# Self-operated Temperature Regulators

# Temperature Regulator Type 9

**Balanced three-way valve**

## Application

Temperature regulator with either mixing or diverting valve
For heating or cooling installations
**Set point values** from **15 °F** to **480 °F** (–10 °C to +250 °C)
**Sizes** ½"to **6"** (15 to 150 mm)
**Pressure ratings ANSI Class 150** and **300**
**Temperatures** up to **660 °F** (350 °C)

The regulators consist of a balanced three-way valve and a control thermostat, comprising a temperature sensor, a set point adjustment head with an excess temperature safety device, a capillary tube and an operating element.

## Features

- Low-maintenance proportional regulators requiring no auxiliary energy
- Wide set point range and easy adjustment of set point indicated on a dial
- Three-way valves with plug balancing by means of a stainless steel bellows.
- Plug arrangement for mixing or diverting
- Flow rate across the cross-sectional area AB is essentially independent of the position of the valve plug
- Valve body available in cast carbon or stainless steel
- Versions with double adapter and manual adjuster are available for attachment of a temperature limiter or a second thermostat. For details, see Technical Data Sheet T 2036.

## Versions

**Temperature Regulator Type 9** · With Type 2119 Three-way Valve and Type 2231 to 2235 Thermostat.
· Three-way valve optionally with plug arrangement for mixing or flow-diverting service
· The versions in sizes ½" to 1" (15 to 25 mm) are applicable for both mixing and flow-diverting services.
· Sizes ½" to 6" (15 to 150 mm)
· ANSI Class 150 to 300

**Type 2119/2231** (Fig. 1) · With Type 2231 Thermostat
· For liquids
· Set points from15 °F to 300 °F (–10 °C to +150 °C)
· Set point adjustment at the sensor.

**Type 2119/2232** (Fig. 2) · With Type 2232 Thermostat
· For liquids and steam
· Set points from 15 °F to 480 °F (–10 °C to +250 °C
· Separate set point adjustment.

**Type 2119/2233** · With Type 2233 Thermostat
· For liquids, air and other gases
· Set points from15 °F to 300 °F (–10 °C to +150 °C)
· Set point adjustment at the sensor.

**Type 2119/2234** · With Type 2234 Thermostat
· For liquids, air and other gases
· Set points from 15 °F to 480 °F (–10 °C to +250 °C)
· Separate set point adjustment.

**Type 2119/2235** · With Type 2235 Thermostat
· For air-heated storerooms, drying, and curing cabinets
· Set points from 15 °F to 300 °F (–10 °C to +250 °C)
· Separate set point adjustment and user-installed sensor tube.

Fig. 1 · Type 9 Temperature Regulator with Type 2231 Thermostat

Fig. 2 · Type 9 Temperature Regulator with Type 2232 Thermostat, version with separate set point adjustment

For details on the application of the thermostats, see Information Sheet T 2010.

**Special versions, accessories and combinations**
– see page 2

For **DIN version** see Technical Data Sheet T 2033 E.

**Principle of operation** (Figs. 3 and 4)

The regulators operate according to the liquid expansion principle. The temperature sensor (11), capillary tube (8) and operating element (7) are filled with an expansion liquid. The temperature-dependent change in volume of this liquid causes the operating element to move and as a result also moves the stem (5) and plug (3) of the control valve.

The position of the plug determines the flow rate of the heat transfer medium across the free area between the seat (2) and plug.

The set point is adjustable with a key (9) to a value which can be read from the dial (10).

The pressure at port B acts through a hole in the plug stem (5) onto the outer surface of the balancing bellows (4.1), whereas the pressure at port A acts onto the inner bellows area. In this way, the forces acting on the valve plugs (3) are equalized.

In mixing valves in sizes ½" to 4" (15 to 100 mm) according to Fig. 3 with plug arrangement I, the process media to be mixed flows through the valve ports A and B. The combined stream leaves at common port AB. The rate of flow from valve ports A or B to common valve port AB depends on the free area of flow between the seats (2) and the valve plugs (3), and in this way, on the position of the plug stem (5). When the temperature rises, port A opens and port B closes.

In flow-diverting valves, by contrast, the process medium flows through common valve port AB, and the partial streams leave at valve ports A or B. The rate of flow from AB to A or B depends on the position of the plug stem.

The flow-diverting valves in sizes ½" to 1" (15 to 25 mm) are supplied with plug arrangement I as shown in Fig. 3. In this case, port A opens and port B closes also in flow-diverting services when the temperature at the sensor rises.

Plug arrangement II (Fig. 4) is only used in 1½" to 4" (32 to 100 mm) flow-diverting valves. In these valves, port A closes and port B opens when the temperature rises.

**Special versions**

- Longer capillary tube: 16, 32 or 50 ft (5, 10 or 15 m)
- Sensor and/or capillary tube of stainless steel
- Capillary tube armored or plastic-coated
- Reduced $C_v$ ($K_{vs}$) values
- Version with reversing device with travel adjuster (for adjustment of minimum flow rate)

**Accessories and combinations**

- **Extension piece** for temperatures above **430 °F** (220 °C) (see Pressure-Temperature Diagram).
- **Distance piece** for the stainless steel version and for preventing medium leakage when the thermostat is removed. In versions for thermal oil, an FKM sealing ring is required.
- **Thermowells with threaded connection or flange** for Type 2231 and 2232 thermostats
- **Thermowell with perforated case and clamp** for Type 2233 and 2234 thermostats
- **Double adaptor (Do)** or **Manual adjuster (Ma)** for details see Technical Data Sheet T 2036
- **Safety Temperature Monitor (STM)** Type 2213 for details see Technical Data Sheet T 2043
- **Safety Temperature Limiter (STL)** Type 2212 for details see Technical Data Sheet T 2046

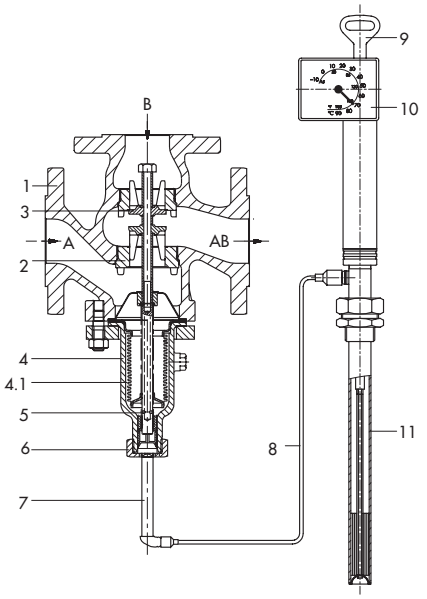



Fig. 3 · Type 9 Temperature Regulator with Type 2231Thermostat and three-way valve with plug arrangement I, arrows indicate mixing service

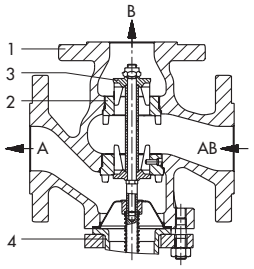



Fig. 4 · Three-way valve with plug arrangement II, arrows indicate flow-diverting service

**Three-way valve**

1 Valve body
2 Seat (exchangeable)
3 Plug
4 Bellows housing
4.1 Balancing bellows
5 Plug stem with spring
6 Nipple with coupling nut

**Control thermostat**

7 Operating element
8 Capillary tube
9 Key for set point adjustment
10 Set point dial
11 Temperature sensor (bulb sensor)

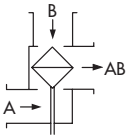
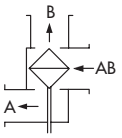
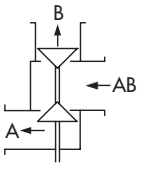
| Plug arrangement I for mixing service Size ½" to 6" | Plug arrangement I for diverting service Size ½" to 1" | Plug arrangement II for diverting service only Size 1½" to 6" |
|---|---|---|
|  |  |  |
| Port B closes and port A opens when the temperature rises | Port B closes and port A opens when the temperature rises | Port A closes and port B opens when the temperature rises |

**Table 1a · Technical data** · All pressures in psi (gauge). The permissible pressures and differential pressures specified are limited by the data given in the Pressure-Temperature Diagram and the pressure ratings (according to ANSI B16.34).

| **Type 2119 Three-way Valve** Pressure rating | | ANSI 150 to ANSI 300 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $C_V$ values and maximum perm. differential pressures $\Delta p$[1] | | | | | | | | | | |
| Nominal size | in | ½" | ¾" | 1" | 1½" | 2" | 2½" | 3" | 4" | 6" |
| Mixing valve | $C_V$ value | 5 | 7.5 | 9.5 | 23 | 37 | 60 | 95 | 145 | 234 |
| For p in B > p in A | $\Delta p$ (psi) | 362 | | | 232 | | 145 | | | 116 |
| For p in A > p in B | $\Delta p$ (psi) | 58 | | | 51 | | 43 | | | 29 |
| Flow-diverting valve | $C_V$ value | 5 | 7.5 | 9.5 | 20 | 31 | 47 | 75 | 120 | 190 |
| | $\Delta p$ (psi) | 58 | | | 51 | | 43 | | | 29 |
| Terms for valve sizing according to IEC 534 parts 2-1 and 2-2, and ISA S75.01and S75.02 | | $F_L$ = 0.95, $X_T$ = 0.75 | | | | | | | | |
| Permissible valve temperature | | See Pressure-Temperature Diagram | | | | | | | | |

| **Type 2231 to Type 2235 Thermostats** | | Size 150 |
|---|---|---|
| Set point range (set point span, each 180 °F) | | 15 to 195 °F<br>70 to 250 °F<br>120 to 300 °F<br>For Types 2232, 2234, 2235<br>210 to 390 °F<br>300 to 480 °F |
| Permissible ambient temperature at the set point adjuster | | –40 to 150 °F |
| Permissible temperature at the sensor | | 180 °F above the adjusted set point |
| Permissible pressure at the sensor | Types 2231/2232 | Without thermowell: Class 300<br>With thermowell: Class 300 (version of copper: Class 125) or Class 600<br>With thermowell with flange: Size 1½" Class 300 or 600 |
| | Types 2233/2234 | Without thermowell: Class 300<br>With flange: Class 300/Size 1½" |
| Length of capillary tube | | 10 ft<br>(special version: 16, 33 or 50 ft) |

[1] For liquids, the differential pressure equals the pressure head of the pump

**Table 2a · Dimensions in inches and weights in lb** (L, H2, H1, H, T in reference to the figures found on page 6.)

| **Type 2119 Three-way Valve** Size | | ½" | ¾" | 1" | 1½" | 2" | 2½" | 3" | 4" | 6" |
|---|---|---|---|---|---|---|---|---|---|---|
| Length L | Class 150 | 7.25 | 7.25 | 7.25 | 8.75 | 10.00 | 10.88 | 11.75 | 13.88 | 17.75 |
| | Class 300 | 7.50 | 7.63 | 7.75 | 9.25 | 10.50 | 11.50 | 12.50 | 14.50 | 18.62 |
| H2 | Class 150 | 3.62 | 3.62 | 3.62 | 4.37 | 5.00 | 5.43 | 5.87 | 6.93 | 8.88 |
| | Class 300 | 3.75 | 3.81 | 3.87 | | | 5.75 | 6.25 | 7.25 | 9.31 |
| H1 | Up to 430 °F (without extension piece) | 11.2 | | | 11.0 | | 12.8 | | 15.6 | 23.2 |
| | Up to 660 °F (with extension piece) | 16.7 | | | 16.5 | | 18.3 | | 21.1 | 28.7 |
| H | Up to 430 °F (without extension piece) | 22.6 | | | 22.4 | | 24.2 | | 27.0 | 34.6 |
| | Up to 660 °F (with extension piece) | 28.1 | | | 28.0 | | 29.7 | | 32.5 | 40.2 |
| Weight, approx. | lb | 15 | 18 | 22 | 43 | 48 | 81 | 127 | 180 | |

| **Thermostat** Type | **2231** | **2232** | **2233** | **2234** | **2235** |
|---|---|---|---|---|---|
| Immersion depth T inch | 11.4 | 9.25 | 16.9 | 18.1 | 136 |
| Weight, approx. lb | 7 | 9 | 7.5 | 8.2 | 8 |

**Arrangement of 3-way temperature regulators - for heating service**

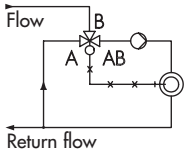
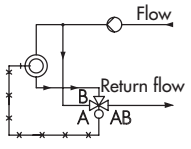
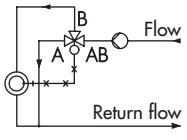
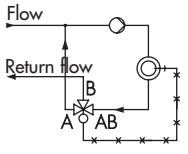
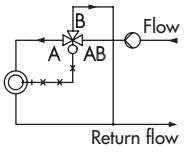
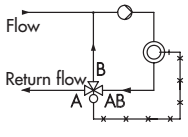
| With mixing valve - plug arrangement I | | With flow-diverting valve - plug arrangement I | | With flow-diverting valve - plug arrangement II | |
|---|---|---|---|---|---|
| in the flow pipe | in the return pipe | in the flow pipe | in the return pipe | in the flow pipe | in the return pipe |
|  |  |  |  |  |  |

**Table 1b · Technical data** · All **pressures in bar** (gauge). The permissible pressures and differential pressures specified are limited by the data given in the Pressure-Temperature Diagram and the pressure ratings (according to ANSI B16.34).

| **Type 2119 Three-way Valve** Pressure rating | | ANSI 150 to ANSI 300 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $K_{VS}$ values and maximum perm. differential pressures $\Delta p$[1] | | | | | | | | | | |
| Nominal size | in | ½" | ¾" | 1" | 1½" | 2" | 2½" | 3" | 4" | 6" |
| Mixing valve | $K_{VS}$ value | 4 | 6.3 | 8 | 20 | 32 | 50 | 80 | 125 | 200 |
| For p in B > p in A | $\Delta p$ | 25 | | | 16 | | 10 | | | 8 |
| For p in A > p in B | $\Delta p$ | 4 | | | 3.5 | | 3 | | | |
| Flow-diverting valve | $K_{VS}$ | 4 | 6.3 | 8 | 16 | 26 | 40 | 64 | 100 | 160 |
| | $\Delta p$ | 4 | | | 3.5 | | 3 | | | |
| Terms for valve sizing according to IEC 534 parts 2-1 and 2-2, ISA S75.01and S75.02 | | $F_L$ = 0.95, $X_T$ = 0.75 | | | | | | | | |
| Permissible valve temperature | | See Pressure-Temperature Diagram | | | | | | | | |

| **Type 2231 to Type 2235 Thermostats** | | Size 150 |
|---|---|---|
| Set point range (set point span, each 100 °C) | | −10 to 90 °C<br>20 to 120 °C<br>50 to 150 °C<br>For Types 2232, 2234, 2235<br>100 to 200 °C<br>150 to 250 °C |
| Permissible ambient temperature at the set point adjuster | | −40 to 80 °C |
| Permissible temperature at the sensor | | 100 °C above the adjusted set point |
| Permissible pressure at the sensor | Types 2231/2232 | Without thermowell: Class 300<br>With thermowell: Class 300 (version of copper: Class 125) or Class 600<br>With thermowell with flange: Size 1½" Class 300 or 600 |
| | Types 2233/2234 | Without thermowell: Class 300<br>With flange: Class 300/Size 1½" |
| Length of capillary tube | | 3 m<br>(special version: 5, 10 or 15 m) |

[1] For liquids, the differential pressure equals the pressure head of the pump

**Table 2b · Dimensions in mm and weights in kg** (L, H2, H1, H, T in reference to the figures found on page 6.)

| **Type 2119 Three-way Valve** | | Size | ½" | ¾" | 1" | 1½" | 2" | 2½" | 3" | 4" | 6" |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Length L | Class 150 | mm | 184 | 184 | 184 | 222 | 254 | 276 | 298 | 352 | 451 |
| | Class 300 | mm | 191 | 194 | 197 | 235 | 267 | 292 | 318 | 368 | 473 |
| H2 | Class 150 | mm | 92 | 92 | 92 | 111 | 127 | 138 | 149 | 176 | 225.5 |
| | Class 300 | mm | 95 | 97 | 98.5 | | | 146 | 159 | 184 | 236.5 |
| H1 | Up to 220 °C (without extension piece) | mm | 285 | | | 325 | | 325 | | 395 | 590 |
| | Up to 350 °C (with extension piece) | mm | 425 | | | 465 | | 465 | | 535 | 730 |
| H | Up to 220 °C (without extension piece) | mm | 575 | | | 615 | | 615 | | 685 | 880 |
| | Up to 350 °C (with extension piece) | mm | 715 | | | 755 | | 755 | | 825 | 1020 |
| Weight, approx. | | lb | 6.9 | 8 | 9.8 | 19.5 | 22 | 37 | 58 | 82 | |

| **Thermostat** | Type | 2231 | 2232 | 2233 | 2234 | 2235 |
|---|---|---|---|---|---|---|
| Immersion depth T | mm | 290 | 235 | 430 | 460 | 3460 |
| Weight, approx. | kg | 3.2 | 4.0 | 3.4 | 3.7 | 3.6 |

**Arrangement of 3-way temperature regulators - for cooling service**

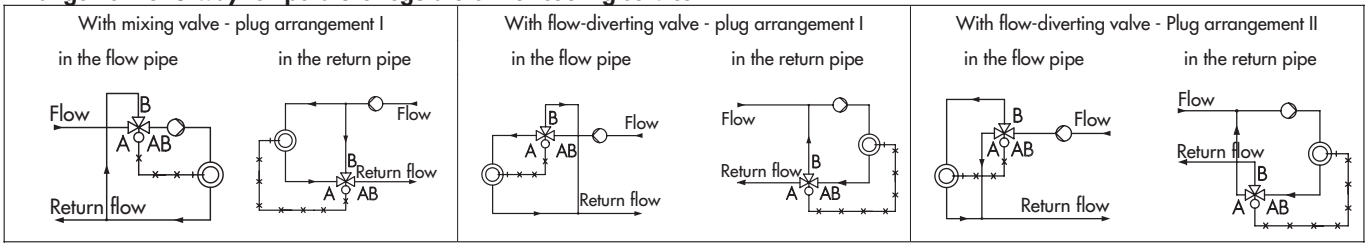


**Table 3 · Materials**

| **Type 2119 Three-way Valve** | | | | |
|---|---|---|---|---|
| Connection | ½" to 6" (15 to 150 mm) | | ½" to 4" (15 to 100 mm) | |
| Nominal pressure | ANSI Class 150 or 300 | | | |
| Body[1] | Carbon steel ASTM A 216 WCB | | Stainless steel ASTM A 351 CF8M | |
| Seat and plug | Stainless steel AISI 410 (AISI 304 for Size 6") | Stainless steel WN 1.4006 (WN 1.4301 for Size 6") | Stainless steel AISI 316 Ti | Stainless steeL WN 1.4571 |
| Plug stem/spring | Stainless steel AISI 304/AISI 301 | | Stainless steel WN 1.4301/WN 1.4310 | |
| Balancing bellows | Stainless steel AISI 316 Ti | | Stainless steel WN 1.4571 | |
| Bellows housing | Carbon steel ASTM A 106 Gr. A | Carbon steel St 35.8 (WN 1.0305) | Stainless steel AISI 316 Ti | Stainless steel WN 1.4571 |
| Body gasket | Graphite on metal core | | | |
| Extension piece/distance piece | Brass (special version: stainless steel AISI 304) | Brass (special version: stainless steel WN 1.4301) | Stainless steel AISI 304 | Stainless steel WN 1.4301 |

| **Types 2231, 2232, 2233, 2234 and 2235 Thermostat** | | | | |
|---|---|---|---|---|
| | Standard version | Special version | | |
| Operating element | Brass, nickel-plated | | | |
| Sensor Types 2231/2 | Bronze, nickel-plated | – | Stainless steel AISI 316 Ti WN 1.4571 | |
| Sensor Types 2233/4 | Copper, nickel-plated | | | |
| Sensor Type 2235 | Copper | | | |
| Capillary tube | Copper, nickel-plated | Copper, plastic-coated | | |
| **Thermowell** with threaded connection | | | | |
| Immersion tube | Bronze, nickel-plated | Copper | AISI 316 Ti | WN 1.4571 |
| Threaded nipple | Brass, nickel-plated | Copper | AISI 316 Ti | WN 1.4571 |
| ... **with flange** | | | | |
| Immersion tube | Steel | Plastic-coated or PTFE [2] | AISI 316 Ti | WN 1.4571 |
| Flange | Steel | | AISI 316 Ti | WN 1.4571 |

[1] Body of cast iron available in DIN version (see Technical Data Sheet T 2033 E. Mating flanges also available from SAMSON upon request.
[2] Plastic coating - for temperatures up to 175 °F (80 °C) - · PVC or PPH coating, PTFE version · Immersion tube: PTFE · Flange: Steel with PTFE bushing

## Installation

Only compatible materials should be combined, for example thermowells of stainless steel should be installed into heat exchangers of stainless steel.

• **Valve**
The valves are to be installed in horizontal pipelines. The valve bonnet, including the operating element of the thermostat, should be oriented vertically downward. This promotes concentric guiding and prevents influence of temperature from the pipeline on the operating element. The direction of medium flow through the valve must coincide with the arrow on the body.

• **Capillary tube**
The capillary tube must be laid in such a way that it is not exposed to large temperature fluctuations and cannot be damaged. The smallest permissible bending radius is 2″ (50 mm).

• **Temperature sensor**
The temperature sensor may be installed in any desired position. Its whole length must be immersed in the medium to be controlled. It should be installed in a location where overheating or considerable idle times cannot occur.

• **Temperature setpoint indicator**
The setpoint of the thermostat is adjusted in the field according to a separate temperature indicator provided by the customer. Once set, the needle of the thermostat dial is calibrated to match. With ambient temperatures below 32 °F (0 °C), the setpoint indicator should be located such that it is protected from precipitation or other moisture.

**Pressure – Temperature Diagram**

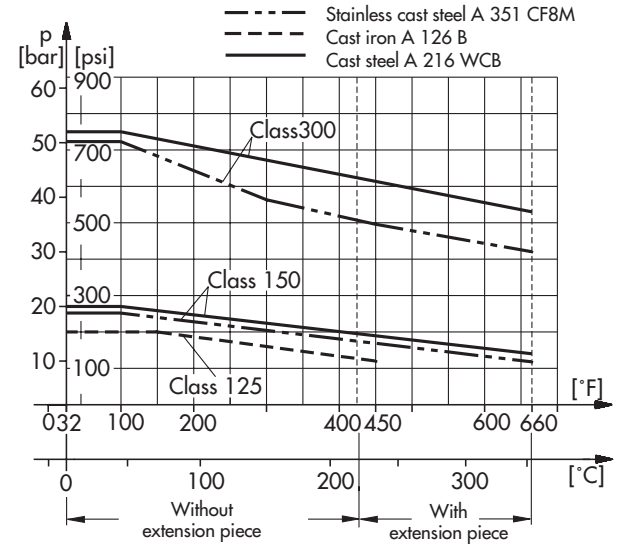
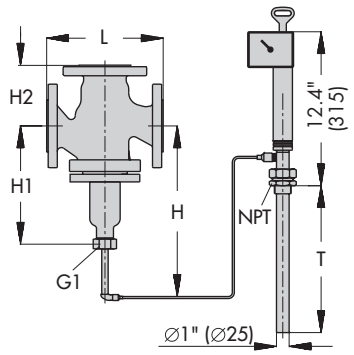



Fig. 5 · Pressure-Temperature Diagram

## Maximum operating pressure

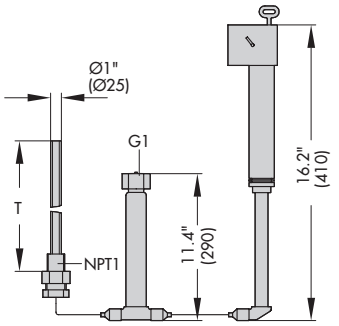
Maximum operating pressures must be within the limits stated in the applicable ANSI standard but Δp must not exceed the maximum permissible differential pressure specified in Table 1 "Technical data".

**Type 2119**



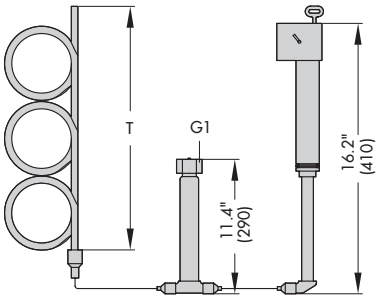

**Types 2231/2233**

**Types 2232/2234**




With separate set point adjustment

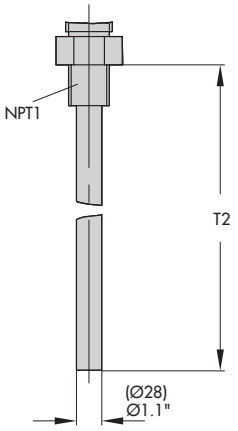
**Type 2235**



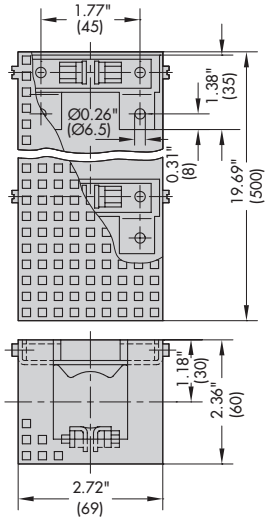

With separate set point adjustment

**Thermowells for Types 2231/2232**

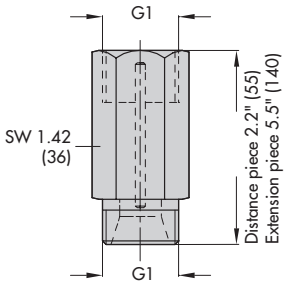
| Thermostat | Type | 2231 | 2232 |
|---|---|---|---|
| Imm. depth T | in | 12.8 | 10 |
| | mm | 325 | 250 |




**Clamps and perforated cover for wall mounting**




**Distance piece**
Weight approx. 0.44 lb (0.2 kg)
**Extension piece**
Weight approx. 1.1 lb (0.5 kg)




When a distance piece is used, the overall heights are: H1 + 2.17″ (55 mm) and H + 2.17″ (55 mm).

For an extension piece these are: H1 + 5.51″ (140 mm) and H + 5.51″ (140 mm).

Fig. 6 · Dimensions in inches; dimensions in parentheses () in mm

**Ordering text**

Temperature Regulator **Type 9**/....,
Size ..., ANSI Class ...
Mixing or flow-diverting valve, Body material ...
With Thermostat Type ..., Set point range...**°F (°C)**,
Length of capillary tube ...ft (m)
Optional special version ..., accessories ...

Specifications subject to change without notice.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