

# **Sine Vibration Control System**

**K2+**

## **SINE Instruction Manual**

**IMV CORPORATION**

Type of Document : Instruction Manual

System Applied : K2+

Software <SINE>

later than Version 20.1.0

Japanese Edition

Version	Date	Contents
1.0.0	2020.10.16	First edition
1.1.0	2021.02.01	Additional description of 'Pause before transitioning to "In excitation"' of 'Fundamental/Control Condition'. Additional description of 'Clear history at operation start' and 'Set the data file name automatically' of 'Set up'.

English Edition

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1.0.0	2020.10.16	First edition
1.1.0	2021.02.01	Additional description of 'Pause before transitioning to "In excitation"' of 'Fundamental/Control Condition'. Additional description of 'Clear history at operation start' and 'Set the data file name automatically' of 'Set up'.

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# Chapter 1 Outline of the System

## 1.1 Specifications

### 1.1.1 SINE

- (1) Control Method : Level control of the swept sine waveform by using the feed-back method
- (2) Control Frequency : 0.1~20 000 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, Manual
  - 2) Control variables: Response signal / Output voltage
- (6) Sweep Operation

Sweep mode : Linear / Log  
Sweep type : double / single  
Direction : forward / backward  
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
  - 1) Number of channels: maximum 64
  - 2) Type of channels: 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
  - 1) Number of channels: 1
  - 2) Waveform distortion: Less than 0.1 % (1V rms)



(10) Analysis / Display Data

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

The trace of the level for drive

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

Control response / Drive transmissibility, Each input channel / Controlled response transmissibility, Each input channel / Drive transmissibility·phase, Transmissibility·phase between the input channels

Distortion and Single Tolerance of the response signal to each input channels

The trend graph of frequency and each level data (only Spot)

(11) Data Save: Automatic / Manual, Display data save as CSV format

(12) External Contact Function

Input Part: Excitation start, Excitation stop, Pause, Restart, etc.

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

(13) Optional Specification: Limit Control, Resonance dwell, Multi Sweep Sine

### 1.1.2 Resonance dwell (Option of SINE)

There are two types of resonance dwelling.

“I. Auto Searching & Dwelling” can work with Resonance Dwell option.

“II. Pre-searching & Dwelling” requires Amplitude Search option in addition to Resonance Dwell option.

#### I. Auto Searching & Dwelling (Resonance Dwell option)

This requires a preliminarily specified phase difference considered as a resonance point. The system automatically dwells upon detection of the specified phase difference since it considers the difference is a resonance point.

##### (1) Method

The methods to operate this function are as below;

Resonance point searching by the method of detecting the phase difference between the specified two response points

Dwelling of the frequency change at the resonance point to be searched

##### (2) Input Channel

Two input channels used as Base channel for the base of observation and Search channel for the resonance search are specified.

##### (3) Search Range of Resonance

Maximum 16 points of search resonance are to be defined. (Its ranges are specified by the lower and the upper limit frequency.)

##### (4) Resonance Point Definition

Phase difference to be detected is specified (within  $-180 \sim +180 : \pm 90^\circ$  as default).

##### (5) Dwell Time

Dwell Time is set by time or by vibration counts.

##### (6) Change Ratio of the Resonance Function

Dwelling operation is to be controlled by changing Resonance Frequency when the frequency exceeds over the specified frequency range. (Initial Resonance Frequency is as a basis.)

#### II. Pre-searching & Dwelling (Amplitude Search option)

This requires that the specified frequency range be preliminarily swept so that frequencies at which Q-value and Amplitude Transmissibility exceed set value are listed as resonance points. A frequency selected from among those listed is used as a frequency at which excitation is performed. The system dwells according to change of the selected resonance frequency.

##### (1) Method

Consisting of three statuses: Resonance Survey, Resonance Search and Resonance Dwell so as to perform dwelling according to change of a resonance frequency that has been specified through Survey and Search.

(2) Input Channel

Two input channels used as Base channel for the base of observation and Search channel for the resonance search are specified.

(3) Number of Resonance point

A maximum of 16 resonance points can be registered.

(4) Resonance Point Definition

A frequency at which Q-value and Amplitude Transmissibility exceed set value is considered as Resonance point.

(5) Dwell Time

Time to be specified.

(6) Change Ratio of the Resonance Function

Dwelling operation is to be controlled by changing Resonance Frequency when the frequency exceeds over the specified frequency range.

(7) Dwelling

There are two types of Dwelling: one that changes frequency within the specified frequency range to maintain it at the initial phase value while detecting the phase change and the other that uses a new peak value as Resonance point while detecting the amplitude change and searching a peak of Amplitude Transmissibility within the specified frequency range. Excitation fixed at Resonance Frequency is available as well.

(8) Data display

The following time-based data can be graphically displayed. No frequency-based graphic display is available.

Control response, transmissibility (amplitude and phase), Q-value, frequency, response level of input channel.

### **1.1.3 Limit Control (Option of 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.

### **1.1.4 Multi Sweep Sine (Option of SINE)**

Multi Sweep Sine test is mainly intended to shorten the time of Sine tests, enabling several different sweep tests to be simultaneously executed.

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

(2) Control Frequency :0.1~20000 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 (However it may depend on conditions.)
- (5) Operation Mode
- 1) Multiple frequency sweep
  - 2) Time delayed sweep
  - 3) Multi spot
- (6) Sweep Operation
- Sweep mode: Log / Linear
- Sweep type: Single / Double
- Direction: Forward / Backward (only multiple frequency sweep)
- Max. number of sine <sup>\*1</sup>: 16(Multi swept sine), 32(Multi spot)
- Manual operation at sweeping: excitation pause / sweep pause, excitation level change
- (7) Test Time: by sweep counts / by time
- (8) Input Channel
- 1) Number of channels: maximum 64
  - 2) Type of channels: Control channel / Monitor channel (possible to duplicate)
  - 3) Peak Amplitude Estimation Method<sup>\*2</sup>: Tracking, Averaged value, rms value
  - 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.
- (9) Output Channel
- 1) Number of channels: 1
  - 2) Waveform distortion: Less than 0.1 % (1V rms)
- (10) Analysis / Display Data
- The trace of the level for controlled response and response of each input channel
- The trace of the level for drive
- Each level data for every moments, accumulated value of the vibration times
- Control response / Drive transmissibility, Each input channel / Controlled response transmissibility, Each input channel / Drive transmissibility • phase, Transmissibility phase between the input channels
- (11) Data Save: Automatic / Manual, Display data save as CSV format

\*1 It depends on the test setting.

\*2 Control channel has to be used 'Tracking' mode.

# Chapter 2 Operation System of K2+ Application

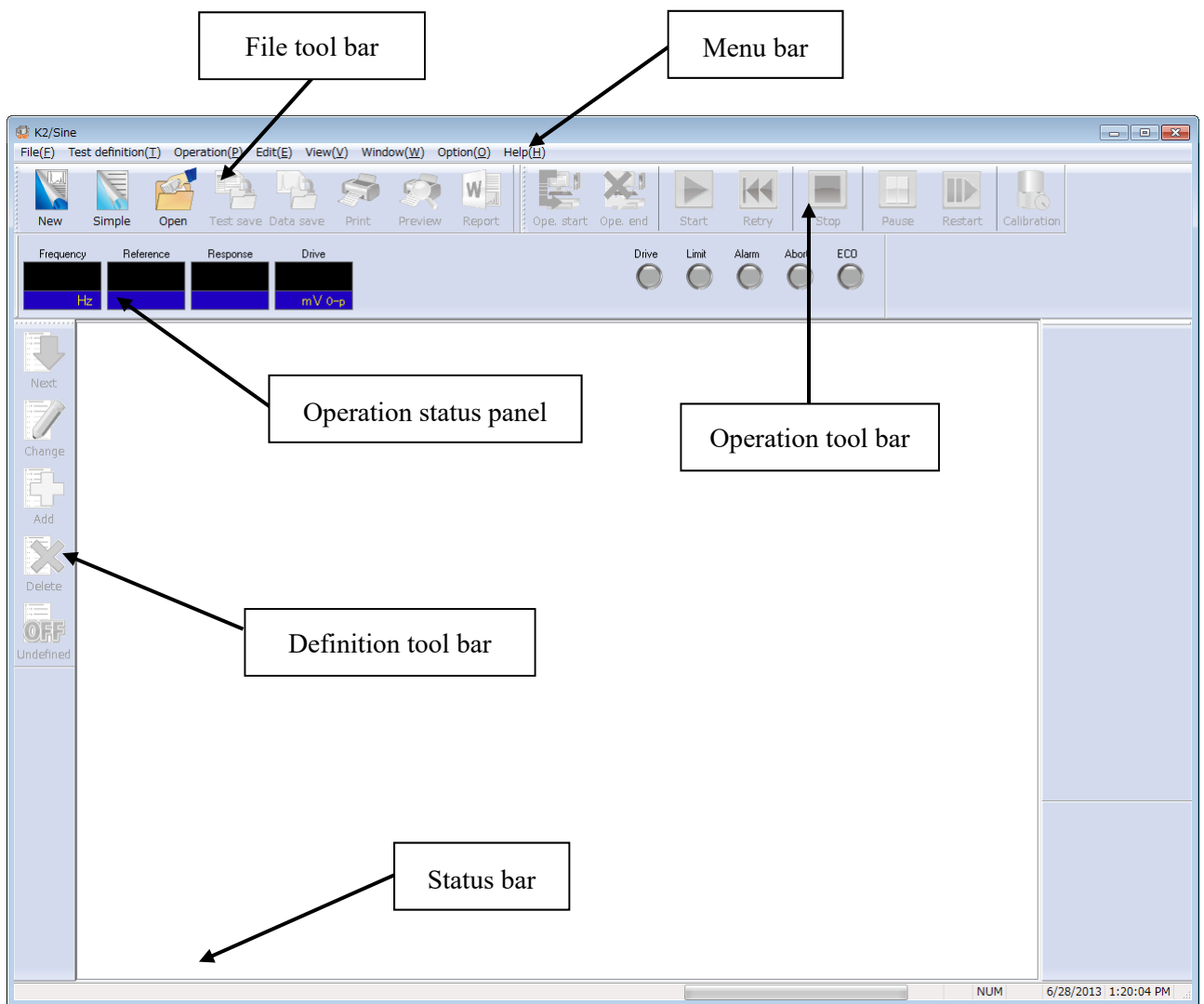
## 2.1 Outline

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 in Ver.20.0.0.0 or later  
K2+/SINE (\*.swp2, \*.spt2, \*.mnl2)  
The file created in Ver.10.0.0.0 or later  
K2/SINE (\*.swp2, \*.spt2, \*.mnl2)  
The file created before Ver.10.0.0.0  
K2/SINE (\*.swp, \*.spt, \*.mnl)
  
- Graph Data File : The file created in Ver.10.0.0.0 or later (\*.vdf2)  
The file created before Ver.10.0.0.0 (\*.vdf)
  
- Environment setting File  
(I/O Module Configuration Information, Excitation System Information, Input channel Information) : SystemInfo.Dat2  
**Note 1) Saved in '\IMV\K2\_Plus' on System Drive. Deleting inhibited.**

## 2.3 Test Type

Three types of tests as below are available in K2+/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.

### ③ Manual test

Manual test is for operating a test by the special method. In this test, the system operates a test only by manual operation.

Control reference condition can be changed arbitrarily during the manual test operation.

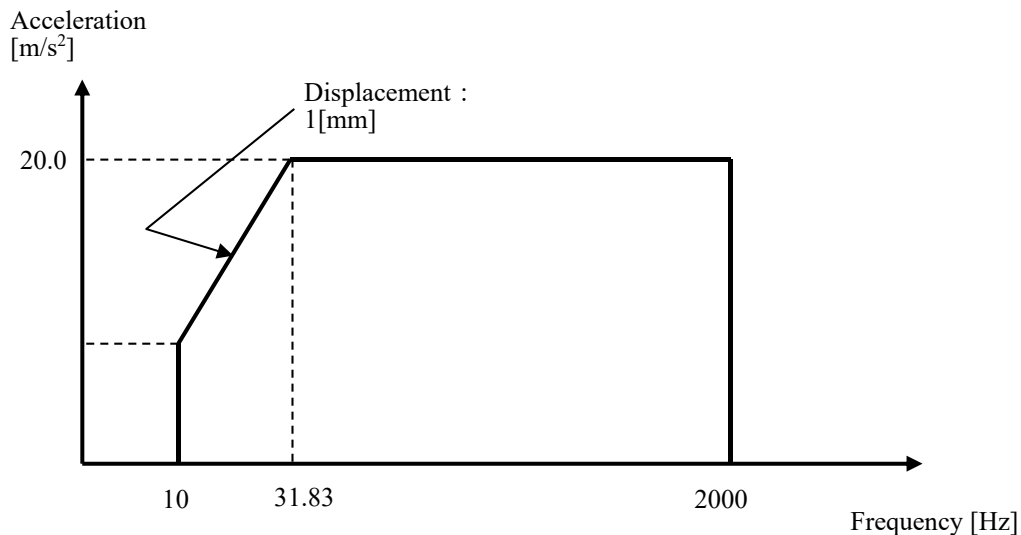
## Chapter 3 Basic Operation

### 3.1 Sweep (Simplified definition)

< Example >

An example of sweep test is described as below ;

[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 : one is used for control and another for monitor.

Ch. 1 : for control, sensitivity  $3\text{pC}/(\text{m/s}^2)$

Ch. 2 : for monitor, sensitivity  $3\text{pC}/(\text{m/s}^2)$

However, these channels must be registered in Input environment information (in this example, 'SysInp01').

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

[Information of specimen]

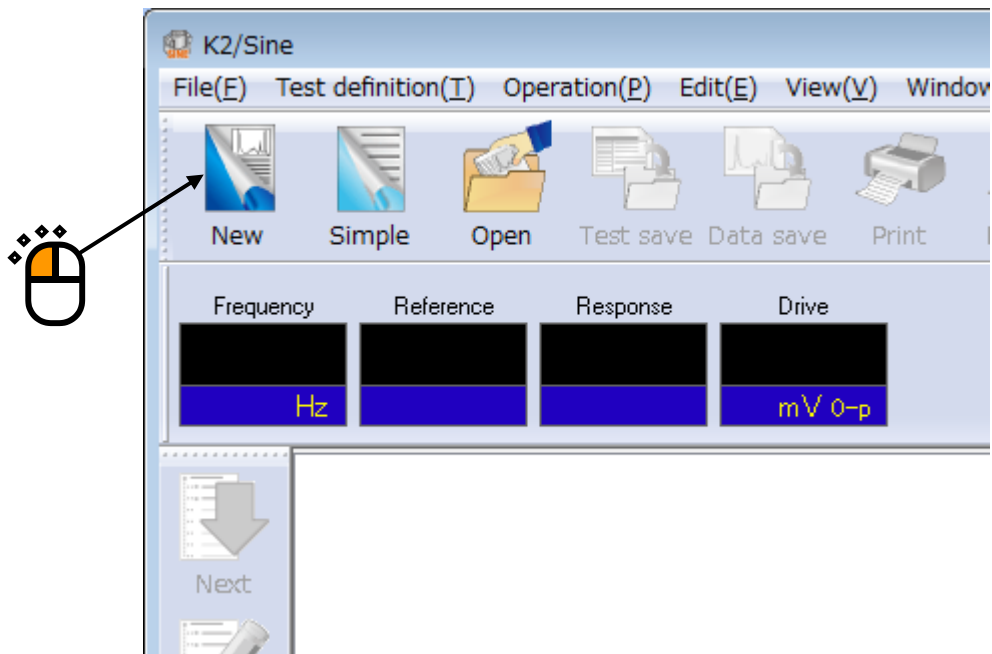
Specimen mass : 10[kg]



< Procedures >

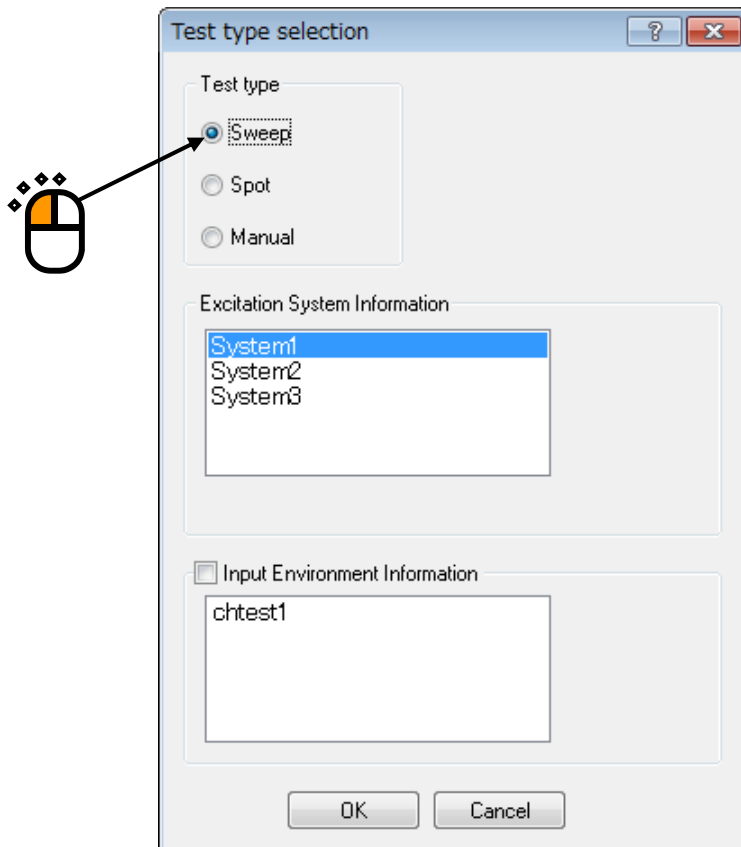
< Step 1 >

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



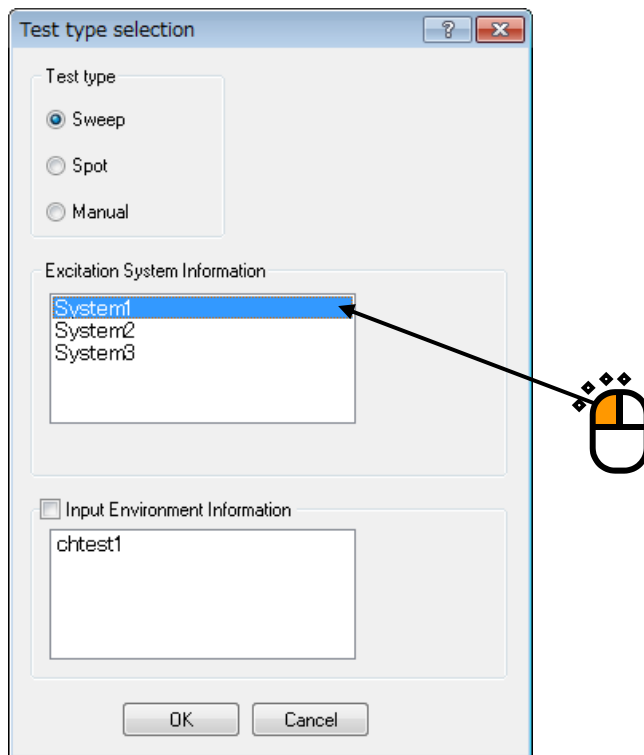
< Step 2 >

Select the item of 'Sweep' in Test type.



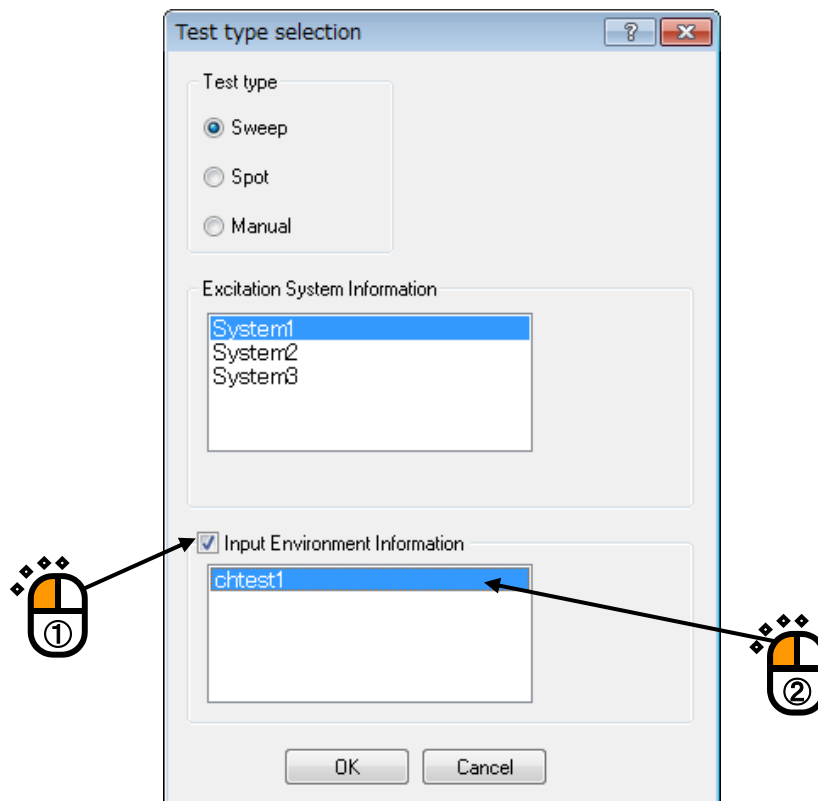
< Step 3 >

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



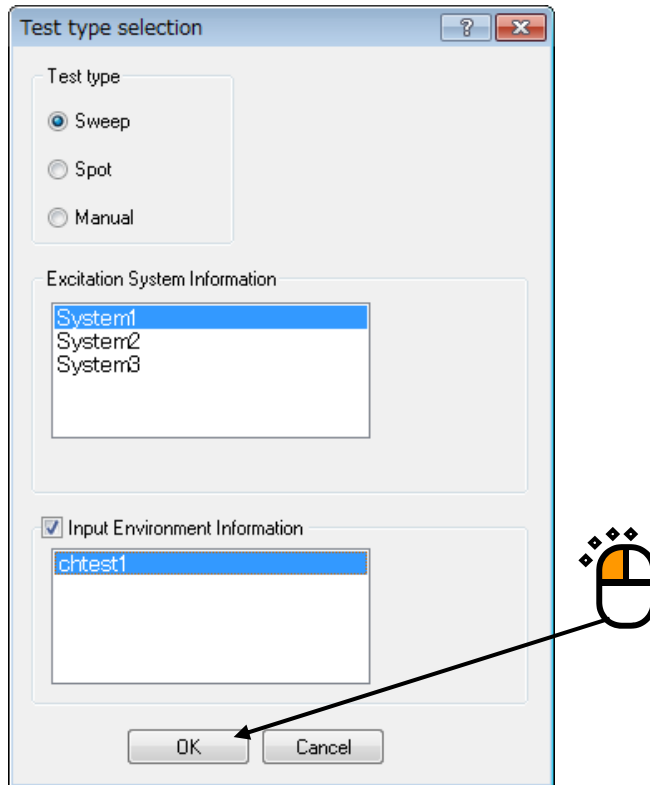
< Step 4 >

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



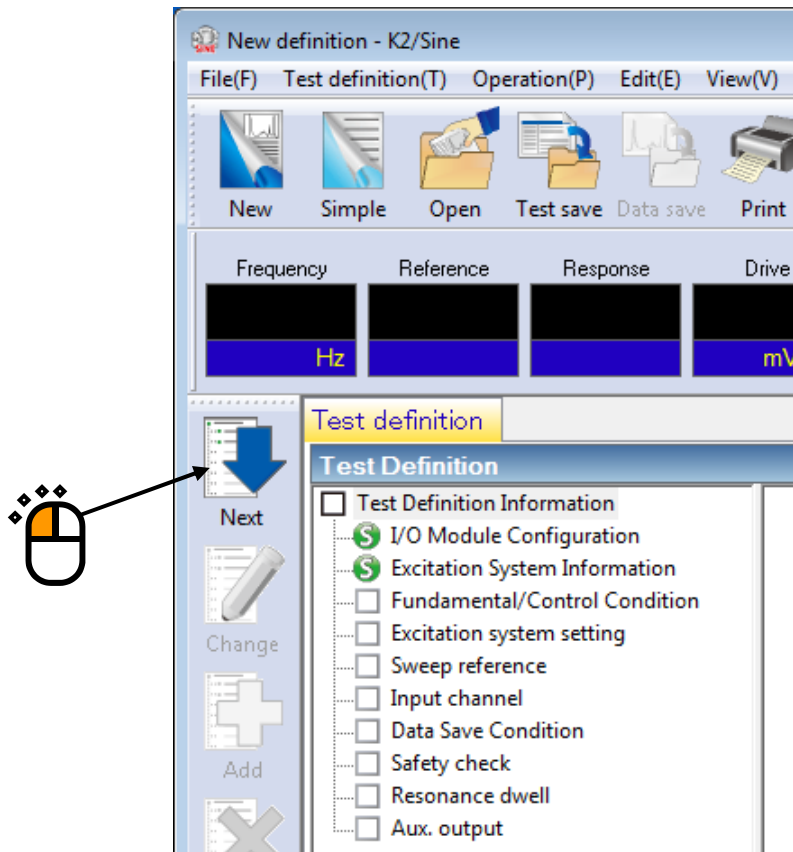
< Step 5 >

Press the button of [OK].



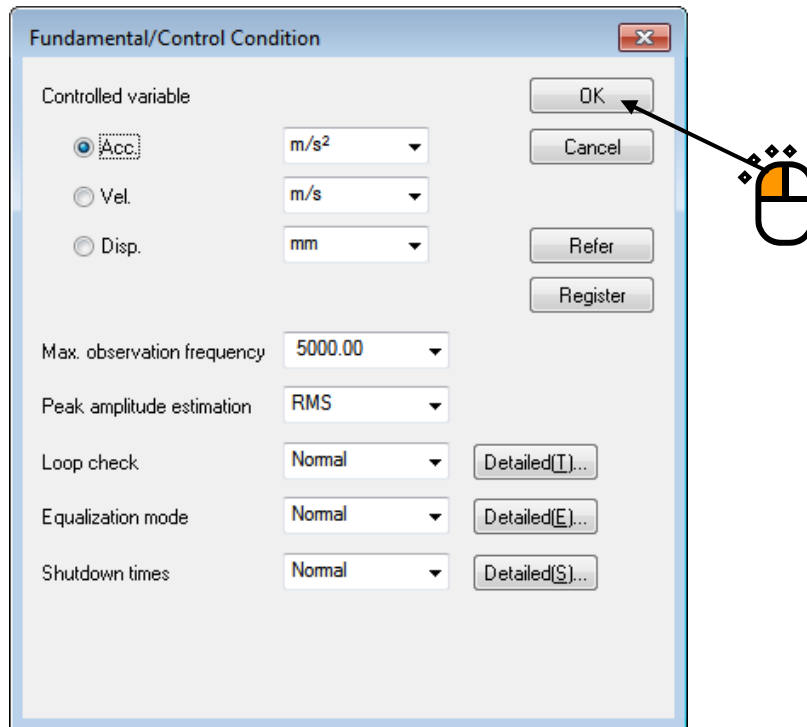
< Step 6 >

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



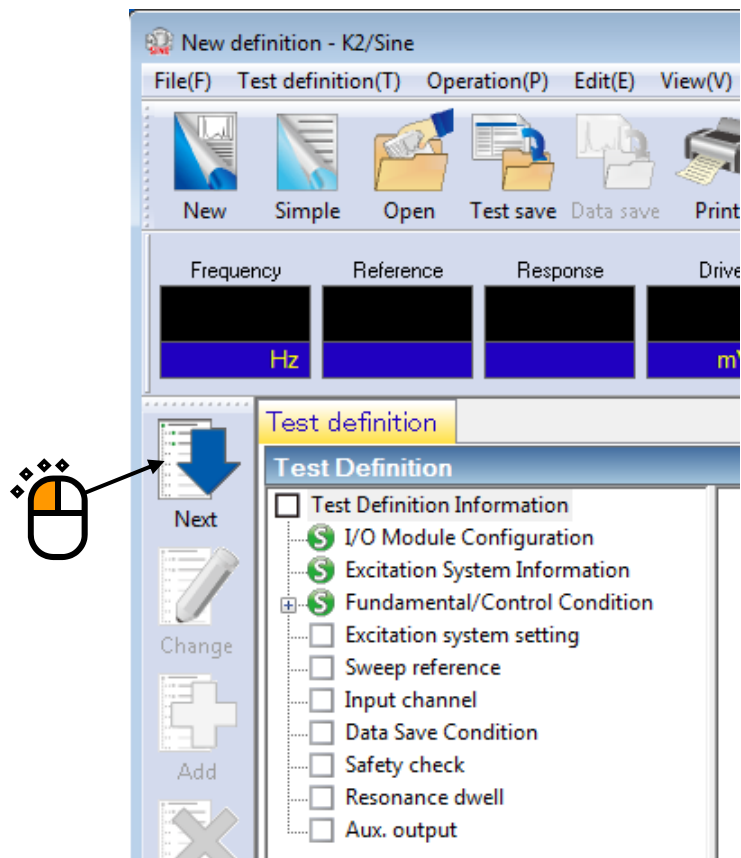
< Step 7 >

Press the button of [OK].



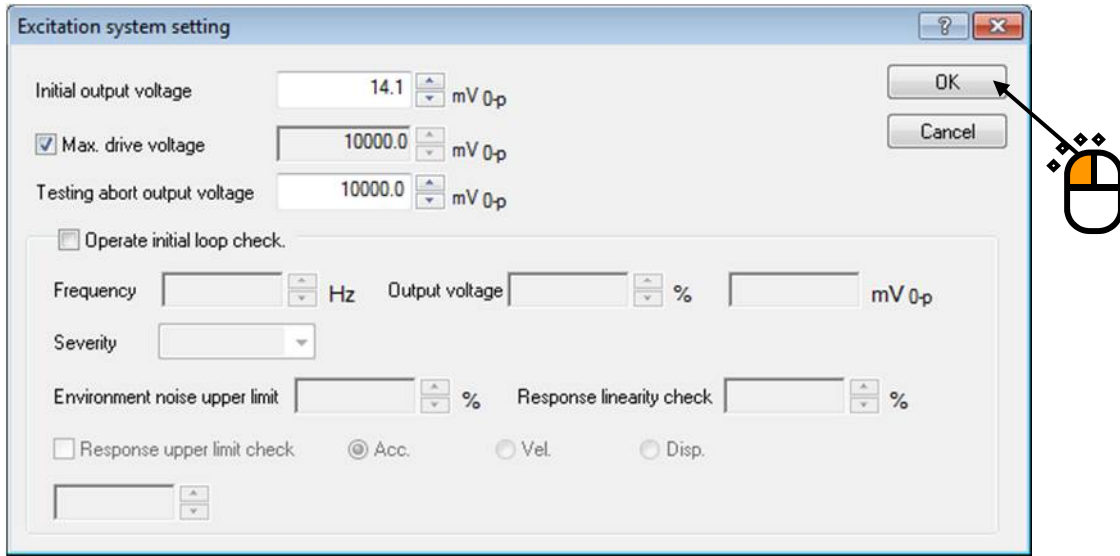
< Step 8 >

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



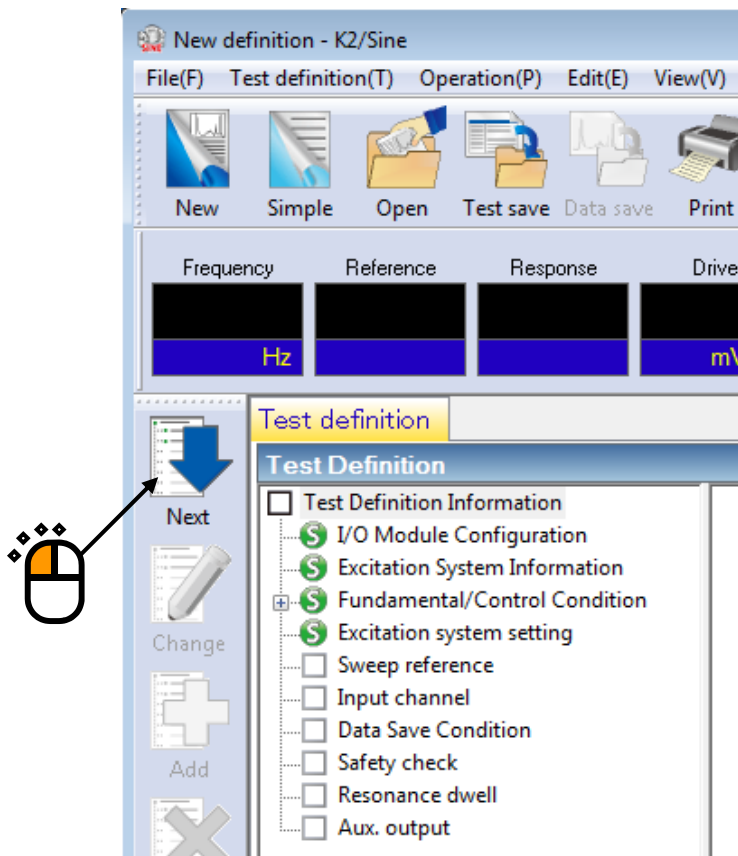
< Step 9 >

Press the button of [OK].



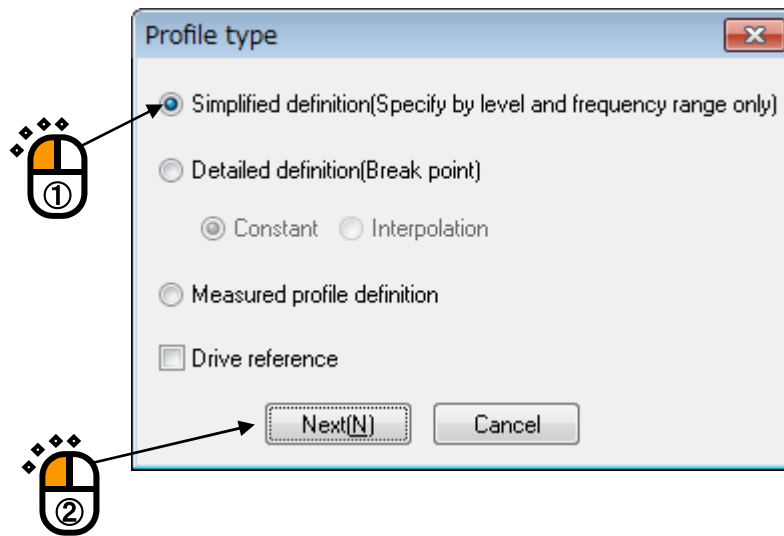
< Step 10 >

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



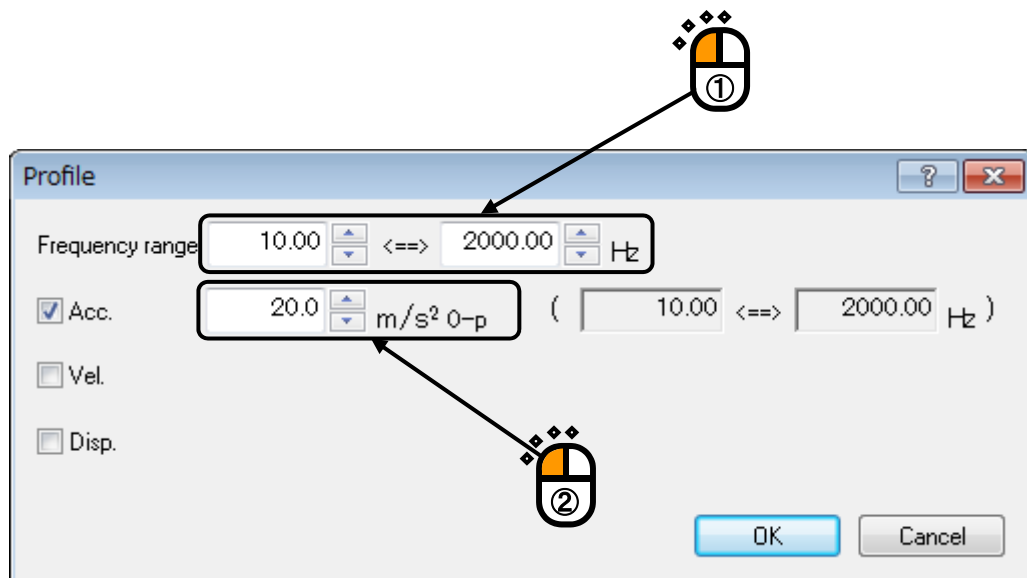
< Step 11 >

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



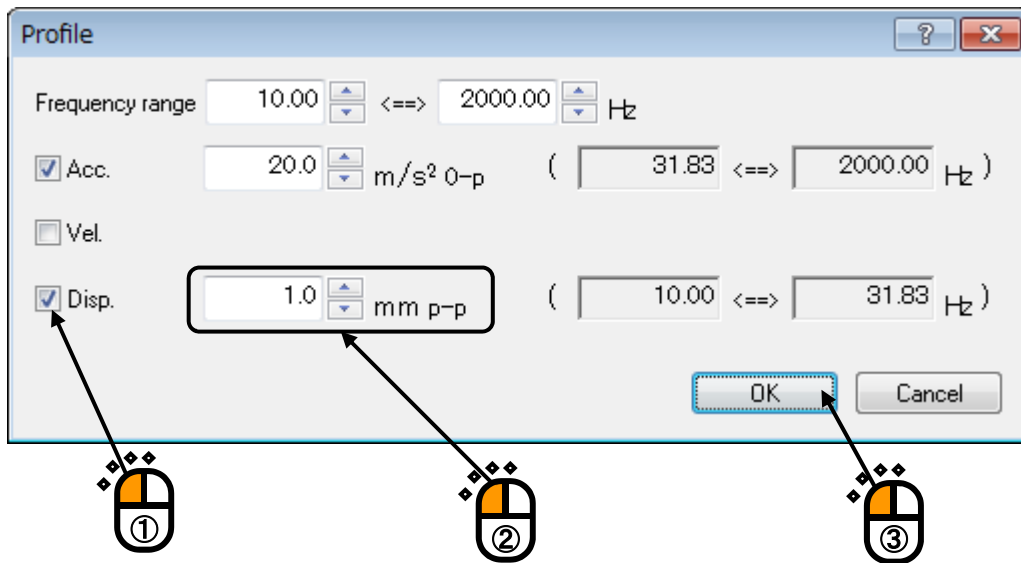
< Step 12 >

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



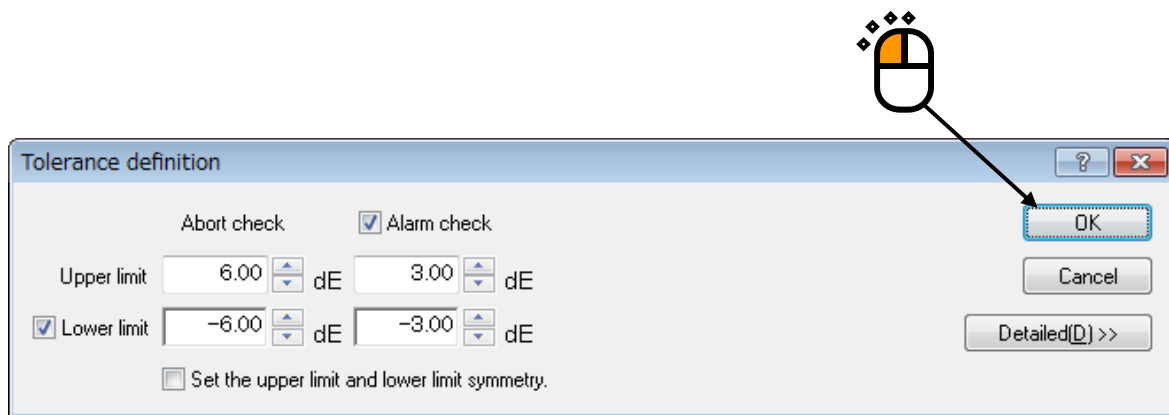
< Step 13 >

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



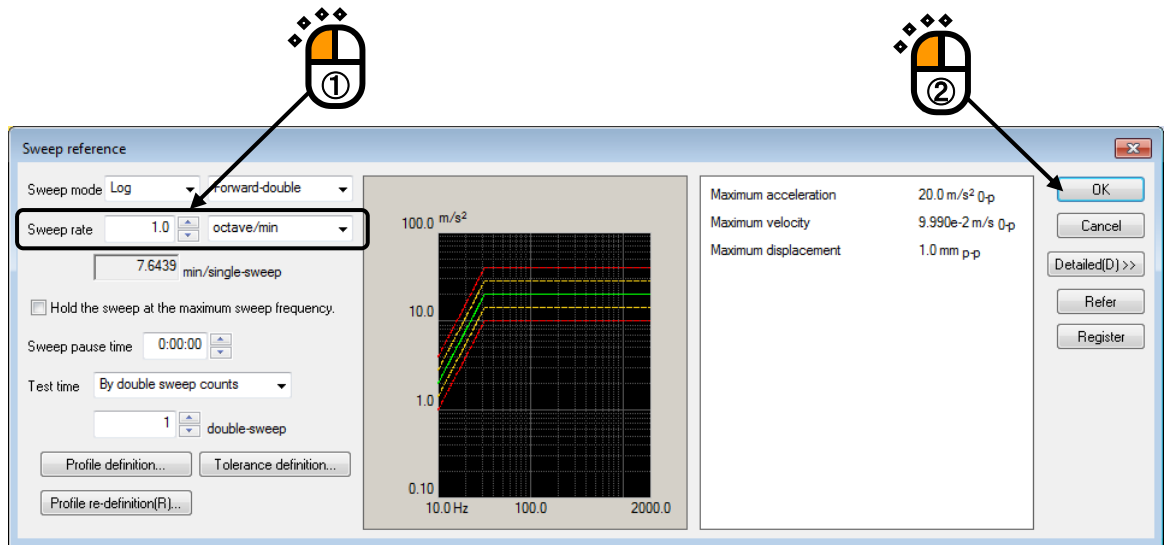
< Step 14 >

Press the button of [OK].



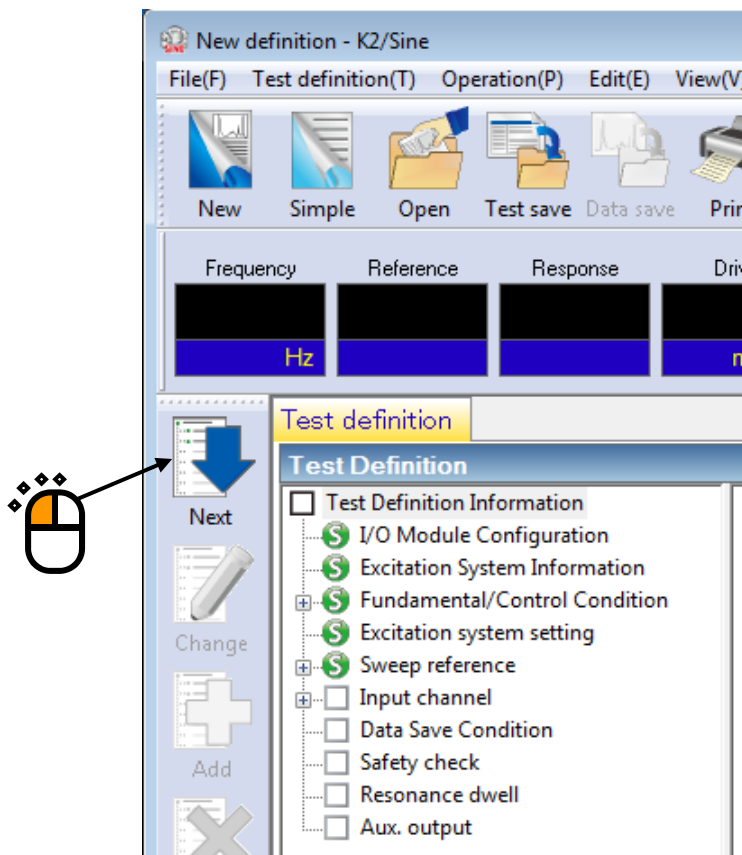
< Step 15 >

Input the value to 'Sweep rate' as 1.000 [octave/min]. And press the button of [OK].



< Step 16 >

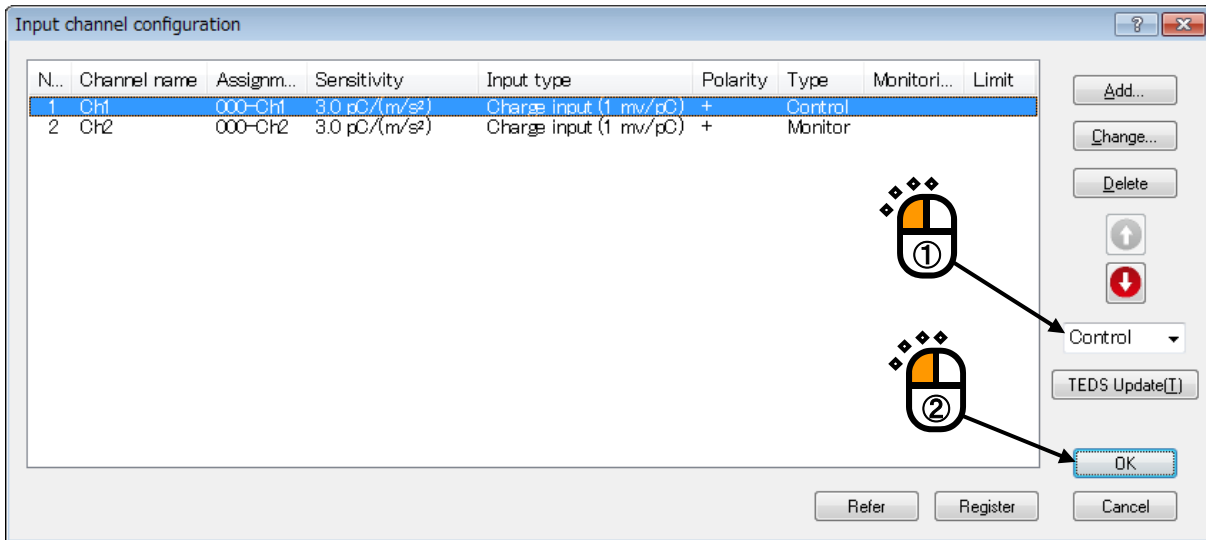
Press the button of [Next] to go to the next definition.





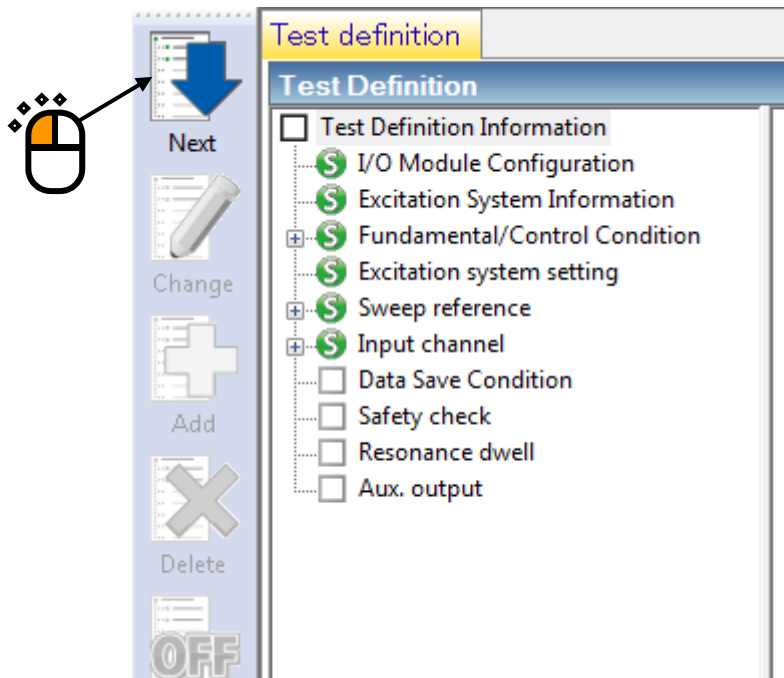
< Step 17 >

Select 'Ch. 1' and check the check box of 'Control'. And select 'Ch. 2' and check the check box of 'Monitor'. Then press the button of [OK].



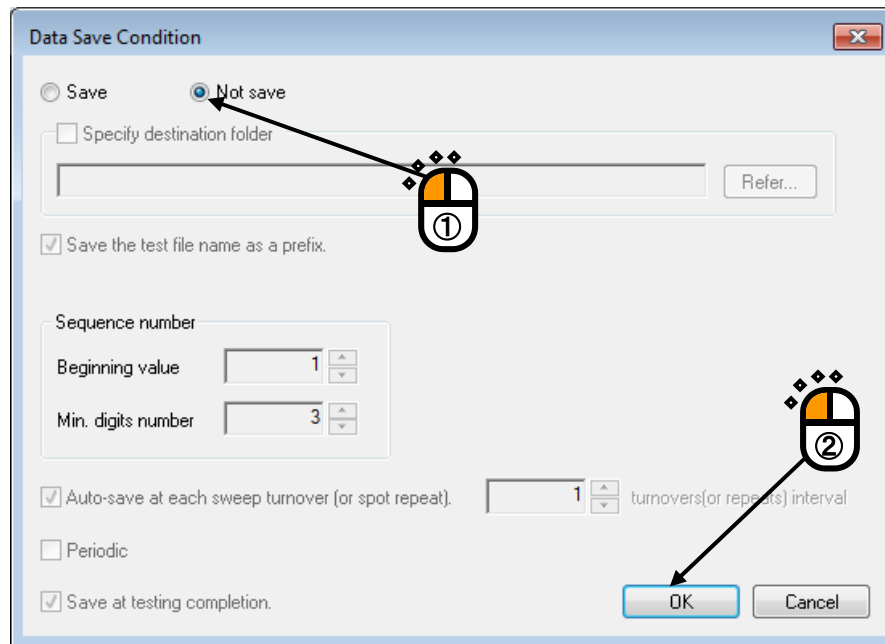
< Step 18 >

Press the button of [Next].



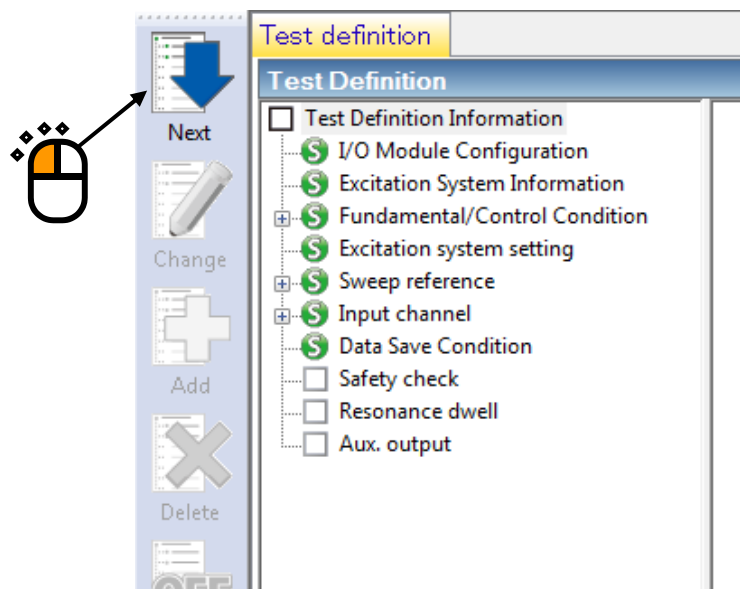
< Step 19 >

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



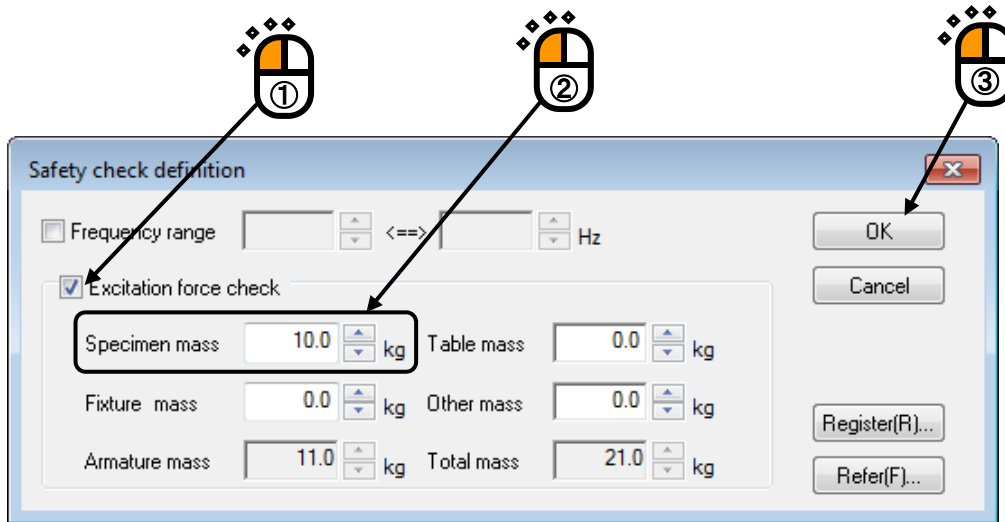
< Step 20 >

Press the button of [Next].



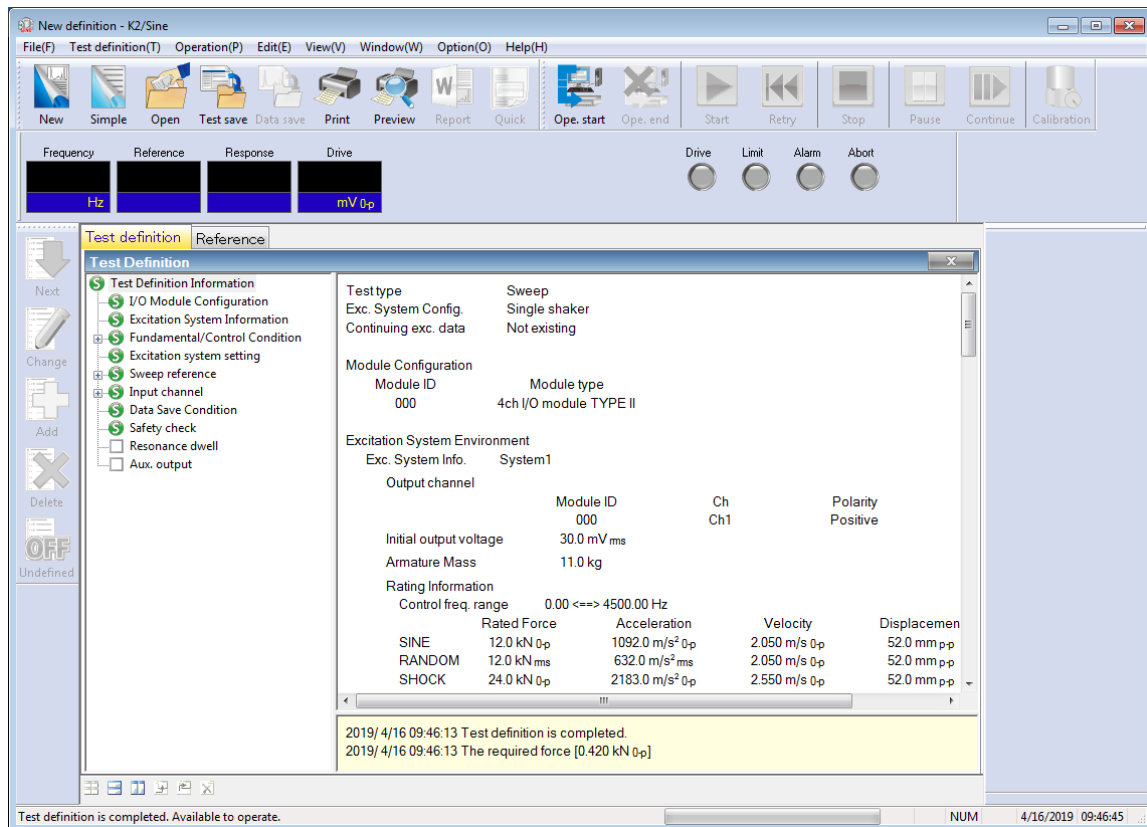
< Step 21 >

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



< Step 22 >

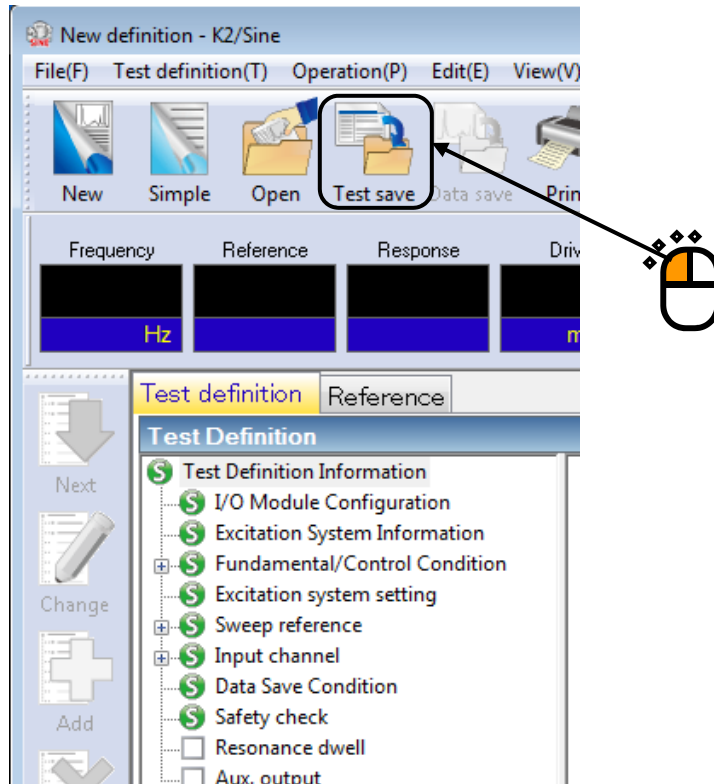
The definition is completed.



< Save test >

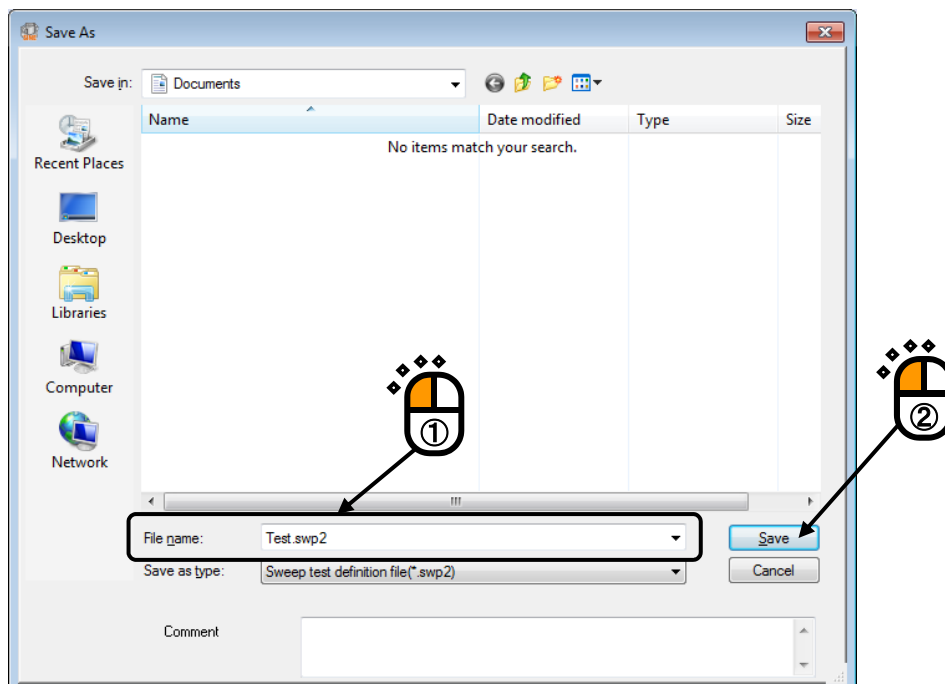
< Step 1 >

Press the button of [Save].



< Step 2 >

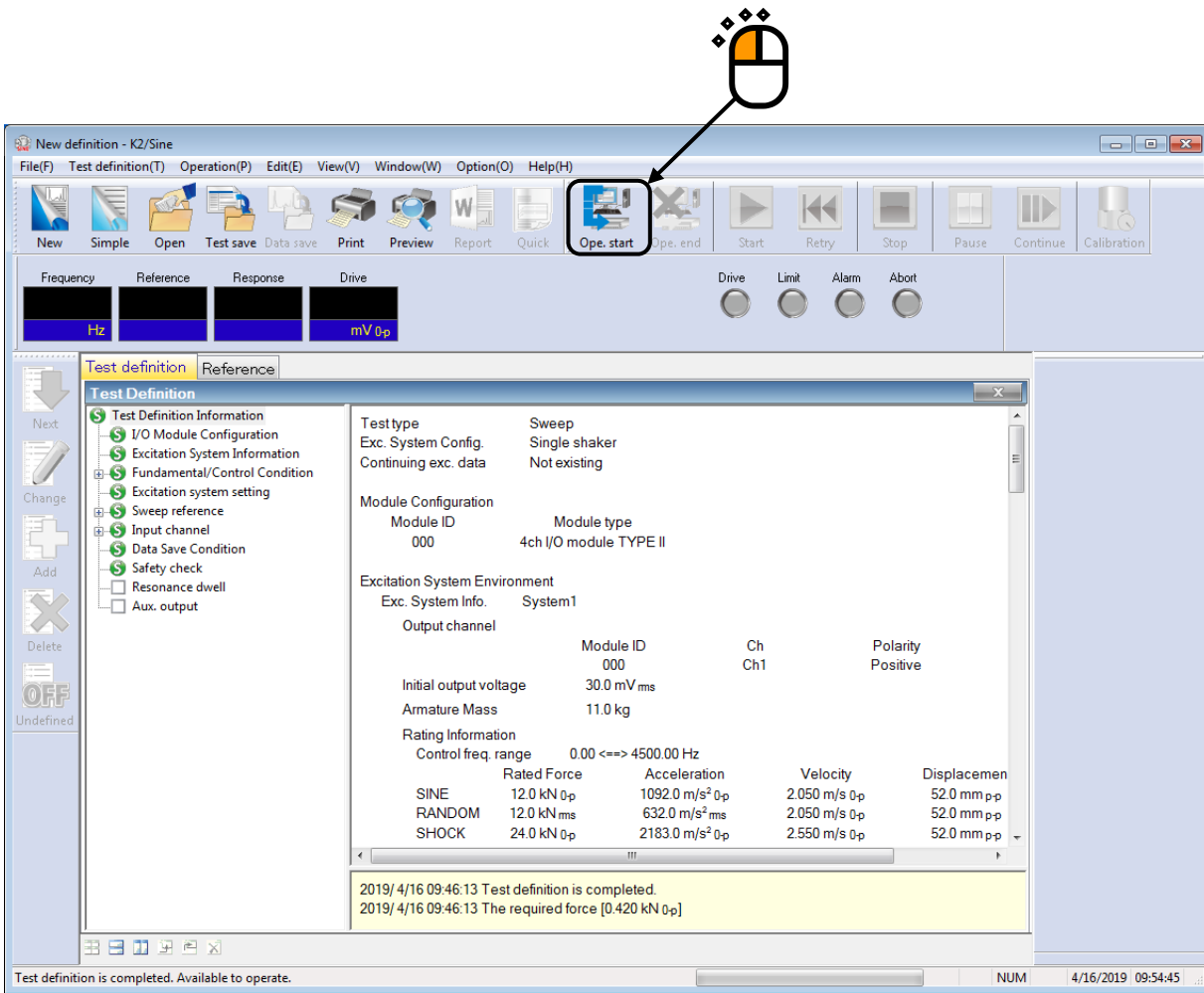
Input a name in 'File name' and press the button of [Save].



< Operation of test >

< Step 1 >

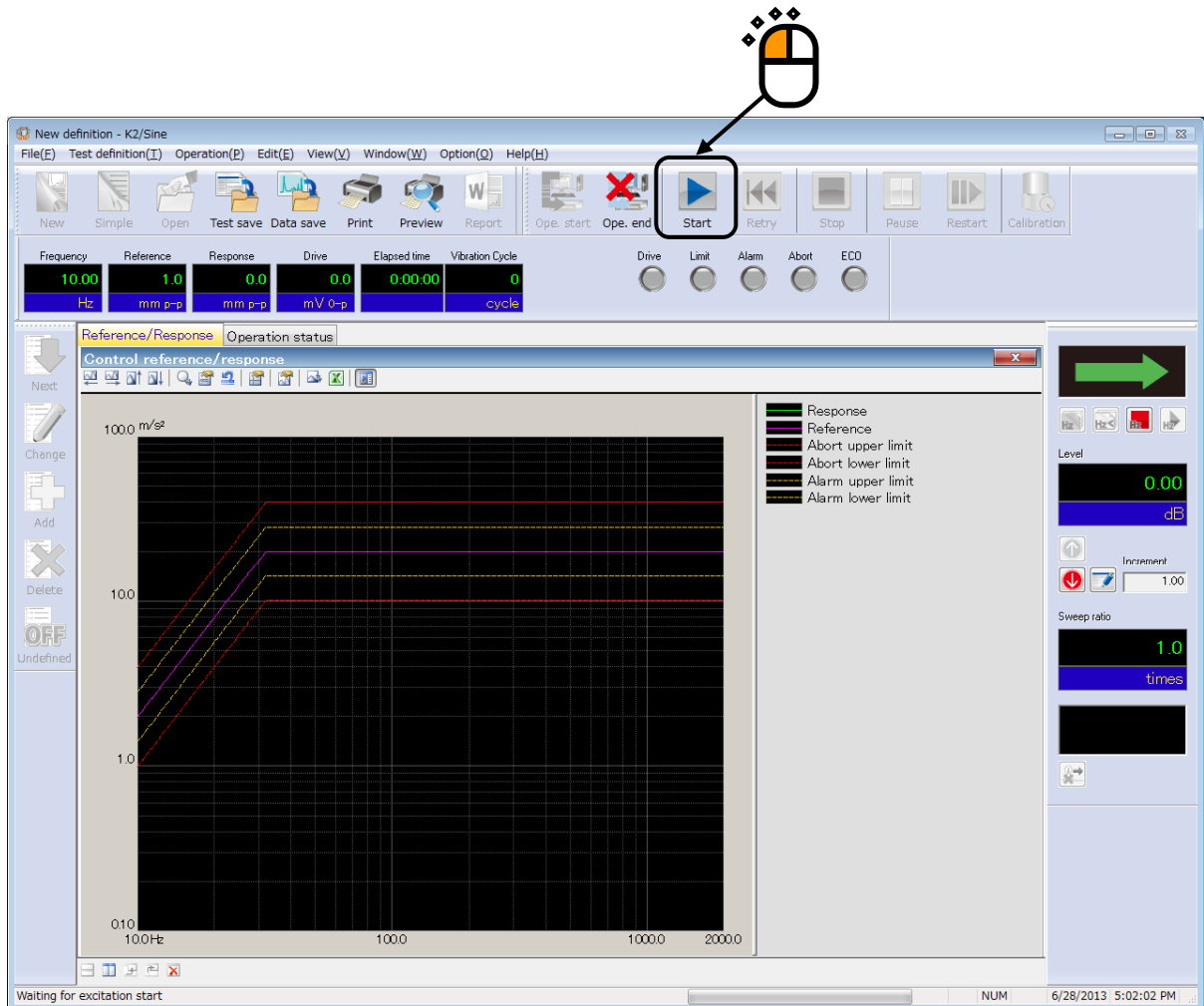
Press the button of [Operation start].



< Step 2 >

Press the button of [Start].

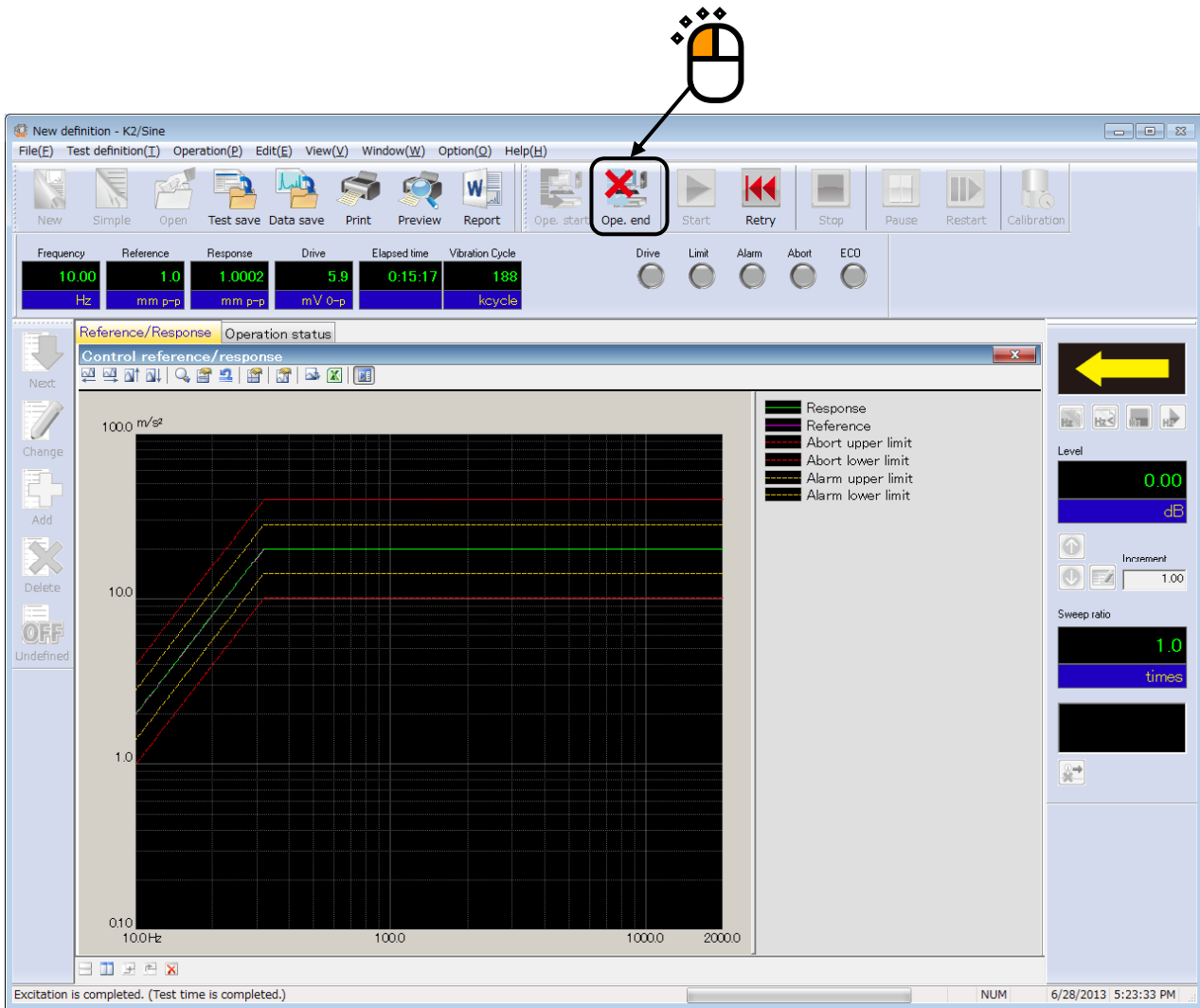
When [Start] is pressed, Initial loop check, and Initial equalization are automatically operated. Then, the test operation is executed.



< Step 3 >

Test operation is completed when the test time passed.

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

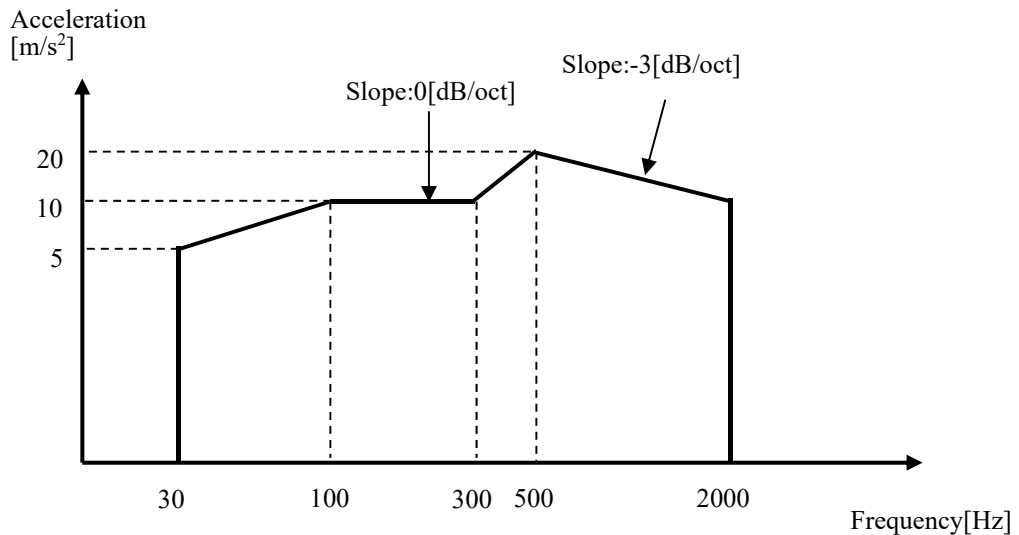


### 3.2 Sweep (Detailed Definition Break Point)

< Example >

An example of sweep test is described as below ;

[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 : one is used for control and another for monitor.

Ch. 1 : for control, sensitivity 3pC/(m/s<sup>2</sup>)

Ch. 2 : for monitor, sensitivity 3pC/(m/s<sup>2</sup>)

However, these channels must be registered in Input environment information (in this example, 'SysInp01').

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

[Information of specimen]

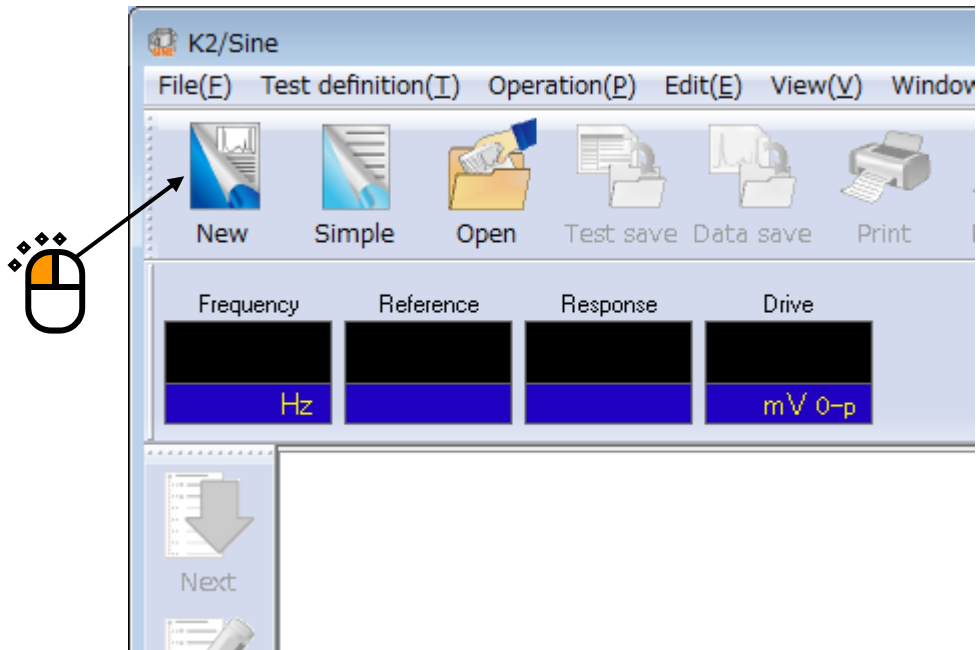
Specimen mass : 10[kg]



< Procedures >

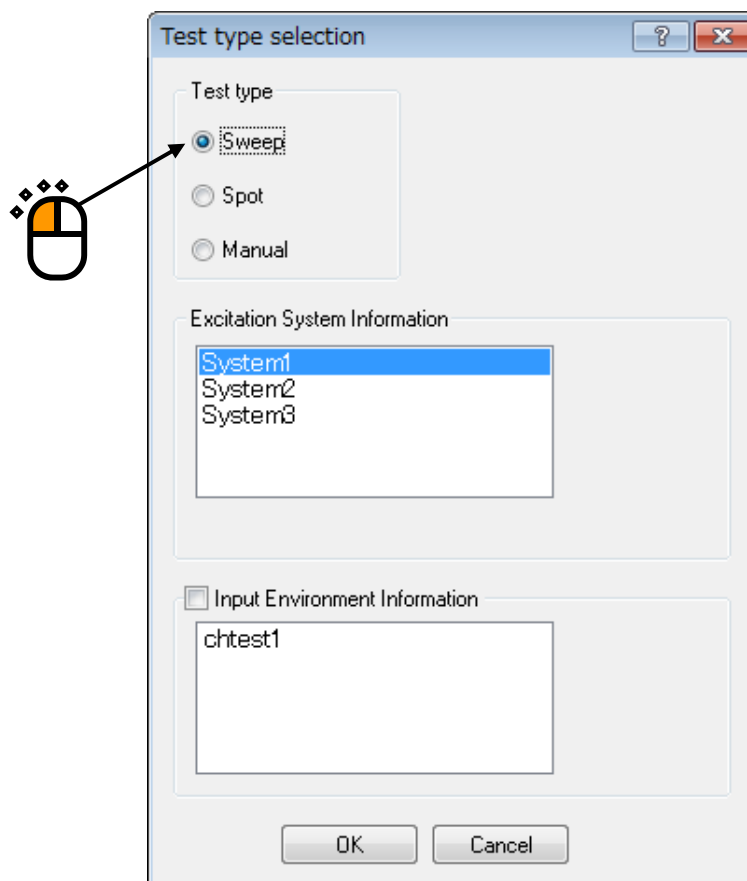
< Step 1 >

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



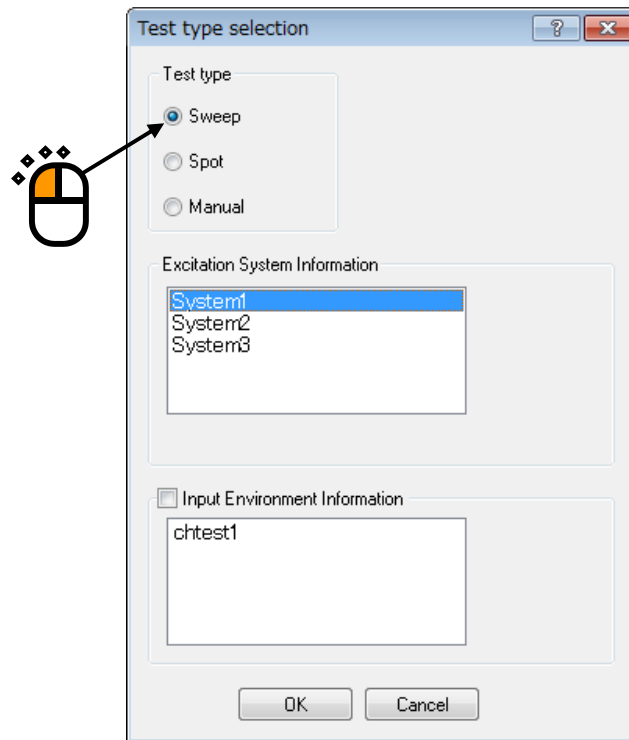
< Step 2 >

Select the item of 'Sweep' in Test type.



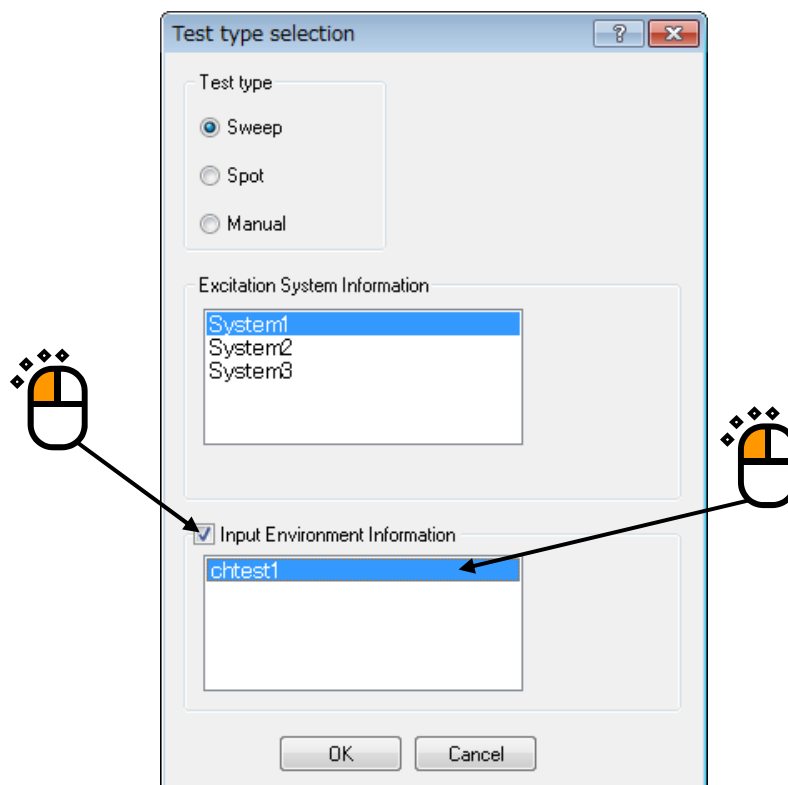
< Step 3 >

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



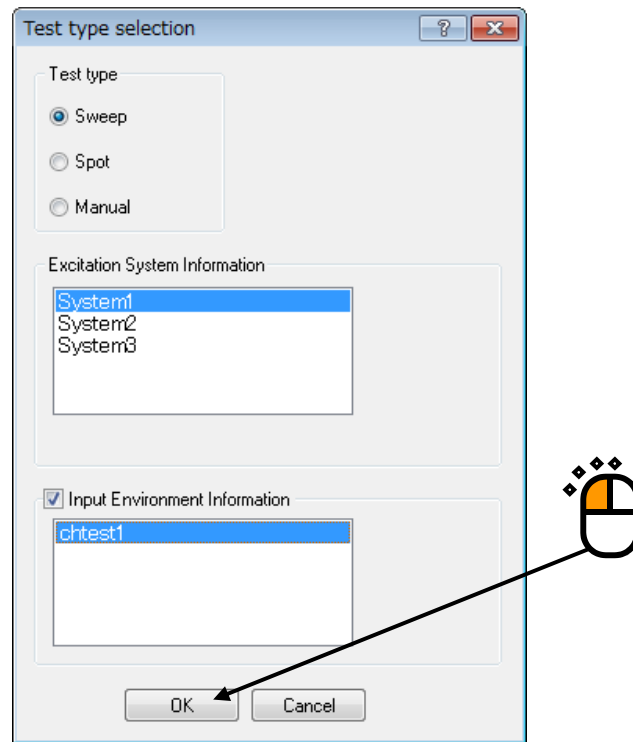
< Step 4 >

Click the checkbox of 'Input Environment Information' and select an input channel information from the list.



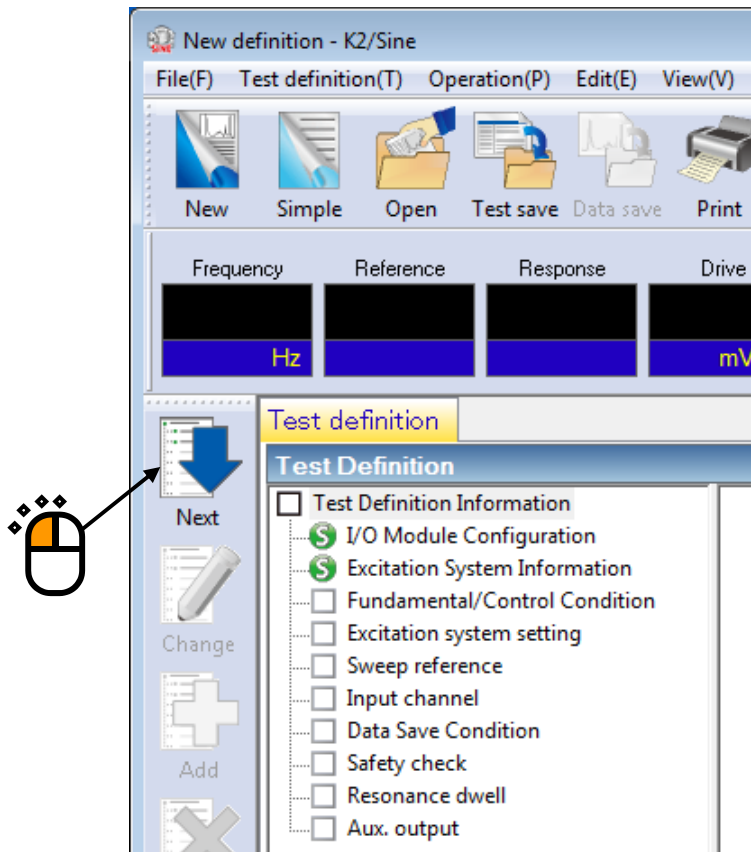
< Step 5 >

Press the button of [OK].



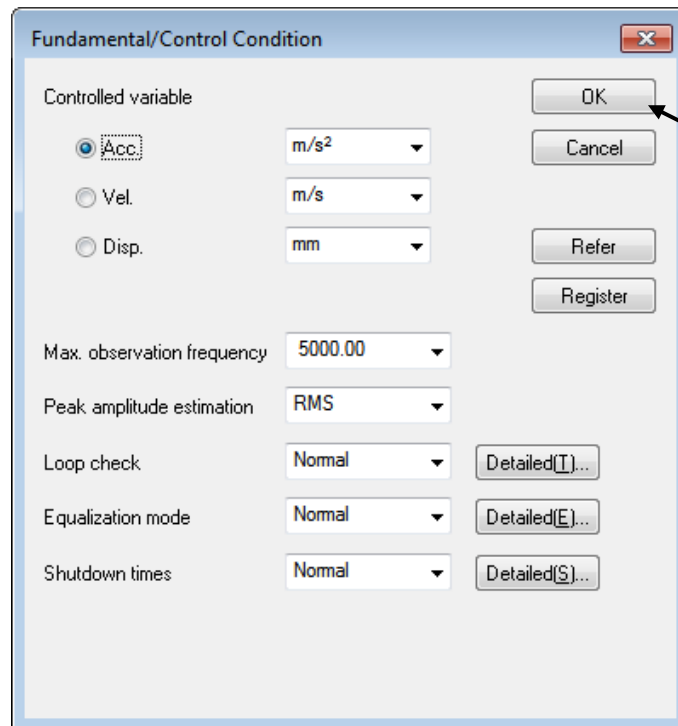
< Step 6 >

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



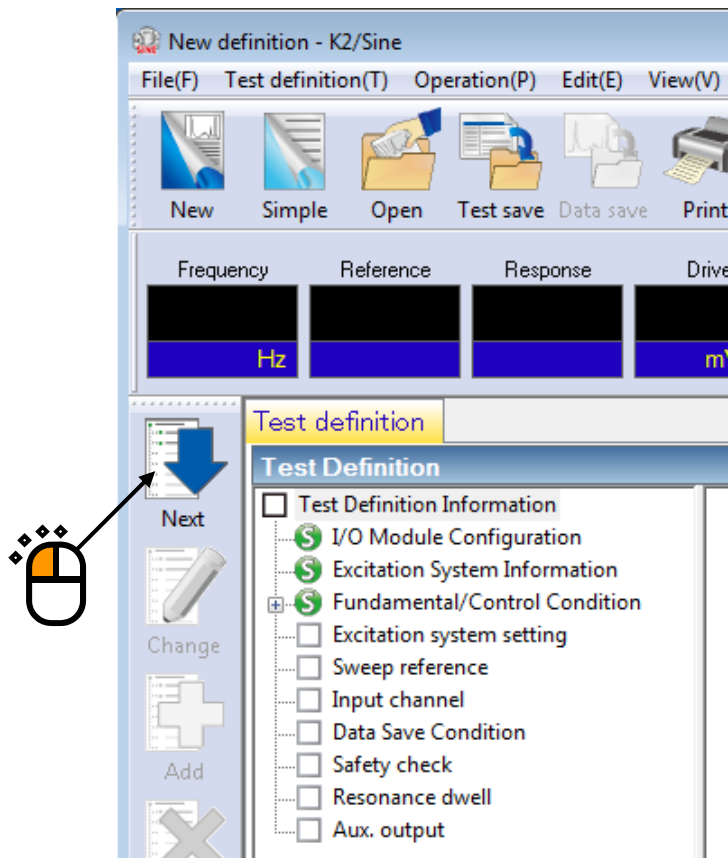
< Step 7 >

Press the button of [OK].



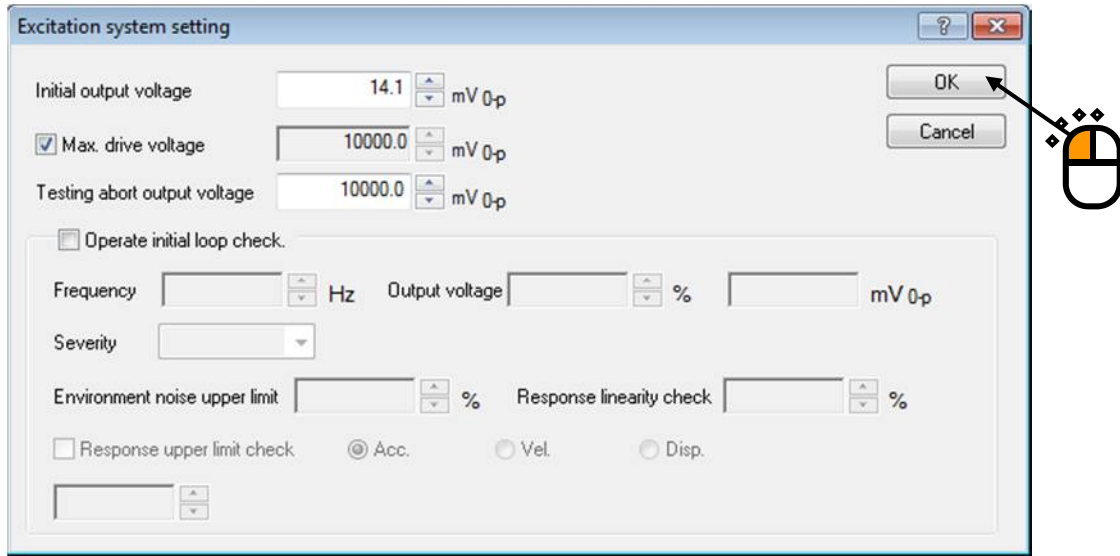
< Step 8 >

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



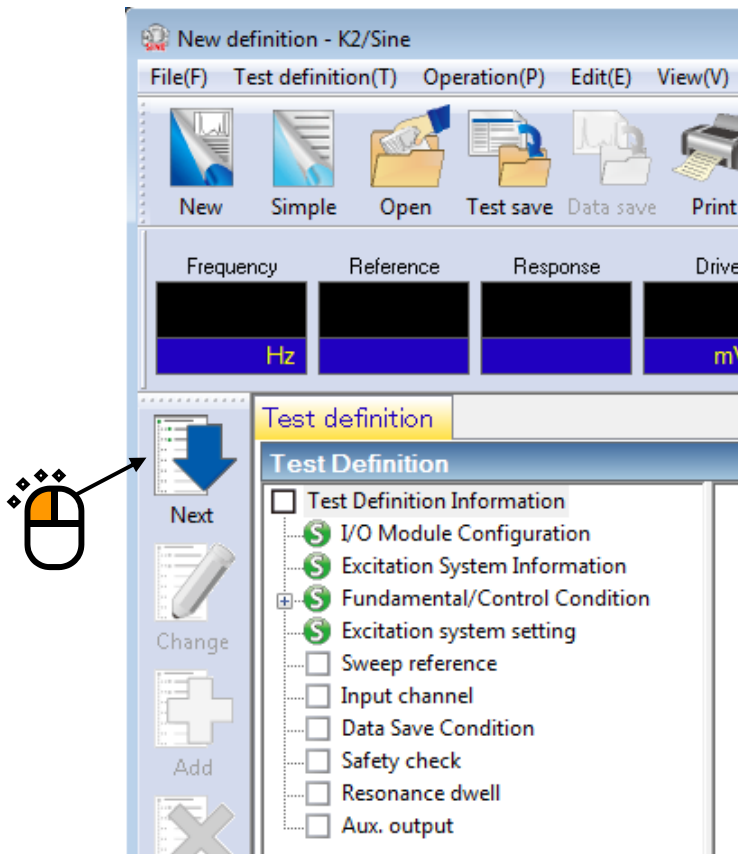
< Step 9 >

Press the button of [OK].



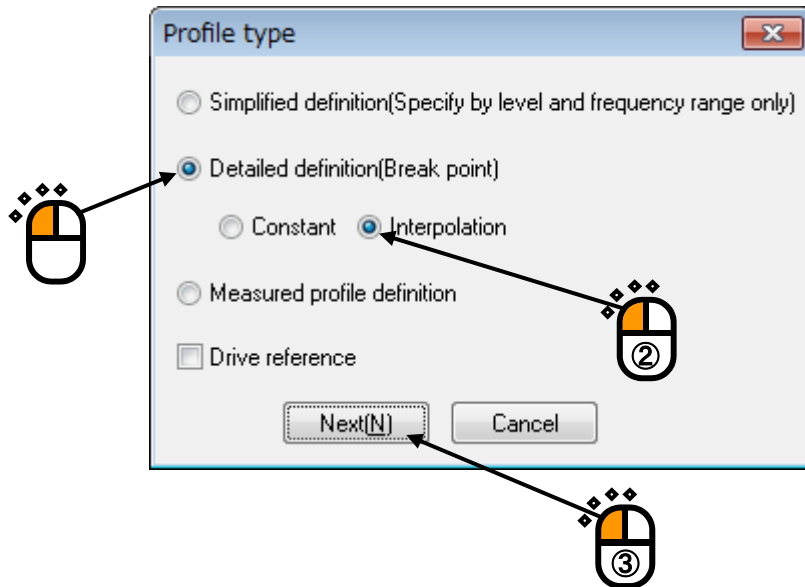
< Step 10 >

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



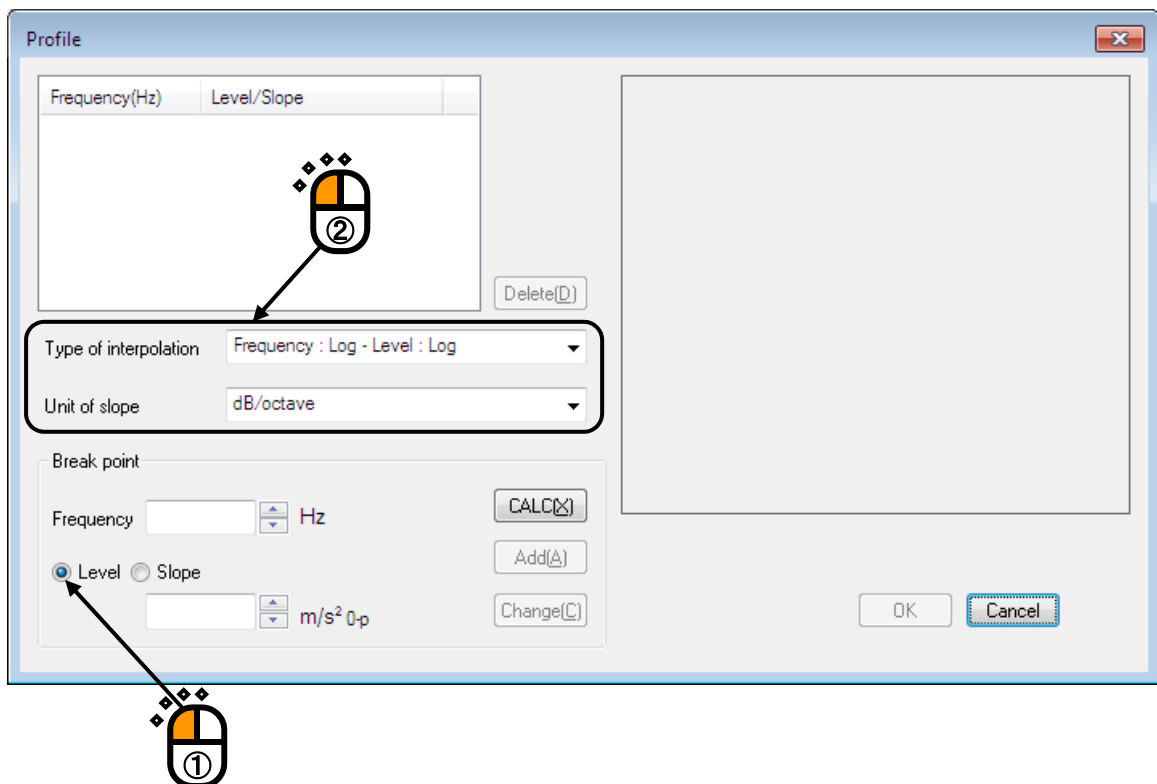
< Step 11 >

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



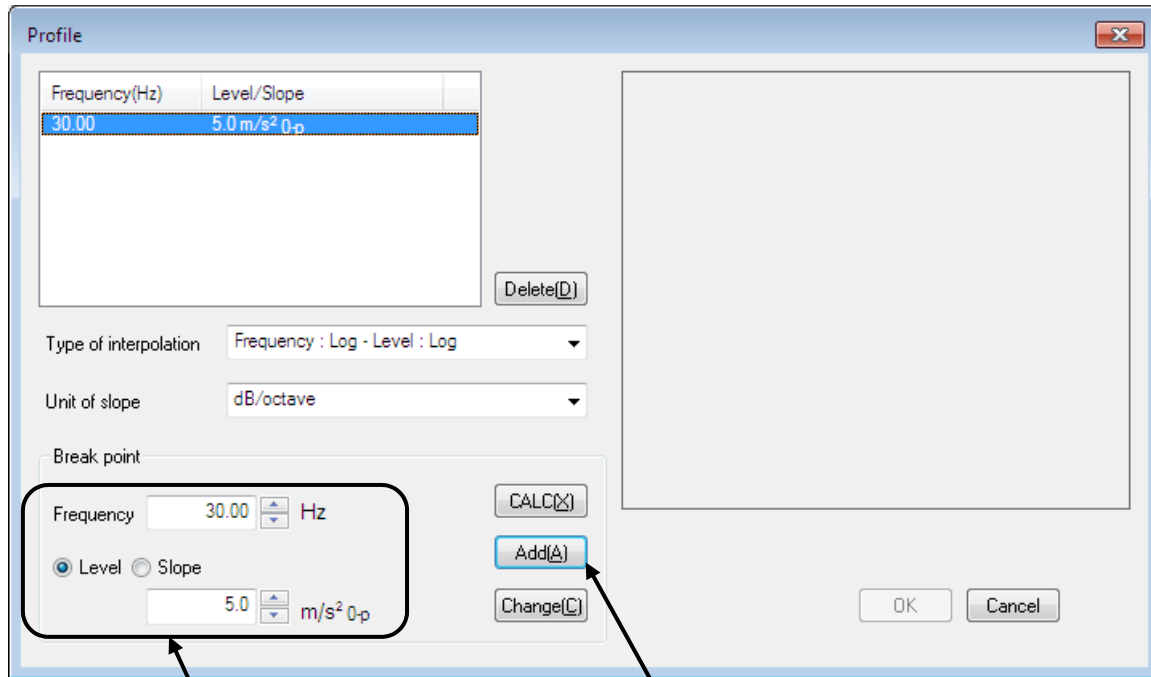
< Step 12 >

Select 'Level'. Specify Type of interpolation as 'Frequency : Log - Level : Log' and Unit of slope as 'dB/octave'.



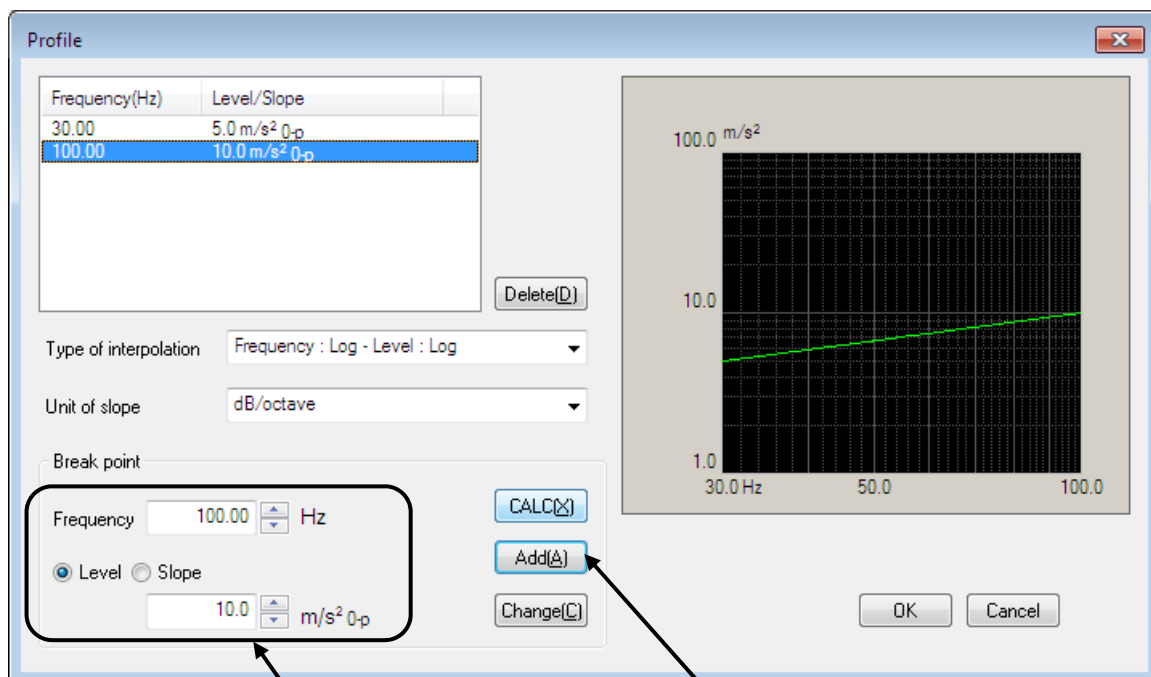
< Step 13 >

Input the values to 'Frequency' as 30 [Hz] and 'Level' as 5.0 [m/s<sup>2</sup>]. And press the button of [Add].



< Step 14 >

Input the values to 'Frequency' as 100 [Hz] and 'Level' as 10.0 [m/s<sup>2</sup>]. And press the button of [Add].



< Step 15 >

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

Profile

Frequency(Hz)	Level/Slope
30.00	5.0 m/s <sup>2</sup> 0-p
100.00	10.0 m/s <sup>2</sup> 0-p
300.00	0.0 dB/octave

Delete(D)

Type of interpolation: Frequency : Log - Level : Log

Unit of slope: dB/octave

Break point

Frequency: 300.00 Hz

Level  Slope

0.0 dB/octave

CALC(X)

Add(A)

Change(C)

OK Cancel

100.0 m/s<sup>2</sup>

10.0

1.0

30.0 Hz 100.0 300.0

① ② ③

< Step 16 >

Select 'Level'. Input the values to 'Frequency' as 500 [Hz] and 'Level' as 20.0 [m/s<sup>2</sup>]. And press the button of [Add].

Profile

Frequency(Hz)	Level/Slope
30.00	5.0 m/s <sup>2</sup> 0-p
100.00	10.0 m/s <sup>2</sup> 0-p
300.00	0.0 dB/octave
500.00	20.0 m/s <sup>2</sup> 0-p

Delete(D)

Type of interpolation: Frequency : Log - Level : Log

Unit of slope: dB/octave

Break point

Frequency: 500.00 Hz

Level  Slope

20.0 m/s<sup>2</sup> 0-p

CALC(X)

Add(A)

Change(C)

OK Cancel

100.0 m/s<sup>2</sup>

10.0

1.0

30.0 Hz 100.0 500.0

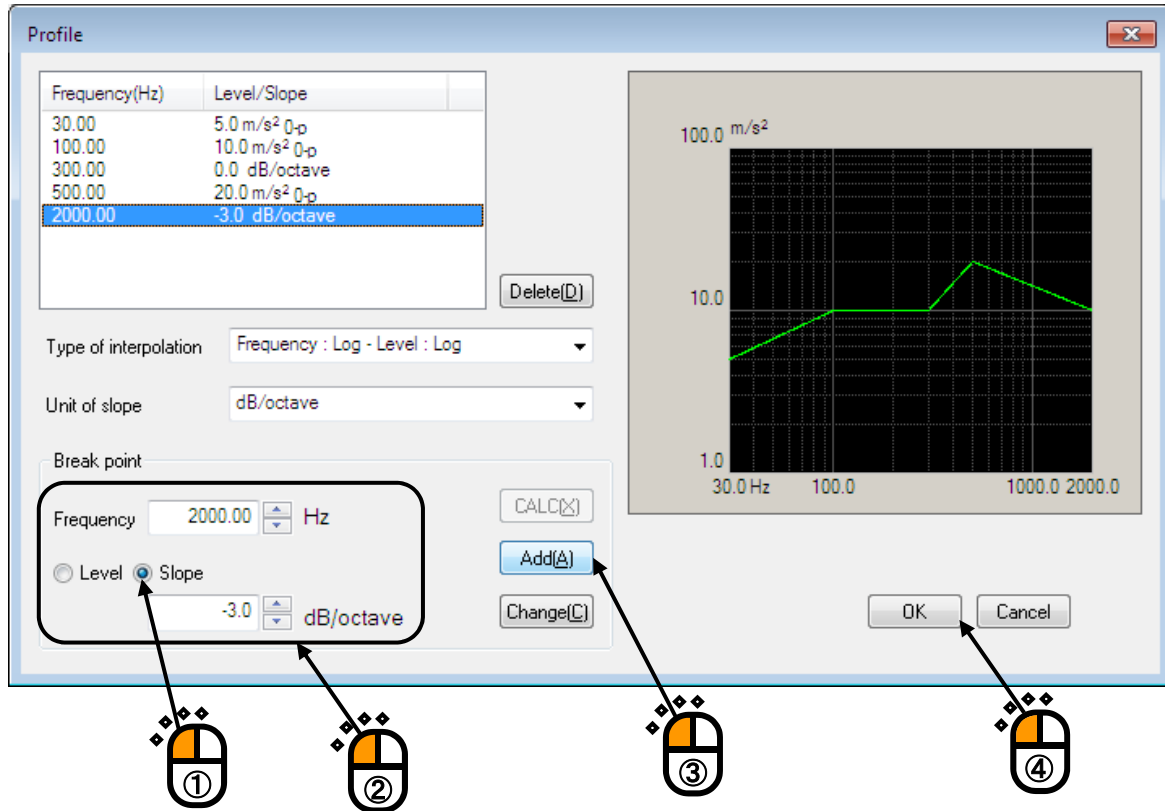
① ② ③



< Step 17 >

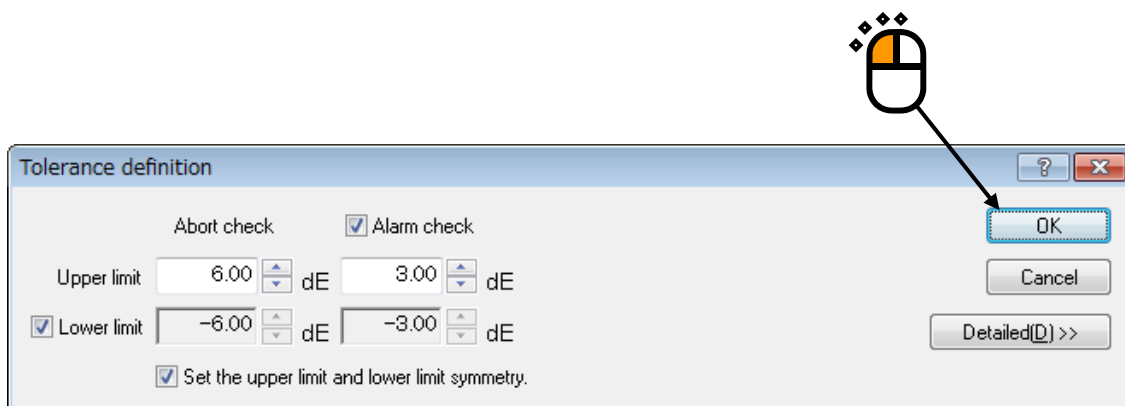
Select 'Slope'. Input the values to 'Frequency' as 2000 [Hz] and 'Slope' as -3.0 [dB/octave]. And press the button of [Add].

Then press the button of [OK].



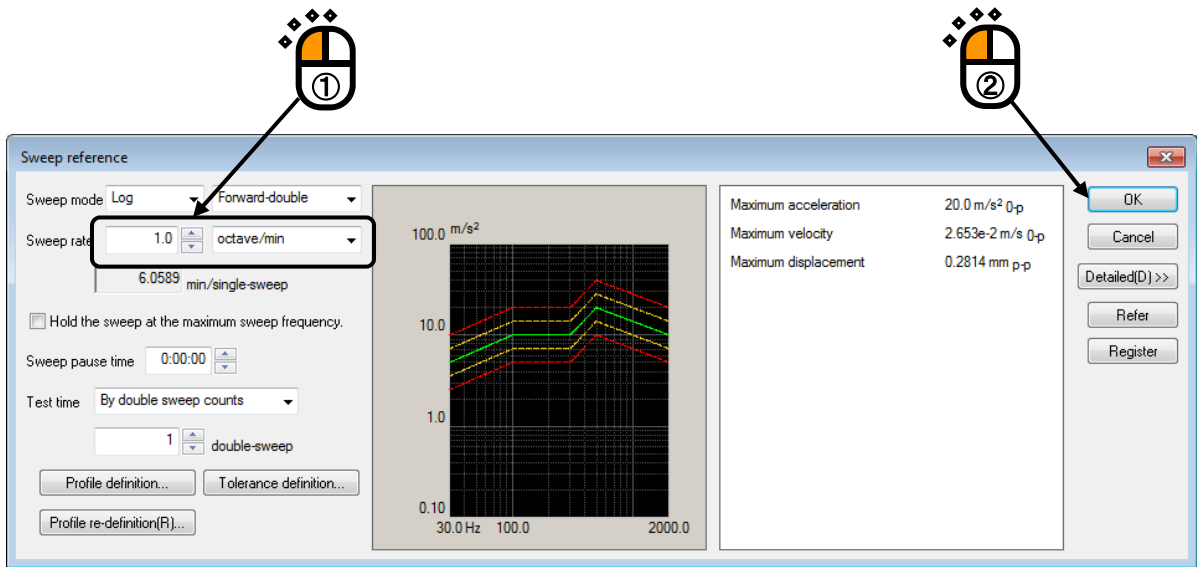
< Step 18 >

Press the button of [OK].



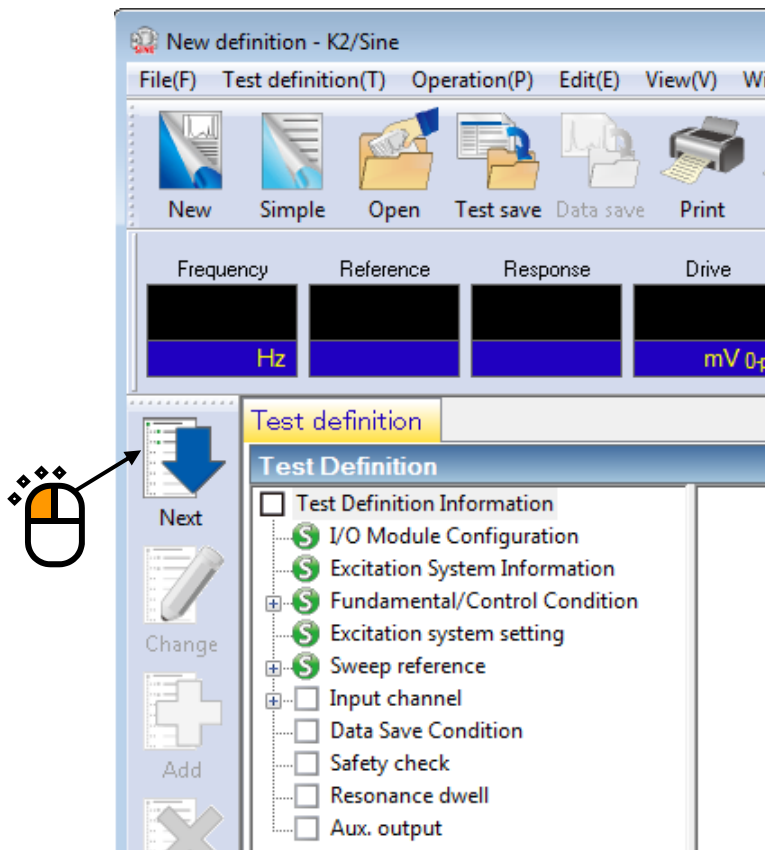
< Step 19 >

Input the value to 'Sweep rate' as 1.000 [octave/min]. And press the button of [OK].



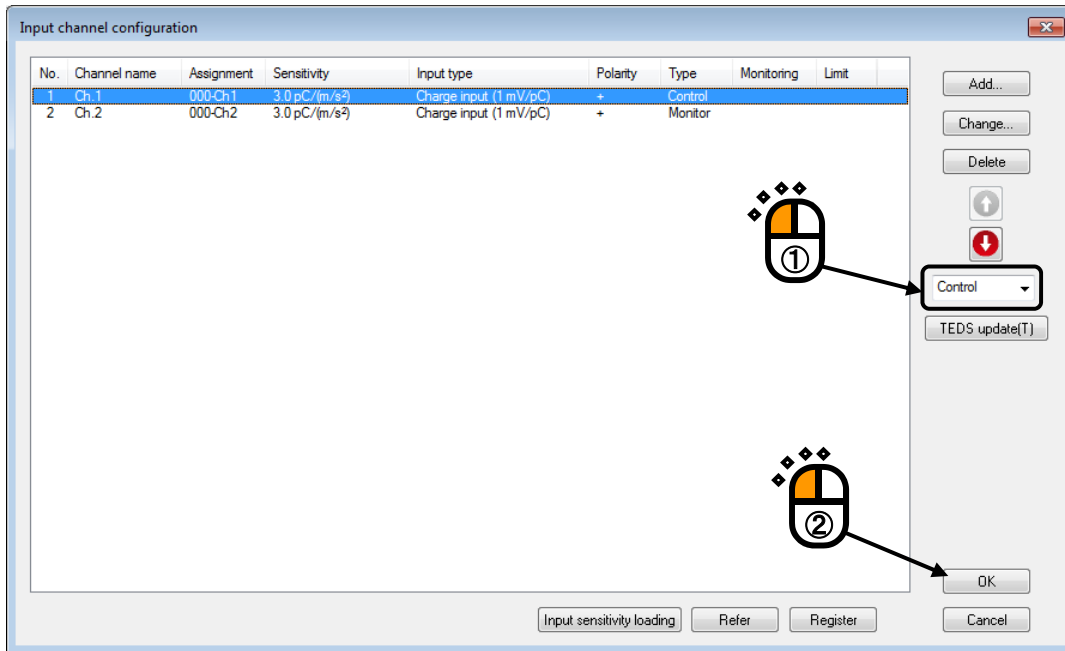
< Step 20 >

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



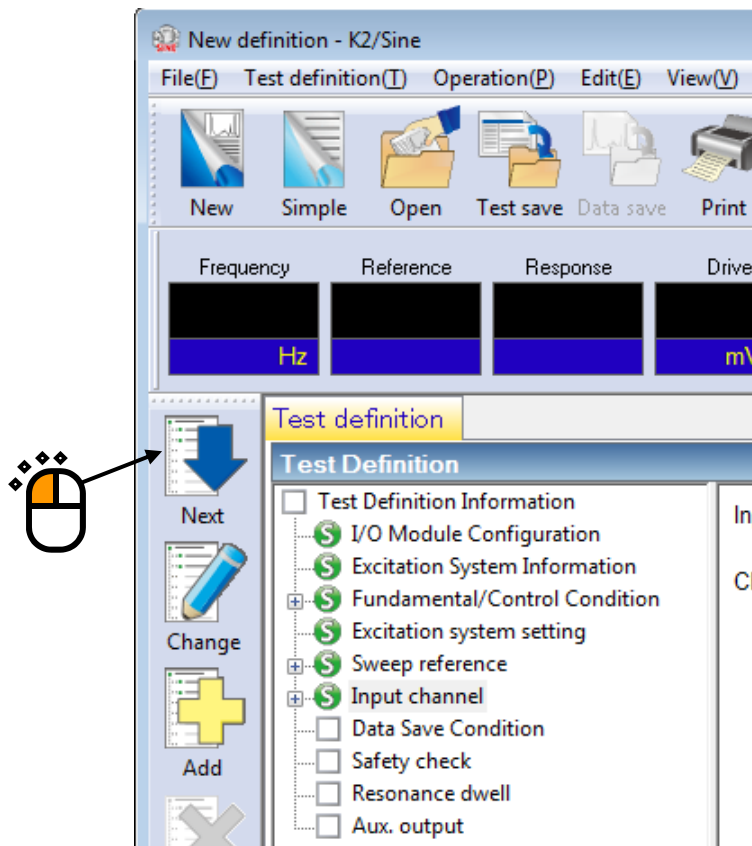
< Step 21 >

Select 'Ch. 1' and check the check box of 'Control'. And select 'Ch. 2' and check the check box of 'Monitor'. Then press the button of [OK].



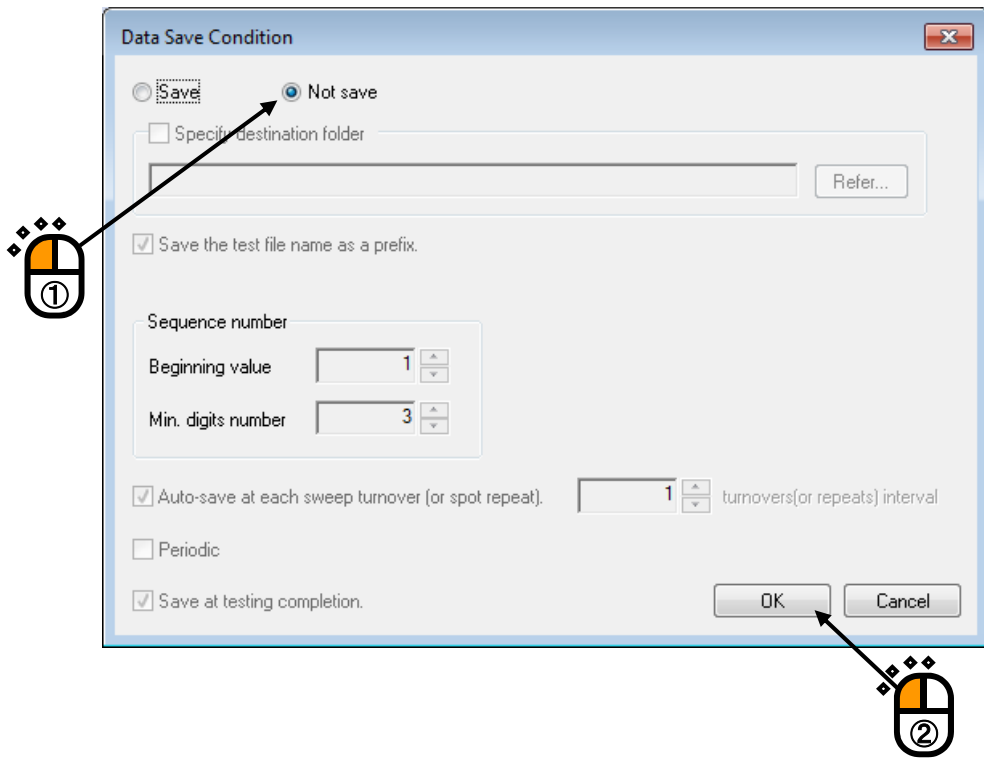
< Step 22 >

Press the button of [Next].



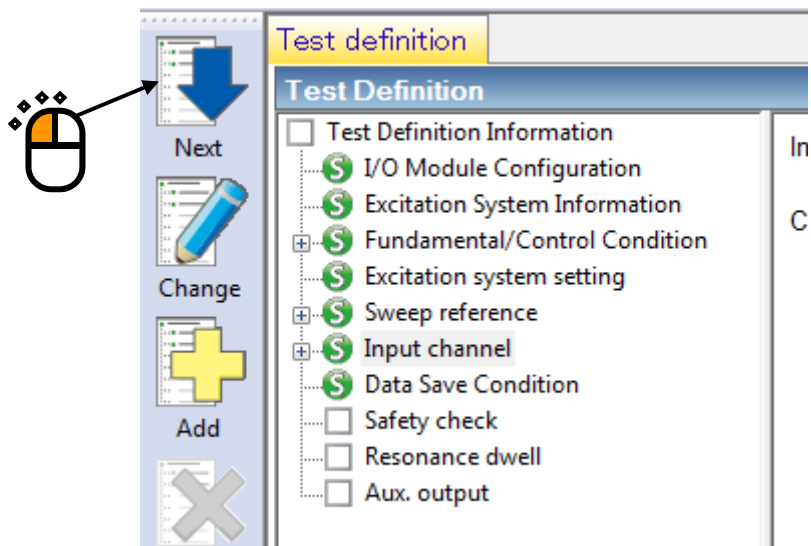
< Step 23 >

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



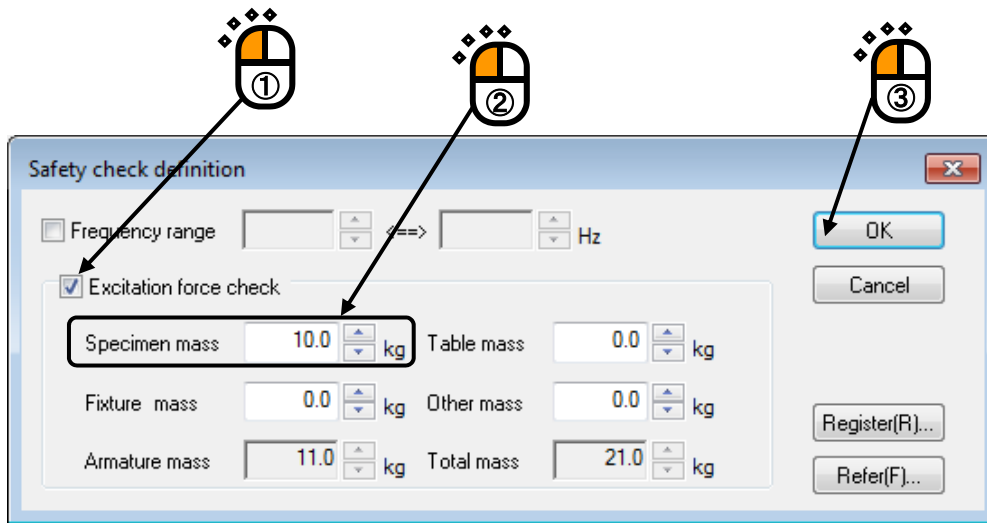
< Step 24 >

Press the button of [Next].



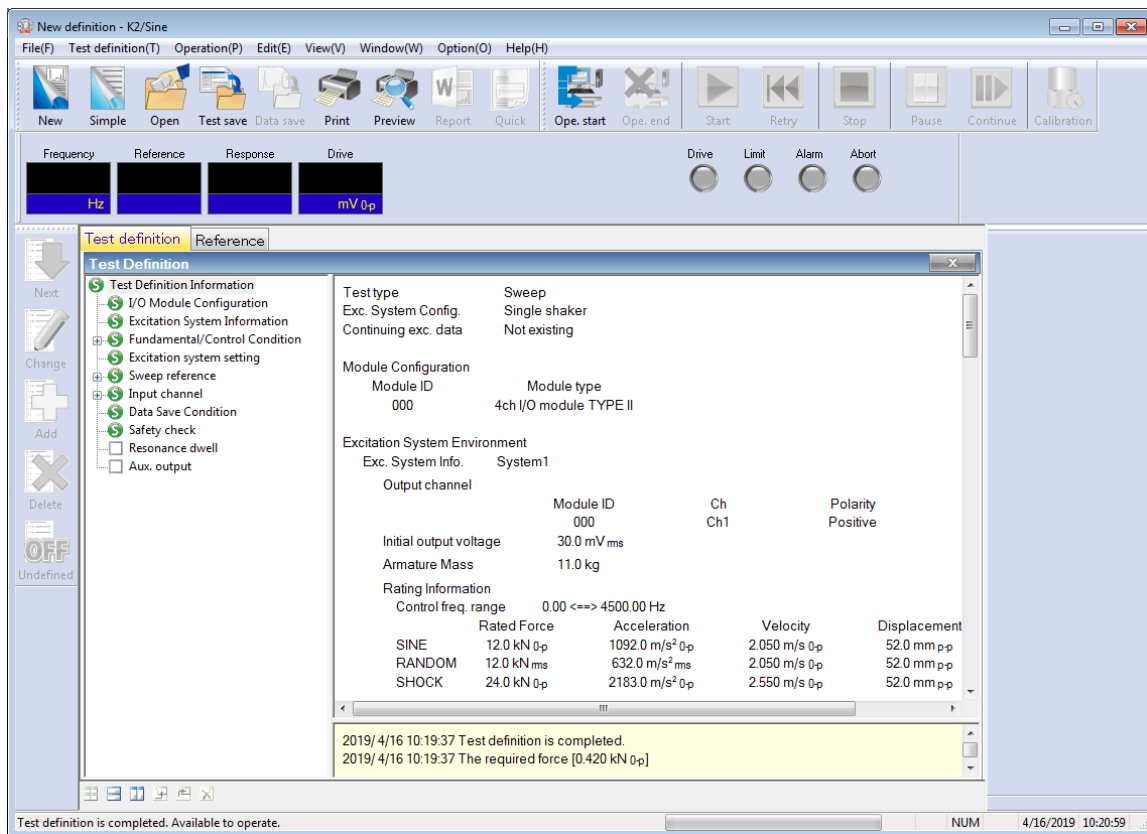
< Step 25 >

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



< Step 26 >

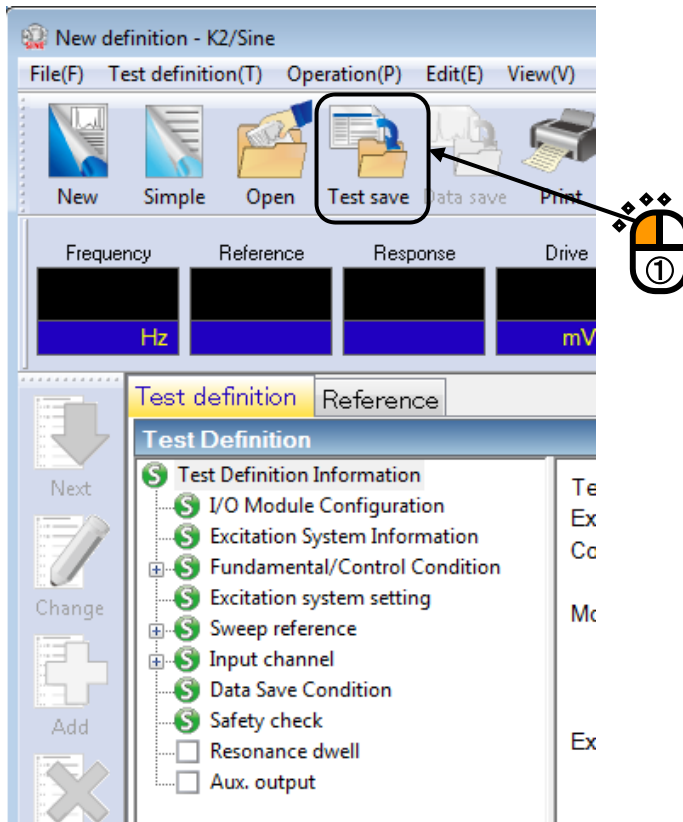
The definition is completed.



< Save of test >

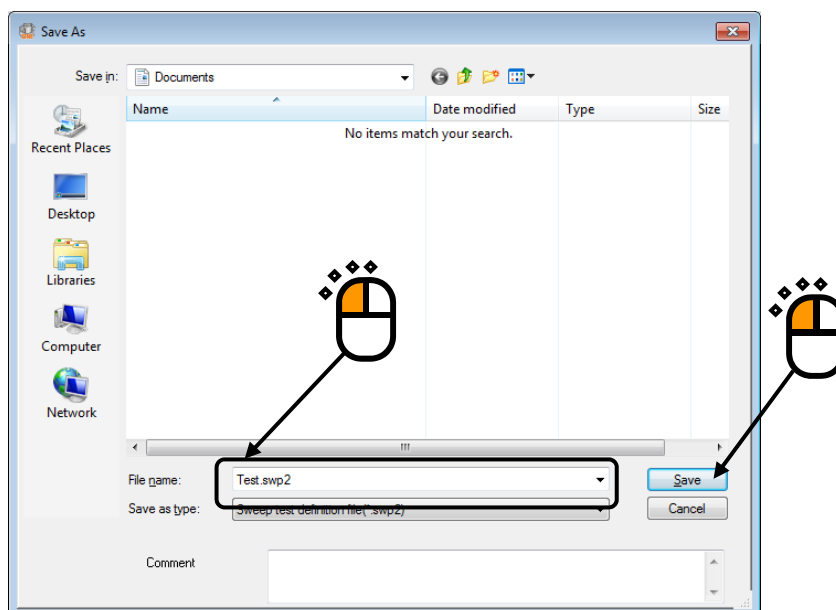
< Step 1 >

Press the button of [Save].



< Step 2 >

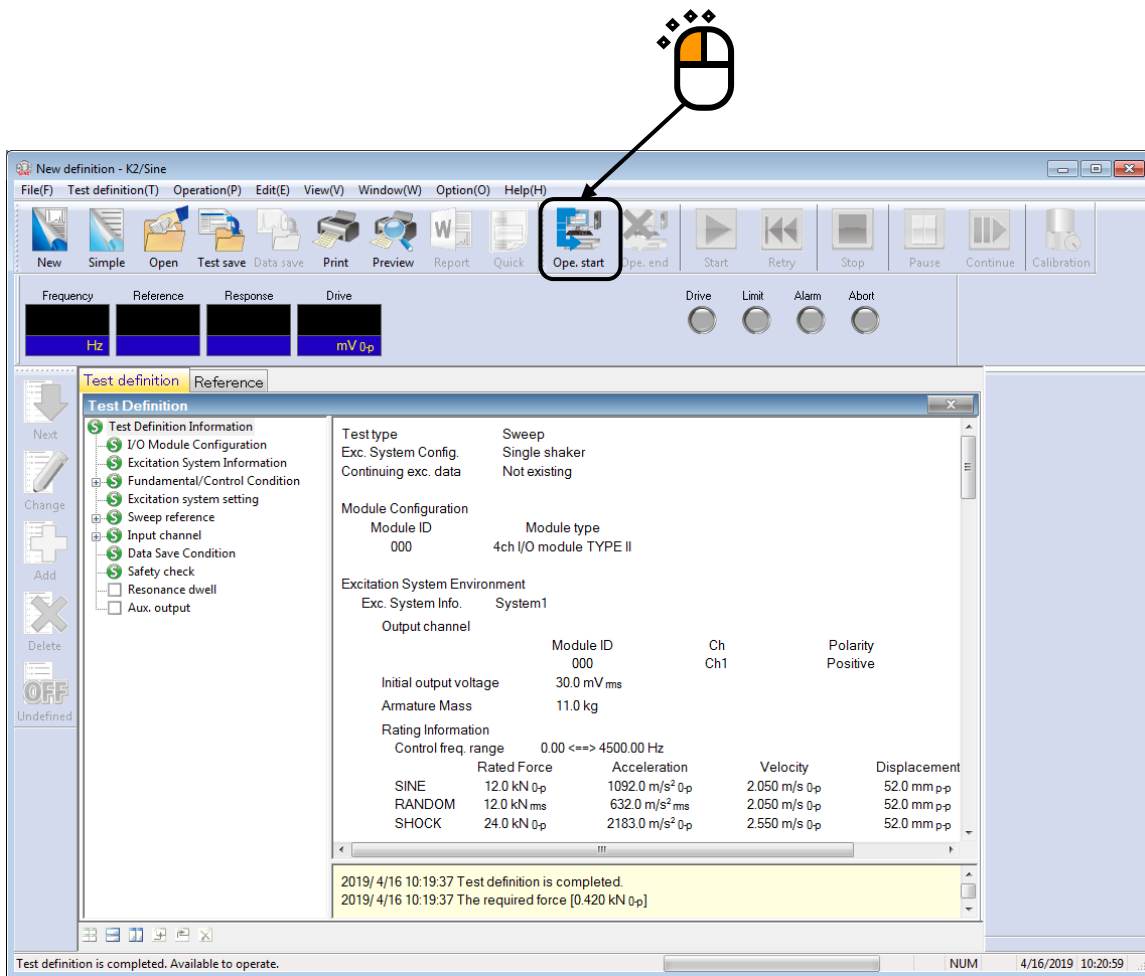
Input a name in 'File name' and press the button of [Save].



< Operation of test >

< Step 1 >

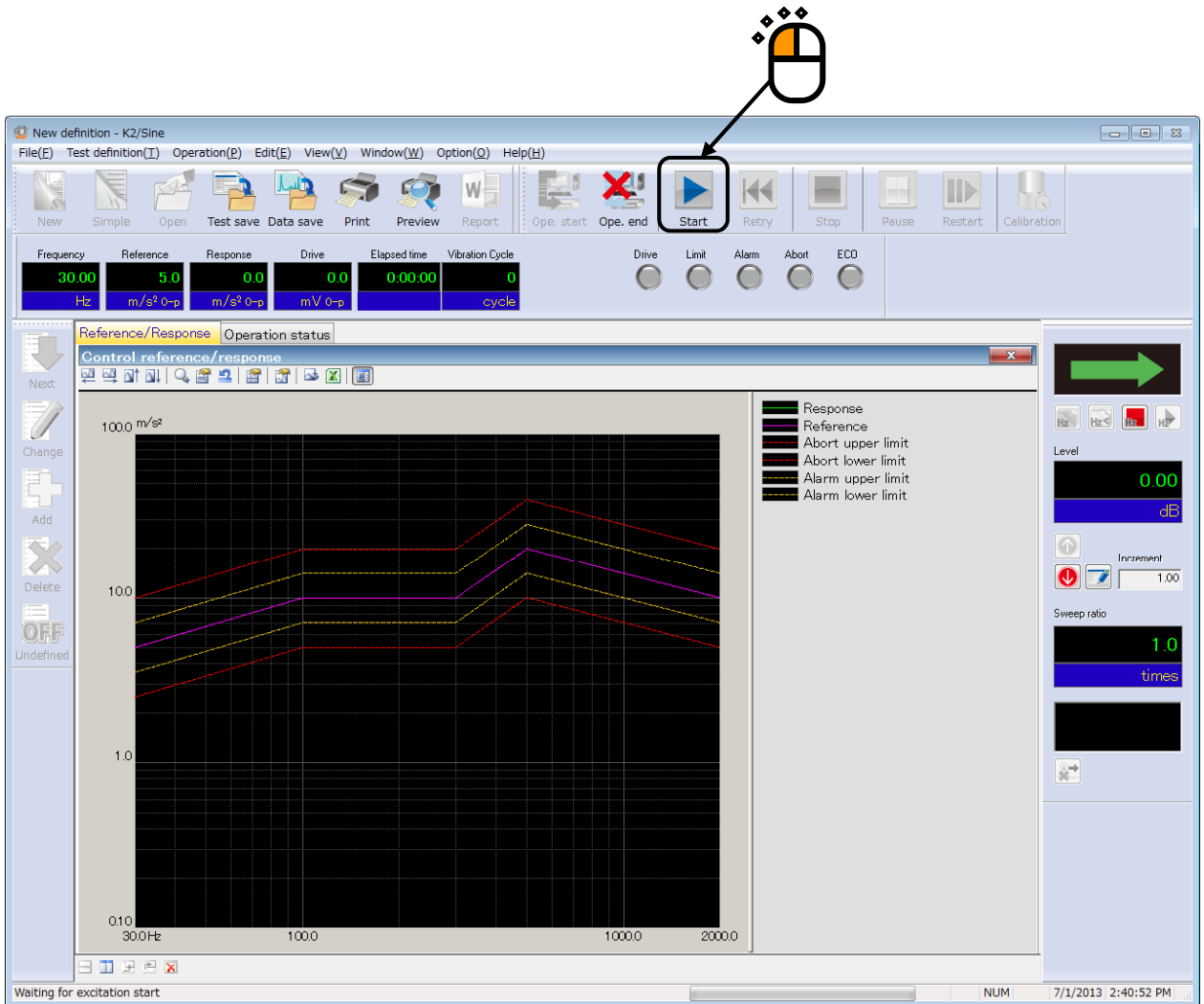
Press the button of [Operation start].



< Step 2 >

Press the button of [Start].

When [Start] is pressed, Initial loop check, and Initial equalization are automatically operated. Then, the test operation is executed.

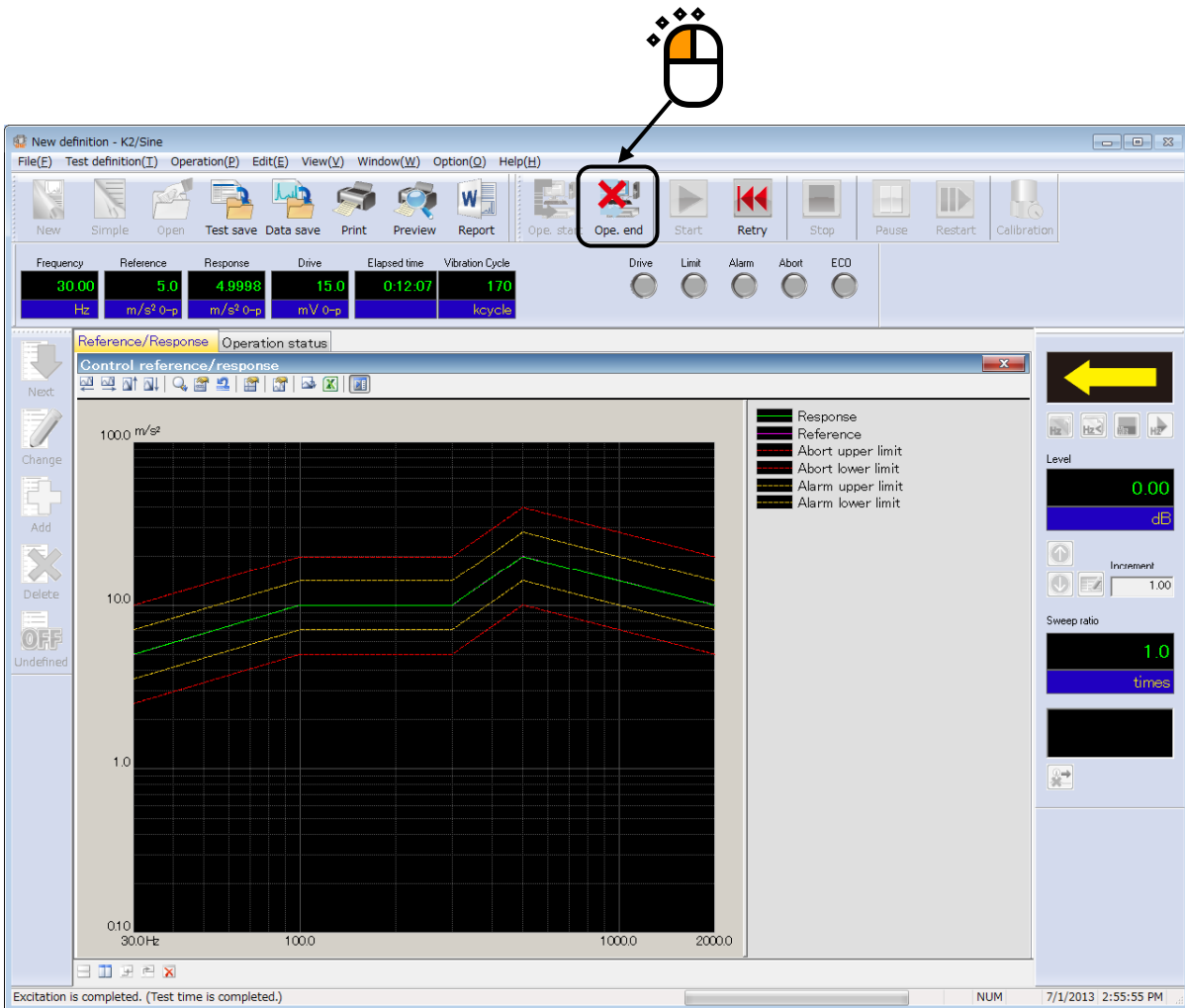




< Step 3 >

Test operation is completed when the test time passed.

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



### 3.3 Spot Test

< Example >

An example of Spot test is described as below ;

[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 <sup>2</sup> 0-p]	10[min.]
2	10[Hz]	20[mm p-p]	100[times]
3	500[Hz]	0.05[m/s 0-p]	300000[times]

[Information of sensors to be used]

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

Ch. 1 : for control, sensitivity 3pC/(m/s<sup>2</sup>)

Ch. 2 : for monitor, sensitivity 3pC/(m/s<sup>2</sup>)

However, these channels must be registered in Input environment information (in this example, 'SysInp01').

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

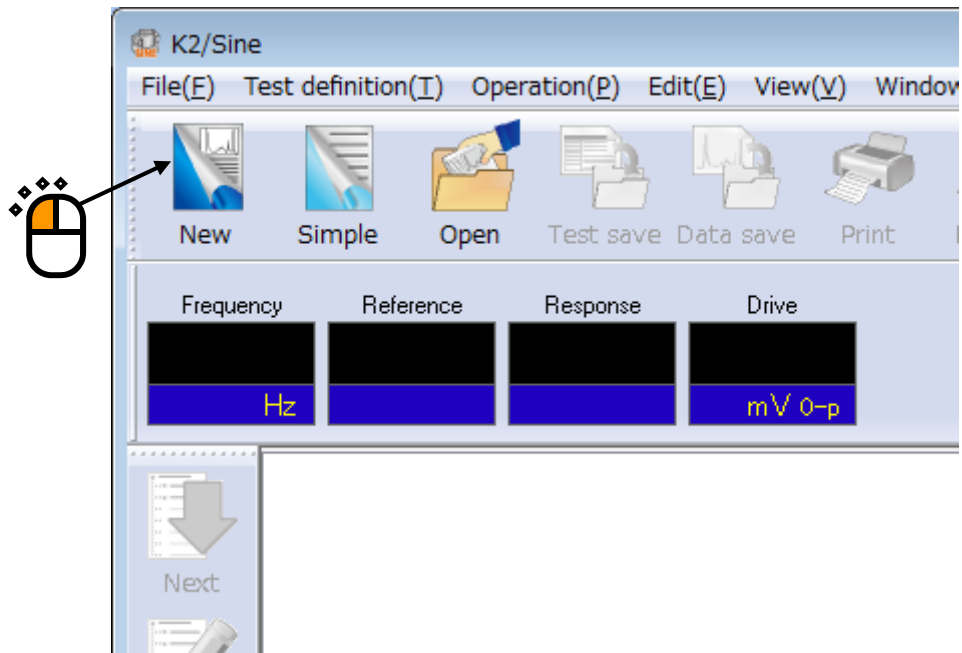
[Information of specimen]

Specimen mass : 10[kg]

< Procedures >

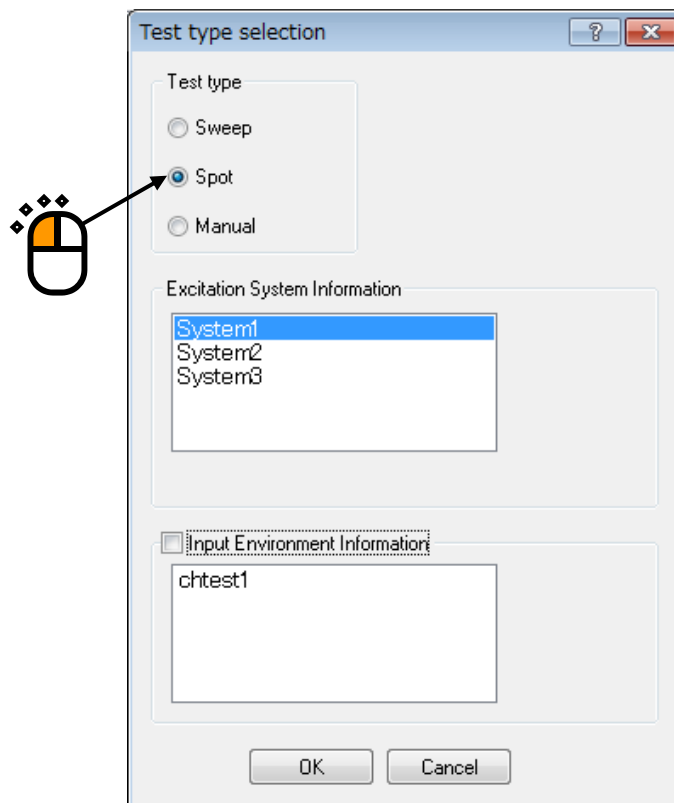
< Step 1 >

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



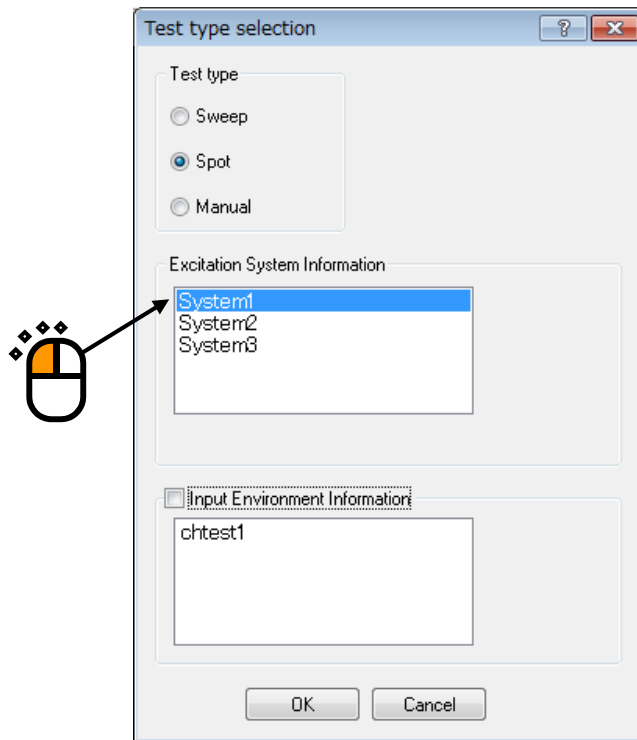
< Step 2 >

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



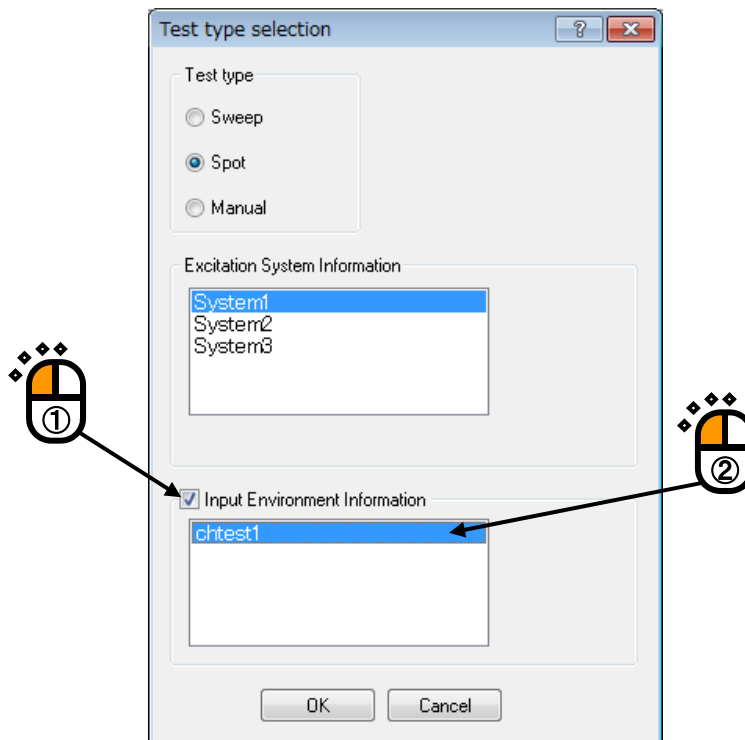
< Step 3 >

Select an excitation system information from the list of 'Excitation System Information'.



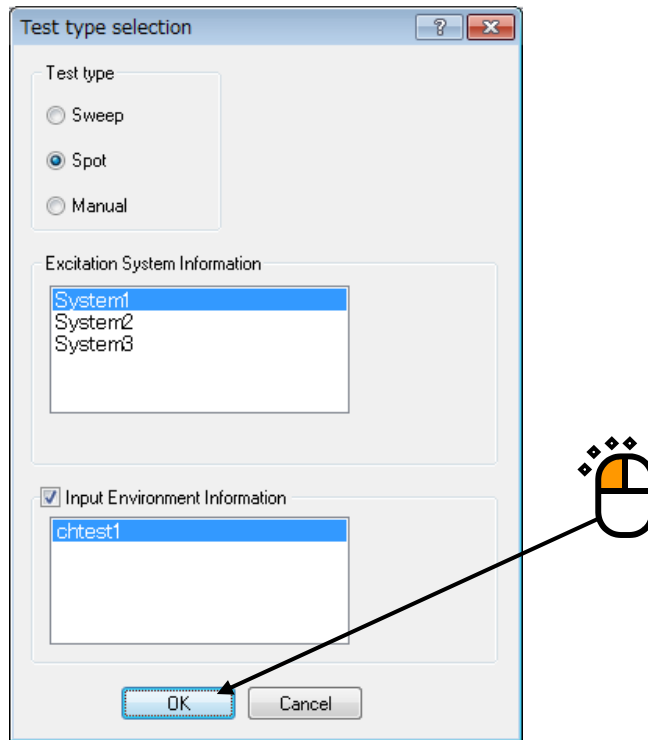
< Step 4 >

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



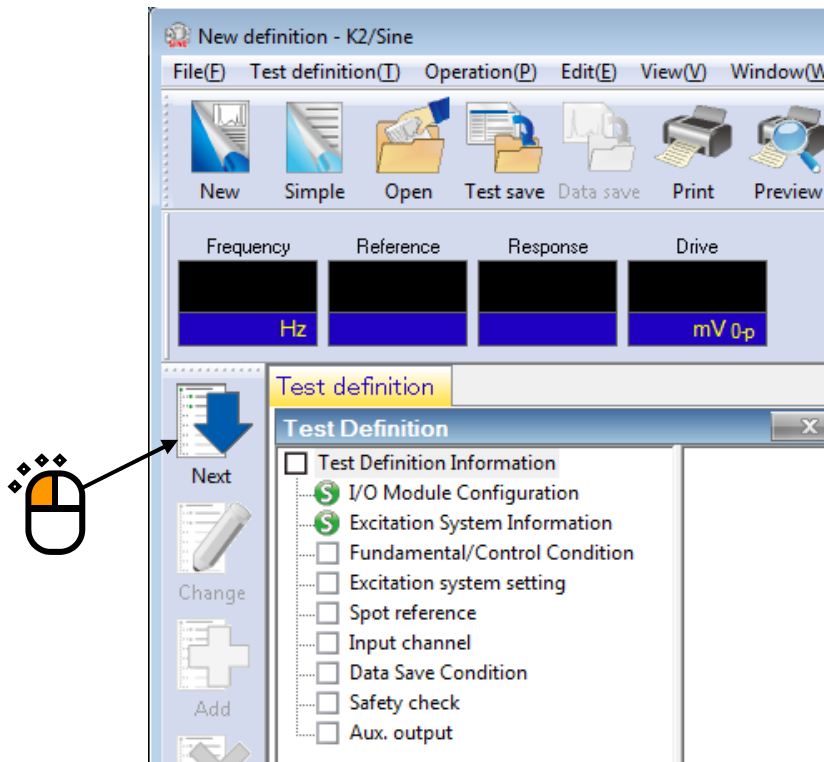
< Step 5 >

Press the button of [OK].



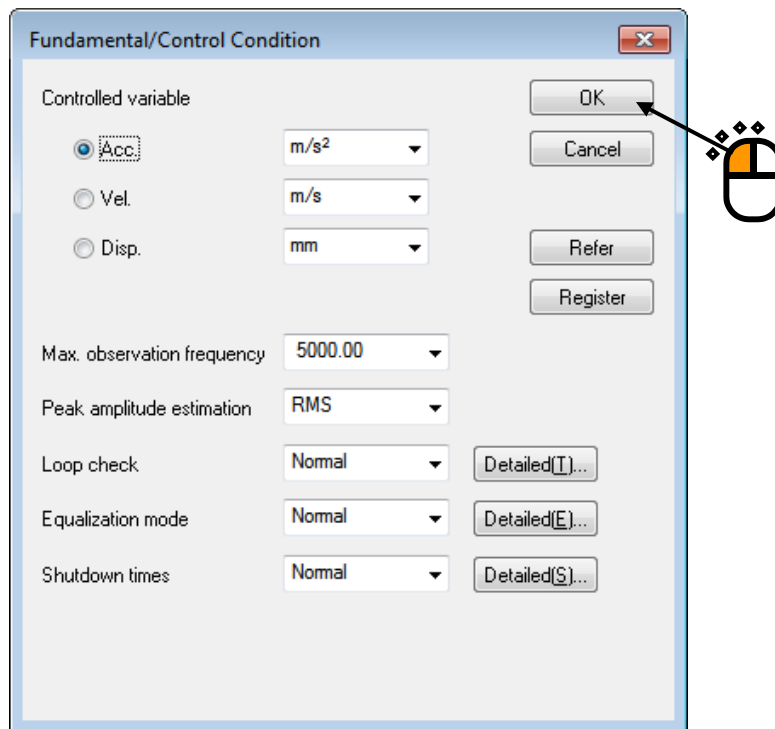
< Step 6 >

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



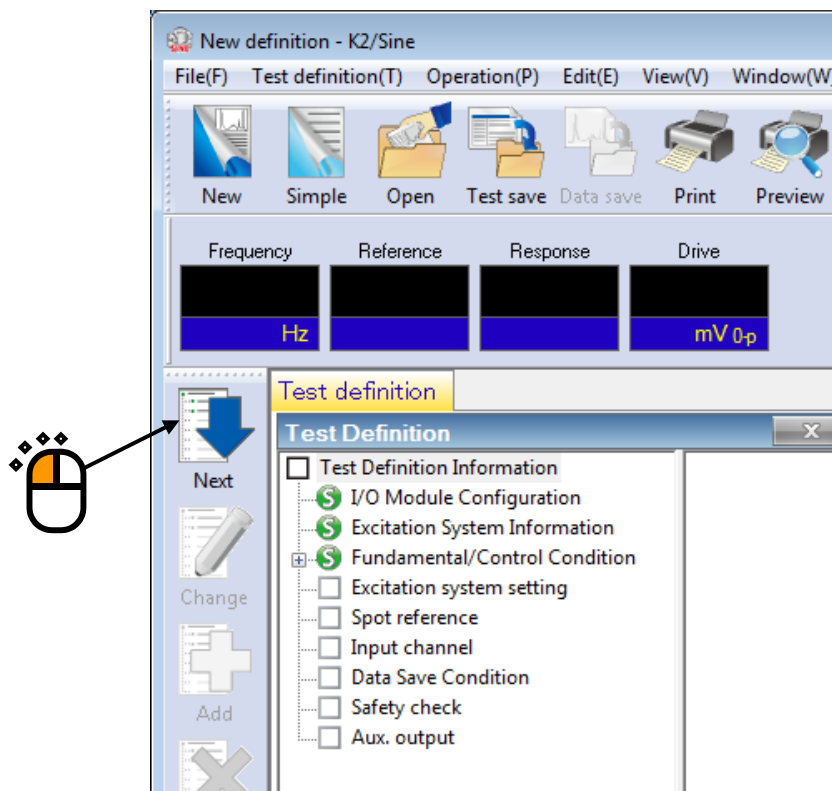
< Step 7 >

Press the button of [OK].



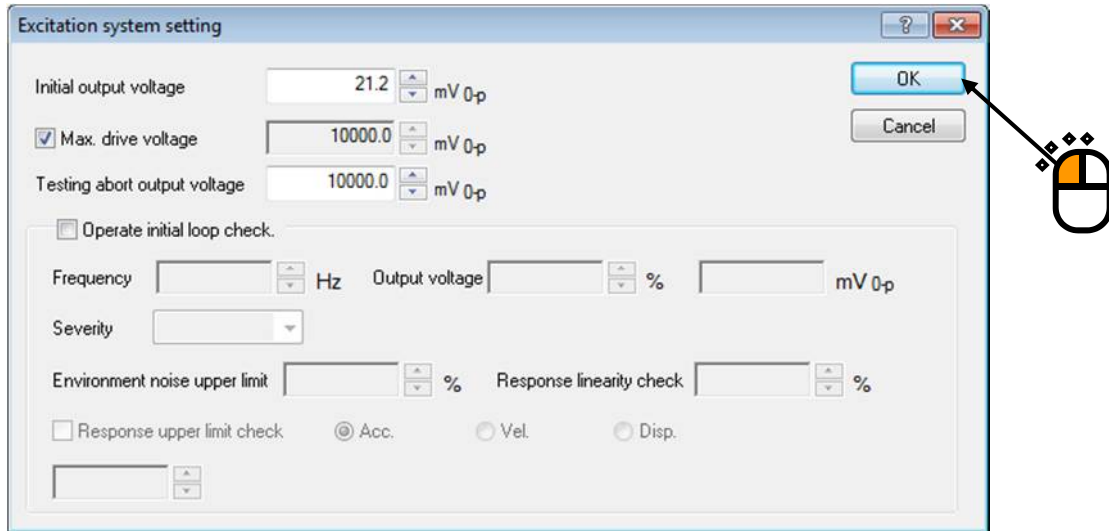
< Step 8 >

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



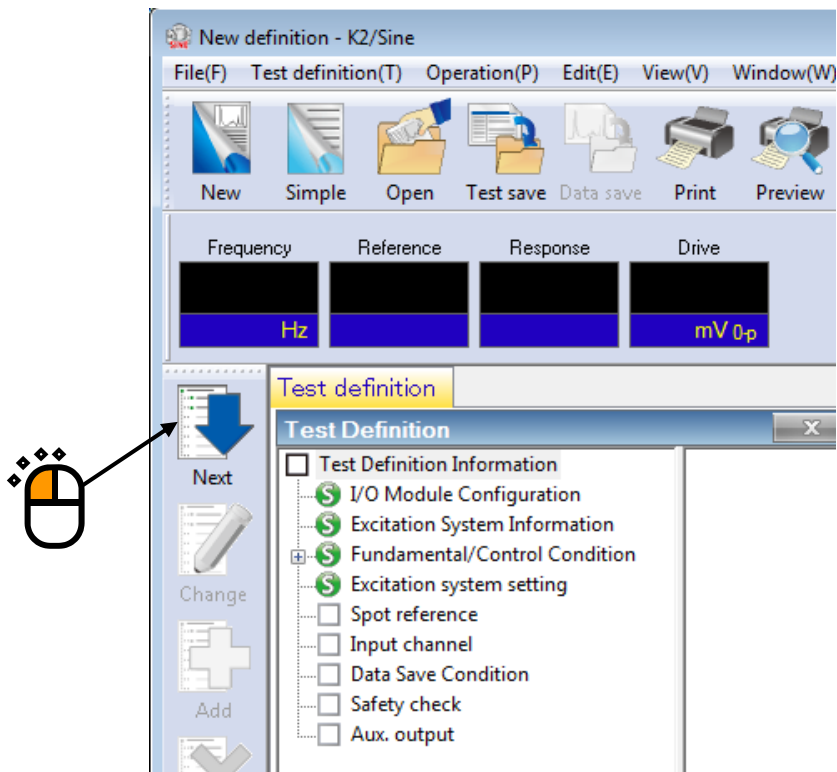
< Step 9 >

Press the button of [OK].



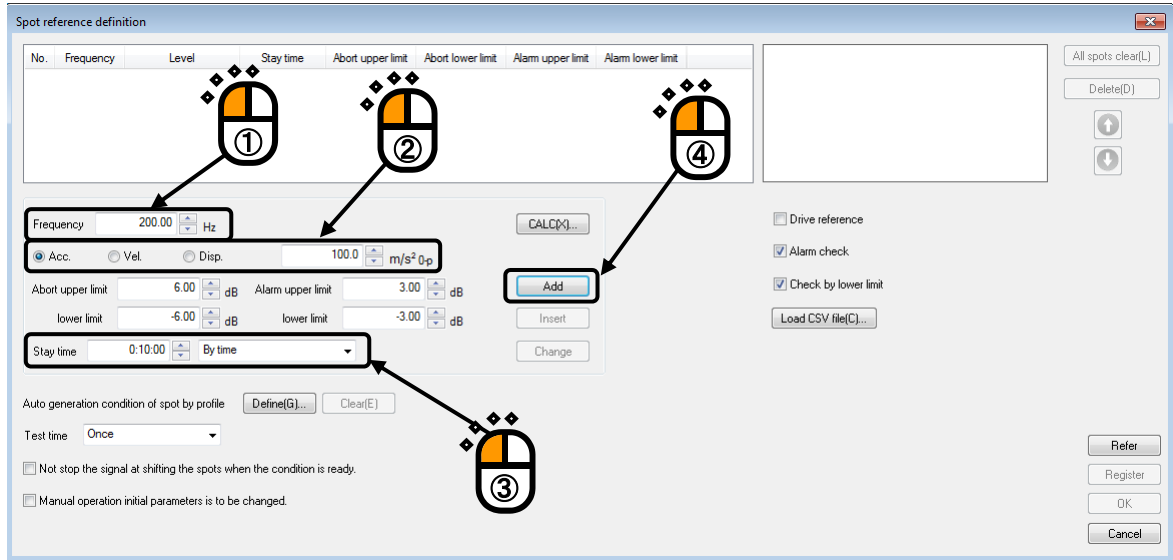
< Step 10 >

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



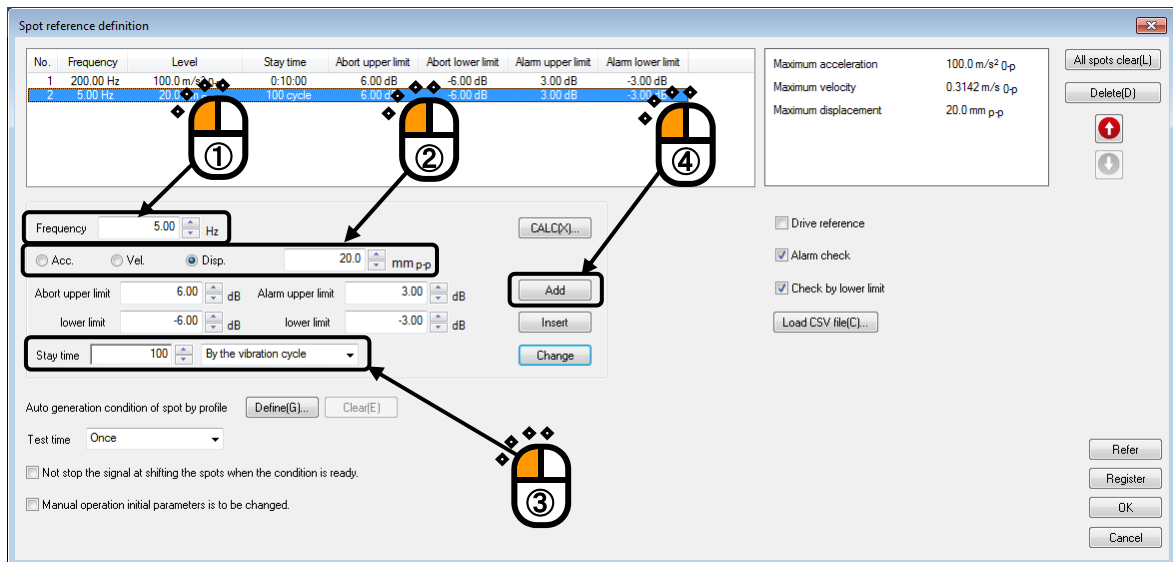
< Step 11 >

Input the values to 'Frequency' as 200 [Hz], 'Level' as 100 [m/s<sup>2</sup>0-p] and 'Stay time' as 10:00 [sec] (10 minutes). Press the button of [Add].



< Step 12 >

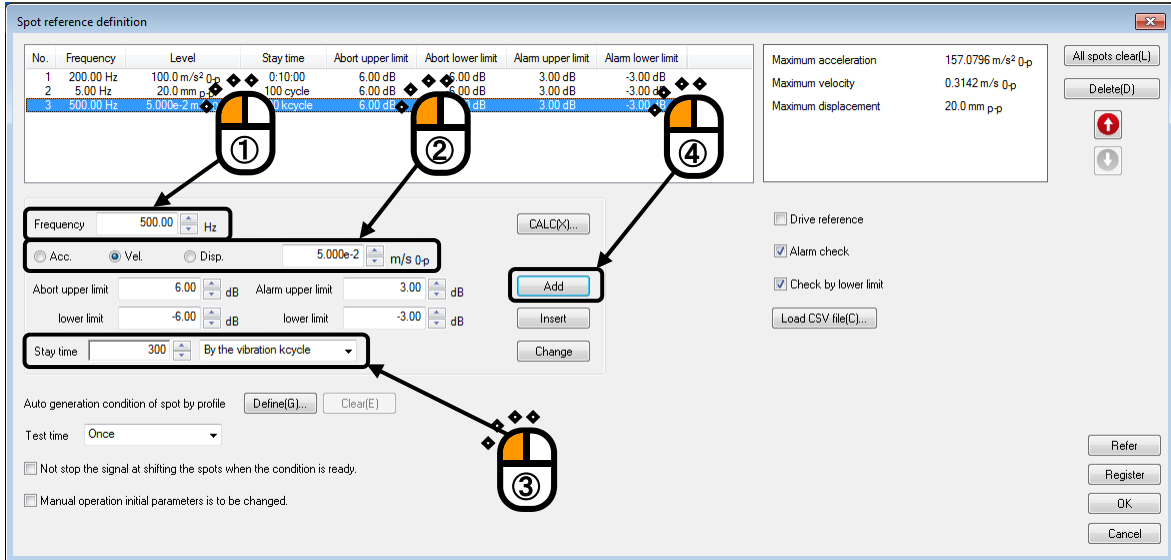
As in the same procedure, input the value to 'Frequency' as 5 [Hz], 'Level' as 20 [mm p-p] and 'Stay time' as 100 [cycle]. Press the button of [Add].





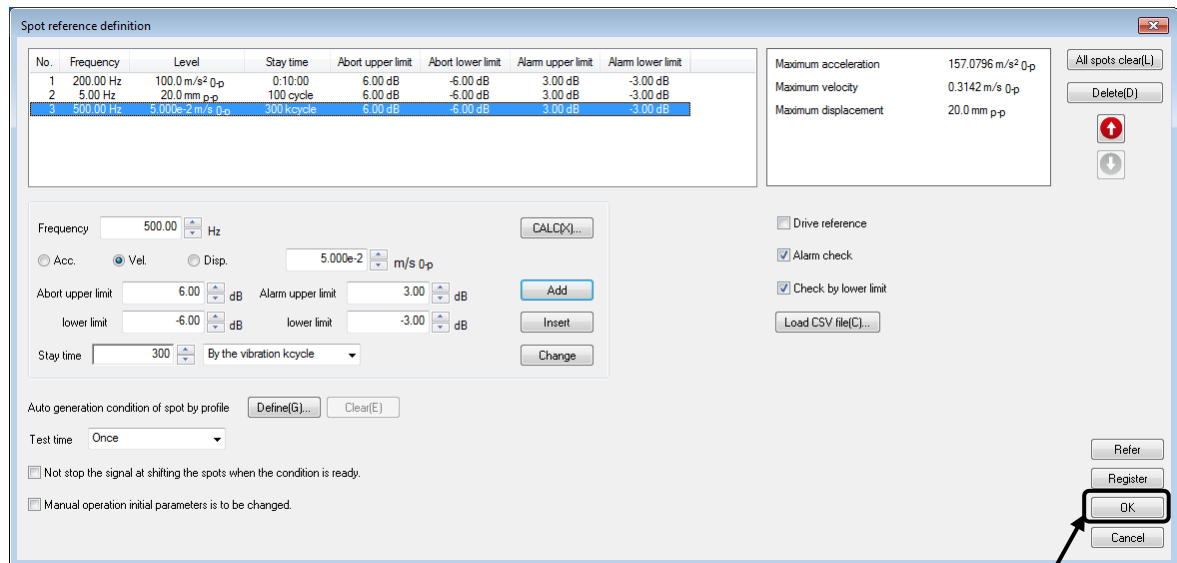
< Step 13 >

As in the same procedure, input the value to 'Frequency' as 500 [Hz], 'Level' as 0.05 [cm/s 0-p] and 'Stay time' as 300 [kcycle]. Press the button of [Add].



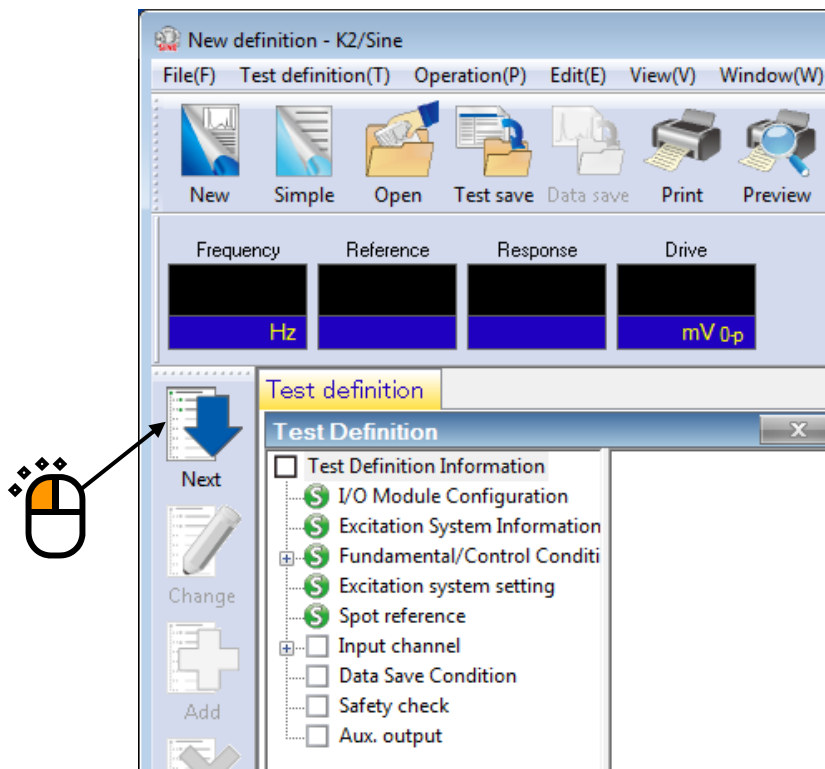
< Step 14 >

Press the button of [OK].



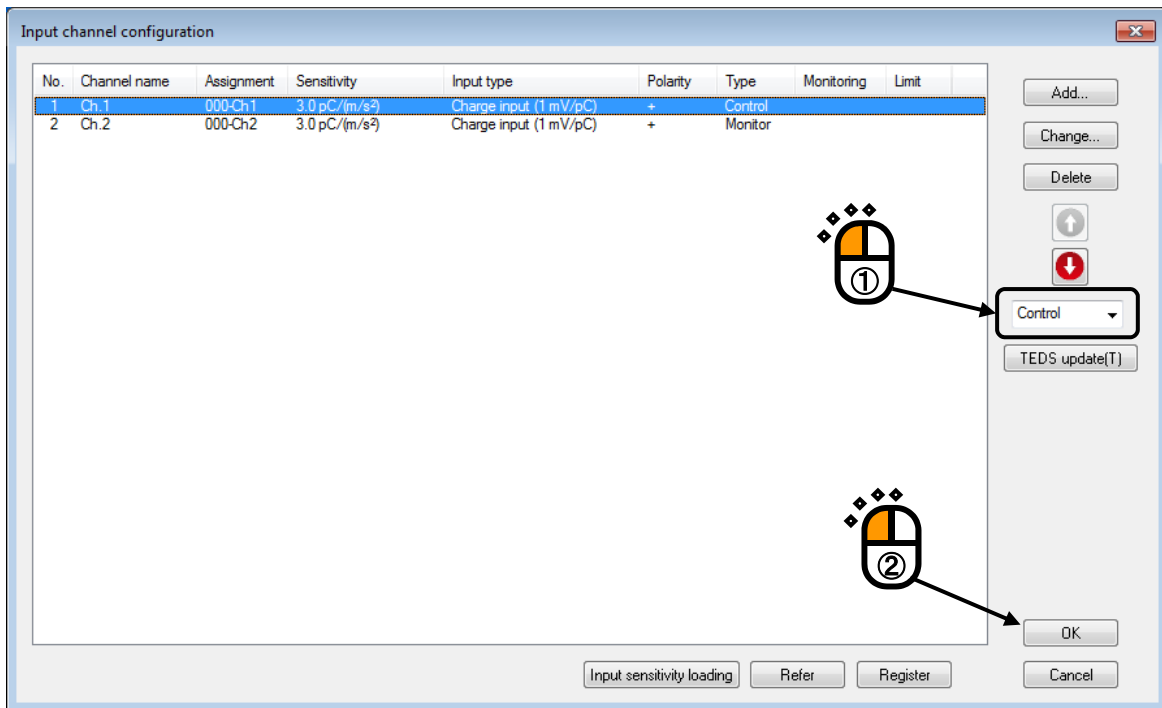
< Step 15 >

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



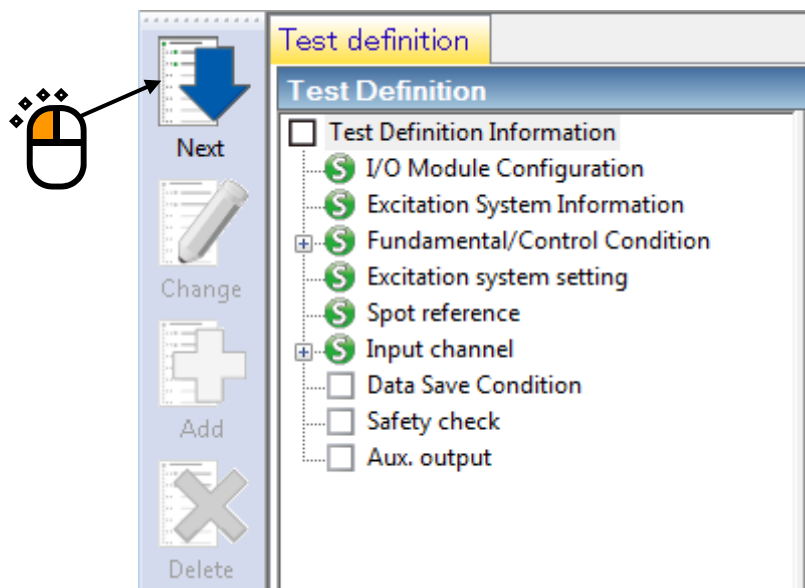
< Step 16 >

Select 'Ch. 1' and check the check box of 'Control'. And select 'Ch. 2' and check the check box of 'Monitor'. Then press the button of [OK].



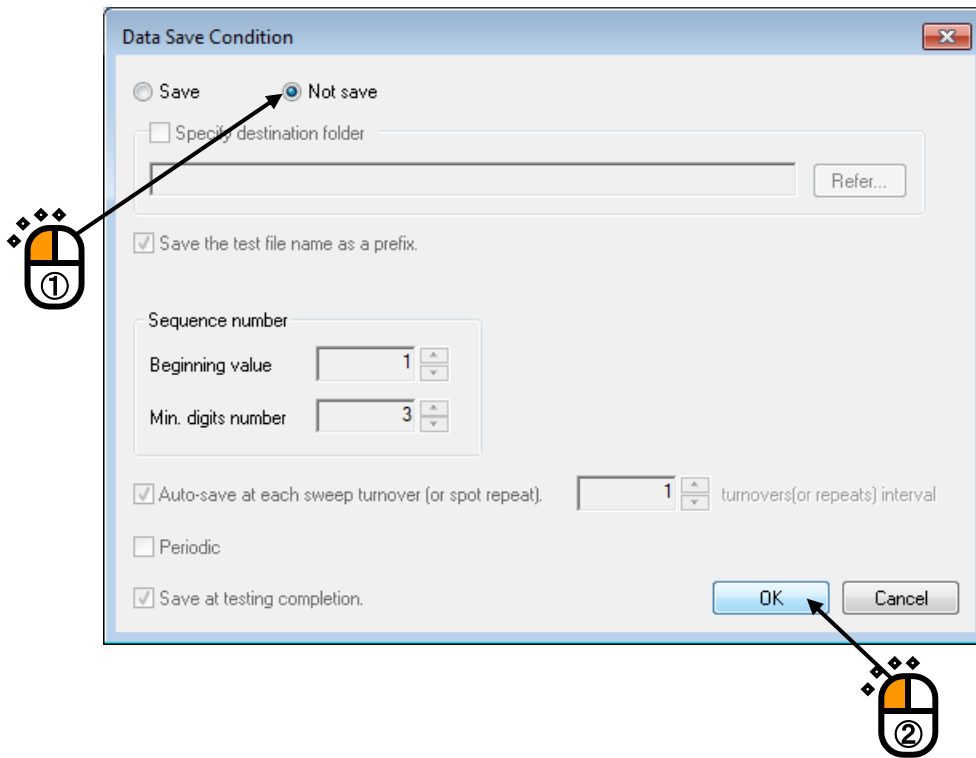
< Step 17 >

Press the button of [Next].



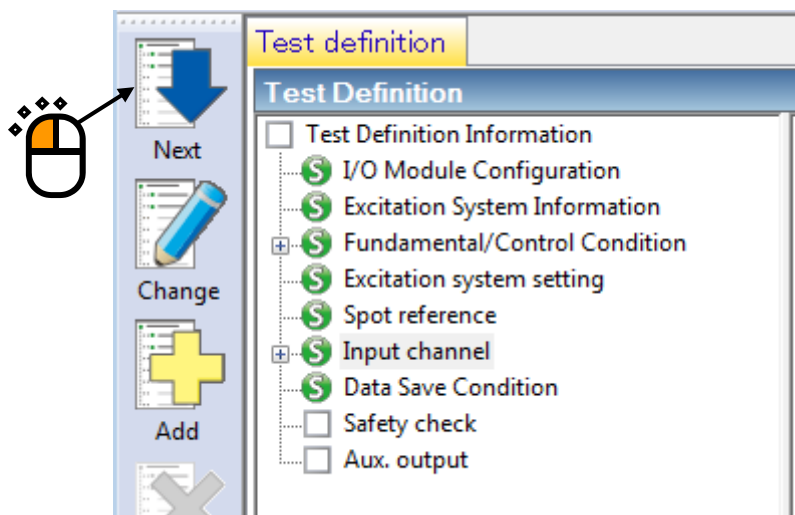
< Step 18 >

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



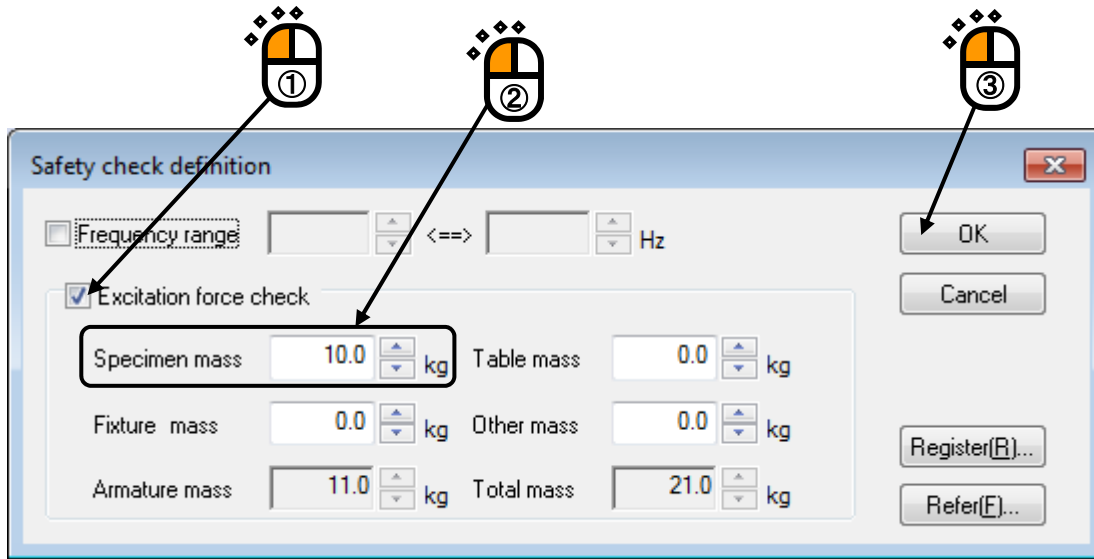
< Step 19 >

Press the button of [Next].



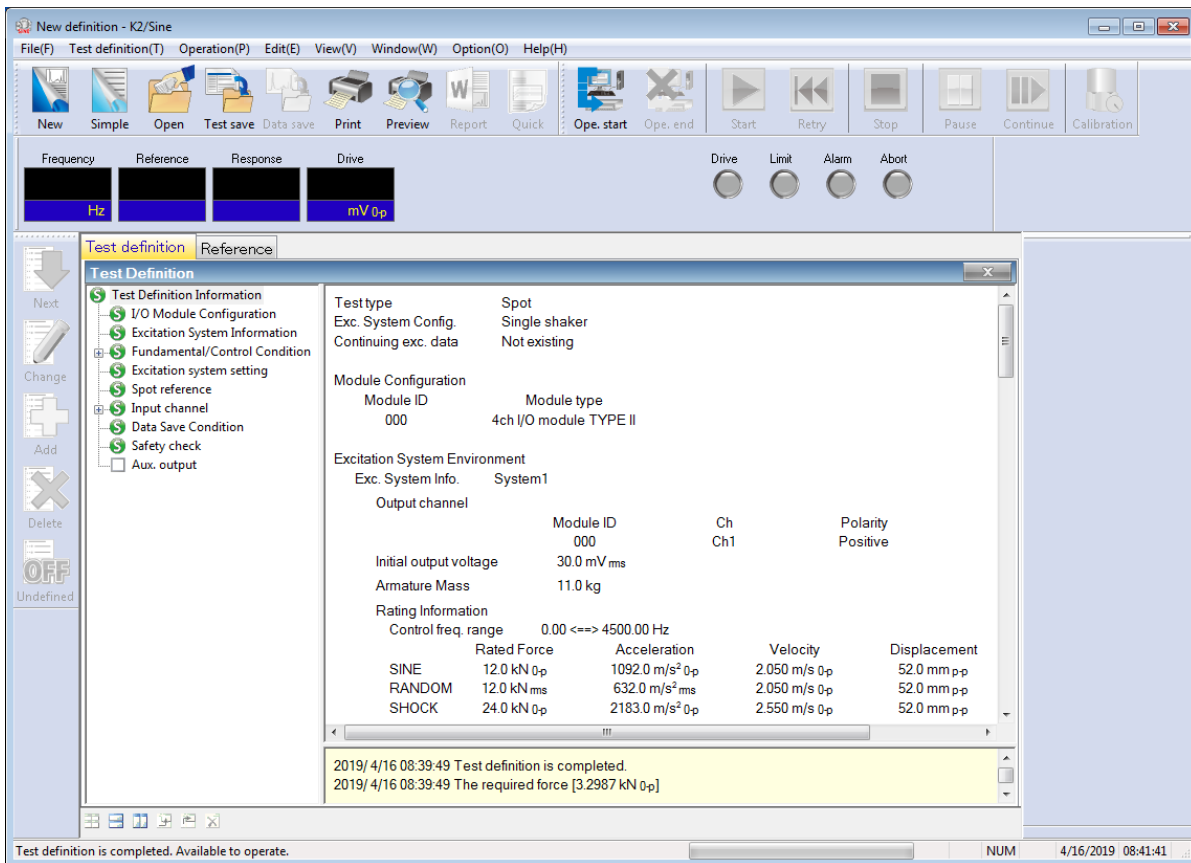
< Step 20 >

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



< Step 21 >

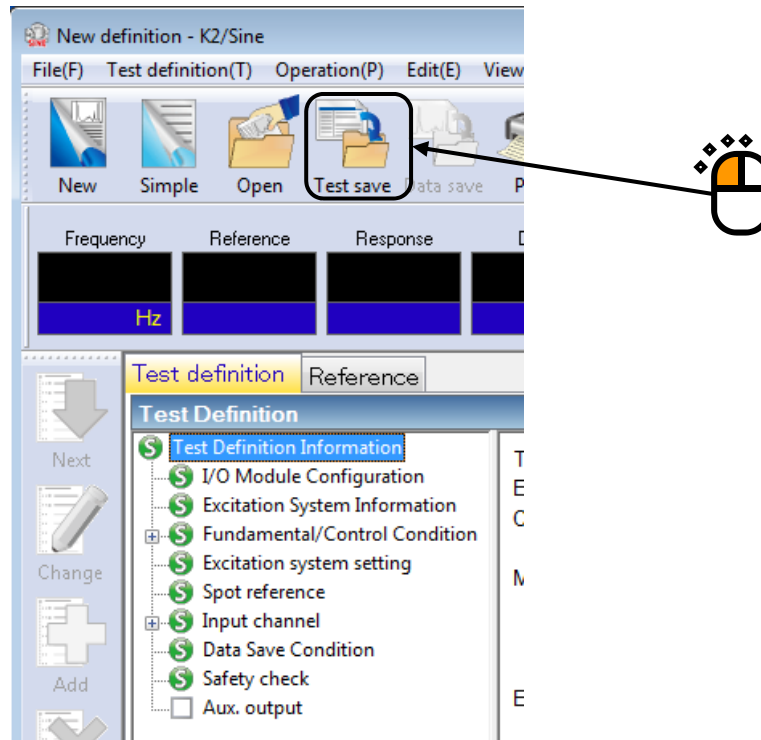
The definition is completed.



< Save of test >

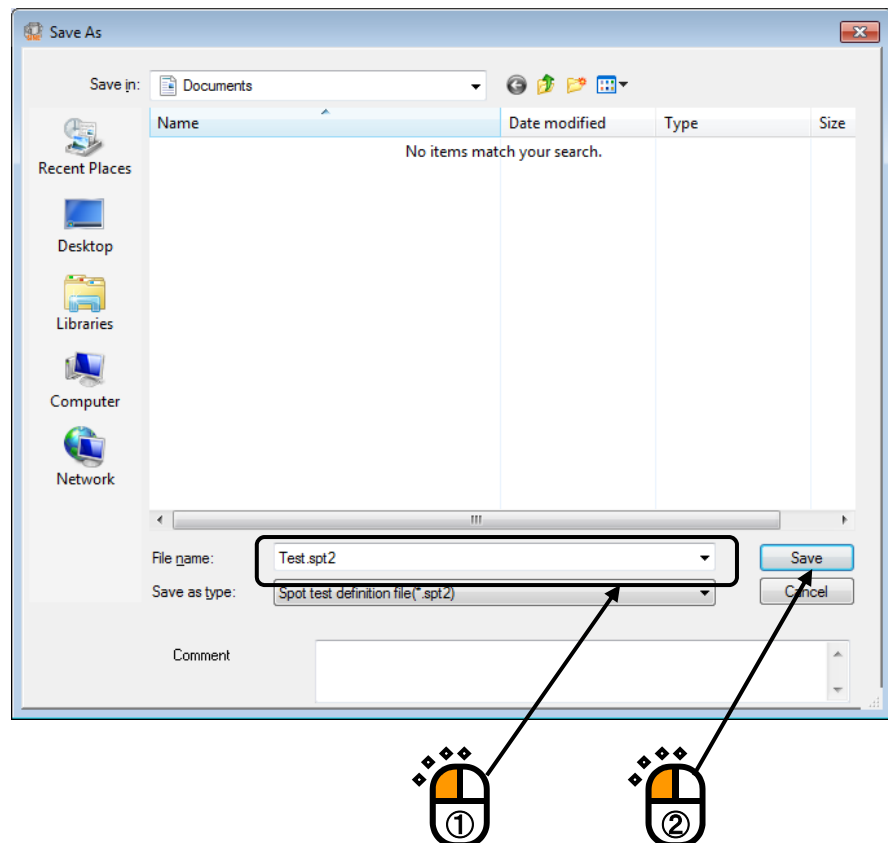
< Step 1 >

Press the button of [Save].



< Step 2 >

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



< Operation of test >

< Step 1 >

Press the button of [Operation start].



The screenshot shows the software interface for test definition and operation. The toolbar at the top contains various icons, with the 'Ope.start' button highlighted by a red box and a mouse cursor. The main window displays the 'Test Definition' section, which includes the following information:

**Test Definition Information**

- I/O Module Configuration
- Excitation System Information
- Fundamental/Control Condition
- Excitation system setting
- Spot reference
- Input channel
- Data Save Condition
- Safety check
- Aux. output

**Test type**: Spot

**Exc. System Config.**: Single shaker

**Continuing exc. data**: Not existing

**Module Configuration**

Module ID	Module type
000	4ch I/O module TYPE II

**Excitation System Environment**

**Exc. System Info.**: System1

**Output channel**

Module ID	Ch	Polarity
000	Ch1	Positive

**Initial output voltage**: 30.0 mV<sub>rms</sub>

**Armature Mass**: 11.0 kg

**Rating Information**

Control freq. range	Rated Force	Acceleration	Velocity	Displacement
0.00 <==> 4500.00 Hz				
SINE	12.0 kN <sub>0p</sub>	1092.0 m/s <sup>2</sup> <sub>0p</sub>	2.050 m/s <sub>0p</sub>	52.0 mm <sub>p-p</sub>
RANDOM	12.0 kN <sub>rms</sub>	632.0 m/s <sup>2</sup> <sub>rms</sub>	2.050 m/s <sub>0p</sub>	52.0 mm <sub>p-p</sub>
SHOCK	24.0 kN <sub>0p</sub>	2183.0 m/s <sup>2</sup> <sub>0p</sub>	2.550 m/s <sub>0p</sub>	52.0 mm <sub>p-p</sub>

**Log:**

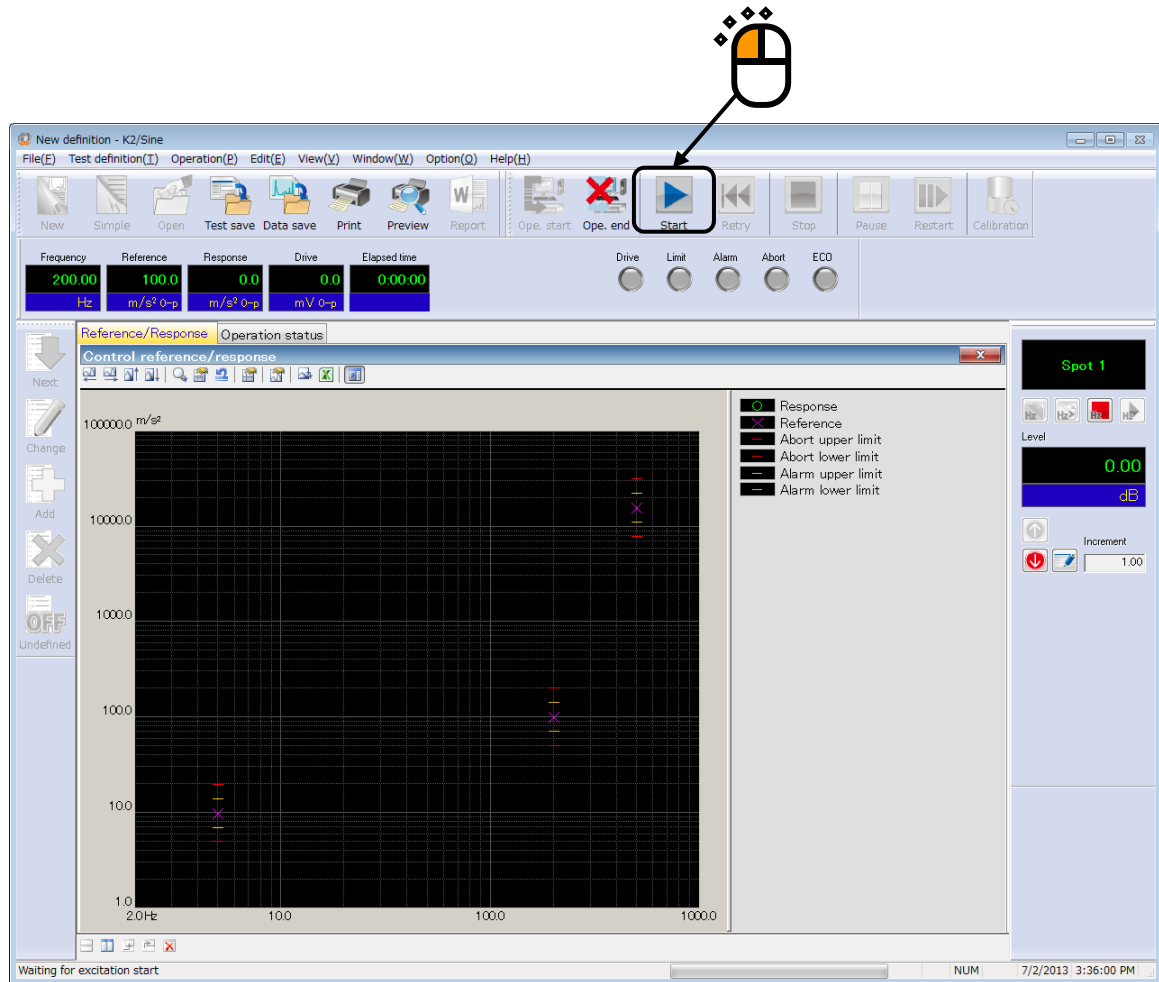
- 2019/ 4/16 08:39:49 Test definition is completed.
- 2019/ 4/16 08:39:49 The required force [3.2987 kN<sub>0p</sub>]

**Status Bar:** Test definition is completed. Available to operate. NUM 4/16/2019 08:47:18

< Step 2 >

Press the button of [Start].

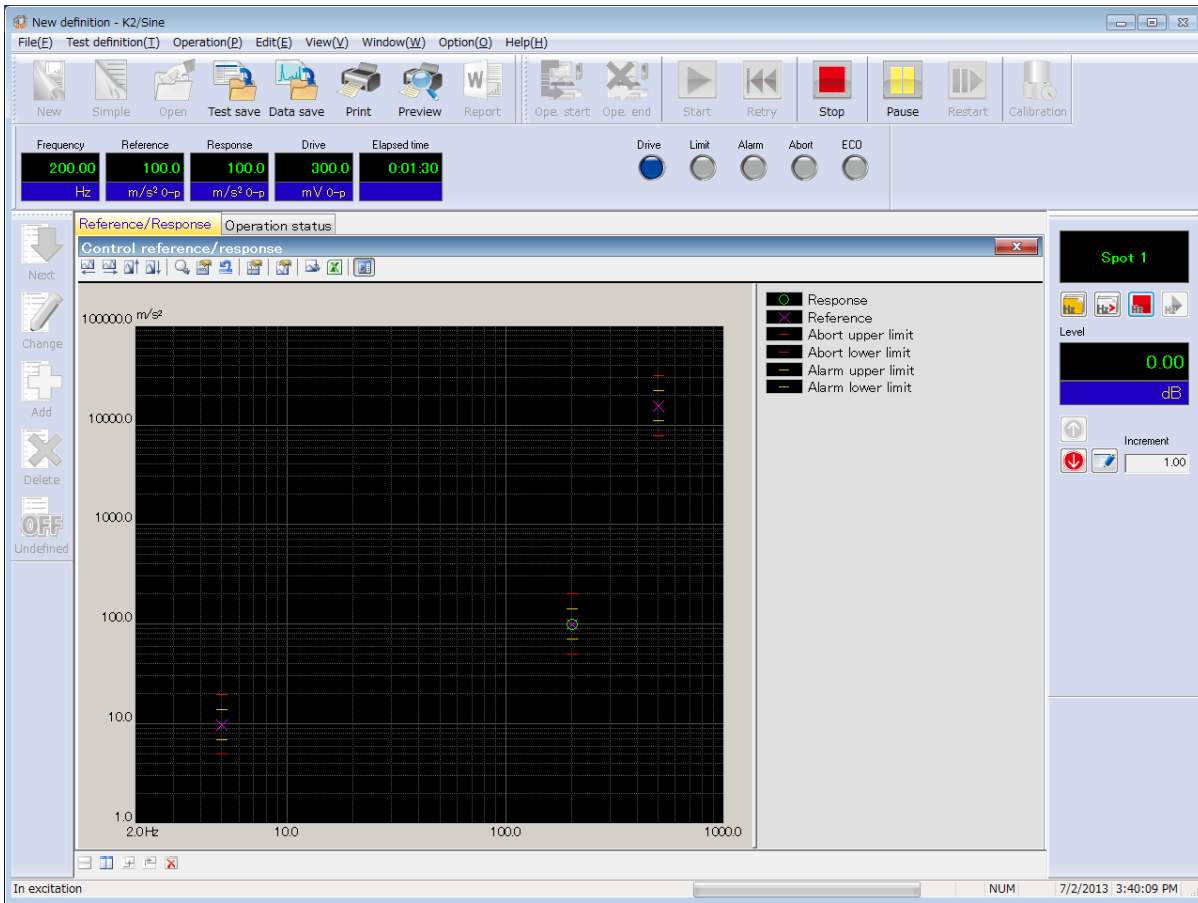
When [Start] is pressed, Initial loop check (only when it is defined) and Initial equalization are automatically operated. Then, the test operation is executed.





< Step 3 >

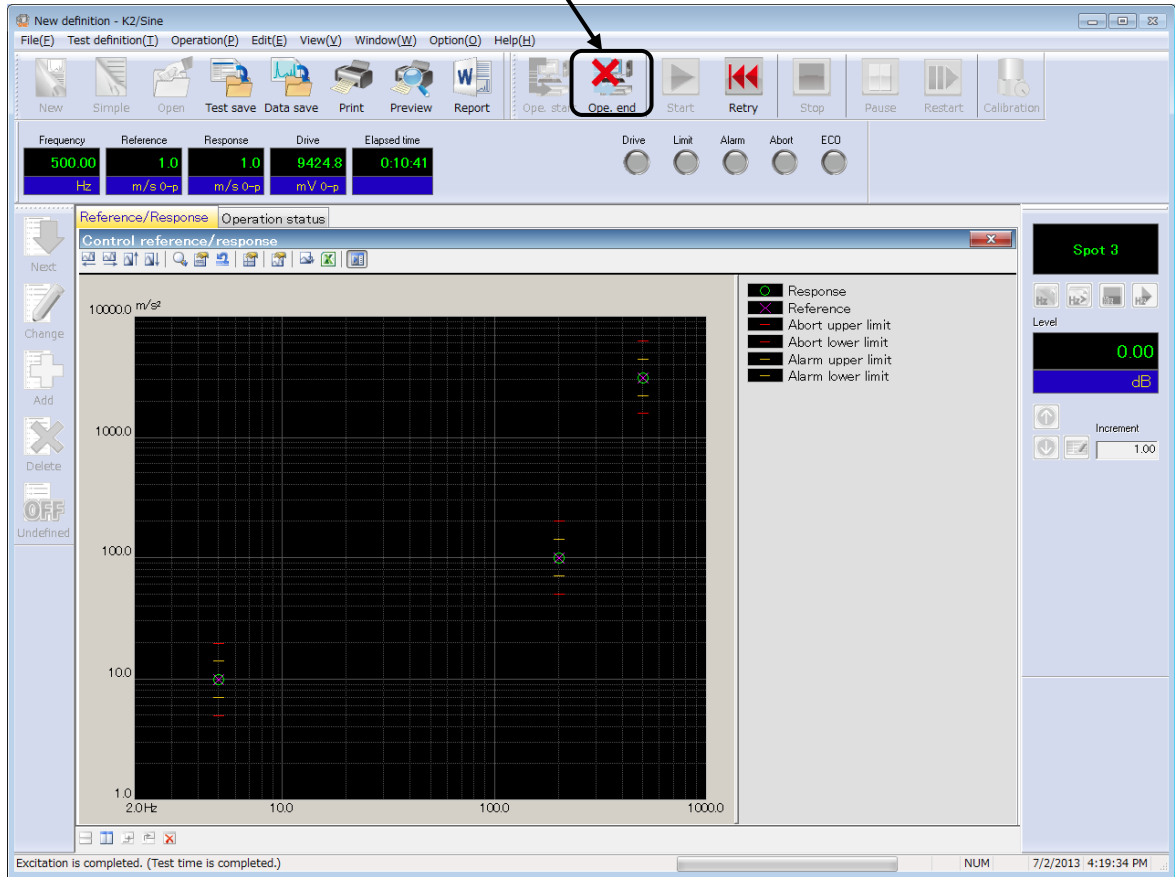
Excitation is executed in the order of the specified spots.



< Step 4 >

Test operation is completed when the schedule of the specified spots are finished.

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



### 3.4 Manual Test

< Example >

An example of Manual test is described as below ;

[Reference pattern]

Frequency : 100 (Hz)

Acceleration : 10 ( $\text{m/s}^2$ )

[Information of sensors to be used]

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

Ch. 1 : for control, sensitivity  $3\text{pC}/(\text{m/s}^2)$

Ch. 2 : for monitor, sensitivity  $3\text{pC}/(\text{m/s}^2)$

However, these channels must be registered in Input environment information (in this example, 'SysInp01').

Also, the rating information of excitation system has already been registered in Excitation system information (in this example, 'System01').

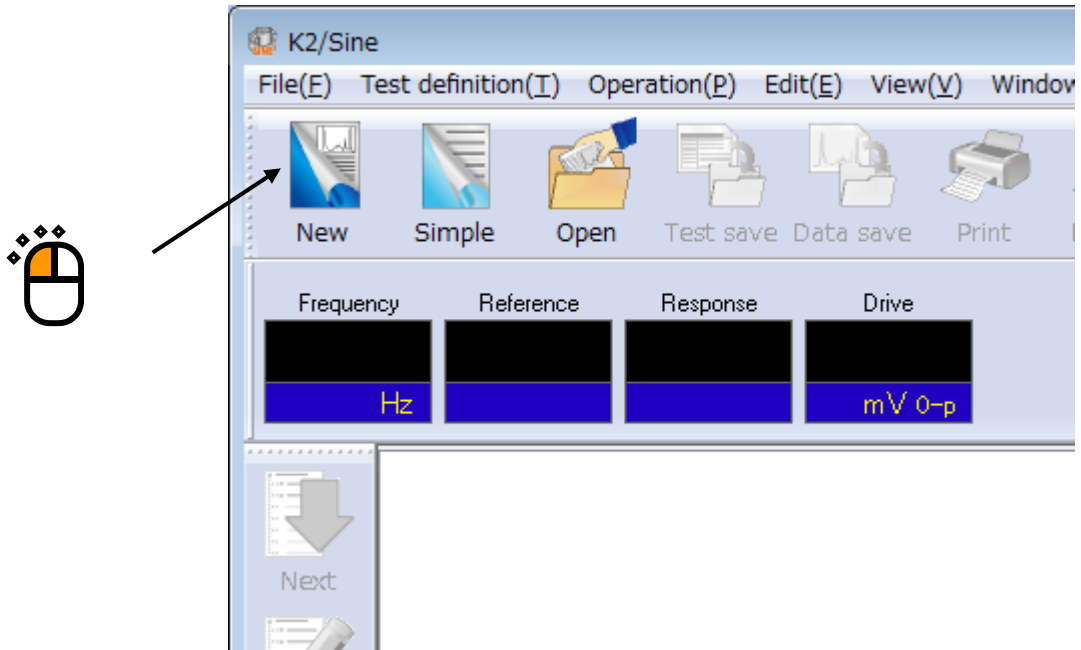
[Information of specimen]

Specimen mass : 10[kg]

< Procedures >

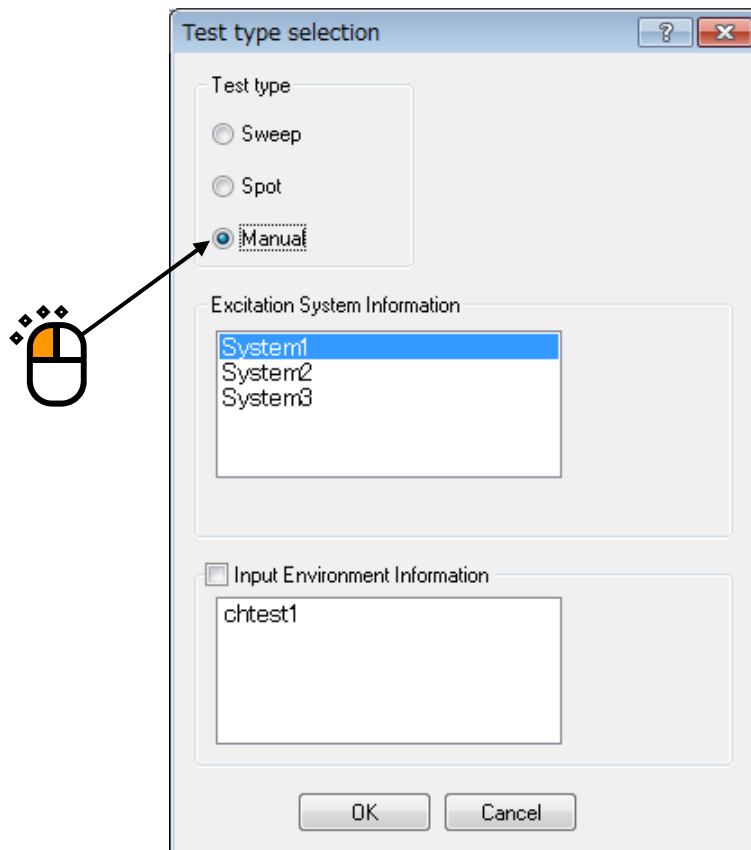
< Step 1 >

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



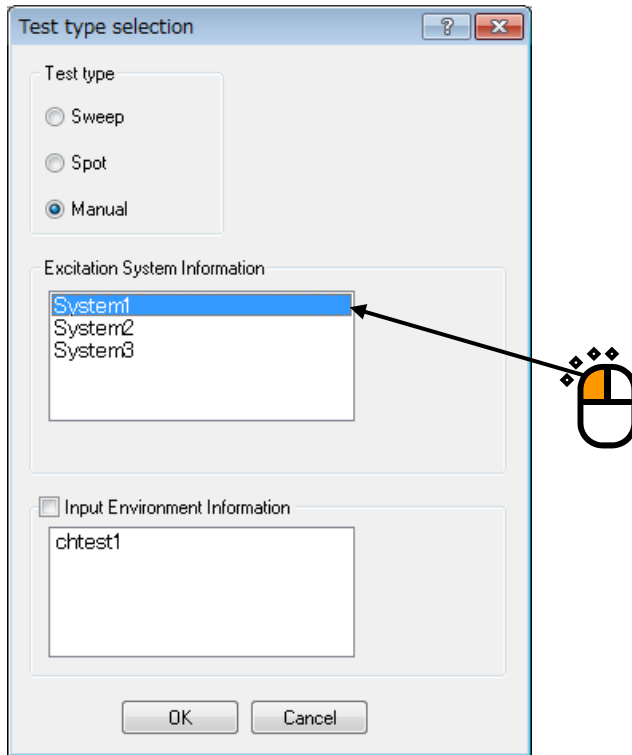
< Step 2 >

Select the item of 'Manual' in Test type.



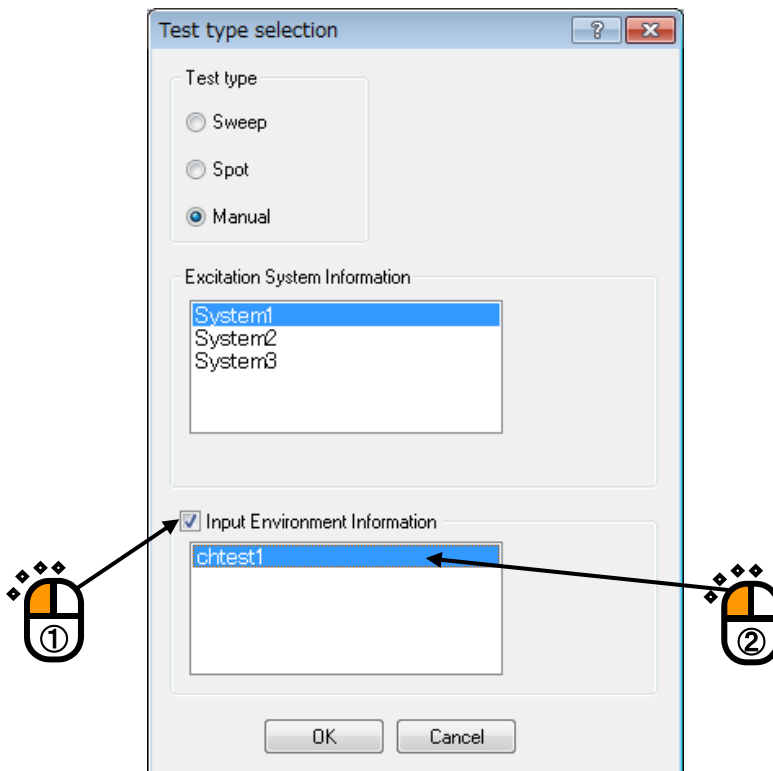
< Step 3 >

Select an excitation system information from the list of 'Excitation System Information'.



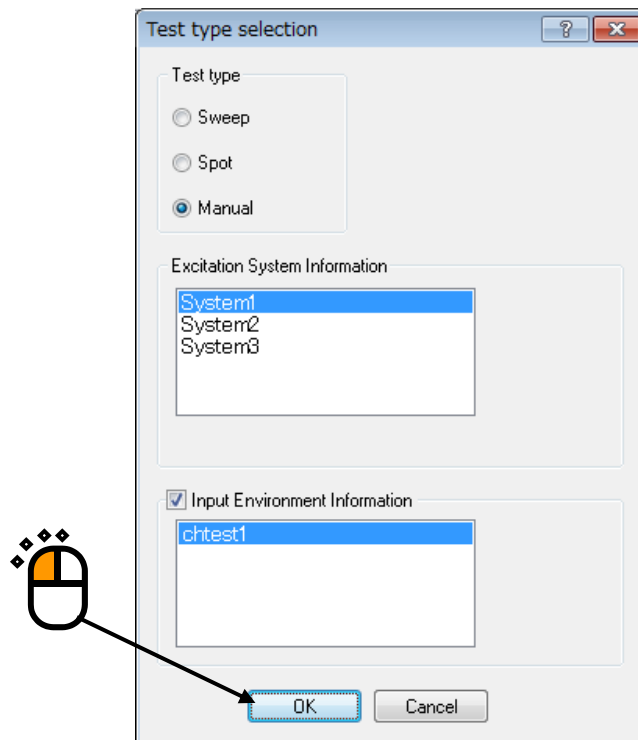
< Step 4 >

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



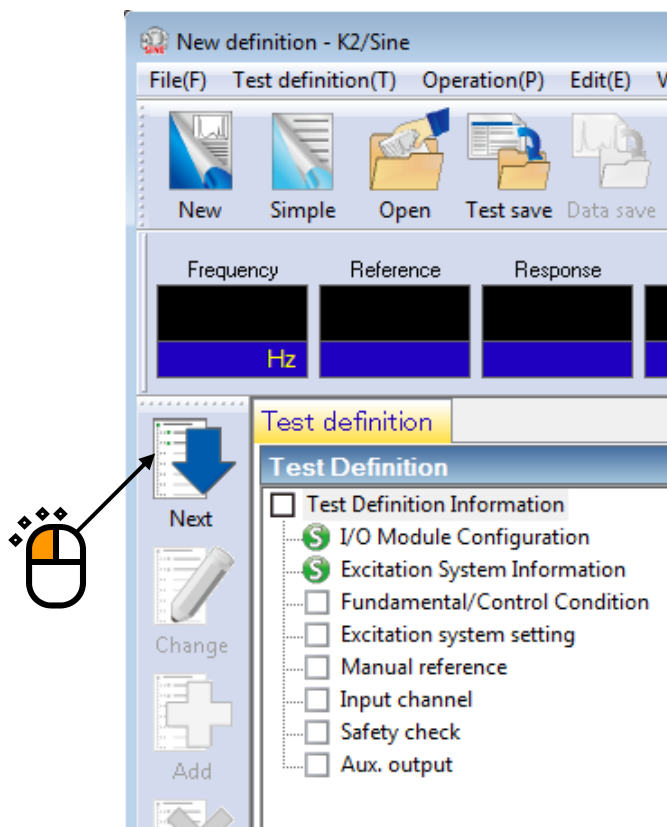
< Step 5 >

Press the button of [OK].



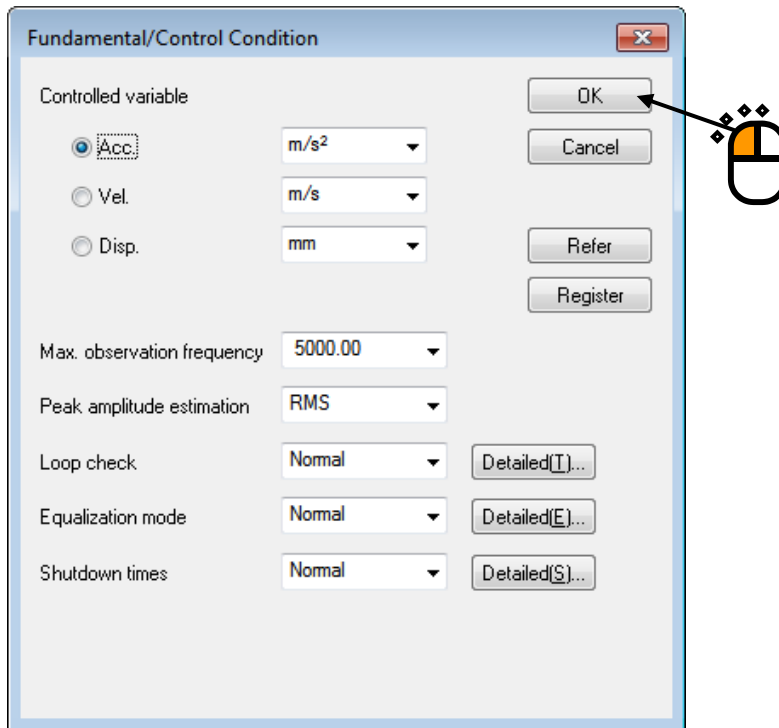
< Step 6 >

Press the button of [Go to the next definition].



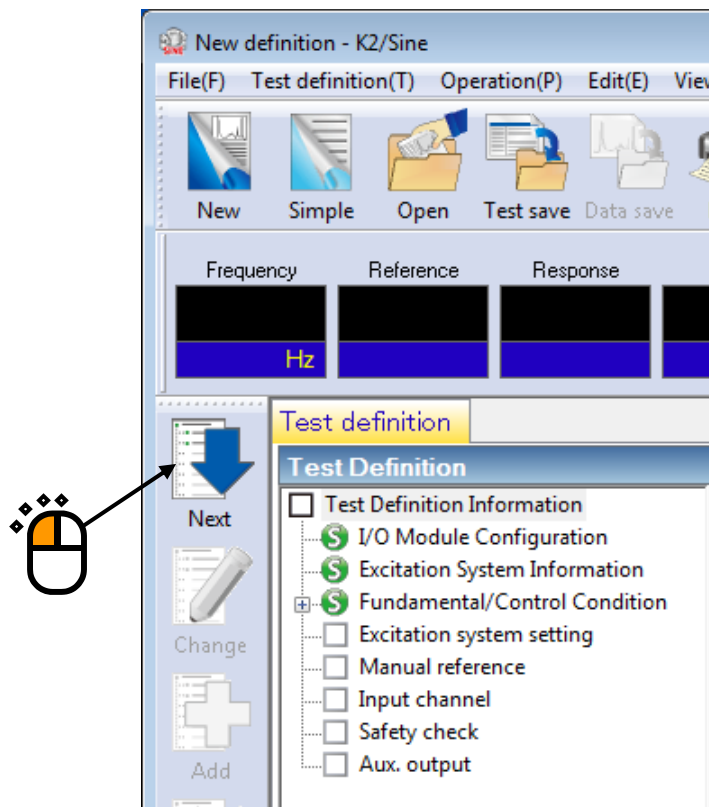
< Step 7 >

Press the button of [OK].



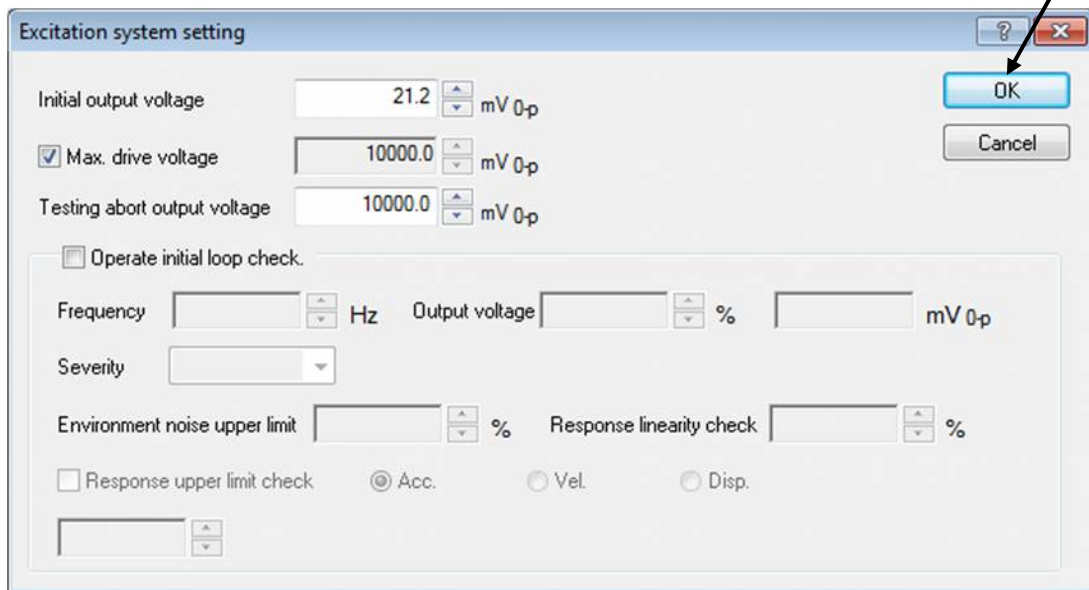
< Step 8 >

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



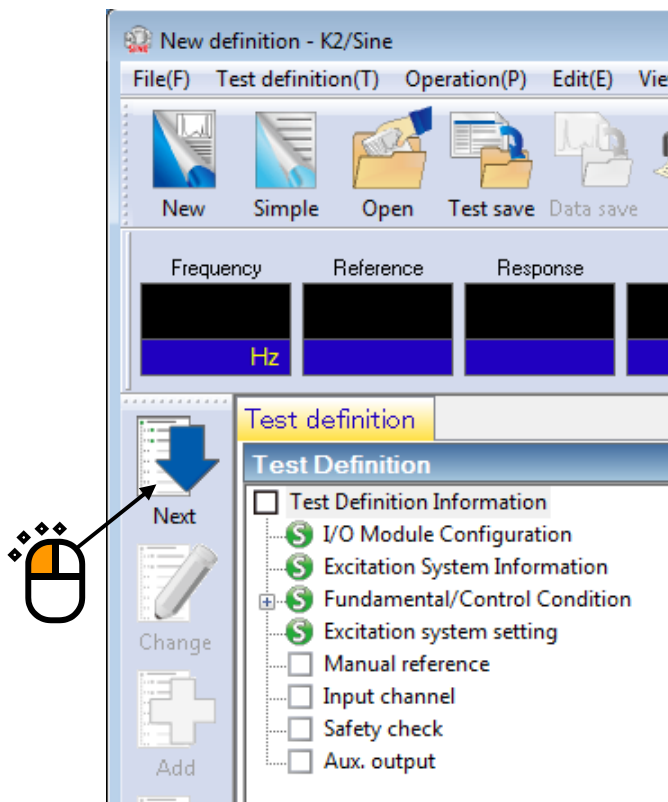
< Step 9 >

Press the button of [OK] button.



< Step 10 >

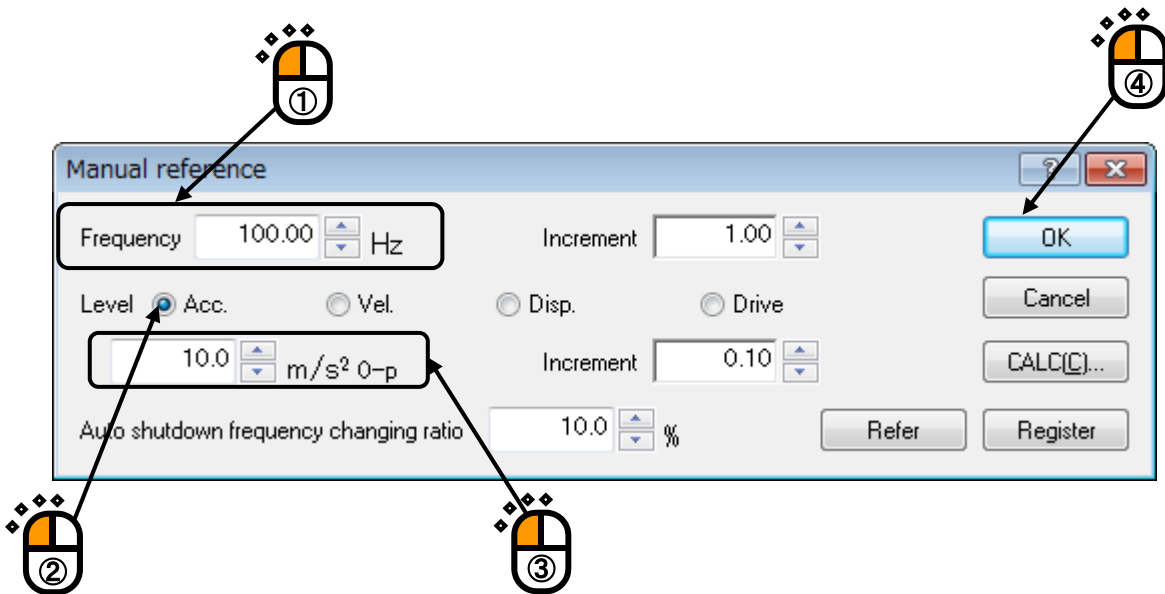
Press the button of [Next] to go to the next definition.





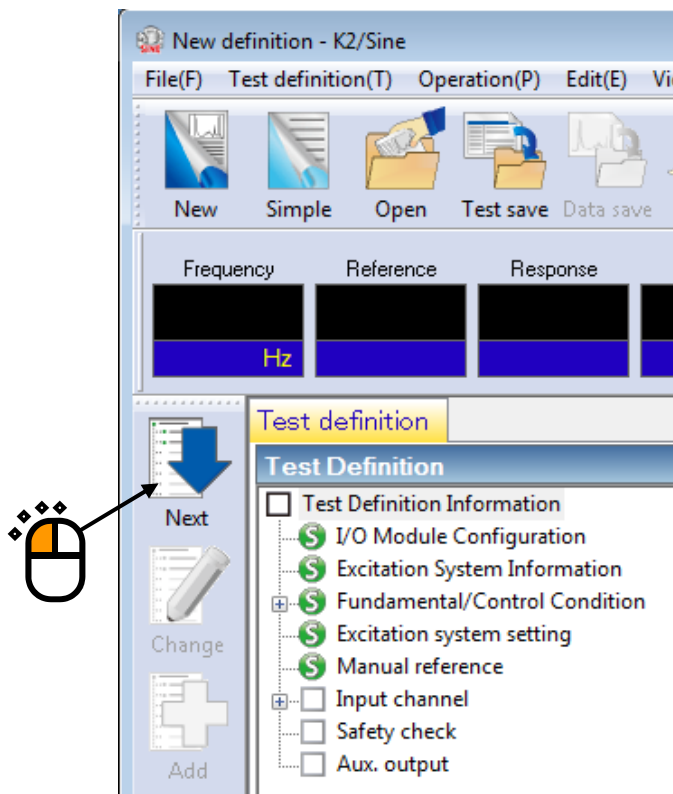
< Step 11 >

Input the values to 'Frequency' as 100 [Hz]. Check the item of 'Acc. (Acceleration)' of Level and input as 10.0 [m/s<sup>2</sup>]. Then press the button of [OK].



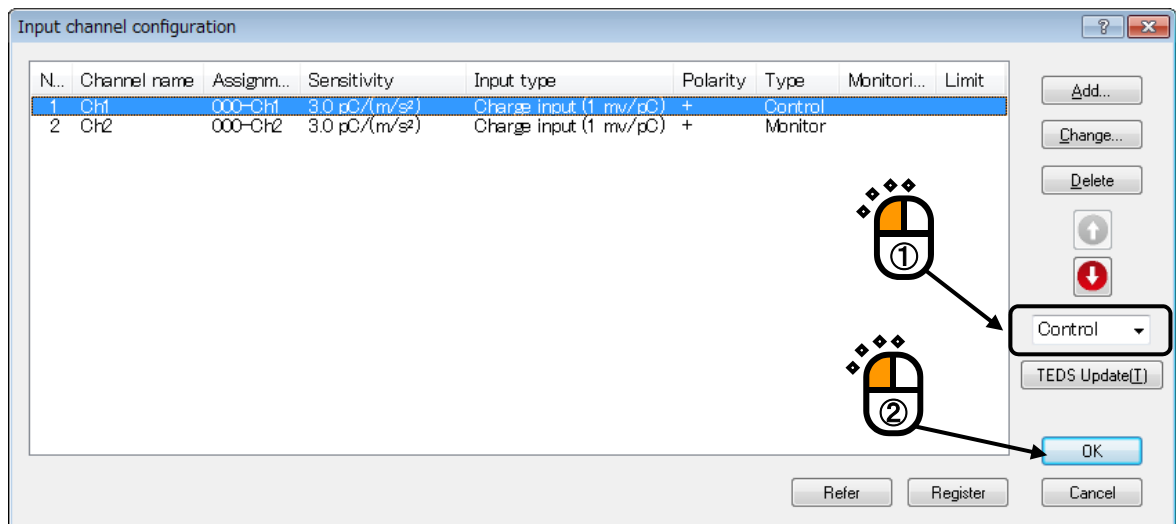
< Step 12 >

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



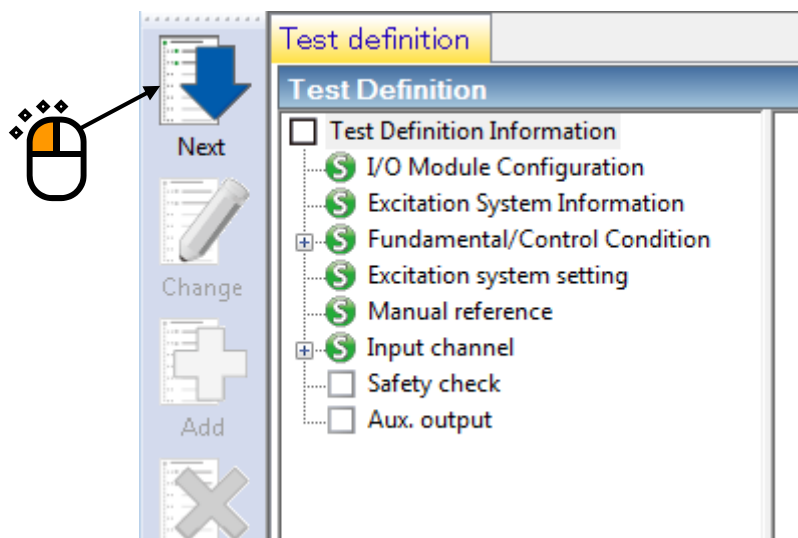
< Step 13 >

Select 'Ch. 1' and check the check box of 'Control'. And select 'Ch. 2' and check the check box of 'Monitor'. Then press the button of [OK].



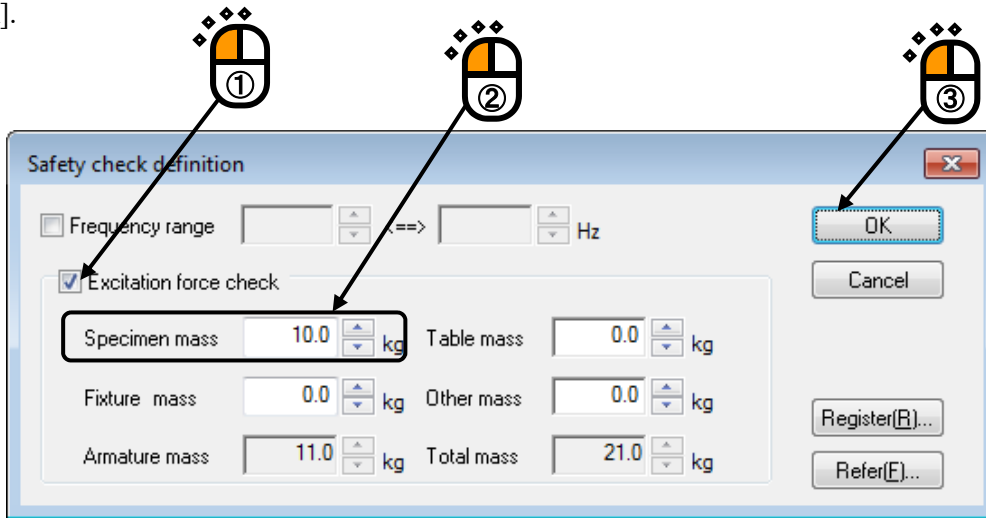
< Step 14 >

Press the button of [Next].



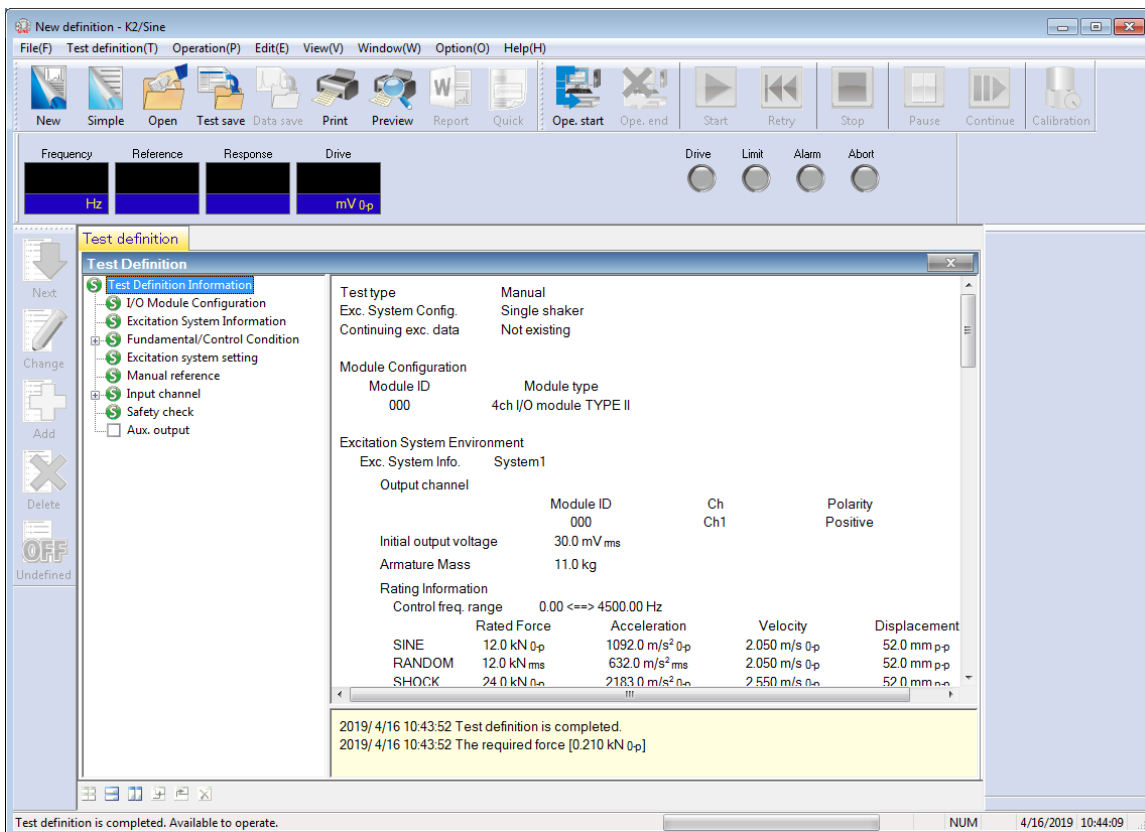
< Step15 >

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



< Step16 >

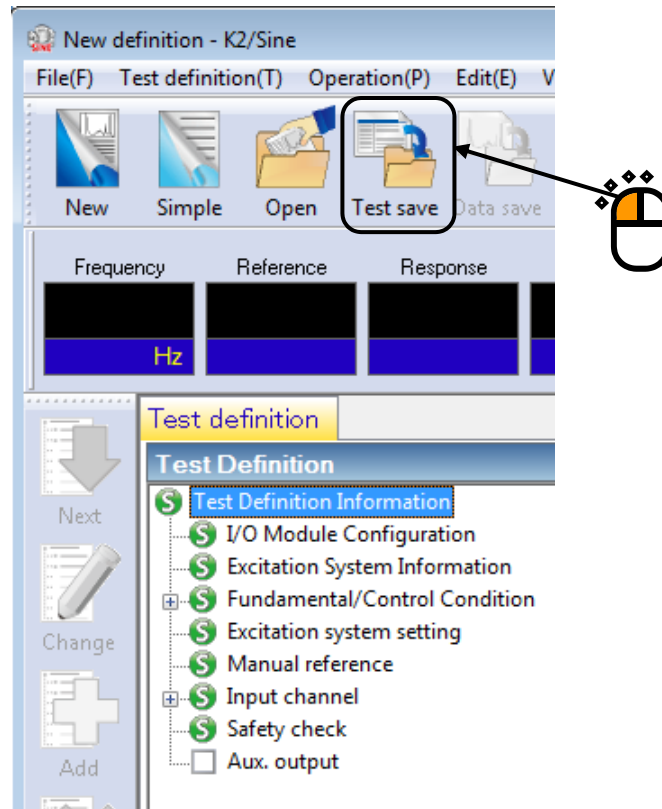
The definition is completed.



< Save of test >

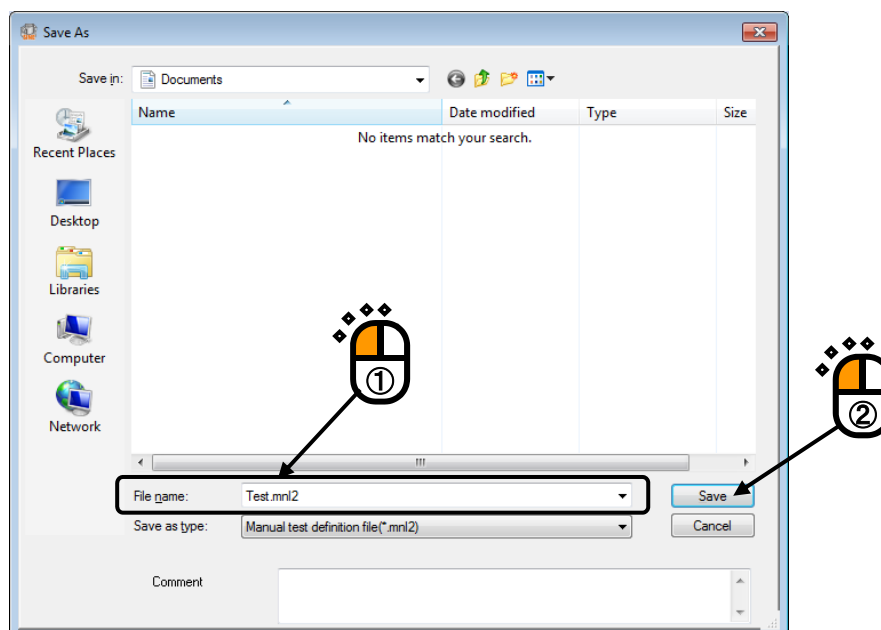
< Step 1 >

Press the button of [Save].



< Step 2 >

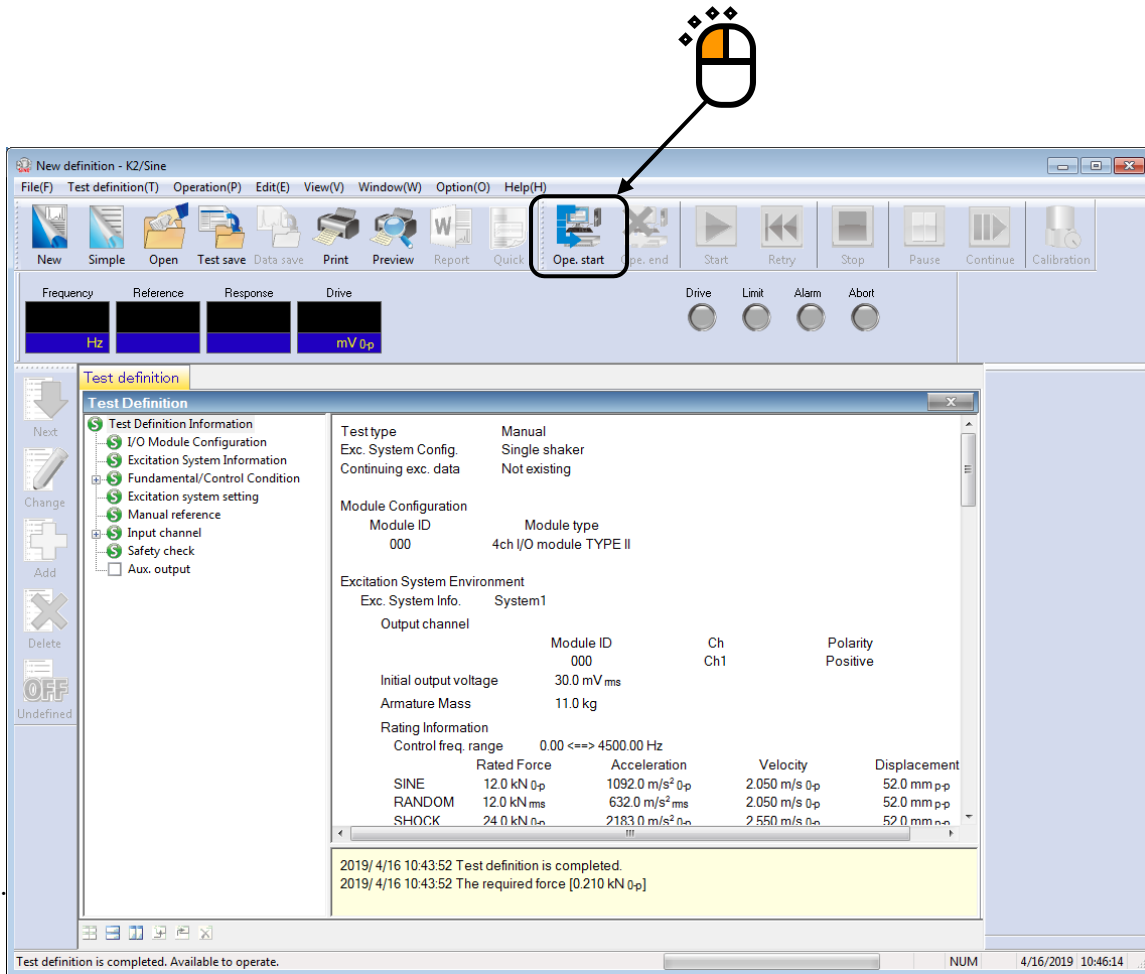
Input a name in 'File name' and press the button of [Save].



< Operation of test >

< Step 1 >

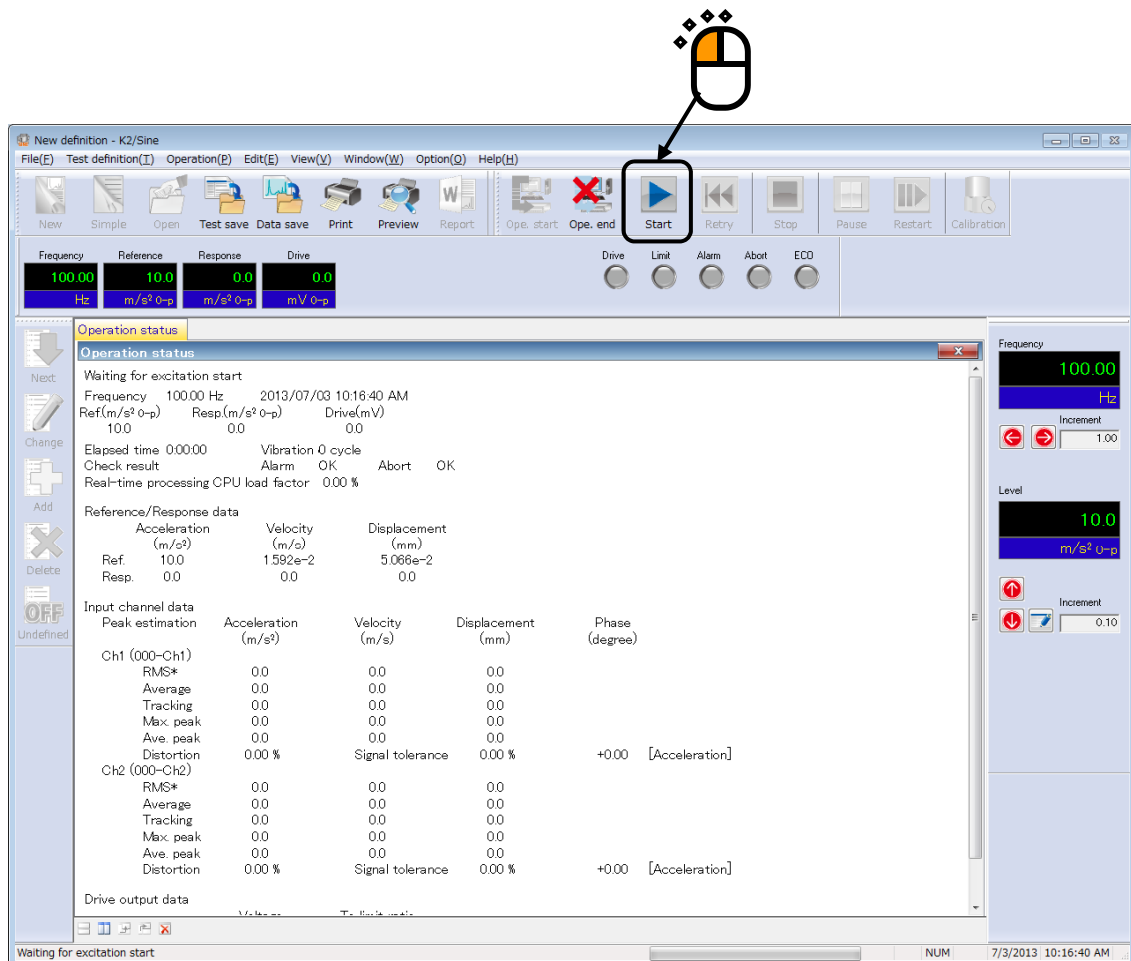
Press the button of [Operation start].



< Step 2 >

Press the button of [Start] (Excitation start).

When [Start] is pressed, Initial loop check (if it is defined) and Initial equalization is automatically operated. Then, test operation is started.



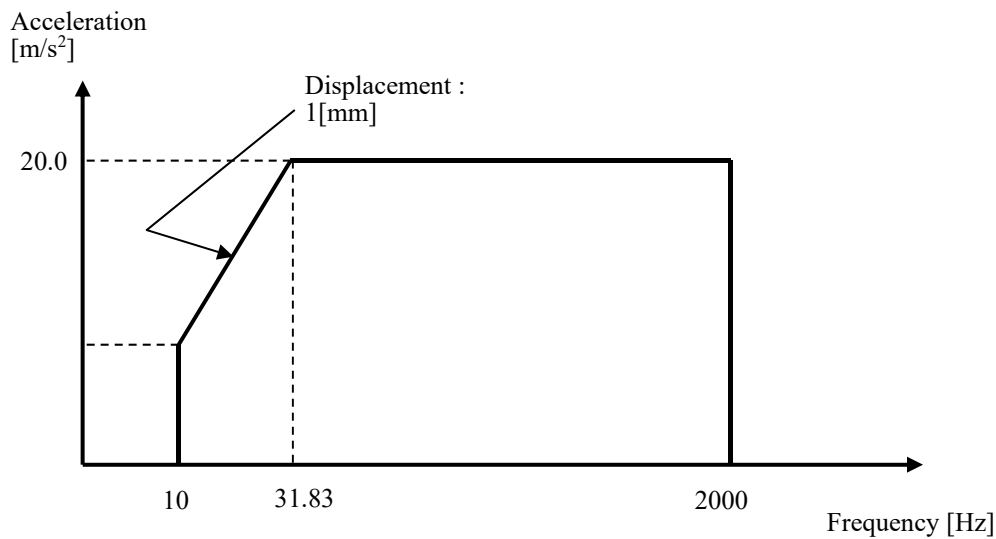
### 3.5 Simplified Definition

Continuous sweep test (Reference profile by simplified definition) can be operated in simple method by using Simplified Definition mode.

< Example >

An example of continuous sweep test is described as below ;

[Reference pattern]



[Test time]

Sweep rate : 1.000 (octave/min)

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

[Information of sensors to be used]

One accelerometer of piezo-electric

Input terminal of K2+ Hardware to be used : Ch.1 of Module ID 0

Channel name : Ch.1 (Sensitivity :3 pC/(m/s<sup>2</sup>))

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

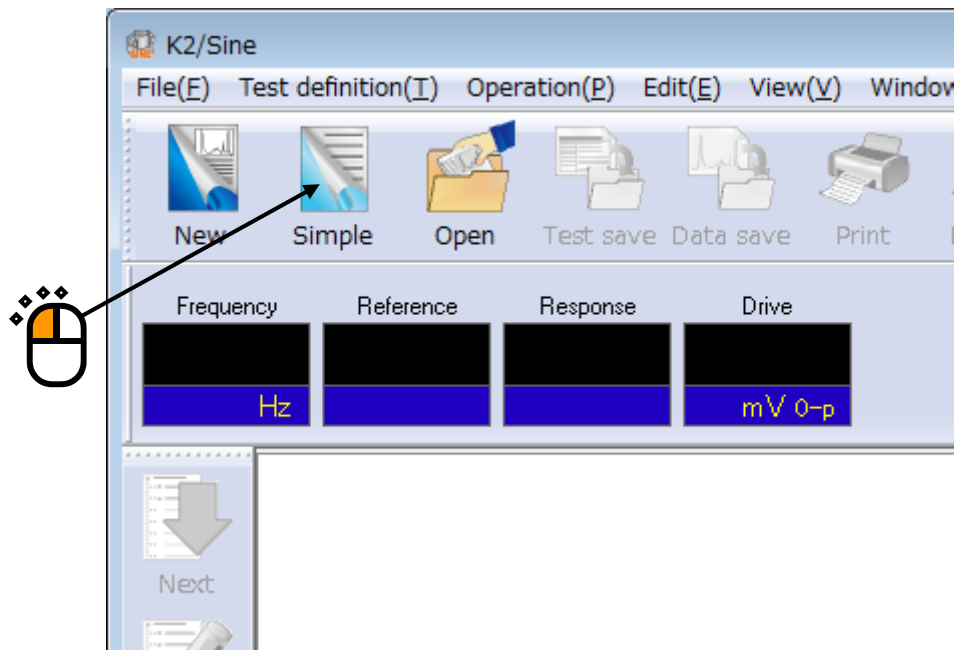
[Information of specimen]

Specimen mass : 10[kg]

< Procedures >

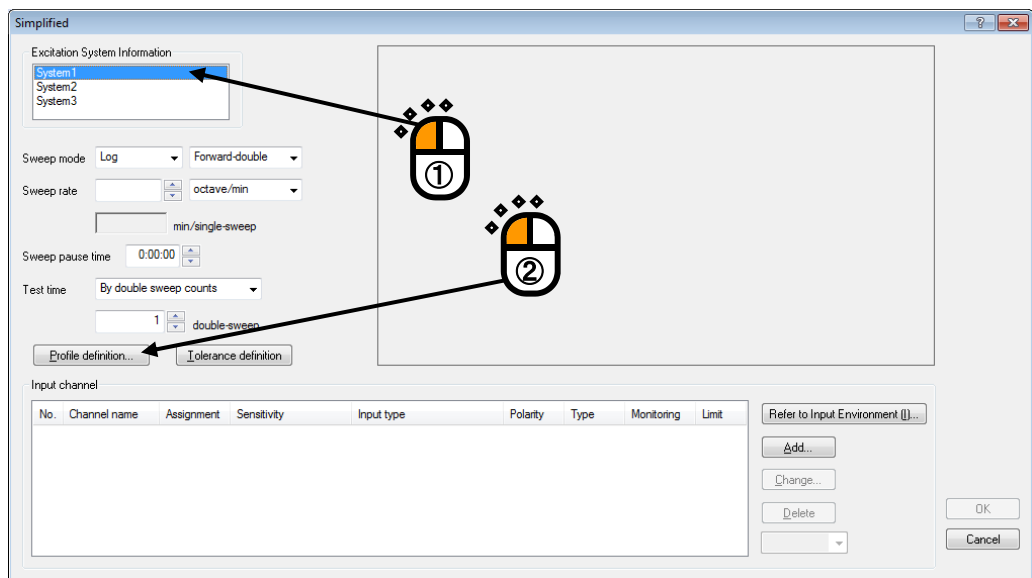
< Step 1 >

Press the button of [Simplified] to start the 'Simplified Definition'.



< Step 2 >

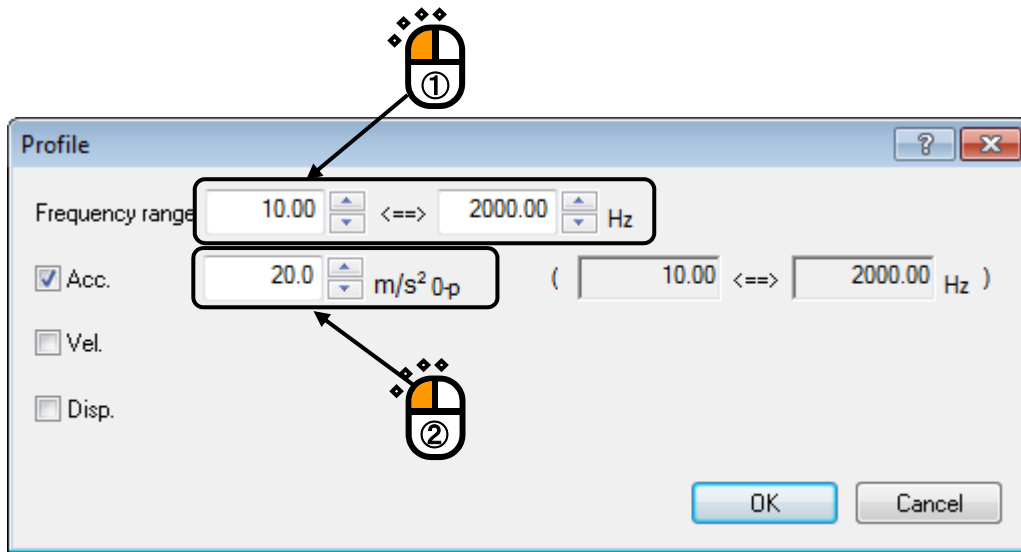
Select 'System1' among the items of Excitation System Information. And press the button of [Profile].





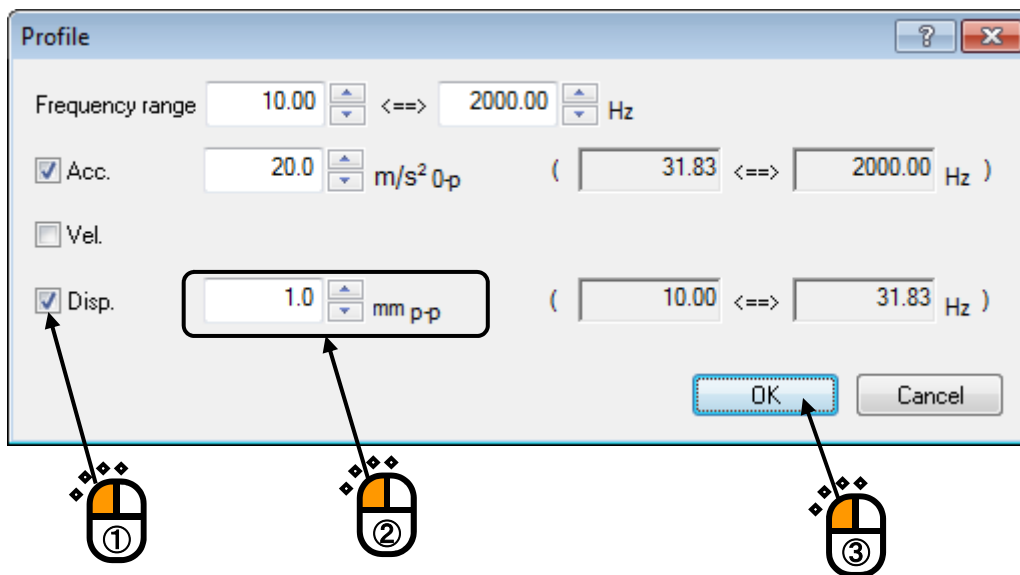
< Step 3 >

Input the values to 'Frequency range' as 10 ~ 2000.0 [Hz] and 'Acc. (Acceleration)' as 20.0 [m/s<sup>2</sup>].



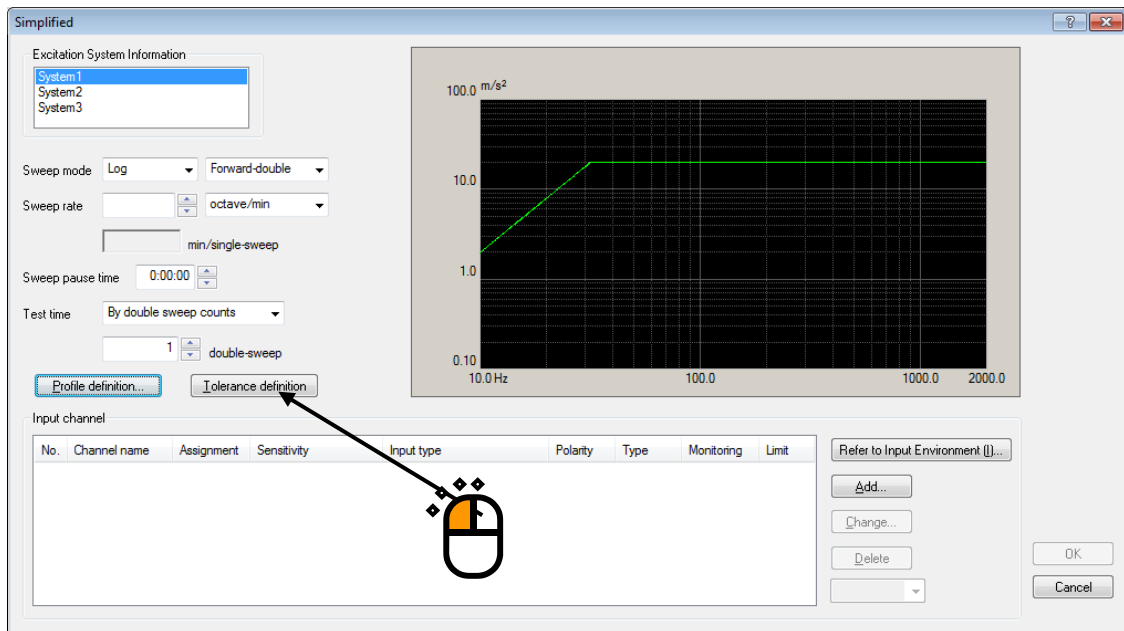
< Step 4 >

Select the check box of 'Disp. (Displacement)' and input the value of 1 [mm].  
And press the button of [OK].



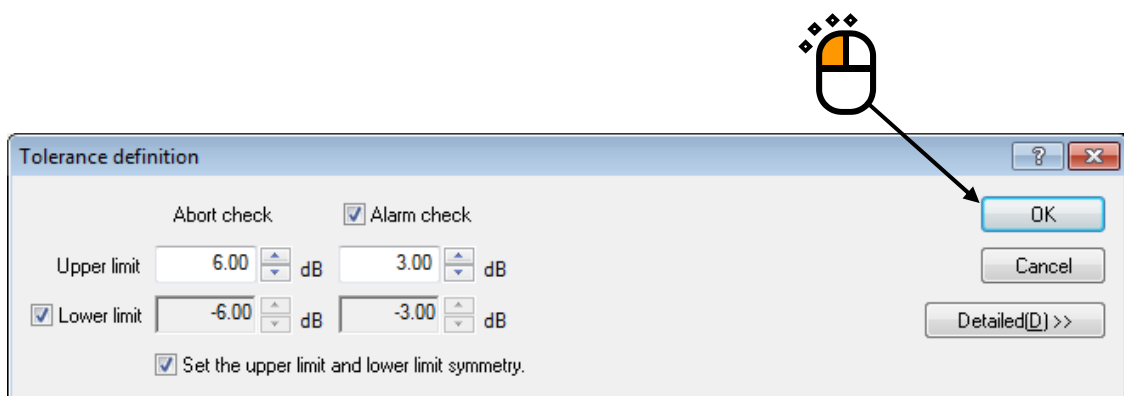
< Step 5 >

Press the button of [Tolerance].



< Step 6 >

Press the button of [OK].



< Step 7 >

Input the value to 'Sweep rate' as 1.0 [octave/min] and press the button of [Add] for Input Channel.

The screenshot shows the 'Simplified' window with the following settings:

- Excitation System Information: System1
- Sweep mode: Log, Forward-double
- Sweep rate: 1.0 octave/min (highlighted with a mouse icon 1)
- Sweep pause time: 0:00:00
- Test time: By double sweep counts, 1 double-sweep (highlighted with a mouse icon 1)
- Input channel table:

No.	Channel name	Assignment	Sensitivity	Input type	Polarity	Type	Monitoring	Limit

Buttons: Profile definition..., Tolerance definition, Add... (highlighted with a mouse icon 2), Change..., Delete, Refer to Input Environment (I)..., OK, Cancel.

Graph: A log-log plot showing acceleration (m/s<sup>2</sup>) vs frequency (Hz) with multiple colored lines representing different sweep profiles.

Annotation: 'Test time' needs to be set to 1 [double-sweep].

< Step 8 >

Set the details of an input channel as below and press the button of [OK] ;

- Channel name : Ch.1
- Module ID : 000
- Ch : Ch.1
- Input sensitivity : 3.0 pC/(m/s<sup>2</sup>)
- Input channel type : Control

The screenshot shows the 'Input channel element' dialog box with the following configuration:

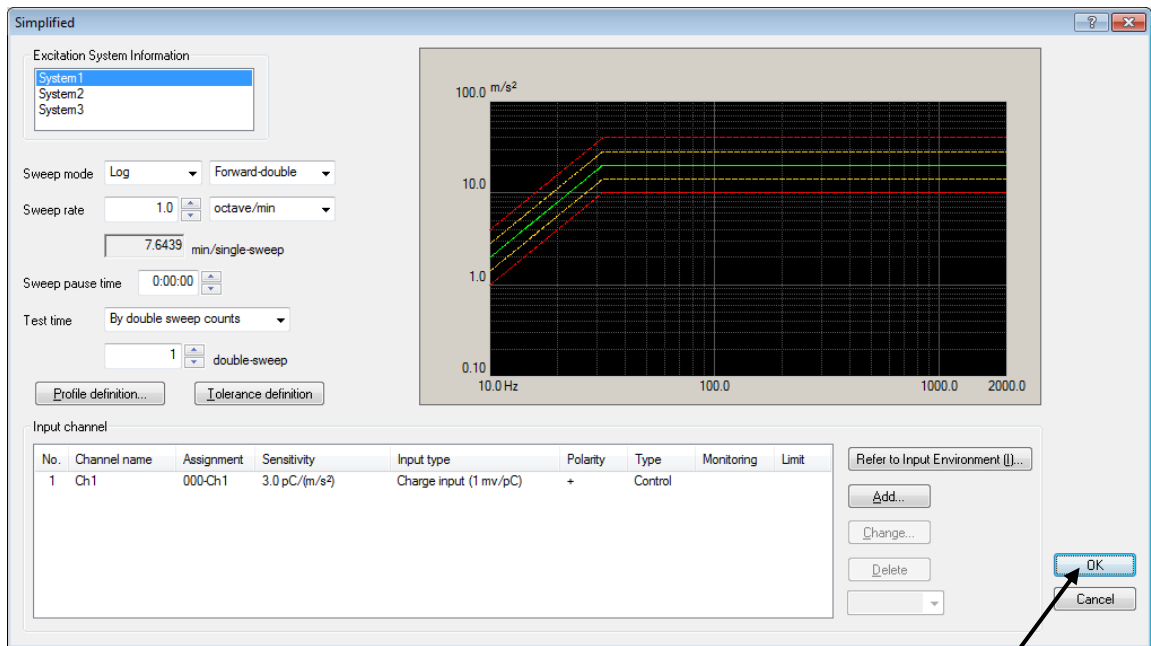
- Name: CH1
- Module ID: 000
- Ch: Ch1
- Quantity: Acceleration
- Input type: Charge input (1 mv/pC) (highlighted with a mouse icon 1)
- Sensitivity: 3.0 pC/(m/s<sup>2</sup>) (highlighted with a mouse icon 1)
- Channel Type: Control
- Polarity: +

Buttons: OK (highlighted with a mouse icon 2), Cancel, Detailed(D) >>, Cal. cancel(R), TEDS connection(E).

Annotation: 'Input type' needs to be set to Charge.

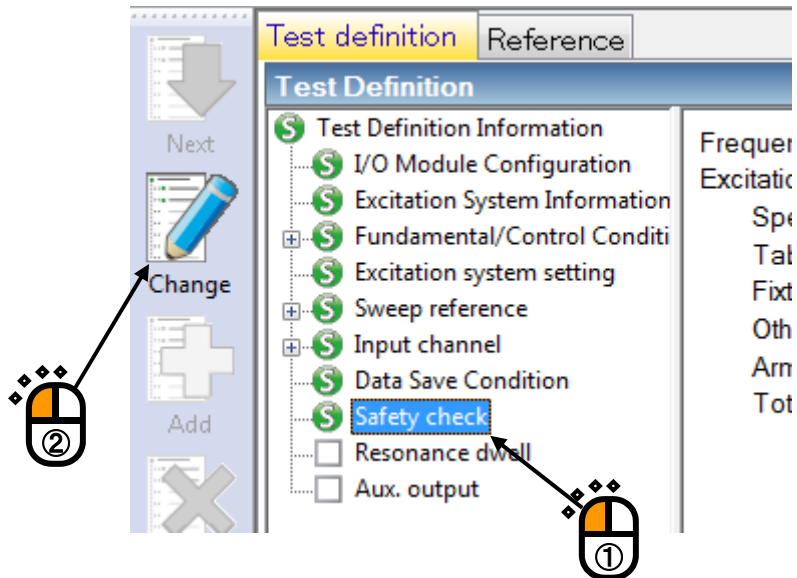
< Step 9 >

Press the button of [OK].



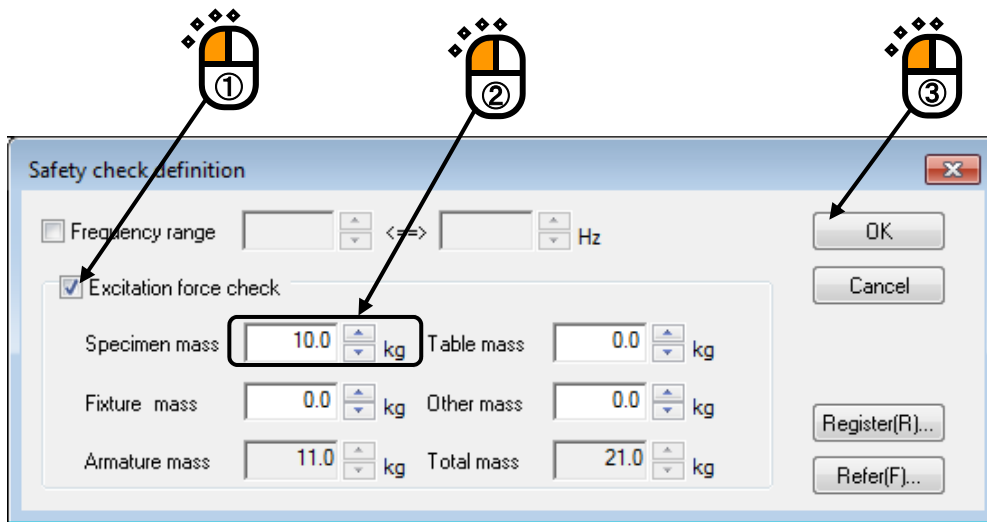
< Step 10 >

Select 'Safety check' and press the button of [Change].



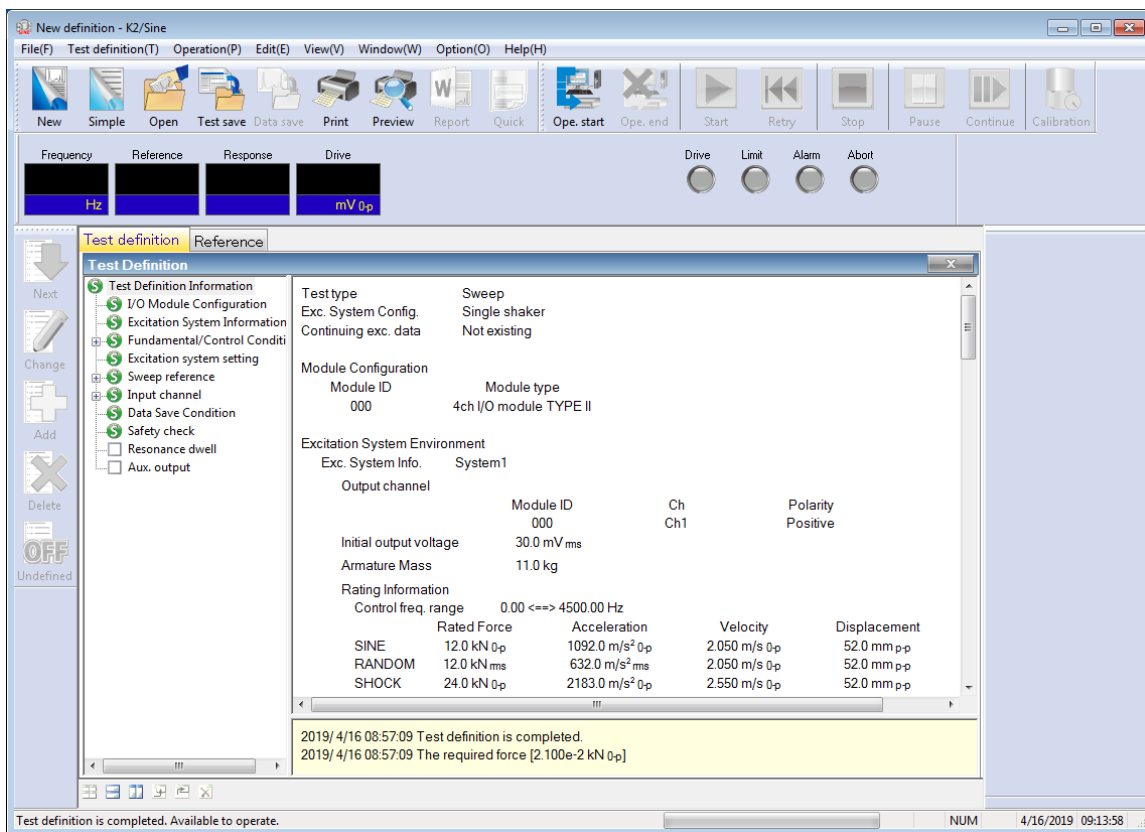
< Step 11 >

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



< Step 12 >

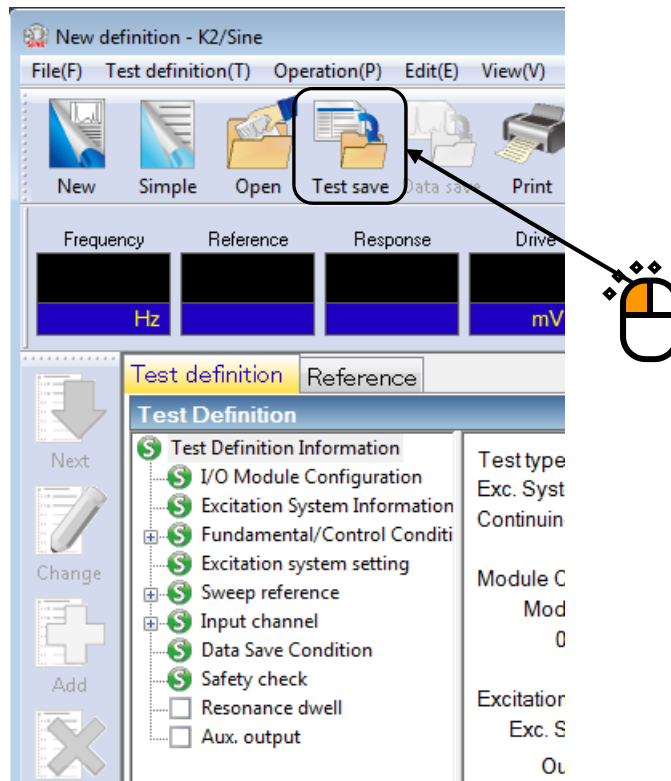
The definition is completed.



< Save of test >

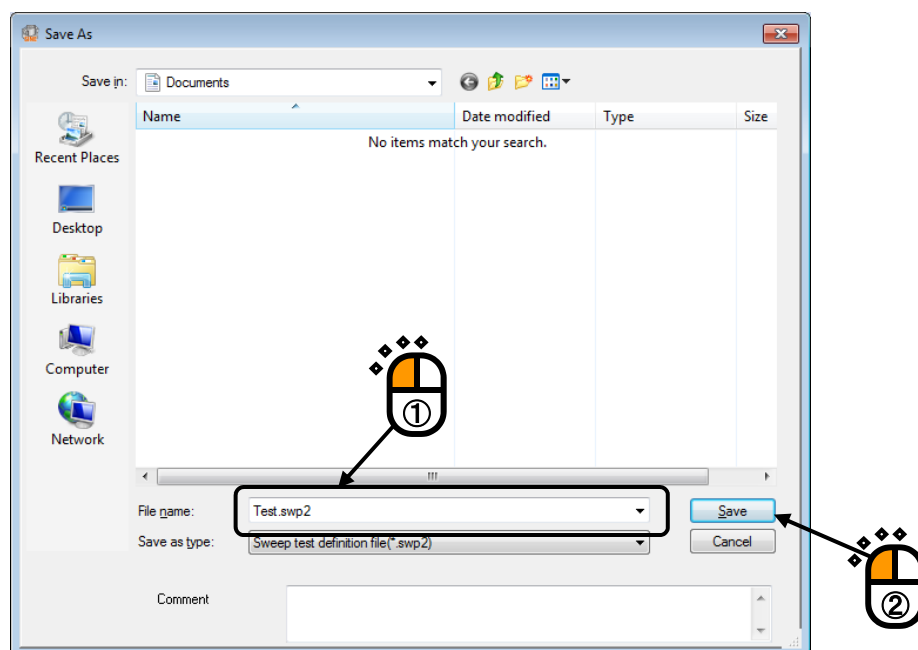
< Step 1 >

Press the button of [Test Save].



< Step 2 >

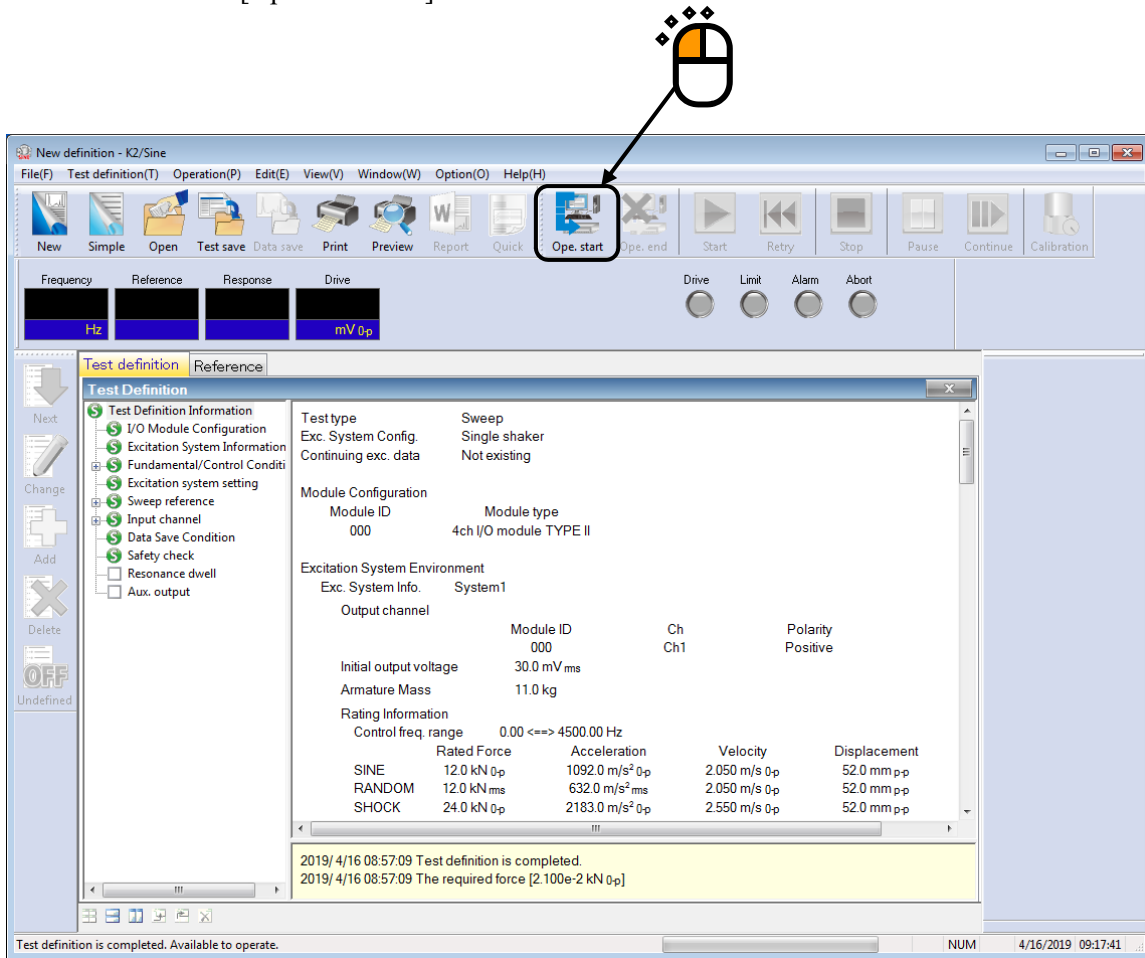
Input a name in 'File name' and press the button of [Save].



< Operation of test >

< Step 1 >

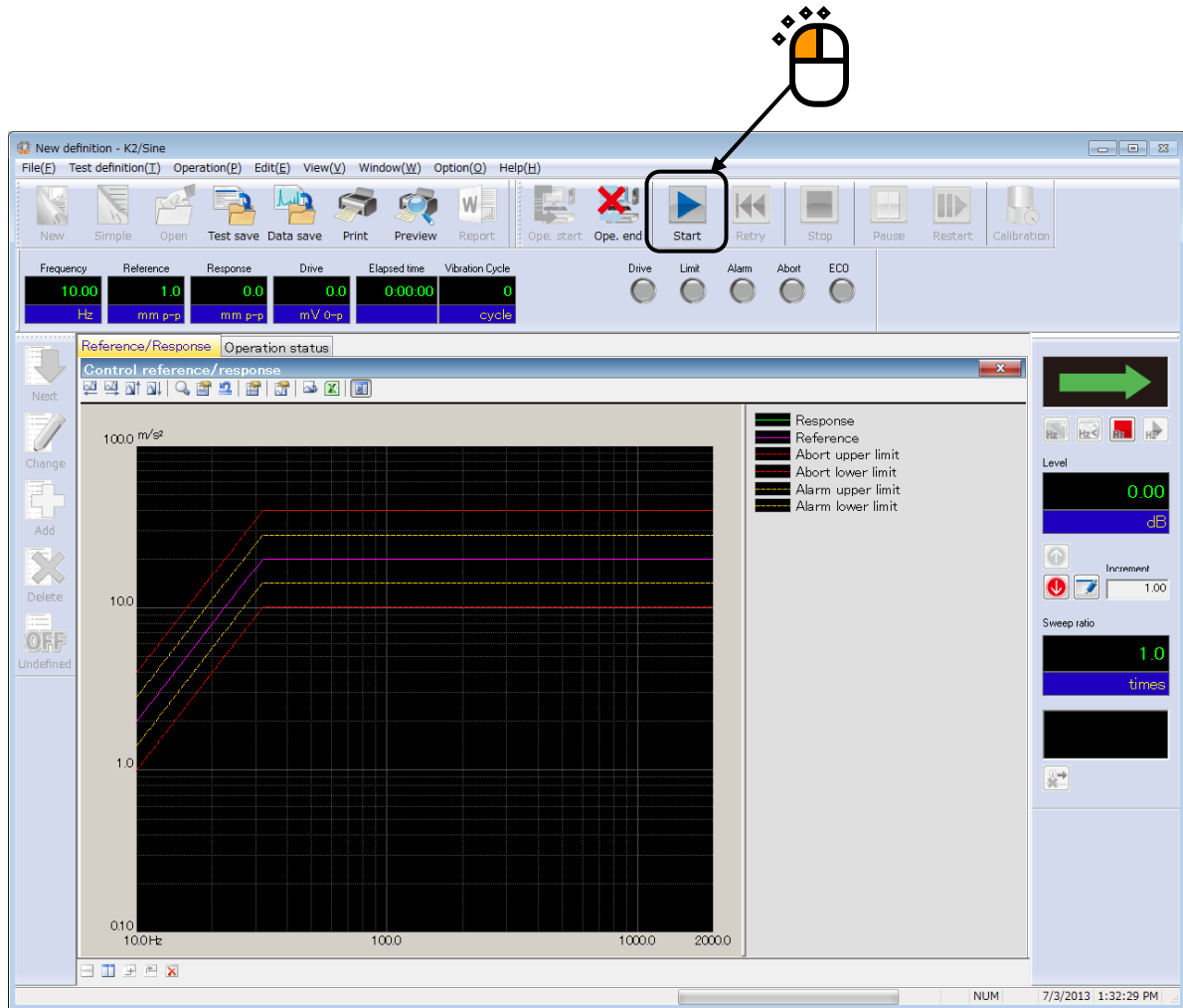
Press the button of [Operation start].



< Step 2 >

Press the button of [Start] (Excitation start).

When [Start] is pressed, Initial loop check and Initial equalization is automatically operated. Then, test operation is started.

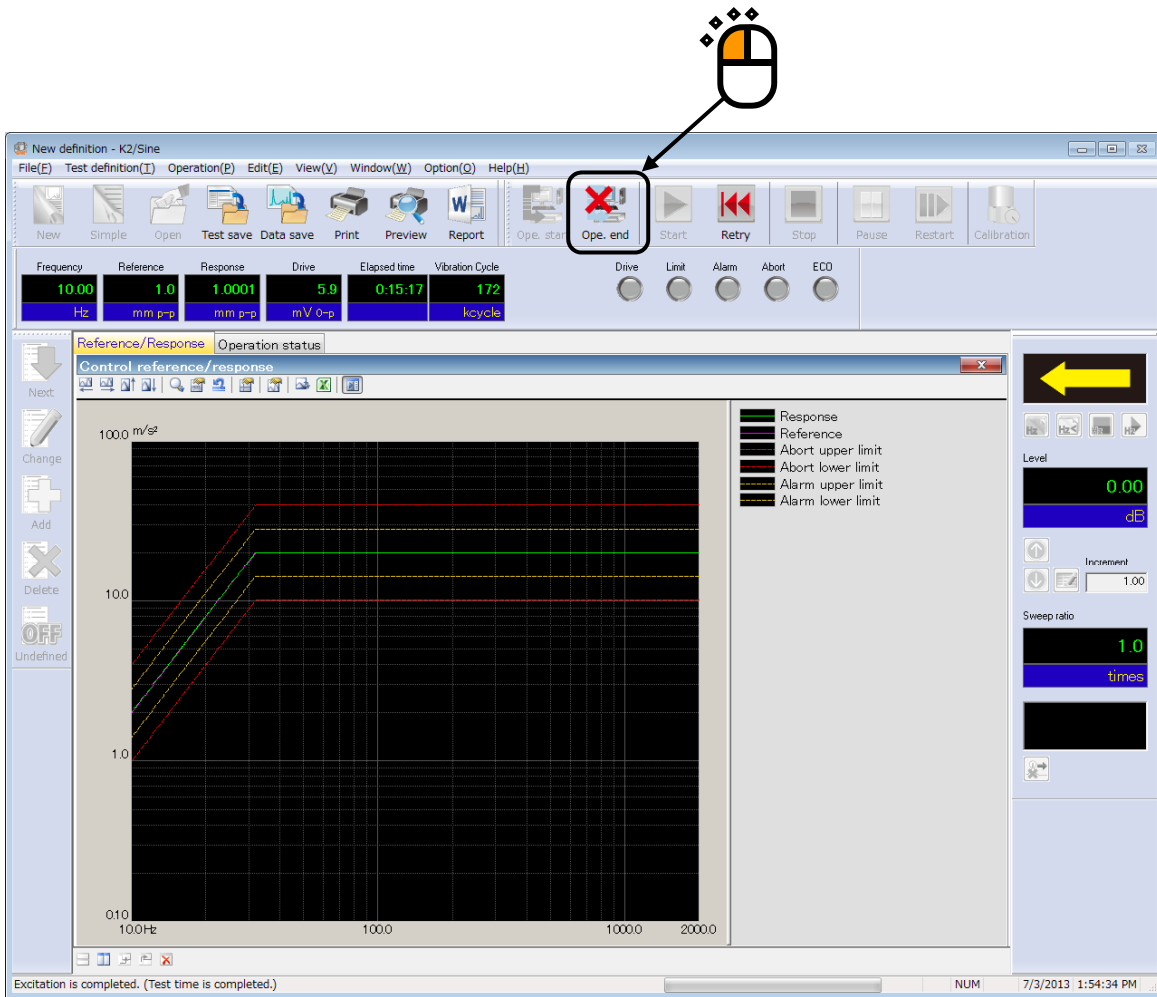




< Step 3 >

Test operation is ended when the test time is completed.

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



# 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.

Three types of Test such as ‘Sweep’, ‘Spot’ and ‘Manual’ 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, ‘(5) 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	Sweep	Spot	Manual
Setting Information			
(1) I/O Module Configuration	○	○	○
(2) Excitation System Information	○	○	○
(3) Fundamental/Control Condition	○	○	○
(4) Excitation System setting	○	○	○
(5) Control Reference	○	○	○
(6) Input Channel	○	○	○
(7) Data Save Condition	○	○	—
(8) Safety check	○	○	○
(9) Resonance dwell	△	—	—
(10) Aux. Output	△	△	△

○ : Information that must be defined

△ : Information that is defined if necessary

— : No items to be defined

Note) Resonance dwell is an optional function.

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.

Fundamental/Control Condition

Controlled variable

Acc. m/s<sup>2</sup>

Vel. cm/s

Disp. mm

Max. observation frequency 5000.00

Peak amplitude estimation RMS

Loop check Normal Detailed(T)...

Equalization mode Soft Detailed(E)...

Shutdown times Normal Detailed(S)...

Pause before transitioning to "In excitation"

OK

Cancel

Refer

Register

### 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  $f_{max}$ ) 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 three 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.

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

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.

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

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

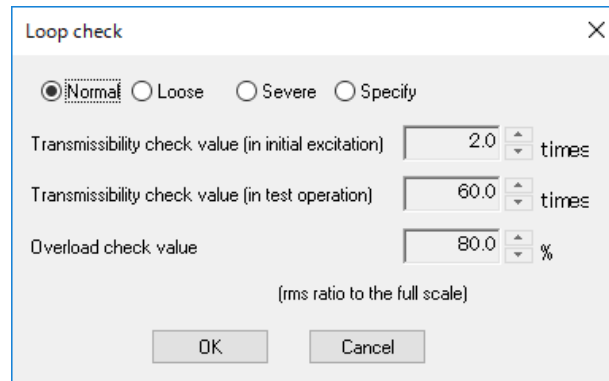
##### 3. Loose

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.

##### 4. Specify (or Detailed definition button)

Parameters of the loop check in 'Severe', 'Normal' and 'Loose' settings are set up appropriately. However, if the loop check cannot be passed by these settings, tune the parameters by 'Specify'.

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.



#### 4.2.4.1 Transmissibility check value [in initial excitation]

(1) Meaning

This item is intended for specifying the allowance for the transmissibility variations at the initial measurement or initial equalization.

If the transmissibility variations exceed the specified value, the test is aborted.

#### 4.2.4.2 Transmissibility check value [in test operation]

(1) Meaning

This item is intended for specifying the allowance for the transmissibility variations during test operation.

If the transmissibility variations exceed the specified value, the test is aborted.

#### 4.2.4.3 Overload check value

(1) Meaning

This item is intended for the continuance of test even if input signal exceeds the input range to some extent. Note that exact control or measurement is unavailable when input signal always exceeds the input range.

#### 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 ····  $A/(B/1000)[\text{Hz}] \leq f \leq A/(C/1000) [\text{Hz}]$
- Transit time upper limit ····  $f \leq A/(B/1000) [\text{Hz}]$
- Transit time lower limit ····  $A/(C/1000)[\text{Hz}] \leq f$

#### **4.2.7 Pause before transitioning to "In excitation"**

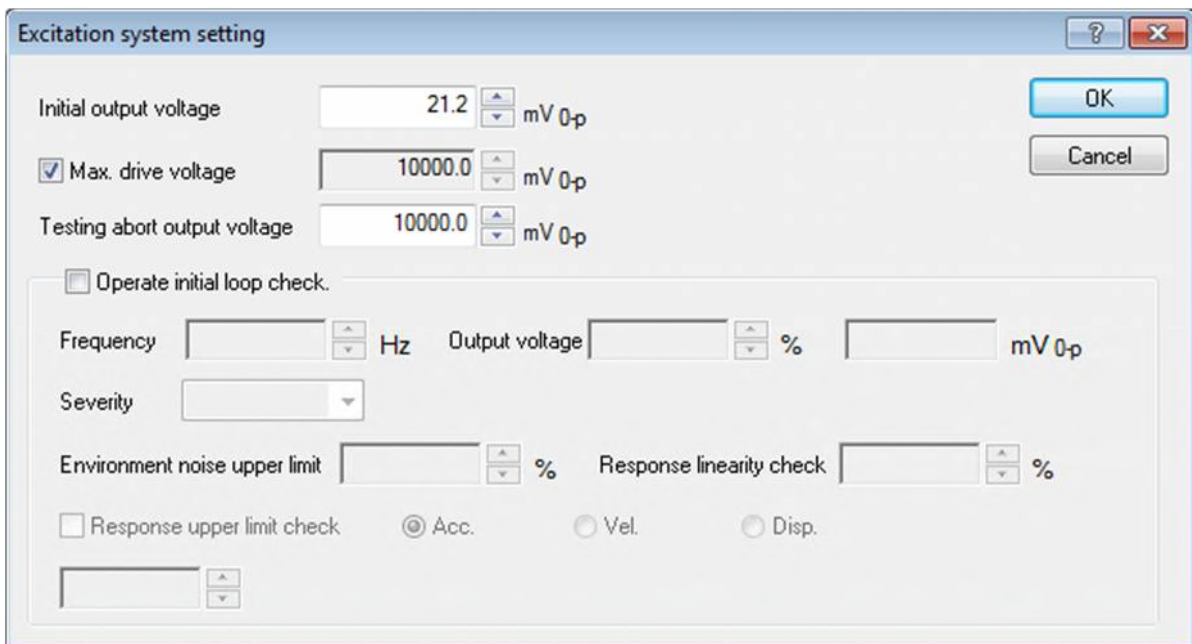
(1) Meaning

After starting the excitation, the response gradually approaches the reference by adjusting the drive output signal. And when the response coincides with the reference, the test status becomes 'In excitation' and the test continues.

When this item is checked, the status becomes 'Pause' and the drive output is stopped before the status transitions to "In excitation".

## 4.3 Excitation system setting

The items of Excitation / Output system for control are defined.



### 4.3.1 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 ( $V_{rms}$ ) 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.**

### 4.3.2 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.

### 4.3.3 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.

### 4.3.4 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.

#### **4.3.4.1 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.

#### **4.3.4.2 Output voltage**

(1) Meaning

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

#### **4.3.4.3 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.

When 'Specify' is selected, input a proper value to each parameter.

#### **4.3.4.4 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.

#### **4.3.4.5 Response linearity check**

(1) Meaning

Refer to the help file.

#### **4.3.4.6 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.

## 4.4 Control reference

This item is for setting of the control reference, and the testing pattern is 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.

In Manual test, no other items but control reference frequency and control reference level are to be defined.

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

In this system, the defined control reference can be saved and registered as a file. If the control reference is saved, its condition can be used in other tests of the same Test type easily. By using the push buttons in the definition display of each control reference, the saved control reference can be referred to and the defined control reference can be saved as a file.

[Refer] : Control reference saved in a file is referred to and its condition is loaded to be used.

[Save] : The defined control reference is saved and registered in a file.

#### 4.4.1 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.



#### 4.4.1.1 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 "4.4.1.3".

##### 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 "4.4.1.3".

#### 4.4.1.2 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 ;

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

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

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

##### 2. Backward single

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

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

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

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

##### 3. Forward double

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

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

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

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

##### 4. Backward double

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

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

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

When this item is selected, a 'single-sweep' or a 'double-sweep' is used as a unit for setting of 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'.

### 4.4.1.3 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 ;

$$1 \text{ decade/min} = 3.3219 \text{ octave/min} \quad (2.5.3)$$

$$(\because 1 \text{ decade} = (1/\log 2) \text{ octave} = 3.3219 \text{ octave} )$$

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.

### 4.4.1.4 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.

### 4.4.1.5 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.

#### 4.4.1.6 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 “4.4.4 Profile definition” about the details.

#### 4.4.1.7 Tolerance definition

(1) Outline

This item is for defining the condition of Tolerance check.

Refer to “4.4.5 Tolerance definition” about the details.

#### 4.4.1.8 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.

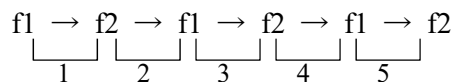
1. Specify by the times of single-sweep

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 ;



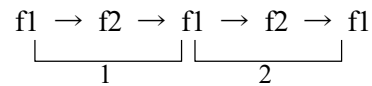
2. Specify by the times of double-sweep

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

## 4.4.2 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<sup>2</sup> of acceleration' at SP#1 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.

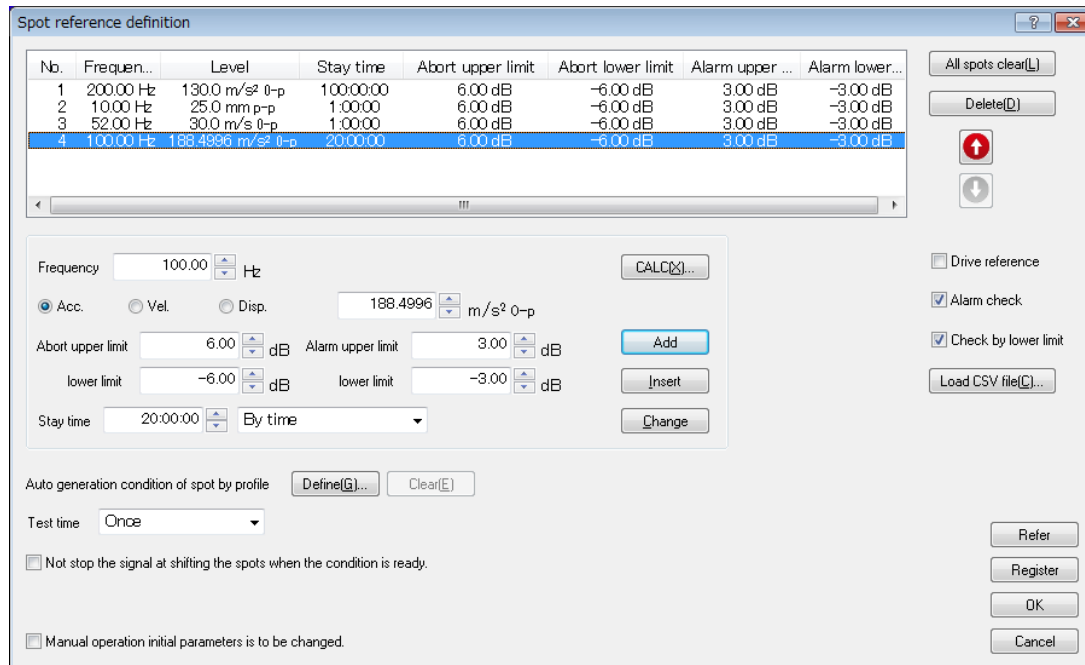
#### 4.4.2.1 Spot Reference definition

##### (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.

#### 4.4.2.1.1 Frequency

(1) Meaning

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

#### 4.4.2.1.2 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 button of [CALC].

Refer to “4.4.6 CALC function” about the details.

#### 4.4.2.1.3 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 if 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.

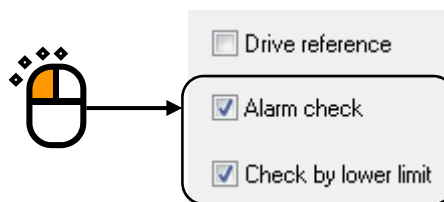
And the meaning of ‘Abort’ is that the system stops the testing operation (the signal output is stopped) when a response exceeding over the range of the set condition is detected.

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  $\leq$  Abort upper limit
- Abort lower limit  $\leq$  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’.





#### 4.4.2.1.4 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.

#### 4.4.2.2 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.

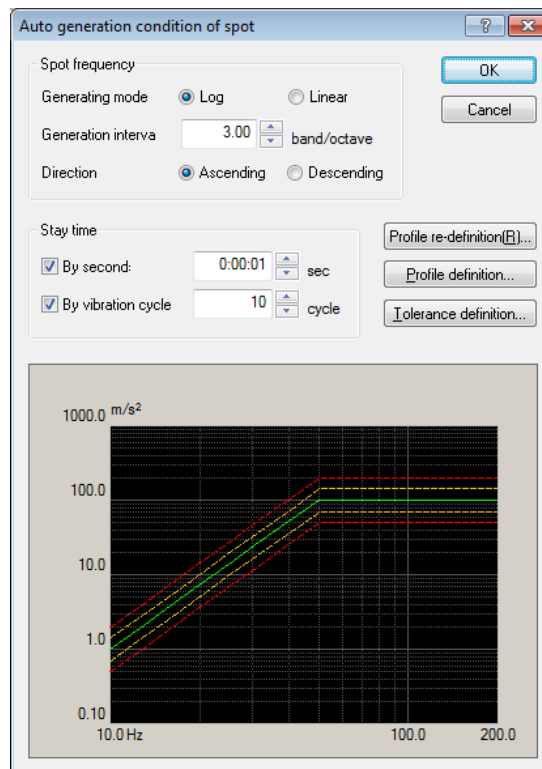
Control reference definition at auto-generation of spot is the same as that of sweep test fundamentally.

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.



#### 4.4.2.2.1 Generating mode

(1) Meaning

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

#### 4.4.2.2.2 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.

#### 4.4.2.2.3 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)

#### 4.4.2.2.4 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 ;

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

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

#### 4.4.2.2.5 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 ;

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

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

#### 4.4.2.2.6 Profile definition

(1) Meaning

Refer to “4.4.4 Profile definition”.

#### 4.4.2.2.7 Tolerance definition

(1) Meaning

Refer to “4.4.5 Tolerance definition”.

#### 4.4.2.3 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.

#### 4.4.2.4 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'.

No.	Frequency	Level	Stay time	Abort upper limit	Abort lower limit	Alarm upper...	Alarm lower...
1	200.00 Hz	130.0 m/s <sup>2</sup> 0-p	100:00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
2	10.00 Hz	25.0 mm p-p	1:00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
3	52.00 Hz	30.0 m/s 0-p	1:00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
4	100.00 Hz	188.4956 m/s 0-p	20:00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB

Frequency: 100.00 Hz  
Level: 188.4956 m/s 0-p  
Stay time: 20:00:00 By time

Abort upper limit: 6.00 dB, lower limit: -6.00 dB  
Alarm upper limit: 3.00 dB, lower limit: -3.00 dB

Test time: Once

Not stop the signal at shifting the spots when the condition is ready. Frequency ratio: [ ] within %

Manual operation initial parameters is to be changed. Level: [ ] d... (Increment: [ ] )

#### 4.4.2.5 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.

#### 4.4.2.6 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.

#### 4.4.2.6.1 Excite from the initial level at shifting spots

##### (1) Meaning

After this check box is checked, excitation level of a spot is set to that of the initial parameter of manual operation after the spot is shifted. If the check box remains unchecked, excitation level is set to that of previous spot.

Spot reference definition
✕

N..	Frequen...	Level	Stay time	Abort uppe...	Abort lower...	Alarm uppe...	Alarm lower...
1	200.00 Hz	100.0 m/s <sup>2</sup> 0-p	0:10:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
2	10.00 Hz	2.5330 mm p-p	100 cycle	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
3	500.00 Hz	5.0 m/s 0-p	300 kcycle	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB

Frequency  Hz CALC(X)...

Acc.  
  Vel.  
  Disp.  
  m/s<sup>2</sup> 0-p

Abort upper limit  dB  
 Alarm upper limit  dB  
 Add

lower limit  dB  
 lower limit  dB  
 Insert

Stay time  By time Change

Auto generation condition of spot by profile Define(G)... Clear(E)

Test time

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

Manual operation initial parameters is to be changed.  
 Level  dE (Increment  )

Excite from the initial level at shifting the spots.

All spots clear(L)

Delete(D)

↑

↓

Drive reference

Alarm check

Check by lower limit

Load CSV file(C)...

Refer

Register

OK

Cancel

#### 4.4.2.7 Load CSV file

This function is valid when the controlled variable is specified among “acceleration / velocity / displacement”.

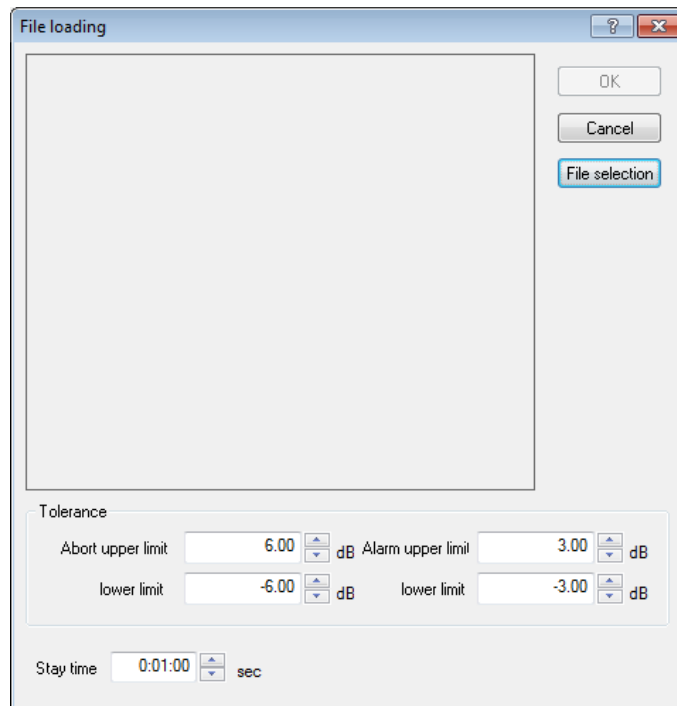
The control reference is defined by the CSV file of the specific format.

##### 4.4.2.7.1 Load the data file

###### (1) Meaning

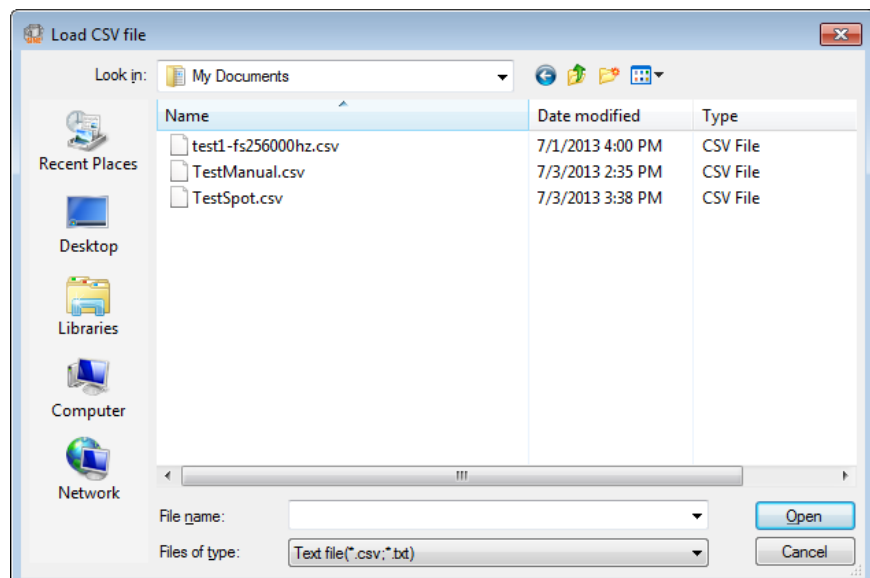
Select a CSV data file to be used as a control reference.

Press the button of [Load CSV file] button. Then the dialog as below appears.

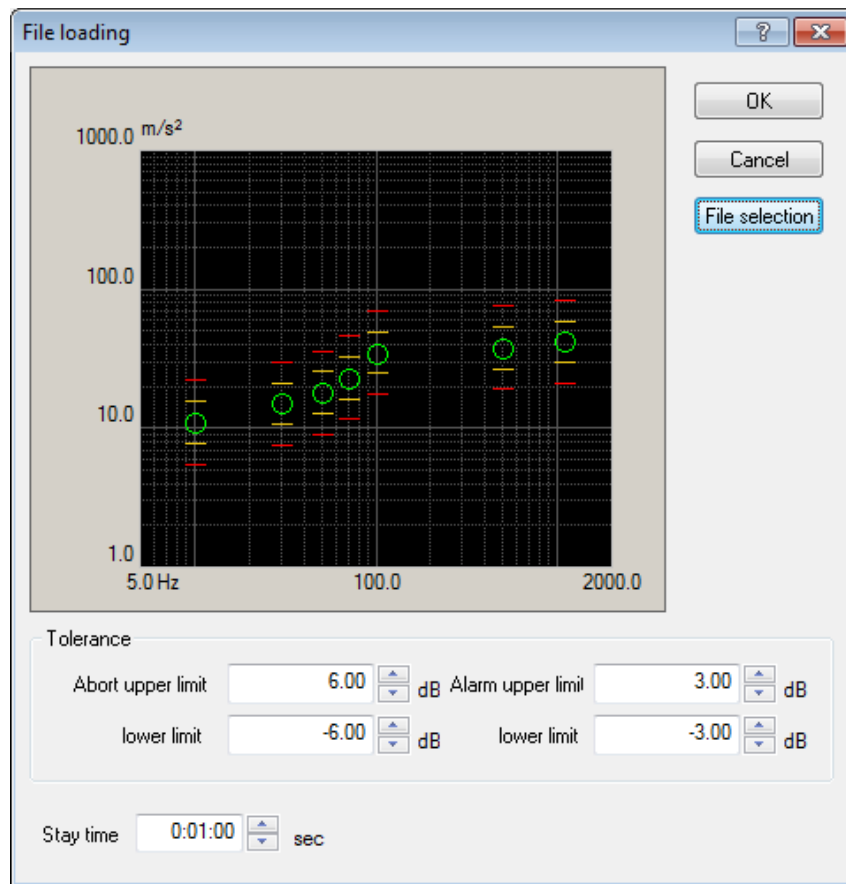


Press the button of [CSV file].

The dialog box to select a CSV file is opened.



After loading the selected CSV file, the graph of control reference is displayed.



#### 4.4.2.7.2 Setting of Tolerance / Stay time

##### (1) Meaning

Tolerance and stay time of control reference is to be defined.

Stay time can be set only by time.

Also, the defined tolerance and stay time are used for all the spot elements as default setting.

To set the different values for each spot, the values can be changed in the dialog of spot reference definition as below after setting the control references once in this mode.

N.	Frequen...	Level	Stay time	Abort upper...	Abort lower...	Alarm upper...	Alarm lower...
1	200.00 Hz	130.0 m/s <sup>2</sup> 0-p	100:00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
2	10.00 Hz	25.0 mm g-p	1.00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
3	52.00 Hz	30.0 m/s 0-p	1.00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB
4	100.00 Hz	188.4956 m/s 0-p	20:00:00	6.00 dB	-6.00 dB	3.00 dB	-3.00 dB

Frequency: 100.00 Hz  
Level: 188.4956 m/s 0-p  
Stay time: 20:00:00 By time

Abort upper limit: 6.00 dB, lower limit: -6.00 dB  
Alarm upper limit: 3.00 dB, lower limit: -3.00 dB

Auto generation condition of spot by profile: Define(G)... Clear(E)  
Test time: Once  
 Not stop the signal at shifting the spots when the condition is ready.  
 Manual operation initial parameters is to be changed.



### 4.4.2.7.3 CSV file format

(1) Meaning

The format of CSV file described as below.

1st column Frequency(Hz),	2nd column Physical quantity code	3rd column Level data
***.***,	***.***,	***.**
***.***,	***.***,	***.**
***.***,	***.***,	***.**
:	:	:
***.***,	***.***,	***.***

- Frequency data is specified in the 1st column. The unit is [Hz].
- Physical quantity code is specified in the 2nd column. The physical quantity data code is selected among the capital alphabet letter of one-byte character below;  
A : acceleration, V : velocity, D : displacement
- Level data is specified on the 3rd column. The defined unit in “Fundamental/control condition” is used as the unit of each physical quantity. Also, the level data of displacement is specified as “p-p” while the others are “0-p”.

For example, the case when the control reference having 3 spot elements is to be defined;

- 1) 100Hz, acceleration 10m/s<sup>2</sup><sub>0-p</sub>
- 2) 5Hz, Displacement 25mm<sub>p-p</sub>
- 3) 15Hz, velocity 0.5m/s<sub>0-p</sub>

In this case the CSV file format is described as;

100, A, 10  
5, D, 25  
15, V, 0.5

Here, the defined unit in Fundamental/control condition is “acceleration [m/s<sup>2</sup>], velocity [m/s], displacement [mm]”.

### 4.4.3 Manual Test

#### (1) Outline

This item is for defining the control reference of Manual test.

Manual test is a special method of test operation in which this system is started by manual operation only. Therefore, this test has the different character from the other types of tests that is executed according to the defined control reference condition of the test definition set previously.

In manual test, the definition condition can be changed arbitrarily during the test operation. The following explanations are for setting of the initial values of the reference.

The characteristic functions of manual mode are described as below ;

- ① Basically, the action specified in this mode is similar to that of the spot test. However, scheduling the spots (the spot sequence and its repetition) cannot be operated.
- ② Instead, the excitation frequency can be changed by manual in addition to the level changing by manual.
- ③ Sweeping operation such as a sweep test is impossible.
- ④ The setting method of the reference level is simple. So the condition can be changed quickly. The reference level can be set by the unit used in definition or by the drive value (when the drive value is used, the open-loop operation is executed.)  
When the unit used in definition is specified as one of 'Acceleration / Velocity / Displacement', the reference level can be selected to a one among 'Acceleration / Velocity / Displacement'.
- ⑤ Setting and managing of Test time are both impossible.
- ⑥ The calibration function for pickup sensitivity is provided in this mode.
- ⑦ Alarm / Abort check for the control response is not operated. However, Alarm / Abort check for the monitor response can be operated for each input channel.

One of the merits in Manual mode is mainly in its simplicity.

This mode is useful when the excitation is needed to be operated for a while on trial.

Manual reference

Frequency 100.00 Hz      Increment 1.00

Level  Acc.     Vel.     Disp.     Drive

10.0 m/s<sup>2</sup> 0-p      Increment 0.10

Auto shutdown frequency changing ratio 10.0 %

OK    Cancel    CALC(C)...    Refer    Register

#### **4.4.3.1 Frequency**

(1) Meaning

This item is for setting of the excitation frequency.

#### **4.4.3.2 Increment (Frequency)**

(1) Meaning

This item is for setting of the value for increasing and decreasing of the excitation frequency at the key operation for 1 time in Manual operation box.

#### **4.4.3.3 Level**

(1) Meaning

This item is for setting of the excitation level.

When the item of 'Drive' is selected, the control operation is not to be executed. That is, the open-loop operation is executed.

#### **4.4.3.4 Increment (Level)**

(1) Meaning

This item is for setting of the value for increasing and decreasing of the excitation level at the key operation for 1 time in Manual operation box.

#### **4.4.3.5 Auto shutdown frequency changing ratio**

(1) Meaning

This item is for stopping the excitation (shutting down the drive output) only when the changing ratio of excitation frequency exceeds over the set value of this item. And after shifting to the next frequency, the excitation is started from the loop check operation.

#### 4.4.4 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)

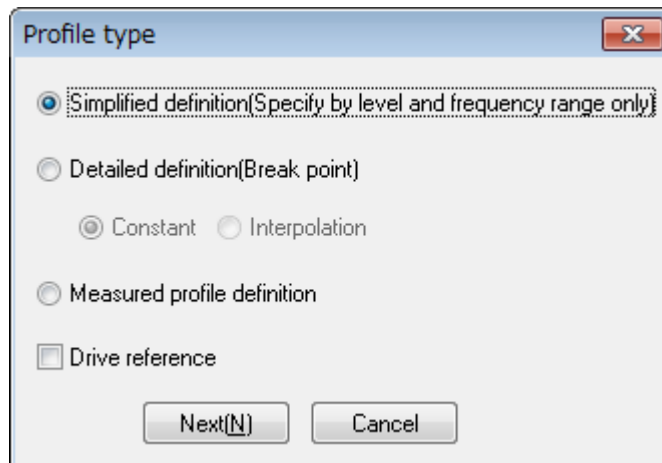
And detailed definition (break point) has two types of the definition method according to the types of data interpolation between the break points as below;

'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 ;



#### 4.4.4.1 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<sup>2</sup> 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<sup>2</sup> of acceleration.

However, in this case, ‘a certain frequency’ as in the above should be the frequency to have 20 m/s<sup>2</sup> 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.

The screenshot shows a 'Profile' dialog box with the following settings:

- Frequency range: 10.00 Hz to 2000.00 Hz
- Acc. (checked): 20.0 m/s<sup>2</sup> 0-p, frequency range 31.83 Hz to 2000.00 Hz
- Vel. (unchecked)
- Disp. (checked): 1.0 mm p-p, frequency range 10.00 Hz to 31.83 Hz

Buttons: OK, Cancel

#### 4.4.4.2 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'.

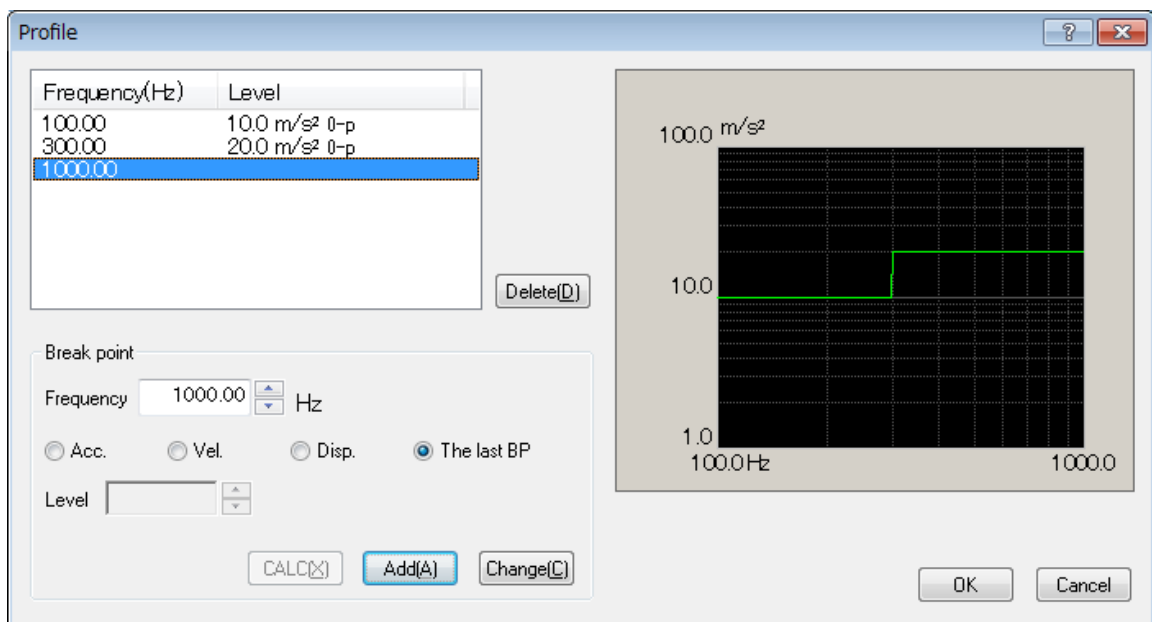
However, the same physical quantity as the specified one must be set when the other physical quantity than these values is specified.

<Example 1>

100[Hz]~300[Hz] : 10 [m/s<sup>2</sup>] Constant

300[Hz]~1000[Hz] : 20 [m/s<sup>2</sup>] Constant

1000[Hz] : The last break point



< Example 2 >

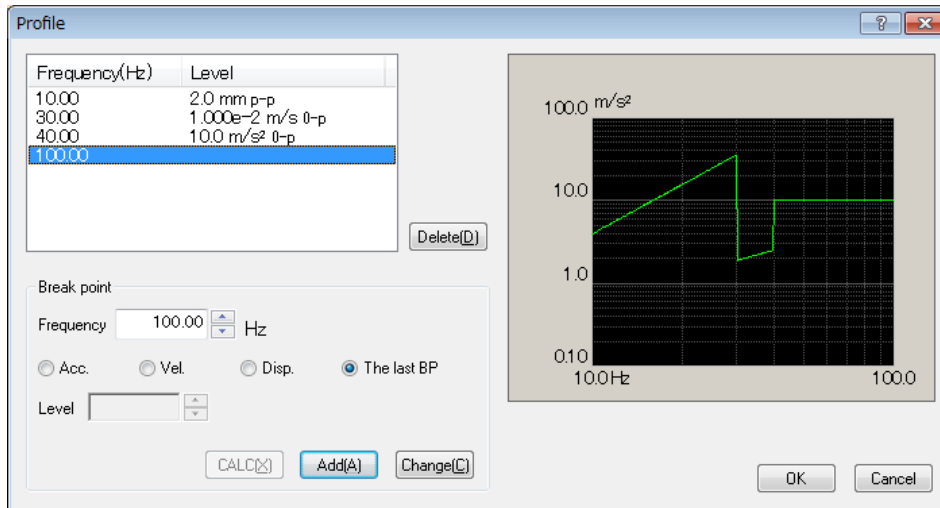
10[Hz]~30[Hz] : 2.0 [mm] Constant

30[Hz]~40[Hz] : 1.0 [cm/s] Constant

40[Hz]~100[Hz] : 10 [m/s<sup>2</sup>] Constant

100[Hz] : The last break point

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



#### 4.4.4.2.1 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 assessed as a break point data.

#### 4.4.4.2.2 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 button of [CALC]. Refer to "4.4.6 CALC Function" about the details.

#### 4.4.4.3 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.

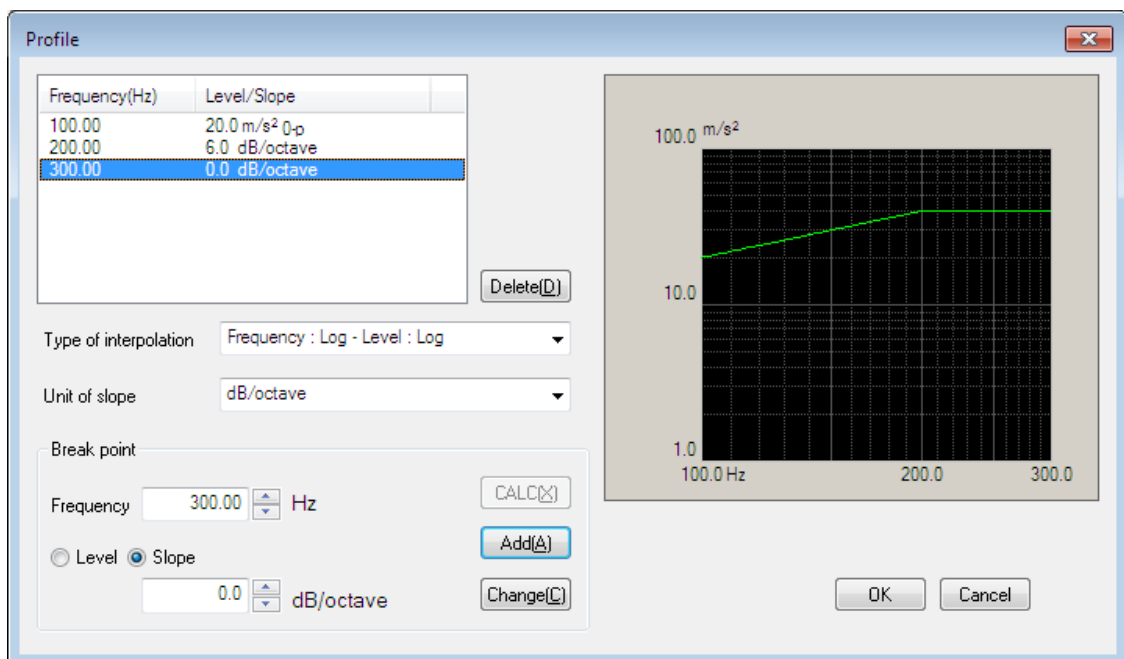
The test in which the quantity is defined by acceleration in the B.P. Connect profile is also called 'Acceleration break point test'.

< Example >

100[Hz] : 2.0 [m/s<sup>2</sup>]

200[Hz] : 6 [dB/octave]

300[Hz] : 0 [dB/octave]





#### 4.4.4.3.1 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

#### 4.4.4.3.2 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'

#### 4.4.4.3.3 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.

#### 4.4.4.3.4 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 button of [CALC].

Refer to "4.4.6 CALC function" about the details.

#### **4.4.4.3.5 Break Point / Slope (Interpolation)**

##### (1) Meaning

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

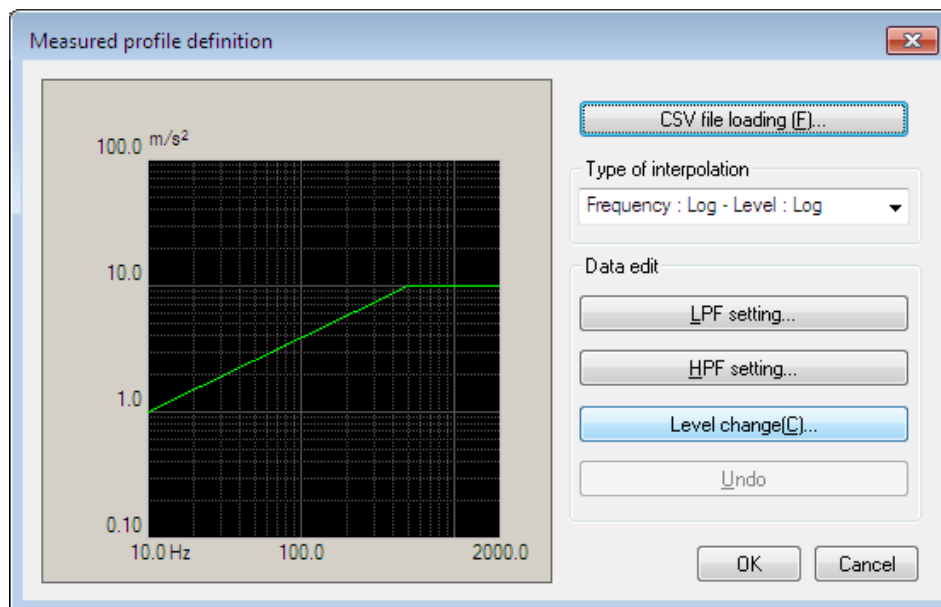
The slope value can be inputted to this item by pressing of the button of [Slope].

#### 4.4.4.4 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. Refer to “4.4.4.4.5 CSV data file (Measured profile)” about the format in detail.

##### 4.4.4.4.1 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.

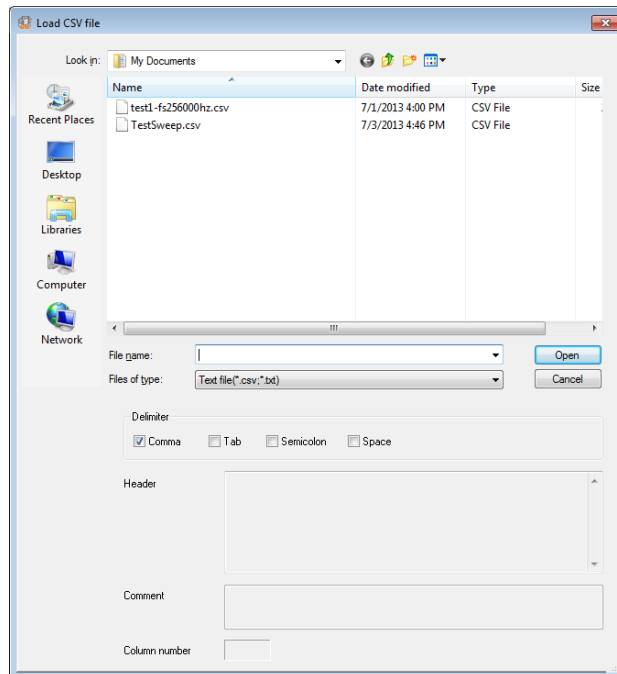
[Undo] : This button is for canceling the editing operation by these buttons in the above and returning to the former state.

#### 4.4.4.4.2 Load the Data File

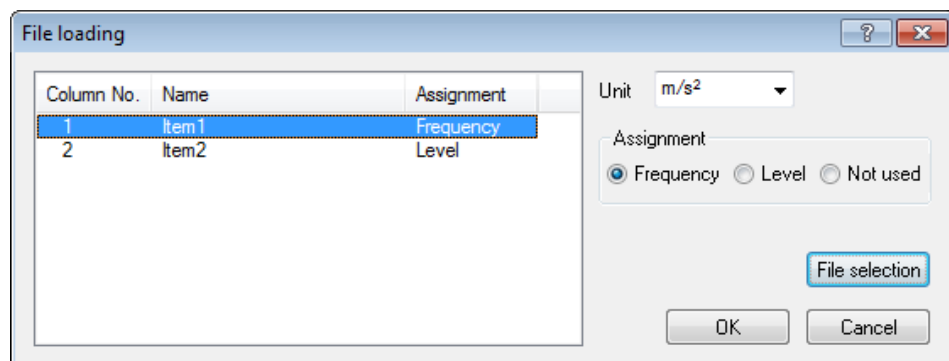
##### (1) Meaning

CSV Data File used as the reference profile is selected.

When the button of [CSV File open] 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.

#### 4.4.4.4.3 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

#### 4.4.4.4.4 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.

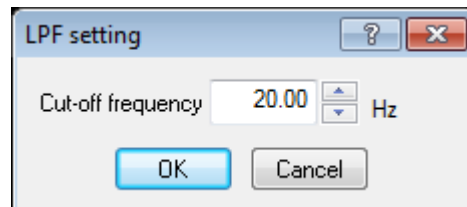
Select a necessary button to process the data, as you need.

##### 4.4.4.4.4.1 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

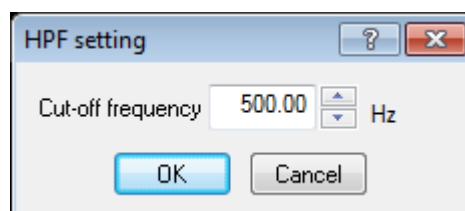
Input the value of cut-off frequency for filtering process.

##### 4.4.4.4.4.2 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

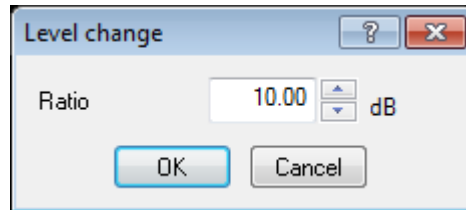
Input the value of cut-off frequency for filtering process.

#### 4.4.4.4.3 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.

#### 4.4.4.4.5 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	$\Delta f$ ,	***.***,	***.**,	.....
	$2\Delta f$ ,	***.***,	***.**,	.....
	:	:	:	:
	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.

#### 4.4.5 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).

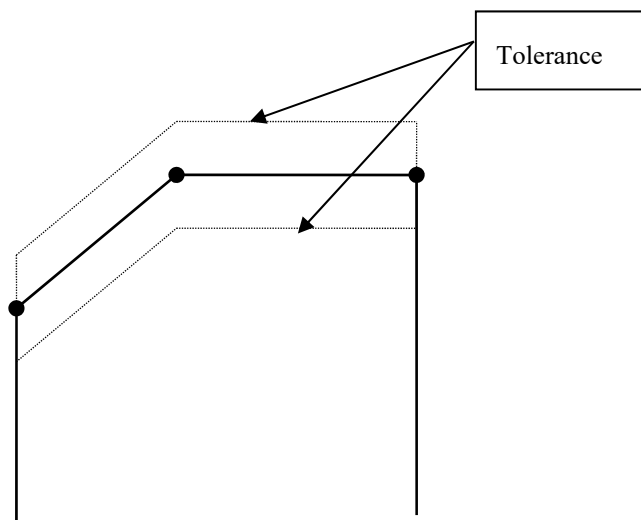
Therefore, the condition for continuing the testing such a case is needed to be defined in advance. This judgment criterion is called Tolerance in this system.

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.



#### 4.4.5.1 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.

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

The screenshot shows a dialog box titled "Tolerance definition". It has a standard Windows-style title bar with a question mark icon and a close button. The main area contains the following elements:

- "Abort check" label with an unchecked checkbox.
- "Alarm check" label with a checked checkbox.
- "Upper limit" label followed by a text box containing "6.00" and a "dE" unit label.
- "Lower limit" label with a checked checkbox, followed by a text box containing "-6.00" and a "dE" unit label.
- A checkbox labeled "Set the upper limit and lower limit symmetry." which is checked.
- Three buttons on the right side: "OK", "Cancel", and "Detailed[D] >>".



#### 4.4.6 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 >

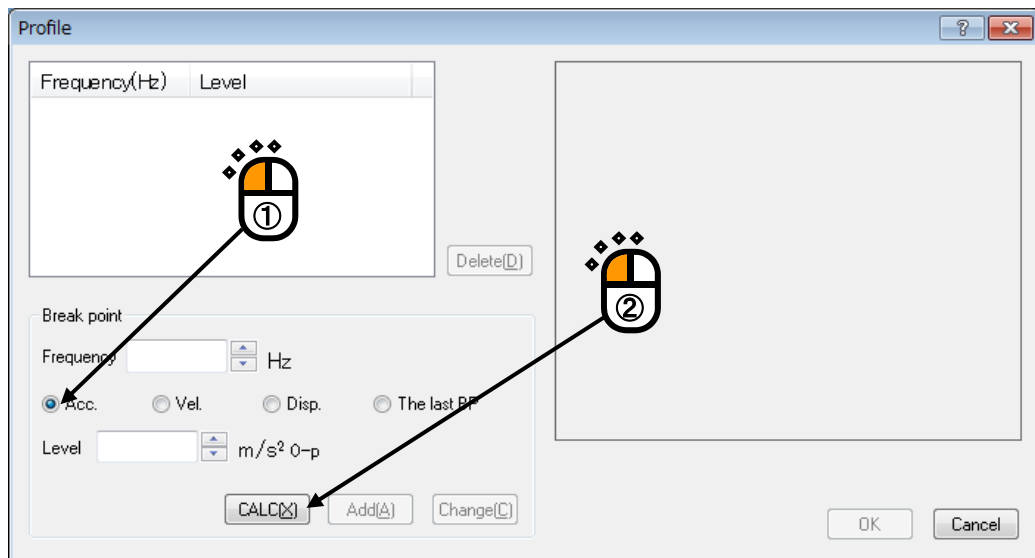
The setting of items as ‘Sweep reference – Detailed definition (break point) – Constant’ are executed.

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 >

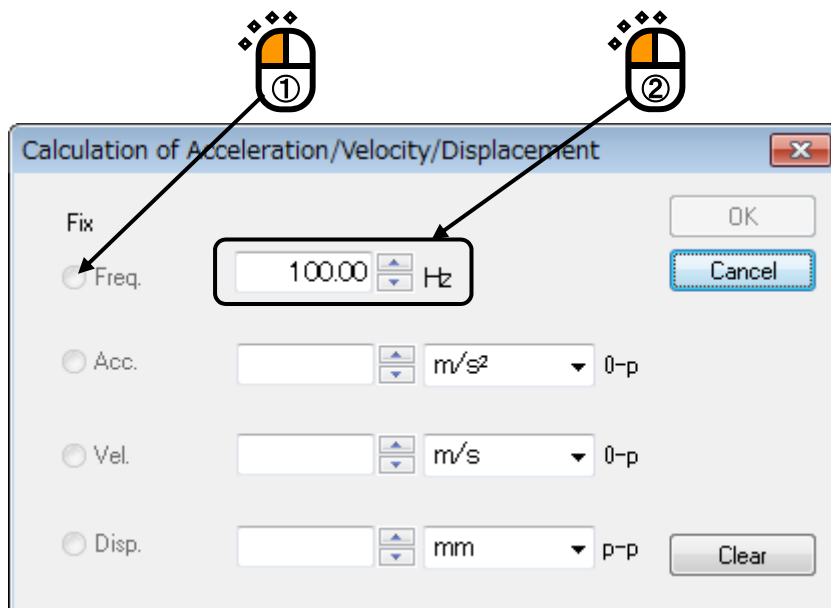
< Step 1 >

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



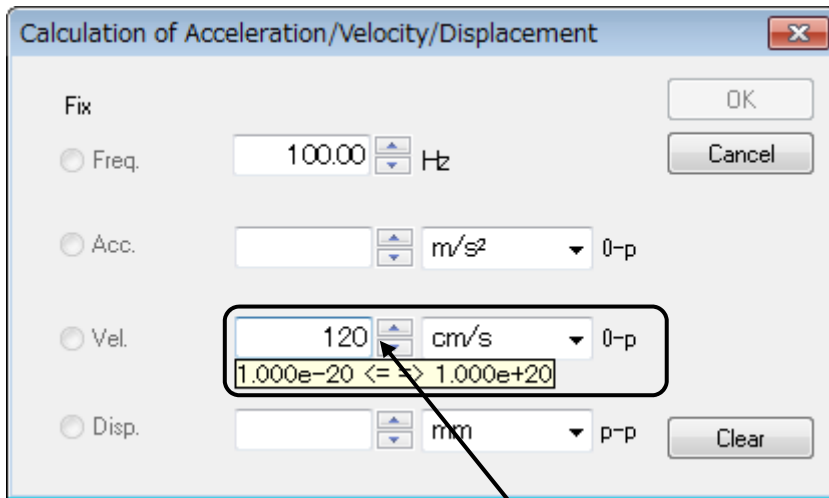
< Step 2 >

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



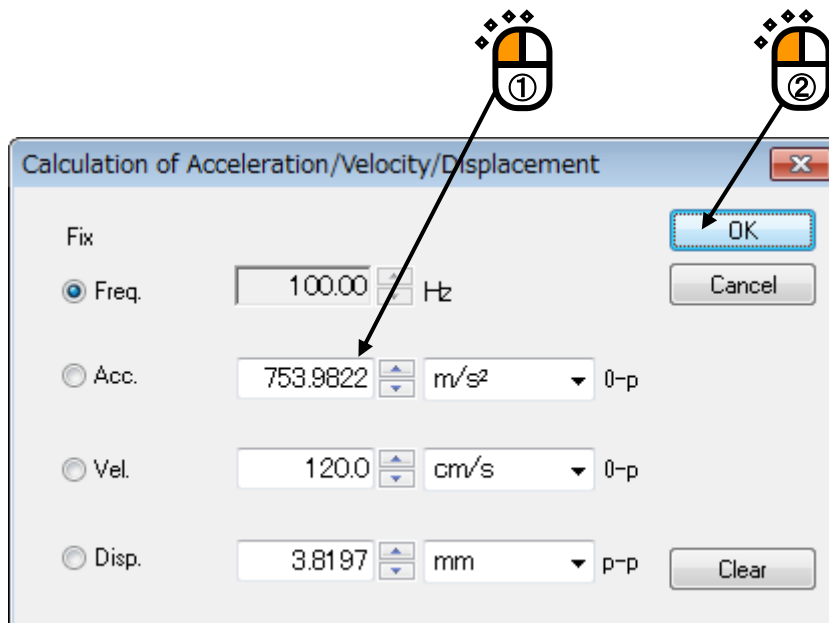
< Step 3 >

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



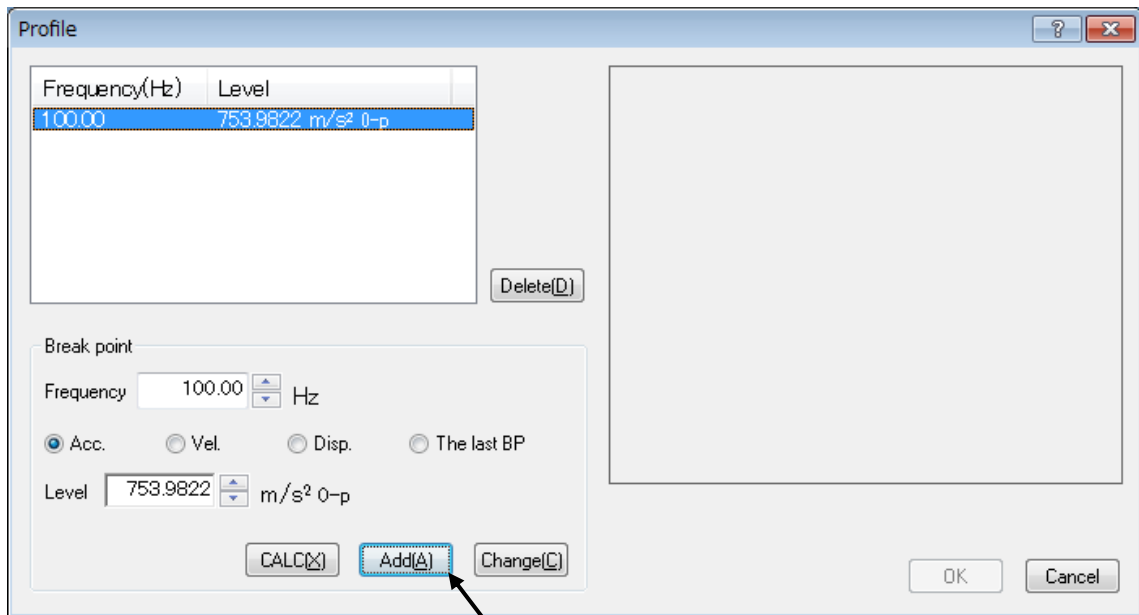
< Step 4 >

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



< Step 5 >

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



## 4.5 Input Channel

### 4.5.1 Outline

In this system, there are two types of response input channels;

- Control channels
- Monitor channels

In this system, all of the used input channels are defined as Monitor channels.

Therefore, Control channels also have the function as Monitor.

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

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 arbitrary to the one among Acceleration / Velocity / Displacement. (The control unit specified in Fundamental Condition decides the graph of Control channel.)

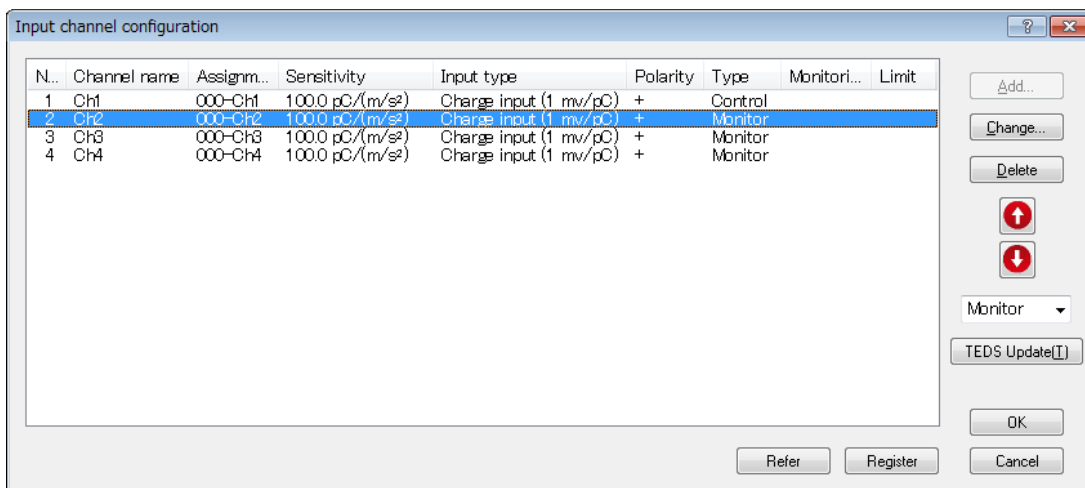
### 4.5.2 Input Channel

Input channels to be used are defined in the dialog of Input Channel.

There are two methods of input channel definition as below ;

Define the input channel at each Test Definition.

Define the Input Channel Information.



[Add] : This item is for adding a new input channel.

[Change] : This item is for changing the contents of a selected input channel.

[Delete] : This item is for deleting the selected input channel from the record.

[Up] [Down] : This item is for changing the order of the registered input channels.

The order of registration is only concerned with the graph display.

[Not used] : The channel is not used.

[Monitor] : This item is for specifying of a channel as Monitor.

- [Control] : This item is for specifying of a channel as Control.
- [TEDS Update]: The input sensitivity is set from the connected TEDS corresponding IEPE sensor automatically. The function is enabled with the TYPEII hardware.
- [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 Resonance dwell

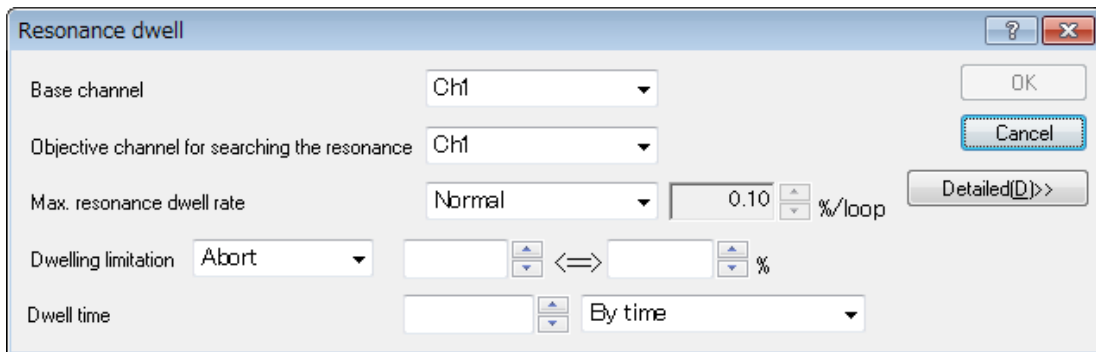
This function is an optional function for Sine Vibration Test System K2+/SINE.

‘Resonance dwell Function’ is for operating the control that seeks the resonance existing in the sweep band at the Swept sine vibration test, and when the resonance is found, the function continues the excitation for set time at the resonance frequency. And if the resonance frequency changes during the operation, the function continues the excitation by tracking the change and following the resonance.

The detecting method of the resonance adopted in this system is based on the orthodox method in which the frequency with the phase difference  $90^\circ$  between the response point as base and the response point for the resonance search is to be detected.

The same observed physical quantity should be used at the response point as base and the response point for the resonance search. However, the observed physical quantity of the response point for the resonance search can be specified to one of Acceleration / Velocity / Displacement when the observed physical quantity of the response point as base is specified among Acceleration / Velocity / Displacement. In this case, the resonance point is calculated by converting the data at each response point to the same physical quantity (acceleration).

‘Tracking function’ is internally used for detecting the phase difference of the ‘Resonance dwell’ function. However, the response estimation method can be selected independently to operate the control itself from ‘Tracking’, ‘Epavg (absolute averaged value)’ or ‘Eprms (rms value)’.



### 4.6.1 Base channel

#### (1) Meaning

This item is for setting of a signal input channel of the response point as base.

Only the channel names defined in Input Channel are available to set to this item. A Control channel is also available.

### 4.6.2 Objective channel for searching the resonance

#### (1) Meaning

This item is for setting of the signal input channel of the response point for the resonance search point. As same as a base channel, the channel number defined in Input Channel can be set. However, the channel name which has already set as a ‘base channel’ can not be specified. The observed physical quantity of search channel should be the same as that of the base channel specified. When the controlled variable and the observed physical quantity of the base channel are specified as one of Acceleration / Velocity / Displacement, the search channel can be selected from among the channels having the observed quantities as Acceleration / Velocity / Displacement.

#### **4.6.3 Max. resonance dwell rate**

(1) Meaning

This item is for setting of the speed for dwelling the resonance frequency change during the resonance dwell function is operated. Max. resonance dwell rate can be selected from among Normal / Fast / Slow / Specify. 'Specify' indicates that what percentage of the resonance point is to be dwelt at the maximum corresponding to the original frequency for one control loop.

#### **4.6.4 Dwelling Limitation**

(1) Meaning

This item is for limiting the frequency band for dwelling the response frequency change during the resonance dwell function is operated. When the frequency exceeds over the specified limit, the system aborts not only dwelling of the resonance but also operating the test.

[No limitation] : Limitation for dwelling of the resonance is not set when this item is selected.

[Limit operation] : Dwelling of the resonance is operated within the set frequency band (ratio). When the resonance frequency exceeds over the set frequency band during the resonance dwell, the resonance dwell is aborted at the upper or lower limit of frequency band. And the excitation is continued at the frequency.

[Abort] : When the resonance frequency exceeds over the set frequency band (ratio) during the resonance dwell, the test operation itself is aborted.

#### **4.6.5 Dwell time**

(1) Meaning

When the resonance is found in the resonance search action, the resonance dwell operation is started and continued for the time defined in this item 'Dwell time'. 'Dwell time' is set by time or vibration counts.

The resonance dwell operation is executed for the set time of this item at each resonance detected.



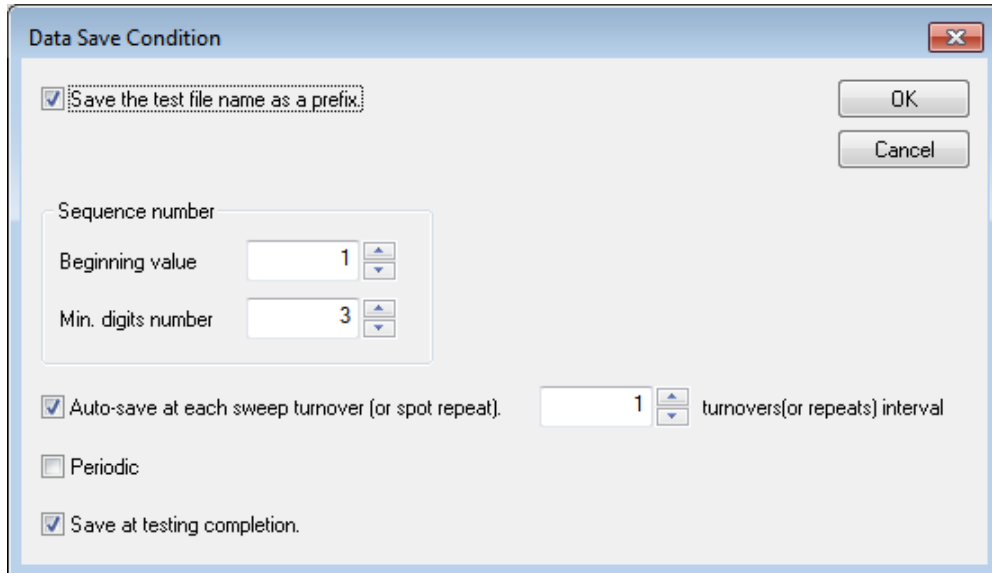
## 4.7 Data Save Condition

### 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 excitation' 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

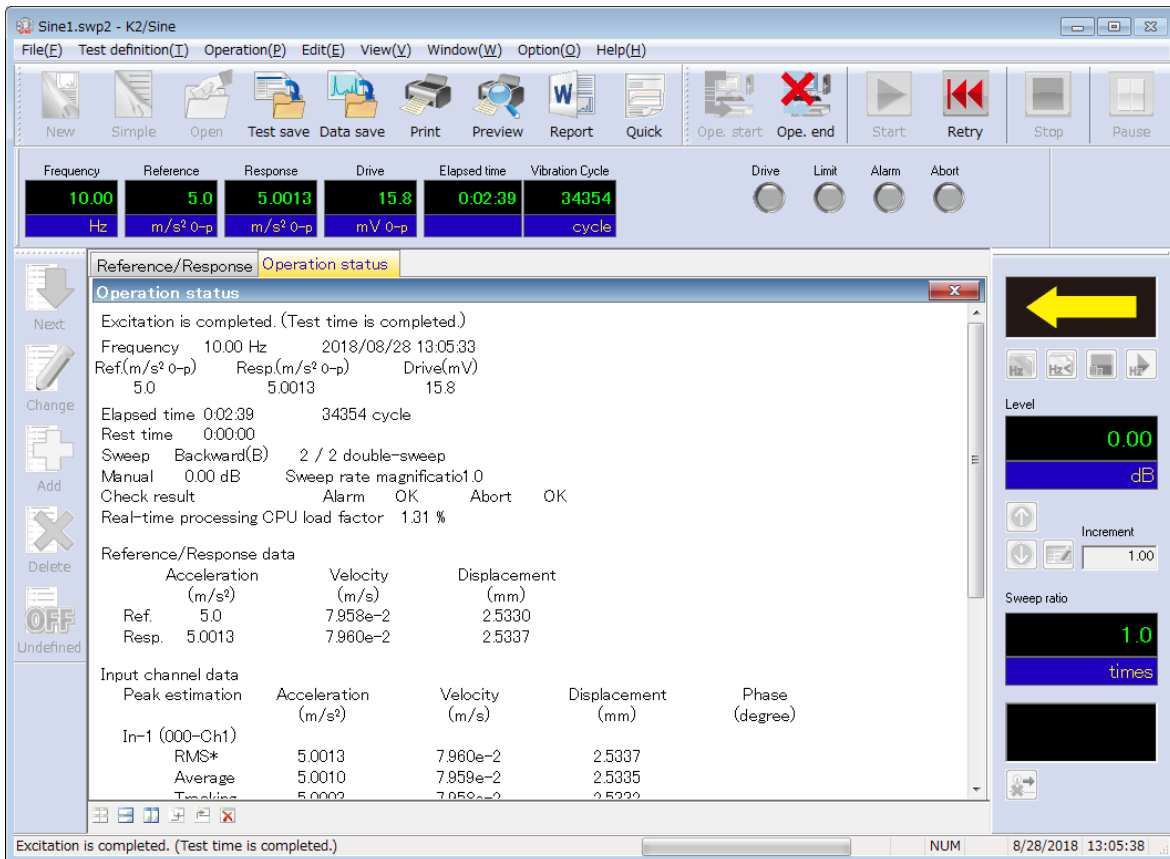
This item is for saving the data automatically when the test time is completed or when the test is aborted by a user.

## 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) Reference

The current control reference level is displayed.

#### 4) Response

The current response level is displayed.

#### 5) Drive

The current drive output voltage actually outputted is displayed.

In the current control loop, the drive output voltage that should be outputted as an ideal and the ratio of its voltage to the maximum drive output voltage (called as 'For limit ratio') are displayed.

In this item, the drive output voltage may exceed over the maximum drive voltage because the displayed voltage value is an ideal value of the drive output voltage that should be outputted.

However, the actual output does not exceed over the maximum value.

The value of 'For limit ratio' indicates the ratio to the drive output voltage that should be outputted as an ideal. The voltage may exceed over 100 %.

When the drive output voltage exceeds over the check rate, the excitation is stopped and 'Abort' is displayed at the right side of this item.

#### 6) 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.

#### 7) Rest time

The time until the test is completed is displayed.

Rest time is displayed when test time is specified by "the times of single-sweep", " the times of double-sweep" or " the vibration cycle "

#### 8) Sweep

Sweep direction and sweep times at present are displayed.

#### 8a) Spot

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

#### 9) Resonance dwell (segment #) : Phase # degree[ ]

The number of the current resonance dwell segment is displayed. Phase indicates the phase difference between the base channel and the Search channel for resonance search, and the phase difference defined for resonance search is displayed in 'degree[ ]'.

When the system operates the test at the frequency in which resonance search is not executed, 'Out of Resonance dwell segment' is displayed.

#### 10) Searching

When the resonance point is found, the resonance dwell action is executed with showing the display as 'Dwelling'. On the side of this display, the elapsed time and the vibration cycles of dwelling are displayed. The remaining of the defined dwell time is displayed also. During the resonance search, 'Searching' is displayed instead of 'Dwelling'.

11) Number of resonance dwell

Total times of the resonance point dwelled in the current sweep and that dwelled in prior sweep is displayed.

12) 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.

13) 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.

14) Real-time processing CPU load ratio

The current CPU load ratio is displayed.

15) 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.

16) 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.

17) 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.

## 4.9 Aux. Output

### 4.9.1 Outline

Aux-output is a function for real-time outputting the information for the control operation as analog signal in addition to the outputting the drive signal for control.

The following output information can be outputted as Aux- output ;

- (1) DC voltage which indicates the quantities as follows (Log / Linear)
  - Excitation frequency
  - Control response level for each input channels
  - Drive voltage level
  - Monitor response level for each input channel
- (2) Sine signal constant level which indicates the excitation frequency at each moment (OCS.OUT)

### 4.9.2 Fundamental Operation Example

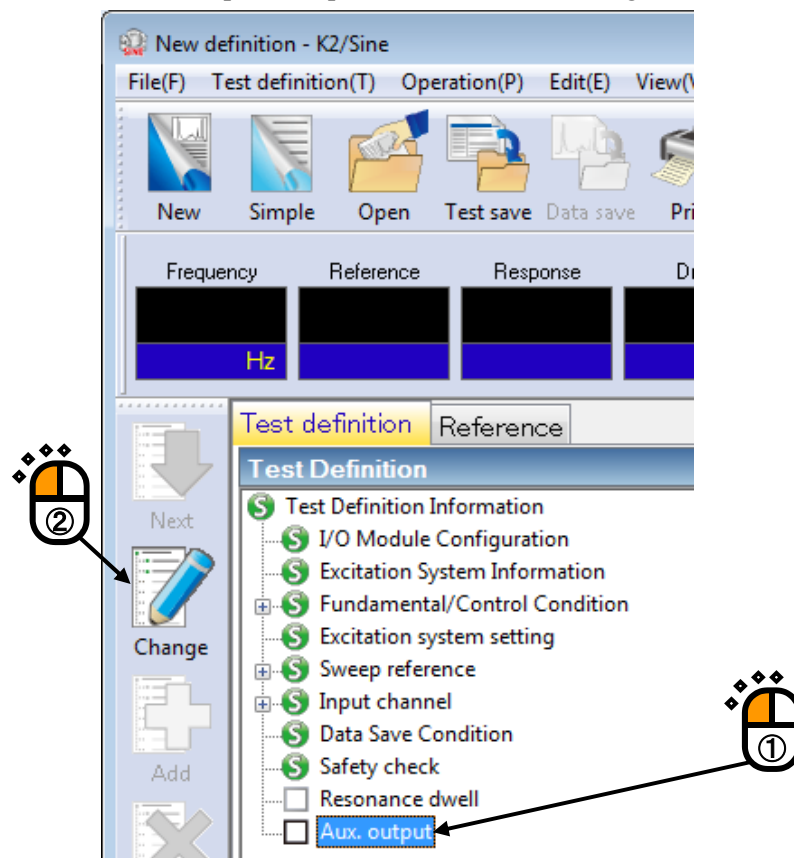
< Example >

Monitor response level (unit : acceleration, range : 1 ~ 100[m/s<sup>2</sup>]) of input channel Ch2 is to be outputted as DC voltage (range : 0 ~ 100[mV], log) . However, output channel Ch2 is used as an Aux-output.

< Procedures >

< Step 1 >

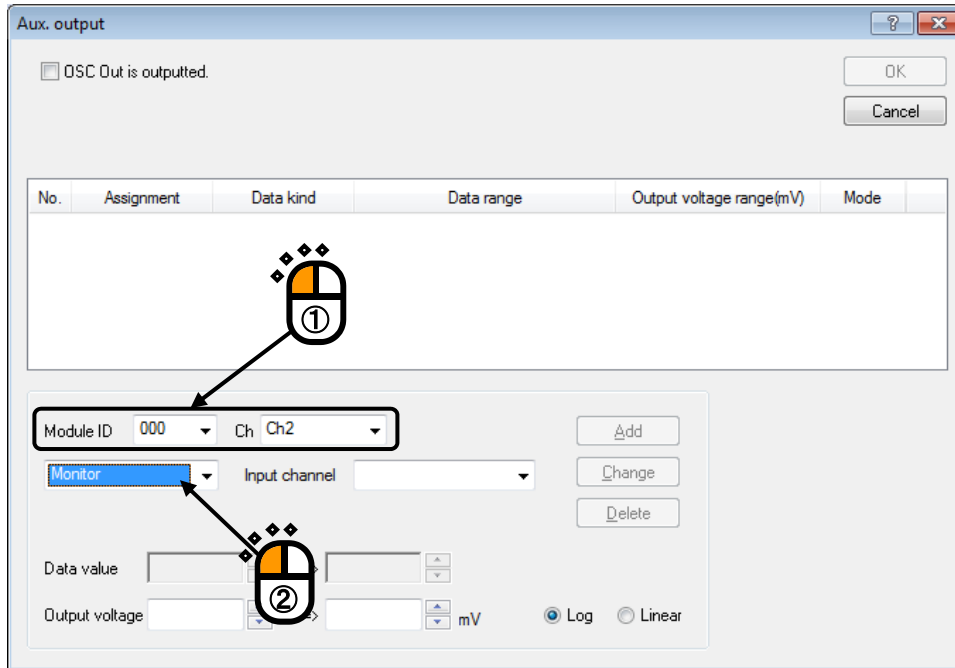
Check the check box of 'Aux. output' and press the button of [Change].



< Step 2 >

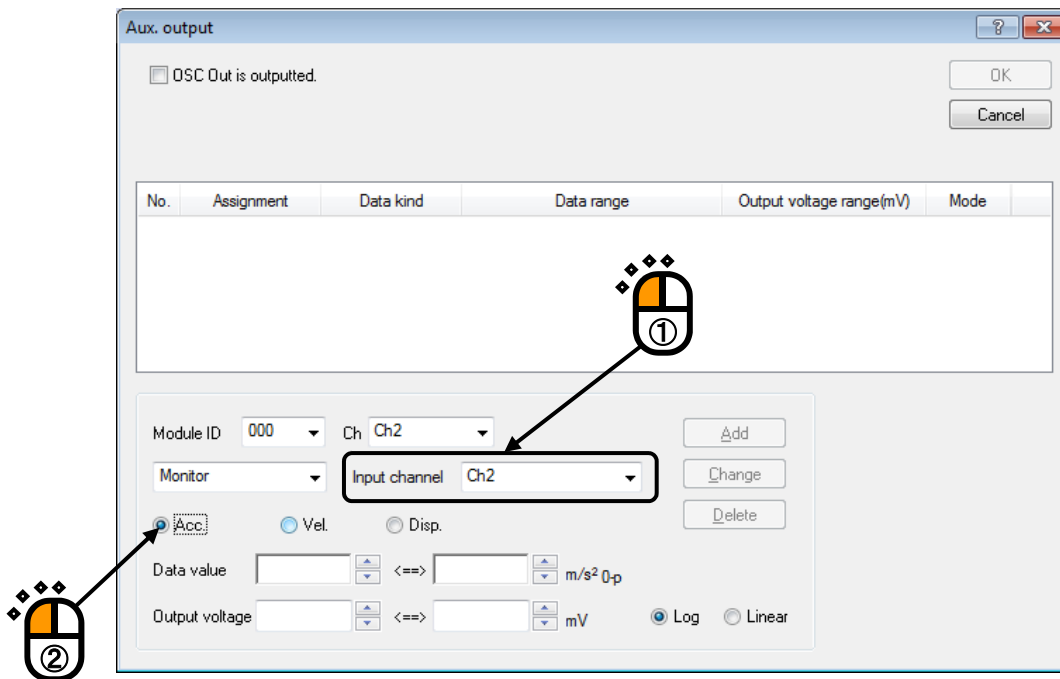
Set the 'Module ID' of I/O board and output channel 'Ch2'.

Select the item of 'Monitor'.



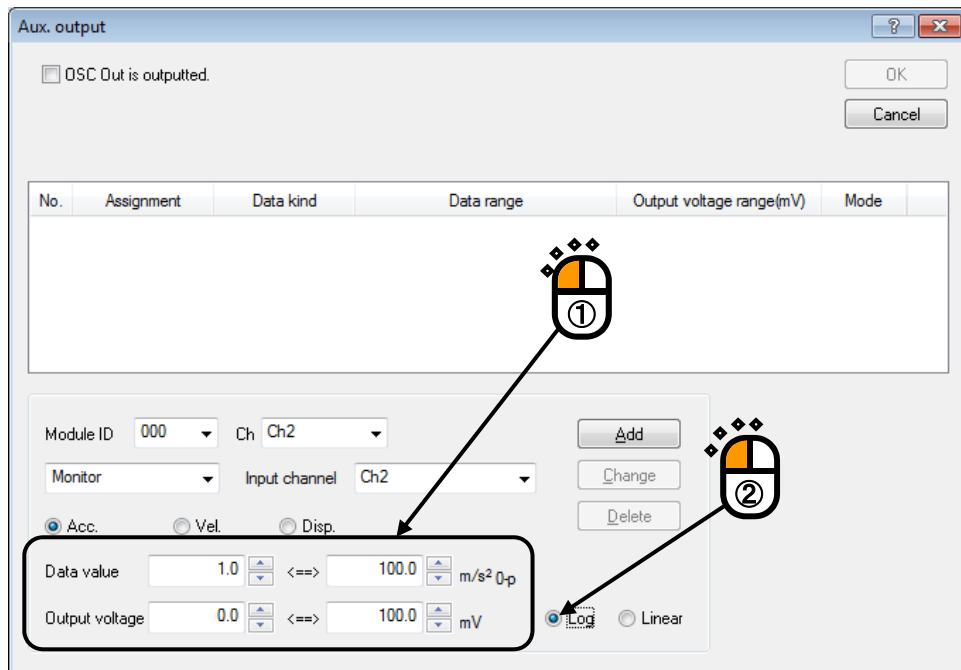
< Step 3 >

Set 'Ch2' to input channel and select the item of 'Acc. (Acceleration)'.



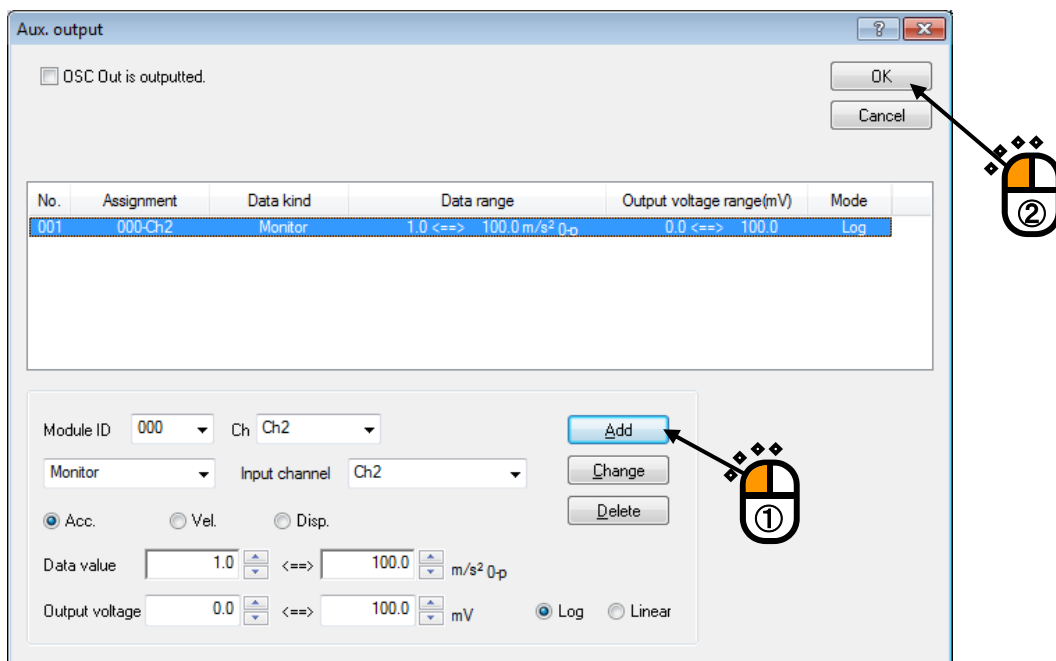
< Step 4 >

Input the values to Data range (1 ~ 100 [m/s<sup>2</sup>]) and DC Output voltage range (0 ~ 100 [mV]).  
Select the item of 'Log'.



< Step 5 >

Press the button of [Add]. Exit from the definition of Aux-output by pressing the button of [OK].





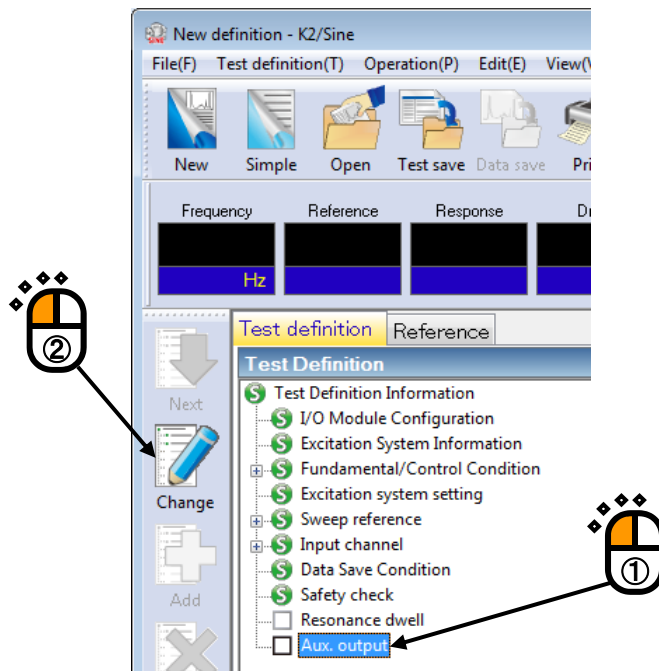
< Example >

The setting of output channel Ch2 to execute the oscillator output (amplitude : 1000 [mV]) is to be explained as below ;

< Procedures >

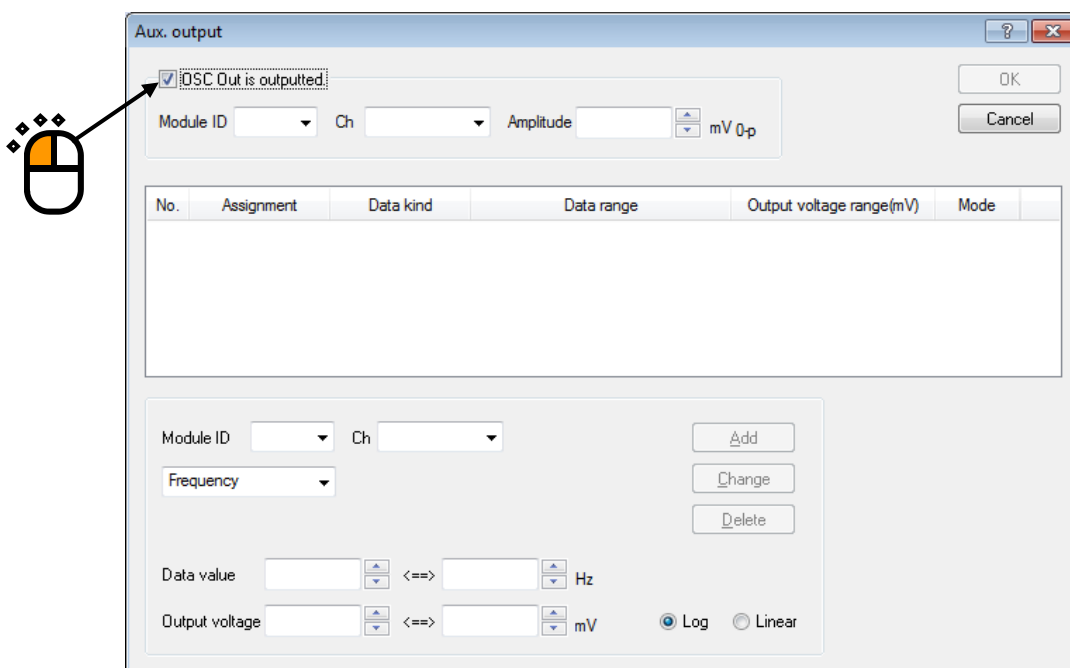
< Step 1 >

Check the check box of 'Aux. output' and press the button of [Change].



< Step 2 >

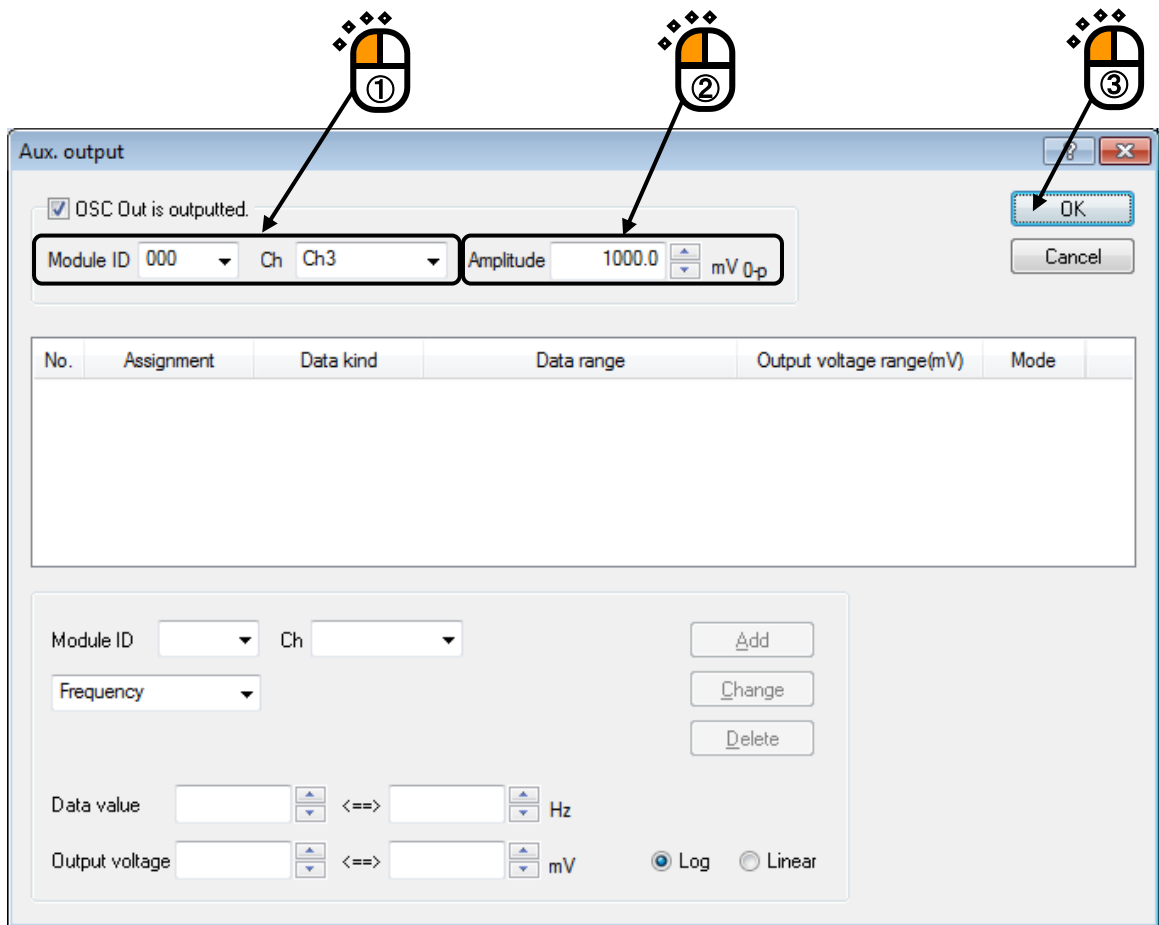
Check the check box of 'OSC Out is outputted.'.



< Step 3 >

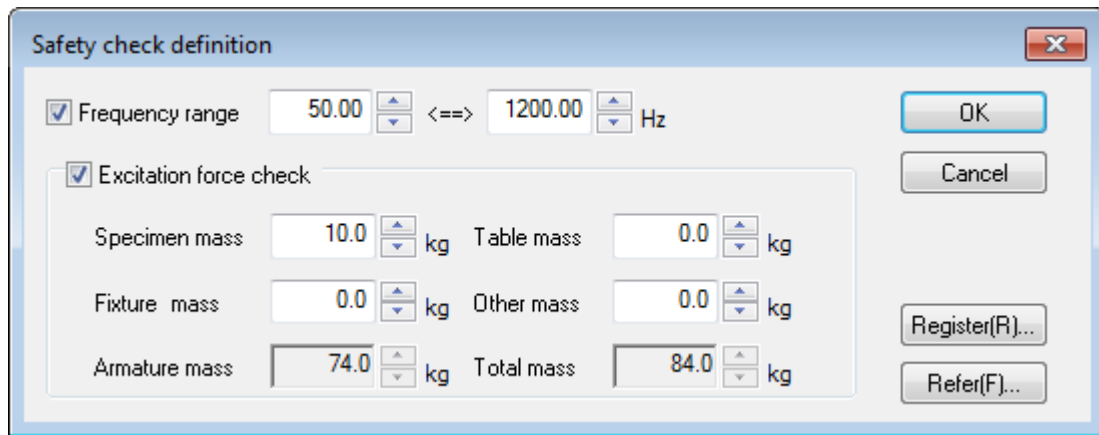
Set the 'Module ID' of I/O board and output channel 'Ch2'.

Input the value of Amplitude as 1000.0 [mV] and press the button of [OK].



## 4.10 Safety check

### 4.10.1 Outline



The system has the feature of Rating check\*<sup>1</sup> to evaluate whether the defined test can be performed on the excitation system as a protective feature. The safety check expands this protective feature and makes it possible to use the excitation system more safely.

#### (1) Excitation force check

This check is made to evaluate whether the excitation force required for the test is held within the excitation system rating.

The excitation force  $F$  required for the test is calculated with the formula shown below.

$$F = M a$$

$a$ : peak value of reference acceleration

$M$ : Total mass

The total mass  $M$  is the sum of “Specimen mass, Table mass, Fixture mass and Other mass” entered in this dialog box and the “Armature mass” specified in the system rating information.

The excitation force check is effective only if the controlled variables were the acceleration, velocity and displacement.

#### (2) Frequency range check

This check is made to evaluate whether the frequency range of reference is within the usable frequency range.

Although there is a similar protective feature of “control frequency range” setting in the excitation system information, this is a feature to perform this check for each test.

While the usable frequency range for the excitation system is defined, it may be limited depending on the characteristics of specimen and fixture etc.. Use this feature in such cases.

[Refer] : The registered definition contents of Safety check is loaded and used.

[Register] : The defined contents of Safety check is saved and registered as a file.

\*1 Feature of standard rating check

- 1) This check is made to evaluate whether the reference level is held within the excitation system rating. If the controlled variables were the acceleration, velocity and displacement, the check is made for the three variables.
- 2) If a “control frequency range” was specified in the excitation system information, a check is made to evaluate whether the frequency range of reference is within the “control frequency range.”

Note)

When specimen and/or fixture is attached to the armature, it may occur that the required acceleration level can not be reproduced within the usable frequency range because of resonance or anti-resonance of the attached specimen and / or fixture.

# Chapter 5 Messages and Meanings

## 5.1 K2+ Sine Error Messages

Message	Meaning / Action
<ul style="list-style-type: none"> <li>• Unusual phenomenon is detected by Pre-check.</li> </ul>	<p>(Meaning)</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>(Action)</p> <p>Check the following points at first.</p> <ul style="list-style-type: none"> <li>• Mistake in system cabling</li> <li>• Incorrect definition of I/O channel information, such as sensitivity and input format.</li> <li>• Cable disconnection</li> <li>• Incorrect installation of the pickups</li> <li>• Unusual condition of the excitation system.</li> <li>• Unusual condition of the specimen.</li> </ul> <p>After checking the points in the above, the treatments for each error are to be done according to the specified numbers.</p> <p>[1] Set the check standard of Pre-check in Excitation System setting to 'Loose'.</p> <p>[2] Increase the value of initial output voltage in Excitation System setting.</p> <p>[3] Decrease the value of initial output voltage in Excitation System setting.</p> <p>[4] Change the frequency of Pre-check in Excitation System setting.</p> <p>[5] Increase the response upper limit value of Pre-check in Excitation System setting.</p> <p>[6] Set the check standard to 'Specify' and increase the upper limit value of environment noise of Pre-check in Excitation System setting.</p>

Message	Meaning / Action
	<p>[7] Set the check standard to 'Specify' and increase the value of response linearity check of Pre-check in Excitation System setting.</p>
<p>• Unusual phenomenon is detected by Loop Check in excitation.</p>	<p>(Meaning)</p> <p>The test operation is aborted by the loop check which observes the response characteristics of controlled system in operation. The content of error is displayed at the input channel having the error in Operation status.</p> <p>A) Loop open is detected at the excitation operation [1] Sudden decrease of response characteristics is judged as an unusual phenomenon in operation.</p> <p>B) Too much response is detected at the excitation operation [1] Sudden increase of response characteristics is judged as an unusual phenomenon in operation.</p> <p>C) Overload [1] [2] A signal having an exceeded level over the maximum input value of the hardware (at voltage input : <math>\pm 10V</math>, at charge input : <math>\pm 10000pC</math> or <math>\pm 1000pC</math>) is inputted to the input channel.</p> <p>(Action)</p> <p>Check the following points at first.</p> <ul style="list-style-type: none"> <li>• Mistake in system cabling</li> <li>• Incorrect definition of I/O channel information, such as sensitivity and input format.</li> <li>• Cable disconnection</li> <li>• Incorrect installation of the pickups</li> <li>• Unusual condition of the excitation system.</li> <li>• Unusual condition of the specimen.</li> </ul> <p>After checking the points in the above, the treatments for each error are to be done according to the specified numbers.</p> <p>[1] Set the loop check in Fundamental Condition to 'Loose'.</p> <p>[2] At charge input, set the input type of input channel to 'Charge input (10000pC0-p)AC'.</p>

Message	Meaning / Action
<ul style="list-style-type: none"> <li>• Aborted by Abort Check.</li> </ul>	<p>(Meaning)</p> <p>The test operation is aborted for an error detected by various abort checks in operation. The content of error is displayed in Operation status.</p> <p>A) Tolerance check error [1] [2] [3] [6] [7] [8] [9]  The test operation is aborted for an error detected by various Tolerance checks.</p> <p>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.</p> <p>(Action)</p> <p>Check the following points at first.</p> <ul style="list-style-type: none"> <li>• Mistake in system cabling</li> <li>• Incorrect definition of I/O channel information, such as sensitivity and input format.</li> <li>• Cable disconnection</li> <li>• Incorrect installation of the pickups</li> </ul> <p>After checking the points in the above, the treatments for each error are to be done according to the specified numbers.</p> <p>[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.</p>
<ul style="list-style-type: none"> <li>• Failed in acquiring the construction information of I/O unit.</li> <li>• Failed in setting of construction information of I/O unit.</li> </ul>	<p>(Meaning)</p> <p>An error is detected in initialization of I/O unit executed prior to the test operation.</p> <p>(Action)</p> <ul style="list-style-type: none"> <li>• The power of I/O unit is not set ON.</li> <li>• Between the PC and I/O unit is not connected.</li> <li>• Incorrect connection of I/O unit board.</li> <li>• Incorrect connection of K2+ I/F board.</li> <li>• Incorrect action of Driver.</li> </ul> <p>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.</p>

Message	Meaning / Action
<ul style="list-style-type: none"> <li>• Protect device is not installed to the server or ID is not readable.</li> <li>• License required to operate the program is not registered in the server.</li> <li>• License information is not existing.</li> </ul>	<p>(Meaning) An error is detected in K2+ Protect information check.</p> <p>(Action)</p> <ul style="list-style-type: none"> <li>• License information</li> <li>• Incorrect action of I/O port (COM or LPT) of the PC connected to the protect devise.</li> <li>• Incorrect connection of the protect devise board.</li> </ul> <p>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.</p>
<ul style="list-style-type: none"> <li>• Test is aborted by the hardware error detected.</li> </ul>	<p>(Meaning) An error is detected in the PC or I/O unit.</p> <p>(Action)</p> <ul style="list-style-type: none"> <li>• The power of I/O unit is not set ON.</li> <li>• Between the PC and I/O unit is not connected.</li> <li>• Incorrect connection of I/O unit board.</li> <li>• Incorrect connection of K2+ I/F board.</li> <li>• Incorrect action of Driver.</li> </ul> <p>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.</p>
<ul style="list-style-type: none"> <li>• Test is aborted by too much loading of CPU.</li> </ul>	<p>(Meaning) Test operation is aborted because too much loading is detected in operation.</p> <p>(Action)</p> <ul style="list-style-type: none"> <li>• Exit form the other applications than K2+ executed by the system when they are used.</li> <li>• Decrease the value of Max. Observation Frequency in Fundamental Condition.</li> <li>• Decrease the numbers of channel to be used.</li> </ul> <p>Check the above points.</p>



## 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+/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	
		Resonance Dwell Time	Time	Counted	
			Vibration	Counted	
			Time	Counted	
	Sweep Pause	Elapsed Time	Vibration	Counted	
			Time	Not counted	
		Resonance Dwell Time	Vibration	Not counted	
			Time	Counted	
	Spot Test	Level : Lower than 0 dB	Elapsed Time	Time	Counted
				Vibration	-
Repeat				Counted	
Spot Stay Time			Time	Counted	
			Vibration	Counted	
			Time	Counted	
Spot Pause	Elapsed Time	Vibration	-		
		Time	Not counted		
	Spot Stay Time	Time	Not counted		
		Vibration	Not counted		

Also, the dependence of the judgment of Test Time completion on the excitation level are 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.

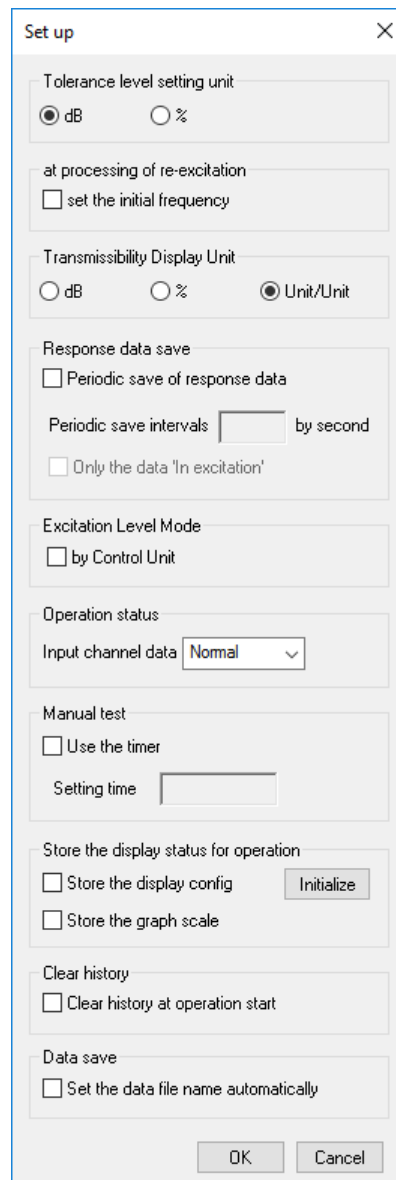
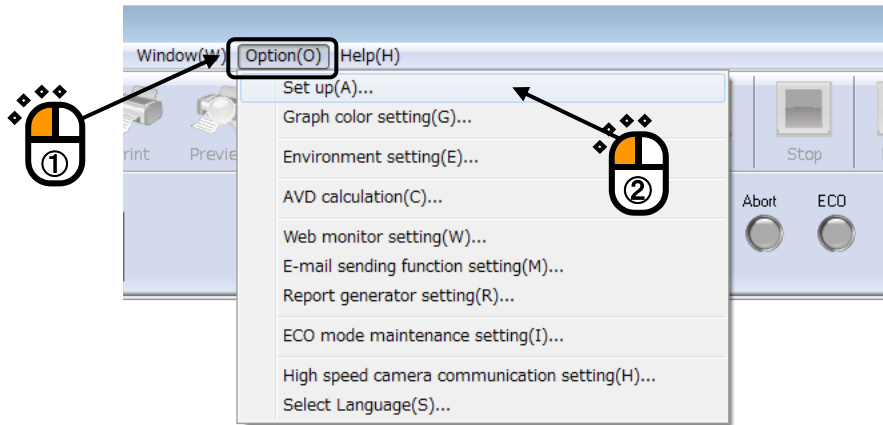
Condition		Judgment of Test Time completion
Sweep Test	Test Time specified by Sweep Counts	Independent of Level
	Test Time specified by Time	Dependent on Level
	Test Time specified by Vibration Cycle	Dependent on Level
Spot Test		Dependent of Level

## 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 ;

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

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

[at processing of re-excitation]

When the item of “Set the initial frequency” is selected, the excitation is always started from the beginning frequency of the first test at restarting excitation after the operation stop.

When this item is not selected, the test is restarted from the point at the operation stop.

[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’.

[Response data save]

‘Periodic save of response data’

The data of Frequency, Reference, Control response and Monitor response are saved as CSV file in time series.

Saving interval is specified in seconds.

The CSV files are generated according to the rule as below.

Test file name XXX-Y.CSV

XXX : The number of data which is numbered serially in the order of testing operation.

Y : The data lines available to be saved in a file are 65536. When the number of data lines exceed over 65536, the file is automatically generated by incrementing the trailing serial number.

The CSV file format to generated are shown as below.

	Column No.1	Column No.2	Column No.3	Column No.4	Column No.5	
Row No.1	<i>Time</i> [Sec.]	<i>Frequency</i> [Hz]	<i>Reference</i> [Unit]	<i>Control response</i> [Unit]	Monitor channel [Unit]	.....
Row No.2	***,	***.***,	***.***,	***.***,	***.***,	.....
	***,	***.***,	***.***,	***.***,	***.***,	.....
	:	:	:	:	***.***,	:
	***,	***.***,	***.***,	***.***,	***.***,	.....

- ”Time”, ”Frequency”, ”Reference” and ”Control response” are the fixed characters. ”[Sec]” and ”[Hz]” are the fixed characters.
- Time data is substituted in Column No. 1.
- Frequency data is substituted in Column No. 2.
- Reference level data is substituted in Column No. 3.
- Control response data is substituted in Column No. 4.
- Monitor response data is substituted in Column No. 5.

‘Only the data ‘In excitation’

Only the data during excitation is subject to saving. Select it when data in the equalization is not needed to be saved.

[Excitation Level Mode]

‘By Control Unit’

Excitation level can be specified by the reference unit when this item is set.

By specifying an excitation level by the reference unit, the unit of Increment is set by the reference unit (rms value). So that, the level can be changed to up or down every ‘1 m/s<sup>2</sup><sub>rms</sub>’.

[Operation status]

‘Input channel data’

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

[Manual test]

- ‘Use the timer’ check box

This item is for setting the initial value to decide whether the function of ending the manual test by the timer should be used or not.

- ‘Setting time’

This item is for setting the initial value of the timer time.

[Store the display status for operation ]

- ‘Store the display config’ check box

Check ‘Store the display config’ to store the display configuration during testing. Display configuration is stored for each test type. If the display configuration is stored, graphs and others based on the same settings as those for the previous testing will be displayed during next testing. Uncheck ‘Store the display config’ not to store the display configuration modified thereafter.

- ‘Store the graph scale’ check box

Check ‘Store the graph scale’ to store the scale of the displayed graphs during testing. The graph scale is stored for each test type. If the graph scale is stored, graphs based on the same scale as those for the previous testing will be displayed during next testing. Uncheck ‘Store the graph scale’ not to store the graph scale modified thereafter.

- ‘Initialize’ button

Select ‘Initialize’ to format the display configuration and the graph scale.

[Clear history]

- ‘Clear history at operation start’ check box

Check ‘Clear history at operation start’ to clear the history of earlier times at operation start automatically.

[Data save]

- ‘Set the data file name automatically’ check box

Check ‘Set the data file name automatically’ to set the destination folder and the file name automatically. If this item is checked, a dialog of [Save as] doesn’t appear even if [Data save] is selected from the menu or the tool bar. The data file name is set to the name of the test definition file plus a 3-digit sequence number, and is saved in the same folder as the test definition file.

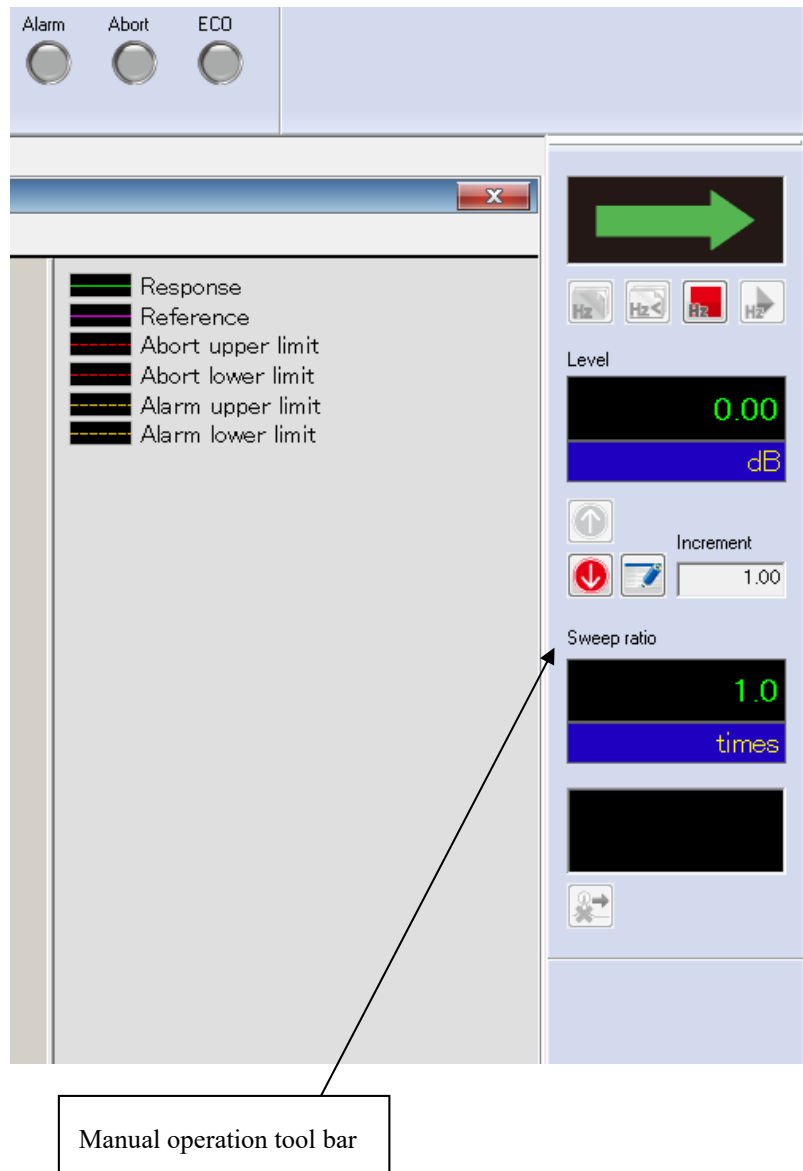
Example) When the test definition file is “C:/K2Data/SineTest.swp2”,  
the data file is saved with the name “C:/K2Data/SineTest001.vdf2”.

If the same name exists, it is saved with the name increased by one sequence number.

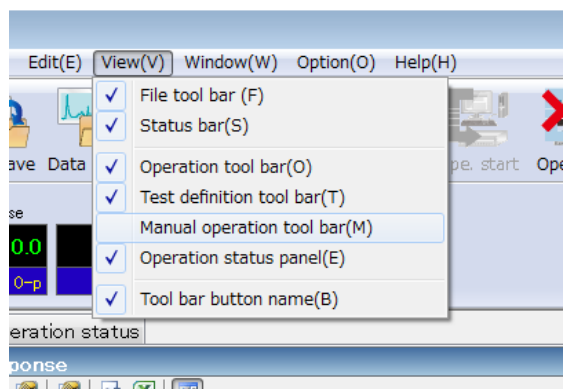
If this item is unchecked, a dialog of [Save as] appears and it is possible to select the folder and the file name as desired.

### 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 holding of Sweep and canceling of Sweep Hold (continuing the sweep operation).

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 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.

The 'Manual' panel includes a large green arrow, four frequency control buttons (Hz, Hz<, Hz, Hz>), a Level display (0.00 dB), an Increment input (1.00), a Sweep ratio display (1.0 times), and a gear icon at the bottom.

The 'Manual' dialog box contains the following fields and buttons:

- Excitation level: 0.00 dB
- (Increment: 1.00 )
- Sweep ratio: 1.0 times
- Buttons: OK, Cancel



< Items in Manual Operation (Spot) >

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 fixing spot and canceling of fixed spot (continuing the spot operation).

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

Manual

Excitation level 0.00 dB

(Increment 1.00 )

OK

Cancel

< Items in Manual Operation (Manual) >

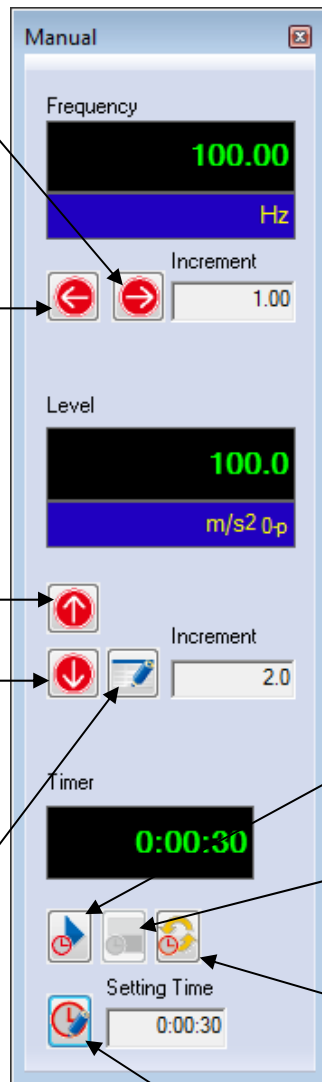
This item is for setting of an upper Frequency by pressing this button once for an increase/decrease value specified.

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

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 the unit of Excitation Level, Excitation Level, the increase/decrease value of Excitation Level, Frequency, the increase/decrease value of Frequency.  
Press this button, then displays the dialog below.

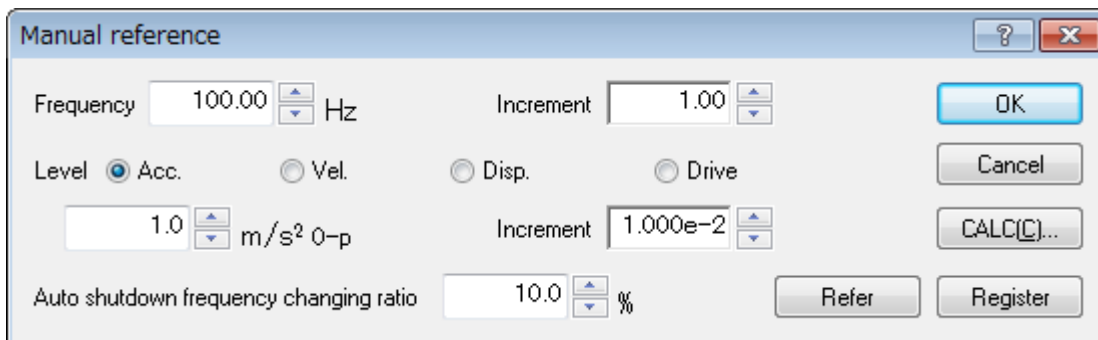


This item is for starting the timer.

This item is for stopping the timer.

This item is for resetting the elapsed time of the timer.

This item is for changing the setting of use/nonuse of the timer and the initial value of the timer time.



### 6.3.1 Use Examples of Manual Timer

< Procedures >

< Step 1 >

Define manual test and start excitation. For details, refer to “3.4 Manual Test”.

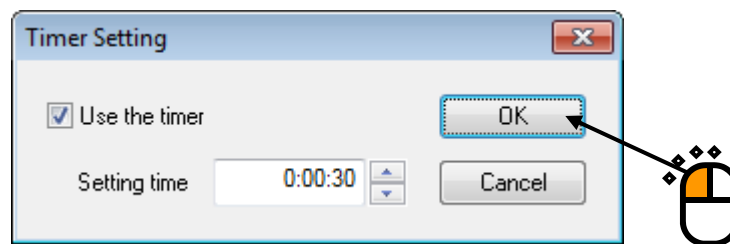
< Step 2 >

Press the button of ‘Timer Setting’.

< Step 3 >

Check ‘Use the timer’ and set the excitation time.

Press the button of ‘OK’ after completing all the steps.



< Step 4 >

Press the button of ‘Timer Start’ at any timing you want to start the timer.

The buttons of ‘Timer Setting’ and ‘Timer Start’ become invalid, and the remaining setting time is decreased.

While excitation is being paused, the timer is stopped.

< Step 5 >

To stop the timer, press the button of ‘Timer Stop’. While the timer is being stopped, the buttons of ‘Timer Setting’ and ‘Timer Start’ are valid.

Then, press the button of ‘Timer Start’. The timer restarts counting from the time remained at that time.

To start the counting of the timer from the beginning, press the button of ‘Timer Reset’.

(The button of ‘Timer Rest’ is valid even while the timer is being operated.)

< Step 6 >

When the remaining time reaches ‘0:00:00’, excitation is automatically finished.

Even the timer is being used, finishing excitation is allowed by pressing the button of ‘Excitation Stop’.

If the button of ‘Excitation Start’ is pressed in excitation completion state, the excitation is started and the remaining time of the timer is initialized to the preset time.

## 6.4 Acceleration Pickup Sensitivity Calibration

Two kinds of calibration method as 'Comparison Calibration method' and 'Absolute Calibration method' are available for the acceleration pickup sensitivity calibration.

Example of operating 'Comparison Calibration method' is described as below;

Operation example :

The pickup after calibration for  $3.06 \text{ pc}/(\text{m}/\text{s}^2)$  of sensitivity is treated as the reference pickup.

The sensitivity calibration is operated by the Comparison method.

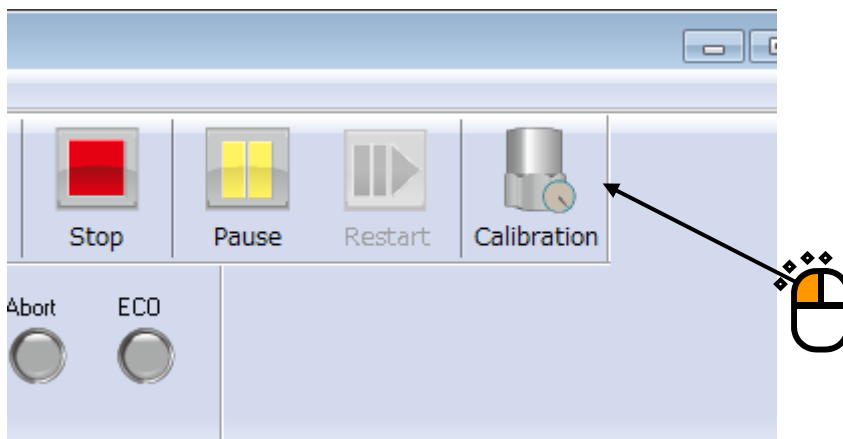
The reference pickup is connected to the channel named as 'Basic', and the objective pickup for calibration is connected to the channel named as 'Object'. The excitation condition is specified as  $10 \text{ m}/\text{s}^2$  at 100 Hz. This control is executed by the pickup connected to the channel named as 'Control'.

< Procedure >

The procedure of test definition is the same as that of Manual test. Refer to "3.4 Manual Test".

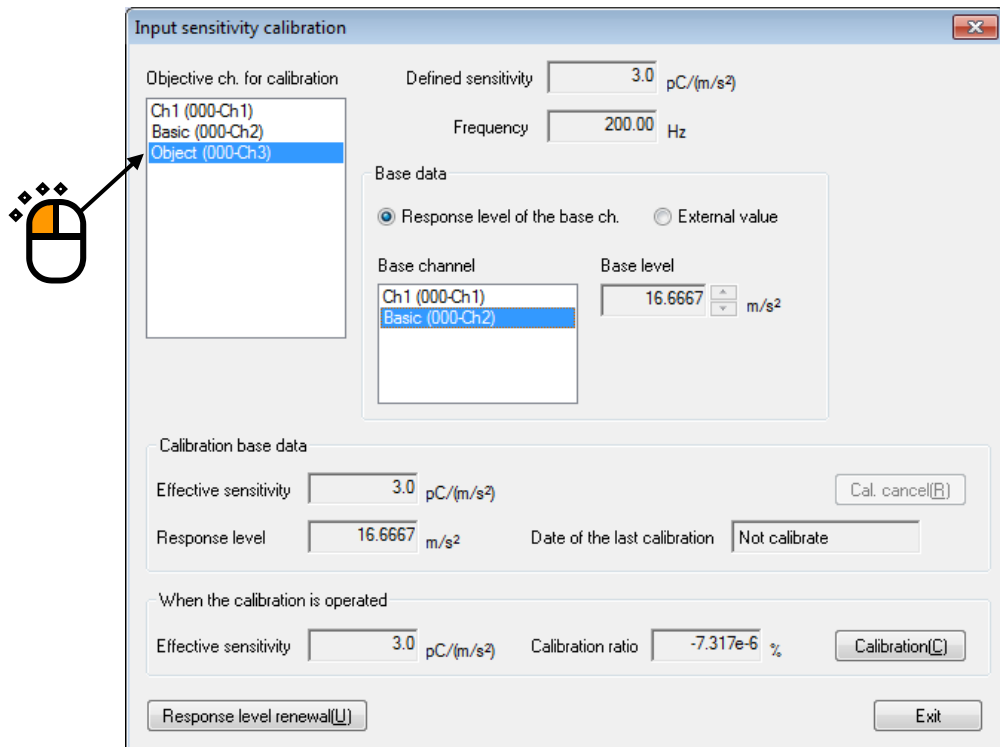
< Step 1 >

Press the button of [Calibration] during the excitation operation.



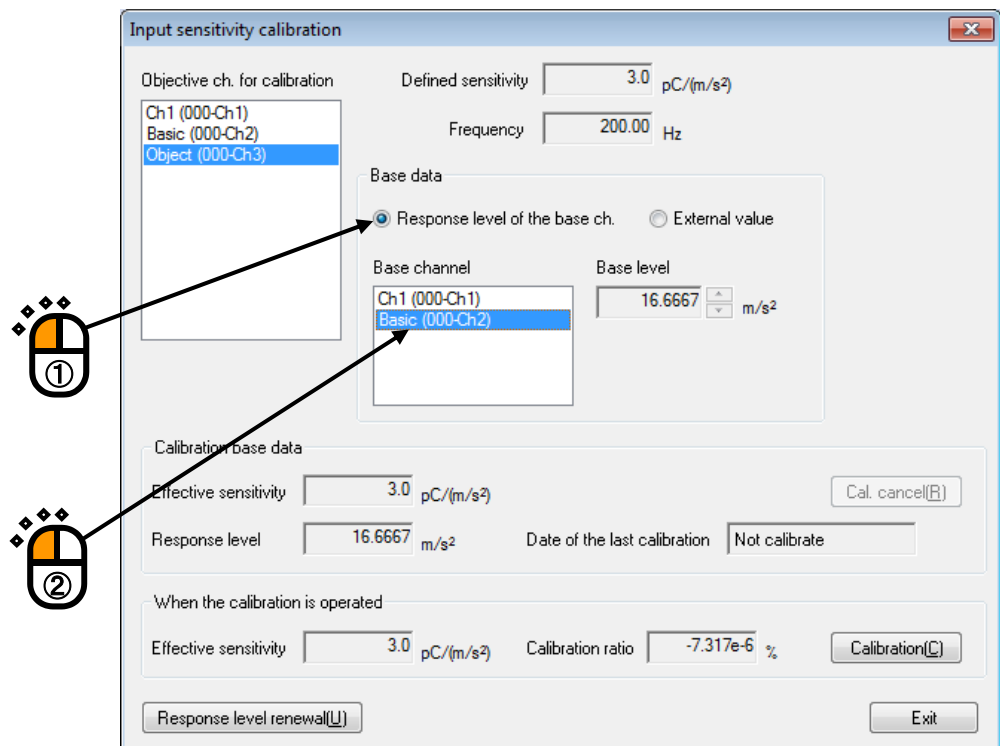
< Step 2 >

Select the 'Object' among the list of Objective channel.



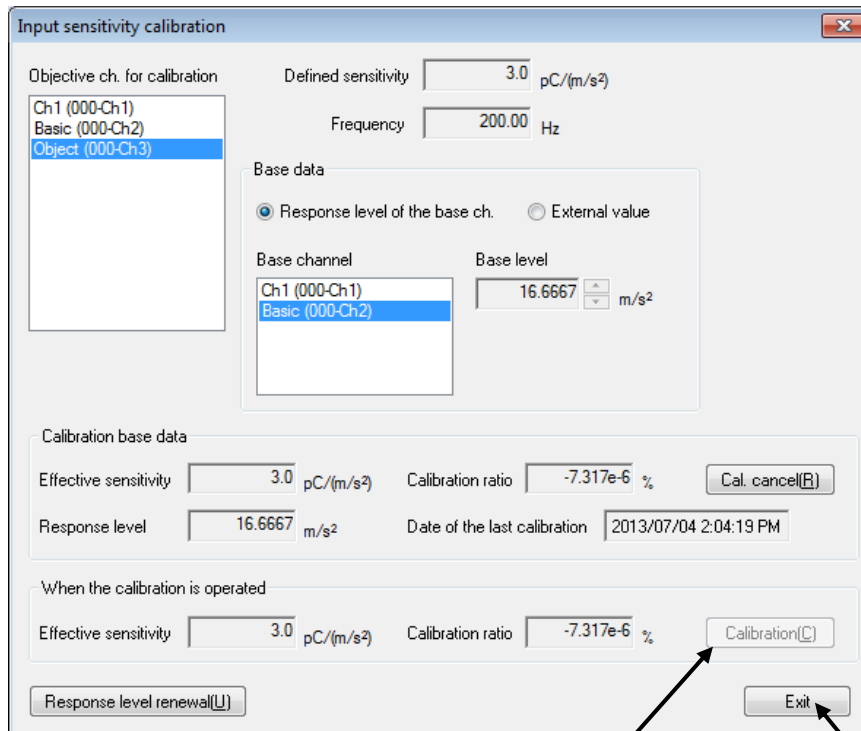
< Step 3 >

Check the item of 'Response level of the base channel' and select 'Basic' in Base channel.



< Step4 >

Press the button of [Calibration] and input the calibration value of the pickup sensitivity for 'Object'. Then, press the button of [Exit].



**Note)** The calibration value is reflected to Input channel information when the function of 'Overwrite to save the Input channel information' or 'New Input channel information saving' is executed after exiting from the operation mode.

Refer to "K2+ Common Part" instruction manual about the operation of Input channel information.

# Chapter 7 Definition-related supplement

## 7.1 Limit control definition

Limit control is a function to continue testing, while observing the responses of the input channel monitor so they do not exceed the selected threshold level.

The function is optional.

In this program, this threshold level is called observation profile.

With the limit control, if it is anticipated that the responses of the input channel monitor surpass the observation profile, the drive signal level will be processed to lower the excitation level by the required extent so the responses of the monitor cannot surpass the observation profile.

Generally, therefore, if limit control works, control response levels will lower.

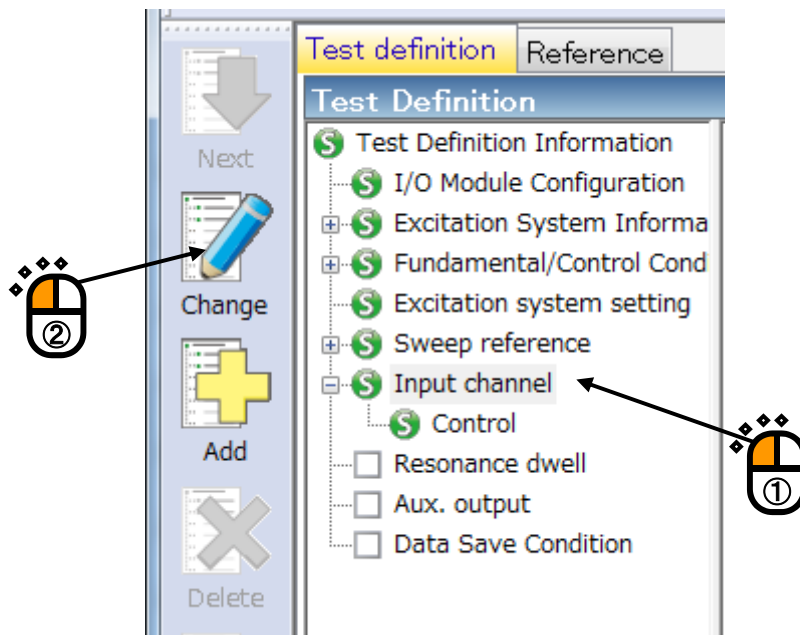
Normally, therefore, when limit control is performed, the reference tolerance lower limit is not used.

It is not necessary to equalize the physical variable of the monitor channel to perform limit control to the control variable. For example, it is optionally available to perform control using acceleration, observe the displacements of some parts using displacement sensors and observe other parts using load sensors.

<Defining procedure>

<Step 1>

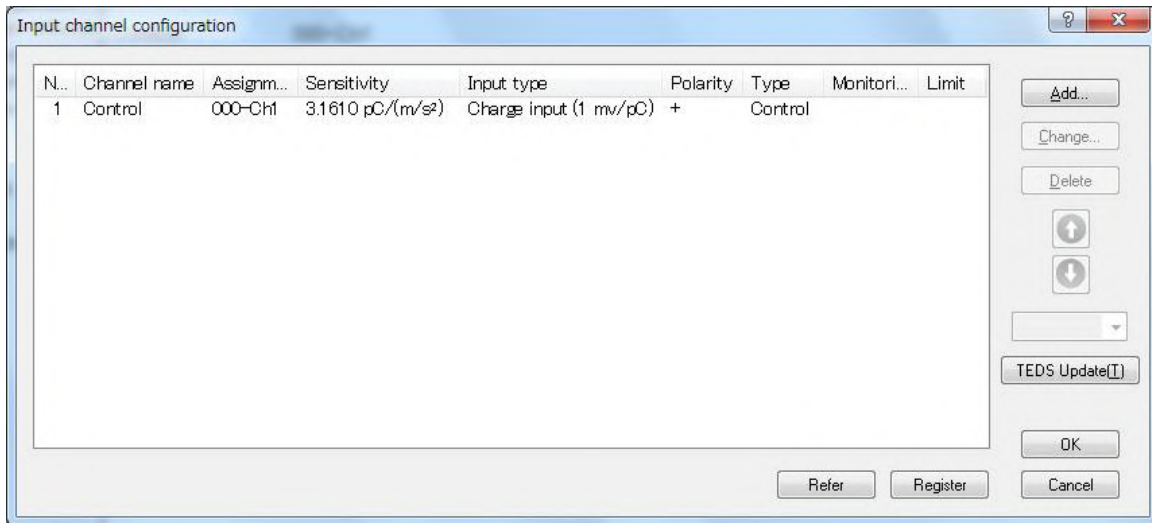
Select a test definition input channel, and then press the button of [Change].



< Step 2 >

Since the input channel configuration window opens, press the button of [Add].

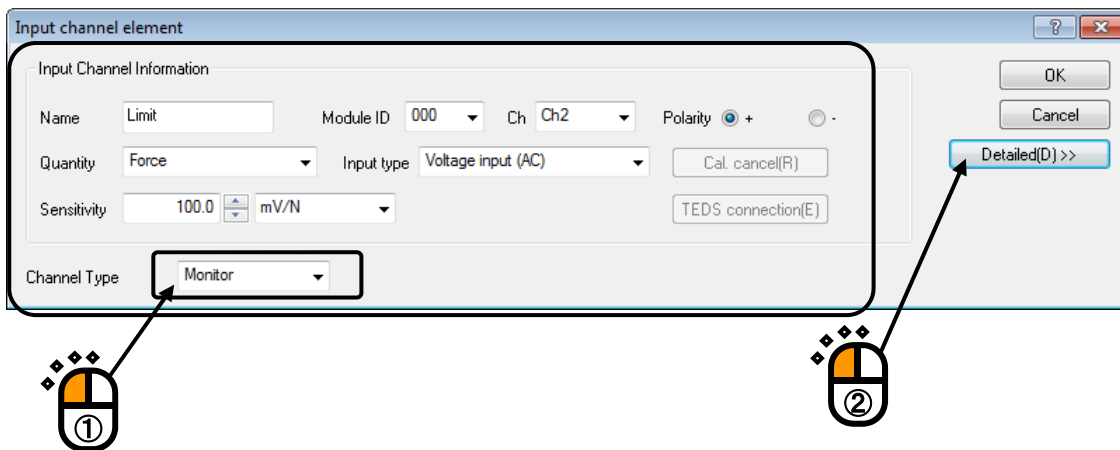
If the input channel for limit control has already been set, select the input channel to set, and then press the button of [Change] button.



< Step 3 >

The input channel element dialog box opens.

Set necessary information, and then press the button of [Detailed].



Normally set channel type to 'Monitor'.

In this example, definition so limit control will be performed using a load sensor.

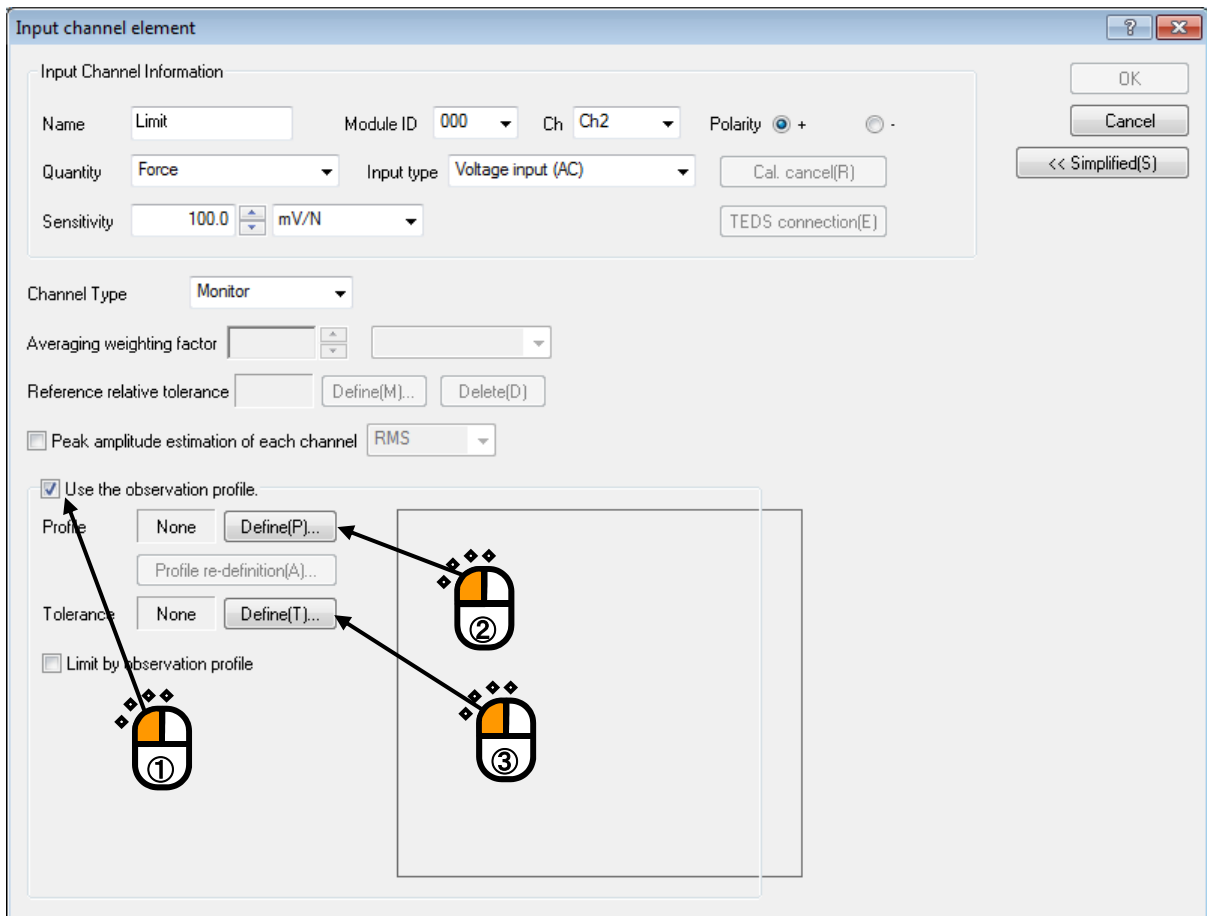


< Step 4 >

Check 'Use the observation profile.'

Press the Profile [Define] button to define the observation profile.

Press the Tolerance [Define] button to define the observation profile tolerance.

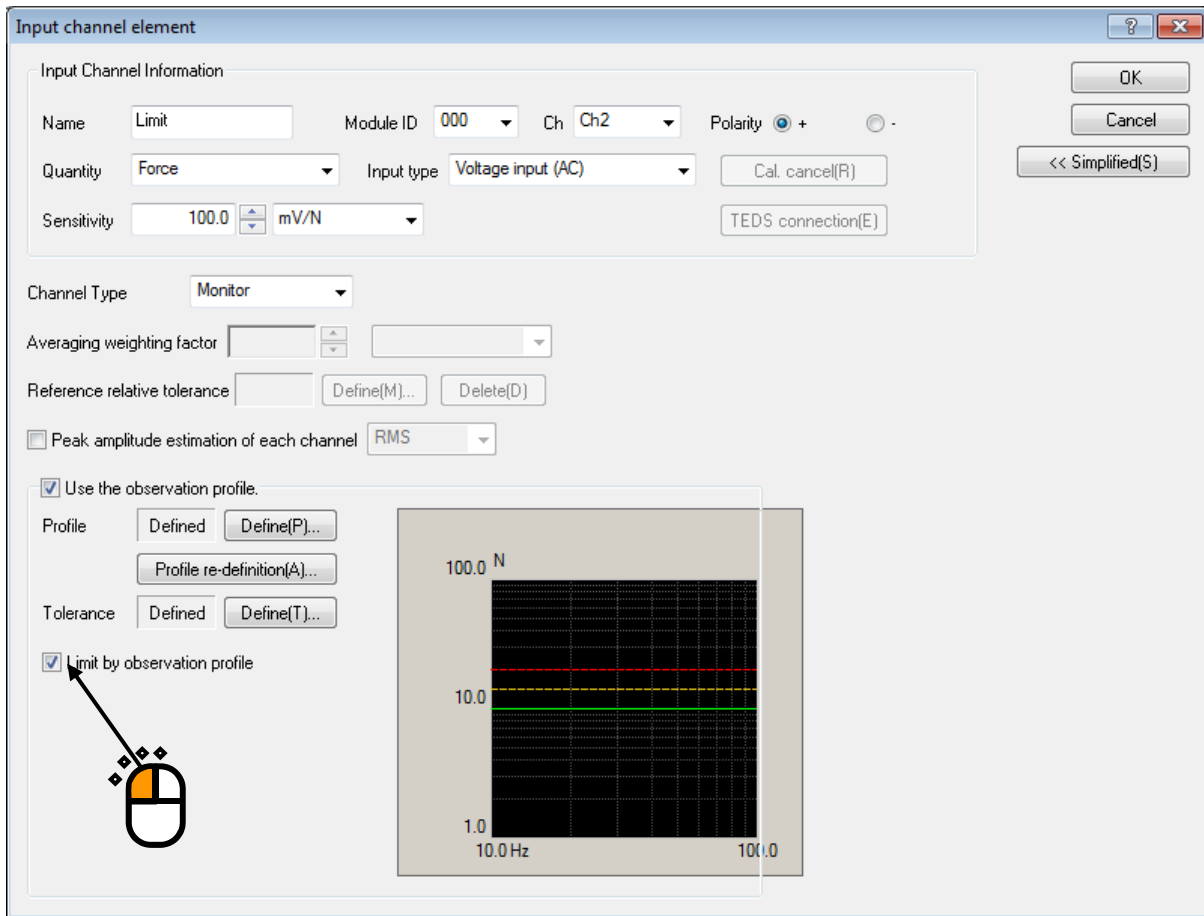


The profile and tolerance defining procedures are the same as the control reference and tolerance defining procedures.

For the details, see “4.4 Control reference” in the instruction manual.

< Step 5 >

When observation profile and tolerance definition is complete, defined data is displayed graphically. To perform limit control, check 'Limit by observation profile'.

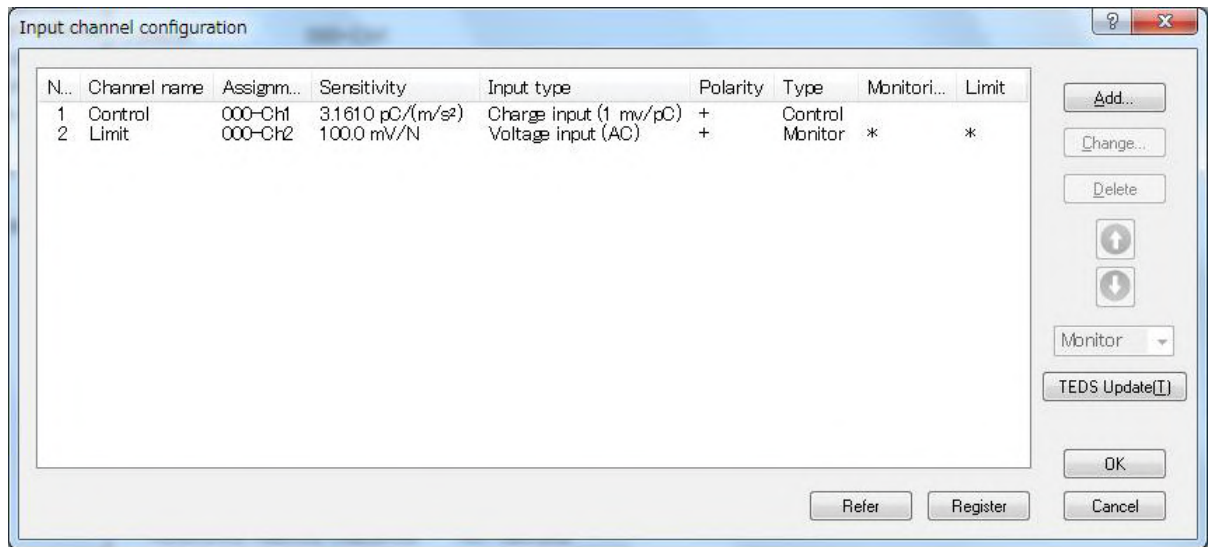


If limit control is not performed, responses of the monitor only will be observed.

Specifically, only the fact whether the responses of the monitor are surpassing the observation profile tolerance is observed, and a warning or interruption will be issued in accordance with the observation results.

< Step 6 >

In the input channel configuration dialog box, 'Monitoring' and 'Limit' of the channel for limit control are marked.



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