WHITE PAPER

FIBRE OPTIC CABLES WITH (SYSTEM) CIRCUIT INTEGRITY CONFORMING TO DIN, EN AND IEC

Electrical cable systems for safety-related installations or equipment have to comply with special fire safety requirements. Many European countries including Germany, Austria, Switzerland, Luxembourg, Belgium, the Czech Republic, Slovakia and Poland consider that circuit integrity is guaranteed only by a *system* audit conforming (or similar) to DIN 4102-12 – i.e. the testing of cables and installation system in a fire chamber. The FO cables marketed as having "functional integrity" conforming to IEC or EN do not meet these requirements.

Electrical cable systems for safety-related installations and equipment stipulated by the building regulations must be designed or be separated by components in such a way that safety-related installations and equipment remain functional (maintain functional integrity) for an adequate period in the event of fire.

These include fire alarm, voice alarm and building radio-communication systems as well as video surveillance systems, emergency telephones, ventilation damper controls and traffic lights. Fibre optic cables are ideally suited to these safety-related installations, particularly those in large building complexes, campuses and traffic tunnels, as they allow the transmission of additional audio, video and data protocols over large distances and with low attenuation losses.

To avoid having to protect the cables with special fire protection ducts, the entire cable system can be designed with system circuit integrity (functional integrity) in accordance with DIN 4102-12, for example. In such an installation, the cables are directly exposed to flames in the event of a fire.

Testing standards

International and, more specifically, European standards describe the minimum requirement as a test procedure resulting in what is known as a "PH Classification". However, this test procedure does not adequately demonstrate the functional integrity of cables, support structure and fastening system (i.e. system circuit integrity).

In Germany the functional integrity of electrical cable systems is defined using a classification conforming to DIN 4102-12, "Fire resistance of electric cable systems; requirements and testing". The classification differentiates between 30 minutes (E30), 60 minutes (E60) and 90 minutes of functional integrity (E90) for the complete cabling installation including the cables. In the Czech Republic and Slovakia cabling installations are classified as P30 to P90 in accordance with a similar national test procedure.

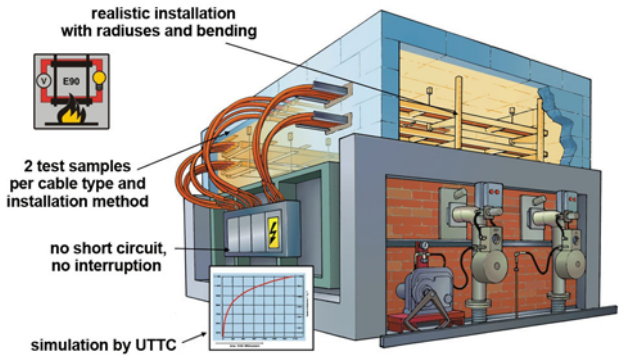
The test methods mentioned above, however, relate only to copper conductors. The failure criteria are "short circuit" or "interruption". These test methods take no account of transmission characteristics or even attenuation – the most important criterion for fibre optic (FO) cables.

Fire chamber testing of FO cables

In such tests the fire conditions are very realistically simulated by a uniform temperature time curve (UTTC): after 90 minutes the temperature exceeds 1,000°C. This makes it perfectly possible to demonstrate transmission characteristics in the event of fire.

Since FO cables have many conductors, only a few cables need to be installed on the different support and fastening systems. Reliable figures for attenuation and transmission characteristics

Figure 1: Fire chamber testing in accordance with DIN 4102-12



are obtained by directing the corresponding service through the test chamber several times.

In the fire chamber it is also very easy to determine the extent to which, for example, the fibres are affected by infrared radiation and insulation ash residue.

In the standard fire chamber the individual lengths (at least 3 metres) are subjected to the uniform temperature time curve. This means that after 30 minutes the temperature reaches 860° C and after 90 minutes exceeds 1000° C (see Fig. 1).

"Functional integrity" in accordance with prEN 50582, EN 50200, IEC 60794 and IEC 60331-25

For almost 15 years there have been test procedures designed to describe transmission characteristics in the event of fire. The most recent key criterion for the classification was an attenuation increase of 0.5 dB at 1550 nm and 1 dB at 1300 nm. This is found in draft standard prEN 50582:2015 "Continuity of signal supply of small optical fibre cables under fire test criteria".

The test equipment selected for this draft standard comes from EN 50200. Here a 50 cm length of cable is exposed to flame at a constant temperature of 842° C. A classification of up to 120 minutes is possible.

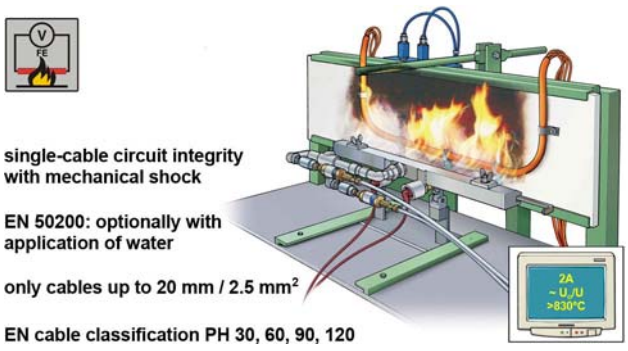
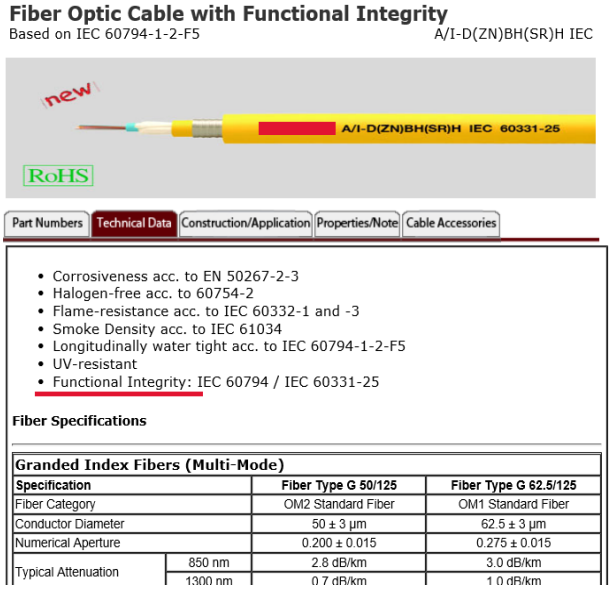


Figure 2: Testing a single cable in accordance with DIN VDE 0882-200 (previously: DIN VDE 0472-814), EN 50200, IEC 60331-25

But this test method is unrealistic. Why?

For one thing, the test stipulated in EN 50200 is very similar to the test for circuit integrity (DIN VDE 0472-814) – a test from which DIN 4102-12 explicitly disassociates itself! In section 3.2 "Functional Integrity", subsection 3.2.1 "General" of DIN 4102-12 it states that:
"Functional integrity [i.e. system circuit integrity] is ascertained when, during the fire testing of a cable system according to Section 7, there is no short circuit and no interruption of the power supply in the electrical cable systems [!] tested.
N.B.: The functional integrity defined here is unrelated to circuit integrity according to DIN VDE 0472-814."

This establishes that the „functional integrity" (system circuit integrity) stipulated is not satisfied by a test procedure in accordance with prEN 50582:2015.


Fiber Optic Cable with Functional Integrity
Based on IEC 60794-1-2-F5 A/I-D(ZN)BH(SR)H IEC

new
A/I-D(ZN)BH(SR)H IEC 60331-25
RoHS

Part Numbers | Technical Data | Construction/Application | Properties/Note | Cable Accessories

- Corrosiveness acc. to EN 50267-2-3
- Halogen-free acc. to 60754-2
- Flame-resistance acc. to IEC 60332-1 and -3
- Smoke Density acc. to IEC 61034
- Longitudinally water tight acc. to IEC 60794-1-2-F5
- UV-resistant
- Functional Integrity: IEC 60794 / IEC 60331-25

Fiber Specifications

Granded Index Fibers (Multi-Mode)			
Specification		**Fiber Type G 50/125**	**Fiber Type G 62.5/125**
Fiber Category		OM2 Standard Fiber	OM1 Standard Fiber
Conductor Diameter		50 ± 3 µm	62.5 ± 3 µm
Numerical Aperture		0.200 ± 0.015	0.275 ± 0.015
Typical Attenuation	850 nm	2.8 dB/km	3.0 dB/km
	1300 nm	0.7 dB/km	1.0 dB/km

Figure 3: In this data sheet a "functional integrity" according to IEC standards is stated.

For the use of cables classified in accordance with EN 50200 as PH 15 to PH 120, standard EN 50200 requires the use of the fastening method employed in the test procedure, i.e. clamps at intervals of 10 cm. This type of installing PH cables – the only permissible one – is, however, unrealistic.

Unfortunately the term "circuit integrity" used in the English version for the circuit integrity described in EN 50200 (= single-cable test) is frequently translated into German as "Funktionserhalt" ("functional integrity") which indicates a system test – even, for example, in EN 50289-4-16 "Communication cables - Specifications for test methods - Part 4-16: Environmental test methods - Circuit integrity under fire conditions".

Due to the fact that there is no more accurate definition (or translation), "fibre optic cables with functional integrity" conforming to IEC or EN are already on the market (see Fig. 3). These do not, however, meet the requirements of *system* testing as stipulated, e.g. in DIN 4102-12.

It is therefore essential that the requisite "functional integrity" is always linked to system testing. Even if there is no E30, E60 or E90 classification for FO cables, cables can be used on the basis of test reports for protective target E30 (P30), E60 (P60) or E90 (P90).

Datwyler Safety fibre optic cables

Types ZGGFR-Safety / U-DQ(ZN)BH and wbGGFR-Safety / U-DQ(ZN)BH are FO safety cables which were specifically developed by Datwyler for use in road and rail tunnels and commercial premises, and which – in conjunction with Datwyler system components – have been tested for a system circuit integrity of maximum 30 minutes in compliance with DIN 4102-12.

The Datwyler cables are a perfect match of fibre coating and flame-retardant stabilising elements as well as rodent protection. They can withstand a strain of up to 1000 and 6000 Newton (N) and a transverse pressure of 2000 and 3000 N respectively. Their fire loads are comparatively low at 301 kWh/km for one and 733 kWh/km for the other.

Both versions are halogen-free and self-extinguishing, and also meet the rigorous EN and IEC requirements in this field relating to their other fire characteristics – low fire propagation and minimal smoke emission.

In combination with fastening components, support systems, firewalls and splice covers tested in accordance with DIN 4102-12, the functional integrity of the entire optical cable system – based on DIN 4102-12 – is guaranteed for a minimum of 30 minutes.

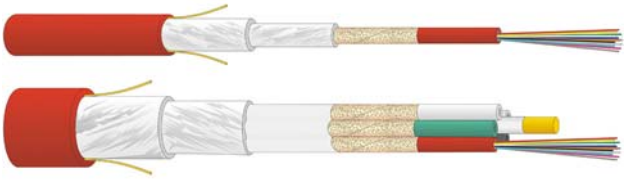


Figure 4: Datwyler's FO Universal Safety cables are tested for a functional integrity / system circuit integrity of max. 30 minutes in compliance with DIN 4102-12.

Datwyler offers customer-specific advice and support for the planning and installation of FO safety systems. Datwyler also organises its own training courses for installers on issues relating to cable systems with system circuit integrity.

