

# Measurement of Frequency Response Function

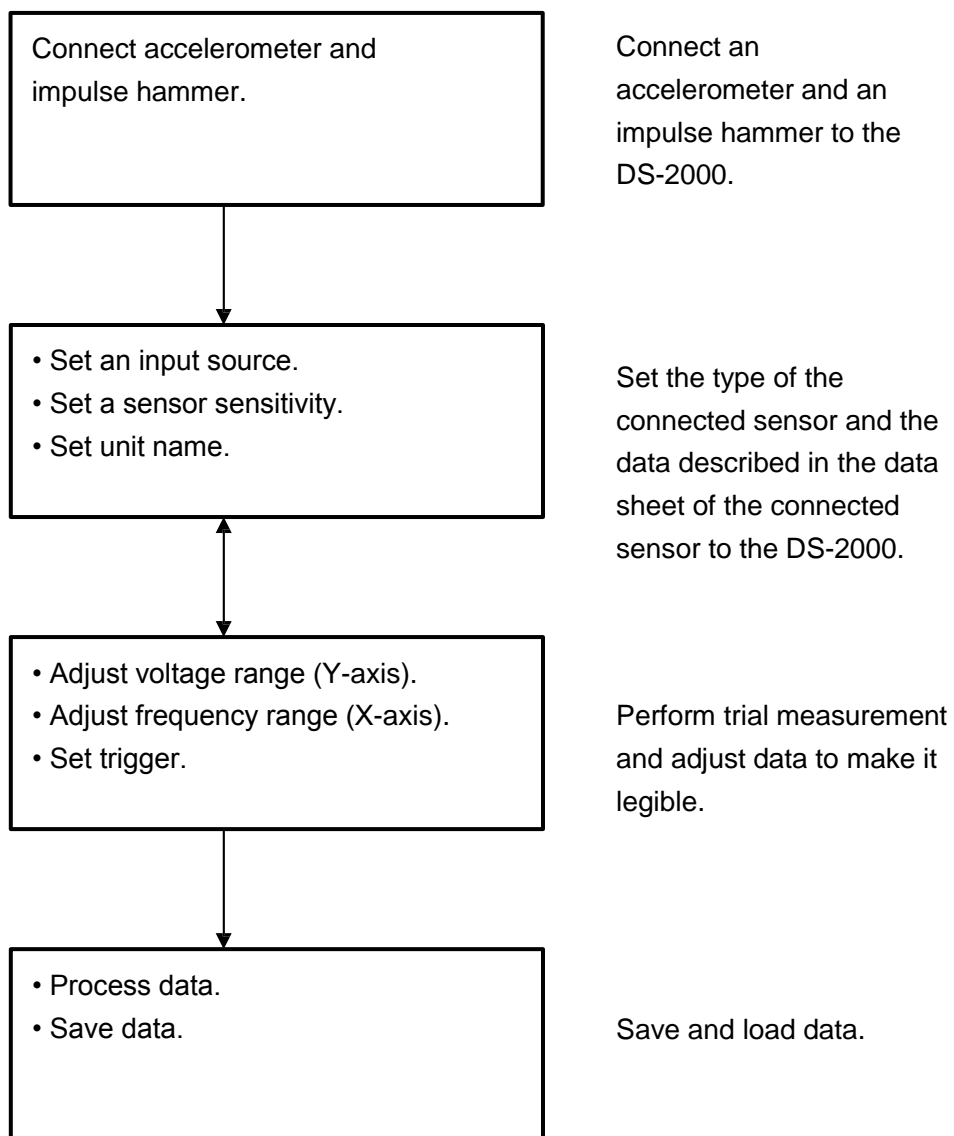


# Contents

1. Flow Chart to Measurement
2. Device Connections
3. DS-2000 Setup
4. Measurement

## 1. Flow Chart to Measurement

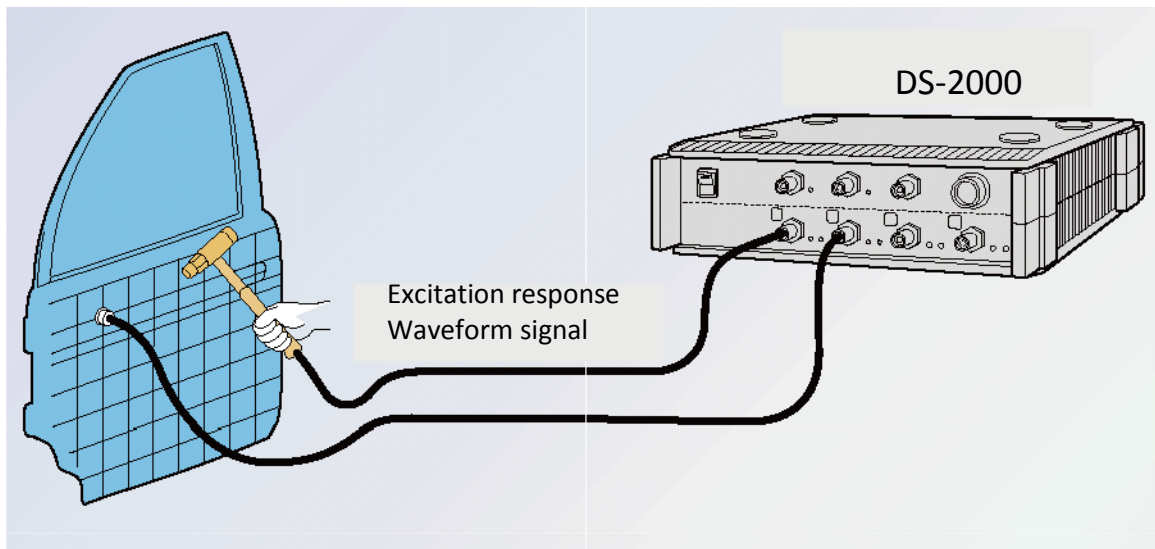
The following explains procedures for measuring the frequency response function using an impulse hammer.



## 2. Device Connections

Connect an "accelerometer" and an "impulse hammer" to the DS-2000. Although the acceleration sensor comes in two types, built-in amplifier type and charge output type, the use of the built-in amplifier type is assumed here. Connect each sensor with the DS-2000 series as shown below.

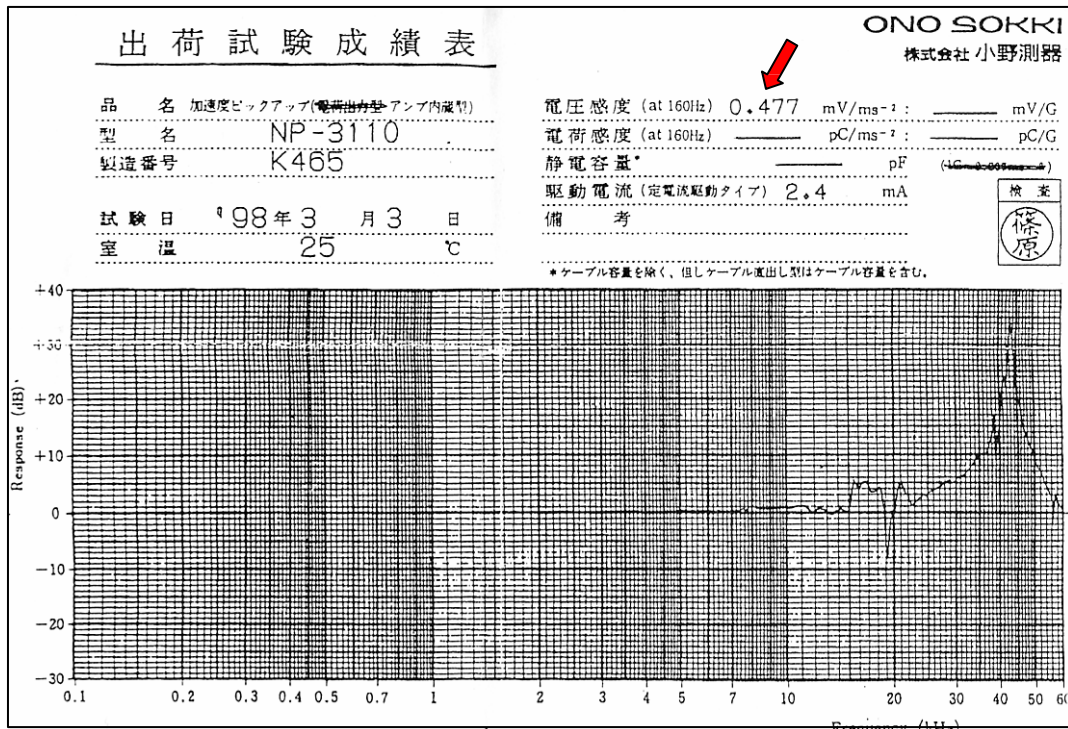
The following shows an example of direct connection of an impulse hammer without using an amplifier. However, when output magnification is to be performed by the amplifier, input the output from the amplifier of the impulse hammer to the DS-2000.



### 3. DS-2000 Setup

#### 3-1 Preparing for Setup

To correctly operate the connected impulse hammer and accelerometer and display data, set operating conditions and sensitivity of the sensor to an FFT analyzer. Sensitivity and operating condition settings are described in the "Calibration Chart" supplied with the accelerometer to be used.



Calibration Chart Supplied with "NP-3130" Acceleration Sensor with Built-in Amplifier

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① → Voltage sensitivity (at 160Hz) 9.75 mV/ms<sup>-2</sup> : 95.6 mV/G  
 Charge sensitivity (at 160Hz) \_\_\_\_\_ pC/ms<sup>-2</sup> : \_\_\_\_\_ pC/G

② → Capacitance\* \_\_\_\_\_ pF (1G=9.807ms<sup>-2</sup>)  
 Drive current (constant current drive type) 2.4 mA  
 Remarks \_\_\_\_\_

Inspected  
篠原

\*The cable capacitance is excluded. However, the cable capacitance is included with the directly connected type.



Set data items of ① and ② on the calibration chart to the FFT.

- ① Voltage sensitivity indicates a voltage to be output by the sensor with an acceleration of 1m/s<sup>2</sup>. Here, a voltage of 9.75mV is output.

- ② Drive current indicates that a current of **2.4mA** is sent to the sensor.  
 In the documents supplied with the "GK-3100" impulse hammer, necessary data are described as follows:

The hammer is provided with an extender (weight for weight adjustment). Plastic and vinyl tips are used.

HAMMER SENSITIVITY:		PLASTIC/VINYL	PLASTIC/VINYL
Hammer Configuration	Tip	PLASTIC/VINYL	PLASTIC/VINYL
	Extender	NONE	STEEL
Hammer Sensitivity (S <sub>v</sub> )	mV/1h	10.1	10.8
	(mV/N)	2.26	2.38

Above data is valid for all supplied tips.

Presence or absence of an extender attached to the rear end of the impulse hammer, with different voltage outputs per 1N (newton).

To make the vibration force constant, it is necessary to hammer an object under measurement using the weight of the hammer itself instead of the force of arm or hand. Therefore, it is recommended to attach an extender at the rear end of the hammer. Here, make sure that the voltage output per 1N (newton) is **2.38mV/N**.

### About tip at the end of hammer

The frequency of the excitation force by the impulse hammer can be roughly adjusted by changing the material of the tip at the end of the hammer.

**HARD TIP (metal)**

Enables steep impulse rise and vibration up to high frequencies. However, there is a risk of double-hammering (hammering twice), and the power spectral density is low.

**SOFT TIP (vinyl)**

The power spectral density is high, and the vibration energy is concentrated in low regions. However, vibration with several Hertz or less is difficult.

**MEDIUM TIP (plastic)**

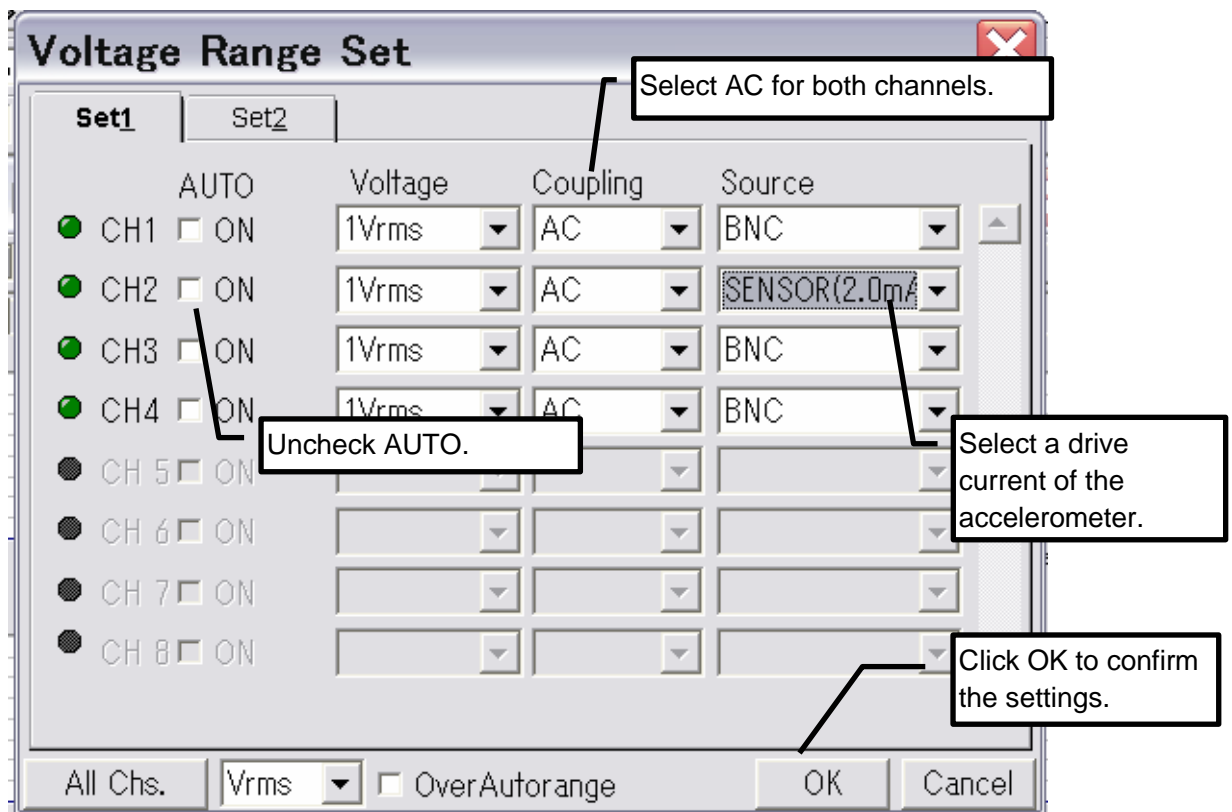
Provides intermediate characteristics between a metal tip and a vinyl tip.

### 3-2 Input Source Setup

Set sensitivity, operating conditions, etc. of the sensor connected to the DS-2000. Here, procedures will be explained on the premise that CH1 is used for impulse hammer and CH2 for accelerometer.

Click the Input menu and then select Voltage Range.

- (1) For both channels, **uncheck** the **[AUTO]** check box.
- (2) For [Coupling], select **AC** (AC coupling) for both channels.
- (3) Open the [Source] dialog.  
**CH1:** When inputting a signal from the impulse hammer power supply, select **[BNC]** (when directly inputting a signal from the impulse hammer, select SENSOR(2mA)).  
**CH2:** Since the drive current in the Calibration Chart is "2.4mV," select **[SENSOR(2.0mA)]**.
- (4) Click **[OK]** to confirm the settings.



### 3-3 Unit Conversion

It is inconvenient that the vibration waveform is still displayed as a voltage. Use the unit calibration function to allow direct read from voltage to acceleration. Click the Input menu and then select Unit / Calibration to open the dialog.

The screenshot shows the 'Engineering Unit' dialog box with the following table of settings:

CH	EU	Name	Factor	Cal. Value	Offset	TEDS Info.
CH1	<input checked="" type="checkbox"/> ON	N	0.00238	V/EU	0dB	EXEC
CH2	<input checked="" type="checkbox"/> ON	m/s <sup>2</sup>	0.00975	V/EU	0dB	EXEC
CH3	<input type="checkbox"/> ON	V	1	EUV	0dB	EXEC
CH4	<input type="checkbox"/> ON	V	1	EUV	0dB	EXEC
CH5	<input type="checkbox"/> ON	V	1			EXEC
CH6	<input type="checkbox"/> ON	V	1			EXEC
CH7	<input type="checkbox"/> ON	V	1			EXEC
CH8	<input type="checkbox"/> ON	V	1			EXEC

Callouts in the image provide the following instructions:

- Input hammer vibration force unit N (newton).
- Input acceleration unit m/s<sup>2</sup>.
- Set a voltage value (sensor sensitivity) per unit.
- Click OK to confirm the settings.

Thereby, the unit of CH1 (impulse hammer side) is converted to **N (newton)** for excitation force, and CH2 (accelerometer side) to **m/s<sup>2</sup>** for acceleration, enabling direct reading with each unit.

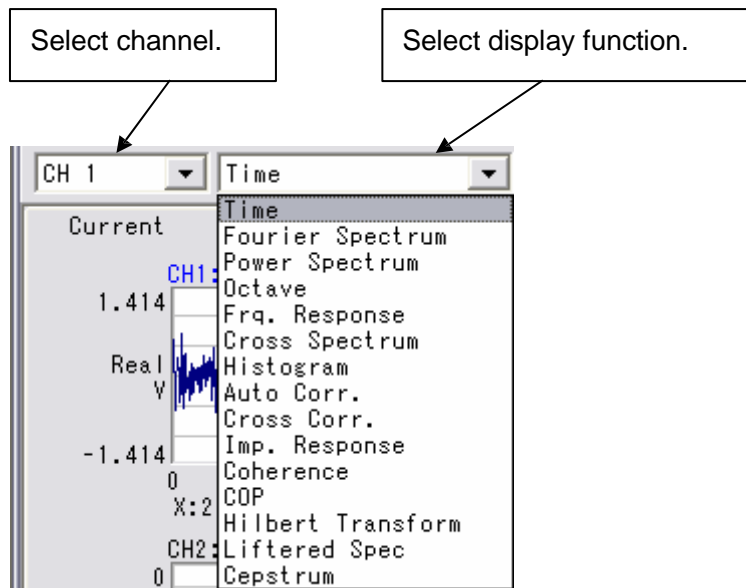
### 3-4 Display Selection

#### Setup in screen

At the time of data measurement, specify the top for time waveform display of CH1 and the bottom for time waveform of CH2.

#### Screen setup

Select a channel and a function to be displayed from the setup drop-down lists.



To change the screen, click the Data Type label at the top left of the data screen to activate it and then make the above settings.

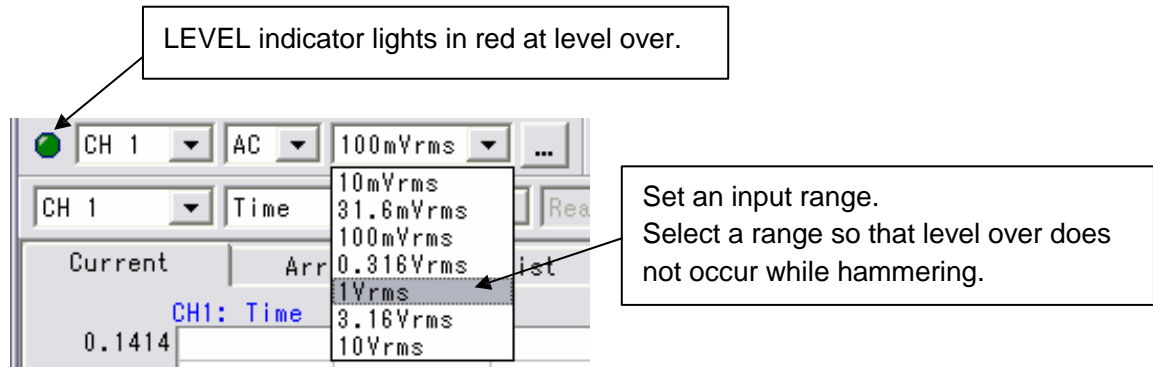
Display time waveforms of CH1 and CH2.



### 3-5 Adjusting Voltage Range

Set a voltage range and a frequency range to a value suitable for measurement.

While hammering the object under measurement (with a constant force) as if it drops by its weight, select a range for displaying a signal waveform as large as possible so that the LED of the **LEVEL indicator** for each channel does not light up.



### 3-6 Applying Trigger

Stop a waveform at a desired position in the screen using the trigger function to make it easier to observe the waveform. Click the Input menu to open the Trigger Set.

Apply trigger to the waveform of CH1 (impulse hammer) while hammering the object under measurement.

Set a trigger position **as leftward as possible in the screen** so that the waveform can be observed without problem.

Select repeat trigger to apply trigger repeatedly.

Select internal trigger to apply trigger with a hammer input signal.

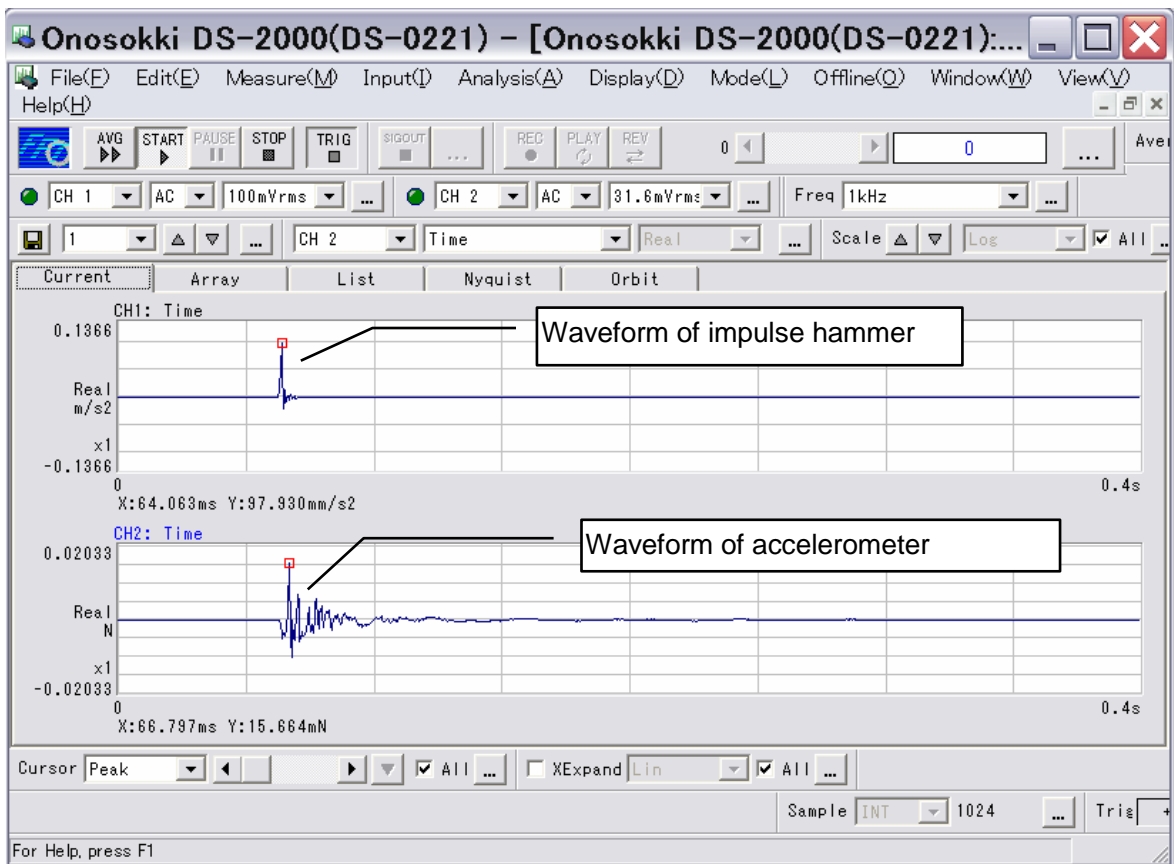
Numerical input is also possible.

Click on a point in the screen to the level and position to apply the trigger. Set a position as leftward as possible in the screen.

Click OK to confirm the settings.

Do not change the Y-axis scale from default. If the scale is changed, scale and level (%) axes are unable to match.

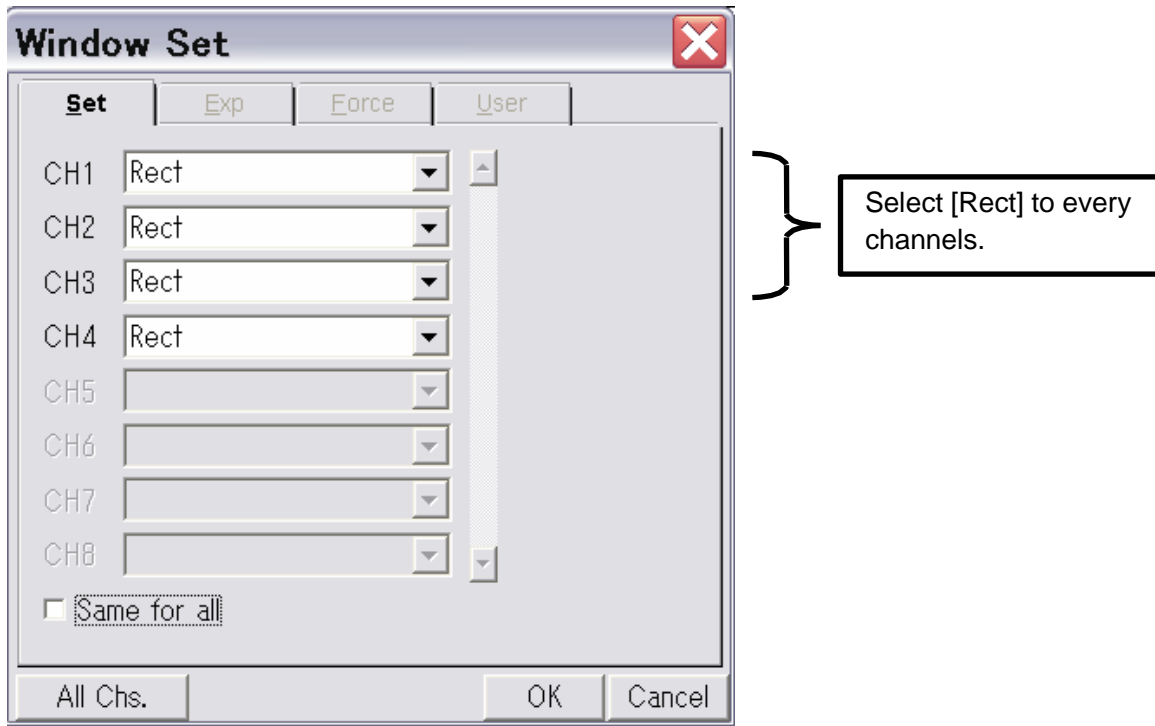
Press the TRIG button in the screen to set to the trigger-ready state.



When you hammer the object under measurement and then the waveform stops at a specified position, trigger is OK.

### 3-7 Window Setup

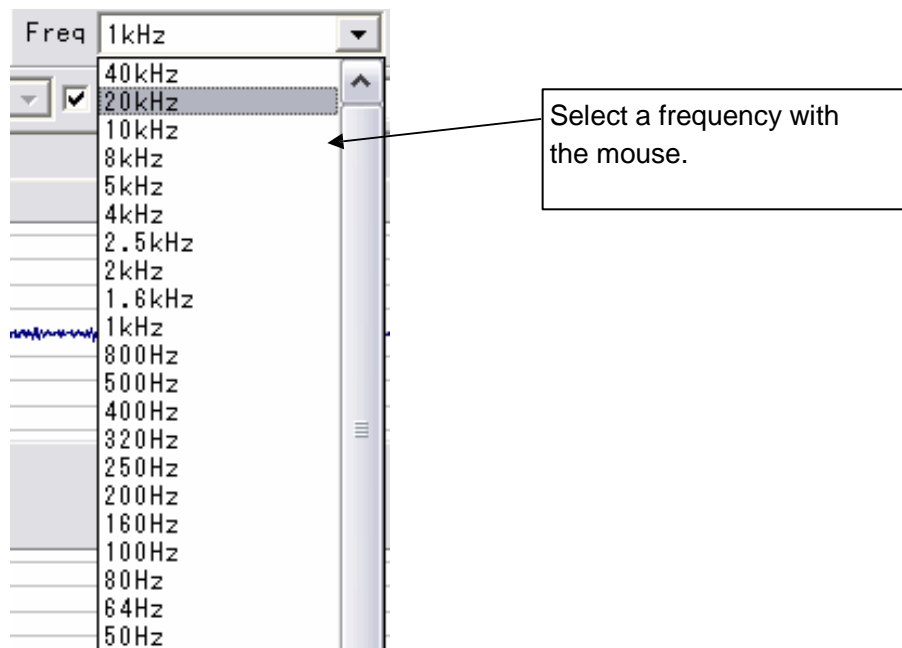
Since the signal of the impulse hammer is a single-shot impact signal, select the **rectangular window** without compensation. Click the Input menu and then select Time Window. Then, make setting for each channel.



### 3-8 Determining Frequency Range

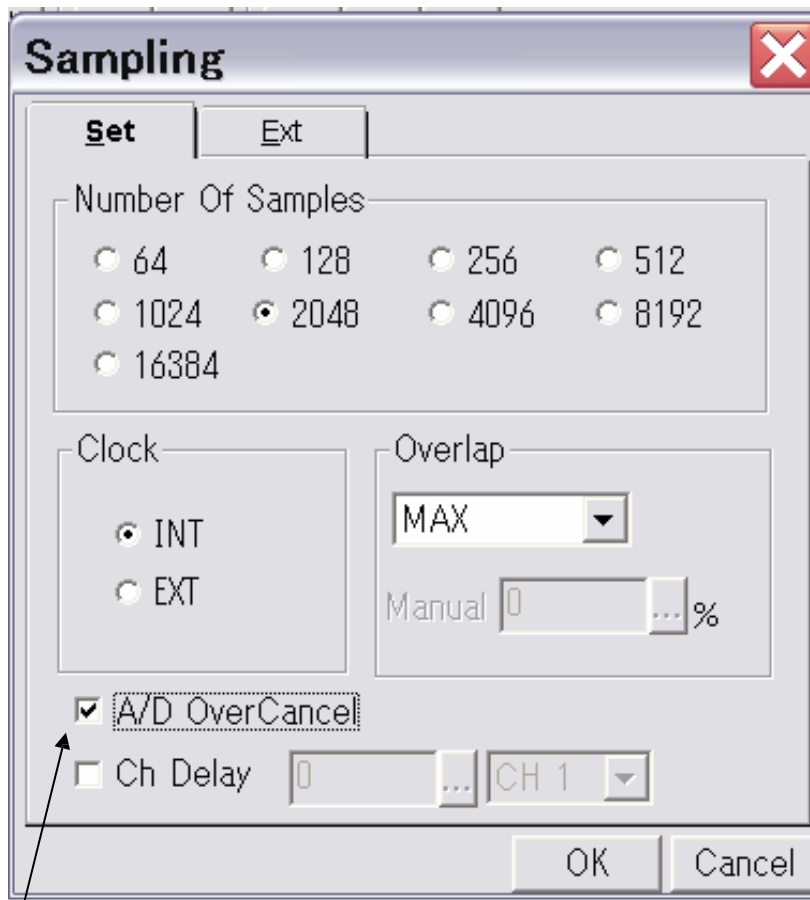
Determine a frequency range based on the following:

- Select it within the analysis frequency range of the sensor (accelerometer)
- Select it from the frequency resolution to be focused (The lower the frequency range, the higher the frequency resolution becomes.)
- Select it from the maximum number of resonance frequencies to be observed (The higher the frequency range, the more numbers of observable modes becomes.)



### 3-9 AD Over Cancel Setup

This function eliminates data if voltage of an input signal exceeds a limit because of excessive hammering. Click the Input menu and then select Sampling condition.



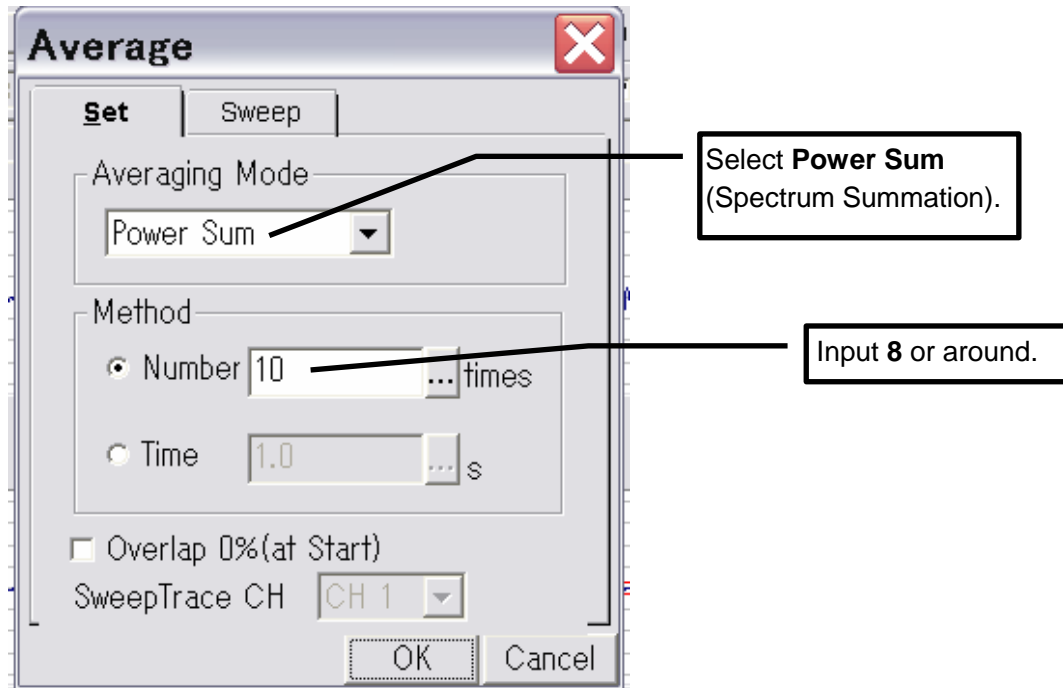
Check A/D OverCancel.

\*Please check whether the trigger is applied before turning on the A/D over cancel.

### 3-10 Average Setup

To minimize a measurement error, data is averaged. In this case, summation averaging of spectrum is used. (This setting is selected as initial setup. If changed, setup is required.)

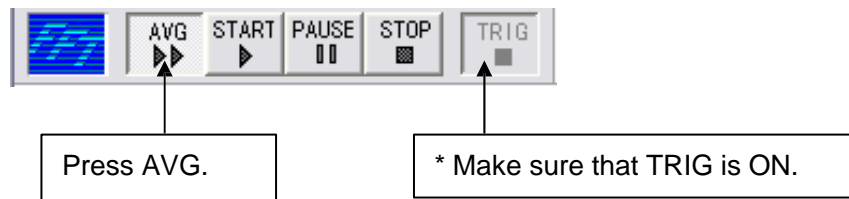
The standard number of averaging is 4 or 8. Click the Input menu and then select **Average**.



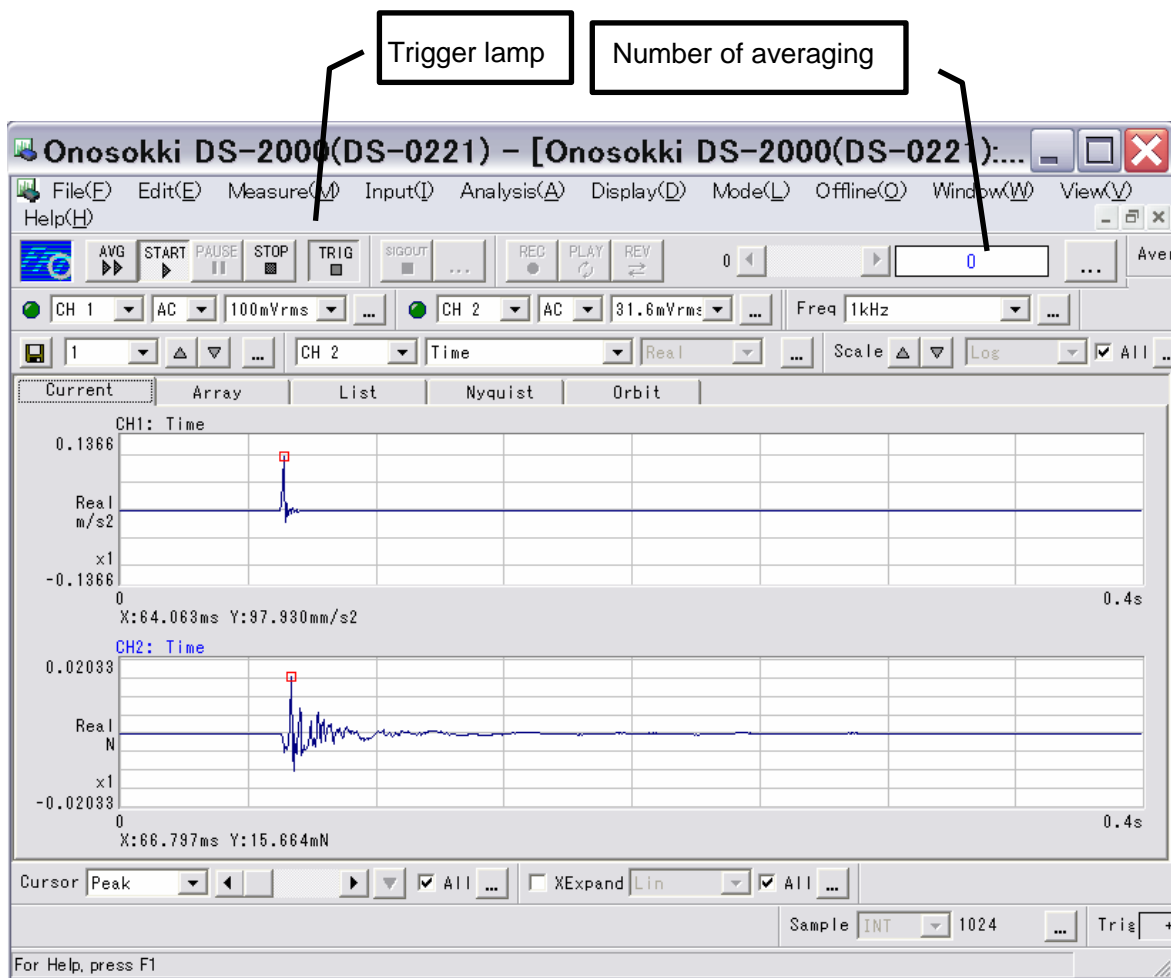
# 4 Measurement

## 4-1 Performing Averaging and Starting measurement

Perform averaging and start measurement.



When you press the switch and a signal is input, averaging starts automatically. Start hammering. When the signal (hammering) is input for the specified number of averaging, averaging stops automatically. Perform measurement while monitoring two time-waveform screens, impulse hammer and acceleration detector, to check whether **double-hammering (hammering twice)** occurs.





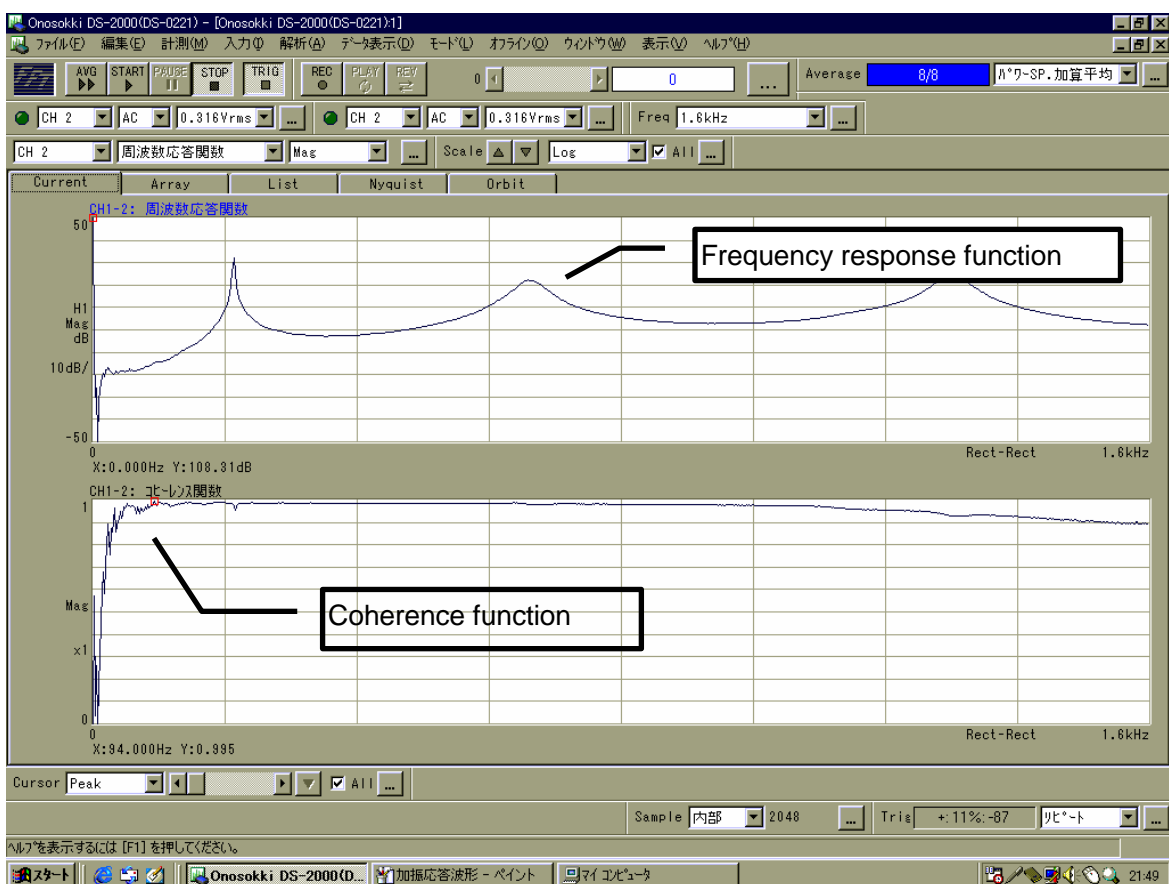
## 4-2 Checking Frequency Response Function Data under Observation

Here, check data by displaying the **frequency response function** at the top and the **coherence function** at the bottom.

\* The **coherence function** represents the correlation between input and output signals. Coherence becomes worse if noise is mixed between input and output or if rattling or other nonlinear factor is present.

The higher the coherence, the higher becomes the reliability of the frequency response function. The coherence is displayed as a level between 0 and 1 in the Y-axis range.

(The coherence function cannot be calculated without averaging.)



### CAUTION:

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3. This procedure manual explains general measurement procedures. Ono Sokki assumes no responsibility for data obtained through a specific operation performed by the customer.