Designation: F2070 – 00 (Reapproved 2022)

An American National Standard

Standard Specification for Transducers, Pressure and Differential, Pressure, Electrical and Fiber-Optic[1]

This standard is issued under the fixed designation F2070; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the requirements for pressure and differential pressure transducers for general applications.

1.2 Special requirements for naval shipboard applications are included in Supplementary Requirements S1, S2, and S3.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard. Where information is to be specified, it shall be stated in SI units.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3951 Practice for Commercial Packaging

2.2 *ANSI/ISA Standards:*[3]

ANSI/ISA S37.1 Electrical Transducer Nomenclature and Terminology

2.3 *ISO Standards:*[4]

ISO 9001 Quality System—Model for Quality Assurance in Design/Development, Production, Installation, and Servicing

3. Terminology

3.1 Terms marked with "ANSI/ISA S37.1" are taken directly from ANSI/ISA S37.1 (R-1982) and are included for the convenience of the user.

3.2 *Definitions:*

3.2.1 Terminology consistent with ANSI/ISA S37.1 shall apply, except as modified by the definitions listed as follows:

3.2.2 *absolute pressure, n*—pressure measured relative to zero pressure (vacuum). **ANSI/ISA S37.1**

3.2.3 *ambient conditions, n*—conditions such as pressure and temperature of the medium surrounding the case of the transducer. **ANSI/ISA S37.1**

3.2.4 *burst pressure, n*—the maximum pressure applied to the transducer sensing element without rupture of the sensing element or transducer case as specified.

3.2.5 *calibration, n*—the test during which known values of measurands are applied to the transducer and corresponding output readings are recorded under specified conditions. **ANSI/ISA S37.1**

3.2.6 *common mode pressure, n*—the common mode pressure is static line pressure applied simultaneously to both pressure sides of the transducer for the differential pressure transducer only.

3.2.7 *differential pressure, n*—the difference in pressure between two points of measurement. **ANSI/ISA S37.1**

3.2.8 *environmental conditions, n*—specified external conditions, such as shock, vibration, and temperature, to which a transducer may be exposed during shipping, storage, handling, and operation. **ANSI/ISA S37.1**

3.2.9 *error, n*—the algebraic difference between the indicated value and the true value of the measurand. **ANSI/ISA S37.1**

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.10 on Electrical.

Current edition approved Oct. 1, 2022. Published October 2022. Originally approved in 2000. Last previous edition approved in 2017 as F2070 – 00 (2017). DOI: 10.1520/F2070-00R22.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

3.2.10 *fiber-optic pressure transducer, n*—a device that converts fluid pressure, by means of changes in fiber-optic properties, to an output that is a function of the applied measurand. The fiber-optic pressure transducer normally consists of a sensor head, optoelectronics module, and connectorized fiber-optic cable.

3.2.11 *hysteresis, n*—the maximum difference in output, at any measurand value within the specified range, when the value is approached first with increasing and then with decreasing measurand. **ANSI/ISA S37.1**

3.2.12 *insulation resistance, n*—the resistance measured between insulated portions of a transducer and between the insulated portions of a transducer and ground when a specified dc voltage is applied under specified conditions.

3.2.13 *line pressure, n*—the pressure relative to which a differential pressure transducer measures pressure. **ANSI/ISA S37.1**

3.2.14 *operating environmental conditions, n*— environmental conditions during exposure to which a transducer must perform in some specified manner. **ANSI/ISA S37.1**

3.2.15 *optical, adj*—involving the use of light-sensitive devices to acquire information.

3.2.16 *optical fiber, n*—a very thin filament or fiber, made of dielectric materials, that is enclosed by material of lower index of refraction and transmits light throughout its length by internal reflections.

3.2.17 *optoelectronics module, n*—a component of the fiber-optic pressure transducer that contains the optical source and detector, and signal conditioner devices necessary to convert the sensed pressure to the specified output signal.

3.2.18 *output, n*—electrical or numerical quantity, produced by a transducer or measurement system, that is a function of the applied measurand.

3.2.19 *overpressure, n*—the maximum magnitude of measurand that can be applied to a transducer without causing a change in performance beyond the specified tolerance.

3.2.20 *pressure cycling, n*—the specified minimum number of specified periodic pressure changes over which a transducer will operate and meet the specified performance.

3.2.21 *pressure rating, n*—the maximum allowable applied pressure of a differential pressure transducer.

3.2.22 *process medium, n*—the measured fluid (measurand) that comes in contact with the sensing element.

3.2.23 *range, n*—measurand values, over which a transducer is intended to measure, specified by their upper and lower limits. **ANSI/ISA S37.1**

3.2.24 *repeatability, n*—ability of a transducer to reproduce output readings when the same measurand value is applied to it consecutively, under the same conditions, and in the same direction. **ANSI/ISA S37.1**

3.2.25 *response, n*—the measured output of a transducer to a specified change in measurand.

3.2.26 *ripple, n*—the peak-to-peak ac component of the dc output.

3.2.27 *sensing element, n*—that part of the transducer that responds directly to the measurand. **ANSI/ISA S37.1**

3.2.28 *sensitivity factor, n*—the ratio of the change in transducer output to a change in the value of the measurand.

3.2.29 *sensor head, n*—the transduction element of the fiber-optic pressure transducer that detects fluid pressure by means of changes in optical properties.

3.2.30 *signal conditioner, n*—an electronic device that makes the output signal from a transduction element compatible with a readout system.

3.2.31 *static error band, n*—static error band is the maximum deviation from a straight line drawn through the coordinates of the lower range limit at specified transducer output, and the upper range limit at specified transducer output expressed in percent of transducer span.

3.2.32 *transducer, n*—device that provides a usable output in response to a specified measurand. **ANSI/ISA S37.1**

3.2.33 *wetted parts, n*—transducer components with at least one surface in direct contact with the process medium.

4. Classification

4.1 *Designation*—Most transducer manufacturers use designations or systematic numbering or identifying codes. Once understood, these designations could aid the purchaser in quickly identifying the transducer type, range, application, and other parameters.

4.2 *Design*—Pressure transducers typically consist of a sensing element that is in contact with the process medium and a transduction element that modifies the signal from the sensing element to produce an electrical or optical output. Some parts of the transducer may be hermetically sealed if those parts are sensitive to and may be exposed to moisture. Pressure connections must be threaded with appropriate fittings to connect the transducer to standard pipe fittings or to other appropriate leak-proof fittings. The output cable must be securely fastened to the body of the transducer. A variety of sensing elements are used in pressure transducers. The most common elements are diaphragms, bellows, capsules, Bourdon tubes, and piezoelectric crystals. The function of the sensing element is to produce a measurable response to applied pressure or vacuum. The response may be sensed directly on the element or a separate sensor may be used to detect element response. The following is a brief introduction to the major pressure sensing technology design categories.

4.2.1 *Electrical Pressure Transducers:*

4.2.1.1 *Differential Transformer Transducer*—Linear variable differential transformers (LVDT) are variable reluctance devices. Pressure-induced sensor movement, usually transmitted through a mechanical linkage, moves a core within a differential transformer. Sensors are most commonly bellows, capsules, or Bourdon tubes. The movement of the core within the differential transformer results in a change in reluctance that translates to a voltage output. An amplifying mechanical linkage may be used to obtain adequate core movement.