SENKO®
Advanced Components

Application Note

Random Mating IL versus IL by Master Jumper

Issued by: Engineering Department
Created by: Ky Ly, Bernard Lee, Andrei Vankov, Emmanuel Kolczynski
Released Date: March, 2012
Revised Date: November 1st, 2021

Introduction

Whether it be a System Designer, System Installer, or Service Engineer, network plans all rely on connectorized fiber optic patch cords deployed into the field to satisfy the required performance expectations. Even when the individual components comply with industry standards, performance can still fall short of expectations.

Insertion Loss (IL) and Return Loss (RL) performance shortfalls are typically symptoms of the fiber optics industry's Achilles' heel, namely, lack of due care and attention during installation, and connector intermateability. Both can manifest themselves as poor IL and/or RL performance.

Variations in IL and/or RL performance are commonly observed when connectorized fiber optic jumpers from different manufacturers are used together as interconnects within a system. In theory, all patch cords should be compliant with industry standards and exhibit the same optical losses, regardless of manufacturer. However, the components of connectors have defined tolerances, and it is the variability in these tolerances that contributes to the inconsistencies in optical losses, even if the patch cords are produced by the same manufacturer.

Overcoming such inconsistencies depends on more than just a tight control of component tolerances, but also on the testing methods and design considerations that allow for optimal intermateability.

Insertion loss

For Insertion Loss specifications, the Telcordia GR-326-CORE Issue 4 states that the IL should have a mean of 0.2 dB and a max of 0.4 dB, while IEC recommends a mean of 0.25 dB and a max of 0.5 dB. To adhere to these specifications, manufacturers test product against a combination of their "best case" Master/Reference patch cord and an adapter in a controlled environment.

It is a common misconception that the IL performance at the manufacturing site will be the same out in the field. The manufacturer reported test data for the IL values will vary at the installation site. Manufacturers IL values may serve as a good reference of performance under controlled conditions, but will be poor indicators of field performance, where various patch cords are mated together using generic adapters. This is why testing in the field is also a requirement. Moreover, testing at the manufacturer site is performed against tightly controlled Master Jumpers that typically have the best possible tolerances. Therefore, loss values are expected to be higher at the installation site in comparison with the originally reported numbers due to what is referred to as, Random Mating.

Random Mating

Random Mating is a method of cross-mating patch cords from different manufacturers or manufactured batches from the same supplier without the use of Master patch cords or adapters. The performance grades for connectors are outlined in IEC 61753-1, "Fiber optic interconnecting devices and passive components - Performance standard". The document provides performance standards for all passive fiber optic products, including connectors. In many ways it is similar to the Telcordia GR-326 document that was adopted in North America and which most people are familiar with. IEC 61300-3-34, "Fiber optic interconnecting devices and passive components - Basic test and measurement procedures - Attenuation of random mated connectors", is another IEC document that specifies random mating procedures. These procedures are intended to give an accurate expected optical loss in the field, including worst case scenarios, taking complex interactions into account between all factors including ferrule and fiber dimensions, end-face geometry, and polish surface quality. IEC 61300-3-34 describes two test methods for measuring optical losses of random mated connectors. Both provide an estimate of the expected average performance of the patch cords. The patch cords and adapters are chosen randomly to provide a statistically unbiased estimate. Method 1 describes the procedure based on the use of 10 patch cords (20 connectors) and 10 adapters. All the plugs are used sequentially as "reference" plugs and all the remaining plugs are tested against them. The result is based on 360 measurements. The matrix is shown in Table 1.

Method 1 is time consuming and typically used for qualifying supplier products. For this reason, Method 2 was developed as a more efficient alternative. Method 2 uses 15 patch cords and 5 adapters. From these 15 patch cords, 5 are chosen at random, and 1 adapter is used as a "reference" plug. The matrix for Method 2 is shown in Table 2. It is important to note that Method 1 is intended to be part of a design approval exercise that may involve one or more suppliers. Once approval is achieved, Method 2 would be relied upon to maintain process control. However, in the event of a dispute, Method 1 would act as the reference measurement method.

Table 1. Random mating “Method 1” matrix.

“Reference” configuration		Patchcord under test																			
		1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b	9a	9b	10a	10b
Adaptor 1	1a	-	-																		
	1b	-	-																		
Adaptor 2	2a			-	-																
	2b			-	-																
Adaptor 3	3a					-	-														
	3b					-	-														
Adaptor 4	4a							-	-												
	4b							-	-												
Adaptor 5	5a									-	-										
	5b									-	-										
Adaptor 6	6a											-	-								
	6b											-	-								
Adaptor 7	7a													-	-						
	7b													-	-						
Adaptor 8	8a															-	-				
	8b															-	-				
Adaptor 9	9a																	-	-		
	9b																	-	-		
Adaptor 10	10a																			-	-
	10b																			-	-
Average																					
Max value																					
Std deviation																					

Summary statistics	*Average*	*Max. value*	*Std. deviation*

Table 2. Random mating “Method 2” matrix.

	“Reference” configurations							
Test plugs	1	2	3	4	5	Average	Max. value	Std. deviation
1a								
1b								
2a								
2b								
3a								
3b								
4a								
4b								
5a								
5b								
6a								
6b								
7a								
7b								
8a								
8b								
9a								
9b								
10a								
10b								
Average								
Max value								
Std deviation								

Summary statistics	*Average*	*Max value*	*Std deviation*

Table 3. Optical performance criteria for single mode connectors. IEC 61753-1 specifies four Random Mating IL performance grades, of which grade A has yet to be defined.

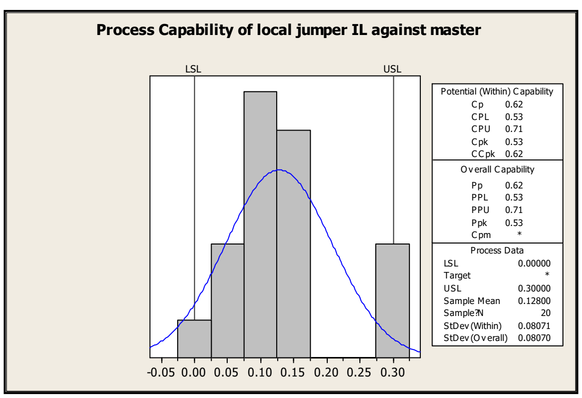
Attenuation grades	IL Requirement Random Mated IEC 61300-3-34 Tested at 1310 nm, 1550 nm, and 1625 nm
Grade A	Undefined
	Undefined
Grade B	≤ 0.12 dB Mean IL
	≤ 0.25 dB Max IL for > 97% of samples
Grade C	≤ 0.25 dB Mean IL
	≤ 0.50 dB Max IL for > 97% of samples
Grade D	≤ 0.50 dB Mean IL
	≤ 1.0 dB Max IL for > 97% of samples

Connector IL difference

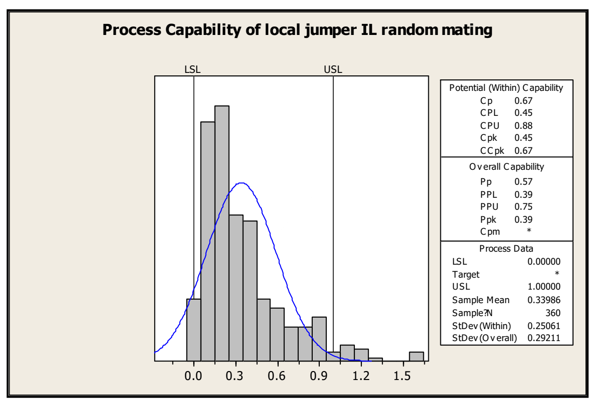
It is difficult to extrapolate optical losses in the field when testing against a Master patch cord. The Random Mating method is a better surrogate for what to expect.

Figures 1 and 2 represent sample batches 1 and 2, both of which comply with the GR-326-CORE specification of a Max IL of 0.4 dB against a Master patch cord. However, when randomly mated, the Max IL of batch 1 exceeds 1.0 dB, whereas batch 2 is 0.2 dB.

Figure 1. Batch 1 Represents SC UPC patch cords using Low Cost Vendor connectors. GR-326-CORE IL against Master and IEC Random Mating; grade D compliant.

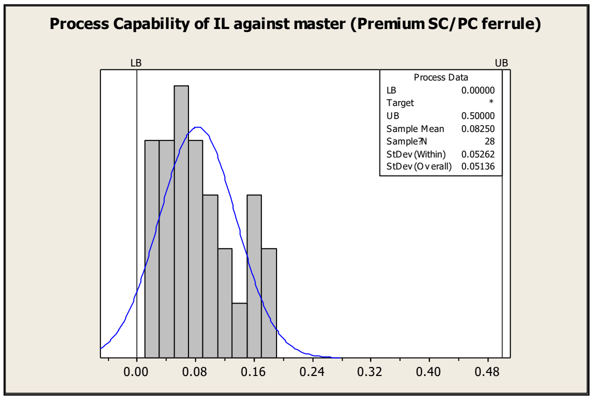


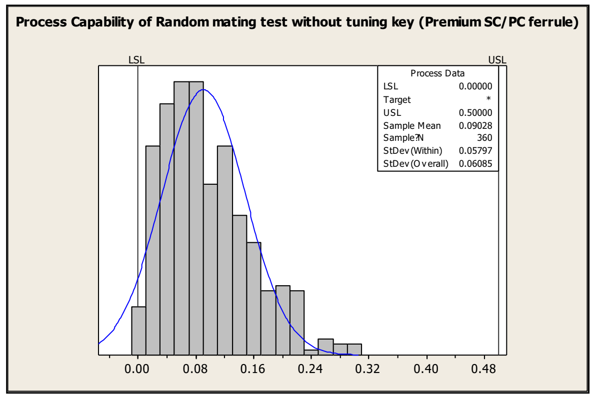
IL measured against a Master patch cord



IL measured by Random Mating

Figure 2. Batch 2 Represents High Quality Vendor SC UPC patch cords using SENKO Premium SM graded connectors.
GR-326-CORE IL against Master and IEC Random Mating; grade B compliant.





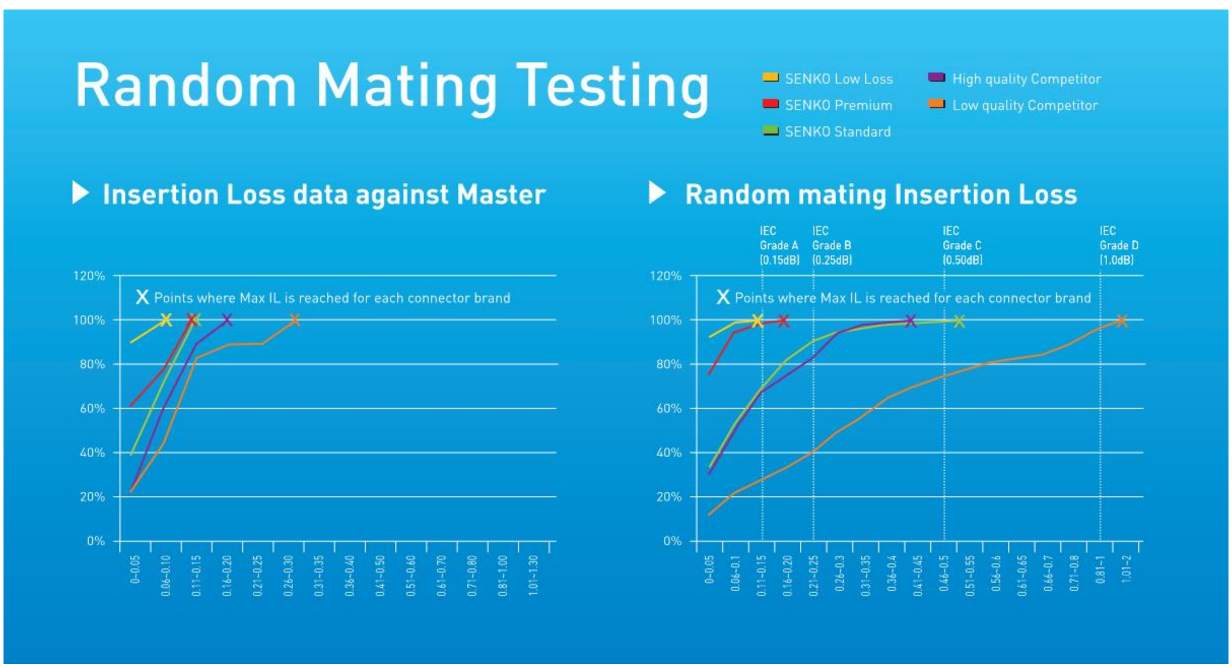
IL measured against a Master patch cord

IL measured by Random Mating

Solution

SENKO has refined the designs on its range of premium connectors to improve performance during Random Mating. Several improvements have been made including, but not limited to, better ferrule bore concentricity and ferrule flange key re-design (to tighten up Key Error). SENKO connectors also improve Apex Offset repeatability and control of free-floating ferrules. These design improvements manifest themselves as lower and tighter optical losses during random mating scenarios.

Figure 3 below illustrates the performance difference between SENKO's connectors versus that of High Quality and Low-Cost alternatives.



SENKO®
Advanced Components

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