

Class B Rtd

A practical guide to class b rtd, covering the reader intent, the relationship to class b rtd, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In the landscape of industrial process control, temperature measurement is as fundamental as pressure or flow. Among the various technologies available, the Resistance Temperature Detector (RTD) is favored for its stability, repeatability, and accuracy. Within the hierarchy of RTD specifications, the Class B RTD stands as the most widely utilized standard across global industries. It represents the baseline for precision in most commercial and industrial applications, balancing cost-effectiveness with reliable performance.

Understanding the nuances of a class b rtd requires an exploration of its construction, the international standards that govern its accuracy, and the practical implications of its tolerance bands in real-world engineering environments. Whether integrated into a complex level measurement system or used for ambient monitoring, the Class B designation provides a predictable framework for thermal data acquisition.

| Measurement Principles of RTDs

The operation of an RTD is based on the physical property of metals to change their electrical resistance in response to temperature changes. This relationship is known as the temperature coefficient of resistance (TCR). As the temperature of the metal increases, the thermal agitation of the atoms increases, which in turn increases the resistance to electron flow.

| The Platinum Standard

While various metals like nickel and copper can be used, platinum is the preferred material for high-precision industrial RTDs. Platinum offers a highly linear resistance-to-temperature relationship, is chemically inert, and maintains stability over a wide temperature range. The most common configuration is the Pt100 sensor, which has a nominal resistance of 100 ohms at 0°C (32°F). Pt1000 sensors, which have a resistance of 1000 ohms at 0°C, are also prevalent in applications where lead-wire resistance needs to be minimized.

| The Alpha Coefficient

The standardized relationship for platinum RTDs is defined by the "alpha" coefficient (α), which represents the average change in resistance per ohm per degree Celsius over the range of 0°C to 100°C. The most common standard, IEC 60751, defines the alpha coefficient as 0.003851 $\Omega/\Omega/^\circ\text{C}$. A class b rtd follows this curve within a specific tolerance band defined by the standard.

| Understanding RTD Accuracy Classes

Accuracy in RTDs is categorized into "classes" based on the allowable deviation from the ideal resistance-temperature curve. These classes are defined by international standards, primarily IEC 60751 (and its regional equivalents like DIN EN 60751).

The four primary classes for platinum RTDs are:

1. Class AA (formerly 1/3 DIN): The highest standard accuracy, used for laboratory and critical process measurements.
2. Class A: High accuracy for precise industrial control.
3. Class B: The standard industrial grade, suitable for the vast majority of process applications.
4. Class C: A lower-precision grade used for non-critical monitoring.

For many engineers, the class b rtd is the default choice because it meets the requirements of most industrial processes without the higher cost associated with Class A or AA sensors. When selecting instruments for level measurement or process monitoring, reviewing the Main Page of a manufacturer's catalog often reveals that Class B is the standard offering for integrated temperature compensation.

Technical Specifications of Class B RTDs

The tolerance of a class b rtd is not a fixed value across its entire operating range. Instead, it is expressed as a formula that accounts for the increasing uncertainty at higher and lower temperatures.

The Tolerance Formula

According to IEC 60751, the tolerance (Δt) for a Class B sensor is calculated as:

$$\Delta t = \pm(0.30 + 0.005 |t|)$$

In this formula, $|t|$ is the absolute value of the temperature in degrees Celsius. This means that at 0°C, the allowable error is $\pm 0.30^\circ\text{C}$. At 100°C, the error expands to $\pm 0.80^\circ\text{C}$, and at 500°C, it reaches $\pm 2.80^\circ\text{C}$.

Temperature vs. Tolerance Table

The following table illustrates the permissible deviation for a class b rtd at various temperature points, compared to the more stringent Class A.

Temperature (°C)	Class B Tolerance ($\pm^\circ\text{C}$)	Class A Tolerance ($\pm^\circ\text{C}$)
-200	1.30	Not Defined (usually Class B only)
-100	0.80	0.35
0	0.30	0.15
100	0.80	0.35
200	1.30	0.55
400	2.30	0.95
600	3.30	Not Defined (usually Class B only)

| Selection Criteria: When to Choose Class B

Choosing between a class b rtd and a Class A sensor depends on several factors related to the specific process requirements, budget, and the capabilities of the measurement system.

| 1. Required Process Precision

If the process requires control within $\pm 1^{\circ}\text{C}$, a Class B sensor is usually sufficient for temperatures up to 140°C . However, if the control window is tighter (e.g., $\pm 0.5^{\circ}\text{C}$), a Class A sensor or a calibrated Class B sensor might be necessary. In many level measurement applications, such as hydrostatic level sensing, the RTD is used for density compensation. Since density changes relatively slowly with small temperature fluctuations, the accuracy of a Class B sensor is typically more than adequate.

| 2. Operating Temperature Range

Class B sensors have a wider standardized operating range than Class A. While Class A is typically defined from -100°C to $+450^{\circ}\text{C}$, Class B sensors are often rated from -196°C to $+600^{\circ}\text{C}$ (depending on whether they are thin-film or wire-wound). For extreme cryogenic or high-heat applications, Class B is often the only standardized option available.

| 3. Cost Considerations

Class B RTDs are significantly more economical to produce. The manufacturing yields for Class B elements are higher, and they require less stringent testing during the quality control phase. For large-scale installations with hundreds of measurement points, the cost savings of using Class B over Class A can be substantial.

| 4. System Integration

It is important to remember that the RTD is only one part of the measurement loop. The transmitter, lead wires, and PLC input cards all contribute to the total system uncertainty. If the transmitter has an accuracy of $\pm 0.2^{\circ}\text{C}$, using a Class A sensor ($\pm 0.15^{\circ}\text{C}$ at 0°C) provides a marginal benefit over a Class B sensor if the overall process tolerance is wide.

| Installation Considerations for Class B RTDs

Proper installation is critical to ensuring that a class b rtd performs within its specified tolerance. Even the best sensor will provide inaccurate data if installed incorrectly.

| Wiring Configurations

RTDs are available in 2-wire, 3-wire, and 4-wire configurations. Because the sensor measures resistance, the resistance of the lead wires can introduce significant errors.

2-Wire: Not recommended for Class B sensors unless the lead wires are very short, as the wire resistance adds directly to the sensor resistance, creating a positive temperature offset.

3-Wire: The most common industrial configuration. It uses a third wire to compensate for lead-wire resistance, assuming all three wires have the same resistance.

4-Wire: The most accurate method, completely eliminating the effect of lead-wire resistance. While often paired with Class A or AA sensors, it can be used with Class B sensors in long-distance runs to maintain the integrity of the Class B tolerance.

| Immersion Depth

To avoid stem conduction errors (where heat travels along the sensor sheath to the ambient environment), the sensor must be immersed deeply enough into the process. A general rule of thumb is an immersion depth of at least 10 times the diameter of the protection tube or thermowell.

| Thermowells and Response Time

In high-pressure or corrosive environments, the RTD is typically housed in a thermowell. While this protects the sensor, it increases the response time. Using a thermal transfer compound between the sensor tip and the thermowell wall can help mitigate this lag. For level measurement applications where temperature changes are gradual, response time is rarely a critical factor.

| Limitations of Class B RTDs

While versatile, the class b rtd has limitations that engineers must consider:

Vibration Sensitivity: Thin-film RTDs, which are common in Class B, are generally robust, but extreme vibration can cause mechanical failure of the lead connections. In such cases, specialized vibration-resistant constructions are required.

Self-Heating: The excitation current used to measure the resistance generates a small amount of heat within the sensor. If the current is too high (typically $>1\text{mA}$), the sensor will report a temperature slightly higher than the actual process temperature.

Interchangeability: While Class B sensors are interchangeable within their tolerance band, replacing a Class B sensor with one from a different manufacturer might result in a slight shift in readings if their manufacturing tolerances sit at opposite ends of the Class B spectrum.

| Application in Level Measurement Systems

In the context of industrial level measurement, temperature data is frequently used to improve the accuracy of level readings.

1. **Hydrostatic Level:** The pressure exerted by a liquid column depends on its density, which is temperature-dependent. A class b rtd integrated into the pressure transmitter allows the system to calculate the correct level regardless of temperature-induced density changes.
2. **Radar and Ultrasonic Level:** While radar is largely unaffected by temperature, the speed of sound used in ultrasonic measurement varies significantly with air temperature. An RTD provides the necessary data for the transmitter to correct the distance calculation.
3. **Tank Gauging:** In large storage tanks, average temperature measurements (often using multiple Class B sensors at different heights) are required to calculate the standard volume of the inventory.

For engineers looking to specify these integrated systems, the Main Page of specialized instrument providers offers a comprehensive overview of how temperature and level technologies are combined for high-accuracy industrial automation.

| Frequently Asked Questions (FAQ)

Q: Can a Class B RTD be calibrated to meet Class A accuracy?

A: A Class B sensor can be calibrated to determine its specific offset and curve, which allows the PLC or transmitter to "tune out" the error. However, it does not technically become a Class A sensor, as its long-term stability and drift characteristics may still follow Class B standards.

Q: Is Pt100 or Pt1000 better for Class B applications?

A: Pt100 is the industry standard and is compatible with the widest range of equipment. Pt1000 is better for battery-powered applications (due to lower current requirements) or 2-wire configurations where lead-wire resistance is a concern.

Q: How often should a Class B RTD be recalibrated?

A: In stable, non-extreme environments, RTDs are known for their longevity. Annual calibration is standard for most ISO-regulated industries, though many Class B sensors remain stable for several years without significant drift.

| Conclusion

The class b rtd remains the workhorse of industrial temperature measurement. By providing a well-defined balance of accuracy and durability, it serves as a reliable component in everything from simple monitoring loops to complex, multi-variable level measurement systems. Understanding its tolerance limits and installation requirements ensures that process engineers can maintain control and safety across a wide range of industrial applications.