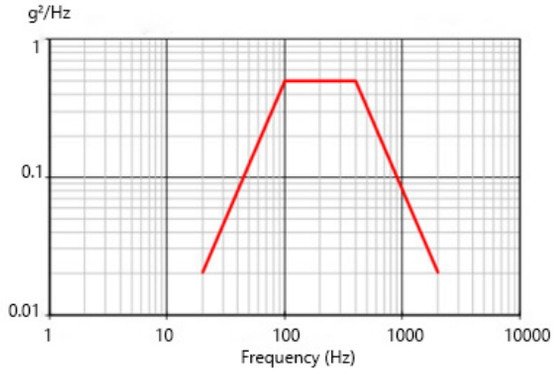
Reliability
Qualification Programs

nanoplus applies strict quality standards to development, production, and customer relations to deliver world-class products, systems, and services for your benefit.

Our management and employees take the initiative in all technological processes to make nanoplus devices highly stable and durable components for your application. All processes in our company are certified according to **ISO 9001:2015** and **14001:2015**.

Environmental Test:

- MECHANICAL
- CLIMATIC
- LIFETIME
- RADIATION HARDNESS
- VIBRATION
- QUALITY



Vibrational test

To guarantee high product quality, our devices undergo **reliability tests** during product development. As part of various **space projects**, well **over 350 parts** have completed additional qualification programs at **ESA, NASA,** and other space facilities worldwide.

This technical note describes the **qualification programs** conducted on more than 200 parts from 2019 through 2021. The test parts included DFB lasers from all material systems mounted in TO5 and TO66 housings.

Qualifying all our products for space would far exceed the cost target for our terrestrial customer applications. The primary reason for starting such additional qualification programs is to be 100% sure the flight modules meet the requirements for space applications. Typically, our space customers order 50 to 100 parts from us - manufactured in one batch and with specifications as close as possible to space qualifications. Most pieces are used in a space qualification program - the remaining items become flight modules.

"Strict quality standards make nanoplus lasers long lifetime components."

Before ordering such large quantities, a design review (RoD) is carried out, and specific space requirements are discussed with our team. We have experience - space applications are nothing new to us. So please use this document as an example only and contact us before ordering any parts. This way, we can ensure you get the service and quality you need!


nanoplus laser in TO5 and TO66 header

The tests listed below are well described in the relevant MIL or IEC standards. Some of them do not apply to our devices, or we already know that our lasers cannot withstand the tests - deviations are necessary. For example, some residual gas analysis tests involve heating parts to 100°C or even 120°C to determine if outgassing is a problem. Our laser will be damaged if treated with temperatures above 85°C. Therefore, we cannot use bake-out temperatures as MIL or IEC standards demand. If you heat the parts to 100 °C, you will have outgassing - but the gases will not be your problem. You see, it is very critical to understand these facts before you start designing your reliability testing program.

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Devices Under Test (DUT): by material and category

The reliability tests evaluated various lasers made of all the materials used by nanoplus. These include gallium arsenide (GaAs), indium phosphide (InP), gallium antimonide (GaSb) and interband cascade lasers (ICL).

wavelength range	material system	test lasers
760 - 1300 nm	GaAs	50 x 760 nm 15 x 770 nm
1300 - 1750 nm	InP	15 x 1620 nm 15 x 1650 nm
1750 - 2800 nm	GaSb	15 x 2330 nm 15 x 2360 nm 30 x 2683 nm
2800 - 6500 nm	ICL	45 x 3720 nm

The lasers were subjected to numerous tests in which, among other things, the mechanical, climatic, and thermal properties were checked. The operation and storage behavior as well as the impact of the environment were also examined. Testing is successful when the parts fulfill all electro-optical properties, and meet all specifications in the same way as before reliability testing.

mechanical	climatic	storage	lifetest	radiation	bond-pulls; shear; ESD	thermal vacuum
mechanical shock (25)	T cycling (24)	HT[4] storage (21)	aging (32)	radiation hard-ness (15)	bond-pull (15)	thermal vaccum (12)
random vibration (25)	moisture (24)	dewpoint (5)	seal; E/O[1]; Dim[2]; DPA[3] (32)	seal; E/O[1]; Dim[2]; DPA[3] (15)	shear (30)	thermal shock (20)
seal; E/O[1]; Dim[2] (25)	dewpoint (8)	LT[5] storage (5)	---	---	ESD (6)	seal; E/O[1] (32)
ESD (2)	seal; E/O[1]; Dim[2]; DPA[3] (24)	seal; E/O[1]; Dim[2]; DPA[3] (21)	---	---	DPA[3] (45)	---
DPA[3] (23)						

[1]E/O: electro-optical [2]Dim: dimensions verifactions [3]DPA: destructive physical analysis [4]HT: high-temperature
[5]LT: low-temperature

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Tests: by type and method

Our lasers passed the following tests by meeting the electro-optical properties and visual inspection conditions. All specifications had to be fulfilled before and after the tests. As the parts were tested under different programs, the test conditions vary. We have simplified some aspects for better readability and overview.

test	method	description
accelerated aging / lifetime	Telcordia GR-468 Sec 5-18 MIL-STD-883TM1005	1500h and MTTF fit
temperature cycling	Telcordia GR-468 Sec 5-20 MIL-STD-883TM1010 MIL-STD-750TM1051 IEC 60068-2-14	cycling -25°C - 65°C
low temperature storage	Telcordia GR-468 Sec 5-20 MIL-STD-883TM1010 IEC 60068-2-1	-40°C one day
high temperature storage	Telcordia TR-NWT-468 IEC 60068-2-2	85°C & 85% RH 7 days
damp heat	MIL-STD-202TM103 IEC 60068-2-3	As we do not use epoxy in our units, this test was not carried out.
vibration	MIL-STD-883TM2007 Telcordia GR-468 IEC 60068-2-64 IEC 60068-2-6	sine (5 - 20Hz slope 3dB up to 50g; 20 - 110Hz 50g) random (20 - 100Hz + 6dB/octave; 100 - 400Hz 0.5g^2/Hz; 400 - 2kHz - 6dB/octave; level 18grms)
mechanical shock	MIL-STD-883TM2002 IEC 60068-2-27	3 shocks per axis 100Hz 15g (some up 100g), 270Hz 70g, 2kHz 200g (some up 2,000g), 10kHz 150g
thermal shock / vacuum	MIL-STD-883TM1011	RT to -30°C
solderability		Methods such as MIL-STD-883TM2003 do not apply to our devices. You can solder a wire to the pins of our lasers if you use a 280°C ESD-safe soldering iron and touch the pins for less than 3 seconds.
internal moisture and dew point	MIL-STD-883TM1018 MIL-STD-883TM1014	A sealing test is done for every package that is sealed.
seal (fine and gross leak)	MIL-STD-883TM1014	Helium leak rate of < 5E-7atm/cc*s
ESD		Methods like Telcordia GR-468 Sec 5-22 are not applicable. Our lasers require ESD protection. Customers have successfully tested the devices with the method: HBM 100pF, 1500Ω, 500V.
bond pull	MIL-STD-883TM2011	
side metal shear test	MIL-STD-883TM2019 & 2027	
radiation	MIL-STD-883TM2012	TID at 220rad/h up to 300krad, protons at 50MeV up to 2E11p/cm^2 or protons at 10MeV up to 4E10 p/cm^2
visual inspection	MIL-STD-883TM2009 MIL-STD-750TM2072	Inspect and select all parts before capping and after capping.
pre-cap visual inspection	MIL-STD-883TM2010 & 1010	Inspect and select all parts before capping.
RGA (residual gas analysis)	MIL-STD-883TM1018	Conducted randomly with 10 parts.
DPA (destructive physical analysis)	MIL-STD-883TM2019	
PIND (particle impact noise detection)	MIL-STD-883TM2020 & 2052	Conducted randomly with 10 parts. Flight modules are all tested.
SEM (scanning electron microscope)	MIL-STD-750TM2077	Only if required.

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