opticalCON QUAD | **Technical Paper**

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Subject:

Mechanical, electrical and optical tests applied to the opticalCON transmission system for Pro Audio / Video and Broadcast purposes with main focus on changes in attenuation.

Optical performance is being examined with regard to attenuation and its variation vs. environmental and mechanical conditions.

This documentation describes the results of the test series conducted at Neutrik AG, University of Applied Sciences of Technology Buchs NTB

The tests were carried out in accordance with the IEC-Standard main groups IEC 60794 and IEC 61300 as well as to Neutrik internal specifications.

Content of Test Reports

1 Vibration

Object:

Examination of following components, receptacle NO4FDW, opticalCON QUAD NKO4* cable connector. The intention of the test was to determine their attenuation in a fiber optic system and the performance before, during and after the vibration test.

The test was carried out by an independent laboratory: NTB, "Interstaatliche Hochschule für Technik Buchs" division "Labor Mess- und Simulationstechnik" located in Buchs/ Switzerland.

Test Set-Up:

For the vibration test six receptacles NO4FDW were mounted. The front side was mated with a NO4MX opticalCON QUAD cable. The rear end was connected with the test instrument via precision measuring cables (fig. 2.a).

The applied test set-up complies with IEC 61300-2-1:2004.

Shaker:	Tira TV56263/LS-340 (Serial Nr. 001/09)
Floor cloth:	Dytran 3136A (Serial Nr. 1313)
Software:	Labworks Inc. Vibe Lab Pro (Version VL144x-4.0)
Interface:	VL144x-R02
Light source (1310nm): Light source (850nm):	09451106 09260003
Power Monitor: Power Meter:	#59451312 FOMD-FM-MM
Wavelength:	1310nm (single-mode) 850nm (multimode)
Frequency range:	10 – 55 Hz sinusoidal
Amplitude displacement:	1.52 mm (3.04 mm p-p)
Sweep rate:	2 min/cycle
Number of sweeps:	15
Axis:	X, Y, Z

1 Vibration (contd.)

After 15 cycles the receptacles were changed to the next axis without disconnecting the pugs to avoid any mismatching.

Test Results:

Measurement during vibrations showed no variation in attenuation. The locking mechanism withstands this extreme vibration without any problems, i. e. no separation or functional deteriorization occurred.

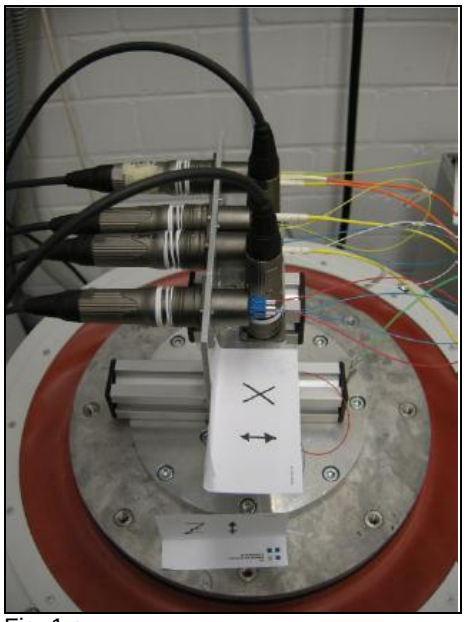

Fig. 1.a

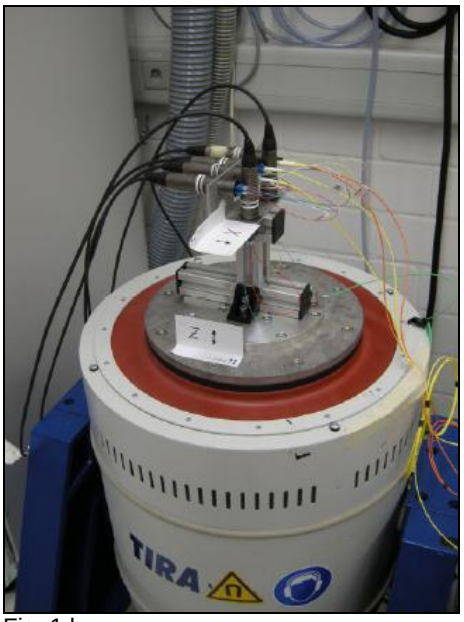

Fig. 1.b

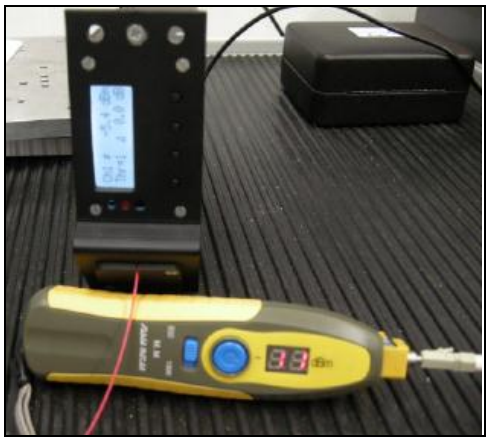

Fig. 1.c

Figure 1.a and 1.b exhibit the test setup for vibration test and figure 1.c the measuring equipment (power monitor, power meter) to monitor the attenuation during test procedure.

1 Vibration (contd.)

Object:

Examination of the sealing dust cover SCNO-FDW-R to analyze the performance and mechanical durability during defined vibration cycles.
The applied test set-up complies with IEC 61300-2-1:2004.

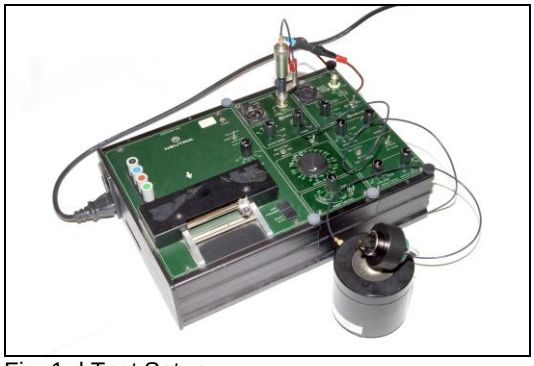

Fig. 1.d Test Setup

Vibration Severity:

Shaker:	Brüel&Kjaer Mini Shaker Type 4810 and Neutrik Frequency Generator
Frequency range:	10Hz – 18kHZ
Amplitude displacement:	1.75mm (3.5mm peak-peak) @ 40Hz
Test components:	NO2-4FDW-R (opticalCON QUAD chassis) SCNO-FDW-R (sealing dust cover)
Axis:	X, Y, Z

Test Results:

No reasonable mechanical degradation of the sealing dust cover during and after vibration test.

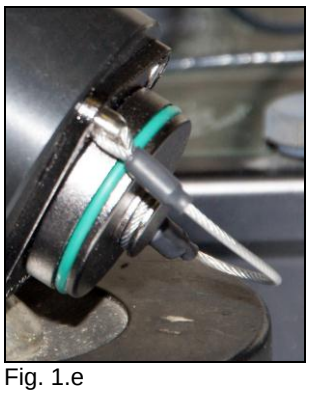

Fig. 1.e

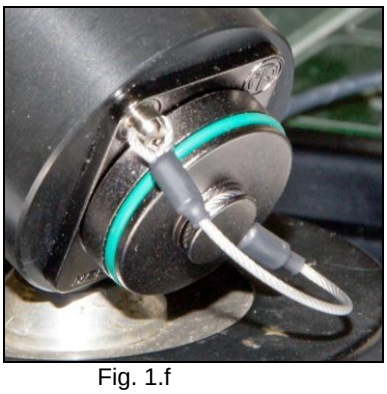

Fig. 1.f

2 Dust

Object:

Variations of attenuation due to massive dust penetration. The test was accomplished with single mode cables where pollution on the fiber is much more critical as on multimode fibers

The test was carried out by an independent laboratory: Electrosuisse, test laboratory PQ/PIK in 8320 Fehraltorf, Switzerland.

Test Set-Up:

The OpticalCON QUAD connector was exposed to dust from both sides in wired condition for 60 minutes. The built-in sealing shutters protected the optical conductor at the front side, the plugged-in LC-Duplex connectors shielded the rear side.

Test procedure according IEC 61753-1-1 Tab. A5 Test No.16 and IEC 61300-3-4

Receptacle:	NO4FDW
Particle size:	d < 150 µm
Dust type:	talcum powder
Temperature:	22.5°C
Relative humidity:	50%
Duration of penetration:	1 h
Launch cables:	LC/LC patch cables (single-mode)
Wavelength:	1550nm
Test Instruments:	light source EXFO FLS-600 power meter EXFO FPM-600

2 Dust (contd.)

Test Result:

Receptacle	Connection	Initial [dB]	After Dust test [dB]	Difference [dB]	Wavelength [nm]
BLUE	A -> B	0.19	0.27	0.08	1550
	B -> A	0.47	0.60	0.13	1550
	a -> b	0.27	0.29	0.02	1550
	b -> a	0.35	0.40	0.05	1550
GREEN	A -> B	0.07	0.12	0.05	1550
	B -> A	0.27	0.37	0.10	1550
	a -> b	0.14	0.14	0.00	1550
	b -> a	0.33	0.38	0.05.	1550

Fig. 2.a

The maximum difference between initial and after dust measuring of the insertion loss at 1550nm is 0.13dB. Additional visual inspection of the ferrule surface couldn't indicate essential soil remains.

Fig. 2.b

The measurement cables are covered with a plastic bag to avoid pollution on powermeter.

2 Dust (contd.)

Fig. 2.c

Figure 2.f and 2.g exhibit two opticalCON chassis NO4FDW with silicon gaskets SCDP*. On the rear side there are standard single-mode LC/LC patch cables plugged. To avoid dust on the ferrules, the unconnected LCs are sealed with a plastic bag.

Fig. 2.d

Fig. 2.e

After dust test: The opticalCON QUAD chassis NO4FDW are completely covered with talcum particle on the front and rear side (fig. 2.d and 2.e). The measured attenuation (figure 2.a) establishes only small variation of the attenuation values after dust test.

3 Change of Temperature

Object:

Variations in attenuation due to temperature changes.
The test was arranged with a single mode cable drum which is more critical than multimode fibers.

Test Set-Up:

Test procedure according to IEC 61300-2-22.
The test was realized in a temperature testing chamber type WEISS WK11-180/40.

Test cycles:	24h
Profile of temperature:	-45°C to +80°C
Light source:	EXFO FLS-600
Power meter	EXFO FPM-600
Launching cables:	0.9 mm precision fibres, assembled by H&S
Measuring wave lengths:	single mode at 1,310 nm
Cable length:	15 m on drum

3 Change of Temperature (contd.)

Test Result:

Time [h]	Attenuation [dB]	Return Loss [dB]
Start	0.11	54.8
2	0.16	61.1
4	0.18	61.6
6	0.18	62.0
8	0.17	61.5
10	0.18	62.2
12	0.19	62.2
14	0.18	62.2
16	0.18	61.7
18	0.16	61.1
20	0.15	61.1
22	0.18	61.5
24	0.19	61.6

Fig. 3.a

The attenuation varied from 0.11dB to maximum 0.19dB within 24 hours. The values are in the Neutrik's attenuation and return loss limits and so for field application with temperature variations suitable.

Temperature Profile:

4 Cable Retention

Object:

Test of the cable retention efficiency. The opticalCON QUAD cables NKO4* were exposed to tractive forces until the cable started to move.

Test Set-Up:

The applied test procedure is referred to IEC 61300-2-4.

Tension test device: Versa Test Mecmesin 0-1,000N

Force tester: AFG-R 1000N Mecmesin

cable type: NKO4S-R-0-5

Result:

Full automatic cable retention test according IEC 61300-2-4
The pulling force went over >500 N

Fig 4.a

The opticalCON QUAD cable is tested and approved for > 500N without any quality and function adverse effects.

5 Impact

Object:

The impact test is performed to show possible deformations or plug malfunction of the internal mechanism due to heavy mechanical exposure.

Test Set-Up:

The applied test procedure is referred to the IEC 61300-2-12 Method A pendulum drop

Test cable: NKO4S-R-0-5

1st part of test: front side of connector protected by a dirt protection (SCNKO4)
(protection cap is supplied with each assembled opticalCON cable)

2nd part of test : no additional connector protection

Parameters of Test:

Distance from centre of rotation:	2.25 m
Number of drops:	5
Height of falling:	1.0 – 1.9 m
Ground:	steel plate, thickness 25 mm
Plug fixation:	small wire

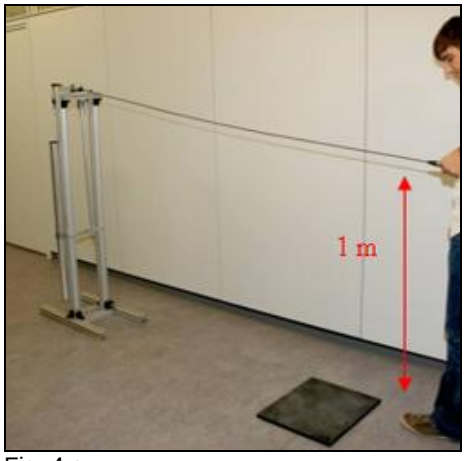

Fig. 4.a

Impact test with different heights
(1.0 - 1.9m) and steel plate.

5 Impact (contd.)

Results

Test #	With cap	Drop height [dB]	Drops	Result
1	Yes	1.0	5	No visible abrasion; full function
2	Yes	1.9	5	No visible abrasion; full function
3	Yes	1.0	5	No visible abrasion; full function
4	Yes	1.5	5	No visible abrasion; full function

Fig. 5.b

After several impact tests on different heights (1.0m - 1.9m) the opticalCON QUAD connector doesn't indicate any visual abrasion or mechanical damages.

6 Flexing

Object:

Variations of attenuation and mechanical damage of fiber optic cable due to a defined flexing procedure.

Test Set-Up:

Measurement of attenuation before, during and after flexing cycles.
Test procedure according to IEC 61300-2-44 in combination with IEC 61300-3-4

Test cycles:	1000 / 5000
Mass of weight:	10 N or 20 N depending on cable type
Flexing angle:	± 90°
Flexing speed:	ca. 12 cycles / min
Light source:	EXFO FLS-600
Power meter:	EXFO FPM-600
Launching cables:	0.9 mm precision fibers, assembled by H&S
Wavelength:	1310nm
Test cable:	NKO4S-R-0-5

Results

a) Change in attenuation:
Single mode 0.05 dB to 0.20 dB

b) Mechanical cable damage:
1,000 cycles: no damage
5,000 cycles: no significant damage

Fig. 6.a

7 Mating Durability

Object:

The mating durability test was carried out to show variations in attenuation (optical) and of electrical contact resistance after lifetime.

Test parameter:

NKO4S-R-0-1 (single mode 4 fibres)

Test Set-Up:

Test procedure according to IEC 61300-2-2 in combination with IEC 61300-3-4 figure 4 with mode filter as defined in table 3 for multimode, no mode filter for single-mode.
Contact resistance measurement according to IEC 60512-2.

Mating cycles:	500 (durability test) 5000 (lifetime test)	
Launching:	light source power meter	EXFO FLS-600 EXFO FPM-600
Microscope:	enlarged x 200	
Measuring cables:	0.9 mm precision fibres, assembled by H&S	
Measuring wave lengths:	single-mode	1310 nm
DUT cable length:	single-mode	1 m

Results:

500 cycles (durability test):
The microscopic assay didn't show any reasonable degradation. The attenuation values still fulfill Neutrik's internal requirements of < 0,5 dB/connection.
Single-mode: 0.32 dB degradation without cleaning, 0.25 dB degradation after cleaning

5000 cycles (lifetime test)
The visual inspection didn't show any reasonable degradation from the condition of the fiber (scratches, soil remains, outbreaks, etc.)
The functionality from the shutters as well as the locking mechanism is warranted.
During measuring procedure there are no significant variations.

Measuring	Before lifetime test	After lifetime test
Return Loss	57.6	56.2
Insertion Loss	0.21	0.39

7 Mating Durability (contd.)

500 cycles - Durability test

Fig. 7.a: measuring setup for durability and lifetime test

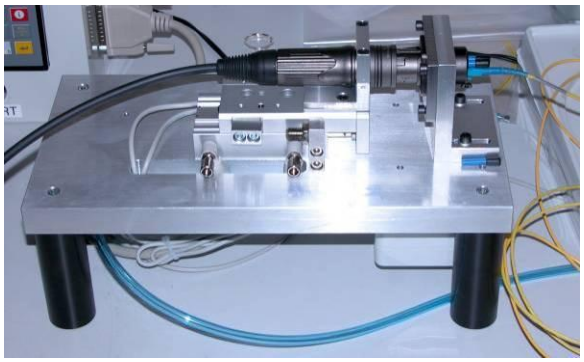
Fig. 7.b fixture for 500 and 5000 mating cycles.

Fiber condition

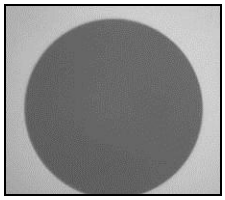
Fig. 7.c

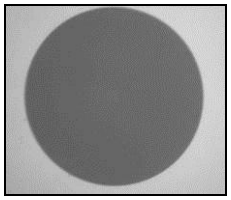
Fig. 7.d

- no visual degradation on all channels.
  no recenable soil remains or scratches.

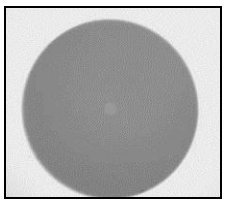
Fig. 7.e

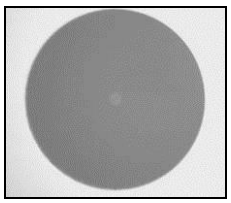
Fig. 7.f

7 Mating Durability (contd.)

5000 cycles - Lifetime test

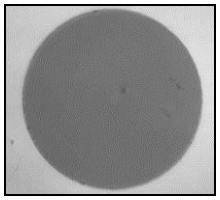
Fig. 7.g

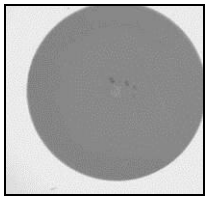
Fig. 7.h

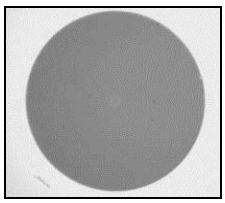
Fig. 7.i

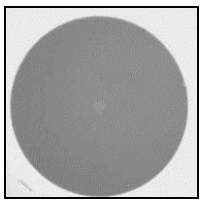
Fig. 7.j

All channels didn't indicate a significant degradation. Partly some soil remains around the core which has no reasonable influence of the measurement parameters.


Fig. 7.g

No mechanical degradations on the opticalCON QUAD cable connector.


Fig. 7.h

Proper functionality of the shutter and locking mechanism

8 Advanced Durability Test

Object:

The advanced durability test is performed to show possible deformations or plug malfunction of the internal mechanism due to heavy mechanical exposure after conditioning cabinet.

Test parameter:

opticalCON chassis: NO4FDW-R

Test Set-Up:

The opticalCON chassis NO4FDW-R stays 24 hours in the conditioning cabinet with defined temperature variations. After the temperature test procedure the opticalCON chassis starts a 5000 mating cycle test.

Mating cycles:	5000
Fixture:	internal mating cycle test fixture (see section 7)
cable	NKO4S-R-0-10
Conditioning cabinet:	WEISS WK11-180/40
Test temperatures:	-20°C / +75°C
Humidity:	10%
Duration:	24 hours

Results:

After 5000 mating cycles and temperature test the opticalCON chassis NO4FDW-R (figure 14) didn't show any significant deformations or mechanical malfunction. The greased O-ring didn't indicate any cracks or rough areas (figure 15).

Fig. 8: Test chassis NO4FDW-R

Fig. 9: O-ring after 5000 mating cycles

9 Cable Drum

Object:

Variations of attenuation and optical return loss (ORL) due to winding quality on cable drums.

First part of the test: attenuation measurement of perfectly wounded drum
Second part of test: attenuation measurement of unwinded cable
Third part of the test: spooling of the cable drum in a typical on stage manner,
i. e. with a lot of crossed cable windings; attenuation measurement

Test Set-Up:

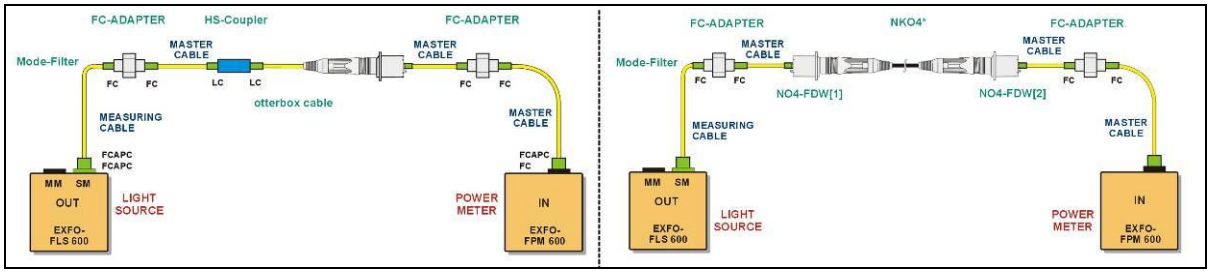

Figure 10

Parameters:

Drum assembly: NKO4S-R-3-300
Cable length: 300 m
Wave length: 1310 nm

Results:

First test (spooled cable drum):

Channel	Insertion Loss [dBm]	Optical Return Loss [dB]
A	0.22	57.3
B	0.36	56.4
a	0.28	59.6
b	0.35	59.8

Second test (unwinded cable drum): change in attenuation - 0.06 dB to - 0.09dB

Third test (spooled cable drum): increase of initial attenuation + 0.03 dB
to + 0.1 dB.