

## Cartridge Heaters Selection Guidelines

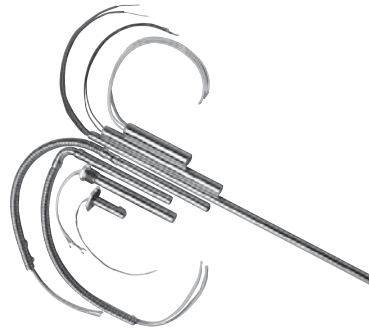


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CARTRIDGE



### *Type CIR High Watt Density*

**Advanced Internal Construction Plus Swaged Leads** — The challenge to Chromalox engineers was to design a cartridge heater that would out perform any brand cartridge heater — under any given set of conditions, and to assure that the customer receives and continues to receive the most heater performance and life possible for his investment.

**Type CIR Cartridge Heater** — Includes several significant advances in cartridge heater technology. Its high performance characteristics have been proven, not only in the laboratory, but also on Customers' equipment on selected problem applications, at 1500°F and higher operating temperatures.

### *Type C-LD, C-HD & C-DE Medium Watt Density*

**Type C Large Diameter Cartridge Heater** — For medium and low watt density applications. The tightly compacted refractory insulation provides excellent heat transfer to the heavy wall stainless steel sheath. This means the resistance wire runs at a lower temperature than competitive units with loose-fill insulation; the result is much longer life. This heavy-duty construction also provides high dielectric strength as well as shock and vibration resistance required for many industrial applications.

**Type CBH Electric Stud Heater** — Used to wrench-tighten bolts or studs to “shrink fit” tightness.

**Type SCB Small Space Heater** — Edison screw base installs in standard porcelain lamp socket to heat very small spaces.

### *Cartridge Heaters — Selection Guidelines*

Model	Applications	Max. Work Temp. (°F)	Watts	Dimensions (In.)		Sheath Material	Sheath Temp. (°F)	Terminal Type	Life Rating	Page
				Length	Dia.					
CIR	Molds, Dies, Platens, Hot Plates, Sealing	1400	75 - 5,000	1-1/4 - 48	1/4-3/4	INCOLOY®	1500	Swaged Leads	Superior	A-102
SST	Molds, Dies	1400	Variable	5-120	3/8-1	INCOLOY®	1600	Flexible Leads	Standard	A-111
QST	Platens, Presses									
C-LD, C-HD, C-DE	Aluminum Extrusion Dies, Container Heaters	600	450 - 1,750	8-25	15/16-1-19/64	Stainless Steel and Brass	750	Bolt	Standard	A-107, A-108
MZ	Hot Press Metal Forming, Zone Control	1800	Variable	18-180	.495, .685, .935	INCONEL® 600	2000	Plug	Standard	A-109
CBH <sup>1</sup>	Shrink Tightening	1200	1,150 - 11,500	18-60	.553-1.106	Steel	1600	Standard Octagon Box with Handle	Standard	A-115
SCB	Closet and Control Cabinet Space Heating	600	50 - 200	4-3/4	1-3/8	Brass	1000	Edison Screw Base (light bulb socket)	Standard	A-113
HTRC	Heat Transfer and Release Coating									A-101

**Note** —

1. Not UL Recognized or CSA Certified.

## Cartridge Heaters Application & Installation Recommendations



### Applications

#### Application at High Watt Densities —

Type CIR cartridge heaters are designed and manufactured to provide watt density capabilities second to none. To obtain best life at the highest watt densities allowed per Curve G-235 in the Application Guidelines, close attention to application details is suggested.

- A. For closest fit and best heat transfer, holes should be drilled and reamed, rather than just drilled to final diameter with a general-purpose drill.
- B. The sensor for the temperature control should be placed between the working surface of the part and the heaters. The temperature of the part approximately 1/2" away from the heaters is used in selecting maximum allowable watt density from the graph.
- C. Control of power is an important consideration in high watt density applications. On/Off control is frequently utilized, but it can cause wide excursions in the temperature of the heater and working parts. SCR power controls are valuable in extending the life of high watt density heaters, since they effectively eliminate on-off cycling.

#### Application at Medium Watt Densities

— Curve G-235 in the Application Guidelines shows maximum allowable watt density for various fits and operating temperatures. The vast majority of applications do not require maximum W/In<sup>2</sup>, however. Use a watt density only as high as you need. Take advantage of the safety margin provided by using ratings less than the maximum allowed. Select and space heaters for most even heat pattern rather than for highest possible wattage per heater.

At medium watt densities, general purpose drills are usually adequate for drilling holes. Typically, these result in holes 0.003 to 0.008" over the normal size of the drill, resulting in fits of 0.01 to 0.015". Of course, the tightest fit is desirable from a heat transfer standpoint, but somewhat looser fits aid in installing and removing cartridge heaters, especially long ones. Holes drilled completely through the part are recommended to facilitate removal of the heater. After drilling, clean or degrease the part to remove cutting lubricants.

**Operation in Vacuum** — When heaters are operated in a block which is in a vacuum, the inside of the holes should be pre-oxidized to

improve emissivity. Substantial reductions in maximum allowable watt density are usually necessary for vacuum operation. Where possible, the installation should be designed so that the lead end of the heater is outside the vacuum. When the lead end of the heater is inside the vacuum, a voltage of 120 volts or less is recommended. On an unsealed heater, outgassing may be expected.

**Operation in Square Grooves** — Round type CIR cartridge heaters may be installed in square or v-shaped grooves if this proves convenient. The inside of the groove should be treated to improve its emissivity (by oxidizing or anodizing). Allowable W/In<sup>2</sup> can be estimated by using the 0.05" fit line in the graph, providing that the square is approximately the same width as the nominal diameter of the heater.

**Operation on 480V** — Chromalox type CIR cartridge heaters 5/8" diameter and larger can be operated on 480 volts. One approach is to take two stock 240 volt heaters and connect them in series on 480 volts. Another is to order specially rated 480 volt cartridge heaters. Check with your Local Chromalox Sales office for recommendations.

Because of higher voltage stresses inside the heater, lower maximum watt densities are allowable in 480 volt applications, either with two 240 volt heaters in series or with specially rated 480 volt units. To determine maximum allowable watt density at 480 volts, enter Curve G-235 with an operating temperature value which is 200°F higher than the actual operating temperature. A maximum operating temperature of 1000°F is suggested.

### Testing Recommendations

**Testing Recommendations** — Testing under simulated operating conditions is suggested when equipment manufacturers design new products. Cartridge heaters of the appropriate physical size are operated on a variable transformer until the heat output is at the proper level. Then, voltage and current measurements are taken and required wattage rating is calculated. Heaters of the correct wattage rating are then ordered for the designed product.

### Installation Recommendations

1. On moving machinery, anchor the leads securely. As little movement as possible should be allowed close to where the leads emerge from the heater. A loop in the lead

wire will frequently extend lead life. If application conditions result in continual lead flexing, terminate the cartridge heater leads at a terminal block which moves with the heated assembly. Flexing is transferred to the extension leads which can be economically replaced.

2. For rapidly vibrating equipment, employ the terminal block described above. Keep leads from heater to block short and well supported to prevent lead movement due to vibration.
3. Protect leads from spray, oil and abrasion. Contaminating liquids and vapors can enter unsealed cartridge heaters and cause insulation breakdown.
4. Avoid tape on leads where they emerge from the cartridge heater. The adhesive on some tapes can enter the heater and turn to carbon which is electrically conductive. Where glass tape cannot be avoided, a tape with a silicone based adhesive is suggested.
5. Design the installation so that the leads are in an ambient temperature which doesn't exceed the rating on the lead insulation (842°F for standard leads). Where temperatures require it, use nickel or nickel-plated copper wire with fluoropolymer insulation, silicone impregnated Fiberglas® or Rockbestos® insulation to extend leads.
6. Graphite and other lubricants to help insert the cartridge heater into the hole are generally not recommended. These are electrically conductive and can get on the lead end of the heater unless extra care is taken. Use Chromalox heat transfer and release coating.
7. As operating temperatures rise, thermal insulation on the heated part becomes more desirable to conserve heat. Thermal insulation results in lower wattage requirements and therefore lower watt density on the heaters. Other benefits are more even work temperatures and greater operator safety and comfort.
8. Leads must not extend into the hole containing the cartridge heater. Generally, the lead end of the heater sheath should be flush with the surface of hole or extended by 1/16 inch.



## Cartridge Heaters Modifications & Options

### Modifications & Options

Cartridge heaters can be easily specified to meet the demands of special applications. Simply select from a variety of standard options and features to customize the heater to your specific needs. For customized engineering or alternative options, contact your Chromalox sales representative for fast turnaround on your specifications.

- Leadwire Types
- End Seal Options
- Lead Options
- Mounting Options
- Built-In Thermocouple

### Leadwire Types

Description	Volts	Operating Temperature	
		(°F)	(°C)
Mica Fiberglas® Insulation	300V Standard 600V	842	450
Fluoropolymer	300V 600V	392	200

### Seal Options

Type	Description/Application
Epoxy	Epoxy seal available on above leads by voiding end of sheath and filling with epoxy to provide a moisture barrier.
Fluoropolymer	A swaged-in seal that provides additional moisture resistance.
RTV	For applications where a moisture barrier is required.
Hermetic	Ceramic-to-metal seal is good for element temperatures up to 1000°F. Specify heater length beyond the seal. Metal portion of the seal overlaps the heater sheath by 3/16".
MR SEOT2	Meets UL File SEOT2.SA 12768

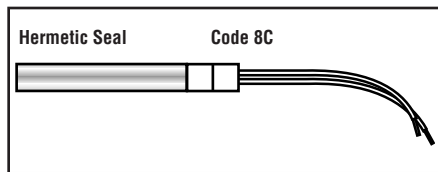
### End Seal Temperature Limits

Description	Operating Temperature	
	(°F)	(°C)
Air Set Cement Standard	1000	538
Epoxy Seal	194	90
Fluoropolymer Seal	392	200
RTV Seal	284 392	140 200
Hermetic Seal	1000	538
MR-SEOT2	374	190

### End Seal Options

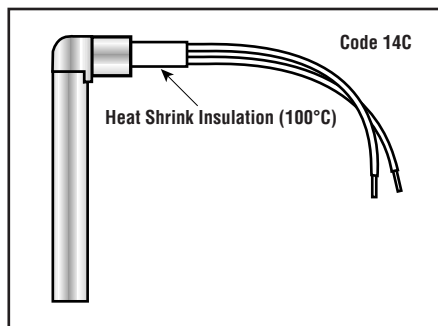
#### Hermetic Seal

Ceramic-to-metal seal is good for element temperatures up to 1000°F. Specify heater length beyond the seal. Metal portion of the seal overlaps the heater sheath by 3/16". For washdown conditions.



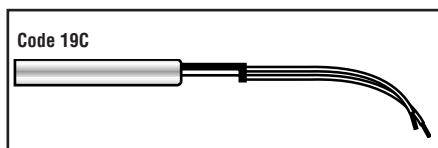
### Lead Options

#### Right Angle Flexible Leads



#### Strain Relief

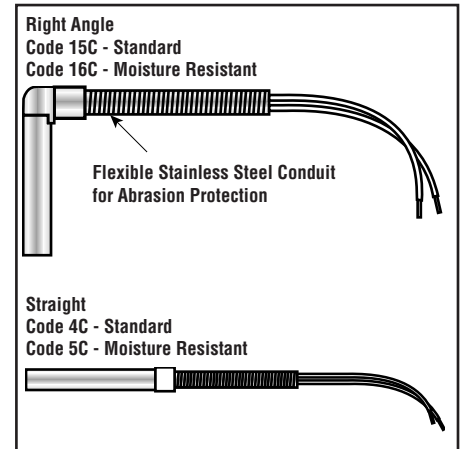
Strain Relief supports leads to reduce bending, crimping and breakage.



### Lead Options (cont'd.)

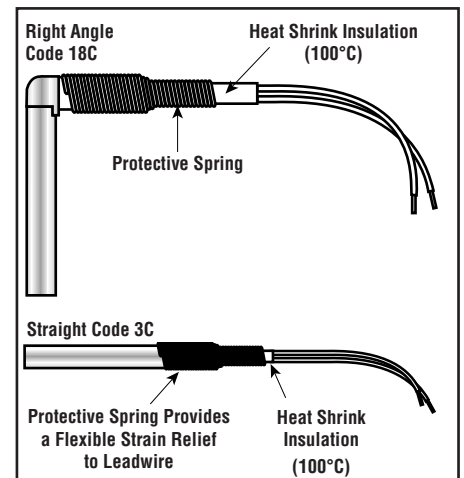
#### Flexible Stainless Steel Conduit

Flexible Stainless Steel Conduit provides leadwire protection from abrasion and sharp edges, and facilitates easier handling in harsh environments. Available in both straight and right angle configurations.



#### Protective Spring

Available in both straight and right angle configurations, the Protective Spring gives strong, yet flexible leadwire protection from bending, fatigue and flexing.



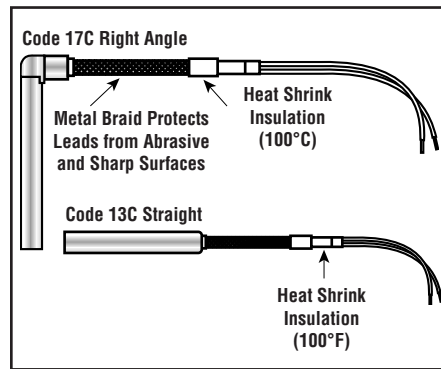
## Cartridge Heaters

### Modifications & Options (cont'd.)

#### Lead Options (cont'd.)

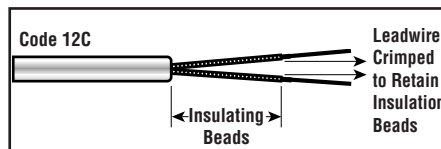
##### Metal Braid

Stainless Steel metal braid protects leadwire from abrasion and sharp edges, yet maintains flexibility and ease of installation. Metal braid is available in both straight and right angle configurations.



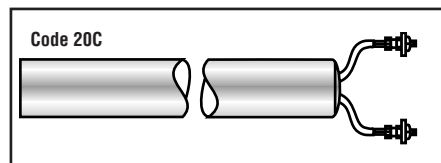
##### Ceramic Beads

Ceramic Bead insulation can be specified to protect leadwires from high ambient temperatures up to 1200°F (649°C). To order, specify ceramic beads length and additional lead length.



##### Threaded Post Terminals

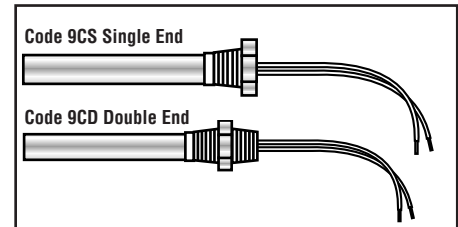
Post Terminals provide a strong, secure connection to buss bars or ring/fork connectors. Available only on 5/8 and 3/4" diameter heaters.



#### Mounting Options

##### Threaded Fittings

Threaded fittings allow the heater to be easily installed into a threaded hole for immersion applications. Available with single or double threaded fittings. The fitting overlaps the cartridge heater sheath by 1/4". Specify "brass" or "stainless steel" threaded fitting.

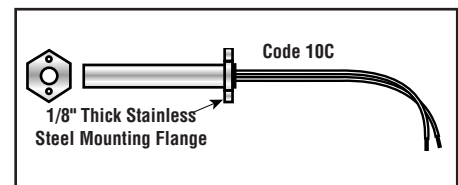


##### Threaded Fitting Sizes

Nom. Heater Diameter (In.)	NPT Size (In.)	Hex Size (In.)
1/4	1/8 - 27	7/16
3/8	1/4 - 18	9/16
1/2	3/8 - 18	11/16
5/8	1/2 - 14	7/8
3/4	3/4 - 14	1-1/16

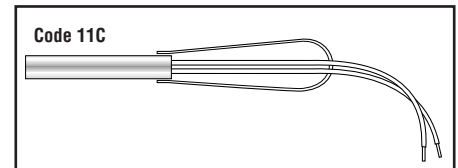
##### Mounting Flange

The mounting flange option allows for easy mounting and specific positioning of the heater within an application.



##### Wire Pull

The Wire Pull assists in heater removal.





## Cartridge Heaters

### Thermocouple Leadwire

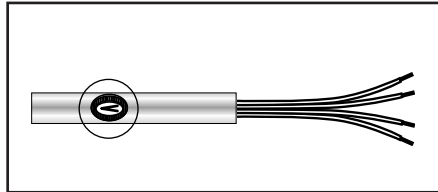
- Process Temperature Control
- Protection from Overheating and Temperature Burnout
- Type J or K

In some applications, the heating element temperature is closely related to the temperature of the platen or mold it is heating. Chromalox Cartridge heaters with built-in thermocouples allow you to precisely measure the temperature at the ideal measurement point within the cartridge heater, and control the internal heater temperature to more closely maintain the optimum process temperature. Longer heater life and increased heat transfer efficiency may be achieved by precisely controlling the heater temperature.

Built-In Thermocouple Cartridge Heaters are available in three styles, each designed for specific application needs.

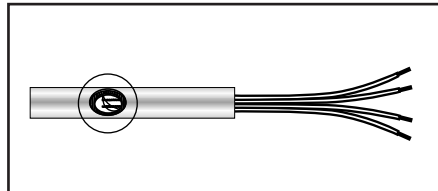
### Thermocouple Cartridge Styles

#### Code T1



Thermocouple (T/C) junction is located in the center of the core and at any point along the length. The T/C is not grounded. Style T1 is used as an overtemperature control or for burnout protection. It can also be used for process temperature control.

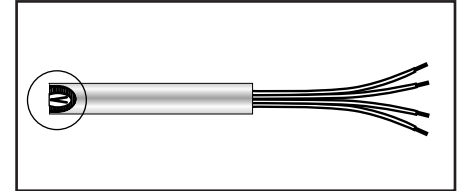
#### Code T2



T/C junction is located at most any point (specify location) along the length of the heater and grounded against the sheath. A 1/2" unheated section must be allowed for the T/C to clear the resistance wire.

Style T2 is used to control process temperature. T/C should be placed along the length of the heater in the most suitable position to control the temperature of the mold or platen being heated.

#### Code T3



T/C junction is embedded in the end disc. The T/C is grounded.

Style T3 is used when the process temperature at the end of the cartridge heater is critical. In applications where the process product flows past the heater end, such as plastic molding, this thermocouple style allows the cartridge end temperature to be closely controlled.

### Thermocouples

Type	Range	
	(°F)	(°C)
Type J	100 - 1400	38 - 760
Type K	100 - 2300	38 - 1260
Diameters	3/8, 1/2, 5/8, 3/4"	
Leadwire Length	Standard 14 inches Maximum length available 36 inches	



### HTRC — Chromalox Heat Transfer and Release Coating (Patented)

Chromalox HTRC is used for improving heat transfer and release in the following applications.

- Cartridge units in drilled holes.
- Tubular units in drilled holes, grooves or clamp-on surfaces.
- Strip and Ring heaters in grooves or clamped on to rough surfaces.

Laboratory tests have demonstrated that in high temperature applications, improved heat transfer can lower the internal wire temperature to provide up to 100% improvement in heater life. Chromalox HTRC is recommended for use in the above applications where sheath temperature of the heater is expected to exceed 750°F.

HTRC has an excellent heat transfer coefficient approaching that of aluminum. Shelf life greater than one year.

- PCN 014293 - 4 oz.
- Max. Temp. -1800°F