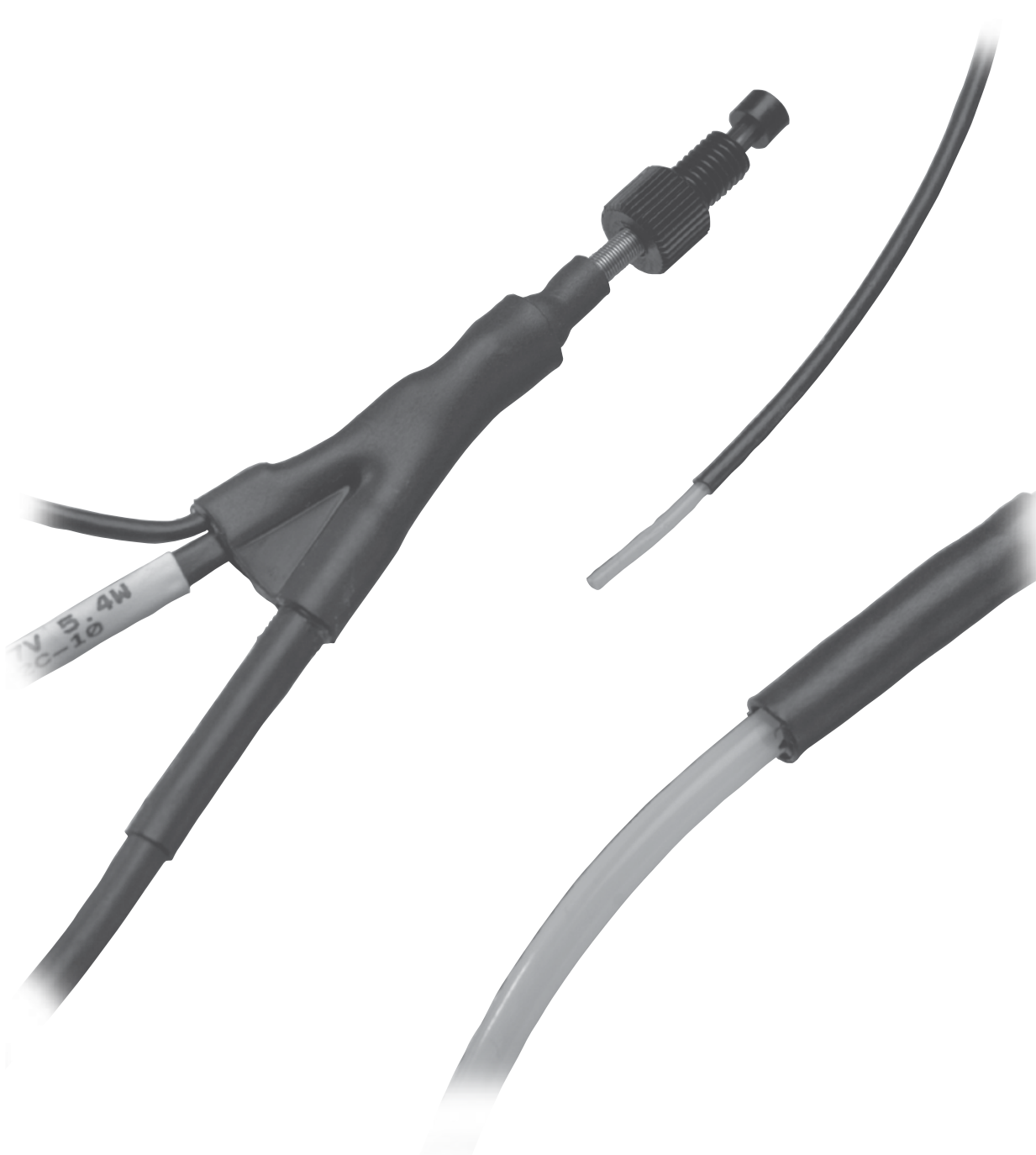


Fluid Delivery Heaters



Fluid Delivery Heaters	Sheath Materials	Max. Operating Temperatures		Typical Max. Watt Densities		Page
		°F	°C	W/in ²	W/cm ²	
FREEFLEX®	Polymeric	212	100	10	1.5	369
Syringe	Polycarbonate laminate	185	85	2	0.3	372
FLUENT® In-line	444 stainless steel (substrate tube), 316L stainless steel (baffle and fittings)	212 (in water)	100	450	70	373



Fluid Delivery Heaters



Fluid Delivery Heaters

**EXTENDED
CAPABILITY**



Extended Capabilities for FREEFLEX® Heaters

Watlow's miniature heated polymeric tubing assemblies provide a flexible heat-up and transport system for moving fluids within diameters as small as 1/32 in. (0.8 mm). The FREEFLEX® heater heats fluids up to 212°F (100°C) and maintains temperature during transfer from a reservoir to a point of use. In some applications, the tubing can actually serve as the reservoir for limited volumes of fluid, helping to reduce start-up times. For higher temperatures, contact your Watlow representative.

Watlow's innovative design places the heating element and sensor directly in contact with the perimeter of the tubing to produce efficient, responsive heating and temperature control of the tube contents. The element is evenly wound to ensure reliable, close contact for uniform heating along a portion or the entire length of the line. A flexible, durable jacket covers the wound element to let the tubing flex and move in a dynamic system. This allows for fluid delivery to multiple locations from a single supply source. In stationary applications, the FREEFLEX heated tubing is conveniently routed through available space or around other system components. This saves space and provides an uncomplicated retrofit in existing systems.

The FREEFLEX heater's efficient heating element design can incorporate an optional thermocouple, thermistor or resistance temperature detector (RTD) temperature sensor into the thermal package. Users can select leads to exit from one or both ends of the assembly. Typical standard PTFE tubing is available in 1/32, 1/16, 1/8 or 3/16 in. (0.8, 1.6, 3.2, 4.8 mm) inside diameters. Contact your Watlow representative for other sizes and materials.

Features and Benefits

Flexible heat-up and transport system

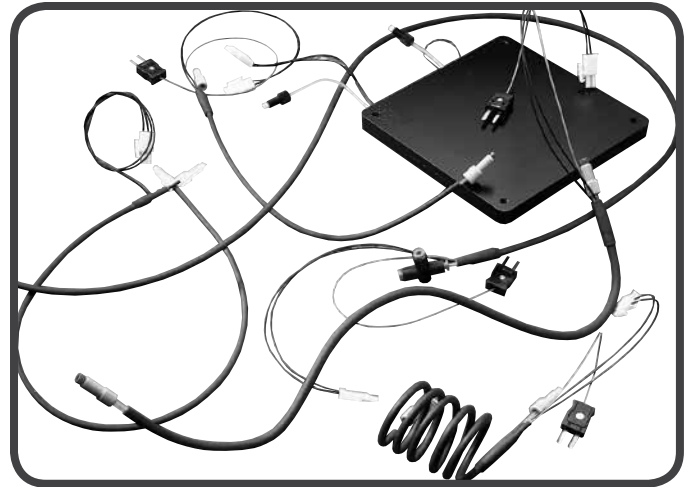
- Eliminates the need for heated reservoir systems in many applications

Direct contact between the heating element and tubing

- Provides fast, efficient, highly responsive heating

Available in three configurations

- FREEFLEX design allows tubing to flex, coil or bend around system components, enabling convenient retrofits
- Pre-formed design allows a longer tube length in a smaller volume
- Molded design provides a compact heating assembly for easy installation



Integral sensors

- Maintain close control of heater and fluid temperatures

Low voltage design

- Ensures safety

Miniature sizes as small as 1/32 in. (0.8 mm) inside diameter

- Heats and transports fluids within tiny spaces

Convenient retrofit

- Allows for routing flexible tubing around system components and using existing control system

UL® recognition

- Available on qualified designs by request

Typical Applications

- **Clinical:** automated clinical analyzers, tissue processing equipment
- **Analytical:** sample preheating for LC and HPLC systems, breathalyzers, immunoassays
- **Semiconductor processing:** wafer drying equipment, DI water heating
- **Printing:** additive manufacturing/3D printing
- **General process:** wax/paraffin processing and non-combustible gas heating
- **Water purification systems**
- **Precision cleaning equipment**
- **Aerospace**
- **Military**

Fluid Delivery Heaters

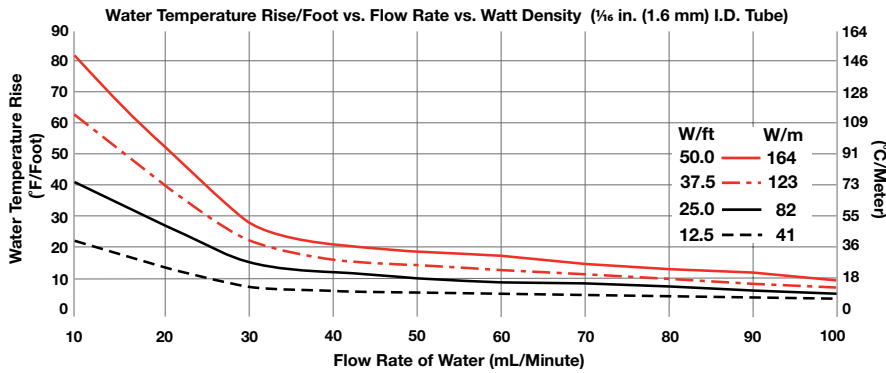
**EXTENDED
CAPABILITY**



Extended Capabilities for FREEFLEX Heaters

Technical Data

Water Temperature Rise/Length Versus Flow Rate Versus Watt Density



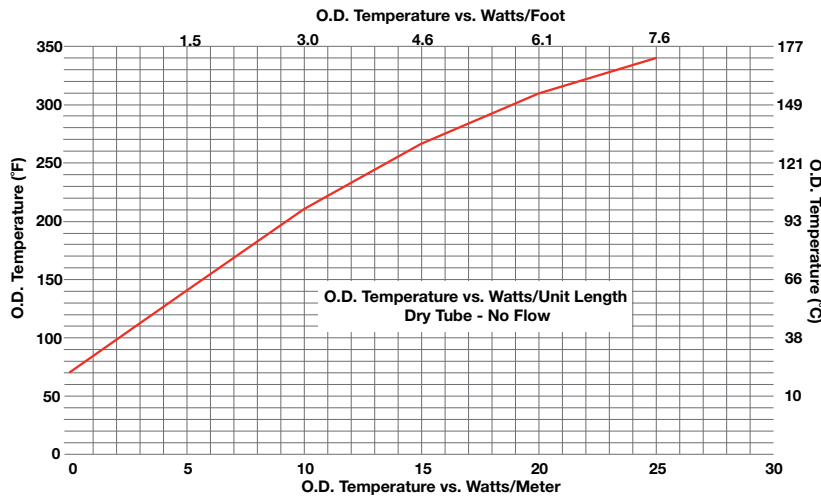
Water Temperature Rise °F/Foot
Flow Rate (mL/minute)

W/ft	10	30	50	100
50.0	82	29	19	10
37.5	64	22	14	7
25.0	41	16	10	5
12.5	22	8	5	3

Water Temperature Rise °C/Meter
Flow Rate (mL/minute)

W/m	10	30	50	100
164	149	52	35	18
123	116	40	26	13
82	75	29	18	9
41	40	15	9	5

FREEFLEX Outside Diameter Temperature Versus Watts/Length



W/ft	W/m	O.D. Temperature °F	O.D. Temperature (°C) (Ambient)
0	0	70	(21)
1.5	5	140	(60)
3.0	10	210	(99)
4.6	15	265	(129)
6.1	20	310	(154)
7.6	25	340	(171)

Fluid Delivery Heaters

**EXTENDED
CAPABILITY**



Extended Capabilities for FREEFLEX Heaters

Typical Application Requirements

When requesting a quote please specify:

- **Fluid type**
- **Inlet temperature**
- **Outlet temperature**
- **Flow rate**
- **Voltage** - Typically less than 36V
- **Watts/ft** - See chart on previous page for typical values
- **Maximum allowable outside surface Temperature**
- **Tube size**
 - 1/32 in. (0.8 mm) I.D. x 1/16 in. (1.6 mm) O.D.
 - 1/16 in. (1.6 mm) I.D. x 1/8 in. (3.2 mm) O.D.
 - 1/8 in. (3.2 mm) I.D. x 3/16 in. (4.8 mm) O.D.
 - 3/16 in. (4.8 mm) I.D. x 1/4 in. (6 mm) O.D.
 - Other (specify size)
- **Tube material**
 - PTFE standard
 - Others upon request
- **Tube length** - 24 to 165 in. (610 to 4191 mm) typical
 - Total
 - Heated
 - Unheated (specify)
- **Tube fittings**
 - No fittings (1 in. [25 mm] bare tubing each end)
 - Other (specify)
- **Tube flexing**
 - Static (to route around components in system)
 - Dynamic (subject to more continuous flexing)
 - Occasional, frequent or continuous

Note: Min. recommended flexing radius

- 1/32 in. (0.8 mm) I.D. x 1/16 in. (1.6 mm) O.D. PTFE
1 in. (25 mm)
- 1/16 in. (1.6 mm) I.D. x 1/8 in. (3.2 mm) O.D. PTFE
1 1/2 in. (38 mm)
- 1/8 in. (3.2 mm) I.D. x 3/16 in. (4.8 mm) O.D. PTFE
2 in. (51 mm)
- 3/16 in. (4.8 mm) I.D. x 1/4 in. (6 mm) O.D. PTFE
3 in. (76 mm)

- **Heater leads**
 - One at each end
 - Both at one end
 - Standard lead insulation (UL® Style 1180 CSA white PTFE)
 - Other insulation (specify)

Heater lead length

- Standard 12 in. (305 mm) w/customer end stripped/tinned 1/2 in. (13 mm)
- Other (specify)

Heater lead exit direction

- Inboard/outboard

Temperature sensor

- Thermocouple (#30 AWG PFA - Type J)
- Thermistor (specify) 10KΩ at 72°F (25°C) standard
- Other temperature sensors size/types (specify)
- Sense heater element or tube temperature

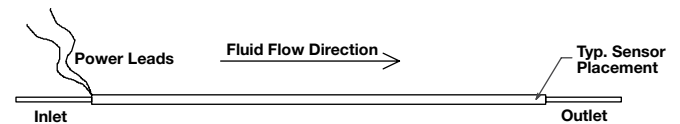
Sensor lead exit direction

- Inboard/outboard

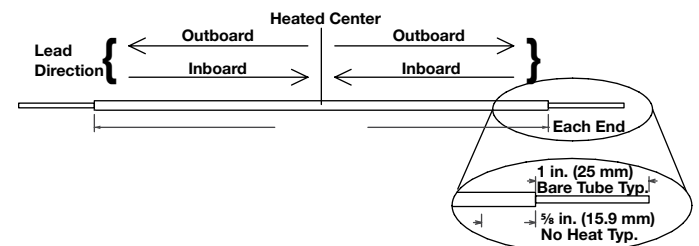
Temperature sensor lead length

- 12 in. (305 mm)
- Other (specify)

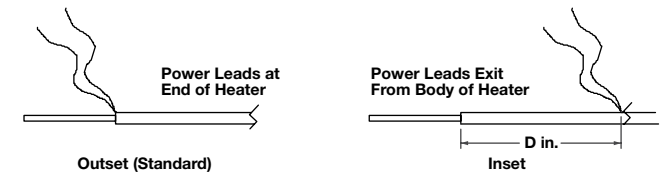
Typical FREEFLEX Layout



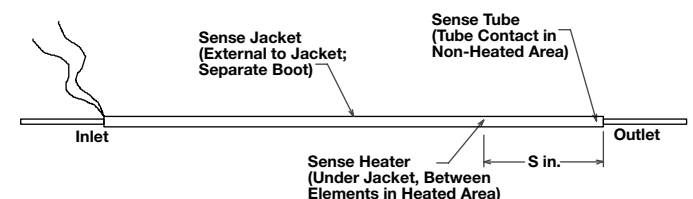
Lead Orientation



Lead Location



Sensor Location/Mounting Description



Fluid Delivery Heaters

**EXTENDED
CAPABILITY**



Extended Capabilities for Syringe Heaters

The Watlow syringe heater was developed to match the unique needs of medical injection applications. It produces consistent results by reducing temperature and viscosity variations. Fluid and drug delivery that maintain precise liquid temperatures and reduce fluid viscosity maximize patient comfort and reduce risk. Body temperature injections are more easily introduced, particularly for patients in a frail or distressed condition.

The Watlow syringe heater is available in two configuration types with an optional, repeatable temperature sensing controller. The silicone/wire configuration accommodates varying syringe size needs. The translucent, high-tech laminate construction of the polycarbonate/foil design enables fluid levels and air bubbles to be easily viewed and monitored. Both heater forms are designed to “snap” on to the syringe with one hand and hold firmly during a procedure.

An overmold design houses the optional electronic controller and/or temperature sensor to allow trouble-free servicing and extend heater life. The overmold can be modified and color matched for seamless, integrated appearance.

Features and Benefits

Long operational life

- Improves system reliability
- Reduces equipment down time and minimizes the need to reschedule procedures

Two heater configurations provide flexibility and adaptability

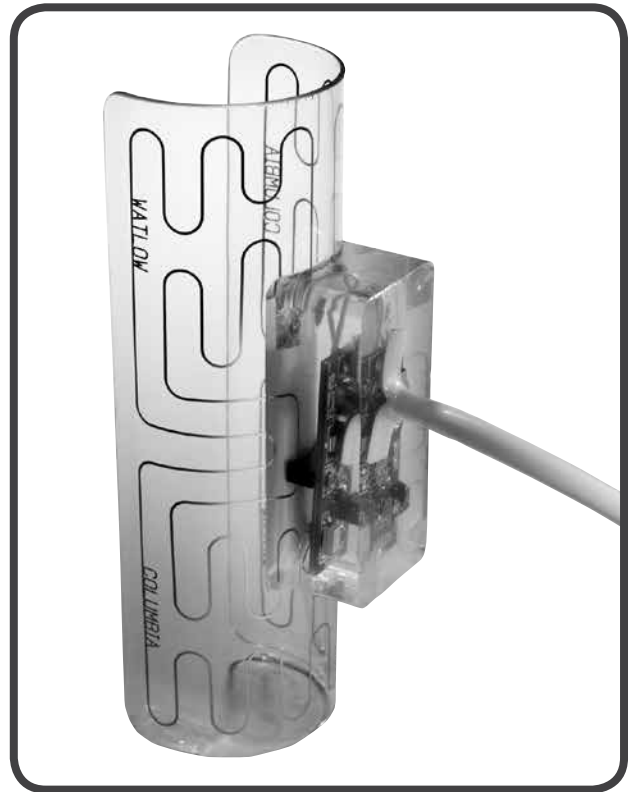
- Silicone wire enables maximum flexibility to accommodate various syringe sizes
- Polycarbonate/foil provides high tech appearance and functionality

Customizable to most OEM requirements

- Allows over-mold to be modified and color matched for a seamless, integrated appearance

Optional precise, repeatable temperature sensing control

- Maximizes patient comfort
- Minimizes patient risk
- Increases the consistency of test results by eliminating temperature and viscosity variations
- Carries a longer product life than bimetal thermostats



Specifications

Silicone/Wire and Polycarbonate/Foil

- Length: 5 in. (127 mm) max.
- Formed heater diameter: formed to fit syringe. Typical diameter is 2 in. (50 mm) to 6 in. (150 mm)*
- Voltage: dependent on application, over 48V may impact agency approvals
- Control accuracy: 5.4°F (±3°C)
- Max. operating surface temperature: 185°F (85°C)
- Approximate control pod dimensions: 1 x 1 x 2.75 in. (25 x 25 x 70 mm)*
- Cord pull strength: Up to 89 N (20 lb_F)*

* Dependent on design requirements.

Fluid Delivery Heaters



FLUENT® In-line Heaters

Watlow's FLUENT® in-line fluid heater is a small, lightweight, high-performance heater that can replace both a traditional immersion type heater or a heater wrapped around a tube as part of a thermal system. Watlow's FLUENT heater is designed as an integrated solution that replaces multiple components in a system. This heater design reduces overall system cost and complexity. Because of its high watt density, it offers ultra-fast response leading to higher system performance. Featuring Watlow's patented layered heater technology, the heater makes use of its entire surface to produce heat, which optimizes heat transfer and temperature uniformity.

Features and Benefits

Small, lightweight, robust heater construction

- Replaces multiple components in a system
- Reduces overall system size
- Lowers total cost of ownership

Patented circuit patterning process

- Facilitates customizable heating profiles
- Enables distributed wattage and/or multiple zones
- Assures precise and repeatable power distribution

High watt density, low mass heater

- Contributes to fast response time
- Allows for efficient heat transfer
- Enables on-demand process start-up



Typical Applications

- Hemodialysis fluid heating
- Food cooking equipment
- Semiconductor purge and carrier gas heating
- Ink preheating systems
- On-demand fluid heating

**For detailed product and technical data,
see the full FLUENT in-line product
section located on pages 445 through 448.**

