ZM2376 SPECIFICATION

Supplementary value: These values show the guideline data for reference and do not guarantee the performance.

1.1 Specification

■ 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	0 Ω, ±(0.001mΩ to 999.999MΩ)
• |Y|	0.00nS to 9.99999kS
• G, B	0 S, ±(0.01nS to 9.99999kS)
• C (Cp, Cs)	0 F, ±(0.00001pF to 99.9999kF)
• L (Ls, Lp)	0 H, ±(0.00001nH to 9.99999GH)
• 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 5.5MHz, Resolution 6 digits (1mHz when < 100Hz),
Accuracy ±0.01%

• Measurement signal

Level Setting range 10mV to 5V, Resolution 3 digits (1mV when < 100mV)

Level accuracy ± (8% + 5mV) ≤ 1MHz (typical value when < 1Hz)
± (10% + 5mV) > 1MHz
RMS values at open output.

• ALC Constant voltage drive / Constant current drive / Disabled
Voltage setting range 10mV to 5V, Resolution 3 digits (1mV when < 100mV)
Current setting range 1μA to 200mA, 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 6Ω / 25Ω / 100Ω (supplementary value).
The minimum output impedance can be selected from the above three values. However, it is limited by the measurement range, the signal level, and the frequency.

• Internal DC bias Setting range 0V to +5V, Resolution 1mV,
Accuracy ± (2% + 5mV) [Level ≤ 2V]
± (2% + 10mV) [Level > 2V]
at signal frequency of 1 MHz or less, 23±10°C (Environmental temperature), and open output.
It can be turned on / off.

• Trigger source
INT Internal (automatic continuous trigger)
MAN Manual
EXT Handler interface
BUS Remote control

• Trigger delay time Setting range 0s to 999.9999s, Resolution 0.0001s
(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

(Typical 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	2ms	5ms	25ms	121ms	501ms
100kHz	2ms	5ms	25ms	121ms	501ms
1MHz	2ms	5ms	25ms	121ms	501ms

Conditions: Measurement range hold, 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. It should be an appropriate trigger delay time and not zero.

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

	RAP	FAST	MED	SLOW	VSLO
(DC)	150ms	150ms	150ms	218ms	616ms

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

• Measurement range

Measurement range	Recommended range	Measureable 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

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

*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	Measureable range
100Ω	100Ω to1.1kΩ	≥90Ω
10Ω	0.9Ω to110Ω	Not limited

Recommended range: Recommended operating range for high accuracy measurement.

Limitations: When frequency > 20kHz, the 1MΩ range cannot be used.

When frequency > 1MHz, the measureable range is limited to between 1Ω and 10kΩ ranges.

When frequency > 2MHz, the measureable range is limited to between 10Ω and 1kΩ ranges.

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

When cable length = 4m and frequency > 200kHz, the measureable range is limited to between 10Ω and 10kΩ ranges.

• 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 definitions, the impedance measurement accuracy is obtained as follows:

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

$Az = (A + B \times U + Kz + Ky) \times K_T + (Kv + K_B) \times U$ (Level ≤ 1V)

$Az = (A + B \times U + Kz + Ky) \times K_T + Kv + K_B \times U$ (Level > 1V)

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

$Pz = 0.573 \times Az$

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

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 (however, 1 when Zx / Zr < 1)
≤ 10Ω	Zr / Zx (however, 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
1MΩ	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
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
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
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
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
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
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

Measurement range Zr	Measurement frequency Hz					
	500k ↑ 200.001k	1M ↑ 500.001k	2M ↑ 1.00001M	3M ↑ 2.00001M	4M ↑ 3.00001M	5.5M ↑ 4.00001M
1MΩ	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---
100kΩ	0.30 0.10	1.00 0.30	--- ---	--- ---	--- ---	--- ---
10kΩ	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	0.15 0.05	0.30 0.06	0.50 0.20	0.60 0.30	0.60 0.30	1.50 0.30
100Ω	0.14 0.03	0.15 0.04	0.30 0.05	0.40 0.08	0.40 0.08	1.50 0.08
10Ω	0.12 0.20	0.12 0.20	0.12 0.60	0.12 0.80	0.15 0.80	0.20 2.00
1Ω	0.30 0.50	0.30 0.50	0.60 0.60	--- ---	--- ---	--- ---
100mΩ	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.

• **Kc**: Cable length coefficient

Frequency range	Kc [%]
DC, Frequency ≤ 1kHz	0.01 x (Cable length[m])
1kHz < Frequency ≤ 100kHz	0.2 x (Cable length[m])
100kHz < Frequency ≤ 1MHz	0.5 x (Cable length[m])^2
1MHz < Frequency	20 x (Cable length[m])^2

Restriction on measurement frequency and signal level depending on cable length

Cable length	Applicable frequency range	Applicable signal level
0m	All ranges including DC	All range
1m	DC, Frequency ≤ 2MHz	All range
2m	DC, Frequency ≤ 2MHz	All range
4m	DC, Frequency ≤ 1MHz	All 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.

• **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	(0.5 + Kc) / Zx[Ω]

• **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 × 10^7)
50kHz < Frequency ≤ 500kHz	Zx[Ω] × (Frequency[kHz])^2 / (2 × 10^{10})
500kHz < Frequency	Zx[Ω] / (1× 10^5)

• **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.

Frequency ≤ 120Hz

Measurement range Zr	Signal level[Vrms]					
	200m ↑ 100m	500m ↑ 201m	999m ↑ 501m	1	2 ↑ 1.01	5 ↑ 2.01
1MΩ	0.40	0.10	0.10	0	0.10	0.15
100kΩ	0.10	0.02	0.02	0	0.03	0.10
10kΩ	0.10	0.02	0.02	0	0.03	0.10
1kΩ	0.10	0.01	0.01	0	0.03	0.10
100Ω	0.10	0.03	0.03	0	0.03	0.15
10Ω	0.20	0.03	0.01	0	0.04	0.04
1Ω	0.40	0.10	0.02	0	0.03	0.03
100mΩ	3.5	0.80	0.50	0	0.03	0.03

120Hz < Frequency ≤ 100kHz

Measurement range Zr	Signal level[Vrms]					
	200m ↑ 100m	500m ↑ 201m	999m ↑ 501m	1	2 ↑ 1.01	5 ↑ 2.01
1MΩ	0.40	0.10	0.10	0	0.10	0.20
100kΩ	0.20	0.05	0.05	0	0.02	0.10
10kΩ	0.10	0.02	0.02	0	0.03	0.20
1kΩ	0.10	0.02	0.02	0	0.03	0.20
100Ω	0.15	0.05	0.05	0	0.10	0.20
10Ω	0.15	0.05	0.05	0	0.10	0.10
1Ω	0.10	0.01	0.01	0	0.01	0.01
100mΩ	1.5	0.20	0.10	0	0.01	0.01

100kHz < Frequency

Measurement range Zr	Signal level[Vrms]					
	200m ↑ 100m	500m ↑ 201m	999m ↑ 501m	1	2 ↑ 1.01	5 ↑ 2.01
100kΩ	4.00	1.00	0.10	0	0.10	0.15
10kΩ	4.00	1.00	0.10	0	0.10	0.15
1kΩ	0.80	0.10	0.10	0	0.30	1.5
100Ω	0.20	0.05	0.05	0	0.50	3.0
10Ω	0.20	0.05	0.05	0	0.10	1.0
1Ω	0.10	0.01	0.01	0	0.01	0.20
100mΩ	1.5	0.20	0.10	0	0.01	0.01

• **KT**: Temperature-dependent coefficient

Ambient temperature (T °C)	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)

• **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	Frequency Hz					
	0 (DC)	120 ↑ 1m	20k ↑ 120.001	100k ↑ 20.0001k	1M ↑ 100.001k	5.5M ↑ 1.00001M
1MΩ	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 accuracy is not guaranteed for "---".

• 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

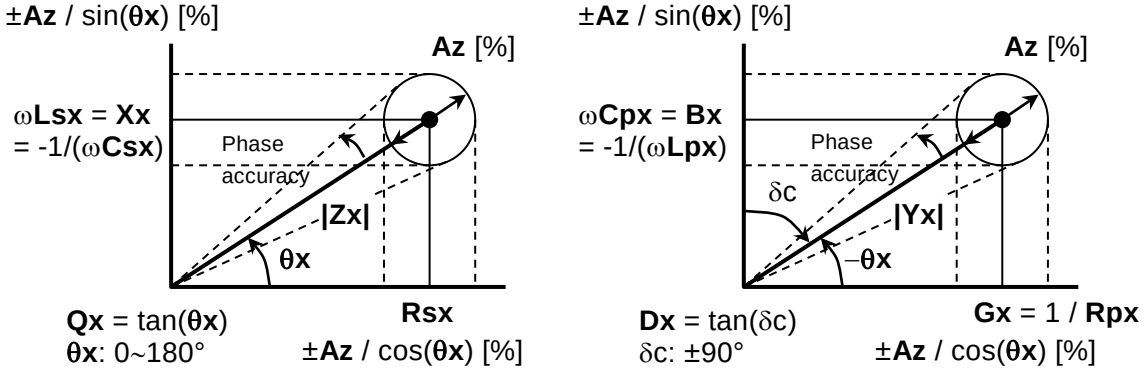
• Measurement accuracy of measurement parameters except Z and θ

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 a parameter indicates a measured value.

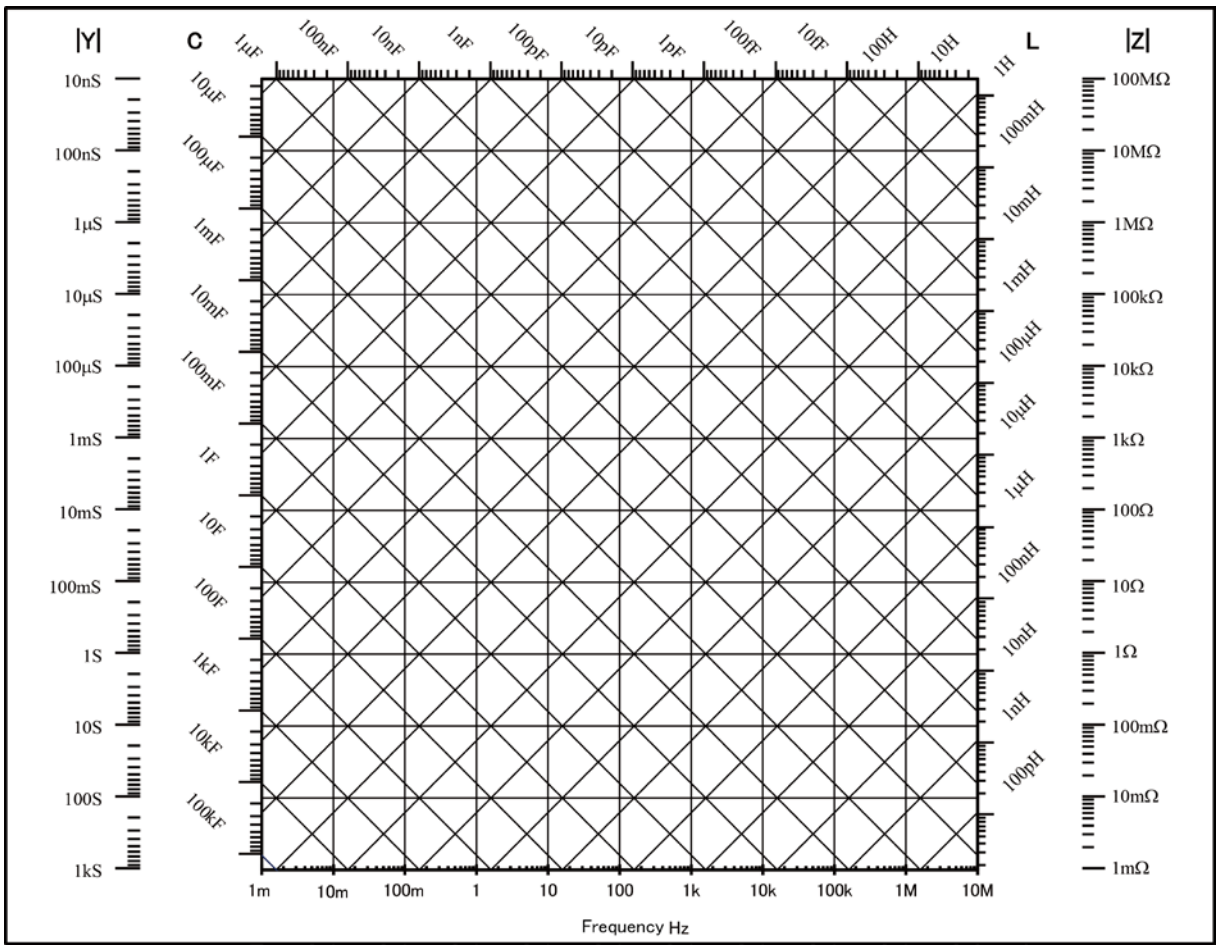
Figure 1-1 Range of error

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.



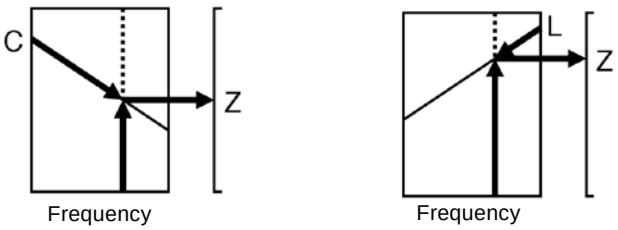


Figure 1-2 LC - Z conversion graph

■ 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	Provided. Based on detection of an abnormally low capacitance or abnormal voltage/current.	
• 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. 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.
	Beeper:	Sounds according to comparison result (Pass / Fail / Off)
• Handler interface	Signal isolation:	All I/O signals are optically isolated (withstand voltage ±42V)
	Input signal:	Trigger, Key lock, Settings/correction value memory designation. High speed recalling with only spot correction value is possible.
	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).
	Rated power voltage:	External +5V to +24V, Internal +5V (non-isolated)
• Multi-measurement	Execute measurement and limit comparison under multiple conditions for the total comparison. Maximum number of steps: 32 Selectable measurement conditions: Measurement frequency, measurement signal level, internal DC bias voltage, measurement parameters, etc.	

• Monitor display

Voltage: Voltage value applied to the DUT

Voltage Monitor Accuracy

±(2%+2mVrms)	from 10Hz to 50kHz
±(3.5%+2mVrms)	over 50kHz to 100kHz
±(5%+5mVrms)	over 100kHz to 1MHz
±(10%+10mVrms)	over 1MHz to 5.5MHz

Current: Current value flowing in the DUT

Current monitor accuracy (supplementary value)

Voltage monitor accuracy + Measurement accuracy of impedance Z

• Discharge protection

4J or less when voltage is below 250V, or 0.5J or less when below 1kV.
(All are supplementary values)
For voltage V[V], the energy stored in capacitance C[F] is $(1/2) \times C \times V^2$[J].

■ 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

Conforms to IEEE 488.1 and IEEE 488.2 Standards

• LAN (optional)

10BASE-T / 100BASE-TX, RJ-45 connector

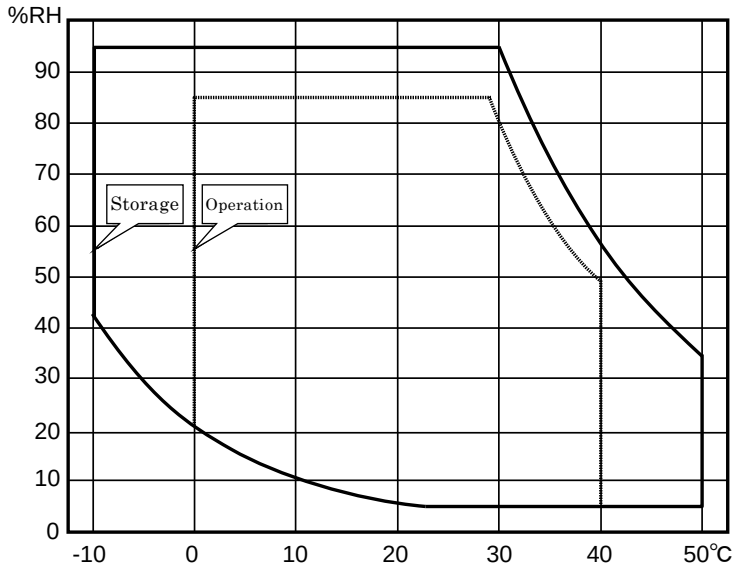
■ General specifications

• Power Supply
- Voltage: AC 100V to 230V ±10%, but 250V or less
- Frequency: 50Hz/60Hz ±2Hz
- 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/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)

• Safety: EN 61010-1:2010

• EMC: EN 61326-1:2013(Group 1, Class A)
EN61000-3-2:2006+A1:2009+A2:2009
EN61000-3-3:2008

• RoHS: Directive 2011/65/EU

• Warm-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 at power-on.

• External dimensions: Approx. 260 (W) × 88 (H) × 280 (D) mm, not including protuberances

• Weight: Approx. 2.4kg (without accessories)

1.2 External Dimensions

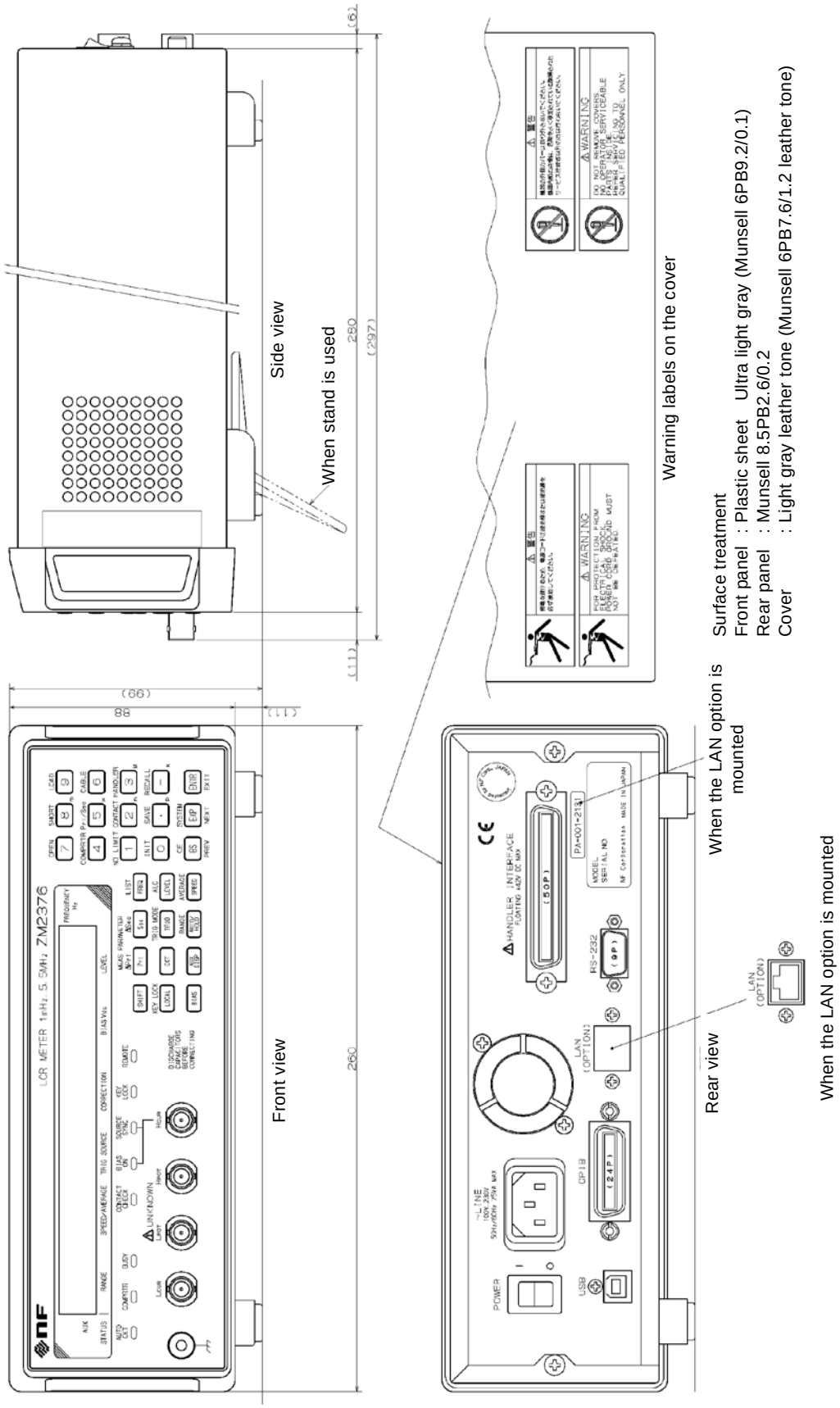


Figure 1-3 ZM2376 external dimensions

WARRANTY

NF Corporation certifies that this product was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory.

All **NF** products are warranted against defects in materials and workmanship for a period of one year from the date of shipment. During the warranty period, **NF** will repair the defective product without any charge for the parts and labor. For repair service under warranty, the product must be returned to either **NF** or an agent designated by **NF**. Purchaser shall prepay shipping charge, duties and taxes for the product to either **NF** or the agent from another country, and shipping charge for the return of the product to purchaser shall be paid by **NF** side.

This warranty shall not apply to any defect, failure or damage caused by a) improper use; b) improper or inadequate maintenance and care; or c) modification by purchaser or personnel other than **NF** representatives.

- Failure due to the handling or storage that violates the operating methods or precautions given in the instruction manual
- Failure or damage caused by a fall or shock during transportation or relocation performed by the purchaser
- Modification made to the product by the purchaser
- Failure by external abnormal voltage or influence of external equipment connected to the product
- Failure or damage caused by fire, earthquake, flood, thunder, rebellion, war, and force majeure including other act of providence.
- Replenishment of consumable parts such as magnetic tapes and batteries

REPAIR

When a failure occurred and the product was found to be defective or you have any uncertainty, please get in touch with NF Corporation or one of our representatives.

In such a case, let us know the model name (or product name), serial number (SERIAL No. given on the nameplate), and symptom and operating conditions as detail as possible.

Though we will make efforts to reduce the repair period, when five or more years have passed since you purchased the product, it may take time due to, for instance, the out of stock of repair parts.

Also, if the production of repair parts is discontinued, the product is extremely damaged, or the product is modified, we may decline the repair.

NOTES

- Reproduction of the instruction manual, part or whole, is forbidden without prior written permission.
- The contents of the instruction manual are subject to change without notice.
- Information provided in the instruction manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of the instruction manual.

  If you have any uncertainty or you found an error or omission, please contact NF Corporation or one of our representatives from which you purchased the product.

ZM2376 Instruction Manual (Basics)

NF Corporation

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223-8508, JAPAN

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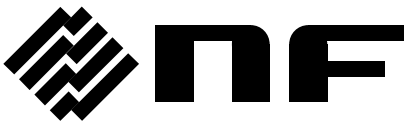
http://www.nfcorp.co.jp/



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