Multi-Degree-Of-Freedom Sine Vibration Control System

K2

Multi-SINE
Instruction Manual

IMV CORPORATION

Type of document	Instruction manual	
System applied	K2	
	Software <K2/Multi-SINE>	later than Version 14.3.0

Japanese edition

Version	Date	Contents
6.0.0	2010.12.01	First edition
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
13.0.0	2017.03.10	Additional description of the setting for skip of saving data files of auto-save at each sweep turnover (or spot repeat), correction of misprints
13.5.0	2017.06.27	Additional description of XFR Measure by white noise
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 slope in interpolation type of control reference profile
14.2.0	2018.09.10	Additional description of “type of interpolation” of control reference profile
14.3.0	2019.04.19	Modified description of Data save condition, correction of misprints

English edition

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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	2016.07.29	Correction of misprints
13.0.0	2017.03.10	Additional description of the setting for skip of saving data files of auto-save at each sweep turnover (or spot repeat), correction of misprints
13.5.0	2017.06.27	Additional description of XFR Measure by white noise
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Chapter 1　Outline of the System

1.1 Specifications

1.1.1 Multi-SINE

(1) Control Method　:　①Amplitude Control Portion　: Level control of the swept sine waveform by using the feed-back method

②Phase Control Portion : Real time waveform control by using the feedforward method（Cross-talk control between each axis）

(2) Control Frequency : 0.1～10,000 Hz (However it may be limited by conditions.)

(3) Frequency Resolution : Less than 10^{-4} of output frequency

(4) Control Dynamic Range : More than 114 dB

(5) Operation Mode

1) Sweep, Spot

2) Control variables : Response signal

(6) Sweep Operation

1) Sweep mode : Linear / Log

2) Sweep type : double / single

3) Direction : forward / backward

4) Manual operation at sweeping excitation pause / sweep pause, reversing of sweep direction, excitation level change

(7) Test Time : by time / by sweep counts / by excitation times

(8) Input Channel　(However it may be limited by conditions.)

1) Number of channels : maximum 64
(Including maximum 32 of 'Principal Control Channels')

2) Type of channels : Principal Control channel / Control channel / Monitor channel
(possible to duplicate)

3) Peak Amplitude Estimation Method : Averaged value, rms value, Tracking

4) Control Response Averaging Method : Averaged value control / Maximum value control / Minimum value control

5) Alarm / Abort function : Level value of Alarm / Abort can be specified for each input channel.

6) Limit Control Function : the maximum allowance profile data can be specified for each input channel. When the response exceeding over the specified value is detected at a concerning channel, the system controls this deviated response not to exceeding over the level of allowance and continues the testing operation without stopping. 'Limit Control Option' is necessary to use this function as above.

(9) Output Channel : (However, it may be limited by conditions.)

1) Number of channels : maximum 16

2) Waveform distortion : Less than 0.1 % (1V rms)

(10) Analysis / Display Data

In Level measurement of Multi-SINE, it is assumed that the object signal for measurement is the sine wave having the same frequency as the rated SINE force. Therefore, the DC signals out of this assumption can not be measured.

1) The trace of the level for controlled response and response of each input channel

2) The trace of the level for drive

3) Each level data for every moments, accumulated value of the vibration times

4) Control response / Drive transmissibility, Each input channel / Controlled response transmissibility

5) Distortion and Signal Tolerance of the Response signal to each input channels

6) The data of Transfer function between Principal Control channel and Drive Output channel,Coherence

(11) Data save : 1) Automatic / Manual

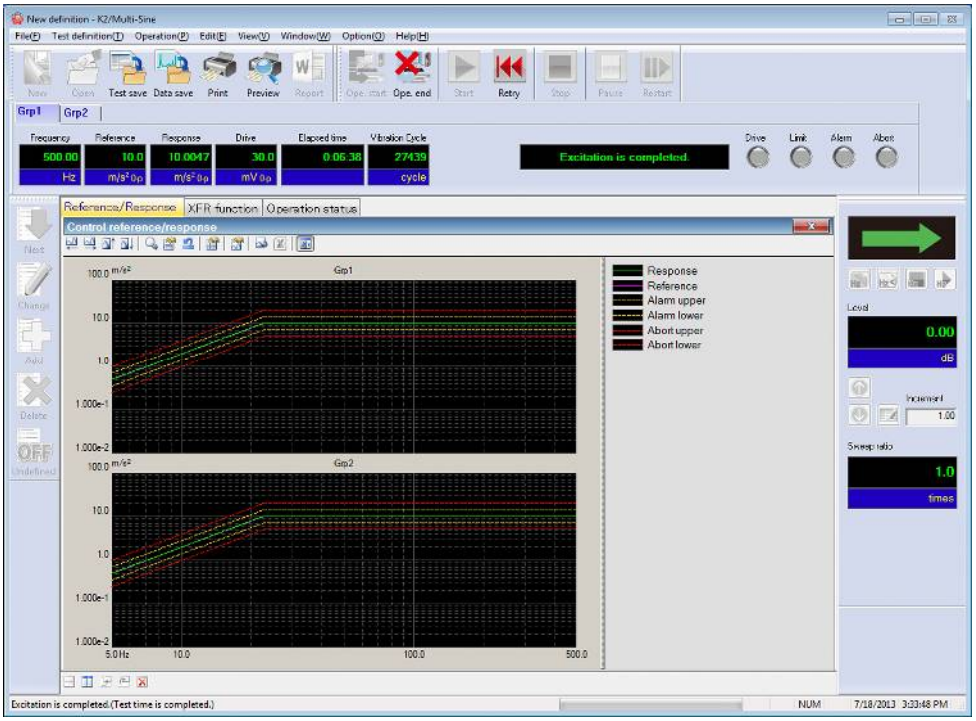
2) Display data save as CSV format

(12) External Contact Function :

1) Input Part : Excitation start, Excitation stop, Pause, Restart, etc

2) Output Part : Waiting for excitation start, In excitation, In pause, Test completed normally, Test completed in error

(13) Option : Limit Control



Display viewing of Multi-Sine

1.1.2 Limit Control (Option of Multi-SINE)

(1) Method

Observation Level is given to each limit control channel.

(2) Number of Channels

All the input channels are available to be used (however, the license is needed to be set.)

(3) Objective Physical Quantities

Physical quantity having a different unit from controlled variables is available to be used as a Limit Control Channel.

Chapter 2　Operation System of K2 Application

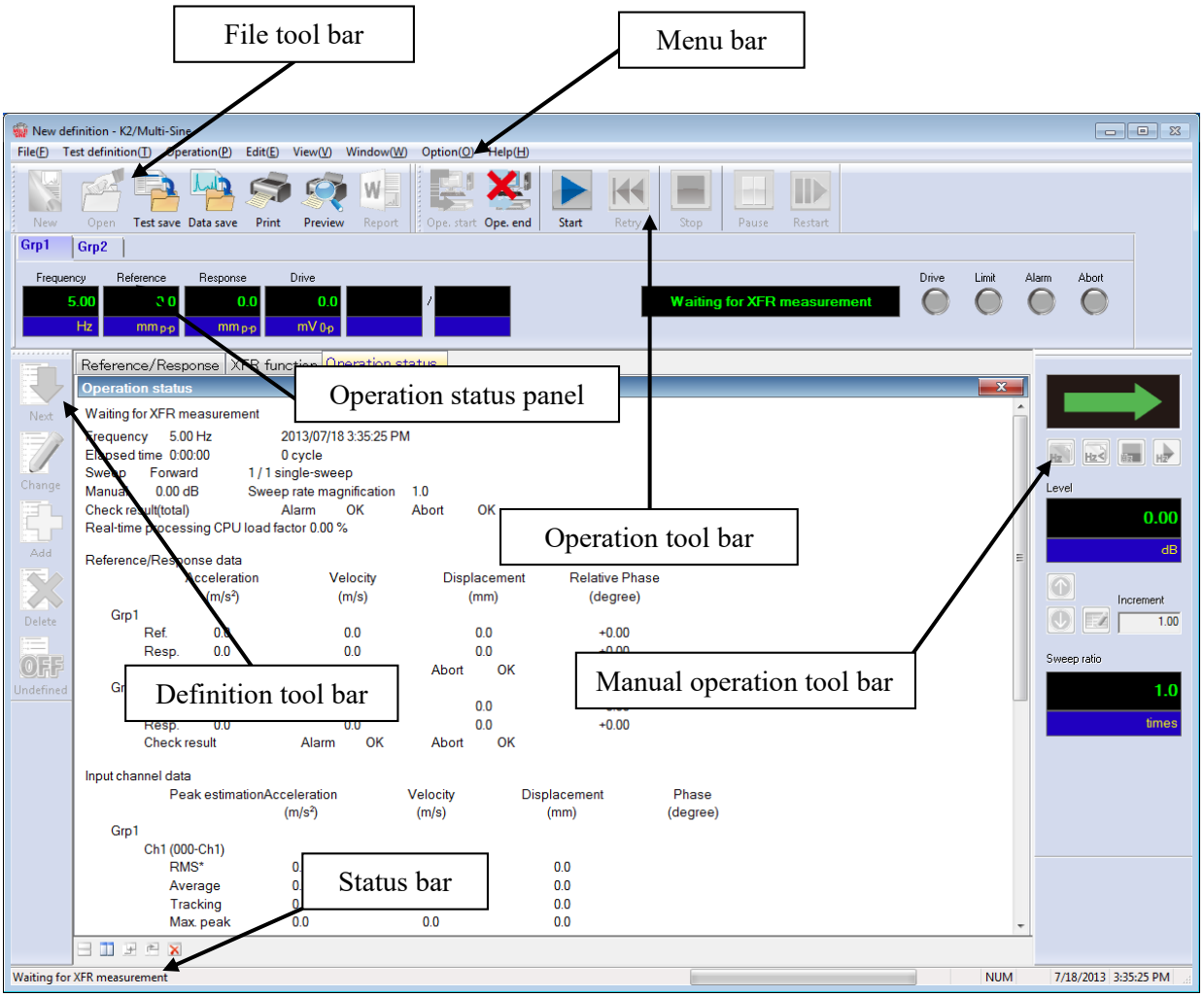
2.1 Outline

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 Menu bar. Each menu is to be opened by clicking on its name and available commands appears as a list.

The commands used frequently are displayed as icons in each Tool bar. A command is executed or a dialog box corresponding to the command is opened when the icon is clicked. Operation status of K2 Controller is displayed in Status bar. The state during the excitation operation is displayed in Operation status panel.



K2 Application Window

2.2 Test File

In K2 application, necessary information to operate a test is saved in a specified file called 'Test file' . Following kinds of Test file are available in this system.

Necessary Test Files for test operation

・Test Definition File : The file created inVer10.0.0.0 or later
K2Multi-SINE（*.mswp2, *.mspt2）
The file created before Ver10.0.0.0
K2Multi-SINE（*.mswp, *.mspt）

・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.

2.3 Test Type

Two types of tests as below are available in K2 Multi-SINE.

① Sweep test

Sweep test is the most popular testing method used in sine vibration test. In this test, the system operates the sine vibration control by changing the frequency continuously according to the specified conditions.

② Spot test

In Spot test, the system operates the excitation of the specified condition in order by using the excitation frequency and reference level specified beforehand.
Sweep operation is not executed in Spot. test
And, arbitrary setting of frequency series is possible in Spot test.

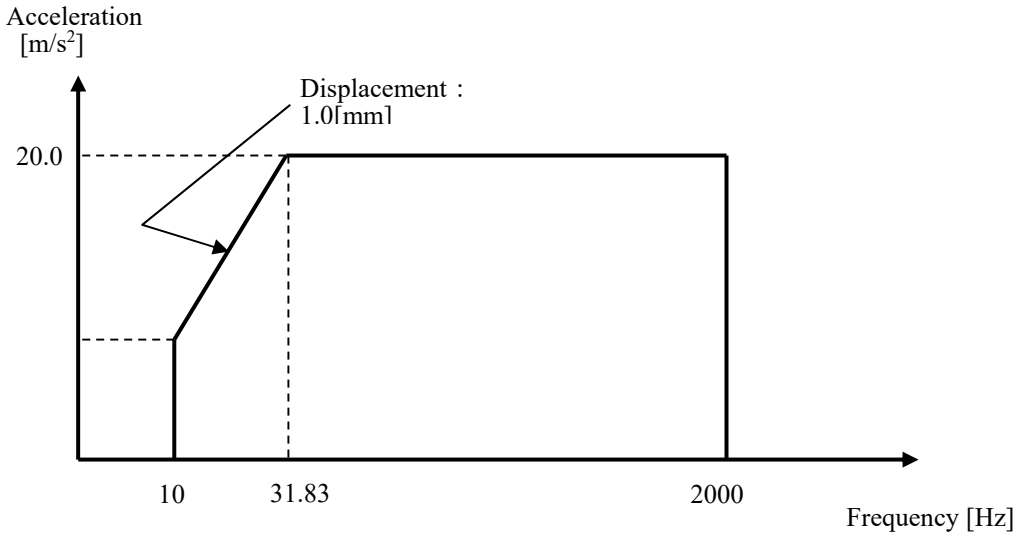
Chapter 3　Basic Operation

3.1 Sweep (Simplified definition)

< Example >

An example of sweep test is described as below ;（two shakers are used）

[Reference pattern]



[Test time]

Sweep rate : 1.000 (octave/min)

The times of double sweep : 1 (double-sweep)

[Information of sensors to be used]

Two acceleration pickups of piezoelectric :

ch1. : for Principal Control,　sensitivity 3pC/(m/s^2)

ch2. : for Principal Control,　sensitivity 3pC/(m/s^2)

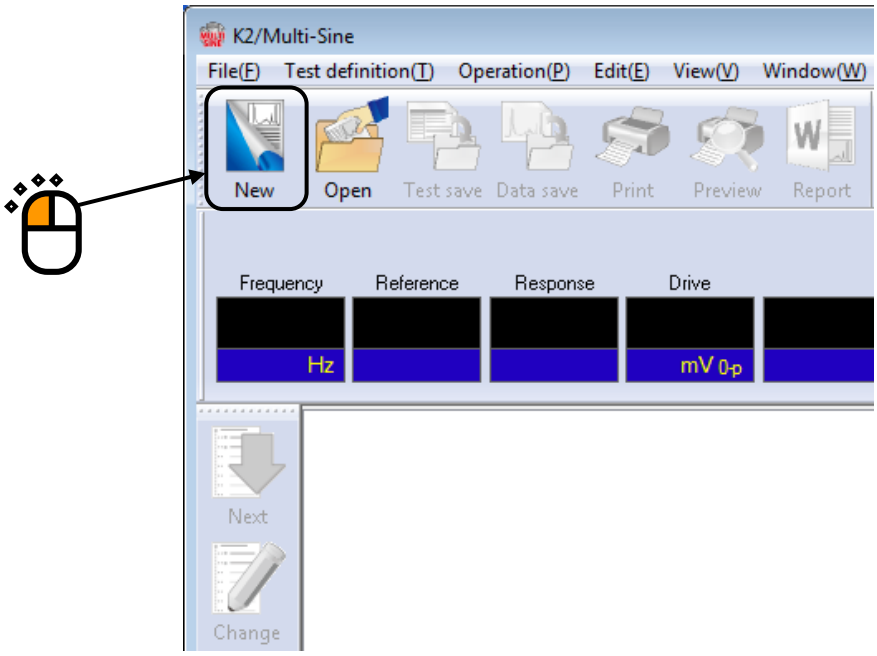
However, these channels must be registered in Input enviroment information (in this example, ‘chtest1’).

Also, the rating information of excitation system has already been registered in Excitation system information (in this example, ‘System1’).

< Procedures >

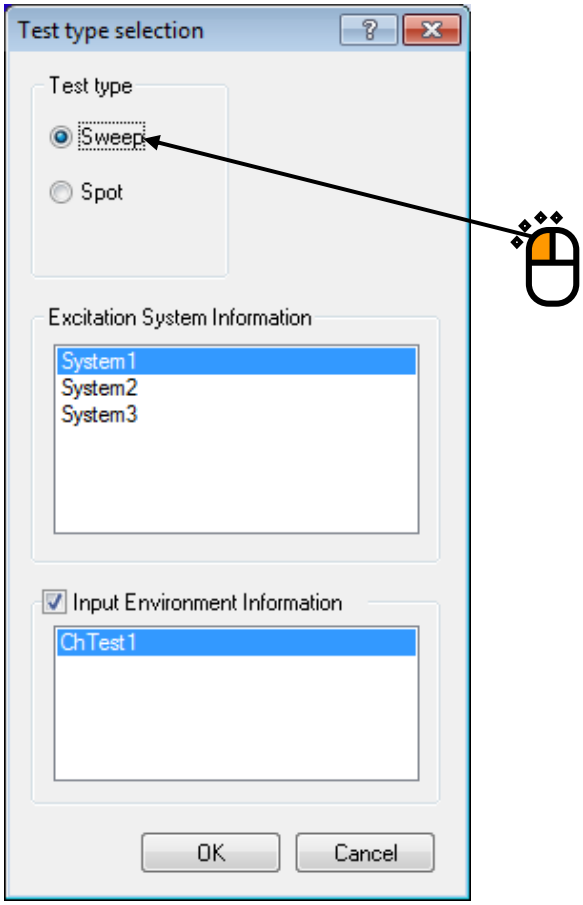
< Step 1 >

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



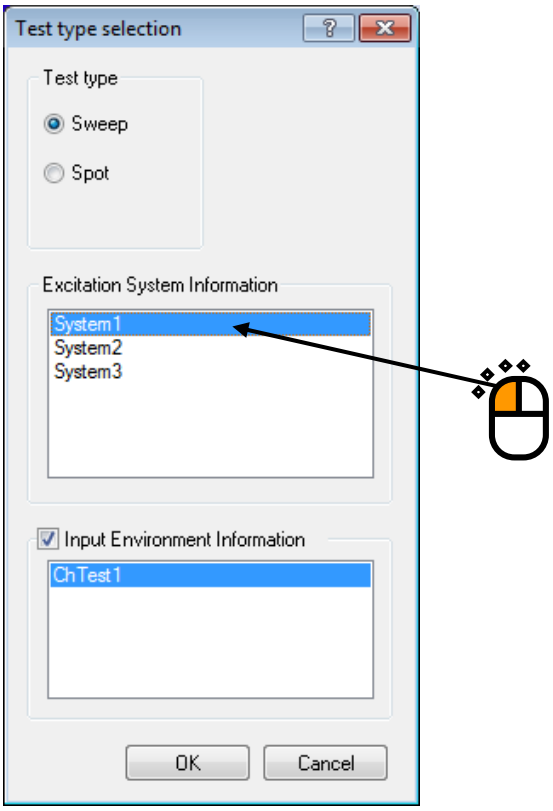
< Step 2 >

Select the item of 'Sweep' in Test type.



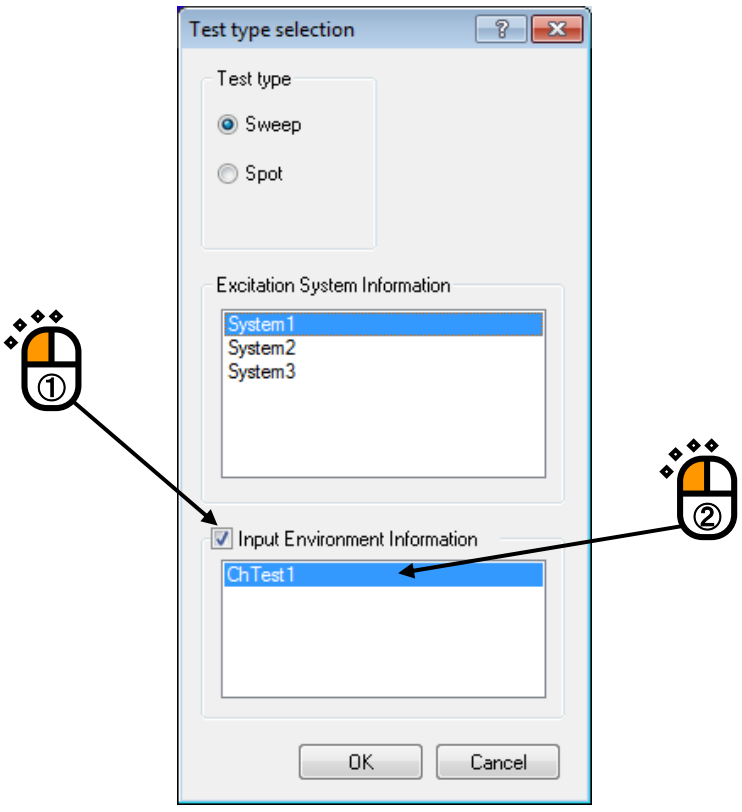
< Step 3 >

Select an excitation system from the list of ‘Excitation System Information’.



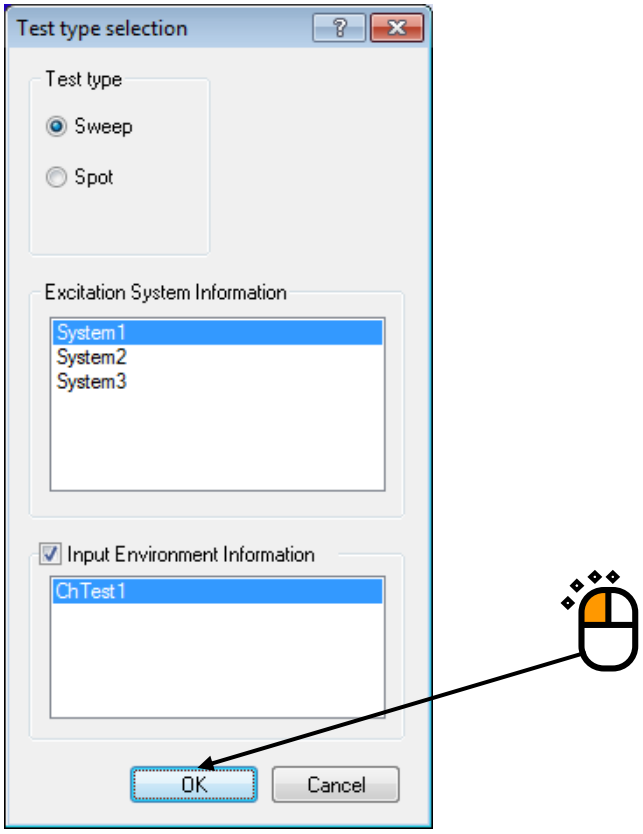
< Step 4 >

Click the checkbox of ‘Input Environment Information’ and select an input environment information from the list.



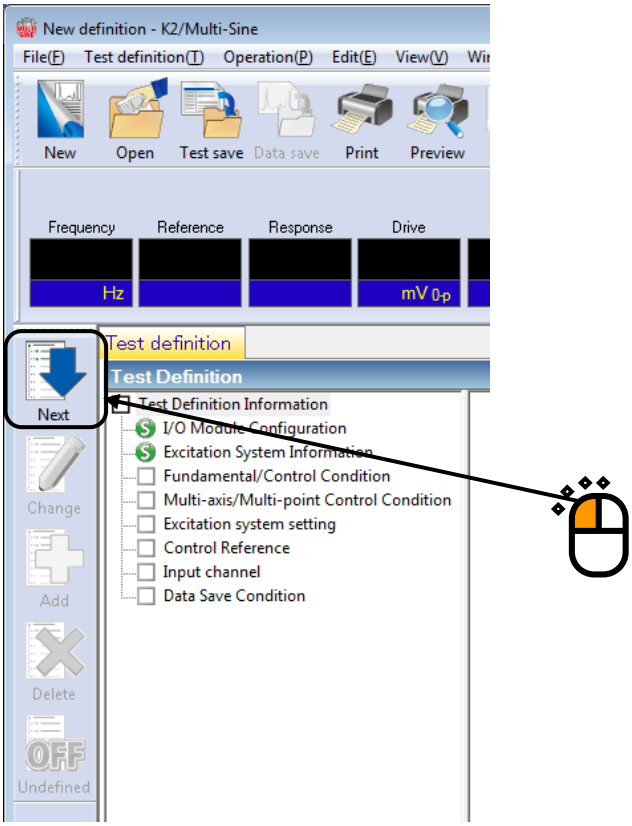
< Step 5 >

Press the [OK] button.



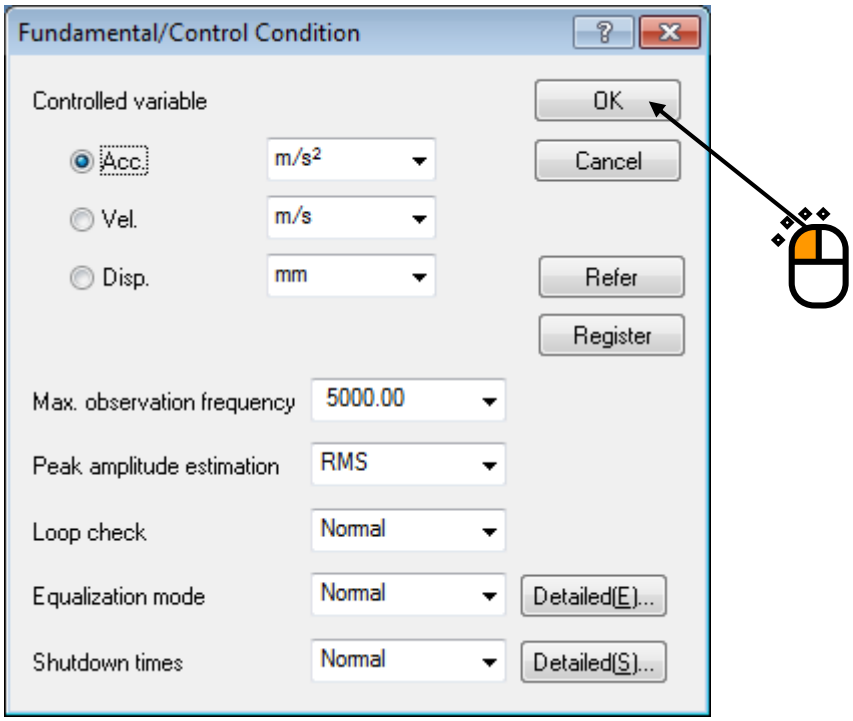
< Step 6 >

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



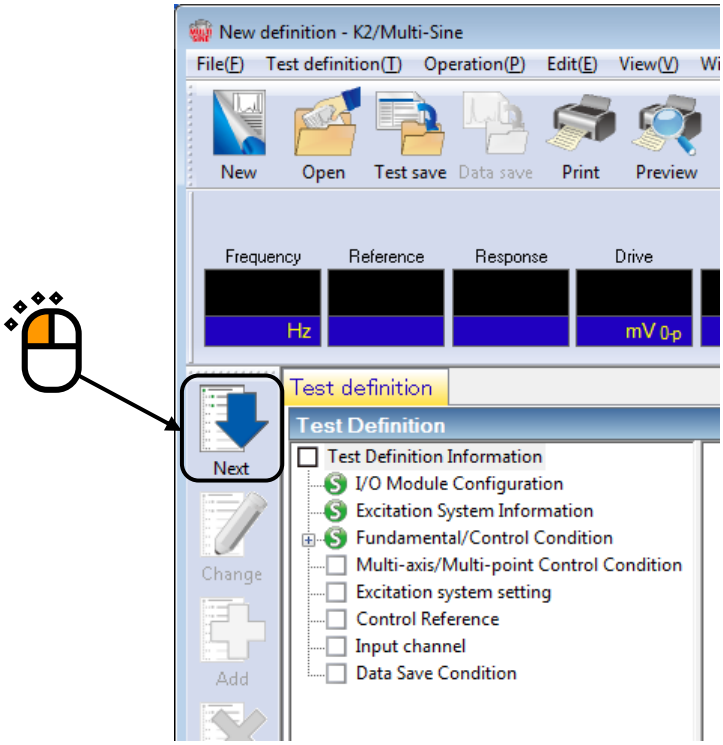
< Step 7 >

Press [OK].



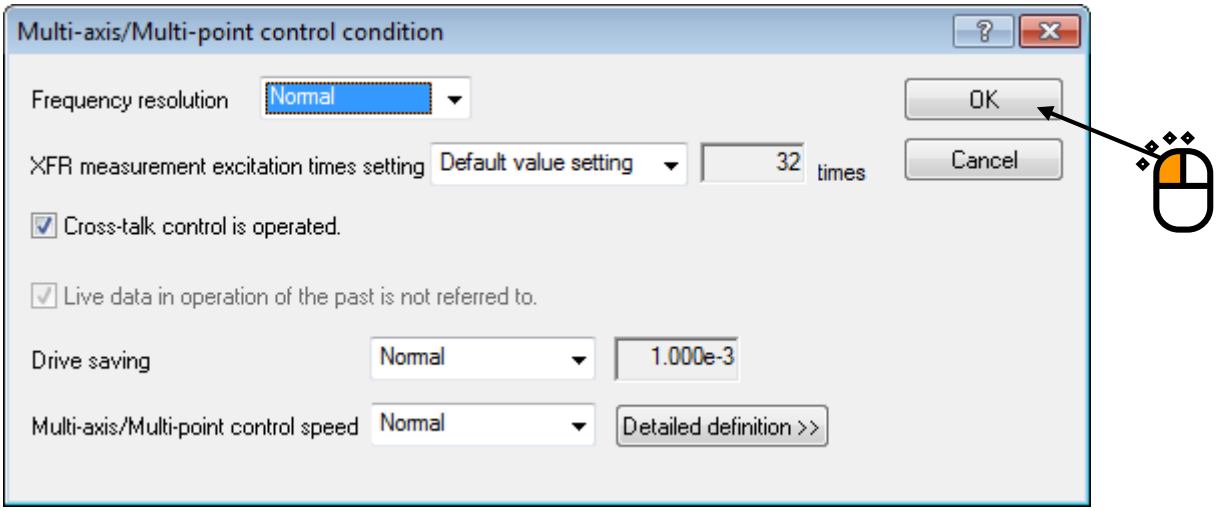
< Step 8 >

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



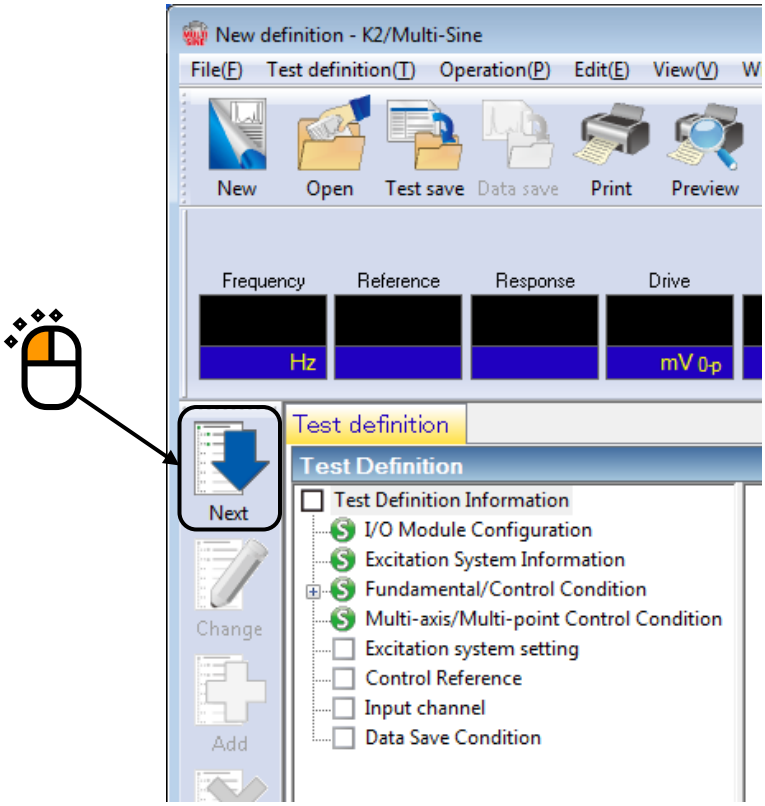
< Step 9 >

Press [OK].



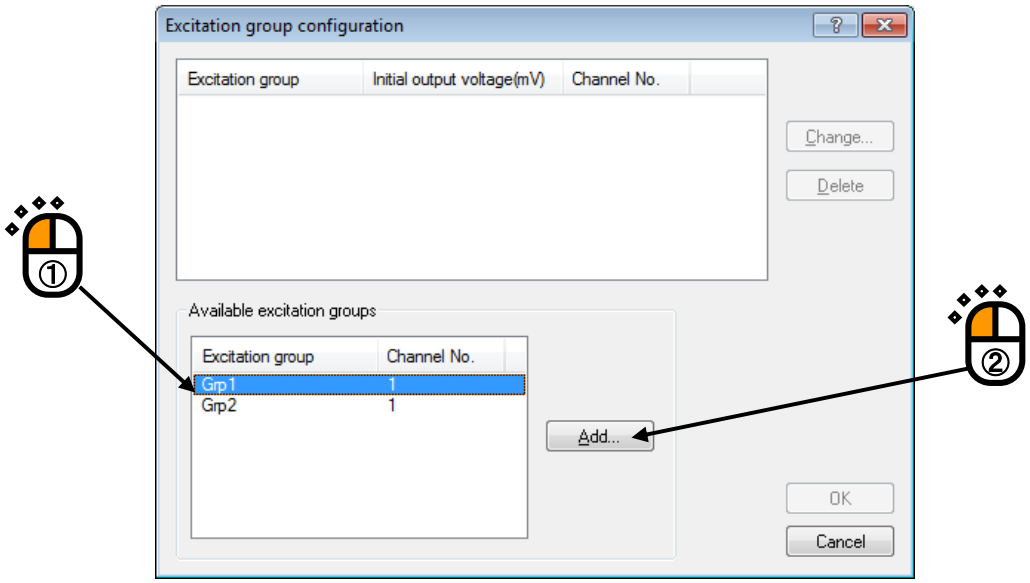
< Step 10 >

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



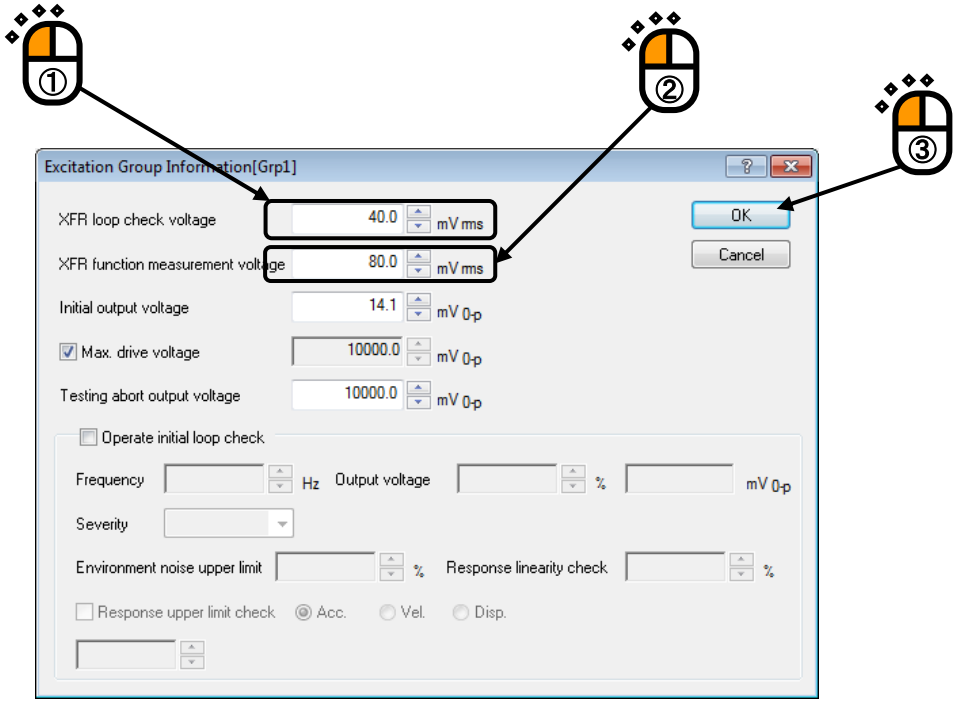
＜Step11＞

Select an excitation group among the available excitation groups. Here, select ‘Grp1’ and press the button to add.



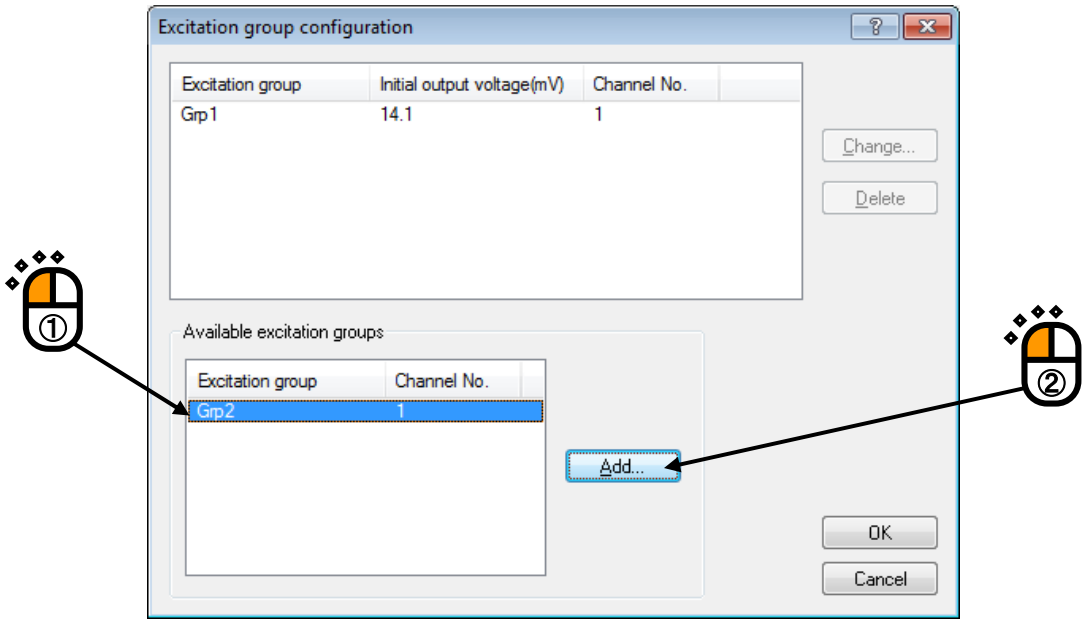
＜Step12＞

Input the values to ‘XFR loop check voltage‘ as 40 [mVrms].and ‘XFR function measurement voltage’as 80.0 [mVrms]. Then press [OK].



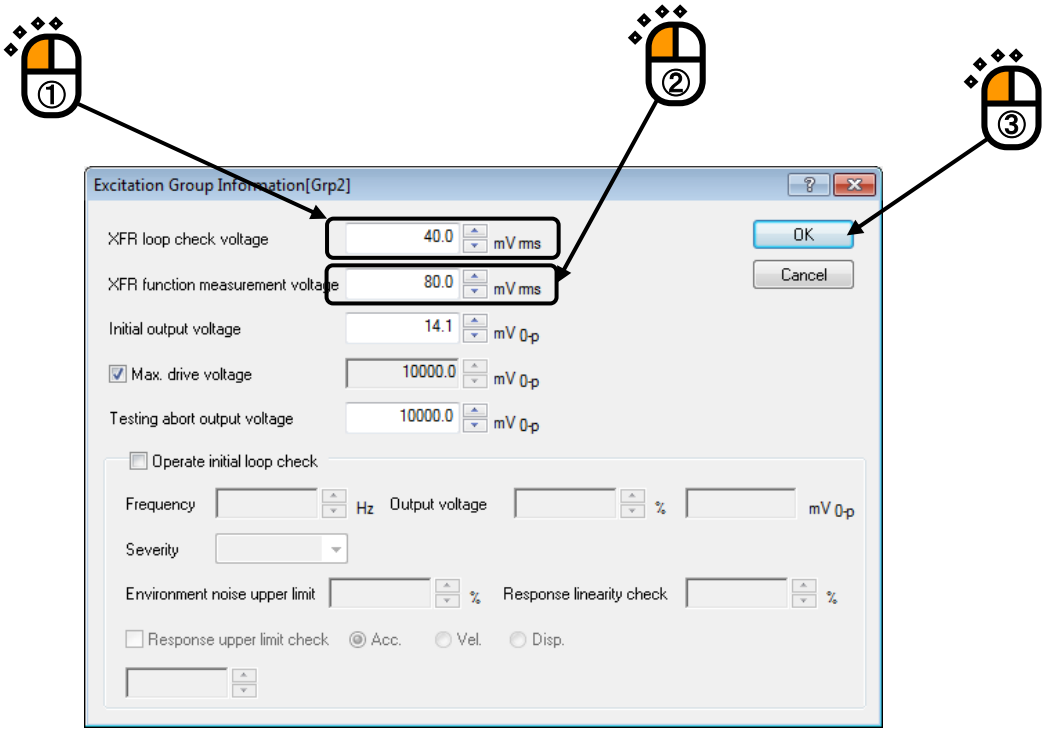
＜Step13＞

Select an excitation group in the available excitation groups. Here, select ‘Grp2’ and press the button to add.



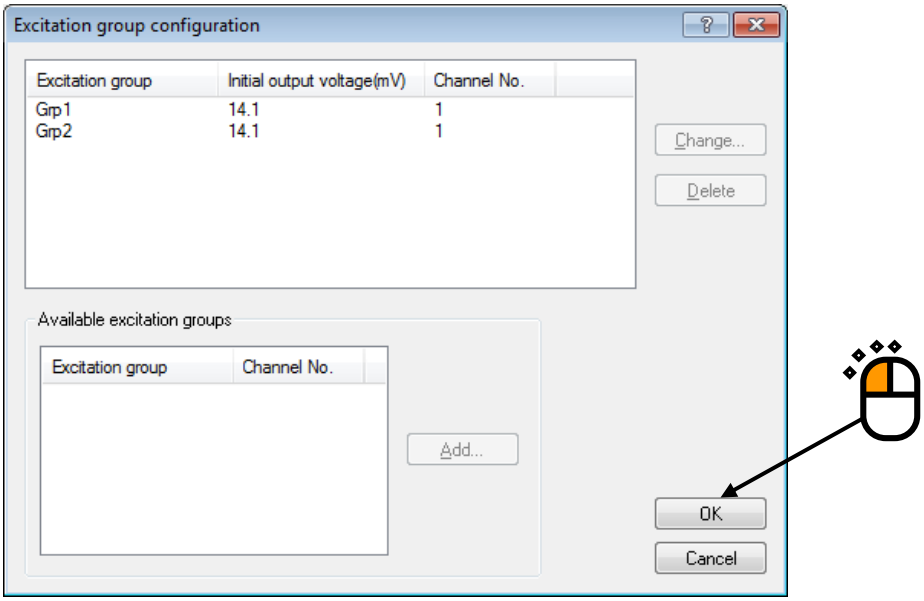
＜Step14＞

Input the values to ‘XFR loop check voltage‘ as 40 [mVrms].and ‘XFR function measurement voltage’as 80.0 [mVrms]. Then press [OK].



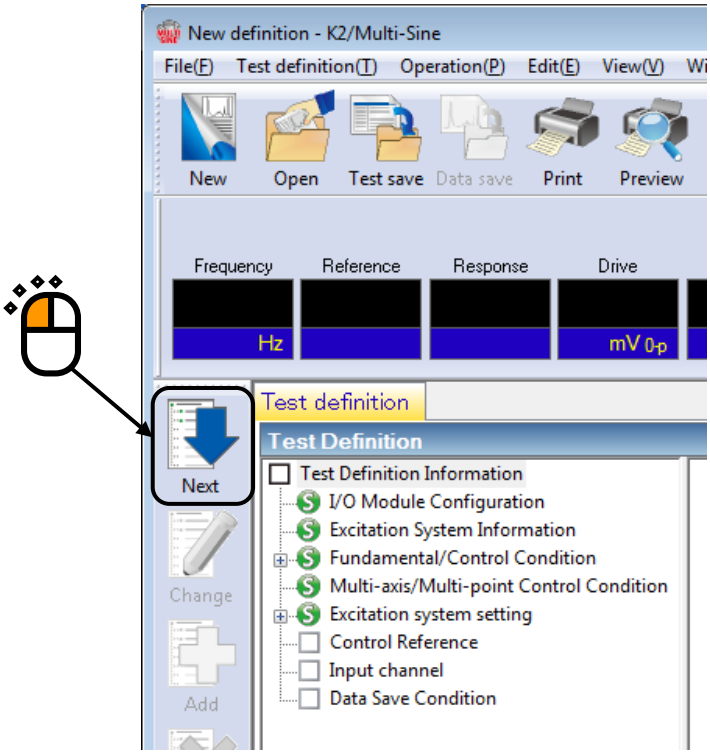
< Step 15 >

Press [OK].



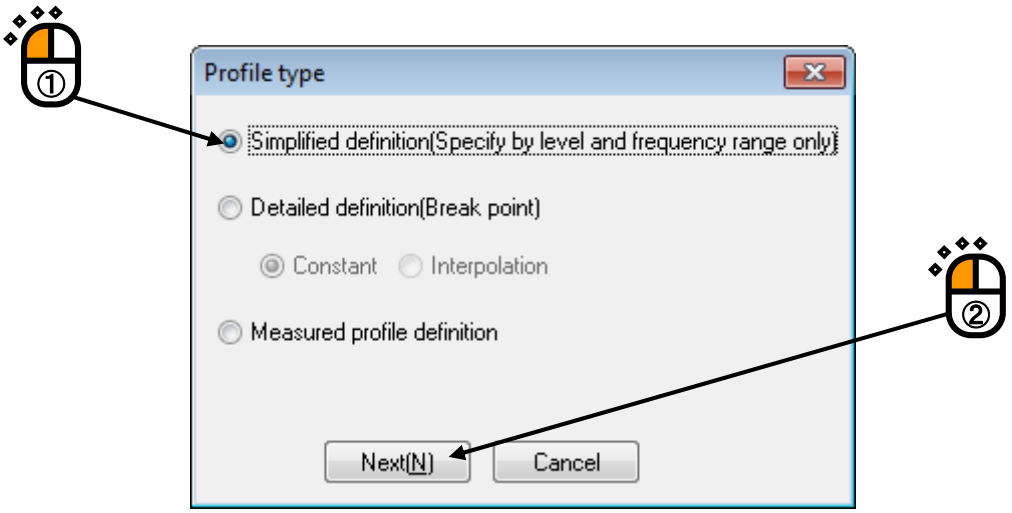
< Step 16 >

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



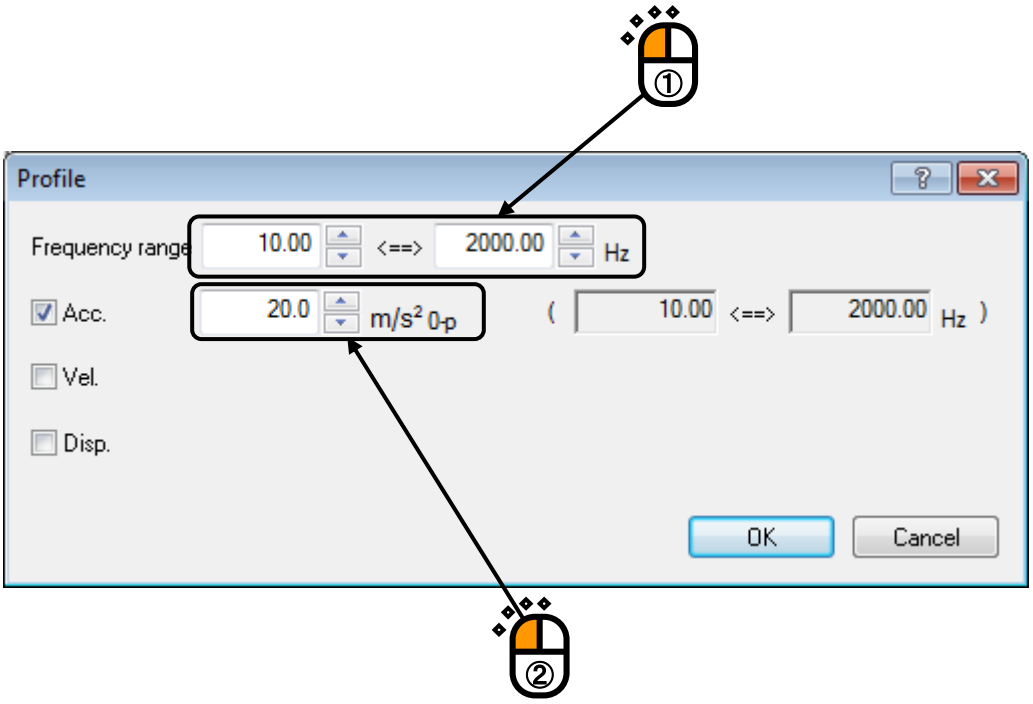
< Step 17 >

Select the item of ‘Simplified definition (Specify by level and frequency range only)’ and press [Next].



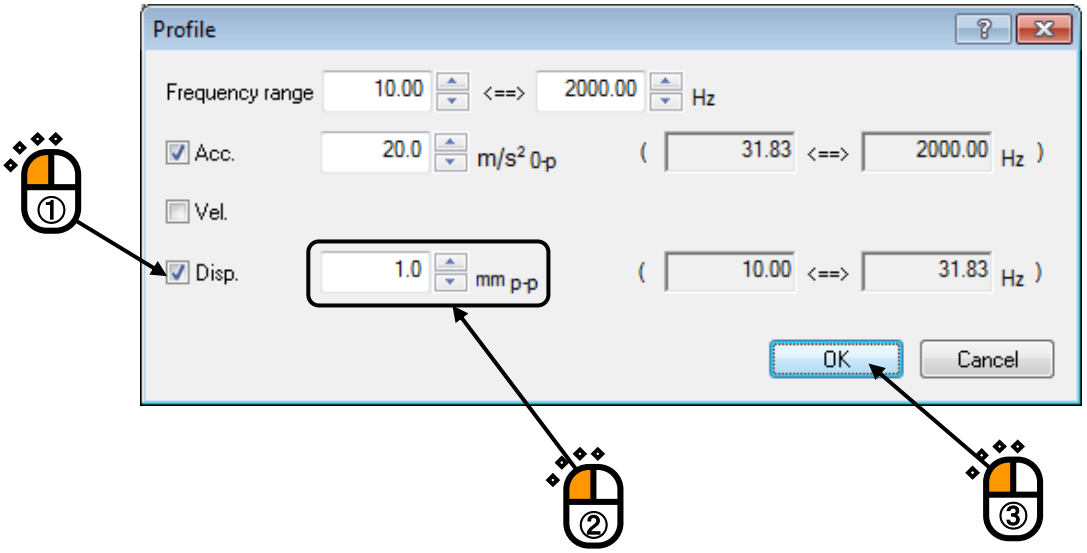
< Step 18 >

Input the values to ‘Frequency range’ as 10～2000.0 [Hz]. Check the item of ‘Acc. (Acceleration)’ and input as 20.0 [m/s^2].



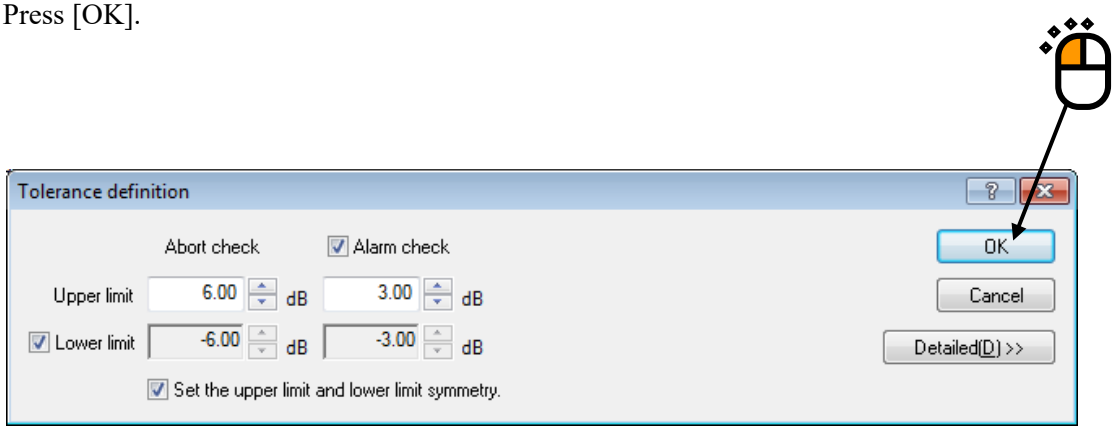
< Step 19 >

Check the item of ‘Disp. (Displacement)’ and input as 1 [mm]. Then press [OK].



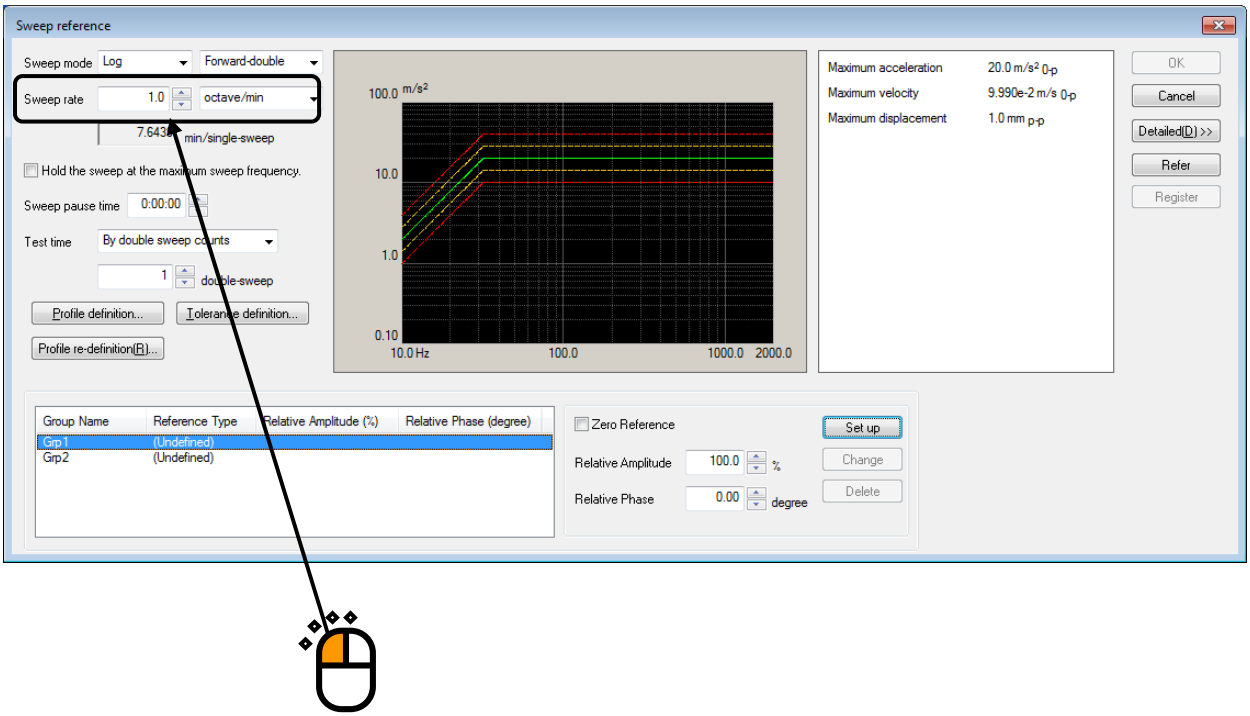
< Step 20 >

Press [OK].



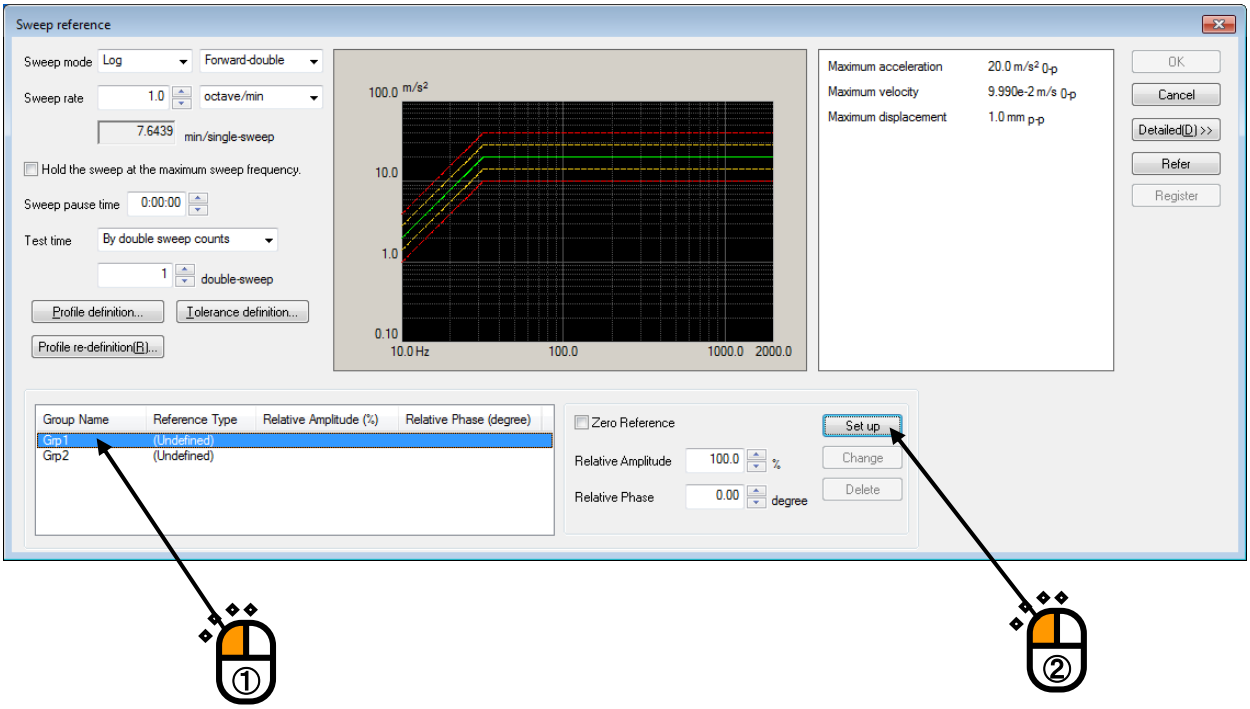
< Step 21 >

Input the value to ‘Sweep rate’ as 1.000 [octave/min]. And press [OK].



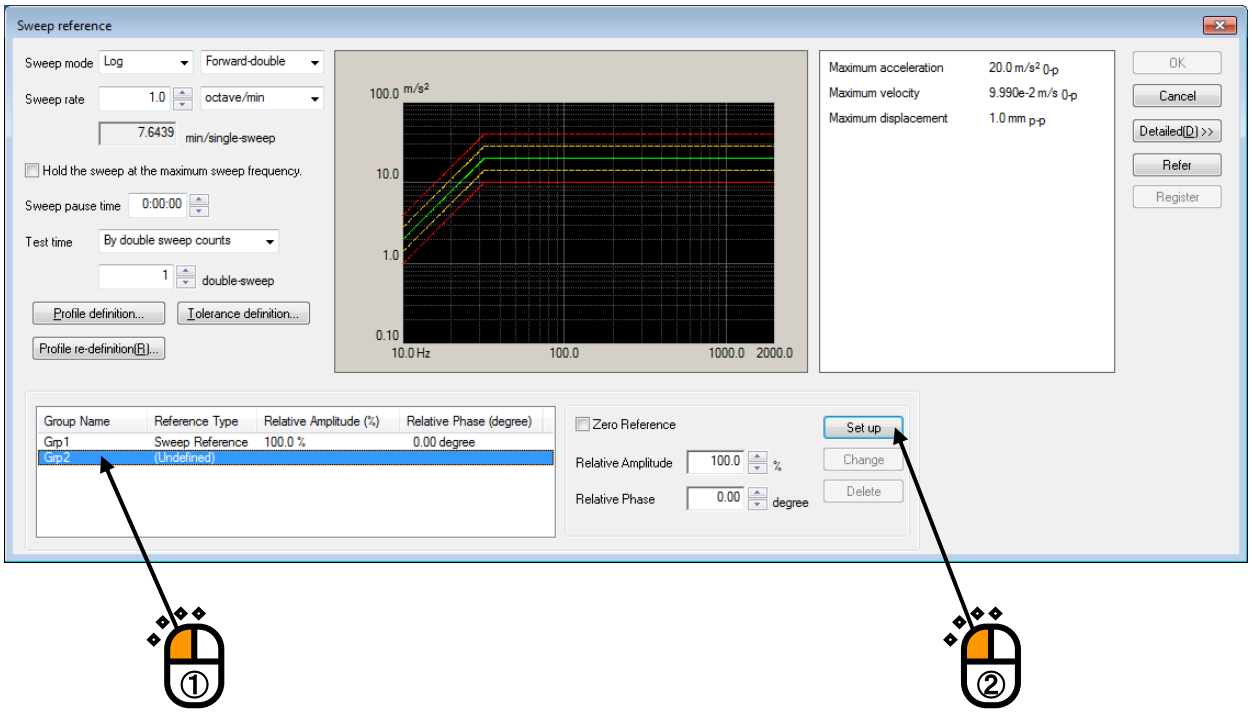
＜Step 22＞

Select a group name, ‘Grp1’. Then press the definition button.



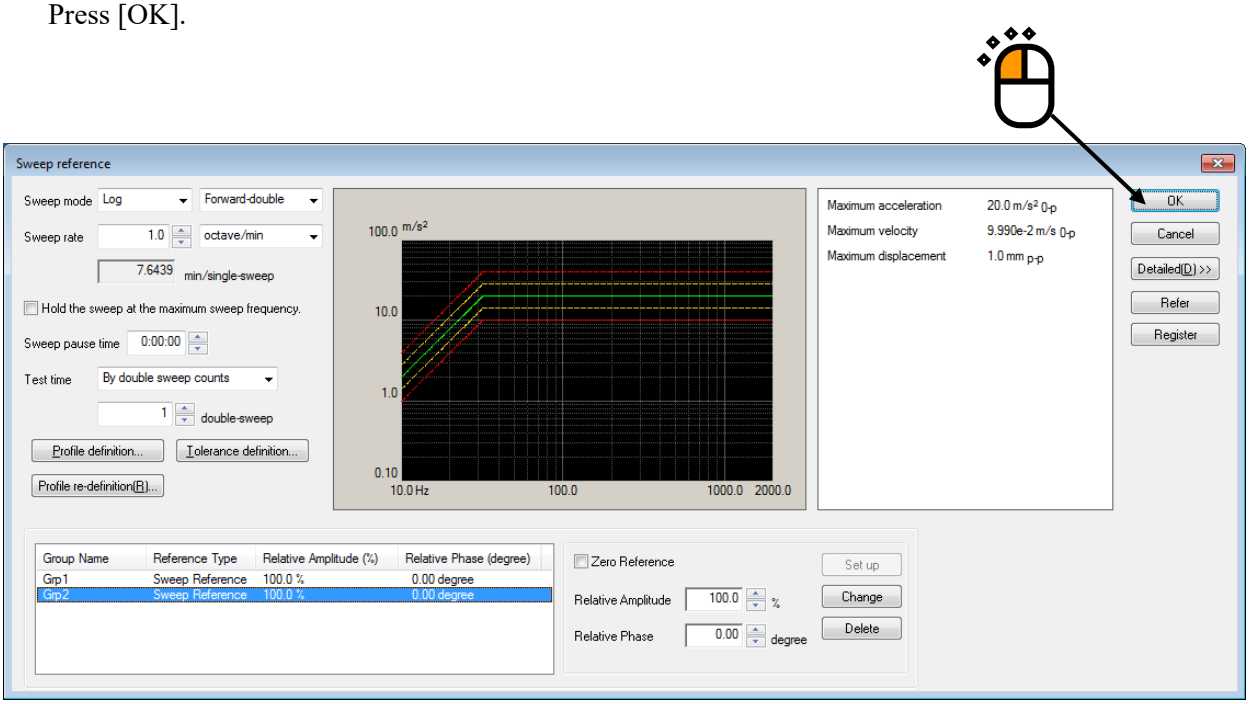
＜Step 23＞

Select a group name, ‘Grp2’. Then press the definition button.



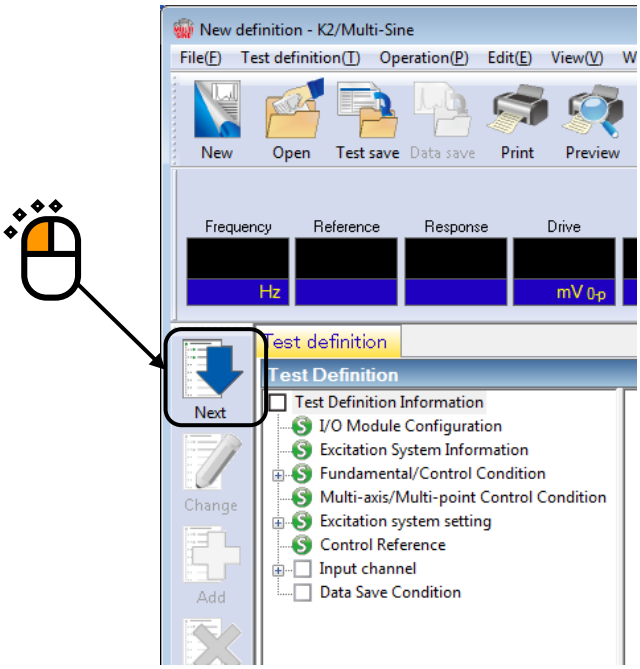
< Step 24 >

Press [OK].



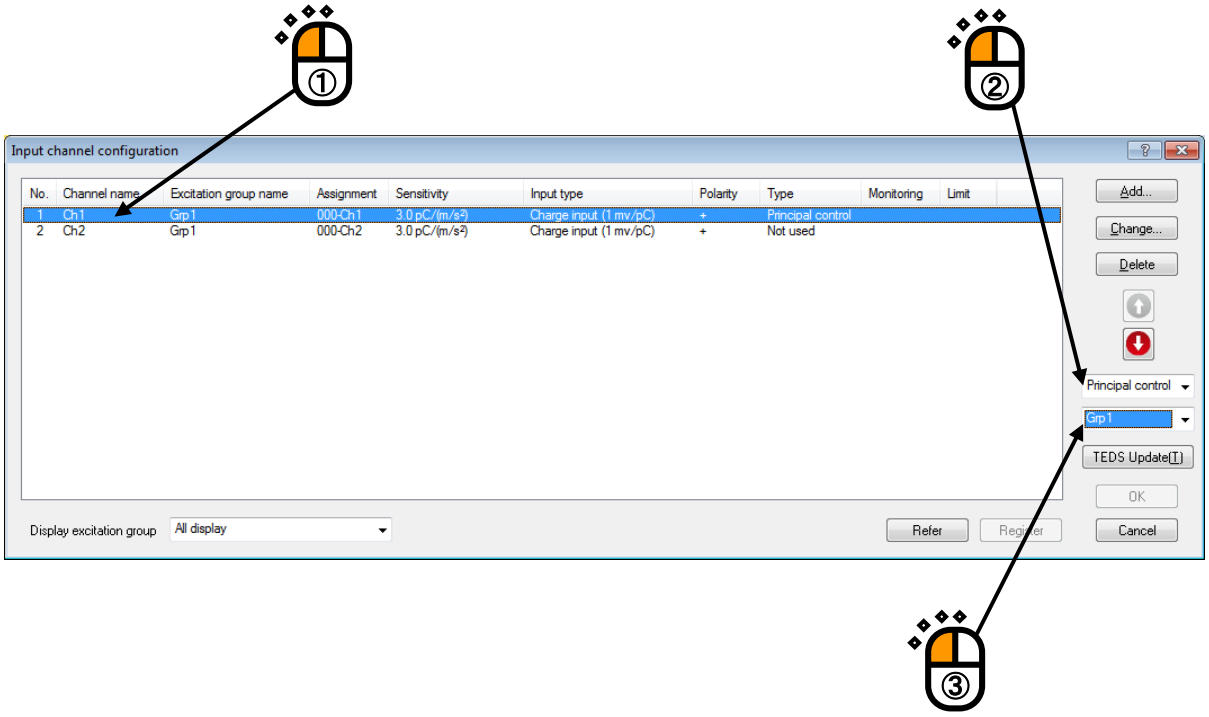
< Step 25 >

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



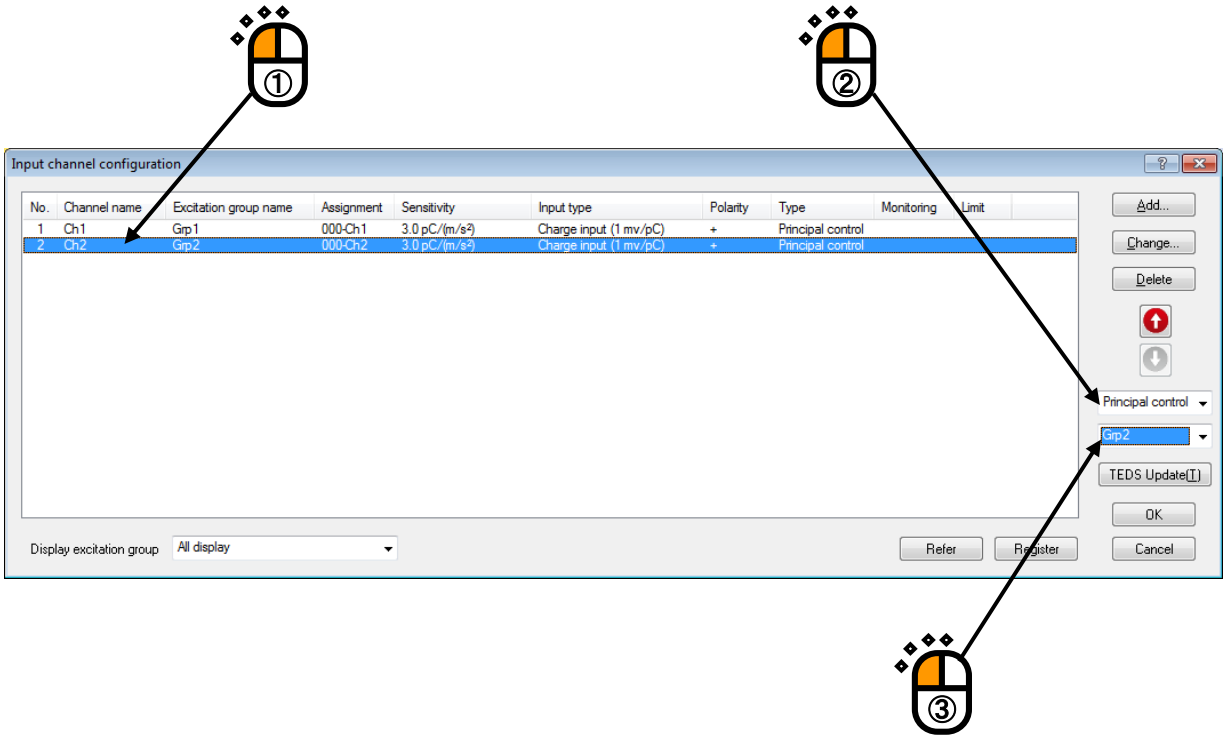
＜Step 26＞

Select a channel name, ‘Ch1’ in the list of input channels. Then Set the channel type to Principal Control and the excitation group to ‘Grp1’



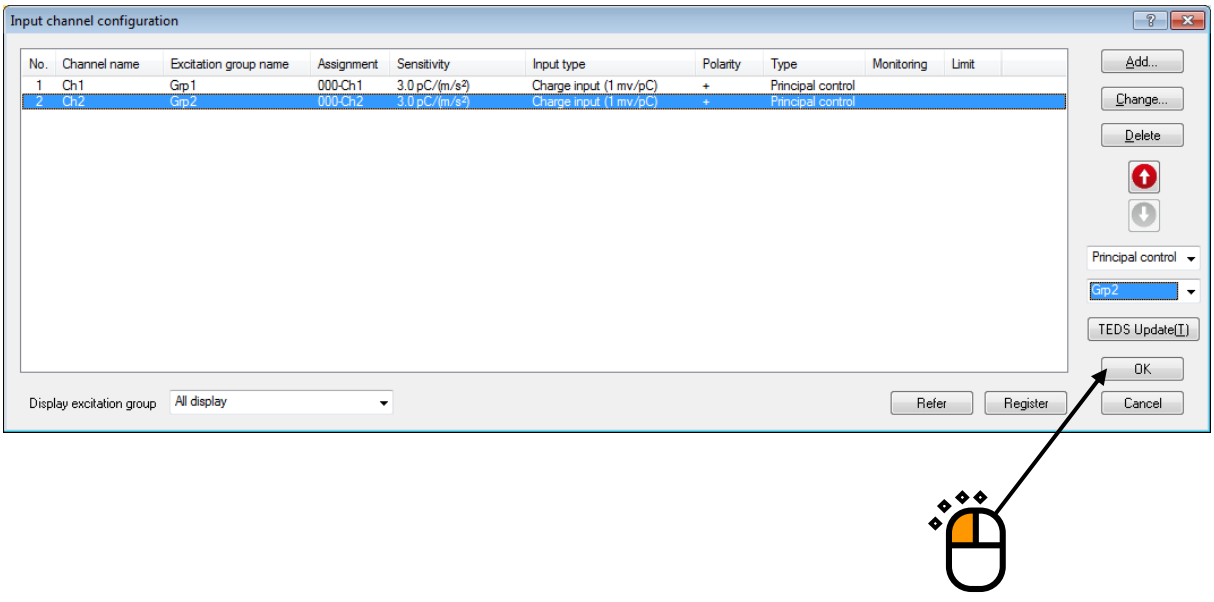
＜Step 27＞

Select a channel name, ‘Ch2’ in the list of input channels. Then Set the channel type to Principal Control and the excitation group to ‘Grp2’



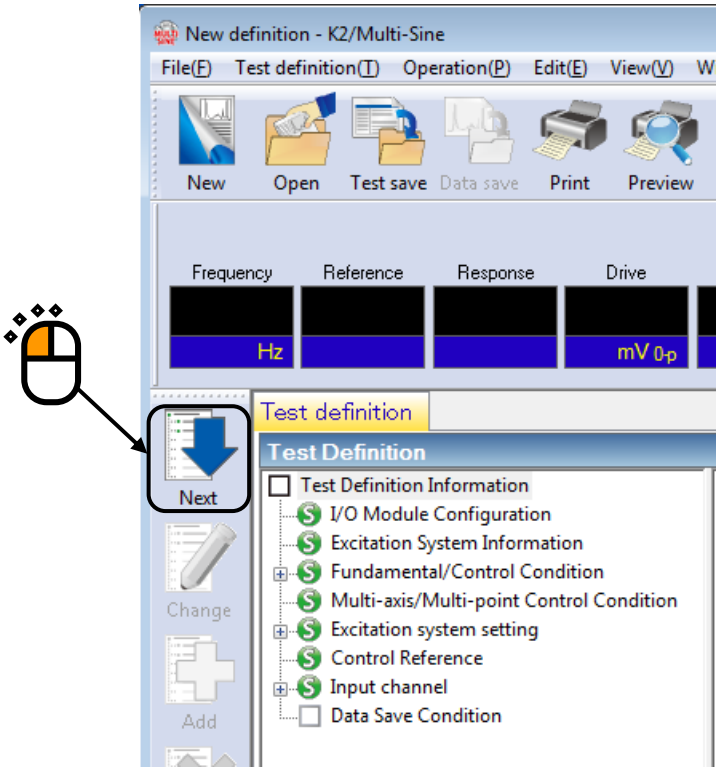
< Step 28 >

Press [OK].



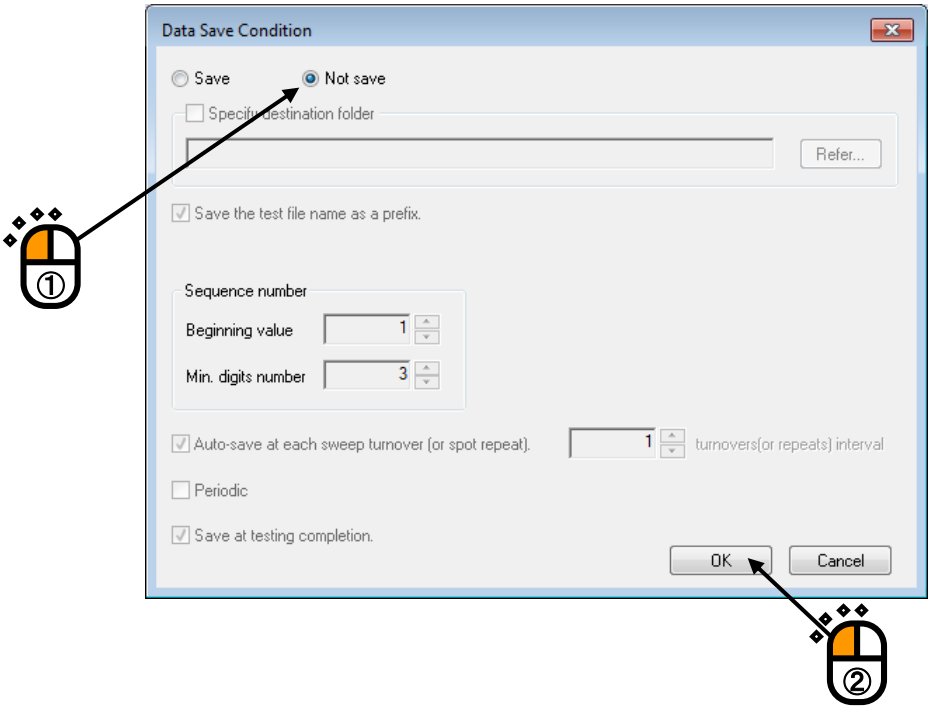
< Step 29 >

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



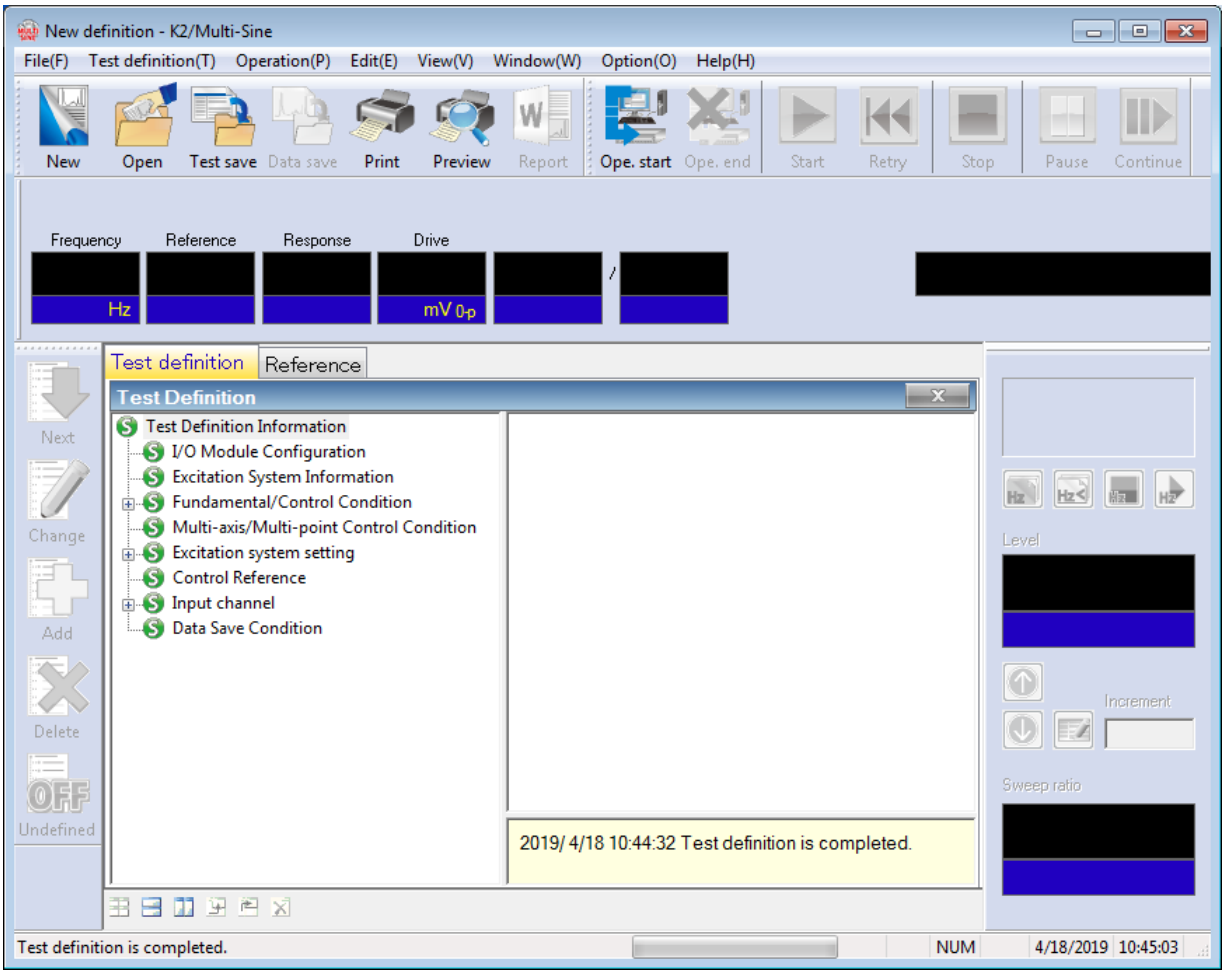
< Step30 >

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



< Step31 >

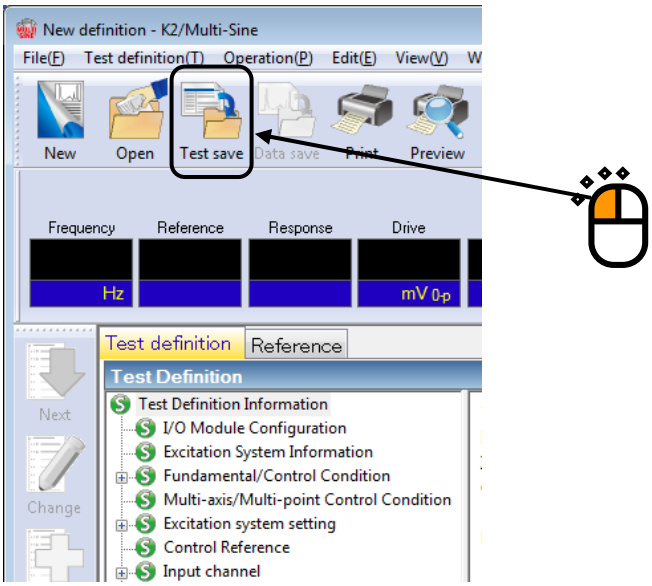
The definition is completed.



< Save test >

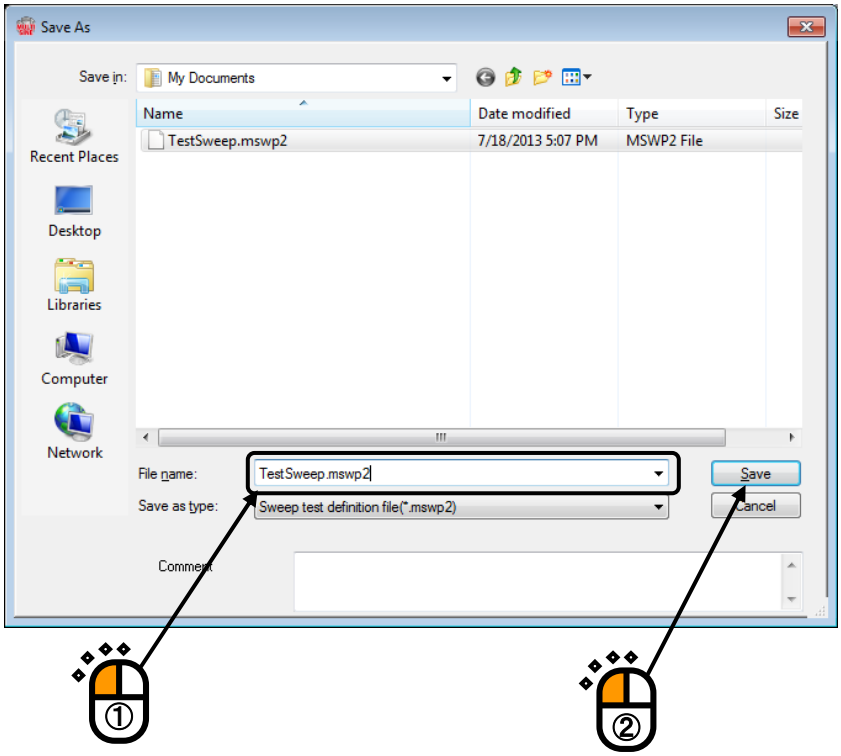
< Step 1 >

Press the button of [Test Save].



< Step 2 >

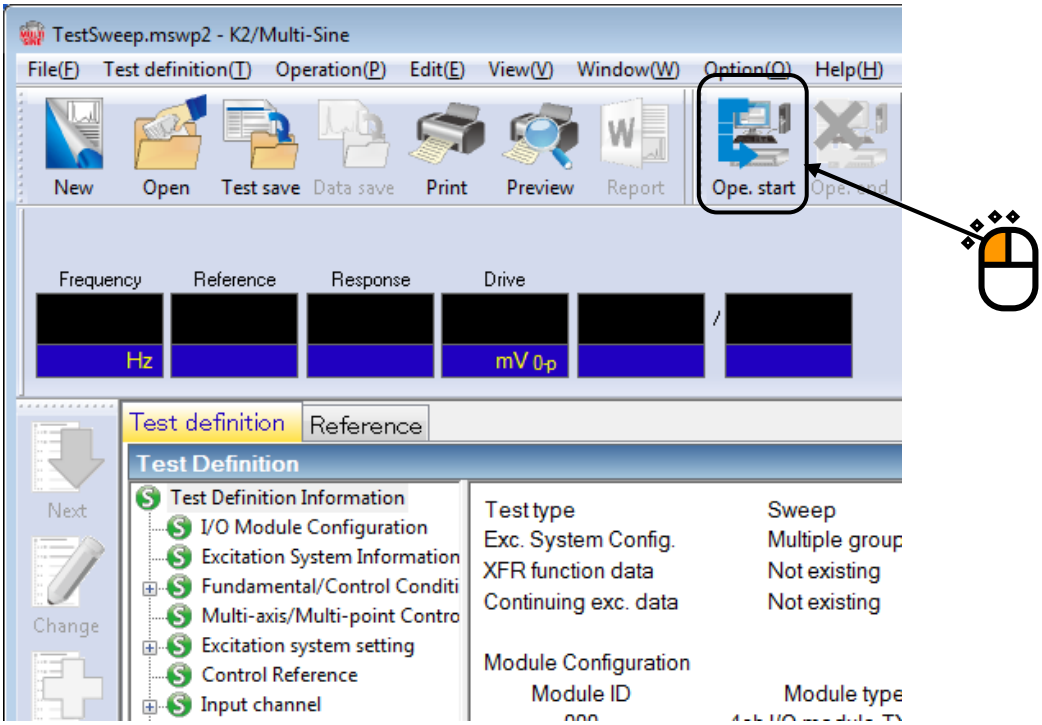
Input a name in 'File name' and press [Save].



< Operation of test >

< Step 1 >

Press the button of [Operation start].

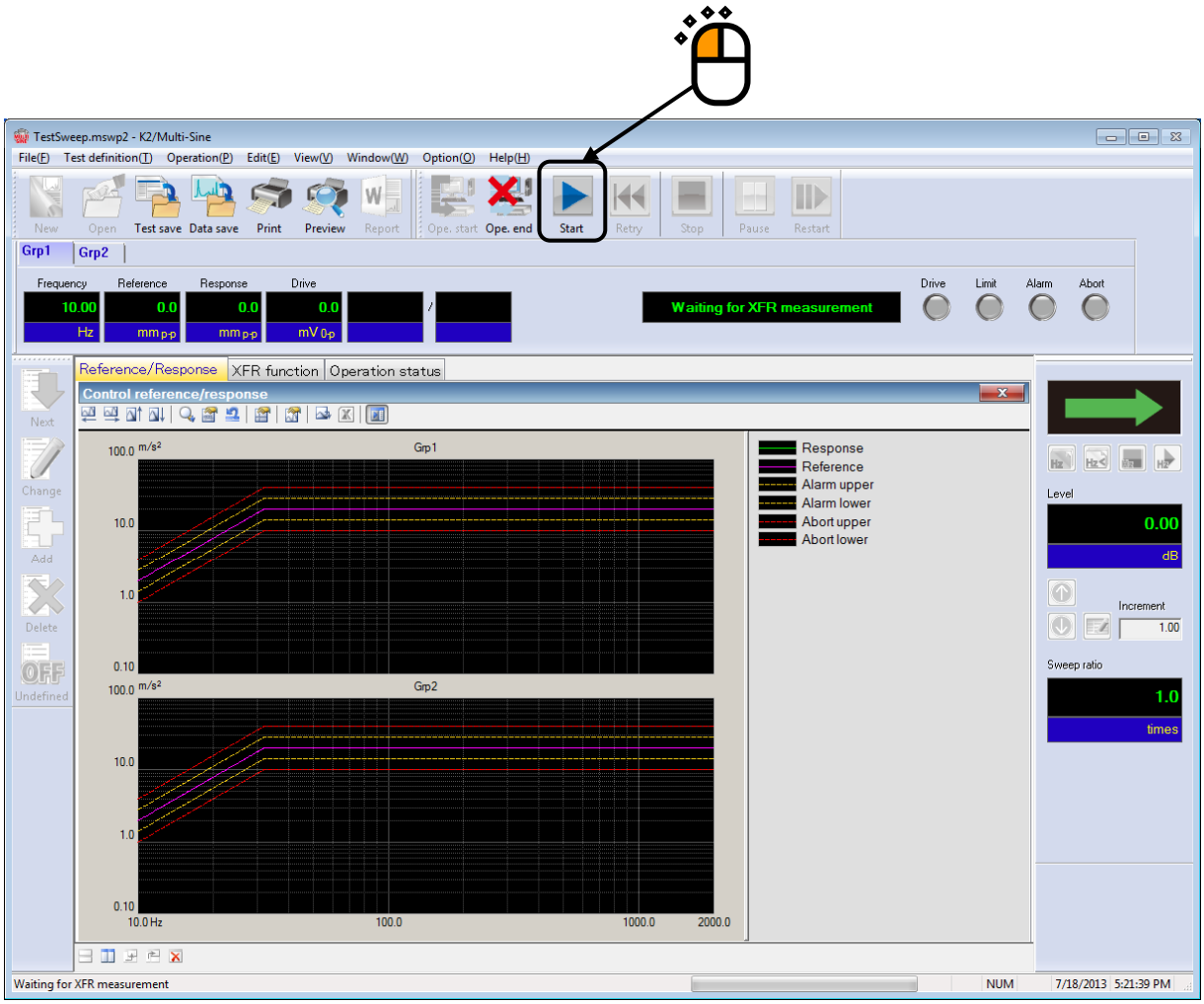


＜Step 2＞

Press the button of XFR measurement start.

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

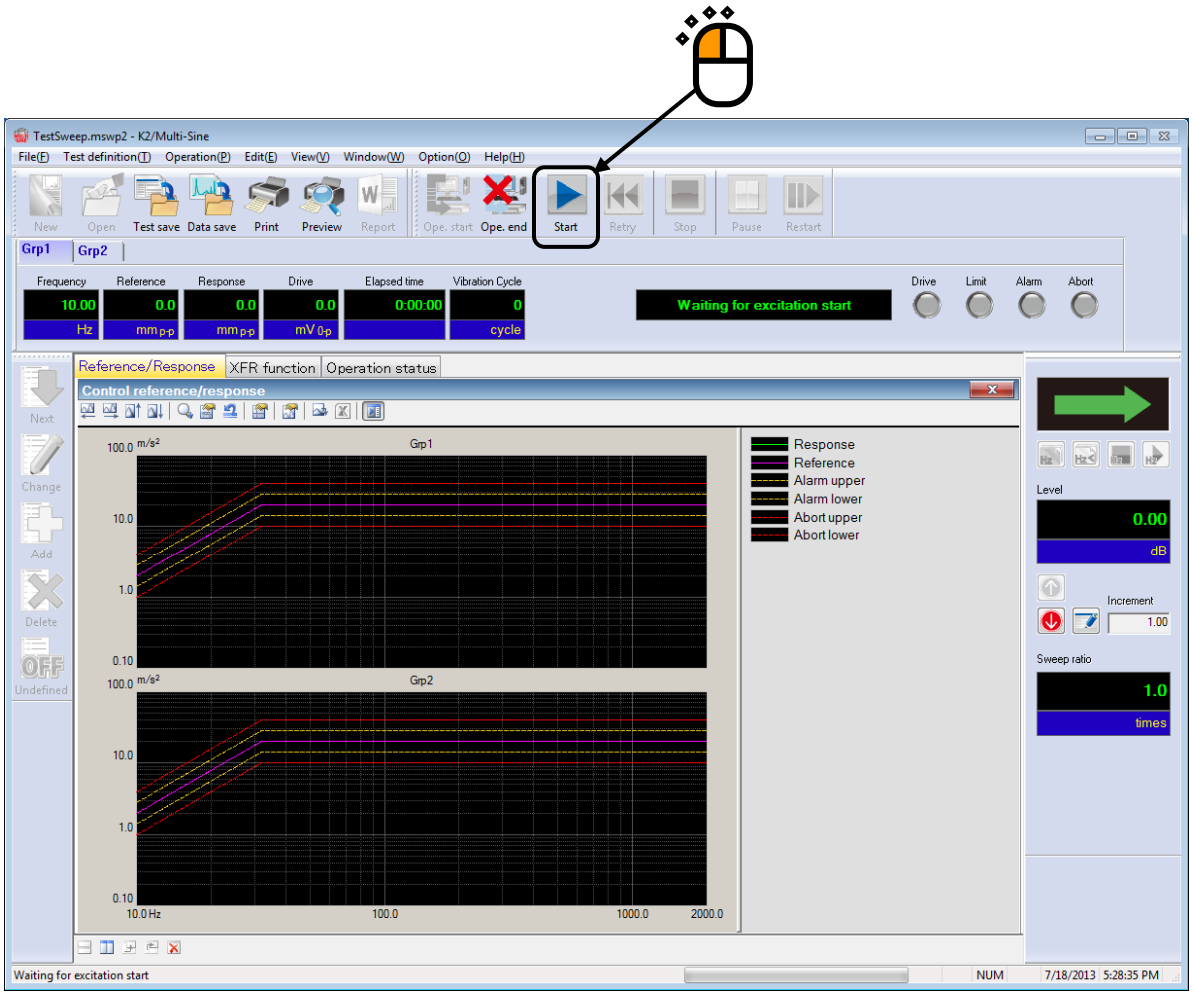
The system proceeds to the state of waiting for excitation start when the XFR measurement is finished.



＜Step 3＞

Press the button of operation start.

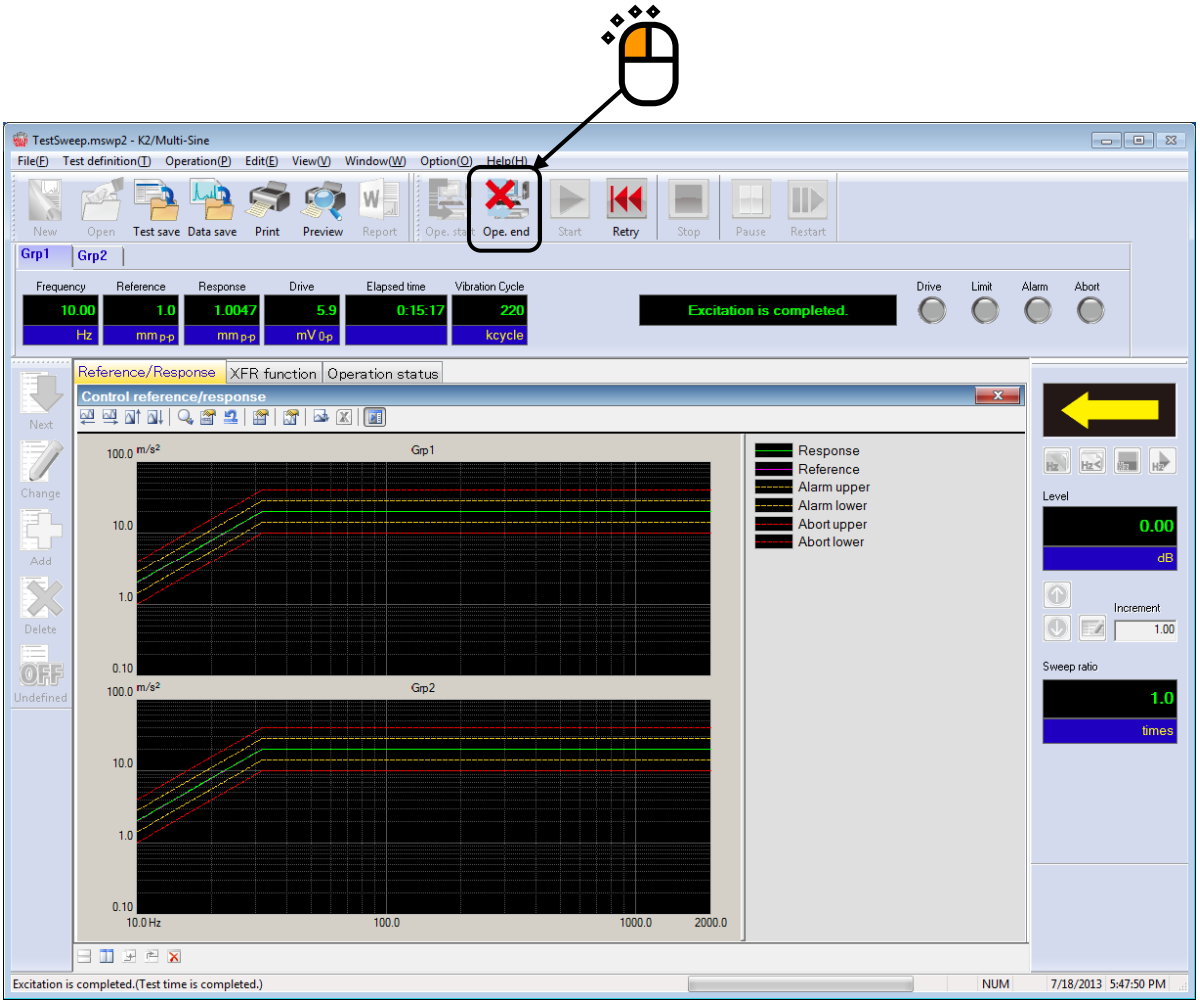
Initial loop check and initial equalization are automatically operated.



< Step 4 >

Test operation is completed when the test time passed.

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

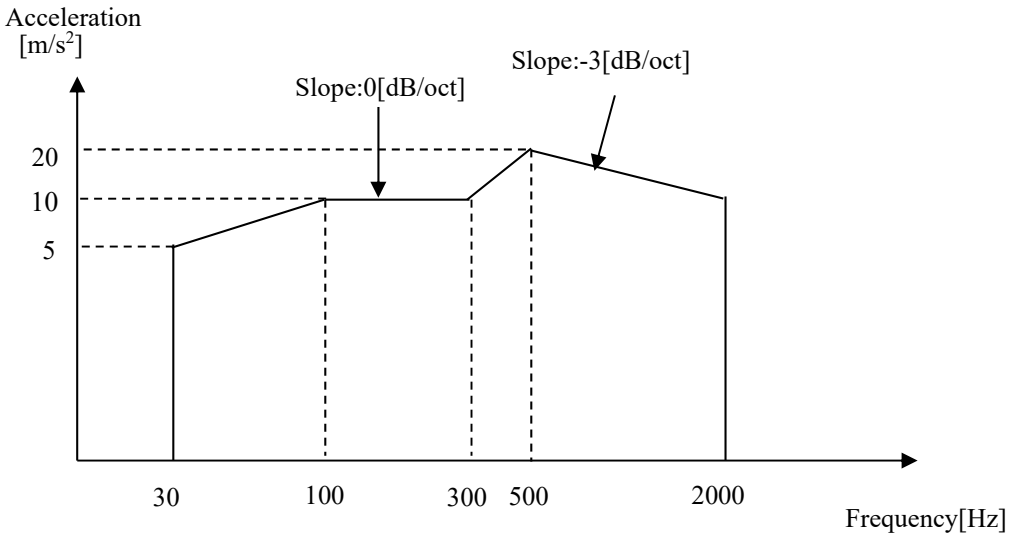


3.2 Sweep (Detailed Definition Break Point)

< Example >

An example of sweep test is described as below ; （two shakers are used）

[Reference pattern]



[Test time]

Sweep rate : 1.000 (octave/min)

The times of double sweep : 1 (double-sweep)

[Information of sensors to be used]

Two acceleration pickups of piezoelectric

ch1. : for Principal Control, sensitivity 3pC/(m/sP^{2P})

ch2. : for Principal Control, sensitivity 3pC/(m/sP^{2P})

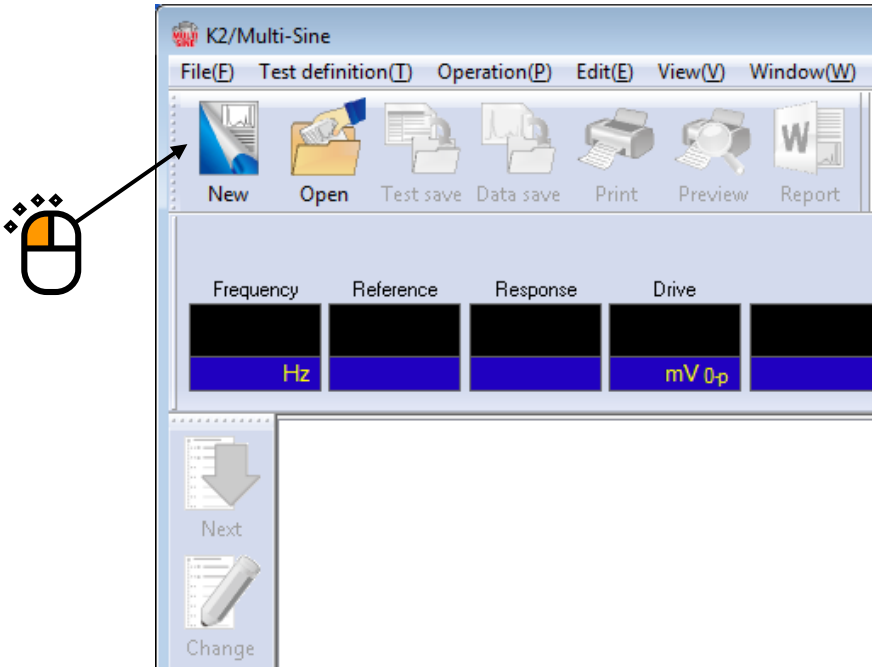
However, these channels must be registered in Input enviroment information (in this example, ‘chtest1’).

Also, the rating information of excitation system has already been registered in Excitation system information (in this example, ‘System1’).

< Procedures >

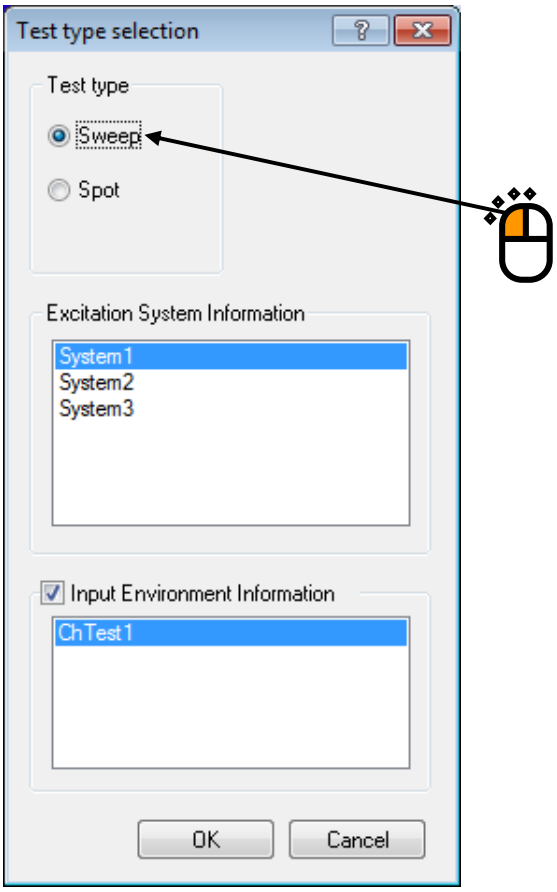
< Step 1 >

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



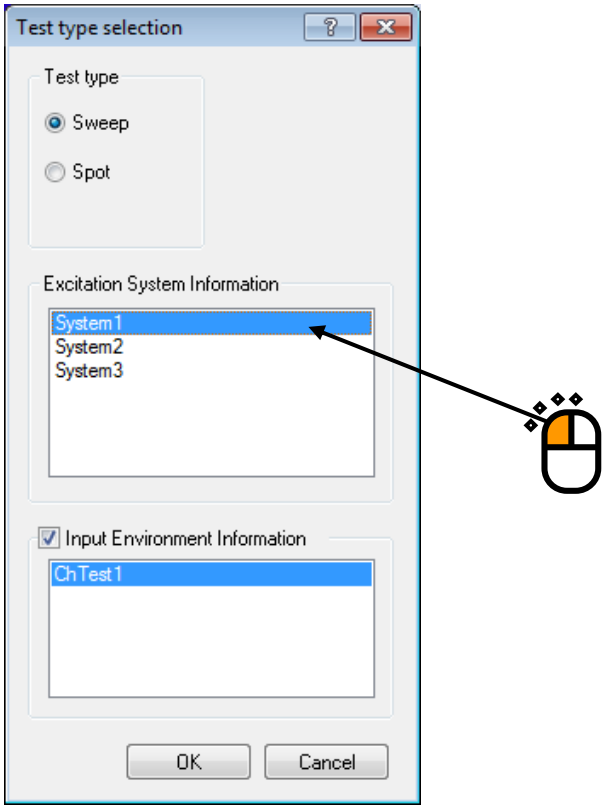
< Step 2 >

Select the item of 'Sweep' in Test type.



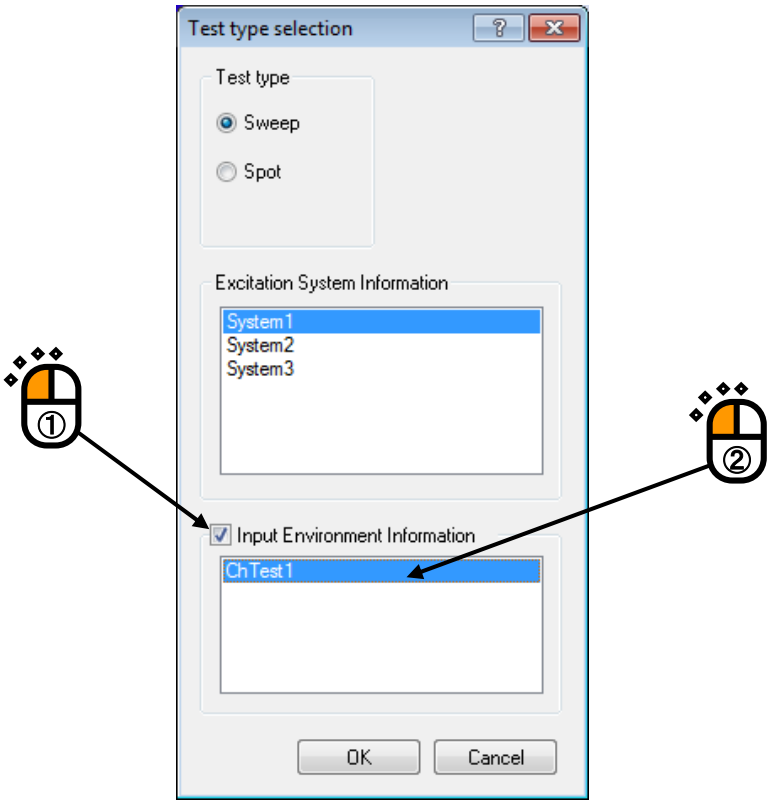
< Step 3 >

Select an excitation system from the list of ‘Excitation System Information’.



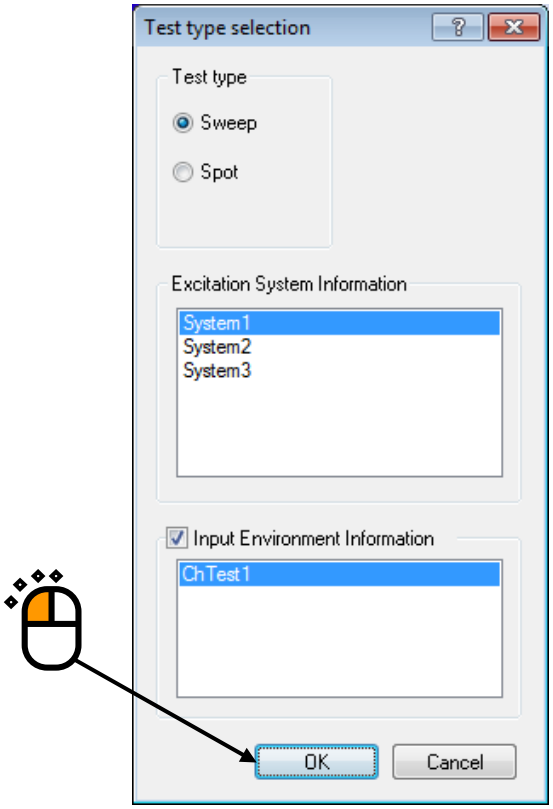
< Step 4 >

Click the checkbox of ‘Input Environment Information’ and select an input environment information from the list.



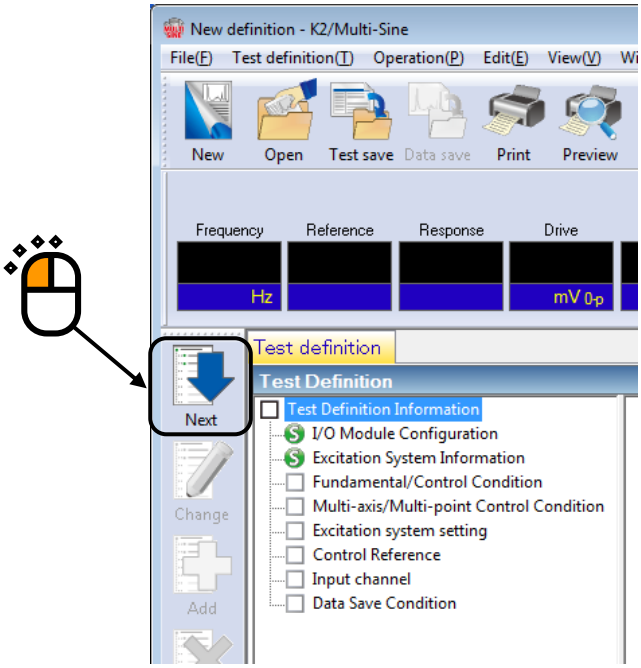
< Step 5 >

Press the [OK] button.



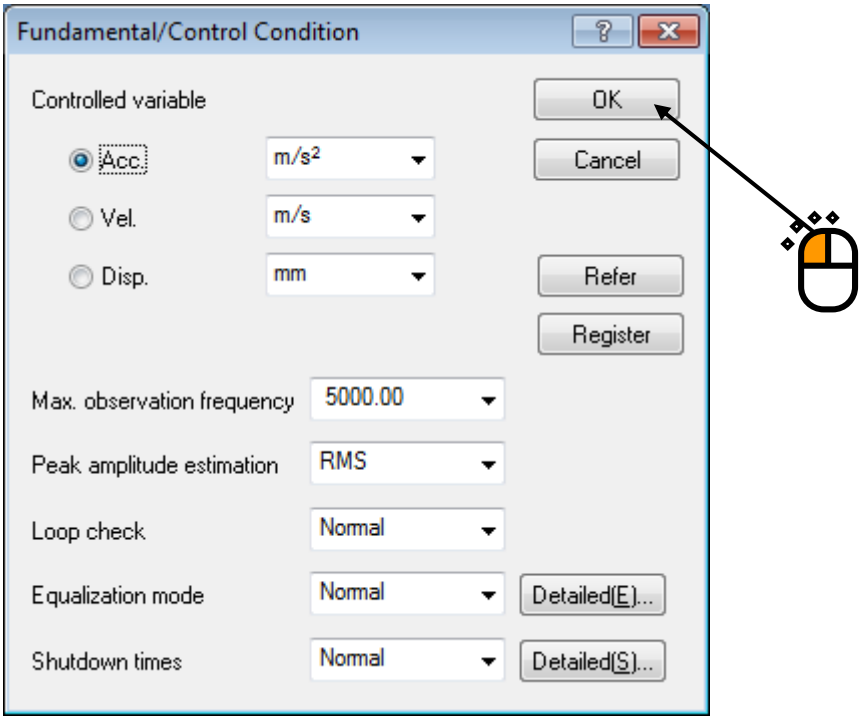
< Step 6 >

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



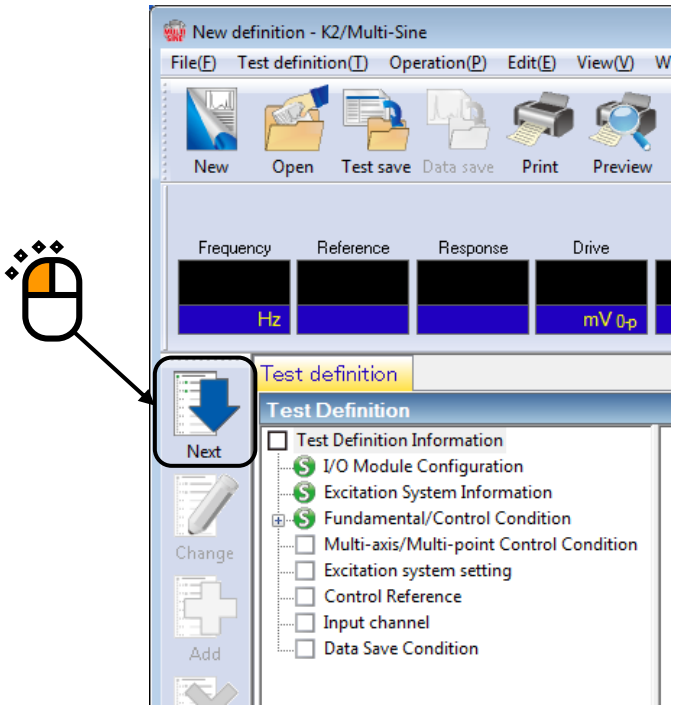
< Step 7 >

Press [OK].



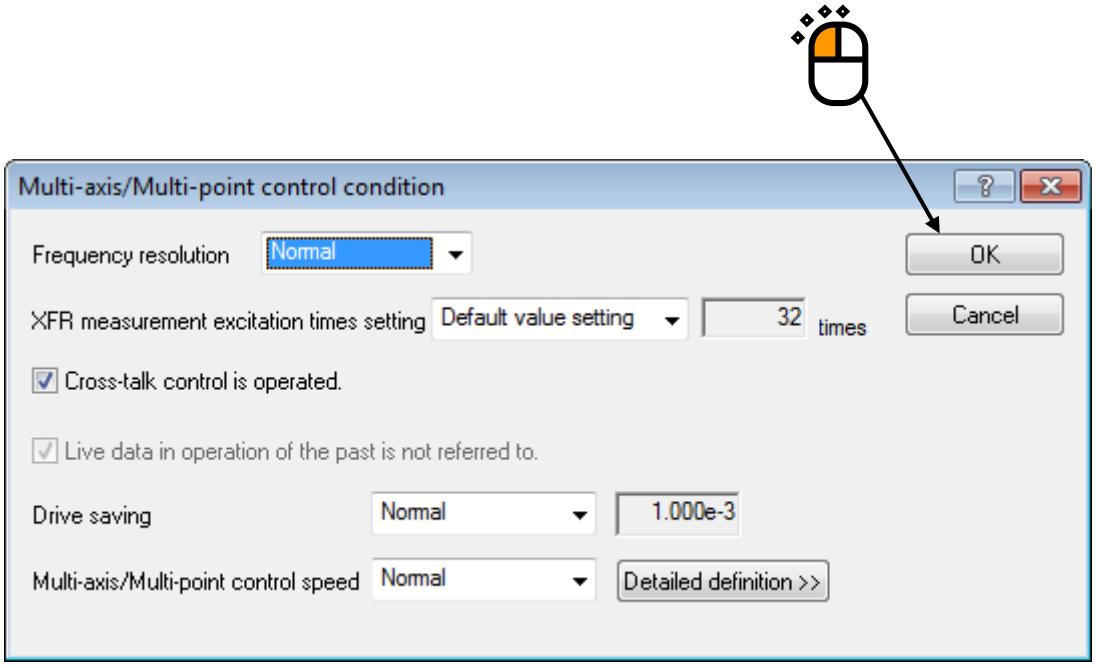
< Step 8 >

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



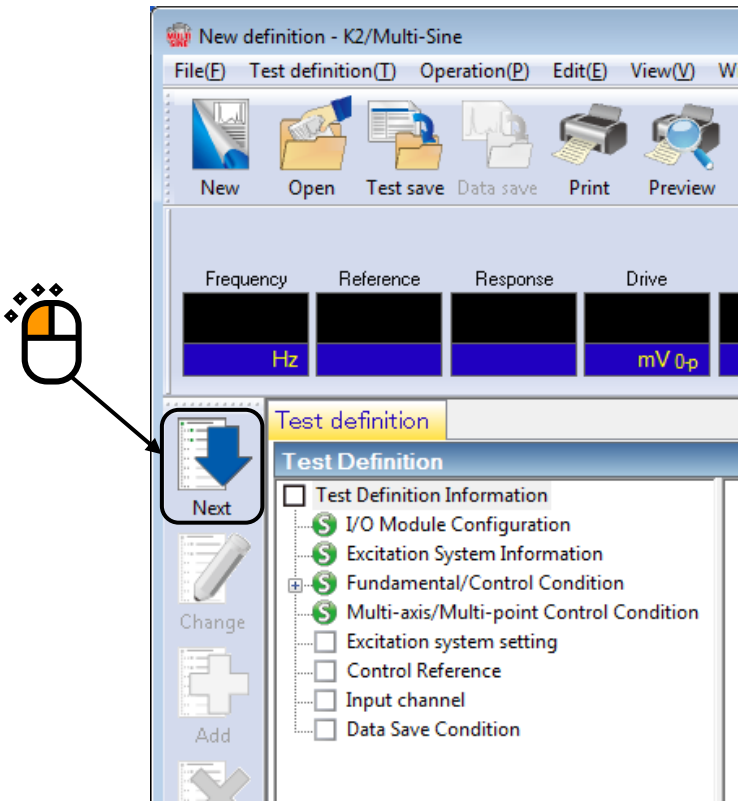
< Step 9 >

Press [OK].



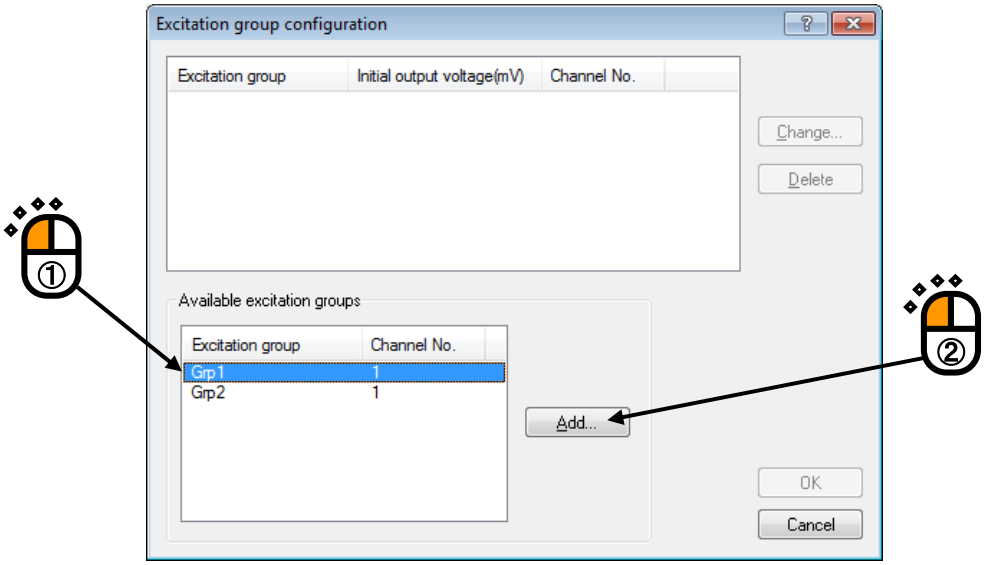
< Step 10 >

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



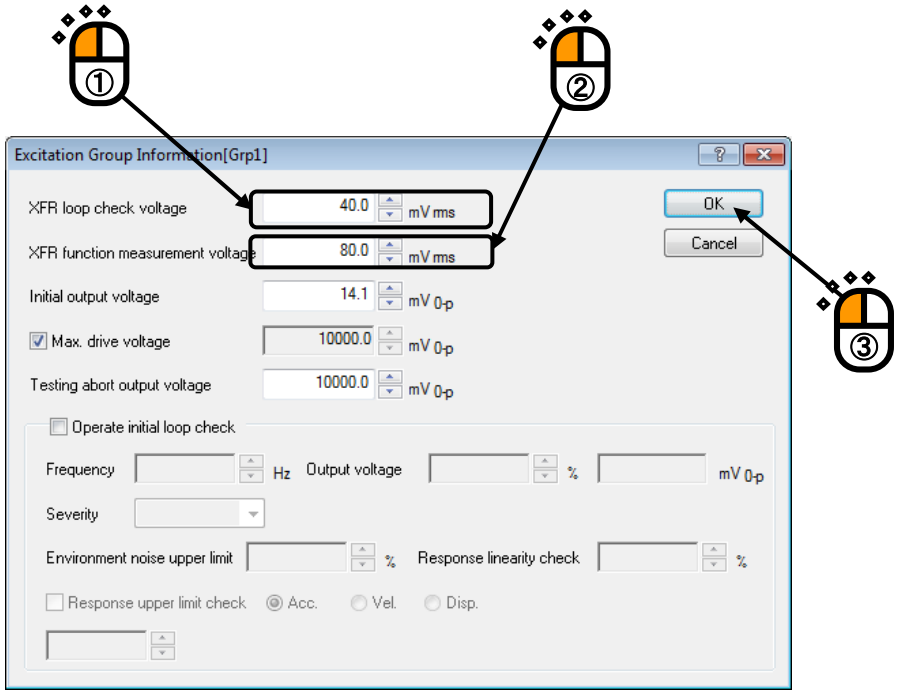
＜Step 11＞

Select an excitation group among the available excitation groups. Here, select ‘Grp1’ and press the button to add.



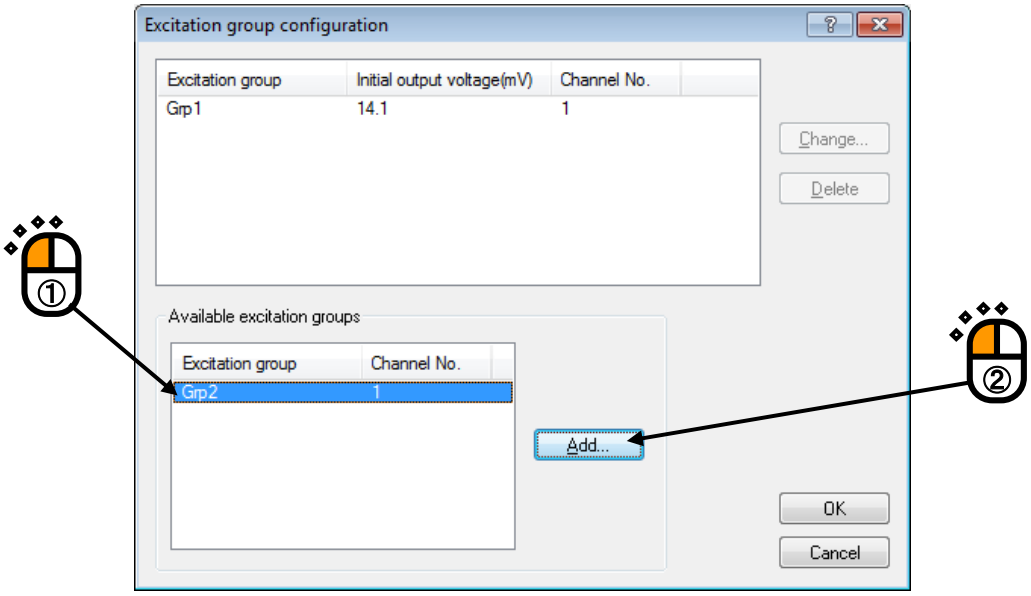
＜Step 12＞

Input the values to ‘XFR loop check voltage‘ as 40 [mVrms].and ‘XFR function measurement voltage’as 80.0 [mVrms]. Then press [OK].



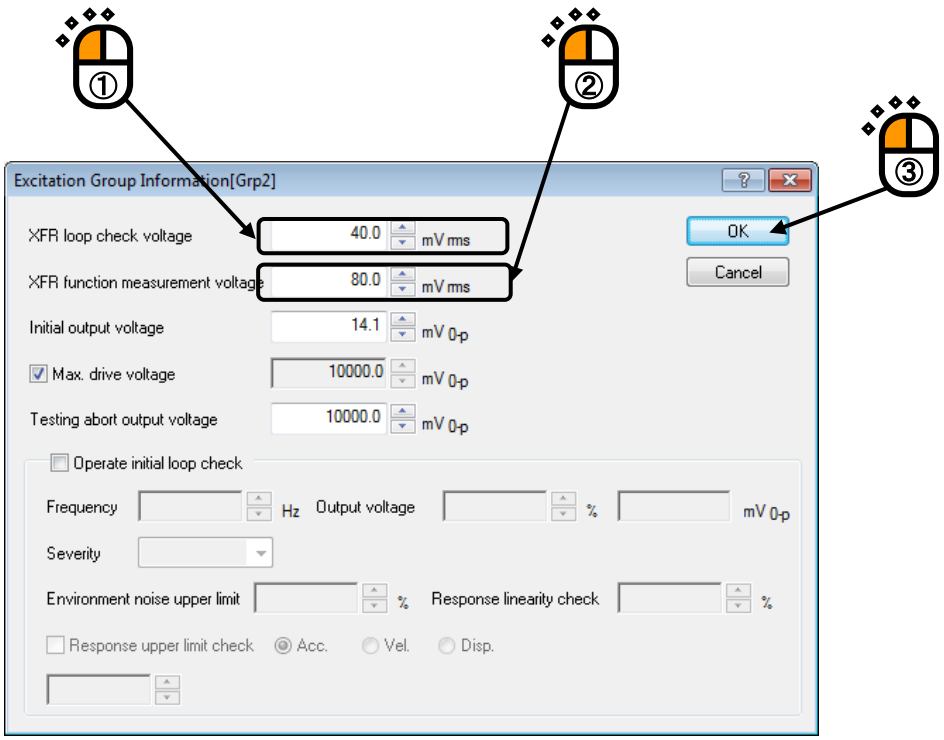
＜Step 13＞

Select an excitation group in the available excitation groups. Here, select ‘Grp2’ and press the button to add.



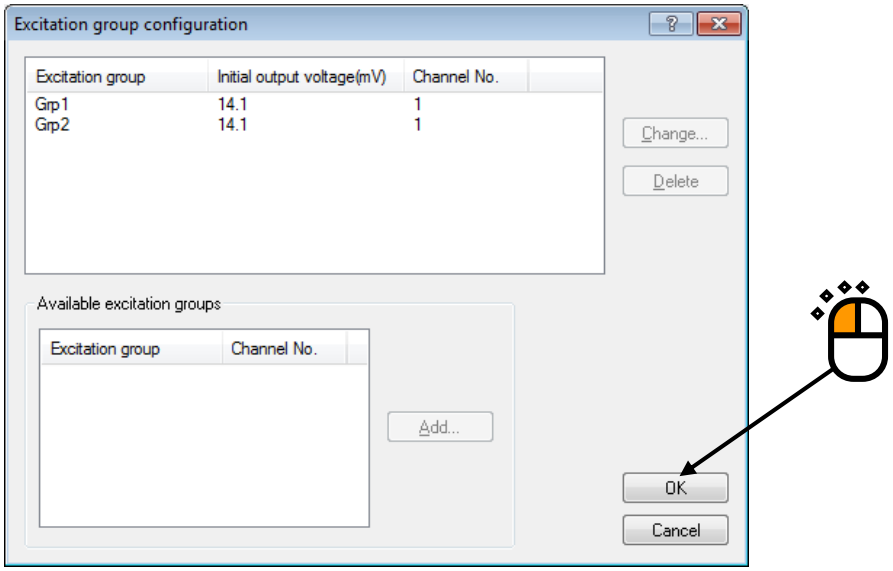
＜Step 14＞

Input the values to ‘XFR loop check voltage‘ as 40 [mVrms].and ‘XFR function measurement voltage’as 80.0 [mVrms]. Then press [OK].



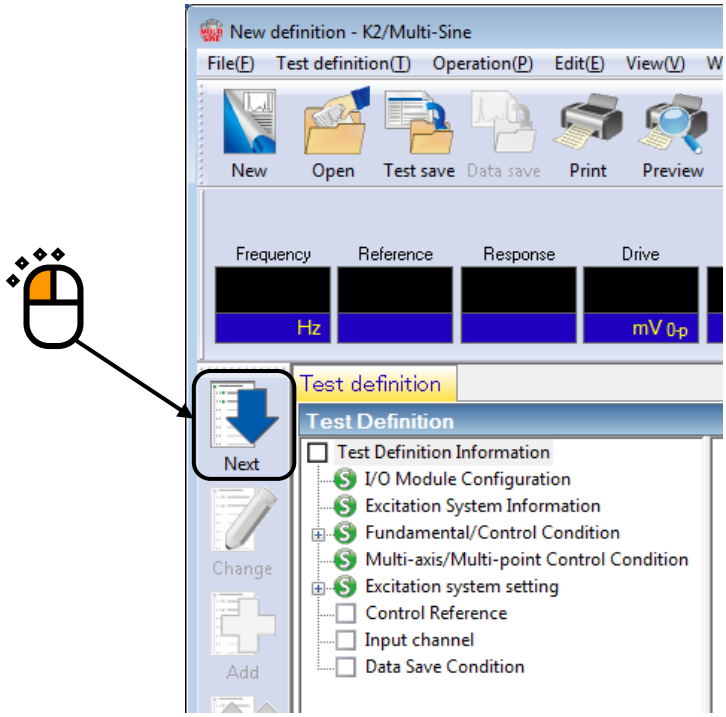
＜Step 15＞

Press [OK].



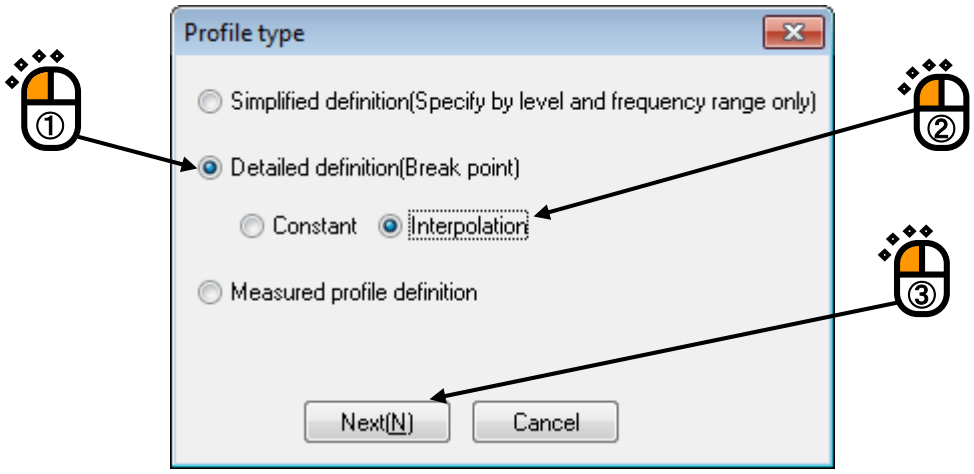
< Step 16 >

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



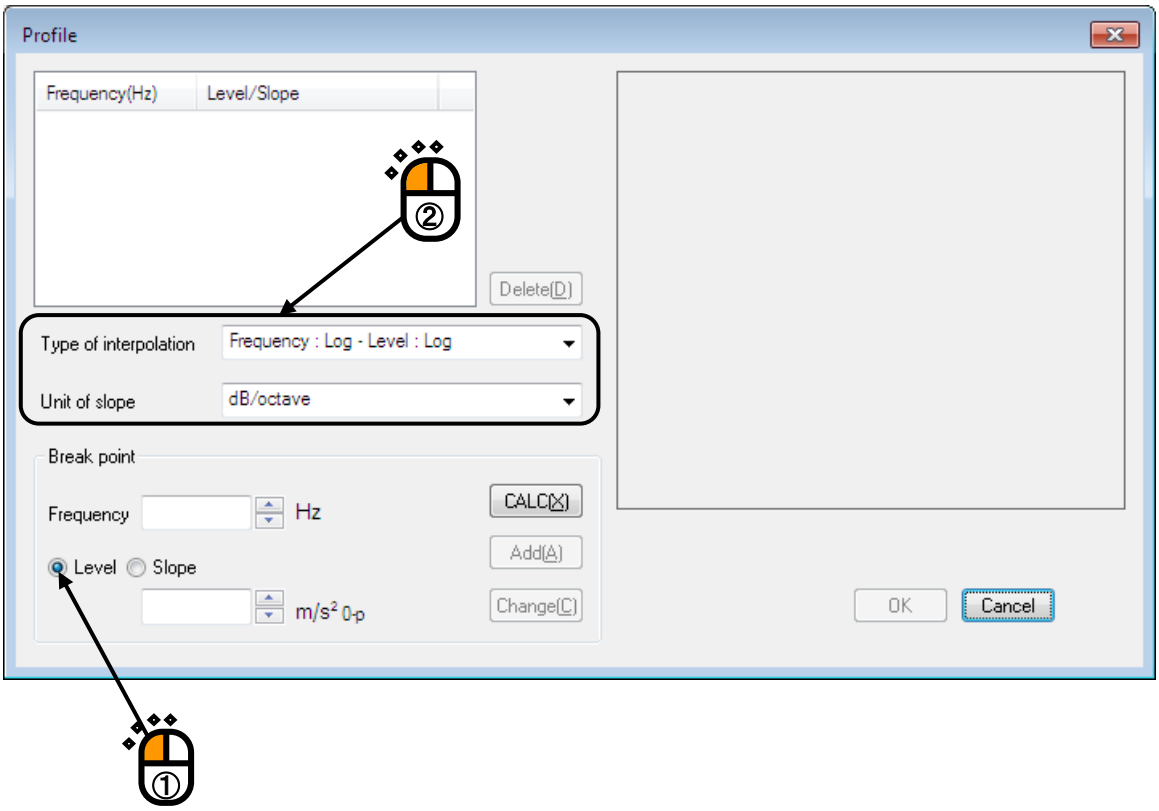
< Step 17 >

Select the item of ‘Detailed definition (Break point)’. And select ‘Interpolation’. Then press [Next].



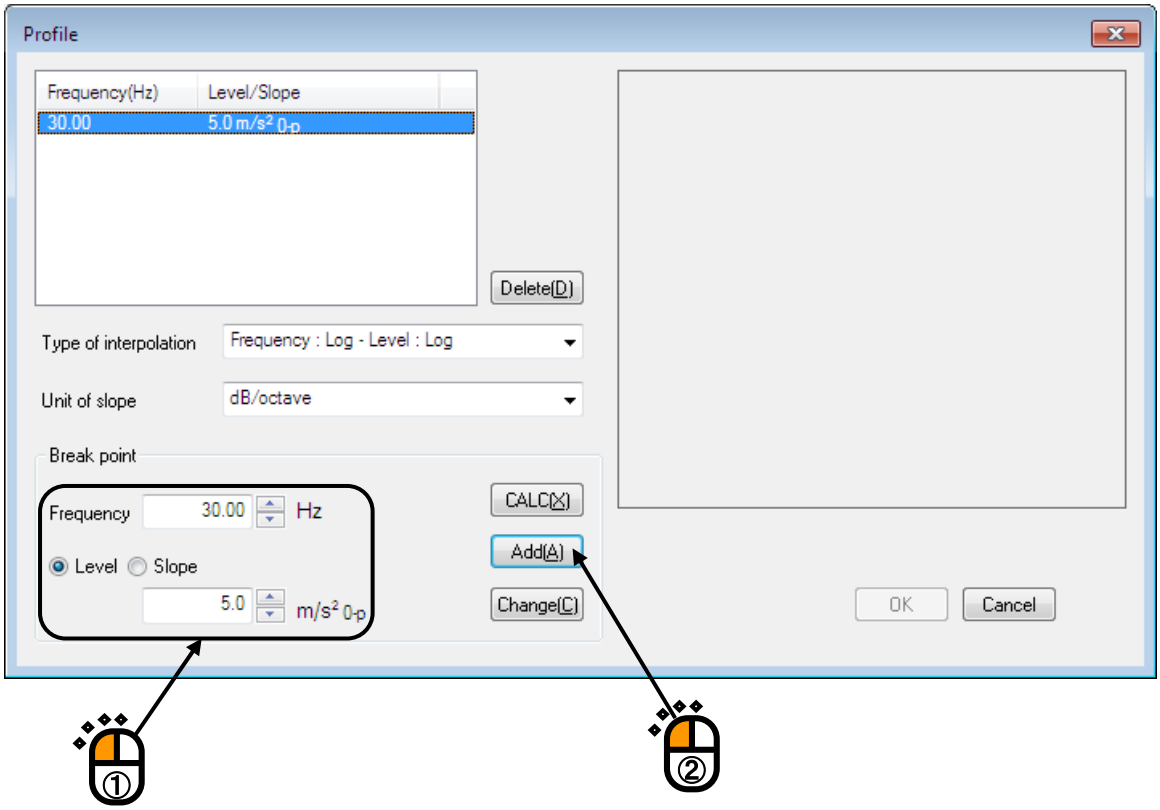
< Step 18 >

Select ‘Level’. Specify Type of interpolation as ‘Frequency : Log – Level : Log’ and Unit of slope as ‘dB/octave’.



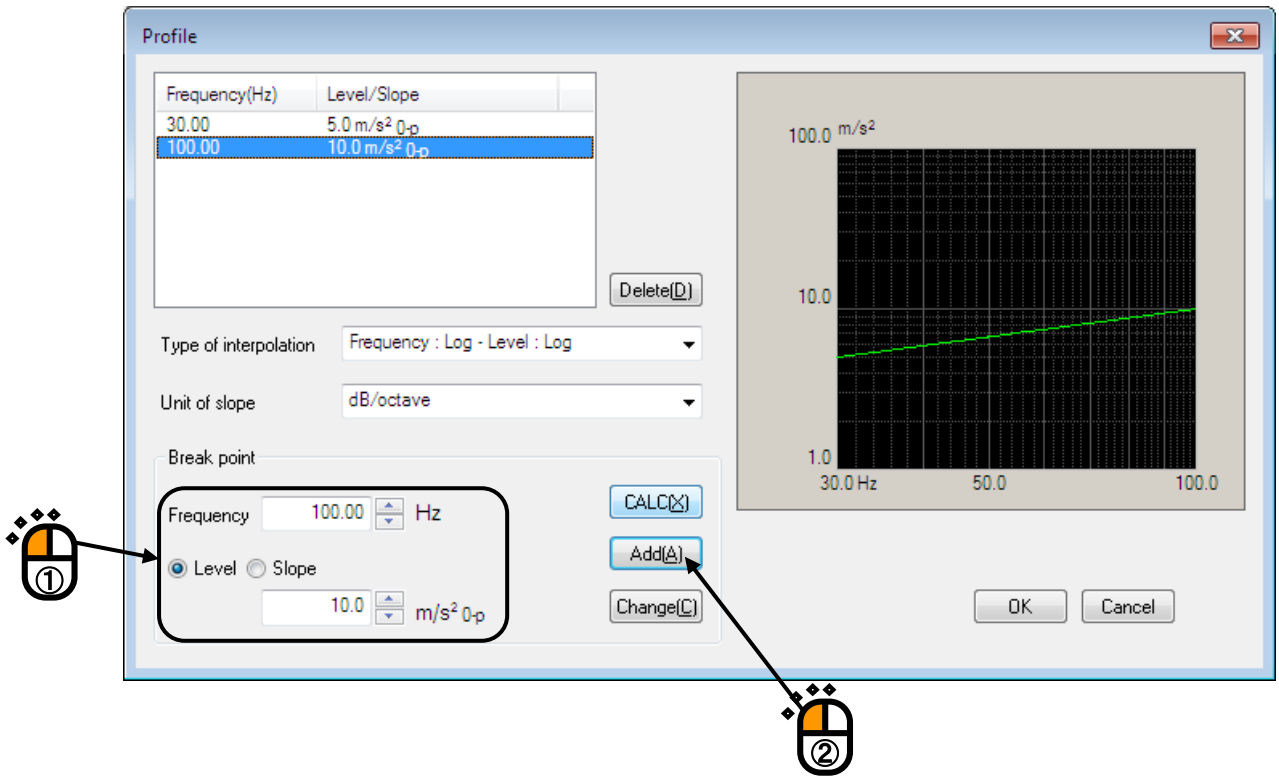
< Step 19 >

Input the values to ‘Frequency’ as 30 [Hz] and ‘Level’ as 5.0 [m/s^2]. And press the [Add] button.



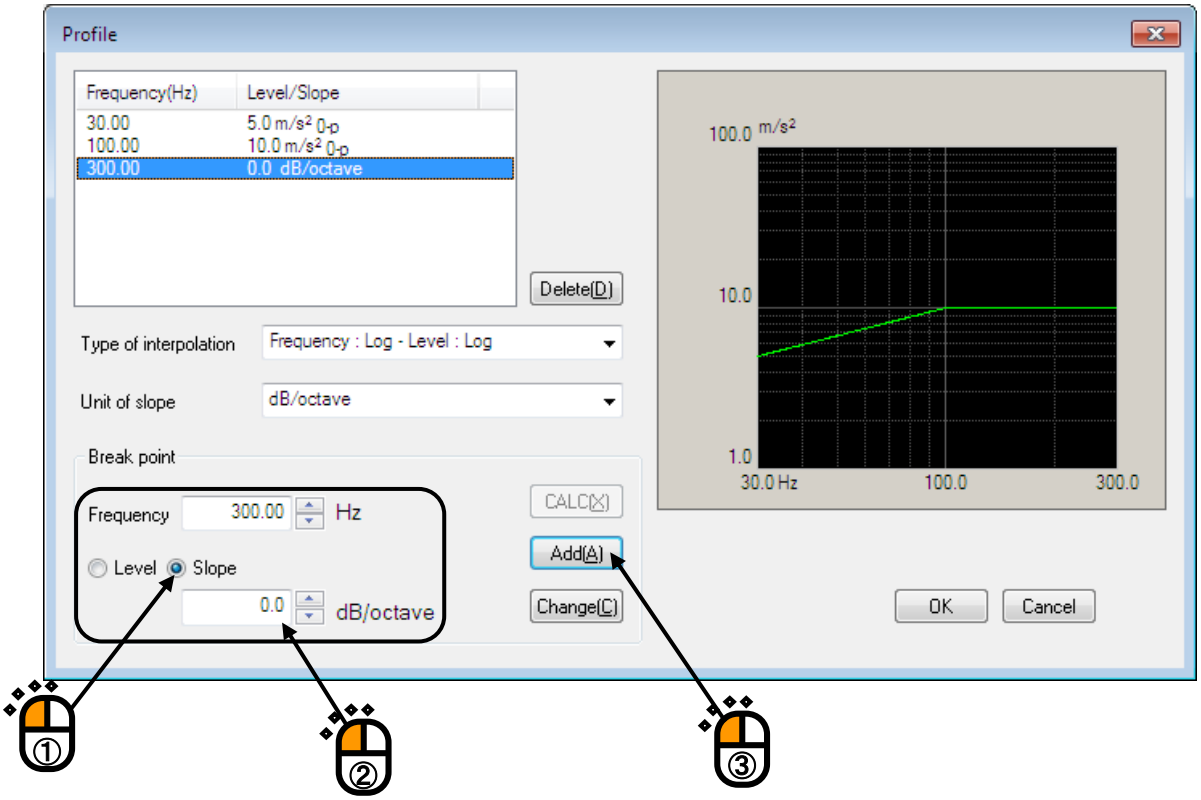
< Step 20 >

Input the values to ‘Frequency’ as 100 [Hz] and ‘Level’ as 10.0 [m/s^2]. And press the [Add] button.



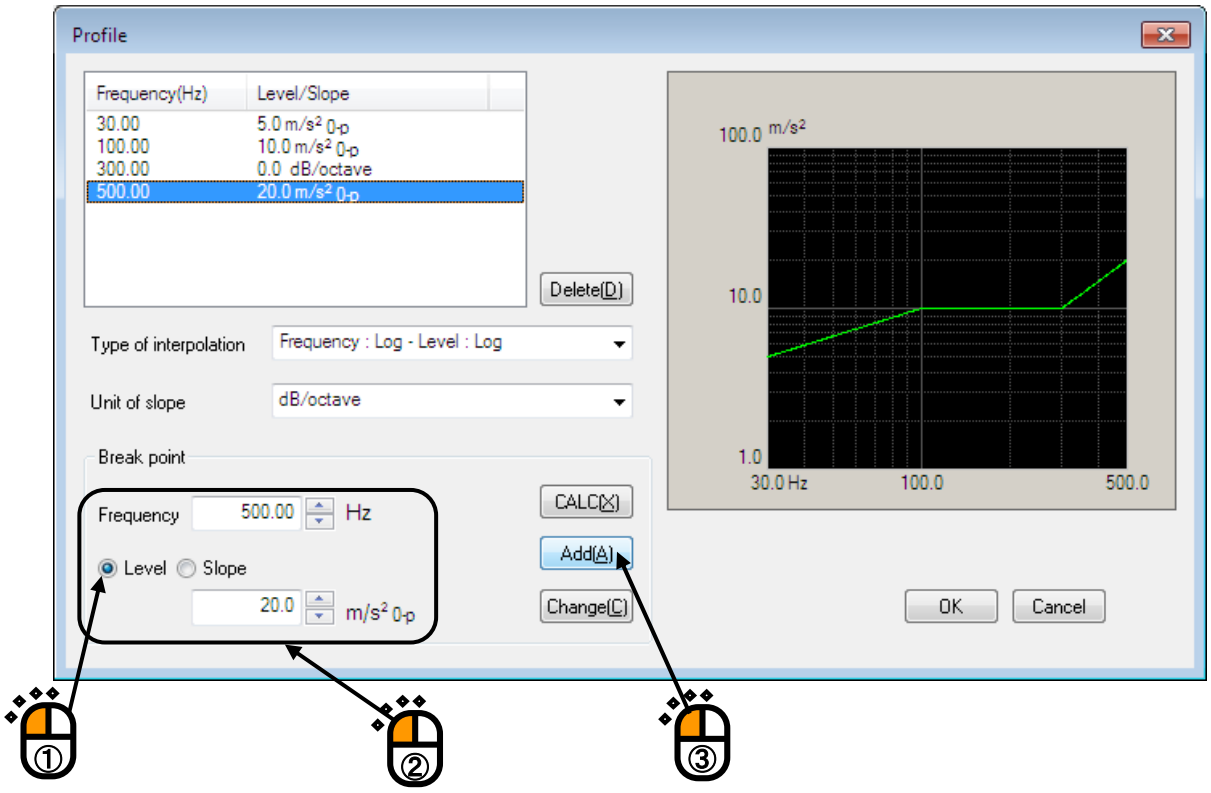
< Step 21 >

Select ‘Slope’. Input the values to ‘Frequency’ as 300 [Hz] and ‘Slope’ as 0.0 [dB/octave]. And press the [Add] button.



< Step 22 >

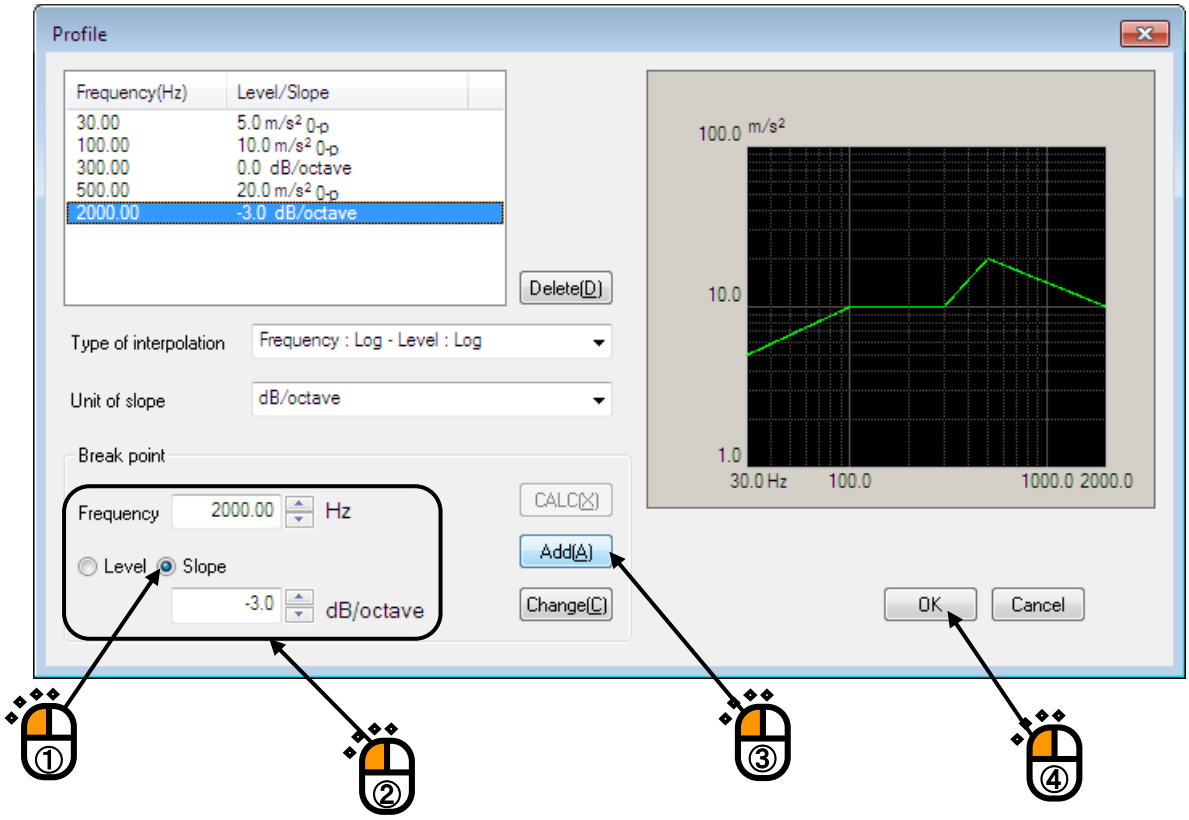
Select ‘Level’. Input the values to ‘Frequency’ as 500 [Hz] and ‘Level’ as 20.0 [m/s^2]. And press the [Add] button.



< Step 23 >

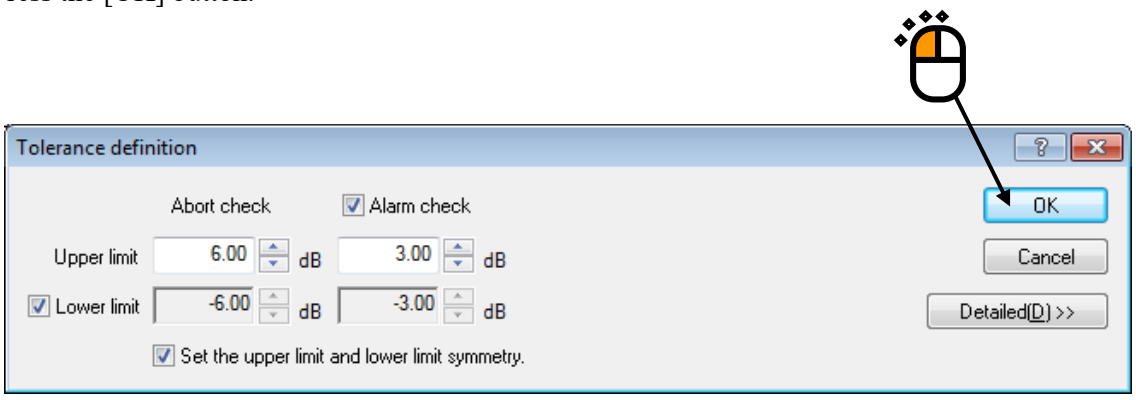
Select ‘Slope’. Input the values to ‘Frequency’ as 2000 [Hz] and ‘Slope’ as -3.0 [dB/octave]. And press the [Add] button.

Then press [OK].



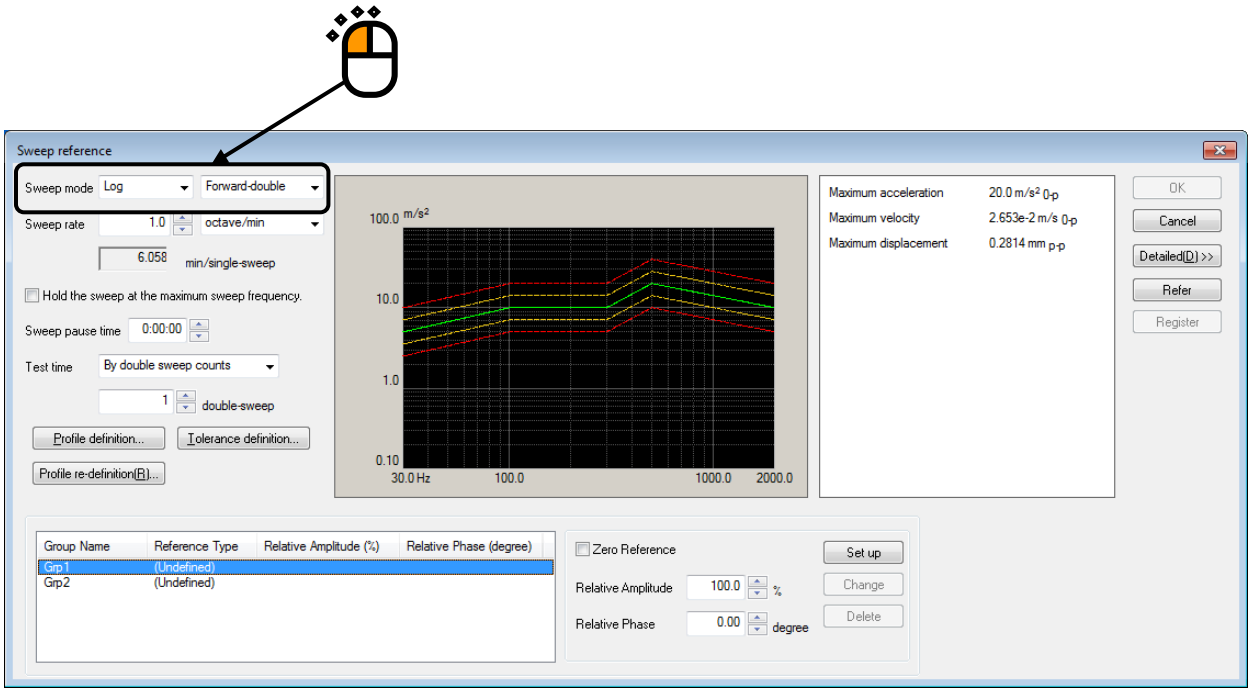
< Step 24 >

Press the [OK] button.



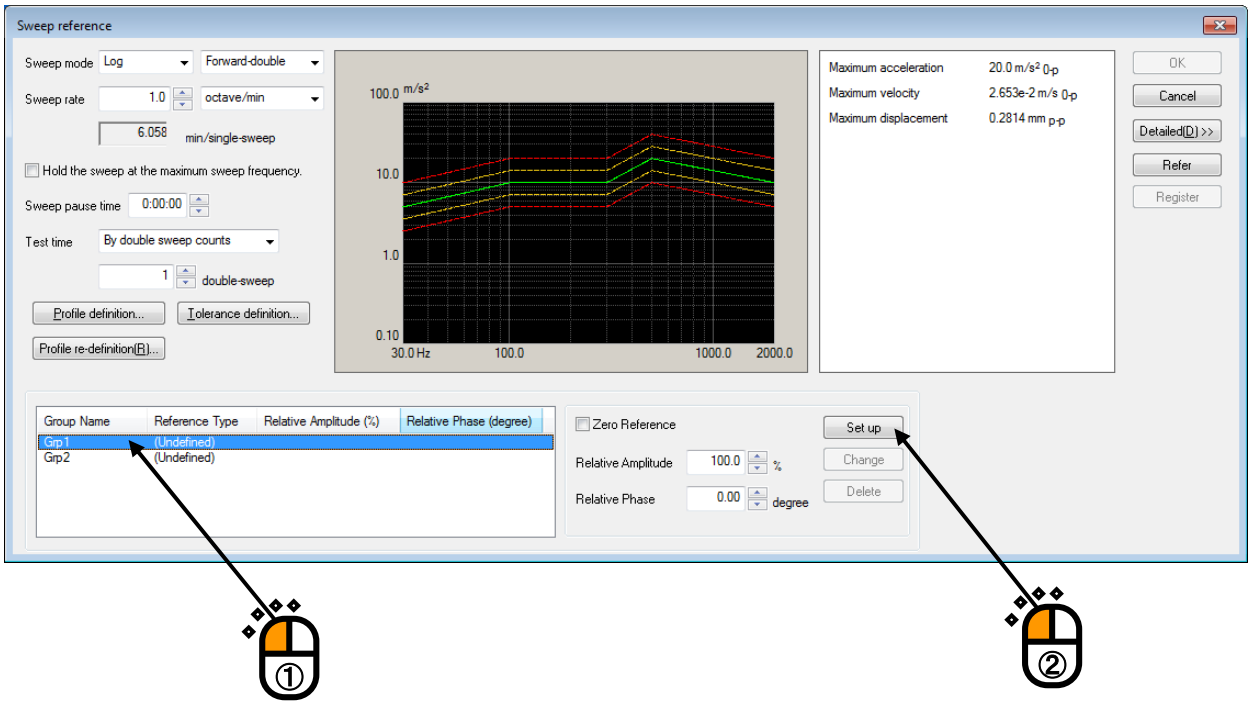
< Step 25 >

Input the value to ‘Sweep rate’ as 1.000 [octave/min].



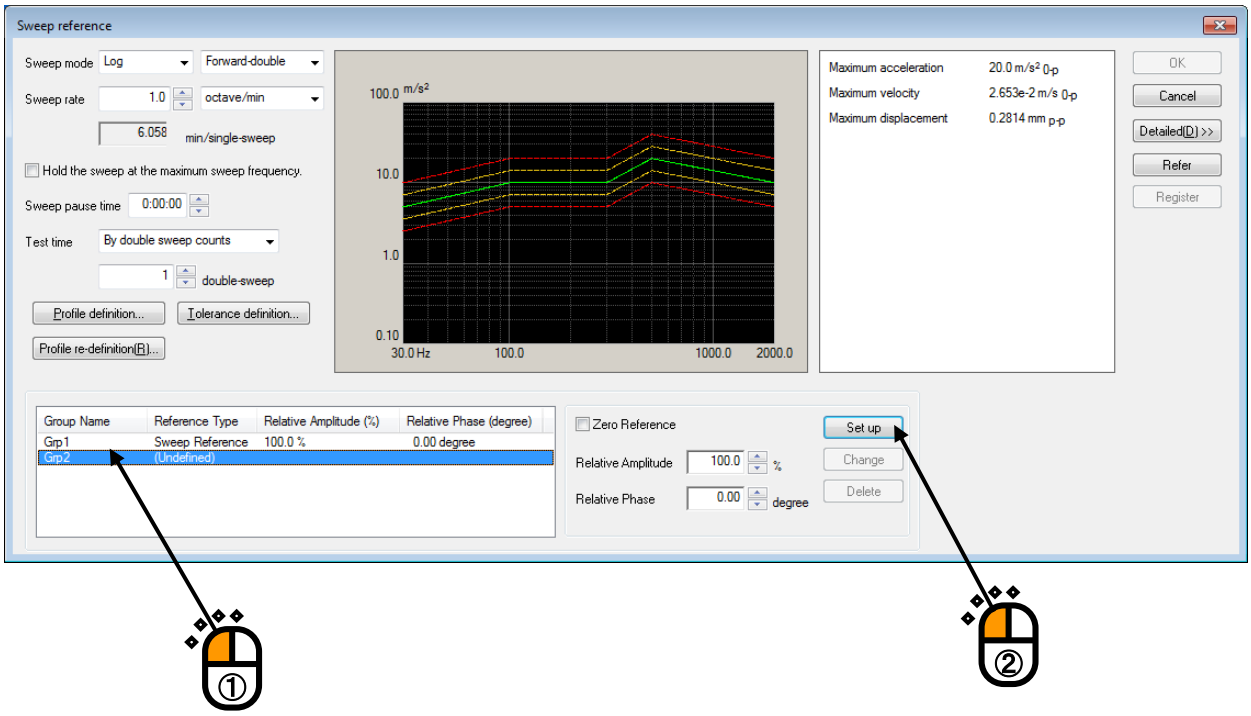
＜Step 26＞

Select a group name, ‘Grp1’. Then press the definition button.



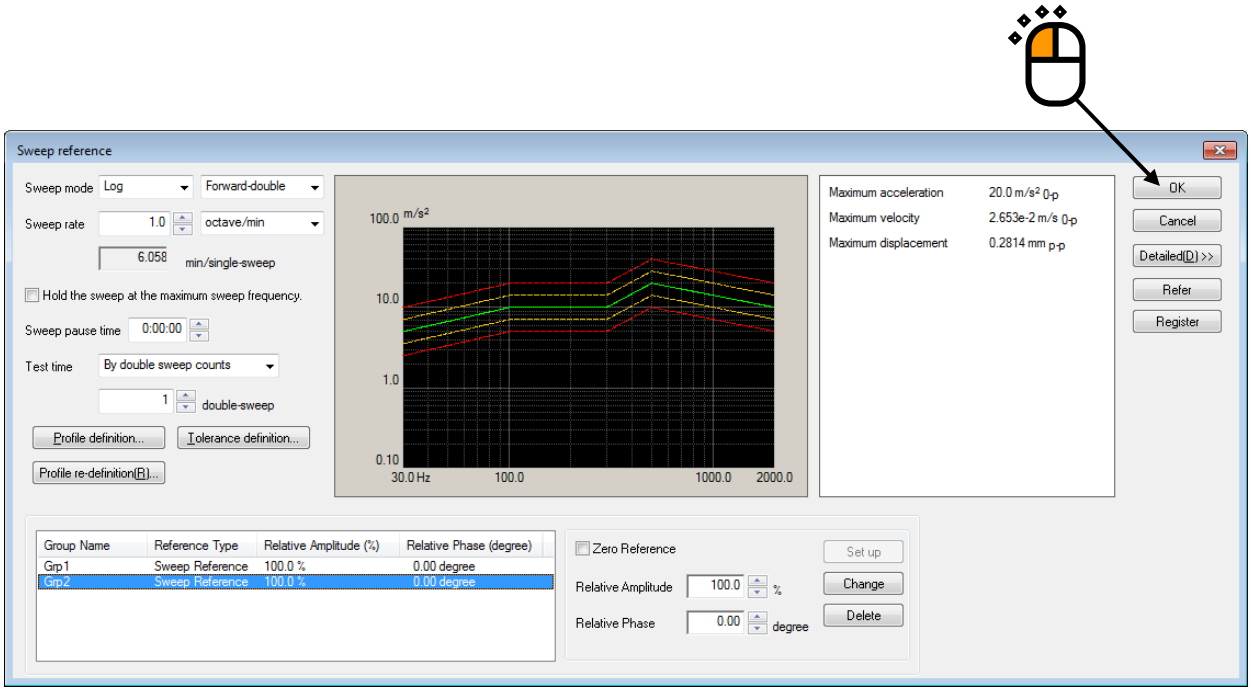
＜Step 27＞

Select a group name, ‘Grp2’. Then press the definition button.



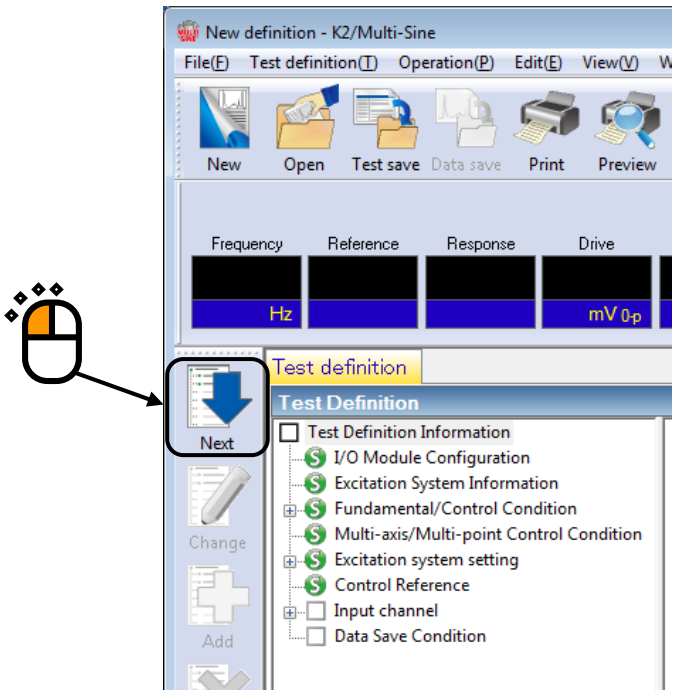
< Step 28 >

Press [OK].



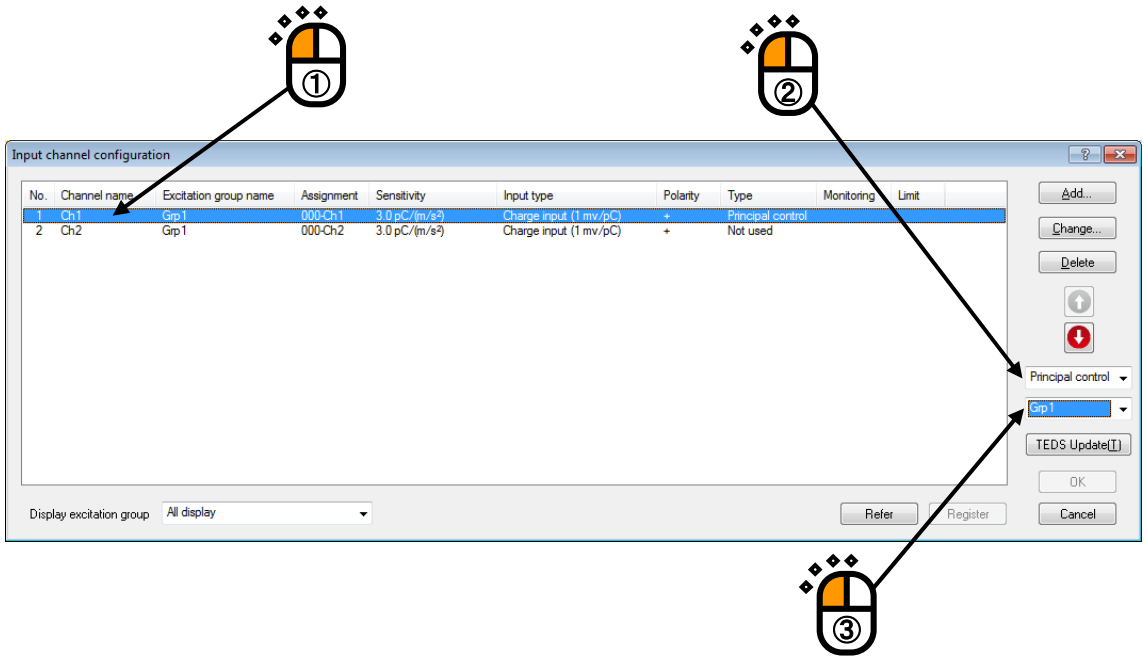
< Step 29 >

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



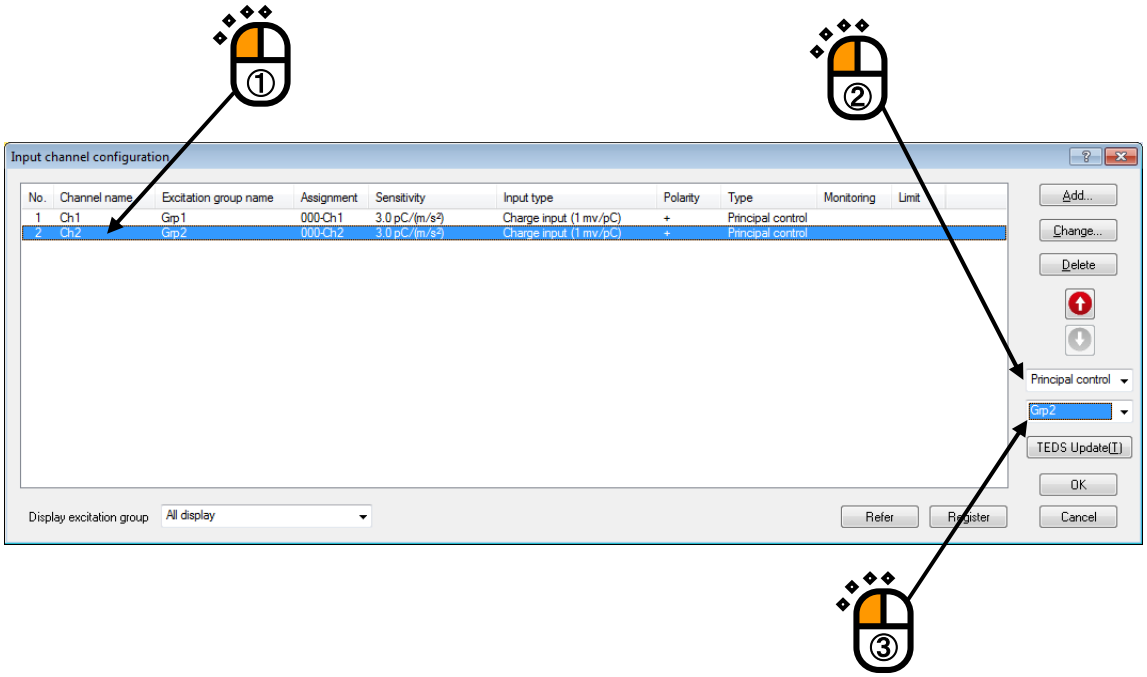
＜Step 30＞

Select a channel name, ‘Ch1’ in the list of input channels. Then Set the channel type to Principal Control and the excitation group to ‘Grp1’



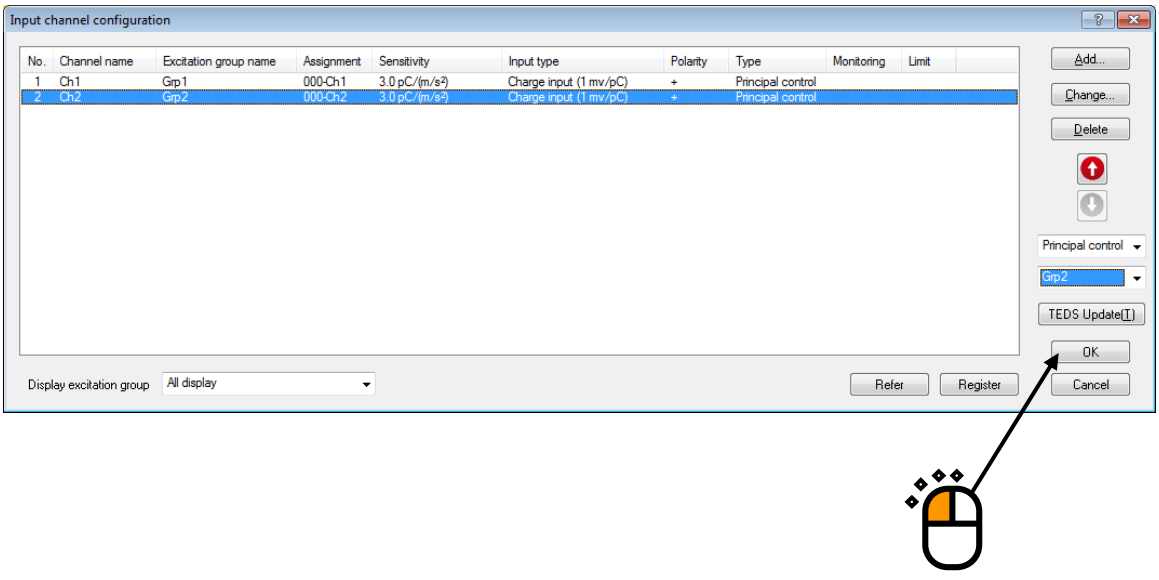
＜Step 31＞

Select a channel name, ‘Ch2’ in the list of input channels. Then Set the channel type to Principal Control and the excitation group to ‘Grp2’



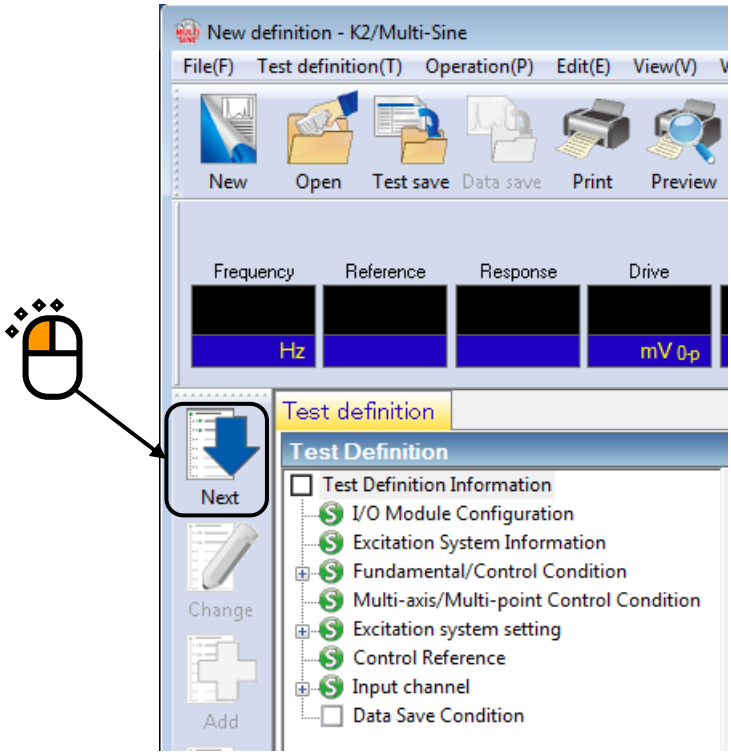
< Step 32 >

Press [OK].



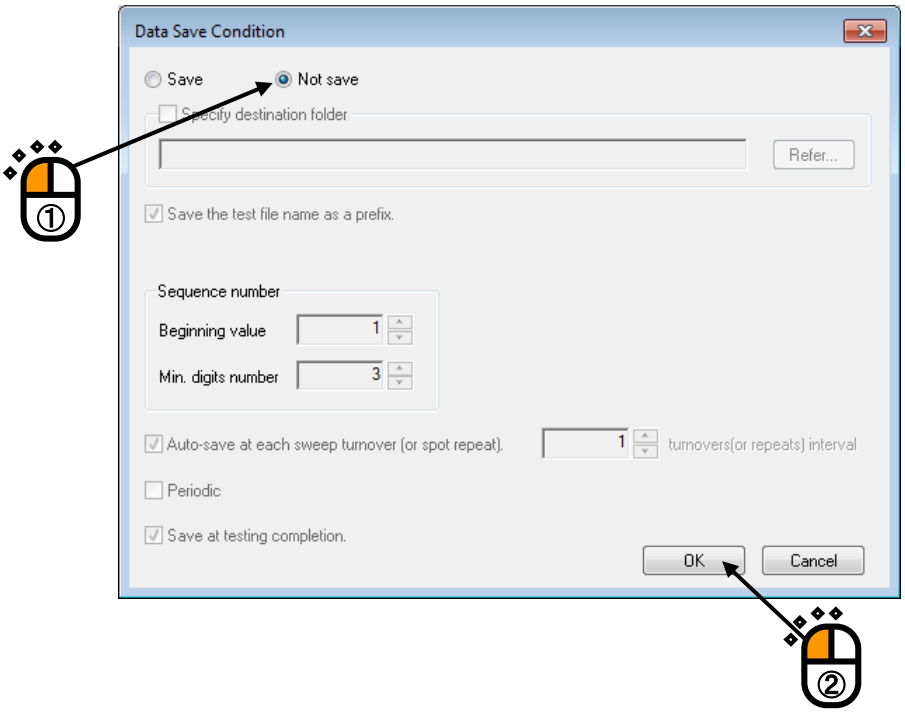
< Step 33 >

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



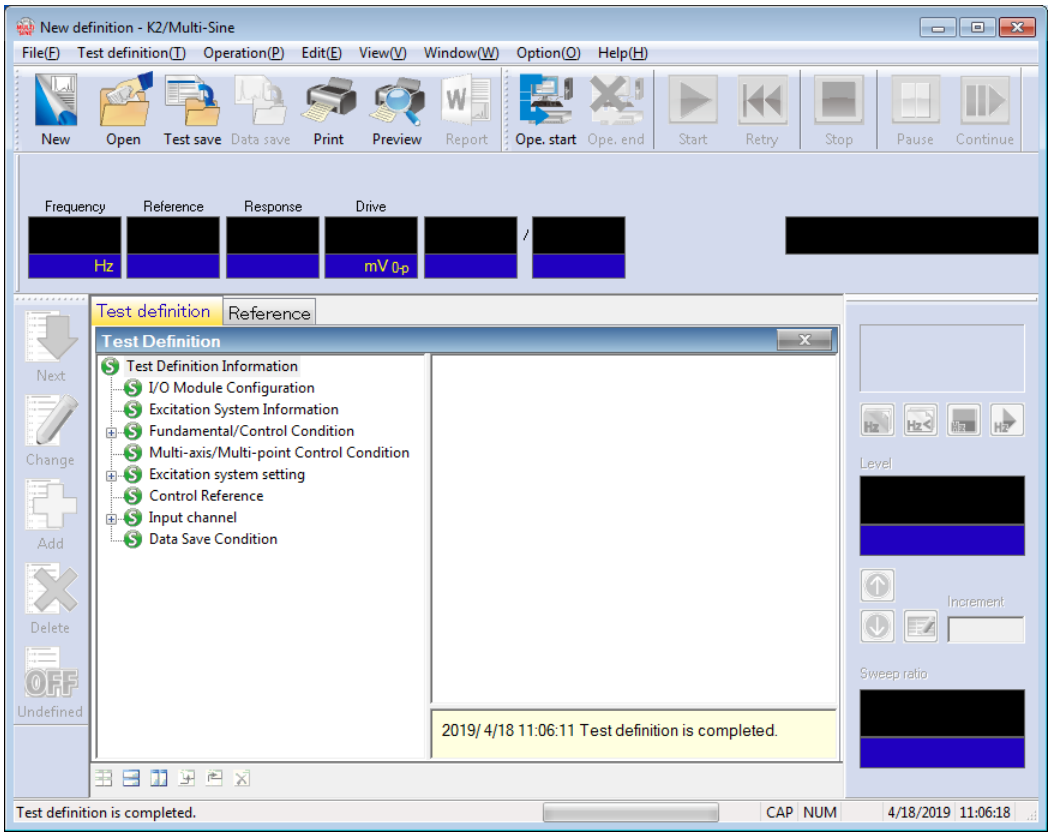
< Step34 >

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



< Step35 >

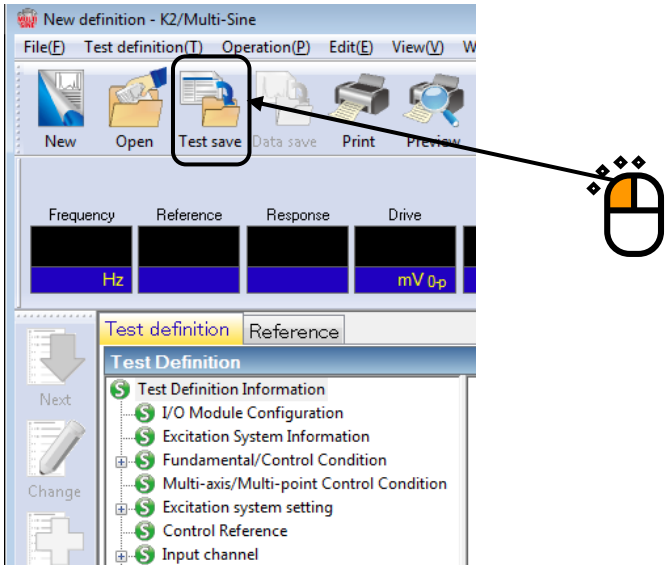
The definition is completed.



< Save test >

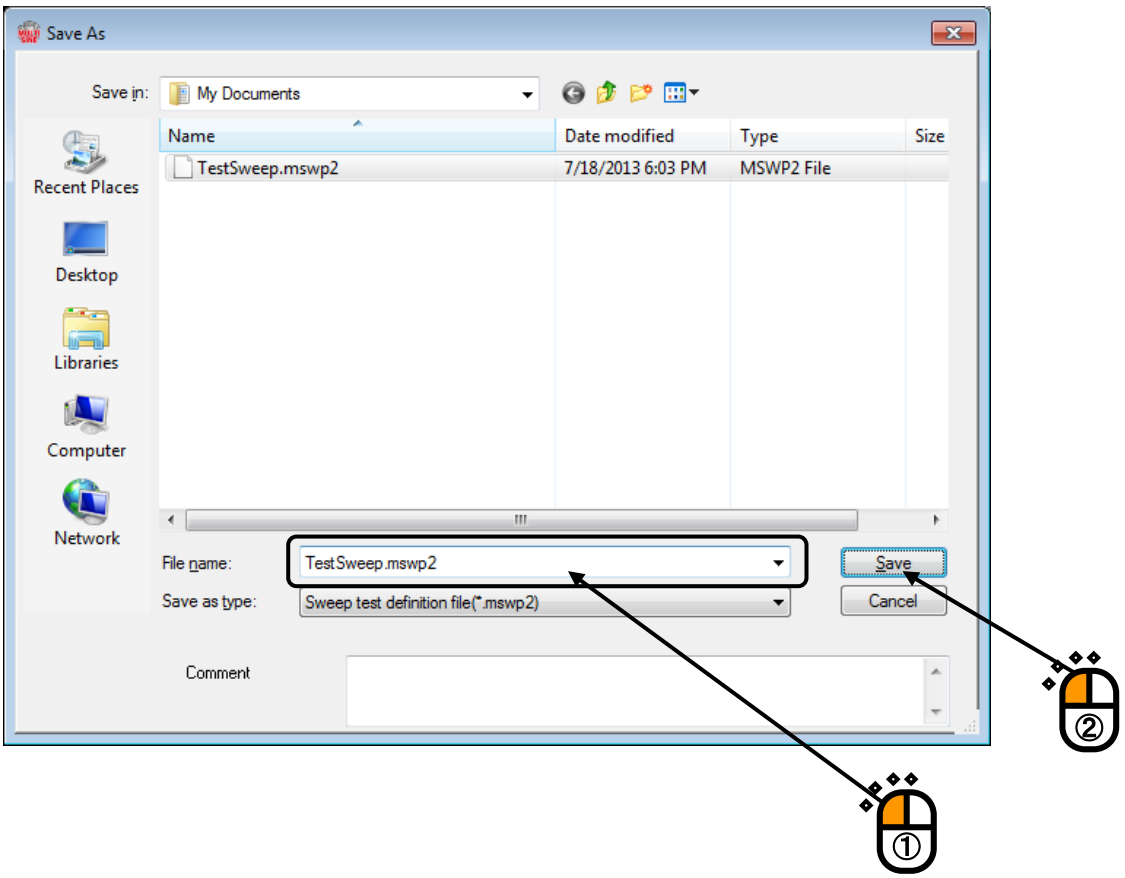
< Step 1 >

Press the button of [Test Save].



< Step 2 >

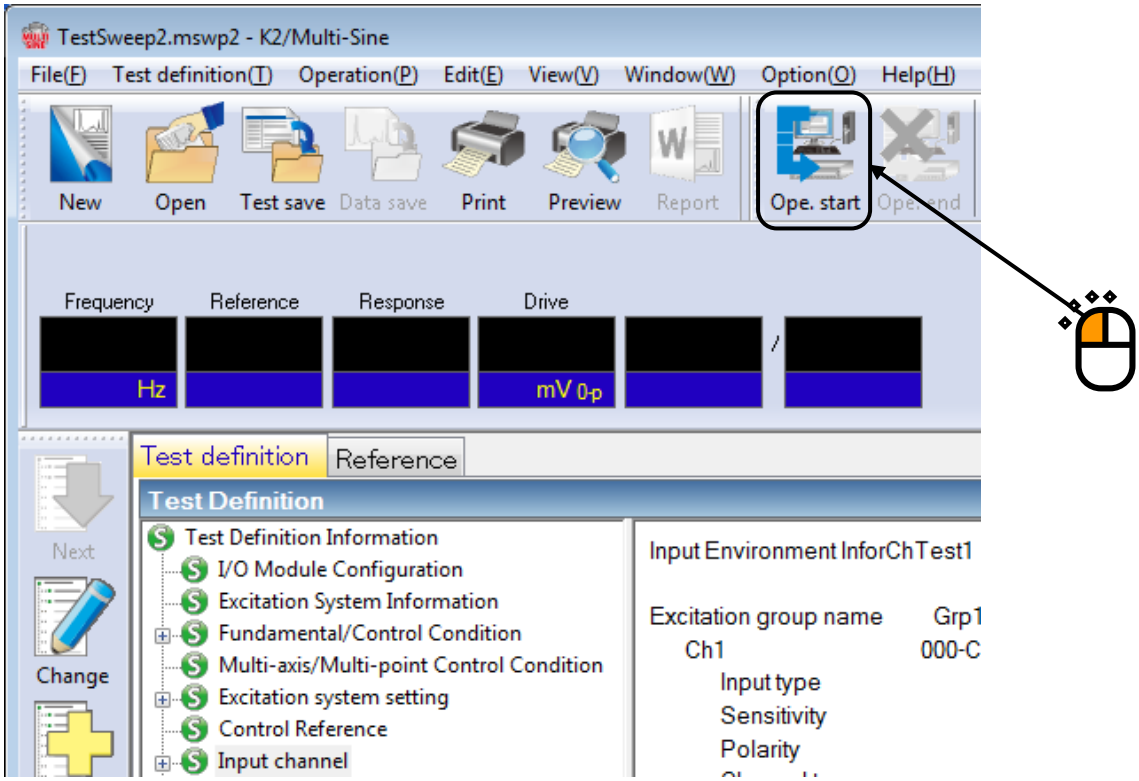
Input a name in 'File name' and press [Save].



< Operation of test >

< Step 1 >

Press the button of [Operation start].

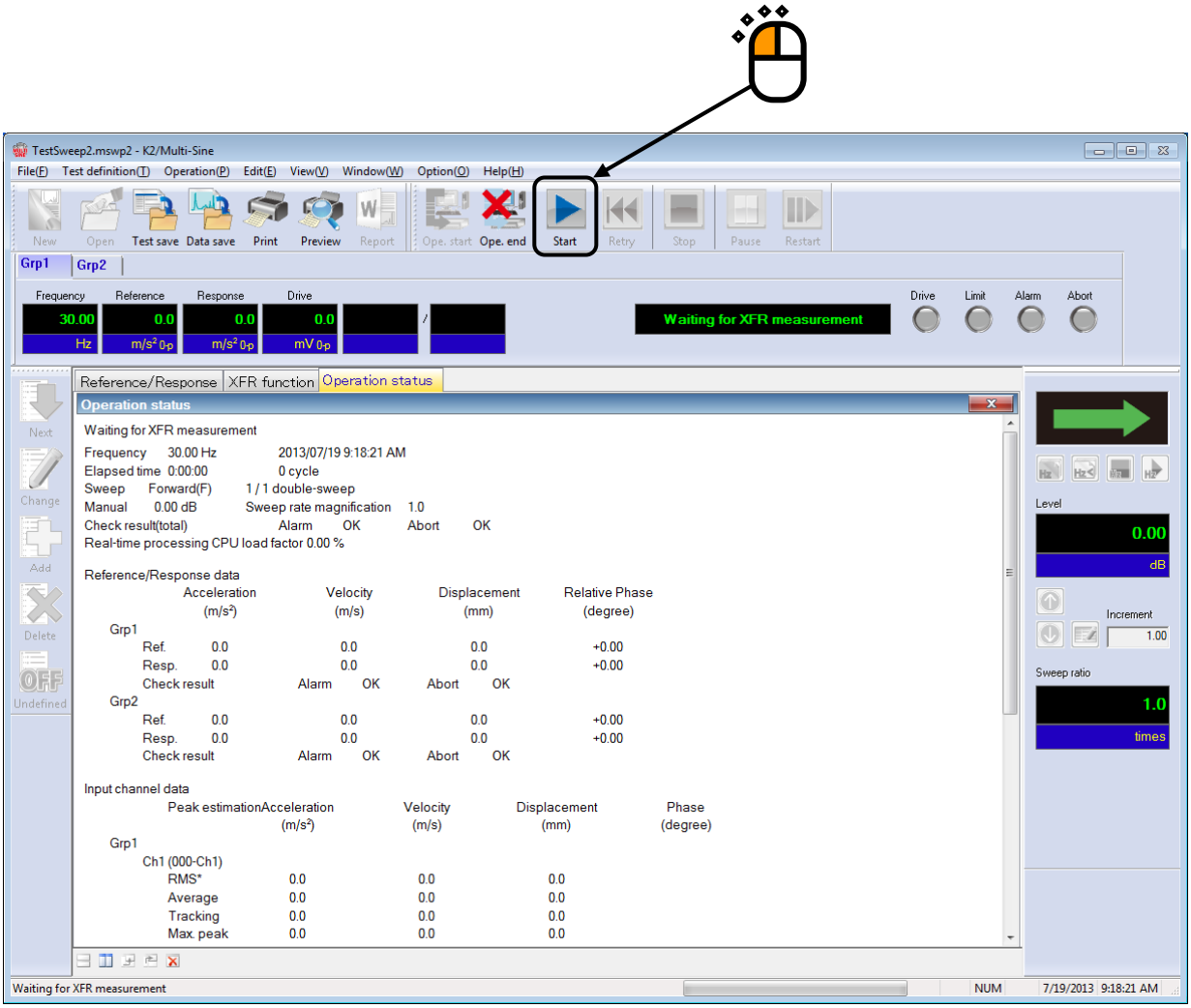


＜Step 2＞

Press the button of XFR measurement start.

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

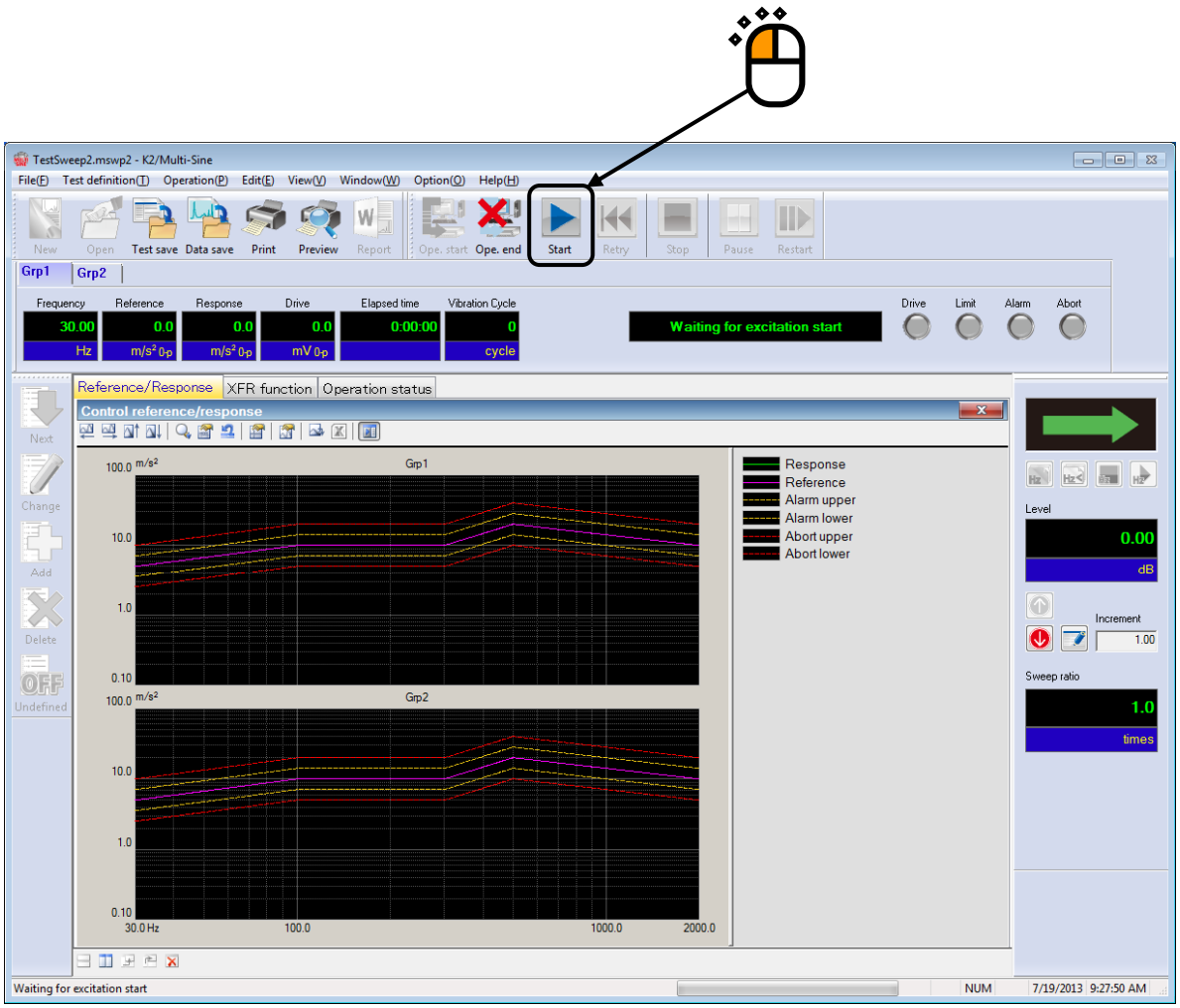
The system proceeds to the state of waiting for excitation start when the XFR measurement is finished.



＜Step 3＞

Press the button of operation start.

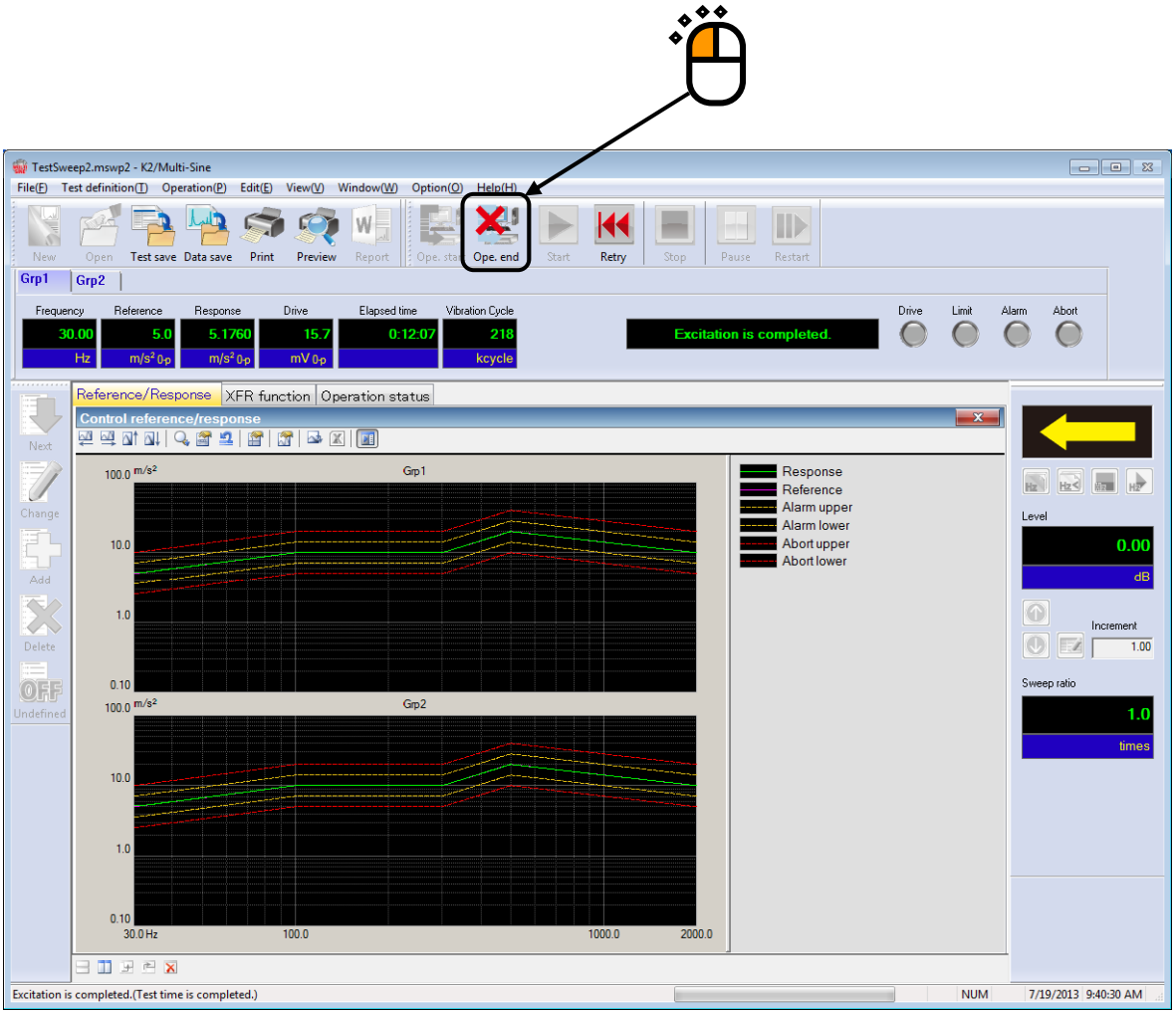
Initial loop check and initial equalization are automatically operated.



< Step 4 >

Test operation is completed when the test time passed.

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



3.3 Spot Test

< Example >

An example of Spot test is described as below ; (two shakers are used. ）

[Reference pattern]

The relation of Frequency and Level in the following list specifies a spot.

No	Frequency	Level	Stay time
1	200[Hz]	100[m/s^2 0-p]	10[min.]
2	10[Hz]	21[mm p-p]	100[times]
3	500[Hz]	0.1[m/s 0-p]	300000[times]

[Information of sensors to be used]

Two acceleration pickups of piezoelectric :

ch1. : for Principal Control, sensitivity 3pC/(m/s^2)

ch2. : for Principal Control, sensitivity 3pC/(m/s^2)

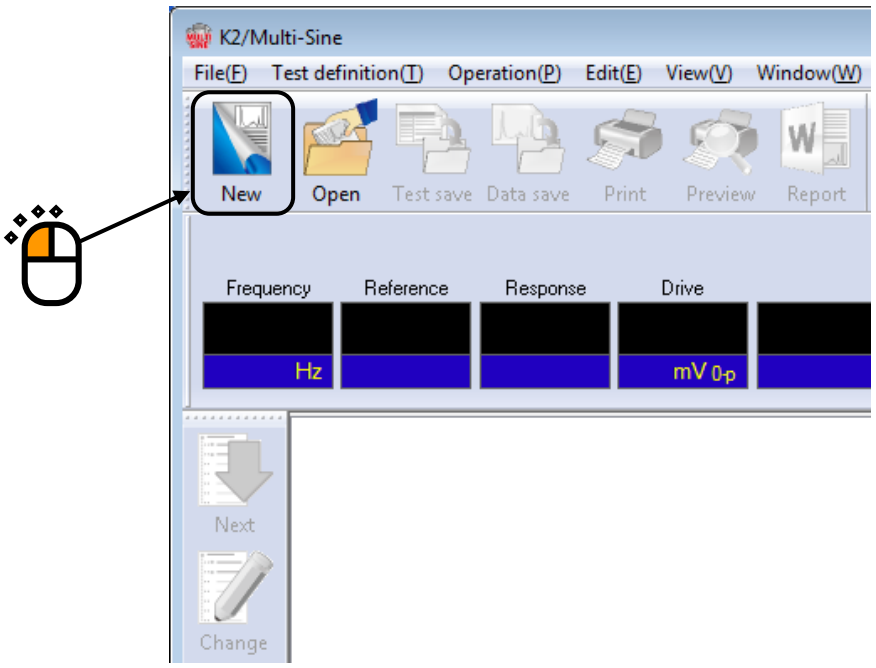
However, these channels must be registered in Input enviroment information (in this example, ‘chtest1’).

Also, the rating information of excitation system has already been registered in Excitation system information (in this example, ‘System1’).

< Procedures >

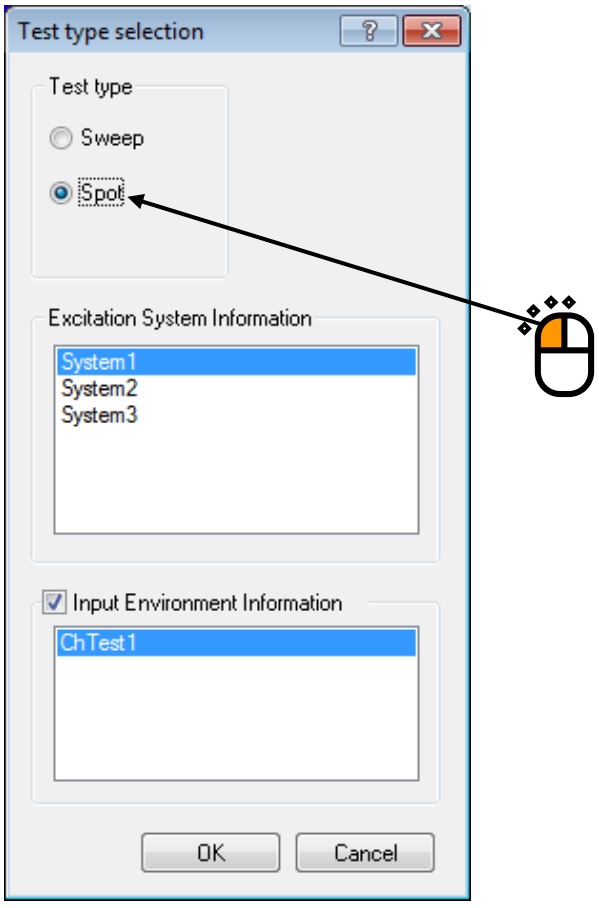
< Step 1 >

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



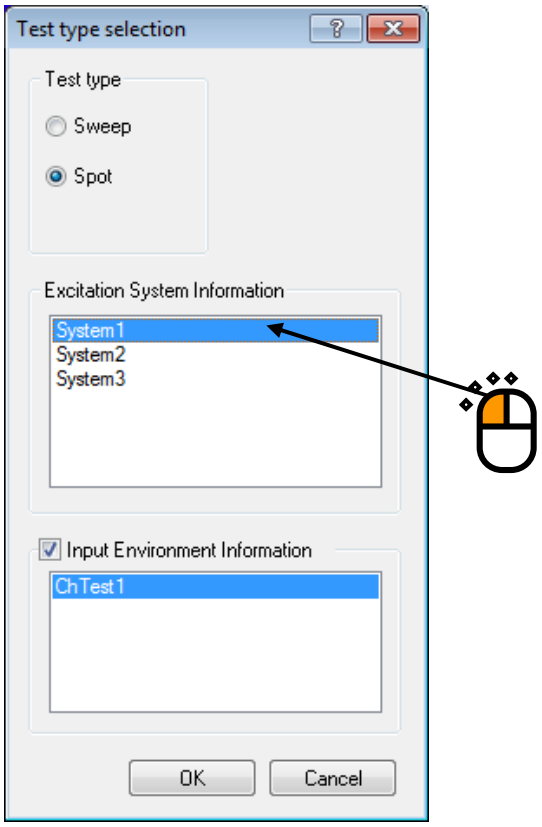
< Step 2 >

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



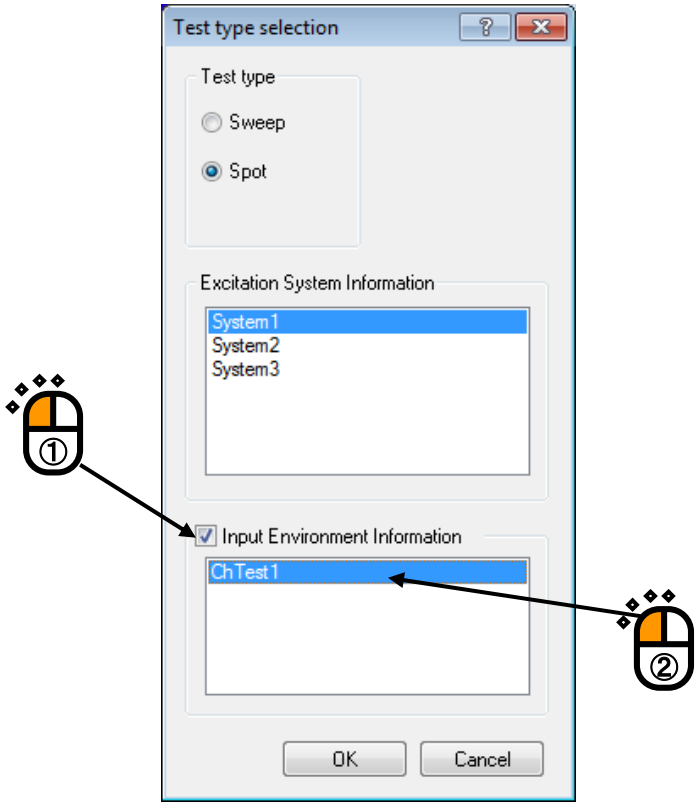
< Step 3 >

Select an excitation system from the list of ‘Excitation System Information’.



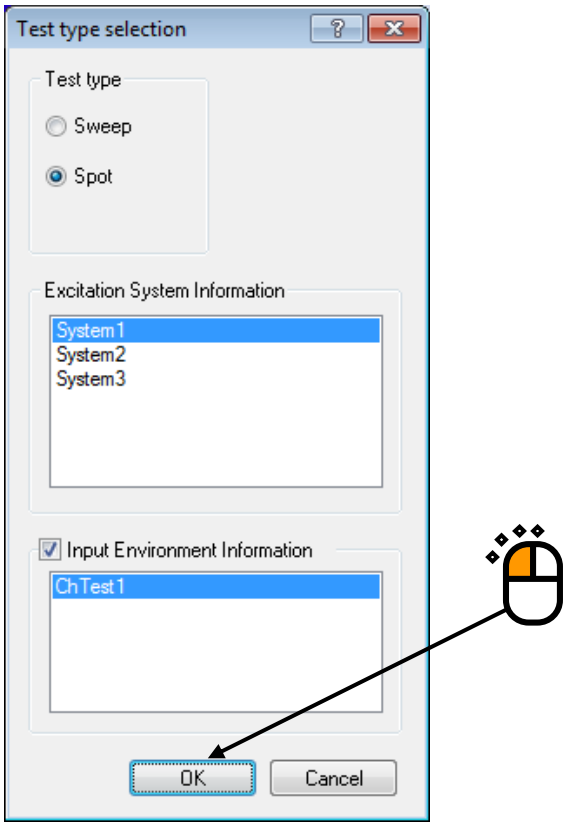
< Step 4 >

Click the checkbox of ‘Input Environment Information’ and select an input environment information from the list.



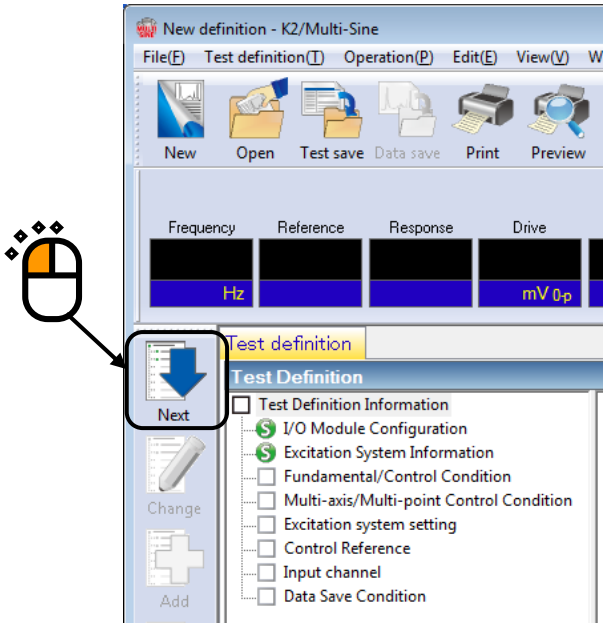
< Step 5 >

Press the [OK] button.



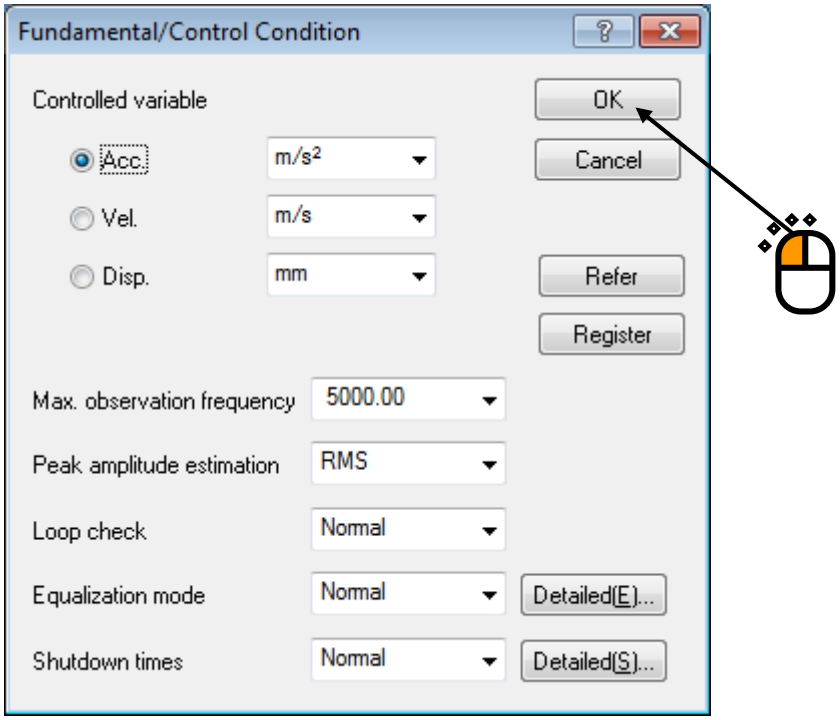
< Step 6 >

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



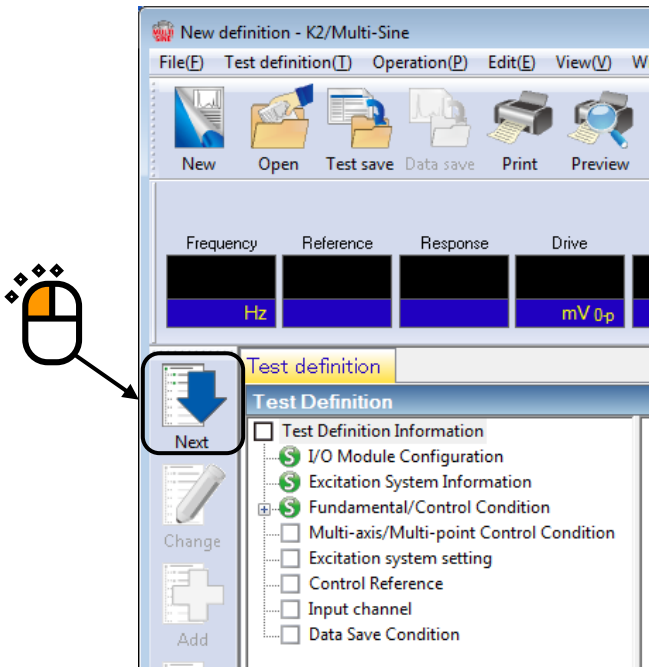
< Step 7 >

Press [OK].



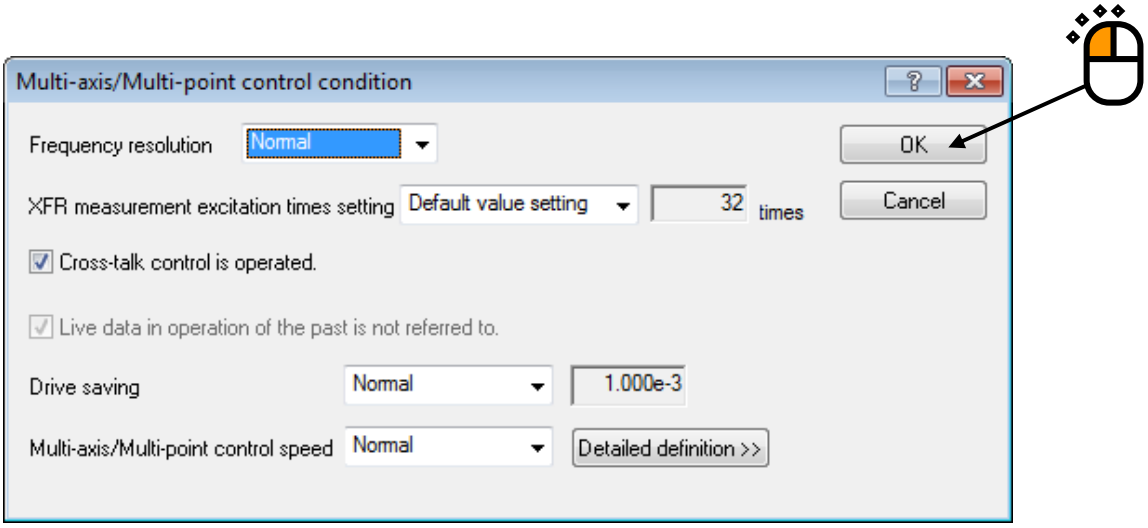
< Step 8 >

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



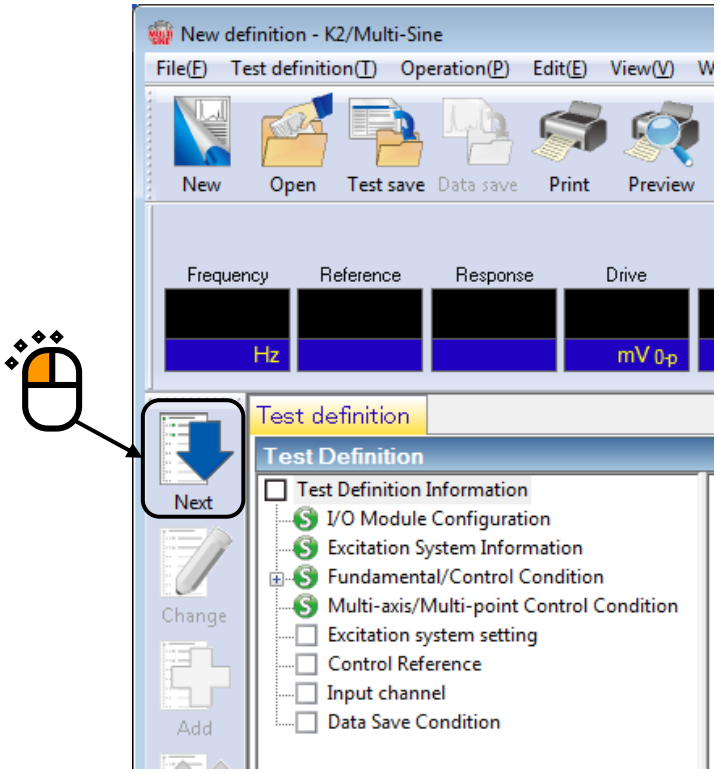
< Step 9 >

Press [OK].



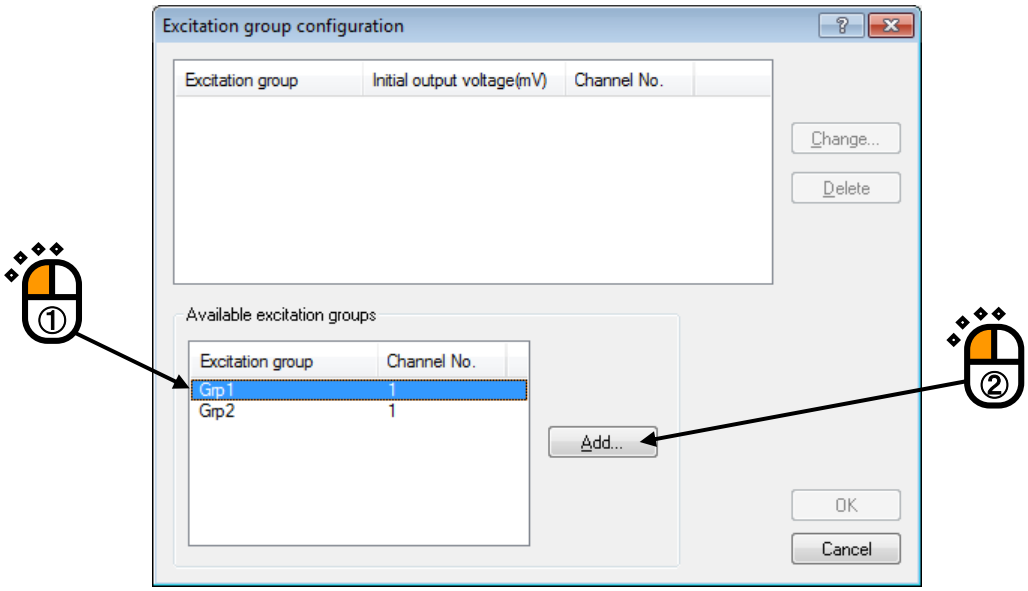
< Step 10 >

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



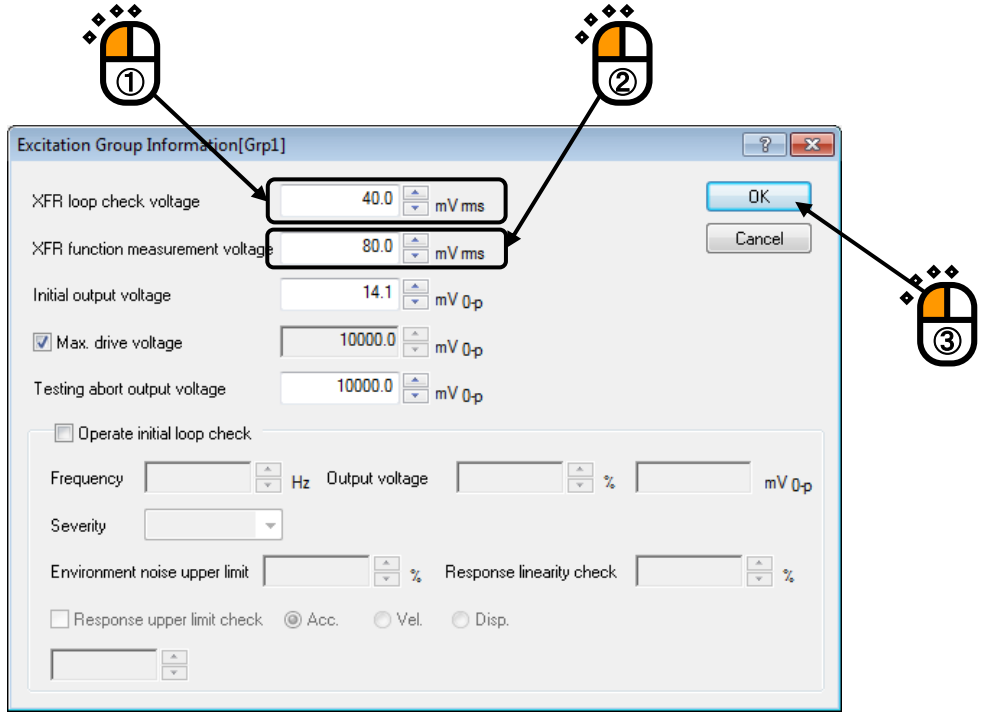
＜Step 11＞

Select an excitation group among the available excitation groups. Here, select ‘Grp1’ and press the button to add.



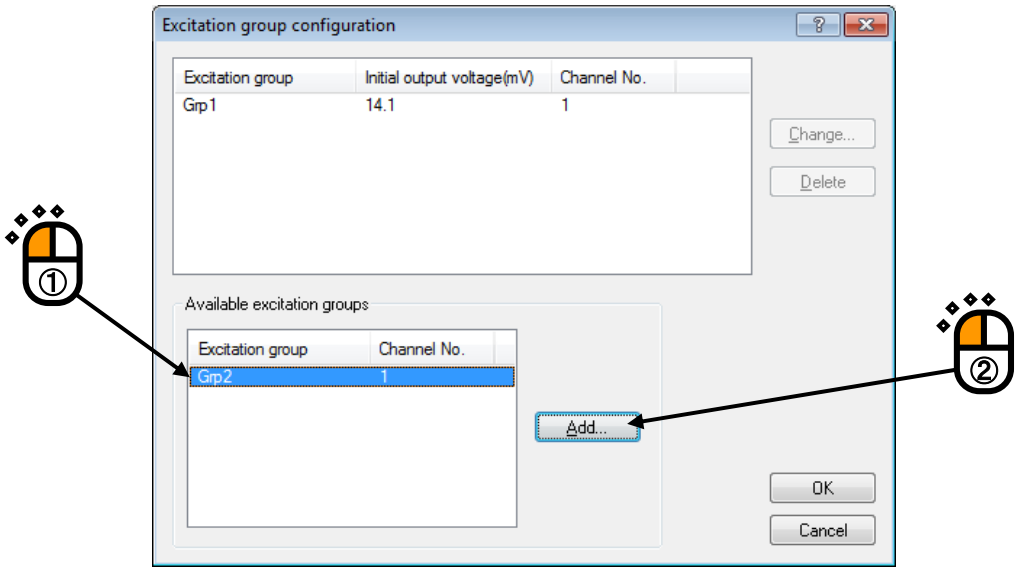
＜Step 12＞

Input the values to ‘XFR loop check voltage‘ as 40 [mVrms].and ‘XFR function measurement voltage’as 80.0 [mVrms]. Then press [OK].



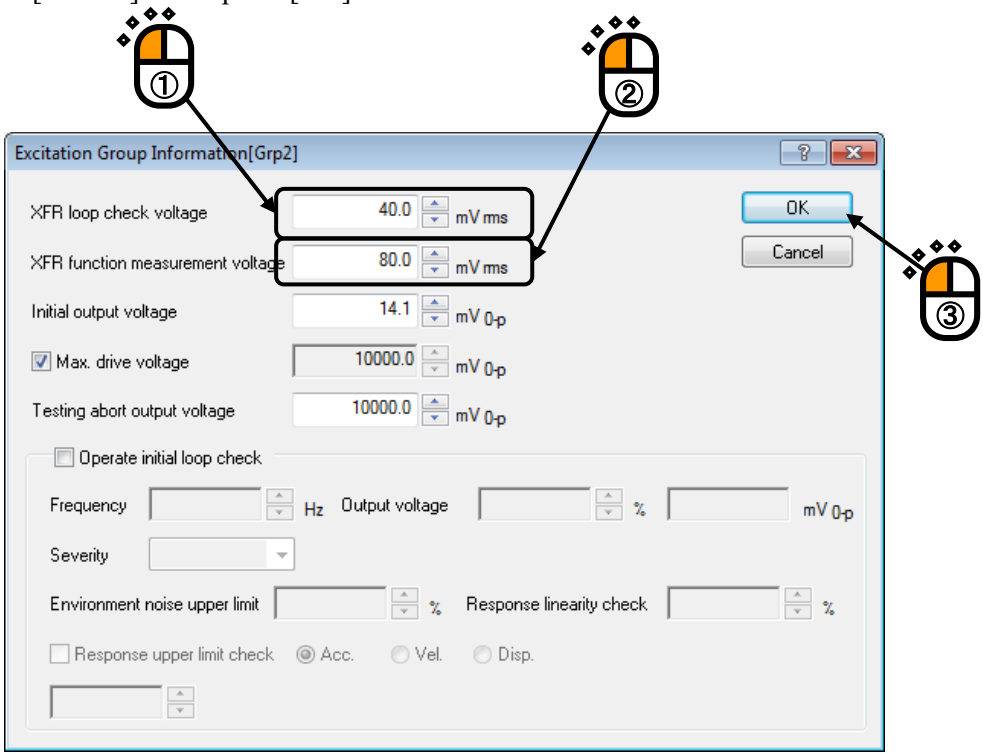
＜Step 13＞

Select an excitation group in the available excitation groups. Here, select ‘Grp2’ and press the button to add.



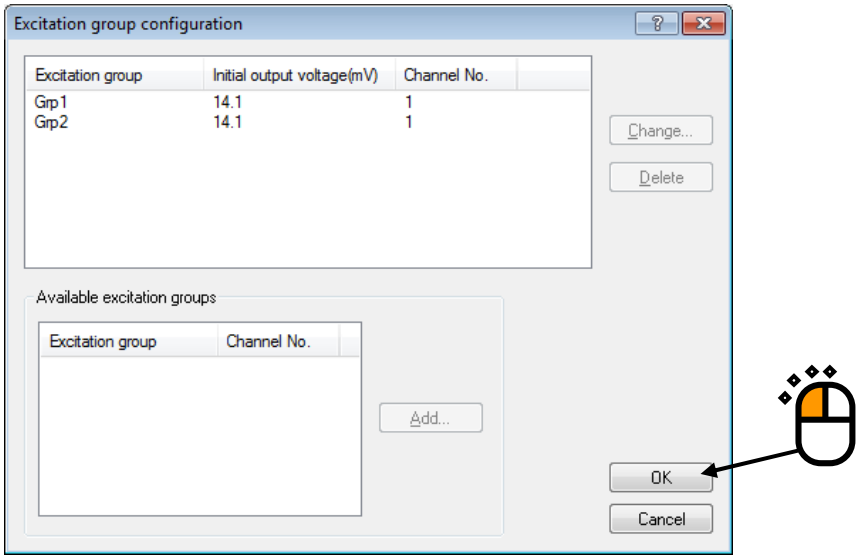
＜Step 14＞

Input the values to ‘XFR loop check voltage‘ as 40 [mVrms].and ‘XFR function measurement voltage’as 80.0 [mVrms]. Then press [OK].



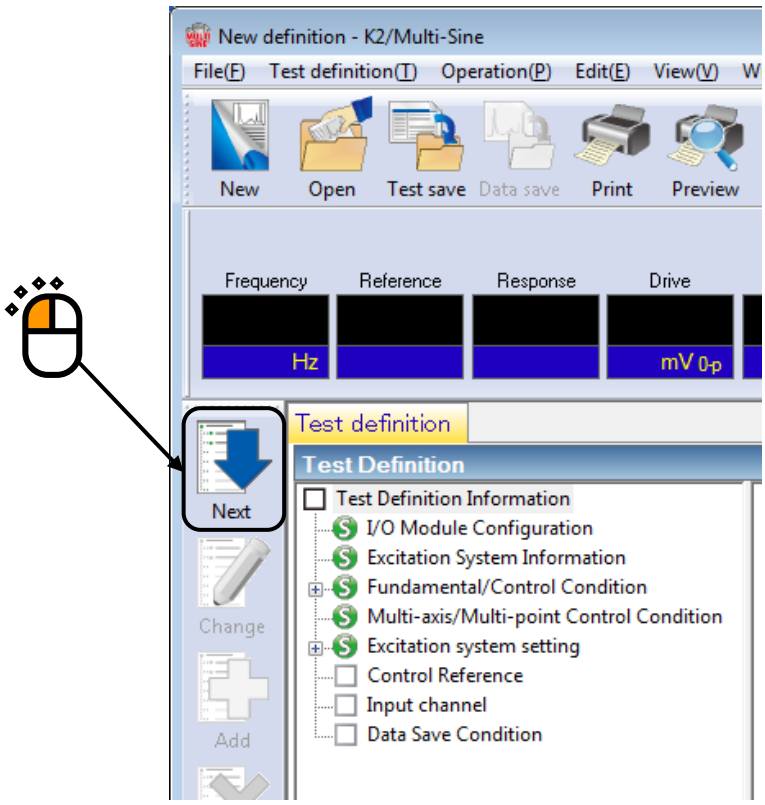
< Step 15 >

Press [OK].



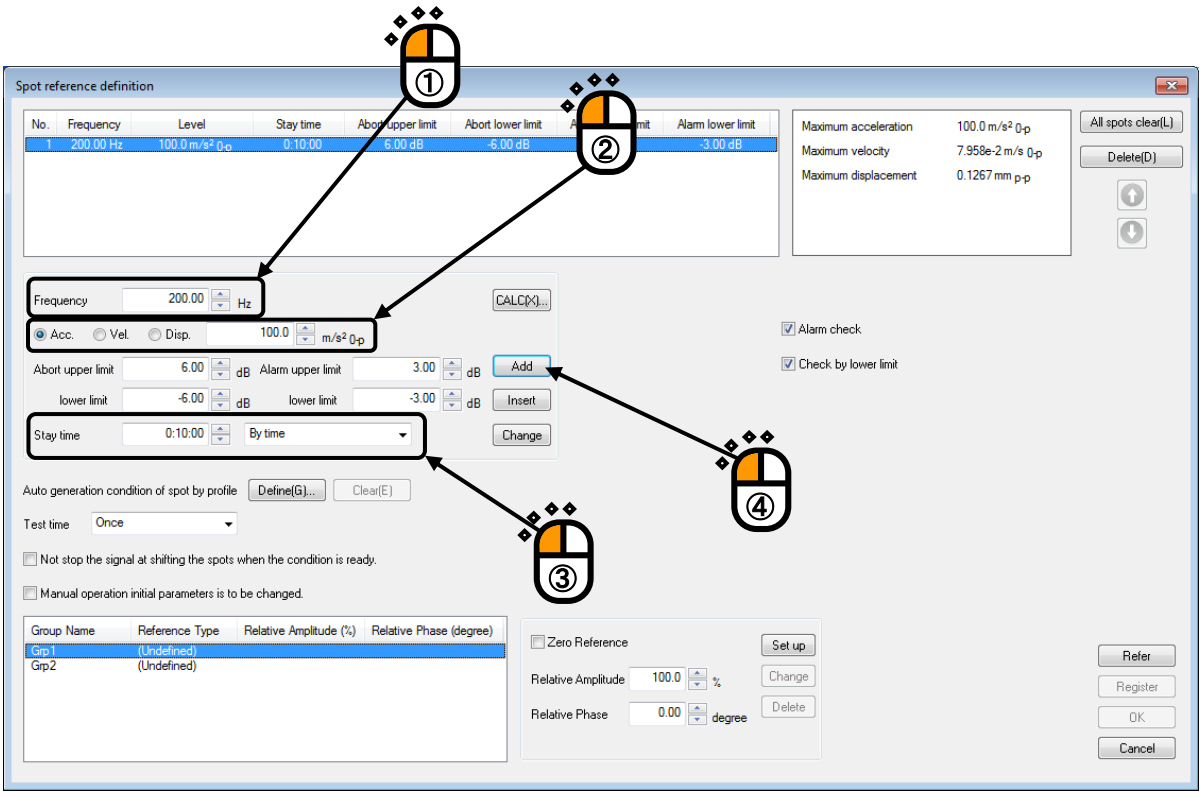
< Step 16 >

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



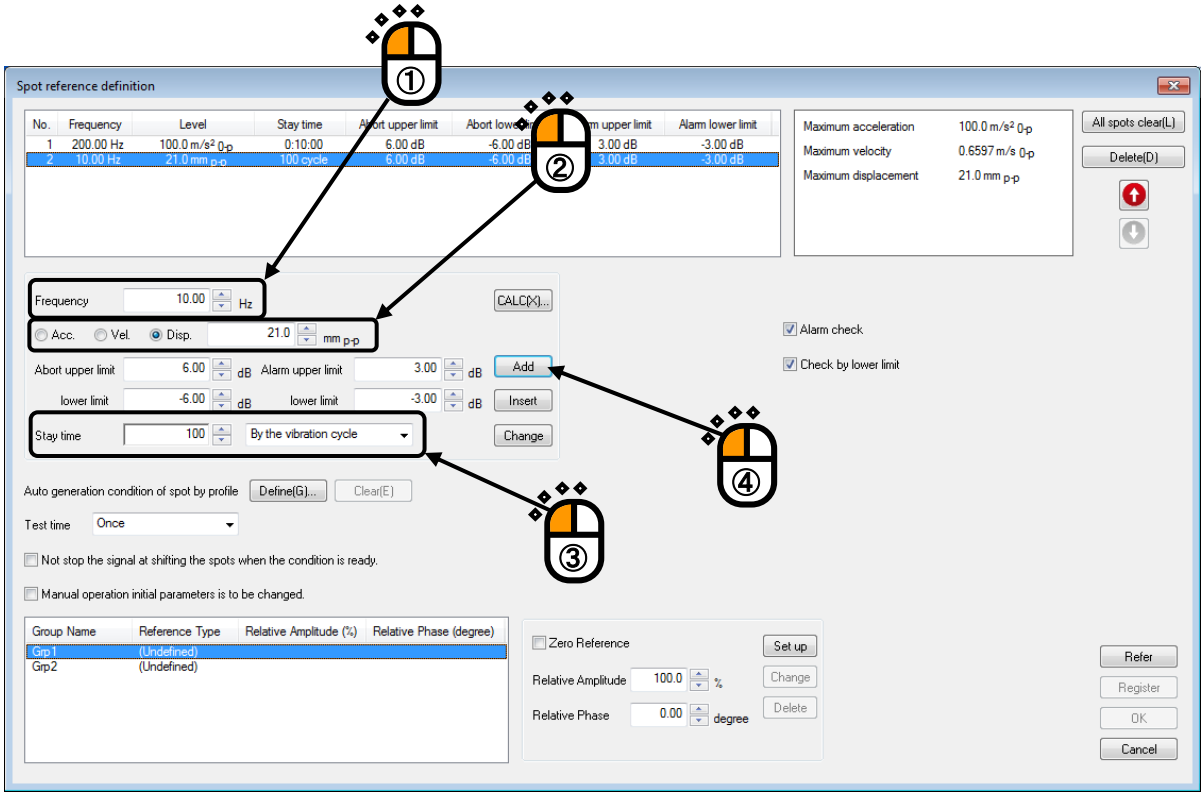
< Step 17 >

Input the values to ‘Frequency’ as 200 [Hz], ‘Level’ as 100 [m/s^{2}0-p] and ‘Stay time’ as 10:00 [sec] (10 minutes). Press the [Add] button.



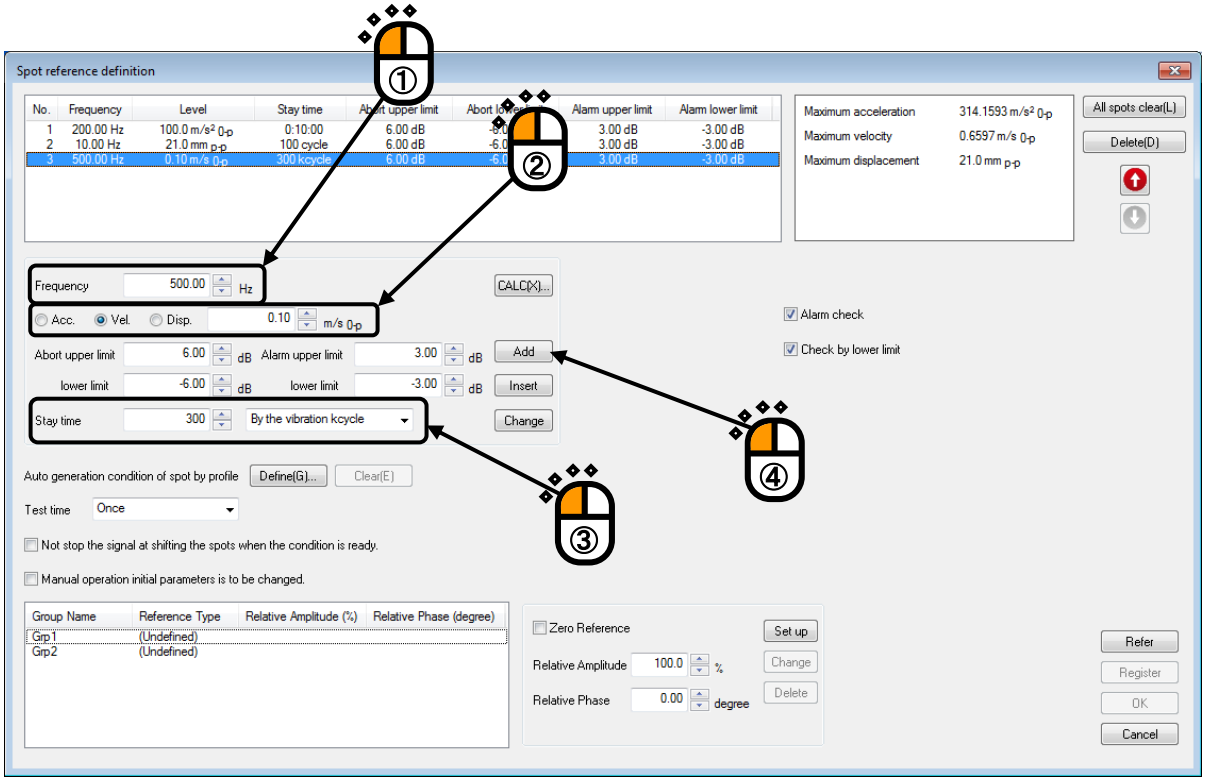
< Step 18 >

As in the same procedure, input the value to ‘Frequency’ as 5 [Hz], ‘Level’ as 21 [mm p-p] and ‘Stay time’ as 100 [cycle]. Press the [Add] button.



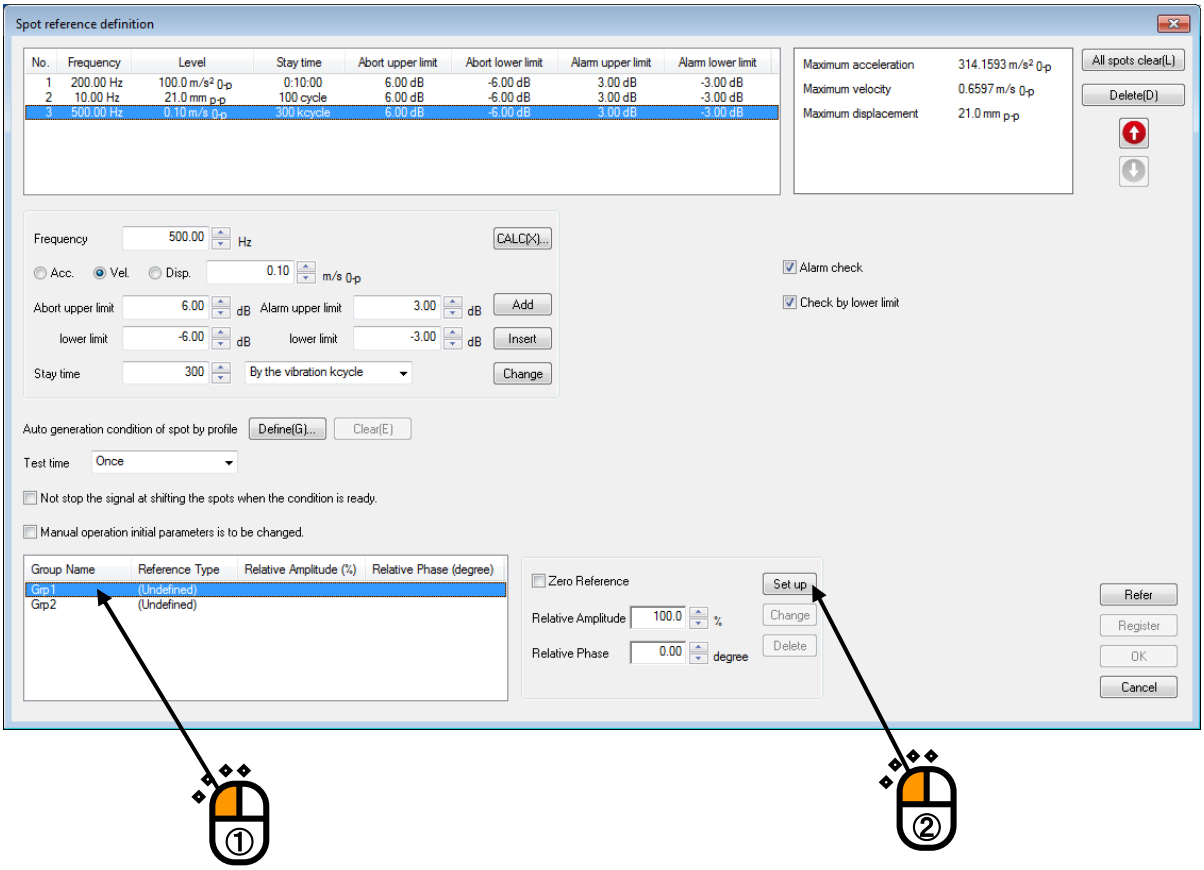
< Step 19 >

As in the same procedure, input the value to ‘Frequency’ as 500 [Hz], ‘Level’ as 5 [cm/s 0-p] and ‘Stay time’ as 300 [kcycle]. Press the [Add] button.



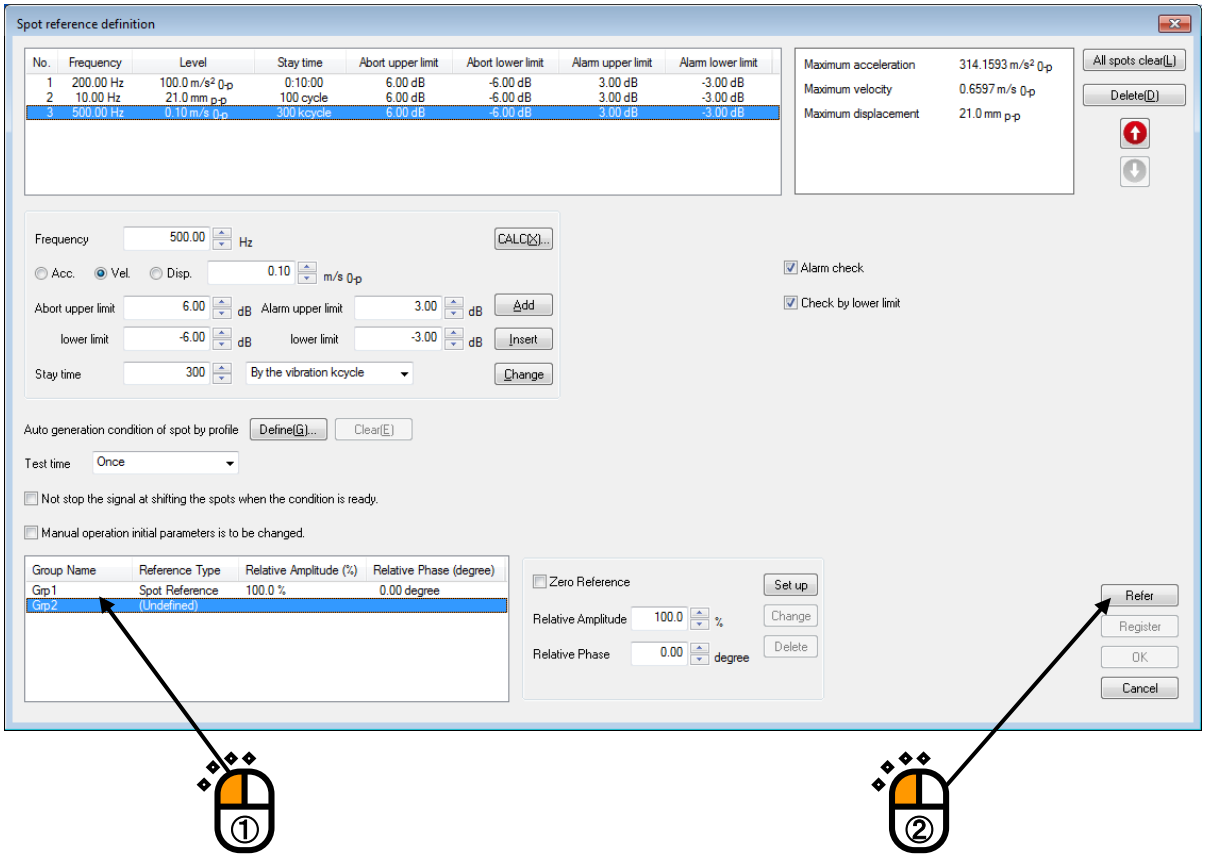
＜Step 20＞

Select a group name, ‘Grp1’. Then press the definition button.



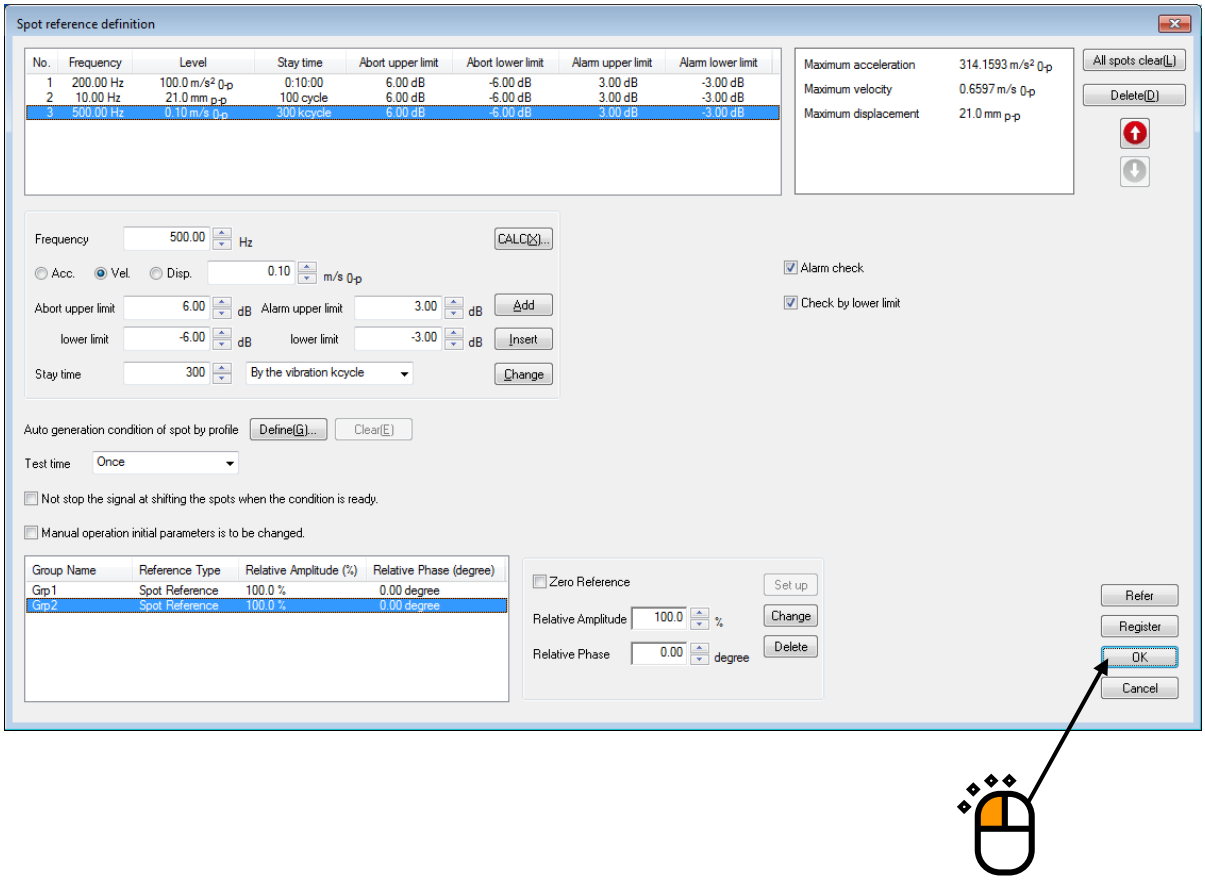
＜Step 21＞

Select a group name, ‘Grp2’. Then press the definition button.



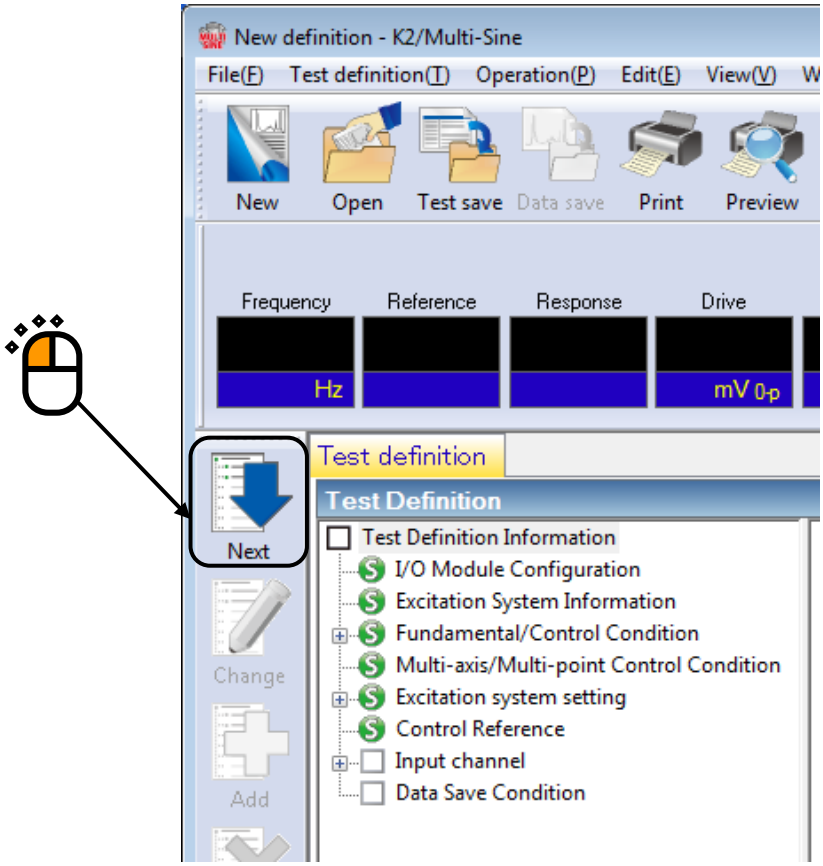
< Step 22 >

Press [OK].



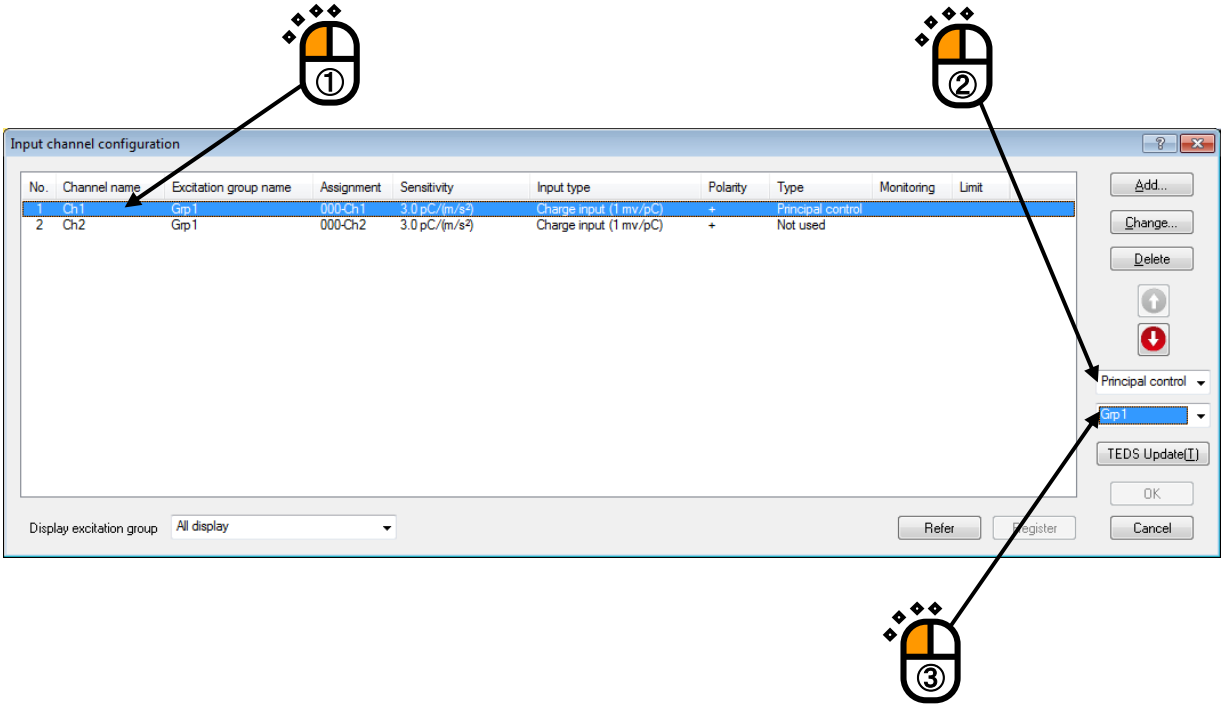
< Step 23 >

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



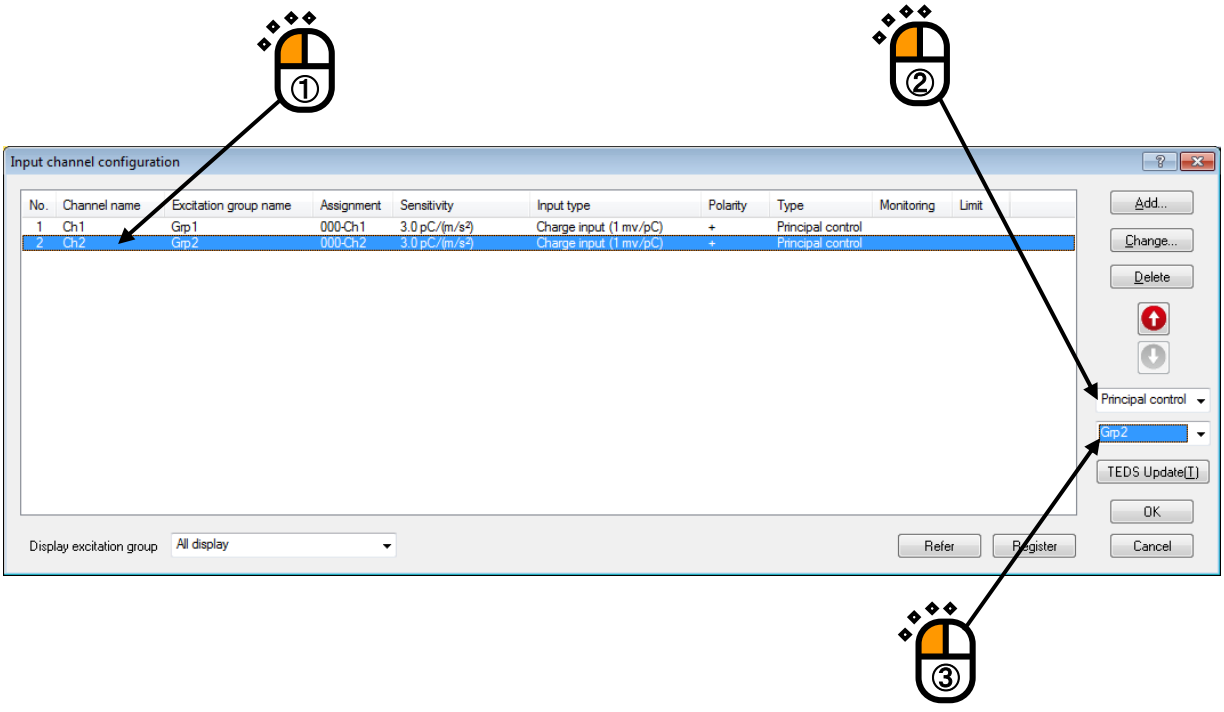
＜Step 24＞

Select a channel name, ‘Ch1’ in the list of input channels. Then Set the channel type to Principal Control and the excitation group to ‘Grp1’



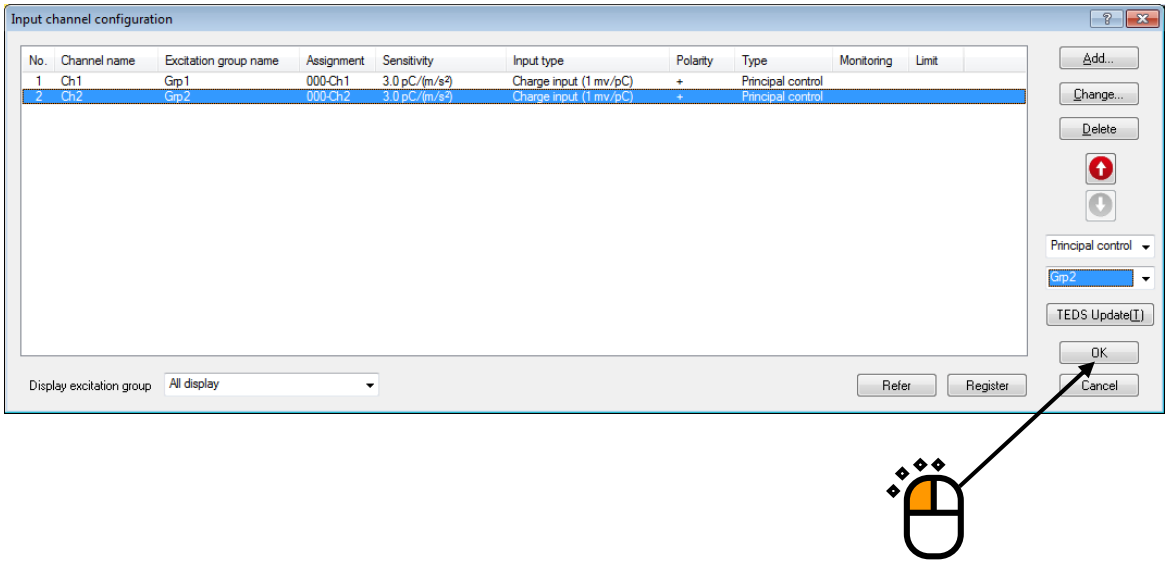
＜Step 25＞

Select a channel name, ‘Ch2’ in the list of input channels. Then Set the channel type to Principal Control and the excitation group to ‘Grp2’



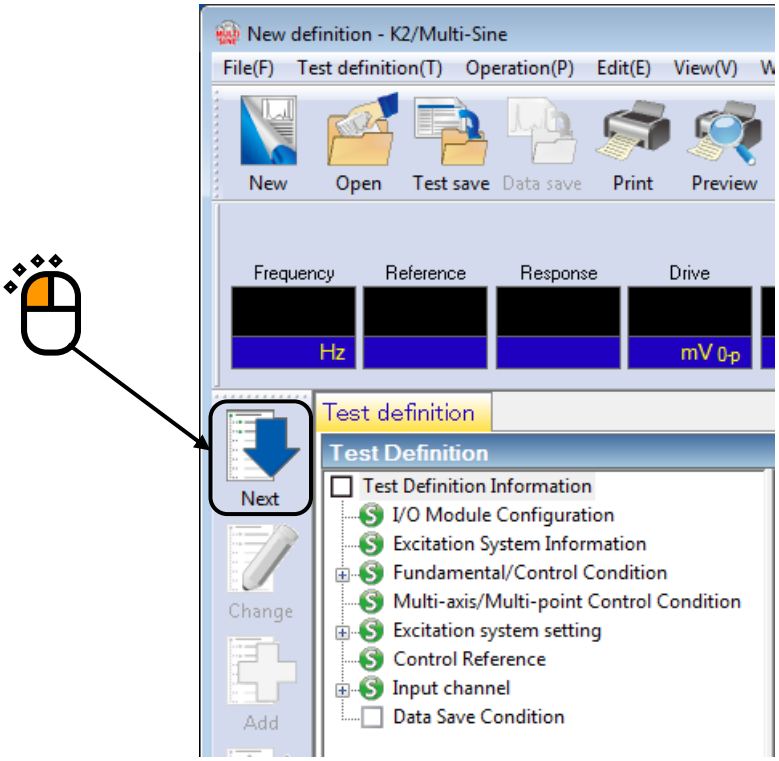
< Step 26 >

Press [OK].



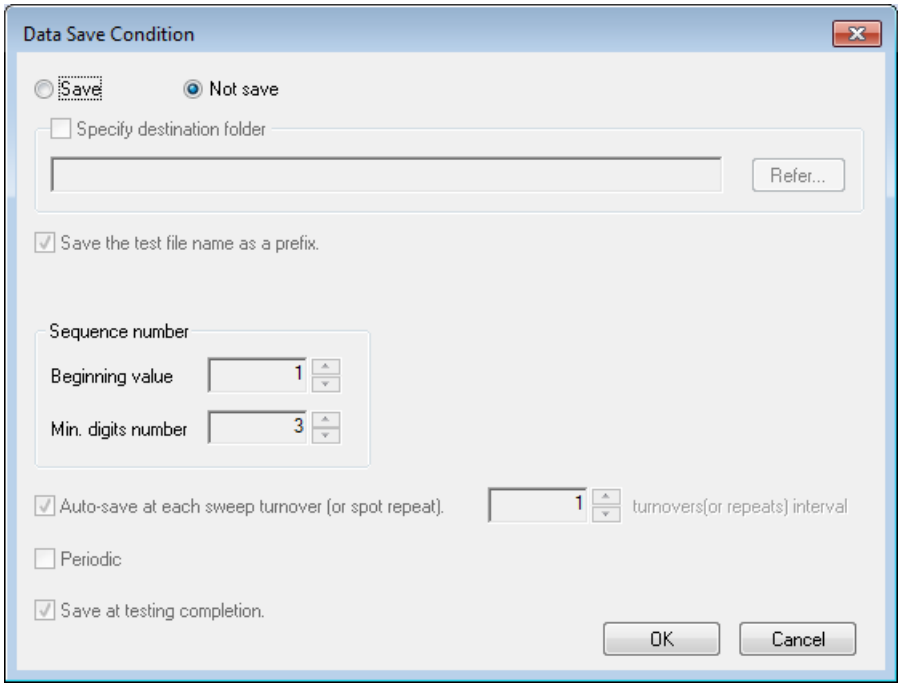
< Step 27 >

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



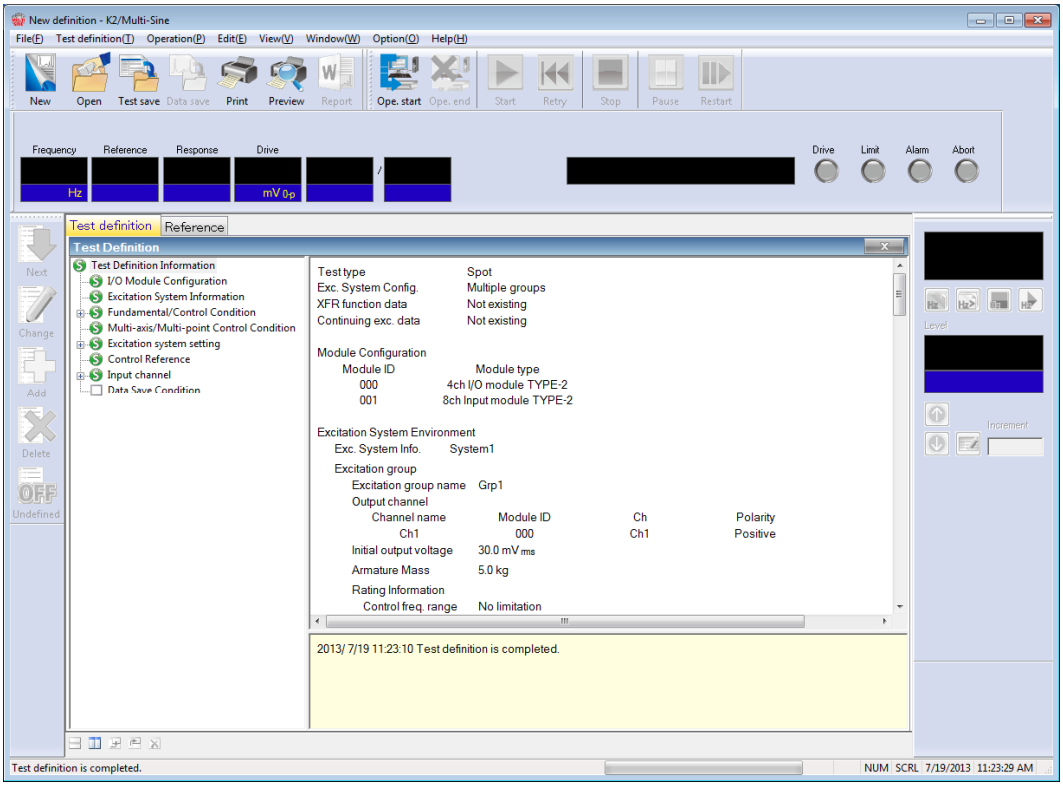
< Step28 >

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



< Step29 >

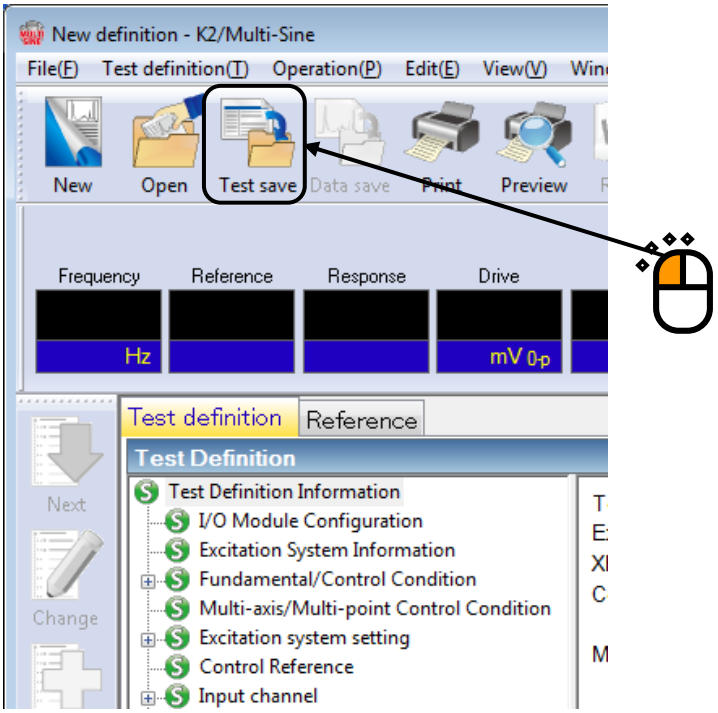
The definition is completed.



< Save test >

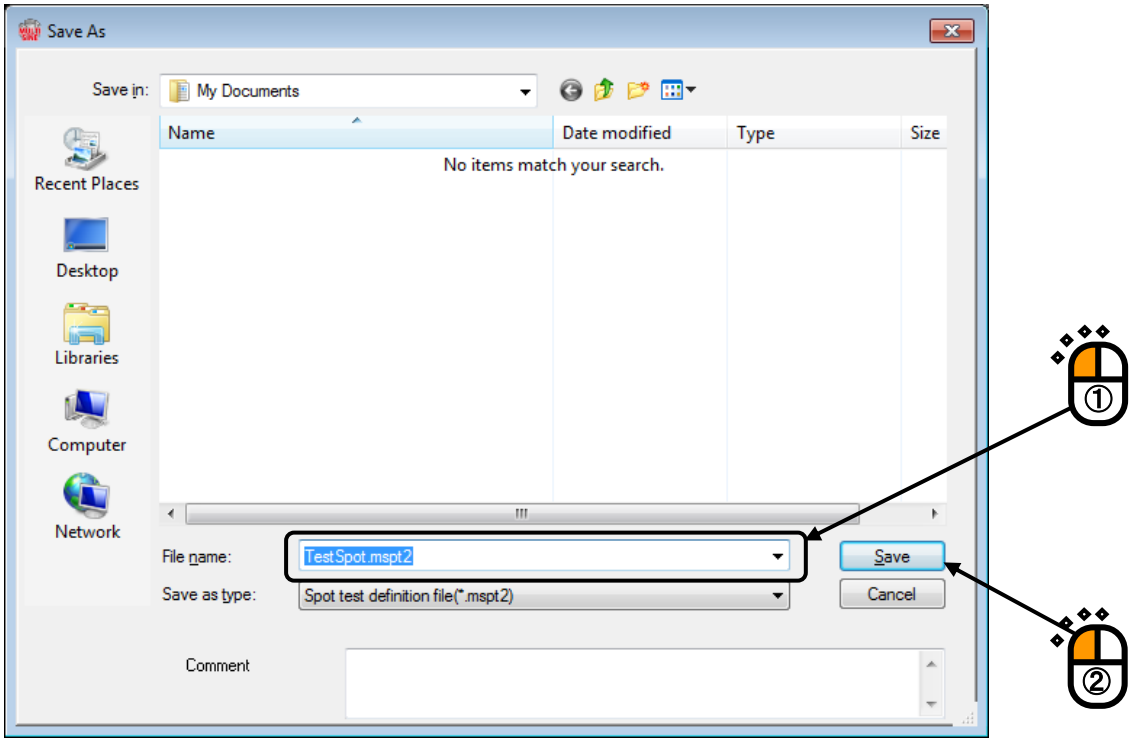
< Step 1 >

Press the button of [Test save].



< Step 2 >

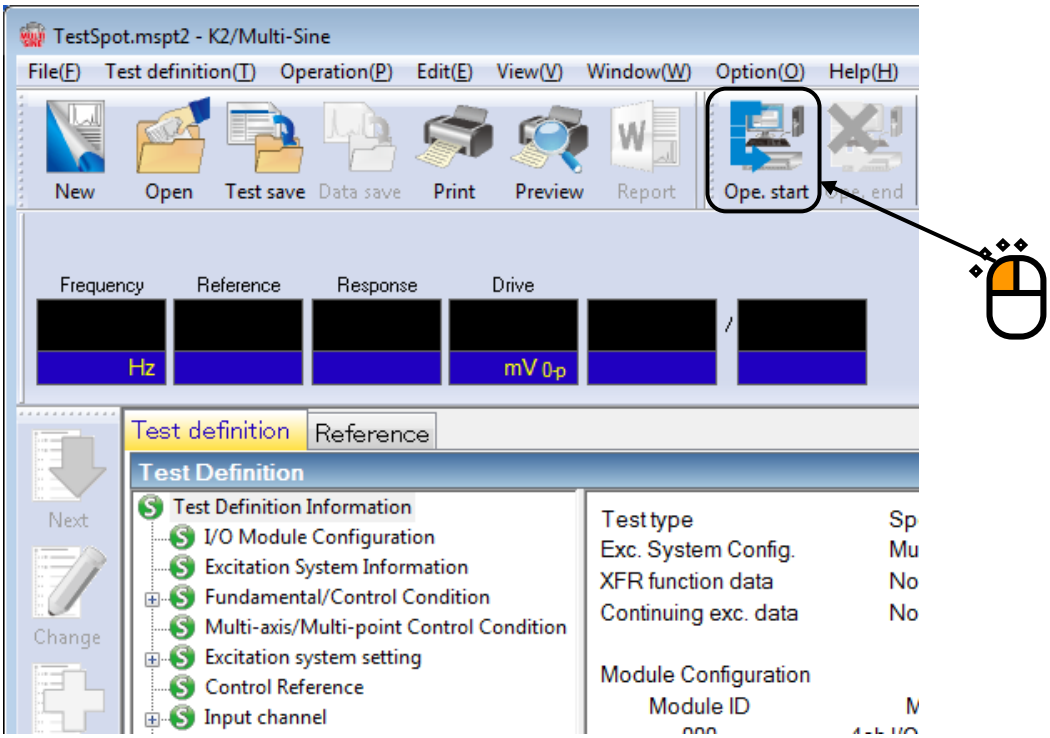
Input a name in ‘File name’ and press [Save].



< Operation of test >

< Step 1 >

Press the button of [Operation start].

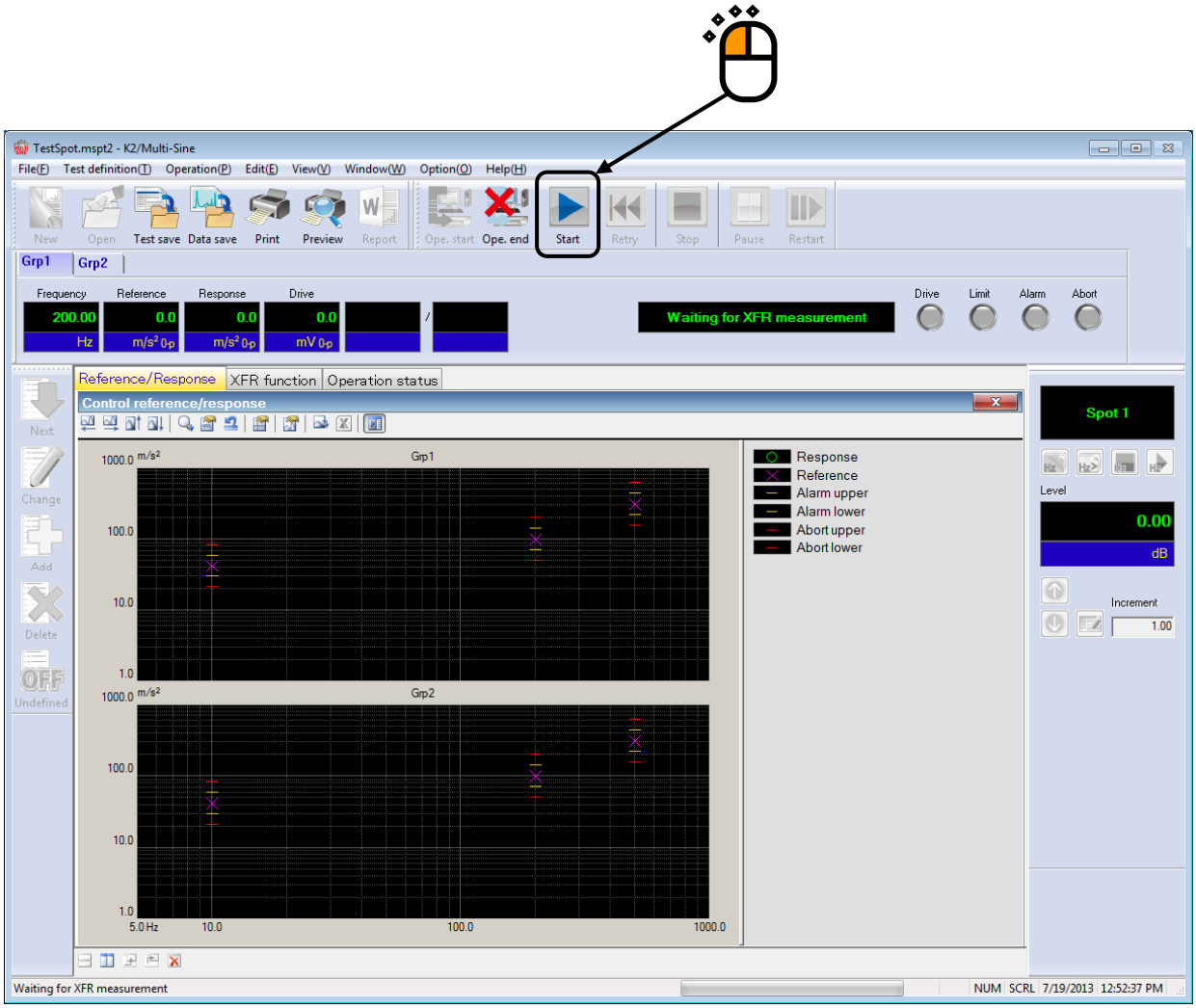


＜Step 2＞

Press the button of XFR measurement start.

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

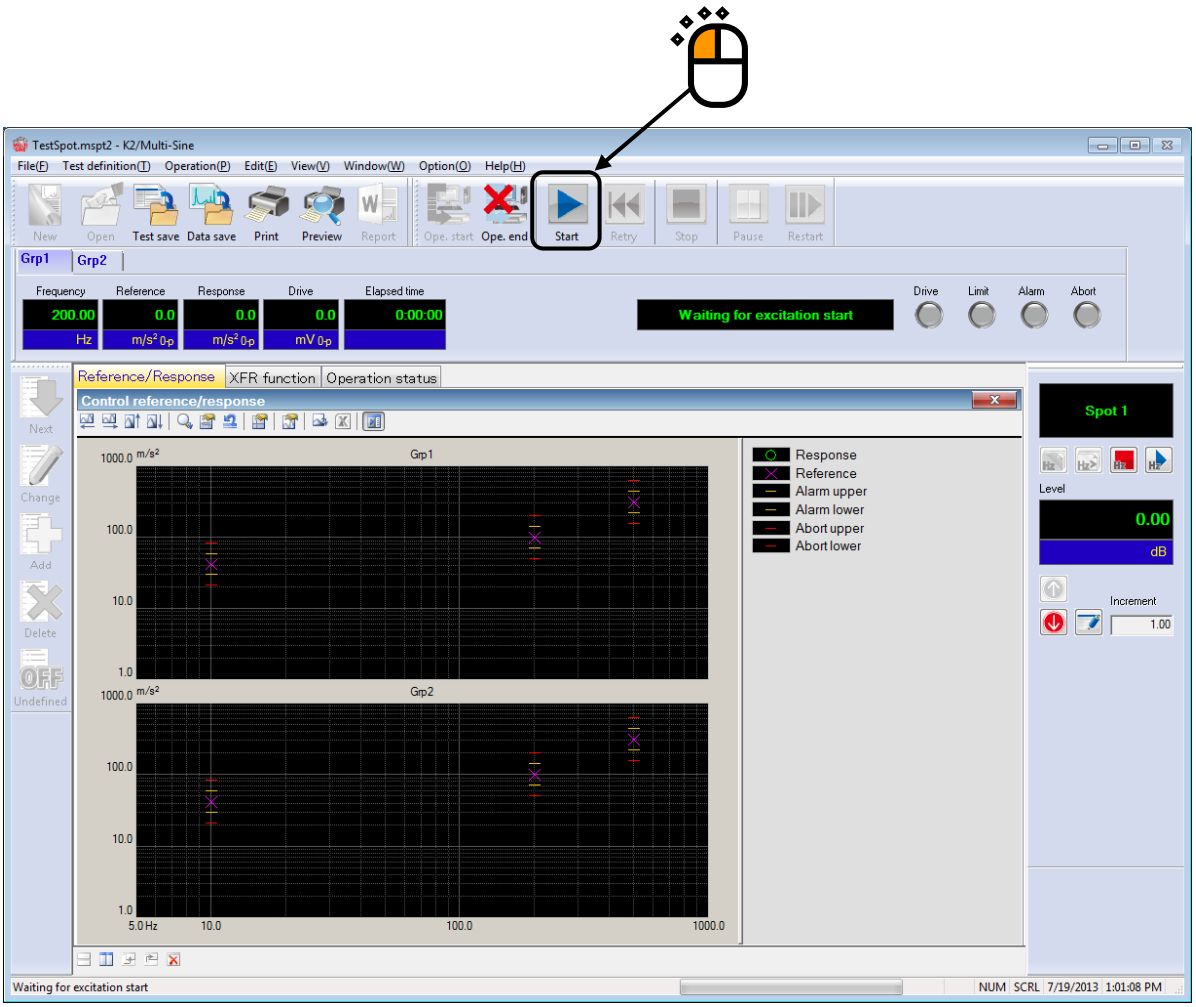
The system proceeds to the state of waiting for excitation start when the XFR measurement is finished.



＜Step 3＞

Press the button of operation start.

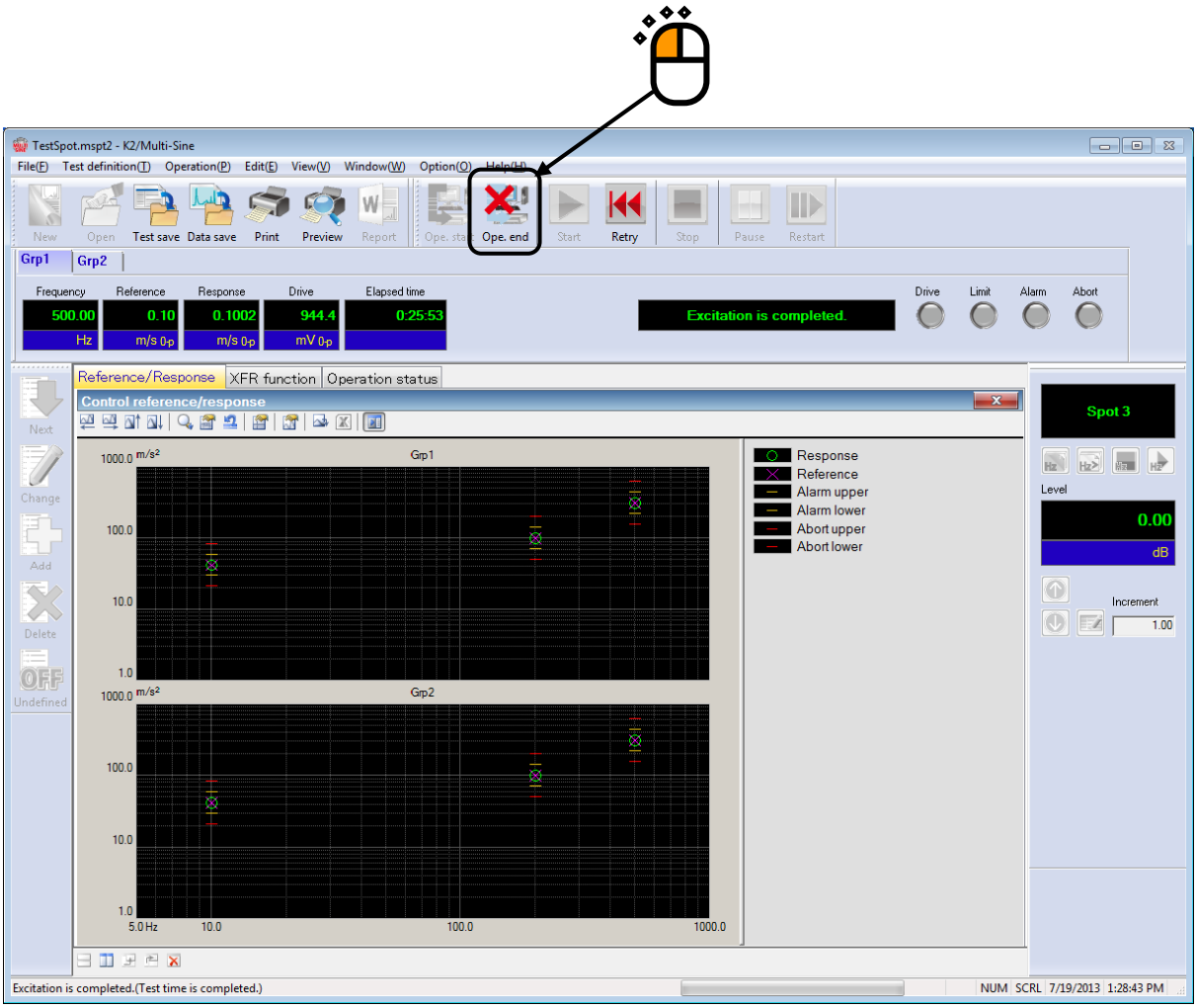
Initial loop check and initial equalization are automatically operated.



< Step 4 >

Test operation is completed when the test time passed.

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



Chapter 4 Test Definition

4.1 Outline

In this system, the series of necessary information to operate a test is called ‘Test’.

It is necessary to define a ‘Test’ at first for the test operation when a specified test is wanted to be operated.

In this chapter, each item for the definition of ‘Test’ is described.

Two types of Test such as ‘Sweep’ and ‘Spot’ are provided to this system. In definition of Test, it follows the procedure that the information in Table 4-1 is defined in order for each Test type.

Setting information and definition contents to be defined vary in each Test type. However, ‘(6) Control Reference’ is mainly different in definition contents between each Test type. The other setting information are almost the same each other.

Table.4-1 Test Type and Definition Information

Test Type / Setting Information	Sweep	Spot
(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

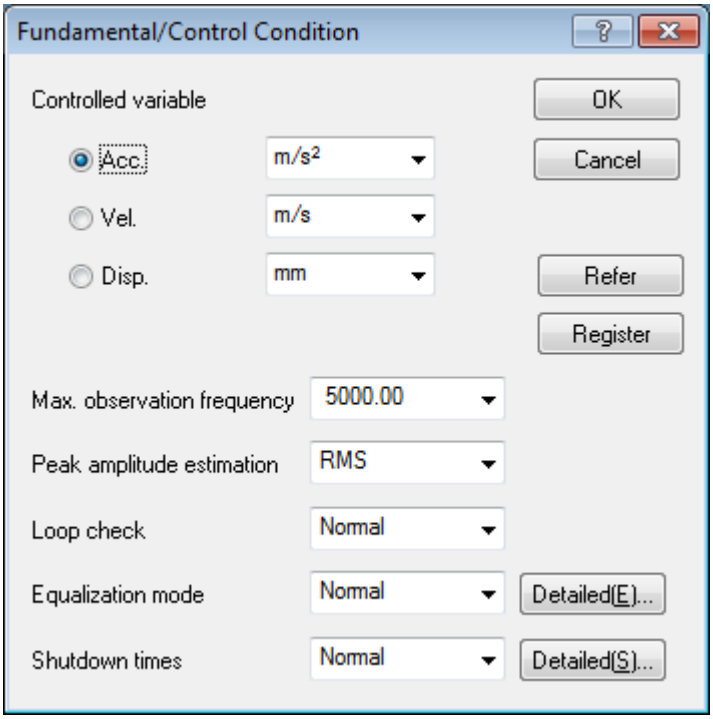
△: Information that is defined if necessary

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 Controlled variable

(1) Meaning

Unit of physical 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 Excitation System Information.

4.2.2 Max. Observation Frequency

(1) Meaning

This item is for setting of the maximum frequency (Max. observation frequency fmax) that is used by this system.

Low-pass filter of the hardware is specified according to the set value of this item. The setting of this item is applied to all of the input channels.

When the operation is executed under the condition that there is a noise always existing outside of the Control Reference band, Tracking the Peak amplitude estimation method is the most valid. In some cases, specifying the Max. observation frequency is also valid.

However, an arbitrary frequency can be set other than the Control Reference band.

4.2.3 Peak amplitude estimation

(1) Meaning

For calculating the amplitude (peak level) of a response signal waveform or the control channel, a method of Peak Amplitude Estimation is selected from the following five types ;

1. rms

Equivalent peak estimation method by rms (Root Mean Square) value : That is, under the assumption that the response waveform is a sinusoid having the frequency of controlled value, the following processing is done ;

To avoid complications, the reference level is consistently set by using the peak level (amplitude) in this system. Therefore the response level is also expressed in the peak level with converting from the rms value. This item is basically the same as the process called 'rms Value Control'. (A displayed Eprms value divided by $\sqrt{2}$ gives the rms value.)

2. Average

Equivalent peak value (EP) is obtained by the following processing ;

The averaged value is calculated from the absolute value of the response signal waveform. Then, under the assumption that this response waveform is a pure sine wave with the specified frequency, this averaged value is equally converted to the sine amplitude value. The equivalent peak value is used as the amplitude estimation value of the response signal.

This peak estimation method had been used generally in the age of analog technique, and it is sometimes called 'Average Value Control'. For this reason, it is often used in this digital controller. (For example, our F2 SINE etc.)

That is if you need to keep consistency of a testing result with that of a previous controller, it is proper to set this item.

3. Tracking

Extracting the fundamental wave component from the response signal waveform by digital technique, the amplitude (peak level) of this fundamental wave is used as the estimated value of the response amplitude.

This method is also called 'Tracking Control' because it is necessary form an excitation accompanied by sweeping to have an extraction mechanism that can follow the varying frequency in the response analysis for extracting the fundamental wave.

In this system, the extraction mechanism of the fundamental wave component is realized by processing the Fourier Integral calculation in real time using the drive signal frequency and response signal. So, this item has a much higher accuracy than using the analog type of Tracking Filter.

If the response signal is distorted much, the response amplitude estimation value of this method becomes a smaller value than the items in the above two that calculate equivalent peak from the value based on the overall value. Then the excitation level of this control

results lager (that is, a severer testing will be operated here).

4. Max. peak

For each cycle of response waveform signal, the peak values at plus (+) and minus (-) direction are detected.

The larger detected peak value (the maximum absolute value of response waveform data for a cycle) is averaged by frequency of analysis. This averaged value is used as amplitude estimation value.

$$\text{Amplitude} = \frac{\sum_{N} \max(|\ \text{WaveData}_N\ |)}{N}$$

Amplitude : amplitude estimation value of response signal

Wave Data : waveform data for a cycle

N : number of periods (cycle) required for amplitude estimation analysis

5. Average peak

For each cycle of response waveform signal, the peak values at plus (+) and minus (-) direction are detected. The value is obtained from the total of both (+) and (-) peak values divided by 2. The value is averaged by frequency of analysis. This averaged value is used as amplitude estimation value.

$$\text{Amplitude} = \frac{\sum_{N} \left(\frac{|\ \max(\text{WaveData}_N)\ | + |\ \min(\text{WaveData}_N)\ |}{2} \right)}{N}$$

Amplitude : amplitude estimation value of response signal

Wave Data : waveform data for a cycle

N : number of periods (cycle) required for amplitude estimation analysis

These peak estimation methods in the above can be selected for the response of each control channel which is used for calculating the control response. However, the peak estimation method for the monitor response of each input channel can be set for each input channel arbitrarily. (Refer to Input Channel Configuration.)

4.2.4 Loop check

(1) Meaning

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

In this system, loop check is done in the following two types of operation :

A : Pre-check

In the state of waiting for the excitation start, when the environment noise (ambient noise) inputted to the input channels is measured just after pressing the button for excitation start, the gain of the excitation system is checked whether it is normal or not before the control operation starts.

B : Loop check in control operation

When the system passes the initial loop check of the above, the control operation is started. During all the processes in the control operation, the gain change of the control loop is checked for monitoring the abnormal event at each response analysis executed quickly for each loop time.

Basically, the control channel is used for loop check. However, the monitor channel for monitoring the level is always treated as the object for loop check (because this channel is required to give the required effect directly when it is necessary to the control operation even if it is specified only as a monitor channel).

Even a monitor channel that is not used for monitoring the level can also be specified as the object for loop check arbitrary.

In this item, an abnormal detection criterion for loop check is selected among the followings ;

1. Severe : The severest criterion is set.
   It can be used for a specimen with a small resonance characteristics and a good linearity.
2. Normal : The criterion allows an ordinary level of resonance characteristics and non-linearity
3. Loose : The criterion allows a larger gain change. Use this criterion when loop check is failed even in 'Normal' caused by severe the characteristics of the specimen or setting of faster sweep rate etc.

Even with a specimen with a good linearity, the gain change of the control loop cannot be avoided in the swept sine testing basically caused by the frequency response changed by the resonance characteristics. And this change rate is the function of the sweep rate. Therefore, in some causes, this setting of 'Loose' may be needed when a fast sweep rate is set.

4.2.5 Equalization mode

(1) Meaning

This item is for specifying the response speed of the feed-back control system composed in this system, when the level control is executed by controlling the drive output level to make the response amplitude estimation value coincide with the value given as the reference level.

In the testing which is difficult to control with general setting parameters, applicable setting of this item should not be decided alone. The setting of this item is much related to the sweep rate.

1. Sharp

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

For controlled system with instability of the response, when the resonance magnification is too high, the control may become unstable and the 'hunting' may occur by this setting.

2. Normal

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

Generally, the setting of 'Normal' is recommended except the case in which the special judging is needed.

3. Soft

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

When the control becomes unstable and the hunting may occurs in the setting of 'Normal', the setting of this item may be useful. For example, this item may be effective for using the control of the hydraulic shaker.

4. Specify (or Detailed definition button)

Control parameter set of equalization mode is properly defined according to the setting of 'Sharp', 'Normal' and 'Soft'. However, this item is provided for the testing with the specimen which is too difficult to control by the setting of the standard items. With using this item, an operator can specify the control parameters of the equalization mode by his own technique.

4.2.6 Shutdown time

(1) Meaning

In this system, the drive signal output can be aborted by the order of 'Excitation stop' during the drive outputting state in the testing. When a 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 (Output start/stop transit 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 the specified time of this item is provided.

Shutdown time is selected from the following three items ;

'Normal', 'Fast', 'Slow', 'Specify'

Generally, 'Normal' is recommended.

Shutdown time is defined by 'Transit vibration cycle / Transit time upper limit / Transit time lower limit'.

When ‘Specify’ is selected or the button of Detailed Definition is pressed, the parameter for the setting of Shutdown Time can be defined arbitrary. In this case, the detailed Definition dialog of the Shutdown Time appears and the suitable values can be inputted to each parameter.

The standard values provided in this system are as follows ;

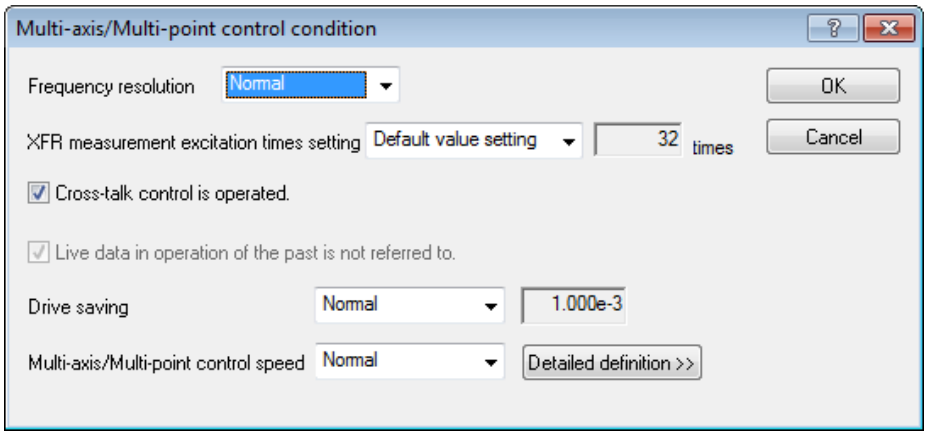
Shutdown time	Normal	Slow	Fast
Transit vibration cycle [cycles]	20	50	10
Transit time upper limit [ms]	2000	5000	1000
Transit time lower limit [ms]	200	500	100

Each of the above definition items has the different frequency band in which these definitions are valid. Denoting Transit vibration cycle as A [cycle], Transit time upper limit as B [ms], Transit time lower limit as C [ms], the frequency ranges (f [Hz]) in which each of these definition items become valid are calculated as below ;

- Transit vibration cycle‥‥ A/(B/1000)[Hz] ≦ f ≦ A/(C/1000) [Hz]
- Transit time upper limit‥‥ f ≦ A/(B/1000) [Hz]
- Transit time lower limit‥‥ A/(C/1000)[Hz] ≦ f

4.3 Multi-axis/multi-point control condition

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



4.3.1 Frequency Resolution

(1) Meaning

This item is for specifying of the Resolution (Line Number) of FFT.

For avoiding the complication of the setting, the Resolution (Line Number) of FFT is defined at the proper value in this system.

Resolution can be selected from the following three levels ;

- 'Normal' : 800 lines （Δ f = 0.4 Hz）
- 'Smooth': 1600 lines （Δ f = 0.1 Hz）
- 'Rough' : 400 lines （Δ f = 0.8 Hz）

The Resolution of the transfer function becomes smoother in order of 'Smooth' > 'Normal' > 'Rough'. And the measurement takes a longer time in order of 'Smooth' > 'Normal' > 'Rough'.

Generally, the setting of 'Normal' is recommended. However, when the transfer function of the controlled system has the steep peak and notch, the setting of 'Smooth' may be applicable.

Note) The defined Frequency resolution is the minimum frequency of control reference.

4.3.2 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.

4.3.3 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.)

4.3.4 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).

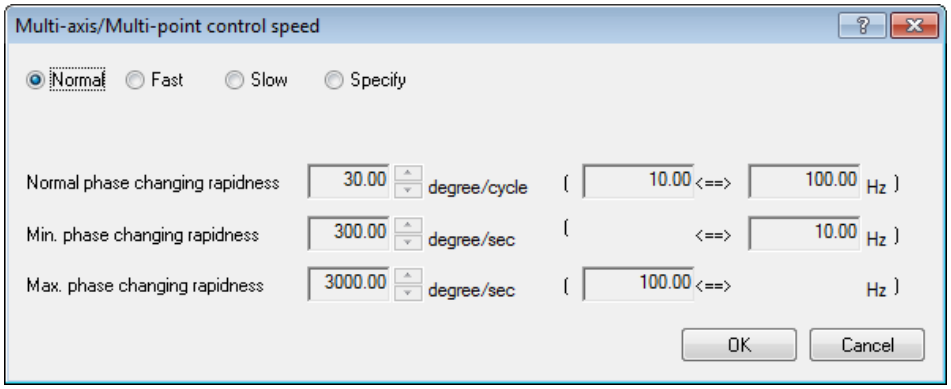
It is needed when the solution (drive) is unstable and unreliable because the simultaneous equations are unstable. In such a situation, the solution may have very large value, but it is not certain whether such large value is correct. Drive saving means using a more reasonable and stable solution (smaller 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 Multi-axis/multi-point control speed



(1) Meaning

Generally, the concept of Multi-Shaker Control Speed means the pursuing ability of the transfer function change in the controlled system during the control operation.

In Multi-Shaker Control, especially, the phase information of the transfer function in the controlled system is important.

For example, when the excitation frequency changes continuously in Sweep Test, the transfer function of the response in the controlled system also changes continuously. In this case, the phase and the level of sinusoidal signal given to each shaker are needed to be changed with pursuing of its transfer function. This item, Multi-Shaker Control Speed is for setting of the upper limit of the changing speed in this operation.

When the control is difficult to operate with general setting parameters, the suitable setting of this item should not be decided alone. The setting of this item is much related to the sweep speed.

1. Fast

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

When the controlled system has the unstability of response or the too high resonance magnification, the control may become unstable and the 'hunting' may occur by this setting.

2. Normal

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

Generally, the setting of 'Normal' is recommended except the case in which the special judging is needed

3. Slow

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

When the control becomes unstable and the hunting may occurs in the setting of 'Normal', the setting of this item may be useful. For example, this item may be

effective for using the control of the hydraulic shaker.

4. Specify (or Detail Definition button)

Control parameter set of Multi- axis / multi- point control speed is properly defined according to the setting of ‘Fast’, ‘Normal’ and ‘Slow’. However, this item is provided for the testing with a specimen which is too difficult to control by the setting of the standard items. With using this item, an operator can specify the control parameters of Multi-Shaker Control Speed by his own technique.

By selecting the ‘Specify’ or pressing the button of the [Detail Definition], the Detail Definition dialogue of Multi- axis / multi- point control speed appears . Then, the suitable values can be specified to each parameter.

The following items are provided for setting of Multi- Shaker Control Speed.

・Phase Change Speed

This parameter is for setting of the upper limit for the pursuing speed of the phase characteristic change in the controlled system at the control operation.

The Phase Control Speed is defined by ‘Std. Phase Change Speed’, ‘Min. Phase Change Speed’ and ‘Max. Phase Change Speed’, and these items has the different frequency band in which each of these items are valid.

When the change speed of the phase characteristic in the controlled system is slower than the set value of this item, the phase of the drive outputted to each shaker is changed according to the change speed of the controlled system. On the other hand, when the change speed of that is faster than the set value of this item, the phase of the drive is not changed faster than the set value.

Denoting the Std. Phase Change Speed as A [degree/cycle], Min. Phase Change Speed as B [degree/sec] and Max. Phase Change Speed as C [degree/sec], the frequency range (f[Hz]) in which each of these are valid can be expressed as below ;

Standard Phase Change Speed : $A/B[Hz] \leqq f \leqq A/C[Hz]$

Minimum Phase Change Speed : $f \leqq A/B[Hz]$

Maximum Phase Change Speed : $A/C[Hz] \leqq f$

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:

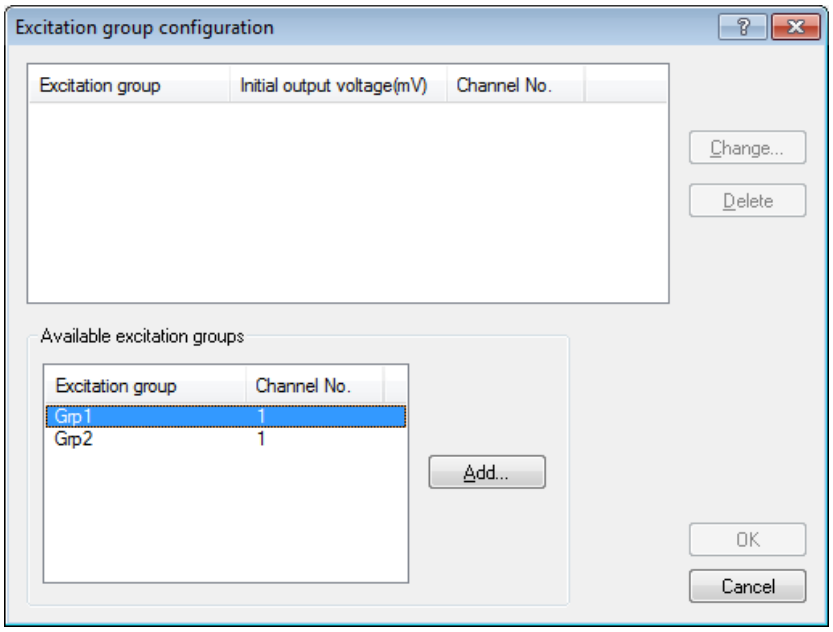
EXC_GRP A : Output Ch. OUTPUT 1 ⇔ shaker A1
: Output Ch. OUTPUT 2 ⇔ shaker A2
: Output Ch. OUTPUT 3 ⇔ shaker A3

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

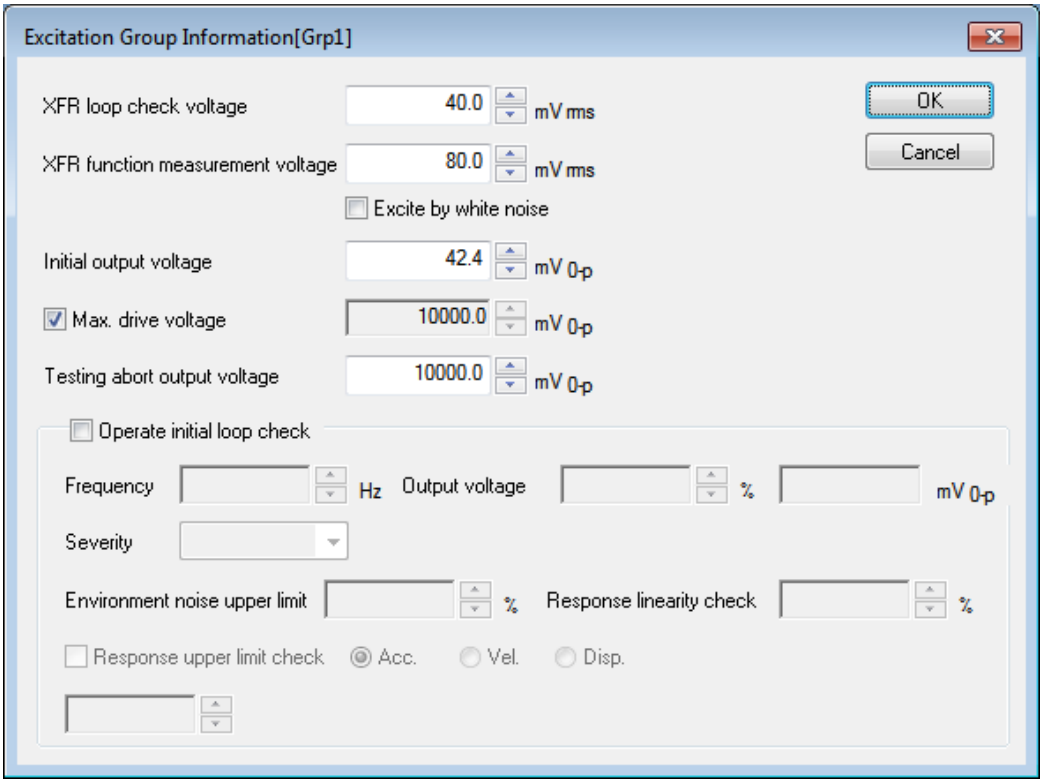
When the button [Add] or [Change] is pressed, the definition display of excitation system is shown. Necessary definition item for the excitation group can be set in this display.

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 XFR loop check voltage

(1) Meaning

The system checks whether the control loop is normal before XFR measurement.

The system outputs the drive of white-noize signal defined as 'XFR loop check voltage' for this loop check.

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 function measure 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 Initial output voltage

(1) Meaning

‘Initial output voltage’ is the voltage that outputted to the shaker at first in control operation. The control operation is always started at the drive voltage defined in this dialog when the excitation begins at zero of drive.

The value of this item is set to the voltage specified by the peak value (single amplitude value 0-p) of [mV] unit. When initial output voltage is not set, the value which is calculated as a peak value from the initial output voltage (Vrms) registered in Excitation System Information is automatically set to this item.

Note) **Initial output voltage should be set to an applicable value to the shaker.**

4.4.3.4 Max. drive voltage

(1) Meaning

This item is for setting of the value of Maximum drive voltage of this system. The drive signal of sinusoid exceeding over the set value of this system will not be outputted.

The following two methods are provided for setting of this item ; the method of using the system rating and setting of the voltage directly.

The system rating is specified as ‘Maximum output voltage’ in the excitation system rate information file which is used in the excitation environment file referred to in the test. Also, in setting of the voltage, the voltage exceeding over the system rating value cannot be set.

4.4.3.5 Testing abort output voltage

(1) Meaning

This item is for setting of the upper limit voltage of drive that allowed in test operation by the system.

The drive voltage to be outputted by the system is limited with in the set value of Max drive voltage. However, in the case that the voltage exceeding over the set value of Max drive voltage is required in operation, the system continues the test operation with ignoring the control result if the outputted voltage is within the set value of Test abort output voltage.

For example, even if a sharp notch exists in the transfer function of the controlled system and the voltage exceeding over the set value of Max drive voltage is required in sweep test, the system continues the sweep operation at that voltage by ignoring the control of the frequency when the voltage is within the set value of test abort output voltage. The sweep test is to be completed without aborting the test operation.

4.4.3.6 Operate initial loop check

(1) Outline

Two types of loop check are available in this system ;

A : Initial loop check

This loop check is operated just after the excitation start button was pressed in the waiting state for excitation start. Before the control operation start, the environment noise (ambient noise) inputted to the input channel is measured and the gain of the excitation system is checked whether it is normal or not.

B : Loop check (in operation)

The control operation is started when the system passes the initial loop check as in the above.

In operation, the system executes the loop check in every process of control operation to observe unusual phenomenon of gain change in the control loop at each time of response analysis operated very quickly.

This item is for setting of whether Initial loop check (A in the above) is operated or not before the control operation start.

Loop check in operation (B in the above) is always executed during the control operation.

Generally, Initial loop check should be set to operate.

Initial loop check is composed by a series of the processes as below ;

At first, the measurement of environment noise is executed, and the loop check at the specified initial loop check voltage is operated. Next, the measurement of system gain is executed by excitation operation at the specified frequency and voltage level.

When ‘Operate initial loop check’ is set to execute, the following items for initial loop check operation specifications are also to be defined.

4.4.3.6.1 Frequency

(1) Meaning

This item is for setting of the frequency of output voltage at initial loop check.

Generally, the setting of 40 [Hz] is applicable to electro-dynamic shaker

4.4.3.6.2 Output voltage

(1) Meaning

This item is for setting of the voltage level at initial loop check.

4.4.3.6.3 Severity

(1) Meaning

This item is for specifying the judgment criterion of unusual phenomenon in loop check.

Following three types are available in this system ;

1. Severe : The severest criterion is set.
   It can be used for a specimen with a small resonance characteristics and a good linearity.
2. Normal : The criterion allows an ordinary level of resonance characteristics and non-linearity.
3. Loose : The criterion allows a larger gain change.
   Use this criterion when loop check is failed even in setting 'Normal' caused by severe the characteristics of the specimen or setting of faster sweep rate etc.

4.4.3.6.4 Environment noise limit

(1) Meaning

This item is for setting of the upper allowance limit of the environmental noise (ambient noise) measured in initial loop check.

If the measured ambient noise exceeds over the set value of this item, the system stops the testing operation.

4.4.3.6.5 Response linearity check

(1) Meaning

This item is for specifying of judgment criterion of the response linearity in excitation of initial loop check.

When the response obtained by excitation of initial loop check exceeds over the set judgment criterion of this item, the test operation is to be aborted.

This item is selected from 'Normal',' Loose', 'Severe' and 'Specify'.

When 'Normal' or ' Loose' or 'Severe' is selected, the judgment criterion is set as follows ;

Response linearity check	Normal	Loose	Severe
Ratio of linearity [%]	50	20	70

4.4.3.6.6 Response upper limit check

(1) Meaning

This item is for specifying of the response abort level (the upper limit) in excitation of initial loop check.

When the response obtained by excitation of initial loop check exceeds over the set value of this item, the test operation is to be aborted.

4.5 Control reference

This item is for setting of the control reference, and the testing pattern us decided by this item.

For the definition of this item, because the definition format peculiar to each test type is needed, the different definition methods are provided for each test type.

However, the main definition contents for the control reference are basically the same for each test type.

For example, the items for the control reference definition are available as below ;

- Reference pattern (control reference frequency and control reference level)
- Test time (Excitation time)
- Abort / Alarm check level

The items in the above are defined in sweep test as below ;

Reference pattern is defined by a profile. Test time is specified by sweep times. And, abort / alarm check level is set by Tolerance definition.

In Spot test, the four items of the above are defined as components of the spot.

Refer to the description of each Test type about the detailed definition method.

4.5.1 Sweep test

(1) Outline

This item is for defining the control reference for Sweep test.

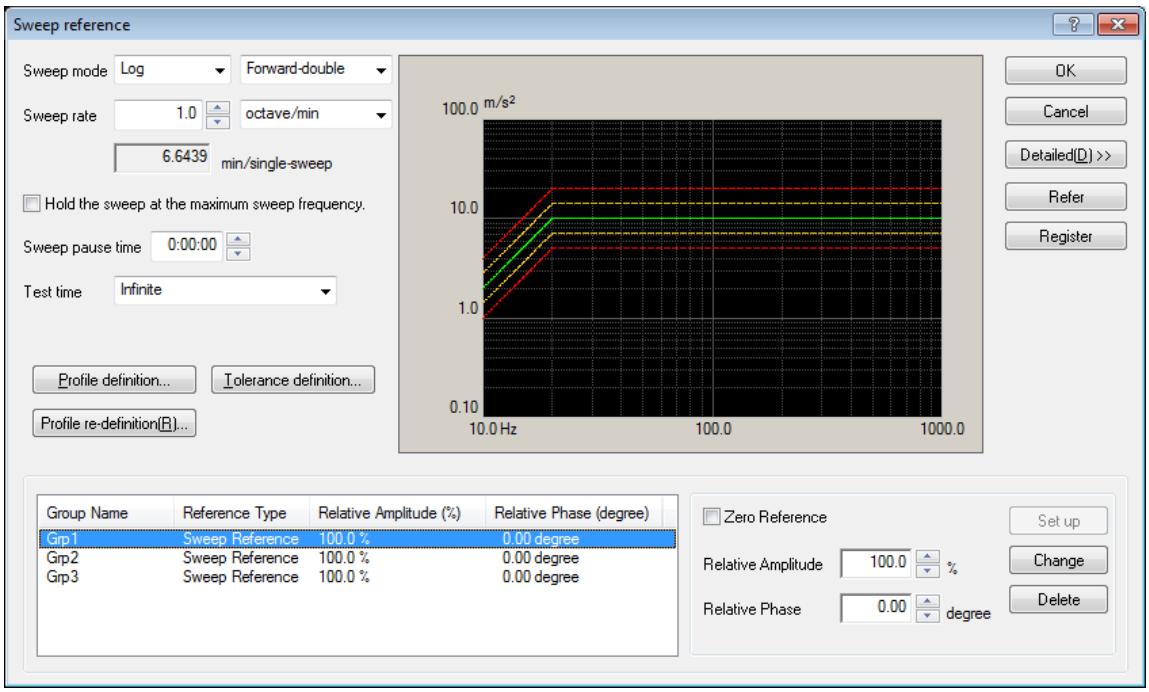
Sweep test is the most popular testing method in the sine vibration tests. In this test, the sine control is executed with changing the frequency continuously according to the specified condition.

The main definition items of control reference for Sweep test are classified as below ;

- Items for defining of Sweep condition and Test time
- Items for defining of Reference pattern
- Items for defining of Alarm / Abort check for the control response

As items for defining of Sweep condition and Test time, this system provides Sweep mode, Sweep direction, Sweep rate, Sweep pause time and Test time.

The reference pattern is defined by a profile and Alarm / Abort check of control response is defined by Tolerance.



4.5.1.1 Sweep mode

(1) Meaning

This item is for setting of the sweep mode by selecting among the two items as below ;

1. Linear

This item is for setting of the sweep mode of which frequency f varies proportionally to the elapsed time t, that is, the operation of 'Linear Sweep' to be done ;

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

Proportional constant R is 'Sweep rate' and is going to be set in the clause of 4.5.1.3.

2. Log sweep

This item is for setting of the sweep mode of which frequency f is expressed by an exponential function of the elapsed time t ;

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

That is, this Sweep is the type of which logarithm of frequency f varies proportionally to the elapsed time t, and it is called 'Log Sweep'.

Proportional constant R is 'Sweep rate' and is going to be set in the clause of 4.5.1.3.

4.5.1.2 Direction

(1) Meaning

When the sweeping operation is executed in the specified sweep band [f1, f2], one of the following for directions are to be selected ;

1. Forward single

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

f1→f2 , f1→f2 , f1→f2

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

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

2. Backward single

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

f2→f1 , f2→f1 , f2→f1

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

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

3. Forward double

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

f1→f2→f1→f2→f1→f2→

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

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

4. Backward double

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

f2→f1→f2→f1→f2→f1→

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

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

When the function of ‘Reverse’ is set to be used in Manual operation box, this item should be set to ‘double-sweep’.

4.5.1.3 Sweep rate

(1) Meaning

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

A : Specify the time to complete one sweeping operation.

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

In the setting method A, Sweep rate is specified by time, so that the same unit can be used either the mode of sweep is set to ‘Linear Sweep’ or ‘Log Sweep’.

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

min / single-sweep

The setting method B, each unit is different as follows according to the different mode of sweep ;

Linear Sweep : Hz / sec

Log Sweep : octave / min

In the case of Log Sweep, a unit of ‘decade / min’ can be used as a Sweep Rate unit. In this case, use the following calculation ;

1 decade/min = 3.3219 octave/min (2.5.3)

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

The testing operation is the setting of a fast Sweep rate realizes a sweep in a short time. But note that, a too fast sweep can make only an insufficient stimulation of specimen at each frequency.

4.5.1.4 Hold the sweep at the maximum sweep frequency

(1) Meaning

The excitation is executed at the maximum frequency for the defined time when the control reference reaches its maximum in sweeping operation. Then, the system returns to the sweeping operation after completing the defined time. The time to operate the fixed excitation is defined by Sweep pause time.

The operation of ‘Sweep hold/cancel’ is invalid during the excitation at the maximum frequency. Also, the function of ‘Sweep pause time’ cannot be usable when this function is adopted.

4.5.1.5 Sweep pause time

(1) Meaning

This item is for setting of the time for signal output stop (Sweep pause time) at the turning of the sweeping between the points at the ending of a sweep and at the beginning of the next sweep.

The excitation stops for the set time of this item at the turning point of sweeping.

4.5.1.6 Profile definition

(1) Outline

This item is for setting of the break point definition of control reference.

The unit level in profile is specified as the same unit as the unit defined in Fundamental/Control Condition.

Refer to "4.5.3 Profile definition" about the details.

4.5.1.7 Tolerance definition

(1) Outline

This item is for defining the condition of Tolerance check.

Refer to "4.5.4 Tolerance definition" about the details.

4.5.1.8 Test time

(1) Meaning

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

In this system, the following items are provided as the setting method of Test time.

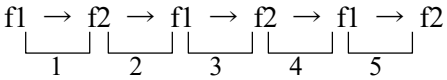
1. Specify by the times of single-sweep

This method is for specifying of the times of single-sweep.

Test time is regulated as an integer number of single-sweep by setting this item. A test finishes just at the turning point of the sweep.

Either 'single-sweep' or 'double sweep' is used as the unit of a sweep according to the setting of direction.

For example, thinking of a sweeping operation condition that the direction is set as 'Forward double' in the sweep band [f1, f2]. The sweeping is operated as below with specifying 'single-sweep' as the unit of sweeping and setting the sweep times to 5 ;



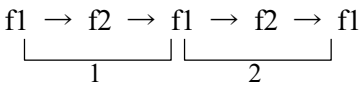
2. Specify by the times of double-sweep

This method is for specifying of the times of double-sweep.

Test time is regulated as an integer number of double-sweep by setting this item. A test finishes just at the turning point of the sweep.

‘double sweep’ is available to be selected only when the direction is specified as ‘Forward double’ or ‘Backward double’. And ‘double-sweep’ is used as the unit of a sweep.

The sweeping is operated as below with specifying ‘double-sweep’ as the unit of sweeping and setting the sweep times to 2 ;



3. Specify by time

This method is for specifying of time for excitation.

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

Two setting methods by time are usable. And the example of a Test time to be set for 1 hour is described as below ;

- Set time by seconds : input ‘3600’
- Set time as hhh:mm:ss with using colons (:) : input ‘1:0:0’

4. Specify by the vibration cycle

This method is for specifying of vibration cycle by excitation (1 time or 1000 times for a unit).

When the set times of vibration cycle have been counted, the test operation is finished even in the middle of a sweep.

5. Infinite

‘Infinite’ means not to specify the finishing condition of a test in this item.

When this method is selected, the system continues the sweep excitation according to the set condition until the order of [Stop] is done or other equivalent operation is carried out.0

4.5.1.9 Zero Reference

(1) Meaning

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 is required basically. Then the reference of response points corresponding to the other excitation axes are to be set to have all ‘zero’ data.

When this item is selected, refrence of the selected excitetion group is set ‘zero’ refrence.

4.5.1.10 Relative Amplitude

(1) Meaning

This item is for setting of the control reference level for the Excitation Group.

The level is set as a relative value(%) to the control reference of the whole testing.

4.5.1.11 Relative Phase

(1) Meaning

This item is for setting of the phase of the control reference for the Excitation Group.

The phase is set as a relative value to the control reference of the whole testing which is specified as ‘zero degree’.

4.5.2 Spot test

(1) Outline

This item is for defining the control reference for Spot test.

In Spot test, the frequency and the reference level at which the excitation is executed are specified at first, and the testing operation of the set condition is executed in order. Therefore, the sweeping is not done in Spot test.

In the control reference definition of Spot test, the frequency for the excitation and the reference level are specified directly.

In this system, the control reference of Spot test is specified by a set of data composed with Frequency, Reference level, Stay time and Alarm/Abort level. This set of data is called 'Spot elements'.

Spot elements : ① Frequency
② Level
③ Stay time
④ Alarm / Abort level

In the case of Spot test, the frequency for each spot is completely independent. Therefore, it is not necessary to set the frequency of each spot in order.

Stay time can be specified by time or also can be specified by vibration counts. Unlike other tests, the item for the setting of 'Test time' is not existing for Spot test. The sum of the defined Spot Stay time has the same meaning as 'Test time' for others.

When 'Unit' in definition is set as 'Acceleration/Velocity/Displacement', the dimension of the reference level value can be selected among 'Acceleration/Velocity/Displacement' independently for each spot.

Expressing the n number of spots as SP#n, for example, it is possible to set '1000 Hz and 10 m/s^2 of acceleration' at SP31 and '200 Hz and 2mm of displacement' at SP#2.

The maximum number of spot element to be defined is **9999**.

In this system, the collection of the multiple defined spot elements is called 'Spot sequence'.

The defined Spot sequence is operated in order from the lower numbers.

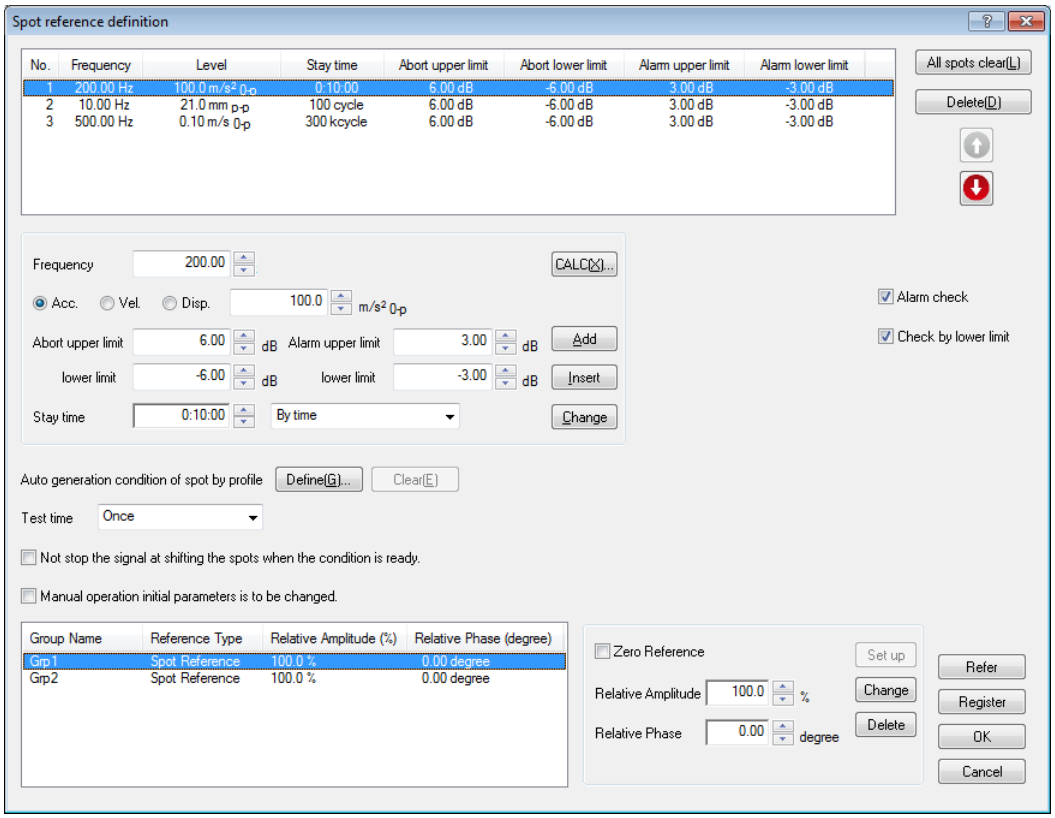
And the defined Spot sequence can be repeated by the set time as a whole.

4.5.2.1 Spot Reference definition

(1) Meaning

This item is for defining the spot element.

The buttons described as below are usable in the definition dialog.



Spot elements can be registered for maximum **9999**.

[Add] : This button is for registering of a new spot element.
A spot element is to be registered and displayed in the list of the definition by pressing of this button after the necessary items to define a spot element such as frequency and reference level were set.

[Change] : This button is for changing of the contents of a registered spot element.
Select a spot element to be changed and correct the contents of the values. And press this button to register the changed spot element.

[Delete] : This button is for deleting a registered spot element.
A spot element selected in the list is to be deleted by pressing this button.

4.5.2.1.1 Frequency

(1) Meaning

This item is for setting of the excitation frequency of a spot element.

4.5.2.1.2 Level

(1) Meaning

This item is for setting of the reference level for the spot element.

The unit or the reference level is to be selected among 'Acceleration / Velocity / Displacement' when the unit used in definition is specified as one of 'Acceleration / Velocity / Displacement' and the drive signal is not used as the reference.

The function of [CALC] is usable for the conversion calculation between 'Acceleration / Velocity / Displacement'. This function can be used by pressing the [CALC] button.

Refer to "4.5.5 CALC function" about the details.

4.5.2.1.3 Abort / Alarm level

(1) Meaning

This item is for setting of Alarm / Abort level for a spot element.

The check level is set by the relative value to the reference level of a spot element.

The function of Alarm and Abort are provided for check in the system. The function of Alarm does not have to be set is it is not necessary.

The meaning of 'Alarm' is that the system sounds an alarm when a response exceeding over the range of the set condition is detected.

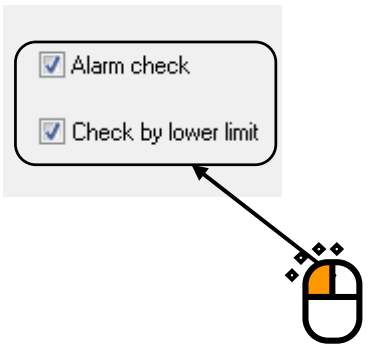
And the meaning of 'Abort' is that the system stops the testing operation (the signal output is stopped when a response exceeding over the range of the set condition is detected.

The lower limit of the check level does not have to be set if it is not necessary.

Abort / Alarm level should satisfy the relations as below ;

- Alarm upper limit ≦ Abort upper limit
- Abort lower limit ≦ Alarm upper limit

Alarm check level and Abort lower limit level can be inputted when the check boxes of 'Alarm check' and 'Abort check' are set to 'ON'.



4.5.2.1.4 Stay time

(1) Meaning

This item is for setting of Stay time for a spot element.

Stay time is to be measured when the excitation level is set as the specified level and the control becomes stationary.

4.5.2.2 Auto-generation condition of the spot by profile

(1) Outline

This function is for generating the fixed frequency excitation of the frequency sequence defined by the specified spacing.

Because the frequency spacing is specified by the constant ratio or the constant interval, the sweep operation (Log/Linear) that is executed continuously in a general sweep test is executed discontinuously. Fixed frequency is operated in order by sine control.

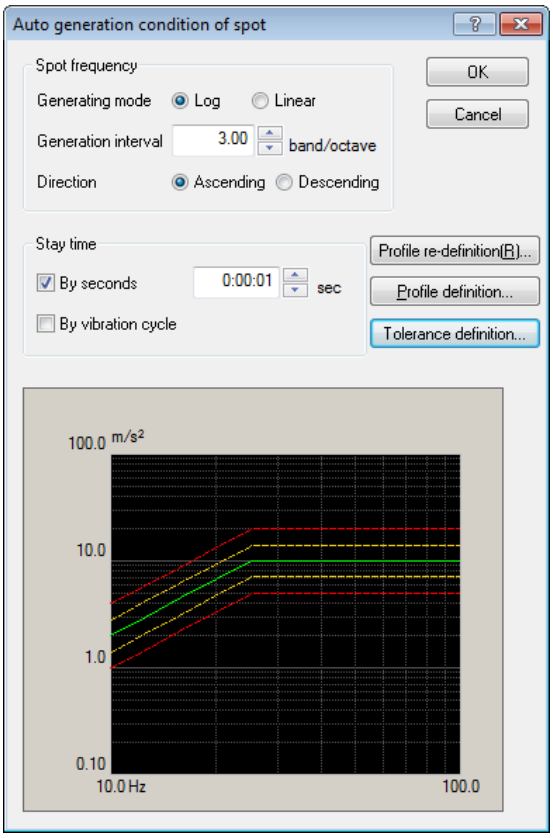
Control reference definition at auto-generation of spot is the same as that of sweep test fundamentally.

For example, the control pattern in Step sweep test is defined by profile and Alarm / Abort check of control reference is defined by Tolerance.

However, the definition part concerning to Sweep rate is different from that of sweep test.

Auto-generation of spot has no concept of Sweep rate because the operation is executed by the fixed frequency excitation.

The equivalent item to Sweep rate in Auto-generation condition of the spot is the definition of step interval and Stay time (excitation time) at each step.



4.5.2.2.1 Generating mode

(1) Meaning

Available generation modes of spot are ‘Log (equivalent ratio)’ and ‘Linear (equivalent ratio)’.

4.5.2.2.2 Generation interval

(1) Meaning

This item is for defining of the frequency interval at each spot.

The definition methods are different according to the Generating mode. Spot interval is set by ‘equivalent interval’ (Hz) when ‘Linear’ is specified as Generating mode and ‘equivalent ratio’ (band/octave) when ‘Log’ is specified as Generating mode.

4.5.2.2.3 Direction

(1) Meaning

This item is for setting of the direction for auto-generation of spots.

Two directions are available for the reference defined in the profile definition ;

Generating the spot from lower to higher frequency (ascending)

Generating the spot from higher to lower frequency (descending)

4.5.2.2.4 Stay time (By seconds)

(1) Meaning

This item is for specifying the stay time of excitation at each spot frequency by seconds.

Excitation time at each spot is specified by the number of vibration cycle in this item and the next item. And these items become valid in different frequency bands.

Denoting the second as St [sec] and the vibration cycle as Sc [cycle]. When both this item and the next item are defined, the excitation time T of spot at the excitation frequency f [Hz] is obtained as below ;

$$T = \max[St, Sc/f] \text{ [sec]} \qquad (a)$$

The measurement of Stay time is executed when the excitation level comes to the specified reference level and the control becomes to stable.

4.5.2.2.5 Stay time (By vibration cycles)

(1) Meaning

This item is for specifying the stay time of excitation at each spot frequency by vibration cycles.

Excitation time at each spot is specified by the number of vibration cycles in this item and the prior item. And these items become valid in different frequency bands.

Denoting the second as St [sec] and the vibration cycle as Sc [cycle]. When both this item and the next item are defined, the excitation time T of spot at the excitation frequency f [Hz] is obtained as below ;

$$T = \max[St, Sc/f] \text{ [sec]} \qquad (a)$$

The measurement of vibration cycle is executed when the excitation level comes to the specified reference level and the control becomes to stable.

4.5.2.2.6 Profile definition

(1) Meaning

Refer to “4.5.3 Profile definition”.

4.5.2.2.7 Tolerance definition

(1) Meaning

Refer to “4.5.4 Tolerance definition”.

4.5.2.3 Test time

(1) Meaning

This item is for setting of the repeat times of defined spot sequence.

1. Once (no repetition)

   When this item is selected, the test operation is completed after executing the defined spot sequence for one time.

2. Infinite

   The repeat times of the spot sequence is set to infinite, that is, the condition of the test completion is not set. When ‘Infinite’ is selected, the spot sequence is repeated until [Stop] is pressed or the equivalent command as stop is executed.

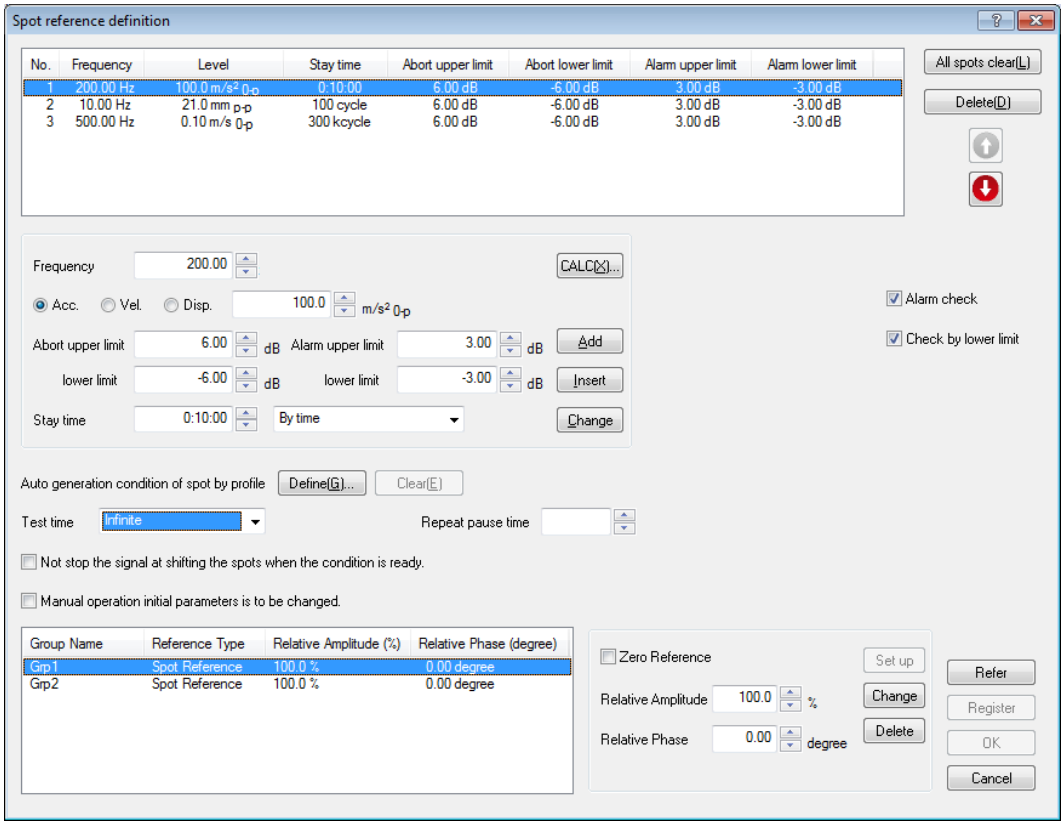
3. Specify by repeat times

   When this item is selected, the test operation is completed after repeating the defined spot sequence for the specified times.

4.5.2.4 Repeat pause time

(1) Meaning

This item is for setting of the time for the signal output stop at the turning point if the spot sequence. The excitation is stopped at the turning point of the spot sequence for the specified times. This item is valid when Test time is set to 'Infinite' or 'Specify by repeat times'.



4.5.2.5 Not stop the signal at shifting the spots when the condition is ready

(1) Meaning

In Spot test, the excitation is generally stopped for safety at shifting between the spots.

However, this function is for operating the test without stopping the excitation at shifting between the spots within the frequency ratio specified in this item.

4.5.2.6 Manual operation initial parameters is to be changed

(1) Meaning

This function is for starting the excitation at the lower reference level specified in this item. This item is for setting of the increase/decrease value of reference level for every operation in Manual operation box.

4.5.2.7 Zero Reference

(1) Meaning

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 is required basically. Then the reference of response points corresponding to the other excitation axes are to be set to have all ‘zero’ data.

When this item is selected, refrence of the selected excitetion group is set ‘zero’ refrence.

4.5.2.8 Relative Amplitude

(1) Meaning

This item is for setting of the control reference level for the Excitation Group.

The level is set as a relative value(%) to the control reference of the whole testing.

4.5.2.9 Relative Phase

(1) Meaning

This item is for setting of the phase of the control reference for the Excitation Group.

The phase is set as a relative value to the control reference of the whole testing which is specified as ‘zero degree’.

4.5.3 Profile definition

(1) Outline

Reference pattern is defined by ‘Profile’ in Sweep test.

‘Profile’ is a table in which the series of break points specified by the frequency data and the level are defined.

In K2 application, three methods of sweep reference definition are available for ‘Profile’ definition as below ;

Simplified definition (Specify by level and frequency range only)

Detailed definition (Break point)

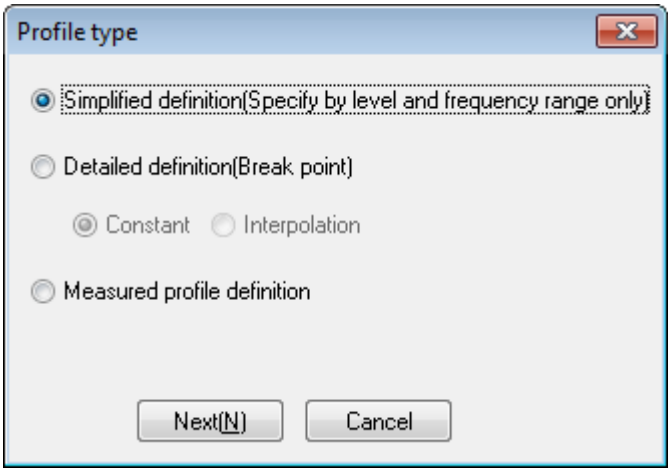
And Detailed definition (break point) has two types of the definition method according to the types of data interpolation between the break points as below ;

‘Constant’ / ‘Interpolation’

Maximum **256** of break points are available to register when ‘Profile’ is defined by the method of detailed definition.

The defined ‘Profiles’ can be saved and registered in a file in this system. The registered ‘Profiles’ are available to be referred to easily in other tests.

The registered ‘Profile’ can be referred to use in a test or the defined ‘Profile’ can be saved and registered in a file by using the push buttons in the dialog of profile definition as below ;



4.5.3.1 Simplified definition

(1) Meaning

Generally, the Sine vibration test is executed by using the quantity of 'Acceleration / Velocity / Displacement' as a reference level, and the reference profile of sweep sine vibration test is defined as follows in the most cases ;

< Example >

A sweep sine vibration test having 1 mm of amplitude and 20 m/s^2 of acceleration value is operated in 10 Hz ～ 2000 Hz of frequency band.

In lower frequency range, the excitation is started from 1 mm of amplitude. When it reaches at a certain frequency, the excitation is proceeded to have 20 m/s^2 of acceleration.

However, in this case, 'a certain frequency' as in the above should be the frequency to have 20 m/s^2 of acceleration and just 1 mm of amplitude.

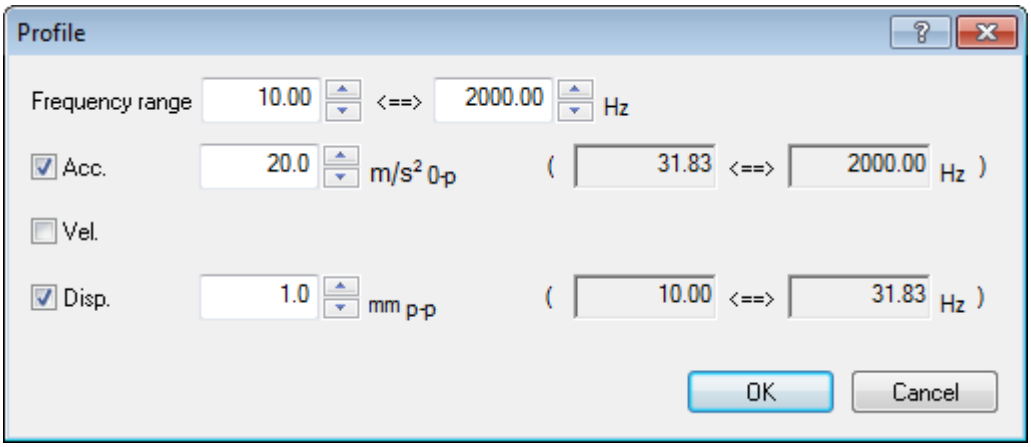
'A certain frequency' in the above is generally called 'cross-over frequency' or 'break point frequency'.

In simplified profile definition, the cross-over frequency is automatically obtained to define the profile only by setting the 'frequency band' and the level of 'Acceleration / Velocity / Displacement'.

Cross-over frequency can be obtained by using [CALC] function in general definition. However, it can be defined more easily by using simplified profile definition.

In this example, the level of 'Acceleration / Displacement' is specified. All the physical quantities can be set as the level and can be specified as any combination among 'Acceleration / Velocity / Displacement'. However, at least one physical quantity is needed to be set as the level.

This function is also usable when another physical quantity other than 'Acceleration / Velocity / Displacement' is set as the level. In such a case, the profile is defined to have the constant level of the set quantity in the specified frequency band.



4.5.3.2 Detailed definition (Constant)

Constant profile is a traditional and the most popular definition method in Sine vibration test, and it defines the level to keep the definition quantity at the constant value in each segment dividing the test range on the frequency axis into some segments.

When a reference level to keep the definition quantity at the constant value in each segment is defined, this level defined at a break point specifies the level in the whole range of the current segment extended to the next break point.

Physical quantity of level can be selected among 'Acceleration / Velocity / Displacement' when the physical quantity is specified one of 'Acceleration / Velocity / Displacement'.

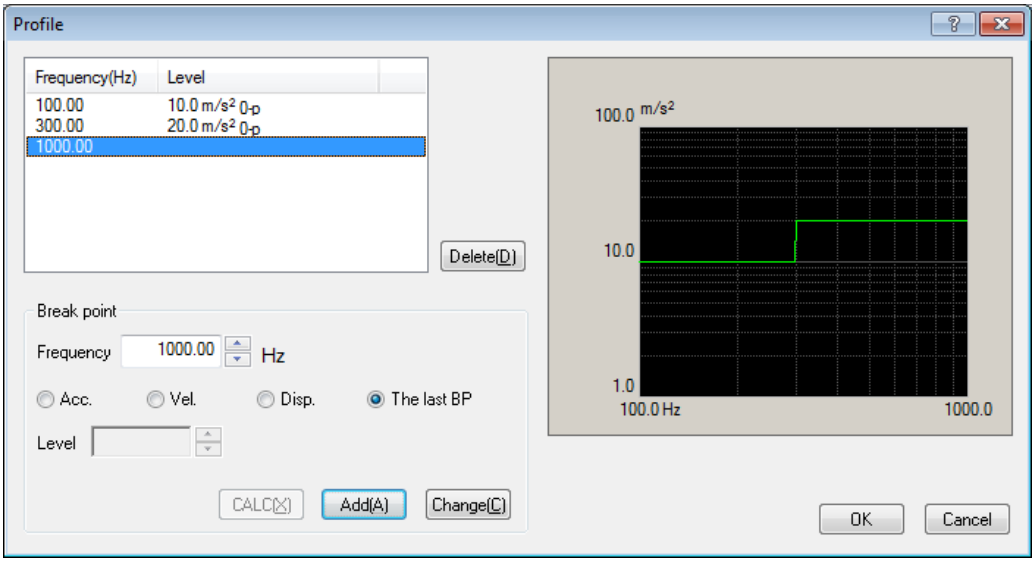
However, the same physical quantity as the specified one must be set when the other physical quantity than these values is specified.

<Example 1>

100[Hz]～300[Hz] : 10 [m/s^2] Constant

300[Hz]～1000[Hz] : 20 [m/s^2] Constant

1000[Hz] : The last break point



< Example 2 >

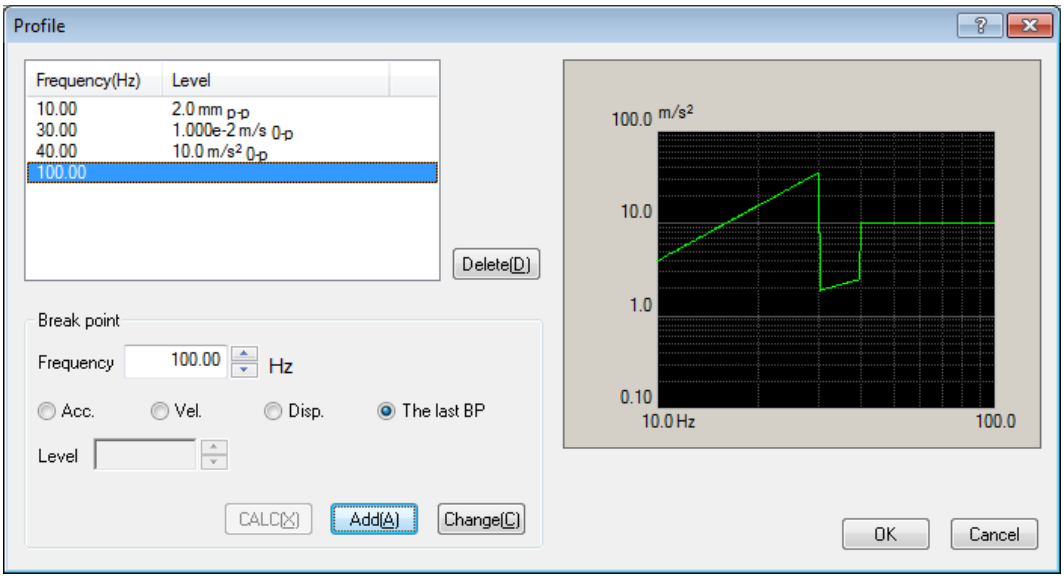
10[Hz]～30[Hz] : 2.0 [mm] Constant

30[Hz]～40[Hz] : 1.0 [cm/s] Constant

40[Hz]～100[Hz] : 10 [m/s^2] Constant

100[Hz] : The last break point

Note) The vertical axis displays the control unit in the graph of profile.



4.5.3.2.1 Break point / Frequency (Constant)

(1) Meaning

A pair of the frequency data and the reference level data that specifies the border of each segment is set from the lower frequency range in order as a break point data.

However, the same break point frequency as the registered one or very close break point frequency to the registered one (within 0.999 ~ 1.001 times) can not be asses as a break point data.

4.5.3.2.2 Break point / Level (Constant)

(1) Meaning

A pair of the level data in each segment and the reference level data in the above is set from the lower frequency range in order as a break point data.

The reference level set in this item is used as the reference value of the segment which has the current break point as the beginning edge and the next one as the ending edge.

When the physical quantity is specified among ‘Acceleration / Velocity / Displacement’, the physical quantity for the set level can be selected to a one among ‘Acceleration / Velocity / Displacement’.

The [CALC function] is usable for the conversion calculation between ‘Acceleration / Velocity / Displacement’. The [CALC function] can be used by pressing the [CALC] button. Refer to “4.5.5 CALC Function” about the details.

4.5.3.3 Detailed Definition (Interpolation)

Interpolation profile has a generalized concept of the constant profile which is popularly used.

The value on the straight line that connects the two adjoining break points in the frequency level plane defines the level for each frequency point in the current segment.

The level is always needed to be set as the same physical quantity. Other physical quantities than the specified one cannot be used.

This definition method is similar to the reference definition method in the random vibration test (only the physical quantity of the vertical axis is different).

In the Interpolation profile, different from the constant profile, the last break point has the same meaning as other break points.

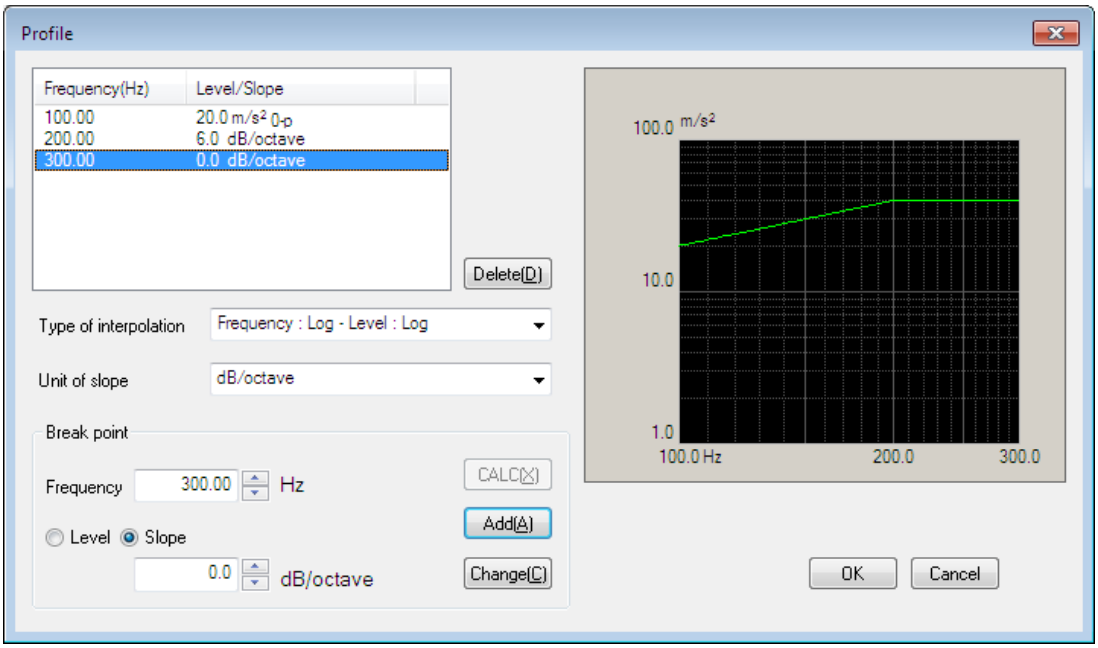
The test in which the quantity is defined by acceleration in the B.P. Connect profile is also called 'Acceleration break point test'.

< Example >

100[Hz] : 2.0 [m/s^2]

200[Hz] : 6 [dB/octave]

300[Hz] : 0 [dB/octave]



4.5.3.3.1 Type of interpolation

(1) Meaning

In this item, interpolation method between the break points is selected among the followings. Also, the initial graph scale (Log or Linear) is set to the same as that of the selected type.

- Frequency : Log – Level : Log
- Frequency : Log – Level : Linear
- Frequency : Linear – Level : Log
- Frequency : Linear – Level : Linear

4.5.3.3.2 Unit of slope

(1) Meaning

Unit of slope is specified. The available units are different as follows according to the selected type of interpolation.

- Frequency : Log – Level : Log → 'dB/octave', 'dB/decade'
- Frequency : Log – Level : Linear → 'control unit/octave ', 'control unit/decade'
- Frequency : Linear – Level : Log → 'dB/Hz'
- Frequency : Linear – Level : Linear → 'control unit/Hz'

4.5.3.3.3 Break Point / Frequency (Interpolation)

(1) Meaning

A pair of the frequency data and the reference data that specify the border of each segment is set from the lower frequency side in order as the break point data.

However, the same break point frequency as the registered one or a very closer break point frequency to the registered one (within 0.999 1.001 times) can not be added as a break point data.

4.5.3.3.4 Break Point / Level (Interpolation)

(1) Meaning

The level data in each segment which is treated as the break point data and makes a pair with the frequency data in the above clause is set from the lower frequency range in order.

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

The reference level set in this item is used as the reference value of the segment which has the current break point as the beginning edge and the next one as the ending edge.

Different from the constant profile, the physical quantity for the set level can be specified as a one of the physical quantities when the physical quantity is specified as ‘Acceleration / Velocity / Displacement’. The [CALC function] is usable for the

conversion calculation between ‘Acceleration / Velocity / Displacement’. The [CALC function] can be used pressing the [CALC] button.

Refer to “4.5.5 CALC function” about the details.

4.5.3.3.5 Break Point / Slope (Interpolation)

(1) Meaning

At registering of the break point data, the slope data corresponding to the frequency data is inputted.

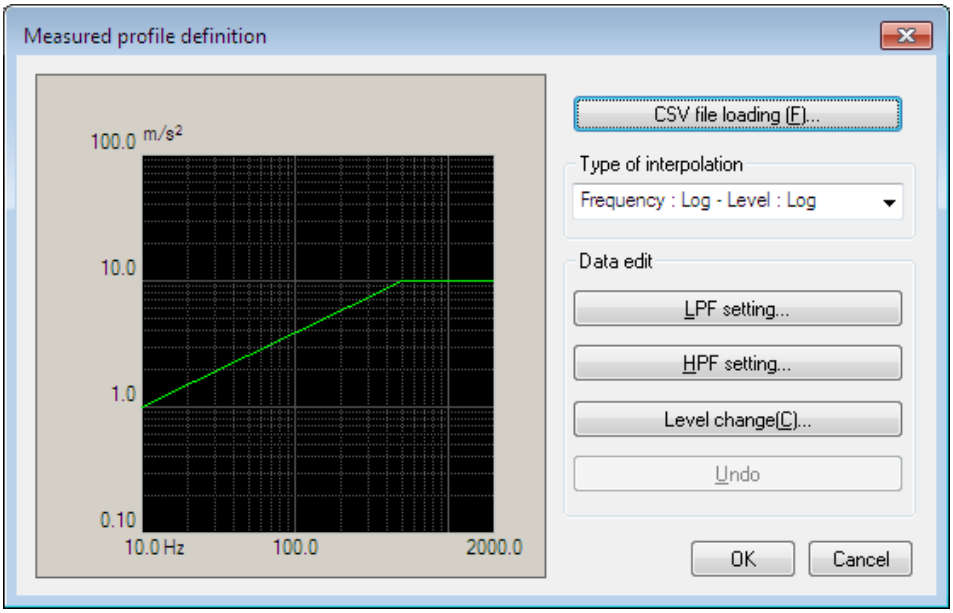
The slope value can be inputted to this item by pressing of the [Slope] button.

4.5.3.4 Measured Profile Definition

An original data file of CSV format written as the specified format or a properly processed data as the demands is used as the reference data. See the common operation manual about the format in detail.

4.5.3.4.1 Outline

Reference profile is defined by using measured data.



<Data File Selection>

Data file can be selected by pressing the button [CSV File open].

Selection of data file appears.

<Type of interpolation>

Interpolation method between the loaded data can be selected.

<Data Processing>

Loaded data can be processed by using the buttons for Data processing.

[LPF setting] : This button is for processing the data by Low Pass Filter.

[HPF setting] : This button is for processing the data by High Pass Filter.

[Level change] : This button is for changing Level by ratio.

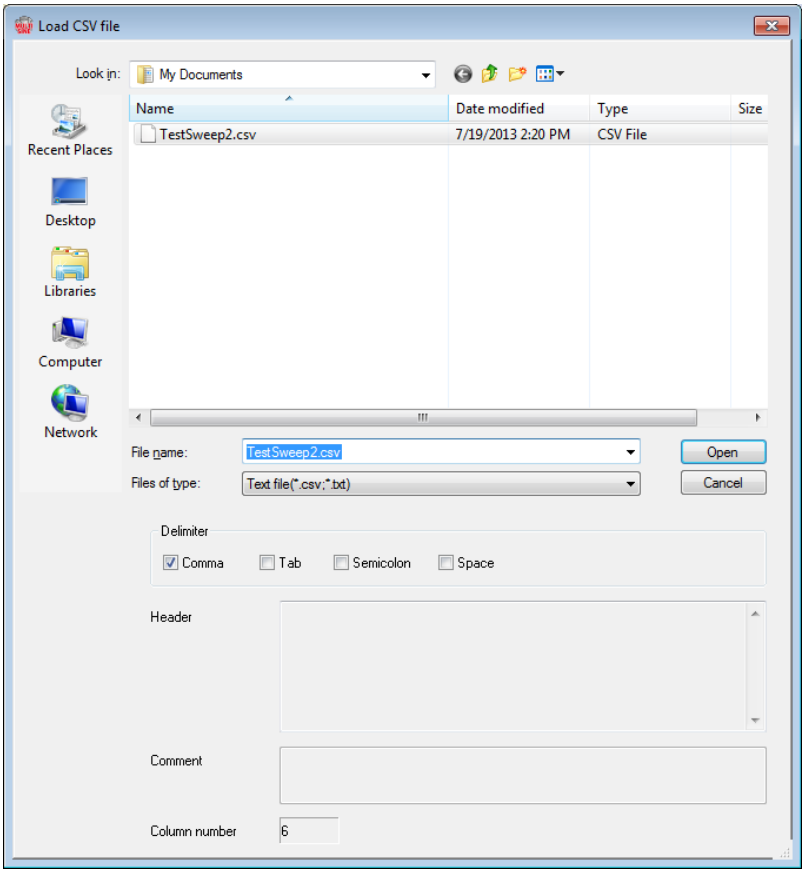
[Undo] : This button is for canceling the editing operation by these buttons in the above and returning to the former state.

4.5.3.4.2 Load the Data File

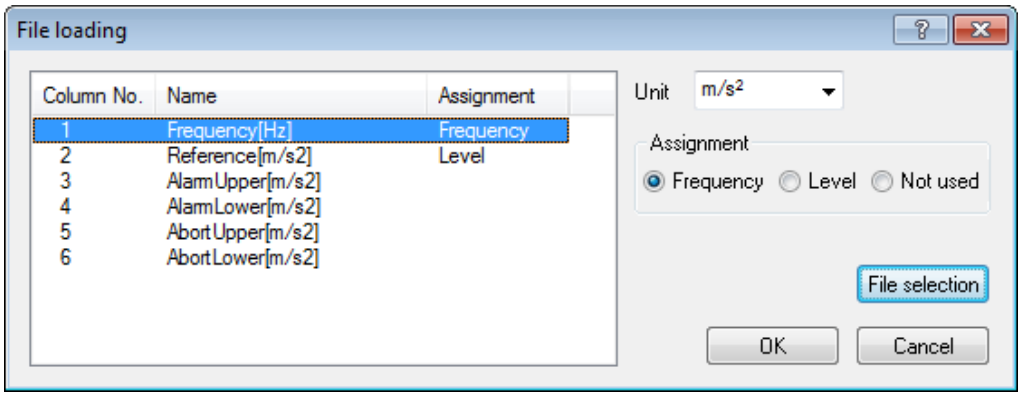
(1) Meaning

CSV Data File used as the reference profile is selected.

When the [CSV File open] button in the dialog of Measured Profile Definition is selected, the dialog box for selecting CSV File appears.



Select a data file to be referred to. And select a data to be used for the definition among the data described in the data file.



<Unit>

This item is for selecting the level unit of the data file.

<Configuration>

The data line corresponding to the frequency data is selected among the data.

<Level>

The data line corresponding to the level data is selected among the data.

4.5.3.4.3 Type of interpolation

(1) Meaning

When the data to be used is specified, the measured data is displayed and the type of interpolation can be selected.

In this item, interpolation method between the loaded data is selected among the followings. Also, the initial graph scale (Log or Linear) is set to the same as that of the selected type.

- Frequency : Log – Level : Log
- Frequency : Log – Level : Linear
- Frequency : Linear – Level : Log
- Frequency : Linear – Level : Linear

4.5.3.4.4 Data Processing

(1) Meaning

When the data to be used is specified, the measured data is displayed and the buttons for Data processing turn to valid in the definition dialog.

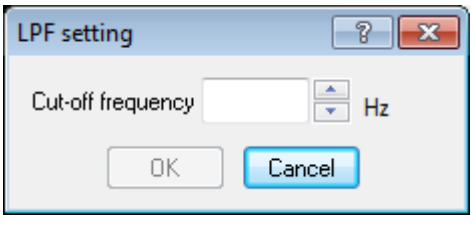
Select a necessary button to process the data, as you need.

4.5.3.4.4.1 LPF (Low Pass Filter) Setting

(1) Meaning

This item is for processing the data by Low Pass Filter.

When the [LPF setting] button is pressed, the dialog box of LPF setting appears.



- Cut-off Frequency

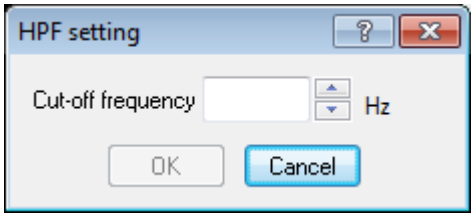
Input the value of cut-off frequency for filtering process.

4.5.3.4.4.2 HPF (High Pass Filter) Setting

(1) Meaning

This item is for processing the data by High Pass Filter.

When the [HPF setting] button is pressed, the dialog box of HPF setting appears.



・Cut-off Frequency

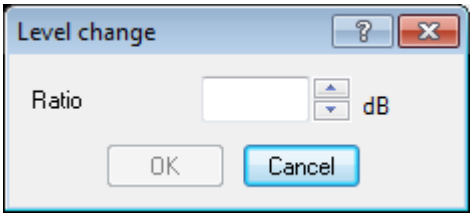
Input the value of cut-off frequency for filtering process.

4.5.3.4.4.3 Level Change

(1) Meaning

This item is for changing the data level by ratio.

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



・Ratio

Specify the data level by the relative value of the original data.

4.5.3.4.5 CSV data file (Measured profile)

(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.

4.5.4 Tolerance definition

(1) Outline

In the operation of the vibration test, it may be difficult to realize the response level that coincide with the reference just as it is required according to the condition of the specimen (sharpness of resonance, having the non-linearity components).

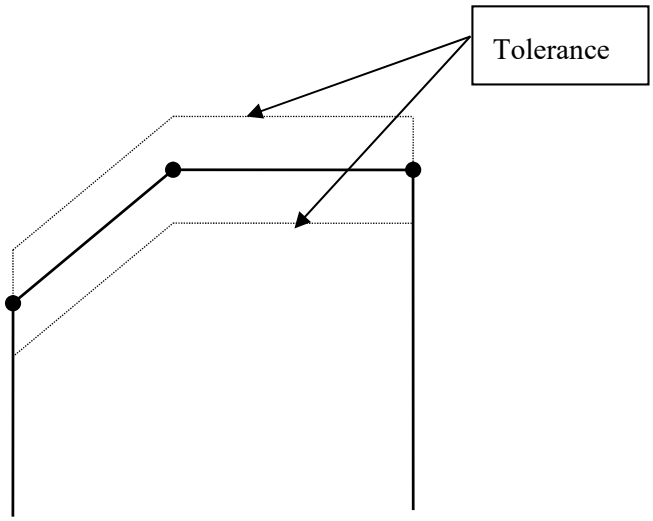
Therefore, the condition for continuing the testing such a case is needed to be defined in advance. This judgment criterion is called Tolerance in this system.

Here, 'Alarm' means that this system sounds an alarm (buzzer) when the response quantity that exceeds over the level of the set condition is detected. And 'Abort' means that the test operation is aborted (the signal output is stopped) when the response quantity that exceeds over the level of the set condition is detected.

Tolerance check is executed only in the band where the profile exists.

In this system, Tolerance is defined in the band based on the rule as below ;

Rule : Tolerance is defined by the relative value (dB value, etc.) to the profile independent of the frequency range of the profile or the break point definition.



4.5.4.1 Tolerance

(1) Meaning

The condition of Tolerance in the whole frequency band is defined in standard definition.

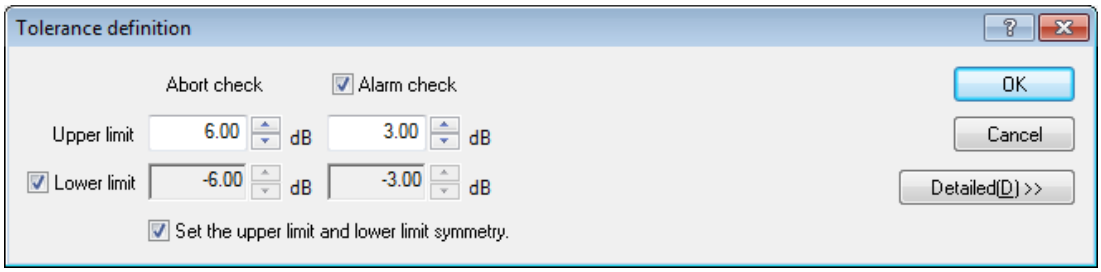
< Level>

Alarm / Abort level for monitoring the deviation from the profile are specified.

Level is specified by a relative level to the profile.

At the setting of Alarm check, the following relation should be satisfied between Alarm and Abort levels.

|Alarm check level ≦ |Abort check level|



4.5.5 CALC Function

(1) Meaning

In the sine vibration test, one vibration state is usually defined by using one of the quantities as Frequency f, Acceleration Acc and Displacement Disp.

Therefore, the conversion calculation between these quantities (Acc / Vel / Disp) is needed to be done quickly.

In this program, a convenient function called 'CALCULATOR' is provided for this purpose.

The method for using this function is described as below ;

Denoting the frequency as f and the amplitude (displacement) as D, a sine vibration is expressed as below ;

$$x(t) = D \cdot \sin(2 \pi ft)$$

In this expression of the above, the following relations between the acceleration amplitude A, the velocity amplitude V and the displacement amplitude D stand ;

$$V = (2 \pi f)D$$

$$A = (2 \pi f)V$$

The function of CALCULATOR is for calculating easily the other two quantities from the two quantities given arbitrary among the four quantities (f, A, V, D).

However, following the custom, the displacement amplitude is expressed by the peak-to-peak (p-p) expression (2D) in this system.

< Example >

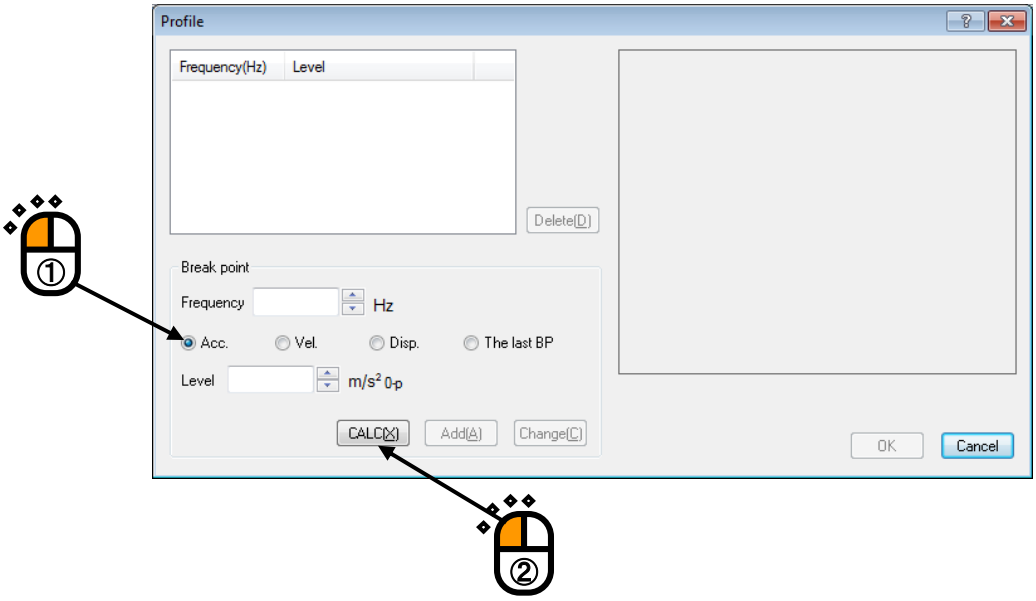
The setting of items as ‘Sweep reference – Detailed definition (break point) – Constant’ are executed.

When f = 100 Hz, V = 120 cm/s are given, the acceleration A [m/s^2] is to be calculated. And the break point is inputted by the acceleration.

< Procedures >

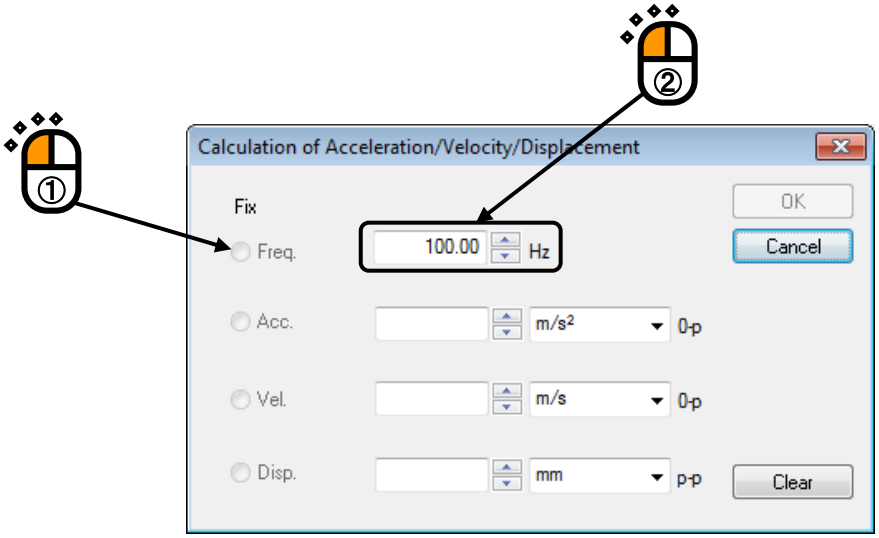
< Step 1 >

Select an input unit of level as [Acc. (Acceleration (m/s$^2_{0\text{-}P}$)] and press the [CALC] button.



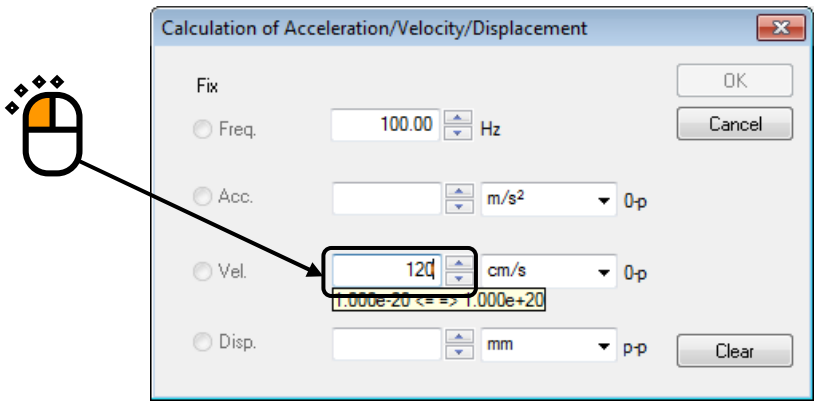
< Step 2 >

The ‘fixed’ Frequency (Freq.) is selected and input 100 to this item.



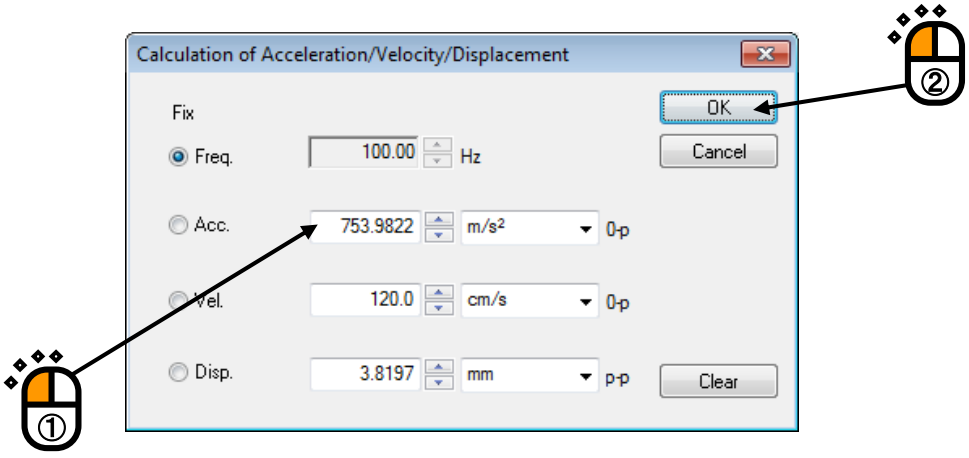
< Step 3 >

Input 120 to the item of Velocity (Vel.).



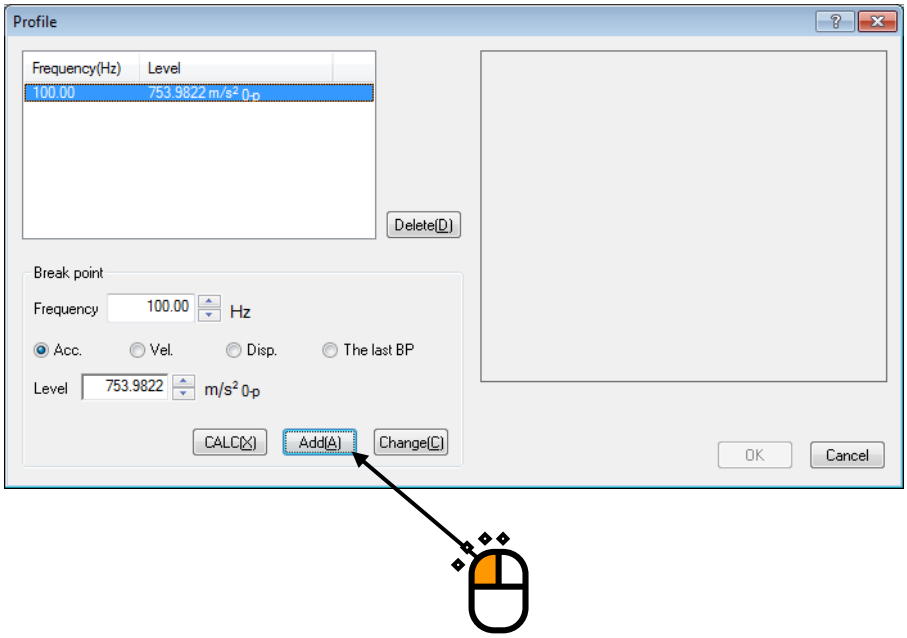
< Step 4 >

Calculation results of Acceleration and Displacement are displayed when the value of Velocity was inputted. Then press [OK].



< Step 5>

Input the value of the break point by pressing of the [Add] button.



4.6 Input Channel

4.6.1 Outline

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

- Principal Control channel
- Control channel
- Monitor channel

<Principal 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 Principal Control channel among the other control channels in the system.

At least one principal control channel is needed to be defined among the all control channels belonging to one excitation group. Normally, one principal control channel is enough to be set.

In this system, the control reference is set for each excitation group. In the waveform control, the waveform to be used as the control reference is the sine waveform which satisfies the requirement of the control reference. Therefore, when the multiple principal control channels are set for one excitation group, the control reference waveforms of each principal control channel are produced as the same sine waveforms. Generally, the specimen can not behave a rigid body in the whole control band, therefore the response waveforms of the multiple input channels do not become the same. Therefore, the requirement that multiple principal control channels are to be set for one excitation group is physically improper in general. However, the controller itself forces to control (excite) to realize even this unrealizable requirement. In the worst case, it may destroy the specimen and the shaker in the operation.

When the multiple principal control channels are set for one excitation group, the setting should be done in consideration of 'Weighting of drive generation' of the next clause with much caution.

<Control channel>

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

The physical quantity controlled by each control channel must have the same dimension.

However, when the controlled variable is specified as one among.

Acceleration/Velocity/Displacement, the physical quantity of the control channel can be selected arbitrarily to the one among Acceleration/Velocity /Displacement. (The controlled variable specified in Fundamental/Control Condition decides the graph of control channel.)

<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 ‘Monitor by absolute value’ in the monitor channel. 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 principal control channels and the control channels.

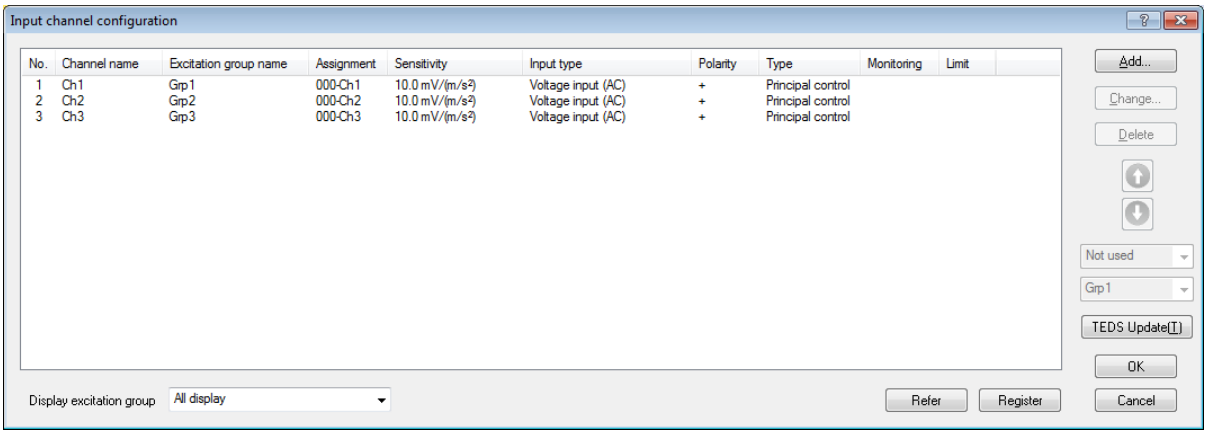
After this definition, the specifications of the input channels for the testing are completely determined.

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

Thus the correspondence between input channels and output channels is determined. Reference 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.

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

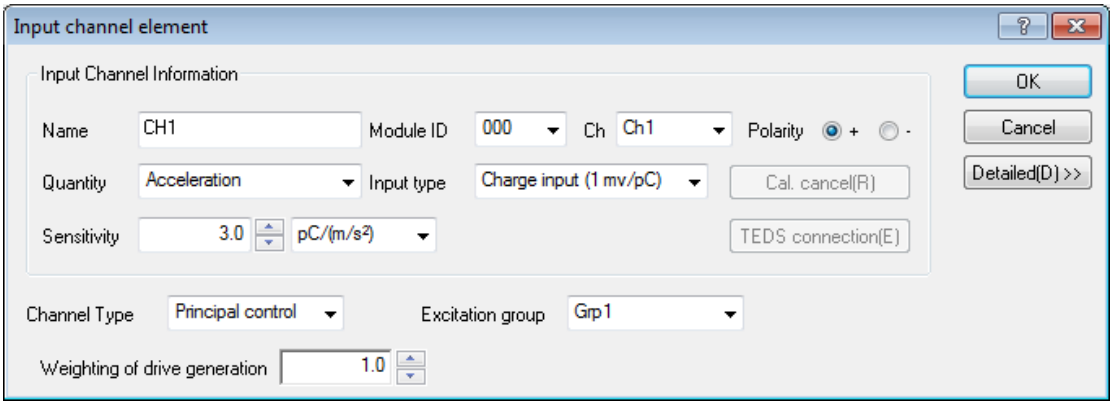
[Refer] : The registered definition contents of input channel configuration is loaded and used.

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

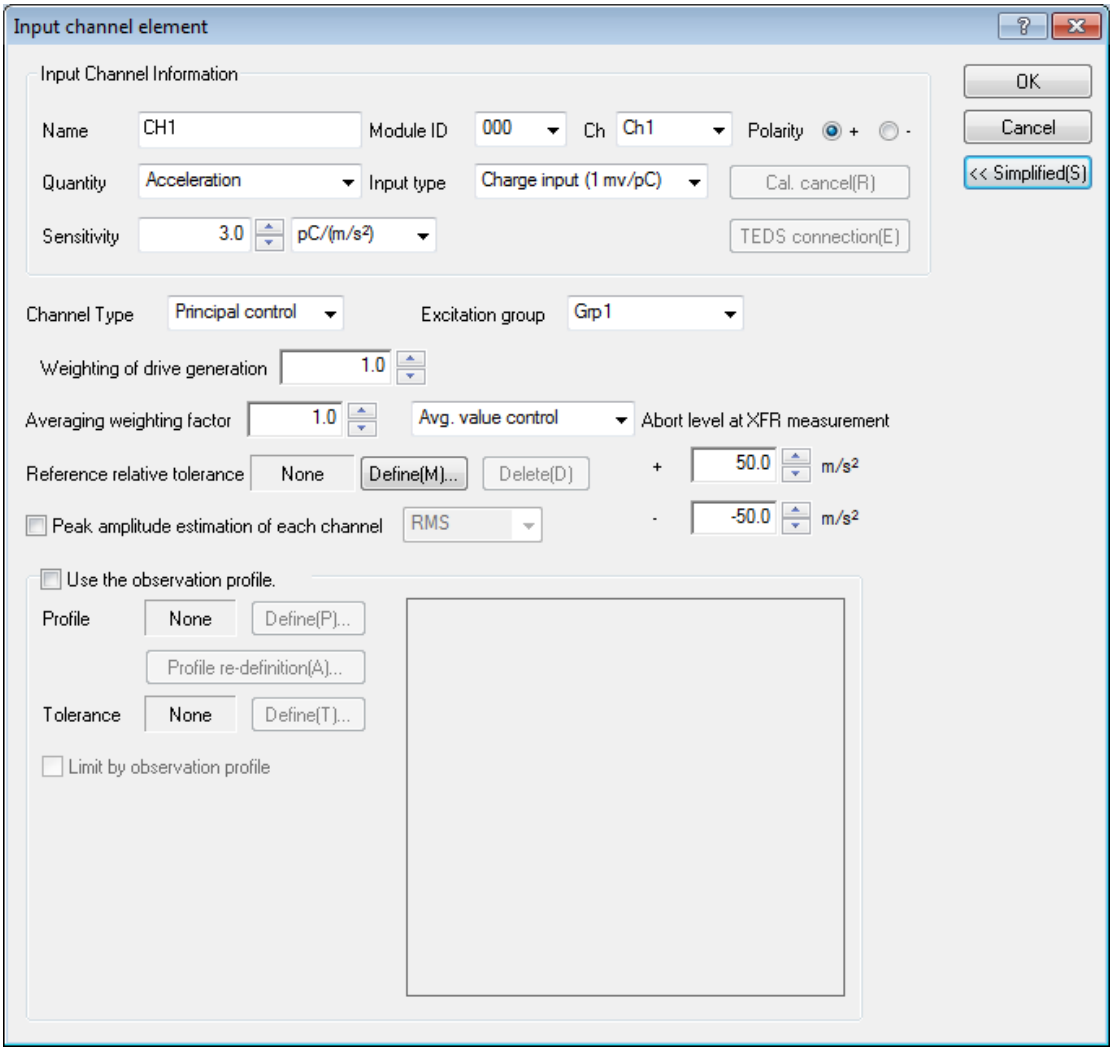
4.6.3 Input channel element

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 Principal 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:

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

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 Principal 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.

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

4.6.3.3 Maximum Control

(1) Meaning

This item can be set only when the given channel is specified as the Principal 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.

4.6.3.4 Reference relative to Tolerance

(1) Meaning

The meaning of 'Reference relative to Tolerance' is that the monitoring level is set by the relative value to the control reference value for each Monitor channel, and the response is monitored.

That is, 'Reference relative to Tolerance' is the function of protection for the execution system. By setting of this item, the response monitor level of this current channel is monitored and the protecting actions are activated at each specified level.

The following two protecting actions are provided ;

Alarm Check

Abort Check

Tolerance is defined by the relative value to the control reference level. Therefore, basically, if the controlled variable does not coincide with the physical quantity monitored at the current channel, this item cannot be set. However, when the controlled variable is specified as one among Acceleration/ Velocity/ Displacement, the physical quantity monitored at the current channel can be selected to the any of one among Acceleration/Velocity/Displacement.

4.6.3.5 Peak Estimation Method peculiar to the Channel

(1) Meaning

This item is for specifying whether the Peak Estimation Method for the monitor response peculiar to the current input channel is executed or not. And when this item is executed, the Peak Estimation Method peculiar to the concerning channel is specified specially.

When this item is selected, the amplitude value of the monitor response is calculated by the selected method of this item instead of the set 'Peak Estimation Method' in '4.2 Fundamental/Control Condition'. Then, the data is displayed as a graph and saved.

This item can be selected even the current input channel is specified as a Control channel. However, in such a case, the response amplitude value for obtaining the control response level is calculated by the set 'Peak Estimation Method' in '4.2 Fundamental/Control Condition'.

4.6.3.6 Abort level at XFR mesurement

(1) Meaning

Abort level at XFR mesurement can be set arbitrarily.

The default setting value is the 5 times of the peak value of reference.

Test is aborted when the response exceeds over the defined abort level in Loop check or XFR meanirement.

4.6.3.7 Use Observation profle

(1) Meaning

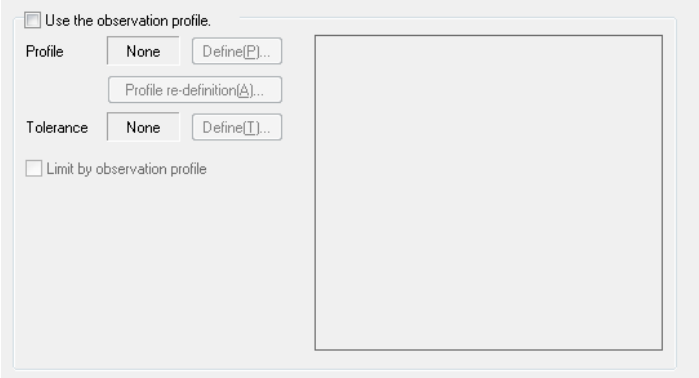
The monitor level is set by the absolute value for monitoring the response at each Monitor channel. The check box of 'Use Observation Profile' is checked when the monitor response is needed to be observed.

The merit of this tem is the function for not only monitoring the response but also executing the Limit Control. The following three monitoring actions are provided ;

- Abort Check
- Alarm Check
- Limit Control

However, Limit Control is an optional function.

The monitor level is defined by an absolute value independent from the reference. Therefore, the physical quantity monitored at the current does not have to coincide with the controlled variable. This item can be defined by any physical quantity for monitoring. For example, it can be set freely that the control is operated by acceleration through some portions are monitored by displacement which is observed by the displacement sensor and some portions are monitored by force which is observed by the force sensor.



4.6.3.7.1 Profile definition

(1) Meaning

The following two Profile definition methods are provided ;

① Definition by Profile

The monitor level is defined by the profile. The monitoring can be done in an arbitrary frequency band and level by defining the monitor level with using profile.

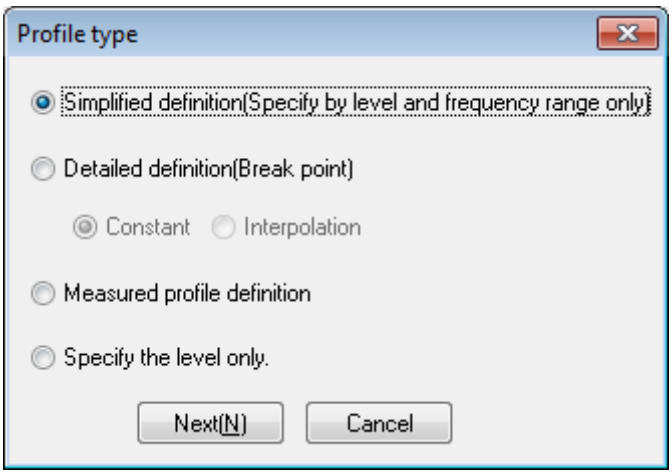
Press [Define] of Observation Profile. (Refer to "4.5.3 Profile definition")

- Simplified definition
- Detailed definition (Constant)
- Detailed Definition (Interpolation)
- Measured Profile Definition

② Definition by Amplitude

The monitor level is specified by an amplitude value in the whole band of the excitation frequency. In this definition method, the monitor level is basically specified at the constant value.

Press [Define] of Observation Profile and select [Specify the level only]. The definition of the monitor level can be done by inputting the numeral values. (Refer to "4.5.3 Profile definition")



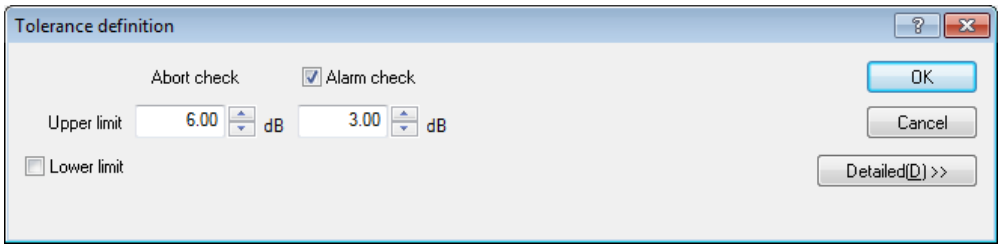
4.6.3.7.2 Tolerance definition

(1) Meaning

Observation toleranceis set.

Press [Define] of Observation Profile. Then the dialog for setting appears.

The definition method of Tolerance is the same as those in “4.5.4 Tolerance definition”.



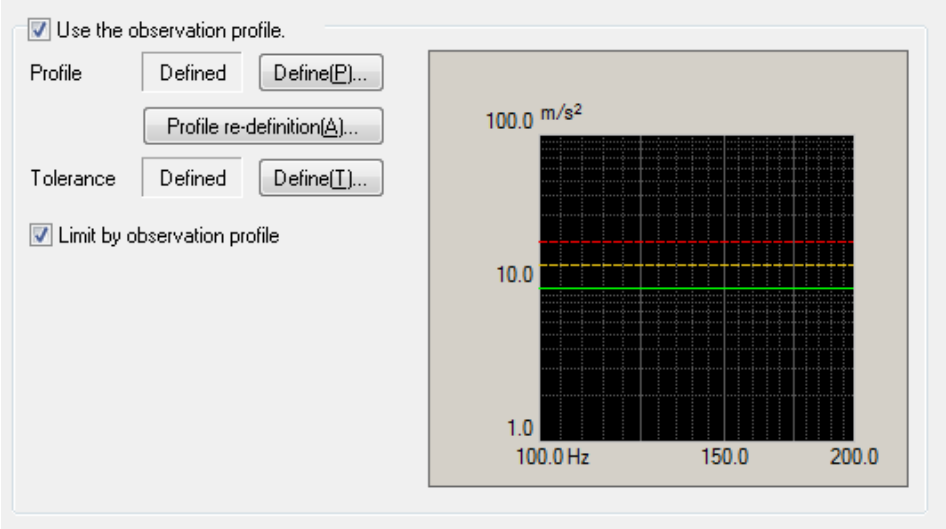
4.6.3.7.3 Limit by Observation Profile

(1) Meaning

Limit Control is to be executed by checking the checkbox of ‘Limit by Observation Profile’.

When Limit Control is set to be executed, the response level to the current input channel is monitored during the control operation. If the monitored level of the current input channel is to exceed over the monitor level set by an absolute value, the function of Limit Control is activated. However, this function is an optional.

When Limit Control is executed, the drive signal is controlled not to exceed over the monitor level. To be exact, the drive signal is regulated by setting the smaller reference level. As a result, the level of the output drive becomes smaller by this control. Generally, the level of the control response and the level of the responses of other input channels become smaller.



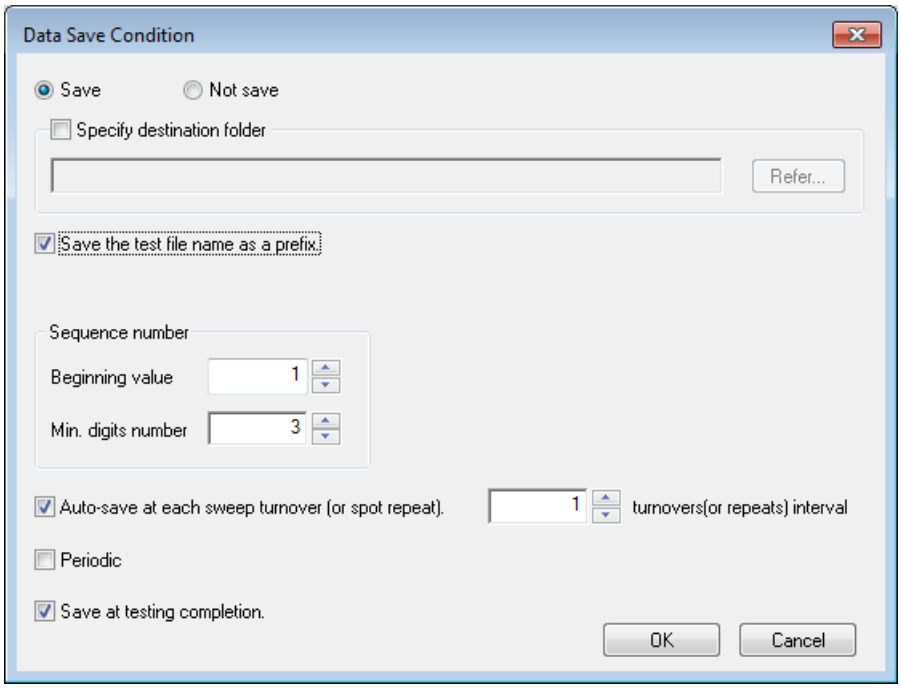
4.7 Data Save Condition

4.7.1 Outline

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

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

However, the data in initial measurement cannot be saved. Only the data in a test operation is treated as a data to be saved.



4.7.2 Save Condition of Data

The items in the dialog of Data Save Condition are explained 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. Save the test file name as a prefix

   A common word can be added as a prefix in the head of all the data file name. The default name is specified as ‘Data’. The name to be saved can be changed when the check of this item is cancelled.

4. Sequence number

The data files added prefixes are given sequence numbers for each.

Beginning value : This item is for setting of a number to start.
Example) Input '1' to this item : 'Data001. VDF'

Min. digits number : This item is for setting of numbers for digit of sequence number.
Example) Input '2' to this item : 'Data01. VDF'

5. Auto-save at each sweep turnover (or spot repeat)

In sweep test, this function is for saving of the specified data automatically and additionally at each single-sweep of both directions during the testing operation. However, the data is not saved at the last single-sweep because the sweep is not turned over. If the data of the last single sweep is also needed to be saved, set the item 'Auto-save at testing completion' to be executed.

In spot test, this function is for saving of the specified data automatically and additionally at each spot sequence during the testing operation. However, the data is not saved at the last spot sequence because the sequence is not repeated. If the data of the last spot sequence is also needed to be saved, set the item 'Auto-save at testing completion' to be executed.

'N turnovers (or repeats) interval' [N: number] is the setting for skip of saving data files. This means that data files are saved every N turnovers (or repeats). And the first data is always saved. When this item is set to '1', data file at every turnovers (or repeats) are saved.

6. Periodic

This item is for saving the data automatically at every period specified by seconds.

7. Save at testing completion

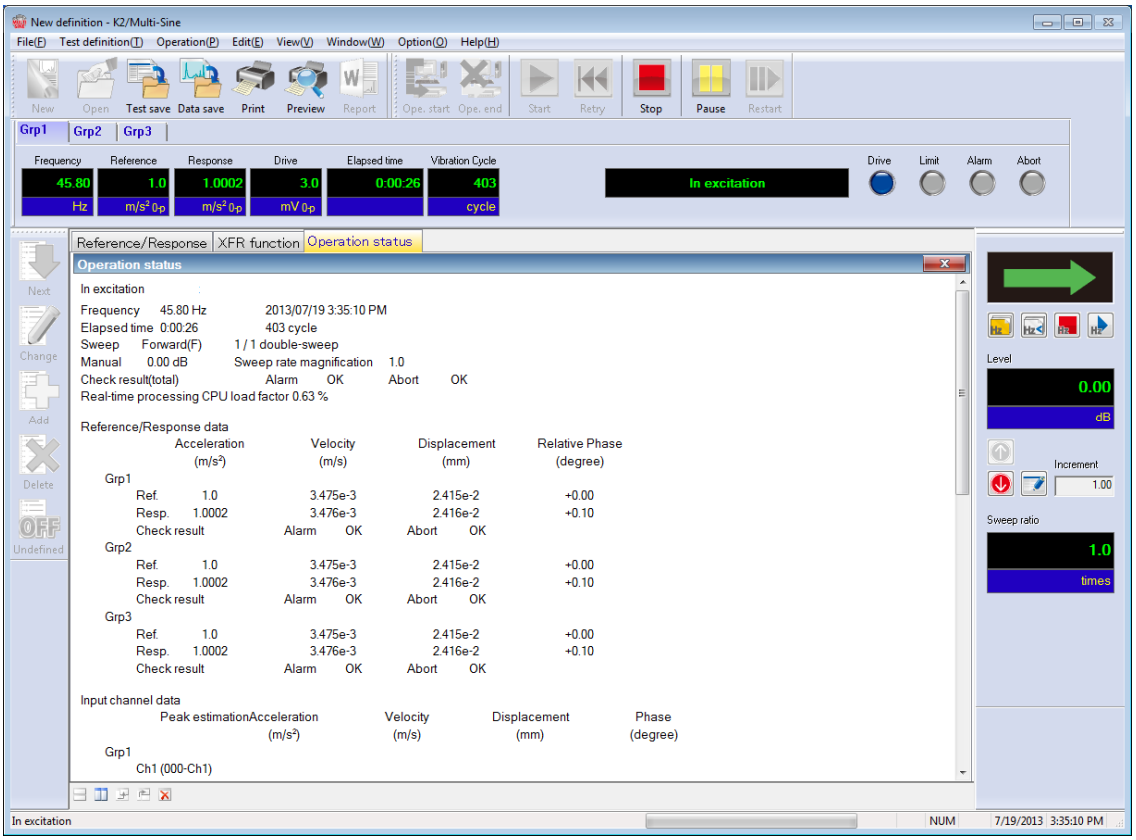
This item is for saving the data automatically when the test time is completed or when the test is aborted by a user.

4.8 Operation Status

(1) Meaning

Various information concerning with the excitation operation is displayed.

The window of Operation status is opened by selecting the commands [Window] – [Operation status] in the menu bar.



< Display contents >

(1) Present status

The message about the present state of the system, such as ‘In operation’, ‘Excitation pause’ and ‘Excitation completed (Stop by operator)’, is displayed.

(2) Frequency

The current excitation frequency is displayed.

(3) Elapsed time

The elapsed time counted from the excitation start to the present and the vibration cycles are displayed.

In Spot test ; The elapsed time counted from the excitation start to the present and the repeat times of spot sequence are displayed.

(4) Sweep

Sweep direction and sweep times at present are displayed.

(4a) Spot

Spot of the current excitation, the stay time and the remaining time at the current spot are displayed.

(5) Manual

The operation status of the present manual operation is displayed. As the operation status, the changing rate of the present excitation level and the changing ration of the present sweep rate are displayed.

(6) Check result (total)

When all the conditions of the Alarm and Abort check defined in the test definition are satisfied, the check results in 'OK'. On the other hand, when even one of these is not satisfied, the check results in 'NG'.

When the Limit Control is executed, the message of 'In limitation' is displayed and the control is operated with the reduced reference for the numeral value shown in the display.

(7) Real-time processing CPU load ratio

The current CPU load ratio is displayed.

(8) Reference / Response data

The value of reference level and reference level in present control loop are displayed. Basically, the level is displayed in the definition unit. However, when the controlled variable is specified as the one among Acceleration / Velocity / Displacement, all the quantities of the Acceleration / Velocity / Displacement are displayed.

The result of Tolerance check is also displayed. When all the conditions are satisfied, 'OK' is displayed. When the condition of Alarm check is not satisfied, 'Alarm' is displayed. And when the condition of Abort check is not satisfied, 'Abort' is displayed.

(9) Input channel data

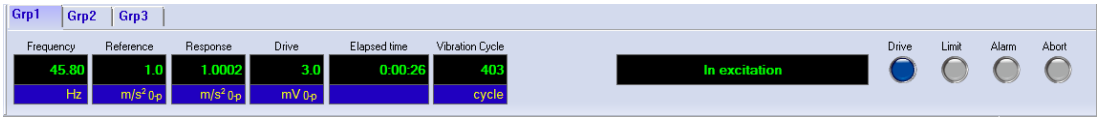
The amplitude value and the phase of each input channel data in the current control loop are displayed. Basically, the amplitude value is displayed as the level in observed physical quantity of input channel. However, when the controlled variable and the physical quantity are specified as the one among Acceleration / Velocity / Displacement, all the quantities of the Acceleration / Velocity / Displacement are displayed.

(10) Drive output data

The value of output voltage at each output channel data is displayed for the current control group. Also, the limit ratio to the available output voltage is displayed.

[Operation status panel]

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



Chapter 5 Messages and Meanings

5.1 Multi-SINE Error Messages

Message	Meaning / Action
Unusual phenomenon is detected by Pre-check.	(Meaning) The test operation is aborted due to the error in Pre-check. The detail about the error is displayed at the input channel in which an error detected in Operation status. A) Too much ambient noise [1] [2] [4] [6] Too small response in Pre-check or too much noise in non-excitation is judged as an unusual phenomenon. B) Loop open is detected at the Pre-check [1] [2] [4] [7] Too small response in pre-check or its non-linearity is judged as an unusual phenomenon. C) Exceeded response is detected at the Pre-Check [1] [3] [4] [5] Too large response in Pre-check is judged as an unusual phenomenon. (Action) 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 check standard of Pre-check in Excitation System setting to 'Loose'. [2] Increase the value of initial output voltage in Excitation System setting. [3] Decrease the value of initial output voltage in Excitation System setting. [4] Change the frequency of Pre-check in Excitation System setting. [5] Increase the response upper limit value of Pre-check in Excitation System setting. [6] Set the check standard to 'Specify' and increase the upper limit value of environment noise of Pre-check in Excitation System setting.

Message	Meaning / Action
	[7] Set the check standard to 'Specify' and increase the value of response linearity check of Pre-check in Excitation System setting.
Unusual phenomenon is detected by Loop Check in excitation.	(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 / Action
	[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.
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 Operation status. A) Tolerance check error [1] [2] [3] [6] [7] [8] [9] The test operation is aborted for an error detected by various Tolerance checks. B) Output voltage limit value error [2] [3] [4] [5] [6] [7] [8] [9] The test operation is aborted for requiring of the output voltage exceeding over the 'Output voltage limit value' of Excitation System setting in operation. (Action) 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 Fundamental Condition. [3] Change the setting of amplitude estimation method in Fundamental Condition. [4] Change the setting of output voltage limit value in Excitation System setting. [5] Set the loop check in Fundamental Condition to 'Loose'. [6] Recheck of Control point. [7] Recheck the pickups used in the system. [8] Recheck the pattern of the test. [9] Recheck the construction of fixture.

Message	Meaning / Action
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.
License required to operate the program is not registered in the server.	(Meaning) An error is detected in K2 Protect information check. (Action) ・ License information ・ Incorrect action of I/O port (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.
Test is aborted by the hardware error detected.	(Meaning) An error is detected in the PC or I/O unit. (Action) ・ 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 Driver. ・’ DMA’ function of HDD in the PC is disable 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 / Action
Test is aborted by too much loading of CPU.	(Meaning) Test operation is aborted because too much loading is detected in operation. (Action) ・ Exit form the other applications than K2 executed by the system when they are used. ・ Decrease the value of Max. Observation Frequency in Fundamental Condition. ・ Decrease the numbers of channel to be used. Check the above points.

Chapter 6 Supplemental Explanation

6.1 Timer

Various operations, such as Level Change and Sweep Pause, can be executed during the Test Operation in K2 Multi-SINE. The relations between these operations and the function of Timer are described as below ;

Condition				
Sweep Test	Level : Lower than 0 dB	Elapsed Time	Time	Not counted
			Vibration	Not counted
			Sweep	Counted
	Sweep Pause	Elapsed Time	Time	Counted
			Vibration	Counted
Spot Test	Level : Lower than 0 dB	Elapsed Time	Time	Not counted
			Vibration	–
			Repeat	Not counted
		Spot Stay Time	Time	Not counted
			Vibration	Not counted
	Spot Pause	Elapsed Time	Time	Counted
			Vibration	–
		Spot Stay Time	Time	Not counted
			Vibration	Not counted

Also, the dependence of the judgment of Test Time completion on the excitation level is described as below.

When the judgment of Test Time completion depends on the excitation level, the Test Time is not counted by setting of the excitation level to lower than 0 dB and the testing operation cannot be completed.

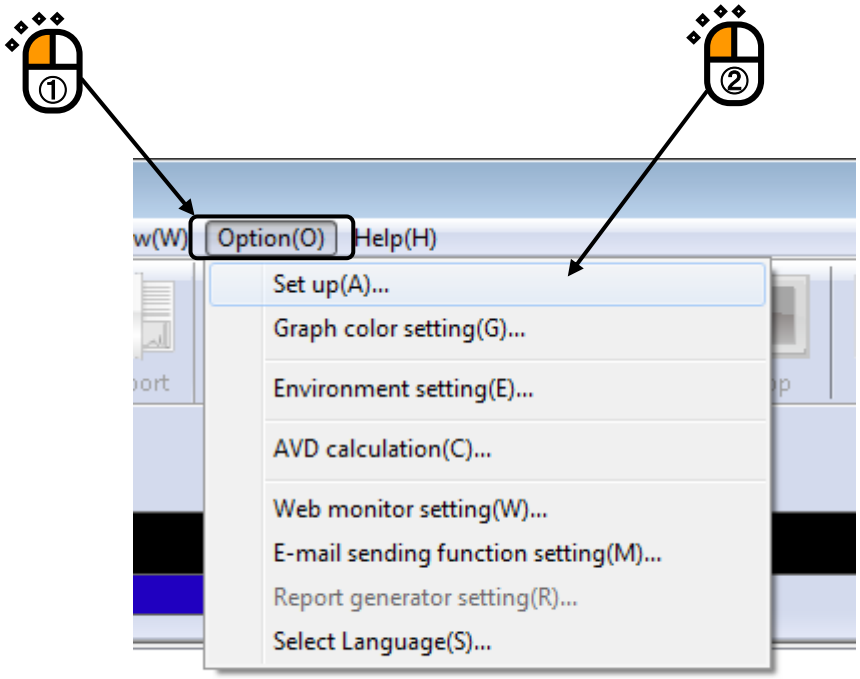
Condition		Judgment of Test Time completion
Sweep Test	Test Time specified by Sweep Counts	Independent of Level
	Test Time specified by Time	Dependent on Level
	Test Time specified by Vibration Cycle	Dependent on Level
Spot Test		Dependent on Level

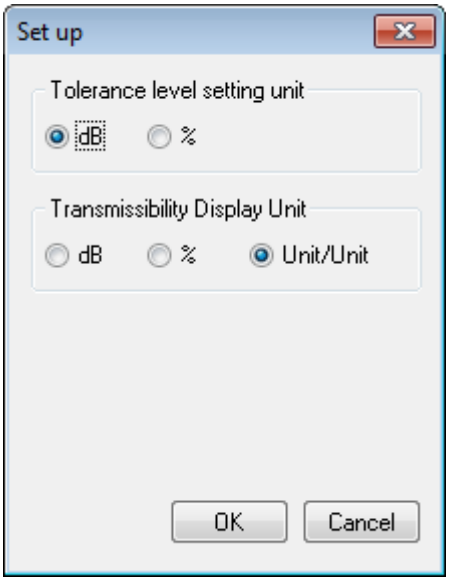
6.2 Set Up

Specifying unit of Tolerance level is specified among ‘dB’ or ‘%’.

<Procedures>

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





[Tolerance level unit setting]

‘dB’, ‘%’

Specifying unit of Tolerance level is specified among ‘dB’ or ‘%’.

Denoting A[dB] and B[%], the relation between ‘dB’ and ‘%’ is described as below ;

$A = 20 \log_{10} (B / 100 + 1)$

$B = (10^{A/20} - 1) \times 100$

[Transmissibility display unit]

This item is for selecting the display unit of amplitude value in Transmissibility Graph.

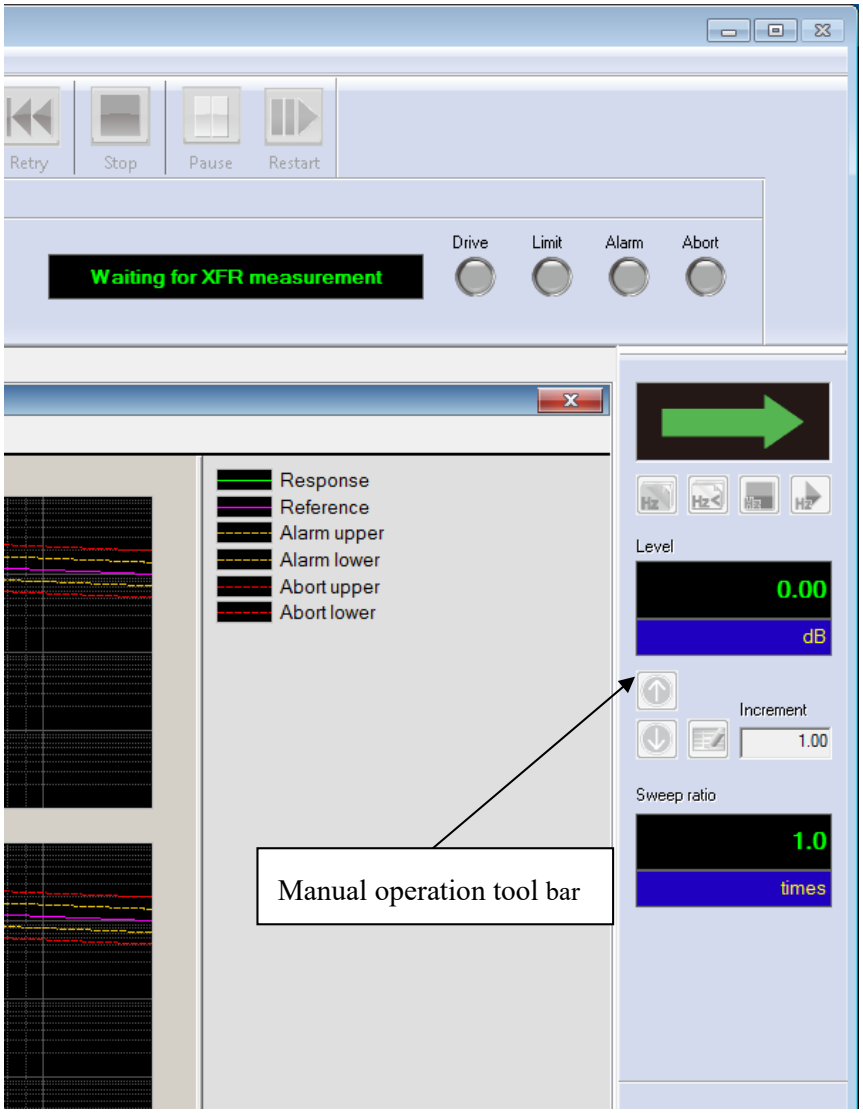
This unit selected in this item is valid only for the transmissibility graphs calculated from the two data giving the same unit.

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’.

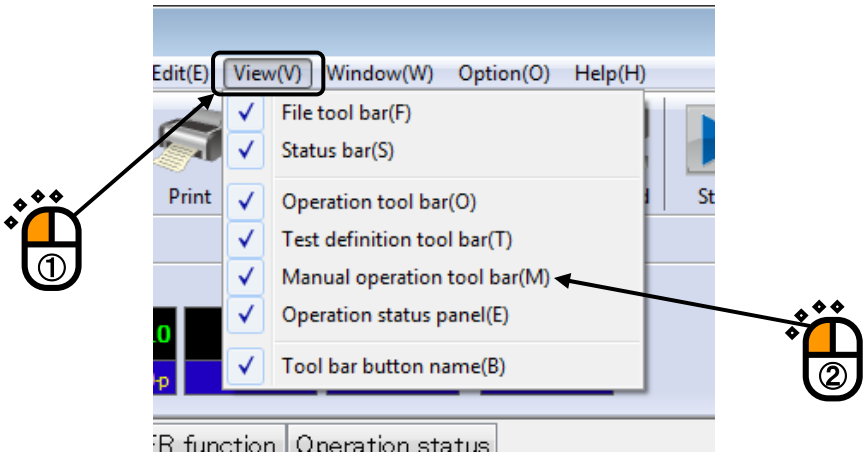
6.3 Manual Operation

Control Reference can be changed during the excitation operation by using Manual operation tool bar.

Usually, “Manual operation tool bar” is displayed at the right side of operation window.



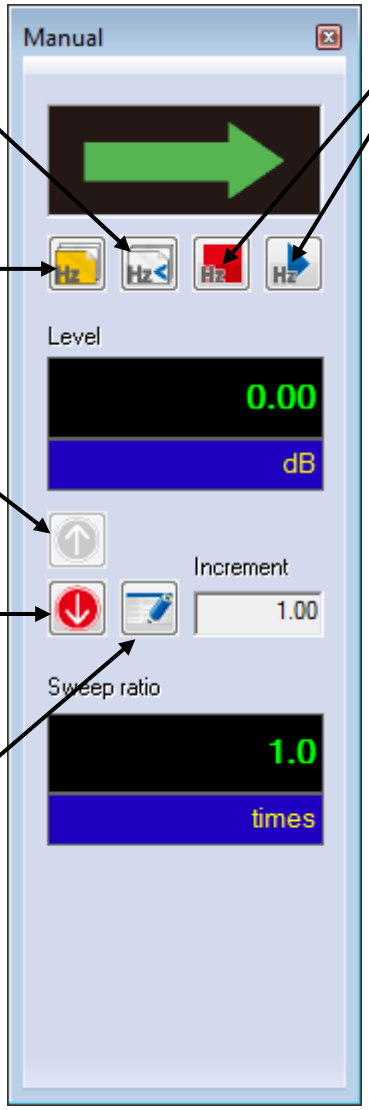
If the tool bar is not displayed, select [Display] and click [Manual operation tool bar].



< Items in Manual Operation (Continuous sweep) >

This item is for reversing the direction of sweep. Sweep is counted when the sweeping is turned at the maximum or minimum frequency of control reference.

This item is for holding of Sweep and canceling of Sweep Hold(continuing the sweep operation).

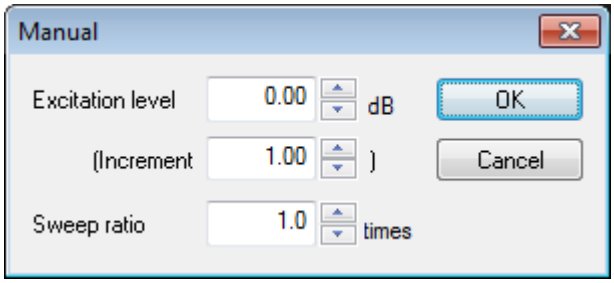


This item is for skipping to the beginning of the next sweep.

This item is for setting of an upper Excitation Level by pressing this button once for an increase/decrease value specified.

This item is for setting of a lower Excitation Level by pressing this button once for an increase/decrease value specified.

This item is for changing of Excitation Level, the increase/decrease value of Excitation Level and Sweep Ratio. Press this button, then displays the dialog below.



< Items in Manual Operation (Spot) >

This item is for fixing spot and canceling of fixed spot (continuing the spot operation).

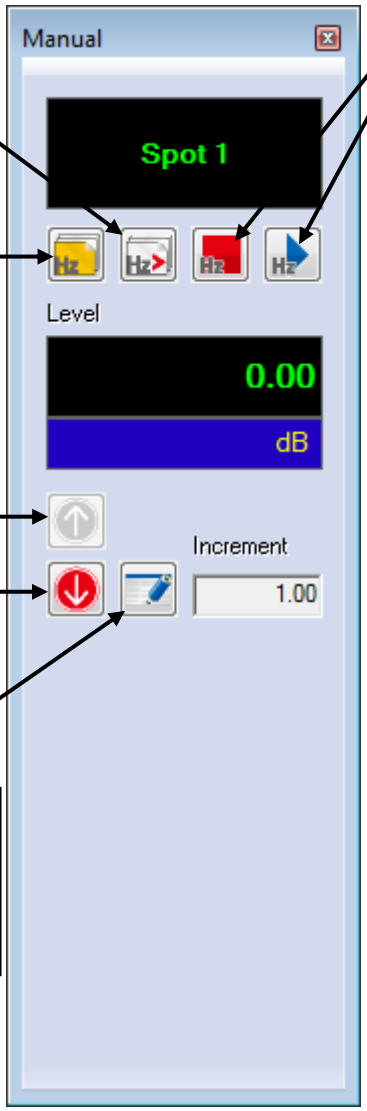
Excitation is stopped at the current spot and skipped to the next spot.

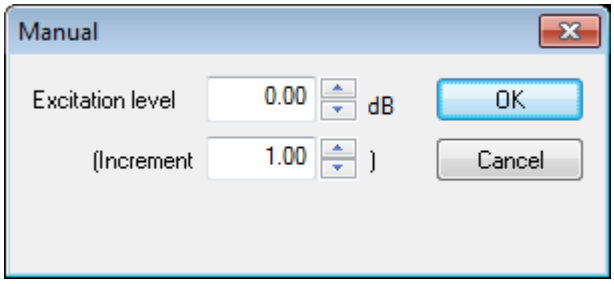
Excitation is stopped at the current spot and skipped to the first spot.

This item is for setting of an upper Excitation Level by pressing this button once for an increase/decrease value specified.

This item is for setting of a lower Excitation Level by pressing this button once for an increase/decrease value specified.

This item is for changing of Excitation Level and the increase/decrease value of Excitation Level.
Press this button, then displayes the dialog below.





6.4 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 the same as in 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.

[Demerit]

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

6.4.1 Using of Live Data in Operation

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

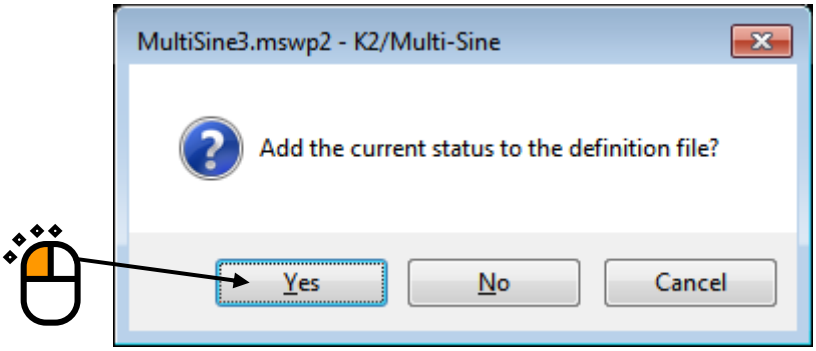
6.4.1.1 Add the live data in operation at finishing the operation

<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

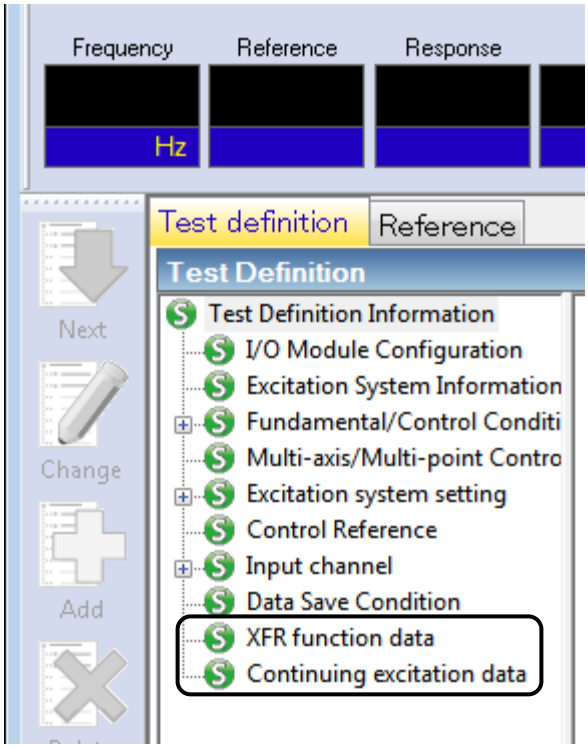
Available to correlate with the definition after XFR measurement.

・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.



6.4.1.2 Add the live data in operation in Test definition mode

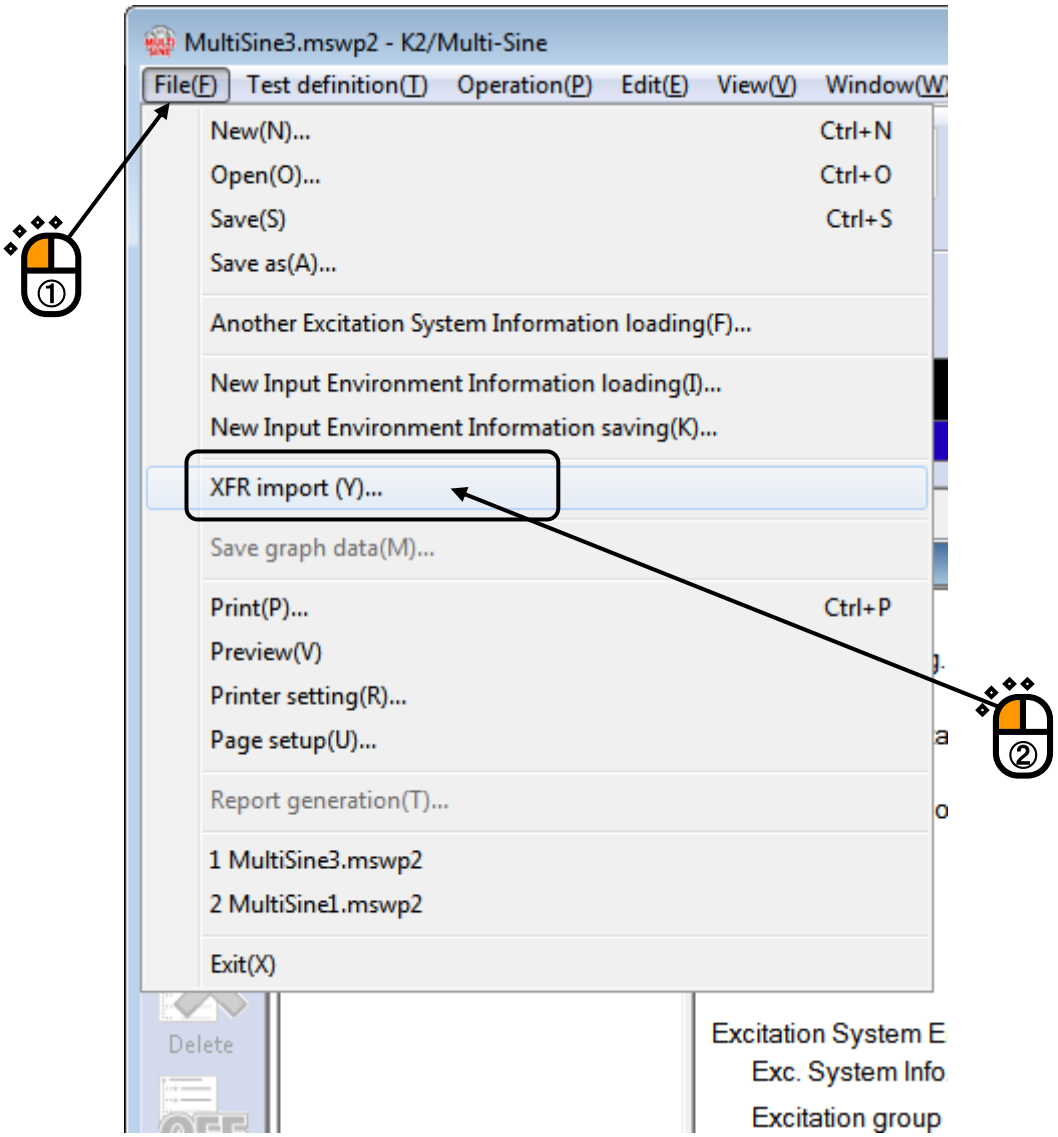
<Procedures>

<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.

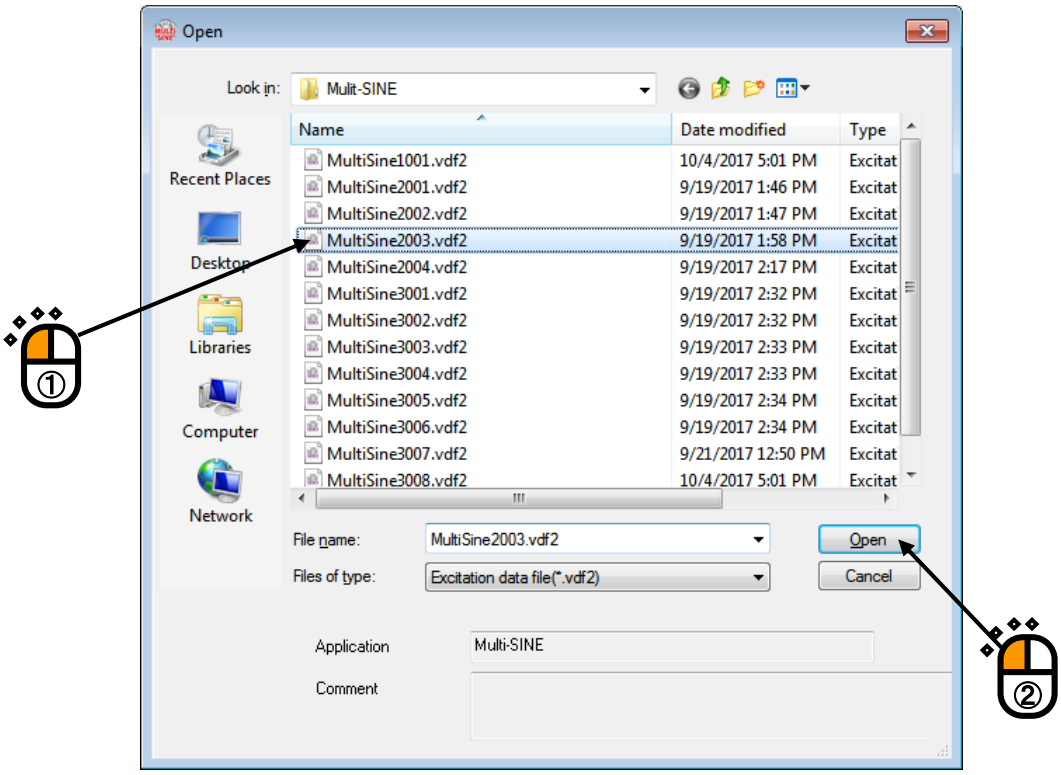
Select [File] → [XFR import] in Menu bar.



<Step2>

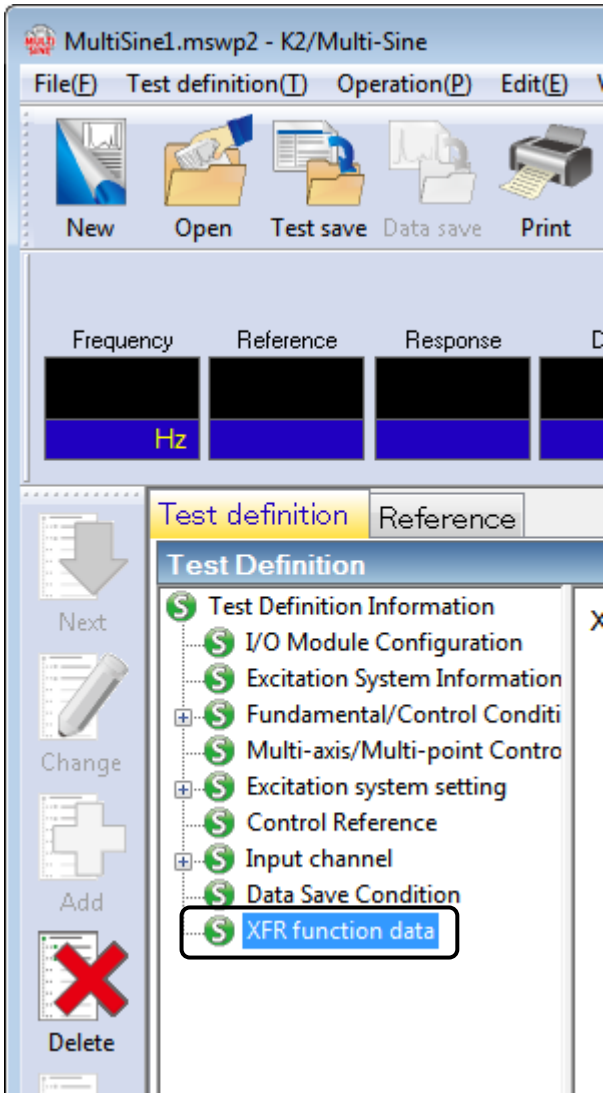
Select a file to import (the XFR function) and press [Open].

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.



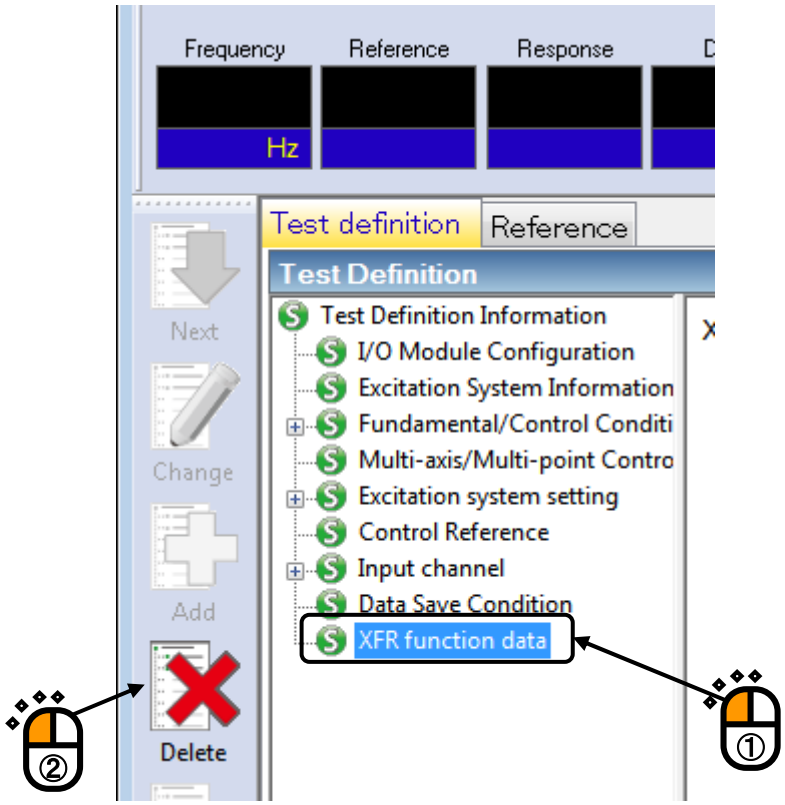
6.4.2 Deleting of Live Data in Operation

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

<Procedures>

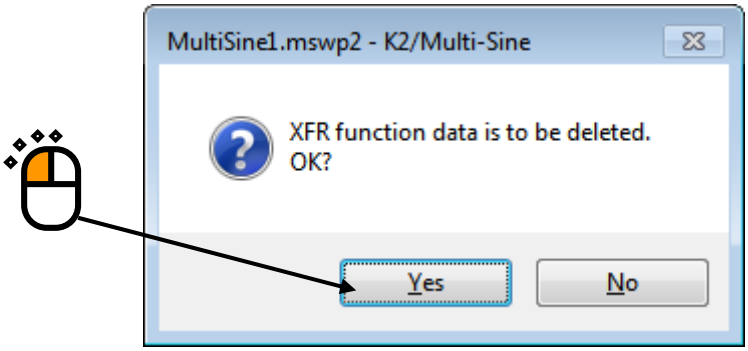
<Step 1>

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



<Step 2>

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



6.5 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.

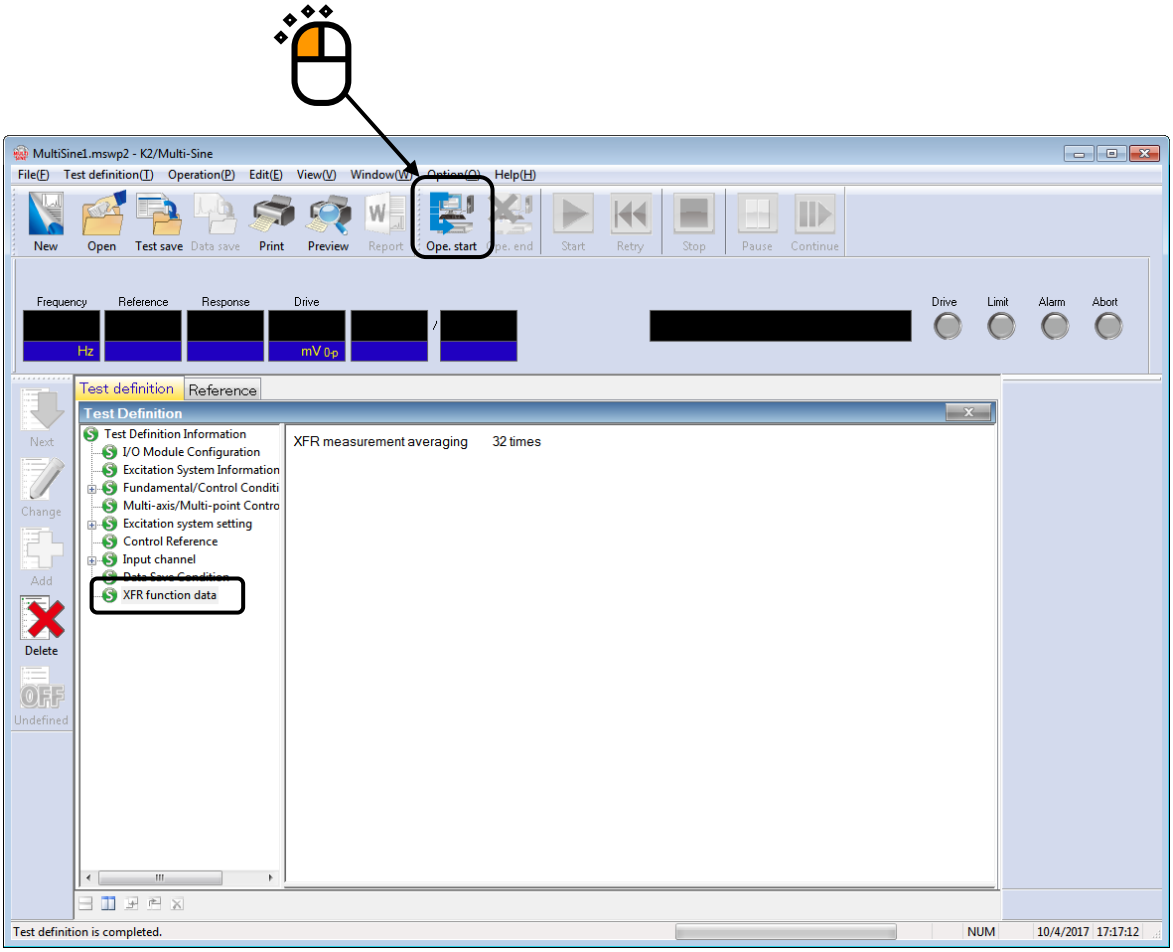
However, pay attention to the danger when the system configuration and the condition of sensors and specimens are different. In such a case, XFR Function is needed to be measured again as the same as in an ordinary test.

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

<Procedures>

<Step 1>

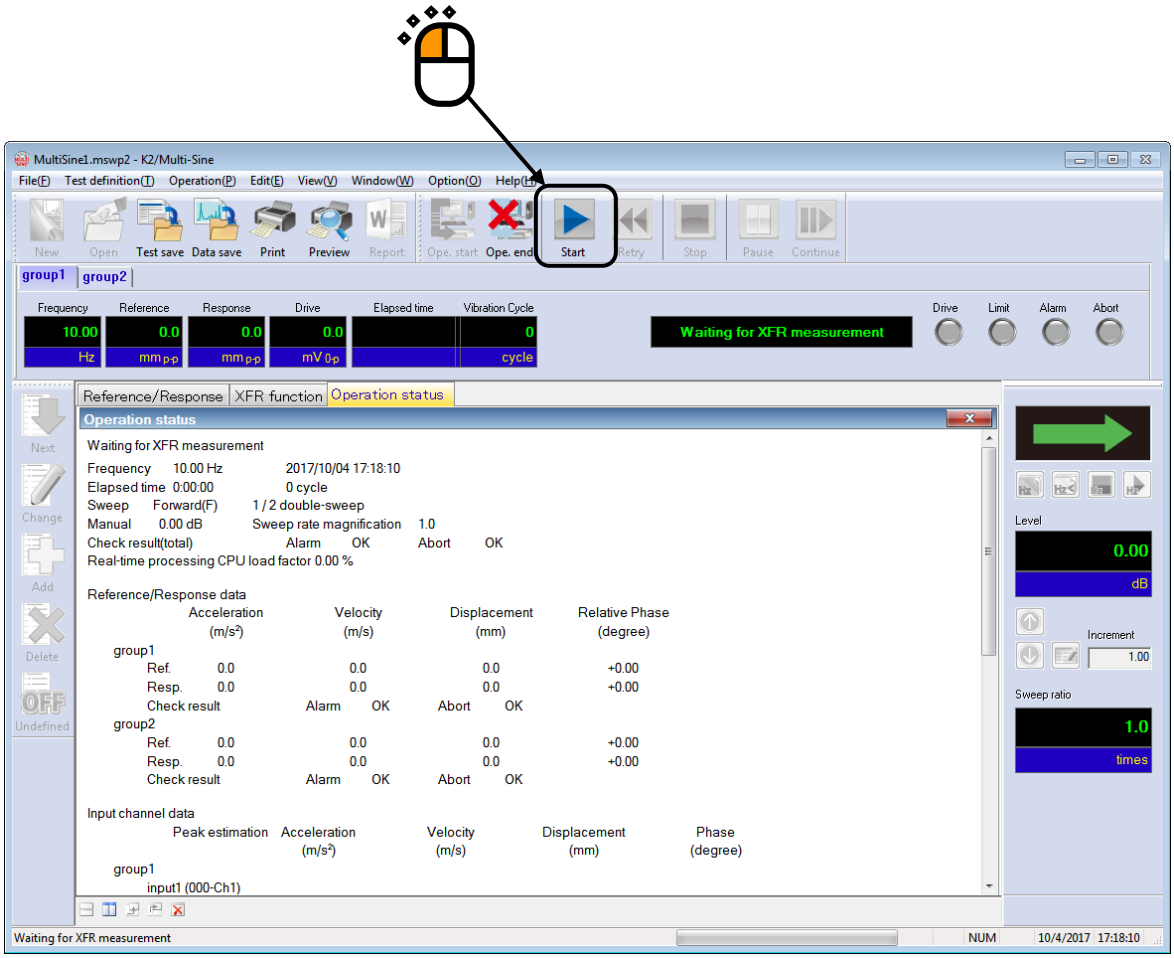
Load the Test File using the XFR Function of Live Data in Operation and press [Operation start] button.



<Step 2>

XFR Measurement of the controlled system is executed.

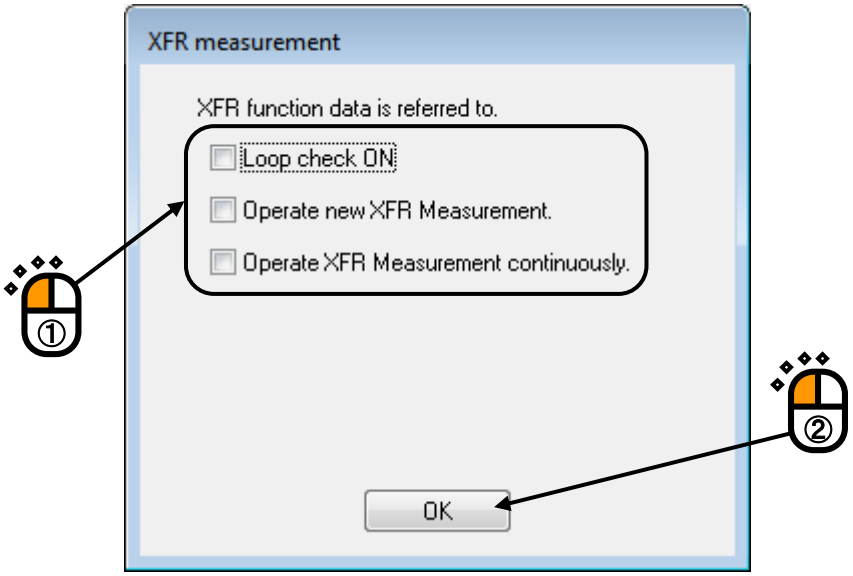
Press [XFR measurement start] button.



<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.

6.6 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.

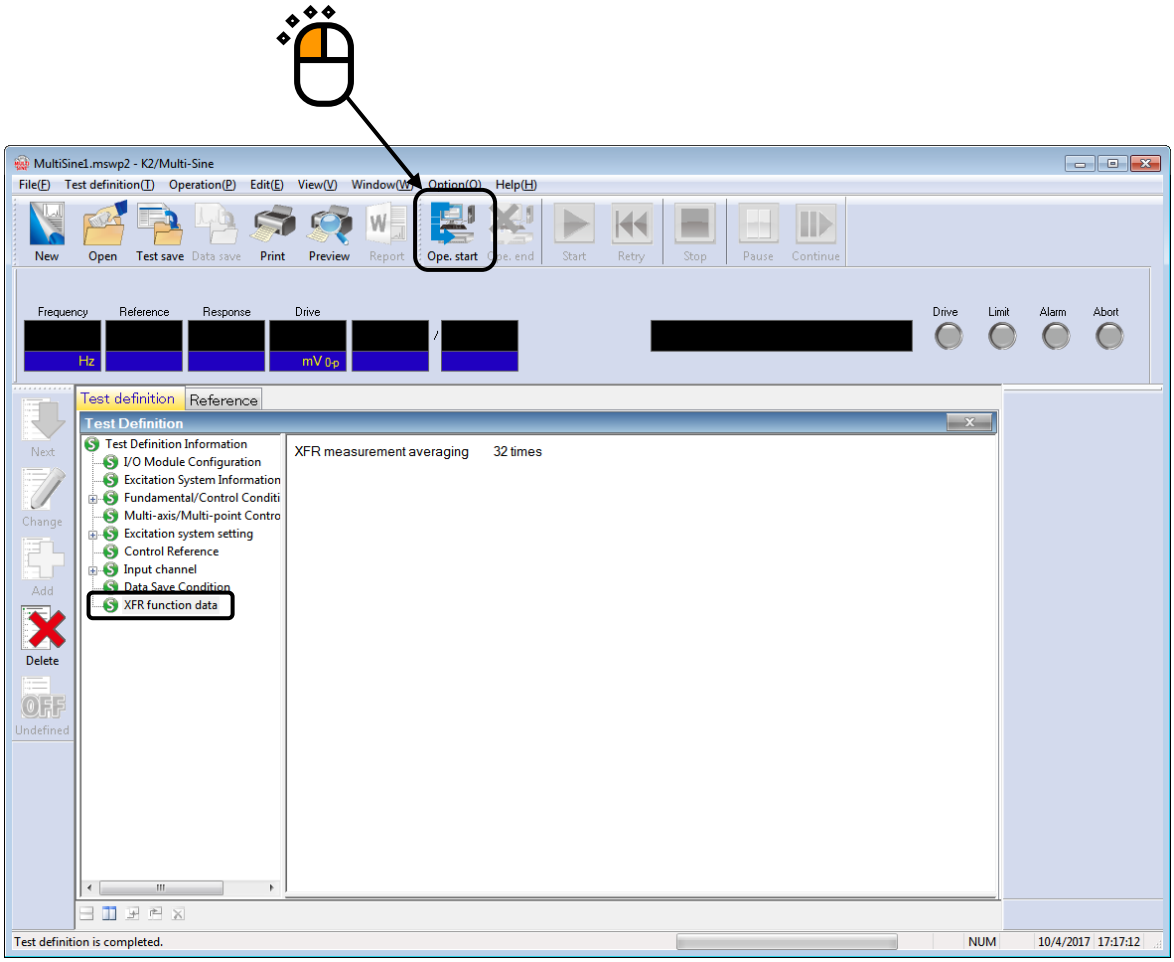
The condition of continuous XFR Measurement is described as below;

- 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

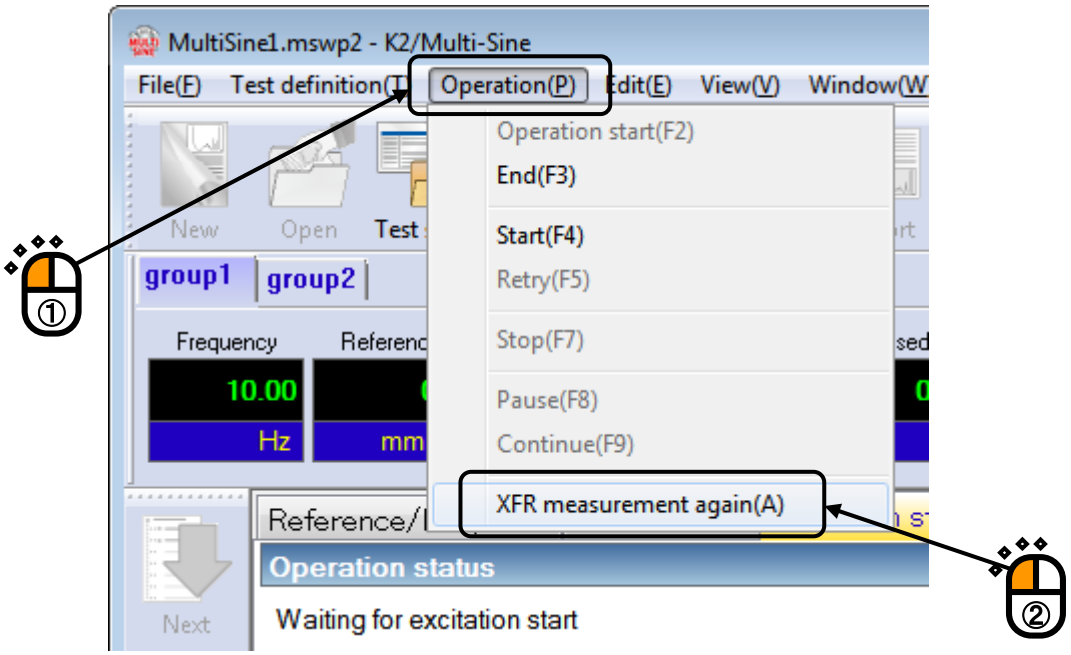
<Procedures>

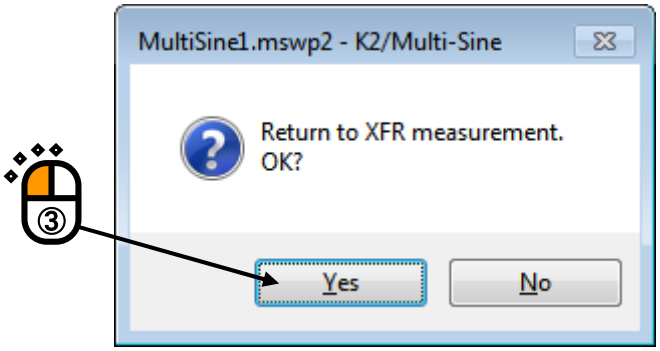
<Step 1>

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



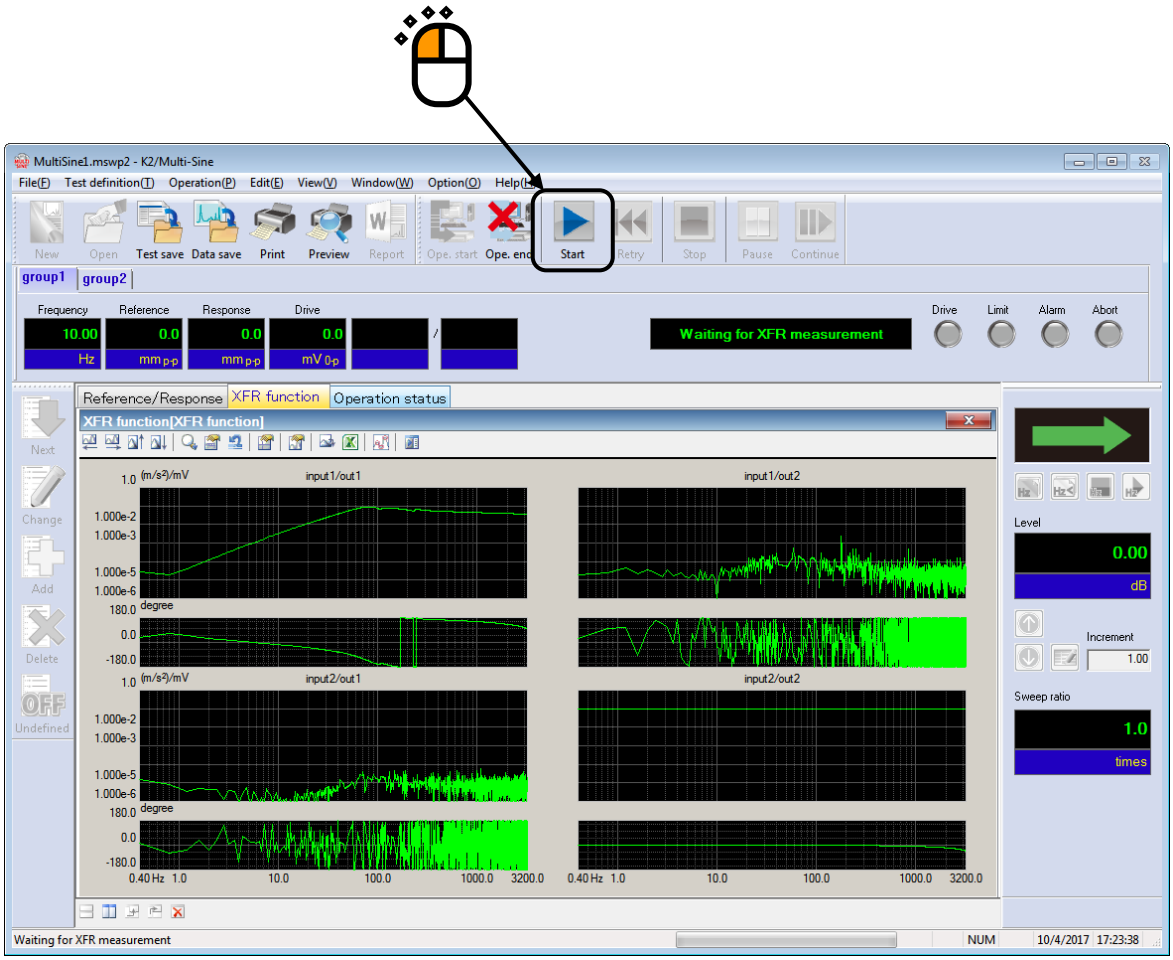
Or otherwise, select [Operation] in the menu bar after completing the XFR Measurement.
Select [XFR measurement again] Then, the confirmation message appears.
Select [Yes] in this dialog.





<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.

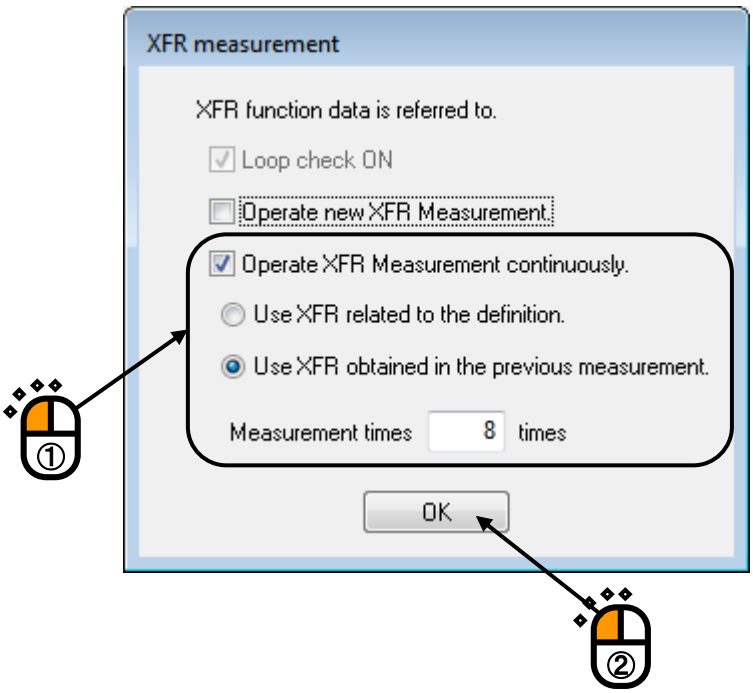
- Specify the objective XFR function to be added

  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”.



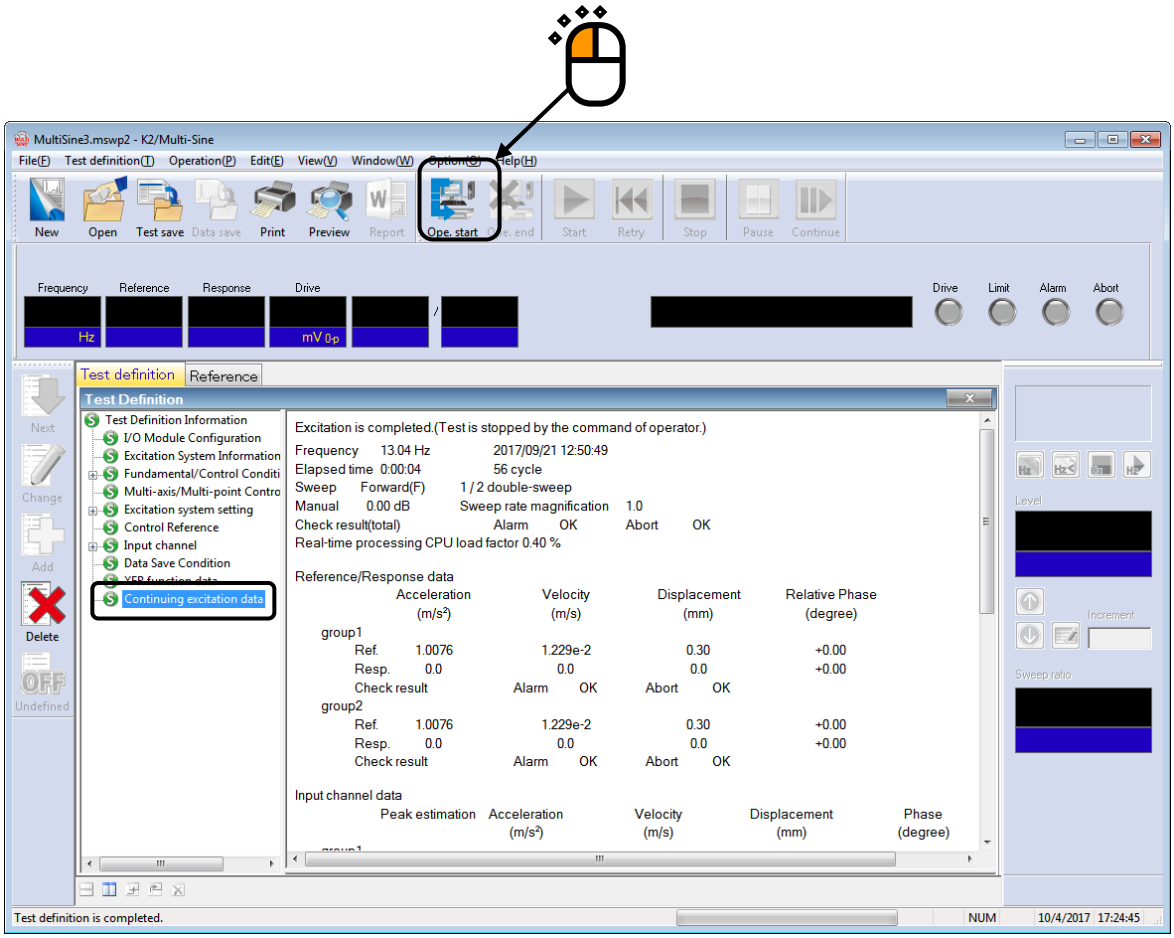
6.7 Restarting suspended test

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>

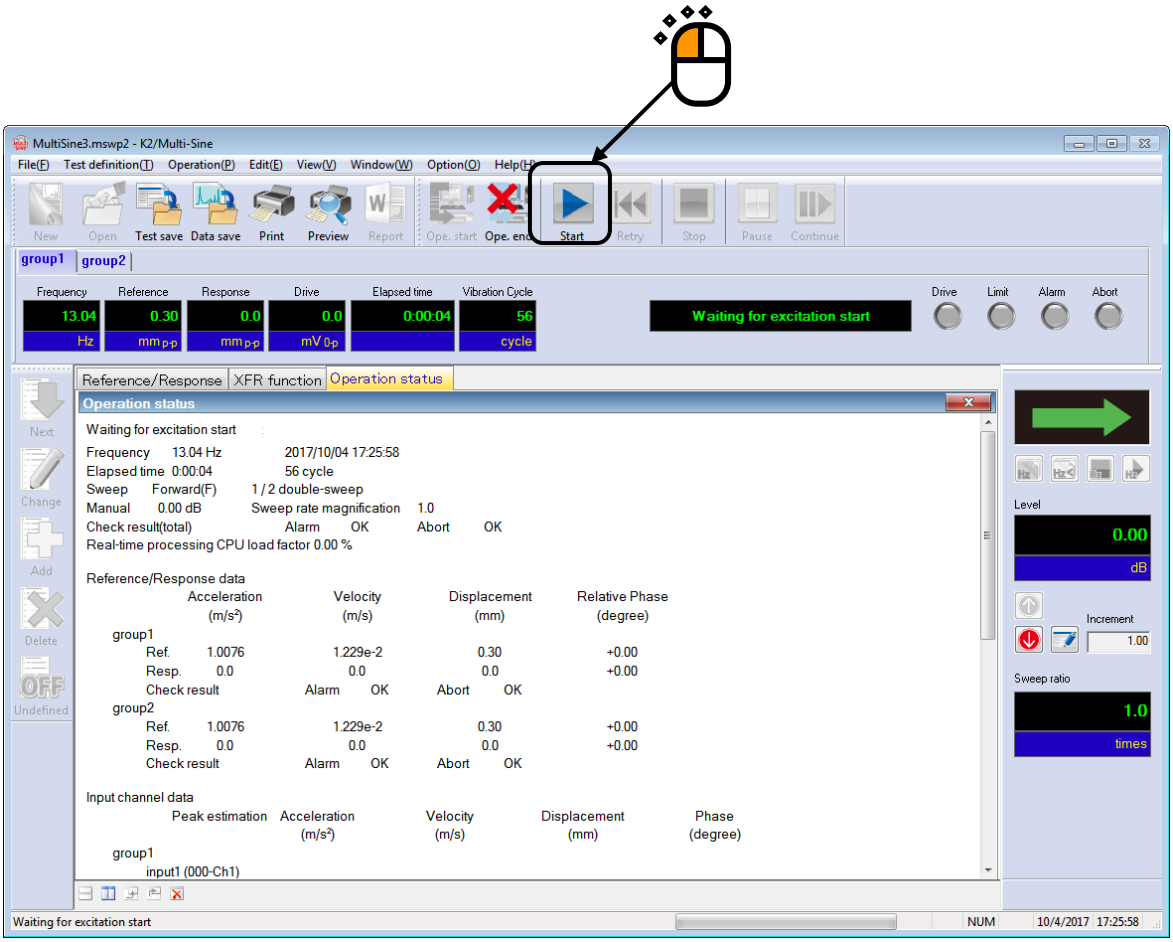
<Step 1>

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



<Step 2>

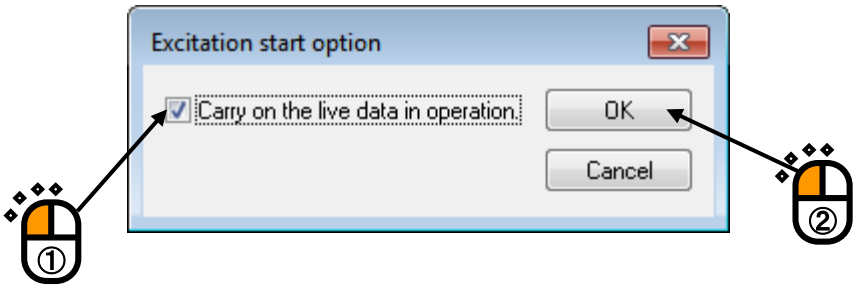
Measure the XFR function of the controlled system, and proceed to the status of waiting for excitation start.



<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 “Carry on the live data in operation”, 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.



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