

**DIAMOND**

**Test & Calibration Laboratory STS 0333 / SCS 0101**

# Product Specification Qualification Test Report



**HE-2000 SM APC 4 ch**

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1) Edition: This column states the date of the Qualification

2) Requalified: This column states the date of the Requalification

The present Qualification Test Report (QTR) summarizes the qualification measurements and tests performed to verify the design and the optical, mechanical and environmental performance of the HE-2000 SM APC 4 channels connector at the accredited test & calibration laboratory STS 0333 / SCS 0101 at Diamond SA, Losone. This current QTR is a summary of the internal qualification reports no. 2974, no. 3191 and no. 3293 performed at the test & calibration laboratory STS 0333 / SCS 0101 ([www.sas.ch](http://www.sas.ch)).

The qualified product is subject to periodic requalification with the purpose of guaranteeing the product compliance to the specifications measured in the present report over the years.

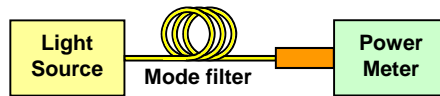
For requalification purposes the principle of similarity is applied, where the qualification data of similar products can be used if they meet the same technology platform and are manufactured using the same process.

For additional information, please contact Diamond or your Diamond Sales Representative.

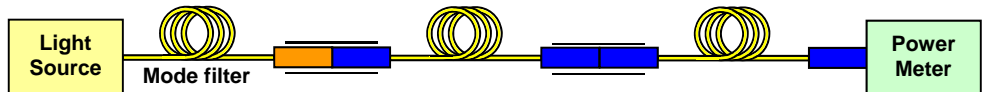
## Insertion loss

**Methods:** Method B according to IEC 61300-3-4

a) Reference measurement:



b) DUT measurement:



**Requirements:**  $IL_{Max} \leq 0.45$  dB

**Samples:**

- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
- Cable/fibre type:
  - Multi-fibre cable 4x9/125/500/900/5500  $\mu$ m, Diamond art. no. 1027987
  - Fibre 9/125/245/900  $\mu$ m, Diamond art. no. 1005155
- Reference connectors: 1 Diamond E-2000™ APC SM reference connector

**Parameters:**

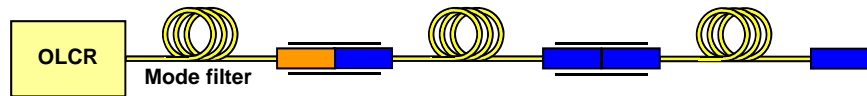
- Wavelengths: 1310 nm / 1550 nm
- No. of measurements: 48

**Results:**

Statistics	Insertion loss IL against reference connector [dB]	
	at 1310 nm	at 1550 nm
Mean value	0.15	0.13
Standard deviation	0.05	0.05
Maximum value	0.28	0.29
Minimum value	0.08	0.06

## Return loss

**Methods:** OLCR method according to IEC 61300-3-6



**Requirements:**  $RL_{Min} \geq 75$  dB

**Samples:**

- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
- Cable/fibre type:
  - Multi-fibre cable 4x9/125/500/900/5500  $\mu$ m, Diamond art. no. 1027987
  - Fibre 9/125/245/900  $\mu$ m, Diamond art. no. 1005155
- Reference connectors: 1 Diamond E-2000™ APC SM reference connector

**Parameters:**

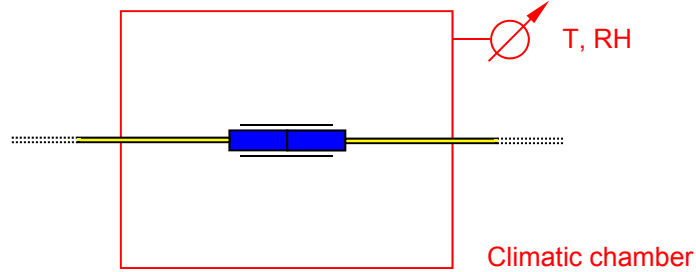
- Wavelengths: 1550 nm
- No. of measurements: 24

**Results:**

Statistics	Return loss RL against reference connector [dB]
	at 1550 nm
Mean value	90.0
Standard deviation	3.4
Maximum value	95.0
Minimum value	84.0

## Change of temperature

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Change of temperature test according to IEC 61300-2-22



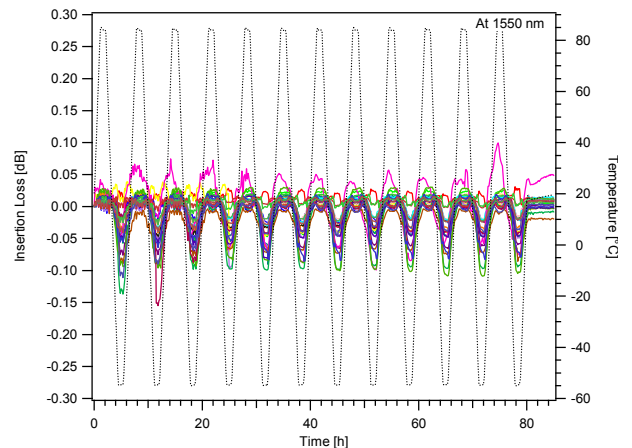
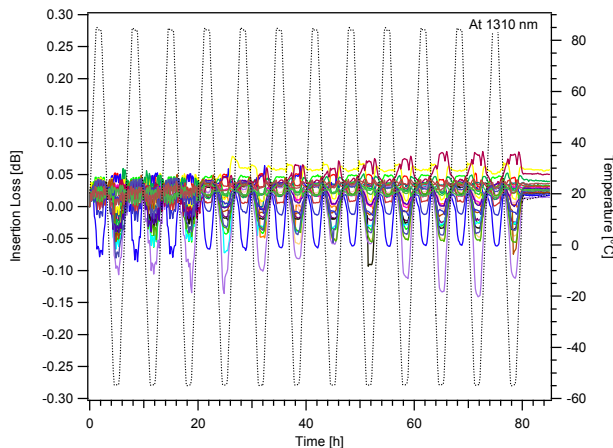
**Requirements:**  $\Delta IL_{Max} \leq 0.30$  dB during test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu$ m, Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu$ m, Diamond art. no. 1005155

- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 24
  - Upper cycling temperature: +85°C
  - Lower cycling temperature: -55°C
  - Relative humidity: Not controlled
  - Dwell time at extreme temperatures: 1 h
  - Variation of temperature at slopes: 1°C/min
  - Number of cycles: 12
  - Duration: 80 h

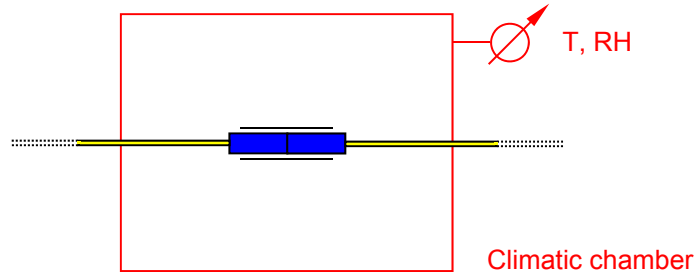
**Results:**

Statistics	Variation of insertion loss $\Delta IL$ during test [dB]	
	at 1310 nm	at 1550 nm
Maximum value	0.18	0.20
Minimum value	0.03	0.02



## Low temperature

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - low temperature test according to MIL-STD-810G, method 502.5, procedure II



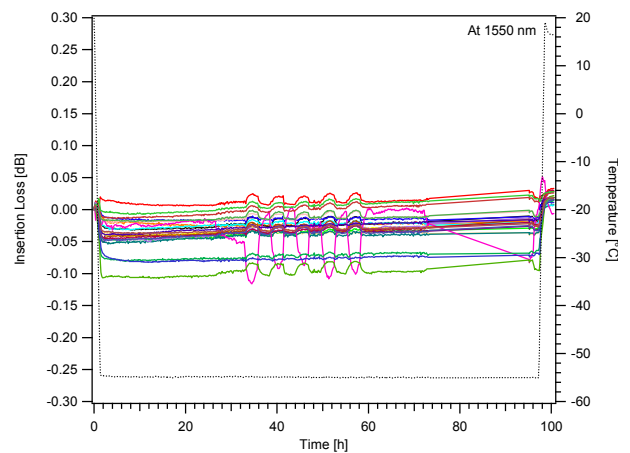
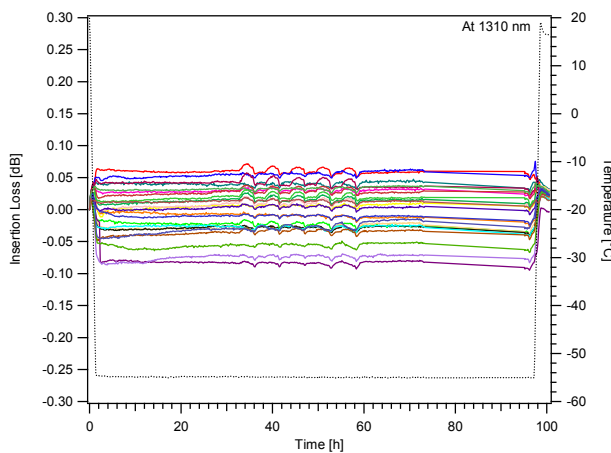
**Requirements:**  $\Delta IL_{Max} \leq 0.30$  dB during test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 24
  - Constant temperature: -55°C
  - Relative humidity: Not controlled
  - Duration: 96 h

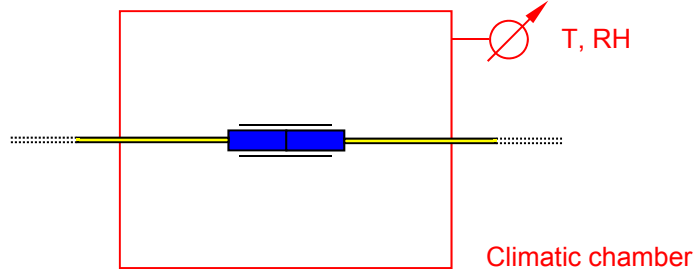
**Results:**

Statistics	Variation of insertion loss $\Delta IL$ during test [dB]	
	at 1310 nm	at 1550 nm
Maximum value	0.12	0.17
Minimum value	0.02	0.03



## High temperature

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - High temperature test according to MIL-STD-810G, method 501.5, procedure II



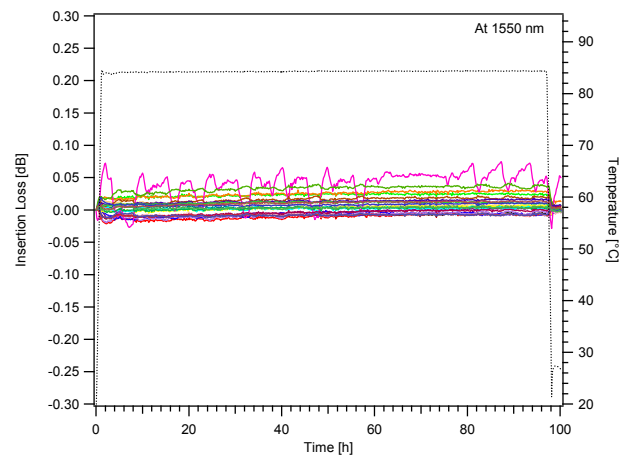
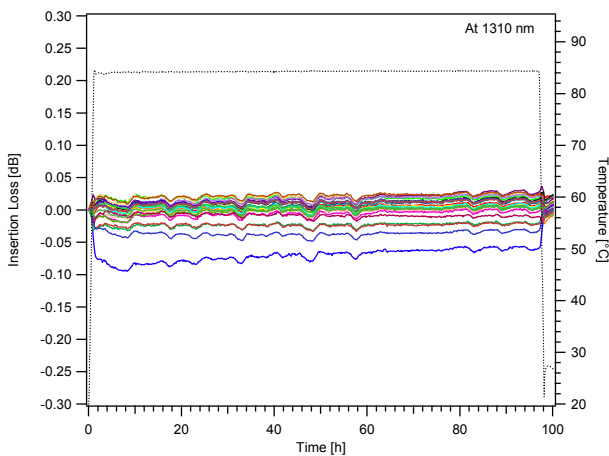
**Requirements:**  $\Delta IL_{Max} \leq 0.30$  dB during test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 24
  - Constant temperature: +85°C
  - Relative humidity: Not controlled
  - Duration: 96 h

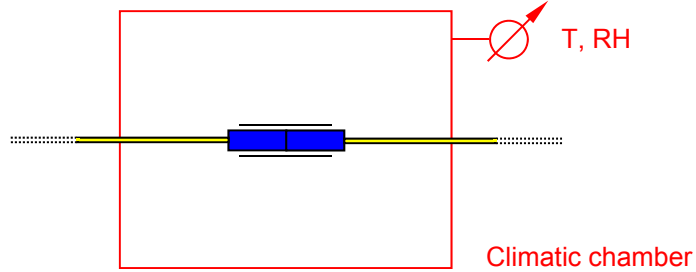
**Results:**

Statistics	Variation of insertion loss $\Delta IL$ during test [dB]	
	at 1310 nm	at 1550 nm
Maximum value	0.11	0.10
Minimum value	0.02	0.01



# Humidity

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Humidity test according to MIL-STD-810G, method 507.5, procedure II



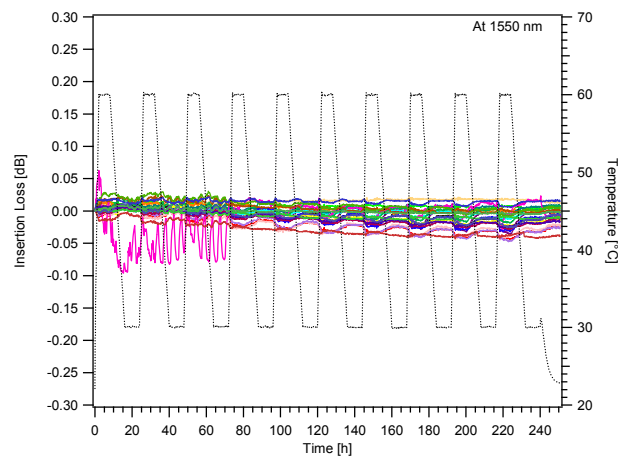
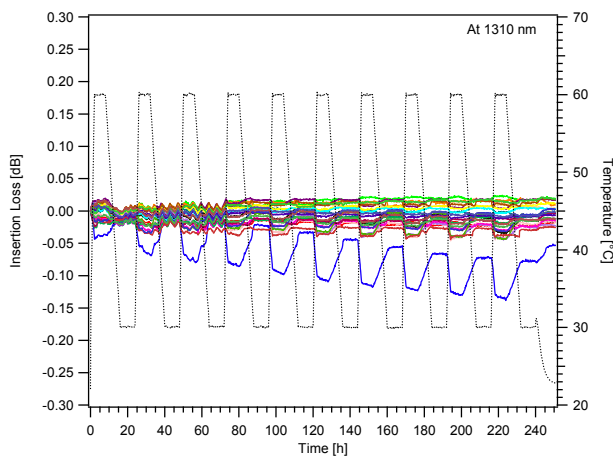
**Requirements:**  $\Delta IL_{Max} \leq 0.30$  dB during test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu$ m, Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu$ m, Diamond art. no. 1005155

- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 24
  - Upper cycling temperature: +60°C
  - Lower cycling temperature: +30°C
  - Relative humidity: 95% r.h.
  - Duration of cycle: 24 h
  - Number of cycles: 10
  - Duration: 240 h

**Results:**

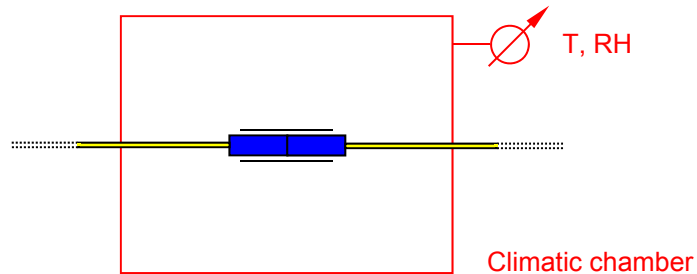
Statistics	Variation of insertion loss $\Delta IL$ during test [dB]	
	at 1310 nm	at 1550 nm
Maximum value	0.14	0.16
Minimum value	0.02	0.02





## Temperature shock

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Temperature shock test according to MIL-STD-810G, method 503.5, procedure I-C



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB before/after test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

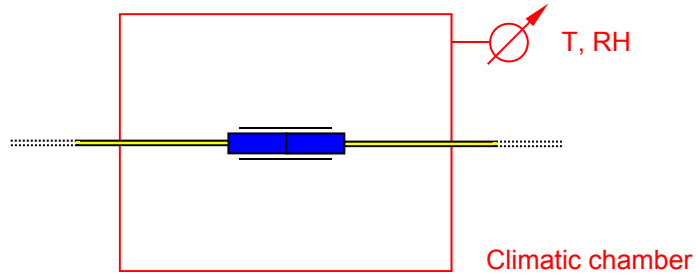
- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 24
  - Upper cycling temperature: +85°C
  - Lower cycling temperature: -55°C
  - Dwell time at extreme temperatures: 30 min.
  - Transfer time: < 1 min.
  - Number of cycles: 10
  - Duration: 10 h

**Results:**

Sample no.		Insertion loss IL [dB]				Variation of insertion loss $\Delta$ IL before / after test [dB]	
		before test		after test		at 1310 nm	at 1550 nm
		at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm		
1	Channel 1	0.09	0.07	0.14	0.10	0.05	0.03
	Channel 2	0.13	0.14	0.12	0.09	0.01	0.05
	Channel 3	0.17	0.16	0.21	0.19	0.04	0.03
	Channel 4	0.20	0.16	0.30	0.19	0.10	0.03
2	Channel 1	0.06	0.06	0.10	0.06	0.04	0.00
	Channel 2	0.11	0.13	0.17	0.15	0.06	0.02
	Channel 3	0.16	0.14	0.21	0.17	0.05	0.03
	Channel 4	0.36	0.27	0.44	0.26	0.08	0.01
3	Channel 1	0.28	0.34	0.28	0.32	0.00	0.02
	Channel 2	0.13	0.13	0.12	0.10	0.01	0.03
	Channel 3	0.06	0.08	0.07	0.07	0.01	0.01
	Channel 4	0.19	0.17	0.19	0.15	0.00	0.02
4	Channel 1	0.12	0.15	0.15	0.17	0.03	0.02
	Channel 2	0.23	0.18	0.21	0.16	0.02	0.02
	Channel 3	0.14	0.18	0.14	0.15	0.00	0.03
	Channel 4	0.25	0.20	0.25	0.17	0.00	0.03
5	Channel 1	0.18	0.15	0.16	0.12	0.02	0.03
	Channel 2	0.11	0.12	0.09	0.08	0.02	0.04
	Channel 3	0.26	0.26	0.27	0.23	0.01	0.03
	Channel 4	0.19	0.12	0.15	0.09	0.04	0.03
6	Channel 1	0.12	0.12	0.11	0.13	0.01	0.01
	Channel 2	0.19	0.13	0.17	0.10	0.02	0.03
	Channel 3	0.10	0.12	0.10	0.08	0.00	0.04
	Channel 4	0.23	0.14	0.21	0.11	0.02	0.03
<b>Maximum value</b>						<b>0.10</b>	<b>0.05</b>
<b>Minimum value</b>						<b>0.00</b>	<b>0.00</b>

## Low pressure / Altitude

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Low pressure / Altitude test according to MIL-STD-810G, method 500.5, procedure I



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB before/after test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

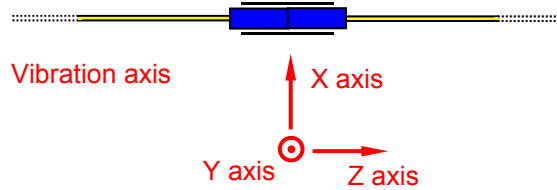
- Parameters:**
- Pressure: 110 mbar
  - Simulated altitude: 50'000 ft / 15'240 m
  - Temperature: ambient
  - Relative humidity: not controlled
  - Duration: 8 h

## Results:

Sample no.		Insertion loss IL [dB]				Variation of insertion loss $\Delta$ IL before / after test [dB]	
		before test		after test		at 1310 nm	at 1550 nm
		at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm		
1	Channel 1	0.12	0.09	0.09	0.05	0.03	0.04
	Channel 2	0.21	0.19	0.19	0.14	0.02	0.05
	Channel 3	0.30	0.19	0.22	0.19	0.08	0.00
	Channel 4	0.10	0.06	0.05	0.03	0.05	0.03
2	Channel 1	0.17	0.15	0.11	0.11	0.06	0.04
	Channel 2	0.21	0.17	0.17	0.12	0.04	0.05
	Channel 3	0.44	0.26	0.40	0.26	0.04	0.00
	Channel 4	0.28	0.32	0.32	0.34	0.04	0.02
3	Channel 1	0.12	0.10	0.13	0.09	0.01	0.01
	Channel 2	0.07	0.07	0.05	0.04	0.02	0.03
	Channel 3	0.19	0.15	0.19	0.16	0.00	0.01
	Channel 4	0.15	0.17	0.11	0.09	0.04	0.08
4	Channel 1	0.21	0.16	0.24	0.16	0.03	0.00
	Channel 2	0.14	0.15	0.14	0.16	0.00	0.01
	Channel 3	0.25	0.17	0.23	0.17	0.02	0.00
	Channel 4	0.16	0.12	0.16	0.12	0.00	0.00
5	Channel 1	0.09	0.08	0.07	0.06	0.02	0.02
	Channel 2	0.27	0.23	0.26	0.24	0.01	0.01
	Channel 3	0.15	0.09	0.15	0.10	0.00	0.01
	Channel 4	0.11	0.13	0.13	0.12	0.02	0.01
6	Channel 1	0.17	0.10	0.14	0.10	0.03	0.00
	Channel 2	0.10	0.08	0.13	0.11	0.03	0.03
	Channel 3	0.21	0.11	0.19	0.11	0.02	0.00
	Channel 4	0.12	0.09	0.09	0.05	0.03	0.04
<b>Maximum value</b>						<b>0.08</b>	<b>0.08</b>
<b>Minimum value</b>						<b>0.00</b>	<b>0.00</b>

## Vibration, sinusoidal

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Sinusoidal vibration test according to MIL-STD-202G, method 204D, condition B



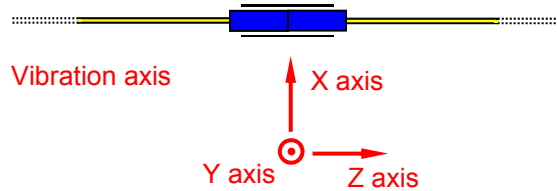
- Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB during test
- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155
- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 12 continuously  
24 before / after test
  - Upper vibration frequency: 2'000 Hz
  - Lower vibration frequency: 10 Hz
  - Constant amplitude (peak-to-peak): 1.52 mm (from 10 Hz to 70 Hz)
  - Constant acceleration: 15 G (from 70 Hz to 2'000 Hz)
  - Sweep rate: 1 Oct/min
  - Sweep cycles: 12
  - Duration per axis: 3 h
  - Vibration axis: X (transversal axis) / Z (longitudinal axis)

Results:

Sample no.	Vibration axis	Insertion loss IL [dB]								Variation of insertion loss $\Delta$ IL during test [dB]		
		before test		minimum, during test		maximum, during test		after test		at 1310 nm	at 1550 nm	
		at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm			
1	Channel 1	X	0.07	0.09	0.07	0.07	0.07	0.09	0.07	0.08	0.00	0.02
		Z	0.08	0.08	0.08	0.07	0.09	0.08	0.08	0.08	0.01	0.01
	Channel 2	X	0.06	0.10	0.03	0.10	0.06	0.12	0.06	0.12	0.03	0.02
		Z	0.08	0.12	0.07	0.12	0.08	0.13	0.07	0.12	0.01	0.01
	Channel 3	X	0.09	0.14	-	-	-	-	0.09	0.13	0.00	0.01
		Z	0.16	0.13	-	-	-	-	0.11	0.15	0.05	0.02
	Channel 4	X	0.15	0.14	-	-	-	-	0.15	0.13	0.00	0.01
		Z	0.20	0.15	-	-	-	-	0.16	0.14	0.04	0.01
2	Channel 1	X	0.06	0.08	0.06	0.08	0.07	0.08	0.06	0.08	0.01	0.00
		Z	0.07	0.06	0.07	0.06	0.07	0.06	0.07	0.06	0.00	0.00
	Channel 2	X	0.11	0.12	0.11	0.12	0.13	0.13	0.12	0.12	0.02	0.01
		Z	0.14	0.12	0.11	0.12	0.14	0.13	0.12	0.11	0.03	0.02
	Channel 3	X	0.17	0.13	-	-	-	-	0.19	0.14	0.02	0.01
		Z	0.18	0.11	-	-	-	-	0.16	0.14	0.02	0.03
	Channel 4	X	0.38	0.25	-	-	-	-	0.40	0.27	0.02	0.02
		Z	0.40	0.24	-	-	-	-	0.39	0.25	0.01	0.01
3	Channel 1	X	0.28	0.35	0.28	0.34	0.28	0.35	0.28	0.34	0.00	0.01
		Z	0.30	0.35	0.29	0.34	0.30	0.35	0.28	0.34	0.02	0.01
	Channel 2	X	0.11	0.11	0.11	0.11	0.14	0.11	0.13	0.11	0.03	0.00
		Z	0.13	0.15	0.13	0.13	0.14	0.14	0.11	0.13	0.03	0.02
	Channel 3	X	0.05	0.07	-	-	-	-	0.07	0.07	0.02	0.00
		Z	0.06	0.09	-	-	-	-	0.04	0.09	0.02	0.00
	Channel 4	X	0.18	0.16	-	-	-	-	0.19	0.17	0.01	0.01
		Z	0.18	0.16	-	-	-	-	0.17	0.17	0.01	0.01
4	Channel 1	X	0.07	0.08	0.07	0.07	0.08	0.08	0.07	0.07	0.01	0.01
		Z	0.07	0.08	0.08	0.06	0.08	0.06	0.07	0.06	0.01	0.02
	Channel 2	X	0.22	0.19	0.21	0.19	0.23	0.22	0.22	0.22	0.02	0.03
		Z	0.23	0.19	0.22	0.19	0.23	0.19	0.21	0.18	0.02	0.01
	Channel 3	X	0.13	0.18	-	-	-	-	0.13	0.19	0.00	0.01
		Z	0.13	0.18	-	-	-	-	0.10	0.17	0.03	0.01
	Channel 4	X	0.27	0.24	-	-	-	-	0.27	0.24	0.00	0.00
		Z	0.27	0.24	-	-	-	-	0.23	0.23	0.04	0.01
5	Channel 1	X	0.15	0.15	0.14	0.13	0.16	0.17	0.16	0.14	0.02	0.04
		Z	0.13	0.11	0.13	0.10	0.13	0.11	0.13	0.10	0.00	0.01
	Channel 2	X	0.08	0.09	0.05	0.07	0.08	0.10	0.08	0.09	0.03	0.03
		Z	0.08	0.08	0.09	0.07	0.10	0.09	0.09	0.09	0.02	0.02
	Channel 3	X	0.23	0.19	-	-	-	-	0.20	0.20	0.03	0.01
		Z	0.23	0.21	-	-	-	-	0.24	0.20	0.01	0.01
	Channel 4	X	0.16	0.12	-	-	-	-	0.14	0.08	0.02	0.04
		Z	0.15	0.09	-	-	-	-	0.16	0.11	0.01	0.02
6	Channel 1	X	0.12	0.13	0.12	0.14	0.13	0.14	0.12	0.14	0.01	0.01
		Z	0.10	0.06	0.10	0.13	0.11	0.15	0.09	0.13	0.02	0.09
	Channel 2	X	0.12	0.09	0.11	0.09	0.13	0.09	0.12	0.09	0.02	0.00
		Z	0.14	0.05	0.10	0.08	0.14	0.09	0.09	0.09	0.05	0.04
	Channel 3	X	0.09	0.08	-	-	-	-	0.09	0.07	0.00	0.01
		Z	0.10	0.07	-	-	-	-	0.05	0.06	0.05	0.01
	Channel 4	X	0.14	0.08	-	-	-	-	0.13	0.06	0.01	0.02
		Z	0.14	0.05	-	-	-	-	0.10	0.07	0.04	0.02
<b>Maximum value</b>										<b>0.05</b>	<b>0.09</b>	
<b>Minimum value</b>										<b>0.00</b>	<b>0.00</b>	

## Vibration, random

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Transient loss measurement according to IEC 61300-3-28
  - Random vibration test according to MIL-STD-810G, method 514.6, category 24 (general minimum integrity exposure)



- Requirements:**
- $\Delta IL_{Max} \leq 0.20$  dB during test
  - Transient Loss < 0.5 dB (4 concatenated channels)

- Samples:**
- DUT: 2 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu$ m, Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu$ m, Diamond art. no. 1005155

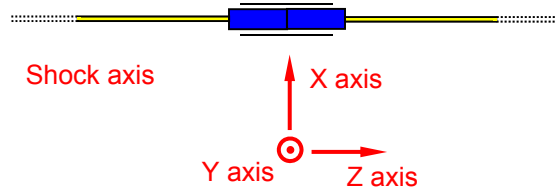
- Parameters:**
- Wavelengths: 1550 nm
  - Monitored channels: 2 (4 concatenated channels per sample)
  - Frequency spectrum: 20 Hz - 2'000 Hz
  - Profile:
    - 20 Hz - 1'000 Hz: 0.04  $g^2/Hz$
    - 1'000 Hz - 2'000 Hz: -6 dB/Oct
  - Acceleration spectral density: 7.7 gRMS
  - Duration per axis: 1 h
  - Vibration axis:
    - X (first transversal axis)
    - Y (second transversal axis)
    - Z (longitudinal axis)

### Results:

Sample no.	Vibration axis	Insertion loss IL at 1550 nm [dB]			Variation of insertion loss $\Delta IL$ at 1550 nm [dB]	Transient loss at 1550 nm [dB]
		before	during	after		
1	X	0.58	0.58	0.58	0.00	< 0.5
	Y	0.61	0.64	0.61	0.03	< 0.5
	Z	0.58	0.59	0.58	0.01	< 0.5
2	X	0.73	0.74	0.73	0.01	< 0.5
	Y	0.73	0.74	0.73	0.01	< 0.5
	Z	0.73	0.74	0.73	0.03	< 0.5
<b>Maximum value</b>					<b>0.03</b>	<b>&lt; 0.5</b>
<b>Minimum value</b>					<b>0.00</b>	<b>-</b>

## Shock

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Transient loss measurement according to IEC 61300-3-28
  - Shock test according to IEC 60068-2-27



- Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB during test  
Transient Loss < 0.5 dB (4 concatenated channels)
- Samples:**
- DUT: 2 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155
- Parameters:**
- Wavelengths: 1550 nm
  - Monitored channels: 2 (4 concatenated channels per sample)
  - Shock type: terminal peak sawtooth
  - Level: 75 g
  - Duration: 3 ms
  - Direction: positive / negative
  - Number of shocks per direction:
    - 2 at 50% level
    - 2 at 75% level
    - 3 at 100% level
  - Shock axis:
    - X (first transversal axis)
    - Y (second transversal axis)
    - Z (longitudinal axis)

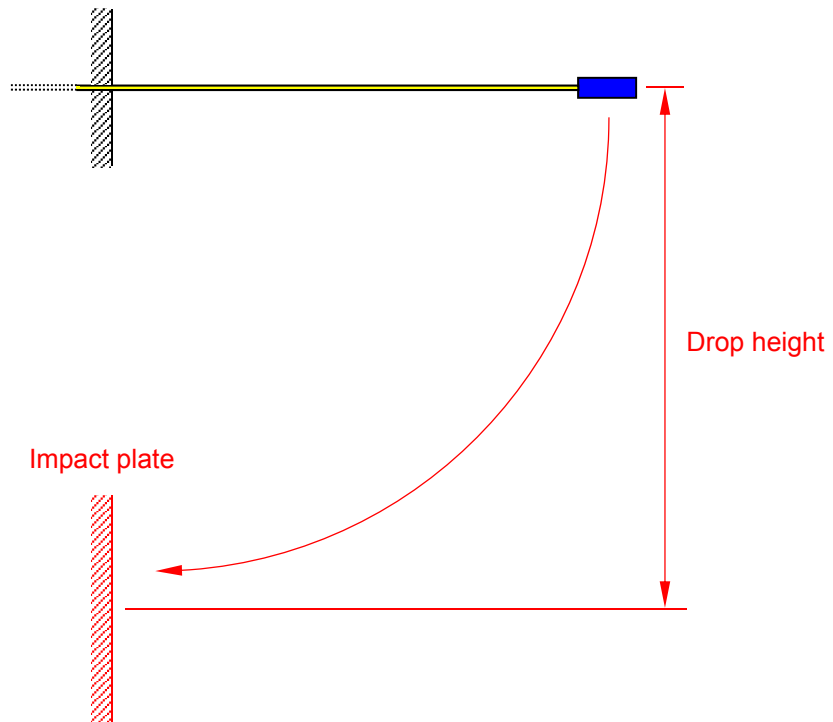
## Results:

Sample no.	Shock axis	Insertion loss IL at 1550 nm [dB]			Variation of insertion loss $\Delta IL$ at 1550 nm [dB]	Transient loss at 1550 nm [dB]
		before	during	after		
1	X	0.58	0.58	0.58	0.00	< 0.5
	Y	0.61	0.64	0.61	0.03	< 0.5
	Z	0.58	0.58	0.58	0.00	< 0.5
2	X	0.73	0.73	0.73	0.00	< 0.5
	Y	0.87	0.87	0.87	0.00	< 0.5
	Z	0.73	0.74	0.73	0.01	< 0.5
<b>Maximum value</b>					<b>0.03</b>	<b>&lt; 0.5</b>
<b>Minimum value</b>					<b>0.00</b>	<b>-</b>



## Shock (impact)

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Shock (impact) test according to MIL-STD-810G, method 516.6, procedure IV



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB before/after test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

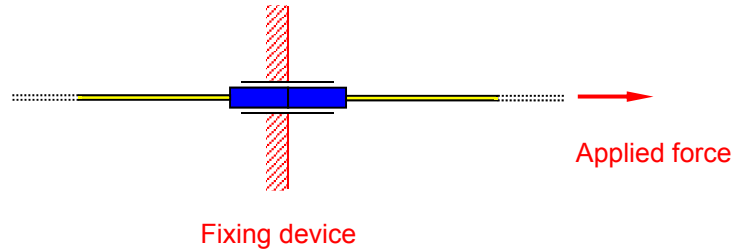
- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Drop height: 1.22 m
  - Number of drops: 26
  - Test condition: connector with protection cap

Results:

Sample no.		Insertion loss IL [dB]				Variation of insertion loss $\Delta$ IL before/after test [dB]	
		before test		after test		at 1310 nm	at 1550 nm
		at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm		
1	Channel 1	0.12	0.08	0.11	0.07	0.01	0.01
	Channel 2	0.20	0.15	0.20	0.15	0.00	0.00
	Channel 3	0.15	0.12	0.13	0.11	0.02	0.01
	Channel 4	0.20	0.13	0.18	0.11	0.02	0.02
2	Channel 1	0.08	0.07	0.08	0.06	0.00	0.01
	Channel 2	0.09	0.08	0.10	0.08	0.01	0.00
	Channel 3	0.18	0.13	0.19	0.14	0.01	0.01
	Channel 4	0.35	0.22	0.36	0.22	0.01	0.00
3	Channel 1	0.25	0.27	0.24	0.28	0.01	0.01
	Channel 2	0.15	0.11	0.15	0.12	0.00	0.01
	Channel 3	0.12	0.12	0.12	0.12	0.00	0.00
	Channel 4	0.19	0.16	0.18	0.16	0.01	0.00
4	Channel 1	0.11	0.07	0.11	0.05	0.00	0.02
	Channel 2	0.24	0.17	0.26	0.17	0.02	0.00
	Channel 3	0.17	0.17	0.19	0.18	0.02	0.01
	Channel 4	0.15	0.12	0.16	0.12	0.01	0.00
5	Channel 1	0.13	0.08	0.14	0.10	0.01	0.02
	Channel 2	0.12	0.09	0.11	0.09	0.01	0.00
	Channel 3	0.11	0.09	0.12	0.12	0.01	0.03
	Channel 4	0.10	0.06	0.11	0.06	0.01	0.00
6	Channel 1	0.08	0.08	0.10	0.09	0.02	0.01
	Channel 2	0.15	0.08	0.15	0.08	0.00	0.00
	Channel 3	0.07	0.07	0.07	0.07	0.00	0.00
	Channel 4	0.15	0.06	0.15	0.07	0.00	0.01
<b>Maximum value</b>						<b>0.02</b>	<b>0.03</b>
<b>Minimum value</b>						<b>0.00</b>	<b>0.00</b>

## Tensile strength of coupling mechanism

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Tensile strength of coupling mechanism test according to IEC 61300-2-6



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB before/after test

- Samples:**
- DUT: 4 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

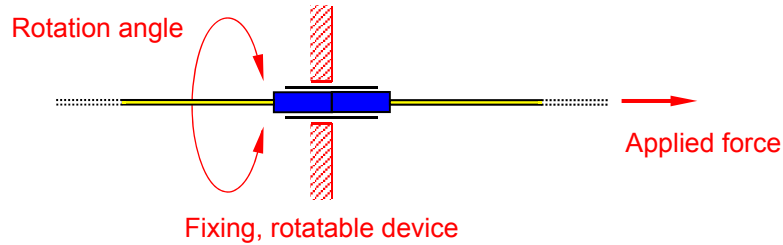
- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 16
  - Applied force: 250 N (on connector side)
  - Force direction: Longitudinal connector axis
  - Duration of applied force: 2 min.
  - Force application distance: 30 cm

## Results:

Sample no.	Insertion loss IL [dB]				Variation of insertion loss $\Delta$ IL before/after test [dB]		
	before test		after test		at 1310 nm	at 1550 nm	
	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm			
1	Channel 1	0.16	0.20	0.16	0.20	0.00	0.00
	Channel 2	0.20	0.15	0.20	0.15	0.00	0.00
	Channel 3	0.17	0.15	0.17	0.16	0.00	0.01
	Channel 4	0.17	0.15	0.15	0.13	0.02	0.02
2	Channel 1	0.09	0.11	0.10	0.12	0.01	0.01
	Channel 2	0.20	0.15	0.20	0.15	0.00	0.00
	Channel 3	0.10	0.08	0.10	0.07	0.00	0.01
	Channel 4	0.23	0.19	0.23	0.20	0.00	0.01
3	Channel 1	0.24	0.14	0.24	0.14	0.00	0.00
	Channel 2	0.21	0.16	0.22	0.18	0.01	0.02
	Channel 3	0.16	0.16	0.17	0.17	0.01	0.01
	Channel 4	0.28	0.19	0.30	0.19	0.02	0.00
4	Channel 1	0.09	0.08	0.08	0.08	0.01	0.00
	Channel 2	0.14	0.11	0.14	0.11	0.00	0.00
	Channel 3	0.22	0.17	0.22	0.17	0.00	0.00
	Channel 4	0.36	0.23	0.35	0.23	0.01	0.00
<b>Maximum value</b>						<b>0.02</b>	<b>0.02</b>
<b>Minimum value</b>						<b>0.00</b>	<b>0.00</b>

## Cable torsion

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Cable torsion test according to IEC 61300-2-5



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB during test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

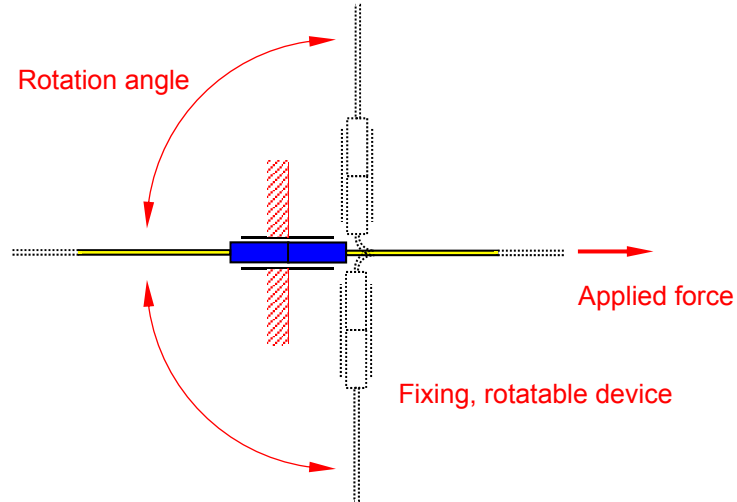
- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 1 continuously  
3 before / after test
  - Applied force: 15 N
  - Force direction: Longitudinal connector axis
  - Rotation angle: +180° to -180° and back
  - Number of cycles: 25
  - Force application distance: 30 cm

Results:

Sample no.		Insertion loss IL [dB]								Variation insertion loss $\Delta$ IL during test [dB]	
		before test		minimum, during test		maximum, during test		after test		at 1310 nm	at 1550 nm
		at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm		
1	Channel 1	0.11	0.08	0.10	0.08	0.11	0.10	0.11	0.10	0.01	0.02
	Channel 2	0.20	0.19	-	-	-	-	0.19	0.18	0.01	0.01
	Channel 3	0.14	0.13	-	-	-	-	0.12	0.13	0.02	0.00
	Channel 4	0.21	0.15	-	-	-	-	0.20	0.15	0.01	0.00
2	Channel 1	0.09	0.08	0.09	0.07	0.11	0.09	0.10	0.08	0.02	0.02
	Channel 2	0.14	0.12	-	-	-	-	0.12	0.10	0.02	0.02
	Channel 3	0.22	0.15	-	-	-	-	0.21	0.14	0.01	0.01
	Channel 4	0.34	0.24	-	-	-	-	0.36	0.23	0.02	0.01
3	Channel 1	0.26	0.29	0.26	0.27	0.27	0.29	0.27	0.28	0.01	0.02
	Channel 2	0.15	0.12	-	-	-	-	0.16	0.11	0.01	0.01
	Channel 3	0.13	0.12	-	-	-	-	0.15	0.13	0.02	0.01
	Channel 4	0.21	0.19	-	-	-	-	0.21	0.18	0.00	0.01
4	Channel 1	0.10	0.05	0.09	0.06	0.10	0.07	0.09	0.05	0.01	0.02
	Channel 2	0.24	0.17	-	-	-	-	0.26	0.21	0.02	0.04
	Channel 3	0.15	0.17	-	-	-	-	0.15	0.18	0.00	0.01
	Channel 4	0.15	0.11	-	-	-	-	0.16	0.12	0.01	0.01
5	Channel 1	0.13	0.09	0.13	0.08	0.14	0.10	0.13	0.09	0.01	0.02
	Channel 2	0.12	0.10	-	-	-	-	0.12	0.11	0.00	0.01
	Channel 3	0.11	0.11	-	-	-	-	0.11	0.10	0.00	0.01
	Channel 4	0.10	0.06	-	-	-	-	0.09	0.07	0.01	0.01
6	Channel 1	0.10	0.11	0.09	0.09	0.10	0.11	0.09	0.09	0.01	0.02
	Channel 2	0.16	0.10	-	-	-	-	0.17	0.10	0.01	0.00
	Channel 3	0.07	0.07	-	-	-	-	0.08	0.08	0.01	0.01
	Channel 4	0.17	0.09	-	-	-	-	0.18	0.10	0.01	0.01
<b>Maximum value</b>										<b>0.02</b>	<b>0.04</b>
<b>Minimum value</b>										<b>0.00</b>	<b>0.00</b>

## Flexing of strain relief

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Flexing of strain relief test according to IEC 61300-2-44



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB during test

- Samples:**
- DUT: 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 2 continuously
  - Applied force: 15 N (on connector side)
  - Force direction: Longitudinal connector axis
  - Rotation angle:  $+90^\circ$  to  $-90^\circ$  and back
  - Number of cycles: 25
  - Force application distance: 30 cm

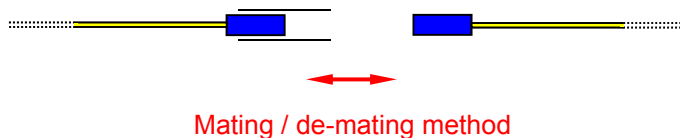
Results:

Sample no.		Insertion loss IL [dB]								Variation insertion loss $\Delta$ IL during test [dB]	
		before test		minimum, during test		maximum, during test		after test		at 1310 nm	at 1550 nm
		at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm		
1	Channel 1	0.11	0.11	0.11	0.09	0.12	0.12	0.12	0.10	0.01	0.03
	Channel 2	0.19	0.18	-	-	-	-	0.21	0.19	0.02	0.01
	Channel 3	0.12	0.13	-	-	-	-	0.15	0.15	0.03	0.02
	Channel 4	0.20	0.15	-	-	-	-	0.21	0.14	0.01	0.01
2	Channel 1	0.10	0.07	0.09	0.06	0.12	0.12	0.12	0.08	0.03	0.06
	Channel 2	0.12	0.10	-	-	-	-	0.10	0.08	0.02	0.02
	Channel 3	0.21	0.14	-	-	-	-	0.20	0.14	0.01	0.00
	Channel 4	0.36	0.23	-	-	-	-	0.37	0.23	0.01	0.00
3	Channel 1	0.29	0.28	0.27	0.26	0.30	0.30	0.28	0.29	0.03	0.04
	Channel 2	0.16	0.11	-	-	-	-	0.19	0.12	0.03	0.01
	Channel 3	0.15	0.13	-	-	-	-	0.19	0.15	0.04	0.02
	Channel 4	0.21	0.18	-	-	-	-	0.21	0.17	0.00	0.01
4	Channel 1	0.11	0.07	0.09	0.05	0.11	0.07	0.11	0.06	0.02	0.02
	Channel 2	0.26	0.18	-	-	-	-	0.24	0.17	0.02	0.01
	Channel 3	0.17	0.17	-	-	-	-	0.15	0.17	0.02	0.00
	Channel 4	0.16	0.11	-	-	-	-	0.15	0.11	0.01	0.00
5	Channel 1	0.14	0.09	0.12	0.08	0.15	0.11	0.14	0.09	0.03	0.03
	Channel 2	0.13	0.12	-	-	-	-	0.12	0.10	0.01	0.02
	Channel 3	0.10	0.12	-	-	-	-	0.11	0.11	0.01	0.01
	Channel 4	0.10	0.06	-	-	-	-	0.10	0.06	0.00	0.00
6	Channel 1	0.11	0.10	0.09	0.08	0.12	0.11	0.10	0.10	0.03	0.03
	Channel 2	0.17	0.10	-	-	-	-	0.17	0.09	0.00	0.01
	Channel 3	0.08	0.08	-	-	-	-	0.08	0.08	0.00	0.00
	Channel 4	0.18	0.10	-	-	-	-	0.15	0.09	0.03	0.01
<b>Maximum value</b>										<b>0.04</b>	<b>0.06</b>
<b>Minimum value</b>										<b>0.00</b>	<b>0.00</b>



## Mating durability

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Active monitoring of attenuation according to IEC 61300-3-3
  - Mating durability test according to IEC 61300-2-2



**Requirements:**  $\Delta IL_{Max} \leq 0.20$  dB during test

- Samples:**
- DUT: 1 HE-2000 SM APC 4 channels connector on multi-fibre cable with fibre bulkhead
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu$ m, Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu$ m, Diamond art. no. 1005155

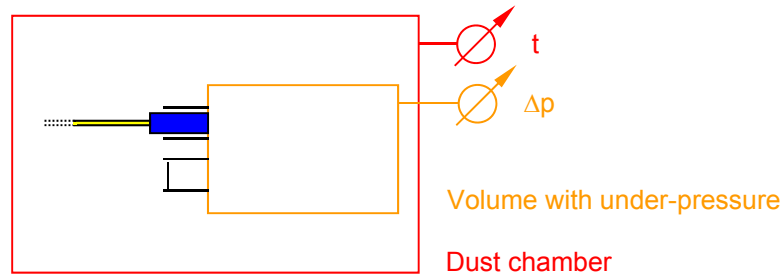
- Parameters:**
- Wavelengths: 1310 nm / 1550 nm
  - Monitored channels: 1 continuously  
3 every 50 mating / de-mating cycles
  - Mating / de-mating cycles: 500

**Results:**

Sample no.	Insertion loss IL [dB]				Variation of insertion loss $\Delta IL$ during test [dB]		
	maximum, during test		minimum, during test		at 1310 nm	at 1550 nm	
	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm			
1	Channel 1	0.12	0.11	0.06	0.07	0.06	0.04
	Channel 2	0.28	0.30	0.23	0.24	0.05	0.06
	Channel 3	0.08	0.11	0.04	0.10	0.04	0.01
	Channel 4	0.15	0.16	0.09	0.11	0.06	0.05
<b>Maximum value</b>						<b>0.06</b>	<b>0.06</b>
<b>Minimum value</b>						<b>0.04</b>	<b>0.01</b>

## IP6X protection degree

**Methods:** IP6X protection degree test according to IEC 60529



**Requirements:** No dust ingress allowed

**Samples:**

- DUT:
  - 2 HE-2000 SM APC 4 channels connectors on multi-fibre cable mated with 2 HE-2000 bulkhead adapters
  - 2 HE-2000 bulkhead adapters, with closed protection cap
- Cable/fibre type: Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987

**Parameters:**

- Under-pressure level: 20 mbar
- Duration: 8 h
- Condition: Sample not in operation

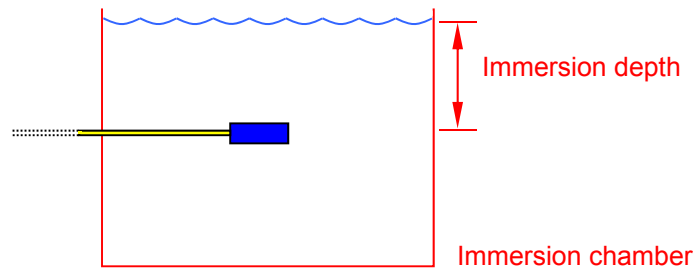
**Remarks:** IP6X protection degree test performed at Mettler-Toledo GmbH, ENL Test Laboratory, Nänikon (Switzerland)

**Results:**

Sample type	Sample no.	Results
HE-2000 connector mated with HE-2000 bulkhead adapter	1	No dust ingress observed
	2	No dust ingress observed
HE-2000 bulkhead adapter, with closed protection cap	1	No dust ingress observed
	2	No dust ingress observed

## IPX7 protection degree

**Methods:** IPX7 protection degree test according to IEC 60529



**Requirements:** no water ingress allowed

**Samples:**

- DUT:
  - 6 HE-2000 SM APC 4 channels connectors on multi-fibre cable mated with 6 HE-2000 bulkhead adapters
  - 6 HE-2000 bulkhead adapters, with closed protection cap
- Cable/fibre type: Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987

**Parameters:**

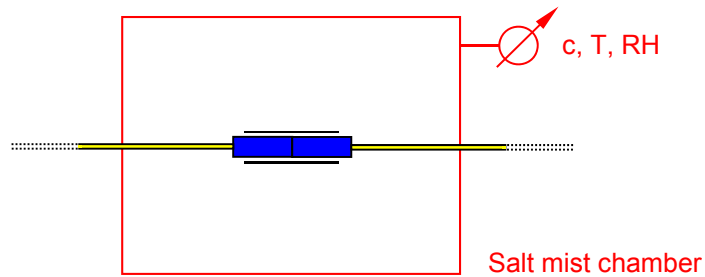
- Water temperature: +23°C
- Immersion depth: 1 m
- Duration: 30 min.
- Condition: Sample not in operation

**Results:**

Sample type	Sample no.	Results
HE-2000 connector mated with HE-2000 bulkhead adapter	1	No water ingress observed
	2	No water ingress observed
	3	No water ingress observed
	4	No water ingress observed
	5	No water ingress observed
	6	No water ingress observed
HE-2000 bulkhead adapter, with closed protection cap	1	No water ingress observed
	2	No water ingress observed
	3	No water ingress observed
	4	No water ingress observed
	5	No water ingress observed
	6	No water ingress observed

## Salt mist

- Methods:**
- Insertion loss measurement method B according to IEC 61300-3-4
  - Salt mist test according to IEC 61300-2-26



- Requirements:**
- $\Delta IL_{Max} \leq 0.20$  dB before/after test
  - no corrosion allowed / no material degradation allowed

- Samples:**
- DUT: 3 HE-2000 SM APC 4 channels connectors on multi-fibre cable with fibre bulkheads
  - Cable/fibre type:
    - Multi-fibre cable 4x9/125/500/900/5500  $\mu\text{m}$ , Diamond art. no. 1027987
    - Fibre 9/125/245/900  $\mu\text{m}$ , Diamond art. no. 1005155

- Parameters:**
- Temperature: +35°C
  - Salt concentration: 5%
  - pH level: 6.5 to 7.2
  - Relative humidity: min. 85% r.h.
  - Duration: 96 h

**Remarks:** Salt mist test performed at MTC Srl, Avigliana TO (Italy)

**Results:**

Sample no.	Insertion loss IL [dB]				Variation of insertion loss $\Delta$ IL before/after test [dB]		
	before test		after test		at 1310 nm	at 1550 nm	
	at 1310 nm	at 1550 nm	at 1310 nm	at 1550 nm			
1	Channel 1	0.14	0.16	0.13	0.18	-0.01	0.02
	Channel 2	0.07	0.10	0.07	0.09	0.00	-0.01
	Channel 3	0.07	0.05	0.08	0.06	0.01	0.01
	Channel 4	0.24	0.21	0.23	0.27	-0.01	0.06
2	Channel 1	0.09	0.06	0.08	0.06	-0.01	0.00
	Channel 2	0.19	0.27	0.17	0.29	-0.02	0.02
	Channel 3	0.15	0.14	0.18	0.17	0.03	0.03
	Channel 4	0.34	0.24	0.30	0.23	-0.04	-0.01
3	Channel 1	0.21	0.21	0.22	0.21	0.01	0.00
	Channel 2	0.18	0.18	0.23	0.16	0.05	-0.02
	Channel 3	0.09	0.12	0.11	0.10	0.02	-0.02
	Channel 4	0.09	0.15	0.15	0.19	0.06	0.04
<b>Maximum value</b>						<b>0.06</b>	<b>0.06</b>
<b>Minimum value</b>						<b>-0.04</b>	<b>-0.02</b>

Sample no.	Results
1	No corrosion observed / no material degradation observed
2	No corrosion observed / no material degradation observed
3	No corrosion observed / no material degradation observed