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TEMPERATURE SENSORS, PLATINUM, HIGH RELIABILITY, SPACE USE, GENERAL SPECIFICATION FOR

JAXA
JAPAN AEROSPACE EXPLORATION AGENCY

This specification was originally written and established in the Japanese language. This specification has been translated into English for international users. Note that this document is a working document for international users and is not subject to configuration control by JAXA. Any discrepancies found in this document should be verified against the latest Japanese document before any significant decisions are made.

TEMPERATURE SENSORS, PLATINUM, HIGH RELIABILITY, SPACE USE, GENERAL SPECIFICATION FOR

1. GENERAL

1.1 Scope

This specification establishes the general requirements and quality assurance provisions for space use, high reliability, platinum, temperature sensors (hereinafter referred to as “temperature sensors”) installed on spacecrafts. This specification complies with JAXA-QTS-2000 (Common Parts/Materials, Space Use, General Specification for) which was recently established to transition to the qualified manufacturing line system and replaces the following specification.

NASDA-QTS-1043B Temperature Sensors, Platinum, High Reliability, Space Use, General Specification for

1.2 Terms and Definitions

The definitions for terms used herein are as follows and as specified in JAXA-QTS-2000.

a) Interchangeability
The maximum allowable tolerance in resistance temperature characteristic within the operating temperature range in sensors of the same type.

b) Pressure dependence
An error in which the resistance of temperature sensors decreases, when an external force is applied to the sensing element.

c) Self-heating
The current that passes through a sensing element causes Joule heating. As a result, the temperature of the sensing element rises above the ambient temperature.

1.3 Classification

Products covered by this specification shall be classified as specified in Table 1.

Table 1. Classification

Name	Types	Corresponding QPL specification
Temperature sensor	General-use, probe type General-use, extension wire type Long-life, radiation hard, probe sheath type Long-life, radiation hard, extension wire sheath type Long-life, radiation hard, surface type	NASDA-QTS-1043B

1.4 Part Number

The part number shall be indicated as follows. The details shall be in accordance with the detail specification.

Example: NASDA(1) 2180 / □□□

Individual identification

Note: (1) "NASDA" indicates the part is for space use and may be abbreviated “N”.

2. APPLICABLE DOCUMENTS

2.1 Applicable Documents

The documents listed below form a part of this specification to the extent specified herein. The latest issues of these documents are the latest version available at the time of contract award or application. If it is necessary to designate an issue, the issue shall be specified in the detail specification.

a)	JAXA-QTS-2000	Common Parts/Materials, Space Use, General Specification for
b)	MIL-STD-202	Test Method Standard, Electronic and Electrical Component Parts
c)	MIL-STD-750	Test Method Standard, Semiconductor Devices
d)	ASTM D2512	Standard Test Method for Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Techniques)
e)	ASTM E595	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
f)	SAE ARP 598	Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems
g)	EIAJ ED 4701	Environmental and Endurance Test Methods for Semiconductor Devices

2.2 Reference Documents

The following document is a reference document.

a)	NASDA-HDBK-4	NASDA Parts Application Handbook

2.3 Order of Precedence

In the event of a conflict between the text of this document and the applicable documents, the following order of precedence shall apply.

a) Detail specifications
b) This specification
c) JAXA-QTS-2000
d) Applicable documents of this specification (paragraph 2.1, except JAXA-QTS-2000)

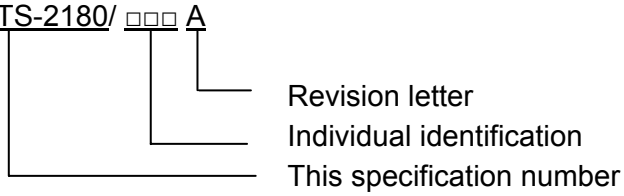
2.4 Detail Specifications

Detailed requirements for the style and performance of the temperature sensors are specified in each detail specification.
The detail specification shall be prepared and implemented by the manufacturer in accordance with Section A.4 of JAXA-QTS-2000. The detailed specification shall also be registered and issued to the Japan Aerospace Exploration Agency (hereinafter referred to as 'JAXA').

2.4.1 Detail Specification Number

The detail specification number shall be indicated in the following form in accordance with paragraph A.2.2.2 of JAXA-QTS-2000.

Example: JAXA-QTS-2180/ □□□ A



2.4.2 Revision Letter of Detail Specification

A revision letter in the detail specification number is assigned in accordance with paragraph A.2.2.2.4 of JAXA-QTS-2000.

2.4.3 Independency of Detail Specification

The detail specification shall be a stand-alone document with a unique number in accordance with paragraph 2.4.1.

2.4.4 Format of Detail Specification

The detail specification format shall be in accordance with A.6 b) of JAXA-QTS-2000 and shall specify each requirement in accordance with section A.4 of JAXA-QTS-2000.

3. REQUIREMENTS

3.1 Certification

3.1.1 Qualification Coverage

Qualification shall be valid for temperature sensors that are produced by the manufacturing line that conforms to materials, designs, constructions, ratings and performance specified in paragraphs 3.3 to 3.8. The qualification coverage shall be fully represented by samples that have passed the qualification test. Within this coverage, the manufacture is allowed to supply qualified products in compliance with the detail specification. If necessary, additional qualification coverage shall be specified in the detail specification.

3.1.2 Initial Qualification

To acquire certification of the temperature sensor in accordance with this specification, a manufacturer shall establish a quality assurance program in accordance with paragraph 3.2.1, perform the qualification tests specified in paragraph 4.4, and acquire a certification status from JAXA as specified in paragraph 3.4.1 of JAXA-QTS-2000. The manufacturer shall be listed on the Qualified Manufacturer List of the Japan Aerospace Exploration Agency (JAXA QML).

3.1.3 Retention of Qualification

To continue supplying temperature sensors in accordance with this specification, a manufacturer must apply for qualification retention in accordance with paragraph 3.4.2.1 of JAXA-QTS-2000 commencing between 30 and 60 days prior to the expiration date of the certification period as specified in paragraph 3.1.4.
The manufacturer shall conduct Group A and B quality conformance inspection as specified in paragraph 4.5 and prepare the test result and an implementation status of the quality assurance program and present these documents with the application for retention of qualification. The manufacturer may apply for retention of qualification without conducting Group B inspection when the following requirements are satisfied.

a) After initial certification, the manufacturer must have demonstrated good manufacturing practices for at least the last three years. Good manufacturing practices may be demonstrated by different products that were designed and manufactured in the same way.
b) No serious defects with the delivered products in last three years.

If products were not shipped during the effective period of certification and a quality conformance inspection was not conducted, the manufacturer may apply for retention of certification without conducting the quality conformance inspection.

3.1.4 Effective Period of Certification

The effective period of certification granted in compliance with this specification shall be three years.

3.1.5 Change of Qualification Coverage

To change the qualification coverage, the manufacturer shall perform procedures for re-qualification in accordance with paragraph 3.4.3 of JAXA-QTS-2000.

3.1.6 Applicable Requirements

Applicable requirements shall vary depending on the type of temperature sensors as specified in paragraph 3.3 to 3.8. When applying for sensor certification, the manufacturer shall identify tests not applicable for the type of sensor in accordance with the qualification test and the quality conformance inspections in the detail specification.

3.2 Quality Assurance Program

3.2.1 Establishment of a Quality Assurance Program

To acquire certification in accordance with this specification, the manufacturer shall be responsible for establishing a quality assurance program that satisfies the requirements specified in paragraph 3.3.1 of JAXA-QTS-2000 and this specification. The manufacturer shall generate a quality assurance program plan in accordance with paragraph 3.3.2 of JAXA-QTS-2000 and provide the plan to JAXA for review in accordance with paragraph 3.3.6 of JAXA-QTS-2000.

3.2.2 TRB Formation

To acquire a certification status in accordance with this specification, the manufacturer shall form and operate the Technical Review Board (TRB) in accordance with paragraph 3.3.5 of JAXA-QTS-2000.

3.3 Parts and Materials

Parts and materials used for manufacturing temperature sensors shall be specified in this specification. Parts or materials not specified in this specification shall satisfy the requirements of this specification and shall be specified in the manufacturing conditions of the quality assurance program.

3.3.1 Parts

3.3.1.1 Machined Parts

Machined parts used in a main structural body shall be subjected to a non-destructive inspection. The inspection shall be in accordance with the detail specification.

3.3.2 Materials

3.3.2.1 Compatibility with Fluids

Materials which come in contact with measured fluids shall be compatible with the basic fluids in Table 2. In addition, such materials shall be compatible with the special fluids designated in each detail specification. The materials shall meet the following requirements.

a) Compatibility with liquid oxygen
The materials shall be compatible with liquid oxygen in accordance with ASTM D2512. When a plumb bob is dropped on a striker pin placed on the material, the material shall not explode, emit light, combust, or discolor.

3.3.2.2 Outgassing

Organic substances used in the exposed external parts of temperature sensors shall meet the following criteria when tested in accordance with ASTM E 595. The application of this provision shall be as specified in the detail specification.

a) Total Mass Loss (TML): 1.0% or less
b) Collected Volatile Condensable Materials (CVCM): 0.1% or less

3.3.2.3 Radiation Hardness (Materials)

When in the atmosphere, the organic materials used in temperature sensors shall withstand a total radiation dose of 1×10^5Gy {1×10^7rad} as specified in the detail specification.

Table 2. Compatibility with Fluids

Fluid group		Fluid type	Standards (for reference)
Basic fluids		Helium gas	MIL-PRF-27407
		Nitrogen gas	MIL-PRF-27401
		Oxygen gas of 6.865Mpa {70kgf/cm^2} G[(1)] pressure as a maximum	MIL-PRF-25508
		Hydraulic fluid	MIL-H-5606
		Isopropyl alcohol	TT-I-753
		Deionized water	The specific resistivity shall be a minimum of 5,000Ωcm.
Special fluids	A-1	Liquid oxygen of 6.865Mpa {70kgf/cm^2} G[(1)] pressure as a maximum	MIL-PRF-25508
	A-2	Liquid oxygen and oxygen gas	MIL-PRF-25508
	B	Liquid nitrogen	MIL-PRF-27401
		Liquid hydrogen and hydrogen gas	MIL-PRF-27201
		Liquid helium	MIL-PRF-27407
	C	Hydrazine	MIL-PRF-26536
		Nitrogen tetroxide	MIL-PRF-26539
	D	Hydrazine (ordinary temperature)	MIL-PRF-26536
	E	Steam and hydrogen gas of high temperature	-

Note: [(1)] "G" indicates Gauge pressure.

3.4 Design and Construction

3.4.1 Major Construction

The temperature sensor assembly shall consist mainly of a sensing element which is built by tightly winding a platinum resistance wire around a mandrel, and a connector to output a temperature signal as a resistance, or an extension wire or a lead wire. The main structure of each type shall be as described below. Also, Figures 1 through 5 shall be used.

a) The probe type shall have a sensing element housed in a probe which is equipped with a protective tube. The mechanical strength of the sensing element shall be increased.

b) The extension wire type shall be such that a sensing element and an extension wire are connected at a transition joint which can be clamped.

c) The sheath type shall have a sensing element enclosed in a sheath to protect against corrosion.
d) The surface type shall be constructed of a sensing element and a lead wire.
e) Connectors shall be hermetically sealed.

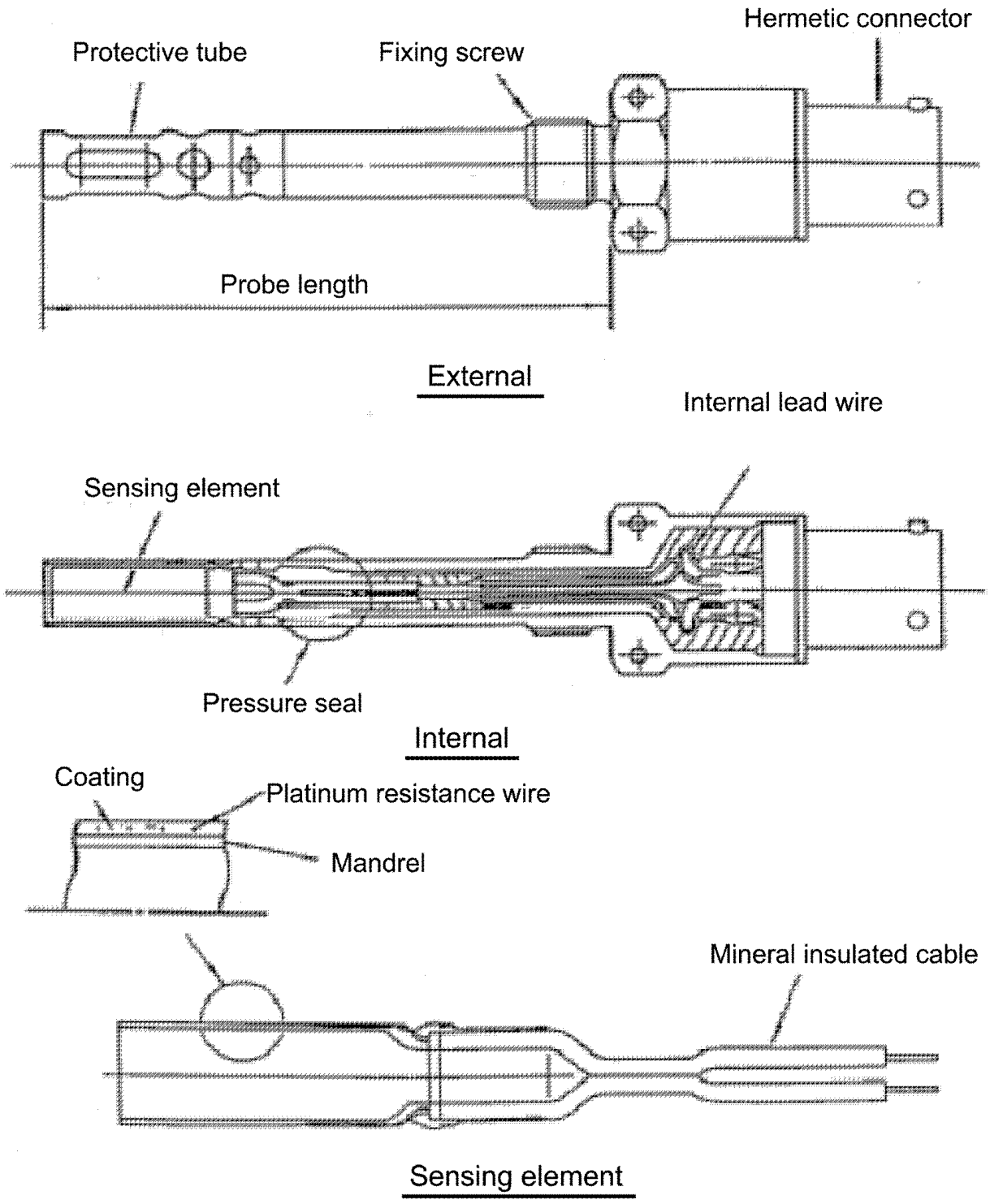


Figure 1. Temperature Sensor, Probe Type

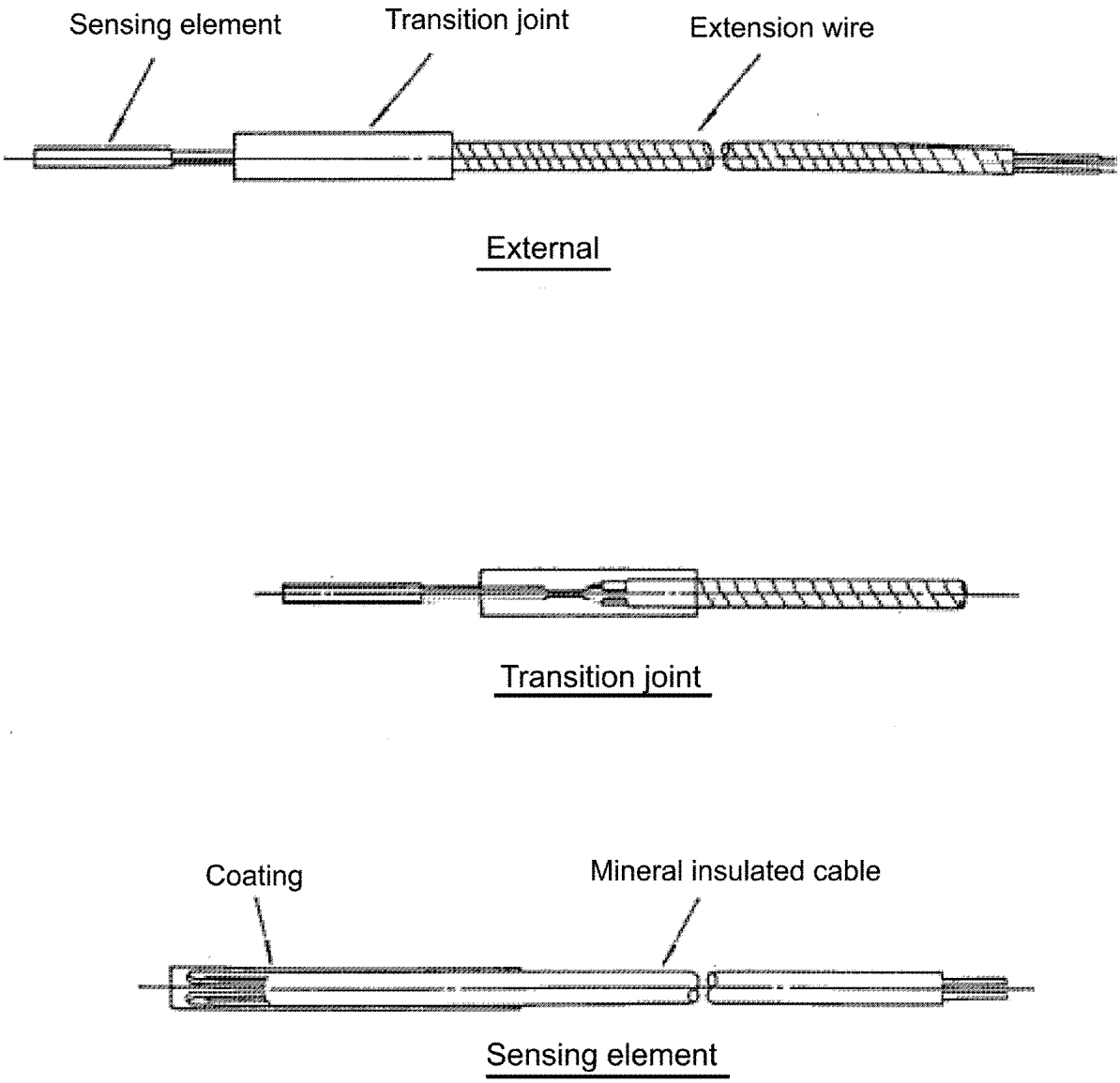
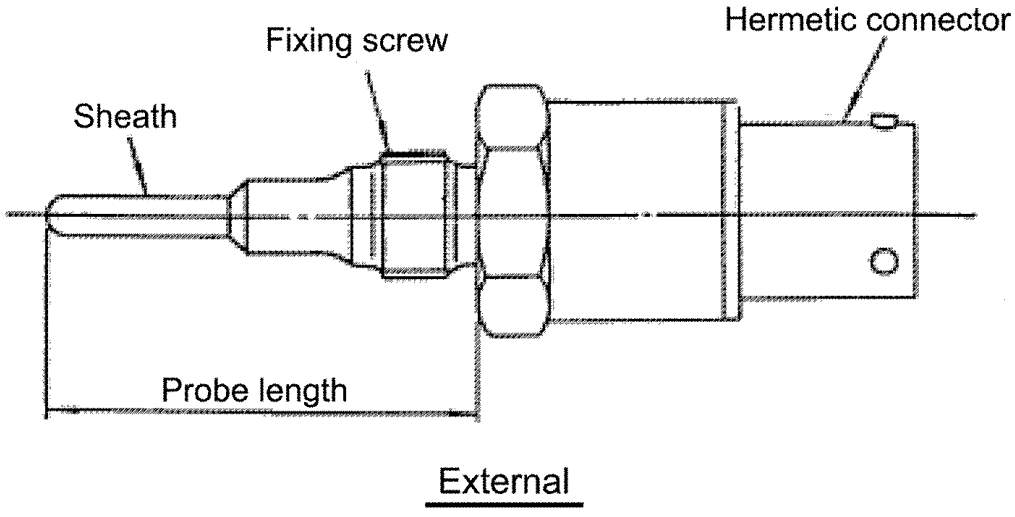
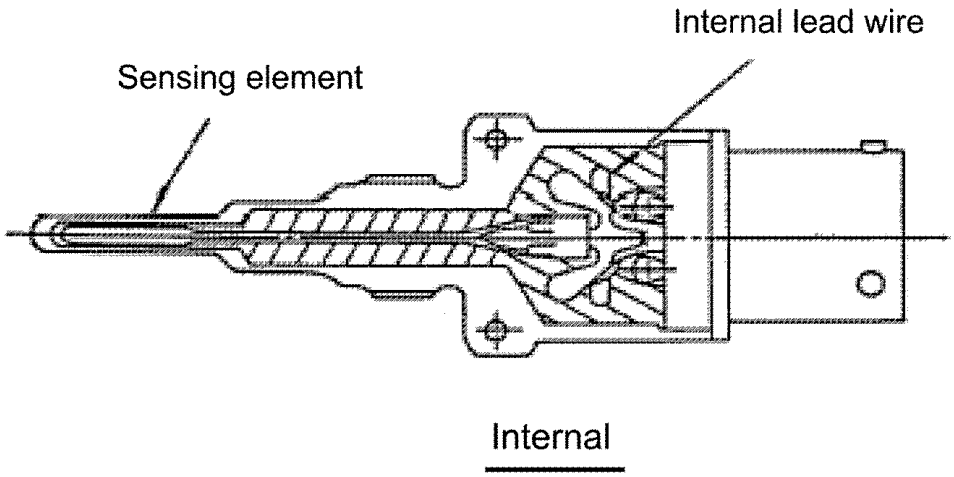


Figure 2. Temperature Sensor, Extension Wire Type





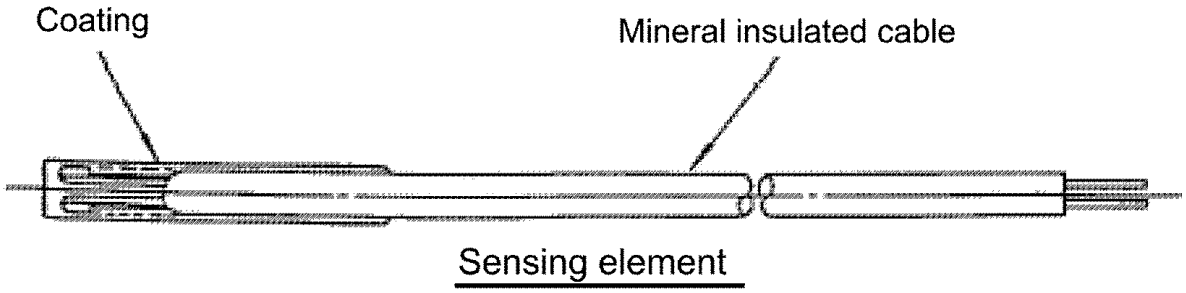


Figure 3. Temperature Sensor, Probe Sheath Type

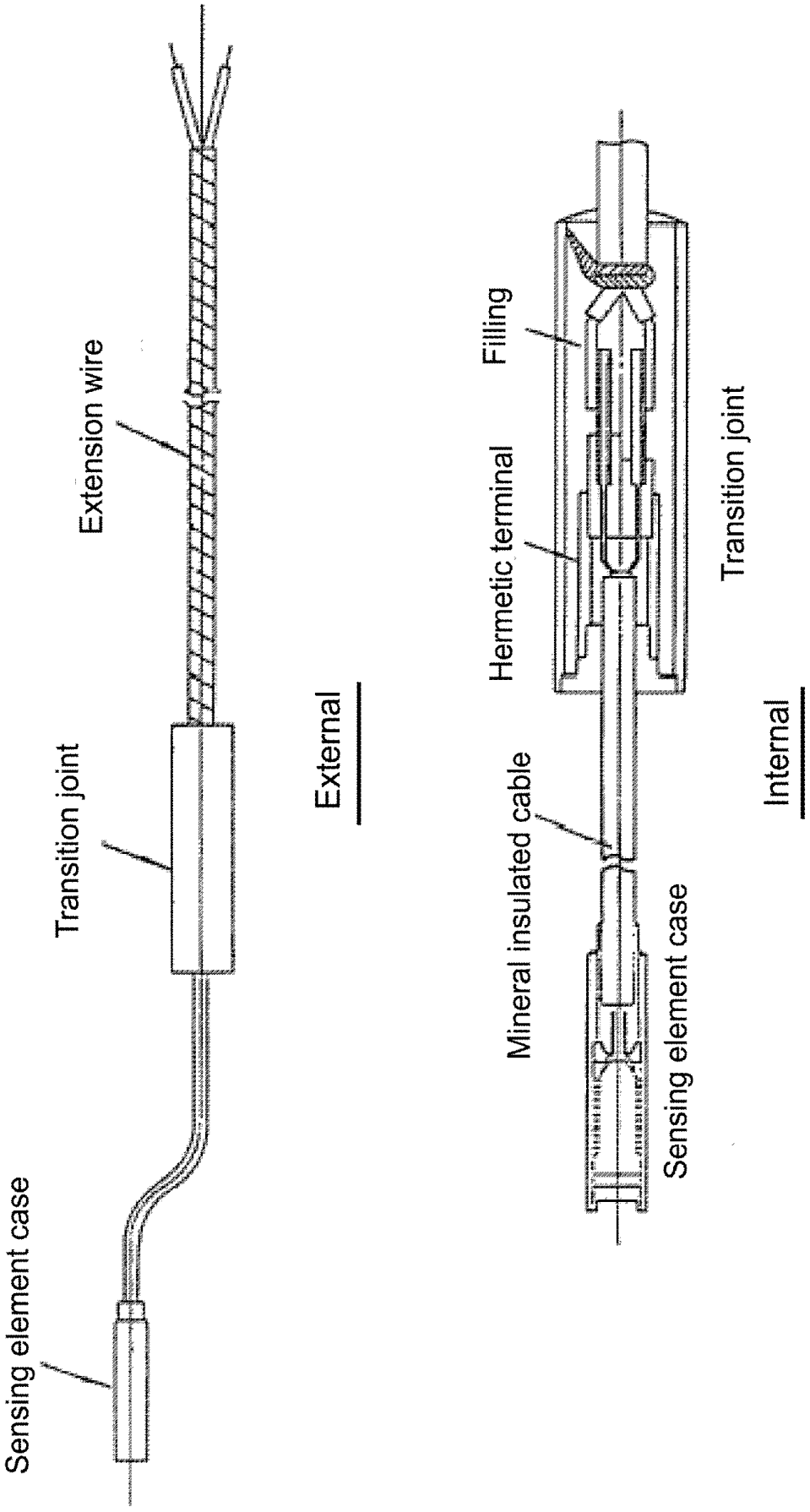


Figure 4. Temperature Sensor, Extension Wire Sheath Type

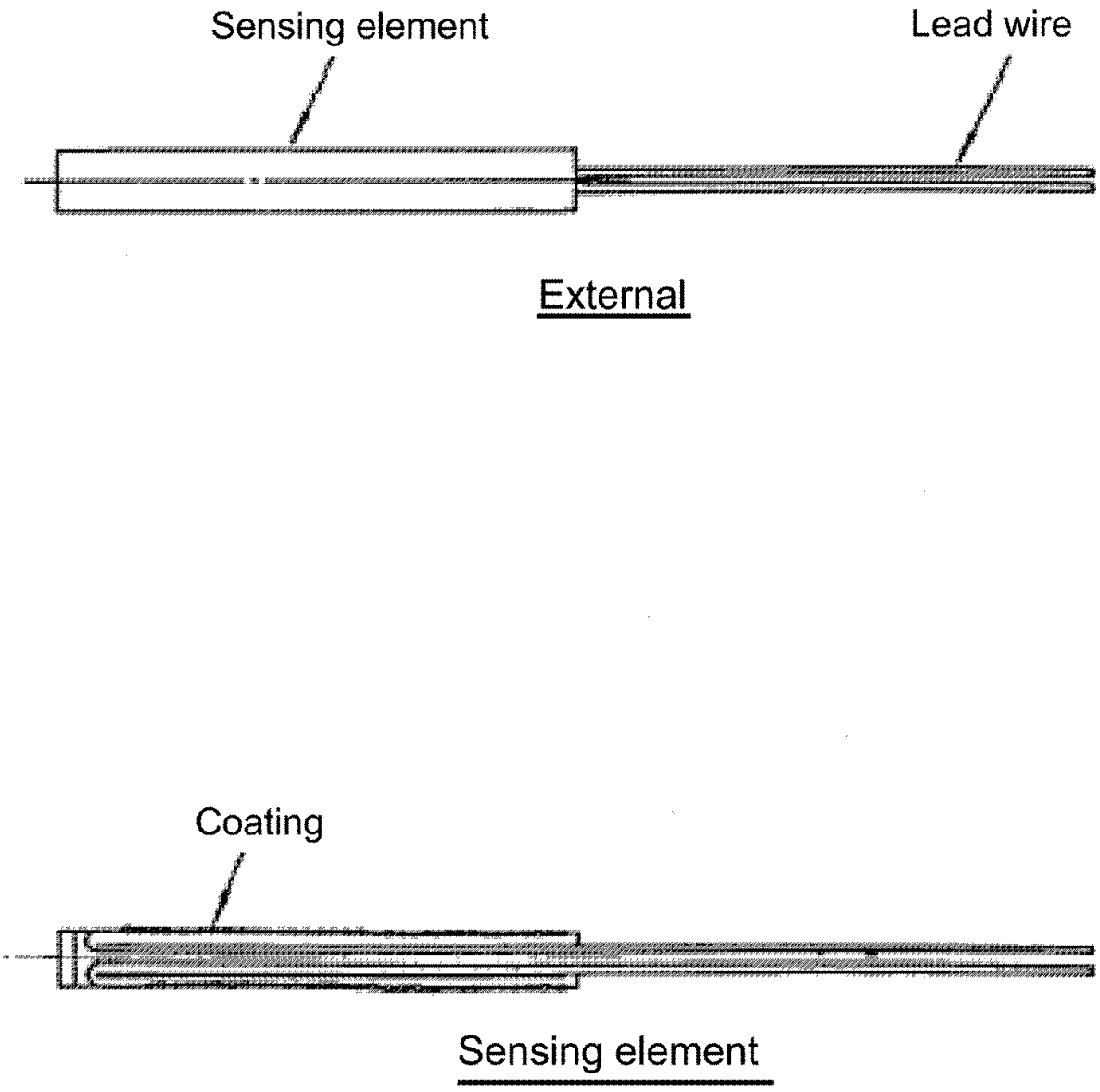


Figure 5. Temperature Sensor, Surface Type

3.5 Externals, Dimensions, Marking and Others

When tested as specified in paragraph 4.6.2, temperature sensors shall satisfy the following requirements.

a) Externals

There shall be no defect which may adversely affect the performance and reliability of temperature sensors.

b) Dimensions, Weight and Interfaces

Temperature sensors shall meet the requirements as specified in the detail specifications.

c) Marking

Unless otherwise specified, the following items shall be marked on the temperature

sensors. If marking on temperature sensors is not practical, a tag may be used for marking. The details shall be as specified in the detail specification.

1) Part name
2) Part number
3) Production number
4) Manufacturer's name
5) Year and month manufactured

3.6 Workmanship

Workmanship shall be in accordance with established manufacturing and inspection processes to assure that temperature sensors meet the requirements of this specification. Temperature sensors shall be processed, assembled and delivered in such a manner to ensure cleanliness and be free of dirt. In particular, processes such as measuring temperature, coating, heat treatment, welding and bonding shall be performed in such a manner to maintain high quality products.

3.6.1 Construction (DPA)

When tested in accordance with paragraph 4.6.3.1, temperature sensors shall satisfy the requirements specified in the detail specification.

3.6.2 Cleanliness

When tested as specified in paragraph 4.6.3.2 per 100ml wash solution, temperature sensors shall meet the following requirements.

a) Particle count
Temperature sensors shall meet the particle count requirements shown in Table 3. The level of the particle count requirements shall be specified in the detail specification.

b) Non-volatile residue
It shall be a maximum of 1mg.

Table 3. Particle Cleanliness Level

Particle size range d (μm)	Allowable particle count	
	Level A	Level B
5 ≤d≤10	N/A	1,200
10<d≤25	N/A	200
25<d≤50	100	50
50<d≤100	10	5(1)
100<d≤250	4	0
250<d	0	0

Note: (1) The metallic particles shall not be included.

3.7 Specification

Temperature sensors shall meet the requirements defined in the detail specification. The requirements shall include the following.

a) Measuring temperature range (operating temperature range)
b) Maximum operating pressure
c) Supply current
d) Nominal resistance

3.8 Characteristic Requirements

3.8.1 General

When tested in accordance with paragraph 4.6, temperature sensors shall meet the following requirements.

3.8.2 Basic Characteristics

3.8.2.1 Proof Pressure

When tested as specified in paragraph 4.6.4.1, temperature sensors shall not exhibit defects such as damaging deformation. In addition, no leakage shall be detected, as leak detection fluid is used.

3.8.2.2 Leakage

When tested as specified in paragraph 4.6.4.2, temperature sensors shall meet the following requirements.

a) Pressure cell
When the maximum operating pressure is applied to the pressure cell, the measured helium leak rate shall be 1.39×10^{-6} Pa·m^3/s {0.05 scch} or less.

b) Parts other than pressure cell
When temperature sensors are tested as specified in paragraph 4.6.4.2 b), the leakage rate through parts other than the pressure cell shall meet the applicable requirement specified in Table 4.

Table 4. Leakage

Unit: $Pa \cdot m^3/s$ {sccs}

Test method	Internal cavity volume (m^3)	Leak rate
4.6.4.2 b) 1) i	Less than $0.4x10^{-6}$	Max. 4.7×10^{-9} {4.7×10^{-8}}(1)
4.6.4.2 b) 1) ii	Min. $0.4x10^{-6}$	Max. 1.9×10^{-8} {1.9×10^{-7}}(1)
4.6.4.2 b) 1) iii	Min. $0.4x10^{-6}$	Max. 9.5×10^{-9} {9.5×10^{-8}}(1)
4.6.4.2 b) 2)	Max. $0.01x10^{-6}$	Max. 4.7×10^{-9} {4.7×10^{-8}}(2)
	More than $0.01x10^{-6}$ and $0.4x10^{-6}$ or less	Max. 9.5×10^{-9} {9.5×10^{-8}}(2)
	More than $0.4x10^{-6}$	Max. 9.5×10^{-8} {9.5×10^{-7}}(2)
4.6.4.2 b) 3)	-	Max. 5×10^{-9} {5×10^{-8}}(1)

Notes:
(1) Measured helium leak rate
(2) Equivalent standard leak rate

3.8.2.3 Insulation Resistance

When temperature sensors are tested as specified in paragraph 4.6.4.3, the insulation resistance of the temperature sensors shall exceed 50MΩ under the conditions specified in the detail specification.

3.8.2.4 Dielectric Withstanding Voltage

When tested as specified in paragraph 4.6.4.4, temperature sensors shall meet the following requirements.

a) The leakage current shall not exceed 0.5mA.
b) There shall be no evidence of damage such as arcing, flashover or insulation breakdown.

3.8.2.5 Interchangeability

When temperature sensors are tested as specified in paragraph 4.6.4.5, the interchangeability in the resistance temperature characteristic shall meet the requirements specified in the detail specification.

3.8.3 Other Characteristics

3.8.3.1 Strength of Extension Wire Connection

When temperature sensors are tested as specified in paragraph 4.6.5.1, there shall be no damage at the connection of the extension wire.

3.8.3.2 Over Current

When tested as specified in paragraph 4.6.5.2, temperature sensors shall meet the following requirements.

a) There shall be no open circuit.

b) The change in the resistance temperature characteristic shall conform to the repeatability requirements.

3.8.3.3 Pressure Dependence

When temperature sensors are tested as specified in paragraph 4.6.5.3, the magnitude of the temperature shift due to pressure application shall be corrected by the following formula.

$$\Delta T=f(T)P+g(T)P^2$$

Where:

ΔT: Magnitude of temperature shift (°C)
P: Pressure applied (MPaG)
T: Measuring temperature (°C)
$f(T)=a_0+a_1T+a_2T^2$
$g(T)=b_0+b_1T+b_2T^2$
a_i, b_i: Correction factor (i = 0, 1, 2)

The correction factors are specified below. The applicable level of the correction factors, pressure and temperature range shall be specified in the detail specification.

a) Level A

a_0	-7.63×10^{-3}	b_0	1.11×10^{-5}
a_1	-3.65×10^{-5}	b_1	1.38×10^{-7}
a_2	-3.37×10^{-8}	b_2	3.31×10^{-10}

b) Level B

a_0	-1.73×10^{-2}	b_0	2.85×10^{-5}
a_1	-7.15×10^{-5}	b_1	1.91×10^{-7}
a_2	-5.74×10^{-8}	b_2	8.60×10^{-10}

c) Level C

a_0	-4.94×10^{-3}	b_0	1.33×10^{-6}
a_1	-5.65×10^{-5}	b_1	2.70×10^{-7}
a_2	2.50×10^{-8}	b_2	-2.35×10^{-10}

d) Level D

a_0	-7.62×10^{-3}	b_0	3.44×10^{-7}
a_1	-2.60×10^{-5}	b_1	9.58×10^{-8}
a_2	-1.24×10^{-8}	b_2	-1.31×10^{-10}

3.8.3.4 Repeatability

When temperature sensors are tested as specified in paragraph 4.6.5.4, the repeatability shall meet the requirements as specified in the detail specification.

3.8.3.5 Response Time

When temperature sensors are tested as specified in paragraph 4.6.5.5, the response time shall be as specified in the detail specification.

3.8.3.6 Self-Heating

When temperature sensors are tested as specified in paragraph 4.6.5.6, the temperature rise due to self-heating shall meet the requirements specified in the detail specification.

3.8.3.7 Thermoelectromotive Force

When temperature sensors are tested as specified in paragraph 4.6.5.7, the thermoelectromotive force shall not exceed 75μV.

3.8.4 Environmental Characteristics

Temperature sensors shall satisfy the environmental characteristic requirements as specified in this section. At the completion of all environmental tests, the tests specified in Table 5 shall be conducted to verify conformance to the requirements specified. In addition, the repeatability test specified in paragraph 4.6.5.4 shall be performed at 0°C and 100°C, and temperature sensors shall meet the repeatability requirements.

Table 5. Post-Environmental Tests Requirements

Test item	Requirement paragraph	Test method paragraph
Externals, dimensions, marking and others	3.5	4.6.2
Proof pressure	3.8.2.1	4.6.4.1
Leakage (parts other than pressure cell)	3.8.2.2 b)	4.6.4.2 b)
Insulation resistance	3.8.2.3	4.6.4.3

3.8.4.1 Dynamic Pressure

When tested as specified in paragraph 4.6.6.1, temperature sensors shall meet the following requirements.

a) There shall be no intermittent output signals for 100μs or longer during the test.
b) There shall be no deformation, destruction or unusual noises.

3.8.4.2 Sinusoidal Vibration (I)

When tested as specified in paragraph 4.6.6.2, temperature sensors shall meet the following requirements.
a) There shall be no intermittent output signals for 100μs or longer during the test.
b) There shall be no deformation, destruction or unusual noises.

3.8.4.3 Sinusoidal Vibration (II)

When tested as specified in paragraph 4.6.6.3, temperature sensors shall meet the following requirements. This requirement shall be applied when specified in the detail specifications.
a) There shall be no intermittent output signals for 100μs or longer during the test.
b) There shall be no deformation, destruction or unusual noises.

3.8.4.4 Random Vibration

When tested as specified in paragraph 4.6.6.4, temperature sensors shall meet the following requirements.
a) There shall be no intermittent output signals for 100μs or longer during the test.
b) There shall be no deformation, destruction or unusual noises.

3.8.4.5 Shock

When tested as specified in paragraph 4.6.6.5, temperature sensors shall meet the following requirements.
a) There shall be no intermittent output signals for 100μs or longer during the test.
b) There shall be no deformation, destruction or unusual noises.

3.8.4.6 Radiation Hardness (Products)

When tested as specified in paragraph 4.6.6.6, temperature sensors shall meet the following requirements.
a) During the test, the output signal shall satisfy the requirements as specified in the detail specification.

3.8.4.7 Pressure Cycle

When tested as specified in paragraph 4.6.6.7, temperature sensors shall meet the following requirements.
a) There shall be no intermittent output signals for 100μs or longer during the test.
b) There shall be no deformation, destruction or unusual noises.

3.8.4.8 Humidity Resistance

When tested as specified in paragraph 4.6.6.8, temperature sensors shall meet the following requirements.
a) There shall be no deformation or destruction. Temperature sensors shall also meet the insulation resistance requirements as specified in the detail specification.

3.8.5 Life Characteristics

Temperature sensors shall meet the requirements on the life characteristics of this section. At the completion of all life tests, they shall conform to the requirements specified in Table 6.

Table 6. Post-Life Tests Requirements

Test item	Requirement paragraph	Test method paragraph
Externals, dimensions, marking and others	3.5	4.6.2
Proof pressure	3.8.2.1	4.6.4.1
Leakage (parts other than pressure cell)	3.8.2.2 b)	4.6.4.2 b)
Insulation resistance	3.8.2.3	4.6.4.3

3.8.5.1 Storage Life

When temperature sensors are tested as specified in paragraph 4.6.7.1, the accuracy of resistance temperature characteristic shall be within twice the limits specified in Table 8 at the temperature specified in Table 7.

Table 7. Calibration Temperature

Level	Calibration temperature
A	-269°C, -183°C, 0°C, 100°C
B	-269°C, -183°C, 0°C, 100°C, 260°C
C	-253°C, -183°C, 0°C, 100°C
D	-183°C, 0°C, 100°C, 260°C
E	0°C, 100°C, 420°C, 660°C, 930°C
F	-80°C, 0°C, 100°C, 420°C, 660°C, 930°C
G	-80°C, 0°C, 100°C, 420°C
H	-60°C, 0°C, 100°C, 420°C

Table 8. Calibration Accuracy of Temperature Sensors

Calibration temperature	Accuracy requirement
-80°C, -60°C, 100°C	Max. ±0.05°C
0, -183°C, -253°C	Max. ±0.02°C
-269°C	Max. ±0.1°C
260°C	Max. ±0.25°C
420°C	Max. ±0.25°C
660°C	Max. ±1.00°C
930°C	Max. ±1.00°C

Accuracy of measuring current: 10μA to 1mA; ±0.1%
Exceeding 1mA; ±0.2%
Accuracy of supply voltage: Max. ±2%

3.8.5.2 Operating Life

3.8.5.2.1 High Temperature Life

When temperature sensors are tested as specified in paragraph 4.6.7.2.1, the change in the resistance temperature characteristic shall meet the requirements specified in the detail specification. The calibration temperatures shall be 0°C and 100°C.

3.8.5.2.2 Temperature Cycling

When temperature sensors are tested as specified in paragraph 4.6.7.2.2, the change in the resistance temperature characteristic shall meet the requirements specified in the detail specification. The calibration temperatures shall be 0°C and 100°C.

3.8.6 Destructive Characteristics

3.8.6.1 Destructive Pressure

When tested as specified in paragraph 4.6.8.1, temperature sensors shall meet the following requirements.

a) They shall not break down.
b) There shall be no leakage when leak detection fluid is applied.
c) They shall conform to the requirements as specified in Table 9 after the completion of the test.

Table 9. Post-Destructive Pressure Test Requirements

Test item	Requirement paragraph	Test method paragraph
Externals, dimensions, marking and others	3.5	4.6.2
Insulation resistance	3.8.2.3	4.6.4.3

4. QUALITY ASSURANCE PROVISIONS

4.1 General Requirements

The QML manufacturer shall be responsible for implementing the quality assurance program specified in paragraph 3.2 and operation of the TRB.

4.2 Classification of Test and Inspection

The tests and inspections shall be classified as follows in accordance with paragraph 4.3 of JAXA-QTS-2000 as follows.

a) In-process inspection
b) Qualification test
c) Quality conformance inspection

4.3 In-Process Inspection

The QML manufacturer shall perform the in-process inspection shown below during the manufacturing process to detect any failure which could seriously affect the reliability and quality of the products, assure the workmanship, and characterize properties which cannot be measured using the finished products. The manufacturing flowchart in the quality assurance program plan shall define the inspection process.

a) Inspection for brazed or welded joints
b) Complete inspection for sensing elements
c) Humidity resistance test (only when specified in the detail specification)

4.4 Qualification Test

4.4.1 Samples

Samples shall be manufactured in accordance with the manufacturing specification, the process and control as specified in the quality assurance programs and shall also typify the qualification coverage.

4.4.2 Manufacturing Records

The manufacturer, which intends to acquire certification status, shall archive material certification, receiving inspection data or test data of parts and materials used, work records related to sample preparation, and in-process inspection data. These records shall be readily available upon request.

4.4.3 Test Items and Number of Samples

Test items and number of samples shall be as specified in Table 10. The test shall be performed in accordance with the flow specified in the Figure 6. Group tests shall be performed in subgroup order as shown in Table 10.

a) Four samples shall be prepared for each part number as specified in the detail specification. Two samples shall be grouped as “sample A” and two samples shall be grouped as “sample B” as shown in Figure 6.

b) When two or more types of temperature sensors are manufactured in accordance with the same design and process, and subjected to the same qualification test, the samples may be used to satisfy the quantity of samples specified in a) above.

c) For probe type temperature sensors manufactured using the same design and process, the temperature sensor with the longest probe shall be chosen as the representative sample as specified in a) above.

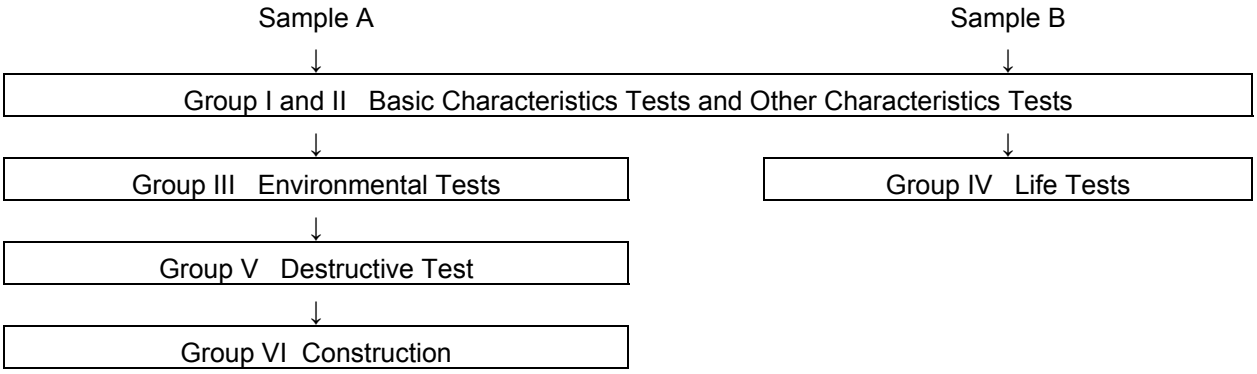


Figure 6. Qualification Test Flowchart

4.4.4 Criteria for Pass/Fail

If a sample fails in any test specified in the Table 10, it shall constitute failure of the qualification tests.

4.4.5 Disposition after Tests

The samples used in the qualification test shall not be delivered.
The products in the same inspection lot that have passed the qualification test may be delivered if they passed Group A inspections.

Table 10. Qualification Test

Group	Sub-group	Order	Test item	Requirement paragraph	Test method paragraph	Number of samples	Quantity of allowable defects
I Basic characteristics tests	A	1	Externals, dimensions, marking and others	3.5	4.6.2	4	0
		2	Proof pressure(1)	3.8.2.1	4.6.4.1		
		3	Leakage(1)	3.8.2.2	4.6.4.2		
	B	1	Insulation resistance	3.8.2.3	4.6.4.3		
		2	Dielectric withstanding voltage	3.8.2.4	4.6.4.4		
	C	1	Interchangeability	3.8.2.5	4.6.4.5		
	D	1	Humidity resistance(1)	3.8.4.8	4.6.6.8		
	E	1	Cleanliness(1)	3.6.2	4.6.3.2		
II Other characteristics tests	A	1	Strength of extension wire connection	3.8.3.1	4.6.5.1	4	0
		2	Over current	3.8.3.2	4.6.5.2		
		3	Pressure dependence	3.8.3.3	4.6.5.3		
	B	1	Repeatability	3.8.3.4	4.6.5.4		
		2	Response time	3.8.3.5	4.6.5.5		
		3	Self-heating	3.8.3.6	4.6.5.6		
		4	Thermoelectromotive force	3.8.3.7	4.6.5.7		
Group III Environmental tests	A	1	Dynamic pressure	3.8.4.1	4.6.6.1	2	0
	B	1	Sinusoidal vibration (I)	3.8.4.2	4.6.6.2		
	C	1	Random vibration	3.8.4.4	4.6.6.4		
	D	1	Shock	3.8.4.5	4.6.6.5		
	E	1	Radiation hardness (products)	3.8.4.6	4.6.6.6		
	F	1	Sinusoidal vibration (II)	3.8.4.3	4.6.6.3		
	G	1	Pressure cycle	3.8.4.7	4.6.6.7		
	H	1	Humidity resistance(1)	3.8.4.8	4.6.6.8		
IV Life tests	A	1	Storage life	3.8.5.1	4.6.7.1	2	0
		2	Operating life – High temperature life	3.8.5.2.1	4.6.7.2.1		
			Operating life – Temperature cycling	3.8.5.2.2	4.6.7.2.2		
V Destructive test	A	1	Destructive pressure	3.8.6.1	4.6.8.1	2	0
VI Construction	A	1	Construction (DPA)	3.6.1	4.6.3.1	2	0
-	-	1	Parts and materials	3.3	N/A	(2)	N/A

Notes:

(1) These tests may be performed during the manufacturing process. The leakage test is performed on the parts other than pressure cell (see 3.8.2.2 b).

(2) Data to certify compliance with design specifications shall be submitted.

4.5 Quality Conformance Inspection

4.5.1 Quality Conformance Inspection (Group A)

All the products shall be subjected to Group A inspection at the time of production.

4.5.1.1 Inspection Items and Sample Size

Group A inspection items, sample size and order of tests shall be as specified in Table 11.

Table 11. Quality Conformance Inspection (Group A)

Group	Sub-group	Order	Inspection item	Requirement paragraph	Test method paragraph	Number of samples	Quantity of allowable defects
I	A	1	Externals, dimensions, marking and others	3.5	4.6.2	All	0
		2	Proof pressure(1)	3.8.2.1	4.6.4.1		
		3	Leakage (parts other than pressure cell)(1)	3.8.2.2 b)	4.6.4.2 b)		
	B	1	Insulation resistance	3.8.2.3	4.6.4.3		
		2	Dielectric withstanding voltage	3.8.2.4	4.6.4.4		
	C	1	Interchangeability	3.8.2.5	4.6.4.5		
	D	1	Humidity resistance(1)	3.8.4.8	4.6.6.8		
II	A	1	Cleanliness(1)	3.6.2	4.6.3.2	All	0

Notes: (1) These tests may be performed during the manufacturing process.

4.5.1.2 Criteria for Pass/Fail

A failure of any test specified in Group A inspections shall constitute failure of the Group A inspections.

4.5.1.3 Disposition after Inspections

The lots rejected in Group A inspections shall not be delivered.

4.5.2 Quality Conformance Inspection (Group B)

Group B inspection shall be performed for the first products manufactured within the effective period of certification. When no products were manufactured during the effective certification period and the qualification retention was obtained without performing the inspection, Group B inspection shall be performed when production resumes.

4.5.2.1 Sample

Group B inspection lots shall consist of samples that have passed Group A inspections.

4.5.2.2 Test Items and Number of Samples

Test items and number of samples shall be as specified in Table 12. The test shall be performed in accordance with the flow specified in the Figure 7. Group tests shall be performed in subgroup order as shown in Table 12.

a) Two samples shall be prepared and be assigned to “sample A” and “sample B”, as shown in Figure 7.

b) Samples from two or more types of the temperature sensors manufactured with the same design and process and subjected to Group B inspection at the same time may be used as samples as specified in a) above.

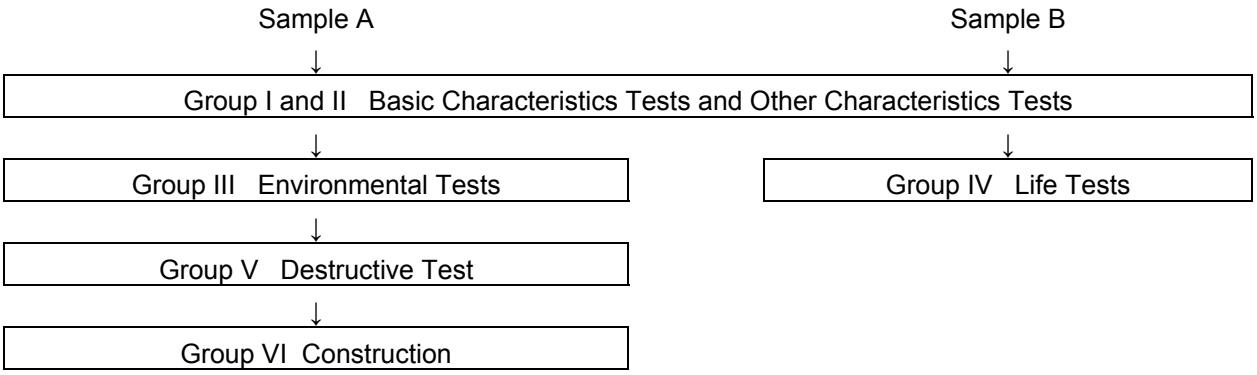


Figure 7. Flowchart of Quality Conformance Inspection (Group B)

4.5.2.3 Criteria for Pass/Fail

A failure of any test specified in Group B inspections shall constitute failure of Group B inspections.

4.5.2.4 Disposition after Inspections

The samples used for Group B inspections shall not be delivered. If the samples fail in Group B inspection, the manufacturer shall conduct a failure analysis on the defects and take corrective actions. Delivery of the products shall be suspended until corrective actions are approved by JAXA.

Table 12. Quality Conformance Inspection (Group B)

Group	Sub-group	Order	Inspection item		Require-ment paragraph	Test method paragraph	Number of samples	Quantity of allowable defects
I Basic characteristics tests	A	1	Externals, dimensions, marking and others		3.5	4.6.2	2	0
		2	Proof pressure(1)		3.8.2.1	4.6.4.1		
		3	Leakage(1)		3.8.2.2	4.6.4.2		
	B	1	Insulation resistance		3.8.2.3	4.6.4.3		
		2	Dielectric withstanding voltage		3.8.2.4	4.6.4.4		
	C	1	Interchangeability		3.8.2.5	4.6.4.5		
	D	1	Humidity resistance(1)		3.8.4.8	4.6.6.8		
	E	1	Cleanliness(1)		3.6.2	4.6.3.2		
II Other characteristics tests	A	1	Strength of extension wire connection		3.8.3.1	4.6.5.1	2	0
		2	Over current		3.8.3.2	4.6.5.2		
		3	Pressure dependence		3.8.3.3	4.6.5.3		
	B	1	Repeatability		3.8.3.4	4.6.5.4		
		2	Response time		3.8.3.5	4.6.5.5		
		3	Self-heating		3.8.3.6	4.6.5.6		
		4	Thermoelectromotive force		3.8.3.7	4.6.5.7		
III Environmental tests	A	1	Random vibration		3.8.4.4	4.6.6.4	1	0
	B	1	Shock		3.8.4.5	4.6.6.5		
IV Life tests	A	1	Operating life	High temperature life	3.8.5.2.1	4.6.7.2.1	1	0
				Temperature cycling	3.8.5.2.2	4.6.7.2.2		
V Destructive test	A	1	Destructive pressure		3.8.6.1	4.6.8.1	1	0
VI Construction	A	1	Construction (DPA)		3.6.1	4.6.3.1	1	0

Note: (1) These tests may be performed during the manufacturing process. The leakage test is performed on the parts other than pressure cell (see 3.8.2.2 b).

4.6 Method for Test or Inspection

4.6.1 Condition of Test and Inspection

Unless otherwise specified, all measurements and tests shall be made under the following conditions.

a) General conditions
   1) Ambient temperature: 23°C±10°C
   2) Relative humidity: 50±30%
   3) Air pressure: Atmospheric pressure (86 to 106kPa)

b) Measurement accuracy
   1) Temperature: ±2°C
   2) Current: ±5%
   3) Supply voltage: ±15%
   4) Pressure: +4%, -0% of the set pressure
   5) Random vibration acceleration:
      5.1) Power spectrum density: ±3dB (sharp peaks and notches: ±6dB)
      5.2) Grms: ±10%
   6) Shock:
      6.1) Shock spectrum: -2dB
   7) Frequency: ±2% or ±1Hz, whichever is greater
   8) Amplitude: ±2dB
   9) Acceleration: +2%, -5%

c) Calibration accuracy
   The calibration accuracy of the temperature sensors shall be as shown in Table 8.

d) Medium
   1) Nitrogen gas
   2) Ethyl alcohol
   3) Helium gas
   4) Liquid helium
   5) Liquid oxygen
   6) Liquid nitrogen
   7) Deionized water

e) Direction of axis: As specified in Figure 8.

f) Pin assignment and wiring diagram: As specified in the detail specifications.

4.6.2 Externals, Dimensions, Marking and Others

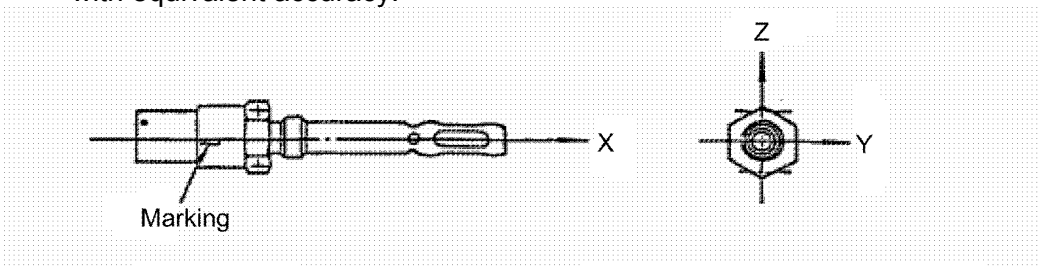
a) Externals
   Temperature sensors shall be inspected visually or by use of an approximate 20x magnifier in accordance with Test Method 2071 of MIL-STD-750.

b) Dimensions and Interfaces
   The dimensions shall be measured with a vernier caliper, micrometer or bench ruler.

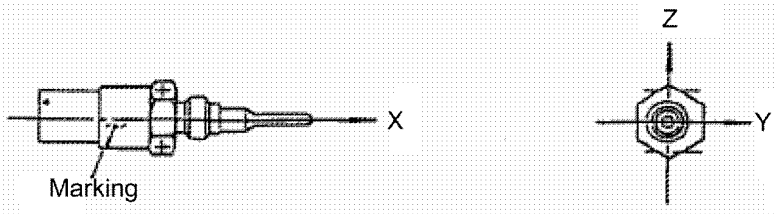
c) Marking
   The marking shall be visually inspected.

d) Mass
   The temperature sensor mass including an extension wire shall be measured using

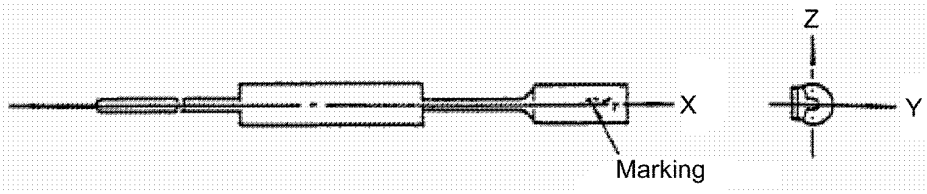
an electronic force balance that is capable of measuring at least 0.1g, or any scale with equivalent accuracy.



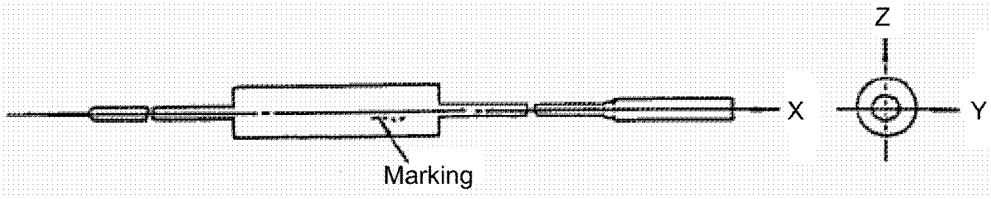
(1) Temperature Sensor, Probe Type



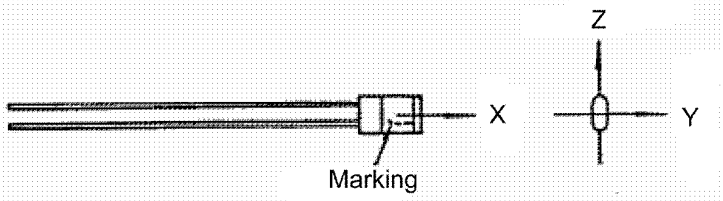
(2) Temperature Sensor, Probe Sheath Type



(3) Temperature Sensor, Extension Wire Type



(4) Temperature Sensor, Extension Wire Sheath Type



(5) Temperature Sensor, Surface Type

Figure 8. Direction of Axis of Temperature Sensors

4.6.3 Workmanship

4.6.3.1 Construction (DPA)

The temperature sensor shall be disassembled to ensure that the processes such as welding have been properly implemented and to verify that the internal structure and materials used are in accordance with the quality assurance program. The destructive physical analysis shall be performed as specified in the DPA manual of the quality assurance program.

4.6.3.2 Cleanliness

The cleanliness test shall be performed in accordance with the following methods by analyzing the 100ml of wash solution that was collected for 0.0929m^2 {1ft^2} of a temperature sensor.

a) Particles shall be counted in accordance with SAE-ARP 598.
b) The mass of non-volatile residue shall be measured.

4.6.4 Basic Characteristics Tests

4.6.4.1 Proof Pressure

A pressure of 1.5 times the maximum operating pressure shall be applied to the pressure cell for 10^{+5}_{0} minutes at ambient temperature. While the temperature sensor is under pressure, leakage through the pressure seal shall be measured with leak detection fluid.

4.6.4.2 Leakage

a) Pressure cell
The maximum operating pressure shall be applied to the pressure cell under the test temperature conditions as specified in Table 13. Under pressure, the leakage rate through the pressure seal shall be measured using a helium leak detector. The applicable level shall be as specified in the detail specification.

Table 13. Test Temperature

Unit: °C

Level	Test temperature
A	-269
B	$+850^{+30}_{0}$
C	$+430^{+30}_{0}$

b) Parts other than pressure cell
The parts other than pressure cell shall be tested in accordance with Test Method 112 of MIL-STD-202 and shall be subjected to either of the following test procedures.

1) Temperature sensors shall be tested under the condition i, ii or iii specified in Table 14 in accordance with the test procedure III a.

Table 14. Pressure and Exposure Time

No.	Internal cavity volume (m^3)	Pressure (kPa {kgf/cm^2})	Exposure Time (h)
i	Less than $0.4x10^{-6}$	411.9±19.6 {4.2±0.2}	$2\,^{+0.2}_{0}$
ii	Min. $0.4\ x10^{-6}$	411.9±19.6 {4.2±0.2}	$2\,^{+0.2}_{0}$
iii	Min. $0.4\ x10^{-6}$	205.9±9.8 {2.1±0.1}	$4\,^{+0.4}_{0}$

2) Temperature sensors shall be tested in accordance with Test Procedure III c, Test Condition C. The pressure and time exposure to helium gas shall be determined such that the measured helium leak rate, converted from the applicable equivalent standard leak rate, shall be $5\times10^{-9}Pa\cdot m^3/s$ or more.
3) The leakage rate shall be measured in accordance with Test Procedure IV, Test Condition C.

4.6.4.3 Insulation Resistance

The insulation resistance shall be measured in atmosphere or water. The applicable method shall be as specified in the detail specification.

a) Measurement in atmosphere
A test voltage of $100V_{DC}$ shall be applied between the two points specified below. The measurements shall be made in accordance with Test Method 302 of MIL-STD-202 using an insulation resistance tester.
1) Between an input/output terminal and the temperature sensor body
2) Between an input/output terminal and the grounded terminal

b) Measurement in water
The sensing element shall be immersed in deionized water maintained at ambient temperature. Measurements shall then be made when a test voltage of $100V_{DC}$ is applied between the two points as specified below.
1) Between an input/output terminal and the deionized water.
Precautions shall be taken to prevent the deionized water from contacting between the input/output terminals.

4.6.4.4 Dielectric Withstanding Voltage

The following dielectric withstanding voltage test shall be performed in accordance with Test Method 301 of MIL-STD-202. A test voltage of $100V_{AC}$ shall be applied for $1\,^{+0.5}_{0}$ minute between the two points specified below. The leakage current shall then be measured. After completion of the test, the temperature sensor external surface shall be inspected using an approximate 20x magnifier in accordance with paragraph 4.6.2.

a) Between an input/output terminal and the temperature sensor body.

b) Between an input/output terminal and the grounded terminal.

4.6.4.5 Interchangeability

A temperature sensor and graduated standard thermometer shall be immersed in a heating medium or heat block which shall maintain the calibration temperature specified in Table 7. A measuring current of 1mA shall be passed through the circuit. After confirming that the current flow is stable, the voltage generated at the sensor terminal shall be measured using a voltmeter. The applicable level of the calibration temperatures shall be as specified in the detail specification.

4.6.5 Other Characteristics Tests

4.6.5.1 Strength of Extension Wire Connection

The housing shall be securely fixed, and a 2.3±0.1kg weight shall be suspended using an extension wire for 5^{+5}_{0} seconds. Temperature sensors shall then be subjected to the following tests.

a) To verify that there are no abnormalities at the connection, the external surface shall be visually inspected using an approximate 20x magnifier.
b) Temperature sensors shall be inspected for conductivity.

4.6.5.2 Over Current

A direct current of 20mA shall be applied to temperature sensors for 10^{+5}_{0} minutes at ambient temperature under atmospheric pressure. The following tests shall then be performed.

a) The conductivity shall be inspected.
b) The interchangeability test as specified in paragraph 4.6.4.5 shall be performed before and after the test at the calibration temperatures of 0°C and 100°C.

4.6.5.3 Pressure Dependence

A temperature sensor shall be put into a vessel so that temperature load and pressure load can be simultaneously applied to the temperature sensing element, together with a graduated standard thermometer which is free from pressure dependent errors. A test pressure shall be applied to the temperature sensor sequentially at the specified temperature. The voltage generated at the terminal shall be measured using a voltmeter, and the pressure dependence shall be determined. The test temperature and pressure shall be as specified in the detail specification.

4.6.5.4 Repeatability

Temperature sensors shall be subjected to either level of the temperature cycling specified in Table 15 and between the upper and lower limits of the operating temperature. The test specified in paragraph 4.6.4.5 shall be performed before, during and after the temperature cycling. The applicable level of the temperature cycling shall be as specified in the detail specification.

Table 15. Temperature Cycling

Level	Number of cycles
A	30
B	10

4.6.5.5 Response Time

Temperature sensors shall be immersed into water with a flow rate of 0.9±0.1m/s and at a constant temperature of 76±4°C. During this immersion, the change in output shall be monitored continuously with a recorder. A 63% response time shall be determined from the recording chart.

4.6.5.6 Self-Heating

Temperature sensors shall be immersed into water with a flow rate of 0.9±0.1m/sec at a constant temperature of 76±4°C. A measuring current shall be passed through the sensing element with a gradual increase from 5mA up to 20mA, and the change in resistance shall be measured. The relationship between the temperature rise and power consumed at the temperature sensor shall be determined.

4.6.5.7 Thermoelectromotive Force

After stabilizing the temperature in an ambient environment, the temperature sensor shall be immersed in 0°C ice water. The thermoelectromotive force generated at the output terminal shall be measured for one minute after immersion using a voltmeter.

4.6.6 Environmental Tests

The environmental tests shall be performed in accordance with each paragraph of this section. After completion of all environmental tests, the tests specified in Table 5 shall be conducted, and the interchangeability test specified in paragraph 4.6.4.5 shall be performed at the calibration temperatures of 0°C and 100°C.

4.6.6.1 Dynamic Pressure

The temperature sensor shall be put into a water flow bath in which the dynamic pressure specified in Table 16 can be applied. The pressure cell shall be maintained under the water flow of ambient temperature for $840\ ^{+30}_{0}$ seconds. The output of the temperature sensor shall be recorded continuously during the test, and it shall be verified that there is no evidence of intermittent signal or abnormalities. The test shall be performed in each of the two mutually perpendicular axes Y and Z. The applicable level of the dynamic pressure in Table 16 shall be as specified in the detail specification.

Table 16. Dynamic Pressure

Level	Dynamic pressure
A	49.0kPa {0.5kgf/cm^2}G
B	98.1kPa {1.0kgf/cm^2}G
C	147.1kPa {1.5kgf/cm^2}G
D	294.2kPa {3.0kgf/cm^2}G

4.6.6.2 Sinusoidal Vibration (I)

The test for sinusoidal vibration shall be performed in accordance with Test Method 204 of MIL-STD-202. The vibration shall be applied to each of the three mutually perpendicular axes X, Y and Z under the conditions specified in Table 17. While being vibrated, the output shall be monitored continuously for evidence of intermittent signal or abnormalities. Within the frequency range of 5 to 34Hz, the test shall be performed under either the 12.7mm double amplitude or the maximum allowable amplitude.

Table 17. Sinusoidal Vibration (I)

Frequency range	Acceleration level	Sweep rate
5 to 100Hz	294.2m/s^2 {30G} (0-p)	2 oct/min

4.6.6.3 Sinusoidal Vibration (II)

The test for sinusoidal vibration shall be performed in accordance with Test Method 204 of MIL-STD-202. The vibration shall be applied to a test temperature of $-196\,^{+26}_{0}$ °C in each of the three mutually perpendicular axes X, Y and Z in accordance with the conditions specified in Table 18. While being vibrated, the output shall be recorded continuously for evidence of intermittent signal or abnormalities. A resonator may be used within the frequency range of 1,850±150Hz to achieve the acceleration level of 3,140m/s^2 (0-p).

Table 18. Test Condition of Sinusoidal Vibration

(High Frequency and High Acceleration)

Frequency range (Hz)	Acceleration level (m/s^2 {G} (0-p))	Other conditions
2,000 to 2,700	Min. 686 {70}	Sweep rate: 0.1oct/min
2,850 to 3,000	Min. 196 {20}	
1,850±150	Min. 3,140 {320}	Duration of vibration: $840\,^{+30}_{0}$ s

4.6.6.4 Random Vibration

The random vibration test shall be performed in accordance with Test Method 214 of MIL-STD-202. The vibration shall be applied to each of the three mutually perpendicular axes X, Y and Z under the condition specified in Table 19. While being vibrated, the output shall be recorded continuously for evidence of intermittent signal or abnormalities. The applicable level of the test conditions in Table 19 shall be as specified in the detail specification.

Table 19. Random Vibration (1/3)

<table>
<tr><th>Level</th><th>Vibration pattern</th><th>Duration of vibration (seconds)</th><th>Test temperature (°C)</th></tr>
<tr><td>A</td><td rowspan="5"><table><tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr><tr><td>10 to 50</td><td>9.62(m/s^2)^2/Hz
{0.1G^2/Hz}</td></tr><tr><td>50 to 100</td><td>+10dB/oct</td></tr><tr><td>100 to 1,200</td><td>101(m/s^2)^2/Hz
1.05G^2/Hz</td></tr><tr><td>1,200 to 2,000</td><td>-3 dB/oct</td></tr></table>Grms: 421.7m/s^2 {43G} (reference value)</td><td>840^{+30}_{0}</td><td>-196^{+26}_{0}</td></tr>
<tr><td>B</td><td>120^{+30}_{0}</td><td>-196^{+26}_{0}</td></tr>
<tr><td>C1</td><td>840^{+30}_{0}</td><td>800^{+100}_{0}
During the vibration time specified left, the test shall be performed at 930^{+70}_{0} °C for 20^{+20}_{0} seconds.</td></tr>
<tr><td>C2</td><td>840^{+30}_{0}</td><td>Ambient temperature</td></tr>
<tr><td>D</td><td>120^{+30}_{0}</td><td>Ambient temperature</td></tr>
<tr><td>E</td><td><table><tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr><tr><td>20 to 100</td><td>+6dB/oct</td></tr><tr><td>100 to 950</td><td>115(m/s^2)^2/Hz
{1.2G^2/Hz}</td></tr><tr><td>950 to 2,000</td><td>-6dB/oct</td></tr></table>Grms: 399.1m/s^2 {40.7G} (reference value)</td><td>120^{+30}_{0}</td><td>Ambient temperature</td></tr>
</table>

Table 19. Random Vibration (2/3)

<table>
<tr><th>Level</th><th>Vibration pattern</th><th>Duration of vibration (seconds)</th><th>Test temperature (°C)</th></tr>
<tr><td>F</td><td rowspan="4">
<table>
<tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr>
<tr><td>10 to 29</td><td>9.62(m/s^2)^2/Hz
{0.1G^2/Hz}</td></tr>
<tr><td>29 to 100</td><td>+6dB/oct</td></tr>
<tr><td>100 to 173</td><td>115(m/s^2)^2/Hz
{1.2G^2/Hz}</td></tr>
<tr><td>173 to 190</td><td>+5dB/oct</td></tr>
<tr><td>190 to 1,050</td><td>135(m/s^2)^2/Hz
{1.4G^2/Hz}</td></tr>
<tr><td>1,050 to 2,000</td><td>-6dB/oct</td></tr>
</table>
Grms: 441.3m/s^2 {45G} (reference value)
</td><td>120^{+30}_{0}</td><td>-196^{+26}_{0}</td></tr>
<tr><td>G1</td><td>840^{+30}_{0}</td><td>430^{+100}_{0}</td></tr>
<tr><td>G2</td><td>840^{+30}_{0}</td><td>Ambient temperature</td></tr>
<tr><td>H</td><td>120^{+30}_{0}</td><td>Ambient temperature</td></tr>
<tr><td>I</td><td rowspan="2">
<table>
<tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr>
<tr><td>10 to 21</td><td>+3.5dB/oct</td></tr>
<tr><td>21</td><td>5.58(m/s^2)^2/Hz
{0.058G^2/Hz}</td></tr>
<tr><td>21 to 31</td><td>+4.3dB/oct</td></tr>
<tr><td>31</td><td>9.62(m/s^2)^2/Hz
{0.1G^2/Hz}</td></tr>
<tr><td>31 to 70</td><td>+6dB/oct</td></tr>
<tr><td>70 to 96</td><td>48.1(m/s^2)^2/Hz
{0.5G^2/Hz}</td></tr>
<tr><td>96 to 320</td><td>+4.3dB/oct</td></tr>
<tr><td>320 to 500</td><td>269(m/s^2)^2/Hz
{2.8G^2/Hz}</td></tr>
<tr><td>500 to 760</td><td>-1dB/oct</td></tr>
<tr><td>760</td><td>231(m/s^2)^2/Hz
{2.4G^2/Hz}</td></tr>
<tr><td>760 to 1,050</td><td>+7.6dB/oct</td></tr>
<tr><td>1,050 to 2,000</td><td>549 (m/s^2)^2/Hz
{5.7G^2/Hz}</td></tr>
</table>
Grms: 882.6m/s^2 {90G} (reference value)
</td><td>120^{+30}_{0}</td><td>-196^{+26}_{0}</td></tr>
<tr><td>J</td><td>120^{+30}_{0}</td><td>Ambient temperature</td></tr>
</table>

Table 19. Random Vibration (3/3)

<table>
<tr><th>Level</th><th>Vibration pattern</th><th>Duration of vibration (seconds)</th><th>Test temperature (°C)</th></tr>
<tr><td>K</td><td>
<table>
<tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr>
<tr><td>20 to 40</td><td>50.5$(m/s^2)^2$/Hz
{0.525G^2/Hz}</td></tr>
<tr><td>40 to 80</td><td>+3dB/oct</td></tr>
<tr><td>80 to 124</td><td>101$(m/s^2)^2$/Hz
{1.05G^2/Hz}</td></tr>
<tr><td>124 to 170</td><td>+10dB/oct</td></tr>
<tr><td>170 to 800</td><td>289$(m/s^2)^2$/Hz
{3G^2/Hz}</td></tr>
<tr><td>800 to 980</td><td>-6dB/oct</td></tr>
<tr><td>980 to 1,200</td><td>192$(m/s^2)^2$/Hz
{2G^2/Hz}</td></tr>
<tr><td>1,200 to 2,000</td><td>-6dB/oct</td></tr>
</table>
Grms: 611m/s^2 {62.3G} (reference value)
</td><td>120^{+30}_{0}</td><td>Ambient temperature</td></tr>
<tr><td>L</td><td>
<table>
<tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr>
<tr><td>10 to 320</td><td>+4.3dB/oct</td></tr>
<tr><td>320 to 500</td><td>269$(m/s^2)^2$/Hz
{2.8G^2/Hz}</td></tr>
<tr><td>500 to 2,000</td><td>-1 dB/oct</td></tr>
</table>
Grms: 627.6m/s^2 {64G} (reference value)
</td><td>120^{+30}_{0}</td><td>-196^{+26}_{0}</td></tr>
<tr><td>M</td><td>
<table>
<tr><th>Frequency range (Hz)</th><th>Acceleration density</th></tr>
<tr><td>10 to 50</td><td>9.62$(m/s^2)^2$/Hz
{0.1G^2/Hz}</td></tr>
<tr><td>50 to 100</td><td>+10dB/oct</td></tr>
<tr><td>100 to 1,000</td><td>96.2$(m/s^2)^2$/Hz
{1G^2/Hz}</td></tr>
<tr><td>1,000 to 2,000</td><td>+10dB/oct</td></tr>
</table>
Grms: 715.9m/s^2 {73G} (reference value)
</td><td>840^{+30}_{0}</td><td>-196^{+26}_{0}</td></tr>
</table>

4.6.6.5 Shock

The shock test shall be performed in accordance with Test Method 213 of MIL-STD-202. The two types of shock pulse at each level specified in Table 20 shall be applied to each of the three mutually perpendicular axes X, Y and Z, for a total of 6 shocks. During the test, the output signal shall be recorded continuously for evidence of intermittent signal or abnormalities. The applicable level of the test conditions in Table 20 shall be as specified in the detail specification.

Table 20. Shock

Level	Frequency range (Hz)	Acceleration level
A	50 to 1,200	+6dB/oct
	1,200 to 4,000	14.7km/s^2 {1,500G}
B	50 to 600	+6dB/oct
	600 to 4,000	19.6km/s^2 {2,000G}
C	100 to 1,350	+9dB/oct
	1,350 to 4,000	19.6km/s^2 {2,000G}
D	33.3km/s^2 {3,400G}, 0.2ms, half-sine shock pulse	

4.6.6.6 Radiation Hardness (Products)

In the atmosphere, temperature sensors shall be radiated with gamma rays (Cobalt 60) at the rate of 0.5×10^4Gy to 1×10^4Gy per hour until the total radiation dose reaches 1×10^5Gy. While being vibrated, the output shall be recorded continuously for evidence of intermittent signal or abnormalities.

4.6.6.7 Pressure Cycle

The pressure cell shall be subjected to the pressure cycles of No. 1 and No. 2, respectively as specified below. During the test, the output shall be recorded continuously for evidence of intermittent signal or abnormalities.

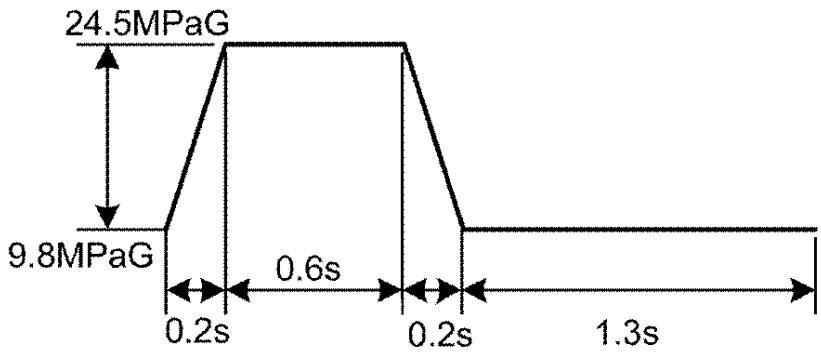
(a) Pressure cycle No. 1

Pressure range	9.8Mpa to 24.5Mpa G {100 to 250kgf/cm^2 G}
Cycle pattern	See the figure below.
Number of cycles	300
Test temperature	130±2°C

(b) Pressure cycle No. 2

Pressure range	9.8Mpa to 29.4Mpa G {100 to 300kgf/cm^2 G}
Cycle pattern(1)	-
Number of cycles	10
Test temperature	38±2°C

Note: (1) Cycle pattern is not specified. The pressure shall be confirmed.



4.6.6.8 Humidity Resistance

The humidity resistance test shall be performed in accordance with Test Method B-123 of EIAJ ED-4701. However, the test condition shall be as specified in Table 21. Level A shall apply when the humidity resistance test is included in the environmental tests. Level B shall apply when the humidity resistance test is included in the basic characteristics tests. The applicable level of the test conditions shall be as specified in the detail specification.

Table 21. Humidity Resistance

Level	A	B
Test temperature	130±2°C	130±2°C
Humidity	100% RH	85±5% RH
Pressure	265kPa±26.5kPa abs {2.7kg/cm^2±0.27kg/cm^2 abs}	226kPa±22.6kPa abs {2.3kg/cm^2±0.23kg/cm^2 abs}
Duration	$4\,^{+1}_{0}$ hours	Min. 2 hours

4.6.7 Life Tests

The life tests shall be performed in accordance with this section. After completion of all the life tests, the tests specified in Table 6 shall be conducted.

4.6.7.1 Storage Life

The temperature sensors shall be kept in a temperature bath in accordance with the test conditions specified in Table 22. The test shall be performed without applying an electric current. After conclusion of the test, the temperature accuracy shall be measured at the calibration temperatures specified in Table 7. The applicable level of the test conditions of Table 22 shall be as specified in the detail specification.

Table 22. Storage Life Test

Level	Ambient temperature	Duration
A	Min. 120°C	$120\ ^{+6}_{0}$ hours
B	Min. 150°C	$336\ ^{+6}_{0}$ hours

4.6.7.2 Operating Life

4.6.7.2.1 High Temperature Life

A temperature sensor shall be immersed in a high temperature bath in accordance with the test conditions specified in Table 23. During the test, the maximum rated current shall be applied continuously to the temperature sensor, and the output shall be recorded. After the test, the change in the resistance shall be inspected at the calibration temperatures of 0°C and 100°C. The applicable level of the test conditions in Table 23 shall be as specified in the detail specification.

Table 23. High Temperature Life

Level	Temperature	Duration	Other conditions
A	Min. +75°C	$240\ ^{+6}_{0}$ hours	
B	Min. +150°C	$2{,}400\ ^{+6}_{0}$ hours	
C	Min. +250°C	$480\ ^{+6}_{0}$ hours	
D	Min. +930°C at the temperature sensing element	$500\ ^{+6}_{0}$ hours	
E	Min. +850°C at the temperature sensing element	$2{,}000\ ^{+60}_{0}$ seconds	The maximum operating pressure shall be applied.
F	Min. +430°C at the temperature sensing element	$500\ ^{+6}_{0}$ hours	

4.6.7.2.2 Temperature Cycling

The temperature sensing element shall be subjected to the temperature cycling test specified in Table 24. During the test, the maximum rated current shall be applied to the temperature sensor, and the output shall be recorded. After the test, the change in the resistance shall be inspected at the calibration temperatures of 0°C and 100°C. The applicable level of the test conditions in Table 24 shall be as specified in the detail specification.

Table 24. Temperature Cycling

Level	Temperature		Number of cycles
A	Low temperature	Lower limit of the operating temperature range	30
	High temperature	Upper limit of the operating temperature range	
B	Low temperature	+40°C	1,000
	High temperature	+85°C	
C	Low temperature	Ambient temperature	2,000
	High temperature	+930°C	
	Low temperature	Ambient temperature	18,000
	High temperature	+510°C	
D	Low temperature	-196°C	1,000
	High temperature	+120°C	
E	Low temperature	Ambient temperature	2,000
	High temperature	+430°C	
	Low temperature	Ambient temperature	18,000
	High temperature	+235°C	

4.6.8 Destructive Test

4.6.8.1 Destructive Pressure

The destructive pressure test shall be performed in accordance with the following procedures.

a) A pressure 2.5 times the maximum operating pressure shall be applied to the pressure cell for 10^{+5}_{0} minutes.

b) Under pressure, the pressure cell shall be visually inspected for any breakage.

c) The leakage through the pressure seal shall be measured using leak detection fluid.
d) At the conclusion of this test, the tests specified in Table 9 shall be performed.

4.7 Long-Term Storage

4.7.1 Disposition of Lots Stored for a Long-Term at the Manufacturer's Site

When products have been stored at the manufacturer's site for 12 months or longer after the Group A inspection, the manufacturer shall perform 100% inspection of the Group A inspection. Only the temperature sensors which have passed such tests can be shipped as products.

4.7.2 Storage by Purchasers

The purchaser's storage conditions and/or shelf life requirements shall be as follows. The anti-pollution bag (vacuum packaging) shall not be opened until immediately before use. When opening the package for acceptance inspection, the purchaser shall meet the requirements specified in the detail specification.

a) Ambient temperature: -30 to +60°C
b) Relative humidity: Maximum 70%
c) Shelf life: 7 years

4.8 Change of Tests and Inspections

Any change of the in-process inspection and quality conformance inspection specified in this specification shall be made in accordance with paragraphs 4.4 and 6.1 of JAXA-QTS-2000.

5. PREPARATION FOR DELIVERY

Preparation for delivery shall be as follows and as specified in section 5 of JAXA-QTS-2000.

5.1 Packaging

The temperature sensors shall be packaged in an appropriate manner for high reliability parts.

a) Unit packaging
Each temperature sensor shall be packaged separately in an appropriate manner.
b) Packaging
The individually packaged temperature sensors shall be wrapped with a cushioning material and packaged in an appropriate case. If necessary, detailed requirements shall be specified in the procurement document.

5.2 Marking on Package

The following shall be marked on a unit package or whole package.

a) Part name
b) Part number
c) Applicable specification number
d) Lot identification code
e) Purchaser's name

f) Manufacturer's name
g) Quantity of packages
h) Date of inspection
i) Inspection result

6. NOTES

6.1 Notes for Manufacturer

6.1.1 Preparation and Registration of Application Data Sheet

The manufacturer shall prepare the application data sheet in accordance with Appendix G of JAXA-QTS-2000 and register it with JAXA. The application data sheet shall contain the following information.

a) Usage
   1) Recommended conditions for securing and bonding a temperature sensor shall be specified.
   2) Measurement error factors as well as effects of thermal-vacuum environments, cavitation and temperature distribution in the extension wire shall be described.

b) Failure rate
   Useful data for estimating failure rates shall be accumulated from test results. The failure rate at a 90% confidence level shall be calculated and described. The failure rate calculation shall be in accordance with paragraph H.3.1 of JAXA-QTS-2000.

c) Conditions of life tests
   The basis for establishing temperature and duration conditions for the storage life test (paragraphs 3.8.5.1 and 4.6.7.1) and high temperature life test (paragraphs 3.8.5.2.1 and 4.6.7.2.1) shall be specified.

d) Special tests
   Special tests shall be performed to determine environmental characteristics. The results shall be specified.

e) Handling procedures and notes
   Recommended methods for storage and notification of transportation and mounting shall be specified.

f) Notification on the procurement documents
   The following shall be specified in the procurement documents.
   1) The length of a mineral insulated cable and extension wire
   2) Bending work of a mineral insulated cable

g) Contact information
   The name of the manufacturer and the contact points shall be specified.

6.2 Notes for Acquisition Officers

Refer to the application data sheet for the detailed product data and notes.

6.2.1 Items to be Specified for Procurement

To purchase temperature sensors manufactured in compliance with this specification, the purchaser shall provide the following information.

a) Part number
b) This specification number
c) Detail specification number
d) Indication of test data or source inspection results to be submitted for delivery
e) Others (Including information specified in 6.1.1 f))

As mentioned in e), requirements other than those defined in this specification may be specified for special applications. However, if there is a conflict with the existing requirements in this specification, the purchaser shall not request the manufacturer to indicate that the temperature sensor complies with this specification.