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Fast is Fine, But Accuracy is Everything

- Wyatt Earp

Extremely Accurate Temperature Measurement is possible through the use of suitably calibrated sensors and instrumentation. The accuracy of these measurements, however, won't mean anything unless the sensors and equipment are used correctly.

Thermocouple accuracy can be defined as the amount of error that exists in its temperature measurement. It demonstrates how close the value of the measured temperature of a given thermocouple is compared to the true temperature value. This is called the error or tolerance. The table "Initial Calibration Tolerances" (Fig. 1) shows us what accuracy or tolerance we can expect from a particular thermocouple.

Thermocouple accuracy is affected by several factors including the *Type* of thermocouple, the *Process* used to manufacture the thermocouple, the *Range* of the thermocouple, the *Purity* of the material used to make the thermocouple, *Corrosion*, *Degradation of the Junction*, and *Electrical Noise* in the system. Thermocouples are typically available in two tolerances; Standard Limits of Error and Special Limits of Error. In the United States, the standard that most commonly controls accuracy is ASTM E230.

Thermocouple Type	°C			°F		
ANSI Symbol	Temperature Range	Standard Limits	Special Limits	Temperature Range	Standard Limits	Special Limits
T	-200 to -65 -65 to 130 130 to 350	±1.5% ±1° ±0.75%	±0.8% ±0.5° ±0.4%	-330 to -85 -85 to 270 270 to 660	±1.5% ±1.8° ±0.75%	±0.8% ±0.9° ±0.4%
J	0 to 285 285 to 750	±2.2° ±0.75%	±1.1° ±0.4%	32 to 545 545 to 1400	±4° ±0.75%	±2° ±0.4%
E	-200 to -170 -170 to 250 250 to 340 340 to 900	±1% ±1.7° ±1.7° ±0.5%	±1° ±1° ±0.4% ±0.4%	-330 to -270 -270 to 480 480 to 640 640 to 1600	±1% ±3° ±3° ±0.5%	±1.8° ±1.8° ±0.4% ±0.4%
K	-200 to -110 -110 to 0 0 to 285 285 to 1250	±2% ±2.2° ±2.2° ±0.75%	-- -- ±1.1° ±0.4%	-330 to -165 -165 to 32 32 to 545 545 to 2300	±2% ±4° ±4° ±0.75%	-- -- ±2° ±0.4%
N	0 to 285 285 to 1250	±2.2° ±0.75%	±1.1° ±0.4%	32 to 545 545 to 2300	±4° ±0.75%	±2° ±0.4%
S	0 to 600 600 to 1450	±1.5° ±0.25%	±0.6° ±0.1%	32 to 1110 1110 to 2650	±2.7° ±0.25%	±1.1° ±0.1%
R	0 to 600 600 to 1450	±1.5° ±0.25%	±0.6° ±0.1%	32 to 1110 1110 to 2650	±2.7° ±0.25%	±1.1° ±0.1%
B	870 to 1700	±0.5%	±0.25%	1600 to 3100	±0.5%	±0.25%
C*	400 to 2300	±1%	--	800 to 4200	±1%	--

**Not an ANSI Symbol*

Fig.1

Tables like these are typically provided by thermocouple manufacturers. Tolerances determined from these tables are valid for:

(a) The specified type of thermocouple listed in the table
(b) The specified temperature range listed in the table

As can be seen in the table above, thermocouples with special limits of error tolerances have higher accuracy than thermocouples with standard limits of error tolerances. Applications where accuracy is one of the critical factors would typically use special limits of error thermocouples. The table above is easy to use. To determine the initial accuracy of a thermocouple, you ascertain the greater of the two tolerances given. Note: Standard and Special tolerances for thermocouples are determined using the same method.

Example: a Type 'K' thermocouples is heated to 800ºF. What is the standard tolerance at this temperature? We can see from the table above that it is +/- 0.4%. To calculate the thermocouple accuracy, simply multiply the tolerance by the temperature. 0.4% x 800 = 3.2ºF. Therefore, at 800ºF, the accuracy of the type 'K' thermocouple is +/-3.2ºF.

The word "Calibration" implies that a thermocouple can somehow be modified if it does not have a sufficient accuracy, or that re-calibration can correct an error. This is a myth. Calibration of a thermocouple permits the user to know the exact error at a given temperature (within the limits of uncertainty measurement). Calibration can be done at any temperature, but for true accuracy it is always best practice to specify a smaller range of temperatures, especially if the temperature at which it will be used is a known constant. For example, if the temperature range in which it is being used is limited to 500ºF, then you should calibrate the material at this temperature. This will show you the error of the thermocouple at this temperature. Modern instruments typically allow you to enter an offset to compensate for the error in the sensor. This allows you to increase the accuracy and repeatability of your process.

Computer scientist and naval rear admiral Grace Hopper once said "One accurate measurement is worth a thousand expert opinions." Author & entrepreneur Jim Rohn once said, "Accuracy builds credibility." Duro-Sense uses Special Limits of Error, low drift, tight tolerance, and high accuracy materials exclusively in all of our products. Our proven track record and reputation for outstanding accuracy puts us at the forefront of precision temperature measurement.

Duro-Sense Corporation –Premium Quality. Guaranteed.

When you're ready to learn more about how Duro-Sense can help you solve your unique temperature sensing challenges and discover how much time, energy, and money we can save you,

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