

3 RESISTANCE THERMOMETER BULBS

Each metallic substance has its own temperature/resistance relationship and, therefore, a material which covers the required measuring range can be definitely selected. The most popular resistance thermometer bulbs are as follows.

- (1) Platinum resistance bulbs
- (2) Nickel resistance bulbs

There also are semiconductor resistance thermometer bulbs, such as thermistor resistance bulbs.

Platinum resistance bulbs are advantageous in that platinum is available in high purity, is easy to be machined, and provides a high accuracy. Nickel resistance bulbs are advantageous in that nickel is more economical, has a larger temperature coefficient and therefore a higher sensitivity as compared with platinum. Advantages of thermistor resistance bulbs are that they have large temperature coefficients and are available in small sizes. Types of thermistor thermometers are as follows:

- (1) Element interchangeable type thermistor resistance bulbs
- (2) Compound-resistance type thermistor resistance bulbs
- (3) Ratio type thermistor resistance bulbs

Element interchangeable type of thermistor resistance bulbs are such that they are interchangeable among themselves without requiring interchange compensation resistors. Compound-resistance type thermistor resistance bulbs are such that they require compensation resistors for interchange. The ratio type thermistor resistance bulbs are such that each bulb circuit consists of a thermistor and a resistor network at a certain ratio and is used as a 3-terminal measuring circuit.

Table 22 Nominal resistances (JIS C 1604-1974)

| Type | Symbol | Nominal resistance(Ω) |
|--------------------------|----------|--------------------------------|
| Platinum resistance bulb | Pt 50 | 50 |
| | Pt 100 | 100 |
| Nickel resistance bulb | Ni 508.4 | 508.4 |

Table 23 Applicable temperature ranges (JIS C 1604-1974)

| Type | Classification | Applicable temperature range |
|--------------------------|-------------------------|------------------------------|
| Platinum resistance bulb | Low temperature type | -200 to +100 °C |
| | Medium temperature type | 0 to 350 °C |
| | High temperature type | 0 to 500 °C |
| Nickel resistance bulb | — | - 50 to +150 °C |

Table 24 Dimensions (JIS C 1604-1974)

| Types | Dimensions (mm) | |
|--------------------------|--------------------------------------|-----------------------------|
| | Length | Outer diameter |
| Platinum resistance bulb | 250, 300, 350, 400 500, 750, 1000 | 32, 48, 6, 8, 10, 12, 15 |
| Nickel resistance bulb | 300, 350, 400, 450 650, 10150 | 10, 17 |

Table 25 Tolerances (JIS C 1604-1974)

| Types | Measuring temperature range | Class | Tolerance |
|--------------------------|-----------------------------|-------|--------------------------------------|
| Platinum resistance bulb | -200 °C to +100 °C | 0.15 | ± 0.15 °C |
| | | 0.3 | ± 0.3 °C |
| | | 0.5 | ± 0.5 °C |
| | +100 °C or over to +500 °C | 0.15 | ± 0.15 % of measured temperature |
| | | 0.3 | ± 0.3 % of measured temperature |
| | | 0.5 | ± 0.5 % of measured temperature |
| Nickel resistance bulb | -50 °C to +150 °C | — | ± 0.3 °C |

Ni

Table 28

Nickel Resistance Thermometer Bulbs Temperature/Resistance Conversion Chart

(IPTS-68)

| Temp. °C | Resistance Value | | | | | | | | | | Ω | $\Omega/1^\circ\text{C}$ | |
|-------------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----------|--------------------------|--|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | | |
| -50 | 398.84 | | | | | | | | | | | | |
| -40 | 419.81 | 417.70 | 415.59 | 413.48 | 411.38 | 409.28 | 407.18 | 405.09 | 403.00 | 400.92 | 2.10 | | |
| -30 | 441.21 | 439.05 | 436.89 | 434.74 | 432.59 | 430.45 | 428.32 | 426.18 | 424.06 | 421.93 | 2.14 | | |
| -20 | 463.07 | 460.86 | 458.66 | 456.46 | 454.27 | 452.08 | 449.89 | 447.71 | 445.54 | 443.37 | 2.18 | | |
| -10 | 485.46 | 483.19 | 480.94 | 478.69 | 476.44 | 474.20 | 471.96 | 469.73 | 467.51 | 465.29 | 2.24 | | |
| 0 | 508.40 | 506.08 | 503.77 | 501.46 | 499.16 | 496.86 | 494.57 | 492.28 | 490.00 | 487.73 | 2.29 | | |
| 0 | 508.40 | 510.73 | 513.06 | 515.39 | 517.74 | 520.08 | 522.44 | 524.80 | 527.16 | 529.54 | 2.35 | | |
| 10 | 531.92 | 534.30 | 536.69 | 539.08 | 541.48 | 543.89 | 546.30 | 548.72 | 551.15 | 553.58 | 2.41 | | |
| 20 | 556.02 | 558.46 | 560.91 | 563.37 | 565.82 | 568.29 | 570.77 | 573.25 | 575.73 | 578.22 | 2.47 | | |
| 30 | 580.72 | 583.23 | 585.74 | 588.25 | 590.77 | 593.30 | 595.84 | 598.38 | 600.92 | 603.48 | 2.53 | | |
| 40 | 606.04 | 608.60 | 611.17 | 613.75 | 616.34 | 618.93 | 621.52 | 624.13 | 626.74 | 629.35 | 2.60 | | |
| 50 | 631.97 | 634.60 | 637.23 | 639.87 | 642.52 | 645.17 | 647.83 | 650.50 | 653.17 | 655.85 | 2.66 | | |
| 60 | 658.53 | 661.22 | 663.92 | 666.62 | 669.33 | 672.05 | 674.77 | 677.50 | 680.24 | 682.98 | 2.72 | | |
| 70 | 685.73 | 688.48 | 691.24 | 694.01 | 696.79 | 699.57 | 702.35 | 705.15 | 707.95 | 710.76 | 2.79 | | |
| 80 | 713.57 | 716.39 | 719.22 | 722.05 | 724.89 | 727.74 | 730.59 | 733.45 | 736.32 | 739.19 | 2.85 | | |
| 90 | 742.07 | 744.96 | 747.85 | 750.75 | 753.66 | 756.54 | 759.49 | 762.42 | 765.36 | 768.30 | 2.92 | | |
| 100 | 771.25 | 774.20 | 777.17 | 780.14 | 783.11 | 786.10 | 789.09 | 792.09 | 795.09 | 798.11 | 2.99 | | |
| 110 | 801.12 | 804.15 | 807.18 | 810.22 | 813.27 | 816.33 | 819.39 | 822.46 | 825.54 | 828.62 | 3.06 | | |
| 120 | 831.72 | 834.82 | 837.92 | 841.04 | 844.16 | 847.29 | 850.43 | 853.58 | 856.73 | 859.89 | 3.14 | | |
| 130 | 863.06 | 866.24 | 869.42 | 872.61 | 875.81 | 879.02 | 882.24 | 885.46 | 888.69 | 891.93 | 3.22 | | |
| 140 | 895.18 | 898.44 | 901.70 | 904.97 | 908.25 | 911.54 | 914.84 | 918.14 | 921.46 | 924.78 | 3.30 | | |
| 150 | 928.11 | | | | | | | | | | | | |