Portable FFT Analyzer CF-9200/9400

Excitation control and Resonance analysis of an electromagnetic exciter using Log sweep/Excitation vibration control function (CF-0942)

November2015

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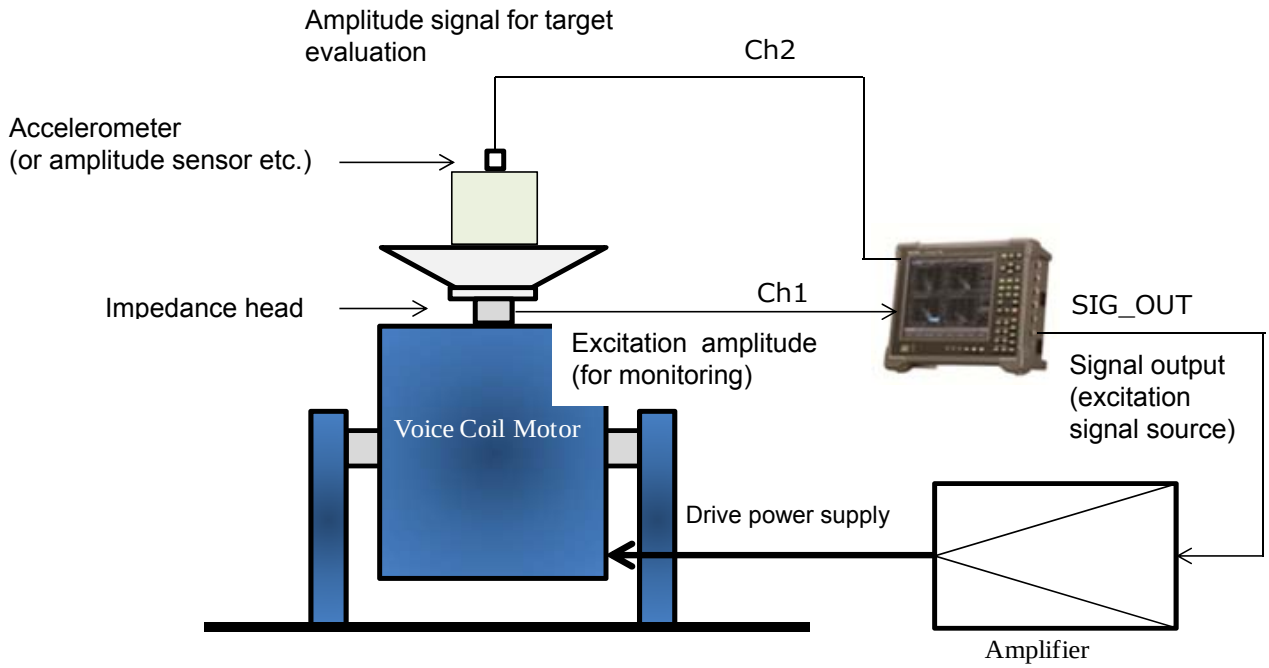
1. Introduction

CF-0971 (1ch signal output module) and CF-0942(Log sweep/excitation control function) equipped to CF9400 enable to analyze the resonance (frequency characteristics) of the object. The analysis is performed while controlling the target with the specified excitation amplitude (acceleration/velocity/displacement) or excitation power (N) by using an electromagnetic exciter.

Also, pinpoint controlling of the amplitude that is applied to a target is possible when laser Doppler vibrometer is used as an excitation control sensor.

Example of excitation control measurement using CF-9200/9400



2. Preparing equipment -Example of amplitude control -

■Portable FFT Analyzer

CF-9200/9400

◇CF-0971(1 CH signal output module) *option

◇CF-0942(Log sweep/Excitation control function) *option

■Amplitude detector for excitation control (acceleration, speed, displacement sensor or impedance head)

■Amplitude detector for response detector (acceleration, speed or displacement sensor)

■Electromagnetic exciter, excitation amplifier

■Various kinds of jigs/cables etc. when needed

◇All the accelerometers used in this tutorial are "accelerometer with built-in preamplifier ".

3. Before measurement

3-1. Setting an electromagnetic exciter, an evaluation target, and a detector

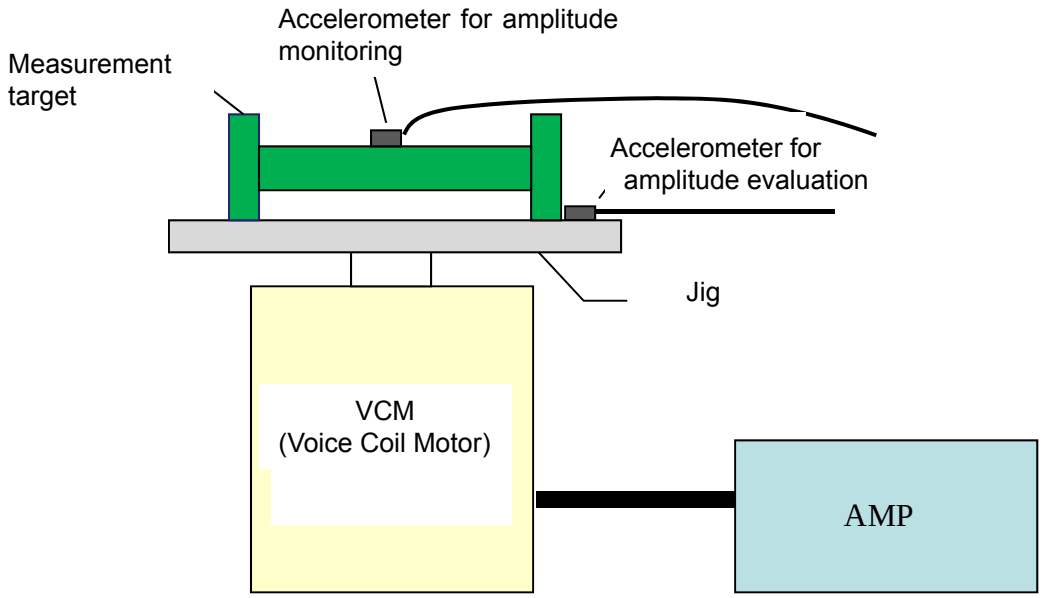
1) Connect a voice coil and amplifier of an electromagnetic exciter
2) Mount a jig to fix the target to an exciter (voice coil) if necessary.
3) Fix the target to the jig
4) Mount a detector for amplitude monitoring to the place where you want to control the excitation/amplitude value by the specified amplitude.
5) Mount the detector at where you want to perform the evaluation of the target amplitude.

*Accelerometers are used in all examples in here.

Amplitude detector: accelerometer, speed sensor, displacement sensor

◎ Mount a detector after calibration when the sensor calibration is performed by a calibrator.

→ Calibration of amplitude sensor using simple calibrator (VX-1100) →Refer to the end of this tutorial.



Electromagnetic exciter

【For successful measurement】

◎Note that the weight ratio of an accelerometer to be mounted and an evaluation target (general guide: 1: 50). Use a light weight accelerometer or non-contact accelerometer as needed.

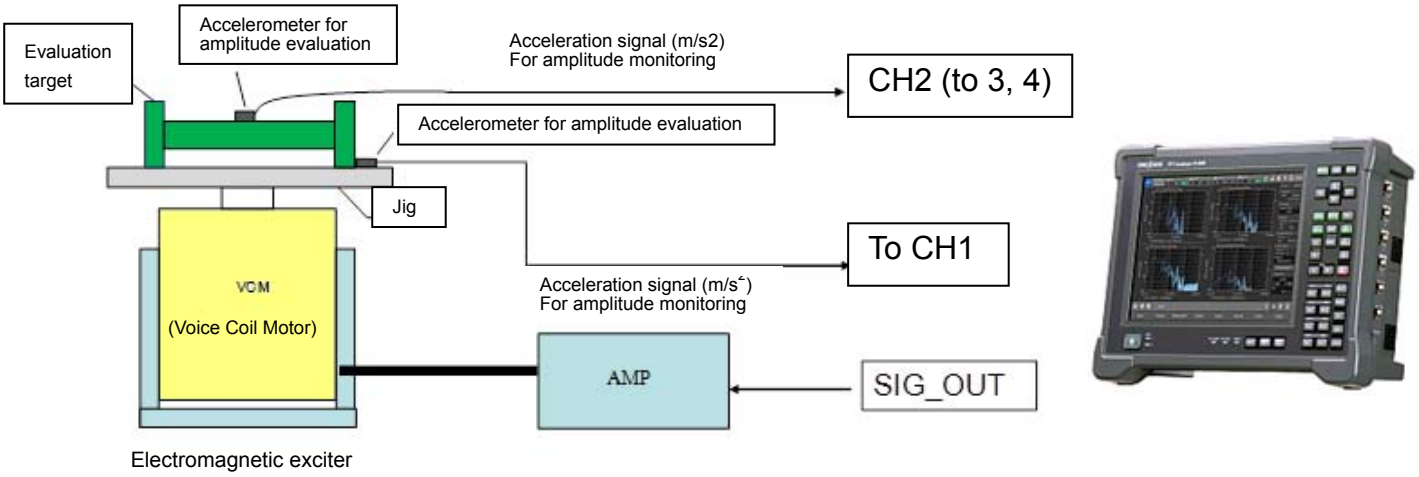
◎An accelerometer for monitoring should be mounted on the place where you want to control the amplitude applied, or near that place.

◎Pay attention to background noise of the sensor mounted place when a non-contact sensor (laser Doppler vibrometer or non-contact type displacement meter) is used.

3-2. Connecting with the CF-9200/9400

1) Connect an accelerometer for control to a signal input terminal [CH-1] on the CF-9200/9400 side.
2) Connect an accelerometer for evaluation to [CH-2 (to CH-3, 4)] on the CF-9200/9400 side.
3) Connect signal output [SIG_OUT] of FFT Analyzer to an external input of the amplifier [EXT_IN].
   *When the amplifier has an internal/external signal selection, select [EXT_IN].

Connection example of the CF-9200/9400 and an exciter



Example of an exciter, input switching of internal and external

3-3. Setting the CF-9200/9400

In here, switch the FFT Analyzer to exclusive mode, and perform various settings.

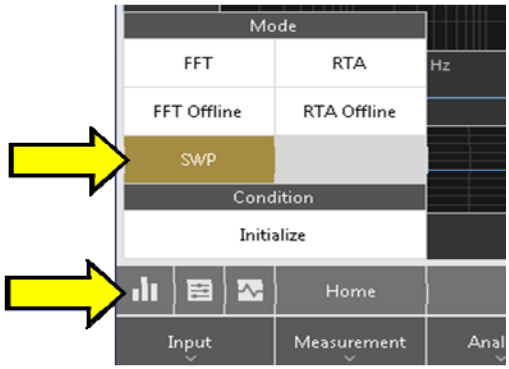
1) Starting the CF-9200/9400

   Press the POWER of CF-9200/9400, and startup the main unit.

   Press and hold the POWER switch for 1 second or more to turn the power ON.

   Touch the mode selection button at lower left of liquid crystal display, and select [SWP] mode.

   * Touch [OK] when a message appears.



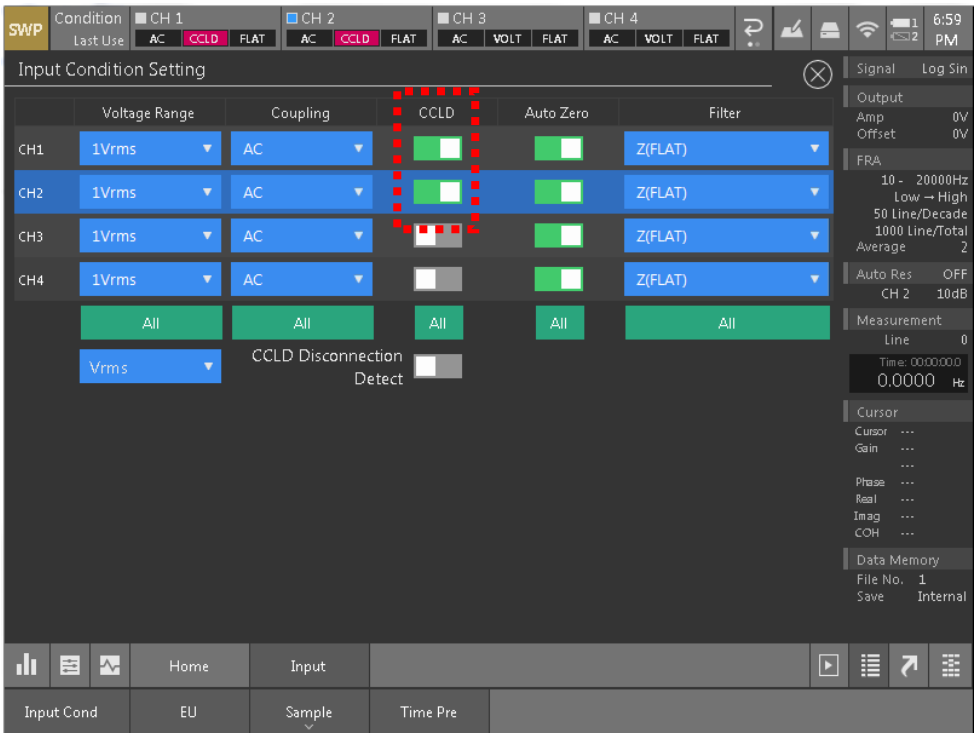
2) Supply power current to the accelerometer which is connected to the CF-9200/9400.*

*This process is not necessary when a TEDS sensor is connected.

Soft key: [Home]>[Input]>[Input_Cond]

Touch (select) [CCLD] of the channel to which the accelerometer is connected, and start to activate the accelerometer by using CCLD.

*CCLD: Constant Current Line Drive



◎After this operation, close the dialog with x.

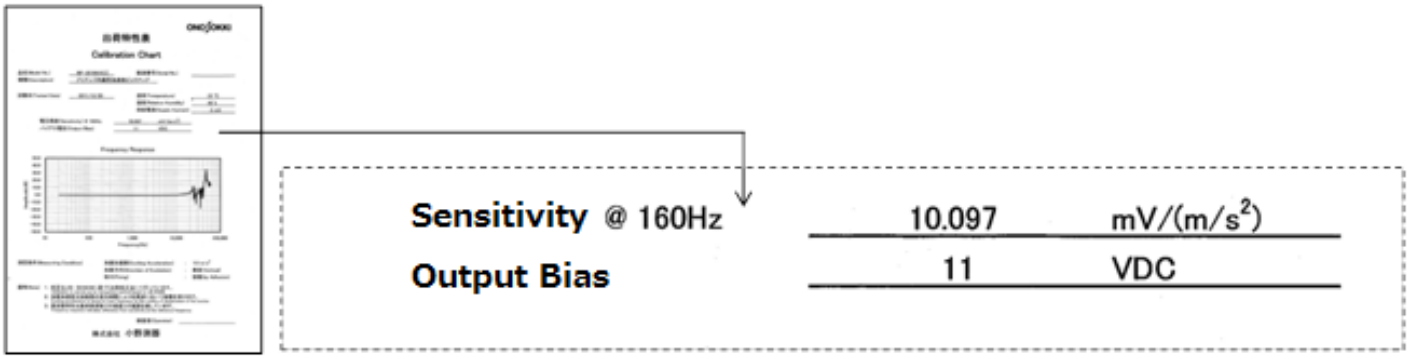
3) Unit calibration of a sensor connected

Input the relationship between the physical quantity (EU) and voltage (V) of the accelerometer which is connected to the CF-9200/9400.

[Calibration by "Calibration Chart"]

① Check the voltage sensitivity described on the “Calibration Chart“ attached to the sensor in use.

→10.097 mV/(m/s^2) (Voltage output of a acceleration per 1 m/s^2 (meters per second))



Voltage sensitivity:10.097 mV/ (m/s^2)

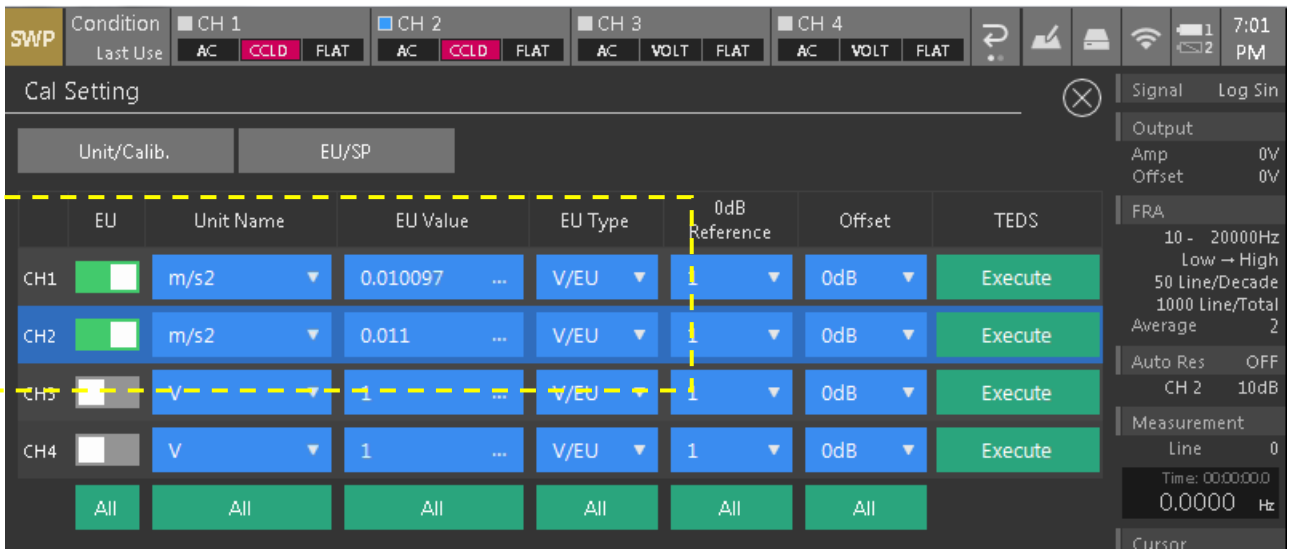
② Input of calibration value to the CF-9200/9400

Input voltage sensitivity to the CF-9200/9400.

Soft key: [Home]>[Input]>[EU]

When a diagram is open, touch [EU] to turn the calibration ON.

- CH1/CH2 **Unito_Name** :m/s^2 ⇐ Select the unit of amplitude value of the sensor connected.
-CH1 **EU_Valu** :0.010097 ⇐ Input the voltage sensitivity of the sensor connected to CH1
-CH1 **EU_Value** :0.011 ⇐ Input the voltage sensitivity of the sensor connected to CH2

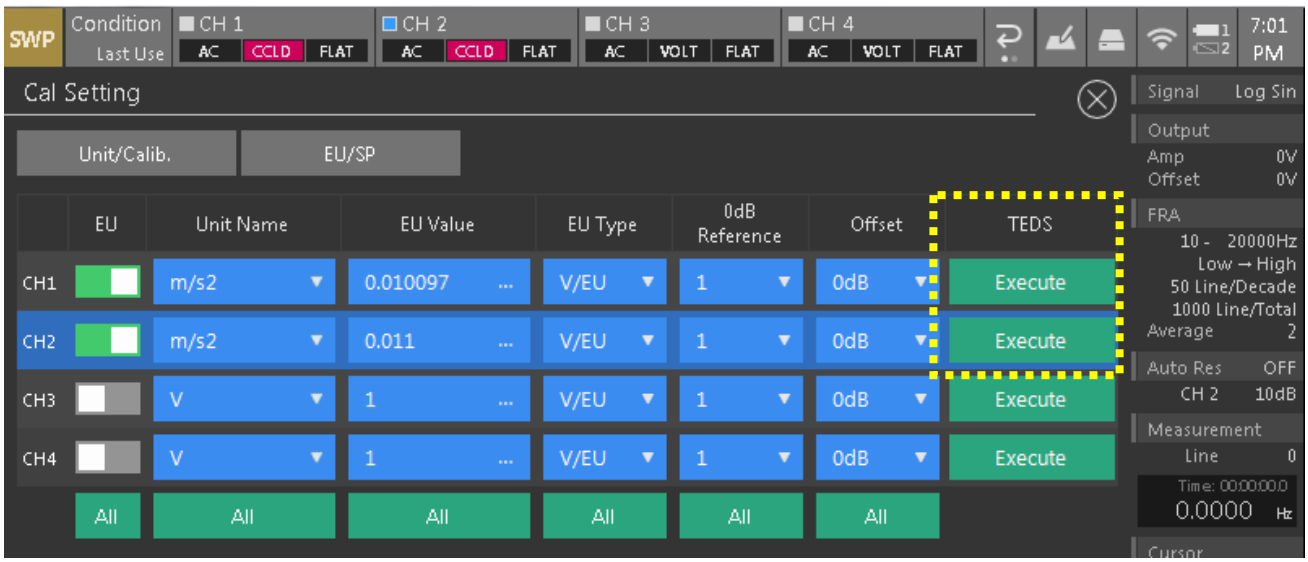


◎After this operation, close the dialog with x.

[Calibration by "TEDS"]

CF-9000 series can read the data from a TEDS sensor, supply power to the sensor and calibrate the unit automatically.

TEDS, abbreviations of “Transducer Electronic Data Sheet”, is the data format that writes sensor-specific information complies with international standards IEEE1451.4.
Any sensor with built-in TEDS data can send the sensitivity, weight and other data about the sensor itself to the connected the TEDS-supported FFT Analyzer. It can recognize such data and unit calibration is automatically performed.



① Check that the TEDS sensor is connected to the CF-9200/9400, and touch TEDS [Execute].
Soft key: [Home]>[Input]>[EU]
Touch TEDS [Execute].
Calibration operation is completed after the data of the sensor connected is read.

- CH1/CH2	**EU**	:ON	
- CH1/CH2	**Unito Name**	:m/s^2	⇐ Unit of amplitude value of the sensor connected.
- CH1	**EU Value**	:0.010097	⇐ Voltage sensitivity of the sensor connected to CH1
- CH2	**EU Value**	:0.011	⇐ Voltage sensitivity of the sensor connected to CH2

◎After this operation, close the dialog with x.

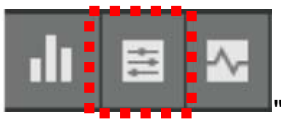
【For successful measurement】

Calibrations by "Calibration Chart" and "TEDS" are not guaranteed the sensor operation and voltage sensitivity on the day of measurement. When you acquire an important data, check the movement and sensitivity of the amplitude sensor by the VX-1100, or calibrate the vibration measurement system by the VX-1100 before use.

→Please refer to "6. Calibration procedure, etc."

3-4. Setting of Log sweep mode (Setting)

1) Select the icon "operation option window" at lower left on the LCD screen.

 "Operation option window" display

2) Setting1

- Switch the Signal to [Log Sin].

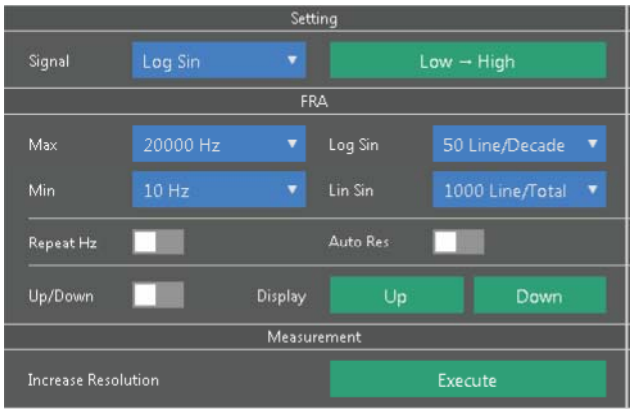
①-Set the sweep direction. [Low → high] ⇔ [High → low]

② -Set the upper limit [Max] (XX Hz) of excitation vibration frequency.

③ -Set the lower limit [Min] (XX Hz) of excitation vibration frequency.

④ -Set the number of lines per 1 Decade (XX Lins/Decade) by [Log_Sin]

⑤ -Select ON/OFF of [Auto_Res].



Recommended setting at operation test

（Each number below is corresponding to the each item number of “Setting-1” above.）

① Set [High → Low] at operation test.

② No upper limit in particular.

③ Higher setting of lower limit [Min] is recommended at operation test (100 Hz or more).

④ Set the fewer number of lines per 1 Decade at operation test (20 to 50 Lines).

⑤ OFF is recommended at operation test.

◇Operation test means setting operation to control the amplitude to be a target value.
The efficiency of setting operation is improved by confirming the operating conditions of amplitude control in a short time, which is possible by lowering frequency resolution and sweeping from high frequency side.

3) Setting2

Setting of Log sweep mode (set in the soft keys)

[Home] > [Measurement] > [Sweep]

① Turn [Auto Range] ON.

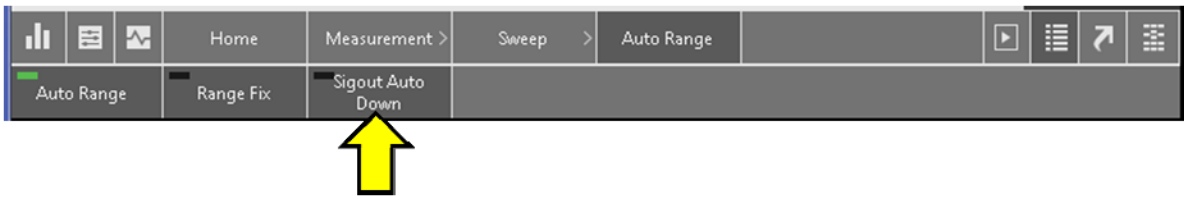
[Home] > [Measurement] > [Sweep] > [Auto Range]

*Automatic selection of input voltage range allows correspondence to the amplitude with wide dynamic range.

② Turn the signal output range adjustment function [Sigout Auto Down] to ON.

[Home] > [Measurement] > [Sweep] > [Auto Range] > [Sigout Auto Down] > [ON/OFF]

*Turn ON the function that can automatically adjust the output signal of CF-9200/9400 according to the target amplitude.



③ Select ON/OFF of auto coupling condition [Auto Coupling]

[Home]>[Measurement]>[Sweep]>[FRA Set]>[Auto Coupling]> [ON/OFF]

[Home]>[Measurement]>[Sweep]>[FRA Set]>[Auto Coupling]>[Change Freq]

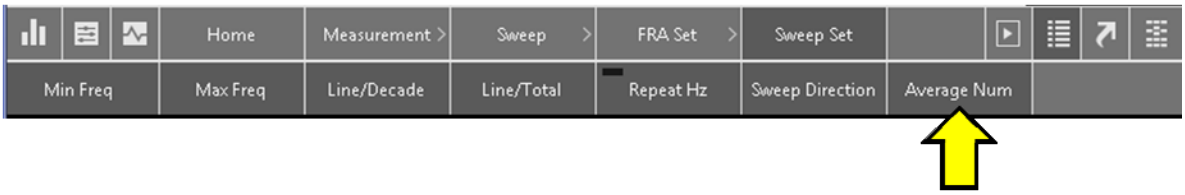
*This function automatically select AC or DC coupling when sweeping is performed in a range which is affected by cut-off frequency of AC coupling input. The cut-off frequency of AC coupling for CF-9200/9400 is 0.5 Hz. The frequency is selected from [Change Freq] as a guide at 1 Decade (5Hz). AC or DC coupling is automatically selected with the selected frequency as the border.

④ Set up the number of averaging [Average Num]

[Home]>[Measurement]>[Sweep]>[FRA Set]>[Sweep Set]>Average Num

*The number of averaging is set. The default value “twice” is set at the time of operation test.

When low frequency less than 100 Hz is in the sweep range, it takes more time for analysis if the averaging number of times is increased.



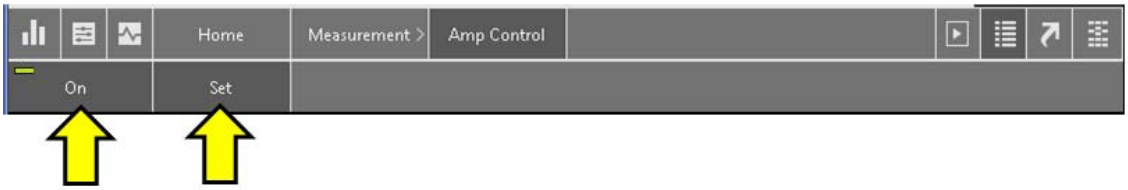
4) **Setting3**

Turn to [ON] the Amplifier control.

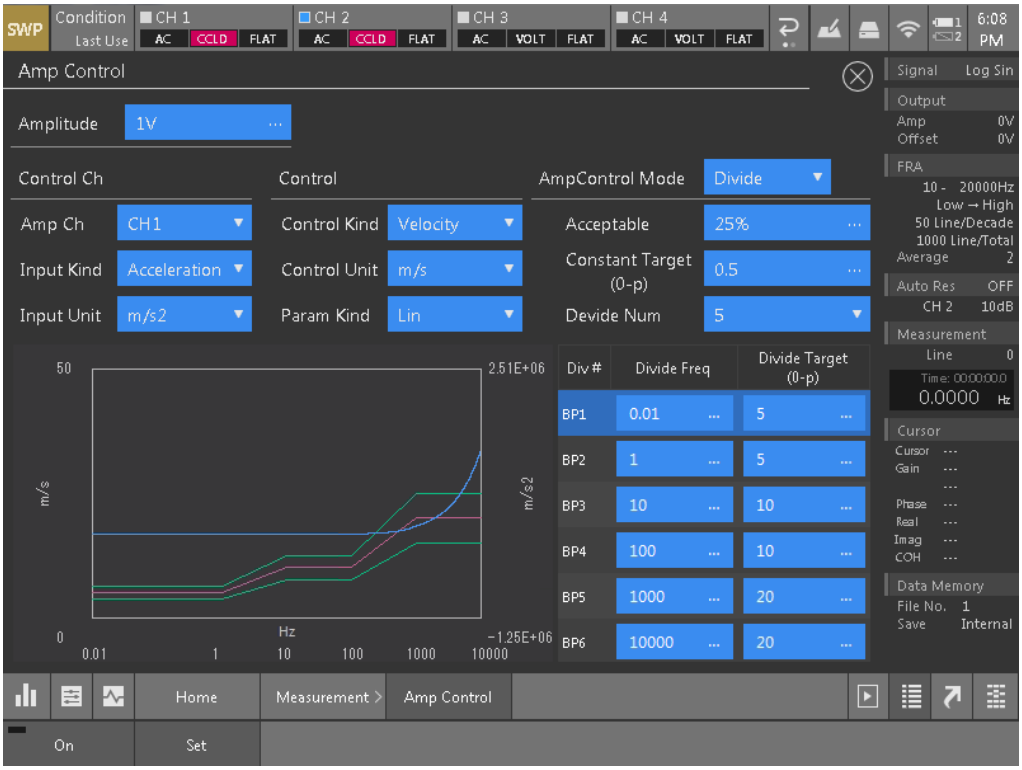
[Home] >[Measurement] > [Amp Control] >[ON]

Set the Output control condition.

[Home] >[Measurement] > [Amp Control] >[Set]



Dialog of AMP Control



①Amplitude] :Signal voltage (V) for input amplifier of an exciter → Set to 0.1 V

② Setting of Control_Ch.

-[Amp Ch]: Select the channel which is connected to a sensor for monitoring amplitude

(CH1 to C H4)

-[Input Kind]: Select a sensor that is used for amplitude controlling.

Accelerometer :[Acceleration]

Speed sensor :(Velocity)

Displacement sensor :(Displacement)

- [Input Unit]: Set the SI Prefix of a sensor unit that is used for amplitude controlling.

*Selecting SI prefix is not available when the amplitude unit of the monitoring side is same as the controlling side.

[Acceleration] :[m/s^2] [mm/s]

[Velocity]: :[m/s][mm/s][μm/s]

[Displacement] :[m][mm][μm][nm]

③Contorol

- [Contotrol Kind]: Select the amplitude unit to be controlled.

[Acceleration]

[Velocity]

[Displacement]

-[Control Unit]: Set the SI prefix for amplitude controlling

*Selecting SI prefix is not available when the amplitude unit of the monitoring side is same as the controlling side.

[Acceleration] :[m/s^2] [mm/s]

[Velocity] :[m/s][mm/s][μm/s]

[Displacement] :[m][mm][μm][nm]

-[Param Kind]:Switch the display setting of amplitude value to Lin/dB.

[Lin]/[dB]

④Amp Control Mode

-[Amp Control Mode]

Select [Constant] when the amplitude in the specified band is controlled to a fixed amplitude.

Select [Divide] when the controlling amplitude is set in each band.

-[Acceptable]: Set the acceptable value of controlling amplitude

Set the acceptable error value of controlling amplitude.

(Caution) Sweep processing may not advance if set acceptable value is too small from the effects of the resonance. We recommend you to set 10 to 25% of the value first, and reduce the set value after you check the control operation.

- [Constant Target] Set the target amplitude value to be controlled (one side amplitude value).
- [Divide Num]

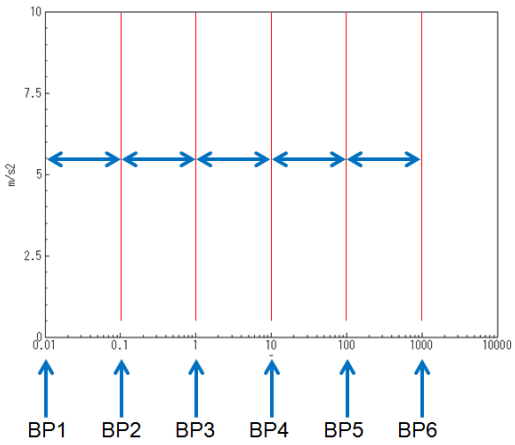
Set the number of divisions of band to sweep when [Divide] is selected in [Amp Control Mode].

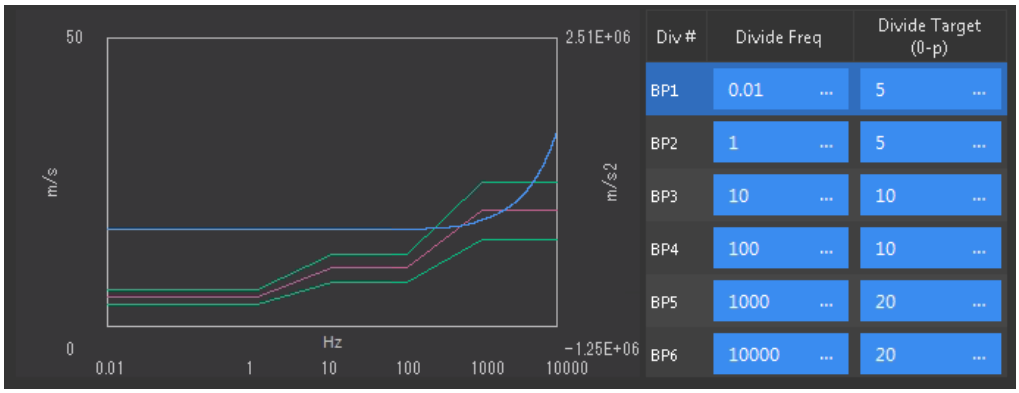
◎ [Amp Control Mode][Divide] (setting condition in each band)

Selecting [Divide] (setting condition in each band) allows it to set controlling amplitude (one side amplitude) to the divided from 2 to 5 bands within the frequency range from 0.01 Hz to 100 kHz.

Control amplitude value (one side amplitude) can be set to an each band divided into 2 to 5 in the range from 0.01 Hz to 100 kHz when [Divide] (setting condition in each band) is selected.

[Divide Num] Images of division into 5 and BP image





Red: Target amplitude (0-p) / Green: Acceptable error range

*Close with × after the end of this operation.

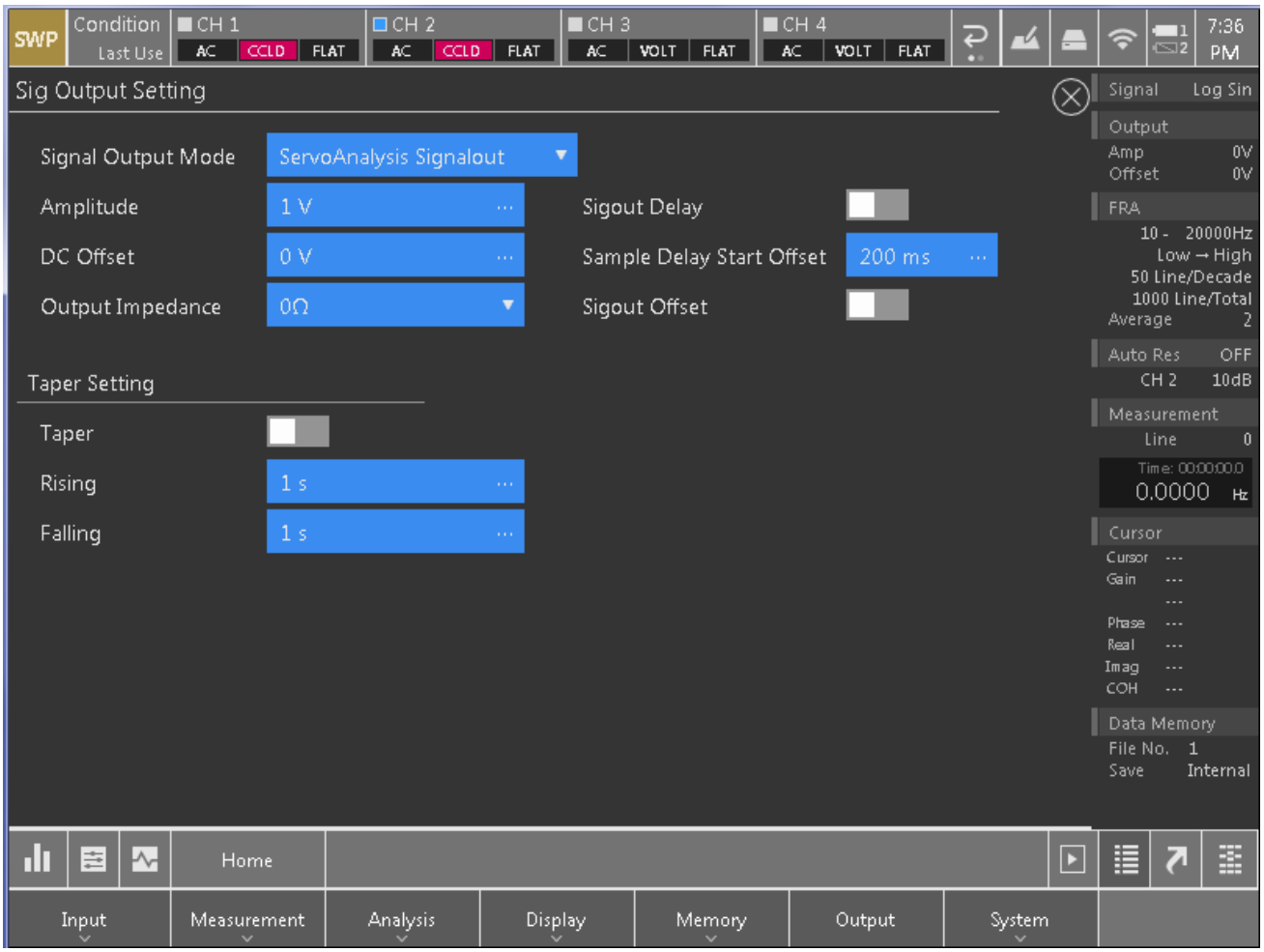
5) Setting4

①Setting of signal output

[Home] >[outputs] >[Signal Output Mode]

◎ There is no item to set here (default). Only description of setting

- [Amplitude]: The input signal to the excitation amplifier in one side amplitude value.
- [DC Offset] no setting.
- [Output Impedance] 50 Ω of output impedance.



②Taper Setting

Specifies the time duration that the signal voltage reaches the specified voltage from 0V, and the time duration the voltage reaches to 0V from the specified voltage.

-[Taper] ON/OFF selection of taper function.

- [Rasing] Setting of taper raising time in (s) unit.
- [Falling] Setting of taper falling time in (s) unit.
- [Sigout Delay] Delay function-of sampling start is OFF.

*Close with × after the end of this operation.

Setting is completed.

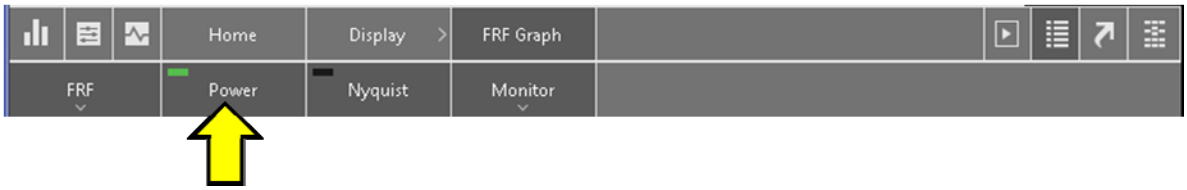
4. Controlling test

Activate an electromagnetic exciter from CF-9200/9400, and perform the test to confirm whether the amplitude is controlled to the target level.

1) Switching to diagram graph

- Select Power spectrum at the upper right display of FRF graph window

  [Home]>[Display]>[FRF Graph] → Power/Nyquist



*Turn ON Power (power spectrum)

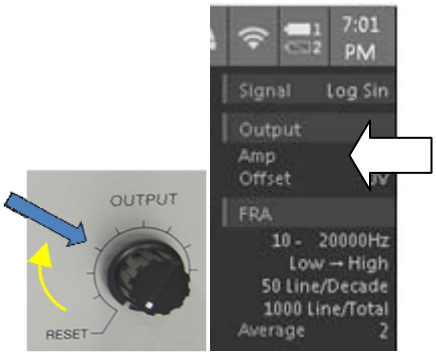
2) Preparation for operation of an electromagnetic exciter

- Turn On the power switch of an electromagnetic exciter
- Set the output volume (knob) from RESET to 10 o'clock position *.

  *10 o'clock: a guideline

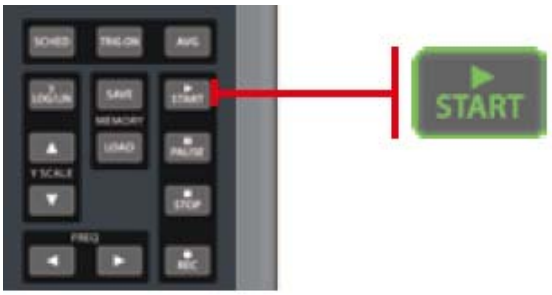
  * If the output volume (knob) is not at RESET position, make sure to set it to RESET position first before setting the knob to 10 o'clock position.

  *If [OUT_PUT VOLTAGE] reaches 10V in vibration excitation, turn the knob further to 12 o'clock position and amplify at the exciter side.



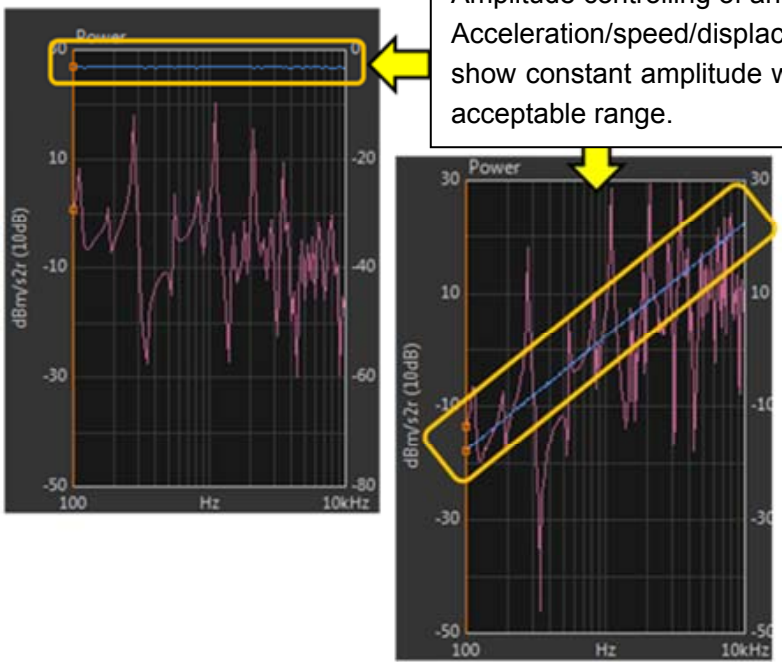
3) Starting of excitation vibration controlling

A vibration excitation and a measurement are started by pressing [START] button of the main unit panel,



4) Confirm the operation of an electromagnetic exciter and check that the sweep operation has been started.

.◎After sweep operation, confirm that the amplitude in the graph shows straight line as a result of control by power spectrum.



[When vibration excitation controlling is not well performed…]

It may have several reasons that excitation vibration control is not performed well.

Please check with focus on the following contents, and change the setting.

☐Request of the control amplitude is too large.

→ Reduce the control amplitude (requested value)

→ Change the electromagnetic exciter to larger one.

☐Controlling acceptable value is too strict.

→ Change the value larger (loosen).

☐Controlling band is too wide, or too low..

→ Check and change the band which the sensor for monitoring covers.

→ Narrow the sweep band.

☐Shortage of voltage for driving an exciter

→ Increase the amplitude factor of an exciter amplifier.

☐Basic operation of equipment

→ Checking the CCLD off of a sensor, cable disconnection, calibration error.

5. Measurement start saving data

1) Check and change the setting of the CF-9200/9400

Review the temporary values used for operation test, and input values for actual measurement again.

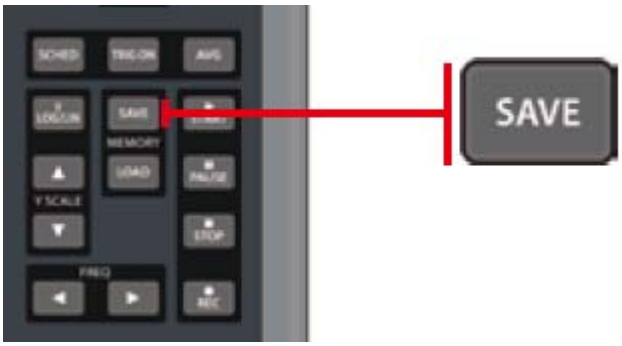
- Number of averaging times
- Line/Decade
- Control amplitude value
- Acceptable value
- Sweep direction.
- Sweep band

2) Pressing [START] button on the panel of a main unit starts the excitation.

- Check the operation and sweep start of an electromagnetic exciter.
- Confirm that the amplitude in the graph shows straight line as a result of control by power spectrum.

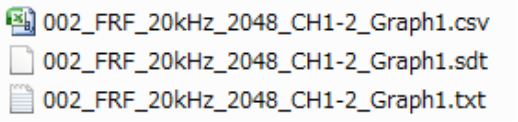
3) Saving data ①

-Pressing [SAVE] button on the main unit saves the acquired data.



Data is saved in up to 4 types of format.

- sdt format (binary format)
- CSV format* *setting at the time of saving
- TXT format* *setting at the time of saving
- BMP format* *setting at the time of saving

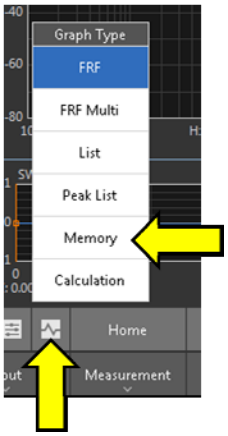


4) Saving data ②.

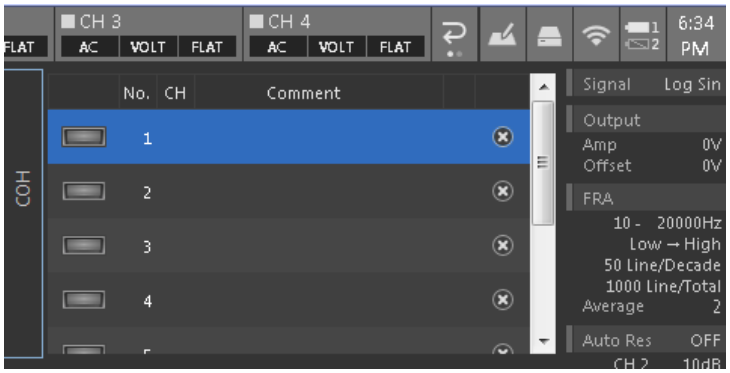
Data can be saved temporary. You can compare the data by overlay graph of measurement targets.

① Graph type switching → Graph Type> Memory

Graph type switching button

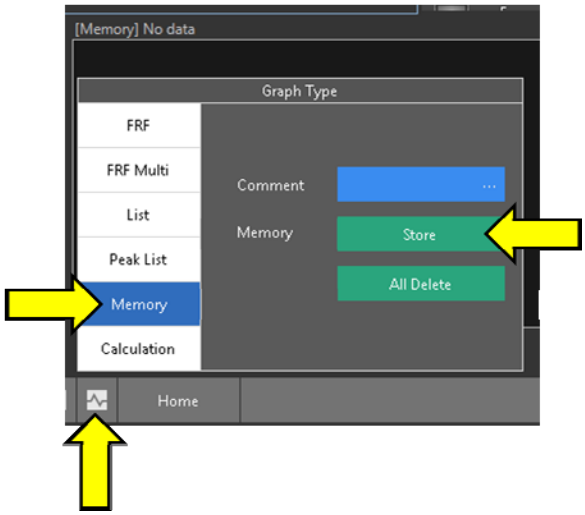


②Select the stack (No.1 to 8) to be saved. (specified by screen touch)

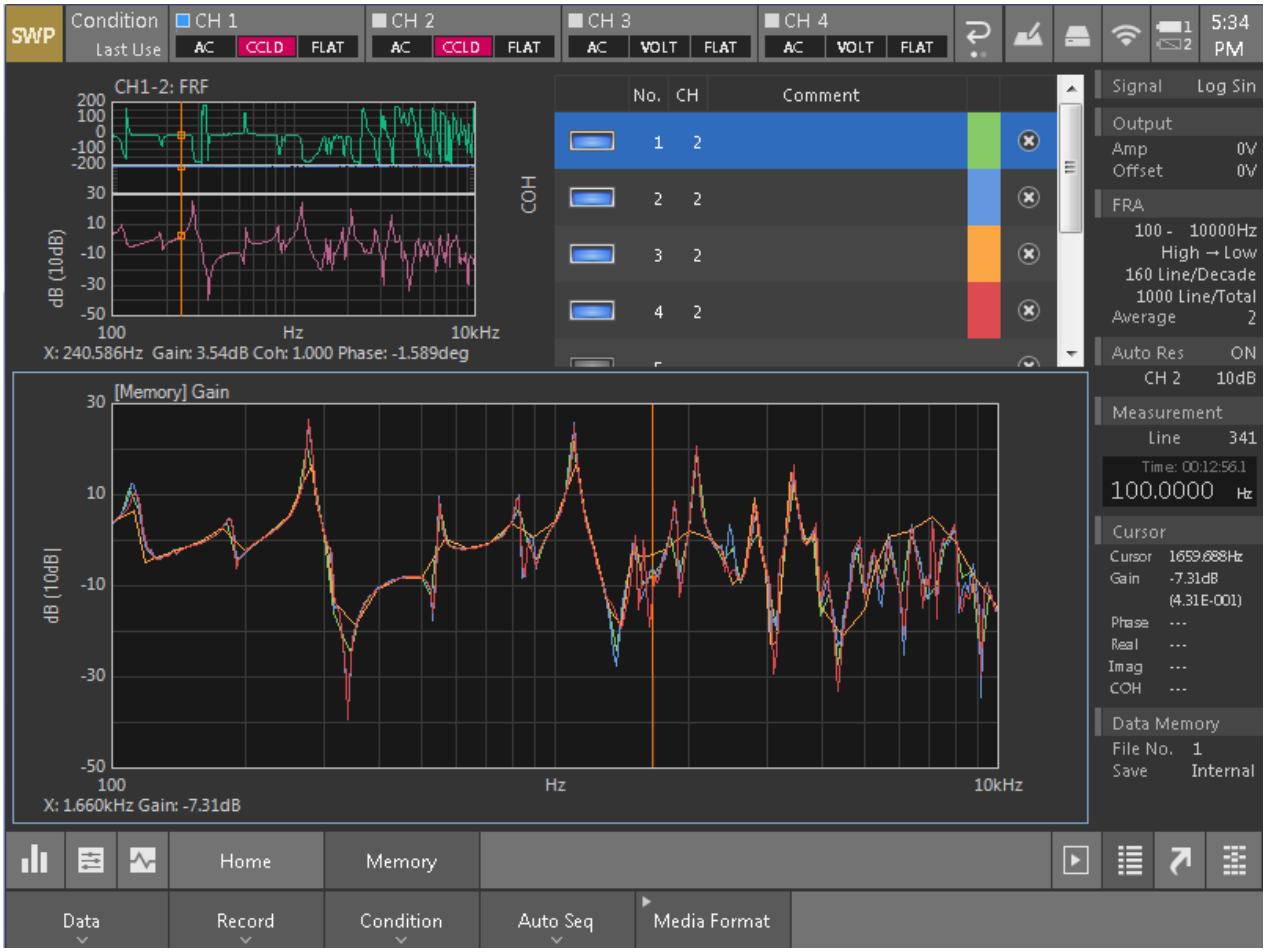


③Select again Graph type switching button＞Graph Type＞Memory

④Tap [Store] in Memory, and save the results.



⑤ Example of overlay graph by data stack

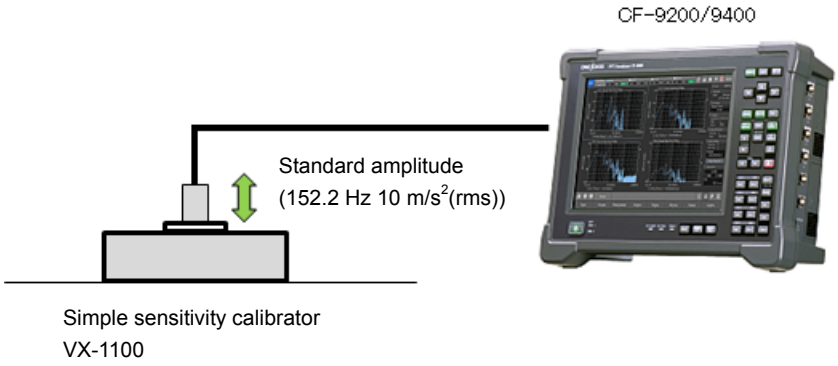


Example of data stack

6. Calibration procedures, etc

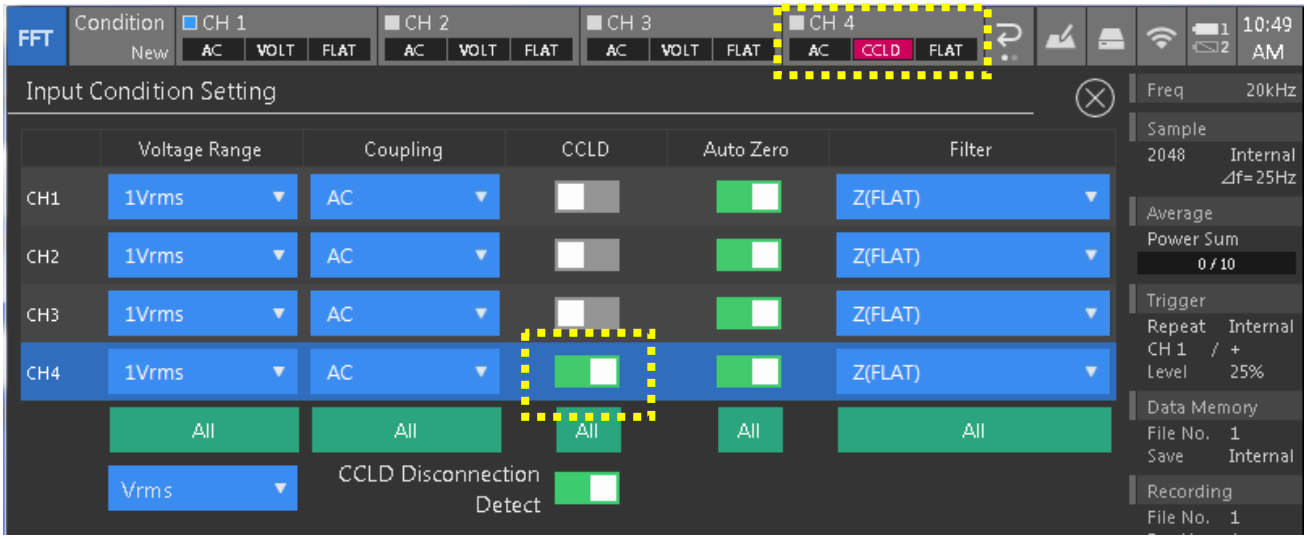
[Calibration of vibration measurement system by the VX-1100]

Apply the standard acceleration (152.2 Hz 10 m/s^2 (rms)) to the accelerometer by using the VX-1100, and perform calibration with measurement system of the accelerometer and the CF-9200/9400.



1) Connect the accelerometer to the CF-9200/9400, and turn ON the CCLD of the channel which is connected to the sensor.

   Soft key: [Home]>[Input]>[Input Cond]



Turn ON the CCLD by touching the [CCLD] of the channel to which the accelerometer is connected.

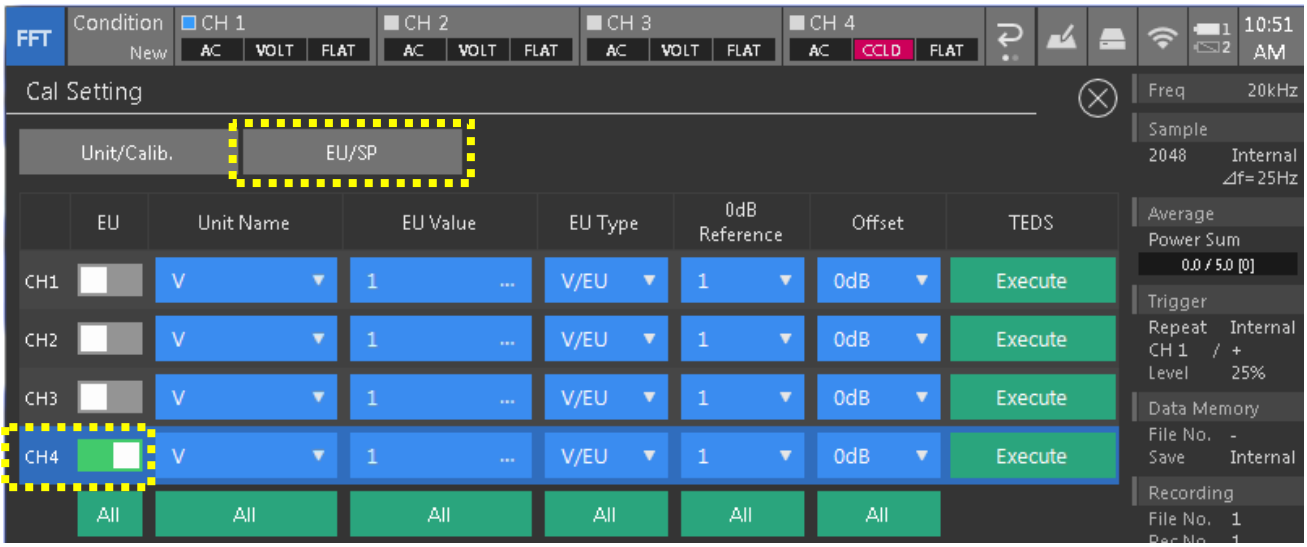
* Turn ON the CCLD of CH4 in this example.

2) Enter to the calibration menu.

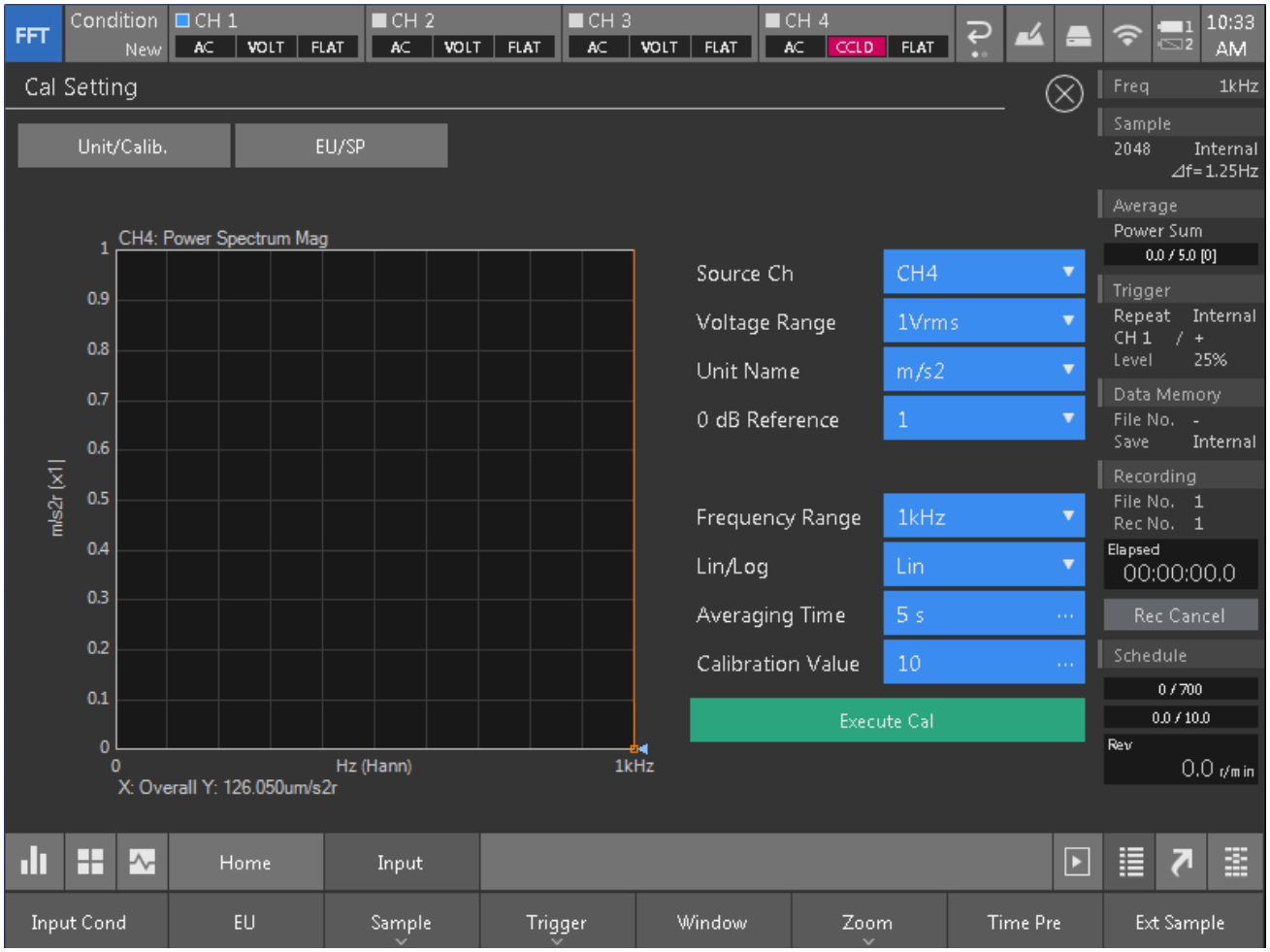
Soft key: [Home]>[Input]>[EU]

① Touch [EU] of the channel to be calibrated to turn it ON.

② Select [EU/S P]



The [Cal Setting] is displayed.

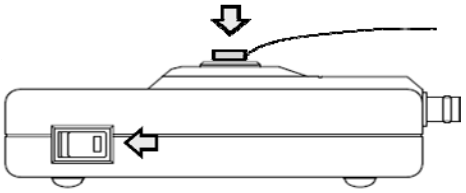


- [Source Ch] :Select the CH to be calibrated (CH4 is selected in this example)
- [Voltage Range] :Input voltage range (1 Vrm (DEFAULT))
- [Unit Name] :Select the unit to be calibrated (m/s^2 is selected in this example)

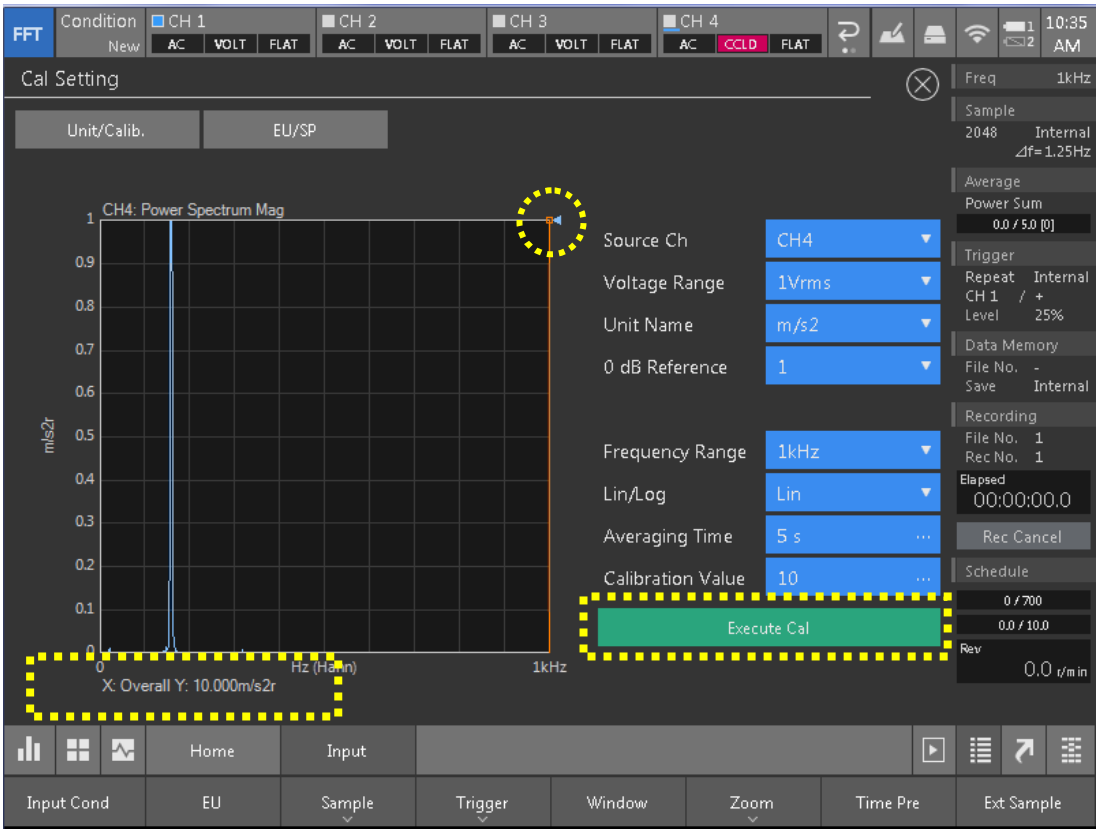
- [0 dB Reference] :Input 0dB reference value (1DEFAULT)
- [Frequency Range] :1 kHz
- [Lin/Log] :Lin
- [Average Time] :5(sec)
- [Calibration Value] :Input the amplitude value to be calibrated(10 m/s^2 in this example)

After the input process, move the search cursor to 1 kHz (right end of the screen) and check that "Overall" is displayed.

3) Mount an accelerometer on the "Accelerometer mount table" of the VX-1100.
4) Turn ON the power and start excitation.



5) When power spectrum appears in the screen, touch [Execute Cal] and execute calibration.
After the calibration, check that the value of Overall is "10 m/s^{2}r" and exit.



【For successful measurement】

Amplitude of the VX-1100 contains the following errors.

- Excitation vibration acceleration :10 m/s^2 (rms)±3 %
- Excitation vibration speed : 10 mm/s(rms)±4 %
- Excitation vibration displacement 10 μm(rms)± 5 %

References

Akio Nagamatsu (1993) [Introduction to mode analysis] CORONA PUBLISHING CO.,LTD

Makoto Kurabe (1998) [Illustration instruction of mode analysis] Taiga publishing

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*Outer appearance and specifications are subject to change without prior notice.

HOME PAGE: http://www.onosokki.co.jp/English/english.htm

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