Amorphous HeatWAVE

USER MANUAL

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VERY IMPORTANT

NEVER ENERGIZE A ROLLED UP HEATING RIBBON

ALWAYS CHECK THE RESISTANCE OF EACH HEATING RIBBON(S) RIGHT AWAY UPON RECEIVING IT/THEM AND MAKE SURE THEY MATCH THE VALUES PROVIDED BY TRUHEAT FOR EACH HEATING RIBBON.

NEVER TRY TO BEND THE HEATING RIBBON WHILE IT IS NOT WARM. TURNS IN THE RIBBON CAN BE MADE BY CREATING A LOOP IN THE CABLE. IF THE PROJECT REQUIRES BENDING, FIRST WARM UP THE BENDING LOCATION OF THE RIBBON WITH A PROFESSIONAL HEAT GUN. BENDING A UN-WARMED RIBBON WILL RESULT IN BREAKING THE AMORPHOUS HEATING RIBBON INSIDE THE CABLE AND WILL VOID WARRANTY.

Introduction

1.1 SCOPE

TruHeat currently supplies two families of the Amorphous HeatWAVE products:

- Outdoor Underground Heating Ribbons and Mats, normally at 24-47 watts/ft^2. Higher outputs can be easily achieved by controlling the spacing between ribbon runs on the ground.
- Pipe and Gutter Freeze Protection / Heat Tracing Ribbons.

Both product families of the Amorphous HeatWAVE ribbons are based on a unique design of fully grounded heat-tracing cables (Heating element) made of amorphous metallic ribbons enclosed in a mechanically strong but flexible enclosure. The heating element is designed per IEEE 515.1 standard for underground and outdoor-exposed applications.

This manual covers TruHeat's first product family of Amorphous HeatWAVE products – Outdoor Underground Heating Ribbons and Mats. The manual provides general information on these products, and specifies the installation procedures for the field technician.

Please request the manual for the Gutter Freeze Protection / Heat Tracing Ribbons separately

1.2 MANUAL ORGANIZATION

The manual is divided into three chapters and two appendices:

Chapter 1 – Introduction
This chapter outlines the purpose and structure of this manual and gives a general outline of the Amorphous HeatWAVE system.

Chapter 2 – Amorphous HeatWAVE System Description & Main Characteristics
This chapter provides a general description of the HeatWAVE Outdoor Underground Heating Ribbons and Mats, describes the Heating element, which is the building block of these systems and gives the main features and specifications of the Heating Ribbons and Mats.

Chapter 3 – Installation Procedure
This chapter provides the field technician with detailed instructions on installing the Amorphous HeatWAVE Heating Ribbons and Mats, including the tools and materials required to execute the installation.

Appendix A – Outdoor-Heating Specifications
This supplement provides a table specifying the heater and outdoor surface temperatures under different weather conditions.

Appendix B –Cable Connection Diagrams
This supplement gives connection diagrams for heating cables with 1, 2 and 3 wires.

1.3 AMORPHOUS HEATWAVE GENERAL OVERVIEW

The HeatWAVE Systems (ribbons/mats) are high quality heating devices designed for melting ice and snow from road and sidewalk surfaces, gutters and ice and snow, mounted on top of roofs during the winter season (see Figure 1-1). The HeatWAVE System is based on a unique and patented amorphous metal heating technology, specifically developed to solve safety hazards caused by harsh cold weather conditions. This product has significant advantages over any other type of hydronic or electrical cables.

The main advantages are as follows:

- Greater surface contact with cold ground or ice
- Innovative design of the heating cable
- Reaching operating temperature rapidly
- Generating heat evenly
- Energy savings
- Less costly
- Reliable and durable
- Installation is extremely simple and easy
- Perfectly safe against electric shock hazards

Figure 1-1. Typical Use of the Amorphous HeatWAVE System during winter season

System Description

2.1 GENERAL DESCRIPTION

This chapter provides a general description of the Amorphous HeatWAVE Outdoor Underground Heating Ribbons and Mats, describes the Heating element, which is the building block of these systems and gives the main features and specifications of the Heating Ribbons and Mats.

2.2 HEATING ELEMENT

2.2.1 HEATING ELEMENT COMPONENTS

The Heating element is patented and manufactured by TruHeat, and consists of the following components (see Figure 2-1):

- Coated amorphous ribbon
- Internal coating
- Return lead (one or two leads according to the application)
- Aluminum Sheath
- Grounding lead
- External coating
- Flame retardant

2.2.1.1 HEATING ELEMENT COMPONENTS

The Heating element is made of amorphous ribbons, with a nominal thickness of 20-30 µm, and various widths ranging from 7 to 25 mm. In certain applications, two parallel (side-by-side) coated amorphous ribbons are embedded in the enclosure.

2.2.1.2 INTERNAL COATING

The internal coating consists of a double-layer (class 2) linear low-density polyethylene with a nominal thickness of 0.5-1.0 mm on each side of the metallic ribbon.

2.2.1.3 RETURN LEAD

According to the application, the heating element may have one or two 1.5 mm^2 leads. The conductor is made of bare copper, insolated by HDPE of width 0.41± 0.06 mm.

2.2.1.4 ALUMINUM SHEATH

The grounding sheath is made of 50 µm aluminum foil coated with 12 µm polyester at a total thickness of 62 µm. The aluminum side faces outward and fully covers the coated amorphous ribbon and return leads.

2.2.1.5 GROUNDING LEAD

The grounding lead is made of a 1.5 mm2 tinned copper conductor. The conductor is in full contact with the aluminum foil.

2.2.1.6 EXTERNAL JACKET

The external jacket is made of a black Liner Low-Density Polyethylene (LLDPE), has a nominal thickness of 1 mm (at least 0.9 mm) and a UV additive as required by the application. For outdoor-exposed applications, an FR additive is added to the coating material.

2.2.1.7 FLAME RETARDANT

A PE Flame Retardant concentrate is added to all applications in order to provide self-extinguishing properties. The Flame Retardant meets UL94 requirements.

NOTE:
Both internal coating and external jacket are characterized by:

- High melting temperature (approximately 120°C)
- Low friction coefficient
- Good abrasion resistance
- Good petroleum-jelly resistance
- Low water absorption
- Well-dispersed, highly effective UV stabilizer in sufficient amount to ensure excellent weathering resistance

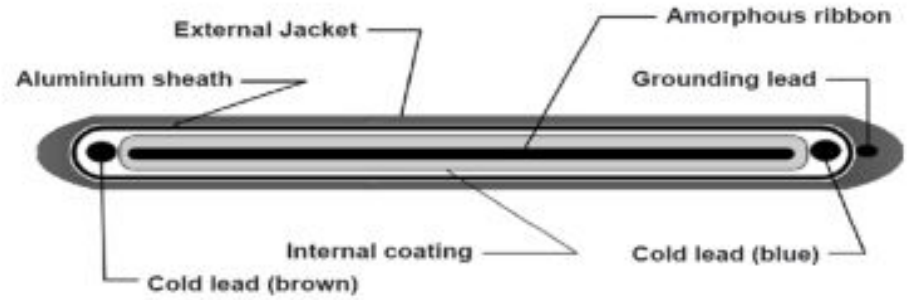


Figure 2-1. Amorphous HeatWAVE Cable Components

2.2.2 HEATING ELEMENT PERFORMANCE

The heating element possess a fixed power per meter length. Thus, using different widths of the amorphous ribbons and different length of the element, one can easily set the required output power per linear meter. The upper limit for the heating element is 62 watts per meter (18.9 watts per foot). This limit corresponds to 5A on a single unit. The heating element can be driven by various AC or DC power sources: 110-120, 208, 220-240, 400 and 600 Volts, as long as the current limit is met.

The heating element's upper working temperature limit is 70°C.

The two embedded electrical leads enable the connection of sequential heating elements to form long heating elements (up to 100 m long), which are fed from a voltage supply located only at one end of the cable.

2.3 AMORPHOUS HEATWAVE MAT

2.3.1 PURPOSE AND USE

The Amorphous HeatWAVE Underground Heating Mat is designed to be laid beneath concrete, asphalt, paving stones, or gravel surfaces, and provides a safe solution against hazards caused by harsh, cold weather conditions in the following sites:

- Pedestrian crossings
- Driveways in front of garages
- Bus and tram stops
- Any other place where the safe walking and entrance to buildings should be maintained

2.3.2 HEATING MAT DESCRIPTION

The Amorphous HeatWAVE Heating Mat is composed of one or more heating elements connected in parallel. The heating elements are either straight or bent, according to site conditions, and can be supplied as a specified heating mat, or as a serpentine cable buried in the ground (see Figure 2-2).

Figure 2-2. Amorphous HeatWAVE Heating Mat

Each heating mat is individually connected to a voltage source through a single cold-lead cable (consisting of three leads: live, neutral and ground, and shielded if local codes require so). The cable is routed to an electrical connection box. The power supply system must include a GFCI or RCD, and a controller that with temperature and moisture sensors.

2.3.3 GEOMETRIC DIMENSIONS AND TOLERANCES

The heating mats are designed so the heating element covers from 15% to 30% of the heated surface, per customized design request, or per project.

Installation Procedure

3.1 GENERAL

This chapter provides the field technician with detailed instructions on installing the Amorphous HeatWAVE Ribbons and Mats, including the recommended installation layers used for various terrains, tools and materials required to execute the installation.

For a detailed installation layers, please refer to page 23.

3.2 INSTALLATION LAYERS

3.2.1 UNDER ASPHALT

The construction profile of the HeatWAVE heating element installed under asphalt should be as shown in Figure 3- 1.

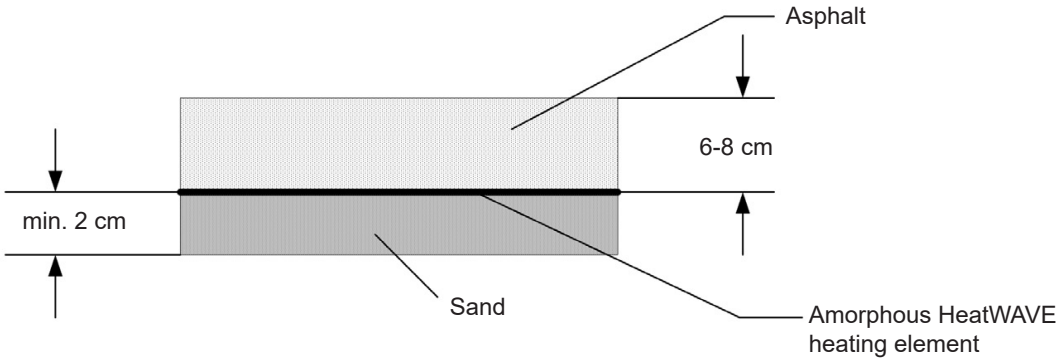


Figure 3-1. Construction Profile Under Cold Asphalt

*****IMPORTANT*****
Asphalt temperature cannot exceed past 180°C (356°F) when pouring on top of the Amorphous HeatWAVE system. Asphalt temperatures of greater than 180°C (356°F) will damage the heating system. We recommend covering the heating system with a thin coat of cement before pouring hot asphalt. Refer to page 24 for more details

3.2.2 UNDER CONCRETE SLAB

The construction profile of the HeatWAVE heating element installed under concrete should be as shown in Figure 3-2.

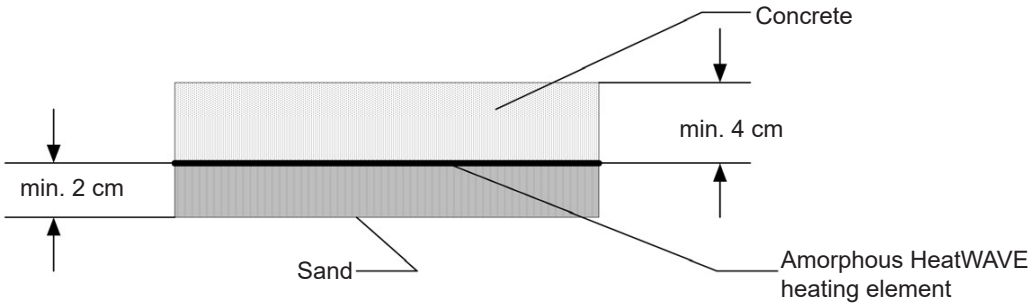


Figure 3-2. Construction Profile Under Concrete

3.2.3 UNDER PAVERS

The construction profile of the HeatWAVE heating element installed under pavers should be as shown in Figure 3-3.

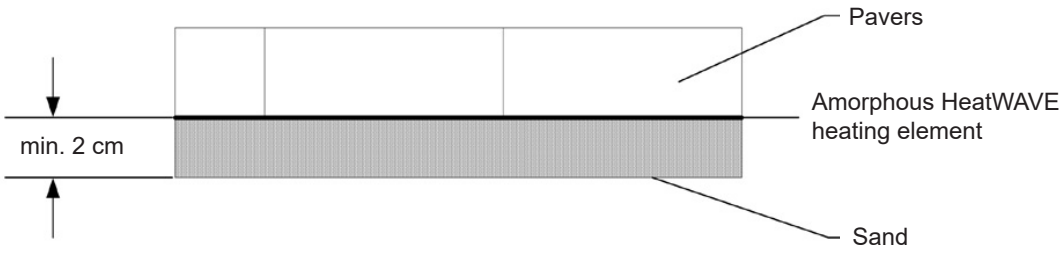


Figure 3-3. Construction Profile Under Pavers

3.2.4 UNDER GRAVEL

The construction profile of the HeatWAVE heating element installed under gravel should be as shown in Figure 3-4.

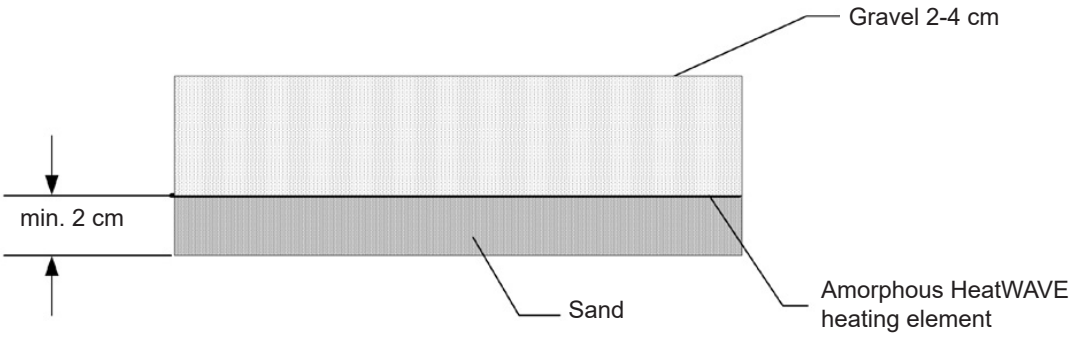


Figure 3-4. Construction Profile Under Gravel

3.3 POWER LOADINGS

This chapter provides a general description of the Amorphous HeatWAVE Outdoor Underground Heating Ribbons and Mats, describes the Heating element, which is the building block of these systems and gives the main features and specifications of the Heating Ribbons and Mats.

PARKING LOTS	250 - 350 W/M^2 (23.23 - 32.51 W/FT^2)
DRIVEWAYS	250 - 300 W/M^2 (23.23 - 27.87 W/FT^2)
SIDEWALKS	250 - 300 W/M^2 (23.23 - 27.87 W/FT^2)
DOOR STEPS	300 - 375 W/M^2 (27.87 - 34.83 W/FT^2)
BRIDGES	300 - 400 W/M^2 (27.87 - 37.16 W/FT^2)

These power restrictions depend on the weather conditions, such as ambient temperature, humidity, wind speed, snowfall rate and level of thermal insulation. The above values correspond to windless weather and typical snow melting rates between 6.35 and 12.7 mm per hour, when the corresponding air temperature ranges from -7°C to -2°C. To prevent ice and snow (melting), the covering surface temperature must be theoretically 0°C (in practice, we recommend 1-2°C). The time

required to reach the melting temperature depends on the heat flux density of the heating element, the depth of the heating element below the covering surface, the thermal and physical properties of the covering surface, and the weather conditions. TruHeat's specialists developed a computer program that enables to calculate the temperature distribution in the covering surface and the heating time to desired temperature. An example of such calculation is presented in Appendix 1.

3.4 PLANNING THE INSTALLATION OF THE HEATING ELEMENT

When planning the installation of the Amorphous HeatWAVE cables for your project, you should determine the number of assembled cables required and the number and lengths of cable sections required to form each assembled cable. If a design package ha sbeen provided by your TruHeat representative, please follow the layout plan mentioned in it. Proceed as recommended below:

VERY IMPORTANT

- **Check the insulation resistance of all cables heater cables upon receiving them.**
- **Never connect rolled up heater cables to a power source.**
- **Use the longest possible cable sections to minimize the number of section connections.**
- **If possible, use cable sections of the same length to form an assembled cable.**
- **Ensure that the source can support the power requirements of the required installation.**
- **Include a control box with a humidity and temperature sensor in your installation, consult with a TruHeat representative.**
- **Have heater cables located at a minimum of 150 mm from the edge of the slab. To minimize the number of bends, the embedded heat tracing should be oriented longitudinally in the slab section. Crossing of expansion joints should be avoided. In cases where an expansion joint transition is required, additional protection is necessary.**
- **The standard distance between adjacent heating is 20 cm, but this could be modified according to meet the required output per square meter, provided the upper limits of the heating cable specifications are not exceeded.**
- **Heater power connections should be in an above grade junction box located, if possible, inside a building or on a structure wall. At or below grade locations should be avoided.**
- **For field assembled heating cable systems, it is desirable to locate the heater end termination inside the junction box to facilitate troubleshooting and enhance reliability.**
- **An insulation resistance test should be conducted with a test voltage of at least 500 V DC. However, for polymer insulated heating cables, 2500 V DC is recommended. The measured value should not be less than 20 M.**
- **The insulation resistance test should be conducted continuously during the pour. The insulation resistance reading at the end of the concrete pour or asphalt application should be recorded.**
- **Upon completion of heating cable installation and before concrete pour or asphalt application, the drawings should be modified to reflect the as-built conditions.**
- **The cables should not be energized until either the concrete has cured or the asphalt has cooled to ambient temperature.**

3.4.1 STEP 1: MEASURING THE PROJECT SITE

Prior to installation, draw an installation plan showing the placement of the heating cable based on the power needed, and the connection boxes. Use this plan to determine the number and length of each assembled cable and the power cord required for the installation (see Figure 3-5).

*****IMPORTANT*****
If a TruHeat representative has provided an installation diagram plan based on your project details, it is important to follow that layout when installing the Amorphous HeatWAVE system. This is because spacing requirements between the ribbon runs have been pre-determined to ensure an error free installation and no over-heating of the ribbons.

3.4.2 STEP 2: DETERMINING THE REQUIRED ASSEMBLED CABLES

Based on the installation plan designed in Step 1, determine the number and length of each cable section, and those of the assembled cables required for the installation. The following example shows an installation in a rectangular site of 10 m × 30 m, where the required power is 40 W/m^2.

3.4.3 STEP 3: DETERMINING THE POWER REQUIREMENTS

Prior to installation, make sure the electrical capacity of the site can support the installation power requirements. Use the following formula to calculate the current required for each assembled cable:

$$I = \frac{V}{R} = \frac{V}{L * \rho}$$

I - Current in amps
R - Resistance
L - Length
V - Volts
ρ - Resistance per meter

Table 3-1 lists the resistance per meter for each cable model.

CABLE MODEL	RESISTANCE PER METER
AHT0300707	17.8 Ω
AHT0300700	8.9 Ω
AHT0301200	5.2 Ω
AHT0302500	2.5 Ω

Table 3-1

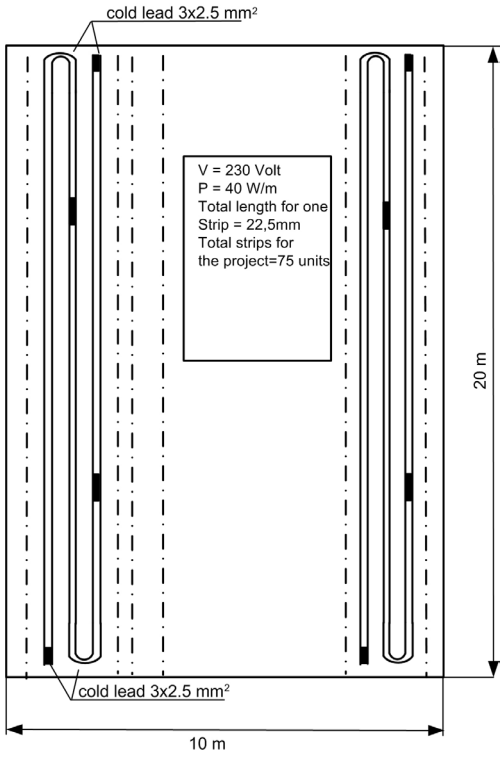


Figure 3-5. Example of an Installation Plan

3.4.4 STEP 4: DETERMINING THE NUMBER OF CONNECTION KITS REQUIRED

Use connection kits for each type of connection required in your installation. There are three types of connection kits. Table 3-2 describes and illustrates each type of connection kit.

*****IMPORTANT*****
For projects where pre-determined lengths of HeatWAVE cables have been provided, there is no need to connect individual cables to each other. Each HeatWAVE cable will have its own cold lead connection. Refer to figure 3-6 for electrical connection diagrams with single phase or three phase connection type.

*****IMPORTANT*****
Skit to section 3.5 if working with pre-cut heater wires.

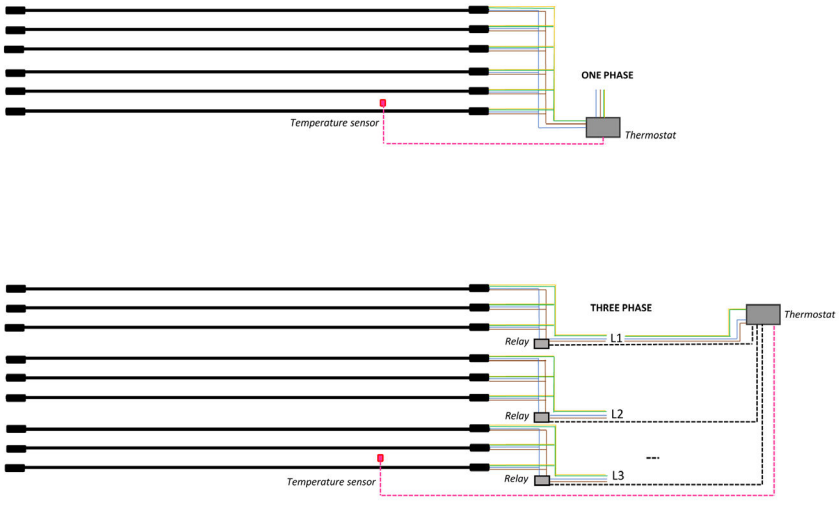


Figure 3-6. Example of Connection Types

* The following illustrations refer only to the 25 mm ribbon kit.*

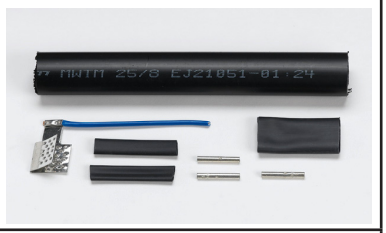
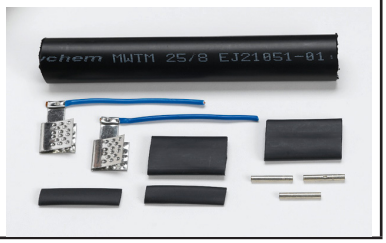
CONNECTION TYPE	KIT TYPE	KIT ILLUSTRATION
Connection between a cable and a power cord	Power Connection Kit	
Sealing of a cable end not connected to a power cord or another cable.	Termination Connection Kit	
Connection between two cable sections in an assembled cable	Section Connection Kit	

Table 3-2

Each cable model has its own set of connection kits. Table 3-3 to Table 3-5 provide lists of connection kits available for each cable model, along with the contents of each kit.

Table 3-3. Connection Kits for Cable Model AHT0302500

KIT TYPE	CONNECTION KIT NO.	CONTENTS
Power Connection Kit	AHT010ckP2500	1 unit – 20 mm crimp connector with 6 cm electrical wire 3 units – copper crimp sleeves, tin plated 2.5 Ø 1 unit – 18/6 shrink tube (5 cm) 2 units – 8/2 shrink tubes (3.5 cm) 1 unit – 25/8 shrink tube (1 cm)
Section Connection Kit	AHT010ckS2500	2 units – 20 mm crimp connectors with 6 cm electrical wire 3 units – copper crimp sleeves, tin plated 2.5 Ø 2 units – 18/6 shrink tubes (5 cm) 2 units – 8/2 shrink tubes (3.5 cm) 1 unit – 25/8 shrink tube (17 cm)
Termination Connection Kit	AHT010ckT2500	1 unit – 20 mm crimp connector 1 unit – 18/6 shrink tube (6 cm) 1 unit – 8/2 shrink tube (2 cm) 1 unit – 25/8 shrink tube (10 cm)

Table 3-4. Connection Kits for Cable Model AHT0301200/700

KIT TYPE	CONNECTION KIT NO.	CONTENTS
Power Connection Kit	AHT01OckP1200/0700	1 unit – 10 mm crimp connector with 6 cm electrical wire 3 units – copper crimp sleeves, tin plated 2.5 Ø 1 unit – 12/3 shrink tube (4 cm) 2 units – 8/2 shrink tubes (3.5 cm) 1 unit – 25/8 shrink tube (1 cm)
Section Connection Kit	AHT01OckS1200/0700	2 units – 10 mm crimp connectors with 6 cm electrical wire 3 units – copper crimp sleeves, tin plated 2.5 Ø 2 units – 12/3 shrink tubes (4 cm) 2 units – 8/2 shrink tubes (3.5 cm) 1 unit – 25/8 shrink tube (16 cm)
Termination Connection Kit	AHT01OckT1200/0700	1 unit – 10 mm crimp connector 1 unit – 12/3 shrink tube (5 cm) 1 unit – 8/2 shrink tube (2 cm) 1 unit – 25/8 shrink tube (10 cm)

Table 3-5. Connection Kits for Cable Model AHT030707

KIT TYPE	CONNECTION KIT NO.	CONTENTS
Power Connection Kit	AHT01OckP0707	2 units – 10 mm crimp connectors with 6 cm electrical wire 3 units – copper crimp sleeves, tin plated 2.5 Ø 2 units – 12/2 shrink tubes (4 cm) 2 units – 8/2 shrink tubes (3.5 cm) 1 unit – 25/8 shrink tube (16 cm)
Section Connection Kit	AHT01OckS0707	2 units – 10 mm crimp connectors with 6 cm electrical wire 1 unit – 20 mm crimp connector 3 units – copper crimp sleeves, tin plated 2.5 Ø 2 units – 12/3 shrink tubes (4 cm) 2 units – 8/2 shrink tubes (3.5 cm) 1 unit – 18/6 shrink tube (5 cm) 1 unit – 25/8 shrink tube (17 cm)
Termination Connection Kit	AHT01OckT0707	1 unit – 20 mm crimp connector 1 unit – 18/6 shrink tube (6 cm) 1 unit – 8/2 shrink tube (2 cm) 1 unit – 25/8 shrink tube (10 cm)

3.4.5 STEP 5: DETERMINING THE AMOUNT OF RESINEX SEALANT REQUIRED

NOTE:
Always wear plastic gloves while using Resinex.

Use Resinex sealant to tightly seal each assembled cable. Each Resinex kit contains sufficient sealant material for 6 to 8 connections. Purchase enough Resinex sets to complete the necessary number of connections.

Once you mix the Resinex components, you must use them within 10 minutes.

To make sure you can use the entire Resinex kit, prepare enough connections and terminations before mixing the Resinex components; then seal all the connections and terminations within 10 minutes after mixing the Resinex.

Proceed as follows to seal the shrink tubes using Resinex:

1. Put on the plastic gloves provided with the Resinex kit.
2. Empty the contents of the bottle into the can.
3. Mix the contents well with the mixing stick.
4. Pour an appropriate amount of Resinex into the shrink tube, enough to fill the tube when sealed with no excess.
5. Wait 20 minutes, and then squeeze the closed shrink tube. Make sure the sealant fills the tube, and no air is left inside.
6. Allow the Resinex to thoroughly dry – it takes from one to four hours.

3.5 INSTALLATION TOOLS REQUIRED

The following tools are required to perform all installations of TruHeat's Heating Ribbons and Mats (see Figure 3-6):

- Heat gun (for sealing shrink tubes) (1)
- Wire stripper (2)
- Pliers (3)
- Wire cutter (4)
- Connection crimper (5)
- Industrial-strength scissors (6)
- Crimper (7)
- Utility knife (Not shown)
- AVO meter (Not shown)
- Megger tester (Not shown)
- Black plastic cable ties (Not shown)
- Metal fixing bands (Not shown)
- Power cord (Not shown)

Figure 3-7. Required Installation Tools

3.6 INSTALLING THE HEATING ELEMENTS

NOTE:
All installations must be performed by a qualified electrician in the country where the installation takes place, and is certified to install its Snow-and-Ice Melting products.

3.6.1 STEP 1: GETTING THE CABLES

NOTE:
The Amorphous HeatWAVE system is sold in rolls or pre-cut cable runs.

*****IMPORTANT*****
Cables which have been pre-cut and pre-assembled by TruHeat for the project do not require any modifications. Skip to step 7 on page 19.

3.6.2 STEP 2: CONNECTING THE CABLES

NOTE:
The cable sections must be connected on a dry, flat surface.

Proceed as follows to prepare the cables for connections and terminations:

1. Use the utility knife to strip ½ to cm of insulation from both ends of each cable. Carefully cut all the way around the cable and peel off the insulation, including the aluminium layer. Do not cut the ribbon or the cable wires.

2. Open the appropriate connection kit and perform the required connection. Refer to the appropriate section for the type of connection required:

- If you are connecting a power cord to the cable, refer to Step 3: Connecting the Power Cord (Section 3.6.3).
- If you are connecting cable sections, refer to Step 4: Connecting Cable Sections (Section 3.6.4).
- When terminating the cable, refer to Step 5: Terminating the Cable (Section 3.6.5).

3.6.3 STEP 3: CONNECTING THE POWER CORD

Use the Power Connection Kit (see Table 3-3 to Table 3-5), and proceed as follows to connect the power cord to the cable:

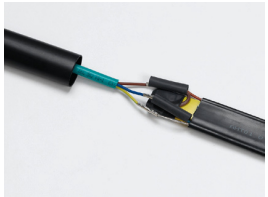
1. Open the Power Connection Kit.

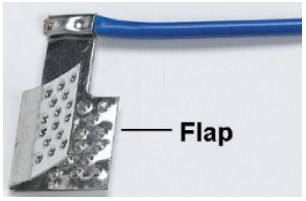
2. Peel off approximately 4 cm of insulation from the end of the power cord.

3. Peel off approximately 4 cm from all wires.

4. Crimp the crimp connector onto the ribbon.

5. Fold the flap onto the crimp connector.





6. Place the 12/3 (or 18/6 if you are using 25 mm cable) shrink tube over the end of the ribbon, and use the fan to seal the tube.

7. Place the 25/8 shrink tube over the cable. Leave all wires exposed.

8. Twist together the crimp wire and the brown wire from the cable and insert the twisted portion of the wires into one of the copper crimp sleeves.

9. Place an 8/2 shrink tube over the brown cable and crimp wires.

10. Insert the brown wire from the power cord into the other end of the copper crimp sleeve covering the brown wire from the cable and the crimp wire and crimp the sleeve closed.

11. Slide the 8/2 shrink tube over the sleeve, and use the fan to seal the tube.

12. Insert the blue wire from the cable into another copper crimp sleeve.

13. Place an 8/2 shrink tube over the blue cable wire.

14. Insert the blue wire from the power cord into the other end of the copper crimp sleeve.

15. Slide the 8/2 shrink tube over the sleeve, and use the fan to seal the tube.

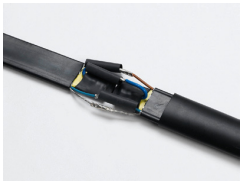
16. Insert the grounding wire from the cable and the yellow wire from the power cord into the ends of the third copper crimp sleeve. It is not necessary to cover these wires with a shrink tube.

17. Slide the 25/ shrink tube over the entire connection area, and use the fan to seal the power cord end of the tube.

18. Use Resinex to seal the other end of the 25/8 shrink tube. Refer to the instructions for using the Resinex sealant provided in Section 3.4.5.

3.6.3 STEP 4: CONNECTING THE CABLE SECTIONS

Use the Section Connection Kit (see Table 3-3 to Table 3-5), and proceed as follows to connect the two cable sections in an assembled cable:



1. Open the Section Connection Kit.

2. Peel off approximately 4 cm from all the wires.

3. Cut a small piece of the ribbon on each cable, to make it shorter than the wires.

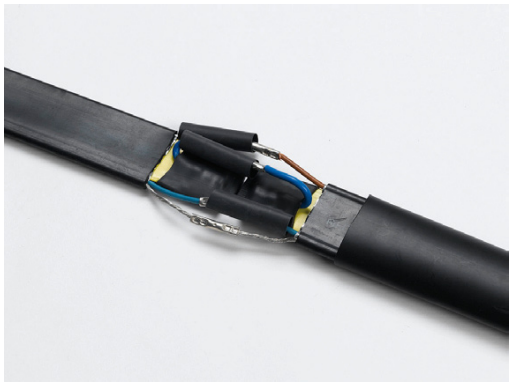
4. Crimp a crimp connector onto each ribbon and fold the flap onto each crimp connector.

5. Place the 12/3 (or 18/6 if you are using 25 mm cable) shrink tube over the end of each ribbon, and use the fan to seal the tube.

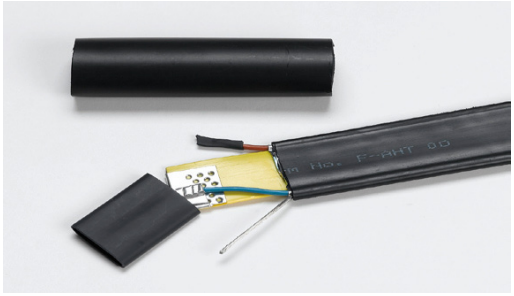
6. Slide the 25/8 shrink tube onto one of the cables, leaving the ribbon and wires exposed.

NOTE:
The procedure for connecting the wires between the two cables differs according to the number of wires (2 or 3) in the assembled cable. In case of 3 wire cables, the wire connection procedure depends on the specific wires to be connected. Table 3-6 provides wire connection instructions for the various types of section connections. Make sure you perform the connections as instructed.

Table 3-6 Wire Connection Instructions

TYPE A CONNECTION	TYPE B CONNECTION
	
• Two Cables in Assembled Cable • Three Cables in Assembled Cable — Connection Adjacent to Termination	• Three Cables in Assembled cable — Connection Adjacent to Power Cord

TYPE A CONNECTION	TYPE B CONNECTION
1. Insert the blue wire from one cable into a copper crimp sleeve. 2. Place one of the 8/2 shrink tubes over the blue cable wire. 3. Insert the blue wire from the other cable into the other end of the copper crimp sleeve. 4. Slide the 8/2 shrink tube over the sleeve, and use the fan to seal the tube. 5. Repeat this procedure for the brown cable wires and the crimp wires. 6. Repeat this procedure with the grounding wires. 7. Slide the 25/8 shrink tube over the entire connection area, and use the fan to seal one end of tube. 8. Use Resinex to seal the other end of the 25/8 shrink tube. Refer to the instructions for using the Resinex sealant provided in Section 3.4.5. **NOTE:** Shrink tubes are not required for ground wires.	1. Twist together the crimp wire and the brown wire from one cable, and insert the twisted portion of the wires into a copper crimp sleeve. 2. Place one of the 8/2 shrink tubes over the twisted wire pair. 3. Twist together the crimp wire and the brown wire from the other cable, and insert the twisted portion of the wires into the other end of the copper crimp sleeve. 4. Slide the 8/2 shrink tube over the sleeve, and use the fan to seal the tube. 5. Insert the blue wire from one cable into a copper crimp sleeve. 6. Place one of the 8/2 shrink tubes over the blue cable wire. 7. Insert the blue wire from the other cable into the other end of the copper crimp sleeve. 8. Slide the 8/2 shrink tube over the sleeve, and use the fan to seal the tube. 9. Repeat this procedure with the grounding wires. **NOTE:** Shrink tubes are not required for ground wires.



3.6.5 STEP 5: TERMINATING THE CABLE

Use the Termination Connection Kit (see Table 3-3 to Table 3-5) to seal each cable end.

Proceed as follows:

1. Open the Termination Connection Kit.
2. Take out the crimp connector and place it on the ribbon.
3. Peel off the blue wire that protruding from the cable.
4. Crimp the blue wire inside the crimp connector, and fold over the connector to secure the wire.
5. Place the 12/3 (or 18/6 if you are using 25 mm cable) shrink tube over the end of the ribbon, and use the fan to seal the tube. (If you are using cable model AHT0300707, place the 12/3 shrink tube over one ribbon, and then place the 18/6 shrink tube over the entire cable).
6. Cut the brown wire protruding from the cable short, enough to fit inside the 8/2 shrink tube.
7. Place the shrink tube over the brown wire, and use the fan to seal the tube.
8. Cut off the silver grounding wire protruding from the cable so that it can be places flush with the end of the insulation.
9. Place the 25/8 shrink tube over the cable end so it covers all wires, and use the fan to seal the end of the 25/8 shrink tube opposite the cable.
10. Use Resinex to seal the end of the shrink tube that is flushed with the cable. Refer to the instructions for using the Resinex sealant provided in Section 3.4.5.

3.6.6 STEP 6: CHECKING CONNECTIVITY

After completing all necessary connections, check the connectivity of each cable assembly as follows:

1. Use a Megger Tester to make sure that leakage is within the range permitted by the applicable law. At one end of the cable, touch ground with one Megger Tester probe, and, at the other end of the cable, touch the lead with the other probe.
2. Use the AVO meter to test the total power.

3.6.7 STEP 7: LAYING OUT/INSTALLING THE ASSEMBLED CABLES

Lay out the assembled cables as follows:

1. Verify the ground surface is flat and smooth with no sharp stones.

2. Lay the heating elements on the ground according to the construction profile (see Section 3.2) and check the insulation resistance of each cable. Refer to the manufacturer's instructions on how far apart cable runs should be placed. This will prevent over heating of the heater cable.

3. Cold leads should be facing the direction of the termination point. When dealing with multiple cables, ensure all the cold lead sections of each cable is placed in the same line facing the termination point.

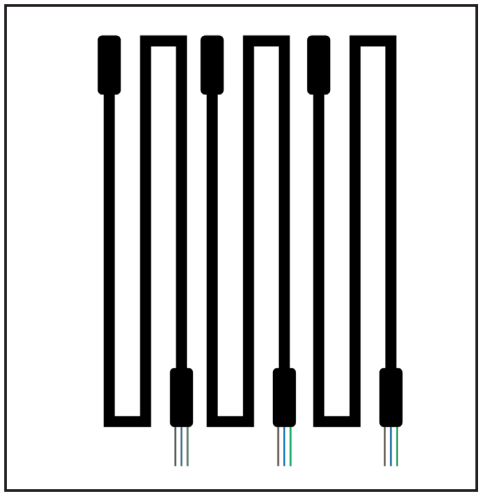
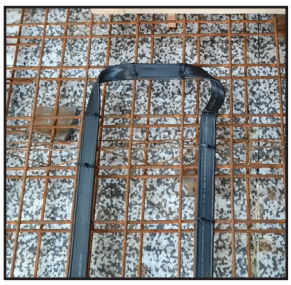


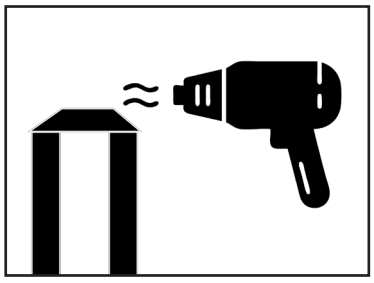
Figure 3-8. All Lead Connectors Facing the Same Direction

NOTE:
Use a U-shaped hook for anchoring the cable where needed. Do not pierce the cable with any fastener (such as nails, screws, rivets, etc.). Nylon zip-ties rated for temperatures higher than 80°C (176°F) may also be used especially to fasten cable to re-bars.

*****IMPORTANT*****
Never try to bend the heater cable while it is not heated. Turns in the heater cable can be made by creating a loop in the cable. If the project requires bending, first warm up the bending location of the ribbon with a professional heat gun. Bending a un-warmed ribbon will result in breaking the amorphous heating ribbon inside the cable and will void warranty.



LOOP METHOD
ON RE-MESH



BEND METHOD
HEAT GUN REQUIRED

4. Pull the cold lead wires out off the surface towards the connection box, according to the installation plans.

5. Make sure the connection box is installed according to local codes, and as close as possible to the installation area.

6. Install the thermostat according to the manufacturer's instructions. The recommended thermostat is 0.J Electronics, model ETO-3550, with a ground sensor for detecting temperature and moisture, or ETOG-5, or any thermostat with the same specifications.

AFTER INSTALLATION MAINTENANCE INFORMATION

A system inspection is recommended before the winter season. For applications classified as critical, inspection is recommended in both the autumn and the spring. All observations and measured values, as appropriate, should be recorded on a log sheet. The checklist consists of the following:

A. Junction boxes should be inspected for water or evidence of previous water ingress. If moisture is present, the enclosure should be dried and the a use of ingress identified and required.

B. Control equipment set points and functionality should be checked per the manufacturer's specifications.

C. The insulation resistance of each circuit should be measured and recorded.

D. The heating performance should be verified by measuring and recording the current draw for each circuit 2 min. to 5 min. after energization. Slab temperature should also be recorded. As an alternative approach to verifying the heating performances, a slab section can be wetted and then monitored for uniform drying after the heater is energized.

E. Major changes in insulation resistance or heater current should be resolved.

Appendix A - Outdoor Heating Specifications

4. APPENDIX A - CABLE CONNECTION DIAGRAMS

This appendix provides a table specifying the heater and outdoor surface temperatures under different weather conditions.

Appendix 1							
Outdoor heating (ice prevention)							
Asphalt							
	In. temp	**Amb. temp**	**Heat flux**	**Wind rate**	**Heater temp**	**Surface temp**	**Heating time**
Thickness	Ti, ^{O}C	Ta, ^{O}C	q, (W/m^2)	v, (m/s)	Th, ^{O}C	Ts, ^{O}C	t (h)
0.07	-5	-10	200	0	11	0	4
	-8	-10	200	0	11.3	0.5	5.3
	-8	-10	200	2	15	0	8.2
	-8	-10	400	0	19.5	0.2	3
	-8	-10	400	2	23.4	0.3	4
	-8	-10	400	4.5	29	0.3	6
	-8	-15	400	0	20.5	0.1	3.3
	-8	-15	400	4.5	34.6	0.2	10
0.1	-5	-10	200	0	16	0	7
	-8	-10	200	0	15.5	0.2	8.7
	-8	-10	200	2	21	0.1	14
	-8	-10	400	0	27.2	0.2	5
	-8	-10	400	4.5	41.6	0.5	11
	-8	-15	400	4.5	48.7	0	17.9
	-12	-15	400	4.5	49.8	0.4	20.2
Concrete							
0.07	-5	-10	200	0	6.3	0.7	1.3
	-8	-10	200	0	6.3	0.8	2
	-8	-10	200	2	7.4	0	2.5
	-8	-10	400	0	10.9	0.6	1
	-8	-10	400	2	12.5	0.4	1.3
	-8	-10	400	4.5	14.8	0.1	1.8
	-8	-15	400	4.5	17.6	0	3

Connection Cable Diagrams

5. APPENDIX B - CABLE CONNECTION DIAGRAMS

This appendix provides connection diagrams for heating cables with 1, 2 and 3 wires.

5.1 3 CABLE CONNECTION CONFIGURATIONS

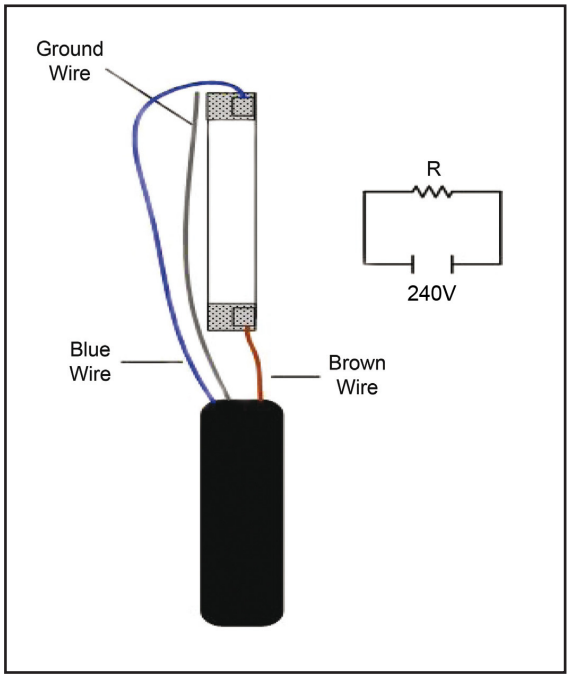


Figure 5-1. Connection Diagram for Single Ribbon Heater

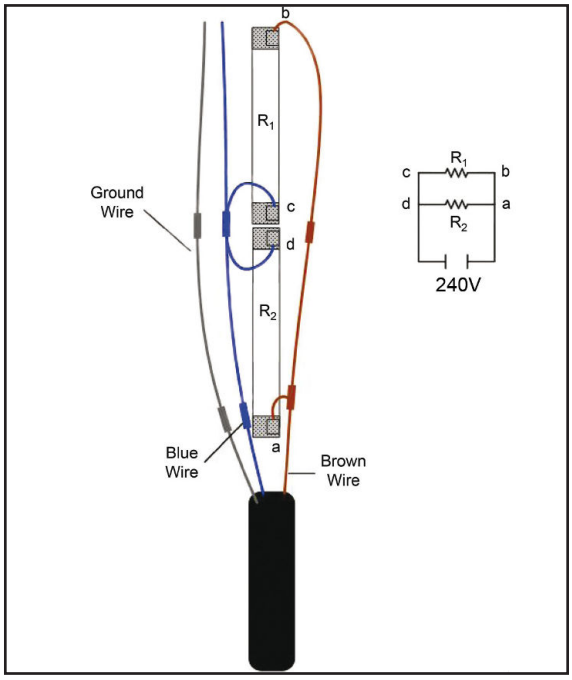


Figure 5-2. Connection Diagram for Connecting 2 Ribbons Together

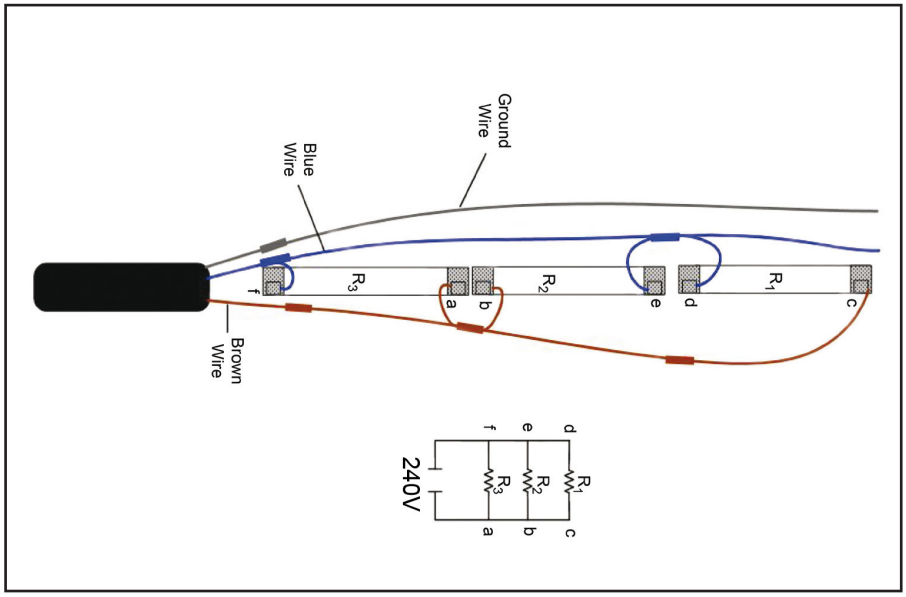
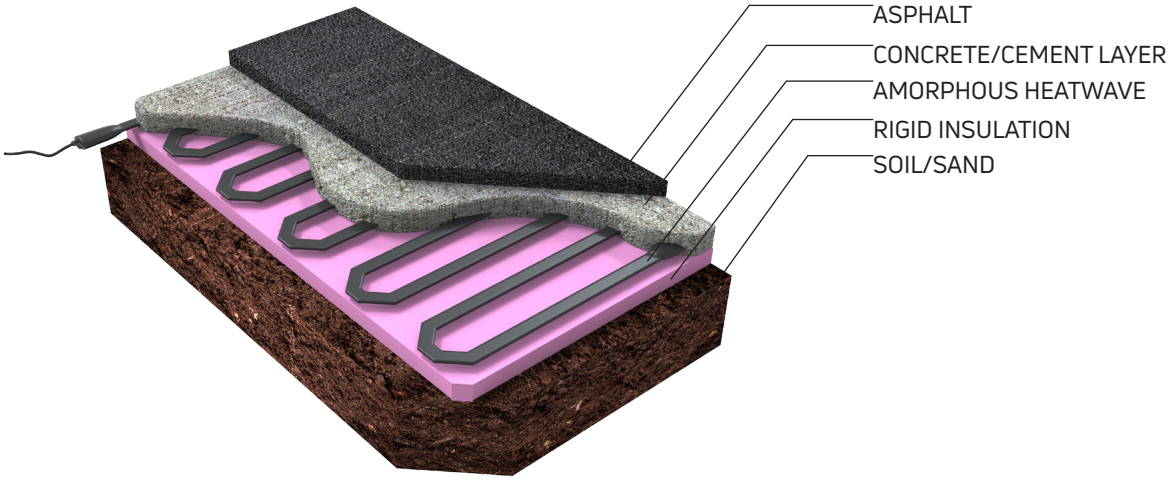


Figure 5-3. Connection Diagram for Connecting 3 Ribbons Together

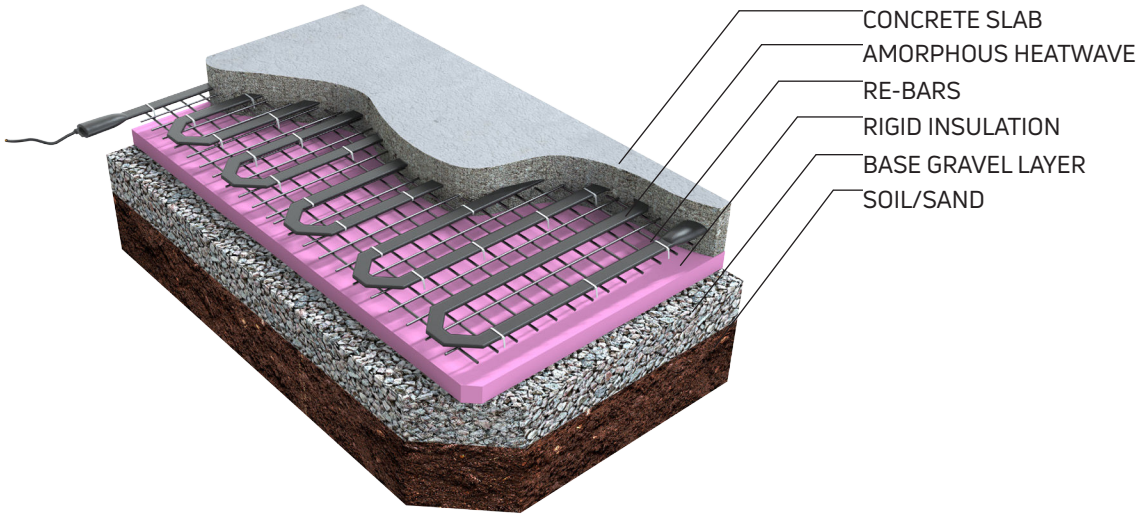
*****IMPORTANT*****
Insulation is not mandatory, but optional. If applied energy consumption will be lower and the surface above will heat quicker at the desired temperature. For the insulation layer we recommend all slab grade insulation with a heat threshold rating of continuous 70°C (158°F).

NOTE:
Use a U-shaped hook for anchoring the cable where needed. Do not pierce the cable with any fastener (such as nails, screws, rivets, etc.). Nylon zip-ties rated for temperatures higher than 80°C (176°F) may also be used especially to fasten cable to re-bars.

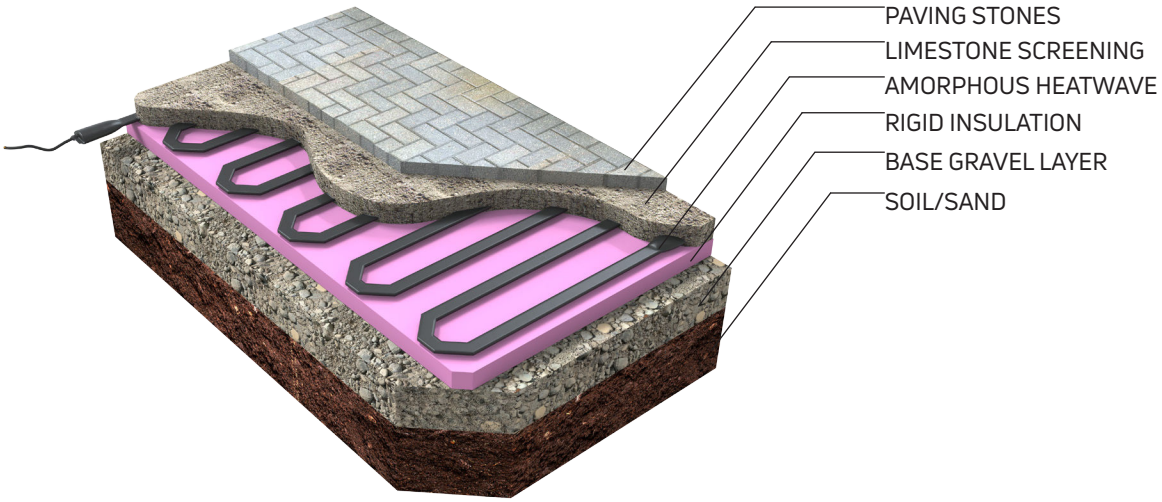
UNDER ASPHALT



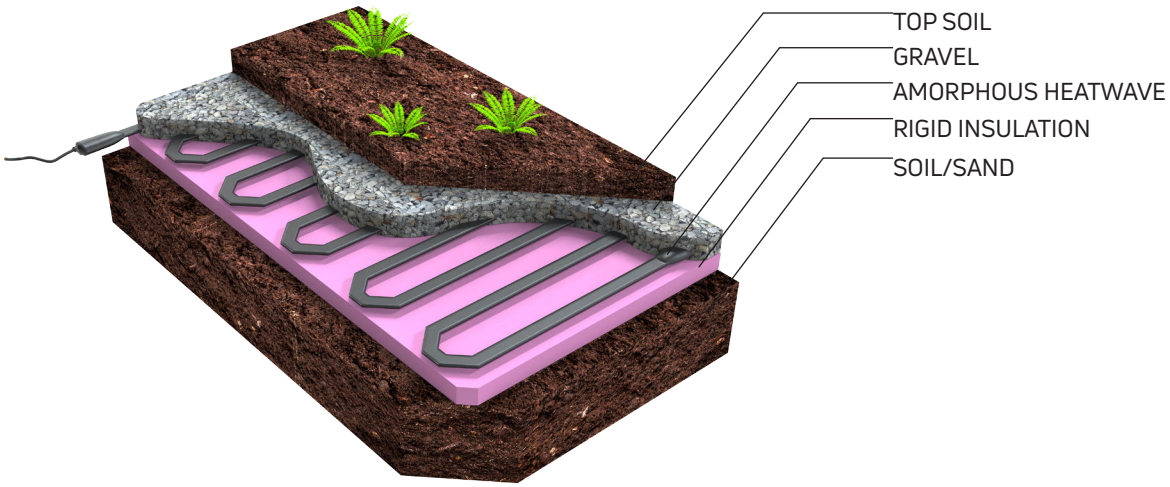
UNDER CONCRETE SLAB



UNDER PAVING STONES



AGRICULTURE / SOIL APPLICATIONS



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