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Optical Fiber Cable–Fault Location Detection Procedure

Abstract

This document describes the guideline for locating the fault in optical fiber cable after installation or during maintenance of the cable.

Keywords

Fiber optic cable, Cable bend / twist, Jacket / sheath zippering

General

This document describes the guideline for locating the fault in optical fiber cable after installation or during maintenance of the cable.
Optical fiber cables are manufactured with excess fiber length in buffer tubes to avoid change in optical characteristic of fiber by any external force during installation. Precise value for this excess fiber length is not available. It varies with the type of cable design. Hence finding out fault location in OFC is a challenging job. This document helps in finding out the most accurate sheath distance where fault has occurred in the cable.
The method is suitable for all types of optical fiber cables and is independent of index of refraction (IOR) used by OTDR, but it has to be kept constant once the process has started.

Equipments Required

1.Optical Time Domain Reflect meter
2.(OTDR). Road meter
3.Dummy fiber Spool of known length
4.Fusion Splicing machine

OTDR Setting:
To find out optical distance of fault point, the OTDR has to be set for the following properties:

1. Index of Refraction
For accurate length measurement of Sterlite Optical fiber, set following group indices of refraction

Single mode fiber	1310 nm	1550 nm
	1.4670	1.4675

2. Pulse width
Use short or medium pulse width depending on cable route length. For longer cable systems, the shortest possible pulse width allowing smoothest OTDR trace should be used.

3. Vertical & Horizontal Scale
Use the minimum dB/division & kilometer/division that can maintain the desired trace on the OTDR display.

4. Dummy Fiber /Pigtail
Use a dummy fiber, which is long enough to encompass the OTDR initial reflection (dead zone). For single mode fiber, use length of more than 300 meters of dummy fiber.

5. Cursor
Place the first cursor “A” in the beginning of the trace to be measured and ensure that it is on the linear portion of trace and not within the splice or connector reflection. Place another cursor “B” as close as possible to the fiber fault reflection and ensure that it is on the linear portion of the trace and not within the fault reflection.

Fault Location Procedure

1. Location of Fault and its nature using OTDR

a. Choose the nearest joint or termination to find the exact location where fault has occurred and connect a dummy fiber to the output adaptor of OTDR.

b. Start measurement in real time.

c. Set/place marker “A” at the end of trace & zoom linear portion of trace.

d. Bend another end of dummy fiber so that perfect square pulse reflection will be observed on trace.

e. Set marker “A” as close as possible to the reflection pulse & note down distance reading.

f. Splice this dummy with faulty fiber using fusion or mechanical splicing & detect fault location

g. Set/place marker “B” as close as possible to the fiber fault reflection.

h. Note the distance reading of marker “B”.

i. Optical distance of fault from the point of test is calculated as follows:

Optical Fault Distance = distance of marker (B) - distance of marker (A).

2. Limitations of using an OTDR by itself:

In fault location finding procedure, it looks OTDR can measure exact distance, however the actual physical location of a fault is uncertain. Even under ideal conditions the distance uncertainty is about 3 1%, eg 20 meters per Km. Some typical causes of error are:

• Even under factory conditions, the accuracy of length markers is about 3 0.5%. By the time cables are laid, this is likely to get worse.

• There is some variation in the 'take up factor', eg the fiber / cabled length ratio. Due to this variation, we understand that experts regard length markers as the most accurate length measurement. Variations in 'take up factor' directly affect the accuracy of length measurement.

• The refractive index may vary along a route due to multiple suppliers cable used. It is often measured & specified to only 3 decimal places. Not all data will be totally accurate, not all installers record it accurately, and not all OTDRs can accept multiple values. Variations in refractive index directly affect the accuracy of length measurement.

• Link length may not match the route distance due to excess being coiled and left in pits, or undocumented detours.

• The exact route may also not be precisely mapped or followed. Minor discrepancies that would not be noticed during construction & acceptance, can cause havoc during precise fault location.

3. Calculate fiber over length correction factor

a. Measure optical length of cable using average of other three continuous fibers.
b.Note down meter marking of cable at both ends using system records /route diagram. Use these values to calculate cable sheath distance as follows.

Cable sheath distance = difference between the meter markings of both ends of cable.

c. Calculate fiber over length correction factor using formula:

$$\text{Correction} = \frac{\text{Cable sheath distance}}{\text{Cable sheath distance}}$$

d. Calculate Sheath distance of fault from testing location:

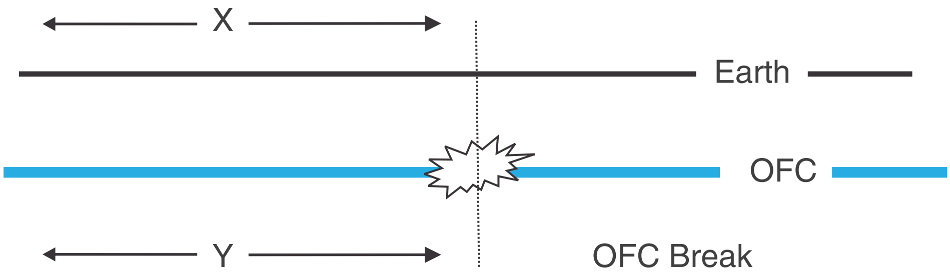
Cable fault sheath length = Fiber length * Correction factor

e. Calculate the cable sheath marking at fault by appropriate addition or deletion of fault sheath length in meter marking of test location.

f. Using road meter & following cable route path locate meter marking of fault location in the field & inspect the cable carefully in this vicinity for any signs of damage.

g. Confirm this fault by bending cable at this point and observe end peak on OTDR trace for jumping pulse.

4. Data Sheet (Typical example):



Meter Marking print on the cable both ends (m)	END 1	A	2005
	END 2	B	5
Physical Length (m)	A - B	PL	2000
Total Optical Length (m)	F1	F1	2021
	F2	F2	2022
	F3	F3	2021
Average Optical Length (m)	(F1+F2+F3)/3	OL	2021.33
Correction Factor Fault	PL/OL	CF	0.99
Optical Length (m)	FL	FL	315
Fault Sheath Distance (m)	FL*CF	FS	311.85

Note: After reaching to the fault location by road meter, inspect the route for any infra work for approx 10meters in both the directions and then start to dig for Fault Location.

beyond tomorrow

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STL is a leading global optical and digital solutions company providing advanced offerings to build 5G, Rural, FTTx, Enterprise and Data Centre networks. The company, driven by its purpose of 'Transforming Billions of Lives by Connecting the World', designs and manufactures in 4 continents with customers in more than 100 countries. Telecom operators, cloud companies, citizen networks, and large enterprises recognize and rely on STL for advanced capabilities in Optical Connectivity, Global Services, and Digital and Technology solutions to build ubiquitous and future-ready digital networks.
STL's business goals are driven by customer-centricity, R&D and sustainability.

Championing sustainable manufacturing, the company has committed to achieve Net Zero emissions by 2030.
With top talent from 30+ nationalities, STL has earned numerous 'Great Place to Work' awards and been voted as the 'Best Organisation for Women'.

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