

DS-0321 FFT Analysis Software

Operation manual

DS-0321 IFFT (Inverse Fast Fourier Transform) Operation Procedure

The DS-0321 FFT Analysis software has the IFFT (Inverse Fast Fourier Transform) operation functions.

Assuming that an input signal is fed to a system, multiplying the input Fourier spectrum by the frequency response function of the system followed by IFFT operation will produce the output time waveform of the system. For example, by separately measuring the floor vibration spectrum and the frequency response function of a test table placed on the floor, a simulation may be performed to display the vibration waveform on the test table when shock or vibration is applied to the floor.

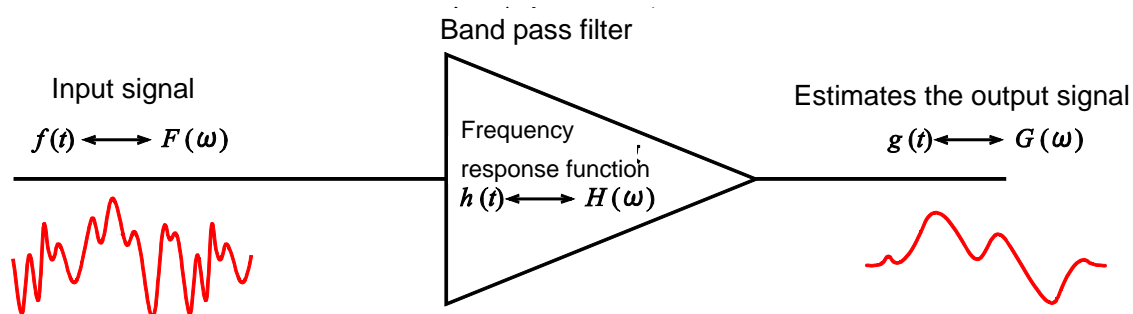
This document describes the IFFT operation procedures to use a frequency response function of a band pass filter and a shock waveform, both measured and recorded as digital data prior to the IFFT operation.

Note that the same frequency range shall be used for the measured data of the frequency response function and the time waveform. Also note that the use of "rectangular" window function may give better results than the use of the "Hanning" window function when measuring the time waveform.

Basic operations of the DS-3000 software are mostly executed in the Configuration window. As the operations in the Configuration window are correspondent with those of the Main menu, the Main menu operations are not included in this manual. For details on the Configuration window operations, refer to the respective procedure manuals (Basic operation for display of Configuration Window and Basic operation procedure for Configuration Setting).

In this instruction manual, a series of clicking operations is described, for example, as follows; "Click "File" > "Project File"> "New Project" > "Exec".

■ Conceptual diagram



Assuming a linear system, the relationship between the input signal, output signal, and transfer function of the system is given by the following equation:

Time domain	Frequency domain (FFT)
$g(t) = f(t) * h(t)$	$G(\omega) = H(\omega) \times F(\omega)$

While convolution is to be calculated in the time domain, it corresponds to a multiplication in the frequency domain. As DS-0321 has the function to perform IFFT operation on the result of the frequency domain multiplication of the frequency response function and the input signal, i.e., in the form of Fourier-transformed spectrum, it can produce a simulated output time waveform for the input spectrum.

■ Operation Flow

- 1 Startup
- 2 Opening a New Project
- 3 Retrieving Stored Data
- 4 IFFT Operation
- 5 X-axis Zooming
- 6 Displaying the Power Spectrum of the Data after IFFT Operation
- 7 Returning to the Measurement Window

■ Operation Procedures

-1 Startup

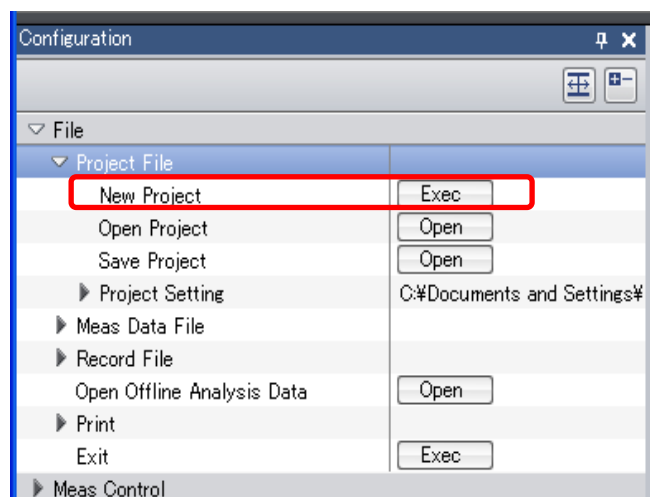
Startup the DS-0321 FFT Analysis software.

-2 Opening a New Project

① □ From the main menu, click "View" and then "Configuration" to open the "Configuration" window.

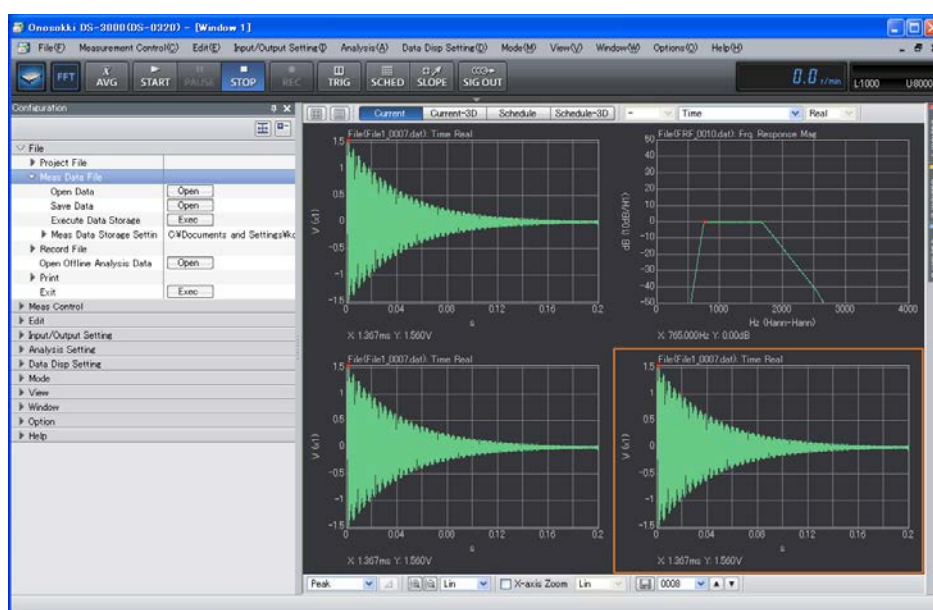
② □ In the "Configuration" window, click "File" > "Project File" > "New Project" > "Exec".

This operation erases the current settings and opens a new (default) project.

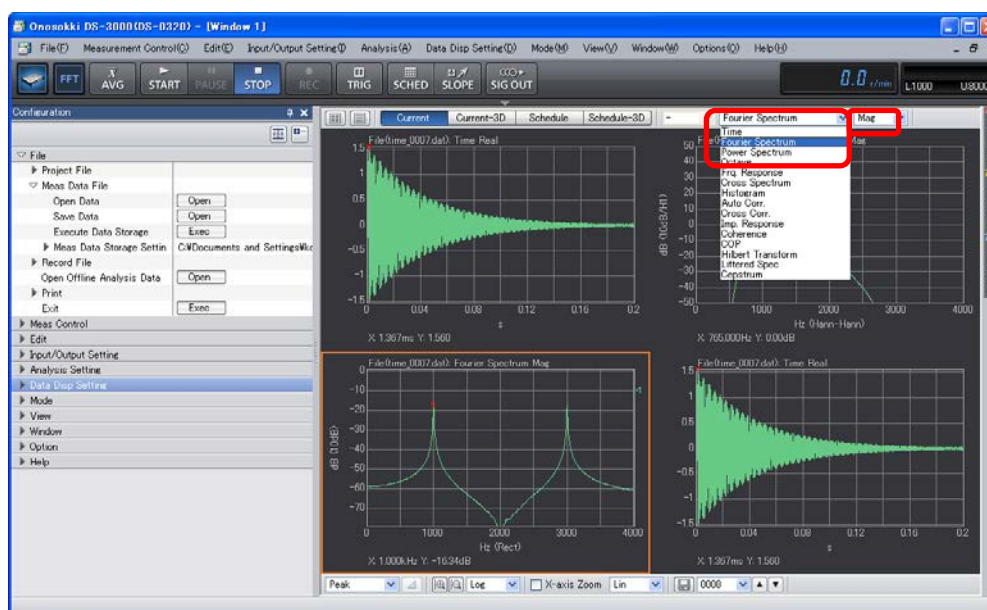


-3 Opening the Stored Data

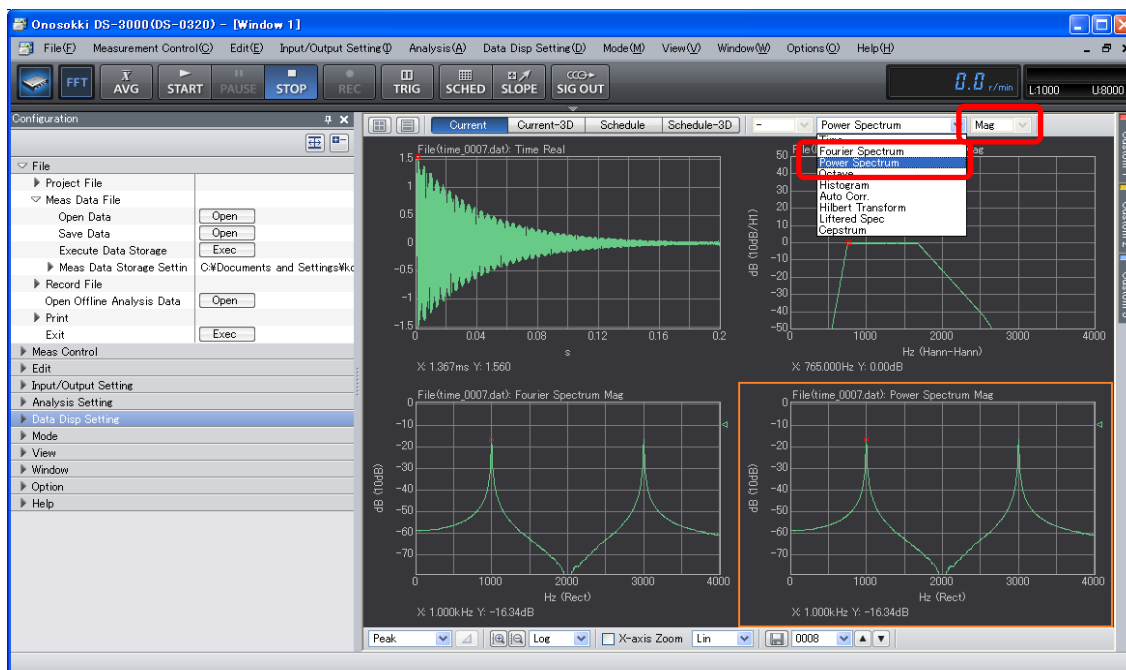
- ① In the graph window, click on the upper left graph to make it active. The data stored in a file will be displayed on this active graph.
- ② In the "Configuration" window, click "File" > "Meas Data File" > "Open Data" > "Open". From the "Open File" dialog box displayed, open the time domain waveform data.
- ③ In a similar manner, open and display the frequency response function on the upper right graph, and display other time domain waveforms on the remaining two graphs.



- ④ Click on the lower left graph to make it active. Then, on the top part of the graph window, select "Fourier Spectrum" and "Mag" from the respective pull-down menus of the input source selection toolbar. Display the Fourier spectrum, to be input to the IFFT operation.

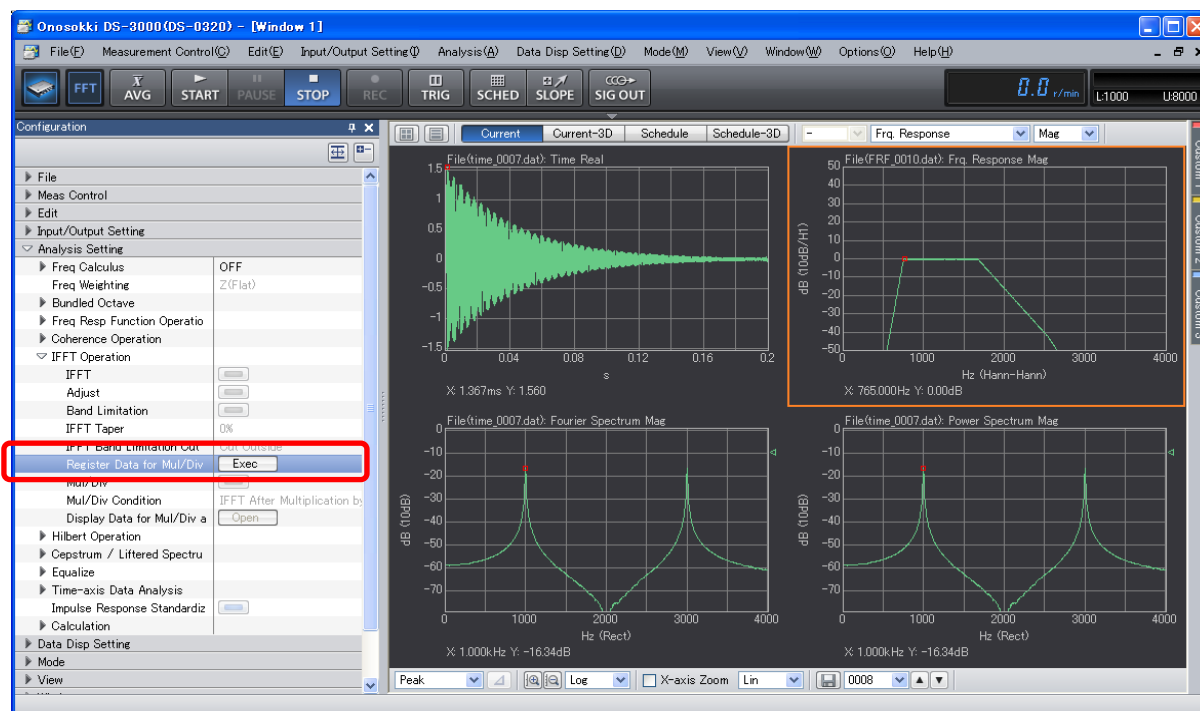


- ⑤ Similarly, click on the lower right graph and specify "Power Spectrum" as the input source. The power spectrum will be used as a reference when comparing the data with each other.

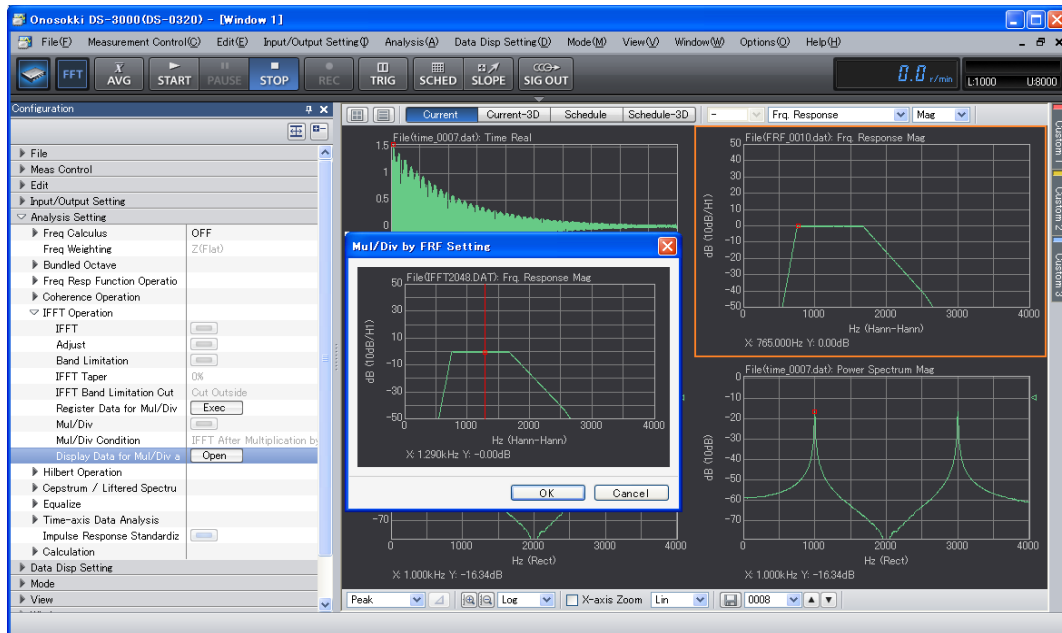


-4 IFFT Operation

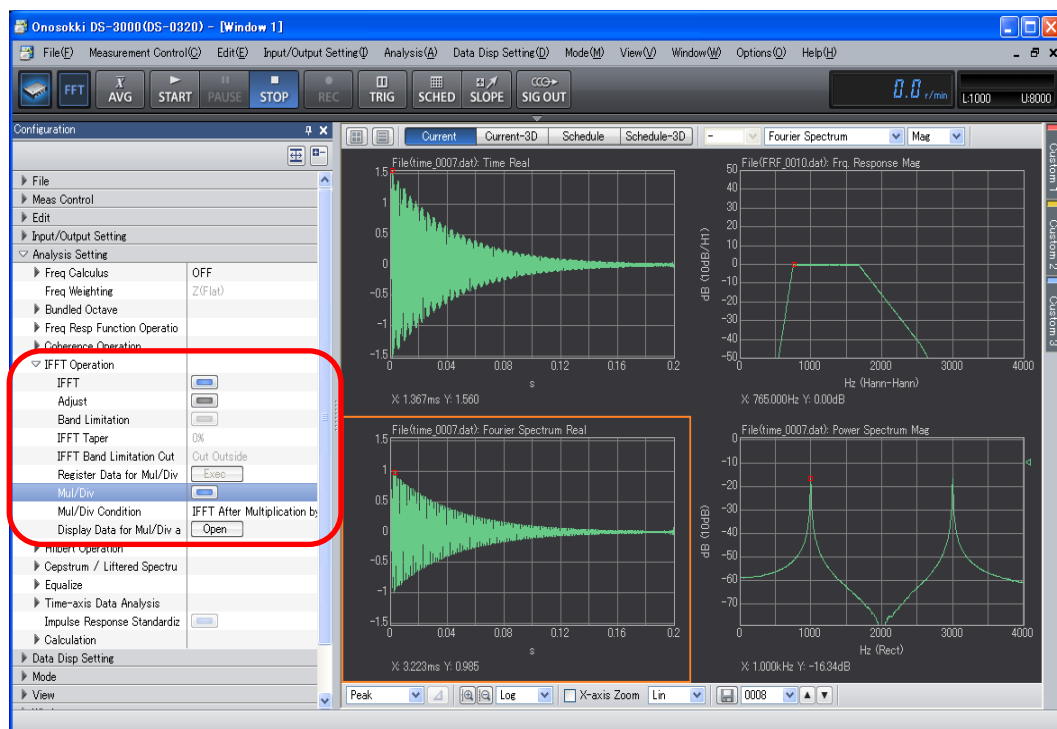
- ① Click on the upper right graph (i.e., FRF: frequency response function) to make it active.
- ② In the "Configuration" window, click "Analysis Setting" > "IFFT Operation" > "Register Data for Mul/Div" → "Exec".



- ③ Similarly, click "Display Data for Mul/Div at FRF" > "**Open**". The "Mul/Div by FRF Setting" dialog box will open. In this dialog box, you can check the frequency response function entered.

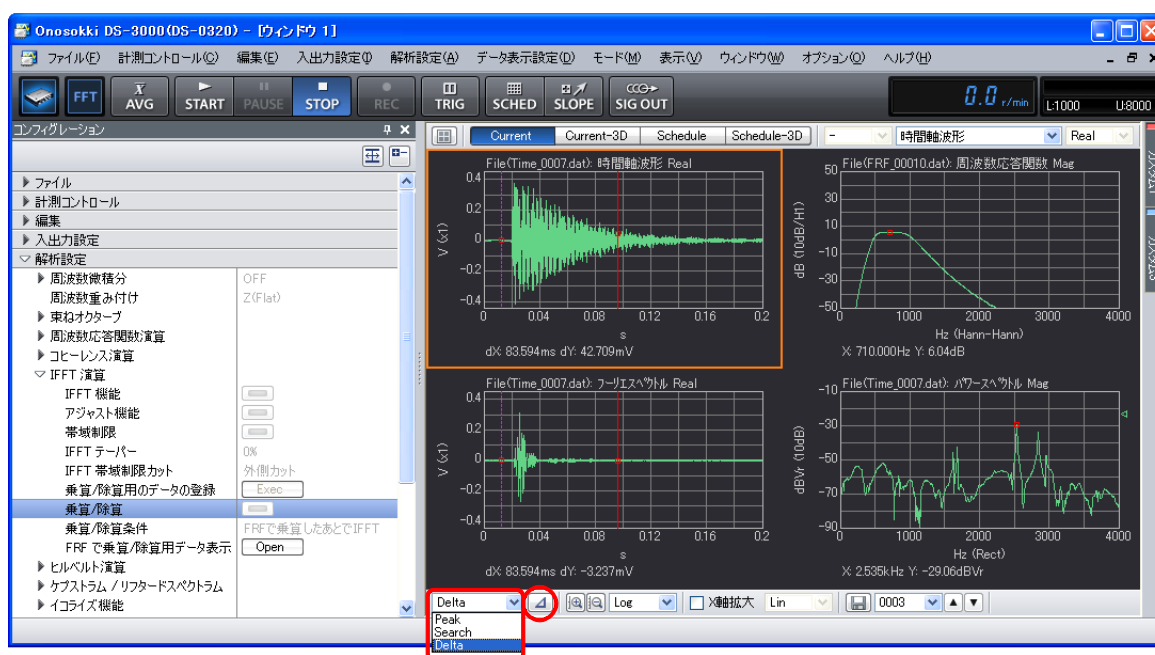


- ④ Click on the lower left graph to make it active.
- ⑤ In the "Configuration" window, click "Mul/Div Condition" > "IFFT After Multiplication by FRF".
- ⑥ Similarly, click "Mul/Div" > "ON". According to the above setup, the active Fourier spectrum will be multiplied by the specified frequency response function upon IFFT operation.
- ⑦ Click "IFFT Operation" > "ON". This operation will display the IFFT operation results.



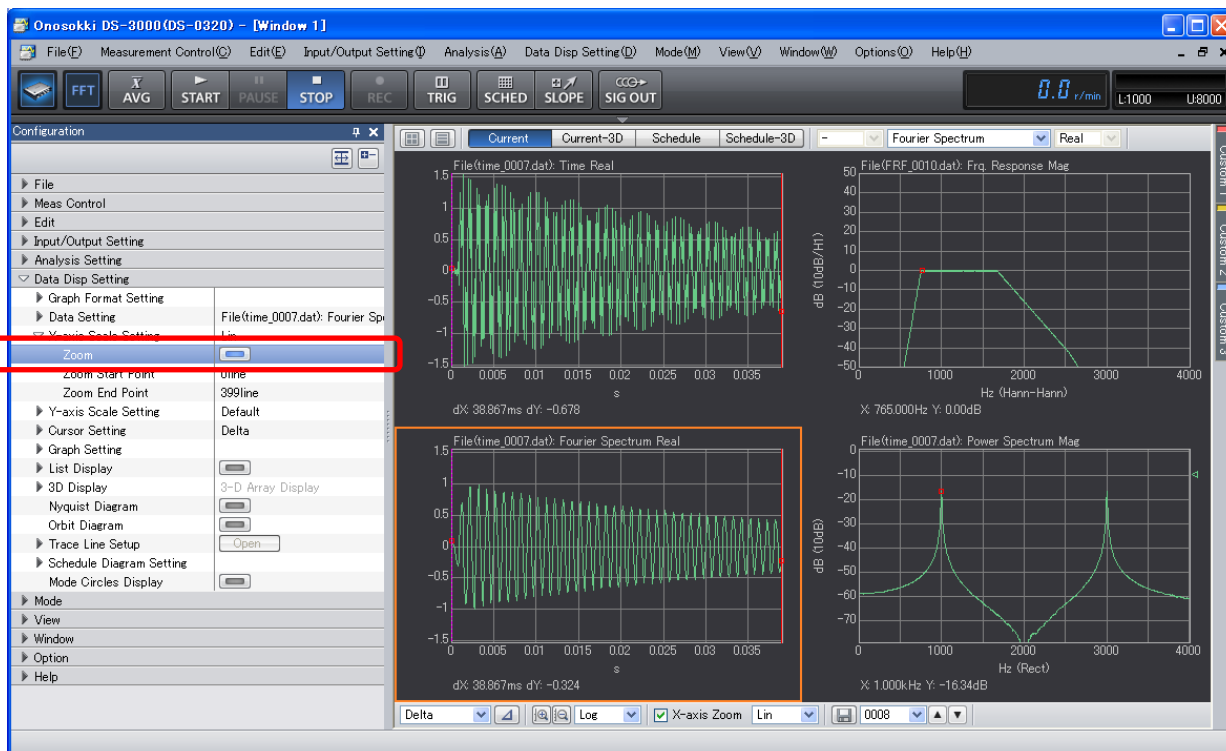
-5 X-axis Zooming


- ① Click on the lower left graph to make it active. Then, select "Delta" in the cursor setup tool shown in the bottom left of the graph window.
- ② Similarly, click on the upper left graph to make it active. Then, select "Delta" in the cursor setup tool shown in the bottom left of the graph window.
- ③ Click on the desired x-axis position to specify the lower end of the zooming range. Then, click the " " button. The red color of the cursor line will change to pink. Then, click on the upper end point of the desired zooming range to show a red cursor line. Both the upper left and lower left graphs will show the same zooming range.

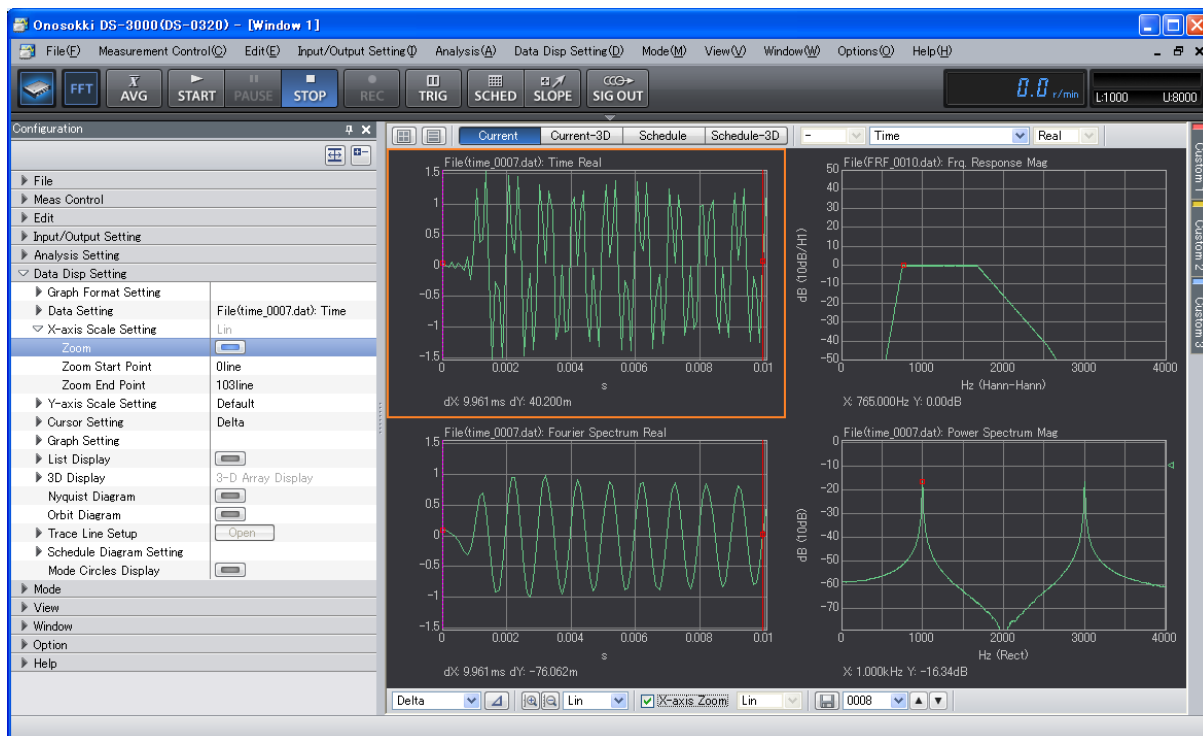


- ④ In the "Configuration" window, click "Data Disp Setting" > "X-axis Scale Setting" > "Zoom" > "ON".
- ⑤ Similarly, click on the character string of "File (time_0007.dat): Fourier spectrum Real" of the lower left graph to make it active. Note that you should click outside the graph area, because clicking inside the graph area will move the cursor.

- ⑥ In the "Configuration" window, click "Data Disp Setting" > "X-axis Scale Setting" > "Zoom" > "ON ".



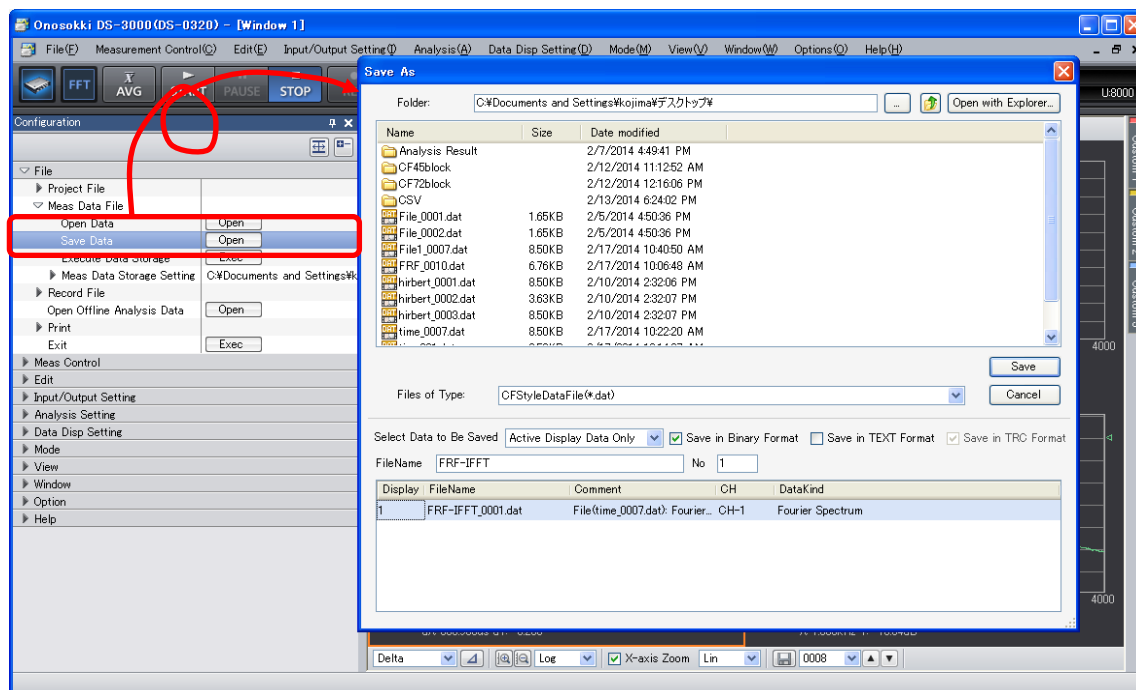
- ⑦ To change the zooming range, select "Zoom" > "OFF " for both the upper left and lower left graphs, and then repeat the above steps ① to ⑥.



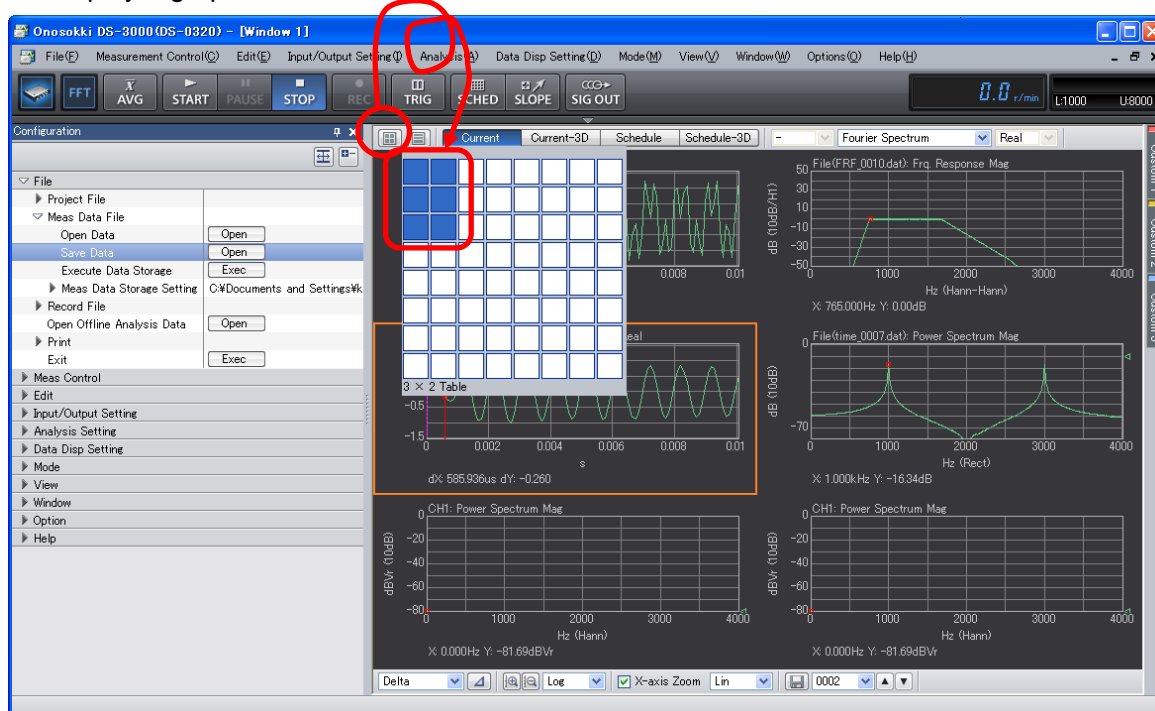
-6 Displaying the Power Spectrum of the Data after IFFT Operation

For this, it is necessary to once save the IFFT data being displayed, and to replay the data.

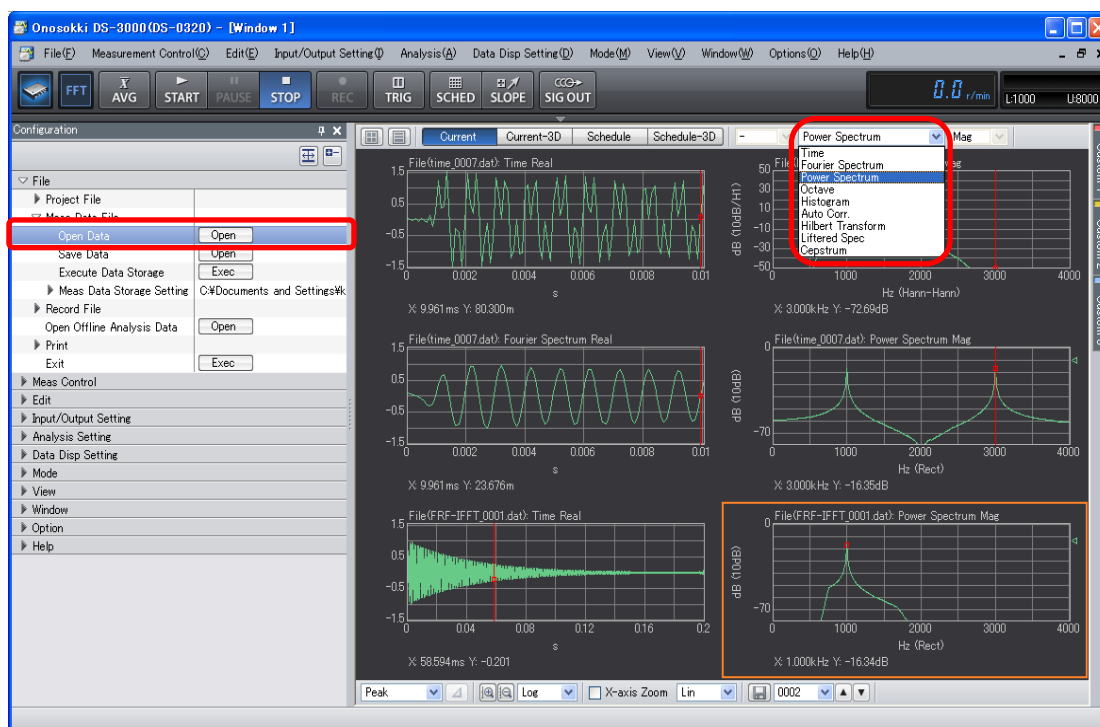
- ① Click on the lower left graph (i.e., IFFT result) to make it active.
- ② In the "Configuration" window, click "File" > "Meas Data File" > "Save Data". When the "Save as" dialog box is displayed, save the file accordingly.



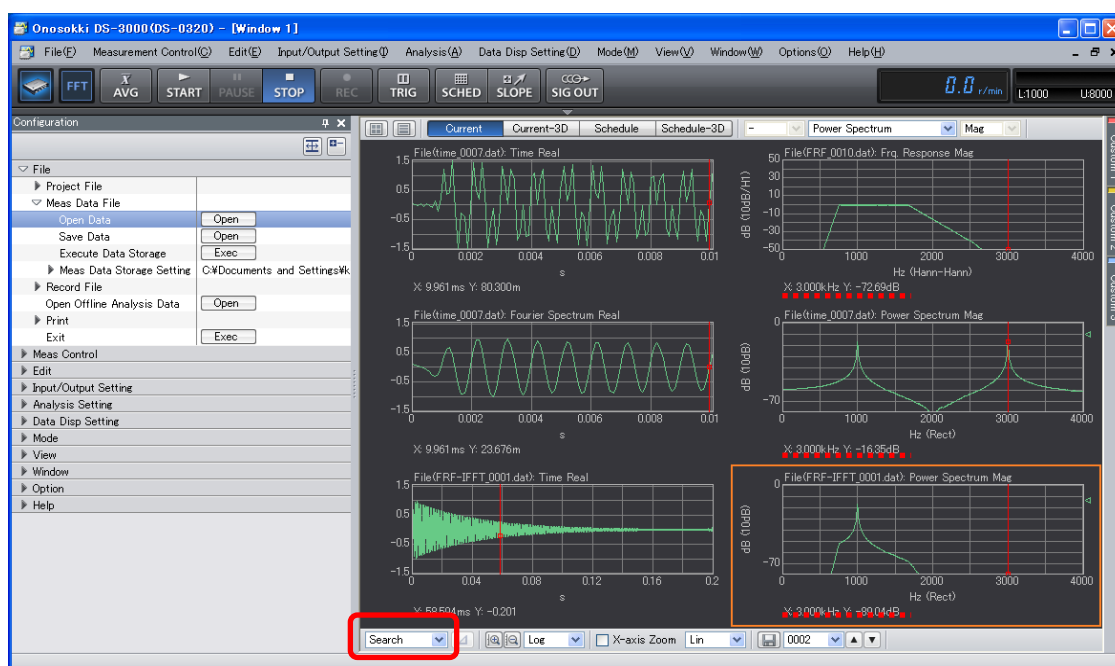
- ③ After clicking on the tool icon in [] the upper left corner of the graph window which is used to specify the number of graph screens, select 6 graph segments as shown in the following figure to display 6 graphs.



- ④ Click on the bottom left graph to make it active.
- ⑤ In the "Configuration" window, click "File" > "Meas Data File" > "Open Data" > "Open" to open the file saved in the above step ②.
- ⑥ Similarly, click on the bottom right graph to make it active to open the same data source. Then, set the input source to "Power Spectrum".



- ⑦ Use the cursor setting tool in the bottom left corner of the graph screen to select "Search" for the three right side graphs. Then, click on any desired point on the power spectrum graph to read the value from the cursor data.



From the above figure, you can read the respective values of the three graphs for the 3000 Hz spectral component, i.e., frequency response function is -72.69 dB, power spectrum level before IFFT operation is -16.35 dB, and power spectrum level after IFFT operation is -89.04 dB.

Because multiplication in linear space is equivalent to addition in log scale (dB), the above relationship is expressed as " $-72.69 + (-16.35) = -89.04$ ".

-7 Returning to the Measurement Window

To return to the measurement window, open a new project by the operation given in Procedure 1.

End