current during start-up when the water in the piping is at ambient temperature will be greater and should be accounted for when sizing circuit breakers.

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[1]...T6 85° C (185° F)

Basic Accessories...

Power Connection: All TTS 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 cables require the ET-6C end cap for terminating the end of the circuit.

Notes . . . 1. 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.

TTS™
Self-Regulating Heating Cable for Pipe Freeze Protection

Certifications / Approvals...

Canadian Standards Association
Ordinary 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 130.1, CSA 130.2, CSA 138

Circuit Breaker Sizing... Maximum Circuit lengths for various circuit breaker amperatures are shown below. Circuit breaker sizing should be based on the 1996 National Electrical Code, article 427-4 (or refer to the Canadian Electrical Code, Rule 62-300[4]).

The 1996 National Electrical code, Article 427-22 states: "Ground fault protection equipment shall be provided for each branch circuit supplying electrical heating equipment." Consult local authority for ground fault circuit protection.

120 Vac Service Voltage		Max. Circuit Length vs. Breaker Size Ft(m)			
Catalog Number	Start-Up Temp. ° C (° F)	15A	20A	30A	40A
TTS 5-1	10 (50)	190 (58)	270 (82)	275 (84)	275 (84)
	-18 (0)	125 (38)	170 (52)	275 (84)	275 (84)
	-29 (-20)	105 (32)	145 (44)	240 (73)	275 (84)
	-40 (-40)	95 (29)	130 (40)	210 (64)	275 (84)
TTS 8-1	10 (50)	150 (46)	205 (63)	220 (67)	220 (67)
	-18 (0)	100 (30)	140 (43)	220 (67)	220 (67)
	-29 (-20)	90 (27)	125 (38)	200 (61)	220 (67)
	-40 (-40)	85 (26)	115 (35)	180 (55)	220 (67)
TTS 10-1	10 (50)	115 (35)	160 (49)	195 (59)	195 (59)
	-18 (0)	80 (24)	115 (35)	180 (55)	195 (59)
	-29 (-20)	75 (23)	100 (30)	160 (49)	195 (59)
	-40 (-40)	70 (21)	95 (29)	145 (44)	195 (59)

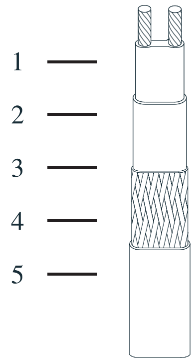
240 Vac Service Voltage		Max. Circuit Length vs. Breaker Size Ft(m)			
Catalog Number	Start-Up Temp. ° C (° F)	15A	20A	30A	40A
TTS 5-2	10 (50)	380 (116)	530 (162)	550 (168)	550 (168)
	-18 (0)	245 (75)	335 (102)	550 (168)	550 (168)
	-29 (-20)	215 (66)	295 (90)	475 (145)	550 (168)
	-40 (-40)	195 (59)	265 (81)	420 (128)	550 (168)
TTS 8-2	10 (50)	295 (90)	410 (125)	435 (133)	435 (133)
	-18 (0)	205 (63)	280 (85)	435 (133)	435 (133)
	-29 (-20)	185 (56)	250 (76)	400 (122)	435 (133)
	-40 (-40)	165 (50)	225 (69)	360 (110)	435 (133)
TTS 10-2	10 (50)	230 (70)	320 (98)	390 (119)	390 (119)
	-18 (0)	165 (50)	225 (69)	360 (110)	390 (119)
	-29 (-20)	150 (46)	205 (63)	325 (99)	390 (119)
	-40 (-40	140 (43)	190 (58)	295 (90)	390 (119)

TTS™

Self-Regulating Heating Cable for Roof & Gutter Snow & 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...

Available watt densities .... 26 w/m @10° C (8 w/ft @50° F)
Supply Voltages .... 110-120 or 208-240 Vac
Minimum installation temperature .... -51° C (-60° F)
Minimum bend radius .... 32 mm (1.25")

Basic Accessories...

Power Connection: All TTS cables require an 18-SXG-KIT power connection kit for terminating the circuit before connecting to power.

End-of-Circuit Termination: TTS cables require the ET-4S end cap for terminating the end of the circuit.

Notes . . . 1. 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.

Data Sheet

TTS™
Self-Regulating Heating Cable for Roof & Gutter Snow & Ice Melting

Certifications / Approvals...

Canadian Standards Association
Ordinary 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 130.1, CSA 130.2, CSA 138

Circuit Breaker Sizing... Maximum Circuit lengths for various circuit breaker amperatures are shown below. Circuit breaker sizing should be based on the local or applicable code. Refer to rule 62-300(4) of the Canadian Electrical Code.

“Ground fault protection equipment shall be provided for each branch circuit supplying electrical heating equipment.” Consult local authority for ground fault circuit protection.

Cable Selection for Roof and Gutter....

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

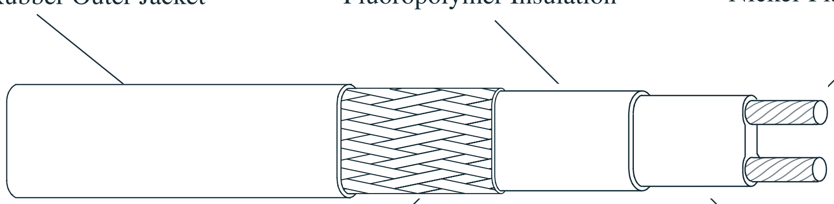
Start-up Temperature	0°F -18°C		
	Voltage	Max Ckt Lngth (feet)	Max Ckt Lngth (meters)
15A breaker	120V 208V 240V	80 145 150	25 45 46
20A Breaker	120V 208V 240V	105 190 200	33 58 61
30A Breaker	120V 208V 240V	155 290 295	48 89 90
40A Breaker	120V 208V 240V	175 350 350	54 107 107

Notes…Due to its self-regulating feature, TTS 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.

3M Innovation

KSR™
Self-Regulating Heating Cable for Surface Snow & Ice Melting

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 .... 32 mm (1.25")
Supply voltage .... 208-277 Vac
Circuit protection .... 30 mA ground-fault protection required

Cable Selection . . .

Catalog 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	24 m (80')	32 m (105')	49 m (160')	64 m (210')
KSR-2	-18° C (0° F)	220 Vac	Direct Burial	24 m (80')	32 m (105')	50 m (165')	66 m (215')
KSR-2	-18° C (0° F)	240 Vac	Direct Burial	26 m (85')	34 m (110')	52 m (170')	66 m (225')
KSR-2	-7° C (20° F)	208 Vac	Direct Burial	26 m (85')	34 m (110')	50 m (165')	67 m (220')
KSR-2	-7° C (20° F)	220 Vac	Direct Burial	26 m (85')	34 m (110')	52 m (170')	69 m (225')
KSR-2	-7° C (20° F)	240 Vac	Direct Burial	27 m (90')	37 m (120')	55 m (180')	69 m (225')

Certifications / Approvals...

Canadian Standards Association

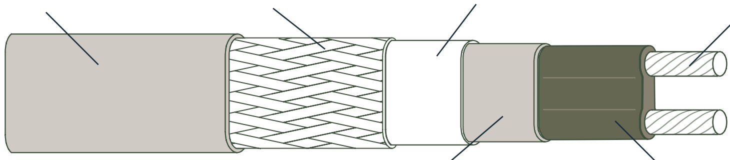
LISTED

Notes . . .

3M strongly recommends the use of ground fault protection with KSR heating cable. Please refer to Rule 62-300(4) of the Canadian Electrical Code.

HSX™
Self-Regulating Heating Cable for Hot Water Temperature Maintenance

Construction...



Ratings...

Bus wire .... 14 AWG nickel-plated copper
Metallic braid .... 14 AWG (equivalent size) tinned copper
Outer jacket .... polyolefin; 1 mm (0.040") nominal
Minimum bend radius .... 13 mm (0.5")
Supply voltage .... 120 or 208 Vac
Circuit protection[1] .... 30 mA ground-fault protection required

Cable Selection . . .

Catalog Number	Outer Jacket Color	Operating Voltage	Nominal Maintain Temperature	Ambient Range	Maximum Circuit Length vs. Breaker Size 15 Amp	20 Amp
HSX 2105-2	Blue	240 Vac	41° C (105° F)	24°-27° C (75°-80° F)	395 m (1296')	525 m (1952')
HSX 2120-2	Green	240 Vac	49° C (120° F)	22°-27° C (72°-80° F)	210 m (688')	280 m (918')
HSX 2140-2	Red	240 Vac	60° C (140° F)	22°-27° C (72°-80° F)	110 m (360')	150 m (492')
HSX 2105-1	Blue	120 Vac	41° C (105° F)	24°-27° C (75°-80° F)	155 m (510')	155 m (510')
HSX 2120-1	Green	120 Vac	49° C (120° F)	22°-27° C (72°-80° F)	110 m (360')	130 m (425')

Certifications/Approvals . . .

LISTED

Notes . . .

1. The National Electrical Code and the Canadian Electrical Code require ground-fault protection of equipment for each branch circuit supplying electric heating equipment. Refer to Rule 62-300 (4) of the Canadian Electrical Code.

Termination Kits

Designed Specifically for 3M™ Heating Cables

Product Specifications

18-SXG-KIT...nonhazardous power connection kit includes rubber boot, RTV adhesive, grommet and gland connector. Junction box not included.

ECA-1-SR-SP . . . is 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

ECT-2-SR . . . is 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

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.

ET-4S...end termination kits are designed specifically for Roof & Gutter applications. Each kit contains one U.V. resistant Heat Shrink end cap.

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.

Termination Kits

Designed Specifically for 3M™ Heating Cables

HS-TBSK... Heat shrink Tee splice kit 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. Used in ordinary non-hazardous locations.

KSR-CFK... Circuit fabrication kit is designed to fabricate a KSR 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.

KSR-EJK... Expansion joint kit is designed to allow KSR 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.

KSR-SR-DB... 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.

PCA-1-SR...is 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

PCS-1-SR...re-enterable in-line or T-splice kit is designed to fabricate outside-the-insulation splices of 3M TTS 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

Controls and Sensors

Designed to Compliment 3M™ Heating Cables

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.

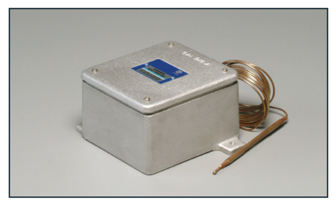
The R1 thermostat is approved for indoor/protected use in ordinary (nonclassified) locations. The R3 is approved for indoor/outdoor use in ordinary (nonclassified) locations.

Thermostats:

Indoor

R1... 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



R3...A gasketed cast aluminum enclosure provides weatherproof protection to the thermostat switch and internal setpoint dial.

Sensors:

Snow / Ice: Use in ordinary non-hazardous locations.

STC-DS-2B...stand-alone snow and ice sensor/controller. 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-2B 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.

Gutter, Snow / Ice: Use in ordinary non-hazardous locations.

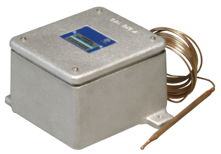
STC-DS-8...gutter snow and ice sensor/ controller. This unit includes remote sensor capabilities with a 10-foot lead wire, which allows sensor placement directly in gutters or downspouts. Controller includes an adjustable temperature trigger set point from 1° C to 7° C (34° F to 44° F) with manual on/off, 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.

Controls and Sensors

Designed to Compliment 3M™ Heating Cables

Ratings/Specifications for R1 / R3 . . .

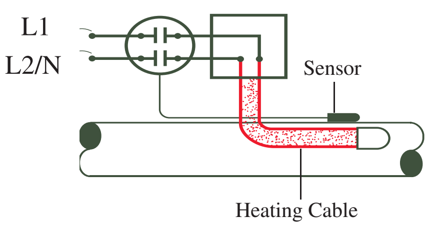
Voltage rating	240 Vac
Switch rating	25 amps
Switch type	DPST
Electrical connection	
R1[1]	screw terminals on switch
R3[2]	12 AWG leads
Adjustable control range	
R1	0° C to 50° C (32° F to 122° F)
R3	0° C to 120° C (32° F to 248° F)
Maximum control differential	
R1	1.8° C (32° F)
R3	4.3° C (7.7° F)
Setpoint 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 x 300 mm (1/4" x 12")
R3	6 x 140 mm (1/4" x 5-1/2")
Bulb material	copper
Capillary length	300 cm (10')
Capillary material	copper



R3

R1

Typical Wiring Diagram . . .

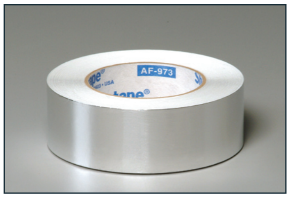


Notes . . .

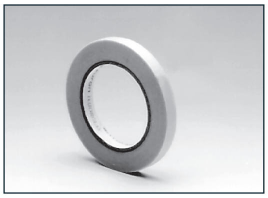
1. The R1 includes two ½" or ¾" conduit knockouts with an internal grounding terminal.
2. The R3 includes two ½" NPT conduit hubs with an internal grounding terminal.

Installation Accessories

Designed to Compliment 3M™ Heating Cables



AL-20P...aluminum tape for securing cable in the bottom of a gutter or on a non-metallic pipe. Tape is designed to hold cable in place and prevent movement. Allow one foot of tape for each foot of heating cable. Tape is 51 mm (2") wide x 46 m (150') long.



BTape...fibreglass cloth tape for circumferential banding cable to piping every 30 cm (12") or as required by code or specification. Tape is 13 mm (1/2") wide x 55 m (180') long.
Max. Exposure Temp 150° C (300° F)
Min. Installation Temp 0° C (32° F)
Min. Operating Temp -40° C (-40° F)

B-9, B-21...stainless steel attachment bands for securing Thermon metallic and nonmetallic power connection and splice kits to pipes. Each kit includes two B-9 bands.

B-9...for pipes up to 203 mm (8") diameter

B-21...for pipes up to 530 mm (21") diameter

CL...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).

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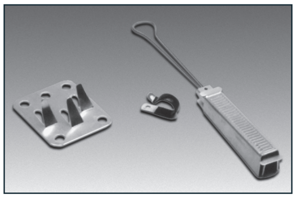
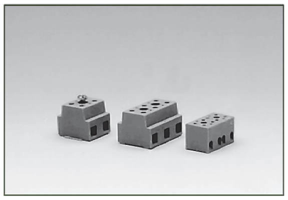


RG-CRF...cable roof fastener (left) is designed to hold heating cable in place and is suitable for most types of roof surfaces. The fastener can be secured to the roof with screws (a waterproof cover material is recommended) or adhesive. (Screws, waterproofing and adhesive are not included.) (25/bag)

RG-CMC...cable mounting clip (center) 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)

RG-DCH...downspout cable hanger (right) 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.



TB-2F, TB-3F, TB-4F...2, 3 or 4 point floating terminal blocks for use inside metallic and nonmetallic junction boxes.

Pipe Freeze Protection Systems
Design Form

3M THERMON®

Date: Project Name:

Customer Name: Phone # : Fax # :

Design Information:

Sketch Layout If Required

Pipe Supports / Hangers are assumed every 20' otherwise: ____________

Number of Valves ________ Number of Flanges ________ Number of Pumps ________

Type of Valves ☐ Screwed ☐ Flanged ☐ Welded Types of Pumps ☐ Screwed ☐ Flanged

Minimum Ambient Temperature (Coldest expected temperature): Indoors ______ ºC Outdoors ______ ºC

Desired Maintenance Temperature ______ What size of EPD Breakers are Available ______ Amps

Voltage		120	208	240	Other
	Preferred	☐	☐	☐	______
	Available	☐	☐	☐	______

Insulation Type ____________ Insulation Thickness ____________

Pipe Material: Metallic ☐ Non Metallic ☐

Pipe Diameter & Length ____________ Area Classification: Non Hazardous ☐ Hazardous ☐

____________ Type of Control: Ambient Sensing ☐ Line-sensing ☐

____

Notes:

Recommended Bill of Materials

Item	Description	Qty	Cost	Extended Cost

Roof & Gutter Snow Melting Systems
Design Form

Date: Project Name:

Customer Name: Phone # : Fax # :

Design Information:

Preferred Voltage Available	120	208	240	Other

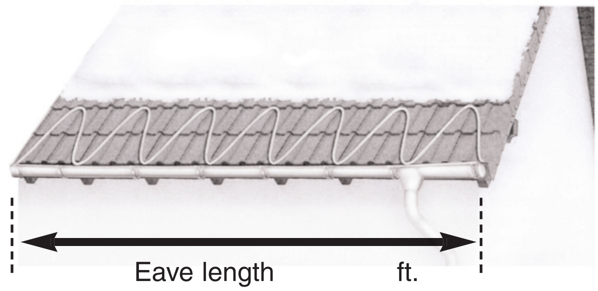
EPD Breaker Size ________ AMPS

Minimum Ambient Temperature ____________
(coldest expected outside temp)

Snow Conditions: Moderate (< 1" / hour) ☐
Heavy (1" – 2" / hr) ☐

Roof Type Metal ☐ Space Between Metal Seams ______
Tile ☐
Shingle ☐

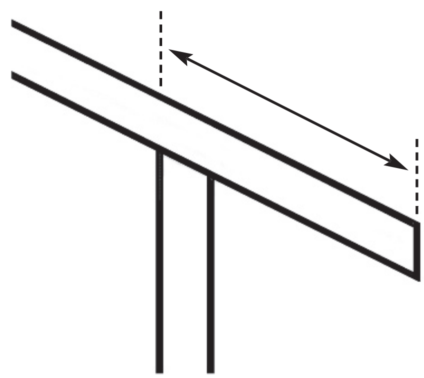
Type of Control Ambient Thermostat ☐
Snow Sensor ☐



Eave length ______ ft.

Gutter width ______ in.

Note: Mark on above diagram
- downspout length(s) and location
- power point location(s)



Overhang distance ______ in.

Notes:

Recommended Bill of Materials

Item	Description	Qty	Cost	Extended Cost

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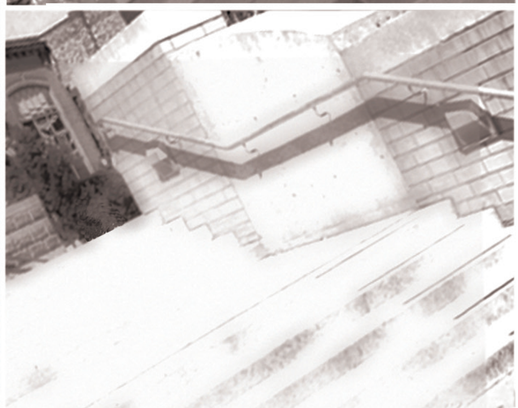

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