



# DIAMOND AVIM Connector

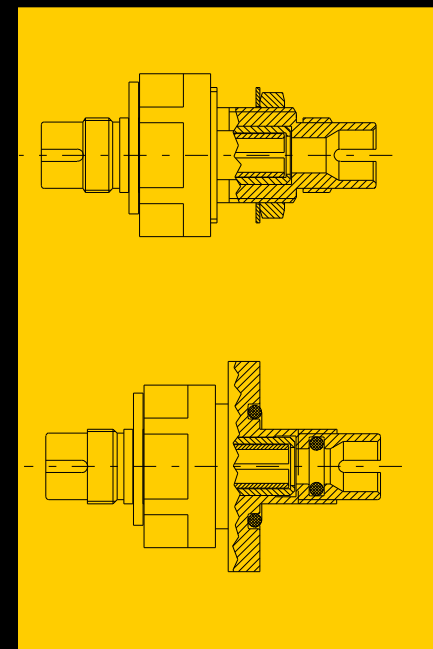
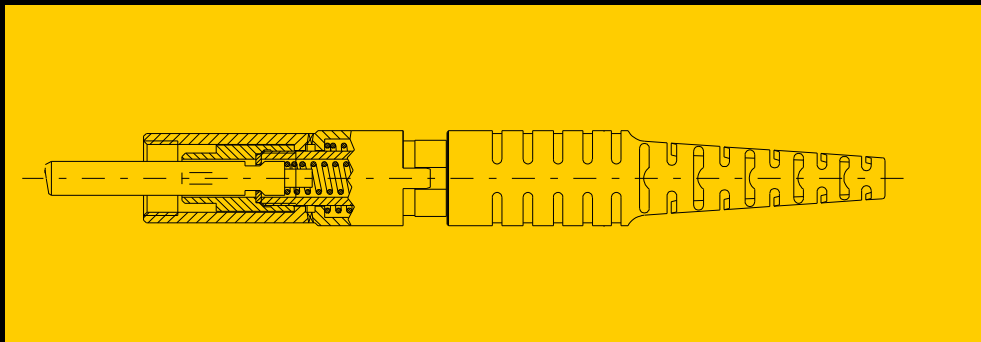
Fiber optic connector for space applications

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# AVIM Connector



→ The AVIM connector family, is designed to be used in high reliability space and aerospace programs. These connectors are designed as Single Terminus, Fiber Optic Connectors applicable for Single mode, Multimode and PM Fibers.





# Product Features

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- Single mode / Multimode / PM Fiber Compatible
  - Active aligned core for lowest insertion loss
  - Unique AVIM 2-piece cleanable Adapter for black box applications
  - Environmentally robust, survives vibration, shock, thermal cycling and repeated mating.
  - Wide temperature operating range:  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
  - Low out gassing materials applied conform to space applications
  - Sealed, flange mounted bulkhead allows pressure feed through
  - Diamond has produced and sold over 10'000 pieces since 1996.
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# Specifications



## Fiber

- Single Mode 1550/1625, 1310, 980nm
- Multimode
- Polarization maintaining

## Optical Requirements

- IL max. 0.5dB
- RL PC >45dB
- APC >70dB
- ER (PM fibers): min. 20 dB

## Thermal Cycling

- Temperature range -55°C (+0, -5°C) to +125°C (+5, -0°C)

## Ferrules - Active Alignment

- The active alignment ferrule

## Shock

- The adapter shall be capable of surviving a shock of 2000g over a frequency range of 100 - 10,000 Hz.

## Vibration

- Samples shall be subjected to vibration at 46.4G<sub>rms</sub> Random for 3 minutes in each axes.

## Temperature Life

- Test condition 240 hours test, temperature 100°C.

## Mating Durability

- Connector pairs (plug-adapter-plug) shall be tested for mating durability for total of 500 mating cycles.

## Bulkhead Adapter

- The bulkhead adapter shall be designed such that the fiber interface of the internal connector plug can be cleaned conventionally without disconnecting the plug. It's a 2-piece cleanable adapter.

## Alignment Sleeve

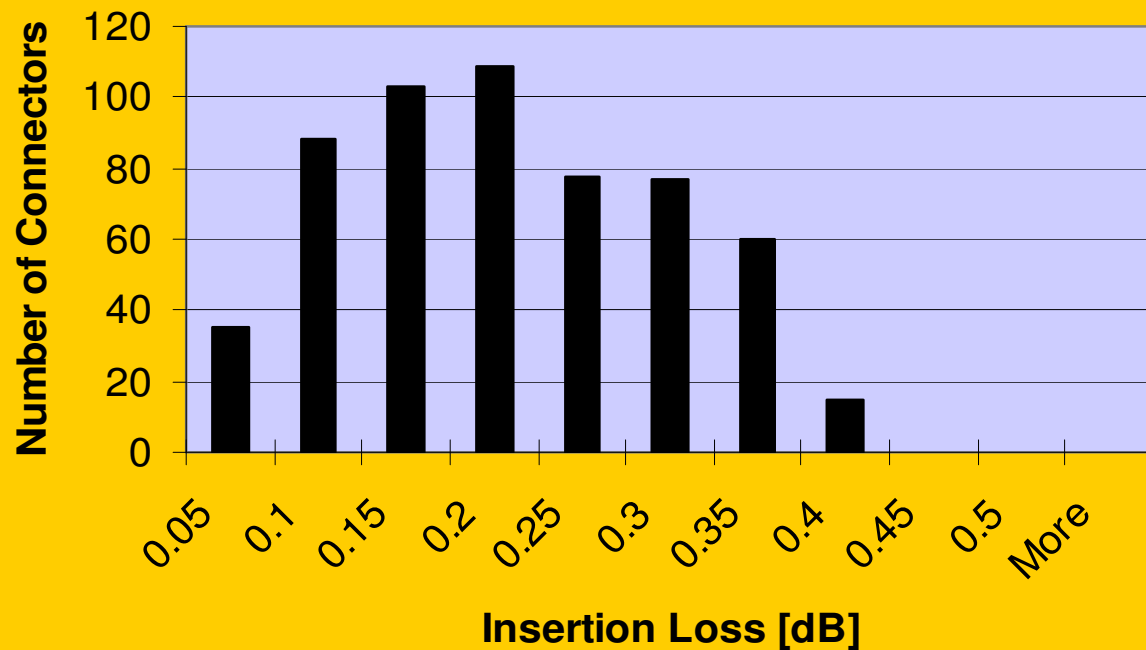
- The alignment sleeve shall be a split-sleeve configuration made from ceramic zirconia.

# AVIM Performance

## Insertion Loss



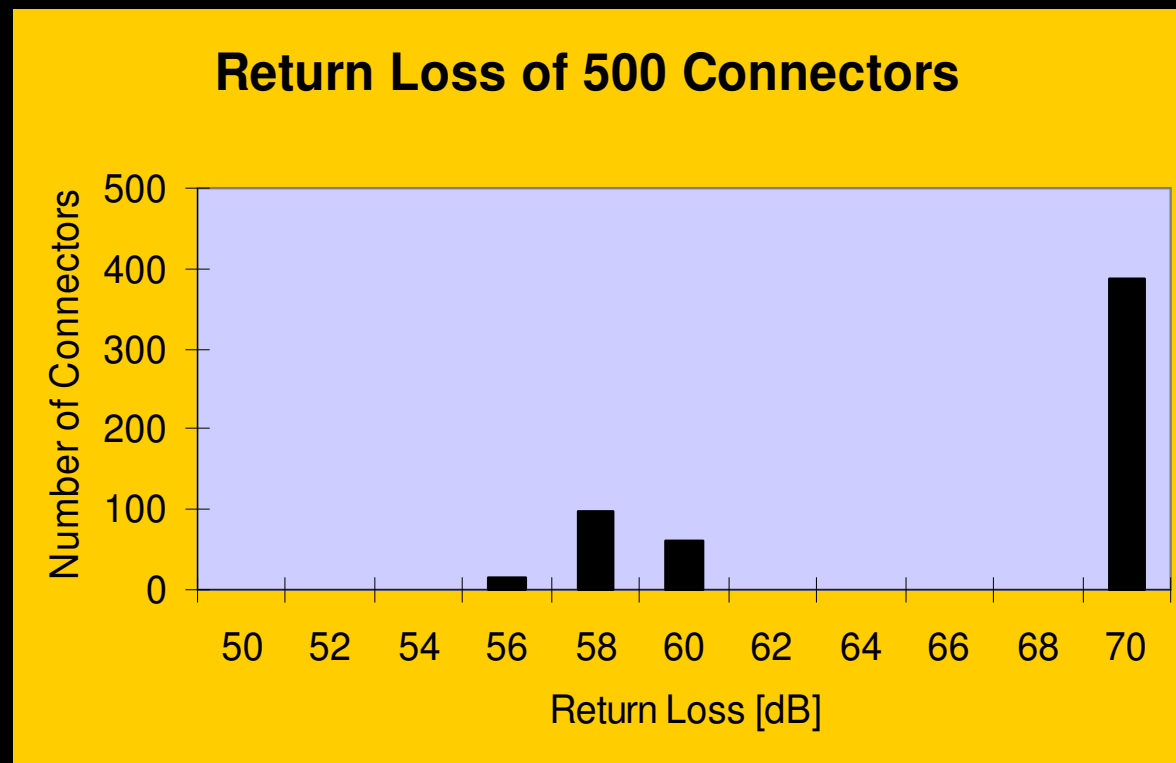
### Loss Results for 500 Connectors



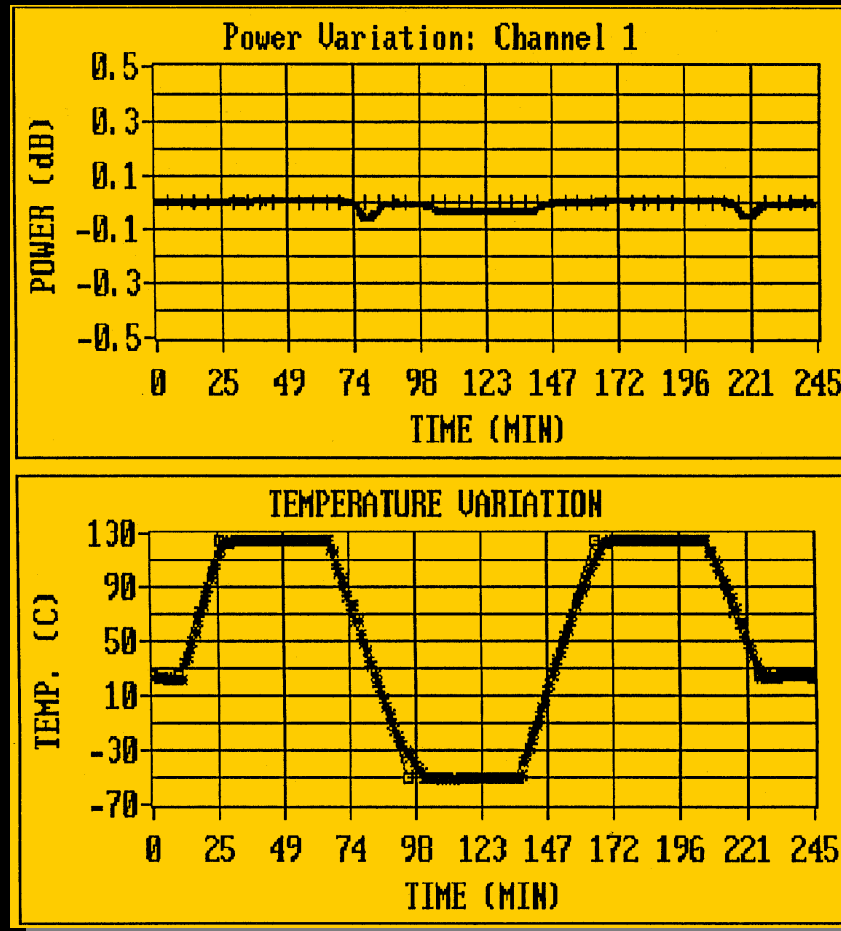
# AVIM Performance

## Return Loss

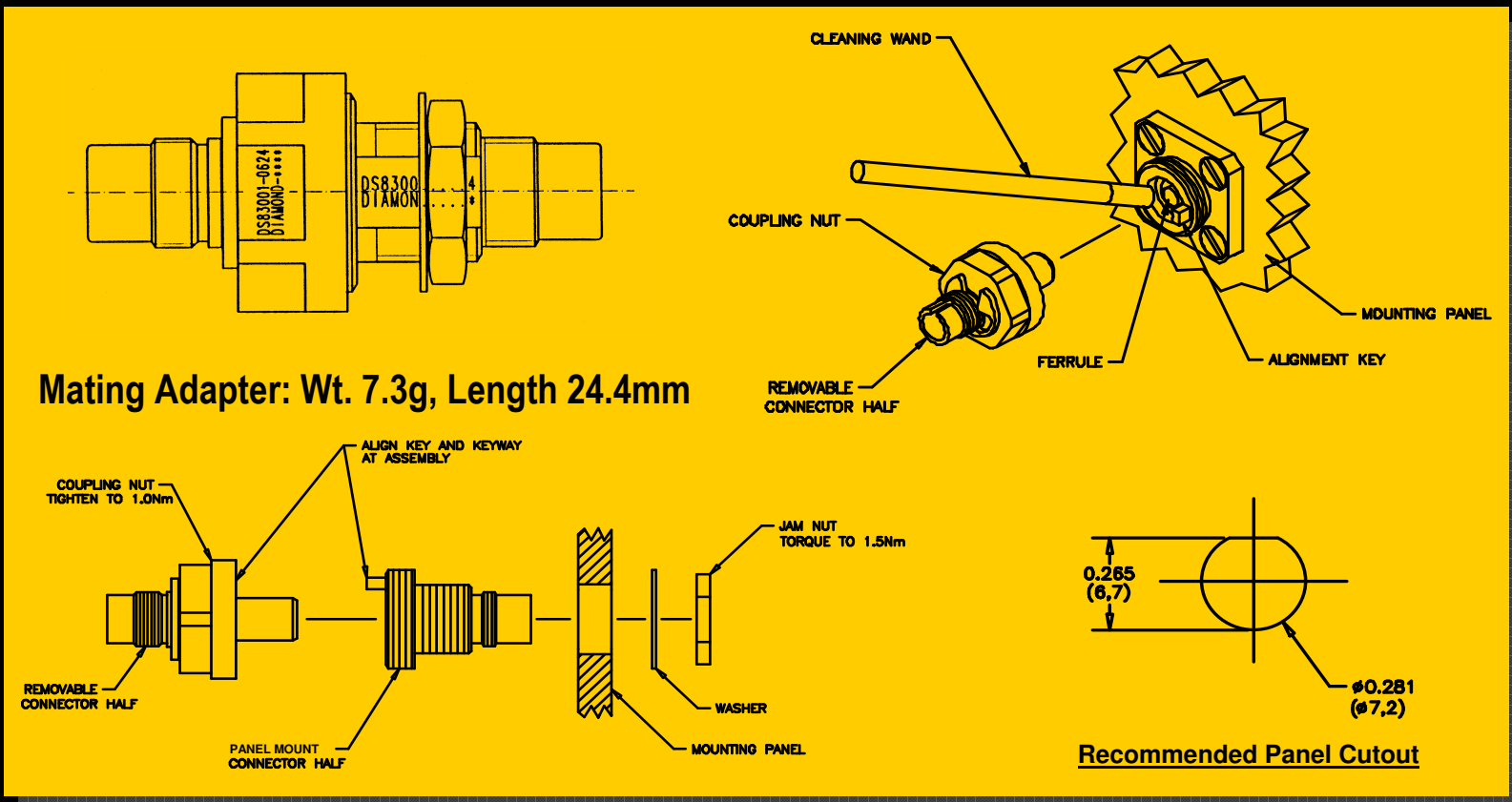
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# AVIM Performance Thermal Cycling

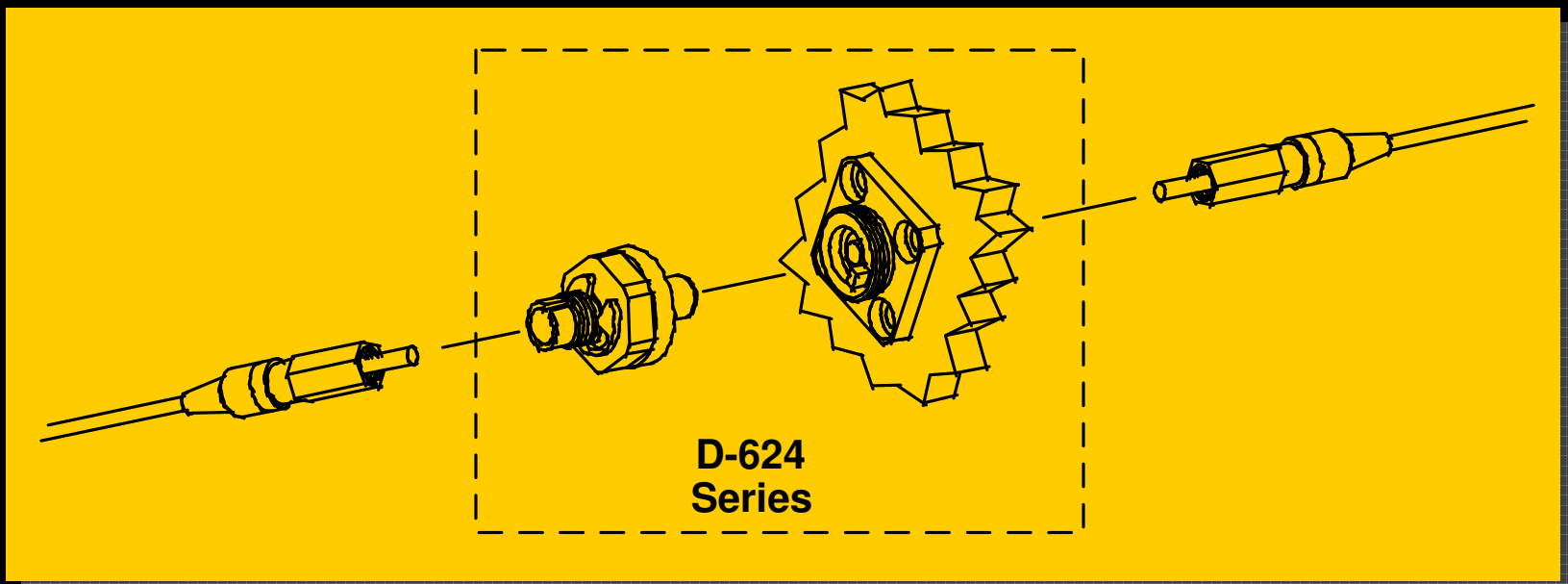


# Cleanable Bulkhead



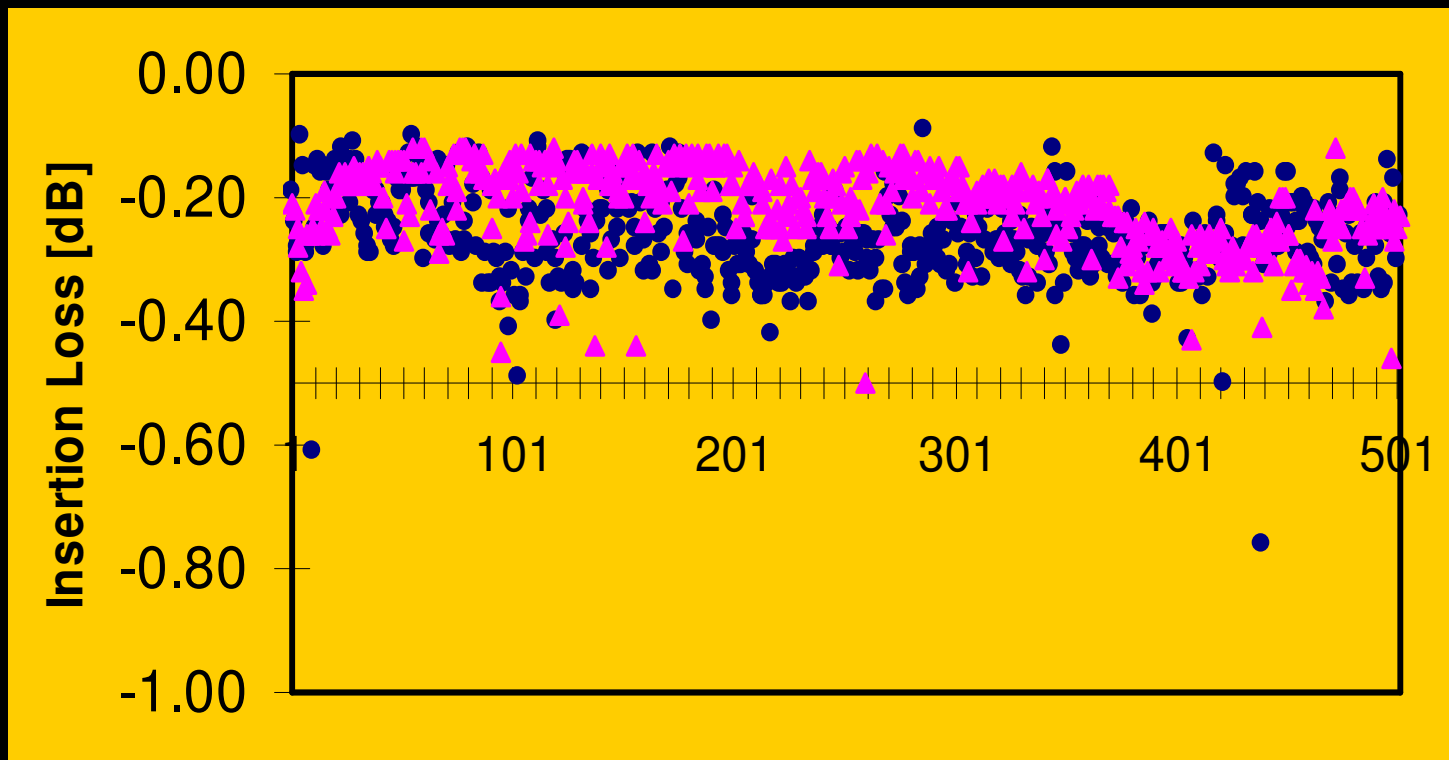


# Sealed Cleanable Bulkhead

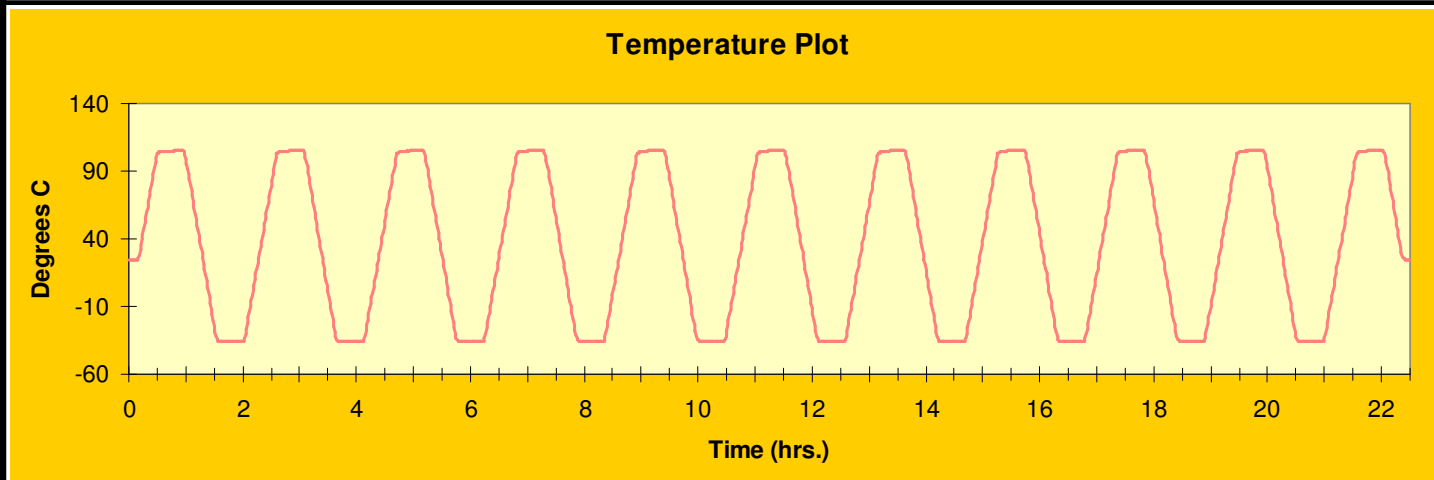
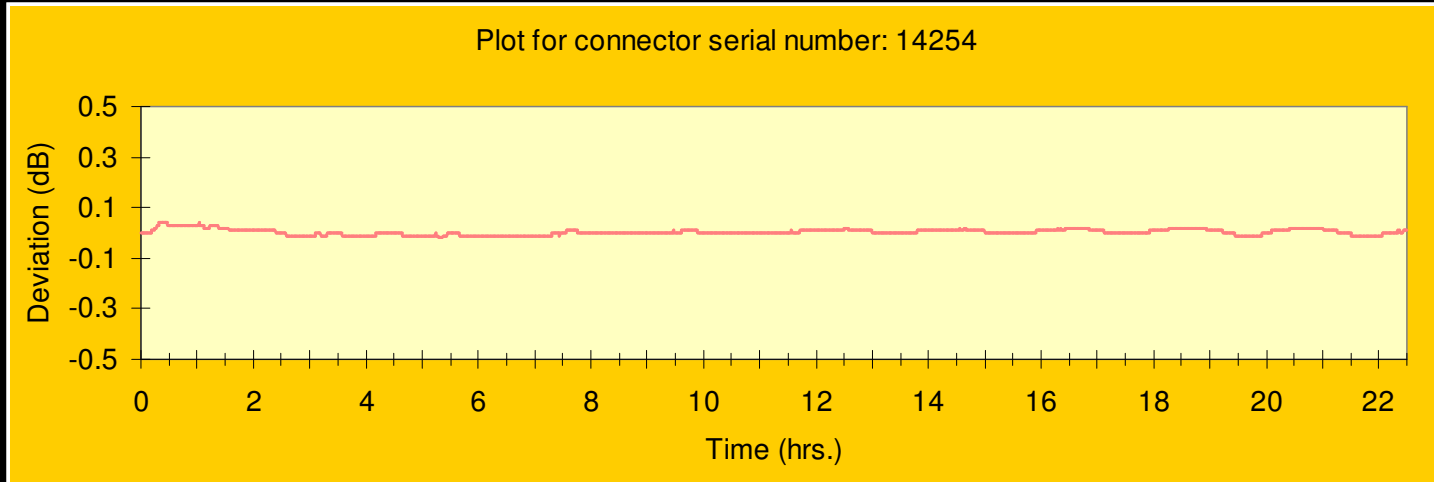


# AVIM Performance

## Durability Test for 500 Matings



# AVIM Performance Temperature Cycling

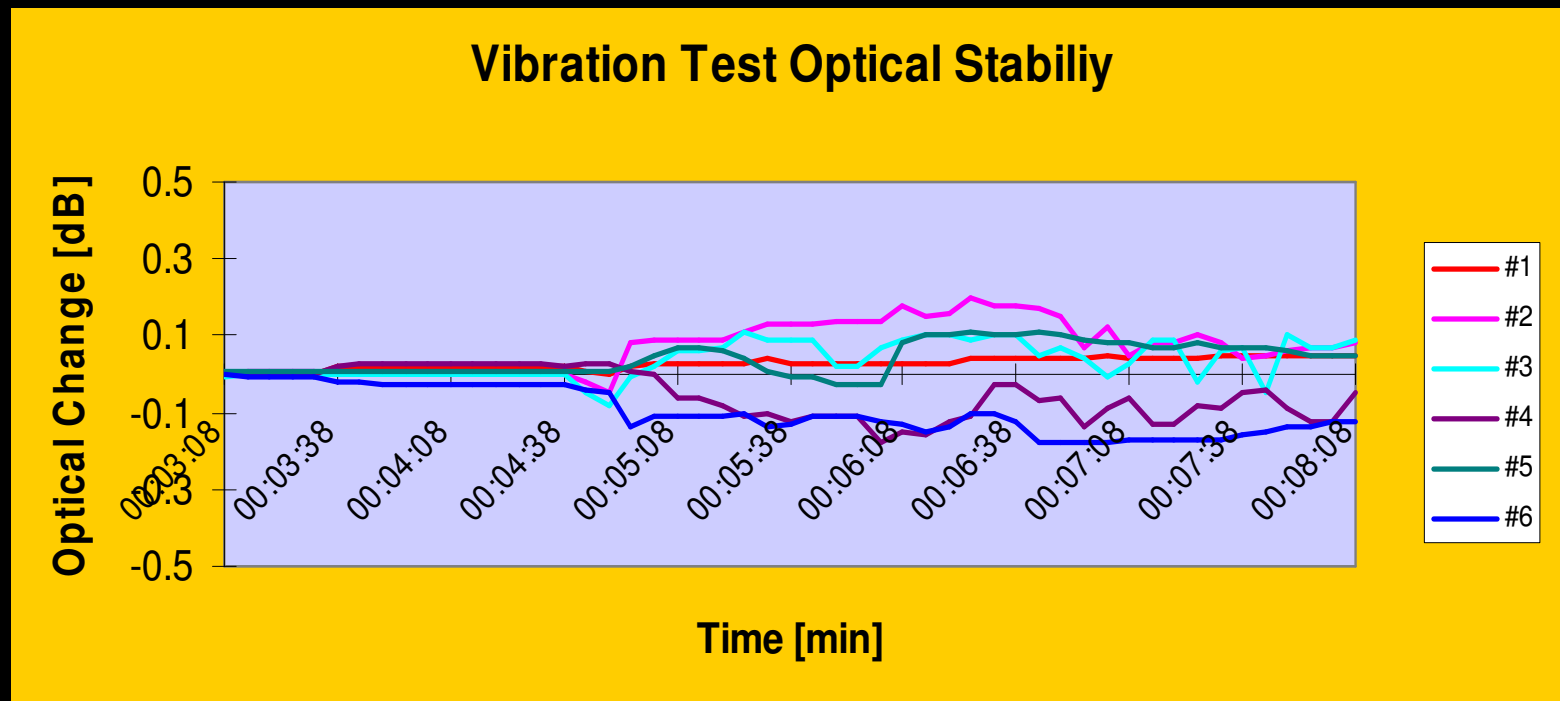


# AVIM Performance

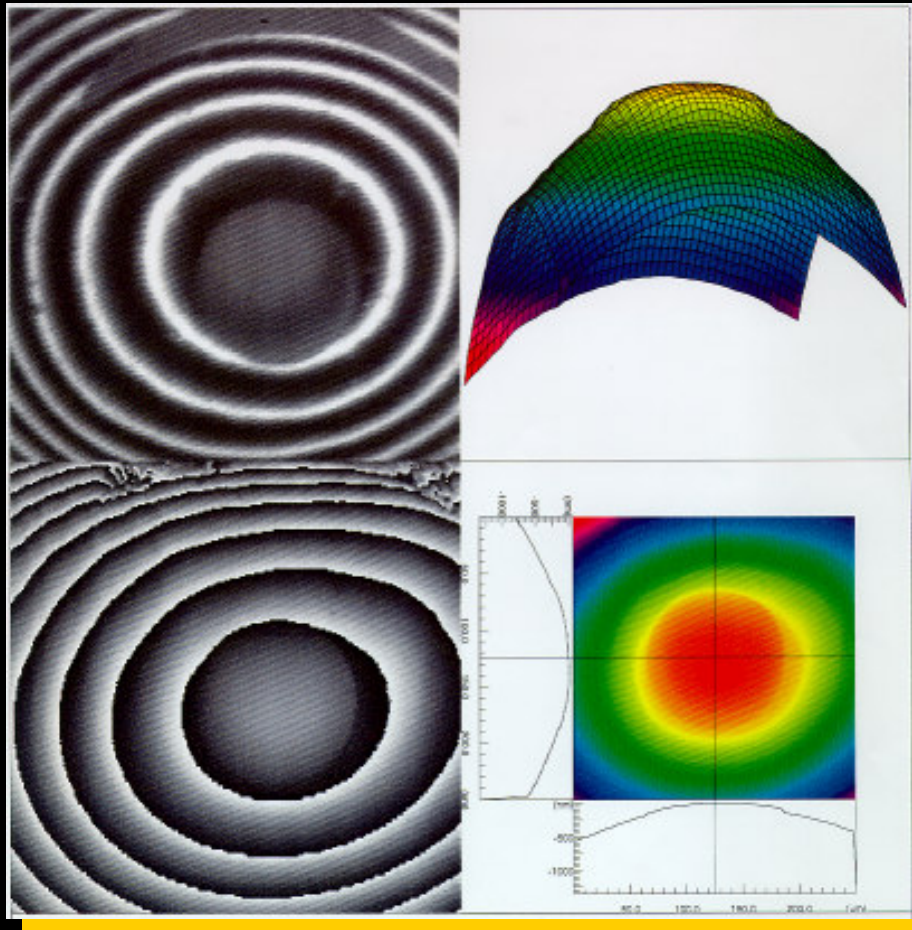
## Vibration Tested to 46.4G<sub>rms</sub>



→ Random Frequency from 20Hz to 2'000Hz



# Polish Analysis on all Flight Critical Connectors



Radius of Curvature: 13.85mm  
Fiber Spherical Height: 0.047 $\mu$ m  
Linear Offset ( $\mu$ m) 17.1 $\mu$ m  
APC Polish Angle: 7.988 $^{\circ}$

## AVIM Connector

# RF Shielding Test Results

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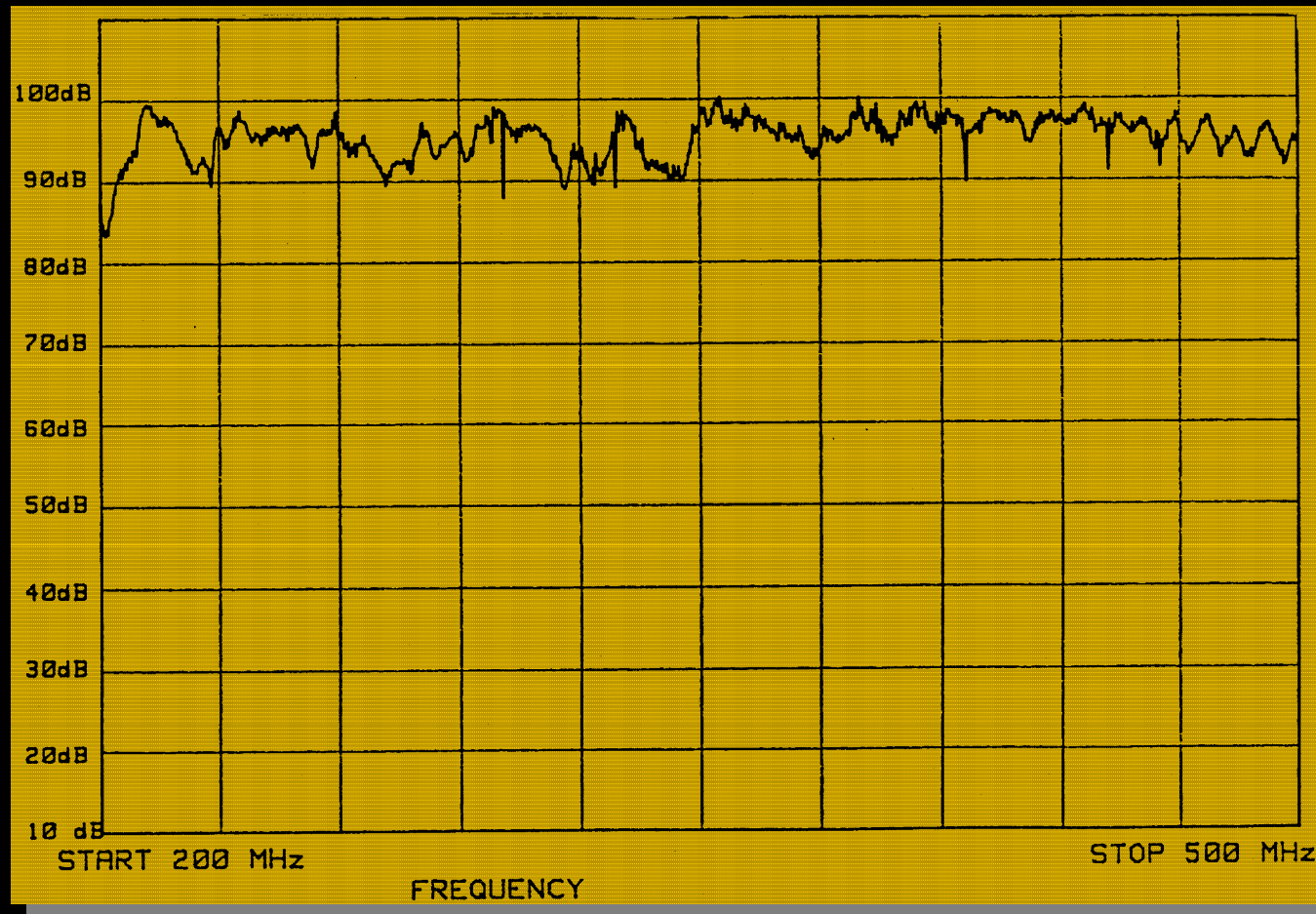


- Test performed from 200MHz to 18GHz
- Test determines the RF attenuation through the Bulkhead
- Shielding is better than 60dB from 200MHz to 5.8GHz
- Shielding from 5.8GHz to 18GHz was measured at better than 30dB but Test Equipment limited.

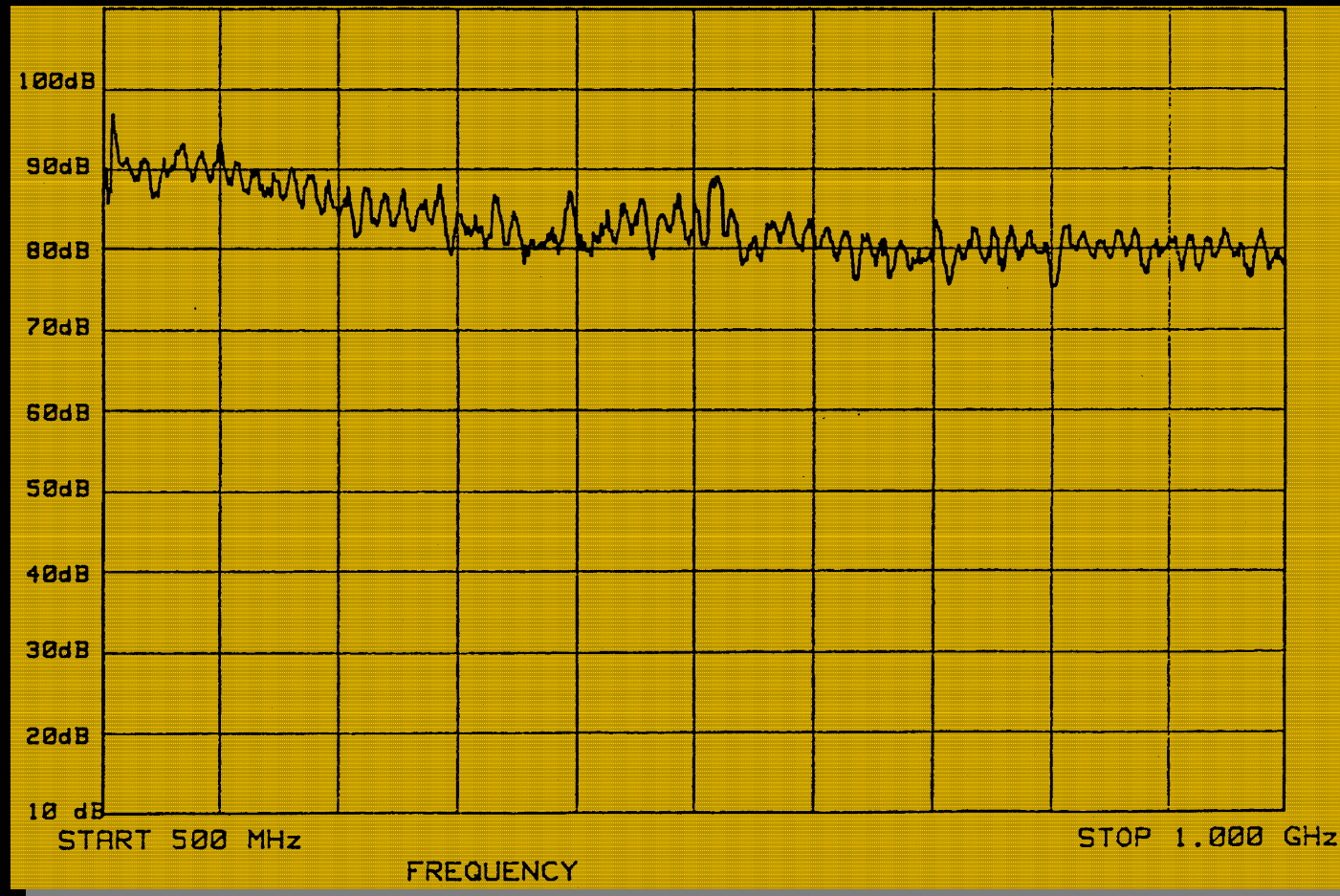
**The Cleanable Bulkhead Adapter is specifically designed to provide excellent RF attenuation.**

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# RF Shielding Effectiveness Test



# RF Shielding Effectiveness Test





## Helium Leakage

# Test on Bulkhead Adapter

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- Test Bulkhead Feed through for pressure leakage
- 5 Connector Samples tested
- Tested into  $1.0 \times 10^{-3}$  TORR

Typical leakage rate:  $< 5 \times 10^{-3}$  cc/min. Helium

The bulkhead adapter is suitable for pressurized hull penetration!

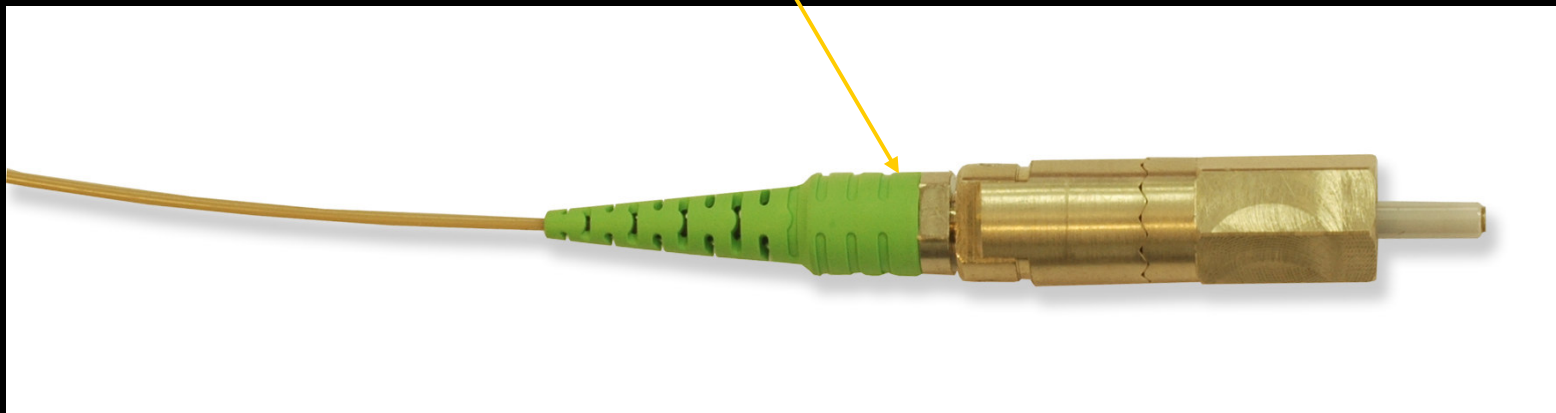
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# On PM fibers

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PM tuning system. Jointed to Diamond's active core alignment, is the guaranty for outstanding ER between fast & slow axis



# AVIM Performance On PM fibers

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**IL** (Insertion Loss) Performed @ at 980 nm

Test performed for TESAT-Spacecom GmbH & Co. KG

**Before thermal cycling**

Ca 23° C

[dB]

0.19

0.08

0.15

**After thermal cycling**

+ 80° C /- 40° C; 20 cycles

[dB]

0.36

0.12

0.23

Fibre type 6L.4944.038.00

PM 6 / 125 / 400

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# AVIM Performance On PM fibers



## ER (Extinction Ratio) @ 980 nm

Test performed for TESAT-Spacecom GmbH & Co. KG

@ +20°C	+80°C	-40°C	+20°C	maximum variation
[dB]	[dB]	[dB]	[dB]	[dB]
26.7	28.6	28.3	28.7	2.0
25.8	21.6	22.6	26.1	4.5

Fibre type 6L.4944.038.00  
PM 6 / 125 / 400

# AVIM Performance On PM fibers



## Mechanical vibration

**IL** @ 980 nm

Test performed for TeSat-Spacecom GmbH & Co. KG

Vibration axis	Min. value [dB]	Max. value [dB]	maximum variation [dB]
transversal (X/Y)	0.21	0.21	0.00
longitudinal (Z)	0.32	0.33	0.01
transversal (X/Y)	0.15	0.15	0.00
longitudinal (Z)	0.05	0.06	0.01

Fibre type 6L.4944.038.00  
PM 6 / 125 / 400

## Influence of the cable

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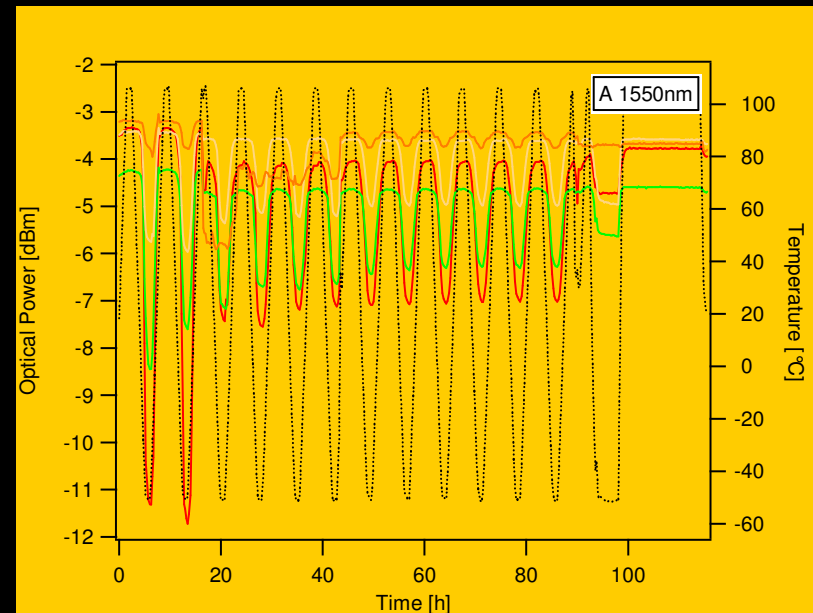
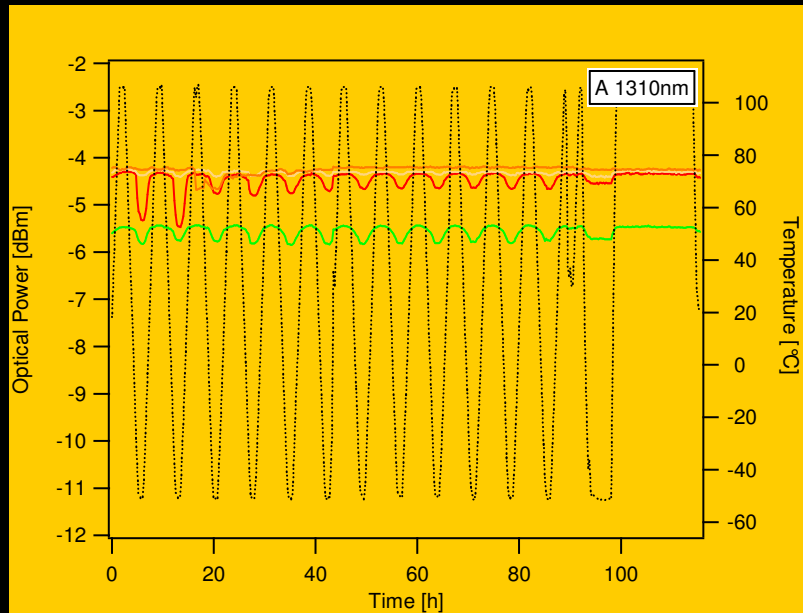
- The features of the fiber cable is a relevant aspect in relation to the global performance of fiber optic patch cords.
  - To prevent that influence, most of the previously presented tests were performed on secondary coated fiber.
  - The features of the materials used for their sheath layers (mainly extensional & retraction properties) are of capital importance.
  - The level of fiber's micro movement permitted in the cable might prejudice good behaviors of the whole assembly
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# AVIM Performance

## Influence of the cable



### Result of unproper matching connector - cable

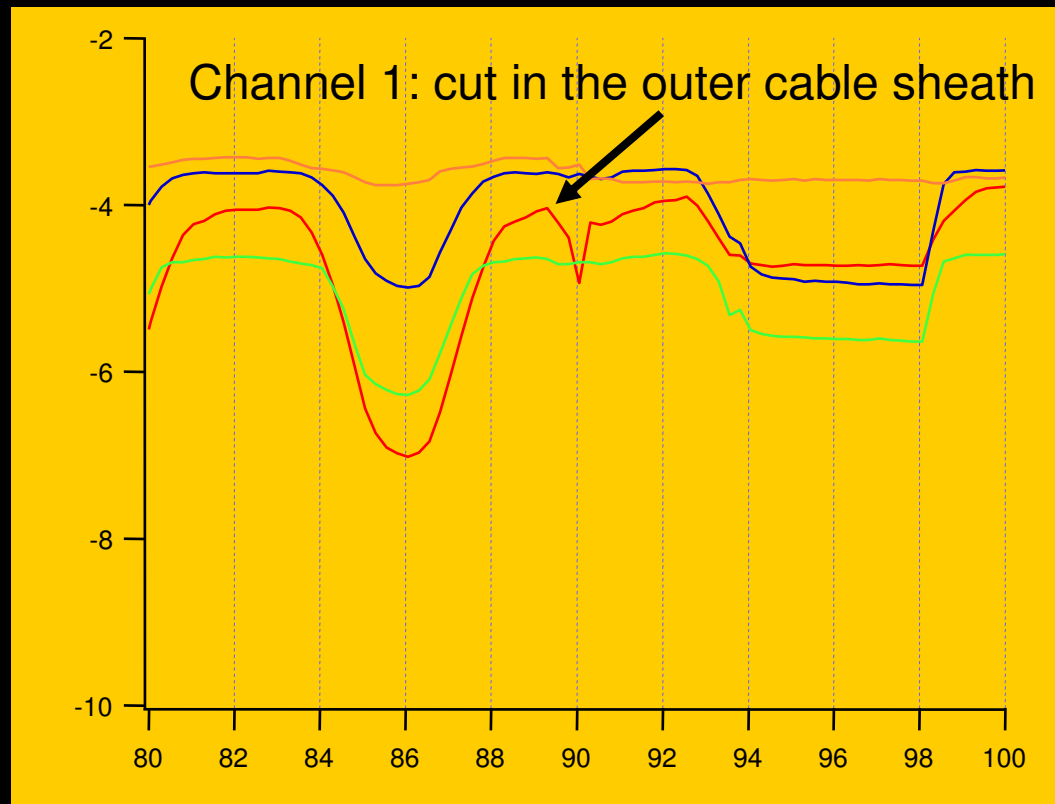


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# Influence of the cable



Restoring





AVIM Performance

## Influence of the cable

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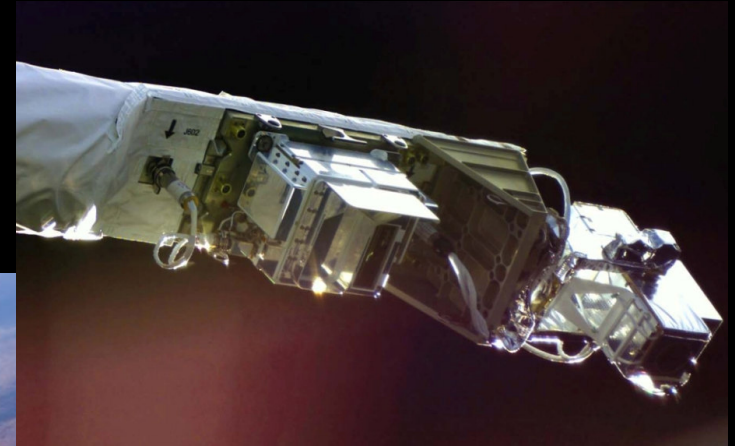


- Diamond has already several solution for a good matching between connector and fiber/fiber cable. Pretreating of the cable, expansion chambers in the connector
  - Only a good collaboration between the connector manufacturer, the cable manufacturer, the user and the termination facility guaranties good results & performances.
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# Applications



Sensor package  
on the Space Shuttle



# Applications

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- Intersatellit Links in the Terasar mission  
TeSat-Spacecom GmbH & Co. KG  
AVIM - PM
  - ESA SMOS mission  
Contraves Space  
AVIM SM
  - Other qualified projects and tests were realised.
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# On the track

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## ESA qualification

Activities are in process to define applicable specifications for a full qualification at the ESA.

EVALUATION TEST PROGRAMM  
FOR  
SIMPLEX OPTICAL FIBER CONNECTOR  
SET  
ESA/SSC Basic specification Nr. 33  
Draft A  
0402

# On the track

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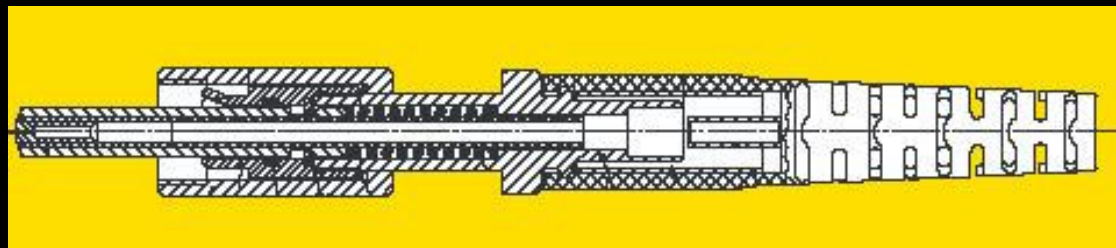
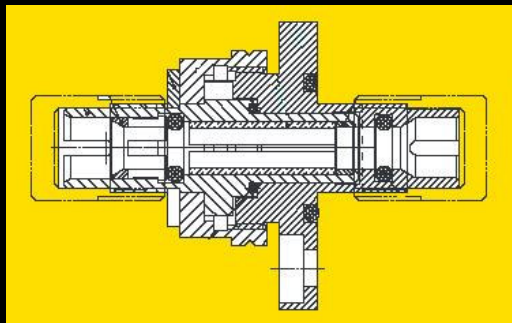
## IP67 Sealed connection



# On the track

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## IP67 Sealed connection



Additional advantages:

- Protection of the full connector against humid environment, prevention of failures due to humidity, salt water, corrosive environment in the inside of the plug.
  - Prevention of ice building within the connector and the mating surface.
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# On the track

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## IP67 Sealed connection

Now under test!

Test procedure:

Immersion in Sweet water at:

- Ca. 23° C
- Depth: 1m
- Time: 30 min

Results:

- ✓ IL (on 9  $\mu$ m fibre core) <0.2 dB (@1310 & 1550 nm)
  - ✓ Variation in IL (before/after) <0.02 dB
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# AVIM in the future

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😊 Thank you for your kind attention

- ▶ The discussion is open
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