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TIA STANDARD

Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement

TIA-526-14-C **April 2015**

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ANSI/TIA Foreword

International Standard IEC 61280-4-1 Ed. 2.0 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. TIA previously adopted the IEC document as ANSI/TIA-526-14-B (a.k.a. OFSTP-14-B) and in so doing added a foreword. That foreword included clarification on major changes between earlier versions of the TIA document and this version including the nomenclature for the three reference methods and text to describe additional encircled flux launch condition uncertainty not previously considered in the IEC document.

This document, ANSI/TIA-526-14-C, changes the nature of the document from an adoption to an adaption because it includes variances from the IEC standard. Material within the previous foreword is retained and augmented with new material that defines the variances. The variances are modifications of the requirements on the encircled flux launch condition with regard to its normative usage for measuring the attenuation of installed multimode fiber cabling. The new material can be found in the last section of this ANSI/TIA Foreword under the heading “Variance from IEC standard”.

Reference methods nomenclature

The different ways in which reference measurements can be made of the power input to the cabling under test are explicitly referred to in the IEC document by the number of test cords that are used in the reference configuration. In the TIA document these were often referenced as configuration A, B or C. A cross reference of these test methods is shown in Table Foreword.1.

Table Foreword.1 – Measurement method cross reference

IEC 61280-4-1 Ed. 2.0		OFSTP-14-A
Name	Location	Name
One-cord reference method	Annex A	Method B
Three-cord reference method	Annex B	Method C
Two-cord reference method	Annex C	Method A

OTDR testing

OTDR testing was not in the original OFSTP-14-A. The use of the OTDR for measuring attenuation is described in Annex D for total attenuation with additional guidance in Annex G including measuring individual component losses.

Inspecting and cleaning connectors

The IEC document highlights the importance of, and gives guidance on, good measurement practices including inspection and cleaning of connector end faces. Clean connector end faces are required prior to mating connectors. End-face inspection can be used to verify cleanliness as well as for troubleshooting.

Test cord insertion loss verification

Annex H describes procedures for checking the insertion loss of test cords that should be performed before undertaking cable plant measurements, as poorly performing test cords invalidate measurements made with them. The procedures are delineated by the reference measurement method and by the type of connector system.

Reference grade connectors

This document recommends the use of ‘reference grade connections’ on test cords to reduce measurement uncertainty. This means that there is now a difference between the test result acceptance criteria and the expected link or channel insertion loss in its final configuration. The insertion loss acceptance criteria should be tightened up accordingly.

Encircled flux

The requirement for the modal launch conditions for the sources used to measure multimode fibers is changed from one based on coupled power ratio (CPR) and mandrel requirements to one based on measurements of the near field at the output of the launching test cord. The launch condition must now meet the requirements of the specified ‘encircled flux template’. Compliance provides significant improvement in measurement repeatability. For information on implementation of encircled flux launch conditions for field measurements refer to TIA TSB-4979. Within TSB-4979 the term used for devices that create an EF launch condition is controller (universal or matched). IEC 61280-4-1 calls these devices conditioners. Note that the encircled flux template example of Figure E.1 unintentionally shows incomplete Target and OFL lines. The red Target line should run continuously thru the center of the shaded Template region, and the blue OFL line should be continuous thru the region from 11 to 15 µm radius.

Encircled flux uncertainty

For field test equipment using a single optical port that launches two wavelengths, a test cord that is conditioned by a mandrel may not allow an alignment on the target for both wavelengths simultaneously. Should this be the case, the use of the same mandrel for both wavelengths will reduce the margin for compliance within the templates and add uncertainty.

Due to the effect of variations in source wavelength, mode controller, temperature changes, other physical variations, and the measurement equipment itself, launch conditions at the time of factory calibration will not be identical in the field should any variable change. The use of attenuation artifacts described in IEC 61280-4-1 can help ensure that the equipment produces a launch condition that performs acceptably.

Alignment of encircled flux targets to eliminate wavelength bias

Efforts were taken to harmonize the expected component losses at 850 nm and 1300 nm wavelengths for a given fiber core diameter. This was accomplished by adjustment of the 850 nm and 1300 nm EF targets to produce comparable extrinsic component losses. An example of matching the attenuation characteristics at the two wavelengths is illustrated in Figure Foreword.1. This elimination of bias provides an opportunity to ensure dual wavelength compliance of a passive component or a short cable plant link using a single source. This alignment is true for traditional multimode fiber. It is not known to apply to macrobend-loss-reduced (a.k.a. “bend insensitive”) multimode fiber.

Figure Foreword.1 – Calculated Wavelength Comparison

Other references

The following references document the foundational work underlying the development of the encircled flux launch condition specifications and can be obtained at the following internet location:

http://ftp.tiaonline.org/TR-42/TR-42.11/Public/TSB-178ReferenceRepository

1) T. Hanson, “Considerations on multimode link loss”, December 13, 2005

2) T. Hanson, “Considerations regarding the target RPD, coupled power, and steady state”, July 13, 2006

3) R. Conte, “Mode Scattering and Steady State Distributions”, August 18, 2006

4) R. Conte, “A Template Based Approach to Source Qualification”, August 18, 2006

5) T. Hanson and J. Luther, “Multimode source boundary experiment”, October, 2006

6) R. Conte, “CPR, MPD, and EF”, December 5, 2006

Variance from IEC standard

Annex E of IEC 61280-4-1 Ed. 2.0 normatively defines encircled flux launch conditions for four cases:

1. measurements of installed 50 µm core fiber cabling at 850 nm,
2. measurements of installed 50 µm core fiber cabling at 1300 nm,
3. measurements of installed 62.5 µm core fiber cabling at 850 nm,
4. measurements of installed 62.5 µm core fiber cabling at 1300 nm.

ANSI/TIA-526-14-C applies only case 1 normatively. For the other three cases the encircled flux launch conditions are informative. However the use of encircled flux launch conditions for cases 2, 3 and 4 is recommended, especially for applications providing channel loss budgets less than 3 dB[1].

For cases 2, 3 and 4, when the launch condition is not known to be encircled flux compliant, the source shall be qualified using the following High Order Mode Loss (HOML) test. This test can be readily created in the field to gauge and adjust launch conditions through a reference-grade launch cord, but attenuation measurements from sources qualified by the HOML test will have greater uncertainty due to launch variation than attenuation measurements made with encircled flux launch conditions. HOML qualified launch conditions are not a substitute for encircled flux compliant launch conditions.

The HOML qualification of the source and launch cord combination involves the use of a launch cord with and without applied mandrel wrap prescriptions.

The launch cord shall be 2 m to 5 m in length and shall contain fiber of the same nominal core diameter and numerical aperture as the cable plant to be measured. The fiber within the launch cord shall not provide macrobend-loss-reduced properties (a.k.a. “bend insensitive” properties), because the use of macrobend-loss-reduced fiber will invalidate the HOML test. The core diameter and numerical aperture of the fiber within the launch cords shall be selected to the properties of Table Foreword.2. These tolerances are tighter than minimally-standards-compliant fiber in order to reduce HOML test uncertainty.

Table Foreword.2 – Launch Cord Fiber Properties

Fiber nominal core diameter / numerical aperture [µm / dimensionless]	Core diameter tolerance [µm]	Numerical aperture tolerance [dimensionless]
50 / 0.200	± 0.7	± 0.004
62.5 / 0.275	± 0.7	± 0.004

The connectors on the launch cord shall mate to the light source receptacle and the power meter receptacle.

Measure the HOML of the light source and launch cord combination as follows:

1. Attach a known-good launch cord appropriate for cable plant loss measurements meeting the properties of Table Foreword.2 to the powered-on and stable light source intended for use in the cable plant loss measurements.
2. Deploy the launch cord in a manner free of bends smaller than 75 mm (3 inches) in radius and measure and record the output power level, P_0, in dBm. See Figure Foreword.2.
3. Without disconnecting the launch cord from the source or mechanically disturbing the connection to the source, wrap and secure the launch cord in five non-overlapping adjacent turns around a smooth circular mandrel of diameter corresponding to the fiber core diameter and cordage outside diameter as prescribed in Table Foreword.3.
4. Measure and record the output power level, P_1, in dBm. See Figure Foreword.3.
5. Calculate HOML using equation Foreword.1.

$$HOML\ [dB] = P_0\ [dBm] - P_1\ [dBm] \qquad \text{(Foreword.1)}$$

[1] This generally applies to applications operating at data rates ≥1 Gb/s. See Table 7 of ANSI/TIA-568-C.0-2 for loss budget guidance on many multimode fiber applications.