



AEROSPACE STANDARD

AS5382™**REV. B**

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Superseding AS5382A

Aerospace Cable, Fiber Optic

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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Documents
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1. SCOPE

1.1 Purpose

This standard covers jacketed single-fiber multimode and single-mode fiber optic cables for aerospace usage.

1.2 Classification

The fiber optic cables covered by this standard shall be as described in the applicable specification sheets and shall be identified by the specification sheet number and title.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS4373	Test Methods for Insulated Electric Wire
AS16781	Fiber Optics Test Methods and Instrumentation
AS5382/1*	Cable, Fiber Optic, Multimode, 100/140/172 μm Graded Index, Hermetic Coated, Tight Buffer
AS5382/2*	Cable, Fiber Optic, Multimode, 100/140/172 μm Graded Index, Nonhermetic, Loose Tube
AS5382/3*	Cable, Fiber Optic, Single-Mode, 6/125/250 μm , Hermetic Coated, Tight Buffer
AS5382/4*	Cable, Fiber Optic, Single-Mode, 4.6/125/450 μm , Hermetic Coated, Tight Buffer

AS5382/5* Cable, Fiber Optic, Multi-Mode, 50/125/450 µm, Graded Index, Hermetic Coated, Tight Buffer

AS5382/6* Cable, Fiber Optic, Multi-Mode, 200/230/500 µm, Step Index, Tight Buffer

AS9100 Aerospace Requirements, Quality Management Systems

* AS5382 specification sheet (detail specification)

2.1.2 ANSI Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI/NCSL Z540-1 Laboratories, Calibration and Measuring and Test Equipment

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 595 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

ASTM D 3032 Standard Test Methods for Hookup Wire Insulation

2.1.4 National Conference Of Standards Laboratories (NCSL) Publications

National Conference of Standards Laboratories, 2995 Wilderness Place, Suite 107, Boulder, CO 80301-5404, Tel: 303-440-3339, www.ncsli.org.

NCSL Z540-1 General Requirements for Calibration Laboratories and Measuring and Test Equipment

2.1.5 TIA/EIA Publications

Available from Telecommunications Industry Association, 2500 Wilson Boulevard, Suite 300, Arlington, VA 22201, Tel: 703-907-7700, www.tiaonline.org/standards/.

TIA/EIA-455 Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

TIA/EIA-455-3 FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components

TIA/EIA-455-11 FOTP-11 Vibration Test Procedure for Fiber Optic Components and Cables

TIA-455-13 FOTP-13 Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies

TIA-455-14 FOTP-14 Fiber Optic Shock Tests (Specified Pulse)

TIA-455-20 FOTP-20 IEC 60793-1-46 - Optical Fibres - 1-46: Optical Fibres - Part 1-46: Measurement Methods and Test Procedures - Monitoring of Changes in Optical Transmittance

TIA/EIA-455-25 FOTP-25 Impact Testing of Optical Fiber Cables

TIA/EIA-455-31 FOTP-31 Proof Testing Optical Fibers by Tension

TIA/EIA-455-33 FOTP-33 Optical Fiber Cable Tensile Loading and Bending Test

TIA/EIA-455-39 FOTP-39 Optical Fiber Cable Water Wicking Test

TIA/EIA-455-41	FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
TIA-455-56	FOTP-56 Test Method for Evaluating Fungus Resistance of Optical Fiber and Cable
TIA/EIA-455-71	FOTP-71 Procedure to Measure Temperature-Shock Effects on Fiber Optic Components
TIA-455-78	FOTP-78 IEC 60793-1-40: Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-455-80	FOTP-80 IEC 60793-1-44: Optical fibres - Part 1-44: Measurement methods and test procedures – Cut-off wavelength
TIA-455-84	FOTP-84 Jacket Self-Adhesion (Blocking) Test for Fiber Optic Cable
TIA/EIA-455-162	FOTP-162 Fiber Optic Cable Temperature-Humidity Cycling
TIA-455-176	FOTP-176 IEC 60793-1-20: Optical fibres - Part 1-20: Measurement methods and test procedures – Fibre geometry
TIA-455-178	FOTP-178 IEC 60793-1-32: Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability
EIA-557	Statistical Process Control Systems

2.1.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-DTL-12000	Cable, Cord, and Wire, Electric; Packaging of
MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-PRF-85045	Cables, Fiber Optic, (Metric) General Specification for
MIL-STD-202	Test Methods Standard Electronic and Electrical Component Parts
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-2223	Test Methods for Insulated Electrical Wire

2.2 Definitions

2.2.1 ACCEPTANCE ANGLE

Half the vertex angle of that cone within which optical power may be coupled into an optical fiber.

2.2.2 ATTENUATION

Diminution of optical power (loss of light). Expressed in dB or (for optical fiber) in dB/km.

2.2.3 BANDWIDTH (FIBER BANDWIDTH)

Range of signal frequencies carried on an optical fiber with a defined maximum signal distortion. For multimode fiber, fiber bandwidth is limited by signal distortion and is expressed as a product of signal bandwidth and propagation distance (MHz-km).

2.2.4 BOUND MODE

In an optical fiber, a mode whose field decays monotonically in the transverse direction everywhere external to the core, and which does not lose power to radiation. Bound modes correspond to guided rays in the terminology of geometric optics.

2.2.5 BUFFER

A typically polymeric coating that is used to protect an optical fiber from physical damage, moisture or chemicals, or to provide mechanical isolation. (See also: Fiber Optic Cable, Loose Tube Type and Tight Buffer Type)

a. PRIMARY BUFFER

The buffer coating applied by the fiber manufacturer during the fiber drawing operation. Sometimes referred to simply as “fiber coating” or “primary coating.”

b. SECONDARY BUFFER

Any number of coatings applied over the primary buffer. Secondary buffers may be applied by the fiber manufacturer in an operation secondary to the draw process or by a cable manufacturer. A secondary buffer may also be known as “upjacketing.”

2.2.6 CLADDING

The optical material surrounding the core of an optical fiber. Cladding may be either glass or polymeric, but must always be a material having an index of refraction lower than that of the core material.

2.2.7 CORE

The central region of an optical fiber through which light is transmitted. The core must always be a material having an index of refraction higher than the surrounding cladding material.

2.2.8 CUTOFF WAVELENGTH

For a single-mode fiber under specified conditions, the wavelength at which the fiber's second order mode is attenuated a specified amount. At wavelengths greater than the cutoff wavelength, a fiber is said to transmit single-mode.

2.2.9 DISPERSION

A phenomenon due to a wavelength-dependent propagation velocity that results in signal distortion and pulse broadening. In optical fibers, several dispersion effects are present. Material (or chromatic) dispersion is that due to the constituent materials forming the fiber. Waveguide dispersion is due to the dependence of the group and phase velocities on the numerical aperture, core diameter, and wavelength. Modal dispersion or distortion, important only in multimode fibers, results from the variation in path lengths for the different modes of the fiber. For single-mode optical fibers, material and waveguide dispersion are the dominant causes of dispersion.

2.2.10 FAR-FIELD REGION

That region, far from a source or radiating aperture, where the diffraction pattern is essentially the same as that observed at an infinite distance.

2.2.11 FIBER OPTIC CABLE

One or more optical fibers contained in a common jacket, usually with an integral strength member.

a. LOOSE TUBE TYPE

A cable design in which the fiber(s) is placed into a cavity which is much larger than the fiber with its primary buffer. This is intended to give the fiber mechanical independence in applications with high relative motions and/or large temperature swings which could cause differential motion or stress inside conventional tight buffer cable structures.

b. TIGHT BUFFER TYPE

A cable design in which the secondary buffer(s) are applied in a manner resulting in firm contact between the primary buffer and subsequent protective layers.

c. SEMI-LOOSE STRUCTURE

A cable design having a modified semi-loose structure that allows slight movement of the fiber and associated buffer between the inner jacket and the outer strength members.

2.2.12 FIBER OPTIC CABLE ASSEMBLY

One or more fiber optic cables terminated with two or more optical terminations (usually connectors) and so arranged that it can be handled as one unit.

2.2.13 HERMETIC COATING

A thin coating (typically several hundred angstroms of amorphous carbon) applied directly to the fiber surface before the application of the primary buffer, for the purpose of sealing the fiber surface against hydrogen ingress and improving the fiber's fatigue resistance.

2.2.14 INDEX OF REFRACTION (REFRACTIVE INDEX)

The index of refraction of a medium, denoted by n , is the ratio of the velocity of light in vacuum to the velocity of light in that medium.

2.2.15 MODE

In any cavity or transmission line, one of those electromagnetic field distributions that satisfies Maxwell's equations and the boundary conditions or that can be designated by a radiation pattern in a plane transverse to the direction of travel. Usually understood to be a single optical path or ray of light.

2.2.16 MODE FIELD DIAMETER

The measure of the width of the guided optical power's intensity distribution in a single-mode fiber. Usually specified instead of fiber core diameter for single-mode fiber.

2.2.17 NEAR FIELD REGION

That region, near a source or radiating aperture, where the diffraction pattern differs significantly from that observed at an infinite distance.

2.2.18 NUMERICAL APERTURE (NA)

A measure of the light gathering ability of a fiber. NA is commonly defined as the sine of the acceptance angle (θ_a) of an optical fiber multiplied by the refractive index of the material in contact with the entrance face of the fiber. For a step index fiber in air, $NA = \sqrt{n_1^2 - n_2^2}$ where n_1 and n_2 are the refractive indices of the core and cladding materials, respectively. (See also: Acceptance Angle)

2.2.19 OPTICAL FIBER

A filament, made of dielectric materials, that guides light.

a. GRADED INDEX OPTICAL FIBER

An optical fiber in which the refractive index of the core varies with radial distance from the fiber axis and is lowest near the cladding.

b. STEP INDEX OPTICAL FIBER

An optical fiber characterized by a uniform refractive index in the core and a sharp decrease in refractive index at the core-cladding interface.

c. SINGLE-MODE OPTICAL FIBER

An optical fiber in which only the lowest order bound mode can propagate at the wavelength of interest. (See also: Bound Mode)

d. MULTIMODE OPTICAL FIBER

An optical fiber which will allow more than one bound mode to propagate. (See also: Bound Mode)

2.2.20 OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

A measurement device used to characterize a fiber, wherein an optical pulse is transmitted through the fiber and the resulting light scattered and reflected back to the input is measured as a function of time. Useful in identifying defects and other localized losses.

2.2.21 PREFORM

A glass structure (usually a rod) from which an optical fiber may be drawn.

2.2.22 QUALIFICATION INSPECTION

Qualification Inspection is a process that demonstrates that a component is capable of fully conforming to all the requirements defined in a standard. Qualification Inspection includes definition of the measurements, tests, analysis, and associated data which provides consistent rationale for acceptance of a particular supplier's design as meeting the standard requirements typically prior to acquisition by the Purchaser.

2.2.23 QUALIFIED PRODUCTS LIST

A Qualified Products List is a list of suppliers whose products have been evaluated to a defined process and who are authorized to provide those products to a purchaser upon request. When a Qualified Products List is specified, only approved suppliers are authorized to provide products under the part number defined in the component standard. A Qualified Products List is established by a Qualifying Activity.

2.2.24 QUALIFYING ACTIVITY

A Qualifying Activity is a function established by a Purchaser or group of Purchasers that has a defined process used to consistently evaluate all suppliers' products in accordance with the component standard.

2.2.25 QUALITY CONFORMANCE INSPECTION

Quality Conformance Inspection is a process which includes measurements, non-destructive tests, analysis, and associated data that will provide verification that a particular individual component continually conforms to the requirements defined in the standard.

2.2.26 PURCHASER

A purchaser is an activity that can issue a purchase order.

2.2.27 REFRACTION

The bending of a beam of light in transmission through an interface between two media with dissimilar indices of refraction. (See also: Index of Refraction)

2.2.28 SUPPLIER

A Supplier is a manufacturer which has design and production control of the processes used to produce a component.

3. REQUIREMENTS

3.1 Specification Sheets

Individual cable requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between the requirements of this standard and the specification sheet, the latter shall govern.

3.2 Physical Characteristics

3.2.1 Construction Description

The optical fiber and cable layer diameters and material makeup shall be as specified in the applicable specification sheets. Mode field diameter shall be specified in lieu of core diameter for single-mode fibers.

3.2.2 Operational Mode

The principal mode of operation shall be defined as either multimode or single-mode as specified in the applicable specification sheets.

3.2.3 Temperature Rating

The maximum and minimum operating temperatures in degrees Celsius (°C) are noted in the applicable specification sheets.

3.2.4 Storage Temperature Rating

The maximum and minimum storage temperatures in degrees Celsius (°C) are noted in the applicable specification sheets.

3.2.5 Jacket Color

The finished color of the cable jacket shall be determined by the fiber size and mode of operation unless otherwise defined by the specification sheets. The following colors in Table 1 have been defined for fiber optic cables. If cable color does not correspond to this table, the applicable specification sheet shall state "non-standard color".

TABLE 1 - COLOR CODING SCHEME FOR FIBER OPTIC CABLE

Fiber Type	Fiber Size (μm)	Jacket Color
Multimode	50/125	Orange
Multimode	62.5/125	Slate
Multimode	85/125	Blue
Multimode	100/140	Green
Multimode	200/240	Purple
Single-mode	All	Yellow

3.2.6 Outer Jacket

The cable jacket shall be as specified in the applicable specification sheets. The diameter of the outer jacket shall be as specified in the applicable specification sheets when tested in accordance with 5.2.3.

3.2.7 Cable Weight

When tested in accordance with 5.2.4, the weight shall be as specified in the applicable specification sheets.

3.2.8 Concentricity of Buffered Fiber

The buffer design shall be as specified in the applicable specification sheets. When tested in accordance with 5.3.4, the concentricity shall be as specified on the applicable specification sheets.

3.3 Optical Fiber Requirements

3.3.1 Attenuation

The attenuation of the fiber prior to cabling or application of other stresses shall be tested in accordance with 5.3.1. The maximum attenuation shall be as specified in the applicable specification sheets. Optical loss shall be given in decibels (dB) per kilometer (km).

3.3.2 Change in Optical Transmittance

The maximum acceptable change in attenuation from the baseline measurement, per unit length, during or after environmental, mechanical or thermal tests shall be as specified in the applicable specification sheets.

3.3.3 Attenuation Uniformity

When tested in accordance with 5.3.3, the fluctuations along the length of the cable shall be as specified in the applicable specification sheet.

3.3.4 Fiber Diameter, Core Offset and Concentricity

When tested in accordance with 5.3.4, the fiber shall meet the dimensional requirements of the applicable specification sheet.

3.3.5 Fiber Tensile Proof Test

When tested in accordance with 5.3.5, the fiber shall meet the requirements of the applicable specification sheet.

3.3.6 Mode Field Diameter

(Single-Mode Only) When tested in accordance with 5.3.6, the fiber mode field diameter shall meet the requirements of the applicable specification sheet.