



Standard Specification for Tachometers, Various¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

- 1.1 This specification covers various tachometers capable of measuring rotational shaft speed.
- 1.2 Special requirements for tachometer types used in naval shipboard applications are included in Supplement S1.
- 1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only: mathematical conversions to inch-pound units that are provided for information only and are not considered standard.
- 1.4 *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](#)

3. Terminology

- 3.1 *Definitions:*
 - 3.1.1 *SI (Le Systeme International d'Unites) Units—Units, n—*units of measurement recognized by the Comite' International des Poids et Mesures (CIPM).
 - 3.1.2 *tachometer—tachometer, n—*an instrument capable of generating, transmitting, and indicating information or signal that can be converted into a function of rotational speed.

4. Classification

- 4.1 *Design Types—*The following are among the types of tachometers available:
 - (1) Centrifugal;
 - (2) Centrifugal, flexible drive;
 - (3) Chonometric;
 - (4) Electrical, alternating current (ac) voltage responsive, direct drive;
 - (5) Electrical reactance;
 - (6) Electrical, magnetovoltmeter, direct drive;
 - (7) Electrical, magnetovoltmeter;
 - (8) Frequency responsive, electrical control box and voltmeter, direct drive;
 - (9) Frequency sensitive, electrical, nonrotating magnetic pickup, direct drive, consists of a magnetic pickup, transducer, and indicator;
 - (10) Photoelectric;
 - (11) Digital contact;
 - (12) Centrifugal, flexible drive; and
 - (13) Vibrating resonant reed.

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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.



5. Ordering Information

5.1 The buyer shall provide the manufacturer with all of the pertinent application data in accordance with the acquisition requirements, 5.2.

5.2 *Acquisition Requirements*—Acquisition documents shall specify the following:

- (1) Title, number, and date of this specification;
- (2) Quantity of tachometers required;
- (3) Range;
- (4) Manufacturer's part number;
- (5) When qualification inspection is required;
- (6) Final disposition of qualification test samples;
- (7) Type of electrical connection;
- (8) Mounting method;
- (9) Environmental requirements;
- (10) Materials;
- (11) Size and weight restrictions;
- (12) Critical service life requirements;
- (13) Performance requirements;
- (14) Surface finish requirements;
- (15) Cleaning requirements;
- (16) When certification is required;
- (17) Marking requirements;
- (18) Packaging requirements; and
- (19) Preservation requirements.

6. Materials and Manufacture

6.1 *Material Selection*—The materials for all parts shall be selected for long-term compatibility with the environment in which the tachometer will be installed or used.

6.2 *Material Inspection*—The manufacturer shall be responsible for ensuring that materials used are manufactured, examined, and tested in accordance with the specifications and standards as applicable.

7. Physical Properties

7.1 *Size and Weight*—The buyer may have intended applications where size and weight are limited. Size and weight limitations shall be specified in the acquisition requirements.

8. Performance Requirements

8.1 *Service Life*—The buyer may have a minimum specified service life requirement. Critical service life requirements shall be specified in the acquisition requirements.

8.2 *Tachometer Performance*—Performance tolerances are usually specified in percentage of range span. The following performance characteristics and environmental exposures may or may not be important to each buyer's intended application.

- (1) Accuracy,
- (2) Repeatability,
- (3) Damping,
- (4) Temperature,
- (5) Humidity,
- (6) Salt spray,
- (7) Vibration,
- (8) Shock, and
- (9) Electromagnetic interference (EMI).

9. Workmanship, Finish, and Appearance

9.1 *Cleaning, Finish, and Appearance*—Any special cleaning, surface finish, and appearance requirements shall be specified in the acquisition requirements.

10. Inspection

10.1 *Classification of Inspections*—The inspection requirements specified herein are classified as follows:

- (1) Qualification testing, and
- (2) Quality conformance testing.

10.2 *Qualification Testing*—Qualification test requirements shall be specified, where applicable. Test methods should be identified for each design and performance characteristic specified. Test report documentation requirements should also be specified.

10.3 *Quality Conformance Testing*—Quality conformance inspection is accomplished when acceptance and qualification testing is satisfied by a previous acquisition or when the product has demonstrated reliability in similar applications. Quality conformance inspection is usually less intensive than acceptance and qualification, often verifying that samples of a production lot meet a few critical performance requirements.

11. Number of Tests and Retests

11.1 *Test Specimens*—The number of test specimens to be subjected to qualification testing shall depend on the tachometer design. If each range is covered by a separate and distinct design, a test specimen for each range will require testing. In instances in which a singular design series may cover multiple ranges and types, it is recommended that three test specimens be tested provided the electrical and mechanical similarities are approved by the buyer. In no case, however, should less than three units, one unit each representing low, medium, and high ranges, be tested, regardless of design similarity.

12. Test Methods

12.1 *Tests*—All tests shall be performed in accordance with ASTM, ASME, American Society of Mechanical Engineers (ASME), or industry standards as specified.

12.2 *Test Data*—All test data shall remain on file at the manufacturer's facility for review by the buyer upon request. It is recommended that test data be retained in the manufacturer's files for at least three years or a period of time acceptable to the buyer and manufacturer.

13. Quality Assurance Provisions

13.1 *Warranty*:

13.1.1 *Responsibility for Warranty*—Unless otherwise specified, the manufacturer is responsible for the following:

- (1) All materials used to produce a unit and
- (2) Manufacturer will warrant his product to be free from defect of workmanship to produce the unit.

14. Certification

14.1 When specified in the purchase order or contract, the buyer shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification, and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Product Marking

15.1 User-specified product marking shall be listed in the acquisition requirements. The minimum data to be clearly marked on each tachometer shall include the following:

- (1) Manufacturer's name,
- (2) Manufacturer's part number,
- (3) Serial number or lot number,
- (4) Date of manufacture, and
- (5) Range.

16. Packaging and Package Marking

16.1 *Packaging of Product for Delivery*—Product shall be packaged for shipment in accordance with Practice **D3951**.

16.2 Any special preservation, packaging, or package marking requirements for shipment or storage shall be identified in the acquisition requirements.

17. Keywords

17.1 tachometer



SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements established for U.S. Naval shipboard application shall apply when specified in the contract or purchase order. When there is conflict between ~~the~~this standard (Specification F2046) and this supplement, the requirements of this supplement shall take precedence for equipment acquired by this supplement. This document supersedes MIL-T-16049C, *Tachometers: Electrical; Self-Generating; Mechanical, Fixed Mounting, and Hand Held; and Vibrating Reed*, for new ship construction. This document also supersedes MIL-T-24797, *Tachometers, Fiber Optic, (Naval Shipboard Use), (Metric) General Specification for*, for new ship construction.

TACHOMETERS: ELECTRIC AND FIBER OPTIC, FIXED MOUNTING

S1. Scope

S1.1 This supplement covers single-range noncontact electric and fiber-optic tachometers capable of generating, transmitting, and indicating information or signal that can be converted into a function of rotational speed. The subject tachometers may be used in shipboard systems, such as gas generators, power turbines, propulsion shafts, and gas steam turbine generators.

S1.2 Vibrating reed resonant-type tachometers are not covered in this specification.

S1.3 The values stated in SI units are to be regarded as ~~the~~ standard. The values given in parentheses are ~~for information only~~mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

S2. Referenced Documents

S2.1 *Commercial Documents:*

S2.1.1 *ASTM Standards:*²

B117 Practice for Operating Salt Spray (Fog) Apparatus

D3951 Practice for Commercial Packaging

S2.1.2 *ANSI/ISA Standards:*³

ANSI/ISA S37.1 (R-1982) Electrical Transducer Nomenclature and Terminology

ANSI/ASQC Q9001-1994 Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, Inspection, Testing, and Servicing

S2.1.3 *Electronic Industries Association (EIA):(EIA) Standards:*⁴

RS-422 Electrical Characteristics of Balanced Voltage Digital Interface Circuit

455-22 FOTP-22 Ambient Light Susceptibility of Fiber Optic Components

455-34 FOTP-34 Interconnection Device Insertion Loss Test

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 Electronic Industries Alliance (EIA), 2500 Wilson Blvd., Arlington, VA 22201, <http://www.eia.org>; IHS Markit Ltd, <https://www.ihs.com/products/eia-standards.html>.

S2.2 Government Documents:

S2.2.1 Military Standards:⁵

MIL-STD-461 Electromagnetic Interference Characteristics of Subsystems and Equipment, Requirements for the Control of MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment (Type I—Environmental and Type II—Internally Excited)

S2.2.1 Military Specifications:⁵

MS3452 Connector, Receptacle, Electric, Box Mounting, Rear Release, Crimp Contact, AN Type

MS3456 Connector, Plug, Electrical, Rear Release, Crimp Contact, AN Type

MIL-C-5015 Connectors, Electrical, Circular Threaded, AN Type General Specification for

MIL-M-24794 Material, Index Matching, Fiber Optics

MIL-F-49291 Fiber, Optical, (Metric), General Specifications for

MIL-C-83522 Connectors, Fiber Optic, Single Terminus, General Specification for

MIL-C-83522/16 Connector, Fiber Optic, Single Terminus, Plug, Adapter Style, 2.5 mm Bayonet Coupling, Epoxy

MIL-C-83522/17 Connector, Fiber Optic, Single Terminus, Adapter, 2.5 mm Bayonet Coupling, Bulkhead Panel Mount

MIL-C-83522/18 Connector Fiber Optic, Single Terminus, Adapter, 2.5 mm Bayonet Coupling, PC Mount

MIL-C-85045 Cables, Fiber Optic, (Metric), General Specification for

MIL-S-901 Shock Tests, H.I. (High Impact), Shipboard Machinery, Equipment, and Systems, Requirements for

S3. Terminology

S3.1 *Definitions*—Terms marked with ~~(ANSI/ISA S37.1)~~ “ANSI/ISA S37.1” are taken directly from ANSI/ISA S37.1 (R-1982) and are included for the convenience of the reader.

S3.1.1 *ambient conditions*~~conditions~~, *n*—conditions, such as pressure and temperature, of the medium surrounding the case of a ~~sensor~~~~sensor~~.

~~(ANSI/ISA S37.1)~~ ~~(ANSI/ISA S37.1)~~

S3.1.2 *calibration*~~calibration~~, *n*—test during which known values of measurands are applied to the sensor and corresponding output readings are recorded under specific ~~conditions~~~~conditions~~.

~~(ANSI/ISA S37.1)~~ ~~(ANSI/ISA S37.1)~~

S3.1.3 *environmental conditions*~~conditions~~, *n*—specified external conditions, such as shock, vibration, and temperature, to which a sensor may be exposed during shipping, storage, handling, and ~~operation~~~~operation~~.

~~(ANSI/ISA S37.1)~~ ~~(ANSI/ISA S37.1)~~

S3.1.4 *error*~~error~~, *n*—the error for a given value of the input variable (measurand) is the difference between the measured value of the output signal and the expected value of the output signal. The expected value of the output signal for any value of the measurand shall be represented by a straight line whose end points are given by:

S3.1.4.1 The specified value of the output signal at the minimum input value of the measurand (for example, 4 mA at the minimum specified rotational speed).

S3.1.4.2 The specified value of the output signal at the maximum input value of the measurand (for example, 20 mA at the maximum specified rotational speed).

S3.1.5 *noncontact tachometer*~~tachometer~~, *n*—any type of tachometer that senses or responds to rotational speed without physical contact or mechanical connection to the shaft being measured.

S3.1.6 *operating environmental conditions*~~conditions~~, *n*—environmental conditions during exposure to which a sensor must perform in some specified ~~manner~~~~manner~~.

~~(ANSI/ISA S37.1)~~ ~~(ANSI/ISA S37.1)~~

S3.1.7 *optical*~~optical~~, *adj*—involving the use of light-sensitive devices to acquire information.

S3.1.8 *optical fiber*—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.

S3.1.9 *optoelectronic module*~~module~~, *n*—a component of the fiber optic tachometer that contains the optical source and detector, and signal conditioner devices necessary to convert the sensed rotational speed to a specified output signal.

S3.1.10 *output*~~output~~, *n*—electrical or numerical quantity, produced by a sensor or measurement system, that is a function of the applied measurand.

S3.1.11 *range*~~range~~, *n*—measurand values, over which a sensor is intended to measure, specified by their upper and lower ~~limits~~~~limits~~.

~~(ANSI/ISA S37.1)~~ ~~(ANSI/ISA S37.1)~~

S3.1.12 *repeatability*~~repeatability~~, *n*—ability of a sensor to reproduce output readings when the same measurand value is applied to it consecutively, under the same conditions, and in the same ~~direction~~~~direction~~.

~~(ANSI/ISA S37.1)~~ ~~(ANSI/ISA S37.1)~~

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://odsssp.daps.dla.mil>; 19111-5094, <http://quicksearch.dla.mil>.



S3.1.13 *sensor element*, *n*—that part of the sensor that responds directly to the measurand. (ANSI/ISA-ANSI/ISA S37.1S37.1).

S3.1.14 *sensor head*, *n*—the transduction element of a fiber optic tachometer that detects rotational speed by means of changes in optical properties.

S3.1.15 *sheath*, *n*—the protective covering of a sensor element.

S3.1.16 *signal conditioner*, *n*—an electronic device that makes the output signal from a transduction element compatible with a readout system.

S3.1.17 *span*, *n*—the algebraic difference between the limits of the measurement range.

S3.1.18 *static error band*, *n*—the maximum deviation from a straight line drawn through the coordinates of the lower range limit at specified sensor output, and the upper range limit at specified output expressed in percentage of sensor span.

S3.1.19 *supporting surface*, *n*—surface on which the equipment is placed.

S3.1.20 *target*—description including items such as material, size, multiple reflectors, and surface features shall be as specified in the acquisition requirements.

S3.1.21 *tachometer*, *n*—an instrument capable of generating, transmitting, and indicating information or signal that can be converted into a function of rotational speed.

S3.1.21 *target*, *n*—description including items such as material, size, multiple reflectors, and surface features shall be as specified in the acquisition requirements.

S3.1.22 *warm-up time*, *n*—the time required for a sensor to operate within specified accuracy, repeatability, and other critical parameters after being energized from a cold (ambient) state.

S4. Design Classification

S4.1 Electric Types:

S4.1.1 *Designation*—Tachometers shall be classified by a series of designations which shall be assigned and listed in the format following.

Example: F2046-20M-BK-A

F2046	20M	BK	A
Specification	Range (see S4.1.2)	Mounting (see S4.1.3)	Indicator (see S4.1.4)

S4.1.2 *Range*—Electric tachometer ranges shall be selected from the standard ranges listed in Table S4.1.

S4.1.3 *Mounting*—Tachometer indicators shall be either bulkhead mounted (designator—BK) or panel (designator—PL) mounted.

S4.1.4 *Indicator*—Tachometer indicators shall be either analog (designator—A) or digital (designator—D).

S4.2 *Fiber-Optic Type*: ai/catalog/standards/sist/7834ddd7-48ad-4d7e-8fb4-02cf399e95f4/astm-f2046-002017

TABLE S4.1 Standard Ranges for Electric Tachometers

Range, RPM	Designation
0–100	10A
0–200	20A
0–500	50A
50–500	50M
0–1000	10B
100–1000	10M
0–2000	20B
200–2000	20M
0–3000	30B
300–3000	30M
0–4000	40B
0–5000	50B
500–5000	50N
0–10 000	10C
1000–10 000	10N
0–20 000	20C
1000–20 000	20N
0–30 000	30C
0–50 000	50C
5000–50 000	50P
0–100 000	10D
500–100 000	10P
1000–100 000	10R
5000–100 000	10T