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Approved September 29, 1995

Standard

Specifications and Tests for Potentiometric Pressure Transducers

ISA-S37.6 — Specifications and Tests for Potentiometric Pressure Transducers

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Preface

This preface, as well as all footnotes and annexes, is included for information purposes and is not part of ISA-S37.6.

This standard has been prepared as a part of the service of ISA, the international society for measurement and control, toward the goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P.O. Box 12277; Research Triangle Park, NC 27709; Telephone: (919) 549-8411; Fax: (919) 549-8288; E-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards, recommended practices, and technical reports. The Department is further aware of the benefits to USA users of ISA Standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, which has been published by the Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1992, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards, recommended practices, and technical reports. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards which ISA develops.

This Standard is intended as a guide for technical personnel at user facilities as well as by manufacturers' technical and sales personnel whose duties include specifying, calibrating, testing or showing performance characteristics of potentiometric pressure transducers. By basing users' specifications as well as technical advertising and reference literature on this Standard, or by referencing portions thereof, as applicable, a clear understanding of the users' needs or of the transducers' performance capabilities, and of the methods used for evaluating or proving performance, will be provided. Adhering to the specification outline, terminology and procedures shown will not only result in simple, but also complete specifications; it will also reduce design time, procurement lead time, and labor, as well as material costs. Of major importance will be the reduction of qualification tests resulting from use of a commonly accepted test procedure and uniform data presentation.

The development of this Standard was initiated as the result of a survey conducted in December, 1960. A total of 240 questionnaires was sent out to transducer users and manufacturers. A strong majority indicated in their replies a need for transducer standardization. As potentiometric pressure transducers were one of the types shown to be most in need of standardization, a project subcommittee, SP37.6, Potentiometric Pressure Transducers, was formed under the cognizance of Committee SP37, Transducers for Aerospace Testing, and a standard was developed and published in 1967. Subsequently, the standard was reviewed extensively, and revised in 1974. The reviewers were selected from a broad cross-section of all industries and sciences in which transducers are applied for measuring purposes.

The following individuals served on the 1969 SP37 committee:

NAME	COMPANY
P. S. Lederer, Chairman	National Bureau of Standards
J. F. Mayo-Wells	National Bureau of Standards
R. R. Bouche	ENDEVCO
H. C. Chandon	Rosemount, Inc.
J. Hilten	National Bureau of Standards
H. N. Norton	Jet Propulsion Laboratory
J. J. Elengo	Revere Corporation of America
O. C. Ingebritsen	NASA/Langley Research Center
R. D. Bronson	Lockheed Electronics Company
J. Z. Inskeep	Jet Propulsion Laboratory

The following individuals served on the ISA Committee SP37, who reaffirmed ISA-S37.5 in 1995:

NAME	COMPANY
E. Icayan, Chairman	Westinghouse Hanford Co.
J. Weiss	Electric Power Research Inst.
P. Bliss, Deceased	Consultant
M. Brigham	The Supply System
D. Hayes	LA Dept. Water & Power
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D. Norton	McDermott Energy Svces Inc.
H. Norton	Consultant
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R. Whittier	Endevco
J. Wilson	Consultant

This standard was reaffirmed by the ISA Standards and Practices Board on September 29, 1995.

NAME	COMPANY
M. Widmeyer, Vice President	Washington Public Power Supply System
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H. Dammeyer	Phoenix Industries, Inc.
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NAME	COMPANY
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R. Reimer	Allen-Bradley Company
R. Webb	Pacific Gas & Electric Company
W. Weidman	Consultant
J. Weiss	Electric Power Research Institute
J. Whetstone	National Institute of Standards & Technology
C. Williams	Eastman Kodak Company
G. Wood	Graeme Wood Consulting
M. Zielinski	Fisher•Rosemount

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1 Scope

1.1 This Standard covers potentiometric pressure transducers, primarily those used in measuring systems.

1.2 Included among the specific versions of potentiometric pressure transducers to which this Standard is applicable are the following:

Absolute Pressure Transducers

Differential Pressure Transducers

Gage Pressure Transducers

1.3 Technology used in this document is defined in ISA-S37.1. Additional terms considered applicable to potentiometric pressure transducers are defined in 4.3 of this document. An asterisk appears after those terms defined in S37.1. A double asterisk appears after those terms defined in 4.3.

2 Purpose

This Standard establishes the following for potentiometric pressure transducers.

2.1 Uniform minimum specifications for design and performance characteristics

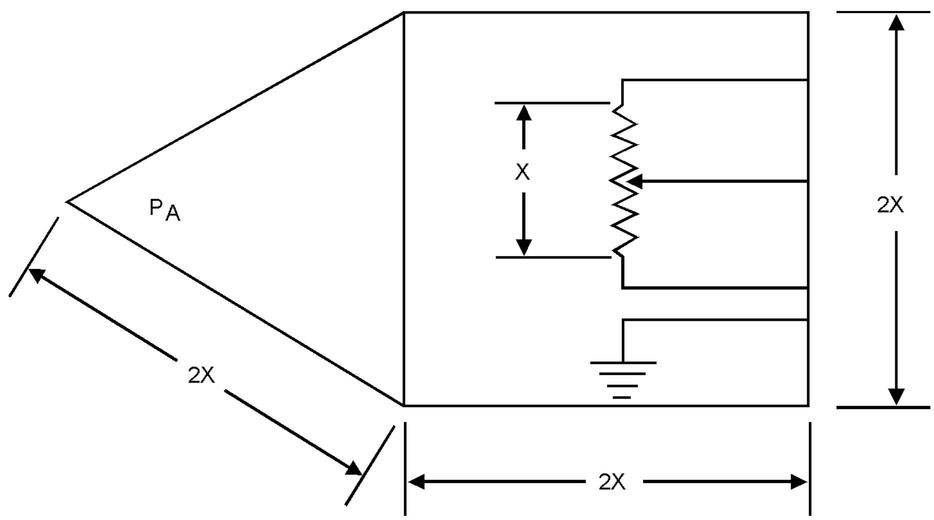
2.2 Uniform acceptance and qualification test methods, including calibration techniques

2.3 Uniform presentation of minimum test data

2.4 A drawing symbol for use in electrical schematics

3 Drawing symbol

3.1 The drawing symbol for a potentiometric pressure transducer is a square with an added equilateral triangle, the base of which is the left side of the square. The letter "P" in the triangle designates "pressure" and the subscripts denote the second modifier (the illustration shows an absolute pressure transducer, as symbolized by "P_A").



Subscripts

A = Absolute
D = Differential
G = Gage
S = Sealed Reference Differential (see 4.3)

3.2 The potentiometer is symbolized by a variable resistance of length x. The lines from it and to ground represent the electrical leads or terminations.

4 Specification characteristics

4.1 Design characteristics

4.1.1 Required mechanical design characteristics

The following mechanical design characteristics shall be listed.

4.1.1.1 Type Of pressure sensed

Absolute Pressure*

Differential Pressure, Unidirectional*

Differential Pressure, Bidirectional*

Differential Pressure, Sealed Reference**

Gage Pressure*

*Defined in ISA-S37.1
**Defined in 4.3

NOTES

1. At present, no provision is made by the SI system of units for abbreviations following the pressure units to indicate the type of pressure, as is done in the U.S. customary system of units; e.g., psia for absolute pressure in psi. In the interim it is recommended that for the SI system, the type of pressure be indicated in this manner: ". . . An absolute pressure of ____Pa." ". . . A differential pressure range of ____ kPa," etc.

2. For differential pressure transducers, the allowable range of reference pressures shall be listed; e.g., "0 to 1MPa" or "0 to 100 psi."

4.1.1.2 Measured fluids*

The fluids in contact with pressure port(s) shall be listed; e.g., nitric acid, liquid oxygen. Requirements for and limitations on the isolating element (if used) shall be listed.

4.1.1.3 Configuration and dimensions

The outline drawing shall show the configuration with dimensions in millimeters (inches). Unless pressure and electrical connections are specified (reference 4.1.1.5 and 4.1.3.4), the outline shall include limiting maximum dimensions for these connections.

4.1.1.4 Mountings and mounting dimensions

Unless the pressure connection serves as a mounting, the outline drawing shall indicate the method of mounting with hole size, centers, and other pertinent dimensions in millimeters (inches), including thread specifications for threaded holes, if used.

4.1.1.5 Pressure connection

The pressure connection(s) shall be indicated on the outline drawing. For threaded fittings, specify Applicable Military or Industry standards or nominal size, number of threads per millimeter (threads per inch), thread series, and thread class. For hose tube fitting, specify tube size.

4.1.1.6 Mounting effects

The maximum mounting force or torque shall be specified if it will tend to affect transducer performance (reference 4.2.28).

4.1.1.7 Mass

The mass of the transducer shall be specified to grams (ounces).

4.1.1.8 Case sealing

If case sealing is necessary, the mechanism and materials used for sealing should be described. The same requirement applies to the electrical connector. The resistance of the sealing materials to cleaning solvents and commonly used measured fluids should be stated.

4.1.1.9 Identification

The following characteristics shall be permanently inscribed on the outside of the transducer case or on a suitable nameplate permanently attached to the case.

a) Nomenclature of transducer (according to Section 3 of ISA-S37.1)

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*Defined in ISA-S37.1

b) Name of Manufacturer, (Part number to reflect one controlled configuration), and Serial Number

c) Range* in Pa (psi) and designation of type of pressure (see 4.1.1.1). Maximum excitation*

d) Transduction element resistance* (Potentiometric Element)

e) Identification of Measured and Reference Ports* (for differential pressure transducers)

f) Reference Pressure Range* (for differential pressure transducers)

g) Identification of Electrical Connections

h) Inscription of the following characteristics is optional:

i) Customer Specification or Part Number or both

j) Type of Electrical Connector and Mating Connector (if applicable)

k) Operating Temperature Range**

l) Proof Pressure*

NOTE — Identification of Pressure Ports may be abbreviated MEAS & REF.

4.1.2 Supplemental mechanical design characteristics

Listing of the following mechanical design characteristics is optional.

4.1.2.1 Case material

Where applicable, state the surrounding environmental condition requirement or compatibility.

4.1.2.2 Sensing element

The sensing element type shall be specified; e.g.,

a) diaphragm (flat or corrugated)*;

b) capsule*;

c) bellows*; and

d) bourdon tube* - "C" or "U" shaped, spiral, helical, or twisted.

NOTE — Where used, an isolating element with transfer fluid shall be detailed as to composition.

4.1.2.3 Damping fluid

Where used, the type, composition, temperature characteristics, and compatibility with transducer components shall be specified.

*Defined in ISA-S37.1
**Defined in 4.3

4.1.2.4 Number of potentiometric elements** or taps**

Where more than one potentiometric transducer element or a tapped element is required, they shall be specified.

4.1.2.5 Dead volume

The dead volume shall be given in cubic millimeters (cubic inches). For differential pressure transducers, the volume of both cavities should be listed.

4.1.2.6 Volume change due to full scale pressure

The change in volume of the sensing element due to application of full scale pressure shall be given in cubic millimeters (cubic inches).

4.1.2.7 Materials in contact with the measured fluid

The materials in contact with the measured fluid shall be listed.

> **NOTE —** For differential pressure transducers, materials in both ports must be considered.

4.1.2.8 Gage vent (port)

In gage pressure transducers where the transduction element is exposed to ambient atmosphere, the allowable types and concentrations of atmospheric contaminant shall be specified.

4.1.2.9 Maximum and minimum temperatures

The maximum and minimum temperatures of fluids or environments, which can be applied to the transducer and which will not cause permanent calibration shift, shall be listed.

> **NOTE —** Exposure time shall be specified, if relevant.

4.1.3 Required electrical design characteristics

The following electrical design characteristics shall be listed. All are applicable at Room Conditions.*

4.1.3.1 Excitation*

Expressed as "____volts (mA) DC" or "____ volts (mA) AC rms at ____ Hz."

4.1.3.2 Maximum excitation

Expressed as "____volts (mA) DC" or "____volts (mA) AC rms at ____ Hz."

4.1.3.3 Transduction element resistance*

Expressed as "____ ± ____ohms."

4.1.3.4 Electrical connections

Whether the electrical termination is by means of a connector or a cable, the pin designations or wire color code shall conform to the following transducer wiring standard.

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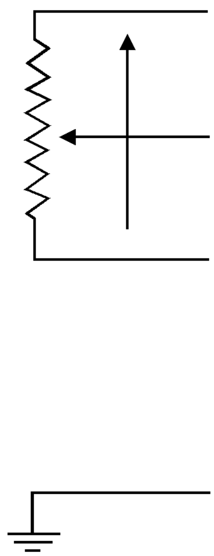
*Defined in ISA-S37.1
**Defined in 4.3



Connector Pin	Function	Wire Color
1 or A	High Pressure (" Positive" Excitation) End of Element	Red
2 or B	Wiper (variable) Termination	Green
3 or C	Low Pressure (" Negative " Excitation or common) End of Element	Black
4 or D	Case Ground	Shield (Optional)

NOTES

1. For differential pressure transducers, the arrow indicates pressure at the measurand port greater than pressure at the reference port.

2. The transduction element(s) shall be arranged with increasing "positive" voltage output as caused by increasing resistance between the wiper and low pressure (common) end of winding.

4.1.3.5 Insulation resistance*

Expressed as " ____ megohms at _____ volts DC between all transduction element terminals in parallel and the transducer case at a temperature of ____ °C and 90 percent relative humidity."

4.1.3.6 Breakdown voltage rating*

Expressed as "Capable of withstanding volts ac-rms at ____ hertz, at a temperature of ____ °C and 90 percent relative humidity for _____ minutes."

4.1.3.7 Load impedance*

Expressed as " ____ ohms" (see 4.2.29).

> **NOTE —** Although load impedance (the impedance presented to the output terminals of the transducer by the associated external circuitry) is not a transducer but a system characteristic, it should be specified in order to define loading error. A single, close-tolerance value of load impedance shall be specified for use during all tests where not otherwise noted.

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*Defined in ISA-S37.1

4.2 Performance characteristics

The performance characteristics of the potentiometric pressure transducers should be tabulated in the order shown. Unless otherwise specified, they apply at Room Conditions as defined in ISA-S37.1. Characteristics are usually referred to the output and expressed as "% VR" (i.e., "percent Voltage Ratio" *).

4.2.1 Range*

Expressed as " – ____ to ____ Pa (psi)" or "+ ____ Pa (psid)."

> **NOTE —** Equivalent pressure units in the SI system are expressed in Pascals.
>
> 1 psi = 6894.8 Pa
>
> 10KPa = 1.4504 psi

4.2.2 End points*

Expressed as " ____ % ± ____ % and ____ % ± ____ % VR."

> **NOTE —** "%VR" is "percent *Voltage Ratio."

End Points shall be omitted where adequately defined using Error Band specifications.

4.2.3 Full scale output*

Expressed as "____ % ± ____ % VR."

> **NOTE —** Full scale output shall be omitted where adequately defined using End Points or Error Band specifications.

4.2.4 Linearity*

Expressed as "____ linearity shall be within ± ____ % VR."

> **NOTE —** The linearity modifier shall be one of those defined in ISA-S37.1; namely, end point, independent, least squares, terminal, or theoretical slope.

4.2.5 Hysteresis*

Expressed as " ____ % VR."

Alternately, 4.2.4 and 4.2.5 may be combined as 4.2.6.

4.2.6 Combined hysteresis* and linearity*

Expressed as "combined hysteresis and linearity within ± ____ % VR."

> **NOTE —** The linearity modifier shall be stated.

4.2.7 Friction error*

Expressed as "within ____% VR."

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*Defined in ISA-S37.1

4.2.8 Repeatability*

Expressed as "within ____% VR over a period of ____ hours."

Alternately, 4.2.2, 4.2.3, 4.2.4, 4.2.5, 4.2.7, and 4.2.8 may be combined as 4.2.9.

4.2.9 Static error band*

Expressed as " ± ____%VR as referred to _______ (curve) ______."

> **NOTE —** The curve shall be stated as
>
> a) End Point Line — a straight line between end points.
>
> b) Best Straight Line — a line midway between the two parallel lines closest together and enclosing all output versus measurand values.
>
> c) Least Square Line — a straight line for which the sum of the squares of the residuals is minimized.
>
> d) Terminal Line — a straight line between 0 and 100% of both measurand and output.
>
> e) Theoretical Slope — a straight line between the theoretical end points.
>
> f) Other curves shall be defined if specified; e.g., mean-output curve.

4.2.10 Friction-free error band*

Expressed as "± ____% VR as referred to _______ (curve) ______."

> **NOTE —** The reference curve shall be specified (see 4.2.9).

4.2.11 Resolution* (see also 4.3)

Expressed as "average resolution within ____% VR and maximum resolution within ____% VR."

4.2.12 Reference-pressure error

Expressed as "change in end points within ± ____% VR for a reference pressure change of ____Pa (psi) over a reference pressure range of ____ to ____Pa (psi)." Alternately expressed as "operation at reference pressures from ____Pa (psi) to ____Pa (psi) shall not cause output readings which exceed the specified error band."

4.2.13 Frequency response*

Expressed as "within ± ____% from zero to ____ Hz."

> **NOTE —** Frequency response should be referred to response at a frequency within the specified frequency range, preferably zero, and to a specific static pressure. Mounting conditions and measured fluid should be specified, as should length and inside diameter of attached tubing.

Alternately, 4.2.13 may be replaced by 4.2.14, 4.2.15, and 4.2.16.

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*Defined in ISA-S37.1

4.2.14 Resonant frequency*

Expressed in "hertz" or "kilohertz."

> **NOTE —** If a number of acoustic or mechanical, resonant frequencies exist, the lowest shall be listed and so identified.

4.2.15 Damping ratio*

Expressed as "____% of critical damping," or as " ___ (ratio) ___ of critical damping."

> **NOTE —** For other than a single-degree-of-freedom system, the ringing period shall be stated.

4.2.16 Ringing period

Expressed as " ____milliseconds."

For transducers with relatively high damping and little overshoot, either 4.2.13 or 4.2.14, and 4.2.16 may be replaced by 4.2.17 and 4.2.18.

4.2.17 Time constant*

Expressed as "____milliseconds (microseconds) for step change in measurand."

4.2.18 Overshoot*

Expressed as "maximum of ____% VR, settling within ____cycles to ____% full range, at a frequency of ____ Hz."

4.2.19 Proof pressure*

Expressed as " ____Pa (psi) for ____minutes" (will not cause changes in end points or in transducer performance characteristics beyond specified tolerances), "with output reading taken within ____ minutes after pressure removal."

4.2.20 Burst pressure rating*

Expressed as " ____ Pa (psi) applied ____ times for a period of____minutes each."

> **NOTE —** Applicability to sensing element or case, or both shall be stated.

4.2.21 Operating temperature range

Expressed as "from ____°C to ____°C."

4.2.22 Temperature error*

Expressed as "within ____ % VR per ____°C." Or "within ____% VR over the operating temperature range."

Alternately 4.2.22 may be specified by 4.2.23.

4.2.23 Temperature error band*

Expressed as "within ± ____% VR from the reference curve established for the Static Error Band and over the operating temperature range."

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*Defined in ISA-S37.1

4.2.24 Acceleration error*

Expressed as "within ____% VR per g_n along ____axis at steady acceleration levels to __g_n."

> **NOTE —** The error shall be listed either for each of the three axis or for the axis with the largest error; i.e., most sensitive axis.

Alternately 4.2.24 may be replaced by 4.2.25.

4.2.25 Acceleration error band*

Expressed as "within ± ____ % VR from the reference curve established for the Static Error Band for steady accelerations up to ____g_n along _____axis."

> **NOTE —** The error band shall be listed either for each of the three axes or for the axis with the largest error; i.e., most sensitive axis.

4.2.26 Vibration error*

Expressed as "within ± ____ % VR along ____axis over the specified vibration program." Signal "dropout" or discontinuities shall be noted.

> **NOTE —** The error shall be listed either for each of the three axis or for the axis with the largest error; i.e., most sensitive axis; and the program shall be detailed, possibly by a graph.

Alternately 4.2.26 may be replaced by 4.2.27.

4.2.27 Vibration error band*

Expressed as "within ± ____ % VR along ____axis from the reference curve established for the Static Error Band over the specified vibration program."

> **NOTE —** The error band shall be listed either for each of the three axes or for the axis with the largest error; i.e., most sensitive axis; and the program shall be detailed, possibly by a graph.

4.2.28 Mounting error*

Expressed as "within ± ____% VR" or "within the Static Error Band."

4.2.29 Loading error*

Expressed as "within ± ____% VR" or "within the Static Error Band."

4.2.30 Cycling life*

Expressed as " ____ cycles at one fourth the designated maximum operating frequency of the transducer."

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*Defined in ISA-S37.1

4.2.31 Other environmental conditions

Other pertinent environmental conditions that shall not change transducer performance beyond specified limits should be listed; the following are examples:

a) Ambient Pressure*

b) Shock – Triaxial

c) High Level Acoustic Excitation

d) Humidity

e) Salt Atmosphere

f) Nuclear Radiation

g) Magnetic Fields

h) Sand and Dust

i) Total Immersion (and in what medium)

j) Solar (or other) Heat Radiation

k) Temperature Shock

4.2.32 Storage life*

Expressed as " ____months (years) without changing performance characteristics beyond their specified tolerances."

> **NOTE —** Environmental storage conditions shall be described in detail. Where performance characteristics require additional tolerances over the storage life, they shall be specified.

4.3 Additional terminology

4.3.1 average resolution: The reciprocal of the total number of output steps over the unit range multiplied by 100 and expressed in percent VR.

4.3.2 damping fluid: A fluid used to damp the single-degree-of-freedom spring/mass system, usually surrounding the reference side (transduction element side) of the sensing element.

4.3.3 isolating element: A movable membrane, usually of metal, that physically separates the measured fluid from the sensing element. Usually this membrane is considerably more flexible than the sensing element and is coupled to the sensing element using a transfer fluid. Its purpose is to provide material compatibility with the measured fluid while maintaining the performance integrity of the sensing element.

4.3.4 maximum excitation: The maximum allowable voltage (current) applied to the potentiometric element at Room Conditions while maintaining all other performance characteristics within their limits. (**Note —** The excitation value is particularly associated with temperature.)

4.3.5 mounting effects: The effects (errors) introduced into transducer performance during installation caused by fastening of the unit or its mounting hardware or by irregularities of the surface on (or to) which the transducer is mounted.

4.3.6 operating temperature range: The range in extremes of ambient temperature within which the transducer must perform to the requirements of the Temperature Error or Temperature Error Band. (See 4.2.22 and 4.2.23, respectively.)

4.3.7 potentiometric element: The resistive part of the transduction element upon which the wiper (movable contact) slides and across which excitation is applied. It may be constructed of a continuous resistance or of small diameter wire wound on a form (mandrel).

4.3.8 pressure connection (pressure port): The opening and surrounding surface of a transducer used for measured fluid access to transducer sensing element (or isolating element). This can be a standard industrial or military fitting configuration, a tube hose fitting or a hole (orifice) in a baseplate. For differential pressure transducers, there are two pressure connections: the measurand port and the reference.

4.3.9 reference pressure error: The maximum change in output at specified measurand values due to a specified change in the Reference Pressure applied at both ports simultaneously.

4.3.10 ringing period: The period of time during which the amplitude of measurand step-function-excited oscillations exceed 10 percent of the step amplitude.

4.3.11 sealed reference differential pressure transducer: A transducer which measures the pressure difference between an unknown pressure and the pressure of a gas in an integral sealed reference chamber.

4.3.12 tap: A connection to a potentiometric element along its length, frequently at the element's center for use in providing bidirectional output.

4.3.13 transfer fluid: A degassed liquid used between an isolating element and a sensing element to provide hydraulic coupling of the pressure between both elements.

4.3.14 worst resolutions: The magnitude of the largest of all output steps over the unit range expressed as a percentage of VR.

4.4 Tabulated characteristics versus test requirements

This table is intended for use as a quick reference for design and performance characteristics and tests of their proper verification as contained in this standard.

Characteristic	Paragraph	Basic	Supple-mental	Verified During	
				Individual Acceptance Test	Qualification Test
Type of Pressure Sensed	4.1.1.1	x		No Test	
Measured Fluids	4.1.1.2	x			Special Test
Configuration, Dimensions, Mounting Pressure Connection	4.1.1.3-4.1.1.5	x		5.2.1	
Mounting Effects	4.1.1.6	x			6.6
Weight	4.1.1.7	x			6.3
Case Sealing	4.1.1.8	x			5.2.1
Identification	4.1.1.9	x		5.2.1	
Case Material	4.1.2.1		x		5.2.1
Sensing Element	4.1.2.2		x		5.2.1
Damping Fluid	4.1.2.3		x		5.2.1
Number of Potentiometric Elements or Taps	4.1.2.4		x	5.2.2 through 5.2.6	
Dead Volume	4.1.2.5		x		6.4
Volume Change Due to Full Scale Pressure	4.1.2.6		x		6.5
Materials in Contact with Measured Fluid	4.1.2.7		x		Special Test
Gage Vent	4.1.2.8		x		Special Test
Maximum Temperature	4.1.2.9		x		Special Test
Excitation	4.1.3.1	x		5.2.6	
Maximum Excitation	4.1.3.2	x			Special Test
Transduction Element Resistance	4.1.3.3	x		5.2.2	
Electrical Connections	4.1.3.4	x		5.2.2	
Insulation Resistance	4.1.3.5	x		5.2.3	
Breakdown Voltage Rating	4.1.3.6	x		5.2.4	
Load Impedance	4.1.3.7	x		5.2.5 (partially)	6.7
Range	4.2.1	x		5.2.6	
End Points	4.2.2	x		5.2.6	
Full Scale Output	4.2.3	x		5.2.6	
Linearity	4.2.4	x		5.2.6	
Hysteresis	4.2.5	x		5.2.6	
Combined Hysteresis and Linearity	4.2.6	x		5.2.6	
Friction Error	4.2.7	x		5.2.6	
Repeatability	4.2.8	x		5.2.6	

Characteristic	Paragraph	Basic	Supple-mental	Verified During	
				Individual Acceptance Test	Qualification Test
Static Error Band	4.2.9	x		5.2.6	
Friction-Free Error Band	4.2.10	x		5.2.6	
Resolution	4.2.11	x			6.2
Reference-Pressure Error	4.2.12	x		5.2.7	
Frequency Response	4.2.13				6.8
Resonant Frequency	4.2.14				6.8
Damping Ratio	4.2.15				6.8
Ringing Period	4.2.16				6.8
Time Constant	4.2.17	x			6.8
Overshoot	4.2.18	x			6.8
Proof Pressure	4.2.19	x		5.2.8	
Burst Pressure Rating	4.2.20	x			6.14
Operating Temperature Range	4.2.21	x			6.9
Temperature Error	4.2.22	x			6.9
Temperature Error Band	4.2.23	x			6.9
Acceleration Error	4.2.24	x			6.10
Acceleration Error Band	4.2.25	x			6.10
Vibration Error	4.2.26	x			6.11
Vibration Error Band	4.2.27	x			6.11
Mounting Error	4.2.28				6.6
Loading Error	4.2.29				6.7
Cycling Life	4.2.30	x			6.13
Other Environmental Conditions	4.2.31	x			6.12
Storage Life	4.2.32				Special Test (accelerated)

5 Individual acceptance tests and calibrations

5.1 Basic equipment necessary to perform individual acceptance tests and calibrations of potentiometric pressure transducers

The basic equipment for acceptance tests and calibrations consists of a source of pressure, a source of electrical excitation for the potentiometer, and a device that measures the electrical output of the transducer directly or as a ratio to excitation input (VR). The errors or uncertainties of the measuring system comprising these three components should be less than one-fifth of the permissible tolerance of the transducer performance characteristic under evaluations. The traceability to national standards for this measuring system shall be well known.

5.1.1 Pressure source

A pressure medium similar to the one that the transducer is intended to measure should be used for testing. The accuracy of the pressure source should be at least five times greater than the permissible tolerance of the transducer performance characteristic under evaluation. The range of the pressure source and monitoring equipment should be selected to provide the necessary pressure, and accuracy, respectively, to 125 percent of the full scale of the transducer.

The pressure source may be either continuously variable over the range of the instrument or may give discrete steps as long as the steps can be programmed in such a manner that the transition from one pressure to the next during calibration is accomplished without eliminating an existing hysteresis (or friction) error in the transducer by overshoot or fluctuation.

NOTE — By "similar" is meant a fluid with similar properties, bearing in mind safety and availability; i.e., H_2, N_2, O_2, silicone oils, and the like.

Examples of pressure sources/monitoring equipment mercury manometer

PRESSURE INDICATING DEVICE

Typical Ranges

100 KPa (about 30 in. Hg) . . .	Accuracy ± 0.02% Full Scale
200 KPa (about 60 in. Hg) . . .	Accuracy ± 0.02% Full Scale
340 KPa (about 100 in Hg) . . .	Accuracy ± 0.01% Full Scale

AIR PISTON (Pressure Source)

Typical Ranges

About 2 to 10 KPa (0.3 to 1.5 psi) . . .	Accuracy ± 0.15% of Reading
About 10 to 350 KPa (1.5 to 50 psi) . . .	Accuracy ± 0.015% of Reading
About 100 KPa to 1 MPa (15 to 150 psi) . . .	Accuracy ± 0.025% of Reading
About 100 KPa to 3.5 MPa (1 to 500 psi) . . .	Accuracy ± 0.025% of Reading

PRECISION DIAL GAGE (Pressure Indicating Device)

Typical Ranges

0 to 30 KPa (about 0 to 120 Hz0) . . .	Accuracy ± 0.1% Full Scale
0 to 100 KPa (about 0 to 30 in. Hg) . . .	Accuracy ± 0.1% Full Scale
0 to 100 KPa (about 0 to 100 psi) . . .	Accuracy ± 0.1% Full Scale
0 to 700 MPa (about 0 to 10,000 psi) . . .	Accuracy ± 0.1% Full Scale

NOTE — Pressure indicating devices generally require a supply of dry gas; e.g., dehumified air, nitrogen, or helium, required for reasons of safety.

OIL PISTON GAGE (Pressure Source)

Typical Ranges

About 40 KPa to 30 MPa (6 to 4000 psi) . . .	Accuracy ± 0.01% of Reading
About 400 KPa to 300 MPa (60 to 40,000 psi) . . .	Accuracy ± 0.01% of Reading
About 14 MPa to 700 MPa . . .	Error in Piston Area Less Than ± 0.009%
About 30 MPa to 1400 MPa (400 to 200,000 psi) . .	Error in Piston Area Less Than ± 0.012%

NOTE — The accuracies cited may be greater than needed for the calibration of many potentiometric pressure transducers but may be required for the calibration of other types of pressure sensing instruments. Economic considerations suggest acquisition of minimum number of pressure sources/monitors to meet calibration needs of majority of transducers in a given installation.

5.1.2 Stable excitation source of accurately known amplitude (unless VR is being measured)

Commonly used sources are chemical batteries such as dry cells and storage batteries or line-powered, electronically regulated, power supplies. (A current limiting device shall be inserted in series with the transducer to preclude accidental damage of the potentiometric element.)

5.1.3 Electronic indicating instrument

Examples of suitable devices are

a) Manually Balanced Ratiometer

achievable accuracy: 1 part in 10,000

b) Self-Balancing Ratiometer

achievable accuracy: 1 part in 10,000

c) Digital Electronic Voltmeter/Ratiometer

achievable accuracy: ± 0.01% of Reading + 1 digit (4 digits display)

± 0.005% of Reading + 1 digit (5 digits display)

NOTE — The input impedance of the readout instrument shall be sufficiently high to produce negligible loading error. Suggested value is 100 times the resistance of the transduction element.

5.2 Calibration and test procedures

Results obtained during the calibration and testing shall be recorded on a data sheet similar to the sample date sheet in Section 7, Figure 1 (see 7.7 for static error and calibration) of this standard. Calibration and testing shall be performed under Room Conditions as defined in ISA-S37.1 unless otherwise specified.

NOTES

1. The definitive paragraph under Section 4 of this document is listed beside each of the parameters for which the test results are to be compared.

2. If more than one potentiometric element is used in the transducer, the performance of every element shall be recorded on its own form.

5.2.1 The transducer shall be inspected visually for mechanical defects, poor finish, and other applicable mechanical characteristics of 4.1.1.

Configuration and Dimensions	4.1.1.3
Mounting and Mounting Dimensions	4.1.1.4
Pressure Connection	4.1.1.5
Identification	4.1.1.9

By use of special equipment, or by formal verification of production methods and materials used, the following additionally can be determined:

Case Sealing	4.1.1.8
Case Material	4.1.2.1
Sensing Element	4.1.2.2
Damping Fluid	4.1.2.3

5.2.2 A precision resistance measuring device shall be used to measure

Transduction Element Resistance	4.1.3.3

and can be used to verify

Number of Potentiometric Elements or Taps	4.1.2.4
Electrical Connections	4.1.3.4

5.2.3 Measure the insulation resistance between all transduction element terminals (or leads) connected in parallel and the case (and ground pin) of the transducer with a megohmmeter device, using a potential of 50 volts unless otherwise specified.

Insulation Resistance	4.1.3.5

5.2.4 Verify the Breakdown Voltage Rating using sinusoidal ac voltage test with all transduction element terminals (or leads) paralleled and tested to case and ground pin.

Breakdown Voltage Rating (ac-rms)	4.1.3.5

5.2.5 The transducer shall be connected to the pressure source and secured as recommended for its use. The appropriate excitation source and indicating instruments shall be properly connected to the transducer and turned on. Adequate warm-up time for indicating instruments shall be allowed before tests are conducted.The pressure source, connecting tubing, and transducer system shall pass a leak test to assure absence of calibration errors. Electrical connections shall be checked for correctness of hook-up including the appropriate load impedance (see 4.1.3.7).

5.2.6 Two or more complete calibration cycles shall be run consecutively. A minimum of eleven data points shall be obtained including both ascending and descending directions. Excitation amplitude shall be monitored as required unless VR is measured.

In order to verify performance between the discrete levels and to assure absence of noise, a full-scale X-Y plot shall be obtained, preferably inscribed diagonally across the test record form, by applying increasing then decreasing pressure to the transducer, and simultaneously to a reference transducer having continuous resolution and suitable linearity, each connected to one axis input of the plotter.

From the data obtained during these tests, the following characteristics should be determined:

End Points	4.2.2
Full Scale Output	4.2.3
Linearity	4.2.4
Hysteresis	4.2.5
(or Hysteresis and Linearity)	4.2.6
Friction Error	4.2.7
Repeatability	4.2.8

NOTE — To determine Friction Error or Friction-Free Error Band, at least one calibration cycle shall be run with the transducer dithered (light but sufficient vibration or shock).

5.2.7 For Differential Pressure Transducers, the performance of a three-point (e.g., 10, 50, and 90 percent) calibration cycle at both the minimum and maximum specified reference pressures shall establish

Reference Pressure Error	4.1.12

5.2.8 After application of the proof pressure, at least a three-point calibration shall be performed to establish that the performance characteristics of the transducer are still within specifications. The first output reading shall be recorded within the period of time specified for this.

Proof Pressure	4.2.19

NOTE — For bidirectional differential transducer, proof pressure shall be applied to both ports individually. For reporting purposes these are identified as "positive" and "negative" proof pressures.

6 Qualification test procedures

Qualification Tests shall be performed as applicable using the test forms of Section 7 as required. Upon completion of all testing, the form of Figure 6 shall be used to summarize all testing.

6.1 Initial performance tests (Figure 2)

The tests and procedures of Section 5 shall be run to establish reference performance during increasing (and decreasing) steps of 0, 20, 40, 60, 80, and 100 percent of range as a minimum (percent of span for bidirectional transducers).

6.2 Resolution test (Figure 6)

An X-Y plotter shall be connected so that the transducer output is connected to the X-Axis and a continuous-resolution reference transducer to the Y-Axis input of the plotter. As the pressure to both transducers is slowly increased (simultaneously on both transducers), the number of steps shall be recorded from 0 to 100 percent of the test transducer's range. The following shall be determined:

Resolution (Average and Worst)	4.2.11

6.3 Weight test (Figure 6)

The transducer shall be weighed on an appropriate balance or scale. The following shall be established:

Weight	4.1.1.7

6.4 Dead volume test (Figure 6)

The pressure cavity shall be filled (both cavities for a differential transducer) with a measurable, noncorrosive liquid (under a vacuum if necessary), and the contents poured into a graduate. The following shall be established:

Dead Volume	4.1.2.5

6.5 Volume change test (Figure 6)

A liquid pressure system shall be connected to a transducer, a parallel pressure gage, and a graduated reservoir. (Provisions for isolating the transducer when filled shall be made.) The pressure system shall be evacuated and filled with liquid, the valve to the transducer closed, the pressure increased to 100 percent of range, the valve opened, and the following shall be determined:

Volume Change due to Full Scale Pressure	4.1.2.6

6.6 Mounting test (Figure 6)

The mounting of the actual installation shall be duplicated as closely as possible following specific instructions and one calibration run performed. The following shall be established:

Mounting Error	4.2.28
Mounting Effect	4.1.1.6

6.7 Loading test (Figure 6)

Approximately 66% of full range pressure shall be applied to the transducer and the total load resistance varied from the highest to the lowest ohmic value allowed. (**Note —** Take into account the resistance of the ratiometer or other indicating instrument.) The following shall be verified:

Loading Error	4.2.29

The loading error of a potentiometric pressure transducer is variable with wiper position ranging from zero at both extremes to a maximum value at approximately 66 percent of VR. As a first approximation, the percentage error is equal to fifteen times the ratio of the potentiometric element resistance to the loading resistance. Unless otherwise stated, assembly adjustments of the transducer apply to the open circuit conditions at the output terminals.

6.8 Dynamic response test (Figure 4a or 4b as applicable)

The dynamic response characteristics of pressure transducers may be either with transient-excitation devices or with sinusoidal pressure generators.

6.8.1 Transient excitation method

A positive step-function of pressure may be generated in gases with a shock-tube or a quick-opening valve. A hydraulic quick-opening valve is used to generate a positive pressure step function in a liquid medium. A burst diaphragm generator produces a negative pressure step in a gas medium. In all cases, the rise time of the generated step function shall be sufficiently short to shock-excite all resonances in the transducer under test. It shall also be one third or less of the anticipated rise time of the transducer under test.

Since the tubing used to mechanically connect the transducer to the test set-up may affect the dynamic characteristics, it is recommended that the shortest possible tubing be installed, or that the tubing used shall duplicate as closely as possible the actual installation, if this condition was specified instead of the characteristics of the transducer alone. Any tubing used shall be described by length, internal diameter, and curvature.

By applying step functions of pressure at Room Conditions within the full scale range of the transducer and analyzing the electronic or electro-optical recording of the transducer output, the following can be determined.

Frequency Response (amplitude and phase)	4.2.13
Resonant Frequency	4.2.14
Damping Ratio	4.2.15
Ringing Period	4.1.16

Alternately for transducers with relatively high damping and little overshoot, the following can be determined:

Time Constant	4.2.17
Overshoot	4.2.18

6.8.2 Sinusoidal excitation method

For frequencies below a few kilohertz, static pressures below 100 MPa (roughly 15,000 psi) and peak dynamic pressures below 10 MPa (roughly 1500 psi), generators that produce sinusoidal pressure wave-forms in either liquids or gases are available. These sinusoidal pressure generators operate either on the piston-phone principle (which is in common use for the absolute calibration of microphones) or by modulating a fluid flow through an orifice.

A sinusoidal pressure waveform of constant amplitude and varying frequency, over a specified frequency range, shall be applied at a specified static pressure. The following shall be determined:

Frequency Response (amplitude and phase)	4.1.13

If within the frequency range covered, the following can be established from the frequency response recording by suitable calculations:

Resonant Frequency	4.2.14
Damping Ratio	4.2.15
Ringing Period	4.2.16
Time Constant	4.2.17
Overshoot	4.2.18

6.9 Temperature tests

6.9.1 Low temperature test (Figure 3)

The transducer shall be placed in a suitable temperature chamber. The temperature of the transducer shall be stabilized for one hour at the lower specified operating temperature and two calibration cycles performed, followed by a positive-proof pressure test and a third calibration cycle. The insulating resistance shall be measured and recorded as in 5.2.3. (For differential pressure transducers only, the second calibration cycle shall be performed with maximum specified reference pressure applied, followed immediately by a negative-proof pressure test.)

These tests shall establish the following:

Temperature Error (at low temperature)	4.2.22
or	
Temperature Error Band (at low temperature)	4.2.23

6.9.2 Post low temperature test (at room conditions) (Figure 3)

The transducer shall be removed from the temperature chamber and permitted to stabilize for one hour at room conditions. The tests of 6.9.1 shall be repeated except that the operating temperature shall be room temperature.

6.9.3 High temperature test (Figure 3)

The tests of 6.9.1 shall be repeated except that the transducer temperature shall be stabilized for one hour at the highest specified operating temperature.

These tests shall establish the following:

Temperature Error (at high temperature)	4.2.22
or	
Temperature Error Band (at high temperature)	4.2.23

6.9.4 Post high temperature test (at room conditions) (Figure 3)

The tests of 6.9.2 shall be repeated after stabilization of the transducer at room temperature for one hour.

> **NOTE —** If required, thermal and post-thermal zero shift and sensitivity shift may also be calculated from the results of these tests.

6.10 Acceleration test (Figure 5)

Acceleration shall be imposed on the transducer in three orthogonal directions by tilting it in the earth's gravitational field or by placing it on a centrifuge. A specific acceleration level shall be applied on specified axes, and the output measured. The following shall be established:

Acceleration Error	4.2.24
or	
Acceleration Error Band	4.2.25

6.11 Vibration test (Figure 5)

With specified measurand levels applied, the transducer shall be vibrated along specified axes at specified acceleration amplitudes over the specified frequency range with an electromagnetic or hydraulic shaker. The transducer output shall be recorded with a high-speed recorder. The following shall be established:

Vibration Error	4.2.26
or	
Vibration Error Band	4.2.27

> **NOTE —** If so specified, the vibration error band can be established as the algebraic sum of maximum vibration errors and the last previously obtained static error band.

6.12 Tests for other environmental conditions (Figure 3)

The transducer shall be exposed to other specified environmental conditions. As specified for each condition, one complete calibration cycle shall be performed during or after the test to establish the ability of the transducer to perform satisfactorily.

See 4.2.31.

6.13 Life test (Figure 3)

After applying the specified number of full range excursions of measurand, or after completion of each of several specified portions of the total number of cycles, at least one complete calibration cycle shall be performed to establish minimum value of

Cycling Life	4.2.30

6.14 Burst Pressure Test (Figure 6)

The transducer shall be connected to a suitable test setup with adequate protection for equipment and personnel. The pressure shall be increased to the specified limit and applied for the specified number of times and durations. The following shall be established:

Burst Pressure Rating	4.2.20

NOTE — If specified, burst pressure is applied to the inside of the case by first puncturing the sensing element.

7 Test report forms

7.1 The test report forms listed below are recommended for use during the testing of Potentiometric Pressure Transducers.

7.2 When using the forms, all pertinent information shall be inserted in its proper place. On some forms, blank space has been provided for additional tests. Where the test is prolonged; e.g., Cycling Life, more than one form may be required.

7.3 Individual acceptance tests and calibrations (Figure 1)

Used during acceptance testing of Section 5.

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR	**POTENTIOMETRIC PRESSURE TRANSDUCER**	SERIAL NO.
CUSTOMER	**INDIVIDUAL ACCEPTANCE TEST AND CALIBRATION RECORD**	RANGE ______ to __________ Pa ________

Visual Inspection:	Electrical Inspection:
Dimensions ☐ Workmanship ☐	Element Resistance ____________ ohms Insulation Resistance __________ Megohms at ______ Vdc
Finish ☐ Nameplate ☐ El. Conn. ☐	Breakdown Voltage Rating @ ______ Vac, _______ Hz ☐ Z_L used _______ M Ω

Calibration @ __________ V __________ Excitation Ambient Temperature ____________ °C

Pressure (Pa)	Theor. Output (%VR)	(Undithered) First Calib. Cycle Output (%VR) Increase	Decrease	(Dithered) First Calib. Cycle Output (%VR) Increase	Decrease	(Undithered) Second Calib. Cycle Output (%VR) Increase	Decrease	(Dithered) Second Calib. Cycle Output (%VR) Increase	Decrease		(Undithered) Max. Error (%VR) +	–	(Dithered) Max. Error (%VR) +	–

*_______________ Linearity : + _______ , – _______ %VR (Allowed: ± _____ %VR); *Hysteresis: _________ %VR (All'd _________ %VR)

* Hysteresis and _______________ Linearity (Combined): + _________ , – _________ %VR (Allowed: _______ ± _________ %VR)

Friction-free Error Band: + _______ , – _______ %VR (Allowed: ± _________ %VR); Friction Error: _________ %VR (All'd: _______ %VR)

Repeatability: __________ %VR (All'd: _______ %VR); *End Points: ________ and _________ %VR (All'd: _________ and _________ %VR)

*Full-Scale Output: _________ %VR (Allowed: _________ ± _______ %VR) NOTE: *Values Determined From _______________ Calib. Cycle

Pressure (Pa)	Theor. Output	P Only: Performance Test @ ______ Pa ______ Ref. Press Output (______)		Error (______)		Δ P Only: Perf. Test ____ Minutes After ___ Pa ___ Neg. Proof Press. (Overload Output: ______ ______) Output (______)		Error (______)		Perf. Test ________ Minutes After ___ Pa ___ Pos. Proof Press. (Overload Output: ______ ______) Output (________)		Error (________)	
				+	–			+	–			+	–
				+	–			+	–			+	–
				+	–			+	–			+	–

Full-Scale X-Y Plot: _______	Static Error Band: + __________ , – _________ %VR (Allowed: ± ____________ %VR) Error Bands Ref. To ______________________________ Ref. Press Error: _______________ %VR

Equipment Used:	Tested By: ____________________ Date: __________________
	Approved By: ________________________________

Figure 1 — Potentiometric pressure transducer individual acceptance test and calibration record

7.4 Initial performance tests and calibrations (Figure 2)

Used for establishing the reference performance for comparison to other test results.

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR	**POTENTIOMETRIC PRESSURE TRANSDUCER**	SERIAL NO.
REPORT NO.	☐ **INITIAL PERFORMANCE TEST**	CUSTOMER
TYPE OF TEST	☐ ____________ **TEST**	RANGE ______ to __________ Pa ________

Visual Inspection:	Electrical Inspection:
Dimensions ☐ Workmanship ☐	Element Resistance ____________ ohms; Insulation Resistance __________ Megohms at ______ Vdc
Finish ☐ Nameplate ☐ El. Conn. ☐	Breakdown Voltage Rating @ ______ Vac, ________ Hz ☐ Z_L used ________ MΩ

Calibration @ __________ V __________ Excitation Ambient Temperature __________ °C

		(Undithered)		(Dithered)		(Undithered)		(Dithered)			(Undithered)		(Dithered)	
Pressure (Pa)	Theor. Output (%VR)	First Calib. Cycle Output (%VR)		First Calib. Cycle Output (%VR)		Second Calib. Cycle Output (%VR)		Second Calib. Cycle Output (%VR)			Max. Error (%VR)		Max. Error (%VR)	
		Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease		+	–	+	–

* ______________ Linearity : + ________ , – ________ %VR (Allowed; ± ______ %VR); *Hysteresis: __________ %VR (All'd: __________ %VR)

* Hysteresis and ______________ Linearity (Combined): + __________ ,– __________ %VR (Allowed: ± __________ %VR)

Friction-free Error Band: + ________ , – ________ %VR (Allowed: ± __________ %VR); Friction Error: __________ %VR (All'd: ________ %VR)

Repeatability: __________ %VR (All'd: ________ %VR); *End Points: ________ and ________ %VR (All'd: ________ and ________ %VR)

*Full-Scale Output: ________ %VR (Allowed: ________ ± ______ %VR) NOTE: *Values Determined From ______________ Calib. Cycle

		Δ P Only: Performance Test @ ______ Pa ______ Ref. Press.				Δ P Only: Perf. Test _____ Minutes After ___ Pa ___ Neg. Proof Press. (Overload Output: ________ ________)				Perf. Test __________ Minutes After ___ Pa ___ Pos. Proof Press. (Overload Output: ________ ________)			
Pressure (Pa)	Theor. Output	Output (_____)		Error (_______)		Output (_______)		Error (_______)		Output (__________)		Error (__________)	
				+	–			+	–			+	–
				+	–			+	–			+	–
				+	–			+	–			+	–

Full-Scale X-Y Plot: ________	Static Error Band: + __________ , – ________ %VR (Allowed: ± ______________ %VR) Error Bands Ref. To ______________________________ Ref. Press. Error: ________________ %VR

Equipment Used:	Defects Noted Or Comments:

Tested By: ____________________ Date: ____________________ Approved By; ______________________________

Figure 2 — Potentiometric pressure transducer initial performance test

7.5 Environmental test record (Figure 3)

Used for Temperature, Maximum Temperature, Life, and other environmental tests.

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR	POTENTIOMETRIC PRESSURE TRANSDUCER	SERIAL NO.
REPORT NO.	ENVIRONMENTAL TEST RECORD	CUSTOMER
TYPE OF TEST		RANGE ______ to ________ Pa __________

Tested While: ☐ Undithered ☐ Dithered	☐ Before ☐ During ☐ After	Type of Environment ____________________	Level ____________________

Pressure	Theoretical	%VR (Run 1)		%VR (Run 2)		Overload	%VR (Run 3)		Maximum Error %VR	
(Pa)	%VR	Increase	Decrease	Increase	Decrease	%VR	Increase	Decrease	+	–
	(Pos. Proof)									
	(Neg. Proof)									

Error Band: +______ % –__________ %VR (Referred To________________________________) Allowed: –__________ %VR

Proof Pressure ______ % Rated Range for _____ Minutes (POS)

Ins. Resistance: ________ Megohms at _____ Vdc

For Diff. Press. Transducers Only:

Zero Shift: ____________________ %VR

Neg. Proof Pressure ________ %Rated Range for ______ Minutes

Sensitivity Shift:____________________ %VR

Ref. Press., Run 2 : ____________________ Pa

Comments: ______________________________

____

____

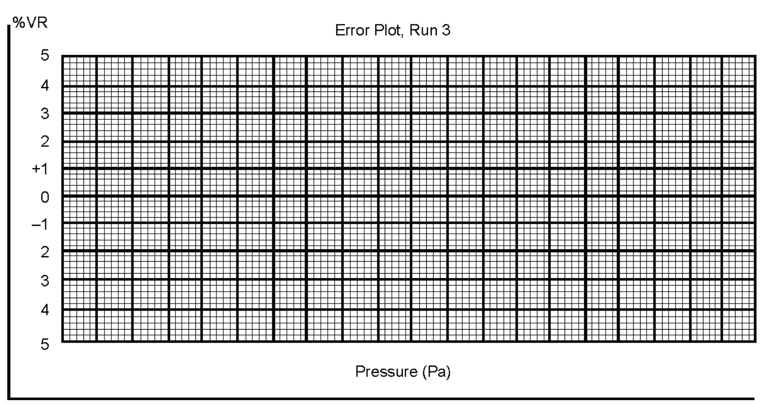
____

____

____

____

____



Tested By. ______________________________ Date Test Started: ______________ Date Test Finished: ______________

Approved By: ______________________________ Approved By: ______________________________

Title: Title:

Figure 3 — Potentiometric pressure transducer environmental test record

7.6 Dynamic response tests (Figure 4)

Used for recording test results of Frequency Response, Resonant Frequency, Damping Ratio, Ringing Period, Time Constant, and Overshoot. (**Note —** use 4a or 4b as applicable.)

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR	**POTENTIOMETRIC PRESSURE TRANSDUCER**	SERIAL NO.
REPORT NO.	**DYNAMIC RESPONSE TESTS**	CUSTOMER
TYPE OF TEST		RANGE ______ to __________ Pa ________

1. Ambient Conditions: Temperature: ________ °C; Pressure: ________ Pa; Humidity ________ %
2. Dynamic Response ________

Excitation Voltage: ________

Step Function Generator: ________ Shock Tube, Dry Air: ________

Mounting Location: End: ________ Side: ________

Shock No.	Initial Pressures		Shock Velocity	Step Pressure	Pronounced Resonances, Hz			Ringing Period / Time Constant
	Hi	Low						

Frequency Response ________ Hz (Allowed ________ Hz), Damping Ratio ________ (All'd ________)

Ringing Period ________ msec. (All'd ________ msec.),

Time Constant ________ msec. (All'd ________ msec.), Overshoot ________ %VR (All'd ________ %VR)

ATTACH OSCILLOSCOPE PHOTOGRAPHS OF TRANSDUCER RESPONSES

Amplitude Scale **SHOCK 1** Time Scale	Amplitude Scale **SHOCK 3** Time Scale
Amplitude Scale **SHOCK 2** Time Scale	Amplitude Scale **SHOCK 4** Time Scale

Tested By: ________ Date Test Started: ________ Date Test Finished: ________

Approved By: ________ Approved By: ________

Title: Title:

Figure 4a — Potentiometric pressure transducer dynamic response tests

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR	POTENTIOMETRIC PRESSURE TRANSDUCER	SERIAL NO.
REPORT NO.	DYNAMIC RESPONSE TESTS	CUSTOMER
TYPE OF TEST	(SINUSOIDAL METHOD)	RANGE _______ to ____________ Pa __________

Ambient Conditions: Temperature: ________ °C; Pressure: __________ Pa; Humidity ____________ %

Dynamic Response:

Excitation (Volts or ma) ______________________________________ ; Transducer Load ______________________________________ ohms

Sinusoidal Generator ______________________________________ ; Test Fluid ______________________________________

Mounting Configuration ____

____

Test Temperature _________ °C Quiescent Static Pressure ______________________________ Pa ______________________________

Sinusoidal pressure ___________ Pa peak; Port excited: ____

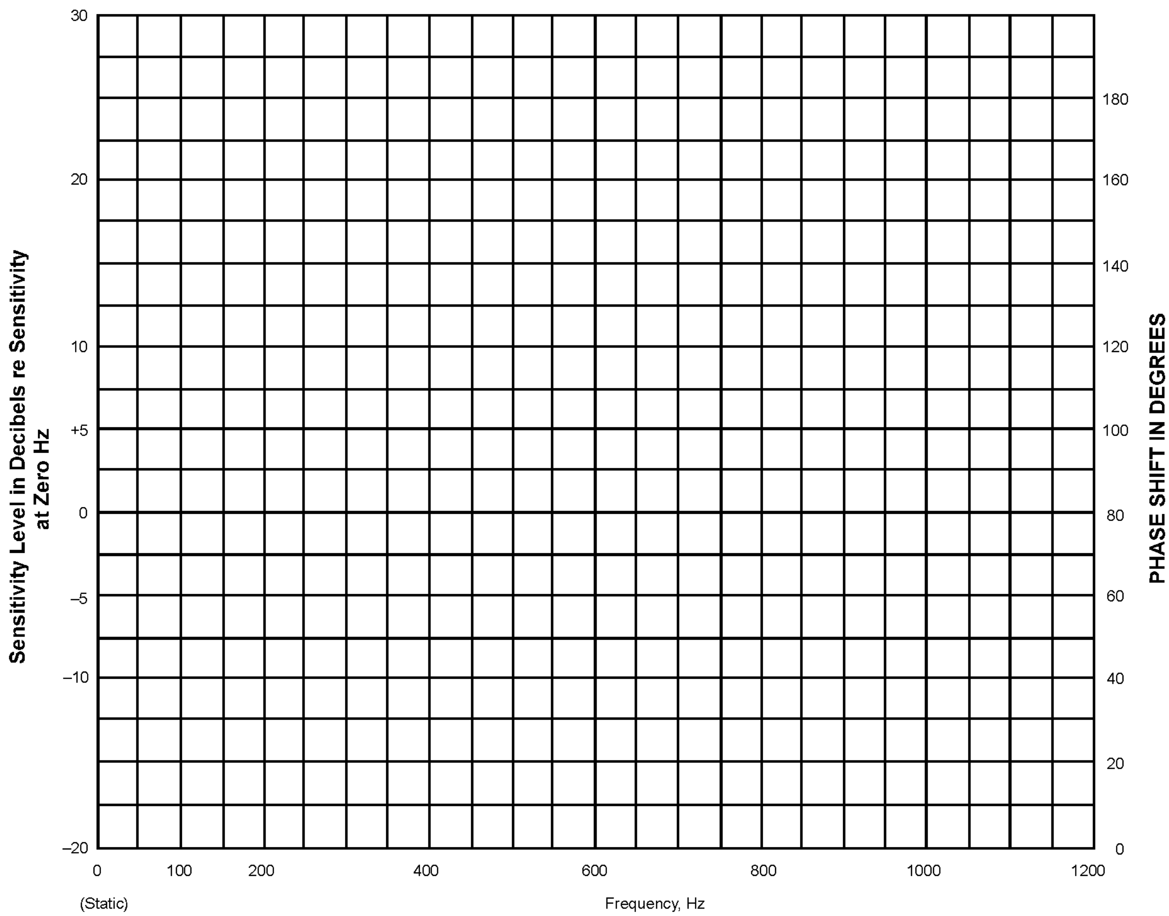


Figure 4b — Potentiometric pressure transducer dynamic response tests (Sinusoidal Method)

7.7 Environmental test record (Figure 5)

Used to record Acceleration and Vibration Test results.

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR	**POTENTIOMETRIC PRESSURE TRANSDUCER**	SERIAL NO.
REPORT NO.	**ACCELERATION/VIBRATION TEST RECORD**	CUSTOMER
TYPE OF TEST		RANGE ______ to ___________ Pa _________

SKETCH OF TRANSDUCER SHOWING AXIS ORIENTATION:

ACCELERATION TEST

AXIS	+X	–X	+Y	–Y	+Z	–Z
Output Before Accel. (%VR)						
Applied Accel. (G)						
Output During Accel. (%VR)						
Accel. Error (%VR)						
Comments						

Pressure Level Used: ____________ Pa

Max. Accel. Error: + ____________ , – ____________ %VR

Pre-Accel.
Static Error Band: + ____________ , – ____________ %VR

Accel. Error Band: + ____________ , – ____________ %VR

(Allowed Accel. Error Band ± ____________ %VR)

Tested By: ______________________ (Technician)

______________________ (Test Engineer)

Date: ____________ Approved By: ____________

Witnessed By: ______________________ (__________)

Witnessed By: ______________________ (__________)

VIBRATION TEST

AXIS	X			Y			Z		
Pressure Level Used	Pa			Pa			Pa		
Output Before Vib.	%VR			%VR			%VR		
	Freq. (Hz)	Error		Freq. (Hz)	Error		Freq. (Hz)	Error	
		Pol.	%VR		Pol.	%VR		Pol.	%VR
Vibration Error									

Max. Vib. Error: + ____________ , - ____________ %VR

Pre-Vib.
Static Error Band: + ____________ , - ____________ %VR

Vib. Error Band: + ____________ , - ____________ %VR

(Allowed Vib. Error Band ± ____________ %VR)

Tested By: ______________________ (Technician)

______________________ (Test Engineer)

Date: ____________ Approved By: ____________

Witnessed By: ______________________ (__________)

Witnessed By: ______________________ (__________)

Comments

Figure 5 — Potentiometric pressure transducer acceleration/vibration test record

7.8 Test summary (Figure 6)

Used to compile the results of all testing.

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR		SERIAL NO.
REPORT NO.	**TRANSDUCER TEST REPORT**	CUSTOMER
TYPE OF TEST	**POTENTIOMETRIC PRESSURE TRANSDUCER**	RANGE ______ to __________ Pa ________

SUMMARY OF RESULTS:

☐ Error
☐ Error Band

Test	Tested Per Proced. No. or Test Waived Per	Par.No.	Pass	Fail: Error	Fail: Electr.	Fail: Mechan.	Fail: See Comments	+ %VR	−% VR
Initial P.T. (Performance Test)									
Resolution								Avg: ___%VR	Max: ___%VR
Weight								__________	__________
Dead Volume								__________Cu.	________
Vol. Change over Press. Range								__________Cu.	________
Mounting									
Loading Max. Z L / Min. Z L									
Frequency Response								Flat (+__%): ____To____Hz	
Response Time								______msec.,	_____%Ovs.
Low Temp. ________________ °C									
P.T. After Low Temp.									
High Temp. + ______________ °C									
Add'l. Temp. ________________ °C									
P.T. After High Temp.									
______________ g_n Vibration									
P.T. After ____________ g_n Vibration									
Acceleration									
P.T. After Accel.									
Life									
Burst Pressure									

Tested By: ______________________________ Date Test Started: ______________ Date Test Finished: __________

Approved By: ______________________________ Approved By: ______________________________

Title: Title:

Figure 6 — Transducer test report potentiometric pressure transducer

7.9 Individual acceptance test record (static error band) (Figure 7)

Used as an alternate for Figure 1 when Static Error Band Calibration is specified.

VENDOR'S PART NO.	TEST FACILITY	CUSTOMER'S PART NO.
VENDOR		SERIAL NO.
PURCHASE ORDER NO.	**POTENTIOMETRIC PRESSURE TRANSDUCER**	CUSTOMER
	INDIVIDUAL ACCEPTANCE TEST AND CALIBRATION RECORD (Static Error Band Calibration)	RANGE _____ TO _____ Pa _____

Visual Inspection: Dimensions ☐ Threads ☐ Finish ☐ Nameplate ☐ Receptacle (or other Electrical Conn.) ☐

Electrical Inspection: Element Resistance _____ ohms Insulation Resistance _____ Megohms at _____ Vdc

Breakdown Voltage Rating @ _____ Vac. _____ Hz ☐ Electrical Connection ☐

Calibration (Undithered) @ _____ V _____ Excitation Z_L used Megohms

Pressure (Pa)	Theor. Output (%VR)	First Calib. Cycle Output (%VR)		Second Calib. Cycle Output (%VR)		Max. Error (%VR)		
		Increase	Decrease	Increase	Decrease	+	-	

All Error Bands Ref.To _____

		P Only: Performance Test ± @ _____ Pa _____ Ref. Press.				Perf. Test _____ Minutes After _____ Pa _____ Neg. Proof Press. (Overload Output _____ _____)				Pref. Test _____ Minutes After _____ Pa _____ Pos. Proof Press. (Overload Output _____ _____)			
Pressure (Pa)	Theor. Output	Output (%VR)		Error (%VR)		Output (%VR)		Error (%VR)		Output (%VR)		Error (%VR)	
				+	-			+	-			+	-
				+	-			+	-			+	-
				+	-			+	-			+	-
		SEB.: + _____ %, - _____ %VR				SEB.: + _____ %, - _____ %VR				S.E.B.: + _____ %, - _____ %VR			

Full-Scale X-Y Plot: _____	Static Error Band (S.E.B.): (Calib.:) + _____ %, - _____ %VR S.E.B.: (All Tests) + _____ %, - _____ %VR Allowed ± _____ %VR

Tested By: _____ Date: _____ Approved By: _____

Figure 7 — Potentiometric pressure transducer individual acceptance test and calibration record (Static Error Band Calibration)

Annex A — References

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B88.1-1971	A Guide for the Dynamic Calibration of Pressure Transducers, ASME, August, 1972
ANSI Z210.1-1973	Standard Metric Practice Guide, ASTM (E-380-72E) March, 1973

Available from: **ANSI**
11 West 42nd Street
New York, NY 10036 Tel. (212) 642-4900

ISA

ISA-S37.1-1982	Electrical Transducer Nomenclature and Terminology
ISA-S37.3-1982 (R 1995)	Specifications and Tests for Strain Gage Pressure Transducers

ISA Transducer Compendium, 2nd Edition Part I, *Pressure, Flow, and Level*; Plenum Press, New York, 1969.

Available from: **ISA**
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, NC 27707 Tel. (919) 990-9200

MISCELLANEOUS

Beckwith, T. G., and Buck, N. L.; *Mechanical Measurements*; Addison-Wesley, 1961.

Cross, J. L.; *Reduction of Data for Piston Gage Pressure Measurements*; National Bureau of Standards Monograph # 65, June, 1963.

Lederer, P.S.; *Methods for Performance Testing of Electromechanical Pressure Transducers*; National Bureau of Standards Technical Note #411, February, 1967.

MIL-E-5272C (ASG); Environmental Testing, Aircraft Electronic Equipment, General Specification For.

MIL-E-5400C (ASG); Environmental Testing, Aeronautical and Associated Equipment, General Specification For.

MIL-STD-810; Environmental Test Methods for Aerospace and Ground Equipment.

Neubert, H.K.P.; *Instrument Transducers*; Oxford at the Clarendon Press, 1963.

Norton, H. N.; *Transducers for Electronic Measuring Systems*; Prentice-Hall, 1969.

PMC 20.1-1973; *Process Measurement and Control Terminology*; August, 1973.

Schweppe et al.; *Methods for the Dynamic Calibration of Pressure Transducers*; National Bureau of Standards Monograph #67, December, 1963.

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