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PRECISION HEAT AND CONTROL

Electrical Heat Tracing Systems Design Guide



ELECTRICAL HEAT TRACING SYSTEMS

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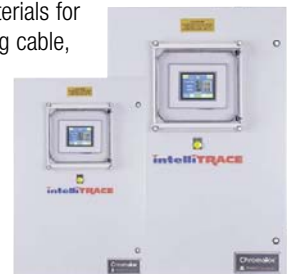
INTRODUCTION



This design guide provides a step-by-step approach for the design, specification, and selection of a bill of materials for an electric heat tracing system. Electric heat tracing systems are designed to make up for the heat lost from process system equipment through the thermal insulation. In some cases, the heat tracing system can be used for system heat-up at initial startup or after a power shutdown.



The information in this design guide will allow the user to design, specify, and select a complete bill of materials for freeze protection or process maintenance applications for a piping system or tank. By following the steps in this guide the user can easily select a complete bill of materials for the system, including heating cable, connection accessories, and temperature controls.



THERMAL DESIGN – PIPES

The first step in designing a heat trace system is to determine the heat loss from each pipe or tank to be traced. Collect the following data for each pipe (for tank applications go to page 6). Then follow the steps below to determine the heat loss.

Maintenance Temperature, T_m : _____
 Minimum Ambient Temperature, T_a : _____
 Location, Indoor/Outdoor: _____
 Wind Speed, if applicable: _____
 Nominal Pipe/Tubing Size, D_p : _____
 Additional Safety Factor, if required: _____
 Thermal Insulation Type and Thickness: _____

Example:

English

Maintenance Temperature, T_m : 40°F
 Minimum Ambient Temperature, T_a : -20°F
 Location, Indoor/Outdoor: Outdoor
 Wind Speed, if applicable: 10 mph
 Nominal Pipe/Tubing Size, D_p : 3" Steel
 Additional Safety Factor, if required: None
 Thermal Insulation Type and Thickness: 2" Cellular Glass

Example:

Metric

Maintenance Temperature, T_m : 4.4°C
 Minimum Ambient Temperature, T_a : -28.9°C
 Location, Indoor/Outdoor: Outdoor
 Wind Speed, if applicable: 16 kph
 Nominal Pipe/Tubing Size, D_p : 76 mm Steel
 Additional Safety Factor, if required: None
 Thermal Insulation Type and Thickness: 51 mm Cellular Glass

Step 1. Calculate ΔT

$\Delta T = T_m - T_a$

English
 = 40°F - (-20°F)
 = 60°F

Metric
 = 4.4°C - (-28.9°C)
 = 33.3°C

Step 2. Determine Pipe Heat Loss

Find Q_p in Table 1 (page 2) for the nominal pipe size and insulation thickness based on ΔT .

For example, for a 3" (76 mm) pipe with 2" (51 mm) insulation and $\Delta T = 60^\circ\text{F}$ (33.3°C), the value for Q_p is 5.5 W/ft (10.8 W/m).

Step 3. Adjust for Insulation

Table 1 (page 2) is based on ASTM C547 Fiberglas® insulation.

Q_p , as found in the step above, must be adjusted for the insulation type. Multiply your heat loss by I_a , the Insulation Adjustment Factor, from the values in Table 2 (page 5).

$Q_F = Q_p \times I_a$

For Cellular Glass, $I_a = 1.48$

English

$Q_F = 3.3 \text{ W/ft} \times 1.48$
 = 4.88 W/ft

Metric

$Q_F = 10.8 \text{ W/m} \times 1.48$
 = 15.98 W/m

Step 4. Correct for Indoor Location/Windspeed

If location is indoors multiply Q_F by 0.9.

Step 5. Correct for Additional Safety Factor

Table 1 is based on 10% safety factor and 20 mph (32 kph) windspeed, add 5% margin for each 5 mph (8 kph) over 20 mph (32 kph).



THERMAL DESIGN-PIPES

THERMAL DESIGN-PIPES



Table 1
Pipe Heat Loss (Q_p) in W/ft and W/m Based on Temperature Differential and Insulation Thickness

Nominal Pipe Size, in. (ID) mm (OD)	Temperature Difference Between Pipe and Ambient															
	Deg°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	140°F	160°F	180°F	200°F	220°F	240°F	260°F
	Deg°C	23.0°C	28.0°C	33.4°C	39.0°C	44.5°C	50.0°C	55.6°C	66.7°C	77.8°C	88.9°C	100.0°C	111.1°C	122.2°C	133.4°C	144.5°C
1" (25.4 mm) Insulation Thickness																
1/2"	W/ft	1.4	1.8	2.1	2.5	2.8	3.2	3.5	4.2	5.1	5.9	6.6	7.7	8.5	9.2	10.0
21.3 mm	W/m	4.6	5.9	6.9	8.2	9.2	10.5	11.5	13.8	16.7	19.4	21.7	25.3	27.9	30.2	32.8
3/4"	W/ft	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.8	5.9	6.7	7.6	8.8	9.7	10.6	11.4
26.7 mm	W/m	5.2	6.6	7.9	9.2	10.5	11.8	13.1	15.7	19.4	22.0	24.9	28.9	31.8	34.8	37.4
1"	W/ft	1.8	2.3	2.8	3.2	3.7	4.1	4.6	5.5	6.8	7.7	8.7	10.1	11.1	12.1	13.2
33.4 mm	W/m	5.9	7.5	9.2	10.5	12.1	13.5	15.1	18.0	22.3	25.3	28.5	33.1	36.4	39.7	43.3
1 1/2"	W/ft	2.4	3.1	3.7	4.3	4.9	5.5	6.1	7.3	9.0	10.2	11.5	13.4	14.8	16.1	17.4
48.3 mm	W/m	7.9	10.2	12.1	14.1	16.1	18.0	20.0	24.0	29.5	33.5	37.7	44.0	48.6	52.8	57.1
2"	W/ft	2.8	3.5	4.1	4.8	5.5	6.2	6.9	8.3	10.1	11.6	13.0	15.2	16.7	18.2	19.7
60.3 mm	W/m	9.2	11.5	13.5	15.7	18.0	20.3	22.6	27.2	33.1	38.1	42.7	49.9	54.8	59.7	64.6
2 1/2"	W/ft	3.2	4.0	4.8	5.6	6.4	7.2	8.0	9.6	11.8	13.4	15.1	17.6	19.4	21.1	22.9
73.0 mm	W/m	10.5	13.1	15.7	18.4	21.0	23.6	26.2	31.5	38.7	44.0	49.5	57.7	63.7	69.2	75.1
3"	W/ft	3.7	4.7	5.6	6.5	7.4	8.4	9.3	11.2	13.7	15.6	17.6	20.5	22.5	24.6	26.6
88.9 mm	W/m	12.1	15.4	18.4	21.3	24.3	27.6	30.5	36.7	44.9	51.2	57.7	67.3	73.8	80.7	87.3
4"	W/ft	4.6	5.8	6.9	8.1	9.2	10.4	11.5	13.8	16.9	19.3	21.7	25.3	27.8	30.4	32.9
114.3 mm	W/m	15.1	19.0	22.6	26.6	30.2	34.1	37.7	45.3	55.4	63.3	71.2	83.0	91.2	99.7	107.9
6"	W/ft	6.4	8.0	9.6	11.2	12.8	14.4	16.0	19.2	23.5	26.9	30.2	35.2	38.7	42.2	45.8
168.3 mm	W/m	21.0	26.2	31.5	36.7	42.0	47.2	52.5	63.0	77.1	88.3	99.1	115.5	127.0	138.5	150.3
8"	W/ft	8.1	10.1	12.1	14.1	16.2	18.2	20.2	24.2	29.7	33.9	38.2	44.4	48.9	53.3	57.8
219.1 mm	W/m	26.6	33.1	39.7	46.3	53.2	59.7	66.3	79.4	97.4	111.2	125.3	145.7	160.4	174.9	189.6
10"	W/ft	9.9	12.4	14.8	17.3	19.8	22.2	24.7	29.6	36.3	41.5	46.7	54.3	59.8	65.2	70.6
273.1 mm	W/m	32.5	40.7	48.6	56.8	65.0	72.8	81.0	97.1	119.1	136.2	153.2	178.2	196.2	213.9	231.6
12"	W/ft	11.6	14.5	17.4	20.3	23.2	26.1	29.0	34.8	42.6	48.7	54.8	63.8	70.2	76.6	82.9
323.9 mm	W/m	38.1	47.6	57.1	66.6	76.1	85.6	95.1	114.2	139.8	159.8	179.8	209.3	230.3	251.3	272.0
14"	W/ft	12.6	15.8	19.0	22.1	25.3	28.4	31.6	37.9	46.5	53.1	59.7	69.5	76.5	83.4	90.4
355.6 mm	W/m	41.3	51.8	62.3	72.5	83.0	93.2	103.7	124.3	152.6	174.2	195.9	228.0	251.0	273.6	296.6
16"	W/ft	14.3	17.9	21.5	25.1	28.7	32.3	35.9	43.0	52.7	60.2	67.8	78.9	86.8	94.6	102.5
406.4 mm	W/m	46.9	58.7	70.5	82.4	94.2	106.0	117.8	141.1	172.9	197.5	222.5	258.9	284.8	310.4	336.3
18"	W/ft	16.0	20.1	24.1	28.1	32.1	36.1	40.1	48.1	58.9	67.4	75.8	88.2	97.0	105.9	114.7
457.2 mm	W/m	52.5	65.9	79.1	92.2	105.3	118.4	131.6	157.8	193.3	221.1	248.7	289.4	318.3	347.5	376.3
20"	W/ft	17.7	22.2	26.6	31.0	35.4	39.9	44.3	53.2	65.1	74.4	83.7	97.5	107.2	117.0	126.7
508.0 mm	W/m	58.1	72.8	87.3	101.7	116.1	130.9	145.3	174.5	213.6	244.1	274.6	319.9	351.7	383.9	415.7
22"	W/ft	19.4	24.3	29.1	34.0	38.8	43.7	48.5	58.2	71.3	81.5	91.7	106.7	117.4	128.0	138.7
558.8 mm	W/m	63.7	79.7	95.5	111.6	127.3	143.4	159.1	191.0	233.9	267.4	300.9	350.1	385.2	420.0	455.1
24"	W/ft	21.1	26.4	31.6	36.9	42.2	47.4	52.7	63.2	77.5	88.5	99.6	115.9	127.5	139.1	150.7
609.6 mm	W/m	69.2	86.6	103.7	121.1	138.5	155.5	172.9	207.4	254.3	290.4	326.8	380.3	418.3	456.4	494.4

Table 1 cont'd.

Nominal Pipe Size, in. (ID) mm (OD)	Temperature Difference Between Pipe and Ambient															
	Deg°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	140°F	160°F	180°F	200°F	220°F	240°F	260°F
	Deg°C	23.0°C	28.0°C	33.4°C	39.0°C	44.5°C	50.0°C	55.6°C	66.7°C	77.8°C	88.9°C	100.0°C	111.1°C	122.2°C	133.4°C	144.5°C
1.5" (38 mm) Insulation Thickness																
½"	W/ft	1.1	1.4	1.7	2.0	2.2	2.5	2.8	3.5	4.1	4.7	5.5	6.2	6.8	7.4	8.0
21.3 mm	W/m	3.6	4.6	5.6	6.6	7.2	8.2	9.2	11.5	13.5	15.4	18.0	20.3	22.3	24.3	26.2
¾"	W/ft	1.2	1.6	1.9	2.2	2.5	2.8	3.1	3.9	4.6	5.2	6.1	6.8	7.5	8.2	8.9
26.7 mm	W/m	3.9	5.2	6.2	7.2	8.2	9.2	10.2	12.8	15.1	17.1	20.0	22.3	24.6	26.9	29.2
1"	W/ft	1.4	1.8	2.2	2.5	2.9	3.2	3.6	4.5	5.3	6.0	7.1	7.9	8.7	9.5	10.3
33.4 mm	W/m	4.6	5.9	7.2	8.2	9.5	10.5	11.8	14.8	17.4	19.7	23.3	25.9	28.5	31.2	33.8
1½"	W/ft	1.8	2.3	2.8	3.2	3.7	4.1	4.6	5.8	6.8	7.7	9.1	10.1	11.1	12.1	13.2
48.3 mm	W/m	5.9	7.5	9.2	10.5	12.1	13.5	15.1	19.0	22.3	25.3	29.9	33.1	36.4	39.7	43.3
2"	W/ft	2.1	2.6	3.1	3.6	4.2	4.7	5.2	6.6	7.6	8.7	10.3	11.4	12.6	13.7	14.9
60.3 mm	W/m	6.9	8.5	10.2	11.8	13.8	15.4	17.1	21.7	24.9	28.5	33.8	37.4	41.3	44.9	48.9
2½"	W/ft	2.4	3.0	3.5	4.1	4.7	5.3	5.9	7.4	8.7	9.9	11.7	13.0	14.3	15.6	16.9
73.0 mm	W/m	7.9	9.8	11.5	13.5	15.4	17.4	19.4	24.3	28.5	32.5	38.4	42.7	46.9	51.2	55.4
3"	W/ft	2.7	3.4	4.1	4.8	5.4	6.1	6.8	8.6	10.0	11.4	13.5	15.0	16.5	18.0	19.4
88.9 mm	W/m	8.9	11.2	13.5	15.7	17.7	20.0	22.3	28.2	32.8	37.4	44.3	49.2	54.1	59.1	63.7
4"	W/ft	3.3	4.2	5.0	5.8	6.6	7.5	8.3	10.5	12.2	13.9	16.4	18.3	20.1	21.9	23.7
114.3 mm	W/m	10.8	13.8	16.4	19.0	21.7	24.6	27.2	34.5	40.0	45.6	53.8	60.0	65.9	71.9	77.8
6"	W/ft	4.5	5.7	6.8	7.9	9.0	10.2	11.3	14.2	16.6	19.0	22.4	24.9	27.3	29.8	32.3
168.3 mm	W/m	14.8	18.7	22.3	25.9	29.5	33.5	37.1	46.6	54.5	62.3	73.5	81.7	89.6	97.8	106.0
8"	W/ft	5.6	7.1	8.5	9.9	11.3	12.7	14.1	17.8	20.7	23.7	27.9	31.0	34.1	37.2	40.3
219.1 mm	W/m	18.4	23.3	27.9	32.5	37.1	41.7	46.3	58.4	67.9	77.8	91.5	101.7	111.9	122.1	132.2
10"	W/ft	6.8	8.0	10.3	12.0	13.7	15.4	17.1	21.5	25.1	28.7	33.9	37.6	41.4	45.1	48.9
273.1 mm	W/m	22.3	26.2	33.8	39.4	44.9	50.5	56.1	70.5	82.4	94.2	111.2	123.4	135.8	148.0	160.4
12"	W/ft	8.0	10.0	12.0	14.0	16.0	18.0	20.0	25.2	29.4	33.6	39.6	44.0	48.4	52.8	57.2
323.9 mm	W/m	26.2	32.8	39.4	45.9	52.5	59.1	65.6	82.7	96.5	110.2	129.9	144.4	158.8	173.2	187.7
14"	W/ft	8.7	10.9	13.0	15.2	17.4	19.5	21.7	27.3	31.9	36.5	43.0	47.7	52.5	57.3	62.1
355.6 mm	W/m	28.5	35.8	42.7	49.9	57.1	64.0	71.2	89.6	104.7	119.8	141.1	156.5	172.3	188.0	203.8
16"	W/ft	9.8	12.3	14.8	17.2	19.7	22.1	24.6	31.0	36.2	41.3	48.7	54.1	59.5	64.9	70.4
406.4 mm	W/m	32.2	40.4	48.6	56.4	64.6	72.5	80.7	101.7	118.8	135.5	159.8	177.5	195.2	212.9	231
18"	W/ft	11.0	13.7	16.4	19.2	21.9	24.7	27.4	34.5	40.3	46.0	54.3	60.3	66.3	72.3	78.4
457.2 mm	W/m	36.1	44.9	53.8	63.0	71.9	81.0	89.9	113.2	132.2	150.9	178.2	197.8	217.5	237.2	257.2
20"	W/ft	12.1	15.1	18.1	21.1	24.2	27.2	30.2	38.1	44.4	50.7	59.8	66.4	73.1	79.7	86.4
508.0 mm	W/m	39.7	49.5	59.4	69.2	79.4	89.2	99.1	125.0	145.7	166.3	196.2	217.9	239.8	261.5	283.5
22"	W/ft	13.2	16.5	19.8	23.1	26.4	29.7	33.0	41.6	48.5	55.4	65.3	72.6	79.9	87.1	94.4
558.8 mm	W/m	43.3	54.1	65.0	75.8	86.6	97.4	108.3	136.5	159.1	181.8	214.2	238.2	262.2	285.8	309.7
24"	W/ft	14.3	17.9	21.5	25.1	28.6	32.2	35.8	45.1	52.6	60.1	70.9	78.8	86.6	94.5	102.4
609.6 mm	W/m	46.9	58.7	70.5	82.4	93.8	105.6	117.5	148.0	172.6	197.2	232.6	258.5	284.1	310.1	336.0

THERMAL DESIGN - THERMAL PIPES



Table 1 cont'd.

Nominal Pipe Size, in. (ID) mm (OD)	Temperature Difference Between Pipe and Ambient															
	Deg°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	140°F	160°F	180°F	200°F	220°F	240°F	260°F
	Deg°C	23.0°C	28.0°C	33.4°C	39.0°C	44.5°C	50.0°C	55.6°C	66.7°C	77.8°C	88.9°C	100.0°C	111.1°C	122.2°C	133.4°C	144.5°C
2" (50.8mm) Insulation Thickness																
1/2"	W/ft	1.0	1.2	1.4	1.7	1.9	2.2	2.4	3.0	3.5	4.0	4.8	5.3	5.8	6.3	7.2
21.3 mm	W/m	3.3	3.9	4.6	5.6	6.2	7.2	7.9	9.8	11.5	13.1	15.7	17.4	19.0	20.7	23.6
3/4"	W/ft	1.1	1.4	1.6	1.9	2.2	2.4	2.7	3.4	4.0	4.5	5.3	5.9	6.5	7.1	8.1
26.7 mm	W/m	3.6	4.6	5.2	6.2	7.2	7.9	8.9	11.2	13.1	14.8	17.4	19.4	21.3	23.3	26.6
1"	W/ft	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.8	4.4	5.0	5.9	6.6	7.3	7.9	9.0
33.4 mm	W/m	3.9	4.9	5.9	6.9	7.9	8.9	9.8	12.5	14.4	16.4	19.4	21.7	24.0	25.9	29.5
1 1/2"	W/ft	1.5	1.9	2.3	2.7	3.0	3.4	3.8	4.8	5.6	6.4	7.5	8.4	9.2	10.0	11.4
48.3 mm	W/m	4.9	6.2	7.5	8.9	9.8	11.2	12.5	15.7	18.4	21.0	24.6	27.6	30.2	32.8	37.4
2"	W/ft	1.7	2.2	2.6	3.0	3.4	3.9	4.3	5.4	6.3	7.2	8.5	9.5	10.4	11.4	12.9
60.3 mm	W/m	5.6	7.2	8.5	9.8	11.2	12.8	14.1	17.7	20.7	23.6	27.9	31.2	34.1	37.4	42.3
2 1/2"	W/ft	1.9	2.4	2.9	3.4	3.8	4.3	4.8	6.0	7.1	8.1	9.5	10.6	11.6	12.7	14.4
73.0 mm	W/m	6.2	7.9	9.5	11.2	12.5	14.1	15.7	19.7	23.3	26.6	31.2	34.8	38.1	41.7	47.2
3"	W/ft	2.2	2.8	3.3	3.9	4.4	5.0	5.5	6.9	8.1	9.2	10.9	12.1	13.3	14.5	16.4
88.9 mm	W/m	7.2	9.2	10.8	12.8	14.4	16.4	18.0	22.6	26.6	30.2	35.8	39.7	43.6	47.6	53.8
4"	W/ft	2.6	3.3	4.0	4.6	5.3	5.9	6.6	8.3	9.7	11.1	13.1	14.5	16.0	17.4	19.7
114.3 mm	W/m	8.5	10.8	13.1	15.1	17.4	19.4	21.7	27.2	31.8	36.4	43.0	47.6	52.5	57.1	64.6
6"	W/ft	3.6	4.5	5.3	6.2	7.1	8.0	8.9	11.2	13.1	15.0	17.6	19.6	21.5	23.5	26.6
168.3 mm	W/m	11.8	14.8	17.4	20.3	23.3	26.2	29.2	36.7	43.0	49.2	57.7	64.3	70.5	77.1	87.3
8"	W/ft	4.4	5.6	6.7	7.8	8.9	10.0	11.1	14.0	16.3	18.6	22.0	24.4	26.9	29.3	33.2
219.1 mm	W/m	14.4	18.4	22.0	25.6	29.2	32.8	36.4	45.9	53.5	61.0	72.2	80.1	88.3	96.1	108.9
10"	W/ft	5.3	6.7	8.0	9.3	10.6	12.0	13.3	16.8	19.6	22.3	26.3	29.3	32.2	35.1	39.8
273.1 mm	W/m	17.4	22.0	26.2	30.5	34.8	39.4	43.6	55.1	64.3	73.2	86.3	96.1	105.6	115.2	130.6
12"	W/ft	6.2	7.8	9.3	10.9	12.4	14.0	15.5	19.5	22.8	26.0	30.7	34.1	37.5	40.9	46.3
323.9 mm	W/m	20.3	25.6	30.5	35.8	40.7	45.9	50.9	64.0	74.8	85.3	100.7	111.9	123.0	134.2	151.9
14"	W/ft	6.7	8.4	10.1	11.8	13.4	15.1	16.8	21.2	24.7	28.2	33.3	37.0	40.7	44.4	50.2
355.6 mm	W/m	22.0	27.6	33.1	38.7	44.0	49.5	55.1	69.6	81.0	92.5	109.3	121.4	133.5	145.7	164.7
16"	W/ft	7.6	9.5	11.3	13.2	15.1	17.0	18.9	23.8	27.8	31.8	37.4	41.6	45.7	49.9	56.5
406.4 mm	W/m	24.9	31.2	37.1	43.3	49.5	55.8	62.0	78.1	91.2	104.3	122.7	136.5	149.9	163.7	185.4
18"	W/ft	8.4	10.5	12.6	14.7	16.8	18.9	21.0	26.5	30.9	35.3	41.6	46.2	50.8	55.4	62.8
457.2 mm	W/m	27.6	34.5	41.3	48.2	55.1	62.0	68.9	86.9	101.4	115.8	136.5	151.6	166.7	181.8	206.0
20"	W/ft	9.2	11.6	13.9	16.2	18.5	20.8	23.1	29.1	34.0	38.8	45.7	50.8	55.9	61.0	69.1
508.0 mm	W/m	30.2	38.1	45.6	53.2	60.7	68.2	75.8	95.5	111.6	127.3	149.9	166.7	183.4	200.1	226.7
22"	W/ft	10.1	12.6	15.2	17.7	20.2	22.7	25.3	31.8	37.1	42.4	50.0	55.6	61.1	66.7	75.5
558.8 mm	W/m	33.1	41.3	49.9	58.1	66.3	74.5	83.0	104.3	121.7	139.1	164.1	182.4	200.5	218.8	247.7
24"	W/ft	11.0	13.7	16.4	19.2	21.9	24.7	27.4	34.5	40.3	46.0	54.3	60.3	66.3	72.3	81.9
609.6 mm	W/m	36.1	44.9	53.8	63.0	71.9	81.0	89.9	113.2	132.2	150.9	178.2	197.8	217.5	237.2	268.7

Table 1 cont'd.

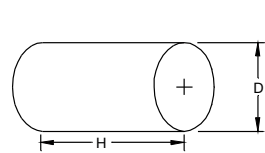
Nominal Pipe Size, in. (ID) mm (OD)	Temperature Difference Between Pipe and Ambient															
	Deg°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	140°F	160°F	180°F	200°F	220°F	240°F	260°F
	Deg°C	23.0°C	28.0°C	33.4°C	39.0°C	44.5°C	50.0°C	55.6°C	66.7°C	77.8°C	88.9°C	100.0°C	111.1°C	122.2°C	133.4°C	144.5°C
3" (76.2 mm) Insulation Thickness																
½"	W/ft	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.5	2.9	3.4	4.0	4.4	4.8	5.5	6.0
21.3 mm	W/m	2.6	3.3	3.9	4.6	5.2	5.9	6.6	8.2	9.5	11.2	13.1	14.4	15.7	18.0	19.7
¾"	W/ft	0.9	1.1	1.3	1.5	1.8	2.0	2.2	2.8	3.2	3.7	4.4	4.8	5.3	6.1	6.6
26.7 mm	W/m	3.0	3.6	4.3	4.9	5.9	6.6	7.2	9.2	10.5	12.1	14.4	15.7	17.4	20.0	21.7
1"	W/ft	1.0	1.3	1.5	1.8	2.0	2.3	2.5	3.2	3.7	4.2	5.0	5.5	6.1	6.9	7.5
33.4 mm	W/m	3.3	4.3	4.9	5.9	6.6	7.5	8.2	10.5	12.1	13.8	16.4	18.0	20.0	22.6	24.6
1½"	W/ft	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.8	4.4	5.0	5.9	6.6	7.3	8.3	9.0
48.3 mm	W/m	3.9	4.9	5.9	6.9	7.9	8.9	9.8	12.5	14.4	16.4	19.4	21.7	24.0	27.2	29.5
2"	W/ft	1.3	1.7	2.0	2.3	2.6	3.0	3.3	4.2	4.9	5.5	6.5	7.3	8.0	9.1	9.9
60.3 mm	W/m	4.3	5.6	6.6	7.5	8.5	9.8	10.8	13.8	16.1	18.0	21.3	24.0	26.2	29.9	32.5
2½"	W/ft	1.5	1.9	2.2	2.6	3.0	3.3	3.7	4.7	5.4	6.2	7.3	8.1	9.0	10.2	11.1
73.0 mm	W/m	4.9	6.2	7.2	8.5	9.8	10.8	12.1	15.4	17.7	20.3	24.0	26.6	29.5	33.5	36.4
3"	W/ft	1.7	2.1	2.5	2.9	3.4	3.8	4.2	5.3	6.2	7.1	8.3	9.2	10.2	11.6	12.6
88.9 mm	W/m	5.6	6.9	8.2	9.5	11.2	12.5	13.8	17.4	20.3	23.3	27.2	30.2	33.5	38.1	41.3
4"	W/ft	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.3	7.4	8.4	9.9	11.0	12.1	13.8	15.0
114.3 mm	W/m	6.6	8.2	9.8	11.5	13.1	14.8	16.4	20.7	24.3	27.6	32.5	36.1	39.7	45.3	49.2
6"	W/ft	2.6	3.3	3.9	4.6	5.2	5.9	6.5	8.2	9.6	10.9	12.9	14.3	15.7	17.9	19.4
168.3 mm	W/m	8.5	10.8	12.8	15.1	17.1	19.4	21.3	26.9	31.5	35.8	42.3	46.9	51.5	58.7	63.7
8"	W/ft	3.2	4.0	4.8	5.6	6.4	7.2	8.0	10.1	11.8	13.4	15.8	17.6	19.4	22.1	23.9
219.1 mm	W/m	10.5	13.1	15.7	18.4	21.0	23.6	26.2	33.1	38.7	44.0	51.8	57.7	63.7	72.5	78.4
10"	W/ft	3.8	4.8	5.7	6.7	7.6	8.6	9.5	12.0	14.0	16.0	18.8	20.9	23.0	26.2	28.4
273.1 mm	W/m	12.5	15.7	18.7	22.0	24.9	28.2	31.2	39.4	45.9	52.5	61.7	68.6	75.5	86.0	93.2
12"	W/ft	4.4	5.5	6.5	7.6	8.7	9.8	10.9	13.7	16.0	18.3	21.6	24.0	26.4	30.1	32.6
323.9 mm	W/m	14.4	18.0	21.3	24.9	28.5	32.2	35.8	44.9	52.5	60.0	70.9	78.7	86.6	98.8	107.0
14"	W/ft	4.7	5.9	7.1	8.3	9.4	10.6	11.8	14.9	17.3	19.8	23.4	26.0	28.6	32.6	35.3
355.6 mm	W/m	15.4	19.4	23.3	27.2	30.8	34.8	38.7	48.9	56.8	65.0	76.8	85.3	93.8	107.0	115.8
16"	W/ft	5.3	6.7	8.0	9.3	10.6	12.0	13.3	16.8	19.6	22.3	26.3	29.3	32.2	36.7	39.8
406.4 mm	W/m	17.4	22.0	26.2	30.5	34.8	39.4	43.6	55.1	64.3	73.2	86.3	96.1	105.6	120.4	130.6
18"	W/ft	5.9	7.4	8.8	10.3	11.8	13.2	14.7	18.5	21.6	24.7	29.1	32.3	35.6	40.6	44.0
457.2 mm	W/m	19.4	24.3	28.9	33.8	38.7	43.3	48.2	60.7	70.9	81.0	95.5	106.0	116.8	133.2	144.4
20"	W/ft	6.4	8.1	9.7	11.3	12.9	14.5	16.1	20.3	23.7	27.0	31.9	35.4	39.0	44.4	48.1
508.0 mm	W/m	21.0	26.6	31.8	37.1	42.3	47.6	52.8	66.6	77.8	88.6	104.7	116.1	128.0	145.7	157.8
22"	W/ft	7.0	8.8	10.5	12.3	14.0	15.8	17.5	22.1	25.7	29.4	34.7	38.5	42.4	48.3	52.3
558.8 mm	W/m	23.0	28.9	34.5	40.4	45.9	51.8	57.4	72.5	84.3	96.5	113.9	126.3	139.1	158.5	171.6
24"	W/ft	7.6	9.5	11.3	13.2	15.1	17.0	18.9	23.8	27.8	31.8	37.4	41.6	45.7	52.2	56.5
609.6 mm	W/m	24.9	31.2	37.1	43.3	49.5	55.8	62.0	78.1	91.2	104.3	122.7	136.5	149.9	171.3	185.4

Table 2
Insulation Adjustment Factors

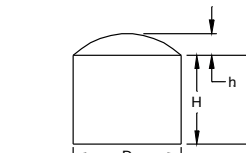
Pipe Insulation Type	Insulation Adjustment Factor
Glass fiber (ASTM C547)	1.00
Calcium silicate (ASTM C533)	1.48
Cellular glass (ASTM C552)	1.48
Rigid cellular urethane (ASTM C591)	0.64
Foamed elastomer (ASTM C534)	1.16
Mineral fiber blanket (ASTM C553)	1.16
Expanded perlite (ASTM C610)	1.90

THERMAL DESIGN - THERMAL PIPES

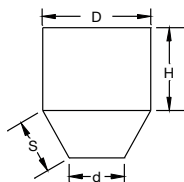
THERMAL DESIGN-TANKS



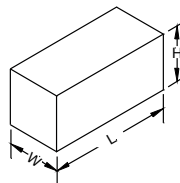
CYLINDRICAL TANK, FLAT
 AREA = AREA (ENDS) + AREA (SIDE)
 $= \pi D^2/2 + \pi DH$



CYLINDRICAL TANK, DISHED
 AREA = AREA (TOP) + AREA (SIDE)
 + AREA (BOTTOM)
 $= (\pi/4)(D^2 + 4h^2) + \pi DH + \pi D^2/4$



CYLINDRICAL TANK, CONICAL
 AREA = AREA (TOP) + AREA (SIDE)
 + AREA (CONE)
 $= \pi D^2/4 + \pi DH + (\pi/2)(D+d) \sqrt{\frac{(D-d)^2}{4} + h^2}$



RECTANGULAR TANK
 AREA = AREA (TOP) + AREA (SIDE)
 + AREA (BOTTOM)
 $= 2(WH + HL + WL)$

Table 3
Heat Loss (Q_T) for Various Insulation Thicknesses

Insulation Thickness		Heat Loss (Q _T)	
in.	mm	W/ft ² /°F	W/m ² /°C
1/2	12.7	0.161	3.120
1	25.4	0.081	1.569
1 1/2	38.1	0.054	1.046
2	50.8	0.040	0.775
3	76.2	0.027	0.523
4	101.6	0.020	0.388
5	127.0	0.016	0.130
6	152.4	0.013	0.252

NOTE: Heat loss values based on 20 mph (32 kph) wind, 10% safety factor, and Fiberglas® insulation at 50°F (10°C).

Collect the following information for each tank.

- Maintenance Temperature, T_m: _____
- Minimum Ambient Temperature, T_a: _____
- Location, Indoor/Outdoor: _____
- Wind Speed, if applicable: _____
- Tank Shape and Surface Area: _____
- Additional Safety Factor, if required: _____
- Thermal Insulation Type and Thickness: _____

Example:

- English**
- Maintenance Temperature, T_m: 40°F
 - Minimum Ambient Temperature, T_a: -20°F
 - Location, Indoor/Outdoor: Outdoor
 - Wind Speed, if applicable: 20 mph
 - Tank Shape and Surface Area: Steel Horizontal Cylinder 3 ft dia. 6 ft long
 - Additional Safety Factor, if required: None
 - Thermal Insulation Type and Thickness: 2" Cellular Glass

Example:

- Metric**
- Maintenance Temperature, T_m: 4.4°C
 - Minimum Ambient Temperature, T_a: -28.9°C
 - Location, Indoor/Outdoor: Outdoor
 - Wind Speed, if applicable: 32 kph
 - Tank Shape and Surface Area: Steel Horizontal Cylinder 0.92 m dia. 1.83 m long
 - Additional Safety Factor, if required: None
 - Thermal Insulation Type and Thickness: 51 mm Cellular Glass

Step 1. Calculate ΔT

$\Delta T = T_m - T_a$

English
 $= 40^\circ\text{F} - (-20^\circ\text{F})$
 $= 60^\circ\text{F}$

Metric
 $= 4.4^\circ\text{C} - (-28.9^\circ\text{C})$
 $= 33.3^\circ\text{C}$

Step 2. Determine Total Surface Area of Tank

Most tanks are a combination of shapes. Determine the surface area of each section and then add the areas for each section to determine the overall surface area, A.

$$A = \pi D^2/2 + \pi DH$$

English

$$= (3.14)(3 \text{ ft})^2/2 + (3.14)(3 \text{ ft})(6 \text{ ft})$$

$$= 70.7 \text{ ft}^2$$

Metric

$$= (3.14)(0.92 \text{ m})^2/2 + (3.14)(0.92 \text{ m})(1.83 \text{ m})$$

$$= 6.6 \text{ m}^2$$

Step 3. Determine Q_r

Find Q_r in Table 3 for the corresponding insulation thickness.

Step 4. Calculate Heat Loss, Q

$$Q = (Q_r)(\Delta T)(A)$$

English

$$= (0.040 \text{ W/ft}^2/\text{°F})(60\text{°F})(70.7 \text{ ft}^2)$$

$$= 170 \text{ W}$$

Metric

$$= (0.775 \text{ W/m}^2/\text{°C})(33.3\text{°C})(6.6\text{m}^2)$$

$$= 170 \text{ W}$$

Step 5. Adjust for Insulation

Q, as found in the step above, must be adjusted for the insulation type. Multiply your heat loss by I_a, the Insulation Adjustment Factor, from the values in Table 2.

Using the Insulation Adjustment Factor (I_a) for cellular glass (1.48):

$$Q_F = Q \times I_a$$

$$= 170 \text{ W} \times 1.48$$

$$= 252 \text{ W}$$

Step 6. Correct for Indoor Location/Windspeed

If the application is indoors, multiply Q_F by 0.9. Since Table 3 is based on 20 mph (32 kph) windspeed, add 5% margin for each additional 5 mph (8 kph) over 20 mph (32 kph).

Step 7. Correct for Additional Safety Factors

Step 8. Additional Equipment Heat Losses

Equipment such as ladders, manways, and support legs act as heat sinks and increase the overall heat loss of the tanks. For each piece of equipment, use Table 4 to calculate equipment heat loss and add to the heat loss calculated above.



For example, additional heat loss for 4 support legs:

$$Q_A = (Q_s) (\Delta T) \times \text{number of legs}$$

English

$$= (0.5 \text{ W/°F})(60\text{°F}) \times 4$$

$$= 120 \text{ W}$$

Metric

$$= (0.9 \text{ W/°C})(33.3\text{°C}) \times 4$$

$$= 120 \text{ W}$$

Step 9. Calculate the Cable Length Required

To determine the length required, take the total heat loss as calculated in the previous steps and divide by the chosen cable output at the maintenance temperature. (See Figures 1-4.)

$$Q = Q_F + Q_A$$

$$= 252 \text{ W} + 120 \text{ W}$$

$$= 372 \text{ W}$$

SRL5-CT Output @ 40°F = 4.8 W/ft

$$L = 372 \text{ W} \div 4.8 \text{ W/ft}$$

$$L = 78 \text{ ft}$$

Table 4
Tank Equipment Heat Loss Calculation (Q_s)

Support Legs	0.5 W/°F (0.9 W/°C) x number of legs
Ladder	2.5 W/°F (4.5 W/°C) x number of ladders
Manways	10.0 W/°F (18.0 W/°C) x number of manways

THERMAL DESIGN TANKS

HEATING CABLE SELECTION

HEATING CABLE SELECTION



To determine the correct cable for your application, determine the following information:

Maintenance Temperature = _____
 Max. Exposure Temperature = _____
 Pipe Material = _____
 Service Voltage = _____
 Chemical Environment = _____
 Area Classification = _____
 Heat Requirement (from Thermal Design Section) = _____

Example:

English

Maintenance Temperature = 40°F
 Max. Exposure Temperature = 100°F
 Pipe Material = Stainless Steel
 Service Voltage = 120V
 Chemical Environment = Organic
 Area Classification = CID2 Group B
 Heat Requirement (from Thermal Design Section) = 4.88 W/ft

Example:

Metric

Maintenance Temperature = 4.4°C
 Max. Exposure Temperature = 37.8°C
 Pipe Material = Stainless Steel
 Service Voltage = 120V
 Chemical Environment = Organic
 Area Classification = CID2 Group B
 Heat Requirement (from Thermal Design Section) = 15.98 W/m

Step 1. Select Heating Cable Family

Based on the maximum maintenance temperature, maximum exposure temperature, and area classification, select the heating cable family from Table 5.

Note: Maximum maintenance temperatures for constant wattage cables (CWM) are dependent upon cable wattage rating and the use of aluminum foil tape. See Table 6 (page 10).

Example:

Based on information, select the SRL (Self-Regulating Low Temperature) Cable Family.

Selection: SRL * - **

Table 5
Heating Cable Families

Heating Cable Family	Area Classification	Pipe Material	Maximum Maintenance Temperature		Maximum Exposure Temperature (Power Off)		Approvals	
			°F	°C	°F	°C	U.S.	Other
SRL (Self-Regulating Low Temperature)	Ordinary	Plastic/Metal	150°F	65°C	185°F	85°C	UL, CSA, FM	GOST, Cenelec, CE, ATEX
	Class I, Div. 2, Gr. B, C, D						CSA, FM (Gr. A, CSA Only)	GOST, Cenelec, CE, ATEX
	Class II, Div. 2, Gr. E, F, G						CSA, FM (Gr. E, CSA Only)	GOST, Cenelec CE
	Class III, Div. 2,						FM Only	GOST, Cenelec, CE, ATEX
SRM/E (Self-Regulating Medium Temperature)	Ordinary	Metal Only	302°F	150°C	420°F	215°C	UL, CSA, FM	GOST, Cenelec, CE, ATEX
	Class I Div. 2, Gr. A, B, C, D,						CSA, FM (Gr. A, CSA Only)	GOST, Cenelec, CE, ATEX
	Class II, Div. 2, Gr. F, G						CSA Only	GOST, Cenelec, CE, ATEX
HSRL (H-Self-Regulating Low Temperature)	Class I, Div. 1, Gr. B, C, D	Plastic/Metal	150°F	66°C	185°F	85°C	FM Only	
	Class II, Div. 1, Gr. E, F, G						FM Only	
	Class III, Div. 1						FM Only	
HSRM (H-Self-Regulating Medium Temperature)	Class I, Div. 1, Gr. B, C, D	Metal Only	302°F	150°C	420°F	215°C	FM Only	
	Class II, Div. 1, Gr. E, F, G						FM Only	
	Class III, Div. 1						FM Only	
CWM (Constant Wattage)	Ordinary	Metal Only	See Table 4		392°F	200°C	UL, CSA	
	Hazardous Area Consult Factory							
MI (Mineral Insulated)	Ordinary	Metal Only	See Section		1,100°F	593°C	Consult Factory	Consult Factory
	Hazardous Area Consult Factory							

NOTE: It is the responsibility of the facility manager or engineer to determine the classification of an area where heat trace will be installed. The factory can help determine a suitable cable based on the information provided.

HEATING CABLE SELECTION



Step 2. Select Heating Cable Construction Options

Select from Table 7 the appropriate construction option for the desired level of mechanical and corrosive chemical protection.

-C option cable is constructed with a tinned copper grounding braid only.

-CR option cable is constructed with a tinned copper braid and polyolefin overjacket.

-CT option cable is constructed with a tinned copper braid and fluoropolymer overjacket.

Note: If your area classification is Class I Division 1, Class II Division 1, or Class III Division 1, the HSRL and HSRM cable families are constructed with -CT option only.

Example:

Since the environment in our example contained organic chemical solutions, choose the -CT option for the fluoropolymer overjacket to provide mechanical and corrosion protection.

Selection: SRL*-* CT

Step 3. Select Thermal Output Rating

1. For Self-Regulating Cable – See Figures 1 and 2 (page 12) if piping is metallic and Figures 3 and 4 (page 13) if piping is plastic. Find your actual heat loss, Q, (as previously calculated on pages 1 or 7) on the Y-axis of the graph and the maintenance temperature required on the X-axis. Select the cable for which the thermal output is $\geq Q$ at T_m .

Example:

In the step above, we have chosen the SRL cable family and our piping is metallic. Therefore, refer to Figure 1. Calculated heat loss, W, is 4.88 W/ft (0 W/m). Find this point on the Y-axis. Maintenance temperature is 40°F (4.4°C). Find this point on the X-axis. Choose the cable that lies above this point on the graph.

Selection: SRL5-*CT

2. For Constant Wattage Cable – Select the cable output that most closely exceeds the calculated heat loss, Q. Cable wattage outputs offered are 4, 8, and 12 W/ft (13, 26, and 40 W/m).

3. For Mineral Insulated Cable – See pages 17 and 18 for information on cable assemblies.

Table 6
Maximum Maintenance Temperatures for Constant Wattage Cables (CWM)

	Cable Rating, W/ft (W/m)					
	4 W		8 W		12 W	
	Maximum Temperature					
	°F	°C	°F	°C	°F	°C
Without Aluminum Tape	325	163	262	128	200	93
With Aluminum Tape	344	174	320	160	296	147

Table 7
Heating Cable Construction Options

Exposure Conditions	SRL, SRM/E, CWM			Mineral Insulated
	-C	-CR	-CT	
Moisture	•	•	•	•
Aqueous Solutions of Inorganic Compounds		•	•	•
Liquid Organic Chemicals			•	•
Acids or Bases			•	•



In some instances, the calculated heat loss, Q, is greater than the thermal output of the highest rated cable. Should this happen, you can:

- Recalculate with thicker insulation.
- Select insulation with a lower K factor and recalculate heat loss.
- Use two or more heating cable runs in parallel.
- Spiral the heating cable. DO NOT SPIRAL WRAP CONSTANT WATTAGE CABLE.

If you choose to spiral the cable: spiral factor, length of cable/ft (m) of pipe = Q/Heater output at T_m.

Example, Using SRL 3-1CT:

4.88 heat loss/3.8 SRL 3-1CT output at 40°F (4.4°C) = 1.28 spiral factor

Bending the heating cable can cause damage. Therefore, it is recommended that multiple straight runs of heat trace be used instead of spiral wrapping, especially if your pipe is smaller than 3" (88.9 mm) IPS. Straight runs facilitate installation significantly.

Step 4. Check T-Ratings

For self-regulating cable, use Table 8 to determine if the T-rating for the cable selected is acceptable for use per area classification guidelines. The T-ratings shown in Table 8 are determined based on the product classification approach method per IEEE Standard 515-1997. Please consult the factory if your application requires a T-rating different from those shown in the table. Please consult the factory to determine sheath temperature for applications using constant wattage or mineral insulated cables in hazardous areas.

Table 8
T-Ratings for Self-Regulating Cable

Cable Family	Watts / Volts	T-Rating	Max. Temp	
			°F	°C
SRL	3-1,3-2	T6	185°F	85°C
	5-1,5-2	T5	212°F	100°C
	8-1,8-2	T5	212°F	100°C
	10-1,10-2	T4A	248°F	120°C
HSRL	3-1,3-2	T6	185°F	85°C
	5-1,5-2	T5	212°F	100°C
	8-1,8-2	T5	212°F	100°C
	10-1,10-2	T4A	248°F	120°C
SRM/E	3-1,3-2	T3	392°F	200°C
	5-1,5-2	T3	392°F	200°C
	8-1,8-2	T3	392°F	200°C
	10-1,10-2	T2D	419°F	(215°C)
	15-1,15-2	T2D	419°F	(215°C)
	20-1,20-2	T2D	419°F	(215°C)
HSRM	5-1,5-2	T3C	320°F	(160°C)
	8-1,8-2	T3C	320°F	(160°C)
	10-1,10-2	T3A	356°F	(180°C)
	15-1,15-2	T2C	446°F	(230°C)
	20-1,20-2	T2C	446°F	(230°C)

NOTE: In Division 2 applications the sheath temperature of the cable should not exceed 99% of the AIT (auto-ignition temperature) in °C of the material with the lowest AIT in the atmosphere. In Division 1, the sheath temperature shall not exceed 80% of the lowest AIT in °C.

HEATING CABLE SELECTION

Figure 1

SRL & HSRL – Thermal Output Ratings on Insulated Metal Pipe

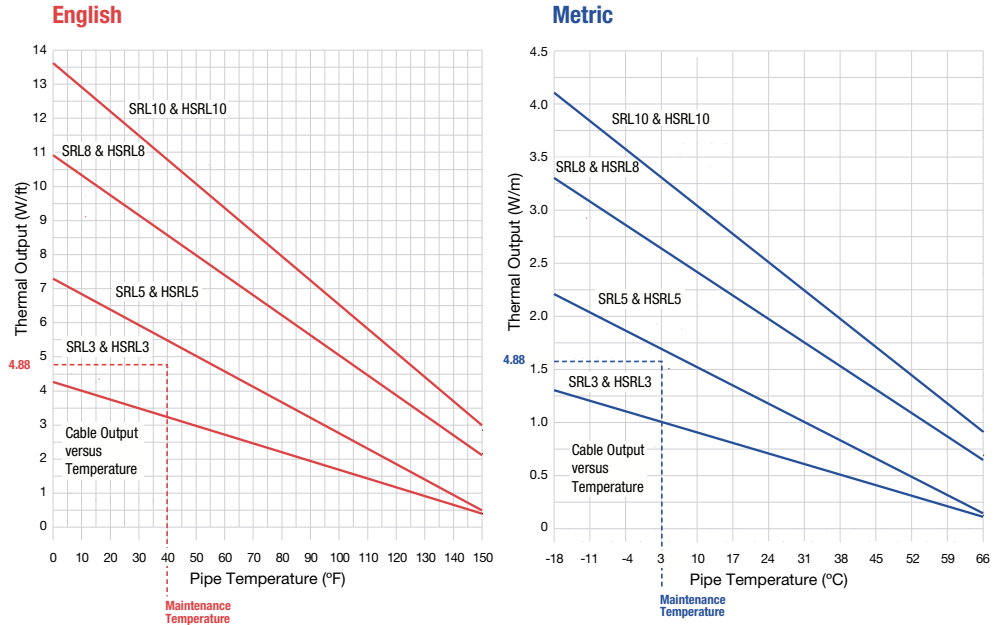


Figure 2

SRM/E & HSRM – Thermal Output Ratings on Insulated Metal Pipe

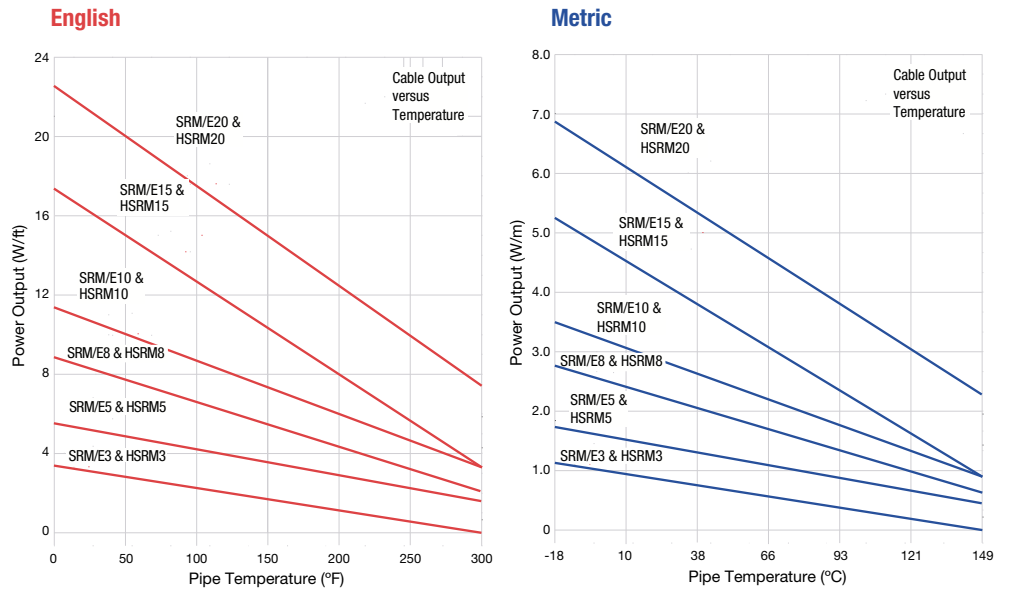


Figure 3

SRL & HSRL – Thermal Output Ratings on Plastic Pipes with Aluminum Tape Over Cable

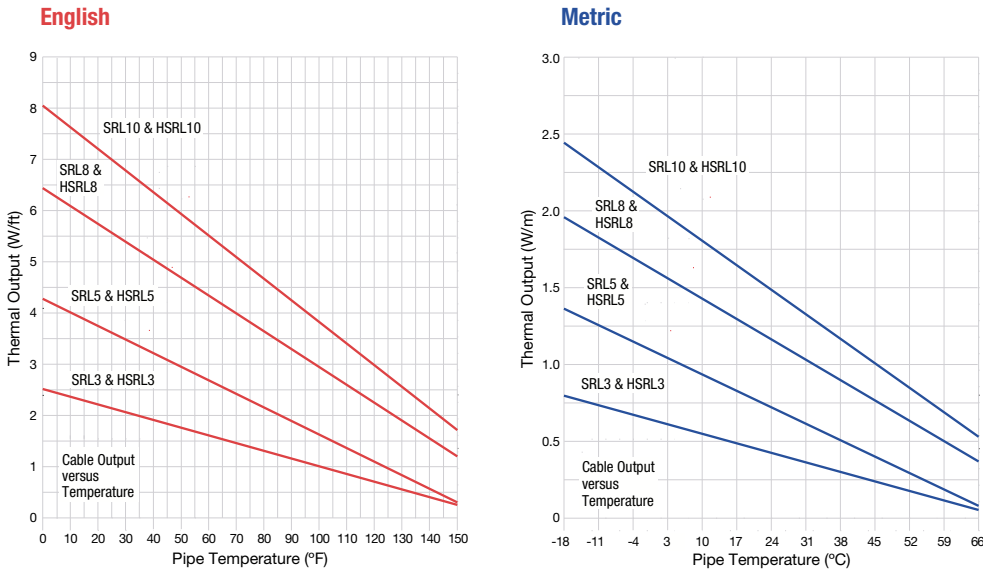
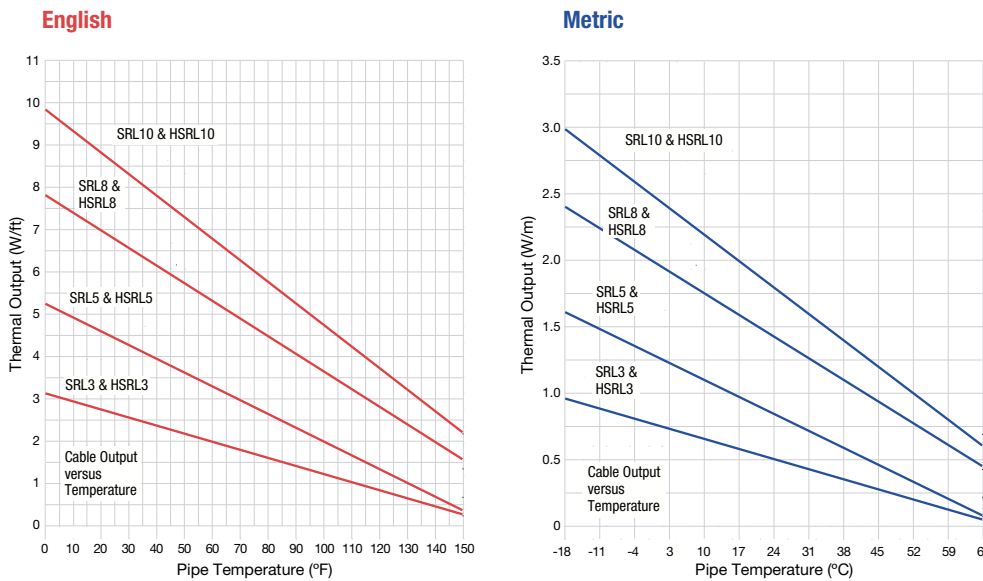


Figure 4

SRL & HSRL – Thermal Output Ratings on Plastic Pipes with Aluminum Tape Under and Over Cable



HEATING CABLE SELECTION



Step 5. Select Voltage Rating and Adjust for Alternate Voltages

Nominal Voltage Options:

- 1 = 120V or
- 2 = 240V

If the service voltage is 208V, 220V, 230V, or 277V, multiply the thermal output rating on the 240V cable by the appropriate power output factor for self-regulating cable or constant wattage cable found in Table 9. This will give the adjusted power output at the service voltage.

Example:

Service Voltage is 120V. No need to apply any adjustment factors. Therefore, choose Option 1.

Selection: SRL 5-1CT

Note: If your service voltage is 208V, 220V, or 230V, make sure that after your output has been adjusted that it does not drop below the calculated heat loss. If heat loss is greater than adjusted power output choose the next highest wattage cable.

Step 6. Determine Chromalox Part Number

To order Chromalox self-regulating or constant wattage heating cable, consult Table 10 (page 15), for the Chromalox model number for the chosen cable.

Table 9
Output Adjustment Factors for Alternate Voltages for Self-Regulating and Constant Wattage Cables

Cable Type	Watts/Volts	208V	220V	230V	240V	277V
SRL or HSRL	3-2	80%	87%	92%	100%	115%
	5-2	82%	90%	92%	100%	113%
	8-2	86%	91%	94%	100%	112%
	10-2	87%	92%	95%	100%	110%
SRM/E or HSRM	3-2	78%	86%	92%	100%	124%
	5-2	79%	87%	92%	100%	123%
	8-2	81%	88%	93%	100%	123%
	10-2	81%	88%	94%	100%	122%
	15-2	85%	90%	95%	100%	123%
	20-2	88%	92%	95%	100%	122%
CWM	4-2	75%	84%	92%	100%	133%
	8-2	75%	84%	92%	100%	133%
	12-2	75%	84%	92%	100%	133%

NOTE: If your service voltage is 208V or 220V, make sure that after your output has been adjusted that it does not drop below the calculated heat loss. If heat loss is greater than adjusted power output choose the next highest wattage cable.



Table 10
Ordering Information for Chromalox Self-Regulating and Constant Wattage Heating Cable

Heating Cable Family	Model Number	Specifications	
SRL Self-Regulating Low Temperature With Tinned Copper Braid	SRL3-1C	3 W/ft @50°F, 120V	
	SRL3-2C	3 W/ft @50°F, 240V	
	SRL5-1C	5 W/ft @50°F, 120V	
	SRL5-2C	5 W/ft @50°F, 240V	
	SRL8-1C	8 W/ft @50°F, 120V	
	SRL8-2C	8 W/ft @50°F, 240V	
	SRL10-1C	10 W/ft @50°F, 120V	
	SRL10-2C	10 W/ft @50°F, 240V	
With Braid and Polyolefin Overjacket	SRL3-1CR	3 W/ft @50°F, 120V	
	SRL3-2CR	3 W/ft @50°F, 240V	
	SRL5-1CR	5 W/ft @50°F, 120V	
	SRL5-2CR	5 W/ft @50°F, 240V	
	SRL8-1CR	8 W/ft @50°F, 120V	
	SRL8-2CR	8 W/ft @50°F, 240V	
	SRL10-1CR	10 W/ft @50°F, 120V	
	SRL10-2CR	10 W/ft @50°F, 240V	
With Braid and Fluoropolymer Overjacket	SRL3-1CT	3 W/ft @50°F, 120V	
	SRL3-2CT	3 W/ft @50°F, 240V	
	SRL5-1CT	5 W/ft @50°F, 120V	
	SRL5-2CT	5 W/ft @50°F, 240V	
	SRL8-1CT	8 W/ft @50°F, 120V	
	SRL8-2CT	8 W/ft @50°F, 240V	
	SRL10-1CT	10 W/ft @50°F, 120V	
	SRL10-2CT	10 W/ft @50°F, 240V	
SRM/E Self-Regulating Medium Temperature With Tinned Copper Braid	SRM/E3-1C	3 W/ft @50°F, 120V	
	SRM/E3-2C	3 W/ft @50°F, 240V	
	SRM/E5-1C	5 W/ft @50°F, 120V	
	SRM/E5-2C	5 W/ft @50°F, 240V	
	SRM/E8-1C	8 W/ft @50°F, 120V	
	SRM/E8-2C	8 W/ft @50°F, 240V	
	SRM/E10-1C	10 W/ft @50°F, 120V	
	SRM/E10-2C	10 W/ft @50°F, 240V	
	SRM/E15-1C	15 W/ft @50°F, 120V	
	SRM/E15-2C	15 W/ft @50°F, 240V	
	SRM/E20-1C	20 W/ft @50°F, 120V	
	SRM/E20-2C	20 W/ft @50°F, 240V	
	With Braid and Fluoropolymer Overjacket	SRM/E3-1CT	3 W/ft @50°F, 120V
		SRM/E3-2CT	3 W/ft @50°F, 240V
SRM/E5-1CT		5 W/ft @50°F, 120V	
SRM/E5-2CT		5 W/ft @50°F, 240V	
SRM/E8-1CT		8 W/ft @50°F, 120V	
SRM/E8-2CT		8 W/ft @50°F, 240V	
SRM/E10-1CT		10 W/ft @50°F, 120V	
SRM/E10-2CT		10 W/ft @50°F, 240V	
SRM/E15-1CT		15 W/ft @50°F, 120V	
SRM/E15-2CT		15 W/ft @50°F, 240V	
SRM/E20-1CT		20 W/ft @50°F, 120V	
SRM/E20-2CT		20 W/ft @50°F, 240V	

HEATING CABLE
SELECTION

HEATING CABLE SELECTION



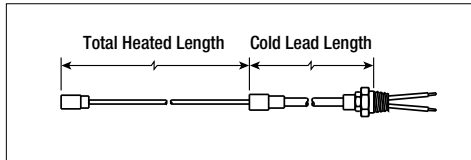
Table 10, cont'd.

Heating Cable Family	Model Number	Specifications	
SRL Self-Regulating Low Temperature Division 1 Hazardous Location Cable	HSRL3-1CT	3 W/ft @ 50°F, 120V	
	HSRL3-2CT	3 W/ft @ 50°F, 240V	
	HSRL5-1CT	5 W/ft @ 50°F, 120V	
	HSRL5-2CT	5 W/ft @ 50°F, 240V	
	HSRL8-1CT	8 W/ft @ 50°F, 120V	
	HSRL8-2CT	8 W/ft @ 50°F, 240V	
	HSRL10-1CT	10 W/ft @ 50°F, 120V	
	HSRL10-2CT	10 W/ft @ 50°F, 240V	
HSRM Self-Regulating Medium Temperature Division 1 Hazardous Location Cable	HSRM5-1CT	5 W/ft @ 50°F, 120V	
	HSRM5-2CT	5 W/ft @ 50°F, 240V	
	HSRM8-1CT	8 W/ft @ 50°F, 120V	
	HSRM8-2CT	8 W/ft @ 50°F, 240V	
	HSRM10-1CT	10 W/ft @ 50°F, 120V	
	HSRM10-2CT	10 W/ft @ 50°F, 240V	
	HSRM15-1CT	15 W/ft @ 50°F, 120V	
	HSRM15-2CT	15 W/ft @ 50°F, 240V	
CWM Constant Wattage Heating Cable With Tinned Copper Braid	CWM4-1C	4 W/ft, 120V	
	CWM4-2C	4 W/ft, 240V	
	CWM8-1C	8 W/ft, 120V	
	CWM8-2C	8 W/ft, 240V	
	CWM12-1C	12 W/ft, 120V	
	CWM12-2C	12 W/ft, 240V	
	With Braid and Fluoropolymer Overjacket	CWM4-1CT	4 W/ft, 120V
		CWM4-2CT	4 W/ft, 240V
		CWM8-1CT	8 W/ft, 120V
		CWM8-1CT	8 W/ft, 120V
		CWM12-1CT	12 W/ft, 120V
		CWM12-2CT	12 W/ft, 240V

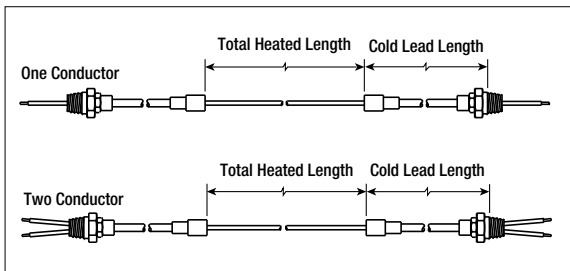


MINERAL INSULATED CABLE DESIGN

Form "A"



Form "E"



Mineral Insulated Cable can be manufactured into the heater designs shown below as Form "A" and Form "E". The following information is required to properly design mineral insulated cable units. Determine the following information and contact the Chromalox Application Group for assistance (see back cover).

For Pipe
 Length: _____
 Diameter: _____
 Material: _____

For Tank
 Length: _____
 Width: _____
 Height: _____
 Radius: _____
 Diameter: _____
 Surface Area: _____
 Material: _____

Type of Insulation: _____
 Insulation Thickness: _____
 Voltage: _____
 Maintenance Temperature: _____
 Minimum Ambient Temperature: _____
 Minimum Startup Temperature: _____
 Maximum Exposure Temperature: _____
 Area Classification: _____
 Indoor or Outdoor: _____
 Maximum Wind Speed: _____
 Corrosive(s) Present: _____
 Safety Factor: _____
 Equipment and Quantity: _____
 Flange Pair: _____
 Pipe Support: _____
 Butterfly Valve: _____
 Ball Valve: _____
 Glove Valve: _____
 Gate Valve: _____
 Desired Cable Form: _____
 Form A: _____
 Form E: _____
 One-Conductor: _____
 Two-Conductor: _____
 Desired Cold Lead Length: _____

**MINERAL INSULATED
CABLE DESIGN**

MINERAL INSULATED
CABLE DESIGN

ELECTRICAL DESIGN

Circuit Breaker Selection

To select the circuit breaker size, determine the following information:

Maintenance Temperature: _____
 Heat Loss per Foot of Pipe, Q_T : _____
 Pipe or Tubing Size: _____
 Pipe Length: _____
 Type and Number of Valves & Supports: _____
 Heating Cable Catalog Number: _____
 Minimum Start-Up Temperature: _____

Example:

English

Maintenance Temperature: 40°F
 Heat Loss per Foot of Pipe, Q_T : 4.88 W/ft
 Pipe or Tubing Size: 3" steel
 Pipe Length: 124 ft
 Type and Number of Valves & Supports: 2 Butterfly Valves, 12 Pipe Hanger Supports
 Heating Cable Catalog Number: SRL 5-1CT
 Minimum Start-Up Temperature: -20°F

Example:

Metric

Maintenance Temperature: 4.4°C
 Heat Loss per Foot of Pipe, Q_T : 15.98 W/m
 Pipe or Tubing Size: 76 mm steel
 Pipe Length: 38 m
 Type and Number of Valves & Supports: 2 Butterfly Valves, 12 Pipe Hanger Supports
 Heating Cable Catalog Number: SRL 5-1CT
 Minimum Start-Up Temperature: -28.9°C

Step 1. Determine the Total Cable Length

In addition to piping, in-line equipment such as valves, flanges, and pipe supports require additional heat tracing to maintain the system operating temperatures.

Example:

Pipe length of 124 ft (38 m) single pass application	=	124 ft (38 m) SRL 5-1CT
2 Butterfly Valves, additional cable 2.5 ft (0.76 m) each valve	=	5.0 ft (1.52 m) SRL 5-1CT
12 Pipe Hanger Supports, additional cable per support is 2.0 ft (0.61 m)	=	24.0 ft (7.3 m) SRL 5-1CT
Total length required	=	153 ft (46.82 m) SRL 5-1CT



See Table 11 (page 19) for additional cable lengths required for each type of in-line equipment based on piping size.

Calculate the total length of heating cable required by combining lengths from each component of the piping system.

Step 2. Determine the Circuit Breaker Rating

1. For Self-Regulating Cable - From Table 12 (page 20) select the circuit breaker trip rating by finding the heating cable type and the minimum expected start-up temperature. Compare the maximum circuit length for each breaker rating to the total cable length required for each pipe. Select the breaker rating whose maximum circuit length just exceeds the total cable required for the pipe.

If the circuit breaker rating is predetermined, use the maximum circuit length shown in Table 12 for the cable type at the minimum startup temperature.

If the required cable length exceeds the maximum circuit length, determine the number of circuits required:

$$\text{Number of Circuits} = \frac{\text{Total Cable Length}}{\text{Maximum Circuit Length}}$$

Table 11
Additional Cable Lengths Required for In-line Equipment

Piping Size	Gate Valve	Globe Valve	Ball Valve	Butterfly Valve	Shoe Support	Hanger Support	Sleeper Support	Flange Pair
	ft/m							
½ in.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.30
21.3 mm	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.09
¾ in.	1.50	1.00	1.00	1.00	1.50	1.00	1.00	0.30
26.7 mm	0.46	0.30	0.30	0.30	0.46	0.30	0.30	0.09
1 in.	2.00	1.00	1.00	1.00	1.50	1.00	1.00	0.30
33.4 mm	0.61	0.30	0.30	0.30	0.46	0.30	0.30	0.09
1½ in.	2.50	1.50	1.50	1.50	2.00	2.00	2.00	0.30
48.3 mm	0.76	0.46	0.46	0.46	0.61	0.61	0.61	0.09
2 in.	2.50	2.00	2.00	2.00	2.00	2.00	2.00	0.30
60.3 mm	0.76	0.61	0.61	0.61	0.61	0.61	0.61	0.09
2½ in.	2.50	2.00	2.00	2.00	2.00	2.00	2.00	0.30
73.0 mm	0.76	0.61	0.61	0.61	0.61	0.61	0.61	0.09
3 in.	3.00	2.50	2.50	2.50	2.00	2.00	2.00	0.50
88.9 mm	0.91	0.76	0.76	0.76	0.61	0.61	0.61	0.15
4 in.	4.00	3.00	3.00	3.00	2.50	2.50	2.50	0.50
114.3 mm	1.22	0.91	0.91	0.91	0.76	0.76	0.76	0.15
6 in.	5.00	3.50	3.50	3.50	2.50	2.50	2.50	0.80
168.3 mm	1.52	1.07	1.07	1.07	0.76	0.76	0.76	0.24
8 in.	7.00	4.00	4.00	4.00	2.50	2.50	2.50	0.80
219.1 mm	2.13	1.22	1.22	1.22	0.76	0.76	0.76	0.24
10 in.	8.00	4.50	4.50	4.50	3.00	3.00	3.00	0.80
273.1 mm	2.44	1.37	1.37	1.37	0.91	0.91	0.91	0.24
12 in.	9.00	5.00	5.00	5.00	3.00	3.00	3.00	0.80
323.9 mm	2.74	1.52	1.52	1.52	0.91	0.91	0.91	0.24
14 in.	10.00	5.50	5.50	5.50	3.00	3.00	3.00	1.00
355.6 mm	3.05	1.68	1.68	1.68	0.91	0.91	0.91	0.30
16 in.	11.00	6.00	6.00	6.00	3.50	3.50	3.50	1.00
406.4 mm	3.35	1.83	1.83	1.83	1.07	1.07	1.07	0.30
18 in.	12.00	7.00	7.00	7.00	3.50	3.50	3.50	1.00
457.2 mm	3.66	2.13	2.13	2.13	1.07	1.07	1.07	0.30
20 in.	13.00	7.50	7.50	7.50	3.50	3.50	3.50	1.00
508.0 mm	3.96	2.29	2.29	2.29	1.07	1.07	1.07	0.30
22 in.	13.00	7.50	7.50	7.50	3.50	3.50	3.50	1.00
558.8 mm	3.96	2.29	2.29	2.29	1.07	1.07	1.07	0.30
24 in.	15.00	8.00	8.00	8.00	4.00	4.00	4.00	1.00
609.6 mm	4.57	2.44	2.44	2.44	1.22	1.22	1.22	0.30

ELECTRICAL DESIGN



Table 12
Maximum Circuit Length by Start-Up Temperature and Breaker Size for Self-Regulating Cable

Cable Rating	Maximum Circuit Length						
	Circuit Breaker						
	10A	15A	20A	25A	30A	40A	50A
	50°F (10°C) Start-Up						
SRL / HSRL 3-1 (ft)	205	305	360	NR	NR	NR	NR
SRL / HSRL 3-1 (m)	62	93	110	NR	NR	NR	NR
SRL / HSRL 3-2 (ft)	400	600	660	NR	NR	NR	NR
SRL / HSRL 3-2 (m)	122	183	201	NR	NR	NR	NR
SRL / HSRL 5-1 (ft)	125	185	250	270	NR	NR	NR
SRL / HSRL 5-1 (m)	38	56	76	82	NR	NR	NR
SRL / HSRL 5-2 (ft)	250	375	505	540	NR	NR	NR
SRL / HSRL 5-2 (m)	76	114	154	165	NR	NR	NR
SRL / HSRL 8-1 (ft)	100	150	200	215	NR	NR	NR
SRL / HSRL 8-1 (m)	30	46	61	66	NR	NR	NR
SRL / HSRL 8-2 (ft)	185	285	375	420	NR	NR	NR
SRL / HSRL 8-2 (m)	56	87	114	128	NR	NR	NR
SRL / HSRL 10-1 (ft)	60	95	130	160	180	NR	NR
SRL / HSRL 10-1 (m)	18	29	40	49	55	NR	NR
SRL / HSRL 10-2 (ft)	100	160	210	260	315	360	NR
SRL / HSRL 10-2 (m)	30	49	64	79	96	110	NR
SRM/E / HSRM 3-1 (ft)	190	285	385	NR	NR	NR	NR
SRM/E / HSRM 3-1 (m)	58	87	117	NR	NR	NR	NR
SRM/E / HSRM 3-2 (ft)	380	575	770	775	780	NR	NR
SRM/E / HSRM 3-2 (m)	116	175	235	236	238	NR	NR
SRM/E / HSRM 5-1 (ft)	115	180	240	295	360	375	NR
SRM/E / HSRM 5-1 (m)	35	55	73	90	110	114	NR
SRM/E / HSRM 5-2 (ft)	235	360	480	590	720	750	NR
SRM/E / HSRM 5-2 (m)	72	110	146	180	219	229	NR
SRM/E / HSRM 8-1 (ft)	90	145	190	235	285	325	NR
SRM/E / HSRM 8-1 (m)	27	44	58	72	87	99	NR
SRM/E / HSRM 8-2 (ft)	185	285	380	470	575	650	NR
SRM/E / HSRM 8-2 (m)	56	87	116	143	175	198	NR
SRM/E / HSRM 10-1 (ft)	60	95	125	155	190	250	NR
SRM/E / HSRM 10-1 (m)	18	29	38	47	58	76	NR
SRM/E / HSRM 10-2 (ft)	125	190	255	310	385	490	NR
SRM/E / HSRM 10-2 (m)	38	58	78	94	117	149	NR
SRM/E / HSRM 15-1 (ft)	45	70	95	115	145	190	210
SRM/E / HSRM 15-1 (m)	14	21	29	35	44	58	64
SRM/E / HSRM 15-2 (ft)	90	145	190	235	290	385	420
SRM/E / HSRM 15-2 (m)	27	44	58	72	88	117	128
SRM/E / HSRM 20-1 (ft)	35	60	75	90	115	155	160
SRM/E / HSRM 20-1 (m)	11	18	23	27	35	47	49
SRM/E / HSRM 20-2 (ft)	75	115	155	185	230	305	350
SRM/E / HSRM 20-2 (m)	23	35	47	56	70	93	107

NOTE: This table takes into account start-up current characteristics of self-regulating cable and the 20% safety factor as required by the NEC Article 384-16(c).
NR = Not Recommended.

Table 12, cont'd.

Cable Rating	Maximum Circuit Length						
	Circuit Breaker						
	10A	15A	20A	25A	30A	40A	50A
	0°F (-18°C) Start-Up						
SRL / HSRL 3-1 (ft)	135	200	270	330	360	NR	NR
SRL / HSRL 3-1 (m)	41	61	82	101	110	NR	NR
SRL / HSRL 3-2 (ft)	275	415	555	660	NR	NR	NR
SRL / HSRL 3-2 (m)	84	126	169	201	NR	NR	NR
SRL / HSRL 5-1 (ft)	90	135	180	225	270	NR	NR
SRL / HSRL 5-1 (m)	27	41	55	69	82	NR	NR
SRL / HSRL 5-2 (ft)	180	270	360	450	540	NR	NR
SRL / HSRL 5-2 (m)	55	82	110	137	165	NR	NR
SRL / HSRL 8-1 (ft)	70	110	145	180	215	NR	NR
SRL / HSRL 8-1 (m)	21	34	44	55	66	NR	NR
SRL / HSRL 8-2 (ft)	135	200	265	335	395	420	NR
SRL / HSRL 8-2 (m)	41	61	81	102	120	128	NR
SRL / HSRL 10-1 (ft)	50	80	105	130	155	180	NR
SRL / HSRL 10-1 (m)	15	24	32	40	47	55	NR
SRL / HSRL 10-2 (ft)	80	125	170	210	255	340	NR
SRL / HSRL 10-2 (m)	24	38	52	64	78	104	NR
SRM/E / HSRM 3-1 (ft)	160	275	375	380	385	NR	NR
SRM/E / HSRM 3-1 (m)	49	84	114	116	117	NR	NR
SRM/E / HSRM 3-2 (ft)	320	540	750	770	780	NR	NR
SRM/E / HSRM 3-2 (m)	98	165	229	235	238	NR	NR
SRM/E / HSRM 5-1 (ft)	100	165	220	255	330	375	NR
SRM/E / HSRM 5-1 (m)	30	50	67	78	101	114	NR
SRM/E / HSRM 5-2 (ft)	200	325	430	510	645	750	NR
SRM/E / HSRM 5-2 (m)	61	99	131	155	197	229	NR
SRM/E / HSRM 8-1 (ft)	80	135	175	205	265	325	NR
SRM/E / HSRM 8-1 (m)	24	41	53	62	81	99	NR
SRM/E / HSRM 8-2 (ft)	165	255	345	345	520	650	NR
SRM/E / HSRM 8-2 (m)	50	78	105	105	158	198	NR
SRM/E / HSRM 10-1 (ft)	55	90	110	135	175	250	NR
SRM/E / HSRM 10-1 (m)	17	27	34	41	53	76	NR
SRM/E / HSRM 10-2 (ft)	105	165	225	270	345	490	NR
SRM/E / HSRM 10-2 (m)	32	50	69	82	105	149	NR
SRM/E / HSRM 15-1 (ft)	40	65	85	105	125	165	210
SRM/E / HSRM 15-1 (m)	12	20	26	32	38	50	64
SRM/E / HSRM 15-2 (ft)	80	120	175	205	270	360	420
SRM/E / HSRM 15-2 (m)	24	37	53	62	82	110	128
SRM/E / HSRM 20-1 (ft)	35	50	65	85	105	140	160
SRM/E / HSRM 20-1 (m)	11	15	20	26	32	43	49
SRM/E / HSRM 20-2 (ft)	70	100	135	170	200	270	350
SRM/E / HSRM 20-2 (m)	21	30	41	52	61	82	107

NOTE: This table takes into account start-up current characteristics of self-regulating cable and the 20% safety factor as required by the NEC Article 384-16(c).
NR = Not Recommended.

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Table 12, cont'd.

Cable Rating	Maximum Circuit Length						
	Circuit Breaker						
	10A	15A	20A	25A	30A	40A	50A
	-20°F (-29°C) Start-Up						
SRL / HSRL 3-1 (ft)	120	185	245	300	360	NR	NR
SRL / HSRL 3-1 (m)	37	56	75	91	110	NR	NR
SRL / HSRL 3-2 (ft)	245	370	495	600	660	NR	NR
SRL / HSRL 3-2 (m)	75	113	151	183	201	NR	NR
SRL / HSRL 5-1 (ft)	80	120	160	205	245	270	NR
SRL / HSRL 5-1 (m)	24	37	49	62	75	82	NR
SRL / HSRL 5-2 (ft)	160	245	325	405	490	540	NR
SRL / HSRL 5-2 (m)	49	75	99	123	149	165	NR
SRL / HSRL 8-1 (ft)	65	100	130	165	200	210	NR
SRL / HSRL 8-1 (m)	20	30	40	50	61	64	NR
SRL / HSRL 8-2 (ft)	120	175	235	300	350	420	NR
SRL / HSRL 8-2 (m)	37	53	72	91	107	128	NR
SRL / HSRL 10-1 (ft)	45	70	95	120	140	180	NR
SRL / HSRL 10-1 (m)	14	21	29	37	43	55	NR
SRL / HSRL 10-2 (ft)	75	120	160	195	240	320	NR
SRL / HSRL 10-2 (m)	23	37	49	59	73	98	NR
SRM/E / HSRM 3-1 (ft)	155	265	365	370	385	NR	NR
SRM/E / HSRM 3-1 (m)	47	81	111	113	117	NR	NR
SRM/E / HSRM 3-2 (ft)	300	525	740	760	780	NR	NR
SRM/E / HSRM 3-2 (m)	91	160	226	232	238	NR	NR
SRM/E / HSRM 5-1 (ft)	95	155	210	245	310	375	NR
SRM/E / HSRM 5-1 (m)	29	47	64	75	94	114	NR
SRM/E / HSRM 5-2 (ft)	195	310	415	480	620	750	NR
SRM/E / HSRM 5-2 (m)	59	94	126	146	189	229	NR
SRM/E / HSRM 8-1 (ft)	75	130	165	195	250	325	NR
SRM/E / HSRM 8-1 (m)	23	40	50	59	76	99	NR
SRM/E / HSRM 8-2 (ft)	155	245	335	390	490	650	NR
SRM/E / HSRM 8-2 (m)	47	75	102	119	149	198	NR
SRM/E / HSRM 10-1 (ft)	50	85	100	125	170	245	250
SRM/E / HSRM 10-1 (m)	15	26	30	38	52	75	76
SRM/E / HSRM 10-2 (ft)	100	155	215	255	330	470	490
SRM/E / HSRM 10-2 (m)	30	47	66	78	101	143	149
SRM/E / HSRM 15-1 (ft)	40	60	80	100	120	150	210
SRM/E / HSRM 15-1 (m)	12	18	24	30	37	46	64
SRM/E / HSRM 15-2 (ft)	80	155	165	200	260	340	420
SRM/E / HSRM 15-2 (m)	24	47	50	61	79	104	128
SRM/E / HSRM 20-1 (ft)	30	45	65	80	100	135	160
SRM/E / HSRM 20-1 (m)	9	14	20	24	30	41	49
SRM/E / HSRM 20-2 (ft)	65	90	130	160	195	255	335
SRM/E / HSRM 20-2 (m)	20	27	40	49	59	78	102

NOTE: This table takes into account start-up current characteristics of self-regulating cable and the 20% safety factor as required by the NEC Article 384-16(c).
NR = Not Recommended.



ELECTRICAL DESIGN

Total heating cable length required for piping is 153 ft (46.82 m) SRL 5-1CT. The minimum start-up temperature for the system is -20°F (-29°C). Therefore, based on Table 12, the circuit breaker required is 20A.

2. For Constant Wattage Cable - Determine the total current draw by determining the circuit load in A/ft (A/m) from Table 13 and multiply this number by the total length required for the piping.

$$\text{Total Circuit Current Draw} = \text{Circuit Load A/ft (A/m)} \times \text{Total Cable Length for the Pipe}$$

Then adjust this total current draw by the 20% safety factor required by the National Electric Code (NEC):

$$\text{Adjusted Current Draw} = \text{Total Circuit Current Draw} \times 1.20$$

Choose the circuit breaker rating that exceeds the adjusted current draw.

To determine the number of circuits required for each pipe, divide the total cable length required by the maximum circuit length shown in Table 13 for the cable selected.

$$\text{Number of Circuits} = \frac{\text{Total Cable Length}}{\text{Maximum Circuit Length}}$$

3. For Mineral Insulated Cable – Find the total current draw by dividing the total cable wattage by the operating voltage:

$$\text{Total Circuit Current Draw} = \frac{\text{Total Cable Wattage}}{\text{Operating Voltage}}$$

Then adjust the total current draw for the 20% safety factor required by the NEC:

$$\text{Adjusted Current Draw} = \text{Total Circuit Current Draw} \times 1.20$$

Choose the circuit breaker rating that exceeds the adjusted current draw.

Step 3. Select the Circuit Breaker

The National Electric Code (NEC 1996) and European Union (EU) code require the use of ground-fault style breakers for heating cable circuit protection. If heating cable is improperly installed or physically damaged to the point that water contacts the bus wires, sustained arcing or fire could result. If arcing does occur, the fault current may be too low to trip conventional circuit breakers. Chromalox recommends the use of thermal magnetic style circuit breakers with a trip rating set at 30mA (equipment protection device) to eliminate nuisance tripping that can occur at low temperatures with magnetic type or lower rated ground fault trip breakers.

The following are some ground-fault breakers that meet these requirements:

- Square D: Type QOB-EPD
- Westinghouse: Types GFEP, GFEPD
- Cutler-Hammer: Type QBGFEP

Table 13
Circuit Load and Maximum Circuit Lengths for Constant Wattage Cable

Model Number	Circuit Load		Maximum Circuit Length	
	A/ft	A/m	ft	m
CWM 4-1	0.033	0.108	350	107
CWM 4-2	0.017	0.056	700	213
CWM 8-1	0.067	0.220	240	73
CWM 8-2	0.033	0.108	480	146
CWM 12-1	0.100	0.328	200	61
CWM 12-2	0.050	0.164	400	122

COMPONENT SELECTION AND ACCESSORIES

Heat tracing circuits require a power connection and an end seal. Splice and tee kits are used as required. See diagrams and tables below and on the following pages for typical system details. Choose a series of components based on area classification and preference.

In addition, choose attachment accessories from Table 18 (page 29) based on requirements listed in Table 19 (page 29).

Figure 5

EL Series Components

EL Series Components - For use in Ordinary and Division 2 Hazardous Areas as shown in Table 14.

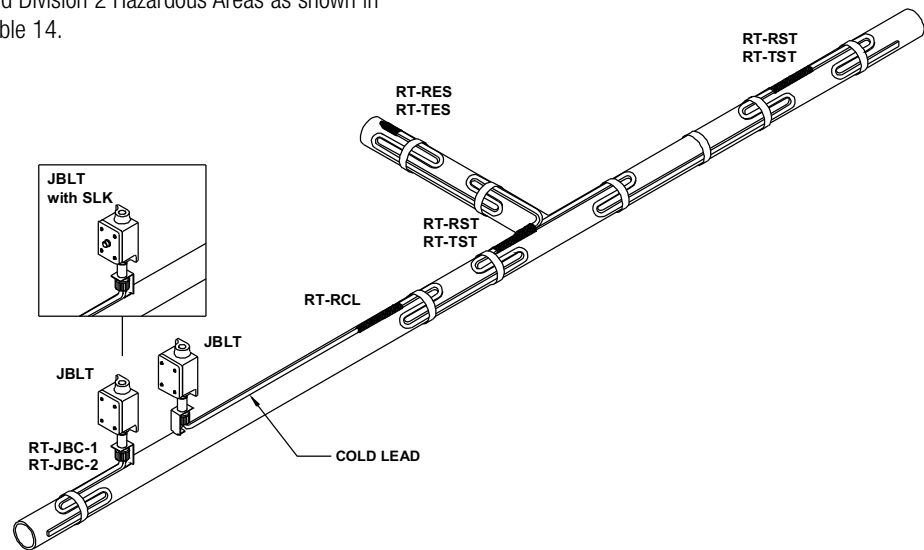


Table 14

EL Series Connection Components for Installation, U.S. Only

Cable Type	Component	Model	Approvals			
			Ordinary Area	Class I Div. 2 Gr. B, C, D	Class II Div. 2 Gr. G	Class III Div. 2
SRL-C, SRL-CR, SRL-CT	Junction Box Connection Kit	RT-JBC-1	UL, CSA, FM	FM	FM	FM
	Junction Box	JBLT	UL, CSA, FM	FM	FM	FM
	End Seal	RT-RES	UL, CSA, FM	FM	FM	FM
	Tee Connection	RT-RST	UL, CSA, FM	FM	FM	FM
	Splice Connection	RT-RST	UL, CSA, FM	FM	FM	FM
CWM-C & CWM-CT	Junction Box Connection Kit	RT-JBC-2	UL, CSA			
	Junction Box	JBLT	UL, CSA, FM	FM	FM	FM
	End Seal	RT-TES	UL, CSA			
	Tee Connection	RT-TST	UL, CSA			
	Splice Connection	RT-TST	UL, CSA			

NOTE: EL Series not to be used with SRME cable. SLK-1 and SLK-2 are no longer offered.

Figure 6

DL Series Components

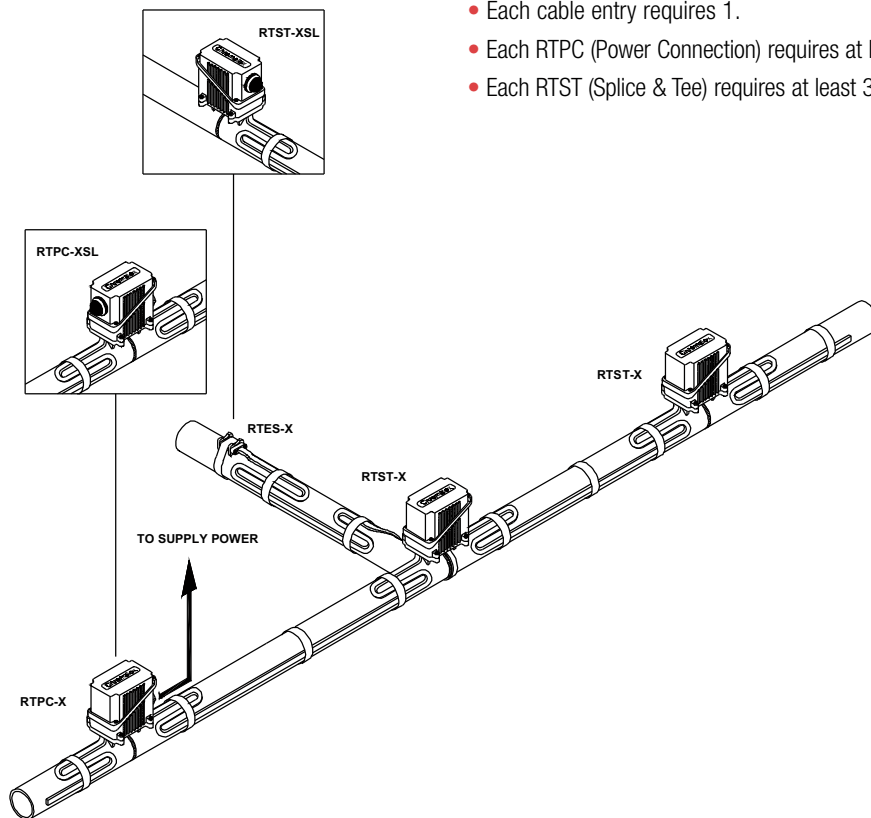
DL Series Components - DL Series Accessories include enclosures molded of durable Ryton PPS plastic material and are rated NEMA 4X. For use in Ordinary and Division 2 Hazardous Areas as shown in the table below.

Additional accessories are required (see Table 18 and Table 19, page 29) for descriptions and part numbers):

- RTPC models require 1 conduit hub.
- RTPC and RTST models require 1 pipe strap each to fasten the kit to the pipe.

Grommets are required for DL Series Components. (See Table 16):

- Each cable entry requires 1.
- Each RTPC (Power Connection) requires at least 1.
- Each RTST (Splice & Tee) requires at least 3.



COMPONENT SELECTION AND ACCESSORIES



Table 15
DL Series Connection Components for Installation, U.S. Only

Cable Type	Component	Model	Approvals			
			Ordinary Areas	Class I Div. 2 Gr. B, C, D	Class II Div. 2 Gr. F, G	Class III Div. 2
SRL-C	Power Connection Kit	RTPC-1	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit w/ Signal Light, 120V	RTPC-1SL1	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 208-240V	RTPC-1SL2	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 277V	RTPC-1SL3	UL, CSA, FM			
	End Seal Kit	RTES-1	UL, CSA, FM	CSA, FM	CSA, FM	FM
	End Seal Kit w/ Signal Light, 120V	RTST-1SL1	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 208-240V	RTST-1SL2	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 277V	RTST-1SL3	UL, CSA, FM			
SRL-CR & SRL-CT	Splice and Tee Kit	RTST-1	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit	RTPC-2	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit w/ Signal Light, 120V	RTPC-2SL1	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 208-240V	RTPC-2SL2	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 277V	RTPC-2SL3	UL, CSA, FM			
	End Seal Kit	RTES-1	UL, CSA, FM	CSA, FM	CSA, FM	FM
	End Seal Kit w/ Signal Light, 120V	RTST-2SL1	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 208-240V	RTST-2SL2	UL, CSA, FM			
SRM/E-C	End Seal Kit w/ Signal Light, 277V	RTST-2SL3	UL, CSA, FM			
	Splice and Tee Kit	RTST-2	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit	RTPC-7	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit w/ Signal Light, 120V	RTPC-7SL1	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 208-240V	RTPC-7SL2	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 277V	RTPC-7SL3	UL, CSA, FM			
	End Seal Kit	RTES-7	UL, CSA, FM	CSA, FM	CSA, FM	FM
	End Seal Kit w/ Signal Light, 120V	RTST-7SL1	UL, CSA, FM			
SRM/E-CT	End Seal Kit w/ Signal Light, 208-240V	RTST-7SL2	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 277V	RTST-7SL3	UL, CSA, FM			
	Splice and Tee Kit	RTST-7	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit	RTPC-8	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit w/ Signal Light, 120V	RTPC-8SL1	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 208-240V	RTPC-8SL2	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 277V	RTPC-8SL3	UL, CSA, FM			
	End Seal Kit	RTES-8	UL, CSA, FM	CSA, FM	CSA, FM	FM
SRM/E-CT	End Seal Kit w/ Signal Light, 120V	RTST-8SL1	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 208-240V	RTST-8SL2	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 277V	RTST-8SL3	UL, CSA, FM			
	Splice and Tee Kit	RTST-8	UL, CSA, FM	CSA, FM	CSA, FM	FM

Table 15, con't.

Cable Type	Component	Model	Approvals			
			Ordinary Areas	Class I Div. 2 Gr. B, C, D	Class II Div. 2 Gr. F, G	Class III Div. 2
CWM-C	Power Connection Kit	RTPC-3	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit w/ Signal Light, 120V	RTPC-3SL1	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 208-240V	RTPC-3SL2	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 277V	RTPC-3SL3	UL, CSA, FM			
	End Seal Kit	RTES-3	UL, CSA, FM	CSA, FM	CSA, FM	FM
	End Seal Kit w/ Signal Light, 120V	RTST-3SL1	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 208-240V	RTST-3SL2	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 277V	RTST-3SL3	UL, CSA, FM			
	Splice and Tee Kit	RTST-3	UL, CSA, FM	CSA, FM	CSA, FM	FM
CWM-CT	Power Connection Kit	RTPC-4	UL, CSA, FM	CSA, FM	CSA, FM	FM
	Power Connection Kit w/ Signal Light, 120V	RTPC-4SL1	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 208-240V	RTPC-4SL2	UL, CSA, FM			
	Power Connection Kit w/ Signal Light, 277V	RTPC-4SL3	UL, CSA, FM			
	End Seal Kit	RTES-4	UL, CSA, FM	CSA, FM	CSA, FM	FM
	End Seal Kit w/ Signal Light, 120V	RTST-4SL1	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 208-240V	RTST-4SL2	UL, CSA, FM			
	End Seal Kit w/ Signal Light, 277V	RTST-4SL3	UL, CSA, FM			
	Splice and Tee Kit	RTST-4	UL, CSA, FM	CSA, FM	CSA, FM	FM

Table 16
Grommets for DL Series Components

Cable Type	Grommet Model No.
RTO/Capillary Type	GRS
Blank	GR0
SRL-C	GR1
SRL-CR, SRL-CT	GR2
CWM-C	GR3
CWM-CT	GR4
SRL-MC	GR5
SRL-MCR, SRL-MCT	GR6
SRM/E-C	GR7
SRM/E-CT	GR8

COMPONENT SELECTION AND ACCESSORIES

Figure 7

HL Series Components

HL Series Components – For use in Division 1 Hazardous Areas with HSRL and HSRM Heating Cables.

Additional accessories are required (see Table 18 and Table 19, page 29 for descriptions and part numbers):

- All models require 2 pipe straps to fasten kit to pipe.

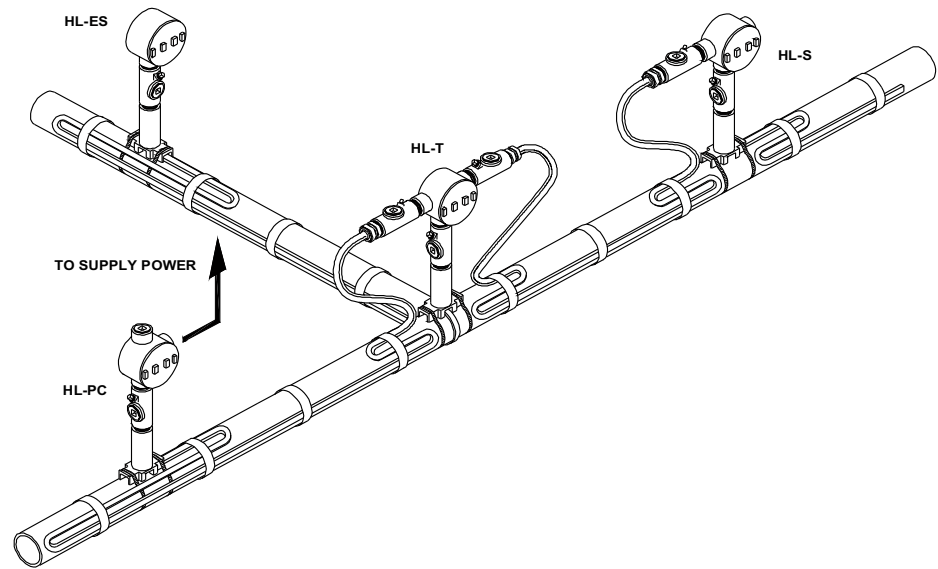


Table 17
HL Series Components

Cable Type	Component	Model	Approvals		
			Class I Div. 1 Gr. B, C, D	Class II Div. 1 Gr. E, F, G	Class III Div. 1
HSRL - CT	Power Connection	HL-PC	FM	FM	FM
	End Seal	HL-ES	FM	FM	FM
	Tee Connection	HL-T	FM	FM	FM
	Splice Connection	HL-S	FM	FM	FM
HSRM - CT	Power Connection	HL-PC	FM	FM	FM
	End Seal	HL-ES	FM	FM	FM
	Tee Connection	HL-T	FM	FM	FM
	Splice Connection	HL-S	FM	FM	FM

Table 18
Attachment Accessories, U.S. Only

Designation	Model
Pipe Strap for 1/2" to 3/4" (21.3 mm to 26.7 mm) pipes	PS-1
Pipe Strap for 1" to 3 1/2" (33.4 mm to 101.6 mm) pipes	PS-3
Pipe Strap for 2 1/2" to 9" (73.0 mm to 262.8 mm) pipes	PS-10
Fiberglass Tape 2 1/2" (73.0 m) wide, 180 ft (55 m) roll	FT-1
Fiberglass Tape 2 1/2" (73.0 mm) wide, 66 ft (20 m) roll	FT-2
Nylon Cable Ties, Interlocking, 100 per pack	CT-100
Aluminum Tape 2 1/2" (73.0 mm) wide, 180 ft (55 m) roll	AT-1
Conduit Hub Attachment 3/4" (18.80 mm) NPT	CCH-1
Conduit Hub Attachment 3/4" (18.80 mm) NPT w/Ground connector	CCH-2
Mounting Plate for Installing RTPC & RTST on Flat Surface	MP-1
Caution Labels, 5 per pack applied at 10 ft (3 m) intervals	CL-1

Table 19
Attachment Requirements - Minimum Number of Kits Required per 100 ft (30 m) of Pipe Length

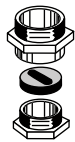
Pipe Size	Minimum No. of Kits Required Per 100 ft (30 m) of Pipe		
	CT-100	FT-1	FT-2
1/2" (21.3 mm)	1	0.31	0.51
3/4" (26.7 mm)	1	0.39	0.64
1" (33.4 mm)	1	0.48	0.79
1 1/4" (42.2 mm)	1	0.61	1.00
1 1/2" (48.3 mm)	1	0.70	1.15
2" (60.3 mm)	1	0.87	1.42
2 1/2" (73.0 mm)	1	1.10	1.80
3" (88.9 mm)	1	1.30	2.13
3 1/2" (101.6 mm)	2	1.50	2.45
4" (114.3 mm)	2	1.70	2.78
5" (141.3 mm)	2	2.00	3.27
6" (168.3 mm)	2	2.40	3.93
8" (219.1 mm)	3	3.20	5.24
10" (273.1 mm)	3	3.90	6.38
12" (323.9 mm)	4	4.70	7.69
14" (355.6 mm)	4	5.10	8.35
16" (406.4 mm)	4	5.90	9.65
18" (457.2 mm)	5	6.60	10.80
20" (508.0 mm)	5	7.30	11.95
24" (609.6 mm)	6	8.80	14.40

NOTE: Strap fiberglass tape or cable ties at 1-ft (0.31-m) intervals to hold cable to metal pipe.
Use aluminum tape for non-metal pipe concentrically under and over heating cable to aid in heat transfer.

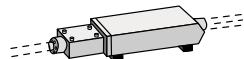
COMPONENT SELECTION AND ACCESSORIES

Table 20
Connection Accessories for Heat Trace Installation Outside of the United States

Cable Type	Component	Model	Approvals
SRL	Power Connection - Polyester	BJP002N	ATEX
	Power Connection - Aluminum	BJA001	ATEX
	Termination Kit for Use with Power Connection Kit	KCA001	ATEX
	End Seal Kit - 150°C Maximum Temperature	KIE002A	ATEX
	Polyamide Ex'e' Gland with Cable Sealing Washer and Backnut	KECPE001	ATEX
	Brass Ex'e' Gland with Cable Sealing Washer and Backnut	KECME001	ATEX
	Splice and Tee Kit - Shrink-On Sleeve	RT-RST	ATEX
	Splice and Tee Kit - Fast Connection	Domo Click	ATEX
SRL-C	Power Connection - Polyester	BJP002N	ATEX
	Power Connection - Aluminum	BJA001	ATEX
	Power Connection - EEx'e' Polyester	BJEP004N	ATEX
	Power Connection - EEx'e' Aluminum	BJEA004	ATEX
	Power Connection - EEx'd' Aluminum	BJDA004N	ATEX
	Termination Kit for Use with Power Connection Kit	KCA001	ATEX
	End Seal Kit - 150°C Maximum Temperature	KIE002A	ATEX
	Polyamide Ex'e' Gland with Cable Sealing Washer and Backnut	KECPE001	ATEX
	Brass Ex'e' Gland with Cable Sealing Washer and Backnut	KECME001	ATEX
	Splice and Tee Kit - Shrink-On Sleeve	RT-RST	ATEX
	Splice and Tee Kit - Fast Connection	Domo Click	ATEX
	In-Line Splice Kit - Hazardous Areas	KEJ-Ex	ATEX
SRL-CR & SRL-CT	Power Connection - Polyester	BJP002N	ATEX
	Power Connection - Aluminum	BJA001	ATEX
	Power Connection - EEx'e' Polyester	BJEP004N	ATEX
	Power Connection - EEx'e' Aluminum	BJEA004	ATEX
	Power Connection - EEx'd' Aluminum	BJDA004N	ATEX
	Termination Kit for Use with Power Connection Kit	KCA001	ATEX
	End Seal Kit - 150°C Maximum Temperature	KIE002C	ATEX
	Polyamide Ex'e' Gland with Cable Sealing Washer and Backnut	KECPE003	ATEX
	Brass Ex'e' Gland with Cable Sealing Washer and Backnut	KECME003	ATEX
	Splice and Tee Kit - Shrink-On Sleeve	RT-RST	ATEX
	Splice and Tee Kit - Fast Connection	Domo Click	ATEX
	In-Line Splice Kit - Hazardous Areas	KEJ-Ex	ATEX
SRME	Power Connection - Polyester	BJP002N	ATEX
	Power Connection - Aluminum	BJA001	ATEX
	Termination Kit for Use with Power Connection Kit	KCA001	ATEX
	End Seal Kit - 150°C Maximum Temperature	KIE002A	ATEX
	Polyamide Ex'e' Gland with Cable Sealing Washer and Backnut	KECPE004	ATEX
	Brass Ex'e' Gland with Cable Sealing Washer and Backnut	KECME004	ATEX
	Splice & Tee Kit - Shrink-On Sleeve	RT-RST	ATEX



KECPE001
KECME001
KECPE003
KECME003
KECPE004
KECME004
KECPE005
KECME005



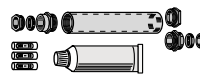
Domo Click



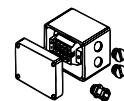
KCA001



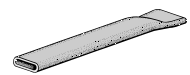
RT-RST



KEJ-Ex



BJP002N
BJA001
BJEP00
BJEA004
BJDA004N



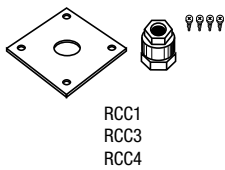
KIE002A
KEI002C

Table 20, con't.

Cable Type	Component	Model	Approvals
SRME-C	Power Connection - Polyester	BJP002N	ATEX
	Power Connection - Aluminum	BJA001	ATEX
	Power Connection - EEx'e' Polyester	BJEP004N	ATEX
	Power Connection - EEx'e' Aluminum	BJEA004	ATEX
	Power Connection - EEx'd' Aluminum	BJDA004N	ATEX
	Termination Kit for Use with Power Connection Kit	KCA001	ATEX
	End Seal Kit - 150°C Maximum Temperature	KIE002A	ATEX
	Polyamide Ex'e' Gland with Cable Sealing Washer and Backnut	KECPE004	ATEX
	Brass Ex'e' Gland with Cable Sealing Washer and Backnut	KECME004	ATEX
	Splice and Tee Kit - Shrink-On Sleeve	RT-RST	ATEX
In-Line Splice Kit - Hazardous Areas	KEJ-Ex	ATEX	
SRME-CT	Power Connection - Polyester	BJP002N	ATEX
	Power Connection - Aluminum	BJA001	ATEX
	Power Connection - EEx'e' Polyester	BJEP004N	ATEX
	Power Connection - EEx'e' Aluminum	BJEA004	ATEX
	Power Connection - EEx'd' Aluminum	BJDA004N	ATEX
	Termination Kit for Use with Power Connection Kit	KCA001	ATEX
	End Seal Kit - 150°C Maximum Temperature	KIE002C	ATEX
	Polyamide Ex'e' Gland with Cable Sealing Washer and Backnut	KECPE005	ATEX
	Brass Ex'e' Gland with Cable Sealing Washer and Backnut	KECME005	ATEX
	Splice and Tee Kit - Shrink-On Sleeve	RT-RST	ATEX
In-Line Splice Kit - Hazardous Areas	KEJ-Ex	ATEX	

Table 21
Attachment Accessories for Heat Trace Installation Outside the U.S.

Designation	Model
Fiberglass Adhesive Tape, 90°C Maximum Temperature, 50 m Long	FT04
Fiberglass Adhesive Tape, 110°C Maximum Temperature, 50 m Long	FT02
Fiberglass Adhesive Tape, 180°C Maximum Temperature, 33 m Long	FT03
Aluminum Adhesive Tape, 95°C Maximum Temperature, 50 m Long	AT03
Through Bulkhead Kit, SRL & SRL-C Cable	RCC1
Through Bulkhead Kit, SRL-CR & SRL-CT Cable	RCC3
Through Bulkhead Kit, SRM & SRM-C Cable	RCC4
Through Bulkhead Kit, SRM-CT Cable	RCC5
Insulation Outlet Kit	KSCA003
Box Support Bracket for use with Power Connection Kit - Vertical	KSB001
Box Support Bracket for use with Power Connection Kit - Horizontal	KSB002
Self-Adhesive Warning Labels	CL02



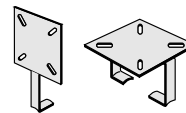
RCC1
RCC3
RCC4



FT02
FT03
FT04



AT03



KSB001
KSB002



KSCA003



RCC1
RCC3
RCC4

COMPONENT SELECTION AND ACCESSORIES

CONTROL SELECTION

Typical heat trace temperature control is accomplished by one of two methods: ambient air sensing or pipe wall sensing. When designing a heat trace system with relatively few circuits, temperature controls can be accomplished by using single-point on/off controls. When designing a system with a large number of circuits or a system that protects critical plant functions, it is often advantageous to use central control panels that employ electronic control.

Ambient Air Sensing Control

In an ambient air sensing control system, a thermostat is used to sense ambient air and switch

the heating cable on and off at a preset ambient temperature. For a small number of circuits single-point thermostats can be used to switch individual circuits on and off. If a large number of circuits is involved, a single strategically located thermostat can be used in conjunction with a contactor to switch all circuits on or off at a preset temperature.

Select your thermostat from among the figures below based on your installation needs for operating voltage, switching current, setpoint range, and area classification. **NOTE: If your circuit current exceeds the switch rating of the device selected, use the device in conjunction with a contactor suitable for your circuit current.**

Figure 8

RTAS Ambient Air Sensing Control Thermostats

Approvals: Ordinary Areas: UL, CSA, FM

Enclosure: NEMA 4X Ryton PPS

Setpoint Range: 0° to 225°F (-18° to 107°C),
Factory Preset at 40°F (4.4°C)

Deadband: 10% of Range

Operating Temperature Range: -40° to 160°F
(-40° to 70°C)

Scale Division: 10°F (5.6°C)

Switch Type: SPDT

Switch Rating: 22A at 120/250/480 Vac

Sensor: 9/16" (14.29 mm) OD x 3" (76.2 mm) L
Stainless Steel

Maximum Sensor Exposure Temperature: 450°F (230°C)

This unit can serve as power connection box. Heating cable can be terminated directly into enclosure.

Requires a sealing grommet for the type of cable being used.

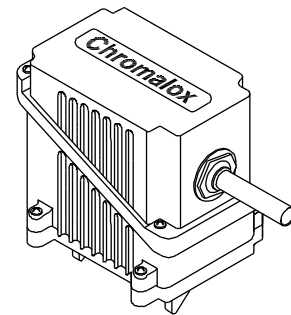


Figure 9**RTAS-EP Ambient Air Sensing Control Thermostats**

Approvals: Ordinary Areas: UL, CSA, FM
 Class I, Div. 2, Groups B,C,D: CSA, FM
 Class II, Div. 2, Groups F,G: CSA, FM
 Class III, Div. 2: FM

Enclosure: NEMA 4X Ryton PPS

Setpoint Range: 0° - 225°F (-18° to 107°C),
 Factory Preset at 40°F (4.4°C)

Deadband: 10% of Range

Operating Temperature Range: -40° to 160°F
 (-40° to 70°C)

Scale Division: 10°F (5.6°C)

Switch Type: SPDT

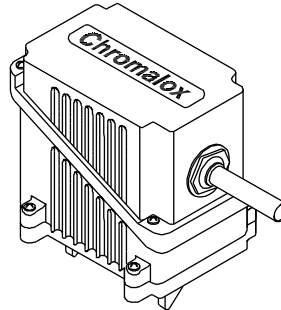
Switch Rating: 11 A at 120/250 Vac

Sensor: 9/16" (14.29 mm) OD x 3" (76.2 mm) L
 Stainless Steel

Maximum Sensor Exposure Temperature: 450°F (230°C)

This unit can serve as power connection box. Heating cable can be terminated directly into enclosure.

Requires a sealing grommet for the type of cable being used.



**CONTROL
SELECTION**

Figure 10**B-100 Ambient Air Sensing Control Thermostats**

Approvals: Ordinary Areas: UL, CSA

Enclosure: NEMA 4X

Setpoint Range: 15° to 140°F (-10° to 60°C)

Deadband: 2% of Range

Operating Temperature Range: -40° to 160°F
 (-40° to 71°C)

Switch Type: SPDT

Switch Rating: 22 A at 120/250/480 Vac

Sensor: 9/16" (14.29 mm) OD x 3" (76.2 mm) L
 Stainless Steel

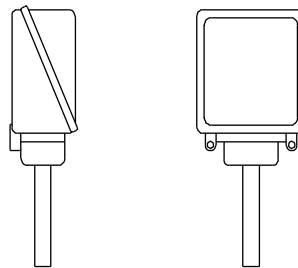


Figure 11

B-121 Ambient Air Sensing Control Thermostats

Approvals: Ordinary Areas: UL, CSA, FM
Class I, Groups B,C,D: FM
Class II, Groups E, F,G: FM
Class III: FM

Enclosure: NEMA 4X,7,9 Cast Aluminum

Setpoint Range: 15° to 140°F (-10° to 60°C)

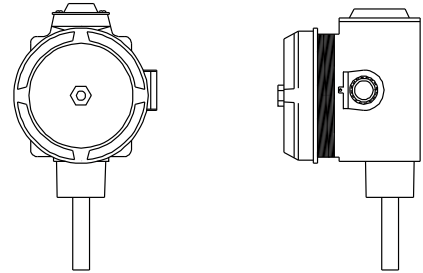
Deadband: 2% of Range

Operating Temperature Range: -40° to 160°F
(-40° to 71°C)

Switch Type: SPDT

Switch Rating: 22A at 120/250/480 Vac

Sensor: 9/16" (14.29 mm) OD x 3" (76.2 mm) L
Stainless Steel



Line Sensing Control

Line sensing control is used for process maintenance applications where the process temperature must be controlled within a moderate or narrow band. In a pipe wall sensing control system, a thermostat or RTD is used to sense pipe wall temperature and switch the heating cable on and off at a preset temperature. For a small number of circuits, single-point thermostats can be used to switch individual circuits on and off. If a large

number of circuits is involved, a centralized panel board and electronic circuit monitoring system is often used. See next section on IntelliTRACE controls.

Select your thermostat from the figures below based on your installation needs for operating voltage, switching current, set point range, and area classification. **NOTE: If your circuit current exceeds the switch rating of the device selected, use the device in conjunction with a contactor suitable for your circuit current.**

Figure 12

RTBC Line Sensing Control Thermostat

Approvals: Ordinary Areas: UL, CSA, FM

Enclosure: NEMA 4X Ryton PPS

Setpoint Range: 0° to 400°F (-18° to 200°C)

Deadband: 10% of Range

Operating Temperature Range: -40° to 160°F
(-40° to 71°C)

Scale Division: 10°F (5.6°C)

Switch Type: SPDT

Switch Rating: 22A at 120/250/480 Vac

Sensor: 1/8" (3.175 mm) OD x 11 5/8" (295.28 mm) L
Bulb, 10 ft (3 m) Stainless Steel Capillary

Maximum Sensor Exposure Temperature: 450°F (230°C)

This unit can serve as power connection box. Heating cable can be terminated directly into enclosure.

Requires a sealing grommet for the type of cable being used.

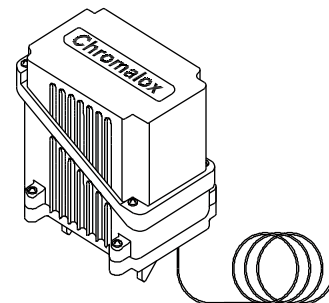


Figure 13

RTBC-EP Line Sensing Control Thermostat

Part No.: 384841

Approvals: Ordinary Areas: UL, CSA, FM
Class I, Div. 2, Groups B, C, D: CSA FM
Class II, Div. 2, Groups F, G: CSA FM
Class III, Div. 2: FM

Enclosure: NEMA 4X Ryton PPS

Setpoint Range: 0° to 400°F (-18° to 200°C)

Deadband: 10% of Range

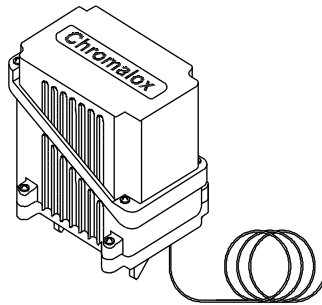
Operating Temperature Range: -40° to 160°F
(-40° to 71°C)

Scale Division: 10°F (5.6°C)

Switch Type: SPDT

Switch Rating: 22A at 120/250/480 Vac

Sensor: 1/8" (3.175 mm) OD x 11 5/8" (295.28 mm) L
Bulb, 10 ft (3 m) Stainless Steel Capillary



Maximum Sensor Exposure Temperature: 450°F
(230°C)

This unit can serve as power connection box. Heating cable can be terminated directly into enclosure.

Requires a sealing grommet for the type of cable being used.

Figure 14

E-100 Line Sensing Control Thermostat

Approvals: Ordinary Areas: UL, CSA

Enclosure: NEMA 4X

Setpoint Range: 25° to 325°F (-5° to 163°C)

Deadband: 2% of Range

Operating Temperature Range: -40° to 160°F
(-40° to 71°C)

Switch Type: SPDT

Switch Rating: 22A at 120/250/480 Vac

Sensor: 1/8" (3.175 mm) OD x 11 5/8" (295.28 mm) L
Bulb, 10 ft (3 m) Stainless Steel Capillary

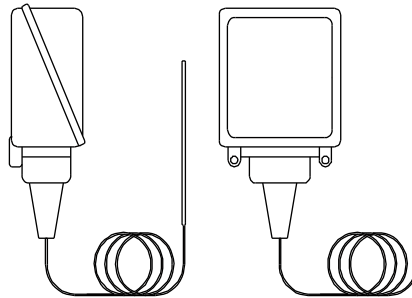


Figure 15

E-121 Line Sensing Control Thermostat

Approvals: Ordinary Areas: UL, CSA, FM
Class I, Groups B,C,D: CSA, FM
Class II, Groups E, F,G: CSA, FM
Class III: FM

Enclosure: NEMA 4X, 7, 9

Setpoint Range: 25° to 325°F (-5° to 163°C)

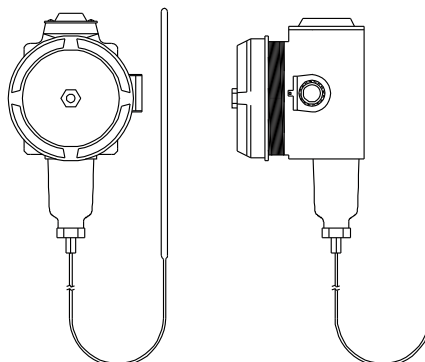
Deadband: 10% of Range

Operating Temperature Range: -58° to 160°F
(-50° to 71°C)

Switch Type: SPDT

Switch Rating: 22A at 120/250/480 Vac

Sensor: 1/8" (3.175 mm) OD x 11 5/8" (295.28 mm) L
Bulb, 10 ft (3 m) Stainless Steel Capillary



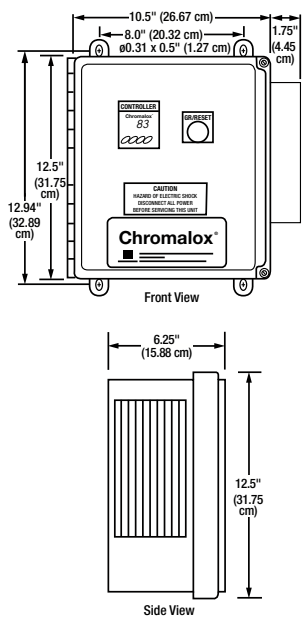
CONTROL CONNECTION SELECTION

intelliTRACE™ CONTROLS

The intelliTRACE™ System is a complete control solution designed for heat trace applications, such as process temperature maintenance, freeze protection, and roof/gutter de-icing. The modular design of the intelliTRACE control panel and components allows users to select only features needed for their specific heat trace installation.

This system uses microprocessor-based control and comes completely pre-wired and assembled. A variety of options is available that include three different AC line voltages (120, 240, and 277), RS-485 communications interface, and ground fault indicator.

Single-Loop Line-Sensing Control Panel



Technical Specifications

- Supply Voltage: 120, 240 and 277
- Operating Environment: 30° to 120°F (0° to 40°C)
- Communications: RS-485 MODBUS*
- Input Voltage: Thermocouple J,K,L,N,R,S,RTD, current, Field Programmable for °F or °C
- Output: Solid State Relay Rated @ 30A @ 40°C
- Current Alarm (Low): 0 to 30A in 1A Increments
- Ground Fault Alarm Trip: 5 to 100mA
- Temperature Alarms: Process, Deviation, Band, High/Low, Latching/Non-Latching (Manual/Automatic Reset) Programmable.
- Control Modes: Field Selectable On/Off, PID, SMART

Ordering Information

Model	HTLS Series Heat Trace Panel					
HTLS	UL Listed Single-Phase Temperature/Monitor Heat Trace Panel. NEMA 4X fiber glass enclosure 12.5" (31.75 cm) H x 10.5" (26.67 cm) W x 6.25" (15.24 cm) D. Includes complete prewired controller, solid state relay mounted on external heatsink, current transformer to measure operating current, and temperature/current alarms. PID or On/Off control, digital dual displays, terminal blocks for field connections, and optional GFI Indication or Shutdown.					
Code	Amps					
1	30					
Code	Voltage					
0	120 Vac					
1	240 Vac					
2	277 Vac					
Code	Digital Indicating Temperature Controller					
0	1604-61230	1/16 DIN Dual Four Digit Display, Alarm Outputs, and Current Input				
1	1604-61430	1/16 DIN Dual Four Digit Display, Alarm Outputs, Current Input and RS-485				
Code	GFI Options					
0	None					
1	120 V (Includes GFI Module, Shutdown Contactor, and Illuminated Reset Switch)					
2	240 V (Includes GFI Module, Shutdown Contactor, and Illuminated Reset Switch)					
3	277 V (Includes GFI Module, Shutdown Contactor, and Illuminated Reset Switch)					
Code	Add to complete model number					
0						
HTLS	1	1	1	1	0	Typical Model Number

*MODBUS is a registered trademark of Gould Inc.

IntelliTRACE™ Dual-Loop Line Sensing Control Panel

Technical Specifications

- Supply Voltage: 120, 208, 240 and 277 Vac Three Phase
- Operating Environment: 30° to 104°F (-1° to 40°C)
- Communications: RS-485 MODBUS*
- Input Voltage: Thermocouple J,K,L,N,R,S,RTD, Current, and Voltage Field Programmable, for °F or °C
- Output: Solid State Relay Rated @ 30A @ 40°C
- Current Alarm (Low): 0 to 30A in 1A Increments
- Ground Fault Alarm Trip: 5 to 100mA
- Temperature Alarms: Process, Deviation, Band, High/Low, Latching/Non-Latching (Manual/Automatic Reset) Programmable.
- Control Modes: Field Selectable On/Off, PID, SMART

Ordering Information

Model	IntelliTRACE 2000 Series Line Sensing Heat Trace Panel					
HTLS	For indoor/outdoor applications. cUL and UL Listed NEMA 4X rated enclosure 16 in. H x 14 in. W x 8 in. D (406mm H x 356mm W x 203mm D). Factory pre-wired for quick installation. Includes solid state relays, current transformer, high/low temperature alarms, low current alarm, on/off or PID control, universal sensor inputs, dual digital displays, terminal blocks for field connections, and loop enable/disable. Options include ground fault monitoring or shutdown and RS-485 communications.					
	Code	Number of Loops				
	2	30A Rating				
		Code	Voltage			
		0	120 Vac			
		1	240 Vac			
		2	277 Vac			
		3	208 Vac			
		Code	Controller			
		0	1604-61230 Controller			
		1	1604-61430 Controller with Communications			
		Code	Ground Fault Monitoring			
		0	None			
		1	GFI 120 Vac (Includes Shutdown Contactor and Illuminate Reset Switch)			
		2	GFI 240 Vac (Includes Shutdown Contactor and Illuminate Reset Switch)			
		3	GFI 277 Vac (Includes Shutdown Contactor and Illuminate Reset Switch)			
		4	GFI 208 Vac (Includes Shutdown Contactor and Illuminate Reset Switch)			
		Code	Enclosure Heater			
		0	None			
		1	Thermostat Controlled Enclosure Heater			
HTLS	2	0	0	0	0	0
Typical Model Number						

IntelliTRACE CONTROLS

IntelliTRACE
CONTROLS

*MODBUS is a registered trademark of Gould Inc.

intelliTRACE™ Multi-Loop Line-Sensing Control Panel



Technical Specifications

- Supply Voltage: 120, 240 and 277 Vac Three-Phase
- Operating Environment: 30° to 120°F (0° to 40°C)
- Communications: RS-485 MODBUS*
- Input: RTD 100Ω Platinum Three-Wire
- Maximum Current: 24A/Ckt
- Temperature Alarms: High/Low 2°F Deadband Non-Latching
- Ground Fault Alarm: Adjustable 25 to 500mA, Factory Set @ 30mA
- Continuity Alarm: < 2A Non-Latching
- Load Management: 15-Second Non-Overlap to Reduce In-Rush
- Auto-Cycle: Programmable to 720 Hr (30 days)
- Failed Sensor Output Setting: 0% to 100%
- Control Mode: On/Off with Adjustable Deadband

Ordering Information

Model	HTLS Series Heat Trace Panel					
HTLS	cUL Listed Floor Mount NEMA 4 Steel Enclosure. Includes prewired controller, two-pole contactors, current transformer to measure operating currents, high/low temperature alarms, On/Off control, RTD sensor input, color touchscreen programming, GFI indication or shutdown, common alarm output, Hand/Off/Auto selection loop enable/disable, and auto-cycle feature.					
	Code	Number of Loops				
	8	Independent Loops of Heat Trace Control				
	12					
	24					
	Code	Voltage				
	0	120 Vac				
	1	240 Vac				
	2	277 Vac				
	Code	Circuit Breaker Rating Selection				
	1	15A Thermal Magnetic Circuit Breakers				
	2	20A Thermal Magnetic Circuit Breakers				
	3	30A Thermal Magnetic Circuit Breakers				
	Code	Cabinet Heater				
	0	None				
	1	Thermostat Controller Enclosure Heater				
	Code	Pressurization Control System				
	0	None				
	1	Type Z for Class I Division 2 Hazardous Location				
HTLS	8	1	2	1	0	Typical Model Number

*MODBUS is a registered trademark of Gould Inc.

intelliTRACE CONTROLS

intelliTRACE™ Multi-Loop Ambient-Sensing Control Panel



Technical Specifications

- Supply Voltage: 120, 240 and 277 Vac Three-Phase
- Operating Environment: 30° to 120°F (0° to 40°C)
- Communications: RS-485 MODBUS*
- Maximum Current: 24A/Ckt
- Ground Fault Alarm: Adjustable 25 to 500mA, Factory Set @ 30mA
- Continuity Alarm: < 2A Non-Latching
- Load Management: 15-Second Non-Overlap to Reduce In-Rush
- Auto-Cycle: Programmable to 720 Hr (30 days)
- Control Mode: Optional Ambient Sensing Controller

Ordering Information

Model	HTAS Series Heat Trace Panel						
HTAS	cUL Listed Floor Mount NEMA 4 Steel Enclosure. Includes optional ambient sensing controller, two-pole contactors current transformer to measure operating currents, continuity alarms, color touchscreen programming, GFI indication or shutdown, common alarm output, Hand/Off/Auto selection, loop enable/disable, and auto-cycle feature.						
Code	Number of Loops						
8	Independent Loops of Heat Trace Control						
12							
24							
Code	Voltage						
0	120 Vac						
1	240 Vac						
2	277 Vac						
Code	Circuit Breaker Rating Selection						
1	15A Thermal Magnetic Circuit Breakers						
2	20A Thermal Magnetic Circuit Breakers						
3	30A Thermal Magnetic Circuit Breakers						
Code	Cabinet Heater						
0	None						
1	Thermostat Controller Enclosure Heater						
Code	Ambient Sensing Controller						
0	None (Remote Mounted)						
1	1601-11030, Three-Digit, Dual Display 1/16 Din Controller w/ Temp Alarms						
2	1603-11030, Three-Digit, Dual Display 1/16 Din Controller w/ Temp Alarms						
Code	Pressurization Control System						
0	None						
1	Type Z for Class I Division II Hazardous Location						
HTAS	12	1	2	1	0	1	Typical Model Number

*MODBUS is a registered trademark of Gould Inc.

intelliTRACE™ Controls for Hazardous Location Applications



Description

The Chromalox HTLSC1D2 series panels are microprocessor based temperature control and monitoring units for heat tracing used in freeze protection and process temperature control applications.

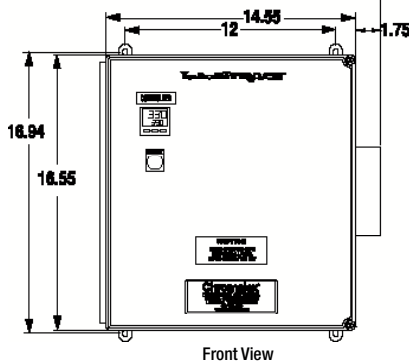
This series of panels can be configured for ambient or line sensing control. The HTLSC1D2 series implement a scaleable design such that they can be configured with or without communications, ground fault monitoring or enclosure heater.

This unique format offers a design that can be tailored both by price and features to meet the most challenging demands in heat trace applications. For example: The HTLSC1D2 series can be networked together via RS-485 MODBUS and the Chromalox Windows based Chromasoft SpecView software package. The optional ground fault monitoring addresses the national electric code requirements and reduces the cost of installing costly ground-fault circuit breakers. In the event of sub-zero temperatures the optional enclosure heater is available. The Chromalox HTLSC1D2 series offers single and dual loop designs and are approved for Class 1 Division 2 Areas.

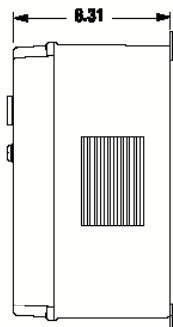
The HTLSC1D2 series have programmable inputs (thermocouple, RTD, mA, VDC), On/Off or PID control, Auto-tune function, High/Low temperature alarms, current alarm, and sensor failure indication. The heat tracing circuit is switched by a 30 amp solid state relay rated at 40°C ambient.

The Chromalox HTLSC1D2 series panel comes ready to install and includes control and power wiring terminal blocks for field connections.

HTLS C1D2 Single-Loop Sensing Control Panel



Front View



Side View

Technical Specifications

Area of Use: Class 1 Division 2

Approvals: UL, cUL, CE

Supply Voltage: 120, 208, 240, 277, and 480 Vac.

Ambient Operating Temperature: 32° to 104°F (0° to 40°C),
-32° to 104°F (-35.5° to 40°C) with Optional Enclosure Heater.

Protection: NEMA 4X Fiber Glass

Communications: RS-485 MODBUS*

Temperature Sensor Input: J, K, T, E, B, R, S, N, L,
PT100, mV, mA, V

Output: Solid State Relay Rated 30A @ 40°C.

Current Alarm (Low): 0 - 50A in .1A Resolution.

Temperature Alarms: Field Selectable Deviation High/Low,
Deviation Band High/Low, Process Low /High, Latching,
Non-Latching.

Control Modes: Field Selectable On/Off, PID, Auto-Tune.

Ground Fault Alarm: Adjustable Trip Level 30 to 300mA;
Adjustable Trip Delay 0 to 1 sec.

Ordering Information

Model HTLSC1D2 Series Heat Trace Panel

HTLSC1D2 cUL, UL and CE Listed Single Loop Line Sensing Temperature/Monitor Heat Trace Panel. Factory pre-wired for quick installation. Includes: Solid State Relay, Current Transformer, High-Low Temperature Alarms, Low Current Alarm, On/Off or PID Control, Universal Sensor Inputs, Dual Digital Displays, Terminal Blocks for Field Connections, Loop Enable/Disable, NEMA 4X rated Enclosure (16"H x 14"W x 8"D) for Indoor/Outdoor Applications. Options Include: Ground Fault Monitoring, Digital Communications and Enclosure Heater.

Code	Amps
1	30
Code	Voltage
0	120 Vac
1	208 Vac
2	240 Vac
3	277 Vac
4	480 Vac
Code	Controller
0	ETR-9300-412690 Controller
1	ETR-9300-412691 Controller with Communications
Code	Ground Fault Monitoring
0	None
1	Ground fault Module (Includes Illuminated Reset Switch)
Code	Enclosure Heater
0	None
1	Thermostat Controlled Enclosure Heater

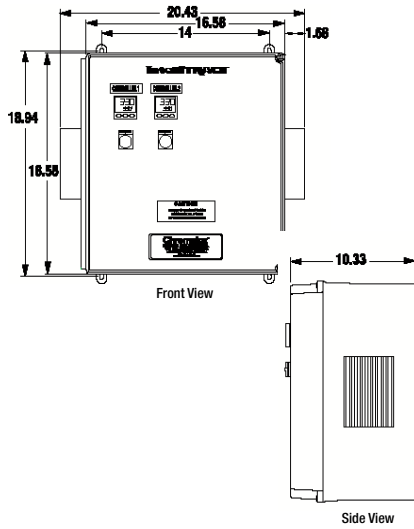
HTLSC1D2 1 0 0 1 0 Typical Model Number

*MODBUS is a registered trademark of Gould Inc.

intelliTRACE CONTROLS



HTLS C1D2 Dual-Loop Sensing Control Panel



Technical Specifications

Area of Use: Class 1 Division 2

Approvals: UL, cUL, CE

Supply Voltage: 120, 208, 240, 277, and 480 Vac.

Ambient Operating Temperature: 32° to 104°F (0° to 40°C),
-32° to 104°F (-35.5° to 40°C) with Optional Enclosure Heater.

Protection: NEMA 4X Fiber Glass

Communications: RS-485 MODBUS*

Temperature Sensor Input: J, K, T, E, B, R, S, N, L,
PT100, mV, mA, V

Output: Solid State Relay Rated 30A @ 40°C.

Current Alarm (Low): 0 to 50A in .1A Resolution.

Temperature Alarms: Field Selectable Deviation High/Low,
Deviation Band High/Low, Process Low /High, Latching,
Non-Latching.

Control Modes: Field Selectable On/Off, PID, Auto-Tune.

Ground Fault Alarm: Adjustable Trip Level 30 to 300mA;
Adjustable Trip Delay 0 to 1 sec.

Ordering Information

Model HTLSC1D2 Series Heat Trace Panel

HTLSC1D2 cUL, UL and CE Listed Dual Loop Line Sensing Temperature/Monitor Heat Trace Panel. Factory pre-wired for quick installation. Includes: Solid State Relay, Current Transformer, High-Low Temperature Alarms, Low Current Alarm, On/Off or PID Control, Universal Sensor Inputs, Dual Digital Displays, Terminal Blocks for Field Connections, Loop Enable/Disable, NEMA 4X rated Enclosure (18"H x 16"W x 10"D) for Indoor/Outdoor Applications. Options Include: Ground Fault Monitoring, Digital Communications and Enclosure Heater.

Code Amps

2 30

Code Voltage

0 120 Vac
1 208 Vac
2 240 Vac
3 277 Vac
4 480 Vac

Code Controller

0 ETR-9300-412690 Controller
1 ETR-9300-412691 Controller with Communications

Code Ground Fault Monitoring

0 None
1 Ground fault Module (Includes Illuminated Reset Switch)

Code Enclosure Heater

0 None
1 Thermostat Controlled Enclosure Heater

HTLSC1D2 2 0 0 1 0 Typical Model Number

*MODBUS is a registered trademark of Gould Inc.

INSTRUMENTS • CONTROLS • VALVES



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