

TIE M+ Demo

Subject Development Committee
Finite Element Analysis Engineering Team

TIE M+ Demo

Report Structure

- 1 Introduction
- 2 Inputs
- 3 Boundary Conditions
- 4 Results
- 5 Conclusions

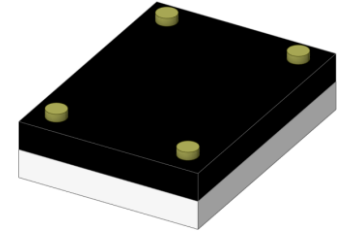
TIE M+ Demo

Introduction

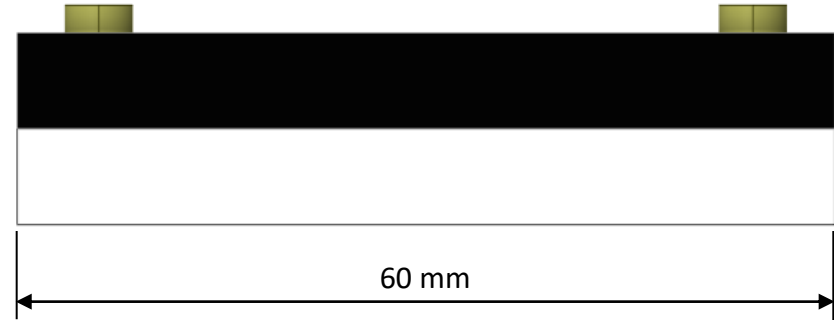
- › **Task description:**
 - › Evaluate stresses and strain in the Demo assembly parts after assembly process.
 - › Determine assembly's resonating frequencies.
 - › Determine the stresses in the steel parts and their fatigue life under random vibration loading.
- › **Scope:** Evaluate the integrity of demo sensor parts and the chip on PCB.
- › **Requestor:** TIE M+ Organizing Committee
- › **Inputs:**
 - › CAD: demo.stp
 - › Material datasheets.

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Inputs: Assembly Dimensions



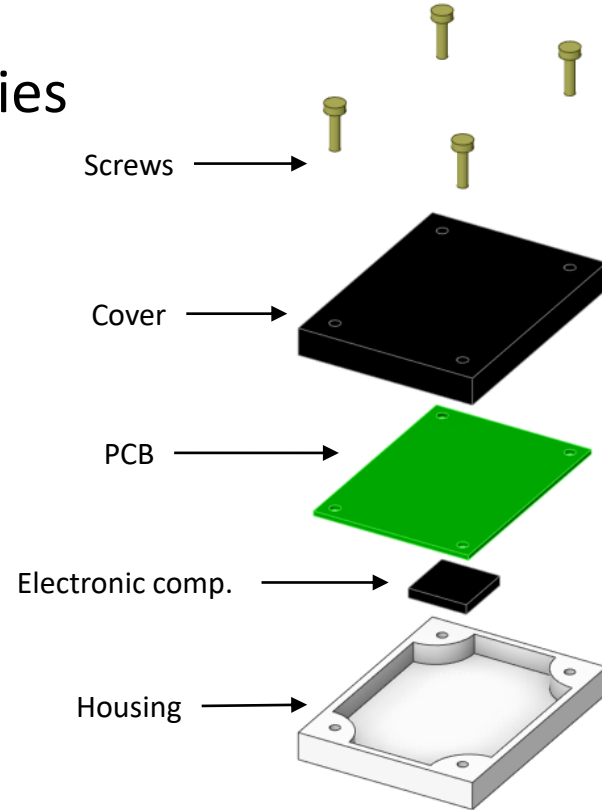
Isometric view



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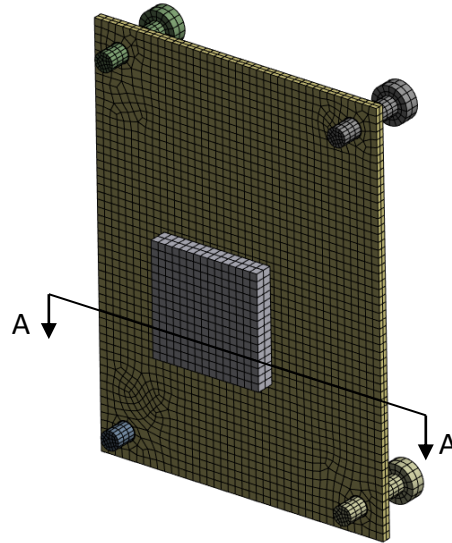
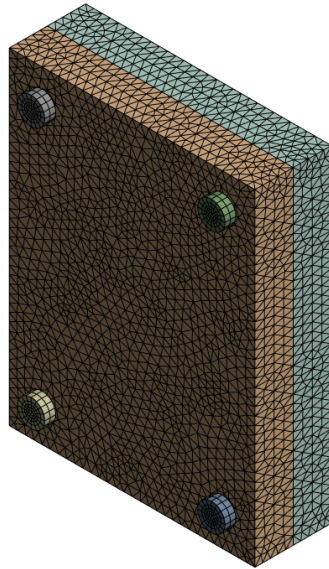
Inputs: Material Assignment Properties

No.	Part name	Solid material	Surface material
1.	Cover	Plastic	black
2.	Housing	Al Die Cast 99.5	natural
3.	PCB	FR4	shellac
4.	Screws	Steel	natural
5.	Electronic comp.	Mold	black

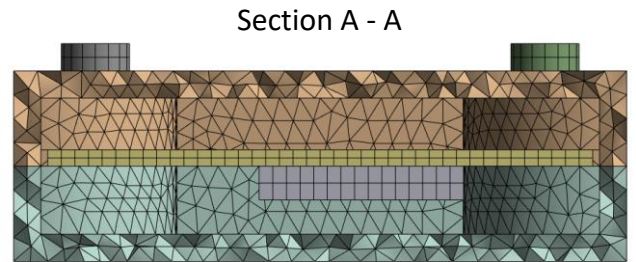


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Inputs: Mesh



- › Element order: quadratic
- › Nodes: 115712
- › Elements: 54540



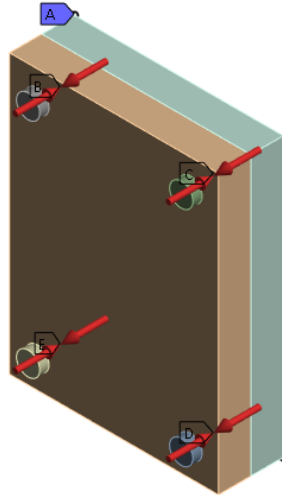
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Boundary Conditions

Ansys Workbench

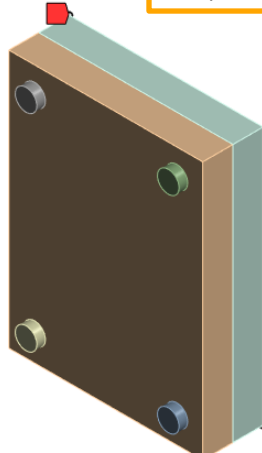
D: Static Structural - DEMO
Static Structural
Time: 1. s
2/8/2023 6:47 PM

- A Fixed Support
- B Bolt Pretension: 1000. N
- C Bolt Pretension 2: 1000. N
- D Bolt Pretension 3: 1000. N
- E Bolt Pretension 4: 1000. N



F: Random Vibration
Random Vibration
Time: 1. s
2/8/2023 6:48 PM

PSD Acceleration

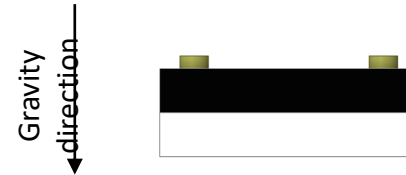


Vibration Profile according to
LV124 / ISO 16750-3 for
components mounted on body.

All contacting surfaces are connected through bonded (tie) surface-to-surface contacts.

Ansys Icepak

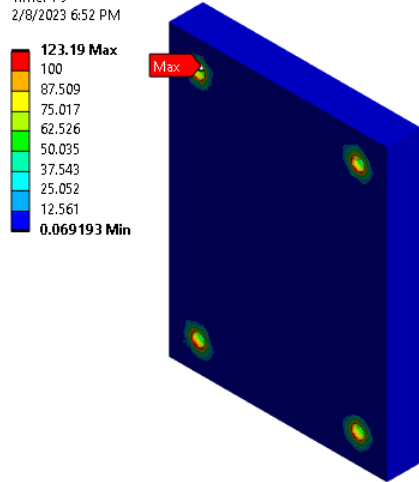
The ambient temperature is 85°C



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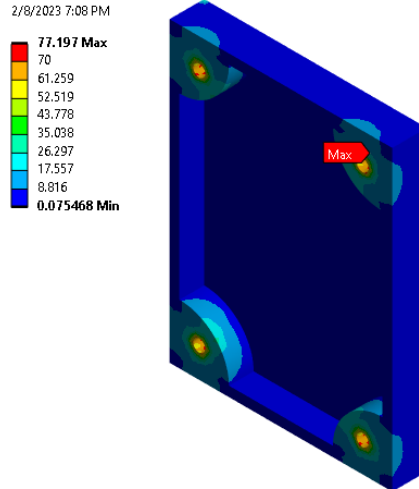
Results: Static Structural Analysis – stress on sensor parts

D: Static Structural - DEMO
Equivalent (von-Mises) Stress - Component1\Cover - 1. s
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
2/8/2023 6:52 PM



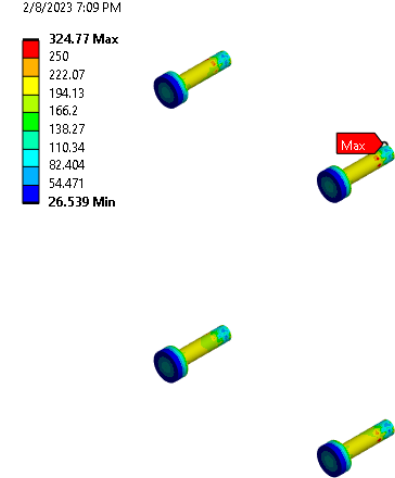
✓ Max stress < Tensile Ultimate Strength of 140 MPa.

D: Static Structural - DEMO
Equivalent (von-Mises) Stress - Component2\Housing - 1. s
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
2/8/2023 7:08 PM



✓ Max stress < Tensile Yield Strength of 236 MPa.

D: Static Structural - DEMO
Equivalent (von-Mises) Stress - Multiple - 1. s
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
2/8/2023 7:09 PM



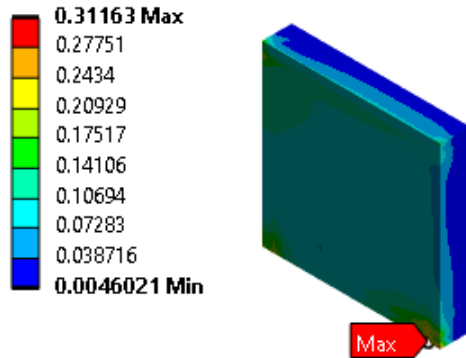
! Max stress > Tensile Yield Strength of 250 MPa.

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Results: Static Structural Analysis – stress and strain on electronics

D: Static Structural - DEMO

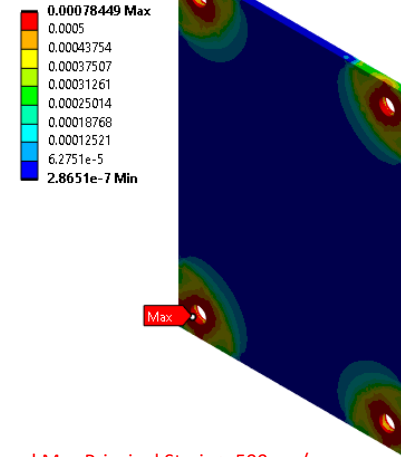
Equivalent (von-Mises) Stress - Component4\Electronic_component - 1. s
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
2/8/2023 7:11 PM



✓ Max stress < Tensile Ultimate Strength of 100 MPa.

D: Static Structural - DEMO

Maximum Principal Elastic Strain - Component3\PCB - 1. s
Type: Maximum Principal Elastic Strain
Unit: mm/mm
Time: 1 s
2/8/2023 7:12 PM

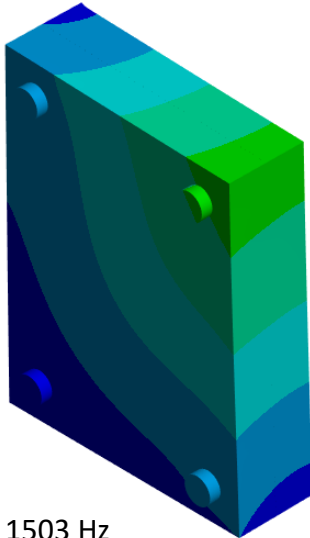
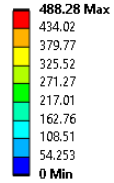


! Max Principal Strain > 500 um/m

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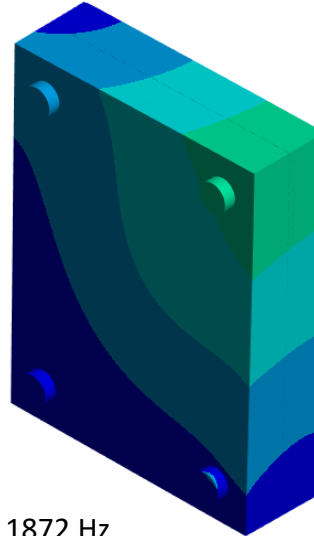
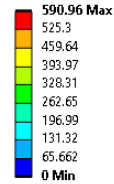
Results: Modal Analysis – eigenfrequencies and eigenmodes

E: Modal
Total Deformation
Type: Total Deformation
Frequency: 1503.1 Hz
Unit: mm
2/8/2023 7:14 PM



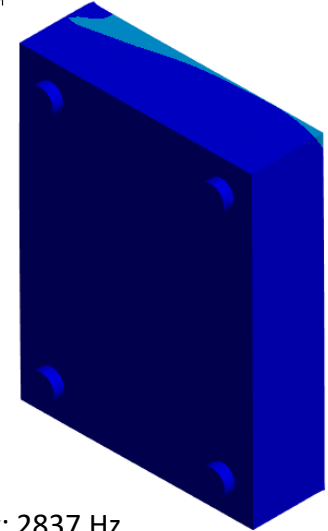
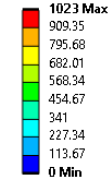
1st Frequency: 1503 Hz

E: Modal
Total Deformation 2
Type: Total Deformation
Frequency: 1871.9 Hz
Unit: mm
2/8/2023 7:14 PM



2nd Frequency: 1872 Hz

E: Modal
Total Deformation 3
Type: Total Deformation
Frequency: 2836.8 Hz
Unit: mm
2/8/2023 7:14 PM

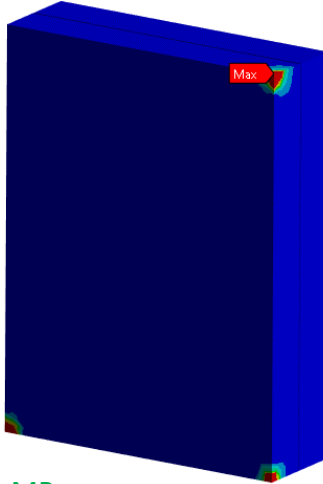
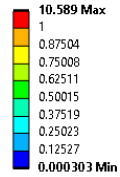


3rd Frequency: 2837 Hz

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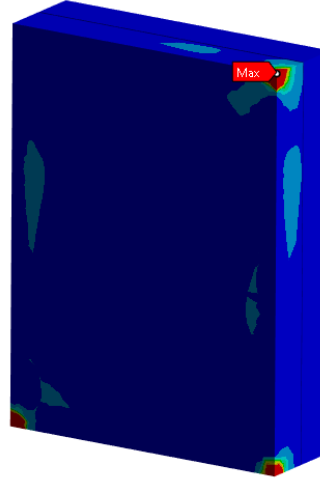
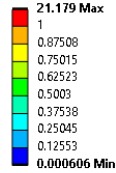
Results: Random Vibration Analysis – stress

F: Random Vibration
Equivalent Stress
Type: Equivalent Stress
Scale Factor Value: 1 Sigma
Probability: 68.269 %
Unit: MPa
Time: 0 s
2/8/2023 7:19 PM



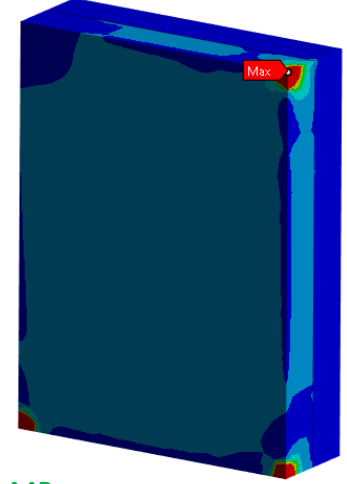
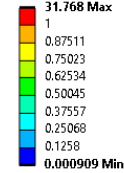
✓ 1sigma: 11 MPa

F: Random Vibration
Equivalent Stress 2
Type: Equivalent Stress
Scale Factor Value: 2 Sigma
Probability: 95.45 %
Unit: MPa
Time: 0 s
2/8/2023 7:20 PM



✓ 2sigma: 21 MPa

F: Random Vibration
Equivalent Stress 3
Type: Equivalent Stress
Scale Factor Value: 3 Sigma
Probability: 99.73 %
Unit: MPa
Time: 0 s
2/8/2023 7:20 PM

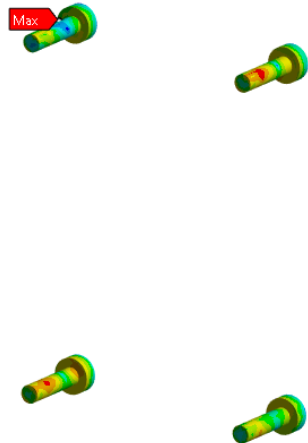
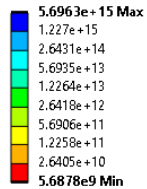


✓ 3sigma: 32 MPa

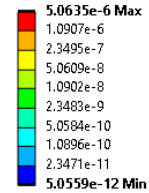
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Results: Random Vibration Analysis – Fatigue

F: Random Vibration
Life
Type: Life
2/8/2023 7:22 PM



F: Random Vibration
Damage
Type: Damage
2/8/2023 7:23 PM



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Conclusions

- › During assembly, the screws suffer plastic deformation, meaning they will lose pretension force.
 - › Solution proposal: lower the pretention force or change the steel grade.
- › During vibration, there is a 99.73% probability that the stress in the housing will be under 32 MPa.
 - › No failure or plastic deformation is expected for the considered vibration load.
 - › The predicted fatigue life of the screws is of 197493 8-hour cycles resulting a damage of 5e-6.

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Appendix

- › The contest subject will include:
 - › CAD in *.step format.
 - › All required elastic material properties, yield and ultimate strength.
 - › All other required material/assembly properties.
 - › Power Point Template for final report.
- › Contestants are expected to:
 - › Perform 3D static structural analysis, modal, random vibration analysis.
 - › Answer FEM / FEA related questions on materials, mechanics and analysis.
 - › Report results by respecting the template and demo presentation, properly scale legends and drawing own conclusions.
 - › Propose solutions / improvements where necessary.

Important dates & places

- › All the related information about the registration, contest guidelines & rules, bibliography, schedule, etc. will be found at the following address:
 - › [TIE-M plus Structural – eecamp](#)
- › Preliminary schedule and important dates:
 - › Demo subject release: **WK102023**
 - › Contest subject requirements release (pdf only): **6 April 2023**
 - › CAD model release (needed to solve the requirements): **10 April 2023**
 - › Final report to be uploaded by the contestants on the platform: **23 April 2023**
 - › Announce the finalists (contestants who will present on 9 May, live): **28 April 2023**
 - › Final presentation and debates with the Technical Committee: **9 May 203**



Registration date:
6-09 April 2023

Note: except for May 9, the other dates may suffer +1-2 days delay.

Thank you
for your attention!