

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

- $|Z|$ 0.000m Ω to 999.999M Ω
- R (Rs, Rp, Rdc), X 0 Ω , $\pm(0.001\text{m}\Omega$ to 999.999M $\Omega)$
- $|Y|$ 0.00nS to 9.99999kS
- G, B 0S, $\pm(0.01\text{nS}$ to 9.99999kS)
- C (Cp, Cs) 0F, $\pm(0.00001\text{pF}$ to 999.999kF)
ex. 0.000pF to 999.999mF (1kHz)
 0.00pF to 9.99999F (120Hz)
- L (Ls, Lp) 0H, $\pm(0.001\text{nH}$ to 99.9999GH)
ex. 0.0000 μ H to 99.9999kH (1kHz)
- Q, D 0, $\pm(0.00001$ to 99999.9)
- θ $\pm 180.000^\circ$
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), $\pm 0.01\%$
- Measurement signal level 10mV to 5.00V, Resolution 3 digits (1mV when < 100mV), $\pm(10\% + 5\text{mV})$
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 1 μ A to 200mA, Setting resolution 3 digits (0.1 μ A when < 10 μ A)
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 5 Ω / 25 Ω / 100 Ω (supplementary values). Automatically selected according to the measurement range.
5 Ω is selected automatically only when the following conditions are satisfied:
 Minimum output impedance setting = 5 Ω ,
 Measurement range $\leq 10\Omega$,
 Measurement signal level $\leq 1\text{V}$, ALC = invalid,
 Internal DC bias = Off, Secondary parameter \neq Rdc
- Internal DC bias 0V to +2.50V, Resolution 0.01V, $\pm(5\% + 3\text{mV})$ when output is open
On/Off is possible

Specifications

- 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 value)

	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

Z_r: Measurement range (100mΩ to 1MΩ)

Z_x: Measured value of impedance magnitude |Z|

With the above definition, the impedance measurement accuracy is obtained as follows:

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

$$A_z = (A + B \times U + K_z + K_y) \times V \times K_T + K_B \times U$$

Accuracy of phase angle θ of impedance ±P_z [°]

$$P_z = 0.573 \times A_z$$

The measurement accuracy when A_z 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**

Z _x	U
> 100Ω	Z _x / Z _r (however, 1 when Z _x / Z _r < 1)
≤ 100Ω	Z _r / Z _x (however, 1 when Z _r / Z _x < 1)

• **V: Signal level coefficient**

Measurement signal level [V _{rms}]	V											
	Z _r = 1MΩ, 100kΩ (> 20kHz)			Z _r = 100kΩ (≤ 20kHz), 10kΩ, 1kΩ, 100Ω)			Z _r = 10Ω, 1Ω			Z _r = 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 × (0.5V _{rms} / Meas. signal level [V _{rms}])		
0.1 < Level ≤ 0.2	2.2	2.2	1.4	1.4	1.4	1.4	3.5	3.5	1.4			
0.05 < Level ≤ 0.1	2.5	2.5	1.6	1.8	1.6	1.6	× (0.2V _{rms} / Meas. signal level [V _{rms}])					
0.02 < Level ≤ 0.05	× (0.1V _{rms} / Meas. signal level [V _{rms}])			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 Z_r = 100kΩ. At all times, V = 1 for the direct-current resistance R_{dc}.

• **Kz: Residual impedance coefficient**

Frequency	Kz [%]
DC (0Hz), Frequency \leq 120Hz	$(0.003 + Kc) / Zx[\Omega]$
120Hz < Frequency \leq 1kHz	$(0.005 + Kc) / Zx[\Omega]$
1kHz < Frequency \leq 10kHz	$(0.005 + 0.002 \times \text{Frequency [kHz]} + Kc) / Zx[\Omega]$
10kHz < Frequency \leq 100kHz	$(0.0025 \times \text{Frequency [kHz]} + Kc) / Zx[\Omega]$

Cable length coefficient $Kc = 0.001 \times \text{Frequency [kHz]} \times (\text{Cable length [m]})^2$

• **Ky: Residual admittance coefficient**

Frequency	Ky [%]
DC, Frequency \leq 120Hz	$Zx[\Omega] / (3 \times 10^8)$
120Hz < Frequency \leq 100kHz	$Zx[\Omega] \times \text{Frequency [kHz]} / (3 \times 10^7)$

• **K_T: Temperature-dependent coefficient**

Ambient temperature (T °C)	K _T
0 to +18	$1 + 0.1 \times (18 - T)$
+18 to +28	1
+28 to +40	$1 + 0.1 \times (T - 28)$

• **K_B: DC bias coefficient**

Internal DC bias	Measurement range Z _r	K _B [%]	
		Frequency \leq 10kHz	Frequency >10kHz
Disabled	All ranges	0	0
Enabled	1M Ω	0.02	0.02
	100 Ω to 100k Ω	0.003	0.01
	10 Ω	0.03	0.05
	1 Ω	0.3	0.5
	100m Ω	Measurement accuracy is not specified	

At all times, $K_B = 0$ for the direct-current resistance R_{dc}.

Specifications

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

Meas. speed	Meas. range Z_r	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 0.06	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 $\leq 20\text{kHz}$
4m	DC, Frequency $\leq 1\text{kHz}$

Calibration cycle 1 year

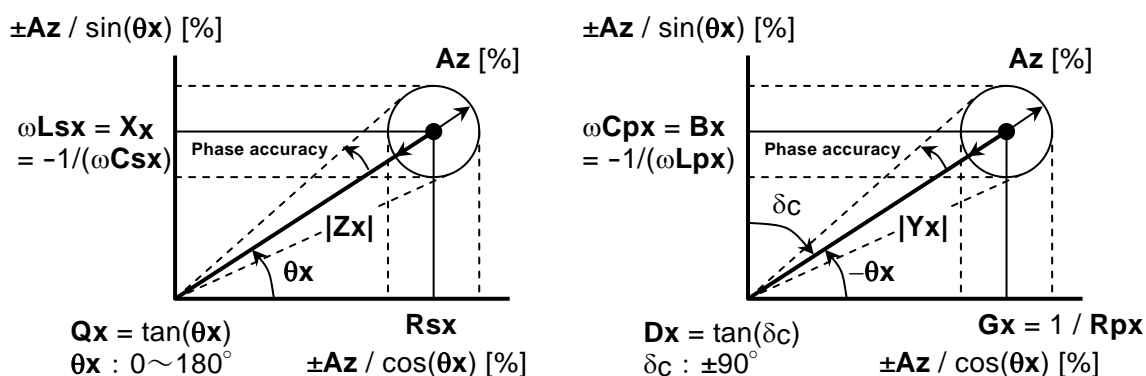
• Measurement accuracy of measurement parameters except Z and θ

From the measurement accuracy of impedance, obtain as follows.

Here, Q_x is a measured value of Q, D_x is a measured value of D, and θ_x is a measured value of θ . θ_x used for accuracy calculation may be obtained from $(90^\circ - \tan^{-1} |1/Q_x|)$ or $(90^\circ - \tan^{-1} |D_x|)$.

Parameter	Measurement accuracy
$ Y $	$\pm A_z$ [%]
L_p, L_s, X	$\pm A_z$ [%] ($ Q_x \geq 10$), $\pm A_z / \sin\theta_x$ [%] ($ Q_x < 10$)
C_p, C_s, B	$\pm A_z$ [%] ($ D_x \leq 0.1$), $\pm A_z / \sin\theta_x$ [%] ($ D_x > 0.1$)
R_p, R_s, G	$\pm A_z$ [%] ($ Q_x \leq 0.1$), $\pm A_z / \cos\theta_x$ [%] ($ Q_x > 0.1$)
Rdc	$\pm A_z$ [%]
Q	$\pm Q_x^2 \times P_e / (1 - Q_x \times P_e)$ ($ Q_x \geq 10, Q_x \times P_e \leq 0.1$) Here, the phase angle error P_e [rad] = $0.01 \times A_z$ [%]. It differs from P_z [°]. Measurement accuracy of Q is absolute value. It is not a % value.
D	$\pm(0.01 \times A_z)$ ($ D_x \leq 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.



$\omega = 2 \times \pi \times$ 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:

$$|Z| [\Omega] = 2 \times \pi \times \text{Frequency [Hz]} \times L [\text{H}]$$

$$|Z| [\Omega] = 1 / (2 \times \pi \times \text{Frequency [Hz]} \times C [\text{F}])$$

Approximate value can be read from the following graph.

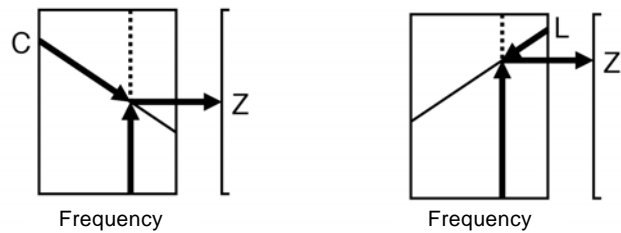
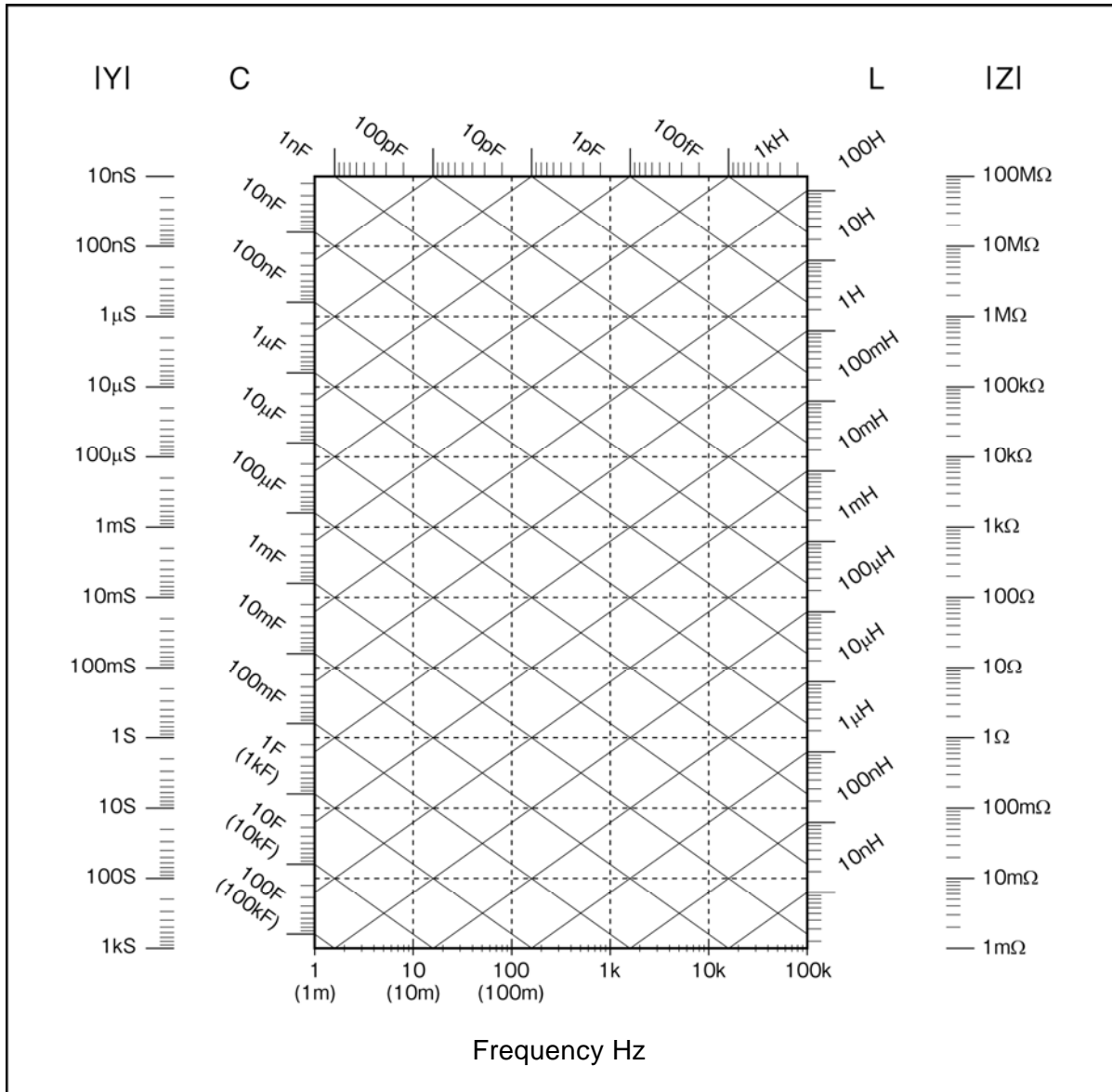


Figure 9-2 LC - Z conversion graph

■ **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 $\pm 42V$)
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 $\pm(2\%+2mV_{rms})$ 10Hz to 50kHz
 $\pm(3.5\%+2mV_{rms})$ 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)

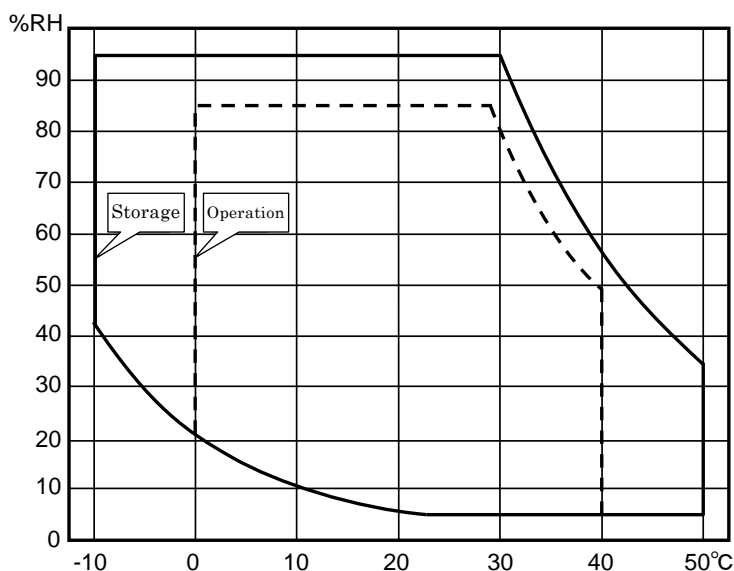
■ **Remote control interface**

- 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 $\pm 10\%$, but 250V or less
 - Frequency: 50Hz/60Hz $\pm 2\text{Hz}$
 - Power consumption: 70VA or less (**ZM2371**),
75VA or less (**ZM2372**)
 - Over voltage category II
- Environmental conditions
 - Operation
 - Temperature: 0 to $+40^{\circ}\text{C}$
 - Humidity: 5 to 85%RH Absolute humidity 1 to $25\text{g}/\text{m}^3$, non-condensing
 - Altitude: 2000m or less
 - Storage
 - Temperature: -10 to $+50^{\circ}\text{C}$
 - Humidity: 5 to 95%RH Absolute humidity 1 to $29\text{g}/\text{m}^3$, 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) \times 88 (H) \times 220 (D) mm, not including protuberances
- Weight Approx. 2.0kg (**ZM2371**), approx. 2.1kg (**ZM2372**) (not including accessories)