DA00014463-004

FREQUENCY RESPONSE ANALYZER

FRA5087

Specification

NF Corporation

Table of Contents

Appended Diagrams

1. Introduction

1.1 Overview

The "FRA5087 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 10 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 10 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 ±180°, –360° to 0, 0 to 360°
- Graph display
  - Bode diagram, Nyquist diagram, Nichols chart, Cole-Cole plot, Impedance display (optional)

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 10 MHz)

A batch sweep and measurement of frequencies are enabled in the range 0.1 mHz to 10 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 FRA5087, 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 (optional) facilitates accurate measurement and display of impedance.

1.3 Application

The FRA5087 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 “FRA5087 Frequency Response Analyzer” are listed below.

Frequency response analyzer FRA5087 ····· 1
Accessories
- FRA5087 Operation Manual ····· 1
- FRA5087 GPIB/USB Operation Manual ····· 1
- Set of power cords (3-pin plug assigned, 2 m) ····· 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

Option
- Impedance display function (PA-001-1231, built-in FRA5087) ··· 1

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

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 10 MHz (Square wave and triangular wave are available only at or below 100 kHz to assure waveform integrity.)
  - Set resolution: 0.1 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 10 MHz)
    (A value obtained immediately after calibration with it being set at 100mV 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 10 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 10 MHz/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 ±5 pF (parallel)
- IMRR (isolation mode rejection ratio)
  Min. 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 10 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: 10 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. 10 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).

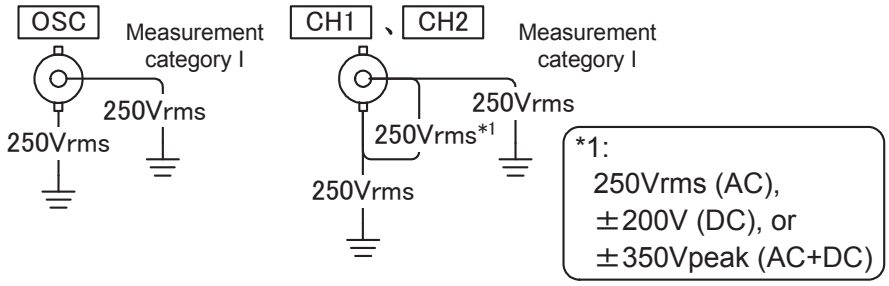


Figure 3-1: Specifications for Isolation Withstand Voltage (with supplied BNC cable used)

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

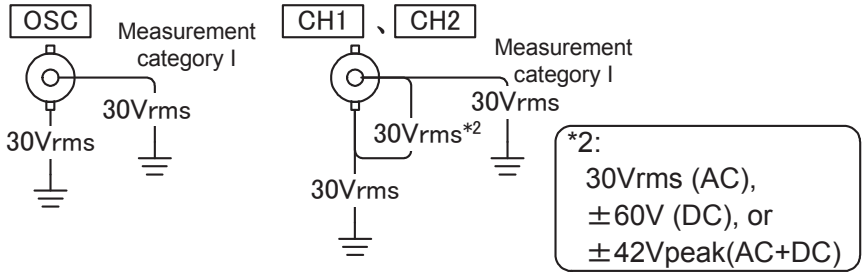


Figure 3-2: Specifications for Isolation Withstand Voltage (with other cable used)

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.

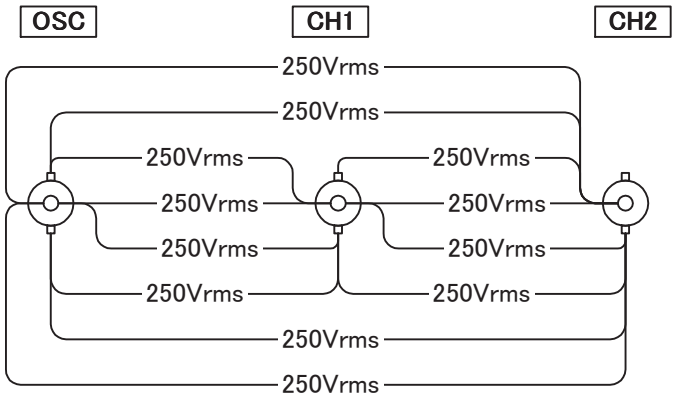


Figure 3-3: Specifications for Isolation Withstand Voltage between Oscillator and Analysis Input (with supplied BNC cable used)

Figure 3-4 shows isolation withstand voltage specifications between the oscillator (OSC) and analysis input (CH1 and CH2) when other cable is used.

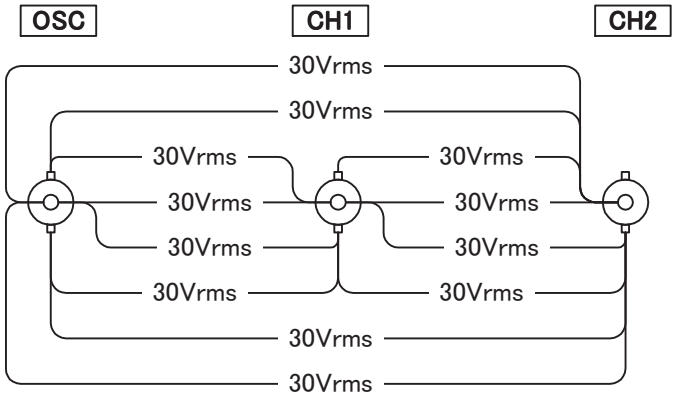


Figure 3-4: Specifications for Isolation Withstand Voltage between Oscillator and Analysis Input (with other cable used)

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 seconds
Set resolution	10 ms

  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 seconds (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 seconds (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 μV, 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: 10 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).

	≦20 kHz	≦500 kHz	≦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 — ±9.999E+7 to ±1.000E-8 , and 0
    - Log — ±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 positive and negative 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 × 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

  Specification 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 Inc.)

- 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 (optional)

- 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
logF	logR	θ
logF	A	B
logF	logA	logB
logF	log(-A)	logB
logF	logA	log(-B)
logF	log(-A)	log(-B)
logF	logR	— — —
θ	logR	— — —

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

- Unit of scale

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

- Voltage/current input

  CH1: Voltage, CH2: Current

- Current shunt input conversion factor

  0 to 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 × Z ÷ (Zp – Z)
ON	ON	Zx = Zp × (Z – Zs) ÷ (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 ±10%, Max. 250 V
Frequency	50 Hz/60 Hz ±2 Hz
Power consumption	Max. 100 VA
Overvoltage Category	II

- Cooling method

Forced air-cooling, rear discharge type

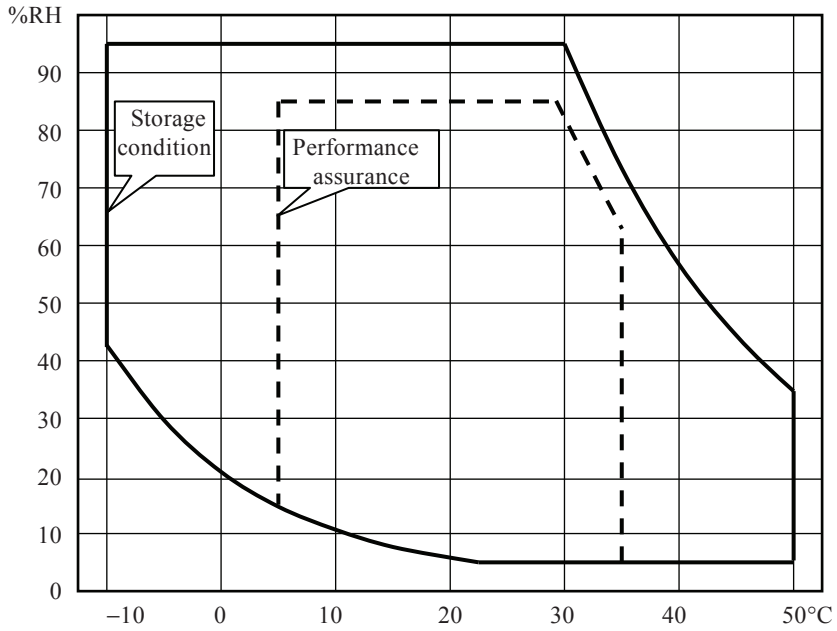
- Installation

System installed on the level (within 10°)

- Environmental condition

Ambient temperature and humidity

Performance assurance	+5 to +35°C, 5 to 85%RH
	(Absolute humidity: 1 to 25g/m^3, no condensation)
Storage	–10 to +50°C, 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)
- Dimensions — 434 (W) × 177 (H) × 453 (D) mm (protrusion excluded)
- Mass — Approx. 12 kg (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

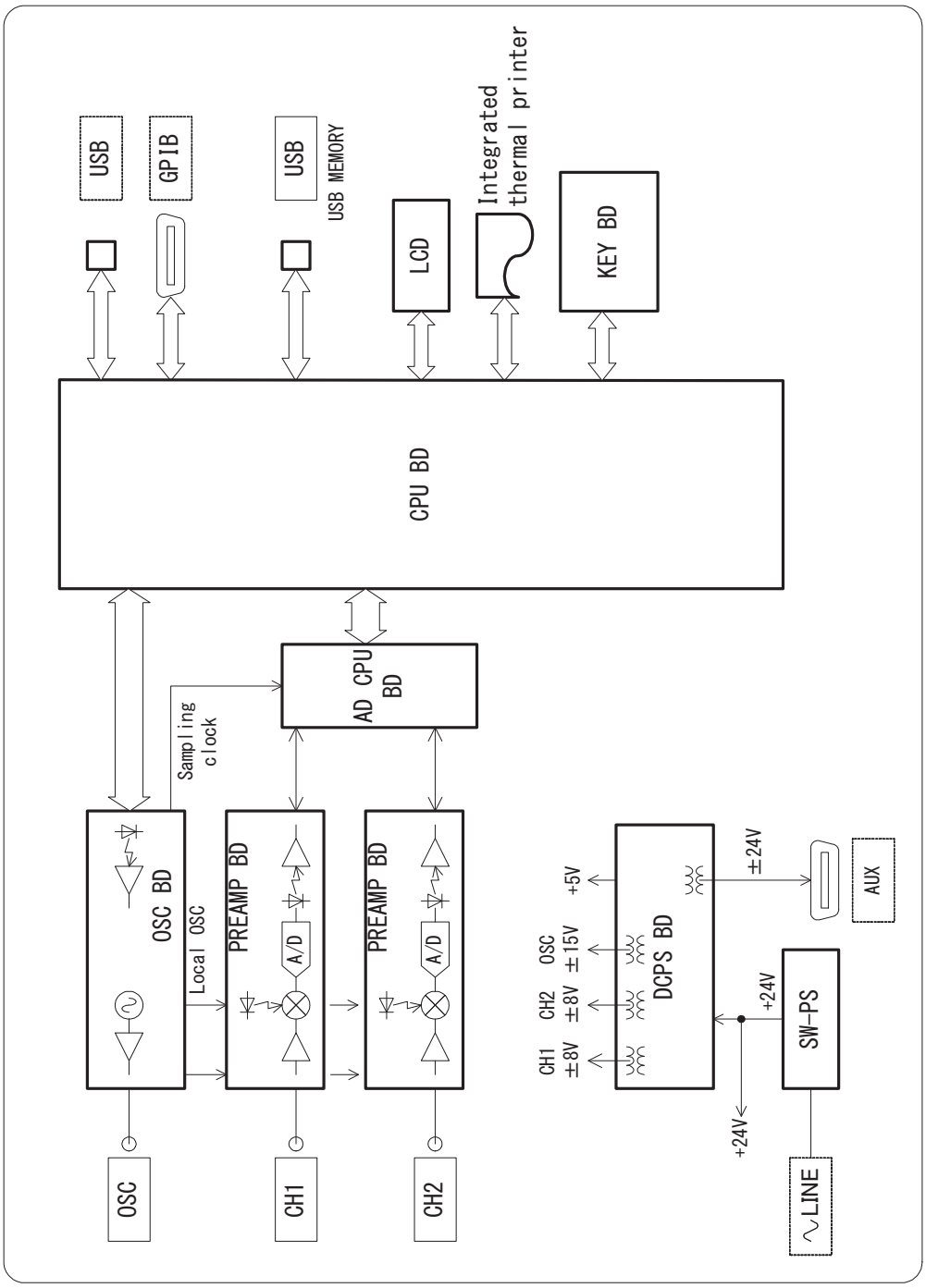


Figure 3-5: Block Diagram

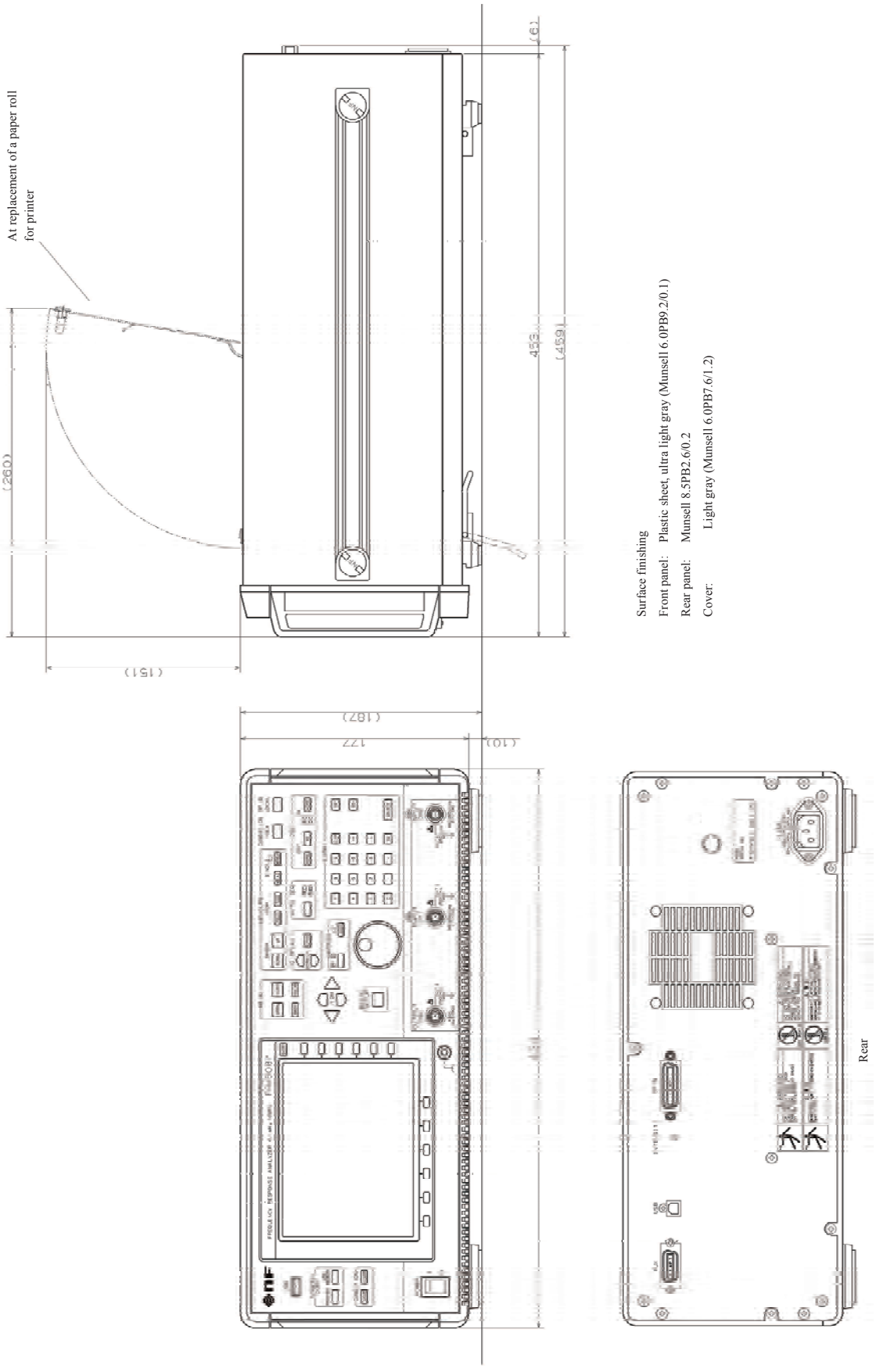


Figure 3-6: Outline Drawing

FRA5087 Specification
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