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# Technical newsletter

# Understanding an optical fibre cable datasheet

**27 July 2022**

**The objective of this document is to give an understanding of an optical cable datasheet. In this document, the interaction between cable features and the couple "Standards + Criteria" is explained with some examples to give guidelines on the way of using a fibre optical cable datasheet.**

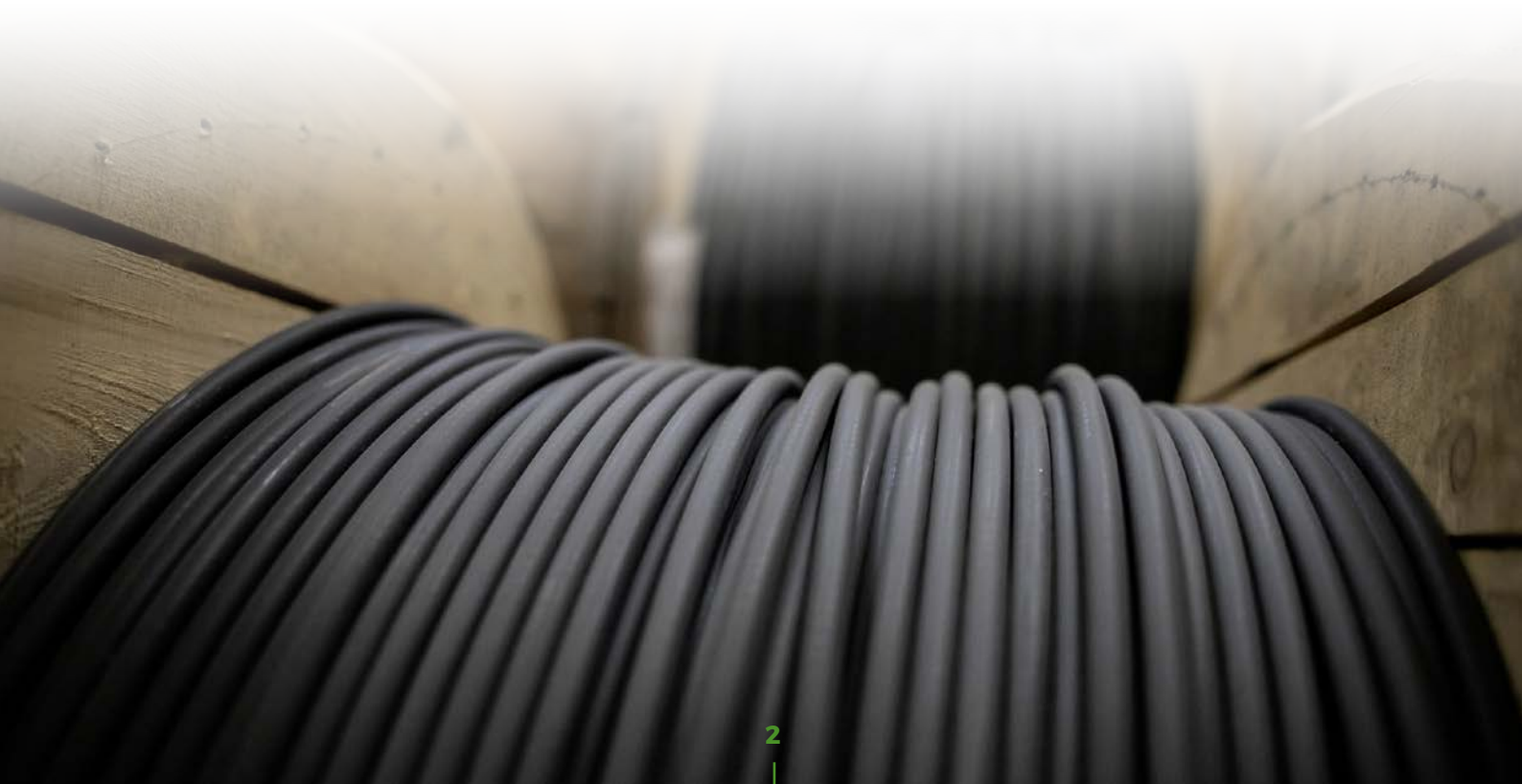
A technical datasheet is usually the first document shared with a user (Purchasing Manager, Technical Manager, and Installation Manager). Indeed, when many optical fibre cables are to be compared with the requirements of a project, a short list could be made based on the datasheet.

However, all datasheets are not equivalent even if they look similar. It is then of importance to know what the minimum relevant data are and how to find them.

Before reading a technical datasheet, it is key to know the optical fibre cable application and the installation method for the project. Application and installation are very dependent of each other and impact a lot the cable features, and so, the relevant content of a datasheet. The reader of the datasheet shall keep in mind these two aspects to define if a cable is fit for its purpose during a selection process.

Description and understanding of the cable characteristics are also very dependent on the Standardization documents referenced in the datasheet. Indeed, a technical value means nothing if it is not given with a clear test method and a clear acceptance criterion.
Moreover, using Standards allows a relevant and fair comparison between various datasheets **if acceptance criteria are equivalent, which is often not the case**.

In this document, the interaction between cable features and the couple "Standards + Criteria" is explained with some examples to give guidelines on a good way of using a fibre optical cable datasheet. **This document underlines that the values given in a datasheet are dependent on criteria which shall be clearly identified and fairly shared by suppliers.**



# 1. Cable application and installation

Before looking at a datasheet, the user shall have a good idea of the future use of the optical fibre cable. In particular, it is key to know the general application of the cable as well as the way it will be installed. Indeed, these two aspects directly impact the optical and mechanical reliability of the cable and, at the end, its design.

## a. Cable applications and key performances

The main relevant performances of a cable are coming from its application type.

This is where the first batch of important features of the cable will be set. The specified performance of a cable in a datasheet must take into account the type of application to ensure the long-term reliability of the fibre.

Typically, an aerial cable should have tensile performances or max span length, **clearly specified for an associated fibre elongation criteria** while tensile performance of a duct cable is a sufficient indicator. An indoor cable must have a fire behaviour compliant with the CPR whereas a pure outdoor cable is not subjected to the CPR. **A direct buried cable KPI is the crush and impact resistance** and so on.

**Cable application must be clearly written and specific key features detailed with their associated criteria.**


## b. Installation operations

The installation method is then a key parameter which highly impacts the cable design and so the relevant inputs to be considered on a datasheet.

The usual type of installation methods are:
- Pulling in duct
- Blowing in duct
- Aerial installation on poles
- Burying the cable in trenches
- Laying in trays in sewers or tunnels

The installation method is a very small part of the cable life, but it influences the cable design in various ways. Usually, a cable installed by pulling is very different from a cable installed by air blowing. The pulled cable must have a high tensile resistance (usually few times its weight) whereas a blown cable is less focused on its tensile performance but must have a small diameter, a small weight, some stiffness.

For example, if a blown cable is installed by pulling there is a high risk of damaging the fibres during the installation operation. At the opposite, trying to install a pulled cable by blowing is possible but is far less efficient (increasing installation time) than doing so with a dedicated blown cable.

As for the application, it is always good to mention on the datasheet the preferred installation method of the cable to avoid any issues later during installation.

Having in mind the cable application and its installation method is the beginning of understanding the relevant inputs to be taken into account when reading a datasheet.

# 2. Standardization documents and criteria

## a. Why using Standards?

The main aim of Standardization is to give a common framework or reference to products to ensure they are fit for a specific purpose. Then, it is possible to compare various products efficiently using a set of dedicated Standard documents.

If some datasheets have to be compared, it is important that they refer to the same Standards for fair and easy analysis by the user. For example, if various optical fibre cables for an indoor application are considered, it is easily done with the CPR Standards which give a unique frame of comparison regarding fire behaviour.

This fire behaviour includes more than only fire performance but also smoke generation, acidity of the smoke, fire spreading which are key factors for security purpose.

As a basic requirement, a datasheet shall give cable performances following at least the IEC generic standards covering optical fibre cables such as:

- IEC 60794-1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods.
- IEC 60794-1-22: Generic specification – Basic optical cable test procedures – Environmental test methods.

These generic documents deal only with the test procedures and do not impose a requirement regarding test acceptance criteria. Then, the user has to understand that even if two cables are tested with the same test procedure, **the given performance in the datasheet may vary a lot if the acceptance criteria are not aligned** (max optical attenuation, max fibre elongation).

To overcome this issue and to be able to compare various datasheets, more specific standards could be used where criteria are mentioned. If such documents are not known nor used, it is then important to have criteria written in the datasheet in addition to the generic standard describing the test procedure.

## b. Why criteria are important?

A criterion used to validate a test result can be seen as a physical limit which simplifies the interpretation of a performance by giving an OK/NOK answer. Usually, few criteria are used to perform a test. For fibre optic cables, most of the tests must show an attenuation criterion linked to a “physical” criterion.

For example, during a mechanical test, attenuation should stay below a limit while the integrity of the cable shall remain without damage. This pair of criteria is a minimum to have but the more criteria are used, the more the cable quality can be assessed.
Here under are some typical criteria examples to be found on datasheets which ensure the long-term reliability of the fibres:

## Optical criteria:

• Attenuation reversibility:
This is to check if the attenuation increase observed during test is returning to 0 dB with a tolerance (typically +/- 0.05dB). It is expected that after a solicitation a cable, so the fibres, are returning to a zero-stress state. If not, it means that after each loading, stresses are accumulating over the fibres which will reduce seriously their lifetime.

• Maximum attenuation during test:
When attenuation is measured, a maximum value of attenuation is set to monitor the stress on the fibre. If this attenuation criterion is not reach during the test, it means that the fibres are well protected in regards of the tested solicitation.

Usually, both reversibility and max attenuation are to be considered for the main performances of an optical fibre cable.

**Optical attenuation criteria should be specified at max 0.1dB@1550nm during test and remain reversible.**


## Mechanical criteria:

• Outer sheath damage:
After a solicitation, it is expected that the outer sheath integrity of a cable is still showing no damage.

• Inner elements damage:
To ensure a high level of cable reliability, all internal elements shall remain intact after test. More specifically, the strength members must be fully operational to ensure the cable handling and the security of the users.

• Fibre elongation during test:
Fibre elongation is monitored during tensile test to ensure that elongation is remaining below a portion of the fibre proof test. This is key for the long-term reliability of the fibre.
For more insights about this topic, the Europacable newsletter “FttH and Optical distribution network reliability” and the technical report IEC 62048/TR/Ed3: Optical fibres - Reliability - Power law theory are giving a lot of relevant inputs.

The general idea is to monitor the stress induced on the fibres to verify that it remains acceptable.

Here under are the definitions of the typical tensile loads to be considered in datasheets following IEC 60794-1-1 and usual terminology of the Cable Industry:

## For non-aerial applications:

**Long-term load, TL:**
Acceptable amount of long-term load which the cable may experience during operation (i.e. after installation is completed).
**Typical fibre elongation: 0.1% to 0.3%**
**Typical attenuation variation: max 0.1 dB and reversible**

**Short-term load, TS:**
Amount of short-term load (typically during installation) that can be applied to a cable without permanent degradation of the characteristics of the fibres, cable elements or sheath.
**Typical fibre elongation: max 0.5%**
**Typical attenuation variation: max 0.1 dB and reversible**

## For self-supporting aerial applications:

**Maximum allowable tension, MAT:**
Maximum tensile load that may be applied to the cable without detriment to the performance requirements (e.g. attenuation, fibre reliability) due to fibre strain. It could be seen as the "short climatic event" which may occurs time to time.
**Typical fibre elongation: 0.2% to 0.3%**
**Typical attenuation variation: max 0.1 dB and reversible**

**Maximum operation tension, MOT**:
Acceptable amount of load which the cable may experience during operation (as installed) where all performances of the cable are guaranteed. It could be seen as the "everyday stress".
**Typical fibre elongation: 0.1%**
**Typical attenuation variation: max 0.1 dB and reversible**

**Breaking tension:**
Tensile load that will produce physical rupture of the cable or if fibre is reaching proof test value or more than its maximum allowable elongation. At this level of elongation, even if no break occurs, the performances of the cable cannot be guaranteed anymore. This tensile value is very important to know for safety purpose of the installation team.

**Datasheet should clearly specify TS, TL, MAT, MOT, max pulling ... or Span length for clearly specified fibre elongation such as from 0.1% to 0.5%.**

## c. Conclusion

Mechanical and Optical criteria ensure the cable and the fibre reliability. The relevance of the features specified in a cable datasheet are strongly dependent on these criteria and a fair comparison requires to compare the values with a clear knowledge of these criteria.

# 3. Usual cable features to consider

Considering the previous topics presented in this newsletter, one can see that a performance "alone" is not enough to ensure the good quality of an optical fibre cable. Indeed, when considering a performance, the user should look for the following items together:

- A performance value
- A test method clearly defined
- A set of criteria

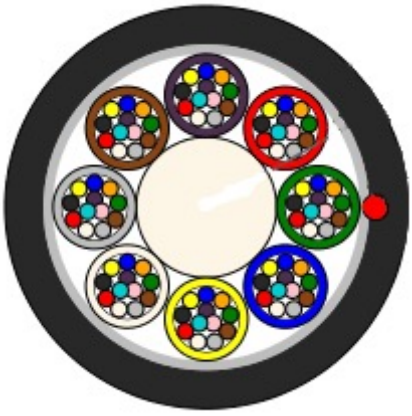
## a. Optical fibre types and characteristics

The first part of a datasheet to be read is the part dealing with the optical fibre itself as it is the core of the product. The first item to be considered is the fibre type which is usually defined by the project needs. Nonetheless, the type of fibre must be defined by a standard document which is usually the ITU or IEC ones which are equivalent. These standards give a frame where many fibre characteristics are described.

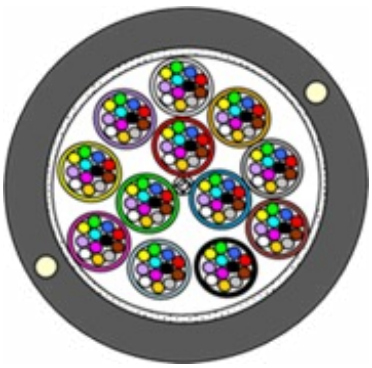
Depending on the application of the cable, some fibre types are more relevant than others but the important values to be given in the datasheet are, at least, the attenuations (at various wavelengths) **after cable manufacturing**. Values before manufacturing are interesting but not relevant because the user is not installing bare fibres. Optical performances of as-received cables must be written in the datasheet. To know more about the fibre standards relevant for optical cable applications, please refer to the Europacable newsletter "**Overview of optical fibres Standardization**" .

## b. Cable cross-section description

After verifying that the optical fibre meets the project needs, the cable design must be able to avoid any issues later on the field. The cable design is usually represented with a drawing of the cross section of the cable. The following pictures show typical cross-sections:



Loose-Tube duct cable



Micromodule duct cable

*Not at scale*

This simplified representation allows a user to evaluate how the cable components are assembled which is very important for later cable opening and fibre preparations.

The presence of compounds, yarns, strength members, is defined at this stage. Ad hoc tooling and preparation procedure can be anticipated at this stage.

Moreover, the application is driven by the cable design, so it is possible to detect a discrepancy between the cable proposed in the datasheet and the final application.

## c. Mechanical behaviour

Immediately after the optical performance of a cable the mechanical performances is key. The application is obviously defining the main mechanical behaviour of the cable, but the installation method is also very important at this stage. Sometimes, the installation may have a bigger impact on the cable design than the final application.

The main mechanical performances are usually:
- Tensile resistance
- Crush resistance
- Impact resistance
- Minimum bending radius

Other performances can be found but the important ones are these the project requires. As said before, a value shall be read with a test method and one or more criteria to be relevant. Here under is an example with the tensile strength.

The following table present two tensile resistance values from two cables concerning the same application:

| | **Maximum tensile resistance (N)** | **Test method** | **Attenuation criteria** | **Remark** |
|---|---|---|---|---|
| **Cable 1** | 1200 | IEC 60794-1-2 (E1) | Reversible | - |
| **Cable 2** | 1000 | IEC 60794-1-2 (E1) | Max 0.1 dB @1550nm during test and reversible | Maximum fibre elongation < 0.3% |

In this example, if the cable 1 seems to have a better performance using the same test method as cable 2, there are differences in the attenuation criteria and the fibre elongation. For users unaware of these criteria, there is a chance to select the wrong cable.

Indeed, maybe the cable 1 was tested above acceptable fibre elongation to reach a high tensile value. Whereas the cable 2 shows a lower value but with an attenuation limit and a maximum fibre elongation which ensure that the stress on the fibre is acceptable up to the given value.

There are many ways to present mechanical performances, thus the best way to proceed is to always consider test method and criteria with the mechanical performance.

## d. Environmental behaviour

Environmental features usually take a small place in the datasheets but play a very important role for the application, but it also gives an idea of the cable quality. This part basically covers the following performances:
- Watertightness
- Storage temperature
- Installation temperature
- Operation temperature

These features are more important for outdoor applications, but the given temperature range could be seen as an image of the cable quality.

In fact, temperature and ageing tests are performed during cable development to determine how the cable behave in extreme temperature and humidity conditions. Indeed, when a cable is subjected to low or high temperature, for example, some stresses are induced in the cable.

This may lead to stress on the fibre. That's why typically the larger the temperature range is the better the cable quality is for a long-term service life.

But here again, it is important to have clearly defined test criteria with the test method to compare the environmental behaviour of cables. **For example, a temperature range must be given with a maximum attenuation value**.

## e. Identification and packaging

The main points to be clearly addressed in a datasheet regarding identification and packaging are:

- **Fibres and tubes colour code**

Colour codes are mandatory to ensure a good interoperability of cables to be spliced with other cables. In the field, splicing different colour codes could lead to important network issues and additional maintenance operations.

Standardized colour codes shall be preferred over specific ones.

- **Cable marking**

Cable marking is covered by Standards when considering its resistance to abrasion to ensure a readable marking all along the service life of the cable. This is key to avoid any issue for later maintenance operations where multiple cables are laid in the same manhole.

- **Drum type and size**

Drum shall be considered as a part of the product as it must respect the cable mechanical performances (bending mainly)... but it also plays an important role in the logistics of a project (outdoor storage, handling conditions and quantity of cable per drum).

These parameters must be clearly defined because a bad choice of drums may have big impacts on project progress.

# 4. Conclusion

The optical fibre cable datasheet goal is to clearly show what a cable can do or not based on the long-term fibre reliability.

The purpose of a cable is to protect the fibres inside for a given application and installation method. So, before reading a datasheet, it is mandatory to know and understand what the application of the project is and how the cable will be installed.

To ensure a good and fair comparison of cable performances among various datasheets, it is key to always consider the datasheet values with test methods and acceptance criteria. These 3 aspects shall not be separated from each other.

The best way to manage this is to use Standard documents which give a common referential frame.

**Europacable recommendations shall be used to ensure the high quality of cables requested for building high reliability European networks.**

**For further information please contact:**
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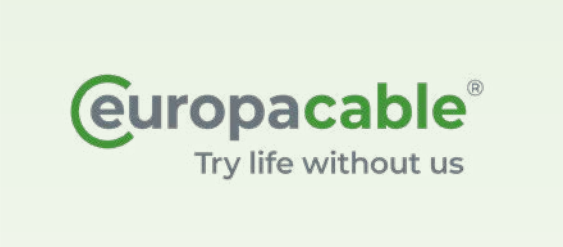


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