NF

FREQUENCY RESPONSE ANALYZER

FRA5097

Specification

NF Corporation

Table of Contents

Appended Diagrams

1. Introduction

1.1 Overview

The "FRA5097 Frequency Response Analyzer" is capable of measuring frequency response characteristics of the system under test through a frequency sweep.

This analyzer is comprised of the following units: synthesizer sweep oscillator that delivers a driving signal to the intended measuring system, analytical unit that not only measures the response of the intended measuring system to the driving signal but derives gain and phase from the results of Fourier integral, and display unit that records and presents the results.

The analysis input channel comes in two that enables the analysis of the frequency range (0.1 mHz to 15 MHz) in terms of amplitude and phase.

This analyzer is endowed with the functions of auto ranging, equalization, auto integration, amplitude squeezing and auto high-density sweep. This feature-laden analyzer actualizes high-accuracy, superior measurement.

Panel setting is enabled from the multiwindow type Menu screen. Easy access to measurement conditions is allowed on the ground of them being stored in USB memory. Power-off setting is backed up that requires no reset on power-on.

The measurement result is displayed on the 6.5" color TFT LCD and easily output to an integrated thermal printer.

This analyzer comes with GPIB and USB that enable an external computer to issue commands to this analyzer and permit data transfer from this analyzer to the external computer.

Major specifications of the frequency response analyzer:

- ● Measuring frequency   0.1 mHz to 15 MHz
- ● Oscillator output (output release)
  - AC amplitude   0 to 10 Vpeak
  - DC bias ± 10 V
- ● Max. input voltage (analytical unit)
  - AC+DC   350 Vpeak
- ● Gain dynamic range   140 dB
- ● Phase display $\pm 180°$, -360° to 0, 0 to 360°
- ●Graph
  - Bode diagram, Nyquist diagram, Nichols chart, Cole-Cole plot

1.2　Features

(1)　High-accuracy, wide dynamic ranging

The embedded oscillator is configured to maintain high frequency accuracy and resolution with the adoption of the synthesizer. The analytical unit is to ensure a wide dynamic range with the use of the high resolution A/D converter and auto ranging. It is also capable of constant measurement with high accuracy with Fourier integrals and self-calibration function.

(2)　Insulated I/O terminal

Individual insulation between analysis input or oscillator output and the cabinet is provided.

(3)　Broadband frequency analysis (0.1 mHz to 15 MHz)

A batch sweep and measurement of frequencies are enabled in the range 0.1 mHz to 15 MHz.

(4)　Outfitted with a color TFT LCD

Frequency response is graphed and a measurement condition setting menu is displayed on the integrated color TFT LCD.

(5)　USB memory-capable (USB host connector on the front panel)

The settings and measurement data can be stored in USB memory. A file format is compatible with that in Windows98SE and later versions with the IBM PC/AT compatible, which allows a USB port-laden IBM PC/AT compatible to perform data reading and writing.

(6)　Battery backup of settings and measurement data

This analyzer is configured to maintain the current settings and measurement data stored in nonvolatile memory when the power is turned off.

(7)　GPIB/USB as standard equipment

With the adoption of GPIB and USB, measurement condition setting and measurement data reading are enabled from an external computer.

(8)　Integrated thermal printer

This analyzer incorporates a thermal printer that produces graphic output off the LCD screen on paper. The thermal printer is of use for saving measurement data and preparing reports.

(9)　Easy impedance display

The combination of the FRA5097, amplifier, and shunt resistor permits impedance measurement with a broad range of voltages and currents that are beyond the capability of a normal LCR meter. The impedance display function facilitates accurate measurement and display of impedance.

1.3   Application

The FRA5097 Frequency Response Analyzer flourishes in diverse fields listed below.
High-accuracy measurement by dynamic ranging with I/O insulated yields favorable effects on the listed fields. An automatic measuring system is to be easily formed by combining GPIB and USB as standard equipment with a computer.

● Servo system   Servo characteristic measurement for DVD players and VCRs

● Electronic circuit   Frequency response measurement for filters and amplifiers
   Loop characteristic measurement for SW power

● Sound   Frequency response measurement for speakers and microphones

● Vibration analysis   Resonance characteristic measurement

● Electrochemistry   Metallic corrosion behavior research,
   battery performance measurement
   (Electrochemical impedance measurement)

2. Accessories

Standard accessories for the "FRA5097 Frequency Response Analyzer" are listed below.

```
Frequency response analyzer   FRA5097   ……………………………… 1
Accessories
    FRA5097 Operation Manual   ……………………………………… 1
    FRA5097 GPIB/USB Operation Manual   ………………………… 1
    Set of power cords (3-pin plug assigned, 2m)   ………………… 1
    Signal cable (BNC-BNC 50 Ω 1 m, 250 Vrms CAT I)   ………… 3
        (High withstand voltage BNC cable   Model: PC-002-3347)
    T-shaped divider (250 Vrms CAT I)   ………………………… 1
    Thermal paper   ………………………………………………… 1
    USB flash drive   ……………………………………………… 1
```

* A supplied signal cable is equivalent to a "high withstand voltage BNC cable PC-002-3347" (optional).

3. Specifications

Accuracy (range) denotes guaranteed performance unless otherwise specified.

Other values are typical values.

3.1 Oscillator

- Number of output channels : 1 channel
- Connector : Insulated BNC connector
- Output waveform : Sinusoidal/rectangular/triangular
- Frequency
  - Range 0.1 mHz to 15 MHz (square wave and triangular wave are available only at or below 100 kHz to assure waveform integrity.)
  - Set resolution 0.1 mHz(Resolution is 1 mHz above 10 MHz.)
  - Accuracy ±10 ppm
- AC amplitude
  - Range 0 V to 10 Vpeak (at no load)
  - Set resolution 3 digits or 0.01 mVpeak, either of whichever are greater
  - Accuracy (sine wave) Within ±0.3 dB (for no more than 100 kHz)

    Within ±1 dB (for no more than 1 MHz)

    Within ±3 dB (for no more than 15 MHz)

    (A value obtained immediately after calibration with it being set at 100 mV to 10 Vpeak)
  - Distortion (sine wave) Max. 0.2% (Max. 100 kHz, BW500 kHz at 10 Vpeak output)
- DC bias
  - Range -10 V to 10 V (at no load)
  - Resolution 10 mV
  - Accuracy ± (1% of DC bias setting + 2% of AC amplitude setting + 30 mV)

    (A value obtained immediately after calibration)
- Output impedance : 50 Ω ±2% (at 1 kHz), unbalanced (BNC junction)
- Max. output (AC+DC)
  - Voltage ±10 V (at no load)
  - Current ±100 mA
- Output control
  - QUICK (instant change to a set voltage or 0 V)
  - SLOW (gradual change to a set voltage or 0 V with increase/decrease in voltage)
  - Phase control (oscillation start and stop phase assignable by 1°)
  - Simultaneous "on/off" function for AC and DC available. Single "off" function for only AC available.
- Frequency sweep
  - Range 0.1 mHz to 15 MHz
  - Density
    - Log sweep : 3 to 20,000 steps/sweep, or 1 to 20,000 steps/decade

      (Min. 3 steps/sweep, Max. 20,000 steps/sweep)
    - Linear sweep : 3 to 20,000 steps/sweep, or 0.1 mHz to 15MHz/step

      (Min. 3 steps/sweep, Max. 20,000 steps/sweep)

- Isolation

Withstand voltage	250 Vrms continuous (between signal/ground and cabinet)
	250 Vrms continuous (between signal/ground and analysis input)
	A voltage when a supplied BNC cable is used
	30 Vrms continuous if other cable is used
Capacitance against enclosure	Max. 250 pF

- Measurement category   I. Maximum transient overvoltage: 1,500 Vrms

3.2   Analyzer input

- Number of input channels   : 2 channels
- Connector   : Insulated BNC connector
- Input impedance   1 MΩ ±2%, 25 pF ±5pF (parallel)
- IMRR (isolation mode rejection ratio)

   Max. 120 dB (DC to 60 Hz)

   Applicable if a signal source impedance is smaller than 1 Ω

- Isolation

Withstand voltage	250 Vrms continuous (between signal / ground and cabinet)
	250 Vrms continuous (between signal / ground and oscillator, between analysis input channels)
	A voltage when a supplied BNC cable is used
	30 Vrms continuous if other cable is used
Capacitance against enclosure	Max 200 pF

- Measurement category   I. Maximum transient overvoltage: 1,500 Vrms
- Frequency range   0.1 mHz to 15 MHz
- Max. input voltage   250 Vrms (AC), ±200 V (DC), or ±350 Vpeak (AC+DC)

   A voltage when a supplied BNC cable is used
   30 Vrms (AC), ±60 V (DC), or ±42 Vpeak (AC+DC) if other cable is used

- Max. measured voltage   250 Vrms

   A voltage when a supplied BNC cable is used
   30 Vrms if other cable is used

- Excessive level detection(over-detection)

Setting range	0 to 250 Vrms
Set resolution	3 digits
Actions taken	Over lamp ON
	Buzzer warning (ON/OFF enabled)
	Sweep abort (ON/OFF enabled)
	Oscillator OFF (ON/OFF enabled)

- Harmonics measurement   Harmonics of order 2 to 10

   (Max. harmonic frequency: 15 MHz)

- Harmonics and noise rejection ratio

Normal mode DC	Min. 60 dB
Wideband white noise	Min. 50 dB (noise bandwidth: 500 kHz, integration: 1,000 cycles)
Harmonics (Max. order 10)	Min. 60 dB (analysis frequency: Max. 100 kHz)
	Min. 40 dB (analysis frequency: Min. 100 kHz)

- Dynamic range   140 dB typ (10 Hz to 1 MHz)

  80 dB typ (Min. 1 MHz, Max. 15 MHz)

  (Larger channel input: Min. 10 Vpeak, integration: 4,000 cycles)

- Input weighting   0 to 1.0E + 6 (resolution: 5-digit or 0.01E-9)

Specifications for isolation withstand voltage between the oscillator (OSC) or analysis input (CH1 and CH2) and the cabinet with the supplied BNC cable used are presented below (figure 3-1).

Figure 3-1: Specifications for Isolation Withstand Voltage (with supplied BNC cable used)

Figure 3-2 shows isolation withstand voltage specifications when other cable is used.

Figure 3-2: Specifications for Isolation Withstand Voltage (with other cable used)

Specifications for isolation withstand voltage between the oscillator (OSC) and analysis input (CH1 and CH2) with the supplied BNC cable used are presented in figure 3-3).

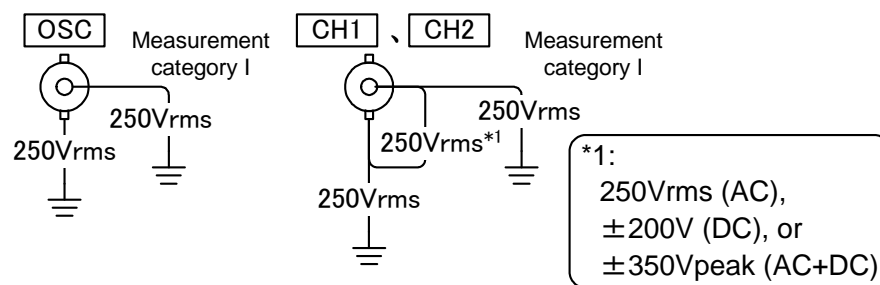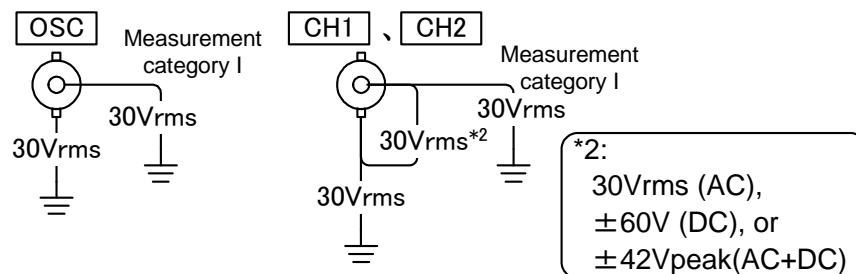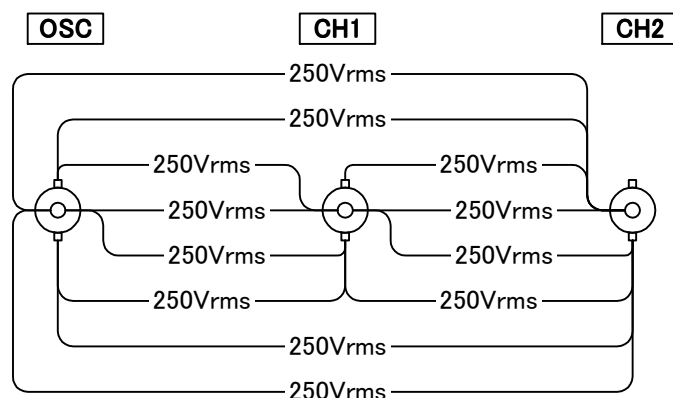Figure 3-3: Specifications for Isolation Withstand Voltage between Oscillator and Analysis Input
(with supplied BNC cable used)

Figure 3-4 shows isolation withstand voltage specifications between the oscillator (OSC) and analysis input (CH1 and CH2) when other cable is used.
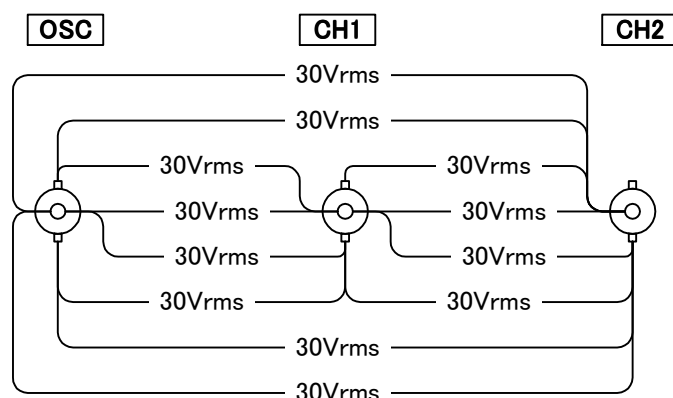
Figure 3-4: Specifications for Isolation Withstand Voltage between Oscillator and Analysis Input
(with other cable used)

3.3 Measurement processing

- Mode

    REPEAT   : Repetitive measurements of fixed frequency

    SINGLE   : Single measurement of fixed frequency

    SWEEP   : Measurement by sweeping between upper and lower limit frequencies

- Auto ranging

    This function allows an input range to switch in response to input signal level.

● Delay

This function is to delay measurement start time after frequency change.

A delayed amount is specified by time or cycle count.

Process of "frequency setting → delay → measurement" is to be repeated during frequency sweep.

Setting by time

Range	0 to 9,999 sec
Set resolution	10ms

Setting by cycle count

Range	0 to 9,999 cycles
Set resolution	1 cycle

● Integration

This function is to integrate data for measurement with noise reduced.

A measuring cycle is specified by cycle count or time.

Setting by cycle count

Range	1 to 9,999 cycles
Set resolution	1 cycle

Setting by time

Range	0 to 9,999 sec (The integral of one cycle must be evaluated regardless of settings.)
Set resolution	10 ms

● Auto integration

This function is to repeat integration until certain reliability is ensured.

Max. integral action time

Setting by cycle count

Range	2 to 9,999 cycles
Set resolution	1 cycle

Setting by time

Range	0 to 9,999 sec (The integral of two cycles must be evaluated regardless of settings.)
Set resolution	10 ms

● Amplitude compression

This function is to control the oscillator to stabilize the amplitude level of the intended measuring system, which prevents the measuring system from getting saturated and damaged. Enter the reference amplitude level in a reference channel.

Reference channel   CH1 or CH2

Reference voltage range

   Setting range   1 mV to 250 Vrms

   Set resolution   3 digits

Oscillator output clamping voltage range

   Setting range   1 mV to 10 Vpeak

   Set resolution   3 digits

Allowable error

   Setting range   0 to 100%

   Set resolution   1%

Number of calibration

   Setting range   1 to 9,999

   Set resolution   1

Correction factor

   Setting range   0 to 100%

   Set resolution   1%

● Frequency axis high-density sweep (automatic slow high-density sweep)

This function is to perform accurate measurement through automatic increase in sweep density between the relevant frequencies in response to substantial changes in measurement data.

Reference channel   CH1 or CH2

Variation width

  a, b, R

   Setting range   0 to 1 GVrms

   Set resolution   3 digits or 1 μ V, either of whichever are greater

  dBR

   Setting range   0 to 1000 dB

   Set resolution   3 digits or 0.01 dB, either of whichever are greater

  Phase

   Setting range   0 to 180°

   Set resolution   3 digits or 0.01° , either of whichever are greater

Operation mode

  Manual   This mode allows you to conduct a measurement in density 4 times higher than normal. If a change above the specified variation is detected, further increase in density is attempted to cut the variation between the measurement points to the specified amount or less, to proceed with measurement.

  Auto   This mode allows you to conduct a measurement in normal density. If a change above the specified variation is detected, increase in density is attempted to cut the variation between the measurement points to the specified amount or less, to proceed with measurement.

- Equalization

    The equalization function is to be utilized with frequency response of the measuring system (sensor, cable) pre-investigated. This function is to sort only characteristic of the intended measuring system from errors upon actual measurement.

- Harmonics analysis

    This function is to measure harmonic content.

    Harmonics of order 2 to 10 ((Max. harmonic frequency: 15 MHz)

3.4 Analysis

- Analysis mode

    Ratio   CH1/CH2, CH2/CH1

    Level   CH1, CH2

- Measurement error

    Conditions: CH1/CH2 or CH2/CH1 immediately after calibration

    An analysis input voltage is in the range of 100 mVpeak to 10 Vpeak (100 mVpeak to 2 Vpeak if frequency is at or above 2.2 MHz).

	$\leqq$20 kHz	$\leqq$500 kHz	$\leqq$2.2 MHz	$>$2.2 MHz
a,b, R	±0.5%	±1%	±10%	±25%
dBR	±0.05 dB	±0.1 dB	±1 dB	±2 dB
Phase	±0.3°	±0.5°	±2°	±5°

3.5 Calculations

- Arithmetical operation

    Data – Data, Data - Numerical value, Numerical value - Numerical value

- Differentiation and integration

    Data differentiation, 2nd order differentiation, integration, double integrals

- Conversion between open and closed loops

    Conversion from open loop to closed loop, conversion from closed loop to open loop

    Feedback characteristics is to be assigned with data or numerical value.

3.6 Auto sequence

- Key sequence store   This is to store key operation in internal memory.
- Key sequence run   This is to perform key operation stored in memory.
- Key sequence delete   This is to delete the stored key operation from memory.

3.7 Display

- Indicator   6.5-inch color TFT-LCD
- Graph   Bode diagram, Nyquist diagram, Nichols chart, Cole-Cole plot

  (cursor-control reading and auto scaling available)

- Display style   SINGLE/SPLIT

  If "SPLIT" is selected, the graph display area on the screen is split in two for simultaneous display of two graphs.

- Measurement data

  Gain

      Linear $\pm$9.999E+7 to $\pm$1.000E-8 , and 0

      Log $\pm$999.999 dB

   Phase   -180.00$°$ to 179.99$°$

                        0.00$°$ to 359.99$°$

                        -360.00$°$ to -0.01$°$

   Expanded display   If the measuring mode is set at "SINGLE" or "REPEAT", measuring data is displayed in the center of the LCD.

- Auto scaling

  This function is to automatically optimize a display scale of the graph.

  Auto scaling is effective for initial data display and data display during measurement.

  Fixed scaling takes effect if auto scaling is not selected.

- Marker display

   Normal marker   With a normal marker displayed on a graph, the marker is used to mark the position in graph. Data on the position marked is expressed in numerical values on the LCD.

   Delta marker   With a normal and delta markers displayed on a graph, the markers are used to mark the positions in graph. A distance between the positions marked is expressed in numerical values.

- Measurement condition display for measurement data

  This is used to display the main conditions for the measurement of the currently displayed data.

- Graph type

   Bode diagram   Graph of amplitude and frequency, of phase and frequency

   Nyquist diagram   Displayed in a+jb

   Cole-Cole plot   Displayed with a plus and minus of the imaginary axis (b) in the Nyquist diagram (a+jb) reversed

   Nichols chart   Graph of a transfer function on the condition that a vertical axis is a gain and a horizontal axis is a phase

- Condition setting and check   Menu mode
- Title

  Measurement and operation data is assigned names, and the names are presented on a graph.

- Date and time

  The current date and time or those of data acquisition are presented.

3.8   Memory

- Memory control

  Data storage in memory

  Data deletion from memory
- Memory type

Mass memory	Variable memory to store measurement data
	(Mass memory is capable of holding data while the power is supplied.)
	No less than 20,000 points of frequencies of equivalent
Permanent memory	Variable memory to store measurement data
	(battery backup assured)
	No less than 2,000 points of frequencies of equivalent

3.9   External memory

- Medium   USB flash drive

  (Behavior of non-attached USB flash drive is not guaranteed.)
- Connector   Front panel, USB-A connector
- File format

  FAT (compatible with a file format in Windows98SE and later versions with the IBM PC/AT compatible)
- Recording content

  Setting conditions

  Measurement data
- File operation

  Directory (file list)

  Rename (file renaming)

  Delete (file deletion)

  Save (saving of data and setting condition)

  Load (reading of data and setting condition)
- Screen image storage

File format	MS Windows bitmap file
	(Extension: .BMP, screen size: 640 $\times$ 480)
File size	Approx. 150 KB
Filename	FRAnnn
	(nnn: 3-digit number, automatic increment, default setting available)

3.10　External I/O

- GPIB

  Interface　　　　　　　　　SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0

- USB

  Spec　　　　　　　　　　USB1.1 (Low Speed, Full Speed)

  Connector　　　　　　　Rear panel, USB-B connector

  Device class　　　　　　TMC

- Thermal printer

  The integrated thermal printer is capable of producing graphic output (measurement data) off the LCD screen on paper.

  Paper size (width)　　　　112 mm

  Applicable paper　　　　　TP-451C (Seiko Instruments Co.,Ltd)

- DC power output

  Power required for NF Corporation signal injector probe 5055 (sold and distributed separately)

  Connector　　　　　　　Rear panel, AUX connector

  Output voltage　　　　　Approx. ± 24 V

  Output current　　　　　Max. 100 mA

3.11　Impedance display

- Display item

  R: Impedance or admittance

  A: Resistance or conductance

  B: Reactance or susceptance

- Supplementary graph

  List of linear graph (linear scale) and log graph (log scale)

X-axis	Y1-axis	Y2-axis		X-axis	Y1-axis	Y2-axis
logF	logR	θ		F	logR	θ
logF	A	B		F	A	B
logF	logA	logB		F	logA	logB
logF	log(-A)	logB		F	log(-A)	logB
logF	logA	log(-B)		F	logA	log(-B)
logF	log(-A)	log(-B)		F	log(-A)	log(-B)
logF	logR	―――		F	logR	―――
θ	logR	―――				

- Unit of scale

  Gain (absolute number) / impedance (Ω, S)

- Voltage / current input

  CH1: Voltage, CH2: Current

- Current shunt input conversion factor

  $0 \sim 1.0E+6$ (resolution: 5-digit or 0.01E-9), phase inversion

- Open/short correction

Open correction	Short correction	Correction formula
OFF	ON	$Zx = Z - Zs$
ON	OFF	$Zx = Zp \times Z \div (Zp-Z)$
ON	ON	$Zx = Zp \times (Z - Zs) \div (Zp - (Z - Zs))$

Zx   Correction result

Z   Measured value (CH1/CH2)

Zs   Short correction data (CH1/CH2)

Zp   Open correction data (CH1/CH2)

Correction calculation is to be performed according to the formula presented above regardless of the analysis mode.

- Max/Min search

Search item   Y1-axis maximum value, Y1-axis minimum value, Y2-axis maximum value, Y2-axis minimum value

Access method   Vertical axis parameter is automatically searched with the press of the corresponding search item function key when the data marker is displayed. The marker moves accordingly in response to searched parameter.

3.12   Others

- Power supply

Voltage   AC100 V/120 V/230 V $\pm$10%, Max. 250 V

Frequency   50 Hz/60 Hz $\pm$2 Hz

Power consumption   Max. 100 VA

Overvoltage Category   II

- Cooling method

Forced air-cooling, rear discharge type

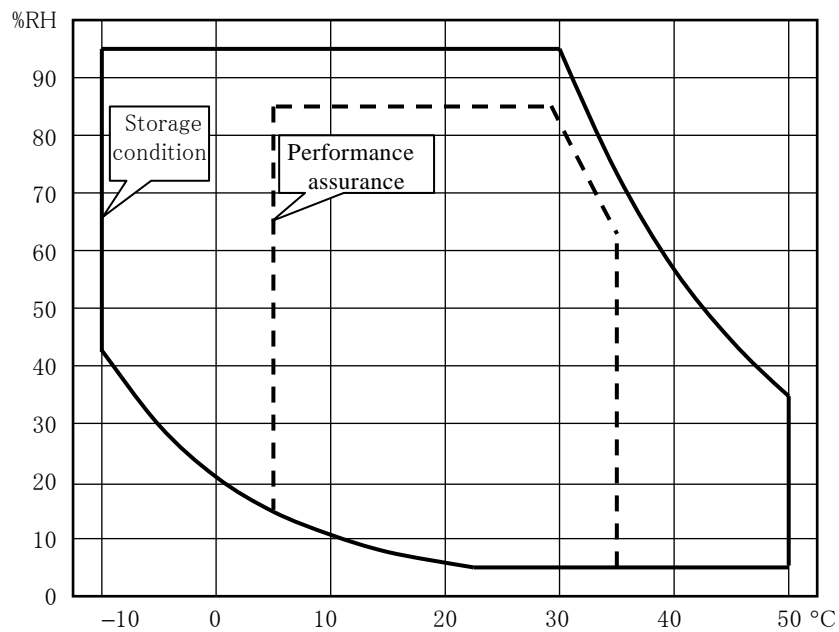- Installation

System installed on the level (within 10°)

- Environmental condition

Ambient temperature and humidity

Performance assurance   +5 to +35℃, 5 to 85%RH

(Absolute humidity: 1 to 25g/m^3, no condensation)

Storage   -10 to +50℃, 5 to 95%RH

(Absolute humidity: 1 to 29g/m^3, no condensation)

Pollution degree   2

- Insulation resistance   Min. 20 MΩ (DC500 V, batch power supply to the cabinets)
- Withstand voltage   AC1500 V (batch power supply to the cabinets)
- Dimension   434 (W) × 177 (H) × 453 (D) mm (protrusion excluded)
- Mass   Approx. 12kg (system mass, accessories and options excluded)
- Safety   EN 61010-1:2010
                            EN 61010-2-030:2010
- EMC   EN 61326-1:2013 (Group 1, Class A)
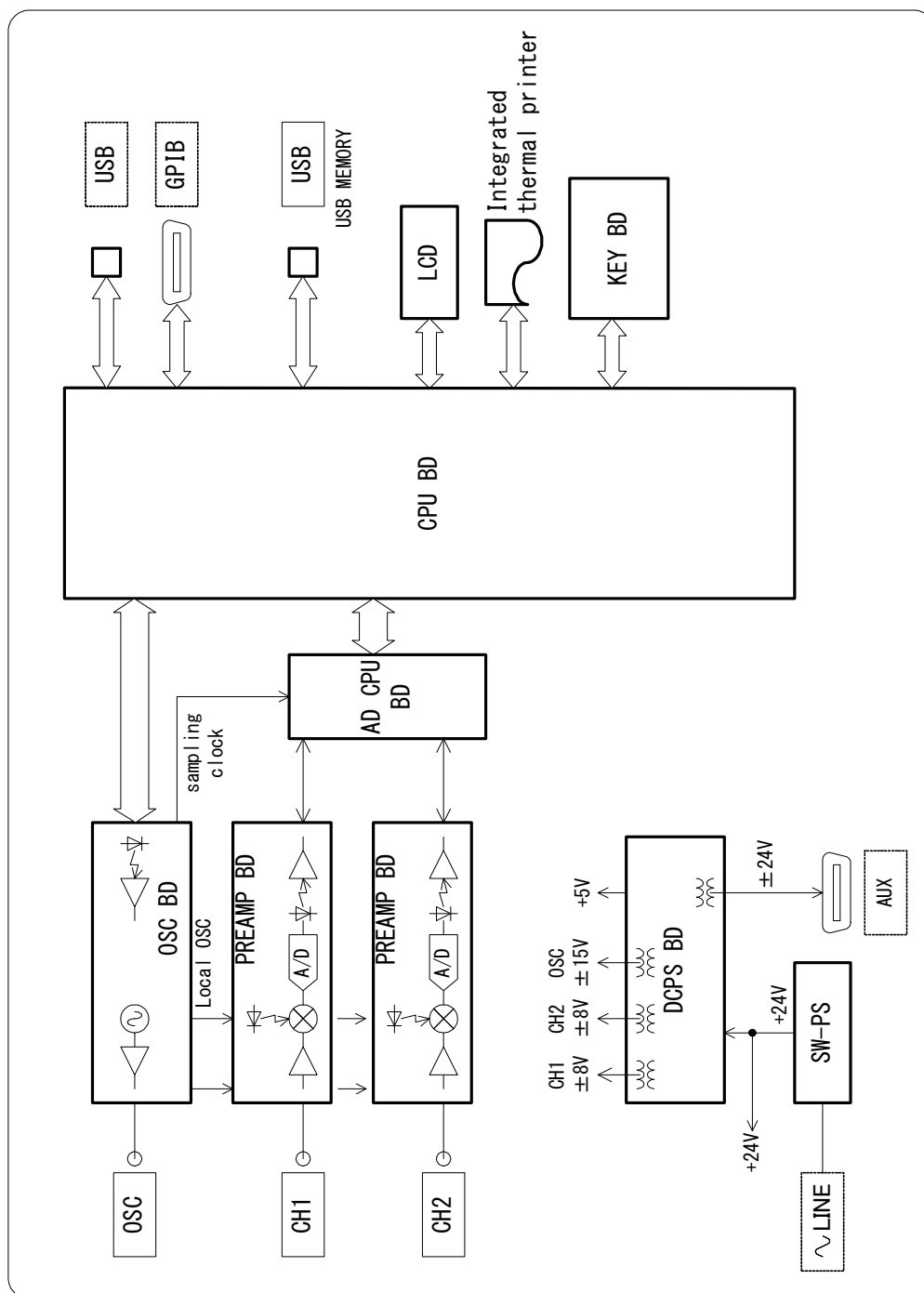   EN 61000-3-2:2006+A1:2009+A2:2009
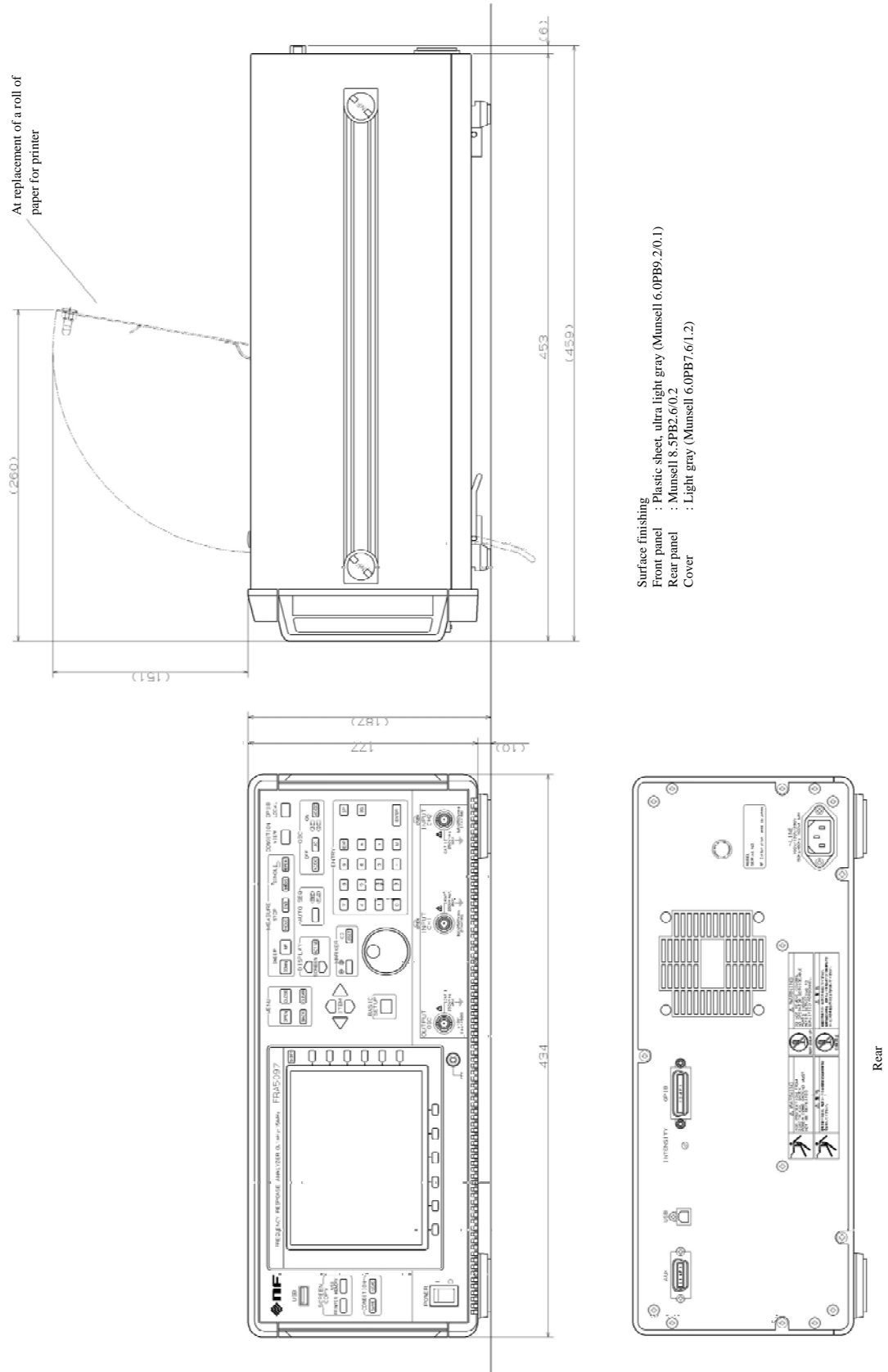   EN 61000-3-3:2013

Figure 3-5: Block Diagram

Figure 3-6: Outline Drawing