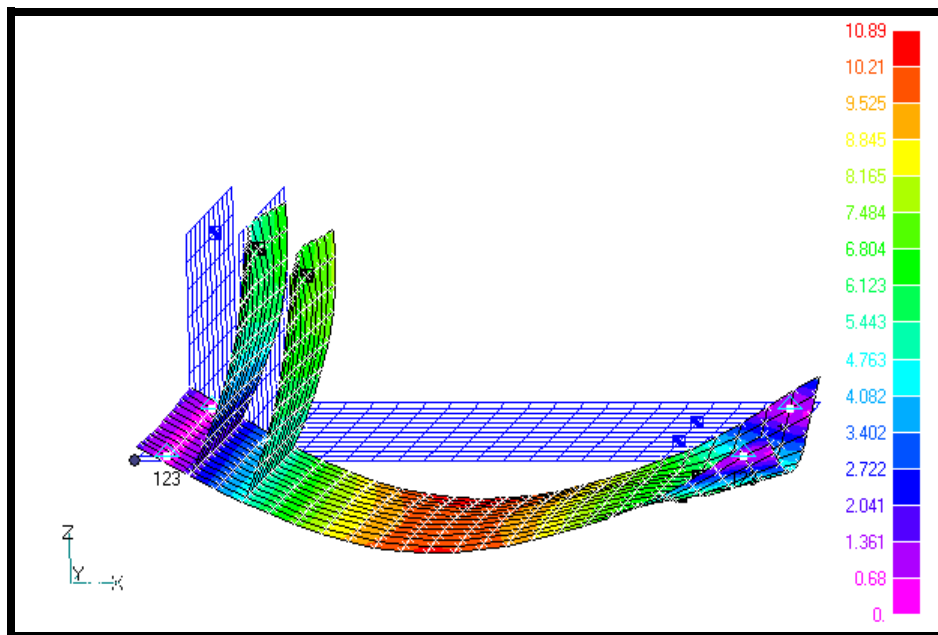


WORKSHOP 12b

Frequency Response of a Printed Circuit Board with an Analysis Restart



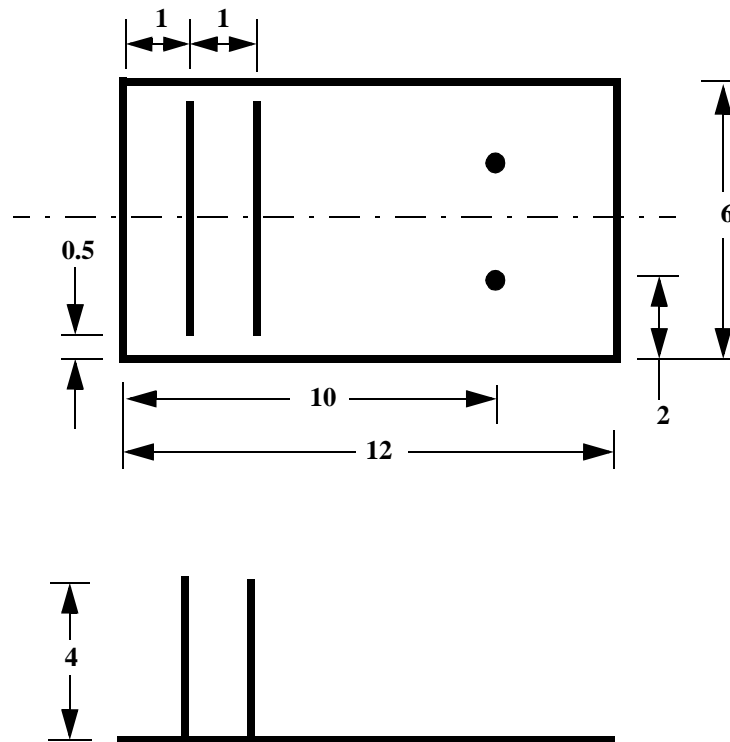
Objectives:

- Define frequency dependent loads on an existing model
- Conduct a frequency response to 50 Hz analysis using modes with frequencies less than 50 Hz saved in a previous Analysis
- Re-run the response using all the saved modes and compare the two sets of results
- Expand the complex results at a critical frequency to see the animated shape

Model Description:

Frequency dependent loads will be defined on the model from workshop 12a. A frequency response analysis from 10-50 Hz will be conducted using the modes that were saved for restart in the previous analysis. The purpose of the analysis is to determine if the two daughter cards will contact under the dynamic load. The load will be a 4 psi. pressure on the outside faces of the two daughter cards. We will first run the analysis using only the saved modes with frequencies below 50 Hz and then with all the saved modes. The results will be compared. Finally, the complex results at the critical frequency will be expanded to allow an animation to be displayed.

Figure 12b.1 - Printed Circuit Board Dimensions



A printed circuit board is pinned at its corners. The material properties data are given below. Determine the first 10 modal frequencies of the circuit board.

Circuit Board Properties:

Elastic Modulus, E =	3.3E6 psi
Poisson's Ratio, ν =	0.3
Mass Density =	0.1 lbs./in ³
Thickness, t =	0.125 in.

Capacitor Properties:

Mass, M =	1 lb
I _x =	4 lbs./in ²
I _y =	4 lbs./in ²
I _z =	3 lbs./in ²
Offset from Board =	2

CPU Properties:

Mass, M =	0.25 lb
I _x =	4 lbs./in ²
I _y =	4 lbs./in ²
I _z =	3 lbs./in ²

Exercise Procedure:

1. Start up MSC.Nastran for Windows V4.0 and begin to create a new model.

Double click on the icon labeled **MSC.Nastran for Windows V4.0**.

On the *Open Model File* form, select **Circuit_board.MOD**.

Open Model File:

Circuit_board.MOD

Open

2. View the undeformed model.

View/Select... (F5)

Deformed Style

None-Model Only

Contor Style

None-Model Only

OK

View/Rotate... (F8)

Diometric

OK

3. Create a unit load function versus frequency.

Model/Function...

Title:

Unit_Load

Type:

3..vs. Frequency

X

1

Y

1

More

X

100

Y

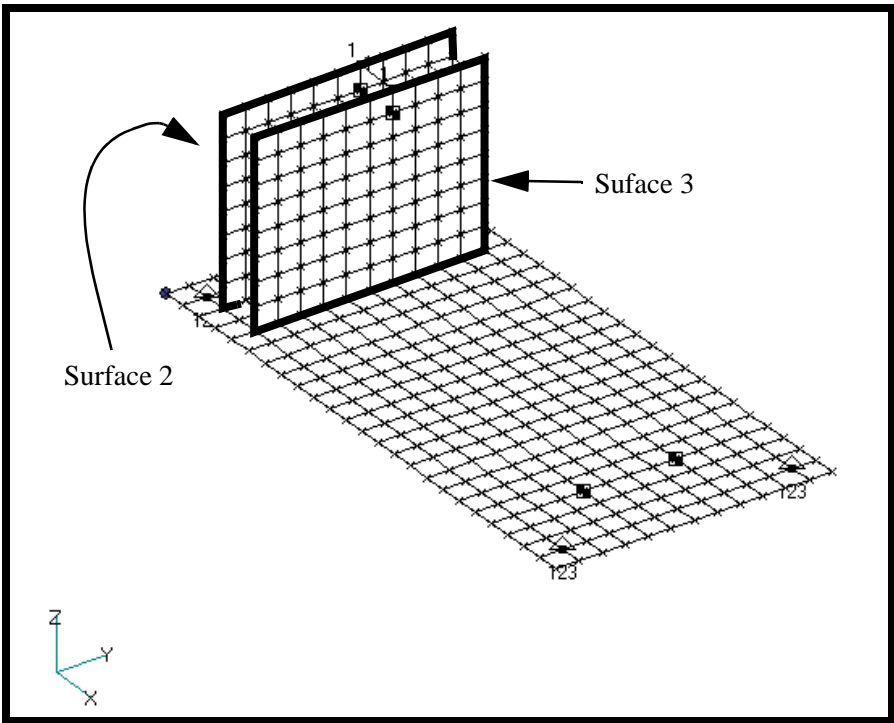
1

More

OK

Cancel

Figure 12b.2 - Finite Element Picute of Circuit Board.



- 4. Create the pressure load of 4 psi on the outside faces of the daughter cards.

Model/Load/Elemental...

Title **Pressure_Load**

OK

Method^

on Surface

Select Surface 2, the card closest to the edge of the main board
<see Figure 12b.2>

ID

OK

On the **Create Load on Elements** menu:

Pressure

Function Dependance

OK

Face

Now, enter the pressure on the second daughter card.

Select Surface 3 <see Figure 12b.2>

ID

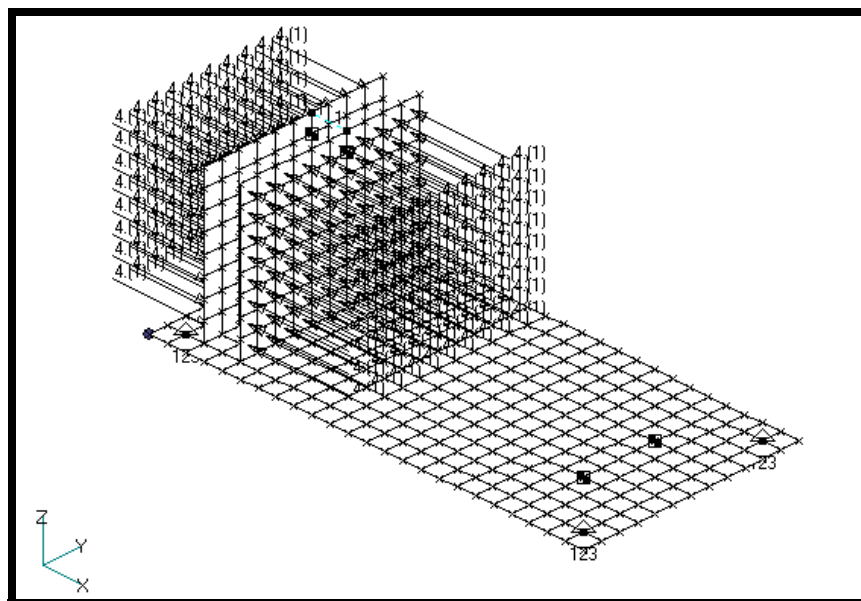
On the **Create Load on Elements** menu:

Pressure

Function Dependance

Face

Figure 12b.3 - Pressure Loading on Daughter Cards.



5. Define the parameters for the dynamic analysis. The analysis will be conducted from 10 to 50 Hz. We will only include modes with frequencies below 50 Hz.

Model/Load/Dynamic Analysis...

Solution Method

● Modal Frequency

Equivalent Viscous Damping

Overall Struct... Coeff(G)

0.1

Response Based on Modes

Highest Frequency (Hz)

50

Modal Freq...

Modal Results

First Freq

1..Mode 1 19.81138 Hz

Last Freq

5..Mode 5 47.16561 Hz

Note: We only want to include frequencies below 50 Hz.

Number of Point per Existing Mode

5

Spread(+/-)

5

OK

OK

6. Add additional solution frequencies every 1 Hz from 10 to 50 Hz.

Modify/Edit/Function...

Entity ID

2..Modal Frequency Table

OK

Data Entry

● Linear Ramp

Delta X

1

X

10

Y

To X

50

To Y

OK

7. Now, save the model with the new settings.

File/Save As..

File name

Prob12b

Save

8. Delete old output sets

Delete/Output/Set...

Select All

OK

Yes

Quick Options... Ctrl+Q

All Entities Off

Draw

Element

Done

9. Submit the model for analysis

File/Export/Analysis Model...

Type

4..Frequency/Harmonic Response

OK

File name

frf12b_50

Write

Additional Info

Run Analysis

Restarts...

Restart Previous Analysis

OK

File name

circuit_board.MASTER

Open

Advanced...

Note: In order for the restart to work correctly, the model constraints and eigenvalue extraction must be exactly the same as in the modal run.

Solution Type

● **Modal**

Eigvalues and Eigenvectors

Number Desired

10

OK

OK

Output Requests

Deselect all of the output options except Displacement

Displacement

OK

PARAM

WTMASS

0.00259

OK

Yes

Continue

10. Plot the results from the relative motion degree of freedom (node 1000, T1).

View/Select... (F5)

XY Style

● **XY vs Set Value**

XY Data...

Output Set

1..Case 1 Freq 10.

Output Vector

2..T1 Translation

Output Location

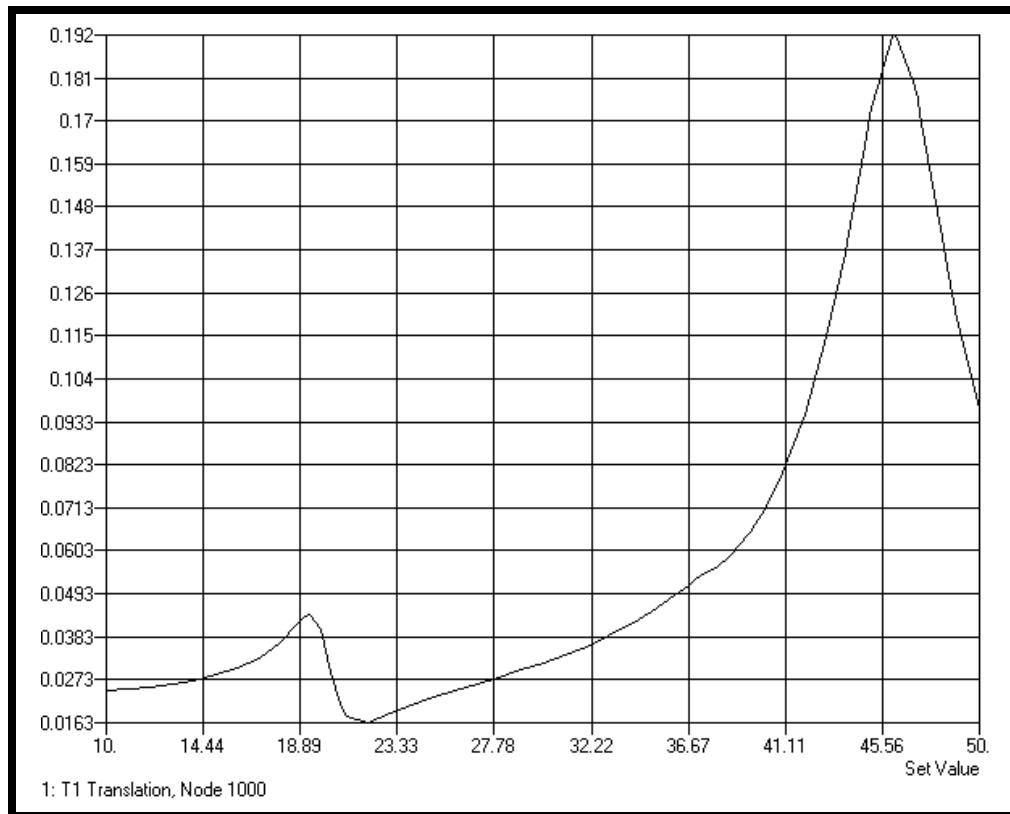
Node

1000

OK

OK

Figure 12b.4 - Relative Motion Plot of Node 1000



What is the magnitude of the largest relative deflection and its frequency?

List/Output/XY Plot..

Double click on the lower message window to view the output from the plot.

Figure 12b.5 - Sample of Output Data from Plot

Mode	Frequency	Value
40.0975	0.070708	1000
41.	0.080472	1000
42.	0.095065	1000
43.	0.11483	1000
43.8365	0.13644	1000
44.	0.14121	1000
44.8073	0.16615	1000
44.9901	0.17166	1000
45.	0.17195	1000
45.9865	0.19164	1000
46.	0.19172	1000
46.1437	0.19217	1000
47.	0.1804	1000
47.1656	0.1759	1000
47.2973	0.17201	1000
48.	0.14929	1000
48.3447	0.13827	1000
48.4509	0.13501	1000
49.	0.11938	1000
49.5239	0.10656	1000
50.	0.096586	1000

Does this indicate contact between the two cards?

Double click on the message window to reform it to the original size.

- Now, re-run the analysis using all 10 saved modes. Setting the Highest Frequency to 0 will cause MSC.Nastran to use all available modes

Model/Load/Dynamic Analysis...

Response based on Modes

Highest Freq (Hz)

File/Export/Analysis Model...

Type

File name

Additional Info Run Analysis

Restart Previous Analysis

File name

Open

Advanced...

Solution Type **● Modal**

Eigvalues and Eigenvectors

Number Desired **10**

OK

OK

Output Request

Deselect all of the output options except displacement

Displacement

OK

PARAM

WTMASS **0.00259**

OK

Yes

Continue

The first analysis results are in output sets 1-66. The second output sets are in 67-132

View/Select... (F5)

XY Style **● XY vs Set Value**

XY Data...

Output Set **67..Case 1 Freq 10.**

Output Vector **2..T1 Translation**

Show Output Sets

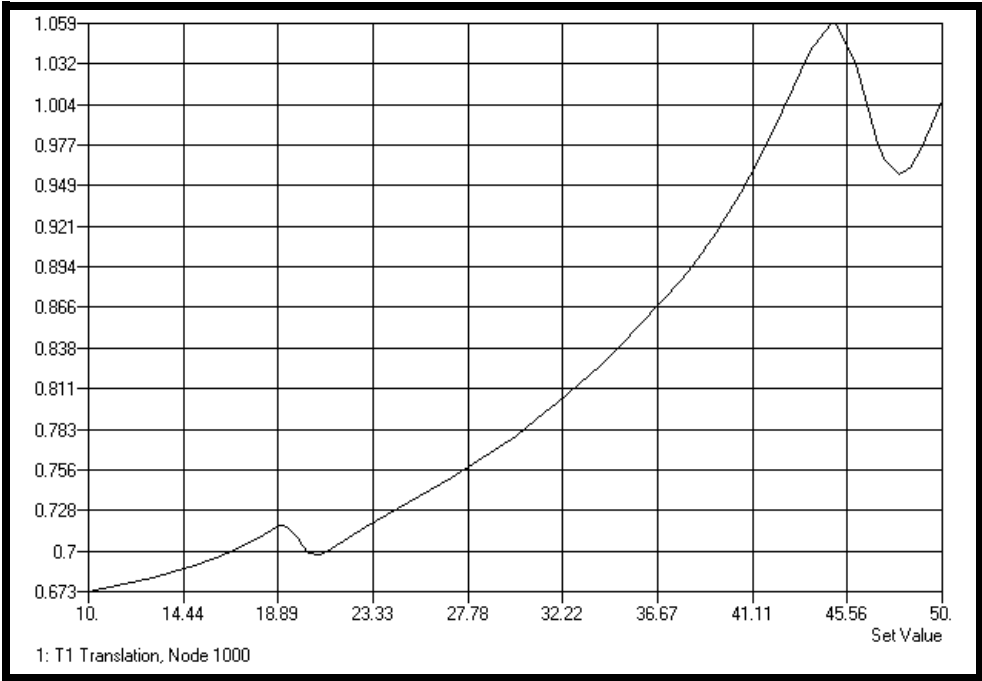
From **67**

To **132**

OK

OK

Figure 12b.6-Relative Motion Plot of Node1000 for All 10 Modes



What is the magnitude of the largest relative deflection and its frequency?

List/Output/XY Plot..

Double click on the lower message window to view the output from the plot

Figure 12b.7 - Sample of Output Data from Plot

Frequency	Displacement	Force
40.6915	0.94747	1000
41.	0.9556	1000
42.	0.98402	1000
43.	1.0151	1000
43.8365	1.04063	1000
44.	1.04505	1000
44.8073	1.05915	1000
44.9901	1.05948	1000
45.	1.05945	1000
45.9865	1.03257	1000
46.	1.03188	1000
46.1437	1.02422	1000
47.	0.97733	1000
47.1656	0.97058	1000
47.2973	0.96613	1000
48.	0.95656	1000
48.3447	0.95937	1000
48.4509	0.96098	1000
49.	0.97352	1000
49.5239	0.98987	1000
50.	1.00685	1000

Does this indicate contact between the two cards?

Double click on the message window to reform it to the original size.

12. Animate the displacement at 44.9901 Hz from the second analysis.

View/Options... (F6)

Catagory

PostProcessing

Options

Deformed Style

% of Model (Actual)

Options

Animated Style

Frames

Delay

View/Select.. (F5)

Model Style

Draw Model

Deformed Style

Animate

Deformed and Contour Data...

Output Set

119..Case 53 Freq 44.9901

Output Vectors

Description

2..T1 Translation

OK

OK

View/Rotate... (F8)

X: -80

Y: 0

Z: -10

Does this indicate contact?

Notice that all motion is in phase. This is because we are only plotting magnitude. To see the true response we must include the phase.

View/Select... (F5)

Deformation Style

● None-Model Only

OK

Model/Output/Expand Complex...

Entire Set

From

Output Set

119..Case 53 Freq 44.9901

Output Vector

2..T1 Translation

First Phase

0

Last Phase

360

Increment

30

OK

View/Options... (F6)

Option

Animate Style

Shape

2..Linear - Half

OK

View/Select... (F5)

Deformed Style

Animate - MultiSet

Deformed and Contour Data..

Output Set

133..Freq 44.99, Phase 0.

Output Vector

Deformation

2..T1 Tanslation

Final Ouput Set

144..Freq 44.99, Phase 330.

OK

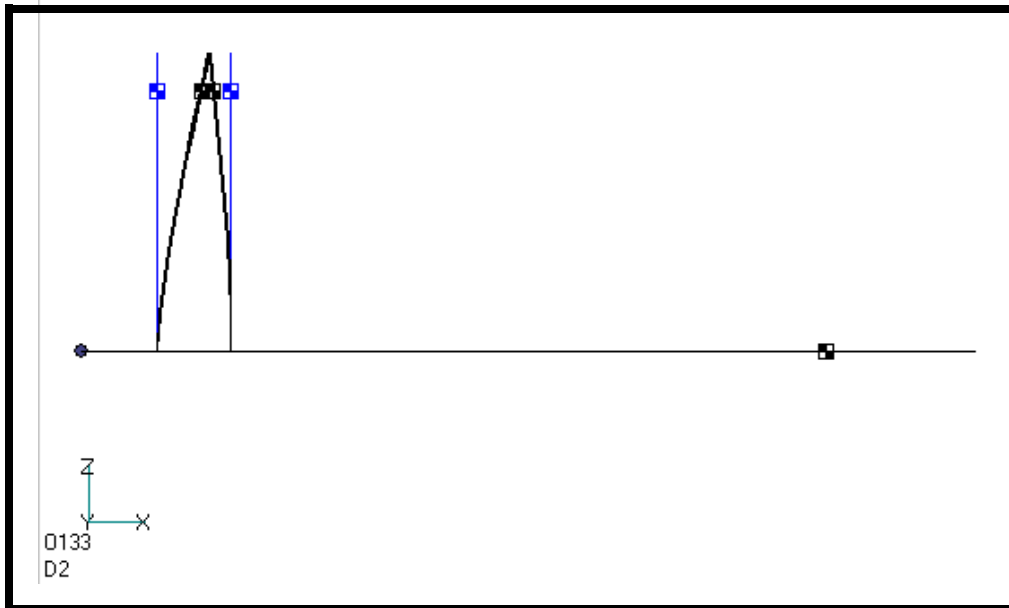
OK

Use Dynamic Rotate and the left mouse button to rotate the model and inspect the phase at which the two daughter cards contact.

Dynamic Rotate Symbol



Figure 12b.8 - Side View of Daughter Cards When in Contact



When finished, exit MSC.Nastran for Windows.

File/Exit

Yes

This concludes the exercise