

# FREQUENCY RESPONSE ANALYZERS

**FRA series**

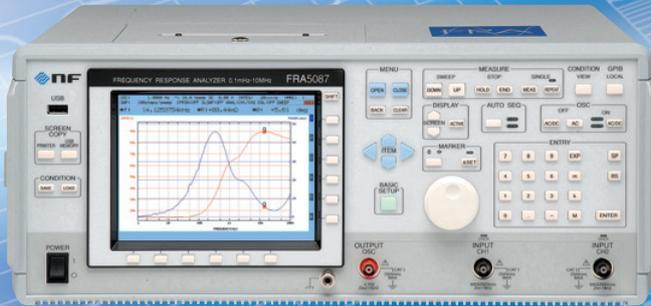
**Measures frequency responses with high accuracy.**

Function and performance further improved.



**FRA5097** **15 MHz** 

0.1MHz to 15MHz, Impedance display



**FRA5087** **10 MHz** 

0.1MHz to 10MHz, Multifunction



**FRA5022** **100 kHz** 

0.1MHz to 100kHz, High C/P model

As FRA servo analyzers, they are useful for a wide range of measurement applications.



Loop response for switching power supplies



Ripple rejection ratio for series regulators



Servo response for magnetic and optical disks



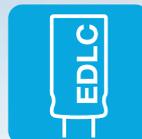
Resonance response for piezo-electric components



Impedance of electronic components



AC impedance of fuel cells



Internal resistance for electric double layer capacitors



For other measurement applications

# FRA5097 <sup>15 MHz</sup> / FRA5087 <sup>10 MHz</sup>

The high accuracy and functionality unique to frequency response analyzers which allow them to achieve sure measurements are dramatically enhanced to make our FRAs even more convenient and useful!

NF Corporation's frequency response analyzers utilize the excellent noise eliminating feature of Fourier transformations to accurately measure frequency response characteristics. Equipped with floating input circuitry and auto ranging functions for constantly optimizing input ranges, our FRAs allow dynamically changing frequency responses to be quickly measured with high accuracy, without the need to be concerned with input signal levels or the ground potential of the device being tested; moreover, operation is quite simple. Experience first-hand just how excellent are accuracy, functions, and operability of our FRAs.

● **Amplitude accuracy : ±0.05 dB**  
**Phase accuracy : ±0.3°**  
 Digital Fourier transforms and a self calibration function assure that measurements will always be highly accurate.

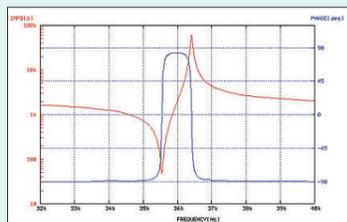
● **Built-in printer**  
 A printer for outputting hard copies of on-screen images onto thermosensitive paper is built-in, which makes saving measurements and creating reports convenient.

● **Frequency range**  
**0.1mHz to 10MHz\* / 15MHz\***  
 From ultra low frequency to high frequency. High density measurements of up to 20,000 points at one sweep are possible. Logarithmic equal interval setting and auto-magnification in sections where values greatly change are possible. Resolution is 0.1mHz.  
\* FRA5087 : 0.1mHz to 10MHz, FRA5097 : 0.1mHz to 15MHz

● **Easy saving and reading by USB memory**  
 ● **USB**  
 Measured data can be stored and loaded into a USB memory device. Furthermore, the following functions are available.  
 ● **Screen copy**  
 A screen can be output to the USB memory and printer by the press of a key.  
 ● **Conditions**  
 Setup conditions can be saved into and loaded from the USB memory by the press of a key.

● **Various graphic outputs**  
 Bode, Nyquist, Nicols, and Cole-Cole plots can be displayed. Following measurement, interconversion is also available.

● **Impedance display function** (optional for FRA5087)  
 Impedance can be accurately measured and displayed. Moreover, open-short correction, maximum and minimum value displays, and screen image storage can be done.



● **Isolation**  
 Oscillator output 2-channel and analysis inputs are isolated from the cabinet by 250Vrms. In this way, the instrument can be protected from damage by an erroneous signal connection.

● **Color TFT LCD**  
 A frequency response graph and setup menu for measuring conditions can be displayed on a crisp color LCD.

● **Battery backup**  
 The contents of the setup and measured data stored in the memory before turning off power are held if power is turned off.

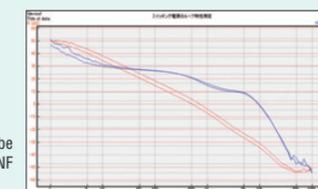
● **Dynamic range : 140dB**  
 Auto ranging which optimizes the measurement range at every measurement point and a high resolution A/D converter secure a wider dynamic range. Measurement is secured if a great change occurs during measurement.

● **Auto ranging**  
 Input range is switched automatically according to the input signal level, so setup of voltage sensitivity is not necessary for the frequency response analyzer.

● **Excellent functions are built-in**  
 An auto-integration function which suppresses the effects of external disturbances and variations of measured results by automatically setting an optimum number of integration times is built-in. In addition, the following functions are available to secure measurements.  
(See page 3 for the major ratings of each.)

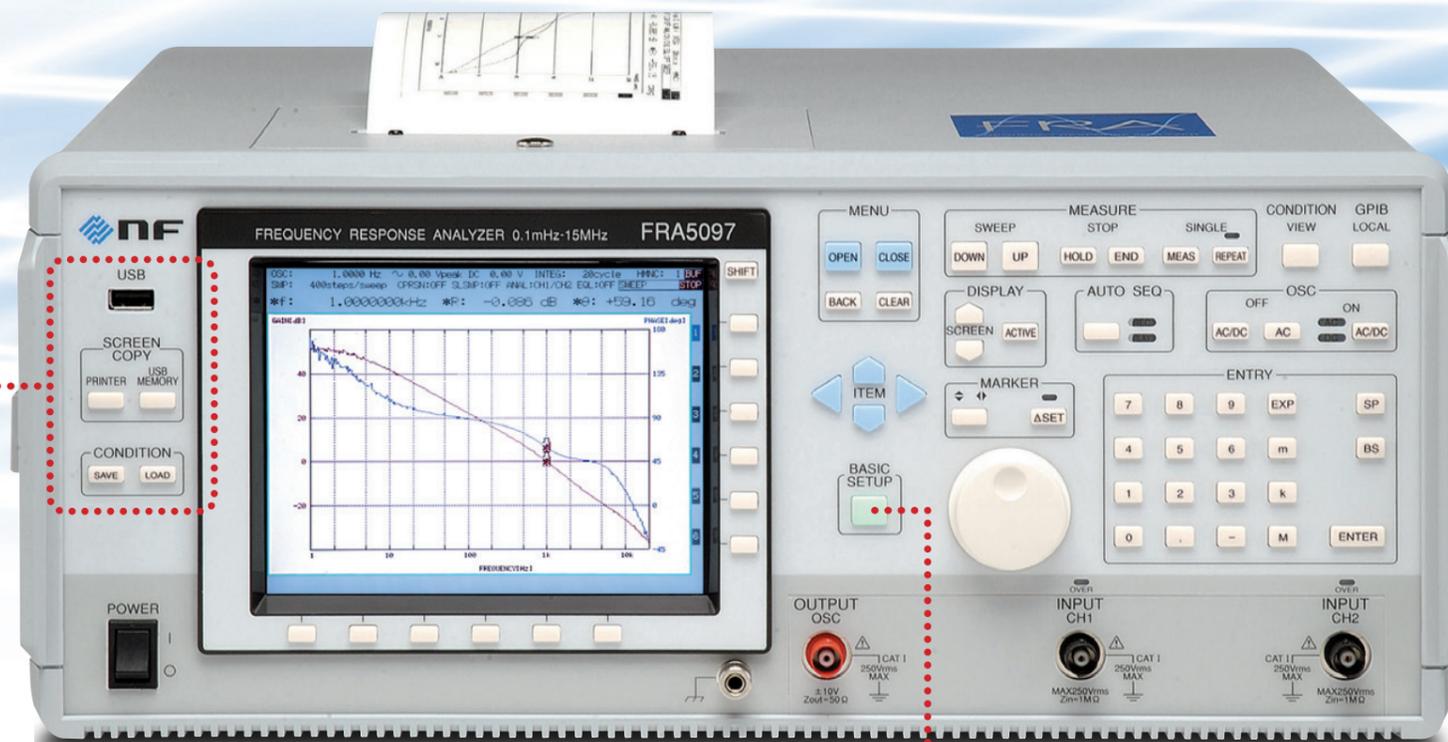
- Frequency axis high-density sweep
- Equalize
- Amplitude compression
- Auto integration
- Delay
- Operation

● **Date display software**  
 Data stored in the USB memory can be read out to a personal computer for graphic display and saving in a CSV format.



(This software can be downloaded from the NF Corporation Web site.)

● **GPIB and USB equipped**  
 Measuring conditions can be set via an external personal computer and measured data can be read out to it via GPIB and USB.

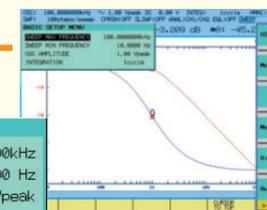


Picture shows FRA5097.

● **A basic setup screen can be displayed by one touch.**  
 A special key is provided to facilitate setting procedure.

● **Basic setup**  
 A basic setup screen is displayed simply by pressing the basic setup key. The upper lower limits, amplitude, and number of integrations for measuring frequency (sweep) can be set on one screen. The conventional model's nuisance of setting each item by switching the screen can thus be avoided.

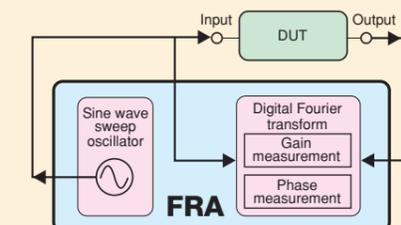
BASIC SETUP MENU	
SWEEP MAX FREQUENCY	100.000000kHz
SWEEP MIN FREQUENCY	10.0000 Hz
OSC AMPLITUDE	1.00 Vpeak
INTEGRATION	1cycle



## Frequency response analyzer mechanism

Frequency response analyzers consist of a sweep oscillator, voltmeter, and phase meter. Digital Fourier transform calculations allow voltage and phase to be obtained simultaneously and with high accuracy, with the oscillator as the reference. When measurement at a frequency ends, the frequency is switched to the next frequency. Thus, an identical measurement is automatically repeated. This is similar to the operations which are performed by using an independent oscillator and phase meter. In this way, setting on the frequency response analyzer is easy. Furthermore, since the range of the voltmeter can be changed for each measuring point, a high dynamic range measurement far beyond the limit of bits of the A/D converter can be done.

**Note: Fourier transform calculations**  
 The products of measured values and a reference (sine wave signal) are integrated. This is similar to operations for obtaining the basic waves of a Fourier series. An asynchronous element such as an external disturbance attenuates in proportion to the square root of integration time.



# FRA5097 15 MHz / FRA5087 10 MHz

## Major specifications

### Oscillator section

Output waveform	Sine wave, Square wave, Triangular wave
Frequency range	Sine wave : FRA5087 0.1mHz to 10MHz Square wave : FRA5097 0.1mHz to 15MHz Triangular wave : 0.1mHz to 100kHz Setting resolution : 0.1mHz Accuracy : ±10ppm
AC amplitude	0V to 10Vpeak (no load) Setting resolution : Three digits or 0.01mVpeak, whichever is greater
DC bias	-10V to 10V (no load) Resolution : 10mV
Output control	Quick : Goes to a set voltage or 0V instantaneously. Slow : Goes to a set voltage or 0V slowly. Phase control : Sets the start and stop phases of oscillation in 1° steps. AC/DC simultaneous ON/OFF and AC only OFF possible.
Frequency sweep	Logarithmic sweep : 3 to 20,000 steps/sweep or 1 to 20,000 steps/decade (3 steps/sweep minimum ; 20,000 steps/sweep maximum). Linear sweep : 3 to 20,000 steps/sweep or 0.1mHz to 10MHz/step (FRA5087), 0.1mHz to 15MHz/step (FRA5097) (where, 3 steps/sweep minimum and 20,000 steps/sweep maximum). Frequency axis high density sweep : When measured data changes greatly, sweep density is made higher around the frequency area automatically for accurate measurement.
Isolation	Withstand voltage : 250Vrms (to chassis, to analysis section input) Measurement category : I

### Analysis section input

Number of input channels	Two (CH1 and CH2)
Isolation	250Vrms (signal and ground to oscillator section and analysis section input channel) Measurement category : I
Maximum input voltage	±350Vpeak (AC+DC)
Maximum measuring voltage	250Vrms
Dynamic range	140dB typ. (10Hz to 1MHz)
Measuring mode	REPEAT, SINGLE, SWEEP
Analysis mode	Ratio : CH1/CH2, CH2/CH1 Level : CH1, CH2
Harmonic measurement	2nd to 10th order (up to 10MHz for FRA5087 and 15MHz for FRA5097)
Harmonic wave and noise rejection ratio	Normal mode DC : 60dB or greater Wide band white noise : 50dB or greater (noise band width 500kHz) Harmonic (10th or less) : 60dB or greater (100kHz or less) 40dB or greater (100kHz or greater)
Auto ranging function	Switches the input range according to the input signal level.
Delay function	Delays time until a start of measurement following switching the frequency. 0 to 9,999 seconds or 0 to 9,999 cycles.
Integration function	Integrates data for measurement, eliminating the noise. 0 to 9,999 seconds or 0 to 9,999 cycles.
Auto integration function	Repeats integration until a certain reliability is obtained. 0 to 9,999 seconds or 2 to 9,999 cycles.
Amplitude compression function	Controls the level of oscillation so that the amplitude level of DUT may stay at a certain value in order to keep the DUT from saturation and damage.
Equalize function	Measures the frequency characteristics of measuring systems such as the sensors and cables beforehand and then removes the error of the system in measurement to obtain the characteristics of the DUT only.
Operation function	Arithmetic operation (data to data, data to logarithmic value, value to value), differentiation of data, second differentiation, integration, second integration, open-loop to closed-loop conversion, closed-loop to open-loop conversion.

### Measurement error

CH1/CH2 or CH2/CH1	≒20kHz	≒500kHz	≒2.2MHz	>2.2MHz
a, b, R	±0.5%	±1%	±10%	±25%
dBR	±0.05dB	±0.1dB	±1dB	±2dB
Phase (deg.)	±0.3°	±0.5°	±2°	±5°

In case analysis input voltage is 100mVpeak to 10Vpeak (2Vpeak maximum when exceeding 2.2MHz) immediately after calibration

### Display section

Display	6.5 inches, color TFT LCD
Graph display	Bode, Nyquist, Nicols, and Cole-Cole plots Interconversion is also available. (reading and auto-scale are available with use of the cursor)
Measured data display	Gain (linear, logarithmic), phase enlarged display possible
Other functions	Auto scaling as well as marker, measurement condition, title, date and time displays

### External memory

Media	USB memory (USB 1.1 or USB 2.0)
Connector	Front panel, USB-A connector
File format	FAT (compatible with Windows 98SE or later, compatible with IBM PC/AT)
Recorded contents	Setting conditions, measured data, screen data (bit map format)
File operation function	Directory, rename, delete, save, load

### External I/O

Interface	GPIB : Condition setting, condition and data inquiry, operation command USB : USB 1.1 (low speed, full speed), TMC rear panel, USB-B connector
Thermosensitive printer	Takes hard copy of LCD screen image on the internally stored thermosensitive paper
DC power supply output	5055 connector (optional), ±24V, 100mA maximum

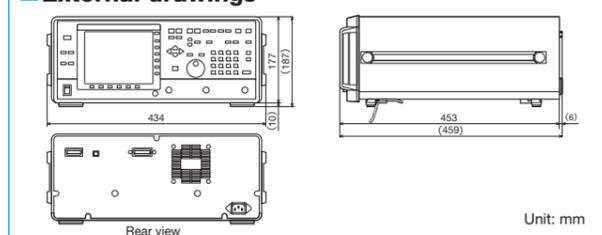
### Impedance display function (optional for FRA5087)

Display items	Impedance, resistance, reactance, admittance, conductance, and susceptance are displayed on linear and logarithmic graphs.
Current shunt input convert coefficient	0 to 1.0E+6 (five digit resolution or 0.01E-9), phase inversion function
Open/short correction functions	Sets the open and short correction memories and displays a graph with open/short correction at measurement.
Maximum, minimum search functions	Searches the maximum and minimum values of vertical axis parameters on a bode diagram, moves the marker, and displays the calculated values.

### Other

Power supply	AC 100V/120V/230V ±10% Where, 250V or less and 50Hz/60Hz ±2Hz
Power consumption	100 VA maximum
Guaranteed temperature and humidity ranges	+5 to +35° C, 5 to 85% relative humidity (Absolute humidity of 1 to 25g/m <sup>3</sup> with no condensation)
Dimensions	434 (W)×177 (H)×453 (D) mm (not including projections)
Weight	Approx. 12kg
Accessories	1 instruction manual, 1 GPIB/USB instruction manual, 1 power supply cable (3-pin, 2m), 3 signal cables (BNC-BNC), 1 T-type divider, 1 roll of thermosensitive paper

### External drawings



※ A rack mount bracket kit is available.

# FRA5022 100 kHz



The FRA5022 is a frequency response analyzer (FRA) for measurement frequencies of 0.1 mHz to 100 kHz. With a slim, space-efficient case design and simple operation for ease of use, it is well suited for integration into production lines and systems.

### Gain accuracy: ±0.05 dB, Phase accuracy: ±0.3°

Digital Fourier transforms and a self calibration function always achieve highly accurate measurements.

### Frequency range: 0.1 mHz to 100 kHz

The FRA5022 covers the frequency range best suited for electrochemicals measurement and mechanical servo analysis, allowing for support of a wide range of applications.

### Dynamic range: 120 dB or wider

Auto ranging and a high resolution A/D converter secure a wider dynamic range. Measurement is secured even if a drastic change occurs during measurement.

### Isolation

Oscillator output and each input are isolated from the case, allowing for easy signal injection during servo loop measurement, thus protecting the instrument from being damaged and preventing errors.

### Quick switching of settings

Multiple presets can be switched with "one touch". This stresses the importance of ease of use on production lines.

### Data display software

Software for loading measurement data onto a PC and displaying graphs is included as standard. Besides display in graphs, measurement data can also be saved in CSV format.

### Oscillator section

Output waveform	Sine wave
Frequency range	Setting range: 0.1 mHz to 100 kHz Setting resolution: 5 digits or 0.01 mHz, whichever greater
AC amplitude	Setting range: 0 to 10 Vpk or 0 to 7.07 Vrms Setting resolution: 0.01 Vpk (amplitude ≥ 1 Vpk), 0.001 Vpk (amplitude < 1 Vpk) or 0.01 Vrms (amplitude ≥ 1 Vrms), 0.001 Vrms (amplitude < 1 Vrms)
DC bias	Setting range: 10 V to +10 V Setting resolution: 0.01 V
Maximum output (AC + DC)	Voltage: ±10 V (no load) Current: ±100 mA
Output impedance	50 Ω, unbalanced
Output control	Both AC and DC on, both AC and DC off, only AC off, SLOW control that gradually changes AC and DC
Isolation	Withstand voltage: 42 Vpk or 30 Vrms Electrostatic capacitance against casing: 250 pF or less

### Analysis input section

Number of input channels	2
Input impedance	1 MΩ, 60 pF in parallel
Frequency range	0.1 mHz to 100 kHz
Maximum input voltage	Measurement range: ±10 V
Over-detection level	Setting range: 0.01 to 19.99 Vrms
Measurement range	Automatic switching (autoranging)
IMRR	120 dB or more
Dynamic range	120 dB or more
Isolation	Withstand voltage: 42 Vpk or 30 Vrms Electrostatic capacitance against casing: 300 pF or less

### Analysis processing section

Measuring mode	CH2/CH1, CH2/OSC
Integration time	Cycle setting range: 1 to 999 Time setting range: 0.01 to 999.99 s
Ratio accuracy	0.1 Hz to 20 kHz: Gain ±0.05 dB (±0.5%), phase ±0.3° Outside the range above: Gain ±0.15 dB (±15%), phase ±1° (Input signal levels of both channels: 10 mVrms or higher)

### Measurement processing section

Measuring operation	Sweep measurement/graph display Spot measurement/numeric display Scan measurement (Up to ten spots are measured in sequence.)
Sweep control	Frequency axes: Linear/logarithmic Sweep operations: Up, down, hold, stop Delay time setting range: 0.00 to 999.99 s

### Display section

Graph display	Bode plots (gain dB, phase vs. frequency split display) Orthogonal coordinate display: Numeric display of the value of a + jb
Spot display	Numeric display of frequency, gain, phase, and amplitude GO/NO-GO judgment based on the range specification of gain and phase
Numeric display of measurement values	Gain: ±199.99 dB when dB 0, ±(1.0000E - 9 to 9.9999E + 9) when linear Phase: Any 360° in ±360.00° a, b: 0, ±(1.0000E - 9 to 9.9999E + 9) Amplitude: 0.000 mVrms to 19.99 Vrms
Measured data memory	Memory units: 2 Memory capacity: up to 1,000 points (per memory unit)
Memory display mode	A, B, A & B (overlapping), A/B (vector ratio)

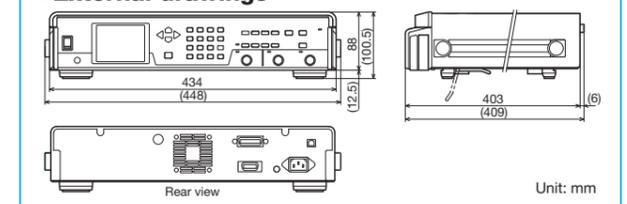
### Other

Setting memory	10
Interface	GPIB, USB: USBTMC
DC power supply output	Connector for 5055 (sold separately), ±24 V
Memory backup	The settings immediately before power-off and measured data are retained.
Power supply	AC 100 V to AC 230 V ±10% (AC 250 V or lower) 50 Hz/60 Hz ±2 Hz
Power consumption	55 VA max.
Overvoltage category	II
Temperature and humidity for guarantee	+5 to +35° C, 5 to 85% relative humidity (Absolute humidity of 1 to 25 g/m <sup>3</sup> with no condensation)
Dimensions	434(W)×177(H)×453(D) mm (not including projections)
Weight	About 6.8 kg
Accessories	1 instruction manual, 1 power supply cable, 1 CD-ROM (data display software, LabVIEW driver, sample program)

### Data display software

Data capture	Measured data loaded from FRA to PC
Data save	Measured data stored in CSV format
Graph display	Bode, Nyquist, Nicols, and Cole-Cole plots
Parameter setting	Main FRA parameters are set and controlled.

### External drawings



※ A rack mount bracket kit is available.

# Reliable FRA that offers excellent performance in various situations. Highly accurate measurement meets the greater demands of customers.

## Measurement applications

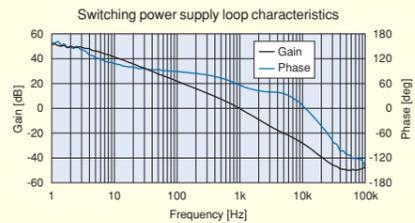
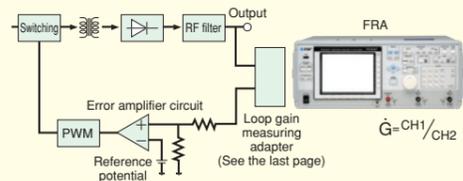
Frequency response analyzers providing consistently high-quality measurements with excellent accuracy and functions are often used for measuring the stability of servo systems, so they are sometimes called "FRA servo analyzers" and for many years have lent powerful support to state-of-the-art technology measurements. The range of applications is broad, covering various fields from electronic circuitry, parts, and materials to electrochemistry, machinery, and vibrations.

- Electronic circuits
- Electronic components
- Electronic materials
- Electrochemistry
- Machinery
- Vibrations
- ...etc.



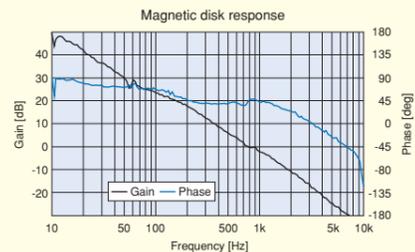
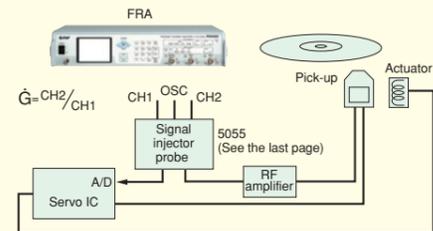
### SWPS Loop characteristics of switching power supplies

Evaluate the dynamic stability (gain margin, phase margin) of a switching power supply. Since the signal source and measured terminal are mutually isolated, unrestricted connection is made possible, even with portions having overlapping direct current. The effect of a phase correction circuit can be measured clearly.



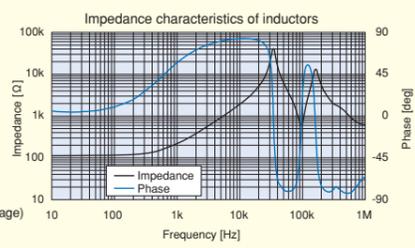
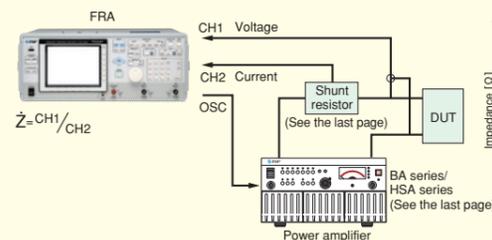
### Servo response for magnetic and optical disks

Measure transfer functions of servo systems which control the pick-ups of magnetic disk optical disks, and measure open loop response in a normal operating status. It can also measure the phase of a high gain area in a stabilized condition because of its higher noise eliminating capacity, with measurement in a dynamic range of more than 140dB, by using the auto ranging operation at every measuring frequency.



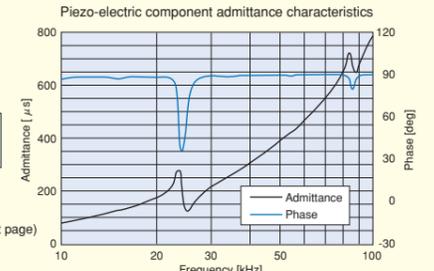
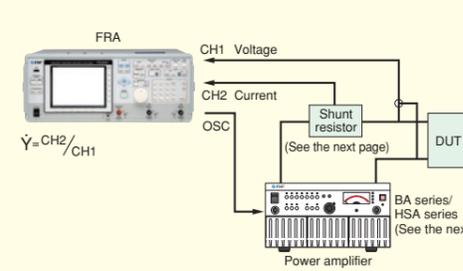
### Impedance of electronic components

Measure the impedance of inductors or capacitors. The frequency response analyzer can provide the impedance characteristics of DUT. Since it can perform measurements under a high voltage or large current in combination with a power amplifier, which cannot be done by an LCR meter, impedance can be measured in a condition closer to an actual state of use.



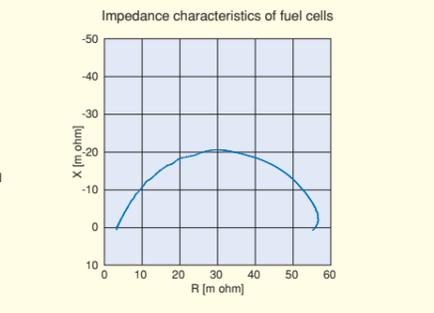
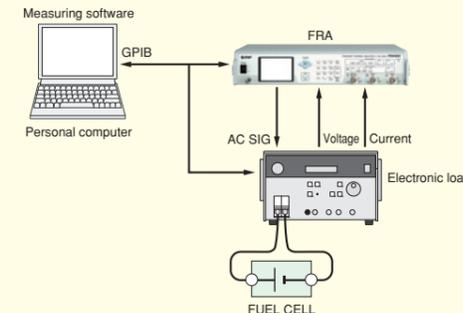
### Resonance characteristics of piezo-electric components

Measure the electric resonance of piezo-electric components such as those used for piezo-electric actuators. The frequency response analyzer can provide high frequency resolution of a specified frequency range, which differs from FFTs, and then detailed characteristics near the resonance point can be known because of high phase accuracy,  $\pm 0.3^\circ$ . By combination with the power amplifier, a large amplitude response can also be measured, not only the small amplitude response.



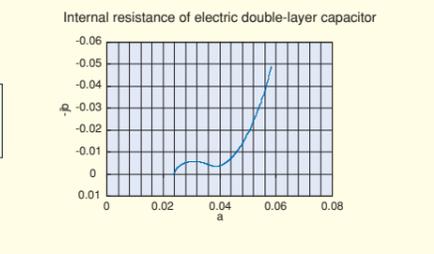
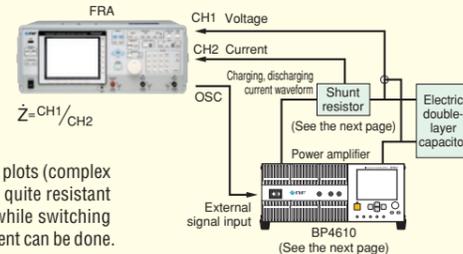
### AC impedance of fuel cells

Measure the AC impedance of fuel cells with an electronic load. Since the frequency response analyzer is not affected by direct current, impedance can be measured accurately with any output current from the fuel cell. Furthermore, measurement at a very low frequency 0.1mHz (almost DC) can be done. Moreover, it can be developed into a system which calculates the parameters (parasitic resistance, reactive resistance, double layer capacity) of an equivalent circuit from the results of measurement.



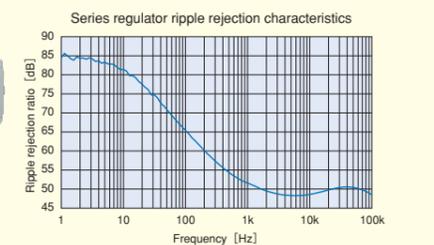
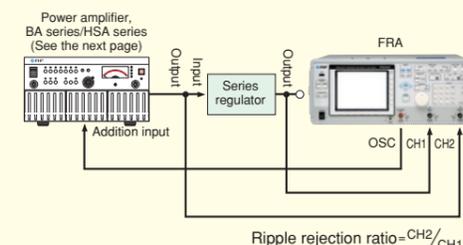
### Internal resistance of electric double-layer capacitors

Measure the internal resistance of an electric double layer capacitor placed intermediately between a capacitor and cell. The frequency response analyzer can perform measurements with a high resolution of up to 0.1mHz. It can also analyze Faraday impedance with Cole-Cole plots (complex impedance display). Moreover, since it is quite resistant to external disturbances, measurement while switching charging and discharging with a large current can be done.



### DCPS Ripple rejection ratios of series regulators

Measure ripple rejection ratios for series regulators. The ripple rejection ratio characteristics are a major feature of a series regulator. Since the frequency response analyzer automatically removes a DC component of up to  $\pm 200V$ , it can measure a high voltage output of the series regulator with a high dynamic range of up to 140dB in combination with a power amplifier (HSA series).



### Other applications...

- Characteristics evaluation for vibration-proofing materials
- Frequency response measurement for filters
- Contact resistance measurement for EV connectors
- Testing for hydraulic equipment such as large vibration benches and fatigue testers
- CMRR PSRR measurements for OP amplifiers
- Internal temperature elevation measurements for transformers
- Characteristics measurements for ultrasonic motors
- Chemical impedance measurements

## Peripheral Equipment

### Impedance Measuring Adapter

PA-001-0368 optional



For FRA5087 and FRA5097

An adapter to measure the frequency response of impedance for electronic components. The shunt resistors for current detection (1Ω, 10Ω, 100Ω) are built-in.

### Loop Gain Measuring Adapter

PA-001-0369 optional



For FRA5087 and FRA5097

An adapter to measure the loop gain of a negative feedback circuit in operation. (Clip cable can be replaced: PC-007-1922)

### High Power Impedance Measurement Adapter

PA-001-1840 (1Ω)  
PA-001-1841 (100Ω) optional



Combine with a bipolar amplifier to measure impedance.  
• Built-in shunt resistor  
• Max. input voltage: 250Vrms  
• Max. input current: 1Arms(1Ω), 0.1Arms(100Ω)

### Shunt Resistor

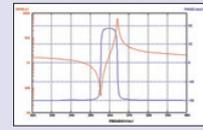
PA-001-0370 optional



A shunt resistor incorporating a 1Ω 4-terminal resistor, used to detect a current (1Arms maximum) flowing through a DUT. It can be used for all FRA models.

### Impedance Display Function

PA-001-1231 optional



For FRA5087

Measures and displays impedance. It can also perform open/short correction, maximum and minimum values displays, and screen image storage. (Standard with FRA5097.)

## Related Production

Boosts up power of FRA's oscillator output.

### Signal Injector Probe 5055



An auxiliary unit to measure the loop response of a servo system or the like with closed loops. It can be used for all FRA models.

### High Speed Bipolar Amplifier BA series



BA4850

- BA4825: DC to 2MHz 100Vrms (300vp-p), 0.5Arms
- BA4850: DC to 50MHz ±20V, ±1A
- Four-quadrant output

### High Speed Bipolar Amplifier HSA series



HSA4012 (DC to 1MHz)

- Six models line up
- DC to 500kHz/1MHz/10MHz
- 150Vp-p/300Vp-p/147Vp-p
- 1Arms/2Arms/4Arms/±1.4A
- Four-quadrant output

### Bipolar Power Supply BP series



BP4610

- ±60V, DC to 150kHz, CV/CC mode
- BP4610 : ±10A (30Ap-p)
- BP4620 : ±20A (60Ap-p)
- Four-quadrant output

## Optional accessories

### High withstand voltage clip set (3 per set)

PA-001-0419



### High withstand voltage alligator clip cable set (small) (3 per set)

PA-001-0420



### High withstand voltage alligator clip cable set (large) (3 per set)

PA-001-0421



### Alligator clip cable set (3 per set)

PA-001-0422



### High withstand voltage BNC adapter (T-branch)

PC-001-4503



### High withstand voltage BNC cable

PC-002-3347



### High withstand voltage extension BNC cable

PC-007-0364



### Replacement printer paper (ten rolls)

PC-007-0382



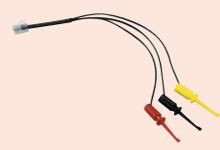
### Impedance measuring adapter kelvin clip cable (for replacement)

PC-007-1490



### Loop gain measuring adapter clip cable (for replacement)

PC-007-1922



\* The contents of this catalog are current as of August 12, 2011.

- External view and specifications are subject to change without prior notice.
- Please check the latest specifications, prices, and lead time for purchase.
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