Sine Vibration Control System
Resonance Dwell Option

K2+

Amplitude Search Option
Instruction Manual

IMV CORPORATION

Type of Document : Instruction Manual

System Applied : K2+

Software <Resonance Dwell> later than Version 20.2.0

This application does not run without **K2+/SINE and Resonance Dwell Option**.

Japanese Edition

Version	Date	Contents
1.0.0	2021.03.15	First edition

English Edition

Version	Date	Contents
1.0.0	2021.03.18	First edition

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Chapter 1　Resonance Dwell Test

1.1 Outline

Resonance Dwell Test requires Amplitude Search option.
Amplitude Search option requires Resonance Dwell option.

Two (2) major features of Amplitude Search option, in comparison with Resonance Dwell option, are as follows.

- Resonance Dwell test using amplitude is available[*1].
- Time-series graphic display of test history is available. Frequency-base graphic display of test history that Resonance Dwell option can offer is not available.

Using two (2) sensors, a controlling sensor and a monitoring sensor that checks on the resonating part of a specimen, Resonance Dwell Test detects the resonance frequency of the specimen and automatically allows dwelling to resonance point even when the resonance frequency varies.

Just before the implementation of Resonance Dwell Test, carry out Pre-sweep test (**Resonance Survey**) over the frequency range that includes resonance frequency. Then, make up a list of resonance frequency based on the measurement data of the sweep test (resonance search) and select the excitation frequency. Last of all, set the test conditions (excitation level, dwell time, etc.).

Start the test after the test definition is complete. Resonance dwelling operation (**Resonance Dwell**) is automatically performed and the test continues until the set time is up.

Resonance Dwell Test uses settings of the Pre-sweep test (**Resonance Survey**) without change and just requires setting of conditions specific to Resonance Dwell Test while normal SINE Test requires setting of I/O module configuration, excitation system information, basic and control conditions, excitation system setting, input channels, etc.

All the defined “Test” information can be saved as “Test File” in specified format.

If there is a previously saved “Test File” of defined “Test” information, a test can be executed only by loading the file.

Note）Resonance frequency may vary depending on the specimen-testing environment such as temperatures. Carry out Resonance Survey right before Resonance Dwell Test and determine an excitation frequency. It will help ensure accurate test results.

*1) In general, viscoelastic materials such as rubber have dynamic properties that change with temperature. In addition, the material itself may generate heat due to vibration. In the case of such materials, transmissibility and phase will change even during the test. To constantly excite at the resonance frequency, it is necessary to periodically re-search for the frequency at which the transmissibility peaks. Since the dynamic characteristics change during the re-search, the re-search time must be short to minimize this effect. The half-power bandwidth method requires sweeping over a wide frequency band, which takes too much time, so this system introduces a unique mechanism that can re-search the resonance frequency with the shortest excitation time. In addition, the Q factor of this system is not calculated by the half-power bandwidth method, but by a method suitable for viscoelastic materials that can be calculated in real time manner even during test.

1.1.1 Resonance Survey

Before executing Resonance Dwell, carry out a sweep test (**peak amplitude estimation: tracking**) in a proper frequency range covering resonance frequencies and measure the resonance frequencies. **It is always necessary to obtain the measurement data through a sweep test before executing Resonance Dwell. Note that some specimens may require Resonance Survey at the excitation level of Resonance Dwell Test in order to obtain measurement data.**

1.1.2 Resonance Search

Based on the measurement data obtained through the sweep test, frequencies meeting the prescribed resonance judgment criteria are list-displayed. An operator shall set the excitation reference by selecting a resonance frequency for Resonance Dwelling among list-displayed excitation target candidates.

1.1.3 Resonance Dwell

During resonance dwelling, the system automatically detects the resonance frequency of a specimen and adjusts the excitation frequency so that it coincides with the newly detected resonance frequency.

- Amplitude search

  This is a method to newly search a resonance frequency by running sweep in a frequency range according to set conditions. Excitation is performed at the resonance point.

- Phase search

  This is a method to perform excitation at a resonance point while maintaining a constant phase difference between the base channel and resonance search channel.

- Frequency fixing

  This is a method to perform excitation at a peak frequency (resonance frequency) of transmissibility detected through pre-sweep.

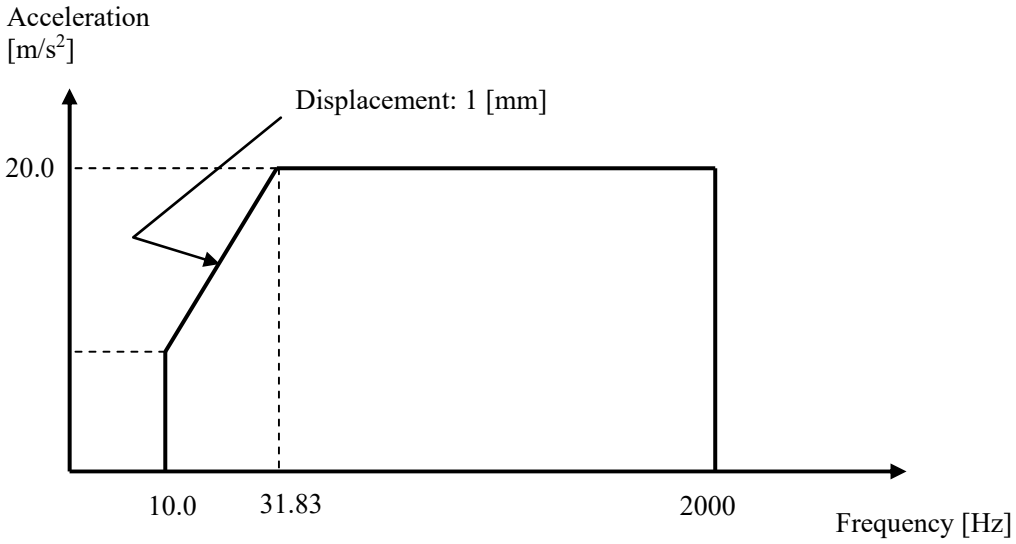
1.2 Resonance Dwell (Resonance search mode: Amplitude search [Normal])

<Example>

This is an example of Resonance Dwell test as given below.

[Fundamental / Control Condition (Resonance Survey)]

Peak amplitude estimation: Tracking



[Reference Pattern (Resonance Survey)]

[Pre-sweep test time]

Sweep time: 1.000 (octave/min)

Times of double sweep: 1 (single-sweep)

[Information of used sensors]

Two (2) piezoelectric acceleration pickups are used: one for control and other for monitoring.

Ch1: Control, Sensitivity of 3pC/(m/s^2)

Ch2: Monitoring, Sensitivity of 3pC/(m/s^2)

This example is based on the assumption that the above information has been entered in Input Environment Information and the excitation system information such as rating has been registered in Excitation System Information as well.

[Resonance Search Condition]

Resonance judgment criteria: Transmissibility is 1.5 and over.

[Resonance Dwell Condition]

Resonance search mode: Amplitude search (Normal)

Resonance frequency: The first peak frequency extracted through Resonance Search is used.

Excitation level: 20.0 (m/s^2)

Alarm upper:	6.0 (dB)	Alarm lower:	−6.0 (dB)
Abort lower limit:	3.0 (dB)	Alarm upper:	−3.0 (dB)

Dwell time: 1 minute Test time: No repetition

Shift judging of resonance frequency: Transmissibility ratio is within −10% to 10%.

Frequency step size: 1.0 (Hz/s)

Resonance frequency search range: Frequency ratio is ±10%.

<Operation Procedure>

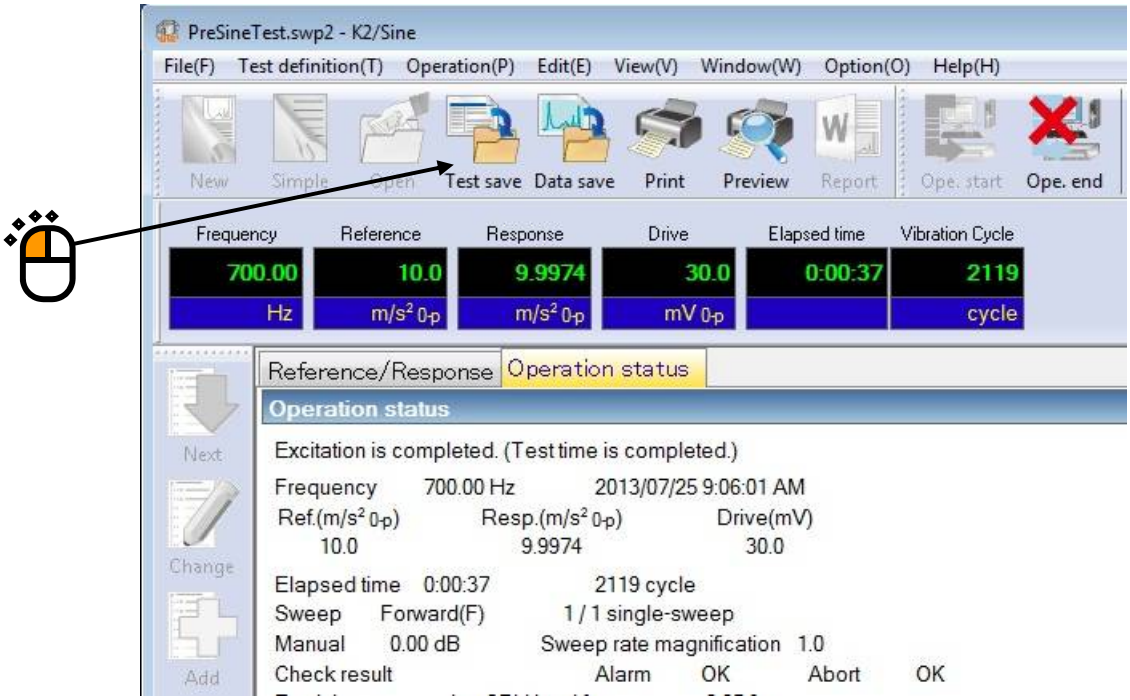
[Resonance Survey]

<Step 1>

Define above-mentioned [Reference Pattern (Resonance Survey)] and [Pre-sweep test time] according to "Chapter 3 Basing Operation Example" of the K2+/SINE Instruction Manual, and measure resonance frequencies. (**Peak Amplitude Estimation: Tracking**)

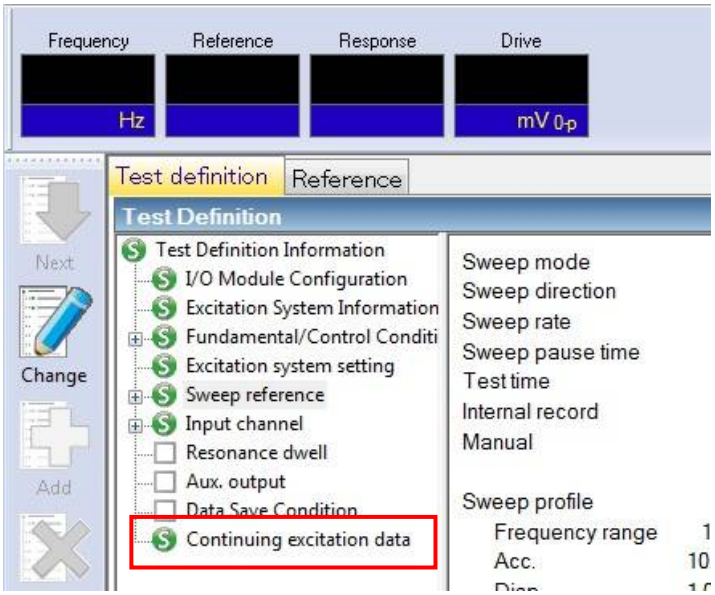
<Step 2>

After "Excitation is completed (Test time is completed)" has appeared in Operation Status window of Pre-sweep test, click [Test save] button.



<Step 3>

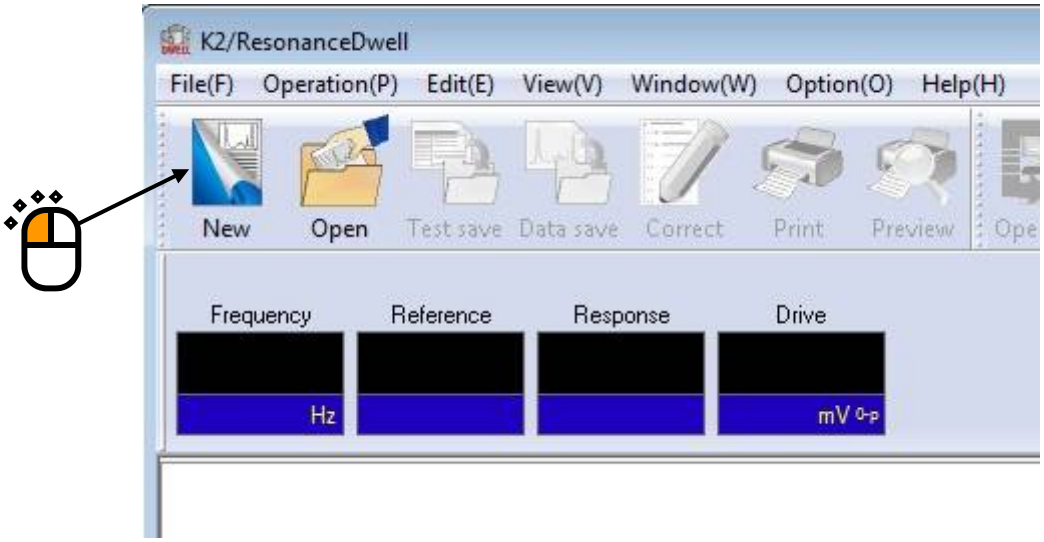
Go back to Test Definition. Then, exit K2+/SINE with "Continuing excitation data" set (SET) in Test Definition Information.



[Resonance Search]

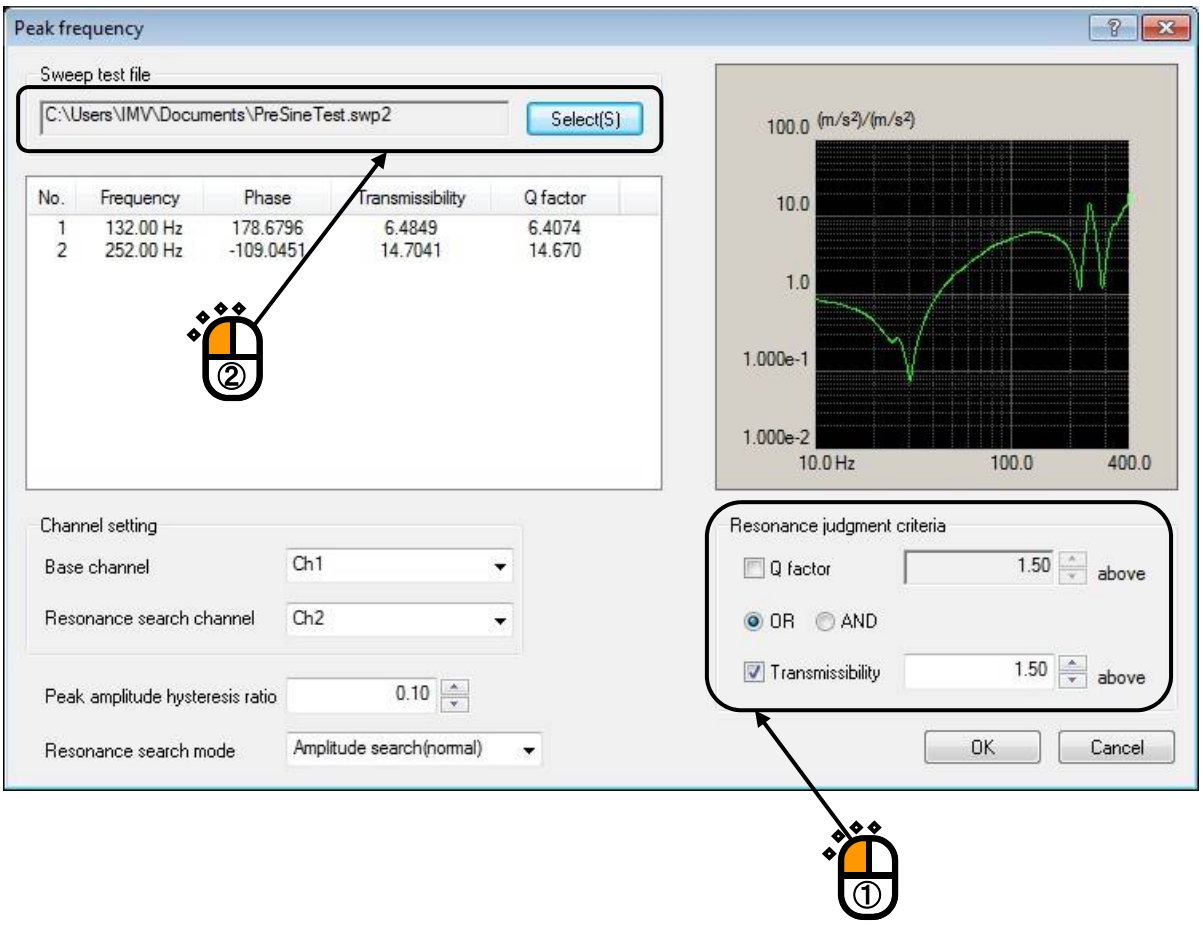
<Step 1>

Start K2+/Resonance Dwell. Then, click [New] button.



<Step 2>

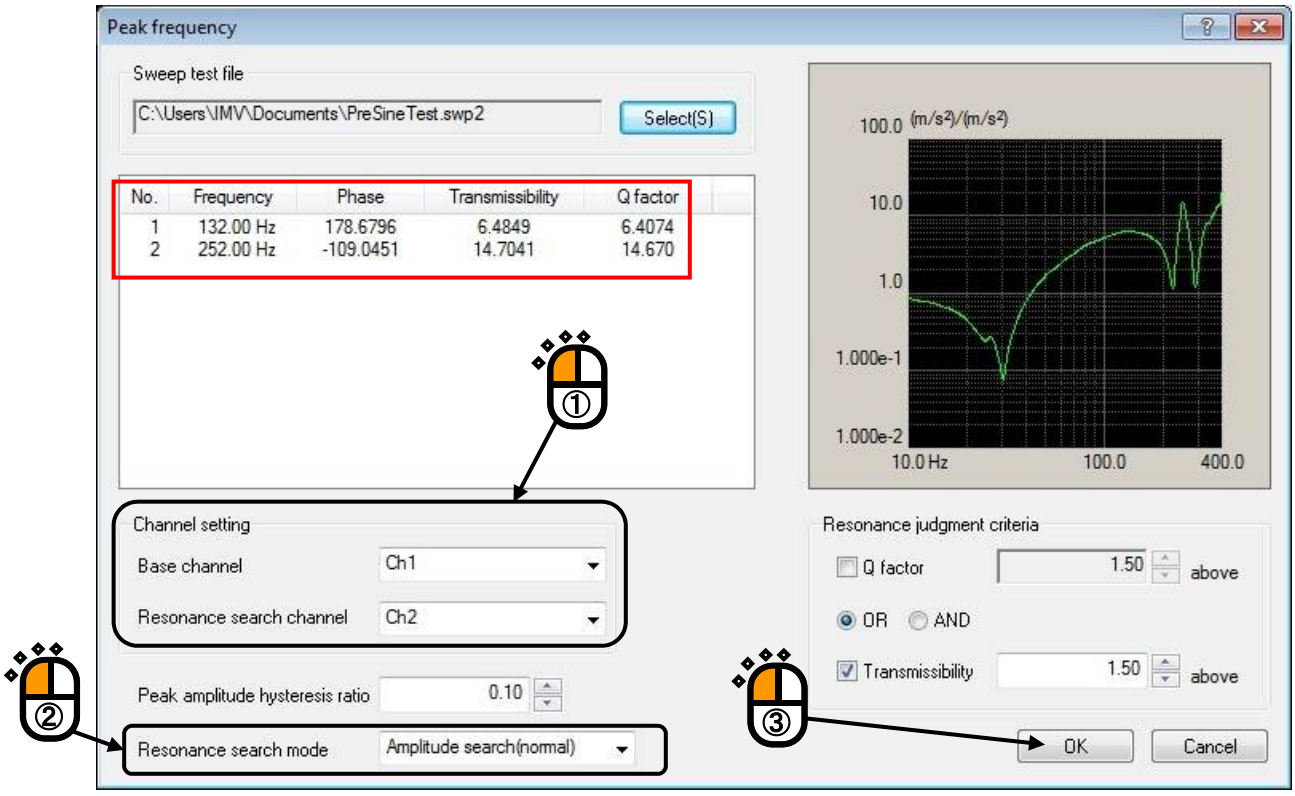
Set the condition of “Resonance Judgment Criteria”. Open the sweep test file saved in “Resonance Survey”.



<Step 3>

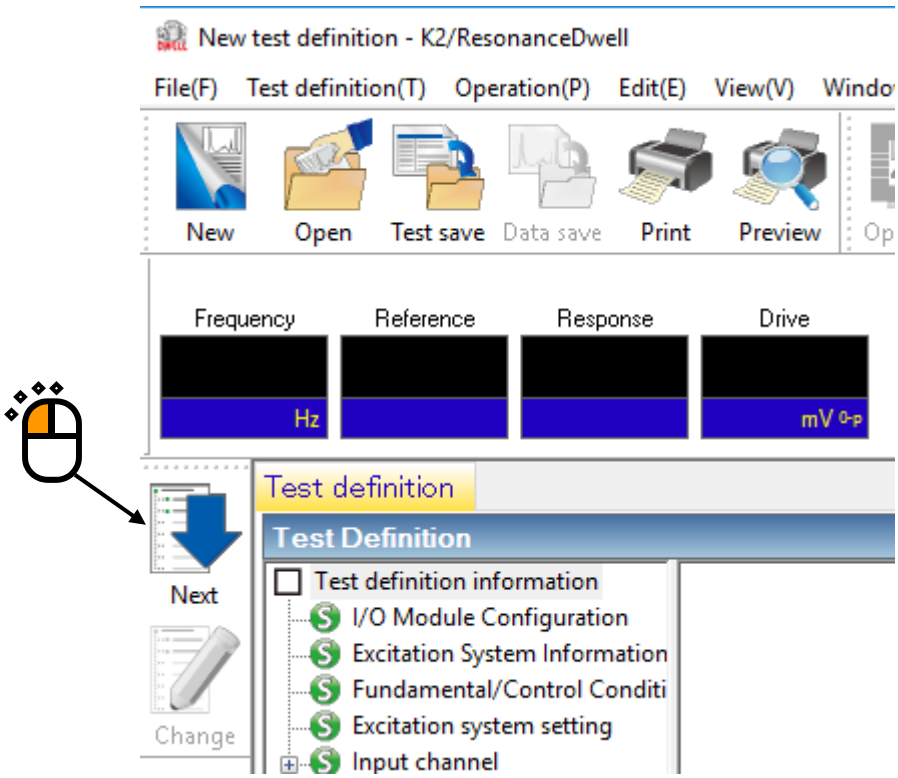
When “Base Channel” and “Resonance Search Channel” are set, the transmissibility (Response data of Resonance Search Channel / response data of Base Channel) is calculated and peak frequencies that meet the resonance judgment criteria are list-displayed. Check that frequencies are list-displayed.

Select “Resonance Search mode: Amplitude search (normal)”. Click [OK] button.



<Step 4>

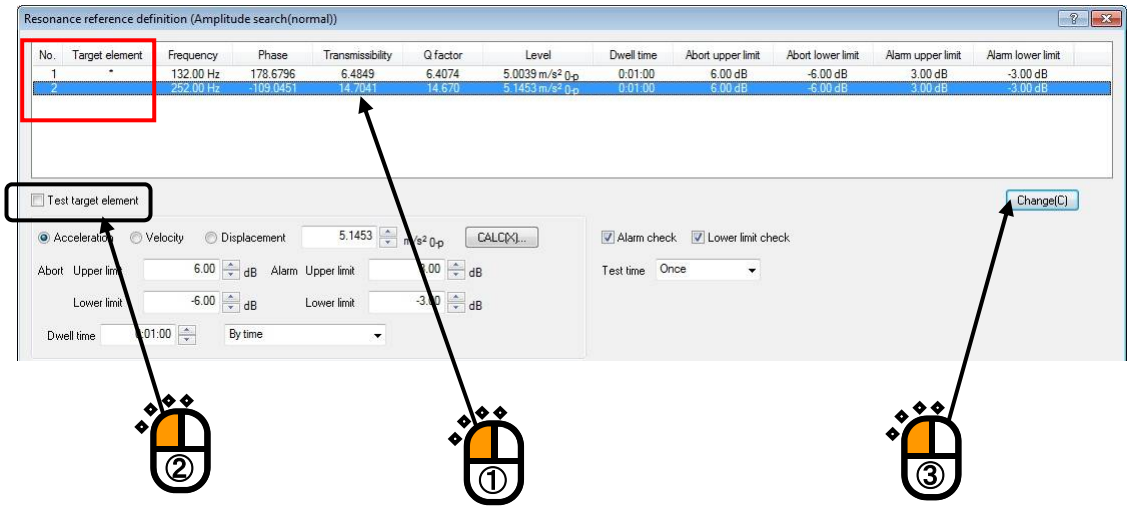
Press the button of [Next] to go to the next definition.



[Resonance Reference Definition]

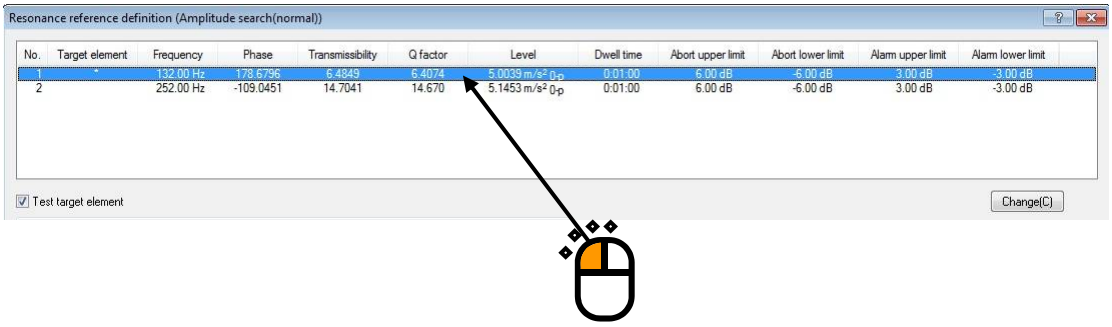
<Step 1>

Note that all of peak frequencies list-displayed in [Resonance Search] are registered as excitation reference by default. Select an inappropriate Target element and uncheck the [Test target element] box. Then, click [Change] button to delete the corresponding peak frequency from the excitation reference list.



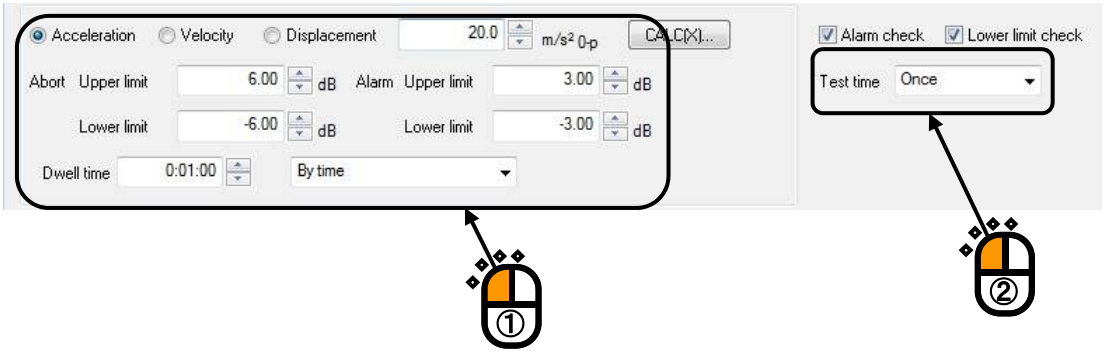
<Step 2>

Select a Target element that requires setting of Resonance Dwell conditions.



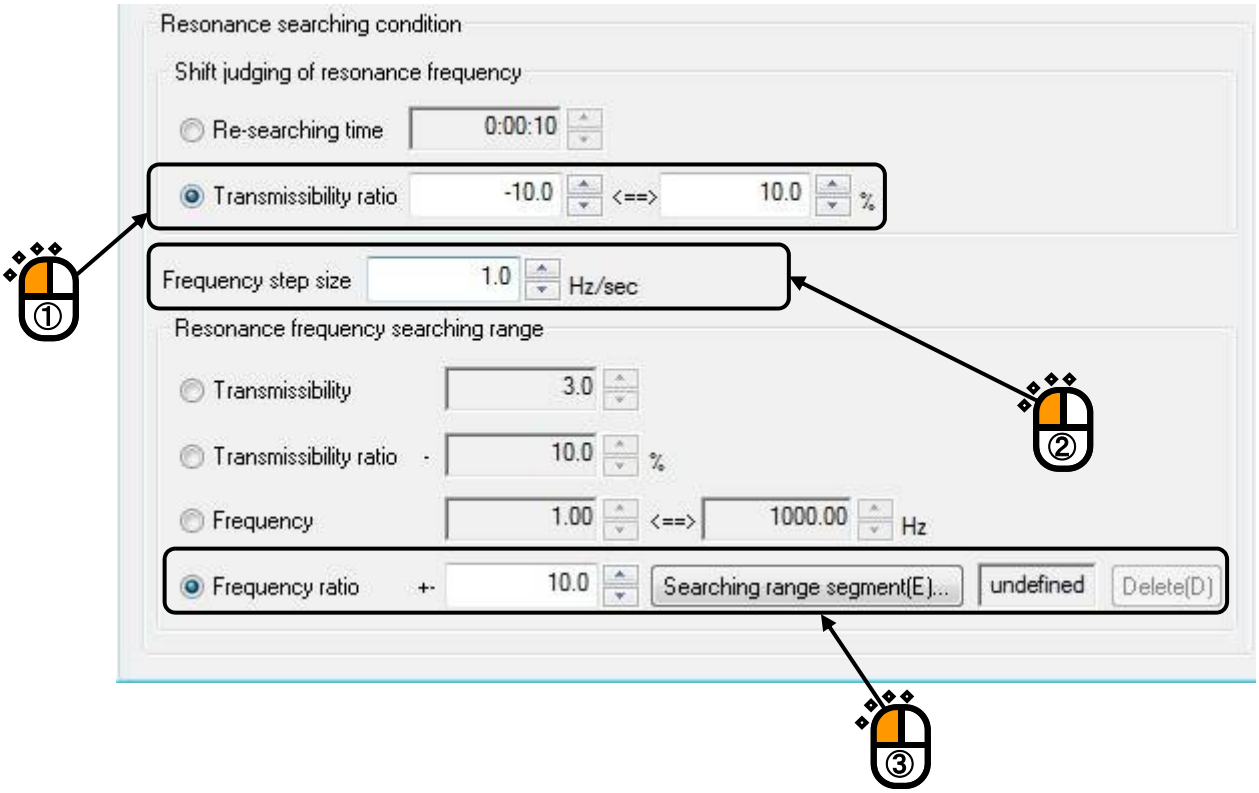
<Step 3>

Set [Excitation level], [Alarm and Abort tolerance], [Dwell time] and [Test time].



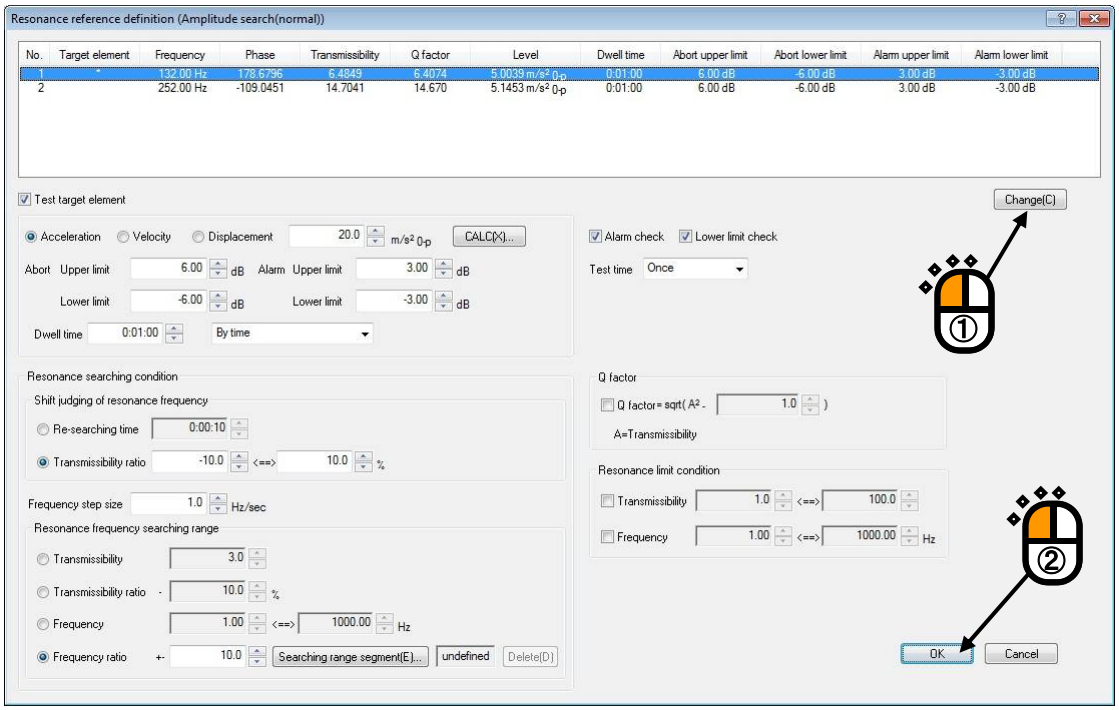
<Step 4>

Set [Shift judging of resonance frequency], [Frequency step size] and [Resonance frequency searching range].



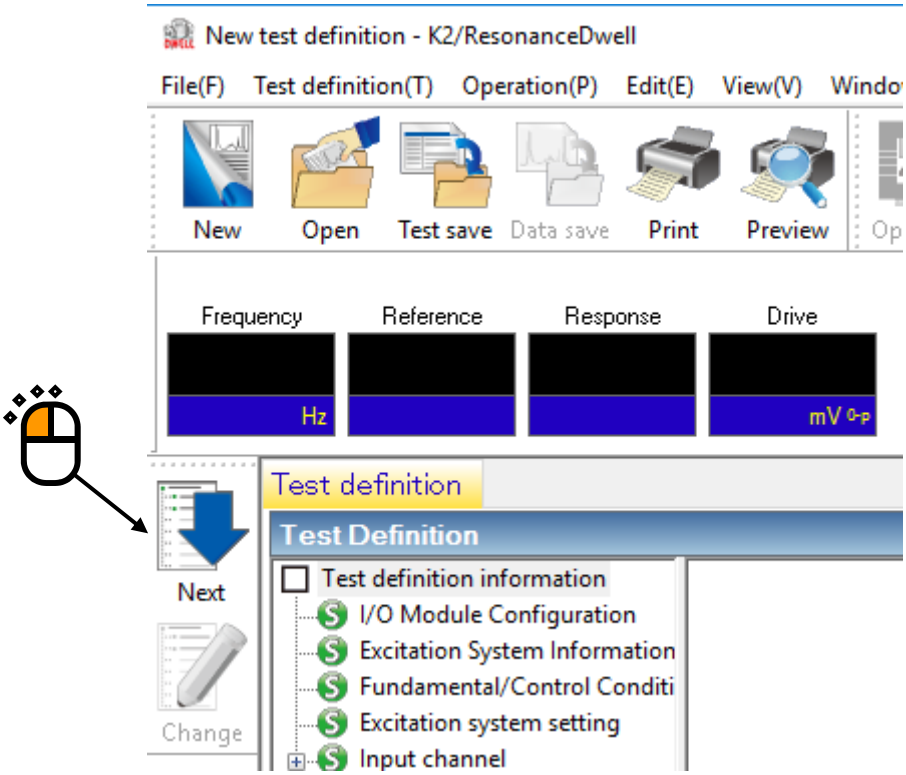
<Step 5>

Click [Change] button to update the reference definition. Then, click [OK] button.



<Step 6>

Press the button of [Next] to go to the next definition.

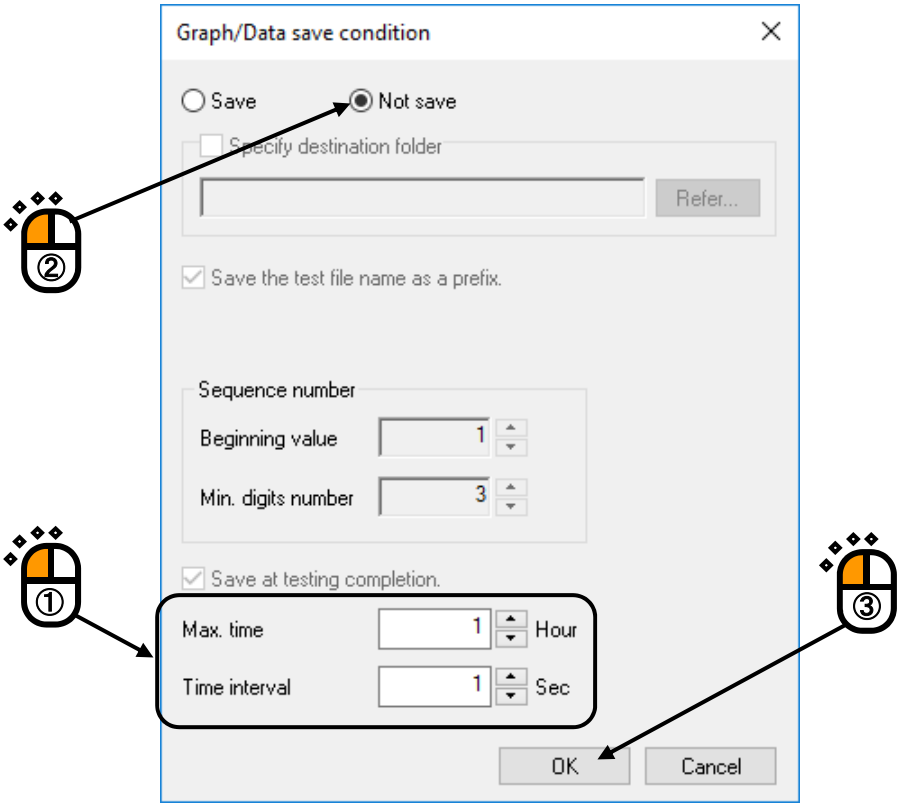


[Graph/Data save condition]

<Step 1>

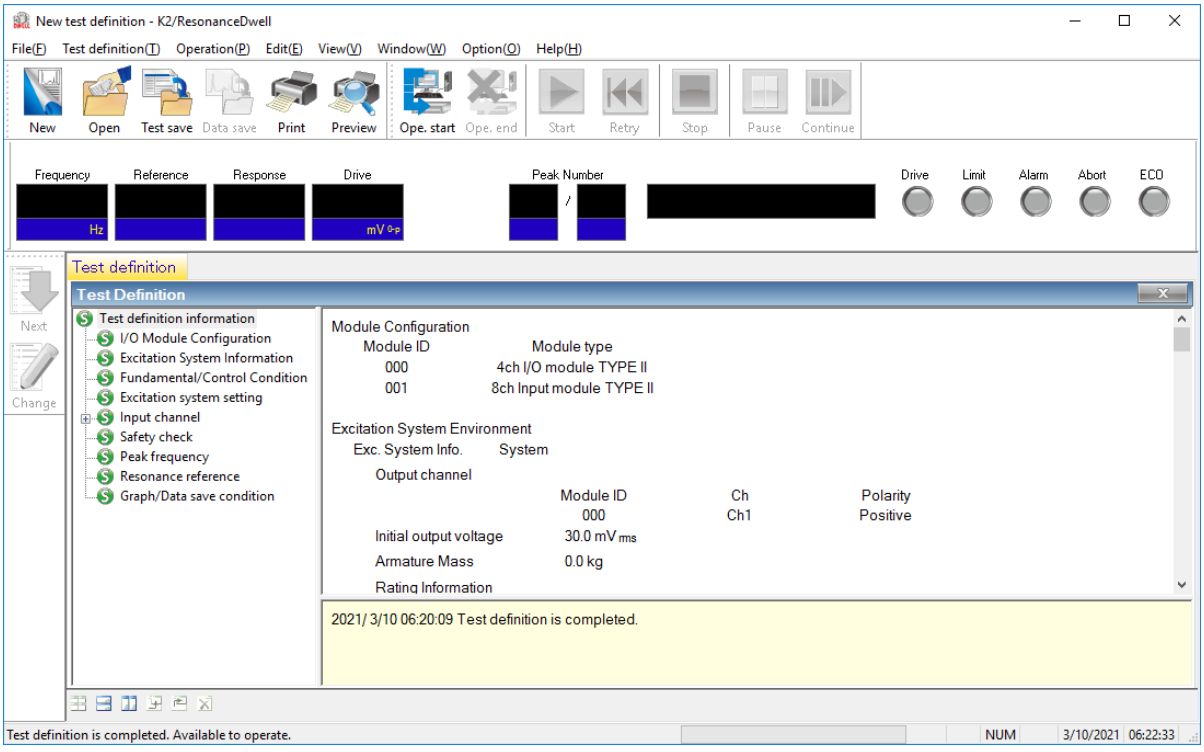
It is imperative “Max time” and “Time interval” are set.

Select ‘Not save’ and press the button of [OK].



<Step 2>

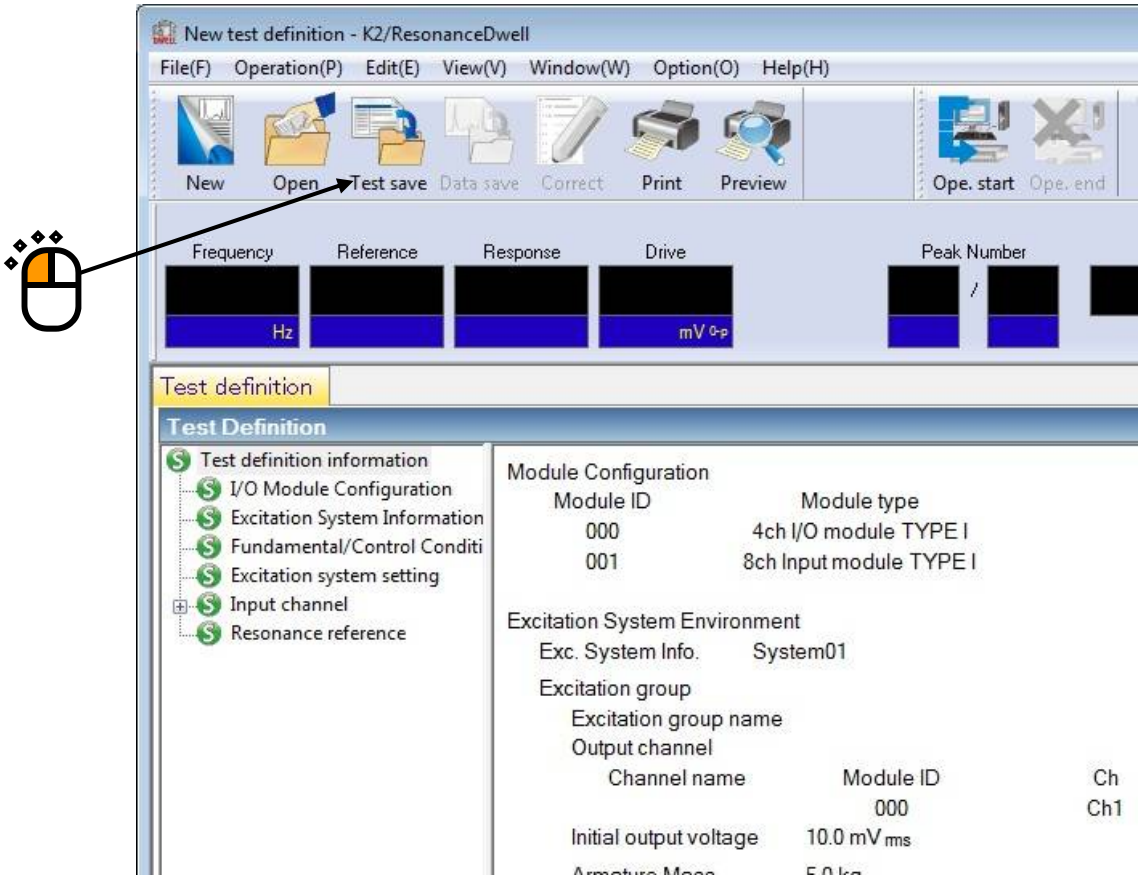
The definition setting is complete.



<Test Save>

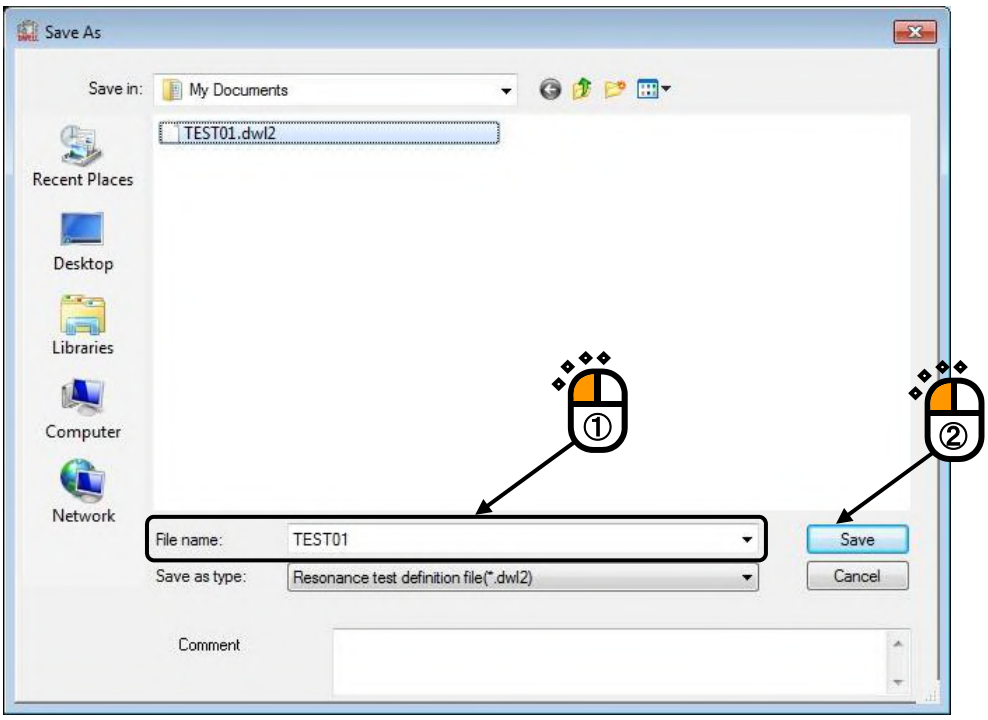
<Step 1>

Click [Test save] button.



<Step 2>

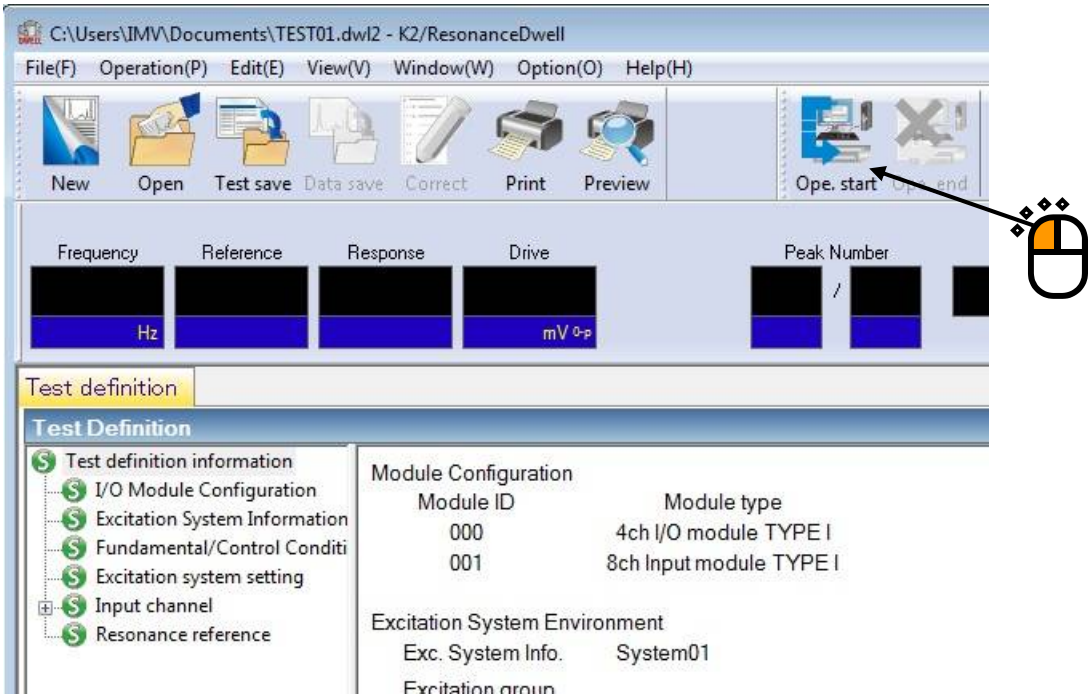
Enter file name. Then, click [Save] button.



<Test Operation>

<Step 1>

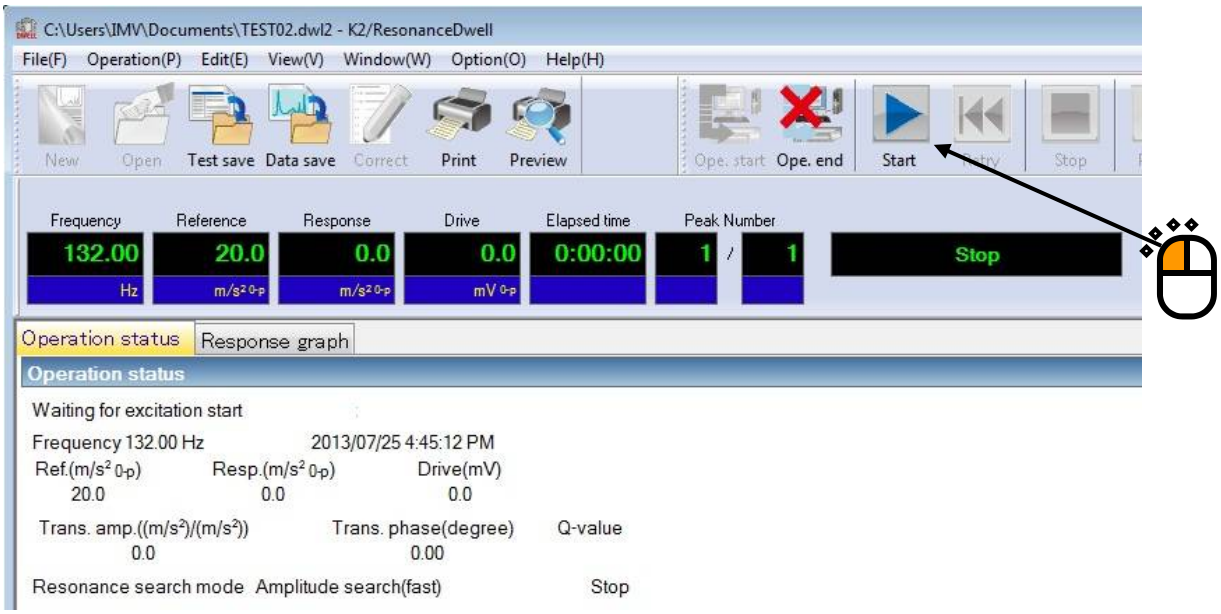
Click [Ope.start] button.



<Step 2>

Click [Start] button.

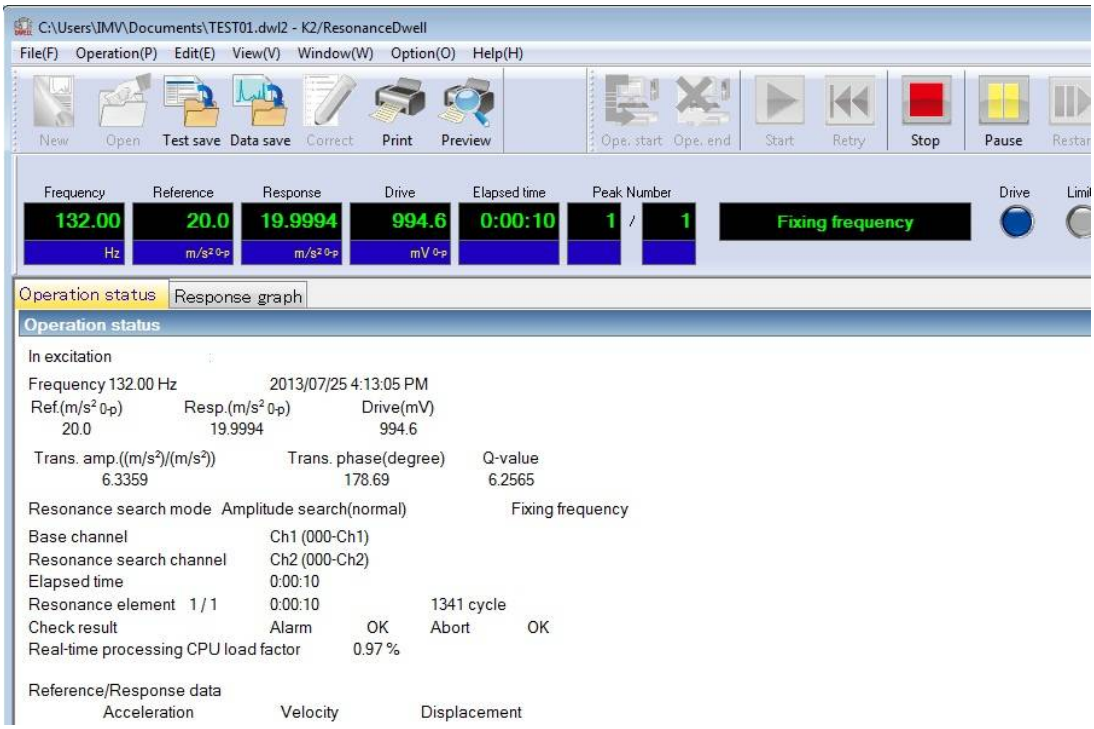
Clicking the button automatically implements Initial loop check and Initial equalization, and executes a test.



<Step 3>

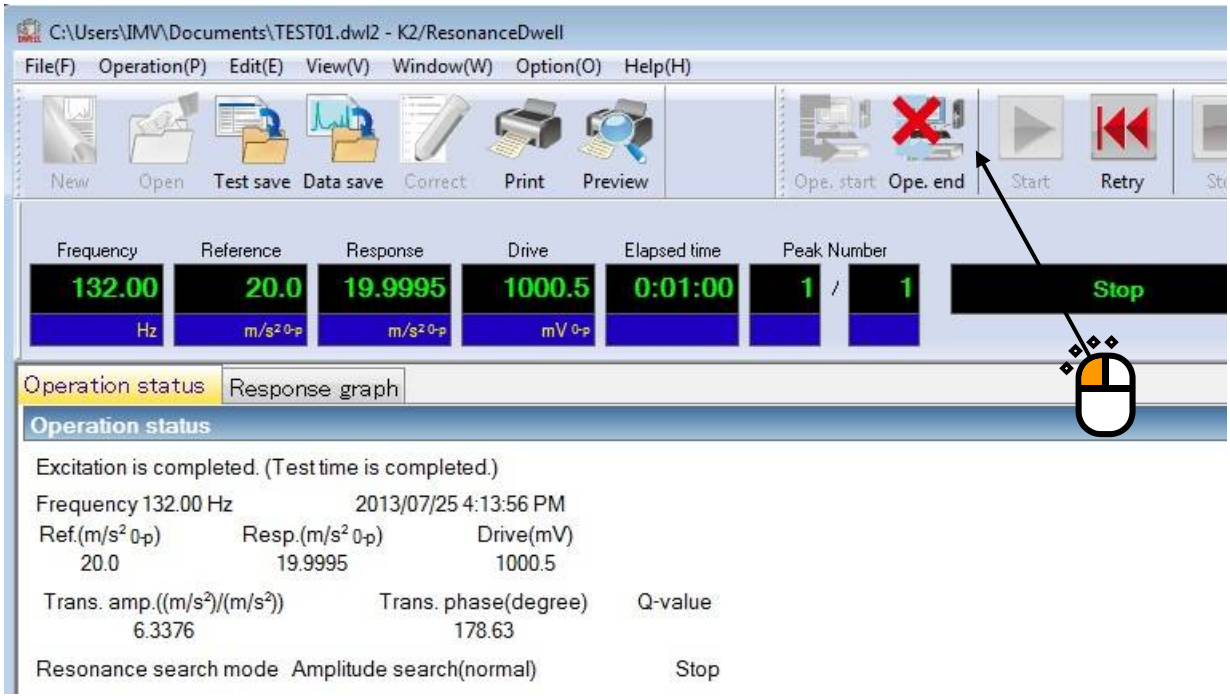
When conditions of Shift judging of resonance frequency are complete, resonance re-search automatically starts to detect a new resonance point. Excitation at the new resonance point continues until the test time is over.

Note: Clicking [Retry] button → [Start] button to execute re-excitation after stopping excitation by clicking [Stop] button initializes all the data, resulting in re-excitation at a peak frequency set in Test definition. On the other hand, stopping excitation by using [Pause] button allows continuing excitation by clicking [Restart] button.



<Step 4>

Clicking [Ope.end] button brings you back to Test definition mode.

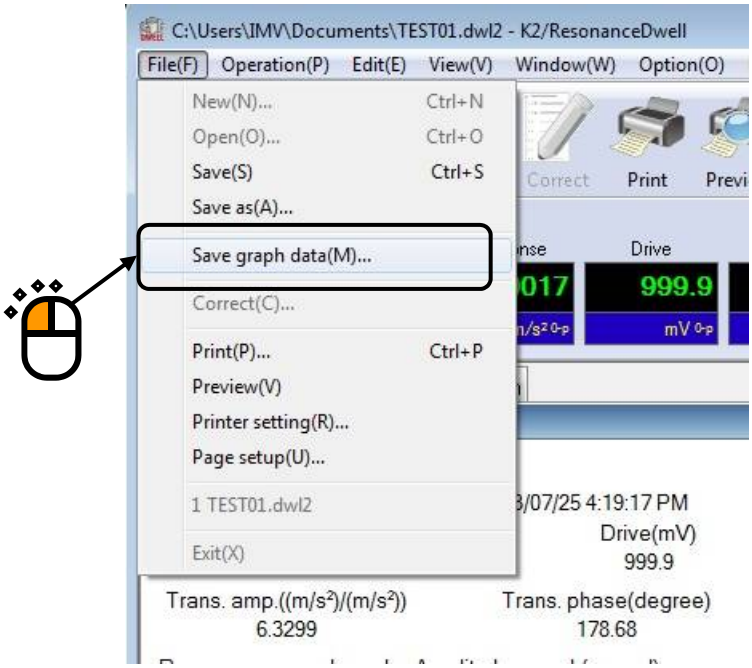


<Graph Data Save>

When saving of graph data during excitation, operate as the below;

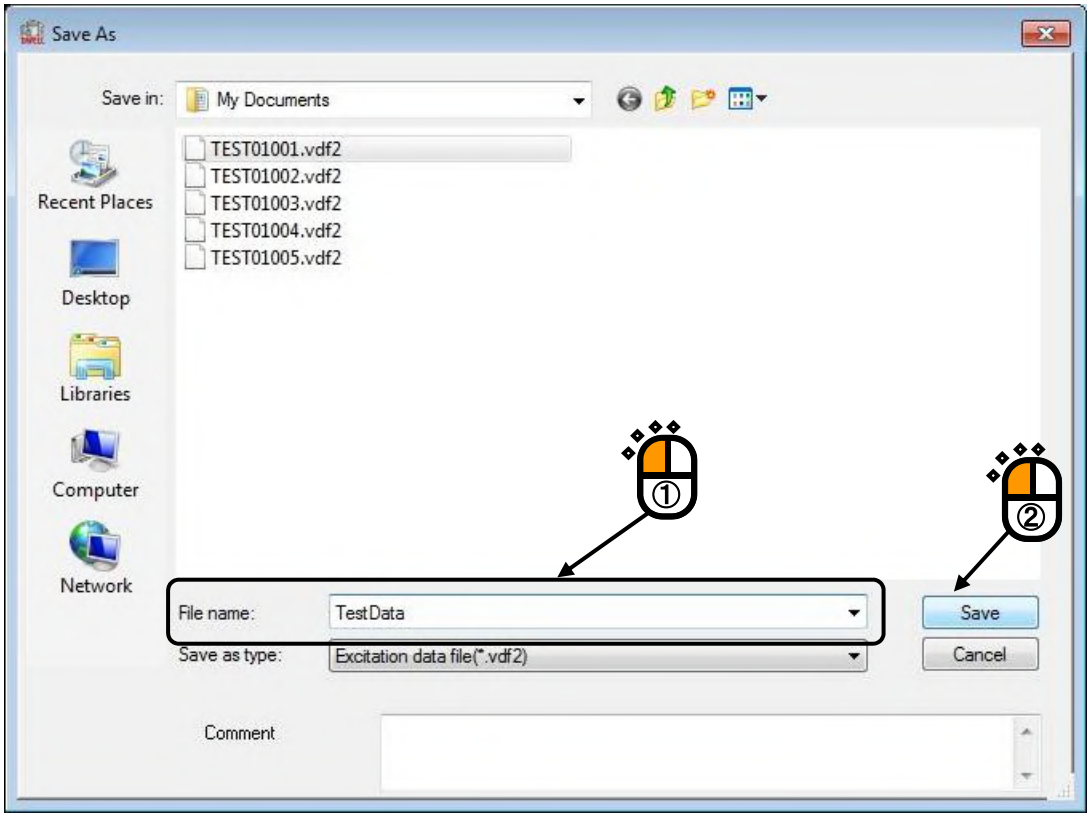
<Step 1>

Select [Save graph data] in the menu bar.



<Step 2>

Enter file name. Then, click [Save] button.



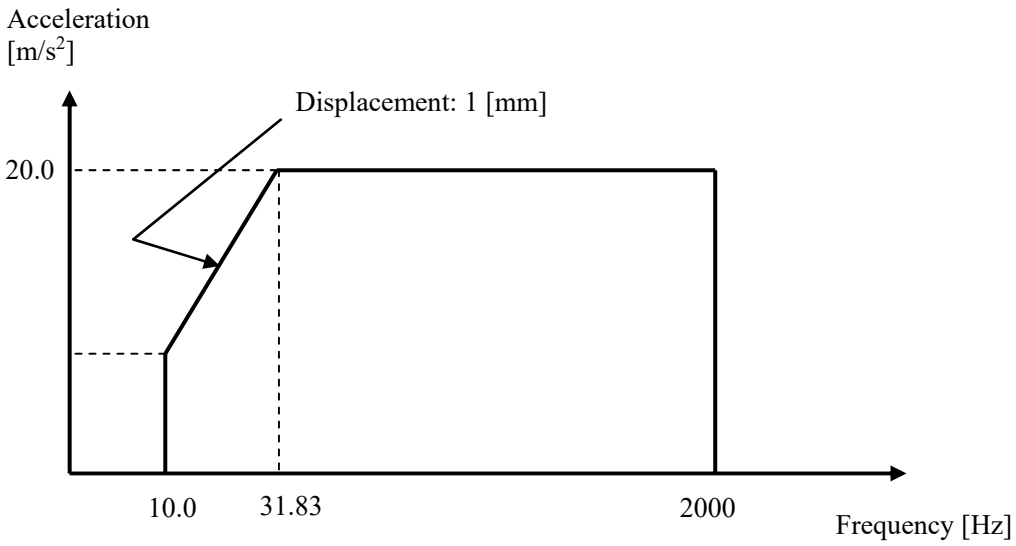
1.3 Resonance Dwell (Resonance search mode: Amplitude search [High speed])

<Example>

This is an example of Resonance Dwell test as given below.

[Fundamental / Control Condition (Resonance Survey)]

Peak amplitude estimation: Tracking



[Reference Pattern (Resonance Survey)]

[Pre-sweep test time]

Sweep time: 1.000 (octave/min)

Times of double sweep: 1 (single-sweep)

[Information of used sensors]

Two (2) piezoelectric acceleration pickups are used: one for control and other for monitoring.

Ch1: Control, Sensitivity of 3pC/(m/s^2)

Ch2: Monitoring, Sensitivity of 3pC/(m/s^2)

This example is based on the assumption that the above information has been entered in Input Environment Information and the excitation system information such as rating has been registered in Excitation System Information as well.

[Resonance Search Condition]

Resonance judgment criteria: Transmissibility is 1.5 and over.

[Resonance Dwell Condition]

Resonance search mode: Amplitude search (High speed)

Resonance frequency: The first peak frequency extracted through Resonance Search is used.

Excitation level: 20.0 (m/s^2)

Alarm upper: 6.0 (dB) Alarm lower: −6.0 (dB)

Abort lower limit: 3.0 (dB) Alarm upper: −3.0 (dB)

Dwell time: 1 minute Test time: No repetition

Shift judging of resonance frequency: Transmissibility ratio is within −10% to 10%.

Frequency step size: 5.0 (Hz/s)

Resonance frequency search range: Max. searching range

Frequency ratio: ± 40% Slope check Frequency ratio:

Frequency ratio 5%.

Peak condition Peak amplitude Hysteresis ratio: 2%

<Operation Procedure>

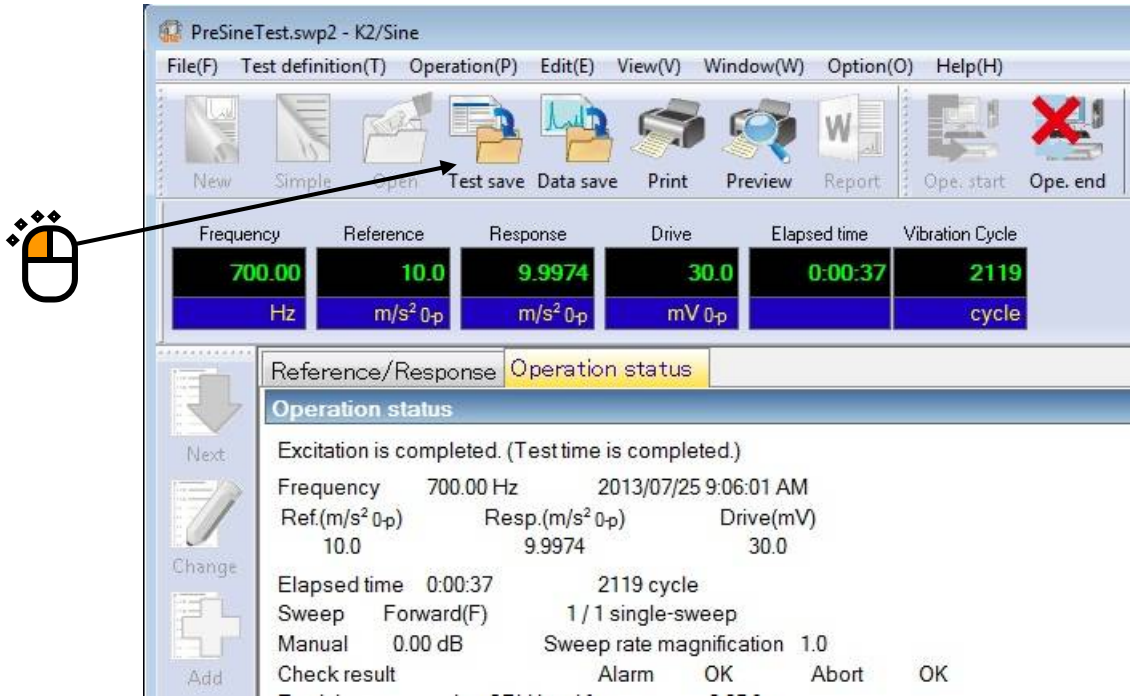
[Resonance Survey]

<Step 1>

Define above-mentioned [Reference Pattern (Resonance Survey)] and [Pre-sweep test time] according to "Chapter 3 Basing Operation Example" of the K2+/SINE Instruction Manual, and measure resonance frequencies. (**Peak Amplitude Estimation: Tracking**)

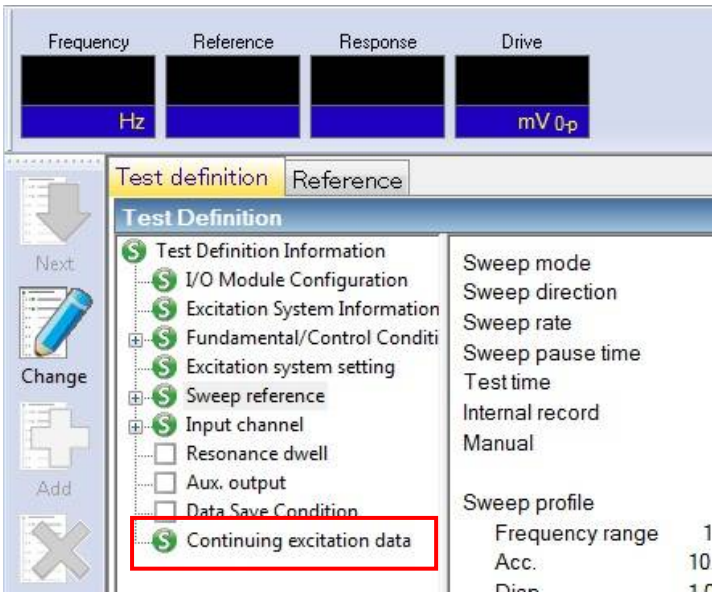
<Step 2>

After "Excitation is completed (Test time is completed)" has appeared in Operation Status window of Pre-sweep test, click [Test save] button.



<Step 3>

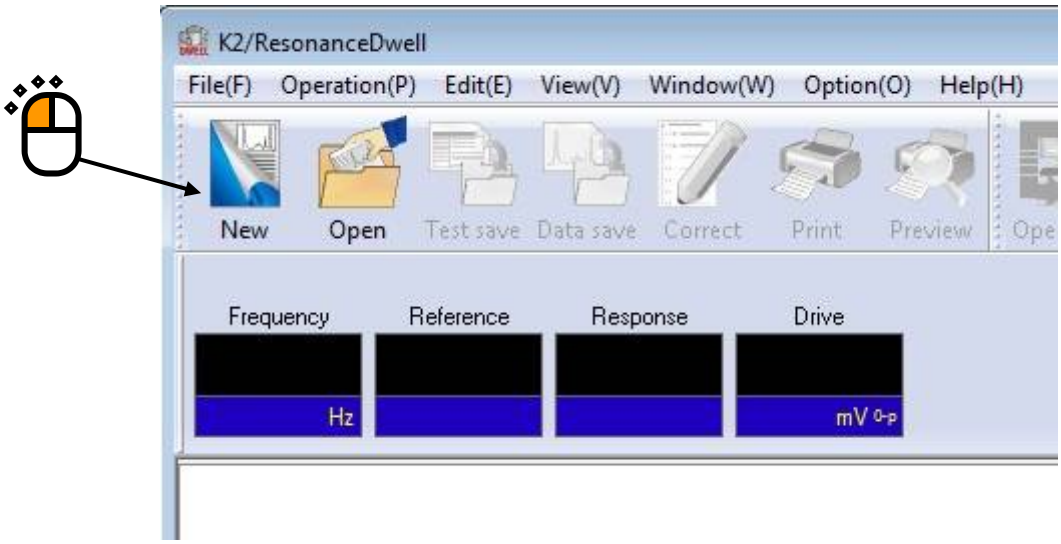
Go back to Test Definition. Then, exit K2+/SINE with "Continuing excitation data" set (SET) in Test Definition Information.



[Resonance Search]

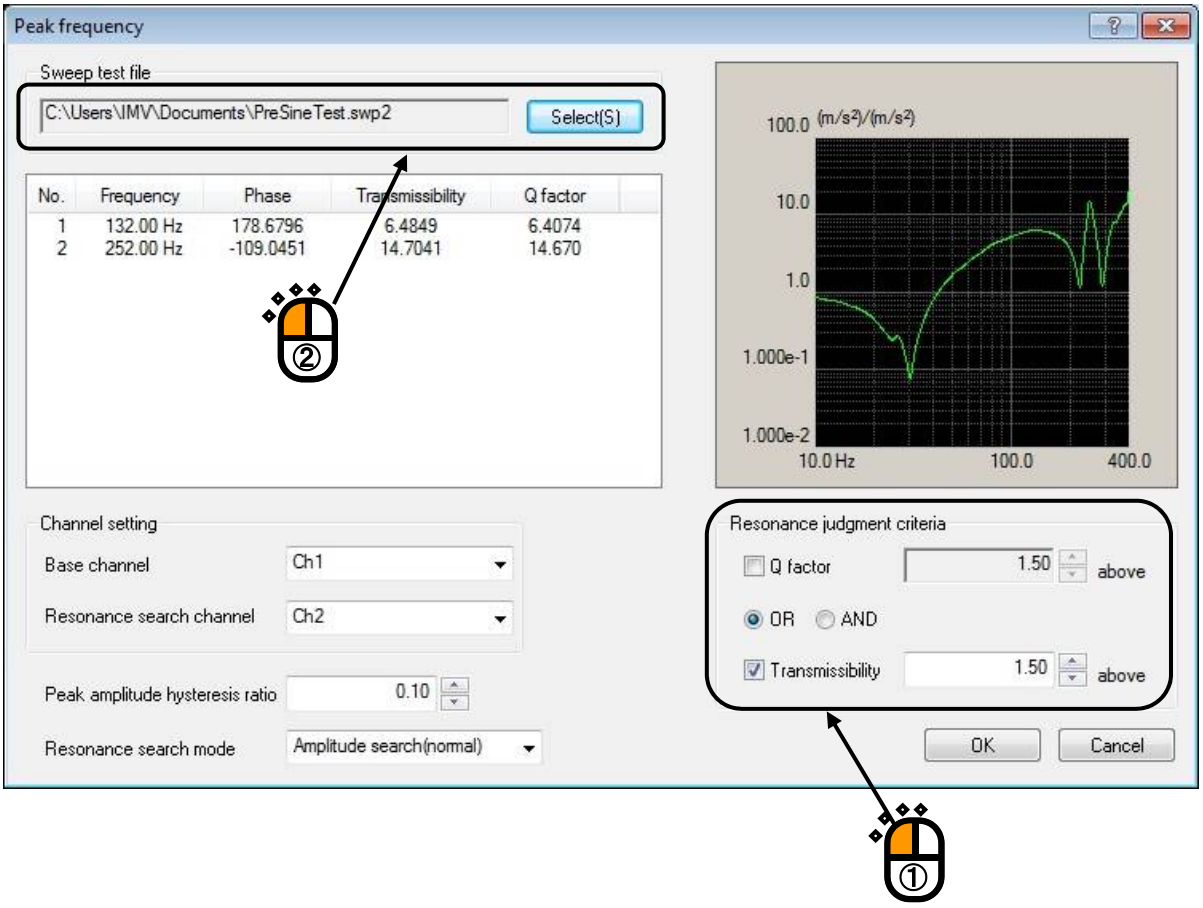
<Step 1>

Start K2+/ResonanceDwell. Then, click [New] button.



<Step 2>

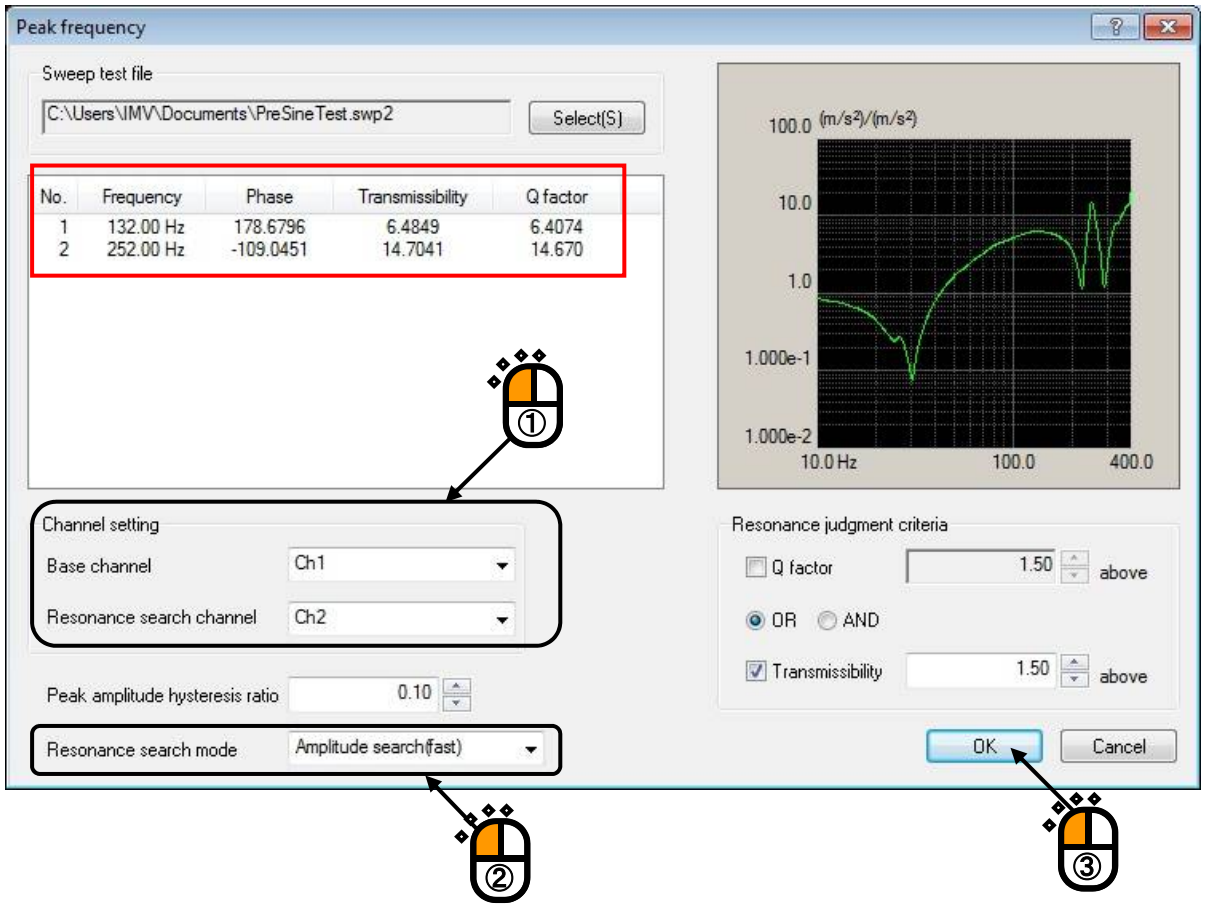
Set the condition of “Resonance Judgment Criteria”. Open the sweep test file saved in “Resonance Survey”.



<Step 3>

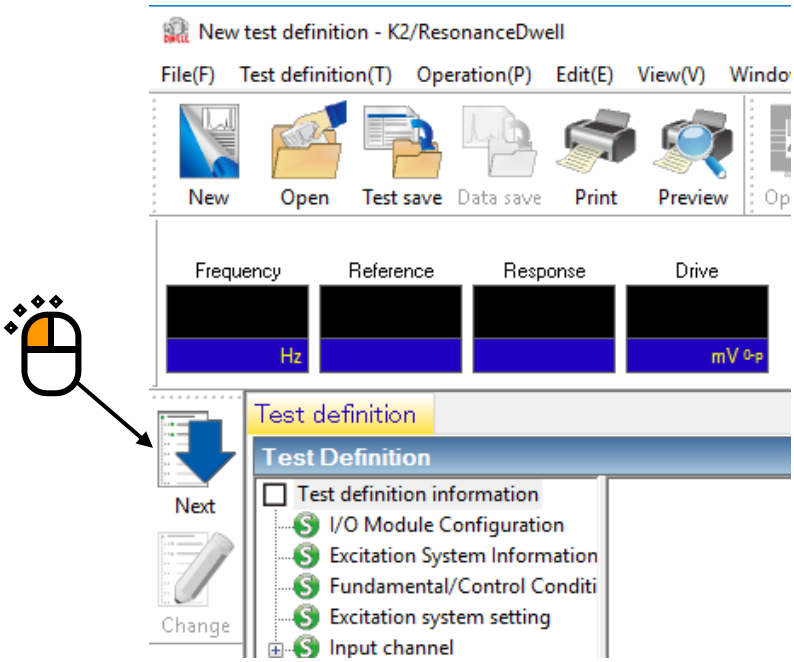
When “Base Channel” and “Resonance Search Channel” are set, the transmissibility (Response data of Resonance Search Channel / response data of Base Channel) is calculated and peak frequencies that meet the resonance judgment criteria are list-displayed. Check that frequencies are list-displayed.

Select “Resonance Search mode: Amplitude search (High speed)”. Click [OK] button.



<Step 4>

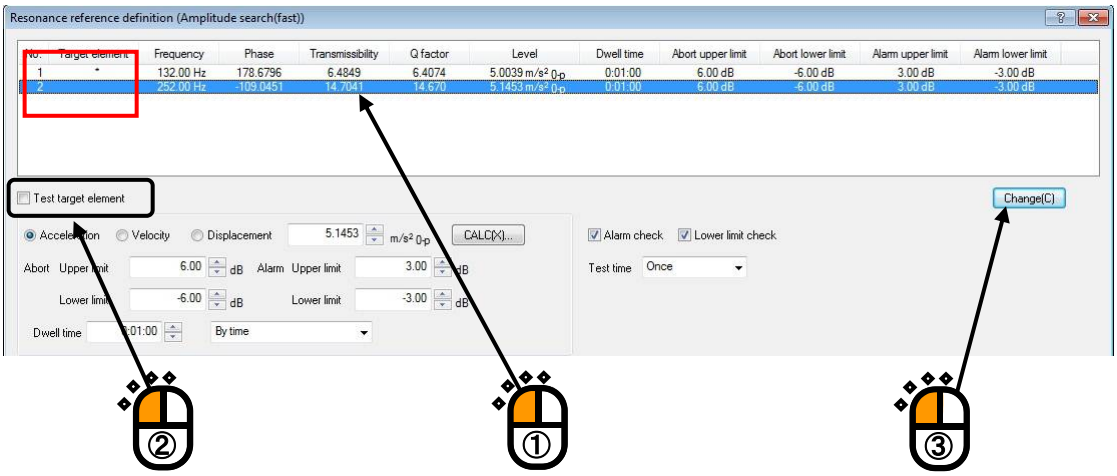
Press the button of [Next] to go to the next definition.



[Resonance Reference Definition]

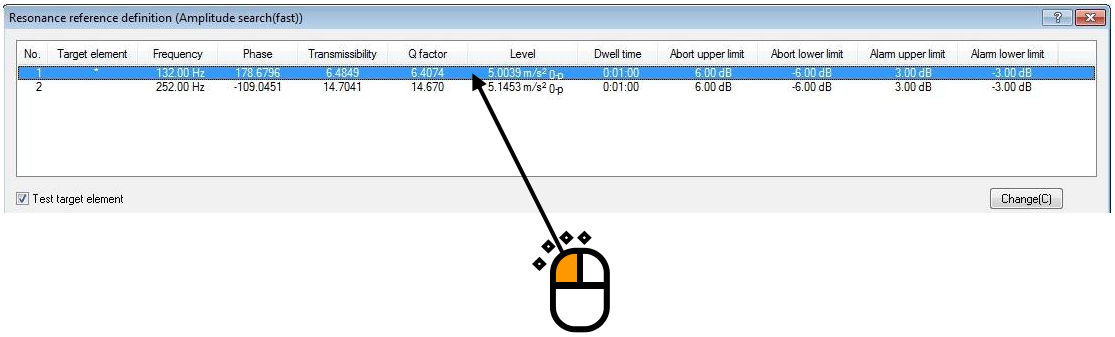
<Step 1>

Note that all of peak frequencies list-displayed in [Resonance Search] are registered as excitation reference by default. Select an inappropriate Target element and uncheck the [Test target element] box. Then, click [Change] button to delete the corresponding peak frequency from the excitation reference list.



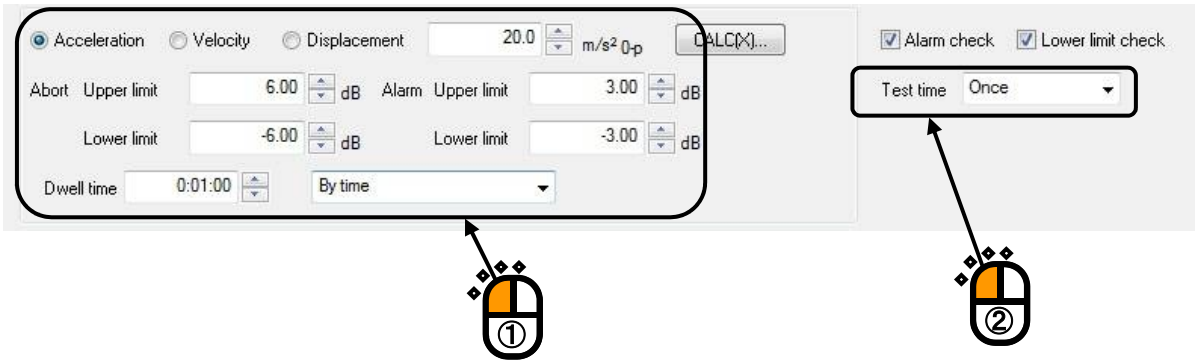
<Step 2>

Select a Target element that requires setting of Resonance Dwell conditions.



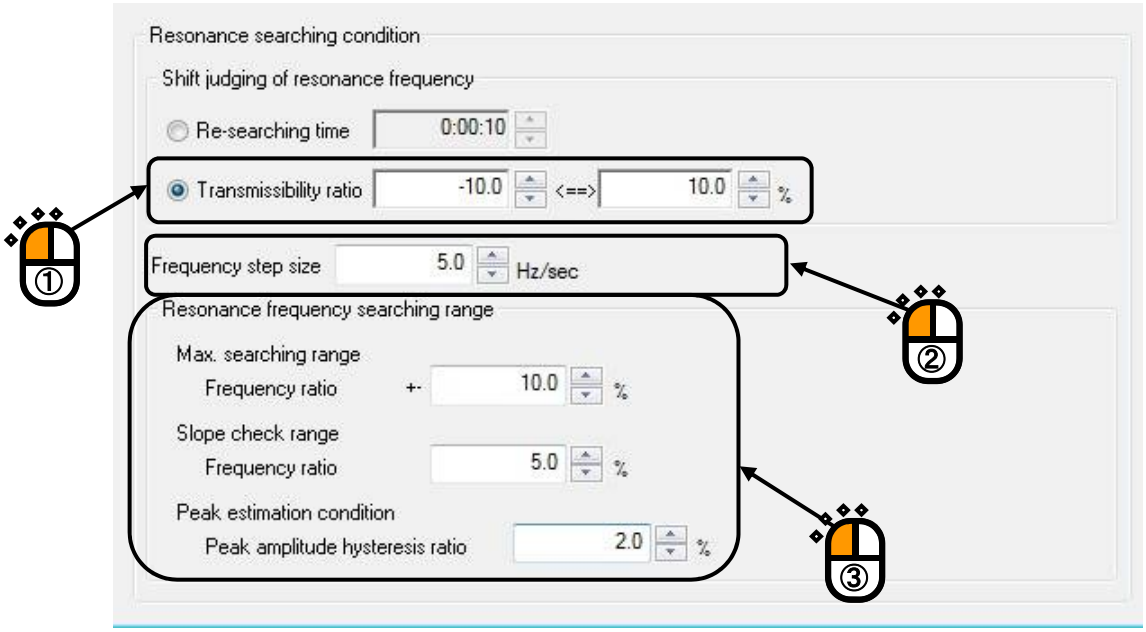
<Step 3>

Set [Excitation level], [Alarm and Abort tolerance], [Dwell time] and [Test time].



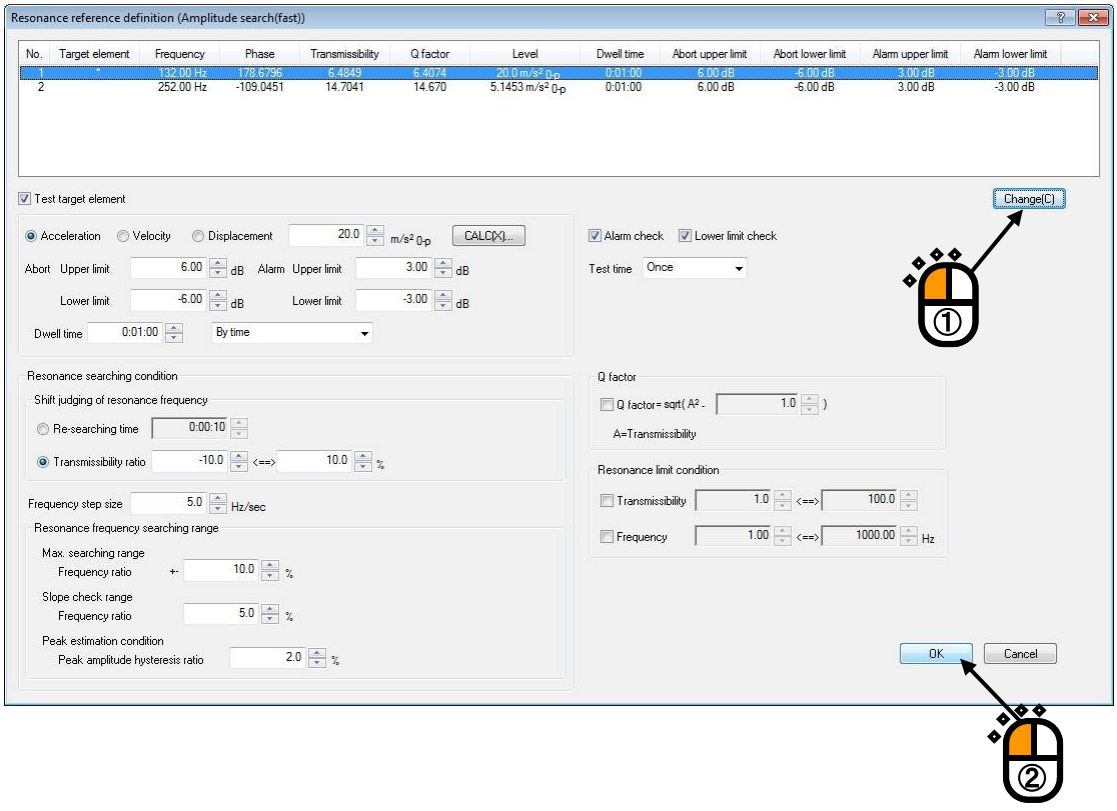
<Step 4>

Set [Shift judging of resonance frequency], [Frequency step size] and [Resonance frequency searching range].



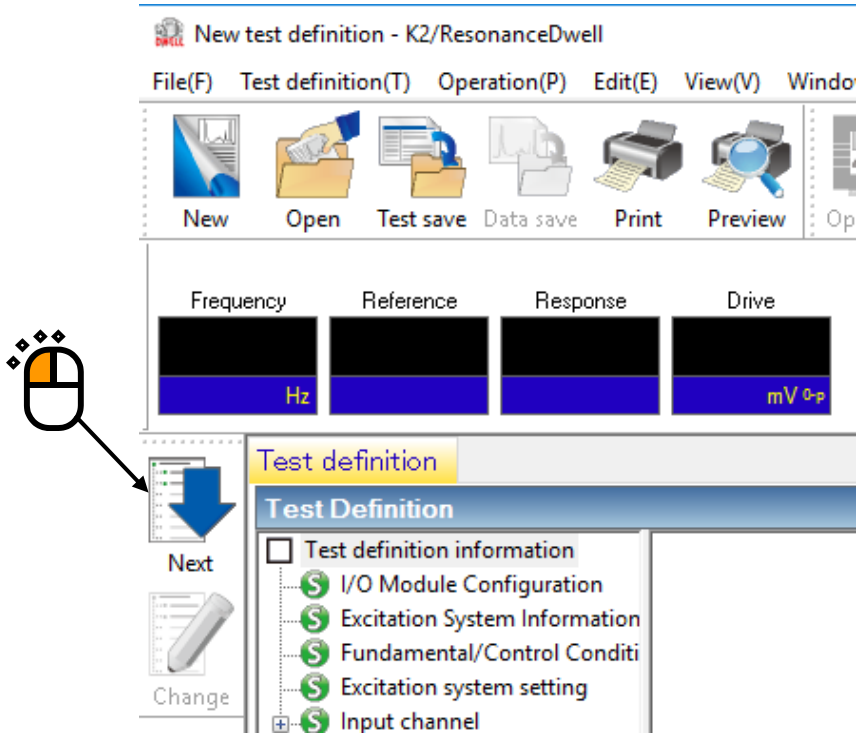
<Step 5>

Click [Change] button to update the reference definition. Then, click [OK] button.



<Step 6>

Press the button of [Next] to go to the next definition.

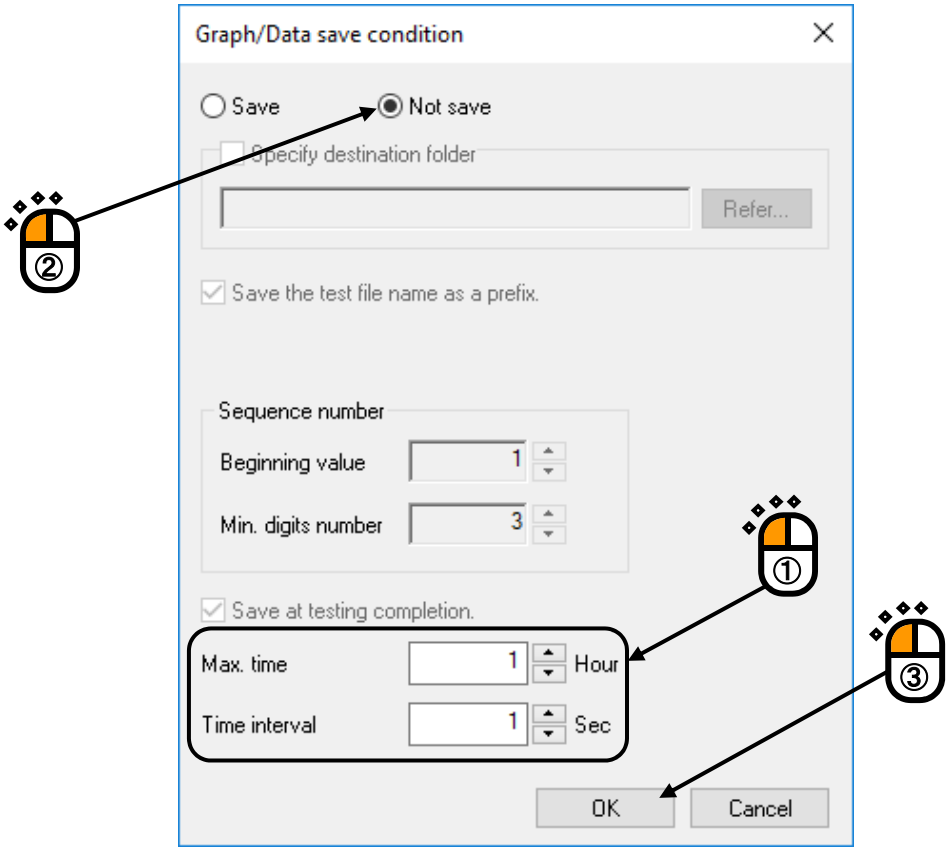


[Graph/Data save condition]

<Step 1>

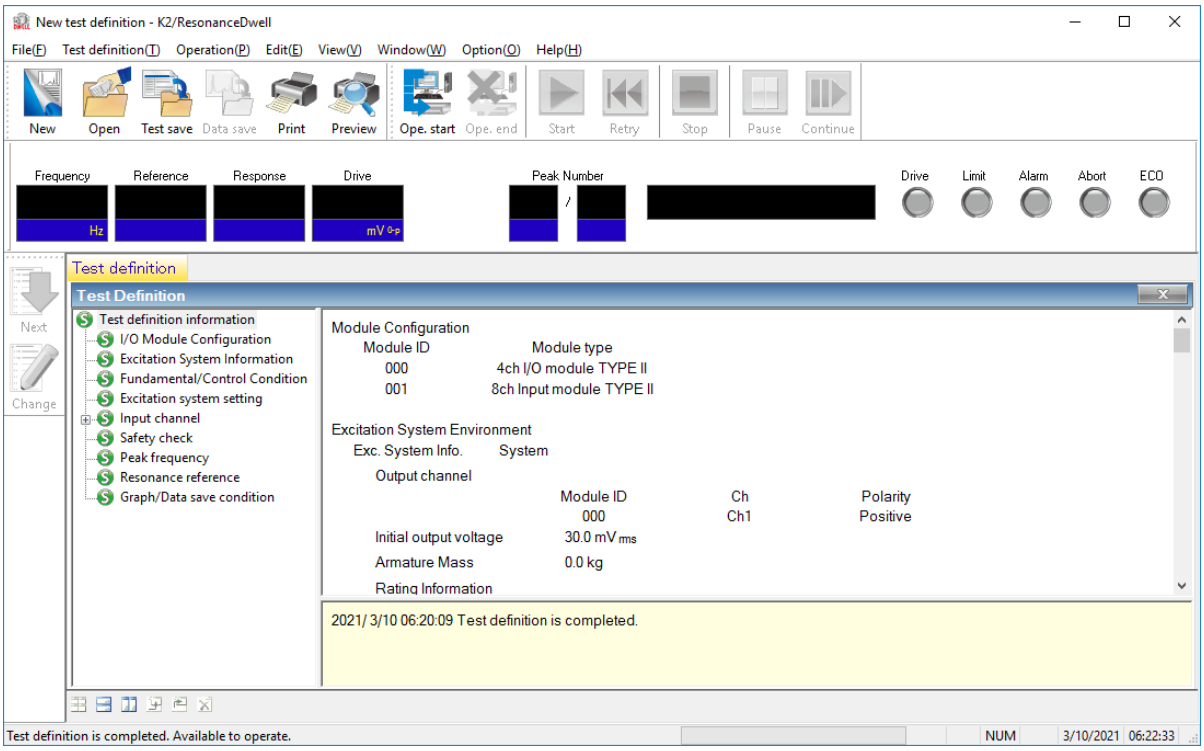
It is imperative “Max time” and “Time interval” are set.

Select ‘Not save’ and press the button of [OK].

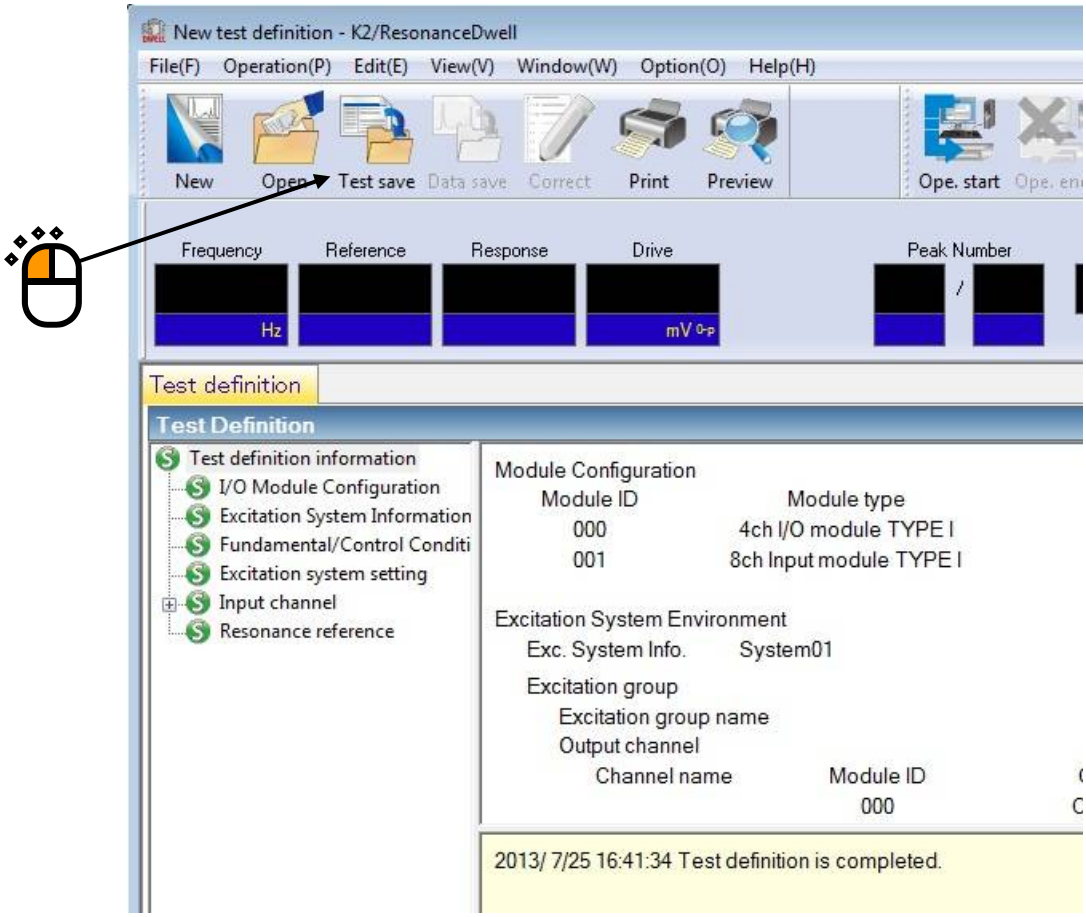


<Step 2>

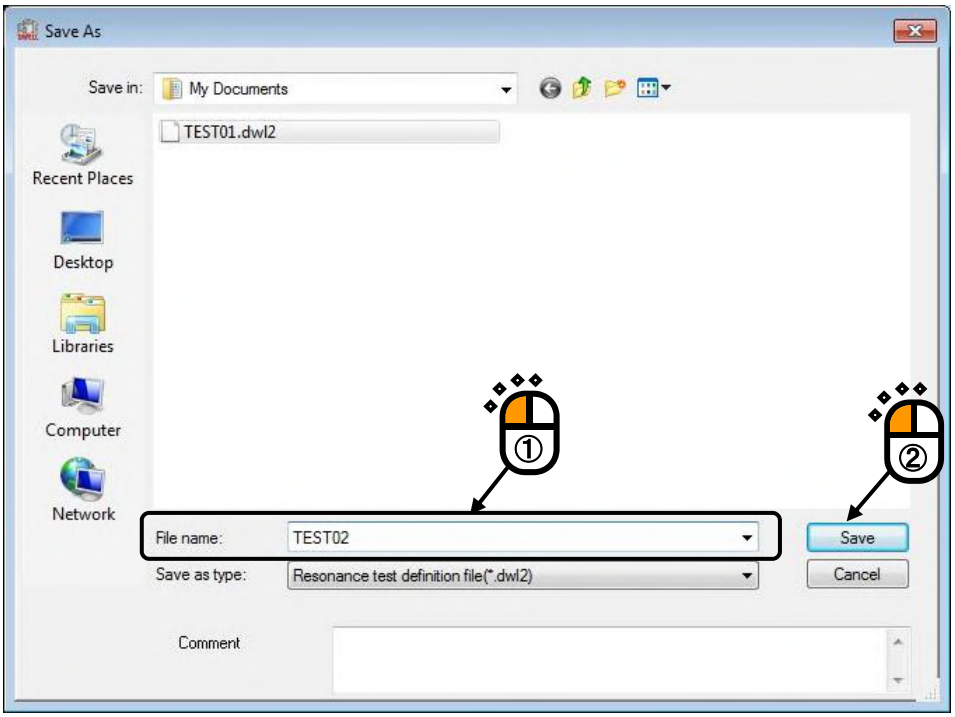
The definition setting is complete.



<Test Save>
<Step 1>
Click [Test save] button.



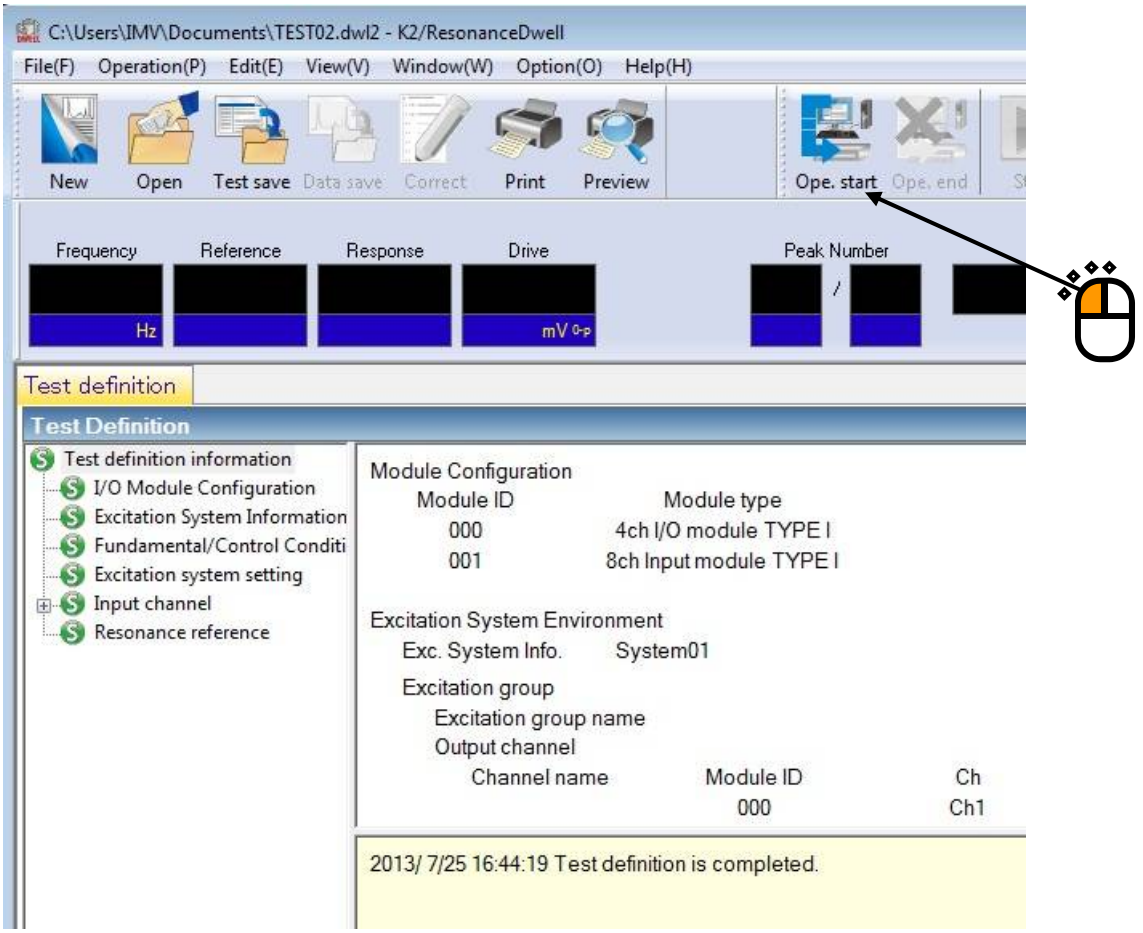
<Step 2>
Enter file name. Then, click [Save] button.



<Test Operation>

<Step 1>

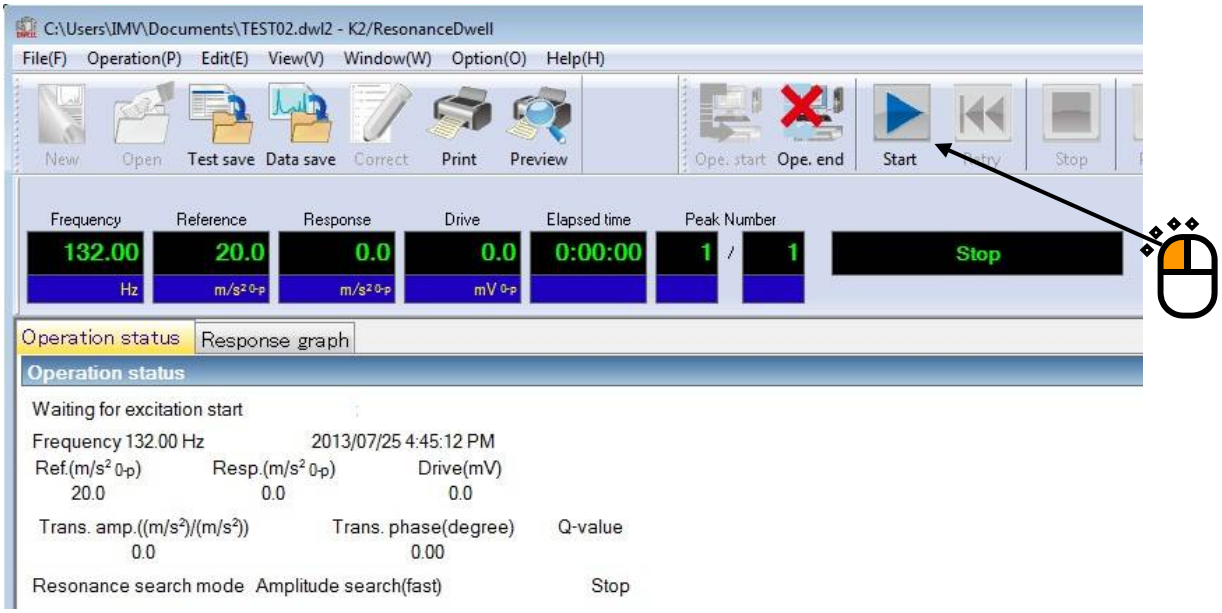
Click [Ope. Start] button.



<Step 2>

Click [Start] button.

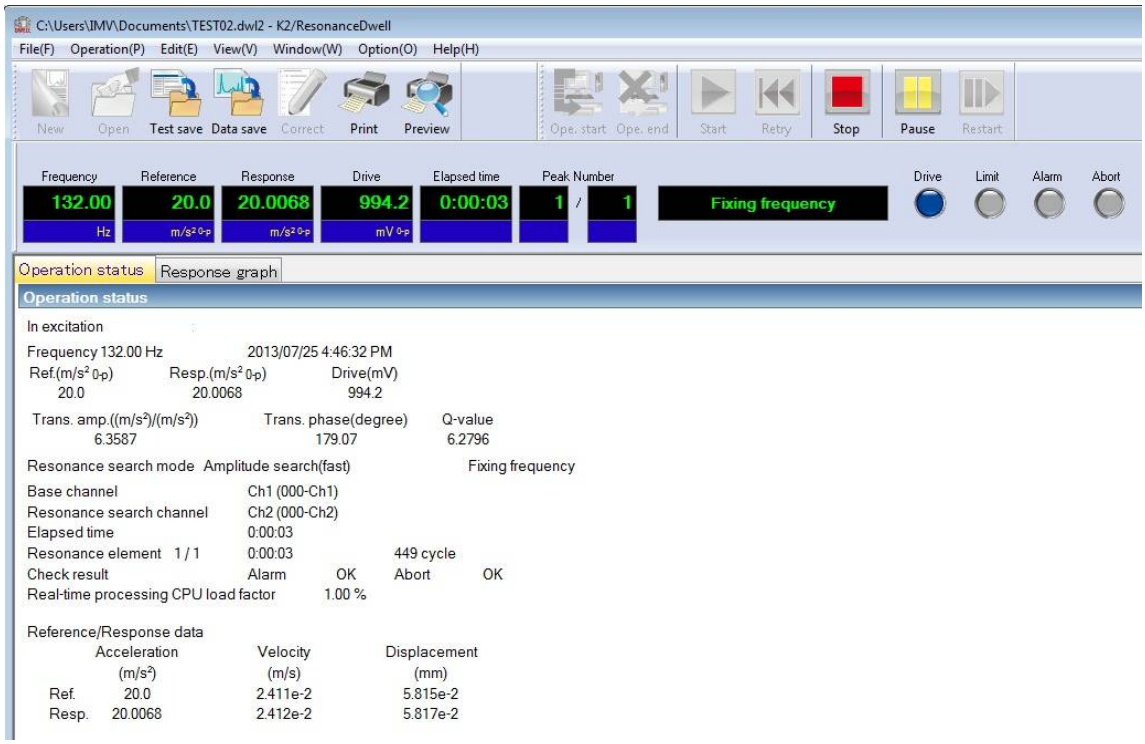
Clicking the button automatically implements Initial loop check and Initial equalization, and executes a test.



<Step 3>

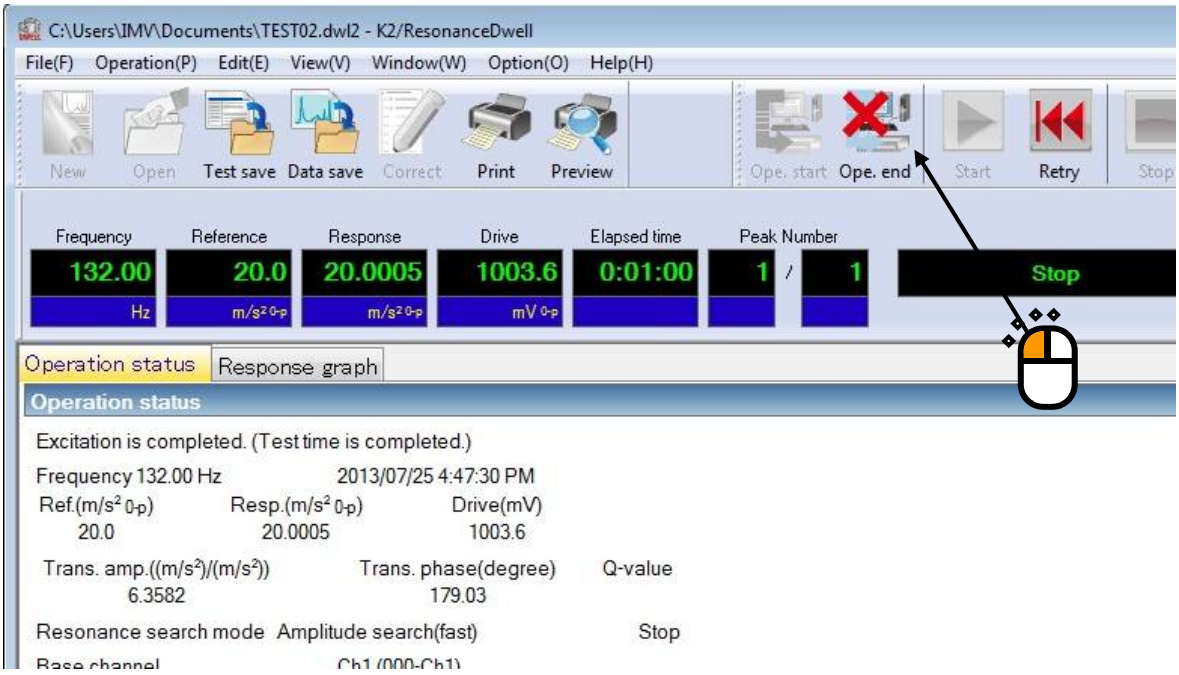
When conditions of Shift judging of resonance frequency are complete, resonance re-search automatically starts to detect a new resonance point. Excitation at the new resonance point continues until the test time is over.

Note）Clicking [Retry] button → [Start] button to execute re-excitation after stopping excitation by clicking [Stop] button initializes all the data, resulting in re-excitation at a peak frequency set in Test definition. On the other hand, stopping excitation by using [Pause] button allows continuing excitation by clicking [Restart] button.



<Step 4>

Clicking [Ope. end] button brings you back to Test definition mode.



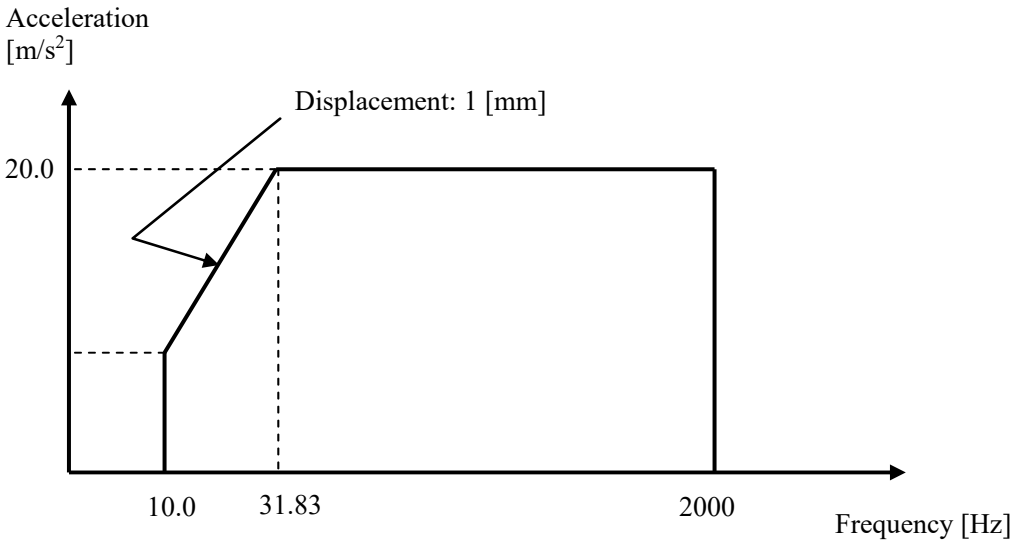
1.4 Resonance Dwell (Resonance search mode: Phase Search)

<Example>

This is an example of Resonance Dwell test as given below.

[Fundamental / Control Condition (Resonance Survey)]

Peak amplitude estimation: Tracking



[Reference Pattern (Resonance Survey)]

[Pre-sweep test time]

Sweep time: 1.000 (octave/min)

Times of double sweep: 1 (single-sweep)

[Information of used sensors]

Two (2) piezoelectric acceleration pickups are used: one for control and other for monitoring.

Ch1: Control, Sensitivity of 3pC/(m/s^2)

Ch2: Monitoring, Sensitivity of 3pC/(m/s^2)

This example is based on the assumption that the above information has been entered in Input Environment Information and the excitation system information such as rating has been registered in Excitation System Information as well.

[Resonance Search Condition]

Resonance judgment criteria: Transmissibility is 1.5 and over.

[Resonance Dwell Condition]

Resonance search mode: Phase Search

Resonance frequency: The first peak frequency extracted through Resonance Search is used.

Excitation level: 20.0 (m/s^2)

Phase difference: Use results of Pre-sweep without change.

Alarm upper:	6.0 (dB)	Alarm lower:	–6.0 (dB)
Abort lower limit:	3.0 (dB)	Alarm upper:	–3.0 (dB)
Dwell time:	1 minute	Test time:	No repetition

Max. resonance dwelling rate: Normal

<Operation Procedure>

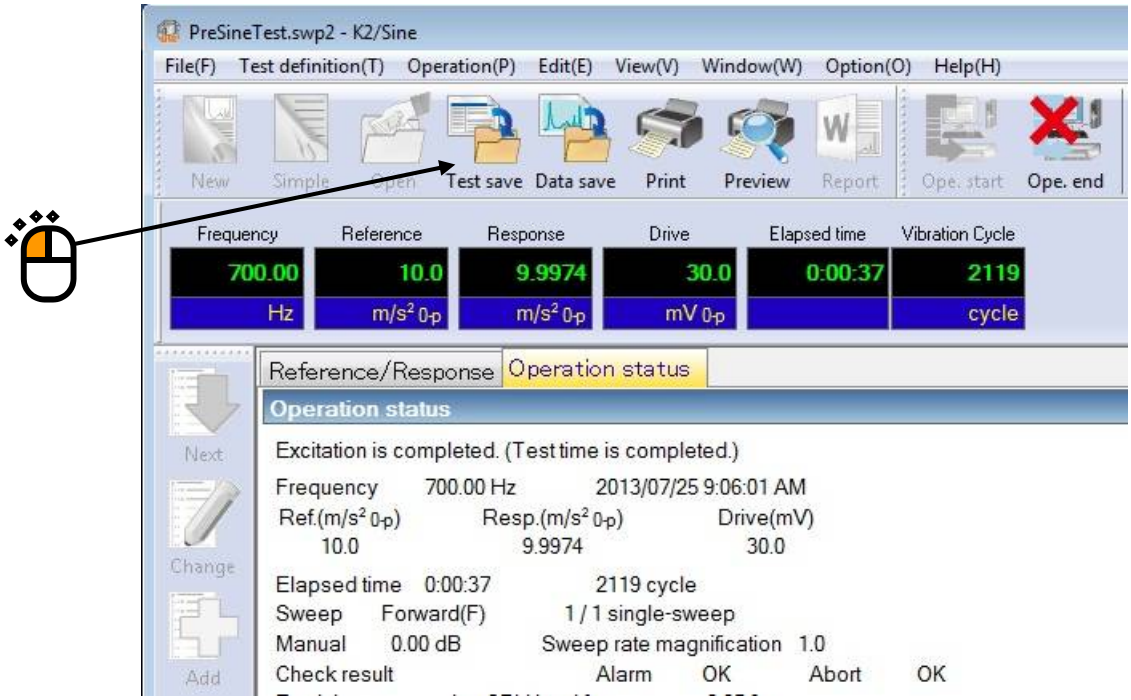
[Resonance Survey]

<Step 1>

Define above-mentioned [Reference Pattern (Resonance Survey)] and [Pre-sweep test time] according to "Chapter 3 Basing Operation Example" of the K2+/SINE Instruction Manual, and measure resonance frequencies. (**Peak Amplitude Estimation: Tracking**)

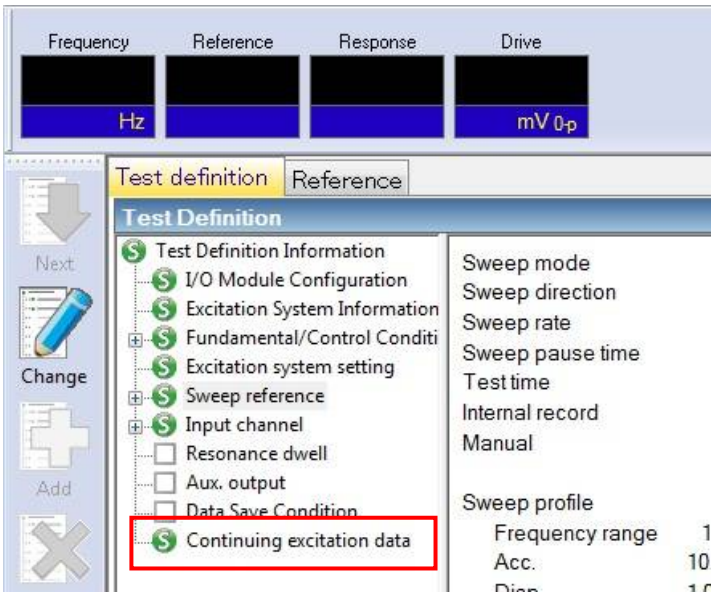
<Step 2>

After "Excitation is completed (Test time is completed)" has appeared in Operation Status window of Pre-sweep test, click [Test save] button.



<Step 3>

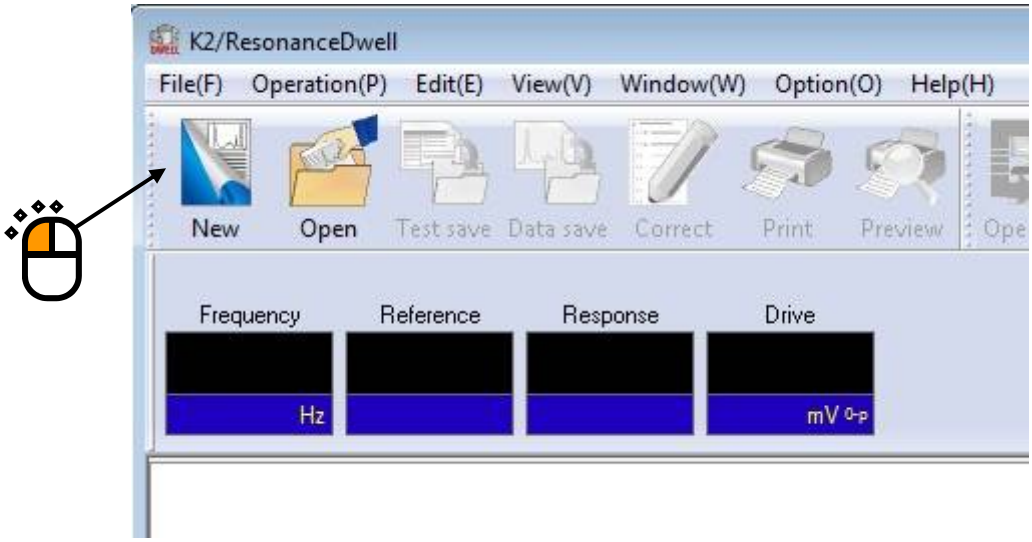
Go back to Test Definition. Then, exit K2+/SINE with "Continuing excitation data" set (SET) in Test Definition Information.



[Resonance Search]

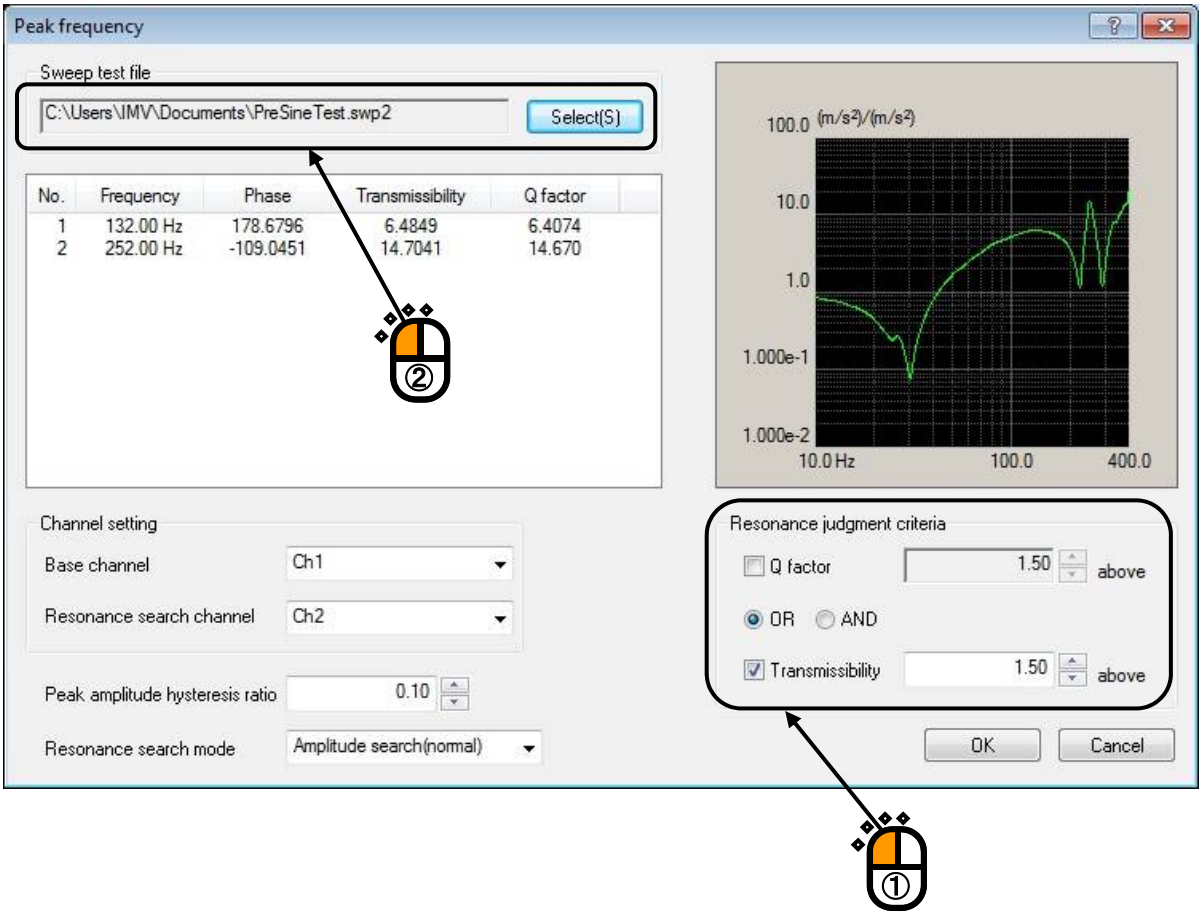
<Step 1>

Start K2+/ResonanceDwell. Then, click [New] button.



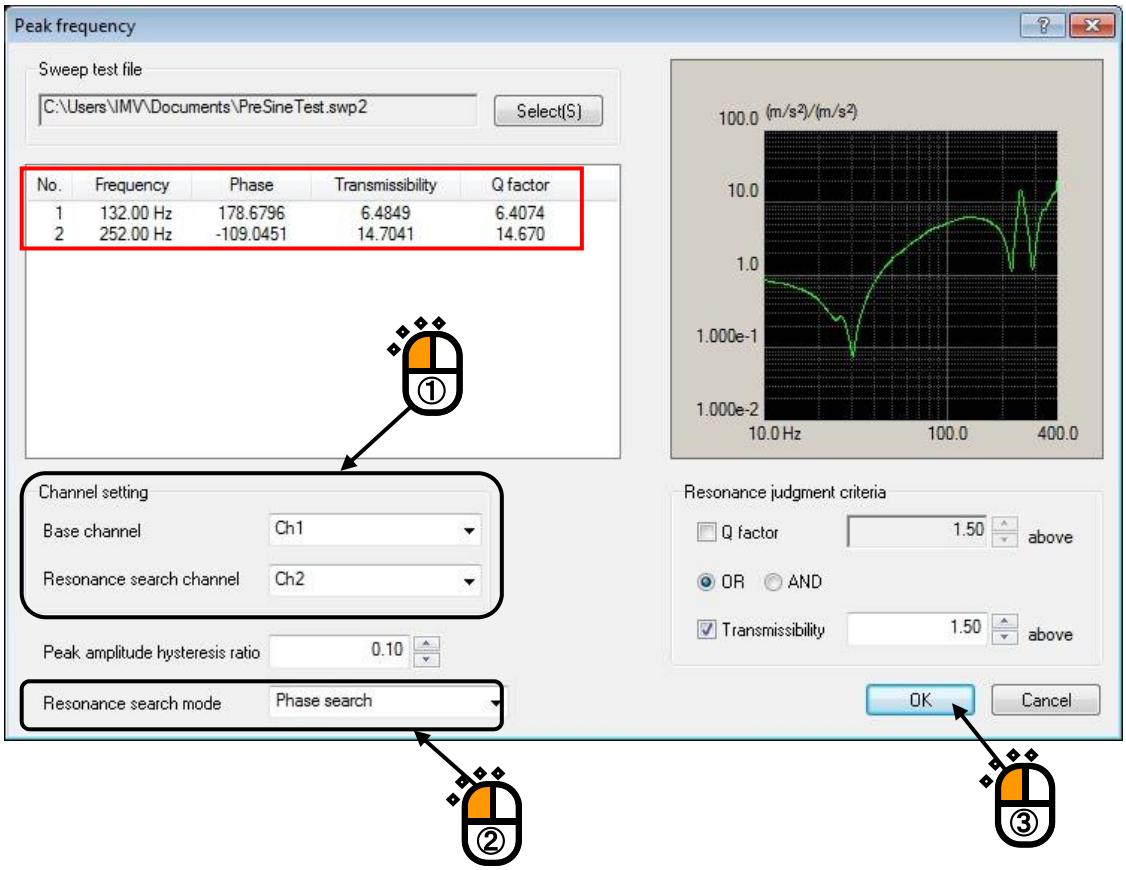
<Step 2>

Set the condition of “Resonance Judgment Criteria”. Open the sweep test file saved in “Resonance Survey”.



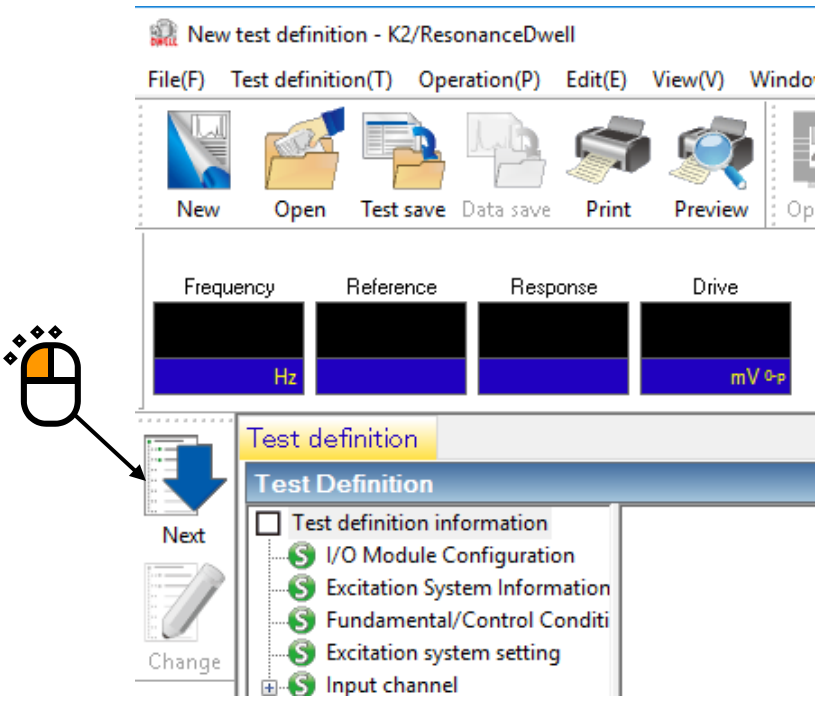
<Step 3>

When “Base Channel” and “Resonance Search Channel” are set, the transmissibility (Response data of Resonance Search Channel l / response data of Base Channel) is calculated and peak frequencies that meet the resonance judgment criteria are list-displayed. Check that frequencies are list-displayed. Select “Resonance Search mode: Phase search”. Click [OK] button.



<Step 4>

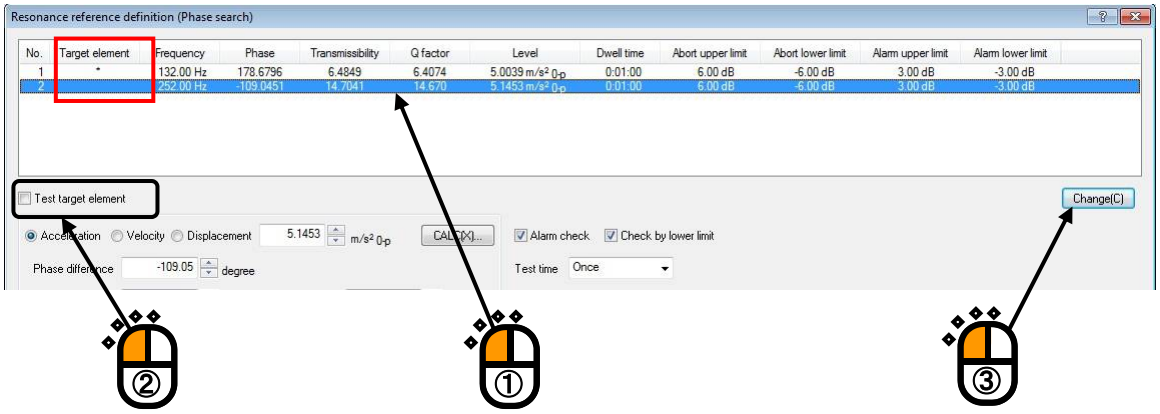
Press the button of [Next] to go to the next definition.



[Resonance Reference Definition]

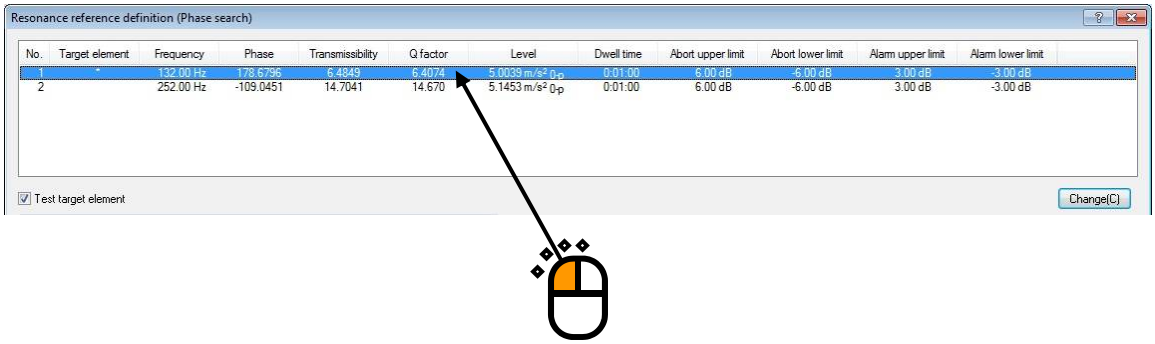
<Step 1>

Note that all of peak frequencies list-displayed in [Resonance Search] are registered as excitation reference by default. Select an inappropriate Target element and uncheck the [Test target element] box. Then, click [Change] button to delete the corresponding peak frequency from the excitation reference list.



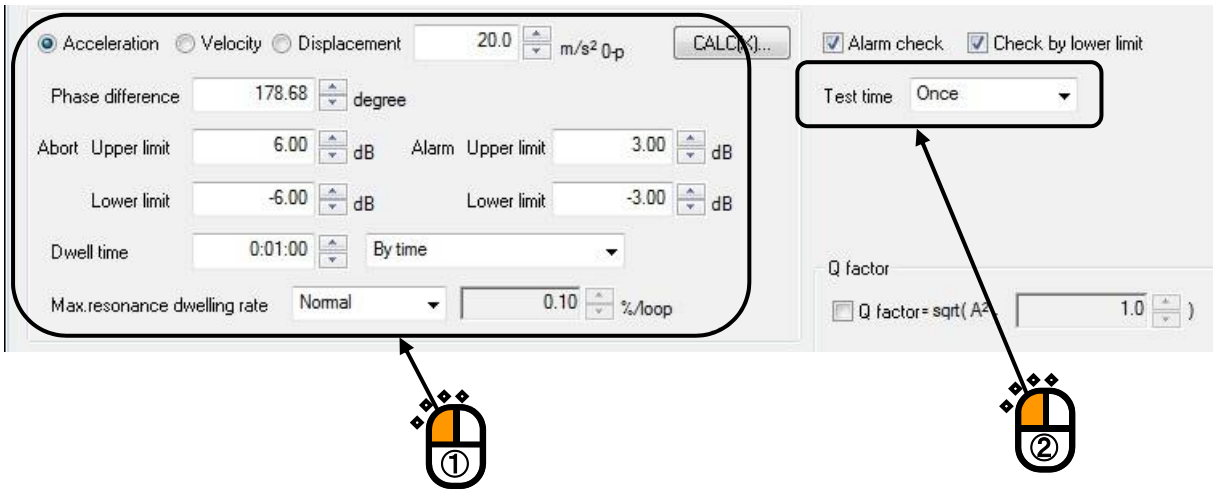
<Step 2>

Select a Target element that requires setting of Resonance Dwell conditions.



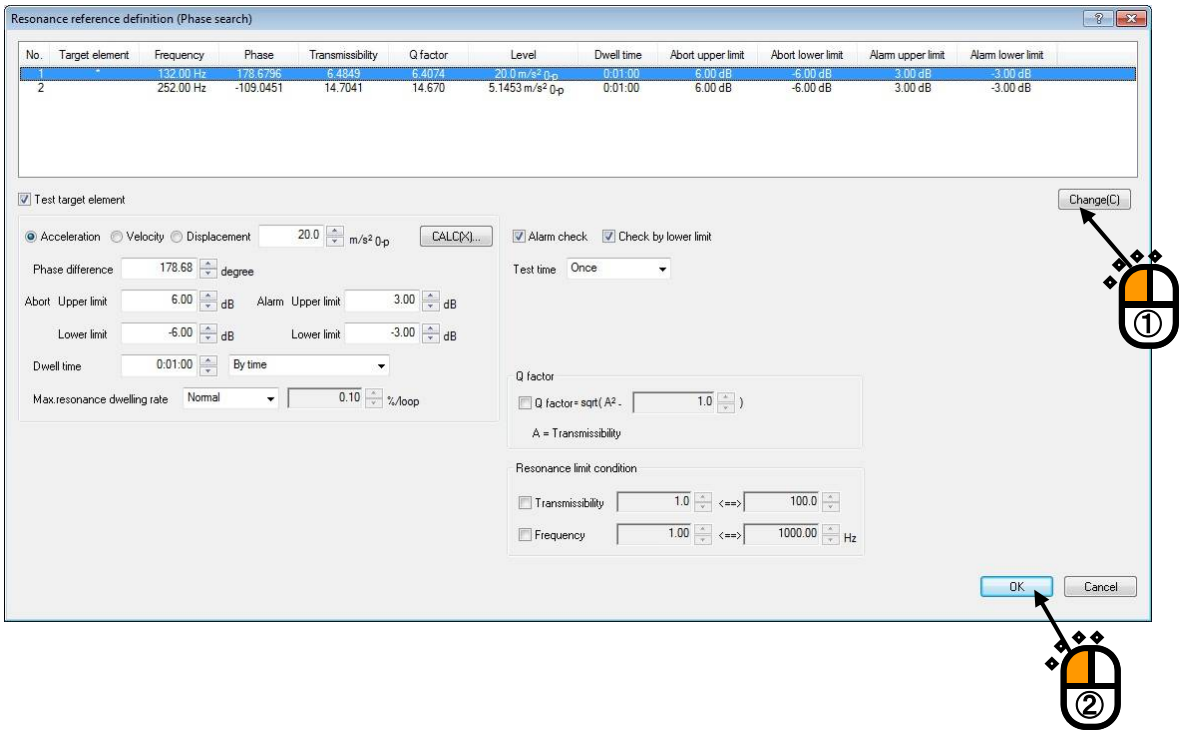
<Step 3>

Set [Excitation level], [Phase difference], [Alarm and Abort tolerance], [Dwell time] [Max. resonance dwelling rate] and [Test time].



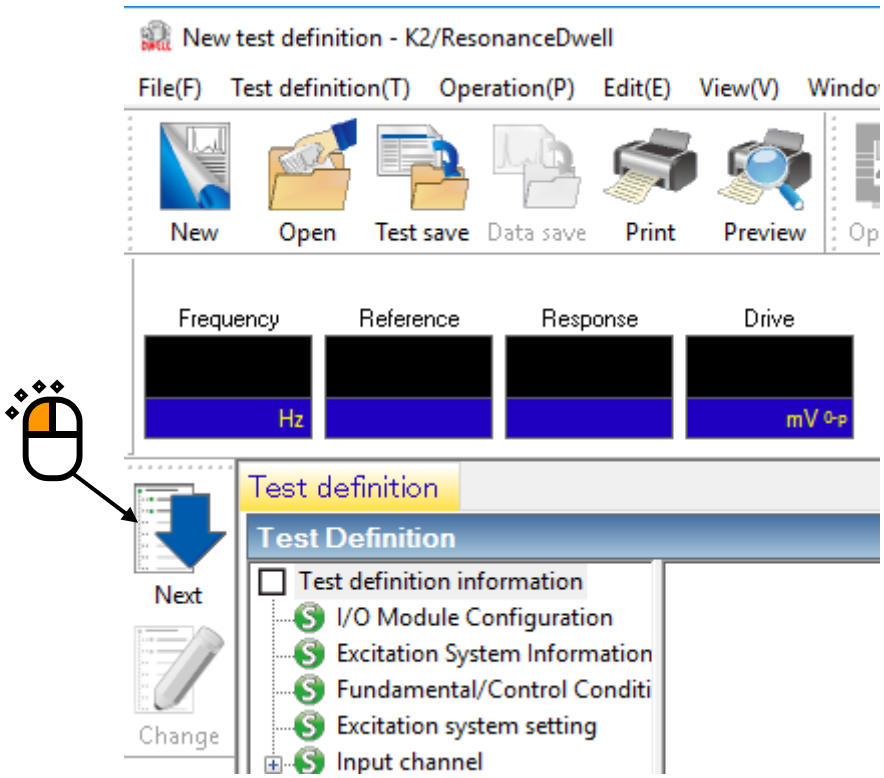
<Step 4>

Click [Change] button to update the reference definition. Then, click [OK] button.



<Step 5>

Press the button of [Next] to go to the next definition.

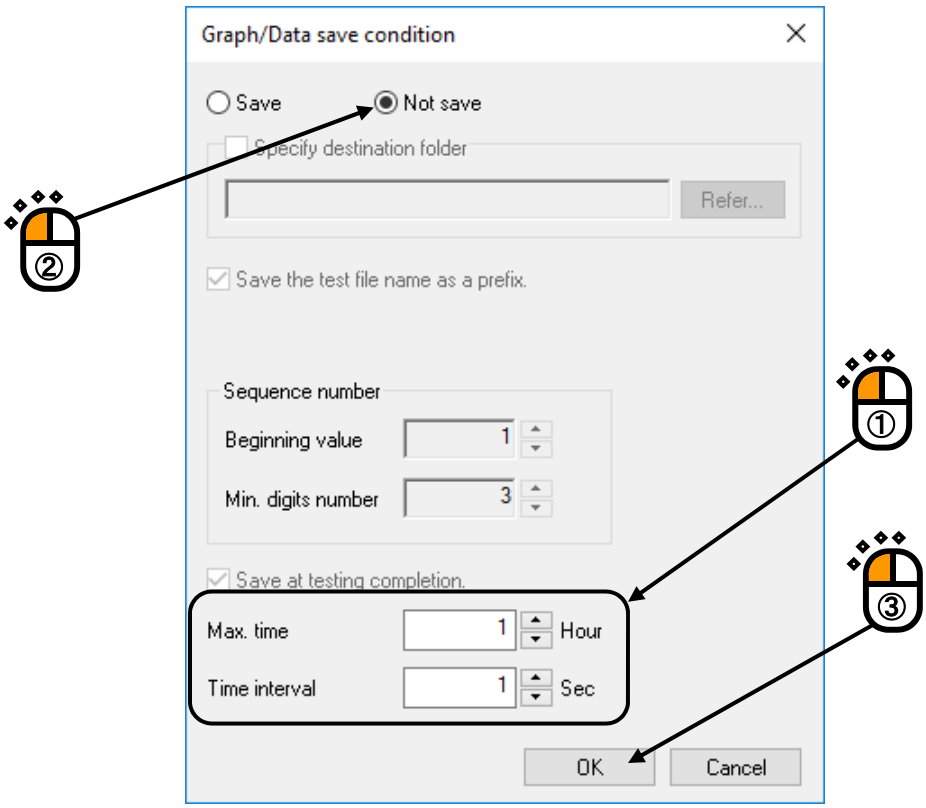


[Graph/Data save condition]

<Step 1>

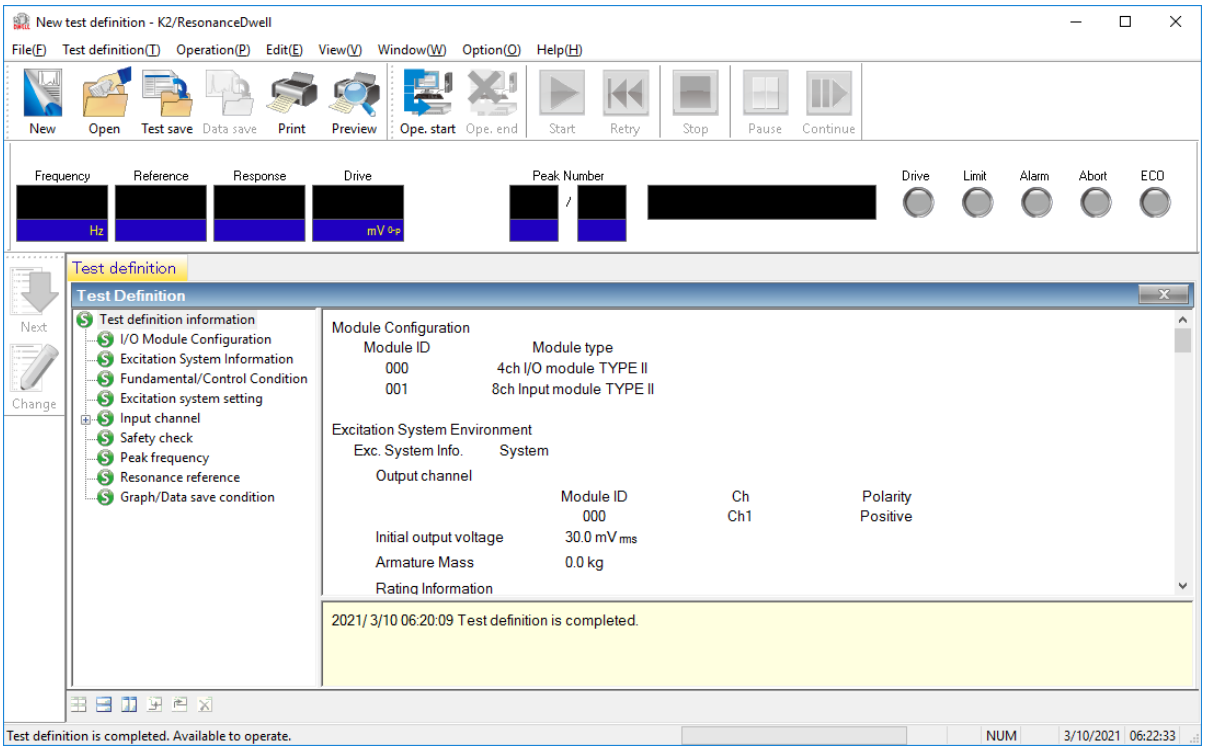
It is imperative “Max time” and “Time interval” are set.

Select ‘Not save’ and press the button of [OK].



<Step 2>

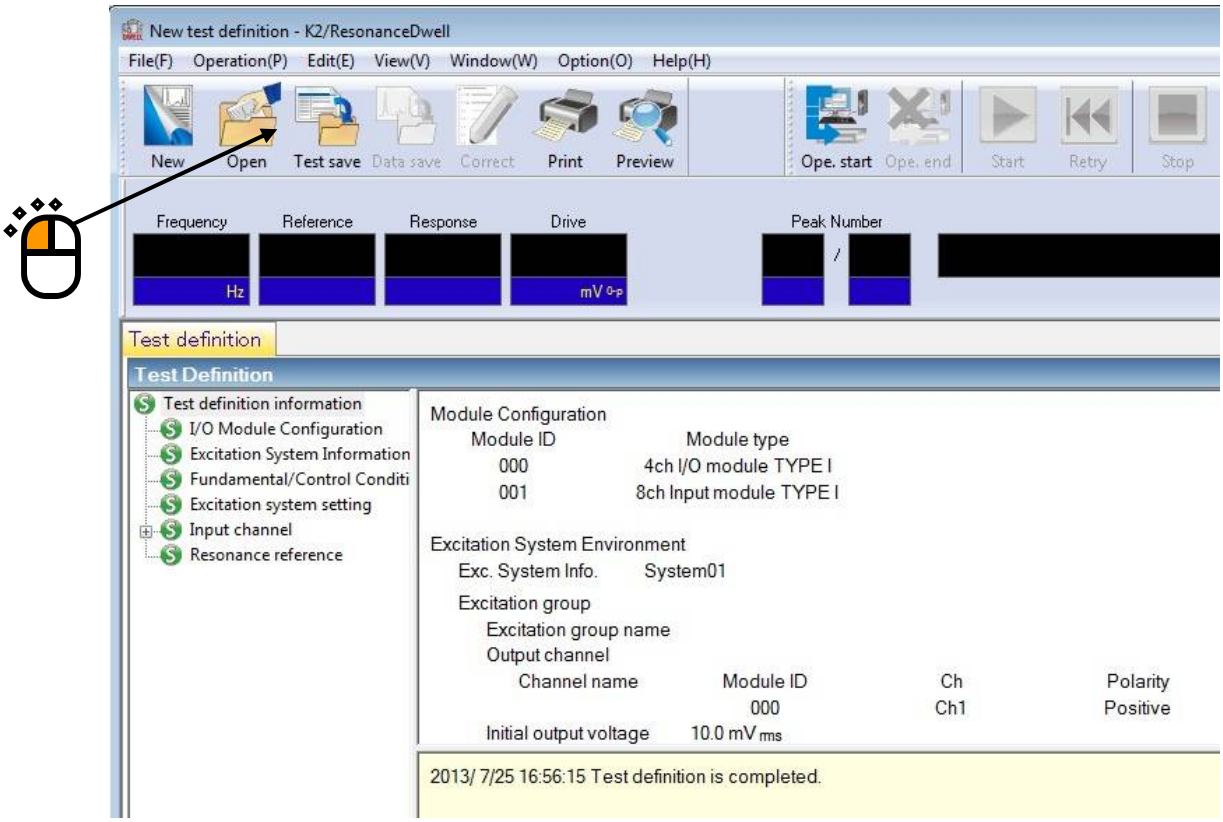
The definition setting is complete.



<Test Save>

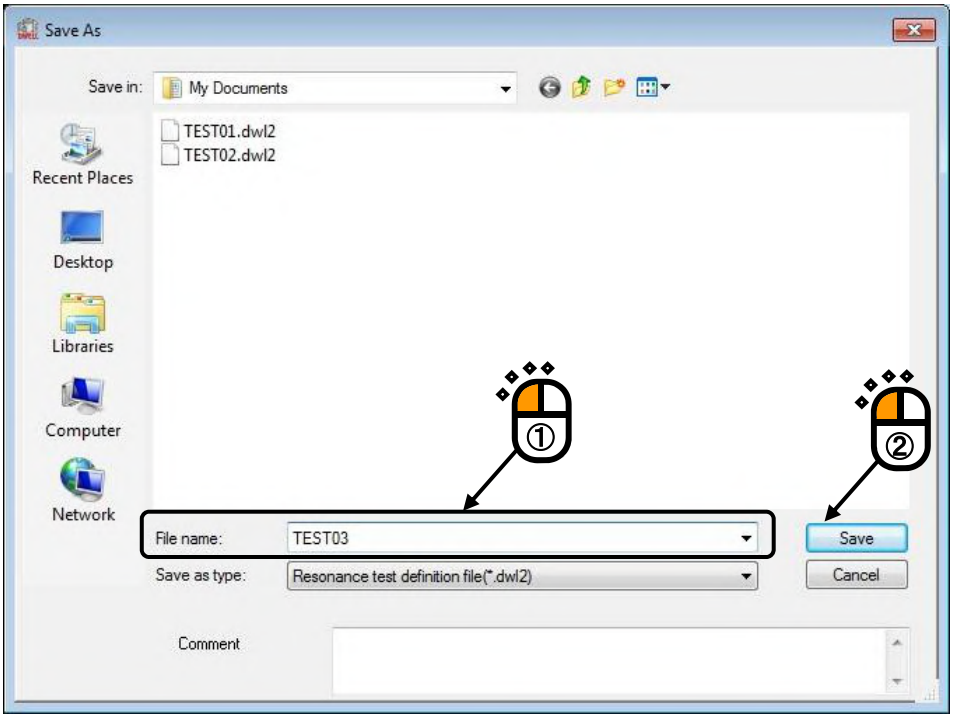
<Step 1>

Click [Test save] button.



<Step 2>

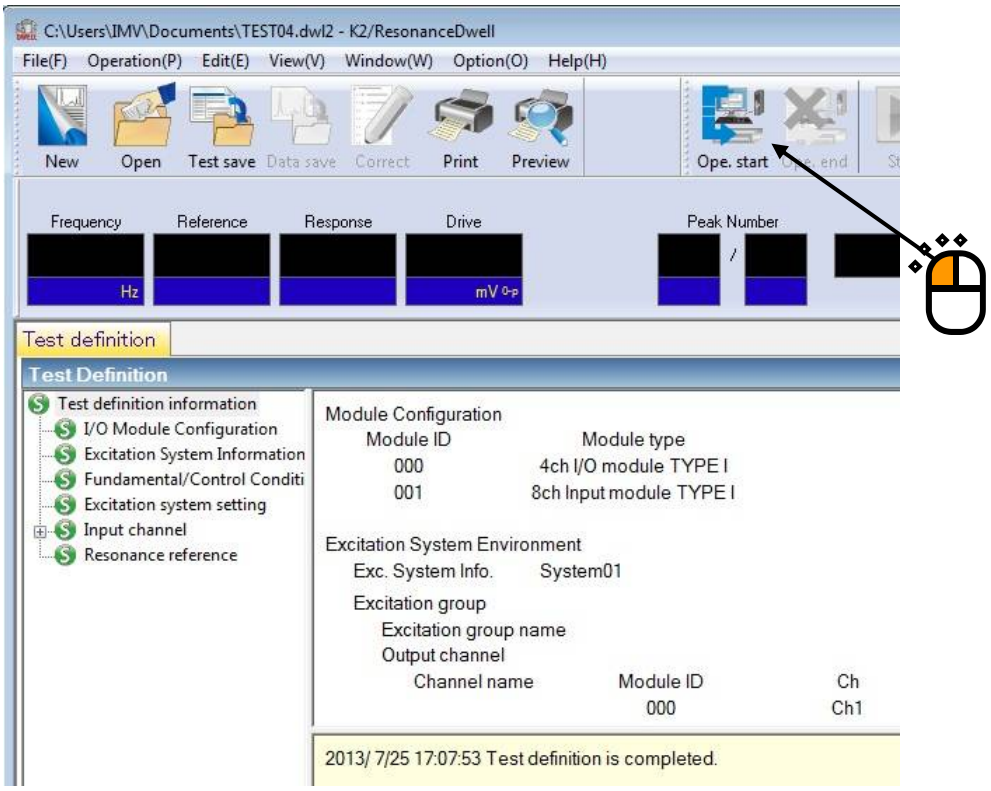
Enter file name. Then, click [Save] button.



<Test Operation>

<Step 1>

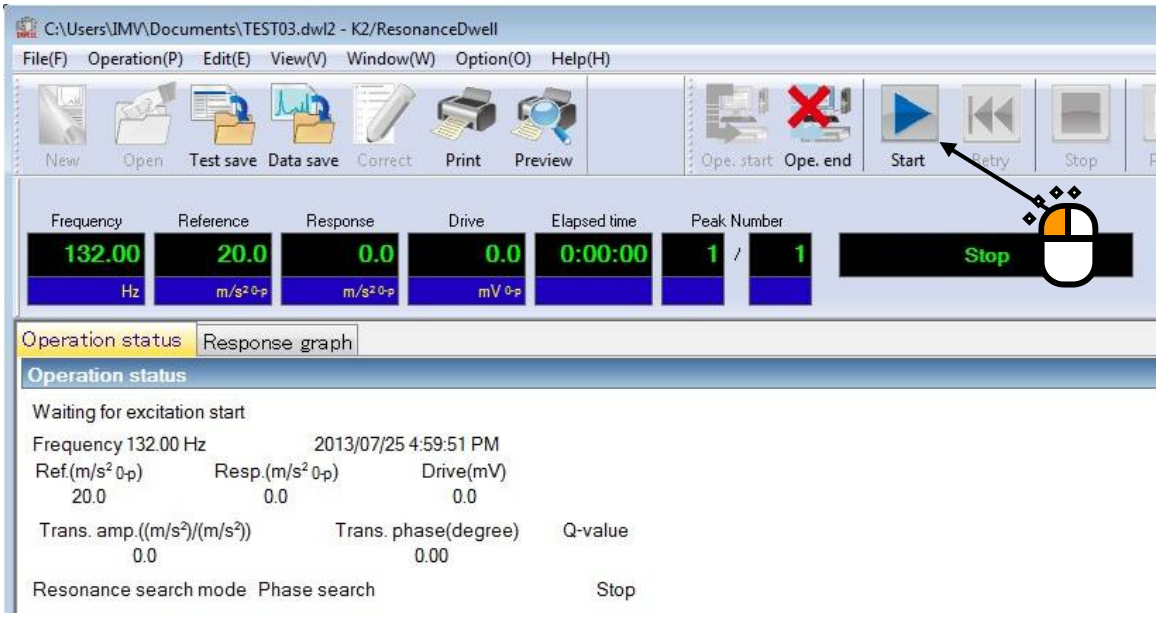
Click [Ope. Start] button.



<Step 2>

Click [Start] button.

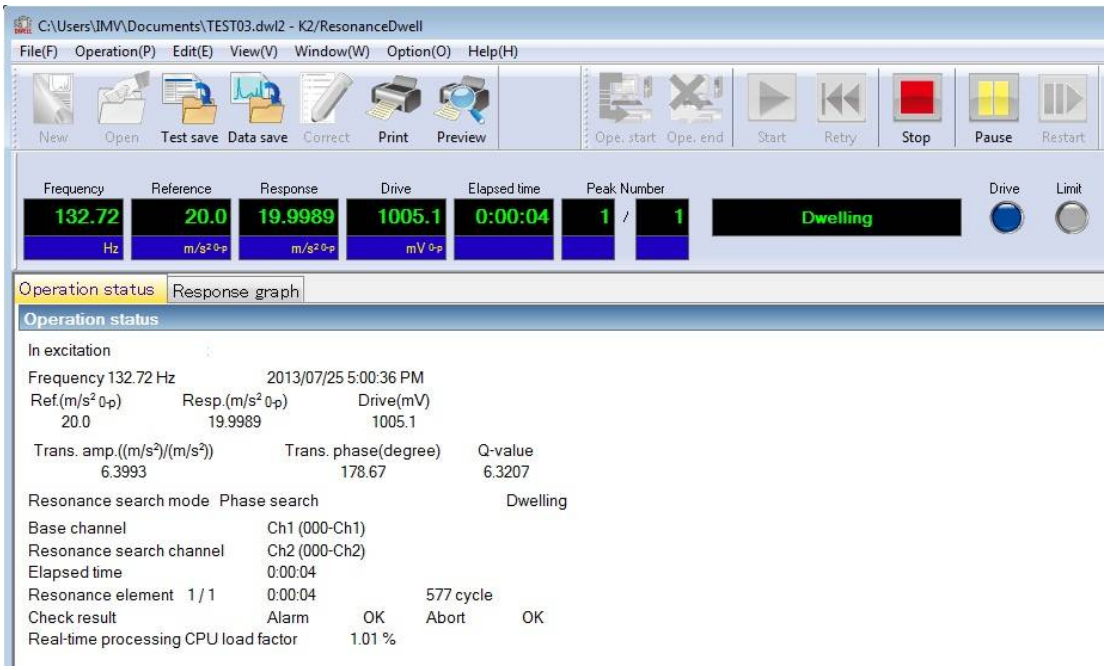
Clicking the button automatically implements Initial loop check and Initial equalization, and executes a test.



<Step 3>

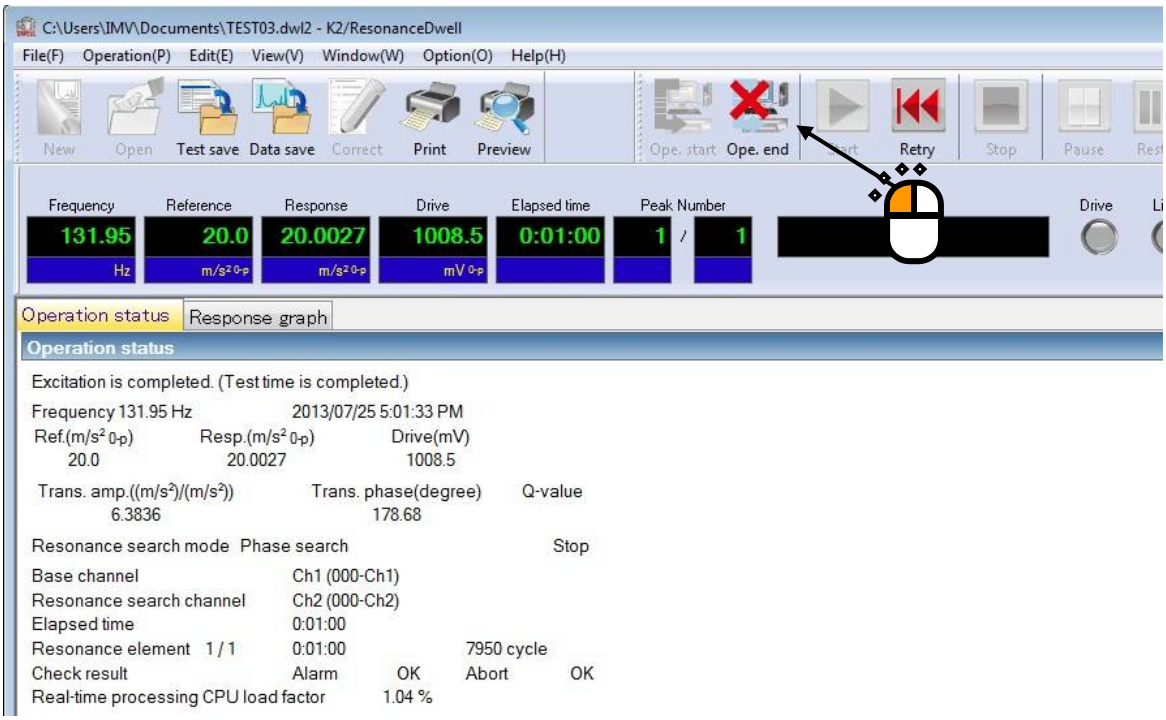
After excitation starts, the system continues Resonance dwelling while adjusting the excitation frequency in such a way that the phase difference registered in the “Resonance reference definition” dialog is satisfied.

Note: Clicking [Retry] button → [Start] button to execute re-excitation after stopping excitation by clicking [Stop] button initializes all the data, resulting in re-excitation at a peak frequency set in Test definition. On the other hand, stopping excitation by using [Pause] button allows continuing excitation by clicking [Restart] button.



<Step 4>

Clicking [Ope. end] button brings you back to Test definition mode.



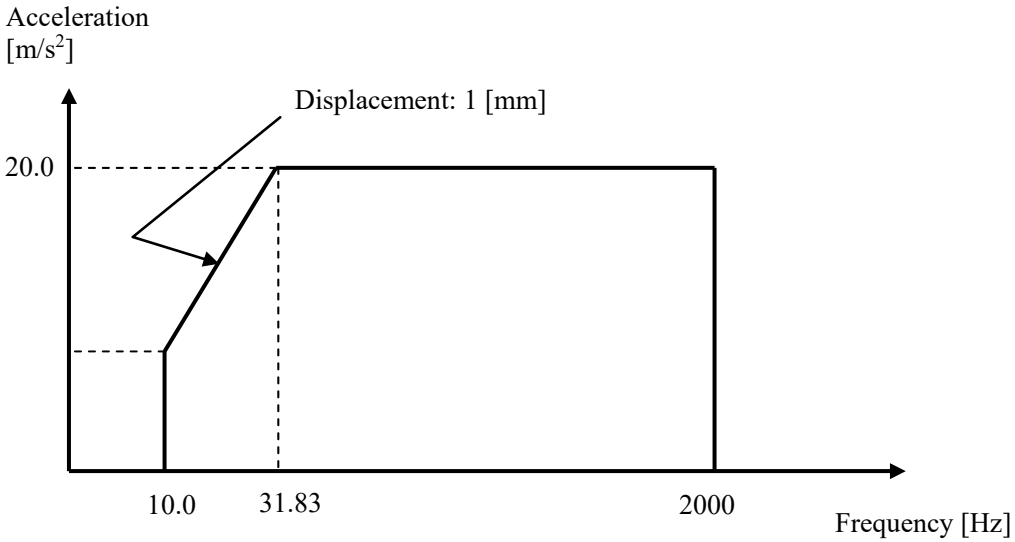
1.5 Resonance Dwell (Resonance search mode: Frequency fixing)

<Example>

This is an example of Resonance Dwell test as given below.

[Fundamental / Control Condition (Resonance Survey)]

Peak amplitude estimation: Tracking



[Reference Pattern (Resonance Survey)]

[Pre-sweep test time]

Sweep time: 1.000 (octave/min)

Times of double sweep: 1 (single-sweep)

[Information of used sensors]

Two (2) piezoelectric acceleration pickups are used: one for control and other for monitoring.

Ch1: Control, Sensitivity of 3pC/(m/s^2)

Ch2: Monitoring, Sensitivity of 3pC/(m/s^2)

This example is based on the assumption that the above information has been entered in Input Environment Information and the excitation system information such as rating has been registered in Excitation System Information as well.

[Resonance Search Condition]

Resonance judgment criteria: Transmissibility is 1.5 and over.

[Resonance Dwell Condition]

Resonance search mode: Frequency fixing

Resonance frequency: The first peak frequency extracted through Resonance Search is used.

Excitation level: 20.0 (m/s^2)

Alarm upper:	6.0 (dB)	Alarm lower:	–6.0 (dB)
Abort lower limit:	3.0 (dB)	Alarm upper:	–3.0 (dB)
Dwell time:	1 minute	Test time: No repetition	

<Operation Procedure>

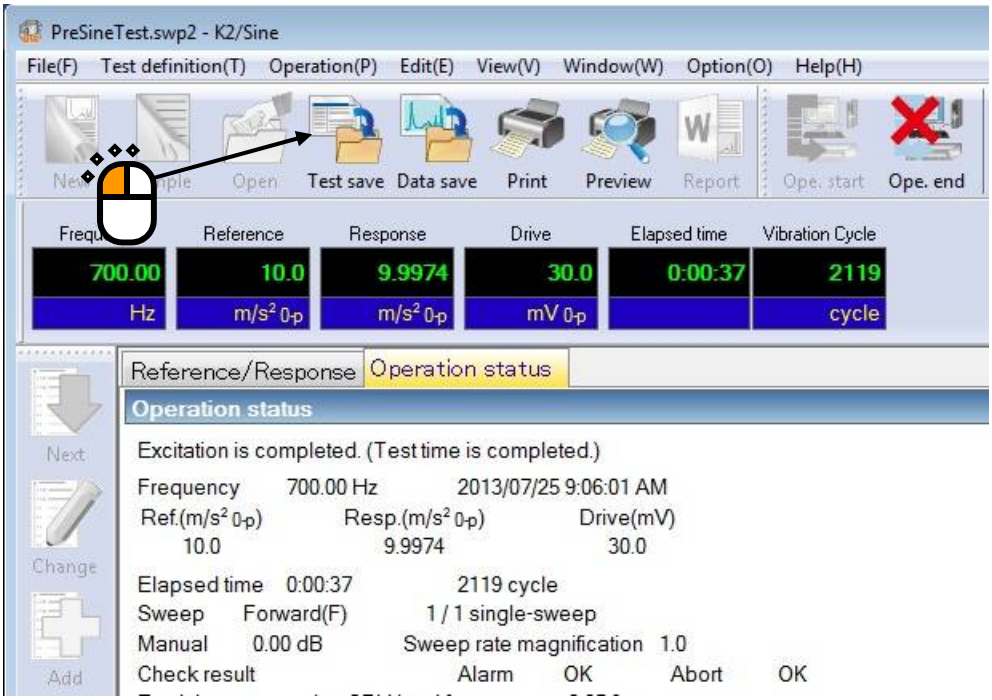
[Resonance Survey]

<Step 1>

Define above-mentioned [Reference Pattern (Resonance Survey)] and [Pre-sweep test time] according to "Chapter 3 Basing Operation Example" of the K2+/SINE Instruction Manual, and measure resonance frequencies. (**Peak Amplitude Estimation: Tracking**)

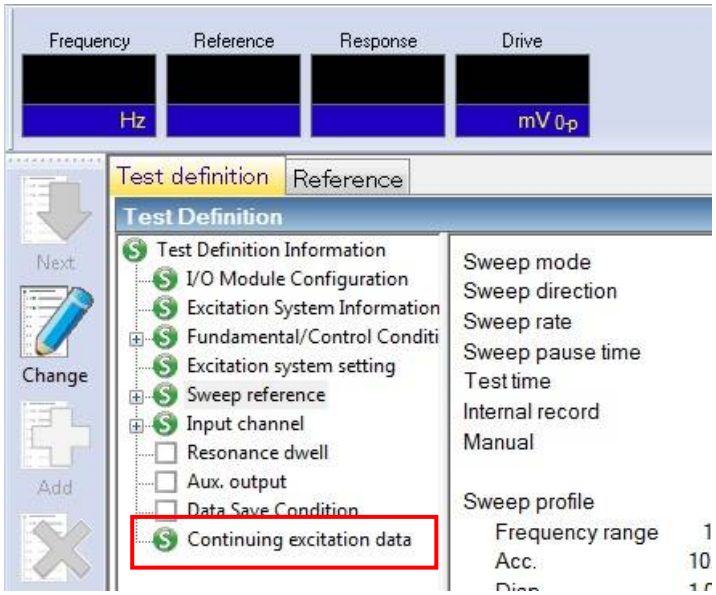
<Step 2>

After "Excitation is completed (Test time is completed)" has appeared in Operation Status window of Pre-sweep test, click [Test save] button.



<Step 3>

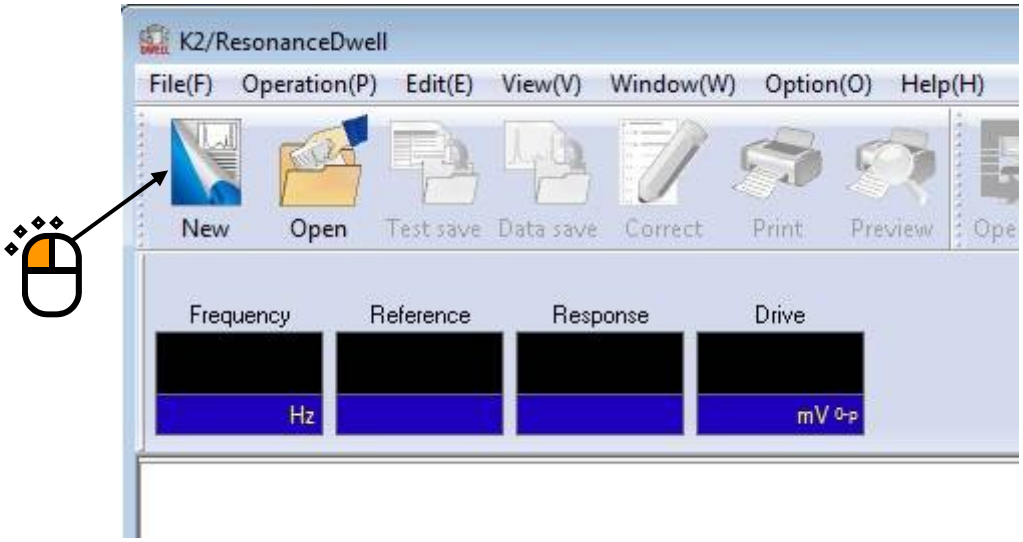
Go back to Test Definition. Then, exit K2+/SINE with "Continuing excitation data" set (SET) in Test Definition Information.



[Resonance Search]

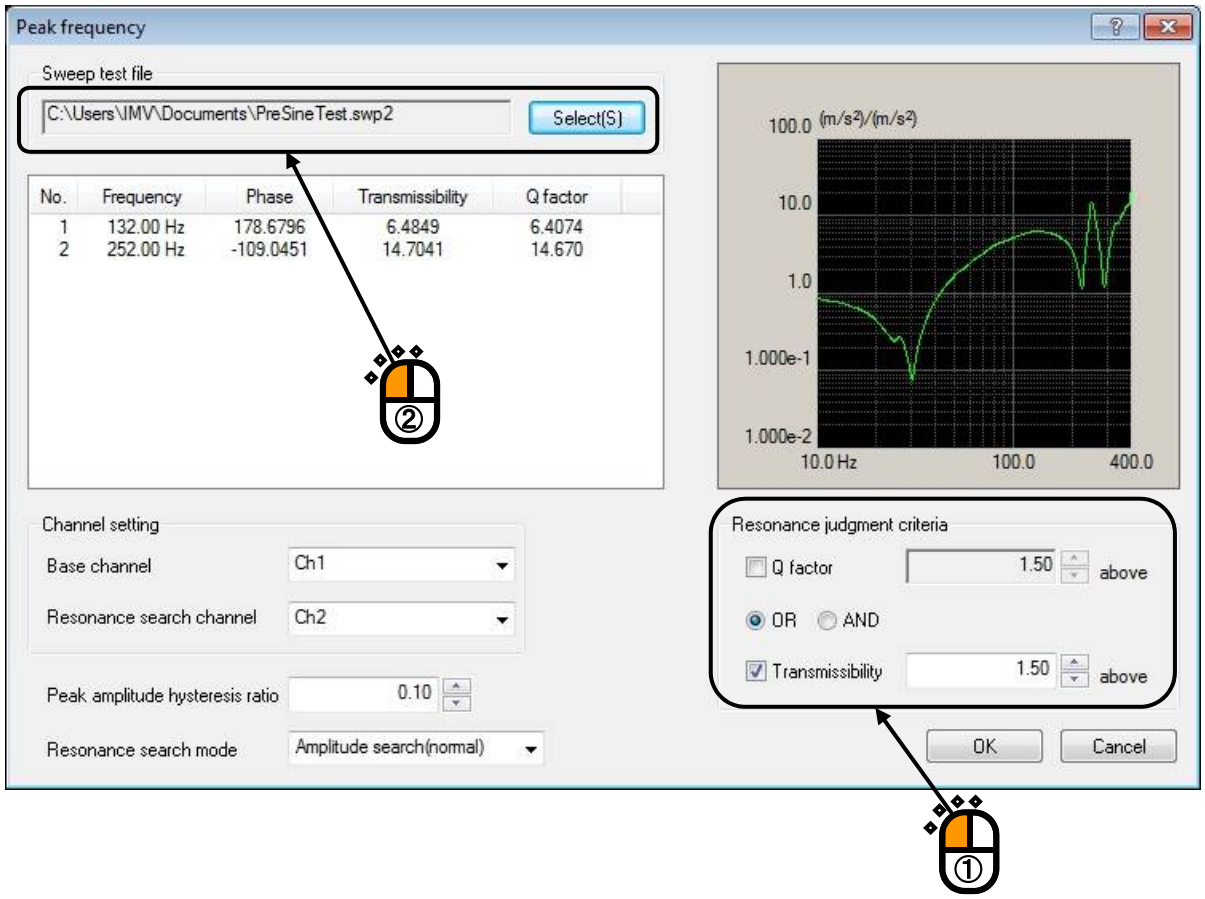
<Step 1>

Start K2+/ResonanceDwell. Then, click [New] button.



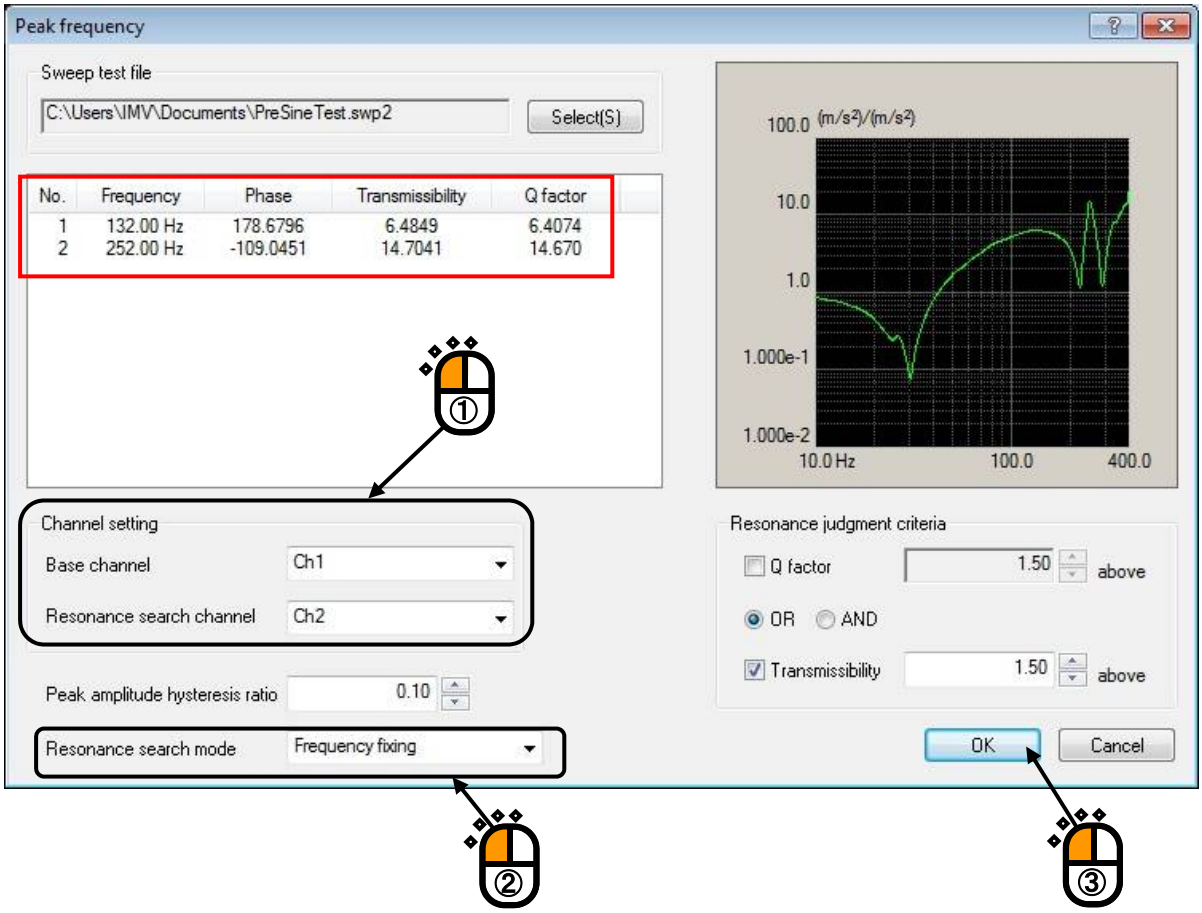
<Step 2>

Set the condition of “Resonance Judgment Criteria”. Open the sweep test file saved in “Resonance Survey”.



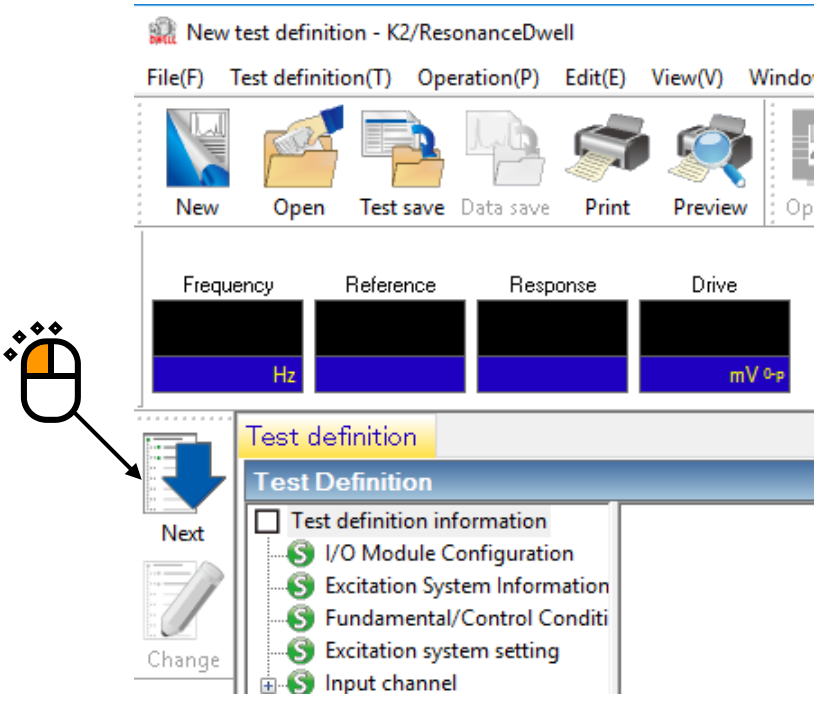
<Step 3>

When “Base Channel” and “Resonance Search Channel” are set, the transmissibility (Response data of Resonance Search Channel / response data of Base Channel) is calculated and peak frequencies that meet the resonance judgment criteria are list-displayed. Check that frequencies are list-displayed. Select “Resonance Search mode: Frequency fixing”. Click [OK] button.



<Step 4>

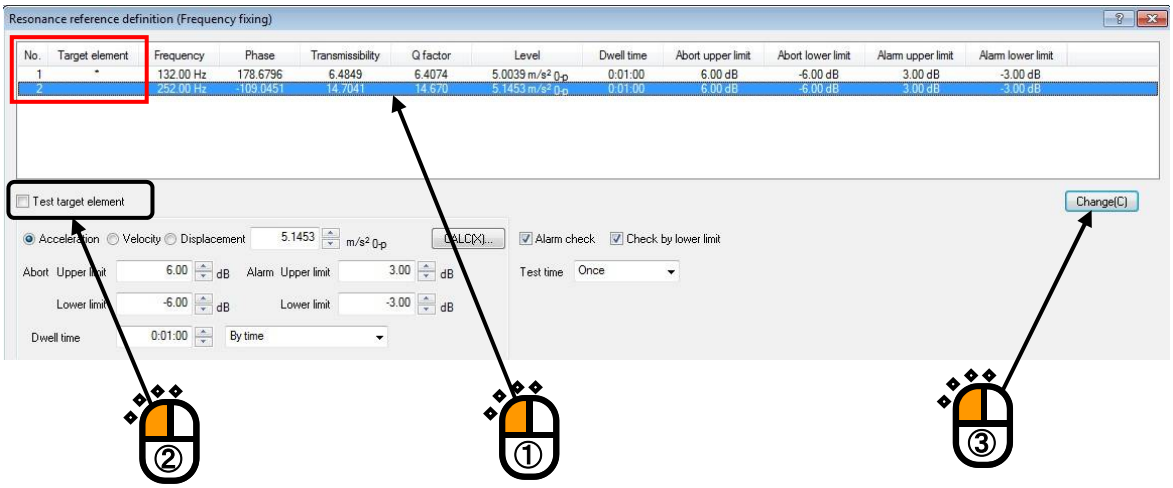
Press the button of [Next] to go to the next definition.



[Resonance Reference Definition]

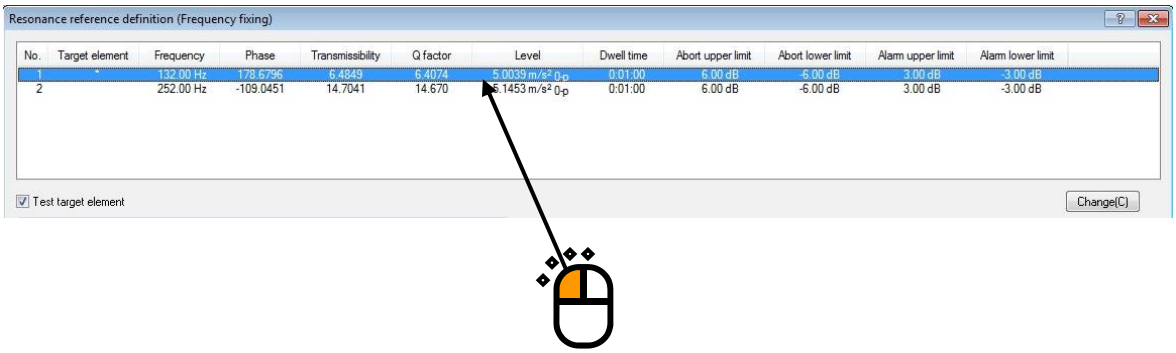
<Step 1>

Note that all of peak frequencies list-displayed in [Resonance Search] are registered as excitation reference by default. Select an inappropriate Target element and uncheck the [Test target element] box. Then, click [Change] button to delete the corresponding peak frequency from the excitation reference list.



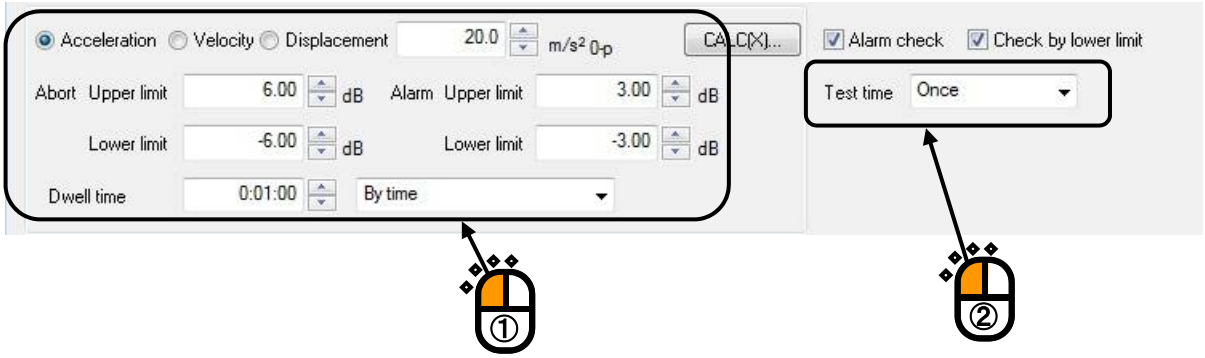
<Step 2>

Select a Target element that requires setting of Resonance Dwell conditions.



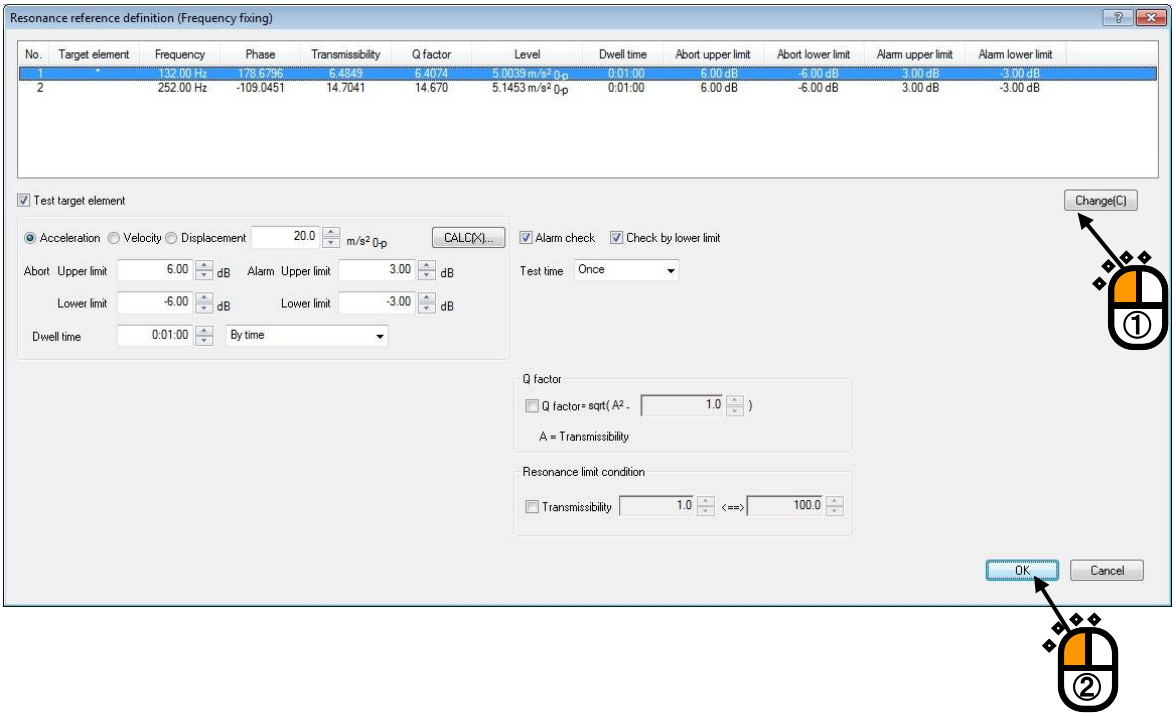
<Step 3>

Set [Excitation level], [Alarm and Abort tolerance], [Dwell time] and [Test time].



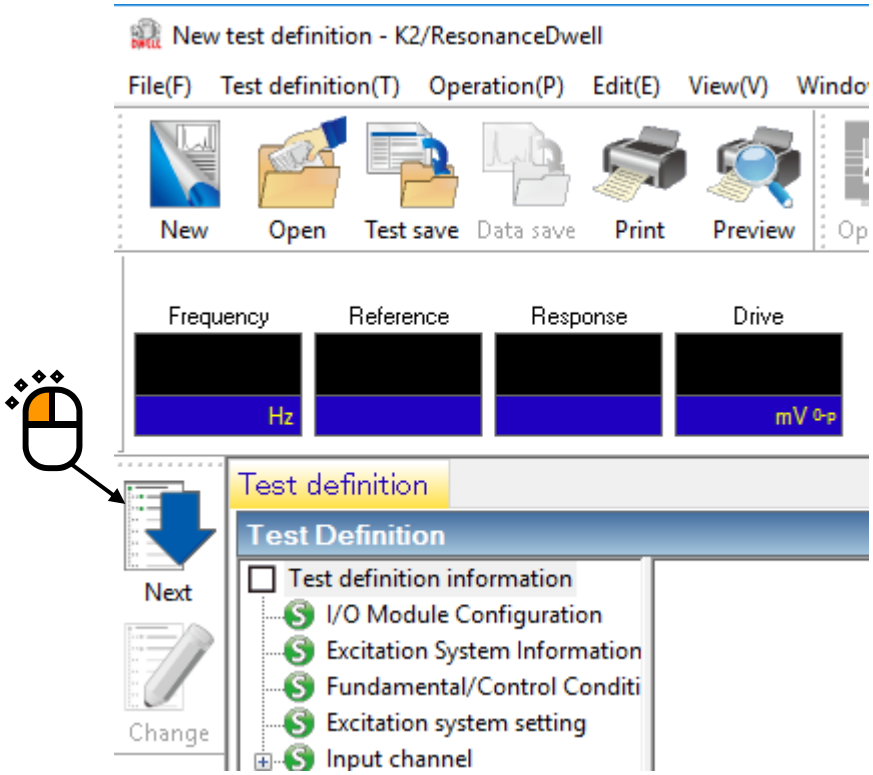
<Step 4>

Click [Change] button to update the reference definition. Then, click [OK] button.



<Step 4>

Press the button of [Next] to go to the next definition.

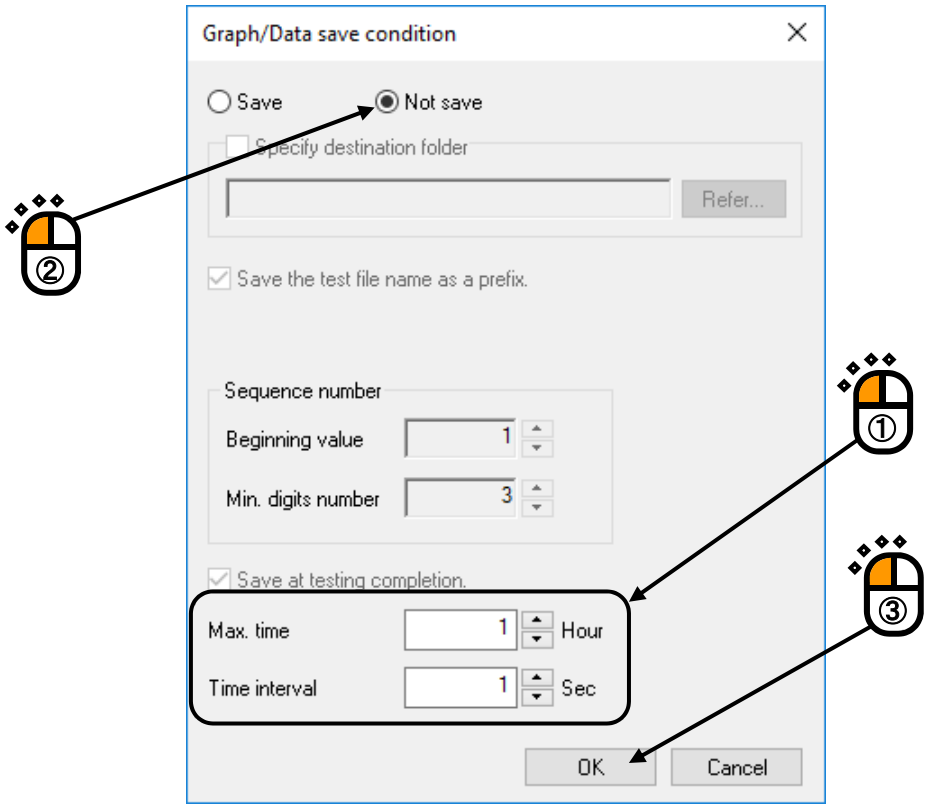


[Graph/Data save condition]

<Step 1>

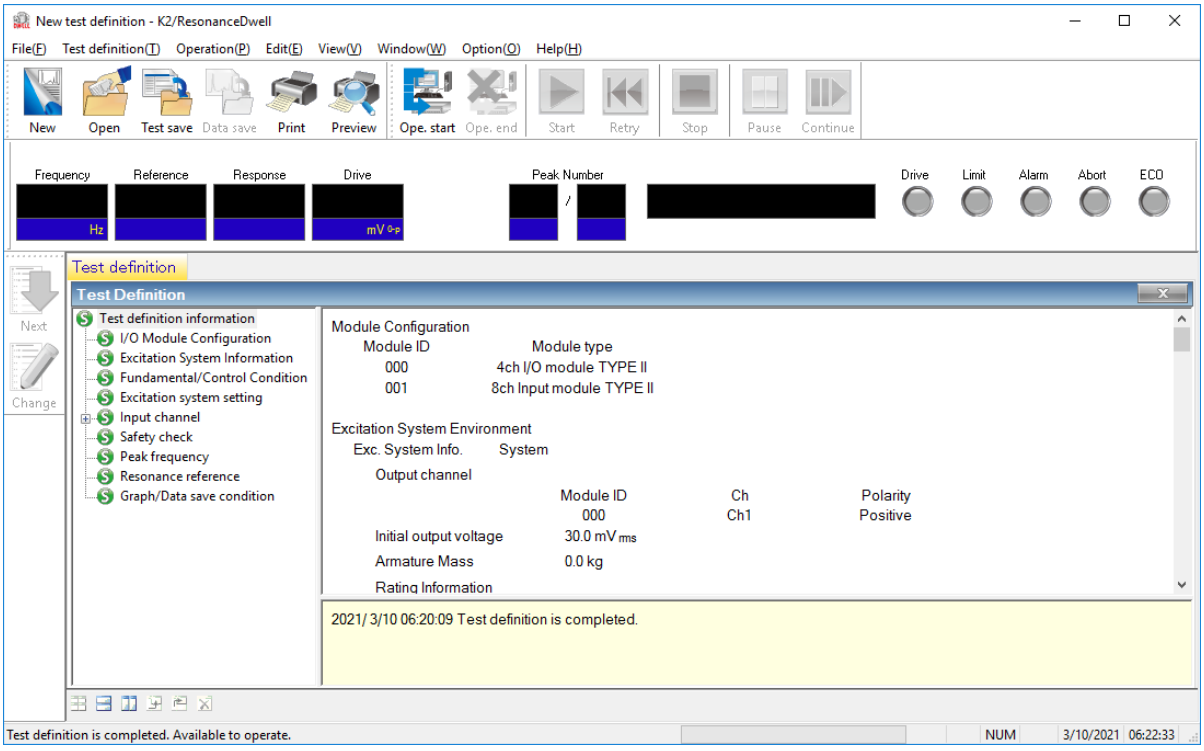
It is imperative “Max time” and “Time interval” are set.

Select ‘Not save’ and press the button of [OK].



<Step 2>

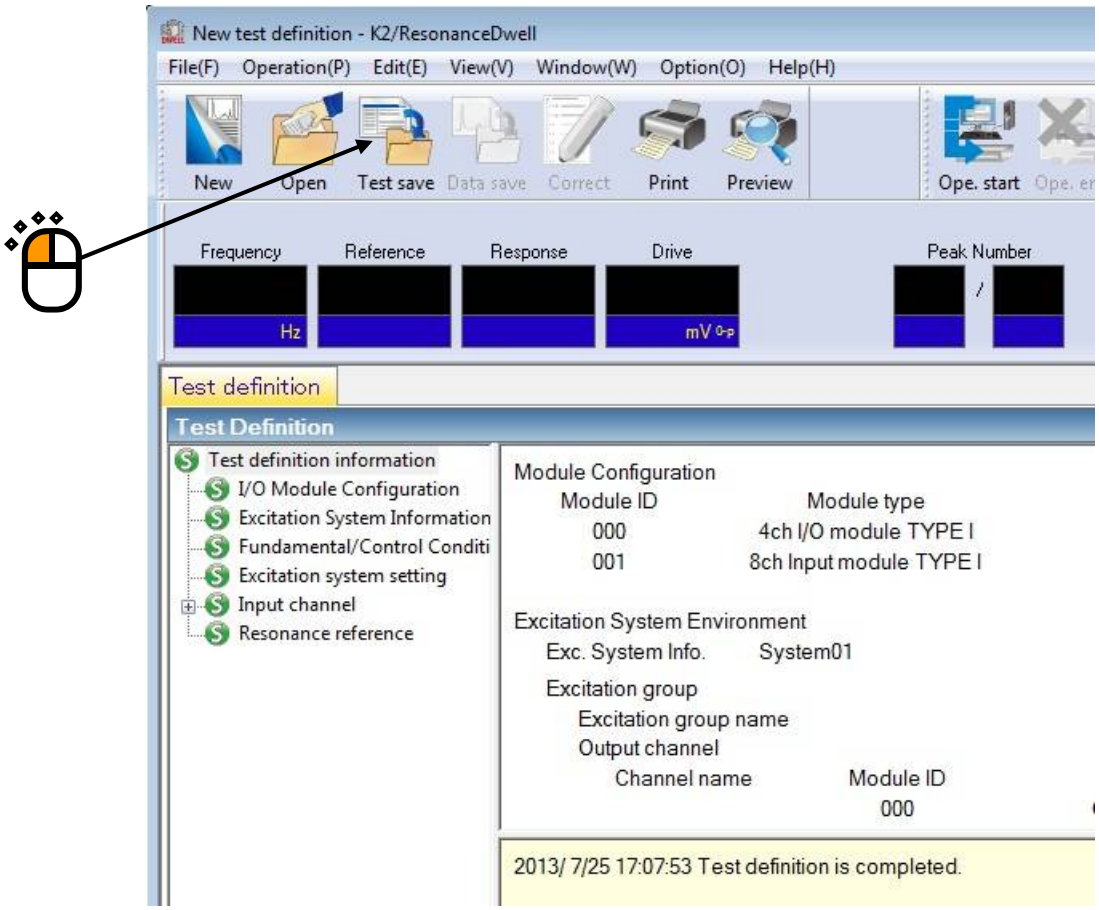
The definition setting is complete.



<Test Save>

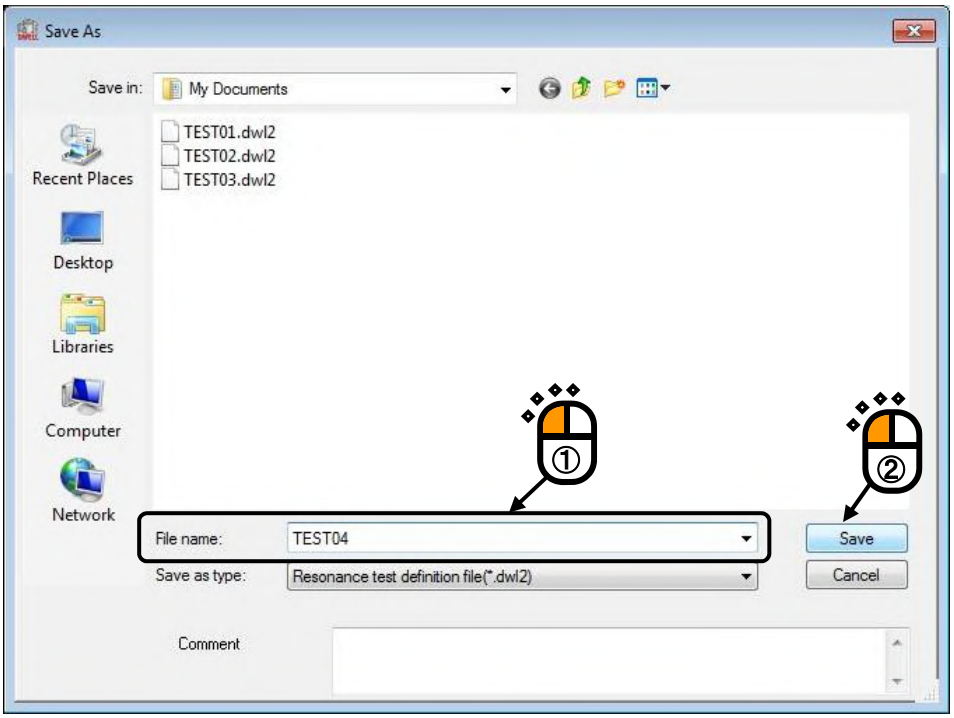
<Step 1>

Click [Test save] button.



<Step 2>

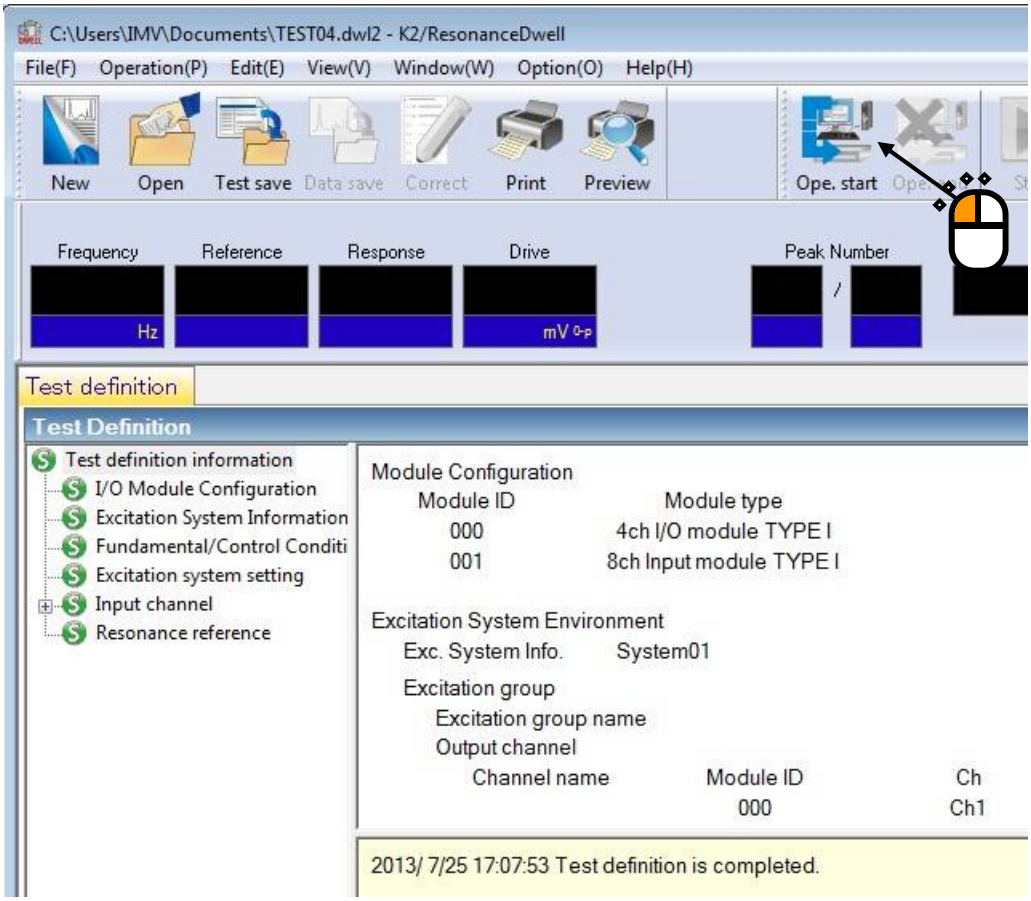
Enter file name. Then, click [Save] button.



<Test Operation>

<Step 1>

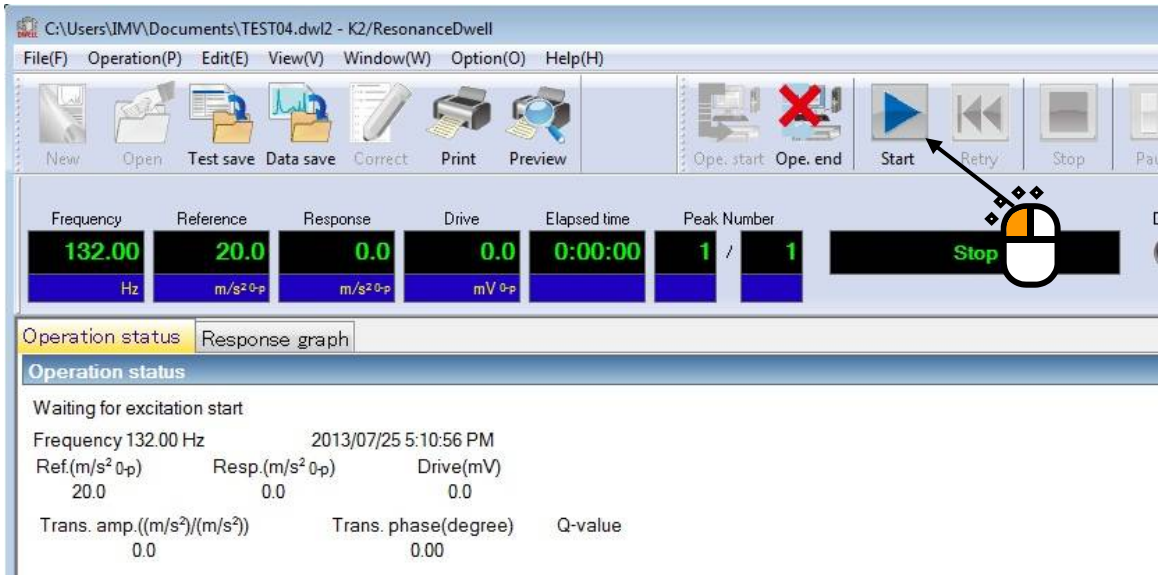
Click [Ope.start] button.



<Step 2>

Click [Start] button.

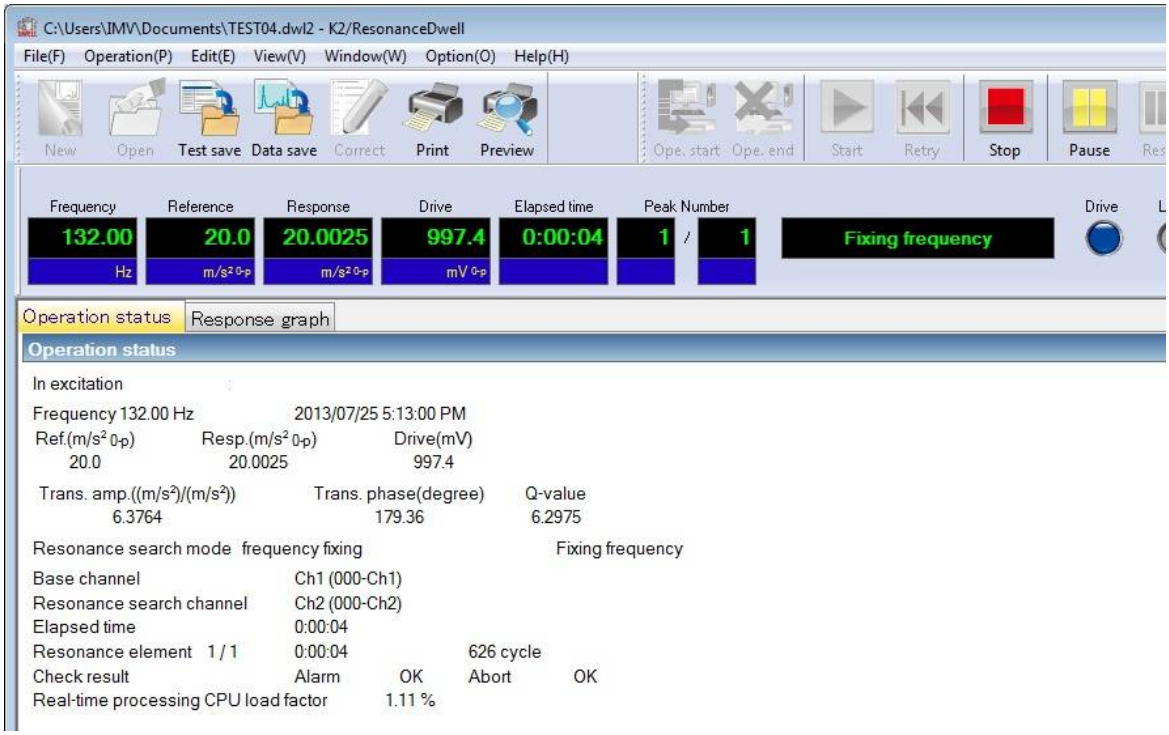
Clicking the button automatically implements Initial loop check and Initial equalization, and executes a test.



<Step 3>

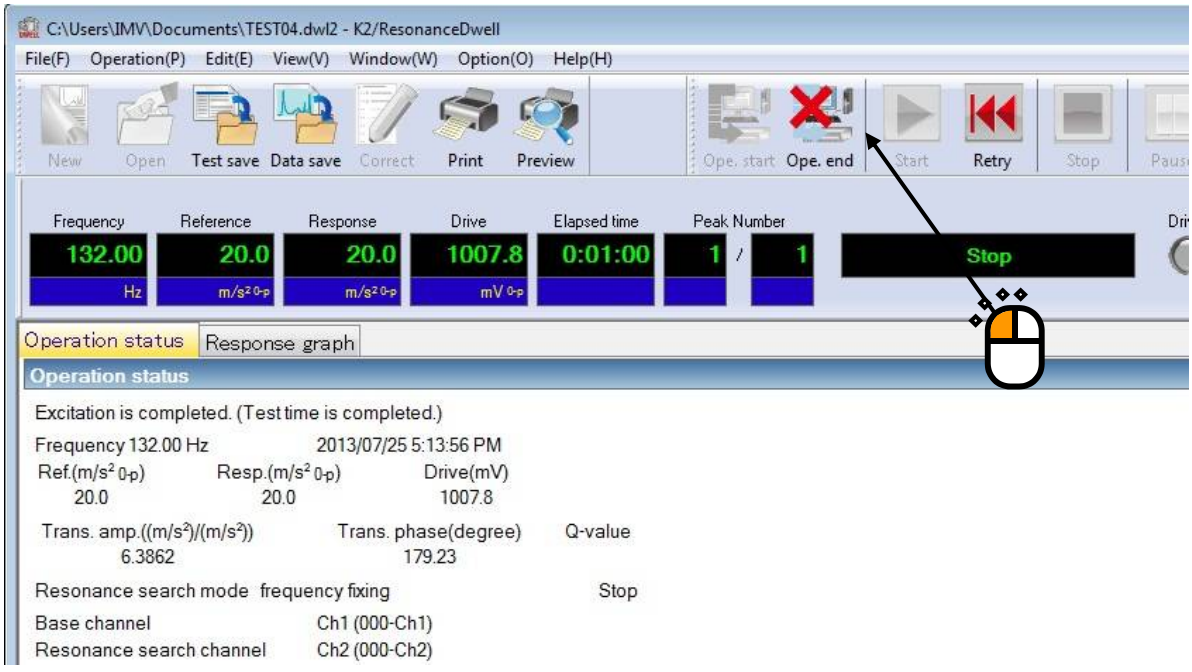
Continue excitation with the frequency fixed until the test time is over.

Note: Clicking [Retry] button → [Start] button to execute re-excitation after stopping excitation by clicking [Stop] button initializes all the data, resulting in re-excitation at a peak frequency set in Test definition. On the other hand, stopping excitation by using [Pause] button allows continuing excitation by clicking [Restart] button.



<Step 4>

Clicking [Ope. end] button brings you back to Test definition mode.



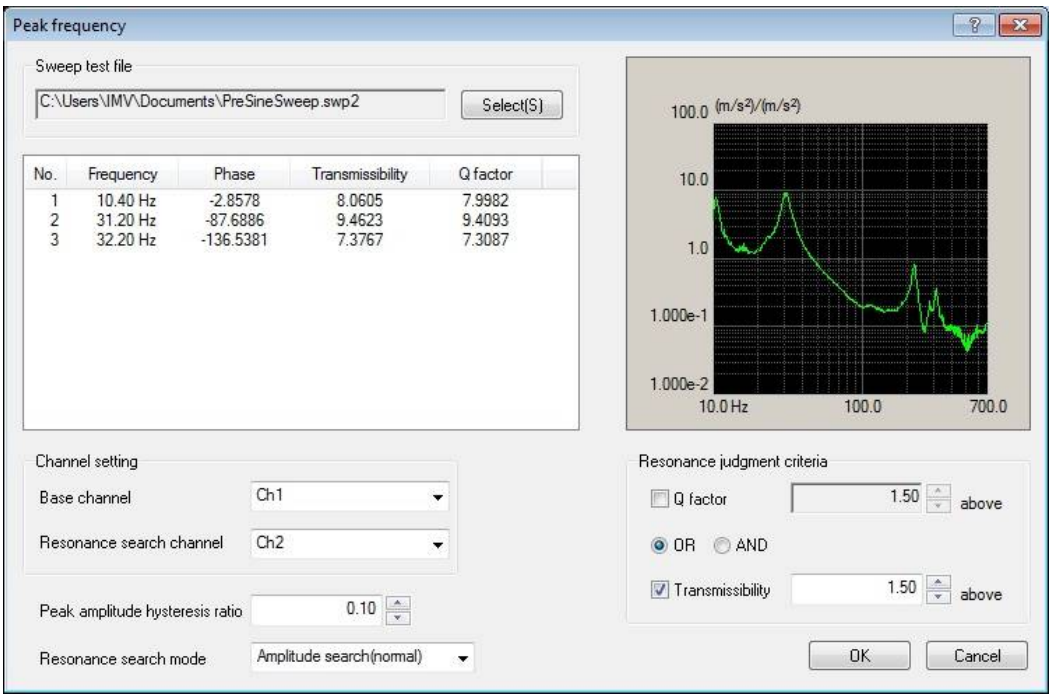
Chapter 2 Test Definition

Chapter 2 describes test definition items required for Resonance Dwell test.

2.1 Peak Frequency

Extract a peak frequency considered appropriate as resonance point from data collected through Pre-sweep test implemented before Resonance Dwell test.

Note: A value of 10.0% of the largest peak amplitude of transmissibility (Peak amplitude hysteresis ratio: 0.1) is used as extraction threshold by default in order to discriminate between peak and noise. When amplitude fluctuation before and after a peak is not more than the extraction threshold, the peak falls under noise and is not list-displayed. You may change the extraction threshold as needed. In addition, Qfactor used for calculation is 0.0 when transmissibility is 1.0 and under. (See "Paragraph 2.5")



2.1.1 Selection of Sweep test file

(1) Meaning

Select a definition file (with continuing excitation data) of Pre-sweep test for searching specimen's resonance point implemented before Resonance Dwell test.

2.1.2 Channel setting

(2) Meaning

Set Base channel and Resonance search channel in order to execute Resonance dwelling. Transmissibility data (Response data of Resonance Search Channel / response data of Base Channel) used for peak frequency detection is created based on the channel setting registered here.

- Base channel: Signal input channel of response point that is reference point
- Resonance search channel: Signal input channel of response point that is resonance search point

2.1.3 Resonance judgment criteria

(1) Meaning

Set conditions used for extracting peak frequencies considered appropriate as resonance point from data collected through implementation of Pre-sweep test. In this window, setting combining Q factor and transmissibility is available.

2.1.4 Resonance search mode

(1) Meaning

Four (4) options are provided for selection: Amplitude search (normal), Amplitude search (high-speed), Phase search and Frequency fixing.

- Amplitude search (normal)

  Resonance dwelling is performed while periodically re-searching peak of transmissibility. Re-search is implemented on both high-frequency and low-frequency sides of the current excitation frequency.

- Amplitude search (high-speed)

  Resonance dwelling is performed while periodically re-searching peak of transmissibility. Prior to re-search, the system estimates whether a new resonance point is in low-frequency side of or high-frequency side of the current excitation frequency based on the slope of transmissibility. By doing so, the search path can be shorter and the search processing speed is faster than that of Amplitude search mode (normal).

- Phase search

  Resonance dwelling is performed while adjusting the frequency in such a way that a constant phase difference between the base channel and resonance search channel can be maintained.

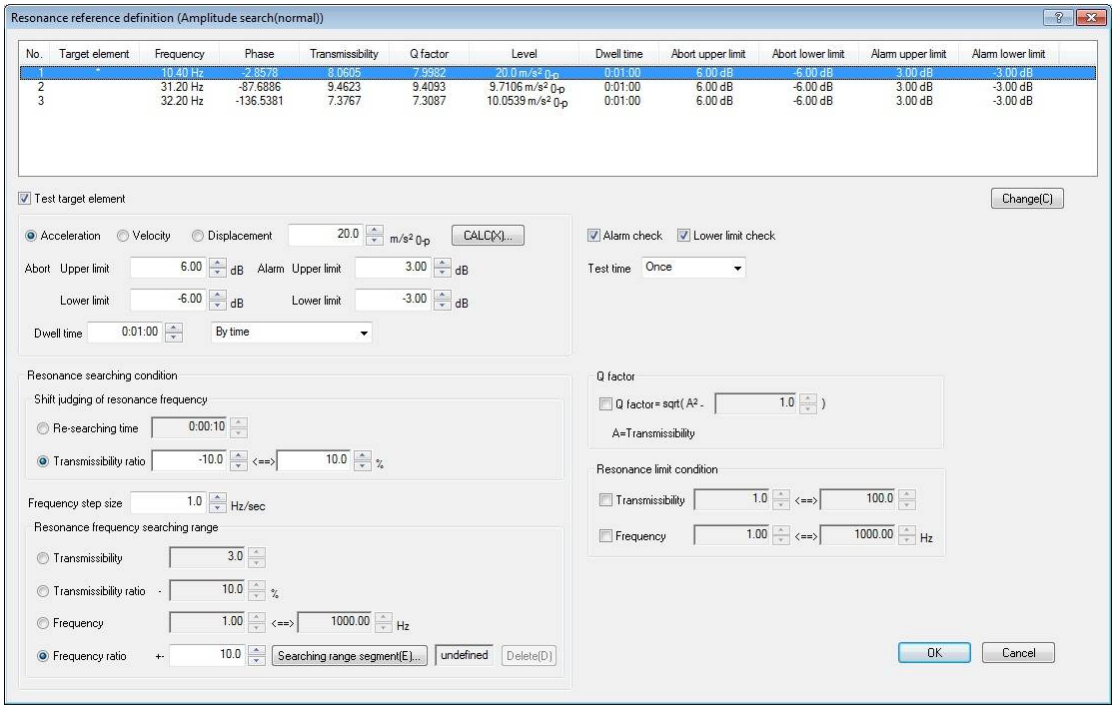
- Frequency fixing

  Excitation is performed at a peak frequency (resonance frequency) detected through Pre-sweep.

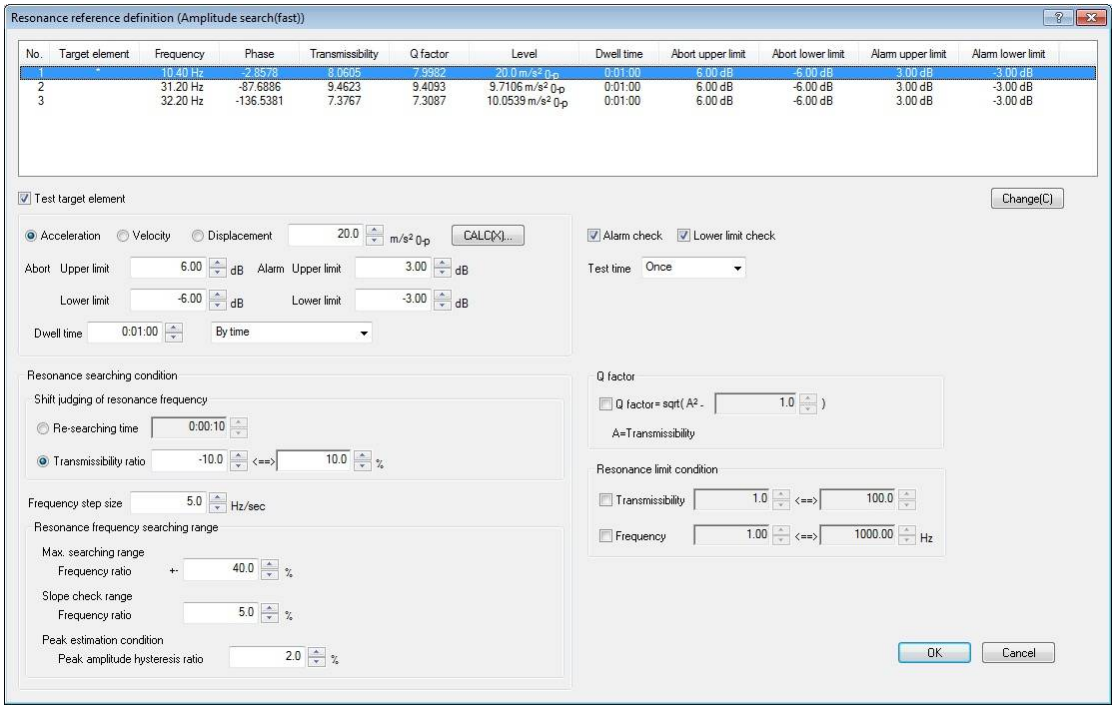
2.2 Resonance Reference Definition

Specify the definition of each of resonance points extracted from results of Pre-sweep.
Following illustrations are definition windows showing respective buttons to use.

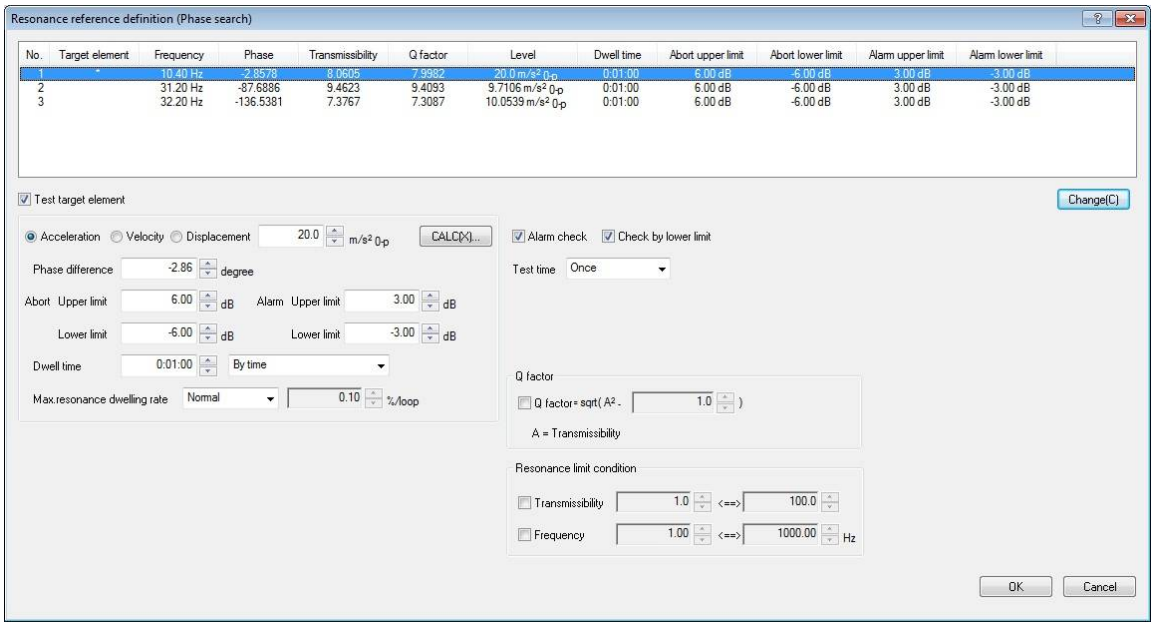
• Resonance Reference Definition: Resonance search mode: Amplitude search (normal)



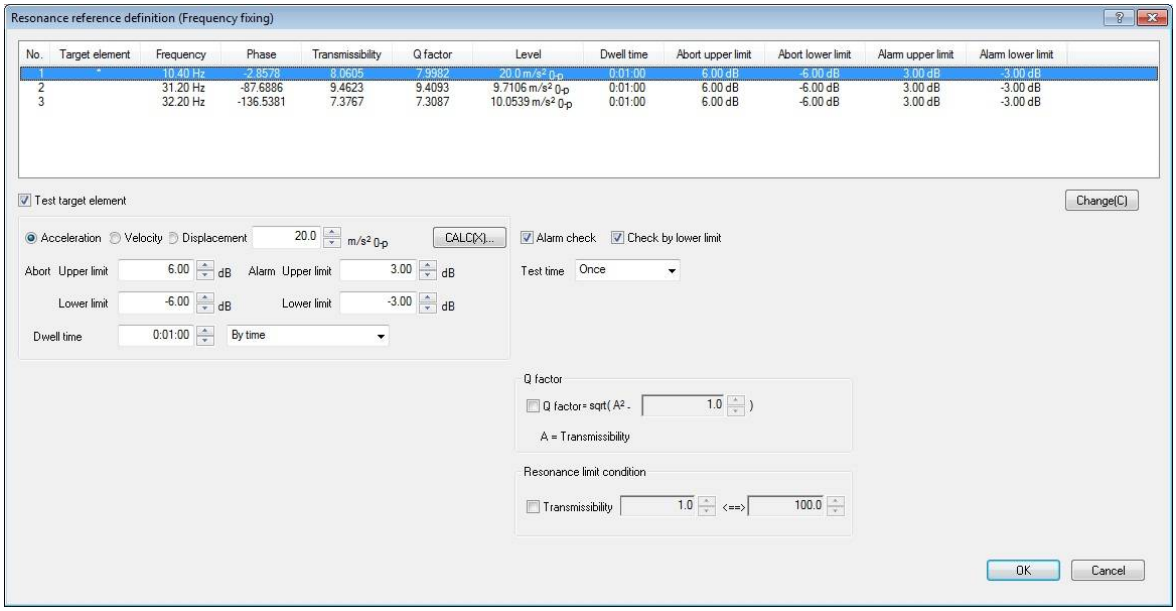
• Resonance Reference Definition: Resonance search mode: Amplitude search (high-speed)



• Resonance Reference Definition: Resonance search mode: Phase search



• Resonance Reference Definition: Resonance search mode: Frequency fixing



[Change]: This button changes the excitation conditions of a selected resonance point.
Select a desired resonance point. Change its excitation conditions. Click [Change] button.

2.2.1 Test target element

(1) Meaning

Registration of a resonance point at which excitation is executed.

First, select a desired resonance point in the list. Secondly, check the [Test target element] box. Then, click [Change] button. By doing so, the resonance point is registered as a test target element.

A symbol [*] in the Target element column of the list indicates that the corresponding frequency has been registered as a test target element.

2.2.2 Resonance reference level

(1) Meaning

Input reference level at each resonance point with a desired resonance point selected in the list.

The unit of reference level can be selected among three options: Acceleration, Velocity and Displacement.

[Calc] is a convenient function for doing objective calculation between Acceleration, Velocity and Displacement. Click [Calc] button to use [Calc] function.

See K2+/SINE Manual "4.4.6 CALC function" for details.

2.2.3 Alarm / Abort level

(1) Meaning

Input Alarm / Abort level of Reference level at resonance point with a desired resonance point selected in the list.

Specify check level using a value relative to the reference level.

Check includes Alarm and Abort. If not needed, you may leave Alarm unset.

[Alarm] herein means that the system issues an alert when detecting response beyond the range of set conditions. [Abort] means that test operation is stopped (signal output stops) at that point.

If not needed, you may leave lower limit of Check level unset.

Note that Alarm and Abort check levels have to satisfy following relations.

- Alarm check level Upper limit ≤ Abort check level Upper limit
- Alarm check level Lower limit ≥ Abort check level Lower limit

In order to enable input of lower limit level of Alarm check level and Abort check level, place a check mark in each box.

2.2.4 Dwell time

(1) Meaning

Set excitation time of each resonance point (Time is counted only during fixing resonance). Excitation stops when Dwell time is over. If there is more than one resonance definition, excitation is executed one by one: excitation at one of resonance points stops, then, excitation at other resonance point follows.

2.2.5 Test time

(1) Meaning

Set Repeat times of a defined resonance series.

1. Once

   Test is over after executing a defined resonance series only one time,

2. By repeat times

   Test is over after executing a defined resonance series repeatedly in accordance with the registered Repeat times.

2.2.6 Repeat pause time

(1) Meaning

Set signal output stop time that is assigned to Sweep turnover point of a resonance series.

Excitation stops for a specified period of Repeat pause time at Sweep turnover point of a resonance series.

This function is enabled when setting of Repeat times is “Infinite” or “By repeat times”

2.2.7 Phase difference (Resonance search mode: Phase search only)

(1) Meaning

Set Phase difference between Base channel and Resonance search channel.

2.2.8 Max. resonance dwelling rate (Resonance search mode: Phase search only)

(1) Meaning

Set Change ratio of excitation frequency per loop in dwelling.

2.3 Resonance Limit Condition

This is to control the change of transmissibility and resonance frequency during each dwelling operation. Exceeding the limit registered in Resonance limit condition stops resonance dwelling and terminates a current test operation itself.

2.3.1 Transmissibility

(1) Meaning

Set Minimum and Maximum ratio of amplitude in excitation at each resonance point. Exceeding the specified range stops excitation. (disabled during dwelling)

2.3.2 Frequency (Resonance search mode: Amplitude search (normal) and (high-speed), Phase search)

(1) Meaning

Set Minimum and Maximum resonance frequency at each resonance point. Exceeding the specified range stops excitation. (disabled during dwelling)

2.4 Resonance Search Condition

2.4.1 Shift judging of resonance frequency (Resonance search mode: Amplitude search (common))

(1) Meaning

Set conditions for resonance re-searching and re-setting. Specify either time or change ratio of amplitude ratio for setting.

2.4.1.1 Re-searching time

(1) Meaning

If Re-searching time is registered, the system performs resonance re-searching and re-setting every time the specified time is over after starting excitation at a resonance point.

2.4.1.2 Transmissibility ratio

(1) Meaning

Set Lower and Upper change ratio to reference transmissibility. Exceeding the specified range automatically starts resonance re-searching and re-setting. Reference transmissibility is set based on Sweep results. The default is a transmissibility given when each resonance point is defined. Reference transmissibility is updated with excitation transmissibility measured every time resonance re-searching and re-setting are executed.

2.4.2 Frequency step size

(1) Meaning

Set Sweep rate (Hz/sec) for resonance re-searching.

2.4.3 Resonance frequency search range (Resonance search mode: Amplitude search (normal) only)

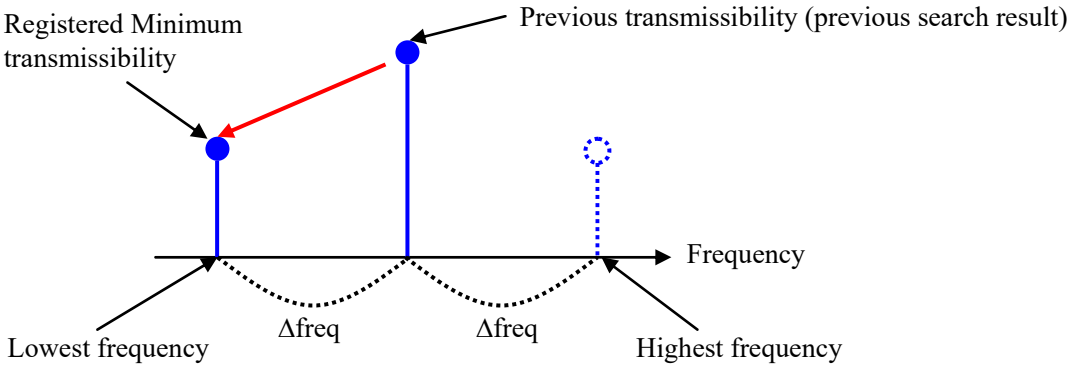
(1) Meaning

Set Sweep range for re-searching. Specify one of Transmissibility, Change ratio of transmissibility, Frequency and Change ratio of frequency for setting.

2.4.3.1 Transmissibility

(1) Meaning

Searching range is set with Minimum transmissibility. In Resonance search ready, sweep is performed toward low frequencies until transmissibility is lower than a specified value and a frequency lowest in the searching range is determined. At this time, Δ freq (= "previous resonance frequency" – "lowest frequency") is calculated, and a frequency highest in the searching range is determined using an equation Highest frequency = "previous resonance frequency" + "Δ freq" in order to specify the searching range.

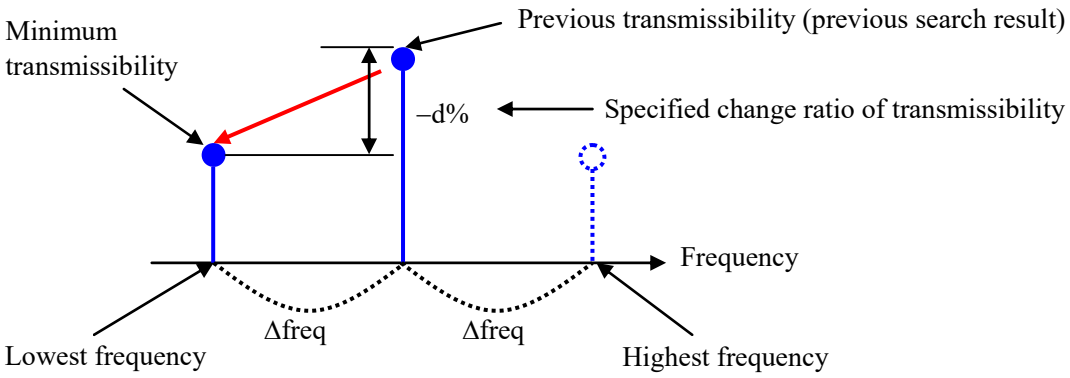


Sweep is executed backward until transmissibility is lower than specified value.

2.4.3.2 Transmissibility ratio

(1) Meaning

Minimum transmissibility is determined by specifying a proper change ratio (%) in negative (–) direction so that Minimum transmissibility dips from reference transmissibility (set based on Sweep results). Based on the determined Minimum transmissibility, specify the searching range by determining the lowest and highest frequencies of the searching range as with "2.3.1 Transmissibility".

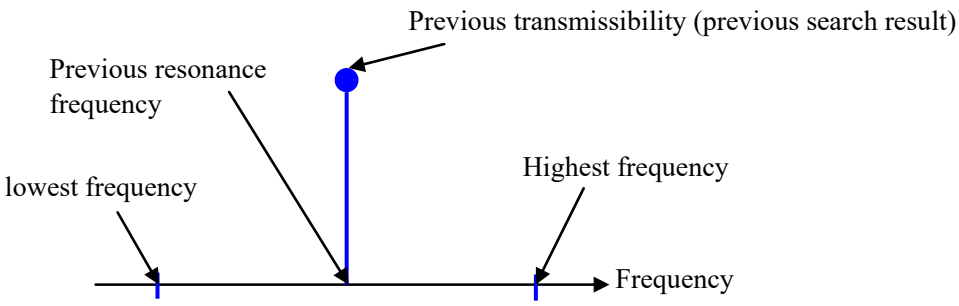


Sweep is executed backward until transmissibility is lower than specified value.

2.4.3.3 Frequency

(1) Meaning

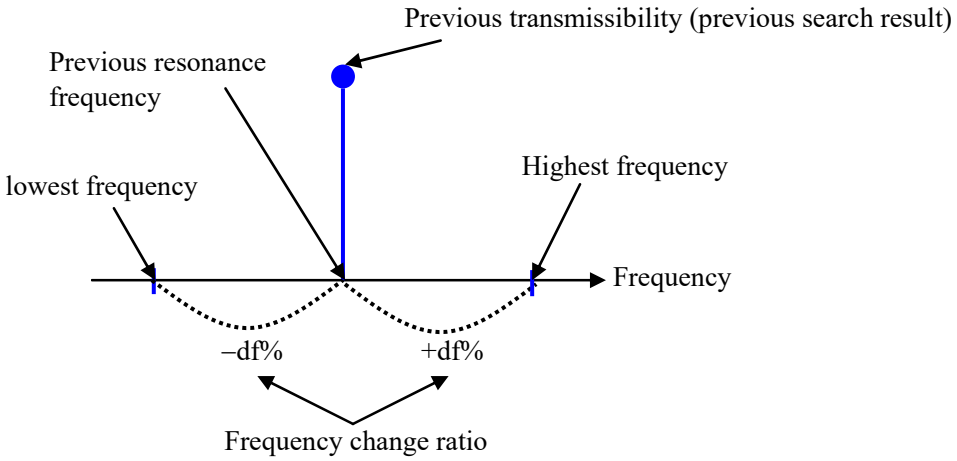
Specify the lowest and highest frequencies to set the searching range.



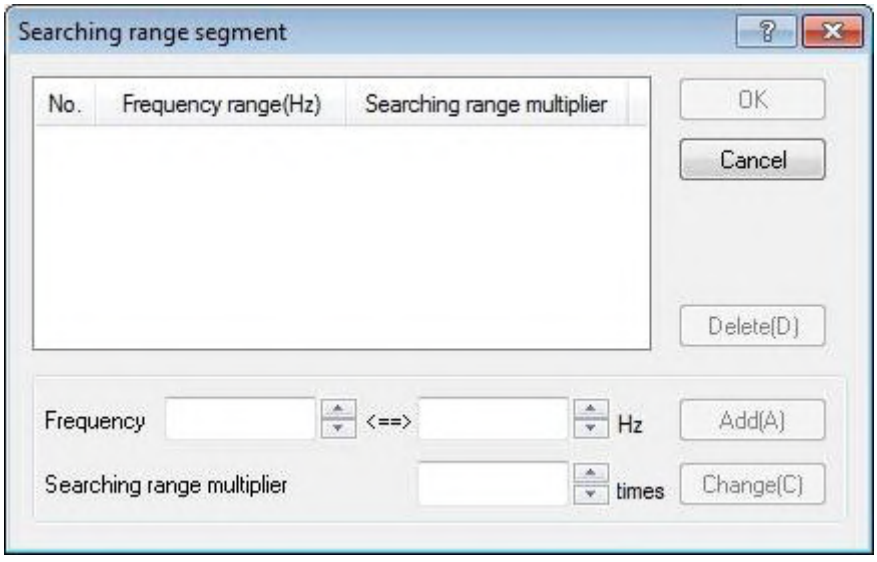
2.4.3.4 Frequency ratio

(1) Meaning

Set the searching range by specifying a proper frequency change ratio (%) in both directions (+ and –) from the previous resonance frequency to determine the lowest and highest frequencies.



2.4.3.5 Searching range segment



(1) Meaning

If the registered frequency range contains resonance point, the searching range is increased and degreased at a specified magnification.

New searching range = “specified magnification” × “current searching range”

2.4.4 Resonance frequency search range (Resonance search mode: Amplitude search (high-speed) only)

(1) Meaning

Set Sweep range for re-searching and conditions for detecting a new resonance point.

2.4.4.1 Maximum search range

(1) Meaning

Set Maximum search range. When search goes beyond the Maximum search range, the system stops excitation, assuming that detection of a new resonance point is unsuccessful.
Maximum search range = “previous resonance frequency” × “frequency ratio (%)”

2.4.4.2 Slope check range

(1) Meaning

Check Slope in order to predict whether a new resonance point is in the low-frequency side or in the high-frequency side of the previous resonance point. For this purpose, set the range within which excitation frequency is slightly increased toward high-frequency side.
Slope check range = “previous resonance frequency” × “frequency ratio (%)”

2.4.4.3 Peak estimation condition

(1) Meaning

Set Peak estimation condition to detect a new resonance point. when a decrement from the peak value detected during re-searching goes beyond Peak amplitude hysteresis (= “previous resonance transmissibility” × “peak amplitude hysteresis ratio (%)”), the detected peak value is judged as a new resonance point.

2.5 Q Factor

(1) Meaning

Define the equation to calculate Q factor for excitation at each resonance point.

By default, the Q factor definition equation is “$Q = \sqrt{A^2 - 1}$” (A: transmissibility). “1” of “$A^2 - 1$” in $\sqrt{\ }$ is a factor. You may assign a proper value to the factor.

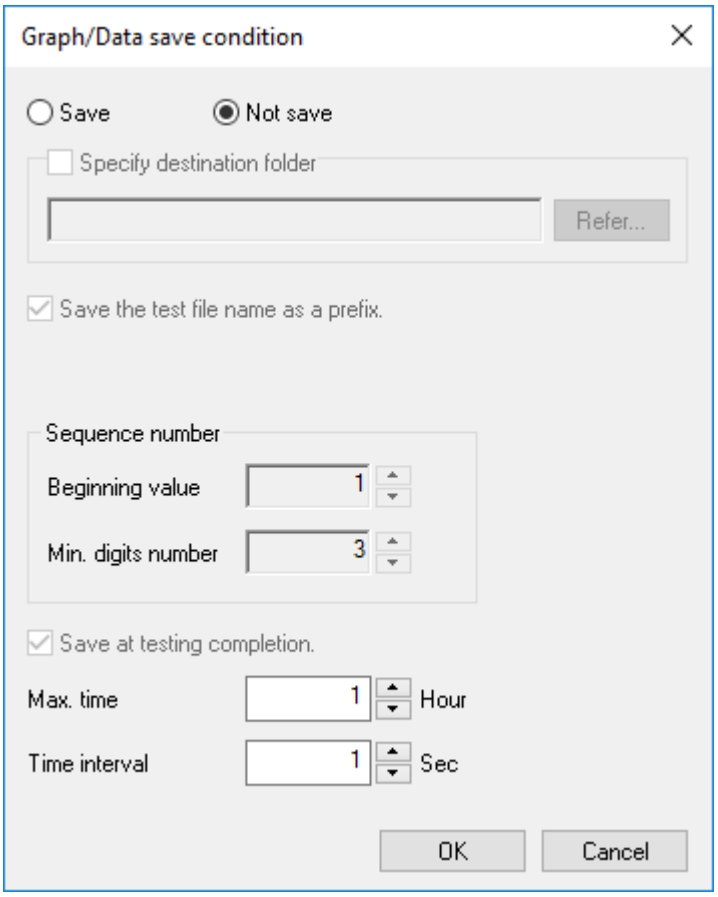
Especially for viscoelastic materials, it is difficult to identify Q factor, so this factor can be changed for adjustment.

Reference book: Handbook of Viscoelastic Vibration Damping (by David I. G. Jones)

2.6 Graph/Data save condition

This function is for setting of each item for displaying the graph and saving to the hard disc the data measured in a test operation.

When select “Save”, Control response, Transmissibility (amplitude), Transmissibility (phase), Q-value, Frequency and Monitor response data of time series are saved automatically in a binary files (*.vdf).



2.6.1 Max time

(1) Meaning

It is imperative to be set even if not want to save data to the file automatically.
The maximum time displayed on the graph and saved in a file is specified.
At the time over this time, the graphs are cleared and then started to draw anew.
Additionally if set to save to a file automatically, the data is saved in a new file.

2.6.2 Time interval

(1) Meaning

It is imperative to be set even if not want to save data to the file automatically.
The time interval of the graph and data is specified.

2.6.3 Time interval

(1) Meaning

In principle, data save conditions of the Resonance Dwell system are the same as those for the standard Sine tests.

For details of each setting item, refer to “4.7 Data Save Condition” of the K2+/SINE Instruction Manual.

2.7 Operation Status

(1) Meaning

Information involved in excitation operation is displayed.

By selecting “Window – Operation status” in the menu bar, Operation status appears.

<Items of display>

[1] Current status

Message showing the current system status:

“In excitation”, “Pause”, “Excitation Completion” (stopped by operator), etc.

[2] Frequency

Current excitation frequency

[3] Reference

Current control reference level

[4] Response

Current response level

[5] Transmissibility

Amplitude and phase of current transmissibility (calculation of transmissibility uses a tracking value.)

[6] Q factor

Current Q value (Status on display: Display is active during fixing resonance and dwelling)

[7] Drive

Actual drive output voltage currently being output

[8] Elapsed time

Elapsed time from start of excitation up to now

- Amplitude search (normal) and Amplitude search (high speed):

  Total time spent on excitation at resonance frequency (Status on display: Fixing resonance) is displayed. (the period of time while Status on display is “In preparation”, “Resonance search ready”, “Resonance search” or “Reference frequency shift” is not included in Elapsed time.) Repeated times and Repeat pause time of resonance series are displayed as well.

- Phase search:

  The time of excitation at resonance frequency (Status on display: Dwelling) is displayed.

- Frequency fixing:

  The time of excitation at resonance frequency (Status on display: Fixing resonance) is displayed.

[9] Resonance search mode

- Amplitude search (normal)

  The system executes resonance frequency dwelling while automatically performing resonance re-search from transmissibility according to specified conditions.

- Amplitude search (high speed)

  The system executes resonance frequency dwelling while automatically performing resonance re-search from transmissibility according to specified conditions. Prior to re-search, the system estimates whether a new resonance point is in low-frequency side of or high-frequency side of the current excitation frequency based on the slope of transmissibility. By doing so, the search path can be shorter and the search processing speed is faster than that of Amplitude search mode (normal).

- Phase search

  The system executes resonance frequency dwelling while adjusting the excitation frequency, according to specified conditions, in such a way that phase difference between the base channel and resonance search channel is maintained.

- Frequency fixing

  Excitation is executed at a peak frequency detected through Pre-sweep.

[10] Current resonance status

Messages showing current system status are as follows.

"Resonance fixing", "In preparation", "Resonance search ready", "Resonance search", "Reference frequency shift" and "Dwelling (Resonance search mode: Phase search only)"

[11] Resonance element

Resonance point currently in excitation and the time of dwelling on the resonance point are displayed.

[12] Base channel

Signal input channel of response point that is reference point.

[13] Resonance search channel

Signal input channel of resonance search point that is reference point.

[14] Check result (total)

Check result is "OK" when all of Alarm check and Abort check conditions registered in Test definition are satisfied and "NG" when not satisfied.

[15] Real-time processing CPU load factor

Current CPU load factor

[16] Reference / Response data

Values of Reference level and Response level in the current control loop are displayed. In principle, the level is displayed definition by definition. If controlled variable is any of Acceleration, Velocity and Displacement, all of Acceleration, Velocity and Displacement are displayed.

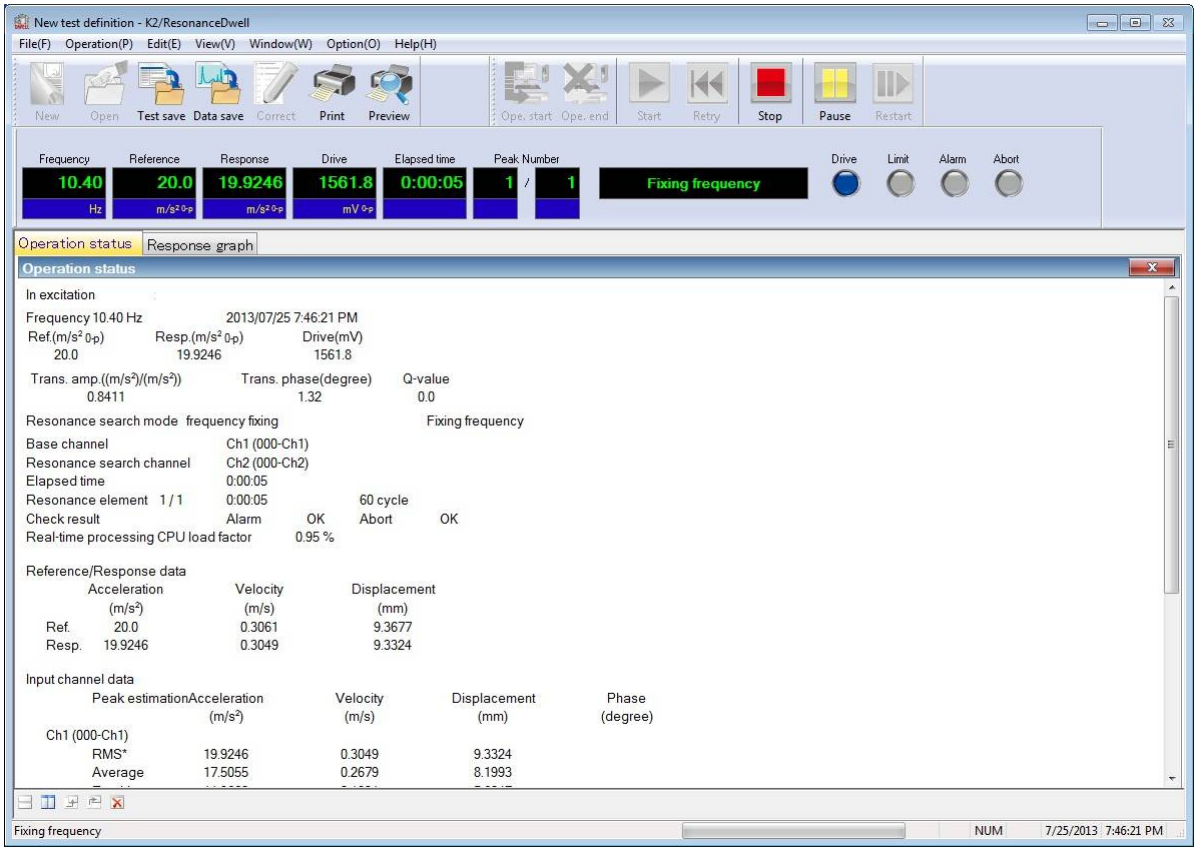
Result of checking Tolerance of response level that is defined relative to the control reference is displayed. “OK” is displayed when all are satisfied. “Alarm” and “Abort” are displayed respectively when inconsistent with Alarm check and when inconsistent with Abort check.

[17] Input channel data

Amplitude and phase of each input channel data in the current control loop are displayed. In principle, amplitude is expressed in observed physical quantity of input channel and displayed in a level format. If controlled variable is any of Acceleration, Velocity and Displacement and observed physical quantity is Acceleration / Velocity / Displacement, all of Acceleration, Velocity and Displacement are displayed.

[18] Drive output data

Output voltage of each output channel data in the current control loop is displayed. Ratio to voltage that can be output is displayed as well.



2.8 Set Up

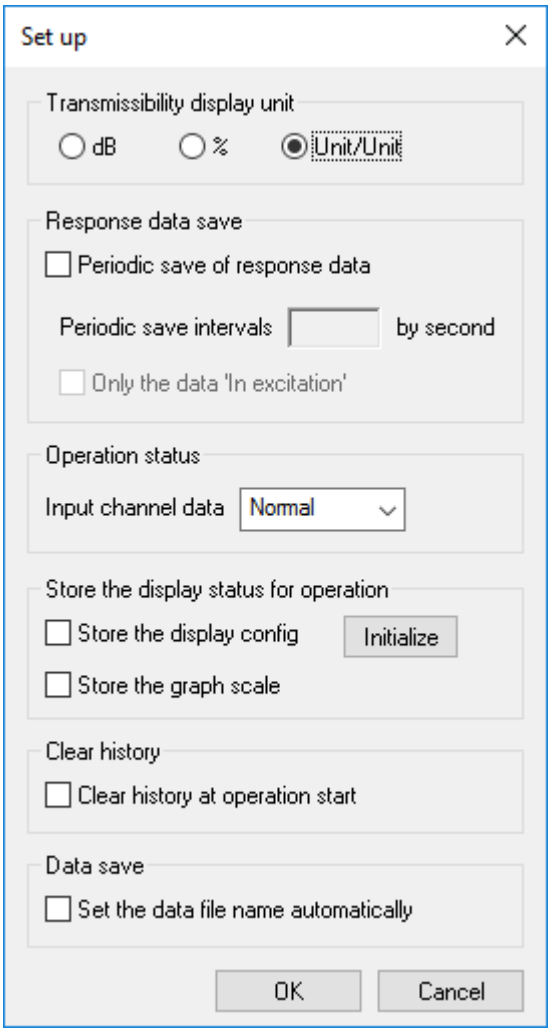
(1) Meaning

Set unit of display of transmissibility and data save condition.

In principle, the setting items are the same as those of the standard Sine system.

Here, only the setting items specific to Resonance Dwell are explained.

For details of each setting item, refer to "6.2 Set Up" of the K2+/SINE Instruction Manual.



<Response data save>

Control response, Transmissibility (amplitude), Transmissibility (phase), Q-value, Frequency and Monitor response data, in time series order, are saved in CSV files. The names of CSV files to be created are as follows.

Test file name XXX.CSV

XXX: Serial number is assigned every time test is executed.

The format of CSV file to be created is as follows.

Column 1 Column 2 Column 3 Column 4 Column 5 Column 6 Column 7 ……

Time [sec],	*Response [unit],*	*Transmissibility (amplitude) [unit],*	*Transmissibility (phase) [unit],*	*Q-value,*	*Frequency [Hz],*	*Monitor response 1 [unit],*	……
.,	***.***,	***.***,	***.**,	***.**,	***.**,	***.**,	……
.,	***.***,	***.***,	***.**,	***.**,	***.**,	***.**,	……
.,	***.***,	***.***,	***.**,	***.**,	***.**,	***.**,	……
:	:	:	:	:	:	:	:
.,	***.***,	***.***,	***.**,	***.**,	***.**,	***.**,	……

- Italic characters are fixed characters.
- Unit of data is given in [unit].
- Time data are substituted in Column 1.
- Data of Control response, Transmissibility (amplitude), Transmissibility (phase), Q-value, Frequency and Monitor* are substituted respectively in Column 2 and after. [* Acceleration only]
- Unit of Transmissibility (amplitude) reflects that of Transmissibility displayed in Test definition status. If the unit of Transmissibility is changed during Test execution status, the unit of Transmissibility (amplitude) in CSV file does not reflect the change.

< Operation status >

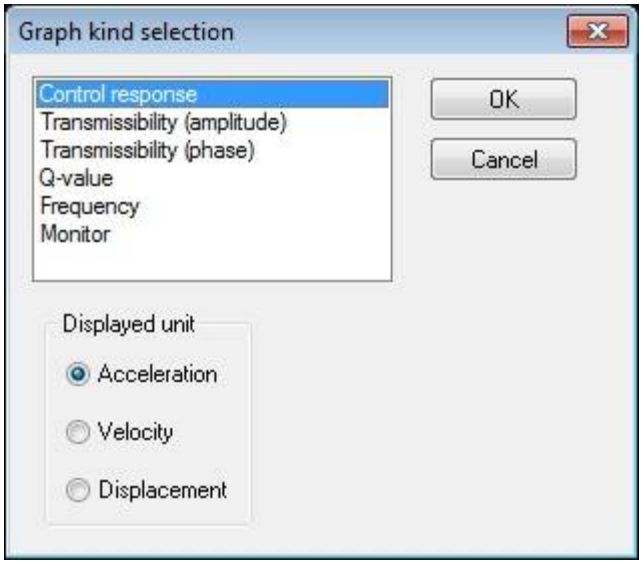
‘Input channel data’

This item is for selecting the amount of information of the displayed input channel data in Operation status.

2.9 Graph Kind Selection

(1) Meaning

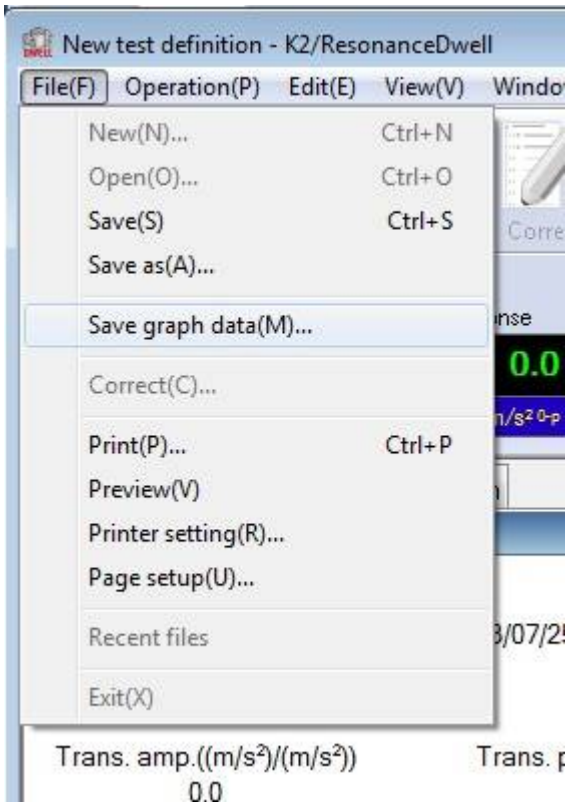
Select a time-series graph (Control response, Transmissibility (amplitude), Transmissibility (phase), Q-value, Frequency and Monitor) to display.



2.10 Graph Data Save

(1) Meaning

If it is necessary to save graph data during excitation, select “File – Graph data save” to save the data.



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