

Random On Random Vibration Control System

K2+

ROR Instruction Manual

IMV CORPORATION

Type of Document : Instruction Manual

System Applied : K2+

Software < RANDOM / ROR >

Later than Version 20.0.0

* To use this application, K2/RANDOM and the ROR option are required.

* To use the Extended ROR feature, the Extended ROR option is required in addition to the above.

Japanese Edition

Version	Date	Contents
1.0.0	2020.10.16	First edition

English Edition

Version	Date	Contents
1.0.0	2020.10.16	First edition

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Chapter 1 ROR

1.1 Outline

To perform a ROR test, PSD reference for Random vibration of broad band and PSD reference for Random vibration of narrow band are needed to be defined.

A complete set of information needed for test operation in conjunction with a normal random test is to be described below ;

Table.1-1 Test types and definition information

Information \ Test type	Random	ROR	Extended ROR *1
(1) I/O Module Configuration	○	○	○
(2) Excitation System Information	○	○	○
(3) Fundamental/Control Condition	○	○	○
(4) Excitation System Setting	○	○	○
(5) Control Reference	○	○	○
(6) ROR Narrow Band Swept Random Reference	—	○	—
(7) Extended ROR Narrow Band Swept Random Reference	—	—	○
(8) Input Channel	○	○	○
(9) Data Save Condition	○	○	○
(10) Safety check	○	○	○
(11) Amplitude probability density analysis	△	△	△

Information of a test completely defined is to be saved in a file as a specified format of 'Test File'.

Test operation can be executed by loading a file in which the information of a test defined beforehand is saved as a test file.

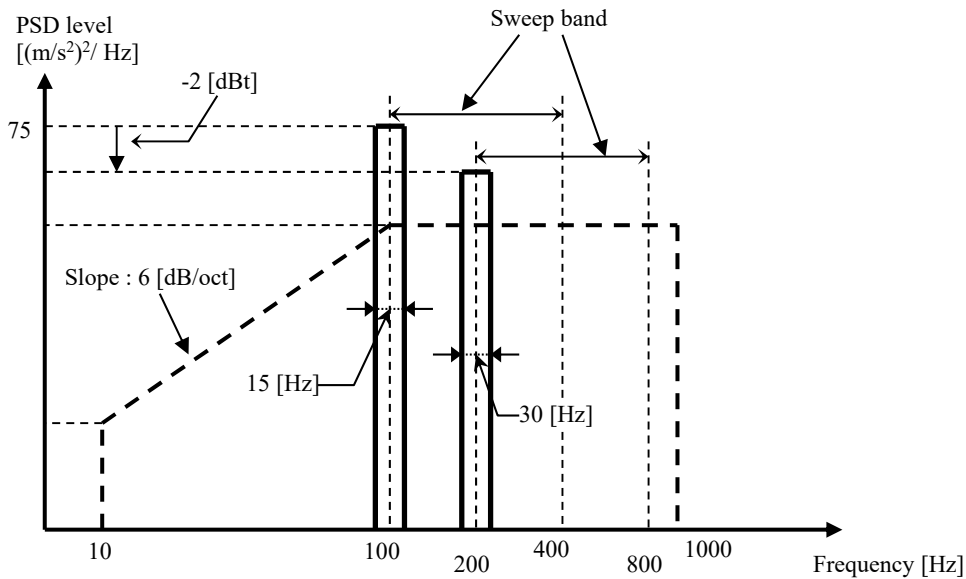
*1 To use the Extended ROR feature, the Extended ROR option is required.

1.2 ROR Test

< Example >

An example of ROR test is described as below ;

[Reference pattern]



- Broad Band Random Reference

Broad band random is specified to have an intensity of 50 [(m/s²)rms] having the PSD shape as in the above between 10 [Hz] and 1000 [Hz].

- Narrow Band Random Reference

The narrow band random reference composed by a fundamental component and a 2nd harmonic component is used.

(Fundamental component)

The PSD having the level of constant 75 [(m/s²)/Hz] and the band width of 15 [Hz] in the swept band between 100 [Hz] and 400 [Hz].

(2nd harmonic component)

The PSD having -2 dB from the level of a fundamental component and the band width of 30 [Hz]

[Test Time]

Sweep rate : 1.000 (octave/min)

Times of double sweep : 5 times from the forward (double-sweep)

[Information of sensors to be used]

Two acceleration pickups of piezoelectric : one is used for control and another for monitor.

Ch. 1 : for control, sensitivity 3pC/(m/s²)

Ch. 2 : for monitor, sensitivity 3pC/(m/s²)

However, these channels must be registered in Input channel information (in this example, 'Input05').

Also, the rating information of excitation system has already been registered in Excitation System

information (in this example, 'Exc01').

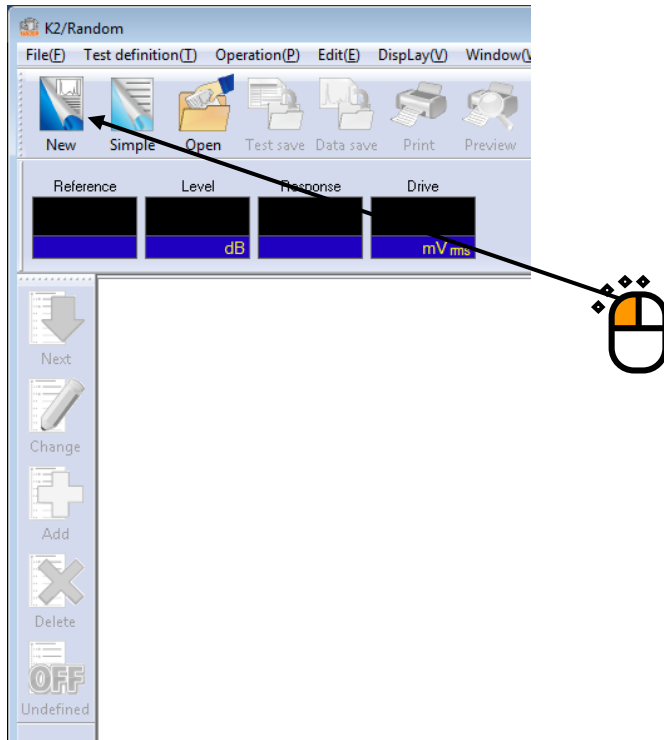
[Information of specimen]

Specimen mass : 10[kg]

< Procedures >

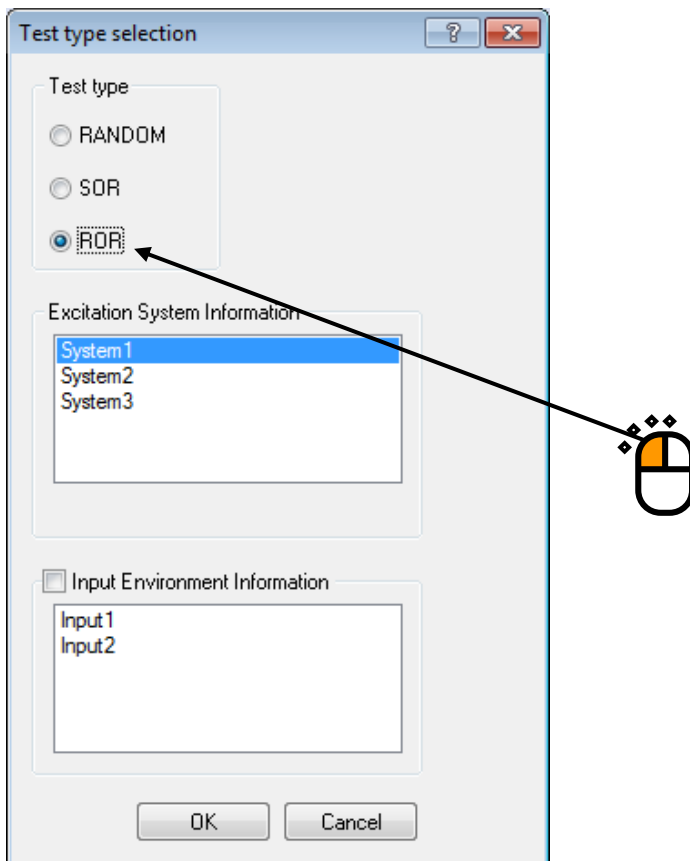
< Step 1 >

Press the button of [New] to start new definition.



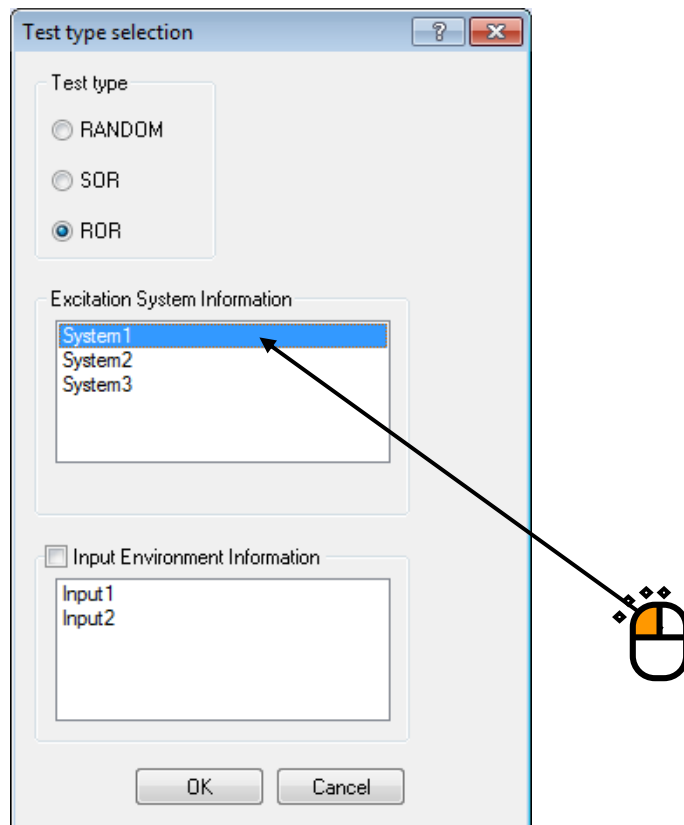
< Step 2 >

Select the item of 'ROR test' in Test type.



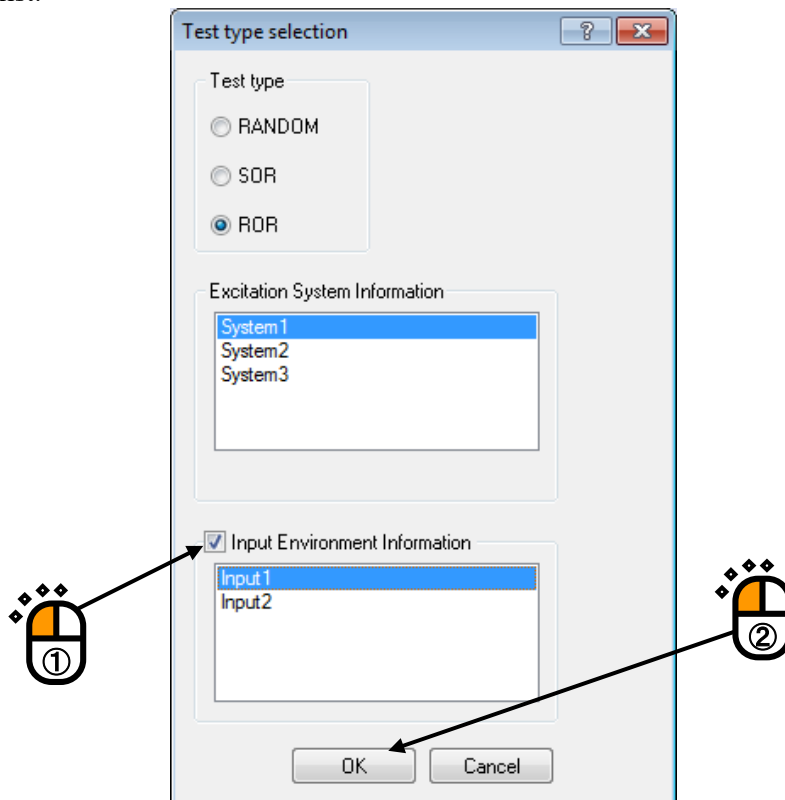
< Step 3 >

Select an Excitation system from the list of 'Excitation system information'.



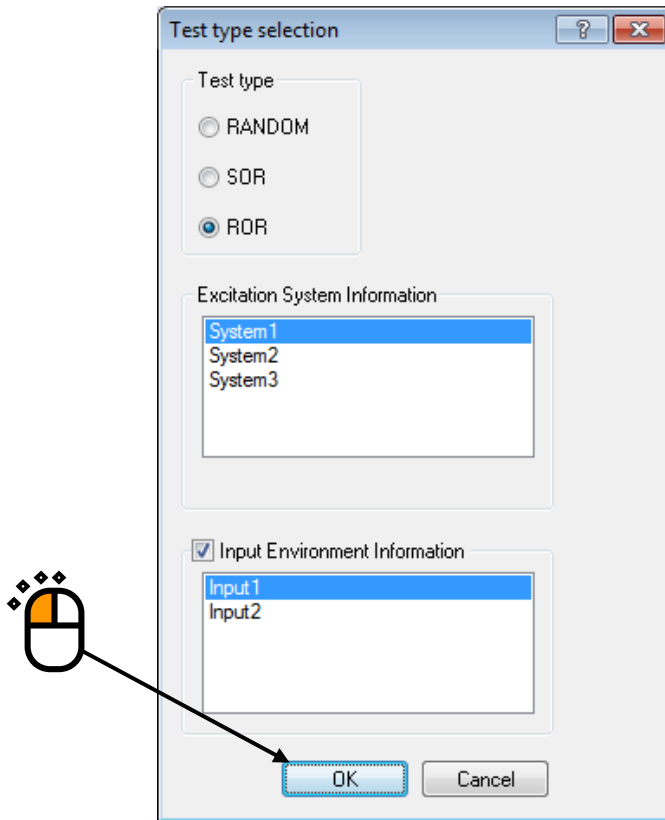
< Step 4 >

Click the checkbox of 'Input channel information selection' and select an Input channel information from the list.



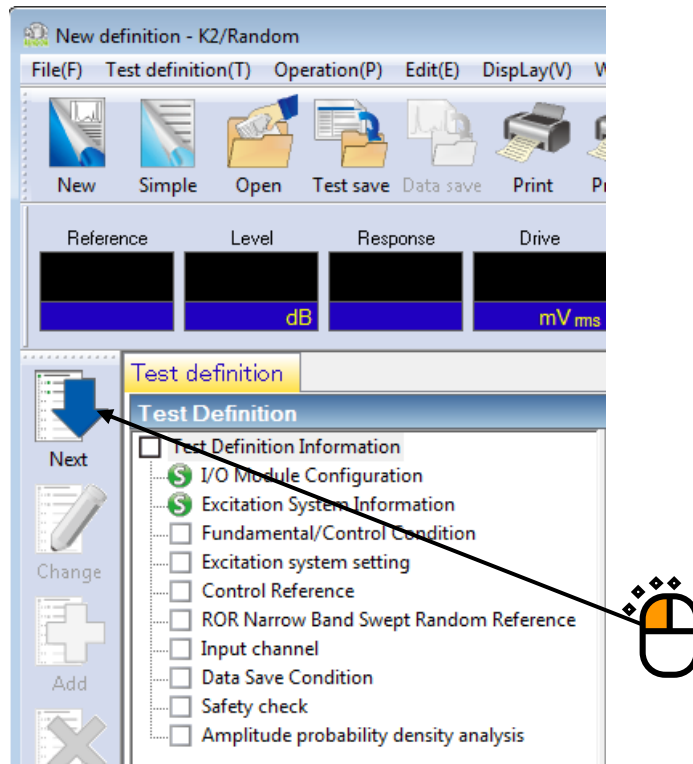
< Step 5 >

Press the [OK] button.



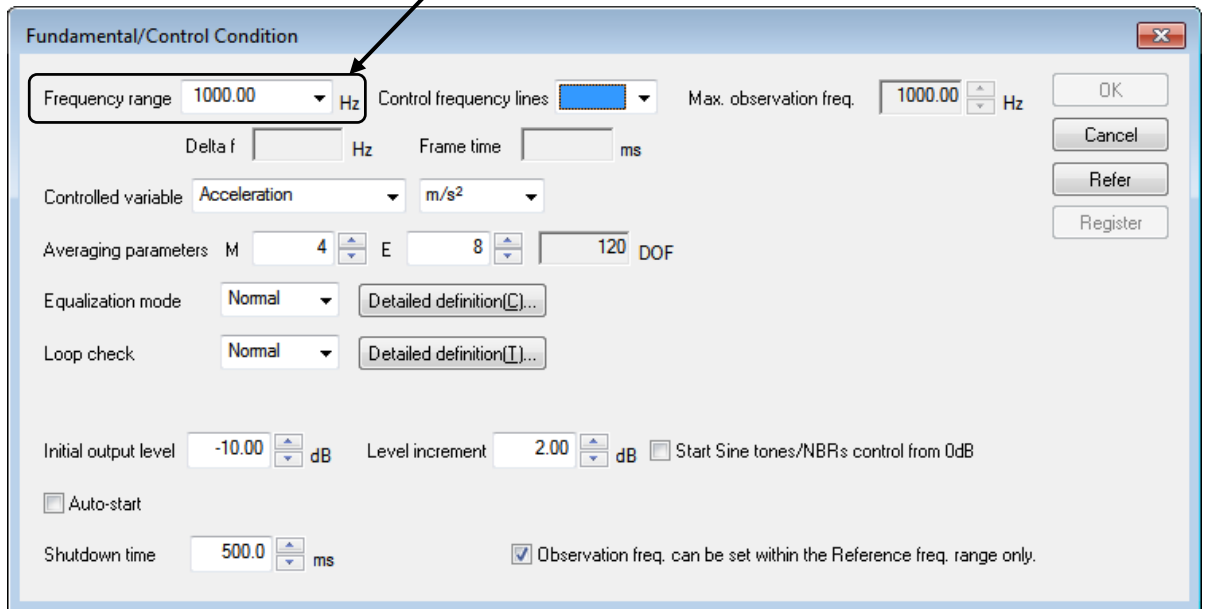
< Step 6 >

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



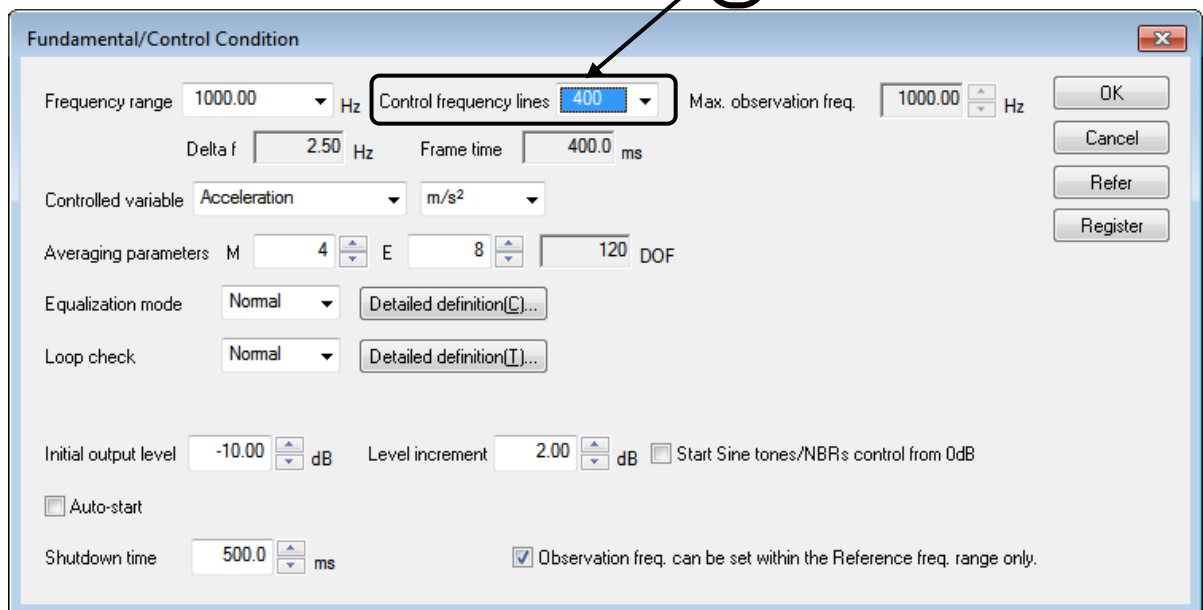
< Step 7 >

Input the value to 'Frequency' as 1000Hz.



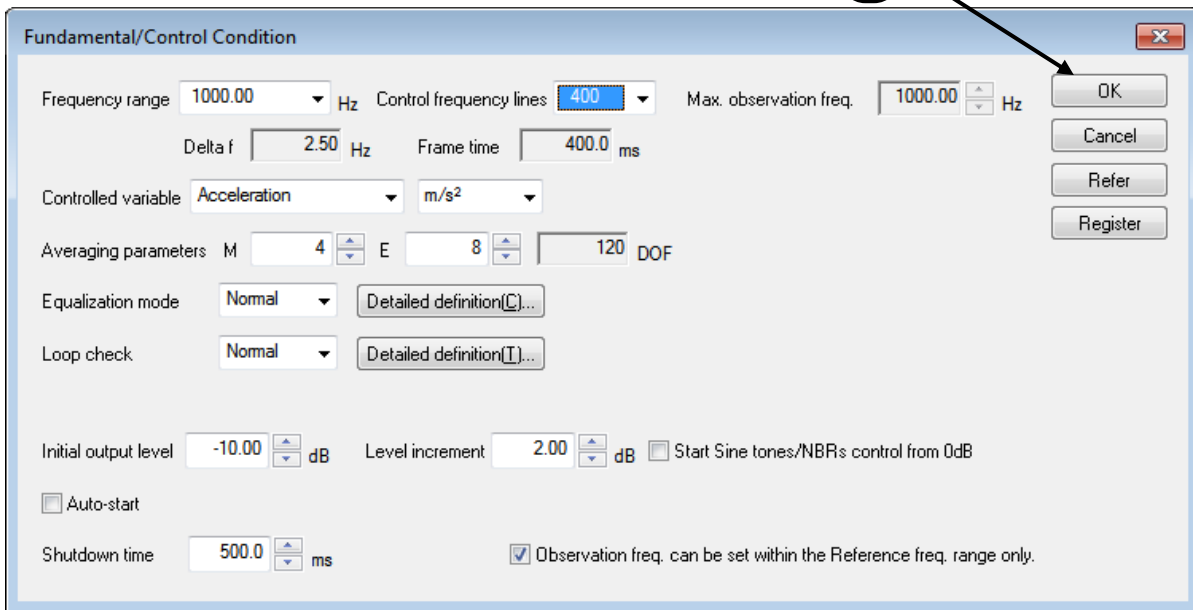
< Step 8 >

Input the value to 'Control frequency lines' as 400.



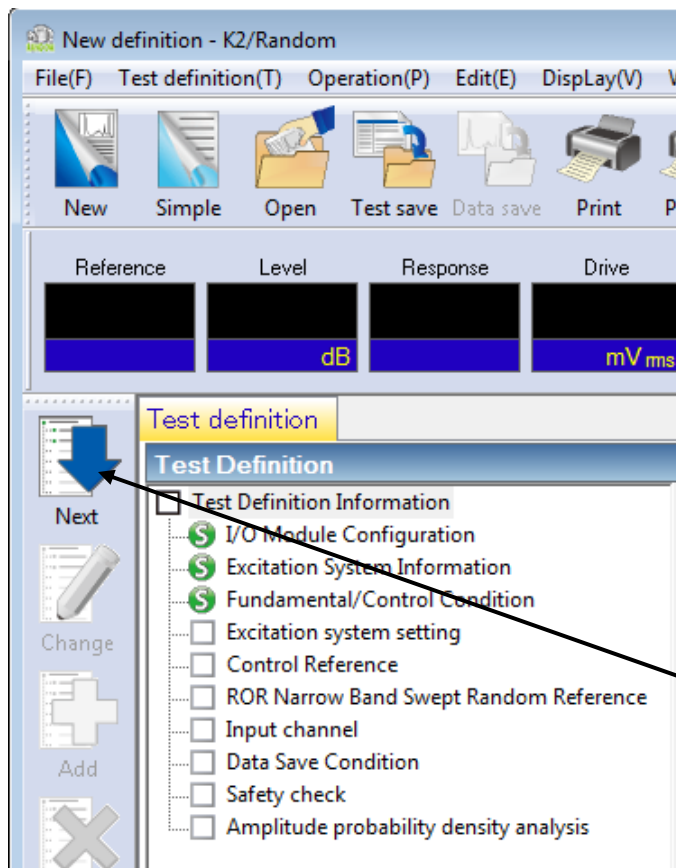
< Step 9 >

Press the [OK] button.



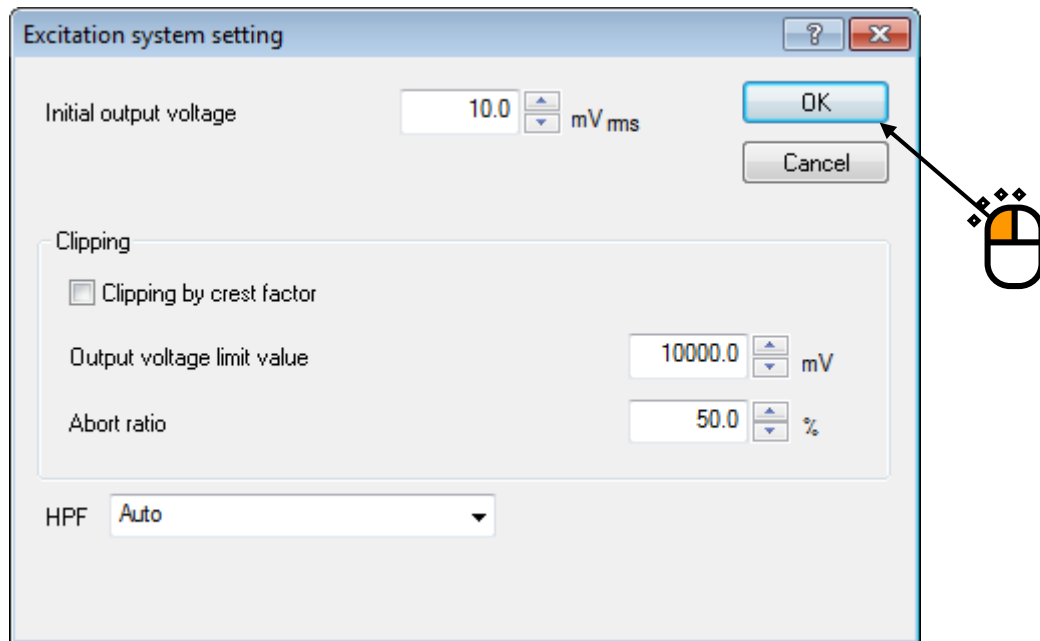
< Step 10 >

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



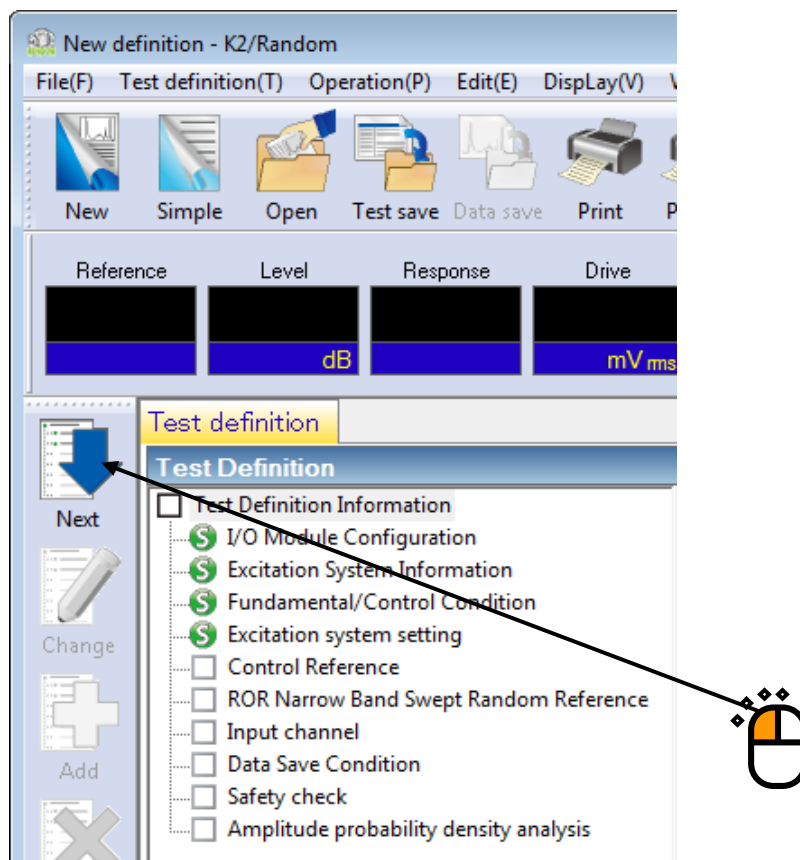
< Step 11 >

Press the [OK] button.



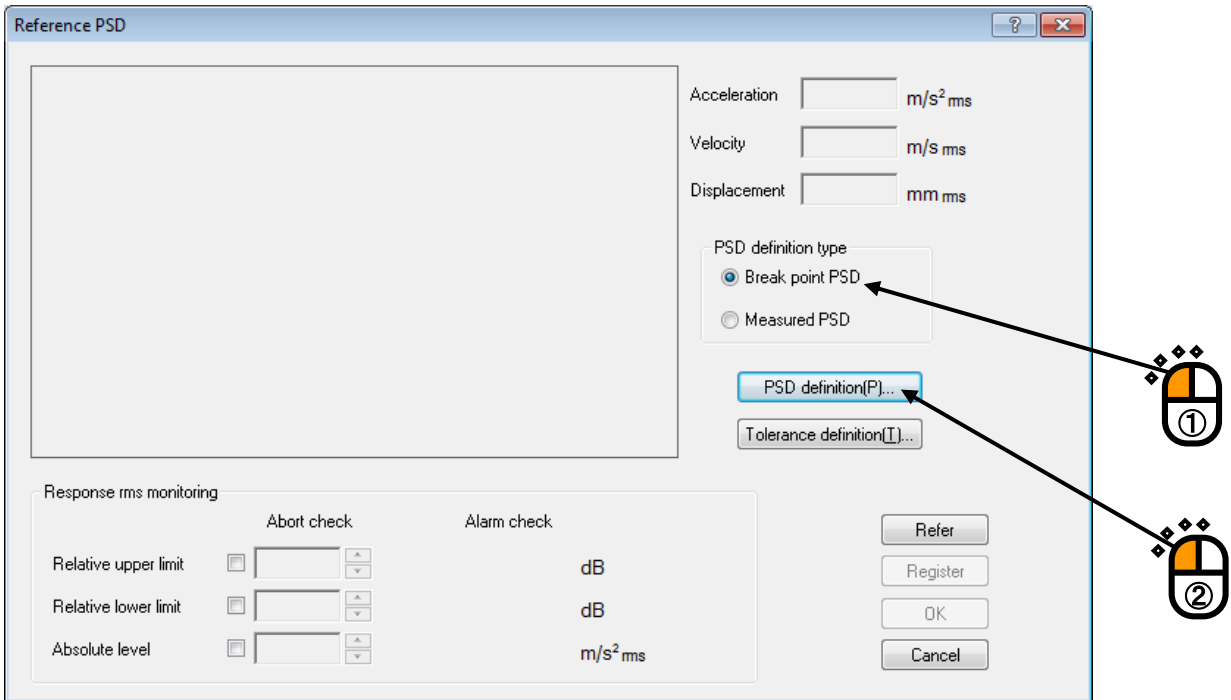
< Step 12 >

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



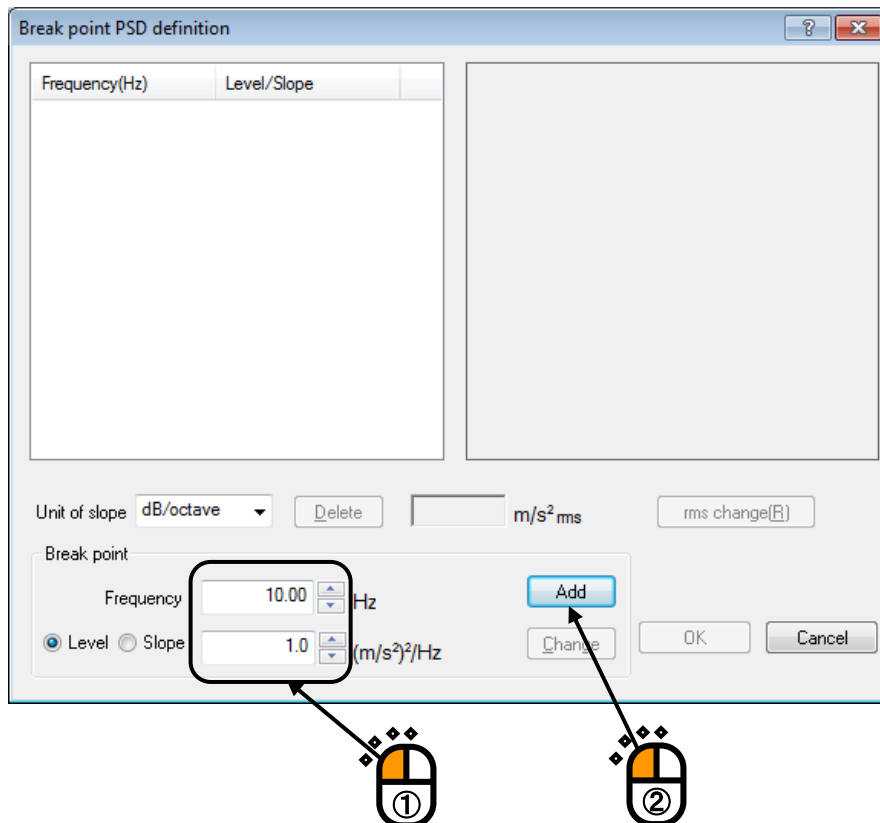
< Step 13 >

Select the item of 'Break point' in PSD definition type. And press [PSD definition].



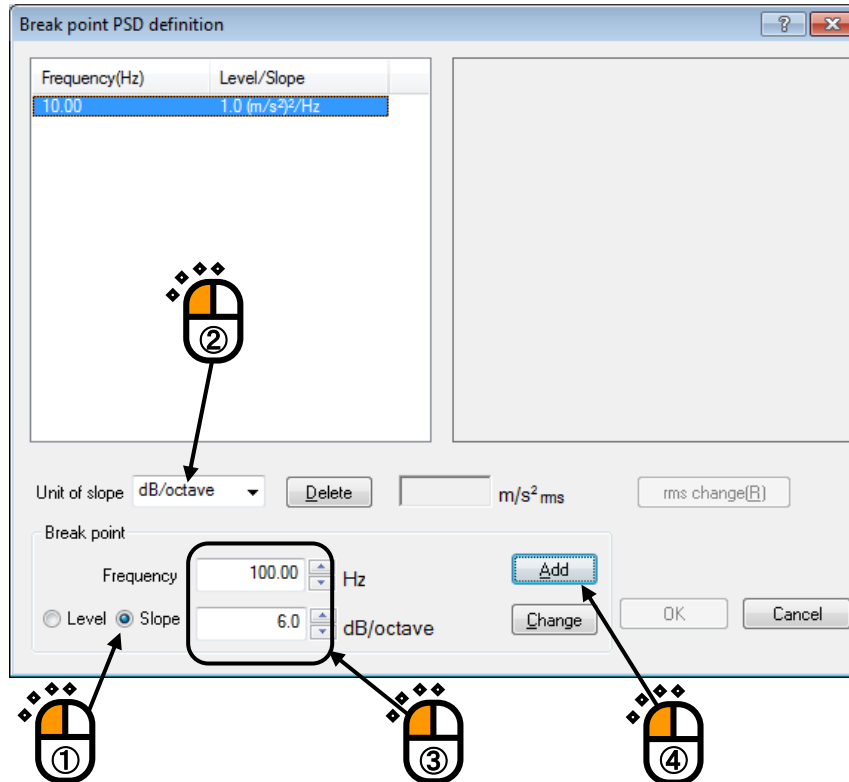
< Step 14 >

Click and select 'Level'. Input the values to 'Frequency' as 10 [Hz] and 'Level' as 1 [(m/s²)²/Hz]. And press the [Add] button.



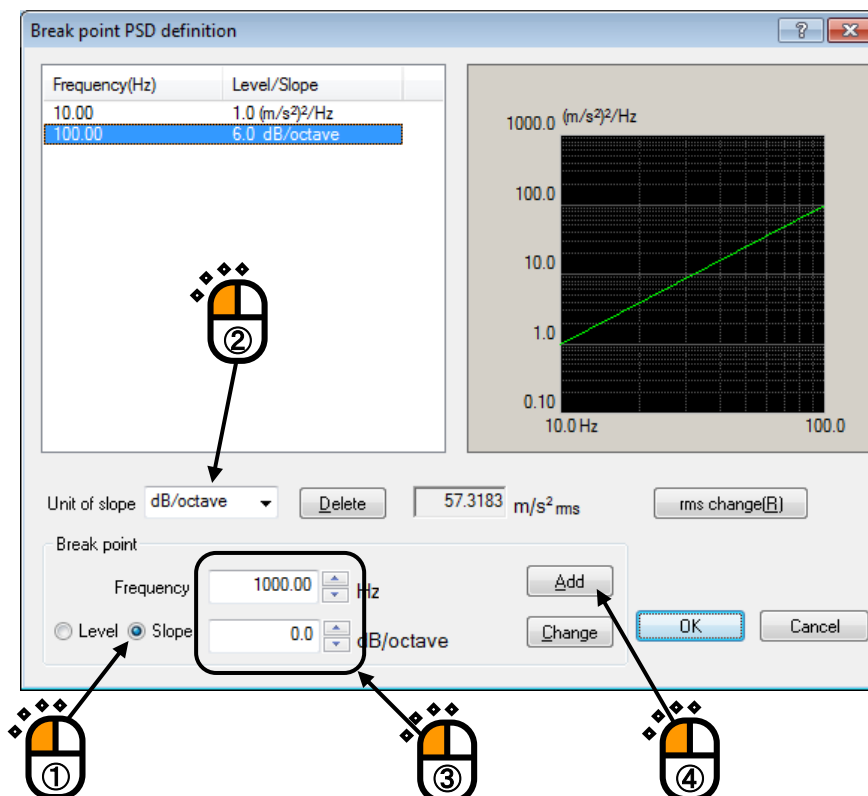
< Step 15 >

Click 'Slope' and select 'dB/octave' as the unit. Input the values to 'Frequency' as 100 [Hz] and 'Slope' as 6 [dB/octave]. Then press the [Add] button.



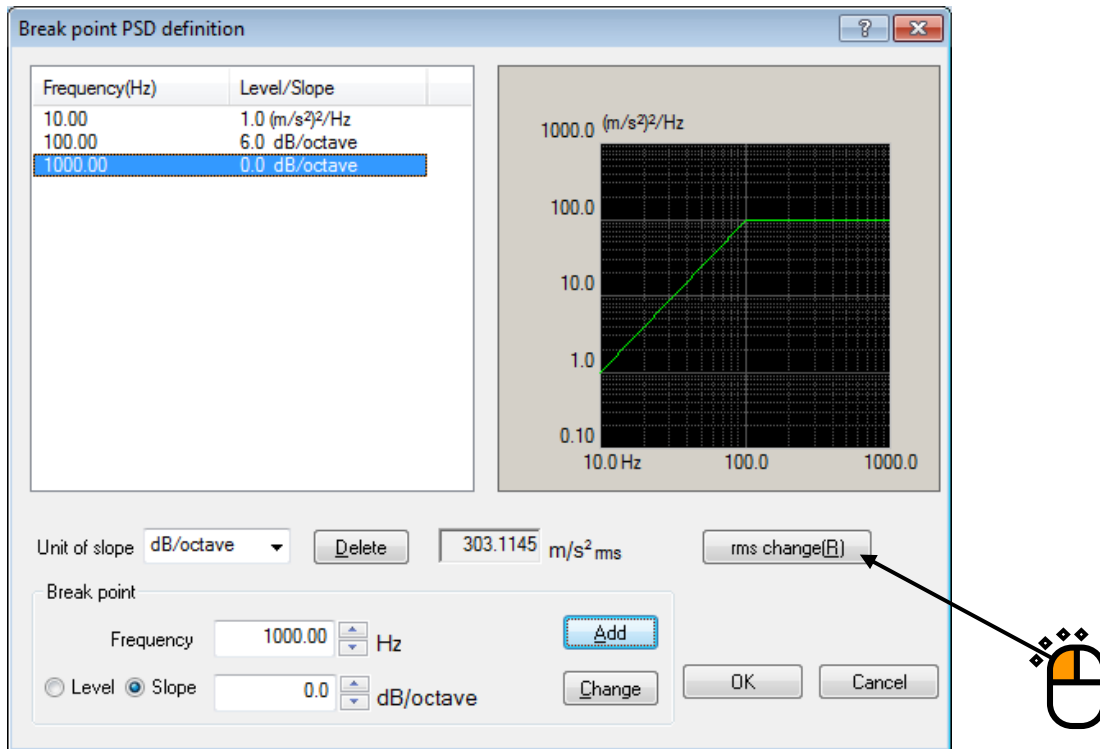
< Step 16 >

In the same way, click 'Slope' and select 'dB/octave' as the unit. Input the values to 'Frequency' as 1000 [Hz] and 'Slope' as 0 [dB/octave]. Then press the [Add] button.



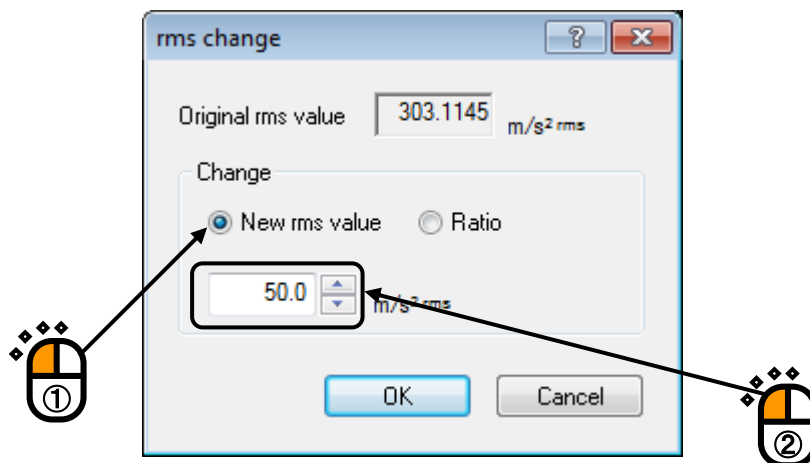
< Step 17 >

Press the button of [rms value change].



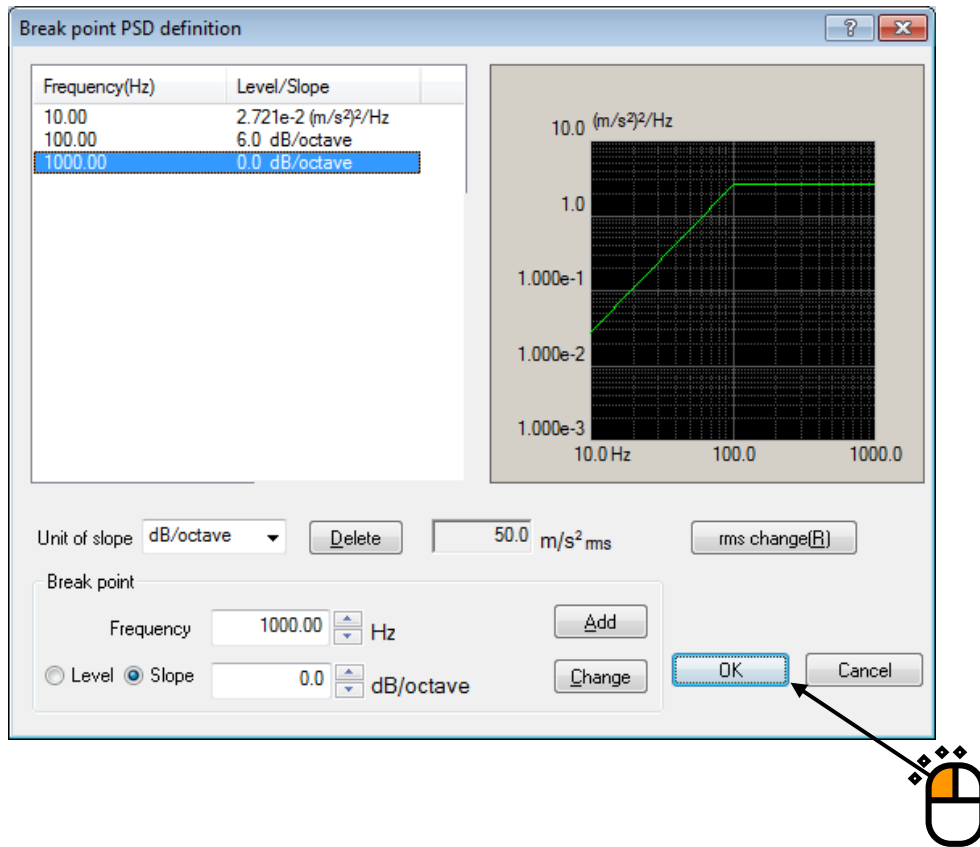
< Step 18 >

Click and select 'New rms'. Input the values to 'New rms' as 50 [(m/s²) rms] and press the [OK] button.



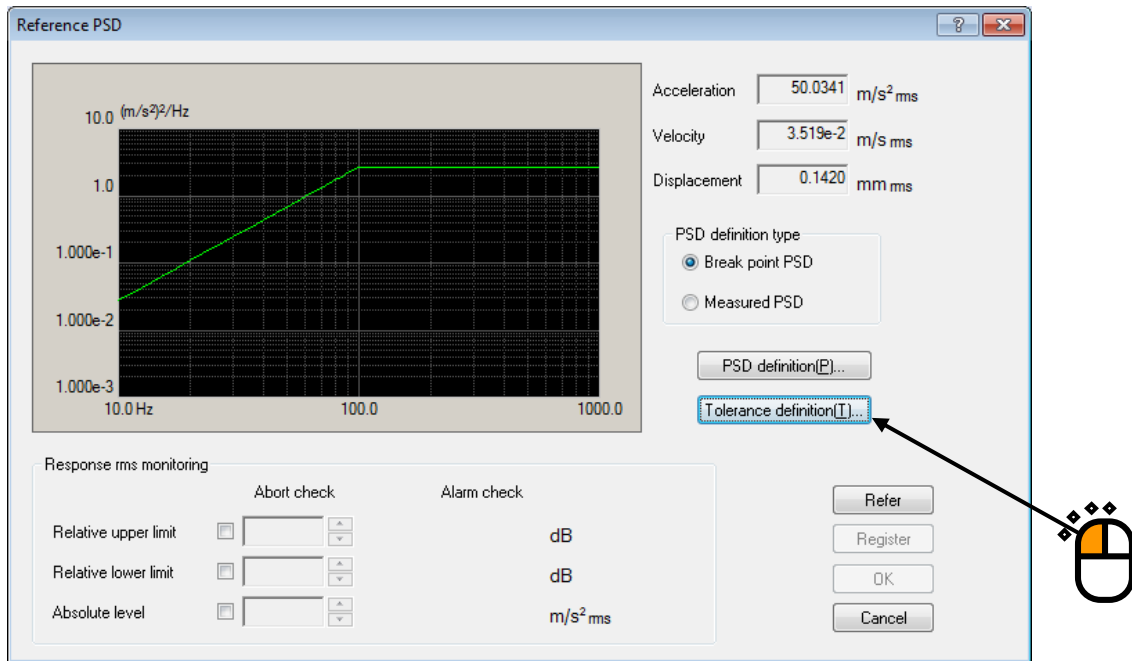
< Step 19 >

Press the [OK] button.



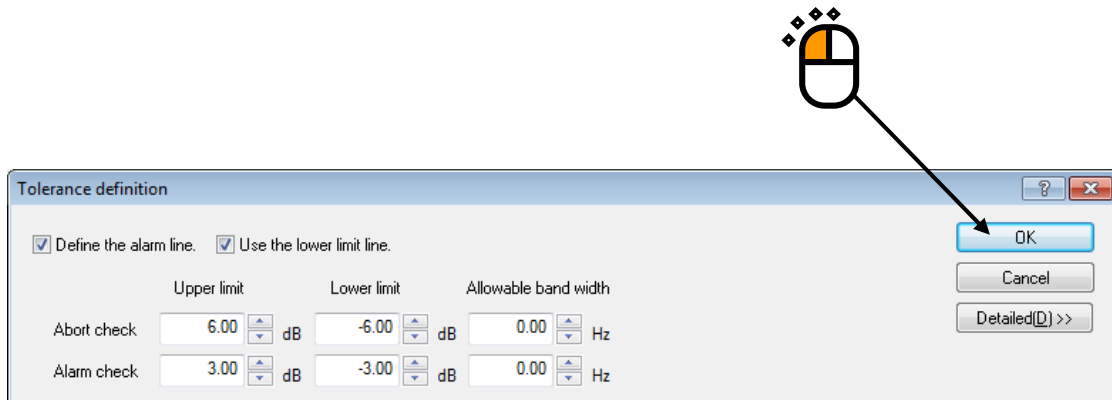
< Step 20 >

Press the button of 'Tolerance'.



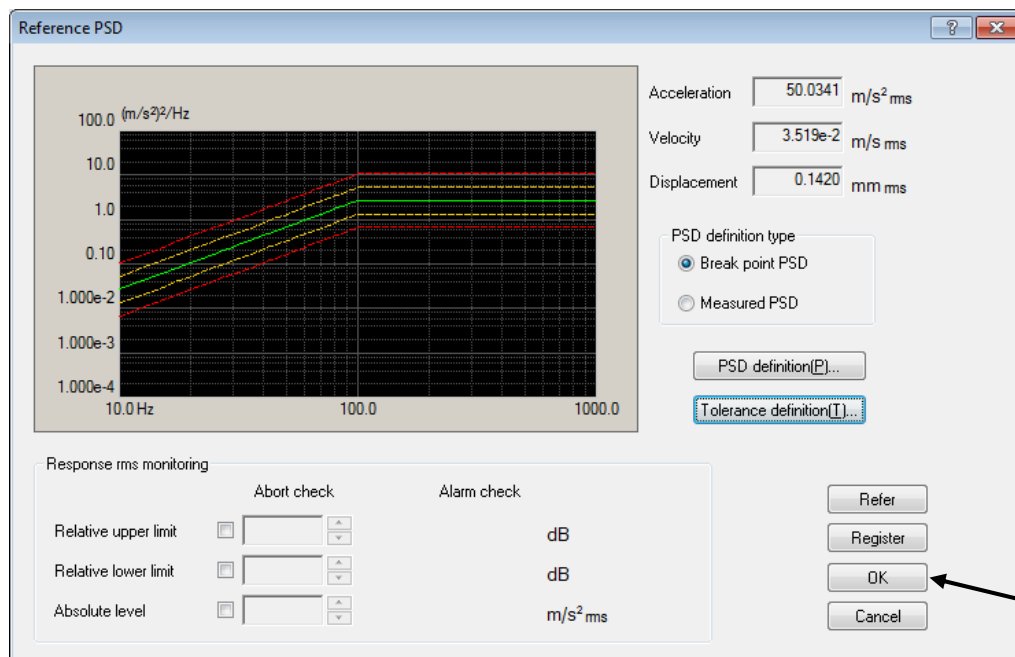
< Step 21 >

Press the [OK] button.



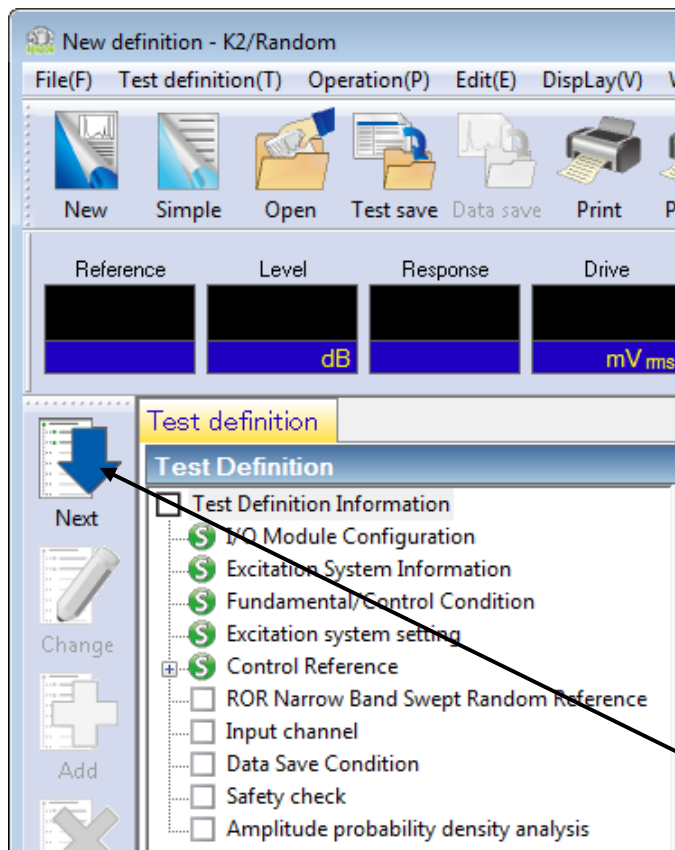
< Step 22 >

Press the [OK] button.



< Step 23 >

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



< Step 24 >

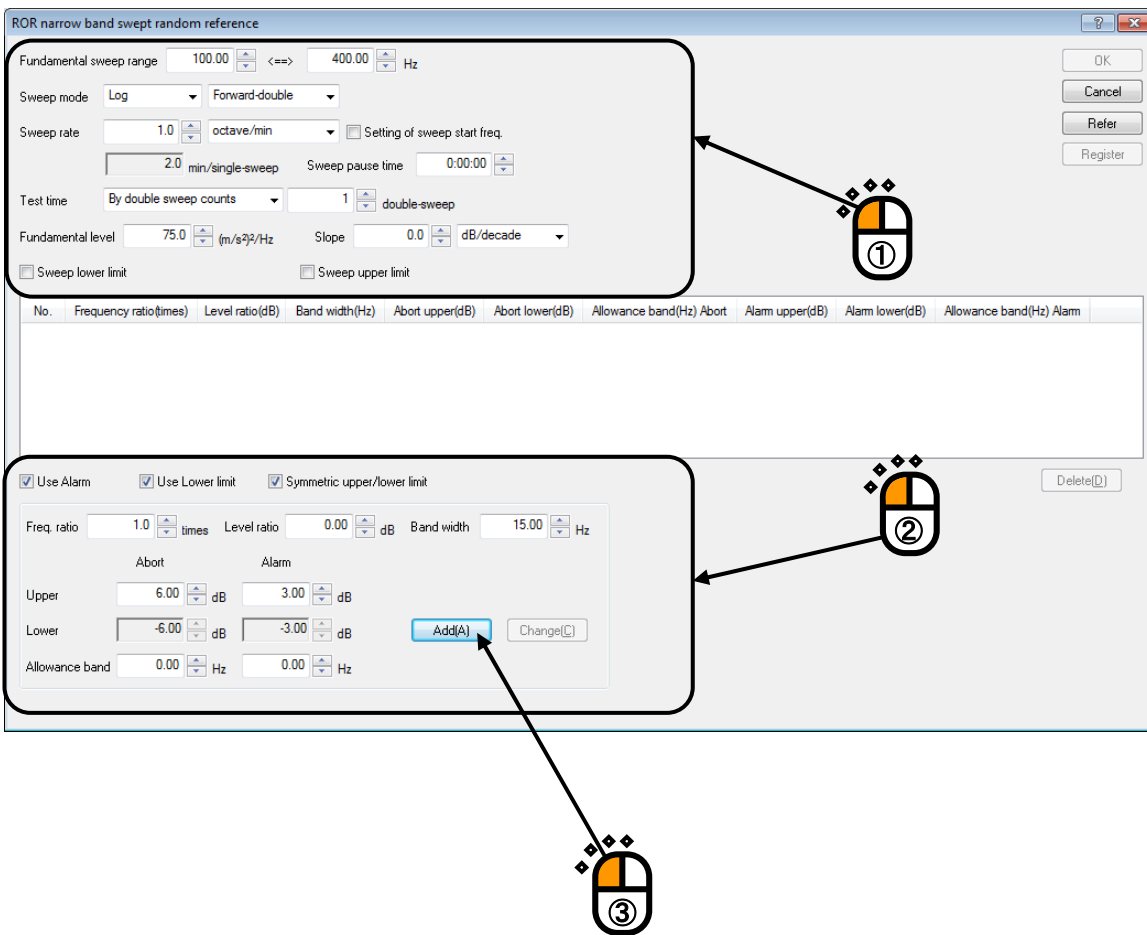
The conditions in the dialog are defined as the fundamental conditions of a narrow band swept random.

- Fundamental frequency range : 100 ~ 400 [Hz]
- Sweep rate : 1 [octave/min]
- Test time : 'By double sweep counts' : 5 [double-sweep]
- Fundamental level : 75[(m/s²)²/Hz]

Next, the elements of a fundamental component are defined.

- Frequency ratio : 1 [times]
- Level ratio : 0[dB]
- Band width : 15 [Hz]

Press [Add] when the condition definition for each items as in the above are completed.

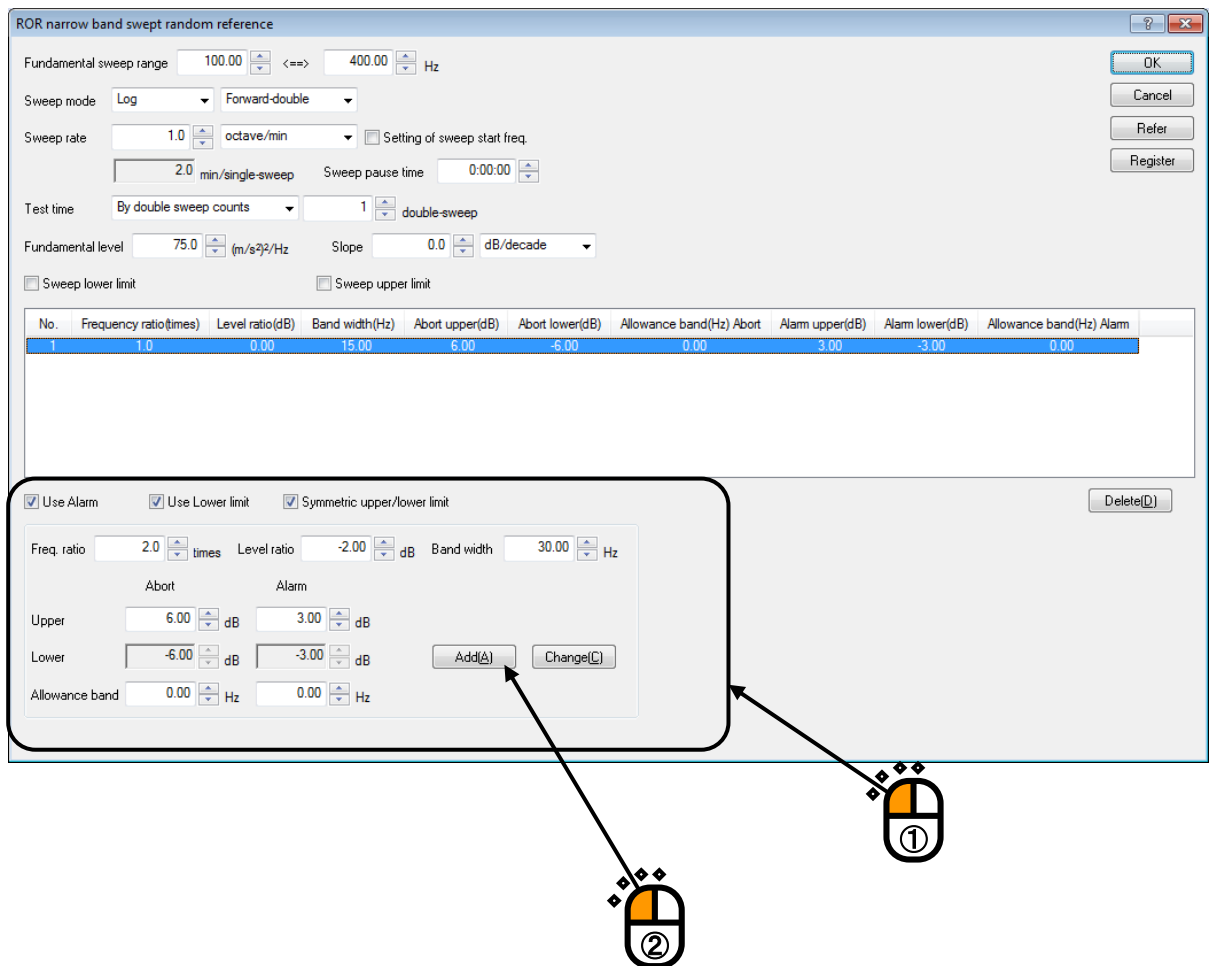


< Step 25 >

The elements of a 2nd harmonic component are to be defined.

- Frequency ratio : 2 [times]
- Level ratio : -2 [dB]
- Band width : 30 [Hz]

Press [Add] when the condition definition for each items as in the above are completed.



< Step 26 >

Press the [OK] button.

Fundamental sweep range: 100.00 Hz <=> 400.00 Hz

Sweep mode: Log, Forward-double

Sweep rate: 1.0 octave/min, Setting of sweep start freq. []

2.0 min/single-sweep, Sweep pause time: 0.00:00

Test time: By double sweep counts, 1 double-sweep

Fundamental level: 75.0 (m/s²/Hz), Slope: 0.0 dB/decade

Sweep lower limit, Sweep upper limit

No.	Frequency ratio(times)	Level ratio(dB)	Band width(Hz)	Abort upper(dB)	Abort lower(dB)	Allowance band(Hz) Abort	Alarm upper(dB)	Alarm lower(dB)	Allowance band(Hz) Alarm	Alarm
1	1.0	0.00	15.00	6.00	-6.00	0.00	3.00	-3.00	0.00	
2	2.0	-2.00	30.00	6.00	-6.00	0.00	3.00	-3.00	0.00	

Use Alarm, Use Lower limit, Symmetric upper/lower limit

Delete[D]

Freq. ratio: 2.0 times, Level ratio: -2.00 dB, Band width: 30.00 Hz

Abort: Upper 6.00 dB, Lower -6.00 dB, Allowance band 0.00 Hz

Alarm: Upper 3.00 dB, Lower -3.00 dB, Allowance band 0.00 Hz

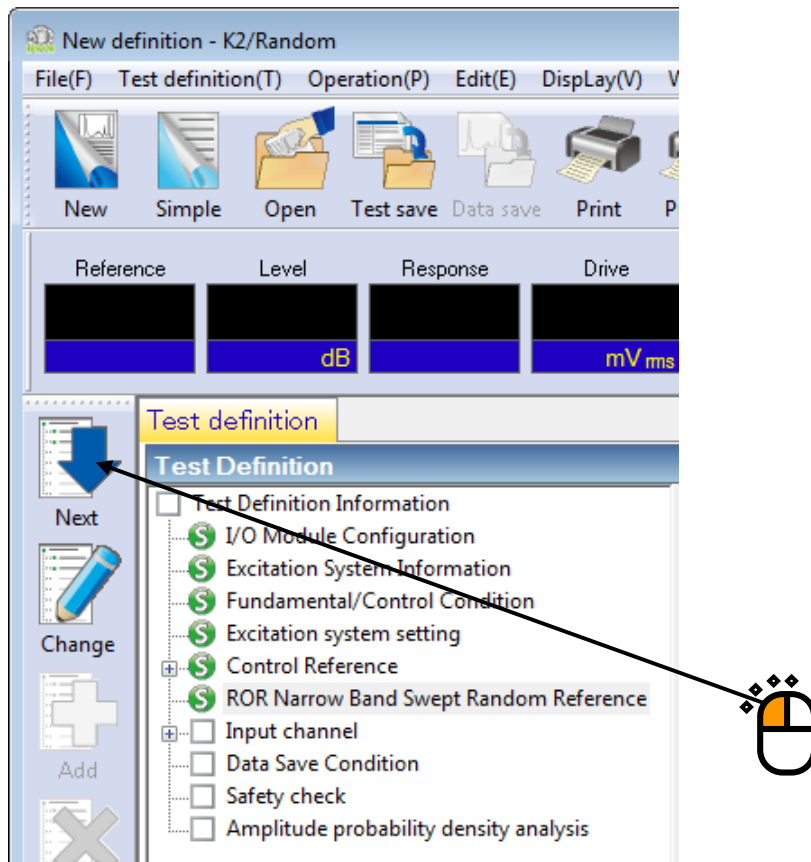
Add[A], Change[C]

OK, Cancel, Refer, Register



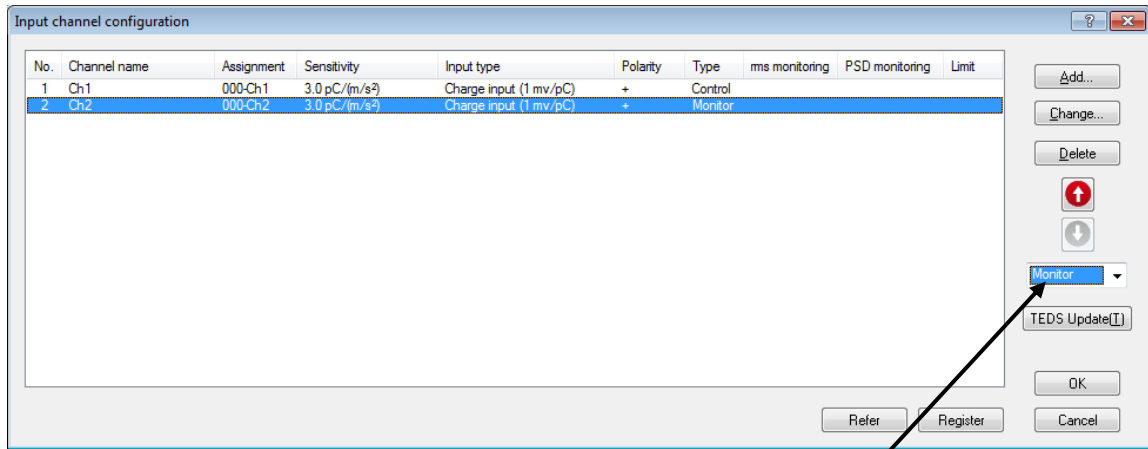
< Step 27 >

Press the [Next] button.



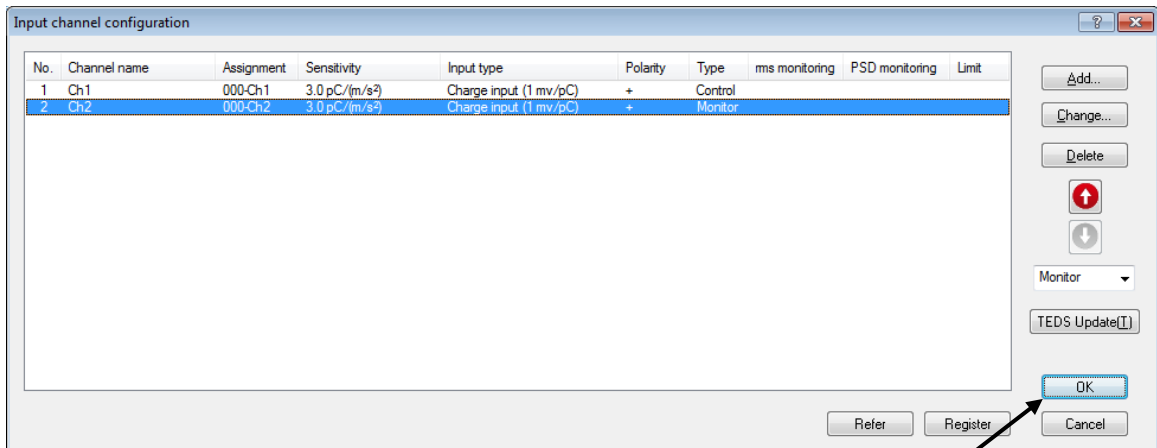
< Step 28 >

Select 'Ch. 1' and specify as 'Control'. And select 'Ch. 2' and specify as 'Monitor'.



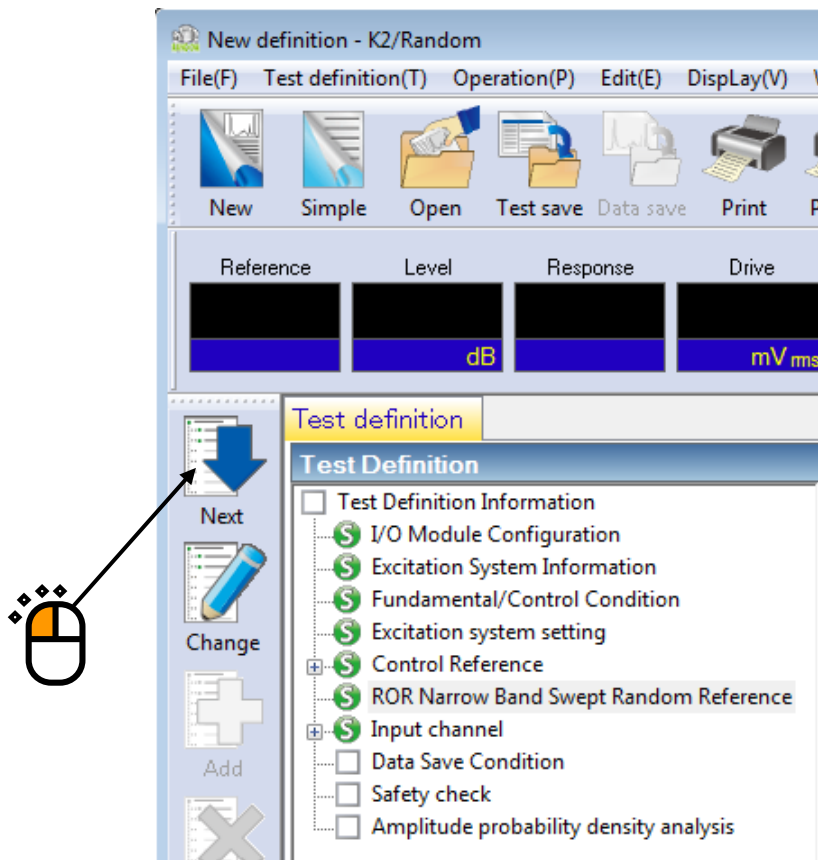
< Step 29 >

After completing the test definition, press the [OK] button.



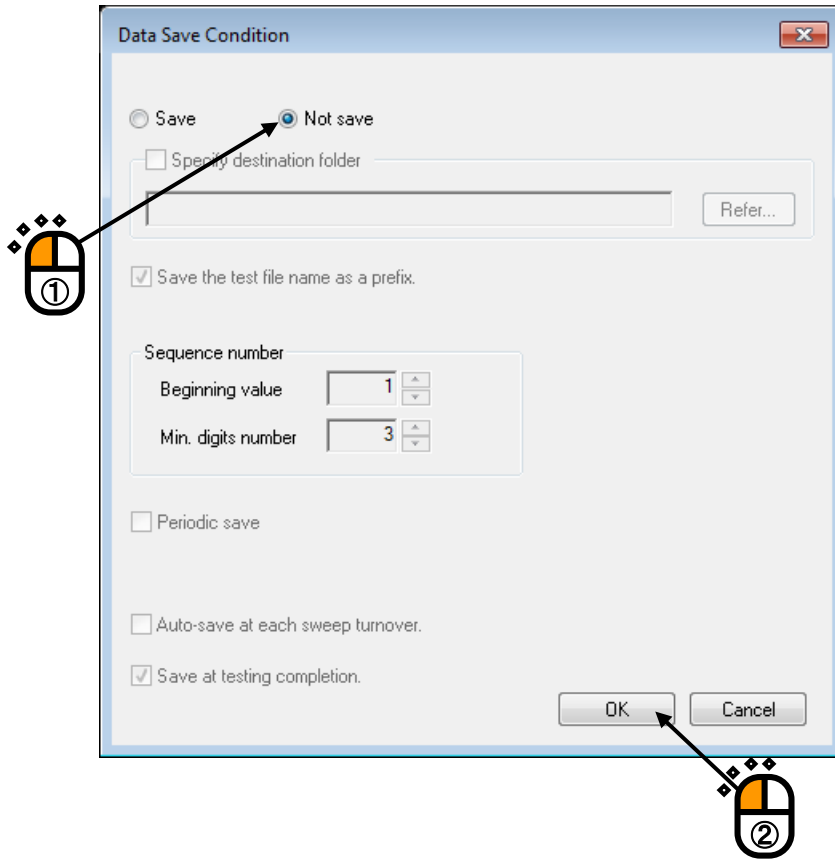
< Step 30 >

Press the button of [Next].



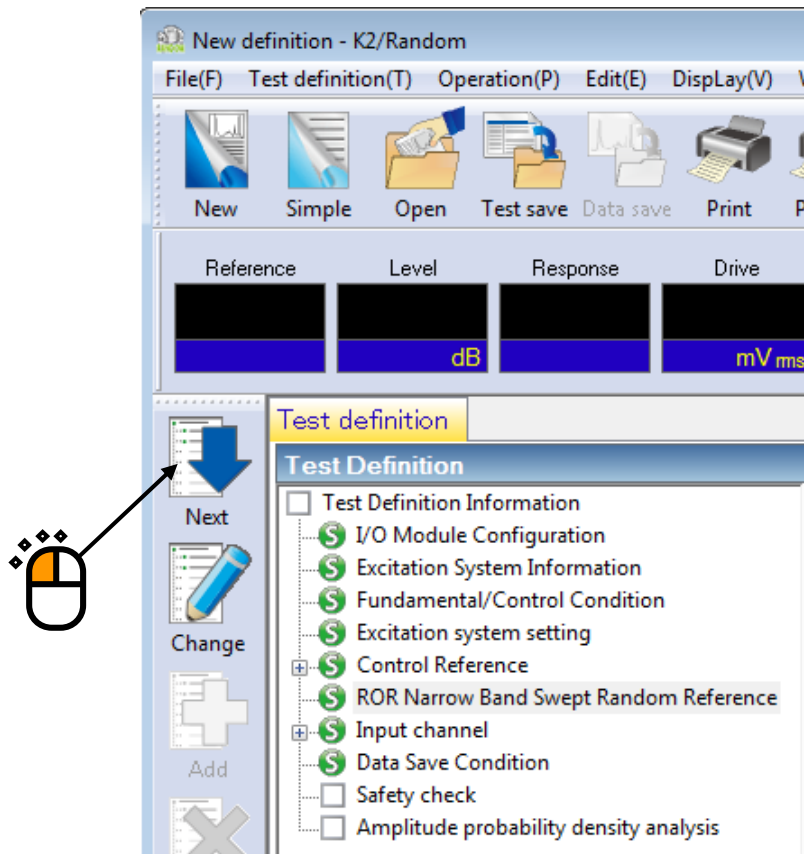
< Step31 >

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



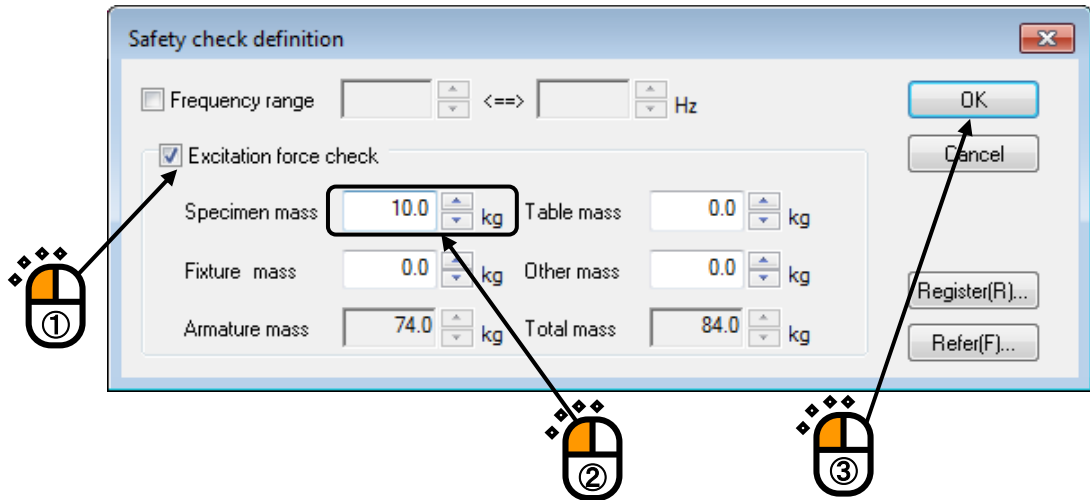
< Step32 >

Press the button of [Next].



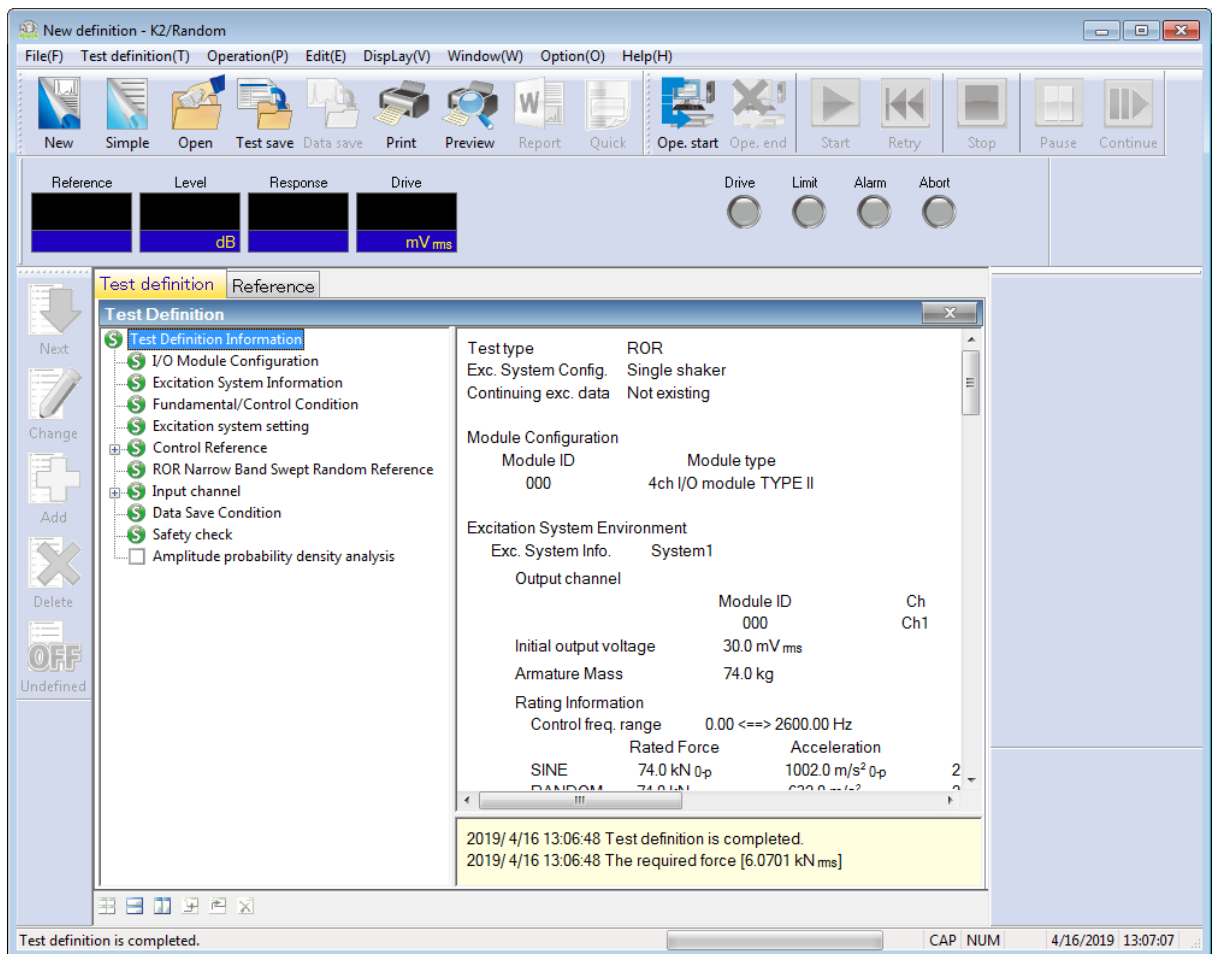
< Step33 >

Select 'Excitation force check' and input the value as 'Specimen mass : 10 [kg]'. And press the button of [OK].



< Step34 >

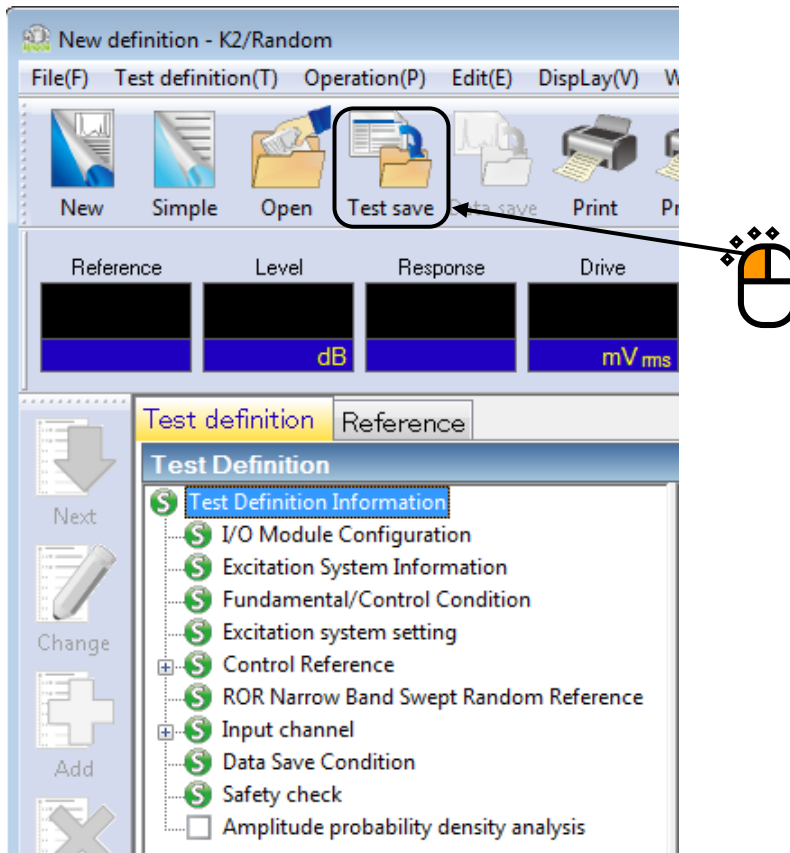
The definition is completed.



< Save of test >

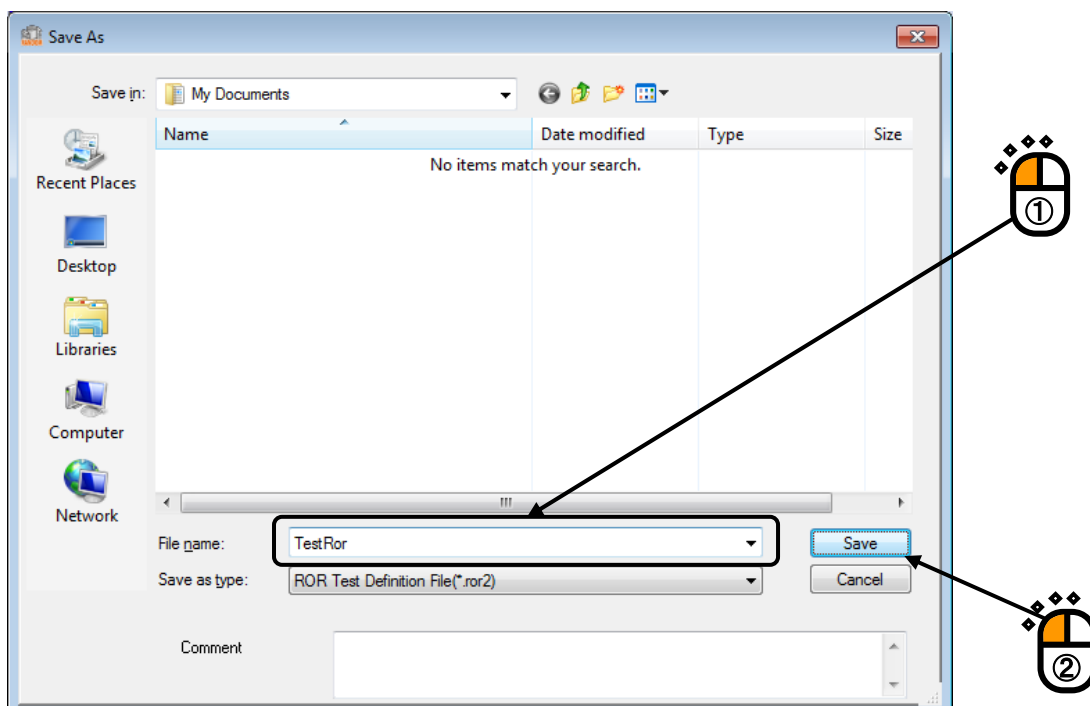
< Step 1 >

Press the button of [Test save].



< Step 2 >

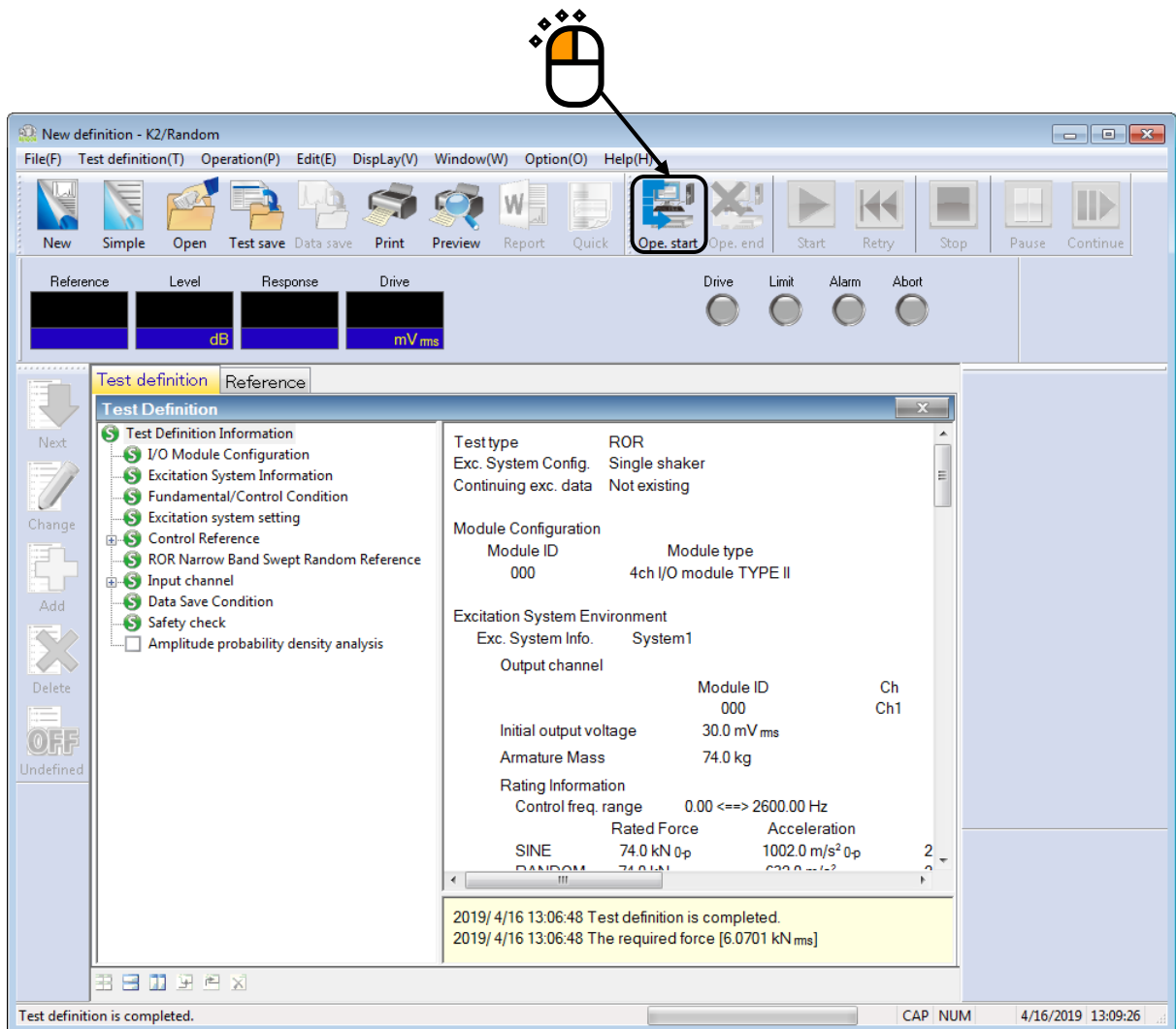
Input a name in 'File name' and press [Save].



< Operation of test >

< Step 1 >

Press the button of [Operation start].

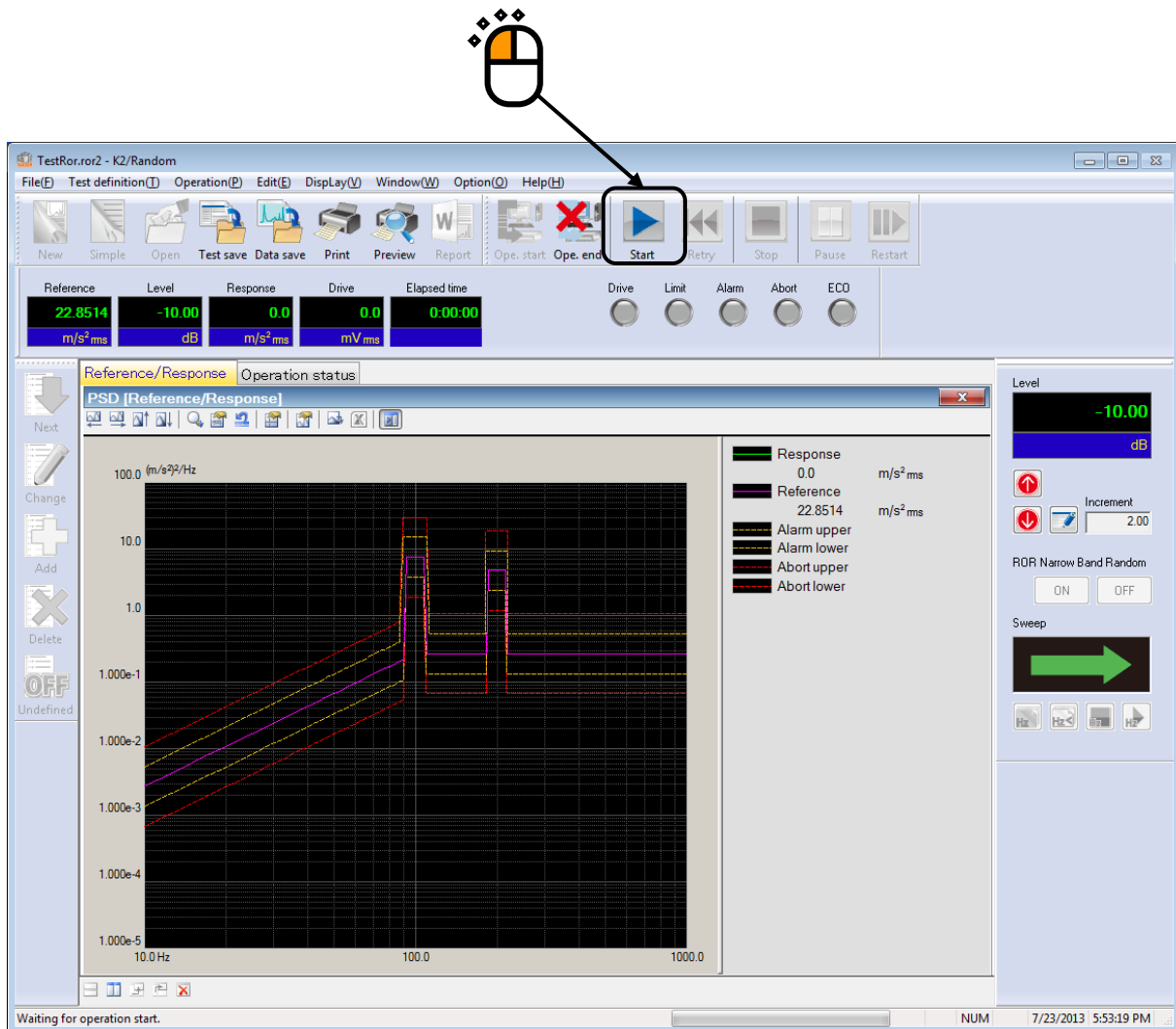


< Step 2 >

Press [Start].

When [Start] is pressed, Initial loop check and Initial equalization are automatically operated.

Then, the test operation is executed at the initial excitation level (in this example, at -10 dB).



The screenshot shows the TestRor software interface. A mouse cursor is pointing to the 'Start' button in the top toolbar. The interface displays the following parameters:

Reference	Level	Response	Drive	Elapsed time
22.8514 m/s ² ms	-10.00 dB	0.0 m/s ² ms	0.0 mV ms	0:00:00

The main window displays a PSD plot with the following legend:

- Response: 0.0 m/s² ms
- Reference: 22.8514 m/s² ms
- Alarm upper
- Alarm lower
- Abort upper
- Abort lower

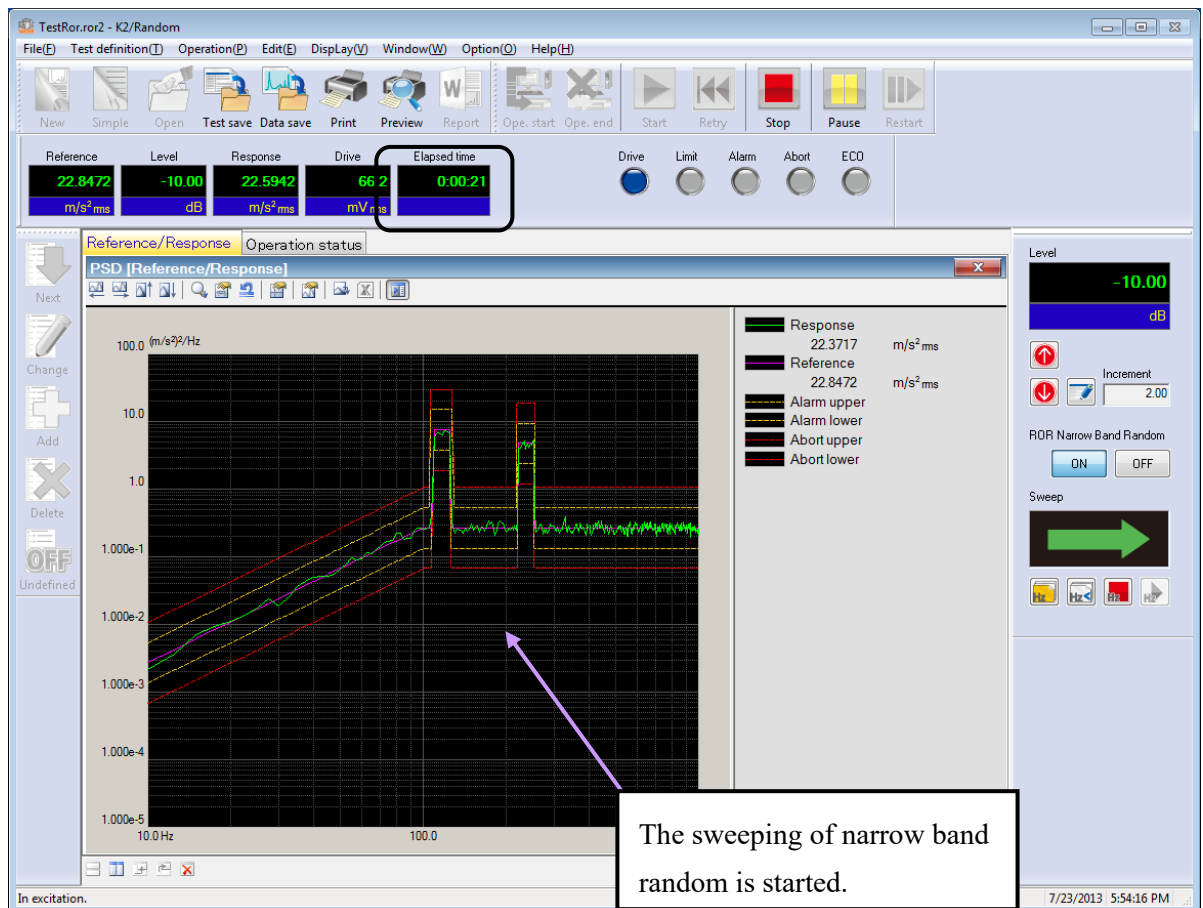
The status bar at the bottom indicates 'Waiting for operation start.' and the date/time is 7/23/2013 5:53:19 PM.

< Step 3 >

The sweeping of narrow band random is operated at the initial excitation level (-10 dB in this example) when the initial equalization is finished.

Test time is stated to be counted without concerning about the excitation level when the sweeping operation is started.

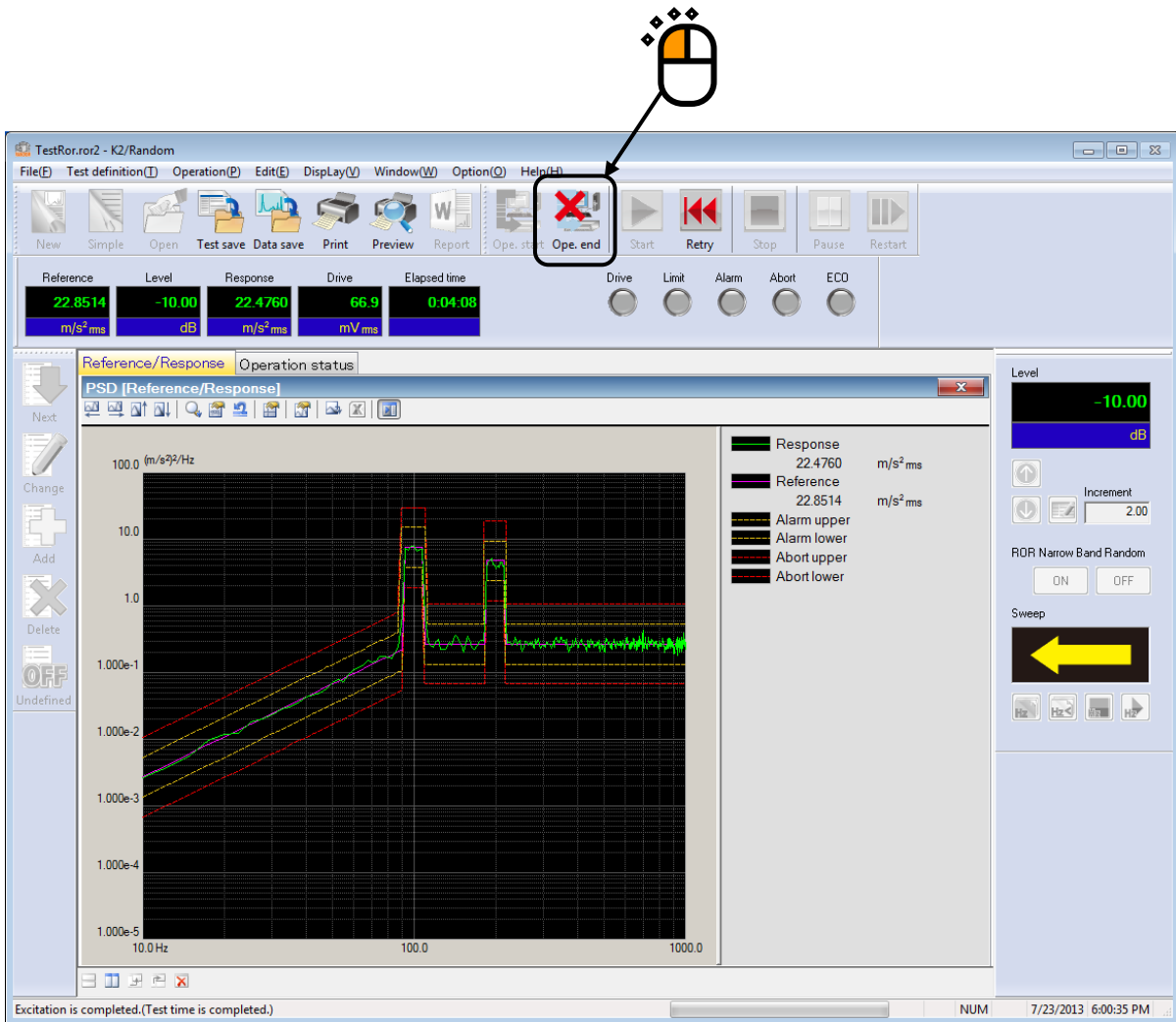
To start the narrow band random control and timer after the excitation level has reached 0dB, check “Start Sine tones/NBRs control from 0dB” in the Fundamental/Control Condition.



< Step 4 >

The test operation is completed when the specified test time has passed.

The system returns to the test definition mode by pressing of [Operation end] button.



1.3 Extended ROR Test

< Example >

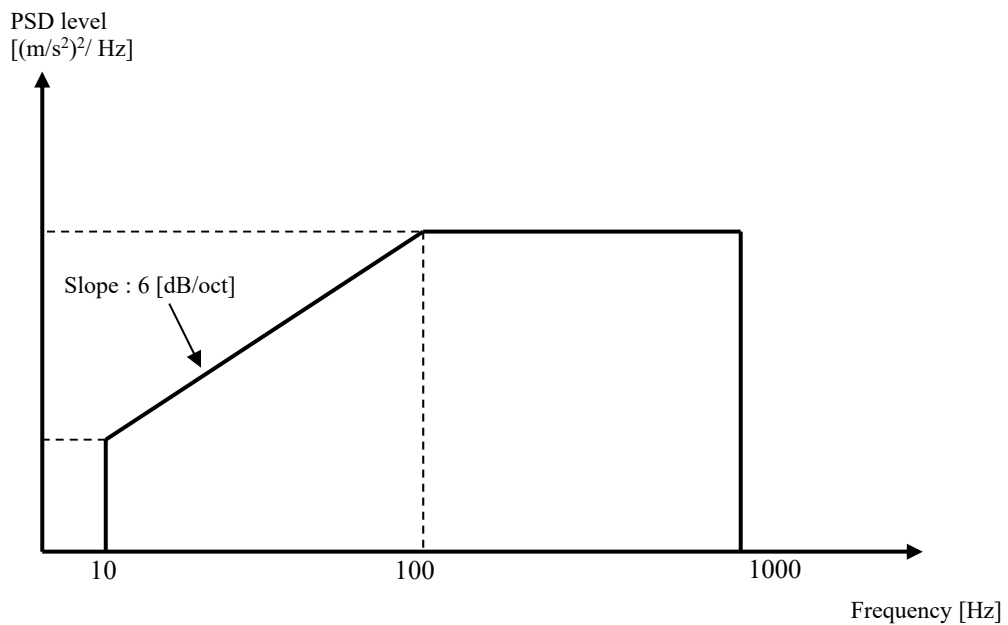
An example of ROR test is described as below ;

(Adopt the maximum values in synthesizing the broad band random and relevant narrow band random.)

[Reference pattern]

< Broad Band Random Reference >

Broad band random is specified to have an intensity of 50 [(m/s²)rms] having the PSD shape as in the below between 10 [Hz] and 1000 [Hz].

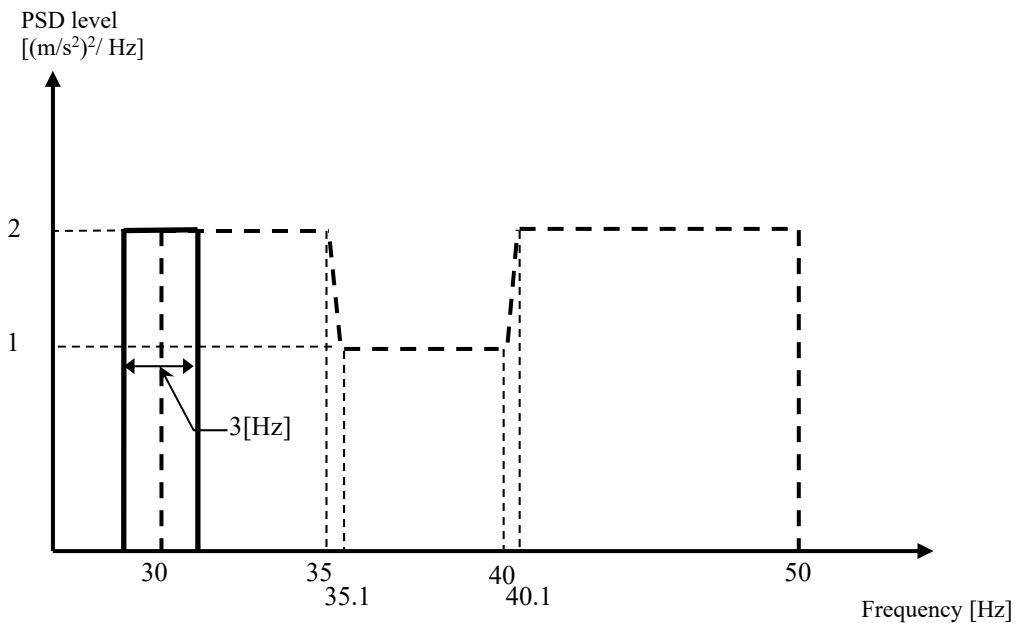


< Narrow Band Random Reference 1 >

The PSD of 3 [Hz] band width for sweeping the range of 30 [Hz] to 50 [Hz] along the dashed line shown in the figure below.

Sweep rate : 1.000 (Hz/sec) [Linear sweep]

Times of double sweep : 5 times from the forward (double-sweep)

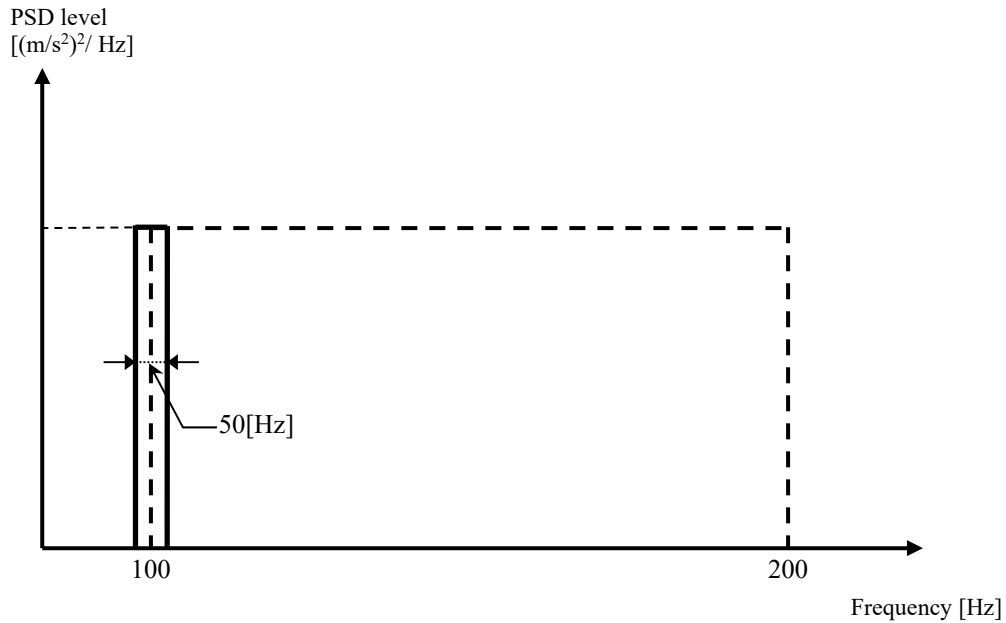


< Narrow Band Random Reference 2 >

The PSD of 5 [Hz] band width for sweeping the range of 100 [Hz] to 200 [Hz] along the dashed line (50 [(m/s²)²/Hz]) shown in the figure below.

Sweep rate : 0.500 (octave/min) [Log sweep]

Times of double sweep : 2 times from the backward (double-sweep)



< Narrow Band Random Reference 3 >

The PSD [Fixed] of 100 [Hz] band width, center frequency of 500 [Hz] and with a constant level of 10 [(m/s²)²/Hz].

Test time : 00:10:00

[Information of sensors to be used]

Two acceleration pickups of piezoelectric : one is used for control and another for monitor.

Ch. 1 : for control, sensitivity 3pC/(m/s²)

Ch. 2 : for monitor, sensitivity 3pC/(m/s²)

However, these channels must be registered in Input channel information (in this example, 'Input1').

Also, the rating information of excitation system has already been registered in Excitation System information (in this example, 'Sample1').

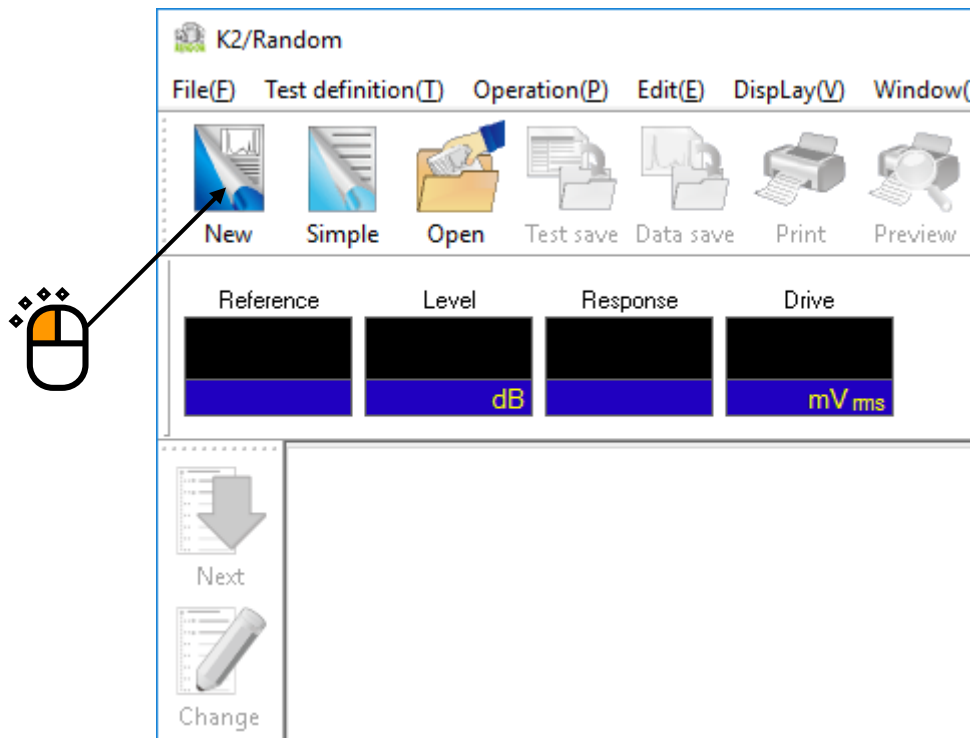
[Information of specimen]

Specimen mass : 10[kg]

< Procedures >

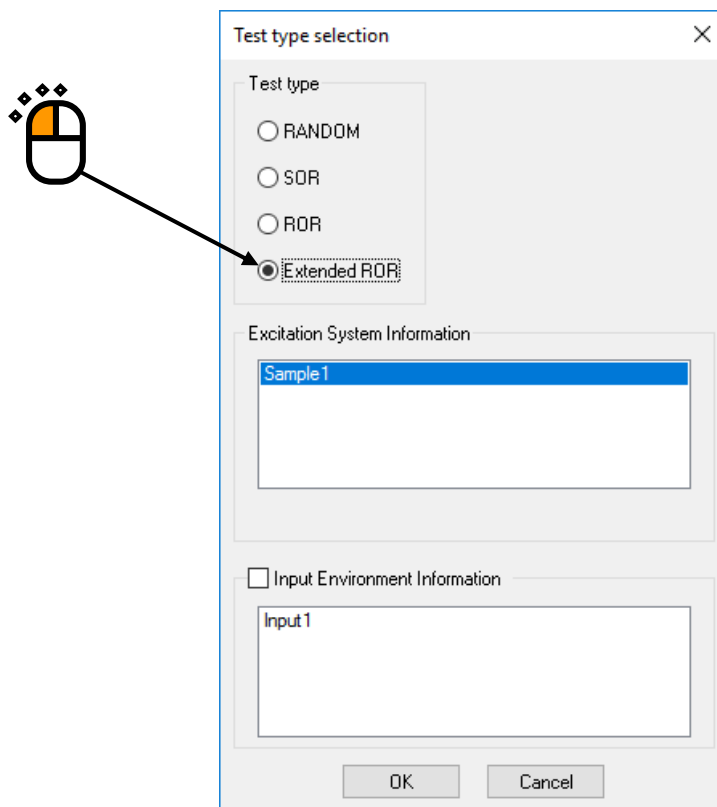
< Step 1 >

Press the button of [New] to start new definition.



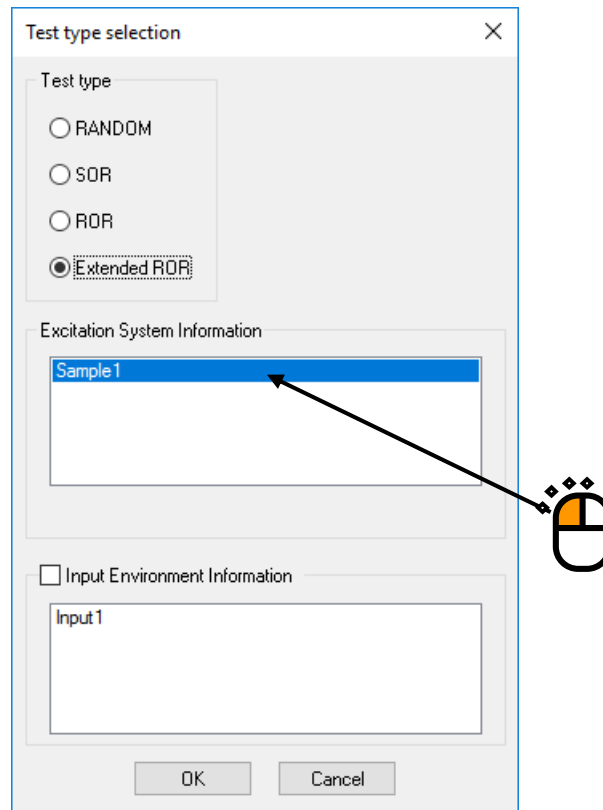
< Step 2 >

Select the item of 'Extended ROR test' in Test type.



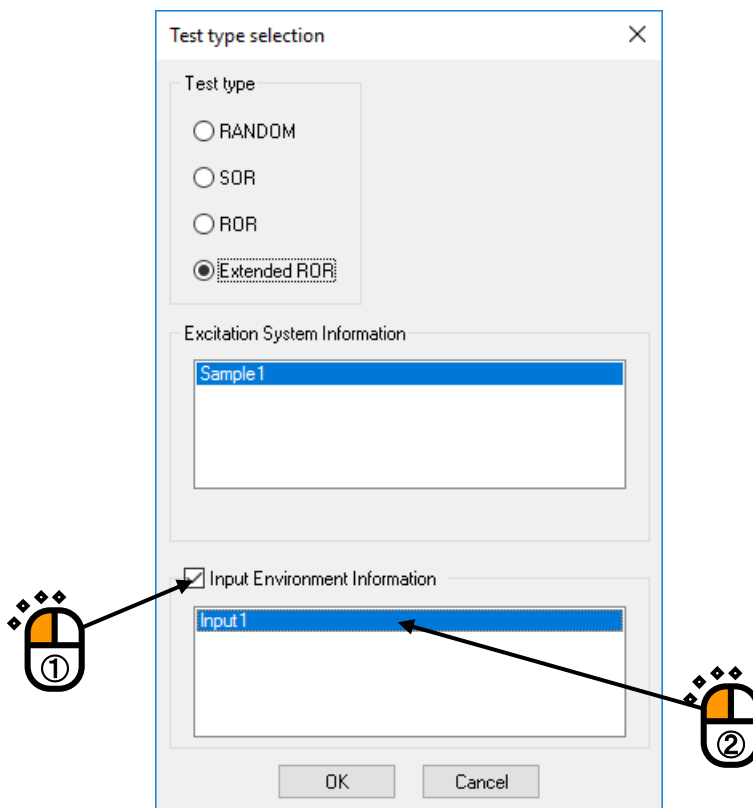
< Step 3 >

Select an Excitation system from the list of 'Excitation system information'.



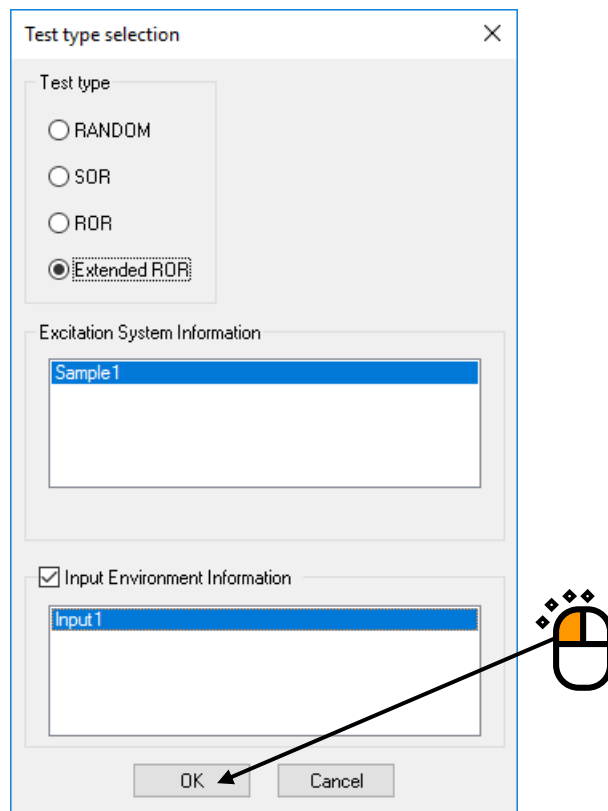
< Step 4 >

Click the checkbox of 'Input channel information selection' and select an Input channel information from the list.



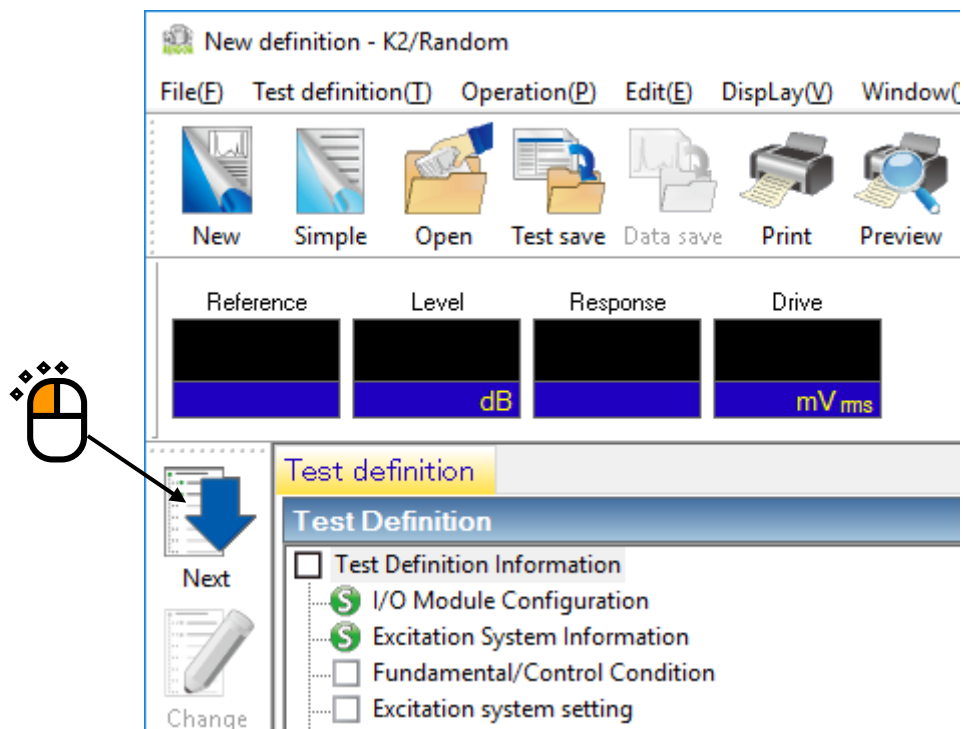
< Step 5 >

Press the [OK] button.



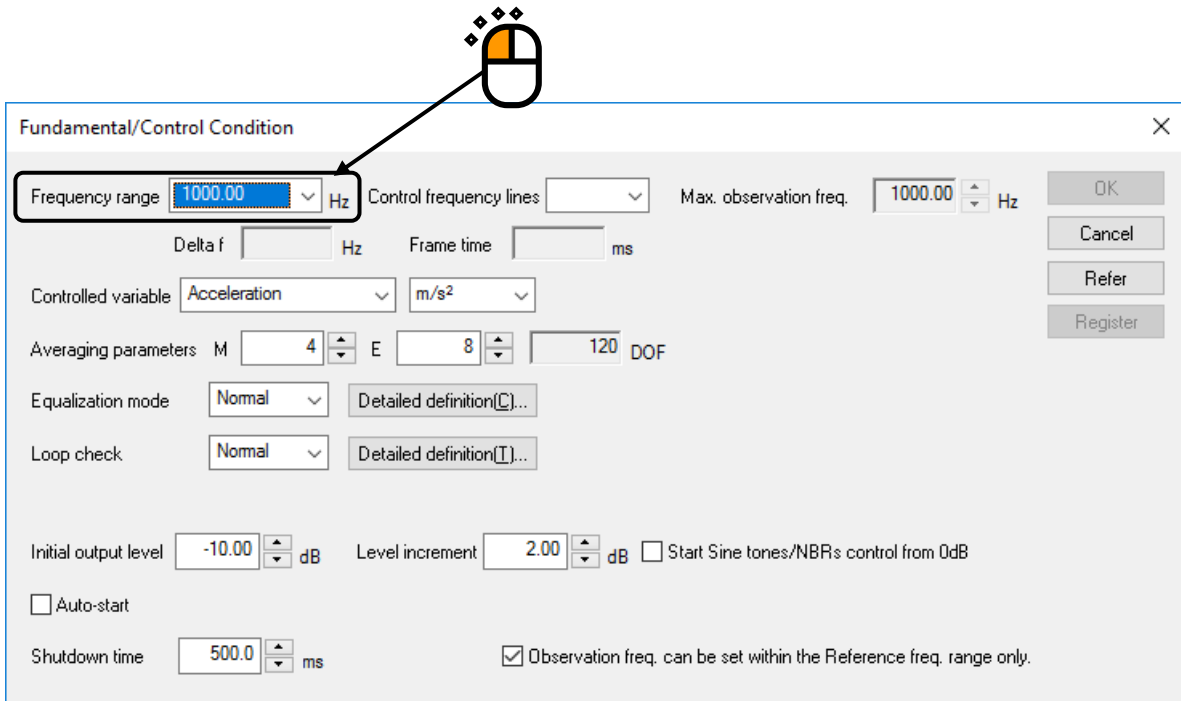
< Step 6 >

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



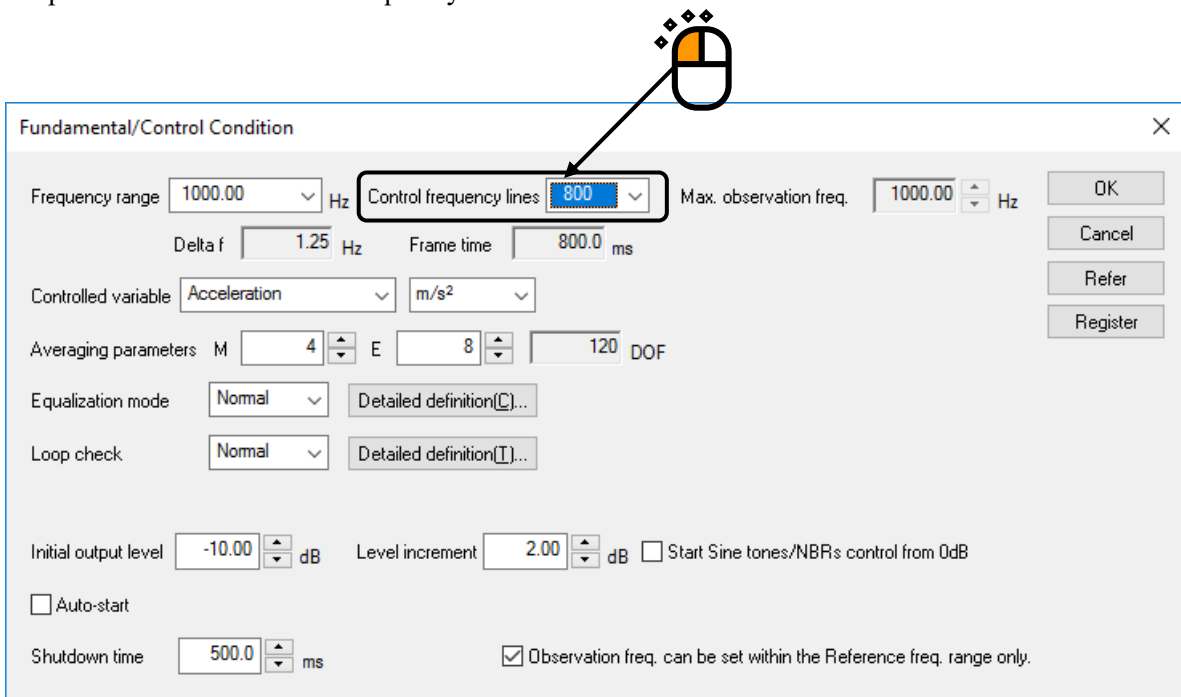
< Step 7 >

Input the value to 'Frequency range' as 1000Hz.



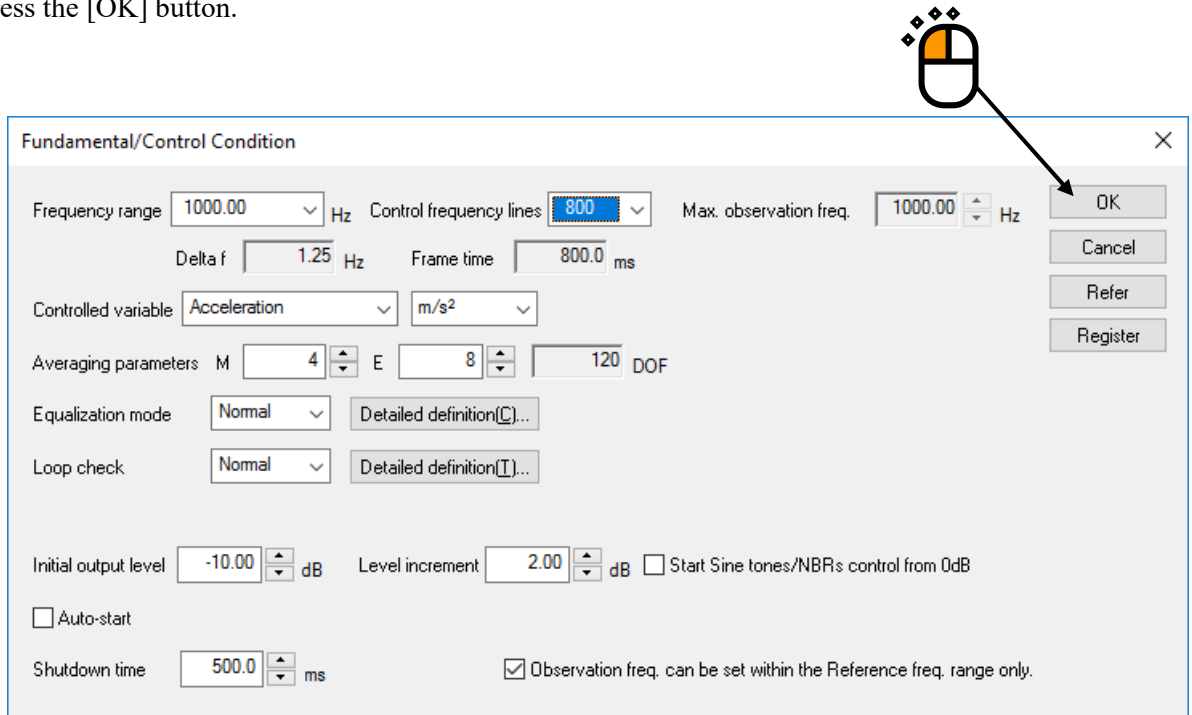
< Step 8 >

Input the value to 'Control frequency lines' as 400.



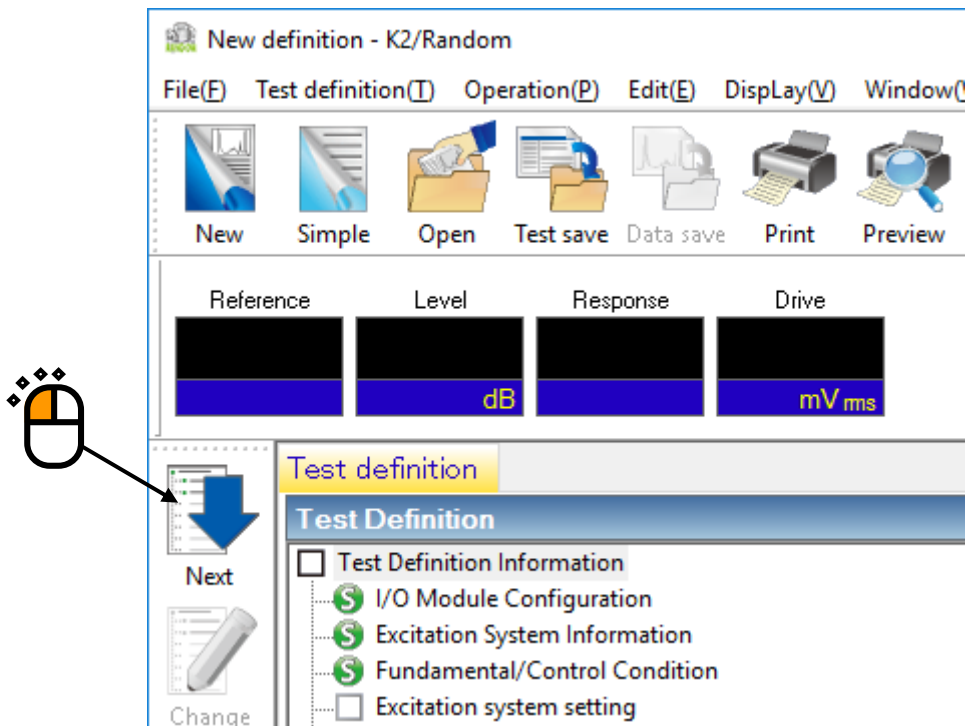
< Step 9 >

Press the [OK] button.



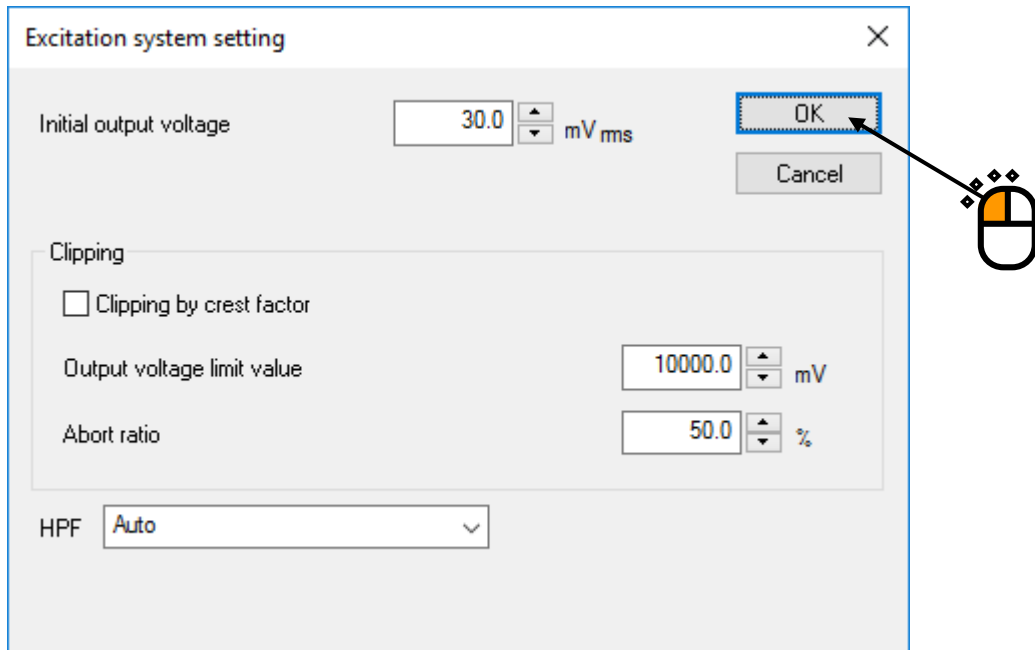
< Step 10 >

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



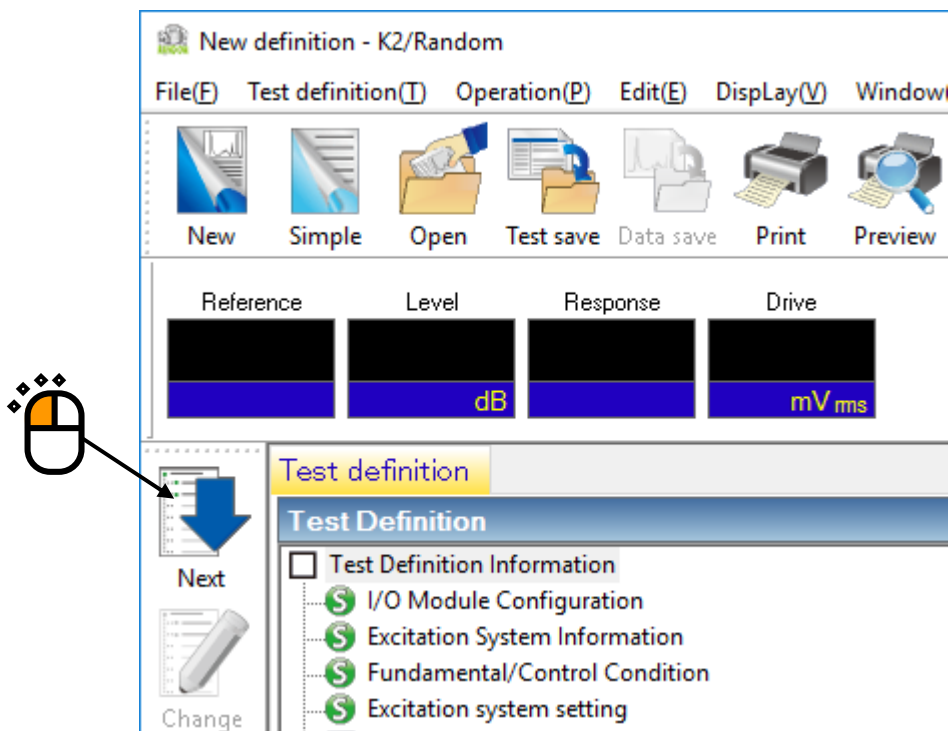
< Step 11 >

Press the [OK] button.



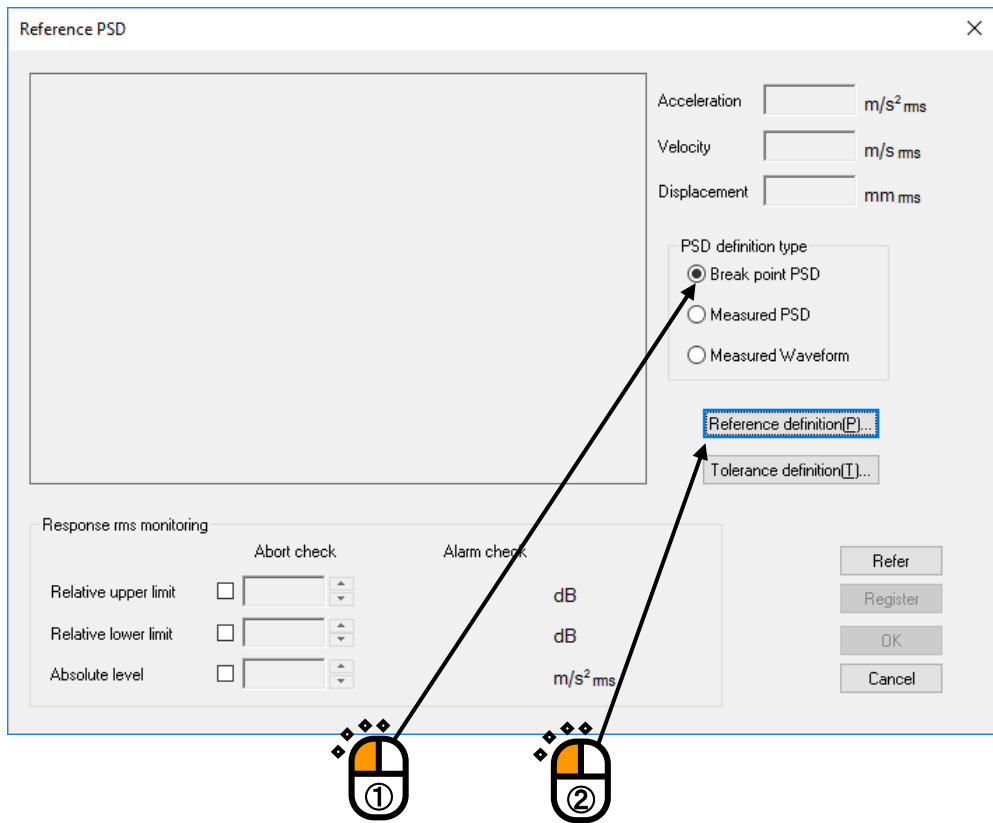
< Step 12 >

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



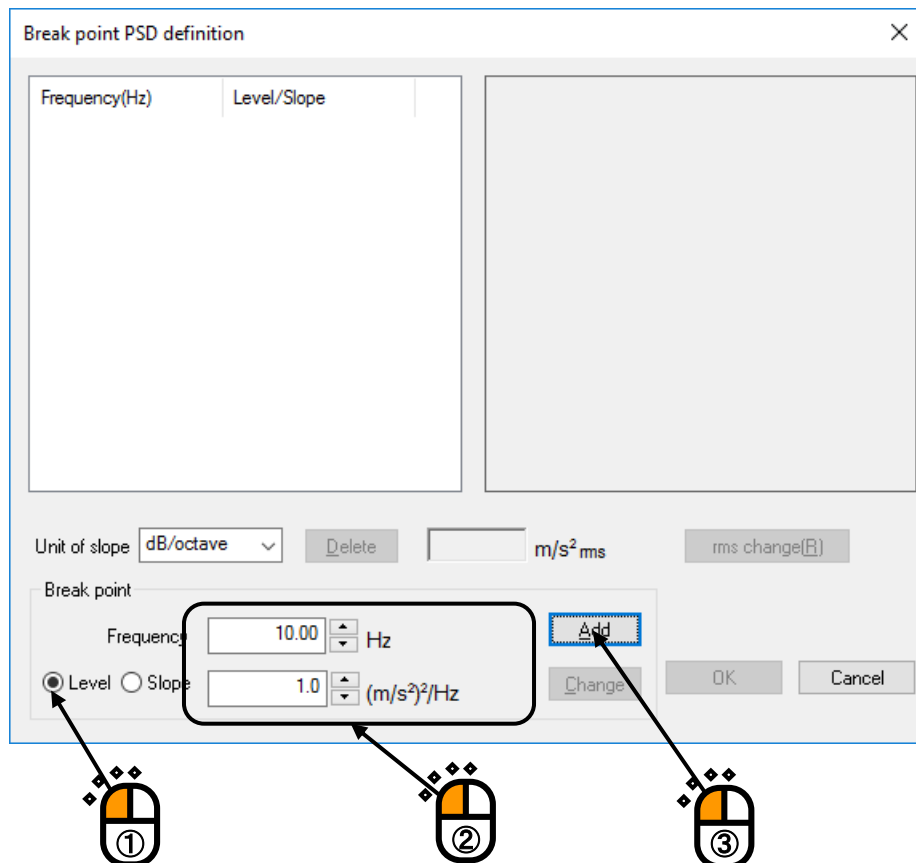
< Step 13 >

Select the item of 'Break point' in PSD definition type. And press [PSD definition].



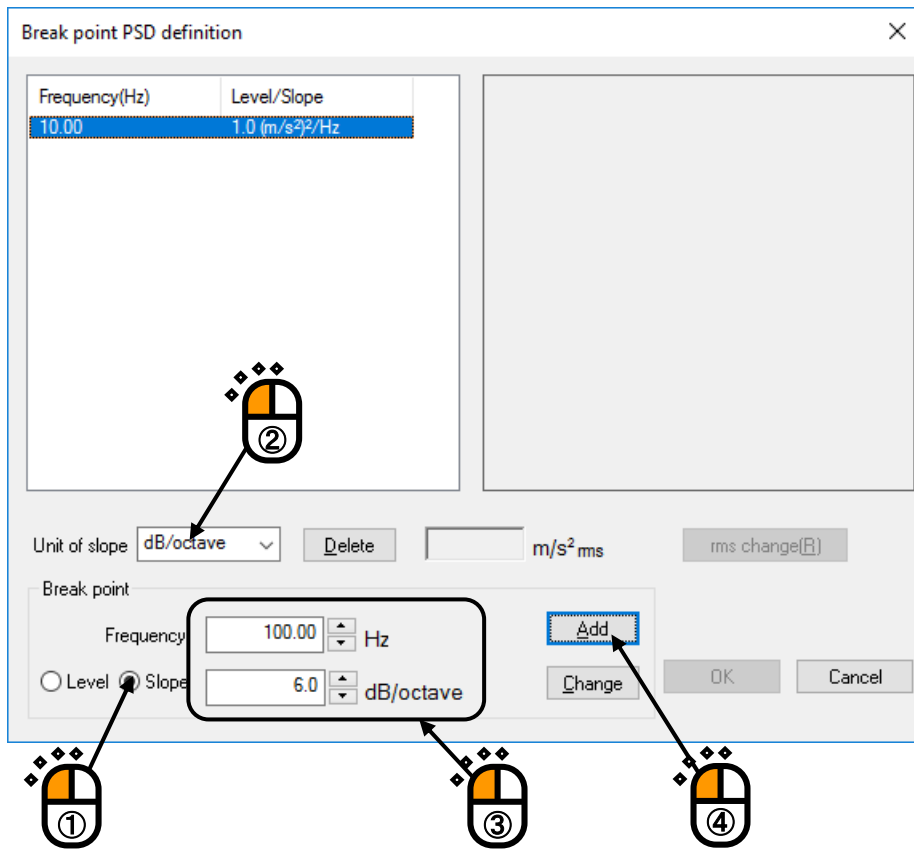
< Step 14 >

Click and select 'Level'. Input the values to 'Frequency' as 10 [Hz] and 'Level' as 1 [(m/s²)²/Hz]. And press the [Add] button.



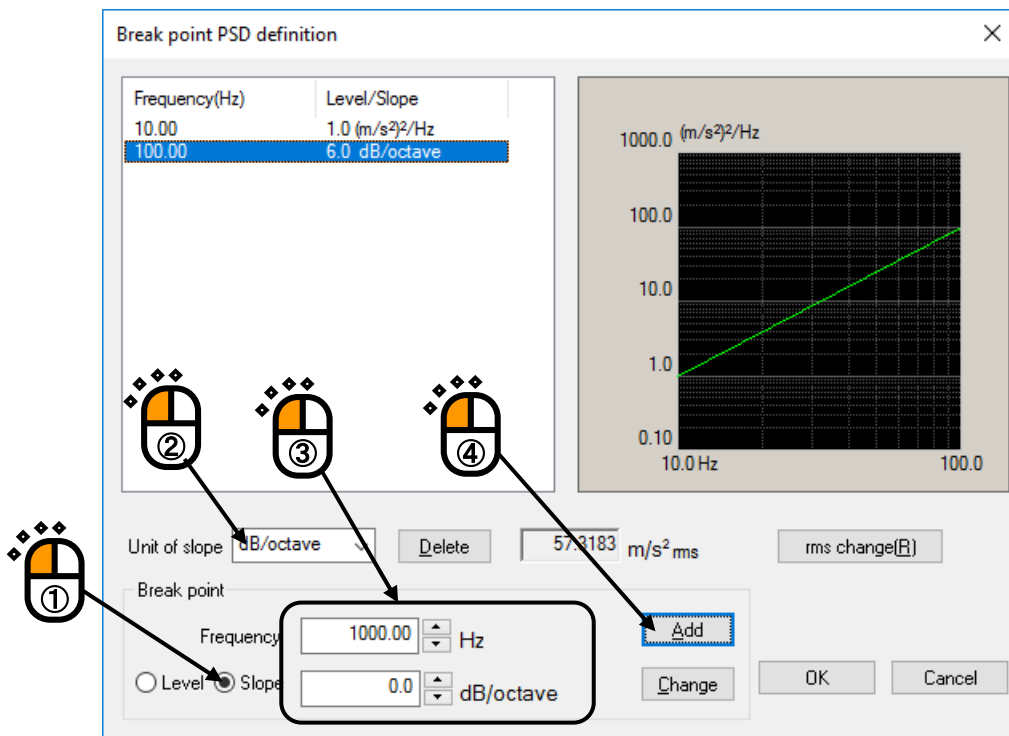
< Step 15 >

Click 'Slope' and select 'dB/octave' as the unit. Input the values to 'Frequency' as 100 [Hz] and 'Slope' as 6 [dB/octave]. Then press the [Add] button.



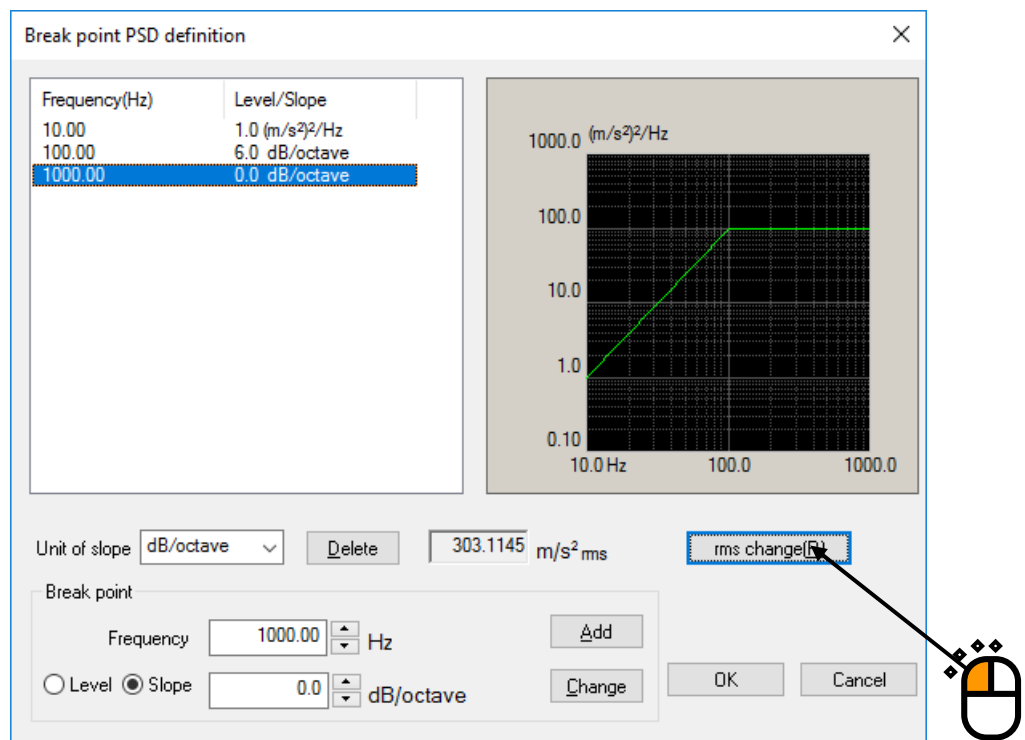
< Step 16 >

In the same way, click 'Slope' and select 'dB/octave' as the unit. Input the values to 'Frequency' as 1000 [Hz] and 'Slope' as 0 [dB/octave]. Then press the [Add] button.



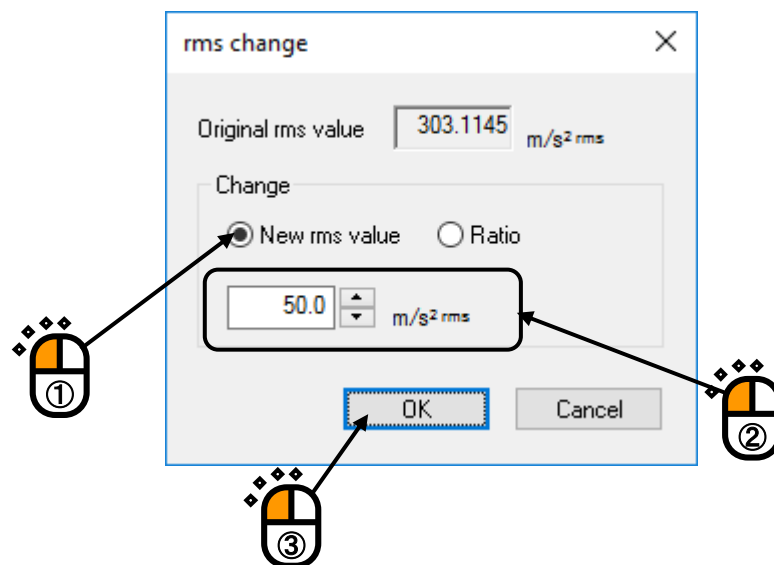
< Step 17 >

Press the button of [rms change].



< Step 18 >

Click and select 'New rms value'. Input the values to 'New rms value' as 50 [(m/s²) rms] and press the [OK] button.



< Step 19 >

Press the [OK] button.

Break point PSD definition

Frequency(Hz)	Level/Slope
10.00	2.721e-2 (m/s ²) ² /Hz
100.00	6.0 dB/octave
1000.00	0.0 dB/octave

10.0 (m/s²)²/Hz

1.0

1.000e-1

1.000e-2

1.000e-3

10.0 Hz 100.0 1000.0

Unit of slope: dB/octave [Delete] 50.0 m/s² rms [rms change(B)]

Break point

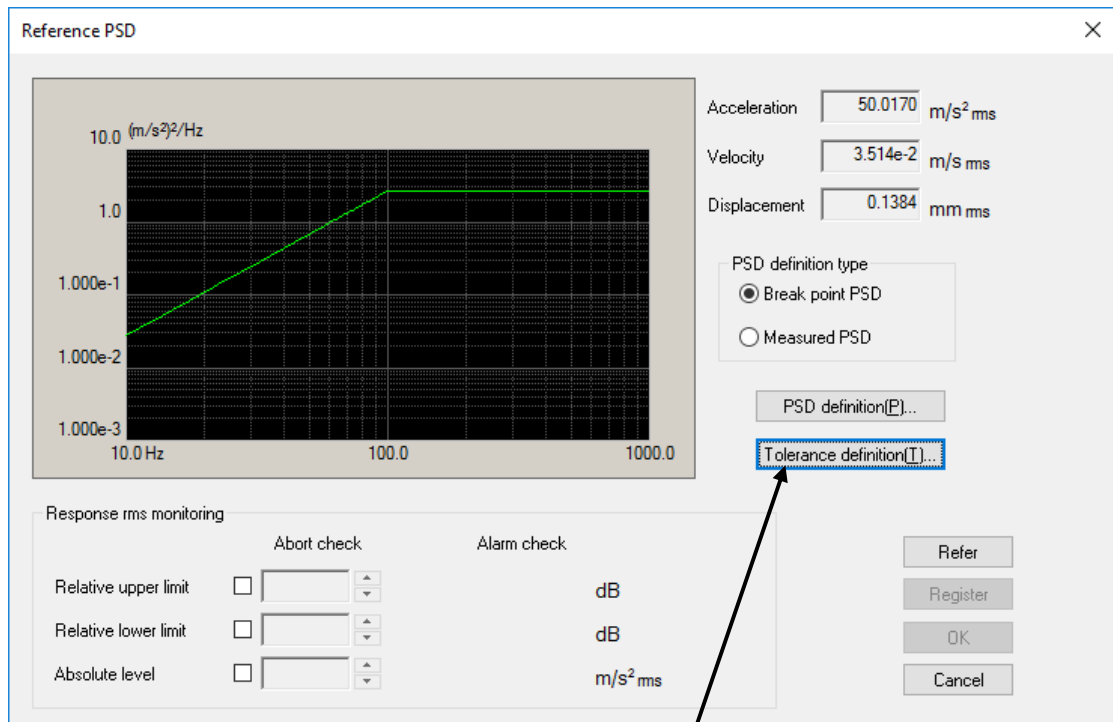
Frequency: 1000.00 Hz [Add]

Level Slope: 0.0 dB/octave [Change]

[OK] [Cancel]

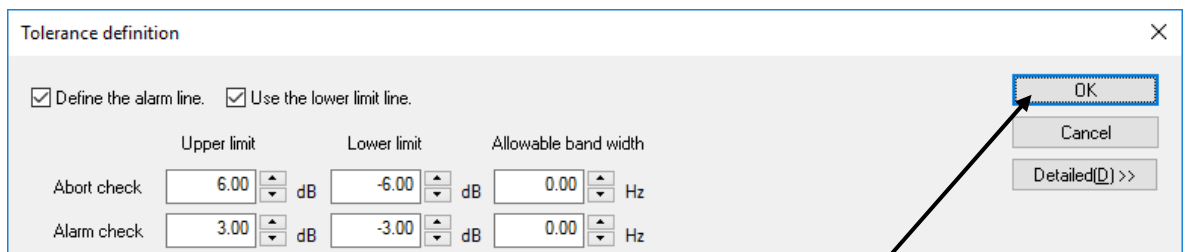
< Step 20 >

Press the button of 'Tolerance definition'.



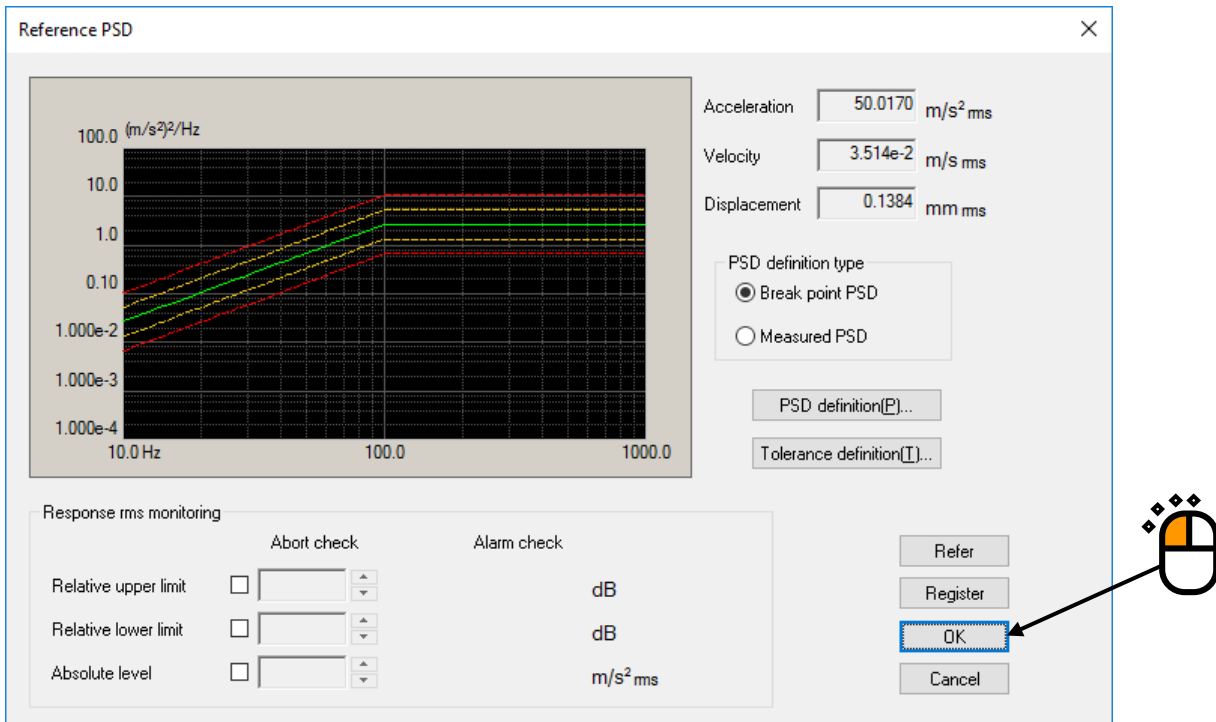
< Step 21 >

Press the [OK] button.



< Step 22 >

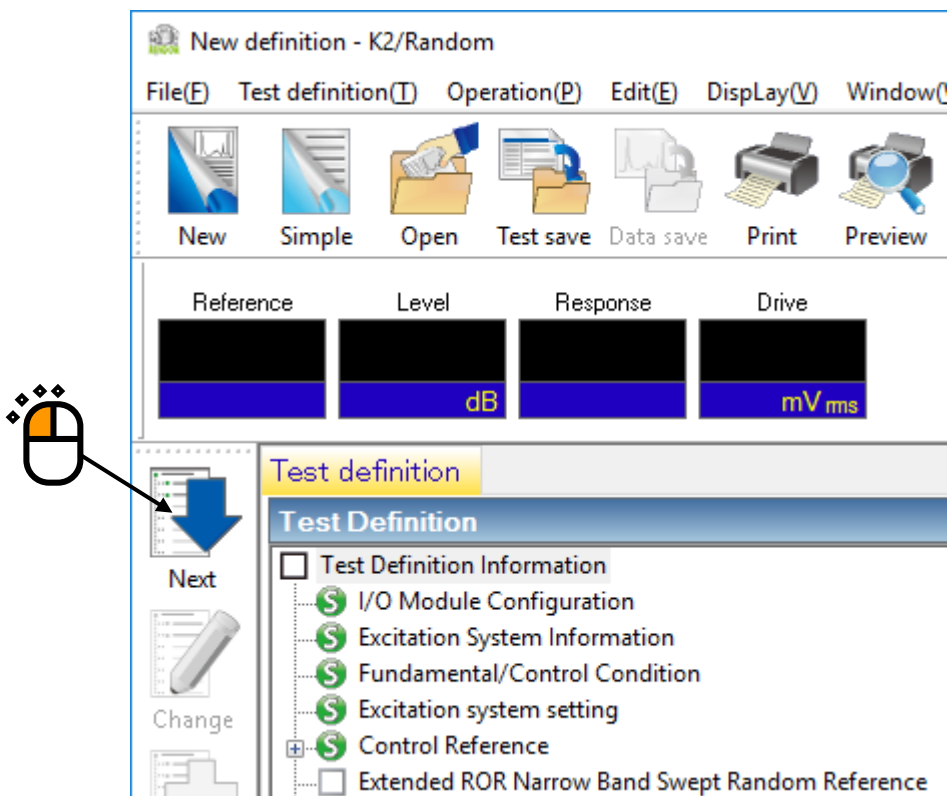
Press the [OK] button.



The Reference PSD dialog box features a log-log plot of Power Spectral Density (m/s²/Hz) versus frequency (Hz). The plot shows three curves (red, green, blue) with dashed lines indicating tolerance bands. The y-axis ranges from 1.000e-4 to 100.0, and the x-axis ranges from 10.0 Hz to 1000.0 Hz. To the right of the plot, there are input fields for Acceleration (50.0170 m/s² ms), Velocity (3.514e-2 m/s ms), and Displacement (0.1384 mm ms). Below these are radio buttons for PSD definition type: Break point PSD (selected) and Measured PSD. There are also buttons for PSD definition(P)... and Tolerance definition(T)... At the bottom right, there are buttons for Refer, Register, OK (highlighted with a mouse cursor), and Cancel. At the bottom left, there is a section for Response rms monitoring with checkboxes for Abort check and Alarm check, and input fields for Relative upper limit, Relative lower limit, and Absolute level, each with a unit (dB or m/s² ms).

< Step 23 >

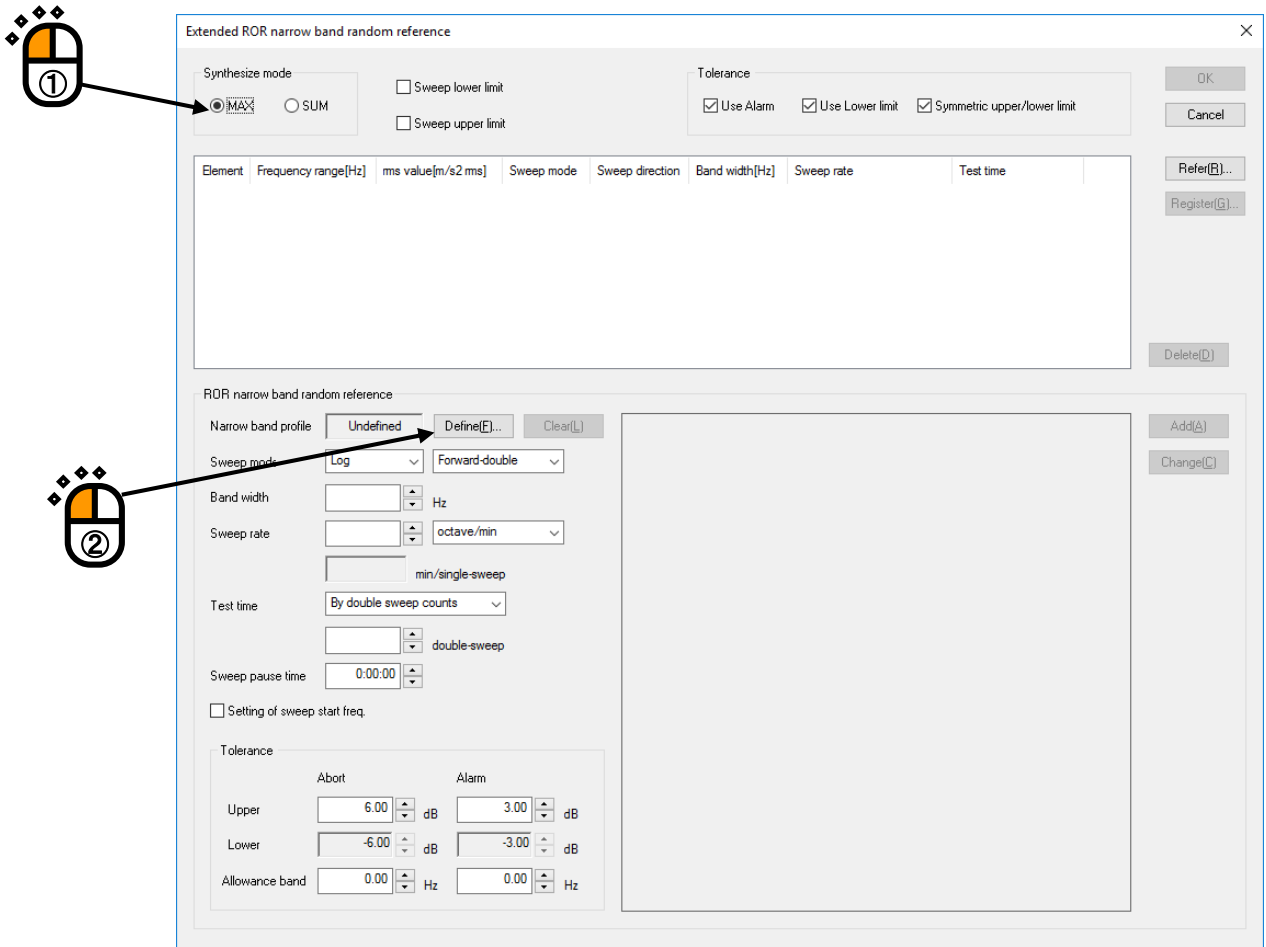
Press the button of [Next] to go to the next definition.



The New definition - K2/Random dialog box has a menu bar (File(F), Test definition(T), Operation(P), Edit(E), DispLay(V), Window(W)) and a toolbar with icons for New, Simple, Open, Test save, Data save, Print, and Preview. Below the toolbar are four tabs: Reference, Level, Response, and Drive. The Level tab is active, showing a value of dB. The Drive tab shows a value of mV ms. At the bottom, there is a Test definition section with a Test Definition list. The list includes: Test Definition Information (unchecked), I/O Module Configuration (checked), Excitation System Information (checked), Fundamental/Control Condition (checked), Excitation system setting (checked), Control Reference (checked), and Extended ROR Narrow Band Swept Random Reference (unchecked). A mouse cursor is pointing to the Next button in the bottom left corner.

< Step24 >

For the “synthesize mode” for random PSD, select MAX and press the [Define] button.



< Step25 >

Define the Narrow Band Random Reference 1.

Enter the frequency and level as shown in the table below and then press the [Add] button.

After adding all combinations, press the [OK] button.

Frequency[Hz]	Level[(m/s ²) ² /Hz]
30.0	2.0
35.0	2.0
35.1	1.0
40.0	1.0
40.1	2.0
50.0	2.0

Break point PSD definition

Frequency(Hz)	Level/Slope
30.00	2.0 (m/s ²) ² /Hz
35.00	2.0 (m/s ²) ² /Hz
35.10	1.0 (m/s ²) ² /Hz
40.00	1.0 (m/s ²) ² /Hz
40.10	2.0 (m/s ²) ² /Hz
50.00	2.0 (m/s ²) ² /Hz

Unit of slope: dB/octave [Delete] 5.9151 m/s²ms rms change(R)

Break point
Frequency: 50.00 Hz
 Level Slope: 2.0 (m/s²)²/Hz

Buttons: Add, Change, OK, Cancel

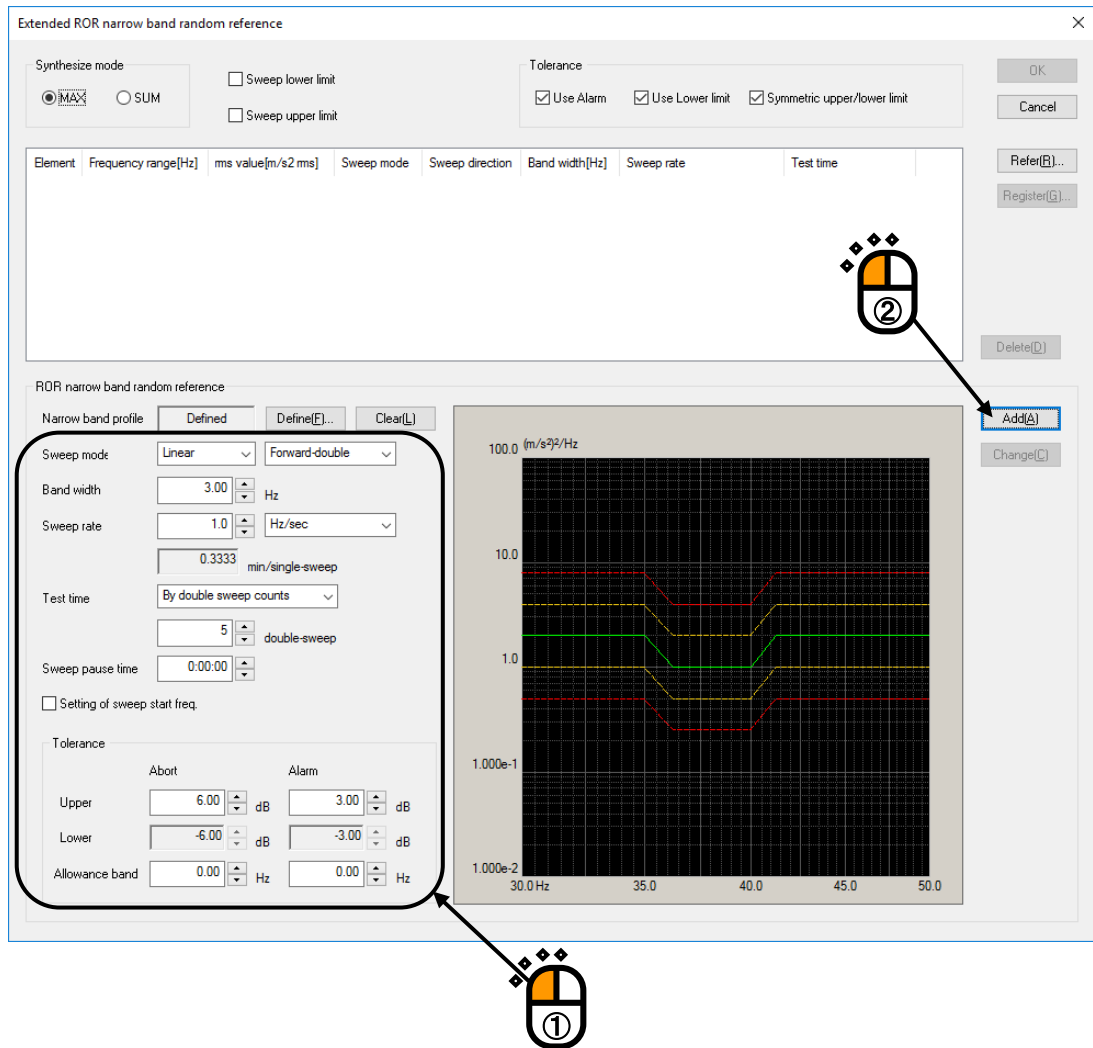
① ②

< Step26 >

Set the conditions for the Narrow Band Swept Random Reference 1 as shown in the figure below.

- Set the 'Sweep mode' to 'Linear' and 'Forward double'.
- Set the 'Band width' to '3 [Hz]'.
- Set 'Sweep rate' to '1 [Hz/sec]'.
- Set the 'Test time' to 'By double sweep counts, 5 [double-sweep]'.

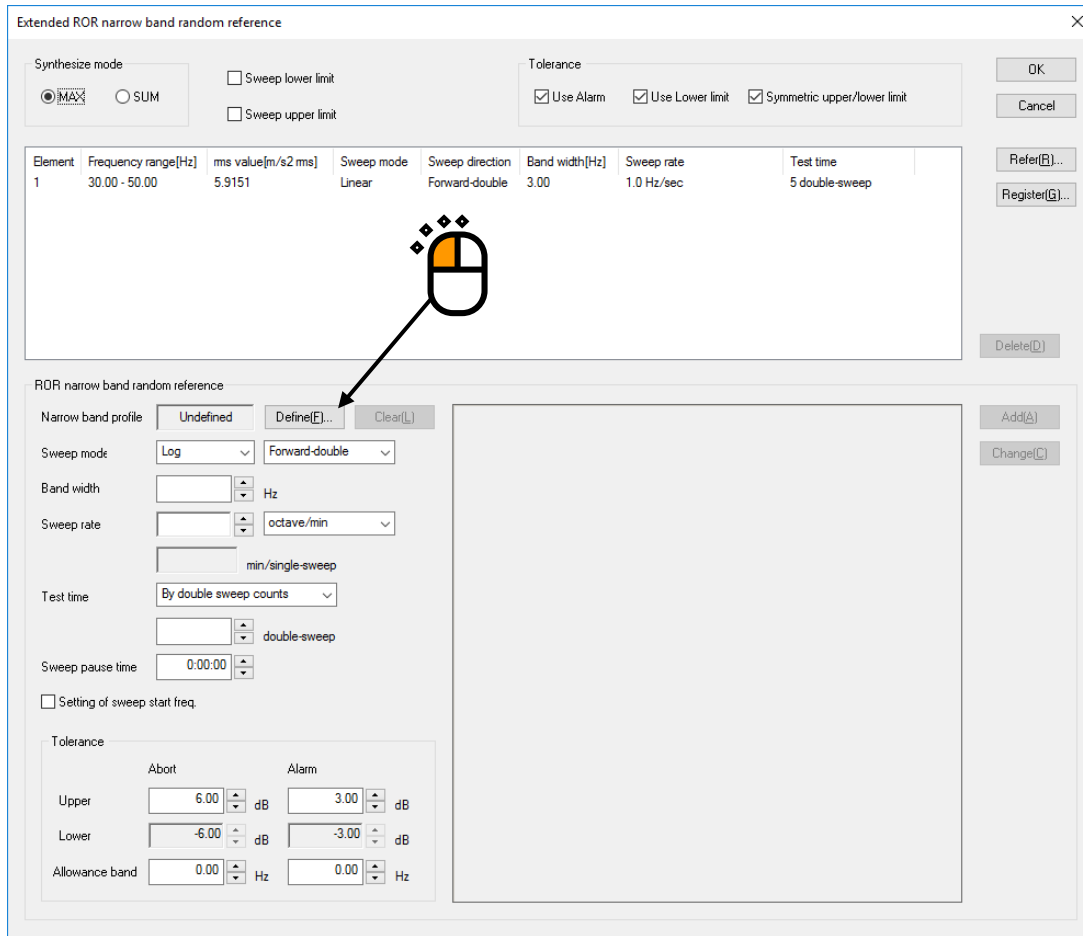
Press the [Add] button.



< Step27 >

Next, define the Narrow Band Random Reference 2.

Press the [Define] button.



< Step28 >

Enter the frequency and level as shown in the table below and press the [Add] button.
After adding all combinations, press the [rms change] button.

Frequency[Hz]	Level[(m/s ²) ² /Hz]
100.0	1.0
200.0	1.0

Break point PSD definition

Frequency(Hz)	Level/Slope
100.00	1.0 (m/s ²) ² /Hz
200.00	1.0 (m/s ²) ² /Hz

Unit of slope: dB/octave | Delete | 10.0 m/s² rms | rms change[R]

Break point

Frequency: 200.00 Hz | Add

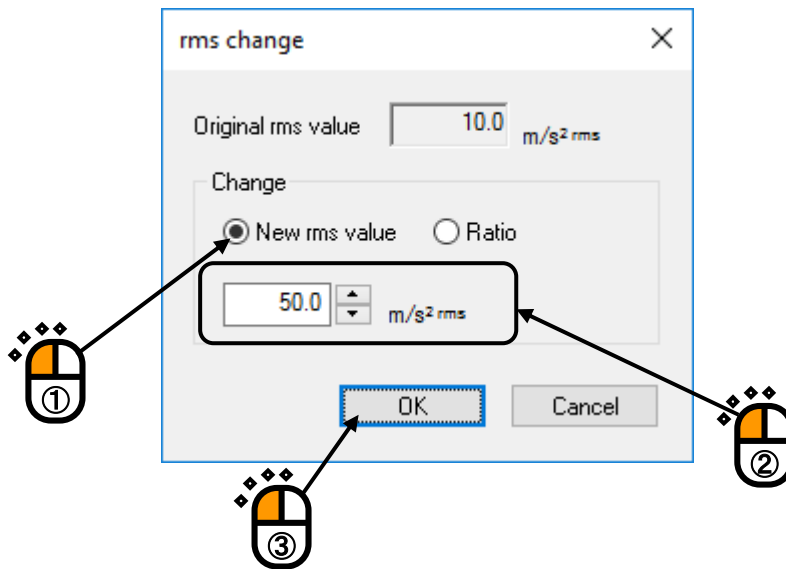
Level Slope | 1.0 (m/s²)²/Hz | Change

OK | Cancel

① | ②

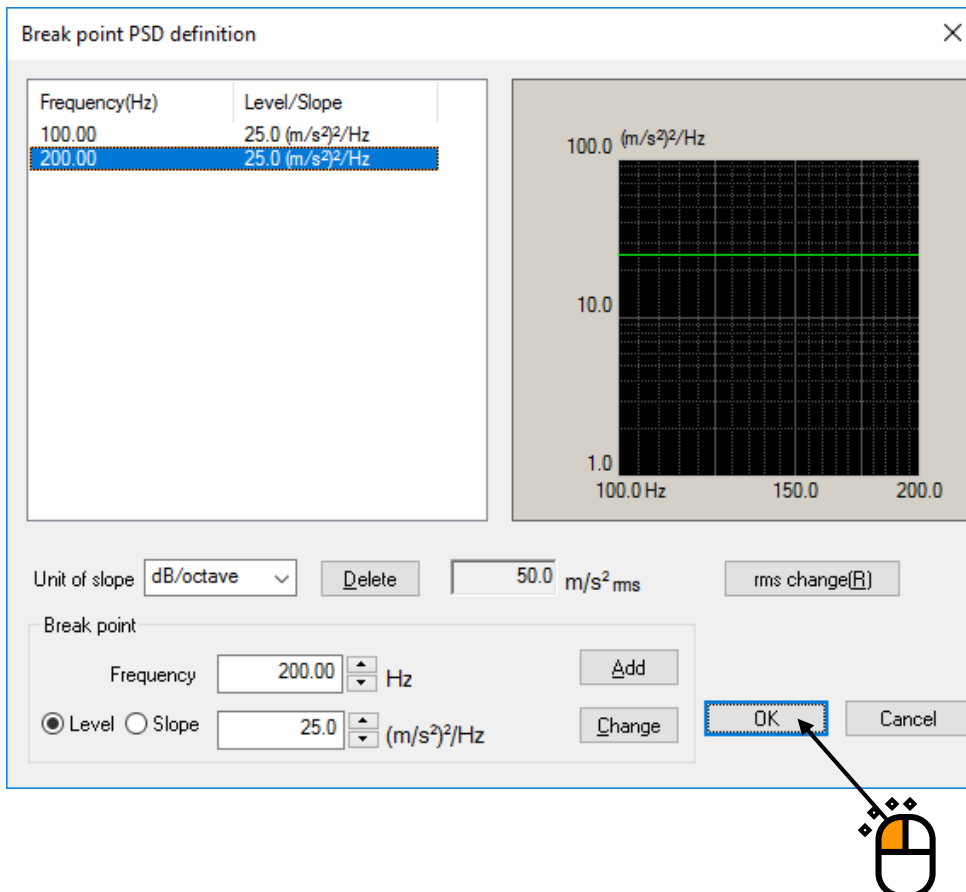
< Step29 >

Click and select 'New rms value'. Input the values to 'New rms value' as 50 [(m/s²) rms] and press the [OK] button.



< Step 30 >

Press the [OK] button.



< Step31 >

Set the conditions for the Narrow Band Swept Random Reference 2 as shown in the figure below.

- Set the 'Sweep mode' to 'Log' and 'Backward double'.
- Set the 'Band width' to '50 [Hz]'.
- Set 'Sweep rate' to '0.5 [octave/min]'.
- Set the 'Test time' to 'By double sweep counts, 2 [double-sweep]'.

Press the [Add] button.

Extended ROR narrow band random reference

Synthesize mode: MAX SUM

Tolerance: Use Alarm Use Lower limit Symmetric upper/lower limit

Element	Frequency range[Hz]	rms value[m/s ² ms]	Sweep mode	Sweep direction	Band width[Hz]	Sweep rate	Test time
1	30.00 - 50.00	5.9151	Linear	Forward-double	3.00	1.0 Hz/sec	5 double-sweep

ROR narrow band random reference

Narrow band profile: Defined Define(E)... Clear(L)

Sweep mode: Log Backward-double

Band width: 50.00 Hz

Sweep rate: 0.50 octave/min

Test time: By double sweep counts

2.0 min/single-sweep

2 double-sweep

Sweep pause time: 0:00:00

Setting of sweep start freq.

Tolerance: Abort Alarm

Upper: 6.00 dB 3.00 dB

Lower: -6.00 dB -3.00 dB

Allowance band: 0.00 Hz 0.00 Hz

1000.0 (m/s²/Hz)

100.0

10.0

0.10

100.0 Hz 120.0 140.0 160.0 180.0 200.0

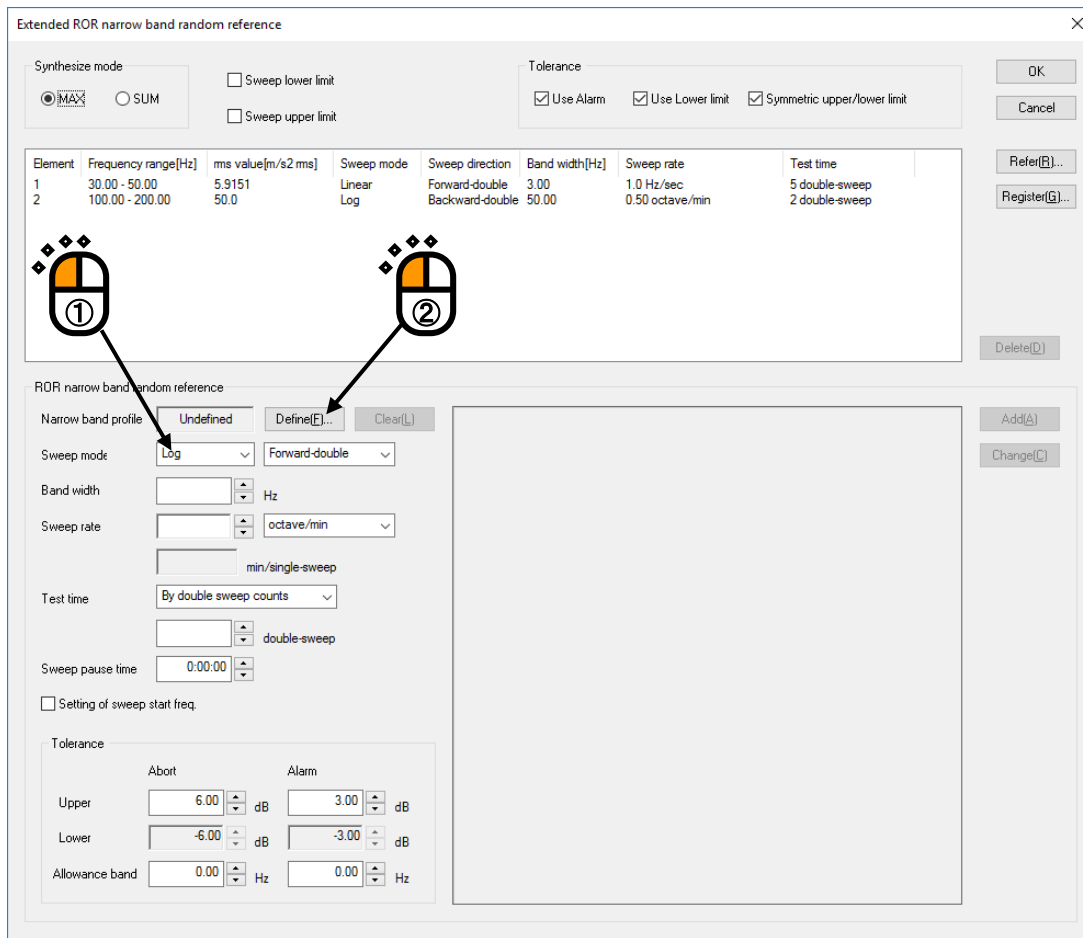
Add(A)

Change(C)

< Step32 >

Next, define the Narrow Band Random Reference 3.

Set the 'Sweep mode' to 'Fixed' and press the [Define] button.

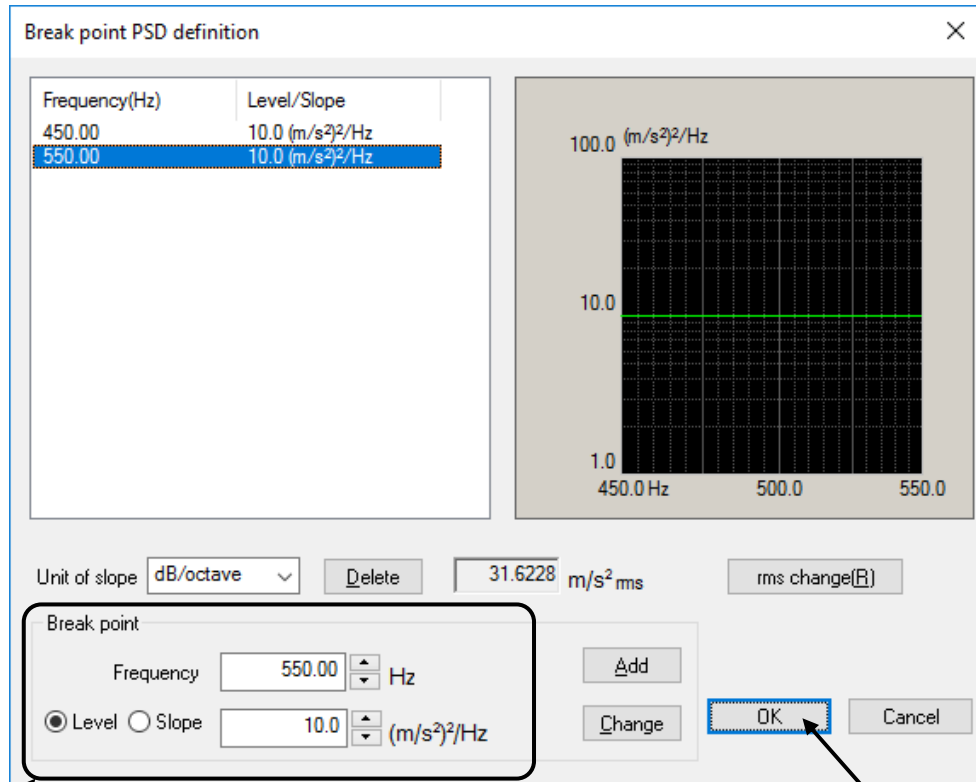


< Step33 >

Enter the frequency and level as shown in the table below and press the [Add] button.

After adding all combinations, press the [OK] button.

Frequency[Hz]	Level[(m/s ²) ² /Hz]
450.0(=500.0-100.0/2)	10.0
550.0(=500.0+100.0/2)	10.0



< Step34 >

Set the 'Test time' to 'By time, 00:10:00' and press the [Add] button.

Extended ROR narrow band random reference

Synthesize mode: MAX SUM

Tolerance: Use Alarm Use Lower limit Symmetric upper/lower limit

Element	Frequency range[Hz]	ms value[m/s ² ms]	Sweep mode	Sweep direction	Band width[Hz]	Sweep rate	Test time
1	30.00 - 50.00	5.9151	Linear	Forward-double	3.00	1.0 Hz/sec	5 double-sweep
2	100.00 - 200.00	50.0	Log	Backward-double	50.00	0.50 octave/min	2 double-sweep

ROR narrow band random reference

Narrow band profile: Defined

Sweep mode: Fixed

Test time: By time (dropdown), 0:10:00 (input)

Tolerance: Abort (Upper: 6.00 dB, Lower: -6.00 dB, Allowance band: 0.00 Hz), Alarm (Upper: 3.00 dB, Lower: -3.00 dB, Allowance band: 0.00 Hz)

Graph: 100.0 (m/s²/Hz) vs 450.0 Hz to 550.0 Hz

Buttons: OK, Cancel, Refer(F)..., Register(R)..., Delete(D), Add(s), Change(C)

< Step 35 >

Press the [OK] button.



Extended ROR narrow band random reference

Synthesize mode
 MAX SUM

Sweep lower limit
 Sweep upper limit

Tolerance
 Use Alarm Use Lower limit Symmetric upper/lower limit

Element	Frequency range[Hz]	ms value[m/s2 rms]	Sweep mode	Sweep direction	Band width[Hz]	Sweep rate	Test time
1	30.00 - 50.00	5.9151	Linear	Forward-double	3.00	1.0 Hz/sec	5 double-sweep
2	100.00 - 200.00	50.0	Log	Backward-double	50.00	0.50 octave/min	2 double-sweep
3	450.00 - 550.00	31.6228	Fixed				0.10.00

Refer(F)...
Register(S)...
Delete(D)

ROR narrow band random reference

Narrow band profile: Undefined [Define(E)...] [Clear(L)] [Add(A)] [Change(C)]

Sweep mode: Log [Forward-double]

Band width: [] Hz

Sweep rate: [] octave/min
[] min/single-sweep

Test time: By double sweep counts [] double-sweep

Sweep pause time: 0:00:00

Setting of sweep start freq.

Tolerance

	Abort	Alarm
Upper	6.00 dB	3.00 dB
Lower	-6.00 dB	-3.00 dB
Allowance band	0.00 Hz	0.00 Hz

< Step 36 >

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

New definition - K2/Random

File(F) Test definition(T) Operation(P) Edit(E) Display(V) Window(W)

New Simple Open Test save Data save Print Preview

Reference	Level	Response	Drive
	dB		mV _{rms}

Next

Change

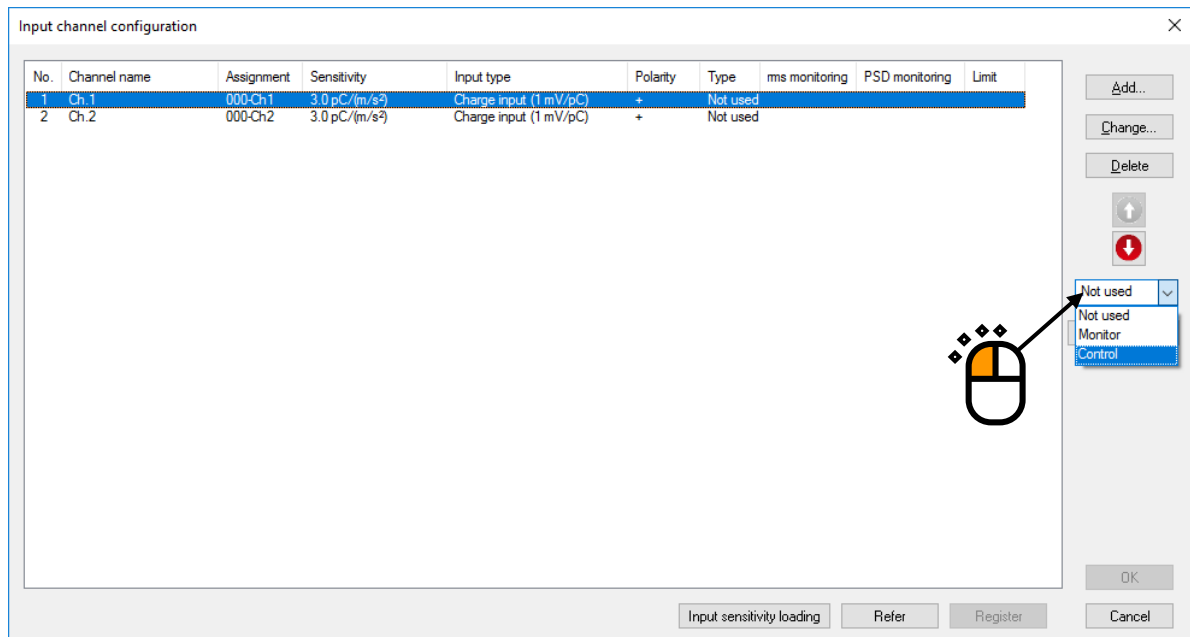
Test definition

Test Definition

- Test Definition Information
- I/O Module Configuration
- Excitation System Information
- Fundamental/Control Condition
- Excitation system setting
- Control Reference
- Extended ROR Narrow Band Swept Random Reference

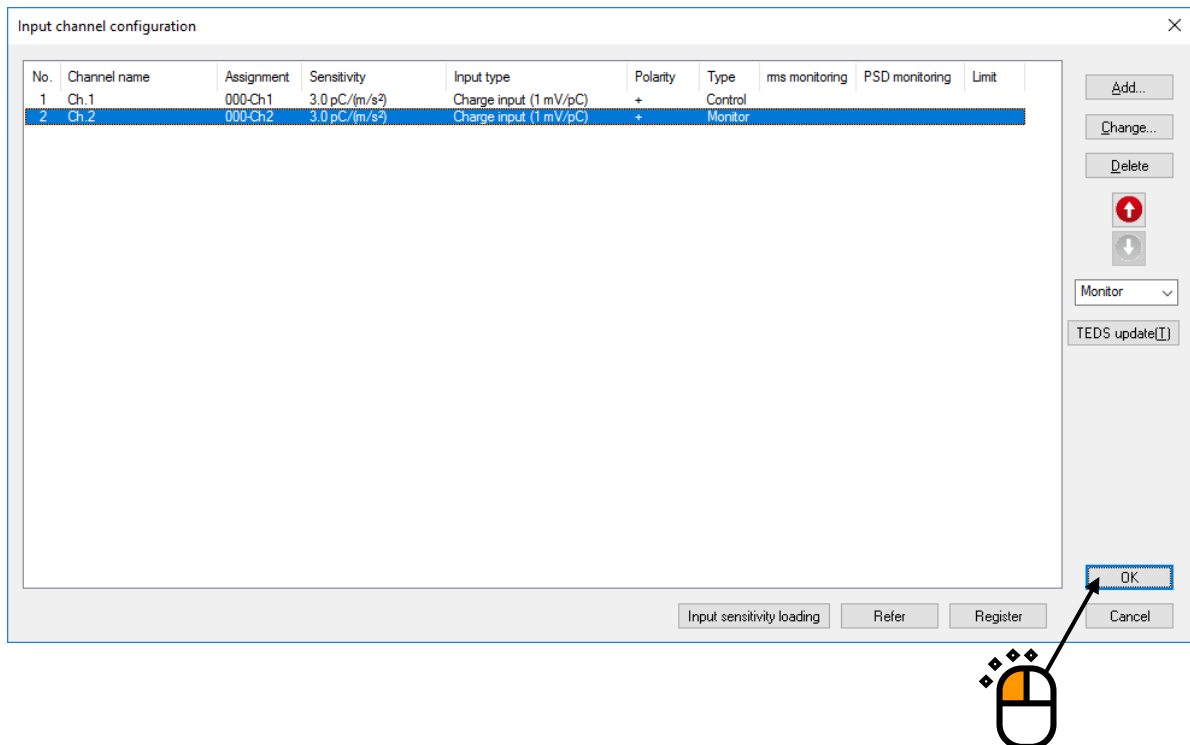
< Step 37 >

Select 'Ch. 1' and specify as 'Control'. And select 'Ch. 2' and specify as 'Monitor'.



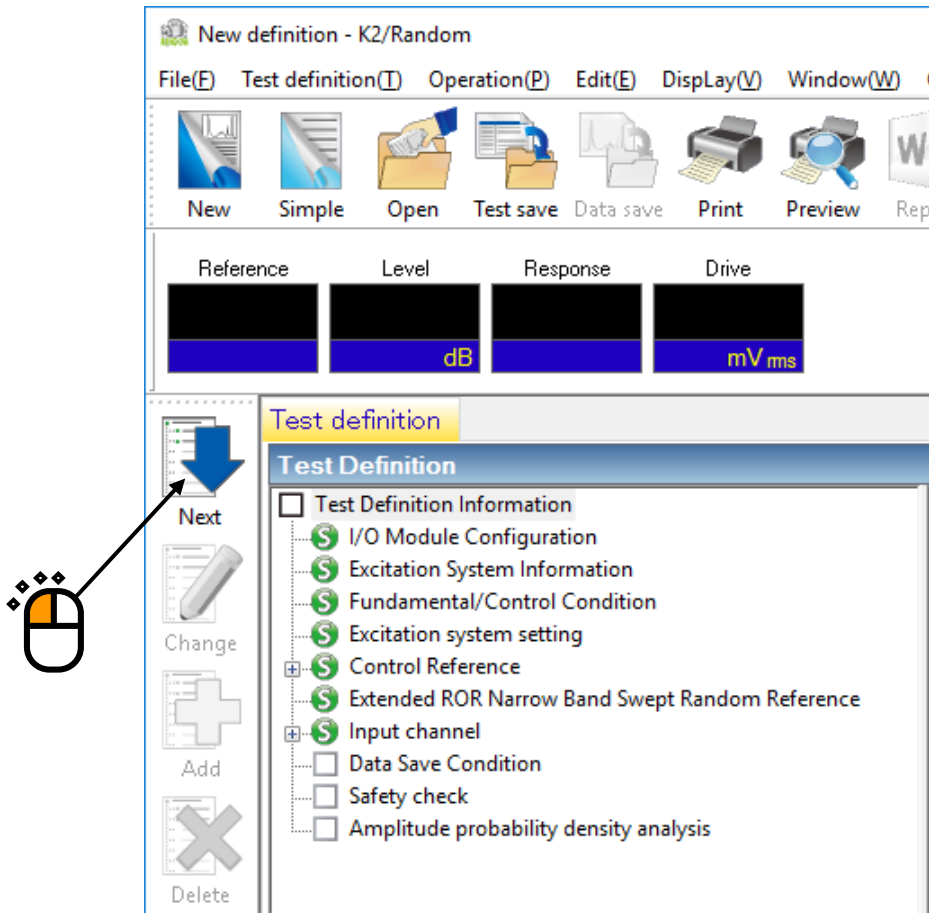
< Step 38 >

After completing the test definition, press the [OK] button.



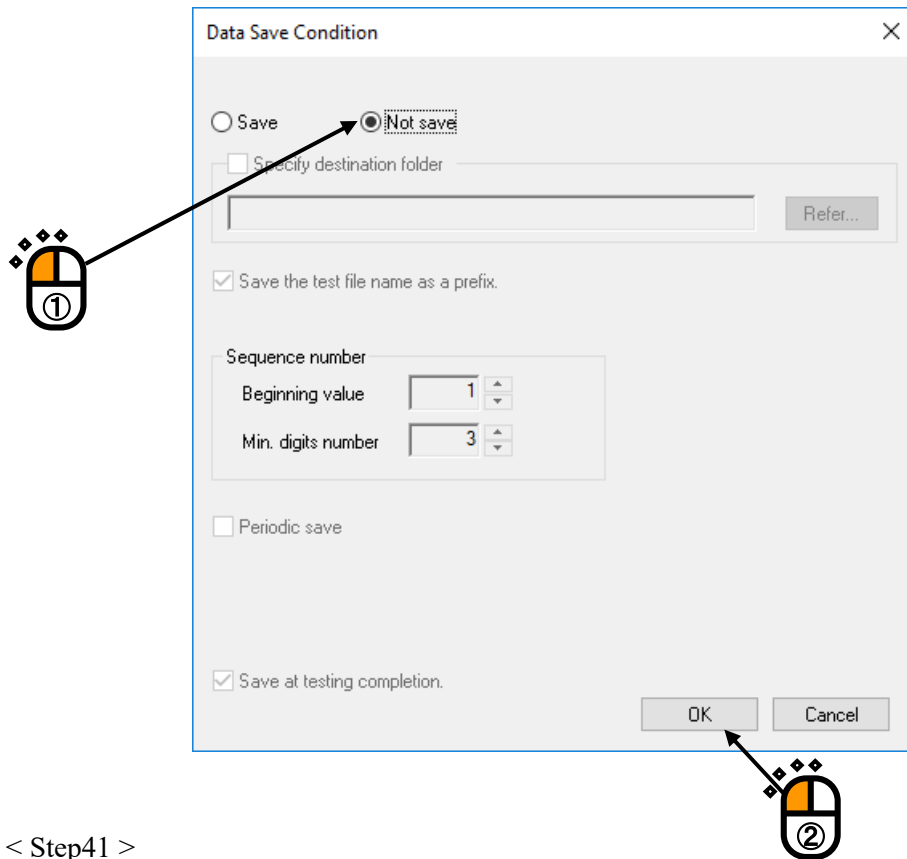
< Step 39 >

Press the button of [Next].



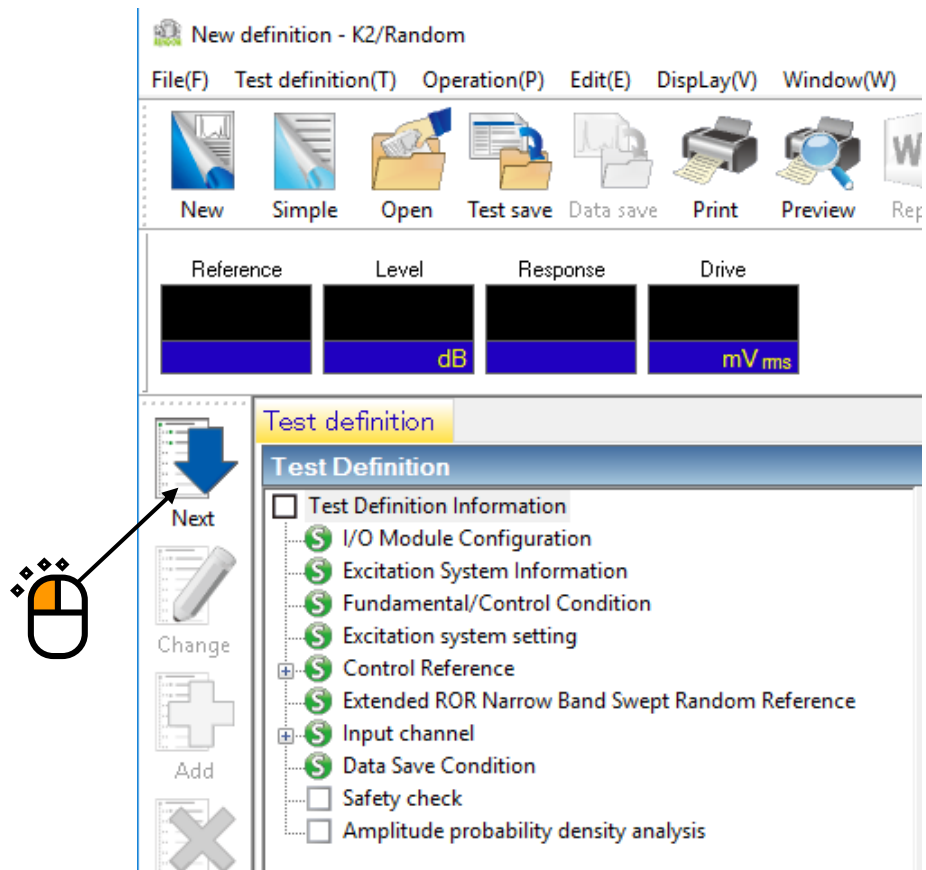
< Step40 >

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



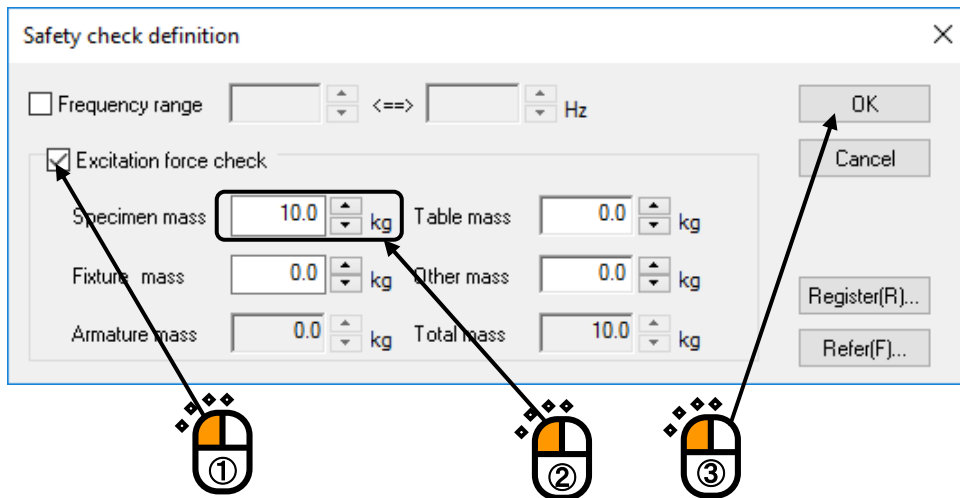
< Step41 >

Press the button of [Next].



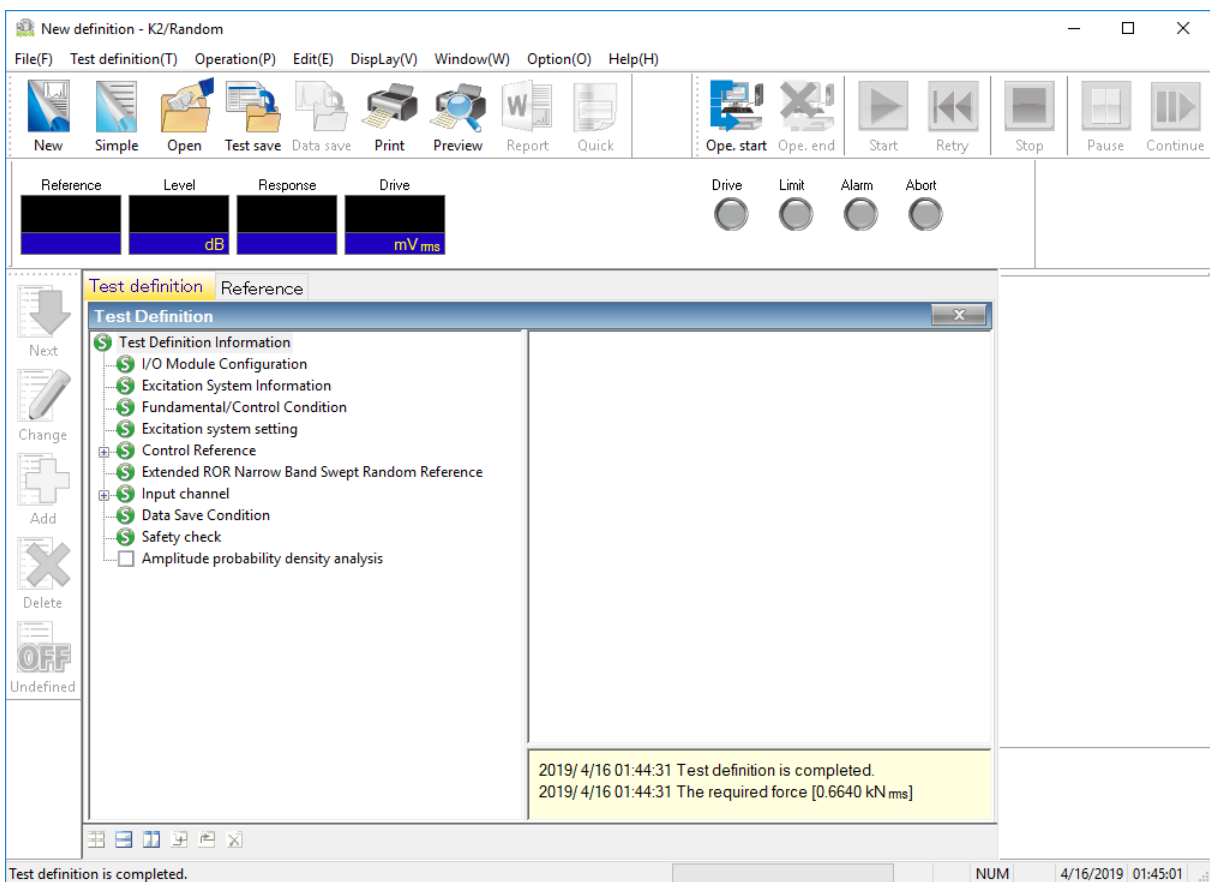
< Step42 >

Select 'Excitation force check' and input the value as 'Specimen mass : 10 [kg]'. And press the button of [OK].



< Step43 >

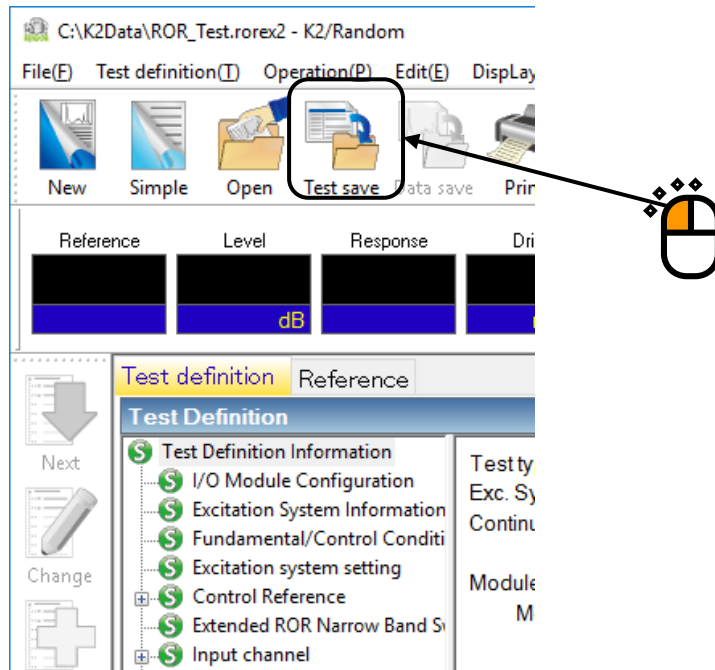
The definition is completed.



< Save of test >

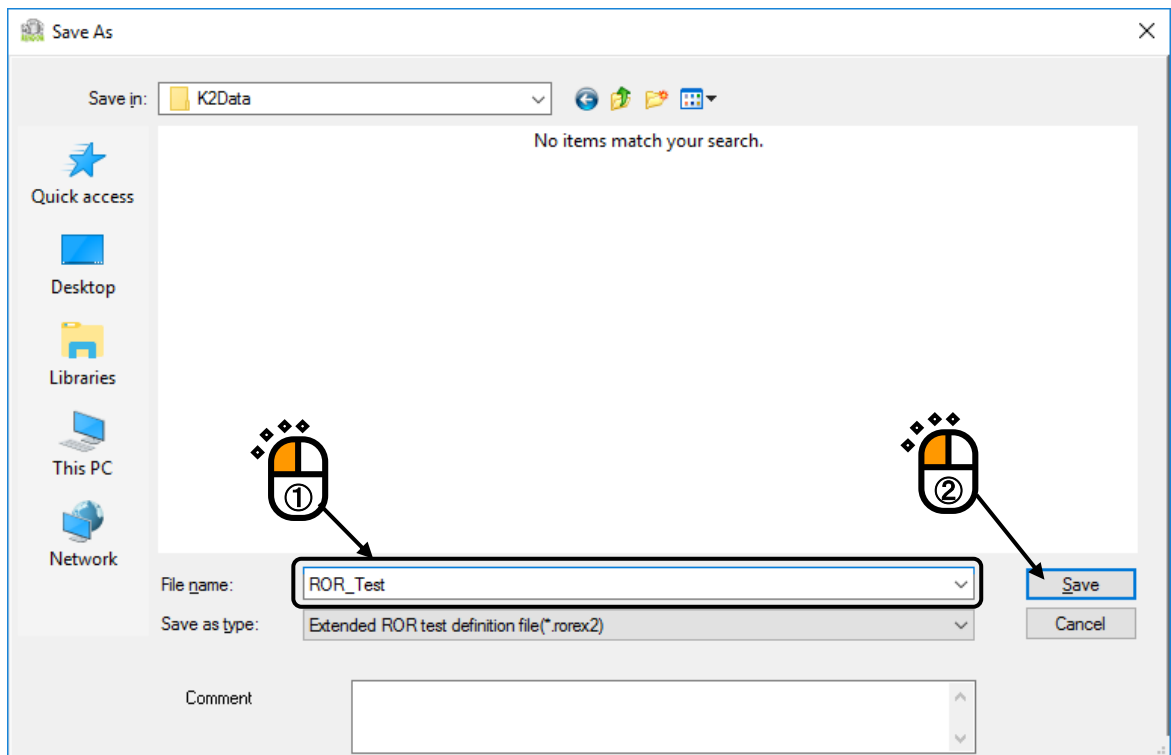
< Step 1 >

Press the button of [Test save].



< Step 2 >

Input a name in 'File name' and press [Save].



< Operation of test >

< Step 1 >

Press the button of [Operation start].



The screenshot shows the 'New definition - K2/Random' software window. The menu bar includes File(F), Test definition(T), Operation(P), Edit(E), Display(V), Window(W), Option(O), and Help(H). The toolbar contains icons for New, Simple, Open, Test save, Data save, Print, Preview, Report, Quick, Ope.start, Ope.end, Start, Retry, Stop, Pause, and Continue. The Ope.start button is highlighted with a red box and a mouse cursor. Below the toolbar, there are sections for Reference, Level, Response, and Drive, with values dB and mV/ms. The main panel shows a tree view of test definition settings, including Test Definition Information, I/O Module Configuration, Excitation System Information, Fundamental/Control Condition, Excitation system setting, Control Reference, Extended ROR Narrow Band Swept Random Reference, Input channel, Data Save Condition, Safety check, and Amplitude probability density analysis. A status bar at the bottom displays 'Test definition is completed.' and '2019/4/16 01:44:31 The required force [0.6640 kN ms]'. The bottom right corner shows 'NUM' and '4/16/2019 01:45:01'.

< Step 2 >

Press [Start].

When [Start] is pressed, Initial loop check and Initial equalization are automatically operated. Then, the test operation is executed at the initial excitation level (in this example, at -10 dB).

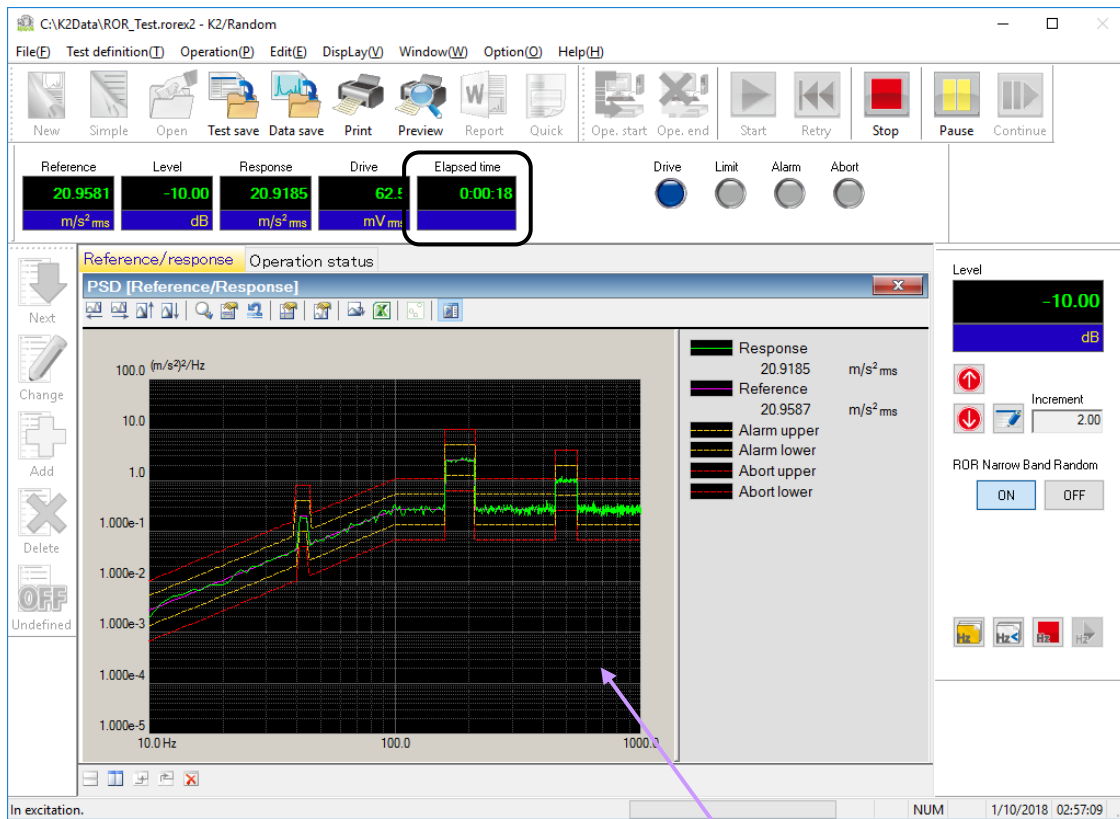
The screenshot shows a software window titled "CNK2Data\ROR_Test.rorex2 - K2/Random". The interface includes a menu bar (File, Test definition, Operation, Edit, Display, Window, Option, Help) and a toolbar with icons for New, Simple, Open, Test save, Data save, Print, Preview, Report, Quick, Ope. start, Ope. end, Start, Retry, Stop, Pause, and Continue. A mouse cursor is pointing to the "Start" button. Below the toolbar, a status bar displays: Reference (20.9608 m/s²ms), Level (-10.00 dB), Response (0.0 m/s²ms), Drive (0.0 mVms), and Elapsed time (0:00:00). There are also Drive, Limit, Alarm, and Abort control buttons. The main display area is titled "PSD [Reference/Response]" and shows a log-log plot of Power Spectral Density (m/s²/Hz) versus frequency (Hz). The plot shows a reference line (purple) and a response line (green) with alarm and abort limits (yellow and red dashed lines). The y-axis ranges from 1.000e-5 to 100.0, and the x-axis ranges from 10.0 Hz to 1000.0 Hz. A legend on the right lists: Response (0.0 m/s²ms), Reference (20.9608 m/s²ms), Alarm upper, Alarm lower, Abort upper, and Abort lower. On the far right, there is a "Level" control set to -10.00 dB, an "Increment" of 2.00, and a "ROR Narrow Band Random" toggle set to "OFF". The status bar at the bottom indicates "Waiting for operation start." and shows the date and time "1/10/2018 02:56:00".

< Step 3 >

The sweeping of narrow band random is operated at the initial excitation level (-10 dB in this example) when the initial equalization is finished.

Test time is stated to be counted without concerning about the excitation level when the sweeping operation is started.

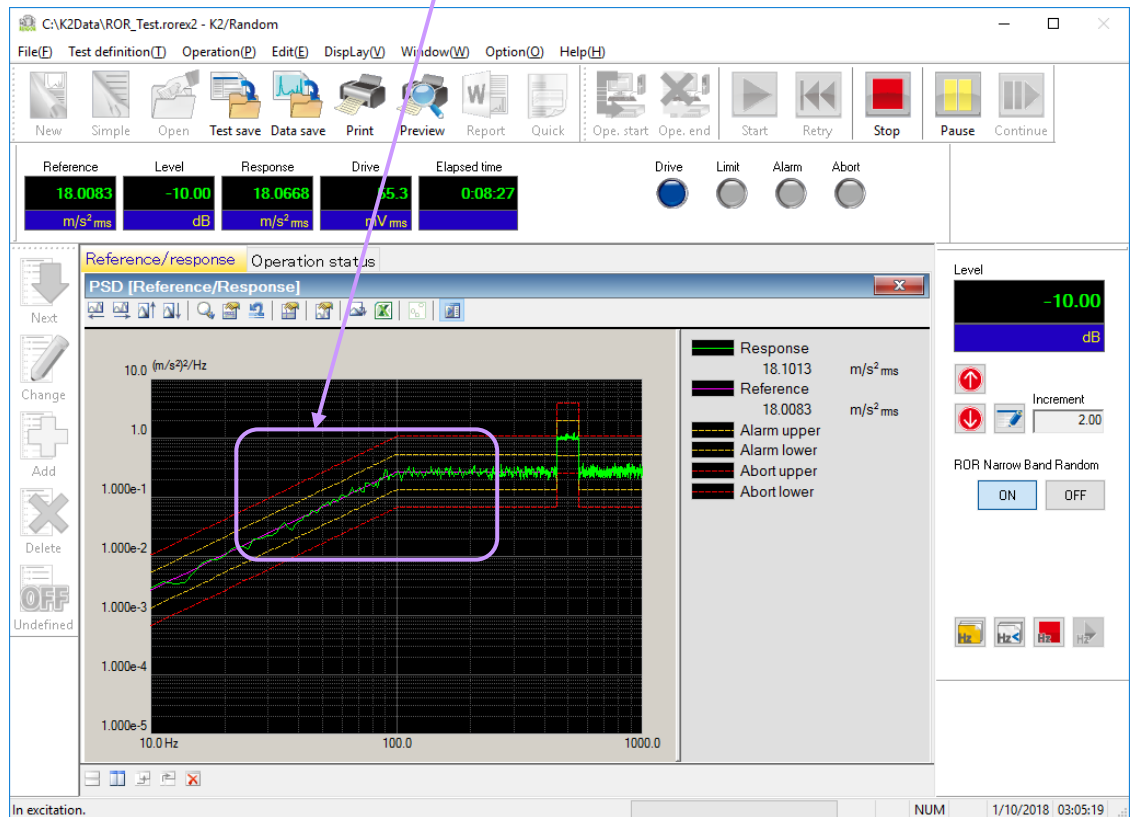
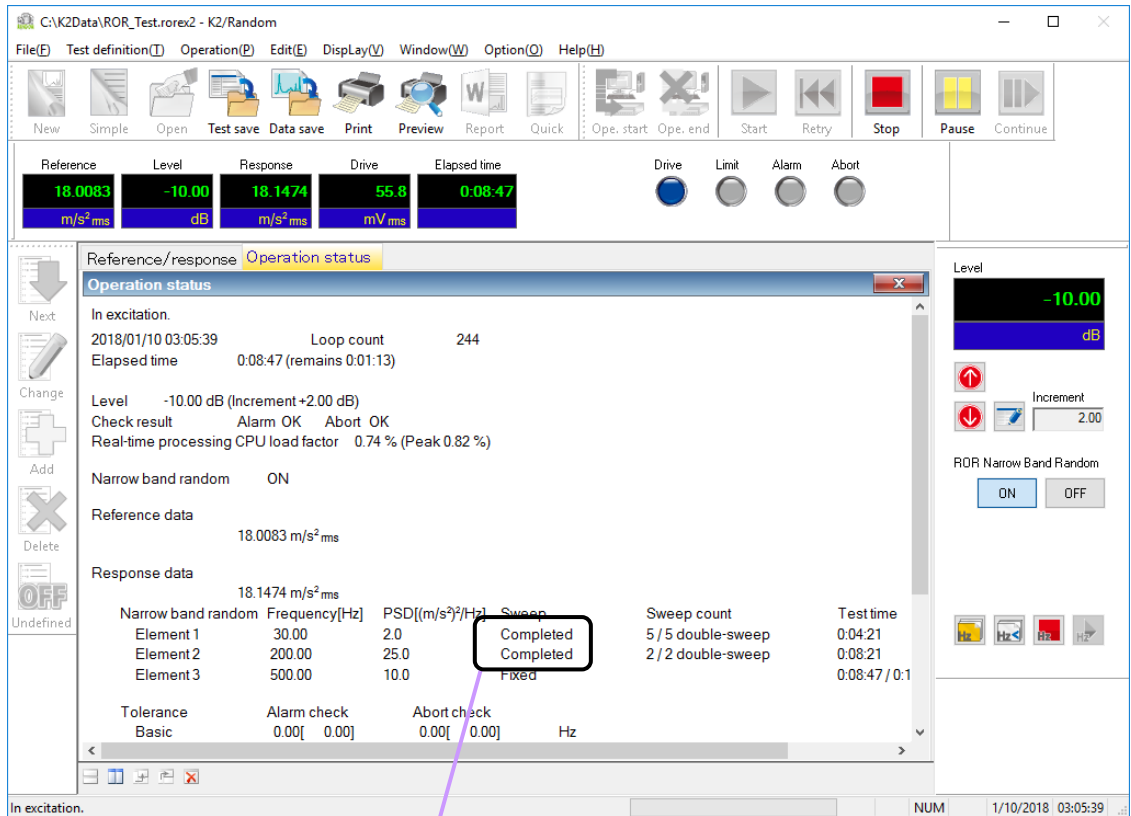
To start the narrow band random control and timer after the excitation level has reached 0dB, check “Start Sine tones/NBRs control from 0dB” in the Fundamental/Control Condition.



The sweeping of narrow band random is started.

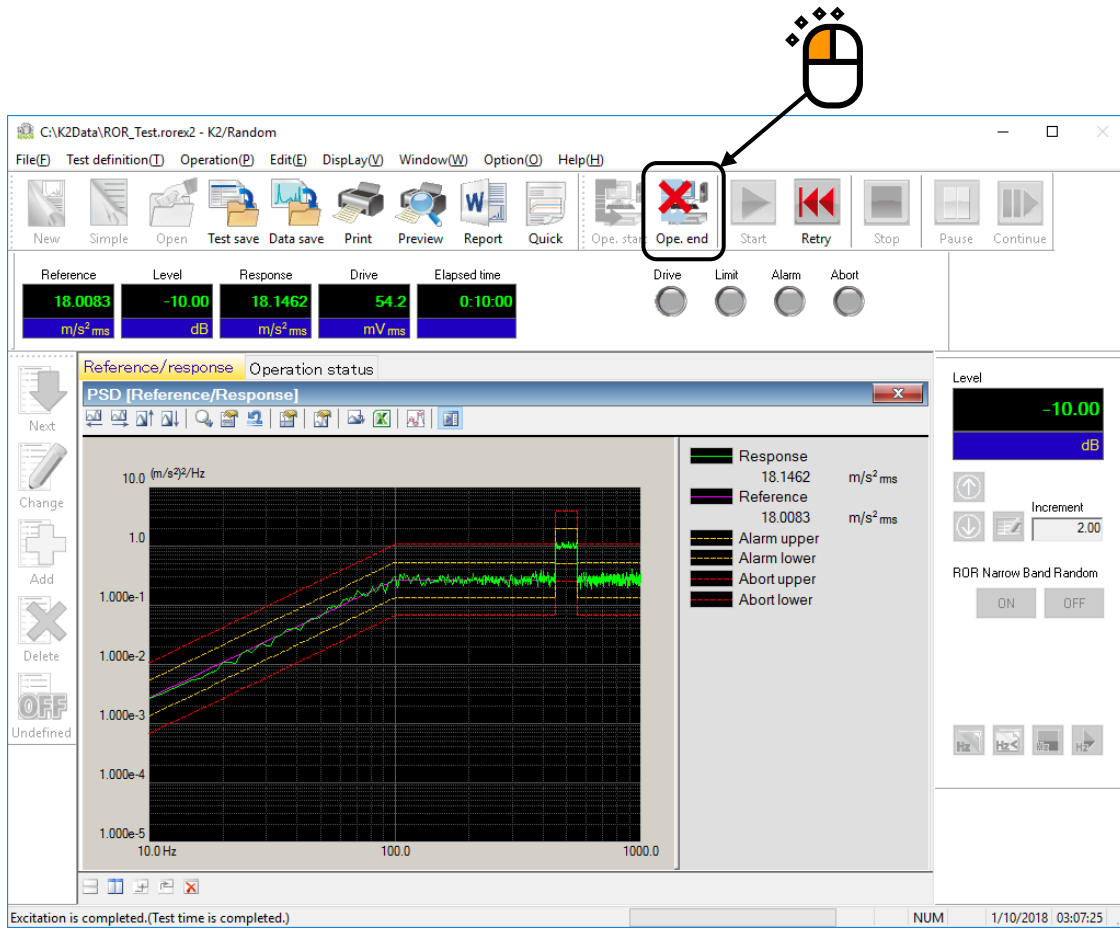
< Step4 >

Each Narrow Band Random will become OFF when the specified test time has passed.



< Step5 >

The test operation is completed when all Narrow Band Random Test have been finished.
The system returns to the test definition mode by pressing of [Operation end] button.



Chapter 2 Test Definition

This chapter describes the test definition items required to ROR test.

Refer to “Chapter 4 Test Definition” of K2+/RANDOM Instruction Manual about the general definition items of random tests.

2.1 Fundamental/Control Condition

2.1.1 Start NBRs control from 0dB

(1) Meaning

This value allows the specification of the timing to start the narrow band random control in ROR test.

Normally, narrow band random control and timer are started after the initial equalization is finished regardless of excitation level. To start the narrow band random control and timer after the excitation level has reached 0dB, check “Start Sine tones/NBRs control from 0dB”.

2.2 ROR Narrow Band Swept Random Reference

(1) Meaning

This dialog is for defining the reference of the narrow band random in ROR test (Random on Random test).

No.	Frequency ratio(times)	Level ratio(dB)	Band width(Hz)	Abort upper(dB)	Abort lower(dB)	Allowance band(Hz) Abort	Alarm upper(dB)	Alarm lower(dB)	Allowance band(Hz) Alarm
1	1.0	0.00	15.00	6.00	-6.00	0.00	3.00	-3.00	0.00
2	2.0	-2.00	30.00	6.00	-6.00	0.00	3.00	-3.00	0.00

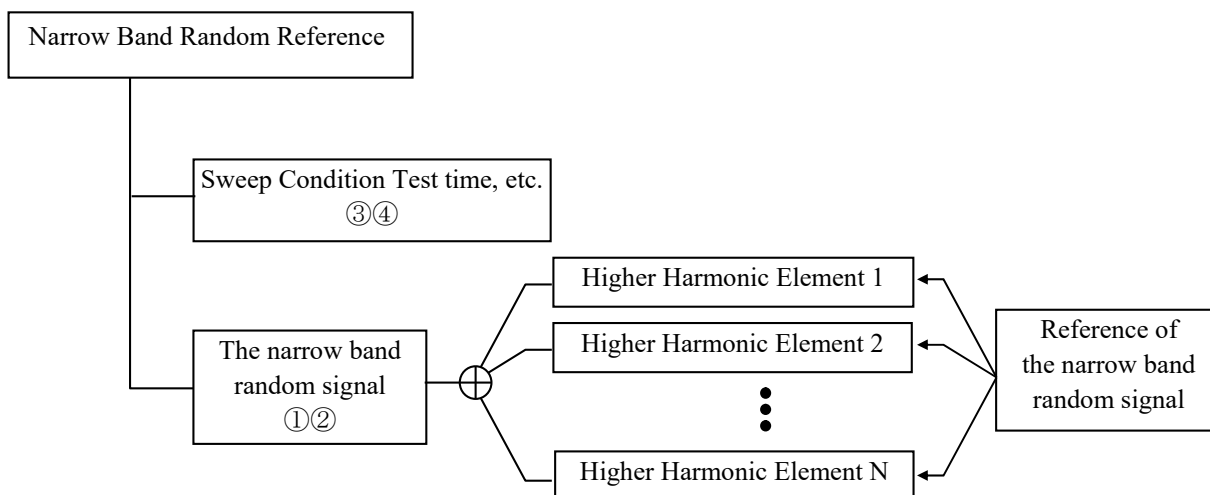
ROR test is a vibration test composed by superimposing a broad band random vibration and a narrow band random vibration with sweeping simultaneously. Therefore, it is necessary to define the references for a broad band random vibration without sweeping and for the narrow band random vibration with sweeping. Here, these references are called the broad band random reference and the narrow band random reference.

This item is for defining the narrow band random reference. The definition of the broad band random reference is done in Reference PSD definition as same as in a general random test. However, Test Time is defined in the definition of the narrow band random reference.

Definition items as below are provided in the narrow band random reference ;

- ① What range does the frequency component exist between? (Frequency range)
- ② How much is the level?
- ③ How long does the sweeping operation take? (Sweep rate)
- ④ How fast is the test time specified for? (Test Time)

The narrow band random waveform is composed by both elements specified according to the concept of the fundamental and the higher harmonic elements. Each element is controlled to be synchronized at sweeping (frequency ratio of each elements are kept constant in frequency change).



The limitations in a narrow band random reference definition are described as below ;

- Number of higher harmonic elements are available up to **maximum 32**.
- Each higher harmonic element should be specified to the value under f_{\max} of frequency range.
- Each higher harmonic element should be specified to the value over Δf of frequency resolution.
- Each higher harmonic element should not be overlaid.

< Tolerance Check >

Tolerance check is independently operated to the broad band random components and the narrow band random components.

The tolerance check for each frequency is operated for either the broad band random or narrow band random, which has been adopted for the reference level. The number of deviation lines in each random does not include the results for frequencies that were not adopted for the reference level.

Definition of Tolerance check is specified for each broad band random and narrow band random. However, Tolerance of the broad band random is defined in Reference PSD as the same as in an ordinary random test.

< Duplication of the Level >

When the broad band random reference and the narrow band random reference are superimposed, the larger value of these levels is adopted as the fundamental level of the current line.

2.2.1 Fundamental sweep range

(1) Meaning

The frequency range as a base of frequency range for sweeping by higher harmonic element is specified.

The frequency range of each higher harmonic element is defined by the relative value to this fundamental sweep range. The narrow band random of each higher harmonic element is swept within the frequency range of each higher harmonic having the center of the band width as a base. Each parameter as below is denoted for the convenience of explanation ;

f1 : This denotes the lower limit value of the frequency range for the reference narrow band random signal.

f2 : This denotes the upper limit value of the frequency range for the reference narrow band random signal.

2.2.2 Sweep mode

(1) Meaning

This item is for specifying the action mode of sweep. Two types of sweep mode are provided.

1. Linear

The sweeping having the sweep frequency f which proportion with the elapsed time t , that is, the 'Linear' sweep is set to operate ;

$$f = f_0 + R \cdot t$$

Proportional constant R means 'Sweep rate' and it is defined in 2.2.4 Sweep Rate.

2. Log

This item is set to operate the sweeping having the sweep frequency f that is explained by the exponential function of the elapsed time t .

$$f = f_0 \cdot \exp(R \cdot t)$$

This type of sweep is called to 'Log' which operates the sweep having the proportion of the elapsed time t to a logarithm of the sweep frequency f .

Proportional constant R means 'Sweep rate' and it is defined in 2.2.4 Sweep rate.

2.2.3 Sweep direction

(1) Meaning

When the sweeping operation is done in the specified sweep band [f1, f2], one of the following four directions can be selected.

1. Forward Single

The single sweeping is operated from lower to higher range, as ;

$$f1 \rightarrow f2, f1 \rightarrow f2, f1 \rightarrow f2$$

This item is for setting of a sweeping direction that swept generally just one-way as above in the sweep band.

When this item is selected, a 'single-sweep' is used as a unit for setting of the sweep count. A sweeping as 'f1→f2' is treated for one time of sweep count.

2. Backward Single

The single sweeping is operated from higher to lower range, as ;

$$f2 \rightarrow f1, f2 \rightarrow f1, f2 \rightarrow f1$$

This item is for setting of a sweeping direction that swept generally just one-way as above in the sweep band.

When this item is selected, a 'single-sweep' is used as a unit for setting of the sweep count. A sweeping as 'f2→f1' is treated for one time of sweep count.

3. Forward Double

The double sweeping is operated from lower range f1, as ;

$$f1 \rightarrow f2 \rightarrow f1 \rightarrow f2 \rightarrow f1 \rightarrow f2 \rightarrow$$

This item is for setting of double way sweep operation in the sweep band.

When this item is selected, a 'single-sweep' or a 'double-sweep' is used as a unit for setting of the sweep count. In case of the setting by 'single-sweep', 'f1→f2' or 'f2→f1' is treated for one time of sweep count. In case of the setting by 'double-sweep', 'f1→f2→f1' is treated for one time of sweep count.

4. Backward Double

The double sweeping is operated from higher range f2, as ;

$$f2 \rightarrow f1 \rightarrow f2 \rightarrow f1 \rightarrow f2 \rightarrow f1 \rightarrow$$

This item is for setting of double way sweep operation in the sweep band.

When this item is selected, a 'single-sweep' or a 'double-sweep' is used as a unit for setting of the sweep count. In case of the setting by 'single-sweep', 'f2→f1' or 'f1→f2' is treated for one time of sweep count. In case of the setting by 'double-sweep', 'f2→f1→f2' is treated for one time of sweep count.

When the function of 'Reverse' is to be used in Manual operation box, the item of 'double-sweep' should be selected.

2.2.4 Sweep rate

(1) Meaning

The setting method of Sweep Rate has the two ways of specifying as below ;

A : Specify the time to complete one sweeping operation.

B : Specify the value for the parameter of a sweep rate, literally.

In the setting method A, Sweep rate is specified by time, so that the same unit can be used either Sweep Mode is set as 'Linear' or 'Log'.

This system takes min (minute) for the time unit. And in this system, 'one time sweep' means 'single-sweep'. That is, the unit of this setting is ;

min / Single-Sweep

The setting method B, each unit is different as follows according to the different Sweep Mode ;

'Linear' : Hz / sec

'Log' : octave / min

When 'Log' is selected, 'decade / min' can be used as a unit of Sweep Rate. In this case, use the following calculation ;

1 decade/min = 3.3219 octave/min

(∵ 1 decade = (1/log2) octave = 3.3219 octave)

However, note that, too fast control speed for the control loop may cause 'the skipping of a sweep'. The sweep operation is limited to once in one control loop. So, only the latest request of sweep operation is to be valid even if more than once of the sweeping is required in one control loop. In this case, the sweeping operation other than the latest one will be ignored and the current narrow band random signal will not be outputted.

The control loop speed is affected by averaging times M for a loop of 'PSD Averaging Parameter (Fundamental/Control Condition)' and 'Frequency Resolution Δf (Control Reference)'.

2.2.5 Sweep start frequency

(1) Meaning

This item is for setting of the frequency at sweep start.

Generally, the sweep operation is started from the lower or higher limit frequency in the fundamental frequency range according to the setting of 'Direction' of sweep. However, an arbitrary value of frequency can be specified for sweep start.

2.2.6 Sweep pause time

(1) Meaning

This item is for specifying the pause time of signal output (sweep pause time) between the ending point of sweep of the narrow band random and the starting point of next sweep (at the sweep turn).

The excitation of the narrow band random is stopped for the time specified in this item at the sweep turn. However, the excitation of the broad band random waveform is continued.

2.2.7 Test time

(1) Meaning

This item is for setting of the operation time of a testing.

In this system, the following items are provided as the setting methods of Test Time.

1. Specify by the times of single-sweep

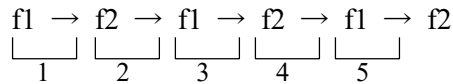
This item is for setting of the test time by the times of single-sweep.

Test time is regulated as an integer number of single-sweep by setting of this item.

A test finishes just at the turning point of the sweep.

Either 'single-sweep' or 'double-sweep' is used as the unit of a sweep.

For example, if a sweeping is operated in the condition that the 'Direction' is set as 'Forward Double' in the sweep band [f1, f2], with specifying 'single-sweep' as the unit of sweeping, the sweeping operated for 5 times



2. Specify by the times of double-sweep

This item is for setting of the test time by the times of double-sweep.

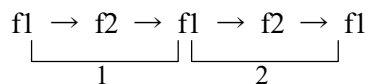
Test time is regulated as an integer number of double-sweep by setting of this item.

A test finishes just at the starting point of the sweep.

'Double-sweep' can be selected only when the 'Direction' is set as 'Forward Double' or 'Backward Double'.

'Double-sweep' is used as the unit of a sweep.

With specifying 'double-sweep' as the unit of sweeping, the sweeping is operated for 2 times as below ;



3. Specify by time

The time for excitation is set.

When the set time elapsed, the test operation is finished even in the middle of a sweep.

The two setting methods by time are usable ;

The example of a test time to be set for 1 hour is described as follows for each methods.

- The case of setting time by seconds ; '3600' is inputted.
- The case of setting time with colons (:) as hhh : mm : ss ; '1 : 0 : 0' is inputted.

4. Infinite

'Infinite' means that the finishing condition is not set in this item.

By setting of this item, this system continues the sweep excitation under the set condition until the [Stop] button is pressed or other equivalent operation is carried out.

2.2.8 Fundamental level

(1) Meaning

This item is for specifying the level of the reference narrow band random signal used as a reference for higher harmonic element.

The fundamental level is set to the lower limit level of Fundamental frequency range.

Denoting each parameter as below for the convenience of explanation ;

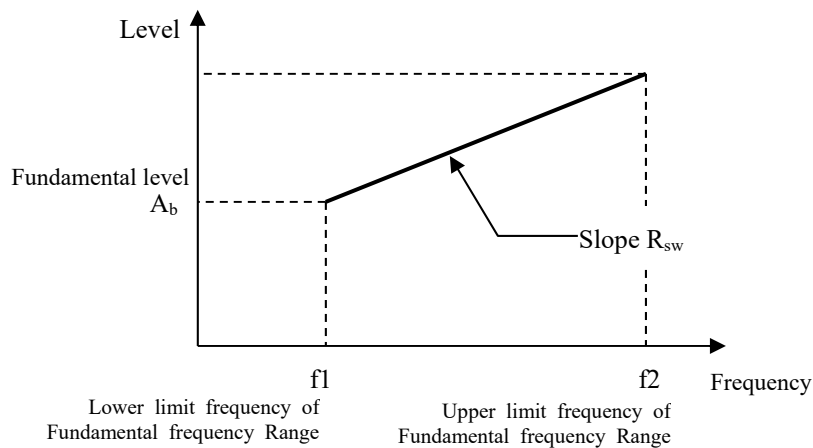
A_b : Level of Reference random signal

2.2.9 Slope

(1) Meaning

This item is for specifying of the slope R_{sw} which is used for increasing the level in accordance with sweeping action of the narrow band random waveform.

A constant sweep operation is executed when the slope is specified to '0'.



2.2.10 Sweep lower limit

(1) Meaning

This item is for specifying the lower limit value of frequency which allows the existence of the narrow band random reference.

For example, thinking of the specimen to which any vibration having lower frequency than the specified value should not be given in any case. When the value is specified in this item, the narrow band random signal having lower frequency than the specified value is not outputted even if the sweep range of the narrow band random reference is lower than the specified value. The narrow band random signal having lower frequency than the specified value is hidden and is not outputted (that is, 'a fictitious sweeping operation' is executed in the band below the specified frequency without outputting a signal).

However, the narrow band random reference must not be lower than the frequency resolution Δf . The narrow band random reference can be set to the value upper than Δf compulsory when Δf is specified for this item.

2.2.11 Sweep upper limit

(1) Meaning

This item is for specifying the upper limit value of frequency which allows the existence of the narrow band random reference.

For example, thinking of the specimen to which any vibration having upper frequency than the specified value should not be given in any case. When the value is specified in this item, the narrow band random signal having upper frequency than the specified value is not outputted even if the sweep range of the narrow band random reference is upper than the specified value. The narrow band random signal having upper frequency than the specified value is hidden and is not outputted (that is, 'a fictitious sweeping operation' is executed in the band over the specified frequency without outputting a signal).

However, the narrow band random reference must not be upper than the frequency range f_{\max} . The narrow band random reference can be set to the value lower than f_{\max} compulsory when f_{\max} is specified for this item.

2.2.12 Setting of higher harmonic element

(1) Meaning

The higher harmonic elements are defined with having the defined reference random signal as a basis.

The higher harmonic elements can be registered up to 32.

Following buttons are used in the definition of the higher harmonic elements ;

[Add] : A new data of the higher harmonic element is defined and registered.

[Change] : The contents of the higher harmonic element data registered is corrected.

[Delete] : A higher harmonic element data registered is deleted.

2.2.12.1 Frequency ratio

(1) Meaning

This item is for specifying the swept frequency range by the relative ratio to the fundamental frequency range.

The same or close value to the defined higher harmonic element can not be inputted when the new definition of the higher harmonic element or the correction definition of the frequency ratio in the defined higher harmonic element is done.

Denoting the frequency ratio as r_f , the swept frequency range of each higher harmonic element is described as below ;

$$f1 \times r_f \sim f2 \times r_f$$

However, the narrow band random reference should be exist between the frequency resolution Δf and the frequency range f_{\max} . The narrow band random reference has a specified band width f_{bw} , and it is swept by using the center of the band width as a reference within the frequency range specified in this item.

$$\Delta f \leq f1 \times r_f - f_{bw}/2 \leq f2 \times r_f + f_{bw}/2 \leq f_{\max}$$

2.2.12.2 Level ratio

(1) Meaning

This item is for specifying the level of the higher harmonic element by the relative ratio to the fundamental level.

Denoting the level ratio as r_{Amp} , the level of each higher harmonic element is described as below ;

$$A_b \times r_{\text{Amp}}$$

2.2.12.3 Band width

(1) Meaning

This item is for specifying the band width (frequency width) of the higher harmonic elements.

The narrow band random having this specified band width is swept by using the center of the band width as a reference within the frequency range that is defined by the frequency ratio.

It is of course that the lower and the upper limit frequency of the narrow band random is changed when the center frequency of the band width is changed according to the sweeping operation. The frequency changes time by time. However, actually, the frequency is limited by the frequency resolution Δf , so that the upper and the lower limit frequency is to be 'rounded' by using the unit of Δf . And, these values are rounded off to the nearest value of control line frequency.

2.2.12.4 Tolerance

(1) Meaning

Tolerance check as same as that in an ordinal random test is operated for each higher harmonic components.

However, the condition, such as 'Use Alarm' or 'Use Lower Limit', should coincides with the Tolerance of the broad band random reference.

And, following processes are adopted for the part where the broad band random reference and the narrow band random reference are overlaid.

< Band for Check >

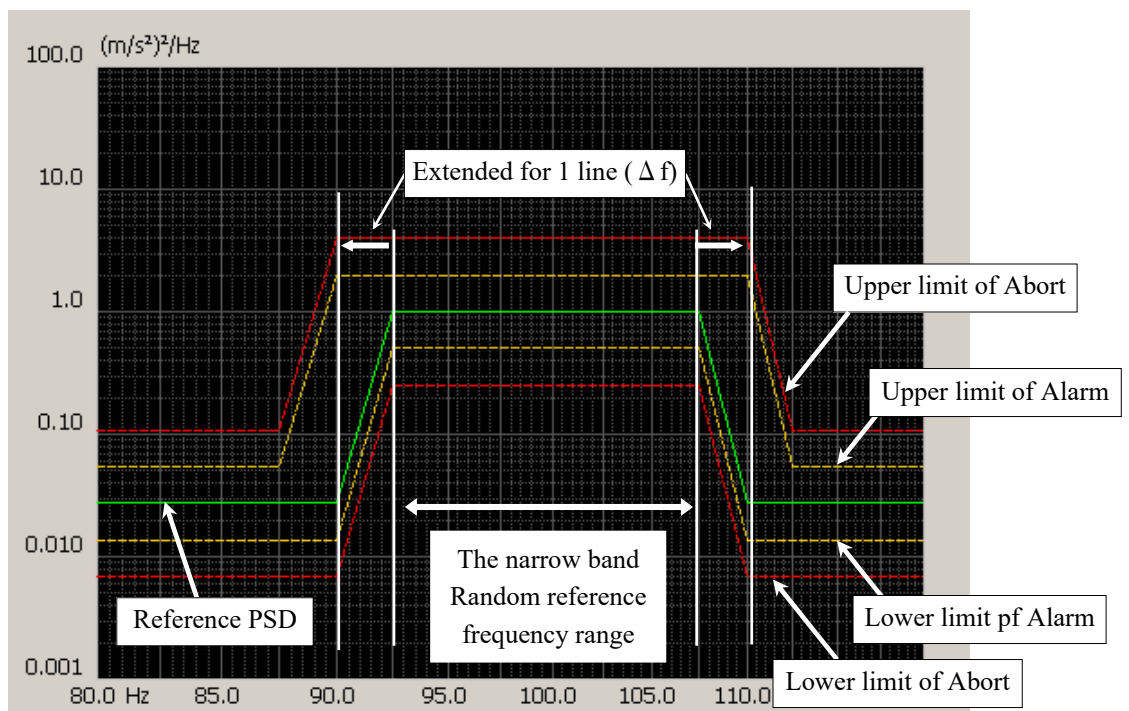
The check of the number of deviation line in the part where the broad band random reference and the narrow band random reference are overlaid is executed with using the allowance band specified by the narrow band random.

< Extension of Alarm/Abort line near the narrow band random >

The upper limit value of the alarm/abort level for the broad band random reference is to be switched to the alarm/abort level of the narrow band random reference within the range for an adjoining line.

It is a treatment for the components oozed from the narrow band random having a large level to the broad band random spectrum of the control line adjoining to the narrow band random reference.

This phenomenon happens logically when the windowing operation, such as Hanning, is done in the spectral analysis process used for the input signal analysis and the output signal calculation.



2.3 Extended ROR Narrow Band Random Reference

(1) Meaning

Set the ROR (Random On Random) Narrow Band Random Reference with a greater freedom.

Element	Frequency range[Hz]	rms value[m/s ² .ms]	Sweep mode	Sweep direction	Band width[Hz]	Sweep rate	Test time
1	30.00 - 50.00	5.9151	Linear	Forward-double	3.00	1.0 Hz/sec	5 double-sweep
2	100.00 - 200.00	50.0	Log	Backward-double	50.00	0.50 octave/min	2 double-sweep
3	450.00 - 550.00	31.6228	Fixed				0:10:00

In the standard ROR described in Section 2.2, all narrow band random references were defined based on the concept of a base narrow band random reference plus its harmonics. Therefore, the shape of random reference, the sweep rate, test time, etc. will be common for all narrow band random references.

On the other hand, the Extended ROR Narrow Band Swept Random Reference makes it possible to operate an ROR test with a greater freedom by defining each narrow band random reference individually.

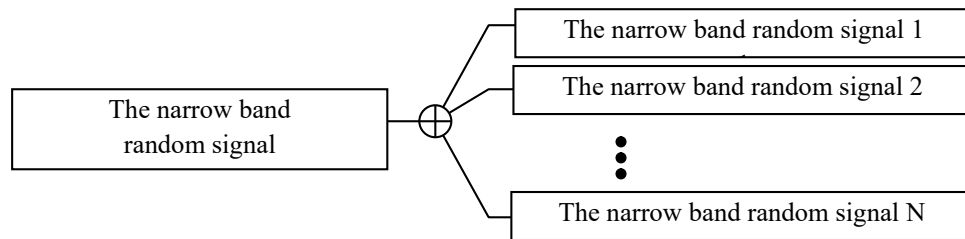
Specifically, definitions of narrow band random reference, such as

- ① What range does the frequency component exist between? (Frequency range)
- ② How much is the level?
- ③ How long does the sweeping operation take? (Sweep rate)
- ④ How fast is the test time specified for? (Test Time)

may be defined individually for each narrow band random reference.

Note that some of the descriptions in this section are common with those in Section 2.2, so descriptions below do not repeat things that have already been explained.

As described earlier, the random reference is a sum of individually defined narrow band random elements.



Note that there are following restrictions for the narrow band random reference similar to the standard ROR test.

- Number of narrow band random elements are available up to **maximum 32**.
- Each narrow band random element should be specified to the value under f_{\max} of frequency range.
- Each narrow band random element should be specified to the value over Δf of frequency resolution.

< Tolerance Check >

Like the standard ROR test, the tolerance check shall be operated separately for the broad band random and narrow band random.

However, if there is an overlap in the frequency of multiple narrow band randoms, the tolerance check will be operated as follows.

- If the synthesis mode is MAX:
Same as the standard ROR test. The tolerance check will be performed for the narrow band random or broad band random adopted for the reference level.
- If the synthesise mode is ADD:
The tolerance check will be operated for the first narrow band random vibration element with overlapped frequency.

Note that the number of deviation lines in each random vibration tolerance check does not include the results for frequencies that were not adopted for the reference level.

The definition of tolerancecheck is the same as that of the standard ROR test.

2.3.1 Synthesize mode

(1) Meaning

The designation of the mode for synthesizing the levels of broad band random reference and relevant narrow band random reference and following two options are available.

MAX : Adopt the largest level among the lines

ADD : Added for each line

2.3.2 Sweep lower limit

(1) Meaning

Same as “2.2.10 Sweep lower limit”.

2.3.3 Sweep upper limit

(1) Meaning

Same as “2.2.11 Sweep upper limit”.

2.3.4 Tolerance

(1) Meaning

Same as “2.2.12.4 Tolerance”.

2.3.5 Setting of narrow band random reference element

(1) Meaning

Defines each narrow band random reference.

In defining it, following buttons are used.

[Add] : A new data of the narrow band random reference element is defined and registered.

[Change] : The contents of the narrow band random reference element data registered is corrected.

[Delete] : A narrow band random reference element data registered is deleted.

2.3.5.1 Narrow band random profile

(1) Meaning

There are two meanings depending on the sweep mode described below.

Fixed : Defines the narrow band random reference PSD.

Log、 Linear : Defines the sweep reference PSD for a narrow band random signal.

In defining it, following buttons are used.

[Define] : Define or modify a narrow band profile.

[Clear] : Delete a registered narrow band profile.

2.3.5.2 Sweep mode

(1) Meaning

This item is for specifying the action mode of sweep. Two types of sweep mode are provided.

1. Linear

Same as “2.2.2 Sweep mode”.

2. Log

Same as “2.2.2 Sweep mode”.

4. Fixed

The narrow band random reference shall not be swept but always be referenced with the PSD defined in the narrow band profile described above.

2.3.5.3 Sweep direction

(1) Meaning

Same as “2.2.3 Sweep direction”.

This entry will be disabled if the sweep mode is set to ‘Fixed’.

2.3.5.4 Band width

(1) Meaning

Same as “2.2.12.3 Band width”.

This entry will be disabled if the sweep mode is set to ‘Fixed’.

2.3.5.5 Sweep rate

(1) Meaning

Same as “2.2.4 Sweep rate”.

This entry will be disabled if the sweep mode is set to ‘Fixed’.

2.3.5.6 Test time

(1) Meaning

Same as “2.2.7 Test time”.

If the sweep mode is set to ‘Fixed’, available options will be limited to ‘By time’ and ‘Infinite’.

2.3.5.7 Sweep pause time

(1) Meaning

Same as “2.2.6 Sweep pause time”.

This entry will be disabled if the sweep mode is set to ‘Fixed’.

2.3.5.8 Sweep start frequency

(1) Meaning

Same as “2.2.5 Sweep start frequency”.

This entry will be disabled if the sweep mode is set to ‘Fixed’.

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