Cascade Engineering Services, Inc.

PCBA Modal Analysis using FEA

Reliability Engineering Group
Cascade Engineering Services, Inc.
6640 185th Ave NE Redmond WA 98052
(425) 895-8617 x 564

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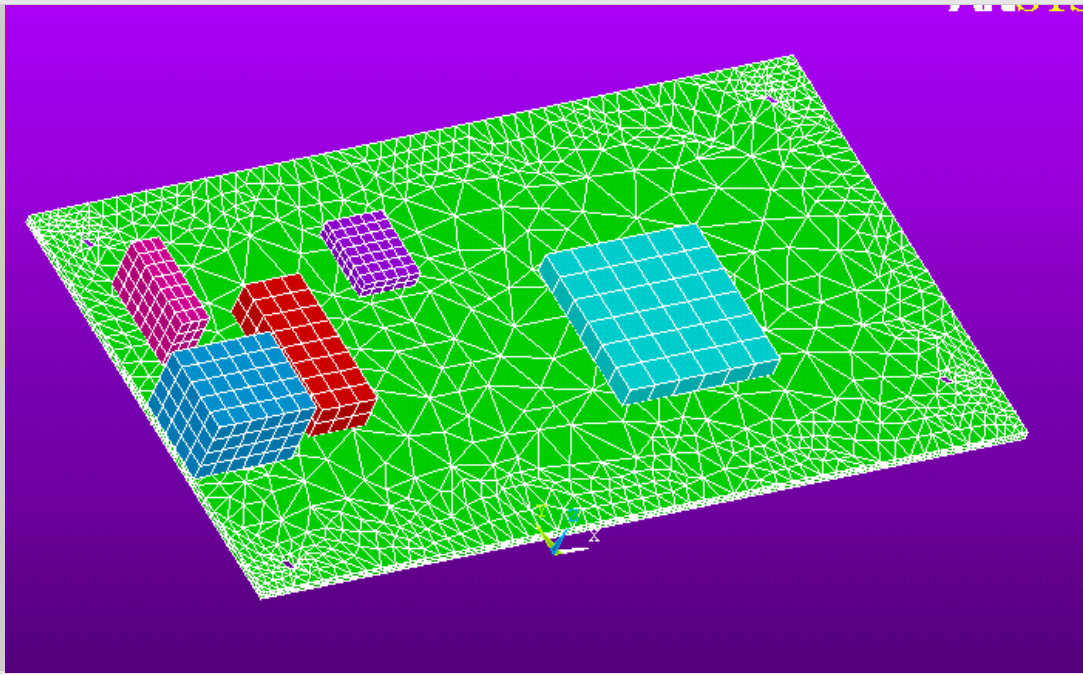
PCBA Modal Analysis

Introduction

- Vibration Modes are inherent properties of a structure, and are determined by the material properties (mass, damping, and stiffness), and boundary conditions of the structure.
- Each mode is defined by a natural (modal or resonant) frequency, modal damping and a mode shape
- Test Case: Modal Analysis of PCBA Assembly with 4 constraint locations to study the inherent property of this structure

Note: Modal Analysis can be considered as a virtual qualification study for Sine sweep tests and random vibration tests.



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FEA Procedure Outline

Test Objective

- To determine fundamental modal frequencies of an electronic PCBA using FEA

Methodology

- Step 1: Geometry and Material Properties
- Step 2: Loads and Boundary Conditions
- Step 3: FEA Model
- Step 4: Sample Results
- Case Study Benefits

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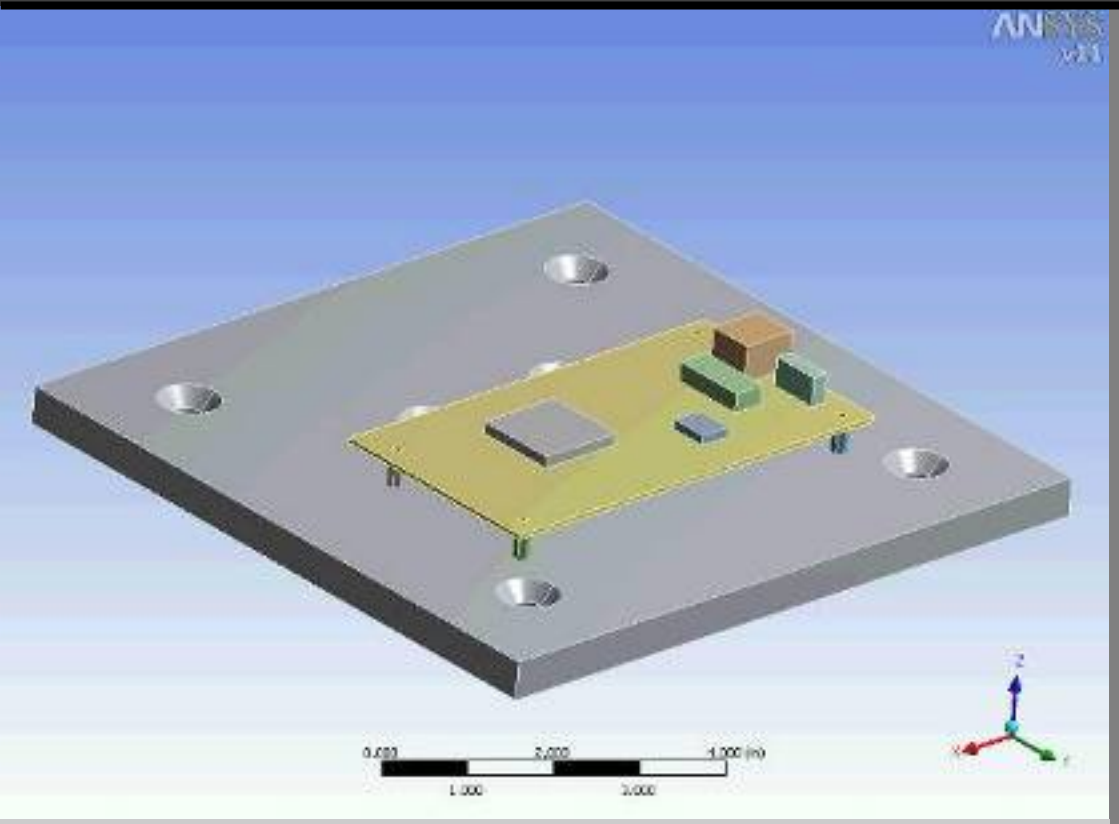
Step 1: Geometric Model & Material Properties



CAD MODEL: PCBA-Fixture setup with standoffs

Unit System	U.S. Customary (in, lbm, lbf, °F, s, V, A)
Angle	Degrees
Rotational Velocity	rad/s

Material	Young's Modulus	Poisson's Ratio	Density	Tensile Strength
	psi		lb/in^3	psi
FR4	2.81E+06	0.35	6.50E-02	38000
Stainless Steel	2.80E+07	0.31	2.80E-01	30023
ABS	3.39E+05	0.3	3.78E-02	5800

Material Properties

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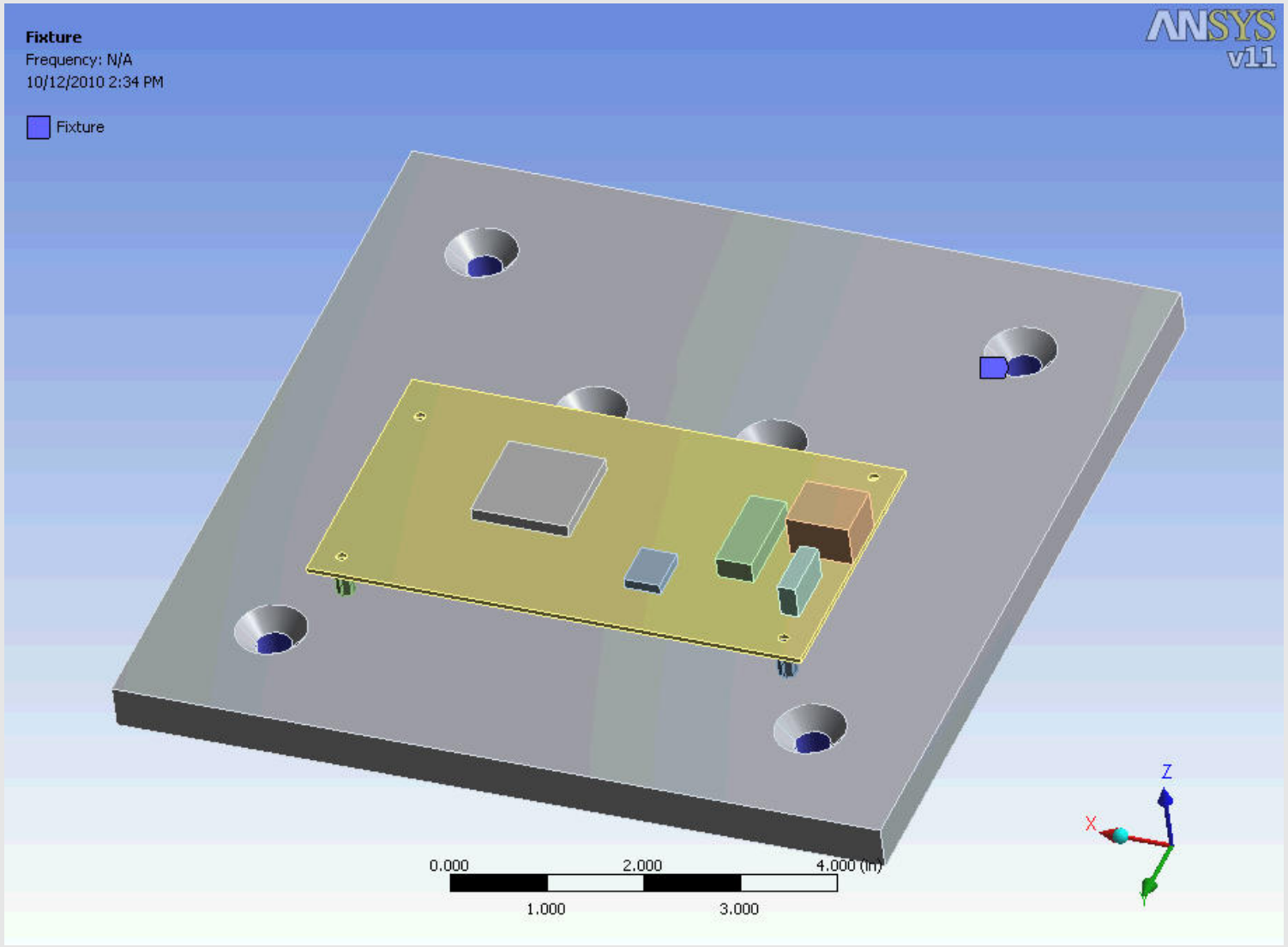
Step 2: Loads & Boundary Conditions



Constraints/BC	Fixed Support
Constraint Location	Mounting holes on fixture-shock table

Modal Analysis helps determine the fundamental frequency modes

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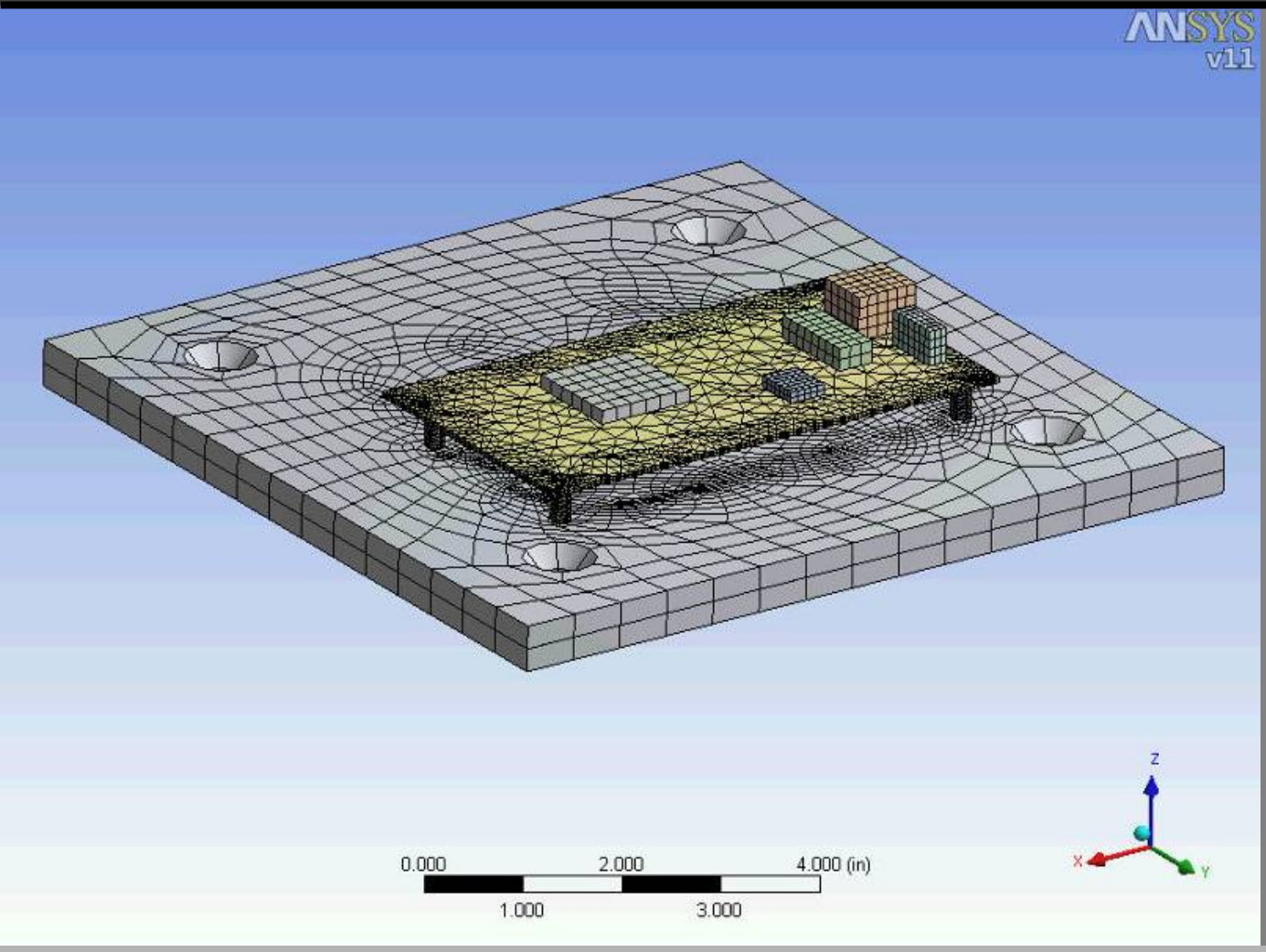
Step 3: FEA Model



Details of "Mesh"

Defaults	
Physics Preference	Mechanical
Relevance	0
Advanced	
Relevance Center	Coarse
Element Size	Default
Shape Checking	Standard Mechanical
Solid Element Midside Nodes	Program Controlled
Straight Sided Elements	No
Initial Size Seed	Active Assembly
Smoothing	Low
Transition	Fast
Statistics	
Nodes	82755
Elements	37650

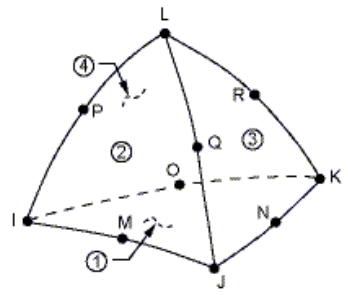
Element Type Used

SOLID187

3-D 10-Node Tetrahedral Structural Solid

10 nodes 3-D space

DOF: UX, UY, UZ

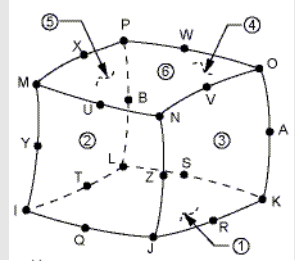


SOLID186

3-D 20-Node Structural Solid or Layered Solid

20 nodes 3-D space

DOF: UX, UY, UZ



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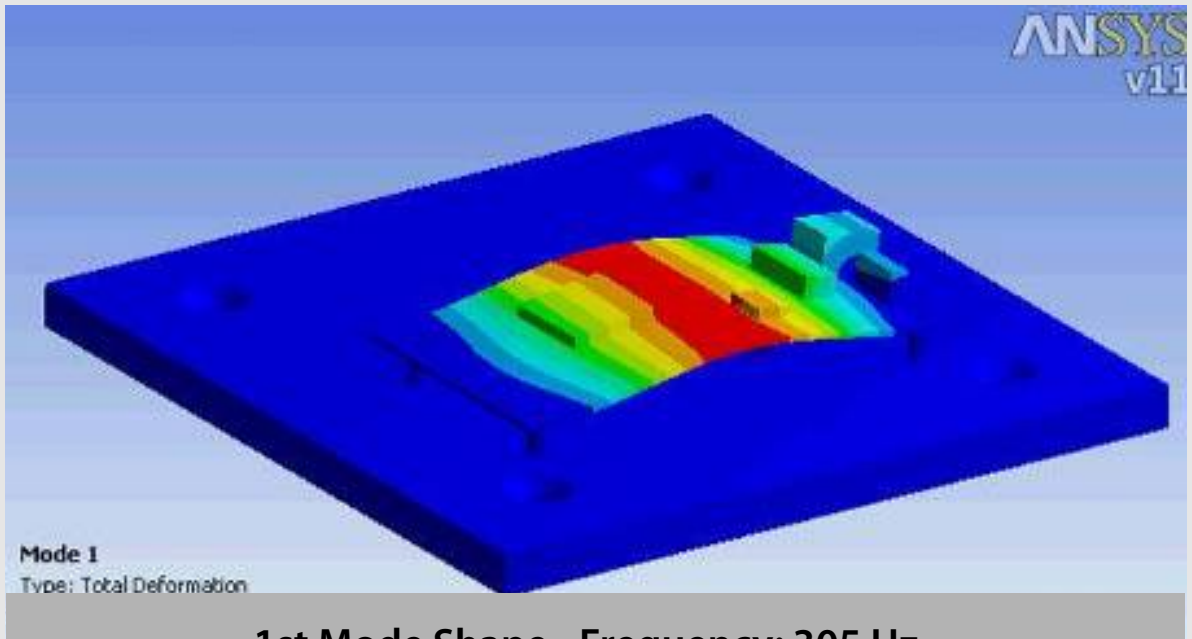
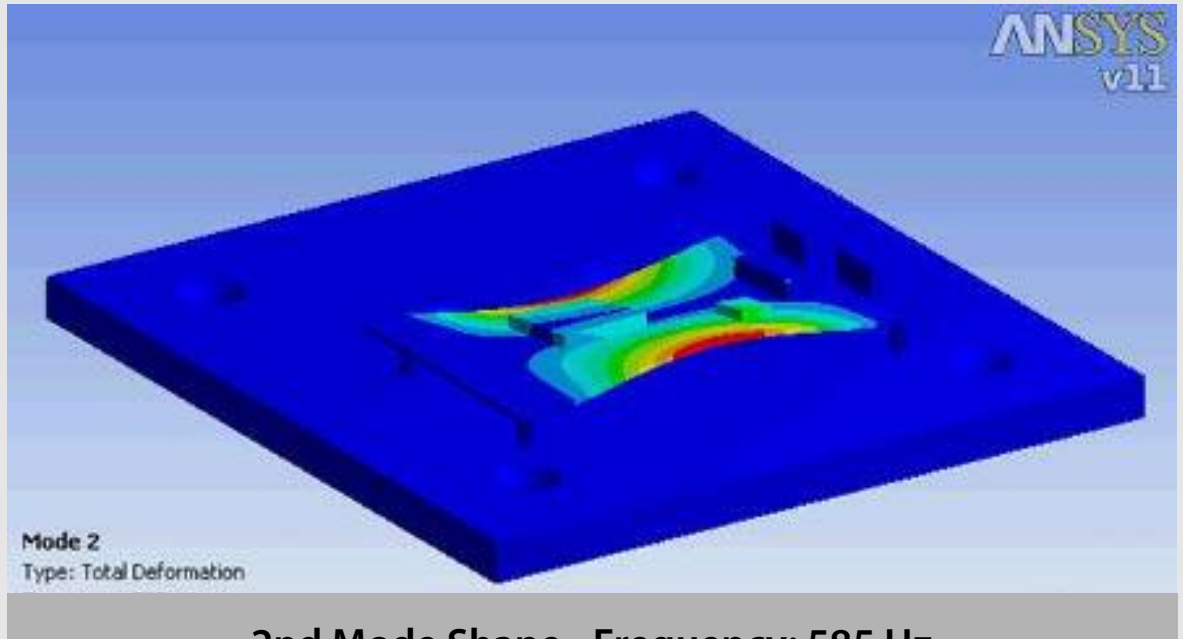
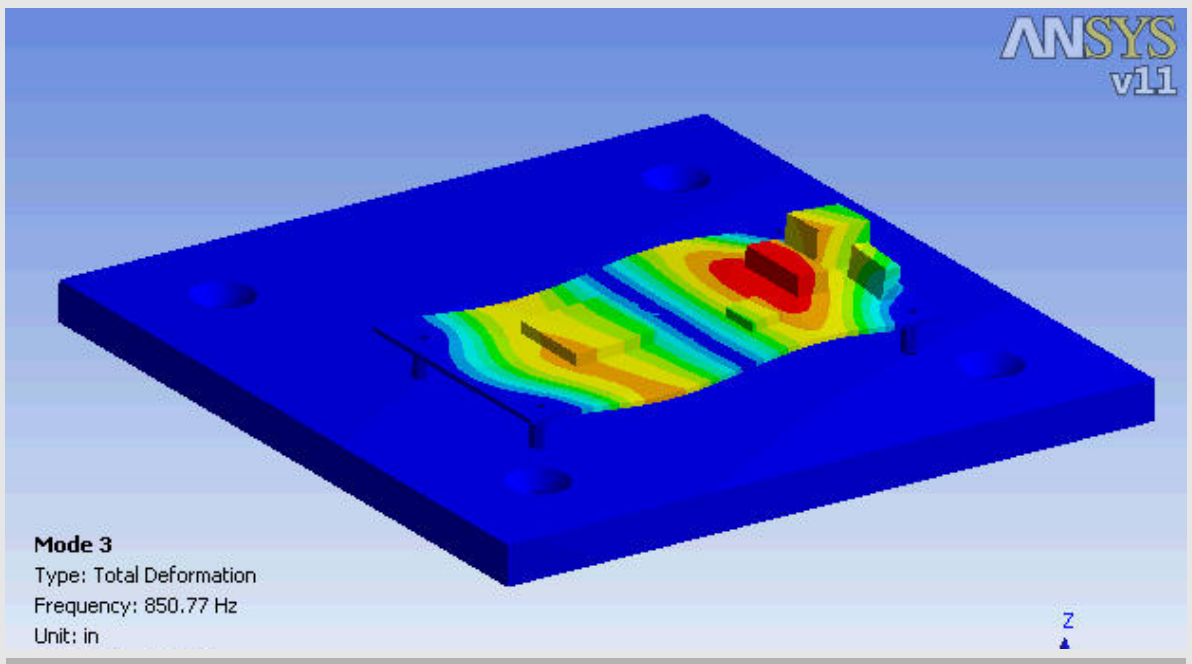
Step 4: Modal Analysis Results



1st Mode Shape - Frequency: 305 Hz



2nd Mode Shape - Frequency: 585 Hz



3rd Mode Shape - Frequency: 850 Hz

Mode #	PCBA only	PCBA with Fixture
1	296 Hz	305 Hz
2	570 Hz	585 Hz
3	819 Hz	850 Hz
4	1048 Hz	1084 Hz
5	1269 Hz	1304 Hz
6	1397 Hz	1429 Hz

Outputs

- Mode Shapes-displacements
- Critical locations for sensor mounting-accelerometer and strain gages

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Case Study Benefits

- Quick and easy analysis for understanding product behavior
- Provides insights for sensor placement and valuable transmissibility information
- Useful and necessary for vibration damage quantification