Quartz-Sheath SPRTs

- Drift rates as low as 0.0005 K
- Proprietary gas mixture ensures high stability
- Most experienced SPRT design team in the business

Choosing the right platinum thermometer as your primary standard may be the most critical purchase decision in your lab. Unfortunately, other manufacturers are pretty secretive about how their SPRTs are made. They won't tell you much more than you can already see by looking at one. Many of the leaders of a few decades ago have lost their original craftsmen and design scientists. Hart Scientific has one of only a few active SPRT design groups in the world today.

So how do you know you're making the best purchase? Self-proclaimed expertise shouldn't convince you. You should expect some sound evidence that the company is qualified in the ongoing science of SPRT development. At Hart, we'll tell you how we make an SPRT. We'll let you talk to the people here who design, build, and calibrate SPRTs. Finally, when you buy one, if you don't like it, we'll take it back and return your money.

Hart has four quartz-sheath SPRTs, covering the ITS-90 range of –200 °C to 1070 °C. The 5681 is used from –200 °C to the aluminum point at 660.323 °C. The 5683 is used from –200 °C to 480 °C with greater long term stability. The 5684 and the 5685 cover higher temperatures up to 1070 °C and can be calibrated at the silver point.

Yes, they have all the features you would expect in a world-class SPRT. They have gold-plated spade lugs, a strain-relieved four-wire cable, convection prevention disks, the finest quartz glass available, delustered stems, and the purest platinum wire available.

The purity of a thermometer's platinum wire is critical to meeting ITS-90 requirements. Platinum resistance is measured by the resistance ratio "W" at specified ITS-90 fixed points. Maintaining that purity over the life of the thermometer impacts long-term stability. The quartz glass tube of the SPRT should be properly sealed to prevent contamination of the platinum wire. Others use mechanical assemblies and epoxy seals. These introduce additional materials to the thermometer's internal environment and can be prone to mechanical failure, risking exposure of the platinum to impurities.

Theoretically, the best seal would be a direct seal between the quartz glass and the platinum wire. However, the quartz glass used in thermometer sheaths has a very small coefficient of expansion while platinum has a much larger coefficient of expansion. If you simply sealed the sheath's glass to the platinum wire, these different rates of expansion would result in a poor seal as the assembly is exposed to changing temperatures.

We've figured out a way to match the expansion coefficients of the glass sheath and the platinum wires. We do it by creating a graduating seal that's made of 18 separate pieces of glass, each with a different coefficient of expansion. The expansion and contraction rate of the innermost piece of glass matches that of the platinum, resulting in an overall seal that prevents gas leakage and impurity penetration for at least 20 years.

Fusing each piece of glass to the next is a painstaking process. Sure it costs us extra, but the results are worth it!

There's more!

We use only pure quartz glass materials for the cross frames, disks, and tubes. We don't use mica or ceramic materials. Additionally, we have a special glass-treating process to increase the resistance of the quartz to devitrification and remove more impurities than the typical cleaning process.

We've done some research to find the best-performing balance of argon to oxygen in the tube. Some oxygen in the sheath is necessary to minimize the danger of the platinum being poisoned by foreign metals at high temperatures, but too much oxygen at temperatures below 500 °C accelerates the oxidation process affecting the integrity of the platinum. We've got a balance that provides exactly the right protection for the platinum.

Each of these seemingly small things adds up to better uncertainties and less drift.

5681: –200 °C to 670 °C

This 25-ohm thermometer is the workhorse of the ITS-90 ranges. It can be calibrated for any of the subranges from the triple point of argon to the freezing point of aluminum. The 5681 meets the ITS-90 requirements for resistance ratios as follows:

$W(302.9146\ K) \geq 1.11807$
and
$W(234.3156\ K) \leq 0.844235$

5683: –200 °C to 480 °C

While SPRTs traditionally cover temperatures to the aluminum point (660 °C), most measurements occur between –100 °C and 420 °C. The 5683 SPRT covers this range and more, from –200 °C to 480 °C, and does so with long-term stabilities that extended range SPRTs can't match. Typical drift is less than 0.5 mK after 100 hours at 480 °C.

Quartz-Sheath SPRTs

Specifications	5681	5683	5684	5685
Temperature Range	–200 °C to 670 °C	–200 °C to 480 °C	0 °C to 1070 °C	0 °C to 1070 °C
Nominal R_{TPW}	25.5Ω		0.25Ω	2.5Ω
Current	1 mA		10 mA	3 or 5 mA
Resistance Ratio	W(302.9146 K) ≥ 1.11807 and W(234.3156 K) ≤ 0.844235		W(302.9146 K) ≥ 1.11807 and W(1234.93 K) ≥ 4.2844	
Sensitivity	0.1Ω/ °C		0.001Ω/ °C	0.01Ω/ °C
Drift Rate	< 0.002 °C/100 hours at 661 °C (typically < 0.001 °C)	< 0.001 °C/100 hours at 480 °C (0.0005 °C typical)	< 0.003 °C/100 hours at 1070 °C (typically < 0.001 °C)	
Self-heating at TPW	< 0.002 °C under 1 mA current		< 0.002 °C under 10 mA current	< 0.002 °C under 3 mA current
Reproducibility	±0.001 °C or better	±0.00075 °C or better	±0.0015 °C or better	
R_{TPW} drift after Thermal Cycling	< 0.00075 °C	< 0.0005 °C	< 0.001 °C	
Sensor Support	Quartz glass cross		Quartz glass strip with notches	Quartz glass cross
Diameter of Sensor Pt Wire	0.07 mm (0.003 in)		0.4 mm (0.016 in)	0.2 mm (0.008 in)
Protective Sheath	Quartz glass, Diameter: 7 mm (0.28 in), Length: 520 mm (20.5 in)		Quartz glass, Diameter: 7 mm (0.28 in), Length: 680 mm (26.8 in)	

5684 and 5685: 0 °C to 1070 °C

ITS-90 extended the use of the platinum thermometer from 630 °C to 962 °C. The 0.25-ohm HTPRT sensor uses a strip-shaped support made from high-purity quartz glass. The 2.5-ohm model uses a quartz glass cross frame. Stability after thermal cycling is excellent, and the design is reasonably tolerant of vibration. Choose from 0.25-ohm or 2.5-ohm nominal R_{TPW} values. In addition to meeting the resistance ratio requirements shown above, these thermometers meet the following additional criterion:

W(1234.93 K) ≥ 4.2844

After all, this really is about W!

Ordering Information

5681-S SPRT 25.5Ω, 670 °C†

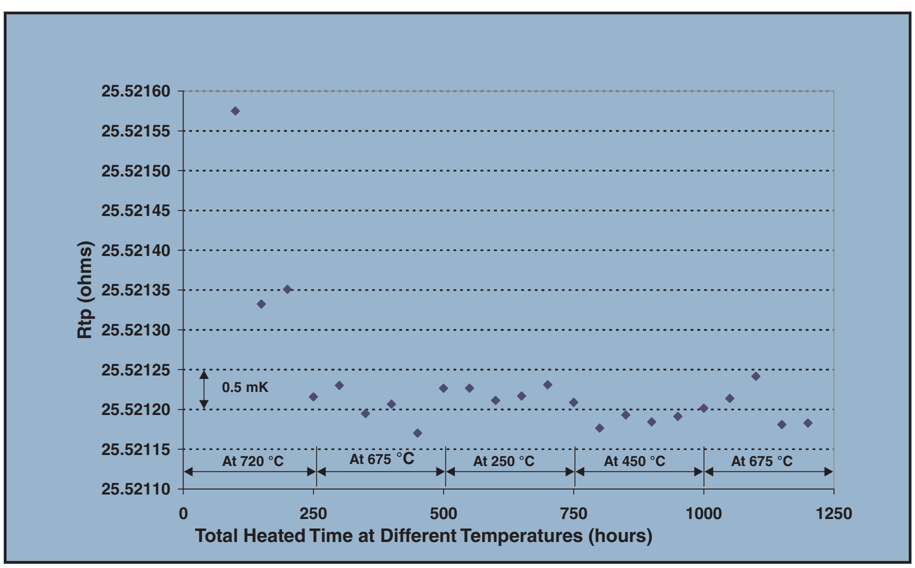
5683-S SPRT 25.5Ω, 480 °C†, Ultrastable

5684-S SPRT 0.25Ω, 1070 °C†

5685-S SPRT 2.5Ω, 1070 °C†

†Maple carrying case included

See page 162 for SPRT calibration options.



A typical stability graph of a 5681 SPRT (#71122). Units are calibrated or shipped to customers after about 250 hours of annealing.

Not all platinum is the same

Platinum resistance thermometers (PRTs) are made from a variety of platinum sensor wire. The differences in the wire affect the thermometers' performance. The two most important variations are purity and thickness.

According to IPTS-68 requirements, platinum purity was measured by its "alpha," or average change of resistance per degree. Alpha 0.00385 was common for industrial thermometers, and alpha 0.003925 was common for SPRTs. ITS-90, in contrast, measures platinum quality with ratios (W) of their resistance at certain fixed points (gallium, mercury, and/or silver) to their resistance at the triple point of water (R_{TPW}). Those meeting the ITS-90-specified ratios are considered SPRT quality.

The thickness of the platinum wire affects its resistance and is indicated by a nominal resistance value at the triple point of water. The thicker the wire, the lower its nominal resistance. 100 ohms at R_{TPW} is common for industrial sensors, and 25 ohms at R_{TPW} is typical for SPRTs.

Which is best for your application? All things equal, lower resistance PRTs are generally more stable because of their thicker sensor wire. However, low-resistance PRTs require higher resolution readout devices to handle the small changes in resistance per degree. The advantages gained by using low-resistance PRTs are not significant in most applications. If they're needed, however, be sure you have the right device to read them. (See Hart readouts on page 36.)