SERVO ANALYZER

FRA5014

Instruction Manual

NF Corporation

DA00019832-005

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FRA5014

Instruction Manual

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— Preface —

Thank you for purchasing the FRA5014 Servo Analyzer.
To ensure safe and proper use of this electric equipment, please read first Safety Precautions on the following pages.

● Caution Symbols Used in This Manual

The following caution symbols are used in this manual. Be sure to observe these caution symbols and their contents to ensure the safety of the user and avoid damage to the equipment.

⚠ WARNING

This symbol indicates information for the avoidance of a hazard such as electric shock that may endanger human life or cause injury during handling of the equipment.

⚠ CAUTION

This symbol indicates information for the avoidance of damage to the equipment during handling.

● This manual has the following chapter organization.

If reading this manual for the first time, start from **1. OVERVIEW**.

1. OVERVIEW

Briefly describes and explains the features, applications, and functions as well as brief operation principles of the FRA5014.

2. PREPARATIONS BEFORE USE

Describes various cautions regarding preparations to be made before using the FRA5014, ranging from installation to connection of the power supply.

3. PANEL AND BASIC OPERATIONS

Describes the functions and actions of the panel controls and their basic operations. Read this chapter while operating the FRA5014.

4. ADVANCED OPERATIONS

Describes how to use advanced functions.

5. REMOTE CONTROL

Describes remote control via GPIB, USB, or RS-232.

6. TROUBLESHOOTING

Describes error messages and handlings when problems occur.

7. MAINTENANCE

Describes how to store, re-pack, and transport the FRA5014 and how to conduct the performance test.

8. SPECIFICATIONS

Lists the specifications (functions and performance) of the FRA5014.

— Safety Precautions —

To ensure safe use, be sure to observe the following warnings and cautions.
NF Corporation shall not be held liable for damages that arise from a failure to observe these warnings and cautions.
This product is a Class 1 product (with protective conductor terminal) that conforms to the JIS and IEC insulation standards.

- **Be sure to observe the contents of this instruction manual.**
  This instruction manual contains information for the safe operation and use of this product.
  Be sure to read this information first before using this product.
  All the warning items contained in this instruction manual are intended for preventing risks that may lead to serious accidents. Ensure to obey them.
- **Be sure to ground the product.**
  This product uses a line filter, which may cause electric shock if the product is not grounded.
  To prevent electric shock accidents, connect it to an earth ground so that ground resistance is 100Ω or less.
- **Check the power supply voltage.**
  This product operates on the power supply voltage indicated in Grounding and Power Supply Connection in this instruction manual.
  Prior to connecting the power supply, check that the voltage of the power outlet matches the rated power supply of the product.
- **In case of suspected anomaly**
  If this product emits smoke, an abnormal smell, or abnormal noise, immediately power it off and stop using it.
  If such an abnormal occurs, prevent anyone from using this product until it has been repaired, and immediately report the problem to NF Corporation or one of our representatives.
- **Do not use this product when gas is present.**
  An explosion or other such hazard may result.
- **Do not remove the cover.**
  This product contains high-voltage parts. Absolutely never remove its cover.
  Even when the inside of this product needs to be inspected, do not touch the inside. All such inspections are to be performed by service technicians designated by NF Corporation.
- **Do not modify this product.**
  Never modify or try to modify the instrument. Your modification of the instrument could cause unexpected accidents or failures. NF Corporation has the right to refuse providing services for any instruments modified by unauthorized persons.
- **Do not expose this product to water.**
  When this product is used in wet condition, it may cause an electric shock and a fire. If this product is exposed to water, unplug the mains supply cord immediately, and contact NF Corporation or one of our representatives.

- **If lightning occurs, power off this product and unplug the mains supply cord.**
  A lightning may cause an electric shock, a fire and a failure.

- **Safety-related symbols**
  The general definitions of the safety-related symbols used on this product and in the instruction manual are provided below.

Instruction Manual Reference Symbol
This symbol is displayed to alert the user to potential danger and refer him/her to the instruction manual.

Electric Shock Danger Symbol
This symbol indicates locations that present a risk of electric shock under specific conditions.

⚠ WARNING

Warning Symbol
This symbol indicates information for avoiding danger to human life or bodily injury while handling this product.

⚠ CAUTION

Caution Symbol
This symbol indicates information for preventing damage to the product when handling it.

- **Other symbols**

This symbol indicates the “on” position of the power switch.


This symbol indicates the “off” position of the power switch.


This symbol indicates when connected to the case.


This symbol indicates when connected to the ground.

- **Waste disposal**

To help ensure environmental protection, please note the following precaution regarding disposal of this product.

- This product contains a lithium battery.

Contents

Figures and Tables

1. OVERVIEW

1.1 Features

The **FRA5014 Servo Analyzer** is equipment to evaluate servo system stability and responsivity through loop characteristics (loop gain and phase vs. frequency) measurement by inputting a sine wave test signal to the servo system under test.
In addition to servo system evaluation, the FRA5014 is capable of impedance measurement and frequency characteristic measurement for amplifiers and filters.
The analyzer block consists of 4 channels. Measurements are performed in the four channels simultaneously, and then 3 combinations of gain and phase using CH1 as the reference (CH2/CH1, CH3/CH1, CH4/CH1) are analyzed and the results are output. During loop characteristic measurement, frequency characteristics for each block constituting the loop can also be measured. Furthermore, it saves measurement time by measuring multiple DUTs simultaneously.
The FRA5014 is a built-in type and dedicated for remote-control via a controller such as a PC.

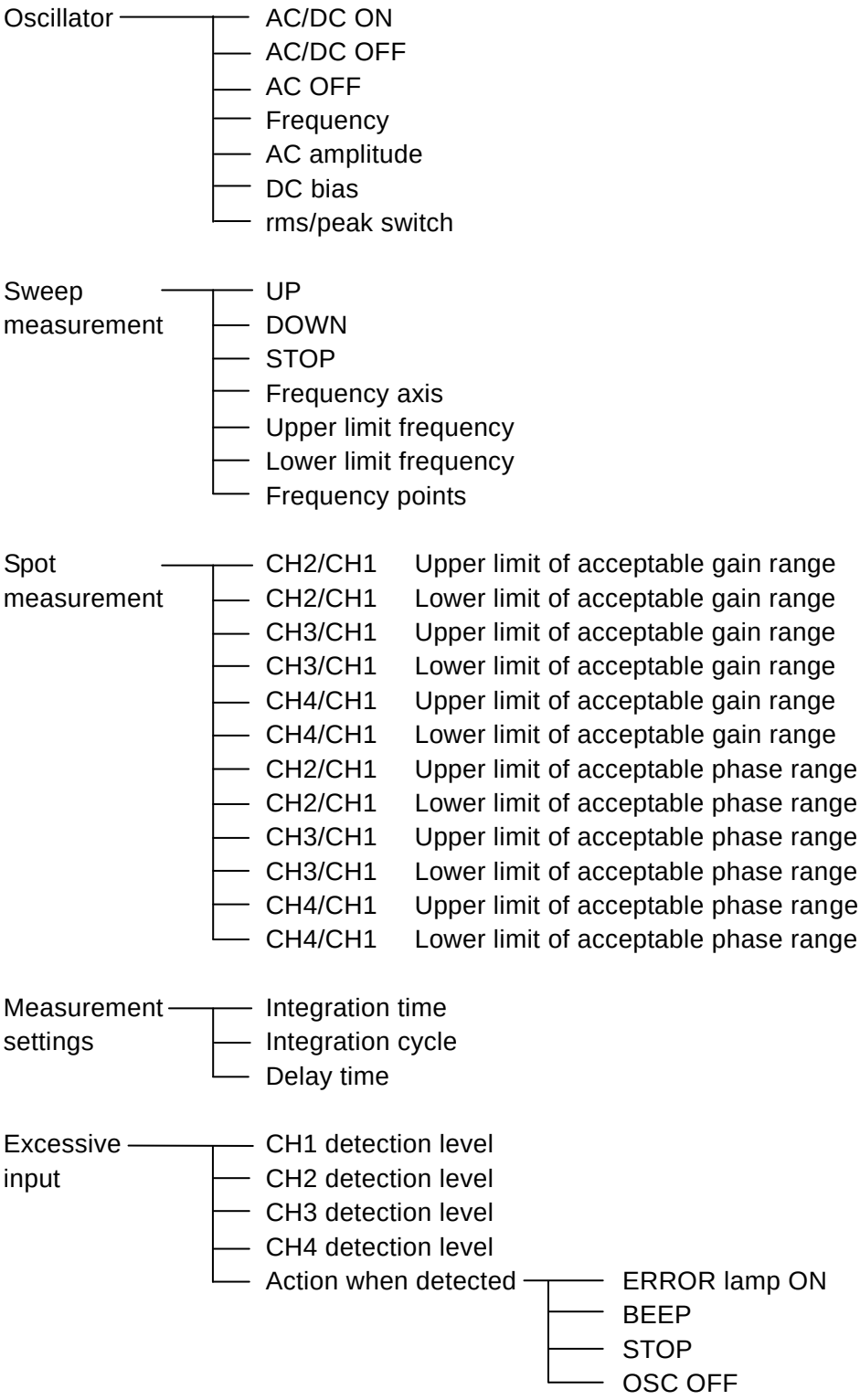
- Oscillation frequency of 0.1 mHz to 100 kHz
  Covers an optimal range for mechanical servo analysis and electrochemical impedance measurement
- Simultaneous 4-channel measurement
  4 channels in the analyzer block simultaneously intake signals. Measurement at low frequencies can thus be performed faster than devices that switch and analyze input channels one at a time.
- Insulated I/O
  Analysis input of each channel and oscillation output are individually isolated from the case. This makes signal input to the system under test during servo analysis easy.
- Slim type
  Slim shape with a height of 88 mm (2U), suitable for building into a system rack
- Data display software
  The standard provided software allows easy data loading into a PC, saving in the CSV format, and various graph displays.
  Measurement setting, control, and data reading are performed by using a PC

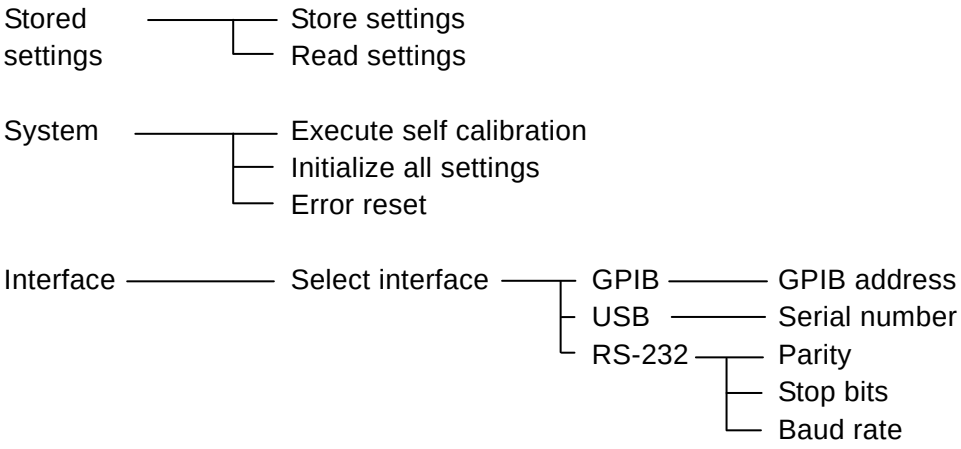
1.2 Applications

- Servo system — Image stabilization servos in cameras, measurement of servo characteristics of CD/DVD players, etc.
- Electronic circuits — Frequency response measurement in filters, amplifiers, etc.
- Acoustics — Frequency response measurement in speakers, microphones, etc.
- Vibration analysis — Measurement of resonance characteristics
- Electrochemicals — Metallic corrosion research and battery performance measurements (electrochemical impedance measurement)

1.3 List of Functions

A tree diagram of functions is shown below.




Stored settings
Store settings
Read settings
System
Execute self calibration
Initialize all settings
Error reset
Interface
Select interface
GPIB
GPIB address
USB
Serial number
RS-232
Parity
Stop bits
Baud rate

1.4 Operation Principles

The FRA5014 uses a built-in oscillator to provide a sine wave test signal V_0 to the system under test, then measures the following in the vector ratios V_2 / V_1, V_3 / V_1, V_4 / V_1 (i.e., frequencies) of the response signals V_1, V_2, V_3, and V_4

Gain $G = | V_2 / V_1 |, \quad | V_3 / V_1 |, \quad | V_4 / V_1 |$

Phase differential $P = \angle V_2 - \angle V_1, \angle V_3 - \angle V_1, \angle V_4 - \angle V_1$

A block diagram of the FRA5014's operations is shown below.

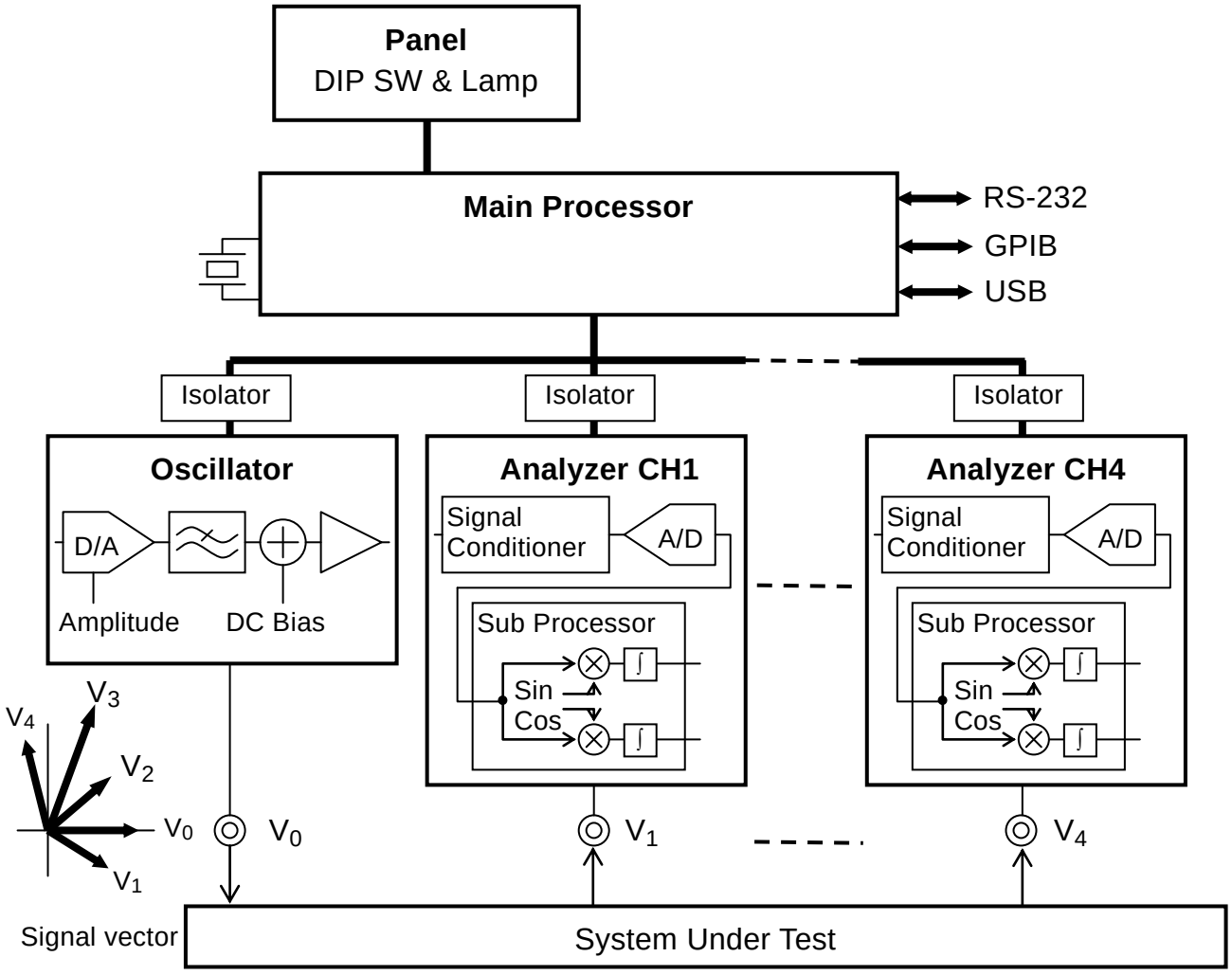


Figure 1-1. Block Diagram

- **Main Processor**

  The main processor controls the oscillator or analyzer based on the user's actions, calculates the ratios of signal vectors obtained by the analyzer, and outputs the data. Employing a quartz resonator as its reference clock, the main processor uses the direct digital frequency synthesis method to generate digital sine wave signals (Sin, Cos) with precise frequencies for use by the oscillator or analyzer.

- **Oscillator**

  The FRA5014's oscillator uses a D/A (digital to analog) converter and filter to convert digital sine wave signals into analog signals. Lastly, DC bias is added prior to output.

- **Analyzer**

  In the analyzer, response signals from the system under test are modified in size, etc., as needed by a signal conditioner, then are converted to digital signals by an A/D (analog to digital) converter. The sub processor performs multiplication and integration operations using the response signal and orthogonal reference signals (Sin, Cos) to obtain two orthogonal signal components, which is to say signal vectors. This process attenuates frequency components that do not match the signal frequency, thereby enabling precise measurement even when a lot of noise is present.

2. PREPARATIONS BEFORE USE

2.1 Checking Before Use

■ Safety check

Before using the FRA5014, carefully read "**Safely Precautions**" at the front of this manual to ensure safety.

Before connecting the mains supply cord, read "**2.3** Grounding and Power Supply Connections" and perform all of the safety checks.

■ Cautions when unpacking

First, make sure that no damage has occurred during shipment.

Before installing the equipment, check that all of the items listed in "Table 2-1. Package Contents" are included.

Table 2-1. Package Contents

FRA5014 main unit	1
Mains supply cord (with 3 pin plug, 2 m)	1
Instruction Manual	1
CD-ROM	1

Contents
- Data display software
- LabVIEW driver
- Sample programs
- FRA5014 Instruction Manual (pdf format)

Using the data display software in the supplied CD-ROM, data can be loaded from the FRA5014 to a personal computer, where it can be stored in CSV format, displayed in various types of graphs, and the main parameters of the data can be easily modified.

This manual does not include instructions on using all of the contents of the CD-ROM. For details of these contents, see the instruction manual that is included in the CD-ROM. To view the CD-ROM contents, Adobe Corporation's Acrobat Reader Ver. 5 is required, and must be installed separately (this program was called "Adobe Reader" when this manual was created).

⚠ WARNING

This product contains high-voltage parts. Never remove the cover.

All internal inspections of this product are to be performed only by service technicians who are familiar with risk prevention and who are qualified by NF Corporation.

2.2 Installation

2.2.1 General precautions for installation

⚠ CAUTION

Note the following precautions to prevent damage to the FRA5014.

- The FRA5014 uses a fan for forced-air cooling. Air intake occurs via the bottom front panel of the unit and air exhaust occurs via the central rear panel. Do not obstruct either the air intake or exhaust areas.
- If the FRA5014 is used with its rear panel facing downward (installed vertically), it may topple easily. Always install it horizontally (with its bottom facing the floor).

■ Handling of panels and case

The FRA5014's front panel is made of plastic. Be careful to prevent damage that may be caused by sharp objects or high temperatures.

When the panel or case surfaces become dirty, use a soft cloth to wipe them. For stubborn dirt, dip the cloth in a neutral detergent and wring it out well before wiping off the dirt. Avoid use of organic solvents such as paint thinner or benzene, or pre-moistened wipes, as they may cause discoloration, clouding, and/or peeling of the surface coating.

2.2.2 Installation conditions

Install the FRA5014 in a location that meets the following conditions for temperature and humidity ranges.

Performance guarantee	+5 to +35 °C, 5 to 85 %RH (Absolute humidity of 1 to 25 g/m^3, with no condensation) Altitude: 2000m or less
Operation	0 to +40 °C, 5 to 85 %RH (Absolute humidity of 1 to 25 g/m^3, with no condensation) Altitude: 2000m or less
Storage	–10 to +50 °C, 5 to 95 %RH (Absolute humidity of 1 to 29 g/m^3, with no condensation)

Do not install the FRA5014 in the following locations:

- Location exposed to direct sunlight or near a heat source
- Locations where dust, salt, and/or metallic powder is prevalent
- Locations where corrosive gas, steam, and/or oily smoke is prevalent
- Location exposed to excessive vibration
- Within or close to sources of strong magnetic fields
- Close to sources of pulsing noise.

When measurement precision is important, warm up the FRA5014 at least two hours before using it, then run self calibration before starting measurements. If the ambient temperature has changed more than 5 °C, or if the FRA5014 has been used continuously for more than 24 hours, running self calibration again is recommended.

Keep the mains supply cord separated from the signal cable. If the mains supply cord and signal cable get too close, operation faults or noise may lead to inaccurate measurements.

2.2.3 Rack mount

When the (optional) rack mount adapter is attached to the FRA5014, it can be inserted into a 19-inch IEC rack, EIA-standard rack, or JIS-standard rack.

Attach the rack mount adapter as described below in "**Figure 2-3 Attachment of Rack Mount Adapter (mm Based)**" or "**Figure 2-4 Attachment of Rack Mount Adapter (Inch Based)**", then insert it into the rack.

⚠ CAUTION

Note the following precautions when inserting the FRA5014 into a rack mount.

- Always install supports such as rack rails for the FRA5014.
  Otherwise, the FRA5014 may fall from the rack, causing possible injury to others or damage to the FRA5014.
- Make sure the rack has spaces to allow ample air circulation, or install a cooling fan. The FRA5014's air intake holes are on its bottom panel. If other units are mounted above and below the FRA5014, leave a gap of at least 20 mm under the FRA5014. Overheating beyond the rated maximum temperature can shorten performance life and otherwise damage the FRA5014.

If any feet have been attached to the rails, remove them as described below in "**Figure 2-5. Removal of Feet**".

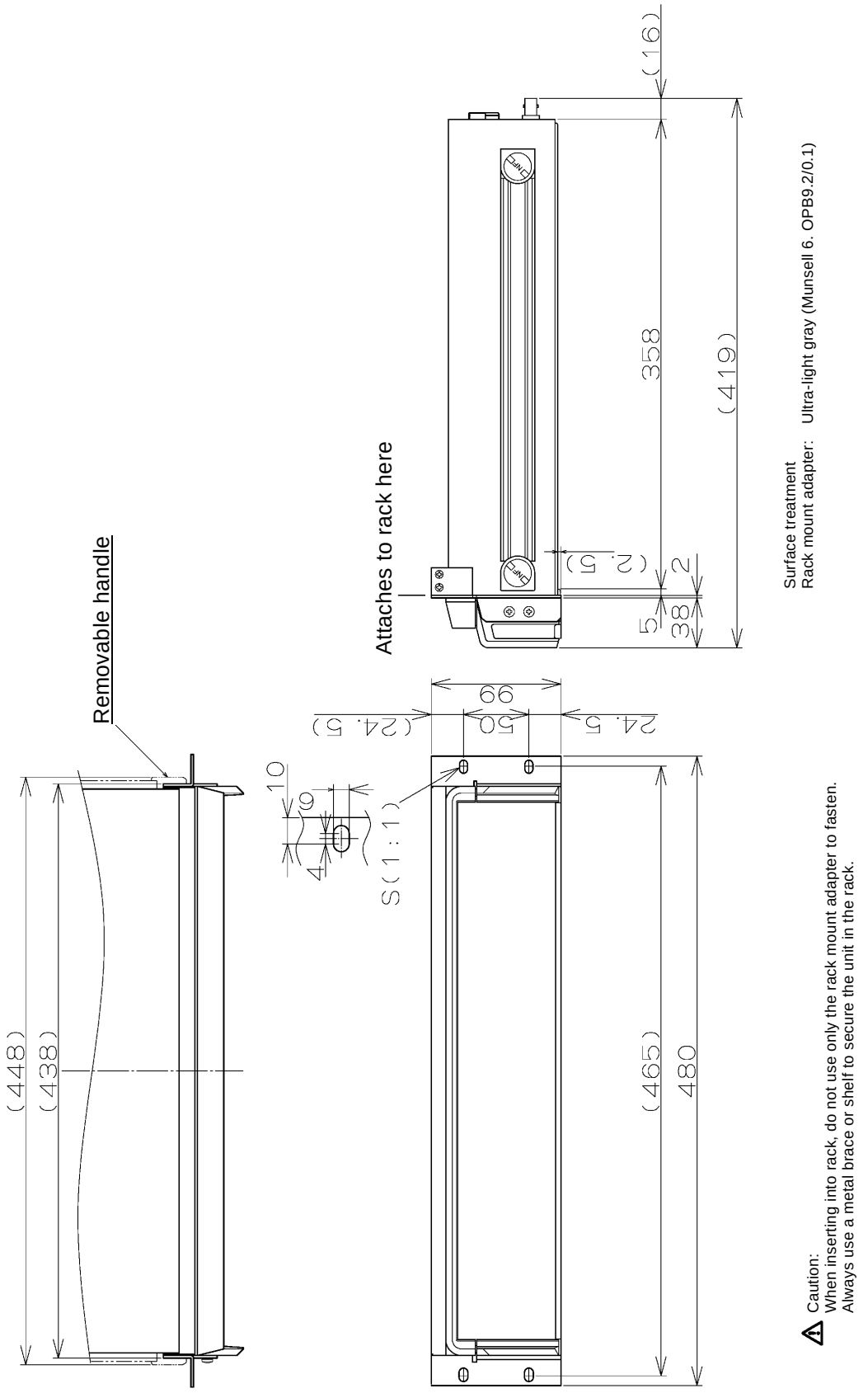


Figure 2-1. Dimensions of Rack Mount (mm Based Rack)

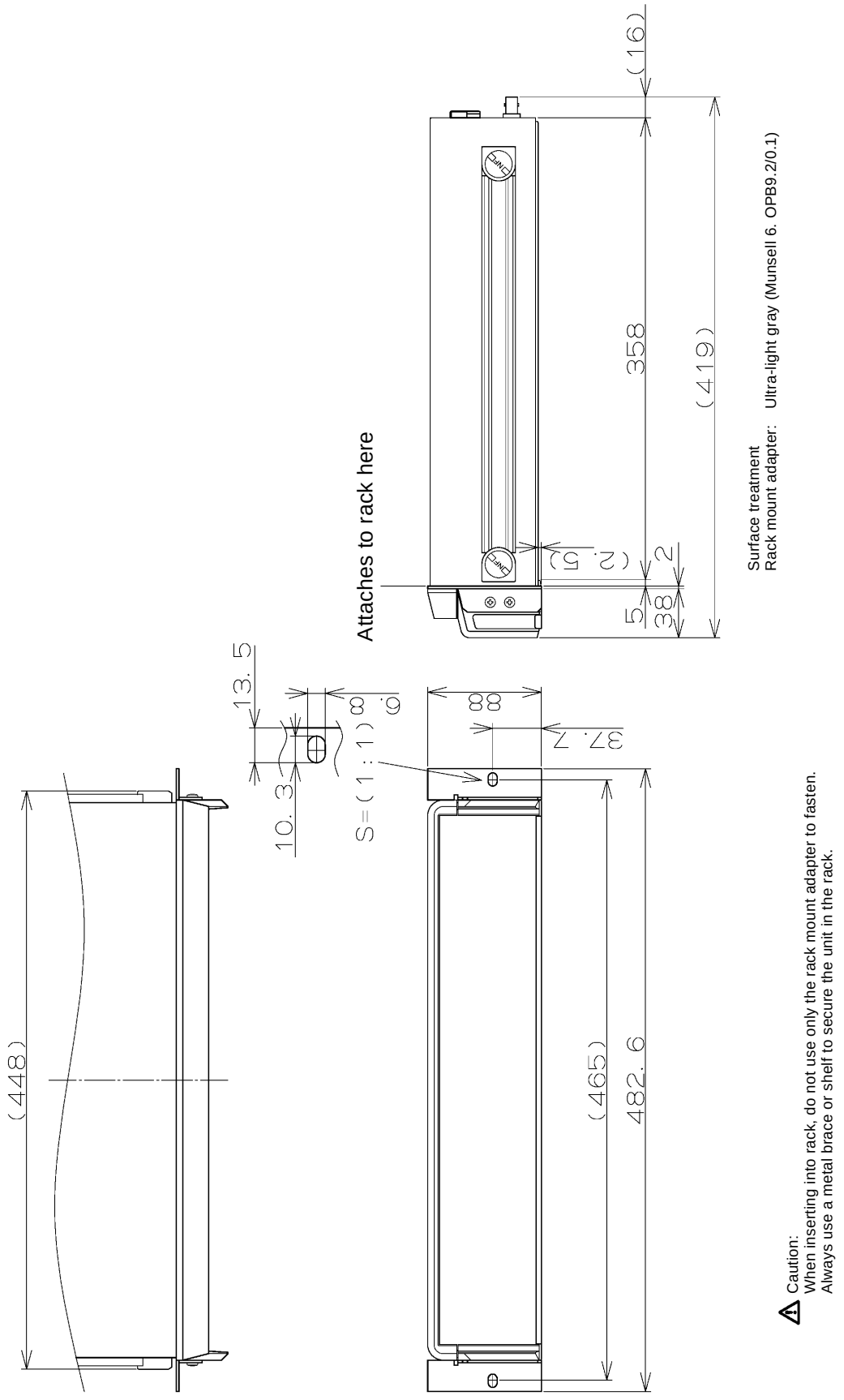
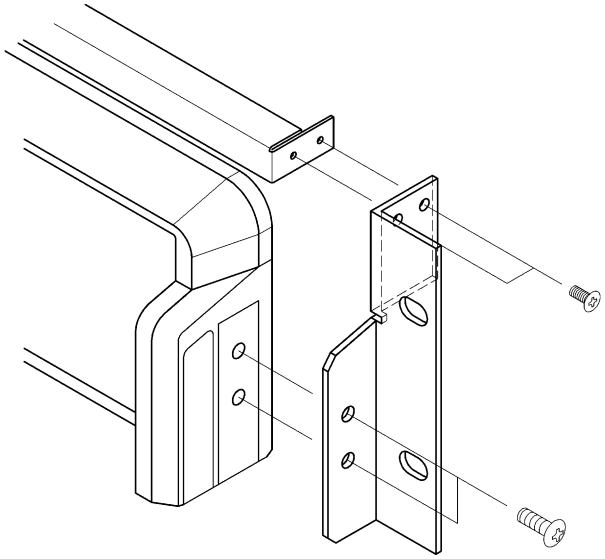


Figure 2-2. Dimensions of Rack Mount (Inch Based Rack)



Rack mount adapter attachment steps

- Remove the two screws (per side) from the front panel.
- Use the screws in the rack mount adapter to attach the rack mount adapter.

Figure 2-3. Attachment of Rack Mount Adapter (mm Based)

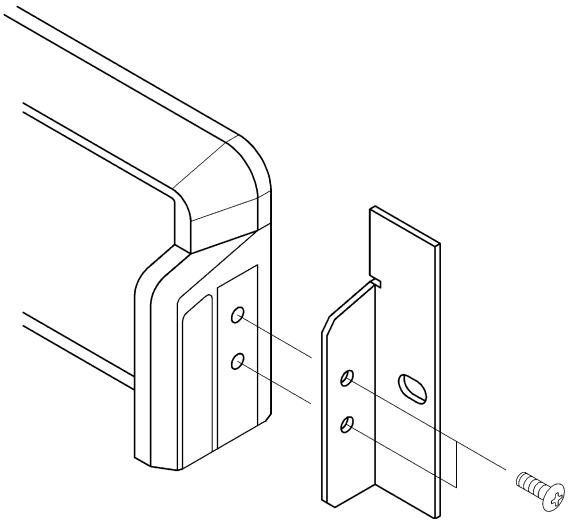


Figure 2-4. Attachment of Rack Mount Adapter (Inch Based)

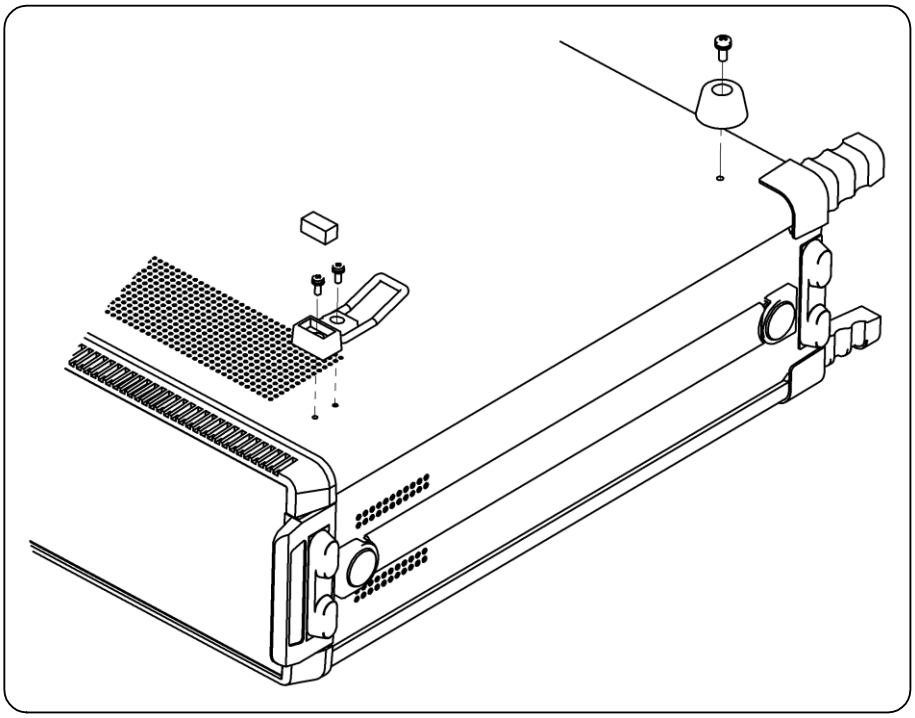


Figure 2-5. Removal of Feet

2.3 Grounding and Power Supply Connections

■ Grounding

⚠ WARNING

Note the following precautions to prevent electric shock.

Before connecting the unit to perform measurements, always connect the protective grounding terminal to a grounding contact.
The FRA5014's protective grounding terminal is the grounding plug pin of the mains supply cord.

■ Power supply

⚠ CAUTION

To prevent the FRA5014 from possible damage, make sure the power outlet's voltage is within the FRA5014's power supply voltage range before connecting to the power source.

The FRA5014 operates under the following commercial power suply.

Power supply voltage range: AC 100 V to 230 V ±10 %, but 250 V max.
Power supply frequency range: 50/60 Hz ±2 Hz

Maximum power consumption is 70 VA.

Before connecting the mains supply cord, make sure the power switch is set to off.
After turning off the FRA5014, wait at least three seconds before turning it on again.

⚠ WARNING

This product contains high-voltage parts. Never remove the cover.

2.4 Simple Operation Checks

FRA5014 operation checks should be performed in the following order before performing important measurements or following extended periods of non-use.

1. Plug the mains supply cord into the outlet and turn on the power switch.
   Shortly after the power goes on, calibration will begin and the CALIBRATION lamp will light. When calibration is completed, the CALIBRATION lamp goes off, and the unit is ready to start taking measurements.
2. Check for I/O insulation.
   - Using a resistance meter such as a tester or multimeter, measure the resistance values between external conductors of the OUTPUT OSCILLATOR. INPUT CH1, CH2, CH3, and CH4 connectors and the grounding terminal in the center of the rear panel, making sure it is at least 10 MΩ.
3. Connect a personal computer to the FRA5014. To do this, use the DIP switch on the rear panel change to change the remote interface setting.
   For details, see ☞ "**5 REMOTE CONTROL**"
4. Initialize the settings.
   - Enter the remote command "*RST".
5. Connect the FRA5014's OUTPUT OSCILLATOR terminal to an oscilloscope, via a BNC-BNC cable (etc.). Set up the oscilloscope as follows.
   - Input impedance: 1 MΩ
   - Input sensitivity: 2 V/DIV
   - Sweep rate: 0.2 ms/DIV
   - Trigger level: 0 V
6. Check the oscillator's output waveform.
   - Enter the remote command "FREQ 2000" to set the frequency to 2 kHz.
   - Enter the remote command "VOLT 5" to set the amplitude to 5 Vrms.
   - Enter the remote command "VOLT:OUTP 2" to output a sine wave with the specified amplitude, and make sure the OSCILLATOR lamp is on.
7. Change the frequency and AC amplitude.
   - Change the frequency setting, then check that a signal at the newly set frequency has been output.
   - Change the AC amplitude setting, then enter the remote command "VOLT:OUTP 2" and check that the amplitude is at newly set value.
   - Lastly, change the amplitude to 1 Vrms and enter the remote command "VOLT:OUTP 2".
8. Use a BNCT type divider (or the like) to split the FRA5014's OUTPUT OSCILLATOR output, then connect them to the INPUT CH1, CH2, CH3, and CH4 terminals.
   Since signal I/O is insulated from the case, also connect each signal ground.
9. Perform a sweep measurement, and check that the overall gain is approximately 0 dB and phase is approximately 0 deg.
   - Enter the remote command "SWE:MEAS DOWN". Make sure the MEASURE lamp is on.
   - After making sure the MEASURE lamp is off, enter the remote command "SENS:DATA:SWE?", query the measurement results, then read the measurement results via the personal computer.

2.5 Calibration

Although calibration periods vary according to the FRA5014's use environment and frequency of use, the performance test described below in "**7.7** Performance Test" should be performed at least once a year.

A performance test should be done before using the FRA5014 for important measurements or tests.

If the rated values are not met during the performance test, NF Corporation can perform modifications or calibrations to restore performance.

To calibrate the FRA5014, contact NF Corporation or our representative.

A calibration fee will be charged.

3. PANEL AND BASIC OPERATIONS

3.1 Panel Components and Operations

The following describes the names and operations of components on the FRA5014's front and rear panels.

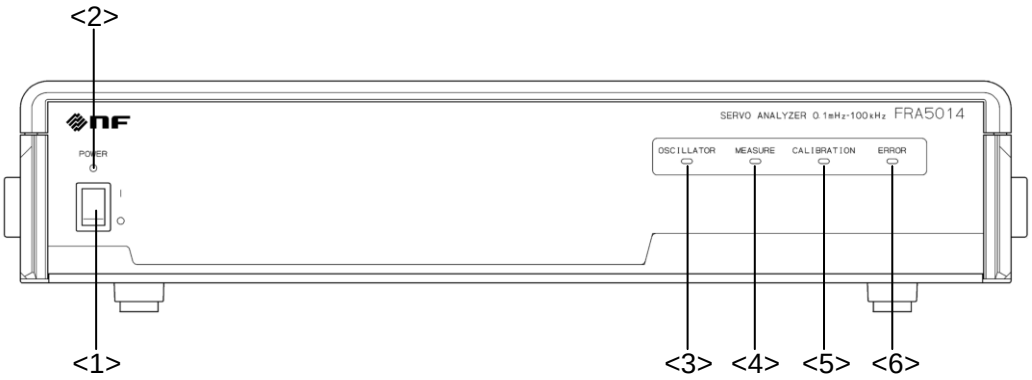


Figure 3-1. Front Panel

<1> Power switch

Press this switch upward to turn the power on and downward to turn it off.

<2> POWER lamp

This lamp is on when the power is on.

<3> OSCILLATOR lamp

This lamp is on when the oscillator is on.

<4> MEASURE lamp

This lamp is on during measurements.

<5> CALIBRATION lamp

This lamp is on during self calibration.

<6> ERROR lamp

This lamp is on during when a command error, output overcurrent, overload input voltage, self calibration error, or self test error has been detected.

When an error query remote command such as "SYST:ERR?" is received, the error queue is emptied and the error lamp goes off. If an output overcurrent or an overload input voltage is detected, the error clear remote command "SYST:OVER:REL" will cause the error lamp to go off, but error messages may remain in the error queue.

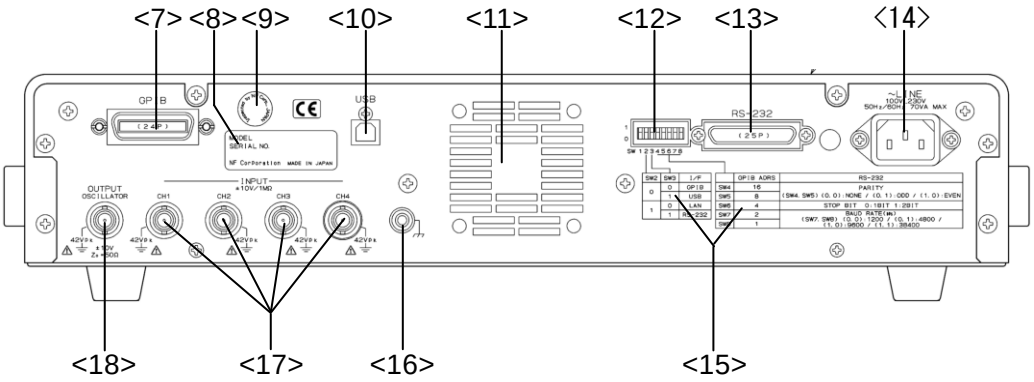


Figure 3-2. Rear Panel

<7> GPIB connector

<8> Serial number label

<9> Inspected label

<10> USB connector

<11> Cooling fan exhaust outlet

<12> DIP switches

For interface settings and various communication settings

<13> RS-232 connector

<14> Power inlet

<15> DIP switch settings list

This lists the interface settings and communications settings made using DIP switches 0 and 1.

<16> Grounding terminal for measurements

This is connected to the case. The system under test's shield or fixed potential is used.

<17> Analyzer input terminals

The maximum input voltage is ±10 V and each signal ground is insulated from other input channels, the case, and the oscillator's output. The ERROR lamp goes on when overload input occurs.

<18> Internal oscillator output terminal

This terminal outputs sine wave signals with frequencies from 0.1 mHz to 100 kHz, with maximums of 10 Vp and 100 mA. The signal ground is insulated from the case and the CH1, CH2, CH3 and CH4 inputs.

3.2 Display and Initial Settings at Power-on

3.2.1 Checks before turning power on

The FRA5014 operates using the following type of power supply.

Power supply voltage range: AC 100 V to 230 V ±10 %, but 250 V max.

Power supply frequency range: 50/60 Hz ±2 Hz

Maximum power consumption is 70 VA.

⚠ CAUTION

Before turning on, make sure that the power outlet's voltage is within the FRA5014's power supply voltage range. Otherwise, the FRA5014 may become damaged.

⚠ WARNING

Note the following precautions to prevent electric shock.

Before connecting the unit to perform measurements, always connect the protective grounding terminal to a grounding contact.
The FRA5014's protective grounding terminal is the grounding plug pin of the mains supply cord.

Before connecting the mains supply cord, make sure the power switch is set to off.
After turning off the FRA5014, wait at least three seconds before turning it on again.

⚠ CAUTION

Wait at least three seconds after turning the power off or on.
If the power is turned on and off repeatedly in quick succession, operation may become abnormal.

Perform the following steps when turning on the power.

- Make sure that the power switch is set to the off position (pressed downward).
- Connect the mains supply cord into the power inlet on the rear panel.
- Insert the mains supply cord's plug into a socket-outlet.
- Press the power switch upward to turn on the FRA5014.

When the power supply is on, the CALIBRATION lamp lights and self calibration begins. When self calibration is completed, the CALIBRATION lamp goes off and the FRA5014 is ready to begin taking measurements.

Display at power-on ☞ "**3.2.2 Display at power-on**"

3.2.2 Display at power-on

Follow the setup instructions described above in "**2 PREPARATIONS BEFORE USE**".

When the power switch is turned on, a beep sounds and then all lamps go on for a few seconds. During this period, memory self check and other processing are performed. If any errors are found, the ERROR lamp goes on.

For details, see ☞ "**6.1.1 Error at power-on**"

For description of initial settings, see ☞ "**3.2.3 Initial Settings**"

If there are no errors in the battery backup, the settings from when the unit was last turned off are restored.

When the above self check is completed normally, a signal check and self calibration are performed. During these operations, the CALIBRATION lamp is on. When self calibration ends normally, the CALIBRATION lamp goes off, and FRA5014 unit is ready to begin taking measurements.

3.2.3 Initial Settings

The FRA5014's initial settings are described below.

- Factory settings
- Error at power-on when settings in memory have been corrupted

  ☞ "**3.2.2 Display at power-on**"
- When the initialization command "*RST" has been entered

The initial settings and their initial values are described below in ☞ "**Table 3-1 Settings and Initial Values**"

Table 3-1. Settings and Initial Values

Setting		Setting range	Initial Value (Factory Setting, When Setting Lost, etc.)
Oscillator	Frequency	0.10 mHz to 100 kHz	1 kHz
	AC amplitude	0.000 to 7.07 Vrms (to 10.00 Vpeak)	10 mVrms
	DC bias	±10.00 V	0.00 V
Measurement	Integration time	0.01 to 999.99 s	0.02 s
	Integration cycle	1 to 999 cycles	1 cycle
	Delay time	0.00 to 999.99 s	0.00 s
Sweep	Frequency axis	Log/linear	Log
	Upper limit frequency	0.11 mHz to 100.00 kHz	100 kHz
	Lower limit frequency	0.10 mHz to 99.999 kHz	1 Hz
	Frequency points	3 to 1,000	100
Input weighting	CH1 weight coefficient	±1.00000E + 06	+1.00000E + 00
	CH2 weight coefficient	±1.00000E + 06	+1.00000E + 00
	CH3 weight coefficient	±1.00000E + 06	+1.00000E + 00
	CH4 weight coefficient	±1.00000E + 06	+1.00000E + 00
Maximum input detection	Detection level CH1	0.01 to 19.99 Vrms	19.99 Vrms
	Detection level CH2	0.01 to 19.99 Vrms	19.99 Vrms
	Detection level CH3	0.01 to 19.99 Vrms	19.99 Vrms
	Detection level CH4	0.01 to 19.99 Vrms	19.99 Vrms
	Response	ERROR lamp is on. Beep sounds. Sweep stops. Oscillator is off.	ERROR lamp is on.
Spot measurements	CH2/CH1 accept/reject gain upper limit	±199.99 dB	199.99 dB
	CH3/CH1 accept/reject gain upper limit	±199.99 dB	199.99 dB
	CH4/CH1 accept/reject gain upper limit	±199.99 dB	199.99 dB
	CH2/CH1 accept/reject gain lower limit	±199.99 dB	–199.99 dB
	CH3/CH1 accept/reject gain lower limit	±199.99 dB	–199.99 dB
	CH4/CH1 accept/reject gain lower limit	±199.99 dB	–199.99 dB
	CH2/CH1 accept/reject phase upper limit	±180.00 deg	180.00 deg
	CH3/CH1 accept/reject phase upper limit	±180.00 deg	180.00 deg
	CH4/CH1 accept/reject phase upper limit	±180.00 deg	180.00 deg
	CH2/CH1 accept/reject phase lower limit	±180.00 deg	–180.00 deg
	CH3/CH1 accept/reject phase lower limit	±180.00 deg	–180.00 deg
	CH4/CH1 accept/reject phase lower limit	±180.00 deg	–180.00 deg
Output on/off		Off/On	Off

3.3 I/O Terminals

3.3.1 Oscillator's output terminal

The following are the main specifications for oscillator output terminal OSCILLATOR.

Maximum output voltage:	±10 V/open, ±5 V/50 Ω
Output impedance:	50 Ω, unbalanced The voltage applied to the load varies according to the load impedance.
Maximum output current:	±100 mA When output is short-circuited and the DC bias is 0 V, setting the AC amplitude to approximately 3.5 Vrms (5 Vpeak) will allow the output current to reach this maximum allowable value.

⚠ CAUTION

Do not connected any load that exceeds the maximum output current and do not apply any signal from an external source.
This may damage the FRA5014.
If the maximum output current is exceeded, the ERROR lamp may go on.

■ **Output voltage restriction**

If the composite voltage from the AC amplitude and DC bias settings exceeds ±10 V/open, output clipping may occur.

■ **Output when power is off**

When the power has been turned off or during the period between power-on and measurement-ready status, the output terminal is cut off the internal oscillator, with termination resistance of 50 Ω. When the power is turned on or off, the output terminal briefly returns to open status.

⚠ CAUTION

Do not apply signals from an external source, even when the power is off.
If voltage exceeding 5 V is applied, the FRA5014 may be damaged.

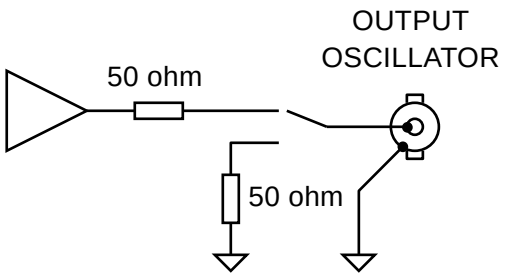


Figure 3-3. Oscillator's Output Terminal

When the oscillator is off, the output voltage goes to 0 V but the output terminal is not cut off from the internal circuits.

3.3.2 Analyzer's input terminals

The main specifications for analyzer inputs CH1, CH2, CH3 and CH4 are described below.

Input impedance:	1 MΩ, parallel 120 pF
Test voltage range:	±10 V
Nondestructive maximum input voltage:	±24 V

⚠ CAUTION

Do not apply any signal that exceeds the nondestructive maximum input voltage.
Doing so may damage the FRA5014.

■ **Input when power is off**

When the power has been turned off or during the period between power-on and measurement-ready status, the input terminal is cut off from the internal circuits, including the external conductor (ground), and is set as open.

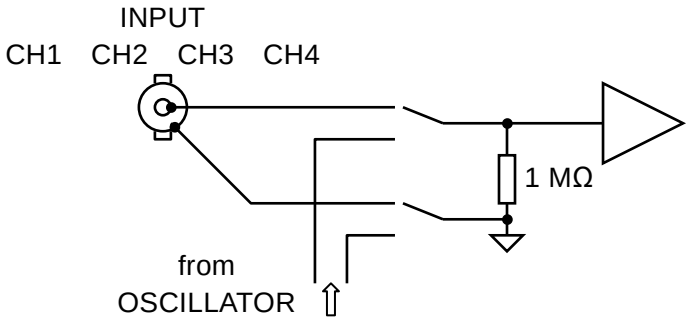


Figure 3-4. Analyzer's Input Terminals

■ **Operations during overload input**

The ERROR lamp on the front panel goes on when an input signal exceeds the measurement range (±10 V) or when the voltage in any channel exceeds the overload input detection voltage setting. Output of a beep warning can be set to occur when operating with overload input. The ERROR lamp will not go off and beep sounds will not stop automatically even when the overload input is stopped. To clear the error status, enter the remote command "SYST:OVER:REL".

3.3.3 Isolation of signal terminals

The oscillator output OSCILLATOR and analyzer inputs CH1, CH2, CH3, and CH4 are each insulated from the case.

The dielectric insulation voltage between parts is 42 Vpk.

OSCILLATOR, CH1, CH2, CH3, CH4
BNC connector

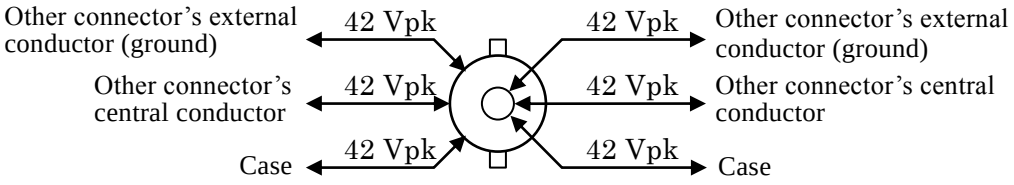


Figure 3-5. Dielectric Insulation Voltage of I/O Terminals

⚠ CAUTION

Do not apply any signal exceeding 42 Vpk between insulated parts.
Doing so may damage the FRA5014.

3.4 I/O Connections

Set the connections between the FRA5014 and the system under test as illustrated below. When a signal is applied from the oscillator's output OSCILLATOR to the system under test, the transfer functions (gain/phase frequency response) is measured between paired points A & B, A & C and A & D in the system under test.

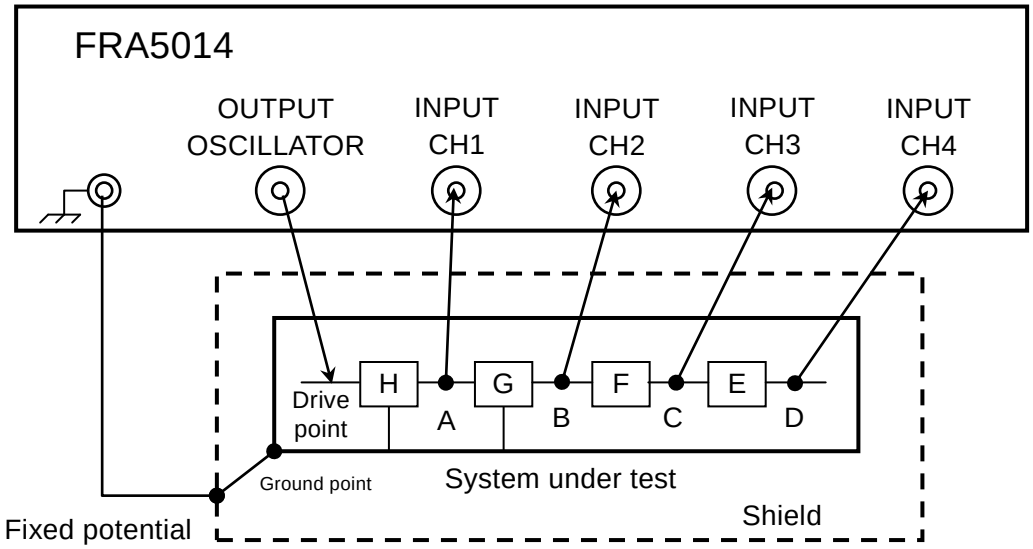


Figure 3-6. Connections with System Under Test

The grounding terminal on the FRA5014's rear panel can be used to ground or shield the system under test.

3.5 Basic Operations

3.5.1 Sweep measurements

During a sweep measurement, a frequency sweep is performed and the gain and phase are measured between CH2 & CH1, CH3 & CH1 and CH4 & CH1, based on CH1.

The main sweep settings are listed below.

- AC amplitude
- DC bias
- Measurement frequency upper limit
- Measurement frequency lower limit
- No. of sweep measurement points
- Sweep measurement frequency axis
- Measurement delay time
- Integration time
- Integration cycle

Setting example

*RST	← Initializes
VOLT 1	← Sets AC amplitude as 1 Vrms
VOLT:OFFS 0	← Sets DC offset as 0 V
SWE:MAX 100 kHz	← Sets measurement frequency upper limit as 100 kHz
SWE:MIN 10 Hz	← Sets measurement frequency lower limit as 10 kHz
SWE:SPAC:POIN 100	← Sets number of sweep measurement points as 100 points
SWE:SPAC LOG	← Sets sweep frequency axis as logarithmic axis
MEAS:DEL 0	← Sets time between changing oscillation frequency and starting measurement as 0 seconds
MEAS:INT:TIME 0.1	← Sets integration time as 0.1 second
MEAS:INT:CYC 10	← Sets integration cycles as 10 cycles

(The actual integration time (cycle) is the larger between the set integration time and the integration cycle, and is set as an integer cycle period.)

VOLT:OUTP 2 ← Sets oscillator output as on

* When oscillator output is on, the oscillator's output setting is reflected in the actual output voltage. When the oscillator's voltage setting is changed, enter the remote command to turn oscillator output on so that it will be reflected in the actual output voltage.

Measurement example

SWE:MEAS DOWN	← Sets the sweep measurement down, from the measurement frequency upper limit toward the measurement frequency lower limit
SENS:DATA:SWE?	← Reads measurement data

(The MEASURE lamp is on during measurement. When the measurement is completed and the MEASURE lamp goes off, read out the measurement data.)

After entering a remote command, set the unit to Talker.

For details, see ☞ "**5.4 Command Descriptions**"

3.5.2 Spot measurements

With spot measurements, one specified frequency point is measured, then its gain and phase are measured for channel pairs CH2 & CH1, CH3 & CH1 and CH4 & CH1. Also, spot measurement enables measurement result data to be read in complex formats.

The main spot measurement settings are listed below.

- AC amplitude
- DC bias
- Measurement frequency
- Measurement delay time
- Integration time
- Integration cycle

Setting example

*RST	← Initializes
VOLT 1	← Sets AC amplitude as 1 Vrms
VOLT:OFFS 0	← Sets DC offset as 0 V
FREQ 10 kHz	← Sets measurement frequency as 10 kHz
MEAS:DEL 0	← Sets time between changing oscillation frequency and starting measurement as 0 seconds
MEAS:INT:TIME 0.1	← Sets integration time as 0.1 second
MEAS:INT:CYC 10	← Sets integration cycles as 10 cycles

(The actual integration time (cycle) is the larger between the set integration time and the integration cycle, and is set as an integer cycle period.)

VOLT:OUTP 2 ← Sets oscillator output as on

Measurement example

SWE:MEAS SPOT ← Runs the spot measurement

SENS:DATA:SPOT? ← Reads measurement data

(The MEASURE lamp is on during measurement. When the measurement is completed and the MEASURE lamp goes off, read out the measurement data.)

After entering a remote command, set the unit to Talker.

For details, see ☞ "**5.4 Command Descriptions**"

3.5.3 Measurement values during overload input

When the input signal to any of the analyzer's channels exceeds the measurement range (±10 V), the measured gain value is shown as the FRA5014's maximum display value. Specifically, the following measurement values are set.

- Gain (dB) +199.99 dB
- Phase 0.00 deg

When overload input occurs in channel 1, the measurement values become as shown above. If overload input occurs in channel 2, 3 or 4, the measurement values become as shown above only for the channel with overload input.

4. ADVANCED OPERATIONS

4.1 Accept/Reject Criteria

During spot measurements, auto judgments are made as to whether or not the measured gain (dB) and/or phase value is within the designated range, and the results can be output.

4.1.1 Accept/Reject range settings

To perform accept/reject judgments, set upper and lower limit values as accept/reject criteria for each channel.

When lower limit ≥ upper limit, no judgment is performed.

■ **Accept/Reject Gain upper limit Gain lower limit**

Range of values −199.99 to 199.99 dB, resolution is 0.01 dB

Gain judgment upper limit

Set this using the remote command "SENS:DATA:SPOT:LIM:GAIN:MAX parameter 1, parameter 2, parameter 3".

Parameter 1: Sets gain judgment upper limit for CH2 & CH1.

Parameter 2: Sets gain judgment upper limit for CH3 & CH1.

Parameter 3: Sets gain judgment upper limit for CH4 & CH1.

Gain judgment lower limit

Set this using the remote command "SENS:DATA:SPOT:LIM:GAIN:MIN parameter 1, parameter 2, parameter 3".

Parameter 1: Sets gain judgment lower limit for CH2 & CH1.

Parameter 2: Sets gain judgment lower limit for CH3 & CH1.

Parameter 3: Sets gain judgment lower limit for CH4 & CH1.

■ **Accept/Reject Phase upper limit Phase lower limit**

Range of values −180.00 to 180.00 deg, resolution is 0.01 deg

Phase judgment upper limit

Set this using the remote command "SENS:DATA:SPOT:LIM:PHAS:MAX parameter 1, parameter 2, parameter 3".

Parameter 1: Sets phase judgment upper limit for CH2 & CH1.

Parameter 2: Sets phase judgment upper limit for CH3 & CH1.

Parameter 3: Sets phase judgment upper limit for CH4 & CH1.

Gain judgment lower limit

Set this using the remote command remote command "SENS:DATA:SPOT:LIM:PHAS:MIN parameter 1, parameter 2, parameter 3".

Parameter 1: Sets phase judgment lower limit for CH2 & CH1.

Parameter 2: Sets phase judgment lower limit for CH3 & CH1.

Parameter 3: Sets phase judgment lower limit for CH4 & CH1.

4.2 Servo System Measurements

With the FRA5014's oscillator inserted in a control loop, servo system loop gain Aβ is able to be determined by measuring the previous and subsequent signals V_1 and V_2.

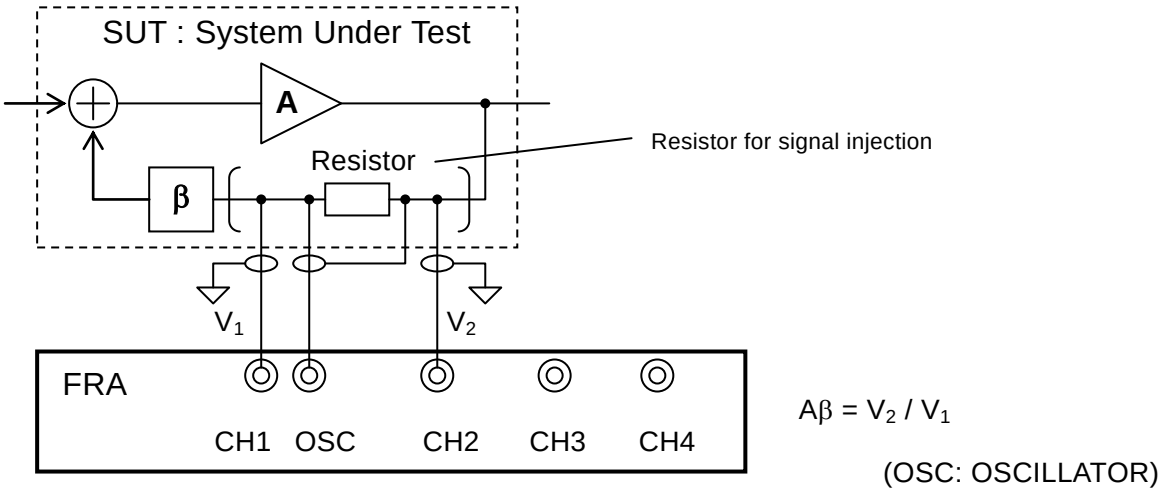


Figure 4-1. Connections for Servo System Measurement

⚠ WARNING

- If the control loop is cut off, a large output may occur, which could damage the system under test and/or pose hazards for users. Always use a signal injection resistor so that the control loop is not left open when the FRA5014's oscillator is disconnected. This resistor should be attached securely so it does not come loose.

- If the injected signal's level (AC amplitude, etc.) becomes too high, a large output may occur, which could damage the system under test and/or pose hazards for users. To ensure safety, always start with a low signal level and raise it gradually.

- When connected to the FRA5014, the system under test may have abnormal operations due to oscillation, etc. The analyzer's input and the oscillator's output each have several hundreds pF of floating capacitance (capacitance with the case), and when combined with the floating capacitance of the connecting cable, it can cause instability in the system under test.

⚠ CAUTION

The FRA5014's maximum output current is ±100 mA.
Unless there is a major impact on the characteristics of the system under test, the signal injection resistor that is inserted into the circuit should be rated at 50 Ω or higher. During measurements, a value that is parallel to this resistance value and the oscillator's output resistance (50 Ω) is inserted into the control loop. If inserting a lower resistance value, set the AC amplitude and/or the DC bias to keep from exceeding the maximum output current. A safe setting is one that prevents the combined peak value from exceeding ±5 V.

If the injected signal level is set low to help ensure stable operations, noise may cause variation in the measurement results. In such cases, split up the frequency range into multiple ranges and set the optimum signal level for each range in order to achieve a balance beteen the reliability and measurements and the stability of operations.

■ Handling system under test when floating

When a system under test is not connected to the ground, the potential of the signal ground fluctuates, the FRA5014's dielectric insulation voltage may be exceeded or common mode noise may occur, which can adversely affect measurements. If this is suspected, use an oscilloscope (etc.) to check the signal ground's potential.

Fluctuation at high frequencies can be reduced by connecting the system under test via a bypass capacitor.

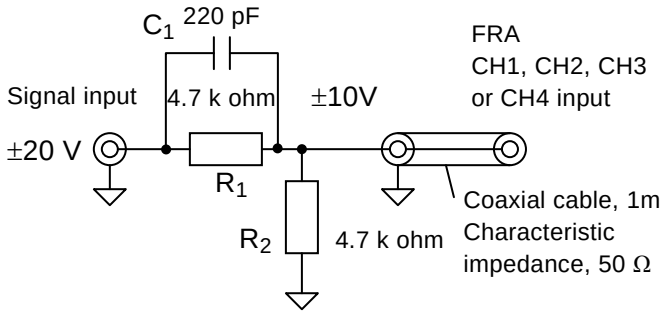
⚠ WARNING

The dielectric insulation voltage of the FRA5014's signals is 42 Vpk.

If it appears that this range may be exceeded, ground the system under test's signal ground, either directly or via an appropriate amount of impedance, to keep within this range during use. Any voltage limiting element can be used as the impedance element, such as a resistor or varistor.

■ Expansion of measurement voltage range

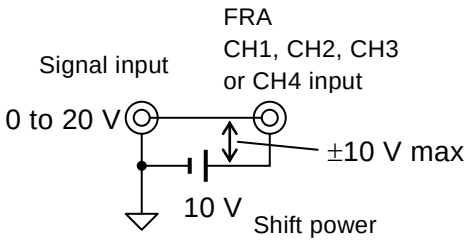
The FRA5014's built-in oscillator has 42 Vpk of dielectric insulation voltage relative to the case. This means that in a circuit where the potential is about ±40 V, signals can be injected directly. By contrast, the analyzer's input voltage range is limited to ±10 V. If the signal exceeds this range, direct measurements become impossible. Even in these cases, measurements can be enabled by attenuating the signal or by shifting the analyzer's ground potential to an external circuit. When attenuating the signal, the signal's attenuation and its frequency response must be corrected.



The amount of error can be reduced by setting the signal source impedance adequately low and having a parallel value of R_1 and R_2 that is no more than a few kΩ.

To change the attenuation rate, set $C_1 R_1 \cong R_2 C_2$. Here, C_2 = cable's capacitance + FRA's input capacitance. If the connecting cable is a 50 Ω coaxial cable (1 m), then C_2 = approximately 220 pF.

As the parallel value of R_1 and R_2 increases, so does the frequency, and the error rate becomes greater. When using an attentuator, evaluate its overall precision carefully.



For the shift power, use a battery (etc.) that has a low internal resistance.

When there is a large gap among signal levels, a shift power supply should be set up for each channel to prevent interference between channels.

The original voltage should not be applied anywhere that exceeds the FRA5014's nondestructive maximum input voltage of ±24 V.

Figure 4-2. Examples of Expanded Measurement Voltage Range

5. REMOTE CONTROL

5.1 Preparations for Use

The FRA5014 can be remotely controlled via a GPIB, USBTMC (TMC: Test and Measurement Class), or RS-232 interface. Control can be exercised by sending program messages from a controller, or by receiving response messages regarding measured values, settings, etc.

- For the GPIB, USB, and RS-232 interfaces, it is assumed that a good environment will be used. Avoid using these interfaces in very noisy environments.

5.1.1 USB setup

Install a USBTMC class driver in the computer to be controlled and connect the computer using the commercially available USB cable. This driver's installation file can be downloaded from the National Instruments Corporation web site. The operation steps for installing the driver are shown below.

1) Go to the National Instruments Corporation web site and either search for the "VISA Run-time Engine" page or go to the following URL and select "VISA driver downloads".
   http://www.ni.com/support/visa/

2) Download the VISA Run-time Engine from the VISA Run-time Engine page at the above website. User registration will be required at that time. Also, make sure the downloaded VISA Run-time Engine is Ver. 3.3 or a later version.

3) The downloaded file is a self-extracting file. After it is extracted, install this file.

4) When installation is completed normally, a USBTMC class driver has been installed.

The above information was current when this manual was written. For more details, see the National Instruments Corporation web site. Note that the web site address and the services described therein are subject to change.

5.1.2 GPIB setup

Insert a GPIB card or controller board into the computer to be used for control, and connect using a commercially available GPIB cable. For more details, see the user's manual for the GPIB card or controller board to be used.

5.1.3 RS-232 setup

Like the GPIB and USBTMC, the RS-232 interface is externally controlled, except for functions that are specific to the GPIB and USBTMC.

1) GPIB functions that are not in RS-232

- Interrupt to controller and serial polling upon service request
  Use "*STB?" to query the contents of the status byte register.
- GPIB-specific commands such as device clear
- Connections to multiple devices
  Only 1-to-1 connections is possible with RS-232.

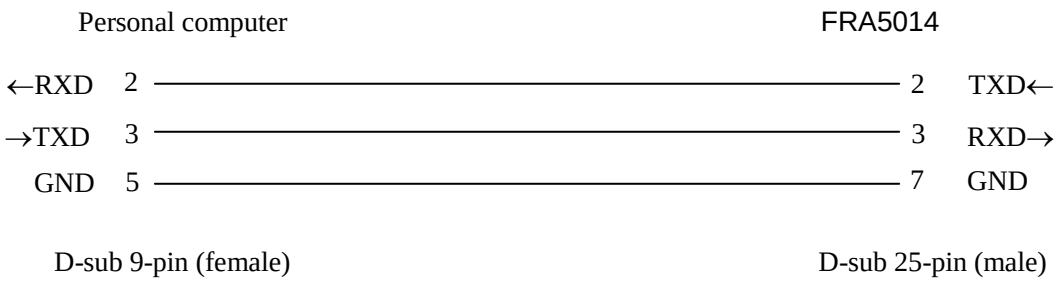
2) Specifications

- Parity None, even or odd
- Stop bits 1 bit or 2 bits
- Baud rate 1200, 4800, 9600, or 38400
  Data has fixed length of 8 bits, flow control is fixed as xon/xoff

3) Connection with personal computer

Use a reverse connection type RS-232 cable to connect the FRA5014 to the personal computer's D-sub 9-pin serial connector.

Connection diagram



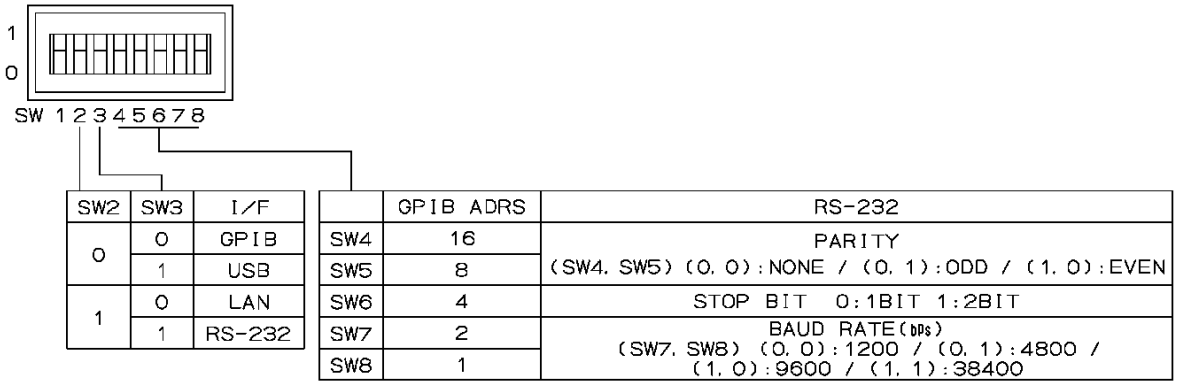
Reverse connection type RS-232 cable

* Do not connect to terminals that are not shown above.

* LAN connections are enabled when using an RS-232/Ethernet converter (such as Lantronix general-purpose device server UDS1100).

5.1.4 Selection of remote control interface

For the FRA5014, select GPIB, USBTMC or RS-232 as the remote control interface. Only one of these can be used at a time. Use the DIP switches on the rear panel to select the interface and the communication settings. The factory setting for the DIP switches is that only SW7 is set to 1, and all other switches are set to 0 (GPIB address 2).



SW2	SW3	I/F
0	0	GPIB
	1	USB
1	0	LAN
	1	RS-232

	GPIB ADRS
SW4	16
SW5	8
SW6	4
SW7	2
SW8	1

RS-232
PARITY (SW4, SW5) (0, 0) : NONE / (0, 1) : ODD / (1, 0) : EVEN
STOP BIT 0 : 1BIT 1 : 2BIT
BAUD RATE(bps) (SW7, SW8) (0, 0) : 1200 / (0, 1) : 4800 / (1, 0) : 9600 / (1, 1) : 38400

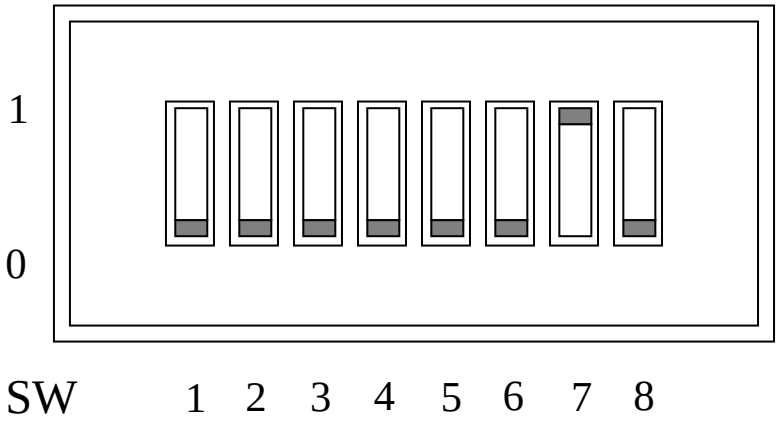
Figure 5-1. DIP Switches on Rear Panel

The "SW2 = 1, SW3 = 0" setting (LAN) is reserved internally. Do not use this setting.

(Example 1)

- Interface GPIB
- GPIB address 2

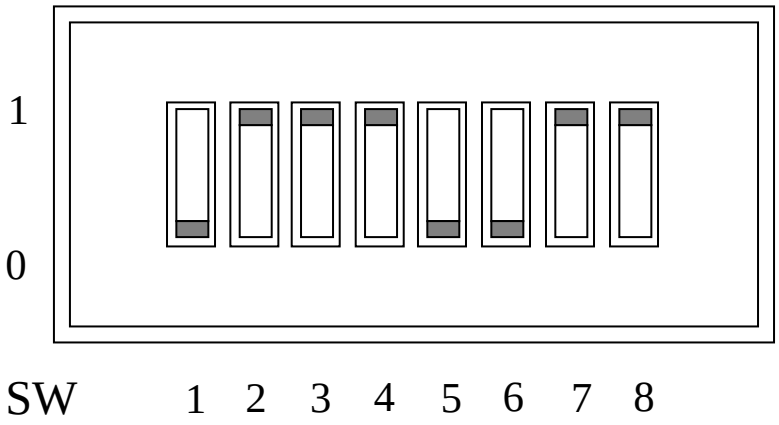
  Set SW1 to SW6 and SW8 to "0" and SW7 to "1".



(Example 2)

- Interface RS-232
- Parity Even
- Stop bit 1
- Baud rate 38400

Set SW1, SW5, and SW6 to “0” and SW2, SW3, SW4, SW7 and SW8 to “1”.



5.1.5 Identification of USB devices

When the FRA5014 is connected via a USB interface to a computer in which a USBTMC class driver has been installed, the FRA5014 is automatically recognized. The FRA5014 in a system can be identified according to the following parameters.

- Vendor No. (Vendor ID): 3402 (0x0D4A) Indicates NF Corporation
  Expressed in decimal (hexadecimal) notation
- Product number (Product ID): 18 (0x0012) Indicates FRA5014
- Serial number (Serial): Manufacturer’s number Unique number for each serial number product unit

Serial number (manufacturer’s number) can be identified by the serial number label on the rear panel.

5.1.6 GPIB address setting

With GPIB, an address specific to each device in the system is used to identify devices. Set a unique GPIB address to each device. The FRA5014’s GPIB address is set via the rear panel’s DIP switches.

Range of values: 0 to 30
(If an address of 31 or higher is set, operations assume it is 30.)

5.1.7 GPIB use precautions

- Turn off the power to all connected devices before attaching or removing the GPIB connector.
- When using the GPIB, turn on the power to all devices that are connected to the bus.
- Up to 15 devices (including the controller) can be connected to the bus via the GPIB.
  The following cable length restrictions apply.
  - Total cable length: ≤ (2 m × number of devices or 20 m, whichever is shorter)
  - Length of one cable ≤ 4 m
- Set a unique GPIB address to each device. If two or more devices that have the same address are connected to the same bus, the devices may be damaged.

5.2 Command Lists

The FRA5014's commands are broadly divided into common commands defined by IEEE488.2 and subsystem commands that support device-specific functions.

Table 5-1 lists the FRA5014's subsystem commands. The common commands supported by the FRA5014 are listed in Table 5-2. The symbols used in Table 5-1 and Table 5-2 are explained below. The parts of key words shown in lowercase letters can be omitted.

- A query command ends with a question mark (?). In the command lists, "query" is omitted in cases where both a setting and a query are enabled.
- Square brackets ([ ]) indicate key words that can be omitted (implicit key words).
- A vertical bar (|) indicates when one of several key words is selected.

Table 5-1. FRA5014 Subsystem Command List (1/2)

Function	Command
	CALibration subsystem
Self calibration	:CALibration[:ALL]?
	INPut subsystem
Overload input detection level	:INPut(1|2|3|4):VOLTage:OVERload[:LEVel]
Processing during overload input	:INPut:VOLTage:OVERload:RESPonse
Input weighting	:INPut:GAIN
	MEASure subsystem
Measurement delay time	:MEASure:DELay[:TIME]
Integration cycle	:MEASure:INTegrate:CYCle
Integration time	:MEASure:INTegrate:TIME
	SENSE subsystem
Read sweep measurement data	:SENSe:DATA:SWEep[:DATA][:ALL]?
Select and read sweep measurement data	:SENSe:DATA:SWEep[:DATA]:SELected?
Read sweep measurement points	:SENSe:DATA:SWEep:POINt?
Read spot measurement data	:SENSe:DATA:SPOT[:DATA][:ALL]?
Read spot measurement data in complex format	:SENSe:DATA:SPOT[:DATA]:COMPlex?
Select and read spot measurement data	:SENSe:DATA:SPOT[:DATA]:SELected?
Spot gain judgment upper limit	:SENSe:DATA:SPOT:LIMit:GAIN:MAXimum
Spot gain judgment lower limit	:SENSe:DATA:SPOT:LIMit:GAIN:MINimum
Spot phase judgment upper limit	:SENSe:DATA:SPOT:LIMit:PHASe:MAXimum
Spot phase judgment lower limit	:SENSe:DATA:SPOT:LIMit:PHASe:MINimum
Read spot judgment results	:SENSe:DATA:SPOT:LIMit:REPort[:ALL]?
Select and read spot judgment results	:SENSe:DATA:SPOT:LIMit:REPort:SELected?
	SOURce subsystem
Oscillator frequency	[:SOURce]:FREQuency[:IMMediate]
Measurement operations	[:SOURce]:SWEep:MEASure
Sweep frequency axis format	[:SOURce]:SWEep:SPACing[:TYPE]
Sweep frequency points	[:SOURce]:SWEep:SPACing:POINt
Sweep upper limit frequency	[:SOURce]:SWEep[:LEVel]:MAXimum
Sweep lower limit frequency	[:SOURce]:SWEep[:LEVel]:MINimum
Oscillation frequency	[:SOURce]:VOLTage:OUTPut[:STATe]
Measurement operations	[:SOURce]:VOLTage:OFFSet[:IMMediate]
Oscillator AC amplitude	[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]
AC amplitude unit	[:SOURce]:VOLTage:UNIT

Table 5-1. FRA5014 Subsystem Command List 2/2

Function	Command
	STATus subsystem
Operation condition register	STATus:OPERation:CONDition?
Operation event enable register	STATus:OPERation:ENABle
Operation event register	STATus:OPERation[:EVENt]?
Operation transition filter (1→0)	STATus:OPERation:NTRansition
Operation transition filter (0→1)	STATus:OPERation:PTRansition
Overload event enable register	STATus:OVERload:ENABle
Overload event register	STATus:OVERload[:EVENt]?
	SYSTem subsystem
Query error	SYSTem:ERRor?
Release error	SYSTem:OVERload:RELease

Table 5-2. Common Command List

	Name	Function
*CLS	Status command clear	Clears status data
*ESE	Standard event status enable command/query	Sets/queries standard event status enable register.
*ESR?	Standard event status register query	Queries standard event status register.
*IDN?	Identification query	Queries device's ID information (model name, etc.).
*OPC	Operation complete command/query	Specifies that "1" is set to OPC bit in standard event status register when all overlap command processing has been completed. When queried, a "1" is returned when all processing has been completed.
*RCL	Recall command	Switches setting according to data in setting memory.
*RST	Reset command	Resets device, sets output to OFF, and returns the measurement settings to their initial values.
*SAV	Save command	Copies currently used settings to setting memory.
*SRE	Service request enable command/query	Sets/queries contents of service request enable register.
*STB?	Status byte query	Queries status byte.
*TST?	Self test query	Queries self test results. * In the FRA5014, the response is always "0".
*WAI	Wait to continue command	Execution of subsequent commands is held pending until all overlap commands have been executed.

Input buffer

- Commands can be sent all at once up to the input buffer's capacity (approximately 4,000 characters).
- After being sent, commands are temporarily stored in the input buffer, then are successively interpreted (parsed) and executed.
- If an illegal command is found during interpretation or execution, subsequent commands are not executed.
- When interpretation and execution are completed, the input buffer is cleared, so that the next command can be input.

Device clear

The following functions clear devices (DCL or SDC) for interface functions.

- Input buffer clear
- Output wait queue clear
- Overlap command completion wait release (using *WAI, *OPC, or *OPC?)

* The RS-232 does not have any device clear functions.

5.3 Command Tree

Figure 5-2 below shows the FRA5014's subsystem command tree.

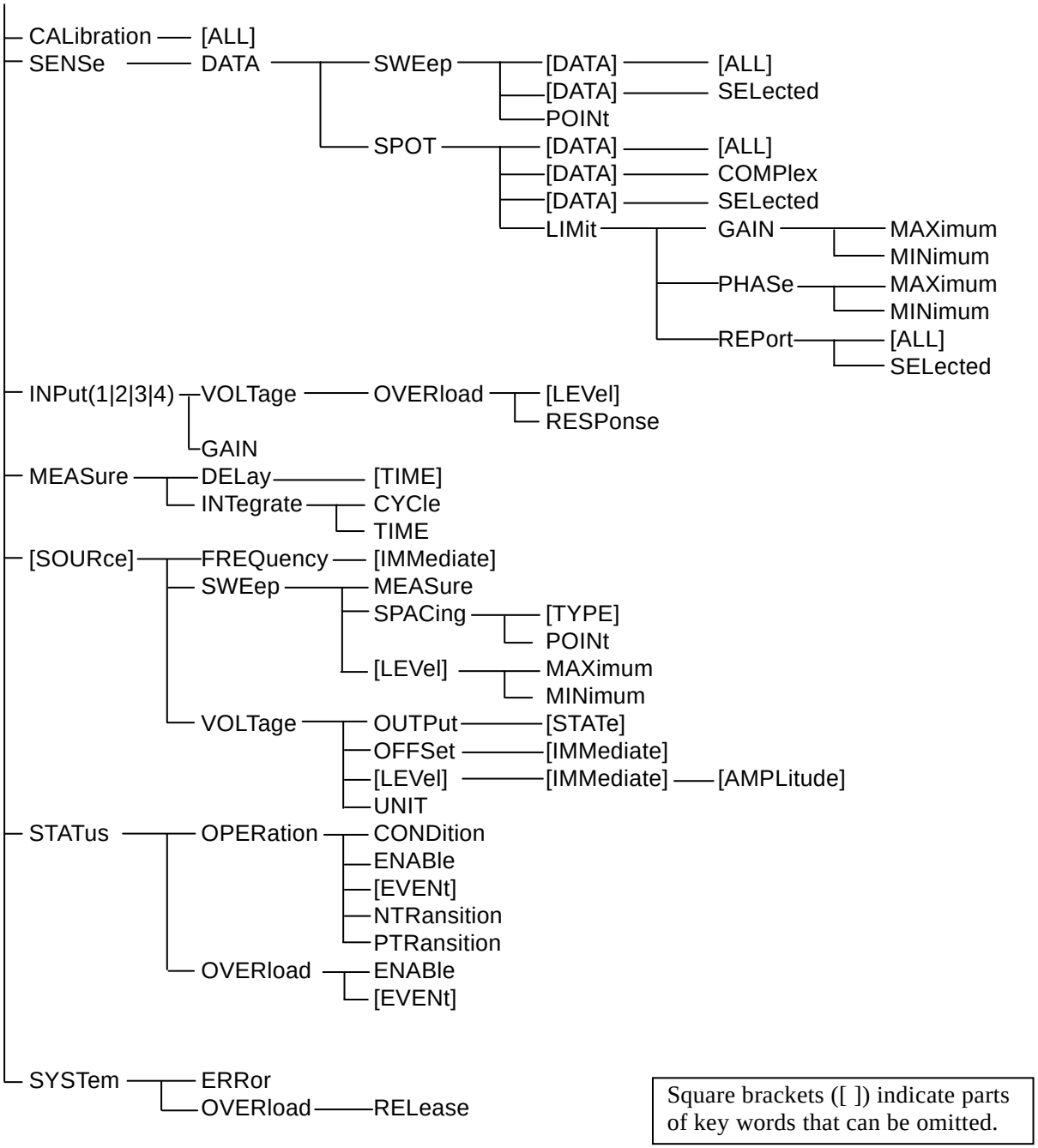


Figure 5-2. Command Tree

5.4 Command Descriptions

5.4.1 Overview of programming language

The programming language is described briefly below.

5.4.1.1 Subsystem commands

Commands are divided into several groups, based on their functions. Subsystem commands are hierarchical, and are defined using a colon (**:**) as the path separator.

5.4.1.2 Path separator

The path separator (**:**) separates the current key word from the key word at the next lower level. In a command string, each time a colon (**:**) is detected, the current path is shifted one level downward. However, if a colon (**:**) is used at the start of a command string, it means that the current path is set as the root. These leading colons (**:**) can be omitted.

```
:MEAS:DEL 999.99
↑   ↑      ↑  ↑
<1> <2>    <3><4>
```

<1> Sets current path as root

<2> MEASure subsystem command (MEASure is the root command)

<3> DELay command that belongs to MEASure subsystem

<4> A space is required between the header and parameter

When a semicolon (;) is used as a separator in a command string, access to subsystem commands on the same level is enabled, without having to change the current path.

5.4.1.3 Simplification of command strings

In this instruction manual, when the command syntax is described, uppercase letters are mixed with lowercase letters in a command (and in some parameters). Uppercase letters are used in abbreviated (short-form) commands. When the part shown in lowercase letters is omitted in a command, the command is still interpreted as if it includes the lowercase letters (i.e., as a long-form command). It is not possible to use an intermediate form that includes only some of the lowercase letters.

This distinction between uppercase and lowercase letters is a convenient method for indicating the short form, but the actual devices do not make this distinction. Uppercase and lowercase letters can be mixed in any order.

Example) :SYSTem:ERRor?→	system:error?	“Acceptable” (lowercase letters)
	SYSTEM:error?	“Acceptable” (mixed uppercase and lowercase letters)
	SYSTE:ERROR?	“Not acceptable” (intermediate form)
	SYST:ER?	“Not acceptable” (overly abbreviated)

5.4.1.4 Implicit key words

Key words shown in square brackets ([ ]) are implicit key words, which can be omitted. The device's operation is the same whether or not the implicit key words are omitted. In the example below, both specifications enter the same setting for the device.

Example) [:SOURce]:FREQuency:SWEep[:LEVel]:MAXimum
→ :SOUR:FREQ:SWE:LEV:MAX 12.3 kHz
:FREQ:SWE:MAX 12.3 kHz

5.4.2 Detailed description of commands

The following describes the functions and command syntax of commands listed in "**Table 5-1. FRA5014 Subsystem Command List**" and "**Table 5-2 Common Command List**".

[Meaning of symbols]

- Square brackets ([ ]) indicate key words that can be omitted. (Implicit key words)
- Curly brackets ({ }) indicate parameters in command strings.
- Vertical bars (|) two or more selectable key words.
- Angle brackets (< >) indicate when a parameter (numerical value, text string, etc.) must be specified.

[Parameter data format]

Symbol	Format	Example
<NR1>	Integer (numerical value)	123
<NR2>	Decimal point format without exponent part (numerical value)	0.072
<NR3>	Decimal point format with exponent part (numerical value)	4.99E+06
<CRD>	Strings	ALL
<SRD>	Strings enclosed in double quotation marks	"No error"
<bool>	Logical value	1, ON, etc.

For settings:

- Numerical value data is accepted in any format (rounded to appropriate values).
- Text data enclosed by quotation marks is accepted, regardless of whether they are single or double quotation marks.

[Remarks]

- In this manual, both commands and queries are referred to as commands.
  When a question mark (?) is included with a key word, it indicates a query.
- Headers do not come with command response messages.
- When a response message's data format includes the text string <CRD>, the response message is in an abbreviated form (short form).

5.4.2.1 Common commands

***CLS**

Description	Clears the status of the following. Standard event status register Operation event register Overload event register Status byte … ☞ Note (see below) Error queue
Parameters	None
Use example	*CLS

Note: The *CLS command does not directly clear the status byte register. However, the status byte is indirectly cleared, except for the MAV bit and RQS bit within that byte. The MAV bit can be indirectly cleared by clearing the input buffer with a device clear command. The RQS bit can be cleared by a serial polling operation to read the status.

***ESE <std_event_enable>**

Description	Sets or queries contents of the standard event status enable register.
Parameter	<std_event_enable> Register contents, format <NR1>, range 0 to 255 For details, … ☞ "**5.5.3 Standard event status**"
Use example	*ESE 255
Response	<std_event_enable>
Query example	*ESE?
Response example	255

***ESR?**

Description	Queries contents of the standard event status register. When queried, all bits of the standard event status register are cleared to 0.
Parameters	None
Response	Register contents, format <NR1>, range 0 to 255 For details, ☞ "**5.5.3 Standard event status**"
Query example	*ESR?
Response example	128

***IDN?**

Description	Queries model name, etc.
Parameters	None
Response	"Manufacturer name, model name, serial number, firmware version, format <SRD>"
Query example	*IDN?
Response example	"NF Corporation,FRA5014,9025257,Ver1.00"

***OPC**

Description	Specifies that "1" will be set to the OPC bit (BIT0) in the standard event status register when execution of all overlap commands is complete. Overlap command … ☞ Description of *WAI command
Parameters	None
Setting example	*OPC
Response	Format <NR1> "1" is returned when all overlap commands have been completed. However, executing *OPC? does not clear the OPC bit in the standard event status register. Use a device clear, *CLS, or *RST command to clear this register.
Query example	*OPC? (Use example: overlap command ; *OPC? <PMT> In this case, PMT: Program Message Terminator)
Response example	1

***RCL <setting_memory>**

Description	Switches to (recalls) the data stored in setting memory for the settings to be measured.
Parameter	<setting_memory> memory number, format <NR1>, range 0
Setting example	*RCL 0

***RST**

Description	Resets the device, turns output off, and returns measurement-related parameters to their initial values (full initialization). For details, … ☞ "**Table 3-1 Settings and Initial Values**"
Parameters	None
Setting example	*RST

***SAV <setting_memory>**

Description	Copies (saves) the currently used settings to the specified setting memory.
Parameter	<setting_memory> Memory number, format <NR1>, range 0
Setting example	*SAV 0

***SRE <srq_enable>**

Description	Sets service request enable register.
Parameter	<srq_enable> Register contents, format <NR1>, range 0 to 255 For details, ☞ "**5.5.1 Overview of status system**"
Use example	*SRE 128
Response	<srq_enable>
Query example	SRE?
Response example	128

***STB?**

Description	Queries contents of the status byte register.
Parameters	None
Response	Register contents, format <NR1>, range 0 to 255 For details, … ☞ "**5.5.2 Status byte**"
Query example	*STB?
Response example	128

***TST?**

Description	Queries the self test results.
Parameters	None
Response	The FRA5014 always returns a '0". Format <NR1>
Query example	*TST?
Response example	0

***WAI**

Description	Makes execution of subsequent commands held pending until all overlap commands have been executed. See the description below.
Parameters	None
Use example	*WAI

■ Overlap command and sequential command

A command such that subsequent commands can be executed while the current command is being executed is referred to as an overlap command.

A command such that subsequent commands can be executed only after the current command has been completed is referred to as a sequential command.

The following command is an overlap command. All commands except for this one are sequential commands.

[:SOURce:]SWEep:MEASure

Use the *WAI command or the *OPC or *OPC? command when there is no need to execute a subsequent command before execution of an overlap command is completed.

Example) Overlap command 1; overlap command 2; *WAI; subsequent command <PMT>
In this case, PMT: Program Message Terminator

Any wait condition set by a *WAI command is cleared by a device clear operation.

5.4.2.2 Subsystem commands

:CALibration[:ALL]?

Description	Executes self calibration.
Parameters	None
Response	Format <NR1>, range 0/1 0: No errors, 1: Error
Use example	CAL?
Response example	0
Note:	Do not enter any other commands until self calibration is completed. Self calibration takes about one minute. Create the control program to cause a timeout to occur before the "self calibration complete" response message is received, so that processing does continue to entry of the next command. If another command is entered before self calibration is complete, subsequent operations may be abnormal. In such cases, once self calibration is completed, enter a device clear command to restore normal operations.

:INPut[1|2|3|4]:VOLTage:OVERload[:LEVel] <over_level>
:INPut[1|2|3|4]:VOLTage:OVERload[:LEVel]?

Description	Sets or queries the overload input detection level. At the start of this command, :INPut1 is specified for CH1, :INPut2 for CH2, :INPut3 for CH3, and :INPut4 for CH4. If the channel specification is omitted, :INPut: … is regarded as specifying CH1.
Parameter	<over_level> detection level, format <NR2>, range 0.01 to 19.99 [unit: Vrms]
Setting example	INP1:VOLT:OVER 3.00 Sets CH1's overload input detection level to 3.00 Vrms
Response	<over_level>
Query example	INP1:VOLT:OVER?
Response example	3.00

:INPut:VOLTage:OVERload:RESPonse <over_response>
:INPut:VOLTage:OVERload:RESPonse?

Description	Sets or queries the processing that occurs when an overload input is detected.	
Parameter	<over_response> Response	
	format <NR1>, range 0 to 5	0: Lamp
		1: Lamp & Beep
		2: Lamp & Beep & Stop
		3: Lamp & Beep & Stop & Off
		4: Lamp & Stop
		5: Lamp & Stop & Off
Setting example	INP:VOLT:OVER:RESP 1	
Response	<over_response>	
Query example	INP:VOLT:OVER:RESP?	
Response example	1	

:INPut:GAIN <gain_ch1>, <gain_ch2>, <gain_ch3>, <gain_ch4>

:INPut:GAIN?

Description	Sets or queries the input weighting coefficient for each channel. When the coefficient is a negative value, the phase is inverted.
Parameter	<gain_ch1> CH1 weight coefficient, <gain_ch2> CH2 weight coefficient, <gain_ch3> CH3 weight coefficient, <gain_ch4> CH4 weight coefficient, Format <NR3>, range –1.00000E + 06 to +1.00000E + 06, resolution is 6 digits or 0.01E – 09 (0 is not included)
Setting example	INP:GAIN 1.0, 0.5, 0.123e-3, -1.22e5
Response	<gain_ch1>, <gain_ch2>, <gain_ch3>, <gain_ch4>
Query example:	INPut:GAIN?
Response example	1.00000E + 00, 5.00000E – 01, 1.23000E – 01, –1.22000E + 05

:MEASure:DELay[:TIME] <delay>

:MEASure:DELay[:TIME]?

Description	Sets or queries the measurement delay time.
Parameter	<delay> measurement delay time, format <NR2>, range 0.00 to 999.99 [unit: s]
Setting example	MEAS:DEL 999.99
Response	<delay>
Query example	MEAS:DEL?
Response example	999.99

:MEASure:INTegrate:CYCle <integ_cycle>

:MEASure:INTegrate:CYCle?

Description	Sets or queries the integration cycle.
Parameter	<integ_cycle> integration cycle, format <NR1>, range 1 to 999 [unit: cycle]
Setting example	MEAS:INT:CYC 999
Response	<integ_cycle>
Query example	MEAS:INT:CYC?
Response example	999

:MEASure:INTegrate:TIME <integ_time>

:MEASure:INTegrate:TIME?

Description	Sets or queries the integration time.
Parameter	<integ_time> integration time, format <NR2>, range 0.01 to 999.99 [unit: s]
Setting example	MEAS:INT:TIME 999.99
Response	<integ_time>
Query example	MEAS:INT:TIME?
Response example	999.99

:SENSe:DATA:SPOT[:DATA][:ALL]?

Description	Outputs the spot measurement results.
Parameters	None
Response	<NR3>, <NR2>, <NR2>, <NR2>, <NR2>, <NR2>, <NR2>
	Frequency, CH2/CH1 gain, CH2/CH1 phase, CH3/CH1 gain, CH3/CH1 phase, CH4/CH1 gain, CH4/CH1 phase
Response example	SENS:DATA:SPOT?
	100.00E +03, –4.72, –118.62, –10.11, 90.02, –20.79, 151.32

:SENSe:DATA:SPOT[:DATA]:COMPlex?

Description	Outputs the spot measurement results in complex format data.
Parameters	None
Response	<NR2>, <NR3>, <NR3>, <NR3>, <NR3>, <NR3>, <NR3>
	Frequency, ch2 gain real part, ch2 gain imaginary part, ch3 gain real part, ch3 gain imaginary part, ch4 gain real part, ch4 gain imaginary part
Response example	100000.000000, –4.72345E +03, 1.23456E +00,…

:SENSe:DATA:SPOT[:DATA]:SELected? <freq>, <gain_ch2>, <phase_ch2>, <gain_ch3>, <phase_ch3>, <gain_ch4>, <phase_ch4>

Description	Outputs only the specified items (up to 7 items) of the spot measurement results.		
1st parameter	<freq>	Frequency output setting	0: No output / 1: Output
2nd parameter	<gain_ch2>	CH2/CH1 gain output setting	0: No output / 1: Output
3rd parameter	<phase_ch2>	CH2/CH1 phase output setting	0: No output / 1: Output
4th parameter	<gain_ch3>	CH3/CH1 gain output setting	0: No output / 1: Output
5th parameter	<phase_ch3>	CH3/CH1 phase output setting	0: No output / 1: Output
6th parameter	<gain_ch4>	CH4/CH1 gain output setting	0: No output / 1: Output
7th parameter	<phase_ch4>	CH4/CH1 phase output setting	0: No output / 1: Output
	Format is all <NR2>		
Response	Only frequency is <NR3>		
	All other items are <NR2>		
Query example	SENS:DATA:SPOT:SEL? 1, 0, 0, 0, 0, 1, 1		
Response example	100.00E+03, –20.79, 151.32		

:SENSe:DATA:SPOT:LIMit:GAIN:MAXimum <gain_upper_limit_ch2>, <gain_upper_limit_ch3>, <gain_upper_limit_ch4>
:SENSe:DATA:SPOT:LIMit:GAIN:MAXimum?

Description	Sets or queries the gain judgment upper limit for each channel's spot measurements.
1st parameter	<gain_upper_limit_ch2> CH2/CH1 gain judgment upper limit Range –199.99 to 199.99
2nd parameter	<gain_upper_limit_ch3> CH3/CH1 gain judgment upper limit Range –199.99 to 199.99
3rd parameter	<gain_upper_limit_ch4> CH4/CH1 gain judgment upper limit Range –199.99 to 199.99
	Format is all <NR2> [unit: dB]
Setting example	SENS:DATA:SPOT:LIM:GAIN:MAX 120.00,130.00,100.00
Response	<gain_upper_limit_ch2>,<gain_upper_limit_ch3>,<gain_upper_limit_ch4>
Query example	SENS:DATA:SPOT:LIM:GAIN:MAX?
Response example	120.00,130.00,100.00

:SENSe:DATA:SPOT:LIMit:GAIN:MINimum <gain_lower_limit_ch2>, <gain_lower_limit_ch3>, <gain_lower_limit_ch4>
:SENSe:DATA:SPOT:LIMit:GAIN:MINimum?

Description	Sets or queries the gain judgment lower limit for each channel's spot measurements.
1st parameter	<gain_lower_limit_ch2> Gain judgment lower limit (CH2/CH1) Range –199.99 to 199.99
2nd parameter	<gain_lower_limit_ch3> Gain judgment lower limit (CH3/CH1) Range –199.99 to 199.99
3rd parameter	<gain_lower_limit_ch4> Gain judgment lower limit (CH4/CH1) Range –199.99 to 199.99
	Format is all <NR2> [unit: dB]
Setting example	SENS:DATA:SPOT:LIM:GAIN:MIN –120.00, –130.00, –100.00
Response	<gain_lower_limit_ch2>,<gain_lower_limit_ch3>,<gain_lower_limit_ch4>
Query example	SENS:DATA:SPOT:LIM:GAIN:MIN?
Response example	–120.00,–130.00,–100.00

:SENSe:DATA:SPOT:LIMit:PHASe:MAXimum <phase_upper_limit_ch2>, <phase_upper_limit_ch3>, <phase_upper_limit_ch4>
:SENSe:DATA:SPOT:LIMit:PHASe:MAXimum?

Description	Sets or queries the phase judgment upper limit for each channel's spot measurements.
1st parameter	<phase_upper_limit_ch2> CH2/CH1 phase judgment upper limit Range –180.00 to 180.00
2nd parameter	<phase_upper_limit_ch3> CH3/CH1 phase judgment upper limit Range –180.00 to 180.00
3rd parameter	<phase_upper_limit_ch4> CH4/CH1 phase judgment upper limit Range –180.00 to 180.00
	Format is all <NR2> [unit: deg]
Setting example	SENS:DATA:SPOT:LIM:PHAS:MAX 120.00,130.00,100.00
Response	<phase_upper_limit_ch2>,<phase_upper_limit_ch3>, <phase_upper_limit_ch4>
Query example	SENS:DATA:SPOT:LIM:PHAS:MAX?
Response example	120.00,130.00,100.00

:SENSe:DATA:SPOT:LIMit:PHASe:MINimum <phase_lower_limit_ch2>, <phase_lower_limit_ch3>, <phase_lower_limit_ch4>

:SENSe:DATA:SPOT:LIMit:PHASe:MINimum?

Description	Sets or queries the phase judgment lower limit for each channel's spot measurements.		
1st parameter	<phase_lower_limit_ch2>	CH2/CH1 phase judgment lower limit	Range –180.00 to 180.00
2nd parameter	<phase_lower_limit_ch3>	CH3/CH1 phase judgment lower limit	Range –180.00 to 180.00
3rd parameter	<phase_lower_limit_ch4>	CH4/CH1 phase judgment lower limit	Range –180.00 to 180.00
	Format is all <NR2> [unit: deg]		
Setting example	SENS:DATA:SPOT:LIM:PHAS:MIN –120.00, –130.00, –100.00		
Response	<phase_lower_limit_ch2>,<phase_lower_limit_ch3>, <phase_lower_limit_ch4>		
Query example	SENS:DATA:SPOT:LIM:PHAS:MIN?		
Response example	–120.00,–130.00,–100.00		

:SENSe:DATA:SPOT:LIMit:REPort[:ALL]?

Description	Queries the spot judgment results. (All items are output.)
Parameters	None
Response 1	CH2/CH1 gain judgment results –1: NG if below lower limit / 0: SUCCESS / 1: NG if above upper limit
Response 2	CH2/CH1 phase judgment results –1: NG if below lower limit / 0: SUCCESS / 1: NG if above upper limit
Response 3	CH3/CH1 gain judgment results –1: NG if below lower limit / 0: SUCCESS / 1: NG if above upper limit
Response 4	CH3/CH1 phase judgment results –1: NG if below lower limit / 0: SUCCESS / 1: NG if above upper limit
Response 5	CH4/CH1 gain judgment results –1: NG if below lower limit / 0: SUCCESS / 1: NG if above upper limit
Response 6	CH4/CH1 phase judgment results –1: NG if below lower limit / 0: SUCCESS / 1: NG if above upper limit
	Format is all <NR1>
Query example	SENS:DATA:SPOT:LIM:REP?
Response example	0,0,1,0,–1,–1

:SENSe:DATA:SPOT:LIMit:REPort:SELected? <gain_ch2>, <phase_ch2>, <gain_ch3>, <phase_ch3>, <gain_ch4>, <phase_ch4>

Description	Outputs only the specified items (up to 7 items) among the spot judgment results.		
1st parameter	<gain_ch2>	CH2/CH1 gain judgment output setting	0: No output / 1: Output
2nd parameter	<phase_ch2>	CH2/CH1 phase judgment output setting	0: No output / 1: Output
3rd parameter	<gain_ch3>	CH3/CH1 gain judgment output setting	0: No output / 1: Output
4th parameter	<phase_ch3>	CH3/CH1 phase judgment output setting	0: No output / 1: Output
5th parameter	<gain_ch4>	CH4/CH1 gain judgment output setting	0: No output / 1: Output

6th parameter	<phase_ch4> CH4/CH1 phase judgment output setting 0: No output / 1: Output
	Format is all <NR1>
Response	<NR1> –1 (NG if below lower limit) / 0 (SUCCESS) / 1 (NG if above upper limit)
	All other items are <NR2>
Query example	SENS:DATA:SPOT:LIM:REP:SELected? 1, 1, 0, 0, 1, 1
Response example	1,0,–1,1

:SENSe:DATA:SWEep[:DATA][:ALL]?

Description	Outputs all sweep measurement results.
Parameters	None
Response	<NR3>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>,<NR2>
	Frequency, CH2/CH1 gain, CH2/CH1 phase, CH3/CH1 gain, CH3/CH1 phase, CH4/CH1 gain, CH4/CH1 phase
Query example	SENS:DATA:SWE?
Response example	100.00E+03,–4.72,–118.62,–10.11,90.02,–20.79,151.32,…
	Commas are used to separate data output for multiple measurement points.

:SENSe:DATA:SWEep[:DATA]:SELlected? <freq>, <gain_ch2>, <phase_ch2>, <gain_ch3>, <phase_ch3>, <gain_ch4>, <phase_ch4>

Description	Outputs only the specified items (up to 7 items) among the sweep measurement results.		
1st parameter	<freq>	Frequency output setting	0: No output / 1: Output
2nd parameter	<gain_ch2>	CH2/CH1 gain output setting	0: No output / 1: Output
3rd parameter	<phase_ch2>	CH2/CH1 phase output setting	0: No output / 1: Output
4th parameter	<gain_ch3>	CH3/CH1 gain output setting	0: No output / 1: Output
5th parameter	<phase_ch3>	CH3/CH1 phase output setting	0: No output / 1: Output
6th parameter	<gain_ch4>	CH4/CH1 gain output setting	0: No output / 1: Output
7th parameter	<phase_ch4>	CH4/CH1 phase output setting	0: No output / 1: Output
Response	Only frequency is <NR3>		
	All other items are <NR2>		
Query example	SENS:DATA:SWE:SEL? 1,0,0,1,1,0,0		
Response example	100.00E+03,–4.72,–118.62,99.00E+03,–4.42,–110.46, …		
	Commas are used to separate data output for multiple measurement points.		

:SENSe:DATA:SWEep:POINt?

Description	Outputs the measurement points in the sweep measurement results.
Parameters	None
Response	<NR1>
Query example	SENS:DATA:SWE:POIN?
Response example	1000

■ Frequency setting

Either k (kilo: 10^3) or m (milli: 10^{-3}) can be used as the multiplier suffix for the upper limit frequency and lower limit frequency values in the oscillator's frequency and sweep measurements. The unit for each suffix is Hz.

Example: FREQ:SWE:MAX 100 kHz

[:SOURce]:FREQuency[:IMMediate] <freq_current>
[:SOURce]:FREQuency[:IMMediate]?

Description	Sets or queries the oscillator frequency.
Parameter	<freq_current> Oscillator frequency
	format <NR3>, range 0.10E−03 to 100.00E+03 [unit: Hz]
Setting example	FREQ 1000
Response	<freq_current>
Query example	FREQ?
Response example	1.0000E+03

[:SOURce]:SWEep:MEASure <measure_operation>
[:SOURce]:SWEep:MEASure?

Description	Specifies a sweep or spot measurement or queries its status.
Parameter	<measure_operation> Measurement operation
	format <CRD>, range STOP | SPOT | UP | DOWN
Setting example	SWE:MEAS UP
Response	<measure_operation>
Query example	SWE:MEAS?
Response example	UP

[:SOURce]:SWEep:SPACing[:TYPE] <freq_spacing>
[:SOURce]:SWEep:SPACing[:TYPE]?

Description	This sets or queries the sweep measurement's frequency axis format.
Parameter	<freq_spacing> Frequency axis format, format <CRD>, range LINear | LOGarithmic
Setting example	SWE:SPAC LIN
Response	<freq_spacing> Response is in short form (LIN | LOG).
Query example	SWE:SPAC?
Response example	LIN

[:SOURce]:SWEep:SPACing:POINt <freq_points>

[:SOURce]:SWEep:SPACing:POINt?

Description	Sets or queries the sweep measurement's frequency points (measurement points). Between the lower limit frequency and upper limit frequency, only the specified frequency points are measured, at an even interval along a linear (Lin) axis or a logarithmic (Log) axis.
Parameter	<freq_points> Frequency points, format <NR1>, range 3 to 1000
Setting example	SWE:SPAC:POIN 1000
Response	<freq_points>
Query example	SWE:SPAC:POIN?
Response example	1000

[:SOURce]:SWEep[:LEVel]:MAXimum <freq_max>

[:SOURce]:SWEep[:LEVel]:MAXimum?

Description	Sets or queries the sweep measurement's upper limit frequency.
Parameter	<freq_max> Upper limit frequency, format <NR3>, range 0.11E−03 to 100.00E+03 [unit: Hz]
Setting example	SWE:MAX 100 kHz
Response	<freq_max>
Query example	SWE:MAX?
Response example	100.00E+03

[:SOURce]:SWEep[:LEVel]:MINimum <freq_min>

[:SOURce]:SWEep[:LEVel]:MINimum?

Description	Sets or queries the sweep measurement's lower limit frequency.
Parameter	<freq_min> Lower limit frequency, format <NR3>, range 0.10E−3 to 99.999E+03 [unit: Hz]
Setting example	SWE:MIN 0.0001
Response	<freq_min>
Query example	SWE:MIN?
Response example	0.10E−03

[:SOURce]:VOLTage:OUTPut[:STATe] <output_state>

[:SOURce]:VOLTage:OUTPut[:STATe]?

Description	Sets or queries the oscillator's ON/OFF status.
Parameter	<output_state> Output status, format <NR1>, range 0 | 1 | 2 0: AC/DC OFF, 1: AC OFF, 2: AC/DC ON When "1" is set, AC is OFF and DC is restored to its previous status.
Setting example	VOLT:OUTP 0
Response	<output_state> Indicates status during each operation.
Query example	VOLT:OUTP?
Response example	0

[:SOURce]:VOLTage:OFFSet[:IMMediate] <dc_offset>

[:SOURce]:VOLTage:OFFSet[:IMMediate]?

Description	Sets or queries the oscillator's DC bias.
Parameter	<dc_offset> DC bias, format <NR2>, range −10.00 to 10.00 [unit: V]
Setting example	VOLT:OFFS 10.00
Response	<dc_offset>
Query example	VOLT:OFFS?
Response example	10.00

[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude] <amplitude> [VRMS|VPK]

[:SOURce]:VOLTage[:LEVel][:IMMediate][:AMPLitude]?

Description	This sets or queries the oscillator's AC amplitude. This setting is interpreted as having the unit value set by the VOLTage:UNIT setting. However, if a numerical value includes a suffix (VRMS or VPK), it is interpreted according to the suffix regardless of the VOLTage:UNIT setting.
Parameter	<amplitude> AC amplitude: <NR2> 0.000 to 7.07 [unit: Vrms] 0.000 to 10.00 [unit: Vpk]
Setting example	VOLT 7.07 Other example) VOLT 10 VPK, VOLT 1 VRMS
Response	<amplitude>
Query example	VOLT?
Response example	7.07

[:SOURce]:VOLTage:UNIT <amplitude_unit>

[:SOURce]:VOLTage:UNIT?

Description	Sets or queries the oscillator's AC amplitude display unit and reponse unit.
Parameter	<amplitude_unit> AC amplitude unit, format <CRD>, range VRMS | VPK
Setting example	VOLT:UNIT VRMS
Response	<amplitude_unit>
Query example	VOLT:UNIT?
Response example	VRMS

■ Setting range for status-related 16-bit registers

The MSB (Most Significant Bit) in status-related 16-bit registers is pre-set as always "0". When set by a command, any value up to 65535 can be entered, but the MSB is always cleared to zero in the target register. Accordingly, the response message for the query is always a value of 32767 or less.

STATus:OPERation:CONDition?

Description	Queries the operation condition register (OPCR).
Parameters	None
Response	Register contents, format <NR1>, range 0 to 32767
	For details, … ☞ "**5.5.4 Operation status**"
Query example	STAT:OPER:COND?
Response example	0

STATus:OPERation:ENABle <opee>
STATus:OPERation:ENABle?

Description	Sets or queries the operation event enable register (OPEE).
Parameter	<opee> Register contents, format <NR1>, range 0 to 65535
	For details, … ☞ "**5.5.4 Operation status**"
Setting example	STAT:OPER:ENAB 0
Response	<opee>
Query example	STAT:OPER:ENAB?
Response example	0

STATus:OPERation[:EVENt]?

Description	Queries the operation event register (OPER).
Parameters	None
Response	Register contents, format <NR1>, range 0 to 32767
	For details, … ☞ "**5.5.4 Operation status**"
Query example	STAT:OPER?
Response example	0

STATus:OPERation:NTRansition <transition_neg>

STATus:OPERation:NTRansition?

STATus:OPERation:PTRansition <transition_pos>

STATus:OPERation:PTRansition?

Description Sets or queries the operation transition filter.

The OPER value is set for each bit, according to the filter settings.

NTR	PTR	OPER
0	0	"1" is not set to OPER even when OPCR has changed.
0	1	"1" is set to OPER when OPCR has changed from 0 to 1.
1	0	"1" is set to OPER when OPCR has changed from 1 to 0.
1	1	"1" is set to OPER whenever OPCR has changed.

Parameter <transition_neg> Negative transition filter, format <NR1>, range 0 to 65535

<transition_pos> Positive transition filter, format <NR1>, range 0 to 65535

For details, … ☞ "**5.5.4 Operation status**"

Setting example	STAT:OPER:NTR 32767	Setting example	STAT:OPER:PTR 0
Response	<transition_neg>	Response	<transition_pos>
Query example	STAT:OPER:NTR?	Query example	STAT:OPER:PTR?
Response example	32767	Response example	0

STATus:OVERload:ENABle <ovee>

STATus:OVERload:ENABle?

Description Sets or queries the overload event enable register (OVEE).

Parameter <ovee> Register contents, format <NR1>, range 0 to 65535

Setting example STAT:OVER:ENAB 0

Response <ovee>

Query example STAT:OVER:ENAB?

Response example 0

STATus:OVERload [:EVENt]?

Description This queries the overload event register (OVER).

Parameters None

Response Register contents, format <NR1>, range 0 to 32767

For details, … ☞ "**5.5.5 Overload status**"

Query example STAT:OVER?

Response example 0

SYSTem:ERRor?

Description	Queries an error.
Parameters	None
Response	Error number, error message
	Error number: format <NR1>, range –32768 to +32767
	Error message: format <SRD>
	For details, … ☞ "**6.1.2 Remote control errors**"
Query example	SYST:ERR?
Response example	0,"No error"

SYSTem:OVERload:RELease

Description	This cancels (releases) an error.
	Examples of errors to be canceled
	• Error when input signal exceeds measurable voltage range
	• Error when overload input detection level for user setting is exceeded
	• Output overload error
Parameters	None
Use example	SYST:OVER:REL

5.5 Status System

5.5.1 Overview of status system

FRA5014's status system is illustrated in Figure 5-3.

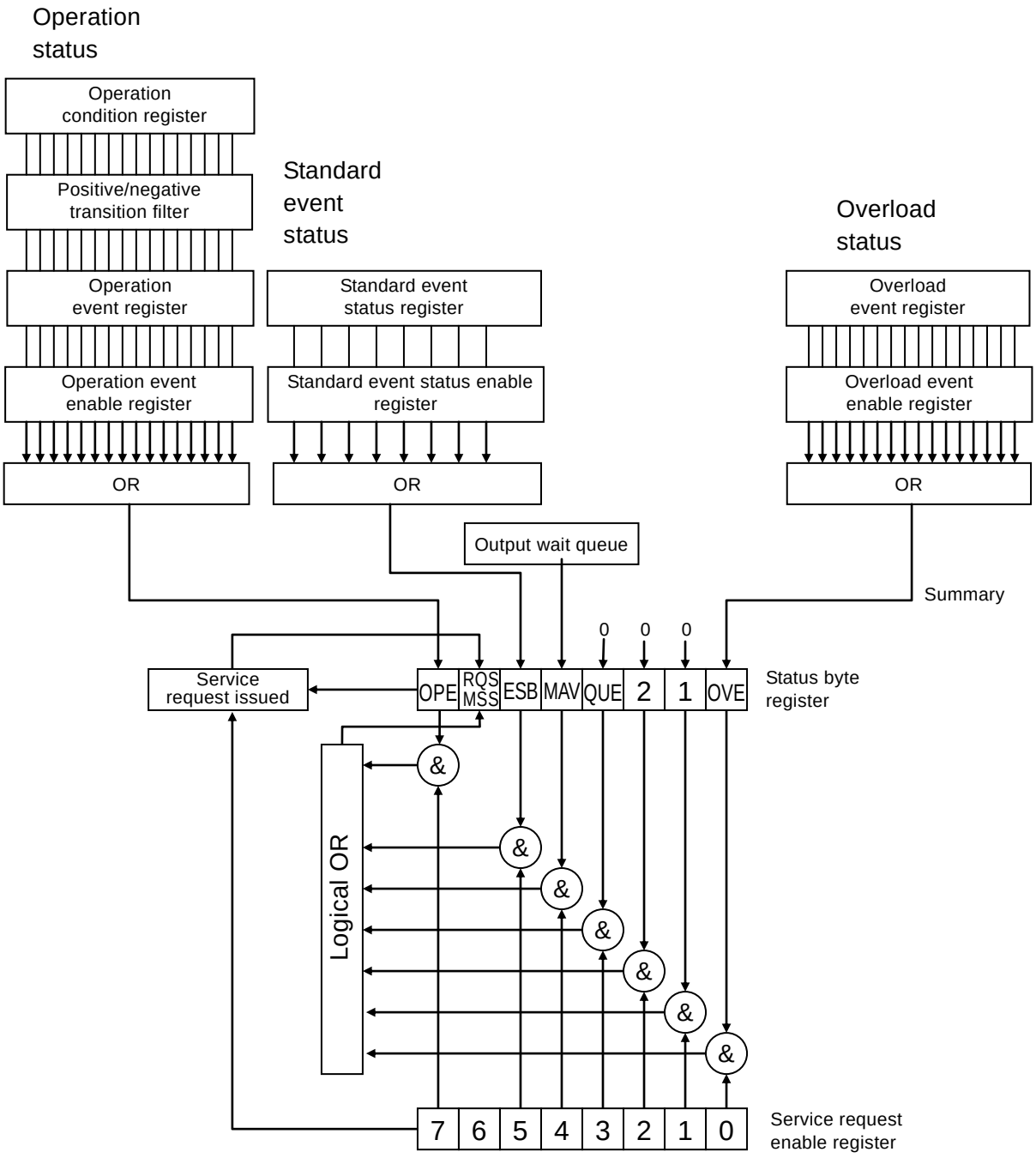


Figure 5-3. Status System

5.5.2 Status byte

The status byte register's definitions are listed in Table 5-3. Each bit in the status byte register becomes valid when "1" is set to the corresponding bit in the service request enable register, and a service request is issued whenever even one valid bit is set (= 1). The status byte can be read by serial polling or an *STB? query.

Table 5-3. Status Byte Register Definitions

Bit		Weight	Condition for setting (= 1)	Condition for resetting (= 0)
OPE	7	128	When "1" is set to any valid bit in the operation event register	When all valid bits in the operation event register are cleared to 0
RQS/ MSS	6	64	When SRQ is sent	RQS: When SRQ was canceled, such as by serial polling MSS: When the original summary bits were all cleared to zero
ESB	5	32	When "1" is set to any valid bit in the standard event status register	When all valid bits in the standard event status register are cleared to 0
MAV	4	16	When a response to query is prepared and can be output	When all responses are output and there are no more responses left to be output
QUE	3	8	–	Always 0 (not being used)
–	2	4	–	Always 0 (not being used)
–	1	2	–	Always 0 (not being used)
OVE	0	1	When "1" is set to any valid bit in the overload event register	When all valid bits in the overload event register are cleared to 0

■ Status check after a query

Usually, after a query command is issued to submit a query, a response can be correctly received simply by receiving a response message. It is not always necessary to check the MAV bit in the status byte.

■ Related commands or queries

*STB?

This queries the contents of the status byte.

Bit 6 in the response is the MSS (Master Summary Status) bit.

During serial polling, bit 6 is the RQS (ReQuest Service) bit.

*SRE / *SRE?

This sets or queries the service request enable register.

Set "0" to clear the enable register to zero.

There are no other commands for clearing.

This register is cleared to zero immediately after power-on.

The parameters in setting messages or response messages for each register are values obtained by adding the weights of all "1" bits.

5.5.3 Standard event status

The structure of the standard event status is illustrated in Figure 5-4. Details of this status information are shown in Table 5-4. When "1" is set to bits in the standard event status enable register, the corresponding bits in the standard event status register become valid, and when the value of any valid bit becomes "1", "1" is also set to the ESB bit in the status bit register.

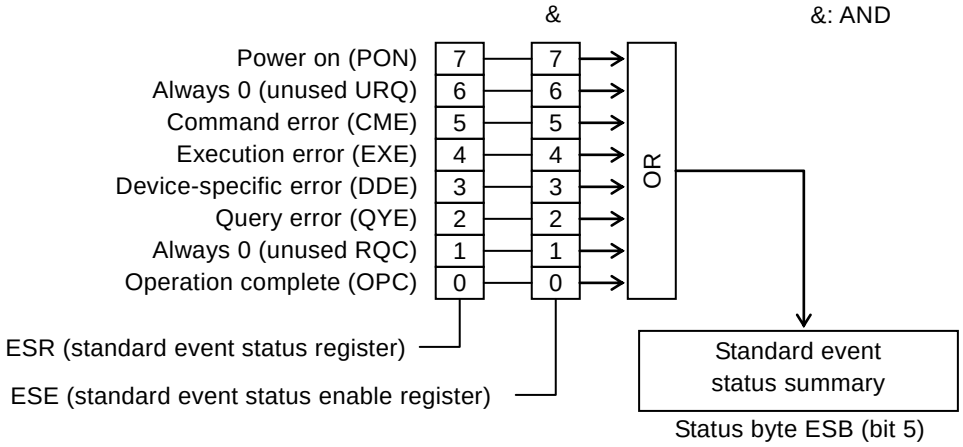


Figure 5-4. Structure of Standard Event Status

Table 5-4. Contents of Standard Event Status Register

Bit		Weight	Description
PON	7	128	Power on "1" is set to this bit when the power is turned on. It is cleared to zero when the register is read, and it remains "0" until the next power-on.
URQ	6	64	User request Always 0 (not being used)
CME	5	32	Command error "1" is set when a program code syntax error occurs.
EXE	4	16	Execution error "1" is set when a parameter is outside the setting range, or when settings are contradictory.
DDE	3	8	Device-specific error "1" is set when a device-specific error occurs (when a device dependent error is detected).
QYE	2	4	Query error "1" is set when attempting to read the output buffer that stores response messages when the buffer is empty, or when the data in the response message buffer has been lost.
RQC	1	2	Request control Always 0 (not being used)
OPC	0	1	Operation complete "1" is set when overlap command processing has been completed.

■ Related commands or queries

*ESR?

This queries the contents of the standard event status register.

A query clears the register to zero. It is also cleared by the *CLS command.

The register is cleared to 0 immediately after power-on. However, “1” is set to the PON bit.

*ESE / *ESE?

This sets or queries the standard event status enable register.

Set “0” to clear the enable register to zero.

There are no other commands for clearing the register.

The register is cleared to 0 immediately after power-on.

The parameters in setting messages or response messages for each register are values obtained by adding the weights of all “1” bits.

5.5.4 Operation status

The structure of the operation status is illustrated in Figure 5-5.

The operation condition register indicates the status of the FRA5014, as is shown in Table 5-5.

If "1" is set to a bit in the positive transition filter register, "1" is set to the corresponding operation event register bit when the corresponding bit of the operation condition register changes from 0 to 1. If "1" is set to a bit in the negative transition filter register, "1" is set to the corresponding operation event register bit when the corresponding bit of the operation condition register changes from 1 to 0. Transitions in both directions (0 → 1 and 1 → 0) can be detected.

When "1" is set to bits in the operation event enable register, the corresponding operation event register bits become valid, and when "1" is set to any valid bit, "1" is also set to the OPE bit in the status byte.

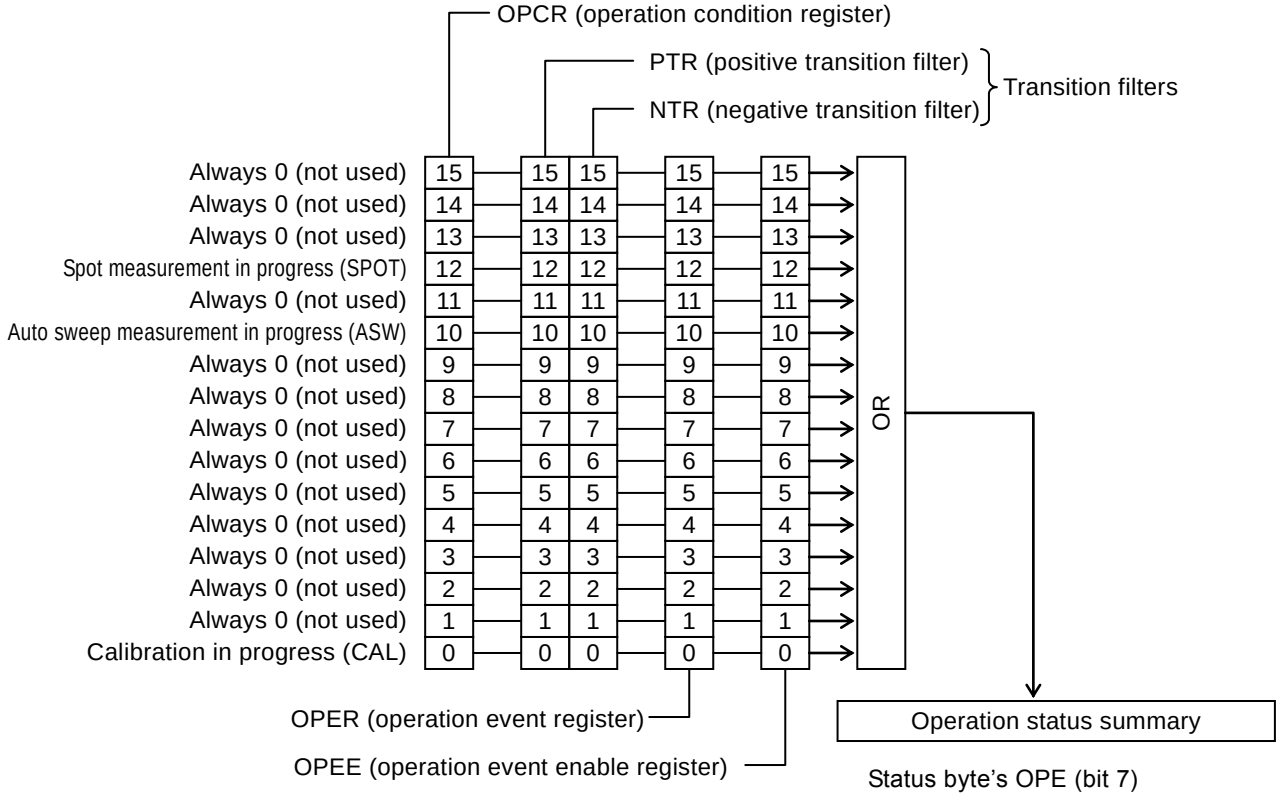


Figure 5-5. Structure of Operation Status

Table 5-5. Contents of Operation Condition Register

Bit		Weight	Description (“1” when specified status is set)
SPOT	12	4096	Spot measurement in progress Each time a measurement is performed, this bit’s value is “1” when measurement starts and “0” when measurement ends.
ASW	10	1024	Sweep measurement in progress
CAL	0	1	Self calibration in progress
Other	–	–	Always 0 (not being used)

■ Related commands or queries

STATus:OPERation:CONDition?

This queries the contents of the operation condition register.

Even when queried, the condition register’s contents are not cleared to zero.

The status of the FRA5014 is always indicated.

STATus:OPERation:NTRansition / STATus:OPERation:NTRansition?

This sets or queries the negative transition filter register.

STATus:OPERation:PTRansition / STATus:OPERation:PTRansition?

This sets or queries the positive transition filter register.

Set “0” to clear these filter register to zero.

There are no other commands for clearing these registers.

These registers are cleared to zero immediately after power-on.

STATus:OPERation[:EVENt]?

This queries the operation event register.

When queried, the event register is cleared to zero.

The event register can also be cleared by the *CLS command.

This register is cleared to zero immediately after power-on.

STATus:OPERation:ENABle / STATus:OPERation:ENABle?

This sets or queries the standard operation event enable register.

Set “0” to clear the enable register to zero.

There are no other commands for clearing this register

This register is cleared to zero immediately after power-on.

The parameters in setting messages or response messages for each register are values obtained by adding the weights of all “1” bits.

5.5.5 Overload status

The structure of the overload status is illustrated in Figure 5-6.

The overload event register shows the I/O status of the FRA5014, as is shown in Table 5-6.

When "1" is set to bits in the overload event enable register, the corresponding bits in the overload event register become valid, and when "1" is set to a valid bit, "1" is set to the OVE bit in the status byte.

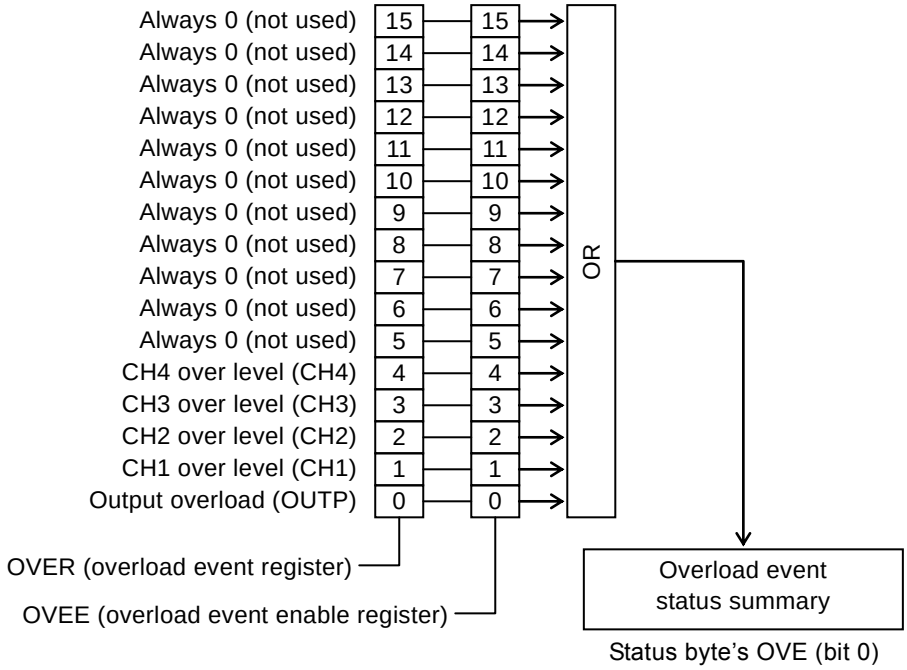


Figure 5-6. Structure of Overload Status

Table 5-6. Contents of Overload Event Register

Bit		Weight	Description ("1" when specified status is set)
CH4	4	16	Overload input was detected at CH4 (ERROR lamp is ON)
CH3	3	8	Overload input was detected at CH3 (ERROR lamp is ON)
CH2	2	4	Overload input was detected at CH2 (ERROR lamp is ON)
CH1	1	2	Overload input was detected at CH1 (ERROR lamp is ON)
OUTP	0	1	Oscillator's output current is over the allowable range (ERROR lamp is ON)
Other	–	–	Always 0 (not being used)

■ **Related commands or queries**

STATus:OVERload:ENABle / STATus:OVERload:ENABle?

This sets or queries the overload event enable register.

Set “0” to clear the enable register to zero.

There are no other commands to clear these bits.

The register is cleared to 0 immediately after power-on.

STATus:OVERload [:EVENt]?

This queries the overload event register.

Even if the cause of the overload event is removed, the register will not be cleared.

When queried, the event register is cleared to zero.

The event register can also be cleared by the *CLS command.

The register is cleared to 0 immediately after power-on.

The parameters in setting messages or response messages for each register are values obtained by adding the weights of all “1” bits.

5.6 Cautions for Programming

■ Caution when transmitting commands

When transmitting a command, add a line feed (0AH) as a program message terminator to the end of the transmit string. If LF is not added, the system may not correctly operate. Transmission of a program message terminator or END message has not been specified separately from the command itself, they will not be output. Although the line feed may be described as a new line, the binary code is the same.

6. TROUBLESHOOTING

6.1 Error Displays

When the power is turned on, all of the lamps go on for a few seconds while a self test is performed. If the self test ends normally, self calibration starts and all lamps except for the CALIBRATION lamp go off. Do not send any remote commands until self calibration is completed. If an error was detected during the self test, the ERROR lamp remains on.

The following lists lamp on patterns along with their causes and required responses.

6.1.1 Error at power-on

Lamp on Pattern	Cause (s)	Required Response
All lamps remain on	• Internal ROM error • Internal SDRAM error • Analyzer operation fault	Turn the power off, then wait at least three seconds before turning it on again. If the error message appears no matter how many times the power is turned on again, repair is needed. Contact NF Corporation or a sales representative.
Self calibration starts while ERROR lamp remains on	Contents saved by battery backup are lost. • Backup battery is depleted. • Backup memory fault • Temporary internal data error, such as when power is turned off during memory operation	
ERROR lamp remains on when self calibration ends	Self calibration error Error in oscillator's or analyzer's signal measurement system.	
OSCILLATOR, MEASURE, CALIBRATION, or ERROR lamp is blinking	Analyzer operation fault	

If the ERROR lamp goes on at power-on, check whether the operation requirements, described above in "**Installation conditions**" in "**2.2** Installation", are met.

If an error is detected in the ROM, SDRAM, or analyzer, operation will not continue.

If contents that are being preserved by battery backup are lost, initialize the memory before starting.

Whenever a backup memory error is detected, "1" is set to the DDE bit in the standard event status register.

For details, ☞ "**5.5.3 Standard event status**"

To turn off the ERROR lamp, enter the remote command "*ESR?".

For details, ☞ "**5.4.2.1 Common commands**"

6.1.2 Remote control errors

Error No.	Error message	Cause(s) of error
0	“No error”	No error
	<Syntax errors>	
–100	“Command error”	An invalid command was received (no specific type).
–102	“Syntax error”	An undefined command or parameter was received.
–110	“Command header error”	Command header was recognized as invalid.
–111	“Header separator error”	Header separator was not detected when parsing header.
	<Execution-related errors>	
–200	“Execution error”	An error occurred when executing a command (no specific type).
–222	“Data out of range”	Command’s parameter is outside of setting range.
–340	“Calibration failed”	Calibration failed.
–350	“Queue overflow”	A newly occurred error cannot be retained due to error queue overflow.
–370	“Invalid (max<=min)”	Settings enabled as upper limit and lower limit settings were reversed.
–371	“OSC AC+DC > +/– 10.5 V”	Oscillator’s output voltage peak is too high, so normal signal output is not possible.
–372	“OSC ac output = off”	Attempted to measure during zero AC output
–373	“OSC is on”	Oscillator is ON; cannot execute self calibration
–377	“In Calibrating”	Attempted to measure during calibration
–378	“In Measuring”	Attempted calibration, etc., during measurement
–381	“CH1 Overload”	Overload occurred in CH1
–382	“CH2 Overload”	Overload occurred in CH2
–383	“CH3 Overload”	Overload occurred in CH3
–384	“CH4 Overload”	Overload occurred in CH4

* The error queue has four stages. If the error queue becomes full and another error occurs, error 350 (“Queue overflow”) is inserted at the end of the queue.

6.2 Troubleshooting

If you suspect any kind of fault, try the following troubleshooting tips. If this does not resolve the issue, contact NF Corporation or a sales representative.

Issue	Possible Cause	Response
Power will not go on	Power supply is outside of rated range.	Use a power supply that is within the rated range. Make sure the mains supply cord is inserted correctly.
Error occurred during self calibration	Operation fault due to external noise, etc.	Turn the power off and on again. Install the system in a more suitable environment.
AC amplitude is not correct	Remote command "VOLT:OUTP 2" was not transmitted after amplitude setting was changed.	Enter the remote command "VOLT:OUTP 2". Otherwise, set value is not reflected in output.
	Vrms and Vpeak units are incorrect.	Select Vrms and Vpeak correctly.
	Low load impedance (load is divided with FRA5014's output impedance of approximately 50 Ω).	Set a higher voltage to accommodate the load impedance.
Too much variation among measurements	Oscillator is off.	Enter the remote command "VOLT:OUTP 2". Otherwise, set value is not reflected in output.
	Drive signal level is lower than was set.	
	Too much noise or signal is too weak.	Increase the AC amplitude or lengthen the integration time.
	Fault in cable connection with oscillator.	Use the voltage monitor on an oscilloscope or spot measurement screen to check the voltage.
Operation differs from that described in the instruction manual.	All settings have not been initialized	Most descriptions in the manual assume that full initialization has been executed. Initialize all settings.

7. MAINTENANCE

7.1 Introduction

The following maintenance tasks should be performed to maintain this equipment in optimum condition.

- Operation check — Check whether equipment is operating correctly.
- Performance test — Check whether equipment meets specified rated values.
- Adjustments and calibration — If rated values are not met, ask NF Corporation to make adjustments and restore performance.
- Repair — If not improved, ask NF Corporation to identify problems and make adjustments and/or repairs.

This manual describes performance test methods that are easy to carry out.

For more advanced tests, adjustments, calibration, or repair, contact NF Corporation or a sales representative.

The following measuring instruments are needed for the performance test.

- Oscilloscope — Frequency band: 10 MHz or higher
- Frequency counter — Accuracy: $\pm 5 \times 10^{-6}$ or higher
- AC voltmeter — Accuracy: ±0.2 %, actual RMS value, frequency band: 100 kHz or higher
- DC voltmeter — Accuracy: ±0.1 % or higher
- Resistance meter (tester) — Measurement range: 10 MΩ or higher

7.2 Routine Checks

Use the FRA5014 where the installation satisfies the conditions for use.

For description of installation conditions, ☞ "**Installation conditions**" in "**2.2 Installation**" above.

If the panel or case becomes dirty, wipe it clean with a soft cloth. For stubborn dirt, dip the cloth in a neutral detergent and wring it well before wiping with it.

Avoid using organic solvents such as thinner or benzene, or chemically treated cloths, since these can cause discoloration or clouding of product surfaces, or may remove the product's outer finish.

7.3 Storage, Repackaging, and Shipping

Always store the FRA5014 in a location that meets the installation conditions.

For installation conditions, ☞ "**2.2.2 Installation conditions**".

When repackaging for shipment, etc., use a strong box with plenty of room for padding, using packing material that can withstand the equipment's weight, and make sure the equipment is fully protected.

During shipment, handle with care and avoid strong impacts.

7.4 Checking the Version Number

The FRA5014's firmware version number can be read by entering the query "*IDN?".

For description of query commands, ☞ "**5 REMOTE CONTROL**"

7.5 Checking Isolation

The FRA5014's oscillator output and analyzer input should each be insulated from the case.

Using a resistance meter (tester, multimeter, etc.), measure the resistance between the external conductors on the rear panel's BNC connectors and the grounding terminal in the center of the rear panel, and make sure it is at least 10 MΩ. Similarly, check insulation between the BNC connectors.

7.6 Checking Oscillator's Output Waveform

Connection:	OUTPUT OSCILLATOR → oscilloscope input (input impedance = 1 MΩ)
Setting:	After initializing settings, enter the remote commands "FREQ 1 kHz" and "VOLT 7.07" to set the frequency as 1 kHz and the amplitude as 7.07 Vrms, then enter the remote command "VOLT:OUTP 2" to turn on the oscillator's output.
Measurement:	Use an oscilloscope to observe the waveform.
Judgment:	Normal if 20 Vp-p sine wave. Make sure there is no distortion or noise.

7.7 Performance Test

This performance test is part of preventive maintenance aimed at preventing degradation of performance in the FRA5014.

The performance test should be implemented during the FRA5014's acceptance inspection, during regular inspections, and during performance checks following repairs.

If the performance test results do not satisfy the rated specifications, calibration or repair is needed. Contact NF Corporation or our representative.

Set the following before implementing a performance test.

- Power supply voltage 100 to 230 V ±10 %, but 250 V max.
- Ambient temperature 23 ±5 °C
- Ambient humidity 20 to 70 % RH, no condensation
- Warm-up period 30 minutes or more

Note the following caution points before measuring performance.

- If use of a coaxial cable is specified, use a cable with characteristic impedance of 50 Ω, thickness of RG-58A/U or above, and length of one meter or less. The coaxial cable should have BNC connectors at both ends.
- When 50 Ω termination is specified, set 50 Ω for the input to the target measuring instrument. If the measuring instrument cannot be set to 50 Ω, terminate by attaching a 50 Ω coaxial feed-through terminator to the input of the measuring instrument.
- The settings for the various test items are items to be changed when output is turned on after the settings are initialized. Initialize all settings before implementing the test.

7.7.1 Frequency accuracy test

Connection: OUTPUT OSCILLATOR → frequency counter input

Setting: After initializing settings, set frequency as 100 kHz, amplitude as 1 Vrms/open, and output on.

Measurement: Use a frequency counter to measure the frequency.

Judgment: Normal if ±50 ppm (99.9950 kHz to 100.0050 kHz).

7.7.2 Oscillator AC amplitude accuracy test

Connection: OUTPUT OSCILLATOR → AC voltmeter input

Setting: After initializing settings, set the frequency and the AC amplitude (Vrms/open) as follows.

Turn output on to have the settings reflected in the output.

Measurement: Use an AC voltmeter to measure the output voltage.

Judgment: Normal if within the ranges specified in the following table.

AC amplitude setting	Specification (1 kHz) ±(2 % of set value +7 mVrms)	Specification (100 kHz) ±(4 % of set value +21 mVrms)
7.07 Vrms	6.9216 to 7.2184 Vrms	6.7662 to 7.3738 Vrms
3.0 Vrms	2.933 to 3.067 Vrms	2.859 to 3.141 Vrms
1.5 Vrms	1.463 to 1.537 Vrms	1.419 to 1.581 Vrms
0.7 Vrms	0.679 to 0.721 Vrms	0.651 to 0.749 Vrms
0.3 Vrms	0.287 to 0.313 Vrms	0.267 to 0.333 Vrms
0.15 Vrms	0.140 to 0.160 Vrms	0.123 to 0.177 Vrms
0 Vrms	0.000 to 0.007 Vrms	0.000 to 0.021 Vrms

7.7.3 Oscillator DC bias accuracy test

Connection: OUTPUT OSCILLATOR → DC voltmeter input

Setting: After initializing settings, set AC amplitude as 0 Vrms and DC bias (V/open) as shown in the following table.

Turn output on to have the settings reflected in the output.

Measurement: Use a DC voltmeter to measure the voltage.

Judgment: Normal if within the ranges specified in the following table.

DC bias setting	Specification ±(0.5 % of absolute setting +30 mV)
+10 V	+9.920 V to +10.080 V
+5 V	+4.945 V to +5.055 V
+1 V	+0.965 V to +1.035 V
0 V	–0.030 V to +0.030 V
–1 V	–1.035 V to –0.965 V
–5 V	–5.055 V to –4.945 V
–10 V	–10.080 V to –9.920 V

7.7.4 Ratio accuracy test

Connection: OUTPUT OSCILLATOR → INPUT CH1, CH2, CH3, CH4 parallel

Use a T divider, etc., to split the oscillator's output into four output channels, and connect them to the analyzer's CH1, CH2, CH3, and CH4.

Use a BNC-BNC coaxial cable one meter long or less, with characteristic impedance of 50 Ω.

Setting: After initializing settings, set frequency lower limit as 10 Hz, frequency upper limit as 100 kHz, frequency points as 100, integration cycle as 1, integration time as 0.10 s, AC amplitude as 7.07, 1, 100 m, 10 mVrms/open

After setting the amplitude, set the output on to have the settings reflected in the output.

Measurement: Perform a sweep measurement at each AC amplitude.

Judgment: Normal if within the following ranges.

Frequency ≤ 20 kHz, gain is 0 ±0.05 dB, phase is 0 ±0.3 °

Frequency > 20 kHz, gain is 0 ±0.15 dB, phase is 0 ±1 °

7.7.5 IMRR test

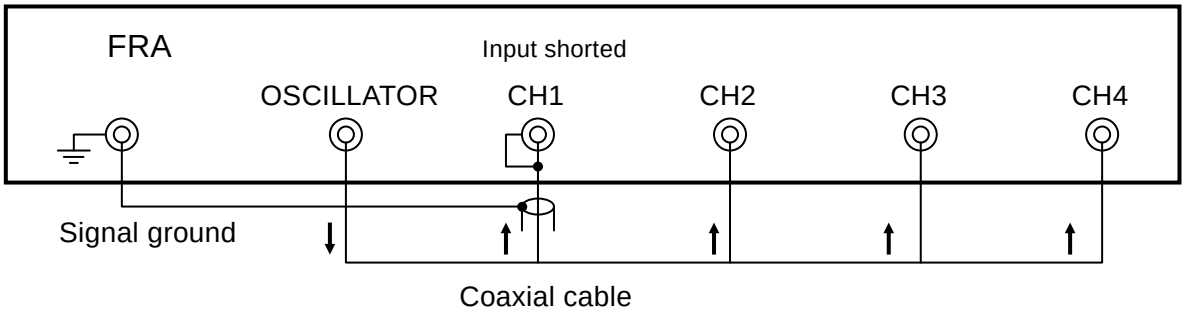
Connection: OUTPUT OSCILLATOR
→ INPUT CH2, CH3, CH4, CH1 central conductor and external conductor (for CH1 test)
→ INPUT CH1, CH3, CH4, CH2 central conductor and external conductor (for CH2 test)
→ INPUT CH1, CH2, CH4, CH3 central conductor and external conductor (for CH3 test)
→ INPUT CH1, CH2, CH3, CH4 central conductor and external conductor (for CH4 test)
Use a T divider, etc., to split the oscillator's output into two output channels.
In the channel under test, short the input connector's central conductor and external conductor, then apply a signal between the input connector and the case. Input a drive signal to the other channels.

Setting: After initializing settings, set the frequency as 60 Hz, the integration time as 10 s, the AC amplitude as 7.07 Vrms, and turn output on to have the settings reflected in the output.

Measurement: Perform a spot measurement and read the results.

Judgment: For CH1 test, normal when gain > 120 dB, for CH2, CH3, and CH4 test, normal when gain < –120 dB.
In an IMRR or dynamic range test, the signal being measured is extremely weak, so several measurements may be required to obtain stable results, but this is normal.

CH1 IMRR test example



7.7.6 Dynamic range test

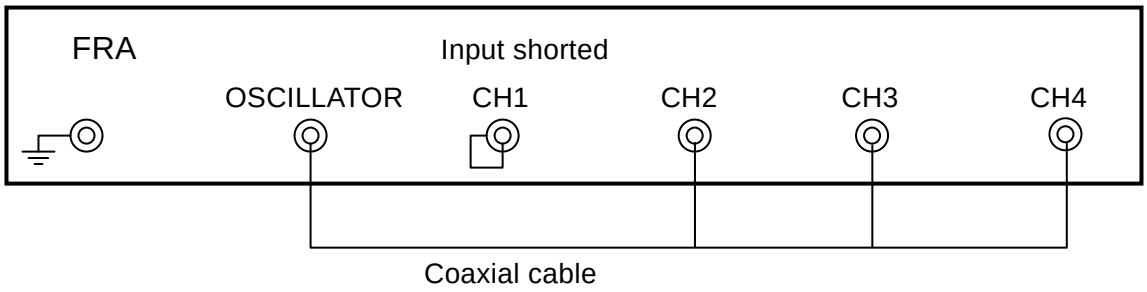
Connection: OUTPUT OSCILLATOR → INPUT CH2, CH3, CH4. CH1 input is shorted (for CH1 test)
OUTPUT OSCILLATOR → INPUT CH1, CH3, CH4. CH2 input is shorted (for CH2 test)
OUTPUT OSCILLATOR → INPUT CH1, CH2, CH4. CH3 input is shorted (for CH3 test)
OUTPUT OSCILLATOR → INPUT CH1, CH2, CH3. CH4 input is shorted (for CH4 test)

Setting: After initializing settings, set the frequency lower limit as 10 Hz, the frequency upper limit as 100 kHz, frequency points as 40, integration time as 10 s, and AC amplitude as 7.07 Vrms. Turn output on to have the settings reflected in the output.

Measurement: Perform a sweep measurement and read the results.
If there is strong electromagnetic interference in the area, certain frequencies may not be within their rated ranges. In such cases, remove the source of noise and try again.

Judgment: For CH1 test, normal if gain is > 120 dB; for CH2, CH3, and CH4 test, normal if gain is < –120 dB.

CH1 dynamic range test example



7.8 Calibration

If the performance test shows that ratings are not met, contact NF Corporation to have adjustments and/or calibration done in order to restore original performance.

When calibration is needed, contact NF Corporation or a sales representative.

A fee will be charged for adjustment or calibration performed after expiration of the warranty period.

8. SPECIFICATIONS

Values without an accuracy (range) shown are typical values.

8.1 Oscillator Block

- Output waveform — Sine wave
- Frequency
  - Setting range — 0.1 mHz to 100 kHz
  - Setting resolution — Larger of 5 digits or 0.01 mHz
  - Accuracy — ±50 ppm
- AC amplitude
  - Setting range — 0 to 7.07 Vrms or 0 to 10 Vpeak
  - Setting resolution — 0.01 Vrms (Amplitude ≥ 1 Vrms), 0.001 Vrms (Amplitude < 1 Vrms)
    Or 0.01 Vpeak (Amplitude ≥ 1 Vpeak), 0.001 Vpeak (Amplitude < 1 Vpeak)
  - Accuracy — ±(2 % of setting + 7 mVrms)
    Or ±(2 % of setting + 10 mVpeak)
    When 10 Hz ≤ Frequency ≤ 20 kHz
    ±(4 % of setting + 21 mVrms)
    Or ±(4 % of setting + 30 mVpeak)
    When 20 kHz < Frequency
    Vpeak is prescribed as a peak value converted from a measured Vrms value
    When output is open
- DC bias
  - Setting range — –10 V to +10 V
  - Setting resolution — 0.01 V
  - Accuracy — ±(0.5 % of set absolute value + 30 mV + 2 % of AC amplitude setting Vpeak value)
    When output is open
- Maximum output (AC + DC)
  - Voltage — ±10 V (when output is open)
  - Current — ±100 mA
- Distortion factor — 0.3 % or less (10 Hz ≤ Frequency ≤ 10 kHz)
  1 % or less (10 kHz < Frequency ≤ 100 kHz)
  With amplitude setting 10 Vpeak, DC bias 0 V, load 50 Ω, BW 500 kHz
- Output impedance — 50 Ω, unbalanced
- Isolation
  - Insulation voltage — 42 Vpk or 30 Vrms, DC to 100 kHz continuous
    Among oscillator output (signal, GND), each channel input in the analyzer block (signal, GND), and the case
  - Case-to-oscillator electrostatic capacitance — 250 pF or less

8.2 Analyzer Input Block

● Number of channels	4
● Input impedance	1 MΩ, 120 pF in parallel
● Input voltage	
Measurement range	±10 V
Non-destructive max. input	±24 V
● Excessive input detection level	Detected by fundamental wave amplitude
Setting range	0.01 to 19.99 Vrms
Setting resolution	0.01 Vrms
Processing method	Beep sound output/sweep stop/oscillator off
● Input weighting	For each channel, Weighting coefficient: –1.00000E + 06 to +1.00000E + 06 Resolution: 6 digits or 0.01E – 09
● Measurement range	Auto switching
● IMRR	At least 120 dB when the frequency is 1 Hz to 60 Hz and signal source impedance ≤ 1 Ω Attenuation when signal ground potential change (vs. case) is mixed into the signal
● Dynamic range	At least 120 dB When the frequency is 1 Hz to 100 kHz, integration time ≥ 10 s and ≥ 100 cycles Signal magnitude ratio when 10 Vpeak signals are input to 3 of 4 channels while the remaining channel is terminated at a signal source impedance of up to 1 Ω.
● Isolation	
Insulation voltage	42 Vpk or 30 Vrms, DC to 100 kHz continuous Among each channel input in the analyzer block (signal, GND), oscillator output (signal, GND), and the case
Case-to-oscillator electrostatic capacitance	300 pF or less

8.3 Analysis Processing Block

- Analysis frequency: 0.1 mHz to 100 kHz (same as oscillator block)
- Measurement items
  - Spot measurement: Gain (dB), phase (deg), real part of gain (ratio), imaginary part of gain (ratio)
  - Sweep measurement: Gain (dB), phase (deg)
- Measurement value range

For gain (dB)	Range: ±199.99 dB, Resolution: 0.01 dB
For phase	Range: ±180.00 deg, Resolution: 0.01 deg
Real/imaginary part of gain	Range: 0, ±(1.00000E – 09 to 9.99999E + 09), Resolution: 6 digits

- Integration time: Shortest integer cycle above the longer of the following settings
  - Cycle setting range: 1 to 999 cycles
  - Time setting range: 0.01 to 999.99 s
- Ratio accuracy

Gain ±0.05 dB (±0.5 %)/phase ±0.3 deg	When the frequency is 0.1 Hz to 20 kHz
Gain ±0.15 dB (±1.5 %)/phase ±1 deg	Other than the above range

  Input signal level ≥ 10 mVrms,
  When self calibration is performed after a 30 minutes warm up
- Sweep points: 3 to 1000 points

* Analysis is performed using CH1 as the reference.

8.4 Measurement Processing Block

- Measurement operation
  - Sweep: Performs measurement by sweeping a frequency between lower and upper limit frequencies
  - Spot: Performs measurement at a specific frequency
- Sweep control
  - Frequency axis: Linear/log
  - Sweep operation: UP (lower limit to upper limit)
    DOWN (upper limit to lower limit)
    STOP (stop measurement)
- Delay time: Time from frequency change to start of signal measurement
  - Setting range: 0.00 to 999.99 s

8.5 Setting Memory

- Memory contents: Saves current settings.

8.6 Remote Control Interface

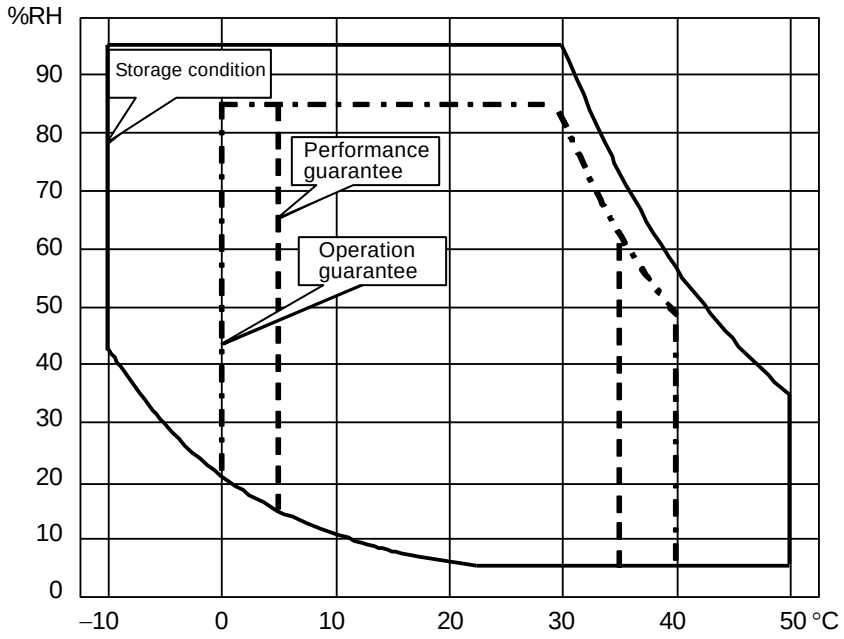
- GPIB — IEEE 488.1, IEEE 488.2
- USB — USBTMC, USB 1.1 full speed
- RS-232 — Parity: none/even/odd
  Stop bit: 1 bit/2 bits
  Baud rate: 1,200/4,800/9,600/38,400 bps
  Data is fixed to 8 bit, flow control is fixed to xon/xoff.

For all I/F, message terminator is fixed to LF.

A LAN (Telnet) can be connected via an RS-232/LAN converter (Lantronix UDS1100 general-purpose device server).

8.7 General Items

- Memory backup — Settings are retained after power-off
  - Battery life — 3 years (Replaced at your expense when it is exhausted)
- Power supply
  - Voltage range — AC 100 to 230 V ±10 %, but 250 V max.
  - Frequency range — 50/60 Hz ±2 Hz
  - Power consumption — 70 VA max.
  - Overvoltage category — II
- Environmental conditions
  - Altitude — Up to 2,000 m above sea level
  - Temperature and humidity ranges
    - Performance guarantee — Temperature: +5 to +35 °C; Humidity: 5 to 85 % RH, where absolute humidity is 1 to 25 g/m^3, with no condensation
    - Operation guarantee — Temperature: 0 to +40 °C; Humidity: 5 to 85 % RH, where absolute humidity is 1 to 25 g/m^3, with no condensation
    - Storage condition — Temperature: –10 to +50 °C; Humidity: 5 to 95 % RH, where absolute humidity is 1 to 29 g/m^3, with no condensation



● Warm-up time	30 minutes, accuracy specification applies after warm-up
● Pollution degree	2 (indoor use)
● Safety	EN 61010-1
	EN 61010-2-030
● EMC	EN 61326-1 (Group 1, Class A)
	EN 61000-3-2
	EN 61000-3-3
● RoHS	Directive 2011/65/EU
● External dimensions	434 (W) × 88 (H) × 403 (D) mm (Projections are not included.)
● Weight	Approximately 8 kg (Accessories are not included.)

Note: Optional goods and related products are subject to change or discontinuation without prior notice. For information on ordering, contact NF Corporation or a sales representative.

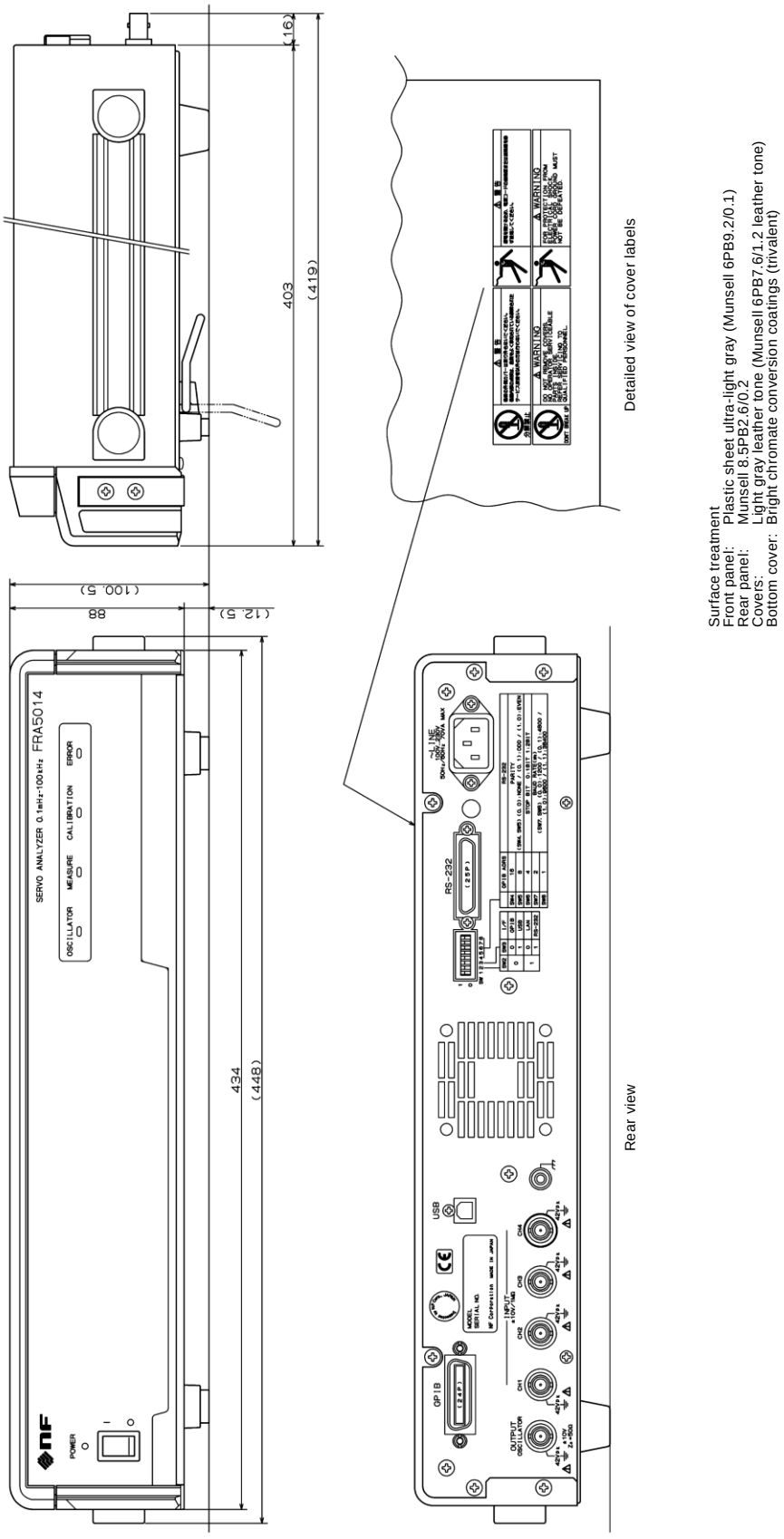


Figure 8-1. External Dimensions Diagram

WARRANTY

NF CORPORATION certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory.

All **NF** products are warranted against defects in materials and workmanship for a period of one year from the date of shipment. During the warranty period of, **NF** will, at its option, either will repair the defective product without any charge for the parts and labor, or either repair or replace products which prove to be defective. For repair service under warranty, the product must be returned to a service center designated by **NF**. Purchaser shall prepay all shipping cost, duties, and taxes for the product to **NF** from another country, and **NF** shall pay shipping charge to return the product to purchaser.

This warranty shall not apply to any defect, failure or damage caused by improper use, improper or inadequate maintenance and care or modified by purchaser or personnel other than **NF** representatives.

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If there are any misplaced or missing pages, we will replace the manual. Contact the sales representative.

NOTES:

- Reproduction of the contents of this manual is forbidden by applicable laws.
- The contents of this manual may be revised without notice.
- Information provided in this manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of this manual.
- We assume no responsibility for influences resulting from the operations in this manual.

FRA5014 Instruction Manual

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