RTD Tolerance Classes Technical Brief

Today's tolerance classes grew out of the practical need to be able to install and replace probes and have them work the same from probe to probe, plug-and-play, so to speak. Think *Interchangeability*.

RTD standards - SAMA, GOST, OIML, JEMIMA, BS, JIS, DIN, ASTM, IEC - most of these specs have identical class names, but not always identical tolerance values! Not to worry - all you need to know is right here.

The first thing is to understand the meaning of the percentage values often used to differentiate tolerance classes. First off, the percentage statement is only a shorthand label. It originated for grouping the platinum resistors into tolerance classes, much in the same way common electronics resistors are grouped by 20%, 10%, 5%, etc. This provides quick identification and comparison at the resistor component level. Well, over time this nomenclature carried over into the classification of industrial RTD probes for choosing the tolerance class of the probe.

These percentage ratings understandably cause confusion: "Class B is .12% and Class A is .06%, so at 100°C class B will vary at the most ± 0.12°C and Class A ± 0.06°C the most, Right?" Answer: "Not even remotely!" The actual values are ± 0.80° and ± 0.35°, respectively (in a moment, we'll show how to get the right values in a snap).

"Where's that come from?" Answer: These requirements (originally applying to the platinum 100Ω resistor as a component) ensured that something labeled Class B would have a max variation of ± .12% in base *resistance value* (*at 0°C only*), Class A ditto, but .06%. But when translated into a *temperature* variation, it becomes ± .3°C! "Why?" Answer: at 0°C ± .12%Ω translates into ± .3°C and ± .06% Ω delivers ± .15°C (again, *only* at 0°C mind you).

One more thing on the percentage ratings. They are still commonly referred to because they have been around, so it seems, forever. Even now, when we hear "Class B" we automatically think ".12%". We hear "Class A", and we immediately envision ".06%". But actually the current specs no longer use percentage statements. (More of this in a moment.)

So to recap, the percentage figures are shorthand to differentiate the tolerance classes, not to give a percentage tolerance of temperature over a range.

Now, how to get correct temperature tolerance values in a snap.

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Here are the current international tolerance classes for RTD thermometers (the three relevant to our industry):

IEC 60751 ed. 2.0 (IEC 60751:2008) specifies these classes for industrial RTD probes:

Class:	Interchangeability:	Temperature Range Tolerance Applies To:
AA	± (0.1 + 0.0017*| t |)	-100/150°C (32/302°F)
A	± (0.15 + 0.002*| t |)	-100/300°C (-22/572°F)
B	± (0.3 + 0.005*| t |)	-196/500°C (-58/932°F)

To calculate the allowable ± for a temperature, simply add-up the two values found in the parentheses for that temperature. The symbol **| t |** means absolute temperature, i.e., ignore the + or – sign (but do make sure to stay within the negative temperature limit shown). Example: for both 100°C or - 100°C, class AA tolerance is 0.1 for the fixed value and .17 (.0017*100) for the multiplied value. Add the two and you get the max deviation of ± 0.27°C.

To further illustrate, here are some temperatures with the corresponding max ± at those temperatures:

Temperature °C	AA ±	A ±	B ±
-190	1.25	1.25	1.25
-100	.27	.35	.80
- 50	.19	.25	.55
0	.10	.15	.30
50	.19	.25	.55
100	.27	.35	.80
200	.44	.55	1.30
300	1.80	.75	1.80
500	2.80	2.80	2.80

Note that the AA and A classes default to class B tolerance outside their temperature range limit (tolerance-wise only, this is not an operating range limitation) for their classes.

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Class B is the standard that's used for most industrial applications. Class A is often used in sanitary processes, and is the standard for our Sanitary RTD product line.

But there is a trend for still higher accuracies than these. Indicators and transmitters have become more sophisticated. The need for more critical temperature control increases as products and production processes grow in complexity and effectiveness.

The Class AA option is available, but rarely requested, likely due to not being much tighter than the class A.

The most accurate commercially available class is called 1/10 B (often carrying the older reference of .01%). The interchangeability typically tightens in practice to .2°C but only within an abbreviated temperature range, such as 0/50 °C. It is not named specifically in the current spec. But the spec refers to special tolerances recommended to be a fraction of class B and requires that the manufacturer state the temperature range to which stated tolerance applies.

One more method though exists, that delivers the highest accuracy, which we offer as the option "**AC**", standing for "High Accuracy" option.

It works by leaving behind class designations, which apply to the general groups of RTD sensors, and focuses only on an individual sensor on its own (not it being part of a bigger group).

By performing an intensive calibration with high-end metrology level equipment on an individual probe, its unique curve can be found, and be characterized by a few "constants" that belong to that probe only. Yes, every RTD has a unique personality all its own!
The IEC spec we started out with gives the three "constants" that all industrial RTDs must fall within for the tolerance classes to work. You don't need to know them because they are programmed into every transmitter, indicator, meter, etc., to provide the plug-and-play interchangeability we've discussed. You can trust the temperature reading your getting because the device and the probe have everything under the hood - no gyrations on your part.

Let's illustrate using cars on a super highway. All industrial class B RTDs will be on the correct 8-lane highway, switching lanes seamlessly all along the way. You can't know which lane, just that it's on the right highway at all times. The tighter classes travel this same highway, but shrink the route to stay within inner 7 lanes or 5, according to the various classes, because the standard constants keep them on track. Again, you don't know which lanes, but that it will stay in the inner 7 or 5 that apply to its class.

But if you do the high accuracy calibration to find the individual curve of that particular RTD, your transmitter, indicator, etc., can track where your sensor is on the super highway down the very lane its in, during the entire ride!

How? By finding the constants which only that RTD possesses, and plugging them into your transmitter, etc., your transmitter now will tell you right where your RTD is at any given moment. Many devices have the option to replace the default constants with the constants of your RTD in their setup utility. With the **"AC"** option, we provide you with a certificate giving the constants, along with the reference temperatures and measured resistances. We can even provide an in-head transmitter with your probe's individual constants already plugged into it! And this high accuracy holds good from all the way down to the liquid nitrogen temperature of -195.798°C all the way up to the freezing point of zinc - 419.527°C! It doesn't get any better than that!

If you need the best accuracy available from your RTD, this is the way to go.