

INSTRUCTION MANUAL
DCS-101A/103A
OPTIONAL FUNCTION OF DCS-100A
EDX-3000A
REAL-TIME PROCESSING
[FOR FFT ANALYSIS]

Thank you for purchasing KYOWA's product DCS-101A/103A.
Read this Instruction Manual carefully in order to make full use of the high performance capabilities of the product.
Do not use the product in methods other than described in this Manual.

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NOTATIONS USED IN THE INSTRUCTION MANUAL

Certain notations are used as necessary to attract your attention to information that requires special care when handling the product, and to information provided for reference purposes.

Examples of Notations

NOTE

Essential precautions required when handling the DCS-100A.

MEMO

Reference items required when handling the DCS-100A.

IMPORTANT PRECAUTIONS WHEN USING DCS-100A

●For PC settings

Do not set your PC to the following state. Or, the DCS-100A may not properly operate.

- Screen saver is set to activate.
- Power consumption function including System standby is set to activate.
- Application software such as virus check software, etc. is set to activate on the way.
- PC is receiving access from the network. Or the PC is accessing to the network.

●For Windows font size

Select the font size "Normal (small)".

- Windows 8/8.1

Right-click the desktop and click **Personalize** on the pop-up-menu.

Click the **Display** given at the bottom of left-sidebar.

Put a check mark to the check box next to the "Let me choose one scaling level for all my displays."

Select the "Smaller - -100% (default)" on the Display window. Click the **Apply** button.

1 Outline

The DCS-100A is a Dynamic Data Recording Software that, by controlling Kyowa's dynamic measuring instrument, is designed to record data. The DCS-101A/103A is software that adds new functions to DCS-100A. The EDX-3000A is a memory recorder/analyzer that is designed to display/record/analyze data with a single unit.

This Manual describes the DCS-100A optional function and FFT analysis of the EDX-3000A real-time processing.

The FFT analysis function is able to analyze the measured data real-time on the FFT analysis window. The FFT analysis function is able to analyze maximum 4-channel data/window. The FFT analysis function is able to save the analysis results as the DAS-200A FFT analysis result file (CSV format file).

NOTE

Windows on the instruction manual are for the EDX-200A.
Items on windows vary with the measuring instrument.

1-1 Control target

To use the FFT analysis function of the DCS-101A/103A, use the following measuring instrument. For how to control the measuring instrument, see "DCS-100A INSTRUCTION MANUAL (FOR *** OPERATION)."

For how to control the EDX-3000A, see "EDX-3000A INSTRUCTION MANUAL (FOR RECORDING DATA)."

For the measuring instrument, see separate volume of "*** INSTRUCTION MANUAL (FOR HARDWARE)."

Measuring instrument	INSTRUCTION MANUAL
EDX-10A	[FOR EDX-10A OPERATION]
EDX-100A	[FOR EDX-100A OPERATION]
EDX-200A	[FOR EDX-200A OPERATION]
EDX-3000A/B	[FOR EDX-3000A/B OPERATION]
EDX-5000A	[FOR EDX-5000A OPERATION]
EDS-400A	[FOR EDS-400A OPERATION]
NTB-500A	[FOR NTB-500A OPERATION]
PCD-300 series	[FOR PCD-300 SERIES OPERATION]
PCD-400A series	[FOR PCD-400A OPERATION]
CTRS-100A	[FOR CTRS-100A OPERATION]

1-2 System requirements

OS	Windows 8.1, Windows 10, Windows 11 Japanese/English, 32-bit/64-bit version (Windows 11 is 64-bit Only) For the 64-bit OS, WOW64 (Windows 32-bit On Windows 64-bit).
CPU	Core i5 2 GHz or more
Memory	For 32-bit OS, 2 GB or more. For 64-bit OS, 4 GB or more.

NOTE

We (Kyowa) does not guarantee that the operation of the product will be uninterrupted or error-free.

When displaying multiple windows, an error may occur due to the PC performance.

At that time, decrease the number of windows.

1-3 Limitations on measuring conditions

- When executing the FFT analysis function, the DCS-100A is not able to execute the static measurements.

- Limitations on controlling the EDS-400A

When executing the FFT analysis function, the DCS-100A limits the sampling frequency 10k Hz or less.

- Limitations on controlling the EDX-100A

When executing the FFT analysis function, the DCS-100A limits the sampling frequency as follows.

Number of units	Sampling frequency limitations	
1 to 2	No limit	
3 to 4	1/2/5 system	1k Hz or less
	2n system:	1,024 Hz or less
5 to 8	1/2/5 system	100 Hz or less
	2n system:	128 Hz or less

- Limitations on controlling the EDX-200A

- When executing the dual-sampling measurements, the DCS-100A is able to analyze the high-speed sampling channels.
- When executing the noise-reduction function, the DCS-100A is not able to execute the FFT analysis function.
- When executing the FFT analysis function, the DCS-100A limits the sampling frequency as follows.

Number of units	Sampling frequency limitations		
1 to 2	No limit		
3	1/2/5 system	5kHz or less	Note1
	2n system:	4,096Hz or less	Note1
4 to 7	1/2/5 system	1kHz or less	Note1
	2n system:	1,024Hz or less	Note1
8	1/2/5 system	500Hz or less	Note1
	2n system:	512Hz or less	Note1

Note 1:

Suppose the Data Save Folder is "EDX-200A CF Card."

You cannot select the current sampling frequency when the number of data bytes is 1,280,000.

Calculate the number of data bytes as follows.

The number of data bytes = (The number of channels × 4 + The number of CAN-IDs × 8 + The number of ECAN-IDs × 8) × Sampling frequency

● Limitations on controlling the EDX-3000A

- When the number of units is 4 or more, the DCS-100A is not able to execute the FFT analysis function.
- When executing the FFT analysis function, the DCS-100A limits the sampling frequency as follows.

Arithmetic processing	Sampling frequency limitations
ON	The following sampling frequency or less $\text{Sampling frequency} = 250,000 / (\text{The number of channels} + \text{The number of CAN-IDs} \times 4)$ Note 1, Note 3
OFF	The following sampling frequency or less $\text{Sampling frequency} = 1,000,000 / (\text{The number of channels} + \text{The number of CAN-IDs})$ Note 2, Note 3

Note 1: The number of channels = The number of analog channels + the number of digital channels

Note 2: The number of channels = The number of analog channels + the number of digital channels + the number of calculation channels

Note 3: When the sampling frequency exceeds 10k Hz, the DCS-100A limits the sampling frequency 10k Hz or less.

● EDX-3000A built-in software

When executing the FFT analysis function, the DCS-100A limits the sampling frequency 10k Hz or less.

2 FFT analysis window

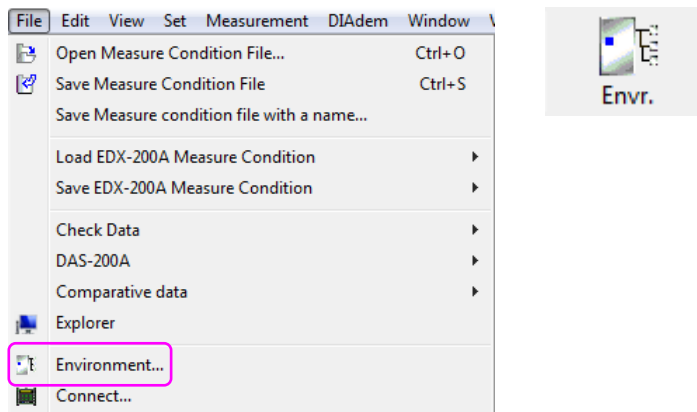
The FFT analysis function is able to analyze the measured data real-time on the FFT analysis window.

The FFT analysis function is able to analyze maximum 4-channel data/window.

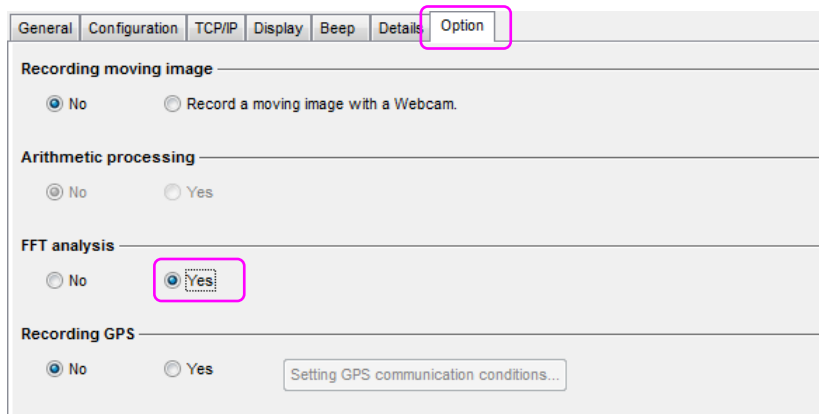
The FFT analysis function is able to save the analysis results as the DAS-200A FFT analysis result file (CSV format file).

■ To add the FFT analysis function

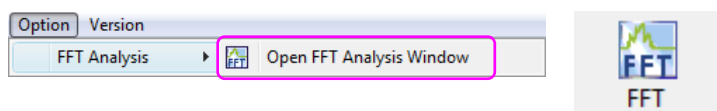
- (1) Click the File - Environment... or click the **Envr.** icon from the toolbar to open the Set Environment window.



- (2) Click the [Option] tab on the Set Environment window.
Select the "Yes" on the FFT analysis section on the [Option] tab.
Click the **OK** button to close the window.



- (3) The FFT analysis menu appears on the main menu and **FFT** icon appears on the toolbar.



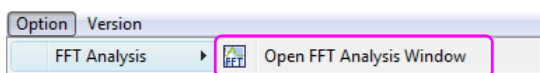
MEMO

When the [Option] tab does not appear on the Set Environment window, the optional function is not installed in the DCS-100A.

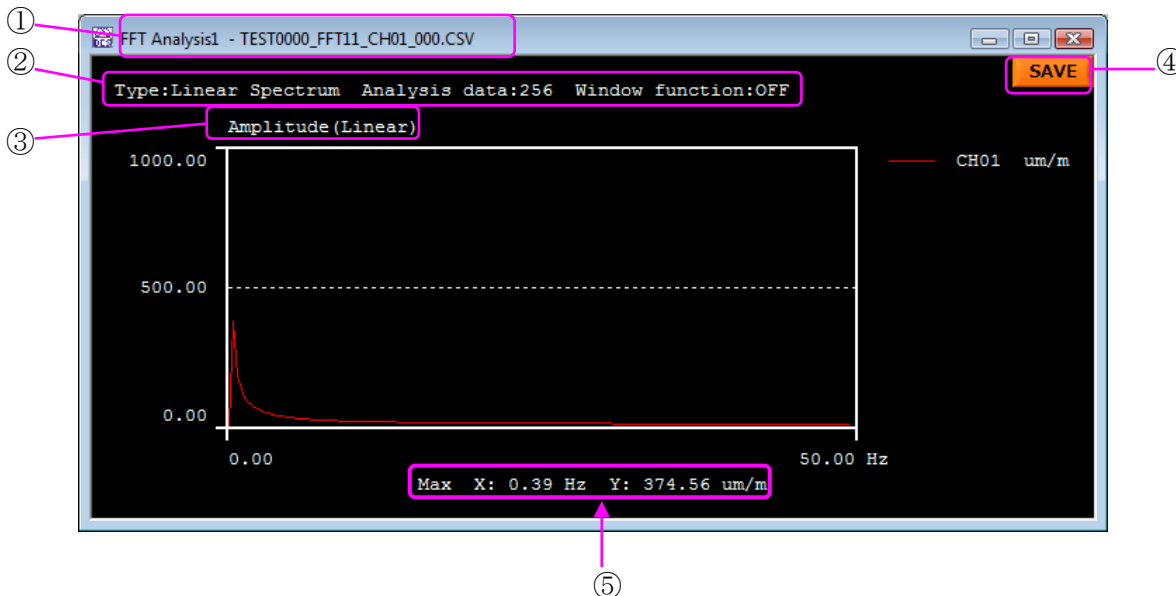
Setup the DCS-100A again to install the DCS-101A/103A.

■ To display the FFT analysis window

(1) Click the Option - FFT Analysis - Open FFT Analysis Window or click the **FFT** icon from the toolbar.



(2) The following window appears.



① Title bar

The window No. and FFT analysis result file name appear.

② Analysis conditions

Current type of analysis, the number of analysis data, and window function appear.

③ Analysis results

Current analysis result data appears.

④ **SAVE** button

Saves the analysis results, currently displaying on the graph, in the FFT analysis result file.

To enable the **SAVE** button, display the analysis results on the graph.

Enabled:



Disabled:



⑤ Maximum amplitude

The maximum amplitude appears when the analysis result data is "Amplitude (linear)."

MEMO

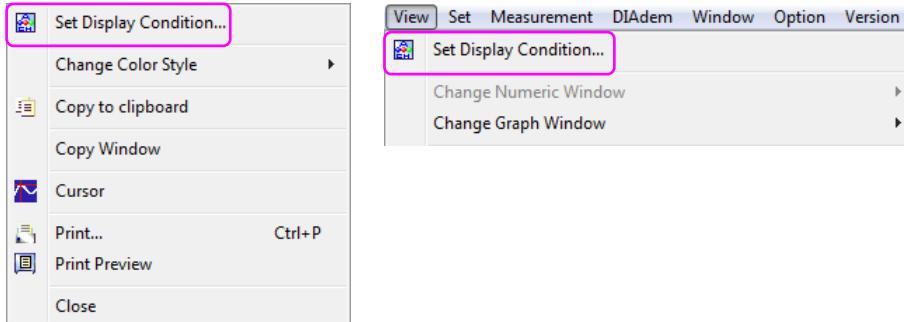
The DCS-100A is able to display up to 8 FFT analysis windows.

2-1 To set analysis conditions and display conditions

This section describes how to select the analysis conditions and display conditions on the Set Display Condition... window.

■ To display the Set Display Condition... window

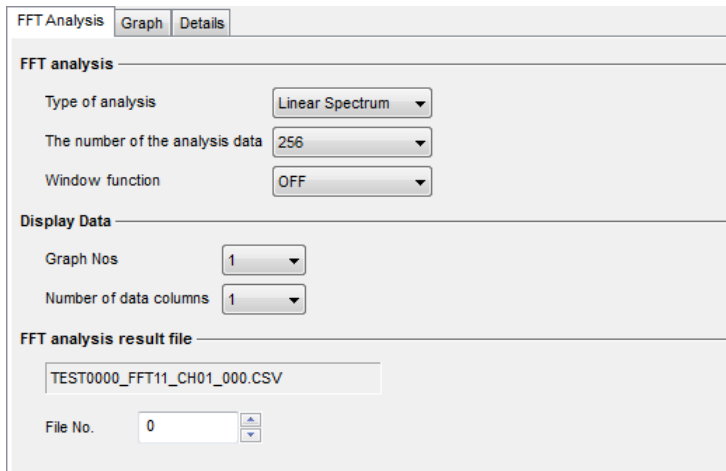
- (1) Right-click the FFT analysis window and click the **Set Display Condition...** or activate the FFT analysis window and click the View - Set Display Condition....



- (2) The Set Display Condition... window appears.

■ [FFT analysis] tab

This section describes how to set the following [FFT analysis] tab. Select the FFT analysis conditions on the [FFT analysis] tab.



(1) FFT analysis

- | | |
|-----------------------------|--|
| Type of analysis | Select the type of analysis.
Linear spectrum, power spectrum, cross spectrum, auto-correlation, cross-correlation |
| The number of analysis data | Select the number of FFT analysis data.
256/512/1024/2048/4096/8192 |
| Window function | Select the FFT analysis window function.
OFF, Hanning, Hamming, Fejer, Blackman, Gaussian |

(2) Display Data

- | | |
|------------------------|--|
| Graph Nos | Select the number of graphs on the FFT analysis window.
The number of channels to be displayed is maximum 1 channel.(Setting range: 1 to 4) |
| Number of data columns | Select the number of data columns on the graph.(Setting range: 1 to 2) |

(3) FFT analysis result file

File name The FFT analysis result file name, saving the analysis results, appear.
FFT analysis result file names are specified as shown below.

① FFT ②③ _CH ④ _ ⑤ . CSV

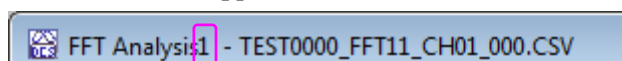
①KS2 format file name

The data file name for saving the measured data

②Window No.

ID No. of the FFT analysis window

The window No. appears on the window title bar as follows.



③Graph No.

ID No. of the graph for displaying the analysis results

④CH No.

CH No. of the target channel

⑤File No.

Select the file No.

As the DCS-100A saves the analysis results, the file No. increments automatically.

Setting range: 0 to 9999

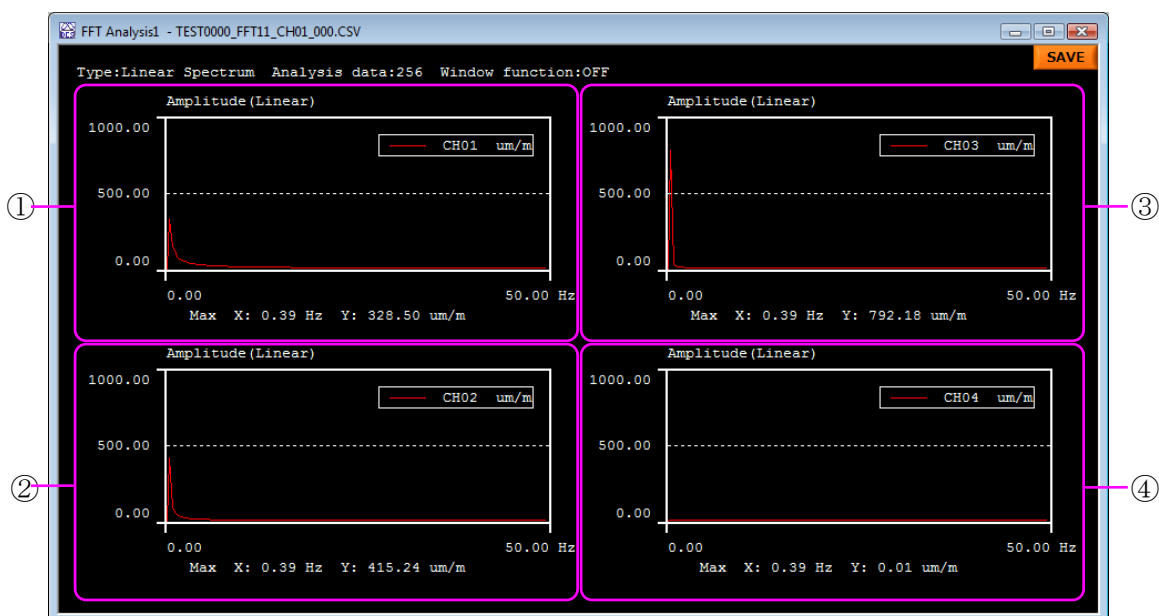
[Example 1]

Suppose the conditions are as follows.

KS2 format file: TEST0000.KS2, Type of analysis: Linear spectrum, Window No.: 1,

Graph Nos: 4, File No.: 2

The DCS-100A saves the analysis results in the following FFT analysis result file.



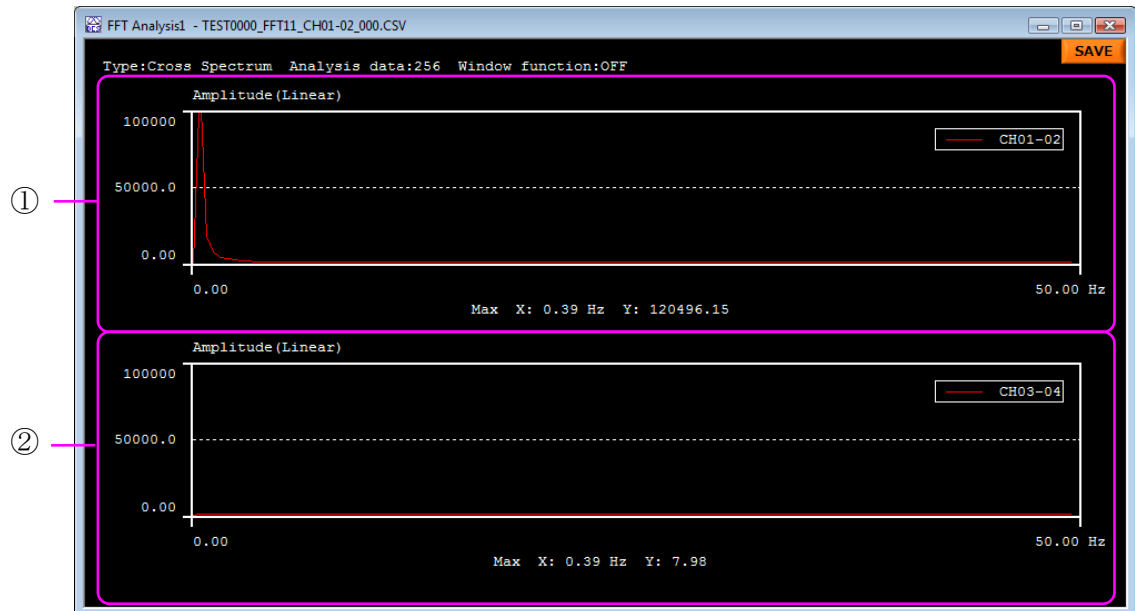
- ①Graph 1 FFT analysis result file name: TEST0000_FF11_CH01_002.CSV
- ②Graph 2 FFT analysis result file name: TEST0000_FF12_CH02_002.CSV
- ③Graph 3 FFT analysis result file name: TEST0000_FF13_CH03_002.CSV
- ④Graph 4 FFT analysis result file name: TEST0000_FF14_CH04_002.CSV

[Example 2]

Suppose the conditions are as follows.

KS2 format file: TEST0001.KS2, Type of analysis: Cross spectrum, Window No.: 3, Graph Nos: 2, File No.: 4

The DCS-100A saves the analysis results in the following FFT analysis result file.



① Graph 1 FFT analysis result file name: TEST0001_FF31_CH01-02_004.CSV

② Graph 2 FFT analysis result file name: TEST0001_FF32_CH03-04_004.CSV

■[Graph] tab

This section describes how to set the following [Graph] tab.

The DCS-100A displays the [Graph] tabs for the number of graphs.

(1) Display Data

Select the target channels, analysis result data, colors, and width
--- on the CH No.: Does not analyze data.

● The number of target channels varies with the type of analysis.

Type of Analysis	Number of target channels
Linear spectrum Power spectrum Auto-correlation	1
Cross spectrum Cross-correlation	2

● The analysis result data varies with the type of analysis.

Type of Analysis	Analysis result data
Linear spectrum Cross spectrum	Amplitude (linear) Amplitude (logarithm) Phase
Power spectrum	Amplitude (linear) Amplitude (logarithm)
Auto-correlation Cross-correlation	Correlation

MEMO

- Channels on the CH Disp Bar are able to be set on the FFT analysis window by drag-and-drop operations.
(For details, see "5-7" in the DCS-100A INSTRUCTION MANUAL [FOR COMMON OPERATION].)
- The **Change channel** button appears on the left on the FFT analysis windows, when you point the mouse cursor on the left (or the **Change channel** button appears on the right on the FFT analysis windows, when you point the mouse cursor on the right).
The **Change channel** button enables you to change the channels to be analyzed.
(For details, see "5-9" in the DCS-100A INSTRUCTION MANUAL [FOR COMMON OPERATION].)

(2)X Axis Scale

Select the scale value, the number of divisions, and deci digits of the scale value on the x axis.

(3)Y Axis Scale

Select the scale value, the number of divisions, and deci digits of the scale value on the y axis.

MEMO

For the X Axis Scale section and Y Axis Scale section, see "3-3-1" in the DCS-100A INSTRUCTION MANUAL [FOR COMMON OPERATION].

■[Details] tab

This section describes how to set the following [Details] tab.

MEMO

For details, see "3-3-1" in the DCS-100A INSTRUCTION MANUAL (FOR COMMON OPERATION.)"

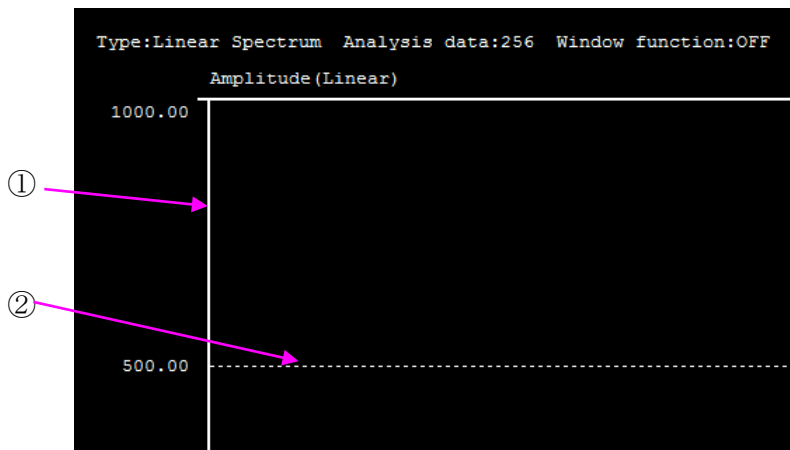
(1) Font



To set the fonts on the FFT analysis window, set them on the "Font" section.

Font			
	Font Name	Size	Color
①	Title	Courier New	10
②	Scale	Courier New	10
③	Axis Label	Courier New	10
④	Legend	Courier New	10

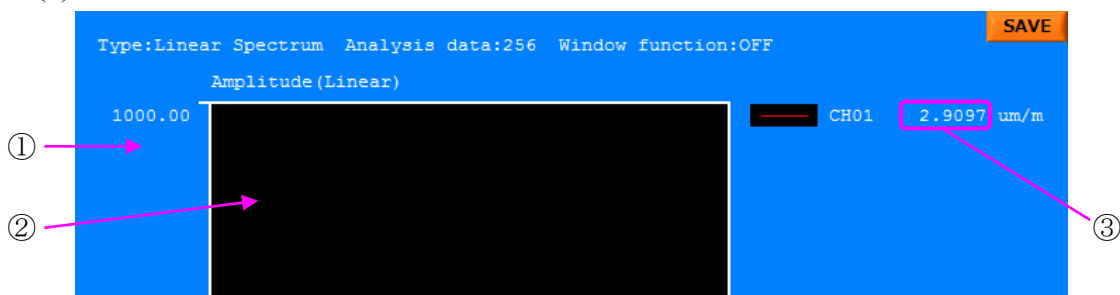
(2) Line



To set the lines on the FFT analysis window, set them on the "Line" section.

Line			
	Width	Style	Color
① Frame Line	2	Solid	
Split Line	1	Dot	
② Cursor	1	Solid	

(3) Color



To set the colors on the FFT analysis window, set them on the "Color" section.

Color	
① Window Background	
② Graph Background	
③ Value (Normal)	

2-2 To analyze data

This section describes how to analyze data on the FFT analysis window.

(1) Activate the FFT analysis window.

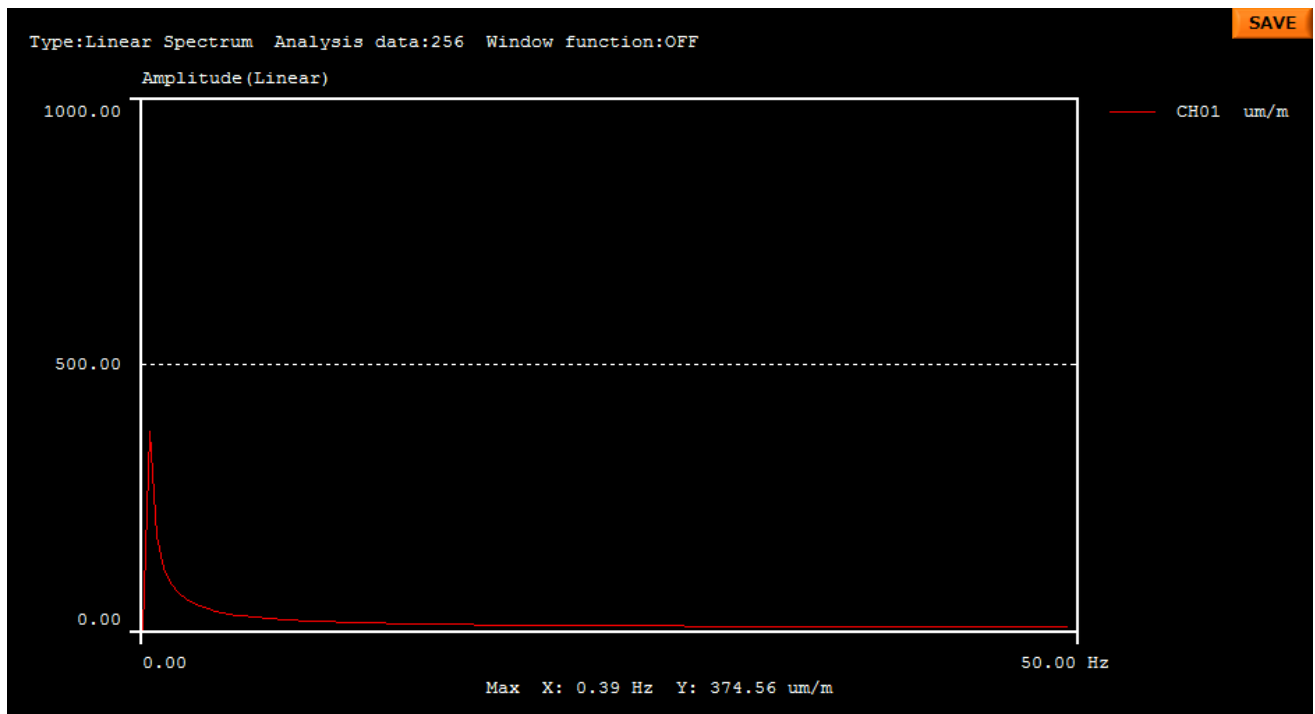
Select the analysis conditions and display conditions on the Set Display Condition... window.

(For details, see “2-1 To set analysis conditons and display conditons.”)

(2) Starts monitoring data by any of the following.

- Click the Measurement - MONITOR.
- Click the **Monitor** icon from the toolbar.
- Click the **MONITOR** button from the Meas Operation Panel.

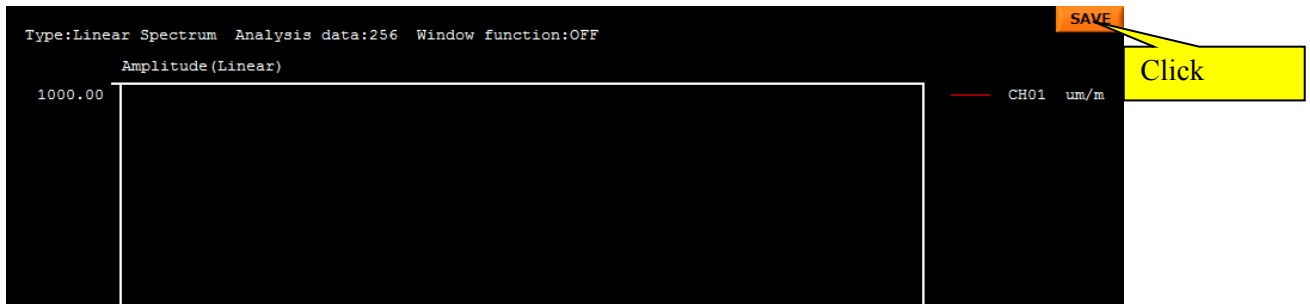
(3) After getting the measured data for the number of analysis data, the DCS-100A analyzes the data and displays the analysis results on graphs.



MEMO

As the DCS-100A gets the measured data for the number of analysis data, the DCS-100A analyzes the data and updates the analysis results on graphs.

- (4) Click the **SAVE** button to save the analysis results, currently displaying on the graph, in the FFT analysis result file.



NOTE

- To save the analysis results, click the **SAVE** button on each window.
- The DCS-100A does not save the analysis results by any of the following.
 - Click the Measurement - REC.
 - Click the **Record** icon from the toolbar.
 - Click the **REC** button from the Meas Operation Panel.

To save the analysis results, click the **SAVE** button on each window.

- (5) As the DCS-100A saves the analysis results, the file No. increments automatically.
The **SAVE** button is disabled until the DCS-100A gets the measured data for the number of analysis data.

2-3 FFT analysis result file

The FFT analysis result file format is described as follows.

The FFT analysis result file includes the measured data, before the FFT analysis, and analysis result data.

"FFT_FILE"	① File title	
"ID No.", "DCS-100A"	② ID No.	
"Title", ""	③ Title	
"Test Date", "2014/10/01", "18:08:52"	④ Analyzed date and time	
"Sampling Rate(Hz)", 10000	⑤ Measured sampling frequency	
"FFT Type", "Linear spectrum"	⑥ Type of analysis	
"Window Function", "OFF"	⑦ FFT analysis window function	
"Data/CH", 8192	⑧ The number of data	
"FFT Point Nos", 8192	⑨ The number of FFT analysis data	
"FFT Data Nos", 4096	⑩ The number of analysis result data	Note 1
"Data Interval (Hz)", 1.220703	⑪ FFT analysis data intervals	
"Average Times", 1	⑫ FFT analysis average times (1 fixed)	
"Shift Data Nos", 0	⑬ The number of the shift data while averaging	
"Unit", "με", "με", "°", "dB"	⑭ Measured data units and analysis result data units	
"Data No.", "CH-A1 data", "Amplitude", "Phase", "Logarithmic Amplitude"	⑮ Data item names on and after the next line.	
1,-2297.813,1.0000e-15,0.0000,-373.5031	⑯ Measured data and analysis result data	
:		
4096,-4396.563,0.3281065,-0.01730974,-83.18274		
4097,-4411.406		
:		
8192,-4971.406		

[Note 1]

The number of analysis result data varies with the type of analysis.

Type of Analysis	Analysis result data
Linear spectrum Cross spectrum Power spectrum	The number of data/2
Auto-correlation Cross-correlation	The number of data/4

3 Definition of FFT analysis

3-1 Definition of various spectrums

DAS-200A is designed to obtain various spectrums by FFT (Fast Fourier Transform). In order to express the FFT results in real amplitude (Coefficient of Fourier series), real number and imaginary number of FFT analysis results, that is a complex form of Fourier series, are doubled, respectively to be used as FFT results.

$$(X_a = R_a + jI_a)$$

Since DAS-200A functions to obtain the average of object time series data before signal waveform is subjected to FFT analysis and compensate the time series data (subtraction), it is not applicable for DC component.

This section describes details of various spectrums processing in DAS-200A.

■ Linear spectrum

DAS-200A serves to obtain the amplitude and phase spectrums of object signal waveform.

The amplitude spectrum is defined by real amplitude of Fourier series to be regarded as half amplitude (0 to peak value) of frequency components. It is expressed in the unit of signal waveform (example: V, $\mu\text{m/m}$, etc.)

Logarithmic display of the amplitude spectrum is a relative display with maximum amplitude of frequency components set to "0" dB. The phase spectrum is expressed by -180 to 180 (degree).

Subscript a in the following equation denotes "Analysis CH-A".

$$\text{Amplitude} \quad |X_a| : \sqrt{R_a^2 + I_a^2}$$

$$\text{Logarithm (dB)} : 20 \log \frac{|X_a|}{|X_a|_{\max}} \quad , \quad |X_a|_{\max} : \text{Maximum amplitude}$$

$$\text{Phase} \quad \theta_a : \tan^{-1} \frac{I_a}{R_a}$$

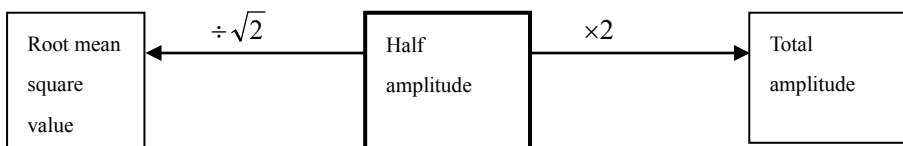
Suppose amplitude spectrum $|X_a|$ is compared with the amplitude spectrum $|C_a|$ that is based on complex form of Fourier series C_a . Then, the amplitude spectrum is doubled as shown in the following equation.

$$|C_a| = \sqrt{C_a \cdot C_a^*} = \sqrt{\left(\frac{a_a - jb_a}{2}\right) \cdot \left(\frac{a_a + jb_a}{2}\right)} = \frac{1}{2} |X_a|$$

where, C_a : Complex form of Fourier series

a_a, b_a : Coefficients of Fourier series

In addition, relations between half amplitude of amplitude spectrum and root mean square value (rms), and between total amplitude (p-p value) are described in the following.



■ Power spectrum

Power spectrum is a square value of the linear spectrum amplitude. It is expressed in the unit of square value of signal waveform (example: V², etc.)

Logarithmic display of the power spectrum is a relative display with maximum amplitude of frequency components set to "0" dB.

Subscript a in the following equation denotes "Analysis CH-A".

$$\text{Amplitude} \quad |X_a|^2 : R_a^2 + I_a^2$$

$$\text{Logarithm} \quad (dB) : 10 \log \frac{|X_a|^2}{|X_a|_{\max}^2}$$

Suppose $|X_a|^2$ is compared with the power spectrum $|C_a|^2$ that is based on complex form of Fourier series C_a . Then, the power spectrum shall be 4 times as large the value as shown in the following equation.

$$|C_a|^2 = C_a \cdot C_a^* = \left(\frac{a_a - jb_a}{2} \right) \cdot \left(\frac{a_a + jb_a}{2} \right) = \frac{1}{4} (a_a^2 + b_a^2) = \frac{1}{4} |X_a|^2$$

where, C_a : Complex form of Fourier series
 a_a, b_a : Coefficients of Fourier series

■ Cross spectrum

The amplitude becomes a product of 2 signal frequency components and the phase expresses the relative difference of both phases. Subscripts a and b in the following equation denotes "Analysis CH-A" and "Analysis CH-B", respectively.

Logarithmic display of the amplitude spectrum is a relative display with maximum amplitude of frequency components set to "0" dB. The phase spectrum is expressed by -180 to 180 (degree).

$$\text{Amplitude} \quad X_{ab} : X_b \cdot X_a^* = \sqrt{R_{ab}^2 + I_{ab}^2} \quad , X_a^* : \text{Complex conjugate number of } X_a$$

$$\text{Logarithm} \quad (dB) : 20 \log \frac{X_{ab}}{X_{ab \max}} \quad , X_{ab \max} : \text{Maximum amplitude}$$

$$\text{Phase} \quad \theta_{ab} : \tan^{-1} \frac{I_{ab}}{R_{ab}}$$

$$(\text{Note}) \quad X_{ab} = X_b \cdot X_a^* = R_{ab} + jI_{ab}$$

■ Auto-correlation function

When the object signal waveform is displaced on the time axis, similarity with the original waveform is displayed and the value shall be between +1 and -1 that is normalized by a value of time lag "0."

F^{-1} The auto-correlation function is obtained by calculating Fourier inverse transformation (F^{-1}) of power spectrum $|X_a|^2$.

Subscript a in the following equation denotes "Analysis CH-A".

$$\frac{F^{-1}|X_a|^2}{F^{-1}|X_a(0)|^2}$$

■ Cross correlation function

When either one of 2 signal waveforms is displaced on the time axis, similarity with the other signal waveform is displayed and the value shall be between +1 and -1 that is normalized by a value of time lag "0."

F^{-1} The cross correlation function is obtained by calculating Fourier inverse transformation (F^{-1}) of cross spectrum $|H_{ab}|$. Subscripts a and b in the following equation denotes "Analysis CH-A" and "Analysis CH-B", respectively.

$$\frac{F^{-1}|H_{ab}|}{F^{-1}|H_{ab}(O)|}$$

3-2 Supplementary description

■ Time series data and FFT analysis results

When analysis object time series data is sampling frequency $\Delta t \times N$ (Number of data) = Cycle (Analysis interval), the k -order frequency f_k and base frequency f_l are expressed as follows.

$$f_k = \frac{k}{T} = \frac{k}{N\Delta t}$$
$$f_l = \frac{1}{T} = \frac{1}{N\Delta t}$$

Maximum order frequency is considered as $k = N/2$ and maximum analysis frequency is obtained by the following equation.

$$f_{N/2} = \frac{1}{2\Delta t}$$

Analysis frequency of the finite Fourier series is decomposed to components in the matter of double integers ($k = 1, 2, 3 \dots N/2$) from f_l to $f_{N/2}$.

($k=0$ is DC component)

The above mentioned base frequency f_l shall be a frequency resolution (Δf) of Fourier series.

In addition, it is the maximum analysis frequency that can be analyzed by $f_{N/2}$ and is called Nyquist frequency.

The FFT analysis in DAS-200A obtains $k=0, 1, 2, 3 \dots N/2-1$ ($N/2$) of data and the actual maximum analysis frequency is $f_{N/2-1}$.

For example, when sampling fundamental frequency 10k Hz (Sampling frequency $\Delta t = 10^{-4}$ sec) and the number of analysis data $N = 4096$ are subjected to FFT analysis, the cycle T (analysis interval) becomes 0.4096 sec. Therefore, base frequency f_l (= frequency resolution Δf) becomes 2.44 Hz and the maximum analysis frequency, $f_{N/2-1} = 4.99756$ k Hz.

4 SPECIFICATIONS

4-1 FFT ANALYSIS

Type of analysis	Linear spectrum, power spectrum, cross spectrum, auto correlation, cross-correlation
The number of analysis data	256, 512, 1024, 2048, 4096, 8192
Window function	OFF (square), humming, hanning, fejer, blackman, Gaussian
Number of analysis channels	Up to 4 channels/window, Up to 8 windows/display
Analysis result data	

Type of Analysis	Analysis result data
Linear spectrum Cross spectrum	Amplitude (linear) Amplitude (logarithm) Phase
Power spectrum	Amplitude (linear) Amplitude (logarithm)
Auto-correlation Cross-correlation	Correlation

Saving	Saves the analysis results as the DAS-200A FFT analysis result file (CSV format file).
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4-2 DCS-101A/103A AND CONTROL TARGET

DCS-101A	EDX-10A, EDX-100A, EDX-200A, EDX-5000A, EDS-400A, NTB-500A, PCD-300 series, PCD-400A series, CTRS-100A
DCS-103A	EDX-3000A