COSINUS MESSTECHNIK GMBH

Impedance Analyzer

ZA57630

Basic accuracy ±0.08 %

Measurement frequency 10 µHz to 36 MHz

For a broad range of impedance measurement requirements, from electronic parts and semi-conductor devices to material and substance characteristics assessments.

For Various DUT

The industry standard from today

True Value

Measuring true characteristics.

Electronic parts, semi-conductor devices, materials, batteries, and so much more.
Taking measurements under actual usage conditions.

NF Impedance Analyzer ZA57630

Basic accuracy

±0.08 %

Measurement Impedance range

10 μΩ to 100 GΩ (Mode: IMPD-EXT)

DC bias

−5 V to +5 V/−40 V to +40 V (more than 1kHz)
−100 mA to +100 mA

Measurement frequency

10 μHz to 36 MHz

Measurement signal amplitude

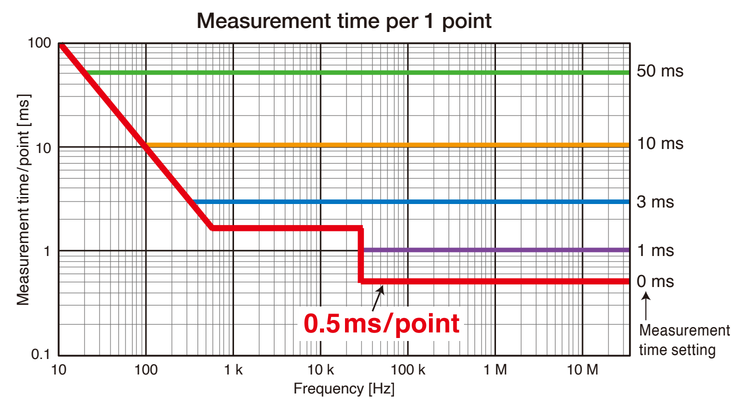
0.01 mVrms to 3 Vrms
0.1 μArms to 60 mArms

Measurement time

0.5 ms/point

Measurement parameter

Z, R, X, Y, G, B, Ls, Lp, Cs, Cp, Rs, Rp, θz, θy, D, Dε, Dμ,
Q, V, I, εs, εs´, εs´´, μs, μs´, μs´´, FREQUENCY



High speed measurement

Industry fastest 0.5 ms/point

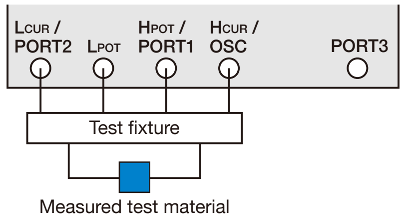
The fastest in the industry at 0.5 ms/point.
Reduce takt time. In addition, by increasing the measurement time to be set, the measurement results are averaged and the influence of noise is reduced. The optimum measurement time can be selected as required.

Four measurement modes

Able to handle a broad range of DUTs

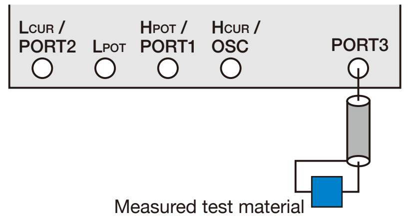
● **IMPD-3T** (Default measurement mode)

This mode provides high-accuracy measurements across a broad range of frequencies. Test leads and test fixtures can be used to suit test materials with a variety of different shapes.



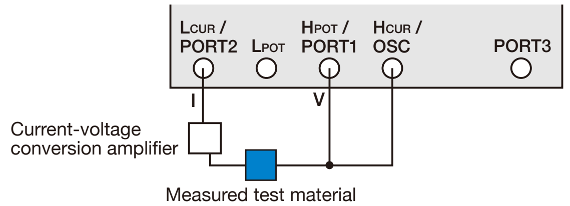
● **IMPD-2T** (High-frequency measurement mode)

This mode allows more stable measurements at high-frequency of 10 MHz or more. 2-terminal measurements using N connectors allows stable measurements even when using long cables.



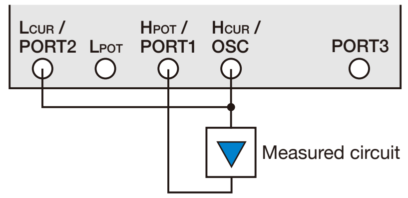
● **IMPD-EXT** (Expanded measurement mode)

Allows external amplifiers, shunt resistors or other devices to be connected. Allows measurements outside of the unit's specifications, like applying high voltages or detecting small voltages/currents.



● **G-PH** (Gain/phase measurement mode)

This mode provides measurements of transmission characteristics of devices like filters and amplifiers. Accurately measures the frequency response (gain, phase) when applying a sweep signal to the measured circuit.



Front panel Measurement connectors

A diverse array of functions to suit any application!

Accurate assessments conducted under actual usage conditions.

Electronic parts and materials may indicate varying characteristics at different measurement frequencies or when different signal levels are applied. To assess true characteristics, it is important to take measurements under actual operating conditions by sweeping the frequency, AC amplitude and DC bias.

SWEEP

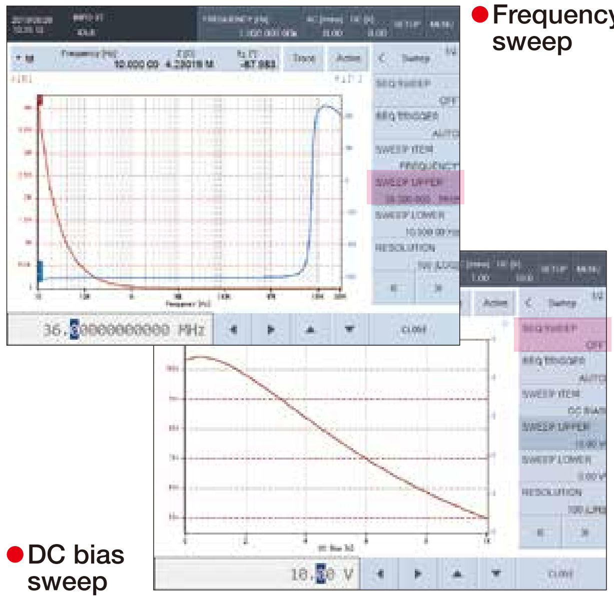
Frequency, AC amplitude, DC bias, zero span

● AC amplitude sweep

Sweep items

- ●FREQUENCY
- ●AC AMPLITUDE
- ●DC BIAS
- ●ZERO-SPAN

● Frequency sweep



● DC bias sweep

● Zero span

Takes measurements under fixed conditions without changing frequency, AC amplitude or DC bias parameters, to observe the change in characteristics over time (horizontal axis: time)

Also capable of spot measurements

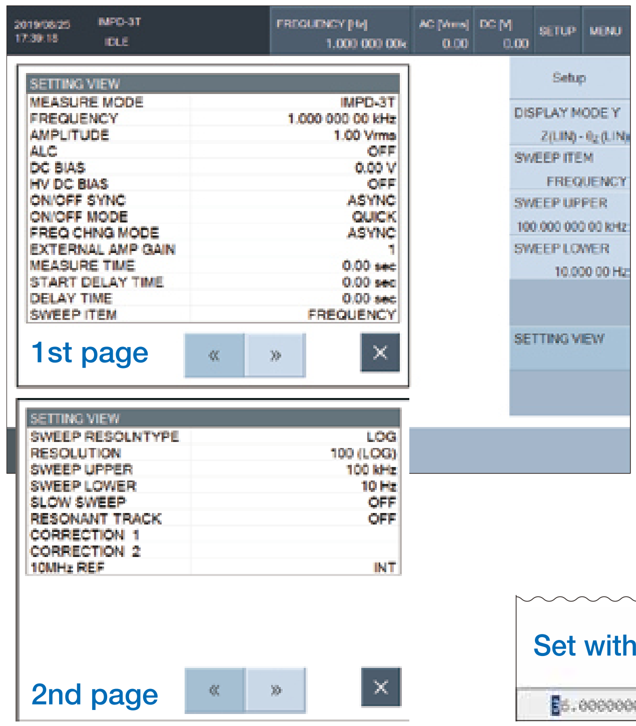
Measures a fixed frequency, AC amplitude and DC bias, and displays the results as numerical values. Up to 6 items can be configured.

For measurements on production lines

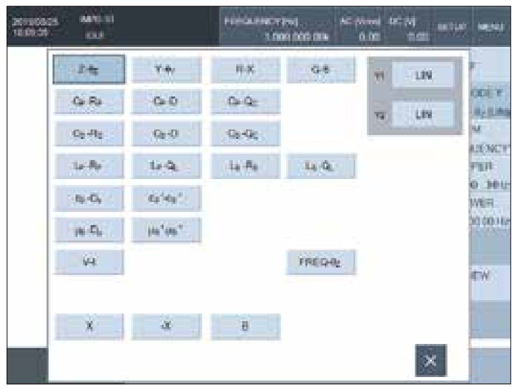
SETTING MEASUREMENT AND OTHER CONDITIONS

Settings intuitively on a single screen

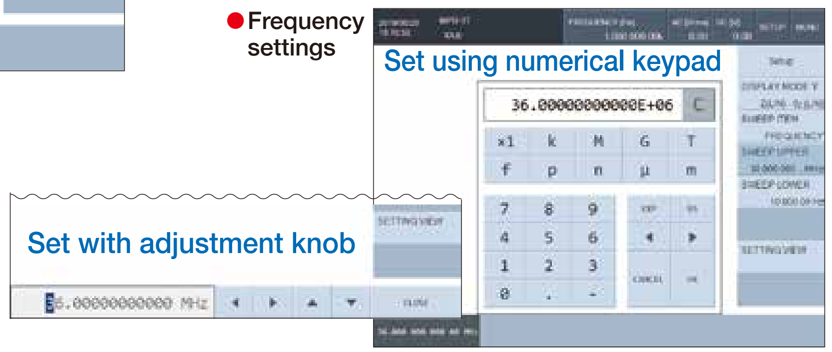
● Setting items (SETTING VIEW)



● Graph axis setting



● Frequency settings



Highly repeatable and accurate measurements.

MEASUREMENT RANGE

● **Auto range**

Takes measurements by setting the optimal measurement range automatically while monitoring measurement results. This is effective when there are significant changes in measurement data.

● **Fixed range**

The measurement range is fixed, which prevents discontinuity (steps) in the measured value caused by changes in the range.

MEASUREMENT DELAY FUNCTION

If sweep parameters such as frequency or AC amplitude are changed while sweep is in progress, incorrect measurement results can be generated due to transient response.

The time until measurements start after parameters are changed can be delayed.

Two delay types are available: “Measurement start delay” and “Measurement delay”

AUTOMATIC HIGH DENSITY SWEEP

This function automatically raises the frequency density only for sections where the measurement data changes suddenly during frequency sweep measurements.

During resonance characteristic measurements of devices like piezoelectric vibrators and crystal oscillators, this function is useful.

MARKER CONTROL

Reads the measurement values for X, Y1 and Y2 shown on the graph. Up to 8 markers can be used.

● **Δ Marker**

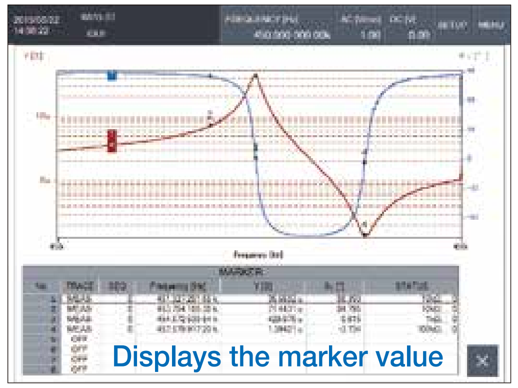
Displays the difference from the standard marker (Marker 1)

● **ΔTRKG Marker**

Displays the difference in the same way as the difference marker. When marker 1 is moved, it moves while keeping the difference in the sweep value constant.

● **Marker search function**

Automatically searches points that match the setting conditions



SEQUENCE MEASUREMENT FUNCTION

Multiple measurement conditions are set in advance, and this function conducts measurements in order under those conditions.

The sweep range can be split into segments, with measurements taken under different conditions for each segment range.

Enables efficient measurements of multilayer ceramic capacitors (MLCC), and other devices with characteristics that vary with voltage.

Corrections to causes of measurement errors, for accurate assessments.

ERROR CORRECTION FUNCTION

To conduct accurate measurements, various measurement error causes such as residual impedance and cable length must be corrected properly.

● **Open correction**

Reduces errors caused by residual admittance

● **Short correction**

Reduces errors caused by residual impedance

● **Load correction**

Corrects deviations from true values using samples with known values as standard impedance

● **Port extension**

Corrects phase errors due to transmission delay time when using long cables

● **Slope compensation**

Removes the effect of potential fluctuation wave included in the measurement signal. Effective for measurements of samples such as batteries with potential changes due to charging and discharging

● **Equalizing**

Measures the frequency characteristics of sensors, cables and other externally connected measurement devices, and corrects the amount of error of those measurement devices

● **Input weighting**

Corrects the probe attenuation or pre-amp gain

● **Self-calibration** Self-calibrates errors

GRAPH DISPLAY

● **SINGLE/SPLIT display**

Select from “SINGLE” with one graph shown per screen, or “SPLIT” with two graphs shown top and bottom

● **Phase display control**

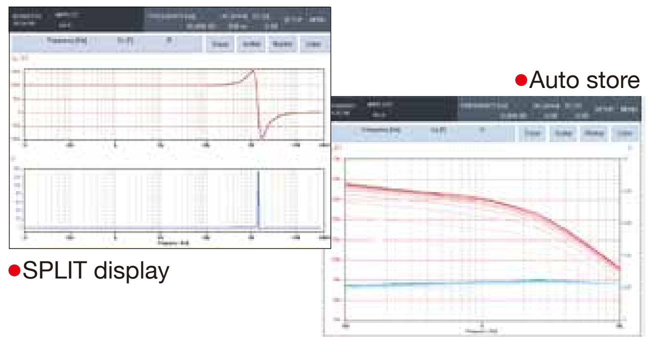
±180°, 0° to +360°, –360° to 0°, UNWRAP (continuous display), 360 ° shift, aperture (group delay characteristics)

● **Trace control**

Allows overwriting of measurement data trace (MEAS) and up to 8 reference data traces (REF)

● **Auto store**

After sweep measurement is completed, this function automatically copies the MEAS trace to the REF trace.



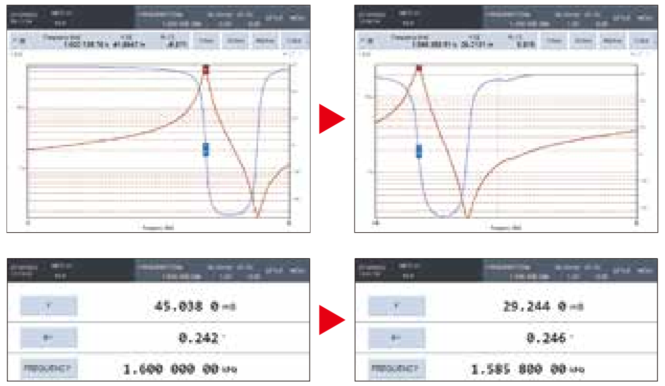
●Auto store

●SPLIT display

RESONANT FREQUENCY TRACKING FUNCTION

During measurement of samples with resonance, this function automatically tracks the measurement frequency with the sample resonant frequency. Measurement can always be conducted to match the resonant frequency. A convenient function for continuous measurements close to the resonant frequency of piezoelectric devices.

Resonant frequency changes (1.6 kHz to 1.5858 kHz), tracks automatically

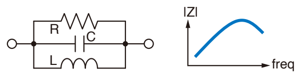


EQUIVALENT CIRCUIT ESTIMATION FUNCTION

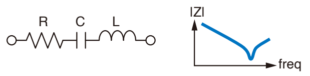
A function that determines the LCR element value (values for impedance, electrostatic capacitance and resistance) by applying the impedance characteristics acquired with frequency sweep measurements to equivalent circuit models. The following 6 models are included.

● Equivalent circuit model

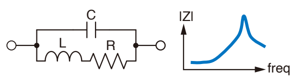
CKT1 • Inductor with high core loss



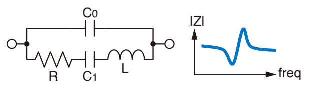
CKT4 • General capacitor with ESR, ESL



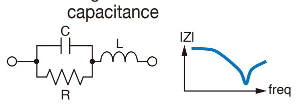
CKT2 • Inductor with high ESR
• Small resistor with ESL



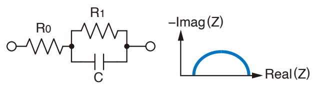
CKT5 • Crystal oscillator, piezoelectric vibrator, etc.

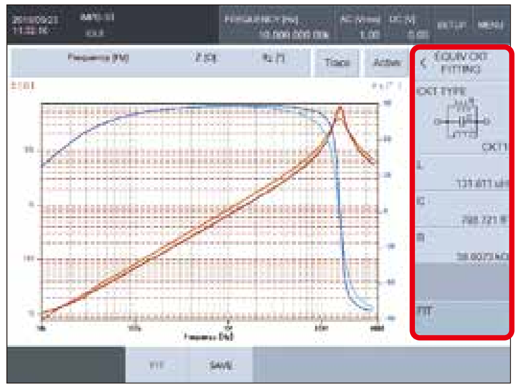


CKT3 • Capacitor with high leakage resistor
• Large resistor with terminal capacitance



CKT6 • Electrochemical impedance such as batteries



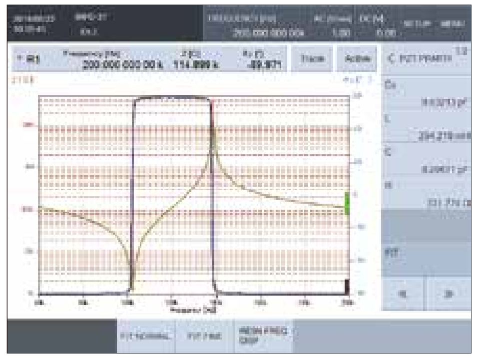


Equivalent circuit estimation

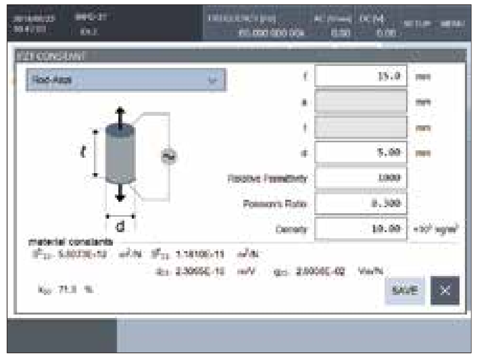
PIEZOELECTRIC CONSTANT CALCULATION FUNCTION

Function that measures frequency-impedance characteristics of piezoelectric ceramics to calculate the electromechanical coupling factor, piezoelectric constant and others.
*JEITA standard-compliant method "EM-4501A Electrical test methods for piezoelectric ceramic vibrators".

● Measurement results



● Constant calculation

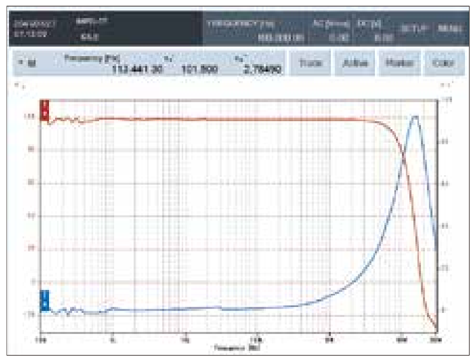


RELATIVE PERMITTIVITY MEASUREMENT

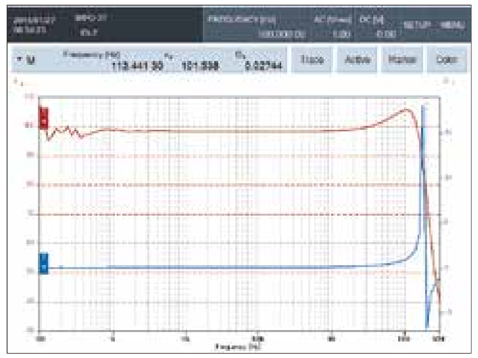
Sample dimensions and other information is set in advance, to calculate and display the complex relative permittivity from impedance measurement results (Cp, Rp).

• Relative permittivity εs • Relative permittivity, real εs′
• Relative permittivity, imaginary εs″ • Loss ratio Dε

εs′ – εs″



εs – Dε



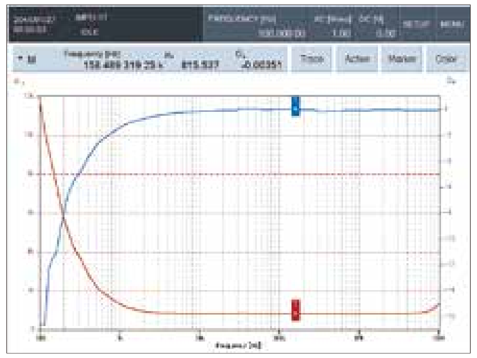
RELATIVE MAGNETIC PERMEABILITY MEASUREMENT

Sample dimensions and other information are set in advance, to calculate and display the complex relative magnetic permeability from impedance measurement results (Ls, Rs).

• Relative magnetic permeability μs
• Relative magnetic permeability, real μs′
• Relative magnetic permeability, imaginary μs″ • Loss ratio Dμ

μs′ – μs″

μs – Dμ



EXTERNAL REFERENCE CLOCK

An external 10 MHz clock signal can be used as the reference clock. Using a reference clock with a higher precision than the internal reference clock helps to improve the measurement frequency accuracy and stability.
The use of a reference clock common with other devices also allows for the same frequency accuracy.

Mounted on rear panel

MEMORY CONTROL

Measurement conditions and measurement data can be saved and loaded onto the internal memory or USB memory storage.

Electrochemical impedance characteristics measurements

Functions cover a range of measurements of electrochemical impedance characteristics, such as battery internal impedance measurements.

- Ultra-low frequencies from 10 μHz
- Phase slope compensation function to limit measurements being affected by potential changes due to charging and discharging
- 0° SYNC function changes the measurement frequency by 0° phase, for zero charge transfer before and after measurements.

Measurement up to 0.5 ms/point to shorten takt time
Also with parts selection function!!

Ideal for production lines!

COMPARATOR/HANDLER INTERFACE

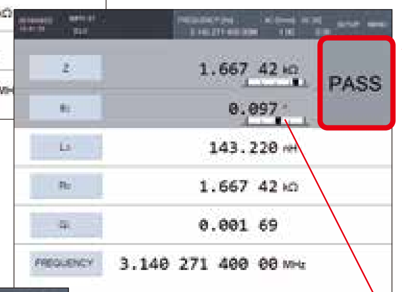
The comparator is a function that allows samples to be sorted or passed/rejected by setting the criteria range in advance based on measurement results.

● Comparator setting screen

◀Results

● Bin sorting
Sorts results in up to 14 categories.

● Limit sorting
Determines pass/reject based on the set range .



◀Results

Bar graph
(relative positions of results)

● Handler interface
The comparator criteria results can be output to the handler interface connector.
Connect a parts handler to create an automated parts sorting system.

● Zone sorting
Determines pass/reject based on sweep measurement results in two-dimensions, X axis (sweep parameter) and Y1, Y2 axes (measurement results).

Specifications

Unless otherwise specified, the conditions are that 23 °C ±5 °C, warming up for at least 30 minutes.

Measurement Modes

Measurement Modes	IMPD-3T (Default measurement mode) IMPD-2T (High-frequency measurement mode) IMPD-EXT (Expanded measurement mode) G-PH (Gain/phase measurement mode)

Measurement Value Display Ranges

IMPD-3T, IMPD-2T

Z		0 Ω to 999.999 GΩ, resolution 6 digits or 1 aΩ
R, X		±(1 a to 999.999 G) Ω and 0 Ω, resolution 6 digits or 1 aΩ
Y		0 S to 999.999 GS, resolution 6 digits or 1 aS
G, B		±(1 a to 999.999 G) S and 0 S, resolution 6 digits or 1 aS
L_S, L_P		±(1 a to 999.999 G) H and 0 H, resolution 6 digits or 1 aH
C_S, C_P		±(1 a to 999.999 G) F and 0 F, resolution 6 digits or 1 aF
R_S, R_P		±(1 a to 999.999 G) Ω and 0 Ω, resolution 6 digits or 1 aΩ
θ_Z, θ_Y	±180°	−180.000° to 179.999°, resolution 0.001°
	0 to 360°	0.000° to 359.999°, resolution 0.001°
	−360 to 0°	−360.000° to −0.001°, resolution 0.001°
	UNWRAP	−9999.999° to +9999.999°, resolution 0.001°
D, D_ε, D_μ		±(0.00001 to 99999.9) and 0 (unitless number), resolution 6 digits or 0.00001
Q_C, Q_L		±(0.00001 to 99999.9) and 0 (unitless number) resolution 6 digits or 0.00001
V		0 to 9.99999 Vrms, resolution 6 digits or 1 aVrms
I		0 to 99.9999 mArms, resolution 6 digits or 1 aArms
ε_S, ε_S', ε_S'' μ_S, μ_S', μ_S''		±(1 a to 999.999 G) and 0 (unitless number), resolution 6 digits or 1 a
FREQUENCY		10 µHz to 36.000 000 000 00 MHz, resolution 10 µHz This item is selectable when resonant frequency tracking measurement.

IMPD-EXT

Z		0 Ω to 999.999 GΩ, resolution 6 digits or 1 aΩ
R, X		±(1 a to 999.999 G) Ω and 0 Ω, resolution 6 digits or 1 aΩ
Y		0 S to 999.999 GS, resolution 6 digits or 1 aS
G, B		±(1 a to 999.999 G) S and 0 S, resolution 6 digits or 1 aS
L_S, L_P		±(1 a to 999.999 G) H and 0 H, resolution 6 digits or 1 aH
C_S, C_P		±(1 a to 999.999 G) F and 0 F, resolution 6 digits or 1 aF
R_S, R_P		±(1 a to 999.999 G) Ω and 0 Ω, resolution 6 digits or 1 aΩ
θ_Z, θ_Y	±180°	−180.000° to 179.999°, resolution 0.001°
	0 to 360°	0.000° to 359.999°, resolution 0.001°
	−360 to 0°	−360.000° to −0.001°, resolution 0.001°
	UNWRAP	−9999.999° to +9999.999°, resolution 0.001°
D, D_ε, D_μ		±(0.00001 to 99999.9) and 0 (unitless number), resolution 6 digits or 0.00001
Q_C, Q_L		±(0.00001 to 99999.9) and 0 (unitless number) resolution 6 digits or 0.00001
V_1, V_2		0 to 999.999 GVrms, resolution 6 digits or 1 aVrms V_1 and V_2 are the voltages resulting from the PORT1 measurement voltage and PORT2 measurement voltage being corrected (multiplied) by the respective input weighting factorsetting values.
ε_S, ε_S', ε_S'' μ_S, μ_S', μ_S''		±(1 a to 999.999 G) and 0 (unitless number), resolution 6 digits or 1 a
FREQUENCY		10 µHz to 36.000 000 000 00 MHz, resolution 10 µHz This item is selectable when resonant frequency tracking measurement.

G−PH

Gain		
	dBR (gain dB)	−999.999 dB to +999.999 dB, resolution 0.001 dB
	R (absolute gain)	0 to 999.999 G (unitless number), resolution 6 digits or 1 a
	a (real part of gain)	±(1 a to 999.999 G) or 0 (unitless number), resolution 6 digits or 1 a
	b (imaginary part of gain)	±(1 a to 999.999 G) or 0 (unitless number), resolution 6 digits or 1 a
θ (phase)	±180°	−180.000° to +179.999°, resolution 0.001°
	0 to 360°	0.000° to +359.999°, resolution 0.001°
	−360 to 0°	−360.000° to −0.001°, resolution 0.001°
	UNWRAP	−9999.999° to +9999.999°, resolution 0.001°
GD (group delay)		±(1 a to 999.999 G) s and 0 s, resolution 6 digits or 1 as
V_1, V_2		0 to 999.999 GVrms, resolution 6 digits or 1 aVrms V_1 and V_2 are the voltages resulting from the PORT1 measurement voltage and PORT2 measurement voltage being corrected (multiplied) by the respective input weighting factorsetting values.

Measurement Connectors

IMPD-3T

Hcur/OSC

Connector		BNC connector (front panel)
Frequency		10 µHz to 36 MHz (when HV DC bias is off) 1 kHz to 36 MHz (when HV DC bias is on) Setting resolution: 10 µHz Accuracy: ±10 ppm (when using internal reference clock)
Measurement signal amplitude		
	Voltage	0 to 3.00 Vrms (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 (Measurement signal amplitude setting [Vrms] × 1.42) + |HV DC bias setting [V]| ≤ 42.0 Setting resolution: 3 digits or 10 µVrms, whichever is the largest Accuracy: ± 0.3 dB or less (1 kHz, 70 mVrms to 3.0 Vrms, no load)
	Current	0 to 60 mArms (Measurement signal amplitude setting [Arms] × 71) + |Normal DC bias setting [A]× 50| ≤ 5.0 Setting resolution: 3 digits or 100 nArms, whichever is the largest Accuracy: nominal value
	Frequency characteristics	±0.3 dB or less (100 kHz or less) ±0.5 dB or less (1 MHz or less) ±1.0 dB or less (15 MHz or less) ±3.0 dB or less (30 MHz or less) ±4.0 dB or less (36 MHz or less) 1 kHz reference, 70 mVrms to 3 Vrms, use normal DC bias, DC bias setting 0 V, 50 Ω load
	Distortion	0.2% or less (no load, 100 kHz or less, BW500 kHz, and 3 Vrms output)
	ALC	{CV (constant voltage) or CC (constant current)}/OFF
	Output limit	Voltage: 10 µVrms to 3.00 Vrms Setting resolution: 3 digits or 10 µVrms, whichever is the largest Current 100 nArms to 60 mArms Setting resolution: 3 dights or 100 nArms, whichever is the largest
Normal DC bias (front panel or rear panel selectable)		
	Voltage	−5.00 V to +5.00 V (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 Setting resolution: 10 mV Accuracy: ±(|1% of normal DC bias setting [V]| + 3% of measurement signal amplitude setting [Vrms] + 30 mV), When no load
	Current	−100 mA to +100 mA (Measurement signal amplitude setting [Arms] × 71) + |Normal DC bias setting [A]× 50| ≤ 5.0 Setting resolution: 100 nA, accuracy: nominal value
HV DC bias		−40.0 V to +40.0 V (when no load) (Measurement signal amplitude setting [Vrms] × 1.42) + |HV DC bias setting [V]| ≤ 42.0 Setting resolution: 10 mV Accuracy: ±(|1% of HV DC bias setting [V]| + 3% of measurement signal amplitude setting [Vrms] + 30 mV), When no load Output Impedance: 1 kΩ (nominal value)
Output Impedance		50 Ω (nominal value)

Hpot/PORT1, Lcur/PORT2

Input connectors	BNC connectors (front panel)
Measurement range	10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, AUTO

IMPD-2T

PORT3

Connector		N connector (front panel)
Frequency		10 µHz to 36 MHz (when HV DC bias is off) 1 kHz to 36 MHz (when HV DC bias is on) Setting resolution: 10 µHz, Accuracy: ±10 ppm (when using internal reference clock)
Measurement signal amplitude		
	Voltage	0 to 3.00 Vrms (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 (Measurement signal amplitude setting [Vrms] × 1.42) + |HV DC bias setting [V]| ≤ 42.0 Setting resolution: 3 digits or 10 µVrms, whichever is the largest Accuracy: ± 0.3 dB or less (1 kHz, 70 mVrms to 3.0 Vrms, no load)
	Current	0 to 60 mArms (Measurement signal amplitude setting [Arms] × 71) + |Normal DC bias setting [A]× 50| ≤ 5.0 Setting resolution: 3 digits or 100 nArms, whichever is the largest Accuracy: nominal value
	Frequency characteristics	±0.3 dB or less (100 kHz or less) ±0.5 dB or less (1 MHz or less) ±1.0 dB or less (15 MHz or less) ±3.0 dB or less (30 MHz or less) ±4.0 dB or less (36 MHz or less) 1 kHz reference, 70 mVrms to 3 Vrms, use normal DC bias, DC bias setting 0 V, 50 Ω load
	Distortion	0.2% or less (no load, 100 kHz or less, BW500 kHz, and 3 Vrms output)
	ALC	{CV (constant voltage) or CC (constant current)}/OFF
	Output limit	Voltage: 10 µVrms to 3.00 Vrms Setting resolution: 3 digits or 10 µVrms, whichever is the largest Current 100 nArms to 60 mArms Setting resolution: 3 dights or 100 nArms, whichever is the largest
Normal DC bias		
	Voltage	−5.00 V to +5.00 V (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 Setting resolution: 10 mV Accuracy: ±(|1% of normal DC bias setting [V]| + 3% of measurement signal amplitude setting [Vrms] + 30 mV), When no load
	Current	−100 mA to +100 mA (Measurement signal amplitude setting [Arms] × 71) + |Normal DC bias setting [A]× 50| ≤ 5.0 Setting resolution: 100 nA, accuracy: nominal value
HV DC bias		−40.0 V to +40.0 V (when no load) (Measurement signal amplitude setting [Vrms] × 1.42) + |HV DC bias setting [V]| ≤ 42.0 Setting resolution: 10 mV Accuracy: ±(|1% of HV DC bias setting [V]| + 3% of measurement signal amplitude setting [Vrms] + 30 mV), When no load Output Impedance: 1 kΩ (nominal value)
Measurement range		1 Ω, 10 Ω, 100 Ω, 1 kΩ, AUTO

IMPD-EXT

Hcur/OSC

Unless otherwise specified, DUT drive amplifier gain setting K= +1.0 and ALC is OFF

Connector		BNC connector (front panel)
Frequency		10 µHz to 36 MHz Setting resolution: 10 µHz, Accuracy: ±10 ppm (when using internal reference clock)
Measurement signal amplitude		
	Setting range	0 to 999 GVrms Limited to (0 to 3.0) × |K| Vrms by K (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 × |K| Setting resolution: 3 digits or 10 µVrms (K=1), whichever is the largest Accuracy: ± 0.3 dB or less (1 kHz, 70 mVrms to 3.0 Vrms, no load)
	Frequency characteristics	±0.3 dB or less (100 kHz or less) ±0.5 dB or less (1 MHz or less) ±1.0 dB or less (15 MHz or less) ±3.0 dB or less (30 MHz or less) ±4.0 dB or less (36 MHz or less) 1 kHz reference, 70 mVrms to 3 Vrms, use normal DC bias, DC bias setting 0 V, 50 Ω load
	Distortion	0.2% or less (no load, 100 kHz or less, BW500 kHz, and 3 Vrms output)
	ALC	PORT1 / PORT2 / OFF
	Output limit	Voltage: 1 aVrms to 999 GVrms Setting resolution: 3 digits or 1 aVrms, whichever is the largest
Normal DC bias		−999 GV to +999 GV Limited to −5.00 × K V to +5.00 × K V by K (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 × |K| Setting resolution: 3 digits or 10 mV (K= 1), whichever is the largest Accuracy: ±(|1% of normal DC bias setting [V]| + 3% of measurement signal amplitude setting [Vrms] + 30 mV), When no load
Output Impedance		50 Ω (nominal value)
DUT drive amplifier gain setting K		Set the gain of the amplifier or attenuator that supplies the measurement signal to the DUT. The measurement signal amplitude and normal DC bias applied to the DUT can be set directly. Setting range: ±(1E−12 to 1E+12) Setting resolution: 3 digits or 1E−12, whichever is the largest

Hpot/PORT1, Lcur/PORT2

Input connectors	BNC connectors (front panel)
Input Impedance	1 MΩ ±2%, 25 pF ±5 pF (Hpot) / 30 pF ±5 pF (Lcur) in parallel
Maximum non-destructive input voltage	±20 V
Measurement range	10 mVrms to 5 Vrms (1−2−5 sequence), 7 Vrms, and AUTO (PORT1 and PORT2 can be set individually.) • Measurement range and max. measurement input voltage (see table below)
Input weighting factor	This function corrects the conversion ratios of the voltage probe, current probe, shunt resistance, etc. for measurement. (PORT1 and PORT2 can be set individually) Setting range ±(1.00000E−15 to 999.999E+09) Setting resolution 6 digits or 1E−15
Over detection	Setting range: Hpot/PORT1 0 to 7 Vrms Lcur/PORT2 0 to 7 Vrms Setting resolution: 3 digits or 1 µVrms, whichever is the largest. Processing: Buzzer alarm sound, or stopping of measurement (can be turned on/off)

Measurement range [rms]	Maximum measurement input voltage	Measurement range [rms]	Maximum measurement input voltage
10 mV	±16 mV	500 mV	±780 mV
20 mV	±31 mV	1 V	±1.6 V
50 mV	±78 mV	2 V	±3.1 V
100 mV	±160 mV	5 V	±7.8 V
200 mV	±310 mV	7 V, AUTO	±11 V

DC BIAS OUTPUT

Connector	BNC connector (rear panel)
Setting range	−999 GV to +999 GV Limited to −5.00 × K V to +5.00 × K V by K (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 × |K| Setting resolution: 3 digits or 10 mV (K=1), whichever is the largest Accuracy: ±(|1% of normal DC bias setting [V]| + 30 mV)
Output Impedance	600 Ω (nominal value)

G-PH

Hcur/OSC

Connector	BNC connector (front panel)
Frequency	10 µHz to 36 MHz Setting resolution: 10 µHz Accuracy: ±10 ppm (when using internal reference clock)

(G-PH continued)

Measurement signal amplitude		
	Setting range	0 to 999 GVrms Limited to (0 to 3.0) × |K| Vrms by K Resolution: 3 digits or 10 μVrms (K=1), whichever is the largest Accuracy: ± 0.3 dB or less (1 kHz, 70 mVrms to 3.0 Vrms, no load)
	Frequency characteristics	±0.3 dB or less (100 kHz or less) ±0.5 dB or less (1 MHz or less) ±1.0 dB or less (15 MHz or less) ±3.0 dB or less (30 MHz or less) ±4.0 dB or less (36 MHz or less) 1 kHz reference, 70 mVrms to 3 Vrms, use normal DC bias, DC bias setting 0 V, 50 Ω load
	Distortion	0.2% or less (no load when 100 kHz or less, BW500 kHz, and 3 Vrms output)
	ALC	PORT1 / PORT2 / OFF
	Output limit	Voltage: 1 aVrms to 999 GVrms Setting resolution: 3 digits or 1 aVrms, whichever is the largest
Normal DC bias		−999 GV to +999 GV Limited to −5.00 × K V to +5.00 × K V by K (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 × |K| Setting resolution: 3 digits or 10 mV (K=1), whichever is the largest Accuracy: ±(|1% of normal DC bias setting [V]| + 3% of measurement signal amplitude setting [Vrms] + 30 mV), When no load
Output Impedance		50 Ω (nominal value)
DUT drive amplifier gain setting K		Set the gain of the amplifier or attenuator that supplies the measurement signal to the DUT. The measurement signal amplitude and normal DC bias applied to the DUT can be set directly. Setting range: ±(1E−12 to 1E+12) Setting resolution: 3 digits or 1E−12, whichever is the largest

PORT1/HPOT, PORT2/LCUR

Input connectors	BNC connectors (front panel)
Input Impedance	1 MΩ ±2%, 25 pF ±5 pF (PORT1) / 30 pF ±5 pF (PORT2) in parallel
Maximum non-destructive input voltage	±20 V
Measurement range	10 mVrms to 5 Vrms (1–2–5 sequence), 7 Vrms, and AUTO (PORT1 and PORT2 can be set individually.) • Measurement range and max. measurement input voltage

Measurement range [rms]	Maximum measurement input voltage	Measurement range [rms]	Maximum measurement input voltage
10 mV	±16 mV	500 mV	±780 mV
20 mV	±31 mV	1 V	±1.6 V
50 mV	±78 mV	2 V	±3.1 V
100 mV	±160 mV	5 V	±7.8 V
200 mV	±310 mV	7 V, AUTO	±11 V

Input weighting factor	This function corrects the conversion ratios of the voltage probe, current probe, shunt resistance, etc. for measurement. (PORT1 and PORT2 can be set individually) Setting range: ±(1.00000E−15 to 999.999E+09) Setting resolution: 6 digits or 1E−15
Over detection	Setting range: HPOT/PORT1 0 to 7 Vrms LCUR/PORT2 0 to 7 Vrms Setting resolution: 3 digits or 1 μVrms, whichever is the largest. Processing: Buzzer alarm sound or, stopping of measurement (can be turned on/off)
Dynamic range	110 dB typ. (10 Hz to 1 MHz) 60 dB typ. (1 MHz to10 MHz) 50 dB typ. (10 MHz to 36 MHz) (The largest of the port inputs is 3 Vrms and measurement time setting 40 s or more)

DC BIAS OUTPUT

Connector	BNC connector (rear panel)
Setting range	−999 GV to +999 GV Limited to −5.00 × K V to +5.00 × K V by K (Measurement signal amplitude setting [Vrms] × 1.42) + |Normal DC bias setting [V]| ≤ 5.0 × |K| Setting resolution: 3 digits or 10 mV (K=1), whichever is the largest Accuracy: ±(|1% of normal DC bias setting [V]| + 30 mV)
Output Impedance	600 Ω (nominal value)

Measured Signal Control Section

Signal output control		
	Measurement synchronous drive	SYNC (AC+DC): The measurement signal and DC bias are turned on at the start of measurement and turned off at the end of measurement. SYNC (AC): The measurement signal is turned on at the start of measurement and turned off at the end of measurement. The DC bias does not change. ASYNC: The measurement signal and DC bias are not changed at the start of measurement and end of measurement.
	ON/OFF mode	QUICK: The measurement signal amplitude and DC bias changes immediately. SLOW: Output changes gradually over a period of approximately 10 seconds. 0° SYNC: This instrument waits until the measurement signal phase becomes 0° and then output turns off.
	Frequency change mode	ASYNC: The frequency changes immediately. 0° SYNC: The frequency changes when the measurement signal phase becomes 0°.
Sweep		
	Item	One of frequency, measurement signal amplitude, DC bias, and time (zero span)
	Type	Either linear or log (frequency or amplitude only)
	Control	SWEEP UP: Sweeps in the direction of lower limit to upper limit. SWEEP DOWN: Sweeps in the direction of upper limit to lower limit. SPOT: Measures with fixed frequency, measurement signal amplitude, and bias. REPEAT: Repeats SWEEP or SPOT when turns on.
	Density	3 to 2,000 steps/sweep
	Time	Frequency: From 0.5 ms/point, Measurement signal amplitude: From 2 ms/point DC bias: From 3 ms/point Zero span: From 0.5 ms/point

Measurement Accuracy

● IMPD–3T

The conditions are that 0 to +40 °C, open and short correction was performed after warming up for at least 30 minutes.

Basic accuracy: ±0.08%

Measurement range Zr	Measurable range	Recommended range
1 MΩ	900 kΩ ≤	1 MΩ to 11 MΩ
100 kΩ	90 kΩ ≤	100 kΩ to 1.1 MΩ
10 kΩ	9 kΩ ≤	10 kΩ to 110 kΩ
1 kΩ	900 Ω ≤	1 kΩ to 11 kΩ
100 Ω	No limitation	9 Ω to 1.1 kΩ
10 Ω	≤ 10 Ω	1 Ω to 10 Ω

Measurable range: Approximate range in which measurement and display are possible (supplementary value).

Recommended range: Operating range in which measurement accuracy is high.

Impedance measurement accuracy

Accuracy of |Z|: $\pm A_Z$ [%]

$$A_Z = \{(A+B\times U+K_Z+K_Y)\times K_V+K_B\}\times K_T$$

Accuracy of phase angle θ of impedance: $\pm P_Z$ [°]

when 10 kHz < f < 30 kHz and measurement range is 1 kΩ

$$P_Z = 0.573\times\{(1.5\times A+1.5\times B\times U+K_Z+K_Y)\times K_V+K_B\}\times K_T$$

when 10 kHz < f < 30 kHz and measurement range is 100 Ω

$$P_Z = 0.573\times\{(2\times A+2\times B\times U+K_Z+K_Y)\times K_V+K_B\}\times K_T$$

other than above $P_Z = 0.573\times A_Z$ f: Measurement frequency

Remark:

–The measurement accuracy when A_Z exceeds 10% is a supplementary value.

–Excluding the highest and lowest measurement ranges that can be used with that frequency, the measurement accuracy for a measured value smaller than half the lower limit of each recommended measurement range or larger than twice the upper limit is a supplementary value.

Each parameter value in the expression of A_Z and P_Z is listed below.

The meaning of the symbol used when calculating each parameter is shown below.

Z_r: Measurement range [Ω]

Z_x: Measurement value [Ω] of magnitude of impedance |Z|

U: Ratio coefficient

Zr	U
≥ 1 kΩ	|Zx / Zr − 1|
≤ 100 Ω	|Zr / Zx − 1|

A (upper row): **Basic coefficient** [%]

B (lower row): **Proportional coefficient** [%]

Measurement time setting is larger than (200 ms or (20/measurement frequency [Hz]) s) or more.

Measurement range Zr	Measurement frequency [Hz]			
	2 m < f ≤ 1 k	1 k < f < 30 k	30 k ≤ f ≤ 50 k	50 k < f ≤ 100 k
1 MΩ	1.50 2.00	0.80 0.60	— —	— —
100 kΩ	0.30 0.20	0.25 0.10	0.70 0.70	0.40 0.40
10 kΩ	0.15 0.03	0.14 0.02	0.15 0.06	0.20 0.03
1 kΩ	0.10 0.01	0.09 0.01	0.09 0.01	0.14 0.02
100 Ω	0.13 0.03	0.06 0.04	0.05 0.05	0.06 0.10
10 Ω	0.30 0.15	0.30 0.20	0.40 0.15	0.40 0.15

Measurement range Zr	Measurement frequency [Hz]			
	100 k < f ≤ 1 M	1 M < f ≤ 2 M	2 M < f ≤ 5 M	5 M < f ≤ 10 M
1 MΩ	— —	— —	— —	— —
100 kΩ	— —	— —	— —	— —
10 kΩ	0.20 0.03	0.80 0.30	— —	— —
1 kΩ	0.15 0.01	0.20 0.07	0.35 0.35	— —
100 Ω	0.15 0.03	0.15 0.05	0.20 0.20	0.30 0.40
10 Ω	0.40 1.20	0.50 2.00	1.50 5.00	— —

The measurement accuracy in the "—" column is not guaranteed.

K_Z: Residual impedance coefficient [%]

Frequency range	Kz [%]
f ≤ 1 MHz	2/Zx [Ω]
1 MHz < f ≤ 10 MHz	f [kHz]×2×10⁻³/Zx [Ω]

K_Y: Residual admittance coefficient [%]

Frequency range	Ky [%]
f < 30 kHz	Zx [Ω]/(1×10⁸)
30 kHz ≤ f ≤ 10 MHz	f [kHz]×Zx [Ω]/(3×10⁹)

K_V: Signal level coefficient

–When the measurement signal amplitude setting is less than 100 mVrms, the measurement accuracy is not guaranteed.

–When the signal level is set as a current, refer to K_V of the value calculated by measurement signal amplitude setting [Arms] × 71 as the signal level [Vrms]. Example) When the measurement signal amplitude setting is 2.1 mArms, refer to K_V of 2.1×10⁻³ × 71 = 149 m [Vrms].

Frequency ≤ 1 kHz

Measurement range Zr	Signal level [Vrms]					
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V < 1.00	V = 1.00	1.00 < V ≤ 3.00
1 MΩ	5.0	2.5	2.0	1.0	1.0	1.0
100 kΩ	4.0	1.8	2.0	1.0	1.0	2.0
10 kΩ	3.0	1.5	1.5	1.0	1.0	2.5
1 kΩ	2.5	1.2	1.2	1.0	1.0	3.5
100 Ω	1.8	1.1	1.1	1.0	1.0	4.0
10 Ω	1.2	1.1	1.1	1.0	1.0	1.8

1 kHz < Frequency ≤ 30 kHz

Measurement range Zr	Signal level [Vrms]					
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V < 1.00	V = 1.00	1.00 < V ≤ 3.00
1 MΩ	5.0	1.8	1.5	1.1	1.0	1.2
100 kΩ	3.5	1.5	1.5	1.1	1.0	2.0
10 kΩ	2.5	1.2	1.2	1.1	1.0	3.0
1 kΩ	2.0	1.2	1.1	1.1	1.0	4.5
100 Ω	2.5	1.2	1.5	1.1	1.0	6.5
10 Ω	1.1	1.1	1.1	1.1	1.0	2.0

30 kHz < Frequency ≤ 100 kHz

Measurement range Zr	Signal level [Vrms]					
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V < 1.00	V = 1.00	1.00 < V ≤ 3.00
100 kΩ	8.0	2.5	1.8	1.1	1.0	2.0
10 kΩ	8.0	2.5	1.8	1.1	1.0	3.0
1 kΩ	6.5	2.0	1.5	1.1	1.0	5.0
100 Ω	6.0	2.0	2.0	1.1	1.0	7.0
10 Ω	1.2	1.1	1.2	1.1	1.0	1.8

100 kHz < Frequency ≤ 1 MHz

Measurement range Zr	Signal level [Vrms]					
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V < 1.00	V = 1.00	1.00 < V ≤ 3.00
10 kΩ	5.0	1.8	1.5	1.0	1.0	3.0
1 kΩ	4.5	1.5	1.5	1.1	1.0	4.0
100 Ω	4.0	1.2	1.5	1.0	1.0	4.0
10 Ω	1.0	1.0	1.0	1.0	1.0	1.8

1 MHz < Frequency ≤ 2 MHz

Measurement range Zr	Signal level [Vrms]					
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V < 1.00	V = 1.00	1.00 < V ≤ 3.00
10 kΩ	1.5	1.0	1.0	1.0	1.0	1.2
1 kΩ	1.5	1.0	1.0	1.0	1.0	3.0
100 Ω	2.0	1.0	1.2	1.0	1.0	4.0
10 Ω	1.0	1.0	1.0	1.0	1.0	1.2

2 MHz < Frequency ≤ 10 MHz

Measurement range Zr	Signal level [Vrms]					
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V < 1.00	V = 1.00	1.00 < V ≤ 3.00
1 kΩ	1.0	1.0	1.0	1.0	1.0	2.0
100 Ω	1.5	1.0	1.0	1.0	1.0	2.0
10 Ω	1.0	1.0	1.0	1.0	1.0	1.0

K_B: DC bias coefficient [%]

–When the normal DC bias setting is 0.00 V, K_B = 0%.

–The K_B [%] when the normal DC bias is output from the front panel HCUR/OSC is as shown in the table below. This is common for the voltage setting and current setting.

Measurement range Zr	Measurement frequency [Hz]		
	f ≤ 1 k	1 k < f ≤ 30 k	30 k < f ≤ 10 M
1 MΩ	5.0	2.0	—
100 kΩ	1.0	0.2	2.0
10 kΩ	0.2	0.1	0.2
1 kΩ	0.1	0.1	0.1
100 Ω	0.3	0.3	0.3
10 Ω	0.5	0.5	0.5

–The K_B [%] when the HV DC bias is enabled is as shown in the table below.

Measurement range Zr	Measurement frequency [Hz]	
	1 k ≤ f < 30 k	30 k < f ≤ 10 M
1 MΩ	2.0	—
100 kΩ	0.5	2.0
10 kΩ	0.2	0.2
1 kΩ	0.2	0.2
100 Ω	0.5	0.5
10 Ω	0.5	0.5

K_T: Temperature-dependent coefficient

Ambient temperature T[°C]	KT
0 to +18	1+k×(18−T)
+18 to +28	1
+28 to +40	1+k×(T−28)

k: Temperature coefficient

Measurement range Zr	Measurement frequency [Hz]			
	f < 30 k	30 k ≤ f ≤ 1 M	1 M < f ≤ 5 M	5 M < f ≤ 10 M
1 MΩ	0.04	—	—	—
100 kΩ	0.05	0.04	—	—
10 kΩ	0.05	0.04	0.04	—
1 kΩ	0.06	0.04	0.06	—
100 Ω	0.08	0.05	0.04	0.08
10 Ω	0.03	0.02	0.02	—

IMPD–2T

The conditions are that 23 ±5 °C, open and short correction was performed after warming up for at least 30 minutes.

Basic accuracy: ±0.32%

Measurement range Z_r	Measurable range	Recommended range
1 kΩ	No limitation	90 Ω to 10 kΩ
100 Ω	≤ 110 Ω	9 Ω to 100 Ω
10 Ω	≤ 11 Ω	0.9 Ω to 10 Ω
1 Ω	≤ 1.1 Ω	0.09 Ω to 1 Ω

Measurable range: Approximate range in which measurement and display are possible (supplementary value).

Recommended range: Operating range in which measurement accuracy is high.

Impedance measurement accuracy

Accuracy of |Z|: ±A_Z [%]　　$A_Z = \{(A+B\times U+K_Z+K_Y)\times K_V+K_B\}\times K_T$

Accuracy of phase angle θ of impedance: ±P_Z [°]　　$P_Z = 0.573\times A_Z$

Remark: The measurement accuracy when A_Z exceeds 10% is a supplementary value.

Each parameter value in the expression of A_Z and P_Z is listed below.
The meaning of the symbol used when calculating each parameter is shown below.
Z_r: Measurement range [Ω]　Z_X: Measurement value [Ω] of magnitude of impedance |Z|

U: Ratio coefficient

Z_r	U
1 kΩ	Z_X/Z_r (however, 0.1 when Z_X/Z_r < 0.1)
Other than 1 kΩ	Z_r/Z_X (however, 1 when Z_r/Z_X < 1)

A (upper row): **Basic coefficient** [%]
B (lower row): **Proportional coefficient** [%]
Measurement time setting is larger than (200 ms or (20/measurement frequency [Hz]) s) or more.

Measurement range Z_r	Measurement frequency [Hz]					
	2 m < f ≤ 1 k	1 k < f < 30 k	30 k ≤ f ≤ 100 k	100 k < f ≤ 1 M	1 M < f ≤ 10 M	10 M < f ≤ 36 M
1 kΩ	0.20 0.15	0.30 0.35	0.30 0.15	0.30 0.60	1.00 2.00	— —
100 Ω	0.30 0.03	0.30 0.02	0.30 0.02	0.30 0.02	1.00 0.15	3.00 0.30
10 Ω	0.20 0.40	0.20 0.30	0.20 0.20	0.20 0.30	1.50 1.00	— —
1 Ω	0.40 3.00	0.20 3.00	0.20 2.00	0.40 2.50	— —	— —

The measurement accuracy in the "—" column is not guaranteed.

K_Z: Residual impedance coefficient [%]

Frequency range	K_Z [%]
f ≤ 100 kHz	0.02/Z_X [Ω]
100 kHz < f ≤ 36 MHz	f [kHz]×2×10⁻⁴/Z_X [Ω]

K_Y: Residual admittance coefficient [%]

Frequency range	K_Y [%]
f < 30 kHz	Z_X [Ω]/(1×10⁶)
30 kHz ≤ f ≤ 1 MHz	f [kHz]×Z_X [Ω]/(3×10⁶)
1 MHz < f ≤ 36 MHz	f [kHz]×Z_X [Ω]/(2×10⁶)

K_V: Signal level coefficient

– When the signal level is less than 100 mV, the measurement accuracy is not guaranteed.
– When the signal level is set as a current, refer to K_V of the value calculated by measurement signal amplitude setting [A_{rms}] × 50 as the signal level [V_{rms}].

Frequency < 30 kHz

Measurement range Z_r	Signal level [V_{rms}]		
	100 m ≤ V ≤ 300 m	300 m < V ≤ 1.00	1.00 < V ≤ 3.00
1 kΩ	1.2	1.0	3.0
100 Ω	1.3	1.0	2.2
10 Ω	1.0	1.0	1.5
1 Ω	1.0	1.0	1.2

30 kHz ≤ Frequency ≤ 1 MHz

Measurement range Z_r	Signal level [V_{rms}]				
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V ≤ 1.00	1.00 < V ≤ 3.00
1 kΩ	1.5	1.0	1.1	1.0	2.5
100 Ω	1.6	1.0	1.1	1.0	2.2
10 Ω	1.5	1.0	1.0	1.0	2.0
1 Ω	1.2	1.0	1.0	1.0	1.2

1 MHz < Frequency

Measurement range Z_r	Signal level [V_{rms}]				
	100 m ≤ V ≤ 300 m	300 m < V ≤ 500 m	500 m < V ≤ 800 m	800 m < V ≤ 1.00	1.00 < V ≤ 3.00
1 kΩ	1.5	1.0	1.1	1.0	1.1
100 Ω	1.6	1.0	1.1	1.0	1.2
10 Ω	1.5	1.0	1.0	1.0	1.0

K_B: DC bias coefficient [%]

– When the HV DC bias is enabled, K_B = 0.1%.
– The K_B [%] when the normal DC bias is output from the front panel PORT3 is as shown in the table below. This is common for the voltage setting and current setting.

Frequency range	normal DC bias	
	0 V	≠ 0 V
f ≤ 1 kHz	0.0	1.00
1 kHz < f	0.0	0.05

K_T: Temperature-dependent coefficient

Ambient temperature T[°C]	K_T	
	f ≤ 10 MHz	10 MHz < f
0 to +18	1+0.03×(18−T)	1+0.04×(18−T)
+18 to +28	1	1
+28 to +40	1+0.03×(T−28)	1+0.04×(T−28)

IMPD–EXT/G–PH

The conditions are that ambient temperature of 0 to +40 °C, within 12 hours since self-calibration was performed after warming up for at least 30 minutes, and ambient temperature variations are within ±5 °C after self-calibration. DUT drive amplifier gain setting K = +1.0 and input weighting factor is 1.0 for both PORT1 and PORT2.

Measurement accuracy: Relative accuracy + Calibration accuracy

Relative accuracy: ±(basic accuracy + dynamic accuracy + inter-range accuracy)

Calibration accuracy: Accuracy of external equipment connected to this instrument, such as a shunt resistance, probe, or calibration standard

Upper: Impedance Z (IMPD–EXT); Middle: Gain (G–PH); Lower: Phase

Basic accuracy

<table>
<tr><th rowspan="2">Measurement range [rms]</th><th colspan="3">Measurement frequency [Hz]</th></tr>
<tr><th>f ≤ 1 M</th><th>1 M < f ≤ 10 M</th><th>10 M < f ≤ 36 M</th></tr>
<tr><td>7 V
:
100 mV</td><td>0.12%
0.01 dB
0.06°</td><td rowspan="2">0.35%
0.03 dB
0.18°</td><td rowspan="2">1.20 %
0.10 dB
0.60°</td></tr>
<tr><td>50 mV
:
10 mV</td><td>0.24%
0.02 dB
0.12°</td></tr>
</table>

Conditions:
- Largest or more of measurement time setting 100 ms and (10 ÷ measurement frequency [Hz]) s
- Measurement range of 10 mV_{rms} to 7 V_{rms}
- Both ports have the same measurement range.
- The Z, gain and phase errors when full-scale signal (max. 3 V_{rms}) input of the measurement range.

Dynamic accuracy

<table>
<tr><th rowspan="2">Measurement range [rms]</th><th colspan="3">Measurement frequency [Hz]</th></tr>
<tr><th>f ≤ 1 M</th><th>1 M < f ≤ 10 M</th><th>10 M < f ≤ 36 M</th></tr>
<tr><td>7 V
:
100 mV</td><td>0.24%
0.02 dB
0.12°</td><td>0.35%
0.03 dB
0.18°</td><td>1.20%
0.10 dB
0.60°</td></tr>
<tr><td>50 mV
:
10 mV</td><td colspan="3">1.20%
0.10 dB
0.60°</td></tr>
</table>

Conditions:
- Largest or more of measurement time setting 100 ms and (10 ÷ measurement frequency [Hz]) s
- Measurement range of 10 mV_{rms} to 7 V_{rms}
- Both ports have the same measurement range.
- The Z, gain and phase variation for when the signal level changes from full-scale (max. 3 V_{rms}) of measurement range to 3/10. The input signal is 1:1 or 1:0.3 between port.

Inter-range accuracy

<table>
<tr><th rowspan="2">Measurement range [rms]</th><th colspan="3">Measurement frequency [Hz]</th></tr>
<tr><th>f ≤ 1 M</th><th>1 M < f ≤ 10 M</th><th>10 M < f ≤ 36 M</th></tr>
<tr><td>7 V</td><td></td><td></td><td></td></tr>
<tr><td>5 V</td><td rowspan="8">0.24%
0.02 dB
0.12°</td><td rowspan="9">0.35%
0.03 dB
0.18°</td><td rowspan="3">1.40%
0.12 dB
0.72°</td></tr>
<tr><td>2 V</td></tr>
<tr><td>1 V</td></tr>
<tr><td>500 mV</td><td rowspan="6">1.20%
0.10 dB
0.60°</td></tr>
<tr><td>200 mV</td></tr>
<tr><td>100 mV</td></tr>
<tr><td>50 mV</td></tr>
<tr><td>20 mV</td></tr>
<tr><td>10 mV</td><td>0.35%
0.03 dB
0.18°</td></tr>
</table>

Conditions:
- Largest or more of measurement time setting 100 ms and (10 ÷ measurement frequency [Hz]) s
- Measurement range of 10 mV_{rms} to 7 V_{rms}
- Z, gain and phase errors when difference of the measurement ranges of both port is one and the input signal levels are the same for both ports (full scale level of smallest measurement range, max. 3 V_{rms}).

Measurement Accuracy of Measurement Parameters Other Than Z and θ

Measurement Modes: IMPD–EXT, IMPD–3T and IMPD–2T

Calculate the measurement accuracy from the impedance measurement accuracy as follows.
Here, Q_X is the measurement value of Q, D_X is the measurement value of D, and $θ_X$ is the measurement value of θ. It is also acceptable to calculate the $θ_X$ used for the accuracy calculation by either (90° – tan⁻¹|1/Q_X|) or (90° – tan⁻¹|D_X|).

Parameter	Measurement accuracy (supplementary value)
|Y|, εs, μs	±A_Z [%]
L_P, L_S, X, εs′, μs′	±A_Z [%] (|Q_X| ≥ 10), ±A_Z/sin$θ_X$ [%] (|Q_X| < 10)
C_P, C_S, B	±A_Z [%] (|D_X| ≤ 0.1), ±A_Z/sin$θ_X$ [%] (|D_X| > 0.1)
R_P, R_S, G, εs″ μs″	±A_Z [%] (|Q_X| ≤ 0.1), ±A_Z/cos$θ_X$ [%] (|Q_X| > 0.1)
Q	±Q_X^2×P_e / (1–|Q_X|×P_e) (|Q_X| ≥ 10 or |Q_X|×P_e ≤ 0.1) Here, phase angle error P_e [rad] = P_Z [°] / 57.3. The measurement accuracy of Q is the actual value and not the % value.
D	±(P_Z [°] / 57.3) (|D_X| ≤ 0.1) The measurement accuracy of D is the actual value and not the % value.

Measurement Accuracy of Measurement Parameters Other Than Gain and θ

Measurement Modes: G–PH

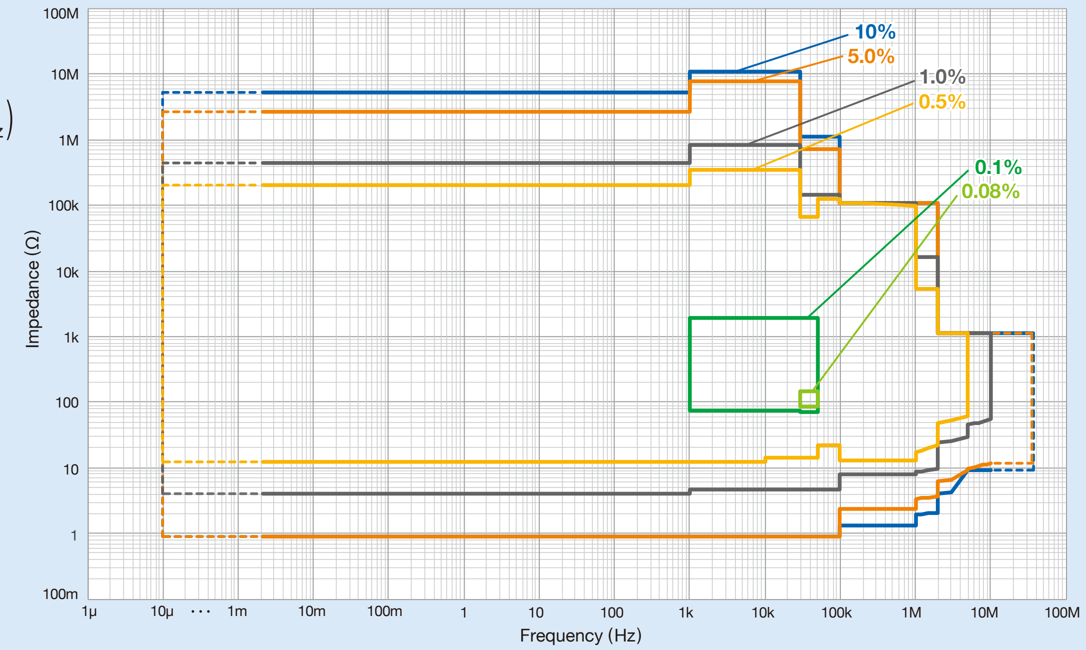
Calculate the measurement accuracy from the phase measurement accuracy as follows.
Here, P_G is the measurement accuracy [°] of θ.

Parameter	Measurement accuracy (supplementary value)
GD	$\pm\frac{P_G}{360\times APT}$ [s]　Here, APT is the aperture frequency (Δf [Hz]), and is aperture setting*1 × sweep measurement frequency interval.

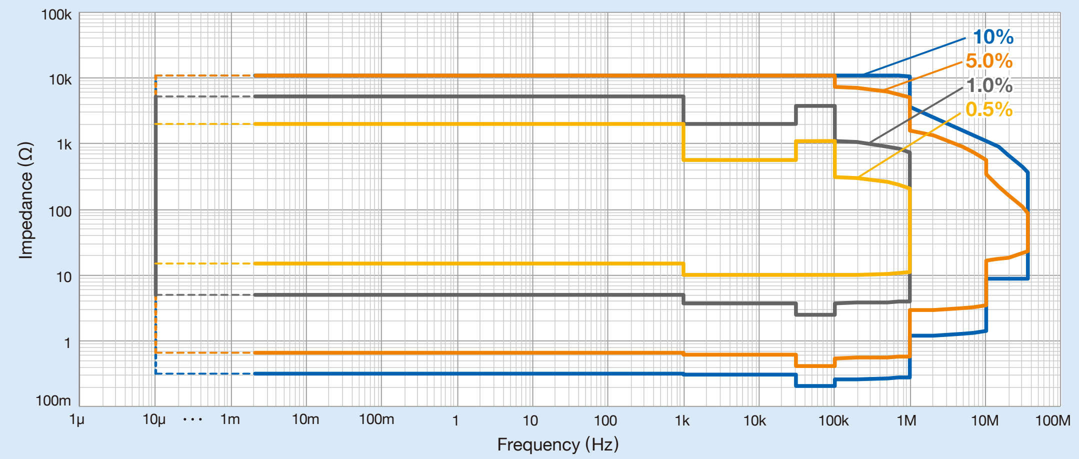
*1: "Aperture setting" is a parameter that is set in this instrument for group delay (GD) measurement.

Measurement accuracy

IMPD-3T
(Reference values below 2 mHz and above 10MHz)



IMPD-2T
(Reference values below 2 mHz)



Measurement Processing Section

Measurement time setting	Setting of time required for one measurement (in the case of sweep measurement, the setting of the measurement time of not the entire sweep but of each point). Measurement results are averaged within the range not exceeding the set time and the influence of noise is reduced. Setting range; 0 ms to 9,990 s Setting resolution: 3 digits or 0.1 ms, whichever is the largest
Measurement delay function	This function delays the start of measurement after the sweep parameters are changed. Setting range: 0 to 9,990 s Setting resolution: 3 digits or 0.1 ms, whichever is the largest
Measurement start delay function	This function delays the start of measurement only when sweeping starts. Setting range 0 to 9,990 s or MANual Setting resolution: 3 digits or 0.1 ms, whichever is the largest
Automatic high density sweep (slow sweep)	When there is a sudden change in the measurement data during frequency sweep measurement, this function performs measurement by automatically increasing the frequency sweep density in the regions before and after that point. <IMPD–EXT, IMPD–3T and IMPD–2T> Z: 1 a to 999 GΩ, setting resolution 3 digits or 1 aΩ, whichever is the largest Y: 1 a to 999 GS, setting resolution 3 digits or 1 aS, whichever is the largest θ: 0.001 to 179.999°, setting resolution 0.001° <G–PH> Gain: Linear 1 a to 999 G, setting resolution 3 digits or 1 a, whichever is the largest Log 0.001 to 999.999 dB, setting resolution 0.001 dB θ: 0.001 to 179.999°, setting resolution 0.001°
Sequence measurement function	This function performs measurements according to the contents of setting memory (condition file). UP SWEEP: The first up sweep is performed over the sweep range set in condition file number 1, the next up sweep is performed over the range set in condition file number 2, and so on continuously up to the upper limit condition file number. DOWN SWEEP: The first down sweep is performed over the range set in the upper limit condition file number, the next down sweep is performed over the range set in the next condition file number down (upper limit condition file number minus 1), and so on continuously down to condition file number 1. Upper limit condition file number: 1 to 32 Setting resolution: 1
Resonant frequency tracking function	This function automatically keeps the measurement frequency tracked to the resonance frequency of the DUT.
Equivalent circuit estimation function	Estimate each constant of the equivalent circuits from the frequency sweep measurement results. (IMPD–EXT, IMPD–3T and IMPD–2T)
Piezoelectric constant calculation function	Calculates the piezoelectric related constants from the frequency sweep measurement results. Piezoelectric constant calculation: Calculates the piezoelectric constants,piezoelectric parameters, resonant frequency, etc. Simulation: Calculates and displays the admittance characteristics from the piezoelectric parameters. (IMPD–EXT, IMPD–3T and IMPD–2T)
Comparator	SPOT: measurement results Max. 14 bins SWEEP: measurement results upper limit and lower limit comparison Number of comparison settings: 1 to 20
Discharge protection	Protection tolerance: 2 J or less (voltage is 100 V or less)
Error correction function	<IMPD–EXT, IMPD–3T and IMPD–2T> Open correction: Corrects the stray admittance. Short correction: Corrects the residual impedance. Load correction: Corrects the voltage-current conversion coefficient of the measurement system. Load standard value: Standard values can be entered for up to 30 frequency points. Port extension: Corrects the error due to phase delay in cables for 2-terminal measurements. Characteristic impedance: 1.00 to 999 Ω, setting resolution 3 digits Electrical length: 0.000 to 999.999 m, setting resolution 0.001 m
(Error correction function continued)	Slope compensation: <IMPD–EXT> This function performs analysis that is unaffected by the DC level for signals that have a composited DC level that varies linearly over time. It is used when measuring the impedance of batteries during charging and discharging. Equalizing: <G–PH> This function acquires the characteristics of only the EUT by measuring the frequency characteristics of the measurement system (sensors, cables, etc.) in advance and then eliminating the error components of the measurement system when actual measurements are taken later. Self-calibration: <IMPD–EXT and G–PH> This function measures and corrects the measurement errors that arise within this instrument itself.

Display Section

Display unit	8.4-inch color TFT-LCD (SVGA) with touch panel
Graphs	Bode plot, Nyquist plot, Cole-cole plot
Graph display styles	SINGLE: One graph is displayed on the LCD. SPLIT: Two graphs are displayed, one above the other.
Graph axis setting	The X, Y1, and Y2 axis can each be set to Lin/Log individually.
Graph traces	9 traces of measurement data (MEAS) and reference data (REF 1 to 8)
Auto scaling	This function automatically optimizes the graph display scale.(on or off)
Marker display	Markers are displayed on a graph, and the data at a marker position is displayed as a numerical value.
Marker search function Search items	Max, Min: Search for the maximum and minimum values. Peak, Bottom: Search for the peak (maximal) and bottom (minimal) values. Next Peak: Search for the next peak. Next Bottom: Search for the next bottom. Prev Peak: Search for the previous peak. Prev Bottom: Search for the previous bottom. Value: Search for the marker value. ⊿Value: Search for the difference between the reference marker and search marker values. X Value: Search for the sweep parameter. BW1: Display the passband gain and cutoff frequency. BW2: Display the center frequency and pass bandwidth. BW3: Display the notch frequency and notch bandwidth. *A search can be performed automatically at the end of sweep measurement.

Memory

Measurement conditions	32 sets (per measurement mode)
Measurement data (MEAS)	Data from sweep measurement Up to 32 sets of data can be saved to the internal storage of this instrument.
Reference data (REF)	Data (up to 8 sets) that can be displayed on a graph together with measurement data (MEAS) This can be measurement data or data copied from a USB memory device. The display can be turned on or off.
Error correction data	Open correction, short correction, load correction, open correction at port extension tip, short correction at port extension tip, load correction at port extension tip, equalizing (each 32 sets)

External Memory

Media	USB memory device
Connector	Front panel, USB-A connector
File system	FAT
Saved items	Setting conditions, measurement data (MEAS) and reference data (REF 1 to 8), equivalent circuit estimation results, piezoelectric constant calculation results, and marker information
File format	CSV format
Screen capture function	A screen capture of the LCD screen can be saved to a USB memory device.

External Input/Output Function

Interface	GPIB: Standards conformance; IEEE488.1 and IEEE488.2 USB: USB 2.0 High Speed LAN: 10/100 Base-T RS–232: Baud rate 4800 to 230400 bps
External monitor	For connecting a projector or external monitor, etc. Connector: VGA connector (mini D-sub 15-pin, female) Signal: 800×600 dot (SVGA), analog RGB component video signal
Reference clock input	Frequency: Within 10 MHz ±100 ppm Input waveform: Sinusoidal or square Input voltage: 0.5 Vp–p to 5 Vp–p Input impedance: 300 Ω (nominal value), AC coupling
Reference clock output	Frequency: 10 MHz ±10 ppm (when using internal reference clock) Output waveform: 1 Vp–p/50 Ω, square waveform Output impedance: 50 Ω (nominal value), AC coupling
Handler interface	(This can be used in Measurement modes IMPD-EXT, IMPD-3T and IMPD-2T.) All I/O signals are optically isolated (withstand voltage ±42 V) Input signal: Trigger, setting condition file number Output signal: Sorting results BIN1 to BIN14
Expansion connector	AUX connector

Miscellaneous Specifications

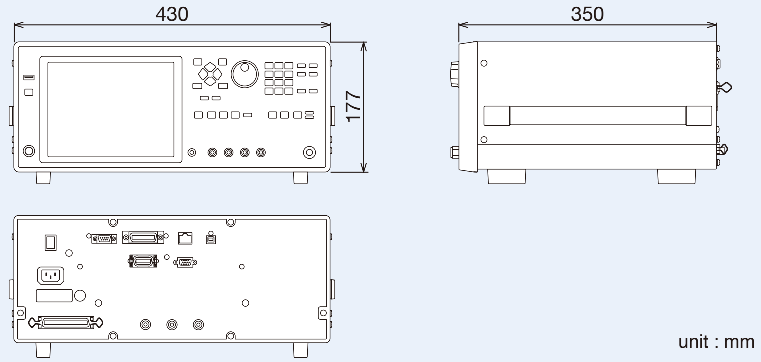
Power input	Voltage: AC 100 V to 230 V ±10 %, however 250 V or less Frequency: 50 Hz/60 Hz ±2 Hz, Power consumption: Max. 100 VA Overvoltage category II
Environmental conditions	Operation 0 to +40 °C, 5 to 85% RH (However, absolute humidity 1 to 25 g/m³, no condensation)
External dimensions	430 (W) × 177 (H) × 350 (D) mm (excluding protruding parts)
Weight	Approx. 7.0 kg
RoHS Directive	Directive 2011/65/EU
Warm-up time	At least 30 minutes
Calibration cycle	1 year
Accessories	Instruction Manual (Basics, Advanced and Remote Control), Power cord set (with 3-pin plug, 2 m) × 1, CALIBRATION BOX × 1, 100 Ω RESISTOR × 1


CALIBRATION BOX


100 Ω RESISTOR

Note: available as option

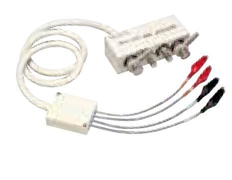
Dimensions



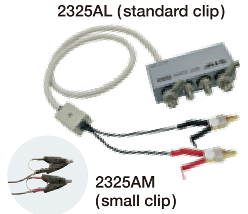
Test fixture/test leads

General-purpose components

Stable measurement for various shapes of DUT



4 terminal alligator clip test leads: 2324
- Measurement frequency: ≤ 100 kHz



Kelvin clip test leads 2325AL, 2325AM
- Measurement frequency: ≤ 100 kHz

Kelvin clip test leads: ZM2392
- Measurement frequency: ≤ 20 kHz

3-terminal alligator clip test leads: ZM2391
- Measurement frequency: ≤ 20 kHz

Lead components

Measuring simply by inserting the sample lead.

Test fixture ZM2363
- Measurement frequency: ≤ 10 MHz

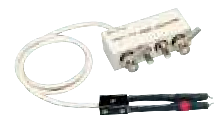
Chip components

Measuring surface mount components with 2-terminal or 4-terminal connection

Chip test fixture ZM2394H
- Measurement frequency: ≤ 36 MHz
- Supported component size: 0603 (0.3mm thick) to 14 mm (square)

Chip test fixture ZM2393
- Measurement frequency: ≤ 1.2 MHz
- Supported component size: 1608 to 5750

Chip component test leads ZM2366
- Measurement frequency: ≤ 10 MHz
- Tip spacing: 1 to 8 mm (typ.)



Chip component test leads 2326A
- Measurement frequency: ≤ 1.2 MHz
- Tip spacing: 1 to 8 mm (typ.)

Option

Model name	Product name	Note
PA–001–3233	100 Ω RESISTOR	For maintenance
PA–001–3234	CALIBRATION BOX	For maintenance
PA–001–3270	RACK MOUNT KIT (EIA)	
PA–001–3271	RACK MOUNT KIT (JIS)	

Related Products

Frequency Response Analyzer **FRA51615**

- Frequency range 10 μHz to 15 MHz
- Basic accuracy Gain : ±0.01 dB, Phase : ±0.06°
- Maximum voltage 600 Vrms (600V/CAT II, 300V/CAT III)
- Measurement speed 0.5 ms/point
- Dynamic Range 140 dB

- Impedance measurement
  Open / Short / Load correction, Port extension

LCR meter **ZM series**

- ZM2371/ZM2372: Measurement frequency 1 mHz to 100 MHz
- ZM2376 : Measurement frequency 1 mHz to 5.5 MHz
- Basic accuracy 0.08%
- Measurement speed fastet 2ms
- Measurement signal level 10mVrms to 5Vrms/1μArms to 200mArms
- Constant voltage and constant current mode, DCR measurement, comparator, deviation,contact check, and data acquisition software

Note: The contents of this catalog are current as of October 25th, 2024
•Products appearance and specifications are subject to change without notice.
•Before purchase contact us to confirm the latest specifications, price and delivery date.

COSINUS Messtechnik - Ihr Partner für Messlösungen in allen elektrischen und physikalischen Anwendungen

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