COSINUS®
MESSTECHNIK GMBH

LCR Meter

ZM2371
ZM2372
ZM2376

- Maximum speed: 2 ms
- Basic accuracy: 0.08%

LCR meter series that achieves high-speed, high-precision stable measurements

For use in laboratories,
for use on production lines

LCR meter

NF's ZM series LCR meters cover a wide frequency range, from the low-frequency region of 1 mHz up to 5.5 MHz. Supports a wide range of applications, from materials research to component production lines, by means of high-speed, low measurement fluctuation.

1 mHz to 100 kHz

ZM2371

USB RS-232

ZM2372

USB GPIB RS-232

Handler interface Contact check function

1 mHz to 5.5 MHz

ZM2376

USB GPIB RS-232 LAN * *Option

Handler interface Contact check function

Lineup & Comparison sheet of specifications

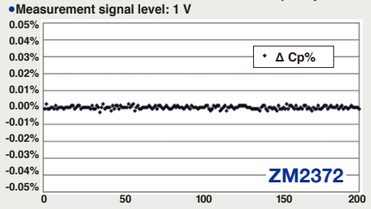
Specificatins & functions	ZM2371	ZM2372	ZM2376
Measurement parameters	Primary parameters: IZI, IYI, L, C, R, G Secondary parameters: Q, D, θ, X, B, Rs, Rp, G, Lp, Rdc		
Measurement frequency	1mHz to 100kHz		1mHz to 5.5MHz
Basic accuracy	0.08%		
Measurement signal level	10mVrms to 5Vrms, 1μArms to 200mArms		
Internal DC bias	0 to +2.5V		0 to +5V
Measurement time 1kHz	Maximum speed: 2ms		
Measurement time 1MHz	–	–	Maximum speed: 2ms
Constant voltage and Constant current mode (ALC)	○	○	○
Contact check	–	○ (4 terminals)	○
Low capacitance check	–	–	○
Comparator	○ (9 bins)	○ (14 bins)	○ (14 bins)
Multi-measurement	–	–	○ (32 steps)
Handler interface	–	○	○

Low measurement fluctuation result, excellent accuracy

Result using the ZM2376 and ZM2372 to measure a 1 nF and a 10 μF capacitor 200 times under the following conditions. With the ZM2376, the accuracy of the measurement has been improved further.

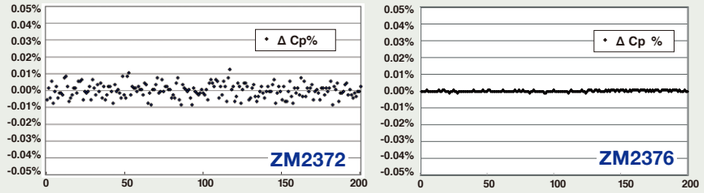
Measurement of 10 μF capacitor

●Measurement time: 10 ms ●Measurement frequency: 120 Hz
●Measurement signal level: 1 V



Measurement of 1nF capacitor

●Measurement time: 5 ms ●Measurement frequency: 100 kHz ●Measurement signal level: 1 V



Supports a wide range of high-speed, high-precision measurements

Wide measurement frequency range and high-resolution settings

ZM2371 and ZM2372 cover a frequency range of 1 mHz to 100 kHz, while ZM2376 covers frequencies from 1 mHz to 5.5 MHz. The resolution can be set to 5 digits or 6 digits* making it possible to perform measurements at frequencies actually used for a variety of components, in addition to evaluation of the frequency dependence of the parameters.

*ZM2371, ZM2372: 5 digits, ZM2376: 6 digits

High speed measurement

Measurement speed is selectable from 5 levels: RAP (rapid) , FAST, MED, SLOW and VSLO (very slow). When set to RAP, high-speed measurement at 2 ms (1 kHz/1 MHz) or 10 ms (120 Hz) can be performed. This high-speed, high-precision LCR meter will help to improve the measurement efficiency of production lines and automatic inspection equipment.

DC bias voltage

The built-in DC bias power supply of 0 to +2.5 V for ZM2371 and ZM2372, and 0 to +5 V for ZM2376 enables the measurement of polar components such as electrolytic capacitors.
With the ZM2376, high-speed impedance measurements, such as for lithium-ion batteries (single cell), are also possible. (See page 3.)
In addition, the use of an optional DC bias voltage adapter* makes it possible to apply a bias voltage of ± 40V to a sample enabling support for such measurements as the voltage dependence of high-capacity multi-layer ceramic capacitors.

*Option

Wide range of test signal and ALC functions

The measurement signal level can be set at a resolution of 3 digits to 10 mVrms to 5 Vrms, or 1 μArms to 200 mArms. In addition, by means of the automatic level control (ALC) functions, constant voltage and constant current mode can be set, making it possible to perform measurements with high reproducibility at a stable signal level that takes into account the voltage and current dependence of the sample.

High precision

With 0.08% basic accuracy, high-precision measurements with up to 6-digit resolution are achieved. Reliable measurements are essential for improving performance and quality, from the development of state-of-the-art devices to the component sorting on inspection lines.

DC resistance (DCR) measurement

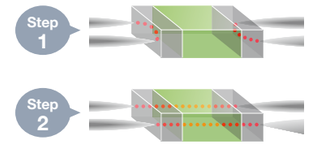
It is possible to perform DC resistance measurements on the winding resistance of such equipment as coils or transformers.
The measured values of the inductance can be displayed in the primary parameters at the same time as the DC resistance in the secondary parameters.

Enhanced features for production lines!

Contact check function

ZM2372 4 terminal contact check

In order to prevent measurement and selection errors due to poor contact between the measurement tip and components, ZM2372 performs a contact check measurement at four terminals to determine defects. This eliminates the output of defective products. (Additional time required for contact check: 4 ms)



Checks whether there is continuity along the dotted lines (contact check).

Determines there is a defect if the contact is defective.

After the contact check in Step 1, perform measurement along the dotted lines (main measurement).

▲ 4 terminal contact check (ZM2372)

ZM2376 Contact check and low capacitance check

Detects abnormally low capacitance, abnormal voltage and current, and can detect contact failures with little additional time.

Triggered synchronous drive

This function can be used to drive a sample for a period of time while contact is being made.
When performing measurements of large-capacity capacitors, it is possible to reduce the damage caused by the contact by removing the sample.
For samples with hysteresis characteristics, when measurements are performed in a short period of time, the measured values have larger fluctuations. By using triggered synchronous drive, the relationships between the time and the phase of the drive signal applied to each sample and the acquired signal are made constant. This suppresses deviations of the measured values and makes it possible to significantly reduce the measurement time.

Deviation display

When measuring a component, a preset value can be set and the deviation and the deviation % of the measured value compared with the preset can be displayed.
This can be useful for making acceptance judgments against standard component tolerance values as well as for temperature characteristic tests.

Comparator

A maximum of 14* primary parameters can be classified in bins, and measurement results can be sorted on a set of upper and lower limits that have been set by secondary parameters. Sorting is possible by measured value, deviation or deviation %, and the comparator results can be output to the handler interface*. In addition, a beeper can be turned on depending on the comparator results.
Using the limit determination function with the remote control interface, is also possible to determine the upper and lower limits (for each one set) of the primary parameters and secondary parameters.

*ZM2371: 9 classifications max. Not equipped with handler interface.

Multi-measurement ---- ZM2376

Multi-measurement is a function used for overall acceptance judgments by performing up to 32 steps for each sample. Multiple measurement conditions can be set for each step such as measurement frequency, measurement signal level, internal DC bias, and measurement parameters.
Measurements and limit determinations can be performed based on the set of upper and lower limits of the primary parameters and the set of upper and lower limits of the secondary parameters.

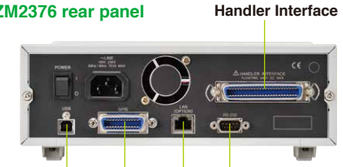
*This function available only on ZM2376.

Interfaces

Equipped with various standard interfaces for remote control. Integrates into production lines and automatic inspection systems without any additional options.

Interfaces	ZM2371	ZM2372	ZM2376
USB	○	○	○
RS-232	○	○	○
GPIB	–	○	○
LAN	–	–	○ (optional)
Handler	–	○	○

ZM2376 rear panel



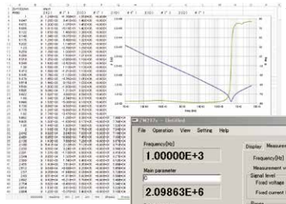
Other features

- Correction functions (Open correction, short correction, load correction, cable length correction)
- Setting and correction value memory (32 sets, switchable to be saved to non-volatile memory)
- Monitor display (voltage and current) ● Discharge protection ● Sample program (C #, VB.NET) included
- LabVIEW driver included (ZM2371 and ZM2372)
- IVI instrument drivers included (LabVIEW drivers automatically generated on the LabVIEW system) (ZM2376)

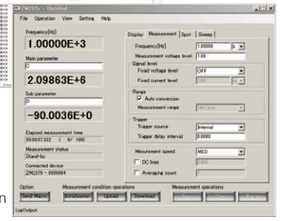
Application software (included as standard accessories)

Software capable of setting various measurement conditions and acquiring and displaying measurement data is included. Measurement data can be acquired in CSV file format, making it convenient to process very large amounts of data for research and development. In addition, measurement of impedance frequency characteristics is supported by means of frequency sweep measurement.

Main operation screen

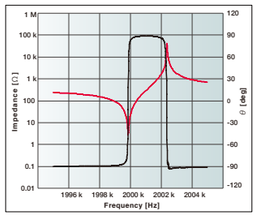


◀ Graph display using Excel



Main configuration screen ▶

Measurement example



*Measured in a small frequency interval

Operating environment

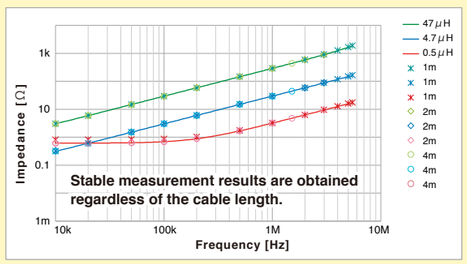
- OS: Windows 10, Windows 8.1, Windows 7,(32-bit / 64-bit)
- Interface: USB

To be able to save settings and measurement data in XLS format, Microsoft Excel 97 or later is required.

For integrating into component production lines and automatic sorting devices.

With measurements at a maximum speed of 2 ms and with small deviation, correction functions to suppress the influence of the cable connecting to the sample, comparator and contact check * functions, as well as handler interfaces* for automatic sorting, this LCR meter supports a variety of line needs.

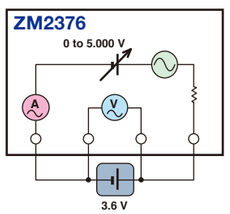
*ZM2371 is not equipped.



Inductor measurement example ▶
(Cable length 1 m, 2 m, 4 m)

For high-speed impedance measurements of lithium-ion batteries.

The internal DC bias voltage of ZM2376 can be set up to +5 V, enabling electromotive force of more than 3 V to be measured in lithium-ion batteries (single cell).
In addition, since measurements can be performed from a low frequency of 1 mHz, a detailed assessment of the internal impedance of the battery is possible.



	ZM2371	ZM2372	ZM2376
Measurement parameters			
Primary parameters	|Z|, |Y|, L, C, R, G For equivalent circuit of L, C, and R, Parallel / Series / Auto Selection are selectable.		
Secondary parameters	Q, D, θ, X, B, Rs, Rp, G, Lp, Rdc		
Auto parameter selection	Primary parameters (including equivalent circuit) and secondary parameters can be selected automatically.		
Measured value display range	*Actual measurement and display ranges of respective parameters are restricted by the measurement range or frequency.		
|Z|	0.000mΩ to 999.999MΩ		
R (R_S,R_P,R_{DC}), X	0Ω, ±(0.001mΩ to 999.999MΩ)		
|Y|	0.00nS to 9.99999kS		
G, B	0S, ±(0.01nS to 9.99999kS)		
C (C_P,C_S)	0F, ±(0.00001pF to 999.999kF)		0F, ±(0.00001pF to 99.9999kF)
L (L_S,L_P)	0H, ±(0.001nH to 99.9999GH)		0H, ±(0.00001nH to 9.99999GH)
Q, D	0, ±(0.00001 to 99999.9)		
θ	±180.000deg		
Measurement conditions			
Measurement frequency	Setting range:1mHz to 100kHz, Resolution 5 digits (1mHz when < 10Hz)		Setting range:1mHz to 5.5MHz, Resolution 6 digits (1mHz when < 100Hz)
	Accuracy: ±0.01%		
Measurement signal level	Setting range: 10mVrms to 5.00Vrms, Resolution 3 digits (1mVrms when < 100mVrms). RMS values at open output. (ZM2376: Limited by frequency and DC bias.)		
	Accuracy: ±(10%+5mV rms)		Accuracy: ±(8%+5mV rms)≦1MHz, ±(10%+5mV rms)>1MHz
Constant voltage mode / Constant current mode (ALC)	Constant voltage mode / Constant current mode / Disabled Voltage setting range:10mVrms to 5.00Vrms, Resolution: 3 digits(＜100mVrms：1mVrms) Current setting range: 1µArms to 200mArms, Resolution: 3 digits(＜10µArms：0.1µArms)		
Output impedance	5Ω/25Ω/100Ω Automatically selected according to the measurement range.		6Ω/25Ω/100Ω Automatically selected according to the measurement range.
Internal DC bias	Setting range: 0V to +2.50V, Resolution: 0.01V, Accuracy: ±(5%+3mV)		Setting range: 0V to +5V, Resolution: 1mV, Limited by the signal level
	It can be turned on / off at open output.		
Trigger source	INT: Internal (automatic continuous trigger), MAN: Manual, EXT: Handler interface, BUS: Remote control		
Trigger delay time	Setting range: 0.000s to 999.999s, Resolution: 0.001s (Time after input of trigger until start of signal acquisition)		Setting range: 0.0000s to 999.9999s, Resolution: 0.0001s (Time after input of trigger until start of signal acquisition)
Triggered drive	Selectable: Drive only at measurement / Continuous drive		
Measurement speed	RAPid/FAST/MEDium/SLOW/VerySLOw		
Measurement time (reference)	From trigger in to end of measurement signal *1, *2		
Measurement range	8 ranges (1MΩ, 100kΩ, 10kΩ, 1kΩ, 100Ω, 10Ω, 1Ω, 100mΩ)		
Measurement range selection	Auto/Manual		
Measurement accuracy			
Basic accuracy	0.08% Refer to appendix (ZM2371/ ZM2372: P. 5, ZM2376: P. 6)		
Other measurement related functions			
Correction function	Open, Short, Load and Cable Length		
Contact check	—	Detects a contact failure at four contact points Additional time 4ms (reference)	Detects of an abnormally low capacitance or abnormal voltage/current
Averaging	1 to 256 times		
Deviation measurement	Primary parameters/Secondary parameters: Deviation and deviation % from reference value can be displayed.		
Comparator	Primary parameters: Max. 9 bins Original measured value / Deviation / Deviation % can be sorted.	Primary parameters: Max. 14 bins Original measured value / Deviation / Deviation % can be sorted.	
	Secondary parameters: Upper limit and lower limit comparison. Original measured value / Deviation / Deviation % can be sorted.		
Handler interface	—	Signal isolation:All I/O signals are optically isolated (withstand voltage ±42V) Input signal: Trigger, Key lock, Settings/correction value memory designation. Output signal: Comparison result BIN1 to BIN11, NC / BIN12, PHI / BIN13, PLO / BIN14, OUT OF BINS, S-NG, ERR, INDEX, EOM (when BIN10 - BIN14 are used, NC, PHI, and PLO cannot be used).	
Multi-measurement	—		Execute measurement and limit comparison under multiple conditions for the total comparison. Maximum number of steps: 32
Monitor display	Voltage value applied to the DUT and current value flowing in the DUT.		
Remote control interface			
USB	USBTMC , USB1.1 Full-speed		
RS-232	Data rate: 4800bps to 230400bps		
GPIB	—	Conforms to IEEE 488.1 and IEEE 488.2 Standards	
LAN (optional)	—		10BASE-T, 100BASE-TX
General specifications			
Power supply	Voltage: AC 100V to 230V ±10%, but 250V or less		
	Frequency: 50/60Hz, ±2Hz		
	Power consumption: 70VA or less	Power consumption: 75VA or less	Power consumption: 75VA or less
	Overvoltage category II		
Environmental conditions	Operation: Temperature: 0 to +40°C. Humidity: 5 to 85%RH. (Absolute humidity 1 to 25g/m³, non-condensing.) Storage: Temperature: -10 to +50°C. Humidity: 5 to 95%RH. (Absolute humidity 1 to 29g/m³, non-condensing.) Pollution degree 2 (indoor use)		
Settings/correction value memory	32 sets. Settings and correction values can be saved and restore individually or together.		
Resume	Last setting and correction value are restore at power-on.		
External dimensions	260(W)×88(H)×220(D)mm (not including protuberances)		260(W)×88(H)×280(D)mm (not including protuberances)
Weight (without accessories)	Approx. 2.0kg	Approx. 2.1kg	Approx. 2.4kg
Accessories	Power code set (3 pole, 2m), Instruction manual, CD-ROM (application software, sample program), LabVIEW driver (ZM2371/ZM2372) IVI drivers (ZM2376).		

Measurement time (reference) ZM2371, ZM2372 *1: Appendix

Measurement frequency	RAP	FAST	MED	SLOW	VSLO
120 Hz	10 ms	10 ms	26 ms	126 ms	501 ms
1 kHz	2 ms	5 ms	25 ms	121 ms	501 ms
10 kHz	3 ms	5 ms	25 ms	122 ms	502 ms
100 kHz	3 ms	5 ms	25 ms	122 ms	502 ms

Measurement time (reference) ZM2376 *2: Appendix

Measurement frequency	RAP	FAST	MED	SLOW	VSLO
120 Hz	10 ms	10 ms	26 ms	126 ms	501 ms
1 kHz	2 ms	5 ms	25 ms	121 ms	501 ms
10 kHz	2 ms	5 ms	25 ms	121 ms	501 ms
100 kHz	2 ms	5 ms	25 ms	121 ms	501 ms
1 MHz	2 ms	5 ms	25 ms	121 ms	501 ms

Specification

Measurement accuracy ZM2371/ZM2372

● Impedance measurement accuracy

Zr: Measurement range (100mΩ to 1MΩ)
Zx: Measured value of impedance magnitude |Z|.
With the above definitions, the impedance measurement accuracy is obtained as follows:

Accuracy of impedance magnitude |Z| ±Az [%]

$$Az = (A + B \times U + Kz + Ky) \times V \times K_T + K_B \times U$$

Accuracy of phase angle θ of impedance ±Pz [°] **Pz = 0.573 × Az**

* The measurement accuracy when Az exceeds 10[%] is a reference.

* The measurement accuracy for the measured value smaller than half the lower limit of each recommended measurement range or larger than twice the upper limit is a reference.

Each parameter value in the expression is listed below.

● U : Ratio coefficient

Zx	U
>100Ω	Zx/Zr (1 when Zx / Zr < 1)
≦100Ω	Zr/Zx (1 when Zr / Zx < 1)

● V : Signal level coefficient

Measurement signal level [Vrms]	V(Zr=1MΩ, 100kΩ (>20kHz))			V(Zr=100kΩ (≦20kHz), 10kΩ, 1kΩ, 100Ω)			V(Zr=10Ω, 1Ω)			V(Zr=100mΩ)		
2<Level≦5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	3	2	1.3
1<Level≦2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.8	1.5	1.2
1	1	1	1	1	1	1	1	1	1	1	1	1
0.5<Level<1	1.4	1.2	1.2	1.4	1.2	1.2	1.5	1.5	1.2	2.5	2	1.2
0.2<Level≦0.5	1.4	1.3	1.3	1.4	1.3	1.3	2.5	2.2	1.3	3	3	1.3
0.1<Level≦0.2	2.2	2.2	1.4	1.4	1.4	1.4	3.5	3.5	1.4	×(0.5Vrms/ Measurement signal level [Vrms])		
0.05<Level≦0.1	2.5	2.5	1.6	1.8	1.6	1.6	×(0.2Vrms/ Measurement signal level [Vrms])					
0.02<Level≦0.05	×(0.1Vrms/ Measurement signal level [Vrms])			4	2.8	2						
0.01≦Level≦0.02				8	5	3						

Three coefficients in each column are applied to the measurement speeds RAP, FAST, MED from the left in order.
The coefficient for measurement speeds SLOW and VSLO is same as MED.
For FAST, the coefficient of MED is applied when measurement frequency≦40Hz.
For RAP, the coefficient of FAST when measurement frequency≦250Hz, or that of MED when measurement frequency≦40Hz is applied.
The coefficient varies depending on the frequency when measurement range Zr = 100kΩ.
At all times, V = 1 for the direct-current resistance Rdc.

● A (upper row): Basic coefficient[%] / B (lower row): Proportional coefficient[%]

・Each values in column "Left side" is FAST Mode, "Right side" is MED/SLOW/VSLO Mode.
・At RAP Mode: Measurement frequency ≦ 250Hz: Use FAST value, > 250Hz: Multiply FAST value by 1.3.

Measurement range Zr	Measurement frequency Hz																	
	0 (DC)		99.999 ↗ 1m		999.99 ↗ 100		1k		1.9884k ↗ 1.0001k		10k ↗ 1.9885k		20k ↗ 10.001k		50k ↗ 20.001k		100k ↗ 50.001k	
1 MΩ	0.14 0.02	0.14 0.02	0.50 0.30	0.50 0.30	0.15 0.025	0.15 0.025	0.12 0.03	0.10 0.02	0.15 0.03	0.15 0.03	0.25 0.03	0.25 0.03	0.25 0.03	0.25 0.03	—	—	—	—
100kΩ	0.12 0.01	0.12 0.01	0.25 0.04	0.25 0.04	0.15 0.02	0.15 0.02	0.09 0.01	0.09 0.01	0.10 0.015	0.10 0.015	0.20 0.025	0.20 0.025	0.25 0.03	0.25 0.03	0.30 0.03	0.30 0.03	0.80 0.03	0.80 0.03
10kΩ	0.09 0.01	0.09 0.01	0.20 0.03	0.20 0.03	0.15 0.02	0.15 0.02	0.08 0.01	0.07 0.01	0.09 0.01	0.09 0.01	0.16 0.015	0.16 0.015	0.20 0.02	0.20 0.02	0.25 0.03	0.25 0.03	0.80 0.03	0.80 0.03
1kΩ	0.09 0.01	0.09 0.01	0.20 0.03	0.20 0.03	0.15 0.02	0.15 0.02	0.08 0.01	0.07 0.01	0.09 0.01	0.09 0.01	0.16 0.015	0.16 0.015	0.20 0.02	0.20 0.02	0.25 0.03	0.25 0.03	0.30 0.03	0.30 0.03
100Ω	0.09 0.01	0.09 0.01	0.20 0.03	0.20 0.03	0.15 0.02	0.15 0.02	0.08 0.01	0.07 0.01	0.09 0.01	0.09 0.01	0.16 0.015	0.16 0.015	0.20 0.03	0.20 0.02	0.25 0.03	0.25 0.03	0.30 0.03	0.30 0.03
10Ω	0.12 0.02	0.12 0.02	0.25 0.03	0.25 0.03	0.17 0.02	0.17 0.02	0.13 0.015	0.12 0.01	0.15 0.02	0.15 0.015	0.20 0.02	0.20 0.017	0.40 0.08	0.40 0.03	0.45 0.08	0.45 0.05	0.50 0.08	0.50 0.06
1Ω	0.14 0.05	0.14 0.05	0.40 0.06	0.40 0.06	0.30 0.02	0.30 0.02	0.22 0.025	0.20 0.02	0.25 0.03	0.25 0.02	0.35 0.03	0.35 0.02	0.60 0.20	0.60 0.03	0.70 0.20	0.70 0.08	0.90 0.20	0.90 0.10
100mΩ	0.14 0.30	0.14 0.30	0.60 0.40	0.60 0.40	0.30 0.15	0.30 0.10	0.30 0.06	0.30 0.04	0.30 0.06	0.30 0.04	0.40 0.06	0.40 0.03	0.80 0.80	0.60 0.06	1.0 0.80	0.90 0.10	1.0 0.80	0.90 0.10

The measurement range "---" is not used.

● KB: DC bias coefficient

Internal DC bias	Measurement range Zr	KB[%]		
		Frequency≦1kHz	1kHz<Frequency ≦10kHz	Frequency>10kHz
Disabled	Full range	0	0	0
Enabled*1	1MΩ	0.005	0.02	0.02
	100kΩ	0.002	0.003	0.01
	100Ω, 1kΩ, 10kΩ	0.001	0.002	0.01
	10Ω	0.01	0.01	0.02
	100mΩ, 1Ω	0.05	0.1	0.2

*1: When open compensation and short compensation are performed at the conditions of internal DC bias enabled and the bias voltage 0V.
At all times, KB=0 for the direct-current resistance Rdc.

● KT: Temperature-dependent coefficient

Ambient temperature (T℃)	KT
0 to +18	1+0.1×(18-T)
+18 to +28	1
+28 to +40	1+0.1×(T-28)

● Ky: Residual admittance coefficient

Frequency range	Ky [%]
DC, frequency≦120Hz	Zx[Ω]/(3×10⁸)
120Hz<frequency≦100kHz	Zx[Ω]×frequency[kHz]/(3×10⁷)

● Kz: Residual impedance coefficient

Frequency range	Kz [%]
DC, frequency≦120Hz	(0.003+Kc)/Zx[Ω]
120Hz<frequency≦1kHz	(0.005+Kc)/Zx[Ω]
1kHz<frequency≦10kHz	(0.005+0.002×frequency[kHz]+Kc)/Zx[Ω]
10kHz<frequency≦100kHz	(0.0025×frequency[kHz]+Kc)/Zx[Ω]

Cable length coefficient Kc=0.001×Frequency[kHz]×(Cable length[m])²

● Other conditions

・Warm-up: 30 min or more
・Zero correction: Execute open correction and short correction
・Cable length correction: Execute according to the connection cable length.
・Calibration cycle 1 year

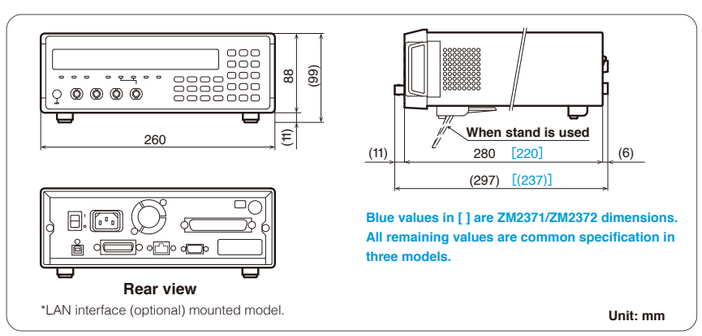
Cable length	Applicable frequency range
0m, 1m	Full range including DC
2m	DC, frequency≦20kHz
4m	DC, frequency≦1kHz

The measurement accuracy is not guaranteed for frequencies out of these ranges.

<Recommended measurement range>

Measurement range	Recommended range	Measurement range
1MΩ	1MΩ to 11MΩ	≧900kΩ
100kΩ	100kΩ to 1.1MΩ	≧90kΩ
10kΩ	10kΩ to 110kΩ	≧9kΩ
1kΩ	1kΩ to 11kΩ	≧0.9kΩ
100Ω	9Ω to 1.1kΩ	No limitation
10Ω	0.9Ω to 10Ω	≦11Ω
1Ω	90mΩ to 1Ω	≦1.1Ω
100mΩ	9mΩ to 100mΩ	≦110mΩ

External Dimensions ZM2376



Measurement range ZM2376

● Impedance measurement accuracy

Zr: Measurement range (100mΩ to 1MΩ)
Zx: Measured value of impedance magnitude |Z|.
With the above definitions, the impedance measurement accuracy is obtained as follows:

Accuracy of impedance magnitude |Z| ±Az [%]

Signal level ≦ 1V $Az = (A + B \times U + Kz + Ky) \times K_T + (Kv + KB) \times U$

Signal level＞ 1V $Az = (A + B \times U + Kz + Ky) \times K_T + Kv + KB \times U$

Accuracy of phase angle θ of impedance ±Pz [°] **Pz = 0.573 × Az**

* The measurement accuracy when Az exceeds 10 [%] is a reference.

* Excluding the highest and the lowest ranges available for each frequency, the measurement accuracy for the measured value smaller than half the lower limit of each recommended measurement range or larger than twice the upper limit is a reference.

Each parameter value in the expression is listed below.

* If the measureable range for the 10Ω range becomes unlimited depending on the minimum output impedance setting,the following values should be used.

Zx	U
>10Ω	Zx/Zr (1 when Zx / Zr < 1)
≦10Ω	Zr/Zx (1 when Zr / Zx < 1)

● U : Ratio coefficient

Zx	U
>100Ω	Zx/Zr (1 when Zx / Zr < 1)
≦100Ω	Zr/Zx (1 when Zr / Zx < 1)

● A (upper row): Basic coefficient [%] / B (lower row): Proportional coefficient [%]

・For the measurement speeds, MED, SLOW, and VSLO, the coefficient is as shown in the table below.
・For the measurement speeds, RAP and FAST, the coefficient is 1.1 times of the value shown below.

Measurement range Zr	Measurement frequency Hz												
	0 (DC)	999.999 ↑ 1m	1k	20k ↑ 1.00001k	50k ↑ 20.0001k	100k ↑ 50.0001k	200k ↑ 100.001k	500k ↑ 200.001k	1M ↑ 500.001k	2M ↑ 1.00001M	3M ↑ 2.00001M	4M ↑ 3.00001M	5.5M ↑ 4.00001M
1 MΩ	0.20 0.15	0.15 0.10	0.12 0.15	0.30 0.30	— —	— —	— —	— —	— —	— —	— —	— —	— —
100kΩ	0.06 0.03	0.06 0.03	0.06 0.03	0.06 0.06	0.08 0.08	0.20 0.08	0.20 0.08	0.30 0.10	1.00 0.30	— —	— —	— —	— —
10kΩ	0.06 0.03	0.06 0.03	0.06 0.03	0.06 0.03	0.07 0.03	0.10 0.04	0.15 0.04	0.20 0.05	0.80 0.10	1.50 0.80	1.50 1.00	1.50 1.20	2.00 2.00
1kΩ	0.06 0.03	0.06 0.03	0.05 0.03	0.05 0.03	0.06 0.03	0.10 0.04	0.12 0.04	0.15 0.05	0.30 0.06	0.50 0.20	0.60 0.30	0.60 0.30	1.50 0.30
100Ω	0.09 0.03	0.12 0.02	0.05 0.03	0.06 0.03	0.06 0.03	0.06 0.03	0.12 0.03	0.14 0.03	0.15 0.04	0.30 0.05	0.40 0.08	0.40 0.08	1.50 0.08
10Ω	0.08 0.04	0.12 0.06	0.10 0.06	0.12 0.08	0.12 0.08	0.12 0.10	0.12 0.10	0.12 0.20	0.12 0.20	0.12 0.60	0.12 0.80	0.15 0.80	0.20 2.00
1Ω	0.20 0.05	0.20 0.05	0.20 0.03	0.30 0.08	0.30 0.08	0.30 0.08	0.30 0.08	0.30 0.50	0.30 0.50	0.60 0.60	— —	— —	— —
100mΩ	0.30 0.40	0.30 0.30	0.20 0.20	0.30 0.40	0.30 0.40	0.40 0.40	0.40 0.40	0.50 1.00	0.50 1.00	— —	— —	— —	— —

The measurement accuracy is not guaranteed for "---". The basic coefficient A of the 100Ω range is increased 1.5 times, when the output impedance is 25Ω or 6Ω below 1MHz.

● Kv: Signal level coefficient

* For the DC resistance Rdc, V = 0. The measurement accuracy is not guaranteed for signal levels < 100mV.
The measurement accuracy is not guaranteed for frequency > 2MHz, range = 10kΩ, and signal level > 2V.
For other measurement parameters, the coefficient is as shown in the table below.

Measurement range Zr		Signal level [Vrms]					
		200m ↑ 100m	500m ↑ 201m	999m ↑ 501m	1	2 ↑ 1.01	5 ↑ 2.01
1 MΩ	frequency≦120Hz	0.40	0.10	0.10	0	0.10	0.15
	120Hz<frequency≦100kHz	0.40	0.10	0.10	0	0.10	0.20
100kΩ	frequency≦120Hz	0.10	0.02	0.02	0	0.03	0.10
	120Hz<frequency≦100kHz	0.20	0.05	0.05	0	0.02	0.10
	100kHz<frequency	4.00	1.00	0.10	0	0.10	0.15
10kΩ	frequency≦120Hz	0.10	0.02	0.02	0	0.03	0.10
	120Hz<frequency≦100kHz	0.10	0.02	0.02	0	0.03	0.20
	100kHz<frequency	4.00	1.00	0.10	0	0.10	0.15
1kΩ	frequency≦120Hz	0.10	0.01	0.01	0	0.03	0.10
	120Hz<frequency≦100kHz	0.10	0.02	0.02	0	0.03	0.20
	100kHz<frequency	0.80	0.10	0.10	0	0.30	1.50
100Ω	frequency≦120Hz	0.10	0.03	0.03	0	0.03	0.15
	120Hz<frequency≦100kHz	0.15	0.05	0.05	0	0.10	0.20
	100kHz<frequency	0.20	0.05	0.05	0	0.50	3.00
10Ω	frequency≦120Hz	0.20	0.03	0.01	0	0.04	0.04
	120Hz<frequency≦100kHz	0.15	0.05	0.05	0	0.10	0.10
	100kHz<frequency	0.20	0.05	0.05	0	0.10	1.00
1Ω	frequency≦120Hz	0.40	0.10	0.02	0	0.03	0.03
	120Hz<frequency≦100kHz	0.10	0.01	0.01	0	0.01	0.01
	100kHz<frequency	0.10	0.01	0.01	0	0.01	0.20
100mΩ	frequency≦120Hz	3.50	0.80	0.50	0	0.03	0.03
	120Hz<frequency≦100kHz	1.50	0.20	0.10	0	0.01	0.01
	100kHz<frequency	1.50	0.20	0.10	0	0.01	0.01

● KB: DC bias coefficient

* For the DC resistance Rdc, KB = 0 [%]. When the internal DC bias is disabled, KB = 0 [%].
When the internal DC bias is enabled, KB [%] is as shown in the table below.

Measurement range Zr	Measurement range Hz					
	0 (DC)	120 ↑ 1m	20k ↑ 120.001	100k ↑ 20.0001k	1M ↑ 100.001k	5.5M ↑ 1.00001M
1 MΩ	0	0.02	0.02	—	—	—
100kΩ	0	0.01	0.01	0.01	0.01	—
10kΩ	0	0.01	0.01	0.01	0.01	0.20
1kΩ	0	0.01	0.01	0.01	0.01	0.20
100Ω	0	0.01	0.01	0.01	0.01	0.30
10Ω	0	0.05	0.05	0.05	0.20	0.50
1Ω	0	—	0.20	0.20	0.50	0.50
100mΩ	0	—	—	—	—	—

The measurement range is not guaranteed for "---".

● Ky: Residual admittance coefficient

* When the cable length is 0m, the coefficient is as shown in the table below.
When an extension cable (1m 2m, or 4m) is used on the frequency of more 20kHz, the coefficient is 10 times of the value shown below.

Frequency range	Ky [%]
DC, frequency≦50kHz	Zx[Ω] / (2×10⁷)
50kHz<frequency≦500kHz	Zx[Ω]×(frequency[kHz])²/(2×10¹⁰)
500kHz<frequency≦5.5MHz	Zx[Ω] / (1×10⁵)

● Kz: Residual impedance coefficient

Frequency range	Kz [%]
DC, frequency≦20kHz	(0.02 + Kc) / Zx[Ω]
20kHz <frequency≦100kHz	(0.05 + Kc) / Zx[Ω]
100kHz <frequency≦5.5MHz	(0.5 + Kc) / Zx[Ω]

● Kc: Cable length coefficient

Frequency range	Kc [%]
DC, frequency≦1kHz	0.01×(Cable length [m])
1kHz<frequency≦100kHz	0.2×(Cable length [m])
100kHz<frequency≦1MHz	0.5×(Cable length [m])²
1MHz<frequency	20×(Cable length [m])²

*Restriction on measurement frequency and signal level depending on cable length.

Cable length	Applicable frequency range	Applicable signal level
0m	Full range including DC	Full range
1m	DC, frequency≦2MHz	Full range
2m	DC, frequency≦2MHz	Full range
4m	DC, frequency≦1MHz	Full range for DC and frequency ≦ 500kHz ≦ 2V for frequency > 500kHz

The measurement accuracy is not guaranteed for frequencies and signal levels out of these ranges.

● KT: Temperature-dependent coefficient

Ambient temperature (T[℃])	KT	
	frequency≦20kHz	frequency>20kHz
0 to +18	1+0.1×(18-T)	1+0.15×(18-T)
+18 to +28	1	1
+28 to +40	1+0.1×(T-28)	1+0.15×(T-28)

● Other conditions

・Warm-up: 30 min or more ・Zero correction: Execute open correction and short correction
・Cable Length Correction: Execute according to the connection cable length.
・Calibration cycle 1 year

<Recommended measurement range>

Measurement range	Recommended range	Measurement range	Output impedance
1MΩ	1MΩ to 11MΩ	≧900kΩ	100Ω
100kΩ	100kΩ to 1.1MΩ	≧90kΩ	100Ω
10kΩ	10kΩ to 110kΩ	≧9kΩ	100Ω
1kΩ	1kΩ to 11kΩ	≧0.9kΩ	100Ω
100Ω	9Ω to 1.1kΩ	No limitation	100Ω*1
10Ω	0.9Ω to 10Ω	≦11Ω	100Ω*1
1Ω	90mΩ to 1Ω	≦1.1Ω	25Ω/6Ω
100mΩ	9mΩ to 100mΩ	≦110mΩ	25Ω/6Ω

The output impedance may be restricted depending on the frequency and signal level.

*1 For the 10Ω and 100Ω ranges, the output impedance may become 25Ω or 6Ω depending on the minimum output impedance setting. In this case, the recommended range and the measureable range for the 10Ω and 100Ω ranges change as follows:

Measurement range	Recommended range	Recommended range
100Ω	100Ω to 1.1kΩ	≧90Ω
10Ω	0.9Ω to 110Ω	No limitation

Test fixture test leads

Accurate and easy-to-perform measurements

A variety of measurement fixtures are available for various applications.
*Measurement frequency range is the recommended measurement range with consideration of an error.

General-purpose components

Test leads provide 4-terminal measurements. Accurate measurement is possible to low impedance. Kelvin clip leads enable one clip to be used for two electrically insulated opposing electrodes.

4 terminal alligator clip test leads: 2324

- Measurement frequency: ≦ 100 kHz

2325AL (standard clip)

2325AM (small clip)

Kelvin clip test leads 2325AL, 2325AM

- Measurement frequency: ≦ 100 kHz

Kelvin clip test leads: ZM2392

- Measurement frequency: ≦ 20 kHz

2-lead terminal connection with a lead shield suitable for high-impedance measurements.

3-terminal alligator clip test leads: ZM2391

- Measurement frequency: ≦ 20 kHz

Chip components

Test fixture for measuring surface-mounted components with a 2-terminal connection. Since a cable is not used, stray capacitance and residual impedance are small, enabling accurate open and short correction.

Chip test fixture ZM2394

- Measurement frequency: ≦ 2 MHz
- Supported component size: 0603 (0.3mm thick) to 14 mm (square)

Chip test fixture ZM2394H

- Measurement frequency: ≦ 30 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 lead in a 3-terminal configuration with shielded measurement contacts. Stray capacitance is small, enabling easy measurement of small-capacity capacitors.

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.)

Lead components

Test fixture that makes 4-terminal measurements as easy as inserting the leads into the sample.
To match the size of the components, the spacing of the measurement terminals can be adjusted.

Test fixture ZM2363

- Measurement frequency: ≦ 10 MHz

Adapter

DC bias voltage adapter

Adapter for applying a DC bias voltage of ±40 V to the sample. This adapter provides easy connection to the LCR meter and test fixture. (4-terminal pair configuration)

ZM2329 (For ZM2376)

ZM2328 (For ZM2371 and ZM2372)

Ordering information

	Product Name	Model name	Overview	Accessories
Main unit	LCR Meter	ZM2371	1 mHz to 100 kHz	Instruction manual, CD (application software, LabVIEW driver), power cord set (3-pole, 2 m)
	LCR Meter	ZM2372		
	LCR meter	ZM2376	1 mHz to 5.5 MHz	Instruction manual, CD (application software, IVI drivers), power cord set (3-pole, 2 m)
Option	LAN interface	PA-001-2131	For ZM2376 (optional order)	——

*Note: The contents of this catalog are current as of July 4, 2019
- Products appearance and specificaitons are subject to change without notice.
- Before purchase contact us to confirm the latest specifications, price and delivery date.

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