Technical Paper | opticalCON® QUAD

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Content

Technical Paper – opticalCON **QUAD**
Title: NTP05

Subject:

Mechanical and optical tests applied to the opticalCON® transmission system for Pro Audio / Video industry 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 and 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.

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1 Optical Attenuation

Object:

Examination of following components, receptacle NO4FDW-A, 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-A were mounted. The front side was mated with a NKO4M* 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 (1310 nm):	09451106	
Light source (850 nm):	09260003	
Power Monitor:	#59451312	
Power Meter:	FOMD-FM-MM	
Wavelength:	1.310 nm	single-mode
	850 nm	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	

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

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.

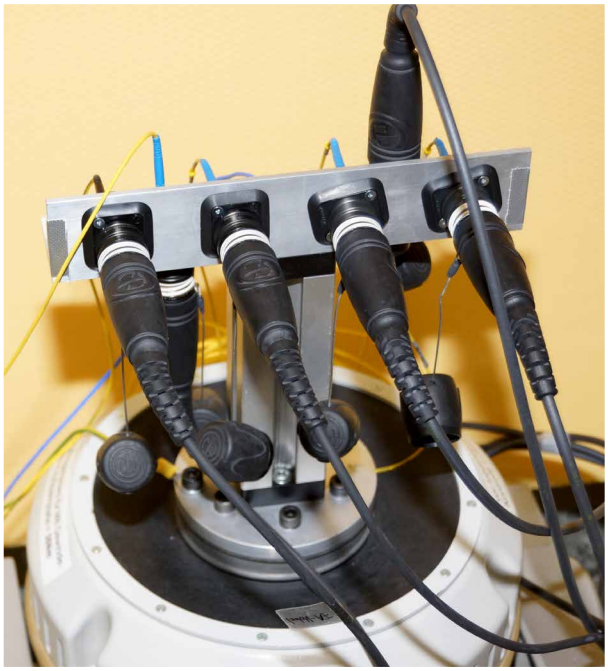

figure 1.a

figure 1.b

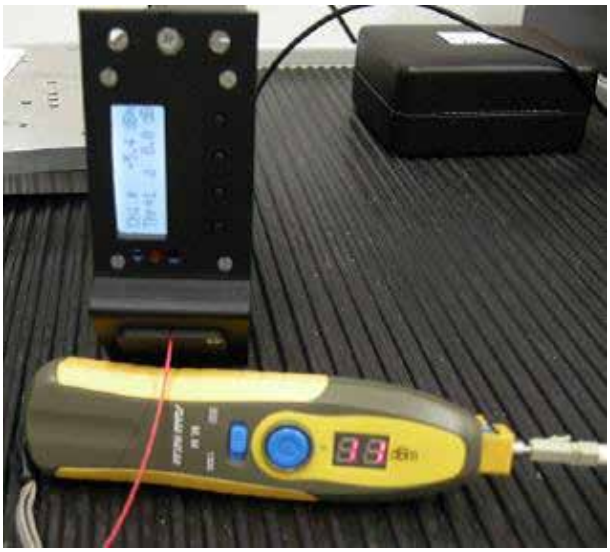

figure 1.c

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.

Object:

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

figure 1.d: Test Setup

Vibration Severity:

Shaker:	Brüel&Kjaer Mini Shaker Type 4810 and Neutrik Frequency Generator
Frequency range:	10 Hz – 18 kHz
Amplitude displacement:	1.75 mm (3.5 mm peak-peak) @ 40Hz
Test components:	NO4FDW-A (opticalCON QUAD chassis) SCNO-FDW-A (sealing dust cover)
Axis:	X, Y, Z

Test Results:

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

figure 1.e

figure 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-A	
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:	1.550 nm	
Test Instruments:	EXFO FLS-600	light source
	EXFO FPM-600	power meter

Results:

RECEPTACLE	CONNECTION	INITIAL [dB]	AFTER DUST TEST [dB]	DIFFERENCE [dB]	WAVELENGTH [nm]
BLUE	A → B	0.19	0.27	0.08	1.550
	B → A	0.47	0.60	0.13	1.550
	a → b	0.27	0.29	0.02	1.550
	b → a	0.35	0.40	0.05	1.550
GREEN	A → B	0.07	0.12	0.05	1.550
	B → A	0.27	0.37	0.10	1.550
	a → b	0.14	0.14	0.00	1.550
	b → a	0.33	0.38	0.05	1.550

The maximum difference between initial and after dust measuring of the insertion loss at 1.550 nm is 0.13 dB. Additional visual inspection of the ferrule surface couldn't indicate essential soil remains.

The measurement cables (figure 2.b) are covered with a plastic bag to avoid pollution on powermeter.

< figure 2.b

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

< figure 2.c

figure 2.d

figure 2.e

After dust test: The opticalCON QUAD chassis NO4FDW-A 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:	24 h	
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:	1.310 nm	single mode
Cable length:	15 m	on drum

Test Results:

TIME [h]	ATTENTUATION[dB]	RETURN LOSS [dB]	TIME [h]	ATTENTUATION[dB]	RETURN LOSS [dB]
Start	0.11	54.8	**14**	0.18	62.2
2	0.16	61.1	**16**	0.18	61.7
4	0.18	61.6	**18**	0.16	61.1
6	0.18	62.0	**20**	0.15	61.1
8	0.17	61.5	**22**	0.18	61.5
10	0.18	62.2	**24**	0.19	61.6
12	0.19	62.2			

figure 3.a

The attenuation varied from 0.11 dB to maximum 0.19 dB 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:

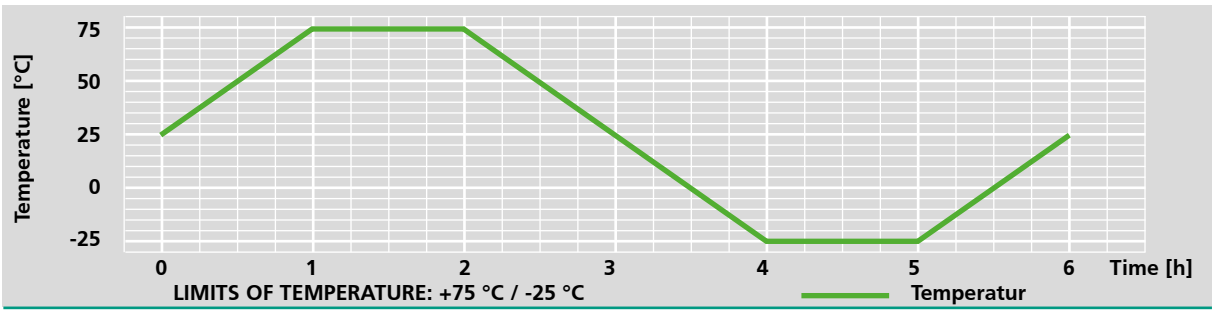

figure 3.a: Increase of the IL due to temperature change

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 – 1.000 N
Force tester:	AFG-R 1.000 N Mecmesin
Cable type:	NKO4S-A-0-5

Results:

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

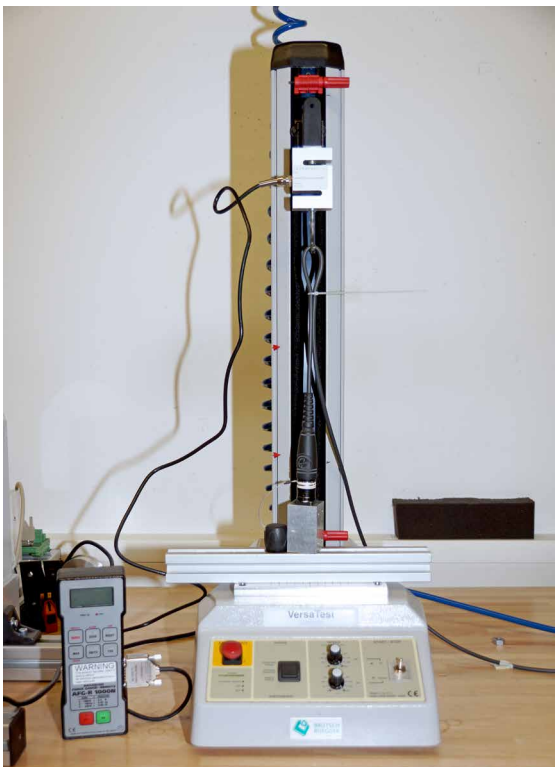

figure 4.a

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

The opticalCON QUAD cable is tested and approved for > 500 N 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-A-0-5
1st part of test:	front side of connector protected by a dirt protection (SCNO-FDW-A) (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

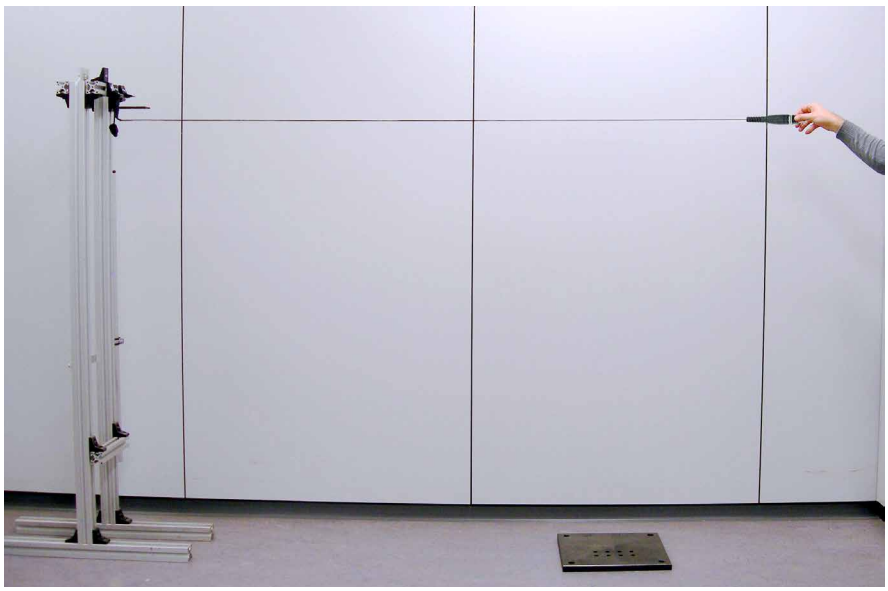

figure 5.a
Impact test with different heights (1.0 m - 1.9 m) and steel plate.

Results:

TEST #	with cap	drop heigh [m]	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

figure 5.b

After several impact tests on different heights (1.0 - 1.9 m) 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:	1.000 / 5.000
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:	1.310 nm
Test cable:	NKO4S-A-0-5

Results

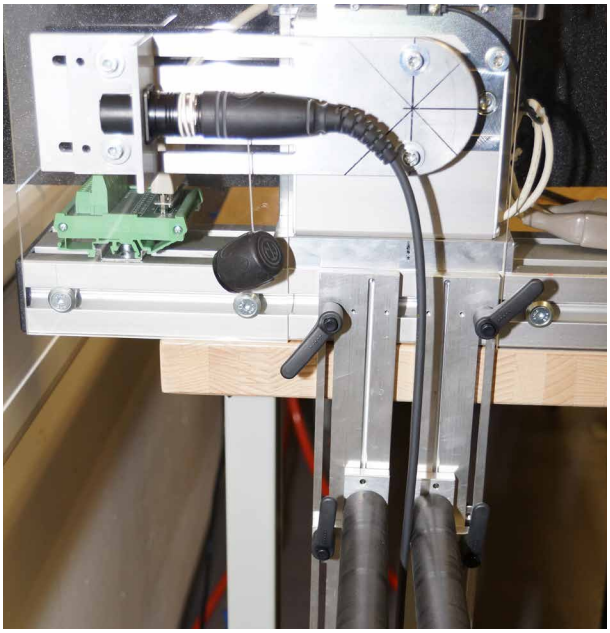

figure 6.a

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

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-A-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)	
	5.000 (lifetime test)	
Launching:	EXFO FLS-600	light source
	EXFO FPM-600	power meter
Microscope:	enlarged x 200	
Measuring cables:	0.9 mm precision fibres, assembled by H&S	
Measuring wave lengths:	1.310 nm	single-mode
DUT cable length:	1 m	single-mode

Results:

500 cycles (durability test):

The microscopic assay didn't show any reasonable degradation. The attenuation values still fulfill Neutrik's internal requirements of < 0,45 dB/connection.
Single-mode: 0.32 dB degradation without cleaning, 0.25 dB degradation after cleaning

5.000 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	BEFOREE LIFETIME TEST [dB]	AFTER LIFETIME TEST [dB]
Return Loss	57.6	56.2
Insertion Loss	0.21	0.39

500 cycles - Lifetime test

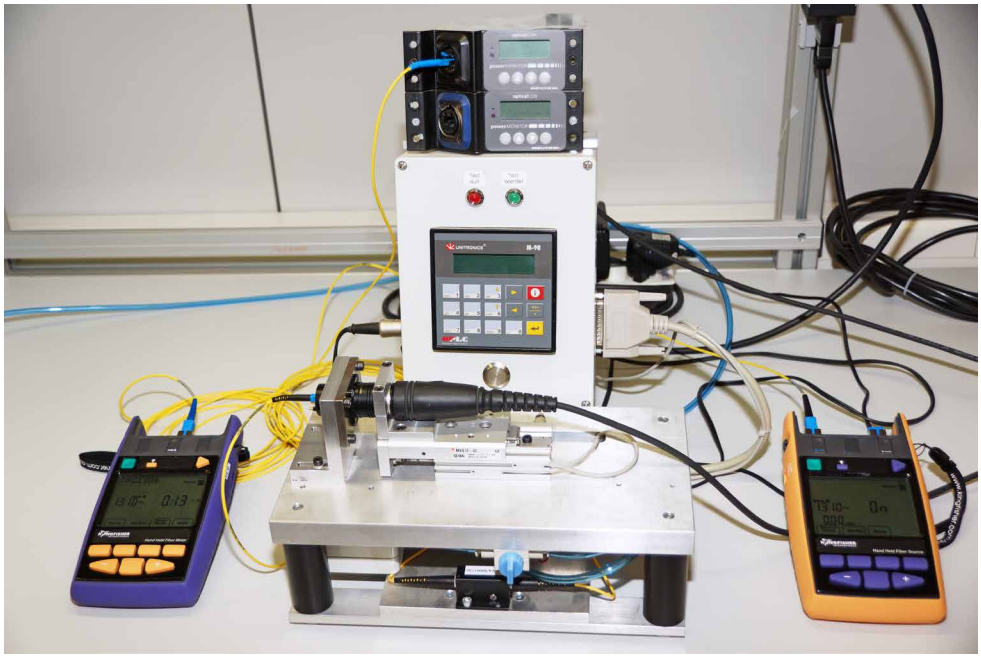

figure 7.a: measuring setup for durability and lifetime test

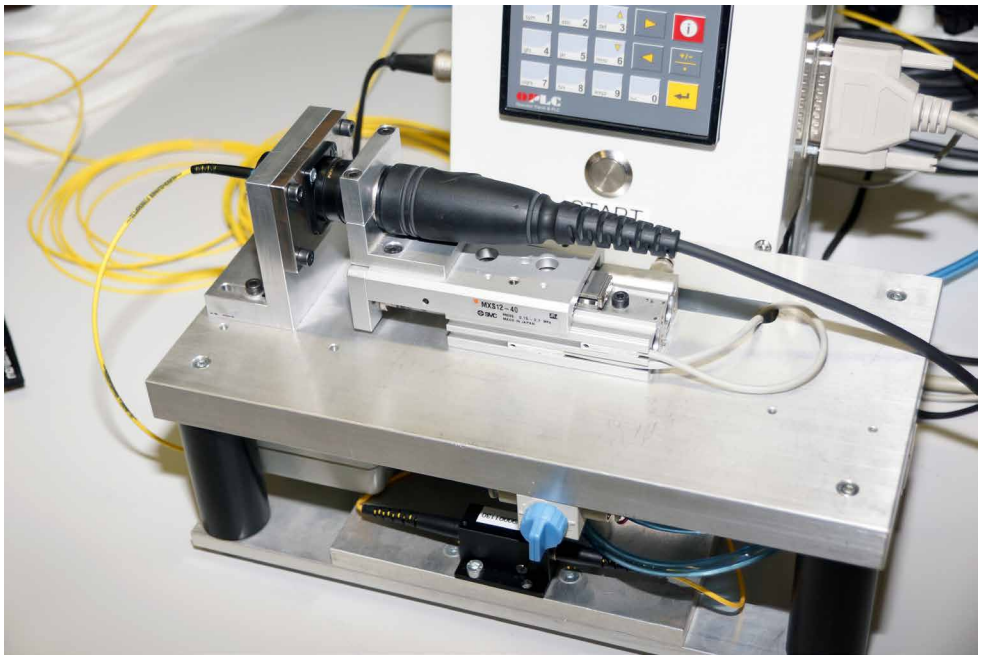

figure 7.b: fixture for 500 and 5.000 mating cycles

Fiber condition

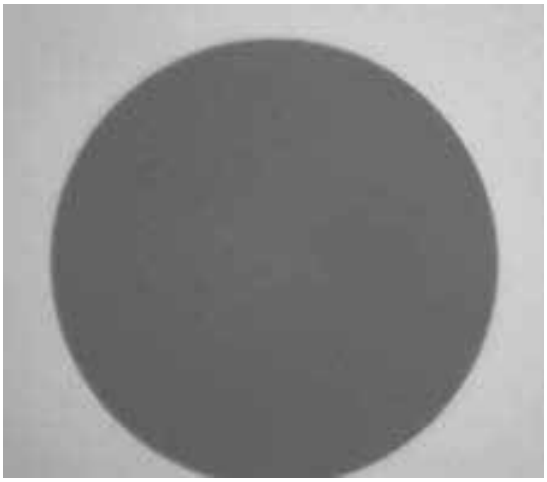

figure 7.c

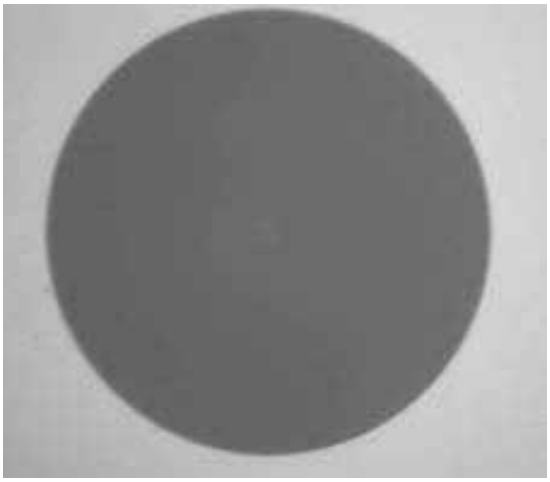

figure 7.d

figure 7.e

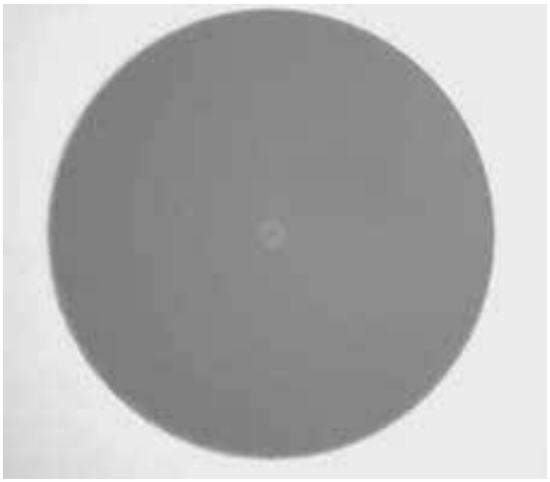

figure 7.f

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

5.000 cycles - Lifetime test

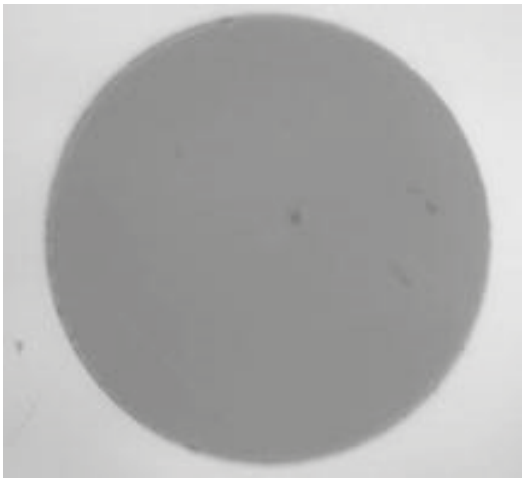

figure 7.g

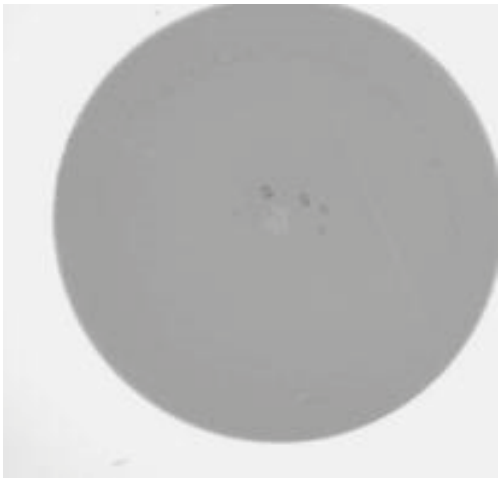

figure 7.h

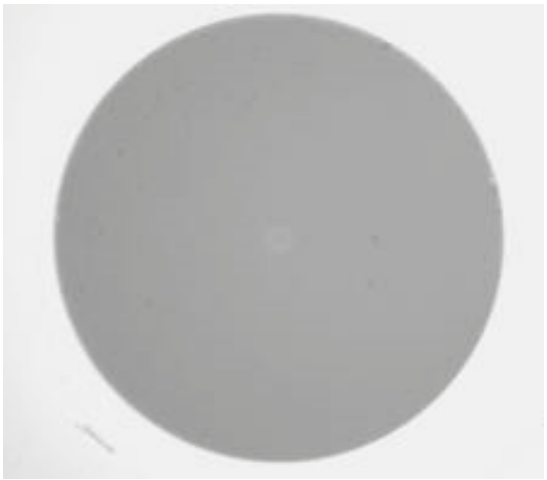

figure 7.i

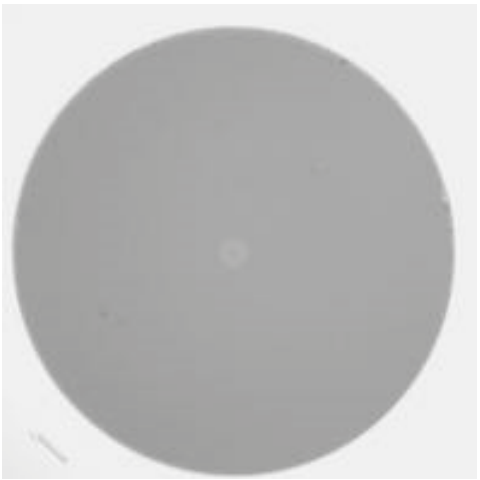

figure 7.j

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

No mechanical degradations on the opticalCON QUAD cable connector.

figure 7.k

Proper functionality of the shutter and locking mechanism

figure 7.l

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-A

Test Set-Up:

The opticalCON chassis NO4FDW-A stays 24 hours in the conditioning cabinet with defined temperature variations. After the temperature test procedure the opticalCON chassis starts a 5.000 mating cycle test.

Mating cycles:	5.000
Fixture:	internal mating cycle test fixture (see section 7)
Cable	NKO4S-A-0-10
Conditioning cabinet:	WEISS WK11-180/40
Test temperatures:	-20 °C / +75 °C
Humidity:	10 %
Duration:	24 h

Results:

After 5.000 mating cycles and temperature test the opticalCON chassis NO4FDW-A (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).

figure 8: Test chassis NO4FDW-A

figure 9: O-ring after 5.000 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:

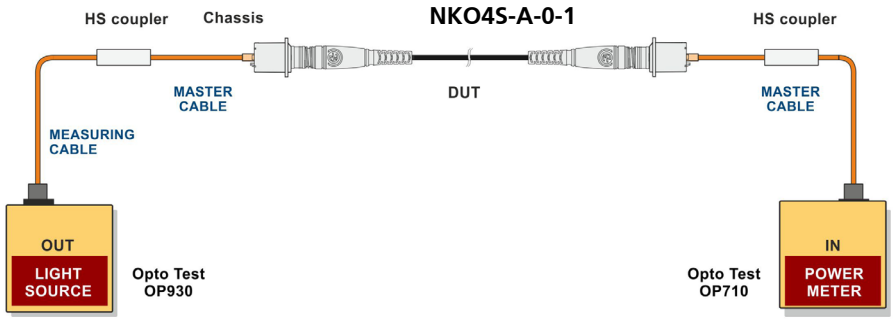

figure 10

Parameters:

Drum assembly:	NKO4S-A-3-300
Cable length:	300 m
Wave length:	1.310 nm

Results:

First test (spooled cable drum):

CHANNELS	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 - 0.09 dB

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

Liechtenstein (Headquarters)
NEUTRIK AG, Im alten Riet 143, 9494 Schaan
T +423 237 24 24, F +423 232 53 93, neutrik@neutrik.com

Germany / Netherlands / Denmark / Austria
Neutrik Vertriebs GmbH, Felix-Wankel-Strasse 1, 85221 Dachau, Germany
T +49 8131 28 08 90, info@neutrik.de

Great Britain
Neutrik (UK) Ltd., Westridge Business Park, Cothey Way
Ryde, Isle of Wight PO33 1 QT
T +44 1983 811 441, sales@neutrik.co.uk

France
Neutrik France SARL, Rue du Parchamp 13, 92100 Boulogne-Billancourt
T +33 1 41 31 67 50, info@neutrik.fr

USA
Neutrik USA Inc., 4115 Taggart Creek Road, Charlotte, North Carolina, 28208
T +1 704 972 30 50, info@neutrikusa.com

Japan
Neutrik Limited, Yusen-Higashinihonbashi-Ekimae Bldg., 3-7-19
Higashinihonbashi, Chuo-ku, Tokyo 103
T +81 3 3663 47 33, mail@neutrik.co.jp

Hong Kong
Neutrik Hong Kong LTD., Suite 18, 7th Floor Shatin Galleria
Fotan, Shatin
T +852 2687 6055, neutrik@neutrik.com.hk

China
Ningbo Neutrik Trading Co., Ltd., Shiqi Street, Yinxian Road West
Fengjia Villiage, Yinzhou Area, Ningbo, Zhejiang, 315153
T +86 574 88250488 800, neutrik@neutrik.com.cn

India
Neutrik India Pvt. Ltd., Level 3, Neo Vikram, New Link Road,
Above Audi Show Room, Andheri West, Mumbai, 400058
T +91 982 05 43 424, anklesaria@neutrik.com

Associated companies

Contrik AG
Steinackerstrasse 35, 8902 Urdorf, Switzerland
T +41 44 736 50 10, contrik@contrik.ch

H. Adam GmbH
Felix-Wankel-Straße 1, 85221 Dachau, Germany
T +49 08131 28 08-0, info@adam-gmbh.de

www.neutrik.com

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