**JMS SOUTHEAST, INCORPORATED**

Temperature Measurement www.jms-se.com

# JMS Southeast Recommendations for care and handling of laboratory thermometers.

JMS Southeast manufactures several types of reference thermometers that can be used to comparison calibrate any type of contact temperature sensor. These also may be used to establish the temperature of a black body for infrared temperature sensors. The following is a document intended to define and to help the user understand the validation, calibration, use, care and maintenance of these devices. These sensors are located in section 4 of the JMS catalog and comprehensive information is available on-line. A catalog page is included in this document. These are all defined in ASTM E220.

The following 5 are the most commonly used thermometers in a calibration laboratory.

1. SPRT:

Standard platinum resistance thermometers (SPRT's) are the most accurate reference thermometer and are used in defining the ITS 90 (International Temperature Scale) from approximately -259 to 962 degrees C. The SPRT sensing element (resistor) is made from pure platinum and supported essentially strain free. Because of the delicate construction, the SPRT s easily damaged by mechanical shock (plus other causes) and must be handled carefully to retain its calibration. FYI, no single SPRT covers the entire range stated above.

2. Secondary Standard PRT:

Certain industrial platinum resistance thermometers are specifically manufactured and subjected to special heat treatment and calibration to establish their measurement uncertainty. These thermometers contain sensing element (resistor) constructions that are not as easily affected by handling as SPRT's. However, they also typically have higher measurement uncertainties and more narrow usage ranges than SPRT's. Testing of industrial resistance thermometers is described in Test Methods ASTM E644.

3. Precision Industrial RTD

This is a ruggedized version of a secondary standard PRT

4. Reference Grade Thermocouple

ASTM 644 (6.4.3) states:
Thermocouples listed in Tables E-230 and Guide E1751 that have been calibrated on the ITS 90 may also be used as reference thermometers. Nobel metal thermocouples are the most commonly used due to their stability and large usable temperature range. JMS manufactures and stocks Platinum vs. Gold Thermocouples for this application.

5. Pristine Thermocouple/RTD

This sensor is made from same batch of materials (must be Lot calibrated) as all the sensors on a particular order so that validation of (no) drift may be performed. A "Lot" calibration is the calibration of ends of a batch of thermocouple material as specified in IEC 61515 and AMS 2750-D). Primarily used for heat treating and type TTT wire thermocouples although any industry can use any thermocouple for the same purpose.

All these comparison probes serve a specific purpose and have their own particular and care procedures. The following table contains JMS Southeast's recommendations.

| | SPRT | Secondary Standard | Precision Ind. RTD | Ref Grade Thermocouple | Pristine Thermocouple |
|---|---|---|---|---|---|
| Shipping | A | A | A | A | A |
| Storage | B | B | B | B | B |
| Usage | C | C | C | C | C |
| Cleaning | D, E | Wipe, E | Wipe, E | D, E | Wipe, E |
| Validation | F | F, G | F, G | F | F |
| Calibration | Call JMS | Call JMS | Call JMS | Call JMS | Call JMS |

A. Care in handling is a must to insure the sensor integrity. Do not Drop.

Thermometers are carefully packed at the factory. Inspect the package for indications of shipping damage. If shipping damage is noticed report it immediately to the shipping company and make the necessary reports. JMS Sensors ship on an FOB factory basis. It is your responsibility to file any claims. Hidden shipping damage can occur (no evident sign of mishandling). If after carefully opening the package, damage is discovered, save all product, shipping material and take pictures of any visible anomalies. Notify and file the proper claims with the shipping company immediately.

B. Store in a stable, clean, dry place at room (25 C) temperature. Avoid areas where stacking or dropping might occur. SPRT's should be stored in the same position with which they are used (horizontal / vertical) in the case they came in. We further recommend that PRT's and ungrounded thermocouples be stored in a sealed bag with a desiccant.
C. Avoid direct flame. If multiple temperatures are to be taken, start at the highest temperature and work down. Avoid thermal shock when possible. Do not twist the wires, do not bend and do not pull by using the wires. Check with JMS of you are unsure about the correct immersion depth for your thermometer. Never subject the handles to high temperatures.
D. Clean with alcohol or acetone after each use. Be sure to remove fingerprints or any grease from quartz tubes.
E. Regularly scheduled maintenance procedures should include inspection and calibration/validation intervals so that life and reliability of the device is improved and the likelihood of sudden failure is reduced. These procedures should be set up by the responsible engineering department and performed by personnel who are familiar with the operating principles upon which the system is based.

F. Validate the sensor periodically* by immersion into a known thermostat (Triple point of water or other fixed point, ice bath, oil bath, calibration furnace) to determine if any errors or biases in reading are present. Use a temperature that is close to the temperature where the probe under test is normally used. If the reading is more than half the uncertainty of the specified tolerance of the probe at that temperature, it might be time to consider a new probe. (We always suggest you keep a spare if your calibrations are critical to your processes) If the thermometer exhibits a bias, it may be possible to anneal the thermometer to recover the correct output at temperature. Consult JMS for this service.

G. Megohm test according to ASTM standard RTD testing procedures. If thermometer fails megohm test, buy a new one. (At room temperature use 10 to 50 VDC. Passing grade is 100 megohms.)

*this period should not be more than 6 months if the thermometer is used regularly. Some laboratories maintain a usage log to determine the validation/calibration interval. This is an acceptable practice. Temperatures, dwell time and frequency are critical in establishing these intervals.

Hints:
Your readings in the lab can be significantly different from your readings in the process and still, both readings can be correct.
In the course of having to calibrate a thermocouple or RTD in an industrial process there are a few factors that may impact the readings that occur in the laboratory vs. what the readings are in the actual process.

1. The heat sink (heat flux, stem loss error, heat wicking) from the tip of the sensor to the cold end can be a significant factor in validation of any particular reading of thermocouples and RTD's. We strongly recommend that the user remove the sensor from the well in the process and insert a comparison probe of the same diameter and material as the process probe to ascertain the reading in the actual process. There is no way to consistently and accurately eliminate or duplicate these stem loss errors in a standards laboratory. This insitu test should be acceptable for an in house validation of the temperature sensor if all other quality objectives are met.
2. A thermocouple has a unique type of measurement. Many books have been written about the subject and they are still writing them. (See Practical Thermocouple Thermometry Johnson - Kerlin ISA Press 2012) The primary issue is how thermocouples de-calibrate over time. It is accepted that this change in output is due primarily of the material changing its physical properties differently along the length of the wires. This is referred to as inhomogeneity. There is no ASTM, IEC or NIST standard test to quantitatively measure this phenomena. This is a good reason to never assume that a furnace or oil bath test of a used thermocouple will give you any results that are realistic. These errors are more obvious at higher temperatures. JMS almost always recommends that the user do the insitu test of accuracy in the

process where all the thermal conditions of the process exist. A lab test can work for you, but in reality an out of the process calibration it is a way for the auditor to audit.

3. An RTD is manufactured with a resistor that can vary in length inside the tube. They are sized from 1/16" long to as much as 2" long. This size is left up to the manufacturer of the thermometer. The user has no real way to visually determine the size used. You can imagine that if you are using one to check the other, there is potential for error. This is a good reason to keep a pristine probe from the same batch on hand in order to consistently validate the readings.
4. An RTD resistor is joined to copper wire somewhere near the back side of the resistor inside the tube. These solder or weld joints between the Platinum wire on the resistor (sometimes Palladium or Nickel) and the copper wire extending to the cold side of the probe might be at different distances from the end of the resistor. Because of space constrictions these joints may not be side by side. If there is a temperature gradient between the two (or four) wires along the length or diameter of the probe where these joints are located, thermoelectric errors will be a part of the reading. This phenomenon is not nearly as significant as the three conditions listed above.

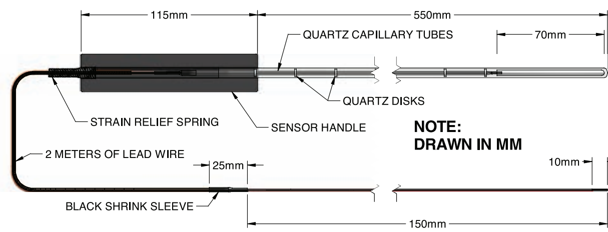
Frank L Johnson 12/7/15

# LABORATORY THERMOMETERS

## STANDARD PLATINUM RESISTANCE THERMOMETERS

The first and most accurate of the laboratory probes is the SPRT. It has the tightest specifications and is also the most fragile and expensive. Typical drift rates are about 0.001°K annually or about 0.002°C after 100 hours at 660°C.

The SPRT allows the user to realize ITS 90. Our most common unit is the 4ZP model which allows the realization from the boiling point of nitrogen (-195.798°C) to the zinc freezing point (419.527°C). The JMS 4AP unit allows the user to realize ITS 90 from 0°C to the freezing point of aluminum (660.323°C).




(Dimensions are in MM)

* Calibration report will document the exact numbers along with the TPW/MPG ratios. ** The "C" in the part number indicates we will provide calibration. If you intend to send the probe to NIST or some other lab for calibration certificate, omit the "C"

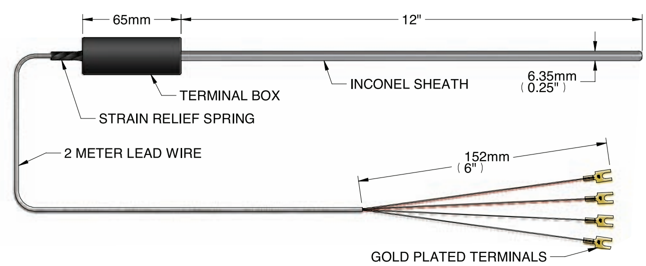
Note: ITS 90 says that an SPRT should have a resistance at melting point of gallium greater than 1.11807 times its water triple point resistance. That means that you should not use an RTD with a 0.00385 alpha coefficient as an SPRT. However the experience of JMS Southeast indicates that they are great as secondary standards and are described on the following pages.

## SECONDARY STANDARD RTDS

These sensors are intended to be used as the standard for a working laboratory. For instance, JMS uses these types of probes as the reference for our day to day comparison calibrations done on the sensors you use in your processes. We use the SPRT mentioned on the previous page to calibrate and validate this secondary standard.

The secondary standard covers the full range from -200°C to 660°C. It is only slightly more drift prone than the SPRT. (<0.003°C per year or <0.005°C after 500 hours @ 600°C (estimated)) It is much more rugged than the SPRT it has an Inconel 600 sheath, which might not break if dropped on a laboratory floor.

* Indicates a standard calibration will be done using 5 points between -200°C and 600°C. Omit "C" if sent to another lab for calibration

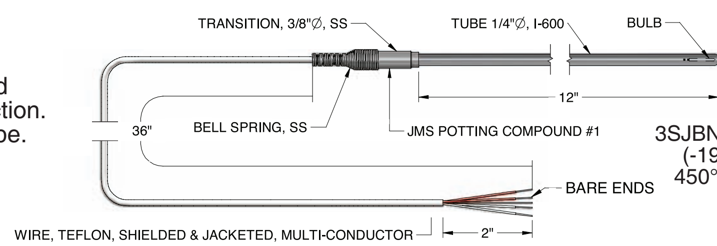



It can be manufactured to any length using the following part numbers:

| | |
|---|---|
| 4SS (length in inches) | 25.5°C*(25.5Ω@0°C) |
| 4SS (length in inches) | 100°C* (100Ω@0°C) |

## PRECISION INDUSTRIAL RTD

Our Precision Industrial RTD can be specified by using the pages from the regular RTD section. They can be made in almost any size or shape.



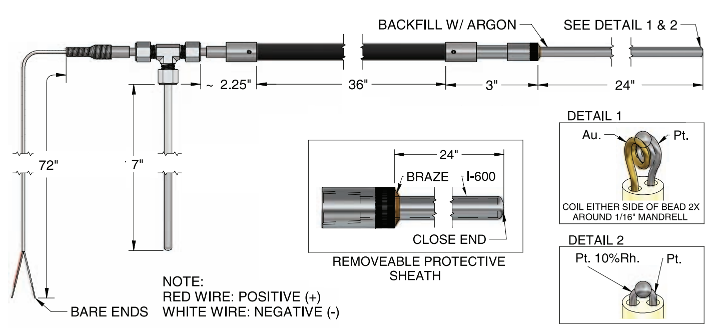

3SJBNM12DZZ336JWTA6
(-196°C, 0°C, 200°C, 450°C @1°C intervals)

## JMS STANDARDS THERMOCOUPLE

IPTS 68 allowed the use of type S thermocouples as a method to realize the temperatures above the range of an RTD. ITS 90 does not speak to the use of thermocouples, but they are recognized by many labs as a secondary standard and are great for comparison calibrations. ASTM and NIST still and will continue to recognize the use of Pt/Au and Pt/PtRh in laboratories, and NIST has defined the millivolt tables (Seebeck Coefficients) which are included in section 1 of this catalog. These tables are taken from ASTM E-1751 and ASTM E-230. Use the appropriate drawing number to order.

These two referenced sensors are an excellent choice for comparing calibration equations in an industrial facility. An accurate and traceable millivolt meter plus one of these probes is all you need to do a totally accurate and effective standards traceable calibration. Order by JMS Part#

| JMS Part #4PTAUC* | JMS Part #4PTRHC* |
|---|---|
| Pt/Au | Pt/PtRh |
| 0 - 1000°C | 0 - 1450°C |
| Non alloyed metals | Higher range |
| Calibration close to standard | |
| ±0.2°C or better | ±1.0°C or better |




REMOVABLE INCONEL 600 PROTECTIVE SHEATH

* A calibration is supplied with any probe. For no calibration, omit the C in the part #. See [1-22] through [1-53] for temperature / EMF Tables.