

# Installation and Operating Instructions

Carbontec® 251-L  
Heating film

Carbontec® 251-S  
Heating film

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# 1 Configurations Available

The Carbontec® 251-L and 251-S heating films are sold in large rolls. As such, the installer can configure them multiple ways. The 251-L film is 2' (0.6 m) wide, and heats large spaces. The 251-S film is thinner, at 6.75" (0.17 m) wide, and heats smaller zones than the 251 L.

Carbontec® films can be cut to length, perpendicular to the copper wiring along the sides. The final lengths cannot exceed the maximum lengths rated for the chosen transformers. Only transformers that are provided by Carbontec® are permissible for use with this heating system. There are limits to the maximum length of Carbontec® heaters that can safely be attached to a single transformer; multiple transformers may be necessary for larger spaces. One can't change the width of the heaters. There are two copper strips on each side of the heater roll that carry the current across the thin film resistance heater. The longer the heater length, the more current and power it can draw.

The transformers are powered by 110VAC line power. The transformers drop the 110VAC to 24VDC for the 251-L, or 12VDC for the 251-S. The 24VDC or 12VDC output of the transformer is then connected to the Carbontec® heaters. **DO NOT CONNECT CARBONTEC® HEATERS DIRECTLY TO 110VAC LINE VOLTAGE. THAT WOULD RESULT IN A SEVERE SAFETY HAZARD, AND DESTROY THE PRODUCT.**

The Carbontec® heater film can be controlled by a number of methods. Simpler installations can use a UL Listed wall-mounted mechanical timer or a light-switch to activate and deactivate the film. For added flexibility and control, a zone of Carbontec® heaters can be equipped with a UL-Listed thermostat or programmable weekly timer.

## 2 Information for Users

### 2.1 Installation

THIS EQUIPMENT SHALL BE INSTALLED ONLY BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THE APPARATUS AND THE RISKS INVOLVED.

THE INSTALLATION OF THIS HEATING PRODUCT SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS AND THE REGULATIONS OF THE AUTHORITY HAVING JURISDICTION. Simply, you must also follow local electrical and building code in addition to this manual.

The secondary circuit must not be grounded to earth.

This installation must be made in accordance with the National Electrical Code, ANSI/NFPA 70.

Please read these instructions carefully and fully before beginning the installation. Follow the instructions during both the installation and the operation of the product.

The Carbontec® 251 heating film is designed to be installed by approved Carbontec® contractors only.

### 2.2 Users

It is not designed to be used by people (including children) who are physically, lacking sensory perception, have intellectual disabilities, unless they are supervised by a person responsible for their safety. Such persons responsible for their safety should receive instructions about how the heating film is to be used. Children should be supervised to make sure that they do not play with the heating film or

controller. A copy of the instructions must remain with the house in case of change of ownership, lessee, or renter. Always inform new occupants about the Carbontec® systems installed in the property and its function and use.

The Carbontec® 251 heating film is an optimized radiant heating system that is designed for moisture reduction and temperature regulation of ceilings and floors. It aids in space heating. It can be used in many different locations, e.g. in seating areas, bathrooms, offices, kitchens, fitness facilities, children's rooms, workrooms, etc. The Carbontec® heating film is only approved for direct heating purposes in accordance with the latest UL certification standards.

With radiant heaters in general, it is advisable to use a UL Listed heating controller with a temperature sensor to regulate the actual surface temperature of the heating element. With the controller and the external sensor, the Carbontec® heating film is given additional protection in the form of a self-monitoring voltage interruption, short circuits, and sensor breakage. Use one controller with an external sensor per room. Any compatible UL Listed switch, dimmer, or timer can be used. All control devices should be installed per the NEC.

It is generally possible for a few small holes to be made in the heating film as further described. Care needs to be taken not to exceed a maximum of two holes per length of heating material, each with a maximum size of 2 inch diameter (50 mm) and at least 1 inch (25 mm) away from each other and from the copper conductors (see Section 3.1). Optimum and rapid heat distribution is achieved with very thin coverings of plaster, ceramics, porcelains, natural stone. All other coverings must be suitable for use with underfloor heating.

**Warning:** Do not penetrate the film with any screws or nails. These would conduct the charge from the heater film and would pose a risk of electrocution.

## 2.3 Operation

Simple handling in both operation and installation is one of the outstanding features of the Carbontec® heating film.

The actual surface temperature of the heating film depends on the floor covering and the heat insulation in and floor structure. It may differ from the perceived room temperature.

Use of a UL Listed controller with an integrated timer or programmable schedule is recommended for maximum energy efficiency. Heating times and monitoring temperatures can also be set conveniently with such a timer. It is recommended that the heater is started up about 30 minutes before the room is used.

## 2.4 Maintenance

The Carbontec® 251 heating film requires no maintenance.

If problems occur, the following activities may be helpful:

- Check the output setting on the controller. If a timer is installed, check the time program setting.
- Check the circuit breakers and disconnect switches in the transformer enclosure.
- Check the relevant fuse or circuit breaker in the building.

If the fault is not eliminated, inform a licensed electrician. It is recommended that the system is checked by a licensed electrician every five years.

## 3 Installation

### 3.1 General preparation

The Carbontec® 251 heating film is suitable for floors and ceilings in building interiors. The heating area chosen is determined on two principal bases: first, avoid areas where furniture and coverings are planned; second, provide optimal heat distribution. Attention is again drawn to point 2.1 of these instructions in this context.

The Carbontec® 251 heating film is not designed for installation as a storage heating system and should not be incorporated in screed. The closer the heating film is to the room surface, the faster the heating system will respond and the faster the pleasant radiant heat will reach the room.

Carbontec® recommends that the installer cut the film to size in accordance with the installation drawing *before* the film is physically installed. Electrical contacts for the heater film are specified.

The Carbontec® 251 heating system has been tested by UL for potential fire and shock hazards. When work is being done on the heating system, these instructions must be given to the installer.

Install the Carbontec® 251 heating film inconspicuously in ceilings or floors. Before beginning the installation, draw a plan and determine the position of the heating film(s), electrical supply lines, transformer, controller, terminal block (if required), and the location of the power rating nameplate. When a controller with a temperature sensor is being used, the position of the temperature sensor (including supply lines) must be recorded as well. After the installation is complete, the plan must be checked and kept as an appropriate document of record.

These heaters are not meant to heat a room, but to heat a person in the room who is in front of the heater. To take optimum advantage of the heat generated, the heating film should be installed in ceiling and floor spaces with minimal covering or furniture that might block the infrared (IR) heat. Efficient IR heating requires line of sight. Simply, IR heaters work best when there is nothing between the heater and the person, other than the floor or ceiling covering.

Floor coverings or carpeting must be suitable for the use of underfloor heating and/or floor temperature regulation systems. The products need to be checked to make sure they are designed for such systems, with particular attention being paid to the information provided about thickness and heat conductivity  $\lambda$  [BTU/(hr·°F·ft) or W/(mK)] and/or the heat transfer resistance “R-value” [(hr·°F·ft<sup>2</sup>)/BTU or m<sup>2</sup>K/W]. The maximum heat transfer resistance of the floor covering, including the underlay that forms part of the floor covering, must not exceed R-value = 1.0 (hr·°F·ft<sup>2</sup>)/BTU (0.15 m<sup>2</sup>K/W).

*Table 1: Approximate planning figures for floor coverings with underfloor heating*

<b>Material</b>	<b>Typical Thickness (in) [mm]</b>	<b>Heat conductivity <math>\lambda</math> (BTU/(hr·°F·ft)) [W/(mK)]</b>	<b>Heat transfer resistance R-value ((hr·°F·ft<sup>2</sup>)/ BTU) [m<sup>2</sup>K/W]</b>
Ceramic tiles	1/2 [13]	0.61 [1.05]	0.07 [0.012]
Natural Stone Slabs	1/2 [12]	0.69 [1.2]	0.06 [0.01]
Carpeting	—	—	0.40 - 0.97 [0.07 - 0.17]
Linoleum	1/8 [2.5]	0.10 [0.17]	0.09 [0.015]
Parquet Flooring	7/16 – 9/16 [11 - 14]	0.05 [0.09 - 0.12]	0.31 – 0.43 [0.055 - 0.076]
Laminate	3/8 [9]	0.10 [0.17]	0.28 [0.05]
Cork — cork laminate	1/8 – 3/8 [3 - 10]	0.06 [0.10 - 0.12]	0.15 – 0.58 [0.027 - 0.102]

The system is designed to be a low-voltage system.

Warning: the heating element may overheat if the installation area is covered by furniture that may restrict ventilation (e.g. cabinets, shelves, thick carpets).

### 3.1.1 Kit number configuration

The Carbontec® heating film kits are available in multiple configurations. Carbontec® uses a configurable part numbering system, allowing the installer to customize their order for the installation space. Use the following information to determine the correct kit.

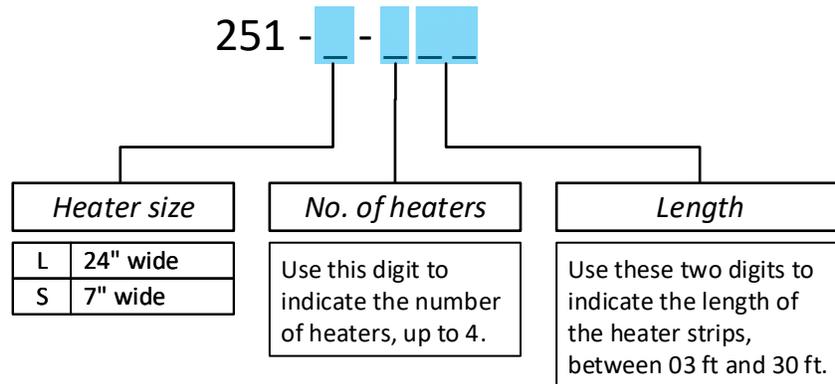


Figure 1: Carbontec® part number configuration

1. 251 is the base part number, and cannot be changed.
2. The first prefix (251 - [ ] - [ ] [ ] [ ] ) is used to indicate the preferred heater size. 251-L is the 2-foot wide film, and 251-S is the 7-inch wide system.
3. The second prefix (251 - [ ] - [ ] [ ] [ ] ) is used to indicate the number of heater film segments that should be included. The maximum is four (4) segments.
4. The last prefix (251 - [ ] - [ ] [ ] [ ] [ ] ) is used to indicate the preferred length of the heater film segments. This can range from three feet to thirty feet (03 to 30). All segments included in the kit will be this length.

For example, if a space requires four sections of 15-foot-long 251-L film, the part number would be written as *251-L-415*.

### 3.1.2 Kit components

Each kit will include the following components, and alternate components shall not be assembled to the heating system:

Table 2: Carbontec® Kit components

#	Item	Details
1	Carbontec® film	According to the quantity and length specified in the generated kit number.
2	Transformer	The appropriate transformer will be selected based on the power requirements of the requested quantity of Carbontec® heater film.
3	Terminal Block	The provided terminal block will allow the installer to split the heater power wires as necessary for routing to multiple heater film segments.
4	Splice connectors	The appropriate amount of TE Connectivity splice connectors for the heater film will be included with the kit. Two connectors will be included per each segment.
5	Labels and	The kit will include a sheet of adhesive labels and warning stickers for use with the

	warning stickers	heater. Appropriate application is detailed in section 3.6: Marking Requirements.
6	Cable Mount	McMaster-Carr Cable Tie Mount. Fastener Mount, 2 Way, 0.30" Tie Width, 3/4" Long, White, #7566K29 and #8 screw, or equivalent.

### 3.1.3 Non-kit components

In order to install the Carbontec® heater film kits, other non-kitted components are required. All of these components must be UL Listed.

Table 3: Contractor-procured components

#	Item	Details
7	Terminal block enclosure	UL Listed, wall-mounting electrical enclosure. For configurations with one terminal block, the enclosure shall have a minimum interior volume of 28 in <sup>3</sup> (460 cm <sup>3</sup> ), with a minimum depth of 1.75 in (4.5 cm). For two terminal blocks, the enclosure shall have a minimum interior volume of 56 in <sup>3</sup> (920 cm <sup>3</sup> ), with a minimum depth of 1.75 in (4.5 cm)
8	TE Connectivity crimping tool	The TE Connectivity splice connectors require a specific crimping tool. This tool is available for purchase at Carbontec®USA.com or Carbontec®Intl.com.
9	Vinyl electrical tape	UL Listed vinyl electrical tape is required for insulating the splice connectors during installation. The electrical tape must be suitable for temperatures up to 160 °F (70 °C).
10	Dimmer/timer	Any UL Listed dimmer or timer must be a magnetic low-voltage dimmer compatible with magnetic transformers and with a power rating higher than the transformer can be used with the Carbontec® system.
11	Wire nut	Any UL Listed twist-on or crimp-on wire connectors can be used to connect the primary transformer leads to AC supply wires.
12	Main voltage supply wire	UL Listed, 14 AWG-minimum stranded copper wire should be used for the primary voltage supply wires. The wire should be rated to 300 V, at a minimum. It is recommended that black and white wires be used for live and return wires, respectively.
13	Heater supply wire	UL Listed, 12-AWG stranded copper wire should be used for the power supply cables to the heaters. The wire should be rated to 300 V, at a minimum. It is recommended that red and blue wires (or another pair of contrasting colors) be used for live and return wires, respectively.
14	Ground wire	UL Listed, 12-AWG stranded copper wire should be used for connecting the transformer's green ground cable to an appropriate grounded connection.
15	Conduit	UL Listed electrical conduit for routing wiring in ceilings, walls, and floors.

**\*Note:** The wiring used to connect the transformer to the heater films is considered nonheating wire. As such, it is governed by NFPA 70: NEC 424.43(A). It is permitted to be single conductors in approved raceways, single or multiconductor Type UF, Type MI, or other approved conductors. Wires and wire insulation must be UL certified.

### 3.1.4 Component sizing

Carbontec® 251-L installation transformers shall be limited to 24VDC. Carbontec® 251-S installation transformers shall be limited to 12VDC. No more than 4 strips of Carbontec® 251 heating film be used with a single transformer. Tables 4 & 5 indicate the transformer size necessary to cover different rectangular areas (i.e. where the heater segments are the same length). For irregularly-shaped installations, refer to the maximum individual and combined heater lengths given in Table 6. Determine

the necessary size area for the room, and consult the table to determine the necessary size of transformer. If the room requires a larger area than shown in the table, multiple transformers must be used, each supplying power to heaters in part of the room. Use these tables to determine the kit part number configuration in section 3.1.1.



Table 5: Transformer sizes (in Watts) for rectangular installation areas for Carbontec® 251-L

		Number of heaters 251 - L - □							
		1	2	3	4				
Length 251 - L - □	3'	250W 24V	250W 24V (split load circuit with terminal block)	500W 24V (jumper on load terminals; split load circuit with terminal block)	500W 24V (jumper on load terminals; split load circuit with terminal block)				
	4'					(max 6.1')	(max 6.1')		
	5'		500W 24V		(max 8.2')			1000W 24V (jumper on 2 pairs of load terminals; split each load circuit with terminal block)	
	6'					(max 12.3')	(max 12.3')		
	7'				500W 24V (jumper on secondary terminals)				1000W 24V (jumper on 2 pairs of load terminals)
	8'					(max 14.1')	(max 14.1')		
	9'	Exceeds 12A heater current limit							
	10'								
	11'								
	12'								
	13'	Exceeds 12A heater current limit							
	14'								
	15'								
	16'								

Table 6: Power limit, primary/secondary currents and maximum length for transformers

	251-L			251-S			
	250	500	1000	100	250	500	1000
<b>Transformer Power (W)</b>	250	500	1000	100	250	500	1000
<b>Transformer Secondary Voltage (V)</b>	24	24	24	12	12	12	12
<b>Power/length (W/ft)</b>	20.3	20.3	20.3	4.1	4.1	4.1	4.1
<b>Primary current (A)</b>	2.2	4.5	8.9	0.9	2.2	4.5	8.9
<b>Max. current per heater circuit (A)</b>	10.4	12	12	8.3	12	12	12
<b>Max. length for one heater segment (ft) [m]</b>	12.3 [3.7]	14.1 [4.3]	14.1 [4.3]	24.6 [7.5]	35.5 [10.8]	35.5 [10.8]	35.5 [10.8]
<b>Max. combined length of all heaters segments (ft) [m]</b>	12.3 [3.7]	24.6 [7.5]	49.2 [15.0]	24.6 [7.5]	61.6 [18.7]	123.1 [37.5]	141.8 [43.2]

Up to four Carbontec® films of varying lengths can be attached to a single transformer, if the following conditions are met:

- Each heater segment cannot exceed the maximum individual length shown in Table 6.
- The combined length of all heater segments cannot exceed the maximum combined length shown in Table 6.

## 3.2 Film Installation

This section relates to installation of the film and the transformer. Installation of the main supply lines and the electrical connections is explained in *Section 3.4 Electrical connection*. Please note that the minimum installation temperature is 40 °F (5 °C).

For ceiling installations, when walls are less than 8 ft (2.3 m) high and ceilings slope less than 45°, the heating film should be about 6 in (15 cm) shorter than the length of the installation area. Ensure that cuts are perpendicular to the copper conducting strips when cutting sections from the Carbontec® roll. The transformer size and the number of heaters used each strip of Carbontec® film will have a minimum and maximum length (see the information given in Table 6 and Section 4 TECHNICAL DATA). Always cut away from the non-contact side of the heating film. Do not inappropriately damage the film, such as tearing it, kinking it, or cutting it in random places. Keep the heating film rolled up in its packaging until it is required for installation (note the minimum bending radius, see Section 4 TECHNICAL DATA).

After completing the installation, one may perforate or make holes in the film as outlined in “Section 2.2 Function and use.”

### 3.2.1 Installation options

Carbontec® 251 film can be installed on ceiling surfaces or beneath floor coverings. For a ceiling installation, the heating film can be installed at any angle in plaster. For an under floor covering installation, the Carbontec® film must be embedded (covered on both sides) with non-conductive, non-flammable material such as mortar. Carbontec® 251 film is non-reactive, and can be used with any types of non-cement that can withstand temperatures up to 160 °F.

Do not install the film above joints that are meant to expand. Flexible adhesive systems are recommended in the case of minor expansion cracks, e.g. tile joints in the 1/32 - 1/16” (1 - 2 mm) range.

When installing multiple Carbontec® heating films, the film segments must be separated by at least 2” (5 cm).

**WARNING:** Risk of electric shock and fire. Damage to supply conductor insulation may occur if conductors are routed less than 2 inches (51 mm) from this heating product. Refer to installation instructions 3.2.4 - 3.2.7 for recommended means of routing supply conductors.

### 3.2.2 Preparation of the substructure

The substructure must be flat and dry. Irregular surfaces must be avoided (e.g. visible wood/stone – brickwork). Under certain circumstances, the surface may need to be evened out beforehand with plaster or a levelling compound. Care must be taken to make sure that no pointed objects like stones, screw heads, nails etc. are projecting out of the substructure.

### 3.2.3 Heat insulation

Heat insulation in the floor is recommended to reduce heat loss through the floor. To limit heat radiation downwards, observe the following minimum ratio of the heat transfer coefficient of the floor structure above the insulation layer to the heat transfer coefficient of all layers below the load distribution layer:

- Intermediate ceiling, above heated rooms:  $U_O \geq 4.0 U_U$  ( $R_U \geq 4.0 R_O$ )
- Floor, adjacent to unheated rooms:  $U_O \geq 6.0 U_U$  ( $R_U \geq 6.0 R_O$ )
- Floor, adjacent to outside air or earth:  $U_O \geq 6.5 U_U$  ( $R_U \geq 6.5 R_O$ )

Where  $U_O$  = heat transfer coefficient of the floor structure above the heat insulation and  $U_U$  = heat transfer coefficient of the floor structure underneath the storage layer

$U_U$  of the component layers between the heating layer and heated rooms underneath should be  $U_U \leq 0.16$  BTU/ h·ft<sup>2</sup>·°F (at 60°F) [0.85 W/(m<sup>2</sup>·K) (at 15°C)]. The figures in parentheses relate to heat transfer resistance  $R_U$  and  $R_O$ . The insulation layers below the floor structure must be chosen in accordance with Table 7. Minimum heat transfer coefficients must be observed. Standardized insulation materials that are suitable for underfloor heating must be used. The insulation layer must not be compressible by more than 3/16" (5 mm). If there are several layers, add the compressibility of the individual layers together.

Table 7: Minimum heat transfer coefficient and minimum heat conductivity of the components.

	$U_{max}$ BTU/ h·ft <sup>2</sup> ·°F [W/(m <sup>2</sup> ·K) ]	$R_{min}$ h·ft <sup>2</sup> ·°F/BTU [m <sup>2</sup> ·K/W]
Intermediate ceilings above heated rooms	0.23 [1.25]	4.3 [0.75]
Intermediate ceilings above partially-heated rooms	0.14 [0.75]	7.1 [1.25]
Heating areas between outside air or earth	0.06 [0.35]	16.2 [2.86]
Cellar ceilings, or ceilings next to unheated rooms	0.06 [0.35]	16.2 [2.86]

### 3.2.4 Installation of the transformer

The enclosure containing the transformer and power components can be installed in an attic, basement, or crawlspace. It should be installed so that it is not likely to be contacted by people. The power unit must be accessible after installation for maintenance and for safety disconnection by the user, if necessary. The power units should be installed as near to the heating film as practical to keep the secondary conductors as short as possible. Additionally, the power unit must be located so that adjacent combustible materials are not subjected to temperatures in excess of 194°F (90°C). The transformer location must meet these specifications and any other standards set in NFPA 70: NEC that are applicable to the selected location.

The power unit should also be located in a place where the main power supply leads can be routed to the building's mains power. The wiring between the transformer power unit and the mains power should be routed through UL-Listed conduit, and use UL-Listed means for splicing any wiring. This wire routing must follow the standards set in NFPA 70: NEC.

Using the mounting bracket included with the transformer enclosure, the transformer should be securely installed to the wall in a basement or crawlspace. If mounting on a framed wall, ensure that at least one of the mounting points on the enclosure is mounted to a wall stud using appropriately-sized screws. If mounting to concrete, brick, mortar or stone, use the appropriate anchors to secure the mounting screws in the wall.

### 3.2.5 Installation under tile floors

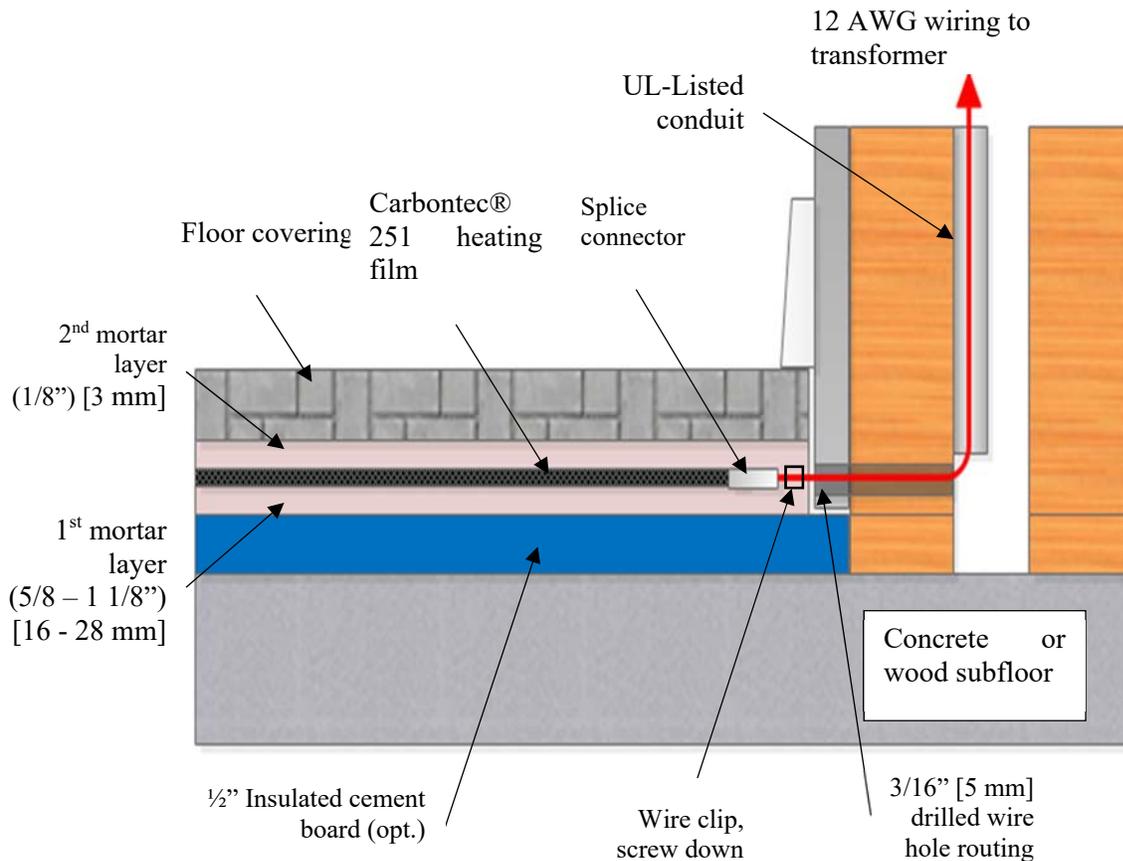


Figure 2: Installation under floors coverings (not to scale)

For a floor installation, the location of the heater films and wiring shall be planned in advance, before any mortar is set. 3/16"-1/4" [5-6 mm] holes should be drilled through the drywall (and wall studs, if need be) to allow for routing the heater supply wire. The heater supply wire must be routed through fully-secured UL-Listed conduit when being routed to the transformer through walls or ceilings.

The film must be incorporated in mortar during the mortar application process. The first layer of mortar thickness shall be 5/8" for tiled areas less than 100 sq ft and 1 1/8" for larger areas. Carefully press the film, splice connections and wiring into the bed while it is still moist using a plastic trowel. Put a thin covering layer 1/8" (3 mm) on top of the heating film afterwards using the same system and finally make the top layer as smooth as possible in preparation for the tile covering.

The Carbontec® film must be completely covered top and bottom with mortar, as shown in Figure 2. The surface must be dried in accordance with the instructions issued by the mortar manufacturer. When several different sections are being installed, ensure that the surface is flat. Installation under floor coverings must comply with NFPA 70: NEC 424.99.

### 3.2.6 Installation in ceilings

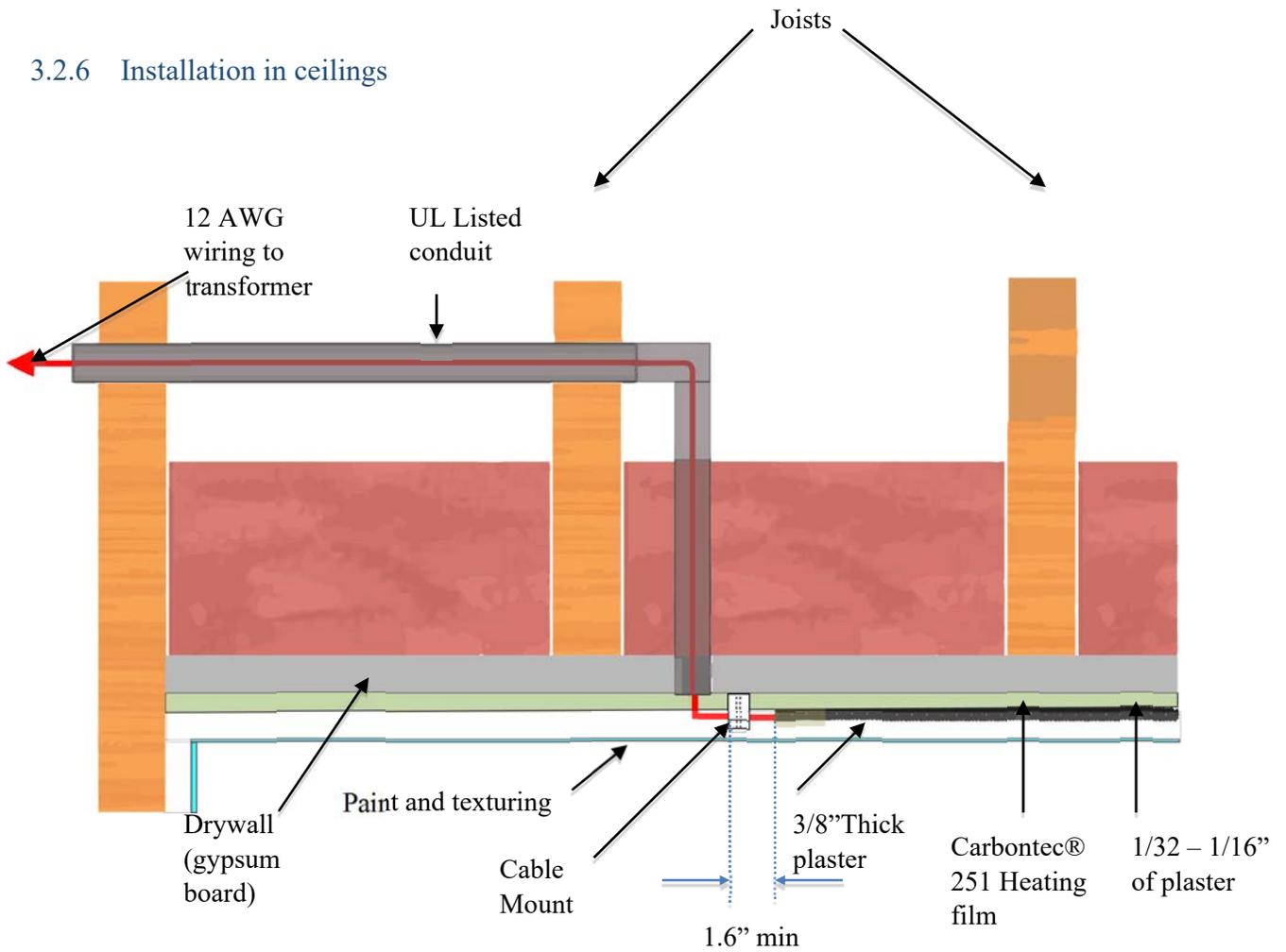


Figure 3: Installation in ceilings (not to scale)

#### Suggested installation order for ceilings:

- Cut the pass through holes
- Install UL Listed conduit from the pass through holes to the UL Listed junction box
- Install the cable mounts
- Crimp the splice connectors to the heater
- Apply minimum 1/32 inch of undercoat plaster
- Place heater with pre-crimped splice connector and wire in the plaster
- Screw down the cable mount on the wire immediately
- Run the wires through the conduit in the ceiling
- Apply 3/8 inch of plaster over the heater
- Fill wire hole

For a ceiling installation, the film requires a thin bed of plaster, drywall compound, or texturizing material of at least 1/32 in (.7 mm) thick. (We refer to plaster, drywall compound, or texturizing material as plaster.) The plaster must be spread flat across dry-wall before attaching the Carbontec® 251 heating film. Install one length of heating film at a time. Once adhered to the ceiling, cover the heating panel with a standard thickness of 3/8" [10 mm] of plaster or drywall compound. The material chosen to cover the heating panel must be able to withstand temperatures up to 160 °F (70 °C). The Carbontec® film must be completely covered, top and bottom, with an electrically non-conductive material (plaster/drywall compound) as shown in Figure 3.

The wires used in a ceiling installation must be routed above the drywall (gypsum board) panels, in accordance with the NEC. The heater supply wire must be routed through fully-secured UL Listed conduit when being routed to the transformer through walls or ceilings. Two small pass-throughs must be cut into the drywall for each heater, at the point where the heater films' crimp connectors will be placed during installation. The wires must be held in place with the screw down cable mounts. [See item 14 in Fig. 4.] Allow a minimum of 1.6" [40mm] from the panel to the wire pass-through hole in order to secure the cable mounts and accommodate the stresses that result from bending the wire. These pass-throughs can be filled in after installation with drywall compound (joint compound). According to NFPA 70: NEC 424.94, wiring located above heated ceilings shall be spaced not less than 50 mm (2") above the heated ceiling. The wiring must be installed in UL Listed conduit that is securely fastened in place.

Crimp on the splice connect to the heater before placing it in the texturing material, as described in Section 3.3.2, Items 6-8 or Section 3.3.3, Items 4-6. After applying the 1/32" under-coating of plaster, immediately place the heater panel on the plaster under-coat, before it dries. Apply the cable mounts and secure the wire leads. The cable mount can be applied before or after application of the plaster. The cable mount will help to keep the stress (caused by the bent secondary wire) from pulling the thin film heater from the plaster while drying. The wire should be placed under the indent in the thin portion of the cable mount.

**WARNING:** The Carbontec® 251 system is not designed or certified for use in a suspended or drop ceiling.

### 3.2.7 Installation in wet conditions forbidden

**WARNING:** The Carbontec® 251 heating film is not designed for installation in wet locations. Do not install the heater panels in wet locations under any circumstances.

## 3.3 Electrical connection

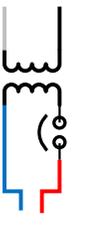
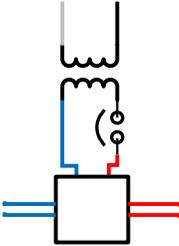
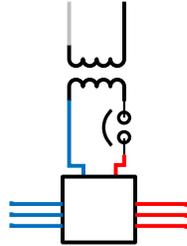
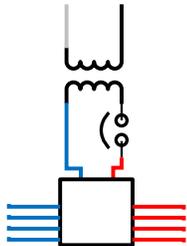
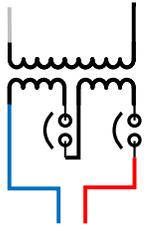
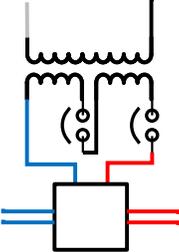
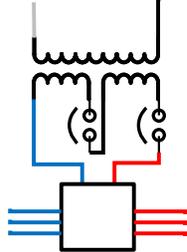
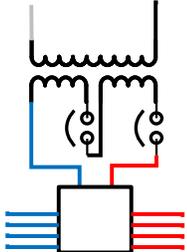
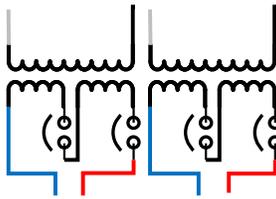
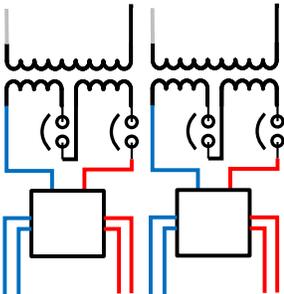
The following section describes the electrical connection aspects of the installation.

### 3.3.1 Wiring schematics

Figure 4 is a system level wiring schematic. It shows the main system blocks: heater panels, transformer, and controller.

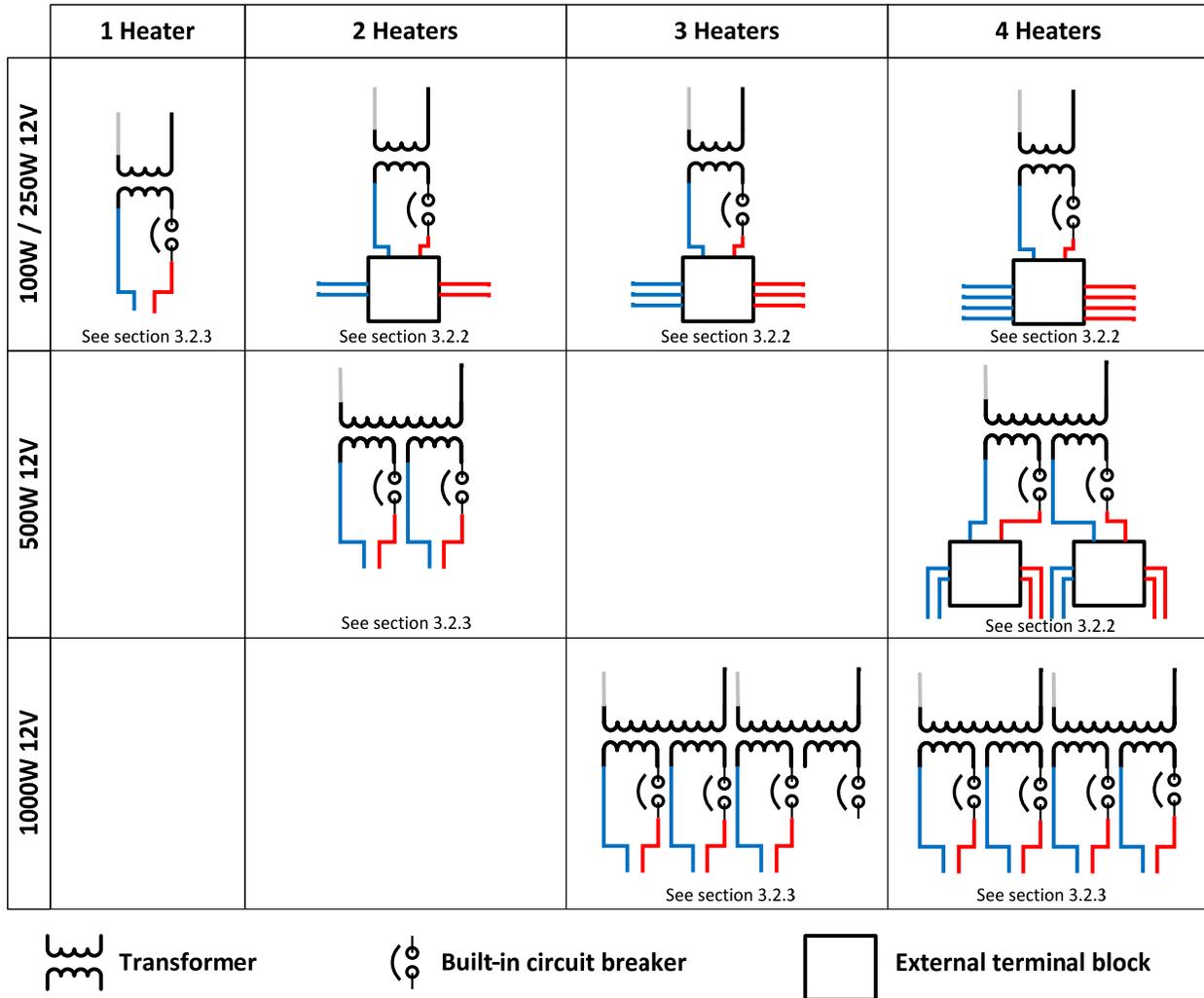


Table 8: Carbontec® 251-L transformer wiring schematics

	1 Heater	2 Heaters	3 Heaters	4 Heaters
250W 24V	 <p>See section 3.2.3</p>	 <p>See section 3.2.2</p>	 <p>See section 3.2.2</p>	 <p>See section 3.2.2</p>
500W 24V	 <p>See section 3.2.3</p>	 <p>See section 3.2.2</p>	 <p>See section 3.2.2</p>	 <p>See section 3.2.2</p>
1000W 24V		 <p>See section 3.2.3</p>		 <p>See section 3.2.2</p>

 Transformer
  Built-in circuit breaker
  External terminal block

Table 9: Carbontec® 251-S transformer wiring schematics



A licensed electrician must install the electrical components. An all-pole mains disconnection facility with a contact opening width per pole of at least 1/8" (3 mm) must be provided for the heating system during installation.

The transformer must be at least 2" (50 mm) away from the film.

The maximum conductor length on the secondary side of the transformer is 30 ft (10 m). All secondary wiring must be permanently installed. Secondary output leads used for installation must be properly rated to 300V, at a minimum.

The maximum conductor length on the mains voltage side, including all possible junctions, is 30 ft (10 m). All primary wiring must be permanently installed. Primary input leads used for installation should be properly rated to 300V, at a minimum.

The electrical conductors must be installed in accordance with the latest version of NFPA 70: NEC (mains conductors with double insulation, conductor cross-section at least 14 AWG for primary side; 12 AWG for secondary side; use the connection terminals supplied). Conductors concealed or extended

through a wall, floor, or ceiling must use any of the suitable wiring methods specified in Chapter 3 of the NEC.

In order to strain relieve the connection between the secondary wires and the crimp to the heater panel, one must install a screw down wire retainer 1 IN (2.54 mm) from the panel. [See item 14 in Fig. 4.]

### 3.3.2 Assembly instructions for a transformer with an external terminal block

If Table 8 or 9 indicate that a terminal block is necessary to split the transformer secondary circuit into multiple circuits, assemble the wiring for the Carbontec® system as shown in Figure 4. All power, control, safety and wiring components that were obtained by the installer, must be assembled and installed on site according to the following instructions.

1. Disconnect the relevant building circuit breakers before beginning installation.
2. Select a suitable location capable of supporting the weight of the transformer [see item 2 in Figure 4.] Mount the transformer case using the mounting bracket included. It is recommended that the transformer be mounted vertically with the wiring compartment pointing down.
3. Install the UL Listed controller [see item 9 in Figure 4] at an intermediate location between the transformer and the AC power supply, using the installation instructions included with the controller.
4. Install the UL Listed terminal block enclosure [see item 6 in Figure 4] at an accessible, intermediate location between the transformer and the area where the heater film segments will be installed. Otherwise, proceed to step 6.
5. Install the included terminal block [see item 3 in Figure 4] within the terminal block enclosure using secure fasteners appropriate for the enclosure material (e.g. 3/16" self-tapping screws or 3/16" bolts through pre-drilled holes).
6. For each heating film, crimp the metal splice connectors [see item 4 in Figure 4] to the copper conductor strips. The splice connectors can be crimped to the copper conductor strips using regular slip joint pliers, linesman's pliers, or similar pliers with wide, flat noses. To ensure the best contact, verify that the crimped connector plates are parallel and that the outer surfaces are 1/8" (3 mm) apart or less.
7. Once the connectors are securely crimped, wrap the corner of the heater in UL Listed vinyl electrical tape [see item 8 in Figure 4], ensuring that the connectors are entirely covered.
8. Strip the insulation off of the ends of the 12 AWG supply wire [see item 12 in Figure 4] to a length of 1/4 - 3/8 in [6 - 9 mm]. Using the 12-10 AWG crimping chamber on the appropriate crimping tool [see item 7 in Figure 4], crimp the splice connectors to the corresponding stripped wire leads. Crimp once in the center of the crimping area.
9. Route the 12 AWG heater cables [see item 12 in Figure 4] from the heater film segments [see item 1 in Figure 4] to the transformer installation location. Any wiring not embedded with the heater strips in mortar must be routed through UL Listed conduit. To reduce the chance of installation errors, use wires with red- and blue-colored insulation (or a similar pair of contrasting colors). Ensure that each heater film segment has one wire of each color routed to it.
  - a. For floor installations, the heater supply wire should be routed on top of the first layer of mortar while it is still moist (see floor installation instructions in Section 3.2.4)
  - b. For ceiling installations, route the cables above or through the ceiling joists as necessary (see ceiling installation instructions in section 3.2.6).
10. Connect the heater supply wires [see item 12 in Figure 4] to the load terminals on the installed transformer. Ensure that each heater strip is connected to both a COM and a 12VDC terminal. The 12VDC terminals should all be connected to wires of the same color, and the COM terminals

should be connected to the wires of the contrasting color. Tighten the line terminal set screws to 35 lbf-in (4 N-m).

11. Connect the transformer black live wire to the black 14 AWG AC-source wire [see item 11 in Figure 4] using UL Listed insulated wire splice connectors [see item 10 in Figure 4]. Route and connect this black 14 AWG AC-source wire to the live load terminal on the controller, according to the instructions included with the controller.
12. Connect the transformer white neutral wire to the AC power source return wire (white) [see item 11 in Figure 4] or to the return load terminal on the controller, depending on the instructions included with the controller. Do not use the blue or yellow neutral wires.
13. Connect the transformer case to an appropriate grounding circuit [see item 13 in Figure 4].
14. Apply the Carbontec® warning labels [see item 5 in Figure 4] as appropriate to the installation, as described in Section 3.5.

### 3.3.3 Assembly instructions for a transformer without an external terminal block

If Table 8 or 9 indicate that a terminal block is necessary to split the transformer secondary circuit into multiple circuits, assemble the wiring for the Carbontec® system as shown in Figure 4 but connect the heater supply cables directly to the transformer secondary terminals. All power, control, safety and wiring components, having been obtained by the installer, must be assembled and installed on site according to the following instructions.

1. Disconnect the relevant building circuit breakers before beginning installation.
2. Select a suitable location capable of supporting the weight of the transformer [see item 2 in Figure 4]. Mount the transformer case to the wall using the two keyholes on the upper tab. Mount the transformer vertically with the wiring compartment pointing down.
3. Install the UL Listed controller at an intermediate location between the transformer and the AC power supply, using the installation instructions included with the controller.
4. For each heating film, crimp the metal splice connectors [see item 4 in Figure 4] to the copper conductor strips. The splice connectors can be crimped to the copper conductor strips using regular slip joint pliers, linesman's pliers, or similar pliers with wide, flat noses. To ensure best contact, verify that the crimped connector plates are parallel and that the outer surfaces are 1/8" (3 mm) apart or less.
5. Once the connectors are securely crimped, wrap the corner of the heater in UL Listed vinyl electrical tape. Ensure that the connectors are entirely covered.
6. Strip the insulation off of the ends of the 12 AWG supply wire [see item 12 in Figure 4] to a length of 0.25-0.281 in [6.35-7.14 mm]. Using the 12-10 AWG crimping chamber on the appropriate crimping tool [see item 7 in Figure 4], crimp the splice connectors to the corresponding stripped wire leads. Crimp once in the center of the crimping area.
7. Route the heater cables from the heater film segments to the load terminals on the installed terminal block. Any wiring not embedded with the heater strips in mortar must be routed through UL Listed conduit. Tighten the load terminal set screws to 7 lbf-in (0.8 N-m).
  - a. For floor installations, the heater supply wire should be routed on top of the first layer of mortar while it is still moist (see floor installation instructions in section 3.2.4)
  - b. For ceiling installations, route the cables above or through the ceiling joists as necessary (see ceiling installation instructions in section 3.2.6).
8. Connect the heater supply wires [see item 12 in Figure 4] to the load terminals on the installed transformer. Ensure that each heater strip is connected to both a COM and a 12VDC terminal. The 12VDC terminals must all be connected to wires of the same color, and the COM terminals

must be connected to the wires of the contrasting color. Tighten the line terminal set screws to 35 lbf-in (4 N-m).

9. Connect the transformer black live wire to the black 14 AWG AC-source wire [see item 11 in Figure 4] using UL Listed insulated wire splice connectors [see item 10 in Figure 4]. Route and connect this black 14 AWG AC-source wire to the live load terminal on the controller, according to the instructions included with the controller.
10. Connect the transformer white neutral wire to the AC power source return wire (white) [see item 11 in Figure 4] or to the return load terminal on the controller, depending on the instructions included with the controller. Do not use the blue or yellow neutral wires.
11. Connect the transformer case to an appropriate grounding circuit [see item 13 in Figure 4].
12. Apply the Carbontec® warning labels [see item 5 in Figure 4] as appropriate to the installation, as described in section 3.5.

#### NOTES:

- All wire connections to the transformer must use a UL Listed insulated wire nuts.
- All wiring outside of the enclosure on the primary and secondary side of the transformer must be installed in UL Listed flexible conduit.
- Type NM and NMC non-metallic sheathed cable is not suitable for installing this product

#### 3.3.4 Pre-startup testing

The electrical resistance level must be measured at the contact points (crimped contacts) and documented for guarantee claim purposes before installation and after installation in the plaster system (Refer to Installation Record and Documentation). If the resistance levels are unchanged, the secondary conductors of the transformer must be attached to the crimped contacts.

Important to remember:

If the final resistance levels differ more than 10% from the original level, expect damage to the contacts or the heating film. Do not put the heating system into operation in this case.

#### 3.4 Marking Requirements

A sheet of labels is included with the Carbontec® 251-L and 251-S heater film rolls. This sheet should contain the following labels:

- 1x “WARNING Risk of electric shock” for ceiling installations. For ceiling installations, this should be affixed to the transformer/breaker enclosure.
- 1x “WARNING Risk of electric shock” for floor installations. For floor installations, this should be affixed to the transformer/breaker enclosure.
- 1x “WARNING Risk of fire” for ceiling installations. For ceiling installations, this should be affixed adjacent to points of access to the space above the ceiling. If that option is not available, the label should be affixed to the transformer/breaker enclosure.
- 1x “CAUTION Radiant heating products installed in this area” for all installations. This label should be affixed adjacent to points of access to concealed areas in which the Carbontec® film is accessible (for example, entrances to attics or crawlspaces).
- 6x “Radiant ceiling heating”. This label should be affixed to individual room heating controls for ceiling installations.
- 6x “Radiant floor heating”. This label should be affixed to individual room heating controls for floor installations.

Each Carbontec® 251 package contains a nameplate tag which should be affixed to a non-heating lead in the transformer enclosure. This nameplate includes the information specified by NFPA 70: NEC 424.28(A) and UL 1683 and 1693 and includes the primary and secondary voltage and current values for the transformer. Some fields on the nameplate are blank, and must be filled in by the installer:

- Total output wattage. Add up the total length of heater strips attached to the transformer, then multiply this length by the appropriate “Output per foot” rating shown in the Technical Data in section 4.
- Date of installation.

### 3.5 Start-up

All wiring connections and mounting hardware must be checked before the equipment is started up and commissioned. All wiring connections must be secure and fully insulated. All mounting hardware must be securely fastened.

Heat the Carbontec® heating film up for the first time for 15 minutes after a drying period of at least 24 hours. The heating system is now ready for operation. Attach the warning sign supplied with the kit now in a highly visible place in the immediate vicinity of the heating film and put the instructions in the circuit breaker panel box.

## 4 Technical Data

	251-L Installation	251-S Installation
<b>Power input:</b>	120VAC	
<b>Output (Carbontec® heating film):</b>	11.2 W/ft <sup>2</sup> (120 W/m <sup>2</sup> )	10.3 W/ft <sup>2</sup> (33.8 W/m <sup>2</sup> )
<b>Output per foot:</b>	20.3 W/ft (66.6 W/m)	4.1 W/ft (13.5 W/m)
<b>Max. number per power circuit:</b>	4 sections of heating film	
<b>Secondary voltage:</b>	24 V	12 V
<b>Primary circuit breaker protection:</b>	Building circuit protector	Building circuit protector
<b>Secondary circuit breaker protection:</b>	25A	25A
<b>Nominal temperature limit:</b>	+ 160 °F (+ 70 °C)	
<b>Minimum installation temperature:</b>	+40 °F (+ 5 °C)	
<b>Minimum bending radius:</b>	R 2” (R 50 mm)	
<b>Material:</b>	PET film with carbon fibers and fillers	
<b>Primary conductor / transformer:</b>	14AWG (to the mains and/or controller)	
<b>Secondary conductor / transformer:</b>	12AWG, max. 30ft (10 m) length	
<b>Heating film dimensions, width:</b>	24” (59 cm)	6.75” (17 cm)
	21” (54 cm) (net heating width)	4.75” (12 cm) (net heating width)
<b>Minimum length:</b>	3 ft (1 m)	
<b>Max. heat transfer resistance “R-value” for floor covering:</b>	1.0 (hr·°F·ft <sup>2</sup> )/BTU (0.15 m <sup>2</sup> K/W)	

## 5 Carbontec® Limited Warranty

### CARBONTEC® LIMITED WARRANTY

Carbontec® (“Manufacturer”) warrants that its Heating Film (“Product”) is free from defects in manufacturing; materials and workmanship and will perform under normal use for 10 years from when product is installed through a certified Carbontec® installer (“Limited Warranty Period”). This warranty shall not be valid under the following conditions: 1) The preparation, conditions and installation of the Product is not in accordance with industry standards, Manufacturer’s installation guidelines, and UL guidelines, 2) the installation is not conducted as per Manufacturer’s written instructions; 3) vertical cracking, settling or displacement occurs; 4) improper installation materials or methods are used, 5) the Product’s heating elements are cut, punctured or tampered with. This limited warranty is extended to the original owner of the property where the Product is installed (the “Owner”) and does not cover damage to the floor or floor covering. This Limited 10 year Warranty is further subject to the exclusions and limitations provided below.

TO OBTAIN WARRANTY SERVICE, FOLLOW THE INSTRUCTIONS IN STEP 4 BELOW. UPON RECEIPT OF THE DEFECTIVE PRODUCT, PAPERWORK, RECEIPT AND RESISTANCE MEASURES, MANUFACTURER WILL EXAMINE AND TEST THE PRODUCT. IF IT IS DETERMINED THAT THE PRODUCT WAS PROPERLY INSTALLED AND FAILED DURING NORMAL USE AS A RESULT OF A MANUFACTURING, DEFECT, THE MANUFACTURER WILL REMEDY THE DEFECT OR FAILURE WITHOUT CHARGE TO THE OWNER PROVIDED MANUFACTURER RECEIVES NOTICE OF THE WARRANTY CLAIM IN THE MANNER PROVIDED BELOW WITHIN THE LIMITED WARRANTY PERIOD. THE REMEDY FOR ANY SUCH DEFECT IS LIMITED, AT MANUFACTURER’S OPTION, TO THE REPAIR, REPLACEMENT, OR REFUND OF THE PURCHASE PRICE OF THE PRODUCT.

THIS LIMITED WARRANTY DOES NOT APPLY AFTER MARKET ACCESSORIES THAT ARE USED WITH CARBONTEC PRODUCT.

MANUFACTURER ASSUMES NO LIABILITY FOR THE COST OF FLOOR COVERING MATERIALS OR THE COST TO REMOVE OR REPLACE THEM.

IMPORTANT: FOR THIS WARRANTY TO BE VALID, THIS PRODUCT MUST BE CONNECTED TO THE ELECTRICAL SOURCE AND PROPERLY GROUNDED ACCORDING TO THE INSTRUCTIONS PROVIDED IN THE INSTALLATION MANUAL AND ELECTRICAL CODE.

### CONDITIONS/EXCLUSIONS TO THE LIMITED WARRANTY

THIS LIMITED 10 YEAR WARRANTY IS FURTHER MADE SUBJECT TO THE FOLLOWING CONDITIONS AND EXCLUSIONS, PLEASE READ THE FOLLOWING CAREFULLY:

1. Required Installation. To be covered by this Limited 10 Year Warranty, the Product must be installed indoors following the exact Manufacturer’s installation instructions for the Product.

2. Limitation on Causes of Defects Covered Under Warranty. This limited warranty covers only defects in manufacturing materials or workmanship and does not cover defects, malfunctions or failures resulting from any other cause including, without limitation: **(i) improper or inadequate installation;** (ii) damage caused by trades people or visitors to the job site or by cutting or puncturing or other post installation damage to the heating elements; (iii) defects caused by fire, flood, tornado, hurricane, earthquake, acts of God, differential settlement, insect infestation, extraordinary environmental conditions, riot or other civil insurrections, or acts of war or conflict; (iii) defects caused by abusive conditions or accidents, such as but not limited to cutting, severe impact or abnormal vibrations; (iv) installation or use of the Product in any manner not recommended by the Manufacturer; and, (v) defects caused by improper or inadequate maintenance, cleaning, use or care of any floor installed over the Product.

3. Controlling Document. This warranty is the sole and exclusive description of warranties applicable to the Product. Any written or oral representation, warranties or guarantees concerning the Product which are inconsistent with or beyond the scope of the description contained herein are superseded by this document and deemed inapplicable or void.

4. Required Procedures to Submit a Warranty Claim. In order to obtain performance of any warranty obligation, the Owner must do the following:

Contact the Manufacturer at the number listed below or by mail at the address listed below, and request a claim form. Complete and return the claim form along with the defective Product, Product Label showing serial number, the original dated sales receipt and a copy of the resistance measures recorded during installation to the Manufacturer by certified mail return receipt requested within the Limited Warranty Period. The phone number and address to contact the Manufacturer for these purposes is as follows:

Carbontec® International  
6701 Mission St., Suite 7  
Daly City, Ca. 94014  
855-737-HEAT (4328)

THIS LIMITED WARRANTY IS GIVEN IN LIEU OF IMPLIED WARRANTIES. IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE ARE DISCLAIMED.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS. YOU MAY ALSO HAVE OTHER RIGHTS THAT VARY FROM STATE TO STATE. TO THE EXTENT ALLOWED BY APPLICABLE LAWS, MANUFACTURER HEREBY DISCLAIMS ANY AND ALL SUCH RIGHTS.

UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE TO THE OWNER, OR ANY OTHER PERSON FOR ANY CONSEQUENTIAL, INCIDENTAL, ECONOMIC, DIRECT, INDIRECT, GENERAL, OR SPECIAL DAMAGES ARISING OUT OF ANY BREACH OF WARRANTY, EXPRESS OR IMPLIED, UNDER THIS CONTRACT.

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.

THIS LIMITED WARRANTY HEREBY SUPERSEDES ALL PRE-EXISTING WARRANTIES, EITHER EXPRESS OR IMPLIED, RELATING TO THE PRODUCT.

## **6 Contact information**

Manufacturing Facility:

US Representative:

Carbontec® International  
6701 Mission St., Suite 7  
Daly City, Ca. 94014  
855-737-HEAT (4328)

Ginensys GmbH, Witzlebenplatz 1  
14057 Berlin, Germany  
HRB 163014 B  
Tel.: +49 (0) 30 9236 8372  
+49 (0) 30 8961 3155

## 7 Installation Record and Documentation

Resistance measurement: (necessary for guarantee claim)

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Resistance of the heating film before installation:

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Date/signature/stamp

Resistance of the heating film after installation:

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Date/signature/stamp

Project data:

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Customer (name)

---

Address

---

Telephone no.

---

Description of the room, installation (floor, ceiling)

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Carbontec® 251-L

Type of controller:

Carbontec®251-S



Model Carbontec 251-L and Carbontec 251-S - FIG. 1 & 2

General -

1. Power Unit - Listed (XPTQ) Model GP1000 by Justin Inc (E200234, rated 120Vac input, 12/24Vac, 1000W output). Employs circuit breaker Type CA2A52AMCW0250BXX-XXXXXWCVBX1-X by Circuit Breaker Industries Ltd (rated 277 V, 25 A, 115°C).  
  
Alternate - Listed (XPTQ) Model GP500 by Justin Inc (E200234, rated 120Vac input, 12/24Vac, 500W output). Employs circuit breaker Type CA2A52AMCW0250BXX-XXXXXWCVBX1-X by Circuit Breaker Industries Ltd (rated 277 V, 25 A, 115°C).  
  
Alternate - Listed (XPTQ) Model GP250 by Justin Inc (E200234, rated 120Vac input, 12Vac, 250W output). Employs circuit breaker Type CA2A52AMCW0250BXX-XXXXXWCVBX1-X by Circuit Breaker Industries Ltd (rated 277 V, 25 A, 115°C).  
  
Alternate - Listed (XPTQ) Model GP250-24 by Justin Inc (E200234, rated 120Vac input, 24Vac, 250W output). Employs circuit breaker Type CA2A52AMCW1200BXX--XXXXXWCVBX1-X by Circuit Breaker Industries Ltd (rated 240 V, 12 A, 115°C).  
  
Alternate - Listed (XPTQ) Model GP100. (E200234, rated 120Vac input, 12Vac, 100W output). Employs circuit breaker Type C-A2A52AMCW0900BXX-XXXXXWCVBX1-X by Circuit Breaker Industries Ltd (rated 277 V, 9 A, 115°C).
2. Non-Heating Lead to Bus Bar Splice Connector - Model 1-330716-2 by TE Connectivity. Copper with electroplated nickel. Shaped as shown in ILL. 2. Crimped with locking tool Model 46447 by TE Connectivity.
3. Heating Panel - Model 251-L measures 24 in. wide, 21 in. heating width. Cold resistance is 1.76 ohms per linear foot at 25°C. Model 251-S measures 6.75 in. wide, 4.75 in. heating width. Cold resistance is 0.89 ohms per linear foot at 25°C. Constructed as follows:
  - A. Bus Bar - Copper, 20 mm wide, 0.020 mm thick.
  - B. Fleece - PET, 0.150 mm thick.
  - C. Carbon Fiber - Carbon, max 0.040 mm thick.
4. Electrical Insulation Tape - Not shown. Any R/C OANZ2 tape rated min. 90°C.
5. Terminal Block - R/C (XCFR2). Not shown. Model 1412400 by Regal Beloit American Inc (E62806, rated 600V, 115A, 110°C). (To be secured within a Listed junction box, minimum 28 square inches per Terminal Block, as identified in the installation instruction manual).
6. Cable Mount - Now shown. McMaster-Carr, Model 7566K29 with #8 screws.