Multi-Degree-Of-Freedom Random Vibration Control System

K2

Multi-RANDOM
Instruction Manual

IMV CORPORATION

Type of document : Instruction manual

System applied : K2
Software <K2/Multi-RANDOM> later than Version 14.3.0

Japanese edition

Version	Date	Contents
1.0.0	2008.01.18	First edition
1.1.0	2008.12.17	Additional description of CSV data file.
6.0.0	2010.10.21	Applied to Windows7
6.1.0	2011.09.26	Additional description of “Minimum value control”
10.0.0	2013.08.09	Renewal of screen display, modified description of test files and modified description of input channels
10.0.1	2013.10.29	Correction of misprints
13.5.0	2017.06.27	Additional description of XFR Measure by white noise, Correction of misprints
13.6.0	2017.10.02	Additional description of operation related to Live data in operation, Correction of misprints
14.1.0	2018.04.27	Additional description of Measured waveform definition
14.3.0	2019.04.19	Modified description of Data save condition, correction of misprints

English edition

Version	Date	Contents
1.0.0	2008.03.10	First edition
1.1.0	2010.02.25	Additional description of CSV data file.
6.0.0	2010.11.05	Applied to Windows7
6.1.0	2011.09.26	Additional description of “Minimum value control”
10.0.0	2013.08.09	Renewal of screen display, modified description of test files and modified description of input channels
13.5.0	2017.06.27	Additional description of XFR Measure by white noise, Correction of misprints
13.6.0	2017.10.02	Additional description of operation related to Live data in operation, Correction of misprints
14.1.0	2018.04.27	Additional description of Measured waveform definition
14.3.0	2019.04.19	Modified description of Data save condition, correction of misprints

CONTENTS

Chapter 1 Outline of the System

1.1 Specification

1.1.1 Multi-RANDOM

(1) Control Method :

1) PSD control of the random waveform signal with the Gaussian nature by using the feed-forward method
2) Real time waveform control by using the feed-forward method
3) Cross-talk control between each axis

(2) Control frequency fmax : Maximum 10 kHz (However, it may be limited by conditions.)

(3) Number of control lines L : Maximum 3200 lines
(However, it may be limited by conditions.)

(4) Control dynamic range : More than 90 dB

(5) Loop Time : Within 450 ms
(At 3 input 3output control, 120 DOF, fmax = 2000 Hz, L = 200 line, cross-talk information average = at 8times/a loop)

(6) Input channel :

1) Number of channels : Maximum 64
(Including maximum 32 of 'Principle Control Channels')
2) Channel type : Principle Control channel / Control channel / Monitor channel
(possible to duplicate)
3) Control response averaging method : Average value control / Maximum value control / Minimum value control
4) Alarm / Abort : For each input channel, the maximum allowance spectrum data (PSD) or RMS value can be specified for setting of Alarm / Abort.
5) Limit control function : For each input channel, the maximum allowance spectrum data (PSD) or/and RMS value can be specified. When the response exceeding over the specified spectrum can be forecasted to be produced at the concerning channel, the system controls the concerning spectrum not to produce the exceeded response over the allowance and continues the testing operation without stopping (however, the linearity of the controlled system is assumed for the above forecasting). Optional function of 'PSD Limit' is necessary to execute the operation as in the above by using PSD data.

(7) Output channel : (However, it may be limited by conditions.)

1) Number of channels : 16
2) Clipping : Voltage value (specifying by σ can also be added.)

(8) Analysis / Display data

1) Reference, Controlled response PSD and Tolerance
2) PSD of each input channel, Waveform data
3) Drive spectrum
4) Transmissibility : Controlled system transmissibility (control response / drive)
   Transmissibility between input channel and drive
   Transmissibility between input channels (amplitude, phase)
5) PSD for Monitoring, Limit control execution ratio
6) Transfer Function between Principal Control Channel and Drive Output Channel, Coherence
7) Excitation Status

(9) Data save : Automatic / Manual
Display data save as CSV format

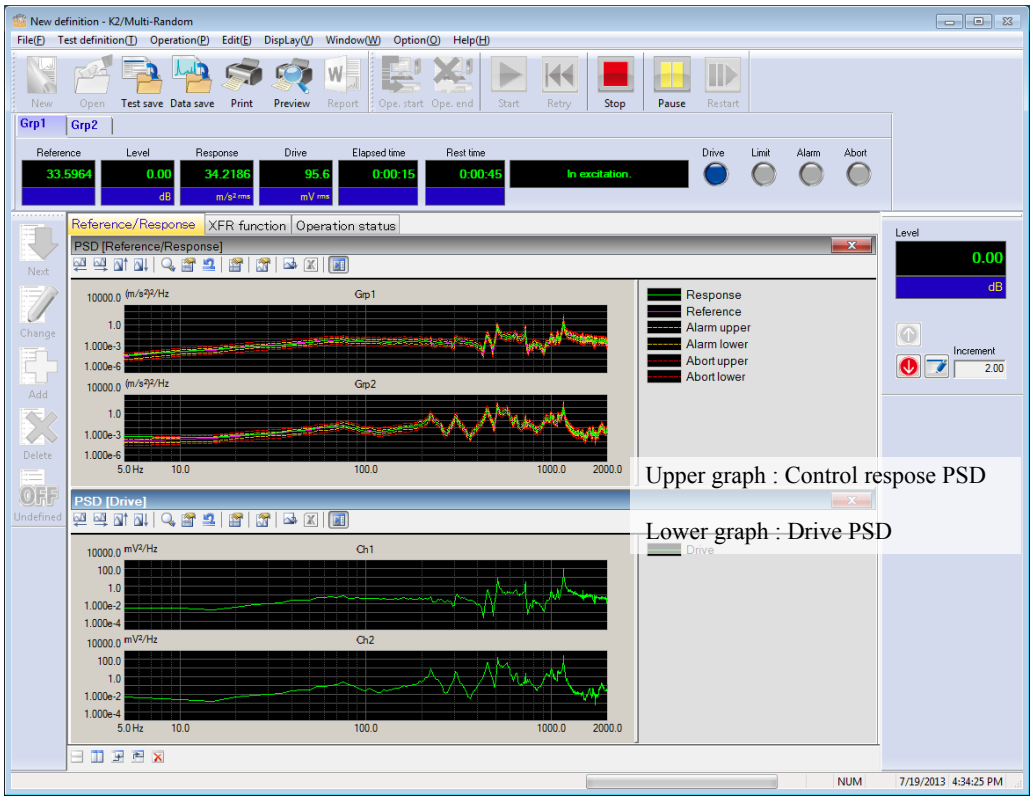
(10) Control operation information save and use

1) Storing of the test operation time information and continuing of test operation (Partial execution of the test)
2) Storing the control information (Live data in operation) and continuing of the control (Prompt mode)

(11) Additional software

K2/RANDOM (the random vibration control system for single-axis) is attached to K2/Multi-RANDOM as standard. The additional option installed in K2/Multi-RANDOM is also usable in its K2/RANDOM.

(12) Option : PSD Limit



Display viewing of Multi-RANDOM

1.1.2 PSD Limit (Option of Multi-RANDOM)

(1) Specifying method : Monitoring level is specified for each limit control channel by PSD.

(2) Number of channels : All the input channels available in the system are usable.
(However, the license setting is required.)

(3) Objective physical quantity : An Input channel having a physical quantity which is different from that of Control Variable is possible to be used as a limit control channel.

Chapter 2　Operation System of K2 Application

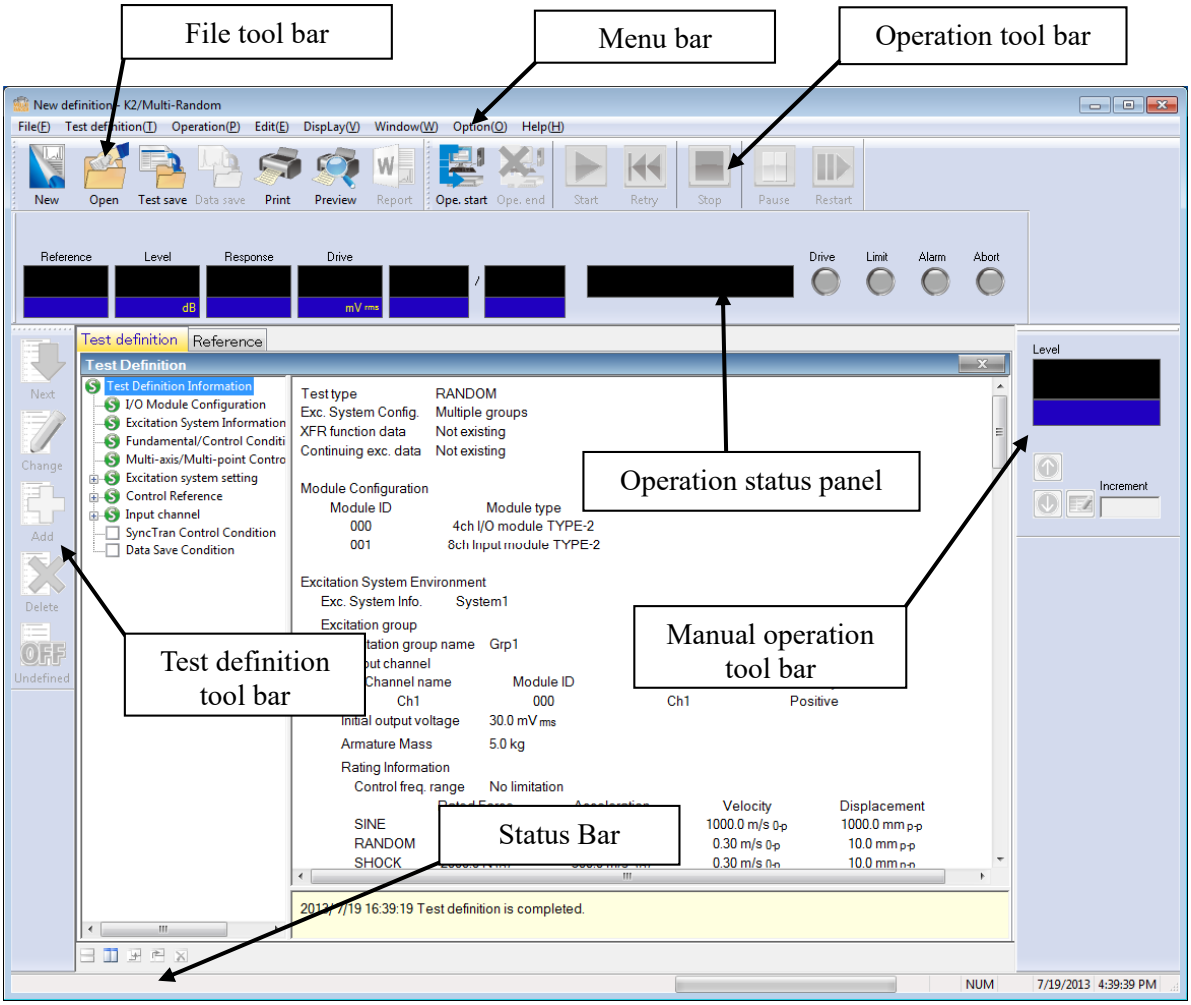
2.1 Outline

In K2 application, operation after booting up is executed by using a keyboard and a mouse.

When this application is started, a window shown as below appears.

All the names of menu in this application are displayed in the menu bar. The menus are to be opened by clicking on its name while the available commands also appear in a list. The commands frequently used are displayed as icons in the tool bar. These icons execute the commands or open the dialog boxes corresponding to the commands by clicking on it.

Operation status of K2 Controller is displayed in the status bar. The state during the excitation operation is displayed in the operation status panel.



Display viewing of K2 application

2.2 Test file

In K2 application, the necessary information to operate a test is saved in a specified file called a ‘test file’.

Following kinds of test files are available in this system.

Necessary Test Files for test operation

・Test Definition File : The file created inVer10.0.0.0 or later
K2Multi-RANDOM（*.mran2）
The file created before Ver10.0.0.0
K2Multi-RANDOM（*.mran）

・Graph Data File : The file created inVer10.0.0.0 or later（*.vdf2）
The file created before Ver10.0.0.0（*.vdf）

・Environment setting File
(I/O Module Configuration Information, Excitation System Information, Input channel Information) : SystemInfo.Dat2

Note 1) Saved in ‘\IMV\K2_2nd’ on System Drive. Deleting inhibited
In K2 of the version before Ver.10.0.0.0, there are saved in ‘\IMV\K2’ on System Drive.
In K2 of the version before Ver.6.0.0.0, there are saved in the Windows folder.

Note 2) If the K2 version is upgraded to Ver10.0.0.0 or later ones from previous ones, the environment setting file will be automatically converted to the format for Ver10.0.0.0 and later ones during installation.

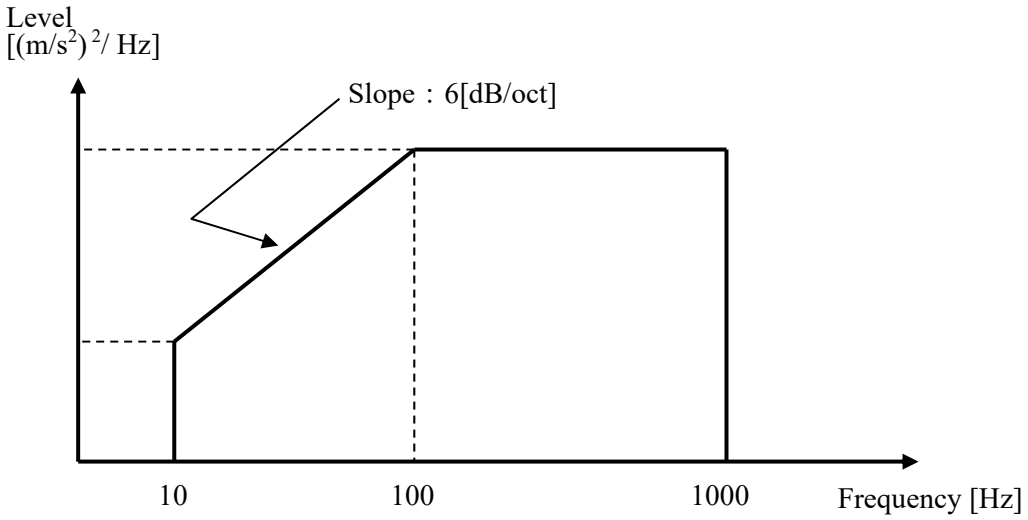
Chapter 3　Basic Operation

3.1 Break point PSD

< Example >

An example of break point PSD is described as below ;

[Reference pattern]



The PSD is specified to 10 [(m/s^2)rms] having the shape as in the above between 10 [Hz] and 1000 [Hz].

[Test time]

1 minute

[Information of sensors to be used]

Two piezoelectric accelerometers are used.

Ch.1 : for Principle Control, sensitivity 3pC/(m/s^2), break point PSD control

Ch.2 : for Principle Control, sensitivity 3pC/(m/s^2), Zero reference control

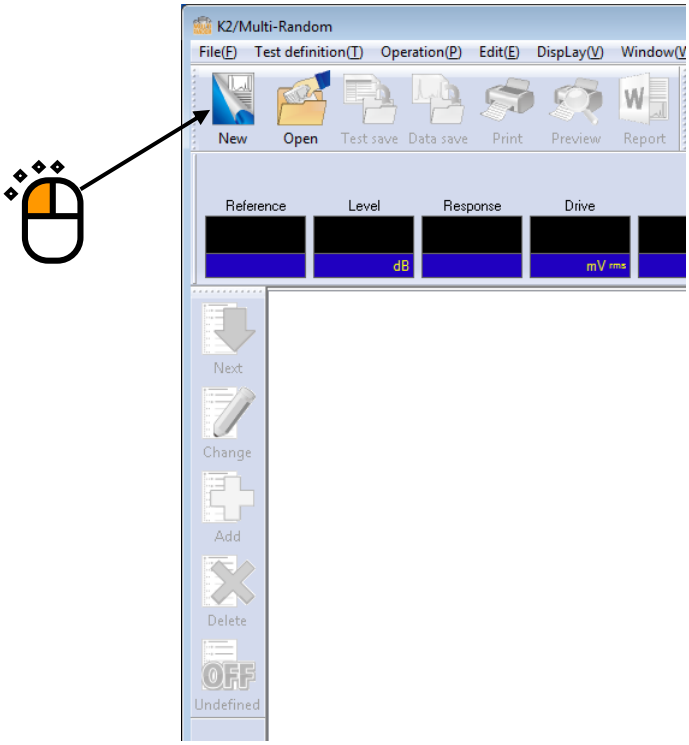
The input channel information of these pickups (channel name and sensitivity) are needed to be registered beforehand. The input channel information is registered as SysInp01 in this example.

Also, the excitation system information (excitation system rating, etc.) is registered. In this example, it is named as System1.

<Procedures>

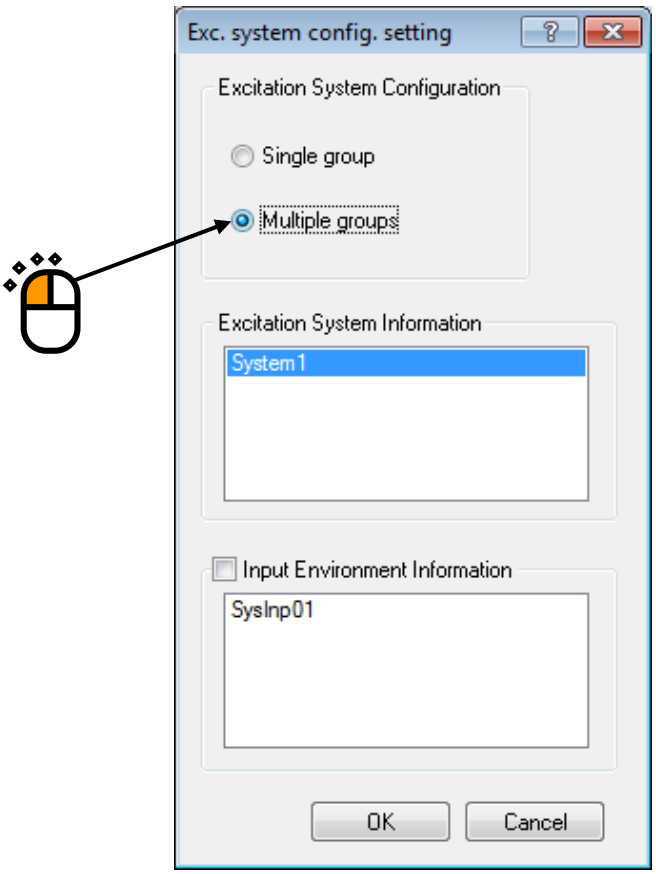
<Step 1>

Press the button to start a new definition.



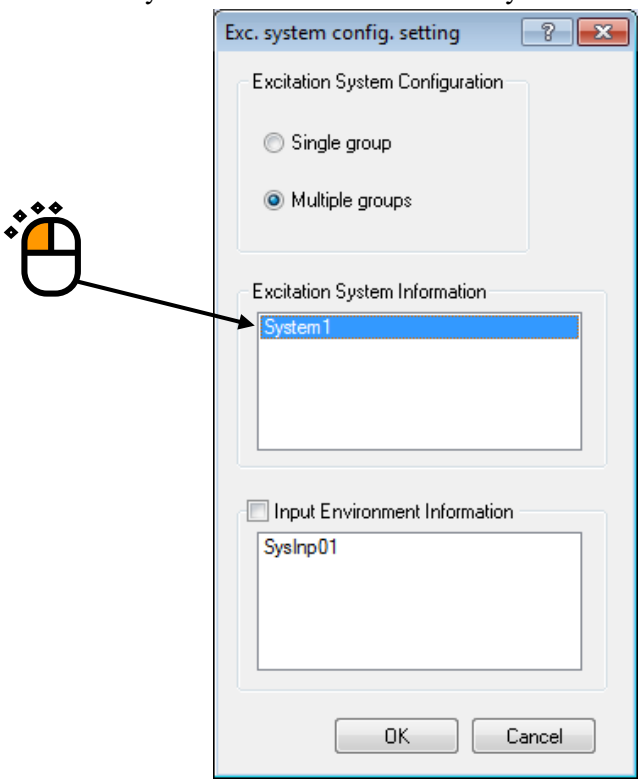
<Step 2>

Select the item of multiple groups in the excitation system configuration.



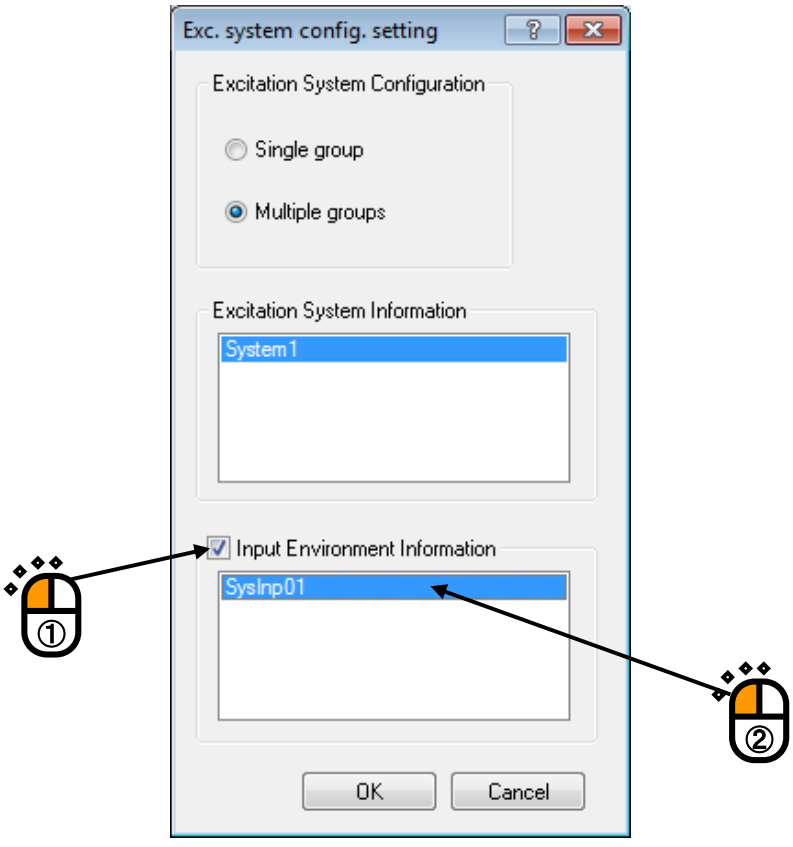
<Step 3>

Select an excitation system in the list of excitation system information.



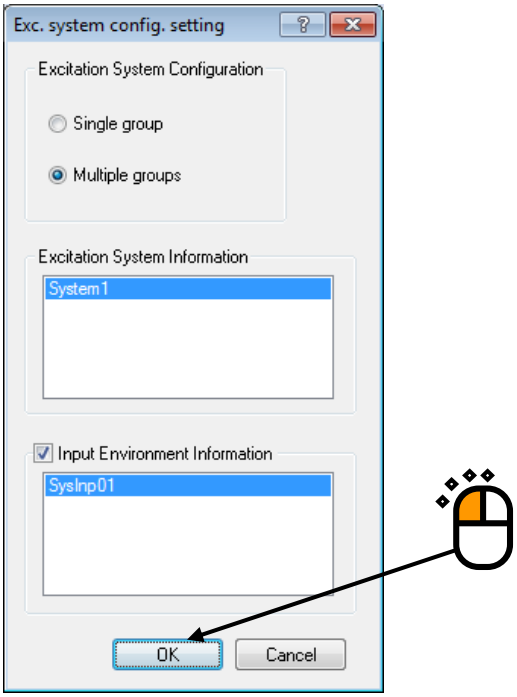
<Step 4>

Click the checkbox of input environment information and select the input channel information in the list.



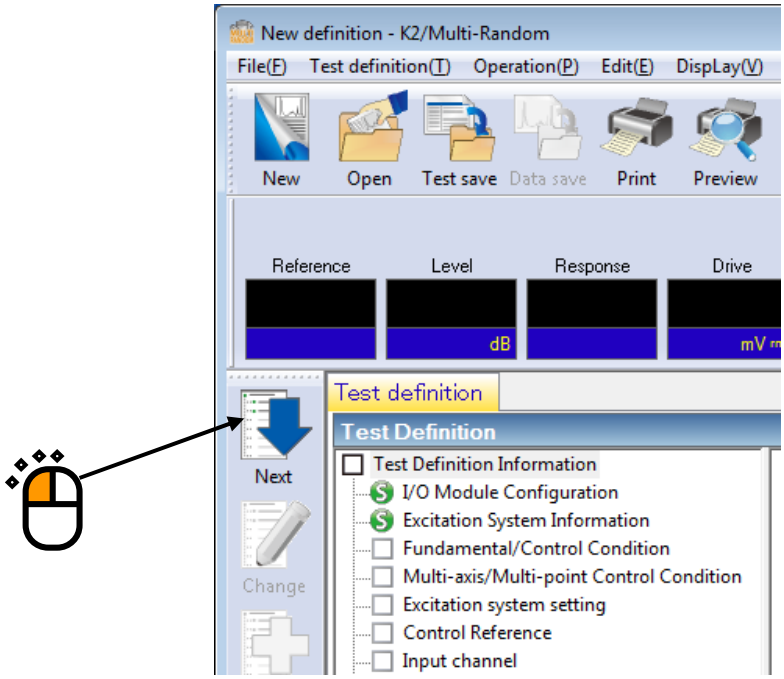
<Step 5>

Press the [OK] button.



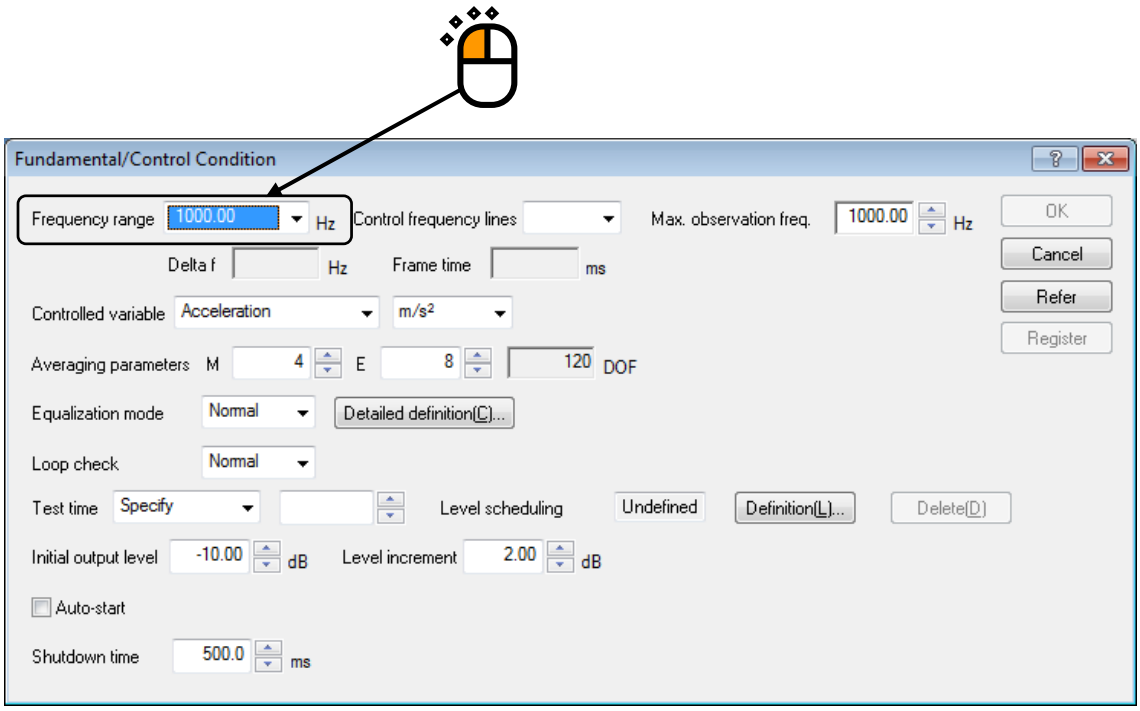
<Step 6>

Press the button to go to the next definition.



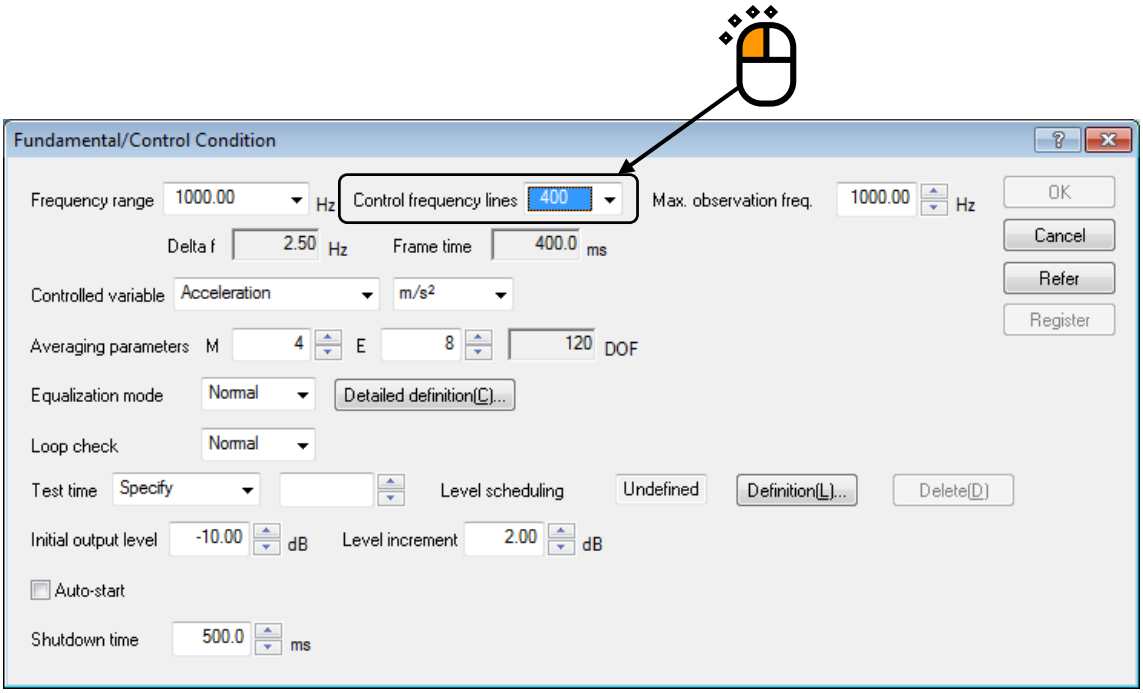
<Step 7>

Set the frequency range to ‘1000Hz’.



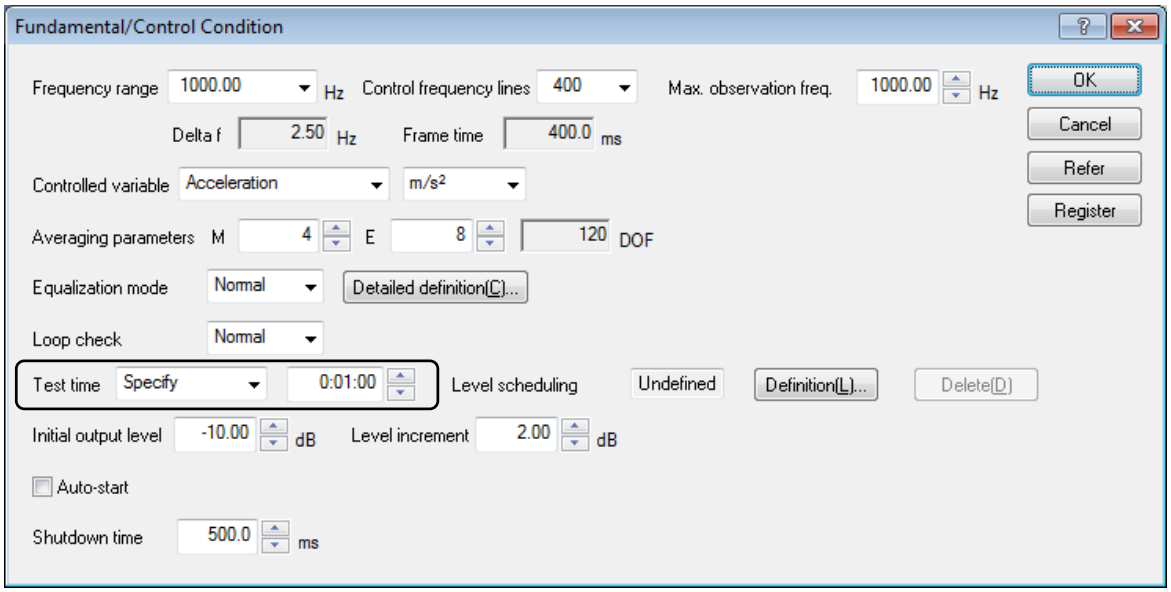
<Step 8>

Set the control frequency lines to ‘400’.



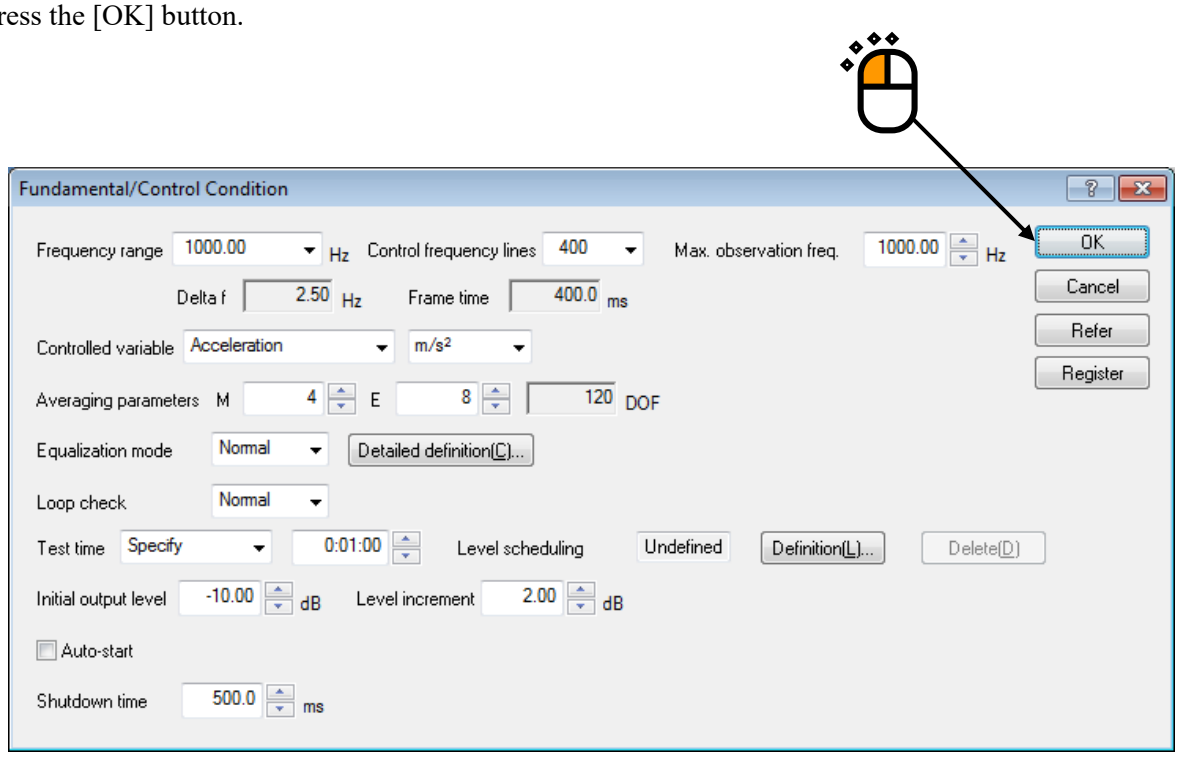
<Step 9>

Set the test time to specify the test time length. Input the value ‘0 : 01 : 00’ (60 sec).



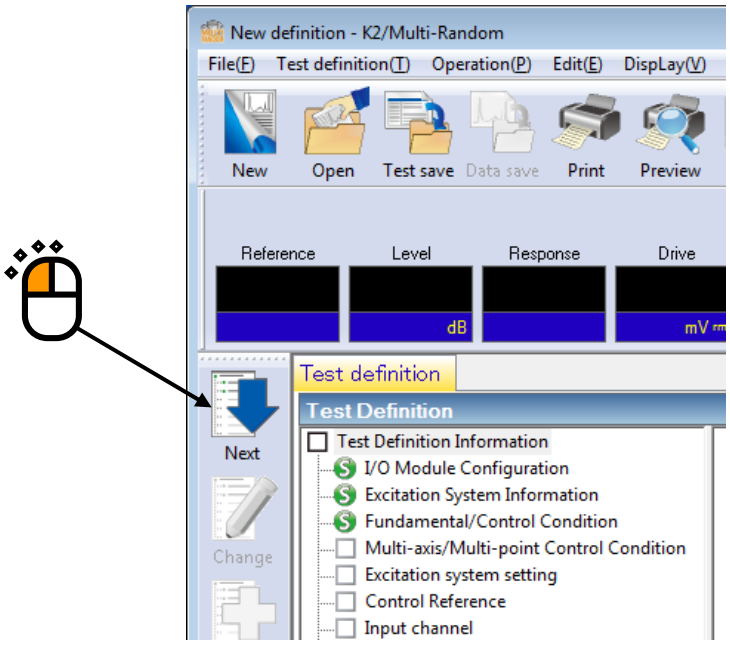
<Step 10>

Press the [OK] button.



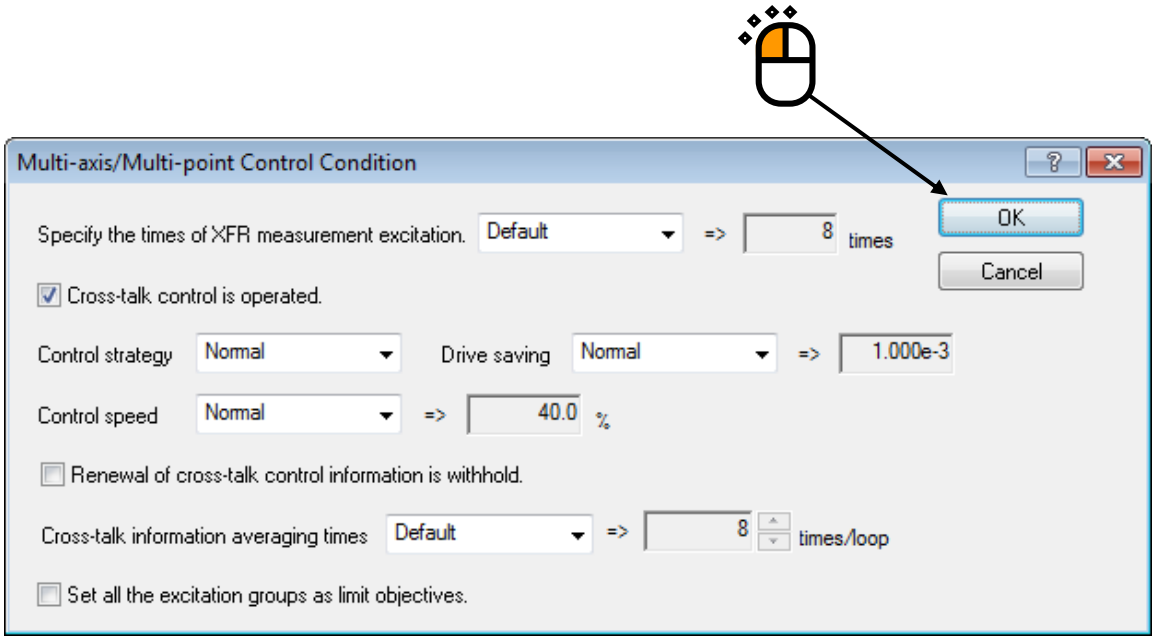
<Step 11>

Press the button to go to the next definition.



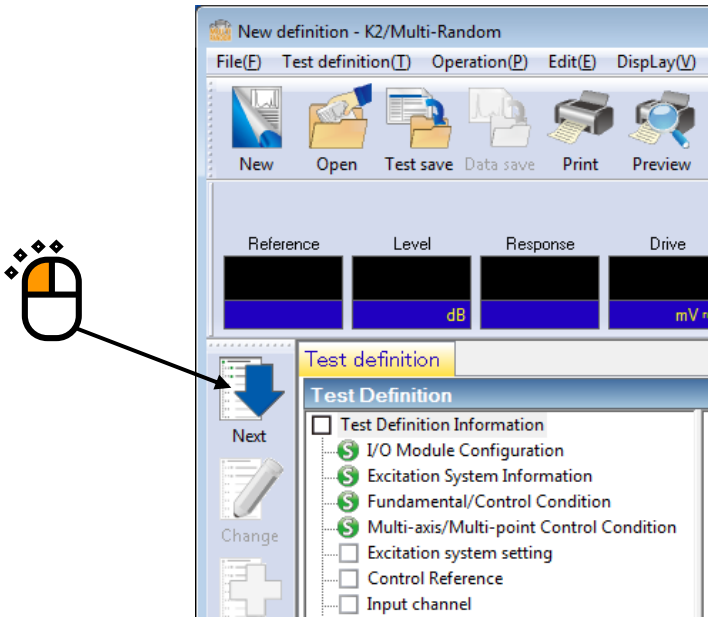
<Step 12>

Press the [OK] button.



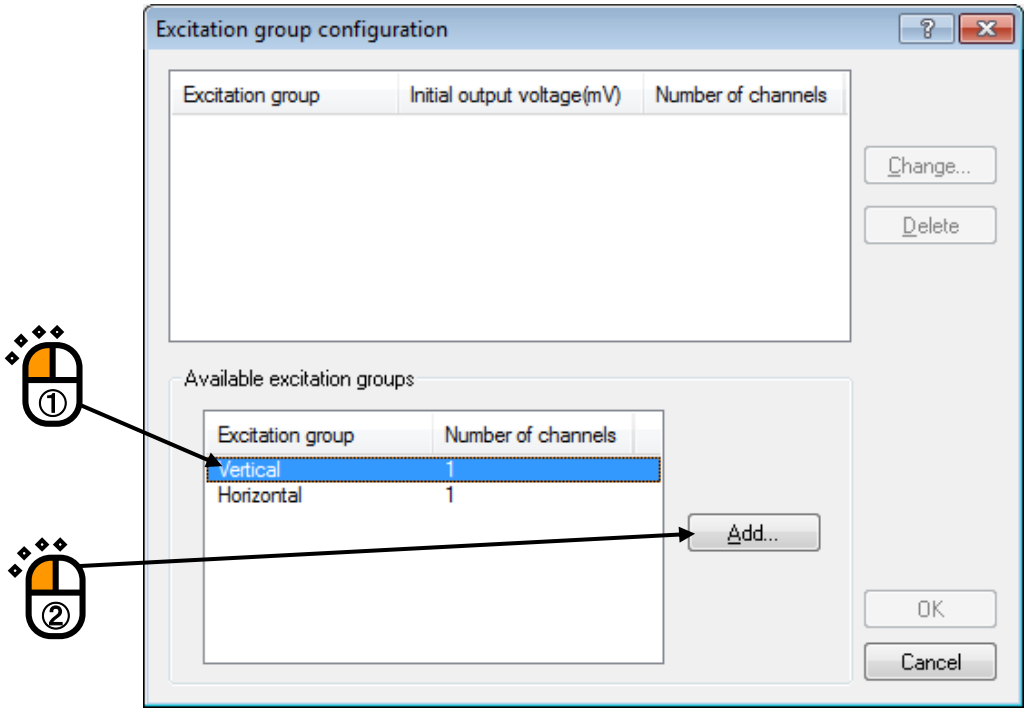
<Step 13>

Press the button to go to the next definition.



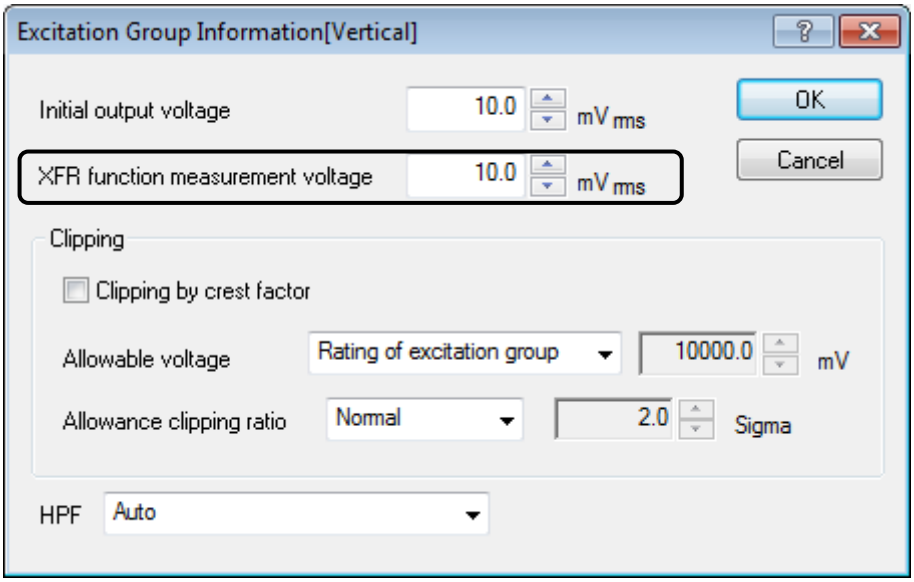
<Step 14>

Select an excitation group among the available excitation groups. Here, select ‘vertical’ and press the button to add.



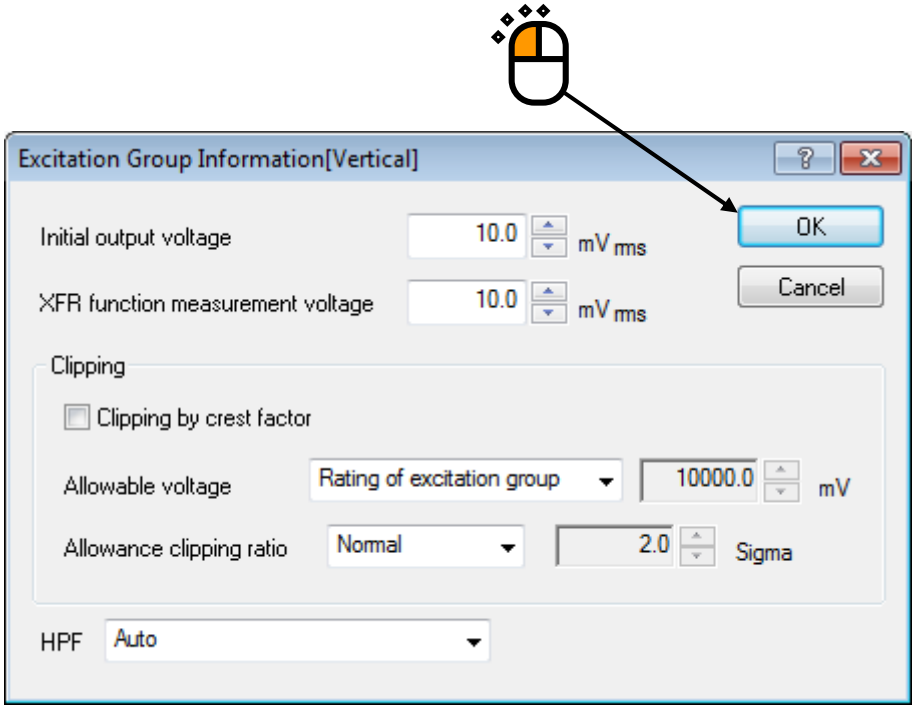
<Step 15>

Set the XFR function measurement voltage to 10 (mV_{rms}).



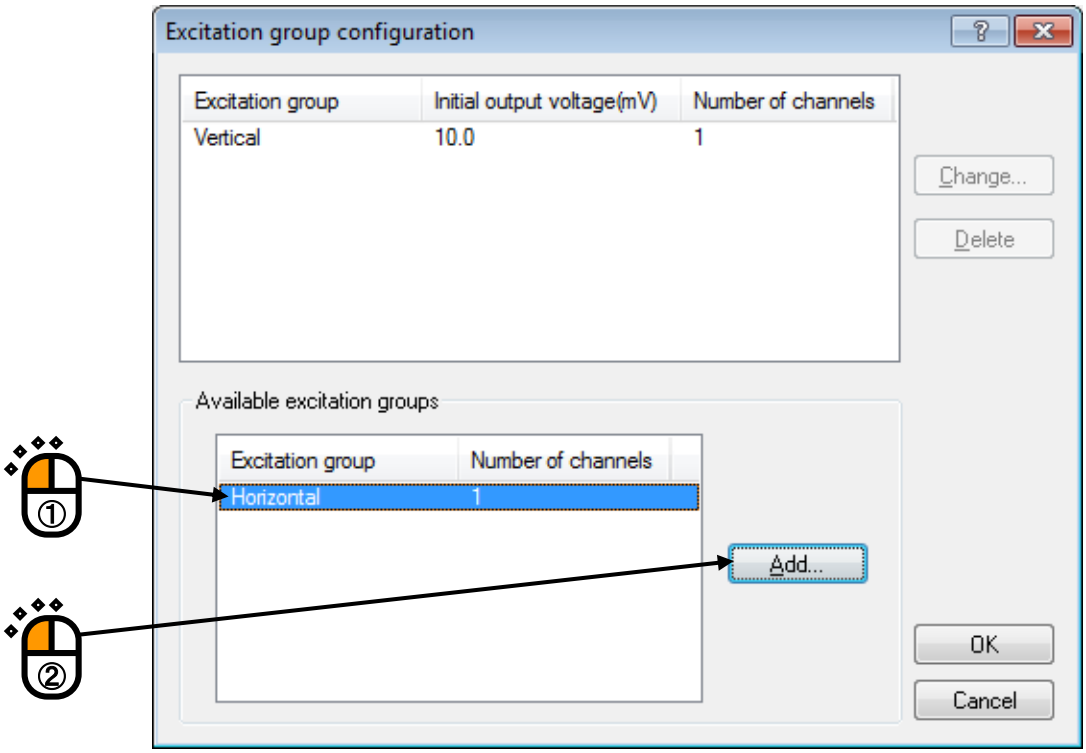
<Step 16>

Press the [OK] button.



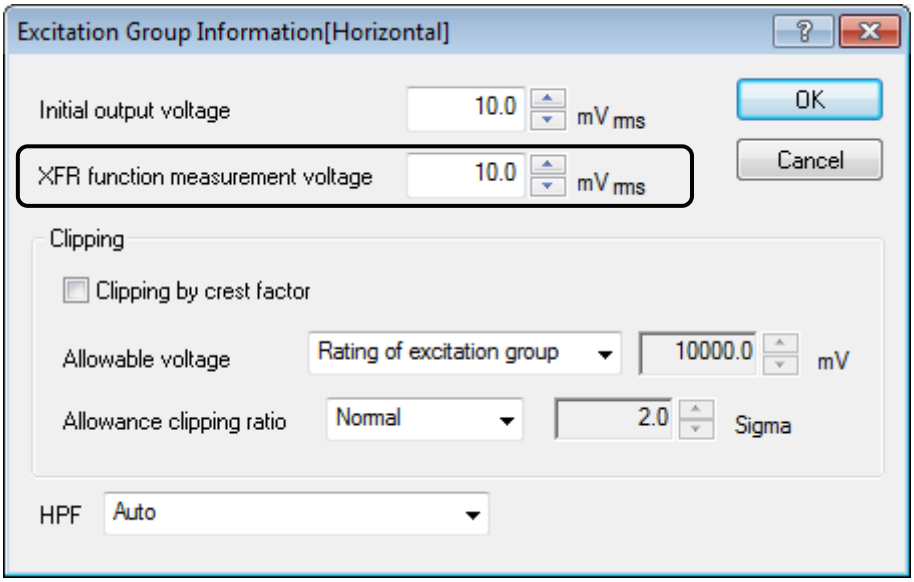
<Step 17>

Select an excitation group in the available excitation groups. Here, select 'horizontal' and press the button to add.



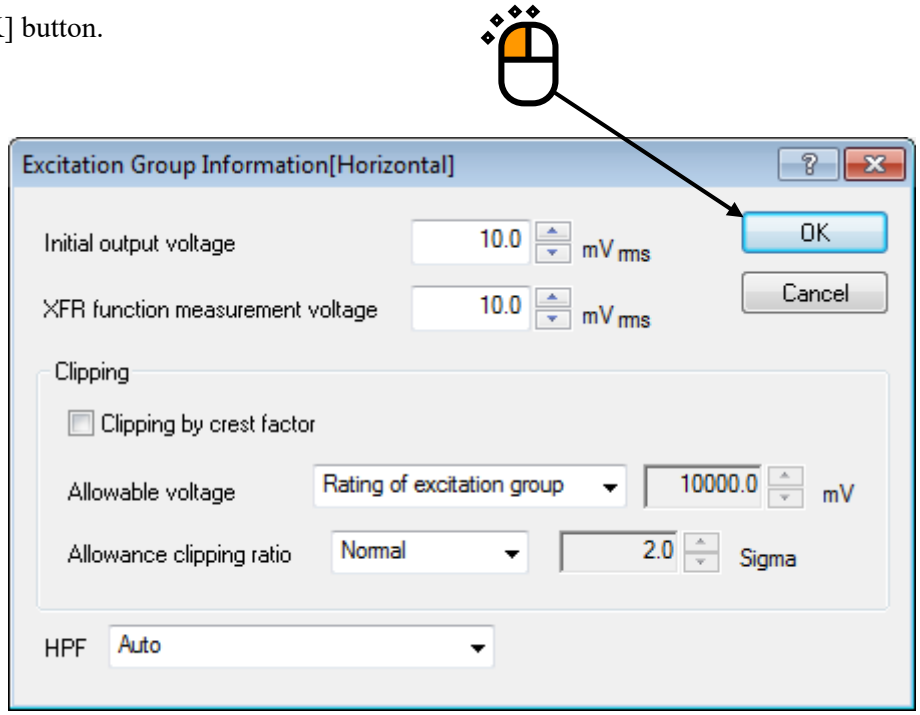
<Step 18>

Set the XFR function measurement voltage to 10 (mV_{rms}).



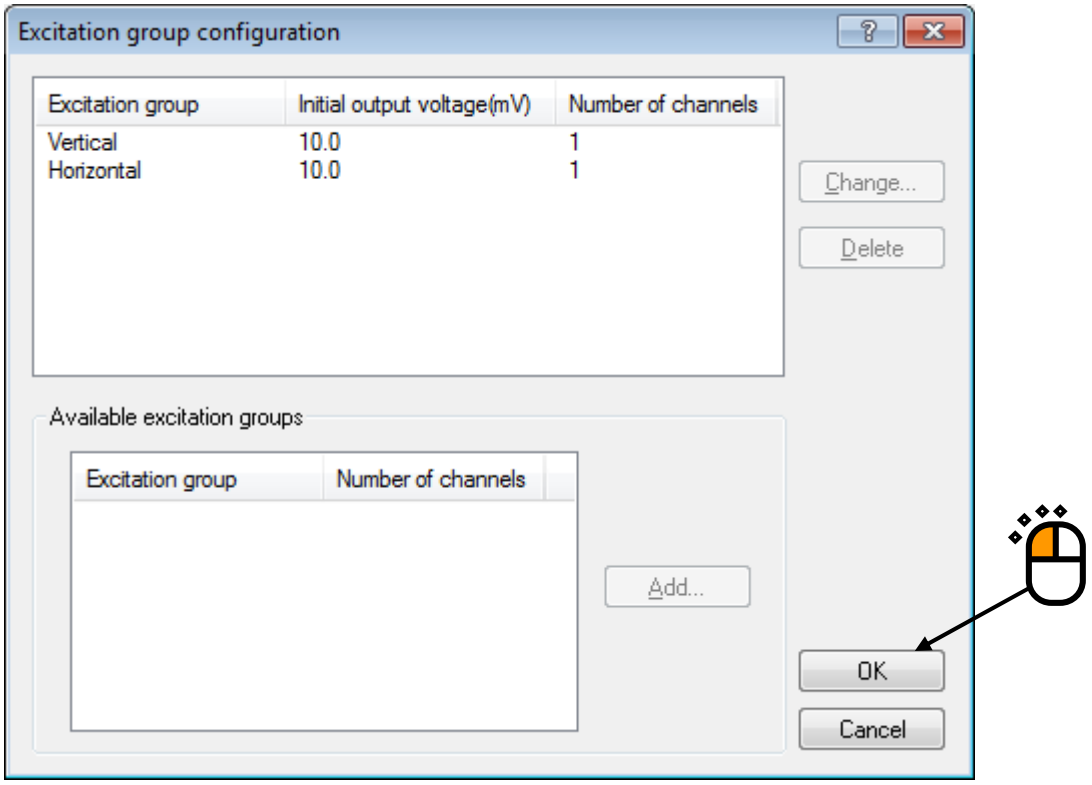
<Step 19>

Press the [OK] button.



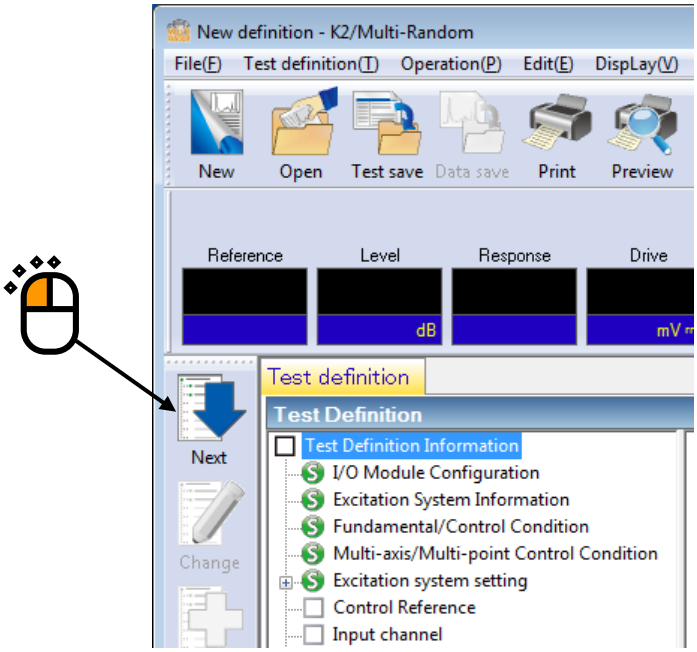
<Step 20>

Press the [OK] button.



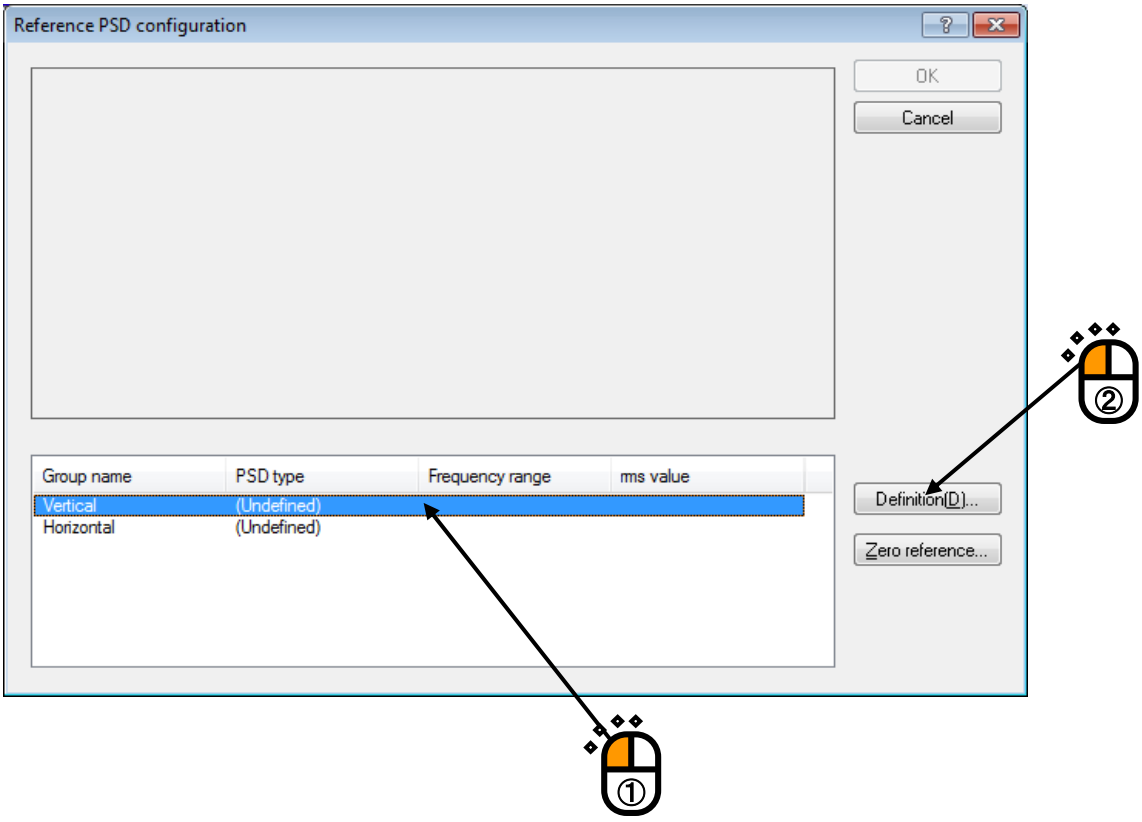
<Step 21>

Press the button to go to the next definition.



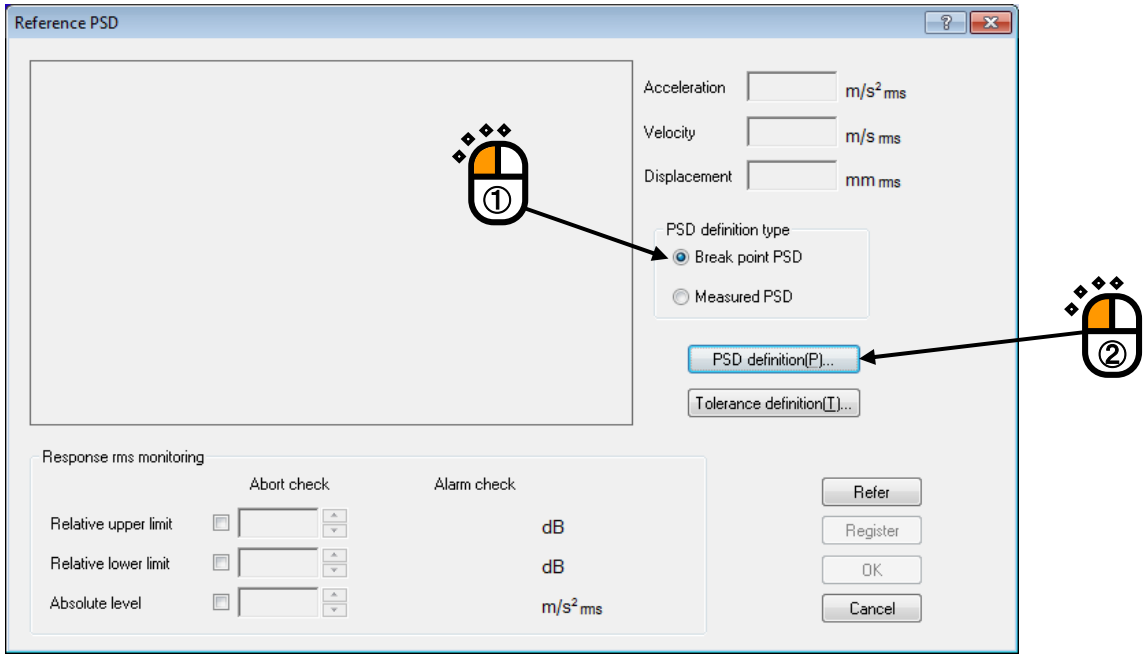
<Step 22>

Select a group name, ‘vertical’. Then press the definition button.



<Step 23>

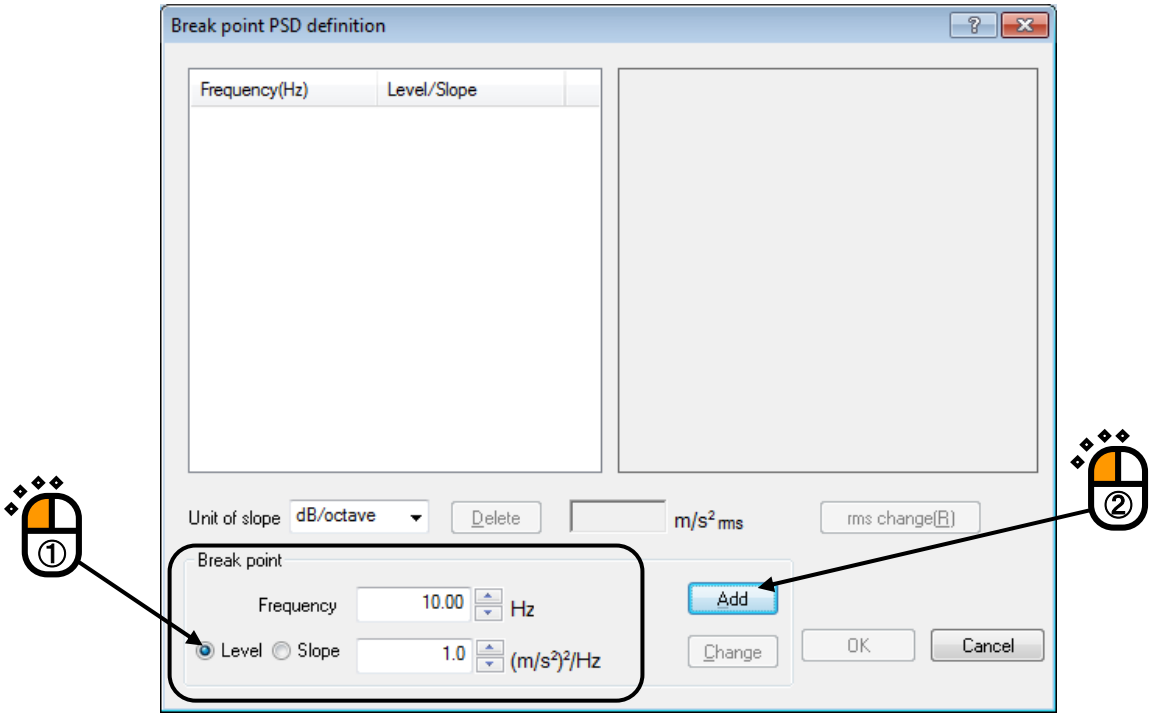
Select the item of the break point PSD and press the button of PSD definition.



<Step 24>

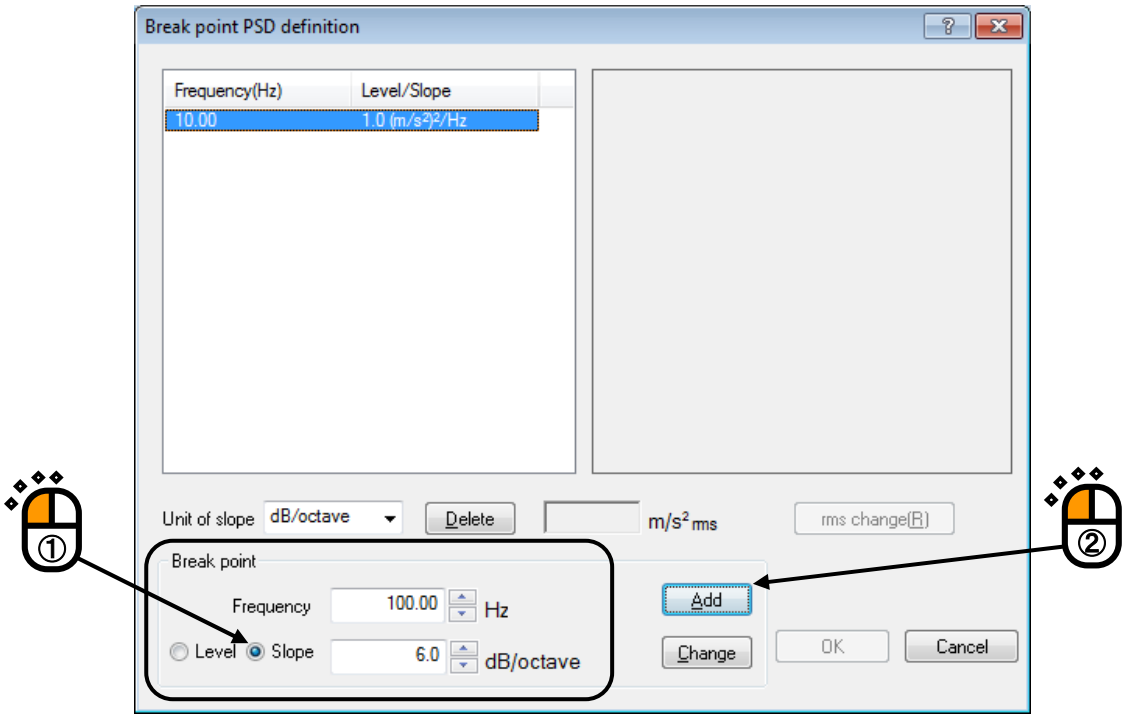
Select the item of level. Input the values for level : 1[(m/s^2)^2/Hz] and for frequency : 10 [Hz].

Then press the button to add.



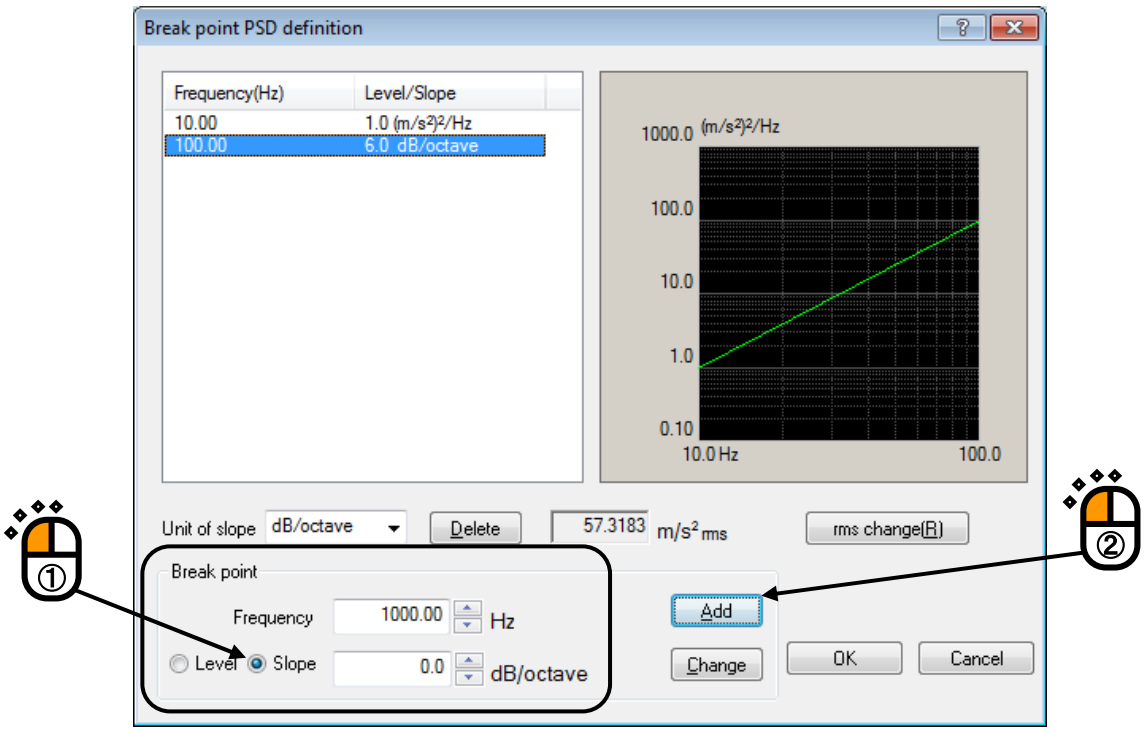
<Step 25>

Select the item of the slope and specify the unit of slope as dB/octave. Input the values for slope : 6 [dB/octave] and for frequency : 100 [Hz]. Then press the button to add.



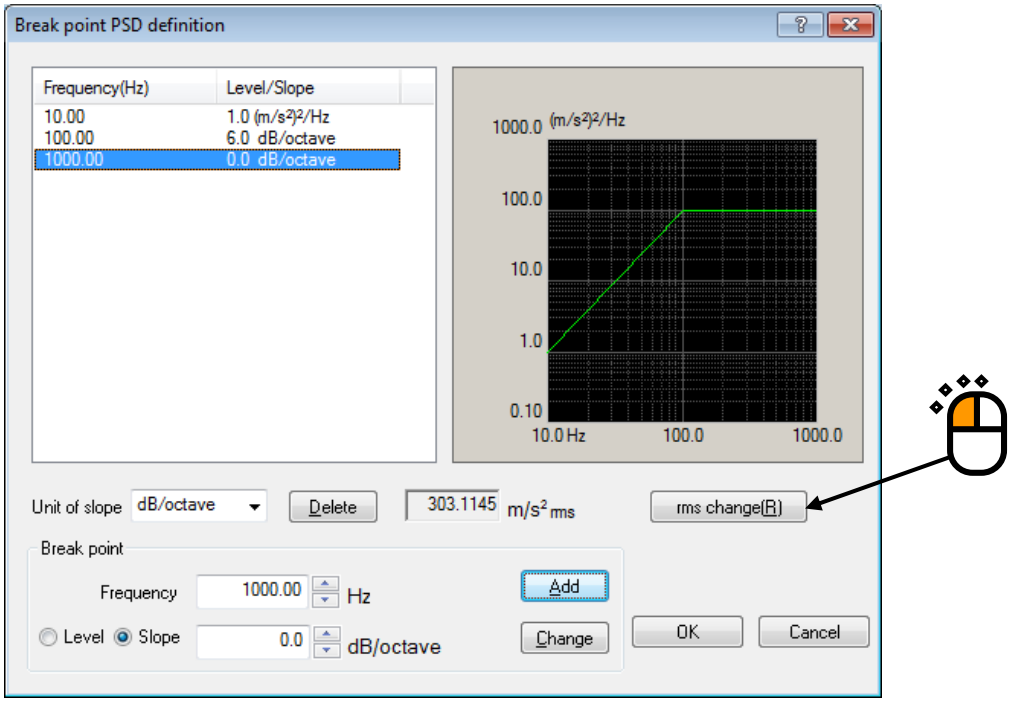
<Step 26>

As in the same way, select the item of the slope and specify the unit of slope as dB/octave. Input the values for slope : 0 $[(m/s^2)^2/Hz]$ and for frequency : 1000 [Hz]. Then press the button to add.



<Step 27>

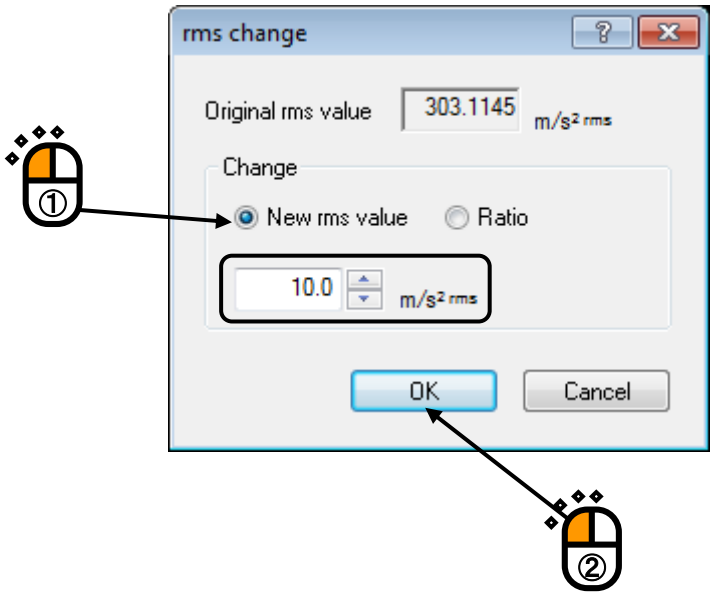
Press the button of rms change.



<Step 28>

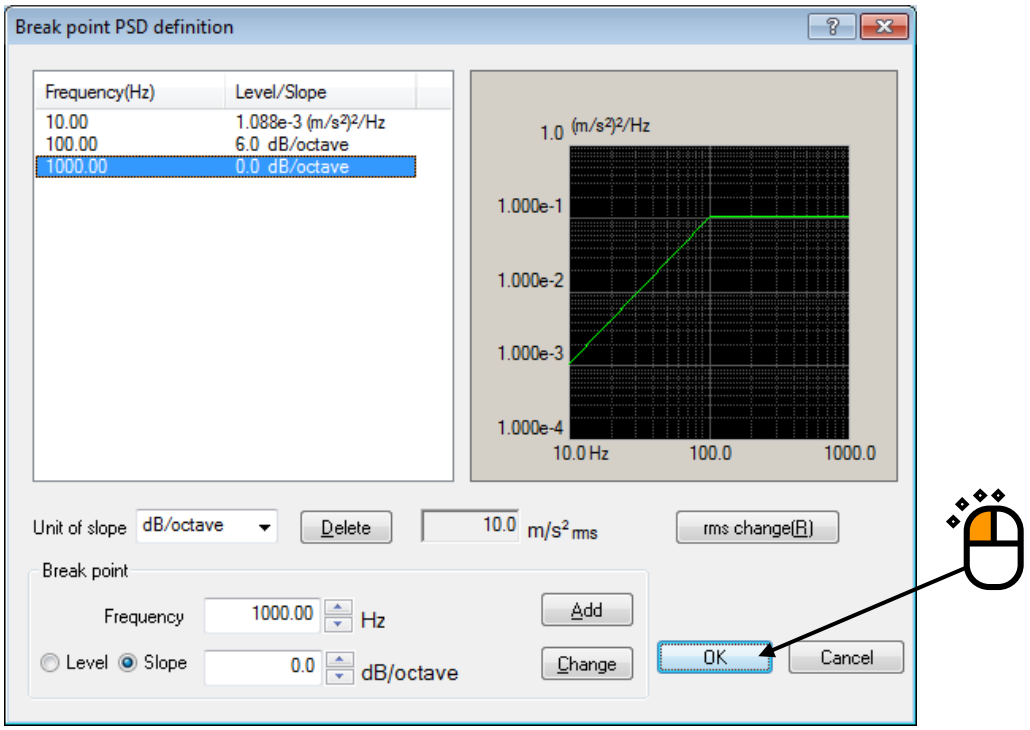
Select the item of new rms value and input the value for the new rms value : 50 [(m/s^2) rms].

And press the [OK] button.



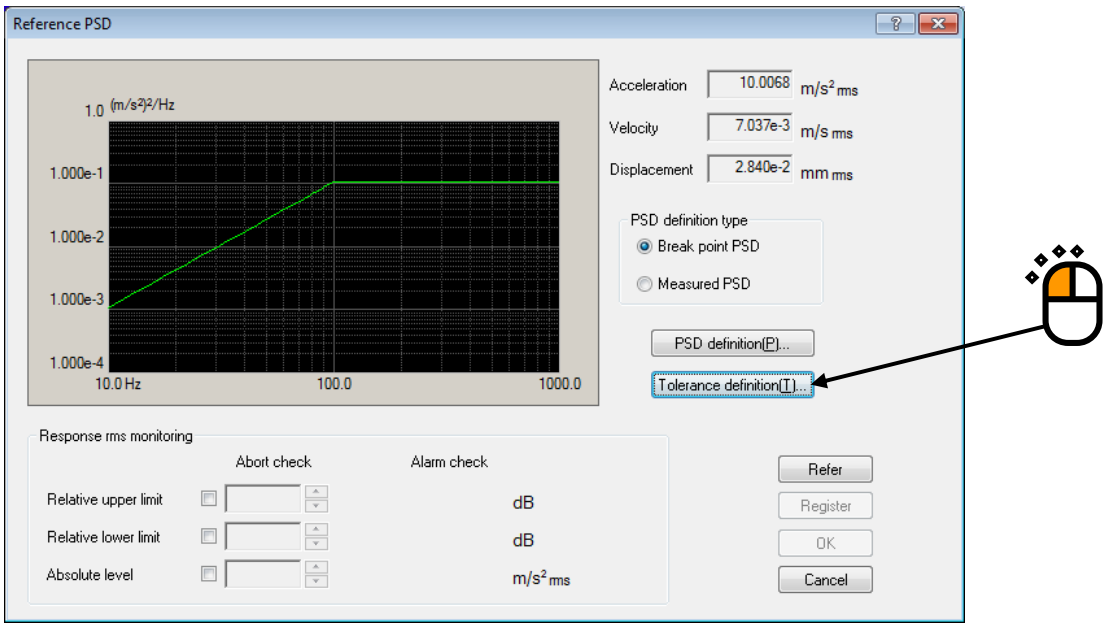
<Step 29>

Press the [OK] button.



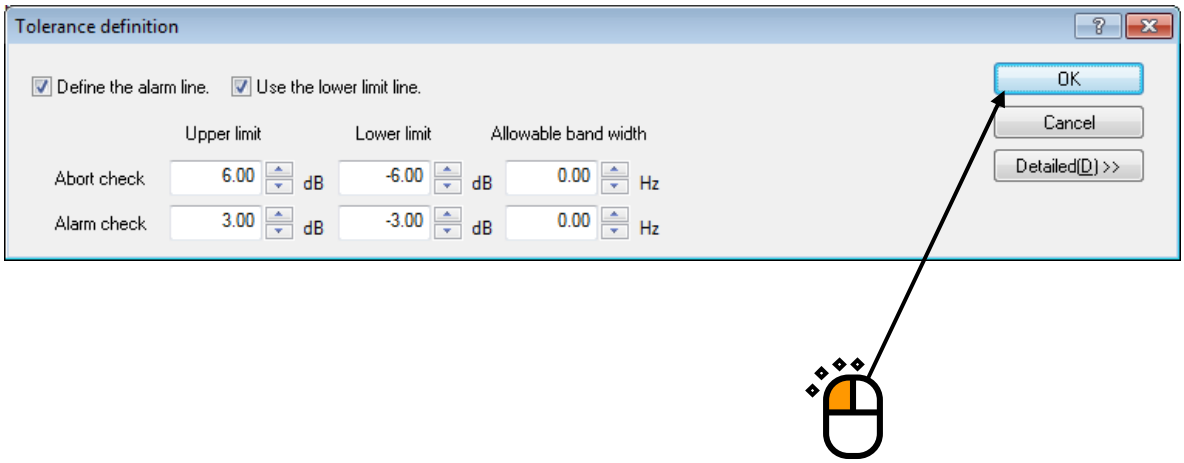
<Step 30>

Press the button of tolerance definition.



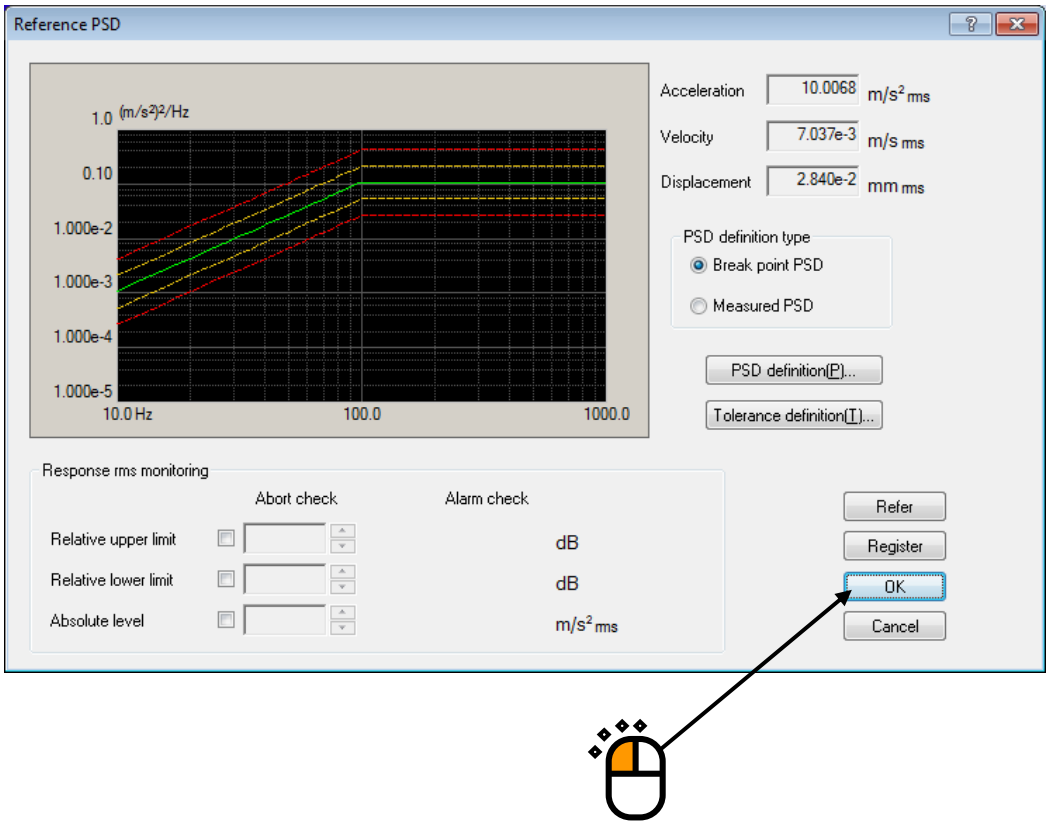
<Step 31>

Press the [OK] button.



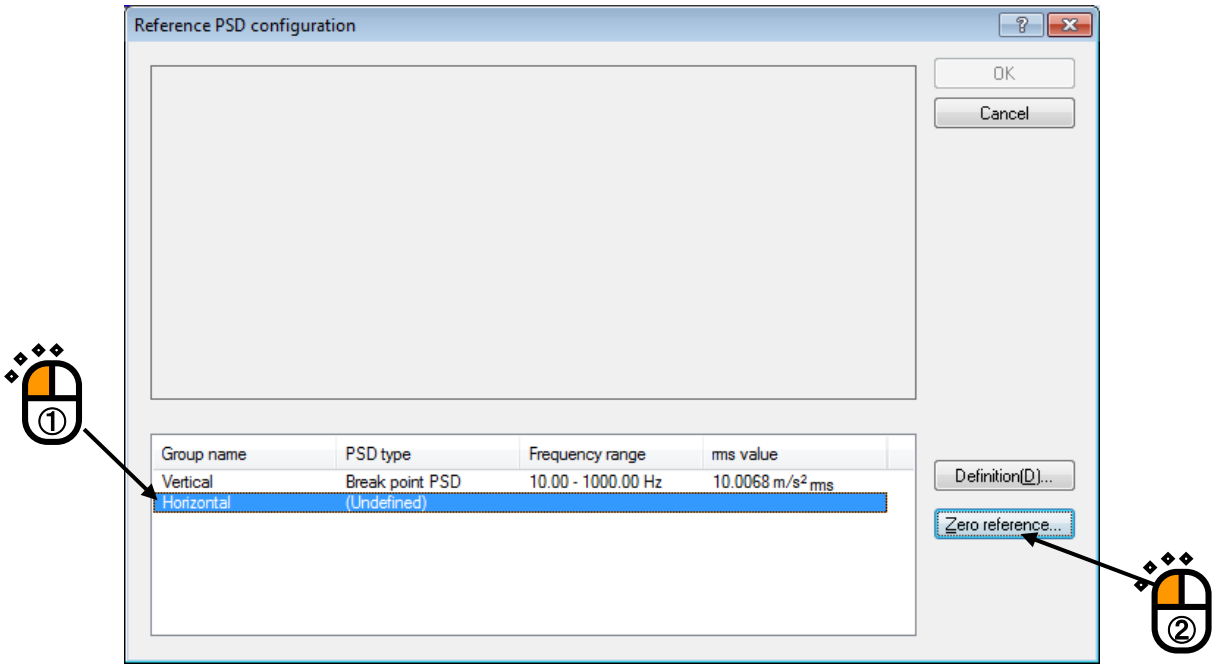
<Step 32>

Press the [OK] button.



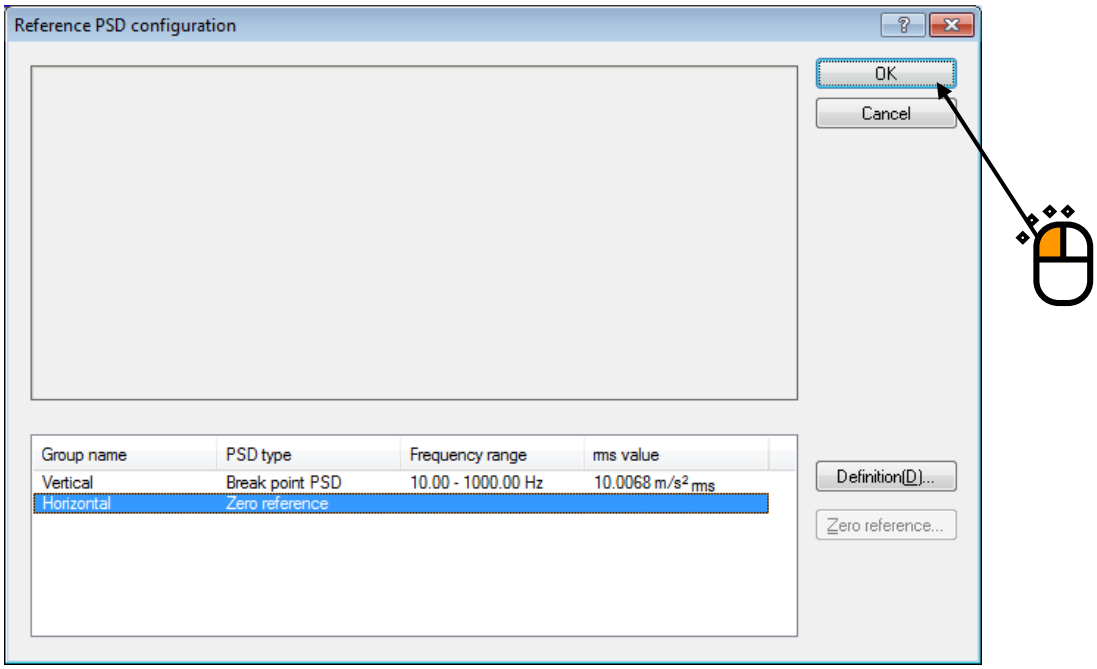
<Step 33>

Select the item of ‘horizontal’ and press the button of zero reference.



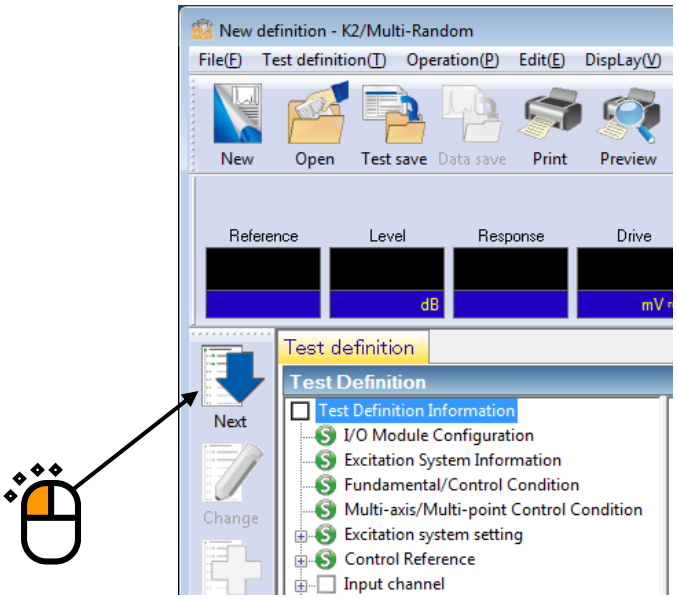
<Step 34>

Press the [OK] button.



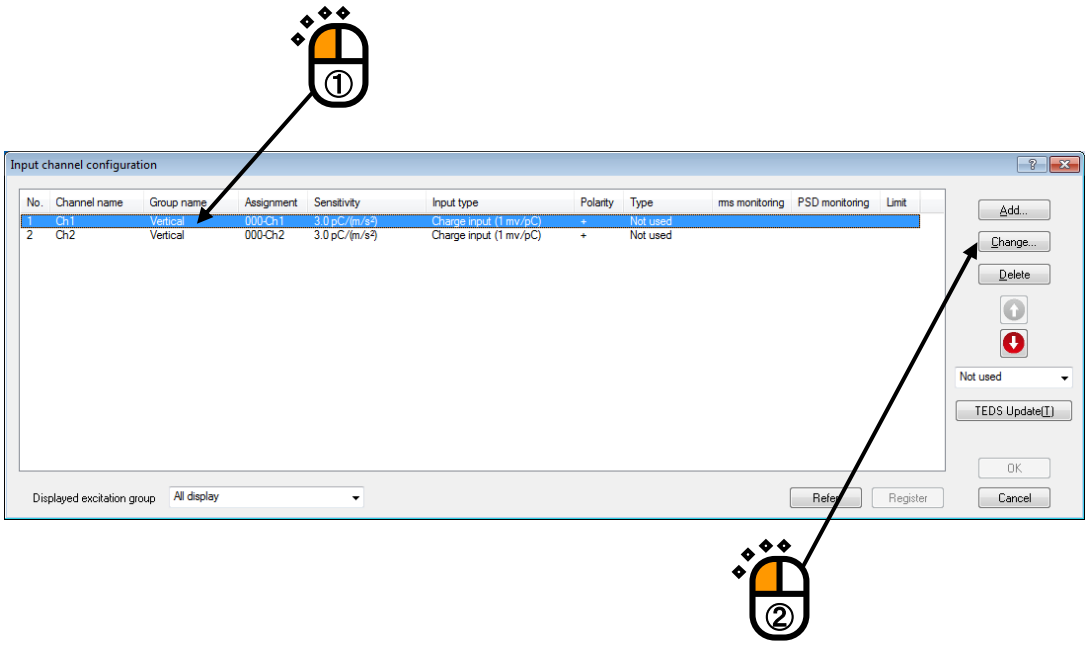
<Step 35>

Press the button to go to the next definition.



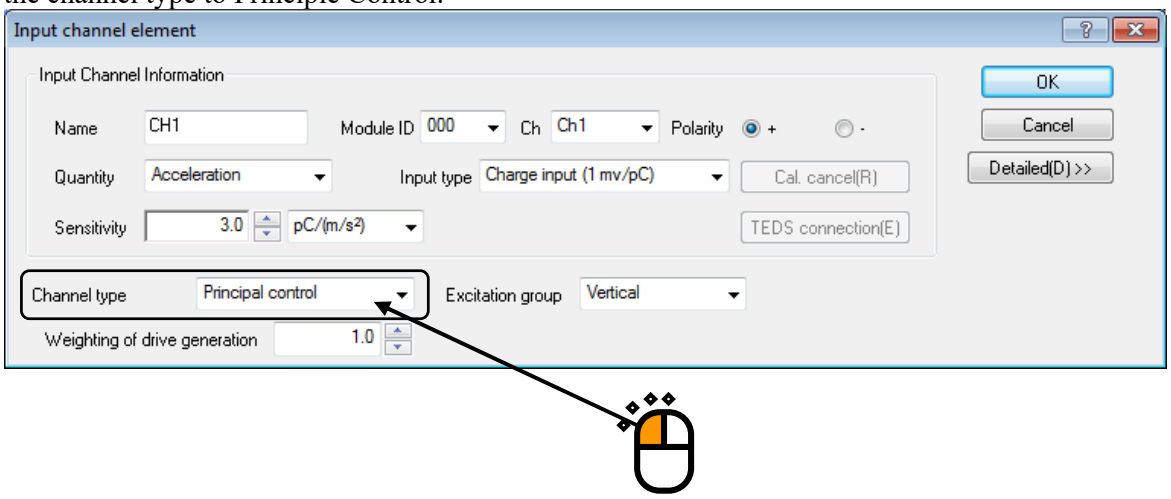
<Step 36>

Select the ch1 in the list of input channels and press the button to change the channel setting.



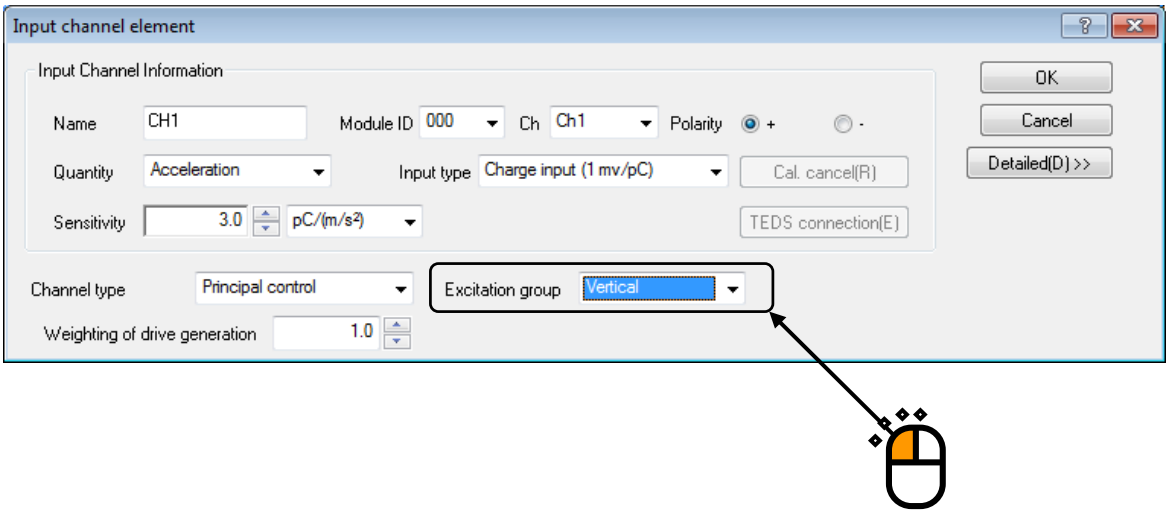
<Step 37>

Set the channel type to Principle Control.



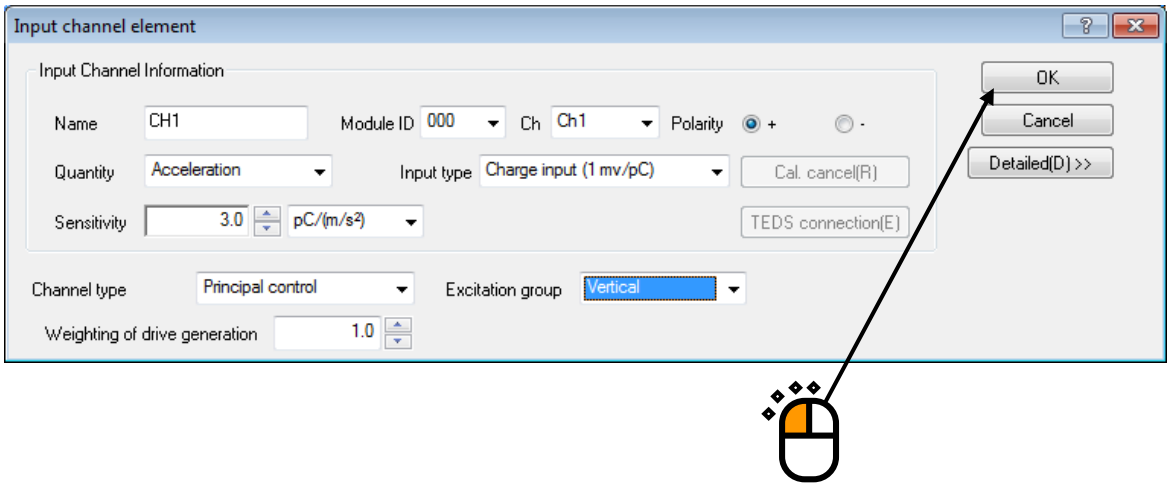
<Step 38>

Set the excitation group to vertical.



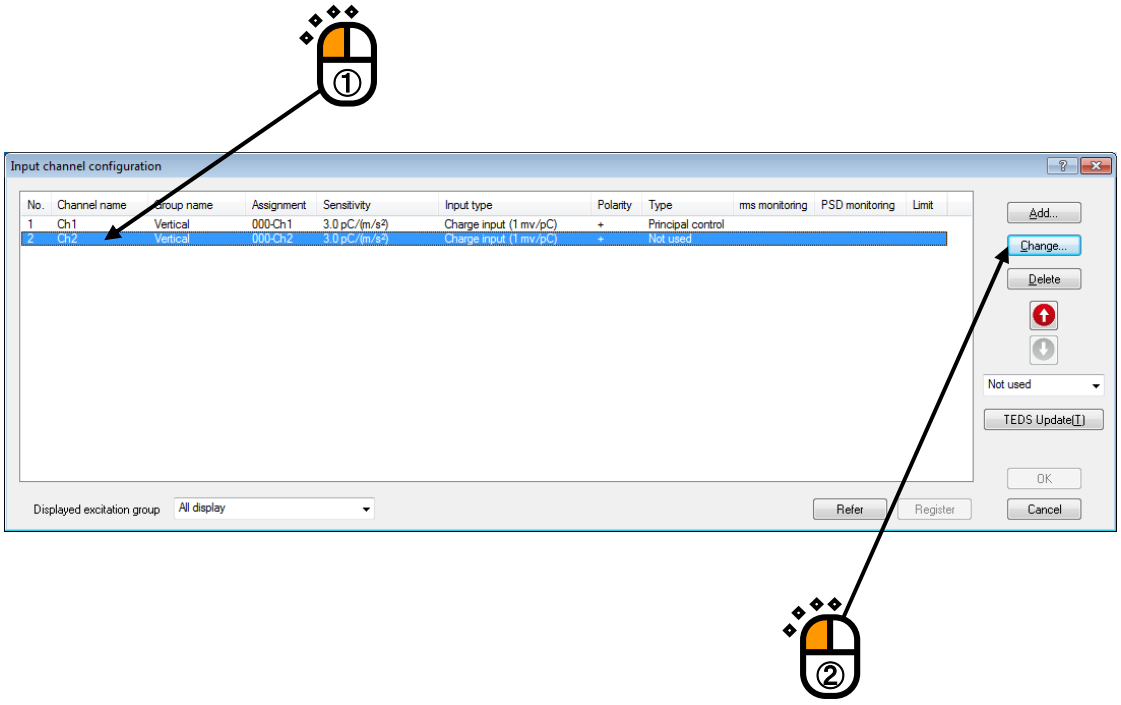
<Step 39>

Press the [OK] button.



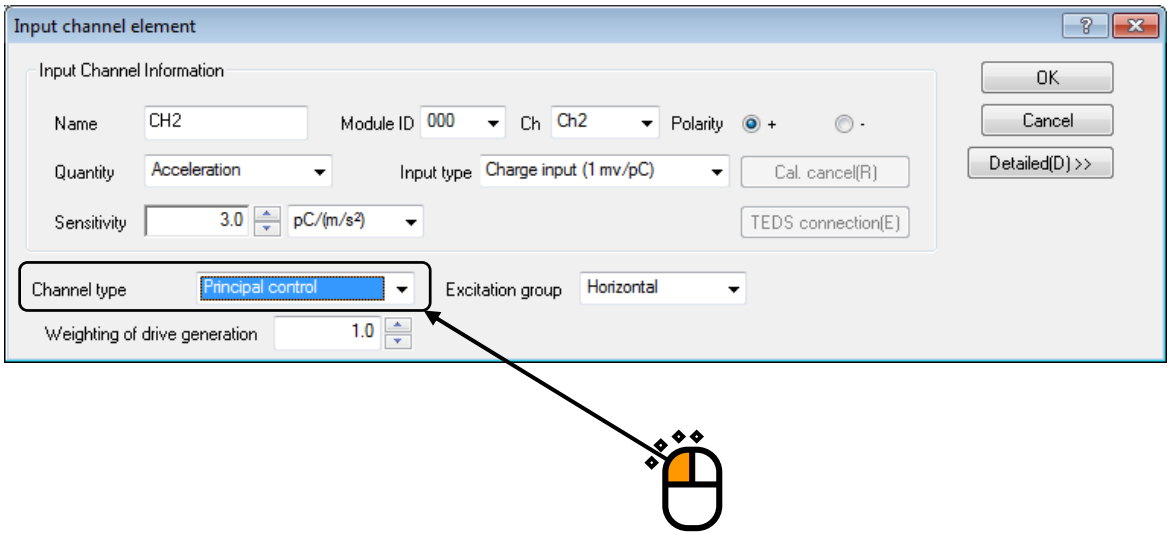
<Step 40>

Select the ch2 in the list of input channels and press the button to change the channel setting.



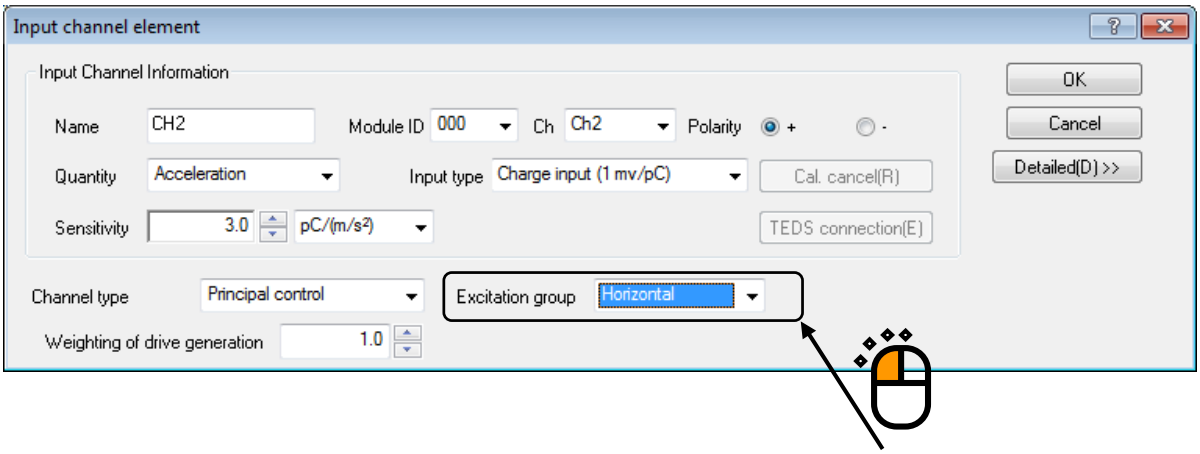
<Step 41>

Set the channel type to Principle Control.



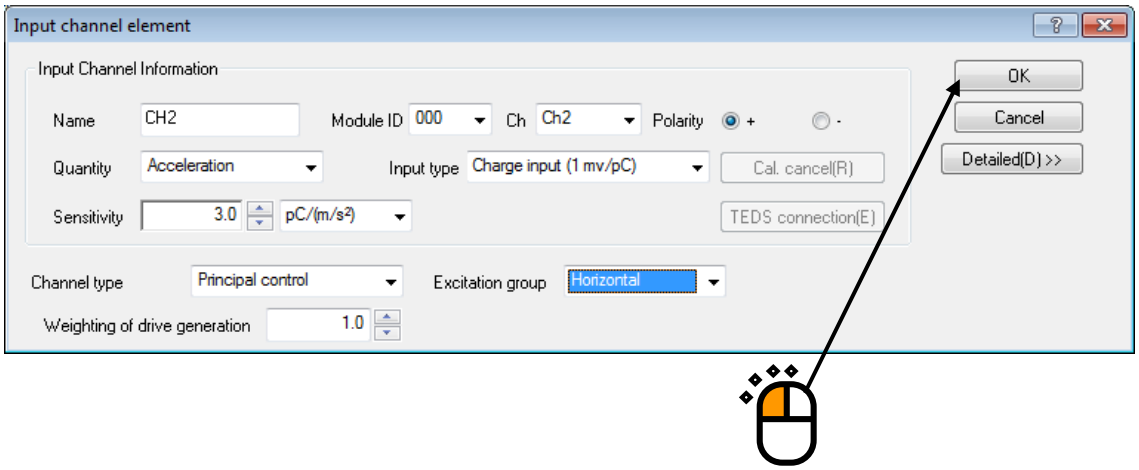
<Step 42>

Set the excitation group to horizontal.



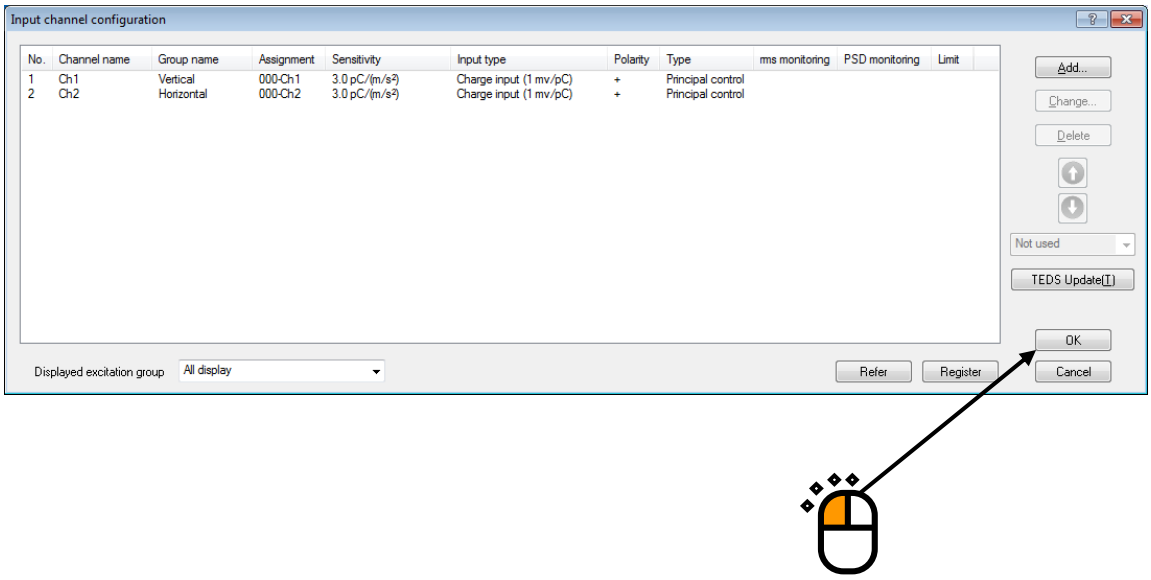
<Step 43>

Press the [OK] button.



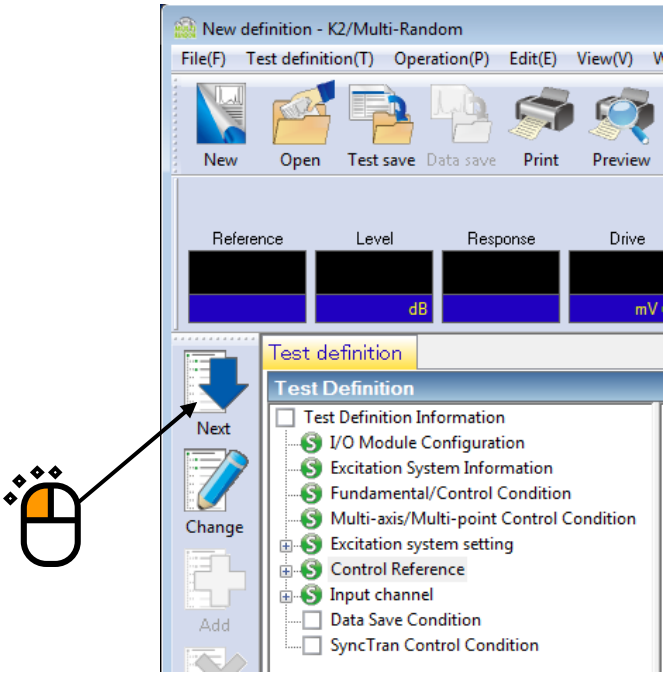
<Step 44>

Press the [OK] button.



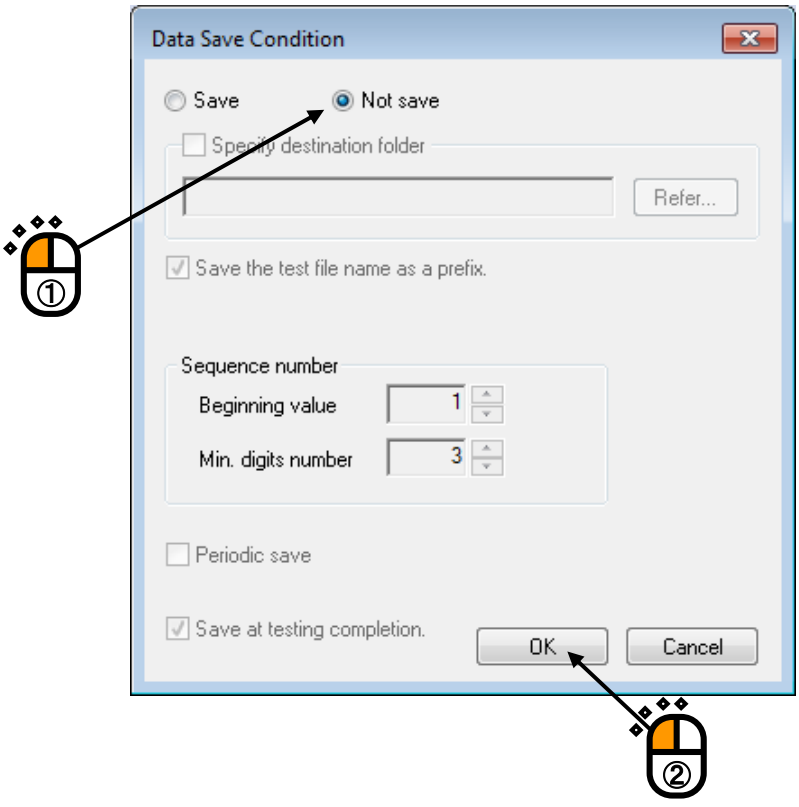
<Step 45>

Press the button to go to the next definition.



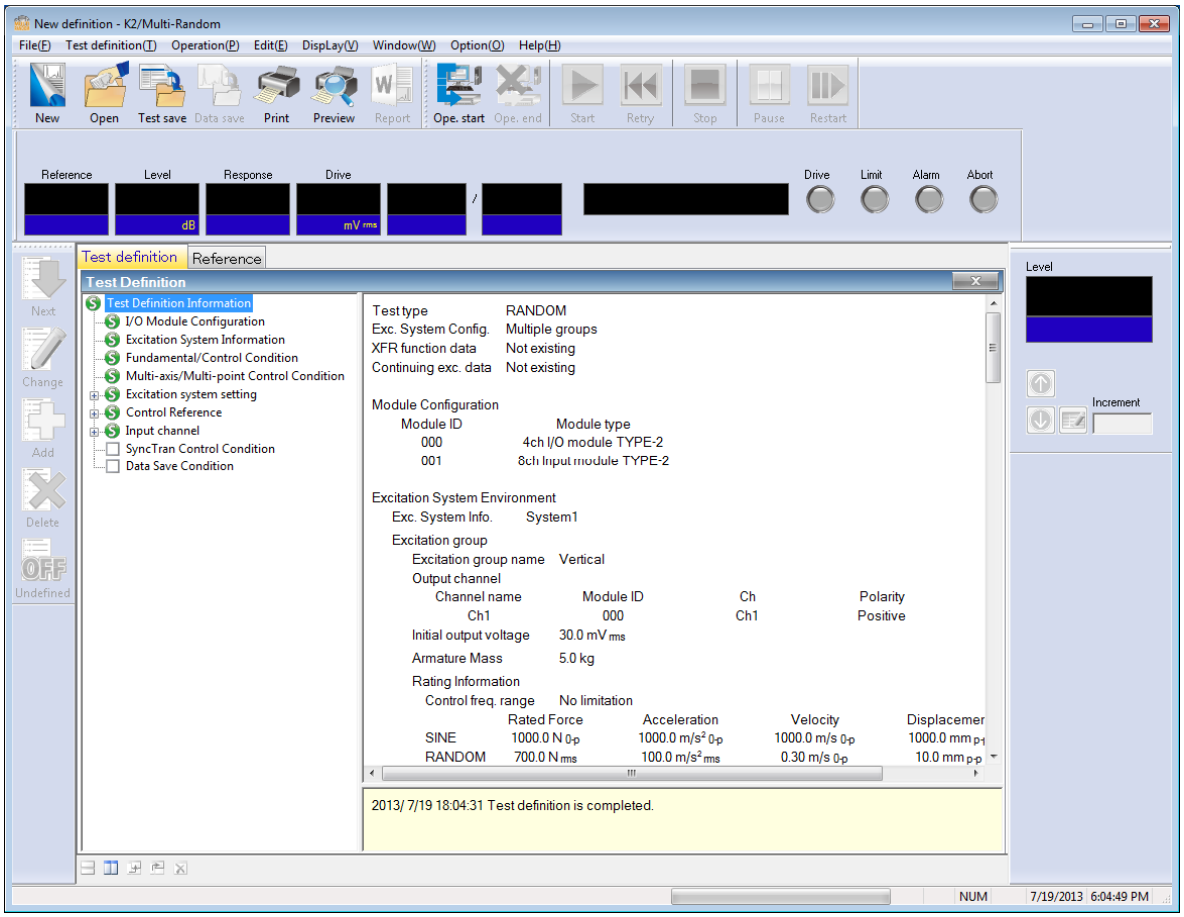
< Step46 >

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



< Step47 >

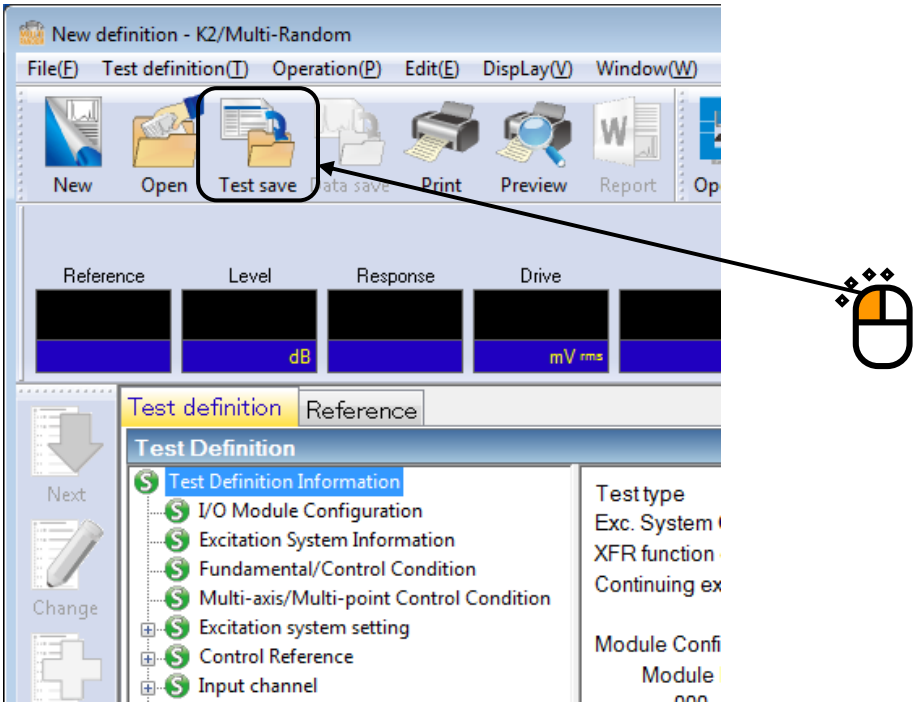
The definition is completed.



<Data save>

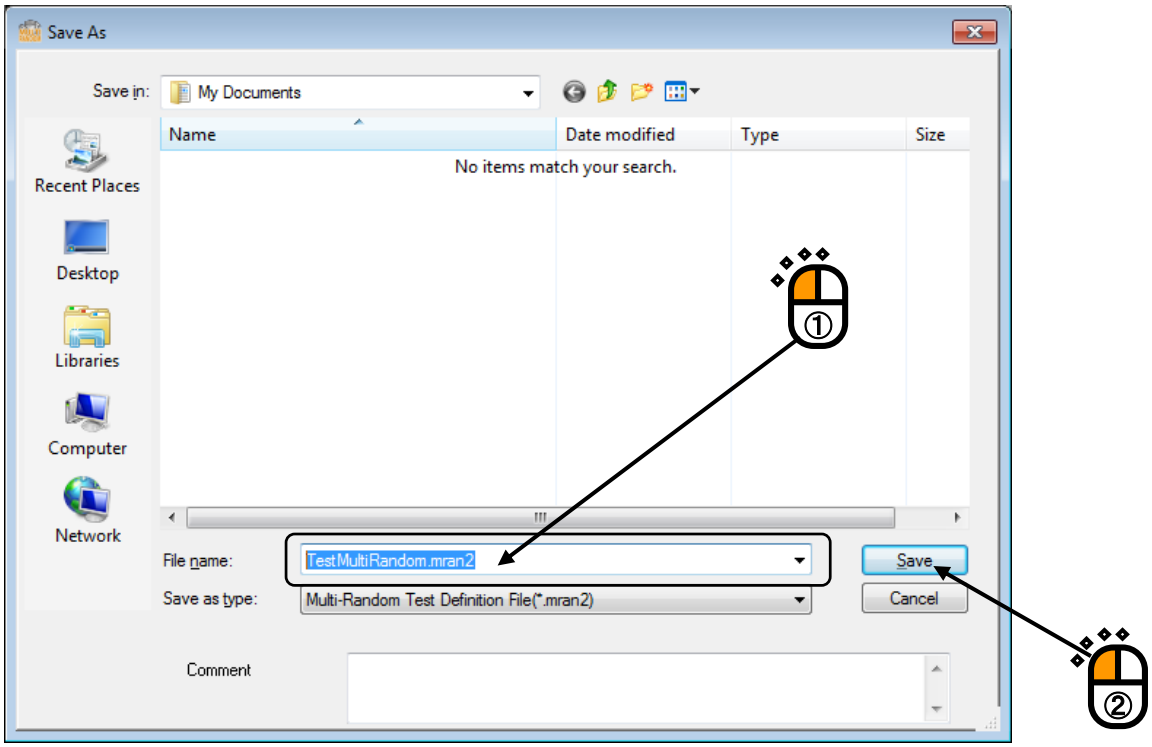
<Step 1>

Press the button to save the test definition data.



<Step 2>

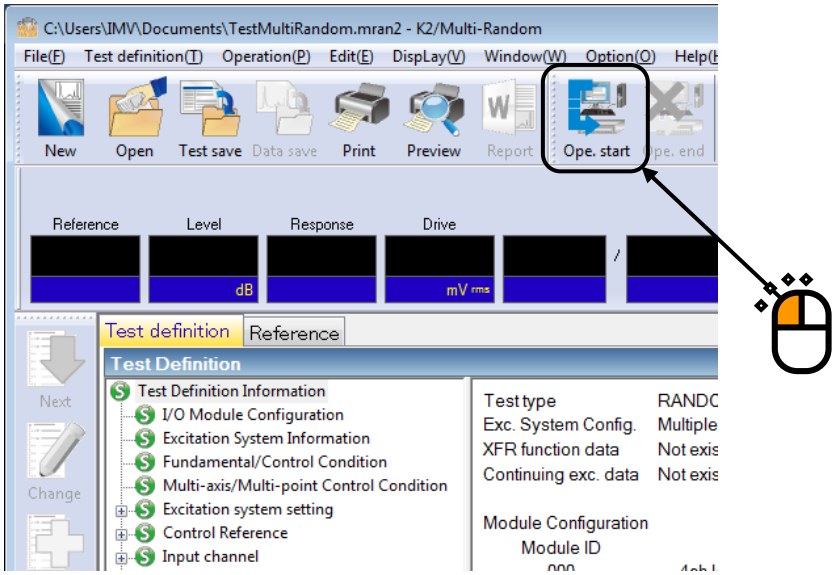
Input the file name and press the button to save the data.



<Test operation>

<Step 1>

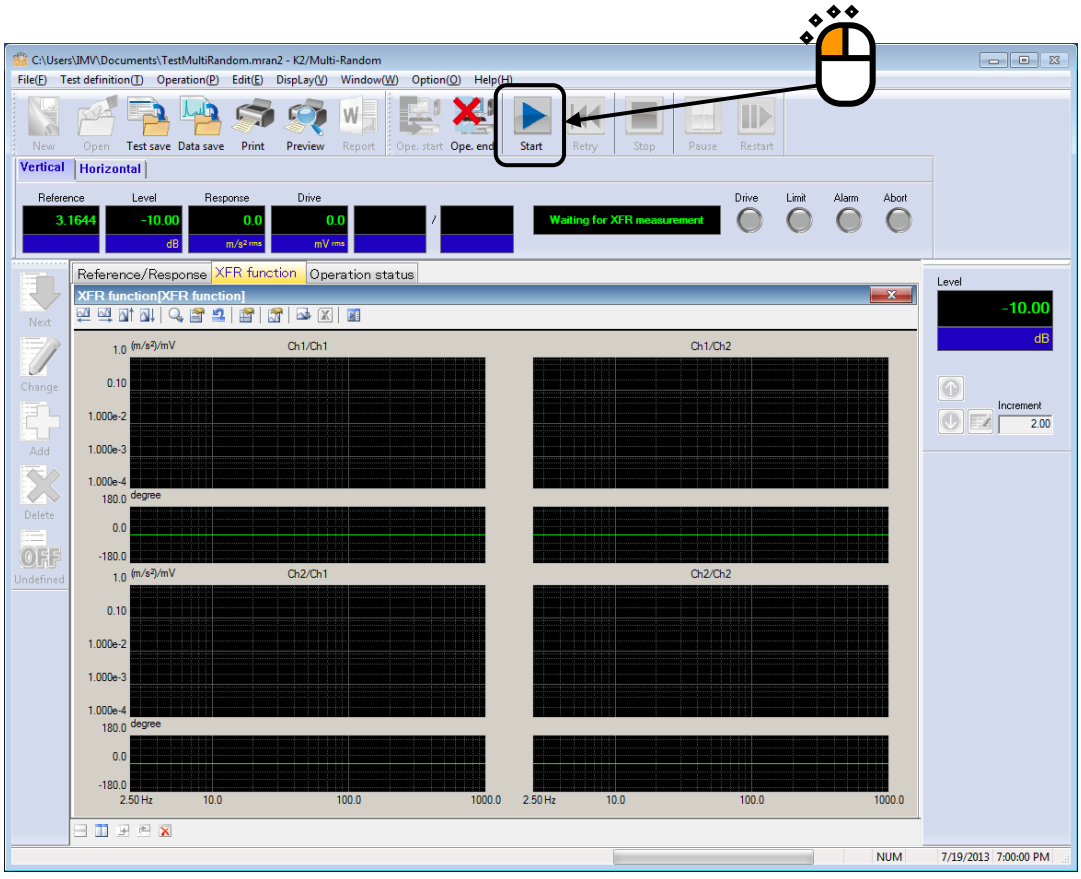
Press the button to start the operation.



<Step 2>

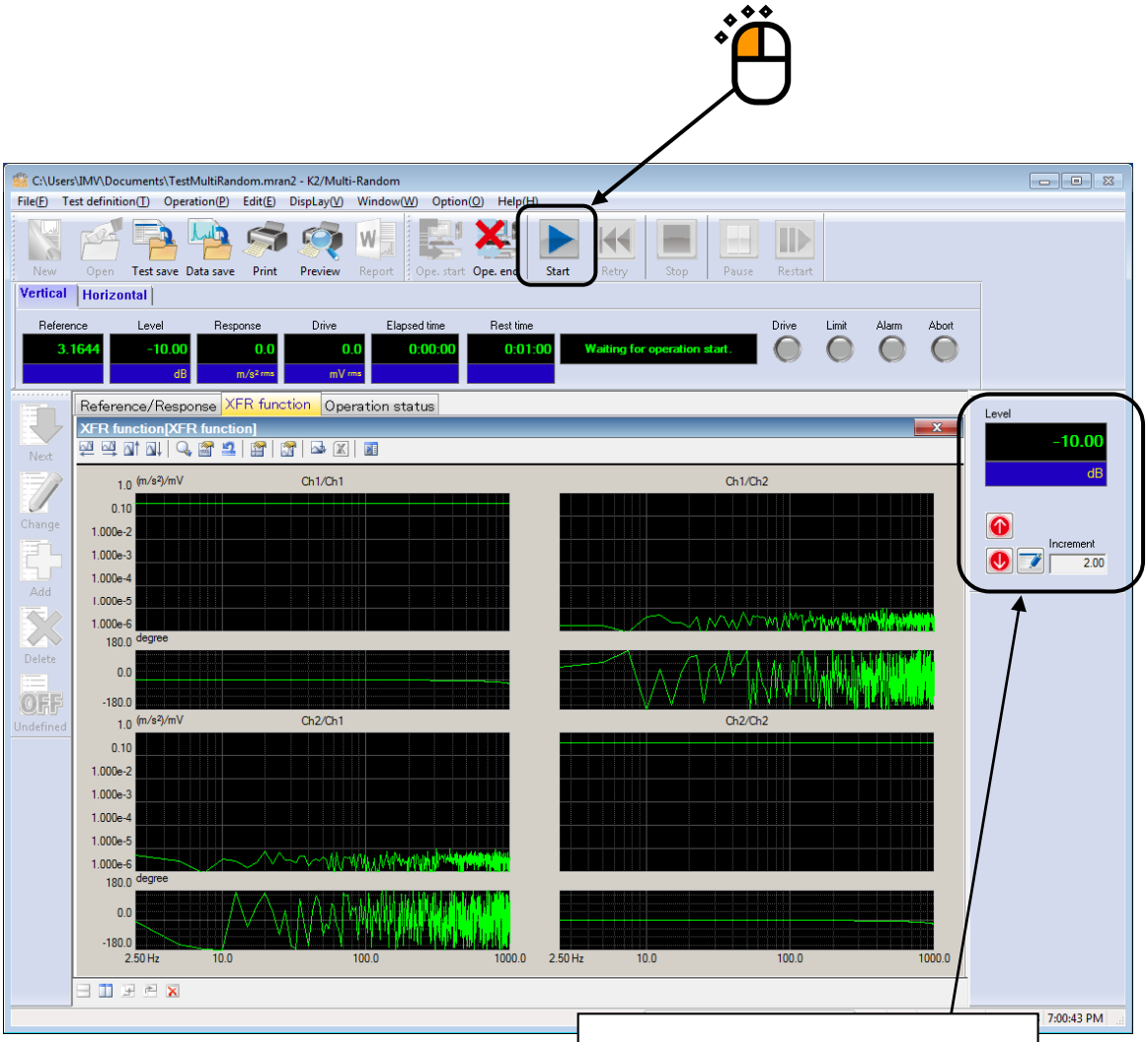
Press the button of XFR measurement start.

Initial loop check is automatically operated and the XFR measurement is started.



<Step 3>

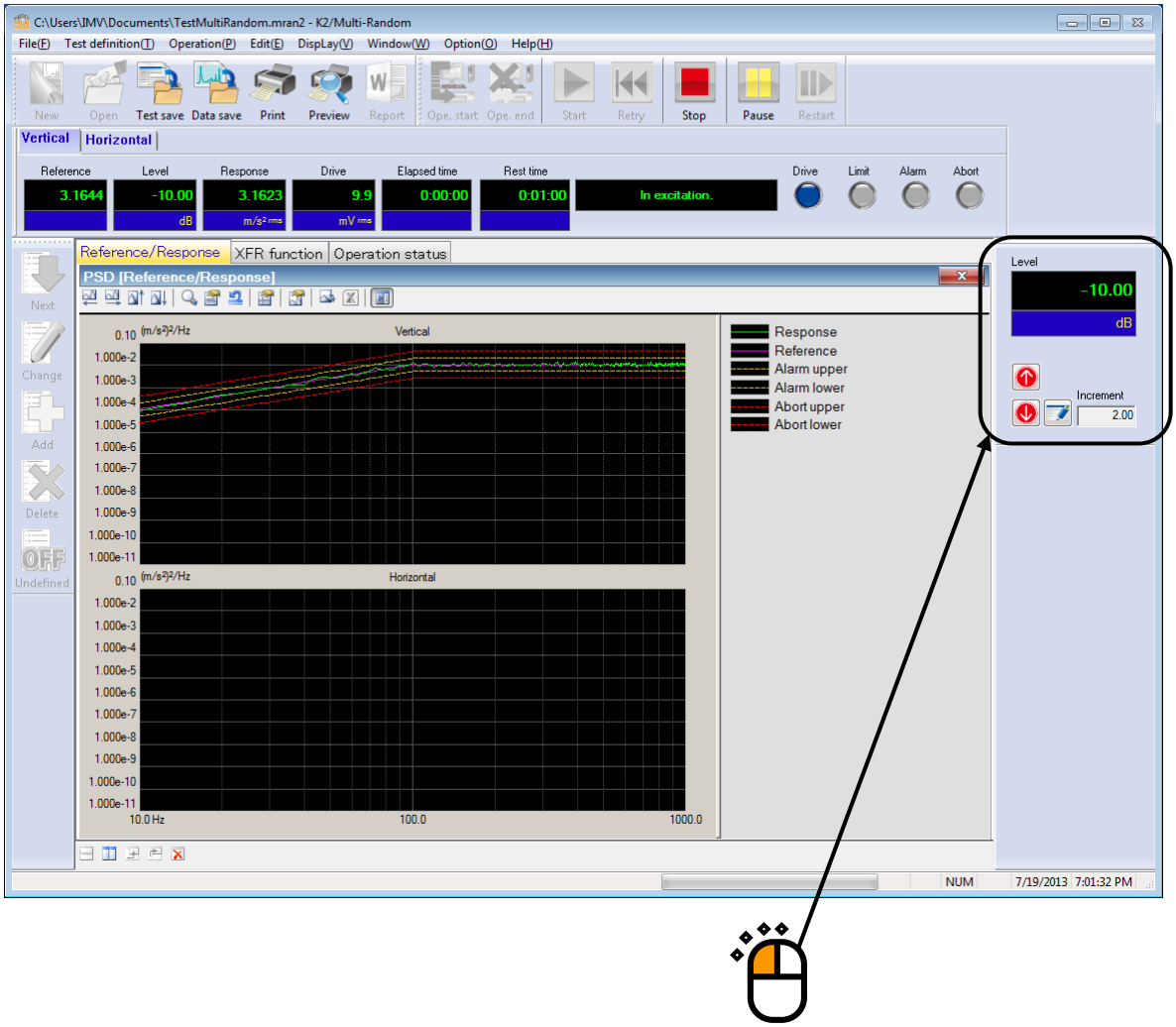
The system proceeds to the state of waiting for operation start when the XFR measurement is finished. Press the button of operation start. Initial loop check and initial equalization are automatically operated. When initial check and initial equalization are finished, the test operation is started at the initial excitation level (-10dB in this example).



<Step 4>

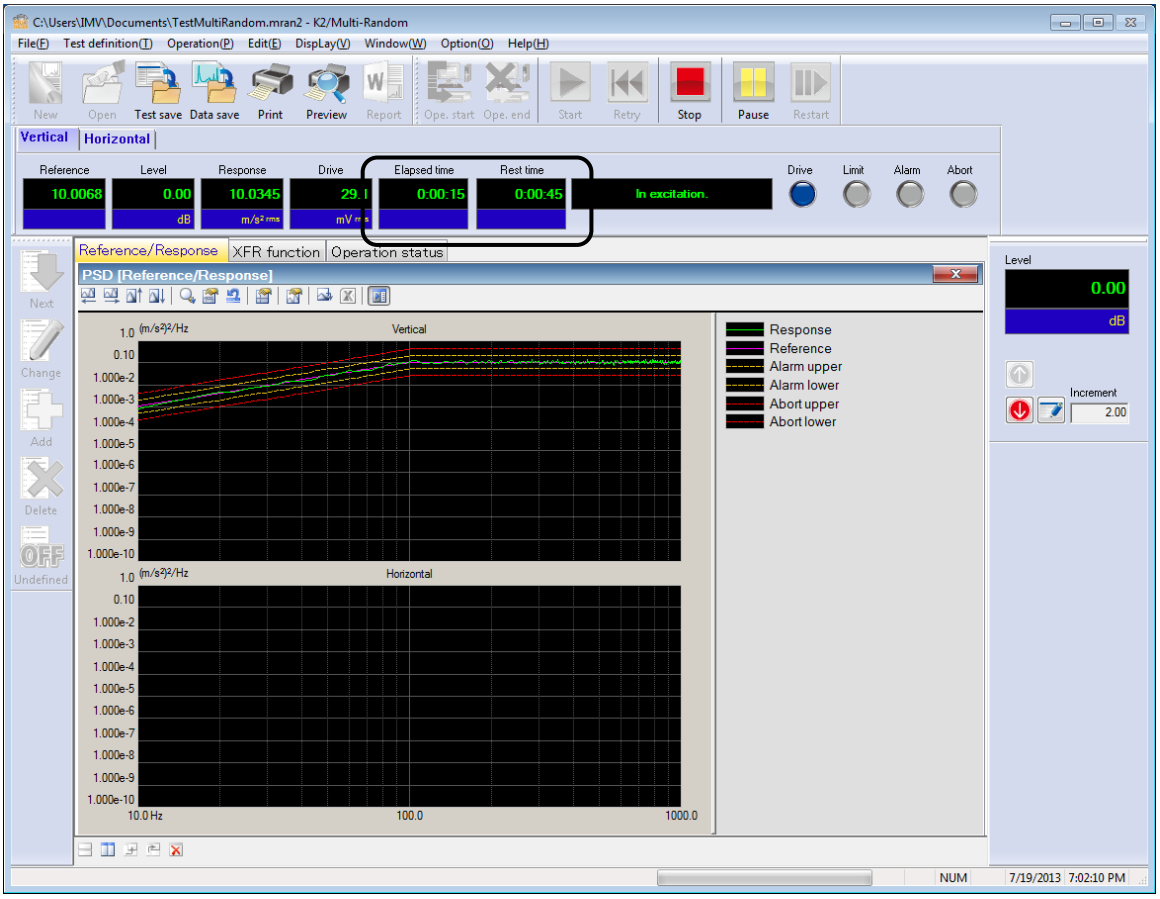
The test operation is started at the initial excitation level (-10dB in this example).

Press the level up button of excitation level and set the value to 0dB.



<Step 5>

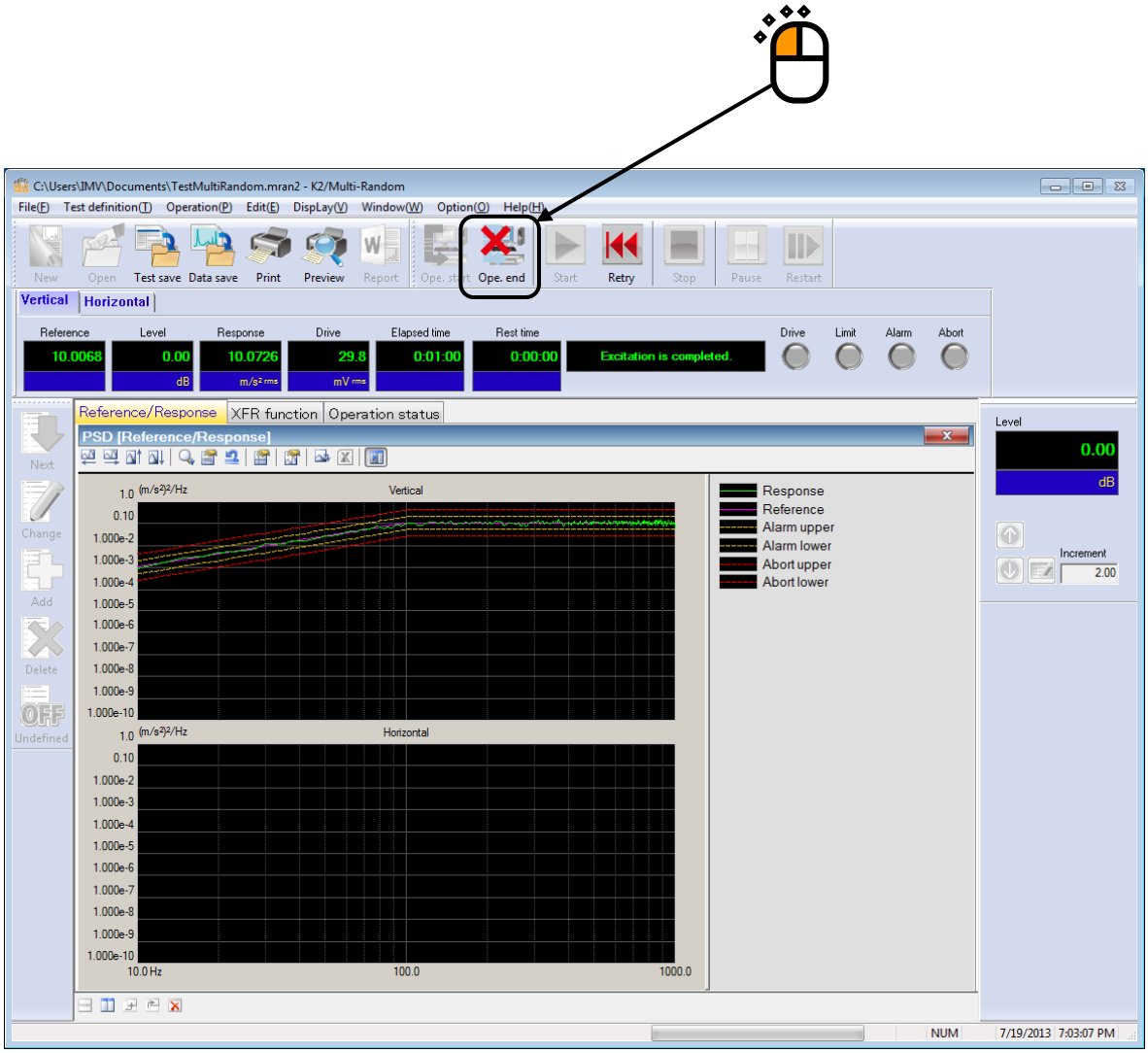
Test time starts to count the elapsed time for test operation when the excitation level is set to 0dB.



<Step 6>

Test operation is stopped when the test time ends.

Press the button of operation end. The system proceeds to the display of test definition mode.



3.2 Measured PSD

<Example>

An example of measured PSD test is described as below.

[Reference pattern]

Measured PSD data for the operation of vertical/horizontal direction.

[Control condition]

Frequency range : 2000Hz

Control lines : 400 lines

[Test time]

1 minute

[Used sensors]

Two of the piezoelectric accelerometers are used in this example.

Ch1 : for Principle Control, sensitivity 3pC/(m/s^2), Measured PSD control

Ch2 : for Principle Control, sensitivity 3pC/(m/s^2), Measured PSD control

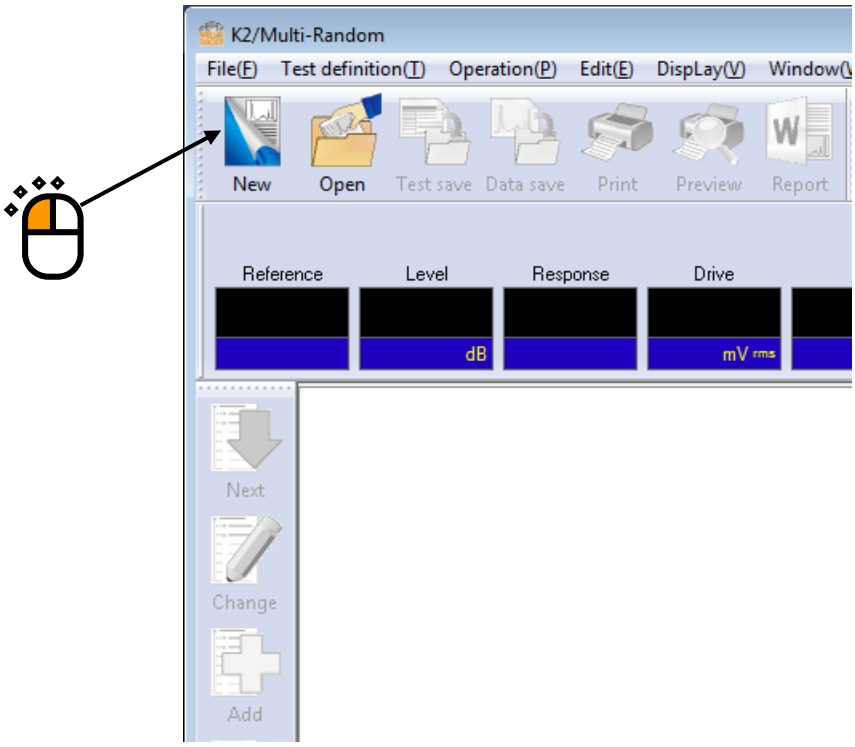
The input channel information of these pickups (channel name and sensitivity) are needed to be registered beforehand. The input channel information is registered as SysInp01 in this example.

Also, the excitation system information (excitation system rating, etc.) is registered. In this example, it is named as System1.

< Procedures>

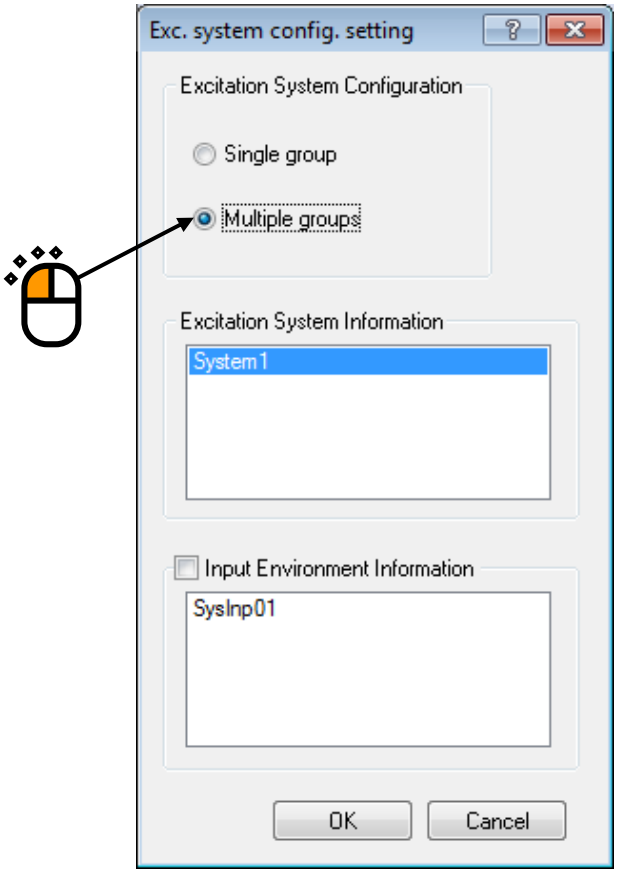
<Step 1>

Press the button to start a new definition.



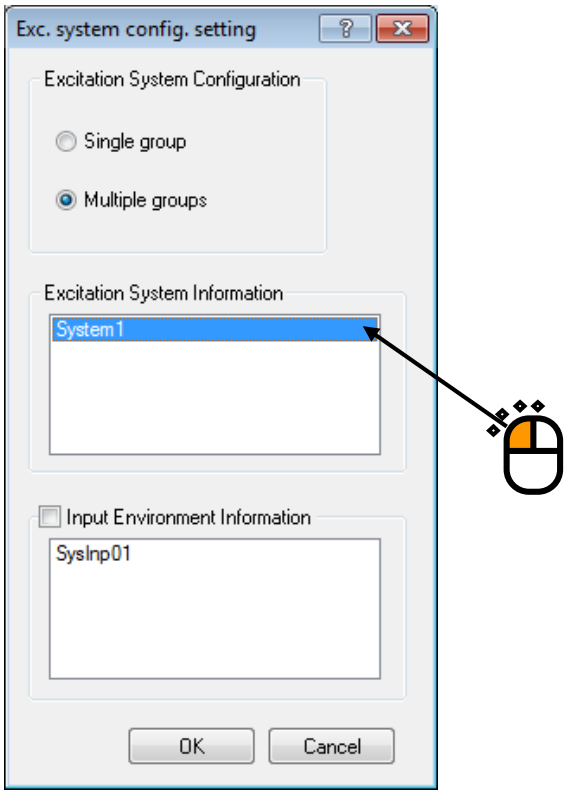
<Step 2>

Select the item of multiple groups in the excitation system configuration.



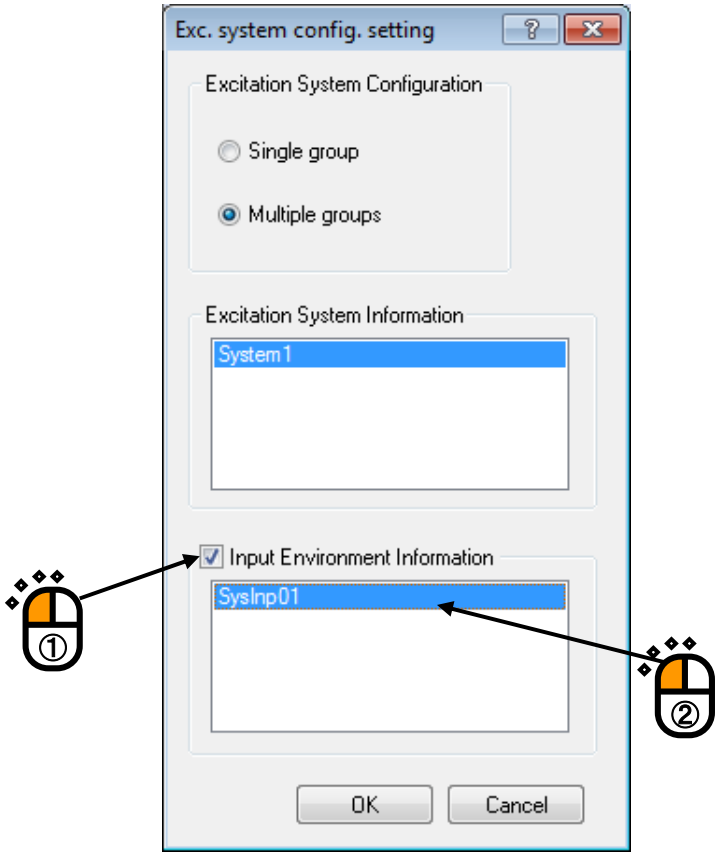
<Step 3>

Select an excitation system in the list of excitation system information.



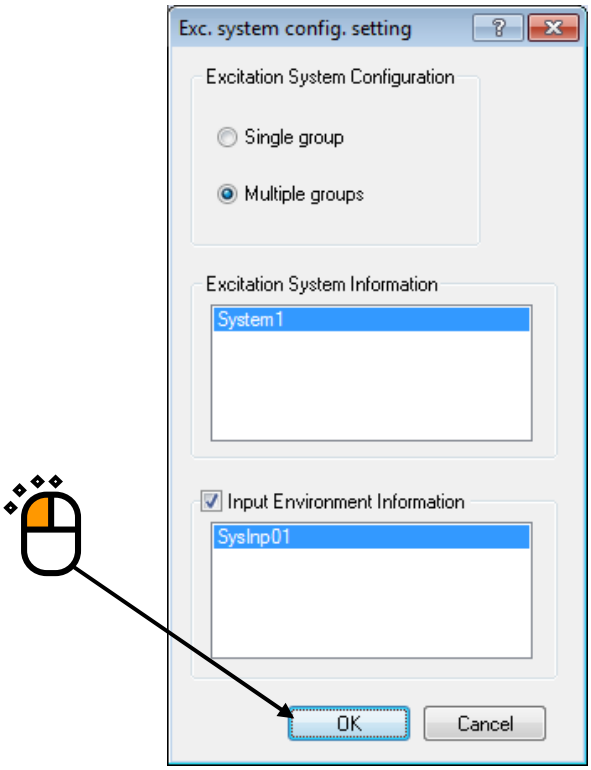
<Step 4>

Click the checkbox of input environment information and select the input channel information in the list.



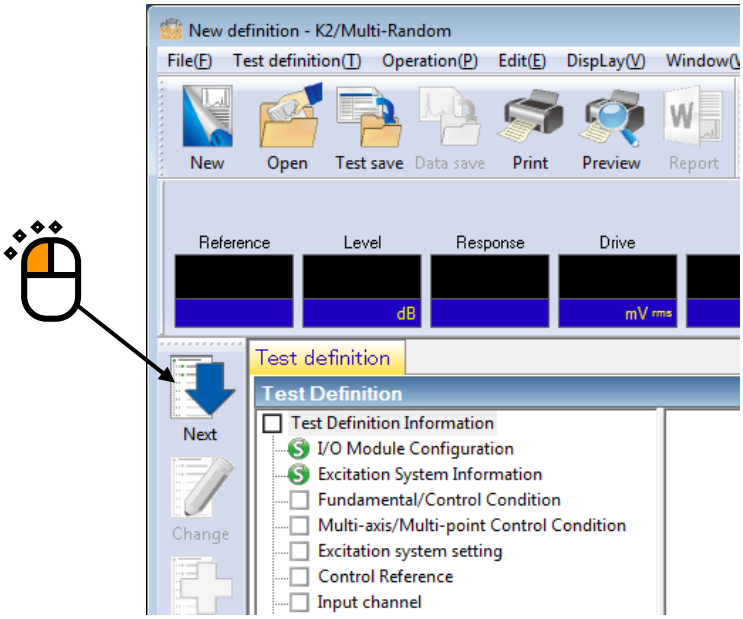
<Step 5>

Press the OK button.



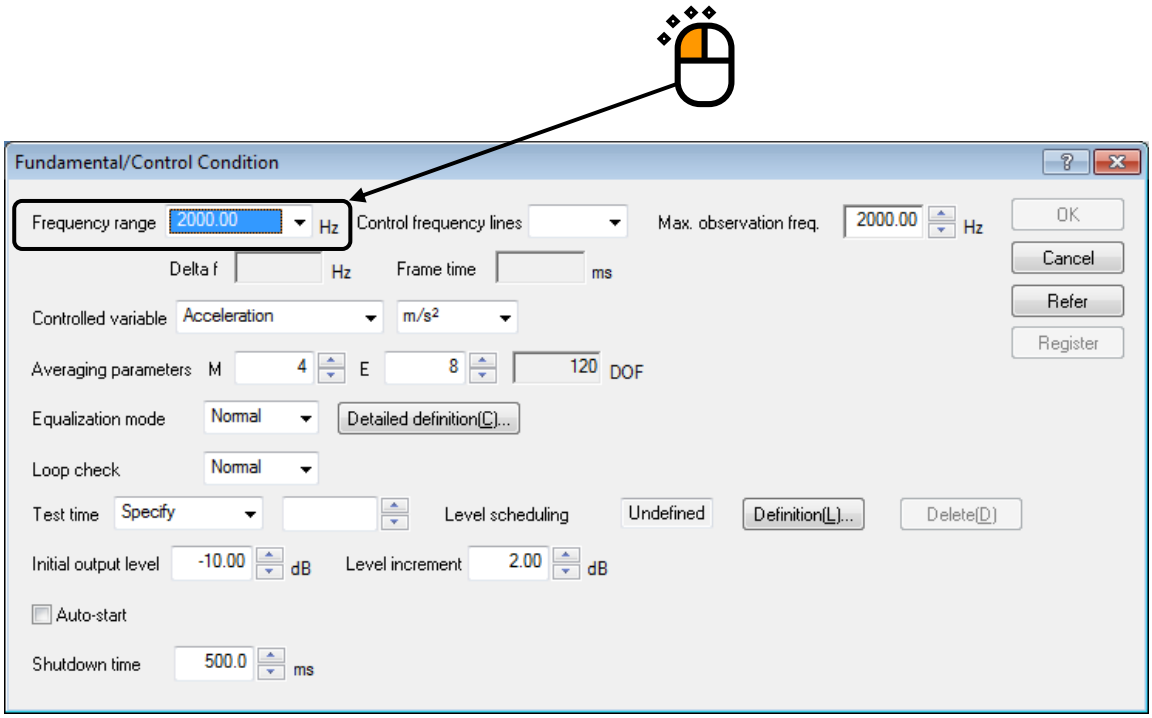
<Step 6>

Press the button to go to the next definition.



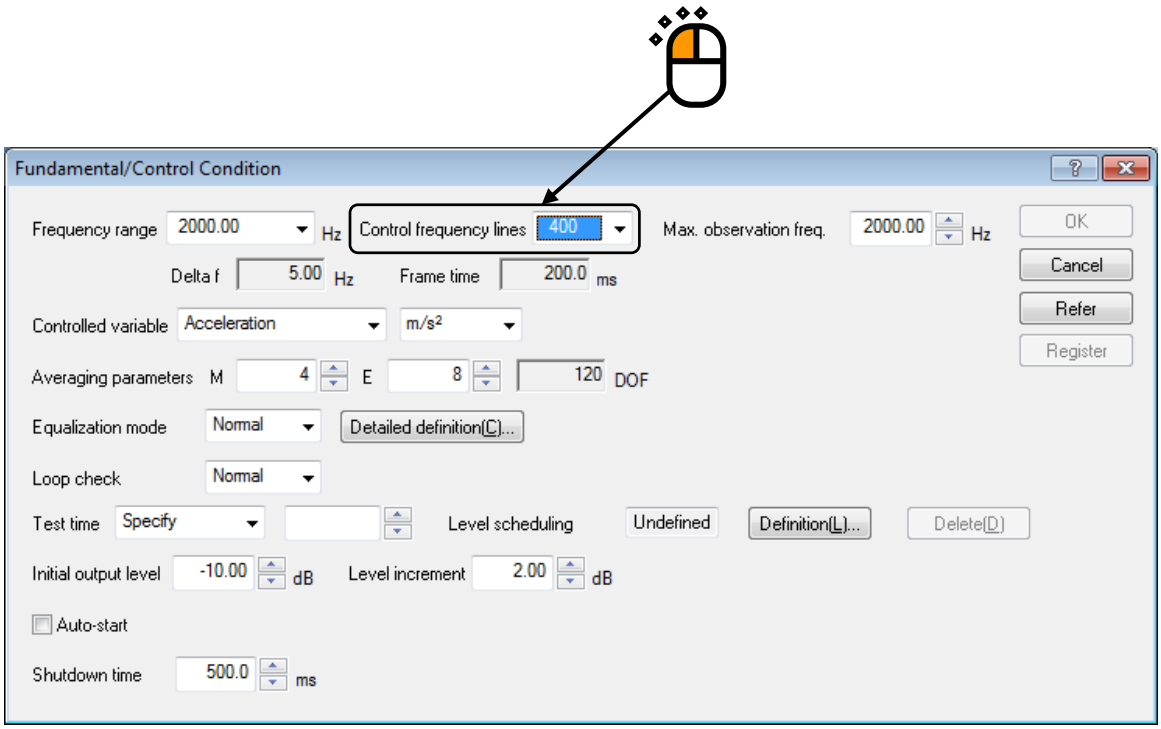
<Step 7>

Set the frequency range to ‘2000Hz’.



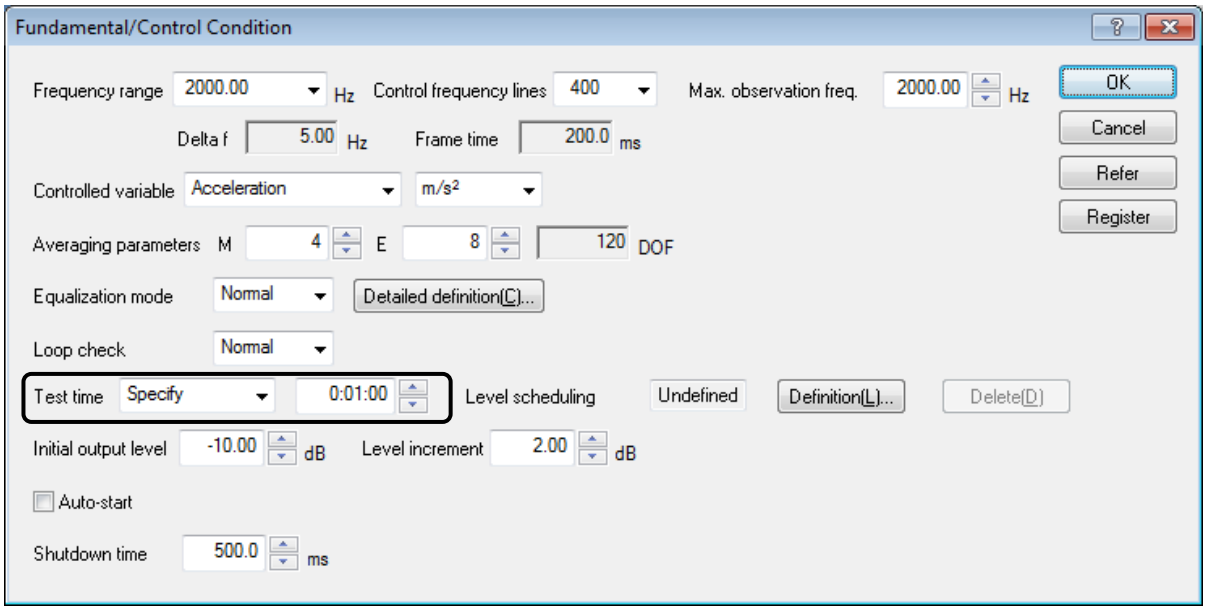
<Step 8>

Set the control frequency lines to ‘400’.



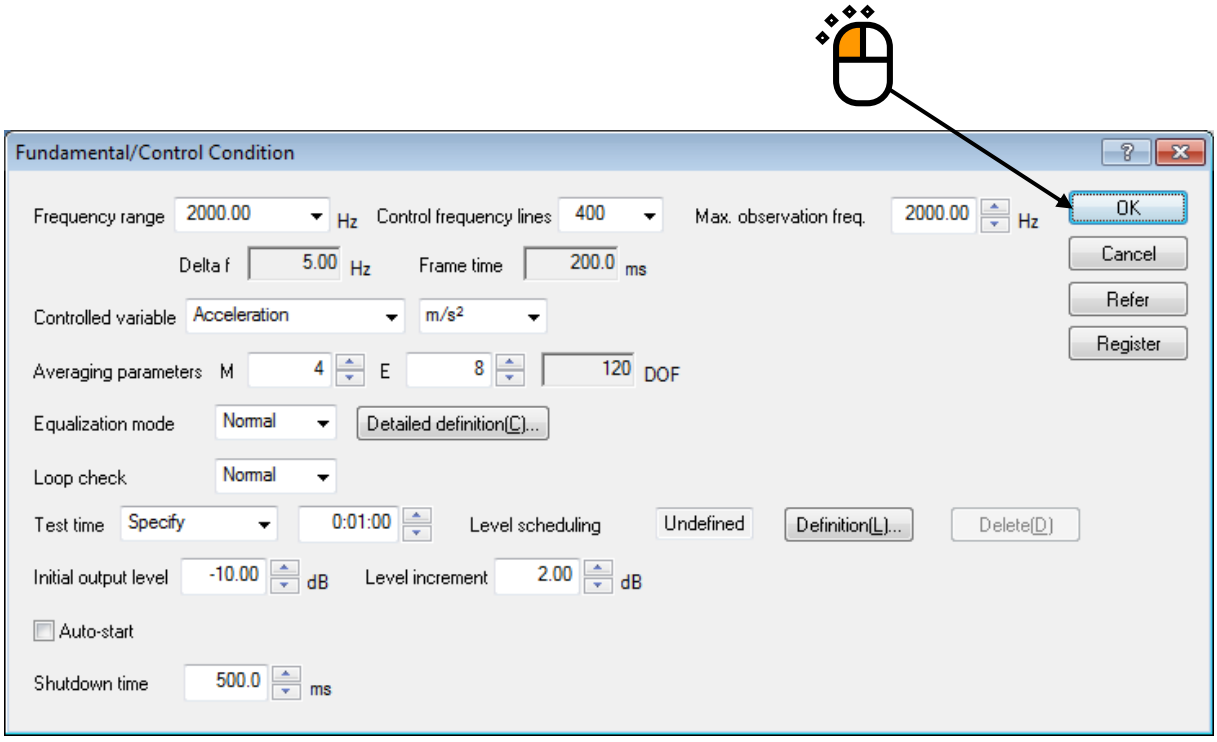
<Step 9>

Set the test time to specify the test time length. Input the value '0 : 01 : 00' (60 sec).



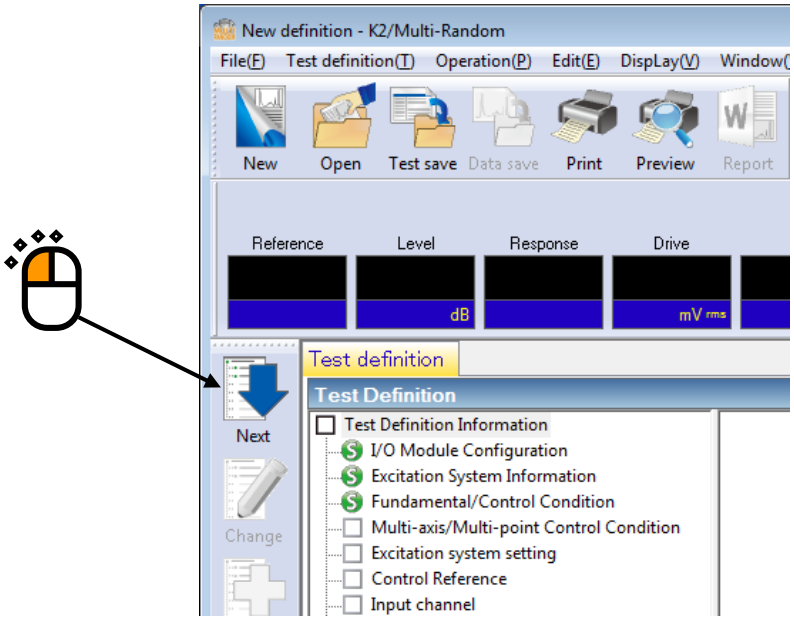
<Step 10>

Press the OK button.



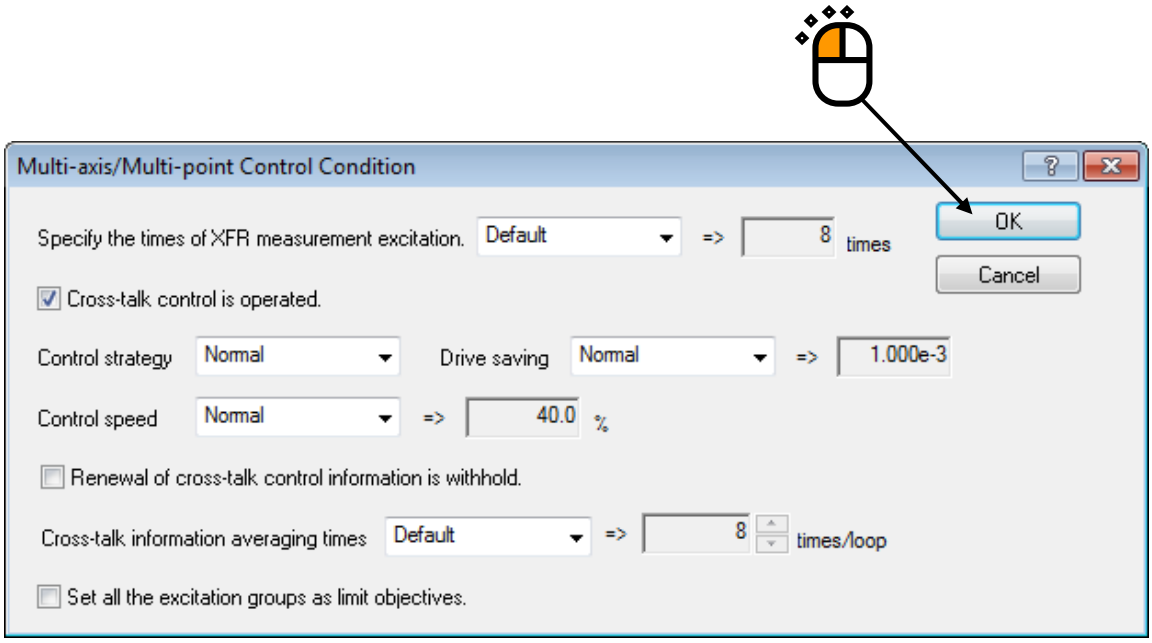
<Step 11>

Press the button to go to the next definition.



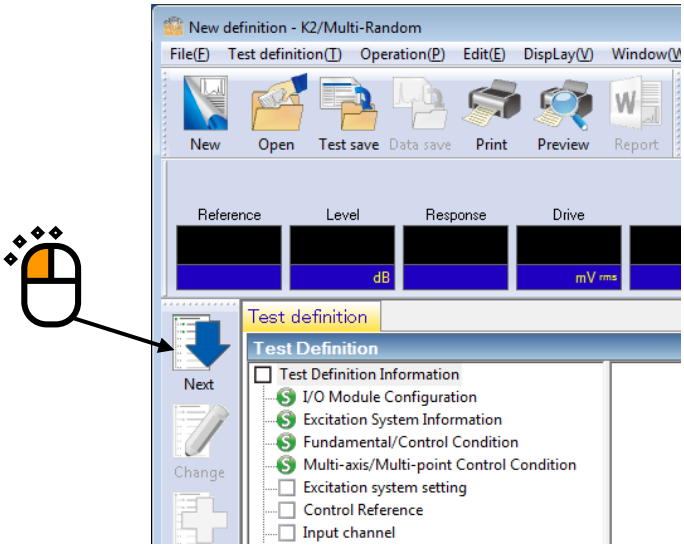
<Step 12>

Press the OK button.



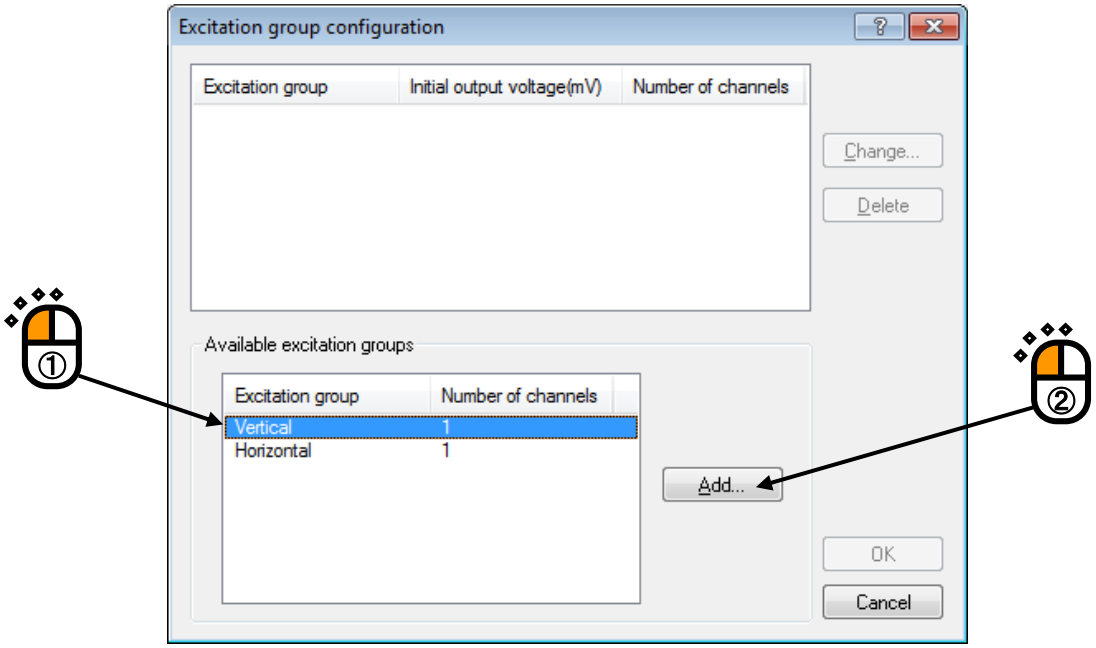
<Step 13>

Press the button to go to the next definition.



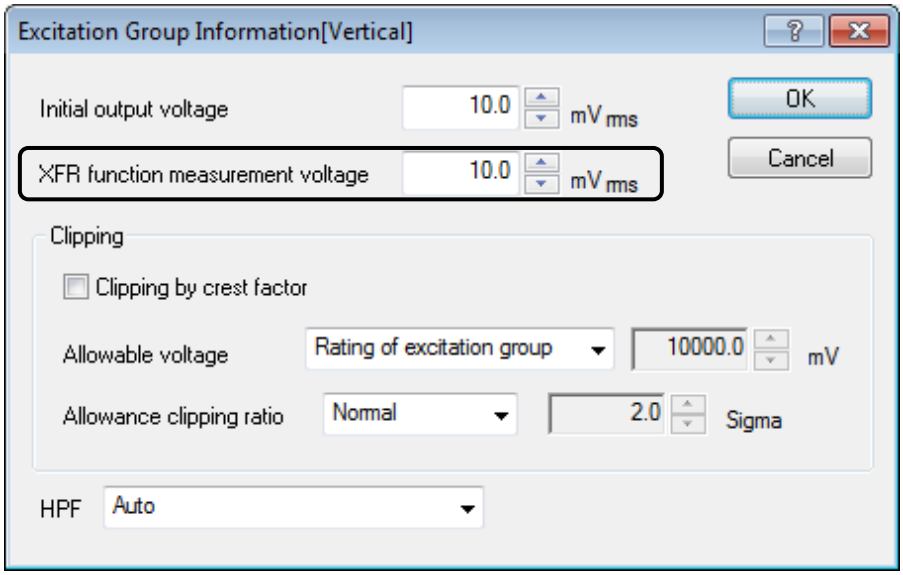
<Step 14>

Select an excitation group among the available excitation groups. Here, select ‘vertical’ and press the button to add.



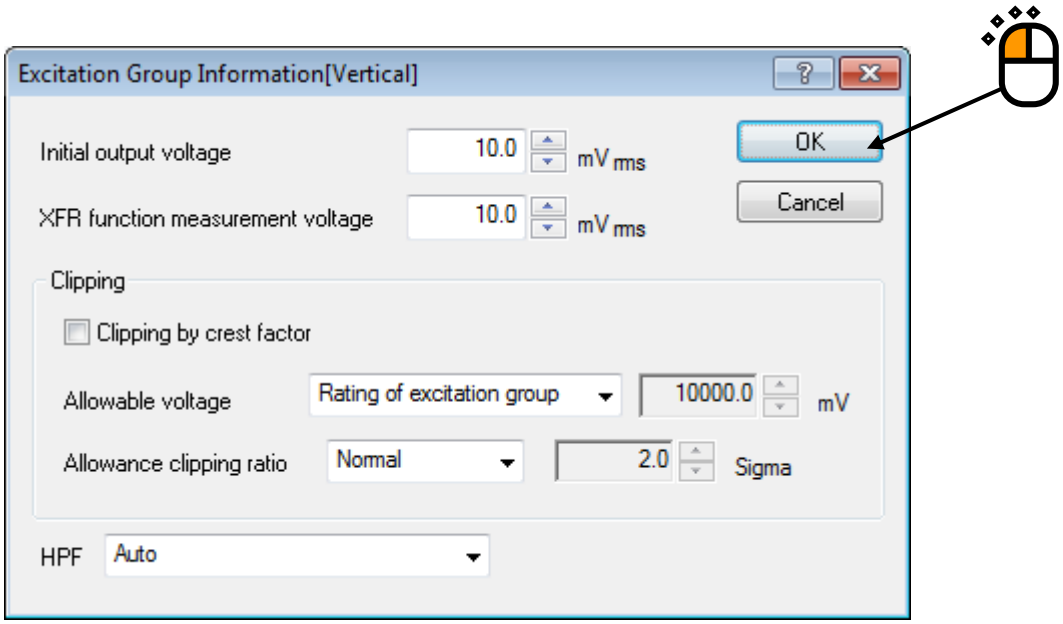
<Step 15>

Set the XFR function measurement voltage to 10 (mV_{rms}).



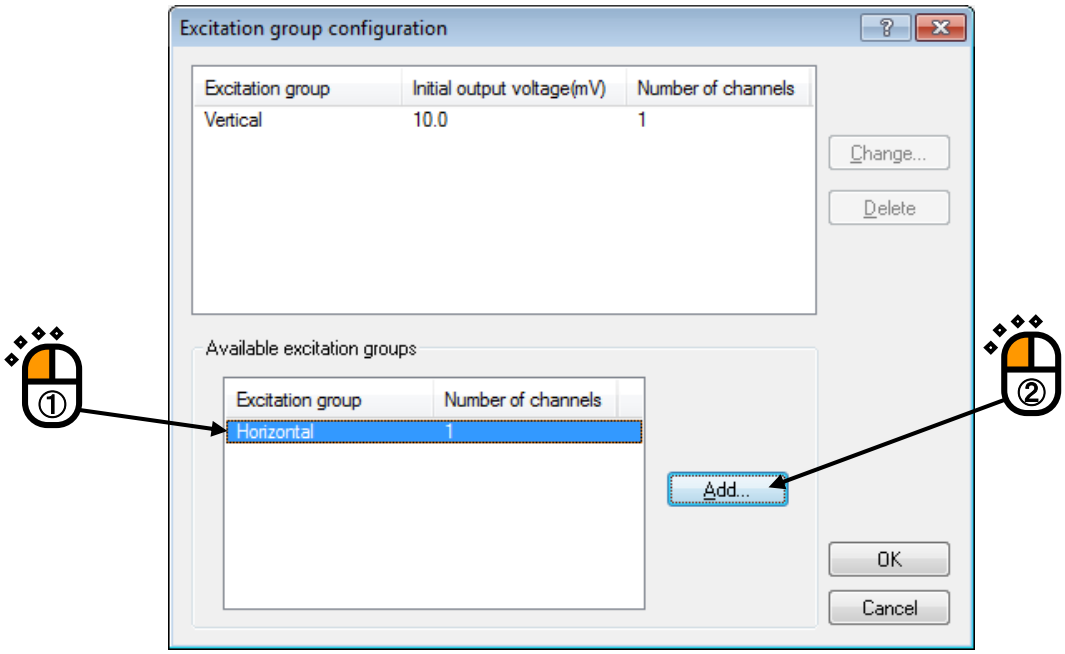
<Step 16>

Press the OK button.



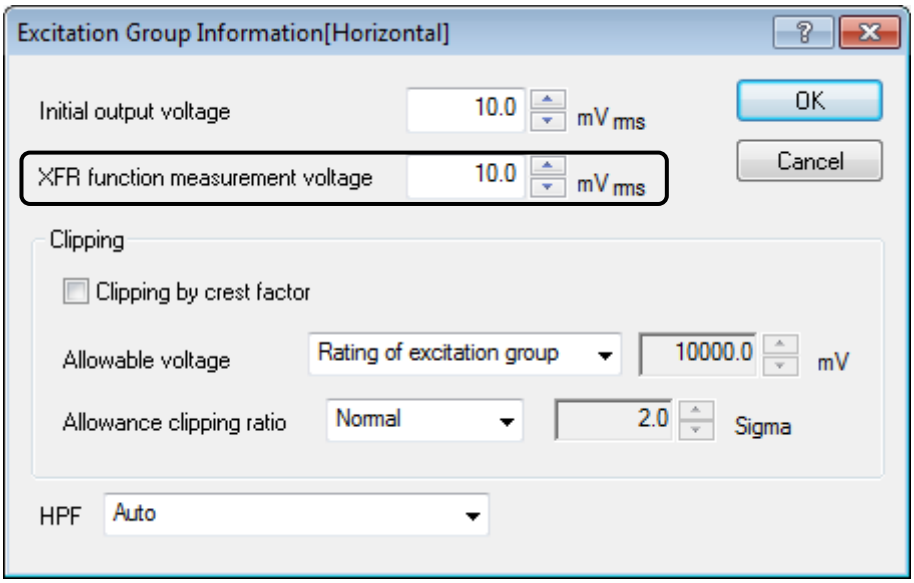
<Step 17>

Select an excitation group in the available excitation groups. Here, select ‘horizontal’ and press the button to add.



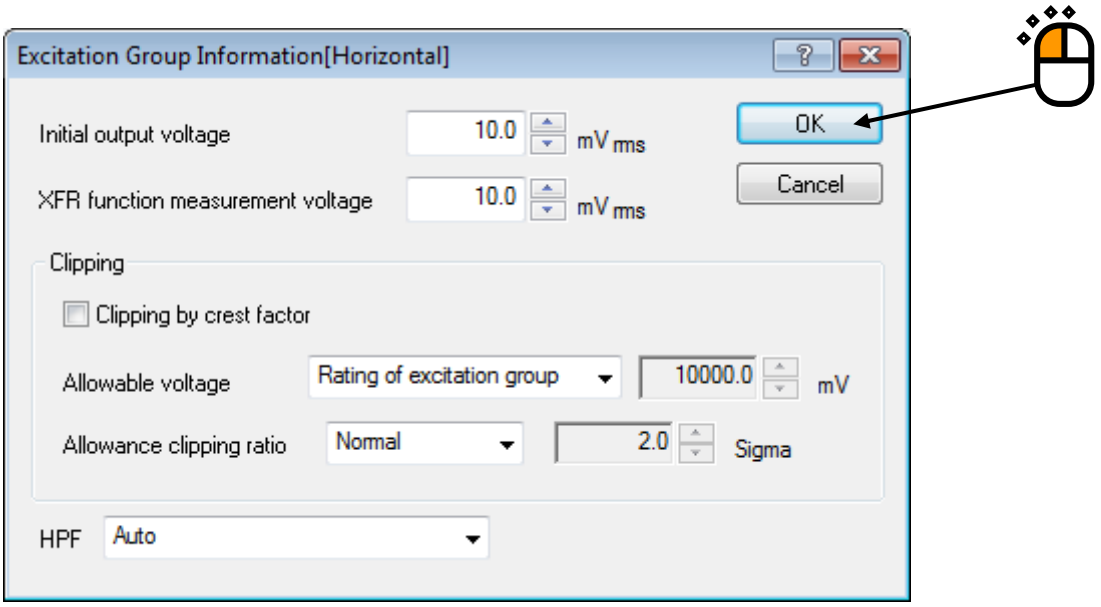
<Step 18>

Set the XFR function measurement voltage to 10 (mV_{rms}).



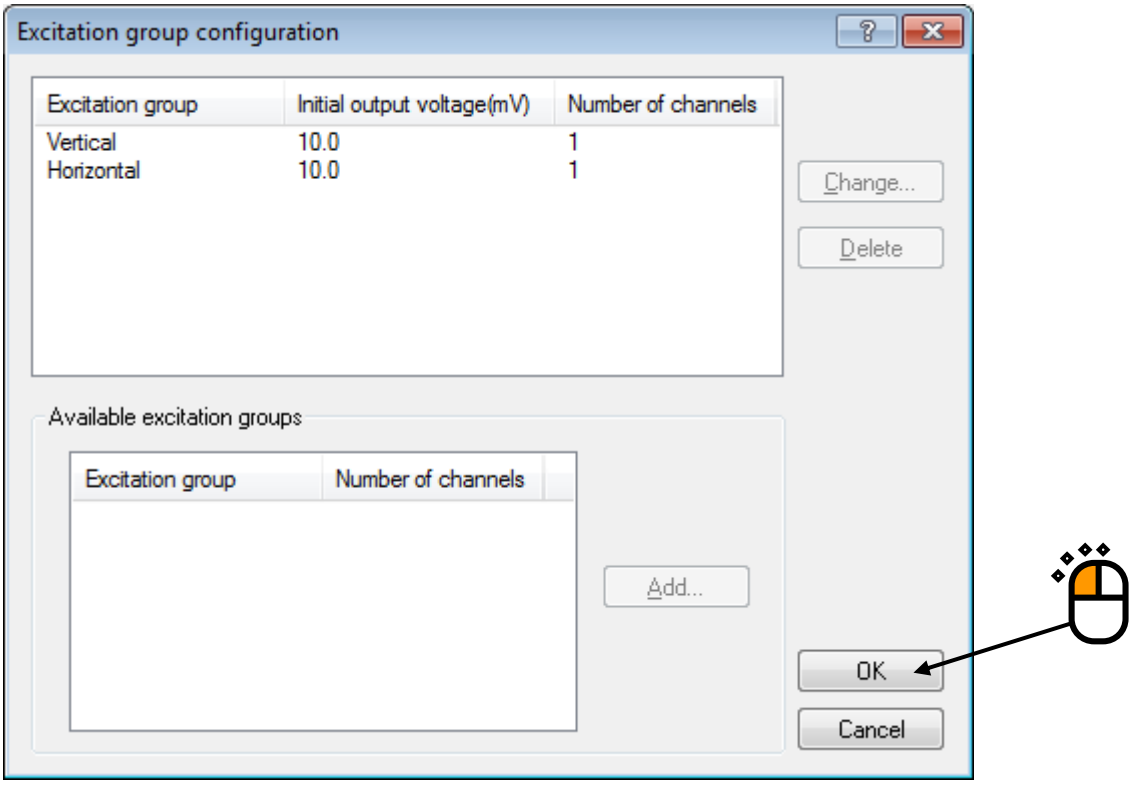
<Step 19>

Press the OK button.



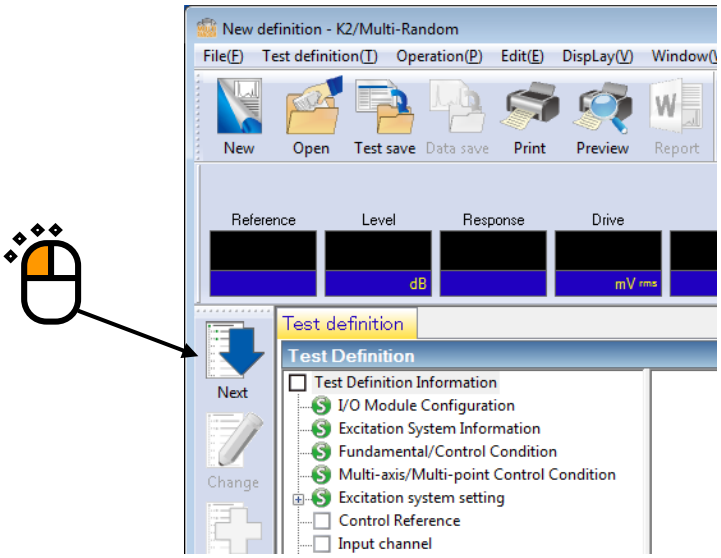
<Step 20>

Press the OK button.



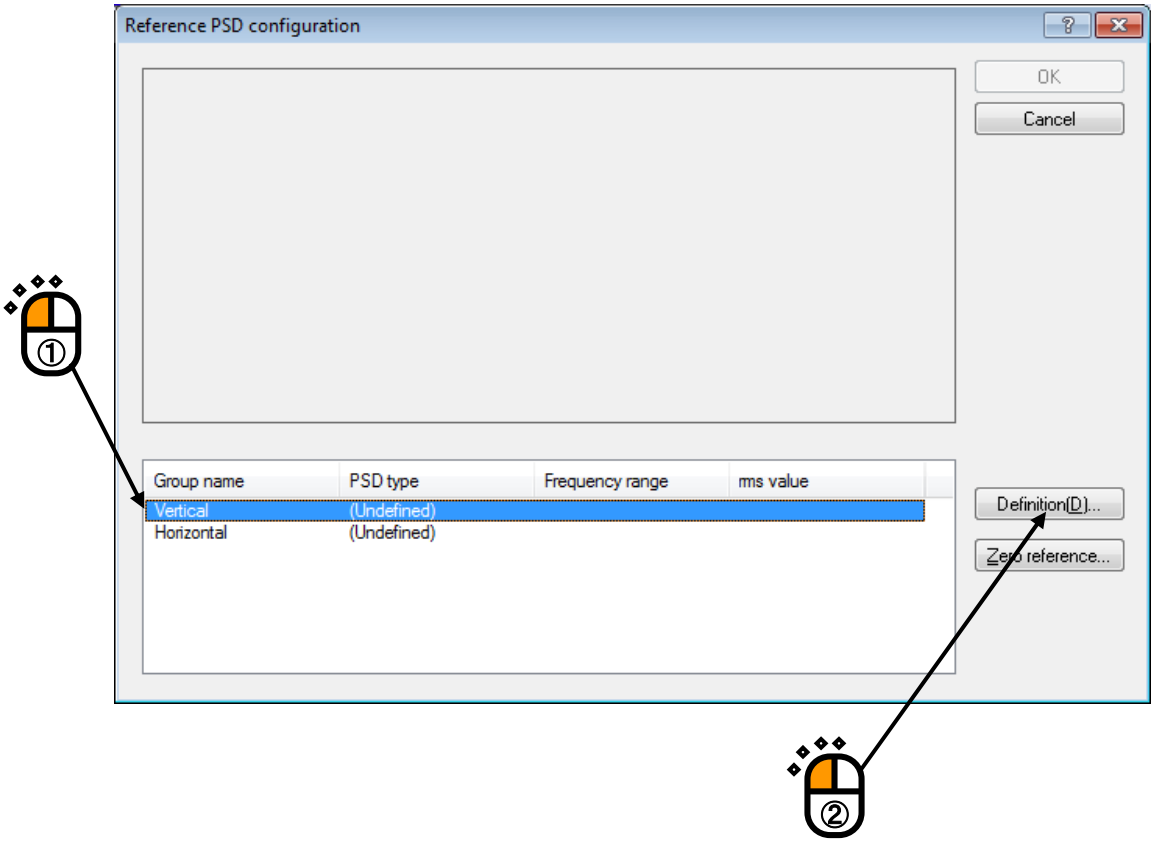
<Step 21>

Press the button to go to the next definition.



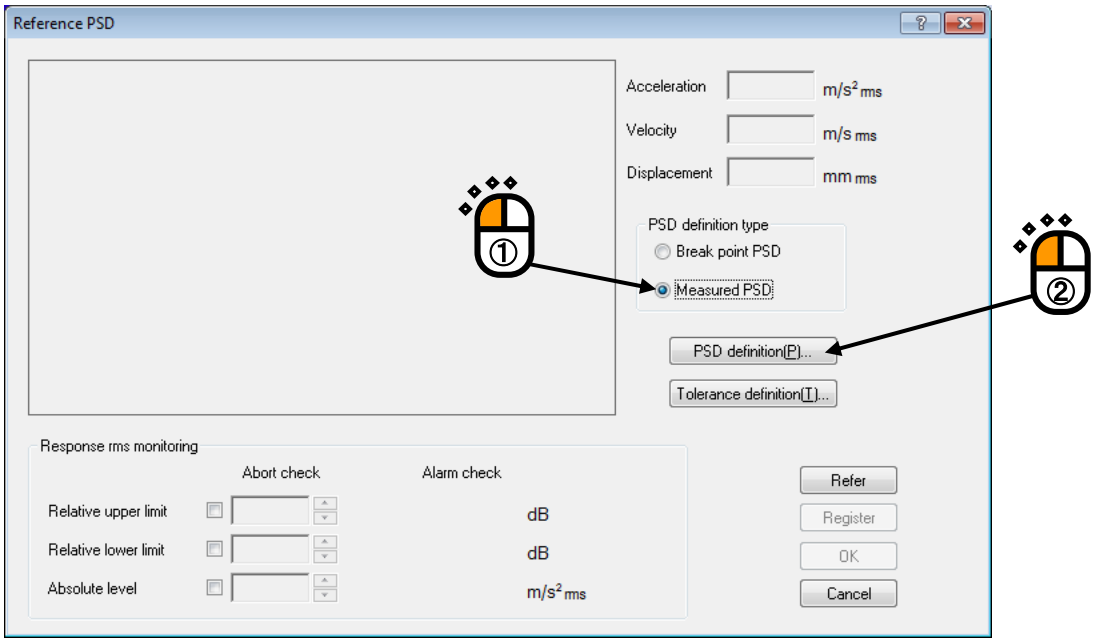
<Step 22>

Select a group name, ‘vertical’. Then press the definition button.



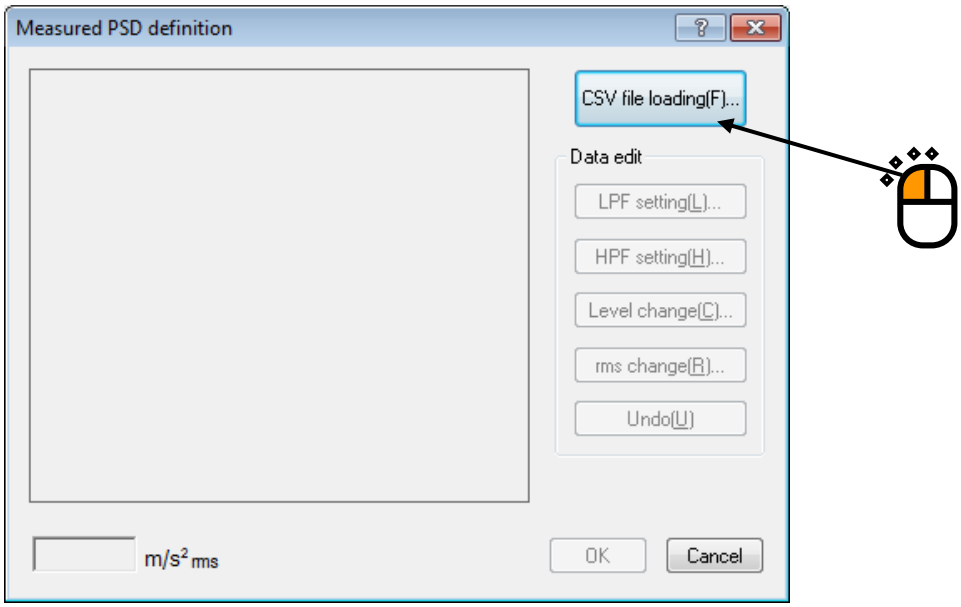
<Step 23>

Select the item of the measured PSD and press the button of PSD definition.



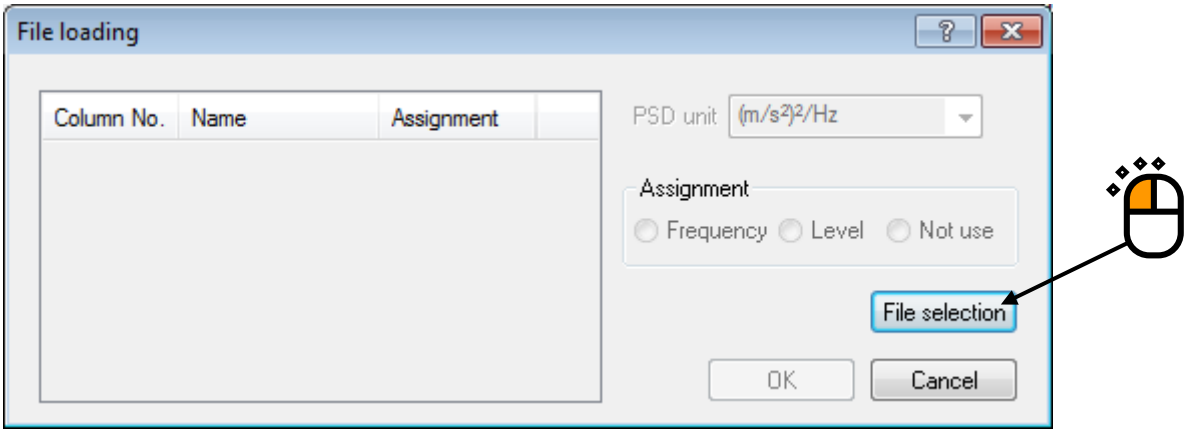
<Step 24>

Press the button of CSV file loading.



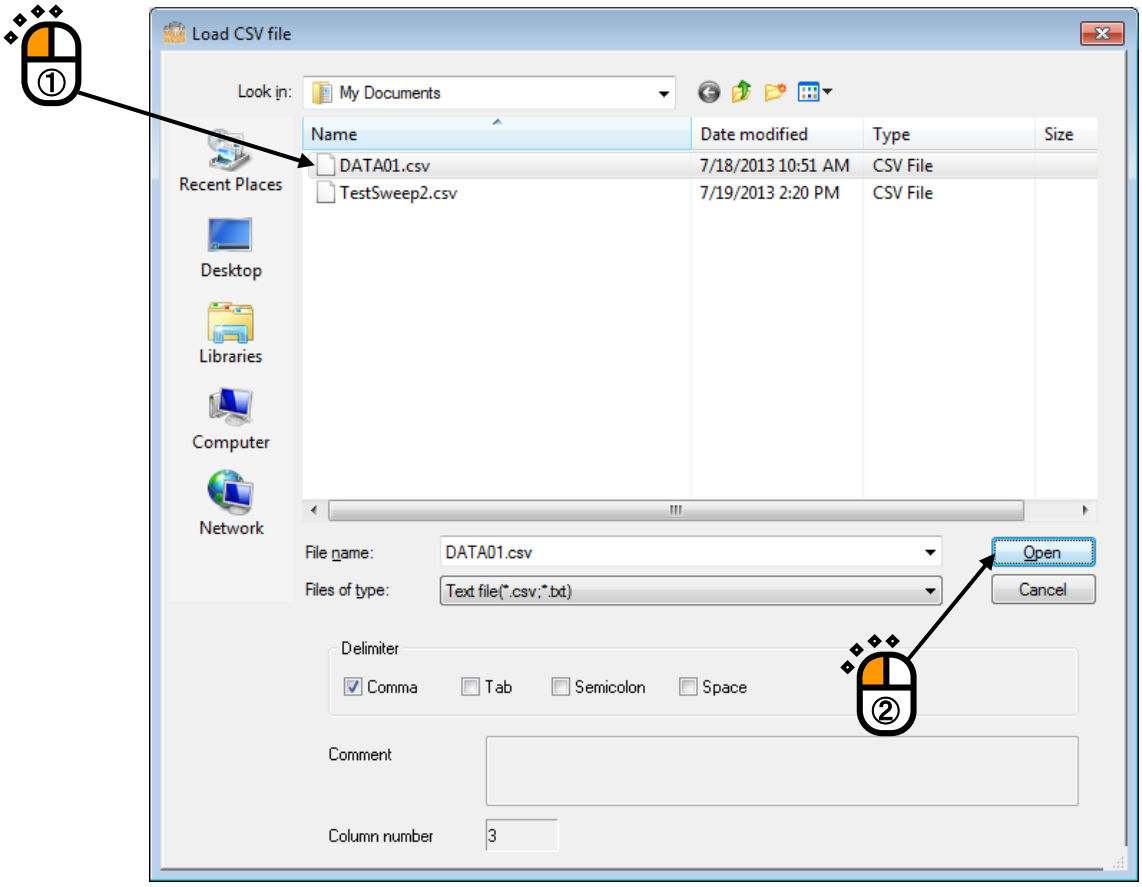
<Step 25>

Press the button of file selection.



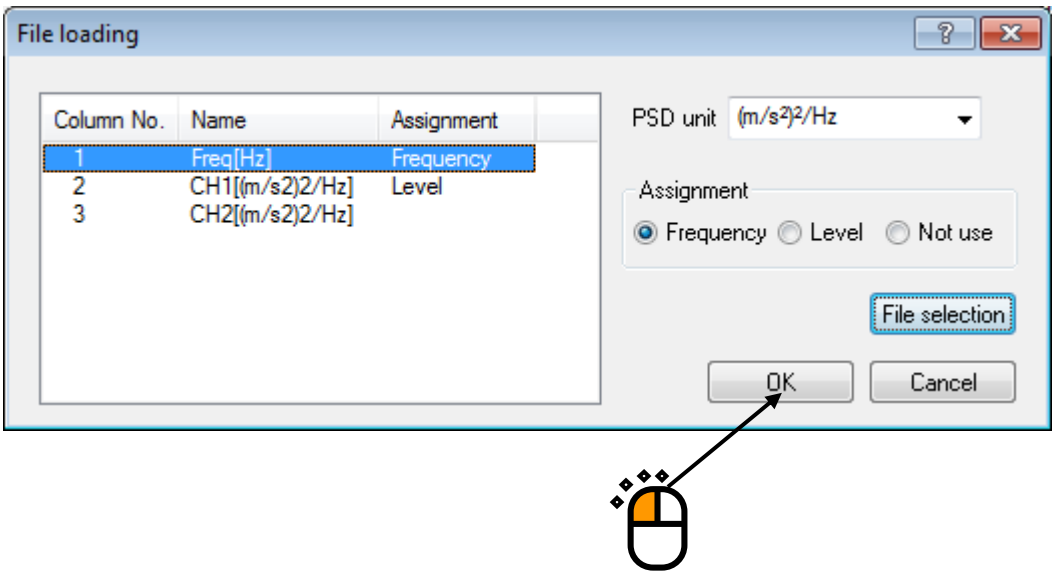
<Step 26>

Select a file name to be loaded and press the button to open the file.



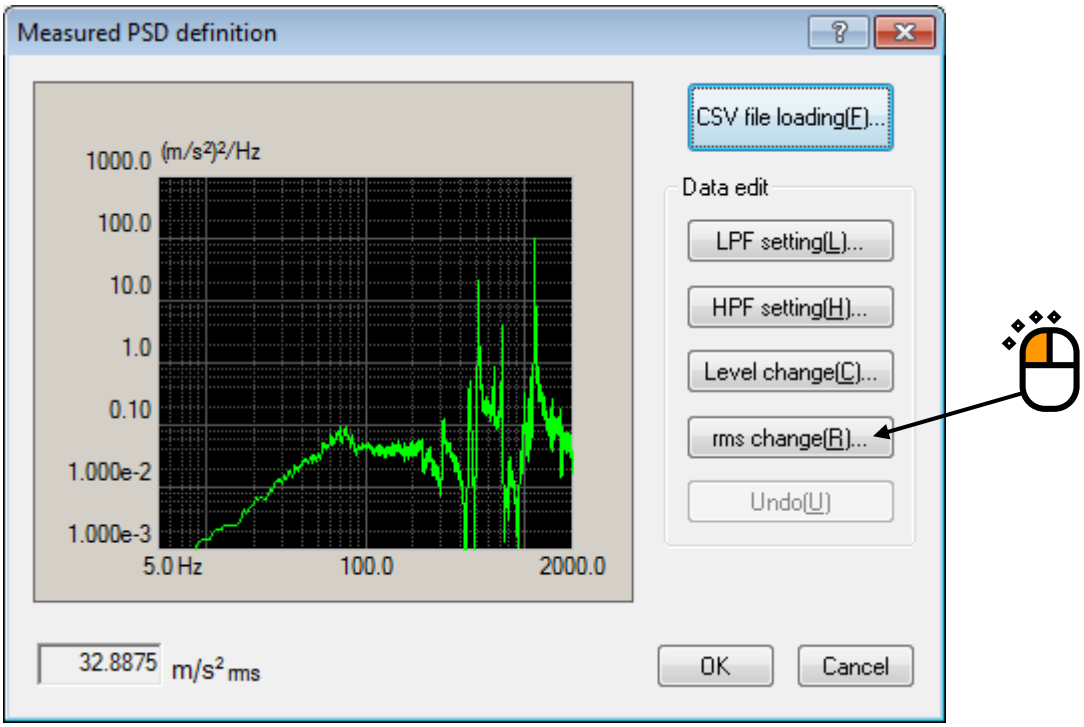
<Step 27>

Press the OK button.



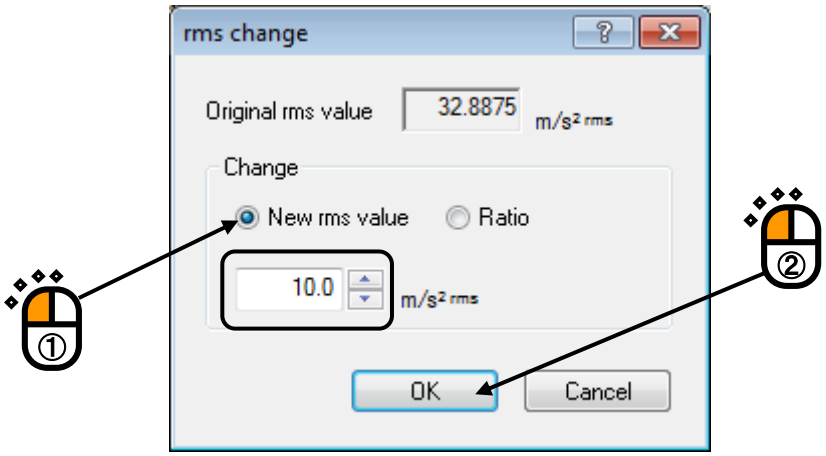
<Step 28>

Press the button of rms change.



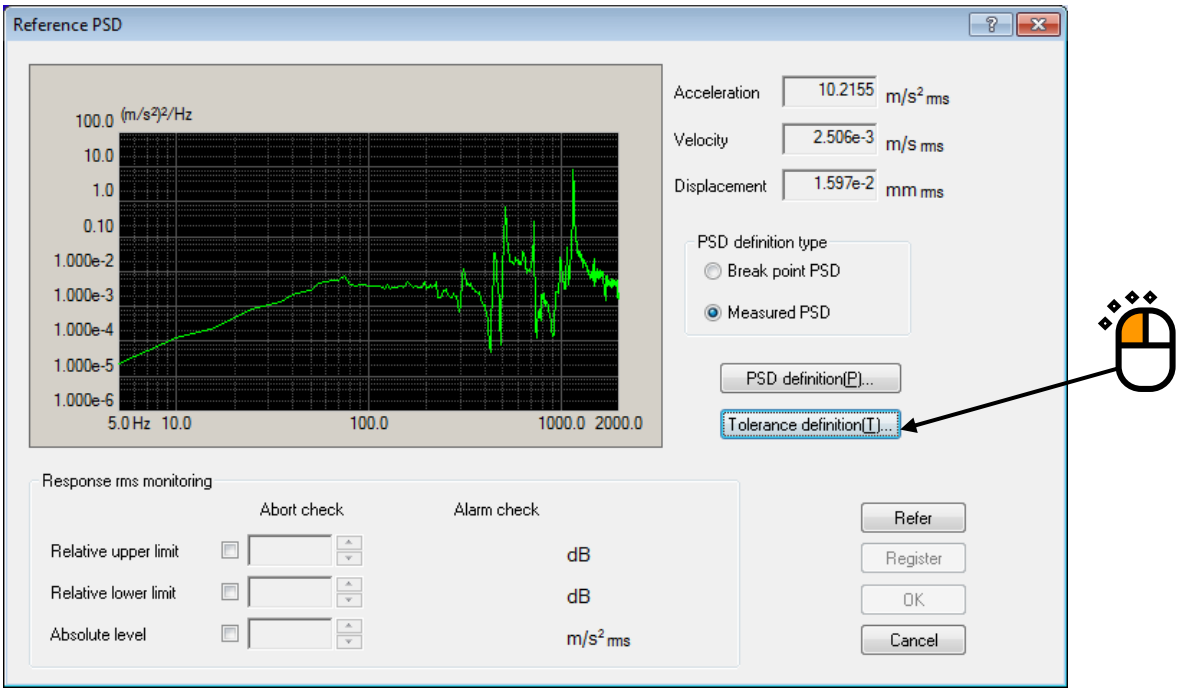
<Step 29>

Select the item of new rms value to be changed. Input the value as 10 [(m/s^2) rms] and press the OK button.



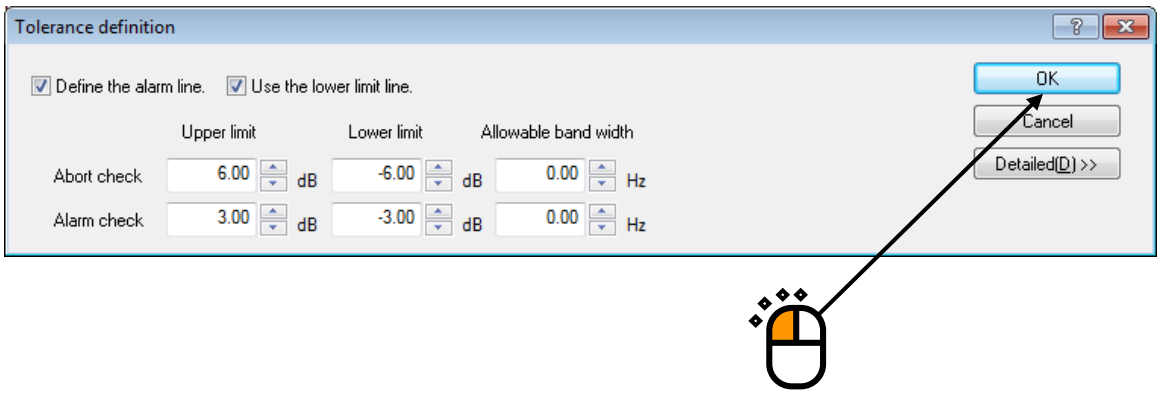
<Step 30>

Press the button of tolerance definition.



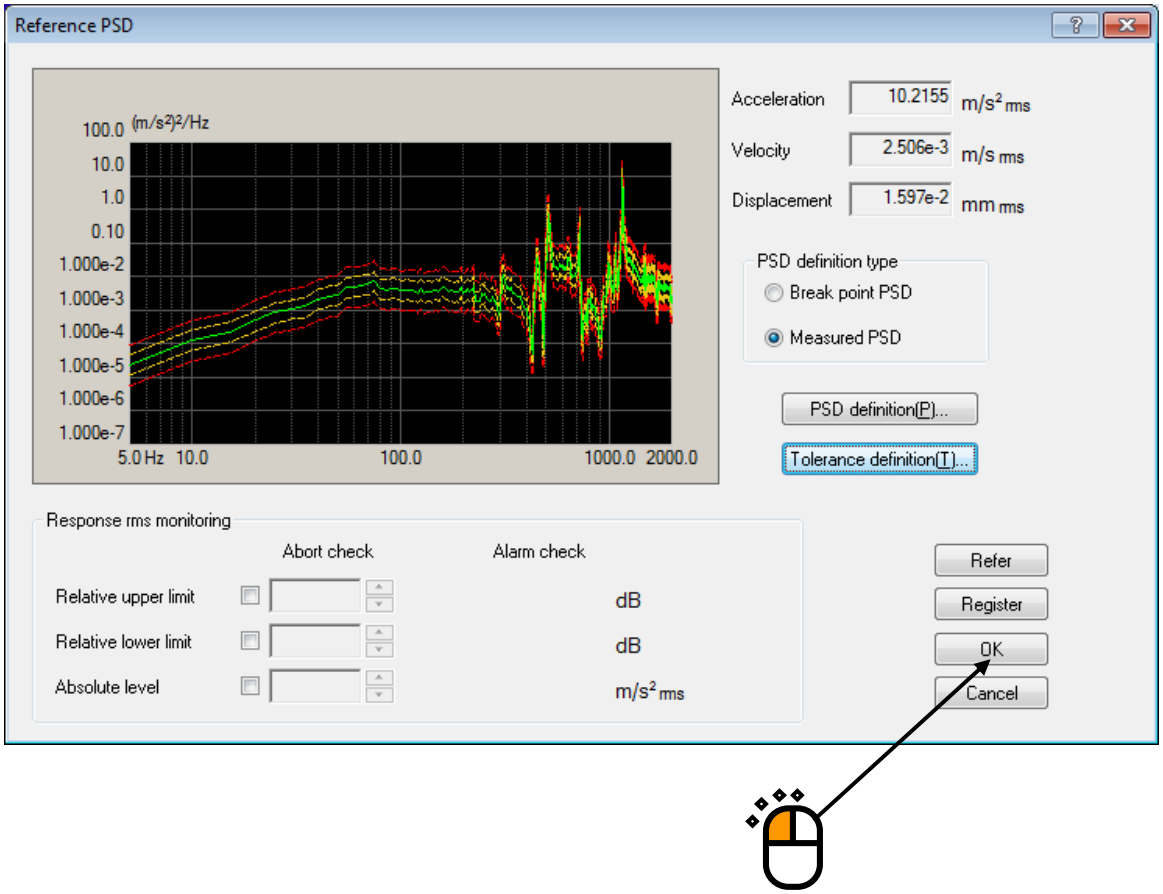
<Step 31>

Press the button of OK.



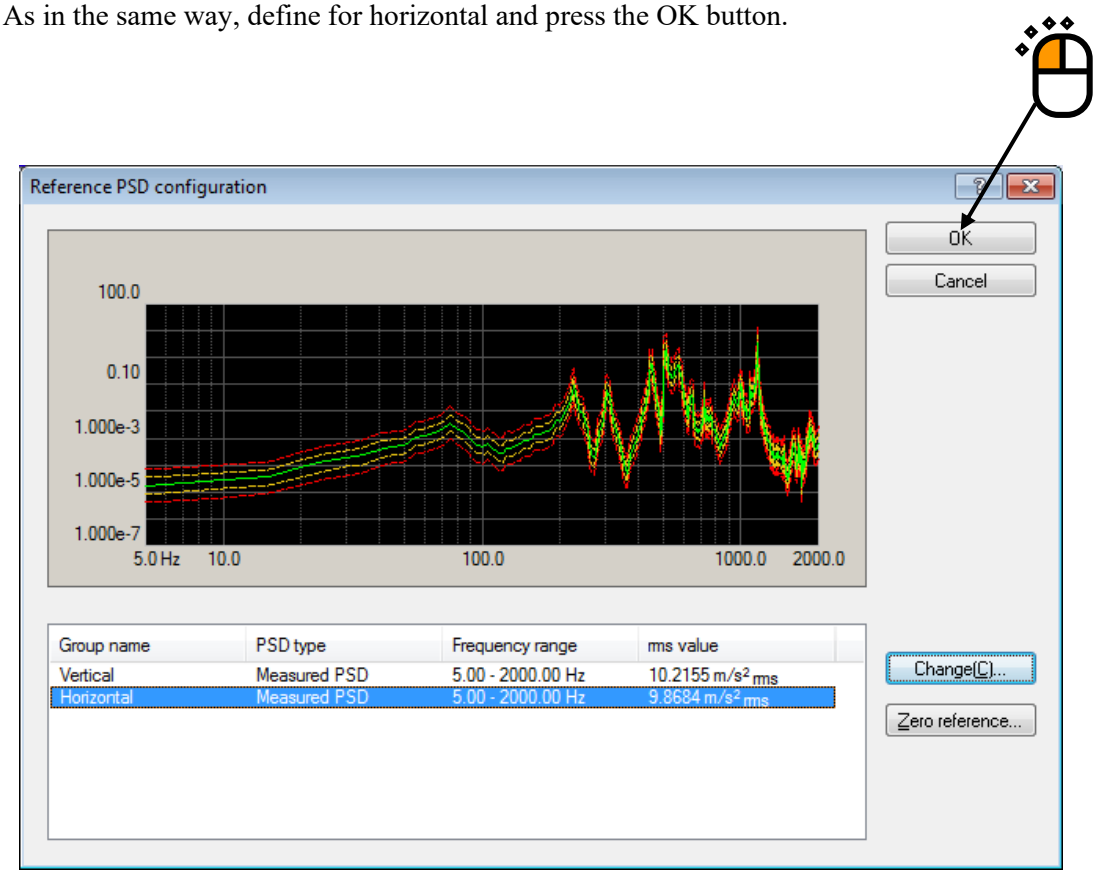
<Step 32>

Press the OK button.



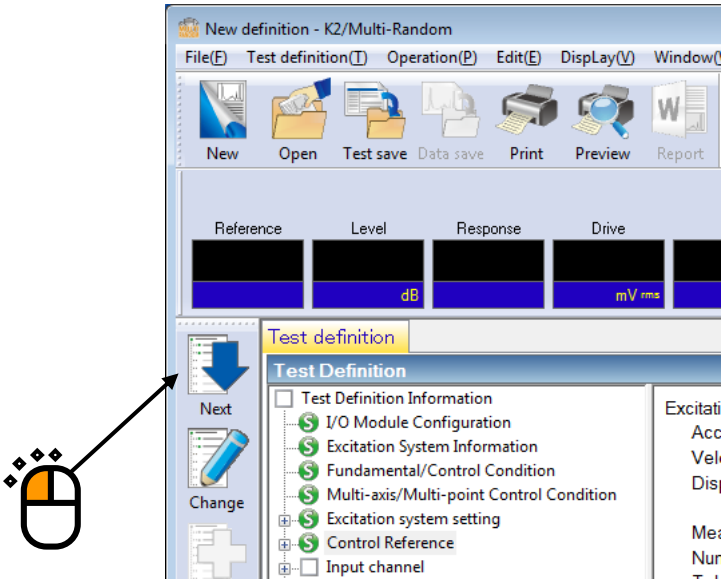
<Step 33>

As in the same way, define for horizontal and press the OK button.



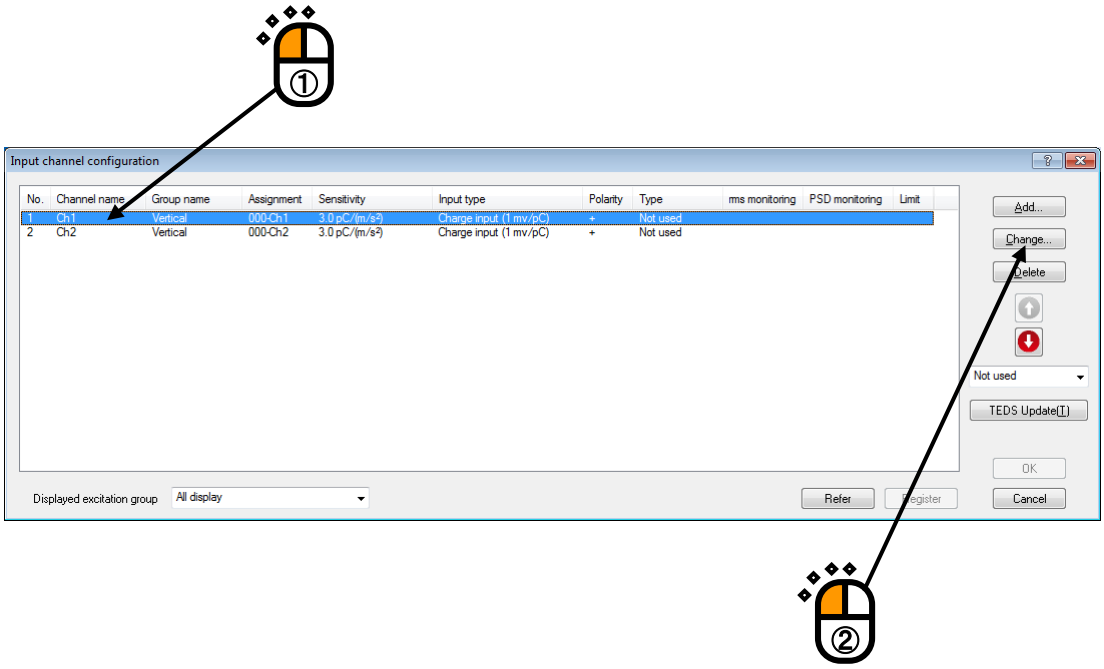
<Step 34>

Press the button to go to the next definition.



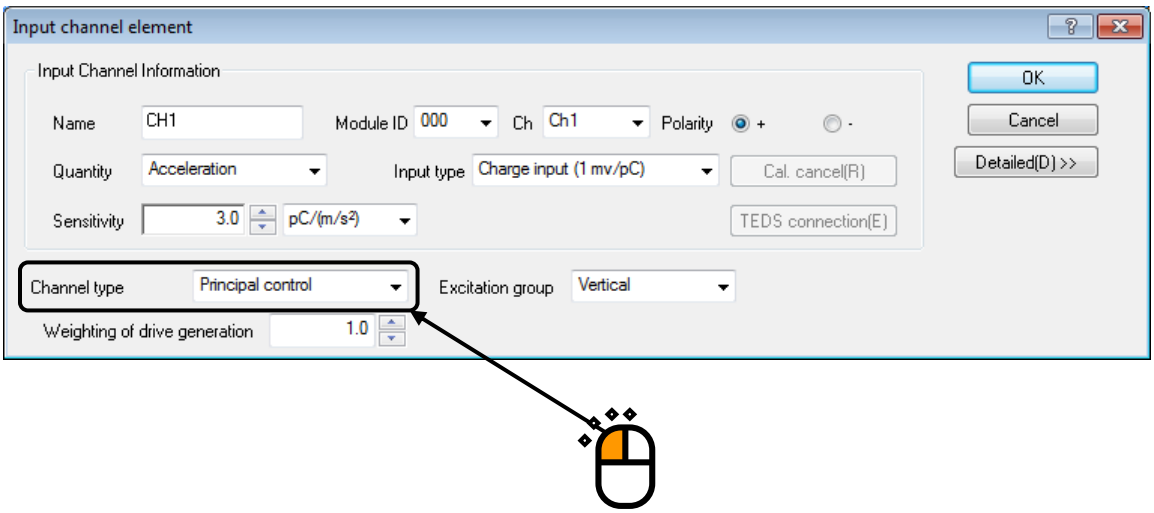
<Step 35>

Select the ch1 in the list of input channels and press the button to change the channel setting.



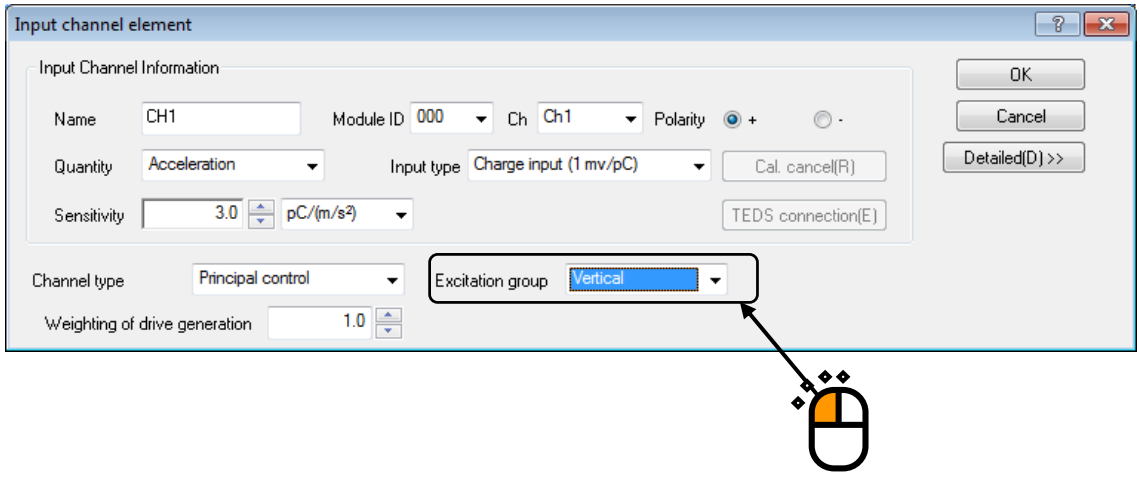
<Step 36>

Set the channel type to Principle Control.



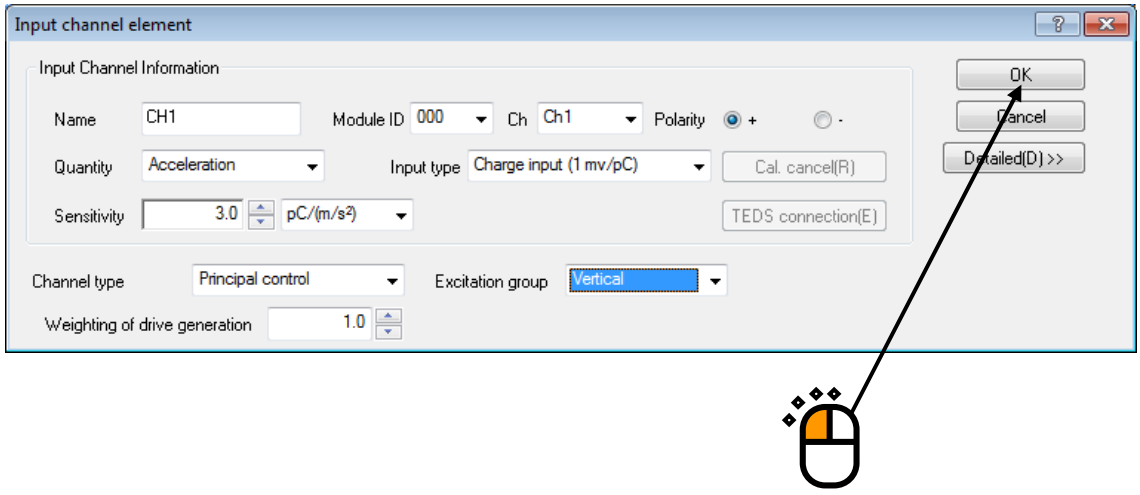
＜Step 37＞

Set the excitation group to vertical.



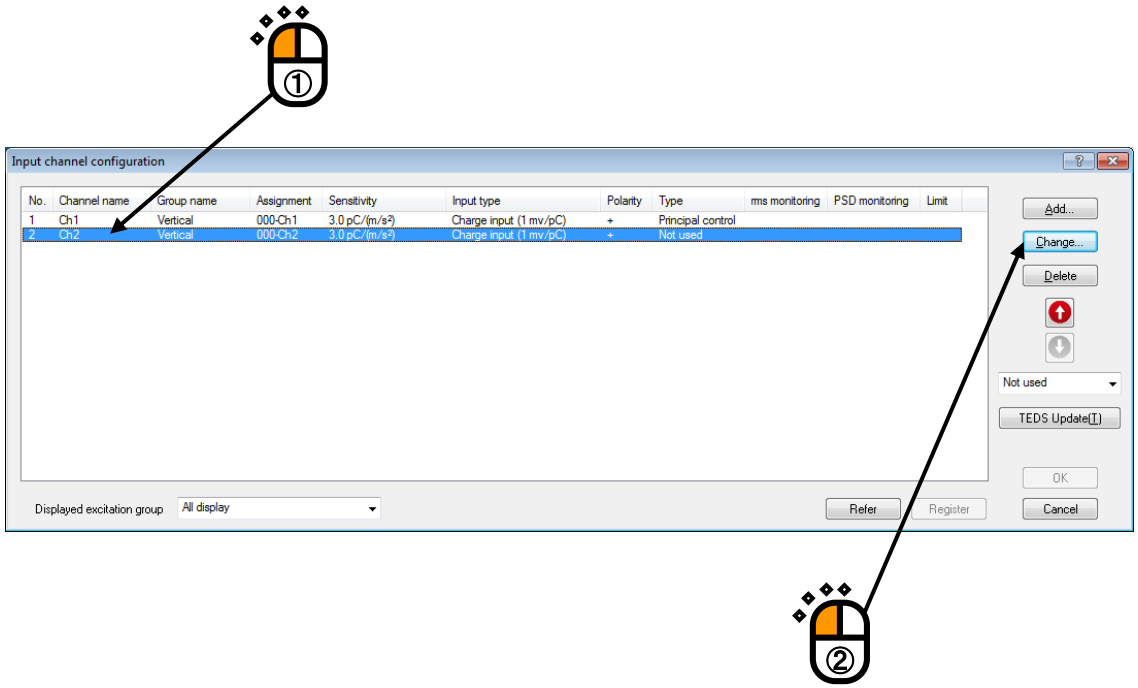
<Step 38>

Press the OK button.



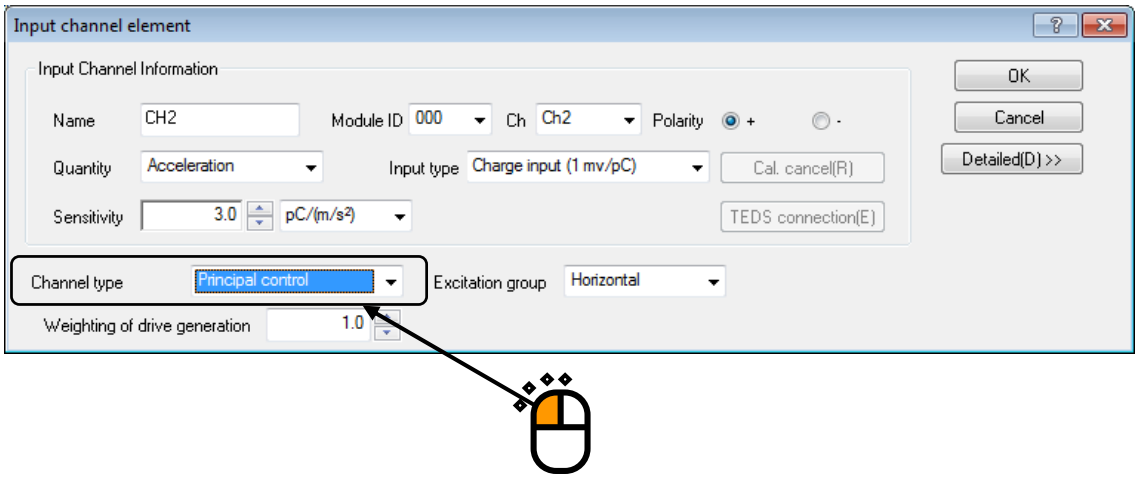
<Step 39>

Select the ch2 in the list of input channels and press the button to change the channel setting.



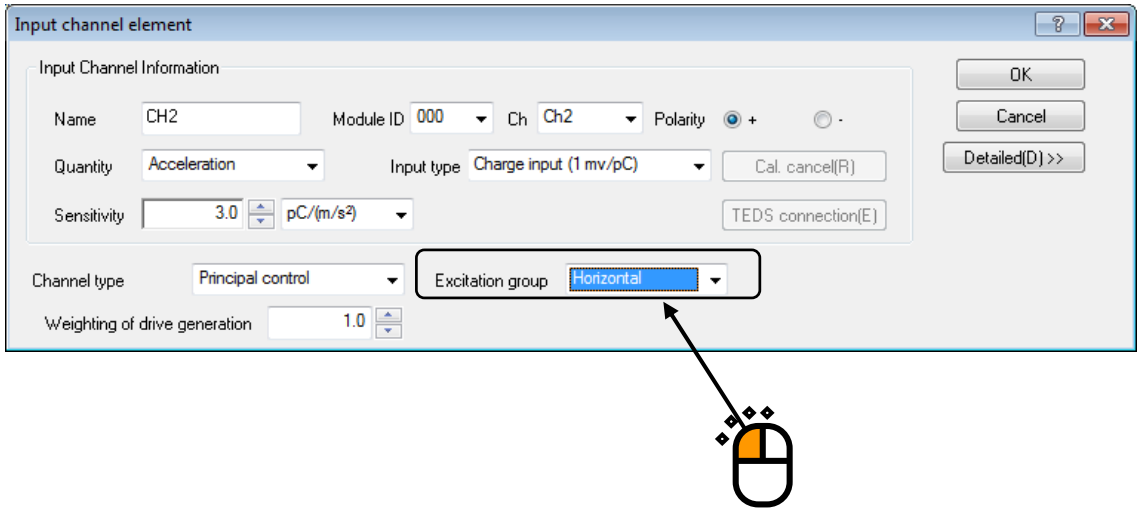
<Step 40>

Set the channel type to Principle Control.



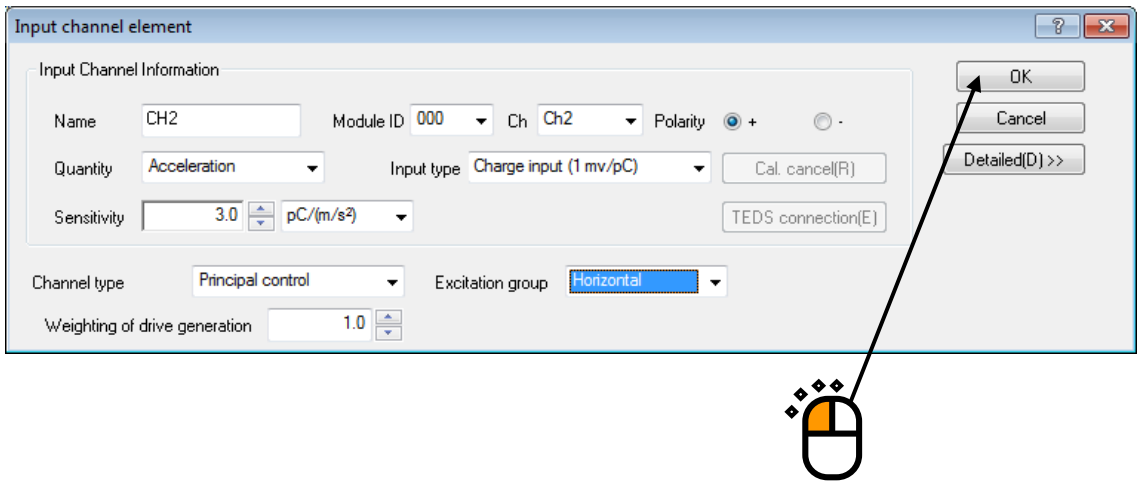
<Step 41>

Set the excitation group to horizontal.



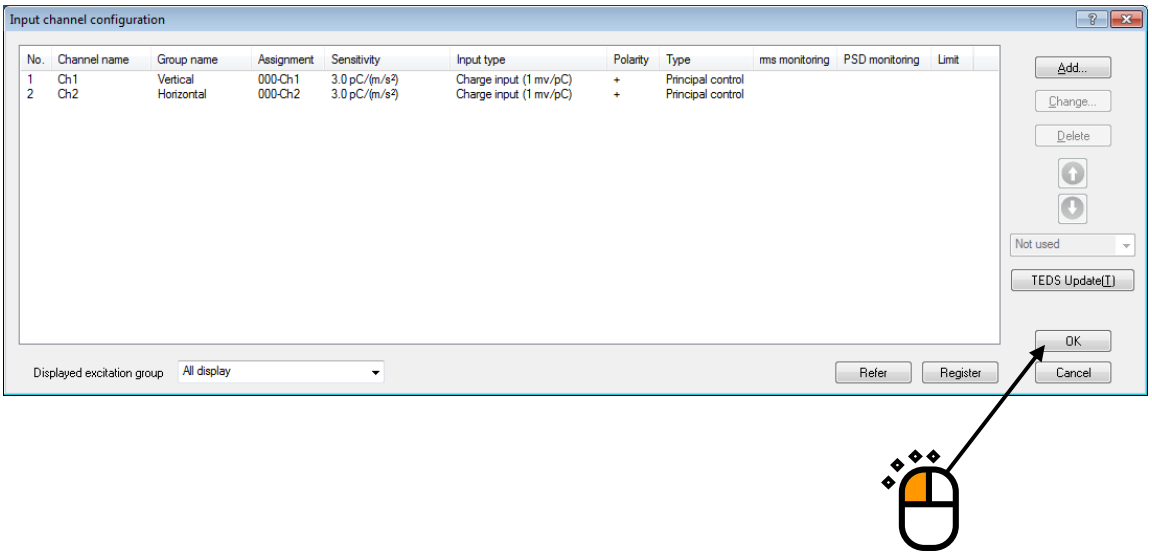
<Step 42>

Press the OK button.



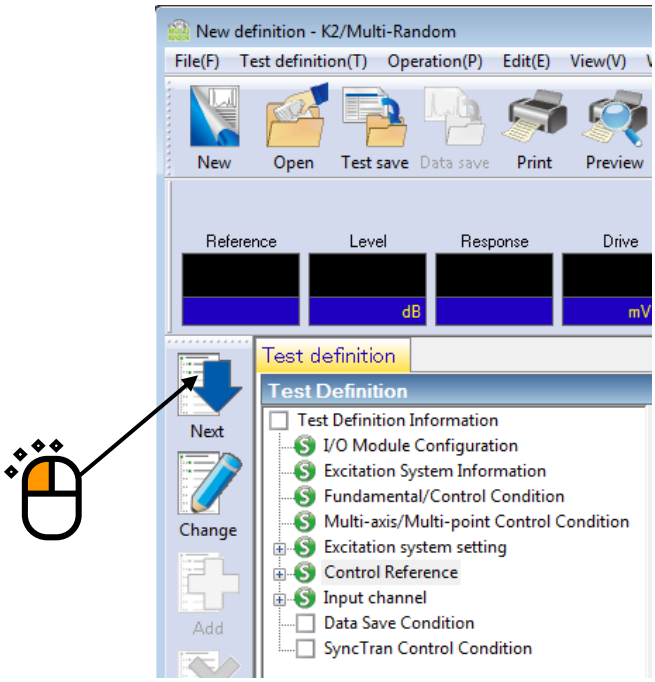
<Step 43>

Press the OK button.



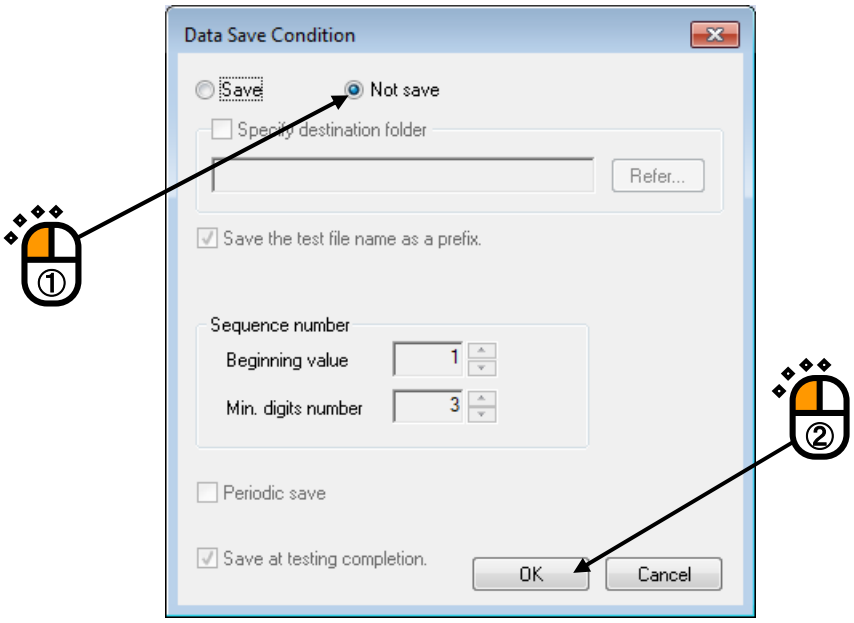
<Step 44>

Press the button to go to the next definition.



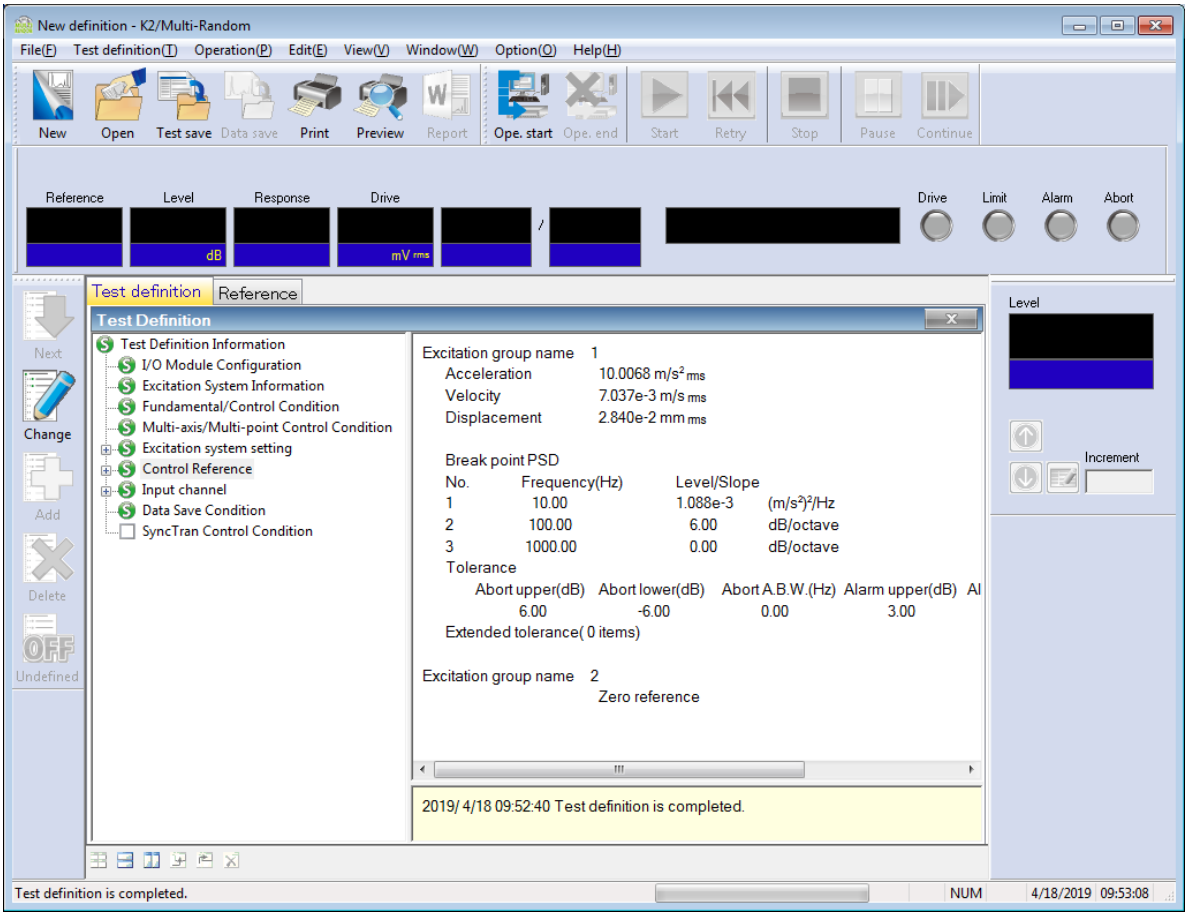
< Step 45 >

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



< Step 46 >

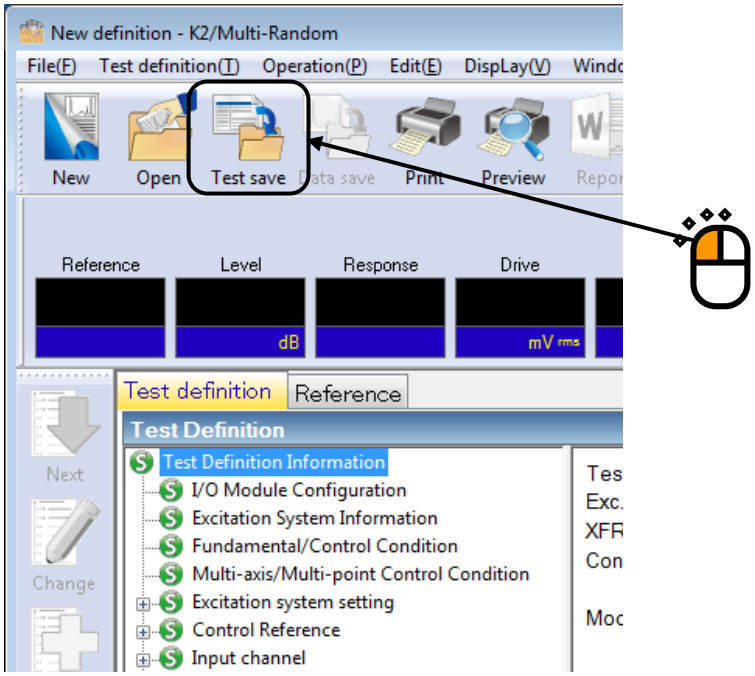
The definition is completed.



<Data save>

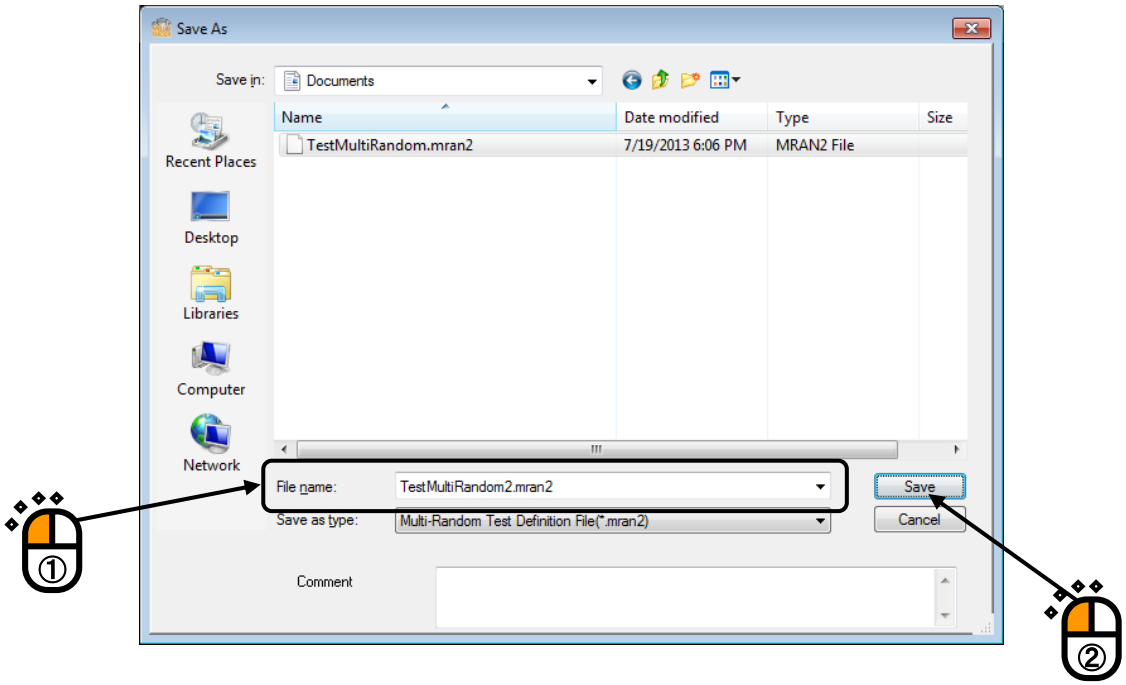
<Step 1>

Press the button to save the test definition data.



<Step 2>

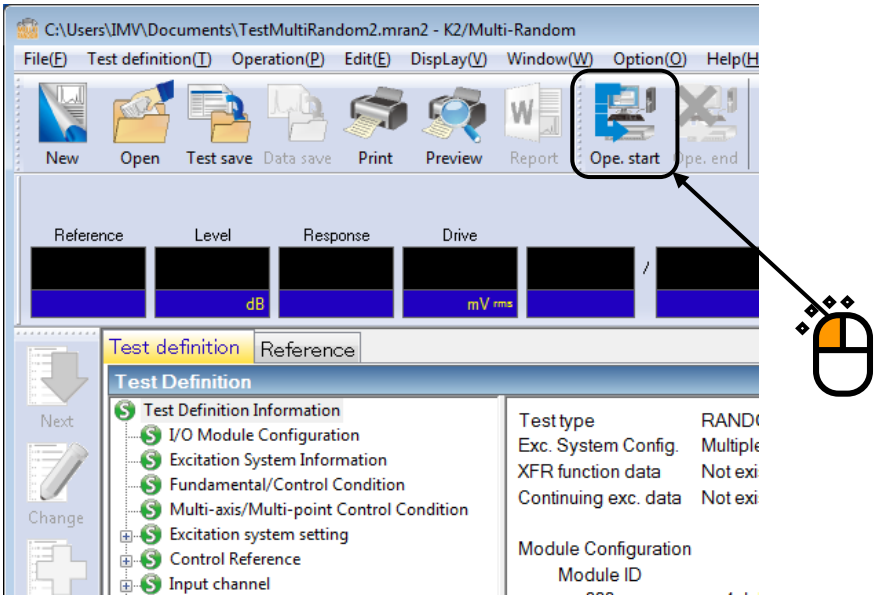
Input the file name and press the button to save the data.



<Test operation>

<Step 1>

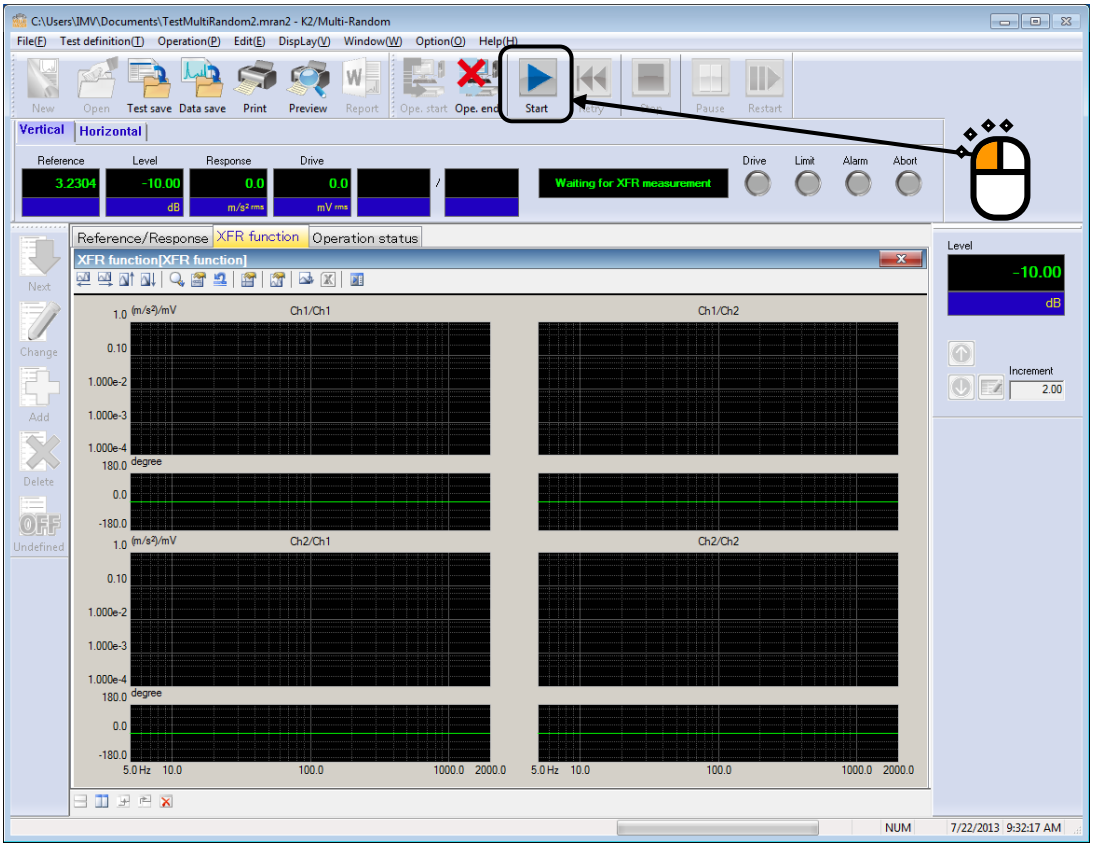
Press the button to start the operation.



<Step 2>

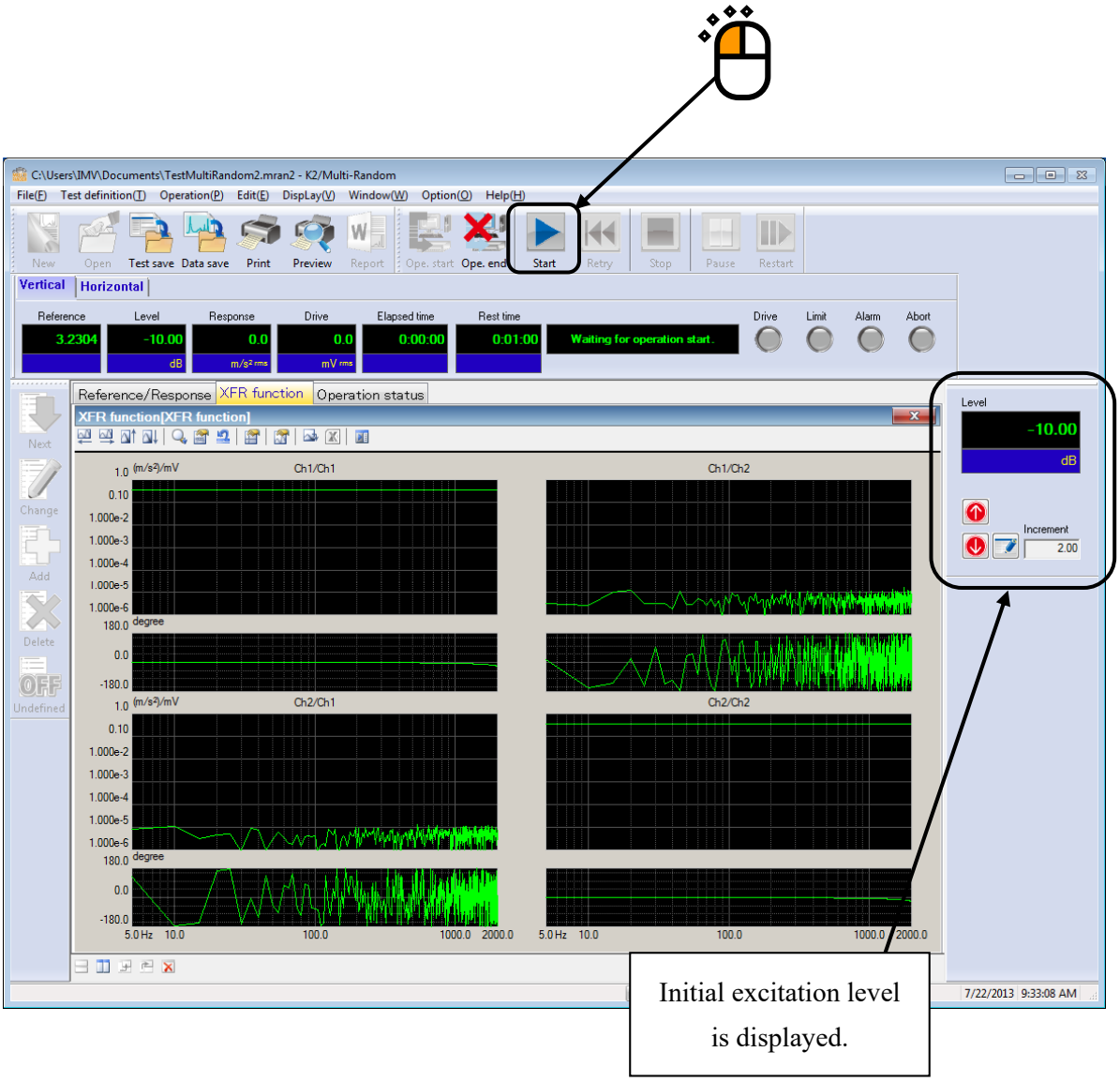
Press the button of XFR measurement start.

Initial loop check is automatically operated and the XFR measurement is started.



<Step 3>

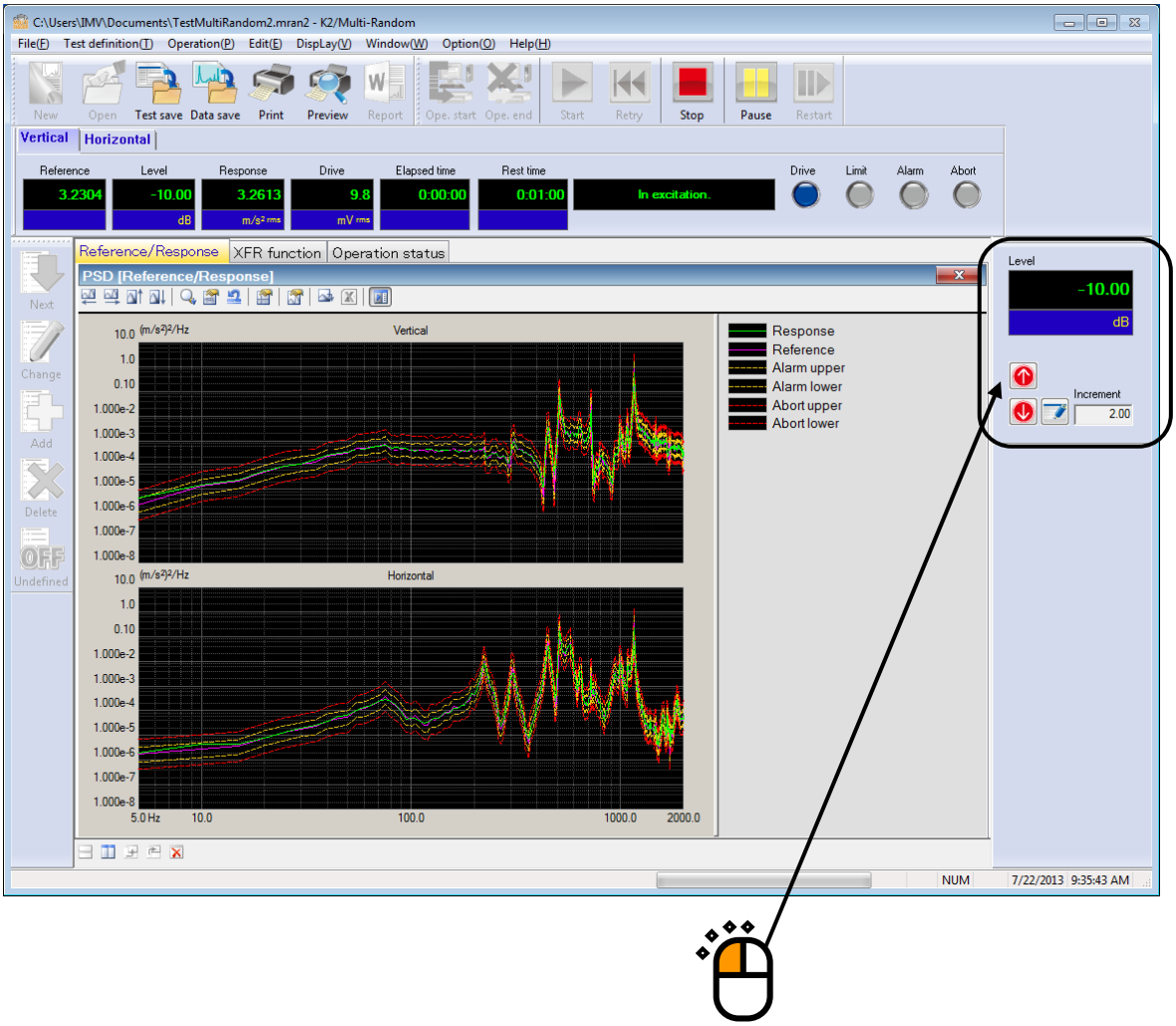
The system proceeds to the state of waiting for operation start when the XFR measurement is finished. Press the button of operation start. Initial loop check and initial equalization are automatically operated. When initial check and initial equalization are finished, the test operation is started at the initial excitation level (-10dB in this example).



<Step 4>

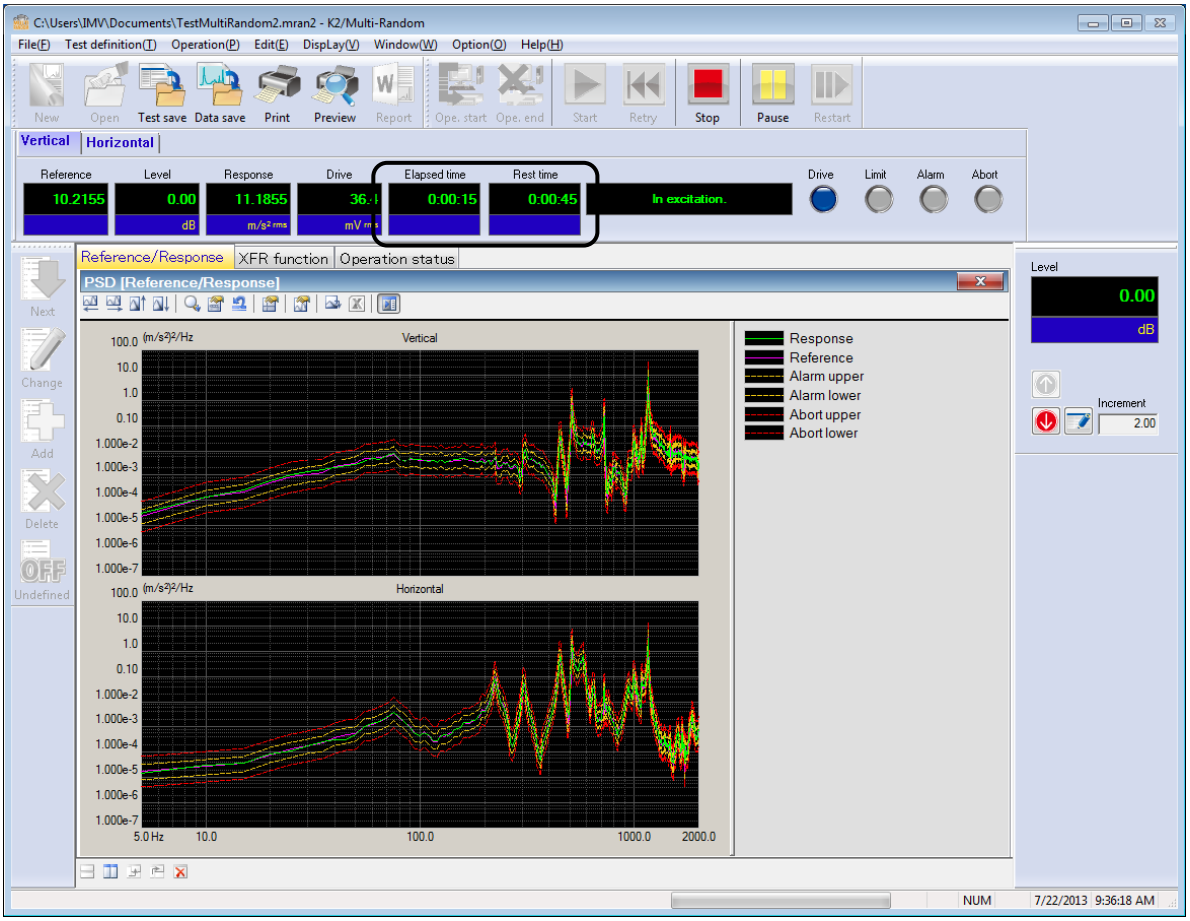
The test operation is started at the initial excitation level (-10dB in this example).

Press the level up button of excitation level and set the value to 0dB.



<Step 5>

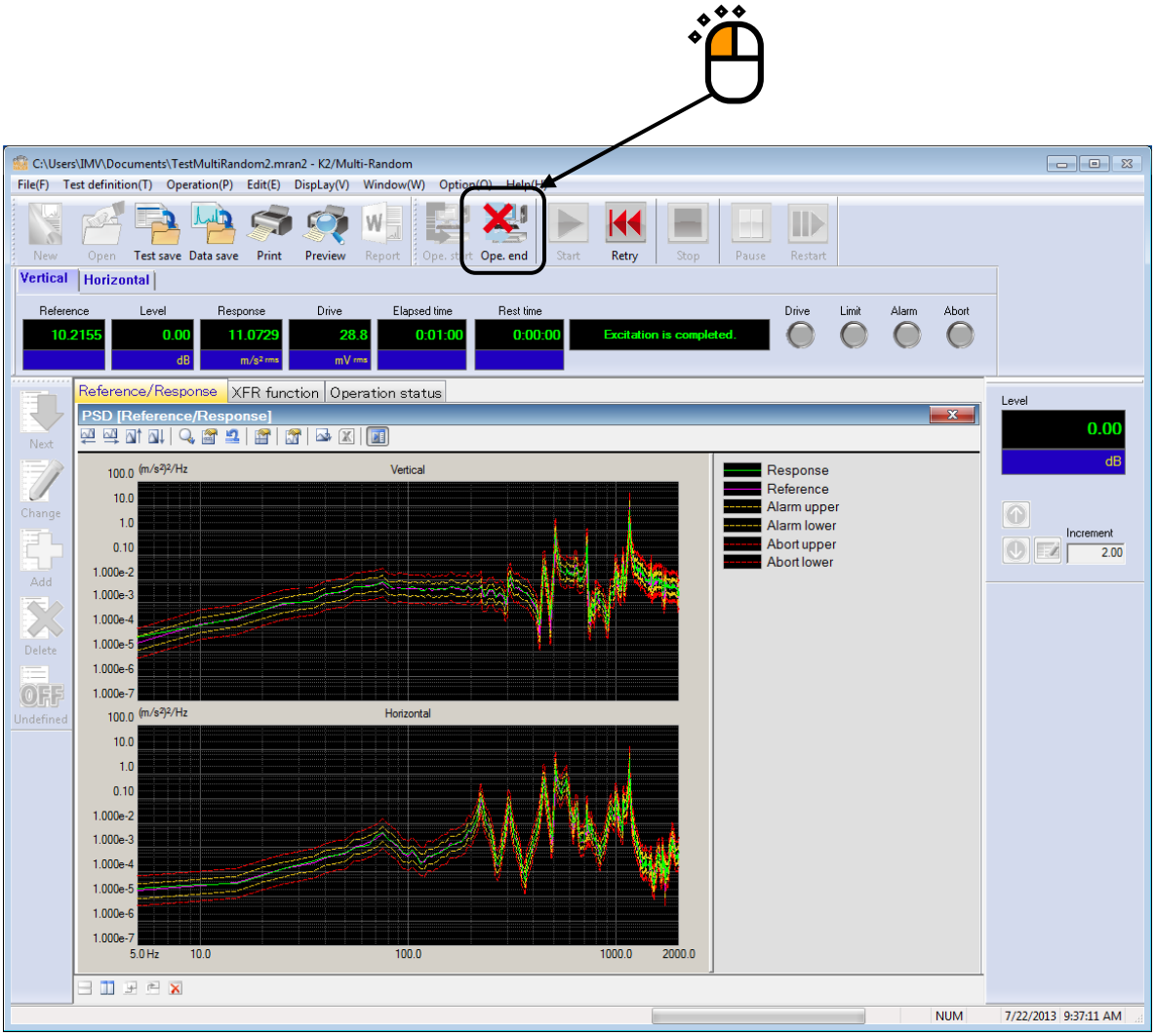
Test time starts to count the elapsed time for test operation when the excitation level is set to 0dB.



<Step 6>

Test operation is stopped when the test time ends.

Press the button of operation end. The system proceeds to the display of test definition mode.



Chapter 4 Test Definition

4.1 Outline

In this system, a complete set of information needed for test operation is called ‘Test’.

To perform a test, Test must be defined first of all.
This chapter describes the procedure to define the Test.

A Test is defined by the setting of the information in Table 4-1 in order for each Test types.

Table 4-1 Test Types and Definition Information

Information \ Test type	Random
(1) I/O Module Configuration	○
(2) Excitation System information	○
(3) Fundamental/Control Condition	○
(4) Multi-axis/multi-point control condition	○
(5) Excitation System Setting	○
(6) Control Reference	○
(7) Input Channel	○
(8) Data Save Condition	○

○ : Information that must be defined

－ : Information that is not necessary to be defined

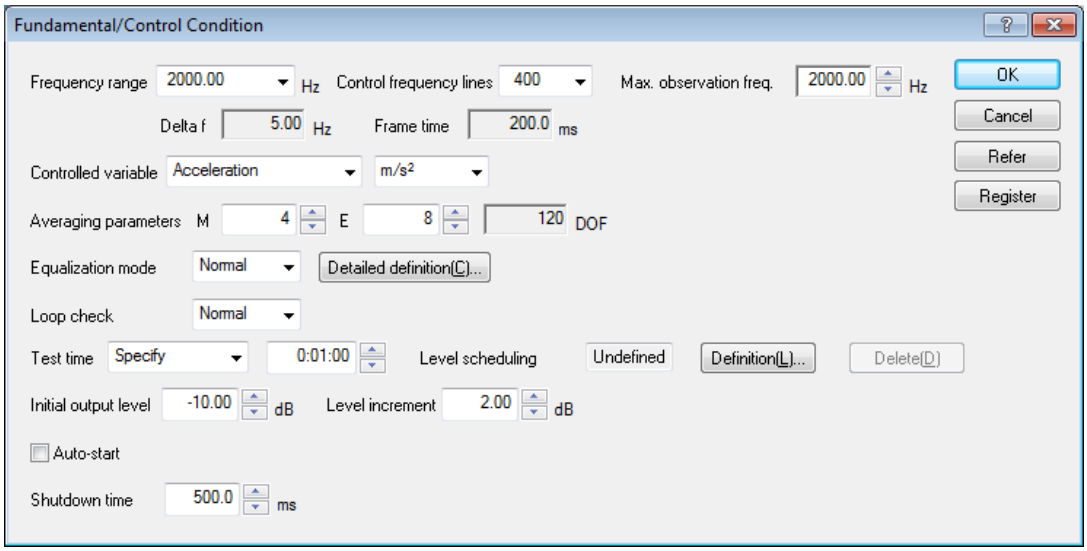
△ : Information that is defined if necessary

Information of 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 test defined beforehand is saved as a test file.

4.2 Fundamental/control condition

Control condition of K2 controller is defined.



4.2.1 Frequency range fmax

(1) Meaning

This item is for specifying the Frequency range for the spectrum analysis.

An appropriate value should be set in order to cover the frequency elements included in the reference PSD to be reproduced.

When the defined value of this item is too large with comparing other specified items such as the number of input channels, the real time operation may not be available due to the limitations of the ability of the CPU.

Correspondence between Sampling Frequency fs and Frequency range fmax is described as below ;

$$fs = 2.56\ fmax$$

4.2.2 Control frequency lines

(1) Meaning

This item is for specifying the resolution of spectrum analysis.

The resolution of spectrum analysis is specified by the number of lines L

In this system, the relation between the number of the lines L and the number of points for spectrum analysis N is described as below ;

$$L = N / 2.56$$

A waveform data for N points corresponding to the control frame length is transformed to the spectral data of complex number for N/2 lines in the Frequency range by spectrum analysis. Concerning to the characteristics of anti-aliasing, the valid data for the control operation is specified from the lower frequency side within the spectral data of complex number for N/2 lines.

Frequency resolution Δf is described as below ;

$$\Delta f = f_{max} / L\ (= f_s / N)$$

< Selection Guide for number of lines >

The number of lines is to be selected based on the transfer characteristics of the controlled system.

For a successful control, almost all the impulse response of the controlled system must be within the set control frame.

If the result of waveform control is unsuccessful, select a larger line number stepwise.

It is better to do it this way rather than that set an excessively large number.

4.2.3 Max. observation frequency (Max. observation freq.)

(1) Meaning

This item is for specifying of maximum value of the frequency observed at input channels.

The default setting value of this item is the setting value of frequency range.

4.2.4 Controlled variable

(1) Meaning

Unit of quantity (controlled variable) used as a control objective for K2 controller is specified. Control unit defined in this item is treated as a unit in test definition.

A unit specified in 'other units' is added as a Control unit only when the rating information of 'other units' is specified in the excitation system information.

4.2.5 Averaging parameters

(1) Meaning

The Degree-Of-Freedom of measurement, that is, the accuracy of spectrum estimation (averaging operation) is specified in this item.

Averaging operation is necessary to execute the accurate spectrum estimation in the analysis of random signal because the spectrum data obtained in FFT analysis for one time has too large dispersion.

Spectrum analysis of random signal has the characteristics as below;

(1) Spectrum analysis data of random signal can not be obtained as a certain value, but it is obtained as an estimated value having characteristics of probability.

(2) The reliability of the estimated value is expressed as the degree-of-freedom. The larger value of the degree-of-freedom is specified, the more reliable estimation value is obtained.

The degree-of freedom is specified by the parameters as below ;

(1) Averaged time for a loop M

The frame number for operating the response analysis for 1 round of control loop is specified.

(2) Averaging weight parameter of loop E

This parameter is for operating the averaging weight for the response spectrum data obtained at each control loop.

When the value of M and E in the above is determined, the degree-of-freedom K of the response analysis is specified ;

$$K = 2M (2E - 1)$$

For composing the stable control system, it is better to set a larger value of K. Therefore, the value s of M and E should be determined in order to specify the value of K according to the following aim ;

$$K > 100$$

However, the control speed (dwelling rate) becomes slower when too large value is set to K.

4.2.6 Equalization mode

(1) Meaning

This item is for setting of the control speed t the initial equalization during the time from the control operation start (a white-noise-like output start), and through the coincidence of the response spectrum with the reference spectrum (within the tolerance), to the beginning point of the elapsed time counting start.

1. Fast

   This item is for setting of the control at a faster response speed.

   It is proper to set ‘fast’ in this item for the specimen with a stable and a high rigid body.

2. Normal

   This item is for setting of suitable control speed for general cases.

   Generally, the setting of ‘Normal’ is recommended except the case in which the special judging is required.

3. Slow

   This item is for operating the control at a slower response speed.

   In case that the specimen having a non-linear response (for example, the response shows the different characteristics when the excitation level is changed), the setting of ‘slow’ may be suitable.

4. Specify (or use the ‘detailed definition’ button)

   Each parameter of equalization mode is properly defined according to the setting of ‘fast’, ‘normal’ and ‘slow’. However, this item ‘specify’ is provided for the testing with the specimen which us too difficult to control by the setting of the standard items. It is for making a fine adjustment of each control parameter when the testing operation having the difficult specimen to control is operated.

As stated at the beginning of this clause, the effect of this item appears clearly in the stage of initial equalization. However, the set value of this item as the control parameter is also valid during the testing operation after the test time counting start.

4.2.7 Loop check

(1) Meaning

This item is for specifying of the strictness of the criteria for monitoring abnormal event in the control loop during control operation using loop check function.

Loop check is to be operated in the following condition ;

(1) at loop check (before measurement of transfer function)

(2) at initial equalization

(3) in control operation

The objective channels for loop check are ;

1. at loop check (before measurement of transfer function)
   - All of the used channels
2. at initial equalization
3. in control operation
   - Principle Control channel
   - Control channel
   - Monitor channel for monitor RMS observing
   - Monitor channel having the monitor profile

The loop check before transfer function measurement is operated by white-noise output signals in the excitation of the shakers one by one. The voltage of loop check is defined by the initial output voltage specified for each excitation group. Refer to "4.4 Excitation group" about the details.

The loop check at initial equalization is operated by white-noise output signals that are defined as the initial output voltage in the excitation groups. It checks the abnormality in the control loop and also observes continuously in the control operation.

The abnormal detection level for loop check is selected among the three items below ;

1. Severe : The severest criterion is set.
   It can be used for a specimen with a good linearity.
2. Normal: The criterion allows an ordinary level of non-linearity.
3. Loose : The criterion allows a larger non-linearity.
   Use this criterion when loop check is failed in setting 'Normal'.

4.2.8 Test time

(1) Meaning

This item is for specifying of the duration of the test operation. That is, the system automatically stops signal output when the specified time elapses after the start of the test.

< Infinite >

When the test time is not needed to be set, the value of ‘infinite’ should be selected.

In this case, the excitation continues unit [Stop] button is pressed except the case of activation of abort using a predetermined protection function.

< Specify time >

When denoting ‘hour’ as ‘h’, ‘minute’ as ‘m’ and ‘second’ as ‘s’, the input format is as below ;

hhh : mm : ss

The conversion such as ‘second’ to ‘minute’ is automatically performed.

(Example 1) The entry of ’10 : 20 : 30’ means ’10 hours, 20 minutes and 30 seconds’.

(Example 2) The entry of ’50 : 0’ means ’50 minutes’.

(Example 3) The entry of ‘1000’ in automatically converted to ’16 minutes, 40 seconds’.

4.2.9 Initial output level

(1) Meaning

Before testing based on the defined reference spectrum, a trial run of the excitation system (to see behavior of the spectrum, etc.) is needed : This trial run is done with reproducing the waveform proportional to the reference spectrum at a lower excitation level.

The lower excitation level, which is the ratio of the initial waveform to the original reference, is called the ‘Initial output level’.

This item defines the ‘Initial output level’, which is defined in the form of a level ratio (dB value) as the standard (0 dB) of the reference waveform level.

The setting of excitation level can be changed (0 dB or less) any time during the testing of actual excitation, but there is a danger to make the mistake of doing excitation at 0 dB from the beginning. This can be avoided by the first setting the required value. This item helps you avoid making this mistake. However this item is available only as a foolproof device.

< Change in Excitation Level in Operation >

To change the defined excitation level is also possible by clicking a specified button with mouse.

The level increases (decreases) just for the defined ‘Level increment’ every one press of the keys.

4.2.10 Level increment

(1) Meaning

This item is for specifying increment value of changing excitation level.

By using dialog box of ‘level change’, this setting value can be changed during operation too.

4.2.11 Auto-start

(1) Meaning

When the value less than 0dB is set for the initial output level, the function of level change that automatically executed from the specified initial output level to 0 dB is called ‘Auto-tart’. This item is for selecting of whether ‘Auto-start’ is executed or not. If 0 dB is specified for the initial output level, this item can not be selected.

When ‘Auto-start’ is needed to be executed, the button of this item should be selected (click the check box to be marked). The level is increased automatically for the specified value at each time when the specified time is elapsed, and this action is repeated until the level reaches at 0 dB.

4.2.12 Shutdown time

(1) Meaning

The drive signal output can be aborted by the order of ‘Excitation stop’ during the drive outputting state in the actual testing. When the response that exceeds over the specified ‘Abort level’ is detected, the drive signal output is automatically aborted.

However, it is dangerous to cut off the drive output suddenly. To prevent this danger, the output level should be gradually reduced to zero with taking proper duration.

The time for reducing the output level is called ‘Shutdown time’ and this quantity can be set in this item.

On the other hand, the same danger of the above may occur at the drive output start. Therefore, for this system, the operation specification that the full level output is produced with taking a specified time of this item is provided.

4.2.13 Level scheduling

(1) Meaning

This item is for operating a test at the scheduled excitation level.

In the setting of level schedule, excitation level / excitation time / tolerance are defined.

The setting of excitation level and test time in level scheduling gets preference over in others. Therefore, when level scheduling is set, each definition items of initial level, test time and auto-start become impossible to define or invalid even if it has defined before hand.

Test time in the level schedule shows the total time of each schedule item.

The definition item of level scheduling cannot be used in SOR / ROR test.

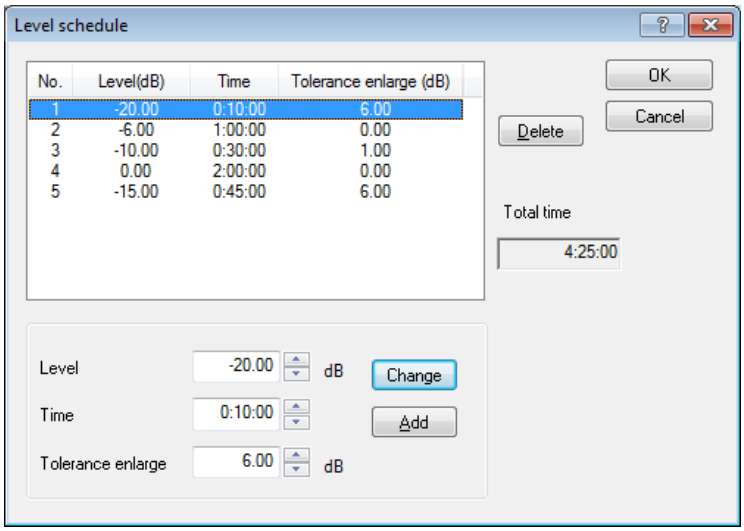
Also, it doesn’t have to be defined when it is not necessary.

[Define] : This button is for defining or correcting the Level scheduling. The dialog box of level schedule definition appears when it is pressed.

[Delete] : This button is for deleting the defined level scheduling.

< Definition of each scheduling item >

The following buttons are used for setting and registering of each schedule item.



[Add] : This button is for registering a new schedule item
After inputting the values to level and time, press this button to register and display the current schedule in the list.

[Change] : This button is for changing the values of a registered schedule. Selecting a schedule by a mouse, input the values to be changed and press this button.

[Delete] : This button is for deleting the registered schedule.
Selecting a schedule to be deleted by a mouse, press this button to delete it.

4.2.13.1 Level

(1) Meaning

This item is for setting of the excitation level. Excitation level is specified as a relative level to Reference PSD defined in 'PSD Definition'.

4.2.13.2 Time

(1) Meaning

This item is for setting of the excitation time.

Time is specified by the same method of setting time in 'Test time'.

4.2.13.3 Tolerance enlarge

(1) Meaning

This item is for setting of tolerance.

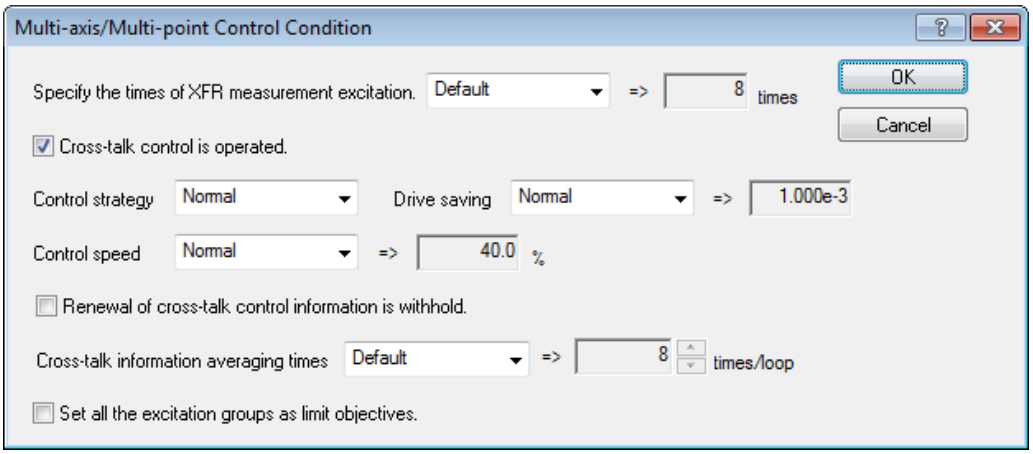
Tolerance is specified as a relative level to the tolerance defined in 'Tolerance Definition'.

By using this item, tolerance can be enlarged if it is necessary. For example, the width of tolerance needs to be enlarged when the too much noise exists in lower excitation level.

When the value of 0dB is set to this item, the value of tolerance is specified at the same value of the tolerance defined in 'Tolerance Definition'.

4.3 Multi- axis / multi- point control condition

The items for the condition of waveform control are defined in the multi-point / multi-axis operation.



4.3.1 Specify the time of XFR measurement excitation

(1) Meaning

This item is for setting the times of excitation / measurement operation in XFR measurement. (The measurement data is to be averaged.)

<Methods of XFR measurement excitation>

1) Initial excitation by white-noise

The loop check before transfer function measurement is operated by white-noise output signals in the excitation of the shakers one by one. The voltage of loop check is defined by the initial output voltage specified for each excitation group.

It checks the abnormality in the control loop for all shakers individually. All channels belonging to the excitation groups of the shakers are sure to be checked and the control loop is judged accurately by all the response of the used input channels of the excitation groups.

2) XFR measurement excitation

The excitation of transfer function matrix measurement is operated by drive output signals defined as XFR measurement output voltage of the excitation groups. This item specifies the excitation times for the measurement.

Also, the spectrum of excitation drive signal is controlled for the purpose of utilizing the measurement as much as possible; the transfer characteristic of controlled system is available to know according to the information of drive and response by white-noise excitation of 1). Generate a random signal satisfying the condition according to the information: determine the drive spectrum to have flat spectrum of responses at all input channels as possible, specify the level of drive signal from the specified excitation level. Then the excitation is to be operated.

The excitation of XFR measurement is operated simultaneously for all the shakers because the XFR measurement data is needed to be acquired in a close condition as actual event as possible.

XFR measurement by simultaneous excitation is achieved by the independent and individual random signal that is used as a drive signal for the excitation of shakers.

4.3.2 Cross-talk control

(1) Meaning

This item is for specifying whether to do cross-talk control or not.

Cross-talk control is the core of multi-point/multi-axis control operation so it must be usually set to 'execute'.

'Not execute' is set only in the following cases :

(1) Too large drive voltage is required if cross-talk control is done. So the cross-talk control can not be done according to the limitation of the excitation system.

(2) Operation without cross-talk control is intentionally tried in order to confirm the effect of cross-talk control.

When setting to 'not execute' is done, the control operation is carried out in the following sequences :

- Cross-talk control between the excitation groups is not done.
- Cross-talk control between output channels that belong to the same excitation group is done. (Consequently, to cease cross-talk control completely, all shakers must be defined so as to belong to different excitation groups.)

4.3.3 Control strategy

This item is ordinarily to be used in the 'normal' mode.

This item is used to partly change the control algorithm when the waveform cannot be controlled by ordinary procedures. The control strategy can be selected from the following three types :

Normal	: In this type, the impulse response of the inverse system (in general, non-causal) created on the basis of the transfer function for equalization is handled evenly before and after the time origin (past and future). This is suitable for the general waveform data which is usually used in this system.
Type A	: In this type, the impulse response of the inverse system is handled somewhat unevenly before and after the time origin (emphasis on the future).
Type B	: In this type, the impulse response of the inverse system is handled unevenly before and after the time origin (emphasis on the future).

In such a situation better control cannot be achieved or the bad influence may increase, especially when the control method of this system is used for executing the control loop.

However, those types may help in the control of transient waveforms (like that used in a shock test).

4.3.4 Drive saving

(1) Meaning

This item is usually to be set to ‘normal’.

When the linear independence of transfer function matrix H becomes unstable, the equalization matrix G calculated from H also becomes unstable, so some regularization is needed.

This item specifies a parameter for regularization.

In general, the regularization process yields a smaller drive signal (the larger the regularization parameter is set, the smaller the drive signal becomes). The name of this item is derived from this relation.

This item is effective only if the calculation of the equalization matrix G is unstable.

Drive saving is not any kind of actual energy-saving measure to achieve the same result.

In the concerning case, a too small H at a frequency component determines too large value for G as the inverse number of H. The small measured value H includes the measured error caused by noise. However, the influence of this measured error of H appears in the inverse number G as much larger error. This is a very significant problem (because the large G produces large drive voltage signals).

It is needed when the solution (drive) is unstable and unreliable because the simultaneous equations are unstable. In such a situation, the solution may have very large value, but it is not certain whether such large value is correct. Drive saving means using a more reasonable and stable solution (smaller than the original one) after regularization.

When simultaneous equations are stable, Drive saving is not needed.

However, regularization admits a sort of ‘abandonment’ in a shortage of rating of an excitation system; a larger drive signal required for a precise inverse matrix solution cannot be output although the original matrix is not completely bad.

In other words, the required drive voltage can be decreased by giving a larger parameter (instead, the control accuracy is worse, but ‘abandonment’ is useful for achieving excitation).

The selection range is described as follows :

Stricter solution : The regularization stated above is not almost done, but a strict mathematical solution is searched. When the solution is unstable or almost unstable, too large a drive voltage may be given. In this event, actual excitation may be impossible, so Stricter Solution is insubstantial. (Equivalent 0.0002 to regularization parameter)

Normal : Moderate regularization is done. When the solution is stable, there is no regularization effect, so Normal is suitable to the ordinary setting. (Equivalent 0.001 to regularization parameter)

Save : Stronger regularization is done. When the solution is unstable or almost unstable, a rough mathematical calculation is done to avoid generating too large a drive voltage. (Equivalent 0.005 to regularization parameter)

Specify : Regulation parameter is set by a number. When the regularization parameter is set to zero, no regularization is done. This setting does not have any advantage, generally.

4.3.5 Control speed

(1) Meaning

Control speed is usually a concept of follow-up speed with response change of the controlled system (if there is one) during control.

This item is for the transfer information (cross-talk control information) corresponding to the waveform control. And, the same item for the transfer information corresponding to PSD control is defined in averaging weight parameter of loop E of averaging parameter in fundamental/control conditions.

In this system, the following-up for the characteristic change of the controlled system is achieved by the consequent action such that when the transfer function is renewed at every renewal of control loop, then this system recognizes the change of the controlled system and it leads to the change in equalization matrix.

Based on the definition of this item, the weighting factor for averaging the old and new data in the correction of transfer function data is varied.

In the procedure to get the averaged data S, the weighting factor e_1 for the new data S^{raw} is adjusted, and S is described as follows

$$S = e_1 \cdot S^{raw} + (1 - e_1)S$$

In the setting of ‘Fast’, the weighting factor of the new data is large, so the change in the measured transfer function value is quickly reflected to the control.

The numeric value is specified in percentage for the weighting factor e_1 which determines the evaluation ratio of the new data.

For example, the definition of ‘25 %’ means $e_1 = 0.25$.

The numeric data corresponding to each set value are as follows:

Fast : 80 %

Normal : 40 %

Slow : 20 %

4.3.6 Cross-talk control loop open

(1) Meaning

There are two kinds of control information in the test of single and multiple excitation groups. The one is the control information for PSD control and the other is cross-talk information for the waveform control operation.

Renewing operation of the control loop is defined in ‘cross-talk control loop open’ of the multi-point/multi-axis control condition and in ‘open loop operation’ of the level change during the operation.

Renewing process of the control loop varies depending on the defined contents (the setting of open loop operation and cross-talk control loop open). And it is also possible to change the setting for the renewing of the control loop during the testing operation.

The precise description of the renewing activity is summarized as follows :

Definition contents	Open loop operation		Not execute (default)		Execute	
Testing operation	Open loop operation		Not execute (default)	Execute	Not execute (default)	Execute
		PSD control information	○	×	○	×
		Waveform control information	○	×	×	×

○: Control information is renewed.

×: Control information is not renewed.

The default setting of this item is to renew the control information, but by setting this item to ‘Not execute’, the control loop operation is set to ‘open’ as the initial setting.

The renewing of transfer function data is suppressed just after the test start when this item is set to execute. Therefore, this system proceeds to the state of open-loop control based on the transfer function data that is obtained at the initial measurement without changing the equalization matrix data.

4.3.7 Cross-talk information averaging times

(1) Meaning

This system adopts the method of renewing of transfer function data (the transfer information for waveform control) for tracking the changing response of controlled system.

The renewing of transfer function data is executed as below ;

The cross spectrum between the drive data and the response data is calculated as the averaged value obtained by the spectrum analysis for the specified frames. By using these data, a new transfer function data is calculated.

In this item, the times of averaging process is specified. The averaging process is operated by using the data for the fixed numbers of frames equal to the averaging times specified in this item. Then, the renewing of transfer function is executed.

This item is for the renewing of transfer information (cross-talk information) corresponding to the waveform control. The same item for renewing of transfer information for PSD control is set in ‘Averaging parameter averaging times for a loop M’ of Fundamental/control condition.

4.3.8 Limit control at all excitation groups

(1) Meaning

In the limit control of multiple excitation groups, there might be the case that an input channel is much influenced by not only the excitation group one belongs to but also the other excitation groups not belong to. The effect of the limit control may not be obtained sufficiently only by executing the limit control for the excitation group one belongs to.

This item is for setting of the limit control operation for not only the objective input channel but also the other input channels of all the excitation groups.

When this item is set to execute, the limit process is carried out for the reference PSD of all the excitation groups. Therefore, when the limit control is executed, the control response and the response of input channels of the excitation groups including not only the objective input channel but also the other input channels of all the excitation groups are influenced.

When this item is set not to execute, the limit process is carried out only for the excitation group one belongs to. In this case, the limit control does not have influence on the control response and the response of the input channel belonging to the other excitation group that has

4.4 Excitation group

Excitation groups/output system for control is defined.

4.4.1 Outline

(1) Meaning

The set of parameters concerning the excitation systems is called as ‘excitation group’.

The excitation and output system composed by the test definition are fixed on the basis of the excitation group defined in this item.

The purpose for this item is to declare the excitation group to be used in the test when there are multiple excitation groups existing.

The definition of excitation group aims at declaring in sequence the excitation groups to be used for the testing.

The usable excitation groups have already been specified in the excitation system information. Therefore, the type of shaker to be used and its rated values are also available to specify when the excitation group is defined.

The correspondence between each shaker and the output channel that gives a drive signal to a shaker also has been determined in the excitation system information.

Similarly, the excitation group to which each output channel belongs has been determined, so all the excitation and output systems are fixed only if the excitation group is defined, as shown in the following example:

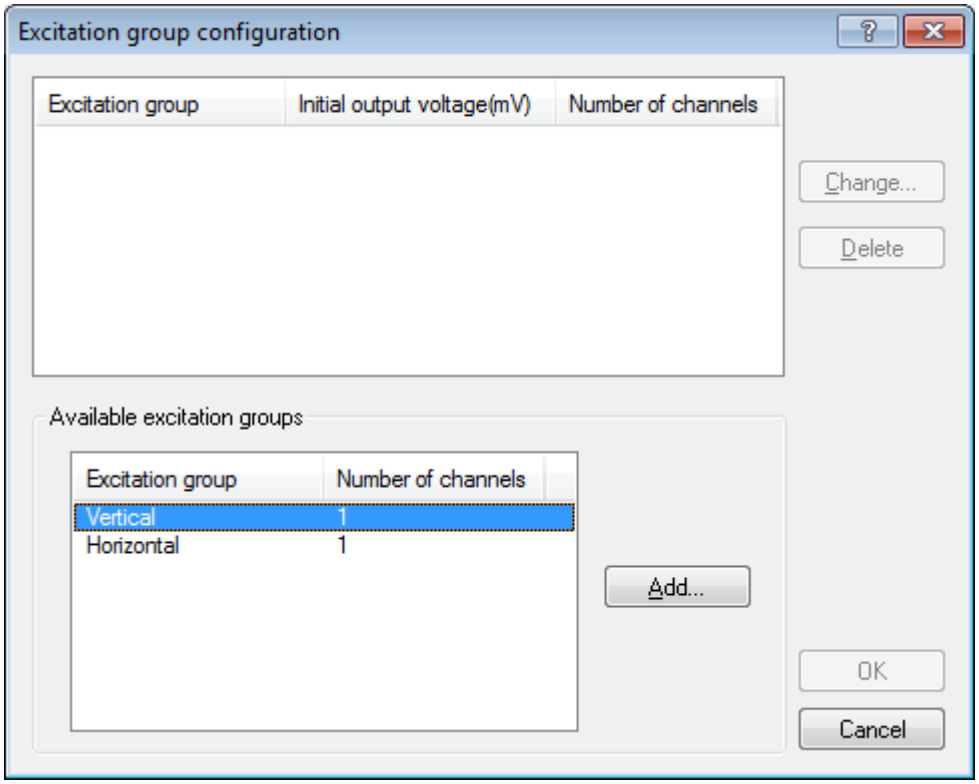
EXC_GRP A : Output Ch. OUTPUT 1 ⇔ shaker A1
: Output Ch. OUTPUT 2 ⇔ shaker A2
: Output Ch. OUTPUT 3 ⇔ shaker A3

EXC_GRP B : Output Ch. OUTPUT 4 ⇔ shaker B1
: Output Ch. OUTPUT 5 ⇔ shaker B2

EXC_GRP C : Output Ch. OUTPUT 6 ⇔ shaker C1
: Output Ch. OUTPUT 7 ⇔ shaker C2

The definition of excitation group is completed by setting the used excitation group as well as the items (initial output voltage and others) to be defined for the group.

4.4.2 Excitation group configuration



(1) Meaning

This item is for setting the used excitation group by operating the buttons in the display of excitation group configuration.

However, only one excitation group can be defined for single group of the excitation group configuration.

[Add] : To add a new excitation group

[Change] : To change the definition of an existing excitation group

[Delete] : To delete the defined excitation group

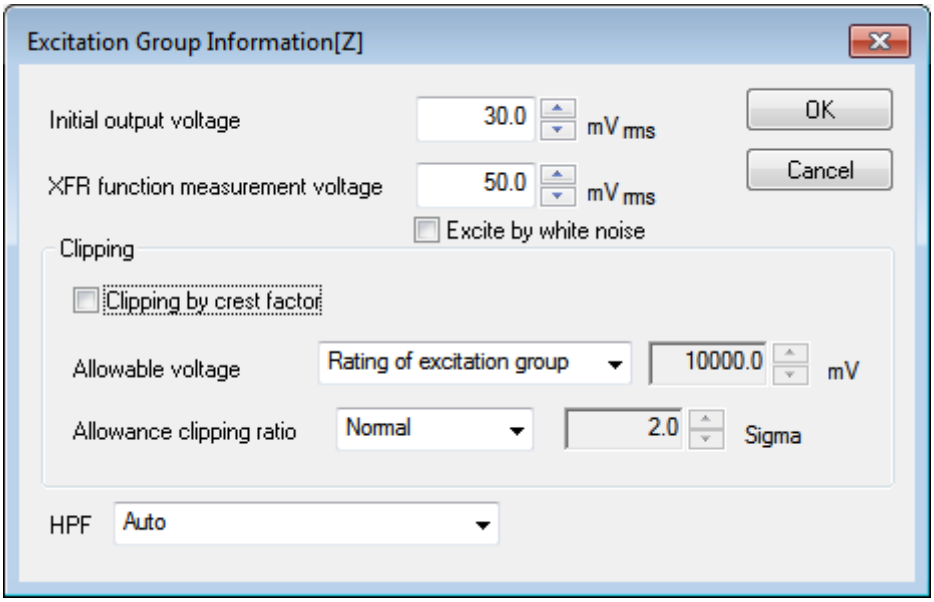
When the button [Add] or [Change] is pressed, the definition display of excitation system is shown. Necessary definition item for the excitation group can be set in this display.

Based on the sequence of the configuration, the order of graphic display of output channels is set. Graphic data of the output channels are displayed in the order of excitation groups declaration to which the output channels belong.

The sequence of output channels belonging to the same excitation group is determined by that of output channels determined in the excitation system information.

4.4.3 Excitation group information

Excitation group information of each excitation group is defined.



4.4.3.1 Initial drive voltage

(1) Meaning

Initial output voltage indicates the voltage to be output to the shakers initially at the first loop check. The control operation is always started by the initial drive voltage at the excitation.

The voltage is set by RMS value of the unit ‘mV’.

Initial output voltage ‘Vrms’ registered in the excitation system information is automatically used as the initial drove voltage when this item is not defined.

Note) A suitable value for the used shaker must be set as the initial output voltage.

4.4.3.2 XFR Measure output voltage

(1) Meaning

Following the initial loop check, the voltage level (RMS) of drive signal given to each shaker is defined in this item for each excitation group when the excitation for transfer function measurement is executed.

The system operates the constant excitation control at the transfer function measurement and outputs the drive of random signal that is equalized to have a flat (averaged, for multiple channels) characteristic of response frequency at all the input channels.

This item defines the level of the drive voltage waveform.

To set flat characteristics to drive output spectrum instead of response frequency components to be equalized to have almost flat spectrum, mark the checkbox for “Excited by white noise”.

This input system is designed to be flexible. Therefore the input channels are not corresponding to a specific shaker (but to an excitation group).

4.4.3.3 Clipping

(1) Meaning

This item is to specify whether to use ‘clipping’ which is carried out in output channel belonging to the concerning excitation group.

Clipping is specified to one of the following two methods;

- Clipping by crest factor
- Clipping by voltage

In this system, the value of clipping by voltage is necessary to be specified. On the other hand, clipping by crest factor is not necessary to be set if it is not needed. It is general that clipping by crest factor is set to ‘not execute’ in this system.

4.4.3.3.1 Clipping by crest factor

(1) Meaning

This item is for selecting whether the function of ‘clipping by crest factor’ is executed.

When the function of ‘clipping by crest factor’ is to be executed, this item is checked and the level of clipping should be specified as a relative ratio to standard deviation σ of the output signal.

4.4.3.3.2 Allowable voltage

(1) Meaning

This item is for setting of the maximum drive voltage of the system.

When an output channel is going to be driven to output the voltage signal that exceeds over the allowable voltage value, the clipping process is done for the drive signal. That is, the specified voltage level of this item has the same meaning of the clipping level by output voltage.

4.4.3.3.3 Allowance clipping ratio

(1) Meaning

In this system, the setting with only ‘clipping by output voltage’ is provided as a standard. In case of the clipping by output voltage, almost all the signals are clipped when the level close to the specified allowable voltage value is outputted. The execution of the clipping process leads to deform the drive spectrum and reduce the ability of spectrum control.

For safety, the system stops the operation when the crest factor of the clipped output signal becomes smaller than a specified value.

Abort operation is judged by the output voltage (RMS value). In this case, the abort voltage is specified as below ;

Abort voltage [mVrms] = Allowable voltage [mV0-p] ÷ Allowance clipping ratio

4.4.3.4 High pass filter (HPF)

(1) Meaning

This item is for setting of inserting or not-inserting of a high pass filter to the drive signal output circuit that is a concrete mechanism to realize the reduction of extra-displacement.

These items are selectable for setting the high pass filter and also the cut-off frequency fc to be used.

- Not use

  High pass filter is not used.

- Auto-setting of fc

  High pass filter is used, and the setting of cut-off frequency fc is automatically done by the system.

- Specify cut-off fc

  High pass filter is used, and the cut-off frequency fc is specified arbitrarily.

<Selection guide>

Generally, Auto-setting of fc that is the default value of this system is recommended.

As the selection guide of cut-off frequency fc setting, it is proper that the relation between the minimum control reference frequency (the frequency at the lower frequency edge of reference PSD) f_edgeL and the frequency resolution Δf is about :

$$fc = f\_edgeL + 0.5 \Delta f$$

However, the filtering is not necessary in the case of $f\_edgeL > 5 \Delta f$

Most of the cases, the setting of fc doesn't have much difficulty because the implemented high pass filter is the secondary function (in some cases, a definitely important effect of the displacement reduction can be obtained).

<Influence on estimated values of necessary velocity and displacement >

The setting value of this item effects on the RMS value of velocity and displacement that is calculated at the same time with the calculation of acceleration RMS value of the reference spectrum.

In a serious case that required displacement is too large to operate a test, it is recommended to observe the calculated value by changing the setting of fc.

On the other hand, the estimated RMS values of velocity and displacement is based on some assumption. Please note that the estimated value does not have absolute accuracy.

< Indication of fc set value >

The set value of fc is to be displayed after completing of the reference PSD definition when 'Auto-setting of fc' is selected.

4.5 Reference PSD

This item is for defining the reference PSD. Test pattern is determined by setting of the definition.

4.5.1 Reference PSD configuration

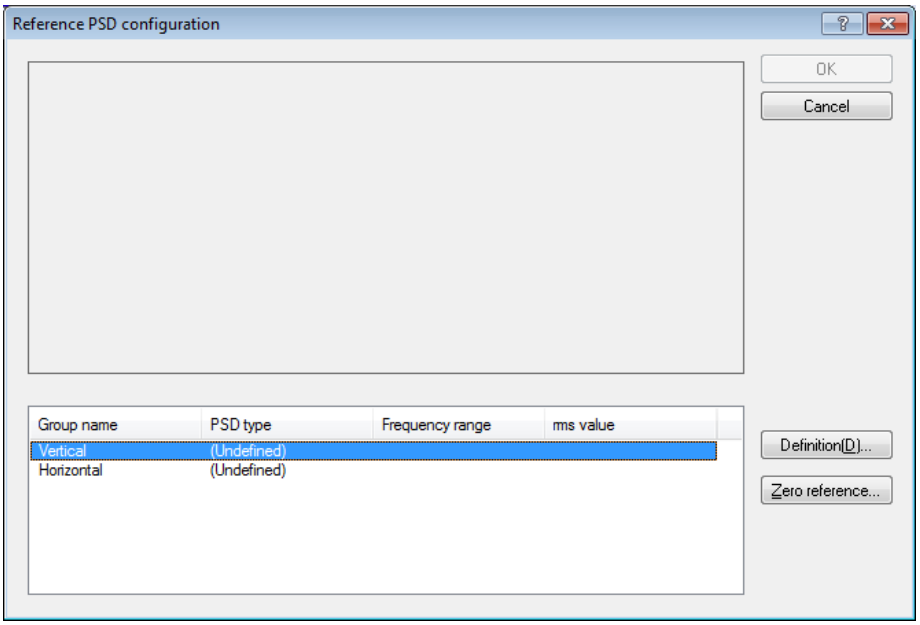
(1) Meaning

This item is for specifying the reference PSD for every excitation groups.

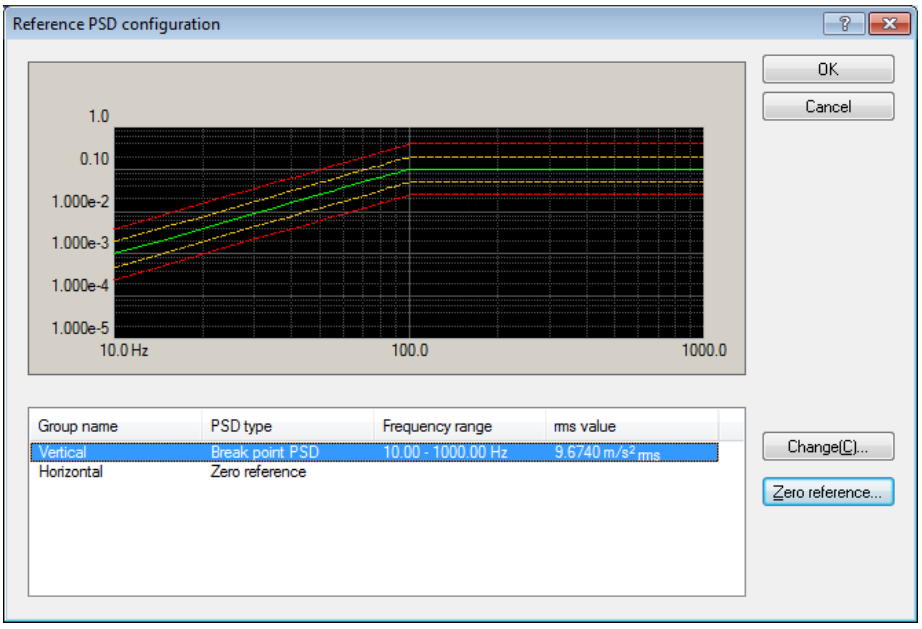
For the test definition having the multiple groups of excitation system, reference PSDs are required to be configured to each excitation group.

The definition and setting the types of the reference PSD are set in this item.

The basic point of the reference PSD configuration is to set the reference PSD used in a test.



Before defining the reference PSD



After defining reference PSD

<Reference PSD definition>

In the definition window of the reference PSD configuration, the excitation groups to be used are defined by selecting one among the excitation group in the display set the conditions for the group with using the push buttons below.

The available excitation group has already been determined in the excitation group configuration.

[Define]	: A new reference PSD is set.
[Correction]	: The definition content of the defined reference PSD is changed.
[Zero-reference]	: Reference PSD is set to zero. The details are described below.

When [Define] or [Correction] is selected, the definition window of reference PSD definition appears. The reference PSD is available to be set in this window for every excitation groups.

<Zero-reference>

As one of the important usage of the multi-axis excitation system, the shakers are used for suppressing of cross-talk vibration in order to realize the exact one directional excitation.

In this case, only one reference PSD is required basically. Then the reference PSD of response points corresponding to the other excitation axes are to be set to have all ‘zero’ data.

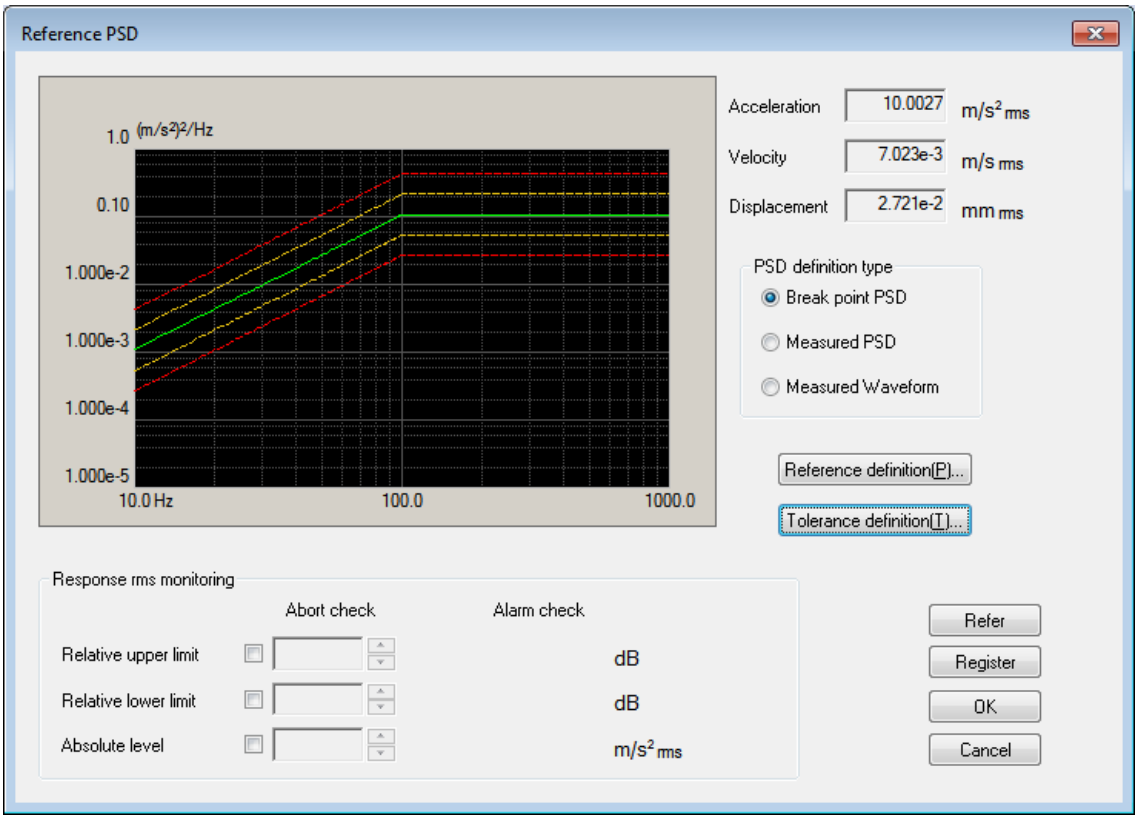
In such a case, it is too troublesome to compose the reference PSD with zero data and to use it as the reference PSD. So, the system automatically set zero data as reference PSD to the concerning groups by pressing the button of [Zero-reference].

Also, the control response check by the tolerance and RMS value is not executed when zero-reference’ is set in this item. The limit control is not available to execute for input channels belonging to the excitation group that has set to zero-reference.

<Display of defined reference PSD>

This defined reference PSD is displayed when the excitation group having the defined reference PSD is selected. However, the graph display does not appear when the reference PSD of a group is set to zero-reference.

4.5.2 PSD definition



(1) Meaning

This item is for specifying the types of PSD.

In this system, the definition method of PSD data are provided as below ;

1) Break point PSD definition

2) Measured PSD definition

3) Measured Waveform definition

Select a definition method of PSD data in PSD definition type.

<Beak point PSD definition>

The PSD data is defined by the break point.

<Measured PSD definition>

The data file of PSD data saved in CSV format written as the dedicated format is used as the reference PSD data as it is or with editing properly if necessary.

<Measured Waveform definition>

Calculate PSD data from the data of waveform data file saved by the specified CSV formats without any editing or with appropriate editing as necessary, and use them as reference PSD data.

<RMS value of PSD data>

When PSD data is defined, the RMS value if the defined PSD data is shown in the display.

(If the control unit is in acceleration, the RMS values of the velocity and the displacement are also shown.)

The RMS value of the PSD data shown in this definition display is the calculated value which depends on the control line (Δf) specified in Spectrum Analysis Condition.

The RMS value recognized as a control quantity of this system is the RMS value which depends on the control line shown in this definition display. The rating check of the system is also executed with this RMS value.

However, these calculated values may be somewhat different from the 'theoretical value' which is calculated from the defined data shown in the break point definition display (it does not depend of Δf).

The RMS value shown in Measured PSD Definition display is the calculated value which depends on Δf of the PSD data file to be used. And, when both of the Δf do not coincide with each other, the RMS values do not coincide neither.

4.5.2.1 Break point PSD definition

4.5.2.1.1 Outline

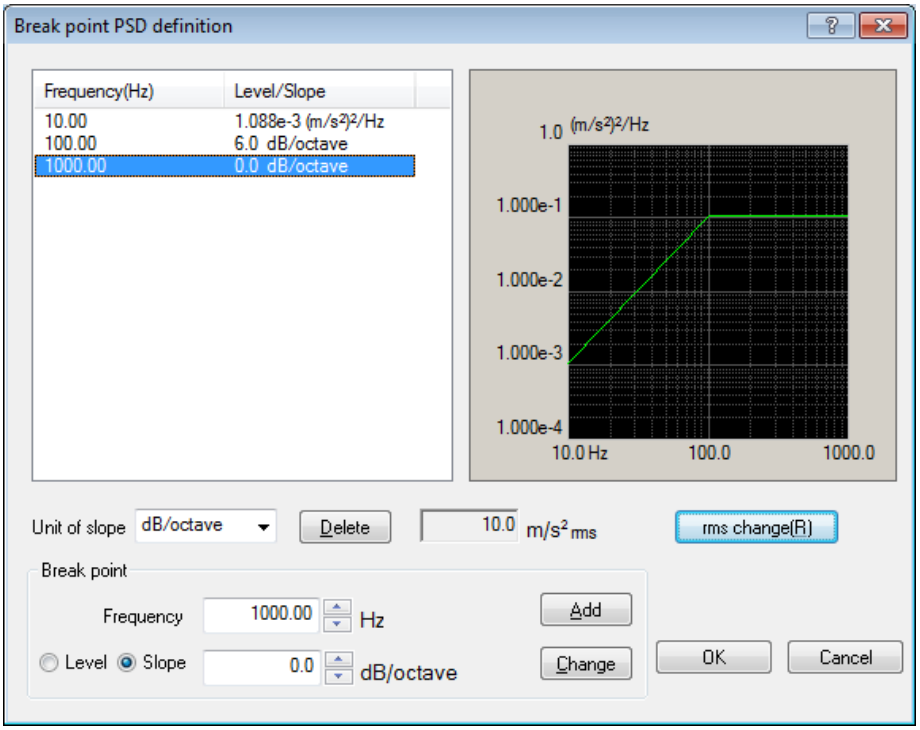
PSD is defined by a pair of the frequency and the level (or the slope).

<Example>

10 [Hz] ~ 100 [Hz] : a spectrum having the slope [6 dB/oct] with 10 [Hz], 0.1 [$(m/s^2)^2$/Hz] as starting point

100 [Hz] ~ 1000 [Hz] : a spectrum having the constant level (the slope [0 dB/oct])

Note) The vertical axis of the graph in the profile is scaled by the control unit.



Break point PSD data definition is independent from the frequency resolution Δf . If the

defined break point PSD data has a component of which frequency has a fraction at dividing by Δf, the PSD data of each control line is defined as; draw a strait line between the PSD levels of the frequency adjoining each other in the defined break point PSD data. Then, calculate the level at the frequency of the control line on this straight line, and define the PSD data of each control line by this calculated value.

However, the frequency components of the PSD data to be defined should exist in the band between the frequency resolution Δf and the control Frequency range fmax.

At least, two lines of the data are needed between Δf and fmax.

Break Point (B.P.) data is registered by using these buttons.

Also the B.P. data can be registered for 256 at the maximum.

[Add] : A new B.P. data is registered.
When this button is pressed after inputting of the frequency or the level of B.P. or the value of slope, the current value is shown in the setting frame and registered as a B.P. data.

Additional registration of a data having the same or similar frequency of the registered B.P. frequency can not be set.

[Change] : The content of the registered B.P. data is changed.
Select the B.P. data line to be changed by a mouse. Then, change the objective item and, press this button.

[Delete] : The registered B.P. data is deleted.

Press this button at the selected B.P. data line to be deleted.

4.5.2.1.2 Frequency

(1) Meaning

This item is for inputting of B.P. frequency.

The frequency data which is the same or too close a value of the registered B.P. frequency can not be added as a new B.P. data.

4.5.2.1.3 Level

(1) Meaning

At registering of B.P. data, the level data corresponding to the frequency data is inputted in the unit off the PSD value.

The PSD value can be inputted to this item by pressing of the [Level] button.

The PSD value is expressed by ‘unit^2 / Hz’. This ‘unit’ expresses the control unit that has already determined in Fundamental/control condition.

4.5.1.1.4 Slope

(1) Meaning

At registering of B.P. data, the slope data corresponding to the frequency data is inputted.

The slope value can be inputted to this item by pressing of the [Slope] button.

The unit of slope can be selected from 2 types, that is, ‘dB/octave’ and ‘dB/decade’. One of these units can be used for a PSD data.

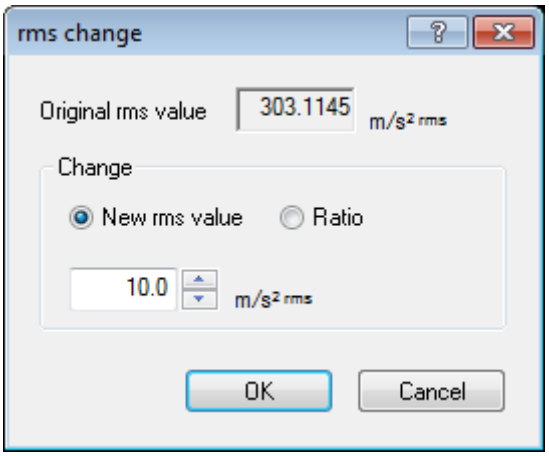
4.5.2.1.5 rms change

(1) Meaning

When the definition of the spectrum stated in the above is completed, the conversion of its RMS value is done.

This function is for proportional converting of reference PSD, that is for converting the defined spectrum into the data having the required RMS value by changing only its level without changing its shape.

The dialog box of RMS change appears by pressing of the RMS change button.



The RMS value can be set in these two methods ;

・New rms value

The changed RMS value is specified in an absolute value.

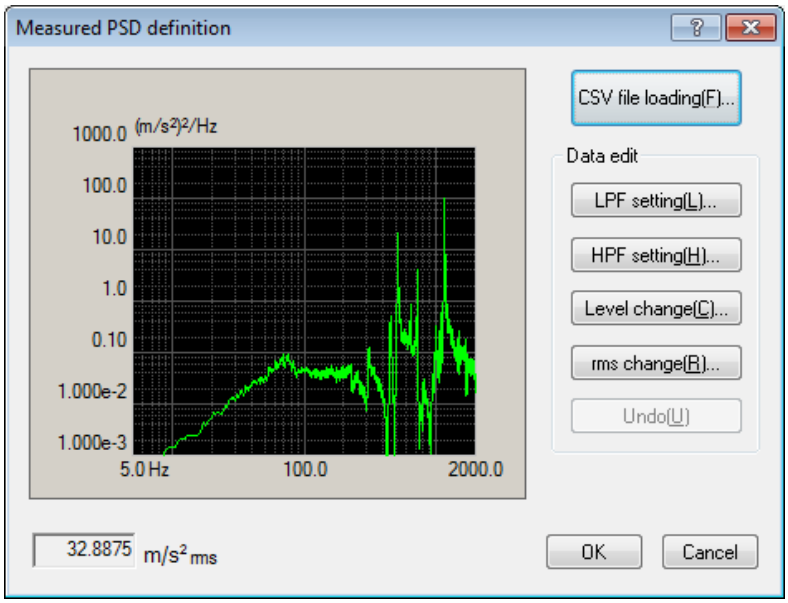
・Ratio

The changed RMS value is specified in a relative value after the change.

4.5.2.2 Measured PSD definition

4.5.2.2.1 Outline

Reference PSD is defined by using of a measured PSD data.



The measured PSD data to be used should be a CSV file written in the specified format. Refer to "4.5.2.2.4 CSV data file" about the details of this format.

The frequency resolution Δf of the used PSD data file is not necessary to coincide with the Δf defined in test definition. If the defined PSD data has a component of which frequency has a fraction when divided by Δf, the PSD data of each control line is defined as follows; draw a straight line between the PSD levels of the frequency adjoining each other in the defined PSD data. Then, calculate the level at the frequency of the control line on this straight line, and define the PSD data of each control line by this calculated value.

However, the frequency components of the PSD data to be defined should exist in the band between the frequency resolution Δf of test definition and the frequency range fmax. When data does not satisfy the above condition this data should be edited to complete the condition. At least, two lines of the data are needed between Δf and fmax.

<PSD data file selection>

PSD data file is selected by using the button as below;

[CSV file loading] : The PSD data file is loaded.

<Data edit>

The loaded data file can be selected by the following buttons;

[LPF setting] : This item is for operating of low pass filtering or truncating of the data.

[HPF setting] : This item is for operating of high pass filtering or truncating of the data.

[Level change] : The specified level of frequency band is changed.

[rms change] : The RMS value is changed.

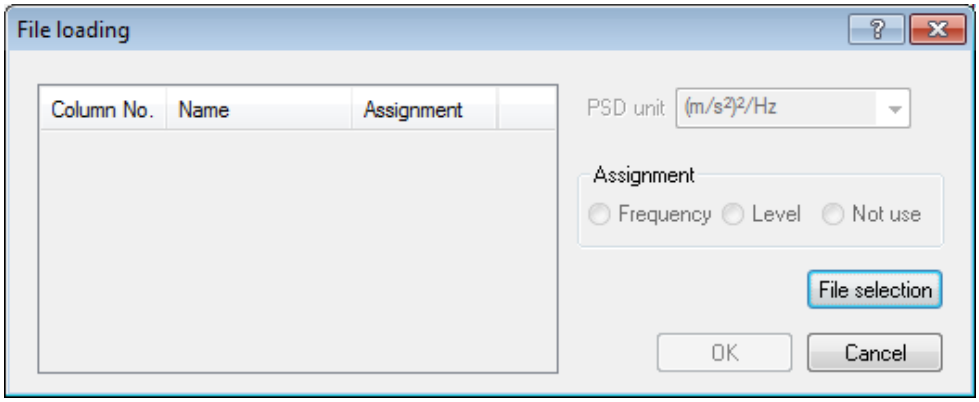
[Undo] : The state of the edited data is returned to the previous state for one step.

4.5.2.2.2 File loading

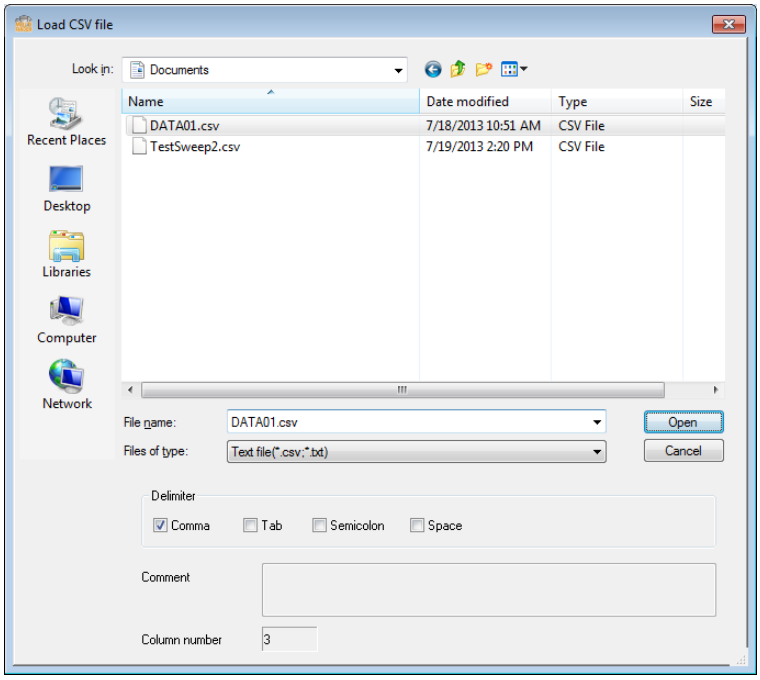
(1) Meaning

This item is for selecting the measured PSD data file to be used as a PSD data.

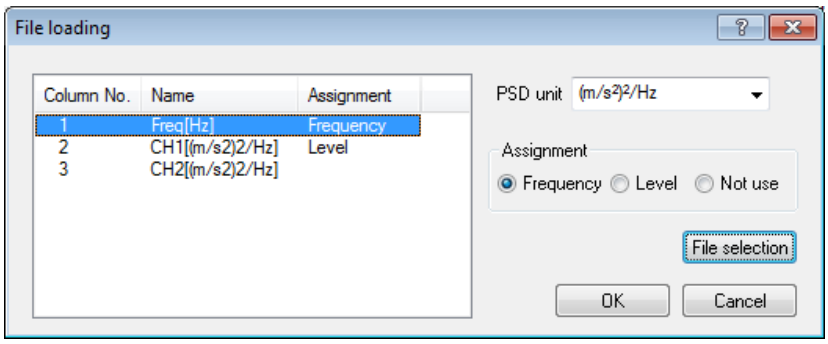
In the dialog of the measured PSD definition, press the [CSV file loading] button to open the dialog box of File loading.



Press the [File selection] button to open a dialog box for CSV file selection.



After the objective data file selection is completed, the data to be used in the definition is to be selected among the data described in the data file.



<PSD unit>

Unit for the level of data file is selected.

<Assignment of frequency data>

The data of column corresponding with the frequency data is selected among the data in data file.

<Assignment of level data>

The data of column corresponding with the level data is selected among the data in data file.

4.5.2.2.3 Data edit

(1) Meaning

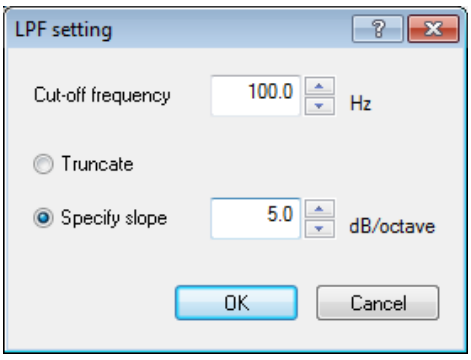
When the PSD data is determined, the selected measured PSD data is displayed and the buttons in 'Data edit' become valid. The data can be edited by a selected button to be executed on demand.

4.5.2.2.3.1 LPF (low pass filter)

(1) Meaning

This item is for operating of low pass filtering of PSD data or truncating the data in unnecessary frequency band to discard.

A dialog box of LPF setting appears by pressing of the [LPF Setting] button.



The items for setting are;

・Cut-off frequency

This item is for setting of the cut-off frequency for a filtering process.

・Processing contents

The processing contents of LPF are;

Truncate : This item is for cutting off the data at the higher band than the specified cut-off frequency. The higher data than fmax should be cut off and discarded from the PSD data when there is higher frequency components than the control frequency range existing.

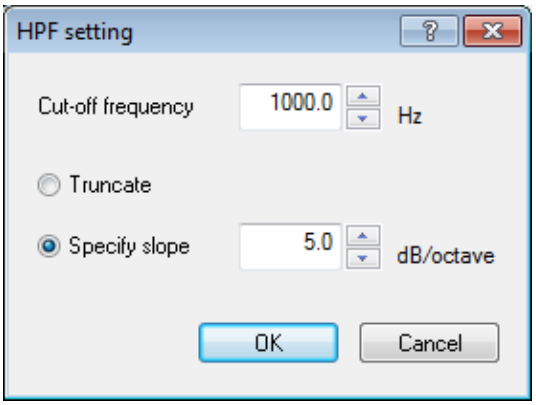
Specify slope : This item is for operating of low pass filtering with the specified slope. The unit of slope is dB/octave.

4.5.2.2.3.2 HPF (high pass filter)

(1) Meaning

This item is for operating of high pass filtering to PSD data at truncating the data in unnecessary frequency band to discard.

A dialog box of HPF setting appears by pressing of the [HPF Setting] button.



The contents and the meaning of these setting items are the same as that of LPF.

・Cut-off frequency

This item is for setting of the cut-off frequency for a filtering process.

・Processing contents

The processing contents of HPF are;

Truncate : This item is for cutting off the data at the lower band than the specified Cut-off Frequency. The lower data than the frequency resolution Δf should be cut off and discarded from the PSD data when there is lower frequency components than the control frequency resolution existing.

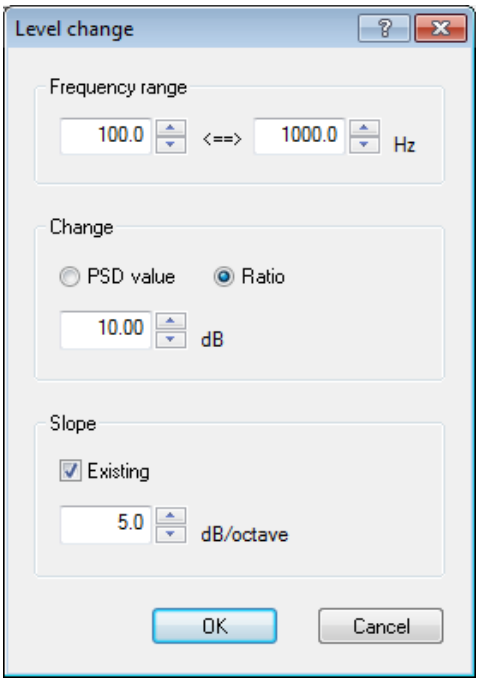
Specify slope : This item is for operating of high pass filtering with the specified slope. The unit of slope is dB/octave.

4.5.2.2.3.3 Level Change

(1) Meaning

This item is for changing the PSD data level in the specified frequency range.

When the button [Level Change] is pressed, the dialog of level change appears.



The items for setting are;

・Frequency range

This item is for setting of the frequency range for level change. The minimum value of the frequency range to be set is the frequency resolution Δf of PSD data file. The level only for one line can not be changed.

・Change

This item is for selecting of the specifying method of PSD level to be changed.

PSD value : The PSD level to be changed is specified by an absolute value.

Ratio : The PSD level to be changed is specified by a relative value.

・Slope

In case that ‘ratio’ is selected in the item of change method, this item is for specifying whether the slope of transportation band is attached or not.

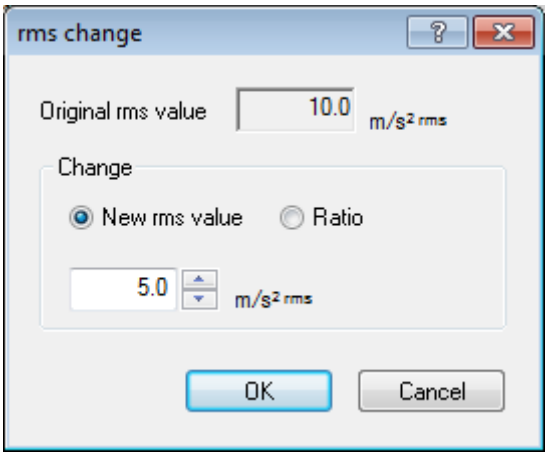
The slope is set outside of the specified frequency range when it is set to be attached. The unit of slope is dB/octave.

4.5.2.2.3.4 rms change

(1) Meaning

This item is for converting the defined PSD into the data having the required RMS value by changing only its level without changing its shape.

When the button [rms change] is pressed, the dialog box of RMS change appears.



Specifying method of RMS value can be selected among the following two methods ;

・Newl rms value

The RMS value to be changed is specified by an absolute value.

・Ratio

The RMS value to be changed is specified by a relative value.

4.5.2.2.4 CSV data file

(1) File Format

Text File (MS-DOS)

(2) Description formats of Data

The frequency domain data are described as follows.

	1st. column	2nd. column	3rd. column	
1st. line	Frequency[Hz],	Data name 1,	Data name 2,	……
2nd. line	0.0,	***.***,	***.**,	……
3rd. line	Δf,	***.***,	***.**,	……
	2Δf,	***.***,	***.**,	……
	:	:	:	:
	F,	***.***,	***.**,	……

・The character-string data of the first line (data name). is not indispensable.

・The order of each Data (row) doesn't have regulations.

・The frequency must be sorted in ascending order.

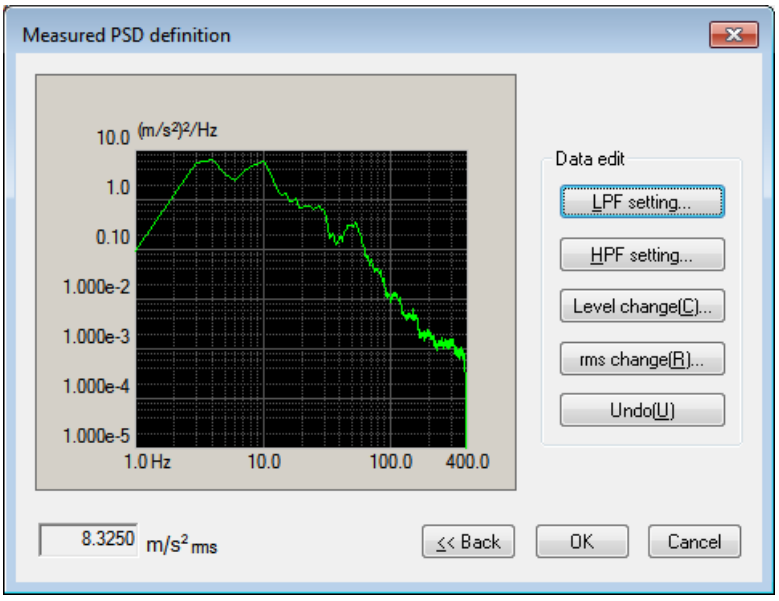
(3) Unit of Data

The unit of data is specified after the data file is selected.

4.5.2.3 Measured Waveform definition

4.5.2.3.1 Outline

Reference PSD is defined by using of a measured waveform data.



First, select waveform data, and edit the waveform as necessary.

Calculate PSD data from the waveform data. Edit the data furthermore as necessary, and use them as reference PSD data.

The measured waveform data to be used should be a CSV file written in the specified format. Refer to "4.5.2.3.4 CSV data file" about the details of this format.

<Data edit>

This item is for editing the PSD.

For details, refer to "4.5.2.2 Measured PSD definition".

<Back>

Returns to the screen to select waveform data and data edit.

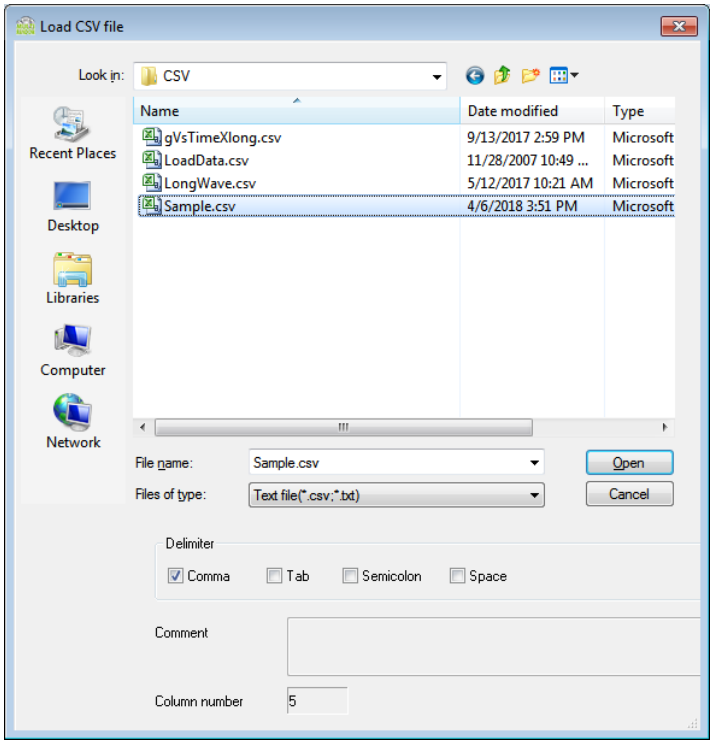
When this screen reappears after waveform data is changed, data edit which has been conducted already is abandoned.

4.5.2.3.2 Waveform Data File loading

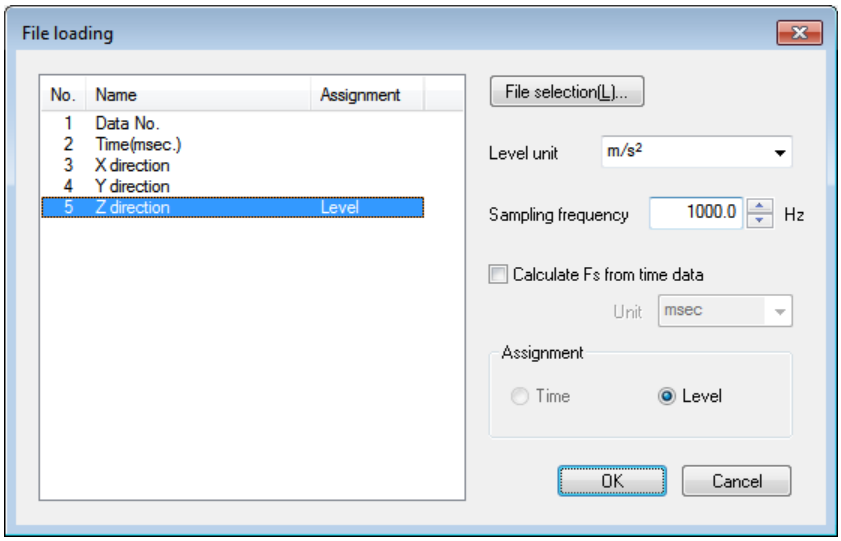
(1) Meaning

The ‘Measured waveformdata file’, the base of PSD data, is selected and edited.

First, a dialogue box to select CSV file is displayed.



After the reference data file is selected, data to be used for definition is selected from the data in the data file.



<File selection>

A dialogue box to select CSV file is displayed, and waveform data file is selected again.

<Selection of level unit>

Unit for the level of data file is selected.

<Sampling frequency>

Sampling frequency of data file is specified.

When sampling frequency is automatically calculated from time data, the calculated sampling frequency is displayed (In this case, changing sampling frequency is not allowed.)

<Calculation of sampling frequency from time data>

Sampling frequency is automatically calculated by the data assigned as time data.

Selecting the correct unit of time data is also needed.

<Assignment of level data>

The data of column corresponding with the level data is selected among the data in data file.

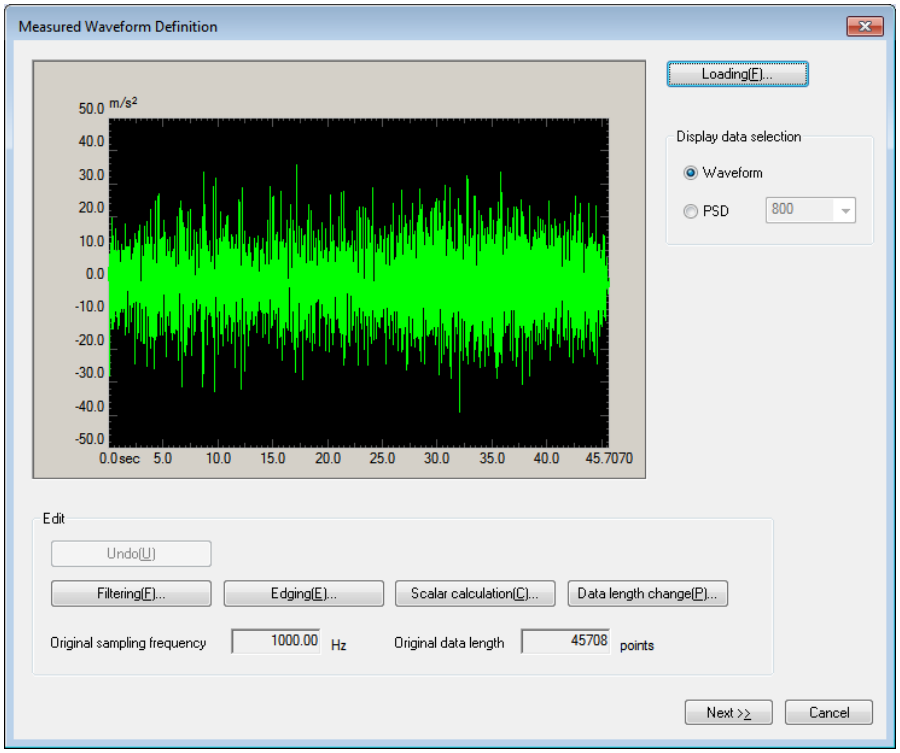
< Assignment of time data>

When sampling frequency is automatically calculated, The data of column corresponding with the time data is selected among the data in data file.

Time data needs to be lined up with constant time intervals.

For details, refer to “4.5.2.3.4 CSV data file”.

When selection of waveform data is completed, the selected waveform measured data is displayed.



<Selection of waveform data file>

Waveform data file is selected by using the buttons shown below.

[File loading]: This button is for loading waveform data files.

<Display data selection>

The graph data can be selected from the items below.

・Waveform display

Waveform graph is displayed.

・PSD display

PSD graph is displayed. The number of lines of PSD can be selected.

<Data editing>

Editing loaded waveform data is allowed by using the buttons shown below.

[Undo]: The state of the edited data is returned to the previous state for one step.

[Filtering]: This item is for operating of filtering.

[Edging]: This item is for operating of Edging, windowing, and clipping.

[Scalar calculation]: This item is for scalar calculation.

[Data length change]: This item is for changing number of data points.

4.5.2.3.3 Data edit

(1) Meaning

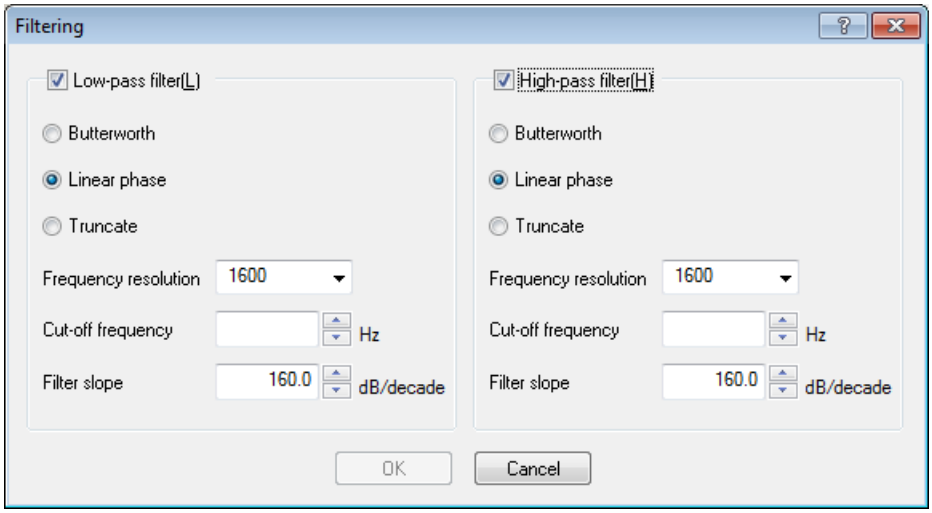
When the PSD data is determined, the selected measured waveform data is displayed and the buttons in 'Data edit' become valid. The data can be edited by a selected button to be executed on demand.

4.5.2.3.3.1 Filtering

(1) Meaning

This item is for operating of Filtering to the waveform data loaded.

The definition dialog of Filtering as below appears by pressing [Filtering] button in the definition dialog.



Setting items are as shown below.

<Type of Filter>

Type of Filter is selected.

・Low-pass filter

In this type, the low frequency component of waveform data is passed.

・High-pass filter

In this type, the high frequency component of waveform data is passed.

<Filter Characteristics>

Filter Characteristic is selected. Generally, the default setting of 'Linear Phase' is used.

・Butterworth

Nth-order Butterworth Filter.

How to specify the order N is described after the next clause.

・Linear phase

The Linear Filter cuts the components without giving any non-linear phase

change to the input signal.

This system adopts the specifications that the slope at the attenuation band can be defined without changing the phase in all the frequency elements at all.

・TRUNCATE

The characteristics of the Frequency range which is the object for the filter processing is truncated to zero bounded by the specified cut-off frequency fc.

The phase characteristics are the same as the 'Linear Phase' in the previous clause.

<Frequency resolution>

The frequency resolution is specified to carry out Fourier Transform and Inverse Fourier Transform by FFT technique for the filter processing of the waveform data.

Therefore, the input lower Cut-off frequency fc is determined when frequency resolution is specified.

<Cut-off frequency>

This item specifies the Cut-off frequency for Filtering.

The possible lower value fc_min is determined by the Sampling frequency fs of the objective waveform data of the Filtering process and the frequency resolution L as follows.

fc_min = Δf [Hz] Δf = fmax/L, fmax = fs/2.56

<Filter order>

This item is defined only when 'Butterworth' is specified for Filter Characteristics.

The order N is inputted that specifies the Cut-off Characteristics of the Filter.

<Filter slope>

This item is defined only when Filter Characteristic is 'Linear Phase'. The Slope of the attenuation transient band characteristics S[dB/decade] that is correspondent to the order of the Filter is specified.

When this item is defined, Filtering process according to the following formula is executed within the objective range.

$$A'(f)\begin{cases} = A(f) & \Delta f \le f < fc \\ = A(f)/(f\ /\ fc)^{S/20} & fc \le f \le f\ \max \end{cases}$$

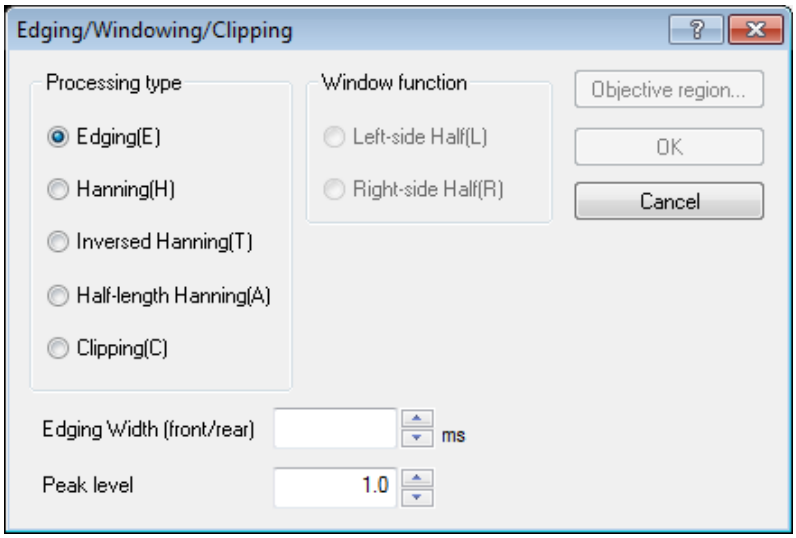
A(f) Amplitude value

4.5.2.3.3.2 Edging

(1) Meaning

This item is for operating the edging process that achieves to smooth the loaded waveform data at the beginning/ending edge to zero. Half-length Hanning Windowing is used in this process.

When [Edging] button is pressed in the definition dialog, the definition dialog of Edging appears as below.



Setting items are as shown below.

<Processing>

Type to be processed can be specified.

・Edging

Half-length-Hanning processing is conducted at front and rear of waveform. For details of Half-length-Hanning, see below.

・Hanning

Hanning generates the Hanning function of the defined peak value in the defined region, and multiplies the given waveform data by the function.

・Rotated Hanning

Rotated Hanning generates the ‘inverse Hanning’ function of the defined peak value in the defined region, and multiplies the given waveform data by the function.

・Half-length Hanning

Half-length Hanning generates the half-length Hanning function of the defined peak value in the defined region, and multiplies the given waveform data by the function.

・Clipping

The waveform data in the defined region is clipped by the defined clipping level.

When the clipping level is positive (+), the data over the level is replaced by the clipping level.

When the level is negative (-), the data below the level is replaced by the clipping level.

Smoothing processing can be achieved to smooth the border between the clipping level.

<Window Function>

This item can be input only if the previous item is set to ‘Half-length Hanning’.

There are two types ;

・Left-side Half

This type generates the Hanning function on the left, (start-up half-length), and multiplies the given waveform data by the function.

・Right-side Half

This type produces the Hanning function on the right (fall half-length), and multiplies the given waveform data by the function.

< Edging (front and rear)>

・Edging

The time for edging Te is specifyed.

Windowing by Half-length Hanning is operated to time data from the beginning to the ending edge.

・Other processing

The objective region in which the processing is conducted is specified.

Although the whole region of waveform data is specified normally, an arbitral region can be specified as necessary.

<Peak Level (Clipping Level)>

In the event of Hanning, this item specifies the peak value of the hanning function. The unit is none because the value has no dimension.

The default value is '1'.

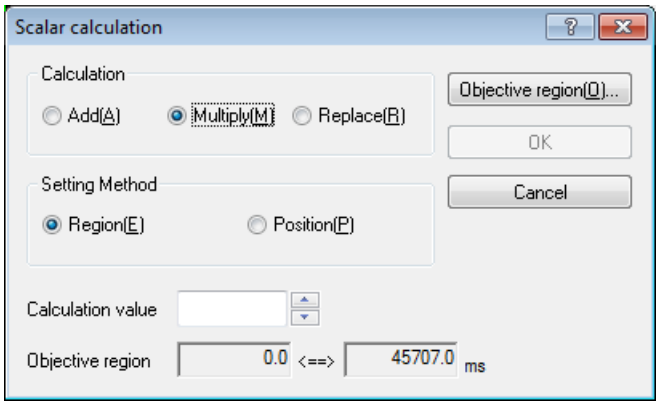
In the event of clipping, this item specifies the clipping level. The unit is the same as the objective waveform data.

4.5.2.3.3.3 Scalar calculation

(1) Meaning

This item is for setting of the calculation between numeral values of the waveform data loaded.

When [Scalar calculation] is pressed in the definition dialog, the definition dialog of Scalar calculation appears as below ;



<Calculation>

This item defines the calculation type between the waveform data and numeric value.

・Add

The defined quantity is uniformly added to the current waveform data.

・Multiply

The waveform data is transformed in proportion to the defined multiplier.

・Replace

The current waveform data is replaced by the defined value.

<Calculation value>

This item defines the value to be calculated.

When the calculation type is specified to ‘Multiply’, this item is set to the untitled value. When the type is specified to ‘Add’ or ‘Replace’, the unit must be the same as that of the current waveform data.

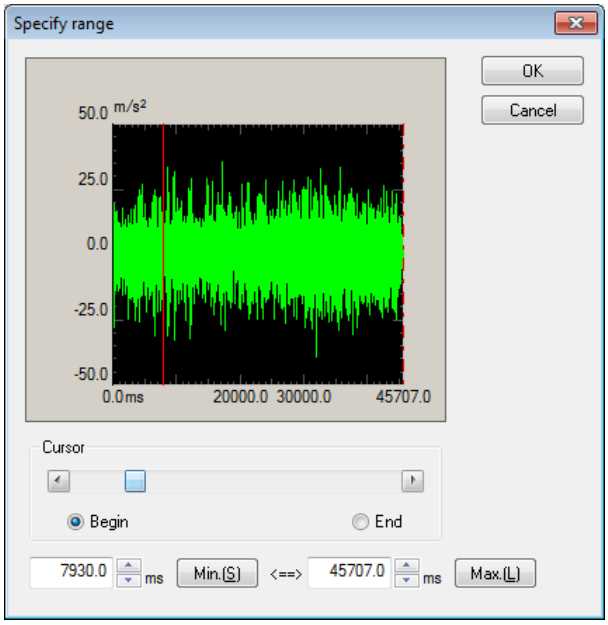
<Setting Method>

This item defines the objective range to be calculated.

・Region

To specify the objective region of the calculation by defining the beginning point and ending point.

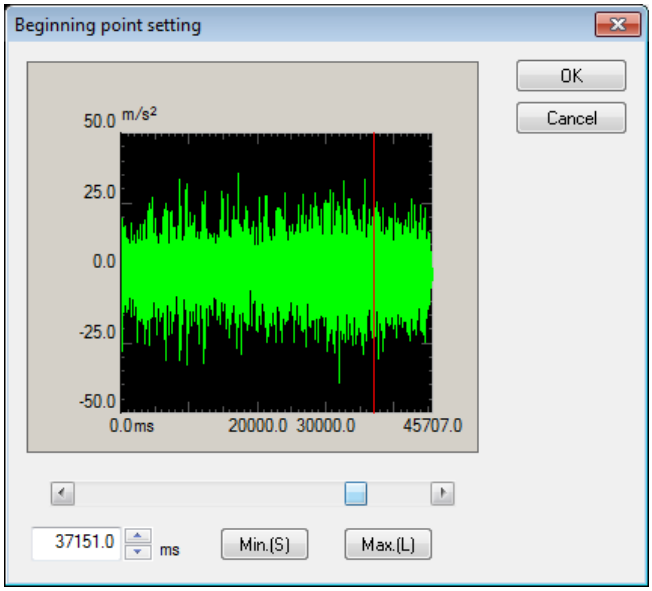
Select [Objective region] to display the dialog as below. And define the beginning and the ending points that become the objects for calculation.



・Position

Only the data of the specified time position is the objective data of the calculation. Namely, only the data for one point on the specified time axis is processed by the calculation.

When [Objective position] is selected, the dialog as below appears. And define the position of the objects for calculation.

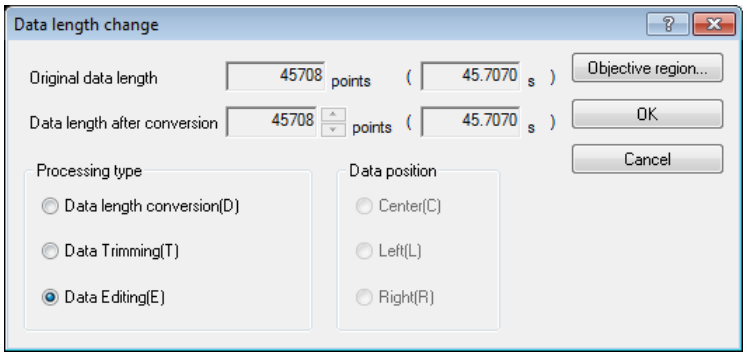


4.5.2.3.3.4 Data length change

(1) Meaning

This item is for changing the waveform data length.

Select [Data length change] in the definition dialog. The definition dialog of Data length change as below appears.



<Processing type>

When Data Length of waveform data is converted, the following methods are available ;

・Data length conversion

The desired Data length which will be converted from the current data length is specified. Data Length can be increased or decreased from the current data length.

・Data trimming

The data in the specified region is trimmed from the objective waveform data and the rest is used as a new waveform data.

Data Length is decreased from the current data length.

・Data editing

The data in the specified region is trimmed from the objective waveform data and the trimmed part is used as a new waveform data.

Data Length is decreased from the current data length.

<Data Length>

This item is specified only when Processing type is specified as Data length conversion and is defined a new Data Length R'.

In this item, the waveform data of a new Data Length is generated, while Sampling frequency fs is kept unchanged.

In other words, the Frame Time T increases or decreases in proportion to the Data Length as follows ;

T = R' / fs [s] R' : A new Data Length

・The old Data Length R > The new Data Length R' ;

Part of the old data is discarded in proportion to the decrease of the Frame Time T (the discarded area depends on the defined data position stated later).

・The old Data Length R < The new Data Length R' ;

Zero data is added to the old data in proportion to the increase of the Frame Time T (the added area depends on the defined data position stated later).

<Data Position>

This item should be inputted only when the Processing type is 'Data length conversion' and this item defines the reference position for changing the waveform data, led by changing the data length.

・Center

The data is increased or decreased with keeping the center of the old data as a base. The data is added or discarded uniformly on the right and the left.

・Left

The data is increased or decreased with keeping the left end of the old data fixed. The data is added or discarded from its right end.

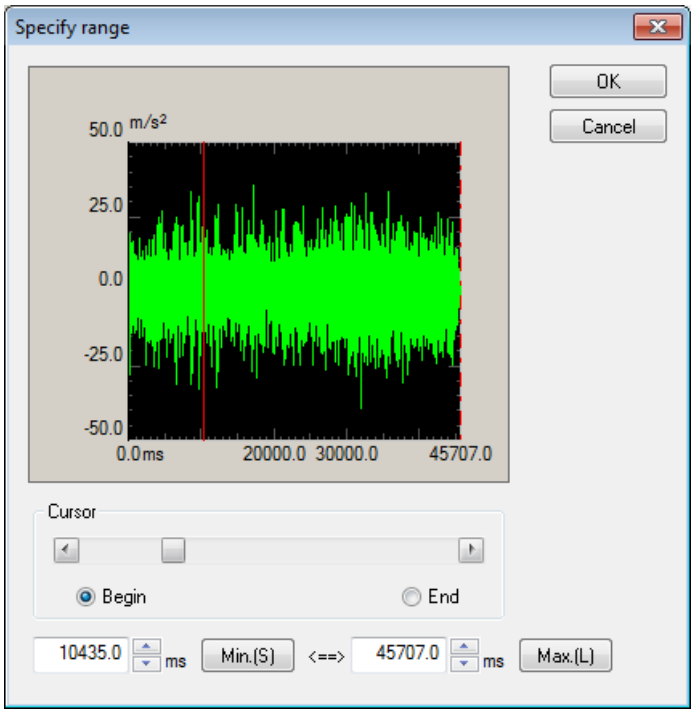
・Right

The data is increased or decreased with keeping the right end of the old data fixed. The data is added or discarded from its left end.

<Objective Region>

This item is valid only when ‘Data trimming’ or ‘Data editing’ is set in Processing type.

When [Objective Region] is pressed, the dialog box for setting of objective region appears.



4.5.2.3.4 CSV data file

(1) File Format

Text File (MS-DOS format)

(2) Data

Sampling frequency data at each time is described as below in order of time passing.

	1st column	2nd column	3rd column		
1st line	Time (ms)	Data Name 1,	Data Name 2,	Data Name 3,	……
2nd line	0.0,	***.***,	***.**,	***.**,	……
3rd line	Δt	***.***,	***.**,	***.**,	……
	2Δt	***.***,	***.**,	***.**,	……
	.	.	.	.	.
	T,	***.***,	***.***,	***.**,	……

- It is not necessary to specify the data in a 1st line.
- The order of data (column) are not specified specially.
- Time data is not necessary to me specified.

(3) Unit of Data

Unit of data to be described is determined by selecting a Data File.

(4) Sampling frequency

Sampling frequency of data to be described is specified after selecting the data file.

Sampling frequency can be calculated automatically from time data when time data exists.

4.5.3 Tolerance definition

(1) Meaning

This item is for defining the condition of tolerance check.

It may be happened that the response PSD control to be equal to the reference PSD cannot be obtained as you need depending on the condition of specimen (degree of sharpness in resonance characteristics, having the non-linearity elements, etc.) in vibration test operation.

In such a case, it is necessary to decide the conditions for continuing the test operation beforehand. This system has four types of check condition for the control response as below ;

A 1) Alarm allowance band width
2) Abort allowance band width

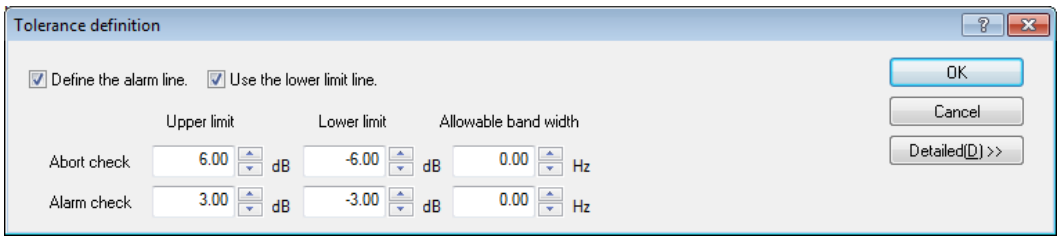
B 1) Alarm RMS level
2) Abort RMS level

Here, 'Alarm' means that this system sounds an alarm (buzzer) when the response quantity which exceeds over the level of the set condition is detected. And, 'Abort' means that the testing operation is aborted (the signal output is stopped) when the response quantity which exceeds over the level of the set condition is detected. The response quantities to be checked are the band width and the RMS value of response spectrum which exceeds over the defined level. These items of A, B are corresponding to the defined values. Tolerance is for specifying the items of A.

Monitoring condition of the response RMS is for specifying the items of B.

Tolerance is necessary to be defined. Observation condition of the response RMS is to be defined if necessary.

The definition dialog of tolerance appears when the button of [Tolerance definition] is pressed in the control reference definition dialog.



<Tolerance check>

Tolerance check is for judging each control line if the response PSD coincides with the reference PSD by using the specified tolerance band as a criterion.

In the tolerance check of this system, the levels for alarm and abort are provided. Alarm level is to be set if it is necessary.

4.5.3.1 Tolerance

(1) Meaning

The condition of tolerance check is defined in the whole band where the reference PSD exists.

Tolerance must be set for every test definition.

The tolerance generally set is called a 'basic tolerance' in the following description.

Tolerance is defined by the definition items as below ;

<Level>

Alarm/abort level for monitoring the deviation from the reference PSD are specified. Level is specified by a relative level to the reference PSD.

At the setting of alarm check, the following relation should be satisfied between the alarm level and the abort level.

| Alarm check level | ≦ | Abort check level |

<Allowance>

The frequency width for allowing the deviation from alarm/abort level is specified. If the total value of the frequency bands in which the detected deviation from alarm/abort level exists is smaller than the set value of allowance, the function of alarm/abort is not activated.

If the defined allowance width is larger (including the case of equal) than the band width in which the reference PSD exists, the function of alarm/abort is not activated even the deviation is detected at all lines.

4.5.3.2 Define the alarm line

(1) Meaning

This item is for setting of the alarm check to be used.

In this system, the abort check must be set. However, the alarm check is not always necessary to be set.

The setting of this item is valid for both of the definitions of the basic tolerance and the extension tolerance.

4.5.3.3 Use the lower limit line

(1) Meaning

This item is for setting of the lower limit value check to be used.

In this system, the upper limit value check must be executed. However, the lower limit value check is not always necessary to be set. For example, the lower limit value check is not used generally when the limit control is executed.

The setting of this item is valid for both of the definitions for the basic tolerance and the extension tolerance.

4.5.4 RMS check

This item is for specifying whether the RMS value of the current control response is to be monitored or not during the testing operation.

The following two items are provided for monitoring.

1) Alarm check by response RMS value

This system sounds an alarm when the RMS value of the control response exceeds over (or falls below) the defined value of this item.

2) Abort check by response RMS value

This system stops the signal output immediately and aborts the testing operation when the RMS value of the control response exceeds over (or falls below) the defined value of this item. The stoppage of the drive signal is done gently. The drive signal is gradually reduced with taking a time that is specified by the set value of shutdown time in Fundamental/control condition.

The methods for setting level of the RMS value that specified to execute the alarm/abort check are;

- Specify the upper level by a relative level to the RMS value of reference PSD.
- Specify the lower level by a relative level to the RMS value of reference PSD
- Specify the upper level by an absolute level

In the case of specifying the level by a relative value, because the level of the RMS value of reference PSD is changed by the excitation level, the level of alarm/abort check is also changed according to it.

4.6 Input Channel

4.6.1 Outline

In this system, there are three types of input channel ;.

- Principle Control channel
- Control channel
- Monitor channel

<Principle Control channel>

This item is available to be set only when an applicable channel is specified as a control channel.

The waveform control between the output channels and the control channel including these phase information is required to be executed in the control operation with multiple output channels. A specified channel having the role of waveform control is used as the Principle Control channel among the other control channels in the system.

The Principle Control channel must be defined at least one among the available channels in an excitation group. Though, one Principle Control channel is sufficient generally.

As stated before, a reference PSD is set for each excitation group. The waveform that satisfies the reference PSD is a random waveform in waveform control. Therefore, the reference waveform set for the Principle Control channel must have the same random waveform even when the multiple Principle Control channels are set in an excitation group.

Generally, the specimen can not realize as a rigid body in all control bands therefore the response waveform of multiple control channels are not be the same in operation. It is natural that the setting of multiple control channels for one excitation group is an impossible requirement for the controller physically. However, the controller tries to execute the operation even if the requirement is not acceptable. It may cause the damage to the specimen and the controller in the worst cases.

Please pay much attention with consideration to ‘weighting of drive generation’ when the multiple Principle Control channels are needed to be set for one excitation group.

<Control channel>

Control channels are important one of which response signals are controlled to meet with the control reference.

<Monitor channel>

Monitor channel is for observing the response at the specified response point independently of the control channels.

The physical quantities of measuring object are available to set to each channel individually.

For example, when a controlled variable is acceleration, one monitor channel can monitor a displacement signal while another can monitor a force signal.

You can also specify RMS value monitoring and PSD spectrum monitoring in the monitor channels. Together with the function stated in the above, for instance, the following types of operation can be done: when the control is done in acceleration, displacement signal of some response point is monitored. And the testing is forced to abort when the displacement exceeds the set limit.

In this system, the used input channels are all defined as monitor channels. So the control channels have the function of monitor channel, too.

Also the same control variables are needed to be used as the objective physical quantities of the Principle Control channels and the control channels.

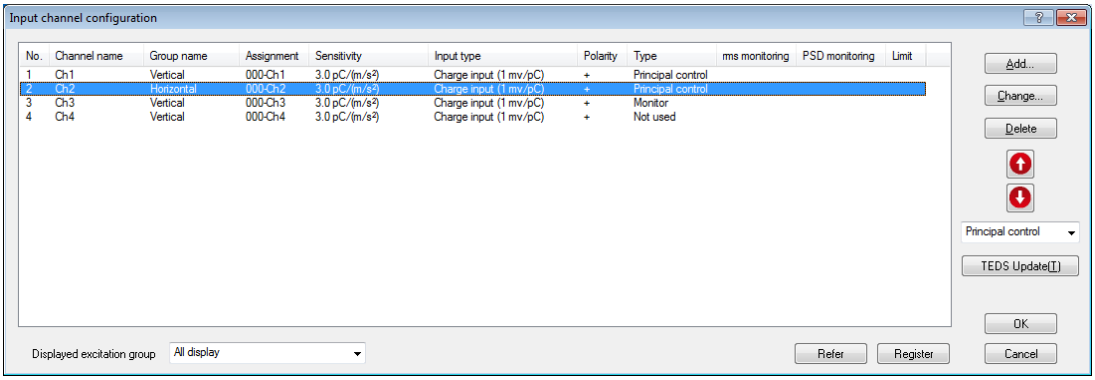
In contrast, the excitation group to which the input channel belongs is defined in this item at all the used input channels.

The excitation group configuration that the used input channels belonging is to be defined.

Thus the correspondence between input channels and output channels is determined. Reference PSD of control channel is also decided by this information.

4.6.2 Input Channel

The input channels to be used are set in the definition dialog of input channel configuration.



[Add] : A new input channel is added.

[Change] : The definition contents of an input channel are changed.

[Delete] : A selected input channel is deleted from the registration.

[Up] [Down] : The registered order of an input channel is corrected. However, the registered order has not much meaning than the order of graph display.

[Not used] : The channel is not used.

[Control] : The channel is used as a control channel.

[Monitor] : The channel is used as a monitor channel.

[Principle Control] : The channel is used as a Principle Control channel.

[TEDS Update] : The input sensitivity is set from the connected TEDS corresponding IEPE sensor automatically. The function is enabled with the TYPEII hardware

[Displayed excitation group] : The channels registered to the specified group are displayed in the list when the registered excitation groups are selected. All the registered channels are displayed when this item is set to ‘All display’.

The definition contents of input channel configuration can be registered as a file in this system. The registered definition condition can be used for another test if necessary.

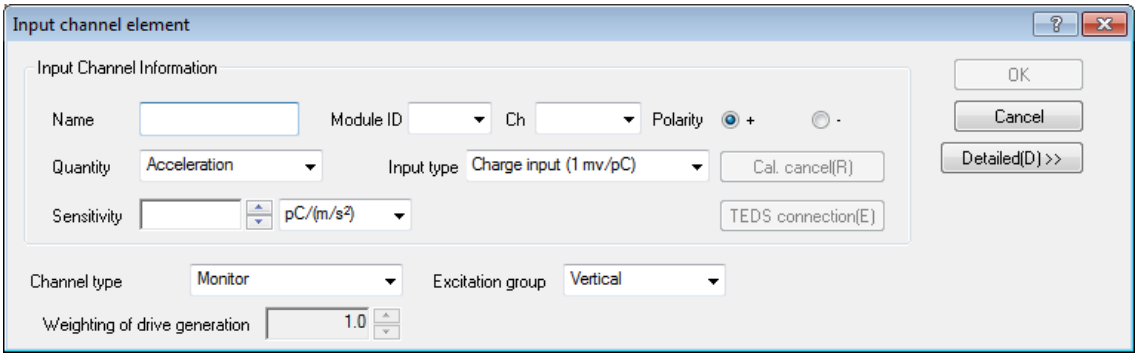
[Refer] : The registered definition contents of input channel configuration is loaded and used.

[Register] : The defined contents of input channel configuration is saved and registered as a file.

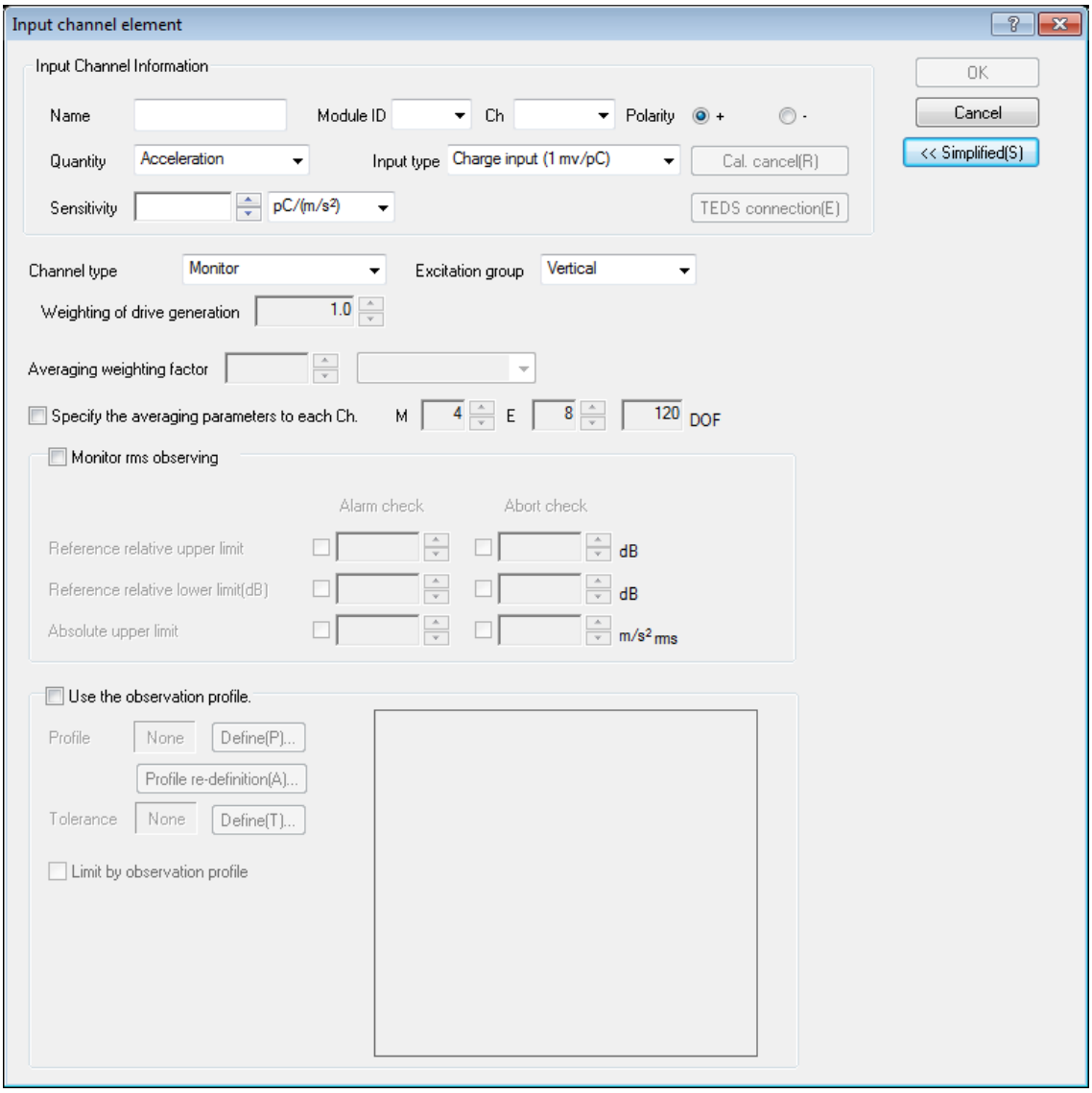
4.6.3 Input channel element

Each input channel element is available to be defined in the display below.

The detailed input channel element is to be defined in the detailed definition display.



Simplified definition display



Detailed definition display

4.6.3.1 Weighting of drive generation

(1) Meaning

This item can be set only when the current channel is specified as the Principle Control channel.

In this system, the weighting factor which can be assigned for each control channel is specified when the equalization matrix G is calculated from the transfer function matrix H (this calculation is basically done as the inverse matrix calculation, however the more complicated calculation is done in this system because it adopts the algorithm which can be used even if H is not a square matrix).

The weighting factor W_i (W_i : i = 1, 2, .., m) is defined for each response point as follows:

$$0 < W_i \leqq 1.0 \qquad i = 1, 2, .., m$$

In normal setting, value 1.0 is to be given to all W_i (uniform weighting).

The effect of weighting factor W_i is explained in the case that the number of response points m is larger than that of shakers n.

We take up an extreme example where there are three control response points for one shaker: in general it is impossible to exactly meet the responses of three points with the reference (except when a specimen behaves as a rigid body and the references of the three points are the same).

In this case, it is possible to give priority to control points to get an approximate solution in the sense of Least-Mean-Squares even if the exact solution is impossible. (If W_i is given, it is possible to specify which response waveform of the control point is to be treated as an important one to coincide with the reference waveform.)

For example, when weighting factors such as $W_1 = 0.1$, $W_2 = 1.0$, $W_3 = 0.1$ are given, control is carried out emphasizing that the response of control point 2 well meets the reference in comparison with the other points.

Instead, the control points 1, 3 are played down their importance.

4.6.3.2 Averaging weighting factor

(1) Meaning

This item can be set only when the given channel is specified as the Principle Control channel or a control channel.

When the multiple control channels belong to an excitation group, the response spectrum of these control channels as a whole should be compared with the reference spectrum. For this reason, one representative spectrum as the control response should be obtained from the response spectrum of all the control channels belonging to the excitation group.

The controlling method in which the data obtained by averaging the response spectrum of each control channel for each line is controlled as a control response spectrum is called the average value control.

In this system, when multiple control channels exist, basically the definition of average value control is executed for all the control channels, and the maximum value control which is explained in the next clause is selected at an arbitrary control channel on demand.

This item is for specifying of weighting factor for each control channel to calculate the average of the control response spectrum for the average value control.

Denoting the response spectrum of the control channel j as $\overline{\phi}^{j}$, the averaging weighting factor as W_j, the control response spectrum $\overline{\phi}$ is expressed as follows ;

$$\overline{\phi} = \frac{1}{W}\sum_{j=1}^{c} W_j \overline{\phi^j}$$

Here, c is the number of the control channels which belong to the concerning excitation group. W in the above expression is expressing the following quantity ;

$$W = \sum_{j=1}^{c} W_j$$

Normally, this weight is set for '1' because each channel should be equally estimated.

In this item, the data $\overline{\phi}^{j}$ of each channel uses the averaging parameter M and E defined in the fundamental/control condition and is done the averaging operation for each channel.

4.6.3.3 Maximum Value Control

(1) Meaning

This item can be set only when the given channel is specified as the Principle Control channel or a control channel.

This item is for setting of whether the maximum value control of this current control channel is executed or not.

When the maximum value control is executed at control channels, the control response $\overline{\phi}$ is determined as the selected maximum value of the line which is obtained by comparing the each response spectrum $\overline{\phi}^{j}$ of control channels and the averaged response spectrum $\overline{\phi}^{M}$ of all the control channels calculated by the averaging weighting factor of the above clause.

Therefore, in the maximum value control at the current control channel, the response spectrum will not exceed over the level of the reference spectrum.

Denoting the response spectrum of the control channel j as $\overline{\phi}^{j}$, the averaged response spectrum as $\overline{\phi}^{M}$, the control response spectrum $\overline{\phi}$ for the maximum value control is expressed as follows ;

$$\overline{\phi} = \mathrm{MAX}\left[\overline{\phi}^{1}, \overline{\phi}^{2}, \ldots, \overline{\phi}^{c_m}, \overline{\phi}^{M}\right]$$

These 1, 2, c_m are the control channels which belong to the excitation group and is used for executing the maximum value control.

In this item, the data $\overline{\phi}^{j}$ of each channel for executing the maximum value control uses the averaging parameter M and E defined in the fundamental/control condition and is done the averaging operation for each channel.

When this current channel is needed to be used only for the maximum value control without using in the averaging calculation of the averaged response spectrum $\overline{\phi}^{M}$ of all the control channels, the value of the averaging weighting factor W_j explained in the above clause should be set as 0.

4.6.3.4 Specify the averaging parameters to each ch.

(1) Meaning

In this system, all the defined input channels are specified as monitor channels.

The input channel specified as a control channel also has the function of a monitor channel.

Monitor channels are for monitoring the response itself of the current channel. The monitor response is also observed with averaging as in the same way as the observation of the control response (the response data of the current channel for calculating the control response).

This item is for specifying whether the parameter M and E for the averaging process of the response spectrum of the input channel, that is, the monitor spectrum $\overline{\phi}^{j}_{MON}$ are independently set or not besides the parameter M, E for the averaging process defined in the fundamental/control condition.

When this averaging parameter specified to each ch. is needed to be defined, the averaging parameter E and M are to be specified by checking the check box of this item. The meaning of E and M are the same as that in the fundamental/control condition.

When this averaging parameter specified to each ch. is not needed to be defined, the averaging parameter of the monitor spectrum for the monitor spectrum of the current channel is specified in the same condition of the fundamental/control.

This item is valid when the current input channel is specified either as the Principle Control channel or a control channel.

4.6.3.5 Monitoring RMS observing

(1) Meaning

This item is for specifying whether the RMS value monitoring is executed or not at the current input channel. The meaning of RMS value monitoring is the same as that of reference PSD in the item of test definition.

RMS value monitoring is the function for protecting the system. By setting of this item, the response monitor RMS value of this current channel is monitored and the protecting actions are activated at specified levels according to the RMS value.

These two of protecting actions are provided for the function of RMS value monitoring.

- Abort check
- Alarm check

In the setting of RMS value monitoring, the alarm check does not have to be specified, but the abort check must be specified. Therefore, if the alarm check is executed, the abort check is sure to be specified at the same time. When these checks are executed in compound, the level of RMS value should satisfy the relation below ;

$$|\text{Alarm check level}| \leqq |\text{Abort check level}|$$

When RMS value monitoring is needed to be executed, the check box of this item should be checked. Then, the monitoring actions to be executed are set.

4.6.3.5.1 Abort Check / alarm Check

(1) Meaning

In this item , the alarm/abort level, the concept of the set value, the definition method and its action are the same as that of RMS value monitoring'. However, these functions treat the different objects for checking. One is the RMS value of the control response $\overline{\phi}$ and another is the monitor spectrum $\overline{\phi}^{j}_{MON}$.

When the alarm/abort check is executed, the RMS value of the analogue input signal to the current input channel (the response of the current input channel) is monitored during the control operation. If this monitor RMS value of the current input channel exceeds over (or falls below) the defined value of this item, this system activates the function of alarm/abort.

In this item, the alarm means that this system sounds an alarm (a buzzer) when the response quantity which exceeds over the level of the set condition is detected. The abort means that the testing operation is aborted (the signal output is stopped) when the response quantity which exceeds over the level of the set condition is detected.

The methods for setting the level which is used as the criteria for the alarm/abort check are as below ;

- ・Specify the reference relative upper limit
- ・Specify the reference relative lower limit
- ・Absolute upper limit

In the case of specifying the level by a relative value, because the level of the RMS value of reference PSD is changed by the excitation level, the level of alarm/abort check is also changed according to it. However, if the dimension of the physical quantity observed at the input channel is different from that of the controlled variable, the level can be specified only by an absolute value.

The abort check and the alarm check is to be executed by checking the check box of each item. Then, specify the level of the RMS value to the selected items.

4.6.3.6 Use the observation profile

(1) Meaning

This item is for setting the observation profile for monitoring the response

The feature of this item is that the monitor response is not only observed but also operated by limit control.

These three types of observing methods are usable ;

- Abort check
- Alarm check
- Limit by observation profile(*Option)

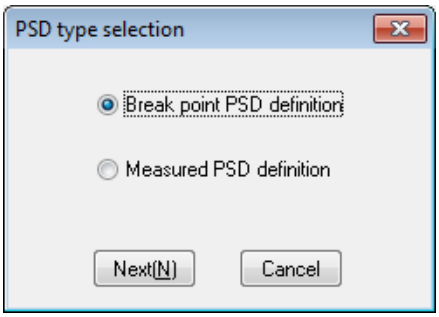
The observation level is defined by the absolute level therefore the observed physical quantity does not have to be the same as the controlled variable. Any observation physical quantities are available to use in this definition.

This function makes it possible to observe one part by a displacement sensor and to observe another by a force sensor while the control variable is defined as the acceleration.

4.6.3.6.1 Profile definition

(1) Meaning

This item is for selecting the PSD type.

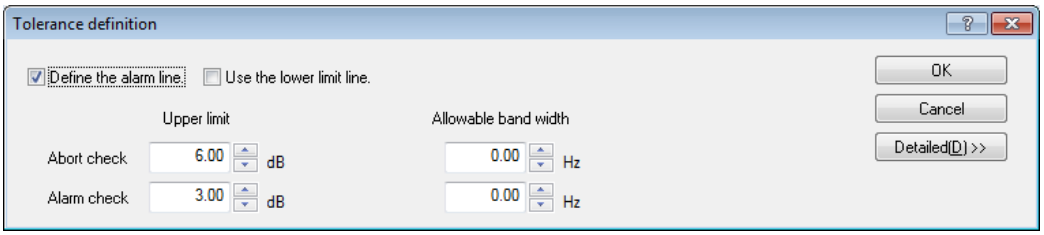


Please refer to “4.5.2 PSD definition” about the details of PSD definition

4.6.3.6.2 Tolerance definition

(1) Meaning

This item for defining the tolerance.



Please refer to “4.5.3 Tolerance definition” about the details of tolerance definition.

The values of upper limit and allowable band width are defined in this item.

4.6.3.6.3 Limit by observation profile

(1) Meaning

When limit control is set to be executed, the response PSD for the current input channel is monitored during the control operation. If the response PSD of the current input channel is to exceed over the level of the PSD for monitoring set by the absolute value, the function of limit control is activated. (This item is an option.)

When the limit control is executed, the output drive is controlled so that the monitor PSD may not exceed over the PSD for monitoring set value. To be exact, the drive signal is regulated by setting a smaller value of reference PSD. As a result, the level of the output drive becomes smaller, then the control response PSD and the response of other input channels also become smaller.

Generally, the limit control is executed for each operation lines.

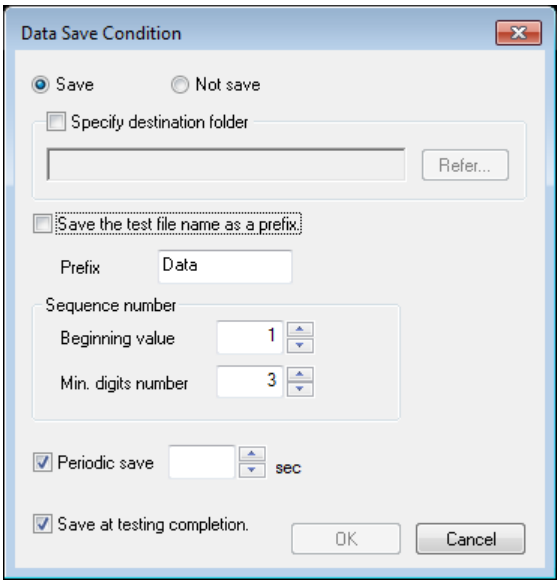
4.7 Data save condition

4.7.1 Outline

Each item for saving the data measured in test operation to the hard disc is defined.

In K2 system, all the data measured in test operation are saved in a binary file (*.VDF).

Only the data ‘In test operation’ is storable. The data ‘In initial measurement’ can not be saved.



4.7.2 Saving condition

Saving conditions are described as below ;

1. “Save” & “Not save” buttons

   Select “Save” to save the data file automatically and select “Not save” if it is not necessary to save the data.

2. Specify the destination folder

   Specify the destination folder for the data file. Press the “Reference” button and specify the folder.

   If the destination folder was not specified, the data file will be saved in the folder for the test file.

3. Use the test file name as prefix

   A common word can be added as a prefix in the head of the data file name. The default setting of this item is ‘Data’. The save file name can be changed by canceling the check of this item.

4. Sequence number

   Sequence numbers is given to the data file being added a prefix.

   Beginning value : The beginning number of data is specified.

   Example) When this item is specified as ‘1’ → ‘Data001.VDF’

Min. digits number : The digits number of sequence is specified.

Example) When this item is specified as '2' → 'Data01.VDF'

5. Save after a specified interval

This function is for automatic saving of the data on specified time (seconds).

6. Auto-save at testing completion

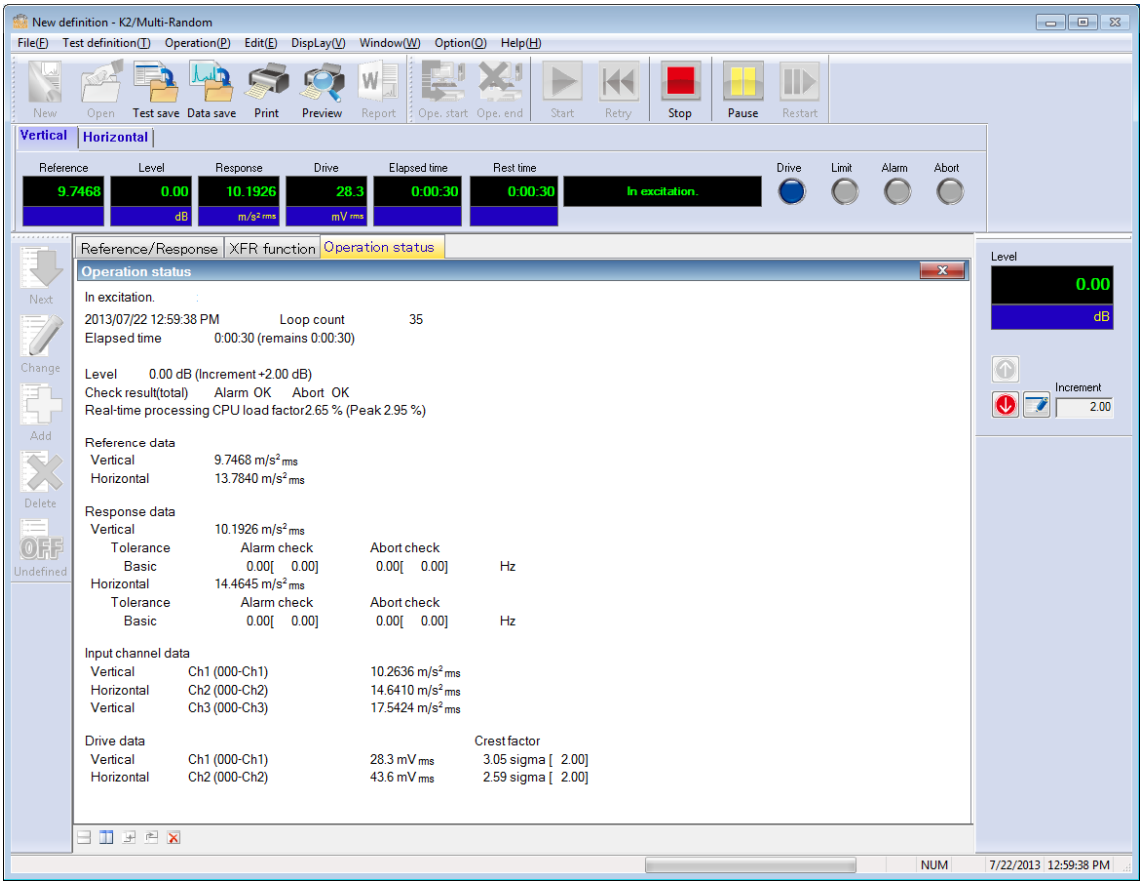
This function is for automatic saving of the data when the test is completed or when the test is aborted by operator.

4.8 Operation Status

(1) Meaning

The information concerning to the excitation operation is displayed in this dialog.

Information in this display are renewed at every control loop time depending on the conditions.



<Display contents>

(1) Status

The message of the current status of the system is displayed.

'In excitation', 'Pause', 'Excitation is completed', '[Test is stopped by the command of operator]', etc.

(2) Loop count

The count of the control loop is displayed.

(3) Elapsed time

The elapsed time of the test excitation at '0 dB' is displayed. (The time counting is stopped under the '0 dB'.)

(4) Level

The current excitation level is displayed.

(5) Check result

All the results of the checks (such as each checks for the control response, the result of the check for the output drive and each checks for the monitor response) are totally displayed.

(6) Real-time processing CPU load factor

The current CPU load factor is displayed.

(7) Reference data

The current control reference level is displayed.

(8) Response data

The current control response level is displayed.

(9) Response check

The results of tolerance check for the control response and the RMS check are displayed.

(10) Input channel data

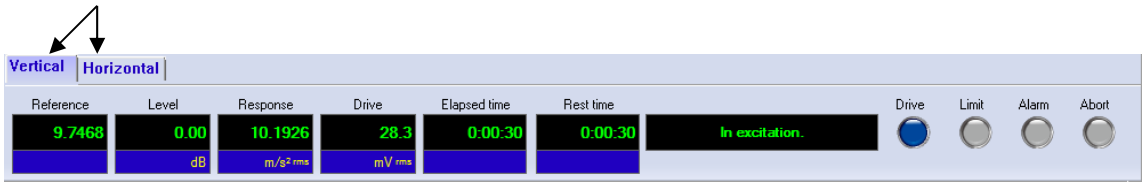
The information of each input channel data (RMS value, etc.) in the current control loop is displayed. If the limit control is used, the operation status is displayed. Detailed results of each check operated at the input channels are displayed too.

(11) Drive

The drive output voltage generated currently is displayed.

[Operation status panel]

The display can be changed one excitation group to another by selecting the tabs.



Chapter 5 Message and meanings

5.1 K2 Multi-Random error message

Message	Meaning / countermeasure
Unusual phenomenon is detected by loop check.	(Meaning) The test operation is aborted due to the error in Initial loop check. The detail about the error is displayed at the input channel in which an error detected in the operation status. A) Too much environment noise is detected. [1] [2] Too small response in Initial loop check or too much noise in non-excitation is judged as an unusual phenomenon. B) Loop open is detected. [1] [2] Sudden decrease of response characteristics is judged as an unusual phenomenon in operation. C) Too much response is detected. [1] [3] Sudden increase of response characteristics is judged as an unusual phenomenon in operation. D) Over load is detected. [1] [4] [5] A signal having an exceeded level over the maximum input value of the hardware (at voltage input : ±10V, at charge input : ±10000pC or ±1000pC) is inputted to the input channel. (Countermeasure) Check the following points at first. ・ Mistake in system cabling ・ Incorrect definition of I/O channel information, such as sensitivity and input format. ・ Cable disconnection ・ Incorrect installation of the pickups ・ Unusual condition of the excitation system. ・ Unusual condition of the specimen. After checking the points in the above, the treatments for each error are to be done according to the specified numbers. [1] Set the loop check in the fundamental/control condition to ‘Loose’. [2] Increase the value of initial output voltage in the excitation system setting.(If error occurred in the initial measurement or in the initial equalization.)

Message	Meaning / countermeasure
	[3] Decrease the value of initial output voltage in the excitation system setting. (If error occurred in the initial measurement or in the initial equalization.) [4] At charge input, set the input type of input channel to 'Charge input (1mV/pC)'. [5] Change the sensor to lower sensibility one.
Test is aborted by Abort check.	(Meaning) The test operation is aborted for an error detected by various abort checks in operation. The content of error is displayed in the operation status. A) Test is aborted by abort check [1] [2] [3] [5] [6] [7] [8] The test operation is aborted for an error detected by various tolerance checks. B) Test is aborted by abort check [Drive] [4] [5] [6] [7] [8] The test operation is aborted for requiring of the output voltage exceeding over the 'output voltage limit value' of excitation system setting in operation. (Countermeasure) Check the following points at first. ・ Mistake in system cabling ・ Incorrect definition of I/O channel information, such as sensitivity and input format. ・ Cable disconnection ・ Incorrect installation of the pickups After checking the points in the above, the treatments for each error are to be done according to the specified numbers. [1] Change the set value of tolerance. [2] Change the setting of equalization mode in the fundamental/control condition. [3] Change the setting of averaging parameters in the fundamental/control condition. [4] Change the setting of output voltage limit value and the abort ratio in the excitation system setting. [5] Recheck of the control point. [6] Recheck the pickups used in the system. [7] Recheck the pattern of the test. [8] Recheck the construction of fixture.

Message	Meaning / countermeasure
Failed in initialization	(Meaning) An error is detected in initialization of I/O unit executed prior to the test operation. (Countermeasure) ・ The power of I/O unit is not set ON. ・ Between the PC and I/O unit is not connected. ・ Incorrect connection of I/O unit board. ・ Incorrect connection of K2 I/F board. ・ Incorrect action of the driver. Check the above points and retry the testing operation for several times. If these errors occur even after checking the above points, please contact with IMV.
The license required for operating the program is not found.	(Meaning) An error is detected in K2 protect information check. (Countermeasure) ・ License information ・ Incorrect action of I/O port (COM, LPT or USB) of the PC connected to the protect devise. ・ Incorrect connection of the protect devise board. Check the above points and retry the testing operation for several times. If these errors occur even after checking the above points, please contact with IMV.
Hardware error	(Meaning) An error is detected in the PC or I/O unit. (Countermeasure) ・ The power of I/O unit is not set ON. ・ Between the PC and I/O unit is not connected. ・ Incorrect connection of I/O unit board. ・ Incorrect connection of K2 I/F board. ・ Incorrect action of the driver. Check the above points and retry the testing operation for several times. If these errors occur even after checking the above points, please contact with IMV.

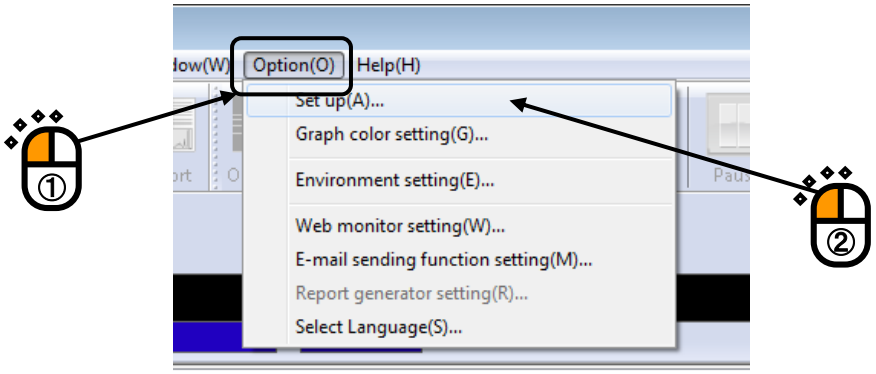
Message	Meaning / countermeasure
Test is aborted by CPU load.	(Meaning) Test operation is aborted because too much loading is detected in operation. (Countermeasure) ・ Exit form the other applications than K2 executed by the system when they are used. ・ Decrease the value of frequency range in the fundamental/control condition. ・ Decrease the value of control frequency lines in the fundamental/control condition. ・ Decrease the numbers of channel to be used. Check the above points.

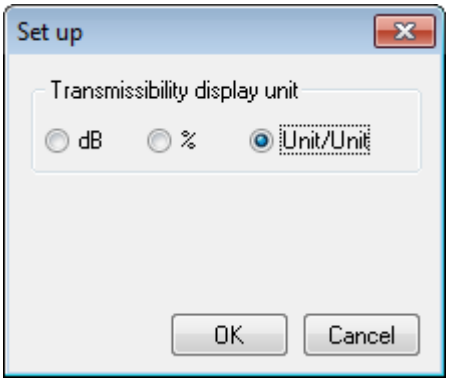
Chapter 6　Supplemental explanation

6.1 Set up

<Procedures>

Select [Option] in the menu bar and click [Set up]. A dialog of set up appears.





<Transmissibility display unit>

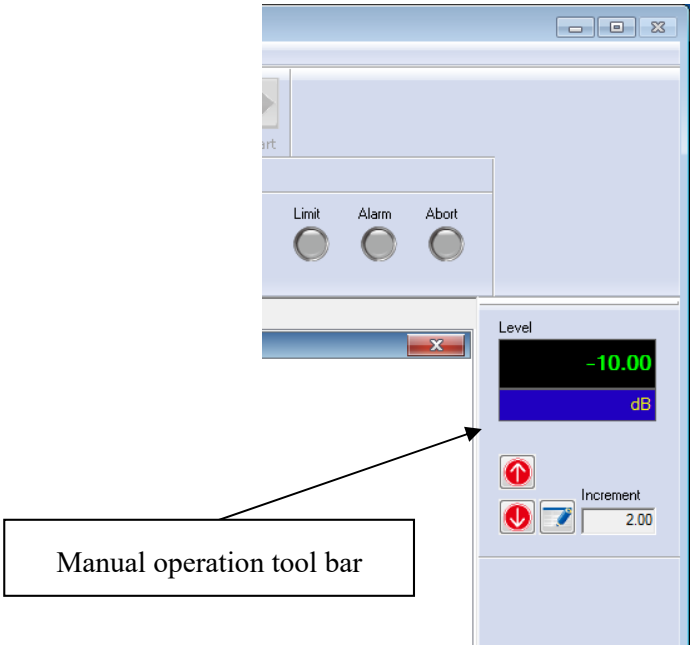
This item is for selecting the display unit of amplitude value in transmissibility graph.

This unit selected in this item is valid only for the transmissibility graphs calculated from the two data giving the same unit.

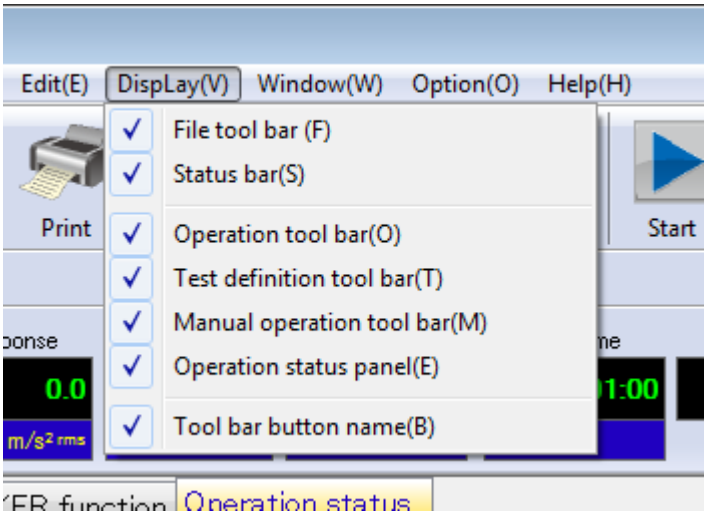
In case that the transmissibility graph is calculated from the two data having different units, the display unit of amplitude always appears as ‘Unit/Unit’.

6.2 Manual Operation

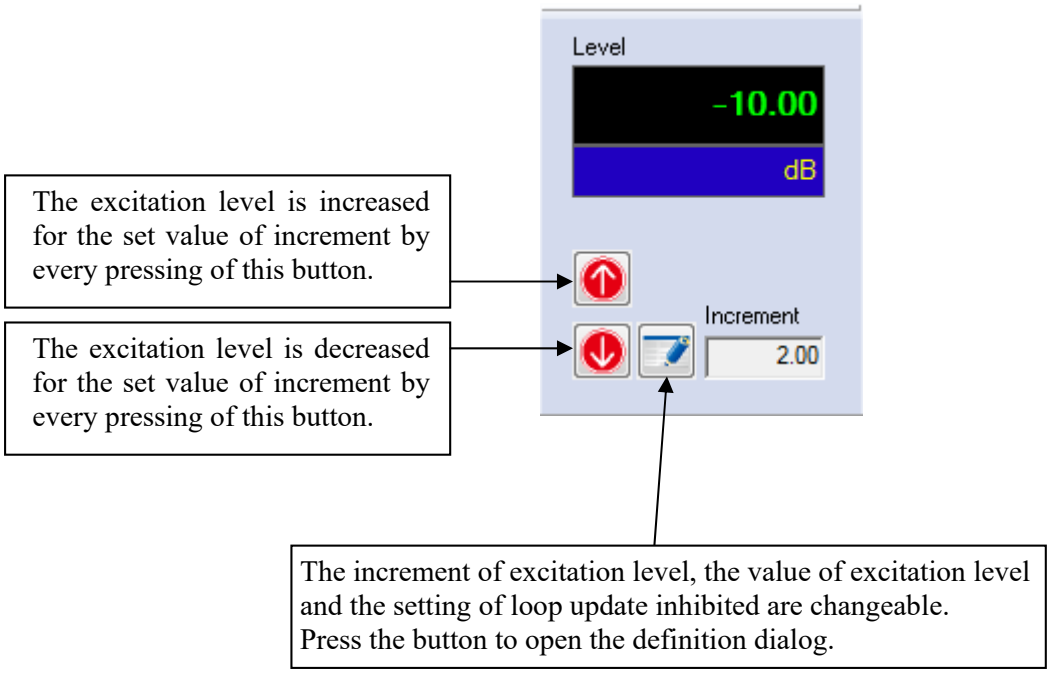
Control reference can be changed during the excitation operation by using the manual operation tool bar. Manual operation tool bar is at right side of window.

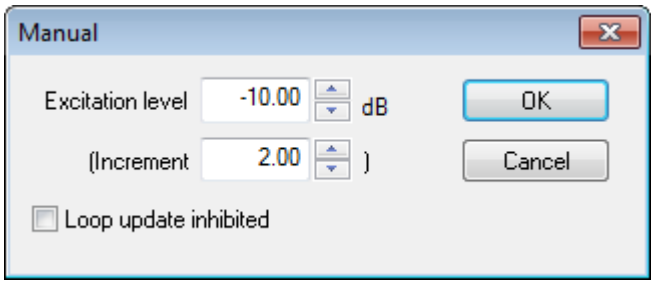


If the manual operation tool bar is not displayed, select [Display] in the menu bar and click [Manual operation tool bar]. Manual operation tool bar appears.



<Items in the manual operation tool bar>





6.3 Using / Deleting of Live Data in Operation

The data (necessary for test operation) obtained at test abort (end) can be used by saving that of Test Definition File in the condition of Excitation Stop.

The saved data is called as Live Data in Operation.

The types of Live Data in Operation are as below ;

- XFR Function
- Continuing excitation data

When Live Data in Operation is saved in Test Definition File, the merits and demerits as below exist ;

[Merit]

There are the following metis. However, pay attention to the danger when the system configuration and the condition of sensors and specimens are different. In such a case, XFR Function is needed to be measured again as in the same way as an ordinary test, and test is needed to be stared from initial equalization.

<Using of XFR Function>

Transfer Function obtained in a test operation can be used in the next test. (XFR Measurement can be skipped.)

<Continuing excitation data>

From the status that the test is suspended, excitation level and test time can be resumed. Additionally, 'Prompt mode' can be also executed. The 'Prompt mode' is for executing at the specified excitation level right away without operating the initial equalization in which the Transfer characteristics of the controlled system is measured at the beginning of the testing operation.

[Demerit]

A part of Test Definition contents cannot be corrected until the used Live Data in Operation is deleted.

6.3.1 Using of Live Data in Operation

Live Data in Operation can be used when the excitation operation is finished.

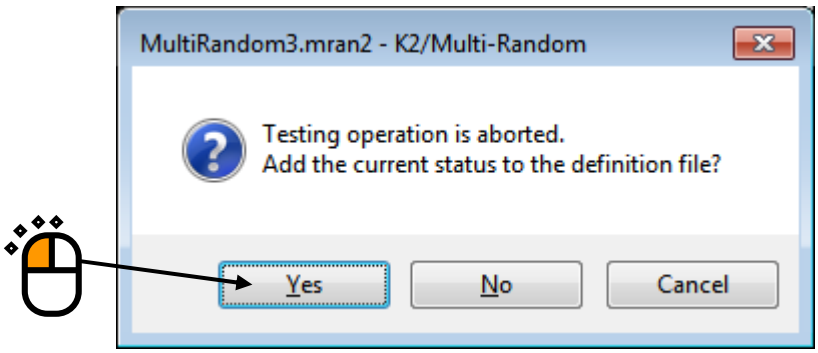
6.3.1.1 Add the live data in operation at finishing the operation

<Procedures>

<Step 1>

At finishing the operation, a message window appears as below. The system asks that the current status is needed to be added to the definition file.

Select [YES].



・ XFR function

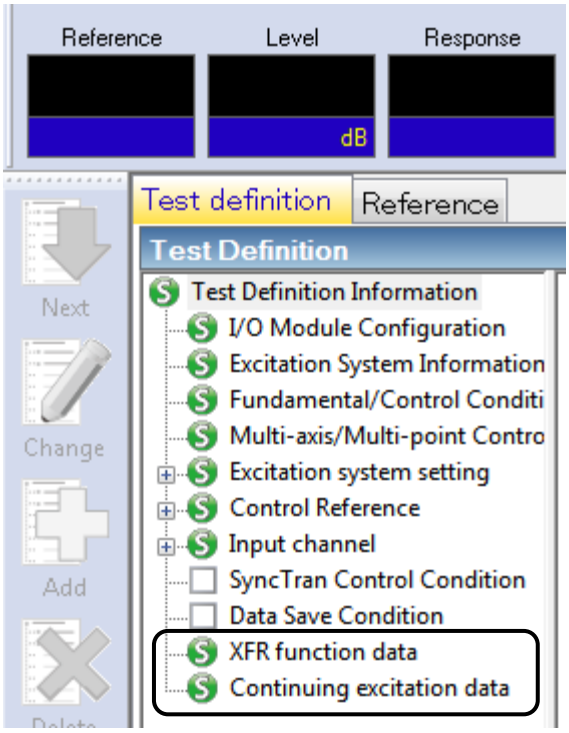
Available to correlate with the definition after XFR measurement.

・Continuing excitation data

Available to correlate with the definition after the initial equalization.

<Step 2>

The names of data related to the definition are added in the display of Test Definition.



6.3.1.2 Add the live data in operation in Test definition mode

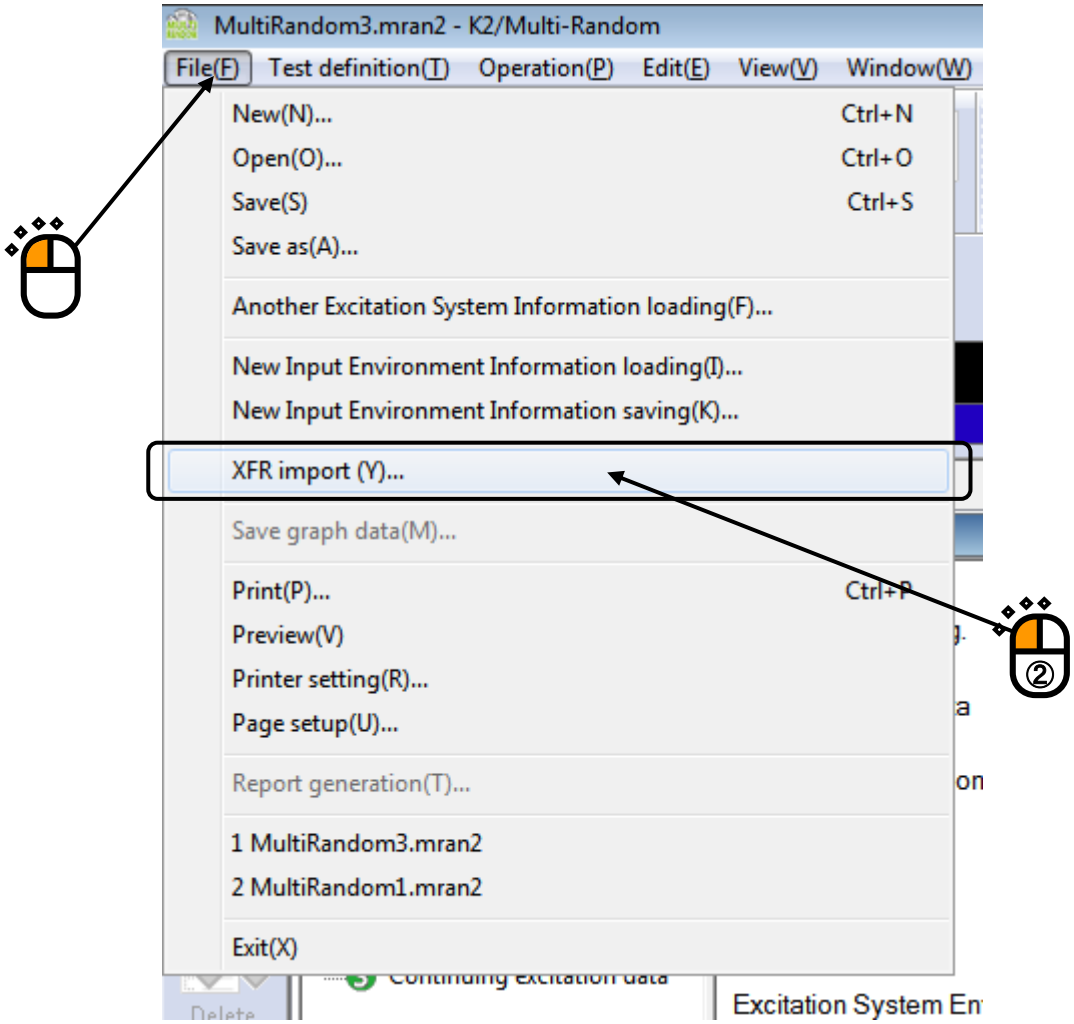
<Procedures>

<Step 1>

In Test definition mode, the XFR function data can be imported from data files by the operation below.

The data available to import is the XFR function.

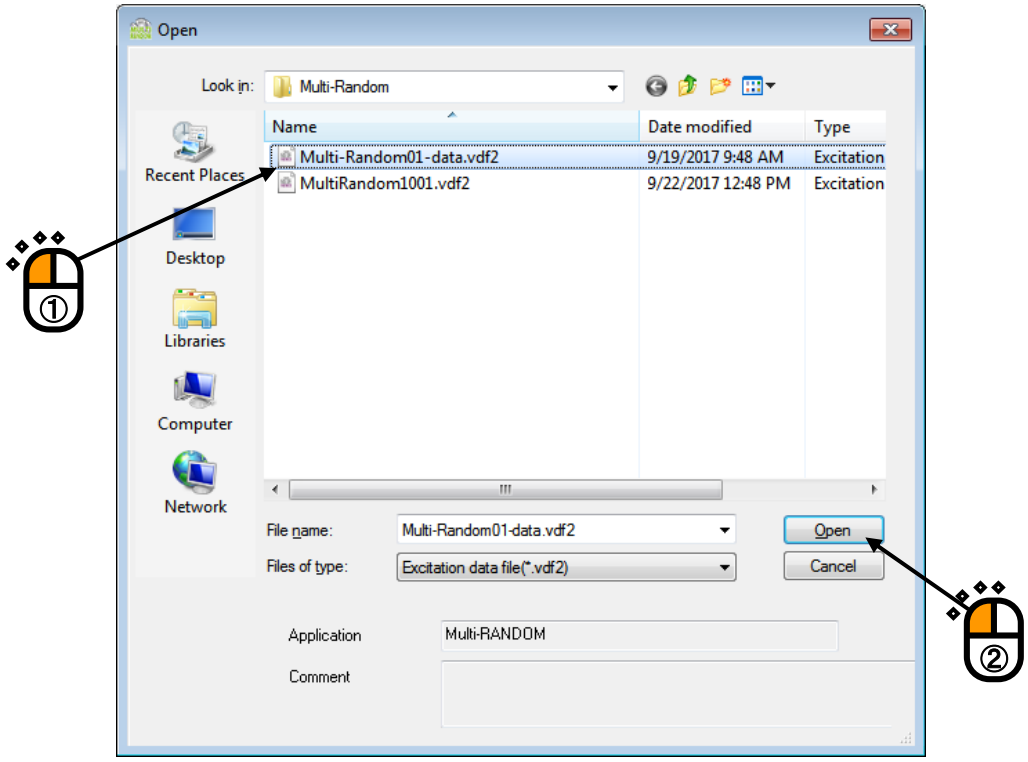
Select [File] → [XFR import] in Menu bar.



<Step2>

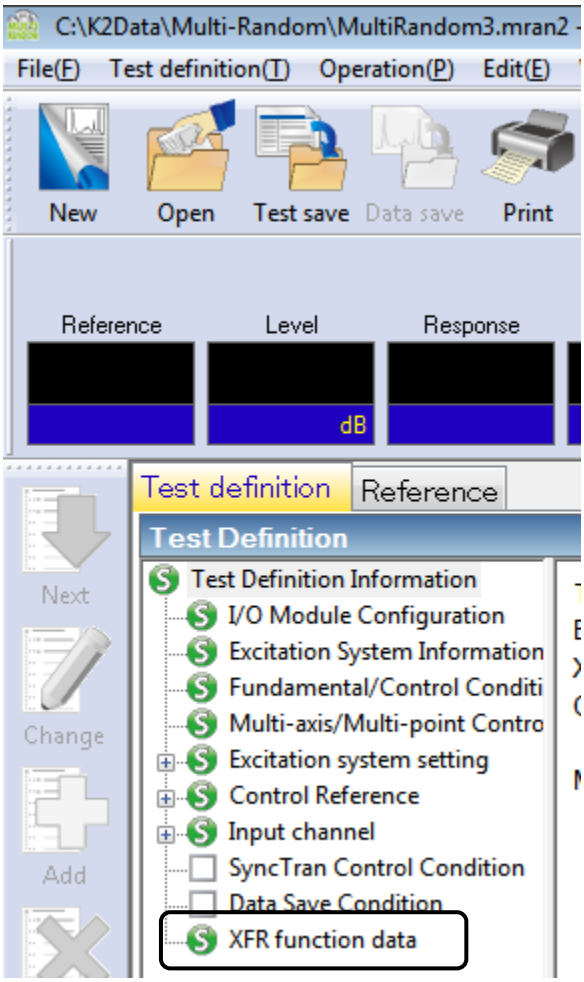
Select a file to import (the XFR function) and press [Open].

These items are available only when the selected test data file has consistent condition having the same sampling frequency other parameters with the Test definition.



<Step3>

The imported data is added and displayed in the Test definition information as a related data.



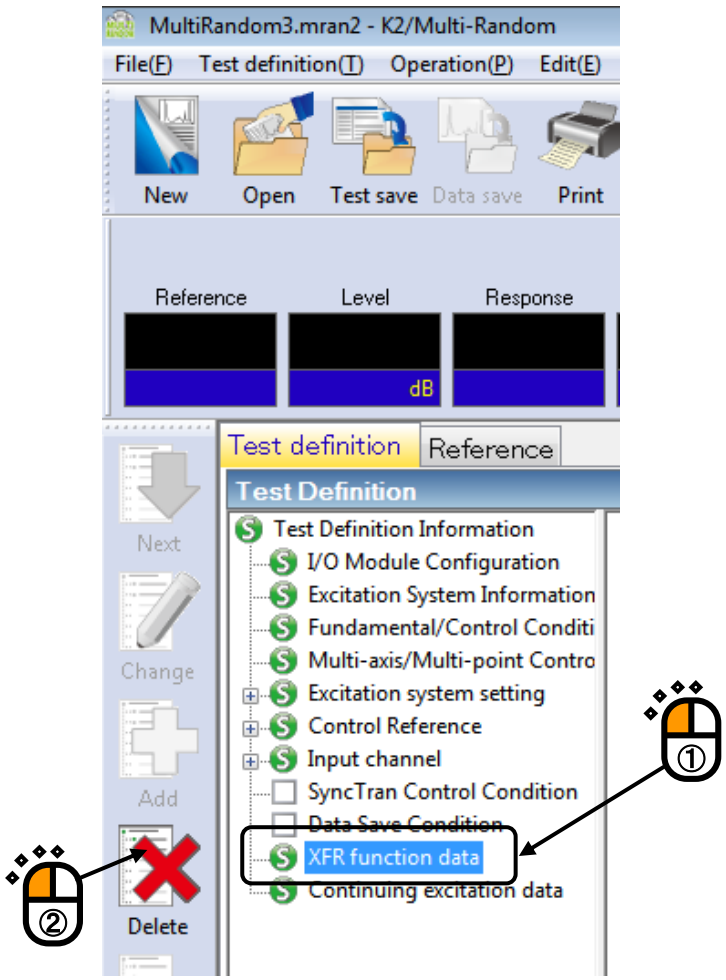
6.3.2 Deleting of Live Data in Operation

The added Live Data in Operation can be deleted by the procedures as below ;

<Procedures>

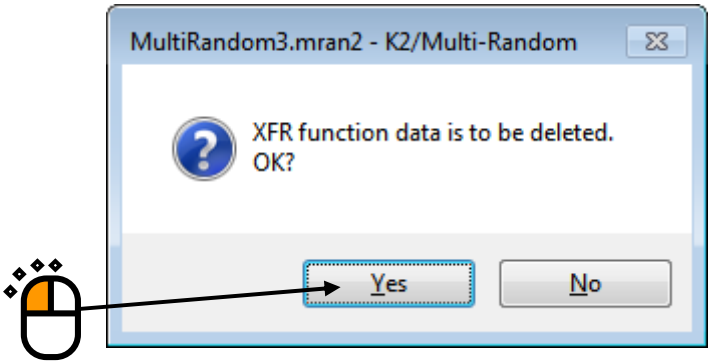
<Step 1>

Select the Live Data in Operation to be deleted. Press the [Delete] button.



<Step 2>

The confirmation message appears as below. Select [Yes].



6.4 Skipping of XFR Measurement (Use the XFR Function of Live Data in Operation)

In a Test File having the XFR Function of Live Data in Operation, the related XFR Function can be used and XFR Measurement can be skipped in test operation.

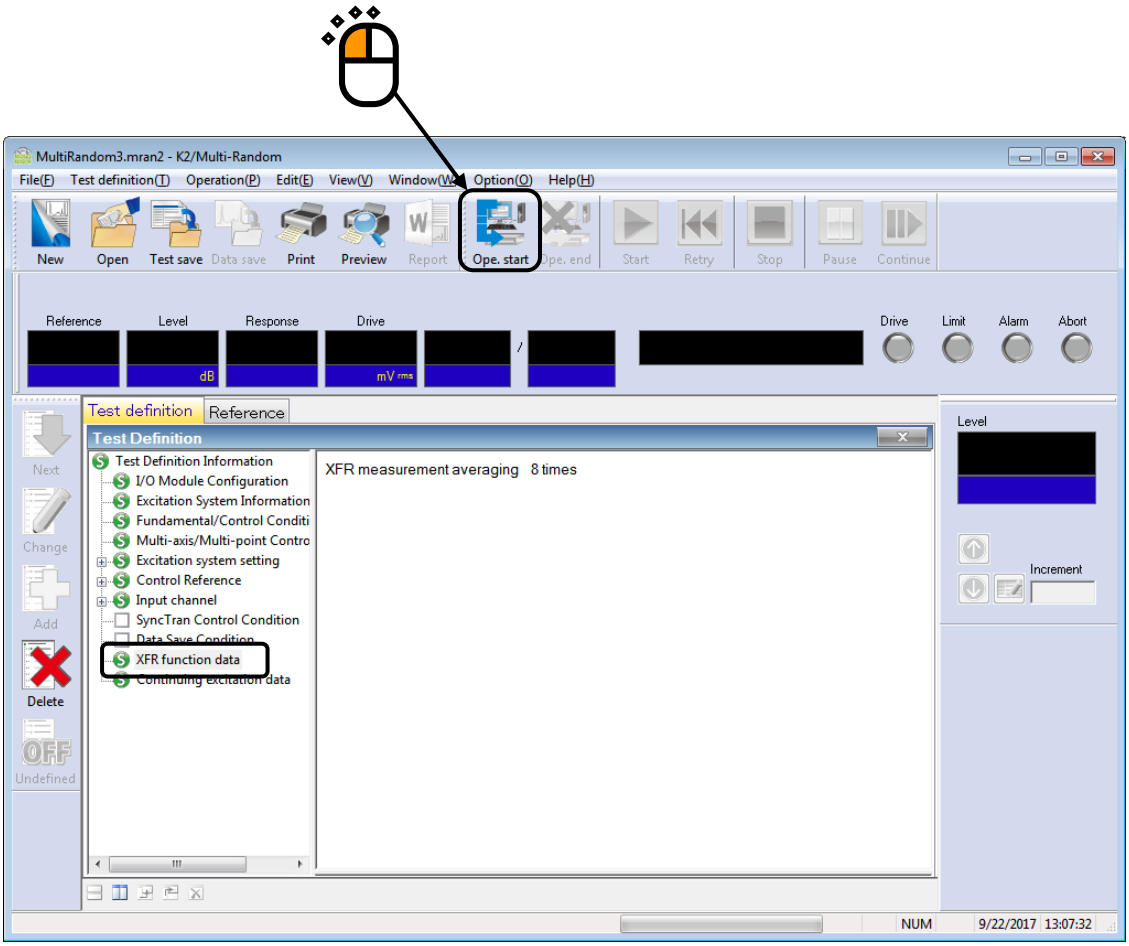
However, pay attention to the danger when the system configuration and the condition of sensors and specimens are different. In such a case, XFR Function is needed to be measured again as the same as in an ordinary test.

Refer to Using / Deleting of Live Data in Operation about the details of using XFR Function.

<Procedures>

<Step 1>

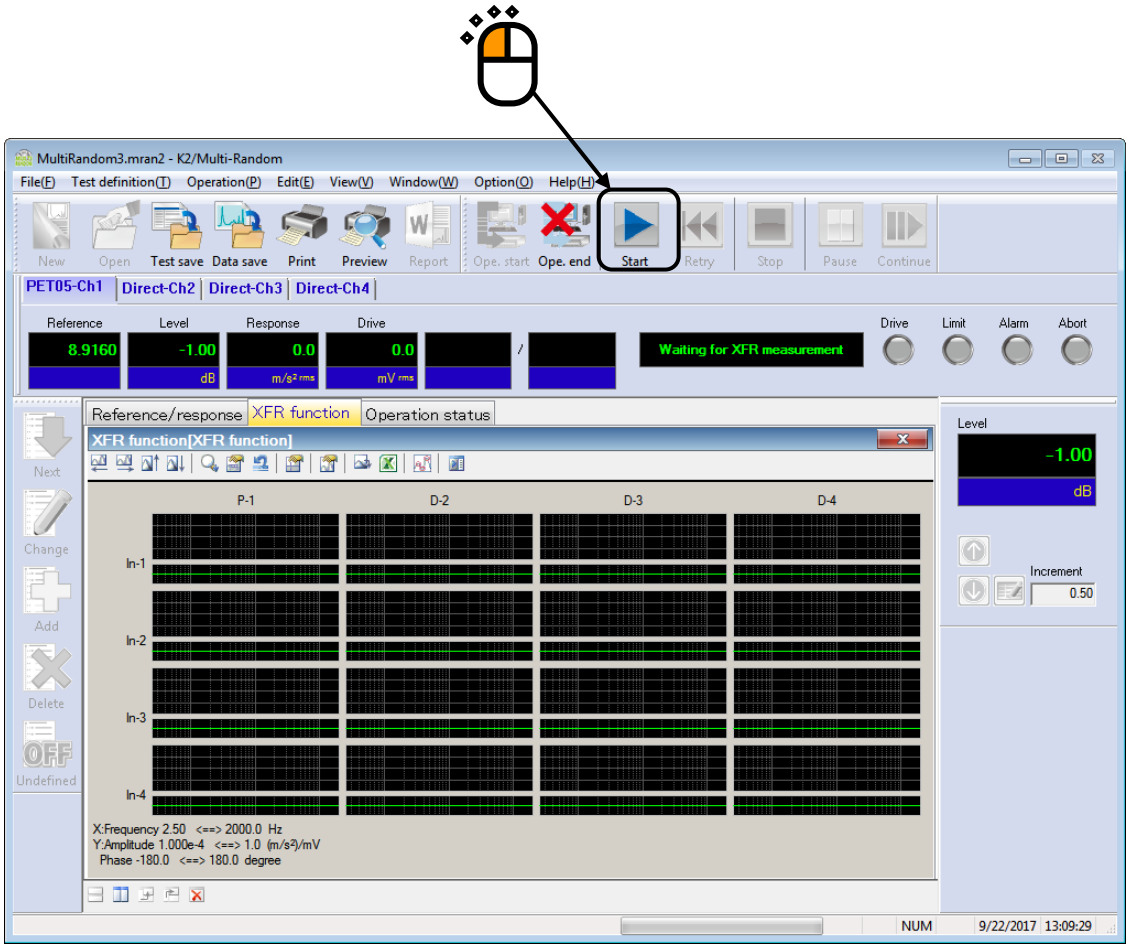
Load the Test File using the XFR Function of Live Data in Operation and press [Operation start] button.



<Step 2>

XFR Measurement of the controlled system is executed.

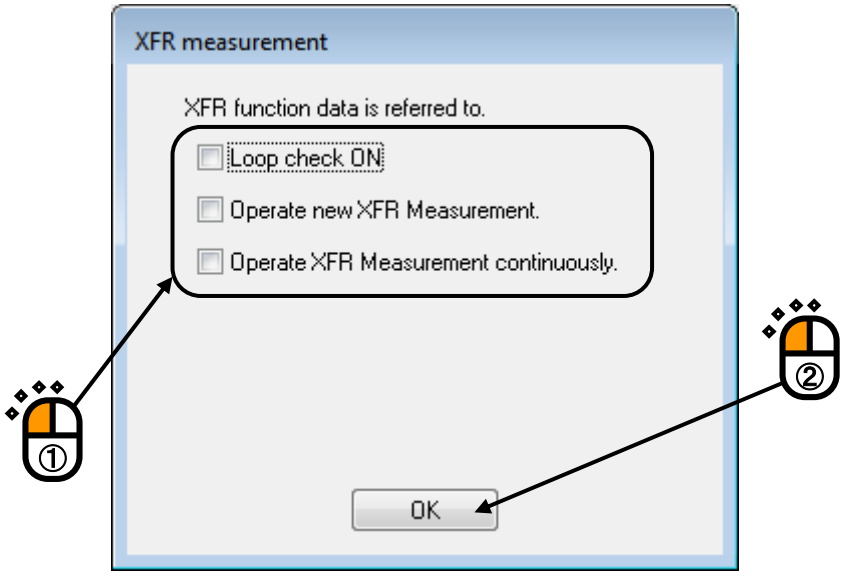
Press [XFR measurement start] button.



<Step 3>

The dialog for selecting operations concerning with XFR Measurement appears when XFR Function of Live Data in Operation is used in the test.

When both Loop Check and XFR Measurement are needed to be skipped, cancel the checks in all of the check boxes and press [OK]. After [OK] button is pressed, XFR Function of Live Data in Operation is loaded and the system proceeds to the state of 'to 0th Drive'.



The phases of XFR Measurement is composed by Loop Check and XFR Measurement. Loop Check is needed to be executed for operating XFR Measurement. Four selections are provided in this item ;

1) Skip both of Loop Check and XFR Measurement (the contents as in the above).
2) Operate Loop Check and skip XFR Measurement only (the check for cables and control system connection).
3) Operate new XFR Measurement. Loop Check is operated automatically before the XFR Measurement.
4) Operate XFR Measurement continuously (See the next clause). Execute XFR Measurement and add the measured data to the current XFR function (to increase the average times of XFR function). Loop Check is not operated.

6.5 Continuous XFR Measurement

This item is for operating XFR measurement continuously and adding the measured data to the current XFR function.

It is usable when the averaging times of XFR function need to be increased after operating XFR Measurement.

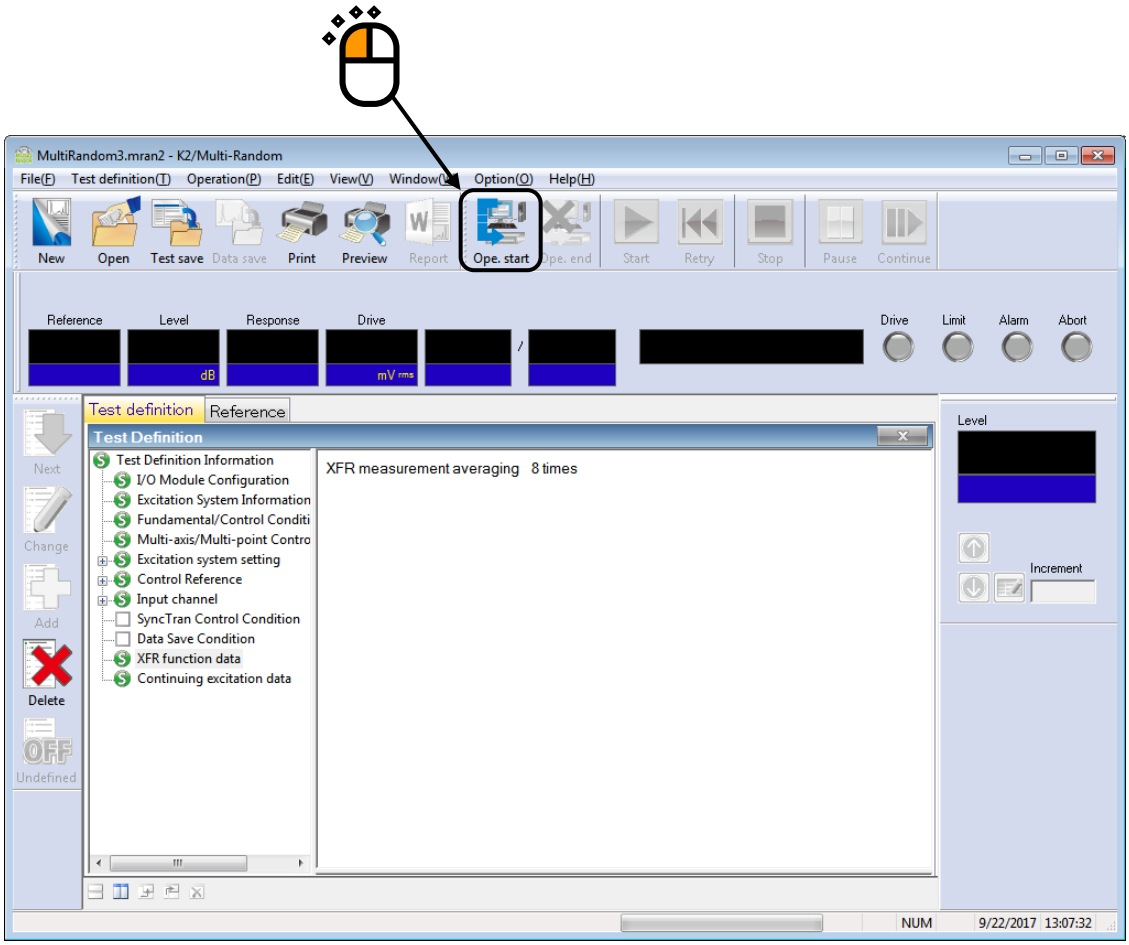
The condition of continuous XFR Measurement is described as below;

- Loop Check is not operated.
- Drive waveform at XFR Measurement is calculated according to the XFR function to be added. So, the drive waveform is obtained as random waveform that equalized to have the flat characteristics in frequency component of control response

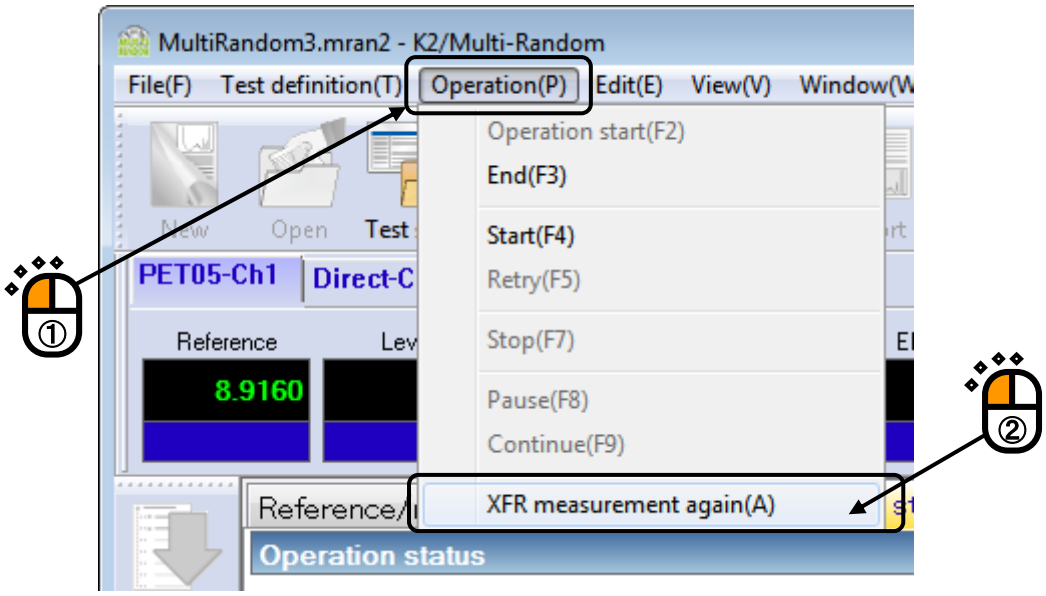
<Procedures>

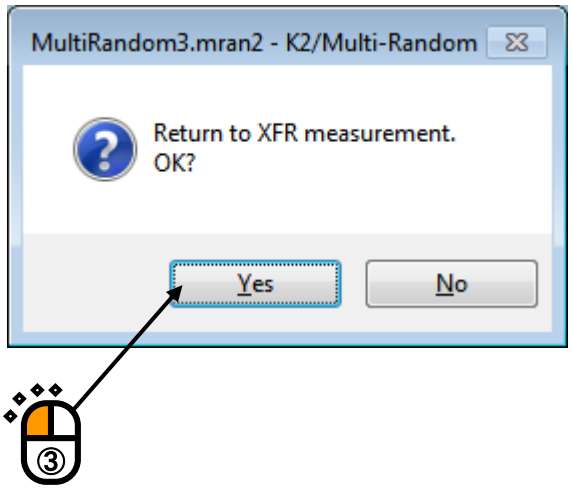
<Step 1>

Load the Test File using the XFR Function of Live Data in Operation and press [Operation start] button.



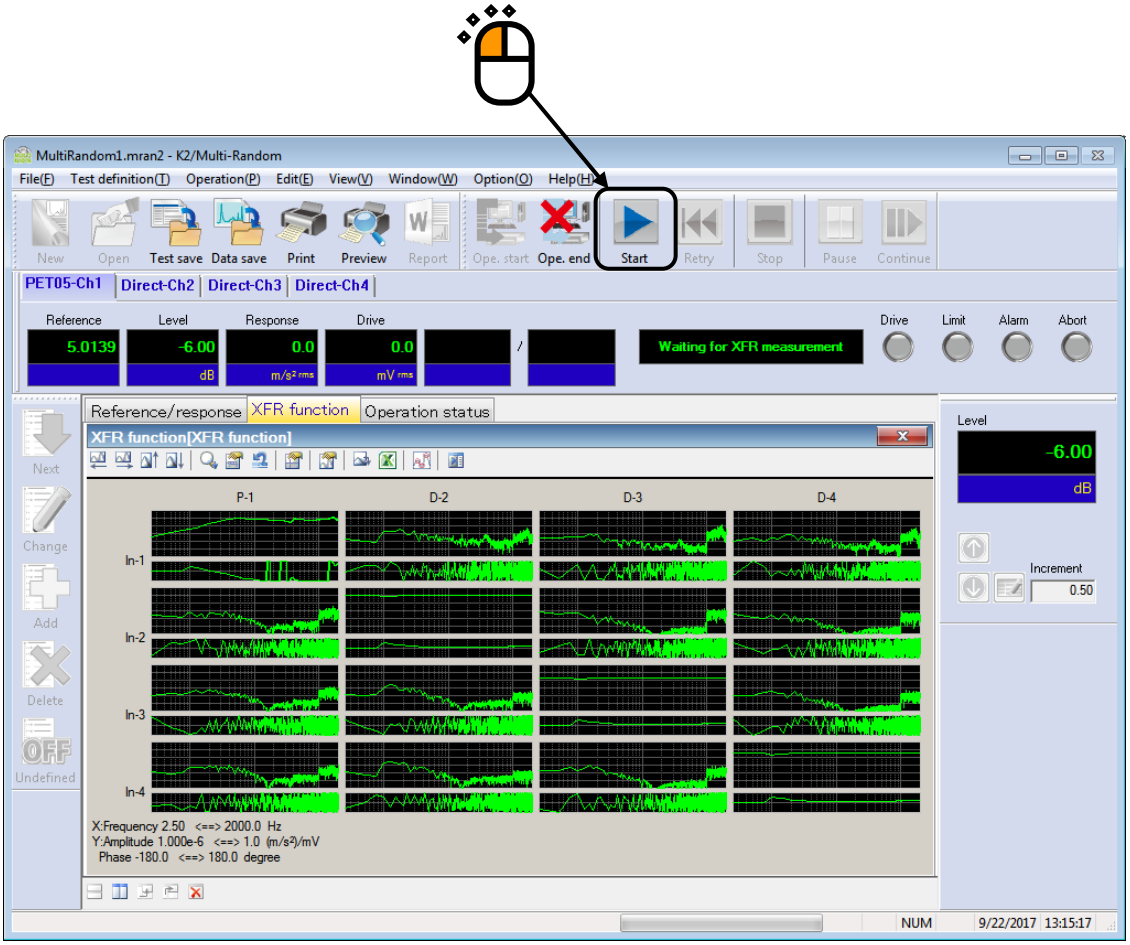
Or otherwise, select [Operation] in the menu bar after completing the XFR Measurement.
Select [XFR measurement again] Then, the confirmation message appears.
Select [Yes] in this dialog.





<Step 2>

Press [XFR measurement start] button.



＜Step3＞

The dialog for specifying the measurement method of XFR function is displayed.

Check the check box of “Operate XFR Measurement continuously” and press [OK] after setting the required usage below. Then, the continuous measurement of XFR function is executed.

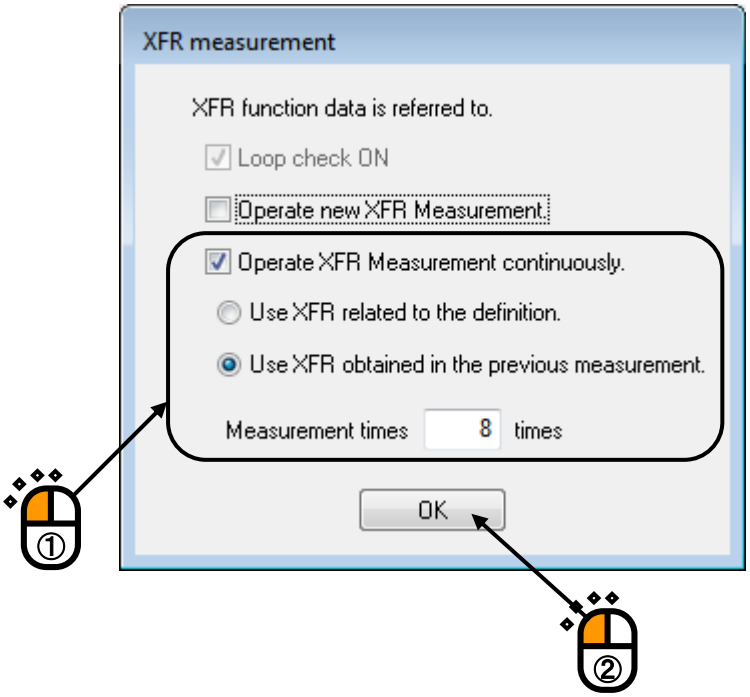
- Specify the objective XFR function to be added

  When the XFR function loaded in a test file needs to be used, select “Use the transfer function related to the definition”.

  When the current XFR function needs to be used, select “Use the transfer function obtained in the previous measurement”.

- Specify the averaging times

  Input the required times of continuous measurement in “Measurement times”.



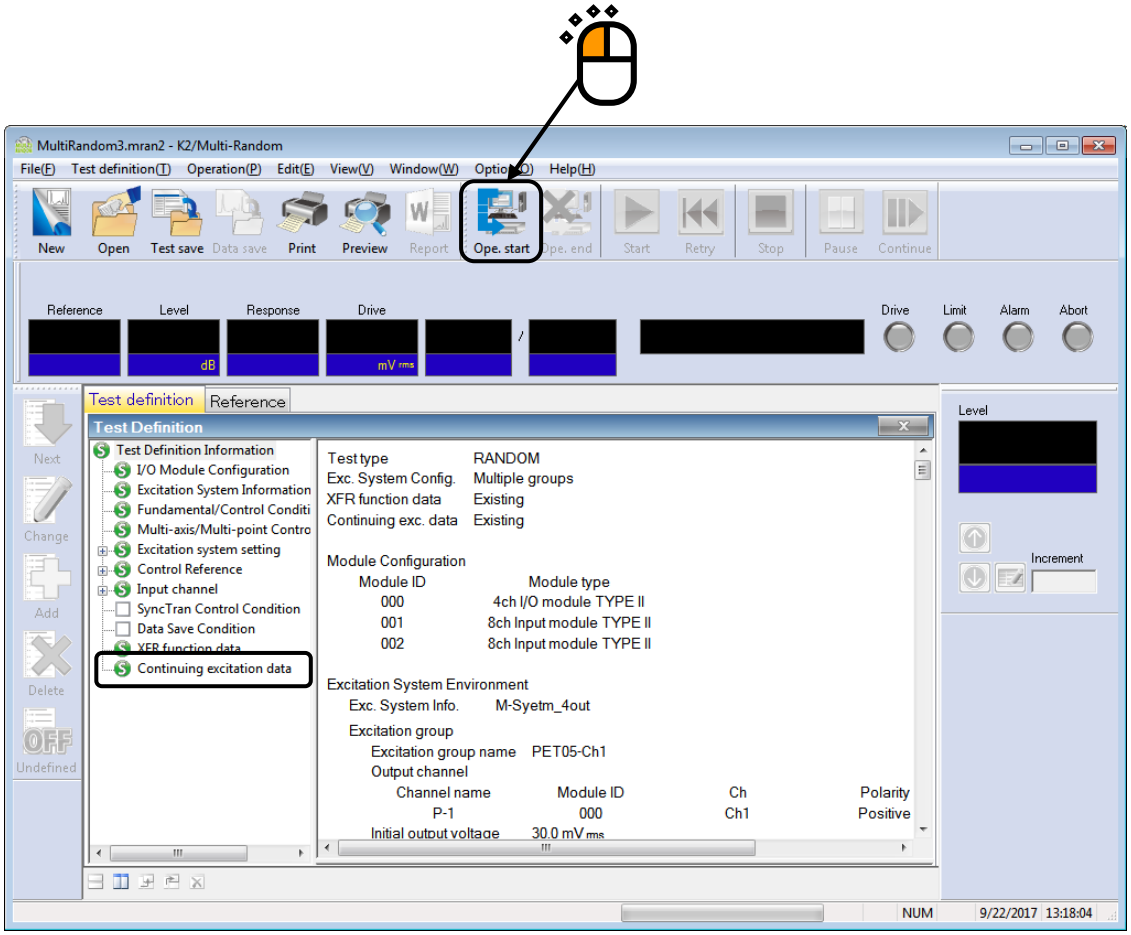
6.6 Restarting suspended test

In the test file that Continuing excitation data was added, the suspended test can be restarted from the status that Continuing excitation data was added.

<Procedures>

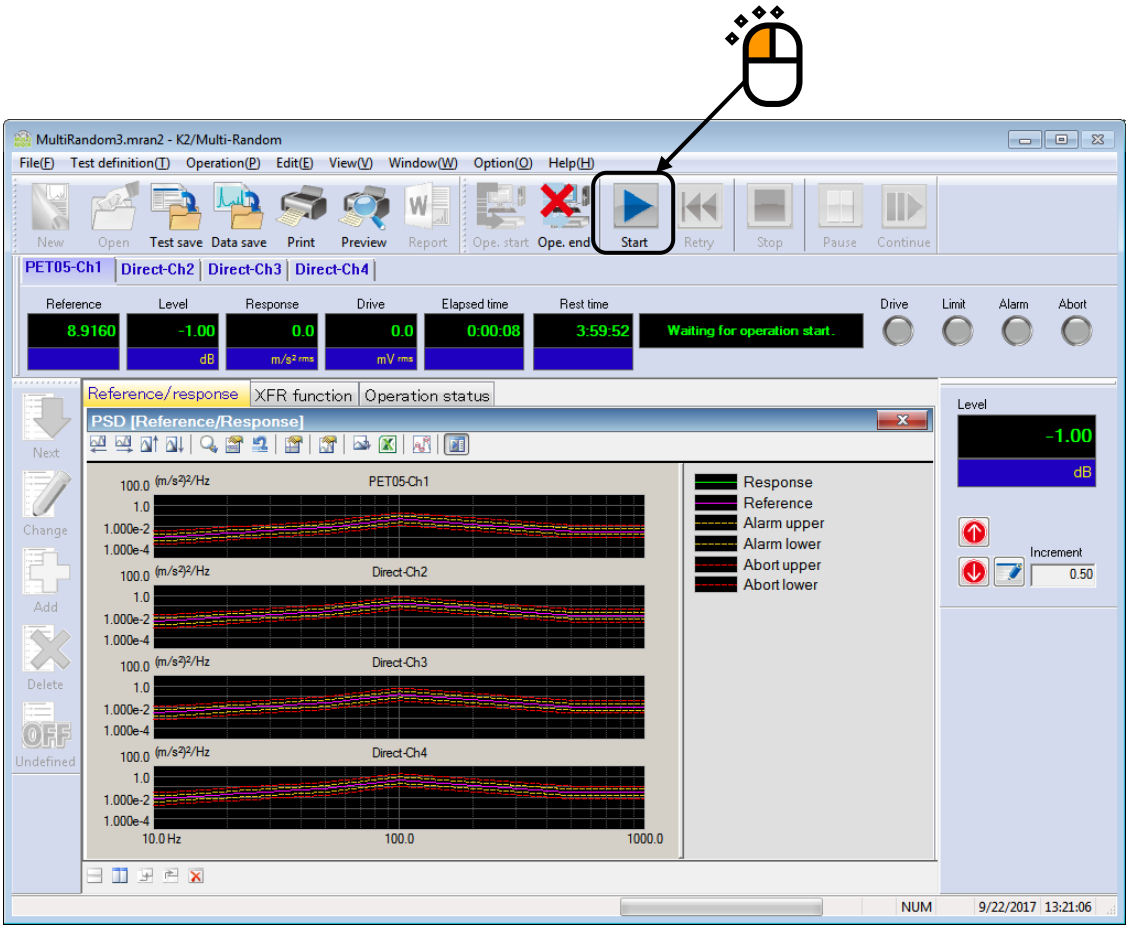
<Step 1>

Load the test file in which Continuing excitation data was added, and press [Operation start] button.



<Step 2>

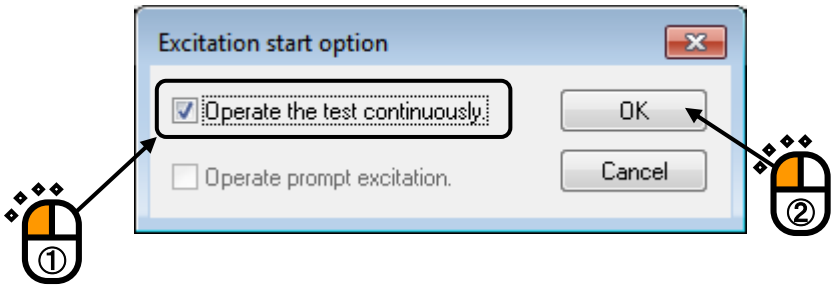
Measure the XFR function of the controlled system, and proceed to the status of waiting for excitation start.



<Step 3>

As for the test that Continuing excitation data was added, a dialogue box to decide whether the test should be continuously executed or not appears.

To restart the test that test was suspended, check “Operate the test continuously”, and press the [OK] button. Then, the test is restarted from the status (with the lapsed time of test and excitation level) that the test was suspended.



6.7 Prompt Excitation

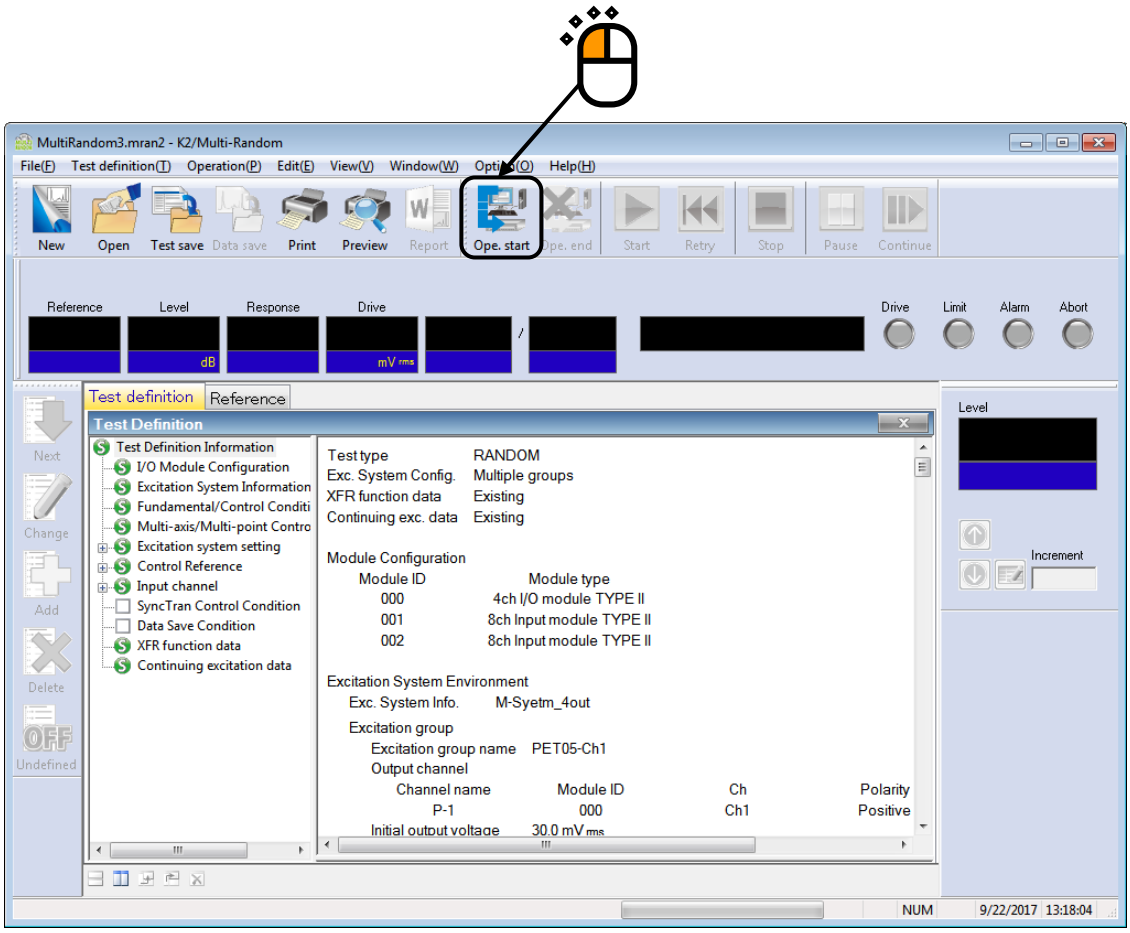
In the test file that Continuing excitation data is added, ‘Prompt mode’ can be executed.

However, pay attention to the danger when the system configuration and the condition of sensors and specimens are different. In such a case, XFR Function is needed to be measured again as in the same way as an ordinary test, and please don't use prompt excitation.

<Procedures>

<Step 1>

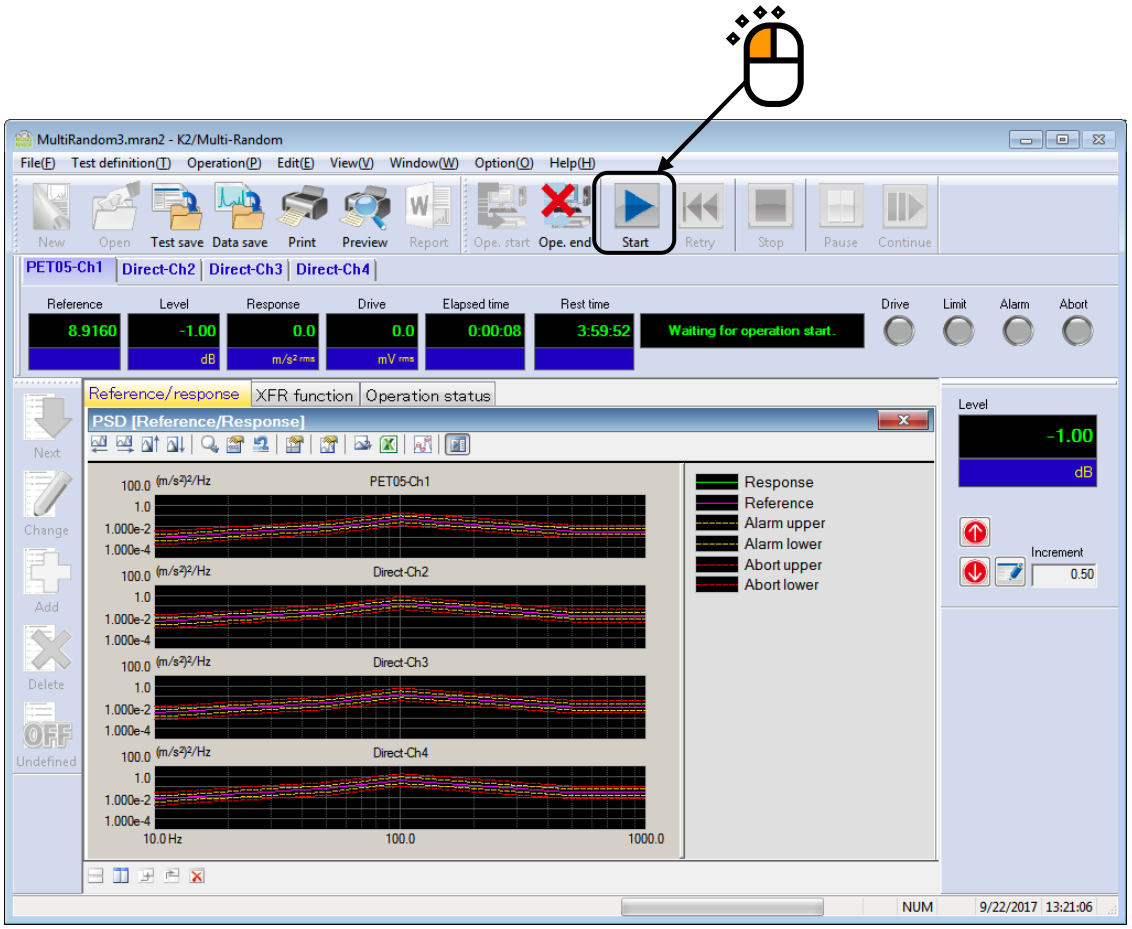
Load the test file in which Continuing excitation data was added, and press the [Operation start] button.



<Step 2>

Measure the XFR function of the controlled system, and proceed to the status of waiting for excitation start.

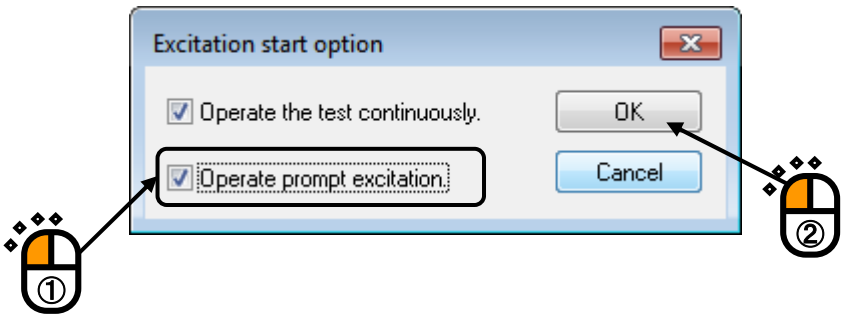
Press [Excitation start] button.



<Step 3>

As for the test that Continuing excitation data was added, a dialogue box to decide whether 'Prompt mode' operation should be executed or not appears.

To execute 'Prompt mode' operation, check "Operate prompt excitation", and press [OK] button. Then, excitation is started immediately with the used of the control operation data including the XFR properties when the test was suspended.



INDEX