

1222™

IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable

IEEE Power Engineering Society

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Power System Communications Committee



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IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable

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Power System Communications Committee
of the
IEEE Power Engineering Society

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Abstract: Construction, mechanical, electrical, and optical performance, installation guidelines, acceptance criteria, test requirements, environmental considerations, and accessories for an all-dielectric, nonmetallic, self-supporting fiber optic (ADSS) cable are covered in this standard. The ADSS cable is designed to be located primarily on overhead utility facilities. This standard provides both construction and performance requirements that ensure within the guidelines of the standard that the dielectric capabilities of the cable components and maintenance of optical fiber integrity and optical transmissions are proper. This standard may involve hazardous materials, operations, and equipment. It does not purport to address all of the safety issues associated with its use, and it is the responsibility of the user to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

Keywords: aeolian vibration, aerial cables, all-dielectric self-supporting (ADSS), buffer, cable reels, cable safety, cable thermal aging, dielectric, distribution lines, electric fields, electrical stress, fiber optic cable, galloping, grounding, hardware, high voltage, optical ground wire (OPGW), plastic cable, sag and tension, self-supporting, sheave test, span length, string procedures, temperature cycle test, tracking, transmission lines, ultraviolet (UV) deterioration

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Introduction

(This introduction is not a part of IEEE Std 1222-2003, IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable.)

All-dielectric self-supporting (ADSS) fiber optic cables are being installed throughout the power utility industry. Because of the unique service environment and design of these cables, many new requirements are necessary to ensure proper design and application of these cables. In order to develop an industry-wide set of requirements and tests, the Fiber Optic Standards Working Group, under the direction of the Fiber Optic Subcommittee of the Communications Committee, brought together the expertise of key representatives from throughout the industry. These key people are from each manufacturer of ADSS cables and a cross section of the end users. All manufacturers and all known users were invited to participate in preparing this standard.

The preparation of this standard occurred over a period of several years, and participation changed throughout that time as companies and individuals changed interests and positions. Effort was always made to include key individuals from each and every manufacturing concern, major user groups, and consulting firms. Membership and participation was open to everyone who had an interest in the standard, and all involvement was encouraged. This worldwide representation helps to ensure that this standard reflects the entire industry.

As ADSS fiber optic cables are a new and changing technology, the working group is continuing to work on new revisions to this standard as the need arises.

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IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable

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, nonmetallic, self-supporting fiber optic (ADSS) cable. The ADSS cable is designed to be located primarily on overhead utility facilities.

The standard provides both construction and performance requirements that ensure within the guidelines of the standard that the dielectric capabilities of the cable components and maintenance of optical fiber integrity and optical transmissions are proper.

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 to determine the applicability of regulatory limitations prior to use.

2. ADSS cable and components

2.1 Description

The ADSS cable shall consist of coated glass optical fibers contained in a protective dielectric fiber optic unit 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 design requirements of the optical cable under all installation conditions, operating temperatures, and environmental loading.

2.2 Support systems

- a) ADSS cable shall contain support systems that are integral to the cable. The purpose of the support system is to ensure that the cable meets the optical requirements under all specified installation conditions, operating temperatures, and environmental loading for its design life. This standard excludes any “lashed” type of cables.

- b) The basic annular construction may have aramid or other dielectric strands or a channeled dielectric rod as a support structure. In addition, other cable elements, such as central members, may be load bearing.
- c) Figure-8 constructions may have a dielectric messenger and a fiber optic unit, both of which share a common outer jacket. In addition, other cable elements, such as central members, may be load bearing.
- d) Helically stranded cable systems may consist of a dielectric optical cable prestranded around a dielectric messenger.
- e) The design load of the cable shall be specified so that support hardware can be manufactured to perform under all environmental loading conditions. For zero fiber strain cable designs, the design load is defined as the load at which the optical fibers begin to elongate. For other cable designs, the design load is defined as the load at which the measured fiber strain reaches a predetermined level.
- f) Other designs previously not described are not excluded from this specification.

2.3 Fiber optic cable core

The fiber optic cable core shall be made up of coated glass optical fibers housed to protect the fibers 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 sufficient to degrade optical performance of fibers within the cable.

2.3.1 Fiber strain allowance

The cable core shall be designed such that fiber strain does not exceed the limit allowed by the cable manufacturer under the operational design limits of the cable. Maximum allowable fiber strain will generally be a function of the proof test level and strength and fatigue parameters of the coated glass fiber.

2.3.2 Central structural element

If a central structural element is necessary, it shall be of reinforced plastic, epoxiglass, 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.

2.3.3 Buffer tube filling compound

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

2.3.4 Cable core filling/flooding compound

The design of the cable may include a suitable filling/flooding compound in the interstices to prohibit water migration along the fiber optic cable core. The filling compound shall be compatible with all components with which it may come in contact.

2.3.5 Binder/tape

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

2.3.6 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.

2.4 Optical fibers

Single-mode fibers, dispersion-unshifted, dispersion-shifted, or nonzero dispersion-shifted, and multimode fibers with 50/125 mm or 62.5/125 mm core/clad diameters are considered in this standard. The core and the cladding shall consist of glass that is predominantly silica (SiO₂). The coating, usually made from one or more plastic materials or compositions, shall be provided to protect the fiber during manufacture, handling, and use.

2.5 Buffer construction

The individually coated optical fiber(s) or fiber ribbon(s) may be surrounded by a buffer for protection from physical damage during fabrication, installation, and performance of the ADSS. Loose buffer or tight buffer construction are two types of protection that may be used to isolate the fibers. The fiber coating and buffer shall be strippable for splicing and termination.

2.5.1 Loose buffer

Loose buffer construction shall consist of a tube or channel that surrounds each fiber or fiber group. The inside of the tube or channel shall be filled with a filling compound.

2.5.2 Tight buffer construction

Tight buffer construction shall consist of a suitable material that comes in contact with the coated fiber.

2.6 Color coding

Color coding is essential for identifying individual optical fibers and groups of optical fibers. The colors shall be in accordance with TIA/EIA 598-A-1995 [B43].¹

2.6.1 Color performance

The original color coding system shall be discernible and permanent, in accordance with EIA 359-A-1985 [B3], throughout the design life of the cable, when cleaned and prepared per manufacturer's recommendations.

2.7 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.

- a) The jacket material shall be dielectric, non-nutrient to fungus, and meet the requirements of 3.1.1.13. The jacket material may consist of a polyethylene that shall contain carbon black and an antioxidant.
- b) The jacket shall be extruded over the underlying element and shall be of uniform diameter to properly fit support hardware. The extruded surface shall be smooth for minimal ice buildup.

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

- c) The cable jacket shall be suitable for application in electrical fields as defined in this clause and demonstrated in 3.1.1.3.

Class A: Where the level of electrical stress on the jacket does not exceed 12 kV space potential.

Class B: Where the level of electrical stress on the jacket may exceed 12 kV space potential.

NOTE—See 7.9 for additional deployment details.²

3. Test requirements

Each requirement in this clause is complementary to the corresponding paragraph in Clause 4 that describes a performance verification or test procedure.

3.1 Cable tests

3.1.1 Design tests

An ADSS cable shall successfully pass the following design tests. However, design tests may be waived at the option of the user if an ADSS cable of identical design has been previously tested to demonstrate the capability of the manufacturer to furnish cable with the desired performance characteristics.

3.1.1.1 Water blocking test

A water block test for cable shall be performed in accordance with 4.1.1.1. No water shall leak through the open end of the 1 m sample. If the first sample fails, one additional 1 m sample, taken from a section of cable adjacent to the first sample, may be tested for acceptance.

3.1.1.2 Seepage of filling/flooding compound

For filled/flooded fiber optic cable, a seepage of filling/flooding compound test shall be performed in accordance with 4.1.1.2. The filling and flooding compound shall not flow (drip or leak) at 65 °C.

3.1.1.3 Electrical tests

Electrical tests shall be performed for Class B cables in accordance with 4.1.1.3. Tracking on the outside of the sheath resulting in erosion at any point that exceeds more than 50% of the wall thickness shall constitute a failure.

3.1.1.4 Aeolian vibration test

An aeolian vibration test shall be carried out in accordance with 4.1.1.4. Any damage that will affect the mechanical performance of the cable or causes permanent or temporary increase in optical attenuation greater than 1.0 dB/km of the tested fibers at 1550 nm for single-mode fibers and at 1300 nm for multimode fibers shall constitute failure.

²Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

3.1.1.5 Galloping test

A galloping test shall be carried out in accordance with 4.1.1.5. Any damage that will affect the mechanical performance of the cable or causes permanent or temporary increase in optical attenuation greater than 1.0 dB/km of the tested fibers at 1550 nm for single-mode fibers and at 1300 nm for multimode fibers shall constitute failure.

3.1.1.6 Sheave test

A sheave test shall be carried out in accordance with 4.1.1.6. Any significant damage to the ADSS cable shall constitute failure. A permanent increase in optical attenuation greater than 1.0 dB/km of the tested fibers at 1550 nm for single-mode fibers and at 1300 nm for multimode fibers shall constitute failure.

Or successful completion of the following three tests may be a substitute for the sheave test:

- a) *Tensile strength of a cable*: The maximum increase in attenuation shall not be greater than 0.10 dB for single-mode and 0.20 dB for multimode fibers when the cable is subjected to the maximum cable rated tensile load.
- b) *Cable twist*: The cable shall be capable of withstanding mechanical twisting without experiencing an average increase in attenuation greater than 0.10 dB for single-mode and 0.20 dB for multimode fibers.
- c) *Cable cyclic flexing*: The cable sample shall be capable of withstanding mechanical flexing without experiencing an average increase in attenuation greater than 0.10 dB for single-mode and 0.20 dB for multimode fibers.

3.1.1.7 Crush test and impact test

3.1.1.7.1 Crush test

A crush test shall be performed in accordance with 4.1.1.7.1. A permanent or temporary increase in optical attenuation value greater than 0.2 dB change in sample at 1550 nm for single-mode fibers and 0.4 dB at 1300 nm for multimode fibers shall constitute failure.

3.1.1.7.2 Impact test

An impact test shall be performed in accordance with 4.1.1.7.2. A permanent increase in optical attenuation value greater than 0.2 dB change in sample at 1550 nm for single-mode and 0.4 dB at 1300 nm for multimode fibers shall constitute failure.

3.1.1.8 Creep test

A creep test shall be carried out in accordance with 4.1.1.8. Values shall correspond with the manufacturer's recommendations.

3.1.1.9 Stress/strain test

A stress/strain test shall be carried out in accordance with 4.1.1.9. The maximum rated cable load (MRCL), maximum rated cable strain (MRCS), and maximum axial fiber strain specified by the manufacturer for their cable design shall be verified. Any visual damage to the cable or permanent or temporary increase in optical attenuation greater than 0.10 dB at 1550 nm for single-mode fiber and 0.20 dB at 1300 nm for multimode fibers shall constitute failure.

3.1.1.10 Cable cutoff wavelength (single-mode fiber)

The cutoff wavelength of the cabled fiber, λ_{cc} , shall be less than 1260 nm.

3.1.1.11 Temperature cycle test

Optical cables shall maintain mechanical and optical integrity when exposed to the following temperature extremes: -40°C to $+65^{\circ}\text{C}$.

The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.20 dB/km, with 80% of the measured values no greater than 0.10 dB/km. For single-mode fibers, the attenuation change measurements shall be made at 1550 nm.

For multimode fibers, the change shall not be greater than 0.50 dB/km, with 80% of the measured values no greater than 0.25 dB/km. The multimode fiber measurements shall be made at 1300 nm unless otherwise specified.

A temperature cycle test shall be performed in accordance with 4.1.1.11.

3.1.1.12 Cable aging test

The cable aging test shall be a continuation of the temperature cycle test.

The change in attenuation from the original values observed before the start of the temperature cycle test shall not be greater than 0.40 dB/km, with 80% of the measured values no greater than 0.20 dB/km for single-mode fibers.

For multimode fibers, the change in attenuation shall not be greater than 1.00 dB/km, with 80% of the measured values no greater than 0.50 dB/km.

There shall be no discernible difference between the jacket identification and length marking colors of the aged sample relative to those of an unaged sample of the same cable. The fiber coating color(s) and unit/bundle identifier color(s) shall be in accordance with TIA/EIA 598-A-1992 [B43].

A cable aging test shall be performed in accordance with 4.1.1.12.

3.1.1.13 Ultraviolet (UV) resistance test

The cable and jacket system is expected to perform satisfactorily in the user-specified environment into which the cable is being placed into service. Because of the numerous possible environmental locations available, it is the user's and supplier's joint responsibility to provide the particular performance requirements of each installation location. These performance criteria are for nonsevere environments. The IEC 60068-2-1 [B12] performance standards should be used to define particular environmental testing requirements for each unique location.

The cable jacket shall meet the following requirements:

Where carbon black is used as a UV damage inhibitor, the cable shall have a minimum absorption coefficient of 0.32 per meter.

Where the other cable UV blocking systems are being employed, the cable shall

- a) Meet the equivalent UV performance of carbon black at 0.32 per meter
- b) Meet the performance requirements as stated in 4.1.1.13 for IEC 60068-2-1 [B12] testing