Product Information 19.11.2010

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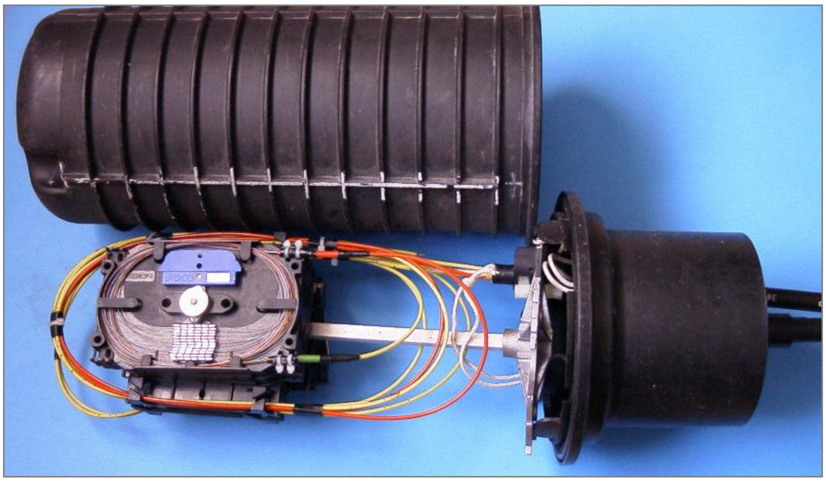
Product Information

Optical fibre water sensor

- Early warning system for ensuring maximum availability of optical transmission routes



1. Requirements for optical cable networks

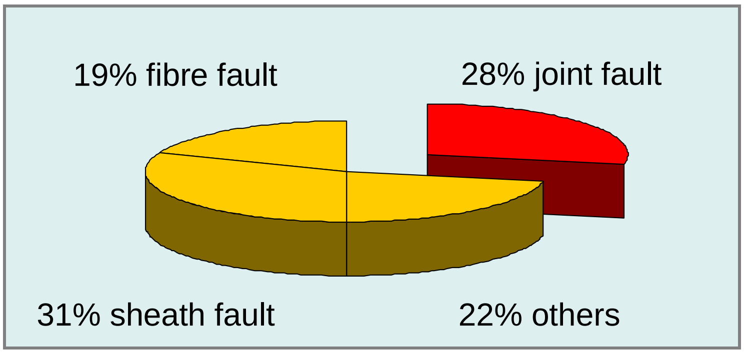
Competitiveness among telecommunication service providers has created high demands on quality, reliability and availability within the optical transmission field. Providers not only run networks, but also tend more and more to rent out single fibres to customers. Optical cable transmission channels are used day and night to carry huge quantities of data and consequently practically 100% availability is expected of them. Breakdowns cause considerable financial loss, installation and measurement procedures necessary for carrying out repairs involve high costs and should therefore be avoided as far as possible.

Reality ?

According to the statistics of the ITU and the Deutsche Telekom AG, faults in monitored cable networks are distributed between WAN and LAN as follows:

LAN	**0,93 faults per 100 cable-km**
WAN	**1,22 faults per 100 cable-km**

Distribution according to fault area



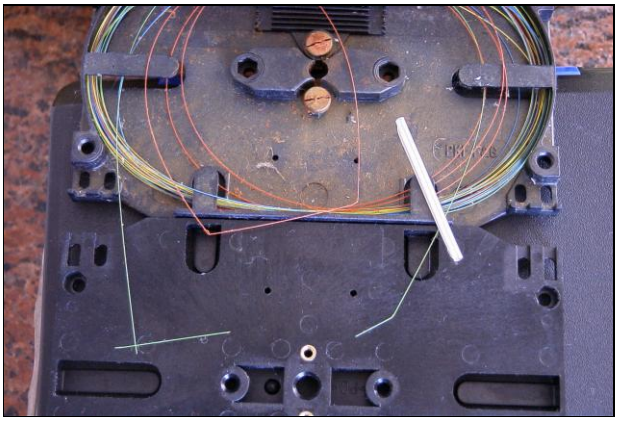
2. Reasons for water leakage into joint-boxes and consequences

2.1 Reasons for water leakage into joint-boxes

installation	cable	joint-box	nature
Cable sealing Cable immobilisation Blind plug Joint-box sealing	Shrinkage of cable end Damaged (holes) cable sheath (double sheath)	Construction Test method	Plant roots Extreme temperature changes

2.1 Consequence of water leakage into joint-boxes

If water penetration goes unnoticed for any length of time the fibres may break, thereby causing network failure due to the product-specific characteristics of both optical fibres and splice protection.



Pic. 1: Example: Fibre breakage caused by water leakage into the joint-box (Location: Rheinufer Düsseldorf, cable had been laid 11/2 years previously, 5 fibres broken in 3 splice cases)

3. Reasons for fibre breakage

3.1 Characteristic properties of optical fibres

Optical fibres have reached a satisfactory state of development for the fulfilment of most standard requirements. If breakage does occur after fibres have been immersed in water for a long time, this is due to “stress cracking corrosion”, caused by water diffusion in component parts.

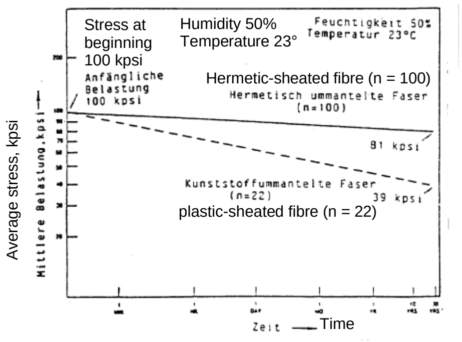
$$\equiv Si\text{-}O\text{-}Si\equiv + OH^- \rightarrow \equiv Si\text{-}OH + {}^-O\text{-}Si\equiv$$

This process intensifies the fine surface cracks already present as a result of fibre production proce-dures. This is further aggravated by mechanical wear and tear (e.g. the relative narrowness of the bend–Ø in splice cassettes or joint-boxes makes them vulnerable.)

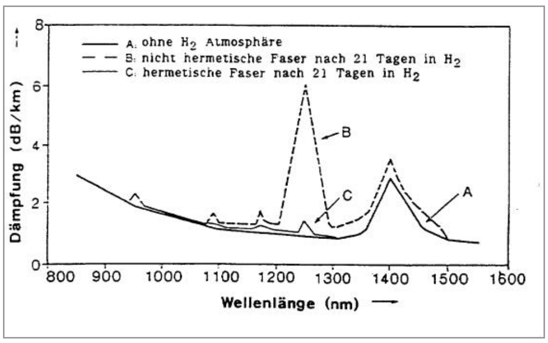
Cable durability is thus consider-ably impaired (IDiag. 1) and ends in fibre breakage [1].

Attenuation increase in glass fibres in a damp environment

Diag. 2 shows attenuation increase in optical fibres in a damp environ- ment, caused by a diffusion of hydrogen in the fibre core. Low attenuation values between 1200 and 1500 nm in atmospheres with a high concentration of hydrogen can only be permanently reached by using glass fibres with a hermetically sealed metal coating [1].



Diagr. 1



Diagr. 2

Sources: [1] Ray Chaudhuri, S. and Schulze, P.C.: Hermetic Coating on Optical Fibres, SPIE’s 1996. Cambridge Symposium on Optoelectronics and Fiber Optic Applications in Science and Engineering, 21-26.9.1986 Cambridge, Massachusetts, USA

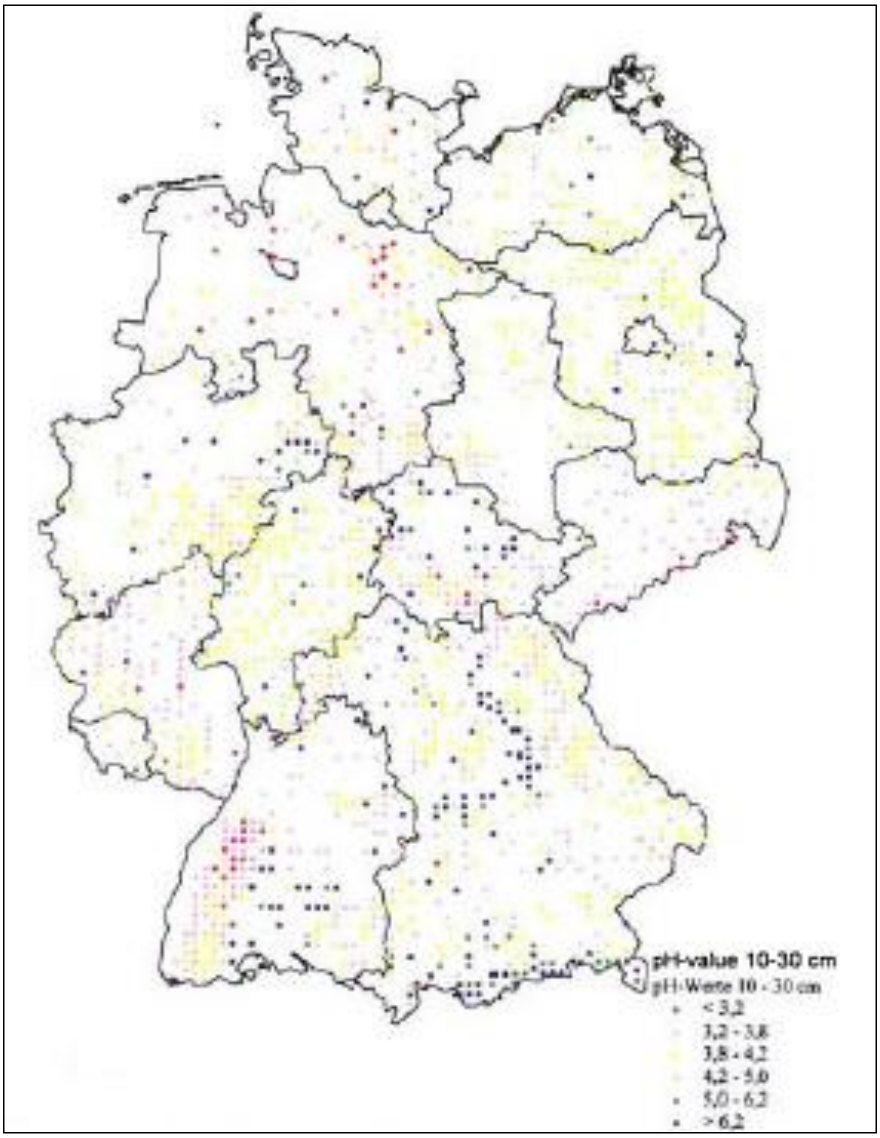
… / 3. Reasons for fibre breakage

3.2 surrounding conditions

Fibre breakage within one year is possible at pH-values 2 – 3 (f.ex. at brown forest soil, forest soils, streets and motor ways

Example 1: pH-value in German forest soils
Distribution of the pH-values in 10-30 cm soil depth
Average pH-values

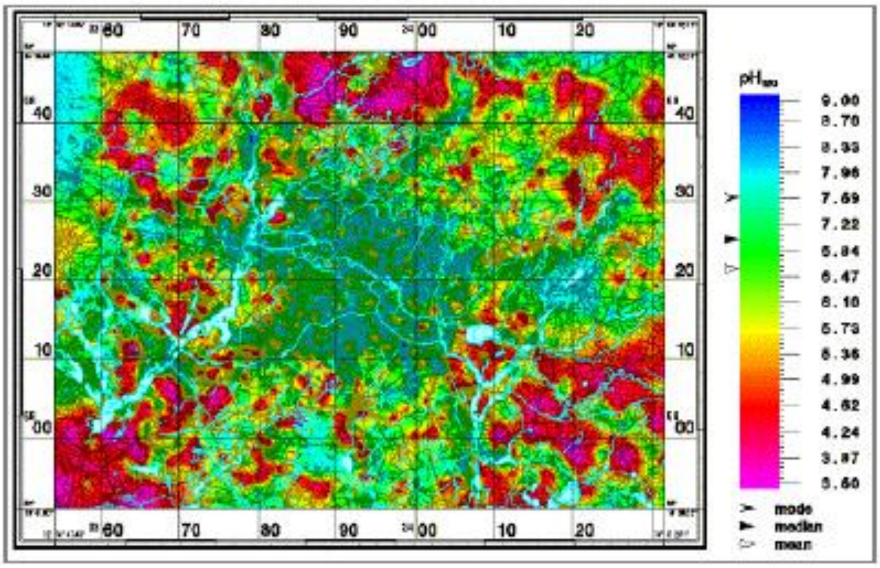
Brown forest soil	pH 2,2 – 4,9		animal husbandry	pH < 4
forest soil	pH	2,8	road salt	pH < 4
high moor	pH	3-4		



Source: (German) Federal Research Institute for forestry and timber industry

… / 3. Reasons for fibre breakage

Example 2: Distribution of the pH-values in the topsoil of the Berlin conurbation



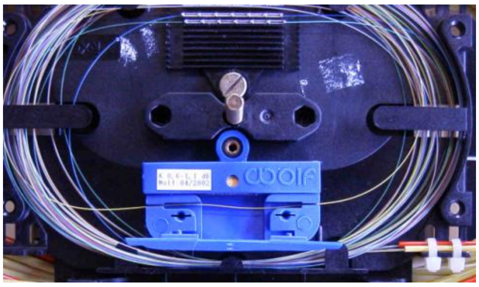
Source: (German) Federal Institute for earth science and raw materials

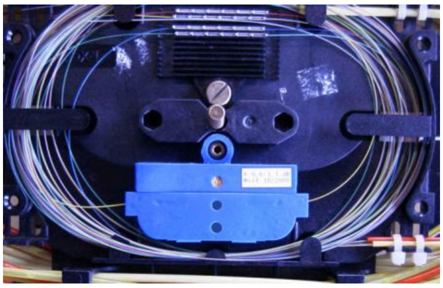
4. How to avoid network failures caused by water leakage into the joint-box

1. **Use water sensor type 1550 and/or type 1625 within joint-boxes**

   Use water sensor type 1310 and/or type 1550 within buildings, manholes or tunnels

   - Fix the water sensor within the splice cassette,
     open the top of the sensor and lay the fibre into the sensor
   - Close the top of the sensor
   - Close the joint-box etc.
   - Place the joint-box inside the manhole in such a way that
     the sensor is at the lowest point





2. **Monitoring of optical cable networks**

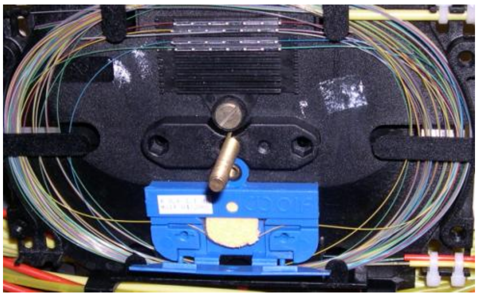
A quick, simple method of servicing optical cable networks by means of water sensors is to carry out regular measurements (OTDR, Optical Power Meter, Remote Test System) on dark or active fibres at wavelengths 1310 nm, 1550 nm or 1625 nm, and to compare the resulting graphs with standard requirements.

In this way cable lines of over 100 km can be quickly monitored and faults easily and precisely identified.

In principle we recommend to clear disturbances within 6 months after detection or before there is danger of frost. An activated water sensor can be changed (after fault clearing, drying of joint-box, installation of a new sensor and measurement) without any interruption or disturbance in the functioning of the network.

5. How the water sensor works

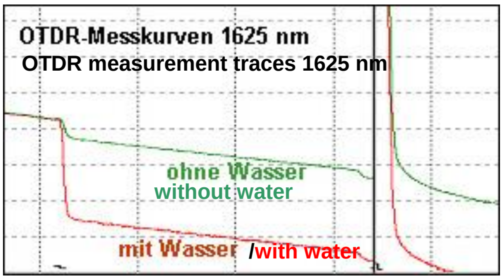
- the water sensor will be activated within less than 5 minutes after water penetration
- the water sensor causes reversible attenuation changes in the monitored single mode fibre, which can be detected by measurement (optical power meter or OTDR)
- the fault position can be located precisely
- the attenuation change is reversible and will disappear after changing the sensor
- no damaging of the fibre



Example 1:
Sensor type WS1625 nm for monitor-ing of dark and active fibres
[sensor type 44 WS1625
Deutsche Telekom MNr. 401 861 28]

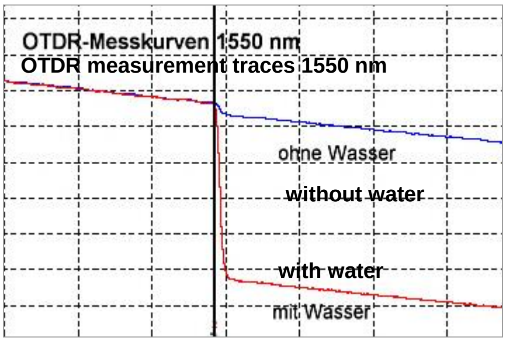
at wave length	attenuation change
1310 nm	approx. 0,02 dB
1550 nm	0,50 dB
1625 nm	0,6 - 1,10* dB

*depends on the macrobending behaviour of the fibre



Example 2:
Sensor type WS1550 nm for monitoring of dark fibres

at wave length	attenuation change
1310 nm	≥ 0,09 dB
1550 nm	≥ 1,8 dB
1625 nm	≥ 2,7dB

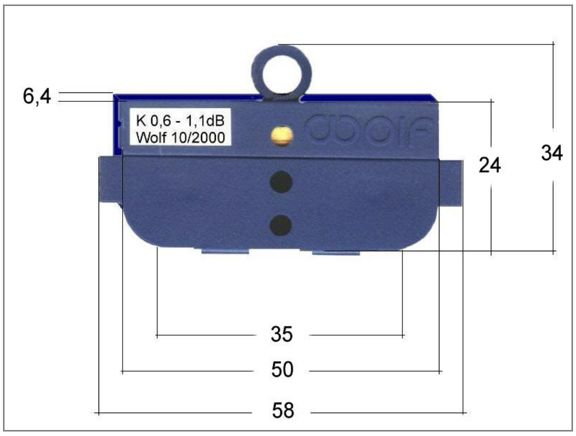


6. Dimensions of the water sensor

6.1 Water Sensor for installation into standard splice cassettes

The Water Sensor will be clicked into the space provided for it opposite the splice holder in the splice cassette.

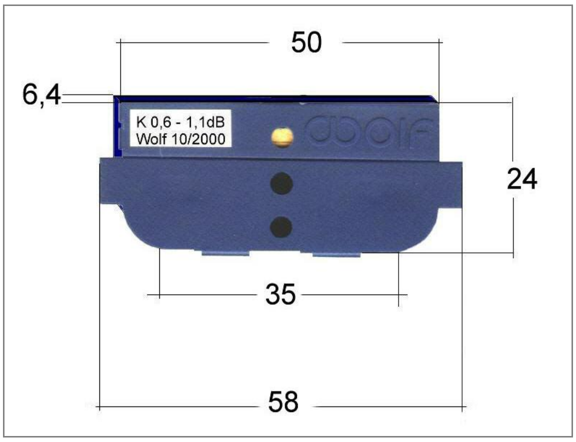
Dimensions [mm] Water Sensor Type 44 WS 1625 and 44 WS 1550



6.2 Water Sensor for installation into FIST splice modules (Tyco Raychem)

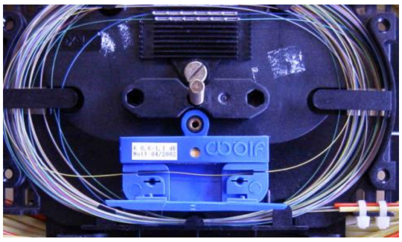
The Water Sensor will be sticked into the space provided for it in the splice module.

Dimensions [mm] Type 44 WS 1625 FIST and 44 WS 1550 FIST

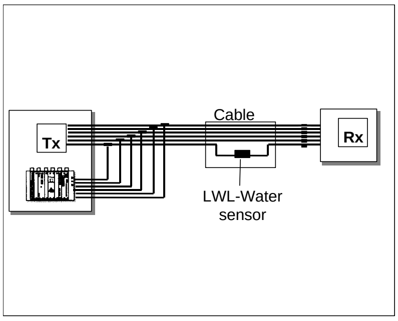


7. Tips on how to instal the Water Sensor for reliable fault detection

1. Installation

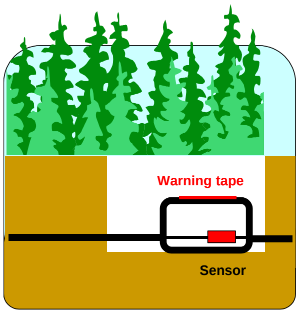


- Ensure that the fibre is free of grease before laying it inside the water sensor
- Check that the fibre has enough space for some movement and that it shows no pressure marks



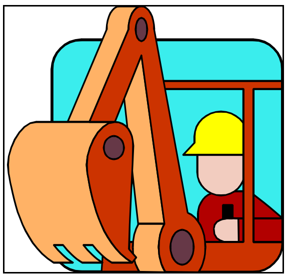
- Check that the fibre has unimpeded passage (measurement)
- Locate the exact position of the water sensor and record it in the event-table/ route plan. If location is not satisfactory, use a RTU/ OTDR with wider dynamic range or another type of instrument as necessary.
  (Advice obtainable from Wolf KT)

2. Labelling the joint-box



- Tape a label indicating the position of the water sensor onto the outside of the joint-box
- Place the joint-box inside the manhole in such a way that the sensor is at the lowest point
- Attach a warning sign to the joint-box

3. Filling the manhole



- Check again that the water sensor is at the bottom of the joint-box and that the warning sign on the top is clearly visible