

Cartridge/Insertion Heaters

Metric FIREROD Cartridge Heaters

The Watlow FIREROD not only sets the industry standard for cartridge heaters, but continues to make improvements in construction and design. Among those improvements is the metric FIREROD, a variation of the FIREROD cartridge heater built to meet the exact specifications of the global market.

Like its counterpart, the metric FIREROD consistently outperforms other cartridge heaters with its design solutions such as its exclusive resistance wire winding and swaging process. These processes bring the resistance wire closer to the sheath and compacts the MgO insulation to maximize heat transfer. The end result is longer service life and better efficiency.

Performance Capabilities

- Part temperatures up to 760°C (1400°F) on alloy 800 sheath
- Watt densities up to 50 W/cm² (330 W/in²)

Features and Benefits

Nickel-chromium resistance wire

- Assures even and efficient distribution of heat to the sheath because the wire is precisely wound and centered in the heater

Conductor pins

- Ensures a trouble-free electrical connection because of the metallurgical bond between the conductor pins and resistance wire

Magnesium oxide insulation of specific grain and purity

- Results in high dielectric strength and contributes to faster heat-up

Alloy 800 sheath

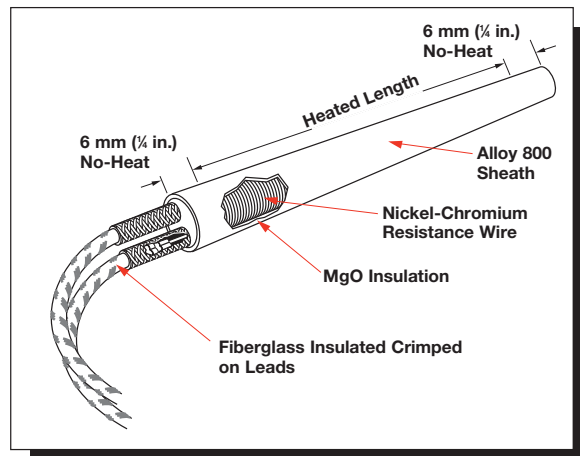
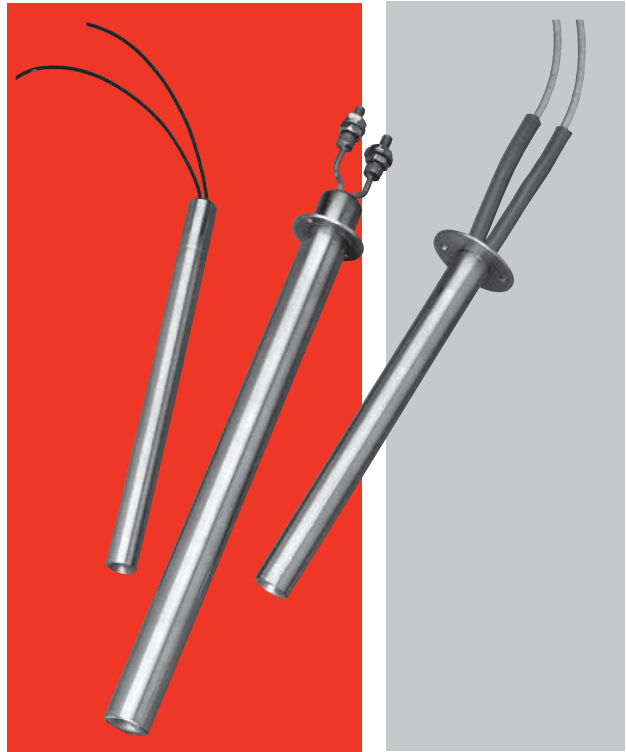
- Resists oxidation and corrosion from many chemicals, heat or atmospheres

Minimal spacing between the element wire and sheath

- Results in lower internal temperature
- Accommodates a design with fewer or smaller heaters operating at higher watt densities

UL® and CSA approved flexible stranded wires

- Insulates the wires to temperatures of 250°C (480°F)



Typical Applications

- Semiconductor chamber heating
- Semiconductor wafer lead connection
- Semiconductor wire and die bonding
- Freeze protection and deicing of equipment in cold climates or applications
- Humidity control
- Patient comfort heating used in medical devices
- Mold die and platen heating
- Seal bars used in packaging equipment
- Test sample heating in gas chromatography equipment

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Applications and Technical Data

The *Electrical Data* table will assist you in selecting the correct metric FIREROD heater for your application, according to available voltage, amperage and wattage.

Electrical Data

Heater Diameter (mm)	6.5	8	10	12.5	16	20
Nominal Diameter (in.)	0.256	0.315	0.394	0.492	0.630	0.787
Max. Voltage	250	250	250	400	480	480
Crimped on Leads						
Max. Amperes	7.2	7.2	16.1	16.1	21	21
Max. Wattage @ 230V	1650	1650	3700	3700	4830	4830
Max. Wattage @ 400V				6440	8400	8400
Swaged-in Leads						
Max. Amperes	5.2/7.2 ^①	5.2/7.2 ^①	12.6	12.6	12.6/21 ^①	21
Max. Wattage @ 230V	1190/1650	1190/1650	2890	2890	2890/4830	4830
Max. Wattage @ 400V	—	—	—	5040	5040/8400	8400

^①On certain lead constructions, maximum amperes are 5.2 or 12.6. In these instances, amperes are determined by internal construction and current carrying capacity of internal parts to the lead wire. For more information about these amperes restrictions or higher current requirements, please contact your Watlow representative.

Tolerances

Diameter: -0.02 mm, -0.08 mm (-0.0008 in., -0.0031 in.)

Length: ±2% with ±2.4 mm (±³/32 in.) min.

Wattage: +10%, -5%, wattage decreases approximately 5% with temperature. Wattage tolerances are for heaters at operating temperature.

Resistance: +5%, -10%, resistance is measured at room temperature following first heater operation.

Camber: 0.25 mm (0.01 in.) max. on any length to 300 mm (12 in.). For lengths over 300 mm:

$$\frac{[\text{Heater Length (mm)}]^2}{182,900}$$

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Maximum Allowable Watt Density

The following four graphs detail maximum allowable watt densities for applications involving metal heating or steam, air and gas heating. Please review these respective graphs and applicable data to determine the correct watt density for the application.

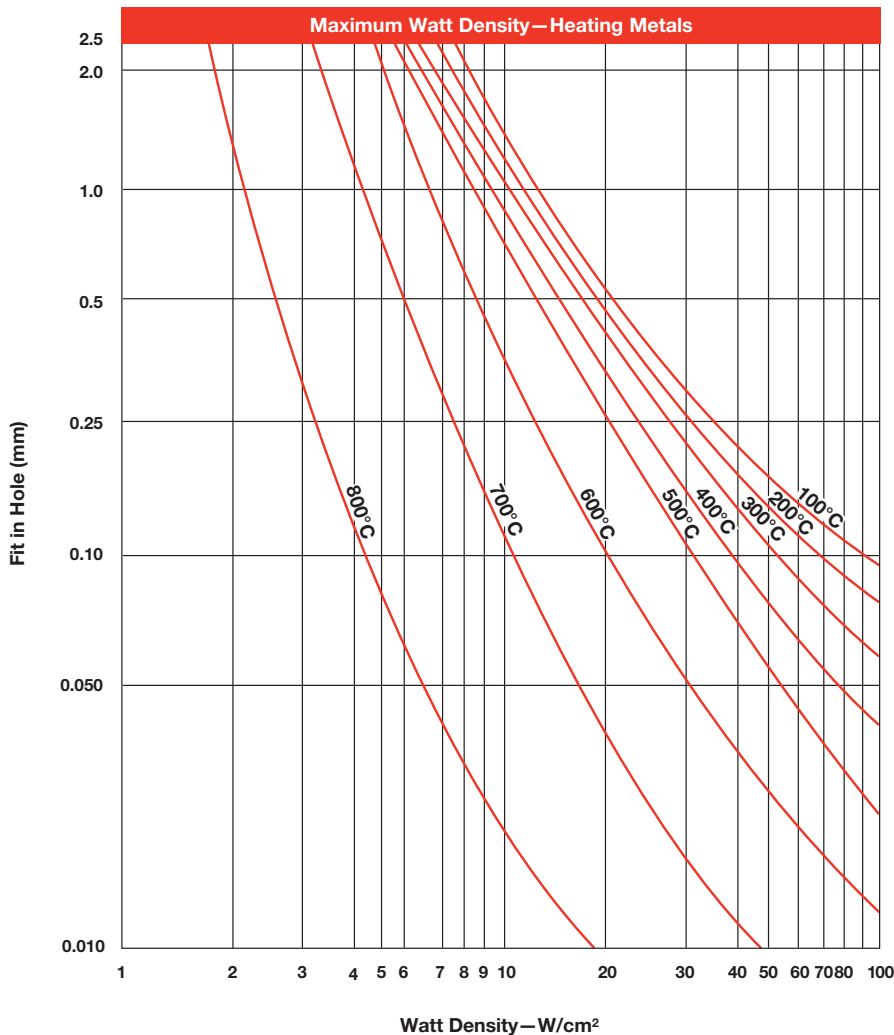
Heating Metals

The *Maximum Watt Density—Heating Metals* graph will show either the maximum hole fit or recommended watt density of the heater. Enter the chart with either known variable, part fit in hole dimension or watt density. Then, find the application temperature by reading up or over on the chart.

If the fit of the heater in the hole dimension is not known, it is easily determined. Subtract the minimum diameter of the metric FIREROD (nominal diameter minus tolerance) from the maximum hole diameter. For example, take a hole diameter of 16.1 mm minus a heater diameter of 16 mm - 0.08 mm. The hole fit would be 0.18 mm. For metric FIREROD heaters in square holes or grooves, contact your Watlow representative for fit in hole dimension.

Correction Factors:

Also note, the *Maximum Watt Density—Heating Metals* graph depicts metric FIRERODs used in steel parts. Therefore, for either stainless steel, aluminum or brass, refer to applicable correction factors ^① and ^②.



^① For SS, enter the graph with a fit 0.04 mm (0.0015 in.) larger than actual.

^② For aluminum and brass, enter the graph with a temperature 55°C (100°F) above actual temperature.

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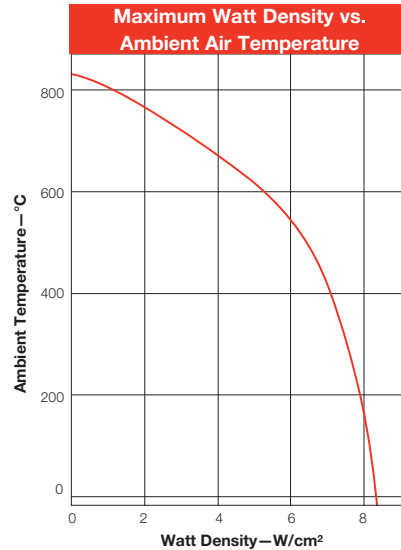
Metric FIREROD Cartridge Heaters

Maximum Allowable Watt Density (Continued)

Watt Density vs. Ambient Air

The *Watt Density vs. Ambient Air Temperature* graph shows the maximum allowable watt density when one metric FIREROD heater is operated in air or similar gas.

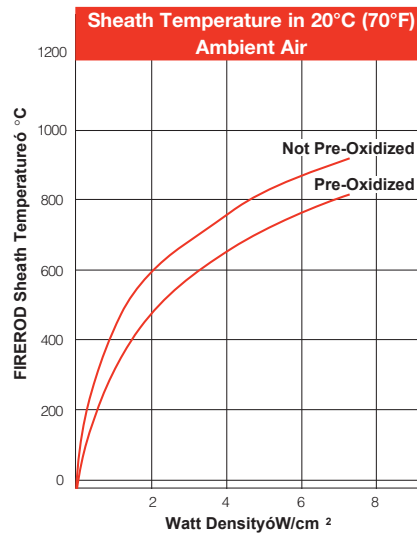
For metric FIRERODs grouped in a single row, with no less than one diameter between elements, multiply value from graph by 0.95. When a reflector is placed behind the heaters, multiply the maximum allowable watt density value from the graph by 0.85.



Sheath Temperature in Ambient Air

The *Sheath Temperature in Ambient Air* graph indicates the watt density required to bring a metric FIREROD heater to a given sheath temperature when operated in 20°C (70°F) ambient air.

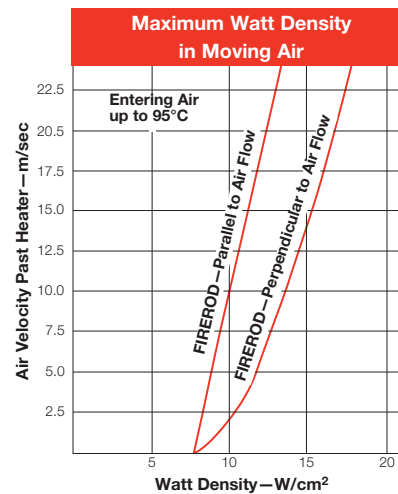
At 7 W/cm² (44 W/in²), the sheath temperature will be 790°C (1450°F). At this temperature, one year of heater life would be expected, provided cycling is not too frequent. Higher temperatures would result in reduced heater life.



Watt Density in Moving Air

The *Watt Density in Moving Air* graph gives the maximum allowable watt density of a metric FIREROD heater in moving air.

If the volumetric flow rate of air is known in m³/s (or CFM), divide this value by the net free area in m² (or ft²) around the heater to determine air flow velocity. The net free area is the total area of the enclosure minus the area occupied by the heater.

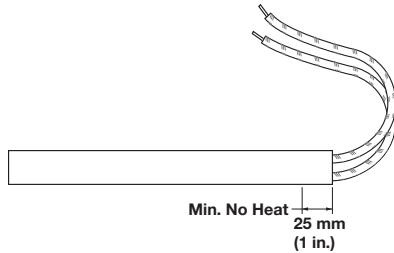


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Termination Options

Swaged-in Flexible Leads



Swaged-in flexible leads, with silicone-fiberglass insulation, are recommended for applications in which the leads must be bent at the exit point from the heater. Unless longer length is specified, 250 mm (10 in.) leads are supplied.

Heaters 150 mm (6 in.) or shorter generally have a 6 mm (1/4 in.) no-heat section. Heaters up to 250 mm (10 in.) require a 25 mm (1 in.) no-heat section. Heaters greater than 250 mm may require more than a 25 mm no-heat section. To order, please specify **swaged-in flexible leads**.

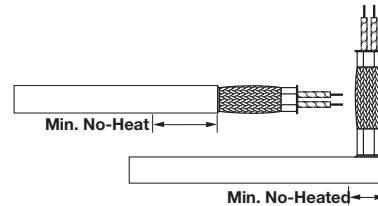
Right Angle Leads



Right angle leads are used in applications with a high degree of flexing and when space limitations are critical. Lead wires exit at a 90° angle through the side of the heater sheath. Right angle tube may be necessary on certain constructions. To order, specify **right angle leads** and lead length.

Metric FIREROD Diameter mm	Min No-Heat Length mm (in.)
6.5	15 (9/16)
8.0	15 (9/16)
10.0	17 (2/3)
12.5	18 (11/16)
16.0	20 (3/4)
20.0	21 (13/16)

Stainless Steel Braid



A stainless steel braid is designed to protect leads from abrasion against sharp edges. It is the most flexible of Watlow's protective lead arrangements.

When the leads exit straight out, the braid is swaged into the no-heat section of the heater. When the leads exit at a right angle, a crimp connector is used to attach the braids.

Unless otherwise specified, leads are 250 mm (10 in.) and the braid is 200 mm (8 in.) long. To order, specify either **straight or right angle stainless steel braid**, lead length and no-heat section.

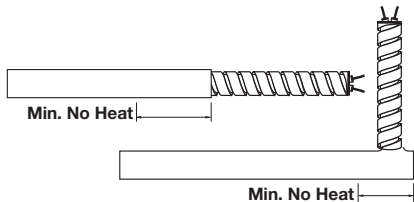
Metric FIREROD Diameter mm	Min. No-Heat Length	
	Straight mm (in.)	Right Angle mm (in.)
6.5	30 (1 1/8)	N/A
8.0	30 (1 1/8)	15 (9/16)
10.0	30 (1 1/8)	17 (2/3)
12.5	30 (1 1/8)	18 (1 1/16)
16.0	30 (1 1/8)	20 (3/4)
20.0	30 (1 1/8)	21 (1 3/16)

Cartridge/Insertion Heaters

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Termination Options (Continued)

Stainless Steel Hose

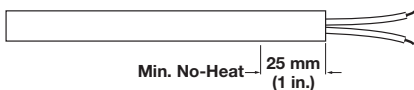


Stainless steel hose provides the best protection against abrasion from sharp edges or abrasive equipment. It also offers ease of handling and wiring in abrasive environments.

When the leads exit at a right angle to the heater, the hose is silver soldered to the sheath. Unless otherwise specified, leads are 250 mm (10 in.) long and the hose is 200 mm (8 in.) long. To order, specify **stainless steel hose**, lead length and no-heat section.

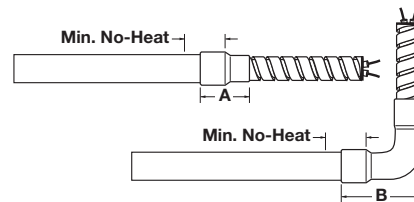
Metric FIREROD Diameter mm	Min. No-Heat Length		SS Hose O.D. mm (in.)
	Straight mm (in.)	Right Angle mm (in.)	
6.5	30 (1 ¹ / ₈)	N/A	4.7 (3 ¹ / ₁₆)
8.0	30 (1 ¹ / ₈)	15 (9 ¹ / ₁₆)	5.7 (7 ¹ / ₃₂)
10.0	30 (1 ¹ / ₈)	17 (2 ¹ / ₃)	7.6 (3 ¹ / ₁₀)
12.5	30 (1 ¹ / ₈)	18 (1 ¹ / ₁₆)	9.5 (3 ¹ / ₈)
16.0	30 (1 ¹ / ₈)	20 (3 ¹ / ₄)	12.7 (1 ¹ / ₂)
20.0	30 (1 ¹ / ₈)	21 (1 ³ / ₁₆)	15.8 (5 ¹ / ₈)

PTFE Seal and Leads



PTFE seal and leads protect the heater against moisture and contamination from lubricating oil, cleaning solvents, plastic material or fumes and organic tapes. This seal is effective to 200°C (400°F) under continuous operation. Please note, when ordering this option, that a 25 mm (1 in.) minimum no-heat section is required to allow construction. Additional no-heat area may be required to keep the seal below effective temperatures. To order, specify **PTFE seal and leads** and lead length.

Galvanized Conduit

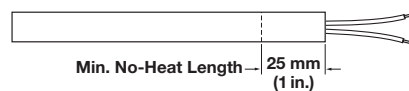


Galvanized conduit equals stainless steel hose in its abrasion protection.

The conduit is attached with a 90° elbow copper coupler, which overlaps the heater sheath. Unless specified, 200 mm (8 in.) conduit is supplied, leads are 50 mm longer than the conduit. To order, specify **galvanized conduit**, lead length and no-heat section.

Metric FIREROD Diameter mm	Min. No-Heat Length mm (in.)	Dimension A mm (in.)	Dimension B mm (in.)	Galvanized Conduit O.D. mm (in.)
6.5	12 (7 ¹ / ₁₆)	22 (7 ¹ / ₈)	29 (1 ¹ / ₈)	10 (3 ¹ / ₈)
8.0	12 (7 ¹ / ₁₆)	22 (7 ¹ / ₈)	29 (1 ¹ / ₈)	10 (3 ¹ / ₈)
10.0	12 (7 ¹ / ₁₆)	22 (7 ¹ / ₈)	29 (1 ¹ / ₈)	10 (3 ¹ / ₈)
12.5	12 (7 ¹ / ₁₆)	28 (1 ¹ / ₈)	30 (1 ³ / ₁₆)	14 (1 ¹ / ₂)
16.0	12 (7 ¹ / ₁₆)	28 (1 ¹ / ₈)	34 (1 ⁵ / ₁₆)	14 (1 ¹ / ₂)
20.0	12 (7 ¹ / ₁₆)	29 (1 ¹ / ₈)	36 (1 ⁷ / ₁₆)	16 (5 ¹ / ₈)

Silicone Rubber Seal and Leads



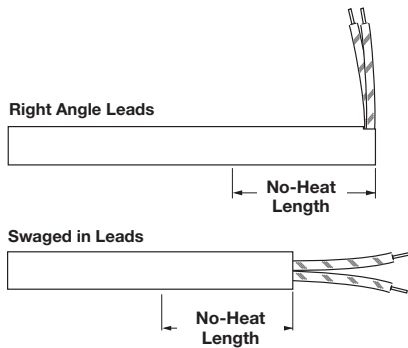
Silicone rubber seals and leads protect the heater against moisture and contamination from lubricating oil, cleaning solvents, plastic material or fumes and organic tapes. This seal is effective to 230°C (450°F) under continuous operation. Epoxy potting for up to 260°C (500°F) for continuous operation is available upon request. Please note, when ordering this option, a 25 mm (1 in.) minimum no-heat section is required to allow for construction. Additional no-heat may be required to keep the seal below effective temperatures. To order, specify **silicone or epoxy seal and leads** and lead length.

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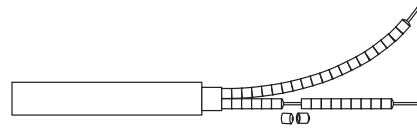
Termination Options (Continued)

No-Heat Section



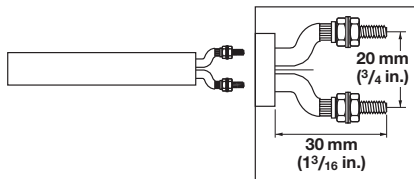
No-heat sections are recommended in applications where leads may be exposed to excessive heat, thus requiring a cooler lead end. Also use when heat is not required along the entire length of the metric FIREROD. No-heat extensions are available on all diameters with both pin style and swaged-in leads. To order, specify **no-heat** section and length of no-heat.

Ceramic Bead Insulation



Ceramic bead insulation protects the leads from high temperature ambients above 450°C (840°F). The beads fit over solid conductors and are extended long enough to reach a cooler area where flexible wires can be attached. To order, specify **ceramic beads** and length, and additional lead length.

Post Terminals



Post terminals provide a quick, secure connection with ring or fork connectors or bus bars. Threaded M4 x 12 mm studs are soldered to the solid power pins. Nuts and washers are provided. This termination is available on 16 and 20 mm (0.63 and 0.79 in.) diameter units. To order, specify **post terminals**.

Cartridge/Insertion Heaters

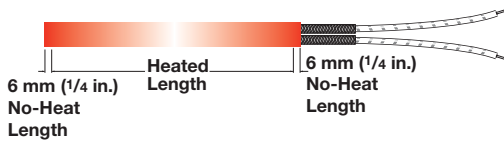
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Options

Accessories WATLUBE™

WATLUBE™ is an electrically non-conductive lubricant acting as a barrier against high-temperature oxidation, thus making heater removal easier. In addition, it aids in the transfer of heat from the metric FIREROD to the block. However, do not use it as a substitute for proper hole fit. WATLUBE is packaged in 118 ml (4 oz) bottles. To order, specify **WATLUBE**.

Distributed Wattage

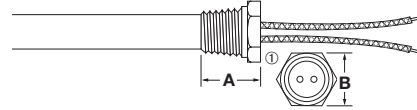


Distributed wattage varies the watt density along the length of the heater. This construction technique is used to compensate for heat losses along the edges of heated parts. To order, specify **distributed wattage** and give the length and wattage for each section.

Dual Voltage

When the metric FIREROD requires the flexibility of operating on two voltages, use this internal construction. Dual voltage is available on 12.5, 16 and 20 mm (0.5, 0.6 and 0.8 in.) diameter units. If not specified, 250 mm (9.8 in.) crimped on leads will be supplied. To order, specify **dual voltage**, voltage requirements and length of crimped on leads.

Threaded Fittings DIN Thread Size



Metric FIREROD Diameter mm	Min. No-Heat Length mm (in.)	Thread Size DIN 13	A mm (in.)	B mm (in.)	Length of Threaded Section
6.5	16 (5/8)	M10 X 1.0	10.0 (3/8)	12 (7/16)	6.0 (1/4)
8.0	16 (5/8)	M12 X 1.0	11.0 (7/16)	14 (1/2)	6.5 (1/4)
10.0	18 (11/16)	M14 X 1.5	11.5 (7/16)	17 (5/8)	6.5 (1/4)
12.5	19 (3/4)	M16 X 1.5	12.0 (7/16)	19 (3/4)	6.5 (1/4)
16.0	20 (3/4)	M20 X 1.5	15.0 (3/8)	24 (15/16)	9.0 (3/8)
20.0	22 (7/8)	M26 X 1.5	16.0 (5/8)	30 (1 1/8)	10.0 (3/8)

① Swaged-in unit pictured.

National Pipe Thread (NPT) Thread Size

Threaded fittings allow for fast, water-tight installation of the heater into a threaded hole. These fittings can be ordered in either brass or stainless steel. Double threaded fittings are also available. See dimensions noted on the *DIN Thread Size and NPT Thread Size* charts or contact your Watlow representative if application exceeds limitations shown. To order, specify stainless steel **threaded fittings**.

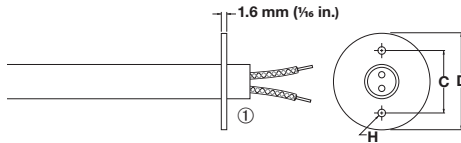
Metric FIREROD Diameter mm	Min. No-Heat Length mm (in.)	Thread Size NPT (in.)	A mm (in.)	B mm (in.)	Length of Threaded Section
6.5	19 (3/4)	(1/8)	13.5 (11/20)	11.0 (7/16)	9.5 (3/8)
8.0	22 (7/8)	(1/4)	17.0 (5/8)	14.0 (1/2)	13.0 (1/2)
10.0	22 (7/8)	(1/4)	17.0 (5/8)	14.0 (1/2)	13.0 (1/2)
12.5	25 (1)	(3/8)	20.0 (7/8)	17.5 (11/16)	14.0 (11/20)
16.0	28 (1 1/8)	(1/2)	23.0 (9/10)	22.0 (15/16)	16.0 (5/8)
20.0	32 (1 1/4)	(3/4)	26.0 (1)	29.0 (1 1/8)	19.0 (3/4)

Cartridge/Insertion Heaters

Metric FIREROD Cartridge Heaters

Options (Continued)

Flanges



Stainless steel flanges are a convenient mounting method as well as a way to position a heater within an application. These flanges can be located in any no-heat section of the heater sheath. To order, specify **flange**, flange size and location.

Metric FIREROD Diameter mm	Flange Size	D mm (in.)	C mm (in.)	H mm (in.)
6.5, 8, 10, 12.5, 16 [Ⓢ]	FS	25.4 (1)	19.1 (3/4)	3.7 (9/64)
6.5, 8, 10, 12.5, 16, 20	FM	38.1 (1 1/2)	28.6 (1 1/8)	4.3 (3/16)
16, 20	FL	51.0 (2)	38.1 (1 1/2)	5.3 (13/64)

^① Swaged-in unit pictured.

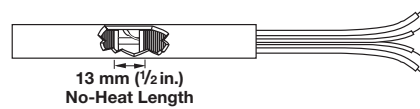
[Ⓢ] FS flange for 16 mm diameter is without holes.

Internal Thermocouple Sensors

Style A



Style B



Style C



The **Style A** internal thermocouple can be used to evaluate heat transfer efficiency of an application, a measure enabling a customer to cut energy costs and increase heater life.

The **Style B** internal thermocouple gives a good approximation of part temperature. The thermocouple junction is in contact with the inside of the heater sheath, located in the 13 mm (1/2 in.) no-heat section anywhere along the heater length.

A **Style C** internal thermocouple is useful in applications where material flows past the end of the heater, as in plastic molding. This junction is embedded in a special end disc. Style C is not available on 20 mm (0.8 in.) diameter units. Unless requested, the disc end is not mechanically sealed.

To order, specify **internal thermocouple Style A, B or C** and thermocouple **Type J or K**. If not specified, 250 mm (10 in.) thermocouple leads are supplied.

Thermocouple Types

ISA Code	Conductor Characteristics		Temperature Range	
	Positive	Negative	°C	(°F)
J	Iron (Magnetic)	Constantan (Non-magnetic)	-20 to 760	(0 to 1400)
K	Chromel [®] (Non-magnetic)	Alumel [®] (Magnetic)	-20 to 1260	(0 to 2300)

For other thermocouple types, contact your Watlow representative.

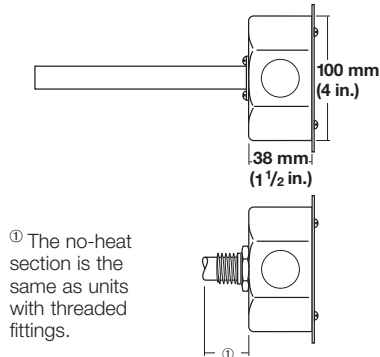
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**EXTENDED
CAPABILITY**

Extended Capabilities For Metric FIREROD Cartridge Heaters

Options

Terminal Box



NEMA 1, NEMA 4 (moisture-proof) and NEMA 7 (explosion-proof) octagonal terminal boxes can be mounted to a flange or threaded fitting on the 12.5, 16 and 20 mm diameter units. These 100 mm (4 in.) terminal boxes have conduit knockouts to protect electrical connections.

Aluminum and macrolon plastic terminal boxes are also available in the following sizes:

- 50 x 50 x 30 mm nominal size for heaters to 10 mm (0.4 in.) in diameter;
- 80 x 80 x 55 mm nominal size for heaters 12.5 mm (9.8 in.) or larger in diameter.

To order, specify **terminal box**, NEMA type and/or material type.

Individually Controlled Heat Zones

Individually controlled heat zones give the flexibility of controlling temperature by zones, along the length of the metric FIREROD. This is an advantage for heating requirements of certain applications, like seal bars.

This internal construction can be ordered on 12.5, 16 and 20 mm diameter units. If not specified, 250 mm crimped on leads will be supplied. To order, specify **individually controlled heat zones** as well as length and wattage per zone and length of crimped on leads.

External Finishing—Centerless Grinding

Centerless grinding can be used to furnish precision diameters, thus permitting closer heater-to-part fit. Therefore, higher watt densities can be used. For centerless ground heaters, the heater must either have PTFE leads and seal (maximum 12 in. (305 mm) lead length) or have crimped on leads. Longer lead lengths are available, but require external connection. The length of a FIREROD available for centerless grinding is dependent on the construction, please contact your Watlow representative for assistance. To order, specify **centerless grinding**.