FLUKE®

Hart Scientific®

5606/5607

Full Immersion PRT

User's Guide

5606-07_UGENG0000

Limited Warranty & Limitation of Liability

Each product from Fluke Corporation, Hart Scientific Division ("Hart") is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year(s) for the Platinum Resistance Thermometer. The warranty period begins on the date of the shipment. Parts, product repairs, and services are warranted for 90 days. The warranty extends only to the original buyer or end-user customer of a Hart authorized reseller, and does not apply to fuses, disposable batteries or to any other product, which in Hart's opinion, has been misused, altered, neglected, or damaged by accident or abnormal conditions of operation or handling. Hart warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Hart does not warrant that software will be error free or operate without interruption. Hart does not warrant calibrations on the Platinum Resistance Thermometer.

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Hart's warranty obligation is limited, at Hart's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Hart authorized service center within the warranty period.

To obtain warranty service, contact your nearest Hart authorized service center or send the product, with a description of the difficulty, postage, and insurance prepaid (FOB Destination), to the nearest Hart authorized service center. Hart assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Hart determines that the failure was caused by misuse, alteration, accident or abnormal condition or operation or handling, Hart will provide an estimate or repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

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1 Before You Start

1.1 Symbols Used

Table 1 lists the International Electrical Symbols. Some or all of these symbols may be used on the instrument or in this manual.

Table 1 *International electrical symbols*

Symbol	Description	Symbol	Description
	AC (Alternating Current)		PE Ground
	AC-DC		Hot Surface (Burn Hazard)
	Battery		Read the User's Guide (Important Information)
	Complies with European Union directives		Off
	DC		On
	Double Insulated		Canadian Standards Association
	Electric Shock		C-TICK Australian EMC mark
	Fuse		The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) mark.

1.2 Safety Information

Use this instrument only as specified in this manual. Otherwise, the protection provided by the instrument may be impaired.

The following definitions apply to the terms "Warning" and "Caution".

"Warning" identifies conditions and actions that may pose hazards to the user.

"Caution" identifies conditions and actions that may damage the instrument being used.

1.2.1 Warnings

To avoid personal injury, follow these guidelines.

- DO NOT use this instrument to measure the temperature of any hazardous live component.
- DO NOT use this unit in environments other than those listed in the user's manual.
- Follow all safety guidelines listed in the user's manual.
- Calibration Equipment should only be used by Trained Personnel.

1.2.2 Cautions

To avoid possible damage to the instrument, follow these guidelines.

- DO NOT remove the label from the handle. This cautions the user concerning the delicate nature of the instrument.
- DO NOT drop or bang the probe in any way. This will cause damage to the probe internally and affect its calibration.
- Read Section entitled "PRT Care and Handling Guidelines" before removing the PRT from the shipping box or case. Incorrect handling can damage the PRT and void the warranty.
- Keep the shipping container in case it is necessary to ship the PRT. Incorrect packaging of the PRT for shipment can cause irreparable damage.

1.3 Authorized Service Centers

Please contact one of the following authorized Service Centers to coordinate service on your Hart product:

Fluke Corporation,
Hart Scientific Division

799 E. Utah Valley Drive
American Fork, UT 84003-9775
USA

Phone: +1.801.763.1600
Telefax: +1.801.763.1010
E-mail: support@hartscientific.com

Fluke Nederland B.V.

Customer Support Services
Science Park Eindhoven 5108
5692 EC Son
NETHERLANDS

Phone: +31-402-675300

Telefax: +31-402-675321
E-mail: ServiceDesk@fluke.nl

Fluke Int'l Corporation

Service Center - Instrimpex
Room 2301 Sciteck Tower
22 Jianguomenwai Dajie
Chao Yang District
Beijing 100004, PRC
CHINA

Phone: +86-10-6-512-3436
Telefax: +86-10-6-512-3437
E-mail: xingye.han@fluke.com.cn

Fluke South East Asia Pte Ltd.

Fluke ASEAN Regional Office
Service Center
60 Alexandra Terrace #03-16
The Comtech (Lobby D)
118502
SINGAPORE

Phone: +65 6799-5588
Telefax: +65 6799-5588
E-mail: antng@singa.fluke.com

When contacting these Service Centers for support, please have the following information available:

- Model Number
- Serial Number
- Complete description of the problem

2 Introduction

2.1 General

The Hart Platinum Resistance Thermometers (PRT) models 5606 and 5607, are designed to be a precision instrument converting temperature to resistance. The PRTs are used with a readout device to detect temperature changes or actual temperature.

2.2 Application

The 5606 and 5607 Full Immersion PRTs are designed to perform in extreme environments where both the transition junction and the lead wires are required to withstand temperatures covering the entire operating range of the probe.

The 5606 Immersion PRT has been designed to be fully immersed in common heat transfer fluids such as silicone oil, mineral oil, ethanol, and liquid nitrogen and can measure temperature ranging from –200 °C to 160 °C.

The 5607 Immersion PRT is intended to be used in dry mediums only but can be fully immersed in ovens, furnaces, or autoclaves over a temperature range of 0 °C to 450 °C

2.3 Calibration

In order for any instrument to be used as a standard it must be calibrated. These instruments are sold uncalibrated unless calibration is requested at time of purchase. They are satisfactory as secondary standards and may be calibrated by comparison to primary standards.

2.4 Recalibration

The recalibration of the 5606/5607 Full Immersion PRT should be scheduled according to the user's company Quality Assurance requirements. Normally, a PRT is recalibrated annually. Unless the PRT is used only over a limited range, calibration over the full range of the PRT is recommended. For information on calibration services for the 5606/5607, contact an Authorized Service Center for an RMA number and current pricing (see Section 1.3, Authorized Service Centers, on page 2)

Depending on the user's Quality Assurance requirements, the PRT drift should be checked periodically at the Triple Point of Water (TPW) or 0 °C. Section 8.1, Troubleshooting, on page 11, provides information on drift with respect to mechanical shock and oxidation. If the R_{tpw} cannot be restored after annealing to within calibration tolerances, a full recalibration should be scheduled.

3 Specifications

3.1 Specifications

Table 2 *Specifications*

Specifications	5606	5607
Temperature range	–200 °C to 160 °C	0 °C to 450 °C
Nominal resistance at 0.01 °C	100 Ω ± 0.1 Ω	
Temperature coefficient	0.00385 Ω/Ω/°C	
Accuracy[1]	± 0.04 °C at 0.01 °C ± 0.06 °C at 160 °C	± 0.04 °C at 0.01 °C ± 0.07 °C at 450 °C
Short-term repeatability[2]	± 0.03 °C at 0.01 °C ± 0.04 °C at 160 °C	± 0.020 °C at 0.01 °C ± 0.035 °C at 450 °C
Drift[3]	± 0.03 °C at 0.01 °C ± 0.04 °C at 160 °C	± 0.02 °C at 0.01 °C ± 0.04 °C at 450 °C
Hysteresis	± 0.015 °C	
Sheath length	50 mm ± 5 mm (2 in ± 0.2 in)	40 mm ± 5 mm (1.6 in ± 0.2 in)
Sheath diameter	3.1 mm ± 0.1 mm (1/8 in ± 0.004 in)	
Sheath material	316 SST	Inconel® 600
Transition junction temperature range[4]	-200 °C to 160 °C	0 °C to 450 °C
Transition junction dimensions	No transition	35 mm x 7 mm (1.4 in x 0.3 in)
Sensor length	30 mm ± 3mm (1.2 in ±0.1 in)	
Sensor location	3 mm ± 1 mm from tip (1.2 in ± 0.04 in)	
Minimum insulation resistance	20 MΩ at 23 °C	100 MΩ at 23 °C
Minimum immersion length	Full immersion	Full immersion
Maximum immersion depth in liquid medium	Full immersion	Use SST or glass tube to protect transition junction
Maximum immersion depth in dry medium	Full immersion	Full immersion
Response time[5]	12 seconds typical	9 seconds typical
Self heating (in 0 °C bath)	± 0.003 °C	
Lead-wire cable type	Enameled copper wire	SST over-braid
Lead-wire length	2.4 meters (8 ft)	
Lead-wire temperature range	160 °C	450 °C
Calibration	Calibration not included. NVLAP accredited calibration available. See ordering information.	

[1] Includes calibration and 100 hr drift (k = 2).
[2] Three thermal cycles from min to max temp, includes hysteresis, 95 % confidence (k = 2).
[3] After 100 hours at max temp, 95 % confidence (k = 2).
[4] Temperatures outside this range will cause irreparable damage.
[5] Per ASTM E 644.

Table 3 *Calibration uncertainty*

	5606	
Temperature	**1924 Calibration Uncertainty†**	**Tolerance w/out Calibration‡**
–197 °C	0.03 °C	0.4 °C
–38 °C	0.03 °C	0.2 °C
0 °C	0.03 °C	0.1 °C
100 °C	0.045 °C	0.3 °C
157 °C	0.05 °C	0.4 °C

	5607	
Temperature	**1924 Calibration Uncertainty†**	**Tolerance w/out Calibration‡**
0 °C	0.03 °C	0.1 °C
157 °C	0.05 °C	0.2 °C
232 °C	0.05 °C	0.3 °C
450 °C	0.055 °C	0.5 °C

† Lab code 200348-0
‡ Each PRT includes a certificate with a measured R0 value.
An uncalibrated 5606 or 5607 meets ASTM E 1137 Grade A Classification of Tolerances. Use the coefficients below to achieve the tolerances listed in the “No Calibration” column or calculate the Grade A tolerance using the following formula: Grade A = ± [0.13 + 0.0017|t|]°C where: |t| = value of temperature (°C) without regard to sign. See ASTM E 1137.
R0: Enter the R0 value provided
A: 3.9083×10^{-3}
B: -5.775×10^{-7}
C: -4.183×10^{-4}

3.2 Lead Wire and Transition Junction

The lead wire of the 5606 Full Immersion PRT is made of single-conductor enameled copper wire which prevents moisture from wicking to the sensing element as it would if a more common,stranded lead wire were used. In order to maintain its small profile, the 5606 PRT was designed without a traditional transition junction and strain relief. Extra care should be taken when handling the lead wires of the 5606.

The lead wire of the 5607 is shielded with braided stainless steel and connected to the transition junction with a strain relief spring. The transition junction and lead wire of the 5607 PRT have been designed to withstand temperatures from 0 °C to 450 °C but should be immersed in dry mediums only. The transition junction and lead wires of the 5607 PRT should not be directly immersed in fluids of any kind. If a measurement must be made in a fluid medium, the transition junction and lead wires of the 5607 can be shielded from exposure to fluids by inserting the entire probe assembly into a sufficiently long, close-ended stainless steel or glass tube. Additional stabilization time should be considered to allow for complete temperature equilibration.

4 Installation

4.1 Environmental Issues

Ideally, temperature calibration equipment should be used in a calibration laboratory or other facility specifically designed for this purpose. Environmental requirements include:

- Stable temperature and relative humidity <80%
- Clean, draft-free area
- Low noise level: low radio frequency, magnetic or electrical interference
- Low vibration levels

4.2 Mounting

When in use, the PRT must be mounted carefully to avoid any damage to the sheath or sensor. If using mechanical clamps to secure the PRTs while in use, care should be taken not to over tighten the clamping device. **Over tightening will damage the sheath or lead wires.** If metal comparison blocks are used in the bath, maintain a close fit between the thermometer sheath and the well in the comparison block. However, allow for the thermal expansion of the thermometer sheath when determining block well tolerances.

4.3 Lead Wire Identification

The 5606 and 5607 PRTs are equipped with a four-wire cable. The same circuit schematic applies to both PRTs (see Figure 1 on this page). Four lead wires are used to cancel lead wire resistance. For best results, the readout device should be equipped to handle four-terminal resistors.

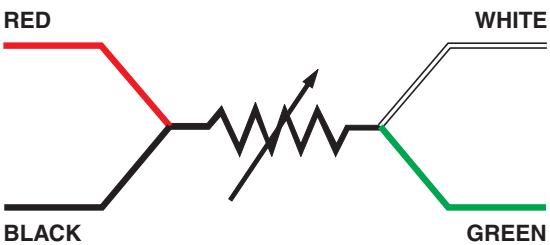

Figure 1 *PRT Schematic*

The lead wires are four different colors. Lead wire pairs attached to each end of the sensor are identified as shown in Figure 1 on this page.

5 PRT Care and Handling Guidelines

5.1 PRT Care

CAUTION: *READ THIS SECTION BEFORE REMOVING THE PRT FROM THE SHIPPING BOX OR CASE*

The 5606 and 5607 Platinum Resistance Thermometers (PRTs) are delicate instruments. Care must be taken in handling the PRTs to maintain calibration accuracy. The partial stress free design of the PRT sensor reduces the effects of mechanical shock. However, care should still be used when handling the PRT even though the metal sheath is durable and provides good protection for the sensor. Correct handling of the PRT will prolong the life expectancy. When not in use, the PRT should be stored in a safe place where the risk of unintentional mechanical shock is minimized.

NOTE: *The PRT sheath changes color after use at high temperatures. The PRT may arrive with a brown tint to the sheath due to calibration at high temperatures.*

5.2 PRT Handling Guidelines

- DO measure the R_{tpw} value of the thermometer after shipment.
- DO keep the thermometer as clean as possible.
- DO immerse the thermometer in the appropriate liquid for the temperature range. If a dry block is used, the well diameter should allow the PRT to comfortably slip in and out without excess movement. For best results, immerse the thermometer as deep as possible to avoid “stem effect” (the temperature error caused by the conduction of heat away from the sensor).
- DO allow sufficient time for the thermometer to stabilize before making measurements. This allows for the best accuracy.
- DO use the correct drive current with the thermometer to prevent error in temperature or resistance. Hart Scientific recommends 1mA.
- DO use the protective shipping box or case provided or other protection when the thermometer is not in use.
- DO NOT subject the thermometer to any physical shock or vibration.
- DO NOT use pliers or other devices to squeeze the sheath. This action can permanently damage the PRT.
- DO NOT subject the thermometer to temperatures above the highest specified operating temperature.
- DO NOT screw a clamp down so tight that it dents the sheath. This can permanently damage the PRT.
- DO NOT expose the 5607 transition junction and lead wires to liquid.

6 Operation

6.1 General

For best results, be familiar with the operation of the heat source and the readout instrument. Be sure to follow the manufacturer's instructions for the readout instrument and the heat source.

6.2 Comparison Calibration of Other Instruments

The uniformity and stability of the heat source and the degree of accuracy required determine the number of temperature measurements necessary. However, to follow "good" practice procedures, always measure the triple point of water (R_{tp}) after each temperature measurement. The following equation provides the most accurate measurement of the ratio:

$$W_t = \frac{R_t}{R_{tp}}$$

All PRTs experience errors caused by self-heating of the element. Self-heating is a combination of two factors, heat dissipation and heat sink. Self-heating error can be reduced to have a negligible effect if the PRT is used with the same excitation current and medium in which it was calibrated.

6.3 Thermal EMF

Two factors contribute to thermal EMF, chemical consistency and physical consistency. Variations in chemical structure due to impurities can contribute to thermal EMF. Also discrepancies in crystal structure can contribute to thermal EMF. These factors are minimized by annealing the full length of wire before construction of the PRT.

Likewise, connection to extension lead wires and readout instruments can be a source of thermal EMF. The thermal EMF is caused by a difference in temperature between two connections. If the two connections are the same temperature, there will be little or no thermal EMF effects. However, if there is a substantial temperature difference between connections, the thermal EMF effects will be significant. Therefore, cover or insulate any exposed bridge or galvanometer terminals to lessen the source of error. The effects of thermal EMF can be canceled by using an AC bridge or a DC bridge with reversible current.

7 Accessories

7.1 Case Options

The 5606/5607 PRT comes in a rigid case, Hart model 2601, appropriate for the length of the probe.

7.2 PRT Termination

The PRT can be terminated in four ways (Figure 2 on this page) depending on the user's requirements:

- Gold Plated Spade Lug
- INFO-CON LEMO
- Bare Wire
- 5-Pin Din Connecto

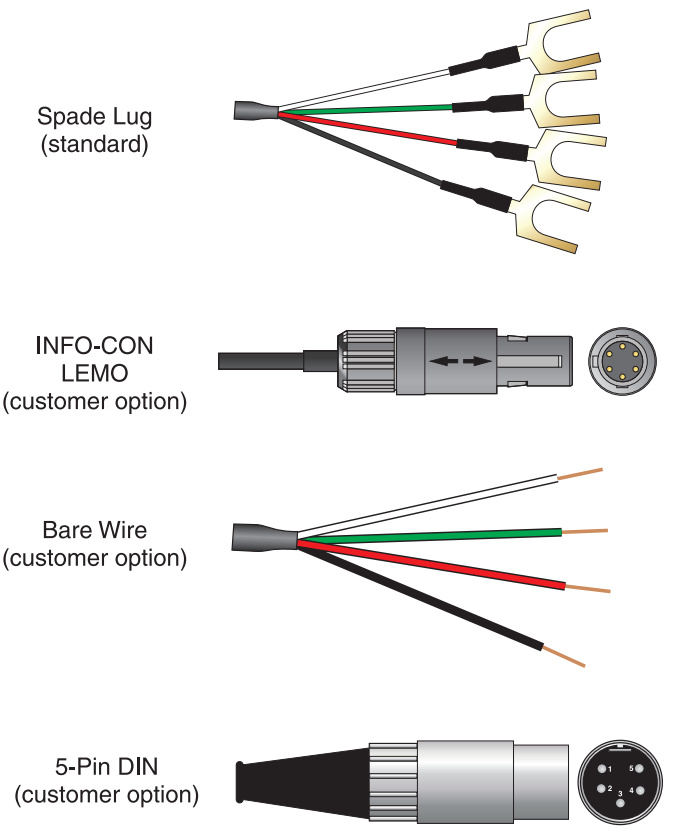

Figure 2 *Probe Termination Examples*

8 Troubleshooting

8.1 Troubleshooting

In the event that the probe appears to function abnormally, this section may be of use in solving the problem. Several possible problem conditions are described along with likely causes and solutions. If a problem arises, please read this section carefully and attempt to understand and solve the problem. If the probe seems faulty or the problem cannot otherwise be solved, contact an Authorized Service Center (see Section 1.3, Authorized Service Centers, on page 2) for assistance. Be sure to have the model number and serial number of your probe available.

Problem	Causes and Solutions
Data changes greater than 0.1°C are observed	Mechanical shock can cause temperature errors as great as 0.5°C. If this is observed, recalibrate the PRT.
Data unstable	If the data is unstable at the Triple Point of Water (TPW), check the connector. If the connector is correct, contact an Authorized Service Center (see Section 1.3, Authorized Service Centers, on page 2). The PRT may be damaged and need repair. If the data is unstable at high temperatures, it may be due to electrical noise in the system. Reduce the temperature and observe the data. If it is stable, electrical noise is interfering with the measurements at high temperatures. Check the grounding of the readout device and the heat source. A faulty ground on either device could interfere with high temperature measurements. A ground wire attached to the metal sheath of the PRT may help to reduce electrical noise interference.
Temperature readout different than expected, e.g. the heat source is set at 300°C, the PRT measures 275°C.	Measure the PRT resistance at TPW. If the resistance of the PRT is less than the rated resistance, e.g. 70Ω for the 5606/5607, there may be a short in the sensor. Contact an Authorized Service Center (see Section 1.3, Authorized Service Centers, on page 2). If the resistance of the PRT is only a few ohms, there may be a short in the four lead-wires. Contact an Authorized Service Center (see Section 1.3, Authorized Service Centers, on page 2). If the PRT is open, the resistance will be “Out of Limits” or in the kilohm or megohm range. Contact an Authorized Service Center (see Section 1.3, Authorized Service Centers, on page 2).