



IMPEDANCE ANALYZER

ZA57630

**INSTRUCTION MANUAL
(ADVANCED)**

NF Corporation

DA00070169-001

IMPEDANCE ANALYZER

ZA57630

**INSTRUCTION MANUAL
(ADVANCED)**

Registered Trademarks

National Instruments, LabVIEW, and Measurement Studio are registered trademarks of National Instruments Corporation in the United States.

WINDOWS® EMBEDDED 8.1 INDUSTRY PRO

Used with permission from Microsoft.

Other company names and product names used in this instruction manual may be trademarks or registered trademarks of their respective companies.

Copyright

NI Measurement Studio

Copyright (C) 2019 National Instruments Corporation

All Rights Reserved.

— Preface —

Thank you for purchasing the "ZA57630 IMPEDANCE ANALYZER".

For safe and correct use of this product, please read the "Safety Precautions" section that follows before attempting to use this instrument.

■ Marks and symbols

For safe operation by the user and to prevent damage to this instrument, please give attention to the following marks and symbols that are used in this manual.

WARNING

This mark indicates information for preventing the possibility of death or serious personal injury from electrical shock or other hazards or damage to this instrument in the use or handling of this instrument.

CAUTION

This mark indicates information for preventing the possibility of injury to the user or damage to this instrument and the use for handling of this instrument.

■ The scope of this Manual

This manual describes the ZA57630 that conform to requirements of CE marking.

Products without CE marking affixed, may not meet directives for CE marking (EMC and others).

Please confirm the CE marking is affixed on the rear panel.

- The manuals provided for the ZA57630 are listed below.
 - Instruction manual (Basics)

This manual describes operation of the ZA57630 from this instrument's control panel, specifications, and other basic matters.

If you're using this equipment for the first time, begin reading from Chapter 1.
 - Instruction manual (Advanced)

This manual describes more advanced operation and maintenance.
 - Instruction manual (Remote Control)

This manual describes remote control of the ZA57630

Basics

1. Introduction

This chapter provides a general description of this instrument, including its features, applications, functions, and basic operating principles.

2. Preparation before use

This chapter describes important preparation that must be done before operating this instrument.

3. Panel operations

This chapter explains the function, operating procedure, default values, and measurement values for each part of the display screen. Read this chapter for a quick overall understanding of the panel and its use.

4. Basic operation

This chapter explains the basic operating procedures of the ZA57630. Refer to this chapter as you use this instrument.

5. Specifications

This chapter describes this instrument specifications (functions and performance).

Advanced

1. Advanced operation

This chapter explains a wider range of operations.

2. File formats

This chapter explains the various file formats for saving data in external storage devices (USB memory device).

3. Troubleshooting

This chapter describes how to deal with error messages and cases in which you think this instrument is malfunctioning.

4. Maintenance

This chapter explains maintenance, repacking, transportation, and performance testing methods.

———— Safety Precautions ————

For safe use of this product, give full attention to the following warnings and cautions.

The NF Corporation shall not be held liable for damages that arise from failure to observe these warnings and cautions.

This product is a Class I device (with protective conductor terminal) that conforms to the IEC insulation standards.

- Be sure to observe the instructions in the instruction manual.

This instruction manual contains information for the safe operation and use of this product.

Read the instructions and information before using the product.

All of the warning items contained in this instruction manual are intended to avoid risks that may lead to serious accidents. Follow the warnings and instructions carefully.

- Be certain that the product is properly grounded.

This product uses a line filter which may cause electric shock if the product is not grounded.

To prevent electrical shock accidents, connect the product to an earth ground so that ground resistance is 100 Ω or less.

This product is automatically grounded by connecting a 3-pin power plug to a power outlet with a protective ground contact.

- Check the power supply voltage.

This instrument operates on the power source voltage described in "2.3 Grounding and Power Connections" in the Basics Instruction Manual.

Before plugging in the power cord, confirm that the outlet voltage conforms to the rated voltage of this instrument.

- If you think something is wrong, ...

If smoke or an unusual odor or sound comes from this instrument, immediately remove the power cord from the socket and cease use of this instrument.

If any such abnormality occurs, take measures to prevent the use of this instrument until repairs have been completed and promptly contact the NF Corporation or its authorized agent.

- Do not use this product when gas is present.

Operating this instrument in the presence of flammable gases may cause an explosion.

- Do not open the product case.

To prevent exposure to high voltages, never remove the cover of this instrument.

Only technicians certified by the NF Corporation are authorized to inspect or touch anything inside the product case.

- Do not modify this product.

Never modify this product in any way. Modification might create new risks. The NF Corporation may refuse to service an instrument that has an unauthorized modification.

- Do not expose this product to water.

Use of this product when it is wet may result in electrical shock or fire. If this instrument becomes wet, immediately unplug the power cord and contact the NF Corporation or its authorized agent.

- If lightning occurs nearby, turn off the power switch and unplug the power cord.

A lightning strike may cause electrical shock, fire, or instrument malfunction.

- Safety-related symbols

The marks and codes defined below are used in this manual or on this instrument itself to indicate safety information or instructions.



Instruction manual reference symbol

This notifies the user of a potential hazard and indicates that the user must refer to the instruction manual.



Electric shock danger symbol

This symbol indicates a location that presents a risk of electric shock under specific conditions.



Warning symbol

This contains information to avoid risks when handling the equipment that could result in the death or serious injury of the operator.



Caution symbol

This contains information to avoid risks when handling the equipment that could result in minor or moderate injury of the operator or damage to property.

- Other symbols



Indicates that the "ON" position of the power switch



Indicates the "OFF" position of the power switch



Indicates that the outer conductor of the connector is connected to this instrument enclosure.



Indicates that the outer conductor of the connector is isolated from this instrument enclosure. However, safe operation of this instrument requires that the potential difference from the grounding potential is restricted to 42 Vpk or less.

This product is grounded when in use, so the electrical potential of this instrument enclosure is equal to the ground potential.

- **Electromagnetic compatibility**

This product is a CISPR 11 Group 1 Class A compliant instrument. It should not be used outside industrial environments. Use of this product in ordinary office or residential areas may result in electromagnetic interference with other devices.

- **Disposal of this product**

To protect the environment, follow the guidelines described below for the disposal of this product.

- a) This device is equipped with a lithium battery. Use the services of an industrial waste disposal contractor to dispose of such batteries.
- b) The LCD backlight module that is used in this product does not contain mercury.
- c) Use the services of an industrial waste disposal contractor for disposal of the entire product.

Contents

	Page
1. Advanced Operation	1-1
1.1 Measurement Time Setting	1-2
1.2 Delay Settings	1-3
1.3 Input Settings	1-4
1.4 Measurement Signal Controls	1-8
1.5 Automatic High Density Sweep	1-14
1.6 Graph Display	1-16
1.7 Marker Operations	1-26
1.8 Error Correction	1-34
1.9 Sequence Measurement	1-62
1.10 Resonant Frequency Tracking Measurement	1-64
1.11 Equivalent Circuit Estimation	1-67
1.12 Calculating Piezoelectric Constants	1-69
1.13 Relative Permittivity Measurement	1-74
1.14 Relative Permeability Measurement	1-75
1.15 Comparator	1-77
1.16 Handler Interface	1-85
1.17 Memory Operations	1-91
1.18 External Reference Clock	1-107
1.19 AUX Port Settings	1-109
1.20 Other Operations	1-110
2. File Formats	2-1
2.1 General	2-2
2.2 Measurement Data File Format	2-2
2.3 Measurement Condition File Format	2-7
2.4 Equivalent Circuit File Format	2-16
2.5 Piezoelectric Constant File Format	2-17
2.6 Marker Information File Format	2-19
2.7 Screen Image File Format	2-20
3. Troubleshooting	3-1
3.1 Error Messages	3-2
3.2 Information Messages	3-8
3.3 Troubleshooting	3-11
4. Maintenance	4-1
4.1 Preface	4-2

Contents

4.2 Daily Maintenance	4-3
4.3 Storage, Repacking, and Transportation.....	4-3
4.4 Checking the Version Number	4-4
4.5 Performance Test.....	4-5
4.6 Calibration.....	4-25

Figures and Tables

	Page
Figure 1-1 Example of Response Waveform Requiring Delay.....	1-3
Figure 1-2 Waveform when Output Turns Off while 0° SYNC Is Set.....	1-9
Figure 1-3 Change in Output Voltage when SLOW	1-10
Figure 1-4 Frequency Change Mode Setting and Change in Waveform	1-11
Figure 1-5 Example of Using ALC (Measurement Mode: IMPD-EXT)	1-13
Figure 1-6 Example of Measurement Using Automatic High Density Sweep	1-14
Figure 1-7 Graph Display Styles.....	1-17
Figure 1-8 Examples of Phase Measurement.....	1-19
Figure 1-9 Differences in Group Delay Display Due to Aperture Setting.....	1-21
Figure 1-10 Example of Auto Store.....	1-25
Figure 1-11 Switching Marker Display	1-27
Figure 1-12 Marker Search Example (Bode Plot, MAX / MIN / PEAK / BOTTOM).....	1-28
Figure 1-13 Marker Search Example (Bode Plot, Y1 VALUE)	1-29
Figure 1-14 Marker Search Example (Bode Plot, Δ Y1 VALUE).....	1-29
Figure 1-15 Marker Search Example (Bode Plot, BW1)	1-29
Figure 1-16 Marker Search Example (Bode Plot, BW2)	1-30
Figure 1-17 Marker Search Example (Bode Plot, BW3)	1-30
Figure 1-18 Marker Search Example (Nyquist Plot, X MAX / PEAK / VALUE)	1-31
Figure 1-19 Marker Search Example (Nyquist Plot, Δ X).....	1-31
Figure 1-20 Error Correction Data Flow (Measurement Mode: IMPD-EXT).....	1-34
Figure 1-21 Error Correction Data Flow (Measurement Mode IMPD-3T or IMPD-2T)	1-34
Figure 1-22 Error Correction Data Flow (Measurement Mode: G-PH).....	1-34
Figure 1-23 Connection for Self-calibration	1-36
Figure 1-24 Description of Open Correction and Short Correction	1-40
Figure 1-25 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-EXT).....	1-41
Figure 1-26 Example of Protection Resistor for Measuring Open / Short Correction Data	1-41
Figure 1-27 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-3T (1)).....	1-42
Figure 1-28 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-3T (2)).....	1-42
Figure 1-29 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-2T)	1-43
Figure 1-30 Load Correction Operation	1-47
Figure 1-31 Example of Port Extension in IMPD-2T Measurement Mode	1-53

Figure 1-32 Operation of Slope Compensation Function.....	1-57
Figure 1-33 Examples of Potential Fluctuation Waveforms That Cannot Be Eliminated.....	1-58
Figure 1-34 Gain and Phase Measurement Connection Example.....	1-59
Figure 1-35 Connections to Measure the Measurement System Errors.....	1-59
Figure 1-36 Piezoelectric Vibrator Measurement Connection Example.....	1-64
Figure 1-37 Search Frequency Range Setting ([POLARITY] = POSITIVE).....	1-65
Figure 1-38 Equivalent Circuit Estimation Examples.....	1-68
Figure 1-39 Example of Frequency Sweep for Which Piezoelectric Constant Calculation Is Possible.....	1-69
Figure 1-40 Position of Each Frequency on Complex Admittance Plane.....	1-71
Figure 1-41 Layout of Piezoelectric Constant Calculation Window.....	1-71
Figure 1-42 Example of Dielectric Substance DUT with Large Error.....	1-74
Figure 1-43 Example of Toroidal Core.....	1-76
Figure 1-44 Bin Sorting Screen Example.....	1-77
Figure 1-45 Limit Comparison Screen Example.....	1-80
Figure 1-46 Zone Comparison Screen Example (When Frequency Sweep).....	1-81
Figure 1-47 Zone Comparison Result Examples.....	1-81
Figure 1-48 Handler Interface Measurement Start Timing.....	1-87
Figure 1-49 Handler Interface Operation Timing (Measurement Synchronous Driving: Off).....	1-87
Figure 1-50 Handler Interface Operation Timing (Measurement Synchronous Driving: On).....	1-88
Figure 1-51 Handler Interface Test Screen.....	1-90
Figure 1-52 Handler Interface Test Screen.....	1-90
Figure 2-1 Structure of Measurement Data File (without Sequence Measurement).....	2-2
Figure 2-2 Structure of Measurement Data File (with Sequence Measurement).....	2-3
Figure 2-3 Structure of Measurement Condition File.....	2-7
Figure 2-4 Structure of Equivalent Circuit File.....	2-16
Figure 2-5 Structure of Piezoelectric Constant File.....	2-17
Figure 2-6 Structure of Marker Information File.....	2-19

Table 1-1 Open and Short Correction Frequencies in IMPD-3T and IMPD-2T Measurement	
Modes	1-46
Table 1-2 Errors due to Potential Slope (Theoretical Values)	1-57
Table 1-3 Equivalent Circuit Types	1-67
Table 1-4 Piezoelectric Constant Calculation Function List	1-72
Table 1-5 Deviation Mode Settings and Sorting Value Interpretation Example	
(Example of C).....	1-79
Table 1-6 Handler Interface Output when Bin Sorting.....	1-85
Table 1-7 Handler Interface Output when Limit Comparison	1-85
Table 1-8 Handler Interface Output when Zone Comparison.....	1-86
Table 1-9 Handler Interface Timing.....	1-87
Table 1-10 Handler Interface Terminal State when Comparator Is Disabled.....	1-89
Table 2-1 Data File Format (Header Part).....	2-3
Table 2-2 Data File Format (Measurement Conditions Part).....	2-4
Table 2-3 Data File Format (Measurement Data Part).....	2-5
Table 2-4 STATUS Information	2-6
Table 2-5 Measurement Condition File Format (Header Part)	2-7
Table 2-6 Measurement Condition File Format (Measurement Conditions Part).....	2-7
Table 2-7 Equivalent Circuit File Format (Header Part)	2-16
Table 2-8 Equivalent Circuit File Format (Equivalent Circuit Data Part).....	2-16
Table 2-9 Piezoelectric Constant File Format (Header Part).....	2-17
Table 2-10 Piezoelectric Constant File Format (Piezoelectric Vibrator Data Part).....	2-17
Table 2-11 Marker Information File Format (Header Part)	2-19
Table 2-12 Marker Information File Format (Marker Information Data Part)	2-19
Table 3-1 Power-On Errors	3-2
Table 3-2 Panel Operation Errors	3-3
Table 3-3 Measurement Errors	3-6
Table 3-4 Other Errors	3-7
Table 3-5 Startup Messages	3-8
Table 3-6 Operation Messages.....	3-8
Table 3-7 In Case of Suspected Anomaly	3-11

1. Advanced Operation

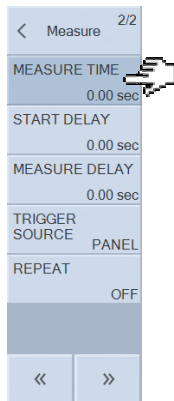
1.1	Measurement Time Setting	1-2
1.2	Delay Settings	1-3
1.3	Input Settings	1-4
1.4	Measurement Signal Controls	1-8
1.5	Automatic High Density Sweep	1-14
1.6	Graph Display	1-16
1.7	Marker Operations	1-26
1.8	Error Correction.....	1-34
1.9	Sequence Measurement	1-62
1.10	Resonant Frequency Tracking Measurement.....	1-64
1.11	Equivalent Circuit Estimation.....	1-67
1.12	Calculating Piezoelectric Constants	1-69
1.13	Relative Permittivity Measurement.....	1-74
1.14	Relative Permeability Measurement.....	1-75
1.15	Comparator	1-77
1.16	Handler Interface.....	1-85
1.17	Memory Operations.....	1-91
1.18	External Reference Clock.....	1-107
1.19	AUX Port Settings	1-109
1.20	Other Operations.....	1-110

1.1 Measurement Time Setting

This instrument performs discrete Fourier transform (DFT) of the voltage or current waveforms of the device under test (DUT) and then calculates and displays the impedance from the obtained voltage amplitude or current amplitude and phase difference. By nature, DFT essentially removes harmonics (distortion components) and noise. However, when the voltage or current amplitude is small, measurement errors increase due to influences such as noise generated inside this instrument. In such cases, measurement with higher accuracy is possible by setting a longer measurement time.

Influence due to white noise is reduced in rough proportion to the square root of the measurement time setting. Noise components other than the measurement frequency component are also reduced by increasing the measurement time, but this naturally increases the time required for measurement.

Set the measurement time in seconds in [Measure]—[MEASURE TIME].



Usually, there will be no problem if you leave the measurement time set to 0 s, but increase it for measurement with higher accuracy or when measuring in an environment with a lot of noise. The actual measurement time will be the time rounded to the integer cycle of the measurement signal frequency.

The set measurement time is the setting for the waveform acquisition time to perform the DFT process. In actual measurement, time will be required for auto range processing and data processing inside this instrument and screen display in addition to the set measurement time. When 0 s is set for both the measurement time and the measurement delay time with fixed measurement range, the total time per measurement point will be approximately the following time depending on the sweep item setting.

Frequency sweep	From 0.5 ms/point
Signal amplitude sweep	From 2 ms/point
DC bias sweep	From 3 ms/point
Zero span sweep	From 0.5 ms/point

Please note that the measurement accuracy specifications of this instrument differ depending on the measurement time setting. For details, refer to “5. Specifications” in Instruction Manual (Basics).

1.2 Delay Settings

If the measurement frequency, amplitude, or DC bias is changed as the sweep progresses when measuring a DUT with a slow response, a transient response causes an error in the measurement results. This instrument has a function to reduce this error by inserting a delay after the frequency, amplitude, or DC bias is changed and before the measurement is started. Set the delay time to match the response characteristics of the DUT. A DUT with abrupt changes in characteristics, such as a crystal oscillator, cannot be measured accurately unless a large delay is set.

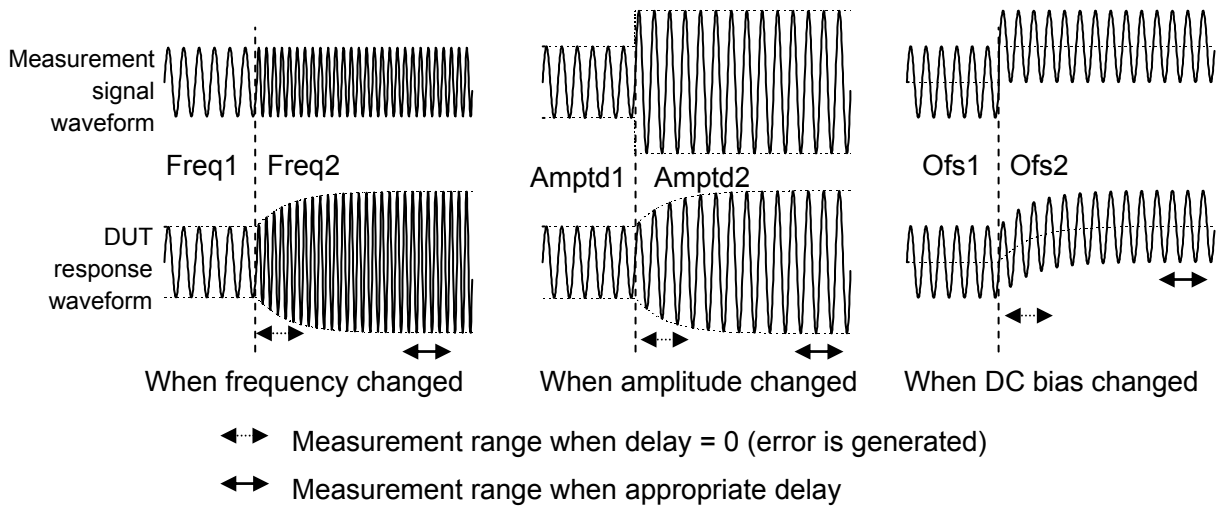
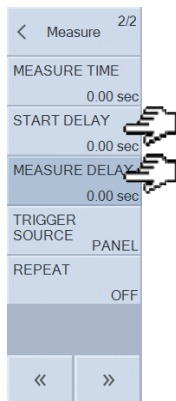


Figure 1-1 Example of Response Waveform Requiring Delay

A delay needs to be considered for during sweep measurement, when a sweep starts, when the measurement signal is changed in spot measurement, when a DUT with a large time constant (e.g., electrolytic capacitor) is connected, etc. There are two delay settings: measurement start delay (START DELAY) and measurement delay (MEASURE DELAY), and the two types of delay differ in the timing with which the delay takes effect. Both delays are set in the [Measure] menu.



[START DELAY] : This delay time is inserted only at the start of sweep measurement or at the start of spot measurement.

[MEASURE DELAY]: This delay time is inserted each time a parameter changes during a sweep.

Find the appropriate delay time by performing measurement while increasing the delay time little by little. An appropriate delay time is one with a little time to spare so that large differences in measurement results do not occur.

1.3 Input Settings

1.3.1 Measurement Range Settings

The setting values and ranges for the measurement range settings differ depending on the measurement mode.

(Measurement mode IMPD-EXT or G-PH)

Set each of the measurement voltage ranges of PORT1 and PORT2 independently. The possible setting range is shown below.

Fixed range: 1-2-5 sequences in the range from 10 m to 5 Vrms, and 7 Vrms

Auto range: AUTO

For the maximum input voltage of each range, the peak voltage including DC voltage is about 1.4 fold of the range nominal value.

The value of each range is the maximum measurement voltage level for the input connectors of this instrument, and is not related to the input weighting factor setting (refer to “1.8.2 Input Weighting”).

Configure the settings in [Range]—[RANGE PORT1] / [RANGE PORT2].

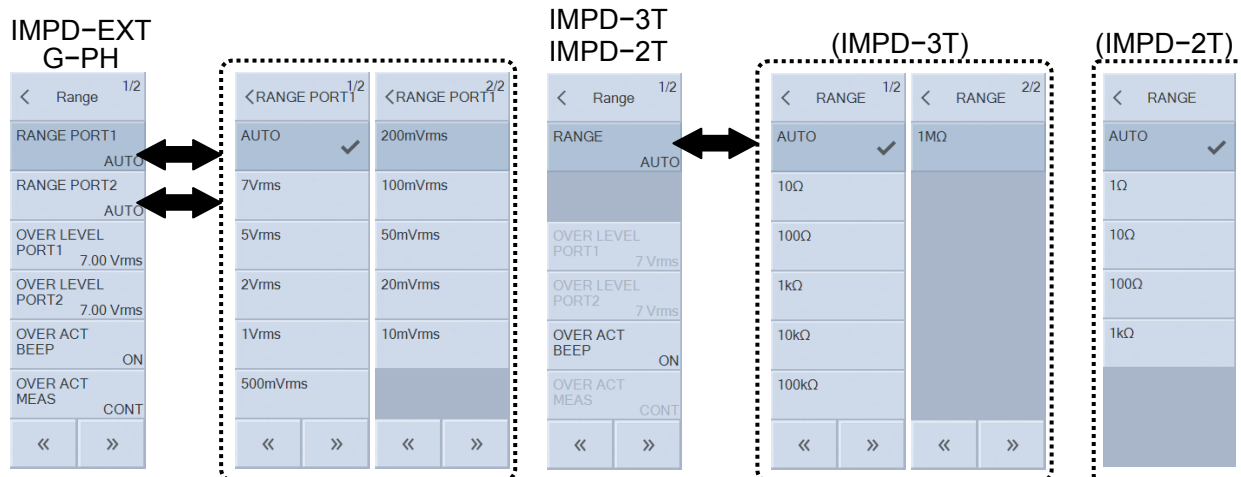
(Measurement mode IMPD-3T or IMPD-2T)

Set the impedance measurement range. The possible setting range is shown below.

Fixed range: Set a range of 10 Ω to 1 MΩ (when IMPD-3T)/1 Ω to 1 kΩ (when IMPD-2T) with a 1-decade resolution.

Auto range: AUTO

Configure the setting in [Range]—[RANGE].



■ Fixed range

Discontinuities (steps) in the measurement values from before and after range changes do not occur because the range does not change during measurement. However, the measurement accuracy will decrease if measurement significantly different from the range full scale is performed.

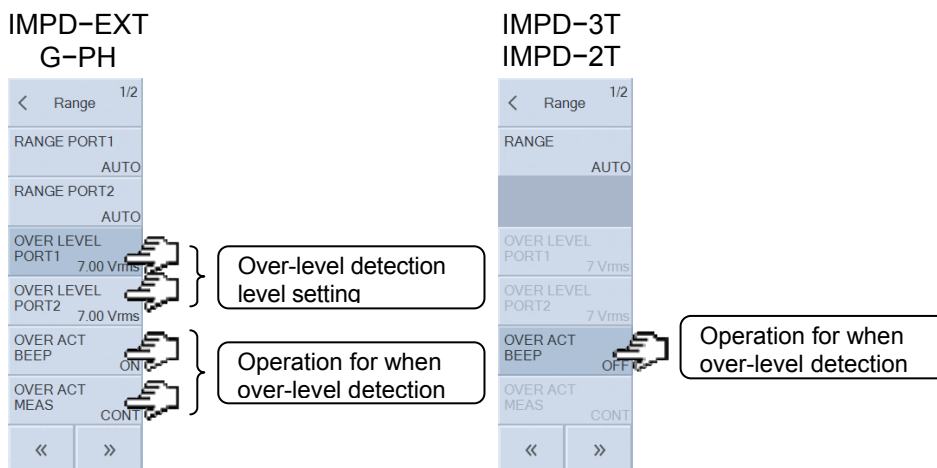
■ Auto range

Perform the measurement while monitoring the measurement results and setting the range to find the optimal range. When the measurement mode is IMPD-EXT or G-PH, expand the range and repeat the measurements if external noise or a DC component that exceed the range is detected.

When a large dynamic range is required (the variations in the measurement data are significant), auto range should be used. Normally, use this instrument with auto range set.

1.3.2 Over-level Detection

This can be set when the measurement mode is IMPD-EXT or G-PH. This function monitors the input signal amplitude and performs operations such as sounding the buzzer when the signal exceeds the set amplitude.



■ Setting the over-level detection level

This can be set when the measurement mode is IMPD-EXT or G-PH.

Configure the setting in [Range]—[OVER LEVEL PORT1] / [OVER LEVEL PORT2]. This has a setting range of up to 7 Vrms and can be set independently for PORT1 and PORT2. It is not related to the input weighting factor setting (refer to “1.8.2 Input Weighting”), and is set as the signal amplitudes input to PORT1 and PORT2 of this instrument.

When the measurement range is set to a fixed range, an input signal that exceeds that range will trigger over-level detection even if it is smaller than the level set here. The DC component and sudden spike noise will also trigger over-level detection. In an environment where the noise or DC component is large, set a wide measurement range or use auto range.

■ Setting the operation for when over-level detection

When over-level is detected, the over-level occurrence message appears on the LCD. In addition to displaying a message, this instrument can also perform the following operations.

- Sound the buzzer.
- Stop measurement (when the measurement mode is IMPD-EXT or G-PH).

Configure the settings in [Range]—[OVER ACT BEEP] and [Range]—[OVER ACT MEAS], respectively. If the measurement stop operation ([Range]—[OVER ACT MEAS]) is set to [STOP], sweep measurement and spot measurement are stopped upon over-level detection. If [OSC]—[ON/OFF SYNC] is set to [SYNC], measurement signal output is turned off together with the stopping of measurement.

■ Measurement data when over-level is detected

The measurement data for which over-level was detected is indicated as “NaN” (Not a Number). The measurement data for which over-level was detected is not plotted on the

graph.

Even if measurement is stopped as a result of over-level detection, the data from the start of the sweep to the over-level is retained. When not stopping measurement upon over-level detection is set, the measurement data for which over-level was detected in the sweep data is indicated as NaN. The measurement data that is stored in the USB memory device is also indicated as NaN.

■ Over-level detection in measurement mode IMPD-3T or IMPD-2T

When the measurement mode is IMPD-3T or IMPD-2T, the over-level detection level is determined internally and cannot be changed. If over-level is detected in either of these modes, move this instrument or DUT away from the source of the noise. If auto range is set or the measurement signal amplitude is set high, there will also be cases where over-level will be less likely to occur.

■ Timing of over-level detection

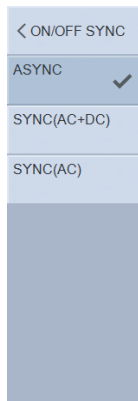
This instrument detects whether the level is over or not over (normal state) at the point in time when measurement is performed. Therefore, this instrument will maintain the over-level state even if measurement signal output is turned off after over-level is detected.

1.4 Measurement Signal Controls

For the basic settings (frequency, AC amplitude, and DC bias) and on/off operation, refer to “4.3 Setting Measurement Signals” in Instruction Manual (Basics). This section describes more advanced measurement signal control.

1.4.1 Measurement Synchronous Drive

This function automatically turns measurement signal output on at the start of measurement and off at the end of measurement. Since a measurement signal is output only during measurement, you can use this when applying a measurement signal to the DUT for a long period of time is undesirable. Configure the setting in [OSC]—[ON/OFF SYNC].



[ASYNC] : Do not control the measurement signal output at the start of measurement and at the end of measurement.

[SYNC(AC+DC)] : Control the measurement signals of both AC amplitude and DC bias.

[SYNC(AC)] : Control the measurement signal output of only AC amplitude.

Set this to SYNC(AC) when changing the DC bias during measurement is undesirable (when frequency sweep or AC amplitude sweep).

Operation is performed in the following order when this is set to SYNC(AC+DC) or SYNC(AC).

Measurement process is started (UP, DOWN, or SPOT key is pressed).



Measurement signal output turns on.



Measurement starts.



Measurement ends.

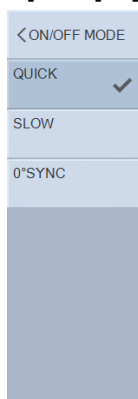


Measurement signal output turns off.

During sequence measurement execution (refer to “1.9 Sequence Measurement”) and repeat measurement, the output turns off once every time each sweep measurement or spot measurement ends.

1.4.2 ON/OFF Mode

This sets the operation for when measurement signal output is turned on/off. Configure the setting in [OSC]—[ON/OFF MODE].



[QUICK] : Turn the output on or off immediately.

[SLOW] : Change the AC amplitude or DC bias gradually over a period of approximately 10 seconds.

[0° SYNC]: When output is turned off, turn it off after waiting until the 0° phase of the waveform.

Set this to SLOW when sudden changes in the signal amplitude are undesirable, such as during mechanical impedance measurement, etc. In electrochemical measurement, set this to 0° SYNC when changes in the charge due to the measurement signals before and after measurement are undesirable.

The following figure shows the difference in the waveform when output turns off while QUICK is set and while 0° SYNC is set.

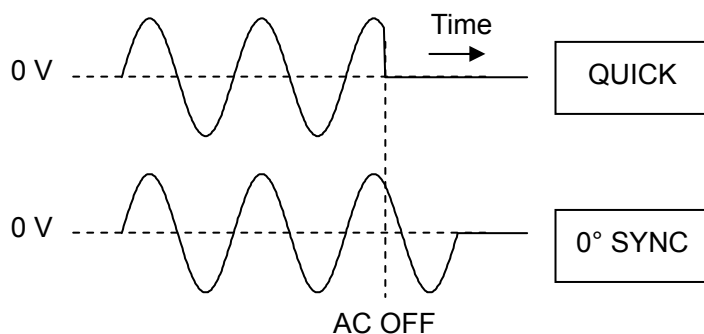


Figure 1-2 Waveform when Output Turns Off while 0° SYNC Is Set

When 0° SYNC is set, please note that it may take approximately one cycle of the signal for the output to actually turn off depending on the timing of turning the output off. For 10 μ Hz, it will take 10^5 s \approx 28 hours to turn off in the worst case.

Please also note that the actual oscillation stop phase may deviate more from 0° if the measurement signal frequency becomes higher than approximately 100 kHz.

The following figure shows an example of operation when this is set to SLOW.

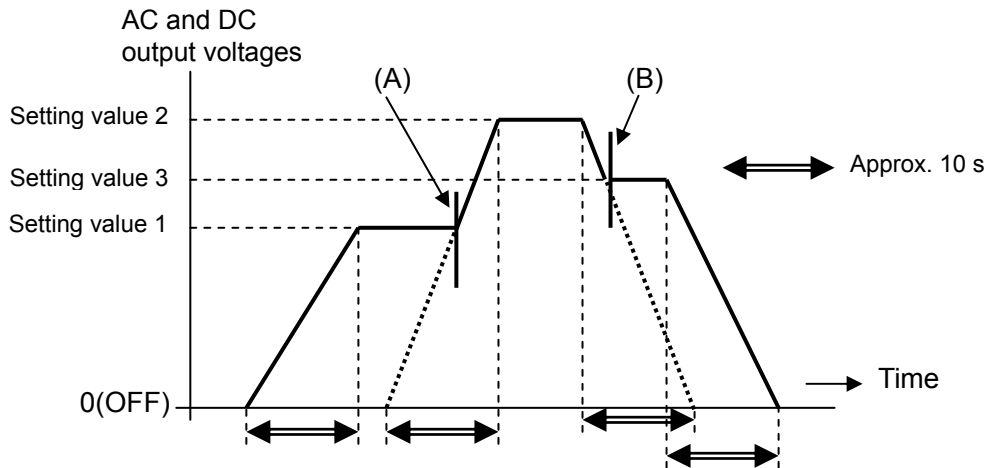


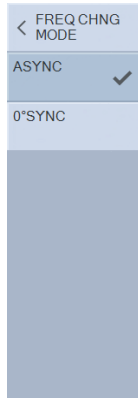
Figure 1-3 Change in Output Voltage when SLOW

When the off state is included before and after the change, such as when changing from the output off state to the output on state or from the output on state to the output off state, the measurement signal outputs (both AC and DC) change continuously. However, please note that when the off state is not included before and after the change (setting value 1 → setting value 2 → setting value 3), discontinuous spike noise of approximately 10 ms is generated in the measurement signal outputs at the timing indicated by (A) and (B) in the figure above. This spike noise can be prevented by turning the outputs off, changing the settings, and then turning the output on.

The **AC** and **DC** lamps on the front panel flash during the SLOW change or during the 0° SYNC wait.

1.4.3 Frequency Change Mode

You can set the timing to change the frequency during frequency sweep measurement or the timing to change the frequency when the frequency setting is changed. Configure the setting in [OSC]—[FREQ CHNG MODE].



[ASYNC] : Change the frequency immediately regardless of the measurement signal phase.

[0° SYNC] : Change the frequency after waiting until the 0° phase of measurement signal output. The average voltage (DC component) between the start and end of the frequency sweep becomes zero.

When 0° SYNC is set, please note that it may take approximately one cycle of the signal for the frequency to actually change depending on the timing of changing the frequency (for 10 μ Hz, it will take 10^5 s \approx 28 hours for the frequency to change in the worst case).

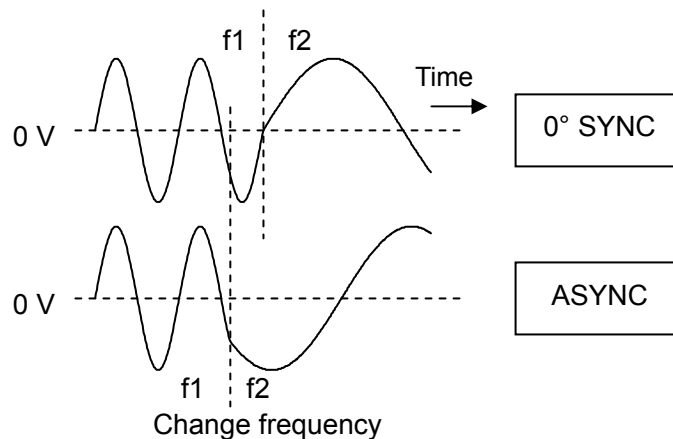


Figure 1-4 Frequency Change Mode Setting and Change in Waveform

The 0° SYNC setting is used for measurement such as electrochemical impedance measurement (EIS). The total amount of electricity injected into the DUT at the start and end of the frequency sweep does not change.

Please also note that the actual frequency switch may deviate more from 0° if the measurement signal frequency becomes higher than approximately 100 kHz.

The frequency indication on the LCD flashes while in the state of waiting until after the 0° phase to change the frequency.

1.4.4 Automatic Level Control (ALC)

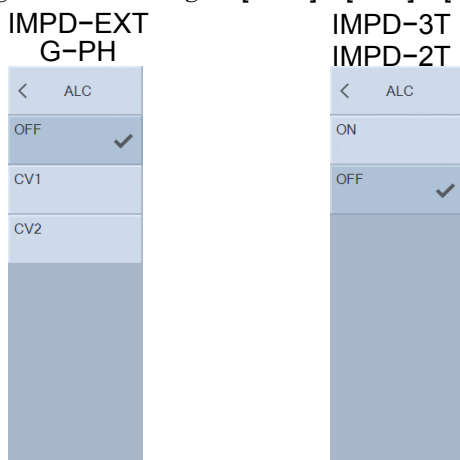
This function automatically controls the level so that the measurement signal amplitude applied to the DUT matches the amplitude set in [OSC]—[AMPLITUDE]. Use this function when you wish to perform measurement with the voltage/current amplitude of the DUT in a constant state by correcting the frequency characteristics of the measurement cable and DUT drive amplifier (when the measurement mode is IMPD—EXT).

ALC : Automatic Level Control

CV : Constant Voltage

CC : Constant Current

Configure the setting in [OSC]—[ALC]—[ALC].



Measurement is performed with the current settings and then the operation to perform measurement again is repeated while adjusting the measurement signal amplitude until the difference from the amplitude set in [OSC]—[AMPLITUDE] comes within the permissible error. The ALC operation is performed as follows depending on the measurement mode.

[ALC]: Set the ALC operation mode.

(Measurement mode IMPD—EXT or G—PH)

[OFF] Do not perform ALC. (Initial value)

[CV1] Automatically control the measurement signal amplitude so that the voltage amplitude input to PORT1 becomes constant.

[CV2] Automatically control the measurement signal amplitude so that the voltage amplitude input to PORT2 becomes constant.

(Measurement mode IMPD—3T or IMPD—2T)

[OFF] Do not perform ALC. (Initial value)

[ON] Perform ALC. Perform constant voltage (CV) control when the setting of [OSC]—[AMPLITUDE UNIT] is V (voltage), and constant current (CC) control when it is A (current).

[TOLERANCE]: Set the permissible error from the set amplitude. Amplitude control will be performed until the difference between the amplitude set in [OSC]—[AMPLITUDE] and the measured

- amplitude becomes this value or lower.
- [RETRY TIMES]: Set the maximum number of times to repeat. If the difference does not become within the permissible error even after exceeding this number of times, amplitude control will stop, but measurement results can still be obtained.
- [CORRECTION FACTOR]: Set the correction factor. Usually, use this instrument with this set to 100%. Amplitude control may not settle and an unstable state may result due to the response of the DUT. If that happens, reduce this value.

The figure below shows a connection example in the IMPD-EXT measurement mode. Controlling the amplitude for the input of PORT1 (CV1) enables measurement while the voltage amplitude applied to the DUT is kept constant. Controlling the amplitude for the input of PORT2 (CV2) enables measurement while the current is kept constant.

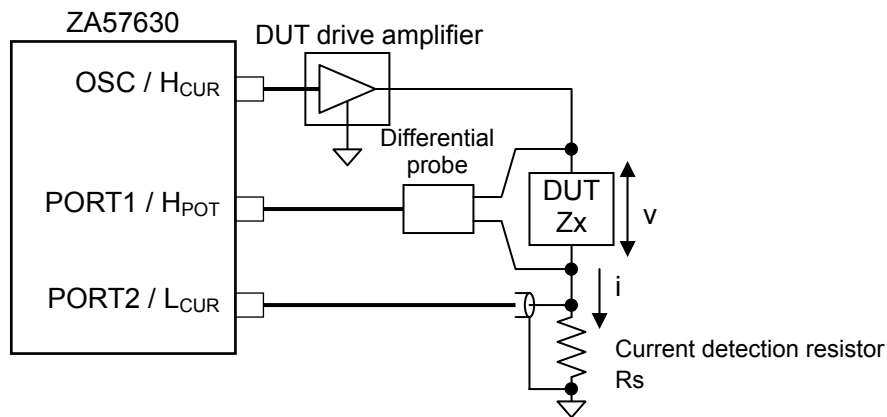


Figure 1-5 Example of Using ALC (Measurement Mode: IMPD-EXT)

■ When amplitude control could not be achieved

If the difference did not become within the permissible error even after exceeding the maximum number of repeat times or when an amplitude setting that exceeds the output amplitude limit has become necessary, amplitude control has failed, but measurement results can still be obtained. In sweep measurement, amplitude control is attempted again with the following sweep parameters (frequency/AC amplitude/DC bias).

■ When correction processing is performed

Even if corrections such as open correction, short correction, load correction, port extension, and equalizing are performed, they will have no effect on ALC operation. The same amplitude control as when measurement is performed with correction off will be performed.

1.5 Automatic High Density Sweep

When the measurement data changes significantly in frequency sweep measurement, this function automatically increases the density of sweep measurement only in the vicinity of that data. Increasing the measurement resolution only where necessary enables accurate results to be obtained in a short time. This function can be used only for a frequency sweep.

This function compares the amount of measurement data change between adjacent measurement points $|d_n - d_{n-1}|$ (where d_n is the measurement data at frequency f_n and d_{n-1} is the measurement data at frequency f_{n-1} immediately before) with the set threshold value [VARIATION]. If the threshold value is exceeded, a measurement frequency point is added between f_{n-1} and f_n and then measurement is performed again. The frequency density is increased automatically until the measurement data variation falls below the threshold. After frequency f_n , measurement is performed at the normal sweep density again.

The figure below shows an example of the automatic high density sweep measurement of the impedance characteristics of a crystal oscillator. The black dots (●) indicate the measurement data points. We can see that the frequency density is automatically made high only in the parts where there is a sudden change in the characteristics.

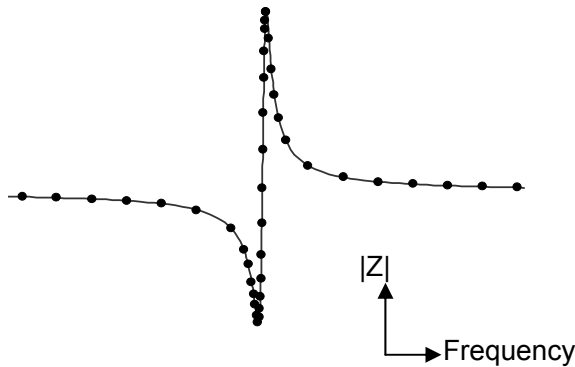


Figure 1-6 Example of Measurement Using Automatic High Density Sweep

Configure the automatic high density sweep settings in [Sweep]—[SLOW SWEEP].

<SLOW SWEEP ^{1/1}	
FUNCTION	OFF
TYPE	θ
VARIATION	10°

[FUNCTION] : Set this to ON when you wish to perform an automatic high density sweep. For normal sweep measurement, set this to OFF.

- [TYPE] : Set the parameter to be monitored.
- [VARIATION] : Set the parameter change threshold value. If the amount of change relative to the measurement value at the previous frequency exceeds the value set here, it is judged to be a sudden change and an automatic high density sweep is performed.

■ Example of automatic high density sweep setting

The measurement of the resonance characteristics of piezoelectric vibrators and crystal oscillators is an example of measurements where the automatic high density sweep is effective. The phase θ changes suddenly in the vicinity of the series/parallel resonant frequency. Accordingly, automatic high density measurement only in the vicinity of the resonant frequency is possible if the monitoring parameter [TYPE] is set to phase θ .

Try performing measurement with a change threshold value [VARIATION] of approximately 10° and then adjust it as necessary. Setting this to a smaller value will produce higher density results, but the measurement time will become longer.

■ Cautions for automatic high density sweep

- Setting [VARIATION] to a smaller value will increase the number of frequency points. If the maximum number of measurement points (20,001) for a high density sweep is exceeded, the -3072 error message is displayed and sweep measurement is ended at that time. Please take note of this because the measurement ends without reaching either the upper measurement frequency limit or lower measurement frequency limit. For details on error messages, refer to “3.1 Error Messages”.
- When the sweep item is other than frequency, an automatic high density sweep will not be performed even if [FUNCTION] is set to ON. Normal sweep measurement is performed instead.
- When sequence measurement is performed, an automatic high density sweep will not be performed even if [FUNCTION] is set to ON. Normal sweep measurement is performed instead. For details on sequence measurement, refer to “1.9 Sequence Measurement”.

1.6 Graph Display

1.6.1 Setting the Title

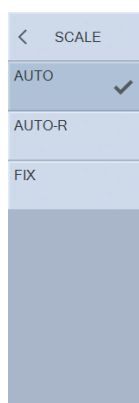
Set the title text for the data that is being displayed. The set text is displayed at the top of the graph. When the data is saved to the internal or external memory, the title is also saved together with the data.

Configure the title text setting in [Graph]—[TITLE SET]. Up to 32 characters can be input.

1.6.2 Setting the Scale

Set the display range of the X, Y1, and Y2 axes of a graph. Usually, the AUTO or AUTO-R setting is convenient, because the ranges are adjusted automatically to suit the data that is being displayed. The FIX setting allows the display range to be set to an arbitrary value.

Configure the setting in [Graph]—[SCALE].



[AUTO] : Automatically adjust the display range for each of the X, Y1, and Y2 axes.

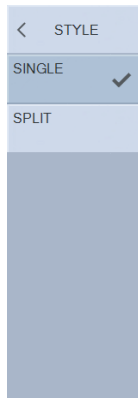
[AUTO-R]: An impedance locus or vector locus that becomes a semicircle in a Cole-cole plot or Nyquist plot is displayed so that it becomes a semicircular shape on the screen.

[FIX] : Manually set the display range for each of the X, Y1, and Y2 axes.

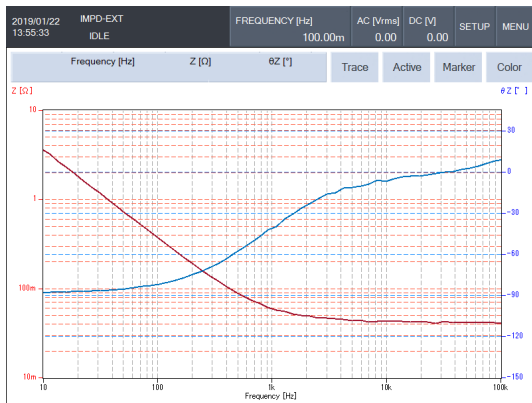
When you configure the range setting of each axis in [Graph]—[SCALE RANGE], a button for setting the graph axis range is displayed in the function keys. In addition to specifying a numerical value directly, you can set a graph range that matches the data range that is being displayed. For details on operating the function keys, refer to “3.5.5 Graph Menu” in Instruction Manual (Basics).

1.6.3 Setting the Graph Style

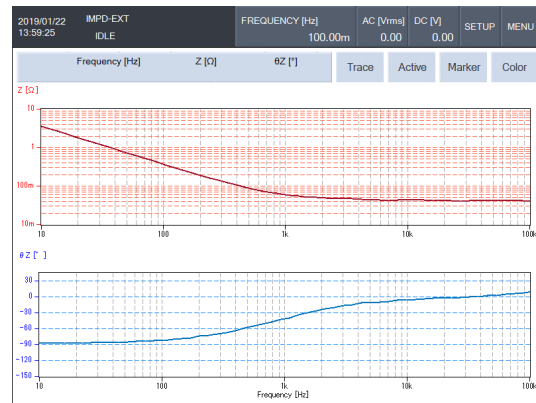
Graphs have two display styles (SINGLE and SPLIT), which can be set in [Graph]—[STYLE].



When split display is set, the Y1-axis data is displayed on the graph in the upper half and the Y2-axis data is displayed on the graph in the lower half.



Single Display



Split Display

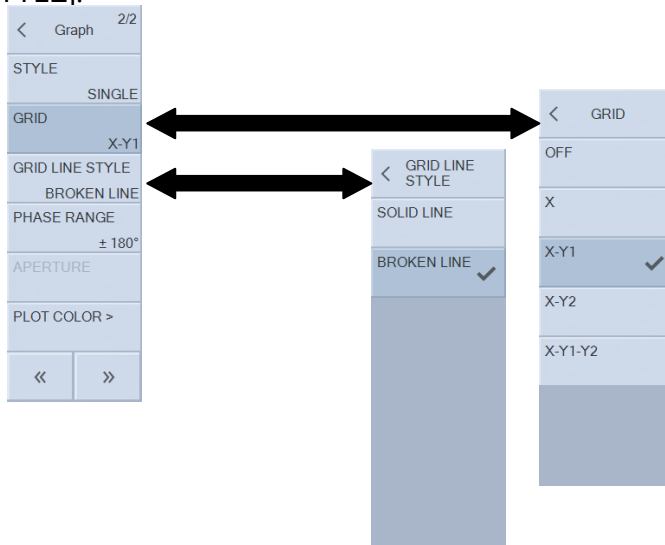
Figure 1-7 Graph Display Styles

■ Split display restrictions

When a Nyquist plot or Cole-cole plot is displayed with the SPLIT display style, a small graph is displayed in the upper half of the screen and the lower half is empty. Use the SINGLE display style to display graphs other than Bode plots.

1.6.4 Grid Display

This function displays a grid on the graph. Configure the settings in [Graph]—[GRID] / [GRID LINE STYLE].



[GRID] : Select the grid display target.

[OFF] Do not display a grid.

[X] Display a grid for the X-axis only.

[X-Y1] Display grids for the X-axis and Y1-axis.

[X-Y2] Display grids for the X-axis and Y2-axis.

[X-Y1-Y2] Display grids for the X-axis, Y1-axis, and Y2-axis.

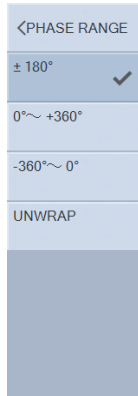
[GRID LINE STYLE] : Select the type of grid line.

[BROKEN LINE] Broken grid lines

[SOLID LINE] Solid grid lines

1.6.5 Setting the Phase Display Operation

Set the phase display range. Configure the setting in [Graph] — [PHASE RANGE].



- [±180°]: Display the phase within the range of $-180^\circ \leq \theta < +180^\circ$.
- [0°~+360°]: Display the phase within the range of $0^\circ \leq \theta < +360^\circ$.
- [-360°~0°]: Display the phase within the range of $-360^\circ \leq \theta < 0^\circ$.
- [UNWRAP]: Display the unwrapped phase. The phase can also exceed $\pm 360^\circ$.

The phase value itself does not change, regardless of the setting. For example, the phase that is -90° when the setting is $\pm 180^\circ$ is displayed as $+270^\circ$ when the setting is 0° to $+360^\circ$, but the phase angle itself is the same. The phase measurement examples in the figure below appear different but all four of them are the same in terms of the phase information.

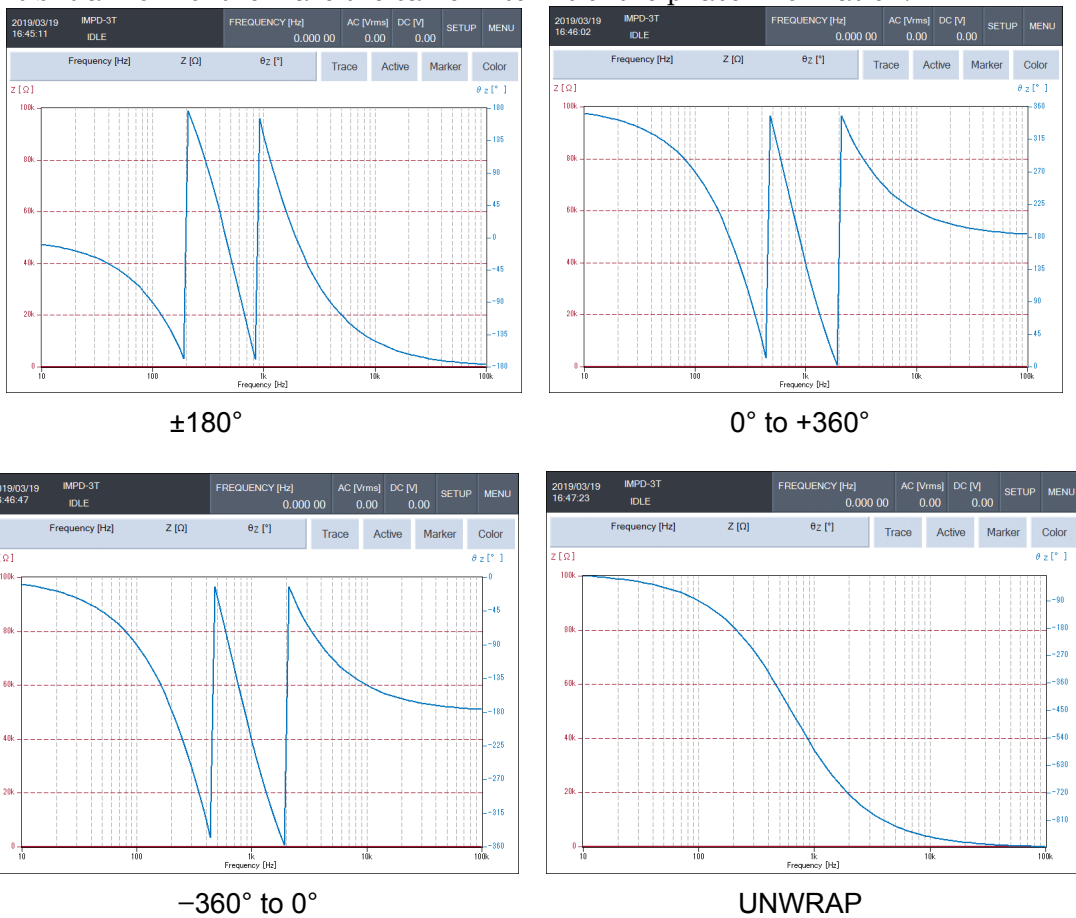


Figure 1-8 Examples of Phase Measurement

■ Unwrapped phase display

For the [UNWRAP] display setting, the unwrapped phase process and display are performed with the phase measurement value at the start of the sweep as the reference. Thus, when DUTs that have exactly the same phase characteristics are measured by up-sweep and down-sweep measurement, the results may be displayed in graphs that differ in phase by an integer multiple of 360°.

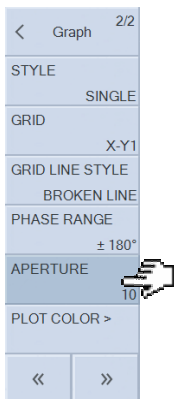
■ About the 360° phase shift function

If you tap either [+360°] or [-360°] of the function keys displayed when [Graph]—[PHASE RANGE] is selected, phase data for which 360° has been added or subtracted to/from the currently displayed phase is displayed in the graph. Use this function if a phase value becomes too large when an unwrapped phase is displayed. Please note that the phase information itself does not change. When the phase display range setting is other than [UNWRAP], the display is not changed.



■ Aperture setting

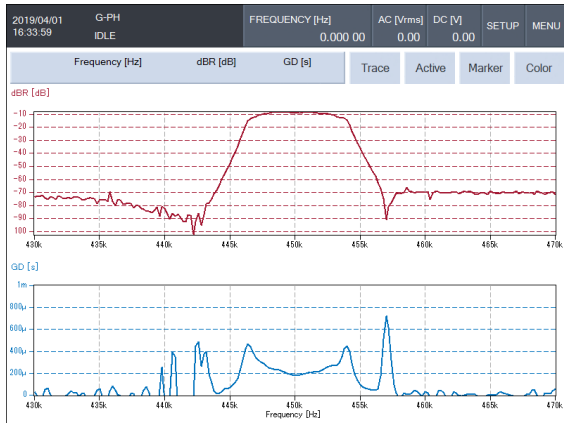
[Graph]—[APERTURE] is the moving average width of the phase characteristic for group delay display. This function is effective when the measurement mode is G-PH, which allows group delay display.



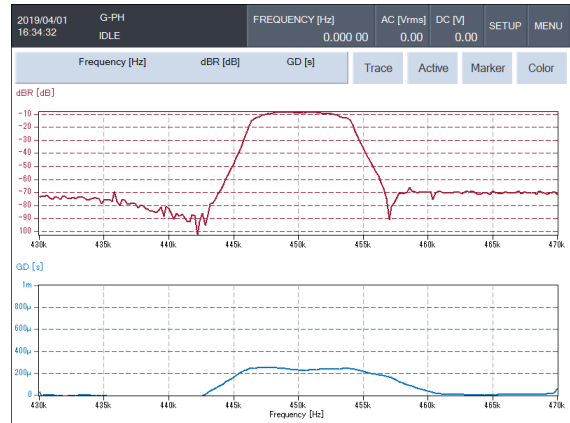
Setting a larger value for this setting reduces the noise and produces a smoother group delay characteristic, but sudden changes are not observed. Set the aperture to an even number that

is less than the number of the frequency points in the sweep (but no more than 200). Set a value that is appropriate for the DUT.

The following figure shows differences in the group delay characteristic due to the aperture setting of the bandpass filter for communication. Each of the upper parts shows the pass characteristic (gain) and each of the lower parts shows the group delay characteristic. We can see that a higher aperture setting results in a smoother group delay characteristic. Please note that the gain and phase characteristics are not affected by the aperture setting.



Aperture setting = 2



Aperture setting = 20

Figure 1-9 Differences in Group Delay Display Due to Aperture Setting

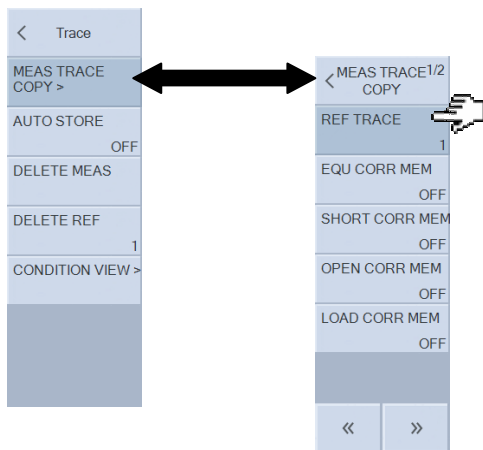
1.6.6 Trace Operations

The graphing function of this instrument can display a total of nine traces, one measurement trace (MEAS TRACE) and up to eight reference traces (REF TRACE), and each of them can be displayed or hidden individually. Furthermore, there is Y1 data and Y2 data for each of the traces.

Data that is obtained by measurement is stored in MEAS TRACE, and that data is overwritten each time a measurement is performed. The REF TRACE data, on the other hand, is retained unless an operation to explicitly remove it is performed. Displaying reference data in REF TRACE allows it to be plotted at the same time as the measurement data so that both data can be compared.

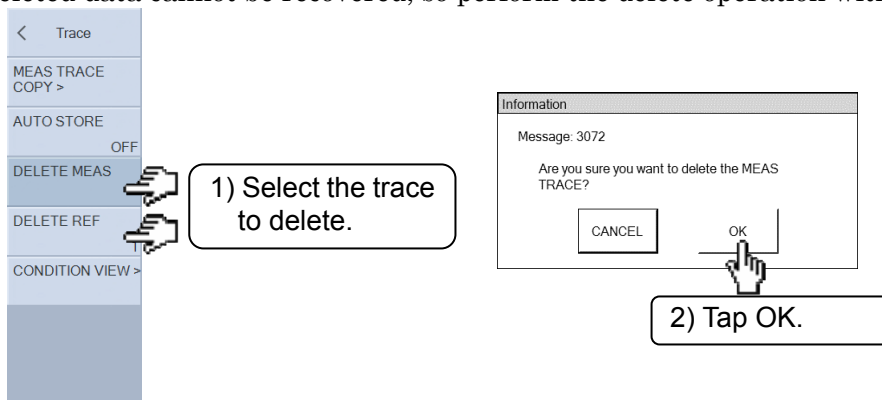
■ Copying MEAS TRACE to REF TRACE

To copy the measurement data (MEAS TRACE) to REF TRACE, tap [Trace]—[MEAS TRACE COPY]—[REF TRACE] and then enter the copy destination reference trace number (1 to 8). Tap the [OK] function key to copy. When copying is finished, a message will be displayed for a short time.



■ Deleting a trace

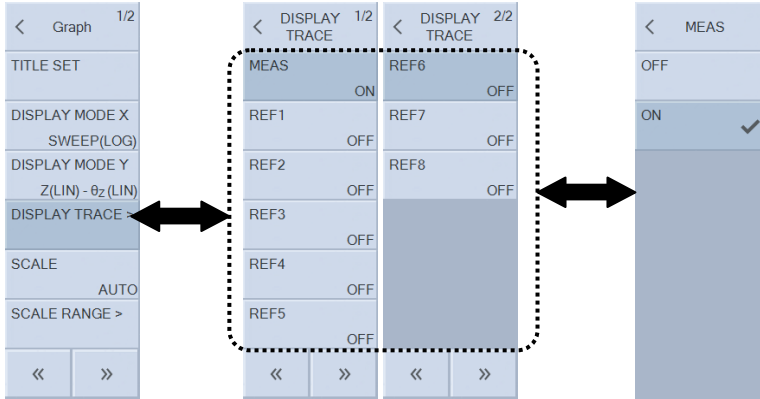
The data of each trace can be deleted in [Trace]—[DELETE MEAS] / [DELETE REF]. In the case of a reference trace, specify the number (1 to 8) of the trace to delete. Tap the [DELETE] function key and then tap [OK] in the deletion confirmation dialog box to delete the target trace. Deleted data cannot be recovered, so perform the delete operation with care.



■ Displaying and hiding traces

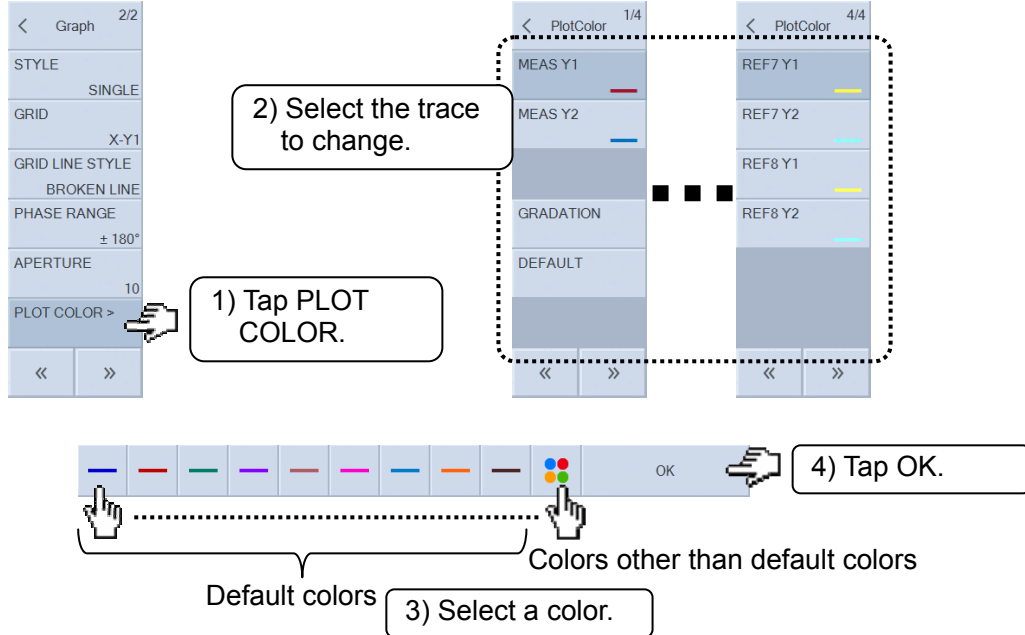
Select [Graph]—[DISPLAY TRACE]—[MEAS] / [REF1] to [REF8] and then tap [ON] or [OFF] in the displayed menu to display or hide the corresponding trace.

Data is retained even when hidden. If you set ON, the data will be redisplayed.



1.6.7 Setting Trace Colors

An arbitrary color can be set for each of the data traces (MEAS and REF1 to REF8) and the Y1 and Y2 traces of each trace. Tap the trace for which to change the color in [Graph]–[PLOT COLOR], select/set the color with the function keys, and tap [OK].



- [MEAS Y1], [MEAS Y2]: Change the color of the MEAS trace.
- [REF n Y1], [REF n Y2]: Change the color of the REF n trace ($n = 1$ to 8).
- [GRADATION]: Automatically set the REF1 to REF8 traces to colors determined by gradually fading using the current MEAS trace color as the base.
- [DEFAULT]: Reset the colors of all traces to the factory default state.

[GRADATION] and [DEFAULT] are executed by tapping the [EXEC] function key.

[GRADATION] is convenient when you use the auto store function (refer to “1.6.8 Auto Store”).

1.6.8 Auto Store

This function automatically copies the measurement data (MEAS trace) to a REF trace when sweep measurement finishes. Each time a sweep finishes, the contents of MEAS and REF1 to REF(n-1) trace data are copied to the respective adjacent REF1 to REF(n) traces (n is a maximum of 8). The latest n sweep data is displayed and updated and data older than that is discarded. This is convenient when, for example, you wish to observe the state of a DUT that changes over time.

Set auto store in [Trace]—[AUTO STORE]. Set the maximum number of data to display (1 to 8) or OFF. If this is set to OFF, the REF traces will not be updated automatically.

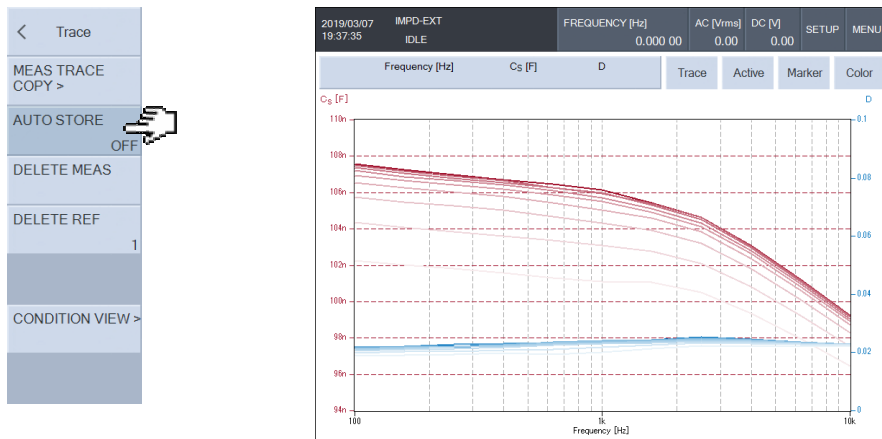


Figure 1-10 Example of Auto Store

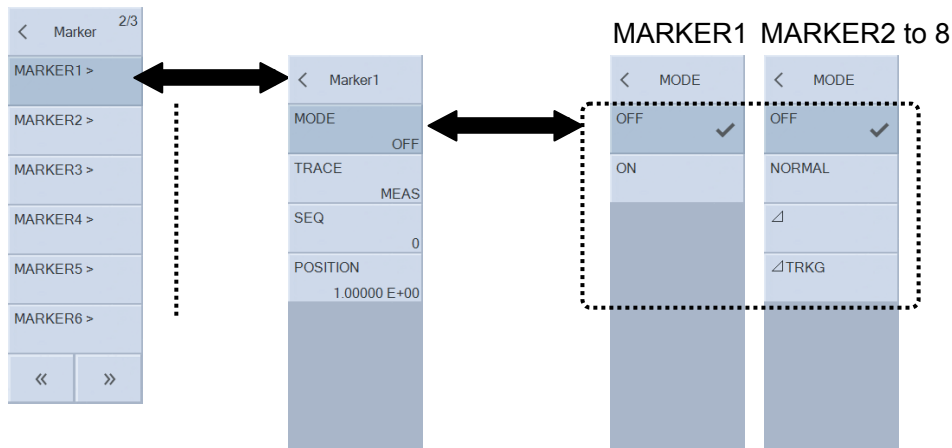
1.7 Marker Operations

Perform sweep measurement and display markers on data of the displayed graph to allow you to read the measurement values. Up to eight markers (MARKER1 to MARKER8) can be used, and the values of the active marker that can be moved with knob are displayed as numerical values in the marker display area at the top of the graph. The values of a maximum of eight markers can be displayed at the same time on the LCD.

For details on the basic operations of markers, refer to “3.1 Functions and Operations of Panel Parts” and “3.5.6 Marker Menu” in Instruction Manual (Basics).

■ Types of markers

There are three type of markers: normal markers, Δ markers, and Δ TRKG markers. Only a normal marker can be selected for MARKER1, but you can freely select from the three types of markers for MARKER2 to MARKER8. Set the type of marker in [Marker]—[MARKER n]—[MODE].



[OFF]: Do not display a marker.

[NORMAL]: Set the marker to a normal marker. The marker position (measurement value) is displayed.

[Δ]: Set the marker to a Δ marker. The difference from MARKER1 is displayed.

[Δ TRKG]: Set the marker to a Δ TRKG marker. The information of the difference from MARKER1 is displayed just like with a Δ marker. If MARKER1 is moved, the marker is moved while keeping the SWEEP value difference constant.

The active marker can be moved with the knob on the front panel, the active marker can be changed with the **ACTIVE** key below the knob, and the data trace indicated by the active marker can be selected with the **TRACE** key.

A normal marker is displayed as “*,” a Δ marker is displayed as “ Δ ,” and a Δ TRKG marker is displayed as “T” on the graph, and the marker numbers (1 to 8) are displayed above the corresponding markers. The active marker is displayed highlighted.

The active marker and its read values are displayed at the top of the graph.

None: When normal measurement (sequence measurement is off)
 01 to 32: Memory number for sequence measurement
 M: Measured data trace
 R1 to R8: Reference trace
 *: Normal marker
 Δ: Δmarker
 T: ΔTRKG marker

Tapping the [Marker] button displays a list of all the markers at the bottom of the LCD.
 Tapping **X** at the bottom right in all-marker display returns to active marker only display.

Display of active marker values only Simultaneous display of all marker values

Figure 1-11 Switching Marker Display

A hidden marker cannot be made the active marker. Furthermore, the read values of a hidden marker are indicated as “NA” in all-marker display.

The STATUS column on the right side of the marker list display is the range and over-level information from when the data indicated by the marker was measured.

(Measurement mode: IMPD-EXT or G-PH) (Measurement mode: IMPD-3T or IMPD-2T)

100mV, 5V, 13 **100Ω, , 0**

Over-level information 0 to 15 Over-level information 0 to 15

PORT2 measurement range (Blank)

PORT1 measurement range. Measurement range

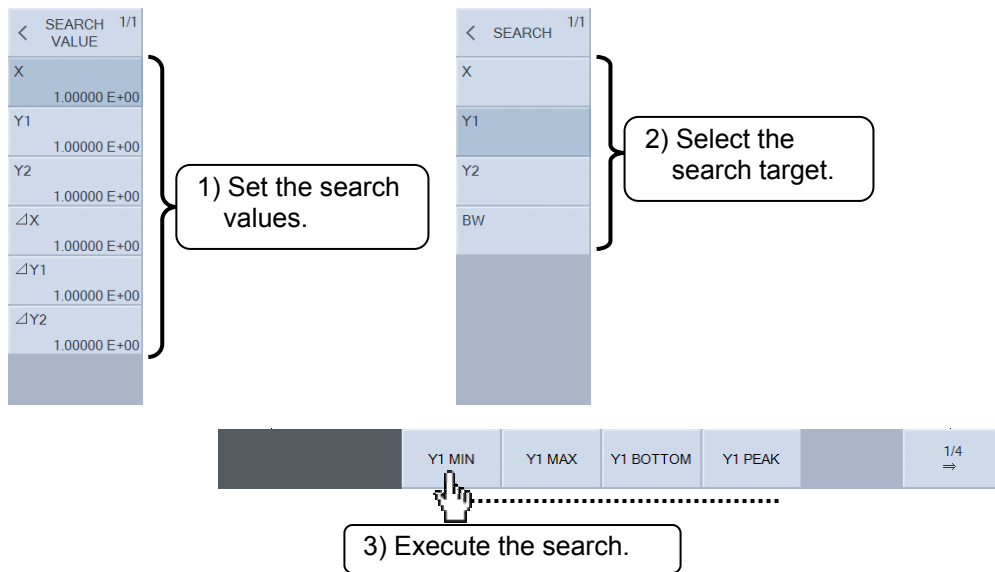
The over-level information is a decimal number from 0 to 15 with the following value added.

- When PORT1 over +8
- When PORT2 over +4
- When over range +2 (when measurement mode is IMPD-3T or IMPD-2T only)
- When ALC error +1

■ About the marker search function

In addition to turning the knob to move the marker and read data values, you can perform an automatic search for locations that match specified conditions. The search conditions include the maximum value (MAX), minimum value (MIN), value (VALUE), peak value (PEAK), and bottom value (BOTTOM) for each of the X-axis, Y1-axis, and Y2-axis. For value, peak value, and bottom value, you can also search for the next candidate (NEXT) or the previous candidate (PREV).

Set the marker search related parameters in [Marker]—[SEARCH VALUE]. Select the search target in [Marker]—[SEARCH] and then execute the search by tapping a displayed function key. For details on the setting items, refer to “3.5.6 Marker Menu” in Instruction Manual (Basics).



The marker search locations for when the X-axis of the graph is SWEEP (frequency, AC amplitude, DC bias, or time) are shown in the figure below. Search with the active marker.

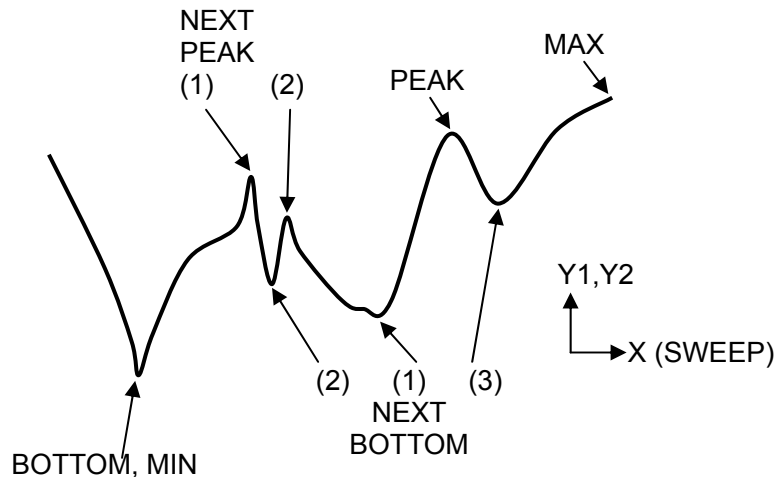


Figure 1-12 Marker Search Example (Bode Plot, MAX / MIN / PEAK / BOTTOM)

The marker search locations after the value search is performed are shown in the following figure. This is an example for the Y1 value search, but it also applies to Y2 values. Search with the active marker.

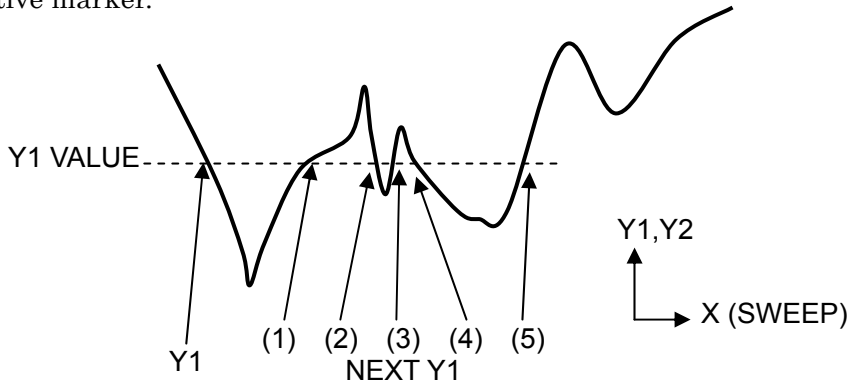


Figure 1-13 Marker Search Example (Bode Plot, Y1 VALUE)

The locations from the $\Delta Y1$ and $\Delta Y2$ marker search are shown in the following figure. Search with the active marker using MARKER1 as the reference. When the active marker is a normal marker, a search is performed with the active marker considered to be set as a Δ marker or Δ TRKGM marker, but the type of the active marker does not change.

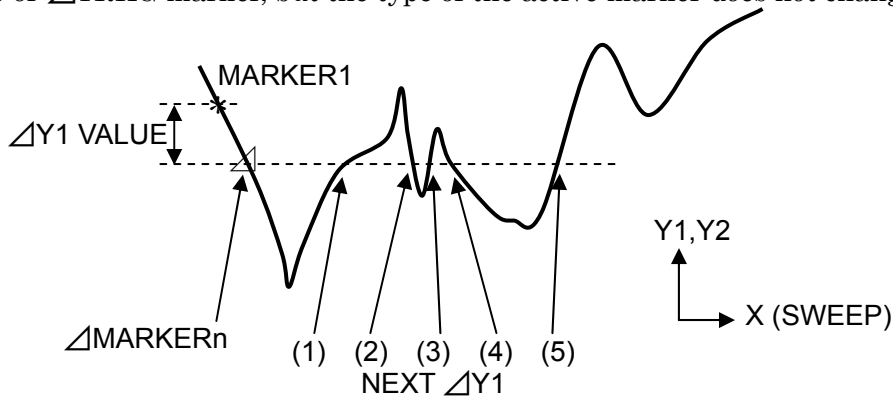


Figure 1-14 Marker Search Example (Bode Plot, $\Delta Y1$ VALUE)

A BW1 search places MARKER1 at the maximum value (MAX) of Y1 and MARKER2 at a location $\Delta Y1$ away using MARKER1 as the reference. MARKER2 is placed at the location that is $\Delta Y1$ away from MARKER1 and nearest to the X position of MARKER1. This is convenient for obtaining the cutoff frequency in lowpass/highpass filter and other transfer characteristic measurement (when the measurement mode is G-PH).

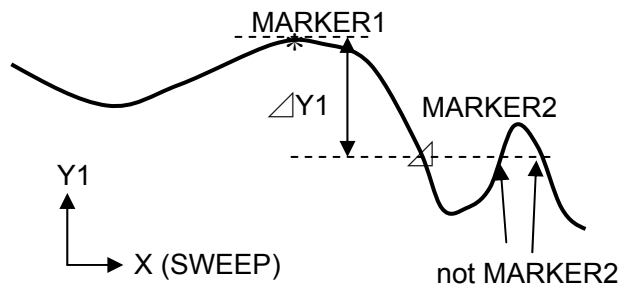


Figure 1-15 Marker Search Example (Bode Plot, BW1)

A BW2 search places MARKER1 at the maximum value. MARKER2 is placed at the location that is $\Delta Y1$ away from MARKER1 and smaller than and nearest to the X position of MARKER1. MARKER3 is placed at the location that is $\Delta Y1$ away from MARKER1 and larger than and nearest to the X position of MARKER1. This is convenient for obtaining the pass bandwidth in the transfer characteristics (measurement mode: G-PH) of a band pass filter.

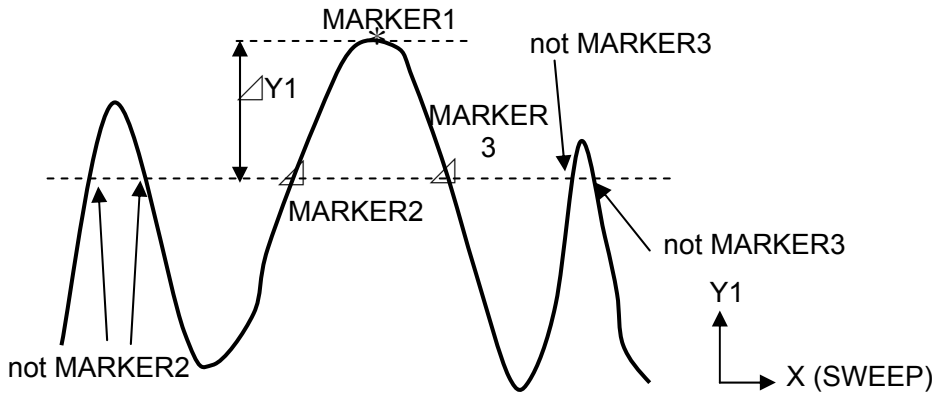


Figure 1-16 Marker Search Example (Bode Plot, BW2)

A BW3 search places MARKER1 at the maximum value. MARKER2 is placed at a location that is $\Delta Y1$ away from MARKER1 and where the X position is the minimum. MARKER3 is placed in a location that is $\Delta Y1$ away from MARKER1 and the X position is the maximum. This is convenient for obtaining the notch width in the transfer characteristics (measurement mode: G-PH) of a band elimination filter.

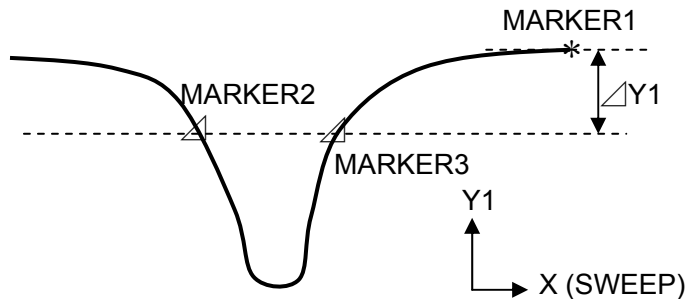


Figure 1-17 Marker Search Example (Bode Plot, BW3)

For graphs that have multiple Y values for an X value, such as Nyquist plot or Cole-cole plot, the X axis is also searched for PEAK / BOTTOM. Search with the active marker.

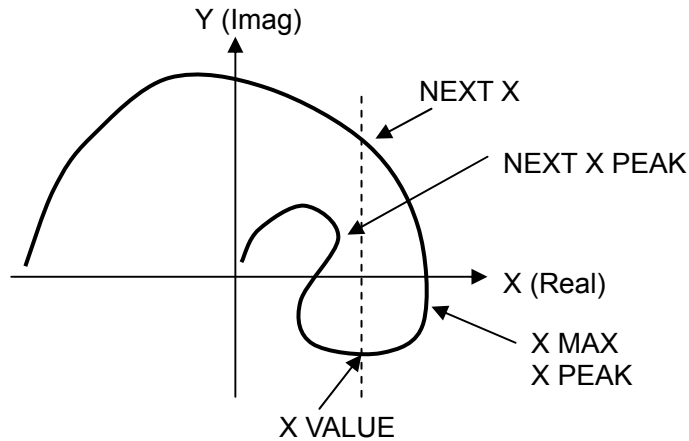


Figure 1-18 Marker Search Example (Nyquist Plot, X MAX / PEAK / VALUE)

An ΔX search searches with the active marker using MARKER1 as the reference in the same way as a Bode plot. When the active marker is a normal marker, a search is performed with the active marker considered to be set as a Δ marker or Δ TRKG marker, but the type of the active marker does not change.

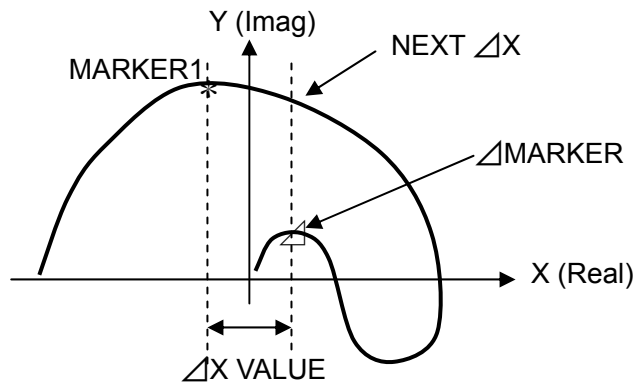
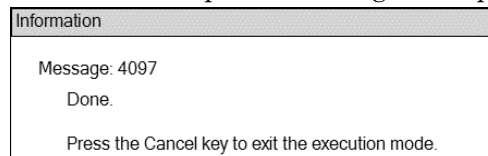


Figure 1-19 Marker Search Example (Nyquist Plot, ΔX)

A PREV search moves the marker in the reverse order of a NEXT search.

■ Marker search procedure

- (1) When performing a value search, set the value to search in each parameter of [Marker]—[SEARCH VALUE].
- (2) Select [SEARCH X], [SEARCH Y1] or [SEARCH Y2] depending on the search target (X, Y1, or Y2).
- (3) Tap the function key for the item to search. There are multiple search items, so scroll with the [1/4 ⇒] to [4/4 ⇒] function keys and tap the desired search item key.
- (4) The marker moves and a search completed message is displayed for a short time.

**■ Data position indicated by a marker**

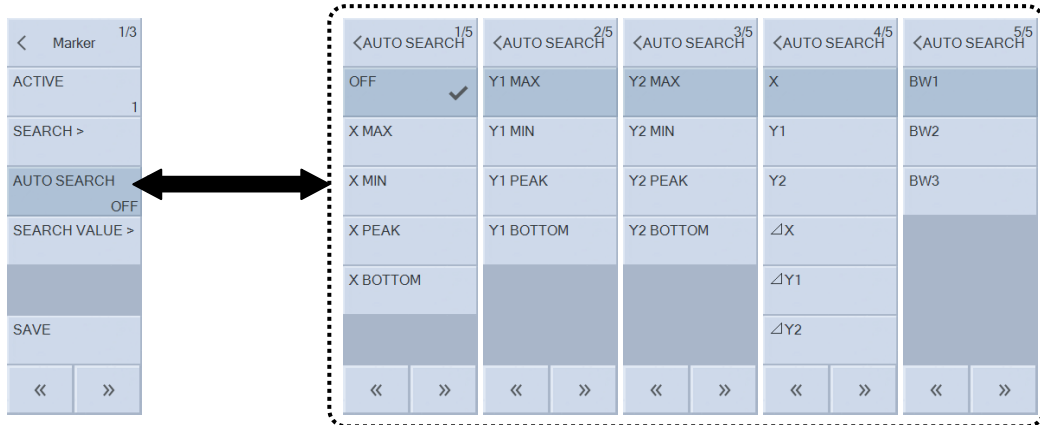
A marker moves only to data that has actually been measured. A marker search also only finds measured data, and a marker is moved to the data position that is nearest to the search conditions. Accordingly, a location that is an exact match to the set value is not usually found. For a more accurate reading of the marker value, increase the sweep resolution ([Sweep]—[SWEEP RESOLN]) and perform the measurement again.

■ Marker search for sequence measurement data

A marker search is performed within the sequence data on which the search target marker is placed. Data for which the sequence number is exceeded cannot be searched.

■ How to execute a marker search automatically when a sweep ends

The marker search settings can be preregistered so that a marker search is performed automatically when sweep measurement ends. Select the search item in [Marker]—[AUTO SEARCH]. If this is set to [OFF], a search is not performed automatically.



The search method is the same as for a manual search. However, the NEXT and PREV operations cannot be set. For the search items that can be set, refer to “3.5.6 Marker Menu” in Instruction Manual (Basics).

A practical example of automatic searching is presented below.

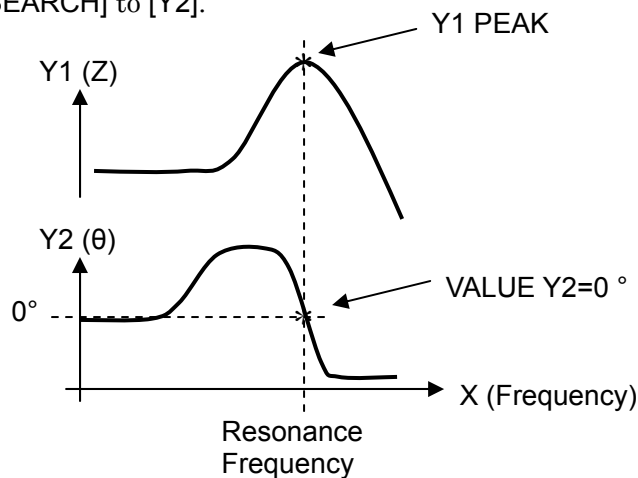
(Measuring the self-resonant frequency of an inductor)

Perform a frequency sweep to measure the impedance-frequency characteristic of the DUT inductor (set Y1 to Z and Y2 to θ).

- Set [AUTO SEARCH] to [Y1 PEAK].

When the sweep ends, the marker moves to the maximum Z value. The marker frequency is the self-resonant frequency. The resonant frequency may also be defined as the frequency for which the phase is 0° . In that case, set the settings of this instrument as shown below.

- Set [SEARCH VALUE Y2] to 0.0.
- Set [AUTO SEARCH] to [Y2].



1.8 Error Correction

This section describes the error correction functions of this instrument. The available correction functions differ depending on the measurement mode.

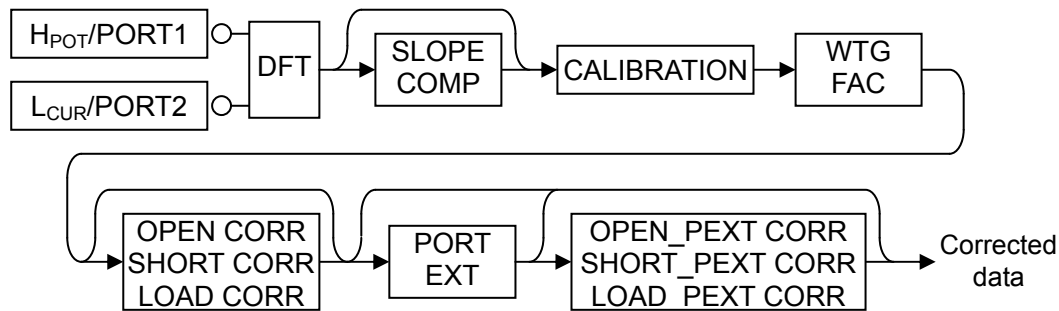


Figure 1-20 Error Correction Data Flow (Measurement Mode: IMPD-EXT)

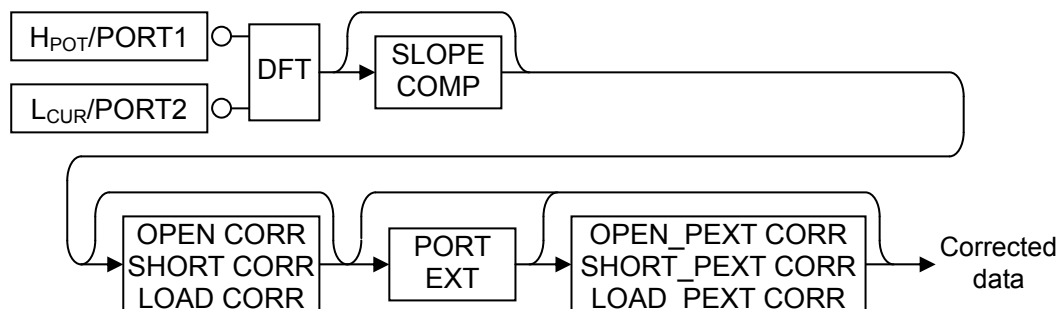


Figure 1-21 Error Correction Data Flow (Measurement Mode IMPD-3T or IMPD-2T)

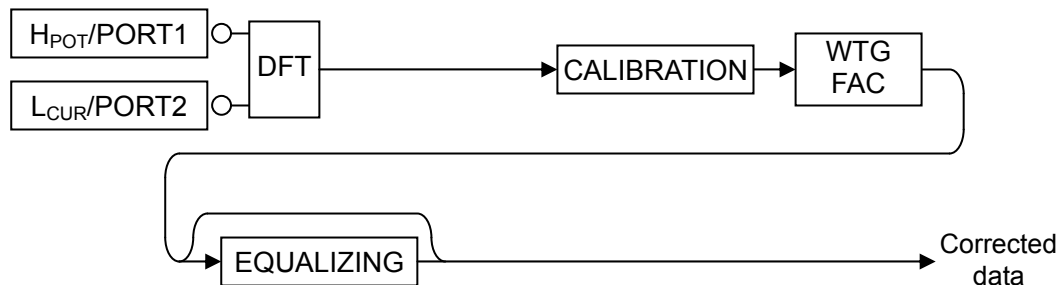


Figure 1-22 Error Correction Data Flow (Measurement Mode: G-PH)

- Self-calibration (CALIBRATION)

This corrects the errors that arise within this instrument itself.

- Input weighting (WaighTingG FACtor)

This corrects the attenuation of a probe or gain of a preamplifier.

- Slope compensation (SLOPE COMPensation)

This removes the effects of changes in electrical potential due to charging and discharging of batteries, etc.

- Port extension (PORT EXTension)

This corrects the phase delay that occurs due to the propagation delay time when a long cable is used.

- Open correction (OPEN CORRection)

This corrects the error caused by stray admittance that remains when measurement connectors are opened.

- Short correction (SHORT CORREction)

This corrects the error caused by residual impedance that remains when measurement connectors are shorted.

- Load correction (LOAD CORREction)

This corrects the deviations from true values. It requires a standard impedance with a known correct value.

There are two sets of corrections for open, short, and load corrections: corrections made on the front panel of this instrument and corrections made at the port extended end. The correction data and impedance standard values are independent for the two sets of corrections.

- Equalizing (EQUALIZING)

This corrects the frequency characteristics of an externally connected cable, probe, amplifier, etc. This correction is used in measurement mode G-PH (gain and phase measurement).

1.8.1 Self-calibration

This function can be set when the measurement mode is IMPD-EXT and G-PH.

Connect the measurement signal output of this instrument to the signal input to perform self-error correction. Perform self-calibration with the CALIBRATION BOX that was included with this instrument connected to L_{CUR} and H_{CUR} .

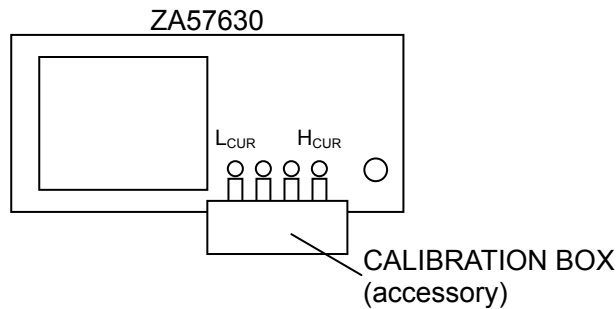
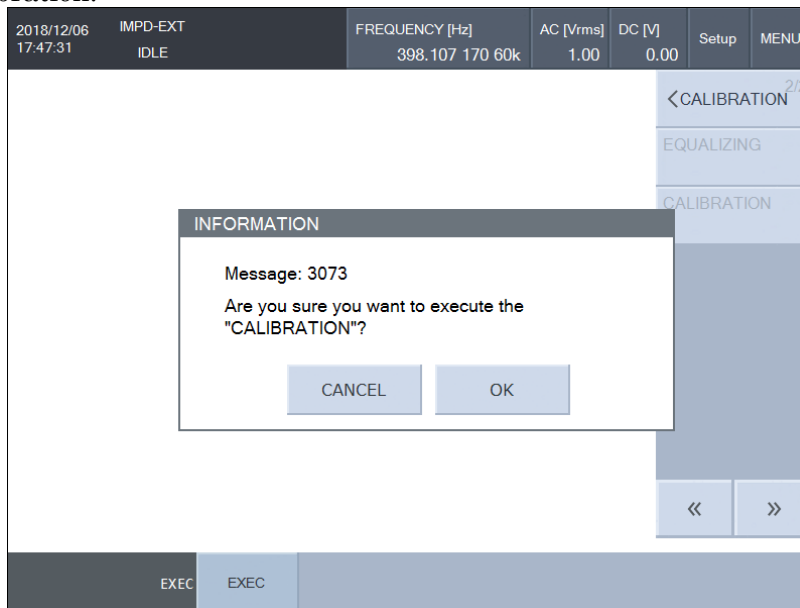


Figure 1-23 Connection for Self-calibration

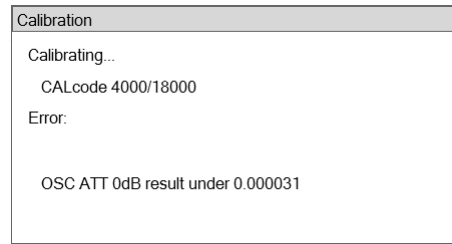
Select [Calibration]—[CALIBRATION] and then tap the [EXEC] function key. A dialog box for confirming whether to start self-calibration appears. Tap the [OK] button to start self-calibration.



A window to indicate the progress is displayed during self-calibration. If an error is detected, an error message is displayed and operation stops. For details on errors, refer to “3.1 Error Messages”.



Display during self-calibration



When error is detected

If an error occurred during self-calibration, this instrument may have malfunctioned. Turn the power off and then back on, check “■ Cautions for self-calibration” below, and then perform self-calibration again. If the error still occurs, contact NF Corporation or its authorized agent.

■ Cautions for self-calibration

- When the measurement mode is set to IMPD-2T or IMPD-3T, it is initialized to the factory calibration state.

The factors listed below cause errors related to measurement itself. If these factors affect self-calibration, they will also affect subsequent measurements (because the self-calibration will be based on measurement results that contain errors).

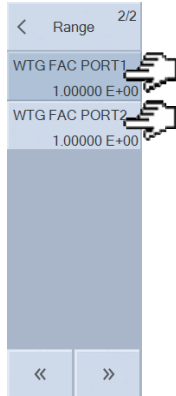
- Do not attach/remove and move the CALIBRATION BOX.
Changes in the pass characteristic may cause errors.
- Do not bring your hands or body near the CALIBRATION BOX.
Stray capacitance, interference noise, etc. may affect self-calibration.
- Move this instrument away from large noise sources

The results of self-calibration performed at the factory are stored in non-volatile memory and are retrieved for use when this instrument is turned on. However, we recommend performing self-calibration at the times listed below.

- When the ambient temperature deviates from $23\pm 5^{\circ}\text{C}$.
- Before performing important measurements

1.8.2 Input Weighting

This function performs gain correction on the results of measurements performed with a 10:1 passive probe for oscilloscopes, a preamplifier, etc. connected to the input connectors of this instrument (PORT1/H_{POT} and PORT2/L_{CUR}) when the measurement mode is IMPD-EXT or G-PH and then displays the results. Conversion to signal amplitudes on the probe or preamplifier input side is performed for measurement. Configure the settings in [Range]-[WTG FAC PORT1]/[WTG FAC PORT2].



[WTG FACT PORT1] and [WTG FAC PORT2]:

Set the factors to be applied to the measurement data of PORT1 and PORT2. If a factor of 1.0 is set, there will be no changes in the measurement data.

If the input weighting settings are set, they will have effect on the ALC operations. Those functions operate with the weighting level on the probe or preamplifier input side applied.

■ Examples of setting weighting factors

Refer to the impedance measurement connection examples of “Figure 4-1” to “Figure 4-3” in Instruction Manual (Basics).

- When using a 10:1 probe for oscilloscopes

When a probe is connected to PORT1/H_{POT}, set 10.0 (= 1/0.1) for [WTG FAC PORT1]. The same applies when an attenuator is connected.
- When using a voltage preamplifier

When a preamplifier that has a gain of 40 dB (× 100) is connected to PORT1/H_{POT}, set 0.01 (= 1/100) for [WTG FAC PORT1].
- When using a current input amplifier

When using a current input amplifier for current-voltage conversion, connect it to PORT2/L_{CUR}. If the conversion gain is 1 GV/A (= × 10⁹), set 10⁻⁹ for [WTG FAC PORT2]. When the conversion gain is a negative value, also set a negative value for the weighting factor. When the conversion gain is -10 GV/A, set -10⁻¹⁰ for [WTG FAC PORT2]. If the polarities are not matched, the phase of the impedance measurement results will be inverted.
- When using a shunt resistor

When performing current-voltage conversion with a current detection resistor (shunt resistor), connect the shunt resistor to PORT2/L_{CUR}. Set the reciprocal of the shunt resistance in [WTG

FAC PORT2]. For example, when using a 10 Ω shunt resistor, set 0.1 in [WTG FAC PORT2].

- When using a current probe

Connect the current probe to PORT2/L_{CUR}. When using a 0.1 V/A current probe, set [WTG FAC PORT2] to 10.0.

■ Input weighting function restrictions

The values that can be set for the input weighting function are limited to real numbers (not complex numbers) that are independent of the measurement frequency. For that reason, the amplitude, gain, and polarity of the measurement results are corrected as constant values, but the gain and phase are not corrected according to the frequency. This is a simple correction method for when the frequency is relatively low.

For more accurate corrections, use open correction, short correction, load correction, port extension, and equalizing.

1.8.3 Open Correction

1.8.4 Short Correction

The open correction function corrects the error caused by stray admittance (in the measurement system) when measurement connectors are opened. The short correction function corrects the error caused by residual impedance (in the measurement system) when measurement connectors are shorted. The following figures show the relationship of the admittance and impedance of the DUT (true values, denoted as Y and Z), and the admittance and impedance measured by this instrument (denoted as Y_m and Z_m).

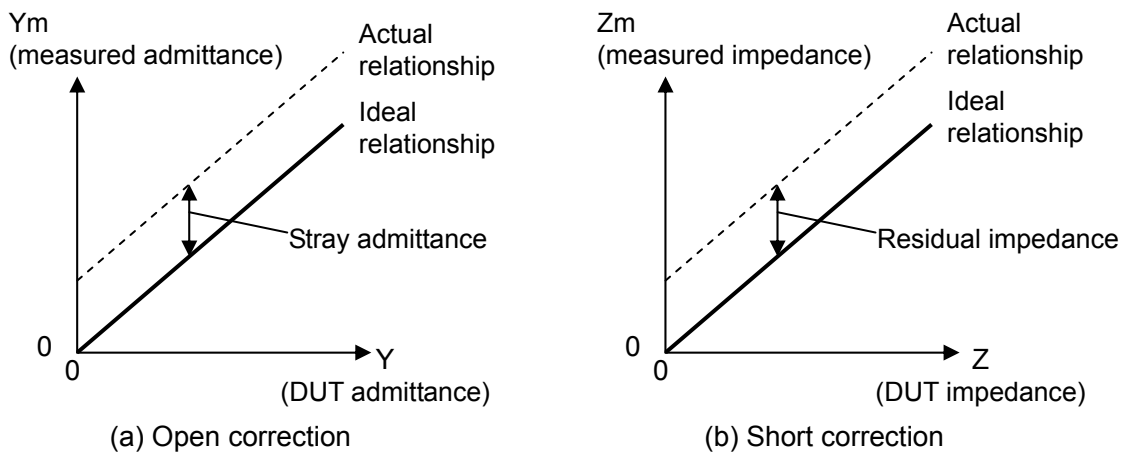


Figure 1-24 Description of Open Correction and Short Correction

Open correction subtracts a pre-measured stray admittance from the measured admittance. Short correction subtracts a pre-measured residual impedance from the measured impedance. These two types of correction can be performed independently or at the same time. They are explained together here because they are similar operations.

The following figure shows the connections for measuring open and short correction data when the measurement mode is IMPD-EXT.

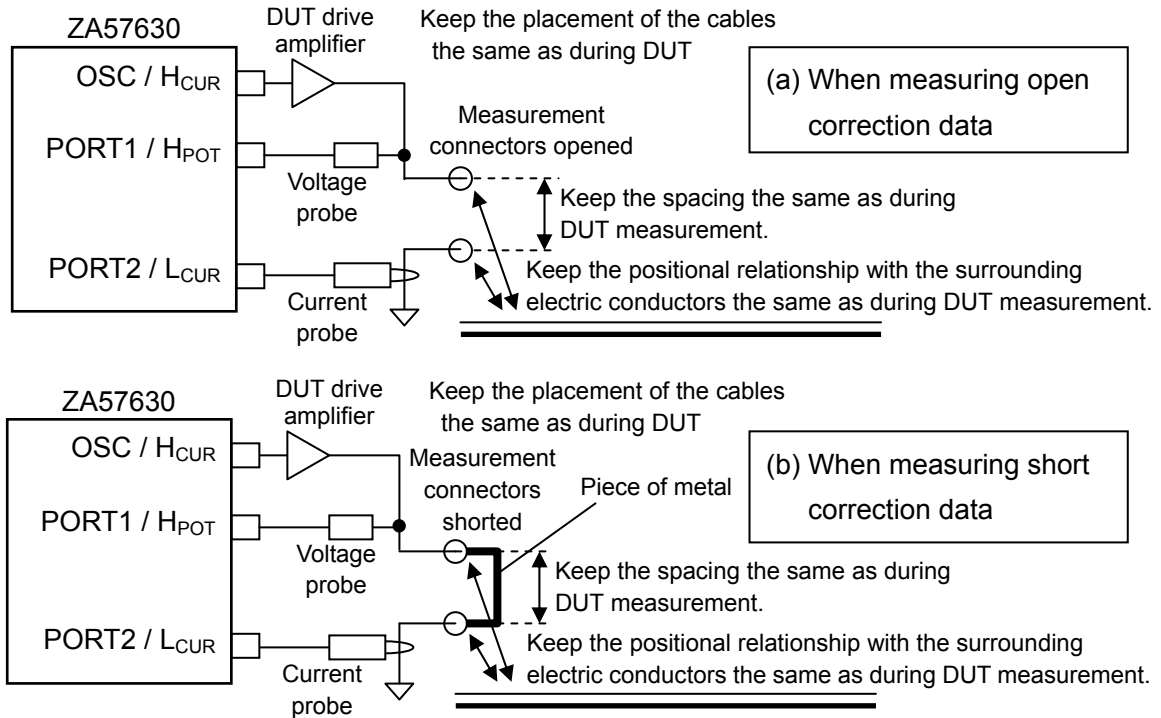


Figure 1-25 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-EXT)

CAUTION

When using a DUT drive amplifier, pay attention to overvoltage / overcurrent caused by the measurement connectors opened / shorted. Take the following measures to prevent damage to the DUT drive amplifier, current probe, voltage probe, etc. when measuring open / short correction data.

- Reduce the measurement signal level of ZA57630 when measuring the correction data.
- Reduce the gain of the DUT drive amplifier when measuring the correction data.
- Add protection resistor. The drive capability of the DUT drive amplifier will decrease.

The following figure shows the examples of additional protection resistor.

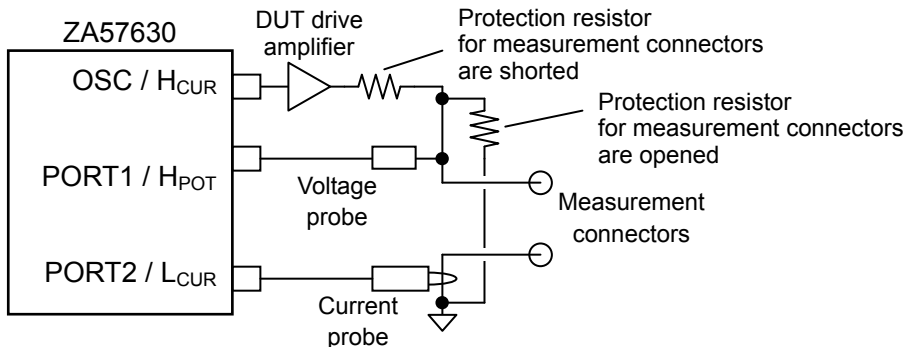


Figure 1-26 Example of Protection Resistor for Measuring Open / Short Correction Data

The following figure shows the connection methods for measuring open and short correction data when using a test fixture type that directly coupled to this instrument in the IMPD-3T measurement mode.

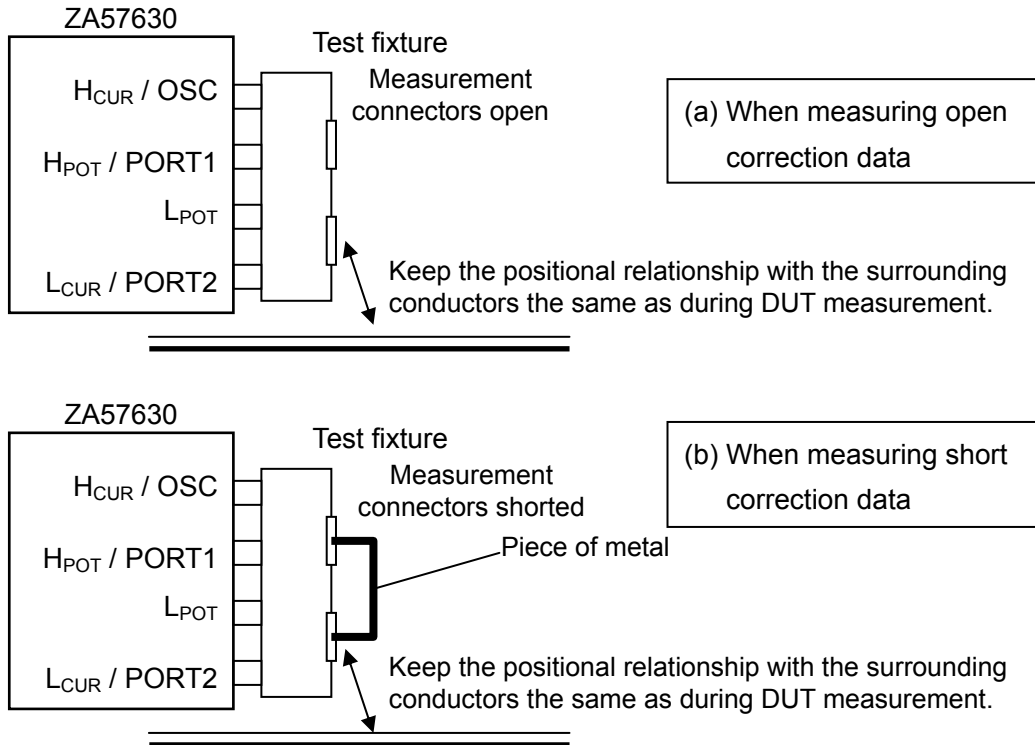


Figure 1-27 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-3T (1))

The following figure shows the connections for measuring open and short correction data when connecting with the DUT using coaxial cables.

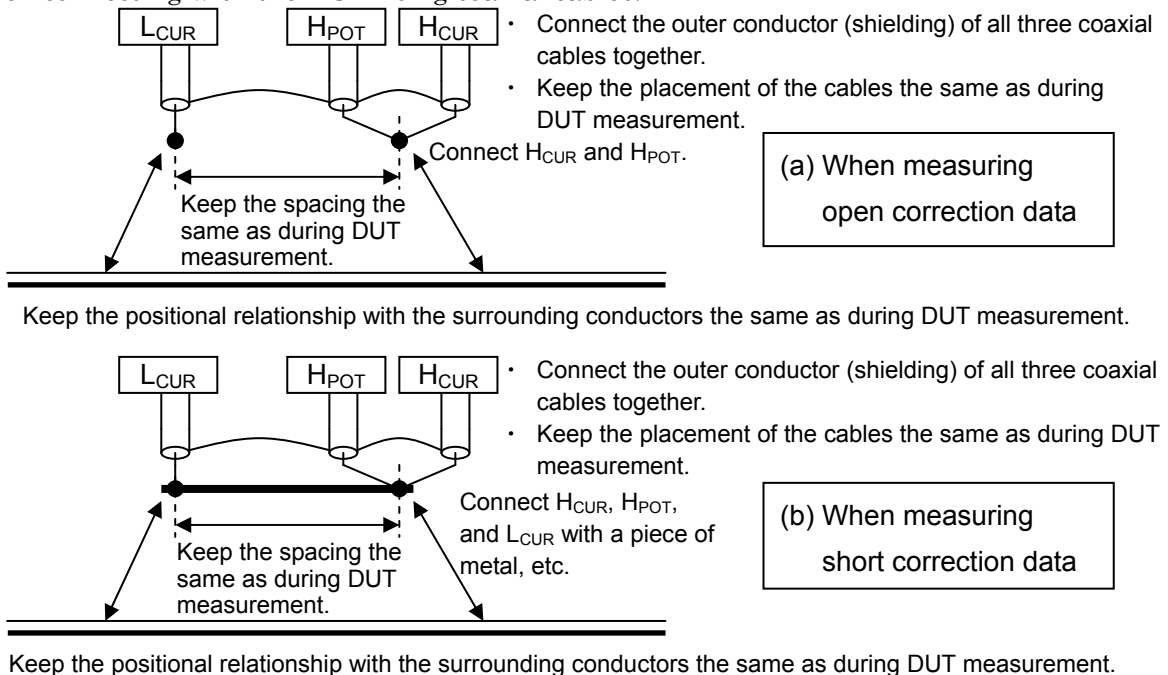
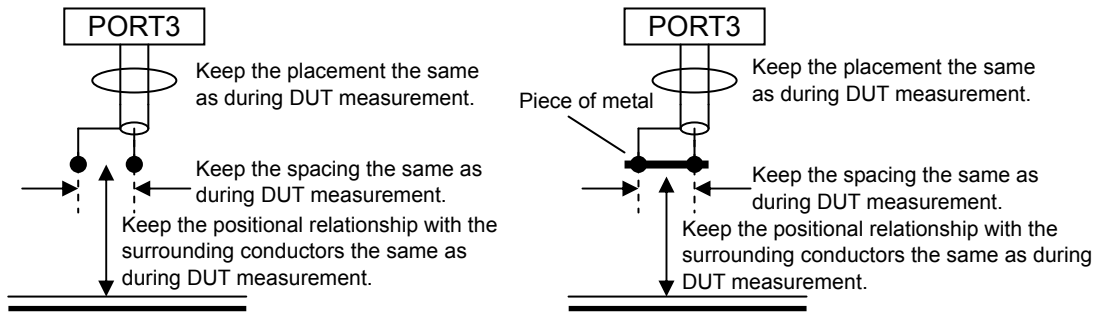


Figure 1-28 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-3T (2))

The following figure shows the connections for measuring open and short correction data when the measurement mode is IMPD-2T.



(a) When measuring open correction data (b) When measuring short correction data

Figure 1-29 Connections when Measuring Open and Short Correction Data (Measurement Mode: IMPD-2T)

No matter which connection method is used, take care that there is no change in the placement of measurement cables and the parts connecting (measurement connectors) with the DUT between when performing open and short correction data measurement and when performing DUT measurement. If the placement changes, correction will not be performed sufficiently because measurement system errors such as stray capacitance will also change.

The method to obtain open and short correction data differs depending on whether the measurement mode is IMPD-EXT or IMPD-3T/IMPD-2T.

(When measurement mode is IMPD-EXT)

Measure the open and short correction data at the frequency for measurement with a frequency sweep. The setup and measurement procedure is described below.

- 1) Set the measurement conditions, including the measurement signal amplitude, DC bias, and measurement range. Also set the frequency sweep range. Even when a frequency sweep will not be performed, set the frequency sweep settings of the range including the measurement frequency.
- 2) Set open and short corrections to OFF.
 - Set [Calibration]—[OPEN CORR] to [OFF].
 - Set [Calibration]—[SHORT CORR] to [OFF].
- 3) Measure the open correction data.

If open correction will not be performed, skip steps 3-1) to 3-3) and begin from step 4).

3-1) Open the measurement connectors.

3-2) Turn on measurement signal output, perform frequency sweep measurement, and wait for the process to end.

3-3) Select [Trace]—[MEAS TRACE COPY]—[OPEN CORR MEM] and then tap the [COPY] function key to copy the measurement data to the open correction memory.

Preparation of the data for open correction is now complete.

4) Measure the short correction data.

If short correction will not be performed, skip steps 4-1) to 4-3) and begin from step 5).

4-1) Short the measurement connectors.

4-2) Turn on measurement signal output, perform frequency sweep measurement, and wait for the process to end.

4-3) Select [Trace]—[MEAS TRACE COPY]—[SHORT CORR MEM] and then tap the [COPY] function key to copy the measurement data to the short correction memory.

Preparation of the data for short correction is now complete.

5) Set the functions you wish to enable to ON. If both the open and short correction functions will be used, turn both of them on.

- [Calibration]—[OPEN CORR] : Open correction

- [Calibration]—[SHORT CORR] : Short correction

Tap the [ON] function key to enable each correction.

Preparation for open and short corrections in the IMPD—EXT measurement mode is now complete. If you connect a DUT to the measurement connectors, you will be able to obtain measurement data that has been corrected for the stray admittance and residual impedance present in the measurement system.

(When measurement mode is IMPD—3T or IMPD—2T)

Measure the open and short correction data with the frequencies predetermined inside this instrument and spot measurement frequency ([OSC]—[FREQUENCY]). The setup and measurement procedure is described below.

1) Set the measurement signal amplitude and spot measurement frequency. During correction data measurement, correction measurement is performed using settings predetermined internally for the sweep frequency range, measurement time, measurement delay time, and measurement start delay time. The measurement range is AUTO and DC bias is turned off.

2) Measure the open correction data.

If open correction will not be performed, skip steps 2-1) to 2-2) and begin from step 3).

2-1) Open the measurement connectors or connect an open standard.

2-2) Select [Calibration]—[OPEN CORR] and then tap the [MEASURE] function key. Tap the [OK] button in the confirmation dialog. The status indication at the top of the LCD becomes CAL and a down-sweep starts. When the status becomes IDLE, open correction data measurement is complete. The correction data is stored in the currently set open correction memory number.

Preparation of the data for open correction is now complete. When short correction will be

performed, skip the following steps.

3) Measure the short correction data.

If short correction will not be performed, skip steps 3-1) to 3-2) and begin from step 4).

3-1) Short the measurement connectors or connect a short standard.

3-2) Select [Calibration]–[SHORT CORR] and then tap the [MEASURE] function key. The status indication at the top of the LCD becomes CAL and a down-sweep starts. When the status becomes IDLE, short correction data measurement is complete. The correction data is stored in the currently set short correction memory number.

4) Set the functions you wish to enable to ON. If both the open and short correction functions will be used, turn both of them on.

- [Calibration]–[OPEN CORR] : Open correction
- [Calibration]–[SHORT CORR] : Short correction

Tap the [ON] function key to enable each correction.

Preparation for open and short corrections in the IMPD–3T or IMPD–2T measurement mode is now complete. If you connect a DUT to the measurement connectors, you will be able to obtain measurement data that has been corrected for the stray admittance and residual impedance present in the measurement system.

The correction data that has been copied to the open correction memory or short correction memory is retained even if the power is turned off, so it is available for use the next time the power is turned on. However, these functions are also executed as a part of the error correction process of this instrument itself, so we recommend that the open/short correction data be measured again after the internal temperature has stabilized after turning the power on (after approximately 30 minutes) and after any change in the ambient temperature.

■ Cautions for open correction and short correction

- Even if the correction data is measured and copied to the respective correction memory, the functions are not executed unless they are enabled (set [Calibration]–[OPEN CORR] and [SHORT CORR] to [ON]).
- Results with the impedance/admittance values corrected are obtained for both open correction and short correction, but please note that the relationship with the voltage amplitude (or PORT1 amplitude) and current amplitude (or PORT2 amplitude) will no longer hold true (corrected impedance and (voltage ÷ current) will not match).
- If the frequency of the correction data is different from the measurement frequency, frequency interpolation is used to calculate the correction data. If the frequency sweep of the correction data is coarse (when measurement mode is the IMPD–EXT), the interpolation error will be large. Whenever possible, measure the correction data at the same frequency as the measurement frequency.
- The frequencies of open and short correction data in the IMPD–3T or IMPD–2T

measurement mode are fixed to the following frequencies regardless of the frequency sweep settings.

Table 1-1 Open and Short Correction Frequencies in IMPD-3T and IMPD-2T Measurement Modes

10, 40, 400, 1 k, 1.00000001 k, 2 k, 5 k, 10 k, 12.5 k, 20 k, 27.5 k, 29.99999999 k, 30 k, 40 k, 50 k, 65 k, 75 k, 100 k, 125 k, 150 k, 175 k, 200 k, 225 k, 250 k, 275 k, 300 k, 360 k, 400 k, 450 k, 500 k, 600 k, 700 k, 800 k, 900 k, 1 M, 1.00000000001 M, 1.13 M, 1.25 M, 1.38 M, 1.5 M, 1.68 M, 1.82 M, 2 M to 9.75 M (0.25 M step), 10.1 M, 10.5 M to 16 M(0.5 M step), 17 M to 36 M(1 M step) [Hz], f

The f in the above table is the frequency when spot measurement is performed using the [OSC]-[FREQUENCY] setting value.

- If you tap the [COPY TO REF8] function key displayed when [Calibration]-[OPEN CORR] or [SHORT CORR] is open, the corresponding correction data stored in the current correction data number is copied to REF8. It can be used to, for example, check the correction data.
- If measurement is performed outside of the measured sweep frequency range with which the correction data was measured, the correction data for the nearest frequency (sweep upper or lower limit frequency) is used for the correction calculation.
- If you set a function to ON without saving correction data, the -3074 error message (when there is no open correction data) or -3075 error message (when there is no short correction data) is displayed (refer to “Table 3-2 Panel Operation Errors”). When measurement is performed in this state, the measurement data is the same as when correction function setting off.
- You can save 32 sets (memory numbers 1 to 32) of correction data independently for each of open correction and short correction. Please note that correction will not be performed if the memory number to which the data was saved and the memory number to be used do not match.

Set the save destination memory numbers and the memory numbers to use in the following.

[Calibration]-[OPEN CORR]
 [Calibration]-[SHORT CORR]

Usually, there is no need to change these settings (memory numbers). Use the initial value of 1.

- When you will switch between multiple measurement paths, such as test fixtures and measurement cables, to perform measurement, measure the open and short correction data with each connection and save each correction data to a different number. This will allow you to switch the correction data for measurement by simply changing the correction data number to use when changing the measurement paths. When you recall settings with the handler interface (refer to “1.16 Handler Interface”) or when you recall setting information in sequence measurement (refer to “1.9 Sequence Measurement”), you can also switch the correction data together with the various measurement conditions.

1.8.5 Load Correction

The open and short correction functions can correct (subtract) the stray admittance and residual impedance contained in the measurement results. Those functions can remove the residual and stray components according to the measurement frequency, but they cannot correct errors caused by gain errors. For example, the conversion error of a current-voltage converter (error in the resistance value of a shunt resistor), gain error of a voltage detector, etc. cannot be improved by open correction and short correction. As illustrated in the following figure, it is necessary to perform load correction to correct errors caused by a gradient.

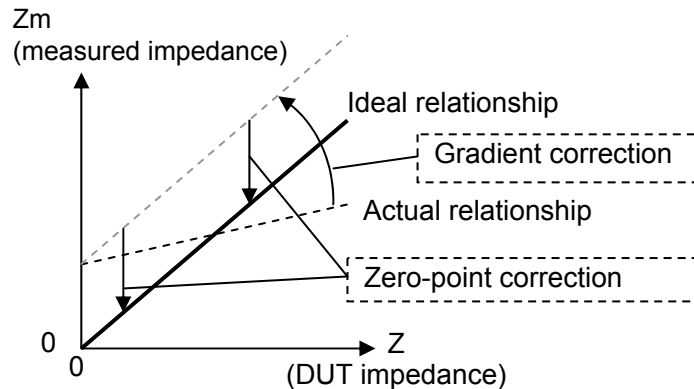


Figure 1-30 Load Correction Operation

Load correction uses a standard impedance that has a known value as a reference to correct measurement errors that are due to the circuit network that connects the measurement connectors of this instrument to the DUT. For accurate correction, an impedance standard with an impedance as close as possible to the impedance of the DUT should be used.

Load correction is always performed together with open correction and short correction.

Assuming a linear two-terminal pair network, it is possible to eliminate errors due to the connection network by performing open, short, and load corrections. Load correction also has the effect of reducing small errors in frequency, signal amplitude, measurement range, etc. that occur under certain conditions. However, if the assumed model differs from the actual mode, errors may actually be increased rather than decreased.

The method to obtain load correction data differs depending on whether the measurement mode is IMPD-EXT or IMPD-3T/IMPD-2T.

(When measurement mode is IMPD-EXT)

Measure the load correction data at the frequency for measurement with a frequency sweep. The setup and measurement procedure is described below.

- 1) Set the measurement conditions, including the measurement signal amplitude, DC bias, and measurement range. Also set the frequency sweep range. Even when a frequency sweep will not be performed, set the frequency sweep settings of the range including the measurement frequency.

- 2) Set the correction function to OFF.
 - Set [Calibration]—[OPEN CORR] to [OFF].
 - Set [Calibration]—[SHORT CORR] to [OFF].
 - Set [Calibration]—[LOAD CORR] to [OFF].
- 3) Measure the open correction data. Also refer to “1.8.3 Open Correction”.
 - 3-1) Open the measurement connectors.
 - 3-2) Turn on measurement signal output, perform frequency sweep measurement, and wait for the process to end.
 - 3-3) Select [Trace]—[MEAS TRACE COPY]—[OPEN CORR MEM] and then tap the [COPY] function key to copy the measurement data to the open correction memory.
- 4) Measure the short correction data. Also refer to “1.8.4 Short Correction”.
 - 4-1) Short the measurement connectors.
 - 4-2) Perform frequency sweep measurement and wait for the process to end.
 - 4-3) Select [Trace]—[MEAS TRACE COPY]—[SHORT CORR MEM] and then tap the [COPY] function key to copy the measurement data to the short correction memory.
- 5) Measure the load correction data and enter the load standard values.
 - 5-1) Connect an impedance standard to the measurement connectors.
 - 5-2) Perform frequency sweep measurement and wait for the process to end.
 - 5-3) Select [Trace]—[MEAS TRACE COPY]—[LOAD CORR MEM] and then tap the [COPY] function key to copy the measurement data to the load correction memory.
- 6) Set the load standard value format. Tap [Calibration]—[LOAD CORR]—[LOAD STD FORMAT] and select the load standard value format.
- 7) Enter the load standard values. Tap [Calibration]—[LOAD STD VALUE] and enter the load standard values in the displayed table. The load standard values for at least three frequencies included in the frequency range to be measured need to be entered. You can enter values for up to 30 frequencies.

Load Standard Value			
No. ↓	FREQUENCY	Cs	D
1	1.000 000 00 kHz	1.00230 uF	5.90000 E-03
2	10.000 000 00 kHz	1.00300 uF	
3			
4			
5			
6			
7			

After entering all the load standard values, tap the [×] button to close the load standard value input table.

- 8) Set [Calibration]—[LOAD CORR]—[FUNCTION] to [ON]. Load correction can also be performed normally with [OPEN CORR] and [SHORT CORR] left set to [OFF].

Preparation for load correction in the IMPD—EXT measurement mode is now complete. If you disconnect the impedance standard and perform measurement with a DUT connected to the measurement connectors, load-corrected measurement data can be obtained.

(When measurement mode is IMPD-3T or IMPD-2T)

Measure the open, short, and load correction data with the frequencies predetermined inside this instrument and spot measurement frequency ([OSC]-[FREQUENCY]). The setup and measurement procedure is described below.

- 1) Set the measurement signal amplitude and spot measurement frequency. During correction data measurement, correction measurement is performed using settings predetermined internally for the sweep frequency range, measurement time, measurement delay time, and measurement start delay time. The measurement range is AUTO and DC bias is turned off.
- 2) Measure the open correction data.
 - 2-1) Open the measurement connectors or connect an open standard.
 - 2-2) Select [Calibration]-[OPEN CORR] and then tap the [MEASURE] function key. The status indication at the top of the LCD becomes CAL and a down-sweep starts. When the status becomes IDLE, open correction data measurement is complete. The correction data is stored in the currently set open correction memory number.
- 3) Measure the short correction data.
 - 3-1) Short the measurement connectors or connect a short standard.
 - 3-2) Select [Calibration]-[SHORT CORR] and then tap the [MEASURE] function key. The status indication at the top of the LCD becomes CAL and a down-sweep starts. When the status becomes IDLE, short correction data measurement is complete. The correction data is stored in the currently set short correction memory number.
- 4) Measure the load correction data.
 - 4-1) Connect an impedance standard to the measurement connectors.
 - 4-2) Select [Calibration]-[LOAD CORR] and then tap the [MEASURE] function key. The status indication at the top of the LCD becomes CAL and a down-sweep starts. When the status becomes IDLE, load correction data measurement is complete. The correction data is stored in the currently set load correction memory number.
- 5) Set the load standard value format. Tap [Calibration]-[LOAD CORR]-[LOAD STD FORMAT] and select the load standard value format.
- 6) Enter the load standard value. Tap [Calibration]-[LOAD STD VALUE] and enter the load standard values in the displayed table. The load standard values of a least three frequencies included in the frequency range to be measured need to be entered. You can enter values for up to 30 frequencies.

After entering all the load standard values, tap the [×] button to close the load standard value input table.
- 7) Set [Calibration]-[LOAD CORR]-[FUNCTION] to [ON]. Load correction can also be performed normally with [OPEN CORR] and [SHORT CORR] left set to [OFF].

Preparation for load correction in the IMPD-3T / IMPD-2T measurement mode is now complete. If you disconnect the impedance standard and perform measurement with a DUT

connected to the measurement connectors, load-corrected measurement data can be obtained.

The data that has been copied to the open, short, or load correction memory is retained even if the power is turned off, so it is available for use the next time the power is turned on. However, these functions are also executed as a part of the error correction process of this instrument itself, so we recommend that the open/short/load correction data be measured again after the internal temperature has stabilized after turning the power on (after approximately 30 minutes) and after any change in the ambient temperature.

■ Cautions for load correction

- Even if the correction data is measured and copied to the respective correction memory, the correction function is not executed unless it is enabled (set [Calibration]—[LOAD CORR] to [ON] and display the correction memory number).
- Use an impedance standard with an impedance as close as possible to the impedance of the DUT. A large difference between the two may produce a large error in the measurement of the load correction data or a large error in internal calculations, resulting in insufficient correction. Use an impedance standard that differs in impedance from the DUT by no more than about a factor of 10 (or a factor of 0.1).
- For the load standard values, you can use either the calibration values of the impedance standard or actual measured values obtained with an impedance measuring instrument (LCR meter, etc.).
- Load correction uses the load standard values as the reference, so the accuracy of the load-corrected measurement data is limited to the accuracy of the load standard values (measurement accuracy cannot exceed the accuracy of the load standard values).
- The load standard values are saved internally in the format of “frequency—Z— θ ”, regardless of the load standard value format setting. When a load standard value is entered and displayed, it is converted according to the load standard value format. For that reason, a value different from the entered value may be displayed if the load standard value format is changed after the load standard value is input. Nevertheless, there is no difference in the operation of the load correction function.
- The load standard values for at least three frequencies need to be entered. Furthermore, correction will not be performed correctly with any frequency outside the frequency range of the entered load standard values.

If measurement is performed outside of the measured sweep frequency range with which the correction data was measured, the correction data for the nearest frequency (sweep upper or lower limit frequency) is used for the correction calculation.

- The values should be entered so that the frequencies of the load standard values are as close to equal intervals on the logarithmic axis as possible. Frequency interpolation is performed internally, so if load standard values are entered for frequencies that are extremely close or extremely far apart (on the logarithmic axis), interpolation errors will increase.

When the measurement mode is IMPD-3T or IMPD-2T, enter load standard values for the frequencies to be actually measured among the frequencies listed in “Table 1-1 Open and Short Correction Frequencies in IMPD-3T and IMPD-2T Measurement Modes”.

- When load correction is performed, the results with the impedance and admittance values corrected are obtained, but please note that the relationship with the voltage amplitude (or PORT1 amplitude) and current amplitude (or PORT2 amplitude) will no longer hold true (corrected impedance and (voltage ÷ current) will not match).
- The frequencies of load correction data in the IMPD-3T or IMPD-2T measurement mode are fixed internally regardless of the frequency sweep settings just like with the open and short correction data. Refer to “Table 1-1 Open and Short Correction Frequencies in IMPD-3T and IMPD-2T Measurement Modes”.
- If you tap the [COPY TO REF8] function key displayed when [Calibration]—[LOAD CORR] is open, the load correction data stored in the current correction data number is copied to REF8. It can be used to, for example, check the correction data.
- If the frequency of the correction data is different from the measurement frequency, frequency interpolation is used to calculate the correction data. If the sweep of the correction data is coarse, the interpolation error will be large. Whenever possible, measure the correction data at the same frequency as the measurement frequency.
- If you set the function to ON without saving correction data, the -3076 error message (refer to “Table 3-2 Panel Operation Errors”) is displayed. When measurement is performed in this state, the measurement data is the same as when correction function setting off.
- The load standard values and the open, short, and load correction data are stored in separate memory. The load standard values are stored in the measurement condition memory and the open, short, and load correction data is each stored in its own dedicated memory. There are 32 sets for each correction data, and which number (1 to 32) of correction data should be used is stored in the measurement condition memory. For that reason, be careful with regard to the correspondence between the open, short, and load correction data numbers and the load standard values when the measurement conditions are restored (by panel operation, remote setting, or handler interface). If the load correction data does not correspond to the load standard values, the load correction results will be inaccurate.
- Set the save destination memory numbers of the correction data and the memory numbers to use in the following.

[Calibration]—[OPEN CORR]

[Calibration]—[SHORT CORR]

[Calibration]—[LOAD CORR]

Usually, there is no need to change these settings (memory numbers). Use the initial value of 1.

- When you will switch between multiple measurement paths, such as test fixtures and measurement cables, to perform measurement, measure the open, short, and load correction data with each connection and save each correction data to a different number.

This will allow you to switch the correction data for measurement by simply changing the correction data number to use when changing the measurement paths. When you recall settings with the handler interface (refer to “1.16 Handler Interface”) or when you recall setting information in sequence measurement (refer to “1.9 Sequence Measurement”), you can also switch the correction data together with the various measurement conditions.

1.8.6 Port Extension

This correction function is for when the measurement mode is IMPD-2T and the cable is long. It corrects the phase delay that occurs due to the propagation delay in a cable.

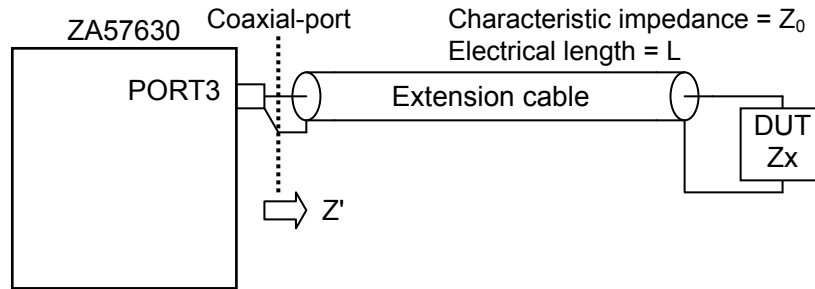


Figure 1-31 Example of Port Extension in IMPD-2T Measurement Mode

Configure the settings in [Calibration]—[PORT EXTENSION].

Open, short, and load corrections are possible at the port extended end (DUT connection location). These corrections at the port extended end are independent from the corrections made using the front panel of this instrument ([Calibration]—[OPEN]/[SHORT]/[LOAD]), and you can store and set correction data, load standard value settings, and other separate values for them.

The setup and measurement procedure is described below.

- 1) Set the measurement signal amplitude and spot measurement frequency. During correction data measurement, correction measurement is performed using settings predetermined internally for the sweep frequency range, measurement time, measurement delay time, and measurement start delay time. The measurement range is AUTO and DC bias is turned off.
Do not connect the extension cable to this instrument yet.
- 2) Measure the open correction data using the front panel of this instrument. Refer to “(When measurement mode is IMPD-3T or IMPD-2T)” in “1.8.3 Open Correction”.
If open correction will not be performed, begin from step 3). Please note that open correction data measurement is required if load correction will be performed.
- 3) Measure the short correction data using the front panel of this instrument. Refer to “(When measurement mode is IMPD-3T or IMPD-2T)” in “1.8.4 Short Correction”.
If short correction will not be performed, begin from step 3). Please note that short correction data measurement is required if load correction will be performed.
- 4) Measure the load correction data using the front panel of this instrument, set the load standard value format, and set the load standard values. Refer to “(When measurement mode is IMPD-3T or IMPD-2T), from step 4)” in “1.8.5 Load Correction”.
If load correction will not be performed, begin from step 5).

Preparation for corrections using the front panel of this instrument is now complete. Next,

carry out the preparation work for the extension cable and corrections at the cable end.

- 5) Enable (set to ON) the correction functions to be used with the front panel of this instrument.
 - Set [Calibration]—[OPEN CORR] to [ON].
 - Set [Calibration]—[SHORT CORR] to [ON].
 - Set [Calibration]—[LOAD CORR] to [ON].

When load correction is set to ON, this instrument will operate with open correction and short correction both regarded as automatically set to ON internally even if those functions remain set to OFF.

- 6) Set the parameters of port extension.
 - [Calibration]—[PORT EXTENSION]—[Z0]
Set the characteristic impedance of the extension cable in ohms.
 - [Calibration]—[PORT EXTENSION]—[ELEC LENGTH]
Set the electrical length of extension cable in meters. Set not the physical length but the electrical length taking into account the velocity factor. When using a coaxial cable with a velocity factor of approximately 67% (RG-58A/U, etc.), the electrical length is 1.49 m for a physical length of 1 m.
 - Set [Calibration]—[FUNCTION] to [ON].

- 7) Measure the open correction data at the port extended end.

If open correction will not be performed, begin from step 8). Please note that open correction data measurement is required if load correction will be performed.

Select [Calibration]—[PORT EXTENSION]—[OPEN_PEXT CORR] and then tap the [MEASURE] function key to measure the port extended end open correction data.

Also refer to “(When measurement mode is IMPD-3T or IMPD-2T)” in “1.8.3 Open Correction”.

- 8) Measure the short correction data at the port extended end.

If short correction will not be performed, begin from step 9). Please note that short correction data measurement is required if load correction will be performed.

Select [Calibration]—[PORT EXTENSION]—[SHORT_PEXT CORR] and then tap the [MEASURE] function key to measure the port extended end short correction data.

Also refer to “(When measurement mode is IMPD-3T or IMPD-2T)” in “1.8.4 Short Correction”.

- 9) Measure the load correction data at the port extended end, set the load standard value format, and set the load standard values.

If load correction will not be performed, begin from step 10).

Select [Calibration]—[PORT EXTENSION]—[LOAD_PEXT CORR] and then tap the [MEASURE] function key to measure the port extended end load correction data.

Also refer to “(When measurement mode is IMPD-3T or IMPD-2T), from step 4)” in “1.8.5 Load Correction”.

- 10) Enable each correction function.

- Set [Calibration]—[PORT EXTENSION]—[OPEN_PEXT] to [ON].
- Set [Calibration]—[PORT EXTENSION]—[SHORT_PEXT] to [ON].
- Set [Calibration]—[PORT EXTENSION]—[LOAD_PEXT] to [ON].

Preparation for port extension corrections is now complete. If you disconnect the impedance standard and perform measurement with a DUT connected, corrected measurement data can be obtained.

The data that has been copied to the correction memory is retained even if the power is turned off, so it is available for use the next time the power is turned on. However, these functions are also executed as a part of the error correction process of this instrument itself, so we recommend that the correction data be measured again after the internal temperature has stabilized after turning the power on (after approximately 30 minutes) and after any change in the ambient temperature.

■ About the port extension function

- This function is effective when the distance to the DUT in terms of the wavelength of the measurement frequency is long (a few percent or more of wavelength).
- This correction applies to an IMPD-2T connection. Enabling this correction in other measurement modes will increase the error rather than reduce it.
- Set not the physical length of the cable but the electrical length (physical length ÷ velocity factor) for the electrical length setting for an extension cable ([ELEC LENGTH]). The velocity factor of an ordinary coaxial cable (RG-58A/U) is approximately 67%, so the electrical length = physical length ÷ 0.67, but you should check the specifications of the cable that you are using for more information.
- Setting an accurate value for the electrical length setting will not necessarily always lead to good results due to factors such as variations in cable characteristics. We recommend that you try taking actual measurements and adjusting the setting value accordingly. This is also a realistic setting method for setting an electrical length with which remarkable resonance characteristics are not noticeable when measurement is performed with the cable end in the open or shorted state.
- If you use a cable with a problem, such as a damaged or deteriorated cable, correction will be insufficient because the characteristic impedance of the cable will not be constant.
- When port extension is performed, the results with the impedance and admittance values corrected are obtained, but please note that the relationship with the voltage amplitude (or PORT1 amplitude) and current amplitude (or PORT2 amplitude) will no longer hold true (corrected impedance and (voltage ÷ current) will not match).
- You can save 32 sets (memory numbers 1 to 32) of correction data independently for each of open correction, short correction, and load correction for each of this instrument front panel and the extension port end respectively. Please note that correction will not be performed if the memory number to which the data was saved and the memory number to be used do not match.

Set the save destination memory numbers and the memory numbers to use in the following.

[Calibration]—[OPEN CORR]

[Calibration]—[SHORT CORR]

[Calibration]—[LOAD CORR]

[Calibration]—[PORT EXT]—[OPEN_PEXT CORR]

[Calibration]—[PORT EXT]—[SHORT_PEXT CORR]

[Calibration]—[PORT EXT]—[LOAD_PEXT CORR]

Usually, there is no need to change these settings (memory numbers). Use the initial value of 1.

- When you will switch between multiple measurement paths, such as test fixtures and measurement cables, to perform measurement, measure the open and short correction data with each connection and save each correction data to a different number. This will allow you to switch the correction data for measurement by simply changing the correction data number to use when changing the measurement paths. When you recall settings with the handler interface (refer to “1.16 Handler Interface”) or when you recall setting information in sequence measurement (refer to “1.9 Sequence Measurement”), you can also switch the correction data together with the various measurement conditions.

1.8.7 Slope Compensation

When the impedance of a DUT such as a battery or high-capacity capacitor is measured, the DC voltage of the DUT will change over time together with the charging/discharging state of the DUT. Since a signal with a ramp-like waveform superimposed will be analyzed, in principle, this will result in errors with ordinary discrete Fourier transform (DFT) processing. The slope compensation function is an analysis method to detect the magnitude and phase of each of a sinusoidal wave and ramp wave individually, assuming that the measurement signal is composed of a sinusoidal wave and ramp wave (potential fluctuation waveform). Only the amplitude and phase of the sinusoidal wave component are used as the measurement results, and the results of measuring the amplitude of the ramp wave component are discarded.

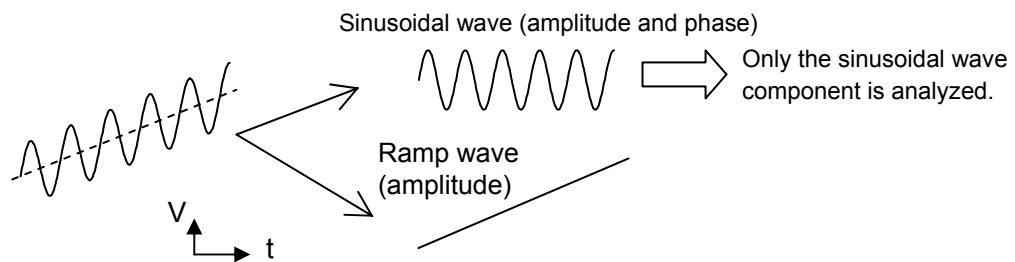


Figure 1-32 Operation of Slope Compensation Function

When the slope compensation function is off, in most cases the errors listed below (theoretical worst-case values) are likely to occur due to potential fluctuation that occurs over one cycle of the sinusoidal wave component.

Table 1-2 Errors due to Potential Slope (Theoretical Values)

Potential fluctuation in one cycle	Amplitude error	Phase error
0 %	0 %	0°
1 %	± 1 %	± 0.5°
10 %	± 7 %	± 4°
100 %	± 70 %	± 40°

When the slope compensation function is on, the above errors theoretically go to zero. Actually, however, errors due to noise, deviation from the ramp wave (nonlinear potential fluctuations), and other such effects remain. Nevertheless, the effects of potential fluctuation are greatly reduced compared to when the function is turned off. Depending on the conditions, there may even be a several tenfold reduction in errors.

The slope compensation function can be set when the measurement mode is IMPD-EXT. Set the function in [Calibration]—[SLOPE COMP]. The setting applies to all ports.

■ Cautions for the slope compensation function

- Usually, this function should be turned off when using this instrument.

This function is for analyzing signals that contain potential fluctuation. Turn this function off for normal measurement. The measurement accuracy specifications for this instrument are defined for operation with the slope compensation function turned off.

- Frequency range restrictions

This function is intended for low-frequency measurements such as electrochemical measurements. It is generally effective at frequencies of approximately 1 kHz or less (period of 1 ms or more).

- Potential fluctuation waveform restrictions

For potential fluctuation, a waveform that changes linearly over time is assumed. Fluctuation waveforms that involve exponential change functions or waveforms for which there is a switching between charging and discharging during the analysis (triangular potential fluctuation waveforms) cannot be eliminated normally. This function is also not effective for waveforms for which there are sudden potential changes.

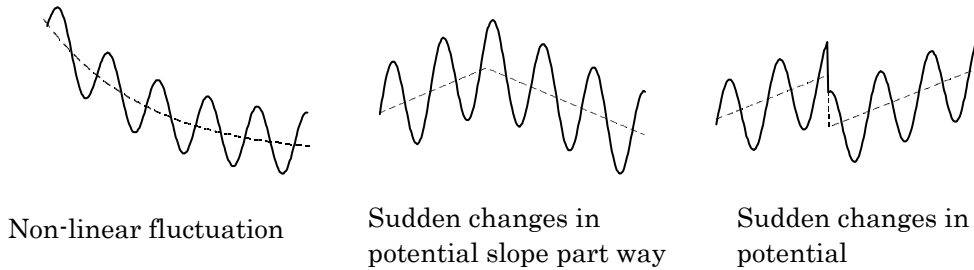


Figure 1-33 Examples of Potential Fluctuation Waveforms That Cannot Be Eliminated

1.8.8 Equalizing

This function is used in the G-PH measurement mode. It corrects the errors of cables, probes etc. connected to this instrument.

The connection example in the following figure illustrates the method to correct measurement system errors by equalizing.

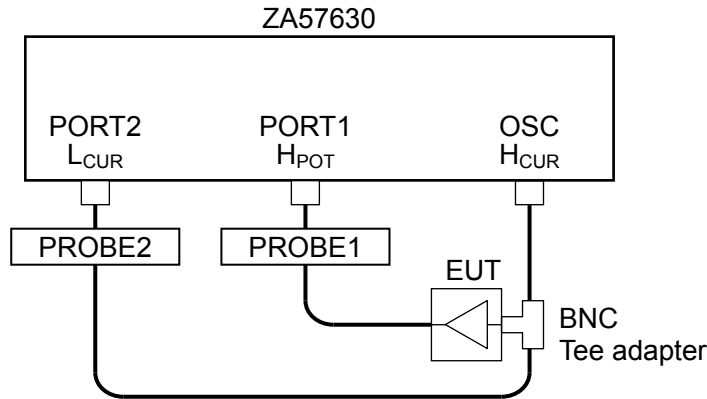


Figure 1-34 Gain and Phase Measurement Connection Example

The setup and measurement procedure is described below.

- 1) Set the measurement conditions, including the measurement signal amplitude, DC bias, and measurement range. Also set the frequency sweep range. Even when a frequency sweep will not be performed, set the frequency sweep settings of the range including the measurement frequency.
- 2) Set [Calibration]—[EQUALIZING] to [OFF].
- 3) Disconnect the equipment under test (EUT) and directly connect (short) the input and output.

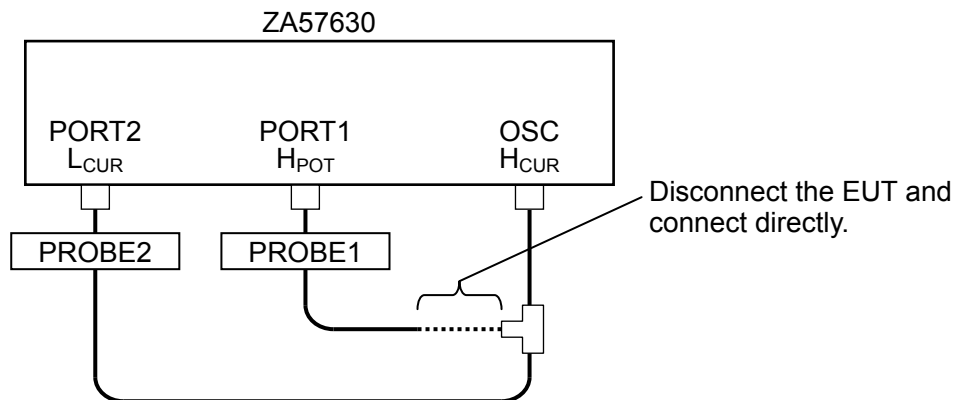


Figure 1-35 Connections to Measure the Measurement System Errors

- 4) Turn on measurement signal output and then perform frequency sweep measurement.
- 5) When sweep measurement ends, select [Trace]—[MEAS TRACE COPY]—[EQU CORR MEM] and then tap the [COPY] function key to copy the measurement data to the equalizing memory.
- 6) Set [Calibration]—[EQUALIZING] to [ON].
- 7) Restore the original connections of the EUT disconnected in step 3) (refer to “Figure 1-34 Gain and Phase Measurement Connection Example”).

Preparation for equalizing is now complete. If you perform measurement, you will be able to obtain measurement data that has been corrected for the errors present in the probes, cables, and other parts of the measurement system.

The correction data that has been copied to the equalizing memory is retained even if the power is turned off, so it is available for use the next time the power is turned on. However, this function is also executed as a part of the error correction process of this instrument itself, so we recommend that the equalizing correction data be measured again after the internal temperature has stabilized after turning the power on (after approximately 30 minutes) and after any change in the ambient temperature.

■ Cautions for equalizing

- Even if the correction data is measured and copied to the equalizing memory, the function is not executed unless it is enabled (set [Calibration]–[EQUALIZING] to [ON]).
- When equalizing is performed, the results with the gain corrected are obtained, but please note that the relationship with the PORT1 amplitude and PORT2 amplitude will no longer hold true (corrected gain and (PORT1 amplitude ÷ PORT2 amplitude) will not match).
- If the frequency of the correction data is different from the measurement frequency, frequency interpolation is used to calculate the correction data. If the sweep of the correction data is coarse, the interpolation error will be large. Whenever possible, measure the correction data at the same frequency (range and density) as the measurement frequency.
- If the correction data is measured outside the range specified by the upper and lower limit frequencies, the correction data for the nearest frequency (upper or lower limit frequency) is used for the equalizing calculation.
- If you set the function to ON without saving correction data, the –3073 error message (refer to “Table 3-2 Panel Operation Errors”) is displayed. When measurement is performed in this state, the measurement data is the same as when correction function setting off.
- You can save 32 sets (memory numbers 1 to 32) of correction data. Please note that correction will not be performed if the memory number to which the data was saved and the memory number to be used do not match.

Set the save destination memory number and the memory number to use in the following.

[Calibration]–[EQUALIZING]:

Usually, there is no need to change these settings (memory numbers). Use the initial value of 1.

- When you will switch between multiple measurement paths, such as probes and measurement cables, to perform measurement, measure the equalizing data with each connection and save each correction data to a different number. This will allow you to switch the correction data for measurement by simply changing the correction data number to use when changing the measurement paths. When you recall setting information in sequence measurement (refer to “1.9 Sequence Measurement”), you can also switch the correction data together with the various measurement conditions.

- If you tap the [COPY TO REF8] function key displayed when [Calibration]—[EQUALIZING] is open, the load correction data stored in the current correction data number is copied to REF8. It can be used to, for example, check the correction data.

1.9 Sequence Measurement

Sequence measurement is a function to perform sweep measurement by reading the settings in the setting memory in numerical order. For one sweep, the sweep range can be divided into up to 32 sweep ranges to enable measurement to be performed with different measurement conditions (frequency, AC amplitude, DC bias, measurement time, etc.) for each sweep range. The item (frequency, AC amplitude, or DC bias) for which sweeping is performed in sequence measurement is in accordance with not the sweep item setting saved to the setting memory but the sweep item setting of this instrument at that current point in time. When the sweep item is set to a time sweep, sequence measurement will not be performed.

If the sweep lower limit ([Sweep]—[SWEEP LOWER]) is set to SWP_{Lm} , and the sweep upper limit ([Sweep]—[SWEEP UPPER]) is set to SWP_{Um} in setting memory number m , sweep measurement for one up-sweep is performed in the following order.

$(SWP_{L1} \rightarrow SWP_{U1}), (SWP_{L2} \rightarrow SWP_{U2}), \dots, (SWP_{L(N-1)} \rightarrow SWP_{U(N-1)}), (SWP_{LN} \rightarrow SWP_{UN})$

For a down-sweep, sweep measurement is performed in the following order.

$(SWP_{UN} \rightarrow SWP_{LN}), (SWP_{U(N-1)} \rightarrow SWP_{L(N-1)}), \dots, (SWP_{U2} \rightarrow SWP_{L2}), (SWP_{U1} \rightarrow SWP_{L1})$

N is the highest setting memory number for which sequence measurement is performed, and is set in [Sweep]—[SEQ NUMBER]. If [OFF] is set, sequence measurement will not be performed.

Within each sweep range, the important parameters such as the frequency, AC amplitude, DC bias, and measurement time settings are read from the setting memory and set together with the sweep range. However, there are also parameters such as graph settings that are not read from the setting memory and for which the current settings are retained. In “Table 3-4 Initial Settings” in Instruction Manual (Basics), parameters for which the sequence target is indicated as “Y” are read from the memory during a sequence, and parameters for which it is indicated as “N” remain unchanged from the current settings.

The data obtained by sequence measurement is handled in the same way as normal sweep measurement results (obtained with sequence measurement set to OFF).

- Graph display: All sweep data is displayed.
- Marker operations: Handled as continuous sweep data.
- Saving or loading to/from data memory: Handled as a single data file.

■ About the trigger for sequence measurement

[Sweep]—[SEQ TRIGGER] sets the progress method of sequence measurement.

[AUTO]: Measurement is performed for the entire sequence with one press of the **UP** or **DOWN** key.

[STEP]: This instrument enters the standby state when each sweep ends, and starts the next sweep when the sweep key (**UP** or **DOWN** key) is pressed again.

Usually, AUTO should be used. Use STEP when you wish to change the external device connection and settings for each sweep in the sequence.

■ Cautions for sequence measurement

- A validity check is not made for the sweep range of each setting memory number. Depending on the settings in the setting memory, the sweep ranges may be greatly separated, overlapped, or reversed when the setting memory number is changed, but measurement is performed in accordance with the settings in the setting memory.
- For marker operations on the sequence measurement data, the markers are moved in the order in which the sequence measurements were performed. If the high and low values of the sweep range are reversed between setting memories, turning the control knob to the right (clockwise) may move the marker in the direction of lower sweep parameters.
- A marker search is not performed across setting memory number is exceeded. A search is performed within the sweep data of the setting memory number on which the search target marker is placed.
- The total number of sweep points in a single sequence measurement is the sum of the number for memory 1 through to the maximum memory number, and the maximum total is 2,001 points. If the maximum number of points is reached while sequence measurement is still in progress, the measurement is stopped at that time. The total number of sweep points is not checked when measurement begins.
- The automatic high density sweep setting is disabled. Normal sweep measurement is performed.
- Sequence measurement cannot be performed from the handler interface or a remote interface. Sequence measurement is performed only when the SWEEP **UP** / **DOWN** key on the front panel is pressed.

1.10 Resonant Frequency Tracking Measurement

This function automatically keeps the measurement frequency tracked to the resonant frequency of the DUT in the impedance measurement of ceramic, crystal, and other piezoelectric vibrators. The measurement frequency is tracked automatically so that the DUT can always be measured with the resonant frequency even if the resonant frequency shifts due to changes in factors such as the ambient temperature and load.

The frequency for which the reactance component of the DUT becomes zero (phase is 0°) is the resonant frequency. The function to track the frequency that becomes the 0° phase is the resonant frequency tracking function, but this instrument allows you to set any phase as the tracking target phase to remove the effects of probes and other parts of the measurement system.

The fluctuation over time of the resonant frequency can also be observed by performing time sweep (zero-span sweep) measurement in addition to spot measurement.

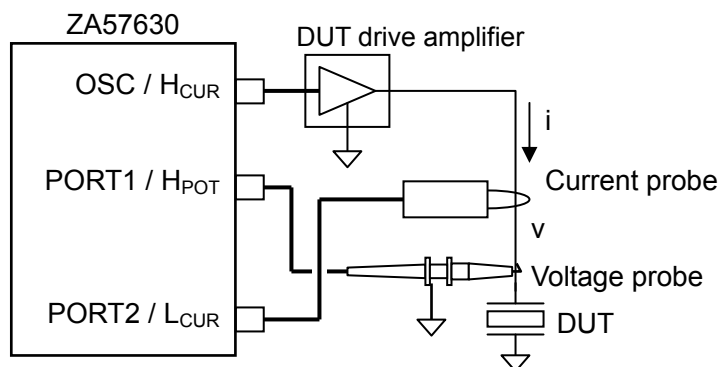


Figure 1-36 Piezoelectric Vibrator Measurement Connection Example

The figure above shows a connection example in the IMPD-EXT measurement mode, but resonant frequency tracking measurement is also possible in the IMPD-3T, IMPD-2T, and G-PH measurement modes.

The setup and measurement procedure is described below.

- 1) Set the measurement signal source (amplitude, DC bias, or frequency), measurement range, and other measurement conditions. For the frequency setting, set a frequency that is near the DUT resonant frequency.
- 2) Configure the following settings in [Sweep]—[RESONANT TRACK].
 - [FUNCTION] : Set this to ON.
 - [UPPER FREQUENCY] : Set the tracking frequency upper limit.
 - [LOWER FREQUENCY] : Set the tracking frequency lower limit.

These are different from the settings for frequency sweep measurement.

 - [TARGET PHASE] : Set the tracking target phase. Normally, set this to 0° .
 - [TOLERANCE] : Set the permissible error.

A smaller value will improve the resonant frequency accuracy, but the tracking response will become slower.

Try performing measurement with this set to approximately 5° and then

adjust it as necessary.

- [POLARITY] : Tracking polarity. For normal resonant tracking (series resonance), set this to POSITIVE.

If you set NEGATIVE, the operation to track the antiresonant frequency (parallel resonance) will be performed.

- [CORR FACTOR] : Frequency correction factor. Normally, set this to 100%.

The setup is now complete. When spot measurement is performed, the measurement signal frequency moves to the resonant frequency. In the repeat measurement state, the measurement will be repeated. Also if a time sweep is performed, data with a measurement frequency that matches the resonant frequency (target phase) will be obtained. With a time sweep, the fluctuation over time of the resonant frequency can be measured if you set the Y-axis to FREQUENCY (tracking frequency).

When the measurement mode is G-PH, the resonant frequency tracking function performs the operation to track the measurement frequency so that the phase of the transfer characteristics becomes the set phase. The phase shifts (the order) $\times 45^\circ$ at the cutoff frequency of a lowpass/highpass filter, so you can use this function to automatically search for the cutoff frequency by setting the target value to that phase.

■ Cautions for resonant frequency tracking measurement

- If the setting for the permissible error of the phase ([TOLERANCE]) is decreased too much, a long time will be required for the tracking response. Use an appropriate setting for the permissible error.
- Set the frequency range to track ([UPPER FREQUENCY] and [LOWER FREQUENCY]) to a range for which the polarity of the phase change in respect to the frequency change will not change.

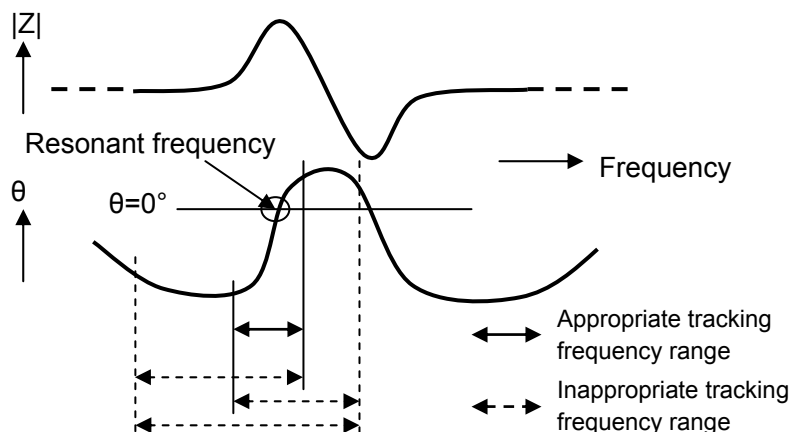


Figure 1-37 Search Frequency Range Setting ([POLARITY] = POSITIVE)

If a range for which the slope of the phase will become positive ($\Delta\theta / \Delta\text{frequency} > 0$) is not set as the search frequency range as shown in the figure above, a correct search will not be possible.

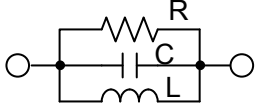
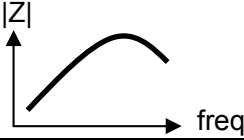
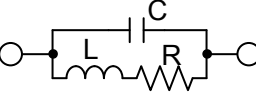
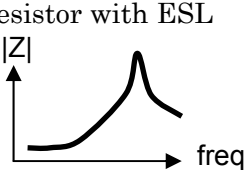
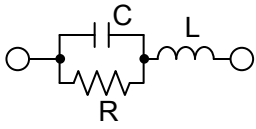
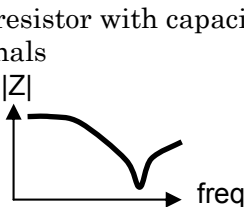
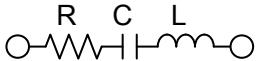
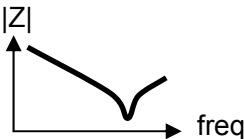
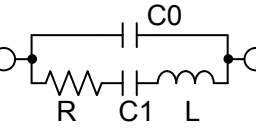
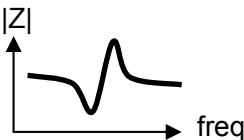
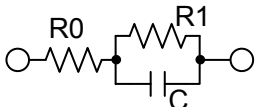
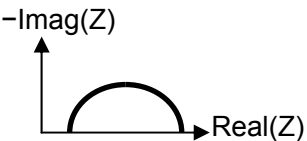
- Change the following settings when measurement frequency continues to fluctuate between a frequency before and after the resonant frequency and does not become stable.
 - Increase [TOLERANCE].
 - Decrease [CORR FACTOR].
 - Increase the measurement delay time setting ([Measure]—[MEASURE DELAY]).

For a DUT with an extremely high Q , such as a crystal oscillator, tracking measurement may not be able to be performed normally unless a sufficiently large measurement delay is set. Also refer to “1.2 Delay Settings”.

1.11 Equivalent Circuit Estimation

This function calculates the values of each LCR element (inductance value, capacitance value, and resistance value) by fitting the impedance characteristic obtained by frequency sweep measurement to the selected equivalent circuit. The following six types of equivalent circuit are provided. This function can be used when the measurement mode is IMPD-EXT, IMPD-3T, or IMPD-2T.

Table 1-3 Equivalent Circuit Types

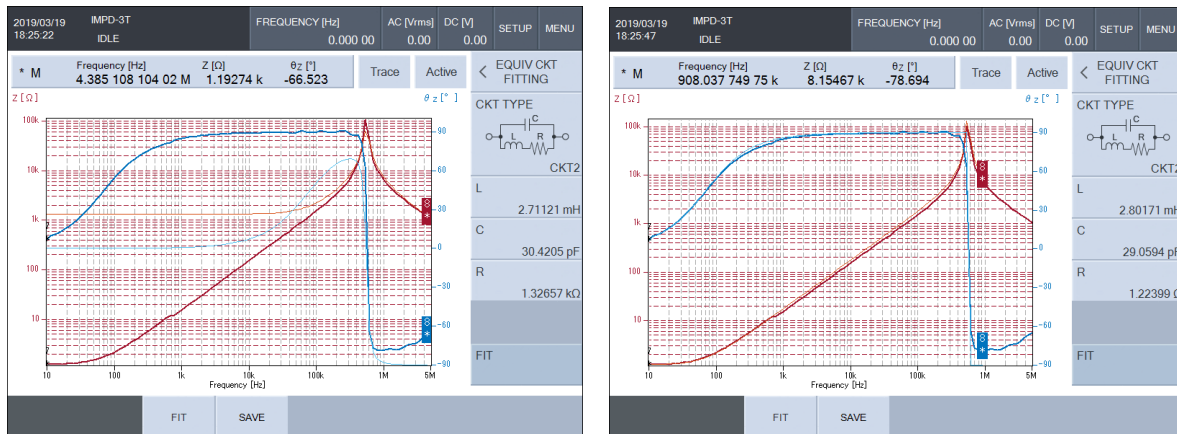
Circuit name and equivalent circuit	Correspondent DUTs and typical impedance characteristic
CKT1 	<ul style="list-style-type: none"> Inductor with large core loss 
CKT2 	<ul style="list-style-type: none"> Inductor with large ESR Low resistor with ESL 
CKT3 	<ul style="list-style-type: none"> Capacitor with large leakage resistance High resistor with capacitance between terminals 
CKT4 	<ul style="list-style-type: none"> General capacitor with ESR and ESL 
CKT5 	<ul style="list-style-type: none"> Piezoelectric vibrator, crystal oscillator, etc. 
CKT6 	<ul style="list-style-type: none"> Electrochemical impedance such as batteries 

Perform equivalent circuit estimation with the following procedure.

- 1) Perform a frequency sweep to measure the impedance characteristic of the DUT.
- 2) Display MARKER7 and MARKER8, and place MARKER7 on the lower limit frequency and MARKER8 on the upper limit frequency to perform equivalent circuit estimation. If MARKER7 or MARKER8 are not displayed, equivalent circuit estimation is performed

- within the range that frequency sweep measurement was performed.
- 3) Select the equivalent circuit in [Calculate]—[EQUV CKT FTG]—[CKT TYPE]. Please note that estimation cannot be performed correctly if an inappropriate equivalent circuit is selected.
 - 4) Tap [EQUV CKT FTG]—[FIT] and then tap the [FIT] function key to perform equivalent circuit estimation. The measured data (MEAS TRACE) and estimated impedance characteristic are displayed. The estimated characteristic is stored in REF1 TRACE.
 - 5) [EQUV CKT FTG]—[R]/[L]/[C] contain each of the estimated values. Tapping the parameters allows you to change any of the element values with the function keys. When an element value is changed, the estimated impedance characteristic is recalculated, and the result is then stored and displayed in REF1 TRACE.
 - 6) The equivalent circuit estimation results (circuit and element values) can be saved as a file in a USB memory device with the [SAVE] function key. For the file format, refer to “2.4 Equivalent Circuit File Format”.

Equivalent circuit estimation examples for CKT2 are displayed in the following figure. Please note that even with the same measurement data, estimation may not be performed correctly depending on the estimation range (positions of MARKER7 and MARKERS8) settings.



(a) Example of incorrect estimation range (b) Example of range enabling correct estimation
Figure 1-38 Equivalent Circuit Estimation Examples

■ Cautions for equivalent circuit estimation

- Equivalent circuit estimation is a function to calculate each element value for the selected equivalent circuit (CKT1 to CKT6). The actually measured impedance characteristics contain errors and noise, so estimation results that exactly match measurement results cannot be obtained.
- If the selection of the equivalent circuit (CKT1 to CKT6) is inappropriate, equivalent circuit estimation cannot be performed correctly. When estimated results and measurement impedance characteristics differ significantly, also revise the equivalent circuit selection.
- Equivalent circuit estimation can not be performed for data other than frequency sweep and data obtained by sequence measurement.

1.12 Calculating Piezoelectric Constants

This function measures the frequency-impedance characteristic of piezoelectric ceramics and then calculates the electromechanical coupling coefficient, piezoelectric constants, etc. These parameters are calculated using methods that conform to “Japan Electronics and Information Technology Industries Association (JEITA) Standard EM-4501 / Electrical test methods for piezoelectric ceramic vibrators”.

This function can be used when the measurement mode is IMPD-EXT, IMPD-3T, or IMPD-2T.

The measurement and calculation procedure is described below.

- 1) Perform frequency sweep measurement to measure the impedance characteristic of the DUT piezoelectric ceramic.

$Z-\theta_Z$ or $Y-\theta_Y$ is suitable for the measurement item (graph Y-axis) setting. At this time, perform the frequency sweep in an appropriate range. If the width of the resonance portion is too narrow or multiple resonance characteristics are included, the calculation cannot be performed correctly.

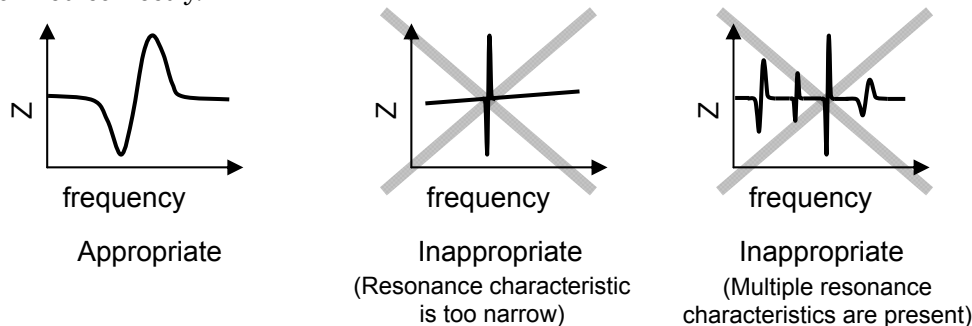
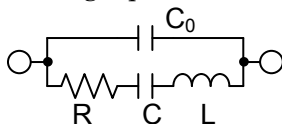


Figure 1-39 Example of Frequency Sweep for Which Piezoelectric Constant Calculation Is Possible

- 2) Perform equivalent circuit estimation for the impedance characteristic.

Display MARKER7 and MARKER8, and place MARKER7 on the lower limit frequency and MARKER8 on the upper limit frequency for analysis. If MARKER7 and MARKER8 are not displayed, equivalent circuit estimation is performed within the range that the frequency sweep was performed.

- 3) Tap [Calculate]—[PZT]—[PZT PRMTR]—[FIT] and then tap the [FIT NORMAL] function key. Estimated characteristics near the measured impedance characteristic (MEAS trace) are stored and displayed as the REF1 trace. The estimated values (C_0 , R , C , L) are the value in the following equivalent circuit.



- 3-1) If the differences between the measurement results and estimation results are significant at this time, change [Calculate]—[PZT]—[PZT PRMTR]—[C_0 MODE] to RESNf / fmax / Gmax / Bavg and perform equivalent circuit estimation again (tap the [FIT NORMAL] function key) so that estimation data close to the actually measured data is obtained. C_0 MODE is an algorithm for calculating the C_0 of an equivalent circuit.

- RESNf: Calculate the C_0 from the series/parallel resonant frequency.
- fmax: Calculate the C_0 from the susceptance of the maximum frequency used in equivalent circuit estimation.
- Gmax: Calculate the C_0 from the frequency at which conductance is the maximum.
- Bavg: Calculate the C_0 from the susceptance average.

- 3-2) If the characteristics in the vicinity of the resonant frequency are unclear due to the frequency density of the measurement data being coarse, increase [Calculate]–[PZT]–[PZT PRMTR]–[FREQ RESOLN]. The characteristics in the vicinity of the resonant frequency can be displayed in detail by setting the frequency resolution of the REF1 data. This setting can be set to any value that is no higher than 2,000 regardless of the setting when frequency sweep measurement was performed.
- 4) Tap the [FIT FINE] function key to perform even more accurate equivalent circuit estimation. However, if the differences between the measurement data and estimation data are large, the differences may become even more significant due to using [FIT FINE].
- 5) The equivalent circuit constants can also be finely adjusted by changing the C_0 , L, C, and R displayed by selecting [Calculate]–[PZT]–[PZT PRMTR].
When each constant is changed, the estimated impedance characteristic is recalculated, and the result is then reflected in the display as the REF1 trace.
- 6) Each characteristic frequency of the DUT is calculated after equivalent circuit estimation ends. Tap [Calculate]–[PZT]–[PZT PRMTR]–[FIT] and then tap the [RESN FREQ DISP] function key to display the resonant frequency, etc. on the screen.

- fs : Series resonant frequency (frequency at which conductance G is the maximum)
- fp : Parallel resonant frequency (frequency at which resistance R is the maximum)
- fa : Antiresonant frequency (highest of the two frequencies at which $\theta = 0^\circ$)
- fr : Resonant frequency (lowest of the two frequencies at which $\theta = 0^\circ$)
- f1 : Quadrant frequency 1 (frequency at which susceptance B is the maximum)
- f2 : Quadrant frequency 2 (frequency at which susceptance B is the minimum)
- fm : Maximum admittance frequency (frequency at which admittance $|Y|$ is the maximum)
- fn : Minimum admittance frequency (frequency at which admittance $|Y|$ is the minimum)
- Qm : Mechanical quality factor (sharpness of resonance)

These parameters are display-only parameters and cannot be changed.

The positions of these frequencies on the complex admittance plane are shown in the figure below. Since each frequency is calculated from the equivalent circuit estimation results, it may be different from the frequency read by the marker from the measurement data.

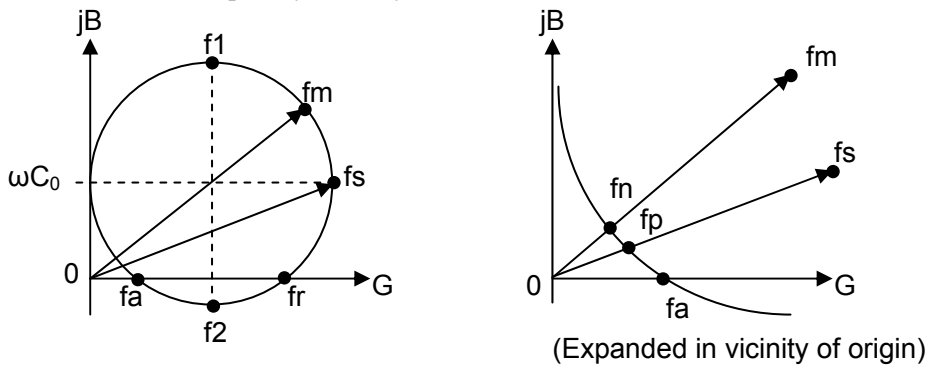


Figure 1-40 Position of Each Frequency on Complex Admittance Plane

- 7) Enter the information of the DUT, such as the type and dimensions of the DUT. Tap [Calculate]—[PZT]—[PZT CONST] to display the window in the figure below.

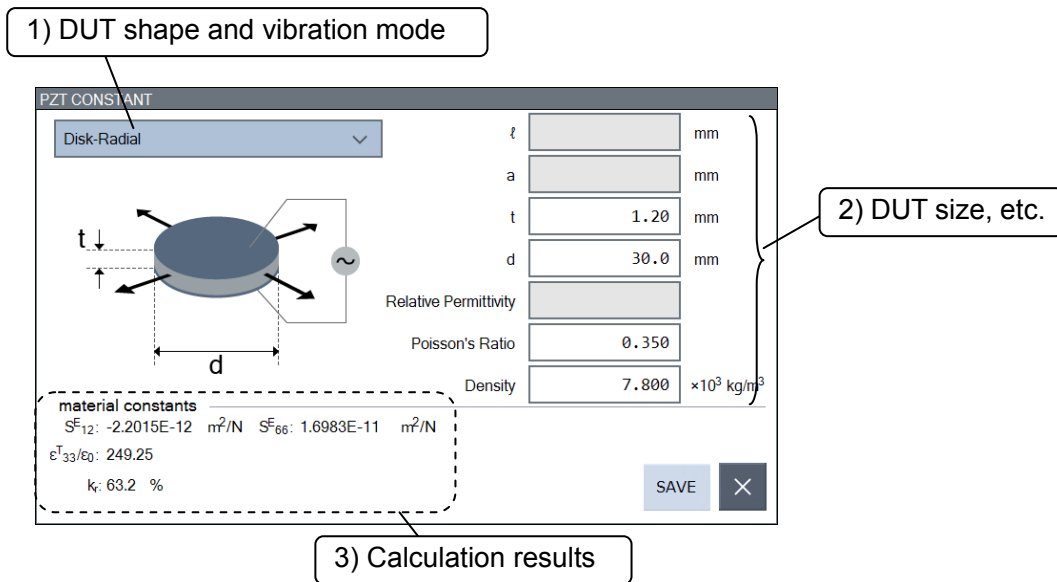
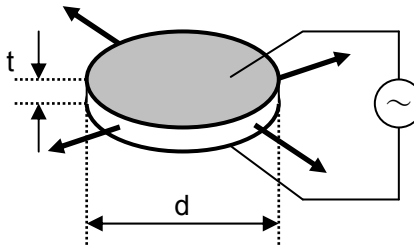
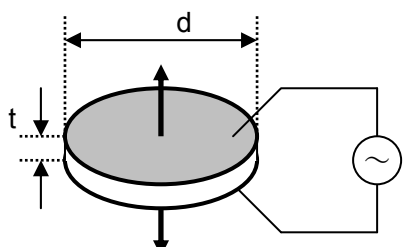
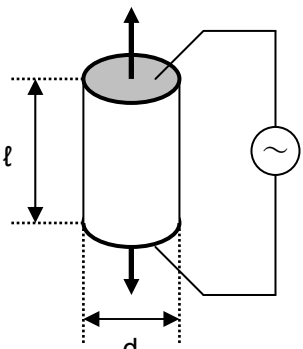
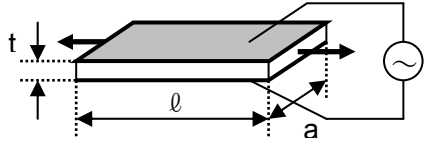
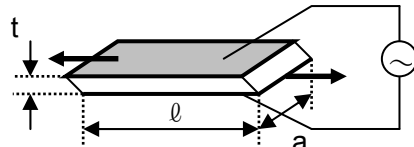


Figure 1-41 Layout of Piezoelectric Constant Calculation Window

- 7-1) Select the shape and vibration mode of the DUT from the pull-down menu. A schematic diagram of the selected DUT shape and vibration mode is displayed in the window.
- 7-2) Enter the parameters, such as the size (dimensions) and Poisson's ratio of the DUT. The required parameters vary depending on the DUT shape and vibration mode selected in 7-1). Parameters that are not required are grayed out. Set all of the parameters that can be entered.
- 7-3) The piezoelectric constant calculation results are displayed. If you change the DUT shape or parameters, the piezoelectric constants are recalculated and then the display is updated.

The DUT shapes and vibration modes that can be set, parameters such as the size that need to be set, and piezoelectric constants that can be calculated are listed on the next page.

Table 1-4 Piezoelectric Constant Calculation Function List

	Disk shaped vibrator, radial vibration	Disk shaped vibrator, thickness extensional vibration
Name	Disk-Radial 	Disk-Thickness extensional 
Set parameters	t (Thickness), d (Diameter), Poisson's Ratio, Density	t (Thickness), d (Diameter), Poisson's Ratio, Density
Calculated constants	$S_{12}^E, S_{66}^E, \epsilon_{33}^T / \epsilon_0, k_r$	$C_{33}^D, C_{33}^E, \epsilon_{33}^T / \epsilon_0, k_t$
	Rod shaped vibrator, Axial vibration	Plate shaped vibrator, length extensional vibration
Name	Rod-Axial 	Plate- Length extensional 
Set parameters	l (Length), d (Diameter), Relative Permittivity ($\epsilon_{33}^T / \epsilon_0$), Poisson's Ratio, Density	l (Length), a (Width), t (Thickness), Poisson's Ratio, Density
Calculated constants	$S_{33}^D, S_{33}^E, d_{33}, g_{33}, k_{33}$	$S_{11}^E, d_{31}, g_{31}, k_{31}$
	Plate shaped vibrator, thickness shear vibration	
Name	Plate-Thickness shear 	
Set parameters	l (Length), a (Width), t (Thickness), Poisson's Ratio, Density	
Calculated constants	$C_{44}^D, C_{44}^E, S_{44}^E, \epsilon_{11}^T / \epsilon_0, d_{15}, g_{15}, k_{15}$	

S_{ij}^E and S_{ij}^D are referred to as compliance [m²/N], C_{ij}^E and C_{ij}^D as stiffness [N/m²], $\epsilon_{ij}^T / \epsilon_0$ as

relative permittivity, d_{ij} as piezoelectric constant [m/V], g_{ij} as piezoelectric constant [Vm/N], and k_{ij} , k_r and k_t as electromechanical coupling coefficient. For details, refer to “Japan Electronics and Information Technology Industries Association (JEITA) Standard EM-4501A / Electrical test methods for piezoelectric ceramic vibrators”.

- 8) Each calculated piezoelectric constant and the set DUT information can be saved to a USB memory device as a file by tapping the [SAVE] button. For the file format, refer to “2.5 Piezoelectric Constant File Format”.

To close the piezoelectric constant calculation window, tap the [×] button.

■ Cautions for piezoelectric constant calculation

- Many resonant characteristics may appear depending on the DUT. The results will differ for the piezoelectric constants depending on the selection of the resonant component to be analyzed and calculated. Check the resonant component in accordance with the vibration mode.
- If stress is applied to the DUT by the holder that is holding the DUT, it will affect the impedance measurement results. Measure the impedance in a state that is as close to the state in which the DUT is actually used.
- The shape of the DUT is assumed to be plate, disk, or rod. If the shape greatly differs from these shapes, such as a plate that is nearly a cube, errors will occur. For guidelines and other information on the shapes of DUTs, refer to “Japan Electronics and Information Technology Industries Association (JEITA) Standard EM-4501A / Electrical test methods for piezoelectric ceramic vibrators”.
- Piezoelectric constants calculating can not be performed for data other than frequency sweep and data obtained by sequence measurement.

1.13 Relative Permittivity Measurement

Setting the dimensions of the DUT and other information in advance enables the impedance measurement results to be converted to the complex relative permittivity and then displayed. This function can be used when the measurement mode is IMPD-EXT, IMPD-3T, or IMPD-2T.

Perform relative permittivity measurement with the procedure described below.

1) Set the following two parameters in [Calculate]—[REL PERMT].

[ELECTD AREA] : Set the electrode surface area of the DUT in mm².

[ELECTD DIST] : Set the distance between electrodes in mm.

2) Set the measurement and display items.

When performing sweep measurement, select the display item from [Graph]—[DISPLAY MODE Y].

$\epsilon_S - D_\epsilon$: Relative permittivity, dissipation factor

$\epsilon_S' - \epsilon_S''$: Real part of relative permittivity, imaginary part of relative permittivity

When performing spot measurement, select the items in [Measure]—[PRMTR1] to [PRMTR6].

ϵ_S : Relative permittivity

ϵ_S' : Real part of relative permittivity

ϵ_S'' : Imaginary part of relative permittivity

D_ϵ : Dissipation factor

Preparation for relative permittivity measurement is now complete. For details on connecting with the DUT and the measurement methods, refer to “4.2.2 Measurement Impedance” to “4.2.4 Measurement Impedance” in Instruction Manual (Basics). When sweep measurement or spot measurement is performed, the relative permittivity is displayed.

■ About relative permittivity measurement

- Relative permittivity is calculated with the following formula from the impedance measurement results (C_P and R_P) of the DUT.

$$\epsilon_S' = \frac{C_P}{C_0}, \quad \epsilon_S'' = \frac{1}{2\pi f C_0 R_P}, \quad \epsilon_S = \sqrt{\epsilon_S'^2 + \epsilon_S''^2}, \quad D_\epsilon = \frac{\epsilon_S''}{\epsilon_S'}$$

f is the measurement frequency [Hz]. C_0 is the electrostatic capacitance of a virtual capacitor when a dielectric substance is a vacuum with the same electrode surface area and distance between electrodes as the DUT.

- Conversion to permittivity is performed on the assumption that all lines of electric force uniformly pass through the DUT (dielectric substance) located between the electrodes. Please note that the error becomes larger if there is a gap between the electrodes and DUT or if the electrode area is smaller in proportion to the distance between the electrodes (more lines of electric force pass through the space).

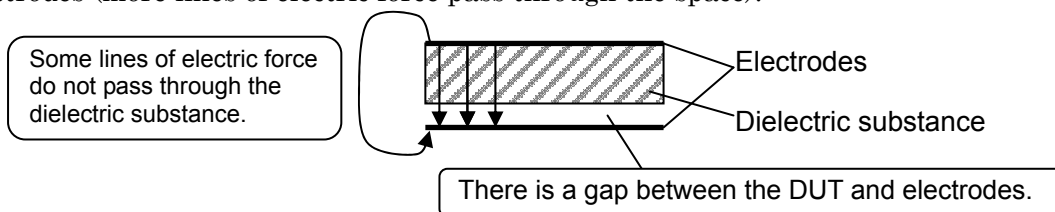


Figure 1-42 Example of Dielectric Substance DUT with Large Error

1.14 Relative Permeability Measurement

Setting the dimensions of the DUT and other information in advance enables the impedance measurement results to be converted to the complex relative permeability and then displayed. This function can be used when the measurement mode is IMPD-EXT, IMPD-3T, or IMPD-2T.

Perform relative permeability measurement with the procedure described below.

1) Set the following six parameters in [Calculate]—[REL PERMB].

[CORE AREA] : Set the effective cross-section area of the DUT magnetic substance in mm².

[MAG PATH LENGTH]: Set the effective magnetic path length of the DUT magnetic substance in mm.

[COIL TURNS] : Set the number of coil turns.

[ONE TURN LENGTH]: Set coil one turn length in mm.

[WIRE DIAMETER] : Set the winding wire diameter in mm.

[WIRE RESISTIVITY] : Set the winding wire resistivity in Ω/m

2) Set the measurement and display items.

When performing sweep measurement, select the display item from [Graph]—[DISPLAY MODE Y].

$\mu_s - D_\mu$: Relative permeability, dissipation factor

$\mu_s' - \mu_s''$: Real part of relative permeability, imaginary part of relative permeability

When performing spot measurement, select the items in [Measure]—[PRMTR1] to [PRMTR6].

μ_s : Relative permeability

μ_s' : Real part of relative permeability

μ_s'' : Imaginary part of relative permeability

D_μ : Dissipation factor

Preparation for relative permeability measurement is now complete. For details on connecting with the DUT and the measurement methods, refer to “4.2.2 Measurement Impedance” to “4.2.4 Measurement Impedance” in Instruction Manual (Basics). When sweep measurement or spot measurement is performed, the relative permeability is displayed.

■ About relative permeability measurement

- Relative permeability is calculated with the following formula from the impedance measurement results (L_S and R_S) of the DUT.

$$\mu_s' = \frac{L_S}{L_0}, \quad \mu_s'' = \frac{R_S - R_W}{2\pi f L_0}, \quad \mu_s = \sqrt{\mu_s'^2 + \mu_s''^2}, \quad D_\mu = \frac{\mu_s''}{\mu_s'}$$

f is the measurement frequency (Hz), L_0 is the virtual inductance when a magnetic substance is a vacuum, and R_W is the winding resistance of the coil.

- Conversion to permeability is performed under the assumption that the magnetic substance is an ideal toroidal core for which all lines of magnetic force pass through the DUT (magnetic substance). Please note that the error becomes larger if there is a magnetic flux leakage (as in the case of a core with a gap or a solenoid coil).

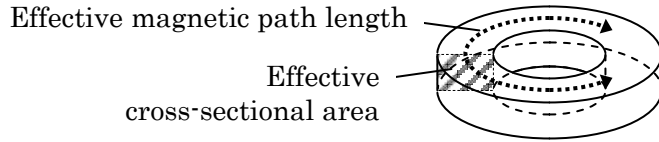


Figure 1-43 Example of Toroidal Core

1.15 Comparator

This function allows you to preset comparison ranges for the measurement results to perform sorting (bin sorting) and pass/fail comparison (limit comparison and zone comparison) for selecting DUTs. This function can be used when the measurement mode is IMPD-EXT, IMPD-3T, or IMPD-2T.

Bin sorting and limit comparison can be performed for spot measurement results and zone comparison can be performed for the sweep measurement results. Comparison results can be displayed on the screen and output to the handler interface and the USB or other remote interface.

1.15.1 Bin Sorting

This function sorts spot measurement results into up to 14 bins (BIN1 to BIN14). The following figure shows an example of the spot measurement screen when bin sorting is performed.

2019/02/01 18:27:55	IMPD-3T IDLE	FREQUENCY [Hz] 1.000 000 000 00M	AC [Vrms] 1.00	DC [V] 0.00	SETUP	MENU
primary parameter	Cs	1.235 76 nF	BIN 2		Sorting result	
secondary parameter	Rs	1.807 81 Ω				
	Z	128.804 Ω				
	θz	-89.196 °				
	R	1.807 81 Ω				
	X	-128.792 Ω				

Figure 1-44 Bin Sorting Screen Example

Bin sorting is performed for the 1st and 2nd parameters of the spot measurement results. The 3rd to 6th parameters have no effect on the bin sorting results. The setup procedure is described below.

- 1) Set the measurement items (1st to 6th parameters) for spot measurement.
- 2) Set the type (deviation mode) to specify the upper and lower limit range of each bin in [Comparator]—[BIN]—[DEVIATION TYPE].

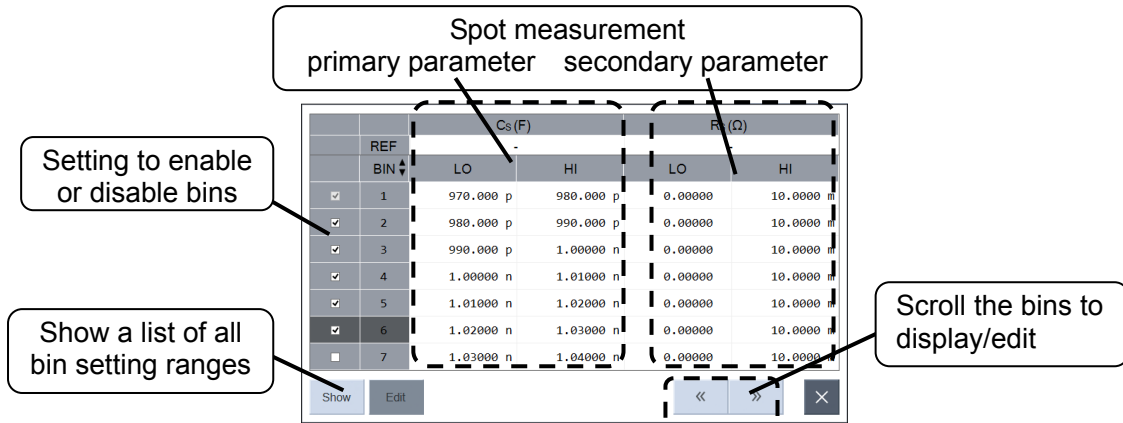
ABS : Directly set the upper and lower limits of the range.

DEV : Set the type with upper and lower limit values in respect to the reference values.

DEV% : Set the type with upper and lower limit values in respect to the reference values as percentages (%) of the reference values.

When setting the deviation with DEV or DEV%, set the reference value of the 1st parameter in [Comparator]—[BIN]—[PRI REF] and the reference value of the 2nd parameter in [Comparator]—[BIN]—[SEC REF].

- 3) Set the upper and lower limit range of each bin. Tap [Comparator]—[BIN]—[BIN SET] to display a palette to set the sorting range. Set the upper and lower limit values of the bins to be used from BIN1 to BIN14. For spot measurement results, the ranges are checked in order from BIN1 and the first bin that passes becomes the sorting result.



When both the 1st and 2nd parameters satisfy the sorting range, that bin becomes the sorting result. Even when the 1st parameter is inside the range, if the 2nd parameter is outside the range, the sorting result will not be that bin but instead the next bin sorting will be performed.

If a check mark on the left is cleared, the corresponding bin sorting will not be performed. Please note that BIN1 cannot be disabled.

Tapping the BIN column (1 to 14) displays functions to edit on a row basis on the function keys. When BIN n (n is 1 to 14) is selected, the operation of each function key is as follows.

[Delete Row]: Delete BIN n . BIN($n+1$) to BIN14 are moved to BIN n to BIN13 and a new row is added for BIN14.

[Insert Row]: Insert a new row at BIN n . The original BIN n to BIN13 are moved to BIN($n+1$) to BIN14, and the previous data of BIN14 is deleted.

[▲]: Swap BIN n and BIN($n-1$). When n is 1, nothing is changed.

[▼]: Swap BIN n and BIN($n+1$). When n is 14, nothing is changed.

If all of BIN2 to BIN14 are turned off (check mark is cleared), bin sorting is not performed and limit comparison is performed instead. For details on limit comparison, refer to “1.15.2 Limit Comparison.”

When all of the sorting ranges are set, tap [X] at the bottom right to close the palette.

- 4) This instrument can also sound a beep for the bin sorting result. When [Comparator]—[ACTION]—[BEEP] is set to ON, this instrument sounds one short beep when the bin sorting result is BIN1 to BIN14, and one long beep when it is OUT OF BINS.
- 5) Set [Comparator]—[BIN]—[FUNCTION] to ON to enable bin sorting. When spot measurement is performed, the bin sorting result is displayed together with the measurement result on the screen. There are the following bin sorting results.

BIN n : Sorted into BIN n ($n = 1$ to 14)

OUT OF BINS : No bin matches the conditions

ERR : The correct measurement value could not be obtained due to some error.

■ About bin sorting

- If NA (Not Applicable) is set for a sorting value, the value will not be applicable. For example, if NA is set for the upper limit, sorting is performed using only the lower limit value. If both the upper and lower limits are set to NA, all measurement results except errors will be judged to be that bin. If you wish to perform bin sorting for only one of the 1st and 2nd parameters, set the upper and lower limit values of the other parameter to NA.
- Bin sorting is performed in order from BIN1. Therefore, if the bin sorting ranges overlap, the result will be sorted into the bin that passes first (bin with the smallest number). If a result does not fit into any of the bin ranges, it is sorted into OUT OF BINS.
- The upper limit value, lower limit value, and reference value are interpreted according to the measurement parameter type (1st and 2nd parameters) and deviation mode setting. For example, the sorting result is interpreted as follows when the measurement parameter is capacitance (C) and lower limit = 1, upper limit = 3, and reference value = 1.5 are set.

Table 1-5 Deviation Mode Settings and Sorting Value Interpretation Example (Example of C)

Deviation mode	Lower limit (= 1)	Upper limit (= 3)	Reference value (= 1.5)
ABS	1F	3 F	---
DEV	2.5 F (=1.5 F+1 F)	4.5F (=1.5 F+3 F)	1.5 F
DEV%	1.515 F (=1.5 F×1.01)	1.545 F (=1.5 F×1.03)	1.5 F

- If you attempt to close the bin sorting setting screen when there are settings that result in upper limit \leq lower limit, an error occurs and the screen cannot be closed. Set the sorting range of each bin so that lower limit < upper limit.
- If a measurement result that matches the bin upper limit or lower limit is obtained, there will be cases where it is determined as that bin and cases where it is not determined as that bin. A displayed measurement result is rounded to the number of significant digits specified in the specifications, but a numerical value with a precision of about 15 digits is stored internally. Bin sorting is performed using the internal numerical value before rounding, so even if a measurement result displayed on the screen is exactly the same, it may be judged as a different bin.

1.15.2 Limit Comparison

This function performs pass/fail comparison using the BIN1 range for spot measurement results. The following figure shows an example of the spot measurement screen when limit comparison is performed.

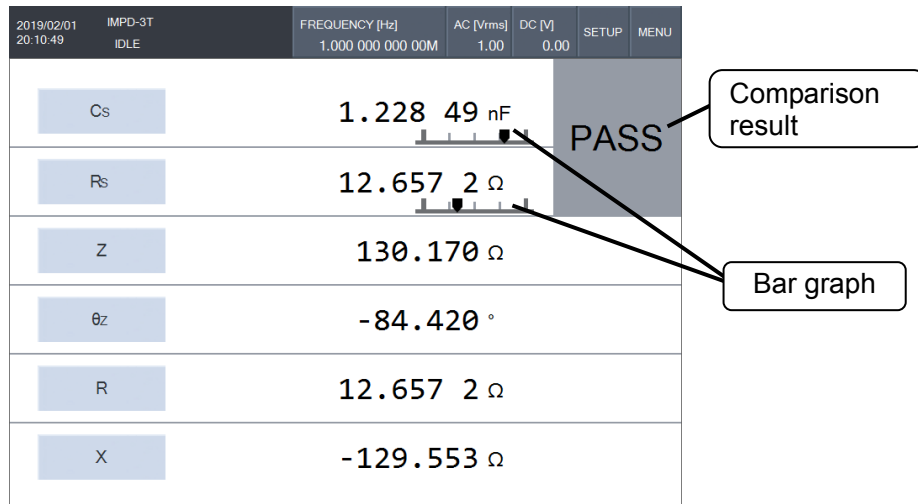


Figure 1-45 Limit Comparison Screen Example

In limit comparison, a bar graph is displayed to indicate the relative position of the measurement result using the BIN1 comparison range as the reference. The limit comparison settings are the same as the bin comparison settings except that BIN2 to BIN14 comparisons are disabled. Refer to “1.15.1 Bin Sorting”.

There are the following indications for limit comparison results.

PASS: Both the 1st parameter and 2nd parameter are within the BIN1 range.

FAIL: Either one of the 1st parameter and 2nd parameter are outside the BIN1 range.

ERR: The correct measurement value could not be obtained due to some error.

1.15.3 Zone Comparison

This function performs pass/fail comparison using the two dimensions of the X-axis (sweep parameter) and Y1/Y2 axes (measurement results) for sweep measurement results. Set any comparison range for each of the Y1 axis and Y2 axis. The following figure shows an example of the sweep measurement screen when zone comparison is performed.

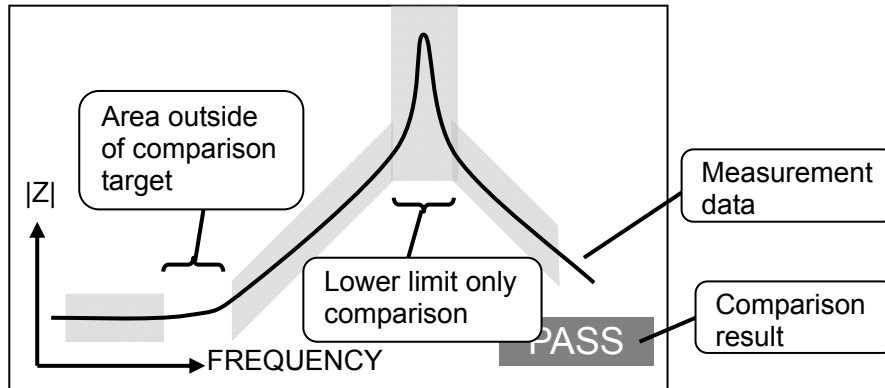


Figure 1-46 Zone Comparison Screen Example (When Frequency Sweep)

The figure above is for a frequency sweep but zone comparison can be performed also for an AC amplitude, DC bias, and time sweep. The measurement result is a pass if the measurement data fits in the semi-transparent shaded area. It is also possible to set some portion of an area to not be a comparison target or upper limit only or lower limit only comparison to be performed.

The comparison result is displayed as white text on a dark background at the bottom right of the screen.

PASS: Pass (All measurement data is within the pass range.)

FAIL : Fail (There is data that is out of the pass range.)

NA : Comparison not possible (Measurement data is not present in the comparison area.)

ERR : The correct measurement value could not be obtained due to some error.

Examples of zone comparison results are shown below.

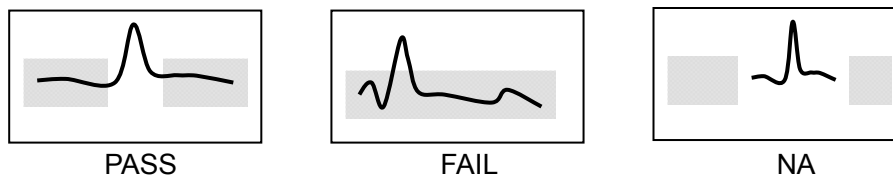


Figure 1-47 Zone Comparison Result Examples

The setup procedure is described below.

- 1) Configure the sweep measurement settings. If zone comparison is set, the pass range is displayed in a semi-transparent state on the graph. To prevent graph display from becoming complicated, we recommend setting the graph style to SPLIT (refer to “1.6.3 Setting the Graph Style”).
- 2) Set the type (deviation mode) to specify the pass range in [Comparator]–[ZONE]–[DEVIATION TYPE].

- IMMED : Directly set the Y1 and Y2 upper and lower limit values.
- REF(DEV) : Set the type with upper and lower limit values using a reference data trace as the reference.
- REF(DEV%) : Set the type with a percentage (%) using a reference data trace as the reference.

The reference data trace that will be the reference of REF(DEV) and REF(DEV%) is any one of REF1 to REF8.

- 3) Set the upper and lower limit values according to the set deviation mode.
 - o Deviation mode: When IMMED
Tap [Comparator]—[ZONE]—[IMMED SET] to display a palette to set the comparison range.
The following shows an example with Y1: Cs and Y2: Rs in a frequency sweep.

	FREQUENCY(Hz)	Cs (F)		Rs (Ω)	
		LO	HI	LO	HI
1	100.000	950.000 n	1.05000 u	0.00000	100.000 m
2	1.00000 k	950.000 n	1.05000 u	0.00000	100.000 m
3	2.00000 k	950.000 n	1.05000 u	0.00000	100.000 m
4	10.0000 k	900.000 n	1.10000 u	0.00000	200.000 m
5	NA	NA	NA	NA	NA

Up to 20 sets of Y1 and Y2 upper and lower limit values can be set for the X-axis (SWEEP value). Enter the X-axis values top-aligned in ascending order from No. 1. The upper limit and lower limit are linearly interpolated for each of them and the enclosed area becomes the pass range in the zone comparison.

Tapping the column at the left end displays functions to edit on a row basis on the function keys. When row *n* (*n* is 1 to 20) is selected, the operation of each function key is as follows.

- [Delete Row]: Delete row *n*. Row (*n*+1) to row 20 are moved to row *n* to row 19 and a new row is added for row 20.
- [Insert Row]: Insert a new row at row *n*. The original row *n* to row 19 are moved to row (*n*+1) to row 20, and the previous data of row 20 is deleted.
- [▲]: Swap row *n* and row (*n*-1). When *n* is 1, nothing is changed.
- [▼]: Swap row *n* and row (*n*+1). When *n* is 20, nothing is changed.

- o Deviation mode: When REF(DEV)
Set the following settings in [Comparator]—[ZONE]—[DEVIATION SET].
 - [REF TRACE]: Set the reference data trace (REF1 to REF8) to be the reference.
 - [Y1 HI]: Set the Y1 upper limit value for the reference data trace.
 - [Y1 LO]: Set the Y1 lower limit value for the reference data trace.
 - [Y2 HI]: Set the Y2 upper limit value for the reference data trace.
 - [Y2 LO]: Set the Y2 lower limit value for the reference data trace.
 (Reference REF trace + lower limit value) to (Reference REF trace + upper limit value) become the pass range. Comparison is not performed for a limit set to NA. For example, if Y1 LO is set to NA, comparison for Y1 is performed using only the upper limit value.

- Deviation mode: When REF(DEV%)

Set the following settings in [Comparator]—[ZONE]—[DEVIATION SET].

[REF TRACE]: Set the reference data trace (REF1 to REF8) to be the reference.

[Y1 HI]: Set the Y1 upper limit value for the reference data trace as a percentage (%).

[Y1 LO]: Set the Y1 lower limit value for the reference data trace as a percentage (%).

[Y2 HI]: Set the Y2 upper limit value for the reference data trace as a percentage (%).

[Y2 LO]: Set the Y2 lower limit value for the reference data trace as a percentage (%).

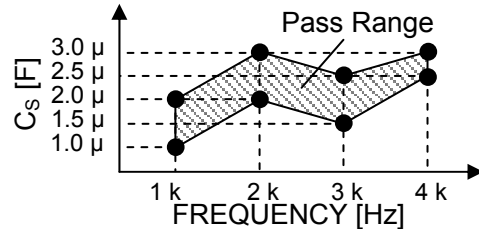
(Reference REF trace × (1 + lower limit value / 100)) to (Reference REF trace × (1 + upper limit value / 100)) become the pass range. Comparison is not performed for a limit set to NA. For example, if Y1 LO is set to NA, comparison for Y1 is performed using only the upper limit value.

- 4) This instrument can also sound a beep for the comparison result. When [Comparator]—[ACTION]—[BEEP] is set to ON, this instrument sounds one short beep when the comparison result is PASS, one long beep when it is FAIL, and two short beeps when it is NA.
- 5) Set [Comparator]—[ZONE]—[FUNCTION] to ON to enable zone comparison. When sweep measurement is performed, the comparison result is displayed in the lower right of the screen together with the measurement result graph.

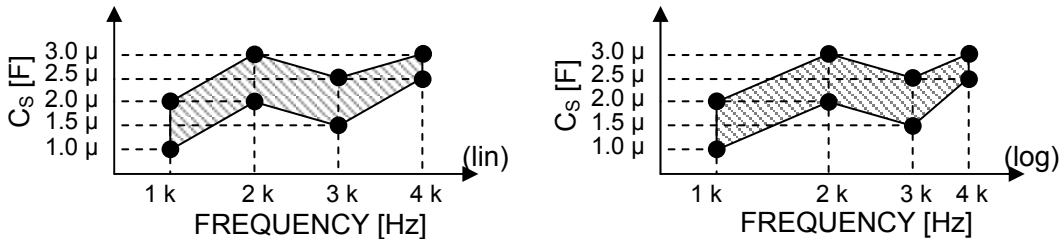
■ About the comparison range when the deviation mode is IMMED

- The comparison range (pass range) becomes the linear interpolation area passing through the set X values and Y1 upper and lower limit values and Y2 upper and lower limit values. The following shows an example of the comparison range when Y1 is set to Cs in a frequency sweep.

No.	FREQUENCY [Hz]	Cs [F]	
		LO	HI
1	1 k	1.0 μ	2.0 μ
2	2 k	2.0 μ	3.0 μ
3	3 k	1.5 μ	2.5 μ
4	4 k	2.5 μ	3.0 μ



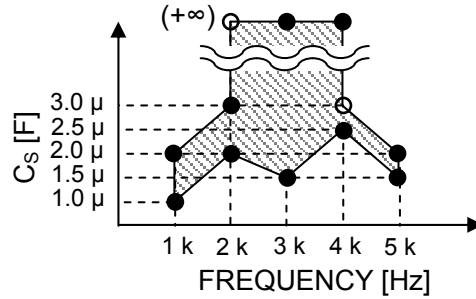
The linearly interpolated range becomes the pass range regardless of whether the graph axis setting is set to linear or log. Therefore, please note that the linearly interpolated pass range will also change if the graph axis setting (linear/logarithmic) is changed. The following figure shows an example of the zone comparison pass range when the X-axis is changed from linear axis to logarithmic axis while leaving the pass range setting as is.



The linearly interpolated pass range on the screen becomes the pass range even when the Y-axis is changed between linear and log.

- If the upper limit or lower limit is set to NA, comparison is not performed for the limit that is set to NA. For example, if the upper limit is set to NA and the lower limit is set to 1.5 μ F, the measurement result is a pass if it is 1.5 μ F or higher (1.5 μ F to $+\infty$ F).

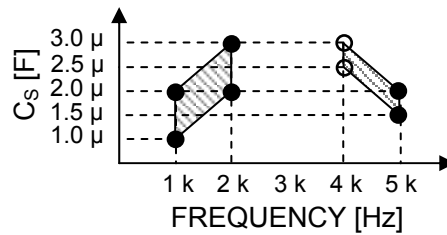
No.	FREQUENCY [Hz]	C _s [F]	
		LO	HI
1	1 k	1.0 μ	2.0 μ
2	2 k	2.0 μ	3.0 μ
3	3 k	1.5 μ	NA
4	4 k	2.5 μ	3.0 μ
5	5 k	1.5 μ	2.0 μ



The upper limit at 2 kHz will be 3 μ F, and the upper limit from above 2 kHz to 4 kHz will be not applicable ($+\infty$ F).

- If the upper limit and lower limit are both set to NA, there will also be no effect on the pass/fail result because comparison itself will not be performed in the range before and after that point on the X-axis. The comparison range will also not be displayed on the screen.

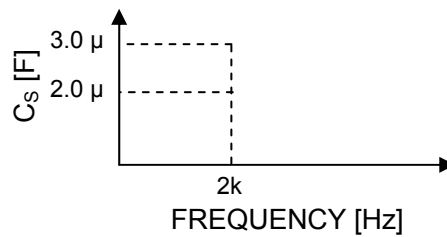
No.	FREQUENCY [Hz]	C _s [F]	
		LO	HI
1	1 k	1.0 μ	2.0 μ
2	2 k	2.0 μ	3.0 μ
3	3 k	NA	NA
4	4 k	2.5 μ	3.0 μ
5	5 k	1.5 μ	2.0 μ



Zone comparison is not performed in the range from above 2 kHz to 4 kHz.

- If the set of upper and lower limit value is only one, the comparison range is not displayed on the screen. The comparison result is always NA.

No.	FREQUENCY [Hz]	C _s [F]	
		LO	HI
1	2 k	2.0 μ	3.0 μ
2			
3			
4			
5			



1.16 Handler Interface

The comparator comparison results are output from the HANDLER INTERFACE connector on the rear panel. For details on the pin assignment and electrical specifications, refer to “3.2.7 Handler Interface” in Instruction Manual (Basics).

Configure the settings related to the handler interface in the following menus of [Remote]—[HANDLER].

[TRIGGER POLARITY] : Select from rising (POSITIVE) and falling (NEGATIVE) for the trigger polarity.

[SWEEP DIRECTION] : Select from UP, DOWN, and SPOT for measurement performed using a trigger from a handler.

The comparison output logic of the handler interface is active low. The output level is high normally and low when asserted.

■ Output when bin sorting

When bin sorting is enabled and spot measurement is performed, one of the following signals is output depending on the bin sorting result.

Table 1-6 Handler Interface Output when Bin Sorting

Bin comparison result	Sorting output of handler interface
BIN1 to BIN14	/BIN1 to /BIN14 (pins 6 to 12, pins 30 to 36)
OUT OF BINS	/OUT OF BINS (pin 37)
ERR	/ERR (pin 14)

Only one signal is output, and there are no cases where multiple outputs will become low simultaneously.

■ Output when limit comparison

When limit comparison is enabled and spot measurement is performed, the following signals are output depending on the limit comparison result.

Table 1-7 Handler Interface Output when Limit Comparison

Limit comparison result	Comparison output of handler interface
1st parameter is:	
Fail (above upper limit)	/P-HI (pin 30)
Passed	/P-IN (pin 6)
Fail (below lower limit)	/P-LO (pin 31)
2nd parameter is:	
Fail (above upper limit)	/S-HI (pin 7)
Passed	/S-IN (pin 32)
Fail (below lower limit)	/S-LO (pin 8)
Both 1st and 2nd parameters passed	/IN (pin 33)
When at least one of 1st and 2nd parameters failed	/OUT (pin 37)
ERR	/ERR (pin 14)

There are also cases where multiple comparison results are output simultaneously. For example, when /IN is output, /P-IN and /S-IN are also output simultaneously.

■ Output when zone comparison

When zone comparison is enabled and sweep measurement is performed, one of the following signals are output depending on the zone comparison result.

Table 1-8 Handler Interface Output when Zone Comparison

Zone comparison result	Comparison output of handler interface
Y1 parameter	
Failed	/Y1-OUT (pin 30)
Passed	/Y1-IN (pin 6)
Comparison not possible	/Y1-NA (pin 31)
Y2 parameter	
Failed	/Y2-OUT (pin 7)
Passed	/Y2-IN (pin 32)
Comparison not possible	/Y2-NA (pin 8)
Both Y1 and Y2 passed	/IN (pin 33)
At least one of Y1 and Y2 passed, and the other comparison not possible	/IN (pin 33)
At least one of Y1 and Y2 failed	/OUT (pin 37)
Comparison of both Y1 and Y2 not possible	/NA (pin 34)
ERR	/ERR (pin 14)

There are also cases where multiple comparison results are output simultaneously. For example, when /IN is output, /Y1-IN and /Y2-IN are also output simultaneously.

1.16.1 Recalling Setting Memory and Changing Correction Memory

The measurement conditions and correction memory can be recalled for measurement by using a trigger from a handler.

■ Recalling setting conditions

If the trigger signal is received when /RCL-VALID is the low level, the setting memory with the number (1 to 32) corresponding to /RCL6 to /RCL0 (negative logic, 7 bits) is recalled and the measurement is performed. If an unsaved setting memory number is specified, the setting state becomes the initial setting state. If a number other than 1 to 32 is specified, an error occurs (/ERR is output) and measurement is not performed.

■ About the trigger source setting

If the trigger source setting ([Measure] – [TRIGGER SOURCE]) of the recalled setting memory is set to other than a handler, a trigger from the handler will become unable to be accepted from the next measurement.

■ Changing the correction memory

Information such as the various correction memory numbers (1 to 32) and load standard values specified in [Calibration] of the restored measurement conditions are also changed together with the restoration of the measurement conditions.

Correction data needs to be saved in advance to the correction memory number to be used. If a number without correction data saved is specified, an error occurs. For how to save correction data, refer to “1.8.3 Open Correction” to “1.8.6 Port Extension” and “1.8.8 Equalizing”.

1.16.2 Handler Interface Operation Timing

■ Timing to start measurement

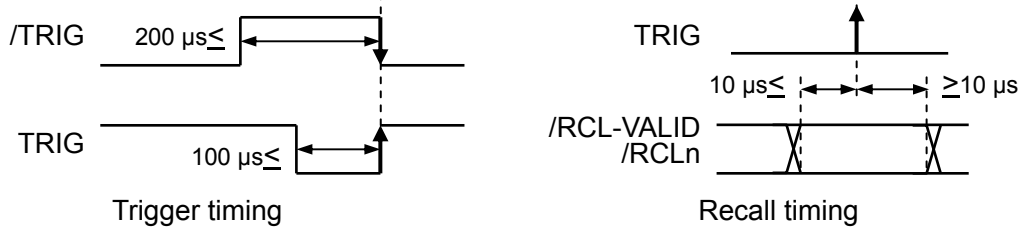


Figure 1-48 Handler Interface Measurement Start Timing

■ Operation timing (measurement synchronous driving: off)

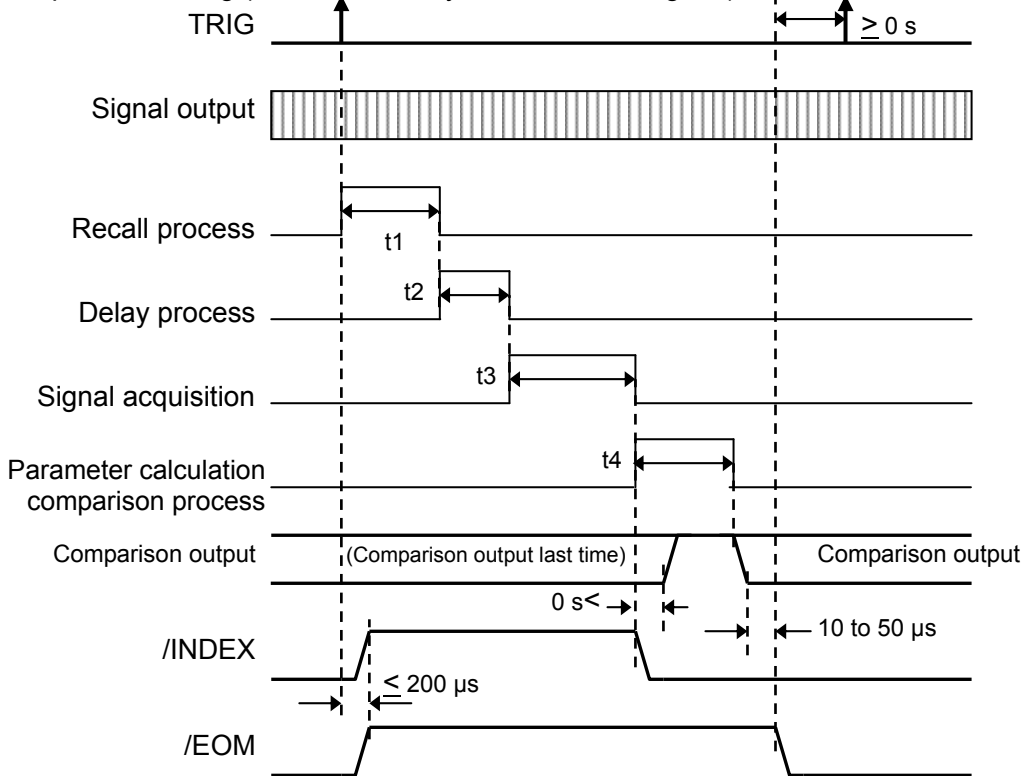


Figure 1-49 Handler Interface Operation Timing (Measurement Synchronous Driving: Off)

When $\overline{\text{INDEX}}$ becomes the low level, it is possible to switch the DUT. When $\overline{\text{EOM}}$ becomes the low level, the comparison result is fixed and the next measurement can start (trigger input is possible). Approximations of t_1 to t_4 are shown below. The actual times vary depending on the settings and DUT measurement results.

Table 1-9 Handler Interface Timing

	Spot measurement:	Sweep measurement:
t1	200 ms or more 0 s when recall not used	400 ms or more 0 s when recall not used
t2	Measurement start delay time setting ^{*1}	
t3	Measurement time setting ^{*2} However, • largest or more of $1/f$ s and 1.5 ms ($f < 30$ kHz) • 0.6 ms or more ($30 \text{ kHz} \leq f$)	$(t_m^{*3} + \text{Measurement delay time setting}^{*4}) \times (N^{*5} + 1)$ + 100 ms or more
t4	0.1 ms or more	200 ms or more

f : measurement frequency (Hz)

*1 : [Measure]—[START DELAY] setting

*2 : [Measure]—[MEASURE TIME] setting

*3 : Measurement time of one point of sweep. Refer to "5. Specifications" in Instruction Manual (Basics).

*4 : [Measure]—[MEASURE DELAY] setting

*5 : [Sweep]—[RESOLUTION] setting

■ Operation timing (measurement synchronous driving: on, ON/OFF mode: SLOW)

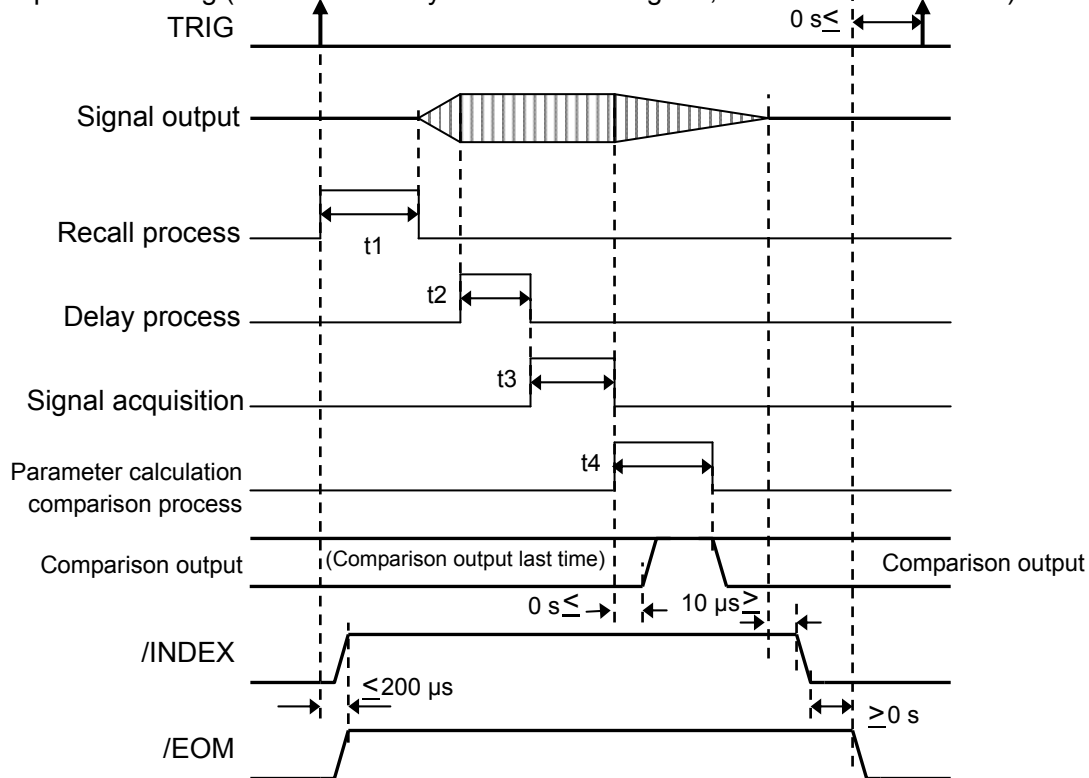


Figure 1-50 Handler Interface Operation Timing (Measurement Synchronous Driving: On)

t1 to t4 are the same as when measurement synchronous driving is off. Refer to "Table 1-9 Handler Interface Timing".

The timing is the same also when the ON/OFF mode is 0° SYNC. When the measurement signal is turned off, /INDEX is kept at the high level until the phase becomes 0°.

■ Handler interface terminal state when the comparator function is not used

When bin comparison, limit comparison, and zone comparison are disabled, the state of each terminal of the handler interface connector is as follows.

Table 1-10 Handler Interface Terminal State when Comparator Is Disabled

Trigger TRIG, /TRIG /RCL-VALID, /RCLn	When the trigger source ([Measure]—[TRIGGER SOURCE]) is set to the handler interface, the recall function is also enabled.
Comparison output Pins 6 to 12 and 30 to 37 /ERR	Always high level
Handshake /INDEX, /EOM	When the trigger source is set to the handler interface, output is at almost the same timing as when comparison is enabled. When the trigger source is set to other than the handler interface, the level is always high.
Power supply INT_DCV, EXT_DCV INT_COM, EXT_COM	The power supply can always be used regardless of the comparator function or trigger source settings.

1.16.3 Handler Interface Test Screen

This screen allows you to output a specific signal to the handler interface and monitor input signals to confirm operation. It can be operated regardless of the comparator function setting. Select [Remote]–[HANDLER]–[TEST SCREEN] and then tap the [TEST] function key to display the test screen.

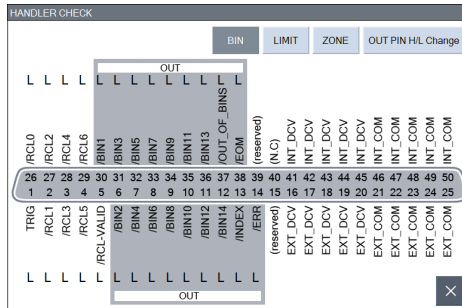


Figure 1-51 Handler Interface Test Screen

Pins 1 to 5 and 26 to 29 indicate the currently input logic levels. Pins 6 to 14 and 30 to 38 indicate the currently output logic levels. Both the input and output are not the true/false of logic but the H/L of the voltage level. If you tap [BIN] / [LIMIT] / [ZONE], the terminal names change to those of the corresponding comparison function. For the terminal names, refer to “Table 3-1 Handler Interface Signal Layout” in Instruction Manual (Basics).

To change the output state, tap the [OUT PIN H/L Change] button at the top right of the screen.

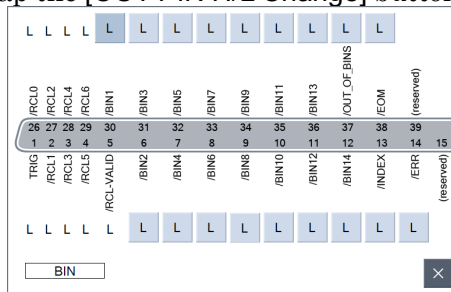


Figure 1-52 Handler Interface Test Screen

The signal names of pins 6 to 14 and 30 to 39 in the figure above are the names for bin comparison. The currently displayed comparator mode (BIN/LIMIT/ZONE) is indicated at the bottom left.

Pins 1 to 5 and 26 to 29 indicate the currently input logic levels. The [H]/[L] buttons of pins 6 to 14 and 30 to 38 indicate the output levels. Tapping a button switches between H and L. Tap the [X] button at the bottom right to close the test screen and return to the state display screen. Even if you changed the output H/L levels in the test screen, they return to the original output state.

■ Cautions for using handler interface

- When the trigger is activated, the menu is closed and the settings can not be changed. When changing the setting, stop the trigger to the handler interface.

1.17 Memory Operations

Measurement conditions and measurement data can be saved to the internal memory of this instrument or a USB memory device, and can be read from memory and reused. It is also possible to output an image of the LCD screen to a USB memory device as a file in bitmap format (.bmp).

The following memory types can be handled by this instrument.

■ Internal memory

(For graph display)	For the operating procedures and other information, refer to “1.6.6 Trace Operations”.
<ul style="list-style-type: none"> • MEAS TRACE • REF TRACE 	<p>This stores the measurement data. The data is displayed in a graph.</p> <p>There are eight reference traces (REF1 to REF8). They are used to copy the data from MEAS TRACE and display it in a graph.</p>
(Data for saving)	For the operating procedures and other information, refer to “1.17.2 Measurement Data”.
<ul style="list-style-type: none"> • DATA FILE 	There are 32 data files. They allow you to save the contents of MEAS TRACE and load the data to MEAS TRACE to redisplay it in a graph.
(Data for correction)	For the operating procedures and other information, refer to “1.8 Error Correction”.

There are 32 memories for each of the following six data types for impedance correction.

- Open correction data (OPEN CORR MEM)
- Short correction data (SHORT CORR MEM)
- Load correction data (LOAD CORR MEM)
- Port extended end open correction data (OPEN_PEXT CORR MEM)
- Port extended end short correction data (SHORT_PEXT CORR MEM)
- Port extended end load correction data (LOAD_PEXT CORR MEM)

There are 32 of the following memory for gain and phase correction.

- Equalizing correction data (EQU CORR MEM)

(Measurement conditions)

- CONDITION FILE There are 32 for each measurement mode.

All data, except the contents of MEAS TRACE, is retained, even if the power is turned off.

■ USB memory device

- | | |
|--|--|
| <ul style="list-style-type: none"> • Measurement data file • Measurement condition file • Equivalent circuit file • Piezoelectric constant file • Marker information file | <p>The extension is “.DATA.CSV”.</p> <p>The extension is “.COND.TXT”.</p> <p>Equivalent circuit estimation results. The extension is “.ECKT.CSV”.</p> <p>Piezoelectric constant calculation results. The extension is “.PZT.CSV”.</p> <p>Marker readings. The extension is “.MKR.CSV”.</p> |
|--|--|

- Screen file File containing an image of the screen. The extension is “.BMP”.

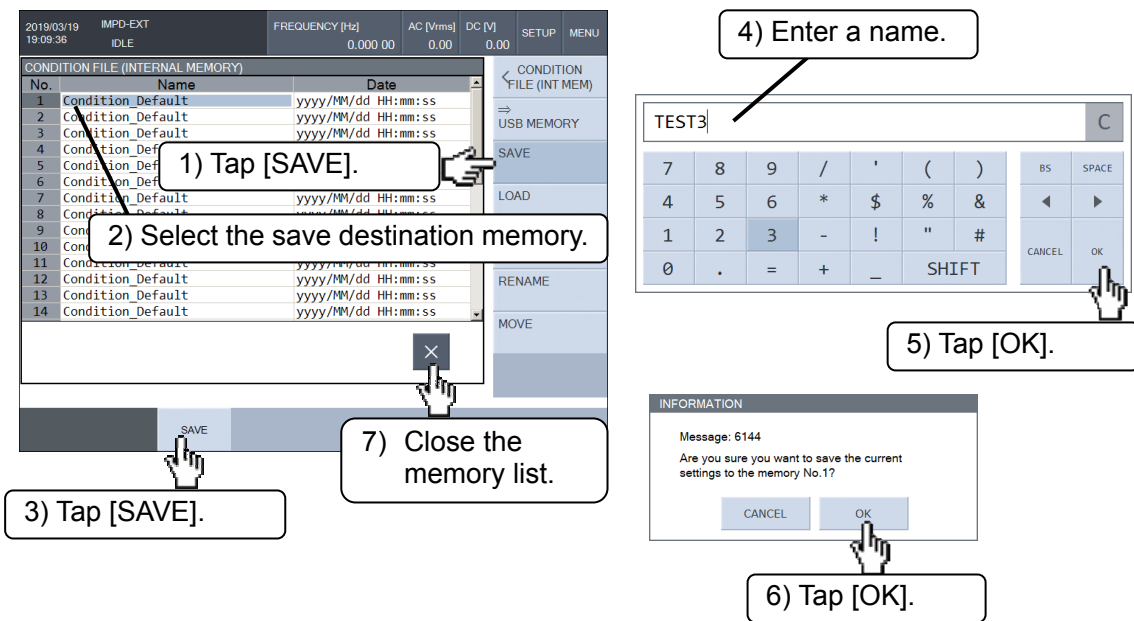
The measurement data file and measurement condition file can be saved and read. The other files are save-only files and cannot be read by this instrument.

1.17.1 Measurement Conditions

The current measurement conditions can be saved to the internal memory of this instrument or a USB memory device and then later read from memory and restored. Up to 32 sets of settings can be saved to the internal memory. The measurement conditions saved in internal memory can also be used for sequence measurement. For details on sequence measurement, refer to “1.9 Sequence Measurement”.

■ Saving measurement conditions (to internal memory)

Tap [Storage]—[CONDITION FILE (INT MEM)]—[SAVE] to display a list of the measurement condition files that are stored in internal memory. The memory that has the name “Condition_Default” contains the factory default settings (initial settings).

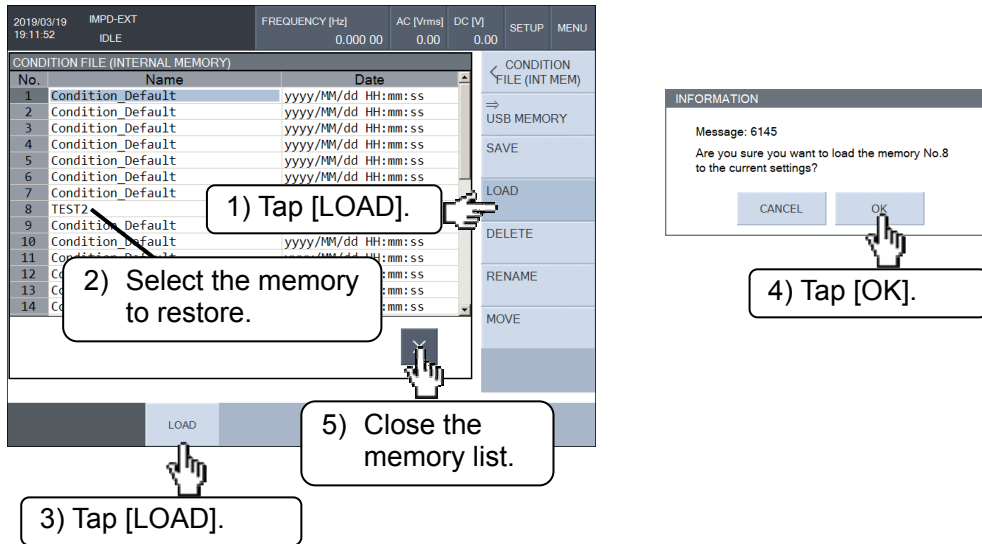


Tap the screen or use the knob or cursor keys to select the save destination memory and then tap the [SAVE] function key. Enter the name of the setting conditions in the text input palette and then tap [OK]. The save confirmation dialog box appears. Tap [OK] to save the measurement conditions.

Tap the [X] button at the bottom right of the memory list dialog box to close list display.

■ Restoring measurement conditions (from internal memory)

Tap [Storage]—[CONDITION FILE (INT MEM)]—[LOAD] to display a list of the measurement condition files that are stored in internal memory. Select the memory to restore and then tap the [LOAD] function key. The restore confirmation dialog box appears. Tap the [OK] button to restore the selected measurement conditions.



(Supplementary explanation)

Separate internal memory for saving measurement conditions is provided for each measurement mode. When you change the measurement mode after saving the measurement conditions, the saved file will disappear from the list. However, it is stored inside this instrument, and will be redisplayed when you switch the measurement mode back to the original mode.

○ Other operations (internal memory)

- [DELETE]

Initialize the selected memory. The title (Name) becomes “Condition_Default”.

- [RENAME]

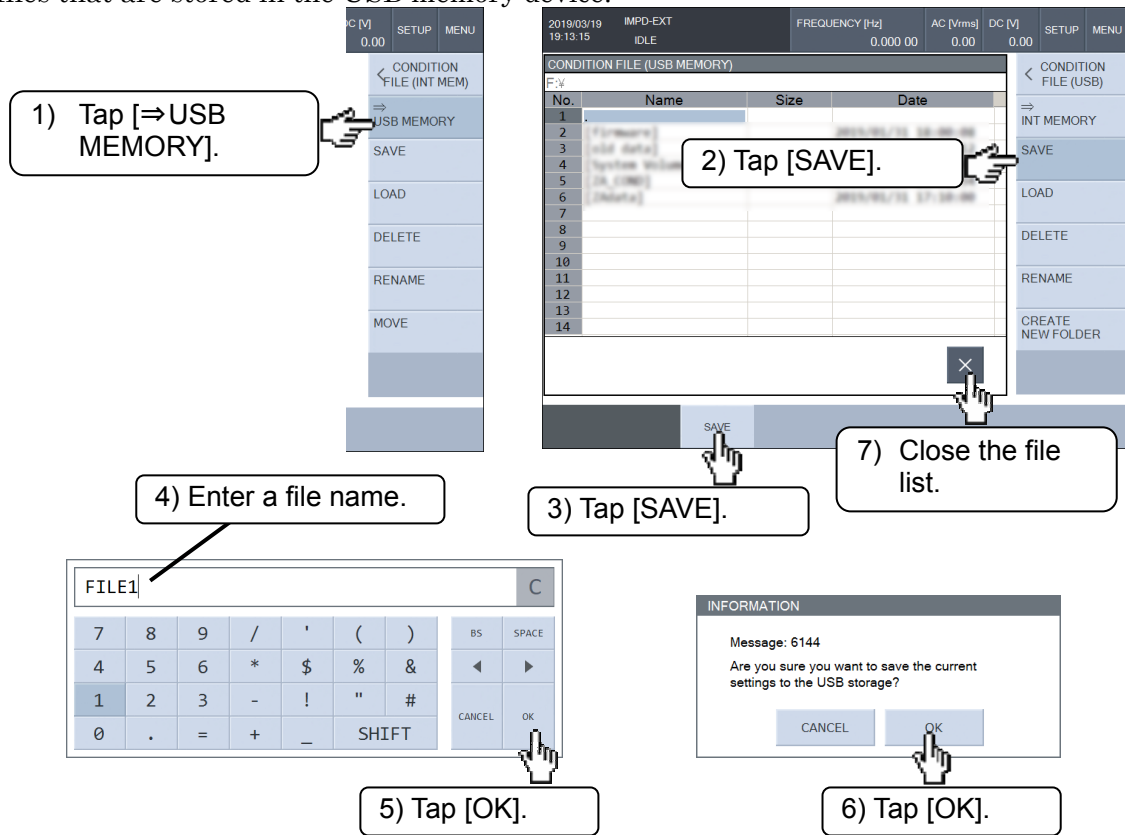
Change the title (name) of the selected memory.

- [MOVE]—[MOVE UP]/[MOVE DOWN]

Tap the [MOVE UP] function key to swap the selected memory with the one directly above (memory that is one number smaller), and the [MOVE DOWN] function key to swap the selected memory with the one directly below (memory that is one number larger). This function is used to change the measurement order for sequence measurement.

■ Saving measurement conditions (to USB memory device)

Insert a USB memory device into the USB port on the front panel. Tap [Storage]— [CONDITION FILE (INT MEM)]—[⇒USB MEMORY] and then tap [SAVE] to display a list of the files that are stored in the USB memory device.

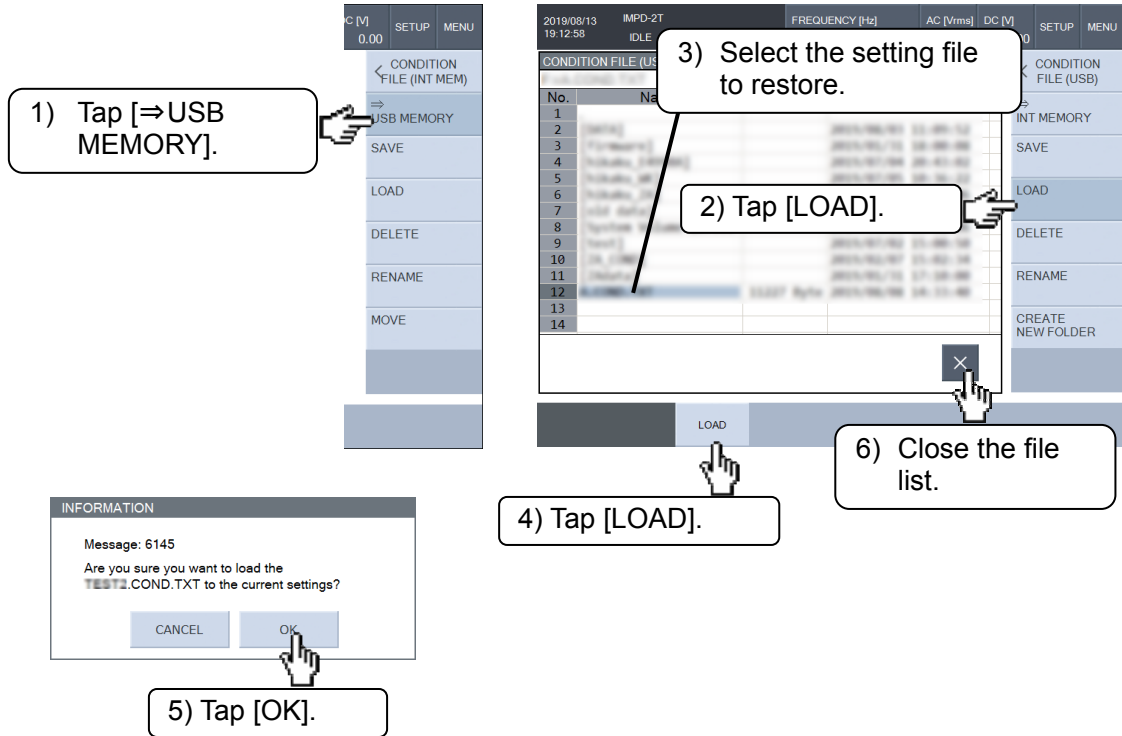


Tap the [SAVE] function key, enter a file name (an extension is not necessary) in the text input palette, and tap [OK]. The save confirmation dialog box appears. Tap [OK] to save the measurement conditions.

The extension of the file name is “.COND.TXT”. The extension does not need to be entered because it is added automatically during saving. Measurement condition files saved to a USB memory device are in text format. For the file format, refer to “2.3 Measurement Condition File Format”.

■ Restoring measurement conditions (from USB memory device)

Insert a USB memory device into the USB port on the front panel. Tap [Storage]— [CONDITION FILE (INT MEM)]—[⇒USB MEM] and then tap [LOAD] to display a list of the files that are stored in the USB memory device.



Select the file to restore and then tap the [LOAD] function key. The restore confirmation dialog box appears. Tap [OK] to restore the selected measurement conditions.

(Supplementary explanation)

A measurement condition file saved in a different measurement mode cannot be loaded.

○ Other operations (USB memory device)

- [DELETE]

Delete the selected file.

- [RENAME]

Rename the selected file.

- [CREATE NEW FOLDER]

Create a new folder.

- Change the current folder.

Subfolders are indicated by file names enclosed in brackets ([]). The file name “..” indicates a folder one level higher in the hierarchy. Tapping a file name changes the current folder.

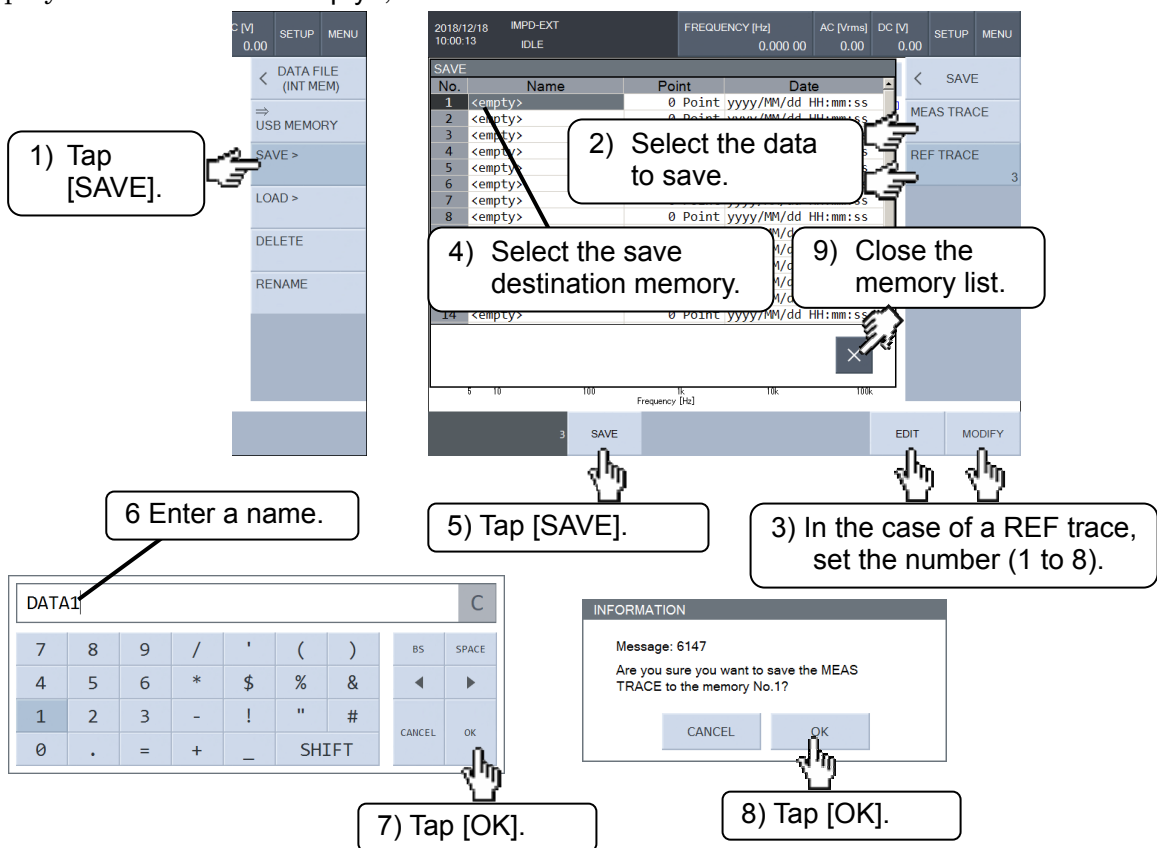
1.17.2 Measurement Data

Measurement data can be saved to the internal memory of this instrument or a USB memory device and then loaded at a later time for use. The data that can be saved is MEAS TRACE and REF TRACE (REF1 to REF8) data. The saved measurement data can be loaded for display in graph form or for use as open correction data and other error correction data.

The internal memory can hold up to 20 sets of measurement data.

■ Saving measurement data (to internal memory)

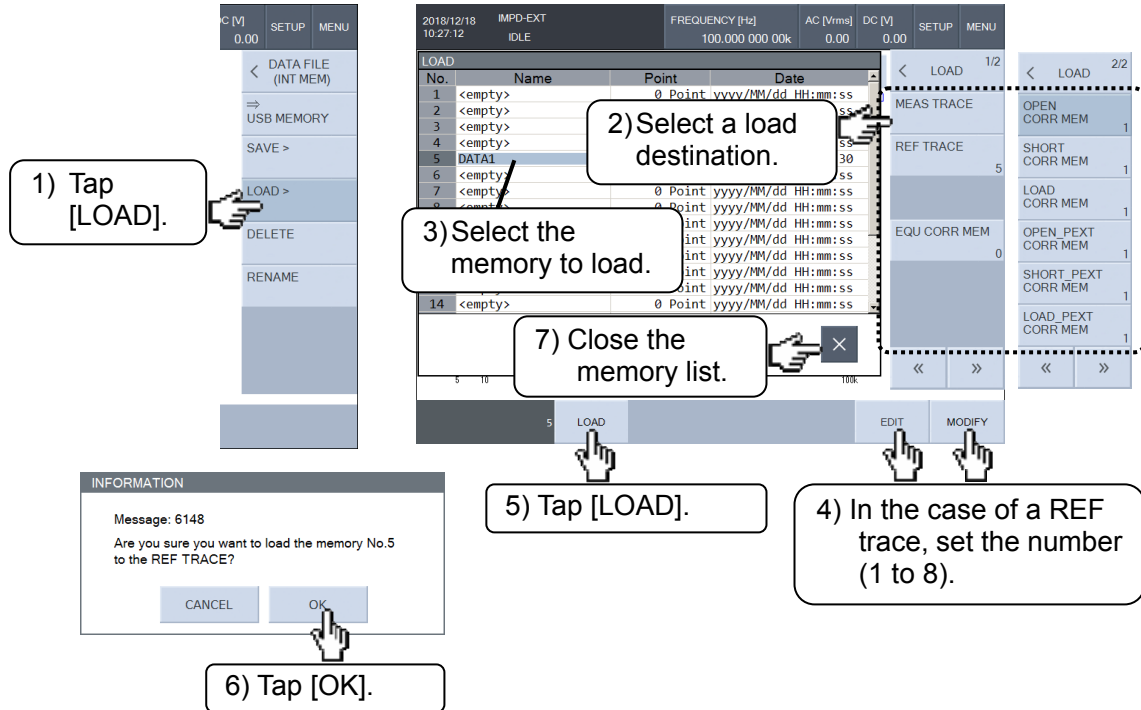
If you tap [Storage]—[DATA FILE (INT MEM)]—[SAVE] and then select the data to save (MEAS TRACE or REF TRACE), a list of the measurement data stored in internal memory is displayed. If a name is “<empty>,” there is no data at that location.



When the data trace to be saved is [REF TRACE], set the reference trace number (1 to 8) to save the data. Select the save destination memory and then tap the [SAVE] function key. Enter the name of the data in the text input palette and then tap [OK]. The save confirmation dialog box appears. Tap [OK] to save the measurement data.

■ Loading measurement data (from internal memory)

If you tap [Storage]—[DATA FILE (INT MEM)]—[LOAD] and then select the load destination (MEAS TRACE, REF TRACE, or correction data), a list of the measurement data stored in internal memory is displayed. If a name is “<empty>,” there is no data at that location.



Select the memory to load. When loading data to a REF trace, specify a load destination number (1 to 8) and then tap the [LOAD] function key. The load confirmation dialog box appears. Tap [OK] to restore the selected measurement data.

[MEAS TRACE] : Load to measurement data trace.

[REF TRACE] : Load to a reference data trace.

Specify the load destination number (1 to 8).

(Measurement Mode: IMPD-EXT, IMPD-3T, or IMPD-2T)

[OPEN CORR MEM] : Load to open correction data.

[SHORT CORR MEM] : Load to short correction data.

[LOAD CORR MEM] : Load to load correction data.

[OPEN_PEXT CORR MEM] : Load to port extended end open correction data.

[SHORT_PEXT CORR MEM] : Load to port extended end short correction data.

[LOAD_PEXT CORR MEM] : Load to port extended end load correction data.

(Measurement mode: G-PH)

[EQU CORR MEM] : Load to equalizing correction data.

When loading to open, short, load, or equalizing correction data is selected, the load destination memory numbers (1 to 32) are displayed on the function keys, but editing (modifying) is not possible in this menu. Modify these load destination numbers in the [Calibration] menu. Refer to “1.8 Error Correction”.

○ Other operations (internal memory)

- [DELETE] function key

Delete the selected memory. The memory name becomes “<empty>”.

- [RENAME] function key

Change the name of the selected memory.

■ Saving measurement data (to USB memory device)

Insert a USB memory device into the USB port on the front panel. Tap [Storage]–[DATA FILE (INT MEM)]–[⇒USB MEMORY]. If you tap [SAVE] and then select the data to save (MEAS TRACE or REF TRACE), a list of the files stored in the USB memory device is displayed.

1) Tap [⇒USB MEMORY].

2) Tap [SAVE].

3) Select the data to save.

4) In the case of a REF trace, set the number (1 to 8).

5) Tap [SAVE].

6) Enter a file name.

7) Tap [OK].

8) Tap [OK].

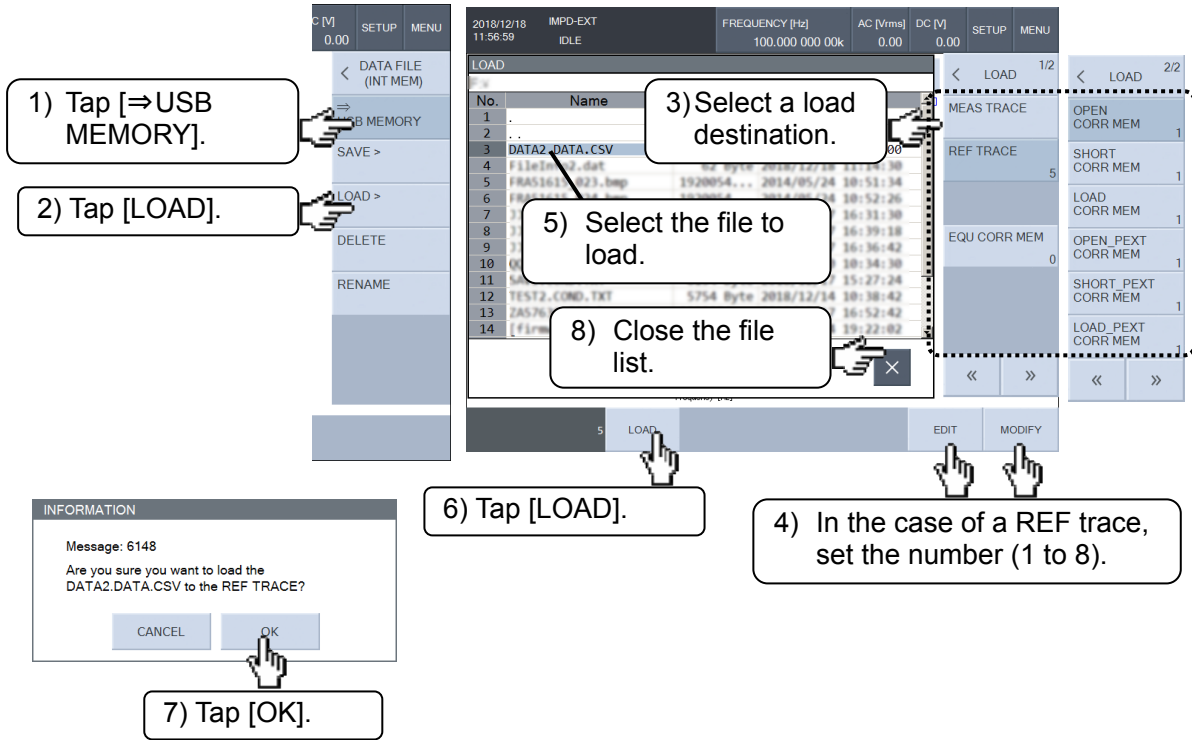
9) Close the file list.

When the [REF TRACE] is selected, set the reference trace number (1 to 8) to save the data. Tap the [SAVE] function key to display the text input palette. Enter a file name (an extension is not necessary) and then tap [ENTER]. The save confirmation dialog box appears. Tap [OK] to save the measurement data.

The extension of the file name is “.DATA.CSV”. The extension does not need to be entered because it is added automatically during saving. Measurement data files saved to a USB memory device are in text format. For the file format, refer to “2.2 Measurement Data File Format”.

■ Loading measurement data (from USB memory device)

Insert a USB memory device into the USB port on the front panel. Tap [Storage]—[DATA FILE (INT MEM)]—[⇒USB MEMORY]. If you tap [LOAD] and then select the load destination (MEAS TRACE, REF TRACE, or correction data), a list of the measurement data stored in the USB memory device is displayed.



When loading data to a REF trace, specify a load destination number (1 to 8). Select the file to load and then tap the [LOAD] function key. The confirmation dialog box appears. Tap [OK] to load the measurement data to the specified load destination.

[MEAS TRACE] : Load to measurement data trace.

[REF TRACE] : Load to a reference data trace.

Specify the load destination number (1 to 8).

(Measurement Mode: IMPD-EXT, IMPD-3T, or IMPD-2T)

[OPEN CORR MEM] : Load to open correction data.

[SHORT CORR MEM] : Load to short correction data.

[LOAD CORR MEM] : Load to load correction data.

[OPEN_PEXT CORR MEM] : Load to port extended end open correction data.

[SHORT_PEXT CORR MEM] : Load to port extended end short correction data.

[LOAD_PEXT CORR MEM] : Load to port extended end load correction data.

(Measurement mode: G-PH)

[EQU CORR MEM] : Load to equalizing correction data.

When loading to open, short, load, or equalizing correction data is selected, the load destination memory numbers (1 to 32) are displayed on the function keys, but editing (modifying) is not possible in this menu. Modify these load destination numbers in the [Calibration] menu. Refer to “1.8 Error Correction”.

- Other operations (USB memory device)

- [DELETE]

- Delete the selected file.

- [RENAME]

- Rename the selected file.

- [CREATE NEW FOLDER]

- Create a new folder.

- Change the current folder.

- Subfolders are indicated by file names enclosed in brackets ([]). The file name “..” indicates a folder one level higher in the hierarchy. Tapping a file name changes the current folder.

1.17.3 Equivalent Circuit Data

The results obtained through equivalent circuit estimation from the frequency-impedance characteristics of the DUT can be saved to a USB memory device. The equivalent circuit file is a save-only file and cannot be read by this instrument.

For details on the equivalent circuit estimation function, refer to “1.11 Equivalent Circuit Estimation”.

When the equivalent circuit estimation operation in [Calculate]—[EQIV CKT FITTING] is finished, insert a USB memory device into the USB port on the front panel and then perform the following procedure.

1) Tap [SAVE].

2) Tap [SAVE].

3) Enter a file name.

4) Tap [OK].

5) Tap [OK].

6) Close the file list.

Tap the [SAVE] function key to display the text input palette. Enter a file name (an extension is not necessary) and then tap [OK]. The save confirmation dialog box appears. Tap [OK] to save the equivalent circuit estimation results.

The extension of the file name is “.ECKT.CSV”. The extension does not need to be entered because it is added automatically during file saving. The equivalent circuit data file is in text format. For the file format, refer to “2.4 Equivalent Circuit File Format”.

The equivalent circuit type (CKT1 to CKT6) of the estimation results and each LCR element value are saved to the equivalent circuit file. The impedance characteristics calculated from the estimated equivalent circuit are stored in the REF1 reference data trace, and are not

saved to the equivalent circuit file. When saving a reference data trace to a USB memory device, refer to “■ Saving measurement data (USB memory device)” in “1.17.2 Measurement Data”.

1.17.4 Piezoelectric Constant Data

The calculated piezoelectric constants of a piezoelectric vibrator and information such as the various characteristic frequencies can be saved to a USB memory device. For details on piezoelectric constant calculation, refer to “1.12 Calculating Piezoelectric Constants”.

■ Saving piezoelectric constant data

When the piezoelectric constant calculation is finished, insert a USB memory device into the USB port on the front panel and then perform the following procedure in the [[PZT CONSTANT]] window.

1) Tap [SAVE].

2) Tap [SAVE].

3) Enter a file name.

4) Tap [OK].

5) Tap [OK].

6) Close the file list.

Tap [SAVE] in the [[PZT CONSTANT]] window and then tap the [SAVE] function key. Enter a file name (an extension is not necessary) in the text input palette and then tap [OK] to confirm the file name. The save confirmation dialog box appears. Tap [OK] to save the piezoelectric constant file.

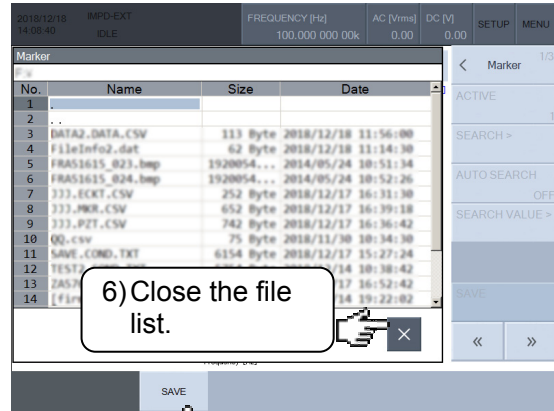
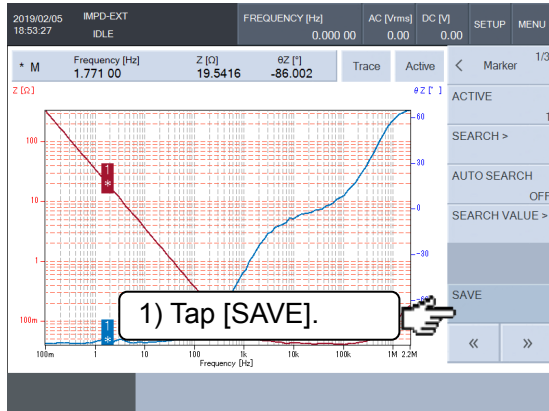
The extension of the file name is “.PZT.CSV”. The extension does not need to be entered because it is added automatically during saving.

Piezoelectric constant files saved to a USB memory device are in text format. For the file format, refer to “2.5 Piezoelectric Constant File Format”.

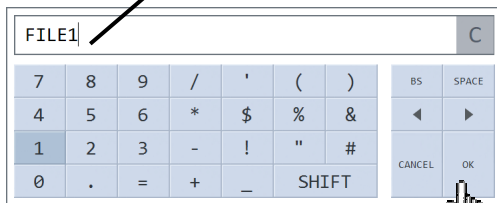
1.17.5 Marker Information

The setting state of the markers and the values of the data indicated by the markers can be saved to a USB memory device as a file. For details on how to use markers, refer to “1.7 Marker Operations”.

Open the [Marker] menu, insert a USB memory device into the USB port on the front panel, and perform the following procedure.

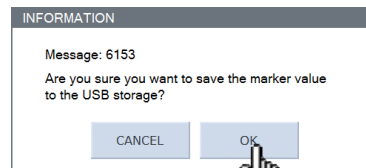


3) Enter a file name.



4) Tap [OK].

2) Tap [SAVE].



5) Tap [OK].

Tap the [SAVE] menu and then tap the [SAVE] function key to display the text input palette. Enter a file name (an extension is not necessary) and then tap [OK]. The save confirmation dialog box appears. Tap [OK] to save the marker information at that point in time as a set to a file.

The extension of the file name is “.MKR.CSV”. The extension does not need to be entered because it is added automatically during saving.

Marker information files saved to a USB memory device are in text format. For the file format, refer to “2.6 Marker Information File Format”.

1.17.6 Screen Copy

This function can capture an image of the LCD screen and save it to a USB memory device. Insert a USB memory device into the USB port on the front panel and then press the **SCREEN COPY** key to create a bitmap file in the USB memory device.



The file name of the created file is "ZA57630_nnn.bmp". The "nnn" is a serial number from 000 to 999 that is incremented by 1 each time a screen image is captured. If there is a file with the same name, it is overwritten. The serial number can be set to an arbitrary three-digit number in [Storage]—[SCRN COPY FILE NUMBER].

The file format is a Microsoft Windows bitmap image, there are 800x600 dots and 16.77 million colors, and the file size is approximately 1.9 MB.

1.18 External Reference Clock

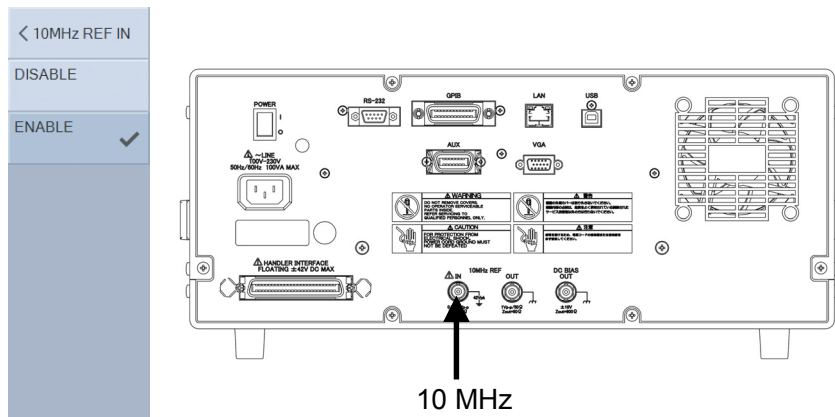
This instrument uses an internal crystal oscillator as the reference clock, but an external 10 MHz clock signal can also be used.

Generally, an external reference clock is used for the following purposes.

- To improve the accuracy and stability of the measurement frequency by using a reference clock (e.g., a rubidium frequency standard) that is more accurate than the internal clock of this instrument.
- To establish a common frequency accuracy by using a reference clock that is shared by other devices.

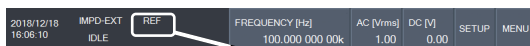
■ Inputting an external 10 MHz reference clock signal

Connect an external 10 MHz reference clock to the 10 MHz REF IN connector on the rear panel. For the specifications for signals that can be input and the cautions, refer to “3.2.5 10 MHz REF IN” in Instruction Manual (Basics).



To enable the external reference clock, set [OSC]—[10 MHz REF IN] to ENABLE. When this instrument is operating with an external reference clock, the status display area in the upper part of the LCD screen will indicate REF. If a valid clock signal is not being input, REF in the status display area will flash.

When [OSC]—[10 MHz REF IN] is set to DISABLE, this instrument will always operate with the internal reference clock. The status display area will be blank (no indication).



Operating with the internal reference clock

(No indication)

(“REF” flashing)

Operating with an external reference clock

Even if a valid 10 MHz reference clock signal is being input to the 10 MHz REF IN connector, this instrument will still operate with the internal reference clock if [OSC]—[10 MHz REF IN] is set to DISABLE.

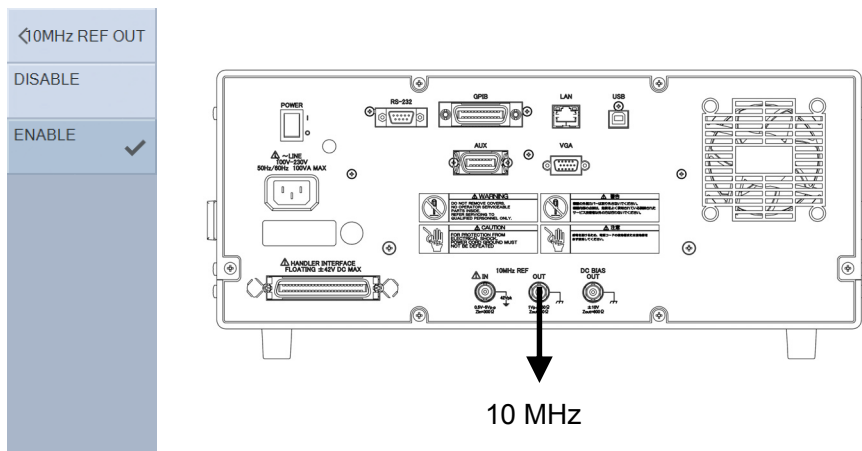
If the external reference clock signal is interrupted during operation, this instrument

automatically switches to the internal reference clock. If the external reference clock is subsequently recovered, operation again continues with the external reference clock. Whether this instrument is operating with the internal reference clock or an external reference clock is always indicated in the status display area at the top of the screen.

■ Outputting a 10 MHz reference clock signal

The 10 MHz reference clock signal with which this instrument is operating can be output. For the signal specifications and cautions, refer to “3.2.6 10 MHz REF OUT” in Instruction Manual (Basics).

When [OSC]—[10 MHz REF OUT] is set to ENABLE, a 10 MHz reference clock signal is output from the 10 MHz REF OUT connector on the rear panel. A signal is not output when DISABLE is set.

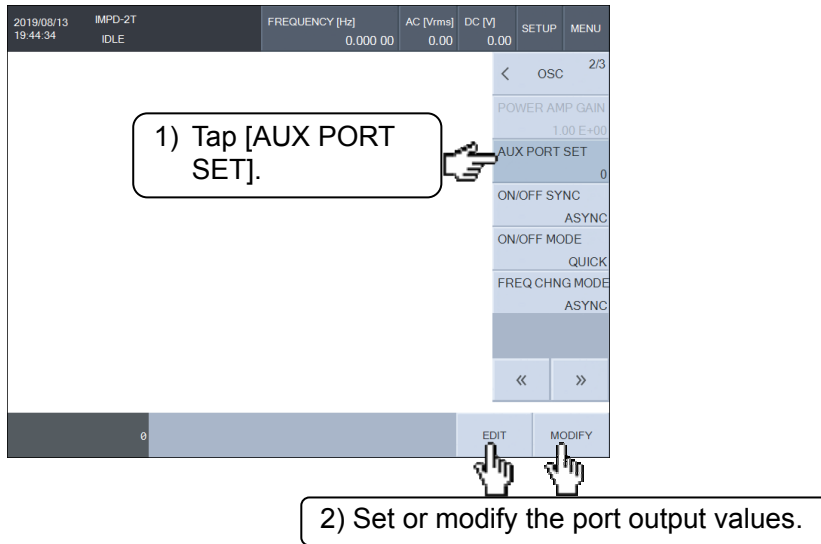


1.19 AUX Port Settings

The AUX port connector on the rear panel has a signal to indicate the measurement signal output on/off state of this instrument as well as 4-bit logic output and 3-bit logic input, and can be used for external device control. For details on the pin assignment and electrical specifications, refer to “3.2.8 AUX” in Instruction Manual (Basics).

■ Setting the AUX port

Set the output signal to D3..D0 of the AUX port in [OSC]—[AUX PORT SET].

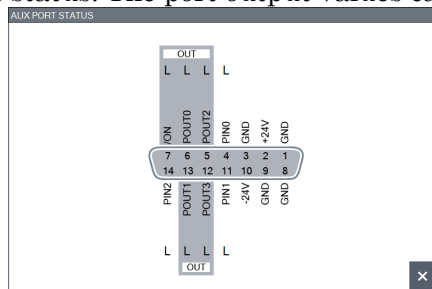


The AUX port output values are saved to the measurement condition data. Therefore, different values can be output to the port by restoring measurement conditions or performing sequence measurement.

The /ON terminal (pin 7) of the AUX connector is determined by the measurement signal output state. The level is low with DC ON and AC+DC ON, and high otherwise.

■ Checking the AUX port status

The input/output status of the AUX port can be displayed. Select [Other] menu—[AUX PORT STATUS] and then tap the [STATUS] function key to display the following window. This screen is only for displaying the port status. The port output values cannot be changed.

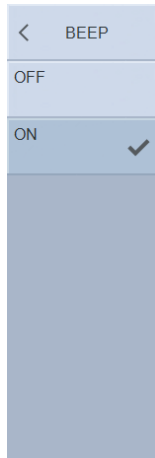


Tap the [X] button at the bottom right to close the AUX port status display screen.

1.20 Other Operations

1.20.1 Setting Beep Sounds

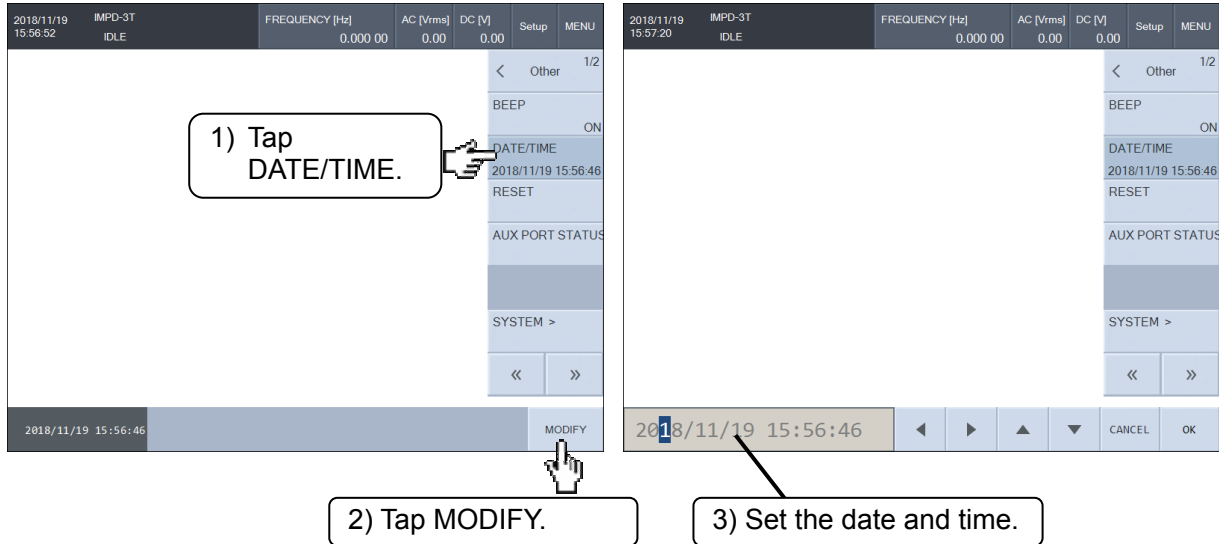
When [Other]—[BEEP] is set to ON, a click sound is output for button operations and a pop-up sound is output when a message is displayed. If you set this to OFF, these sounds will not be output.



1.20.2 Setting Internal Clock

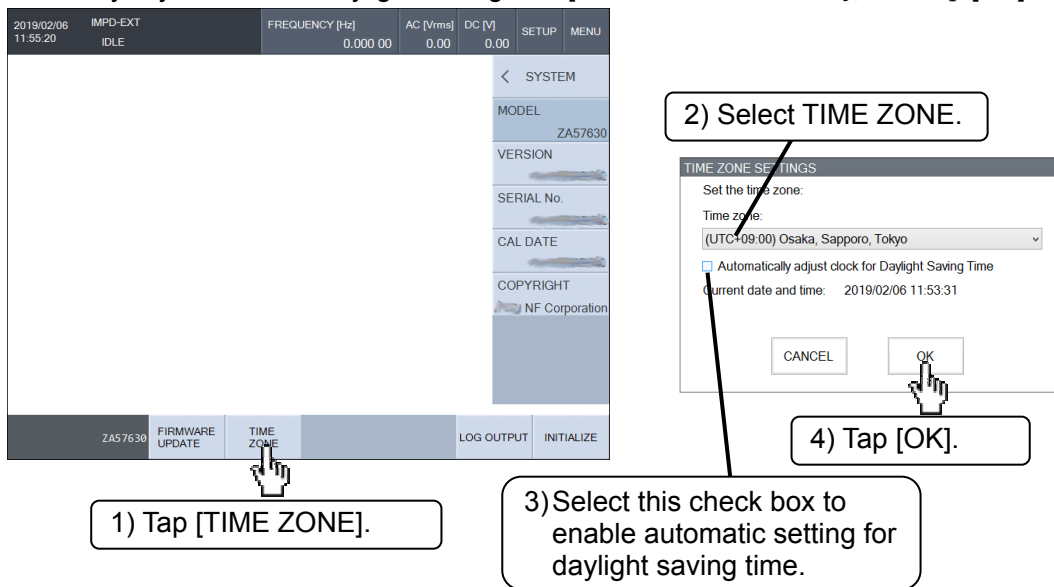
■ Setting the date and time

Set the date and time of the internal clock in [Other]—[DATE/TIME]. The date is in the yyyy/mm/dd format, and the time is in the hh:mm:ss format and uses the 24-hour system.



■ Setting the time zone

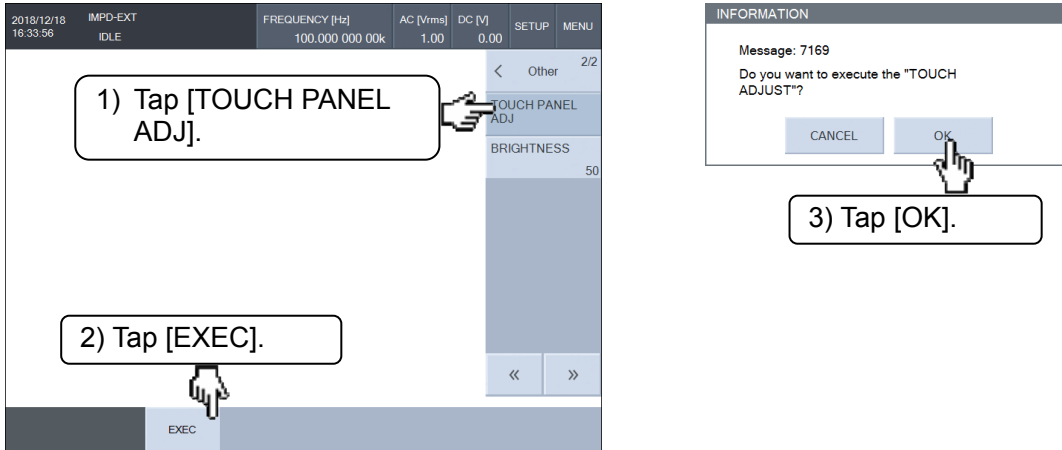
Tap [Other]—[SYSTEM] and then tap the [TIME ZONE] function key. Select the time zone, select the [Automatically adjust clock for Daylight Saving Time] check box if necessary, and tap [OK].



1.20.3 Adjusting Touch Panel

Perform touch panel position adjustment when there is a difference between the location touched on the screen and the touch position recognized by this instrument. It is not normally necessary to perform this adjustment. The adjustment procedure is described below.

- 1) Tap [Other]—[TOUCH PANEL ADJ] and then tap the [EXEC] function key. The adjustment start message appears. Tap [OK].



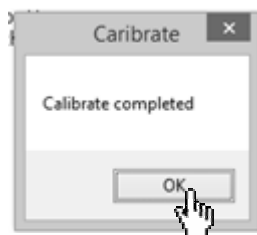
- 2) The following confirmation message appears. Tap any location on the screen twice consecutively.
 Tap this monitor twice to start setting.
 Press the Enter or ESC button to end.
 To not perform adjustment, press **CANCEL**/ESC. The adjustment screen will close.
- 3) A red mark like the one shown below is displayed on the screen. Tap the center of the mark with your finger.



When you tap the mark, the mark will be displayed in another location. Tap the center of the mark. The mark will be displayed in a total of four locations in the upper, lower, left, and right parts of the screen.

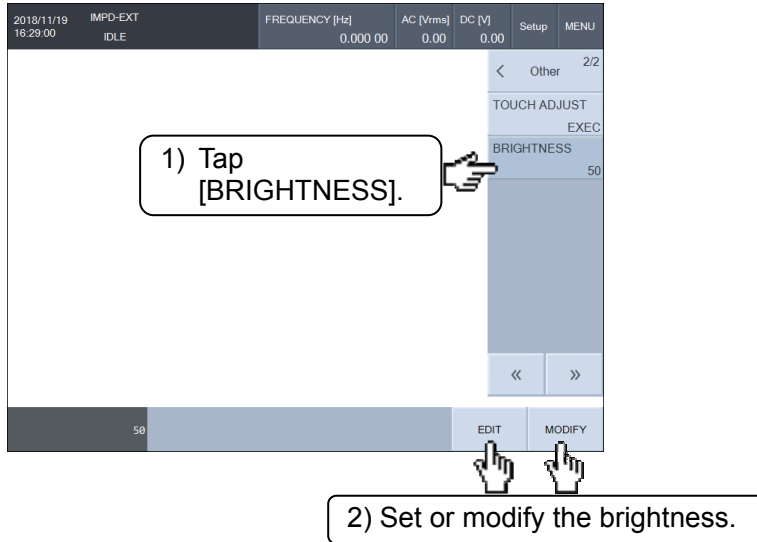
You can cancel the adjustment any time by pressing **CANCEL**/ESC. If you cancel adjustment, the results of the adjustments made up until now will be cleared and this instrument will be restored to the state before you started adjustment.

- 4) After you tap the four locations, the following message appears. Tap the [OK] button to end touch panel position adjustment.



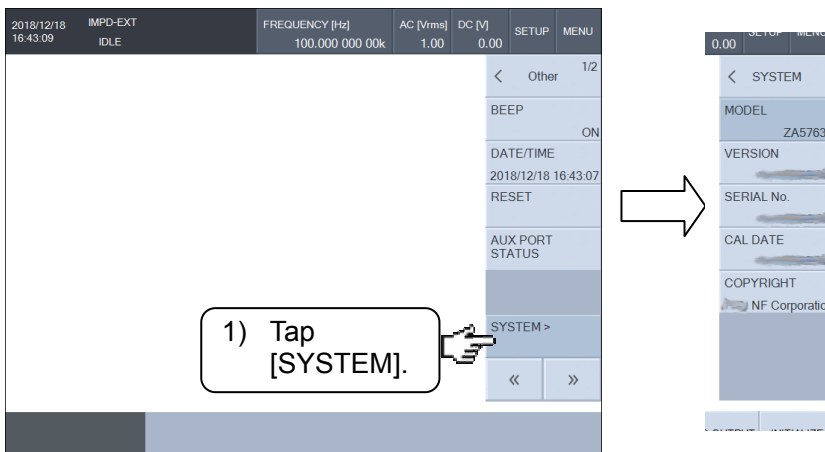
1.20.4 Adjusting LCD Backlight Brightness

You can adjust the brightness of the LCD backlight of this instrument in [Other]—[BRIGHTNESS]. The brightness can be set from 0 to 100, with a larger value indicating greater brightness. Please note that setting 0 does not completely turn off the backlight.



1.20.5 Displaying System Information

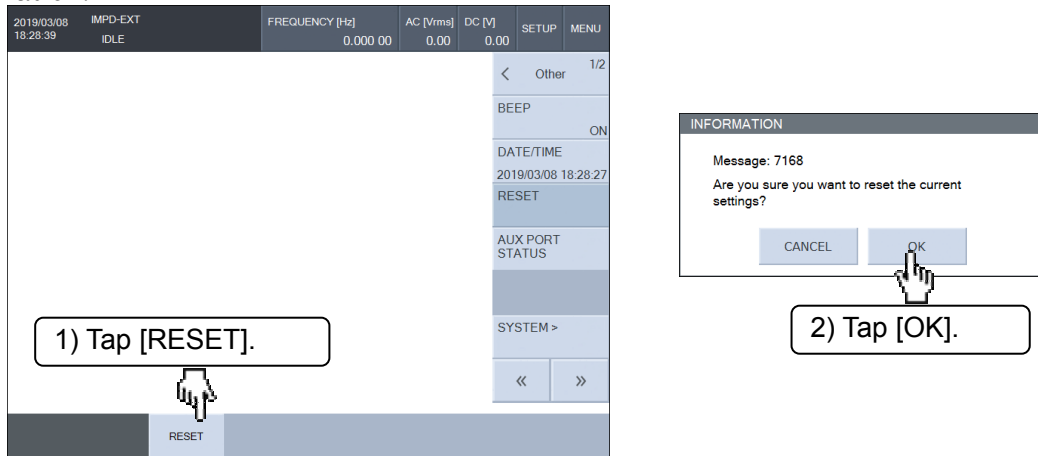
Select [Other]—[SYSTEM] to display this instrument model name, firmware version, serial number, last calibration date, and copyright information. There is no item to set.



1.20.6 Resetting Settings

Reset the settings of this instrument. Tap [Other]—[RESET] and then tap the [RESET] function key. A confirmation dialog box appears. Tap [OK] to reset the settings.

The settings cannot be initialized during measurement. Stop measurement and then perform the operation.

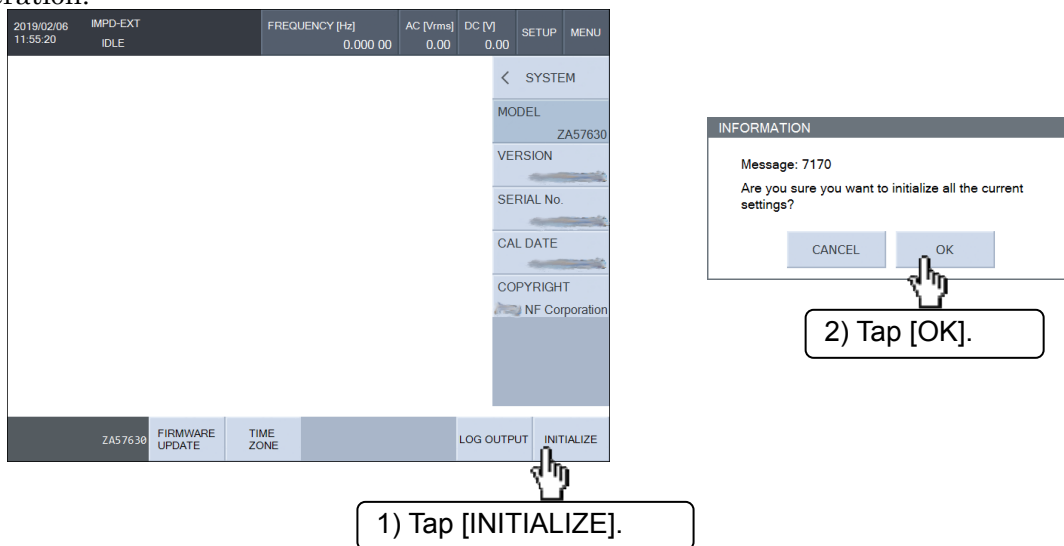


For details on the settings that are reset, refer to “Table 3.4 Initial Settings” in Instruction Manual (Basics).

1.20.7 Restoring Settings to Factory Default State

Restore all this instrument settings to the factory default state. Tap [Other]—[SYSTEM] and then tap the [INITIALIZE] function key. A confirmation dialog box appears. Tap [OK] to restore this instrument to the factory default state.

The settings cannot be initialized during measurement. Stop measurement and then perform the operation.



Performing the operation described above restores all settings, including the measurement mode and remote interface settings, the measurement data saved in internal memory, and the measurement condition files saved in internal memory (which are used in sequence

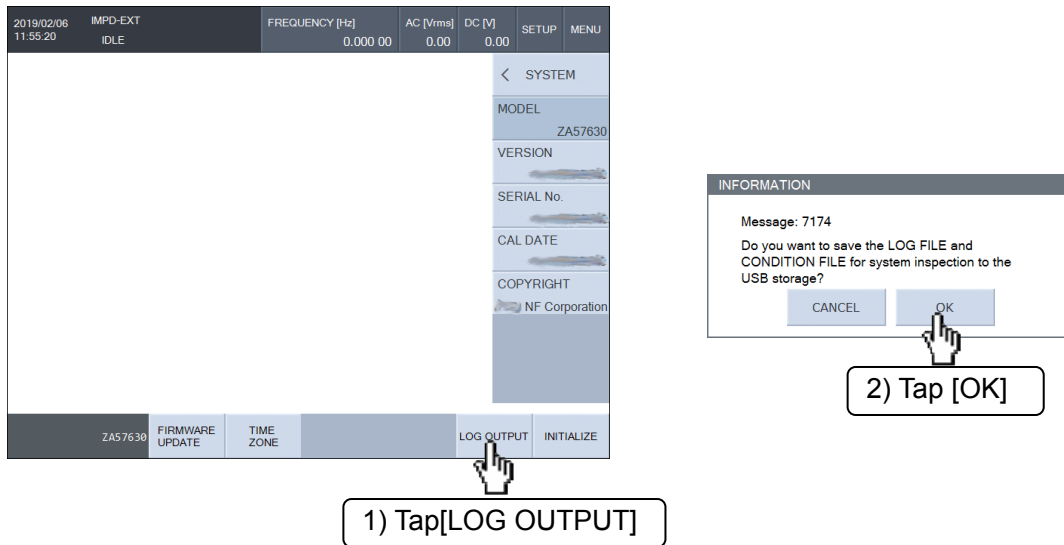
measurement), to the state when this instrument was shipped from the factory. Also, the time zone setting window appears the next time the power is turned on after performing this operation (refer to “■ Setting the time zone” in “1.20.2 Setting Internal Clock”). The time zone setting window does not appear when the power is turned on from the second time.

For details on the factory default settings, refer to “Table 3.4 Initial Settings” in Instruction Manual (Basics).

1.20.8 Outputting Log File

This function outputs a log file for analyzing the operation of this instrument to a USB memory device.

When you report that a problem has occurred with the operation of this instrument, we may ask you to output and provide the log file. A log file is not required in cases other than that. Insert a USB memory device into the USB port on the front panel. Select [Other]–[SYSTEM] and then tap the [LOG OUTPUT] function key. Tap [OK] to output the log file to the USB memory device. The time required to output the log file varies depending on the log size but it usually takes several minutes. The log file name will be “ZA57630_yyyymmddhhmm.LOG”.



Please note that the log file is encrypted so you will not be able to read its contents. Even if you mistakenly output a log file, there will be no effect on the operation of this instrument. Delete the log file created in the USB memory device.

2. File Formats

2.1	General	2-2
2.2	Measurement Data File Format.....	2-2
2.3	Measurement Condition File Format	2-7
2.4	Equivalent Circuit File Format	2-16
2.5	Piezoelectric Constant File Format	2-17
2.6	Marker Information File Format.....	2-19
2.7	Screen Image File Format.....	2-20

2.1 General

This instrument can save the measurement data, measurement conditions, equivalent circuit, piezoelectric constants, marker information, and LCD screen images as files to a USB memory device inserted in the USB port on the front panel. They can also be read by personal computers and other IBM PC/AT compatible machines. A measurement data file, and measurement condition file can be reloaded and used by this instrument or loaded and used by another ZA57630.

All files except screen image files are in text format, and there are the following formats for the parameters contained in each file.

[Parameter formats]

Symbol	Format	Example
(NR1)	Integer (numerical value)	123
(NR2)	Decimal point notation without exponent (numerical value)	0.075
(NR3)	Decimal point notation with exponent (numerical value)	4.99E+06
(CRD)	Text	ALL
(SRD)	Text enclosed in double quotation marks	"No error"
{CRD1 CRD2 ..}	Any one of text of CRD1, CRD2, ...	{ON OFF}
(bool)	Boolean value	ON,OFF,1,0

2.2 Measurement Data File Format

This file is in text format (CSV format) and can be handled by text editors, spreadsheet software, and other PC software. The extension of the file name is ".DATA.CSV".

The structure of the measurement data file differs depending on whether or not the data was obtained by sequence measurement.

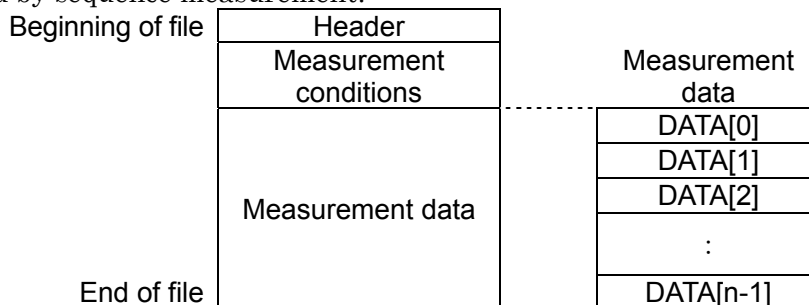


Figure 2-1 Structure of Measurement Data File (without Sequence Measurement)

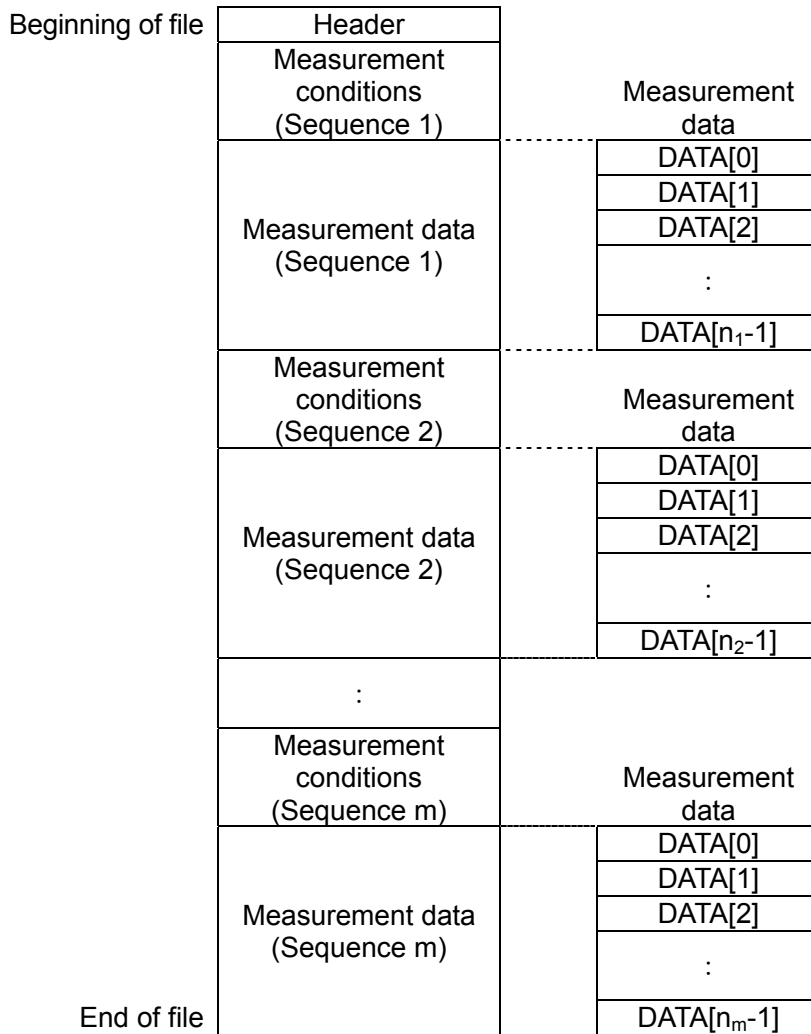


Figure 2-2 Structure of Measurement Data File (with Sequence Measurement)

The measurement conditions part and the measurement data part have the same format, regardless of whether or not there is sequence measurement.

Table 2-1 Data File Format (Header Part)

Line number	Format (example)	Description
1	Idn,"NF Corporation",ZA57630, 0123456,Ver1.00	Manufacturer, model name, serial number, firmware version
2	FileFormatVer,1.00	File format version
3	FileType,DATA	File type (measurement data)
4	DateTime,(CRD)	Date and time file saved yyyy/mm/dd,hh:mm:ss
5	Mode,{IMPD-EXT IMPD-3T IMPD-2T G-PH}	Measurement modes

Table 2-2 Data File Format (Measurement Conditions Part)

Relative line number	Format (example)	Description
+0	Date,(CRD)	Measurement start date and time in yyyy/mm/dd,hh:mm:ss format
+1	DataNum,(NR1)	Number of data items (sweep resolution setting + 1)
+2	SweepSequence,(NR1)	Number of sequences This is 0 when there is no sequence measurement.
+3	OscFrequency,(NR2)	Measurement signal frequency Hz
+4	OscAmplitudeUnit,{V A}	Amplitude unit of measurement signal
+5	OscAmplitude,(NR3)	Measurement signal AC amplitude Vrms or Arms
+6	OscDCbiasValue,(NR3)	Measurement signal DC bias V or A
+7	OscHVBias,{ON OFF}	Measurement signal, HV DC bias
+8	MeasTime,(NR3)	Measurement time s
+9	MeasStartDelayTime,(NR3)	Measurement start delay time s
+10	MeasDelayTime,(NR3)	Measurement delay time s
+11	SweepItem,{FREQUENCY AMPLITUDE DCBIAS ZERO-SPAN}	Sweep item
+12	SweepResType,{Log Lin}	Sweep resolution type
+13	GraphTitleSet,(SRD)	Graph title
+14	GraphXaxis,{SWEEP R G P a}	Graph X-axis display item
+15	GraphYaxis,{Z-P Y-P R-X G-B Cp-Rp Cp-D Cp-Q Cs-Rs Cs-D Cs-Q Lp-Rp Lp-Q Ls-Rs Ls-Q V-I V1-V2 es-D es1-es2 us-D us1-us2 FREQ-Pz X -X B R-P dBR-P R-GD dBR-GD a-b FREQ-P R dBR b}	Graph Y1-axis and Y2-axis display items es, es1, and es2 are the abbreviated forms of ϵ_s , ϵ_s' , and ϵ_s'' , respectively, and us, us1, and us2 are the abbreviated forms of μ_s , μ_s' , and μ_s'' , respectively.

The line number of the first line of the setting conditions part relative to the beginning of the file can be calculated with the formula shown below, denoting the number of measurement data items (DataNum) for sequence number m as n_m .

The line number of the first line of setting conditions part = $6 + (16 + n_1) + (16 + n_2) + \dots + (16 + n_m)$

If there is no sequence measurement ($m = 0$), the line number of the first line of the setting conditions part would be 6.

Table 2-3 Data File Format (Measurement Data Part)

Relative line number	Format (example)	Description
+0	(CRD),(CRD),(CRD), (CRD),(CRD),(CRD),(CRD),STATUS	Text indicating contents of measurement data part
+1	(NR3),(NR3),(NR3), (NR3),(NR3),(NR3),(NR3),(NR1)	DATA[0] SWEEP* ¹ , V1(Vrms)* ² , V2(Vrms)* ³ , Z(Ω)* ⁴ , θ * ⁴ ($^{\circ}$), Y1* ⁵ , Y2* ⁵ , STATUS* ⁶
+2	(NR3),(NR3),(NR3), (NR3),(NR3),(NR3),(NR3),(NR1)	DATA[1] SWEEP, V1(Vrms), V2(Vrms), Z(Ω), θ ($^{\circ}$), Y1, Y2, STATUS
:	:	:
+n	(NR3),(NR3),(NR3), (NR3),(NR3),(NR3),(NR3),(NR1)	DATA[n-1] SWEEP, V1(Vrms), V2(Vrms), Z(Ω), θ ($^{\circ}$), Y1, Y2, STATUS

- *1: This is the sweep value. Any one of frequency (Hz), AC amplitude (Vrms or Arms), DC bias (V or A), and time (s) is output.
- *2: This is the monitored voltage. V1 (Vrms) is output when the measurement mode is IMPD-EXT or G-PH, and V (Vrms) when it is IMPD-3T or IMPD-2T.
- *3: This is the monitored voltage or monitored current. V2 (Vrms) is output when the measurement mode is IMPD-EXT or G-PH, and I (Arms) when it is IMPD-3T or IMPD-2T.
- *4: These are the measurement results. Z (Ω) and θ_z ($^{\circ}$) are output when the measurement mode is IMPD-EXT, IMPD-3T, or IMPD-2T, and R (unitless number) and θ ($^{\circ}$) when it is G-PH.
These are the values for which each correction was performed, so the relationship with the monitored voltage and monitored current will not match (Z and $V \div I$ will not match).
- *5: These are the Y1-axis value and Y2-axis value of each graph. The axis display items are in accordance with the graph settings when the file was saved, and are saved to relative line number 15: GraphYaxis of the measurement conditions part. When the graph X-axis is other than SWEEP, the Y1 is the X-axis value and Y2 is the Y-axis value.

If normal measurement could not be performed due to a problem such as over-level detection, "NaN" (Not a Number) is output for the monitored voltage, monitored current, measurement result, and Y1 and Y2 values.

- *6: This information indicates the measurement range and over-level state. It is a numerical value that indicates the 16-bit values as a decimal number (0 to 65535) in "Table 2-4 STATUS Information".

Table 2-4 STATUS Information

	Measurement Modes		
	IMPD-EXT G-PH	IMPD-3T	IMPD-2T
(MSB) D15..D12	PORT1 measurement range 0001:7 Vrms 0010:5 Vrms 0011:2 Vrms 0100:1 Vrms 0101:500 Vrms 0110:200 Vrms 0111:100 Vrms 1000:50 Vrms 1001:20 Vrms 1010:10 mVrms	(Invalid)	
D11..D8	PORT2 measurement range Same as D15..D12	(Invalid)	
D7..D4	Always 0000	Measurement range 0001:1 M Ω 0010:100 k Ω 0011:10 k Ω 0100:1 k Ω 0101:100 Ω 0110:10 Ω 0111:1 Ω	
D3	0: Not over level 1: PORT1 over level	0: Not over level 1: Over voltage level	0: Not over level 1: Over current level
D2	0: Not over level 1: PORT2 over level	0: Not over level 1: Over current level	0: Not over level 1: Over voltage level
D1	Always 0	0: Not over level 1: Over range	
D0 (LSB)	0: ALC properly 1: ALC error		

2.3 Measurement Condition File Format

This file is in text format (.TXT format) and can be handled by text editors, spreadsheet software, and other PC software. The extension of the file name is “.COND.TXT”.

The structure of the measurement condition file is shown below.

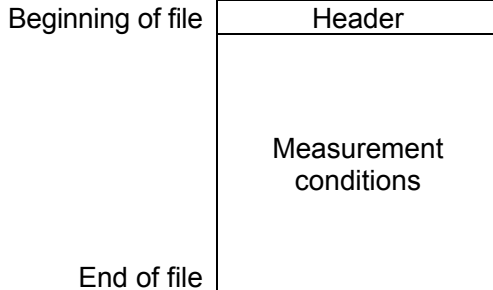


Figure 2-3 Structure of Measurement Condition File

Table 2-5 Measurement Condition File Format (Header Part)

Line number	Format (example)	Description
1	Idn,"NF Corporation",ZA57630, 0123456,Ver1.00	Manufacturer, model name, serial number, firmware version
2	FileFormatVer,1.00	File format version
3	FileType,CON	File type (setting condition file)
4	DateTime,(CRD)	Date and time file saved yyyy/mm/dd,hh:mm:ss
5	Mode,{IMPD-EXT IMPD-3T IMPD-2T G-PH}	Measurement modes

Table 2-6 Measurement Condition File Format (Measurement Conditions Part)

Line number	Format (example)	Description
6	OscFrequency,(NR2)	Measurement signal frequency Hz
7	OscAmplitudeUnit,{V A}	Amplitude unit of measurement signal
8	OscAmplitude,(NR3)	Measurement signal AC amplitude Vrms or Arms
9	OscAmplitudeLimit,(NR3)	Measurement signal AC amplitude limit Vrms or Arms
10	OscALC,{ON OFF CV1 CV2}	Automatic level control
11	OscALCTolerance,(NR1)	Permissible error %
12	OscALCRetry,(NR1)	Maximum number of retries
13	OscALCCorrectionFactor,(NR1)	Correction factor %
14	OscDCbias,(NR3)	Measurement signal DC bias V or A
15	OscDCbiasHV,(NR3)	Measurement signal, HV DC bias voltage
16	OscHVbias,{ON OFF}	Measurement signal, HV DC bias ON/OFF

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
17	OscOutputConnector, {FRONT REAR}	Normal DC bias output connector
18	OscPowerAmpGain,(NR3)	DUT drive amplifier gain
19	OscAUXPort,(NR1)	AUX port output value 0 to 15
20	OscOnOffSync, {ASYNC SYNC(AC+DC) SYNC(A C)}	Measurement synchronous drive
21	OscOnOffMode,{QUICK SLOW S YNC}	ON/OFF mode
22	OscFrequencyChangeMode, {ASYNC SYNC}	Frequency change mode
23	Osc10MHzRefIn, {DISABLE ENABLE}	Reference clock selection
24	Osc10MHzRefOut, {DISABLE ENABLE}	Reference clock output
25	MeasParam1,{Z Pz Y Py R X G B Cs Cp D Qc Ls Lp Ql Rs Rp es es1 es2 De us us1 us2 Du FREQUENCY V1 V2 V I R dBR P a b STATUS NA}	Spot measurement 1st to 6th parameters
26	MeasParam2,{...}	
27	MeasParam3,{...}	
28	MeasParam4,{...}	
29	MeasParam5,{...}	
30	MeasParam6,{...}	
31	MeasTime,(NR3)	Measurement time s
32	MeasStartDelayTime,(NR3)	Measurement start delay time s
33	MeasDelayTime,(NR3)	Measurement delay time s
34	MeasTriggerSource, {PANEL REMOTE HANDLER}	Trigger Source
35	MeasRepeat,{ON OFF}	Repeat measurement
36	SweepSequence,(NR1)	Sequence sweep number 0 to 32
37	SweepSequenceTrigger,{AUTO STEP}	Sequence trigger mode
38	SweepItem,{FREQUENCY AMPLITUDE DC BIAS ZERO-SPAN}	Sweep item

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
39	SweepLowerFrequency,(NR2)	Sweep lower frequency limit Hz
40	SweepUpperFrequency,(NR2)	Sweep upper frequency limit Hz
41	SweepLowerAmplitude,(NR3)	Sweep lower amplitude limit Vrms or Arms
42	SweepUpperAmplitude,(NR3)	Sweep upper amplitude limit Vrms or Arms
43	SweepLowerDCbias,(NR3)	Sweep lower DC bias limit V or A
44	SweepUpperDCbias,(NR3)	Sweep upper DC bias limit V or A
45	SweepLowerHVbias,(NR3)	Sweep lower HV DC bias limit V
46	SweepUpperHVbias,(NR3)	Sweep upper HV DC bias limit V
47	SweepRes,(NR1)	Sweep resolution 3 to 2,000
48	SweepResType,{LOG LIN}	Sweep type
49	SweepSlowSweep,{ON OFF}	Automatic high density sweep
50	SweepSlowSweepVarType, {Z Y dBR R P}	Automatic high density sweep, monitoring parameter
51	SweepSlowSweepVarZ,(NR3)	Automatic high density sweep, Z threshold value Ω
52	SweepSlowSweepVarY,(NR3)	Automatic high density sweep, Y threshold value S
53	SweepSlowSweepVarDBR,(NR2)	Automatic high density sweep, dBR threshold value dB
54	SweepSlowSweepVarR,(NR3)	Automatic high density sweep, R threshold value
55	SweepSlowSweepVarP,(NR2)	Automatic high density sweep, P threshold value $^{\circ}$
56	SweepResonantTrack,{ON OFF}	Resonant frequency tracking measurement
57	ResonantTrackUpper,(NR2)	Tracking frequency upper limit Hz
58	ResonantTrackLower,(NR2)	Tracking frequency lower limit Hz
59	SweepResonantTrackTarget,(NR2)	Target phase $^{\circ}$
60	SweepResonantTrackTolerance,(NR2)	Permissible error $^{\circ}$
61	SweepResonantTrackCorrection,(NR1)	Correction factor %
62	SweepResonantTrackPolarity, {POSITIVE NEGATIVE}	Tracking polarity
63	GraphTitleSet,(SRD)	Graph title
64	GraphStyle,{SINGLE SPLIT}	Graph display style
65	GraphGridType, {OFF SOLIDLINE BROKENLINE}	Graph grid line style

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
66	GraphGridStyle, {OFF X X-Y1 X-Y2 X-Y1-Y2}	Graph grid display axis
67	GraphAxisType,{LIN LOG}, {LIN LOG},{LIN LOG}	Type of graph X, Y1, and Y2 axes
68	GraphXaxis,{SWEEP P R G a}	Graph X-axis display item
69	GraphYaxis,{Z-P Y-P R-X G-B Cp-Rp Cp-D Cp-Q Cs-Rs Cs-D Cs-Q Lp-Rp Lp-Q Ls-Rs Ls-Q V-I V1-V2 es-D es1-es2 us-D us1-us2 FREQ-Pz X -X B R-P dBR-P R-GD dBR-GD a-b FREQ-P R dBR b}	Graph Y1-axis and Y2-axis display items es, es1, and es2 are the abbreviated forms of ϵ_s , ϵ_s' , and ϵ_s'' respectively, and us, us1, and us2 are the abbreviated forms of μ_s , μ_s' , and μ_s'' respectively.
70	GraphTrace,{ON OFF},{ON OFF}, {ON OFF},{ON OFF},{ON OFF}, {ON OFF},{ON OFF},{ON OFF}, {ON OFF}	Graph display trace selection From beginning: MEAS, REF1, REF2,..., REF8
71	GraphPhaseRange,{0 1 2 3}	Phase display range 0: $\pm 180^\circ$, 1: 0 to $+360^\circ$, 2: -360 to 0° , 3: UNWRAP
72	GraphPhaseAperture,(NR1)	Aperture size (for group delay calculation)
73	GraphTraceColor, (CRD),(CRD),(CRD),(CRD),(CRD), (CRD),(CRD),(CRD),(CRD),(CRD), (CRD),(CRD),(CRD),(CRD),(CRD), (CRD),(CRD),(CRD)	Trace color 0x000000 to 0xFFFFFFFF From beginning: MEAS Y1, MEAS Y2, REF1 Y1, REF1 Y2,..., REF8 Y2
74	GraphScaleMode, {AUTO AUTO-R FIX}	Graph axis scale mode
75	GraphScaleX,(NR3),(NR3)	Graph X-axis range Lower limit to upper limit
76	GraphScaleY1,(NR3),(NR3)	Graph Y1 axis range Lower limit to upper limit
77	GraphScaleY2,(NR3),(NR3)	Graph Y2 axis range Lower limit to upper limit

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
74	GraphScaleMode, {AUTO AUTO-R FIX}	Graph axis scale mode
75	GraphScaleX,(NR3),(NR3)	Graph X-axis range Lower limit to upper limit
76	GraphScaleY1,(NR3),(NR3)	Graph Y1 axis range Lower limit to upper limit
77	GraphScaleY2,(NR3),(NR3)	Graph Y2 axis range Lower limit to upper limit
78	MarkerMkr1, {OFF ON DELTA DELTA-T}, {MEAS REF1 ... REF8}, {SEQ0 ... SEQ32},(NR3)	Marker 1 to marker 8 information Mode, Target trace, Target sequence number, position
79	MarkerMkr2,{...},{...},{...},{...}	
80	MarkerMkr3,{...},{...},{...},{...}	
81	MarkerMkr4,{...},{...},{...},{...}	
82	MarkerMkr5,{...},{...},{...},{...}	
83	MarkerMkr6,{...},{...},{...},{...}	
84	MarkerMkr7,{...},{...},{...},{...}	
85	MarkerMkr8,{...},{...},{...},{...}	
86	MarkerActive,(NR1)	Active marker 1 to 8
87	MarkerSearchValueX,(NR3)	Marker X search value
88	MarkerSearchValueDeltaX,(NR3)	Marker Δ X search value
89	MarkerSearchValueY1,(NR3)	Marker Y1 search value
90	MarkerSearchValueDeltaY1,(NR3)	Marker Δ Y1 search value
91	MarkerSearchValueY2,(NR3)	Marker Y2 search value
92	MarkerSearchValueDeltaY2,(NR3)	Marker Δ Y2 search value
93	MarkerAutoSearch, {OFF XMAX XMIN XPEAK XBOTTOM Y1MAX Y1MIN Y1PEAK Y1BOTTOM Y2MAX Y2MIN Y2PEAK Y2BOTTOM X Y1 Y2 DELTAX DELTAY1 DELTAY2 BW1 BW2 BW3}	Marker automatic search mode
94	TraceAutoStore,{OFF 1 2 ... 8}	Trace auto store

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
95	InputRangePort1,{AUTO 7V 5V 2V 1V 500mV 200mV 100mV 50mV 20mV 10mV}	PORT1 and PORT2 measurement ranges (Measurement mode: IMPD-EXT or G-PH)
96	InputRangePort2,{...}	
97	InputRange,{AUTO 1M 100k 10k 1k 100 10 1}	Measurement range (Measurement modes IMPD-3T, IMPD-2T)
98	InputOverLevel,(NR3),(NR3)	Over-level detection level PORT1, PORT2
99	InputOverActionBeep,{ON OFF}	Beep sound setting for over-level detection
100	InputOverActionMeasStop,{STOP CONT}	Sweep stop setting for over-level detection
101	InputWeightingFactor,(NR3),(NR3)	Input weighting factor PORT1, PORT2
102	RemoteHandlerSweepDirection,{UP DOWN SPOT}	Measurement operation for handler trigger
103	CalOpenCorrection,{ON OFF}	OPEN correction
104	CalOpenCorrectionNumber,(NR1)	Data memory number 1 to 32
105	CalShortCorrection,{ON OFF}	SHORT correction
106	CalShortCorrectionNumber,(NR1)	Data memory number 1 to 32
107	CalLoadCorrection,{ON OFF}	LOAD correction
108	CalLoadCorrectionNumber,(NR1)	Data memory number 1 to 32
109	CalLoadFormat,{Cs-D Cp-D Rp-Cp Rs-Ls Rs-X Z-P}	Load standard value format
110	CalLoad1,(NR3),(NR3),(NR3)	Load standard values 1 to 30 Frequency Hz, Z Ω, θz °
:	:	
139	CalLoad30,(NR3),(NR3),(NR3)	

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
140	CalPortExtension,{ON OFF}	Port extension
141	CalPortExtensionZ0,(NR3)	Characteristic impedance Ω
142	CalPortExtensionElectricalLength, (NR2)	Electrical length m
143	CalPortOpenCorrection,{ON OFF}	OPEN correction
144	CalPortOpenCorrectionNumber,(NR1)	Data memory number 1 to 32
145	CalPortShortCorrection,{ON OFF}	SHORT correction
146	CalPortShortCorrectionNumber,(NR1)	Data memory number 1 to 32
147	CalPortLoadCorrection,{ON OFF}	LOAD Correction
148	CalPortLoadCorrectionNumber,(NR1)	Data memory number 1 to 32
149	CalPortLoadFormat,{Cs-D Cp-D Rp-Cp Rs-Ls Rs-X Z-P}	Load standard value format
150	CalPortLoad1,(NR3),(NR3),(NR3)	Load standard values 1 to 30 Frequency Hz, Z Ω , θ_z °
:	:	
179	CalPortLoad30,(NR3),(NR3),(NR3)	
180	CalSlopeCompensation,{ON OFF}	Slope compensation
181	CalEqualize,{ON OFF}	Equalizing function
182	CalEqualizeCorrectionNumber,(NR1)	Data memory number 1 to 32
183	CalcDielectricPermittivityArea,(NR3)	Relative permittivity measurement, electrode surface area mm ²
184	CalcDielectricPermittivityDistance, (NR3)	Distance between electrodes mm

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
185	CalcMagneticPermeabilityCoreArea, (NR3)	Relative permeability Core effective cross-sectional area mm ²
186	CalcMagneticPermeabilityCoreMagn eticPathLength,(NR3)	Core effective magnetic path length mm
187	CalcMagneticPermeabilityCoilTurns, (NR1)	Number of coil turns
188	CalcMagneticPermeabilityWireDiam eter,(NR3)	Winding wire diameter mm
189	CalcMagneticPermeabilityOneTurnL ength,(NR3)	Coil one turn length mm
190	CalcMagneticPermeabilityWireResist ivity,(NR3)	Winding wire resistivity Ωm
191	CalcEquivCkt,{CKT1 ... CKT6}	Equivalent circuit type
192	CalcPZTEquivCkt, {RESNf fmax Gmax Bavg},(NR1)	Piezoelectric constant Equivalent circuit C0 mode, frequency resolution
193	CalcPZTShape-Mode, {Disk-Radial Disk-Thickness Rod-Axial Plate-Length Plate-ThicknessShear}	DUT shape, vibration mode
194	CalcPZTSize,(NR3),(NR3),(NR3), (NR3),(NR3),(NR3),(NR3)	DUT shape Length mm, width mm, thickness mm, diameter mm, relative permittivity, Poisson's ratio, density ×10 ³ kg/m ³

Table 2-6 Measurement Condition File Format (Measurement Conditions Part) Continued

Line number	Format (example)	Description
195	CalcComptr,{OFF ON}	Bin comparison
196	CalcComptrType, {ABS DEV DEV%},{(NR3),(NR3)}	Deviation mode, 1st parameter reference value, 2nd parameter reference value
197	CalcComptrBIN1,ON, (NR3),(NR3),(NR3),(NR3)	Bin 1 comparison range*1 1st parameter upper level, lower level, 2nd parameter upper level, lower level
198	CalcComptrBIN2,{ON OFF}, (NR3),(NR3),(NR3),(NR3)	Bin 2 to 14 comparison range*1 Enabled or disabled,
:	:	1st parameter upper level, lower level,
210	CalcComptrBIN14,{...},{...},{...},{...}	2nd parameter upper level, lower level
211	CalcComprActionBeep,{ON OFF}	Pass/fail beep sound setting
212	CalcZone,{OFF ON}	Zone comparison
213	CalcZoneMode, {IMMED REF_DEV REF_DEV%}	Comparison mode
214	CalcZoneImmed1, (NR3),(NR3),(NR3),(NR3),(NR3)	IMMED mode 1 to 20 comparison range*1
:	:	SWEEP value
233	CalcZoneImmed20,..., ..., ..., ..., ...	Y1 lower limit value, Y1 upper limit value Y2 lower limit value, Y2 upper limit value
234	CalcZoneRef, (NR1),(NR3),(NR3),(NR3),(NR3)	REF_DEV mode comparison range*1 Reference REF trace number (1 to 8), Y1 lower limit value, Y1 upper limit value Y2 lower limit value, Y2 upper limit value

*1: "NaN" (Not a Number) is output to the file for a parameter with "NA" (Not Applicable) set in the screen.

2.4 Equivalent Circuit File Format

This file is in text format (.CSV format) and can be handled by text editors, spreadsheet software, and other PC software. The extension of the file name is “.ECKT.CSV”.

The structure of the equivalent circuit file is shown below.

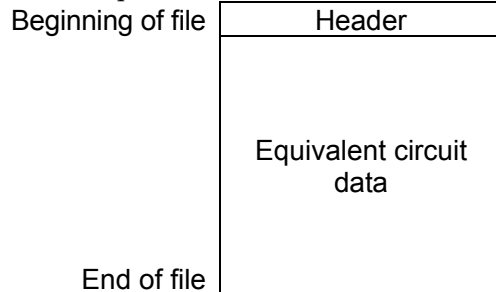


Figure 2-4 Structure of Equivalent Circuit File

Table 2-7 Equivalent Circuit File Format (Header Part)

Line number	Format (example)	Description
1	Idn,"NF Corporation",ZA57630, 0123456,Ver1.00	Manufacturer, model name, serial number, firmware version
2	FileFormatVer,1.00	File format version
3	FileType,EQUIV	File type (equivalent circuit file)
4	DateTime,(CRD)	Date and time file saved yyyy/mm/dd,hh:mm:ss
5	Mode,{IMPD-EXT IMPD-3T IMPD-2T G-PH}	Measurement mode

Table 2-8 Equivalent Circuit File Format (Equivalent Circuit Data Part)

Line number	Format (example)	Description
6	CKTType,{CKT1 CKT2 CKT3 CKT4 CKT5 CKT6}	Equivalent circuit type CKT1 to CKT6
7	EquivalentCktTitle,(CRD)	Equivalent circuit element title
	CKTType=1 to 4 : "C[F]", "R[ohm]", "L[H]", "---" CKTType=5 : "C0[F]", "C1[F]", "R[ohm]", "L[H]" CKTType=6 : "C[F]", "R0[ohm]", "R1[ohm]", "---"	
8	EquivalentCkt, (NR3),(NR3),(NR3),(NR3)	Each constant of equivalent circuit elements
	CKTType=1 to 4 : C[F], R[Ω], L[H], Nan CKTType=5 : C0[F], C1[F], R[Ω], L[H] CKTType=6 : C[F], R0[Ω], R1[Ω], Nan	

2.5 Piezoelectric Constant File Format

This file is in text format (.CSV format) and can be handled by text editors, spreadsheet software, and other PC software. The extension of the file name is “.PZT.CSV”.

The structure of the piezoelectric constant file is shown below.

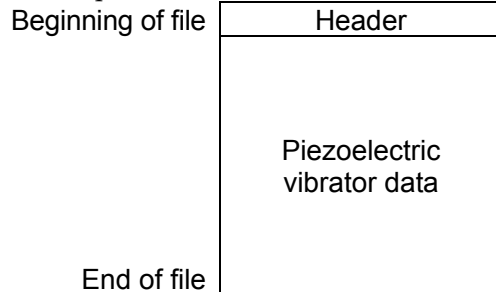


Figure 2-5 Structure of Piezoelectric Constant File

Table 2-9 Piezoelectric Constant File Format (Header Part)

Line number	Format (example)	Description
1	Idn,"NF Corporation",ZA57630, 0123456,Ver1.00	Manufacturer, model name, serial number, firmware version
2	FileFormatVer,1.00	File format version
3	FileType,PZT	File type (piezoelectric constant file)
4	DateTime,(CRD)	Date and time file saved yyyy/mm/dd,hh:mm:ss
5	Mode,{IMPD-EXT IMPD-3T IMPD-2T G-PH}	Measurement modes

Table 2-10 Piezoelectric Constant File Format (Piezoelectric Vibrator Data Part)

Line number	Format (example)	Description
6	PZTEquivCktTitle,"Cdmode","C0[F]", "C[F]","R[ohm]","L[H]","FreqRes"	Equivalent circuit constant title text
7	PZTEquivCkt, {RESNf fmax Gmax Bavg}, (NR3),(NR3),(NR3),(NR3),(NR1)	Equivalent circuit constants C0 mode, C0[F], C[F], R[Ω], L[H], Frequency resolution (3 to 2,000)
8	PZTResonantFrequencyTitle,"fs","fp", "fr","fa","fm","fn","f1","f2","Qm"	Characteristic frequency title text
9	PZTResonantFrequency, (NR2),(NR2),(NR2),(NR2), (NR2),(NR2),(NR2),(NR2),(NR3)	Characteristic frequency fs[Hz], fp[Hz], fr[Hz], fa[Hz], fm[Hz], fn[Hz], f1[Hz], f2[Hz], Qm

Table 2-10 Piezoelectric Constant File Format (Piezoelectric Vibrator Data Part) Continued

Line number	Format (example)	Description
10	PZTShape-Mode, {Disk-Radial Disk-Thickness Rod-Axial Plate-Length Plate-ThicknessShear}	DUT shape, vibration mode
11	PZTSizeTitle,"Length[mm]", "Width[mm]", "Thickness[mm]", "Diameter[mm]", "RelativePermittivity", "Poisson's Ratio", "Density[10 ³ kg/m ³]"	Size and other DUT information title text
12	PZTSize,(NR3),(NR3),(NR3),(NR3), (NR3),(NR3),(NR3)	DUT size Length [mm], width [mm], thickness [mm], diameter [mm], relative permittivity, Poisson's ratio, density [10 ³ kg/m ³]
13	PZTConstantTitle,(CRD),(CRD), (CRD),(CRD),(CRD),(CRD),(CRD)	Piezoelectric constant title text
	PZTShape-Mode= Disk-Radial : "SE12", "SE66", "eT33", "kr", "----", "----", "----" Disk-Thickness : "CD33", "CE33", "eT33", "kt", "----", "----", "----" Rod-Axial : "SD33", "SE33", "d33", "g33", "k33", "----", "----" Plate-Length : "SE11", "d31", "g31", "k31", "----", "----", "----" Plate-ThicknessShear : "CD44", "CE44", "SE44", "eT11", "d15", "g15", "k15"	
14	PZTConstant,(NR3),(NR3), (NR3),(NR3),(NR3),(NR3),(NR3)	Piezoelectric constants
	PZTShape-Mode= Disk-Radial : $s_{12}^E, s_{66}^E, \epsilon_{33}^T, k_r, \text{Nan}, \text{Nan}, \text{Nan}$ Disk-Thickness : $c_{33}^D, c_{33}^E, \epsilon_{33}^T, k_t, \text{Nan}, \text{Nan}, \text{Nan}$ Rod-Axial : $s_{33}^D, s_{33}^E, d_{33}, g_{33}, k_{33}, \text{Nan}, \text{Nan}$ Plate-Length : $s_{11}^E, d_{31}, g_{31}, k_{31}, \text{Nan}, \text{Nan}, \text{Nan}$ Plate-ThicknessShear : $c_{44}^D, c_{44}^E, s_{44}^E, \epsilon_{11}^T, d_{15}, g_{15}, k_{15}$	

2.6 Marker Information File Format

This file is in text format (.CSV format) and can be handled by text editors, spreadsheet software, and other PC software. The extension of the file name is “.MKR.CSV”.

The structure of the marker information file is shown below.

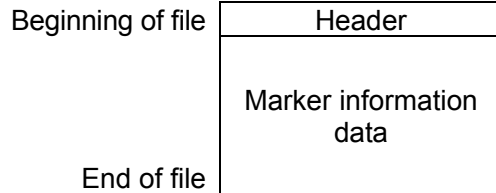


Figure 2-6 Structure of Marker Information File

Table 2-11 Marker Information File Format (Header Part)

Line number	Format (example)	Description
1	Idn,"NF Corporation",ZA57630, 0123456,Ver1.00	Manufacturer, model name, serial number, firmware version
2	FileFormatVer,1.00	File format version
3	FileType,MKR	File type (marker information file)
4	DateTime,(CRD)	Date and time file saved yyyy/mm/dd,hh:mm:ss
5	Mode,{IMPD-EXT IMPD-3T IMPD-2T G-PH}	Measurement Modes

Table 2-12 Marker Information File Format (Marker Information Data Part)

Line number	Format (example)	Description
6	MkrTitle, MODE, TRACE, SEQ, {FREQUENCY AC DC TIME}, {Z Y R ...},{P X ...}	Marker information title SWEEP, Y1, Y2
7	Mkr1,{OFF ON DELTA DELTA-T}, {MEAS REF1 ... REF8}, {SEQ0 ... SEQ32}, (NR3),(NR3),(NR3)	Marker 1 to 8 information Mode, target trace, sequence number, SWEEP, Y1, Y2
8	Mkr2,{...},{...},{...},{...},{...},{...}	
9	Mkr3,{...},{...},{...},{...},{...},{...}	
10	Mkr4,{...},{...},{...},{...},{...},{...}	
11	Mkr5,{...},{...},{...},{...},{...},{...}	
12	Mkr6,{...},{...},{...},{...},{...},{...}	
13	Mkr7,{...},{...},{...},{...},{...},{...}	
14	Mkr8,{...},{...},{...},{...},{...},{...}	

2.7 Screen Image File Format

This file contains an image of this instrument's LCD screen.

The file is in uncompressed Microsoft Windows bitmap (BMP) image format. There are 800×600 dots and 16.77 million colors, and the file size is approximately 1.9 MB.

3. Troubleshooting

3.1	Error Messages	3-2
3.1.1	Power-On Errors	3-2
3.1.2	Panel Operation Errors.....	3-3
3.1.3	Measurement Errors.....	3-6
3.1.4	Other Errors.....	3-7
3.2	Information Messages	3-8
3.2.1	Startup Messages.....	3-8
3.2.2	Operation Messages	3-8
3.3	Troubleshooting.....	3-11

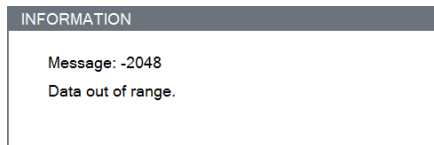
3.1 Error Messages

This section describes the main errors that occur during the self-diagnosis process performed when the power is turned on, during panel operations, and during normal measurement, as well as their causes and the remedies required to resolve the problems.

If repair is required, contact NF Corporation or its authorized agent.

When requesting repair of this instrument, please include the error message code (error number) and a description of any error message that was displayed.

An example of an error message is shown below. The error message code is the number beginning with a minus sign after “Message” in the INFORMATION window. In the example shown below, the error message code is “-2048”. Please note that there are error message codes that have the same numbers as information message codes (refer to “3.2 Information Messages”), and differ only in that they are negative numbers.



Rare events such as malfunctions due to strong external noise may cause error messages not described in this manual to be displayed.

Unusual operations such as firmware updates may cause error messages not described in this manual to be displayed. If other manuals have been provided, refer to them as well.

For details on errors that occur only with remote control, refer to “Instruction Manual (Remote Control)”.

3.1.1 Power-On Errors

The self-diagnosis process is performed when the power is turned on. The following error message may appear on the screen in the event of an error during that time.

Table 3-1 Power-On Errors

No.	Error Message	Description and Cause	Remedy
-1024	Settings load error. Initialize and start up.	The settings were initialized because the contents of the resume memory were lost.	Turn the power off and then back on. If the error recurs, there may be a failure requiring repair.

3.1.2 Panel Operation Errors

The errors that may occur during panel operation are listed below.

Table 3-2 Panel Operation Errors

No.	Error Message	Description and Cause	Remedy
-2048	Data out of range.	The set parameter is out of the range.	Set a value that is within the correct range.
-2049	Settings conflict.	There is a violation of constraints among multiple setting items.	Set a value that is within the correct range.
-2050	Not allowed character.	An invalid character has been entered.	Enter only valid characters.
-2051	String length error.	The permitted number of characters has been exceeded.	Reduce the number of characters.
-2052	Execution error.	Execution was prevented by constraint conflicts among multiple setting items.	Change the settings so that the constraint conditions are satisfied.
-2053	Syntax error.	There is an error with the input numerical value.	Input the numerical value using correct syntax.
-2054	Can't execute fitting. Fitting can be performed only with frequency sweep data.	The equivalent circuit estimation cannot be performed because the data is not measurement data resulting from a frequency sweep.	Specify frequency sweep data.
-2055	Can't execute. Fitting must be done.	Execution was not possible because equivalent circuit fitting has not been performed.	Perform equivalent circuit fitting.
-3073	Insufficient data for equalize correction. It may not work correctly.	The equalizing correction data is invalid. Equalizing correction may not be performed correctly.	Store correct equalizing correction data.
-3074	Insufficient data for open correction. It may not work correctly.	The open correction data is invalid. Open correction may not be performed correctly.	Store correct open correction data.
-3075	Insufficient data for short correction. It may not work correctly.	The short correction data is invalid. Short correction may not be performed correctly.	Store correct short correction data.

Table 3-2 Panel Operation Errors (Continued)

No.	Error Message	Description and Cause	Remedy
-3076	Insufficient data for load correction. It may not work correctly.	The load correction data is invalid. Load correction may not be performed correctly.	Store correct load correction data.
-3077	Can't execute calibration. Please turn off the oscillator output.	Self-calibration cannot begin because measurement signal output is turned on.	Turn measurement signal output off and then try performing self-calibration again.
-3080	Input over:(place).	The input level has been exceeded. Place denotes the measurement connector where over-level was detected, and is PORT1 or PORT2.	Set auto range or revise the circuit connecting with the DUT.
-3081	Insufficient data for open correction. It may not work correctly.	The open correction data at the port extension tip is invalid. Open correction may not be performed correctly.	Store correct open correction data at the port extension tip.
-3082	Insufficient data for short correction. It may not work correctly.	The short correction data at the port extension tip is invalid. Short correction may not be performed correctly.	Store correct short correction data at the port extension tip.
-3083	Insufficient data for load correction. It may not work correctly.	The load correction data at the port extension tip is invalid. Load correction may not be performed correctly.	Store correct load correction data at the port extension tip.
-6144	Can't access USB storage.	The USB memory device cannot be accessed.	<ul style="list-style-type: none"> • Insert a normal USB memory device. • Firmly insert the USB memory device into the connector.
-6145	There is already a file of the same name.	The file could not be renamed because the same file name already exists.	Specify a different file name.

Table 3-2 Panel Operation Errors (Continued)

-6146	USB storage overflow.	There is insufficient available space on the USB memory device.	Insert a USB memory device that has sufficient available space.
-6147	File load error due to illegal header.	The file could not be loaded because it is an invalid file (e.g., measurement mode differs or header part is invalid).	Specify a correct file.
-6148	File load error due to illegal data.	The file could not be loaded because it contains invalid data (e.g., sweep item differs or header part is invalid).	Specify a correct file.
-6149	Failed to save.	Saving the file failed (USB memory device).	Remove the read-only attribute from the file.
-6150	Failed to load.	Loading the file failed (USB memory device).	Load a normal file.
-6151	Failed to delete.	Deleting the file failed (USB memory device).	Remove the read-only attribute from the file.
-6152	Can't load empty memory.	Loading the measurement data failed (attempted to load empty internal memory).	Specify internal memory with data saved.

3.1.3 Measurement Errors

The errors that may occur during measurement are listed below.

Table 3-3 Measurement Errors

No.	Error Message	Description and Cause	Remedy
-3072	Measurement terminated due to measurement points over 20,001.	Sweep measurement was terminated because the number of measurement points exceeded 20,001.	Revise the threshold setting when you wish to perform an automatic high density sweep.
-3078	Calibration is failed. Please check the connection.	Self-calibration failed because the measurement error is large.	Turn the power off and then back on, refer to "1.8.1 Self-calibration," and then perform self-calibration again. If the symptom occurs frequently, this instrument may be malfunctioning. Contact NF Corporation or its authorized agent.
-3079	Measurement terminated due to measurement points over 2,001.	Sweep measurement was terminated because the number of measurement points exceeded 2,001.	Revise the number of measurement points for each step when you wish to perform a sequence measurement.

3.1.4 Other Errors

The errors that may occur irregularly during use of this instrument are listed below.

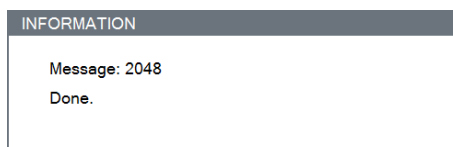
Table 3-4 Other Errors

No.	Error Message	Description and Cause	Remedy
-7168	Measurement state mismatch.	An error was detected in internal communication (measurement section).	If the front panel or touch panel cannot be operated, turn the power off and then back on. If the symptom occurs frequently, this instrument may be malfunctioning. Contact NF Corporation or its authorized agent.
-7169	Measurement section no response.	Internal communication (measurement section) was interrupted.	
-7170	System section no response.	Internal communication (UI section) was interrupted.	
-7171	Remote section no response.	Internal communication (remote interface section) was interrupted.	
-7172	Internal error.	An internal processing error occurred.	

3.2 Information Messages

This section describes the messages that are displayed when, for example, operations or measurements are completed normally.

An example of an information message is shown below. The information message code is the positive number after “Message” in the INFORMATION window. In the example shown below, the information message code is “2048”. Please note that there are information message codes that have the same numbers as error message codes (refer to “3.1 Error Messages”), and differ only in that they are positive numbers.



3.2.1 Startup Messages

The messages that may be displayed when the power is turned on are listed below.

Table 3-5 Startup Messages

No.	Message	Description
1024	Settings have been initialized due to firmware update.	All settings have been initialized as a result of a firmware update.
1025	Last shutdown caused by power failure.	This instrument started up with the settings of setting memory number 1 because last time the power was turned off without entering the standby state.

3.2.2 Operation Messages

The messages that may be displayed during normal operation are listed below.

Table 3-6 Operation Messages

No.	Message	Description
100	Are you sure you want to reset the current LAN settings?	This is a confirmation for executing the LAN reset operation.
101	Interface setting in progress.	Setting of the remote interface is in progress.
2048	Done.	The operation has completed.
2049	Are you sure to change the measurement mode? The current settings are reset.	This is a confirmation for changing the measurement mode.

Table 3-6 Operation Messages (Continued)

No.	Message	Description
3072	Are you sure you want to delete the <meas data>?	This is a confirmation for clearing the measurement data trace or reference data trace.
3073	Are you sure you want to execute the "CALIBRATION"?	This is a confirmation for executing a self-calibration.
4096	Done. <Graph Min Phase> to <Graph Max Phase> Press the Cancel key to exit the execution mode.	Executing a phase shift.
4097	Done. Press the Cancel key to exit the execution mode.	Searching for a marker.
4098	Are you sure you want to change the plots color?	Confirmation of graph trace color change. ([Graph]-[PLOT COLOR]-[GRADATION])
4099	Are you sure you want to reset the plots color?	Confirmation of graph trace color change. ([Graph]-[PLOT COLOR]-[DEFAULT])
6144	Are you sure you want to save the current settings to the <dist>?	This is a confirmation for saving to a setting data file.
6145	Are you sure you want to load the <file> to the current settings?	This is a confirmation for loading a setting data file.
6146	Are you sure you want to delete the <file>?	This is a confirmation for clearing a setting data file.
6147	Are you sure you want to save the measurement data to the <dist>?	This is a confirmation for saving to a measurement data file.
6148	Are you sure you want to load the <file> to the <dist1>?	This is a confirmation for loading a measurement data file.
6149	Are you sure you want to delete the <file>?	This is a confirmation for clearing a measurement data file
6150	<file> already exists. Are you sure you want to replace it?	This is a confirmation for overwriting a file in a USB memory device.
6251	Are you sure you want to save the equivalent circuit to the USB storage?	This is a confirmation for saving to an equivalent circuit data file.

Table 3-6 Operation Messages (Continued)

No.	Message	Description
6152	Are you sure you want to save the PZT constant to the USB storage?	This is a confirmation for saving to a piezoelectric constant file.
6153	Are you sure you want to save the marker value to the USB storage?	This is a confirmation for saving to a marker information file.
6154	Are you sure you want to measure the <dist> data?	Confirm start of correction data measurement.
7168	Are you sure you want to reset the current settings?	This is a confirmation for resetting the settings.
7169	Do you want to execute the "TOUCH ADJUST"?	This is a confirmation for starting touch panel position adjustment.
7170	Are you sure you want to initialize all the current settings?	This is a confirmation for initializing to the factory default state.
7171	USB connected.	A USB memory device has been connected.
7172	USB disconnected.	A USB memory device has been disconnected.
7173	Are you sure you want off the Power?	This is a confirmation for turning off the power (standby).
7174	Do you want to save the LOG FILE for system inspection to the USB storage?	This is a confirmation for outputting a log file.

<dist>: The save destination is indicated as "memory No.X" (where X is a number from 1 to 20) in the case of internal memory of this instrument, and "USB storage" in the case of a USB memory device.

<dist1>: This is indicated as one of "MEAS TRACE," "REF TRACE," "Equalize correction memory," "Open correction memory," "Short correction memory," and "Load correction memory" depending on the save destination.

<file>: The load source is indicated as "memory No.X" (where X is a number from 1 to 20) in the case of internal memory of this instrument, and a file name in the case of a USB memory device.

3.3 Troubleshooting

If you suspect a problem, check the following list for a solution at once. If the problem is not resolved or remains unchanged after applying the suggested remedy, contact us or our agent.

Table 3-7 In Case of Suspected Anomaly

Description	Possible Cause	Remedy
Power cannot be turned on.	Bad power cord connection.	Securely plug in the power cord.
	The power source is out of the rated range.	Use a commercial power supply that is within the rated range.
	External noise or another factor is causing misoperation.	Use this instrument in a location with suitable conditions.
	The internal temperature of this instrument has become high.	Use this instrument in an environment within the operating temperature and humidity ranges (0 to +40 °C and 5 to 85 %RH). If an abnormal temperature is detected, the power supply is automatically shutdown to prevent destruction.
Panel operations are not possible.	Remote control is enabled.	Tap the [LOCAL] button. In the local lock-out state, this operation is disabled. Use the external controller to re-enable local control.
Measurement is not possible (trigger is not applied).	The trigger source setting is not appropriate.	Check the trigger source setting. For example, to start measurement by remote control (USB, RS-232, GPIB, or LAN), set [Measure] – [TRIGGER SOURCE] to REMOTE. The START <input type="button" value="UP"/> , <input type="button" value="SPOT"/> , and <input type="button" value="DOWN"/> keys on the front panel do not work at this time.
This instrument does not operate as described in the instruction manual.	Setting initialization has not be executed.	Many descriptions presume settings have been initialized. Select [Other] – [RESET] and then tap [OK].
	The measurement mode is incorrect.	Refer to “3.5.1 Mode Menu” in Instruction Manual (Basics) and then set the measurement mode correctly.

Table 3-7 In Case of Suspected Anomaly (Continued)

Description	Possible Cause	Remedy
An error occurs during self-calibration.	Measurement accuracy has deteriorated due to the influence of external noise.	Use this instrument in a location with suitable conditions.
	The CALIBRATION BOX (accessory) is not connected.	Connect the CALIBRATION BOX to the H _{CUR} , H _{POT} , and L _{CUR} connectors on the front panel. For details, refer to “1.8.1 Self-Calibration”.

Table 3-7 In Case of Suspected Anomaly (Continued)

Description	Possible Cause	Remedy
There are large variations in measurement values.	The measurement speed is too fast.	Reduce the measurement speed to within the allowable range.
	The signal amplitude is too small.	Increase the signal amplitude.
	Measurement starts before the signal settles.	Make the measurement delay time longer. When the large variations are only immediately after a sweep starts, increase the measurement start delay time. Perform measurement after the contacts with the DUT stabilize and the signal settles.
	There is noise interference.	<Electrostatic induction> When measuring high impedance, sufficiently shield the signal wires from electrostatic induction; in particular, the low side. If the signal wires are exposed, this instrument will be affected by peripheral potential variations. Furthermore, ground the enclosure and peripheral conductors. <Electromagnetic induction> Route the connection cables so that a large loop is not formed.
	Contact with the DUT is unstable.	Clean the contacts.
	Measurement signals become small due to the measurement signal source being damaged or the connection cable being defective.	Display the voltage and current levels and then check the magnitude of the signal. If the DUT is discharged to the measurement connectors, the measurement signal source, voltage detector, and current detector may be damaged. Check the cables for disconnection and shorting between the core wires and outer conductor.

Table 3-7 In Case of Suspected Anomaly (Continued)

Description	Possible Cause	Remedy
Measured values significantly differ from the expected values, measurement is not possible, or correction values cannot be measured.	Abnormal correction values are set.	Try turning off all of the correction functions, including the open, short, load, and port extension correction functions. Check the frequency range for correction. Measure or set the correction values again.
	Measurement conditions are incorrect.	Set the frequency and signal amplitude to the specified values. The measured values may vary significantly with the measurement conditions depending on the DUT.
	Fixed to an inappropriate measurement range.	Switch the range setting to an appropriate measurement range or change the range setting to the auto range setting.
	A cable connected to the DUT or the contacts are defective.	Check the cables for conductivity, shorting between the core wire and outer conductor, and dirt on the connecting points.
	The low side of the DUT is grounded or the DUT is grounded with low impedance (when measuring in the IMPD-3T measurement mode).	In the IMPD-3T measurement mode, do not connect the connectors of the DUT to the ground. The same applies for the measurement of correction values. When measuring a grounded DUT, use this instrument in the IMPD-2T or IMPD-EXT measurement mode.
	There is noise interference. Exposed signal wires (in particular, the low side) and a part with extreme potential variations are near each other.	When measuring high impedance, such as in open correction, shield the signal wires from electrostatic induction or perform the measurement away from noise sources. Ground the enclosure and peripheral conductors. If the signal amplitude is small or the frequency is high, there is likely to be interference.

Table 3-7 In Case of Suspected Anomaly (Continued)

Description	Possible Cause	Remedy
Measurement is slow.	A long measurement time is set.	Reduce the measurement time so that the variations in measurement results are within the allowable range. However, a time less than the time equivalent to one 1 cycle of the measurement frequency is not possible.
	A long delay time is set.	Check the measurement delay time and measurement start delay time, and set them to the minimum necessary values.
	The measurement range is set to auto range. The measurement range is switched frequently due to noise or a contact failure.	When measuring a large number of DUTs with almost the same value using spot measurement, set the range setting to a fixed range.
	ALC is operating. Measurement variations are large and many measurements are performed before the signal amplitude settles.	Revise the ALC settings (increase the [TOLERANCE] value and reduce the [RETRY TIMES] value). Set ALC to OFF if it is not necessary.
	An automatic high density sweep is operating.	Revise the automatic high density sweep setting (increase the [VARIATION] value). Set automatic high density sweep to OFF if it is not necessary.
	The internal temperature of this instrument has become high.	Use this instrument in an environment within the operating temperature and humidity ranges (0 to +40 °C and 5 to 85 %RH). If an abnormal temperature is detected, this instrument operates with the operation clock value automatically decreased to reduce self-heating. Therefore, measurement becomes slow.

(Blank)

4. Maintenance

4.1	Preface.....	4-2
4.2	Daily Maintenance.....	4-3
4.3	Storage, Repacking, and Transportation	4-3
4.4	Checking the Version Number.....	4-4
4.5	Performance Test	4-5
4.5.1	Outline.....	4-5
4.5.2	Measurement Signal Frequency Accuracy	4-7
4.5.3	Measurement Signal Amplitude Accuracy	4-8
4.5.4	Measurement Signal Amplitude Frequency Characteristic.....	4-9
4.5.5	DC Bias Voltage Accuracy (H_{CUR} , Normal DC Bias)	4-11
4.5.6	DC Bias Voltage Accuracy (H_{CUR} , HV DC Bias).....	4-12
4.5.7	DC Bias Voltage Accuracy (PORT3, Normal DC Bias) .	4-13
4.5.8	DC Bias Voltage Accuracy (PORT3, HV DC Bias)	4-14
4.5.9	DC Bias Voltage Accuracy (DC BIAS, Normal DC Bias)	4-15
4.5.10	Impedance Measurement Accuracy (Measurement Mode IMPD-3T).....	4-16
4.5.11	Impedance Measurement Accuracy (Measurement Mode IMPD-2T).....	4-20
4.5.12	Gain and Phase Measurement Accuracy (Measurement Mode G-PH)	4-23
4.5.13	Analysis Section Dynamic Range (Measurement Mode G-PH)	4-24
4.6	Calibration.....	4-25

4.1 Preface

This chapter describes the following topics.

- Precautions and storage method when the product is not used for a long period of time.
- Precautions for repacking and transportation when the product is transported.
- Performance test necessary when, for example, performing preventive maintenance and verifying performance during acceptance inspection and after repair.

For the basic operation checks, refer to “2.4 Simple Operation Check” in Instruction Manual (Basics).

This manual describes basic operation checking and performance testing procedures.

For advanced inspection, adjustment, calibration, or failure repair, contact NF Corporation or its authorized agent.



There are high voltage parts inside this instrument. Never remove the 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.

4.2 Daily Maintenance

Install this instrument in a location that satisfies the installation conditions.

For details on the installation conditions, refer to “2.2.2 Installation Conditions” in Instruction Manual (Basics).

The front panel of this instrument is made of plastic. Avoid damage from contact with sharp or hot objects.

When the panel or case needs cleaning, wipe with a soft cloth. To remove persistent contamination, wipe with a soft cloth soaked with neutral detergent and wrung out. Never use any organic solvents like thinner or benzene or a chemical cleaning cloth, as they may cause the surface finish to deteriorate or peel off.

When the surface of the LCD touch panel becomes dirty, wipe it with absorbent cotton or a soft cloth. Avoid using detergents, organic solvents, etc., as they may cause deterioration or tarnishing.

4.3 Storage, Repacking, and Transportation

• Storage when not used for a long period of time

- Disconnect the power cord from the outlet and this instrument.
- Store the product in a location free from falling objects and dust, such as a shelf or rack.

If dust may be present, cover the product with a cloth or polyethylene cover.

- The environmental conditions for storage are $-10\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$ and 5 % to 95 %RH. However, avoid a location where the temperature fluctuates significantly or where the product will be exposed to direct sunlight, and store the product in an environment as close to room temperature as possible.

• Repacking and transportation

When repacking the product to transport or send it for repairs, pay attention to the following instructions.

- If this instrument has moving parts, fix them in place.
- Wrap this instrument in a polyethylene bag or sheet.
- Prepare a carton box that can well withstand the weight of this instrument and is of a large enough size to accommodate it.
- Fill the carton box with a cushioning material so that the top, bottom, and four sides of the main unit can be protected.
- When making a request for transportation, inform the transport operator that the product is a precision instrument.

4.4 Checking the Version Number

Instruments of the same model may have different versions due to functional improvements and fault repairs. Behavior can differ according to version, so if an anomaly is detected, provide us with the version information along with the symptoms.

Our website provides guidance for updating the firmware.

After startup, the version information can be confirmed by the following procedure.

Open [Other]—[SYSTEM] and then check the firmware version. The number below “VERSION” is the version.



4.5 Performance Test

4.5.1 Outline

A performance test is performed as part of preventative maintenance to prevent performance deterioration of this instrument.

A performance test is conducted when necessary to verify performance during acceptance inspection, periodic inspection and after repair.

The simple performance test described here is performed using commercially available standards and measurement instruments.

For advanced testing, ask NF Corporation or its authorized agent. We conduct tests for a fee.

If the specifications are not satisfied after a performance test, calibration or repair is required.

Contact NF Corporation or its authorized agent.

1) Test environment confirmation

Conduct performance testing in the following environment.

- Ambient temperature 23 ±5 °C
- Ambient humidity 20 to 70 %RH, non-condensing
- Power outlet voltage AC100 to 230 V ±10 % however 250 V or less
- Warm-up time At least 30 minutes

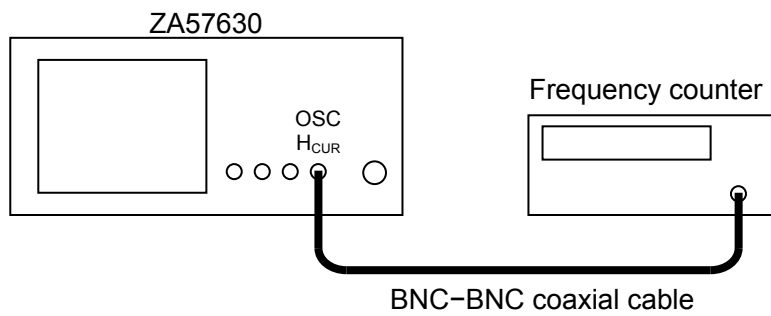
2) Test preparation

Before conducting a performance test, reset the settings. Reset the settings in [Other]—[RESET]. For details, refer to “■ Resetting settings” of “4.2.1 Common Operations” in Instruction Manual (Basics).

4.5.2 Measurement Signal Frequency Accuracy

Before performing each of the following measurements, reset the settings of this instrument.

- Instrument settings : Set the measurement mode to IMPD-EXT, measurement signal frequency to 1.0 MHz, and AC amplitude to 1.0 Vrms.
- Measurement instrument settings : Use a frequency counter. Set the gate time to 10 seconds.
- Connections : Connect OSC / H_{CUR} of this instrument to the frequency counter with a coaxial cable.
- Measurement method : Read the measured value on the frequency counter.



Comparison

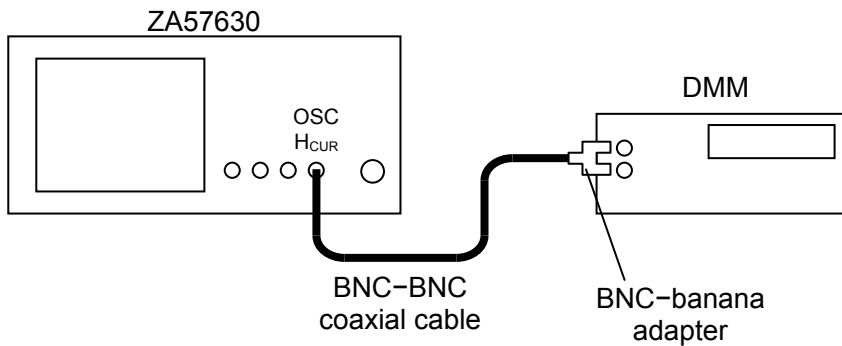
Pass range: 0.999990 MHz to 1.000010 MHz

Measured value: _ . _ _ _ _ _ MHz

4.5.3 Measurement Signal Amplitude Accuracy

- Instrument settings : Set the measurement mode to IMPD-EXT and the frequency to 1 kHz.
- Measurement instrument settings : Set the digital multimeter to the AC voltage mode (true rms).
- Connections : Connect OSC / H_{CUR} of this instrument to the digital multimeter with a coaxial cable.
- Measurement method : Set the AC amplitude of this instrument to 70 mV_{rms}, 1 V_{rms}, and 3 V_{rms} and read the AC voltage with the digital multimeter.
- Calculate the amplitude accuracy with the following formula from the read AC voltage values.

$$\text{Amplitude accuracy (dB)} = 20 \times \log_{10} \frac{\text{AC voltage measurement value } V_{\text{rms}}}{\text{Measurement signal amplitude setting } V_{\text{rms}}}$$



Comparison

Measurement signal amplitude setting	AC voltage measurement value	Amplitude accuracy	Pass range
70 mV _{rms}	__ . __ mV _{rms}	__ . __ dB	-0.30 to +0.30 dB
1 V _{rms}	__ . __ V _{rms}	__ . __ dB	-0.30 to +0.30 dB
3 V _{rms}	__ . __ V _{rms}	__ . __ dB	-0.30 to +0.30 dB

4.5.4 Measurement Signal Amplitude Frequency Characteristic

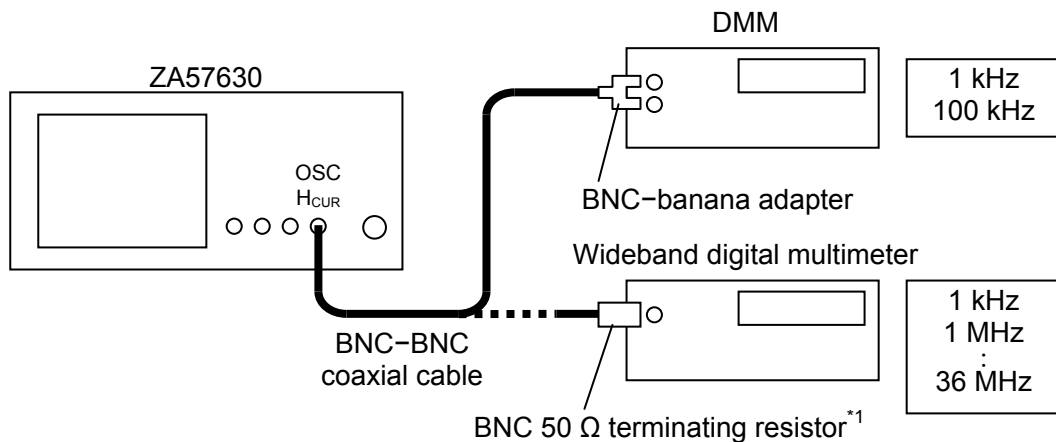
- Instrument settings : Set the measurement mode to IMPD-EXT, frequency to 1 kHz, and AC amplitude to 70 mVrms.
- Measurement instrument settings : Set the digital multimeter and wideband digital multimeter to the AC voltage mode (true rms).
- Connections : Connect OSC / H_{CUR} of this instrument to the digital multimeter with a coaxial cable via a BNC 50 Ω terminating resistor.
- Measurement method : Set the frequency of this instrument to 1 kHz, 100 kHz, 1 MHz, 15 MHz, 30 MHz, and 36 MHz. Read the AC voltage values with the digital multimeter for 100 kHz or less and with the wideband digital multimeter for 1 kHz and 1 MHz or more.

Calculate the amplitude frequency characteristic with the formula below from the read AC voltage values using the AC voltage measurement value at 1 kHz of each of the digital multimeter and wideband digital multimeter as the reference.

AC amplitude frequency characteristic (dB)

$$= 20 \times \log_{10} \frac{\text{AC voltage measurement value at each frequency } V_{\text{rms}}}{\text{AC voltage measurement value at 1 kHz } V_{\text{rms}}}$$

Set the AC amplitude to 1 Vrms and 10 Vrms and calculate the frequency amplitude characteristic using the AC voltage measurement value at 1 kHz as the reference in the same way.



*1 A 50 Ω terminating resistor is not necessary if the input impedance of the wideband digital multimeter is 50 Ω.

Comparison

(Digital multimeter)

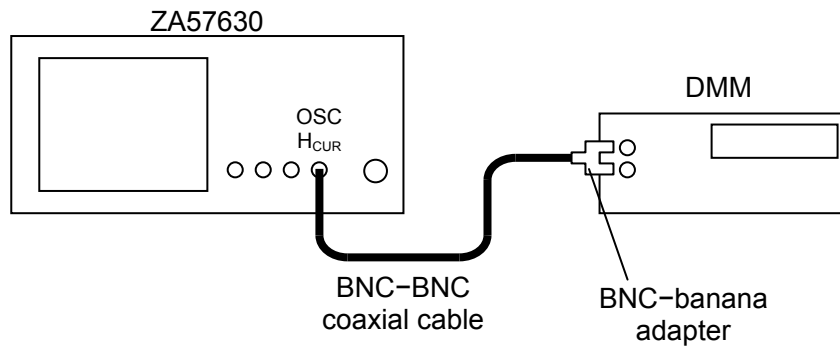
Measurement signal amplitude setting	Frequency setting	AC voltage measurement value	AC amplitude frequency characteristic	Pass range
70 mVrms	1 kHz	___. __ mVrms	0.00 dB	(Reference)
	100 kHz	___. __ mVrms	___. __ dB	-0.30 to +0.30 dB
1 Vrms	1 kHz	_. ____ Vrms	0.00 dB	(Reference)
	100 kHz	_. ____ Vrms	___. __ dB	-0.30 to +0.30 dB
3 Vrms	1 kHz	___. __ Vrms	0.00 dB	(Reference)
	100 kHz	___. __ Vrms	___. __ dB	-0.30 to +0.30 dB

(Wideband digital multimeter)

Measurement signal amplitude setting	Frequency setting	AC voltage measurement value	AC amplitude frequency characteristic	Pass range
70 mVrms	1 kHz	___. __ mVrms	0.00 dB	(Reference)
	1 MHz	___. __ mVrms	___. __ dB	-0.5 to +0.5 dB
	15 MHz	___. __ mVrms	___. __ dB	-1.0 to +1.0 dB
	30 MHz	___. __ mVrms	___. __ dB	-3.0 to +3.0 dB
	36 MHz	___. __ mVrms	___. __ dB	-4.0 to +4.0 dB
1 Vrms	1 kHz	_. ____ Vrms	0.00 dB	(Reference)
	1 MHz	_. ____ Vrms	___. __ dB	-0.5 to +0.5 dB
	15 MHz	_. ____ Vrms	___. __ dB	-1.0 to +1.0 dB
	30 MHz	_. ____ Vrms	___. __ dB	-3.0 to +3.0 dB
	36 MHz	_. ____ Vrms	___. __ dB	-4.0 to +4.0 dB
3 Vrms	1 kHz	___. __ Vrms	0.00 dB	(Reference)
	1 MHz	___. __ Vrms	___. __ dB	-0.5 to +0.5 dB
	15 MHz	___. __ Vrms	___. __ dB	-1.0 to +1.0 dB
	30 MHz	___. __ Vrms	___. __ dB	-3.0 to +3.0 dB
	36 MHz	___. __ Vrms	___. __ dB	-4.0 to +4.0 dB

4.5.6 DC Bias Voltage Accuracy (H_{CUR} , HV DC Bias)

- Instrument settings : Set the measurement mode to IMPD-3T, AC amplitude to 0 Vrms, and HV bias to ON.
- Measurement instrument settings : Set the digital multimeter to DC voltage mode.
- Connections : Connect OSC / H_{CUR} of this instrument to the digital multimeter with a coaxial cable.
- Measurement method : Set the DC bias of this instrument to -40.0 V, 0.0 V, and +40.0 V and read the DC voltage with the digital multimeter.

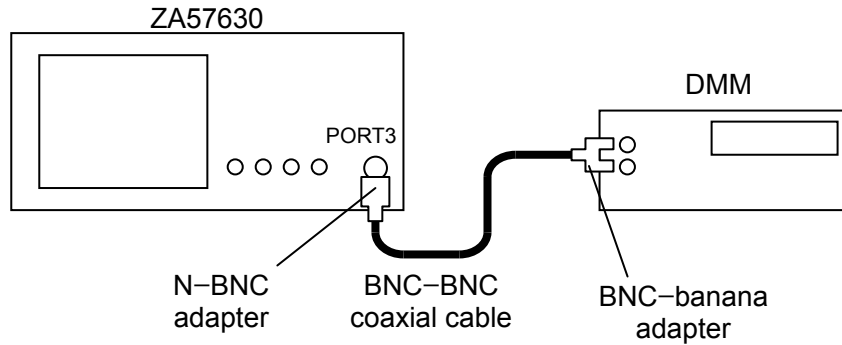


Comparison

DC bias setting	DC voltage value	Pass range
-40.0 V	- _ _ . _ _ _ V	-40.430 to -39.570 V
0.0 V	_ _ _ . _ mV	-30.0 to +30.0 mV
+40.0 V	+ _ _ . _ _ _ V	+39.570 to +40.430 V

4.5.7 DC Bias Voltage Accuracy (PORT3, Normal DC Bias)

- Instrument settings : Set the measurement mode to IMPD-2T and AC amplitude to 0 Vrms.
- Measurement instrument settings : Set the digital multimeter to DC voltage mode.
- Connections : Connect PORT3 of this instrument to the digital multimeter with a coaxial cable.
- Measurement method : Set the DC bias of this instrument to -5.0 V, 0.0 V, and +5.0 V and read the DC voltage with the digital multimeter.

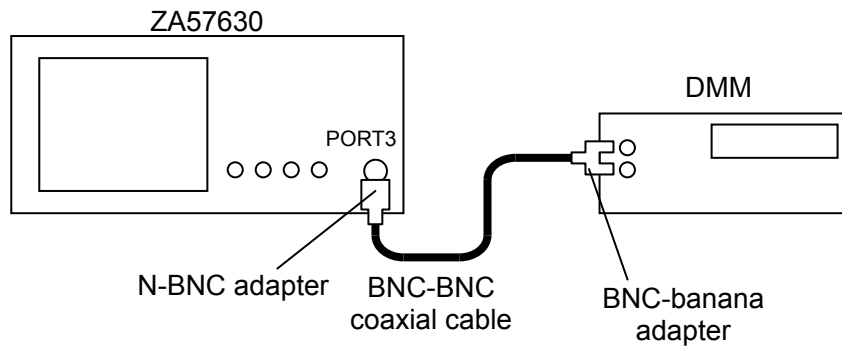


Comparison

DC bias setting	DC voltage value	Pass range
-5.0 V	- V	-5.080 to -4.920 V
0.0 V mV	-30.0 to +30.0 mV
+5.0 V	+ V	+4.920 to +5.080 V

4.5.8 DC Bias Voltage Accuracy (PORT3, HV DC Bias)

- Instrument settings : Set the measurement mode to IMPD-2T, AC amplitude to 0 Vrms, and HV bias to ON.
- Measurement instrument settings : Set the digital multimeter to DC voltage mode.
- Connections : Connect PORT3 of this instrument to the digital multimeter with a coaxial cable.
- Measurement method : Set the DC bias of this instrument to -40.0 V, 0.0 V, and +40.0 V and read the DC voltage with the digital multimeter.

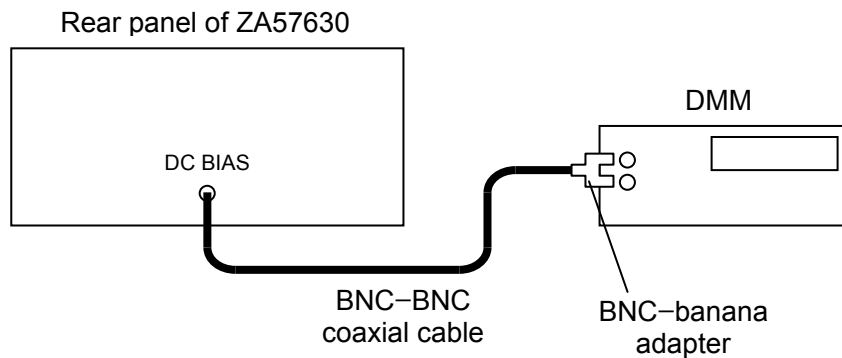


Comparison

DC bias setting	DC voltage value	Pass range
-40.0 V	- _ . _ _ V	-40.430 to -39.570 V
0.0 V	_ . _ mV	-30.0 to +30.0 mV
+40.0 V	+ _ . _ _ V	+39.570 to +40.430 V

4.5.9 DC Bias Voltage Accuracy (DC BIAS, Normal DC Bias)

- Instrument settings : Set the measurement mode to IMPD-EXT, AC amplitude to 0 Vrms, and DC bias output to DC BIAS on the rear panel.
- Measurement instrument settings : Set the digital multimeter to DC voltage mode.
- Connections : Connect DC BIAS of this instrument to the digital multimeter with a coaxial cable.
- Measurement method : Set the DC bias of this instrument to -5.0 V, 0.0 V, and +5.0 V and read the DC voltage with the digital multimeter.



Comparison

DC bias setting	DC voltage value	Pass range
-5.0 V	- _ . _ _ _ V	-5.080 to -4.920 V
0.0 V	_ _ _ . _ mV	-30.0 to +30.0 mV
+5.0 V	+ _ . _ _ _ V	+4.920 to +5.080 V

4.5.10 Impedance Measurement Accuracy (Measurement Mode IMPD-3T)

This section describes a simple check method. For an accurate test, ask NF Corporation to perform the test.

Standard: To perform an accurate test, prepare a standard that has an accuracy of approximately 1/3 or less in respect to the accuracy of this instrument.

If a standard is not available, prepare a stable standard DUT that has been calibrated with an accurate measuring instrument. Perform the test in accordance with the accuracy and stability of the prepared standard.

A pseudo-capacity standard using a transformer cannot be used with this instrument.

Reference: If the frequency characteristics are good (within the range of around 10 Ω to 100 kΩ), you can even use a resistor whose impedance calibration value is not provided at each frequency to perform a simple test using the following calculation formula.

- Calibration value R_{DC} of DC resistance
- Equivalent series inductance L_S [H] at 1 MHz or equivalent parallel capacitance C_P [F]

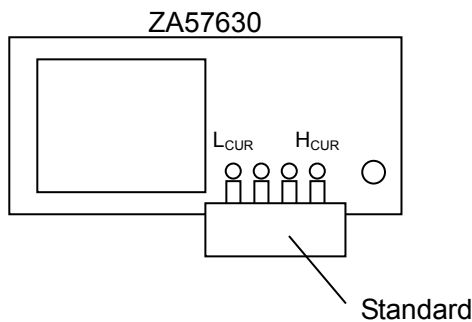
$$\text{Complex impedance } \dot{Z} = R_{DC} + j \omega L_S \text{ or } \dot{Z} = \frac{R_{DC} - j \omega C_P (R_{DC})^2}{1 + (\omega C_P R_{DC})^2}$$

$$|\dot{Z}| = \sqrt{R_{DC}^2 + (\omega L_S)^2} \quad \text{or} \quad |\dot{Z}| = \frac{R_{DC}}{\sqrt{1 + (\omega C_P R_{DC})^2}}$$

$$\theta(=\angle \dot{Z}) = \tan^{-1}\left(\frac{\omega L_S}{R_{DC}}\right) \quad \text{or} \quad \theta = -\tan^{-1}(\omega C_P R_{DC})$$

Here, angular frequency $\omega = 2\pi f$ and f is the measurement frequency [Hz].

- Instrument settings : Set the measurement mode to IMPD-3T, AC amplitude to 1 Vrms, and measurement speed to 0.2 s.
- Connections : Connect the standard to H_{CUR} / H_{POT} / L_{POT} / L_{CUR} of this instrument.
- Measurement method : Perform open correction and short correction. Then, measure the standard in accordance with the table below.



Comparison : The measurement value is normal if it is within the following range.
 Calibration value of standard \pm (calibration accuracy of standard + accuracy specifications of ZA57630)

The specification values in the following table are calculated considering the calibration values of the standard as being equal to the nominal values, and are rounded to 2 significant digits. Insufficient calibration accuracy of standard may allow the difference to get out of range of the specification.

Measurement frequency 1 kHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 M Ω	1 M Ω	Z M Ω	Z M Ω	Z %	Z \pm 1.5 %
		θ °	θ °	θ °	θ \pm 0.87 °
100 k Ω	100 k Ω	Z k Ω	Z k Ω	Z %	Z \pm 0.30 %
		θ °	θ °	θ °	θ \pm 0.17 °
10 k Ω	10 k Ω	Z k Ω	Z k Ω	Z %	Z \pm 0.15 %
		θ °	θ °	θ °	θ \pm 0.086 °
1 k Ω	1 k Ω	Z k Ω	Z k Ω	Z %	Z \pm 0.10 %
		θ °	θ °	θ °	θ \pm 0.058 °
100 Ω	100 Ω	Z Ω	Z Ω	Z %	Z \pm 0.15 %
		θ °	θ °	θ °	θ \pm 0.086 °
10 Ω	10 Ω	Z Ω	Z Ω	Z %	Z \pm 0.50 %
		θ °	θ °	θ °	θ \pm 0.29 °

4.5 Performance Test

Measurement frequency 10 kHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 MΩ	1 MΩ	Z _____ MΩ	Z _____ MΩ	Z _____ %	Z ± 0.81 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.46 °
100 kΩ	100 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.25 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.14 °
10 kΩ	10 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.14 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.080 °
1 kΩ	1 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.092 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.053 °
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.080 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.046 °
10 Ω	10 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.50 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.29 °

Measurement frequency 1 MHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
10 kΩ	10 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.20 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.12 °
1 kΩ	1 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.15 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.087 °
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.17 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.097 °
10 Ω	10 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.60 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.34 °

Measurement frequency 10 MHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.50 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.29 °

4.5 Performance Test

Measurement frequency 1 kHz, signal amplitude 0.1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 kΩ	1 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.26 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.15 °
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.27 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.15 °

Measurement frequency 1 MHz, signal amplitude 0.1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 kΩ	1 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.68 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.39 °
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.68 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.39 °

Measurement frequency 1 kHz, signal amplitude 3 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 kΩ	1 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.36 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.20 °
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.60 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.34 °

Measurement frequency 1 MHz, signal amplitude 3 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 kΩ	1 kΩ	Z _____ kΩ	Z _____ kΩ	Z _____ %	Z ± 0.61 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.35 °
100 Ω	100 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.68 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.39 °

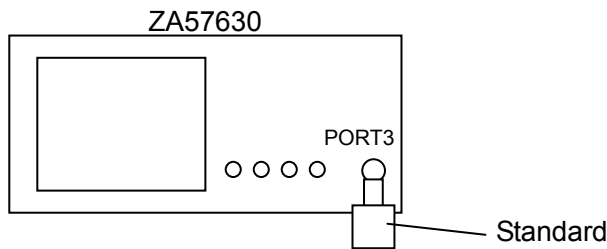
4.5.11 Impedance Measurement Accuracy (Measurement Mode IMPD-2T)

This section describes a simple check method. For an accurate test, ask NF Corporation to perform the test.

Standard: To perform an accurate test, prepare a standard that has an accuracy of approximately 1/3 or less in respect to the accuracy of this instrument.

If a standard is not available, prepare a stable standard DUT that has been calibrated with an accurate measuring instrument. Perform the test in accordance with the accuracy and stability of the prepared standard.

- Instrument settings : Set the measurement mode to IMPD-2T, AC amplitude to 1 Vrms, and measurement speed to 0.2 s.
- Connections : Connect the standard to PORT3 of this instrument.
- Measurement method : Perform open correction and short correction. Then, measure the standard.



- Comparison : The measurement value is normal if it is within the following range.
Calibration value of standard ± (calibration accuracy of standard + accuracy specifications of ZA57630)

The specification values in the following table are calculated considering the calibration values of the standard as being equal to the nominal values, and are rounded to 2 significant digits. Insufficient calibration accuracy of standard may allow the difference to get out of range of the specification.

Measurement frequency 10 kHz, signal amplitude 1 Vrms

Measure- ment range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference	Specification
				$100 \times (B-A)/A$ B-A	
1 kΩ	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.34 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.19 °
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z ± 0.34 %
		θ _____ °	θ _____ °	θ _____ °	θ ± 0.20 °

The specifications when the measurement range is 1 kΩ is a supplemental value because it is out of the recommended range.

4.5 Performance Test

Measurement frequency 1 MHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification
				B-A	
1 k Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 0.38 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	θ \pm 0.22 $^\circ$
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 0.36 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	θ \pm 0.21 $^\circ$

The specifications when the measurement range is 1 k Ω is a supplemental value because it is out of the recommended range.

Measurement frequency 10 MHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification
				B-A	
1 k Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 1.5 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	θ \pm 0.85 $^\circ$
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 1.6 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	θ \pm 0.91 $^\circ$

The specifications when the measurement range is 1 k Ω is a supplemental value because it is out of the recommended range.

Measurement frequency 30 MHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification
				B-A	
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 4.5 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	θ \pm 2.6 $^\circ$

Measurement frequency 36 MHz, signal amplitude 1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification (supplementary value)
				B-A	
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 4.6 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	θ \pm 2.7 $^\circ$

4.5 Performance Test

Measurement frequency 10 kHz, signal amplitude 0.1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification (supplementary value)
				B-A	
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 0.44 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	$\theta \pm 0.25^\circ$

Measurement frequency 1 MHz, signal amplitude 0.1 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification (supplementary value)
				B-A	
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 0.58 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	$\theta \pm 0.33^\circ$

Measurement frequency 10 kHz, signal amplitude 3 Vrms

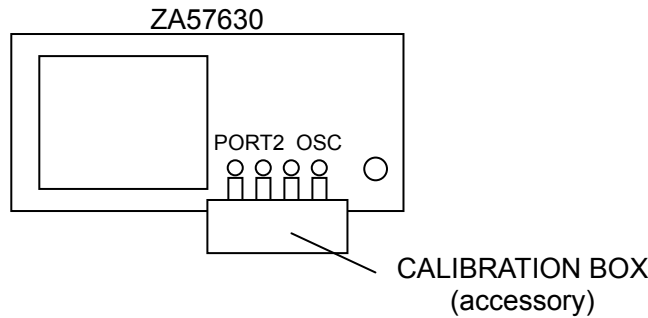
Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification (supplementary value)
				B-A	
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 0.75 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	$\theta \pm 0.43^\circ$

Measurement frequency 1 MHz, signal amplitude 3 Vrms

Measurement range	Standard (nominal value)	Calibration value of standard A	Measured value B	Difference $100 \times (B-A)/A$	Specification (supplementary value)
				B-A	
100 Ω	50 Ω	Z _____ Ω	Z _____ Ω	Z _____ %	Z \pm 0.79 %
		θ _____ $^\circ$	θ _____ $^\circ$	θ _____ $^\circ$	$\theta \pm 0.46^\circ$

4.5.12 Gain and Phase Measurement Accuracy (Measurement Mode G-PH)

- Instrument settings : Set the measurement mode to G-PH, AC amplitude to 1 Vrms, measurement range fixed to 1 Vrms for both PORT1 and PORT2, frequency sweep range to 100 Hz to 36 MHz, and measurement speed to 100 ms.
- Measuring instrument connections: (None)
- Connections : Connect the included CALIBRATION BOX to OSC / PORT1 / PORT2.
- Measurement method : Perform a frequency up-sweep and then read each of the maximum and minimum values at 1 MHz or less, 10 MHz or less, and 36 MHz or less of the measurement values (gain dB and phase °) displayed on the LCD screen.

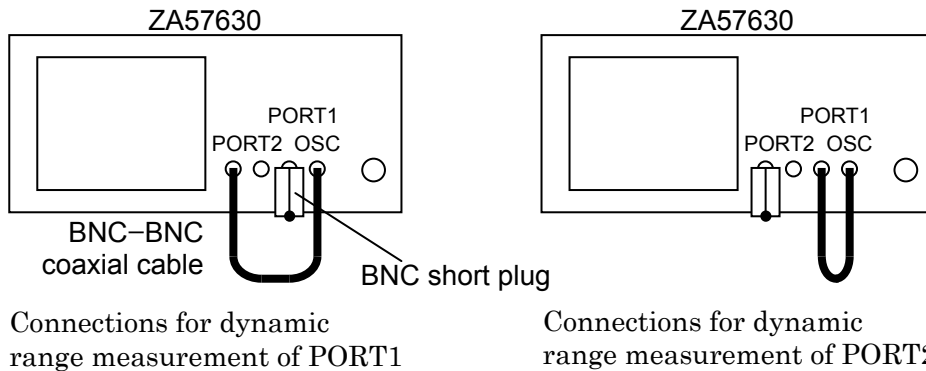


Comparison

Frequency range	Measured value	Pass range
100 Hz < f ≤ 1 MHz	(Minimum) __. ___ to (maximum) __. ___ dB (Minimum) __. ___ to (maximum) __. ___ °	-0.01 to +0.01 dB -0.06 to +0.06°
1 MHz < f ≤ 10 MHz	(Minimum) __. ___ to (maximum) __. ___ dB (Minimum) __. ___ to (maximum) __. ___ °	-0.03 to +0.03 dB -0.18 to +0.18°
10 MHz < f ≤ 36 MHz	(Minimum) __. ___ to (maximum) __. ___ dB (Minimum) __. ___ to (maximum) __. ___ °	-0.1 to +0.1 dB -0.6 to 6°

4.5.13 Analysis Section Dynamic Range (Measurement Mode G-PH)

- Instrument settings : Set the measurement mode to G-PH, AC amplitude to 3 Vrms, frequency sweep range to 10 Hz to 36 MHz, and measurement speed to 40.0 s.
- Measuring instrument connections: (None)
- Connections : Connect the BNC short plug to PORT1. Connect OSC to PORT2.
- Measurement method : Perform frequency up-sweep measurement with this instrument and then read the gain maximum values for the ranges of 10 Hz to less than 1 MHz, 1 MHz to less than 10 MHz, and 10 MHz to 36 MHz from the graph on the LCD, and record the values with the polarity reversed.
- When measurement is finished, change the connections to those for PORT2 dynamic range measurement. Perform frequency up-sweep measurement and read and record the gain minimum value at each frequency range from the LCD screen.



Comparison

Connection	Frequency range	– (Maximum measured value)	Pass range*1
PORT1 Dynamic range	10 Hz $\leq f < 1$ MHz	____. _ dB	110 dB or higher
	1 MHz $\leq f < 10$ MHz	____. _ dB	60 dB or higher
	10 MHz $\leq f \leq 36$ MHz	____. _ dB	50 dB or higher

Connection	Frequency range	Minimum measured value	Pass range*1
PORT2 Dynamic range	10 Hz $\leq f < 1$ MHz	____. _ dB	110 dB or higher
	1 MHz $\leq f < 10$ MHz	____. _ dB	60 dB or higher
	10 MHz $\leq f \leq 36$ MHz	____. _ dB	50 dB or higher

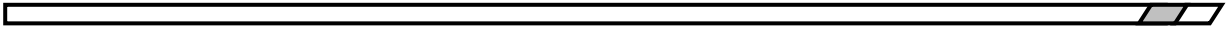
*1: This value may not be satisfied due to the effects of electromagnetic noise in the environment or other such factors, but determine the test to be a pass if most of the data resulting from sweep measurement satisfies this value.

4.6 Calibration

If the performance test results do not satisfy the specifications, NF Corporation will perform adjustment or calibration to restore the original performance.

If calibration is required, contact NF Corporation or its authorized agent.

After warranty expiration, we provide adjustment and calibration for a fee.



(Blank)

WABUN: (DA00070168-001)

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.

Copyright 2019. **NF Corporation**

ZA57630 INSTRUCTION MANUAL (ADVANCED)

NF Corporation

6-3-20, Tsunashima Higashi, Kohoku-ku, Yokohama

223-8508 JAPAN

Phone +81-45-545-8128 Fax +81-45-545-8187



<http://www.nfcorp.co.jp/>

NF Corporation

6-3-20, Tsunashima Higashi, Kohoku-ku, Yokohama 223-8508 JAPAN

Aufgrund laufender Weiterentwicklungen sind Änderungen der Spezifikationen vorbehalten. Alle Angaben vorbehaltlich Satz- und Druckfehler.

nbn Austria GmbH

Riesstraße 146, 8010 Graz

Tel. +43 316 40 28 05 | Fax +43 316 40 25 06

nbn

nbn@nbn.at | www.nbn.at