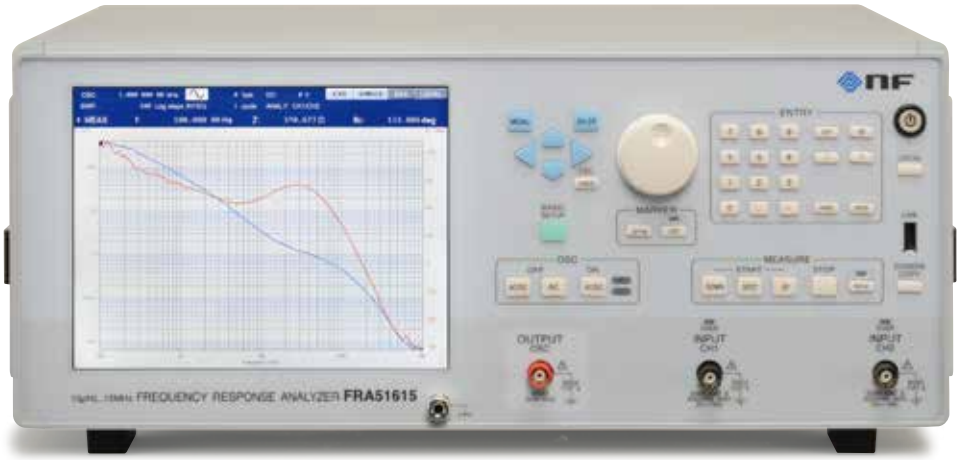
Frequency Response Analyzer

FRA51615

From power electronics such as inverters and to servo control, evaluation of electronic components and even advanced bioresearch.



CE

Significantly improved performance, functionality, and ease of use for many applications.

- Frequency range
  10 μHz to 15 MHz
- Testing speed
  0.5 ms/point
- Fundamental accuracy
  Gain ±0.01 dB, Phase ±0.06°
- Isolation / Maximum input voltage
  600 V CAT Ⅱ / 300 V CAT Ⅲ
- Maximum test voltage
  600 Vrms

- Sequence measurement
- Marker search function
- Group delay measurement
- Phase control during frequency changes
- Load correction
- Port extension function
- Potential slope elimination

Faster than ever

NF Corporation

Loop Characteristics | Servo Characteristics | Transfer Characteristics | Impedance
Admittance | PSRR | PLL Response Characteristics
Vibration Transfer Characteristics | Electrochemical Impedance (EIS)

NF FRAs are the best choice, when accuracy of frequency response measurements matters

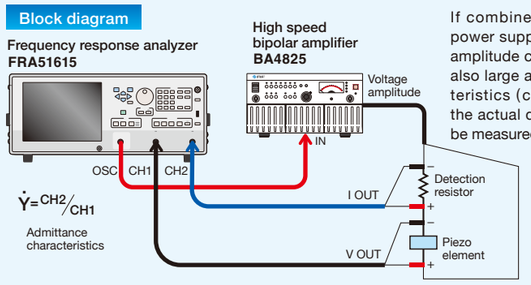
Applications

Impedance measurement

Measurement of resonance characteristics of piezo element

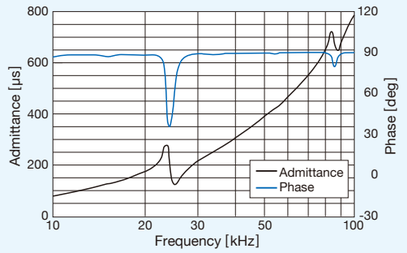
Unlike the FFT analyzer, the FRA51615 can make the frequency resolution of a specific frequency range finer and has high phase accuracy, so it is possible to know the characteristics near the resonance point in detail.

Block diagram



If combined with a bipolar power supply, not only small amplitude characteristics but also large amplitude characteristics (characteristics at the actual drive voltage) can be measured.

Measured data



Characteristics measurement of multilayer ceramic capacitor with applied voltage

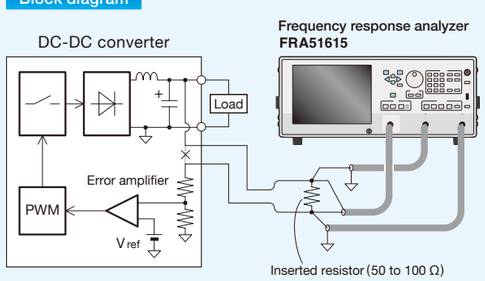
Internal impedance measurement of battery

Gain-phase measurement

Loop gain measurement of power supply circuit

The loop gain characteristics of the DC-DC converter are measured under actual driving conditions, and the stability of the circuit is quantitatively evaluated from the phase margin and gain margin. With 600 V CAT II / 300 V CAT III, It can also be used to measure non-isolated PFC circuits connected to a commercial power supply.

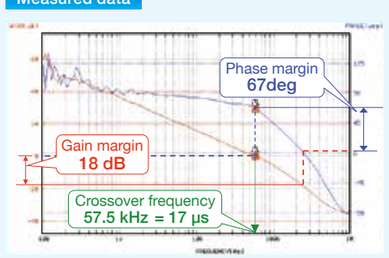
Block diagram



Results

- **Phase margin and gain margin.**
  The larger the margin, the more ringing and oscillation can be suppressed.
- **Crossover frequency**
  It is a guide of responsiveness at load fluctuation.

Measured data



Conditions Load : DC-DC converter with switching frequency 1 MHz
Sweep frequency 100Hz to 1MHz, Inserted resistor 51 Ω

Point! Automatic marker search function

At the end of the sweep, if Value “0dB” for automatically search, the phase margin can be detected automatically, and if Value “0°”, the gain margin can be detected, so it is easily to read the value.

Wireless charging efficiency measurement

Filter input / output characteristics measurement

Vibration analysis

Specifications & Functions

FRA51615

Newly Designed to Support Many Testing Scenarios

Specifications and Functionality to Ensure Reliable and Highly Accurate Measurements

Measurable frequency range 10 µHz to 15 MHz

Supports low frequencies of 10 µHz all the way to 15 MHz. Resolution has also been increased to 10 µHz. Ultra-low frequencies required for electromechanical impedance testing is also supported.

Testing speed 0.5 ms/point

Maximum sweep speed of 0.5 ms/point is definitely fast. This device can help reduce production line tact times.

Fundamental accuracy
Gain ±0.01 dB, Phase ±0.06°

Highly accurate measurements are achieved with digital Fourier conversion and self-calibration functionality.
*Accuracy varies depending on testing conditions.

Dynamic range 140 dB

A larger dynamic range has been achieved with a high-resolution A/D converter and auto ranging functionality that optimizes testing ranges per frequency measurement point. Highly accurate measurements can be taken even when changes occur during testing.

Isolation 600 V CAT Ⅱ / 300 V CAT Ⅲ

The oscillator output (OSC) and 2 analysis inputs (CH1 and CH2) are isolated from the chassis. Terminals are also isolated from each other. Available isolation ratings include 600 V CAT II and 300 V CAT III.
For the loop and gain testing of power circuits such as high-voltage inverters and PFC circuits, this further expands the range of applications supported by FRAs.

Auto range

This feature automatically tracks the input signal level so that the range is constantly optimized during testing. Once noise that exceeds the range is detected, the system automatically sets a larger range. Measurement data will not become saturated within specific ranges. It is also possible to select a fixed range in order to avoid discontinuities in the measurement values associated with range changes.

Automatic, high-density sweeps

The FRA51615 supports high-density testing of up to 20,000 points as well as automatic adjustment of frequency density specifically during intervals of sudden changes in measurement data.

Amplitude compression

To prevent saturation and damage of test devices, oscillator levels are controlled to match the amplitude level of the test device.

Integrator

The data integrator is used to remove the effects of noise while measuring. The period of repeated testing is configured in cycles or time.

Automatic integrator

Integrals are repeated until variation in measurements due to noise lower than a preconfigured value.

Delay function

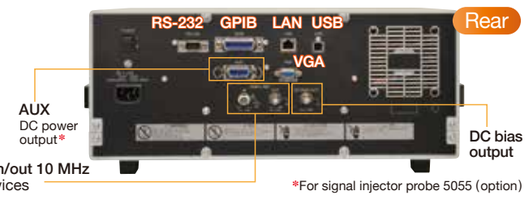
This function delays the start of testing to reduce error caused by transient responses during frequency changes. A function has also been added to delay the start of testing only for start of sweep testing or spot testing.

Differential and integral operations

This feature calculates differentials, second-order differentials, integrals, and double integrals for the time domain of measurement data. For example, this is useful for calculating displacement, speed, and acceleration from acceleration sensor or laser doppler vibrometers.

Interfaces GPIB, USB, LAN, RS-232, VGA

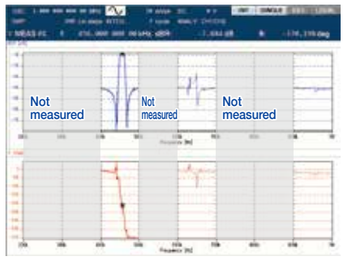
With these interfaces, automated testing systems can be built. A VGA port is also included on the rear to connect with external monitors. Refer to the description of the right figure of the rear side of the device for more information on other output ports.



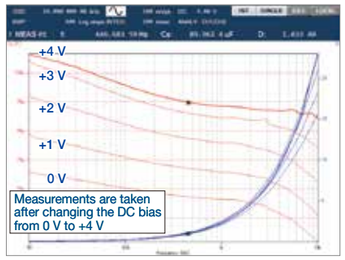
Increasing testing efficiency!

Sequential testing

Sweep measurements can be performed in accordance with a numerical order that is read from configuration memory. The frequency range can be divided up to 20 parts per sweep so that these different frequency ranges can be measured using different amplitude and integral settings. This is useful in accurately measuring specific frequency ranges of filters, piezoelectric elements, and so on. This is also useful in measuring components with a bias dependency, such as multilayer ceramic capacitors (MLCC), inductors, and transformers.



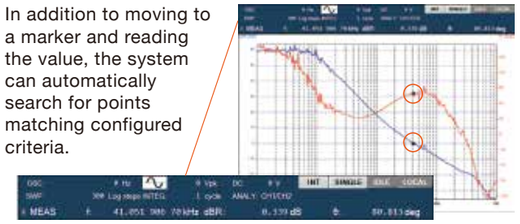
Measuring filter's pass bands
Only required frequency ranges are measured



Measuring MLCC static electricity capacity
Measuring the same frequency range at different test conditions

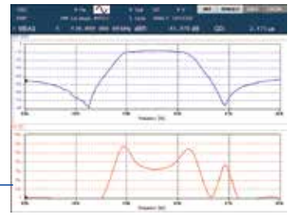
Marker search functionality

In addition to moving to a marker and reading the value, the system can automatically search for points matching configured criteria.



Group delay measuring

This system can display group delay (GD, phase differentials between input and output by frequency) used to evaluate reproducibility of waveforms of filters and other electronic components.



Phase control during frequency changes

Frequencies are changed at the timing at which the phase of the oscillator output signal is at 0° . As a result, there are no DC components from the start to the end of the frequency sweeps, which enables the impedance of batteries to be tested without changing the charge/discharge state. And the frequency response of high-pass filters (HPF) can be measured without any DC transient responses.

Error correction

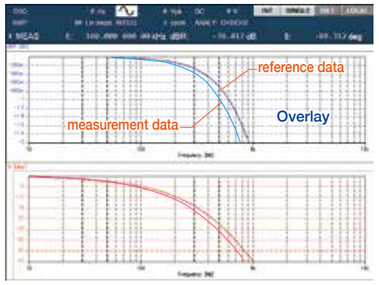
Open/Short/Load Correction, Port Extension Functionality, Potential Gradient Removal, and Equalization

- **Open correction/short correction**
  Corrects errors in measurements due to stray admittance of open circuits and residual impedance of shorted circuits. [Impedance testing]
- **Load correction**
  Test devices of known values are used as reference impedance to correct related errors. [Impedance testing]
- **Port extension functionality**
  Corrects errors due to propagation delays when long cables are used. [Impedance testing]
- **Potential gradient removal**
  Amplitude and phase of sine waves and ramp waves are individually detected given that test signals are composed of sine waves and ramp waves (fluctuating potential waveforms). This removes the effects of changes in potential that accompany charging/discharging cycles of batteries. [Impedance testing]
- **Equalization**
  Corrects measurement-related errors by measuring the frequency response of externally connected sensor, cables, and other components involved in measurements beforehand. [Gain/phase testing]

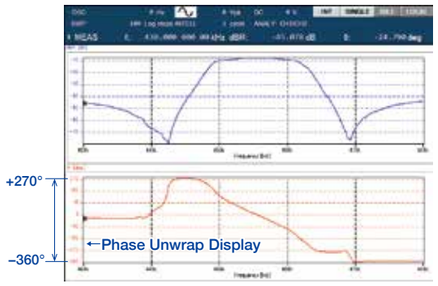
*Correction features used for the types of measurements indicated in [ ].

Graph display

- **SPLIT display**
  Both a SINGLE mode that displays one graph per page and a SPLIT mode that displays an upper graph and lower graph are available.
- **Data trace**
  A reference data trace (REF) and a measurement data trace (MEAS) can be drawn as overlays.



- **Phase unwrap display**
  Displays the phase continuously without using 0°, 180°, and 360° as cross-over points.
  Phases exceeding ±360° can also be displayed.



Specifications

Oscillator

Connector	Insulated BNC (front panel, OSC)
Frequency	10 µHz to 15 MHz Setting resolution : 10 µHz Accuracy : ±10 ppm
AC signal amplitude	0 to 10 Vpk Setting resolution : 3 digits or 0.01 mVpk, whichever is greater
DC bias	–10 V to +10 V, Setting resolution : 10 mV
Output impedance	50 Ω ±2% (1 kHz)
Maximum output (AC + DC)	Voltage : ±10 V Current : ±100 mA
Sweep	Sweep density : 3 to 20,000 steps/sweep Sweep type : Linear or log, selectable Sweep time : Fastest 0.5 ms (per frequency point)
Output control	QUICK : immediately changes to the set voltage or to 0 V SLOW : changes to the set voltage or to 0 V gradually over a period of about 10 seconds Function for turning off at 0° phase Function for changing the frequency at 0° phase It is possible to turn the AC and DC on / off at the same time or to turn off the AC only. It is possible to turn on automatically at the start of measurement and to turn off automatically at the end of measurement.
Isolation	600 V CAT II or 300 V CAT III (BNC grounded to the enclosure)
Capacitance relative to the enclosure	150 pF or less
DC BIAS OUT (rear panel)	Connector : BNC Setting range : –10 V to +10 V Output resistance : 600 Ω ±2%

Analysis input

Input channels	2 (CH1, CH2)
Connectors	Insulated BNC
Input impedance	1 MΩ ±2%, 20 pF ±5pF
Measurement range	10 ranges (30 m/100 m/300 m/1/3/10/30/100/300/600 Vrms), and AUTO. CH1 and CH2 can be set independently.
Maximum input voltage	600 V CAT II or 300 V CAT III
Maximum measurement voltage	600 Vrms (the bundled signal cable is used)
Over-level detection	0 to 600 Vrms (over lamp lights, buzzer warning sound, stop sweep measurement)
Dynamic range	140 dB (10 Hz to 1 MHz) 80 dB (1 MHz to 15 MHz)
IMRR	Isolation mode rejection ratio 120 dB or more (DC to 60 Hz)
Isolation	600 V CAT II or 300 V CAT III (BNC ground to the enclosure)
Capacitance relative to the enclosure	200 pF or less

Measurement processing

Measurement operations	UP SWEEP [In order of increasing frequency] DOWN SWEEP [In order of decreasing frequency] SPOT [At the current frequency (no sweep)] REPEAT [Repeatedly measurements] SINGLE [A single measurement]
Integration function	This function performs integration on measurement data to remove the effects of noise. 0 to 9,990 s or 1 to 9,999 cycles
Measurement delay function	This function delays the beginning of a measurement after the frequency is changed. 0 to 9,990 s or 0 to 9,999 cycles
Start delay function	This function delays the beginning of a measurement only from the start of a sweep or spot measurement. 0 to 9,990 s or 0 to 9,999 cycles
Automatic integration function	This function repeats the integration process until the variation in the measurement values falls below a set value. Setting : FIX, SHORT, MED, or LONG.
Amplitude compression	This function automatically adjusts the oscillator output amplitude so that the amplitude of the signal input to the reference channel satisfies the target amplitude. Target amplitude setting : 1 µV to 600 Vrms Voltage limit for the oscillator : 1 mV to 10 Vpk Allowable error : 1 to 100% Maximum number of retries : 1 to 9,999 Correction factor : 1 to 100%
Automatic high density sweep	This function automatically increases the sweep density in the region just before and after a point where there is a large change in the measurement data. Variation : a, b, R (0 to 600 Vrms) dBR (0 to 1000 dB) Phase (0 to 180°)
Sequence measurement function	This function performs measurements according to the content of a measurement condition memory. UP SWEEP The first up sweep is performed over the frequency range that is set in memory number 1. The next up sweep is performed over the range that is set in memory number 2, and so on continuously up to the upper limit memory number. DOWN SWEEP The first down sweep is performed over the range set in the memory number specified by the upper limit memory number. The next down sweep is performed over the range that is set in the next lower memory number and so on continuously down to memory number 1. Upper limit memory number : 1 to 20

Analysis processing

Display unit	Gain (ratio, unitless number) or impedance

Measurement accuracy

Fixed range

Measurement accuracy = Relative accuracy + Calibration accuracy

Relative accuracy = ± (|Basic accuracy| + |Dynamic accuracy| + |Inter-range accuracy × N|)

Calibration accuracy : The accuracy of external equipment that is connected to the instrument, such as a shunt resistor or probe, or the accuracy of the calibration standard equipment.

Basic accuracy Upper : gain (ratio) ; Middle : impedance Z ; Lower : phase

Measurement range (rms)	Frequency			
	≤ 100 kHz	≤ 200 kHz	≤ 1 MHz	≤ 2 MHz
600 V	±0.2 dB ±2.4% ±1.2°	—	—	—
300 V	±0.1 dB ±1.2% ±0.6°		—	—
100 V	±0.05 dB ±0.58% ±0.3°		—	—
30 V to 30 mV	±0.01 dB ±0.12% ±0.06°		±0.025 dB ±0.29% ±0.15°	±0.1 dB ±1.2% ±0.6°

Analysis processing (continued)

Measurement range (rms)	Frequency	
	≤ 5 MHz	≤ 15 MHz
10 V to 30 mV	±0.2 dB	±0.5 dB
	±2.4%	±5.9%
	±1.2°	±3.0°

[Conditions]
- At least 30 cycles of integration
- Fixed measurement range and the same range for both channels.
- The gain, Z and phase error for when the signal input is at the full scale of the measurement range for both channels.

*For the cells that contain only " —— ", either the measurement is not possible or there is no accuracy specification for it.

Dynamic accuracy (excerpt) : Gain (ratio) / Impedance Z / Phase

≤ 100 kHz and 300 mV to 600 V ranges : ±0.1 dB / ±1.2% / ±0.6°
≤ 15 MHz and 100 mV to 10 V ranges : ±0.5 dB / ±6.0% / ±3.0°

[Conditions]
- At least 30 cycles of integration
- Fixed measurement range and the same range for both channels.
- Gain, Z and phase variation for when the signal level changes from full-scale of measurement range to 1/10. The input signal level is 1:1 or 1:0.1 between channels.

Inter-range accuracy (excerpt) : Gain (ratio) / Impedance Z / Phase

≤ 100 kHz and ≤ 300 V range : ±0.05 dB / ±0.58% / ±0.3°
≤ 15 MHz and≤ 10 V range : ±0.05 dB / ±0.58% / ±0.3°
≤ 100 kHz and 600 V range : ±0.1 dB / ±1.2% / ±0.6°

[Conditions]
- At least 30 cycles of integration
- Fixed measurement range for both channels
- The gain, Z and phase error for when the measurement range difference between channels is 1, the input signal levels of both channels are equal, and equal to the range full scale level of the smaller range.

Auto-range

Measurement accuracy = Relative accuracy + Calibration accuracy

Relative accuracy = ± (|Basic accuracy| + |Dynamic accuracy|)

Calibration accuracy : The accuracy of external equipment that is connected to the instrument, such as a shunt resistor or probe, or the accuracy of the calibration standard equipment.

Basic accuracy Upper : gain (ratio) ; Middle : impedance Z ; Lower : phase

Signal level (rms)	Frequency			
	≤ 100 kHz	≤ 200 kHz	≤ 1 MHz	≤ 2 MHz
7 V	±0.02 dB	±0.02 dB	±0.05 dB	±0.1 dB
	±0.24%	±0.24%	±0.58%	±1.2%
	±0.12°	±0.12°	±0.3°	±0.6°

Signal level (rms)	Frequency	
	≤ 5 MHz	≤ 15 MHz
7 V	±0.2 dB	±0.5 dB
	±2.4%	±5.9%
	±1.2°	±3.0°

[Conditions]
- At least 30 cycles of integration
- Auto-range for both channels
- The gain,Z and phase error for when the input signal level is the same for both channels.

Dynamic accuracy (excerpt) : Gain (ratio) / Impedance Z / Phase

≤ 100 kHz and signal level of 30 Vrms to 600 Vrms :
±0.1 dB / ±1.2% / ±0.6°
≤ 15 MHz and signal level of 100 mVrms to 20 Vrms :
±0.5 dB / ±6.0% / ±3.0°

[Conditions]
- At least 30 cycles of integration
- Auto-range for both channels
- The gain,Z and phase variation for when input signal level with the greater signal level channel changes from 7 Vrms to the value above, when the input signal level between channel is 1:1 or 1:0.1.

Error correction function	Corrects for measurement errors that arise within the instrument itself (Calibration).

Gain

Analysis modes	Ratio : CH1/CH2, CH2/CH1 Amplitude : CH1, CH2
Graph types	Bode plot, Nyquist plot, Nichols plot
Measurement items	dBR (gain dB), θ (phase), GD (group delay), R (absolute gain/amplitude), a (real part of gain/real part of amplitude), b (imaginary part of gain/imaginary part of amplitude)
Error correction function (Equalizing)	Measuring the frequency characteristics of the measurement system (sensors, cables, etc.) in advance and then eliminate that error component.

Impedance

Voltage and current input	Voltage is measured as the measurement amplitude at CH1 and current is measured as the measurement amplitude at CH2.
Analysis modes	Impedance : CH1/CH2 Admittance : CH2/CH1 Voltage : CH1 Current : CH2
Graph types	Bode plot, Nyquist plot, Cole-cole plot
Measurement items	Z (impedance) R, X (resistance, reactance) Y (admittance) G, B (conductance, susceptance) Ls, Lp (inductance) Cs, Cp (capacitance) Rs, Rp (resistance) V (voltage) I (current) θ (phase) D (dissipation factor) Q (quality factor)
Error correction function	Open correction Short correction Load correction Load standard value : Standard values can be entered for up to 10 frequency points. Port extension : Corrects the error due to phase delay in cables for 2-port measurements. Slope compensation This function performs analysis that is unaffected by the DC level for signals that have a superimposed DC level that varies linearly over time.

Display

Display unit	8.4-inch color TFT-LCD (SVGA) with touch screen
Graph display styles	SINGLE : One graph is displayed on the screen. SPLIT : Two graphs are displayed on the screen, one above the other.
Data traces	Reference data trace (REF) Measurement data trace (MEAS)
Auto scaling	This function automatically optimizes the graph display scale.(on or off)
Marker display	Main marker, Delta marker
Marker search function	Search items Max, Min : The maximum and minimum values Peak, Bottom : The peak (maximal) and the bottom (minimal) values NextPeak : The next peak NextBottom : The next bottom Value : The marker value ΔValue : The difference between the delta marker and the main marker values X Value : Frequency *It is possible to automatically perform a search at the end of a sweep measurement.

Memory

Measurement data (MEAS)	The data from the sweep measurement Up to 20 sets of data can be stored in internal memory.
Reference data (REF)	Data that can be displayed on a graph together with the measurement data (MEAS). This can be measurement data or data loaded from a USB memory device. (on/off)
Error correction data	Open correction, Short correction, Load correction, Equalize
Measurement conditions	20 sets
Data retention	Except for data that is not stored in internal memory yet, measurement data is retained, even if the power is turned off.

External memory

Media	USB memory device
Connections	Front panel, USB-A
File system	FAT
Screen capture function	MS Windows bitmap file (extension : .BMP, image size: 800 × 600)

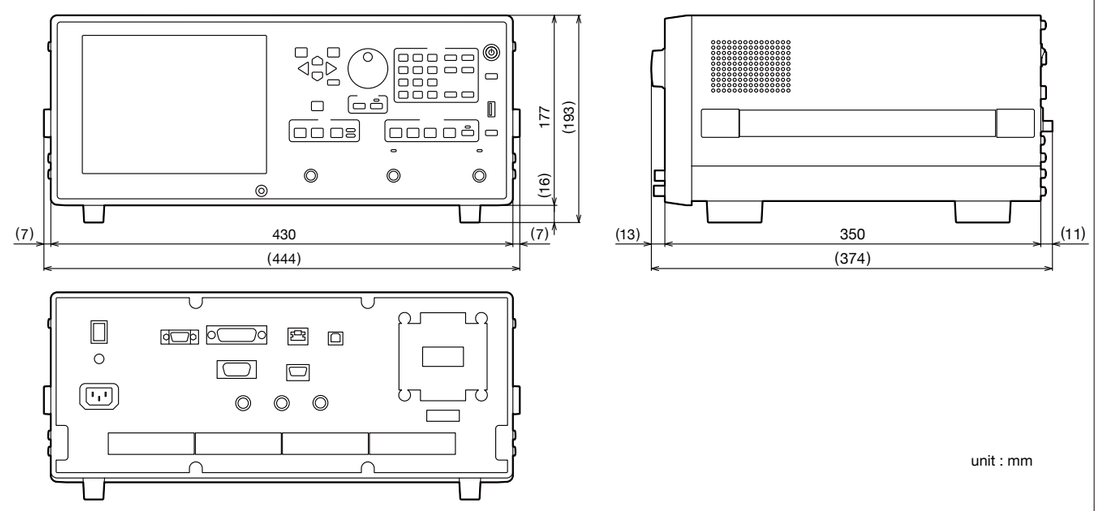
External input/output function

Interface	GPIB : Standards conformance ; IEEE488.1 and IEEE488.2 USB : USB 2.0 HighSpeed LAN : 10/100Base-T RS-232 : Baud rate 4800 to 230400 bps
External monitor	Connector : VGA (mini D-sub15 pin, female) Signal : 800 × 600 pixels (SVGA), analog RGB component video signal
Reference clock input	Frequency : 10 MHz ±100 ppm or under Input waveform : Sinusoidal or square Input voltage : 0.5 Vp-p to 5 Vp-p
Reference clock output	Output impedance : 50 Ω (nominal), AC coupling Frequency : 10 MHz ±10 ppm (when operating on the internal reference clock) Output waveform : 1 Vp-p / 50 Ω, square waveform
DC power output	Power supply outlet that is used by the "5055 SIGNAL INJECTOR PROPE" (option) Connector : Rear panel, AUX Output voltage : Approximately ±24 V

Miscellaneous specifications

Power input	Voltage : AC 100 V to 230 V ±10%, 250 V or less Frequency : 50 Hz/60 Hz ±2 Hz
Power consumption	100 VA or less
Range of ambient temperature and humidity	+5 °C to +40°C, 5 to 85% RH (absolute humidity 1 to 25 g/m³, no condensation)
Dimensions	430 mm (W) × 177 mm (H) × 350 mm (D) (excluding protruding parts)
Weight	Approximately 8.5 kg
Accessories	Instruction Manual (operation and remote control) Power Cord Set (2 m, with three-pin plug) Signal Cables (BNC-BNC, 50 Ω, 1 m, 600 V CAT II) ×3 Calibration Cables (BNC-BNC, 50 Ω, 20 cm) ×2 BNC Adapter (600 V CAT II)

Dimensions



unit : mm

Options

MODEL	NAME	NOTE
5055	SIGNAL INJECTOR PROBE	Limit to ±11 V
PA-001-0368	IMPEDANCE MEASUREMENT ADAPTER*1	
PA-001-0369	LOOP GAIN MEASUREMENT ADAPTER*1	
PA-001-1840	HI-POWER IMPEDANCE MEASUREMENT ADAPTER (1 Ω)*2	
PA-001-1841	HI-POWER IMPEDANCE MEASUREMENT ADAPTER (100 Ω)*2	
PA-001-1838	TEST FIXTURE ADAPTER (1 Ω)*1	
PA-001-1839	TEST FIXTURE ADAPTER (100 Ω)*1	
PA-001-0370	SHUNT RESISTOR*2	
PA-001-3746	HIGH WITHSTAND VOLTAGE CLIP CABLE SET (3 PER SET)	
PA-001-0420	HIGH WITHSTAND VOLTAGE ALLIGATOR CLIP CABLE SET (SMALL) (3 PER SET)	300 V CAT II or less
PA-001-0421	HIGH WITHSTAND VOLTAGE ALLIGATOR CLIP CABLE SET (LARGE) (3 PER SET)	
PA-001-0422	ALLIGATOR CLIP CABLE SET (3 PER SET)*1	
PA-001-3058	HIGH WITHSTAND VOLTAGE BNC EXTENSION CABLE SET (15 cm, 3 CABLES)	
PC-007-0364	HIGH WITHSTAND VOLTAGE EXTENSION BNC CABLE (1 m)	
PA-001-3059	HIGH WITHSTAND VOLTAGE BNC CABLE SET (20 cm, 2 CABLES)	For maintenance
PC-001-4503	HIGH WITHSTAND VOLTAGE BNC ADAPTER (T-BRANCH)	For maintenance
PC-002-3347	HIGH WITHSTAND VOLTAGE BNC CABLE	For maintenance
PC-007-1490	IMPEDANCE MEASUREMENT ADAPTER KELVIN CLIP	For maintenance
PC-007-1922	LOOP GAIN MEASUREMENT CLIP	For maintenance
PA-001-3036	RACK MOUNT KIT (EIA)	
PA-001-3037	RACK MOUNT KIT (JIS)	

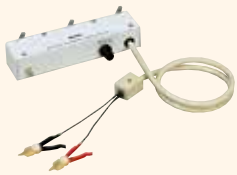
*1 Safe operation of the instrument requires that the potential difference from the grounding potential is restricted to 42 Vpk or less.
*2 No MEASUREMENT CATEGORY, Circuits not intended to be directly connected to the mains

Peripheral equipment

5055
SIGNAL INJECTOR PROBE

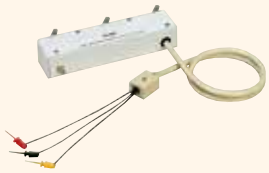
An auxiliary unit to measure the loop response of a servo system or the like with closed loops.

PA-001-0368
IMPEDANCE MEASUREMENT ADAPTER



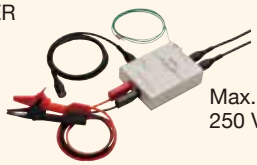
An adapter to measure the impedance. The shunt resistors for current detection (1 Ω, 10 Ω, 100 Ω) are built-in.

PA-001-0369
LOOP GAIN MEASUREMENT ADAPTER



An adapter to measure the loop gain of a negative feedback circuit in operation.

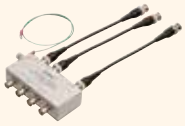
PA-001-1840 (1 Ω)/ **PA-001-1841** (100 Ω)
HI-POWER IMPEDANCE MEASUREMENT ADAPTER



Max. input 250 Vrms

Combine with a bipolar amplifier to measure impedance at the actual operating voltage.
• Built-in shunt resistor : 1 Ω/100 Ω

PA-001-1838 (1 Ω)/ **PA-001-1839** (100 Ω)
TEST FIXTURE ADAPTER



Can be connected to test fixtures for LCR meters
• Built-in shunt resistor : 1 Ω/100 Ω

PA-001-0370
SHUNT RESISTOR

A shunt resistor incorporating a 1 Ω 4-terminal resistor, used to detect a current (1 Arms maximum) flowing through a DUT.

Note : The contents of this catalog are current as of November 6th, 2024
●Products appearance and specifications are subject to change without notice.
●Before purchase contact us to confirm the latest specifications, price and delivery date.

NF Corporation

Head Office
6-3-20 Tsunashima Higashi, Kohoku-ku, Yokohama 223-8508, Japan
Phone : +81-45-545-8128 Fax : +81-45-545-8187
http://www.nfcorp.co.jp/english/