Application Note

Meeting the Encircled Flux Launch Standard

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Scope: Guidance on how to test to the Encircled Flux (EF) multimode launch standard using existing optical test equipment and the Optronics Encircled Flux Launch Controller (EFLC)

1.0 Introduction

The current state of multimode OTDR and Light Source and Power Meter (LSPM) Insertion Loss (IL) testing is as follows:

- OTDR optical loss measurements can vary significantly from one piece of equipment to another.
- LSPM optical loss measurements can vary significantly from one set of equipment to another.
- OTDR losses can vary significantly from losses measured by LSPM.
- Differences of 50% or more between methods and equipment have been reported!

This current optical network loss test situation is problematic for a number of reasons:

- Can existing gigabit and 10 gigabit network certifications be considered reliable due to test equipment launch variability?
- Current network standards such as the Gigabit Ethernet (1000BASE-SX and 10GBase – SR) 2002 specify tightened channel insertion losses over previous standards. Channel insertion losses in a network are now more critical than ever before! Power budgets are being squeezed!

FibreFab propose a solution to this optical problem: the Optronics Encircled Flux Launch Controller (EFLC).

2.0 Discussion

We are concerned with:

- “Mode profile” (the degree to which optical power is distributed amongst the modes in a graded index multimode optical fibre core). This is the Mode Power Distribution (MPD).
- 50/125 & 62.5/125 OM1, OM2, OM3 & OM4 optical fibres in high speed gigabit and 10 gigabit LAN’s (Premise Networks).
- Different sources give different degrees of core and mode filling. LED’s can give an overfilled launch which tends to lead to pessimistic “worse than expected” test results

and underfilled launches such as those provided by VCSEL lasers can give overfilled "better than expected" results.

A pictorial representation of mode fill is given in Diagram 1 below:

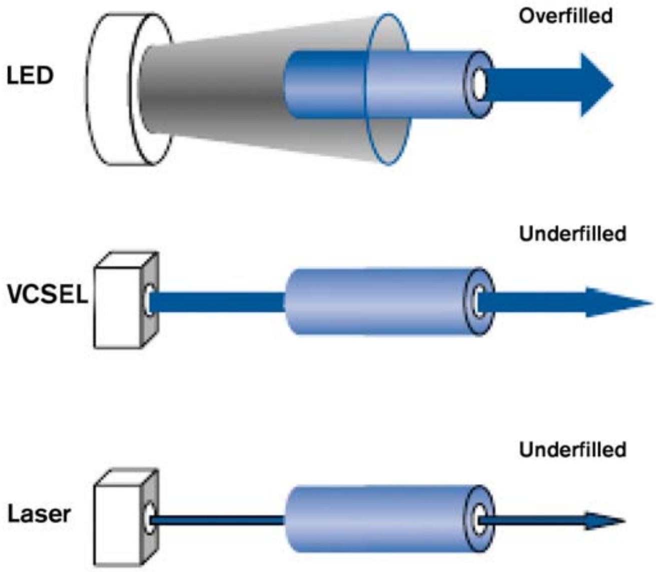

Diagram 1: Mode Fill

From Diagram 1 it can be seen that neither the "overfilled" launch condition that fills the core and cladding, nor the "underfilled" launch condition where only the central portion of the fibre core is filled is ideal for testing accuracy or consistency. We propose a solution to this problem: the Optronics EFLC to control the "Modal Power Distribution", also referred to as the "Launch Condition".

So far variation in mode fill and (MPD) (power distribution across the fibre core), have been identified as sources of inaccuracy and inconsistency.

"What then would be the best solution for testing high speed multimode LAN links using existing test equipment?"

"What is the best industry practice that will lead to reduced testing costs due to reduced errors and re-testing?"

The solution is the Optronics EFLC!

"What is the Encircled Flux standard?"

Encircled Flux (EF) – "is a quantitative measure of the percentage of the total optical power radiating from the end of a multimode optical fibre as a function of fibre core radius."

The Optronics EFLC is available as a 50/125 fibre unit or a 62.5/125 unit. Both units work at 850nm and 1300nm transmission wavelengths. The Optronics EFLC meets the requirements of the relevant IEEE and IEC specifications.

The IEEE specification specifies the distribution of light energy across the core of a multimode fibre within concentric zones. For example, the 10 gigabit specification IEEE 802.3ae for 50/125 fibre specifies that less than 30% of the optical power must be radiated within a 4.5µm radius zone of the core, and that more than 86% of the optical power must be within a zone of 19µm radius. This is represented pictorially in the fibre end face Diagram 2 below:

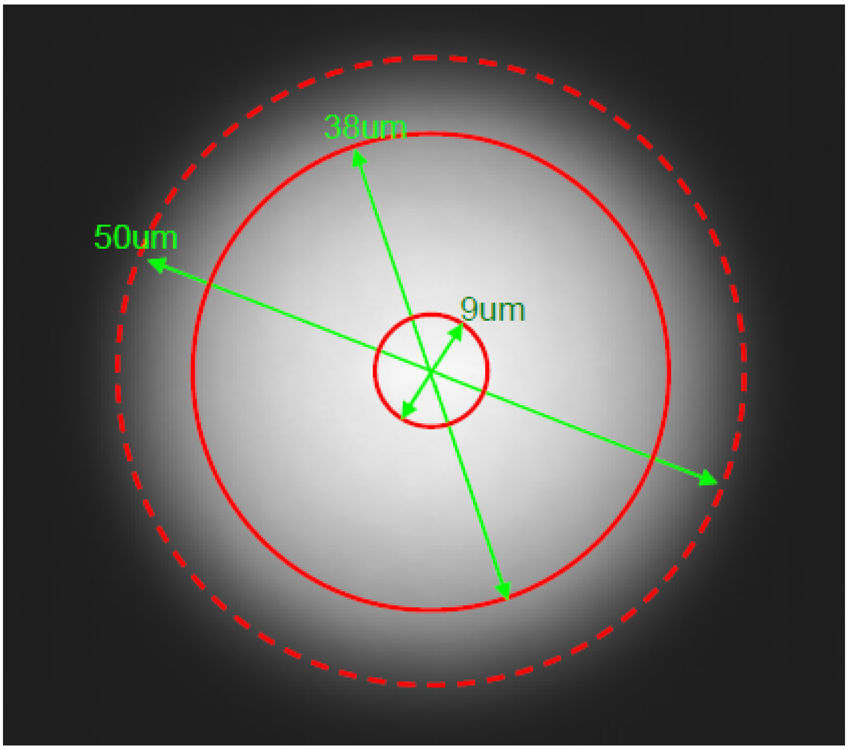

Diagram 2: Encircled Flux Core Zones

Graphically the compliant EF IEEE power distribution is shown in Diagram 3. Radiated power is shown in cumulative form on the Y axis with 1.0 representing 100% distributed power.

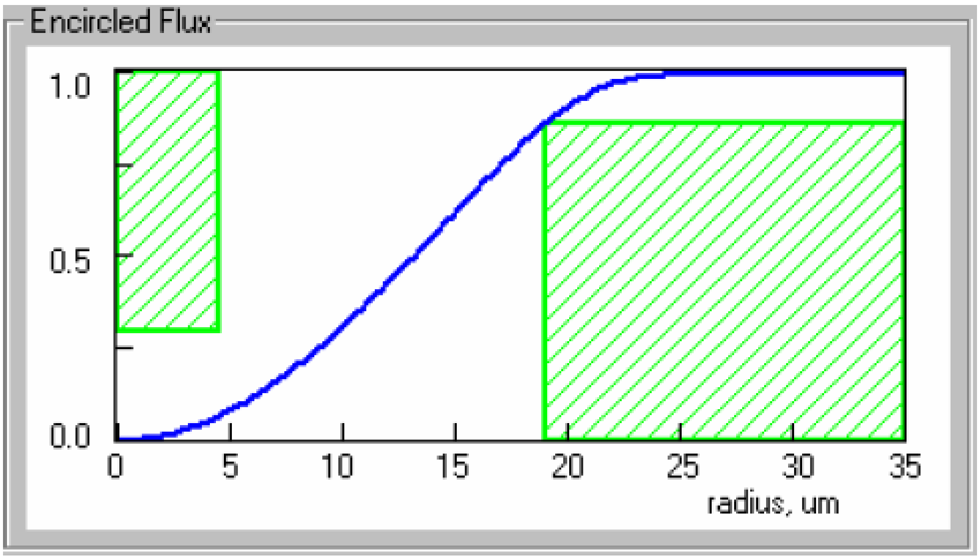

Diagram 3: IEEE Encircled Flux Core Power Distribution Template

Templates exist for 50/125 @ 850nm & 1300nm and 62.5/125 fibre @ 850nm & 1300nm. The IEEE templates are applicable to near field (near fibre end) measurements. The method uses a video processing technique with data represented graphically.

For channel losses, the IEC 61280-4-1 Ed. 2.0 and TIA-526-14-B "Multimode Cable Plant Attenuation Methods" technique is applicable using a channel loss template. The channel power loss distribution must fall within the control point markers as shown on the template in Diagram 4 below:

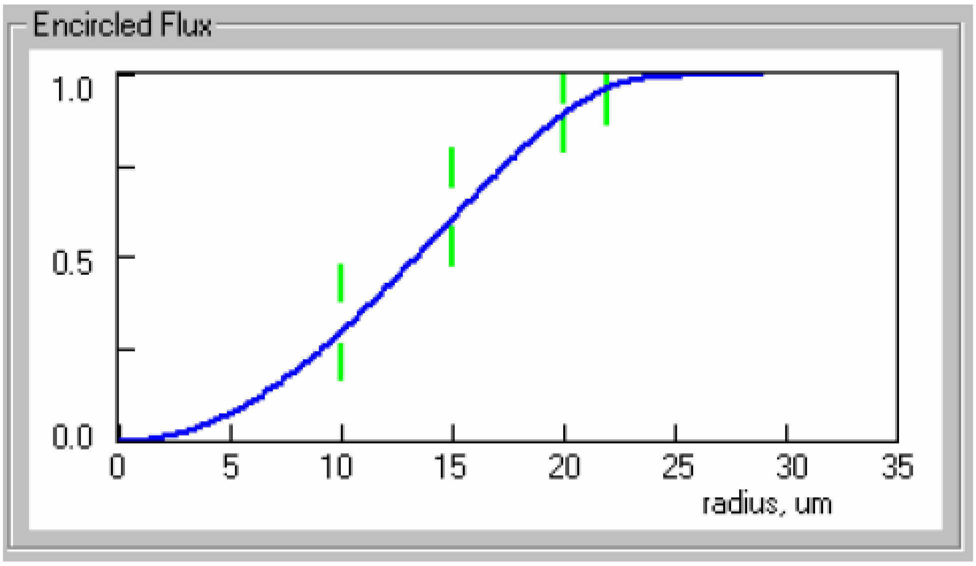

Diagram 4: IEC Encircled Flux Core Power Distribution Template

The Optronics EFLC will allow a user with an 850nm or 1300nm laser OTDR source or LED LSPM optical source to meet the Encircled Flux standard. This means that if you couple an existing OTDR or optical LSPM source to an Optronics EFLC you will achieve an Encircled Flux launch condition in accordance with the relevant international standards.

The Optronics EFLC will reduce the variability in measured test results from ±50% or more to typically less than ±10%. This means that the difference in readings between two test instruments will typically not differ by more than 0.6dB.

"What are the benefits of an EF launch?"

There are many benefits of an EF compliant launch using an Optronics EFLC, including:

- Universal multimode launch condition
- Eliminate the need for mandrel wraps
- Allows consistent and accurate comparison of loss measurements between instruments
- Fully compliant with international standards
- Achieves future testing and certification requirements now
- Allows accurate power margin analysis in high speed multimode networks
- Uses existing OTDR and LSPM equipment
- Stable launch condition for MM link testing
- Automatically improves agreement and consistency of measurement results

3.0 Conclusions

The requirements for the testing of gigabit and 10 gigabit high speed LAN's is becoming more critical as power margins become squeezed. Testing standards for high performance LAN's are now specifying test equipment launch conditions. The standardised launch condition for current and future high speed LAN networks is the Encircled Flux standard!

The Optronics EFLC will ensure that test equipment launches into 50/125 and 62.5/125 multimode optical fibres will fill the whole fibre core in a precise controlled manner without the problems associated with overfilled or underfilled launches.

Achieve the Encircled Flux launch standard now using existing optical test equipment for loss testing of multimode high performance links with the Optronics EFLC!

4.0 Specification

Parameter	Value
Insertion Loss (IL) @ 850nm 50/125 fibre	<3.0dB
Insertion Loss (IL) @ 850nm 62.5/125 fibre	<3.0dB
Dimensions	100mm x 50mm x 25mm
Weight	185g

Table 1: EFLC Specification

5.0 Features

- Available with a range of standard connectors including SC, FC, ST and LC
- 50/125 and 62.5/125 versions available
- Available with a range of hybrid adaptors to suit most connector types
- Supplied in a durable foam lined carry case
- Connector re-polishing service available

6.0 Benefits

- Get ahead of the game and sharpen your competitive edge – "be better than the rest ! at optical loss testing"
- More reliable testing means less chance of being called back for re-work. Use the EFLC to save time and save money!
- Without an EFLC, testing you will not be EF standards compliant!
- Simple to use, the labelled connections connect to the equipment end and the Device Under Test (DUT) network end through the adaptors supplied

7.0 EFLC, Carry Case & Adaptors

8.0 Part Number Generator

Connector Master Side	Connector Equipment Side	Fibre Type 62=62.5/125 OM1 50=50/125 OM2, OM3, OM4	EFLC Configuration
SC	SC	50	ENFLUXLC
FC	FC	62	
ST	ST		
LC	LC		

Table 2: EFLC Part Number Generator

9.0 Case Study

A comparative study was carried using standard Exfo and Standard Fluke light sources and power metres, with the ELFC and a standard 1m 50/125 SCSC patchcord. The equipment used is given below, testing was carried out at 850nm:

- Exfo ELS-100 Source
- Exfo EPM-500 Power Meter
- Fluke SFMULTIMODESOURCE
- Fluke SFPOWERMETER
- 1 x Standard 50/125 multimode 1m patchcord with SC connectors
- 2 x Standard SC multimode adaptors
- Optronics 50/125 EFLC with SC connectors

The results including the EFLC are given below in Table 3:

Source	Power Meter	Value
Exfo Source with EFLC	EXFO Power Meter	22.09 dBm reference
Exfo Source with EFLC	Fluke Power Meter	21.96 dBm reference
		0.13 dB difference
Fluke Source with EFLC	EXFO Power Meter	24.64 dBm reference
Fluke Source with EFLC	Fluke Power Meter	24.37 dBm reference
		0.27 dB difference

Table 3: LSPM Results With EFLC Launch

The results without the EFLC launch (patchcord only) are given below in Table 4:

Source	Power Meter	Value
Exfo Source with EFLC	EXFO Power Meter	19.04 dBm reference
Exfo Source with EFLC	Fluke Power Meter	18.84 dBm reference
		0.20 dB difference
Fluke Source with EFLC	EXFO Power Meter	21.75 dBm reference
Fluke Source with EFLC	Fluke Power Meter	21.39 dBm reference
		0.36 dB difference

Table 4: LSPM Results Without Launch

The results using the Exfo source showed that the inclusion of the EFLC reduced the difference in results from 0.2dB to 0.13 dB an improvement of 0.07 dB

The results using the Fluke source showed that the inclusion of the EFLC reduced the difference in results from 0.36dB to 0.27 dB an improvement of 0.09 dB

The EFLC has been shown here to significantly reduce the variation in LSPM results between calibrated but unrelated multimode sources and power meters in compliance with the EF concept ?

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