



IEEE Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines

IEEE Power and Energy Society

Developed by the
Power System Communications and Cybersecurity Committee

IEEE Std 1222™-2019
(Revision to IEEE Std 1222-2011)



STANDARDS

IEEE Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines

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Power System Communications and Cybersecurity Committee
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Approved 7 November 2019

IEEE-SA Standards Board

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Abstract: The construction, mechanical, electrical, and optical performance, installation guidelines, acceptance criteria, test requirements, environmental considerations, and accessories for a nonmetallic, all-dielectric self-supporting (ADSS) fiber optic cable are covered by this standard. The ADSS cable is designed to be located primarily on overhead utility facilities.

Keywords: ADSS, all-dielectric self-supporting fiber optic cable, IEEE 1222™, overhead utility

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Introduction

This introduction is not part of IEEE Std 1222-2019, IEEE Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines.

This standard was first published in 2004 and updated in 2011. It is used worldwide to purchase and specify the performance of all-dielectric self-supporting (ADSS) cables. The original purpose of the standard was written to fill a need for standardization of terminology, performance, and test requirements for ADSS cables.

The original title was “IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable.” Over the years, the document has been used primarily as a test standard. To better reflect how the standard is presently used, the title previously changed to “IEEE Standard for Testing and Performance for All-Dielectric Self-Supporting Fiber Optic (ADSS) Cable for Use on Electric Utility Power Lines.”

This revised standard documents the collective experience gained by the industry since the updated publication of the standard in 2011. Changes have been made in the following areas:

- Functional requirements
- Test requirements

Additional requirements related to ADSS Cable Hardware and Cable/Hardware Compatibility are addressed in IEEE Std 1591.2 [B10].¹

¹ The numbers in brackets correspond to those of the bibliography in Annex F.

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1. Overview

1.1 Scope

This standard covers the construction, mechanical, electrical, and optical performance, installation guidelines, acceptance criteria, test requirements, environmental considerations, and accessories for ~~an all-dielectric,~~^a nonmetallic, all-dielectric self-supporting (ADSS) fiber optic cable. The ADSS cable is designed to be located primarily on overhead utility facilities.

1.2 Purpose

This standard provides both construction and performance requirements for maintenance of the proper optical fiber integrity and optical transmission capabilities of ADSS cable.

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

2.1 ~~Optical fiber standards~~

ASTM D1603, Standard Test Method for Carbon Black Content in Olefin Plastics.¹²

EIA/TIA-598, Optical Fiber Cable Color Coding~~of Fiber Optic Cables.~~²³

IEC 60793-2-10, Optical ~~fibers~~ fibres—Part 2-10: Product specifications—Sectional specification for category A1 multimode ~~fibers~~ fibres.⁴³

IEC 60793-2-50, Optical ~~fibers~~ fibres—Part 2-50: Product specifications—Sectional specification for class B single-mode ~~fibers~~ fibres.

2.2 ~~Test standards~~

IEC 60794-1-21, Optical fibre cables—Part 1-21: Generic specification—Basic optical cable test procedures—Mechanical tests methods.

² ASTM publications are available from the American Society for Testing and Materials, ~~100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA~~ (<https://www.astm.org/>).

³ EIA/TIA publications are available from Global Engineering Documents, ~~15 Inverness Way East, Englewood, CO 80112, USA~~ (<https://global.ihs.com/>).

⁴ IEC publications are available from the ~~Sales Department of the~~ International Electrotechnical Commission, ~~Case Postale 131, 3, rue de Varembe, CH 1211, Genève 20, Switzerland/Suisse~~ (<http://www.iec.ch/>) ~~IEC~~ and the American National Standards Institute (<https://www.ansi.org/>) ~~publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA~~ (<http://www.ansi.org/>).

[IEC 60794-1-22, Optical fibre cables—Part 1-22: Generic specification—Basic optical cable test procedures—Environmental test methods.](#)

IEC 61395, Overhead electrical conductors—Creep test procedures for stranded conductors.

TIA-455-3, FOTP-3 Procedures to Measure Temperature Cycling Effects on Optical ~~Fibers~~[Fiber Units](#), Optical Cable, and Other Passive Fiber ~~Optic~~ Components.⁵

TIA-455-25, FOTP-25 Impact Testing of Optical Fiber Cables.

TIA-455-33, FOTP-33 Optical Fiber Cable Tensile Loading and Bending Test.

~~TIA-455-37, FOTP-37, Low or High Temperature Bend Test for Fiber Optic Cable.~~

TIA-455-41, FOTP-41 Compressive Loading Resistance of Optical Fiber Cables.

TIA-455-78, FOTP-78, [IEC 60793-1-40 Optical Fibres—Part 1-40: Measurement Methods and Test Procedures—Attenuation.](#)

TIA-455-81, FOTP-~~81~~, Compound Flow (Drip) Test for Filled Fiber Optic Cable.

TIA-455-82, FOTP 82, [B](#) Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable.

[TIA-455-85, FOTP-85 Fiber Optic Cable Twist Test.](#)

[TIA-455-104, FOTP-104 Fiber Optic Cable Cyclic Flexing Test.](#)

[TIA-455-244, FOTP-244 Methods for Measuring the Change in Transmittance of Optical Fibers in Expressed Buffer Tubes When Subjected to Temperature Cycling.](#)

~~TIA-455-85, FOTP-85, Fiber Optic Cable Twist Test”TIA-455-104, FOTP-104, “Fiber Optic Cable Cyclic Flexing Test.~~

~~TIA-455-244, FOTP-244, Expressed Buffer Tube Optical Loss Measurement Methods.~~

⁵ TIA publications are available from the Telecommunications Industry Association (<https://www.global.tia.com>).

3. Definitions, acronyms, and abbreviations

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary: ~~Glossary of Terms & Definitions~~ Online* should be ~~referenced~~consulted for terms not defined in this clause.⁴⁶

3.1 General definitions

~~ADSS: All-Dielectric Self-Supporting Fiber-Optic Cable.~~

~~breaking strength~~~~-or breaking tension: Breaking strength is:~~ The maximum tensile load that the cable shall withstand without mechanical failure. The maximum rated cable load (~~MRCL~~) is typically less than 60% of the breaking strength. The breaking strength should be calculated. The design model ~~must~~ shall be validated; the cables do not need to be tested to their breaking strength. Syn: breaking tension.

breaking tension: See: breaking strength.

everyday tension (EDT): The ~~everyday tension is the~~ final tension with no ice and no wind at the average annual mean temperature throughout the year. This temperature is assumed as 16 °C (60 °F). This number is often used in specifying motion control devices such as vibration dampers.

hardware: Attachments or fittings that are in direct contact with the cable.

maximum installation tension (MIT)~~-or sagging tension (SAT): This is:~~ The initial tension at which the cable is pulled during the sagging portion of the installation process. This tension is used to achieve the appropriate installation sag defined by the manufacturer. Syn: sagging tension.

NOTE—This is the same as the initial everyday tension (~~EDT~~) when specified at 16 °C (60 °F).⁵⁷

⁶ IEEE Standards Dictionary: ~~Glossary of Terms & Definitions~~ Online is available at: ~~http://shop.ieee.org/~~http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

⁷ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

maximum rated cable load (MRCL): ~~This is~~ The maximum tensile load the cable is designed to withstand during its lifetime. This is sometimes called the maximum rated design tension (~~MRDT~~) by the IEEE or the maximum allowed tension (~~MAT~~) by IEC. This is typically the load the cable is designed to take when the cable is installed in its maximum specified span length while experiencing the maximum specified weather load.

pulling tension: See: **stringing tension.**

sagging tension: See: **maximum installation tension.**

stringing tension (STT): The ~~stringing tension, also known as the pulling tension is defined as the~~ tension used to pull the cable through sheaves during the stringing portion of the installation process. This should never be greater than the sagging tension. Syn: **pulling tension.**

system (ADSS system): The cable and hardware described in IEEE Std 1222 that function as an integrated unit.

torque balance dielectric members: The cable strength yarns are wound in opposite directions as opposed to a single direction to minimize cable twisting when under tension.

3.2 Electrical definitions

corona: A luminous discharge due to ionization of the air surrounding an electrode caused by a voltage gradient exceeding a certain critical value.

NOTE—For the purpose of this standard, electrodes may be conductors, hardware, accessories, or insulators.

3.2 Electrical definitions

dry band arcing: When wet pollution on ~~ADSS~~ [all-dielectric self-supporting](#) cable jacket dries, high-resistance dry bands form. Induced voltage of sufficient magnitude across dry bands ~~will produce~~ [produces](#) an arc that can potentially damage the jacket.

electric field [strength](#): The change in space potential over a change in distance. Basic concept is $E \cong dV/ds$ and E is a vector that has magnitude and direction. Magnitude described in units of volts/~~per~~ [meter](#) (common abbreviations are V/m, kV/m, and kV/cm). Direction may be in the form of components such as E_x , E_y , and E_z or given by unit direction vectors (U_x , U_y , U_z).

~~induce~~ [induced](#) voltage (Voc): In IEEE Std 1222, Voc refers to the induced voltage across a formed dry band in the absence of an arc, often called “voltage open circuit.”

NOTE—Refer to Annex D for more information.

pollution resistance: ~~Is~~ The wet pollution resistance on [all-dielectric self-supporting](#) (ADSS) jacket surface in ohms/~~per~~ [meter](#). This parameter is used to determine currents in the wet pollution layer as well as for computing dry band arc voltage.

NOTE 1—These currents and voltages form the basis of the test described in Annex E.

NOTE 2—ADSS cable wet pollution is normally very conductive compared to dry pollution. In general, 10^8 ~~ohm/meter~~ [Ω/m](#) or less is considered conductive.

pollution index: ~~This is~~ The exponent of the wet pollution linear resistance in ~~ohm/~~ [ohms per](#) meter. For example, an index of 5.7 indicates a resistance of $10^{5.7}$ or 501 ~~kilo-ohm/meter~~ [kΩ/m](#).

space potential: A level of voltage in space between energized as well as grounded objects (e.g., conductors of a high-voltage transmission line and tower members). The magnitude is described in units of volts. Mathematically this is a scalar value. ~~(See: electric field.)~~

surface gradient: ~~Defined as~~ The electric field [strength](#) on a surface. Levels near 20 kV ~~/~~ [\(rms\)](#)/cm are high enough to break down air resulting in corona.

3.3 Acronyms and abbreviations

ADSS	all-dielectric self-supporting
EDT	everyday tension
MAT	maximum allowed tension
MIT	maximum installation tension
MRCL	maximum rated cable load
MRDT	maximum rated design tension
SAT	sagging tension
STT	stringing tension

4. ADSS cable and components

4.1 Descriptions

The ADSS cable shall consist of coated glass optical fibers ~~contained~~ grouped in one or more protective dielectric ~~fiber-optic~~ units surrounded by or attached to suitable dielectric strength members and jackets. The cable shall not contain metallic components. The cable shall be designed to meet the requirements under all specified installation conditions, operating temperatures, and environmental loading.

4.2 Fiber optic cable core

The fiber optic cable core shall be all-dielectric and shall ~~be made up of~~ contain coated glass optical fibers ~~housed to protect the fibers~~ that are protected from mechanical, environmental, and electrical stresses. Materials used within the core shall be compatible with one another, shall not degrade under the electrical stresses to which they may be exposed, and shall not evolve hydrogen in quantities sufficient to degrade optical performance of fibers within the cable.

4.2.1 Fiber strain allowance

The cable shall be designed such that fiber strain does not exceed the limit allowed by the cable manufacturer under the operational design limits (MRCL) of the cable. Maximum allowable fiber strain ~~will~~ is generally ~~be~~ a function of the proof test level, and the strength and fatigue parameters of the coated glass fiber. The maximum fiber strain shall not exceed the limit specified in 6.5.1.2. The optical fiber attenuation increase while under fiber strain shall also meet the requirements listed in ~~this subclause~~ 6.5.1.2.

4.2.2 Central strength element

If a central strength element is necessary, it shall be of reinforced plastic, epoxy glass, or other dielectric material. If required, this element shall provide the necessary tensile strength to limit axial stress on the fibers and minimize fiber buckling due to cable contraction at low temperatures. The strength element shall also meet the stress strain fatigue requirements in 6.5.1.3.

4.2.3 Buffer tube filling compound

Loose buffer tubes shall be water-blocked with a suitable material compatible with the tubing material, fiber coating, and coloring, to protect the optical fibers and prevent moisture ingress.

4.2.4 Cable core water blocking compound

The design of the cable may include suitable water blocking materials in the interstices to prohibit water migration along the fiber optic cable core. The water blocking material shall be compatible with all components with which it may come in contact.

4.2.5 Binder/tape

A binder yarn~~(s)~~ or yarns and/or a layer~~(s)~~ or layers of overlapping non-hygroscopic tape(s) may be used to hold the cable core elements in place during application of the jacket.

4.2.6 Inner jacket

A protective inner jacket or jackets of a suitable material may be applied over the fiber optic cable core, isolating the cable core from any external strength elements and the cable outer jacket.

4.3 Optical fibers

Single-mode fibers such as dispersion-unshifted, dispersion-shifted, or non-zero dispersion shifted~~;~~ and as well as multimode fibers with 50/125 μm or 62.5/125 μm core/clad diameters are considered in this standard.

All single-mode fibers shall meet the requirements of IEC 60793-2-50.⁶⁸ All multimode fibers shall meet the requirements of IEC 60793-2-10. The core and the cladding shall consist of all glass that is predominantly silica (SiO_2). The coating is usually made from one or more materials, such as acrylate, and shall protect the fiber during manufacture, handling, and operation.

4.4 Buffer construction

The individually coated optical fiber(s) or fiber ribbon(s) may be surrounded by a tube for protection from physical damage during fabrication, installation, and operation of the ADSS cable. Loose buffer construction is a typical type of protection that may be used to isolate the fibers. The fiber coating shall be strippable for splicing and termination.

4.4.1 Loose buffer

Loose buffer construction shall consist of a tube that surrounds each fiber or fiber group such that the inner diameter of the tube is greater than the outside diameter of the fiber or fiber group. The interstices inside and outside the tube shall contain a water blocking material.

4.5 Color coding and performance

Color coding is essential for identifying individual optical fibers and groups of optical fibers. The colors shall be in accordance with EIA/TIA-598. The original identification of fibers and units shall remain discernible throughout the design life of the cable when cleaned and prepared per manufacturer's recommendations.

4.6 Jackets

The outer jacket shall be designed to house and protect the inner elements of the cable from damage due to moisture, sunlight, environmental, thermal, mechanical, and electrical stresses.

⁸ Information on references can be found in Clause 2.

- a) All jacket materials shall be dielectric, non-nutrient to fungus and meet the general requirements in 5.4 and 6.5.4. The jacket material may be polyethylene. The outer jacket shall contain a minimum concentration of 2.35% furnace black (carbon black) when measured in accordance with ASTM D1603 to provide ultraviolet shielding. The raw jacket material shall contain an antioxidant to provide long-term stabilization.
- b) The jacket shall be extruded over the underlying element and shall be of uniform diameter to properly fit support hardware.
- c) The cable jacket shall be suitable for application in electrical environments as defined in 6.5.4.
- d) Jacket classification shall be according to the following:
 - 1) *Class A*: The jacket's electrical dry band arcing performance is at least equal to the characteristics of the typical polyethylene material used for ADSS jackets (see 6.5.4). The supplier shall specify the maximum space potential for proper dry band arcing performance.
 - 2) *Class B*: This is a higher performance dry band arcing jacket compared to polyethylene. For Class B jackets, the supplier shall specify the maximum space potential for proper dry band arcing performance.

NOTE—This type of jacket is commonly referred to as a “track-resistant jacket.”

5. ADSS application requirements and recommendations

ADSS cable has the purpose of providing telecommunications capacity utilizing optical fibers. These cables are typically co-located with high-voltage power lines. As such, an ADSS cable is required to withstand the effects of installation and long-term in-service exposure to mechanical, electrical, and environmental loads with no significant degradation in performance. An ADSS cable shall be made up of optical telecommunications fibers contained in one or more protective fiber optic units combined with torque balanced dielectric members in multiple layers.

5.1 Cable design characteristics

ADSS cable designs are dependent on the application conditions and operating environment in which they are installed. Key characteristics that should be agreed upon between the supplier and customer are provided in Table 1⁹ and Table 2.

Table 1—Customer-provided information

Fiber type and number of fibers	
Cable design	
Maximum cable span required	m (ft)
Installation cable sag	%
Maximum weather loading (wind, ice, etc.)	CSA C22.3 [B2] (Canada) or NESC [B1] (USA) Heavy, Medium, Light Loading; or other load defined by the customer (wind speed in mi/h or m/s, ice thickness on cable in mm or in, etc.)
For each different ADSS location, a description of the power line geometry to include: — line voltage, line phasing, conductor bundle configuration (conductor diameter, number of conductors per phase, distance between conductors within the bundle), distances between phases, and clearances to ground; or — the ADSS cable space potential compatibility requirement at these locations.	V, degrees, mm (in), m (ft)
Intended locations of ADSS cable in relation to the described geometries, or the ADSS cable space potential compatibility requirement at these locations.	m (ft)
Maximum vertical or horizontal cable sag allowed during the maximum weather loading. This may be important for clearance considerations.	kV
Pollution environment the ADSS cable may be exposed (see 6.5.4). It is important that the customer provide this information if the cable exposed to a pollution environment.	m (ft)

(New)

⁹ The numbers in brackets correspond to those of the bibliography in Annex F.

Fiber type and number of fibers	
Cable design	
Maximum cable span required	m (ft)
Installation cable sag	%
Maximum weather loading (wind, ice, etc)	CSA 22.3 (Canada) or NESC (USA) Heavy, Medium, Light Loading; or other load defined by the customer (wind speed in mph or m/s, ice thickness on cable in mm or inches, etc)
For each different ADSS location, a description of the powerline geometry to include: line voltage, line phasing, conductor bundle configuration (conductor diameter, number of conductors per phase, distance between conductors within the bundle), distances between phases, and clearances to ground. OR the ADSS cable space potential compatibility requirement at these locations.	V, degrees, mm (in), m (ft)
Intended locations of ADSS cable in relation to the described geometries, OR the ADSS cable space potential compatibility requirement at these locations.	m (ft) kV
Maximum vertical or horizontal cable sag allowed during the maximum weather loading. This may be important for clearance considerations.	m (ft)
Pollution environment the ADSS cable may be exposed (see 6.5.4). It is important that the customer provide this information if the cable exposed to a pollution environment.	

(Deleted)

Table 2—Supplier-provided information (based on information from Table 1)

Cable diameter and unit weight	mm (in), kg/km (lb/kf)
MRCL (maximum rated cable load) designed for the above maximum weather loading at the maximum specified span and installation sag	N (lbf)
Installation tension and sag at different span lengths	N (lbf) tension and m (ft), sag%
Maximum vertical and horizontal sag at the maximum weather loading at different span lengths	m (ft)
Maximum span length for specified loading criteria	m (ft)
Maximum cable space potential value shall be compatible with the calculated space potential based on the customer-provided transmission line voltage, cable placement location, and any environmental pollution exposure.	kV

(New)

Cable diameter and unit weight	mm (in), kg/km (lb/kf)
MRCL (maximum rated cable load) designed for the above maximum weather loading at the maximum specified span and installation sag	N (lbf)
Installation tension and sag at different span lengths	N (lbf) tension and m (ft), sag%
Maximum vertical and horizontal sag at the maximum weather loading at different span lengths	m (ft)
Maximum span length for specified loading criteria	m (ft)
Cable space potential performance—must be compatible with the calculated space potential based upon the customer provided transmission line voltage, cable placement location and any environmental pollution exposure.	kV

(Deleted)

If the customer does not provide the information listed in Table 1, they shall take into consideration the supplier's cable performance information/specifications to determine compatible installation conditions.

5.2 Mechanical requirements

5.2.1 Sag and tension performance

The following are recommended as minimum sag and tension criteria when designing and installing ADSS cable:

- a) The ADSS cable sag should be specified by the customer to meet ground or conductor clearances. The installation sag shall be specified along with any maximum sag requirements at the maximum weather load. ADSS performs differently from optical ground wire (OPGW) or metal conductors and therefore both installation and worst case environmental conditions should be considered.
- b) The customer shall adhere to the appropriate country standards for ADSS cable sag clearances such as the National Electrical Safety Code® (NESC®) [B1]⁷¹⁰ for the United States.
- c) ADSS cable placement and sags should be designed to provide sufficient spacing from conductors to prevent clashing during loaded conditions; including wind and ice load conditions.
- d) The maximum rated cable load (MRCL) of the ADSS cable shall not be exceeded.
- e) It is recommended that tension limits for a specific application be chosen through a coordinated study that should include the requirements of the user, recommendations from the cable supplier, and recommendations from the supplier of all supporting hardware.

¹⁰ The numbers in brackets correspond to those of the bibliography in Annex F.

5.2.2 Vibration performance

Sag and tension recommendations regarding vibration protection should be obtained from the ADSS cable supplier or from a vibration protection hardware supplier approved by the cable supplier.

The cable shall be designed such that it can withstand Aeolian vibrations with either permanent or temporary attenuation increases less than the criteria indicated in 6.5.3.1.

5.3 On-site optical acceptance testing

Upon receipt of the ADSS cable from the supplier, it is recommended that the purchaser visually inspect each reel. If physical damage to the reel or lagging is found, the cable should be inspected for damage and the manufacturer notified prior to taking acceptance of the shipment. A check should be made to verify the received reel quantities and lengths correspond to the ordered quantities.

Upon receipt of the cable, it is recommended that acceptance tests be performed to verify that the optical characteristics of the fiber meet the order requirements and to determine if optical fibers have been damaged during shipment. The results of these tests and the supplier's certified quality control information, which is attached to each reel, should be compared to the fiber requirements specified in the purchase order.

These tests may be performed by either of [following](#) two methods. ~~The first method is to use an~~;

- a) [Optical Time Domain Reflectometer \(OTDR\)](#) ~~and the second is to use a light source and a power meter.~~