

# CALIBRATION SERVICES

Hart's NVLAP accredited Metrology Laboratory (lab code 200348-0) provides temperature calibrations from approximately  $-200^{\circ}\text{C}$  to  $1100^{\circ}\text{C}$  using fixed-point and comparison methods. Our accredited uncertainties are among the lowest commercially available anywhere in the world. Our prices are very competitive and our turn-around times are excellent. Our reports are comprehensive and include as-found and as-left data as well as pass/fail criteria (where applicable) and a concise statement of the method used. All of the calibrations performed at Hart are traceable to NIST and meet ISO Guide 25 requirements (see page 3).

For fixed-point calibrations, we use Hart fixed-point cells and apparatus, Hart SPRTs as check standards, and conventional DC bridges with DC standard resistors. Our fixed-point calibration procedure is based on accredited procedures, so you can be confident that the technique is correct.

For comparison calibrations, we use Hart baths or furnaces, Hart SPRTs, and Hart readouts. We use several different techniques to minimize uncertainties



When Ron works in the lab, he seems to need 10 of everything.

while maximizing efficiency to keep the costs as low as possible without compromising quality. All Hart-manufactured instruments (except SPRTs and some thermocouples, which come uncalibrated) are certified before they are shipped to you. We don't simply provide a "certificate of conformance" with a

couple of NIST numbers like some other manufacturers and then sock you with a high fee if you require a proper calibration. We are the laboratory of choice for many of our customers because they know that they can depend on us for correct, complete, and on-time calibrations at reasonable prices.

## Hart Scientific Metrology Laboratory Capabilities

Type	Temperature	Accuracy	Technique
SPRT (Fixed Point)	$-197^{\circ}\text{C}$ $-38.834^{\circ}\text{C}$ $0.010^{\circ}\text{C}$ $29.7646^{\circ}\text{C}$ $156.5985^{\circ}\text{C}$ $231.928^{\circ}\text{C}$ $419.527^{\circ}\text{C}$ $660.323^{\circ}\text{C}$ $961.78^{\circ}\text{C}$	$\pm 0.5$ mK $\pm 0.4$ mK $\pm 0.2$ mK $\pm 0.4$ mK $\pm 0.9$ mK $\pm 0.9$ mK $\pm 1.1$ mK $\pm 2.1$ mK $\pm 10.0$ mK	Calibration at TPHg, TPW, MPGa, FPIn, FPSn, FPZn, FPAI, FPAg, and comparison at NBPLN <sub>2</sub> .
Noble Metal Thermocouple (Fixed-Point)	0.00 to $1084.62^{\circ}\text{C}$	$\pm 0.10$ to $0.25^{\circ}\text{C}$ $\pm 0.18$ to $0.45^{\circ}\text{F}$	Calibration at FPSn, FPZn, FPAI, FPAg, and FPCu.
SPRT (Comparison)	$\approx -200$ to $\approx 660^{\circ}\text{C}$	$\pm 2.0$ to $8.0$ mK	Comparison calibration on the ITS-90 to SPRT.
RTD (Comparison)	$\approx -200$ to $\approx 660^{\circ}\text{C}$	$\pm 5.0$ to $10.0$ mK	Comparison calibration on the ITS-90 to SPRT.
Thermistor (Comparison)	$\approx -95$ to $300^{\circ}\text{C}$	$\pm 2.0$ to $10.0$ mK	Comparison calibration on the ITS-90 to SPRT.

**Notes:** The values listed above in the Accuracy column are either the summation of the rated accuracy of the standard(s) used or the expanded uncertainty of the calibration process at a coverage factor,  $k=2$ . The method used will be stated on the Report of Calibration. Not all instruments submitted will be capable of being calibrated over the temperature ranges shown or to the above levels of uncertainty.

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## SPRT Calibration by ITS-90 Fixed Point

All calibrations in this section include the following: (1) calibration at two levels of current and extrapolation to zero power, (2) ITS-90 deviation function coefficients and interpolation tables for the nominal current calibration and the zero-power calibration, and (3) analysis for compliance to ITS-90 criteria for a standard interpolating instrument of the ITS-90.

Order No.	Temperature	ITS-90 Subranges	Fixed Points Used	Price
1910-4	-200°C to 0°C	4	comp at NBPLN <sub>2</sub> , TPHg, TPW	
1910-4-11	-200°C to 30°C	4, 11	comp at NBPLN <sub>2</sub> , TPHg, TPW, MPGa	
1910-4-10	-200°C to 157°C	4, 10	comp at NBPLN <sub>2</sub> , TPHg, TPW, FPIIn	
1910-4-9	-200°C to 232°C	4, 9	comp at NBPLN <sub>2</sub> , TPHg, TPW, FPIIn, FPSn	
1910-4-8	-200°C to 420°C	4, 8	comp at NBPLN <sub>2</sub> , TPHg, TPW, FPSn, FPZn	
1910-4-7	-200°C to 660°C	4, 7	comp at NBPLN <sub>2</sub> , TPHg, TPW, FPSn, FPZn, FPAI	
1910-5-10	-40°C to 157°C	5, 10	TPHg, TPW, MPGa, FPIIn	
1910-5-9	-40°C to 232°C	5, 9	TPHg, TPW, MPGa, FPIIn, FPSn	
1910-5-8	-40°C to 420°C	5, 8	TPHg, TPW, MPGa, FPSn, FPZn	
1910-5-7	-40°C to 660°C	5, 7	TPHg, TPW, MPGa, FPSn, FPZn, FPAI	
1910-11	0°C to 30°C	11	TPW, MPGa	
1910-10	0°C to 157°C	10	TPW, FPIIn	
1910-9	0°C to 232°C	9	TPW, FPIIn, FPSn	
1910-8	0°C to 420°C	8	TPW, FPSn, FPZn	
1910-7	0°C to 660°C	7	TPW, FPSn, FPZn, FPAI	
1910-6	0°C to 962°C	6	TPW, FPSn, FPZn, FPAI, FPAg	

## Noble-Metal Thermocouple Calibration by ITS-90 Fixed Point

All calibrations in this section include the following: (1) ITS-90 polynomial coefficients in accordance with NIST Monograph 175, and (2) bound interpolation table in 1-degree increments in terms of EMF vs. T<sub>90</sub>.

Order No.	Temperature	Fixed Points Used	Price
1918-A	0°C to 1000°C	FPSn, FPZn, FPAI, FPAg (for Au-Pt TCs)	
1918-B	0°C to 1450°C	FPSn, FPZn, FPAI, FPAg (for other noble-metal TCs)	
1918-C	0°C to 1450°C	FPSn, FPZn, FPAI, FPAg, FPCu (for other noble-metal TCs)	

## SPRT Calibration by Comparison

All calibrations in this section include the following: (1) ITS-90 deviation function coefficients for the nominal current calibration, (2) bound interpolation table in 1-degree increments in terms of resistance vs. T<sub>90</sub> for the nominal current calibration, and (3) analysis for compliance to ITS-90 criteria for a standard interpolating instrument of the ITS-90.

Order No.	Temperature	Comparison Points Used	Price
1920-4-9	-200°C to 232°C	-197.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C	
1920-4-8	-200°C to 420°C	-197.0°C, -38.8°C, 0.01°C, 231.9°C, 419.5°C	
1920-4-7	-200°C to 660°C	-197.0°C, -38.8°C, 0.01°C, 231.9°C, 419.5°C, 660.3°C	
1920-D-9	-100°C to 232°C	-100°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C	
1920-D-8	-100°C to 420°C	-100°C, -38.8°C, 0.01°C, 231.9°C, 419.5°C	
1920-D-7	-100°C to 660°C	-100°C, -38.8°C, 0.01°C, 231.9°C, 419.5°C, 660.3°C	
1920-5-9	-40°C to 232°C	-38.8°C, 0.01°C, 156.6°C, 231.9°C	
1920-5-8	-40°C to 420°C	-38.8°C, 0.01°C, 231.9°C, 419.5°C	
1920-10	0°C to 157°C	0.01°C, 156.6°C	
1920-9	0°C to 232°C	0.01°C, 156.6°C, 231.9°C	
1920-8	0°C to 420°C	0.01°C, 231.9°C, 419.5°C	
1920-7	0°C to 660°C	0.01°C, 231.9°C, 419.5°C, 660.3°C	

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## Precision PRT (RTD) Calibration by Comparison

All calibrations in this section include the following: (1) ITS-90 deviation function coefficients for the nominal current calibration, and (2) interpolation table in 1-degree increments in terms of resistance vs.  $T_{90}$ .

Order No.	Temperature	Comparison Points Used	Price
1922-4-9	-200°C to 232°C	-197.0°C, -100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C	
1922-4-N	-200°C to 300°C	-197.0°C, -100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C, 300°C	
1922-4-8	-200°C to 420°C	-197.0°C, -100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C, 419.5°C	
1922-4-7	-200°C to 660°C	-197.0°C, -100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C, 419.5°C, 660.3°C	
1922-D-9	-100°C to 232°C	-100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C	
1922-D-N	-100°C to 300°C	-100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C, 300°C	
1922-D-8	-100°C to 420°C	-100.0°C, -38.8°C, 0.01°C, 156.6°C, 231.9°C, 419.5°C	
1922-5-9	-40°C to 232°C	-38.8°C, 0.01°C, 156.6°C, 231.9°C	
1922-5-N	-40°C to 300°C	-38.8°C, 0.01°C, 156.6°C, 231.9°C, 300°C	
1922-5-8	-40°C to 420°C	-38.8°C, 0.01°C, 156.6°C, 231.9°C, 419.5°C	
1922-10	0°C to 157°C	0.01°C, 100.0°C, 156.6°C	
1922-9	0°C to 232°C	0.01°C, 156.6°C, 231.9°C	
1922-N	0°C to 300°C	0.01°C, 156.6°C, 231.9°C, 300°C	
1922-8	0°C to 420°C	0.01°C, 156.6°C, 231.9°C, 419.5°C	

## Precision Thermistor Calibration by Comparison

All calibrations in this section include the following: (1) polynomial solution with coefficients in Steinhart-Hart or third order, and (2) bound interpolation table in 0.01- or 0.1-degree increments (depending upon span of calibration) in terms of resistance vs.  $T_{90}$ .

Order No.	Temperature	Comparison Points Used	Price
1925-A	100°C span	6 points over span	
1925-B	60°C span	7 points over span	
1925-C	100°C span	11 points over span	
1925-D	10°C span	3 points over span	

## Precision Digital Thermometer Calibration by Comparison

All calibrations in this section include programming of probe coefficients, if applicable, and as-left temperature measurement at the selected points.

Order No.	Temperature(s)	Comparison Points Used	Price per Temperature Point
1929-0	0.01°C	TPW	
1929-2	-200°C to 660°C	Specify minimum of two temperatures (RTD probe)	
1929-5	-50°C to 150°C	Specify minimum of two temperatures (thermistor probe)	
1929-8	0°C to 1100°C	Specify minimum of two temperatures (TC probe)	

\*\$100 per standard temperature (-197°C, -100°C, -38°C, 0.01°C, 156°C, 232°C, 300°C, 420°C, 500°C, 660°C); \$200 for any other temperature.

## Other Calibration Services

All calibrations in this section are traceable to NIST and include certificates compliant with ANSI/NCSS Z540-1 and ISO Guide 25.

Order No.	Calibration	Description	Price
1960	Standard DC Resistor	Any nominal value from 0.1Ω to 10 KΩ	
1904	Thermometric Fixed-Point Cell	Direct comparison with a Hart laboratory cell traceable to NIST; any ITS-90 fixed-point cell from mercury to silver.	
1980	Humidity Sensor (electronic)	One temperature point at 20°C or 30°C and three customer-selected humidity points between 10% RH and 90% RH (additional points \$50 each); includes as-found data, as-left data, and adjustments.	

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## Instrument Calibrations

All calibrations in this section include as-found and as-left data and a comprehensive report of calibration. As-found data can be omitted with a small cost savings.

Model No.	Type of Calibration	Notes	Price
1502/3/4	Resistance		
1506	Resistance		
1521	Resistance		
1522	Resistance		
1529	Resistance and/or Voltage		
1560	Resistance or Voltage	Each module	
1575	Resistance and Ratio		
1590	Resistance and Ratio		
3125	Dry-Block Temperature	50°C, 120°C, 190°C, 260°C, 330°C, 400°C	
6102	Bath Temperature	50°C, 100°C, 150°C, 200°C	
7102	Bath Temperature	-5°C, 25°C, 55°C, 90°C, 121°C	
7103	Bath Temperature	-25°C, 0°C, 25°C, 50°C, 75°C, 100°C, 125°C	
9007	Dry-Block Temperature	-40°C, 0°C, 25°C, 75°C, 140°C (each at 3-inch and 6-inch depth)	
9009	Dry-Block Temperature	Cold Well: -8°C, 0°C, 25°C, 75°C, 100°C, 110°C Hot Well: 50°C, 100°C, 150°C, 200°C, 250°C, 300°C, 350°C	
9023	Dry-Block Temperature	50°C, 100°C, 200°C, 300°C, 400°C, 500°C, 650°C (each at 3-inch and 6-inch depth)	
9100	Dry-Block Temperature	50°C, 100°C, 150°C, 200°C, 250°C, 300°C	
9101	Dry-Block Temperature	0°C	
9102	Dry-Block Temperature	-10°C, 25°C, 50°C, 55°C, 100°C, 122°C	
9103	Dry-Block Temperature	-25°C, 0°C, 25°C, 50°C, 75°C, 100°C, 140°C	
9105	Dry-Block Temperature	-25°C, 0°C, 75°C, 140°C	
9107	Dry-Block Temperature	-40°C, 0°C, 75°C, 140°C	
9113	Dry-Block Temperature	420°C, 1000°C	
9122	Dry-Block Temperature	100°C, 200°C, 300°C, 400°C, 500°C, 600°C	
9123	Dry-Block Temperature	100°C, 200°C, 300°C, 400°C, 500°C, 600°C	
9125	Dry-Block Temperature	40°C, 80°C, 120°C, 160°C, 190°C	
9127	Dry-Block Temperature	100°C, 200°C, 300°C, 400°C, 500°C, 600°C	
9130	Dry-Block Temperature	40°C, 80°C, 120°C, 160°C, 190°C	
9131	Dry-Block Temperature	50°C, 120°C, 190°C, 260°C, 330°C, 400°C	
9135	Dry-Block Temperature	50°C, 100°C, 150°C	
9140	Dry-Block Temperature	50°C, 100°C, 150°C, 200°C, 250°C, 300°C, 350°C	
9141	Dry-Block Temperature	100°C, 200°C, 300°C, 400°C, 500°C, 600°C	
9150	Dry-Block Temperature	150°C, 300°C, 450°C, 600°C, 800°C, 1000°C, 1200°C	
9210	Dry-Block Temperature	-10°C, 0°C, 25°C, 50°C, 75°C, 100°C, 120°C	
9260	Dry-Block Temperature	100°C, 156°C, 232°C, 420°C, 660°C	

Note: Additional points for dry-wells or micro-baths \$75 each.