Specifications

■ 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 (direct-current resistance)
・Auto parameter selection	Primary parameters (including equivalent circuit) and secondary parameters can be selected automatically.

■ Measured value display range

・|Z|	0.000mΩ to 999.999MΩ
・R (Rs, Rp, Rdc), X	0Ω, ±(0.001mΩ to 999.999MΩ)
・|Y|	0.00nS to 9.99999kS
・G, B	0S, ±(0.01nS to 9.99999kS)
・C (Cp, Cs)	0F, ±(0.00001pF to 999.999kF) ex. 0.000pF to 999.999mF (1kHz) 0.00pF to 9.99999F (120Hz)
・L (Ls, Lp)	0H, ±(0.001nH to 99.9999GH) ex. 0.0000μH to 99.9999kH (1kHz)
・Q, D	0, ±(0.00001 to 99999.9)
・θ	±180.000° Actual measurement and display ranges of respective parameters are restricted by the measurement range or frequency.

■ Measurement conditions

・Measurement frequency	1mHz to 100kHz, Resolution 5 digits (1mHz when < 10Hz), ±0.01%
・Measurement signal level	10mV to 5.00V, Resolution 3 digits (1mV when < 100mV), ±(10% + 5mV) RMS value when output is open
・ALC	Constant voltage drive / Constant current drive / Invalid Voltage setting range 10mV to 5.00V, Setting resolution 3 digits (1mV when < 100mV) Current setting range 1μA to 200mA, Setting resolution 3 digits (0.1μA when < 10μA) The constant control range will be narrower than the above specifications depending on the product dispersion or DUT's impedance. The current range is restricted depending on the measurement range.
・Output impedance	5Ω / 25Ω / 100Ω (supplementary values). Automatically selected according to the measurement range. 5Ω is selected automatically only when the following conditions are satisfied: Minimum output impedance setting = 5Ω, Measurement range≦10Ω, Measurement signal level≦1V, ALC = invalid, Internal DC bias = Off, Secondary parameter ≠ Rdc
・Internal DC bias	0V to +2.50V, Resolution 0.01V, ±(5% +3mV) when output is open On/Off is possible

・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)

・Triggered drive
Drive only at measurement / Continuous drive selectable
(Measurement signal can be output only during the time from trigger to completion of signal acquisition)

・Measurement speed
RAPid / FAST / MEDium / SLOW / VerySLOw

Typical measurement time
(Supplementary value. Time from input of trigger to output of measurement end signal EOM)

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

Conditions: Measurement range fixed, Trigger delay time = 0, Averaging count = 1, Secondary parameter≠Rdc

Signal acquisition time is the value subtracted by about 1ms from the above value.

DUT can be replaced immediately after the completion of signal acquisition.

After replacement of DUT, the signal settling time is required additionally.

Additional time when measuring direct-current resistance Rdc (supplementary vaue)

	RAP	FAST	MED	SLOW	VSLO
(DC)	148ms	148ms	148ms	215ms	613ms

Conditions: DC resistance measurement range fixed, Trigger delay time = 0, Averaging count = 1

・Measurement range

Measurement range	Recommended range	Measurable 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

Measurable range: Approximate range in which measurement and display are possible (supplementary value).
Recommended range: Recommended operating range for high accuracy measurement.

Limitation by frequency
When frequency > 20kHz, 1MΩ range cannot be used.

・Measurement range selection
Auto / Manual

■ Measurement accuracy

・Basic accuracy 0.08%

・Impedance measurement accuracy

Zr: Measurement range (100mΩ to 1MΩ)

Zx: Measured value of impedance magnitude |Z|

With the above definision, 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 [°]

$$Pz = 0.573 \times Az$$

The measurement accuracy when Az exceeds 10 [%] is a supplementary value.

The measurement accuracy of the 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 is listed below.

・U: Ratio coefficient

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

・V: Signal level coefficient

<table>
<tr><td rowspan="2">Measurement signal level [Vrms]</td><td colspan="12">V</td></tr>
<tr><td colspan="3">Zr = 1MΩ, 100kΩ (> 20kHz)</td><td colspan="3">Zr = 100kΩ (≦20kHz), 10kΩ, 1kΩ, 100Ω)</td><td colspan="3">Zr = 10Ω, 1Ω</td><td colspan="3">Zr = 100mΩ</td></tr>
<tr><td>2 < Level≦5</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.3</td><td>3</td><td>2</td><td>1.3</td></tr>
<tr><td>1 < Level≦2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.2</td><td>1.8</td><td>1.5</td><td>1.2</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>0.5 < Level < 1</td><td>1.4</td><td>1.2</td><td>1.2</td><td>1.4</td><td>1.2</td><td>1.2</td><td>1.5</td><td>1.5</td><td>1.2</td><td>2.5</td><td>2</td><td>1.2</td></tr>
<tr><td>0.2 < Level≦0.5</td><td>1.4</td><td>1.3</td><td>1.3</td><td>1.4</td><td>1.3</td><td>1.3</td><td>2.5</td><td>2.2</td><td>1.3</td><td rowspan="4">3 3 1.3 × (0.5Vrms / Meas. signal level [Vrms])</td></tr>
<tr><td>0.1 < Level≦0.2</td><td>2.2</td><td>2.2</td><td>1.4</td><td>1.4</td><td>1.4</td><td>1.4</td><td rowspan="3">3.5 3.5 1.4 × (0.2Vrms / Meas. signal level [Vrms])</td></tr>
<tr><td>0.05 < Level≦0.1</td><td rowspan="3">2.5 2.5 1.6 × (0.1Vrms / Meas. signal level [Vrms])</td><td>1.8</td><td>1.6</td><td>1.6</td></tr>
<tr><td>0.02 < Level≦0.05</td><td>4</td><td>2.8</td><td>2</td></tr>
<tr><td>0.01≦Level≦0.02</td><td>8</td><td>5</td><td>3</td></tr>
</table>

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.

・Kz: Residual impedance coefficient

Frequency	Kz [%]
DC (0Hz), 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 × Fequency [kHz] × (Cable length [m])^2

・Ky: Residual admittance coefficient

Frequency	Ky [%]
DC, Frequency≦120Hz	Zx[Ω] / (3 × 10^8)
120Hz < Frequency≦100kHz	Zx[Ω] × Frequency [kHz] / (3 × 10^7)

・K_T: Temperature-dependent coefficient

Ambient temperature (T °C)	KT
0 to +18	1 + 0.1 × (18−T)
+18 to +28	1
+28 to +40	1 + 0.1 × (T−28)

・K_B: DC bias coefficient

Internal DC bias	Measurement range Zr	KB [%]	
		Frequency≦10kHz	Frequency >10kHz
Disabled	All ranges	0	0
Enabled	1MΩ	0.02	0.02
	100Ω to 100kΩ	0.003	0.01
	10Ω	0.03	0.05
	1Ω	0.3	0.5
	100mΩ	Measurement accuracy is not specified	

At all times, K_B = 0 for the direct-current resistance Rdc.

- **A (upper row): Basic coefficient [%]**
- **B (lower row): Proportional coefficient [%]**

Meas. speed	Meas. 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
MED, SLOW, VSLO	1MΩ	0.14 0.02	0.50 0.30	0.15 0.025	0.10 0.02	0.15 0.03	0.25 0.03	0.25 0.03	–	–
	100kΩ	0.12 0.01	0.25 0.04	0.15 0.02	0.09 0.01	0.10 0.015	0.20 0.025	0.25 0.03	0.30 0.03	0.80 0.03
	10kΩ	0.09 0.01	0.20 0.03	0.15 0.02	0.07 0.01	0.09 0.01	0.16 0.015	0.20 0.02	0.25 0.03	0.80 0.03
	1kΩ	0.09 0.01	0.20 0.03	0.15 0.02	0.07 0.01	0.09 0.01	0.16 0.015	0.20 0.02	0.25 0.03	0.30 0.03
	100Ω	0.09 0.01	0.20 0.03	0.15 0.02	0.07 0.01	0.09 0.01	0.16 0.015	0.20 0.02	0.25 0.03	0.30 0.03
	10Ω	0.12 0.02	0.25 0.03	0.17 0.02	0.12 0.01	0.15 0.015	0.20 0.017	0.40 0.03	0.45 0.05	0.50 0.06
	1Ω	0.14 0.05	0.40 0.06	0.30 0.02	0.20 0.02	0.25 0.02	0.35 0.02	0.60 0.03	0.70 0.08	0.90 0.10
	100mΩ	0.14 0.30	0.60 0.40	0.30 0.10	0.30 0.04	0.30 0.04	0.40 0.03	0.60 0.06	0.90 0.10	0.90 0.10
FAST	1MΩ	Same as above	0.50 0.30	0.15 0.025	0.12 0.03	0.15 0.03	0.25 0.03	0.25 0.03	–	–
	100kΩ		0.25 0.04	0.15 0.02	0.09 0.01	0.10 0.015	0.20 0.025	0.25 0.03	0.30 0.03	0.80 0.03
	10kΩ		0.20 0.03	0.15 0.02	0.08 0.01	0.09 0.01	0.16 0.015	0.20 0.02	0.25 0.03	0.80 0.03
	1kΩ		0.20 0.03	0.15 0.02	0.08 0.01	0.09 0.01	0.16 0.015	0.20 0.02	0.25 0.03	0.30 0.03
	100Ω		0.20 0.03	0.15 0.02	0.08 0.01	0.09 0.01	0.16 0.015	0.20 0.03	0.25 0.03	0.30 0.03
	10Ω		0.25 0.03	0.17 0.02	0.13 0.015	0.15 0.02	0.20 0.02	0.40 0.08	0.45 0.08	0.50 0.08
	1Ω		0.40 0.06	0.30 0.02	0.22 0.025	0.25 0.03	0.35 0.03	0.60 0.20	0.70 0.20	0.90 0.20
	100mΩ		0.60 0.40	0.30 0.15	0.30 0.06	0.30 0.06	0.40 0.06	0.80 0.80	1.0 0.80	1.0 0.80
RAP	–	Same as above	For measurement frequency > 250Hz, multiply FAST value by 1.3. For measurement frequency≦250Hz, use FAST value.							

・Other conditions

Warm-up 30 minutes or more

Zero correction Execute open correction and short correction.

Cable length correction Execute according to the cable length.

Measurement accuracy is not guaranteed in a range other than the following applicable frequency range.

Cable	Applicable frequency range
0m, 1m	All ranges including DC
2m	DC, Frequency≦20kHz
4m	DC, Frequency≦1kHz

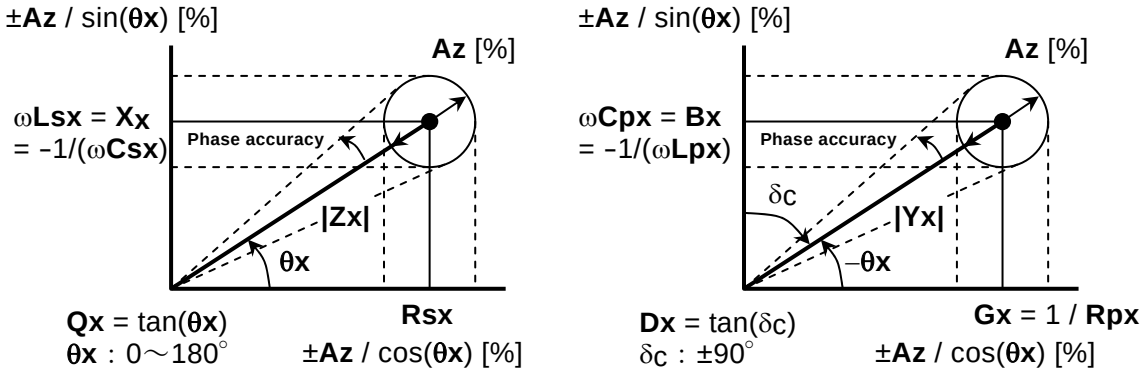
Calibration cycle 1 year

・Measurement accuracy of measurement parameters except Z and θ

From the measurement accuracy of impedance, obtain as follows.
Here, Qx is a measured value of Q, Dx is a measured value of D, and θx is a measured value of θ. θx used for accuracy calculation may be obtained from $(90° - \tan^{-1}|1/Qx|)$ or $(90° - \tan^{-1}|Dx|)$.

Parameter	Measurement accuracy
|Y|	±Az [%]
Lp, Ls, X	±Az [%] (|Qx|≧10), ±Az / sinθx [%] (|Qx|< 10)
Cp, Cs, B	±Az [%] (|Dx|≦0.1), ±Az / sinθx [%] (|Dx|> 0.1)
Rp, Rs, G	±Az [%] (|Qx|≦0.1), ±Az / cosθx [%] (|Qx|> 0.1)
Rdc	±Az [%]
Q	$\pm Qx^2 \times Pe / (1 - \|Qx\| \times Pe)$ (|Qx|≧10, |Qx| × Pe≦0.1) Here, the phase angle error Pe [rad] = 0.01 × Az [%]. It differs from Pz [°]. Measurement accuracy of Q is absolute value. It is not a % value.
D	±(0.01 × Az) (|Dx|≦0.1) Measurement accuracy of D is absolute value. It is not a % value.

In general, a range of each measurement parameter (maximum value and minimum value) can be calculated based on an error circle of the impedance.



ω = 2 × π × Measurement frequency [Hz], Suffix "x" of the parameter indicates a measured value.

Figure 9–1 Range of error

Pure L [H] and C [F] can be converted into |Z| [Ω] by the following expression:

|Z| [Ω] = 2 × π × Frequency [Hz] × L [H]

|Z| [Ω] = 1 / (2 × π × Frequency [Hz] × C [F])

Approximate value can be read from the following graph.

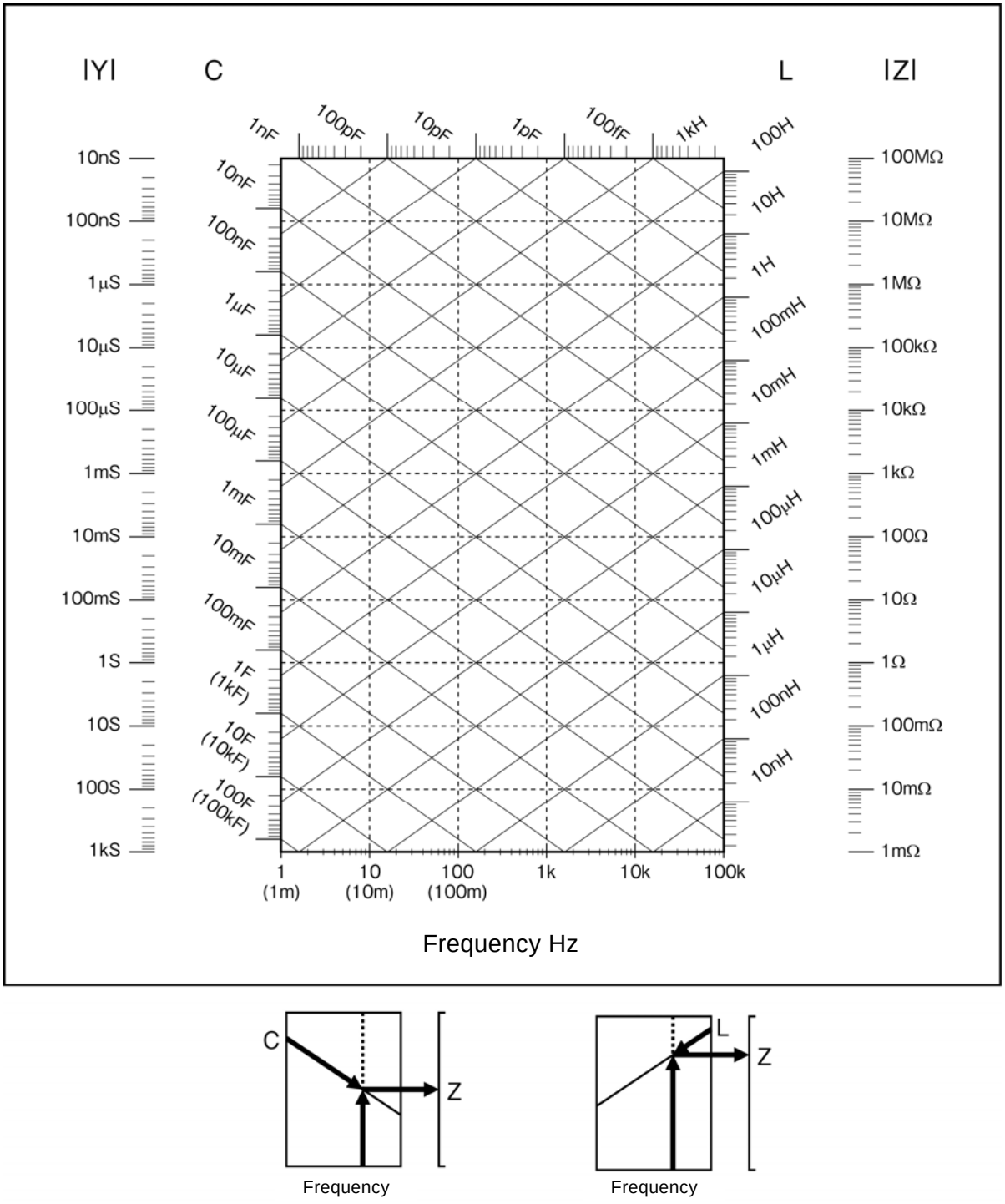


Figure 9–2 LC - Z conversion graph

■ Other measurement related functions

・Zero correction	Open correction and short correction provided. Both can be turned on or off.	
・Load correction	Provided. It can be turned on or off.	
・Cable length correction	0m / 1m / 2m / 4m	
・Contact check	(Standard for **ZM2372**. Not provided for **ZM2371**) For all 4 terminals, a contact failure to DUT is detected. Additional time 4ms (supplementary value)	
・Averaging	1 to 256 times	
・Deviation measurement	Primary parameters:	Deviation and deviation % from reference value can be displayed.
	Secondary parameters:	Deviation and deviation % from reference value can be displayed.
・Comparator	Primary parameters:	Max. 9 bins **(ZM2371)** / Max. 14 bins **(ZM2372)** Original measured value / Deviation / Deviation % can be sorted.
	Secondary parameters:	Upper limit and lower limit comparison Original measured value / Deviation / Deviation % can be sorted.
	Beeper:	Sounds according to comparator result (Pass / Fail / Off)
・Handler interface	(Standard for **ZM2372**. Not provided for **ZM2371**)	
	Signal isolation:	All I/O signals are optically isolated (withstand voltage ±42V)
	Input signals:	Trigger, Key lock, Settings/correction value memory designation
	Output signals:	Comparator result BIN1 to BIN11, NC / BIN12, PHI / BIN13, PLO / BIN14, OUT OF BINS, S-NG, ERR, INDEX, EOM (NC, PHI, and PLO cannot be used when BIN10 - BIN14 are used)
	Rated power voltage:	External +5V to +24V, Internal +5V (non- isolated)
・Monitor display	Voltage: Voltage value applied to the DUT Voltage monitor accuracy ±(2%+2mVrms) 10Hz to 50kHz ±(3.5%+2mVrms) 50kHz <	
	Current: Current value flowing in the DUT Current monitor accuracy (supplementary value) Voltage monitor accuracy + Measurement accuracy of impedance Z	
・Discharge protection	8J or less when voltage is below 250V, or 1J or less when below 1kV. However, for output impedance 5Ω, below 250V and 2J or less. (All are supplementary values)	

■ Remote control interface

・USB　　USBTMC, USB 1.1 full speed

・RS-232　　Data rate

4800 / 9600 / 19200 / 38400 / 57600 / 115200 / 230400bps
For the data rate exceeding 19200bps, communication may fail depending on the characteristics of cable or controller.

Flow control

None, Software (X-ON/X-OFF), Hardware (RTS/CTS)

・GPIB (standard for **ZM2372**. Not provided for **ZM2371**)

Conforms to IEEE 488.1 and IEEE 488.2 Standards

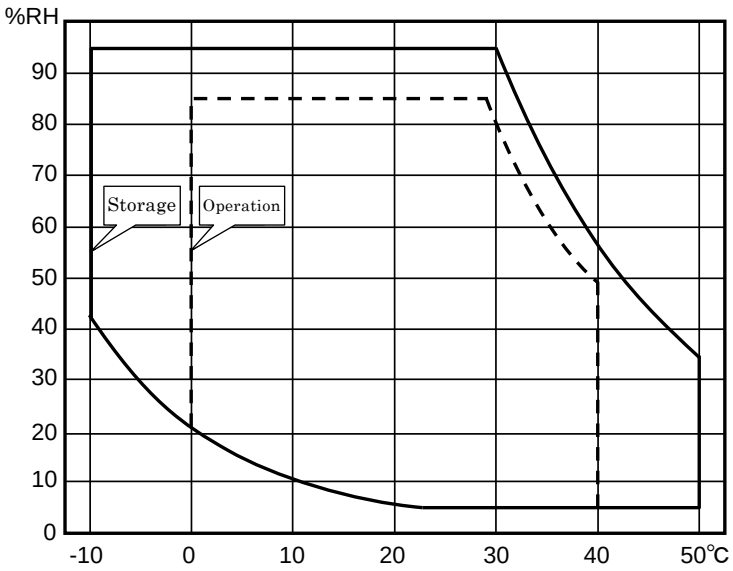
■ General specifications

・Power supply
Voltage: AC 100V to 230V ±10%, but 250V or less
Frequency: 50Hz/60Hz ±2Hz
Power consumption: 70VA or less **(ZM2371)**,
75VA or less **(ZM2372)**
Over voltage category II

・Environmental conditions

Operation
Temperature: 0 to +40°C
Humidity: 5 to 85%RH Absolute humidity 1 to 25g/m^3, non-condensing
Altitude: 2000m or less

Storage
Temperature: -10 to +50°C
Humidity: 5 to 95%RH Absolute humidity 1 to 29g/m^3, non-condensing



Pollution Degree 2 (indoor use)

・Warn-up time 30 minutes

・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 when power is turned on.

・Safety regulation EN 61010-1: 2001

・EMC EN 61326-1: 2006

・External dimensions Approx. 260 (W) × 88 (H) × 220 (D) mm, not including protuberances

・Weight Approx. 2.0kg **(ZM2371)**, approx. 2.1kg **(ZM2372)** (not including accessories)