FRA51615 Specifications

Nominal, Typical, Supplemental, and Approximate values

These values are supplemental data do not represent a guarantee of the performance of this product.

Unless stated specifically otherwise, the assumed conditions are sinusoidal waveform, a temperature of 23°C ±5°C, no more than 12 hours has passed since calibration has been performed after a warm-up period of at least 30 minutes, and change in ambient temperature of not greater than ±5°C after calibration.
Unless stated specifically otherwise, the shell (outer cover) and signal grounds are connected to the instrument enclosure (not isolated).

1.1 Oscillator section

The oscillator section can output an AC signal and the DC bias for measurement. The AC signal is output from the OSC connector on the front panel. The DC bias can be output from either the OSC connector on the front panel or the DC BIAS OUT connector on the rear panel. You can select the connector from which the DC bias is output. If the OSC connector on the front panel is selected for DC bias output, the signal output from the OSC connector is a composite of the AC signal and the DC bias.

1.1.1 Front panel OSC

- Connector — Insulated BNC connector (front panel, OSC)
- Output waveform — Sinusoidal, square, or triangular
- Frequency
  - Setting range — 10 µHz to 15 MHz
    The quality of square and triangular waveforms deteriorates at frequencies above 100 kHz.
  - Setting resolution — 10 µHz
  - Accuracy — ±10 ppm
    Conditions: The instrument is operating on the internal reference clock.
- AC signal amplitude
  - Setting range — 0 to 10 Vpk Conditions: No load
  - Setting resolution — 3 digits or 0.01 mVpk, whichever is greater
  - Accuracy — ±0.3 dB
    Conditions: sinusoidal waveform, 1 kHz, 100 mVpk to 10 Vpk, no load
  - Frequency characteristic — ±0.3 dB or less (100 kHz or less)
    ±1 dB or less (1 MHz or less)
    ±3 dB or less (15 MHz or less)
    Conditions: 1 kHz reference, sinusoidal waveform, 100 mVpk to 10 Vpk, 50 Ω load
  - Distortion (sinusoidal) — 0.2% or less, supplementary value
    Conditions: 100 kHz or less, BW 500 kHz, 10 Vpk output
- DC bias

  The DC bias output is superimposed on the AC signal only when the DC bias output is set to the OSC connector on the front panel of the instrument.
  - Setting range — -10 V to 10 V
  - Setting resolution — 10 mV
  - Accuracy — ±(|1% of DC bias setting | + 2% of AC amplitude settings + 30 mV)
    Conditions: sinusoidal waveform, no load

- Output impedance 50 Ω ±2% Conditions: 1 kHz
- Maximum output (AC + DC)
  Voltage ±10 V Conditions: no load
  Current ±100 mA
- 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 independently.
  It is possible to turn on automatically at the start of measurement and to turn off automatically at the end of measurement.
- Sweep
  Sweep density 3 to 20,000 steps/sweep
  Sweep type Linear or log, selectable
  Sweep direction Up or down, selectable
  Pressing the front panel START UP key or DOWN key starts the sweep.
  Sweep time Conditions: Integration cycle 1, delay 0 s, the sweep time per frequency point for when a fixed range is set for both analysis input channels (supplementary value)

  For when the sweep density is 3 to 200 steps/sweep

Frequency f	Sweep time per frequency point
10 μHz ≦ f ＜ 1.36 kHz	(1/f) s
1.36 kHz ≦ f ＜ 50 kHz	1 ms to 1.5 ms
50 kHz ≦ f	0.5 ms

  When the sweep density is 201 to 20,000 steps/sweep, add 1 ms to the values in the above table.
- Isolation 600 V CAT II or 300 V CAT III (BNC grounded to the enclosure)
  Below 45 Hz: 600 Vpk (AC + DC)
  45 Hz to 100 kHz: 600 Vrms (AC)
  100 kHz to 3 MHz: 600 Vrms (AC) × 100 ÷ F
  where F is frequency in units of kHz.
  3 MHz to 15 MHz: 20 Vrms (AC)
  At 45 Hz and above, the voltage including DC must be 600 Vrms or less and 849 Vpk or less.

  Capacitance relative to the enclosure 150 pF or less

1.1.2 Rear panel DC BIAS OUT

The DC bias is output only when the DC BIAS OUT is set as the output connector for the DC bias.

- Connector BNC connector (rear panel, DC BIAS OUT)
- Setting range -10 V to 10 V Conditions: no load
- Setting resolution 10 mV
- Accuracy ±(|1% of DC bias setting | + 30 mV)
- Output resistance 600 Ω ±2%

1.2 Analysis input section

- Input channels 2
- Connectors Insulated BNC connector (front panel, CH1 and CH2)
- Input impedance 1 MΩ ±2%, 20 pF ±5pF
- Measurement range 30 mV to 600 V (rms), and AUTO. CH1 and CH2 can be set independentry.

Measurement range and maximum measurement input voltage

Measurement range (rms)	30 mV	100 mV	300 mV	1 V	3 V
Maximum measurement input voltage	±42.5 mV	±142 mV	±425 mV	±1.42 V	±4.25 V

Measurement range (rms)	10 V	30 V	100 V	300 V	600 V AUTO
Maximum measurement input voltage	±14.2 V	±42.5 V	±142 V	±425 V	±849 V

There is restricted by frequency. See "● Maximum input voltage" below.

- Maximum input voltage 600 V CAT II or 300 V CAT III (BNC signal to BNC ground)

  Below 45 Hz: 600 Vpk (AC + DC)
  45 Hz to 100 kHz: 600 Vrms (AC)
  100 kHz to 3 MHz: 600 Vrms (AC) × 100 ÷ F
  where F is frequency is units of kHz.
  3 MHz to 15 MHz: 20 Vrms (AC)

  At 45 Hz and above, the voltage including DC must be 600 Vrms or less and 849 Vpk or less.

- IMRR (isolation mode rejection ratio)

  120 dB or more (DC to 60 Hz)
  Conditions: Input shorted, integration 200 cycles or more, and common mode voltage 10 Vpk

- Isolation 600 V CAT II or 300 V CAT III (BNC ground to enclosure)

  Below 45 Hz: 600 Vpk (AC + DC)
  45 Hz to 100 kHz: 600 Vrms (AC)
  100 kHz to 3 MHz: 600 Vrms (AC) × 100 ÷ F
  where F is frequency in units of kHz.
  3 MHz to 15 MHz: 20 Vrms (AC)

At 45 Hz and above, the voltage including DC must be 600 Vrms or less and 849 Vpk or less.

Capacitance relative to enclosure 200 pF or less

- Frequency range 10 µHz to 15 MHz
- Maximum measurement voltage

  600 Vrms

  When the provided signal cable is used.

  When the other signal cables are used, the voltage is restricted to the rated voltage of the cable or to 600 Vrms, whichever is less.
- Over-level detection

  Setting range 0 to 600 Vrms

  Setting resolution 3 digits

  Processing Over lamp lights.

  Buzzer warning sound (can be turned on / off)

  Stop sweep measurement (can be turned enable / disable)

  Over-level detection occurs when the amplitude or maximum measurement input voltage that is set as described above is exceeded. (See "1.2 Analysis input section, ● Measurement range".)
- Dynamic range 140 dB (10 Hz to 1 MHz)

  80 dB (1 MHz to 15 MHz)

  The maximum measurable gain, limited by the noise floor and cross talk between channels.

  Conditions: The larger channel input is at least 10 Vpk, integration is 300 cycles, and the measurement range is AUTO for both channels.
- Input weighting Setting range is 0 to 1.00000E+12, resolution 6 digits or 1E-12

  CH1 and CH2 are set independently

  The weight is a coefficient that is applied to measurement results of CH1 or CH2 to correct the attenuation or gain of probes, amplifiers, or other such equipment that is connected to the instrument.
- Phase inversion function ON or OFF

  This function is used when the polarity of connection to the circuit being tested is reversed. This is set to on when the optional "PA-001-0368 impedance measurement adapter" is used.

The isolation specifications for between the oscillator (OSC) and analysis input (CH1 or CH2) and the instrument enclosure is illustrated in Figure 1-1. The isolation specifications between the OSC, CH1, and CH2 signal connectors is illustrated in Figure 1-2.

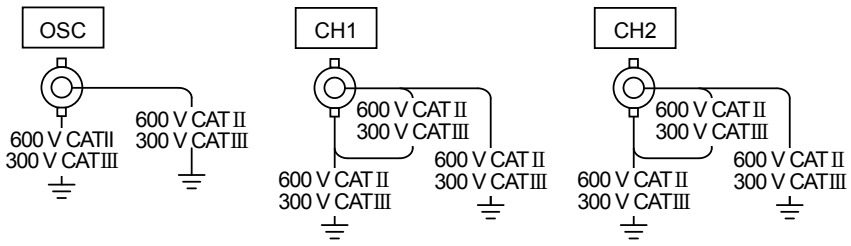


Figure 9-1 Isolation voltage specifications relative to the enclosure

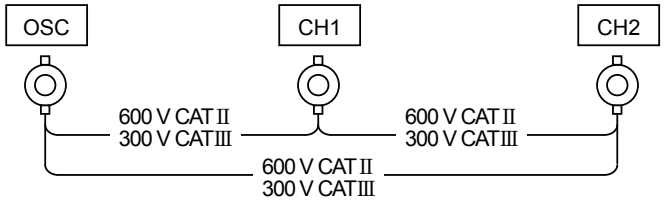


Figure 1-2 Isolation voltage specifications between signal connectors

When cables or probes, etc. are connected to the instrument, the voltage is restricted to the withstand voltage specifications of the connected cable or probe, etc. or to the withstand voltage of the instrument, whichever voltage is lowest.

1.3 Measurement processing section

- Measurement operations

SPOT	Do a measurement at the current frequency (no sweep)
UP SWEEP	Do a sweep measurement (in order of increasing frequency)
DOWN SWEEP	Do a sweep measurement (in order of decreasing frequency)
REPEAT	Do measurements repeatedly
SINGLE	Do a single measurement

- Measurement delay function

This function delays the beginning of a measurement after the frequency is changed.

Delay can be set either a duration or a number of cycles.

Time settings

Setting range	0 to 9,990 s
Setting resolution	3 digits or 0.1 ms, whichever is greater

Cycle settings (set in units of measurement frequency cycle)

Setting range	0 to 9,999 cycles, but no more than 9,990 s
Setting resolution	1 cycle

- Start delay function

This function delays the beginning of a measurement only from the start of a sweep or spot measurement.

Delay can be set either a duration or a number of cycles.

Time settings

Setting range 0 to 9,990 s
Setting resolution 3 digits or 0.1 ms, whichever is greater
Cycle settings (Set in units of measurement frequency cycles)
Setting range 0 to 9,999 cycles, but no more than 9,990 s
Setting resolution 1 cycle

- Integration function

This function performs integration on measurement data to remove the effects of noise. Measurement repetition can be set either a duration or a number of cycles.

Time setting
Setting range 0 to 9,990 s (The measurement is performed for at least 1 cycle, regardless of the setting.)
Setting resolution 3 digits or 0.1 ms, whichever is greater
Cycle settings (set in units of cycles, taking the signal acquisition time *1 to be one cycle)
Setting range 1 to 9,999 cycles
Setting resolution 1 cycle

*1: The signal acquisition time is one cycle of the measurement frequency f when f is approximately 1 kHz or less. For higher frequencies, the signal acquisition time ranges between 1.0 ms and 20 ms, depending on the value of f and the cycle setting.

- Automatic integration function

This function repeats the integration process until the variation in the measurement values falls below a set value. However, integration is stopped if the value specified in "9.3 Measurement processing section, ● Integration function" is exceeded.

Setting FIX, SHORT, MED, or LONG.
FIX: The integration is performed with the settings specified in "1.3 Measurement processing section, ● Integration function", regardless of the variation and measurement values.
Other than FIX: The integration is performed until the variation becomes small, but the measurement time becomes longer in the order of SHORT < MED < LONG.

*1: The signal acquisition time is one cycle of the measurement frequency f when f is approximately 1 kHz or less. For higher frequencies, the signal acquisition time ranges between 1.0 ms and 20 ms, depending on the value of f and the cycle setting.

- 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 that is set. This function maintains a constant amplitude for the measurement system to prevent saturation and damage to the measurement system.

Reference channel CH1 or CH2
Target amplitude setting
Setting range 1 μV to 600 Vrms (value before input weight processing)
Setting resolution 3 digits
Voltage limit for the oscillator output
Setting range 1 mV to 10 Vpk
Setting resolution 3 digits

Allowable error
Setting range 1 to 100%
Setting resolution 1%
Maximum number of retries
Setting range 1 to 9,999
Setting resolution 1
Correction factor
Setting range 1 to 100%
Setting resolution 1%

- Automatic high density sweep (slow 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.

Reference channel CH1 or CH2
Variation
a, b, R
Setting range 0 to 600 Vrms (before input weighting)
Setting resolution 3 digits or 1 μV, whichever is greater
dBR
Setting range 0 to 1000 dB
Setting resolution 0.01dB
Phase
Setting range 0 to 180°
Setting resolution 0.01°

- Sequence measurement function

This function performs measurements according to the content of a measurement condition memory. When an up sweep measurement is performed, 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 memory number that has been set as the upper limit memory number.

For down sweep measurement, 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
Setting resolution 1

1.4 Analysis processing section

The SI prefixes (k, M, etc.) that are placed before units of measurement and the scales they represent are a (10^{-18}), f (10^{-15}), p (10^{-12}), n (10^{-9}), μ (10^{-6}), m (10^{-3}), k (10^{3}), M (10^{6}), and G (10^{9}).

1.4.1 Common items

- 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|), where N is | number of measurement range steps between channels |.
Example: If the measurement ranges of each channels are 300 Vrms and 1 Vrms, N is 5 (300 V to 100 V to 30 V to 10 V to 3 V to 1 V).

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 : 30 mV	±0.01 dB ±0.12 % ±0.06°		±0.025 dB ±0.29 % ±0.15°	±0.1 dB ±1.2 % ±0.6°

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

Conditions: At least 30 cycles of integration, fixed measurement range for both channels, and both channels have the same range.　The gain 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 " – ", the measurement range exceeds the maximum input voltage (see "1.2 Analysis input section, ● Maximum input voltage"), so either the measurement is not possible or there is no accuracy specification for it.

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

Measurement range (rms)	Frequency				Measurement range (rms)
	≦ 100 kHz	≦ 200 kHz	≦ 1 MHz	≦ 2 MHz	
600 V	±0.1 dB ±1.2 % ±0.6°	—	—	—	600 V
300 V			—	—	300 V
100 V			—	—	100 V
30 V : 300 mV				±0.2 dB ±2.4 % ±1.2°	30 V : 300 mV
100 mV					100 mV

Measurement range (rms)	Frequency	
	≦ 5 MHz	≦ 15 MHz
600 V : 30 V	—	—
10 V : 100 mV	±0.2 dB ±2.4 % ±1.2°	±0.5 dB ±6.0 % ±3.0°

Conditions: At least 30 cycles of integration, fixed measurement range for both channels, and both channels have the same measurement range. Gain 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.

*For the cells that contain only " – ", the measurement range exceeds the maximum input voltage (see "1.2 Analysis input section, ● Maximum input voltage"), so either the measurement is not possible or there is no accuracy specification for it.

Inter-range accuracy Upper: gain (ratio); Middle: impedanse Z; Lower: phase

Measurement range (rms)	Frequency			
	≦ 100 kHz	≦ 200 kHz	≦ 2 MHz	≦ 15 MHz
600 V	—			
	±0.1 dB ±1.2 % ±0.6°	—	—	—
300 V				
	±0.05 dB ±0.58 % ±0.3°	±0.1 dB ±1.2 % ±0.6°	—	—
100 V				
	±0.05 dB ±0.58 % ±0.3°		—	—
30 V				
	±0.05 dB ±0.58 % ±0.3°			—
10 V				
	±0.05 dB ±0.58 % ±0.3°			
3 V				
	±0.05 dB ±0.58 % ±0.3°			
1 V				
	±0.05 dB ±0.58 % ±0.3°			
300 mV				
	±0.05 dB ±0.58 % ±0.3°			
100 mV				
	—			

Conditions: At least 30 cycles of integration and fixed measurement range for both channels.
The gain 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.

*For the cells that contain only " – ", the measurement range exceeds the maximum input voltage (see "1.2 Analysis input section, ● Maximum input voltage"), so either measurement is not possible or there is no accuracy specification for it.

- Measurement accuracy (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: impedanse Z; Lower: phase

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

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

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

Dynamic accuracy Upper: gain (ratio); Middle: impedanse Z; Lower: phase

Signal level (rms)	Frequency				Signal level (rms)
	≦ 100 kHz	≦ 200 kHz	≦ 1 MHz	≦ 2 MHz	
≦ 600 V	±0.1 dB ±1.2 % ±0.6°	—	—	—	≦600 V
≦ 300 V		±0.1 dB ±1.2 % ±0.6°	—	—	≦300 V
≦ 60 V			±0.1 dB ±1.2 % ±0.6°	—	≦60 V
≦ 30 V				±0.2 dB ±2.4 % ±1.2°	≦30 V
≦ 300 mV					≦300 mV
100 mV ≦					100 mV≦

Signal level (rms)	Frequency	
	≦ 5 MHz	≦ 15 MHz
≦ 20 V	±0.2 dB ±2.4 % ±1.2°	±0.5 dB ±6.0 % ±3.0°
100 mV ≦		

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

*For the cells that contain only " – ", the measurement range exceeds the maximum input voltage (see "1.2 Analysis input section, ● Maximum input voltage"), so either the measurement is not possible or there is no accuracy specification for it.

- Error correction function

  Calibration This function corrects for measurement errors that arise within the instrument itself. It is executed with the provided calibration cables and BNC adapter, connected to the OSC, CH1 and CH2 connectors.

1.4.2 GAIN

- Analysis modes

Ratio	CH1/CH2, CH2/CH1
Amplitude	CH1, CH2

- Graph types

Bode plot	A graph with the frequency on the X axis
Nyquist plot	A graph with the real part on the X axis and the imaginary part on the Y axis
Nichols plot	A graph with gain on the X axis and phase on the Y axis

- Measurement data items and display range

The actual measured values and display range for each parameter are constrained by the measurement range and the frequency, etc.

dBR (gain dB)±999.999 dB, resolution 0.001 dB

θ (phase)

±180°	-180.000° to 179.999°, resolution 0.001°
0 to 360°	0.000° to 359.999°, resolution 0.001°
-360 to 0°	-360.000° to -0.001°, resolution 0.001°
UNWRAP	-9999.999° to + 9999.999°, resolution 0.001°

GD (group delay) ±(1 a to 999.999 G)s or 0 s, resolution 6 digits or 1 as

(when the analysis mode setting is CH1/CH2 or CH2/CH1)

R (absolute gain)	0 to 999.999 G (ratio, unitless number), resolution 6 digits or 1 a
a (real part of gain)	±(1 a to 999.999 G) or 0 (ratio, unitless number), resolution 6 digits or 1 a
b (imaginary part of gain)	±(1 a to 999.999 G) or 0 (ratio, unitless number), resolution 6 digits or 1 a

(when the analysis mode setting is CH1 or CH2)

R (amplitude)	0 Vrms to 999.999 GVrms, resolution 6 digits or 1 aVrms
a (real part of amplitude)	±(1 a to 999.999 G) Vrms or 0 Vrms, resolution 6 digits or 1 aVrms
b (imaginary part of amplitude)	±(1 a to 999.999 G) Vrms or 0 Vrms, resolution 6 digits or 1 aVrms

- Measurement accuracy for other than R and θ

Accuracy of measurement items other than R (absolute gain) and θ (phase). Where defined the accuracy of R as Ra %, the accuracy of θ as θa, and the measurement value of θ as θx, specified in "1.4.1 Common items, ● Measurement accuracy (fixed range) and ● Measurement accuracy (AUTO range)".

GD (group delay)	±{θa / (APT × 360)} s APT: The unit for aperture in the group delay display is hertz
a (real part of gain)	±(Ra / cos θx)%
b (imaginary part of gain)	±(Ra / sin θx)%

- Error correction function

Equalizing	This function obtains the characteristics for the measurement target alone by measuring the frequency characteristics of the measurement system (sensors, cables, etc.) in advance and then eliminate that error component for the measurement system when the actual measurements are performed later.

1.4.3 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	A graph with the frequency on the X axis.
Nyquist plot	A graph with the real part on the X axis and the imaginary part on the Y axis.
Cole-cole plot	A graph with the real part on the X axis and the imaginary part on the Y axis. However, the upper side of Y axis is minus.

- Measurement data items and display range

The actual measured values and display range for each parameter are constrained by the measurement range and the frequency, etc.

Z (impedance)	0 Ω to 999.999 GΩ, resolution 6 digits or 1 aΩ
R, X (resistance, reactance)	±(1 a to 999.999 G)Ω and 0 Ω, resolution 6 digits or 1 aΩ
Y (admittance)	0 S to 999.999 GS, resolution 6 digits or 1 aS
G, B (conductance, susceptance)	±(1 a to 999.999 G)S and 0 S, resolution 6 digits or 1 aS
Ls, Lp (inductance)	±(1 a to 999.999 G)H and 0 H, resolution 6 digits or 1 aH
Cs, Cp (capacitance)	±(1 a to 999.999 G)F and 0 F, resolution 6 digits or 1 aF
Rs, Rp (resistance)	±(1 a to 999.999 G)Ω and 0 Ω, resolution 6 digits or 1 aΩ

The suffixes s and p for L, C, and R respectively represent the serial component and parallel components.

V (voltage)	0 Vrms to 999.999 GVrms, resolution 6 digits or 1 aVrms
I (current)	0 Vrms to 999.999 GArms, resolution 6 digits or 1 aArms
θ (phase)	
±180°	-180.000° to 179.999°, resolution 0.001°
0 to 360°	0.000° to 359.999°, resolution 0.001°
-360 to 0°	-360.000° to -0.001°, resolution 0.001°
UNWRAP	-9999.999° to +9999.999°, resolution 0.001°
D (dissipation factor)	±(0.00001 to 99999.9) and 0 (unitless number)
Q (quality factor)	±(0.00001 to 99999.9) and 0 (unitless number)

- Measurement accuracy for other than Z and θ

Accuracy of measurement items other than Z (impedance) and θ (phase). Where defined the accuracy of Z as Za %, and the measurement value of θ as θx, specified in "9.4.1 Common items, ● Measurement accuracy (fixed range) and ● Measurement accuracy (AUTO range)".

Y	±Za %
R, Rs, Rp, G	±(Za / cos θx) %
X, B, Ls, Lp, Cs, Cp	±(Za / sin θx) %
D	±(0.01×Za) When |Dx| ≦ 0.1; Dx is the measured value of D. The measurement accuracy of D is not a percent value, but the value itself.
Q	±{(Qx^2 × Pe / (1−|Qx| × Pe)} When (|Qx| ≧ 10) and (|Qx|×Pe ≦ 0.1). Qx is the measured value of Q. Pe = 0.01 × Za. The measurement accuracy of Q is not a percent value, but the value itself.

- Error correction function

Open correction	Corrects the residual admittance
Short correction	Corrects the residual impedance
Load correction	Corrects the voltage-current conversion coefficient of the measurement system
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.
Characteristic impedance	
Setting range	1.00 Ω to 999 Ω, resolution 3 digits
Electrical length	
Setting range	0.000 m to 999.999 m, resolution 0.001 m
Slope compensation	ON/OFF This function performs analysis that is unaffected by the DC level for signals that have a superimposed DC level that varies linearly over time. It is used when measuring the impedance of batteries during charging and discharging.

1.5 Display section

- 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.
- Graph axis setting — The X, Y1, and Y2 axes can each be set to Lin, Log individually.
- Data traces — Reference data trace (REF) or measurement data trace (MEAS)
- Auto scaling — On or off
  This function automatically optimizes the graph display scale.
- Marker display
  - Main marker — The main marker is displayed on the data, and the data value at the position specified by the marker is displayed.
  - Delta marker — The delta marker and the main marker are displayed on the data, and the difference between the data values indicated by the two markers is displayed.
- Marker search function
  Search items
  - Max, Min — Search for the maximum and minimum values
  - Peak, Bottom — Search for the peak (maximal) and the bottom (minimal) values
  - NextPeak — Search for the next peak
  - NextBottom — Search for the next bottom
  - Value — Search for the marker value
  - ⊿Value — Search for the difference between the delta marker and the main marker values
  - XValue — Search for frequency

  It is possible to automatically perform a search at the end of a sweep measurement.
- Display of the measurement conditions for the measured data

  The main measurement conditions for when the data that is being displayed was measured are displayed.
- Title display — It is possible to specify titles for the measurement data and reference data.

1.6 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. The display can be turned on or off.
- Error correction data — Data that is used for equalizing
- Measurement conditions — 20 sets

Except for data that is not stored in internal memory, measurement data is retained, even if the power is turned off.

1.7 External memory

- Media: USB memory device
- Connections: Front panel, USB-A connector
- File system: FAT
- Memory contents: Measurement conditions, measurement data (MEAS), reference data (REF), and screen capture data
- Screen capture function
  - File format: MS Windows bitmap file (extension: .BMP, image size: 800 × 600)
  - Approximate file size: 1.9 MB
  - File name: FRAnnn.BMP (nnn: three digit number, incremented automatically, initial value can be set)
  - File save destination: Root folder

1.8 External input/output function

- GPIB
  - Standards conformance: IEEE488.1 and IEEE488.2
  - Connector: Rear panel, GPIB connector
  - Interface functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0, E1
- USB
  - Specification: USB 2.0 HighSpeed
  - Connector: Rear panel, USB-B connector
  - Device class: TMC
- LAN
  - Specification: 10/100Base-T
  - Connector: Rear panel, RJ-45 connector
  - Protocols: TCP/IP (socket communication)
- RS-232
  - Baud rate: 4800 / 9600 / 19200 / 38400 / 57600 / 115200 / 230400 bps
    At baud rate that exceed 19200 bps, the characteristics of the cable and controller may prevent communication.
  - Flow control: None / software (X-ON/X-OFF) / hardware (RTS/CTS)
- External monitor: For connecting a projector, external monitor, etc.
  - Connector: Rear panel, VGA (mini D-sub15 pin, female)
  - Signal: 800 × 600 pixels (SVGA), analog RGB component video signal
  - Horizontal frequency: 37.9 kHz
  - Vertical frequency: 60.3 Hz
  - Scanning: Progressive

- Reference clock input

Connector	Rear panel, BNC connector
Input impedance	300 Ω (nominal), AC coupling
Frequency	10 MHz ±100 ppm or under
Input waveform	Sinusoidal or square
Input voltage	0.5 Vp-p to 5 Vp-p
Maximum nondestructive input voltage	10 Vp-p
Signal grounding	Isolated from the enclosure, maximum 42 Vpk (DC + ACpk)

- Reference clock output

Connector	Rear panel, BNC connector
Output impedance	50 Ω (nominal), AC coupling
Frequency	10 MHz ±10 ppm (when operating on the internal reference clock) When the instrument is operating on an external reference clock, the input reference clock frequency is output as it is.
Output waveform	1 Vp-p / 50 Ω, square waveform

- DC power output

This is a power supply outlet that is used by the "5055 SIGNAL INJECTOR / PROPE" (optional) manufactured by the NF Corporation.

Connector	Rear panel, AUX
Output voltage	Approximately ±24 V

- Thermal printer

If the thermal printer described below is connected to the instrument via the USB port on the front panel, it is possible to print a hard copy of the image displayed on the LCD screen of this instrument.

Manufacturer	Seiko Instruments Inc.
Name	Thermal printer
Model	DPU-S445-00B-E

Only the printer described above can be used.

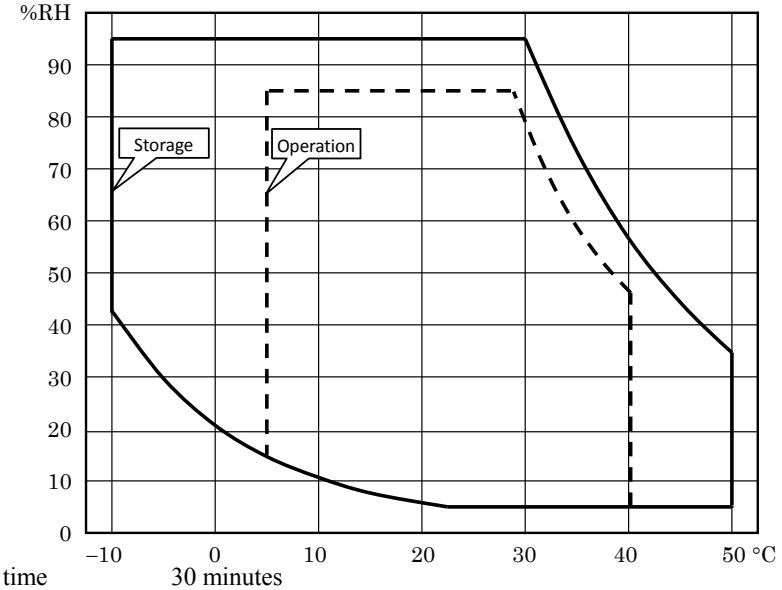
The printer is not handled by the NF Corporation. For more information on the printer, please refer to the instruction manual for the printer.

1.9 Miscellaneous specifications

- Power input
  - Voltage: AC 100 V to 230 V ±10%, however 250 V or less
  - Frequency: 50 Hz/60 Hz ±2 Hz
  - Power consumption: 100 VA or less
  - Overvoltage category: II
- Cooling: Forced air cooling, rear exhaust
- Installation attitude: Horizontal (±10° or less)
- Environment

Range of ambient temperature and humidity

- Operation: +5 °C to +40°C, 5 to 85% RH
  (absolute humidity 1 to 25 g/m^3, no condensation)
  Altitude of 2000 m or less
- Storage: -10°C to + 50°C, 5 to 95%RH
  (absolute humidity 1 to 29 g/m^3, no condensation)
- Pollution degree: 2



- Warm-up time: 30 minutes
- External dimensions: 430 mm (W) × 177 mm (H) × 350 mm (D) (excluding protruding parts)
- Weight: Approximately 8.5 kg
  (Main unit only, excluding accessories and optional equipment, etc.)
- Safety standards and EMC: EN61010-1, EN61010-2-030
  EN61326-1 (Group 1, Class A), EN61326-2-1
  EN61000-3-2, EN61000-3-3
  Note: Applies to products that have a CE marking displayed on the rear panel.
  Note: The measurement error may occor if this equipment is exposed to a strong radiated radio frequency electromagnetic field.
- RoHS directive: Directive 2011/65/EU

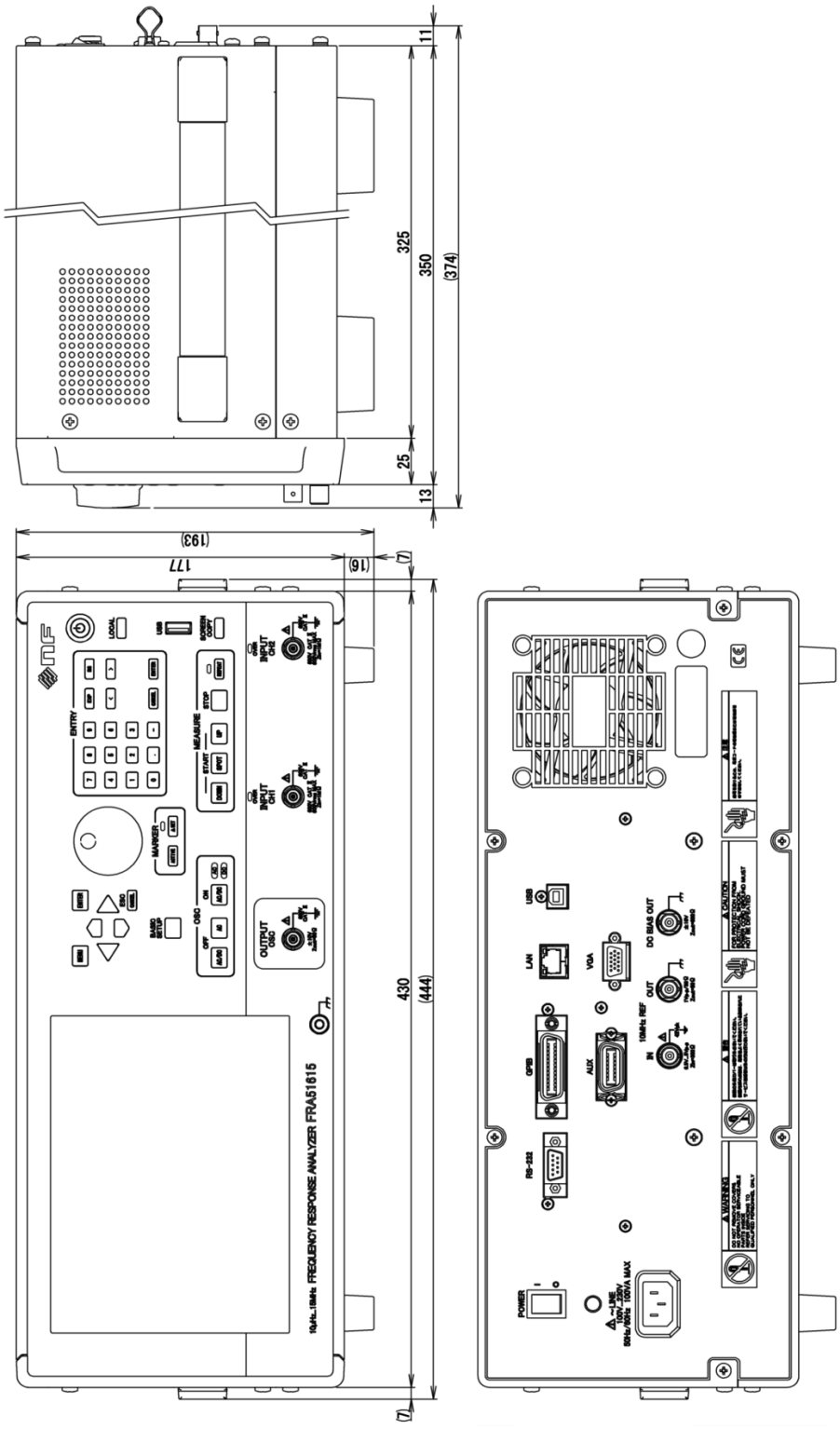


Figure 1-3 External dimensions