Guidelines for the use of Optical fiber cables in LHCb

LHCB Technical Note

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Abstract

This document gives a few recommendations on the use and handling of optical fiber cable. Some advises concerning optical fiber cables are given in order to keep all optical links working properly.

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1. Introduction

In LHCb, most of the data transportations, from the sub-detector front-end to the counting house and from the on-line PC farm to the surface control room, are done via optical links. A total of more than 7500 optical links is foreseen to be installed in the LHCb experiment. This amount of optical links that will be installed implies that the people who will be brought to handle optical cables must have certain knowledge on the optical fibers and some good practical skills. This note describes a few but important points to be followed when optical fiber cables are used.

2. Optical fiber used in LHCb

In LHCb different type of optical fibers are used depending on the technical constraints and needs:

- Multimode 50/125um for the readout link between the front-end electronics and the counting house.
- Singlemode fiber cables for the TTC transmission between the TTCtx and the TTCrxs on the sub-detectors front-end electronics.
- Single and multi modes fibers for the links between the counting house and the surface control room.

Different types of connectors are also used depending on the needs.

- MTP connectors with 12 fibers.
- SC for single fiber connection.
- ST for TTC connections.
- …

3. Handling guidelines

3.1. Optical cables

Fiber optic cables require proper handling. Follow these basic guidelines in addition to manufacturers' specifications will help to maintain good interconnections for all links present in the experiment:

Do not stretch, puncture, or crush the fiber cable(s) with staples, heavy equipment, doors, etc.

Always maintain the minimum bending radius specified by the cable manufacturer. The minimum bend radius is usually 10 times the cable's outer diameter. In the case of single optical fiber that is not in a cable, the minimum bending radius to be observed is 3cm. In general, the more the cable is bended (in terms of radius and number of bend) the more power loss will appear on the optical link.

3.2. Optical patch cords

When used within an electronics rack between the patch panel and the electronics board, the patch cord cables must be well attached to the rack cable trays in the front and on both sides of the racks. The patch cord cables should not be pending in front of the rack to avoid having an optical link hanged by somebody or something and pulled out accidentally.

A transparent protection plate is foreseen to be placed in front of the rack containing optical patch cord cables. This protective plate should be mounted when the rack is not under maintenance or reconfiguration.

3.3. Connectors

Whenever an optical cable is disconnected a protective caps must be placed on the connector and on the adapter transmitter or receiver. This must be done rigorously to avoid any dust and other undesirable particles soiling the end faces of the optical connectors. Protective caps are delivered with optical cables and patch cord cables. Adapters as well as transmitter and receiver modules are usually also provided with protective caps. When a reconfiguration of the optical cables is foreseen, the user should always have a number of appropriate caps with him in order to do the change in a proper fashion.

Figure 1: Example of optical fiber connectors, MTP-12, multi fiber connector on the left, SC, single fiber connector on the right.

3.3.1. Connector cleaning

Cleaning of connectors is one of the most important steps for ensuring good performance of optical connectors. Rigorous cleaning with the proper equipment should always be performed prior to installation of the connector in an interconnection sleeve and after every reconfiguration. This must be done even if protective caps have been used during the time the cable was disconnected.

The CERN store proposes a universal connector cleaning cassette [1]. This Universal Connector Cleaning Cassette uses a special cloth tape over two pin-clearance runners to clean the connector end face of either

MT-RJ or MTP® connectors which have guide pins. The center section of the cleaning area between the two runners may be used to clean any pin-less connector, including single fiber connectors.

Wipe the end face surfaces of the connector with the cleaning cassette. Make certain both the sides and end face are well wiped. It is also recommended that the connector coupler or sleeve be cleaned out with compressed air. This cleaning procedure applies to cleaning of all fiber optic connectors during installation and configuration.

Do not allow the end face of the connector to touch any surfaces except as prescribed. Failure to do so may damage the connector or cause increased attenuation.

The use of a cloth made of synthetic fibers to polish the connectors must be avoided as this will charge up the fiber and attract dust.

In some cases when the cleaning with the cassette shows not to be sufficient, it is recommended the use of Isopropyl Alcohol and compressed air. This has to be done only if needed because it has been seen, in some cases, that the optical fiber gets disconnected from the ferule of the connector.

3.4. Testing

Different tests can be done on optical links. OTDR (Optical Time Domain Reflectometer) give a detailed view of the optical link over its full length. Total power loss, return loss as well as connectors can be seen precisely. OTDR are expansive and can be quite complicated to use. At CERN, CMS has bought an OTDR with the participation of the experiments. This OTDR is specially designed for short distance links (few hundreds of meters) and can be lent when required (in case of broken links for example).

The most useful and easy test to be done is a power loss measurement. The instruments needed for this test are quite cheap. It consists in a handheld power source and power meter and a number of reference adaptation cables. This test method allows measuring of the loss level the system will experience when in operation, and ensures that proper system polarity is achieved. Corning proposes a written procedure for power loss testing of multi-fiber cables [2].

3.5. Reparation

If a long distance optical fiber cable is broken or partially broken, it can, in some cases, be repaired. This can be done by replacing the broken section of a cable and splicing the fibers. At CERN, as the OTDR, an automatic splicing machine has been purchased by CMS and can be lent when needed. This splicing machine can splice ribbon up to 12 fibers at once. Only well qualified and trained people can splice fibers.

More information on fiber splicing and on optical fibers in general can be found here [3].

4. References

[1] CERN store: https://edh.cern.ch/edhcat/Browser Item (SCEM) No.: 34.10.01.xxx.x

[2] Corning test procedure:
http://www.corningcablesystems.com/web/library/AENOTES.NSF/$ALL/AEN078/$FILE/AEN078.pdf

[3] Corning discovery center web site:
http://www.corningcablesystems.com/web/college/college.nsf/ehtml/index