Digital Storage Oscilloscope APP

FREQUENCY RESPONSE ANALYZER

ISO-9001 CERTIFIED MANUFACTURER

GW INSTEK

Jan 2018

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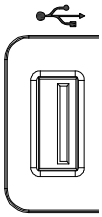
INSTALL THE SOFTWARE

Step

1. Make sure firmware version is V1.34 or higher.

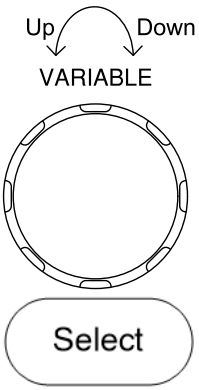
2. Insert the USB memory stick with the "FRA.gz" into the USB port on the front panel.

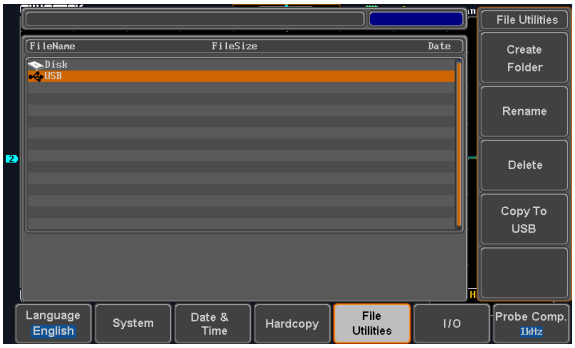


3. Press the *Utility* key.

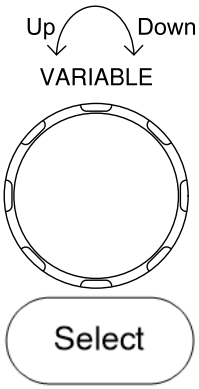
4. Select *File Utilities* from the bottom menu.

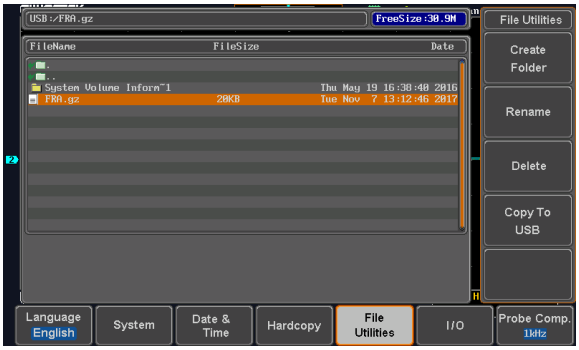
5. Use the *Variable* knob to select the USB memory stick and then press the *Select* button.





6. Use the *Variable* knob to select FRA.gz and then press the *Select* button to select it.





7. Press the *Select* button again to start installation.

8. The installation is complete when a message showing “Please turn off the oscilloscope and turn on again” is displayed.

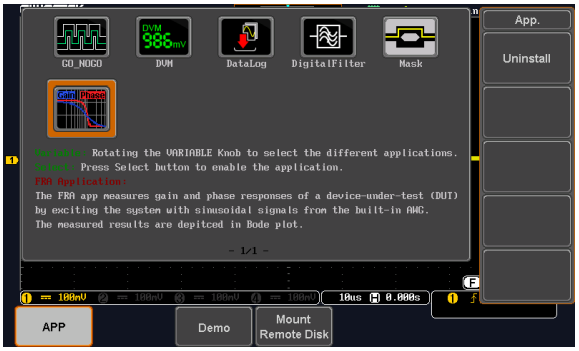
UNINSTALL THE SOFTWARE

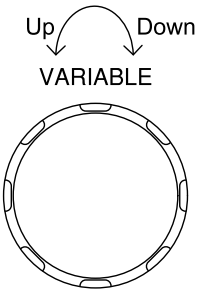
Step

1. Press the *APP* key on the front panel

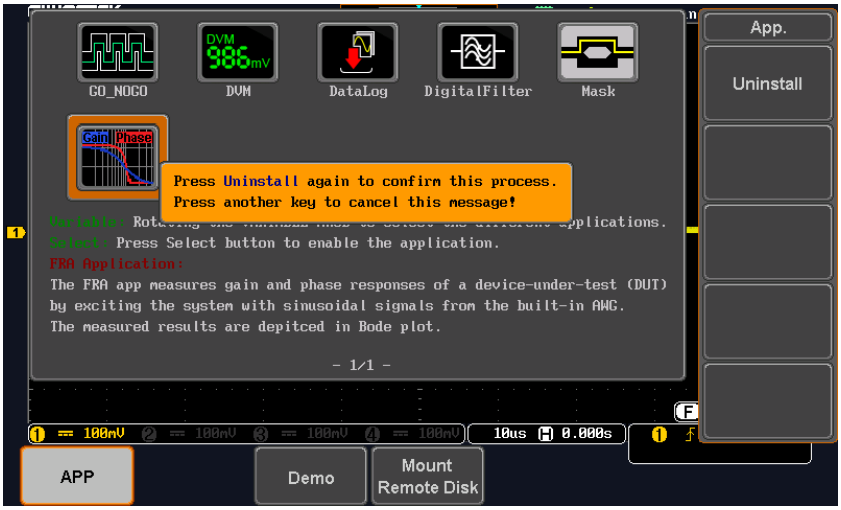
2. Press the *APP*. button from the bottom menu.

3. Use the *Variable* knob to select the FRA APP.





4. Press the *Uninstall* button from the side menu.



5. Press the *Uninstall* button from side menu again to start the uninstallation process.

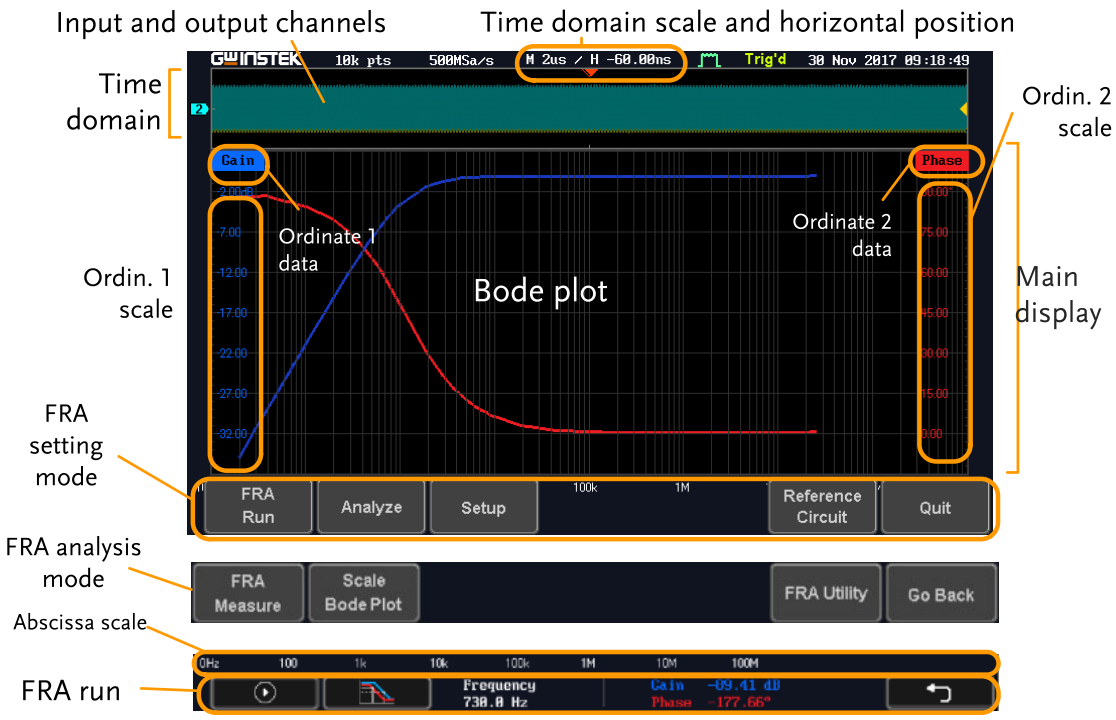
6. Uninstallation process is complete when a message showing “Please turn off the oscilloscope and turn on again” appears.

FREQUENCY RESPONSE ANALYZER

Overview

Background	The Frequency Response Analyzer (FRA) is a feature application for digital storage oscilloscope with an integrated arbitrary waveform generator. It can plot gain and phase responses at the output of a device-under-test (DUT) when its input is excited by a frequency-swept sinusoidal signal. Bode plots can be created, stored for future reference and analyzed. The FRA application uses the output of the Arbitrary Wave Generator (AWG) to generate the frequency-swept signal.
Functions	Bode plots. Stores plots for future use and analysis, Precise analysis of the measured data in a plot with the aid of cursor measurement.
⚠ Note	*Please note that this Frequency Response Analyzer function only available for oscilloscope firmware version 1.34 or later version.*

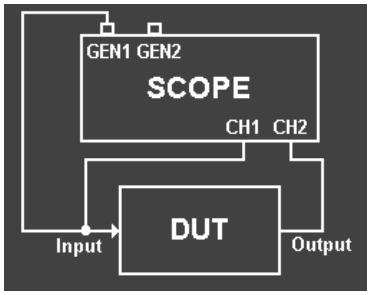
Display Overview

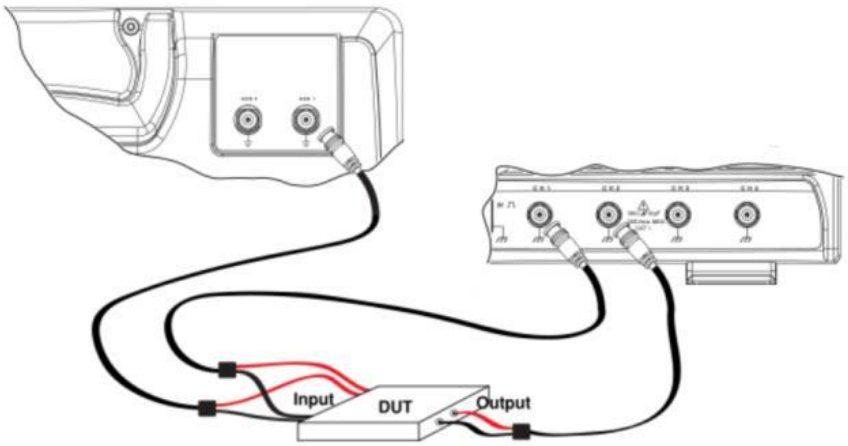


Introduction	The FRA application is divided into two main operation modes: Setting and Analysis mode. When in Setting mode (the FRA Run menu icon appeared), the user can setup the FRA analysis and then start it right after the FRA Run button is pressed.
Time domain	When the FRA application is in Setting mode, the top portion of the display window shows time-domain waveforms of the input and the output channel. This window disappears when in Analysis mode.
Main display	In either mode, the FRA main display shows a Bode plot with corresponding abscissa and ordinates scales.

Connections

Background	The FRA application uses two analog channels of the DSO as well as the GEN1 output of the Arbitrary Wave Generator (AWG).
Connection	1. Connect the AWG output GEN1 to the input of the Device-Under-Test (DUT). 2. Connect one DSO analog channel to the input of the DUT. 3. Connect the output of the DUT to another DSO analog channel.





Launching the FRA application

Background

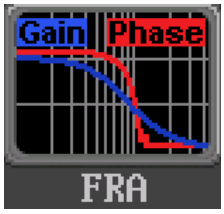
The FRA application is launched from the *APP* menu.

Panel Operation

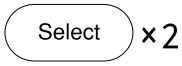
1. Press the *APP* key.

2. Press the *APP* button from the bottom menu.

3. Scroll through the applications using the *Variable* knob until the FRA application is highlighted.



4. Launch the FRA application by pressing the *Select* key twice.



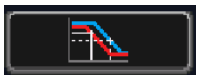
Setting mode

In Setting mode(*FRA Run* button appeared), the user can define the sources and setup the frequency-swept sinusoidal signal generated by the AWG. In addition, FRA data acquisition is launched from this mode.

FRA Run

Background	Once the FRA application is fully setup and the DUT is correctly connected, data can be acquired by pressing the "*FRA Run*" button.
⚠ Note	Please be aware that the total time required for measuring the frequency response may vary according to your setup, e.g. the number of points per decade or when sweeping at lower frequencies. Please note that the FRA application only allows a DSO record length of 10,000 points.
Panel operation	1. In Setting mode (*FRA Run* button appeared), press the *FRA Run* button to start the frequency response analysis. 2. The data acquisition will stop automatically when the stop frequency is reached. The button is then toggled back to STOP and the data is ready for analysis. If the user needs to cancel an on-going FRA measurement, the button can be pressed.

3. Using the second *Analyze menu* button will switch to the Analysis mode. Details regarding this mode will be explained in later sections.

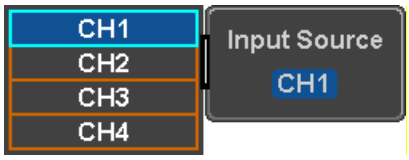


4. Press the icon to return to the upper-level menu.

Setup

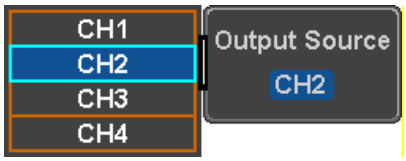
Background	Use the Setup menu to define the sources and configure the AWG output GEN1.
⚠ Note	Please make sure that the two analog channels used by the FRA application are activated first.
Panel operation	1. Toggle the *Setup* button.

2. Press *Input Source* from the side menu and select the channel that is connected to the input of the DUT.



Range CH1 ~ CH4 for 4-channel models
CH1 ~ CH2 for 2-channel models

3. Press *Output Source* from the side menu and select the channel that is connected to the output of the DUT.



Range CH1 ~ CH4 for 4-channel models
CH1 ~ CH2 for 2-channel models

4. Each frequency decade is equally divided in a pre-set number of points. By pressing the *Points/Decade* button and using the *variable* knob, you will define the number of points per decade of frequency.

Example: for the 100-1000Hz decade and 15 points per decade, the frequency sweep step is given by (1000-100)/15 = 60Hz, i.e. measurements will be taken at 100Hz, 160Hz, 220Hz, 280Hz, …, 940Hz.

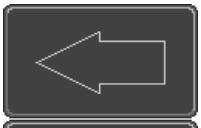
Range	10, 15, 30, 45, 90

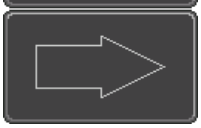
5. Then press the *AWG Setup* button from the side menu to configure the frequency-swept input signal.

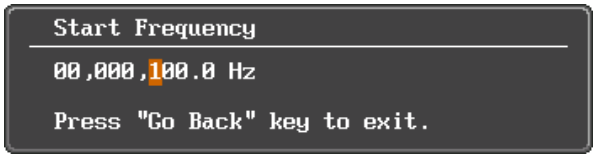
Start

6. Press *Start* button to configure the start frequency.

Use the arrows to select a base unit and the *variable* knob to further tune the selected base unit.

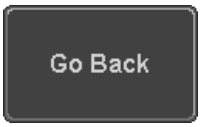






Alternatively press the *Default* button to set the Start Frequency to 100.00 Hz (default setting).

Press *Go Back* to return to the previous menu.

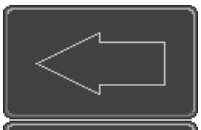


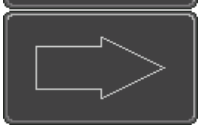
Range 20Hz ~ 25MHz

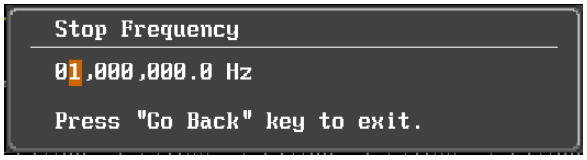
Stop

7. Press *Stop* to configure the stop frequency.

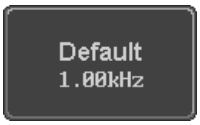
Use the arrows to select a base unit and the *variable* knob to further tune the selected base unit.



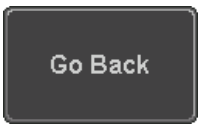




Alternatively press the *Default* button to set the Stop Frequency to 1.00 kHz (default setting).



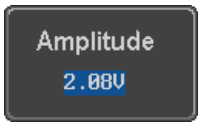
Press *Go Back* to return to the previous menu.



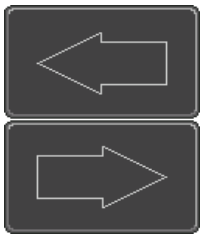
Range 20Hz ~ 25MHz

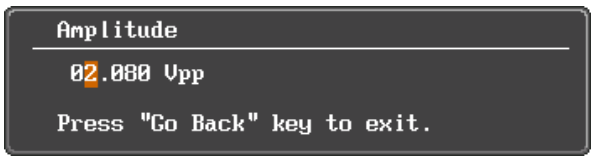
Amplitude

8. Press *Amplitude* to configure the amplitude of the frequency-swept signal.



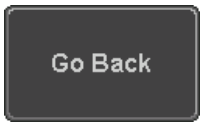
Use the arrows to select a base unit and the *variable* knob to further tune the selected base unit.





Alternatively press the *Default* button to set the amplitude to 200 mV.

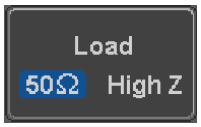
Press *Go Back* to return to the previous menu.



Range 0.01~2.5Vpp (50 ohms load)
0.02~5Vpp (High-Z load)

Load

9. Press *Load* button to configure the load resistance.

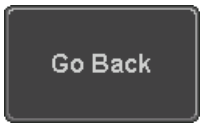


Press repeatedly the *Load* button to select the 50Ω or High Z load resistance.

Range 50Ω, High Z

Go Back

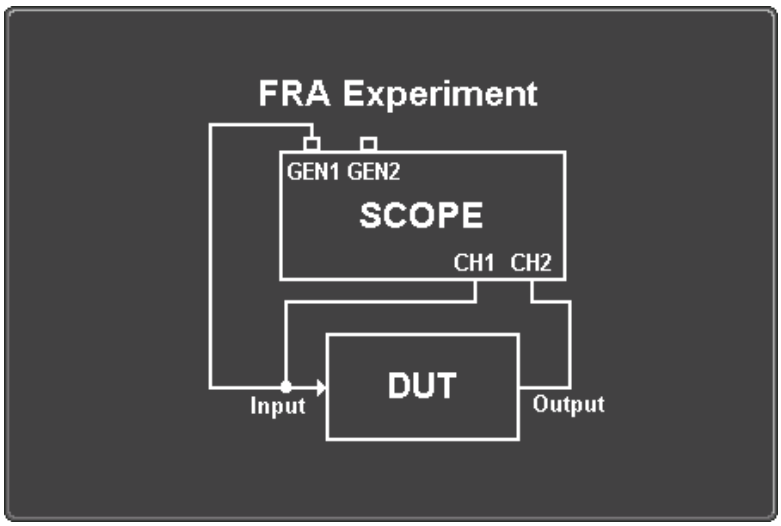
Press Go Back to return to the Setup menu.



Reference Circuit

Background	A diagram depicts the connectively necessary for the FRA application to properly operate.
Panel operation	1. Toggle the *Reference Circuit* button from the bottom menu.

2. A simple diagram reminding the connections required is shown on the display.



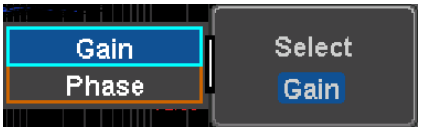
Quit

Background	Quit the FRA application.
Panel operation	Toggle the *Quit* button to return the APP menu.

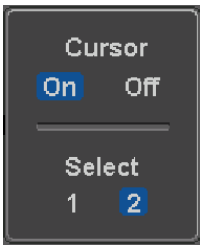
Analysis mode

There are three main functions in the Analyze menu. Users can perform the cursor measurement, adjust the scale and the offset of the plot, and save FRA results for future recall as well as post-processing on the computer.

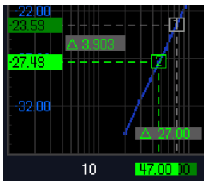
FRA Measure

Background	FRA Measure uses cursors to precisely measure the data in absolute or relative values.
Panel operation	1. Under Analysis mode, press the *FRA Measure* button to enter the FRA measure menu. 2. Press the *Select* button and use the *Variable* knob and then the *Select* key to set the active trace, showing on top of the other trace, and refresh the cursor measurement accordingly.  Range : Gain, Phase

3. The cursor 1 and 2 will appear along the active trace whenever the cursor state turns on. Press Select button to change the active cursor highlighted in green color.



Move the active cursor along the active trace using the *Variable* knob. The corresponding frequency value in Hertz (X-axis), gain value in dB (left Y-axis) or phase value in degree (right Y-axis) will be shown along the axis.



A delta measurement between the two cursor's values is also displayed along the X-axis and the left- or the right-Y axis.

Scale Bode Plot

Background

The Scale Bode Plot menu allows the user to adjust the scale and the offset of the plot on the display.

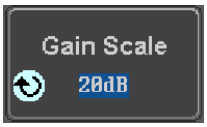
Panel operation

1. When in Analysis mode, press the *Scale Bode Plot* button to enter the scale bode plot menu.

2. There are four settings which can be adjusted: *Gain Scale*, *Gain Offset*, *Phase Scale*, and *Phase Offset*, respectively. Press the *Autoscale* button to automatically preset these parameters suitable for viewing the displayed traces.

Gain Scale

3. Press the *Gain Scale* from the side menu and use the *Variable* knob to adjust the value.



Range 5, 10, 15, 20dB

Gain Offset

4. Press the *Gain Offset* from the side menu and use the *Variable* knob to adjust the value.

Range (-300+4*Gain Scale) ~(300-4*Gain Scale) dB

Phase Scale

5. Press the *Phase Scale* from the side menu and use the *Variable* knob to adjust the value.

Range 15°, 30°, 45°, 60°

Phase Offset

6. Press the *Phase Offset* from the side menu and use the *Variable* knob to adjust the value.

Range (-720+4*Phase Scale) ~(720-4*Phase Scale) degrees

Autoscale

7. Alternatively, users can press the *Autoscale* from the side menu to have the FRA App configuring these parameters automatically.

FRA Utility

Background

With FRA Utility, the user can recall previously saved FRA files (.FRD), convert FRA files to Excel CSV files, and view FRA Info containing experimental details regarding the underlying bode plot.

Panel operation

1. When in Analysis mode, press the *FRA Utility* button to enter the FRA utility.

Recall From File (.FRD)

Press the *Recall From File (.FRD)* from the side menu.

Browse through the folders and files to locate a FRA file (*file*.FRD) and press the *Select* key to recall it. A pop-up window then subsequently confirms the success of the operation. For a successful recall, the display will immediately show the newly recalled data on the current plot.

Save To File (.FRD)	2. Press the *Save To File (.FRD)* from the side menu and save the present plotted data to a file for future reference.	Save To File(.FRD)
Save To CSV	3. Press the *Save to CSV* button to save the present plotted data in the CSV format for post-processing on the computer.	Save To CSV
FRA Info	4. For more information regarding the current plotted data, press this *FRA Info* button.	FRA Info

Go Back	5. Press Go Back button to return to the Setting menu.	Go Back

Remote Control Commands

The remote control command overview chapter lists all Frequency Response Analyzer commands in functional order. The command syntax section shows you the basic syntax rules you have to apply when using commands.

:FRA:RUN

Set → → Query

Description	Sets or queries the FRA analysis function.	
Syntax	:FRA:RUN :FRA:RUN?	
Return parameter	RUN	FRA analysis function is running.
	STOP	FRA analysis function is in idle state.
Example	`:FRA:RUN` Turns the FRA analysis function on.	
Note:	1. Only the :FRA:STOP setting command and others query commands can be executed while the :FRA:RUN command running. 2. The FRA analysis function will be placed in idle state after the :FRA:RUN procedure is completed.	

:FRA:STOP

Set → → Query

Description	Stops or queries the FRA analysis function.	
Syntax	:FRA:STOP :FRA:STOP?	
Return parameter	RUN	FRA analysis function is running.
	STOP	FRA analysis function is in idle state.
Example	`:FRA:STOP?` >STOP Returns STOP, the FRA analysis function is in idle state now.	

:FRA:SOURce:INPut

Set → → Query

Description	Sets or queries the input source of the FRA.	
Syntax	:FRA:SOURce:INPut {CH1 | CH2| CH3 | CH4} :FRA:SOURce:INPut?	
Parameter/Return parameter	CH1	Channel one
	CH2	Channel two
	CH3	Channel three
	CH4	Channel four
Example	`:FRA:SOURce:INPut CH2` Sets the input source of FRA to channel two.	

:FRA:SOURce:OUTPut

Set → / → Query

Description	Sets or queries the output source of the FRA.	
Syntax	:FRA:SOURce:OUTPut {CH1 | CH2| CH3 | CH4} :FRA:SOURce:OUTPut?	
Parameter/Return parameter	CH1	Channel one
	CH2	Channel two
	CH3	Channel three
	CH4	Channel four
Example	`:FRA:SOURce:OUTPut CH1` Sets the output source of FRA to channel one.	

:FRA:FREQuency:STARt

Set → / → Query

Description	Sets or queries the FRA start frequency.	
Syntax	:FRA:FREQuency:STARt {<NRf>|?}	
Parameter/ Return parameter	<NRf>	Manually sets the FRA start frequency. (Range: 20Hz ~ 25MHz).
Example	`:FRA:FREQuency:STARt 100` Sets the FRA start frequency to 100Hz.	

:FRA:FREQuency:STOP

Set → / → Query

Description	Sets or queries the FRA stop frequency.	
Syntax	:FRA:FREQuency:STOP {<NRf>|?}	
Parameter/ Return parameter	<NRf>	Manually sets the FRA stop frequency. (Range: 20Hz ~ 25MHz).
Example	`:FRA:FREQuency:STOP 500` Sets the FRA stop frequency to 500Hz.	

:FRA:AWG:LOAD

Set → → Query

Description	Sets or queries the AWG load impedance.	
Syntax	:FRA:AWG:LOAD {FIFty | HIGHZ | ?}	
Related Commands	:FRA:AWG:AMPlitude	
Parameter/ Return parameter	FIFty	50Ω
	HIGHZ	High impedance
Example	`:FRA:AWG:LOAD HIGHZ` Sets the AWG load impedance to high impedance.	

:FRA:AWG:AMPlitude

Set → → Query

Description	Sets or queries the AWG amplitude.	
Syntax	:FRA:AWG:AMPlitude {<NRf> | ?}	
Related Commands	:FRA:AWG:LOAD	
Parameter/ Return parameter	<NRf>	Manually sets the AWG amplitude. When AWG load impedance = 50Ω, Range: 0.01Vpp ~ 2.5Vpp. When AWG Load impedance = High impedance, Range: 0.02Vpp ~ 5Vpp
Example	`:FRA:AWG:AMPlitude 0.2` Sets the amplitude to 0.2Vpp.	

:FRA:POINt

Set → / → Query

Description	Sets or queries the number of processing points per decade.	
Syntax	:FRA:POINt {<NR1>|?}	
Parameter/ Return parameter	<NR1>	The number of point per decade. (Range: 10, 15, 30, 45, 90)
Example	`:FRA:POINt 15` Sets the 15 points per decade.	

:FRA:SAVe

Set →

Description	Saves the present plotted data to a file (*.FRD).
Syntax	:FRA:SAVe

:FRA:RECAll

Set →

Description	Recalls the plotted data from internal memory or USB flash drive.	
Syntax	:FRA:RECAll {<file path> ("Disk:/xxx.FRD", "USB:/xxx.FRD")}	
Parameter/ Return parameter	<file path>	Recalls the plotted data from internal memory or USB flash drive.
Example	`:FRA:RECAll "Disk:/FRA00001.FRD"` Recall the FRA plotted data from the internal memory.	

:FRA:DATA

→ Query

Description	Queries the status of settings and FRA plotted data (as a header plus raw data) to computer. The raw data is queried in three comma-separated columns of FRA data for each step in the sweep: Frequency (Hz), Gain (dB), and Phase (◦).
Syntax	:FRA:DATA?
Example	`:FRA:DATA?`

```
Format,2.0E;Firmware,V1.34;APP Name,FRA APP;Input
Source,CH1;Output Source,CH2;Total
Points,546;Points/Decade,90;AWG Setup;Start Freq,20.0Hz;Stop
Freq,25.0000000MHz;Ampl,80.000mV;Offset,0.0V;Record
Data;Frequency,Gain,Phase;
#5294842.000000e+01,-8.862180635333e-03,-7.475754618645e-02,
2.100000e+01,-3.896592557430e-02,-6.966306567192e-01,
2.200000e+01,-2.990882843733e-02,-5.042185187340e-01,
2.300000e+01,-3.826960921288e-02,-2.487841397524e-01,
2.400000e+01,-5.097014456987e-02,-7.971150875092e-01,
.............
```

:FRA:SAVETOCsv

Set →

Description	Saves the present plotted data to internal memory in CSV file format.
Syntax	:FRA:SAVETOCsv

Specifications

Frequency Range	20Hz to 25MHz
Input and Output Sources	Channel 1 or 2 (3 or 4 for four channel models)
Number of Test Points	10, 15, 30, 45, 90 points per decade selectable
Dynamic Range	>80dB (typical)
Test Amplitude	10mVpp to 2.5Vpp into 50Ω, 20mVpp to 5Vpp into High-Z Fixed amplitude across entire sweep
Test Results	Logarithmic overlaid gain and phase plot
Manual Measurements	Tracking gain and phase markers
Plot Scaling	Auto-scaled during test