Thermometers

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HANNA instruments

Part Number	Range	Accuracy	Printing Logging	WP*	Probe included	Special Feature	User Cal	LDC with Backlight	Page
Infrared Thermometers									
HI 99550-00	-10 to 300°C	±2%			N.A.				030
HI 99550-01	14 to 572°F	±2%			N.A.				030
HI 99551-00	-10 to 300°C	±2%			N.A.				031
HI 99551-01	14 to 572°F	±2%			N.A.				031
HI 99551-10	-20.0 to 199.9°C	±2%			N.A.				031
HI 99556-00	-10 to 300°C	±2%			•				031
HI 99556-01	14 to 572°F	±2%			•				031
HI 99556-10	-20.0 to 199.9°C	±2%			•				031
Thermistor Thermometers									
HI 8751	-40.0 to 150.0°C	±0.5% FS			•				014
HI 8752	-58 to 338°F	±0.5% FS			•				014
HI 8753	-40.0 to 150.0°C; -58 to 338°F	±0.5% FS			•				014
HI 9040	-50.0 to 150.0°C; -58.0 to 302.0°F	±0.4°C; ±0.8°F			•	min/max			016
HI 93510	-50.0 to 150.0°C; -58.0 to 302.0°F	±0.4°C; ±0.8°F		•	•	min/max			018
HI 93510N	-50.0 to 150.0°C; -58.0 to 302.0°F	±0.4°C; ±0.8°F		•	•	min/max	•	•	018
HI 93512	-50.0 to 150.0°C; -58.0 to 302.0°F	±0.4°C; ±0.8°F		•	•	min/max and 2 probes			019
HI 93522	-50.0 to 150.0°C; -58.0 to 302.0°F	±0.4°C; ±0.8°F		•	•	min/max and 2 probes	•	•	019
HI 9060	-50.0 to 150.0°C; -58.0 to 302.0°F	±0.4°C; ±0.8°F		•	•	min/max			020
HI 98710	-50.0 to 150.0°C; -55.0 to 300.0°F	±0.4°C; ±0.8°F	Printing		•			•	032
HI 98740	-50.0 to 150.0°C; -55.0 to 300.0°F	±0.4°C; ±0.8°F	Printing			4 probes		•	032
HI 98810	-50.0 to 150.0°C; -55.0 to 300.0°F	±0.4°C; ±0.8°F	Both		•			•	035
HI 98811	-50.0 to 150.0°C; -55.0 to 300.0°F	±0.4°C; ±0.8°F	Both		•	i-Button®		•	036
HI 98840	-50.0 to 150.0°C; -55.0 to 300.0°F	±0.4°C; ±0.8°F	Both			4 probes		•	035
Thermocouple Thermometers									
HI 8757	-50.0 to 1350°C	±0.5% FS							015
HI 8758	58.0 to 2462°F	±0.5% FS							015
HI 9043	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS				min/max			017
HI 9044	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS			•	min/max			017
HI 9063	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS		•		min/max			021
HI 9063C	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS		•		min/max			021
HI 935005	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS		•		min/max			022
HI 935005N	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS		•		min/max	•	•	022
HI 935002	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS		•		min/max and 2 probes			023
HI 935009	-50.0 to 1350°C; -58.0 to 2462°F	±0.2% FS		•		min/max and 2 probes	•	•	023
HI 93530	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•					024
HI 93530N	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•			•	•	024
HI 93531	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max			025
HI 93531N	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max	•	•	025
HI 93531R	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max and RS232	•	•	025
HI 93532	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max and 2 probes			026
HI 93532N	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max and 2 probes	•	•	026
HI 93532R	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max, 2 probes, RS232	•	•	026
HI 93551	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max, KJT			027
HI 93551N	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max, KJT	•		027
HI 93551R	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		RS232, KJT	•	•	027
HI 93542	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max, average, 2 probes, KJT			028
HI 93552	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max, average, 2 probes, KJT	•	•	028
HI 93552R	-200.0 to 1371°C; -328.0 to 2500°F	±0.5°C; ±1°F		•		min/max, average, 2 probes, RS232, KJT	•	•	028
HI 98701	-200.0 to 1370°C; -300.0 to 2500°F	±0.5°C; ±1°F	Printing			KJT		•	033
HI 98704	-200.0 to 1370°C; -300.0 to 2500°F	±0.5°C; ±1°F	Printing			4 probes, KJT		•	033
HI 98801	-200.0 to 1370°C; -300.0 to 2500°F	±0.5°C; ±1°F	Both			KJT		•	037
HI 98804	-200.0 to 1370°C; -300.0 to 2500°F	±0.5°C; ±1°F	Both			4 probes, KJT		•	037
Pt100 Thermometers									
HI 955501	-199.9 to 850°C	±0.2°C							029
HI 955502	-199.9 to 850°C	±0.2°C			•				029
HI 955201	-200.0 to 850.0°C	±0.1°C	Printing						034
HI 955202	-200.0 to 850.0°C	±0.1°C	Printing			2 probes			034
HI 955301	-200.0 to 850.0°C	±0.1°C	Both						038
HI 955302	-200.0 to 850.0°C	±0.1°C	Both			2 probes			038

Temperature Indicators & Controllers			***Description***		Page
HI 140	-30.0 to 70.0°C, depending on model	±1.5°C	Compact dataloggers that store up to 7600 samples		010
	-22.0 to 158.0°F, depending on model	±3°F	Compact dataloggers that store up to 7600 samples		010
HI 141	-40.0 to 125.0°C, depending on model	±0.4°C	Compact dataloggers with 1 or 2 sensors (internal or external)		011
	-40.0 to 257.0°F, depending on model	±0.8°F	Compact dataloggers with 1 or 2 sensors (internal or external)		011
HI 142	-30.0 to 120.0°C, depending on model	±0.3°C	Compact dataloggers with telecontrol feature		012
	-22.0 to 248.0°F, depending on model	±0.6°F	Compact dataloggers with telecontrol feature		012
Luxmeter				WP*	
HI 97500	0.001 to 199.9 klux	±0.001; ±0.01; ±0.1 klux		•	039

Note: Some of these instruments measure in multiple ranges with different resolutions. See page references for complete specifications.

* Waterproof.

Thermometers

Precise process control is one of the most important factors in maintaining high quality in production, just as precision and accuracy are the key to research. Temperature is one of the most important variables today, in research, as well as in production. Thermometers have been an integral part of our lives for eons. But right up to a few decades ago, thermometers had remained virtually unchanged. They were mainly either glass or dial/metal type.

Glass and metal thermometers use thermal expansion to measure temperature. This method uses a physical law which gives a false sense of reliability. One assumes the measurement is "true" because he or she can see how it works. This system is no longer suitable for many reasons. Their accuracy and range are very limited. The glass construction is fragile and can be dangerous to ones health, as well as to the environment. For these reasons, an alternative way of measuring temperature has become necessary.

Electronic thermometers have provided the versatility asked for by operators in all areas of temperature measurement. Speed is important when reactions being monitored are changing rapidly. Small compact sensors are preferable for tightly arranged areas, such as electronics and other miniature applications. Electronic thermometers allow users to monitor maximum, minimum and even average temperatures. Mechanical stress is no longer a worry with an electronic thermometer. Field measurements can be very harsh. Rain, cold, dust and other natural obstacles are overcome with our rugged instruments.

In order to meet these requirements, a special source is needed. Dedicated research teams, precision process control, integrated production facilities and an overall dedication is required. HANNA instruments® has all the prerequisites necessary to accomplish this. Local sales offices with customer assistance that respond to the customer's needs immediately and products ranging from waterproof to logging in multiple channels constitute what has been a recipe for success.

Temperature Measurement

Measurement Unit

Temperature is one of the most common physical properties in our everyday life. It is defined as the property of a body that determines the transfer of heat to or from other bodies. Physically, temperature affects variations in the macroscopic parameters of a body such as volume and pressure, among others.
The fundamental temperature scale is the absolute, thermodynamic or Kelvin scale. The Kelvin (K) is defined as the fraction 1/273.15 of the thermodynamic temperature of the triple point of water. The triple point of water is a standard fixed point at which ice, liquid water, and water vapor are in equilibrium.
Two empirical temperature scales are in common use: the Celsius and the Fahrenheit scales. These scales are based on two fixed points.
The Celsius (formally Centigrade) temperature scale uses the Celsius (°C) units, defined as 1/100th fraction of the difference between the temperature of boiling (100 °C) and freezing points (0 °C) of water. The relationship between the Kelvin and Celsius scales is given by:

$$K = °C + 273.15$$

The Fahrenheit scale uses Fahrenheit (°F) units, where the temperature of boiling point of water is taken as 212 °F, and the temperature of the freezing point as 32 °F. The scale originally used the temperature of a mixture of ice and common salt as 0 °F, and the inventor's body temperature as 96 °F. The relationship between the Fahrenheit and Celsius scales is calculated by:

$$°F = 9/5\ °C + 32$$

Thermometer Accuracy

As previously described, modern technology has made it possible to produce, at a reasonable cost, electronic thermometers that use various principles and measurement sensors.

With digital indicators it is easy to show resolutions of 0.1°C. There is no relationship between resolution and accuracy of measurements.
Here is a list of the main causes of errors in temperature measuring systems:

- **Instrument:** The instrument may have an extended scale and 19,000 points of measurement may be obtained. Within these 19,000 points the instrument may perform differently because of internal linearity.
- **Electronic Components:** The internal electronics have a drift that depends on the ambient temperature. For this reason the accuracy of the instrument is stated at a specific temperature of 20 or 25°C, and the drift has to be specified for each degree of variations with respect to the reference temperature.
- **LCD:** Liquid crystals have an operating limitation which is a function of temperature. Their normal range is between 0 and 50°C, but there are components capable of performing between -20°C and +70°C.
- **Batteries:** Instrument battery power supply also has limitations of use.
- **Temperature Sensor:** This is a separate accuracy, which is to be added to the instrument's error.

These examples indicate the various errors, which contribute to define and therefore guarantee the accuracy of the instrument.

If the probe is supplied connected to the meter, during factory calibration the probe error is eliminated. It will reappear if the probe is replaced.

User Calibration

To calibrate your thermometers you need:
- for Pt100 thermometers, a resistance simulator
- for thermometers with NTC/PTC sensor, at least two thermostatic baths
- for thermocouple thermometers, a simulator of the emf (electromotive force) generated by the thermocouple
- for infrared thermometers, a heat source (panel) at controlled temperature

Few users can afford this investment in time and materials for checking their thermometers' accuracy.

IMPORTANCE OF ACCURACY IN TEMPERATURE READINGS

Up to a few years ago, accuracy was not a very critical aspect and tolerances of a few °C did not jeopardize a process. From the time that HACCP programs became a necessity, measurement accuracy has become a discriminating factor. Now an error of a few tenths of a degree can decide whether food can still be kept or must be discarded, with economic damage as a consequence. In 1990, HANNA instruments® began to produce thermometers for our customer's HACCP programs to comply with new European regulations. Soon enough, HANNA instruments® became the market leader in Europe as a result of the technological solutions offered to our users in need of accuracy.

Cal-Check® Feature

As previously described, the electronic components of an instrument shift with time. HANNA instruments® has made it possible for the user, with the simple touch of a button, to verify whether the response of the instrument is within the tolerance limit of ±0.02°C.
The Cal-Check® system acts by substituting the sensor with an internal resistor, which corresponds to 0°C, and thus simulates the response that the temperature probe would have at 0°C.

Standardization

HANNA instruments® has designed a series of pre-calibrated temperature probes with a maximum error of 2°C for trouble free replacement.

Calibration of Thermocouple Thermometers

Although quite fast, thermocouple thermometers read with a response time much slower than other sensors and other technologies. Unfortunately, the measurement of the thermocouple emf loses accuracy because of the measuring system itself, based on the emf generated by the temperature difference between cold and hot junctions. The same emf may be generated under different conditions:
- hot junction at 100°C; cold junction at 20°C; difference: 80°C

or:
- hot junction at 90°C; cold junction at 10°C; difference: 80°C

So that a temperature difference of 80°C is obtained with two different temperatures of the sample. It is, therefore, very important to determine the cold junction temperature very precisely. The ability to do this has a large effect on the accuracy of the measuring system. A thermocouple thermometer is made of two thermometers, one that measures the cold junction, and one for measuring the emf generated by the thermocouple. The cold junction is usually measured with an NTC type sensor, which has response times different from those of the thermocouple. Another crucial point is measuring the actual value of the cold junction, without any environmental influence and dispersions.

To partially solve this problem, HANNA instruments® has devised the calibration of the instrument-thermocouple system, by dipping the probe in melting ice, and thus allowing the user to calibrate the measuring system at 0°C.
Thanks to this solution, it is now possible to use thermocouple thermometers for HACCP controls with an accuracy of ±0.3°C, which is the same performance of our Pt100 or NTC thermometers, but with a higher response time.

Calibration Test Keys

To check the calibration status of the instrument, calibrated keys have been prepared in the range from -18°C to 70°C. These keys reproduce the value of the sensor at different temperatures. Simply disconnect the measuring probe, replace it with the key and make sure that the instrument reads the simulated value.
HANNA instruments® calibrates all thermometers with a standard probe. All NTC temperature probes are inspected and calibrated with standard instruments. During quality inspection our technicians make sure that the reading errors are within the stated accuracies.
In addition, HANNA instruments® provides you with the necessary tools to verify that your thermometers read accurate values.
In case of unacceptable readings, please return the instrument to the nearest HANNA instruments® technical service center.
Our complete line of electronic thermometers provides fast and precise measurements down to a tenth of a degree Celsius.
HANNA instruments®' thermometers may be divided into four main categories: thermistor thermometers, thermocouple thermometers, Pt100 thermometers and infrared thermometers.

Thermistor Thermometers

The thermistor is a semiconductor device whose resistivity (ρ) varies as a function of temperature (T)

$$\rho = \rho_O (1 + \alpha T)$$

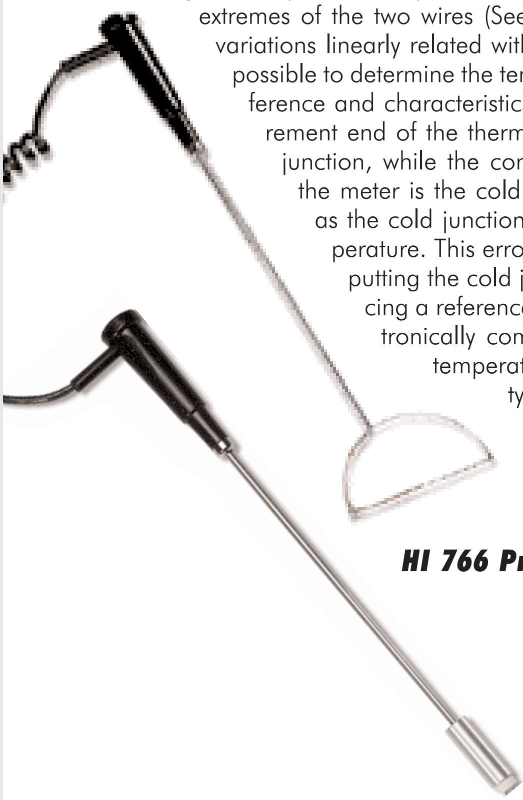
where

ρ_O = characteristic resistivity of material
α = temperature resistance coefficient of material

The temperature resistance coefficient is the parameter that determines if the resistivity variation is positive (as with the Positive Temperature Coefficient sensors) or negative (as with the Negative Temperature Coefficient thermistors). It is possible to determine the temperature by applying a potential difference and measuring the resistance.
Thermistor sensors are suitable for a temperature range of -50 to 150°C (-58 to 302°F). Higher temperatures may damage the semiconductor sensor. Accurate temperature measurements are possible (tenths of degree) due to the high sensitivity of the sensor.

Thermocouple Thermometers

The thermocouple consists of the junction of two wires of different metals. At a given temperature, a potential difference results at the opposite extremes of the two wires (Seebeck effect), with the respective variations linearly related within small intervals. It is therefore possible to determine the temperature given the potential difference and characteristics of the two metals. The measurement end of the thermocouple probe is called the hot junction, while the connection of the thermocouple to the meter is the cold junction. An error is introduced as the cold junction is exposed to the ambient temperature. This error can be eliminated by physically putting the cold junction into an ice bath and forcing a reference temperature of 0°C, or by electronically compensating for the cold junction temperature effect. There are various types of thermocouples, identified by an ANSI code using a letter of the alphabet. The K type is the most commonly used.



HI 766 Probes

Pt100 Thermometers

The operating principle of resistance thermometers is based on the increase of electric resistance of metal conductors (RDT: Resistance Temperature Detectors) with temperature.
This physical phenomenon was discovered by Sir Humply Davy in 1821. In 1871 Sir William Siemens described the application of this property using platinum, thereby introducing an innovation in the manufacturing of temperature sensors. Platinum resistance thermometers have been used as international standard for measuring temperatures between hydrogen triple point at 13.81 K and the freezing point of antimony at 630.75°C.
Among the various metals to be used in the construction of resistance thermometers, platinum, a noble metal, is the one that can measure temperatures throughout a wide range, from -251 to 899°C, with a linear behavior.
Platinum RTD thermometers were common in the seventies but now they have been replaced with thermistor sensors because of their smaller dimensions (weight) and faster response to temperature changes. The most common RTD sensor, using platinum, is the Pt100, which means a resistance of 100Ω at 0°C with a temperature coefficient of 0.00385Ω per degree Celsius. For a higher price one can buy platinum sensors with 250, 500 or 1000Ω (Pt1000).
The main disadvantage of RTD probes is the resistance of the connection cable. This resistance prevents the use of standard two-wire cables for lengths over a few meters, since it affects the accuracy of the reading. For this reason, to obtain high levels of accuracy in industrial and laboratory applications, the use of a three or four-wire system is recommended.
For all its Pt100 thermometers and probes, HANNA instruments® has chosen the multiple-wire technology for higher accuracy.

Infrared Thermometers

All objects emit a radiant energy in the infrared (IR) spectrum that falls between visible light and radio waves.
The origins of IR measurements can be traced back to Sir Isaac Newton's prism and the separation of sunlight into colors and electro-magnetic energy. In 1800, the relative energy of each color was measured, but it was not until early 20th century that IR energy was quantified. It was then discovered that this energy is proportional to the 4th power of the object's temperature.
IR instrumentation using this formula has been around for over 50 years. They almost exclusively use an optic device that detects the heat energy generated by the object that the sensor is aimed at. This is then amplified, linearized and converted into an electronic signal which in turn shows the surface temperature in Celsius or Fahrenheit degrees.
Infrared measurements are particularly suitable for areas where it is difficult, or undesirable to take surface measurements using conventional contact sensors. Applications for IR meters include non-destructive testing of foodstuffs, moving machinery, high temperature surfaces and hazardous areas, such as high voltage wires.

An ideal surface for IR measurements is a black body or radiator with an emissivity of 1.0. Emissivity is the ratio of the energy radiated by an object at a certain temperature to that emitted by a perfect radiator at the same temperature.
The shinier or more polished the surface, the less accurate the measurements. For example, the emissivity of most organic material and rough or painted surfaces is in the 0.95 region and hence, suitable for IR measurements.
On the other hand, surfaces of highly polished or shiny material, such as mirrors or aluminum, may not be appropriate for this application without using some form of filtration. This is due to other factors, namely, reflectivity and transmissivity. The former is a measure of an object's ability to reflect infrared energy while the latter is its ability to transmit it.
Another important and practical concern is the field of view. Infrared meters measure the average temperature of all objects in their field of view. To obtain an accurate result, it is important that the object completely fills the instrument's field of view and there are no obstacles between the meter and the object. The distance-to-target ratio, or the optic coefficient, is therefore an important consideration.

Reference Temperatures

In 1990, NIST established 17 fixed points of the International Temperature Scale (ITS-90) related to reproducible physical phenomena in nature. The ITS-90 Fixed Points are shown in the chart below:

Equilibrium state	**K**	**°C**
Vapor pressure point of helium	3 to 5	-270.15 to -268.19
Triple point of hydrogen	13.8033*	-259.346*
Boiling point of hydrogen at a pressure of 33.330.6 Pa	17.042*	-256.108*
Boiling point of equilibrium hydrogen	20.28*	-252.87*
Triple point of neon	27.102	-246.048
Triple point of oxygen	54.361	-218.789
Triple point of argon	83.8058	-189.3442
Triple point of mercury	234.3156	-38.8344
Triple point of water	273.16	0.01
Triple point of gallium	302.9146	29.7646
Melting point of indium	429.7485	156.5985
Melting point of tin	505.078	231.928
Melting point of zinc	692.677	419.527
Melting point of aluminum	933.473	660.323
Melting point of silver	1234.93	961.78
Melting point of gold	1337.33	1064.18
Melting point of copper	1357.77	1084.62

* Given for e-H_2, which is hydrogen at the equilibrium concentration of the ort and para molecular forms.