Altair® FluxMotor® 2026

Synchronous machines with wound field – Inner salient pole - Inner rotor

Motor Factory – Test – Mechanics

General user information

Altairhyperworks.com

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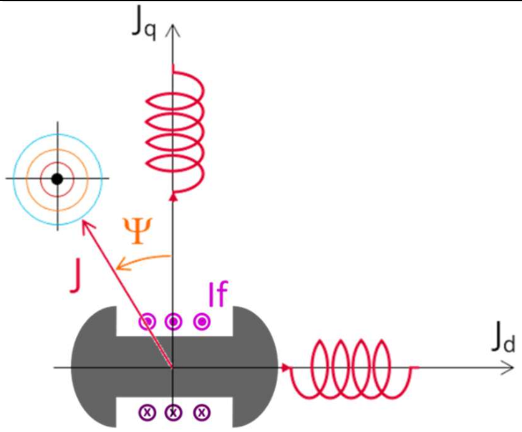
1 MECHANICS – NVH – WORKING POINT – If - I - Ψ - N

1.1 Overview

1.1.1 Positioning and objective

The aim of the test “Mechanics – NVH – Working point – If-I-Ψ-N” is to perform NVH analysis of the machine when operating at the targeted working point defined with the following inputs values If,I,Ψ,N (Magnitude of field current, magnitude of current, Control angle, Speed).



“Working point – Sine wave – Motor – If, I, Ψ, N” illustration

This test give data allowing NVH prediction in early electromagnetic and design stage.
The modal analysis of the stator mechanical structure, the radiated sound power and the magnetic forces applied on teeth are computed and displayed.

This test helps to answer the following question:

- Could the machine have any risks in connection with NVH? Yes / No.

The following table helps to classify the test “Mechanics – NVH – Working point – If-I-Ψ-N”.

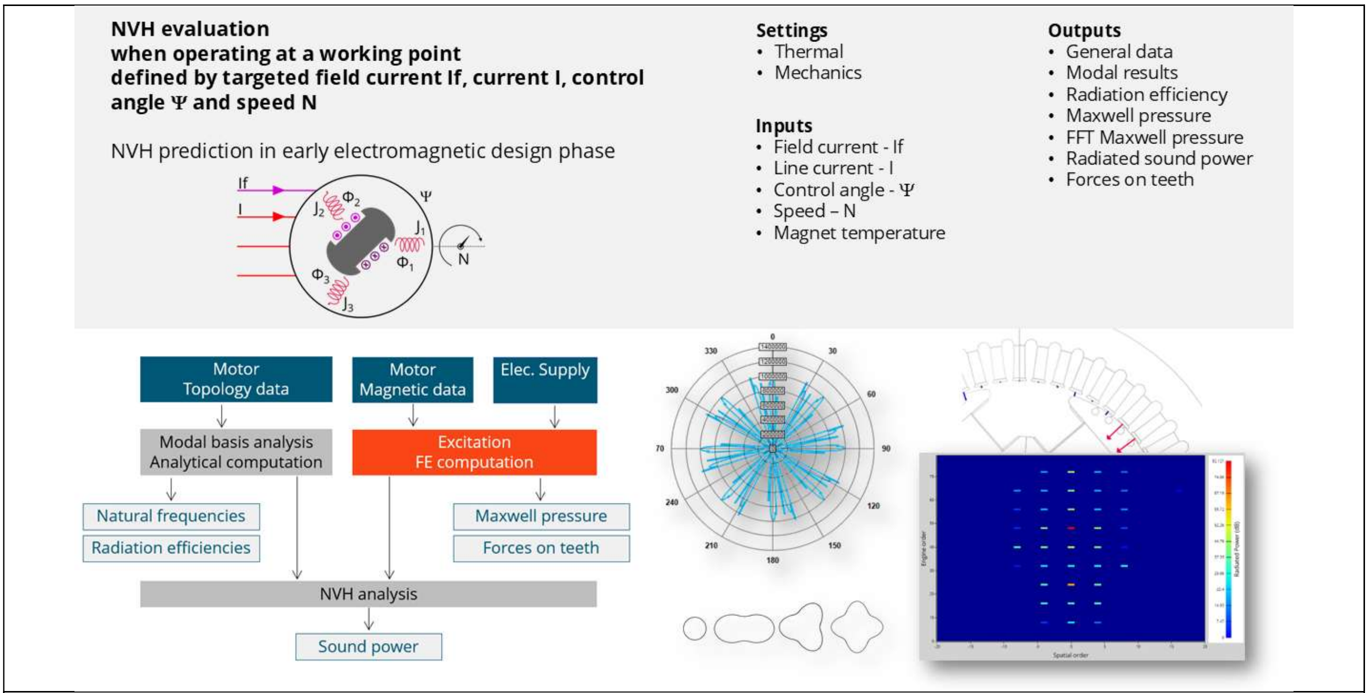
Family	Mechanics
Package	NVH
Convention	#
Test	Working point - If - I - Ψ - N

Positioning of the test “Mechanics – NVH – Working point – If-I-Ψ-N”.

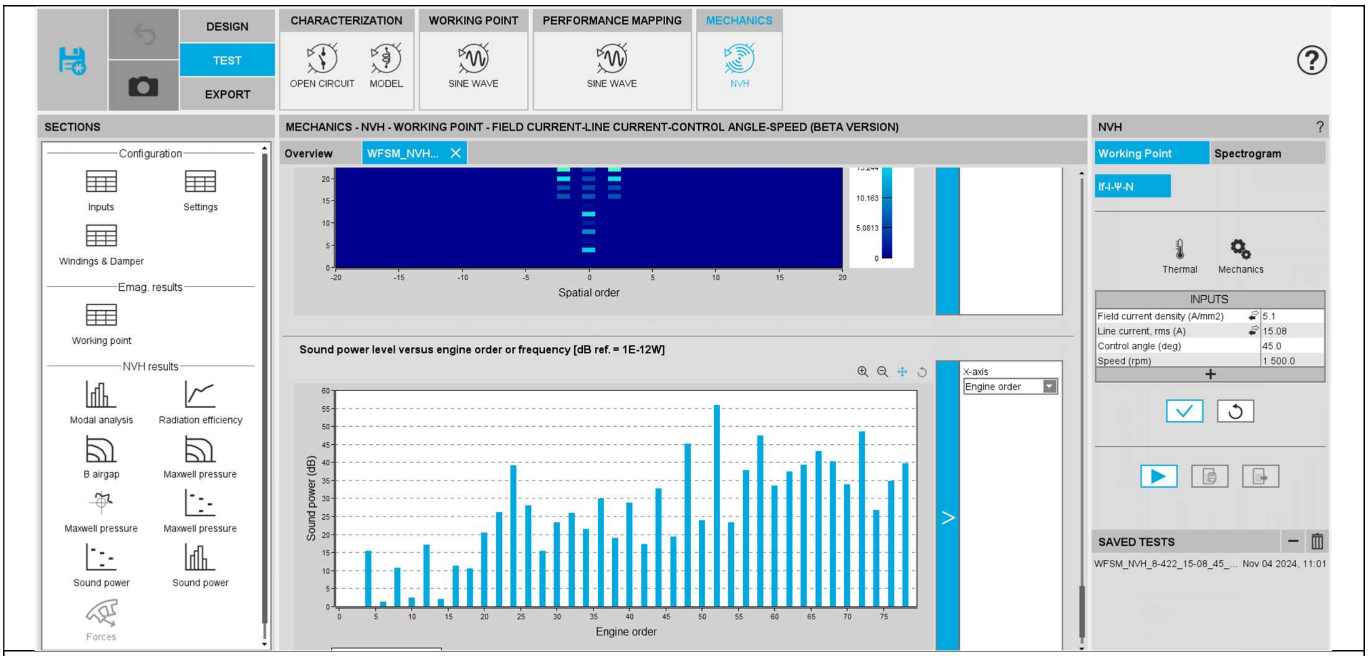
1.2 Main principles of computation

1.2.1 Introduction

Here are illustrations which give an overview of the test NVH – Working point (If, I,Ψ,N):



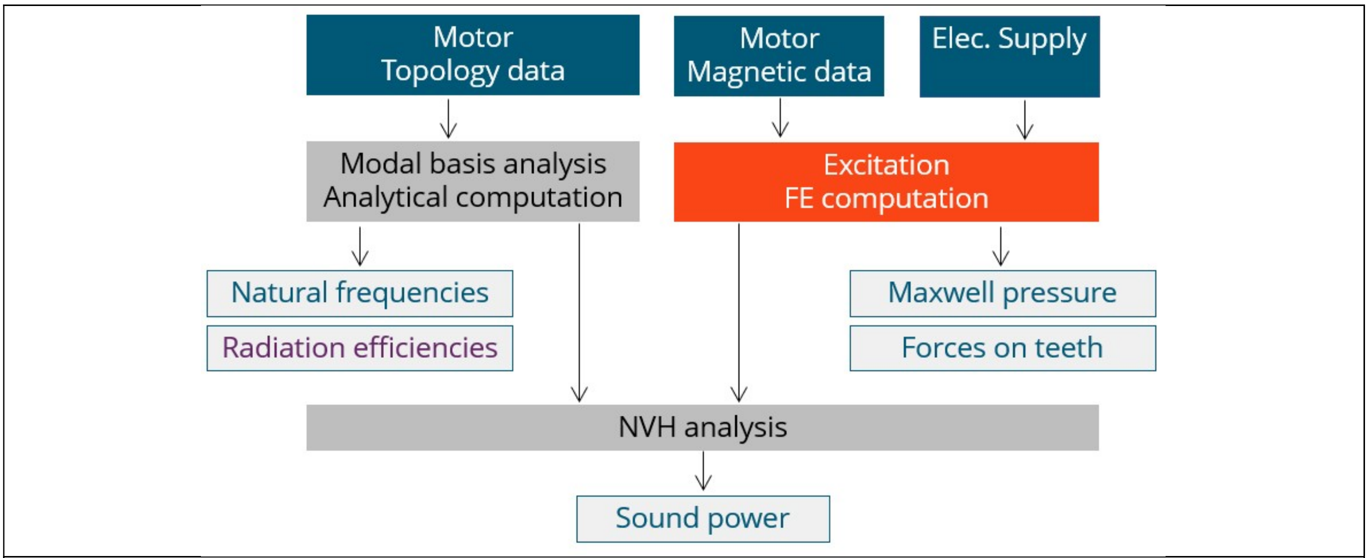
Mechanics – NVH – Working point (If, I, Ψ,N) - Overview



Mechanics – NVH – Working point (If, I, Ψ,N) - Test results

1.2.2 Flow chart

Here is the flowchart illustrating the internal process of the mechanical test.



NVH – Working point – If-I-Ψ-N test – Internal process flowchart

The inputs of the internal process are the parameters of:

- Motor topology data
- Motor magnetic data
- Electrical supply

The resulting NVH evaluation is based, first, on analytical computations allowing to characterize the modal analysis of the machine stator. Then, a time-space harmonic analysis of the Maxwell pressure computed in the airgap is performed. The Maxwell pressure is obtained from the normal flux density in the airgap computed in a 2D finite elements transient analysis.

Once this harmonic decomposition of the Maxwell pressure is performed, it is combined with the modal analysis of the machine to extract the acoustic power.

1.3 Limitation of computations - Advice for use

The modal analysis as well as the radiation efficiency are based on an analytical computation where the stator of the machine is considered as a vibrating cylinder.
The considered cylinder behavior is weighted by the additional masses like the fins or the winding and the subtractive masses like the slots and the cooling circuit holes.
This assumption allows to get fast evaluation of the behavior of machine in connection to NVH. In no way this can replace a mechanical Finite Element modeling and simulation.

Among possible reasons for deviations of results can be the following ones:

- The limits of the analytical model are reached or overpassed
- Unusual topology and/or dimensions of the teeth/slots
- Complexity of the stator-frame structure when it is composed with several components for instance
- The ratio between the total length of the frame L_{frame} and the stack length of the machine L_{stk} in any case, this ratio must be lower than 1.5:

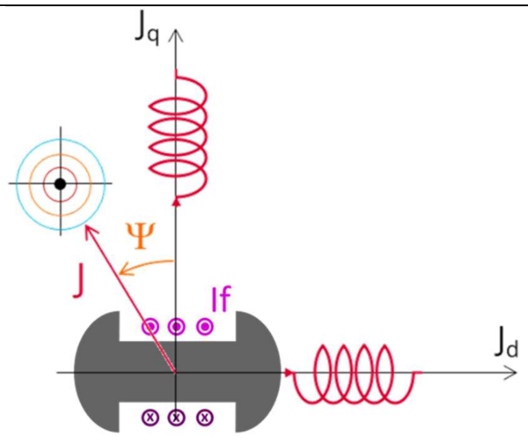
$$\frac{L_{Frame}}{L_{stk}} \leq 1.5$$

2 MECHANICS – NVH – SPECTROGRAM – If - I - Ψ - N

2.1 Overview

2.1.1 Positioning and objective

The aim of the test "Mechanics – NVH – Spectrogram – If-I-Ψ-N" is to perform NVH analysis on the machine when operating at a set of targeted working points defined with the following inputs values If,I,Ψ,N (Magnitude of field current, magnitude of current, Control angle, Speed).



"Working point – Sine wave – Motor – If, I, Ψ, N" illustration

This test give data allowing NVH prediction in early electromagnetic and design stage.
The modal analysis of the stator mechanical structure, the radiated sound power spectrogram per engine order versus speed and the resulting overall weighted radiated sound power versus speed are computed and displayed.
These results allow to see if there are any problems linked with NVH over the considered speed range.

And finally, this test helps to answer the following question:

- Could the machine have any risks in connection with NVH? Yes / No.

The following table helps to classify the test "Mechanics – NVH – Spectrogram – If-I-Ψ-N".

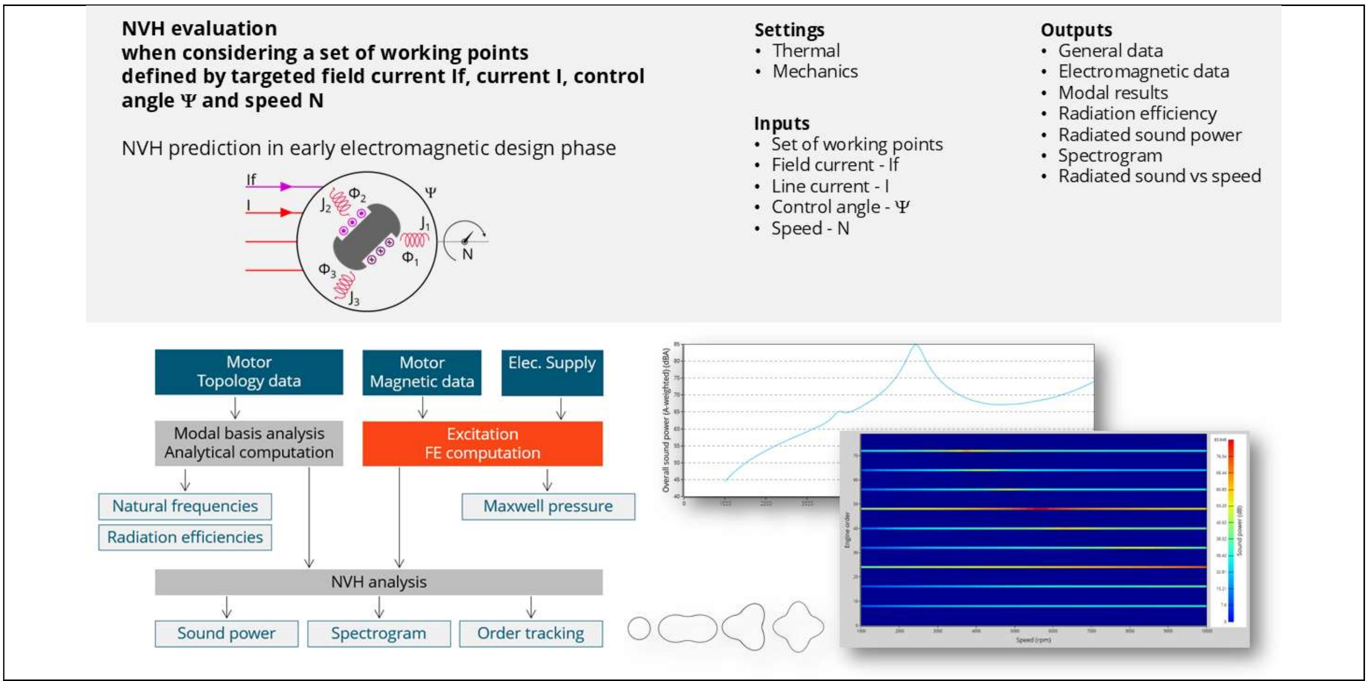
Family	Mechanics
Package	NVH
Convention	#
Test	Spectrogram - If - I - Ψ - N

Positioning of the test "Mechanics – NVH – Spectrogram – If-I-Ψ-N"

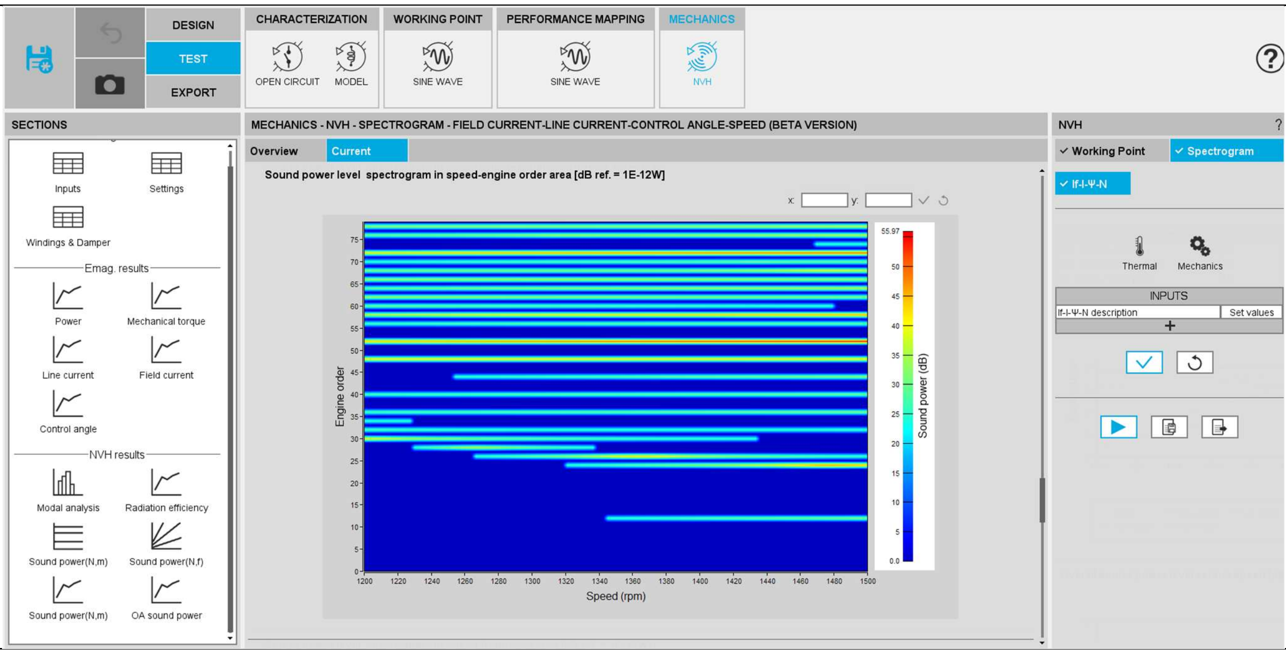
2.2 Main principles of computation

2.2.1 Introduction

Here are illustrations which give an overview of the test NVH – Spectrogram (If,I,Ψ,N):



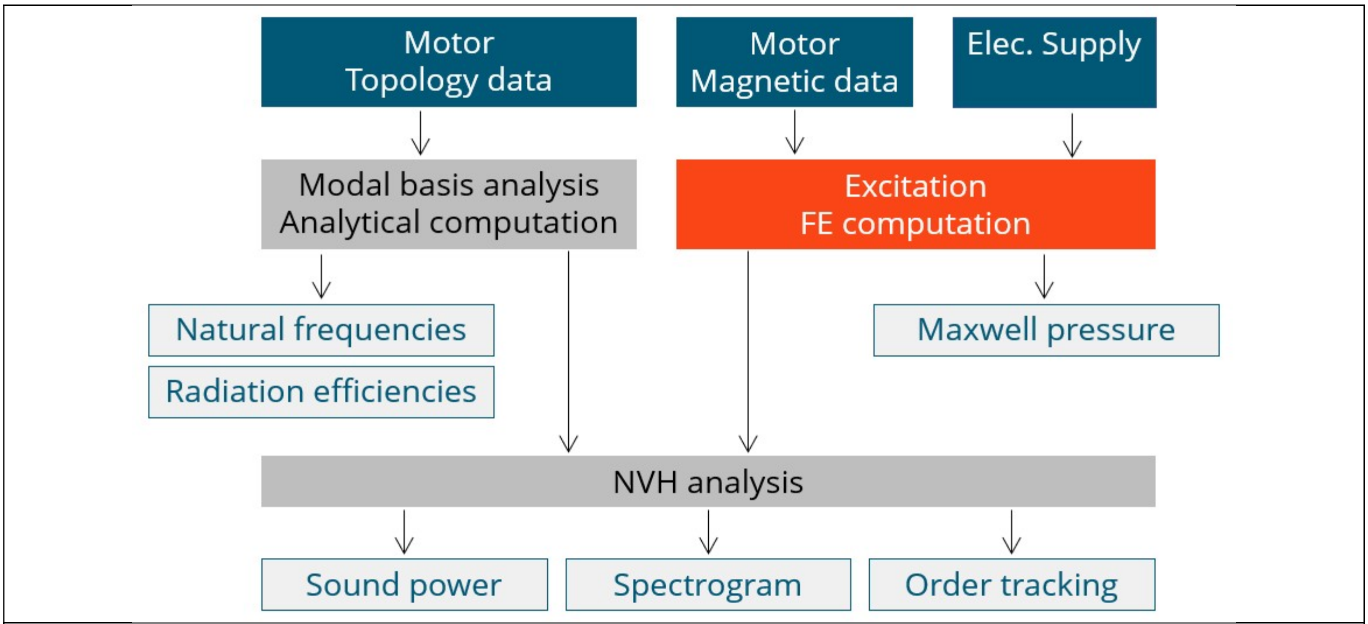
Mechanics – NVH – Spectrogram (If, I, Ψ,N) - Overview



Mechanics – NVH – Spectrogram (If, I, Ψ,N) - Test results

2.2.2 Flow chart

Here is the flowchart illustrating the internal process of the mechanical test.



NVH – Spectrogram (If, I, Ψ,N) test – Internal process flowchart

The inputs of the internal process are the parameters of:

- Motor topology data
- Motor magnetic data
- Electrical supply

For each point of the If-I-Ψ-N description, the process described in the previous test is performed. Once it is done, interpolations between the targeted working points are made to produce a high-quality order tracking/ spectrogram graph.

2.3 Limitation of computations - Advice for use

The modal analysis as well as the radiation efficiency are based on an analytical computation where the stator of the machine is considered as a vibrating cylinder.
The considered cylinder behavior is weighted by the additional masses like the fins or the winding and the subtractive masses like the slots and the cooling circuit holes.
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$$\frac{L_{Frame}}{L_{stk}} \leq 1.5$$