IMPEDANCE/GAIN-PHASE ANALYZER

ZGA5920

Frequency response analyzer (FRA)

Analysis performance and user-friendliness have been improved, with the basic features of a FRA unchanged.

A comprehensive analyzer for evaluating the characteristics of various electronic materials, components and circuits

- Piezoelectric material — Piezoelectric measurement
- Dielectric material — Dielectric measurement
- Magnetic material — Magnetic measurement
- Inductor — Inductor measurement
- Capacitor — Capacitor measurement
- Resistor — Resistor measurement
- Transformer — Leakage inductance measurement
- Transformer — Mutual inductance measurement
- Transformer — Coupling coefficient measurement
- Transformer — Turns ratio measurement
- Diode — Varactor diode measurement
- Servo — Feedback loop measurement
- Servo — Closed loop gain measurement
- Servo — Open loop gain measurement
- Amplifier circuit — Gain-Phase measurement
- Amplifier circuit — CMRR measurement
- Amplifier circuit — PSRR measurement
- Amplifier circuit — DG/DP measurement
- Amplifier circuit — Saturation measurement
- Filter circuit — Filter measurement
- Material — Impedance measurement
- Circuit — Gain-Phase measurement

Measurements can be done in an actual operating environment.

NF Corporation

What we provide are
a better environment and better information.

This analyzer supports problem-solving by researchers and engineers who are seeking to improve performance and reliability.

Improvements in the performance and reliability of electronic materials, components and circuits for electronic equipment have been increasingly called for in our society––one of remarkable technical advances in household electrical appliances, automotive electronic equipment and energy-saving power electronics equipment.
ZGA5920 was developed as a comprehensive analyzer for measuring impedance and gain-phase, and for accurately determining the responses and performance of measurement objects.
To provide the measurement information that researchers and engineers need, we offer a measurement environment that achieves highly reproducible measurements.
ZGA5920 is as easy to use as a personal computer. In addition to having the functions of measurement, analysis, simulation using the analysis results, outputting of reports and data management, it's equipped with functions including the ability to link with external devices, remote control, and the provision of measurement support information.

It' s a tool that expands the boundaries of measurement equipment.

Features

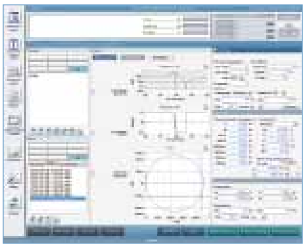
Highly reliable measurements for a wide range of measurement object

- **Capable of measuring from ultra-low frequency ranges**
  Measurement frequency: 0.1 mHz to 15 MHz
- **Supports measurement of power devices and high-voltage circuits**
  Maximum input voltage: 250 Vrms; Dynamic range: 140 dB
- **Isolation between inputs and outputs**
  Isolation voltage: 250 Vrms
- **Extensive range of measurement sweep parameters and high-density sweeping of the frequency axis**
  Frequency, AC amplitude, DC bias, Time
- **Various functions that increase the reliability of the measured data**
  Open-short correction, equalization
- **Amplitude compression (pseudo-constant current output measurement)**
- **A wide array of optional peripheral devices are available, such as a power amplifier for amplifying the driving signal and fixtures for the measurement of various items.**

Upgraded measurement and analysis efficiency! Smooth utilization of data and smooth system linkages

- **Administration of measurement conditions and results data**
- **Automatic repetition measurement**
- **Measurement support**
- **Linkage with external devices**
  Control I/O 8 channels
- **Data logging**
  Equipped for analog signal input
- **Linkage with the user system**
  A software developer kit (SDK) is provided.

User-friendliness and data management just like those of a personal computer



Results from a simulator: Who knows what they mean? Conventional LCR meters and impedance analyzers can't measure what you need!

▲Example of system configuration

To correctly evaluate the characteristics of electronic components and circuits, it's fundamental to make measurements in an actual operating environment.

■ Impedance measurement of electronic parts.

Inductors and capacitor are used in large quantities in electronic equipment. To design high-performance equipment, it' s extremely important to accurately know the characteristics of electronic components used in equipment. LCR meters or impedance analyzers are generally used for measuring electronics components; however, measurable voltage and current are as small as a few volts and about sevral milliamperes. Some components are used under a voltage of 100V or higher and current of 10A or higher. The values measured by LCR meters and impedance analyzers may differ from those of actual operating conditions.

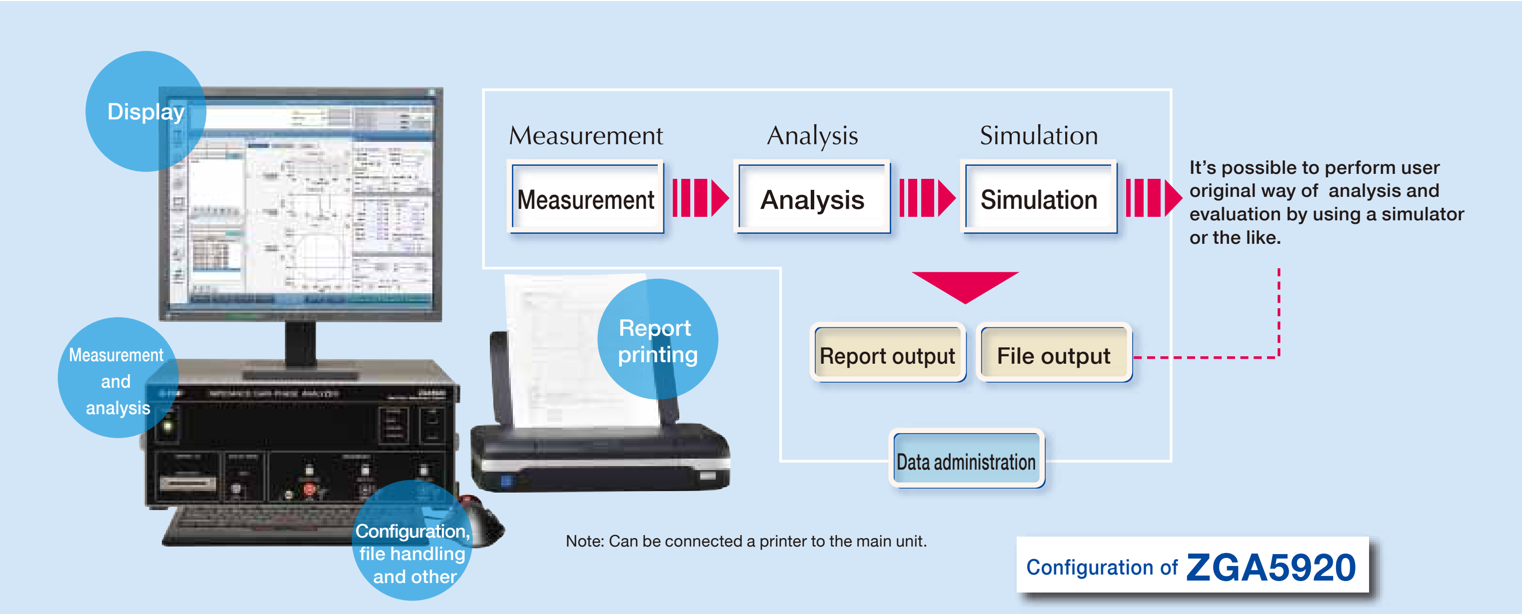
ZGA5920 provides measurements under actual operating conditions, with its
- High-voltage input, • Wide dynamic range, • Isolation between inputs and outputs,
- High-voltage, high-current power driver amplifier and
- Measurement adapter with a current detector circuit.

In measuring and evaluating piezoelectric elements that are used as actuators, it really excels.

■Measurement of loop gain of the switching regulator

To evaluate the stability of the circuit, loop gain is measured.

ZGA5920:
- Injects the signal into the loop, and measures the open loop gain under closed loop operating conditions.
- Automatically calculates the phase margin and the gain margin that are used in quantitatively evaluating stability.



Configuration of **ZGA5920**

It can measure 11 types of measurement objects and 22 measurement parameters.

The measurement results can be provided, without complicated calculations or data processing, in a diagram according to the required use. Calculation for the equivalent circuit constant and analysis of transfer function identification are also provided. It' s possible to utilize measured and analyzed data in various ways, for example by loading the identified transfer function data into a simulation tool such as MATLAB.

Measurement objects / **Measurement and analysis parameters**

- ● Measurement parameters
- ■ Analysis and calculation

Electronic Materials

Piezoelectric material
- ● Admittance ● Phase
- ● Conductance ● Susceptance
- ■ Parameter extraction
- ■ Matching inductance
- ■ Parameter simulation

Dielectric material
- ● Parallel capacitance
- ● Parallel resistance
- ■ Dielectric permittivity
- ■ Dissipation factor

Magnetic material
- ● Series self-inductance
- ● Series resistance
- ■ Magnetic permittivity
- ■ Dissipation factor

Electronic & Electrical Components

Inductor
- ● Series self-inductance
- ● Parallel self-inductance
- ● Series resistance
- ● Parallel resistance
- ● Phase ● Quality factor
- ■ Equivalent circuit estimation
- ■ Equivalent circuit simulation

Capacitor
- ● Series capacitance
- ● Parallel capacitance
- ● Series resistance
- ● Phase ● Dissipation factor
- ● Quality factor
- ■ Equivalent circuit estimation
- ■ Equivalent circuit simulation

Resistor
- ● Impedance
- ● Resistance
- ● Reactance
- ● Phase
- ■ Equivalent circuit estimation
- ■ Equivalent circuit simulation

Transformer
- ● Leakage inductance
- ● Turn ratio
- ■ Mutual inductance
- ■ Coupling coefficient

Diode
- ● CV characteristics
- ● Parallel capacitance
- ● Quality factor
- ■ Tuning characteristics simulation

Electronic Circuits

Servo
- ● Loop gain characteristics
- ● Closed loop characteristics
- ● Open loop characteristics
- ● Feedback transfer function
- ■ Phase margin, gain margin
- ■ Circuit model identification
- ■ Circuit model simulation

Amplifier Circuit
- ● Gain-phase characteristics
- ● CMRR characteristics
- ● PSRR characteristics
- ● Saturation characteristics
- ● Differential gain/phase characteristics
- ■ Transfer function identification
- ■ Transfer function simulation

Filter Circuit
- ● Frequency characteristics
- ■ Transfer function identification
- ■ Transfer function simulation

Impedance measurement | **Gain-phase measurement**

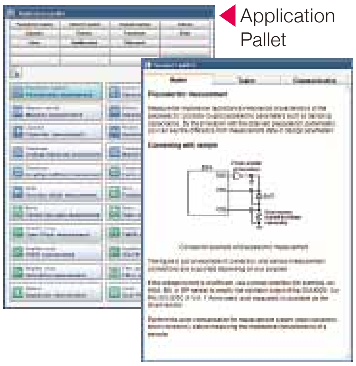
A/D converted input signals undergo discrete Fourier transform (DFT) to calculate complex impedance values and obtain parameters and characteristics specific to the DUT, such as its capacitance, inductance and quality factor. Original NF algorithms are also applied to allow equivalent circuits made up of R, L and C along with the constants for those circuits to be estimated from the complex impedance spectrum obtained by sweeping the frequencies.
In servo analysis, data such as the loop cycle gain and closed-loop gain are used to obtain transfer functions (circuit model) and run simulations of the loop cycle gain and closed-loop gain.
This highly detailed and integrated analysis of a wide range of diverse characteristics makes this analyzer invaluable not just for materials research and the development of application products, but for problem solving in all sorts of fields.
For measurements that are not among the 11 prepared types of measurement objects, User original way of evaluation and analysis is supported by provision of the graph display, data output and correction functions.

Measurement and data administration can be comprehensively set in one window.

Preparation ▶ Setting ▶ Measurement ▶ Analysis ▶ Simulation ▶ Report

Measurement, Analysis and Simulation

●Preparation



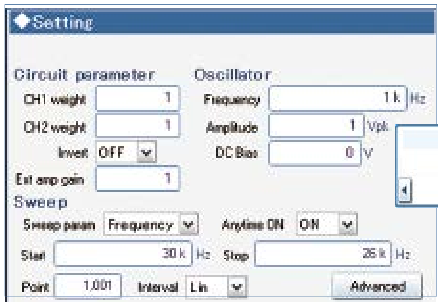
Application Pallet

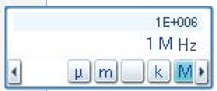
Measurement Support Information

From your first use of ZGA5920, the measurement objects and measurement parameters are easily selected on the Application Pallet.
The measurement, analysis and simulation windows can be directly activated whenever the power is turned on after that.
Measurement support information is provided on the Support Pallet.

●Setting the measurement conditions

Input the values in the displayed measurement parameter field.

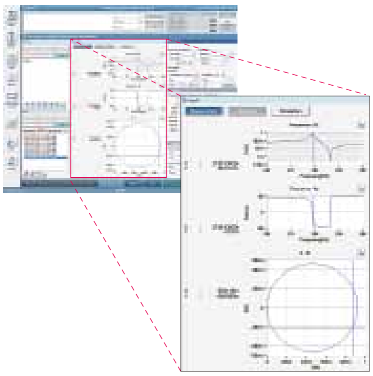




Unit setting is easy on the Number Input Pallet.

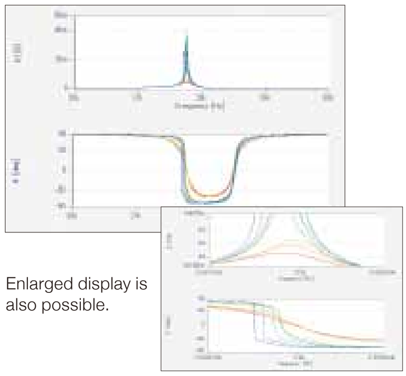
●Graph display of the measurement results

The measurement results are displayed as a graph. "Graph Details" lists all the types of graphs that can be used to display the measurement results. It's also equipped with a graph overwriting function and a marker for reading the values.



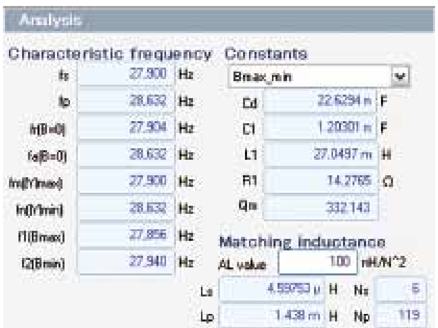
Graph Details

Overwriting



Enlarged display is also possible.

●Analysis



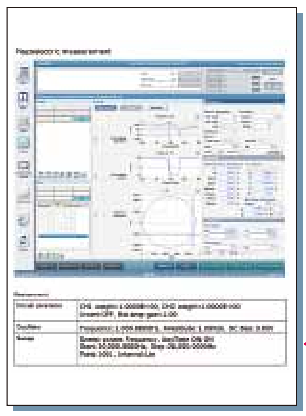
Based on the measurement results, the parameters specific to the measurement object are analyzed.
For piezoelectric materials, response frequencies such as the resonance frequency are extracted and the piezoelectric constant is estimated.
It's possible to estimate the matching inductance between the piezoelectric transducer and the driving circuit.

●Simulation

Simulation can be executed by freely changing the parameters.
The characteristics are displayed on the graph.

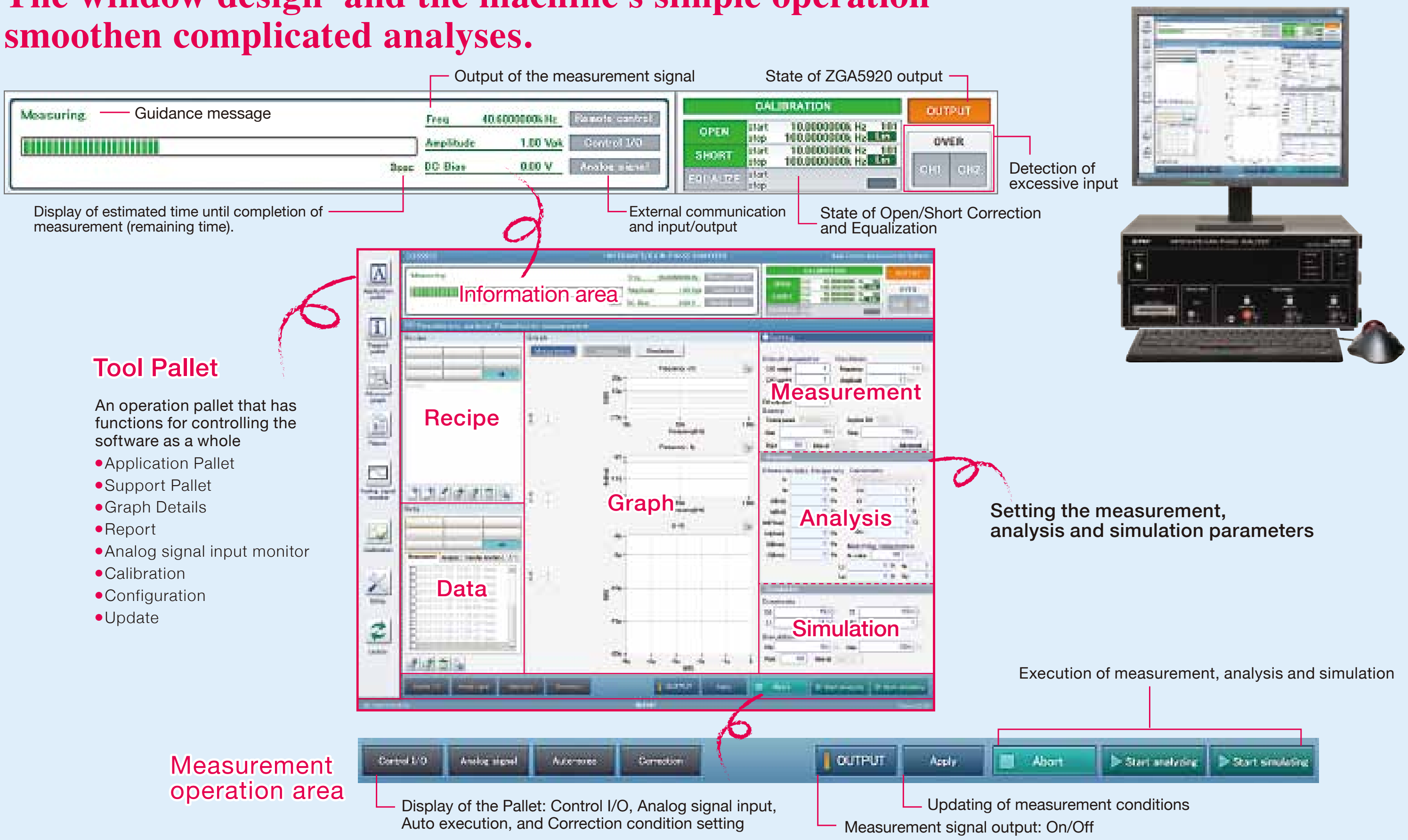
●Report output

The measurement results are saved as a printable PDF. It' s possible for the user to create a PDF template file.
The characteristic graph can be saved as a BMP file.



Report output in PDF format.

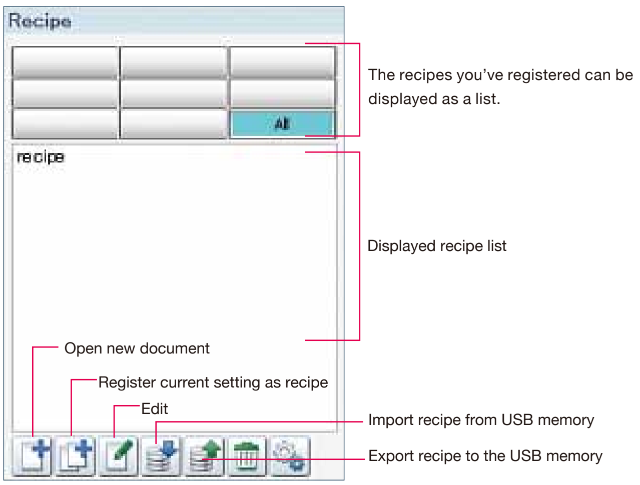
The window design and the machine's simple operation smoothen complicated analyses.



Data Administration

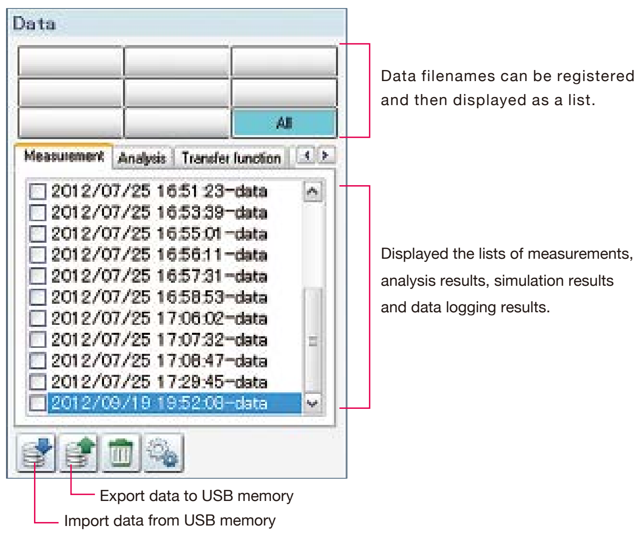
●Recipe

This is a function for administering the measurement conditions of the application. The measurement, analysis and simulation conditions and correction values can be pre-registered for each specimen to be measured, which makes it unnecessary to set the conditions for each measurement.



●Data

This is a function for administering the results of measurement, analysis and simulation.



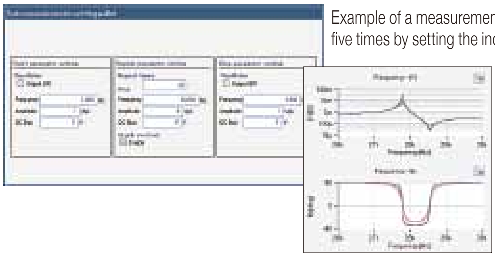
■Recipe, measurement and analysis data, simulation data, and analog input data are saved in XML format, and transfer function data are saved in TXT format.

■The import and export of various data is possible by using the dedicated utility software or USB memory.

Automated measurement, linkage with the other systems and so on . . . The range of applications will expand.

Automatic Measurement

An automated increment of measurement signals can be set. It’s possible to assign measurement repetition by setting the increment of frequency, AC amplitude and DC bias. It’s possible to display up to the latest 16 measurement results by using the graph overlay function.
Even when ZGA5920 is linked with external devices, automated measurement is possible by means of the Control I/O.



Example of a measurement that was repeated five times by setting the increment of AC amplitude as 1V.

Data Logger

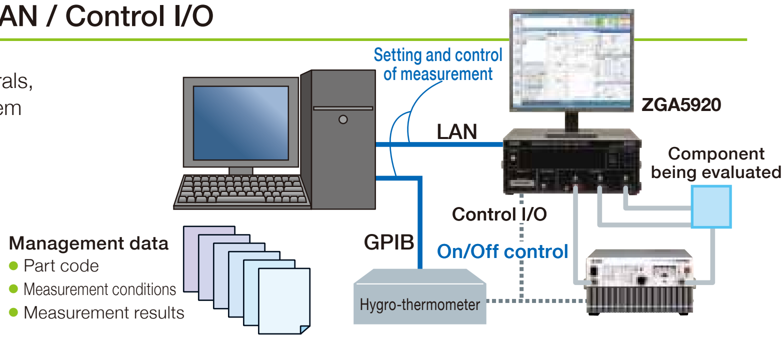
ZGA5920 is equipped with an analog signal input function with the input range of ±10V.
It’s possible to log any necessary data, such as temperature and humidity. Data logging starts with Measurement Start/End and Output On/Off. Setting of delay time is also possible.
The input signal during data logging can be monitored by using the Analog Signal Input Monitor of the Tool Pallet.

Linkage with Other Systems　LAN / Control I/O

LAN interface and Control I/O are included as standard peripherals, and it’s possible to flexibly configure a test and evaluation system combined with external measurement devices.

Example of system configuration:

Electronic Components Evaluation Test Management System



Software Developer Kit (SDK) and Utility Software

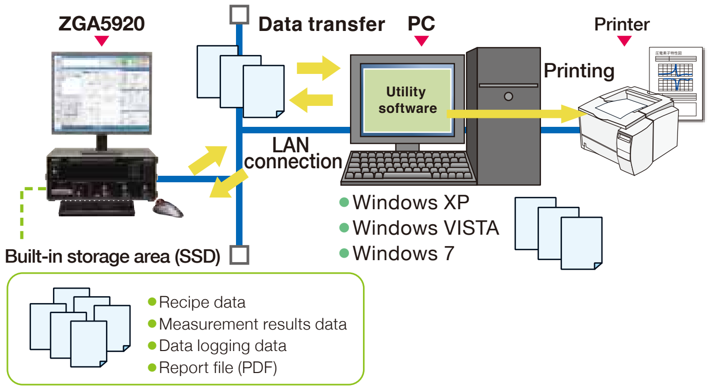
●ZGA5920 Utility Software

This PC application is used for retrieving ZGA5920 data by file and printing them out.

●ZGA5920 Software Developer Kit (SDK)

Controlling ZGA5920 and transferring recipes and measurement results are possible in an ordinary PC programming environment.

■Development environment
Microsoft123　Visual Studio 2008
.NET Framework 3.5
■Development language
Visual Basic 2008／Visual C++ 2008／Visual C# 2008



Real-Driven Measurement Systems

The four-quadrant output facilitate a stable output either with L load or C load.

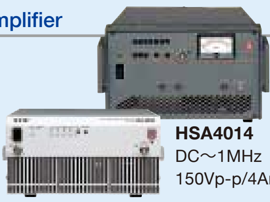
Drive amplifier

Measurement under actual operating conditions including those of high voltage or large current is possible by amplifying the signal output of ZGA5920 using a bipolar power amplifier.
The bipolar power amplifier is used mainly for measuring the impedance of electronic materials and parts.

High-speed bipolar power amplifier

BA Series/HSA Series

- Max. 300Vp-p / Max. 4Arms
- DC - max. 50MHz
- Four-quadrant operation
- BA Series: 2 Models
  HSA Series: 6 Models
  Any of several variations of frequencies, output voltages and output currents can be selected.



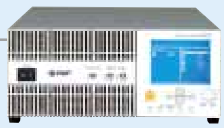
HSA4014
DC～1MHz
150Vp-p/4Arms

BA4850
DC～50MHz、±20V/±1A

Bipolar DC power supply

BP Series

- High voltage: ±60V ● DC - 150kHz
- High current
  ±10A (BP4610)／±20A (BP4620)
- Constant voltage / Constant current operation
- voltage and current: four-quadrant operation



BP4610
DC～150kHz, ±60V/±10A
CV/CC

High-Power Impedance Measurement Adapter: PA-001-1840/PA-001-1841

Impedance measurement of large amplitude (max. 250Vms / 1Arms) can be done in combination with the bipolar power supply.

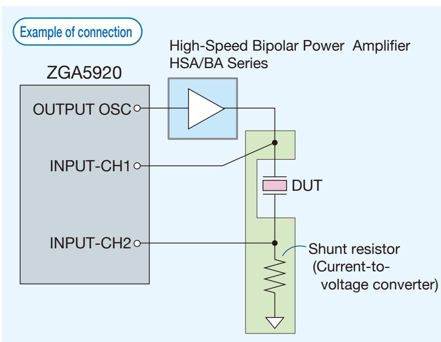
Examples of Measurement and Analysis

	Measurement objects	Sweep parameters: Frequency	DC bias	AC amplitude	Time	Measurement parameters	Analysis and calculation
	Piezoelectric material	○	—	—	○	Admittance (|Y| [S]), phase (θ [deg]), Conductance (G [S]), susceptance (B [S])	Characteristic frequency, piezoelectric parameter
	Dielectric material	○	○	—	○	Parallel capacitance (Cp [F]), parallel resistance (Rp [Ω])	Dielectric permittivity (εs、εs′、εs″), dissipation factor (tanδ)
	Magnetic material	○	○	—	○	Series self-inductance (Ls [H]), series resistance (Rs [Ω])	Magnetic permittivity (μs、μs′、μs″), dissipation factor (tanδ)
	Inductor	○	○	○	○	Series self-inductance (Ls [H]), parallel self-inductance (Ls [H]), series resistance (Rs [Ω]), parallel resistance (Rs [Ω]), phase (θ [deg]), quality factor (Q)	Equivalent circuit estimation, equivalent circuit estimation
	Capacitor	○	○	○	○	Series capacitance (Cs [F]), parallel capacitance (Cp [F]), series resistance (RS [Ω]), parallel resistance (RS [Ω]), phase (θ [deg]), dissipation factor (D), quality factor (Q)	Equivalent circuit estimation, equivalent circuit estimation
	Resistor	○	○	○	○	impedance (Z [Ω]), phase (θ [deg]), resistance (R[Ω]), reactance (X [Ω]),	Equivalent circuit estimation, equivalent circuit estimation
Transformer	Leakage inductance	○	—	—	○	Lleak [H]	—
Transformer	Mutual inductance	○	—	—	—	Inductance ([H])	Mutual inductance (M[H])
Transformer	Coupling coefficient	○	—	—	—	Inductance ([H])	Coupling coefficient (k)
Transformer	Turn ratio	○	—	—	○	Turn ratio (Nr)	—
	Diode	○	○	—	○	Parallel capacitance (Cp [F]), quality factor (Q)	Tuning characteristic simulation (resonance frequency [Hz])
Servo	Loop gain characteristic	○	—	—	—	Gain, phase [deg], real part of gain, imaginary part of gain	Phase margin [deg], gain margin [dB], loop bandwidth [Hz]
Servo	Closed loop gain characteristic	○	—	—	—	Gain, phase [deg]	Phase margin [deg], gain margin [dB], loop bandwidth [Hz], closed to open loop conversion, circuit model identification and simulation
Servo	Open loop gain characteristic	○	—	—	—	Gain, phase [deg]	Phase margin [deg], gain margin [dB], loop bandwidth [Hz], open to closed loop conversion, circuit model identification and simulation
Amplifier circuit	Gain-phase characteristics	○	—	—	○	Gain, phase [deg], group delay [s]	Transfer function identification and simulation
Amplifier circuit	CMRR characteristics	○	—	—	—	Gain, phase [deg]	CMRR characteristics diagram
Amplifier circuit	PSRR characteristics	○	—	—	—	PSRR	—
Amplifier circuit	Differential gain / differential phase characteristics	—	○	—	—	Gain, phase [deg]	—
Amplifier circuit	Saturation characteristics	—	—	○	—	Gain (deviation from max. gain)	1dB compression level ([Vpk] / [dB])
	Filter circuit	○	—	—	—	Gain, phase [deg], group delay [s]	Low-pass cutoff frequency [Hz], high-pass cutoff frequency [Hz], pass band gain.max. attenuation, pass-band ripple, BEF attenuation, BPF bandwidth [Hz], transfer function identification and simulation

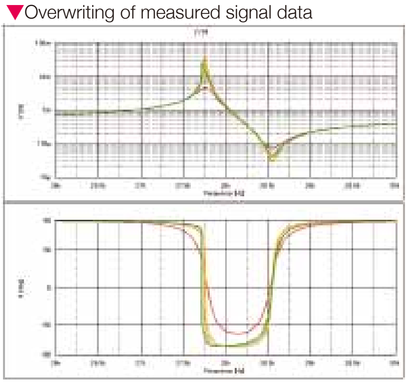
Following is an introduction of representative examples of measurements and analyses of 11 types of measurement objects and examples of high-voltage, high-current measurements and analyses achieved by using a drive amplifier and a measurement adapter.

Piezoelectric material

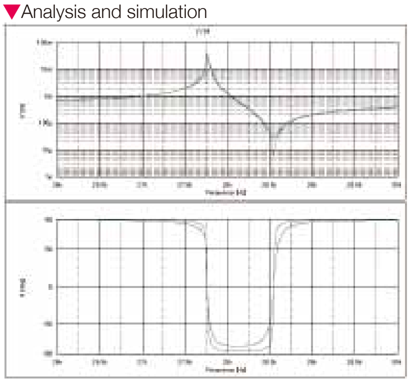
The resonance responses can be measured at the same signal level as when the sample is actually used.
The signal level of general impedance analyzers is about 1V or lower, so the resulting responses may differ greatly from the responses under actual operating conditions.

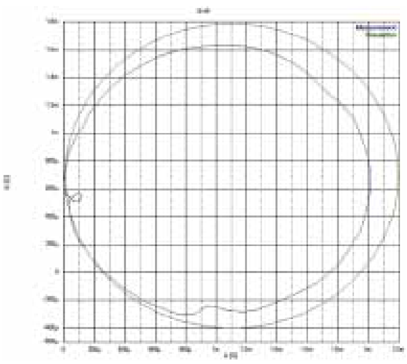


▼Overwriting of measured signal data



▼Analysis and simulation

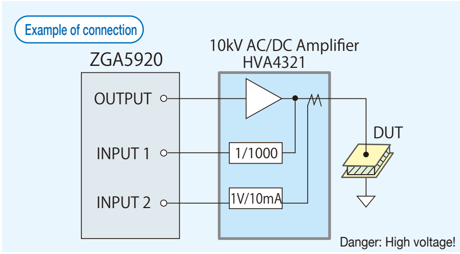


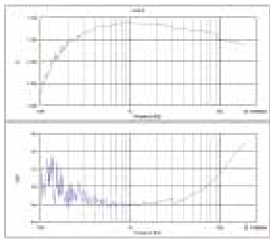


Examples of Measurements and Analyses

Dielectric material

The dielectric permittivity can be measured by applying the DC bias/ AC signal with a maximum of 10kV to the DUT (dielectric material) with electrodes attached.

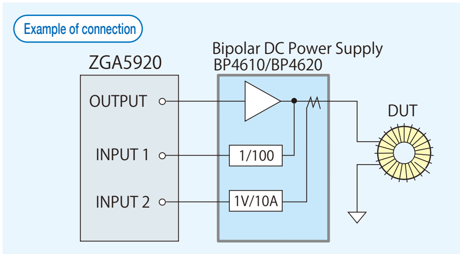


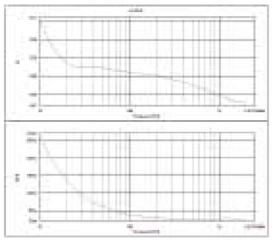


▲Calculation of dielectric permittivity

Magnetic material

Magnetic permittivity can be measured by applying DC bias /AC signals of a maximum of 20A to the DUT (magnetic material) which is wrapped with an inductor.

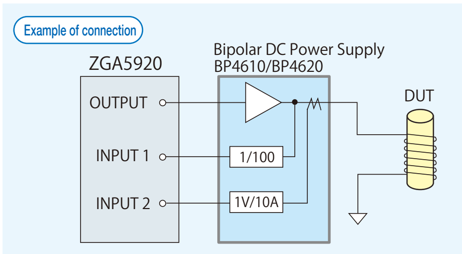


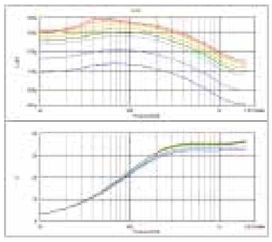


▲Determination of magnetic permittivity

Inductor

The impedance can be measured by applying DC superposed current and a signal current of a maximum of 20A.



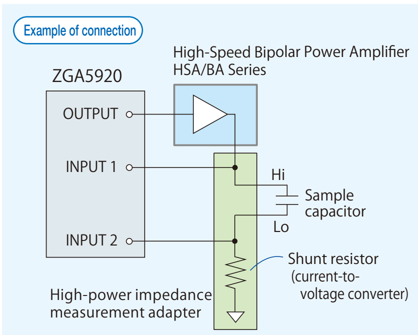


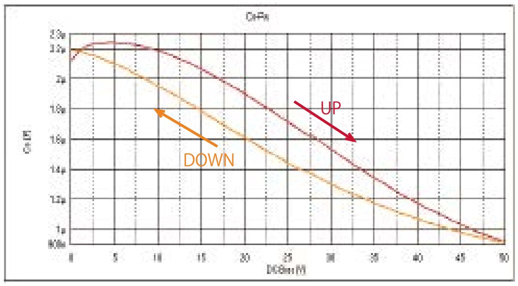
▲Overlay of measurement data for each bias current

Capacitor

Example of laminated ceramic capacitor

The DC bias dependence of laminated ceramic capacitor (those with high dielectric permittivity) can be measured by applying the DC bias sweep at a maximum of ±300V. A high-power impedance measurement adapter facilitates an easy connection for measurement.



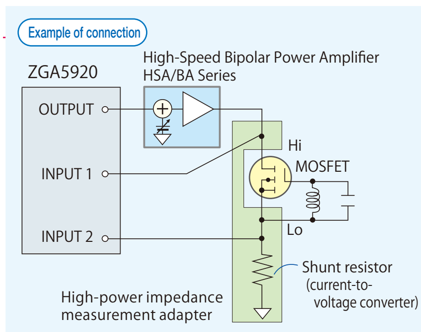


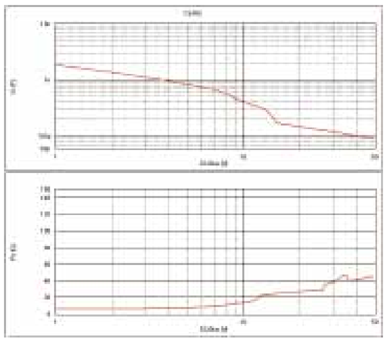
▲Hysteresis measurement for a capacitor by DC bias sweep direction

■Application of capacitor measurement

Measurement of the capacity between terminals of the power MOSFET

The capacity between terminals can be measured by applying DC bias with maximum of ±300V.

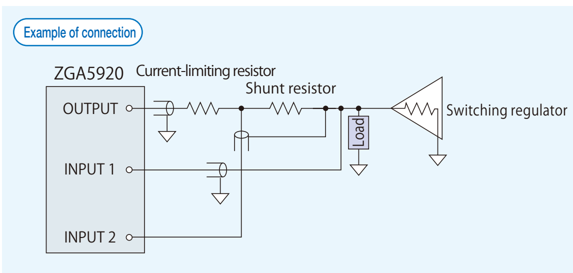


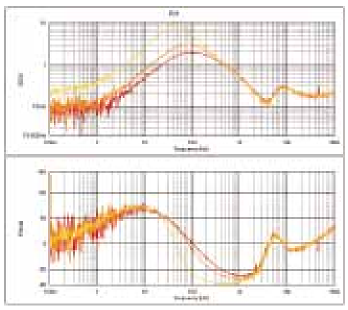


◀Measurement of the capacitance between the MOSFET drain and source

Resistor

The output impedance can be measured for a power source or an amplifier circuit with one line grounded.
LCR meters or impedance analyzers cannot measure the impedance of a DUT single-ended.

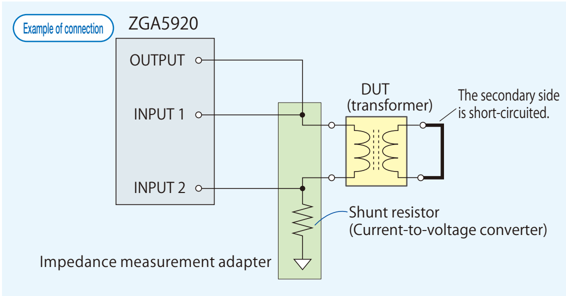




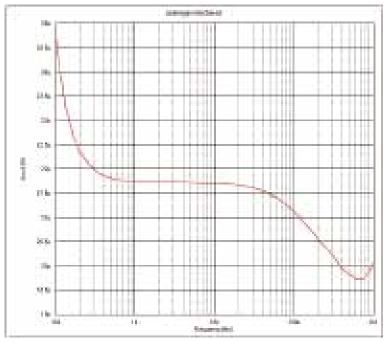
Output impedance of a switching regulator for each load▶

Transformer

In addition to measuring leakage inductance, it's possible to measure the mutual inductance and the coupling coefficient.
The impedance measurement adapter facilitates an easy connection for measurements.

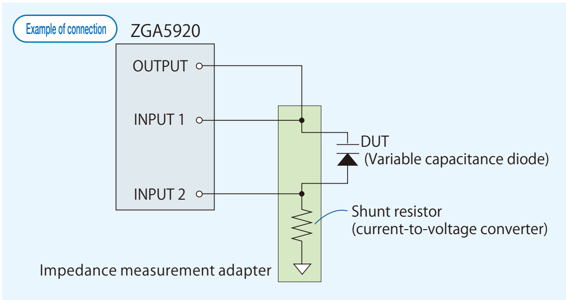


Leakage inductance measurement

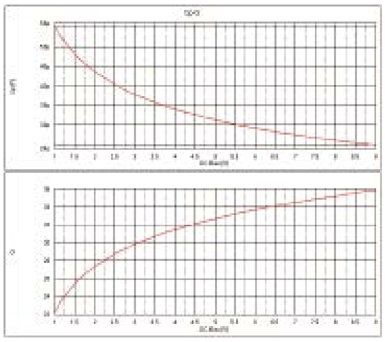


Diode

The tuning characteristic can be simulated by measuring the CV responses.
Connection for measurements is easily done by using the impedance measurement adapter.

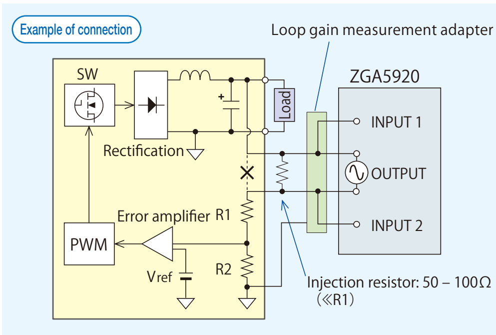


CV responses of the diode

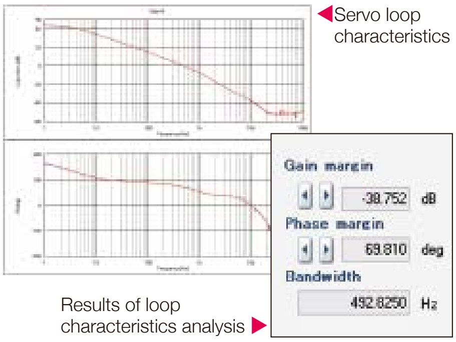


Servo

The loop gain characteristics of the switching regulator can be measured by applying a maximum output voltage of 200V.
Automatic search for the phase margin and the gain margin makes it possible to quantitatively evaluate the loop gain stability.



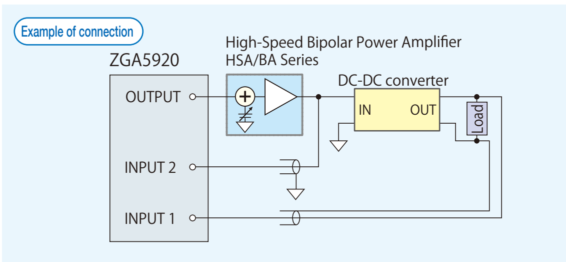
Servo loop characteristics



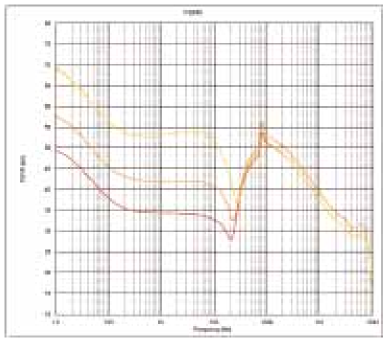
Results of loop characteristics analysis

Amplifier circuit

The PSRR (power supply rejection ratio) of a DC-DC converter can be measured.

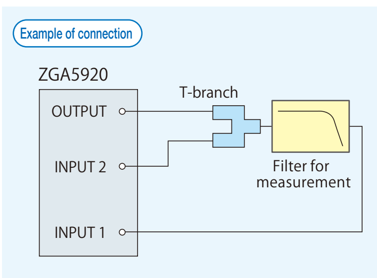


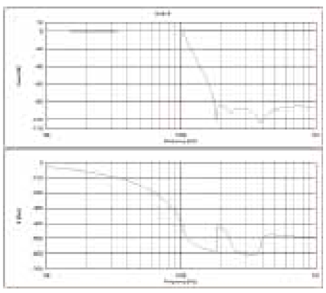
The PSRR characteristics of a DC-DC converter



Filter circuit

Basic parameters such as the -3dB frequency (cutoff frequency) and the pass band ripple are automatically extracted and displayed based on the measured filter responses.





Frequency responses of the LPF

Specifications

■ Analysis Processing

Basic mode	Impedance measurement function	Measures and displays the complex impedance and phase characteristics of a sample Graph format: Bode diagram, Nyquist diagram, Cole Cole plot Measurement item: |Z|, |Y|, θ, R, X, G, B Open/short correction function
	Gain-phase measurement function	Measures and displays the complex gain and phase Graph format: Bode diagram, Nyquist diagram Measurement items: |R|,θ, A (real part of gain), B (imaginary part of gain), Equalization function
Advanced mode		Refer to p. 3 to 6

■ Display Range and Measurement Accuracy

Conditions;

- 100 Hz < Measurement frequency range ≤ 20 kHz
- Immediately after calibration
- Measurement signal input voltages are from 100 mVpeak to 10 Vpeak (up to 2 Vpeak over 2.2 MHz)
- Accuracy when measuring impedances, using "Shunt Resistor PA-001-0370"

Parameters with a subscript x (θx, tanδx, Qx and kx) are obtained from actual measurements. Simbol " * " indicates accuracy of the value itself, not the percent (%).

▼ Basic Mode

Impedance Measurement

Parameter	Display range	Measurement accuracy
|Z| [Ω]	± (1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5%
R [Ω]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx|>5 deg)
X [Ω]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
G [S]		±1.5% (|θx| ≤5 deg) ±1.5%/cosθx (|θx| >5 deg)
B [S]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg

Gain-Phase Measurement

Parameter	Display range	Measurement accuracy
Gain [dB]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.05 dB
Real part of gain A	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±0.5% (|θx| ≤ 5 deg, 175 deg ≤ |θx|) ±0.5%/cosθx (5 deg<|θx|<175 deg)
Imaginary part of gain B		±0.5% (85 deg ≤ |θx| ≤ 95 deg) ±0.5%/sinθx (|θx| < 85 deg, 95 deg < |θx|)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg

▼ Advanced Mode

Piezoelectric Material

Parameter	Display range	Measurement accuracy
|Y| [S]	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5%
G [S]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
B [S]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg

Dielectric Material

Parameter	Display range	Measurement accuracy
Cp [F]	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Rp [Ω]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
εs		±1.5%
tanδ	±(0.000001 to 99,999.9) and 0, up to 6 digits	±0.015 (|tanδx| < 0.1) *
εs'	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|tanδx| ≤ 0.1) ±1.5%/sinθx (|tanδx| > 0.1)
εs"		±1.5% (|tanδx| ≥ 10) ±1.5%/cosθx (|tanδx| < 10)

Magnetic Material

Parameter	Display range	Measurement accuracy
Ls [H]	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Rs [Ω]		±1.5% (|θx| ≤ 5deg) ±1.5%/cosθx (|θx| > 5 deg)
μs		±1.5%
tanδ	±(0.000001 to 99,999.9) and 0, up to 6 digits	±0.015 (|tanδx| < 0.1) *
μs'	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|tanδx| ≤ 0.1) ±1.5%/sinθx (|tanδx| > 0.1)
μs"		±1.5% (|tanδx| ≥ 10) ±1.5%/cosθx (|tanδx| < 10)

Inductor

Parameter	Display range	Measurement accuracy
Ls [H]	(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Lp [H]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Rs [Ω]		±1.5% (|θx|≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
Rp [Ω]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg
Q	(0.000001 to 99,999.9) and 0, up to 6 digits	±Qx²×0.0052 / (1-0.0052Qx) *

Capacitor

Parameter	Display range	Measurement Accuracy
Cs [F]	(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Cp [F]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Rs [Ω]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
Rp [Ω]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg
Q	±(0.000001 to 99,999.9) and 0, up to 6 digits	±Qx²×0.0052 / (1-0.0052Qx) *
D		±0.015 (|tanδx| < 0.1) *

Resistor

Parameter	Display range	Measurement accuracy
|Z| [Ω]	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5%
R [Ω]		±1.5% (|θx| ≤ 5 deg) ±1.5%/cosθx (|θx| > 5 deg)
X [Ω]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg

Transformer

Parameter	Display range	Measurement accuracy
Leakage inductance Lleak [H]	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Inductance at aiding/ opposing connection Inductance [H]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Mutual inductance M [H]		±1.5%/sinθx (Inductance at aiding connection) >(Inductance at opposing connection ×10)
Inductance when secondary side is shorted/opened Inductance [H]		±1.5% (|θx| ≥ 85 deg) ±1.5%/sinθx (|θx| < 85 deg)
Coupling coefficient k	0.000 to 1.000 with 0.001 resolution	±0.03×(1-kx)%
Turn ratio Nr	0.0001 to 9,999, up to 4 digits	±1.5%

Diode

Parameter	Display range	Measurement accuracy
Cp [F]	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±1.5% (Qx ≥ 10) ±1.5%/sinθx (Qx < 10)
Q	±(0.000001 to 99,999.9) and 0, up to 6 digits	±Qx²×0.0052 / (1-0.0052Qx) *

Servo

Parameter	Display range	Measurement accuracy
Loop gain Gloop [dB]	-999.999 to +999.999 dB with 0.001 dB resolution	±0.05 dB
Real part of loop gain Real (Gloop)	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±0.5% (|θx| ≤ 5 deg, 175 deg ≤ |θx|) ±0.5%/cosθx (5 deg < |θx| < 175 deg)
Imaginary part of loop Imag (Gloop)		±0.5% (85 deg ≤ |θx| ≤ 95 deg) ±0.5%/sinθx (|θx| < 85 deg, 95 deg < |θx|)
Feedback gain Gfbk [dB]	-999.999 to +999.999 dB with 0.001 dB resolution	±0.05 dB
Real part of feedback gain Real (Gfbk)	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±0.5% (|θx| ≤ 5 deg, 175 deg ≤ |θx|) ±0.5%/cosθx (5 deg < |θx| < 175 deg)
Imaginary part of feedback gain Imag (Gfbk)		±0.5% (85 deg ≤ |θx| ≤ 95 deg) ±0.5%/sinθx (|θx| < 85 deg, 95 deg < |θx|)
Closed loop gain Gclose [dB]	-999.999 to +999.999 dB with 0.001 dB resolution	±0.05dB
Real part of closed loop gain Real (Gclose)	±(1E-18 to 999.999E+15) and 0, up to 6 digits	±0.5% (|θx| ≤ 5 deg, 175 deg ≤ |θx|) ±0.5%/cosθx (5 deg < |θx| < 175 deg)
Imaginary part of loop gain Imag (Gclose)		±0.5% (85 deg ≤ |θx| ≤ 95 deg) ±0.5%/sinθx (|θx| < 85 deg, 95 deg < |θx|)
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 dB resolution	±0.3 deg

Amplifier Circuit

Parameter	Display range	Measurement accuracy
Gain [dB]	-999.999 to +999.999 dB with 0.001 dB resolution	±0.05 dB
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg
Group delay GD [s]	±(1E-15 to 9,999.99) s and 0 s, up to 6 digits	$\pm\frac{1}{1200\times APT}$ s *1
Common-mode gain GainCOM [dB]	-999.999 to +999.999 dB with 0.001 dB resolution	±0.05 dB
Normal-mode gain GainNORM [dB]		±0.05 dB
CMRR [dB] (When normal-mode gain are measured)		±0.1 dB
CMRR [dB] (When normal-mode gain are setting constant)		±0.05 dB
PSRR [dB]		±0.05 dB
Differential gain DG [dB]		±0.05 dB
Differential phase DP [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg
ΔGain [dB] (circuit saturation characteristics measurement)	999.999 to +999.999 dB with 0.001 dB resolution	±0.1 dB

Filter Circuit

Parameter	Display range	Measurement accuracy
Gain [dB]	-999.999 to +999.999 dB with 0.001 dB resolution	±0.05 dB
θ [deg]	-9,999.999 to +9,999.999 deg with 0.001 deg resolution	±0.3 deg
Group delay GD [s]	±(1E-15 to 9,999.99) s and 0 s, up to 6 digits	$\pm\frac{1}{1200\times APT}$ s *1

*1 APT: aperture setting (Δf[Hz])

■ Measurement Processing

Auto ranging	Switches the input range in accordance with the input signal level.
Delay	Delays time until start of measurement following switching of frequency.
Integration	Integrates data for measurement, eliminating the noise.
Frequency axis high-density sweep (automatic slow high-density sweep)	When there is a wide variation in the measurement data, the sweep density is automatically increased for the adjacent frequency areas.
Amplitude compression	Controls the oscillation level so that the amplitude level of DUT may stay at certain value in order to keep the DUT from saturation and damage
Equalization (Gain-phase measurement)	Measures the gain-phase frequency response of measurement systems such as sensors and cables beforehand and then removes the error of the system in measurement to obtain the characteristics of the DUT only.
Open/short correction (Impedance measurement)	Measures the frequency response of the residual impedance and residual admittance for measurement systems such as shunt resistors and cables beforehand and then excludes the measurement system residual values in measurement to obtain the characteristics of the DUT only.
Calibration	System checking and self-error correction.

■ Analyzer Input (CH1/CH2)

Number of input channels	2 channels (The impedance measurement assumes the CH-1 as voltage and the CH-2 as a value converted from current to voltage.)
Connector	Insulated BNC connector
Input impedance	1 MΩ ±2%, 25 pF ±5 pF (parallel)
IMRR (Isolation mode rejection ratio)	Max. 120 dB (DC to 60 Hz) Applicable if a signal source impedance is smaller than 1 Ω
Isolation withstand voltage	250 Vrms continuous (between signal/ground and cabinet, between signal/ground and oscillator, between analysis input channels)
Max. measurement voltage	250 Vrms (when a supplied BNC cable is used)
Dynamic range	140 dB typ. (10Hz to 1MHz)

■ Oscillator (OSC)

Number of output channels	1
Connector	Insulated BNC connector
Output waveform/ Frequency range	Sine wave 0.1 mHz to 15 MHz, 0.1 mHz resolution
AC amplitude	0 V to 10 Vpeak (at no load)
DC bias	-10 V to +10 V (at no load)
Output impedance	50 Ω ±2% (at 1 kHz) , unbalanced (BNC junction)
Max. output voltage (AC+DC)	±10 V (at no load)
Sweep	Any of Frequency, Amplitude, DC bias, and Zero span (time)
Isolation withstand voltage	250 Vrms continuous (between signal/ground and cabinet, between signal/ground and analysis input)

■ Internal Storage

Measurement recipe, measurement result data, setting information, correction data, data logger data

■ External Storage

External memory	USB1.1 or USB2.0 compliant USB memory
Connector	Front panel, USB-A connector
File system	FAT32
Maximum capacity	32 GB
File type	Report output: PDF format Graph output: BMP format (hardcopy of graph area) Measurement recipe: XML format Measurement result data: XML format, transfer function: text format Data logger: WDB format (a proprietary binary file format)

■ Peripheral Input/Output Function

USB (host)	USB2.0, 6 ports, USB-A connector
USB (function) *2	USB1.1, 1 port, USB-B connector (USBTMC)
LAN (Ethernet)	10 BASE-T/100 BASE-TX/1000 BASE-T, 1 port, RJ-45 type, 8-pin modular jack
VGA	Analog RGB, Number of ports: 1, mini D-Sub 15-pin, female
DC power output	Power output connected to Signal Injector Probe 5055 *3
Control I/O	Control external devices and operate them in conjunction Signal input: 8 channels, TTL Input signals: Start measuring, abort measuring, output ON/OFF Output signals: Start measuring, complete measuring, elapsed time since the start of measurement, output ON/OFF, measuring/Idle
Analog signal input	Perform data logging in concert with measurements 1 channel, ±10 V, DC to 10 kHz

*2 Connect with an external PC when using ZGA5920 as an FRA compatible unit. *3 Sold separately

■ Miscellaneous Specifications

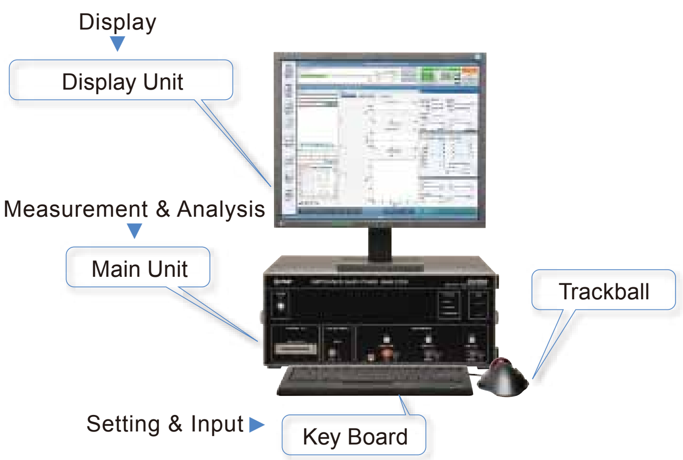
▼System common specifications

Power input	AC100 V to 132 V/180 V to 240 V, 50 Hz/60 Hz Overvoltage category: II
Ambient temperature/ humidity range (excluding printer)	Performance guaranteed *3 : +5˚C to +35˚C, 30% to 80% RH Storage conditions *3 : -10˚C to +50˚C, 30% to 80% RH Pollution degree: 2

Main unit	Power consumption: Max. 150 VA, Weight: approx. 12.5 kg Dimension: 430 (W) ×173 (H) ×438 (D) mm (without protrusions)
Monitor unit	1280×1024 dot, 19 inch, Power consumption: Max. 45 W Dimension: 405 (W) ×416 (H) ×205 (D) mm, Weight: approx. 6 kg
Key board unit	Power source: supplied from the main unit USB port Dimension: 338 (W) ×37 (H) ×251 (D) mm
Trackball unit	Power source: supplied from the keyboard USB port Dimension: 87 (W) ×43 (H) ×166 (D) mm

*3 no condensation

Configuration



Accessories

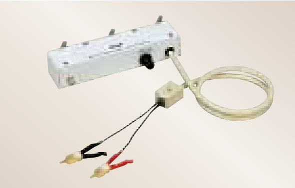
- CD-ROM 1
  ZGA5920 Utility Software
  ZGA5920 Software Developer Kit (SDK)
- ZGA5920 Instruction Manual 1
- Signal Cable (BNC-BNC 50 Ω, 1 m, 250 Vrms CAT I) 3
- BNC T-Branch (250 Vrms) 1
- Ferrite Core (clamp type) 1
- Power Code Set (2 m, with 3-prong plug) 1

Can be connected a printer to the main unit.
Recommended printer: HP Officejet 100, HP Officejet H470
*Inquire us about other connectable printers.

Measurement Adapters / Peripherals

For correct measurement, a correct connection with the DUT is important. Various measurement adapters and peripherals are provided for various measurement objects.

For impedance measurement



Impedance measurement adapter PA-001-0368

Measurement adapter that has built-in shunt resistors for current detection (1Ω, 10Ω, 100Ω)

Note: Analyzable frequencies: 200kHz or lower

High-power impedance measurement adapter PA-001-1840(1Ω) / PA-001-1841(100Ω)

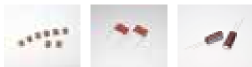
Voltage and current can be determined by simply connecting the sample with the adapter when an external amplifier is used. Two types of built-in shunt resistors (1Ω and 100Ω) are provided.

- Maximum voltage input: 250Vrms
- Maximum current input: 1Arms / (1Ω), 0.1Arms (100Ω)

Test fixture adapter PA-001-1838(1Ω) / PA-001-1839(100Ω)

This adapter allows impedance to be measured by connecting the adapter to various test fixtures and test leads of the LCR meter. Two types of built-in shunt resistors (1Ω and 100Ω) are provided.

It can be used with lead and chip parts of various shapes.

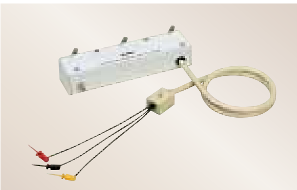


Test fixtures/leads for LCR meter

Shunt resistor PA-001-0370

Built-in 1Ω four-terminal resistors, and detects a maximum current of 1Arms.

For loop gain measurement

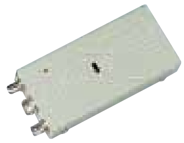


Loop gain measurement adapter PA-001-0369

This adapter is for measuring the loop gain of a negative feedback circuit in operation.

Signal injector probe 5055

This is a unit for measuring the loop gain characteristics of a servo system and the like while the loop closed. Measurement with small error is possible.



Ordering Information

Main machine

Type	Product name	Remarks
ZGA5920	Impedance / gain-phase analyzer	Accessories: CD-ROM (Utility software; Software Developer Kit), signal cables, BNC T-branch, a ferrite core and a power cable set

Options and peripherals

Type	Product name
PA-001-0368	Impedance measuring adapter
PA-001-1840	High power impedance measurement adapter (1Ω)
PA-001-1841	High power impedance measurement adapter (100Ω)
PA-001-1838	Conversion adapter for test fixtures (1Ω)
PA-001-1839	Conversion adapter for test fixtures (100Ω)
PA-001-0369	Loop gain measuring adapter
PA-001-0370	Shunt resistor
5055	Signal injector probe

Type	Product name
PA-001-0419	High Withstand Voltage clip set (3 per set)
PA-001-0420	High Withstand Voltage alligator clip cable set (small) (3 per set)
PA-001-0421	High Withstand Voltage e alligator clip cable set (large) (3 per set)
PA-001-0422	alligator clip cable set (3 per set)
PC-001-4503*	High Withstand Voltage BNC adapter (T-shaped divider)
PC-002-3347*	High Withstand Voltage BNC cable
PC-007-0364	High Withstand Voltage BNC extension cable
PC-007-1490	Kelvin clip for the impedance measuring adapter (for replacement)
PC-007-1922	Loop gain measuring adapter clip cable (for replacement)

*This is the same product as the one that comes with the main machine.

Note: The contents of this catalog are current as of February 1, 2013.

- External view and specifications are subject to change without prior notice.
- Please check the latest specifications, prices, and lead time for purchase.
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