EMA Correlation

The **Correlation** tab compares the mode shapes you measured (EMA) with the mode shapes predicted by a finite element analysis (FEA) model. It answers two questions:

- **Do the shapes match?** EDM calculates the Modal Assurance Criterion (MAC) between every EMA mode and every FEA mode.
- **Do the frequencies match?** EDM pairs each EMA mode with the FEA mode closest in frequency and shows the difference in %.

Use this tab to validate an FEA model against test data, or to find which test mode corresponds to which predicted mode.

Fix Me! **Screenshot:** The full Correlation tab, with the shape selectors, MAC table, frequency error row and parameter tables on the left, and the 3D animation view on the right.

The tab has two panes:

Shape- the import and calculation buttons, the shape selectors, the MAC table, the frequency error, and the mode and DOF tables for both shapes.

Animation- a 3D view where you can animate the EMA and FEA mode shapes.

NOTE: The Correlation tab requires the correlation option on your license. You cannot use this tab while a test is running.

Workflow

1. Calculate and save an EMA shape (see the Stability Diagram page).
2. **Import** the FEA geometry and the FEA mode shapes.
3. Choose the **EMA shape** and the **FEA shape**.
4. Use **Modal mapping** to match the FEA nodes to the EMA test points.
5. Click **Calculate MAC**, and review the MAC table and the frequency errors.
6. Use **Display MAC chart** and the animations to check the results.

Importing FEA Data

Click **Import** and choose what to import:

Model- Imports the FEA geometry (mesh). Supported files are `.xml`, `.unv`, and `.nas`.

Mode shape- Imports the FEA mode shapes from a Universal File (`.unv`) with mode shape records (dataset 55). If the file also contains the geometry, it is imported too, and you do not need to import the model separately.

Fix Me! **Screenshot:** The MAC table after a calculation, with high values along the diagonal.

The **MAC table** has one row for each EMA mode and one column for each FEA mode. Each cell is the MAC between that pair of modes.

How to read the table:

- Each EMA mode should have one FEA mode with a high MAC (typically above 80–90%) and low values for all the others. That FEA mode is its match.
- If the modes are listed in the same order, the high values form a diagonal line.
- An EMA mode with no high value has no matching FEA mode. The FEA model may be missing that mode, or the test may not have measured it well.
- Two EMA modes that both match the same FEA mode may be one mode that was picked twice, or the test points may be too few to tell the shapes apart.

NOTE: The EMA and FEA shapes must have the same measurement points. If they do not, EDM shows *"Please perform the modal mapping operation first."* Run **Modal mapping** and try again.

Frequency Error

The **Relative error of modal frequency** row pairs each EMA mode with the FEA mode closest in frequency and shows the difference as a percentage of the EMA frequency:

$Error = |f(EMA) - f(FEA)| / f(EMA) \times 100\%$

NOTE: This pairing is by frequency only. Always check the MAC table to make sure the paired modes also have the same shape. Two modes can have close frequencies but different shapes.

Display MAC Chart

Click **Display MAC chart** to show the MAC table as a 3D bar chart. Each bar is one EMA-FEA pair, and its height is the MAC value.

Fix Me! **Screenshot:** The Modal Assurance Criterion window showing the 3D MAC bar chart.

Default- Resets the view of the chart.

Export chart- Saves the chart as a `.png` image.

Calculate the MAC before you open the chart.

Animating the Shapes

Right-click the Shape pane to animate the shapes in the **Animation** pane:

Match EMA Points / Match FEA Points- Links the DOFs in the table to the points of the geometry in the Animation pane.

EMA Animate Display / FEA Animate Display- Animates the enabled mode of the EMA or FEA

shape.

Animate an EMA mode and its matching FEA mode one after the other to compare them visually.

Fix Me! **Screenshot:** The Animation pane showing an FEA mode shape next to the matching EMA mode.

NOTE: Each DOF must have a valid format (for example +2X or +2X**:** -1Y), and no two DOFs can be the same. If a DOF is not valid, EDM highlights that cell in the table and does not animate.

FAQs

Why does Calculate MAC show "Please perform the modal mapping operation first."?- The FEA shape does not have the same points as the EMA shape yet. Run **Modal mapping**, or run it again if you have changed the EMA shape.

Why are all the MAC values low?- The mapping may be wrong (for example, the FEA model is rotated relative to the test geometry), or the DOF directions in the test do not match the model axes. Check the mapping and the DOF directions.

Why did my FEA shapes disappear?- Importing a new mode shape file replaces all the FEA shapes that were imported before.

Does disabling a mode remove it from the MAC?- No. The **Enabled** check box only controls which mode is shown and animated. All the modes are always included.

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