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Advanced Components

Application Note

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# T.W.A.L Transmission with Applied Tensile Load

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Issued by:
Engineering
Department

Created by:
Andrei Vankov
Emmanuel Kolczynski


## 1.0 Introduction

It wasn't that long ago that people were limited to TV content that was broadcasted over the airwaves. Today they can stream television programs, movies, and music to their TVs at their convenience. On-demand services such as Netflix, Amazon Prime, Hulu, and Google TV, among others, allow viewers to consume select TV content at their own schedule. With on-demand, viewers can play, pause, fast-forward, rewind, and re-watch programs. Internet Protocol TV (IPTV) offerings continue to improve, turning TVs into media hubs with added features to enhance the user experience. Now more than ever before, fiber optic-based transport and access networks are an integral part of the overall end-to-end voice, data, and video transmission. Recent advances with IPTV and mobile network technologies have expanded digital consumption to smartphones and tablets (via LTE or WiFi connections). Any household with internet access can access these IPTV services.

What is an IPTV system? IPTV is a multimedia delivery platform based on a hardware and software infrastructure that is interconnected via a computer network (either optically or wirelessly). These networks and technologies are expected to be reliable to satisfy customer needs. More compact, high-density enclosures are used in datacenters and various FTTx terminals to provide faster and more stable networks. Using fiber optic interconnect in confined spaces provides challenges to the integrity of any server/network architecture.

## 2.0 Problem Statement

Fiber optic cables are not designed to be severely bent and crammed into tight spaces. In many cases, it is difficult to organize extensive lengths of cable in a manner that prevents excessive bending and strain. Long lengths of vertical cable used for interconnects between racks are not only tightly coiled, but also subjected to tensile loading and stresses, resulting in macro bending and leading to degradation and/or loss of optical signal. This could lead to downtime, loss of revenue, and data loss.

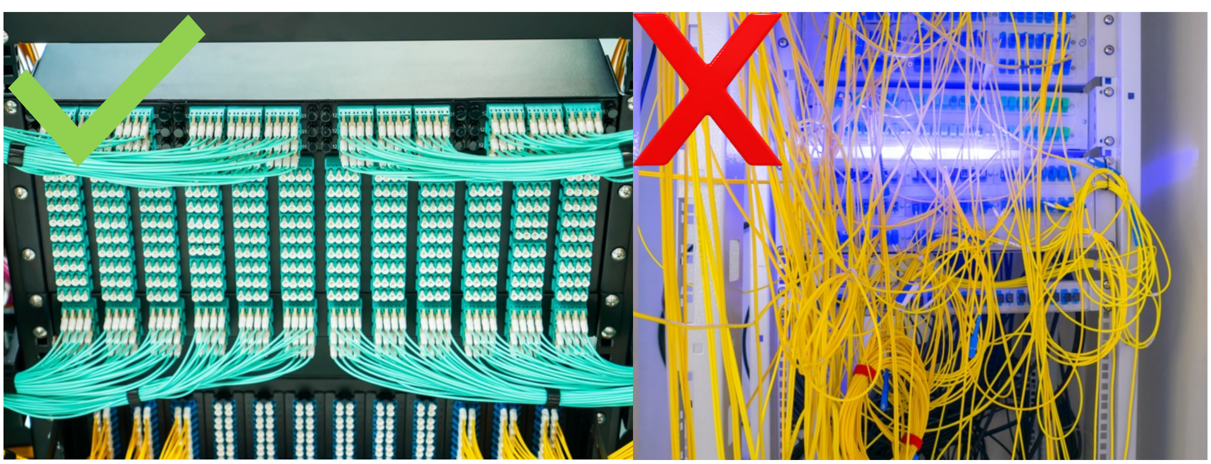


*Figure 1: Good fiber arrangement vs. Bad fiber arrangement*

For use in confined spaces, fiber optic cables and interconnect solutions must utilize bend-tolerant fibers supported by well-designed strain relief boots at the connection points. The use of bend-tolerant fibers allows for shorter boot lengths, but the shorter boot design must still support tensile loads intended for a standard long boot in order to maintain signal integrity.

## 3.0 Telcordia GR-326-CORE T.W.A.L. why does it matter?

GR-326-CORE, developed by Telcordia, is the most complete and rigorous standard for fiber-optic connectors. Issue 4 outlines the latest requirements for connectors used in cable assemblies and for joining optical fibers.

Telcordia GR-326-CORE, section 4.4.3.5, describes testing of interconnect for Transmission With Applied Load (T.W.A.L.). T.W.A.L. is a live Insertion Loss (IL) test where varying tensile loads are applied at specific angles and the IL is measured during the application of such loads. As an example, IL should not exceed 0.5 dB with a connector held at a 135° angle with a 0.25 kgf tensile load. The test also verifies that the boot ensures that the minimum fiber bend radius is not violated during 90° side loads.

Unlike taking measurements before and after applying loads at different angles, live testing more accurately replicates real-life scenarios to ensure signal service integrity. This is compliant with Telcordia GR-326-CORE, section 4.4.3.5. This is necessary for the use of fiber optic cable assemblies in confined spaces making the use of a properly designed, short strain relief boot, essential.

## 4.0 T.W.A.L test setup

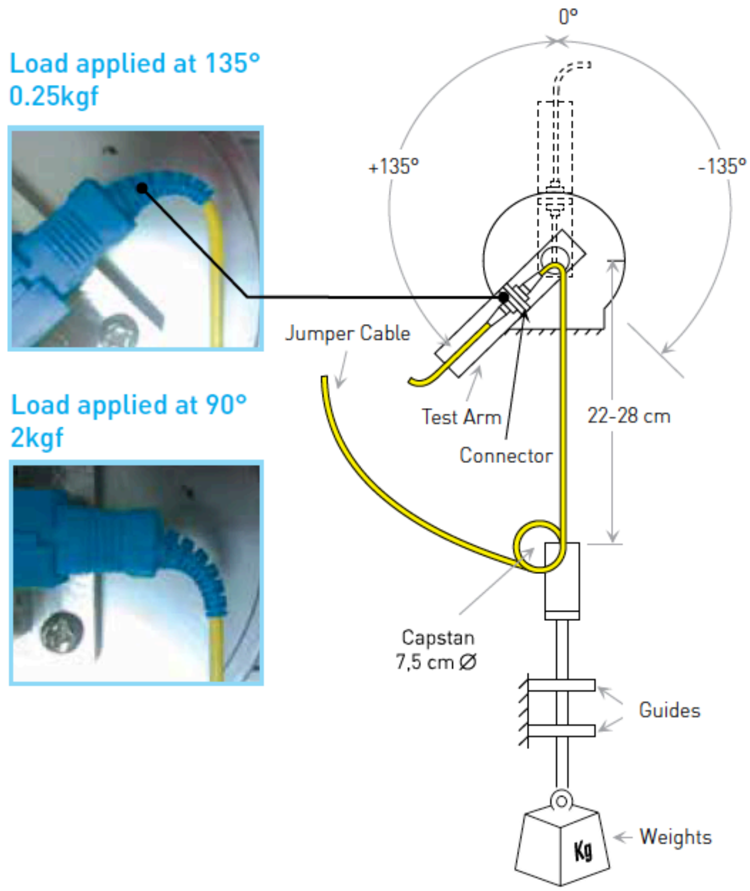



*Figure 2: Load Angle Applied During Test*

## 5.0 What about pre-angled boots?

In this paper, pre-angled type boots are not considered to be Load and Angle applied during test alternatives to the short strain relieves. Typically, pre-angled boots are not compliant with the GR-326-CORE standard.

## 6.0 Solution

SENKO has designed a Mini Boot series using novel materials compared to the previous series of standard boots. Various designs and materials were considered during the testing and selection processes. The final design and materials were agreed upon after the samples passed T.W.A.L. Jumper assemblies using the new Mini Boots and cables utilizing bend-insensitive fiber easily satisfy Telcordia GR-326-CORE, section 4.4.3.5. T.W.A.L criteria. These qualities made it possible for SENKO to develop a shorter boot. This shorter boot, when used in conjunction with

SENKO's current connectors, reduces the overall connector length by up to 30%, making the interconnect suitable for use in confined enclosures and spaces.

*Table 1: This table demonstrates the benefits of SENKO's new Mini Boots in comparison to SENKO's standard boots that comply with the key criteria from Telcordia GR-326-Core, section 4.4.3.5. T.W.A.L. testing listed below.*

| Load | 0° | 90° | 135° |
|---|---|---|---|
| **Media Type I (2 mm or 3 mm jacketed type)** | | | |
| 0.25 kgf (0.55 lbf) | X | X | X |
| 0.7 kgf (1.54 lbf) | X | X | |
| 1.5 kgf (3.3 lbf) | X | X | |
| 2.0 kgf (4.4 lbf) | X | X | |
| **Media Type II (900 µm buffer type)** | | | |
| 0.25 kgf (0.55 lbf) | X | X | X |
| 0.7 kgf (1.54 lbf) | X | X | |
| **Media Type III (250 µm bare fiber)** | | | |
| 0.25 kgf (0.55 lbf) | X | X | |
| 0.5 kgf (1.1 lbf) | X | X | |

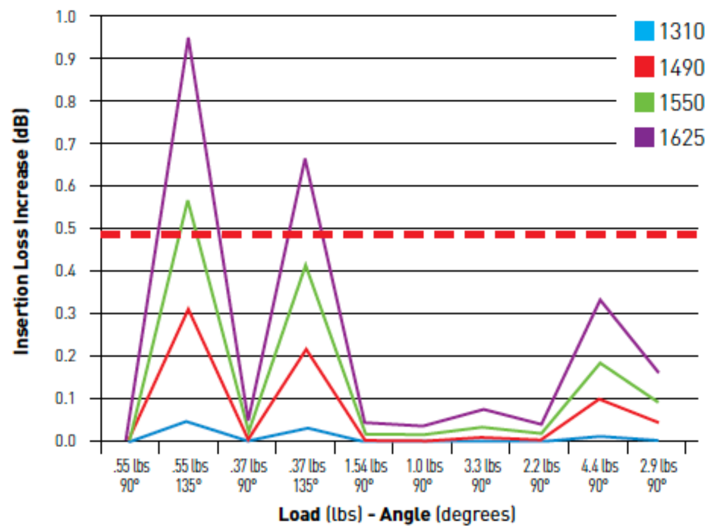
## 7.0 Summary

The SENKO Mini Boot, although much shorter, easily outperforms the conventional boot at all four wavelengths, with all applied loads; especially with applied loads at 135°, where the attenuation is roughly 60% less compared to the conventional boot.

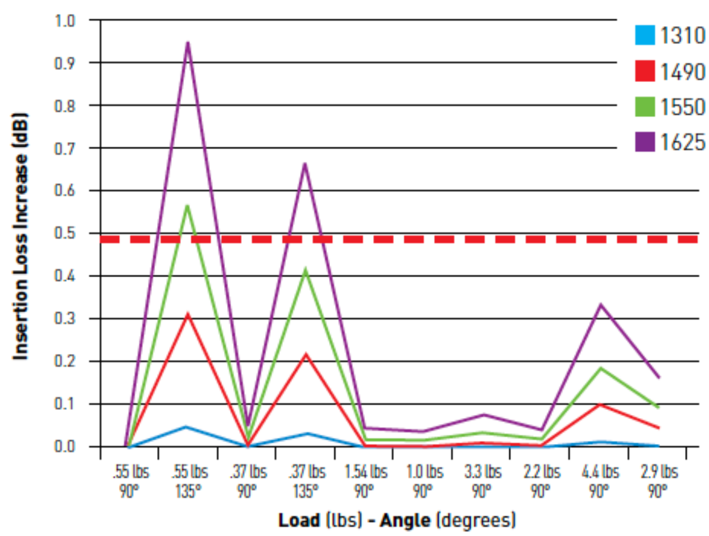
Although the weight of typical 2-meter LC 2 mm and 3 mm outer-diameter (OD) patch cords is approximately 10 g and 15g, respectively, cable management systems will increase the tensile loading stress and bend the cable beyond 90°, highlighting the importance of applied load testing beyond 90°.

The importance of the of Mini Boot's performance at 1625 nm cannot be understated. With the growing use of this wavelength in the L-band range, having cable assemblies that are able to pass T.W.A.L. at 1625 nm saves countless hours of potential network downtime and upgrade costs.

Refer to the two graphs below for a comparison of the Mini Boot with a conventional boot. Notice the improvement in Insertion Loss between the bend tolerant G657.A1 (Bending Radii 10 mm) and standard conventional G652.D fibers (Bending Radii 30 mm).

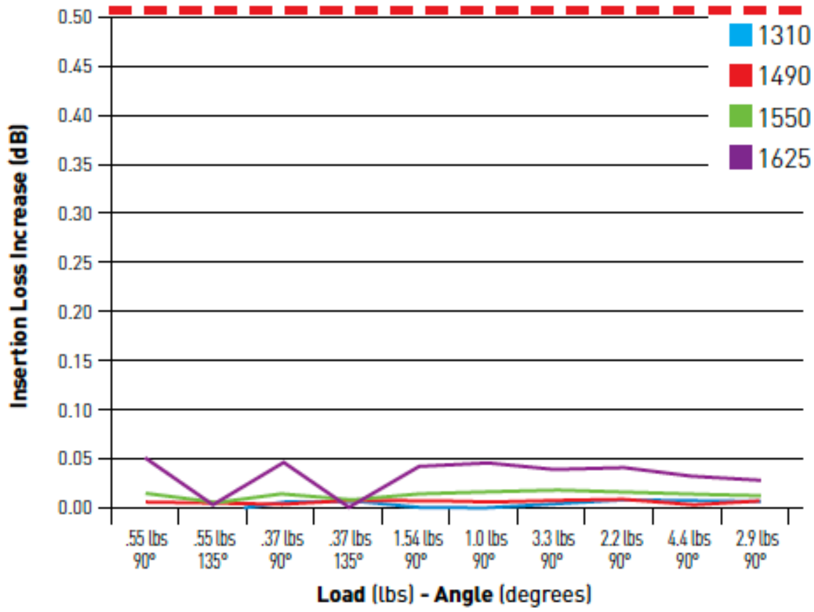



*Graph 1: **SENKO 2 mm LC Mini Boot** Average IL loss with G657.A1 (Bend Tolerant R10) fiber*




*Graph 2: **Conventional 2 mm LC boot** Average IL loss with G652.D conventional (Bend Tolerant R30) fiber*

The combination of bend insensitive fibers and high-quality strain relief boots offers performance benefits that are essential for T.W.A.L. compliance. The performance graph for G657.A2 fiber (max bend radius = 7.5 mm), which has a tighter bend radius and bend tolerance compared to G657.A1 grade fiber (max bend radius = 10 mm), shows almost no changes in IL at all wavelengths and applied loads tested at 90° and 135° (refer to graph on right). This comparison illustrates that it is not the bend insensitive fibers alone, but also the high-quality strain relief boots, which help satisfy T.W.A.L compliance criteria.



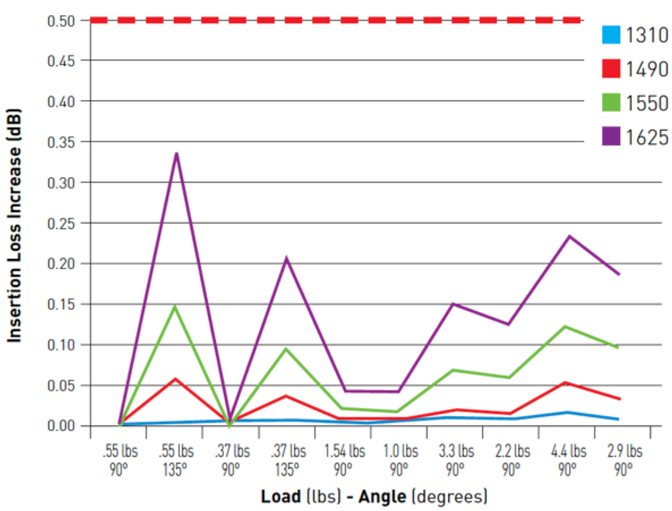

*Graph 3: **SENKO 2 mm LC Mini Boot** Average IL loss with G657.A2 (Bend Tolerant R7.5) fiber*

## 8.0 Supplemental Comparisons

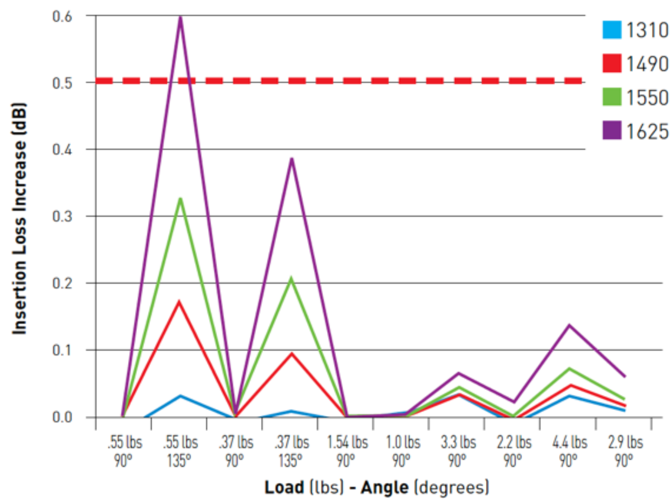
SENKO Mini Boots

VS

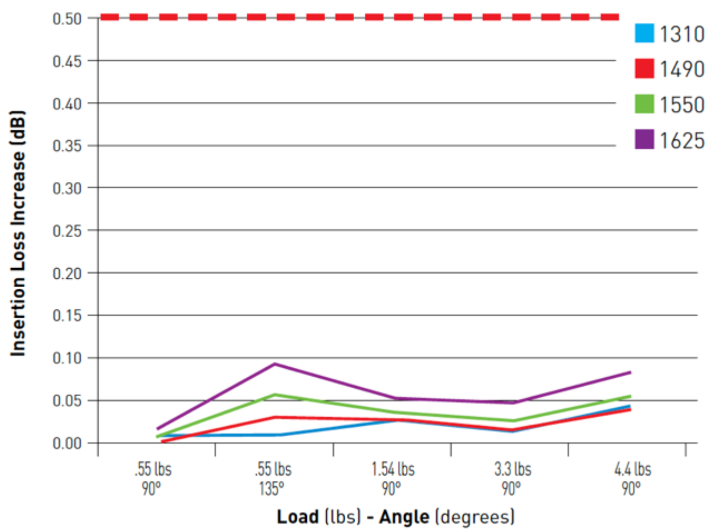
Competitor with conventional boots



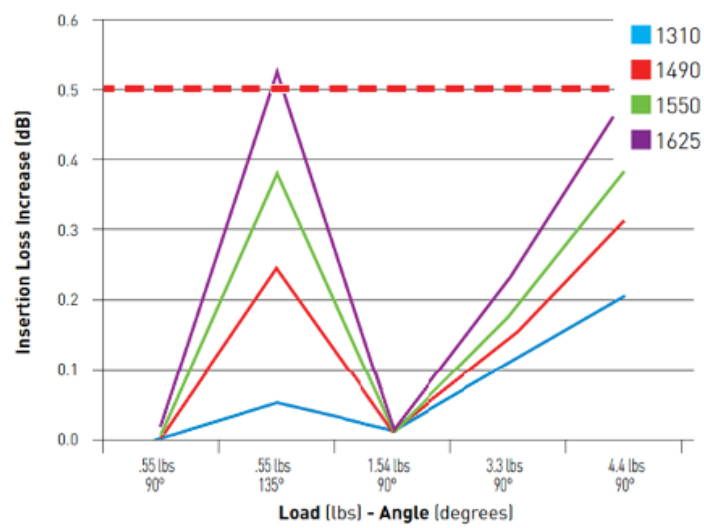

*Graph 5: **SENKO 2 mm LC Mini Boot***
*Average IL loss with G657A1 (R10) fiber*




*Graph 4: **Competitor 2 mm LC***
*Average IL loss with G657A1 (R10) fiber*




*Graph 7: **SENKO 2 mm SC APC***
*Average IL loss with G657A1 (R10) fiber*




*Graph 6: **Competitor 2 mm SC APC***
*Average IL loss with G657A1 (R10) fiber*

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# Contact us


## USA
East Coast +1-508-481-9999
West Coast +1-858-623-3300
Texas +1-972-661-9080
Sales-Americas@senko.com

Mexico & Central America +1-858-623-3300
Sales-Mexico@senko.com

Brazil and South America +55-21-3736-7065
Sales-Brazil@senko.com

## Asia-Pacific
Hong Kong +852-2121-0516
Shanghai +86-21-5830-4513
Shenzhen +86-755-2533-4893
Thailand +66(0)2-163-2798
Australia +61(0)3 9755-7922
Sales-Asia-Pacific@senko.com

## Japan
Yokkaichi City +81-59-352-1121
Tokyo +81-3-5825-0911
Sales-Japan@senko.com

## United Kingdom
UK +44(0) 1256 700880
Sales-UK@senko.com

## Europe
**Spain & Portugal**
Sales-Iberia@senko.com

**Germany**
Sales-Germany@senko.com

**Italy**
Sales-Italy@senko.com

**France**
Salesfrance@senko.com

**Other European Countries**
+44(0) 1256 700880
Sales-Europe@senko.com