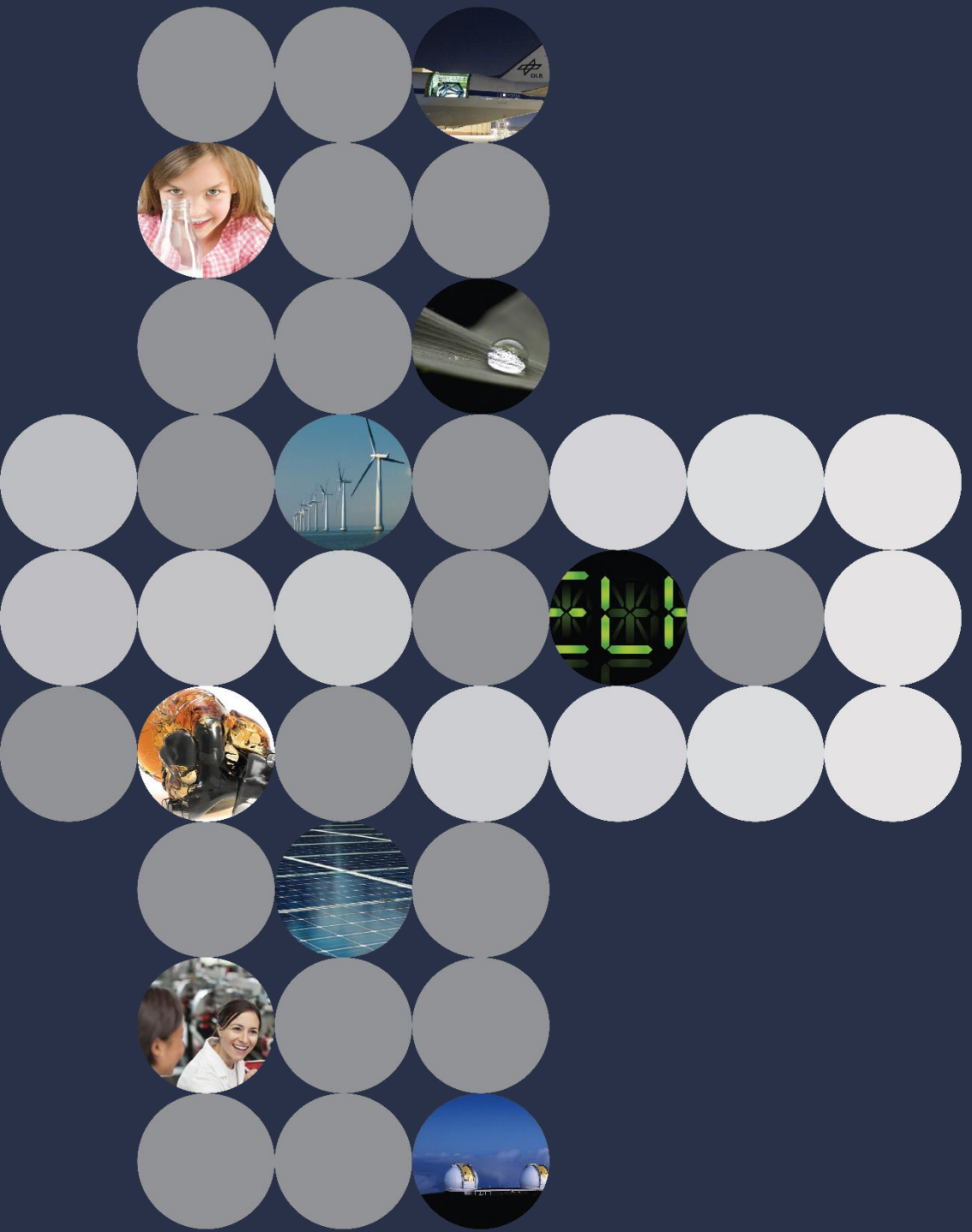


CSEM

Trends in Micro Nano

Miniaturisierte Gehäuse von der Medizintechnik bis ins Weltall

Mark Fretz, 28. October 2019

EMPA, St. Gallen

mark.fretz@csem.ch

CSEM - Swiss Center for Electronics and Microtechnology - Centre Suisse d'Electronique et de Microtechnique

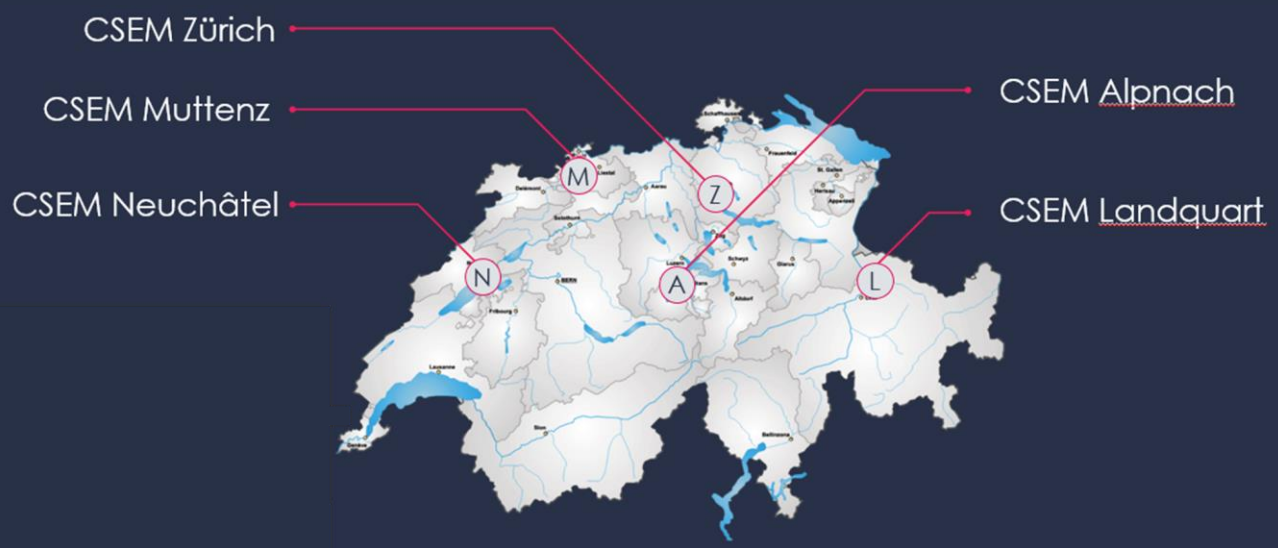
Our mission

Development and transfer of microtechnologies to the industrial sector

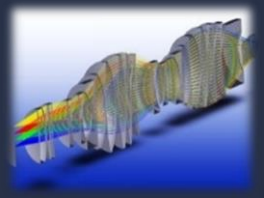
- Close to industry, leveraging Swiss academic research
- Cooperation agreements with established companies
- Encouraging the creation of start-ups

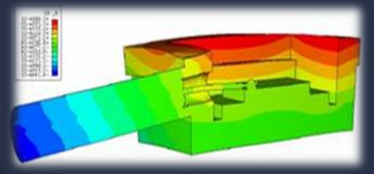
Non-profit RTO organization

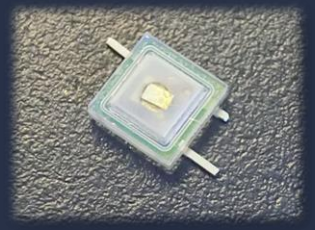
- 470 people
- 44 New ventures (last 20 years)
- 206 Industrial clients
- 76 European projects



Packaging & Assembly: Portfolio of Offerings







Modelling

Zemax, Comsol

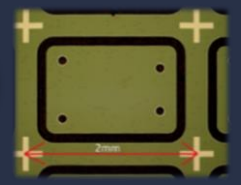
Harsh Environment Packaging

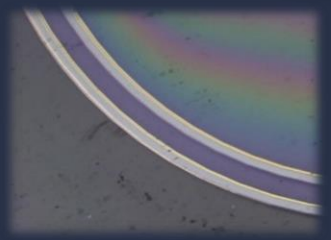
Microsystems Packaging & Integration

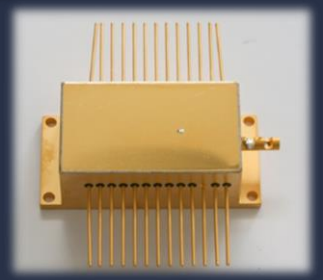
Optical Assemblies

Hybrid Integration

Hermetic Sealing







CSEM approach for hermetic sealing:

Laser Assisted Diffusion Bonding

Laser soldering & welding station in cleanroom environment

Specs

- Fibre laser @ 1070 nm
- Single mode
- Peak power: 1500 W
- Pulse energy: 15 J
- Pulse width: 0.2 – 50 ms
- average power: 250 W

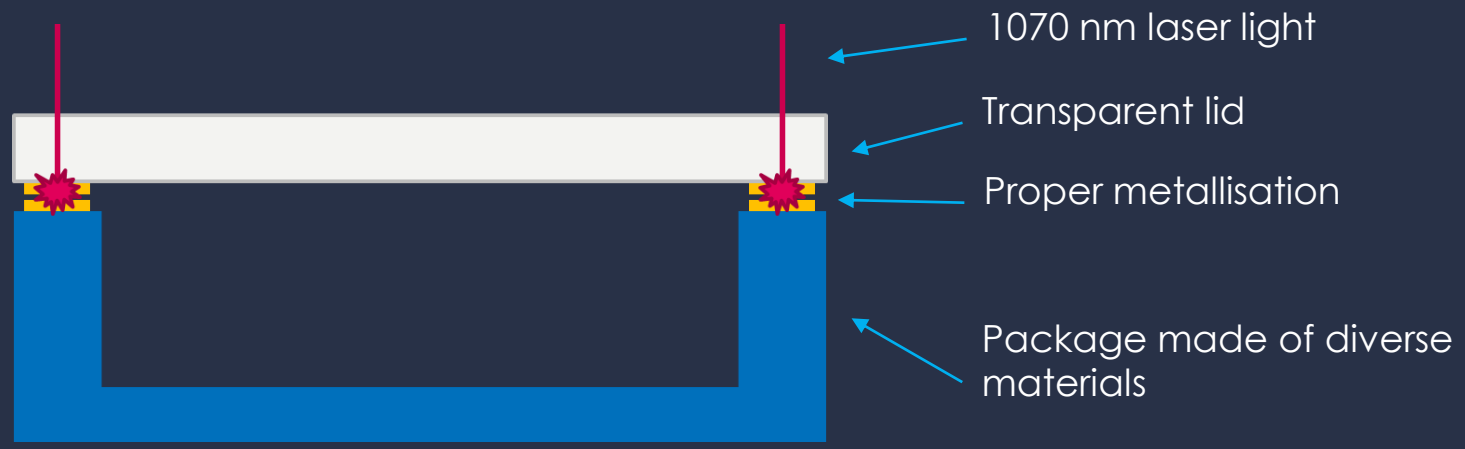
CSEM approach for hermetic sealing: Laser Assisted Diffusion Bonding

Benefits

- **High temperatures only locally at the joint (~100 mm wide)**
- **Very low stress, as parts inside the cavity will not heat up**
- **Very high shear strength > 100 MPa and temperature stability to 500°C**

Requirements

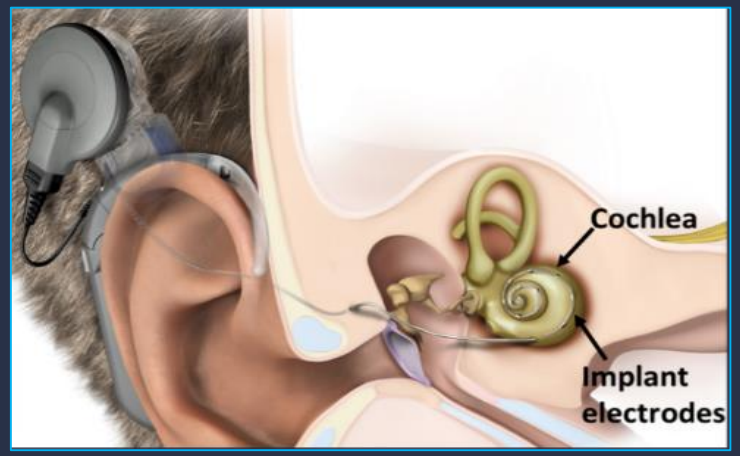
- **Clean environment**
- **Good quality and flat mating surfaces**
- **Co-planarity**

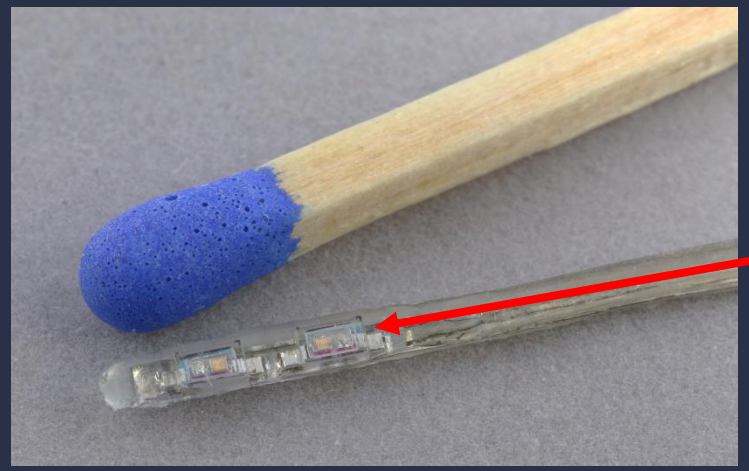


Proprietary sealing technology

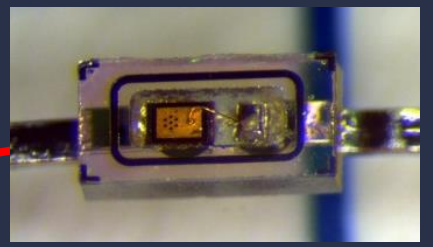
Application: Implantable VCSEL actuator for stimulation of hearing nerves

- Optically transparent, biocompatible, low permeability Sapphire package comprises
  - Long wavelength VCSEL laser array (1x19) at 1550 nm
  - Lens array for collimation
  - Pt/Pt-Ir leads with 400 µm pitch
- Successful stimulation of hearing nerves in-vivo in guinea pigs by opto-acoustic effect
- Hermetic sealing of package by laser assisted diffusion bonding



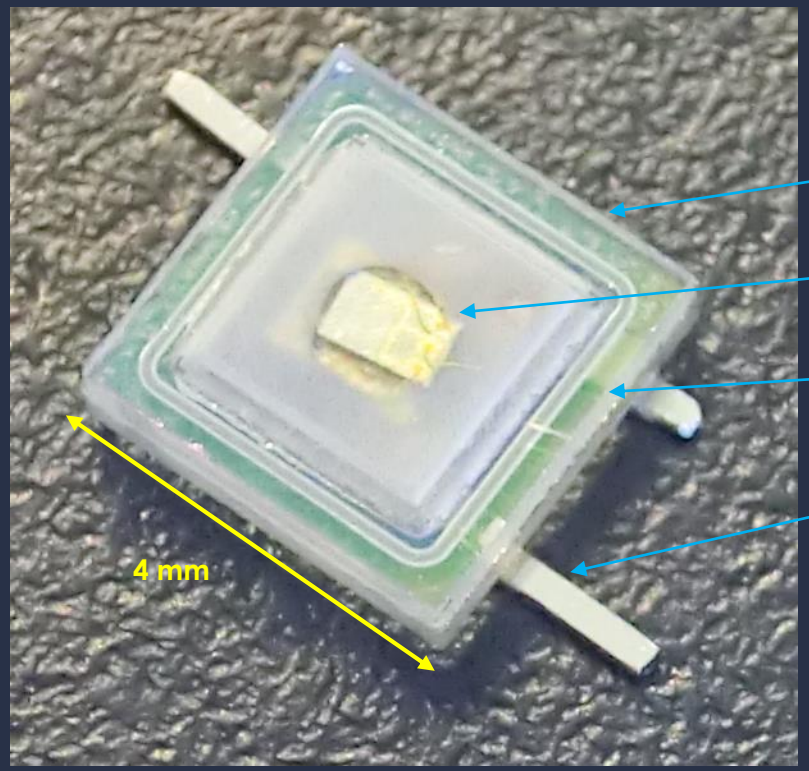


Laser-cut, multiple laser,
platinum electrode encapsulated in silicone



$0.6 \times 0.6 \times 1\ mm^3$

Implantable Pressure Sensor



Implantable pressure sensor technology

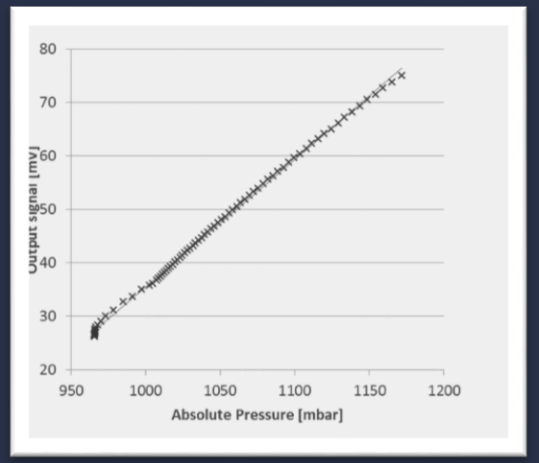
Sapphire package

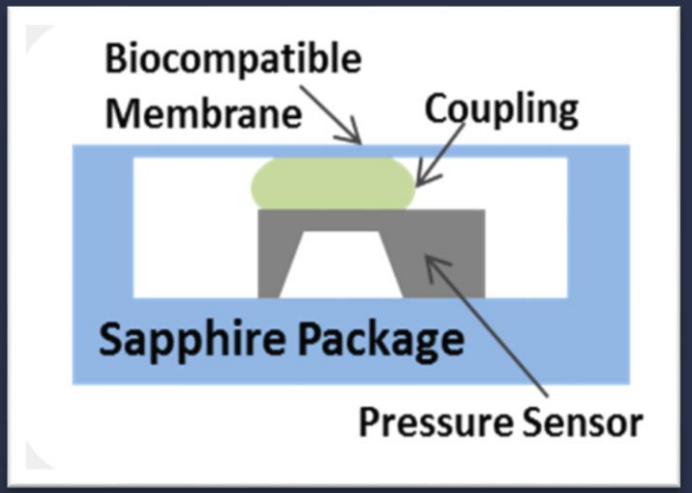
Commercial pressure sensor

LADB seal

Hermetic Feedthroughs

- Biocompatible materials only in contact with tissue/bodily fluids
- Suitable for long term implantation
- Relies on commercial piezo-resistive pressure sensors





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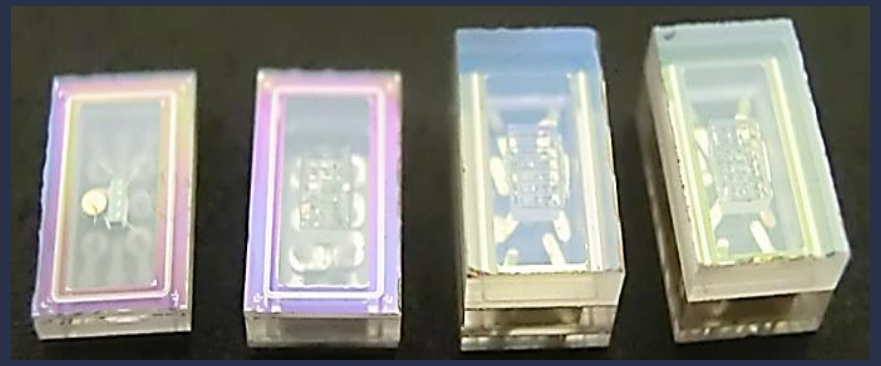
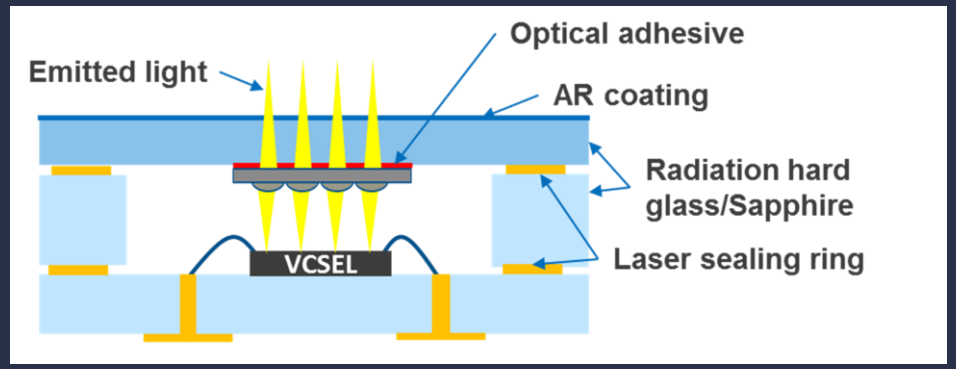
Application: Optical transmitter with 1x4 VCSEL array for space





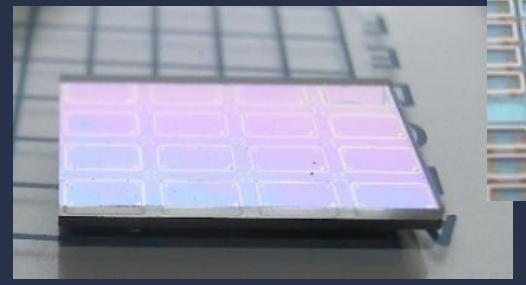
4 different designs with rad hard materials

Sapphire with and w/o lens

Schott N-BAF4 & N-ZK7 type glasses

Towards wafer-level sealing

Dissimilar materials possible: e.g. glass on silicon



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Application: Optical transmitter with 1x4 VCSEL array for space

Technology readiness level 4 (TRL4) achieved,

through intensive reliability testing

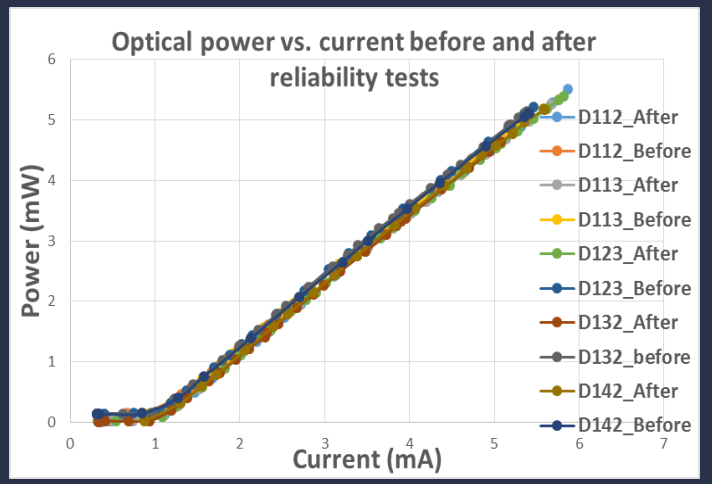
Mechanically robust for space applications

- Operating conditions 0 to +85°C
- Storage conditions -40°C to + 125°C
- Shock resistance to 1000 g

Packaged 1x4 VCSEL array @ 850 nm & lens array

Hermetically sealed → Including interconnects

Reliability Test name	Test standard reference	Test parameters
Vibration	MIL-STD-750 method 2056	20 Hz - 2g_N 80/1000 / 2000 Hz - 20g_N 4 minutes/axis/sweep dir.
Mechanical shock	MIL-STD-750 method 2016	100x 1000g, Tau< 1ms
Moisture resistance	MIL-STD-750 method 1021	10 cycles with 3h dwell time
Temperature cycling	MIL-STD-750 method 1051	Condition B (-40°C+100°C), 1000 cycles
Resistance to glass cracking	MIL-STD-750 method 1057	10x dipping in boiling & cold (0°C) water
High temperature storage	JEDEC-JESD22-A103D	100°C for 1000 hours.



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