LCR METER

ZM2353/ZM2354

INSTRUCTION MANUAL

NF Corporation

DA00011497-001

Errata Table

Page	Old	New
Fifth line of secound paragraph of page 12-3	50Ω	50kΩ
Third line of first paragraph of page 12-4	80%RH	85%RH
First line of "Table of Basic Accuracy" of page 12-5	Frequency	Frequency[Hz]

DA00010403-001

LCR METER

ZM2353/ZM2354

INSTRUCTION MANUAL

For safe use of the ZM2353/ZM2354 LCR Meter

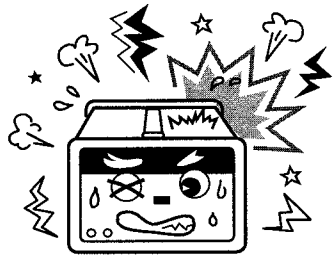
The ZM2353/ZM2354 LCR Meter is designed and tested taking into consideration safety and protection and shipped after confirmation of safety.
In order to use the ZM2353/ZM2354 safely, the following warnings and instructions must be observed.
NF Corporation shall not be responsible to, nor will compensate, damage caused by usage that violates these instructions.

Observe information given in this instruction manual

This instruction manual contains information to ensure safe operation and use of the ZM2353/ZM2354.
Before using the ZM2353/ZM2354, be sure to read this instruction manual first. After reading, store the manual carefully so that it will be referenced later when any uncertainty is encountered.

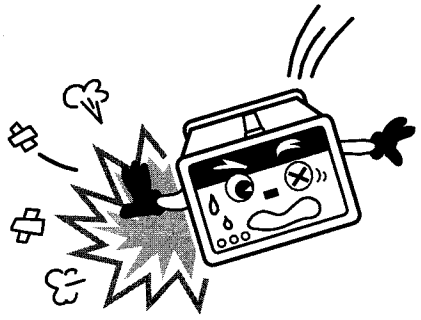
Observe information labeled with ⚠WARNING and ⚠CAUTION

Be sure to observe the information given by the "WARNING" and "CAUTION" indications contained in this instruction manual and affixed to the ZM2353/ZM2354, which are intended to prevent danger leading to serious accidents.

⚠ **WARNING**	This indication on the ZM2353/ZM2354 or in the text herein describes information to avoid the hazard to which user's life and body may be exposed when the user is handling the ZM2353/ZM2354.	
⚠ **CAUTION**	This indication on the ZM2353/ZM2354 or in the manual herein describes information to avoid the damage to which the ZM2353/ZM2354 is exposed.	
⚠	This indication on the ZM2353/ZM2354 indicates the part or function before using which the user has to refer to this manual.	

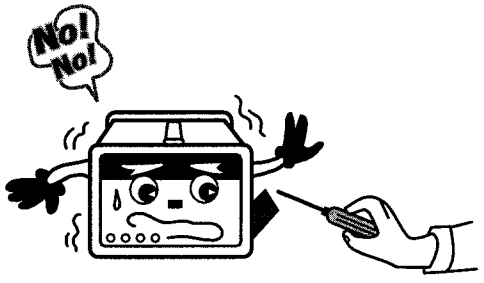
Damage during transport and storage

- If the ZM2353/ZM2354 is damaged by excessive vibration or impact, its functions for safety protection may have been lost. Leave the ZM2353/ZM2354 as it is, and immediately contact the NF Corporation or the sales representative.

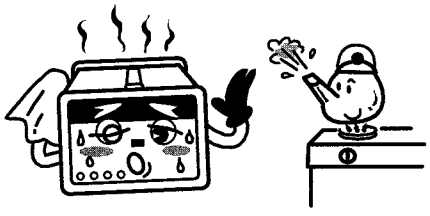


Forbidden cover removal and modification

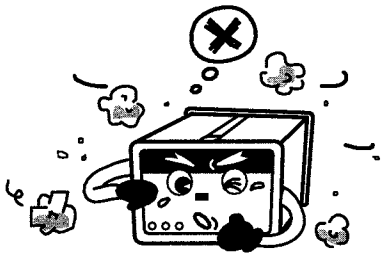
- Never remove the cover. Never carry out internal repair, inspection, or adjustment.
- Never modify internal ZM2353/ZM2354. It may cause failure or accidents.



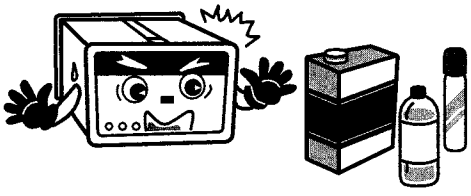
Never install the ZM2353/ZM2354 in the following locations



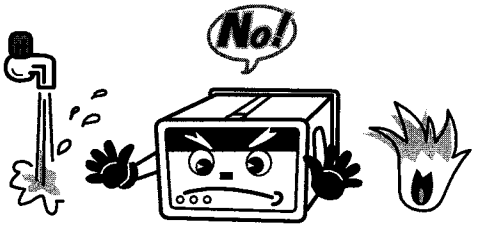
- A humid place where condensation is likely to occur.



- A dusty or linty place



- A place exposed to explosive or flammable gases.

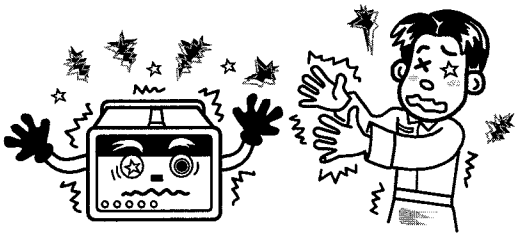


- A place involving fire or water

⚠ WARNING

Caution to electric shock

- Do not touch directly the power supply part or the circuit board of the ZM2353/ZM2354. They involve high voltage.



- Be sure to connect the ZM2353/ZM2354 to the ground before connection for measurement.

⚠ CAUTION

Instructions on installation

- Use the ZM2353/ZM2354 within the rated range of ambient temperature and humidity.

  Performance rating: +5 to +40°C, 5 to 85% RH
  (Absolute humidity: 1 to 25 g/m^3, no condensation)

  Storage conditions: −10 to +50°C, 5 to 95% RH
  (Absolute humidity: 1 to 29 g/m^3, no condensation)

- The ZM2353/ZM2354 unit has an exhaust vent on the side and inlet port on the rear. Place the ZM2353/ZM2354 10 cm away from walls to secure air circulation.

- Avoid using the ZM2353/ZM2354 in the vicinity of any device that emits pulsating noise, a strong magnetic field, or a strong electric field such as an SCR-controlled large power supply or a CRT display, which would cause malfunction or reduced measurement precision.

Instructions on use

- Before turning on the power switch, confirm that the voltage of your power outlet fits the ZM2353/ZM2354 rating voltage.

- Clean the air filter of the inlet port regularly. Dust deposited on the air filter would impede the air circulation.

Expressions used in this manual

⚠ WARNING

This indication on the ZM2353/ZM2354 or in the manual herein describes information to avoid the hazard to which user's life and body may be exposed when the user is handling the ZM2353/ZM2354.

⚠ CAUTION

This indication on the ZM2353/ZM2354 or in the manual herein describes information to avoid the damage to which ZM2353/ZM2354 is exposed.

Be careful!

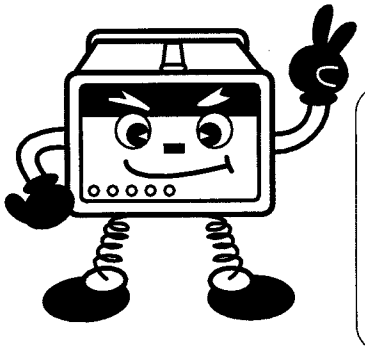
This describes mistakable operation.

Note

This provides the user with useful information.

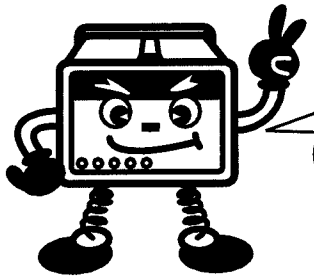
Contents

Introduction 1



Those who would like to use the ZM2353/ZM2354 right away should first read Chapter 4. "How to Measure."

Introduction Outline of the ZM2353/ZM2354



Hi, there!
My name is "LCR Meter, ZM2353/ZM2354".
You may call me "ZM".
Let me introduce my features before giving you a close explanation.

Wide range of frequency

The user can specify the frequency in a range as wide as 40 Hz to 200 kHz with fine resolution level of two or three digits.

Quick measurement

Measurement time is as short as 25 ms or less (typically), which is half or less them by conventional equipment.
(Comparison with our existing product model 2345)

High precision

Basic accuracy of 0.1%
Resolution of 4 and 1/2 digits (Resolution of D is 0.0001)

Clear LED display and easy button operation

7-segment LEDs are adopted to facilitate monitoring the measurement.
Both a numerical keypad and modifier buttons are adopted in order to enhance ease of operation.

Wide range of measurement signal level

The user can set a signal level in the range of 10 mVrms to 5 Vrms (with resolution of 1 mV or 10 mV).

High DC bias level

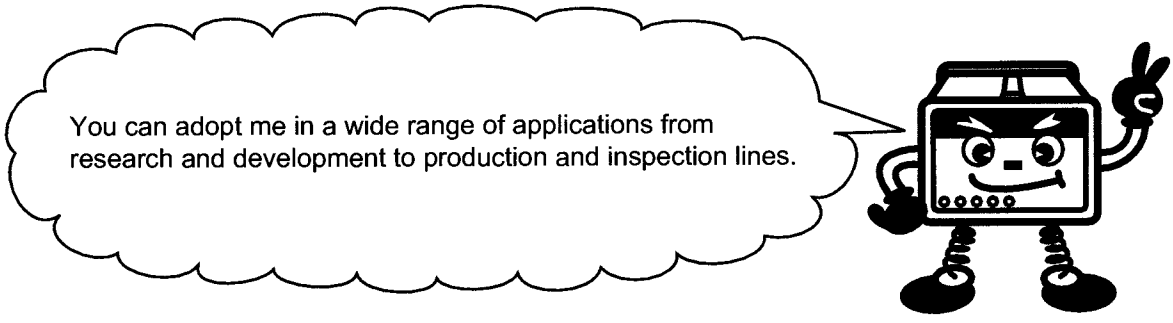
A 2.5 V DC biasing power supply incorporated in the ZM2353/ZM2354 allows C-measurement of polarity components such as electrolytic capacitor and semiconductors.
Further, voltage of maximum ±35 V can be applied from outside.

Variety of parameters

The equivalent series resister ESR, parallel conductance G, serial reactance X, and impedance expressed in polar coordinates $|Z|$- θ, are available in addition to common components of L, C, R, D and Q.

Standard components

The ZM2353/ZM2354 is provided as standard with a GPIB, which is a standard interface for measurement instruments.
The ZM2354 is equipped with a handler interface that is used on parts production lines.



Measurement in R&D division and production field

The automatic setting function enables even a beginner to execute measurement just by turning on the power.
Further, changing parameters manually can display various sort of parameters.

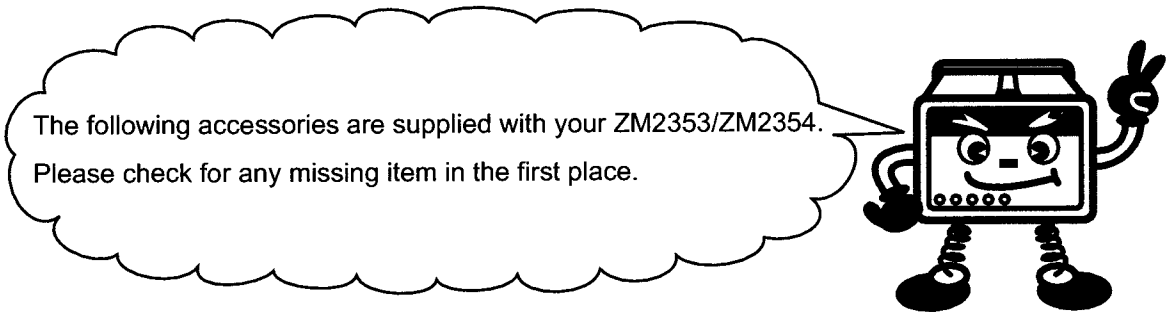
For evaluation of frequency characteristics of parts (L, C and R)

Since frequency can be set in the range from 40 Hz to 200 kHz in two-digit resolution (three-digit resolution for 100 kHz or higher), the user can see the frequency characteristics of parts.

For screening of parts (L, C and R)

The basic precision of 0.1% and 21-classification comparator function as well as 10 sets of setting memory make the ZM2353/ZM2354 suitable for component screening.
Combined with a handler interface, the ZM2354 can be used in automatic screening lines for electronic parts.

First check the contents of main unit and accessories!

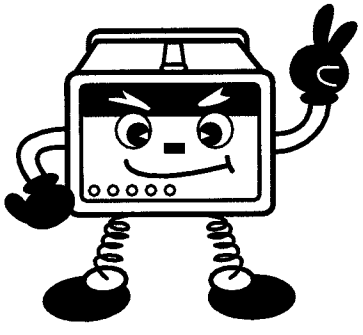


A main unit of ZM2353/ZM2354 LCR Meter

A copy of manual for "ZM2353/ZM2354" (this manual)	1
"Guide to Test Fixtures and Test Leads"	1
A power cord set (2 meter long with three pins)	1
A power fuse of 0.8 A 250 V, time-lag type, 5.2Ø x 20 mm	1

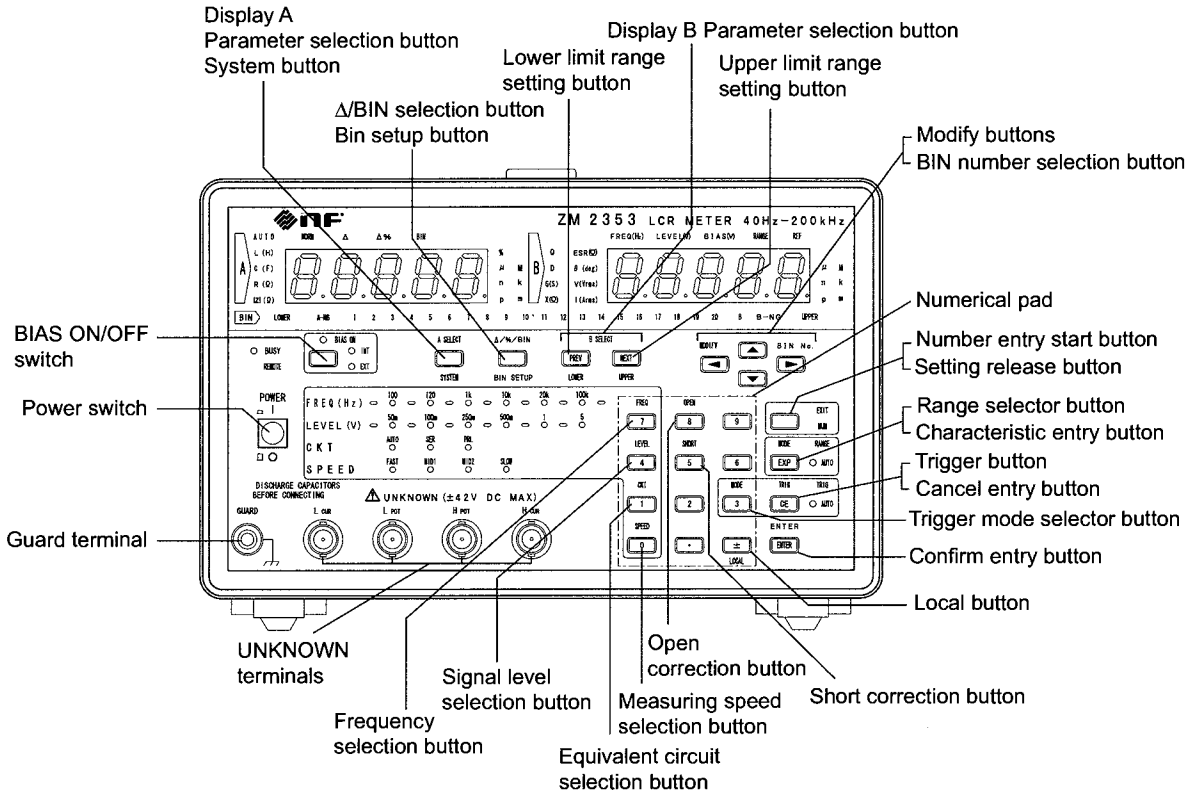
If any of the above is missing, contact NF Corporation or NF representives.
Replace the power cord set and power fuse before using this product outside of Japan. Contact NF Corporation or NF representives.
The provided power cord set is customized for this product and is for use in Japan only. Do not use this power cord set with other products or for other purposes.

Names of Parts 2

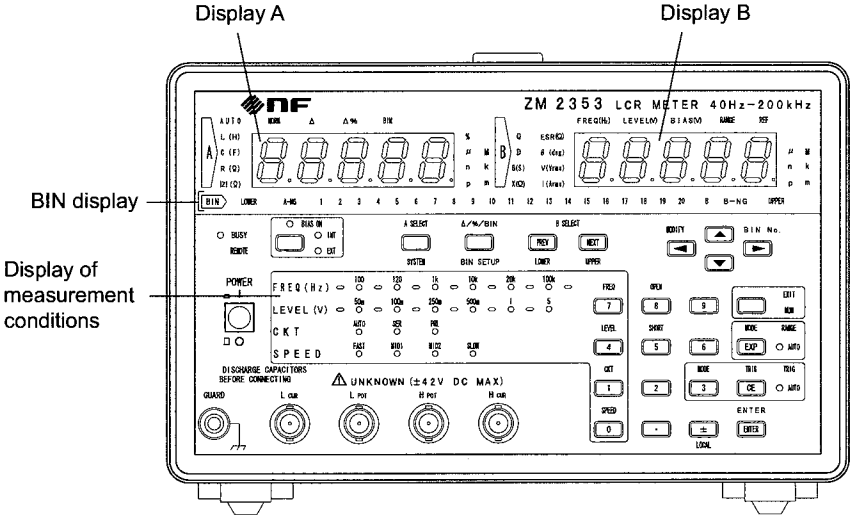


Front panel

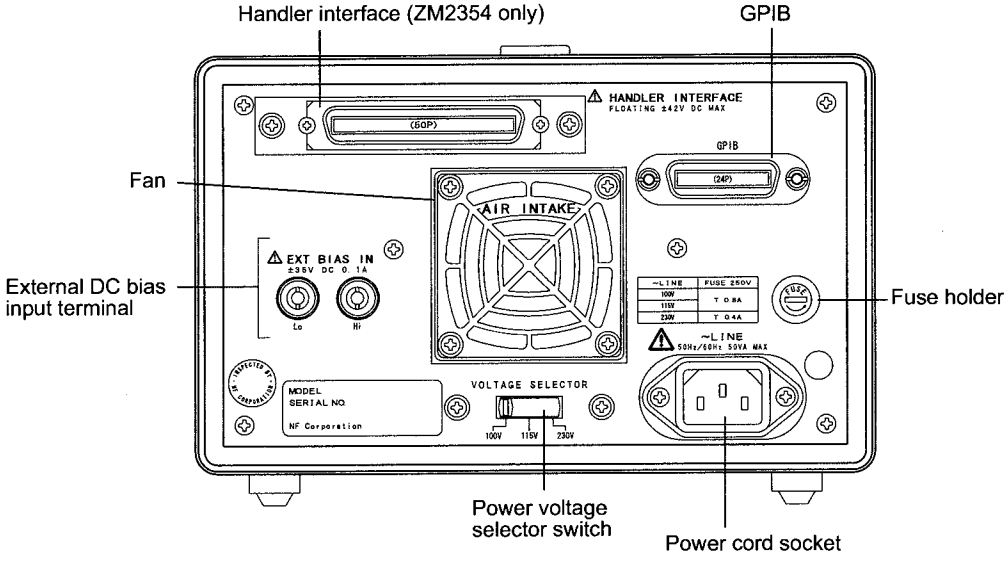
Controls and terminals



Displays



Rear panel



Note

[Button operation]

- If the character(s) are lighting near the button, then the function indicated by the character(s) is available.
- Entry of number
  Press NUM, and the character(s) lamp will go out on the numerical pad, enabling the user to enter numbers.

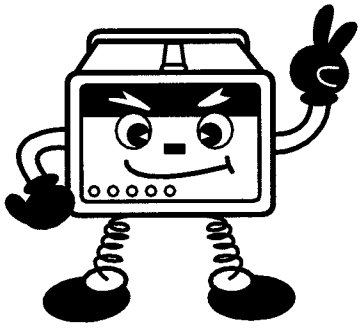
[Special button operation]

To enter the system mode or bin setup mode, press the two buttons simultaneously.

- To enter the system mode: while pressing ENTER, press A SELECT / SYSTEM.
- To enter the bin setup mode: while pressing ENTER, press Δ/%/BIN / BIN SETUP.

Before Starting Operation

3



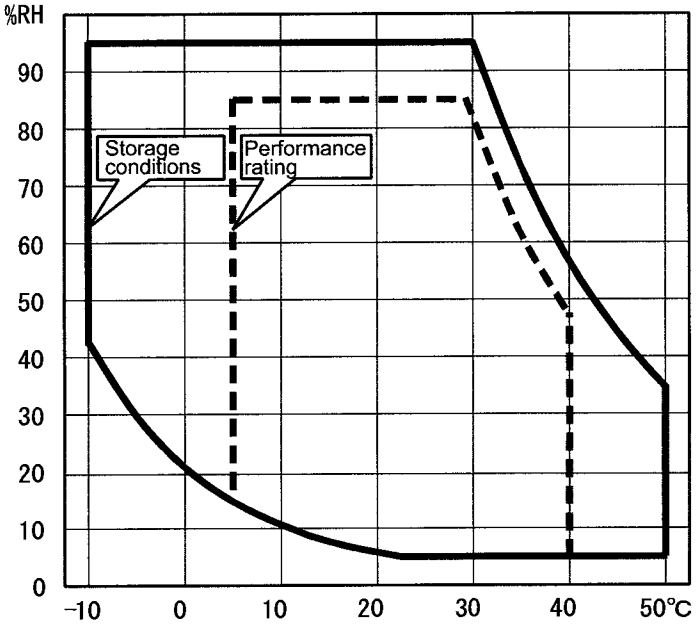
Instructions on installation

○ Keep the ZM2353/ZM2354 in allowable ranges of temperature and humidity as follows:

Performance rating: +5 to +40°C, 5 to 85% RH
(Absolute humidity: 1 to 25 g/m^3, no condensation)

Storage conditions: −10 to +50°C, 5 to 95% RH
(Absolute humidity: 1 to 29 g/m^3, no condensation)

○ For installation of the ZM2353/ZM2354, select a place with little dust and vibration, free of direct sunlight, where the temperature and humidity are within the ranges specified above.



Power supply and grounding

Power cord set and grounding

For prevention of electric shock accidents, be sure to connect the ZM2353/ZM2354 to the ground before connection for measurement.

A three-pin power cord set with a grounding terminal is supplied with the ZM2353/ZM2354. Use this cable with the plug connected to a three-pin power receptacle that has a protective ground contact, and the ZM2353/ZM2354 will be grounded.

The provided power cord set, which is for use in Japan only, has a rated AC voltage of 125 V, with maximum voltage of 1250 Vrms/minute. The power cord set must be replaced to enable use at higher voltages or outside of Japan. Contact NF Corporation or NF representatives.

The provided power cord set is customized for this product. Do not use this power cord set with other products or for other purposes.

Power fuse

Use a fuse with capacity of 0.8 A for 100/115 V AC and 0.4 A for 230 V AC. The fuse must be of time lag type and be rated at 250 V with the size of 5.2ϕx 20 mm. Select adequate one to the user power voltage. The product is supplied with a 0.8 A fuse as standard on shipping. If the user needs a 0.4 A fuse, contact NF corporation or NF representives.

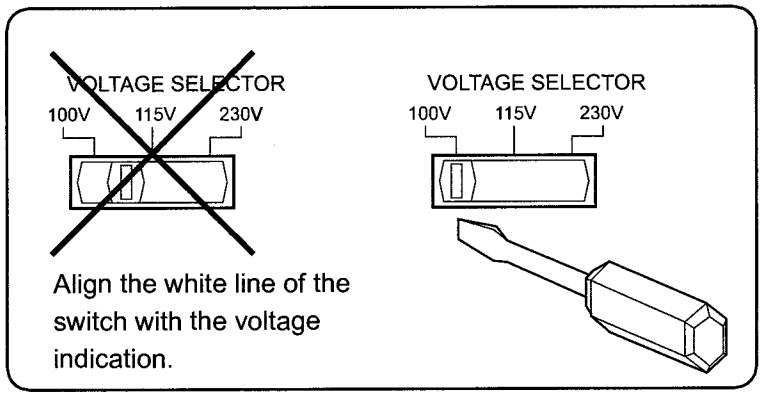
⚠WARNING

Use only the specified fuse. Use of an otherwise rated fuse, or use of copper or other wires may cause failure or fire.

Power supply voltage

The ZM2353/ZM2354 works under the following power voltage:
100/115/230 V AC ±10%
50/60 Hz ±2 Hz
Power consumption of 50 VA or less

The power voltage is set to 100 V AC as standard on shipping. Check the selector switch on the rear panel. To use the ZM2353/ZM2354 under other voltage than 100 V AC, unplug the power cord and set the power voltage selector switch to the given voltage.



Changing the Power Voltage

⚠CAUTION

Do not change the power voltage with the power cord plugged in the connector.
This may damage the ZM2353/ZM2354.

Line filter

ZM2353/ZM2354 uses a line filter.
The leakage current is maximum 1 mA rms at 250 V AC and 60 Hz. Therefore, electric shock may be caused if the user touches a metallic part of the ZM2353/ZM2354 enclosure.

⚠WARNING

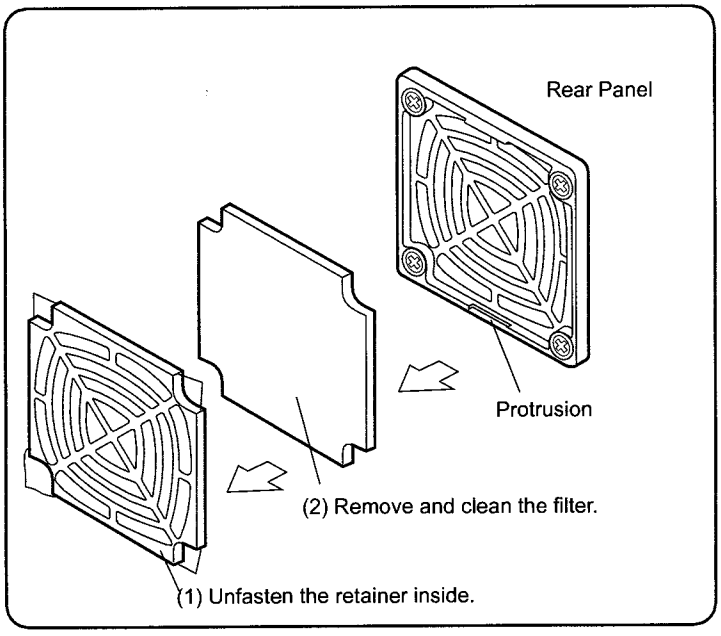
The ZM2353/ZM2354 enclosure must be grounded. Otherwise, electric shock may be caused.

Fan

The ZM2353/ZM2354 is forcibly air-cooled by a fan. Obstructions to the air circulation may cause failure.

⚠ Caution

- Keep the ZM2353/ZM2354 10 cm or more away from the wall when installing the ZM2353/ZM2354, which has an air intake port on the rear side.
  If the ZM2353/ZM2354 is used in a sealed rack or in other closed space, the ambient temperature will rise, resulting in insufficient cooling. Keep a clear space at the rear of the ZM2353/ZM2354.
- ZM2353/ZM2354 has an air exhaust port on the side, which must not be blocked during usage.
  Deposited dust on the air filter at the air intake port will impede air circulation. Regularly clean the air filter every three months as a normal guideline. If the unit is used in a dusty environment, the guideline should be reduced to one month. Remove the air filter retainer of the fun, and the user can take out the air filter.
- Should the user notice the fan not running, immediately turn off the power, and contact NF corporation or NF representives. Use of the ZM2353/ZM2354 with the fan not working would expand the damage, resulting in an unrepairable condition.

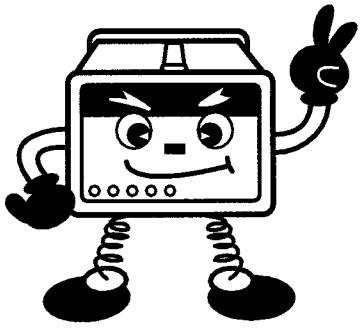


Cleaning the Air Filter

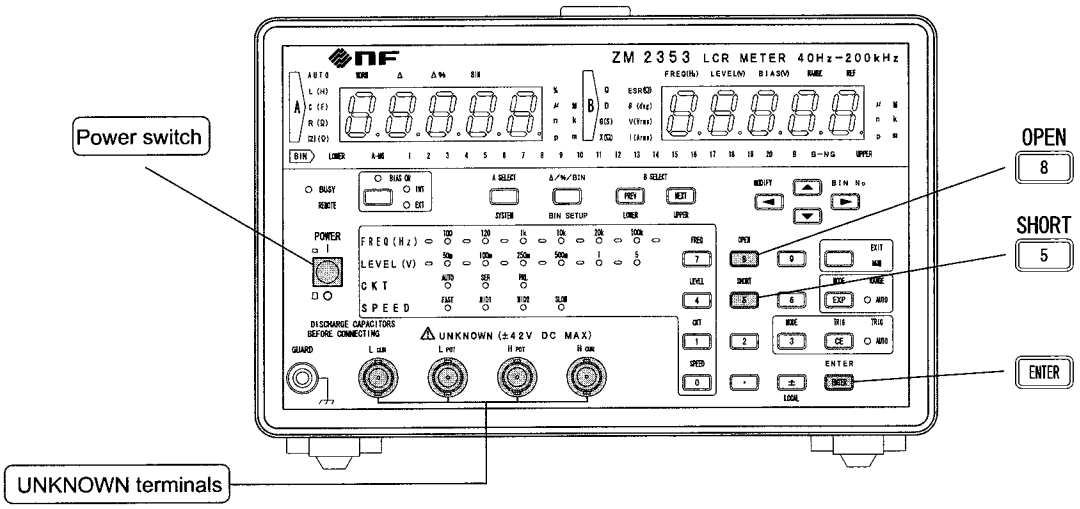
⚠ WARNING

Turn off the power switch before removal and reinstatement of the air filter for prevention of danger.

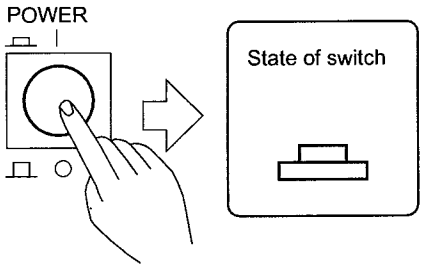
How to Measure 4



Measurement in AUTO Mode



1 Turn on the power switch to energize the ZM2353/ZM2354.



2 All indicators on Displays A and B and all LED lamps light up.

Be careful!

Be alert to any unlit indicator on Displays A or B or unlit lamp.

If any of them is found unlit, contact NF Corporation or NF representives.

3 When the internal circuit has been checked, [01] is indicated on Display B, and then measurement starts.

* If any anomaly is detected, error message will be shown.
* Perform a warm-up run for at least 30 minutes.

Note

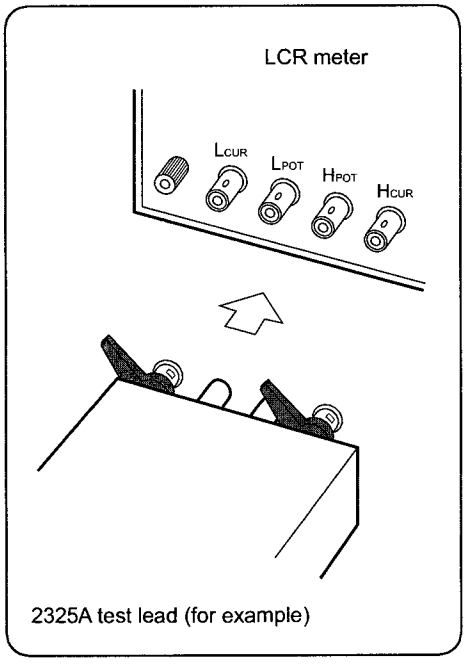
The system selects the following conditions (the initial setting) automatically.

Mode: AUTO

FREQ: 1 kHz

LEVEL: 1 V

4 Connect the 2325A Test Lead (test fixture).

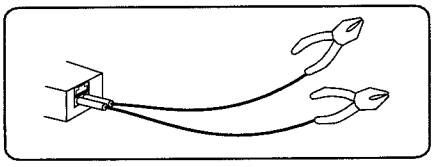


Note

For description of LCR Meter Test Lead and Test Fixture (optional), see the "Guide to Test Fixtures and Test Leads".

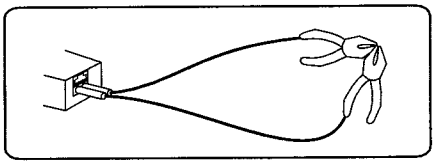
5 Execute zero correction.

- Execute open correction.



Press OPEN 8.

- Execute short correction.



Press SHORT 5.

Be careful!

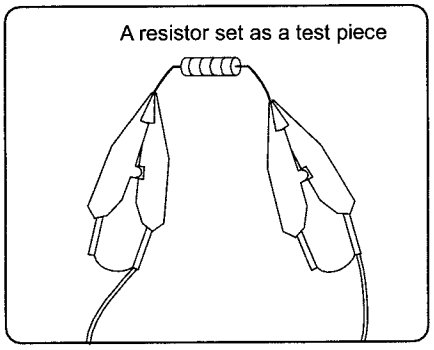
If SHORT 5 is pressed with two clips kept open, or if OPEN 8 is pressed with two clips kept closed, then an error will be caused.

6 Press ENTER.

Be careful!

Even though measurement can be performed without executing zero correction, the measurement will not produce correct result.

7 Attach a test piece to the test lead (test fixture).



8 Execute measurement.
AUTO and R (Ω) light up.
* Display A will show the measurement.

Note

If it is a capacitor: AUTO and C (F)

If it is a coil: AUTO and L (H)

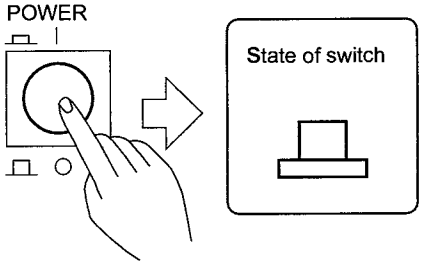
Q lights up.
* Display B will show the value of Q.

Note

If it is a capacitor: D

If it is a coil: Q

9 Press the power switch to turn off the power.



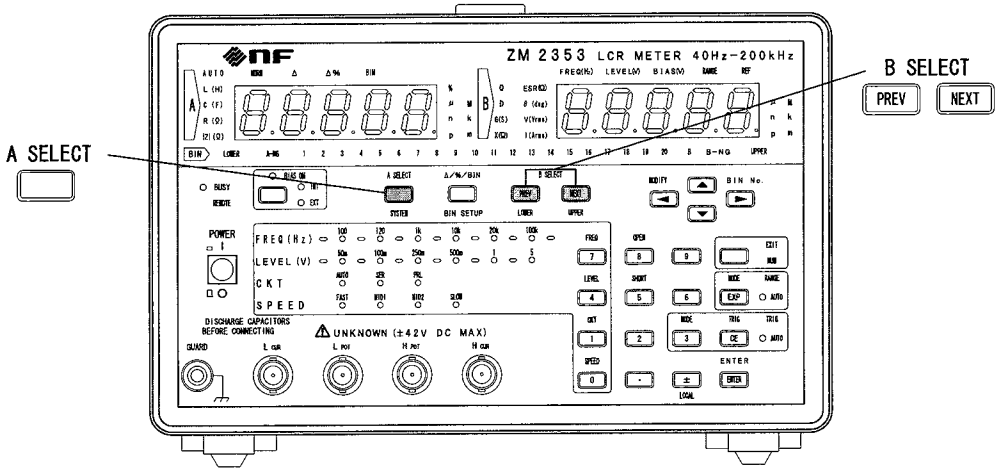
Note

The operation procedures for measurement items written on the next page and on should be performed between Steps ③ and ⑧.

③ After display B has shown [01].

⑧ After the measuring result has been shown

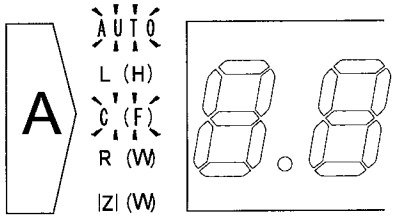
Selecting measurement parameter



Automatic selection of parameter

1. Once the test piece is attached, L, C, R, and |Z| will be selected automatically according to the phase angle of the impedance.

Example: If it is C:



Note

Automatic selection by the phase angle of impedance

If θ = +90 ±30°: L, Q

If θ = 0 ±30°: R, Q

If θ = −90 ±30°: C, D

If θ = otherwise: |Z|, θ

Arbitrary selection of parameter

1. Every press on A SELECT, the button for selection of the main parameter (on Display A) will change the indication on Display A in turn.

Example: If it is C:

AUTO + C(F) →L(H)→C(F)→R(Ω)→|Z|(Ω)

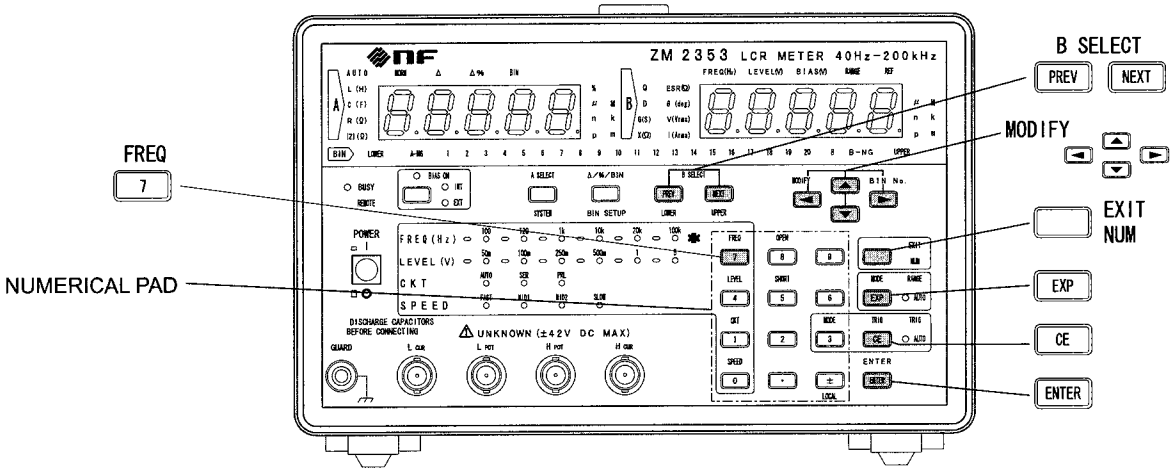
Select the desired indication when it is lighting.

2. Press one of them of B SELECT PREV NEXT (the button for selection of the sub parameter on Display B).
Every press on NEXT (regular direction) or PREV (opposite direction) will change the indication on Display B in turn.
Example: If NEXT is pressed (PREV will produce the opposite result):

→Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
→V(Vrms)→I(Arms)→FREQ(Hz)
→LEVEL(V)→BIAS(V)→RANGE→REF

Select the desired indication when it is lighting.

Setting the measurement frequency



Use of direct buttons

1. Every press on FREQ [7] will change the six indications of FREQ (Hz) in turn:

   1k→10k→20k→100k→100→120

   Select the desired indication when it is lighting.

Note

To select your desired frequency, use the numerical pad or the Modify button.

Using the numerical pad

1. Press one of buttons of B SELECT [PREV] [NEXT]. Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.
   Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

   Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
   →V(Vrms)→I(Arms)→FREQ(Hz)
   →LEVEL(V)→BIAS(V)→RANGE→REF

   Select FREQ (Hz) when it is lighting.

2. Press [NUM].

Note

This button activates the numerical pad, when the indication lamps on the numerical pad go out.

3. Press buttons on the pad to make a desired two- or three-digit number for resolution setting.

   Example: To specify 125 kHz:
   Press [1], [2], [5] and then press [EXP] to light up (k) for the units.

   B 125 k

   Example: To specify 250 Hz:
   Press [2], [5] and [0].

   B 250

Note

- A value in the range from 40 to 200 kHz can be entered.
The number in the one place will be rounded off into the nearest ten.
Example: If 115 Hz is entered:

115 ⇨ 120

- The measure for the units will be shown automatically.
Example: If 10000 Hz is entered:

10000 ⇨ 10.0 k

- If you entered a wrong number, then press [CE] and retry the entry.
- If [EXIT] is pressed, the system will return to Step 1.
- Every press on [EXP] will change the measure (characteristic) in turn.

(4) Press [ENTER] to complete the setting.
Select FREQ (Hz) when it is lighting.

Note

Frequency is set in the resolution as follows:
40 Hz to 99 Hz: resolution of 1 Hz
100 Hz to 990 Hz: resolution of 10 Hz
1.0 kHz to 9.9 kHz: resolution of 100 Hz
10 kHz to 200 kHz: resolution of 1 kHz

Use of Modify button

(1) Press one of buttons of [PREV] [NEXT] (B SELECT).
Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.

Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

Q→D→G(S)→X(Ω)→ESR→θ(deg)
→V(Vrms)→I(Arms)→FREQ→LEVEL
→BIAS→RANGE→REF

Select FREQ (Hz) when it is lighting.

(2) Press any of the four buttons of:
[MODIFY] [◄] [▲] [▼] [►]

Note

The press will activate the Modify button.

(3) Press one of buttons of [MODIFY] [◄] [►] to specify the digit.
The selected value will blink.

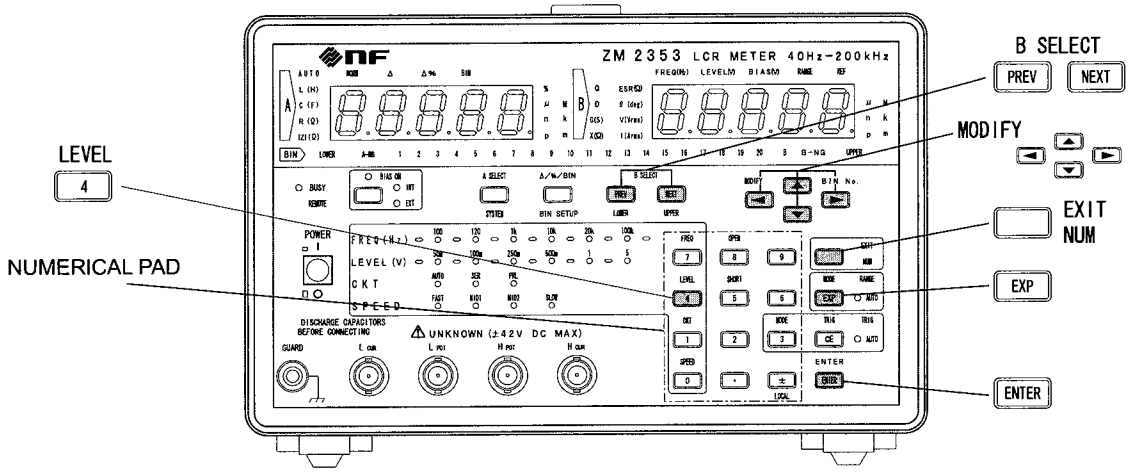
(4) Press the buttons of [▲] [▼] to make a desired two- or three-digit number for resolution setting and complete the setting.
A press on [▲] will increase the value.
A press on [▼] will decrease the value.
Example: to decrease from 1.00 kHz to 900 Hz:
In the state of

1.00 k

Press [▼] and
You will get:

900

Setting the measurement voltage



Use of direct buttons

1. Every press on LEVEL [4] will change the indication of LEVEL (V) in turn:

   1→5→50m→100m→250m→500m

   Select the desired indication when it is lighting.

   Note

   To select your desired voltage, use the numerical pad or the Modify button.

Using the numerical pad

1. Press one of buttons of B SELECT [PREV] [NEXT]
   Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.
   Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

   Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
   →V(Vrms)→I(Arms)→FREQ(Hz)
   →LEVEL(V)→BIAS(V)→RANGE→REF

   Select LEVEL (V) when it is lighting.

7. Press [ ] NUM .

   Note

   This button activates the numerical pad, when the indication lamps on the numerical pad go out.

3. Press buttons on the pad to make a desired two- or three-digit number for resolution setting.

   Example: To specify 125 mV:
   Press [1], [2], [5] and then press [EXP] to light up (m) for the units.

   B 125 m

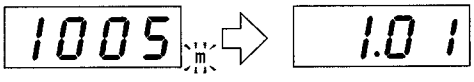
   Example: To specify 2.5 V:
   Press [2], [•], [5] and 2.50 will be indicated.

   B 2.50

4. How to Measure

Note

- A value in the range from 10 m to 5 V can be entered.
  The number in the one place will be rounded off into the nearest ten, and the measure for the units will appear automatically.
  Example: If 1005 m is entered:



- If you entered a wrong number, then press [CE] and retry the entry.
- If [EXIT] is pressed, the system will return to Step 1.
- Every press on [EXP] will change the measure (characteristic) in turn.

4 Press [ENTER] to complete the setting.

Note

10 mV to 999 mV: Resolution of 1 mV
1.00 V to 5.00 V: Resolution of 10 mV

Use of Modify button

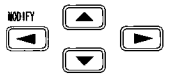
1 Press one of buttons of [PREV] [NEXT] (B SELECT).
Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.

Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

→Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
→V(Vrms)→I(Arms)→FREQ(Hz)
→LEVEL(V)→BIAS(V)→RANGE→REF

Select LEVEL (V) when it is lighting.

2 Press any of the four buttons of:

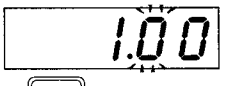


Note

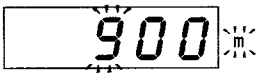
The press will activate the Modify button.

3 Press one of buttons of [MODIFY ◄] [►] to specify the digit.
The selected value will blink.

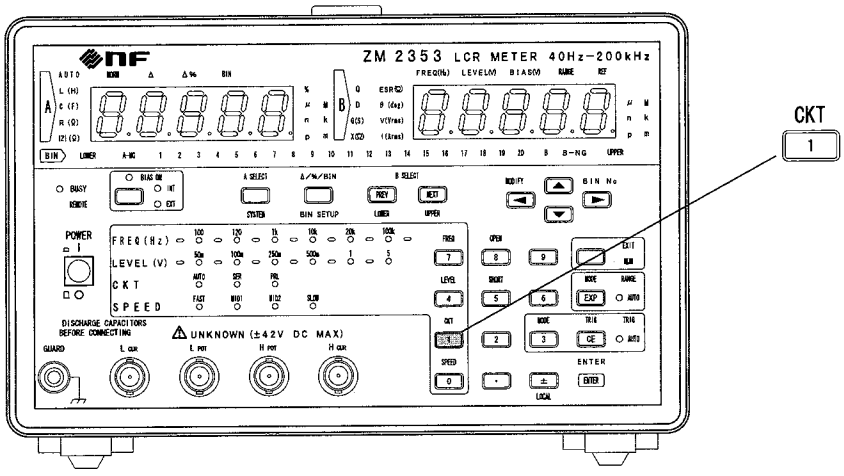
4 Press the buttons of [▲] [▼] to make a desired three-digit number for resolution setting and complete the setting.
A press on [▲] will increase the value.
A press on [▼] will decrease the value.
Example: to decrease from 1.00 V to 900 mV:
In the state of



Press [▼] and
You will get:



Selecting an equivalent circuit



Automatic selection of an equivalent circuit

1. When the test piece has been attached, SER or PRL will be selected automatically according to the magnitude of impedance, and parameters selected on Displays A and B.

If SER is selected:

If PRL is selected:

Note

If AUTO has been selected on Display A, also AUTO is selected for the equivalent circuit.

Note

- SER: This selects a series equivalent circuit.
- PRL: This selects a parallel equivalent circuit.

Arbitrary selection of equivalent circuit

1. Every press on CKT 1 changes the indication of equivalent circuits in turn. If SER has been selected automatically:

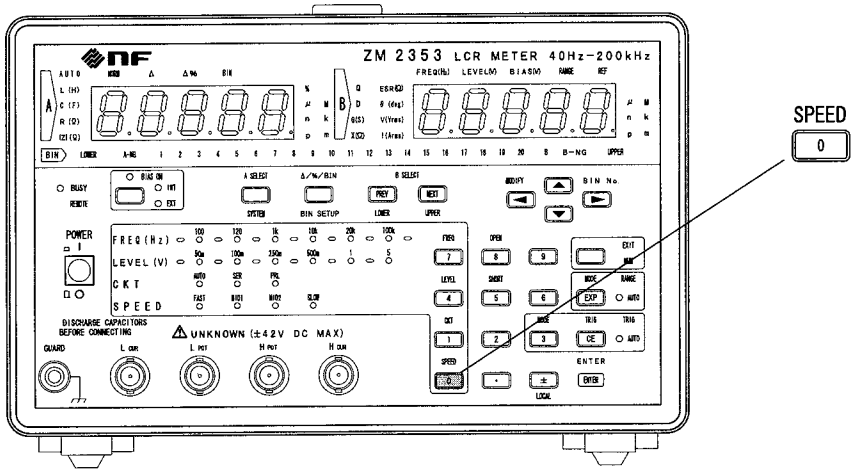
AUTO
+ → SER → PRL
SER

Select the desired indication when it is lighting.

Note

- Conditions to select series:
  - L, C, R, and |Z| - ESR, X
  - L, C (|Z| ≤ 1 kΩ) - Q, D, θ, V, I, settings
  - R ($\theta \leq 0$) - Q, D, θ, V, I, settings
  - |Z| - Q, D, θ, V, I, settings
- Conditions to select parallel:
  - L, C, R, and |Z| - G
  - L, C (|Z| > 1 kΩ) - Q, D, θ, V, I, settings
  - R ($\theta < 0$) - Q, D, θ, V, I, settings

Selecting the measuring speed



Use of direct buttons

1. Every press on MODE 3 changes the indication of SPEED in turn.

MID2→SLOW→FAST→MID1

Select the desired indication when it is lighting.

Note

- Measuring speed

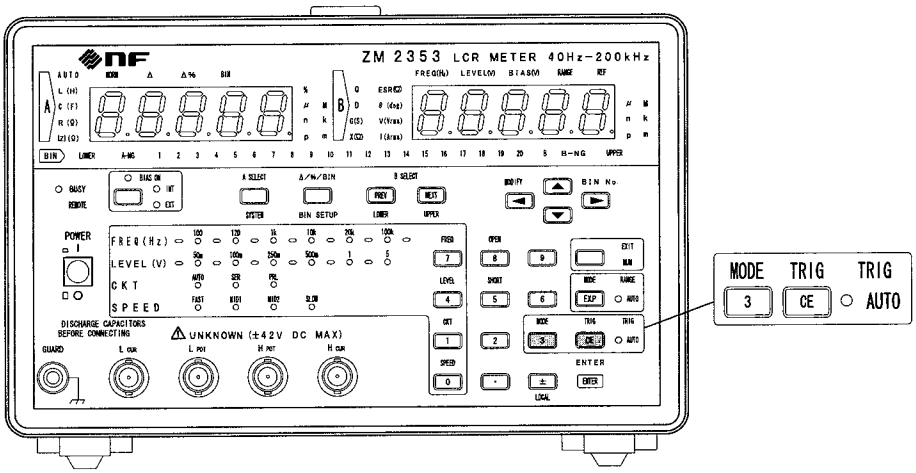
This selection specifies the time necessary for the measurement as follows:

FAST: 25 ms (typ.)
MID1: 64 ms (typ.)
MID2: 150 ms (typ.)
SLOW: 480 ms (typ.)

Note

The higher measuring speed you select, the shorter will be the time for the measurement, however, the fluctuation will be larger in the measurements.

Trigger mode



Selection of Mode

1 Every press on MODE 3 will toggle the trigger mode as follows:

[AUTO] ↔ [MAN]

TRIG ○ AUTO TRIG ● AUTO

Automatic mode (AUTO TRIG)

1 When TRIG ○ AUTO is lighting, next measurement will be started when the current measurement is finished.

Note

In automatic trigger mode, measurement is performed in succession, and the result will appear one after another.

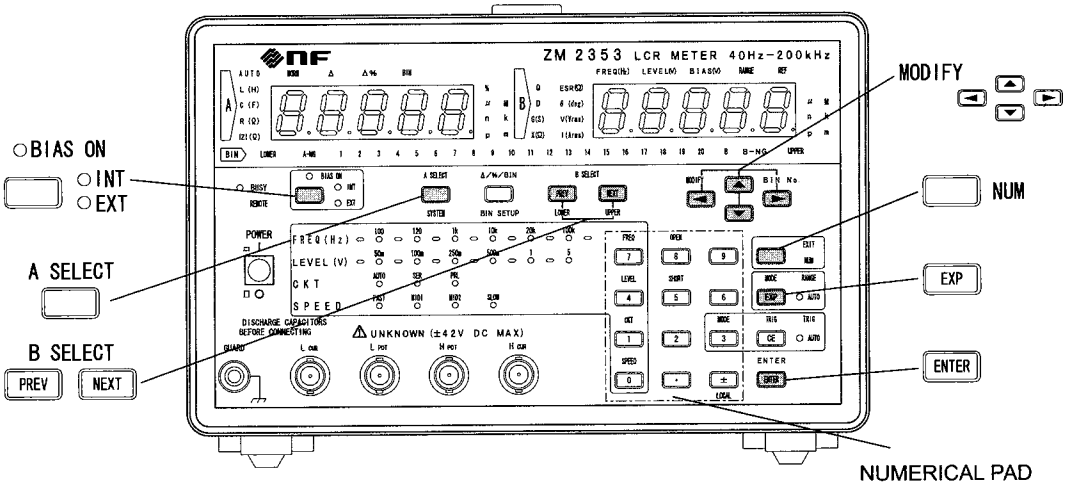
Manual mode (MANUAL TRIG)

1 When TRIG ● AUTO is not lighting, a press on TRIG CE will execute one measurement, and the result will appear.

Note

In manual trigger mode, the result will be held and the system will not move.

Application of internal DC bias



During measurement of C (capacity), the user can apply a DC bias voltage. The DC voltage bias is applicable at 0 to +2.5 V internally or using a DC power supply from outside.
☞For the settings for use of external DC power supply and change of internal and external methods, see Chapter 7 "System Menu".

Setting of DC bias voltage

Using the numerical pad

1. Press one of buttons of [PREV] [NEXT] (B SELECT). Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.

   Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

   →Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
   →V(Vrms)→I(Arms)→FREQ(Hz)
   →LEVEL(V)→BIAS(V)→RANGE→REF

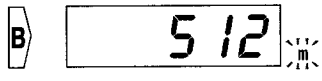
   Select BIAS (V) when it is lighting.

2. Press [NUM].

   Note
   This button activates the numerical pad, when the indication lamps on the numerical pad go out.

3. Press buttons on the pad to make a desired three-digit number for resolution setting.

   Example: To specify 512 mV:
   Press [5], [1], [2] and then press [EXP] to light up (m) for the units.

4. Press [ENTER] to complete the setting.

Use of Modify button

1. Press one of buttons of [PREV] [NEXT] (B SELECT). Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.

   Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

   Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
   →V(Vrms)→I(Arms)→FREQ(Hz)
   →LEVEL(V)→BIAS(V)→RANGE→REF

   Select BIAS (V) when it is lighting.

2. Press any of the four buttons of:

   [MODIFY] [▲] [▼] [►]

   Note

   The press will activate the Modify button.

3. Press one of buttons of [MODIFY] [►] to specify the digit.
   The selected value will blink.

4. Press the buttons of [▲] [▼] to make a desired number for setting.
   A press on [▲] will increase the value.
   A press on [▼] will decrease the value.

5. Press [ENTER] to complete the setting.

   Note

   0 mV to 999 mV: Resolution of 1 mV
   1.00 V to 2.50 V: Resolution of 10 mV

Application of internal DC bias

1. Every press on [ ] (A SELECT) will change the indication on Display A in turn.
   Example: If it is C:

   AUTO + C(F) →L(H)→C(F)→R(Ω)→|Z|(Ω)

   Select C (F) or |Z| (Ω).

   Be careful!

   Be sure to select C or |Z| before turning BIAS ON.
   If AUTO + C, AUTO + |Z|, L or R is selected, you cannot turn BIAS on, and an error message will appear.

2. If [ ] (BIAS ON) is pressed, DC BIAS will be applied and the lamp will light up.

   BIAS ON

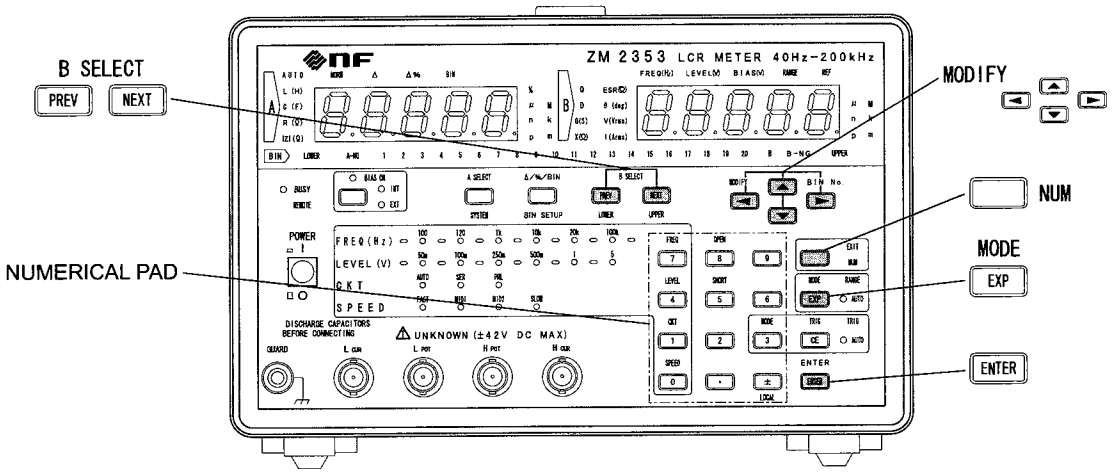
   Note

   Every press on [ ] (BIAS ON) will toggle the DC bias between ON and OFF.

   ON state — BIAS ON

   OFF state — BIAS ON

Setting the measurement range

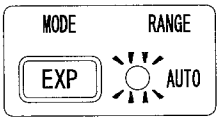


The measurement range has two modes: one is automatic (Auto) and the other is fixed (Fixed).
In automatic (Auto) mode, the range is changed automatically and measurement will be indicated in the optimal range.
In fixed (Fixed) mode, measurement will be executed in the range, which is fixed to the setting.

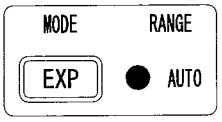
Selection of mode

1. Every press on MODE [EXP] toggles the mode between automatic and fixed modes.

Automatic mode (Auto)
↕
Fixed mode (Fixed)



AUTO lamp lighting

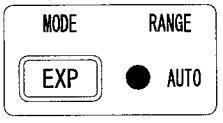


AUTO lamp not lighting

Selection of measurement range (fixed)

Using the numerical pad

1. Press MODE [EXP] to enter the Fixed mode.



AUTO lamp not lighting

Note

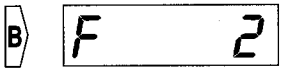
The range is fixed the range that was selected for AUTO measurement.

2. Press one of buttons of B SELECT [PREV] [NEXT]. Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.

Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
→V(Vrms)→I(Arms)→FREQ(Hz)
→LEVEL(V)→BIAS(V)→RANGE→REF

Select RANGE when it is lighting.



* Steps 1 and 2 may be taken in the reverse order.

3. Press [ ] NUM .

Note

This button activates the numerical pad, when the indication lamps on the numerical pad go out.

4. On the numerical pad, select a number button from [1] to [6] that corresponds to the range number for fixing and press it.

5. Press [ENTER] to complete the setting.

Note

The ZM2353/ZM2354 provides six ranges.
☞ See "Measurement range" in Chapter 8 "Measurement"

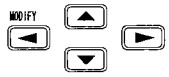
Be careful!

If any number other than 1 to 6 is pressed, an error message will appear.

Use of Modify button

1. Take Steps 1 and 2 in "Use of numerical pad".

2. Press any of the four buttons of:



Note

The press will activate the Modify button.

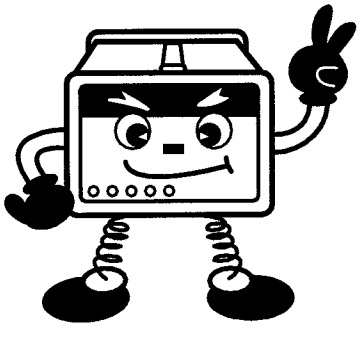
3. Press the buttons of [▲] [▼] to select six ranges.
   A press on [▲] will increase the value.
   A press on [▼] will decrease the value.

Be careful!

If "6" is shown for the range, pressing [▲] will not change the number, and
if "1" is shown for the range, pressing [▼] will not change the number either.

3. Press [ENTER] to complete the setting.

Operation of Comparator Functions 5



Comparator mode

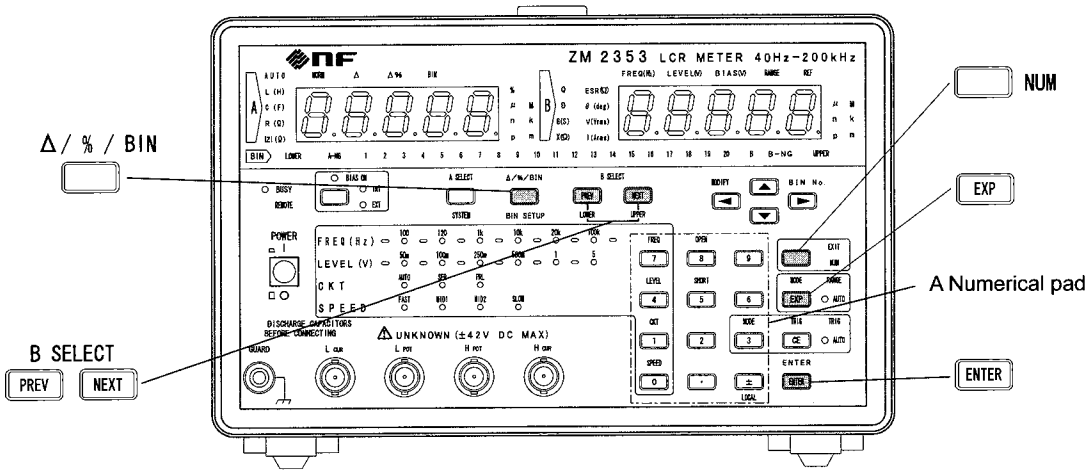
The ZM2353/ZM2354 is provided with comparator functions of maximum 21 classifications. The user can set the upper and lower limit values for the main parameters (indications on Display A) in BIN 1 to BIN 20 and also can set the upper and lower limit values for the sub parameters (indications on Display B) in BIN B.

The set values for upper and lower limit will determine the measurements and indicate the number of the BIN in which they are stored.

BIN B is enabled only when any item of Q, D, G, X, ESR, θ, V and I has been selected on Display B. If any of other items (FREQ, LEVEL, BIAS, RANGE, REF) has been selected, BIN B is disabled.

In addition, the result of determination will be supplied to the handler interface (ZM2354 only).

Viewing deviation data



The user can view the deviation data (Δ) of main parameters (indications on Display A) in relation to the reference value, and its percentage (Δ%).

Δ = Measurement – Reference value

Δ% = {(Measurement – Reference value) / Reference value} x 100

Setting the reference value

1. Press one of buttons of B SELECT [PREV] [NEXT]
   Every press on [NEXT] (regular direction) or [PREV] (opposite direction) will change the indication on Display B in turn.
   Example: If [NEXT] is pressed ([PREV] will produce the opposite result):

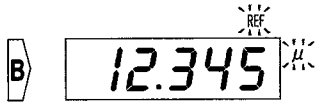
   Q→D→G(S)→X(Ω)→ESR(Ω)→θ(deg)
   →V(Vrms)→I(Arms)→FREQ(Hz)
   →LEVEL(V)→BIAS(V)→RANGE→REF

   Select REF when it is lighting.

2. Press [NUM].

   Note
   This button activates the numerical pad, when the indication lamps on the numerical pad go out.

3. Press buttons on the numerical pad to set a reference value in the resolution of 4-1/2 digits.
   Example: To set 12.345 μ:
   Press [1], [2], [•], [3], [4], [5] and then press [EXP] several times, and the unit "μ" will light up.



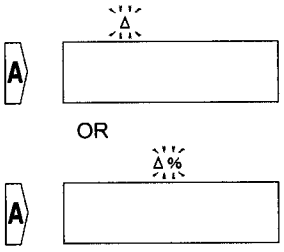
4 Press ENTER to complete the setting.

Display of deviation data

1 Every press on Δ/%/BIN changes indications on Display A in turn.

NORM→Δ→Δ%→BIN→ Δ + BIN → Δ% + BIN

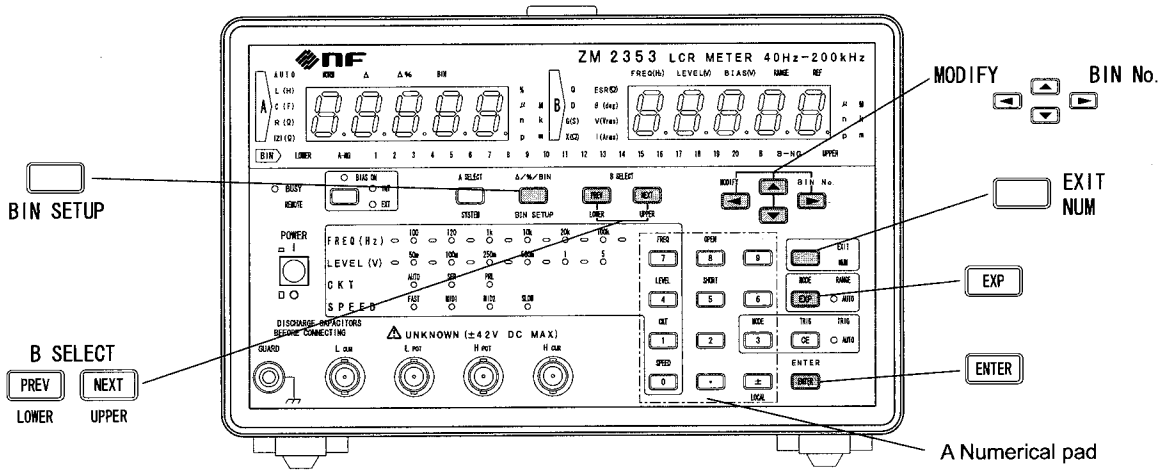
Select Δ or Δ% for deviation data when it is lighting.



Note

When deviation data (Δ) or deviation data percentage (Δ%) is displayed, "OF" or "UF" may be displayed if the valued is far away from the reference value.

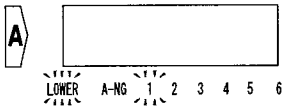
Setting the comparator mode



To set upper and lower limits for BIN determination, select BIN SETUP mode and enter upper and lower limit values for each Bin number from the numerical pad.

Entry to BIN SETUP mode

1. While pressing ENTER press BIN SETUP. BIN Number "1" and "LOWER" start blinking, and a lower limit value appears on Display A and an upper limit value on Display B.



Note

The user can set upper and lower limit values in the BIN Number that is blinking.

Exit from BIN SETUP mode

1. Press EXIT and the system returns to the measuring state.

Upper and lower limit setting

1. Enter the BIN SETUP mode.
   ☞ See "Entry to BIN SETUP mode".

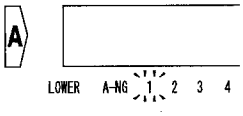
Selection of BIN number

2. Every press on ◄ or ► of MODIFY ◄ ▲ ▼ ► changes the bin number in turn.

   Press ◄ and the indication moves leftward.
   Press ► and the indication moves rightward.

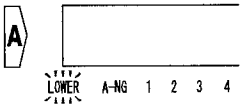
   1 ↔ 2 ↔ 3 ..... 19 ↔ 20 ↔ B

   Example:
   Here, select BIN 1.



To set lower limit

3. The system is ready for entry of a lower limit value.



Note

This button activates the numerical pad, when the indication lamps on the numerical pad go out.

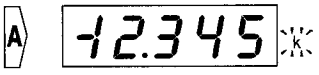
4. Press NUM.

Note

This button activates the numerical pad, when the indication lamps on the numerical pad go out.

5. Press buttons on the numerical pad to set the resolution of 4-1/2 digits.

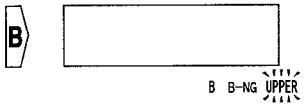
   Example: To set –12.345 k:
   Press ±, 1, 2, •, 3, 4, 5 and then press EXP, and the measure "k" will light up.



6. Press ENTER to complete the setting.

To set upper limit

7 Press [NEXT UPPER], and the system will be ready for entry of an upper limit value.

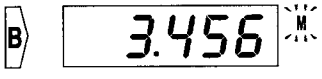


Note

When the UPPER lamp is blinking, the system is ready for entry of an upper limit value even if [NEXT UPPER] has not been pressed.

8 Press buttons on the numerical pad to set the resolution of 4-1/2 digits.

Example: To set 3.456 M:
Press [3], [.], [4], [5], [6] and then press [EXP], and the measure "M" will light up.



9 Press [ENTER] to complete the setting.

Note

If any of [◄], [►], [PREV LOWER] or [NEXT UPPER] is pressed before [ENTER] is pressed, the value the user has just entered will not be established.

Next BIN setting

10 By repeating the procedure of Steps 2 to 10, select the BIN number and enter upper and lower limit values.

Note

If the entered values are valid (i.e., the lower limit < the upper limit) in a BIN number, then the BIN number will light up.

Conclusion of setting

11 Exit from the BIN SETUP mode.
☞ See "Exit from BIN SETUP mode".

Be careful!

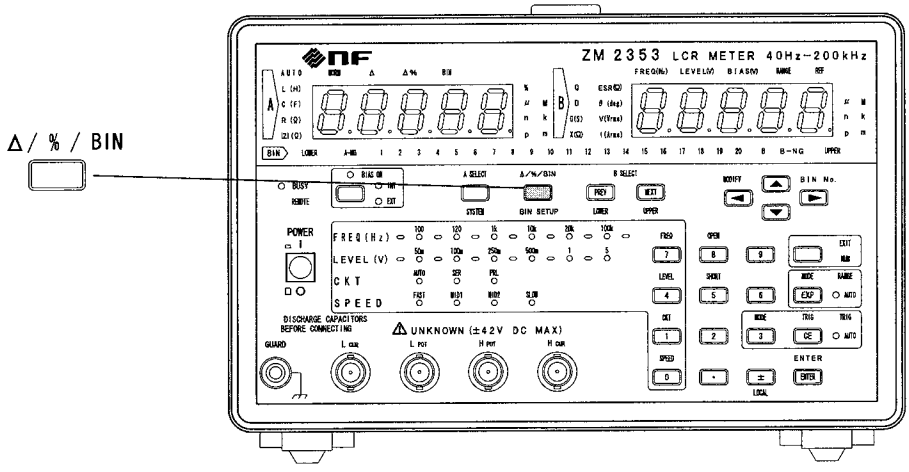
In any of BINs 1 to 20, if the lower limit value and the upper limit value are in a relation of:
The lower limit value ≥ The upper limit value,
then BIN judgment will be disabled for that bin number and forward.

Example:

	Lower limit	Upper limit
BIN 1	–10	10
BIN 2	0	0
BIN 3	–20	20

In the above case, the lower limit value is equal to the upper limit value in BIN 2. Therefore, judgment will be conducted only in BIN 1, and no judgment will be conducted in BIN 3.

Display in comparator mode (measurement)



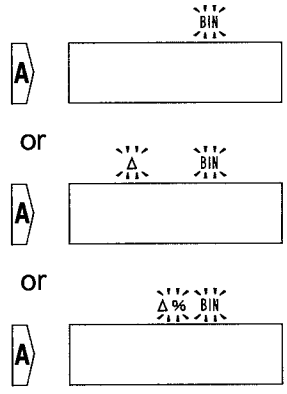
In measurement that uses the comparator functions, classification by deviation data (Δ) and deviation data percentage (Δ%) is available in addition to classification by measurement.
On Displays A and B, the user can also view the lower and upper limit values for that Bin number in which judgment was made rather than the measurements (including deviation data).
☞ See Chapter 7 "System Menu".
Using the comparator functions, the system can supply output of judgment signal to the handler interface.
☞ See Chapter 6 "Handler Interface".

1. Press Δ/%/BIN, and the system changes to measurement by comparator after display of deviation data.

2. Every press on Δ/%/BIN will change the indication on Display A in turn.

NORM→Δ→Δ%→BIN→ Δ + BIN → Δ% + BIN

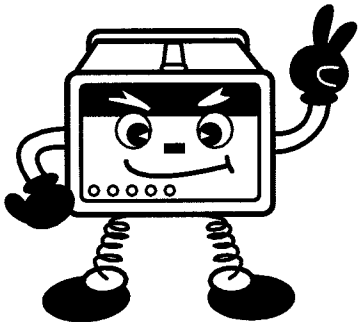
3. Select any of BIN, Δ + BIN and Δ% + BIN.



3. Result of judgment will be the number lighting on the BIN display.

Handler Interface
(ZM2354 only)

6



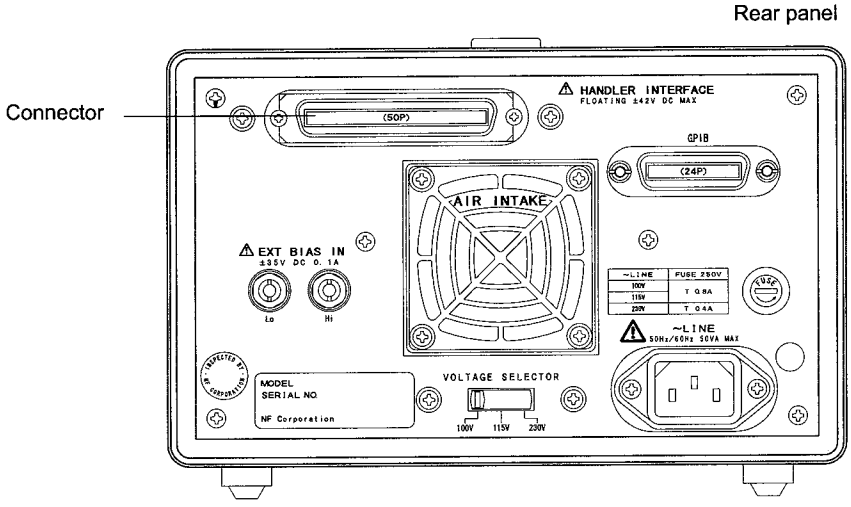
The ZM2353 is not equipped with a handler interface.
This chapter applies only to the ZM2354.

Handler interface

The handler interface can output result of judgment by maximum 21 classifications when the ZM2354 comparator functions are used. In addition, panel lock input, trigger input and memory select input are provided and all inputs and outputs are isolated from the enclosure. Further, it can issue a beep sound according to the result of judgment when measurement is complete.

Connecting handler interface I/O

Connector



The ZM2354 uses a 50-pin connector. Use the special connector (DDK 57-30500) or an equivalent item as the connection cable to the handler.

25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26

DDK 57-40500 equivalent REAR VIEW

Array of Connector Pins

Signal allotment to handler interface

PIN No.	Signal name	I/O	Description
1	--	--	To be connected to ground via 100 kΩ
2	--	--	To be connected to ground via 100 kΩ
3	BIN1	OUT	Judgment result for Bin 1
4	BIN2	OUT	Judgment result for Bin 2
5	BIN3	OUT	Judgment result for Bin 3
6	BIN4	OUT	Judgment result for Bin 4
7	BIN5	OUT	Judgment result for Bin 5
8	BIN6	OUT	Judgment result for Bin 6
9	BIN7	OUT	Judgment result for Bin 7
10	BIN8	OUT	Judgment result for Bin 8
11	BIN9	OUT	Judgment result for Bin 9
12	BIN10	OUT	Judgment result for Bin 10
13	BIN11	OUT	Judgment result for Bin 11
14	BIN12	OUT	Judgment result for Bin 12
15	BIN13	OUT	Judgment result for Bin 13
16	BIN14	OUT	Judgment result for Bin 14
17	--	OUT	Auxiliary output
18	LOCK	IN	Disable panel operation
19	TRIG	IN	Start measurement trigger
20	--	--	To be connected to ground via 100 kΩ
21	--	--	To be connected to ground via 100 kΩ
22	SET0	IN	Select memory (0)
23	SET1	IN	Select memory (1)
24	+5 V	--	+5 V output (output of 0.1 A max., in combination with pin 25)
25	+5 V	--	+5 V output (output of 0.1 A max., in combination with pin 24)
26	GND	--	Ground
27	GND	--	Ground
28	BIN15	OUT	Judgment result for Bin 15
29	BIN16	OUT	Judgment result for Bin 16
30	BIN17	OUT	Judgment result for Bin 17
31	--	OUT	Auxiliary output
32	BIN B	OUT	Judgment result for Bin B
33	--	OUT	Auxiliary output
34	BIN18	OUT	Judgment result for Bin 18
35	BIN19	OUT	Judgment result for Bin 19
36	BIN20	OUT	Judgment result for Bin 20
37	--	OUT	Auxiliary output
38	A NG	OUT	Wrong main parameter
39	B NG	OUT	Wrong sub parameter
40	--	OUT	Auxiliary output
41	STROBE	OUT	Judgment complete pulse
42	--	OUT	Auxiliary output
43	BUSY	OUT	Under measurement flag
44	EOM	OUT	Measurement complete signal
45	GND	--	Ground
46	GND	--	Ground
47	SET2	IN	Select memory (2)
48	SET3	IN	Select memory (3)
49	GND	--	Ground
50	GND	--	Ground

The ground of the handler interface is different from the ground of the enclosure; it is DC-isolated.

Auxiliary output is always inactive.

Cable

For connection with the handler, use a shielded twist pair wire as short as practicable. Be sure to connect one of the twist pair wire to the grounding terminal. If the wire is very long or noise is high, then take measures to prevent malfunction as follows:

- Raise the signal level (voltage) to 15 V in order to increase the noise allowance.
- Change cable arrangement to prevent malfunction or measurement variation.

Processing of ground

The handler interface and the ZM2354 are DC-isolated in the following range:

Voltage between two ground terminals: within ±42 V

It may happen that connection of the handler to the ground of the ZM2354 would make the system stronger against noise, depending on the conditions, but normally, the shield of the cable should be connected to the ground (or the case) of either the handler or the ZM2354.

If the handler uses photocoupler for communication:

Connect the shield of the cable to the ground of the handler.

If the handler uses photocoupler for communication:

For the purpose of reinforcing the AC insulation, connect the shield of the cable to the ZM2354 if the handler uses a photocoupler for sending and receiving.

The connector shell of the handler interface is connected to the signal ground of the handler interface, and it is isolated from the ground of the ZM2354.

⚠CAUTION

Do not apply voltage exceeding ±42 V between the enclosure and the ground of handler interface. Application of excessive voltage may damage the ZM2354 or the handler.

Setup before starting

Confirmation of connection cable

Before turning on the power supply, do not fail to ensure the cable is connected to the handler interface connector on the rear panel.

Panel LOCK

If the user wants to return settings back to those of just before the last power turning off when the power supply is turned on, or if the user wants to protect settings from accidental change, then set the LOCK signal to the low level.

If the ZM2354 is powered with the LOCK signal set to the low level, the settings just before the last power turning off will be read out from the memory, and moreover, the zero correction value will be returned to the original value.

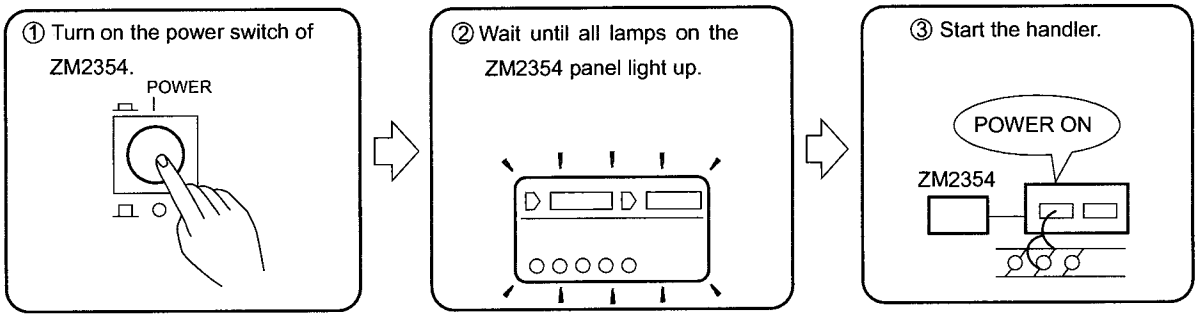
Be careful!

Note that zero correction value may change over time. If zero correction is not carried out for an extended time, measurement error will increase. Be sure to regularly check the variation of zero point or carry out zero correction.

Starting

Turning power on

Observe the following procedure to start operation if the ZM2354 is to be used with the handler connected.



This procedure is intended to ensure the output of the handler interface will be stabilized when a certain period of time has passed after power turning on.

Starting the handler interface

The user presses Δ/%/BIN, and the Bin lamps of Display A light up, and the system gets ready for comparator measurement, when the handler interface also starts up. In a measurement status with the comparator not used, all output signals of the handler interface remain inactive and also the beeper is inoperative.

The input signals of handler interface, LOCK, TRIG, SET0, SET1, SET2 and SET3 are active even in the measurement status without using the comparator.

Setting the measurement conditions

Setting from panel

To make setting from the panel, first release the LOCK signal of the handler interface. If the LOCK signal is active (at low level), the user cannot do any operation other than error releasing. Setting of measurement conditions and zero correction (OPEN button and SHORT button) are disabled too.

If the LOCK signal is active (at high level) when the ZM2354 is powered, settings just before the last power-off will be read including zero correction values.

Operation through GPIB

Setting of measurement conditions through GPIB will not be disabled by the LOCK signal.

Setting of beeper

The user can select beep sounding on judgment completion by changing the parameter of selection of beep [bEEP] in the system menu.

☞ See "Selection of beep when comparator is used" in Chapter 7 "System Menu".

Display B	Description
0	Beep OFF
1	Beep ON for BIN 1 to 20
2	Beep ON for BIN A NG
3	Beep ON for all cases

Setting of indications

By changing the parameter on the selection of display, [diSP], in the system menu, the user can select which to be shown on Displays A and B with comparator being used, the measurement or the upper and lower limit values of the bin number that has been judged.

☞ See "Selection of indications when comparator is used" in Chapter 7 "System Menu".

Display B	Description
0	Measurements are shown.
1	Upper and lower limit values of the BIN number are shown that has been judged.

Setting of width of strobe signal

The user can change the pulse width of strobe signal.

By changing the value of selection of strobe width in the system menu, the pulse width of strobe signal can be changed.

☞ See "Pulse width of strobe signal" in Chapter 7 "System Menu".

The pulse width of strobe signal can be changed in the range of 1 ms to 19999 ms (in resolution of 1 ms).

Selection of output signal polarity

The user can select the signal level, low or high, if the output of the handler interface is active.

By changing the parameter of output polarity in the system menu, low or high level can be selected.

☞ See "Selection of output signal polarity of handler interface" in Chapter 7 "System Menu".

Display B	Description
Lo	Low level when active (negative logic)
Hi	High level when active (positive logic).

Signal output

Types of signals

● BIN1 to BIN20: Bin judgment

Only bin signal classified according to the resulting judgment of measurement selected on Display A will be activated.

● A NG: Wrong main parameter

If the result does not fall in any of the range of Bin 1 to Bin 20 by the above bin judgment, this signal will be activated. However, if the range of Bin 1 is set such that "Lower limit ≥ Upper limit", then this signal will not be activated.

● BIN B: Judgment of sub parameter

If the result falls in the judgment range (set by BIN B) of sub parameter (Display B), this will be activated. Judgment will be made on the measurement selected by Display B. If the selected items of Display B are any of FREQ, LEVEL, BIAS, RANGE and REF (set value), then judgment will not be made and the item is always inactive.

● B NG: Wrong sub parameter

If the result does not fall in the judgment range of sub parameter (Display B), this will be activated.

However, if the range of Bin 1 is set such that "Lower limit ≥ Upper limit", or if the selected items of Display B are any of FREQ, LEVEL, BIAS, RANGE and REF (set value), then this signal will not be activated.

● STROBE: Judgment complete flag

When measurement and judgment are over, and output of signals of BIN1 to BIN20, A NG, BIN B, B NG have been stabilized, this will be activated.

The pulse width is specified by the STROBE width in the system mode.

● BUSY: Under measurement flag

This signal will be activated only when the test piece is connected. If this is inactivated, the current test piece will be changed to the next one (the same as the BUSY lamp on the front panel).

● EOM: Measurement complete signal

This is activated for the period from start of to measurement to judgment completion.

When BUSY is activated, this is also activated at the same time, and this is inactivated at the same time when STROBE is activated.

Signal level

An output signal is output from open collector, at TTL level and of negative logic.

It can directly drive a logic IC of TTL and CMOS. In addition, it can also drive a relay up to 24 V.

- Maximum rating:

  Pull-up voltage: 30 V

  Sink current: 48 mA

- TTL load

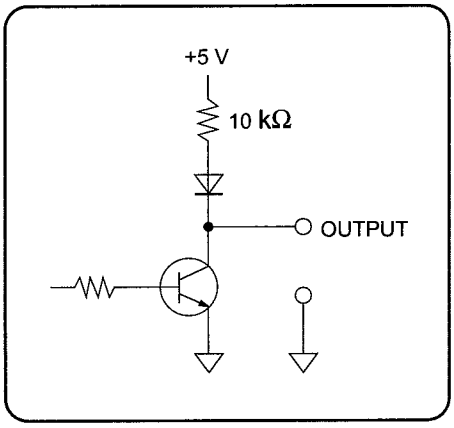
  10 standard TTLmax

- High-level output voltage under no load

  ≥ 3.6 V (Load ≥ 100 kΩ)

Output circuit of handler interface

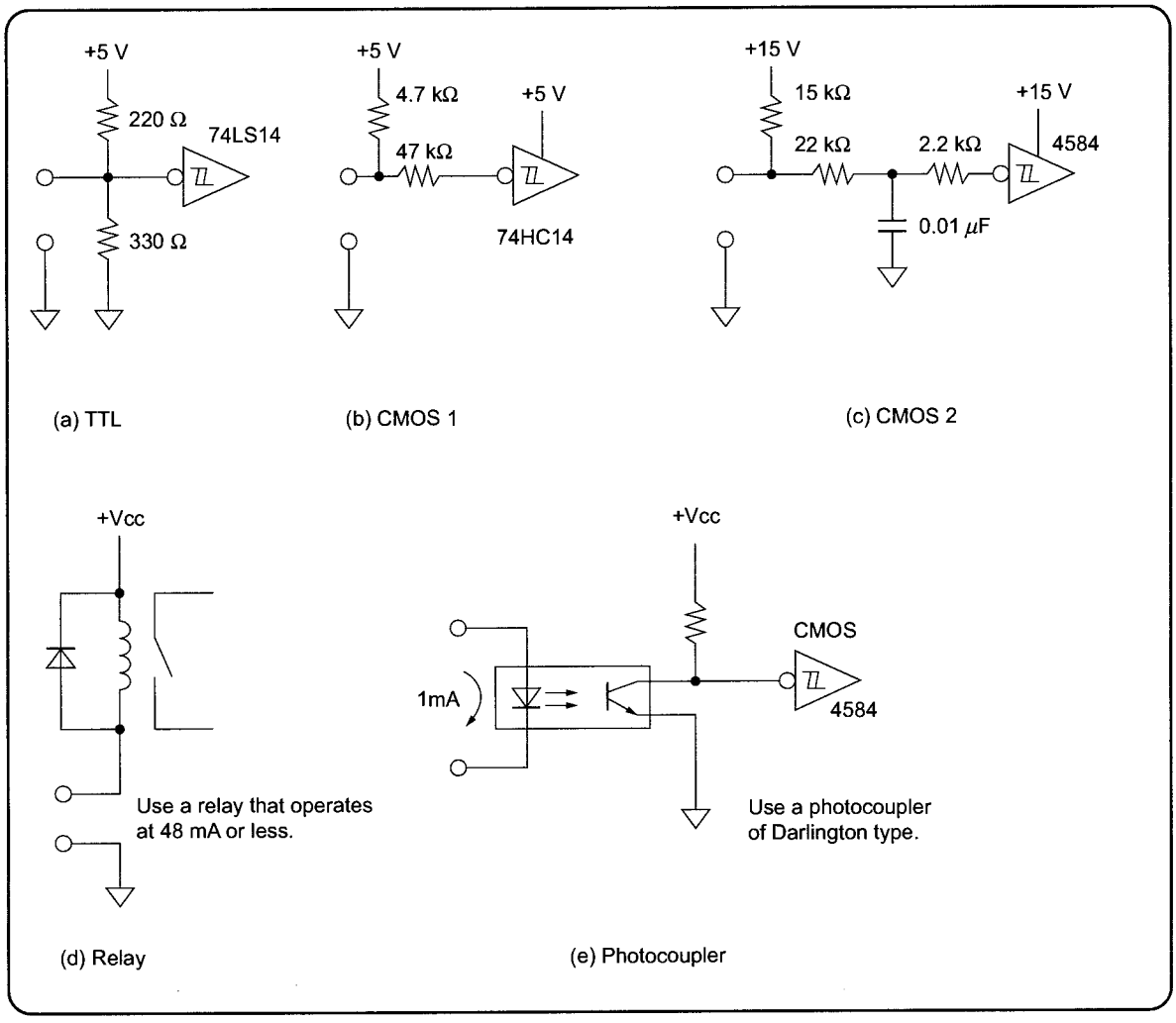
The diagram below shows an output circuit of handler interface.



Output Circuit of Handler Interface

Exemplary reception circuit

The diagram below shows an example of circuit to receive signals on handler side.



An Example of Reception Circuit on Handler Side

Input signal

Trigger

- TRIG: Trigger

This signal is a trigger to start measurement. It has a pulse width (at Lo level) ≥ 100 μs. Since the trigger signal is neglected as long as the strobe signal is active, give the next trigger when the strobe signal has finished.

- LOCK: Panel lock

This signal disables panel operation (except error releasing). It does not disable setting through the GPIB.

- SET0, SET1, SET2, and SET3: Select memory signal

These signals read measurement conditions stored in the memory from the handler interface. Selection signals are a 4-bit input.

Signal level

- TRIG

  TTL level, negative logic (triggered at low level)

  Low level input voltage = –1.5 V to +0.8 V

  High level input voltage = +2.4 V to +30 V

  (Current of 2mA max flows in when +5 V is exceeded.)

  Low level input current = –0.33 mA

  (Negative sign means outward flow.)

- LOCK

  Negative logic (becomes locked at low level)

  Low level input voltage = –1.5 V to +0.8 V

  High level input voltage = +3.5 V to +30 V

  Low level input current = about –3 mA (at input voltage = 0 V)

- SET0, SET1, SET2, and SET3

  Low level input voltage = –1.5 V to +0.8 V

  High level input voltage = +3.5 V to +30 V

  Low level input current = about –3 mA (at input voltage = 0 V)

Since the terminal for input signal has been pulled up to +5 V by a resistor, a high level is obtained if the input signal terminal is kept open.

Not only TTL but also the open collector and the mechanical contact can work as a driving signal.

Selection of memory

The relationship between the memory number for selection and the input signal of SET0, SET1, SET2 and SET3 is shown below.

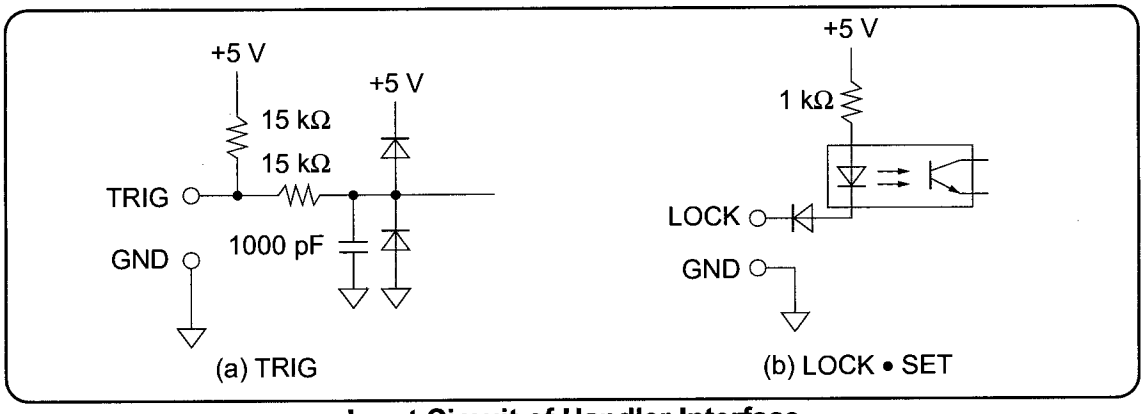
SET3	SET2	SET1	SET0	Memory number to be selected
Hi	Hi	Hi	Hi	None selected
Hi	Hi	Hi	Lo	Memory number 1
Hi	Hi	Lo	Hi	Memory number 2
Hi	Hi	Lo	Lo	Memory number 3
Hi	Lo	Hi	Hi	Memory number 4
Hi	Lo	Hi	Lo	Memory number 5
Hi	Lo	Lo	Hi	Memory number 6
Hi	Lo	Lo	Lo	Memory number 7
Lo	Hi	Hi	Hi	Memory number 8
Lo	Hi	Hi	Lo	Memory number 9
Combinations other than the above				None selected

(Hi and Lo stand for high level and low level, respectively.)

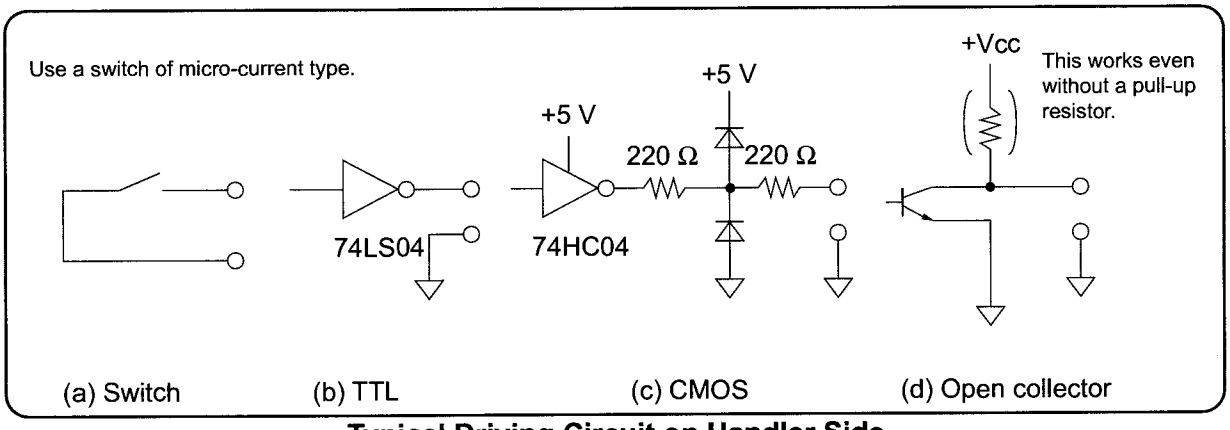
If "None selected" is set for the memory numbers selected via the SET0 to SET3 input signals, settings in the ZM2354 do not change.

To change the selection signal of the memory, do this only after the measurement is finished and when a strobe signal has been output. If the signal is changed during the measurement, the measurement will be suspended and it will be changed to the selected memory.

Input circuit of handler interface



Input Circuit of Handler Interface



Typical Driving Circuit on Handler Side

Trigger

Trigger

The manual trigger (for starting measurement) when the handler interface is used is a logic sum of the following signals:

- TRIG button on the panel
- Trigger-corresponding command (GET, "TG") of the GPIB
- TRIG input of handler interface

With an automatic trigger, the above three signals are invalid and measurement will be continued.

TRIG button

This is enabled only when it is local and the LOCK signal is inactive.

GPIB command

GET and "TG" are valid only when they are remote.

Further, the LOCK signal does not disable operation through GPIB.

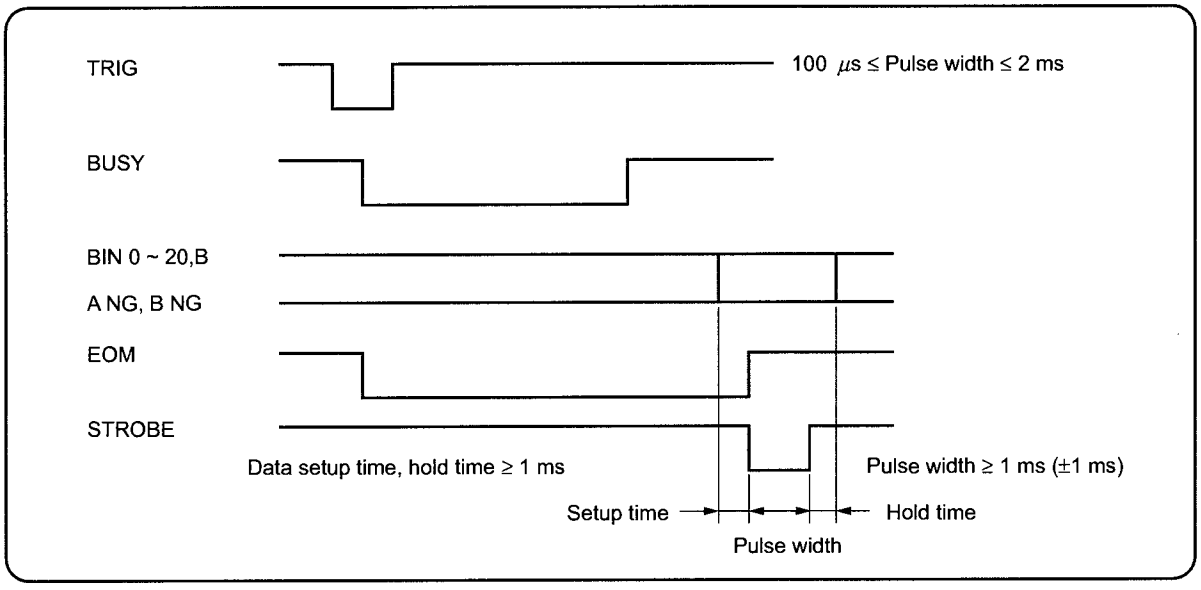
TRIG input

Measurement will be started at the falling edge from high level to low level of the TRIG input.

(The pulse width of low level must be 100 μs or longer.)

Sequence of operation

The following diagram shows the standard timing when a handler interface is used.

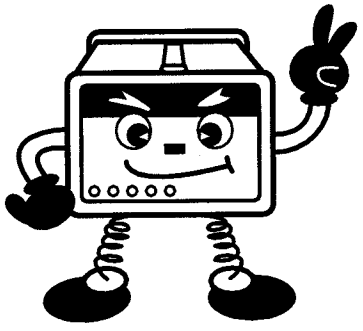


Timing Chart

Note

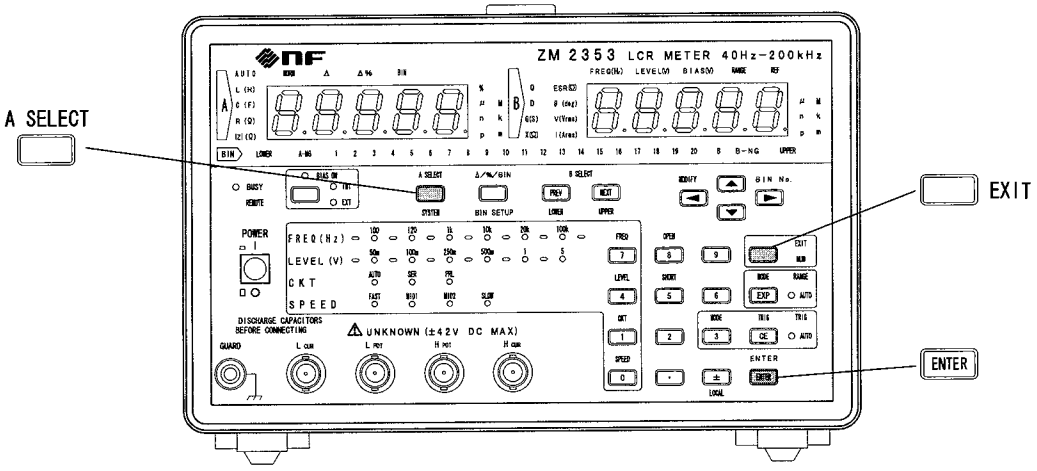
Once a TRIG signal is accepted, next TRIG will not be accepted until the measurement is finished, judgment signal is output, and strobe signal has been output. Therefore, the next trigger must be input when the strobe signal has changed from active to inactive.

System menu 7



System menu

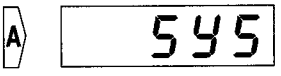
System menu functions are ready for user to make settings within the ZM2353/ZM2354 as well as setting items concerning the handler interface



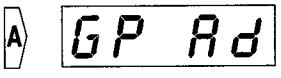
Entry to system menu mode

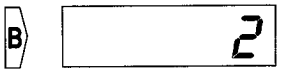
1. While pressing [ENTER] in a measuring state, press [A SELECT], and the control enters into the system menu mode.

2. When the system menu is entered, [SyS] appears on Display A for two seconds.



3. Then, setting items of GPIB address appear.

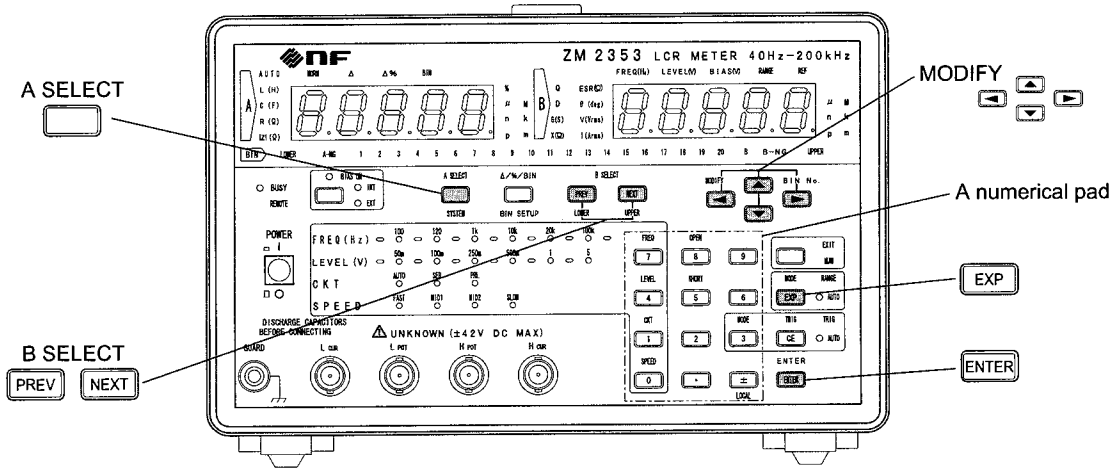




Exit from system menu mode

1. Press [EXIT], and the control quits the system menu mode and enters into the measurement mode.

Items of system menu



GPIB address [GP Ad]

1. Press A SELECT, or MODIFY ◄ ► several times to show [GP Ad] on Display A.

A GP Ad

2. Using the numerical pad, make setting of GPIB address.
   Example: If the address is 5:
   Press 5 and ENTER.

B 5

Note

A GPIB address is the ZM2353/ZM2354's address used for communications made with computer through GPIB. The address is a number ranging from 0 to 30. It is set to 2 when the ZM2353/ZM2354 is shipped.

GPIB terminator [GP tr]

1. Press A SELECT, or MODIFY ◄ ► several times to show [GP tr] on Display A.

A GP tr

2. Press B SELECT PREV NEXT or ▲ ▼ and * to select a GPIB terminator.
   * Every press on the buttons will change the indication of terminators as shown below.

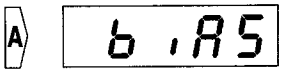
B CrLF
↕
B Cr
↕
B LF

Note

The GPIB terminator will be the ZM2353/ZM2354's terminator (a separator between messages) when communications are made with computer through GPIB.
"CrLF" is selected when the product is shipped.

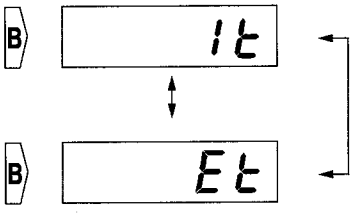
Selection of internal/external for DC bias voltage [biAS]

1. Press A SELECT , or MODIFY ◄ ► several times to show [biAS] on Display A.



2. Press B SELECT PREV NEXT or ▲ ▼ and * to select a DC bias volt.

* Every press on the buttons will change the indication of DC bias voltages as shown below.



Be careful!

The external DC bias should be set within the range of ±35 V.

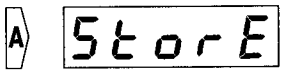
Note

It: Internal DC bias voltage is used.
The DC bias voltage set by the ZM2353/ZM2354 will be output when DC BIAS is ON.

Et: External DC bias voltage is used.
The voltage of DC bias source connected to the rear panel DC BIAS will be output.

Store memory [StorE]

1. Press A SELECT, or MODIFY ◄ ► several times to show [StorE] on Display A.



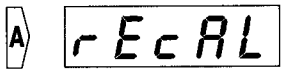
2. Set desirable measurement conditions for storage, and enter the memory number from the numerical pad.
Example:To store the current measurement conditions in Memory No. 4:
Press 4 and ENTER.

Note

Memory numbers range from 1 to 9.

Recall memory [rEcAL]

1. Press A SELECT, or MODIFY ◄ ► several times to show [rEcAL] on Display A.



2. From the numerical pad, enter the number of memory in which your desired measurement conditions are stored.
Example: To call the measurement conditions in Memory No. 3:
Press 3 and ENTER.

Note

Memory numbers range from 1 to 9.
Memory No. 0 stores the measurement conditions just before power is turned off.

Note

[Items to be stored in one memory number]

- Display A parameter
- Display B parameter
- Comparator mode
- Measurement frequency
- Measurement level
- Measurement equivalent circuit
- Measuring speed
- Measurement range
- Measurement trigger
- Internal DC bias level
- Reference value
- Upper and lower limit values of comparator.

ON/OFF of DC bias is not contained in the setting conditions of the memory.
* Whenever a memory number is called, the DC bias setting becomes OFF.

Trigger delay [dELAy]

1. Press A SELECT, or MODIFY ◄ ► several times to show [dELAy] on Display A.

2. From the numerical pad, enter the value of delay time from trigger input to measurement start.

   Example: If the delay time is 5.12 seconds:

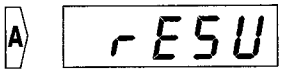
   Press 5 • 1 2 and ENTER.

Note

Delay time should be 0 s or any value between 10 ms and 199.99 s, where resolution is 10 ms.

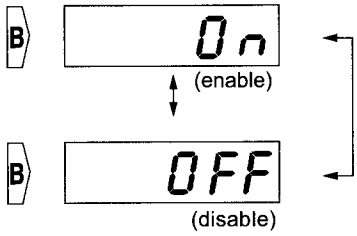
Resume function [rESU]

1. Press A SELECT, or MODIFY ◄ ► several times to show [rESU] on Display A.



2. Press B SELECT PREV NEXT or ▲ ▼ and * to select whether to enable or disable the resume function.

   * Every press on the buttons will toggle the indication as follows:



Note

If the resume function is enabled, power energizing of the ZM2353/ZM2354 retrieves the settings just before the last power turning off.
At the same time, also the zero correction value (OPEN/SHORT correction value) is retrieved.

⇩

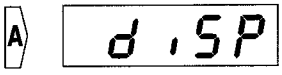
However, ON/OFF of DC bias will not be retrieved; DC bias will be OFF whenever the power switch is turned on.

[Items to be retrieved]

- Display A parameter
- Display B parameter
- Comparator mode
- Measurement frequency
- Measurement level
- Measurement equivalent circuit
- Measuring speed
- Measurement range
- Measurement trigger
- Internal DC bias level
- Reference value
- Upper and lower limit values of comparator
- Selection of internal/external of DC bias voltage
- Trigger delay time
- Indications on Displays A and B when comparator is used
- Beep when comparator is used
- Width of strobe signal
- Polarity of output signal of handler interface
- Length of measurement cable
- Zero correction value (OPEN/SHORT correction value)

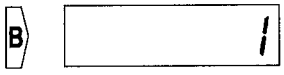
Selection of indication when comparator is used [diSP]

1. Press A SELECT, or MODIFY ◄ ► several times to show [diSP] on Display A.



2. Press B SELECT PREV NEXT or ▲ ▼ and * to select indications on Displays A and B.

[Indication of 1]



* Every press on the buttons will toggle the indication as follows:

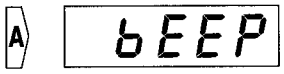
- 0 Displays A and B will show the measurement.
- ↓
- 1 Displays A and B will show the upper and lower limit values of BIN number

Note

If the parameter is set to 1, the indication of the upper and lower limit values of the BIN number will be the indications of BIN number of the upper and lower limit values for Display A. Indication of the upper and lower limit values for Display B is not available.

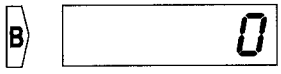
Selection of beep when comparator is used [bEEP]

1. Press A SELECT, or MODIFY ◄ ► several times to show [bEEP] on Display A.



2. Press B SELECT PREV NEXT or ▲ ▼ and * to select whether or not to sound beep according to the result of judgment when the comparator is used.

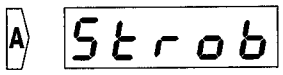
[Indication of 0]



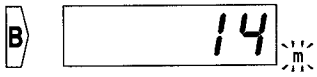
- 0 Do not sound a beep
- ↓
- 1 Sound a beep in low tone (2 kHz) for BIN 1 to 20
- ↓
- 2 Sound a beep in high tone (4 kHz) for BIN A NG
- ↓
- 3 Sound a beep for every case

Specification of strobe signal width [Strob]

1. Press A SELECT, or MODIFY ◄ ► several times to show [Strob] on Display A.



2. From the numerical pad, enter the value of the strobe signal pulse width of the handler interface.
   Example: If the pulse width is 14 ms:
   Press 1 4 and then press EXP to light up (m) for the units.



3. Press ENTER.

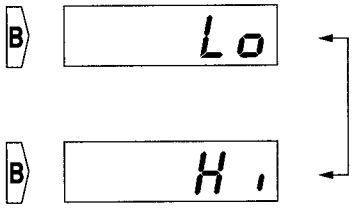
Note

The setting value should be any value between 1 ms and 19.999 s, where resolution is 1 ms.
When the handler interface is used, change the pulse width of strobe signal according to the pulse response time of the handler.
If this strobe signal is active, a trigger signal cannot be input (Any trigger signal will be neglected).
This setting is not significant because the ZM2353 has been installed but is not equipped with a handler interface. Set 1 ms (default value) to prevent slowing of measurement speed.

Selection of output signal polarity of handler interface [HAndL]

1. Press A SELECT, or MODIFY ◄ ► several times to show [HAndL] on Display A.

2. Press B SELECT PREV NEXT or ▲ ▼ and * to select the polarity of output judgment result when the comparator is used.
   * Every press on the buttons will toggle the indication as follows:



Note

Lo: Lo (low level) if output is active
Hi (high level) if output is inactive
Hi: Hi (high level) if output is active
Lo (low level) if output is inactive

The user can change the polarity by the signal input of the handler to be connected.

This setting is not significant because the ZM2353 has been installed but is not equipped with a handler interface.

Selection of connection cable length [CAbLE]

1. Press A SELECT, or MODIFY ◄ ► several times to show [CAbLE] on Display A.

A CAbLE

2. Press B SELECT PREV NEXT or ▲ ▼ and * to select the length of the cable to be connected to the UNKNOWN terminal.
[Indication of 0]

B 0

* Every press on the buttons will toggle the indication as follows:

0 Cable length of 0 m
↓
1 Cable length of 1 m
↓
2 Cable length of 2 m
↓
4 Cable length of 4 m

Note

Select the value nearest to the length of the practical cable to be connected.
For description of cable length settings for our company's test fixtures and test leads, see the "Guide to Text Figures and Test Leads".

Gain correction [CAL]

1. Press A SELECT, or MODIFY ◄ ► several times to show [CAL] on Display A.

A CAL

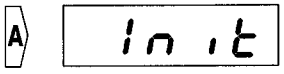
2. Press ENTER to start internal gain correction.

Note

This gain correction function corrects the internal circuit.
Do not connect anything to the UNKNOWN terminal when executing gain correction.
If gain correction is not conducted properly, "Err26" will appear when the unit is powered.
If this error is fixed, measurement will be available, however the precision will not be guaranteed.

Initial settings [Init]

1. Press A SELECT, or MODIFY ◄ ► several times to show [Init] on Display A.



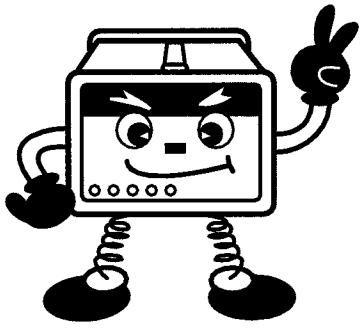
2. Press ENTER and the initial settings will be the measurement conditions.

Note

Items	Initially set values
Display A	AUTO
Display B	As per Display A
Comparator mode	NORM
Measurement frequency	1 kHz
Measurement level	1 Vrms
Measurement equivalent circuit	AUTO
Measuring speed	MID2
Measurement range	AUTO
Measurement trigger	AUTO
Internal DC bias level	0, mV
Reference value	0
Upper and lower limit values of comparator	Upper limit value: 0, lower limit value: 0
Selection of internal/external of DC bias voltage	Internal
DC bias	OFF
Trigger delay time	0 s
Indications on Displays A and B when comparator is used	Measurement
Beep when comparator is used	Do not sound
Width of strobe signal	1 ms
Polarity of output signal of handler interface	LO
Length of measurement cable	0 m
Zero correction value (OPEN/SHORT correction value)	Do not correct (default)

For the GPIB address and terminator, the initial settings will be effective at any time.

Measurement 8



Connection of test piece

Measurement terminal

The ZM2353/ZM2354 adopts a four-terminal pair measurement technique, which provides most high precision in measurement. The measurement terminals labeled "UNKNOWN" include BNC connectors for test piece connection and a guard terminal as follows:

HCUR: Drive signal output terminal
HPOT: Voltage detection terminal (High)
LPOT: Voltage detection terminal (Low)
LCUR: Current detection terminal
G: Grounding terminal for guard

The grounding terminal for guard is connected to the enclosure of the ZM2353/ZM2354.

The current supplied from the HCUR terminal flows through the test piece and reaches the LCUR terminal, and thus the current value is measured. In addition, the voltage across the HPOT and LPOT terminals is measured as the voltage applied to the test piece. The guard terminal, G, is used to lessen the induction noise from AC power supply and other sources by shielding jigs and test pieces.

With the four-terminal pair measurement technique, the measurement current that has flowed from HCUR to LCUR through the core conductor of the current cable returns to the signal source, HCUR via the same cable.

The automatic bridge incorporated in the ZM2353/ZM2354 unit functions so that the potential detected by the LPOT will be zero in order to minimize the error current that flows to the ground to an almost zero level. Therefore, the external conductor of four connection cables must be connected altogether near the test piece.

Any test piece that has a grounded terminal cannot be measured by the ZM2353/ZM2354 because of the principle of measurement.

☞ See Fig. 1 "Four-terminal Pair Connection".

Be careful!

Pay attention to the following instructions when connecting a test piece:

- Be sure to connect the voltage terminal to the DUT side (inner side) than the current terminal.
- Connect four external conductors (i.e., shield wires) altogether to the measurement terminal.

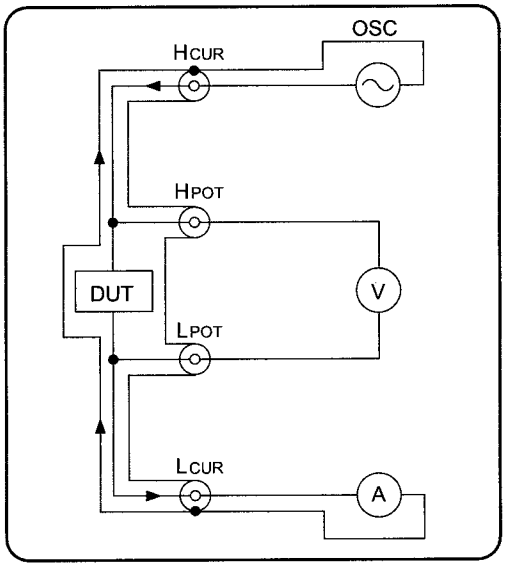


Fig. 1 Four-terminal Pair Connection

If the test piece (DUT) and the voltage and current terminals are to be connected separately with each independent cable, observe the following instructions:

- Be sure to connect the voltage detection terminal to the test piece side (inner side) than the current terminal.
- Use as short a coaxial cable as practicable.
- If the user's cable is rather long, twist the voltage cables (V) and the current cables (I) so that four wires will be intertwined with a V opposing another V and an I opposing another I.
- Connect four external conductors (i.e., shield wires) altogether to the measurement end.

If the system is experiencing any noise induction, wrap and guard the test piece with the external conductor of the voltage cable or the conductive material that is connected to the guard terminal "G". Just a shield board will be effective if it is placed under the test piece as shown in Fig. 2 "Connection of Test Piece".

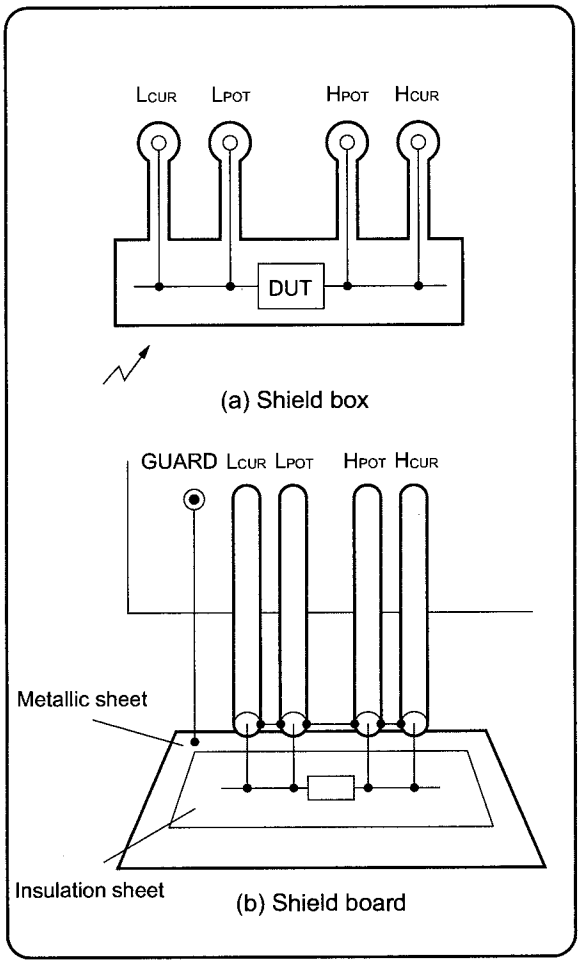


Fig. 2 Connection of Test Piece

Extension cable

If the user wants to extend the measuring terminal, the four-terminal pair structure should be maintained up to the tip as much as possible. Use coaxial cables and bundle and twist them as shown in Fig. 3 "Extension Cable". If it is hard to twist all four wires together, then twist two current cables and two voltage cables separately. Keep the cable within a length of 4 meters. The shorter the cable is, the less will be the error.

Zero correction of OPEN and SHORT should be carried out in a condition as near to the practical condition of use as possible.

In the cable length of the ZM2353/ZM2354 system menu, specify a value near to the length of the actual extension cable.

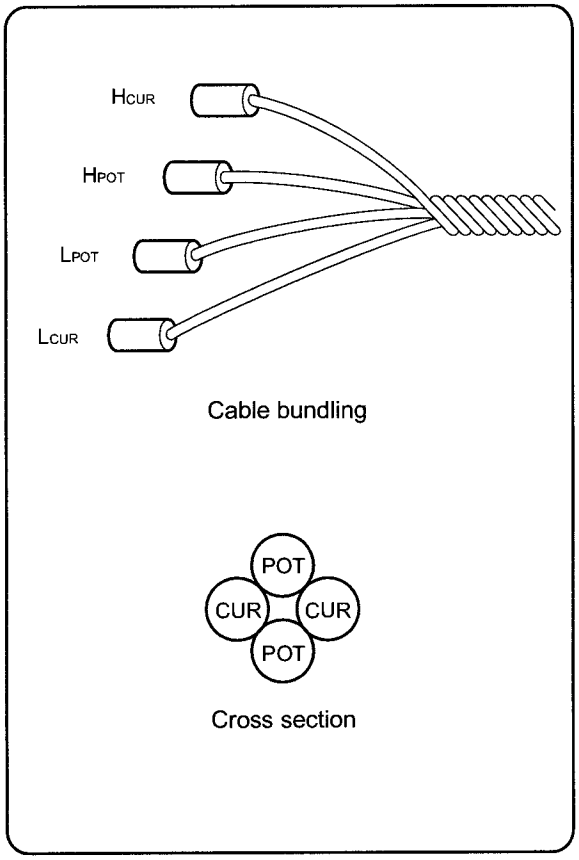


Fig. 3 Extension Cable

Test fixture and test lead (optional)

Test fixtures and test leads are ready for users option.

Select according to the application, as described in the "Guide to Text Figures and Test Leads".

Scanner

When a scanner is used to measure a number of test pieces by switching, it often happens that long cables are connected to the measurement terminals. As a result, various problems are likely to take place. The following sections provide some effective instructions. will be effective if it is placed under the test piece as shown in Fig. 2 "Connection of Test Piece".

Restraint on cable length

● Keep the effective cable length within 4 m or so. With too long cables, not only the precision in measurement lowers but also it may become too unstable to continue measurement. In the case of long cables, change the measurement conditions or ambient temperature to check and see if operation is sufficiently stabilized and necessary precision is secured.

● Measurement error becomes higher with longer cables.
Particularly the influential factor is the capacity (electrostatic capacity of central and external conductors) of the connection cable on the Low side (LCUR and LPOT). Therefore, take proper measures such as to minimize the total length of the cables connected to the Low side during measurement, and also to limit the floating capacity to the ground such as switches as much as possible.
Avoid a configuration such that the ends of all test pieces are connected to the Low side.

These measures are effective also for prevention of noise induction.

● Difference in cable length by channels would result in a variation of errors produced. Therefore, keep to a certain length of cables connected to test pieces during measurement. However, the floating capacity on High side (HCUR and HPOT) is not so influential.

Noise induction

If a number of cables are used for connection of test pieces, the system is prone to noise induction.
Use shielded connection cables and connect the scanner casing to the guard terminal, G of "UNKNOWN", in order to prevent noise induction as much as possible.

Error caused by floating capacity

If a number of shielded cables are used, higher errors are produced due to the cable capacity of the cables.
In particular, error becomes greater if measurement is made with higher frequency. In such cases, use cables with low capacity, and calibrate the measurement by measuring the standard element. To calibrate the measurement, determine the impedance and phase of the test piece.
In the case of frequency ≤ 10 kHz, let the measured impedance be Z, and the true impedance Zx will be given by the following equation:

$$Zx = K \bullet Z$$

where the constant K is calculated by using the value of Zm resulting from measurement of standard element Zstd, as follows:

$$K = Zstd / Zm$$

Here, all of Z, Zx, Zstd, Zm and K are complex numbers.

The value of K depends on the frequency and the reference resistance (measurement range) inside the ZM2353/ZM2354. If the impedance of measured test piece is too high, or too low, this correction method cannot correct the measurement properly.

Operations on power energizing

Power turning-on

☞ See "Measurement in auto mode" in Chapter 4 "How to Measure".

⚠ CAUTION

Should the user notices the fan not running, immediately turn off the power, and contact the NF Corporation or distributors. Use of the ZM2353/ZM2354 with the fan not working would expand the damage, resulting in an unrepairable condition.

Before turning on the power switch, wait for three seconds or longer after the last power turning-off. If the unit is energized immediately after the power switch is turned off, the ZM2353/ZM2354 may not work normally.

Self-check

Self-check is conducted in the order of memory check, indicator lamp check, version display and internal circuit check.

Memory check

CPU-based ROM and RAM are checked.

Indicator lamp check

All lamps are lit up. Also for 7-segment numeral indicators, all segments in all places, including decimal points, will be turned on. Confirm that every lamp is lighting.

Indication of version number and setting conditions for startup

After all indication lamps are lit, the version number (e.g., "1.20") is shown on Display A, and the measurement condition settings (resume function and settings when comparator is used) after energization are shown on Display B.

On display B, "r0_c0" or similar indication appears, indicating the condition of setting when resume and comparator are used.

The following items and their descriptions are shown in display B.

Display B Resume setting	Resume setting	Comparator setting
r0_c0	Resume function OFF	Handler I/F output Lo Indication Measurement
r0_c1	Resume function OFF	Handler I/F output Hi Indication Measurement
r0_c2	Resume function OFF	Handler I/F output Lo Indication Upper/lower limit value
r0_c3	Resume function OFF	Handler I/F output Hi Indication Upper/lower limit value
r1_c0	Resume function ON	Handler I/F output Lo Indication Measurement
r1_c1	Resume function ON	Handler I/F output Hi Indication Measurement
r1_c2	Resume function ON	Handler I/F output Lo Indication Upper/lower limit value
r1_c3	Resume function ON	Handler I/F output Hi Indication Upper/lower limit value

Resume function: Changes the settings of measurement conditions back to those just before power turning-off.
Handler I/F output: Shows the polarity of output signal of handler interface. (Valid for the ZM2354 only.)
Indication: Shows the condition of indication on Displays A and B when comparator is used.

Internal circuit check

After showing the version number and setting conditions for startup, the internal circuit will be checked.

Now, "SEtUP" is shown on Display A while countdown is conducted on Display B.

Display A	Display B
SEtUP	07 to 01

Settings of measurement conditions

If self-check detects no anomaly, the settings of ZM2353/ZM2354 will be made the initial values if resume function is disabled.
However, the GPIB address and terminator, the polarity of output signal of handler interface, and the indication items on Displays A and B when comparator is used will be the settings just before the last power turning-off.

Initial setting items when power switch is turned on

Display A	AUTO
Display B	(AUTO)
Deviation indication	NORM
Measurement frequency	1 kHz
Measurement level	1 Vrms
Equivalent circuit	AUTO
Measuring speed	MED2
DC bias	OFF
DC bias (INT/EXT)	INT
DC bias level	0 mV
Measurement range	AUTO
Trigger	AUTO
Trigger delay time	0.00 s
Reference value	0
Comparator upper/lower limit value	0 for all
Cable length	0 m
Beep	OFF
Strobe signal width	1 ms
Zero correction (OPEN/SHORT)	No correction

Items in which the settings just before last power turning-off is retrieved

GPIB address and terminator
Polarity of output signal of handler interface□
Indication items on Displays A and B when comparator is used (Measurement/Upper and lower limit values)

If the resume function is enabled and the LOCK signal of handler interface (ZM2354 only) is activated (low level), then the ZM2353/ZM2354 settings will be set to the settings just before last power turning-off.
On this occasion, also the zero correction value (OPEN/SHORT correction value) will be set to the value just before last power turning-off.

Should the setting data be lost due to memory backup error, "Err21" appears. When the error is fixed (pressing any button releases the error), the initial settings are retrieved.
Then, the GPIB address, the polarity of handler interface, and the indication items when comparator is used will be as follows: induction as much as possible.

GPIB address and terminator	Address 2 Terminator CRLF
Polarity of handler interface	Lo (low level)
Indication items when comparator is used	Measurement

Should the gain correction value be lost due to memory backup error

Should the gain correction value be lost due to memory backup error
"Err26" appears.
When the error is fixed (pressing any button releases the error), a temporary value is assigned to the gain correction value in order to resume measurement. However the precision of measurement cannot be guaranteed. In such cases, carry out gain correction (CAL) in system mode.

Indication of measurements

Selection of measurement parameter

Display A

AUTO: Automatic selection of parameters for Displays A and B and equivalent circuit from the measured test piece
L: Self-inductance (H)
C: Electrostatic capacity (F)
R: Resistance (Ω)
|Z|: Magnitude of impedance (Ω)

Display B

Q: Quality factor
D: Dissipation factor (= tan δ = 1/Q)
G: Parallel conductance (S)
X: Serial reactance (Ω)
ESR: Equivalent series resistance (Ω)
θ: Phase angle of impedance (deg)
V: Voltage monitor value (Vrms)
I: Current monitor value (Arms)
FREQ: Measurement frequency (Hz)
LEVEL: Measurement signal level (Vrms)
BIAS: Internal DC bias level (V)
RANGE: Measurement range
REF: Reference value

Indication format for parameter and range for indication

● |Z|, R, ESR, X

Format	Exponential expression
Resolution	4-1/2 digits (maximum 19999) Minimum resolution = 0.1 mΩ
Range of indication	0.0 m, ±(0.1 m to 19.999 M) Ω

● C

Format	Exponential expression
Resolution	4-1/2 digits (maximum 19999)
Range of indication	0.000 p, ±(0.001 p to 199.99 m) F

|C| ranges differently by frequency as follows:

For 40 to 150 Hz:	0.0 p to 199.99 mF
For 160 to 1.5 kHz:	0.00 p to 19.999 mF
For 1.6k to 15 kHz:	0.000 p to 1.9999 mF
For 16k to 159 kHz:	0.000 p to 199.99 μF
For 160k to 200 kHz:	0.000 p to 19.999 μF

● L

Format	Exponential expression
Resolution	4-1/2 digits (maximum 19999)
Range of indication	0.00 n, ±(0.01 n to 19.999 k) H

|L| ranges differently by frequency as follows:

For 40 to 150 Hz:	0.0 μ to 19.999 kH
For 160 to 1.5 kHz:	0.00 μ to 1.9999 kH
For 1.6k to 15 kHz:	0.000 μ to 199.99 H
For 16k to 159 kHz:	0.0 n to 19.999 H
For 160k to 200 kHz:	0.00 n to 1.9999 H

● Q, D

Format	Floating-point expression
Resolution	4-1/2 digits (maximum 19999)
Range of indication	.0000, ±(.0001 to 19999)

● G

Format	Exponential expression
Resolution	4-1/2 digits (maximum 19999)
Range of indication	0.0 n, ±(0.01 n to 199.99) S

● θ

Format	Floating-point expression
Resolution	0.01 deg
Range of indication	−180.00 to +179.99 deg

● V

Format	Exponential expression
Resolution	3-1/2 digits (maximum 1999)
Range of indication	0.0 m to 19.99 Vrms
Practical indication is shown only up to 5 V or so due to the output level.	

● I

Format	Exponential expression
Resolution	3-1/2 digits (maximum 1999)
Range of indication	0.0 μ to 19.99 mArms
Practical indication is shown only up to 50 mA or so due to the output level. In addition, resolution is limited by the measurement range as follows: 1 μA and more for reference resistance of 100 Ω 0.1 μA and more for reference resistance of 1 kΩ 0.01 μA and more for reference resistance of 10 k, 50 kΩ	

● Special indication

OF	Value is too great for indication.
UF	Value is too small for indication.
OU	Operation range of internal circuit is exceeded, disallowing normal measurement.

If any of the above indication appears, check the indication range, setting of range, condition of test piece connection, and noise induction.

● Others

For R, ESR and G, measurement range and resolution will be more limited with the phase angle
θ being farther away from 0° or –180° (+180°).

For L, C and X, measurement range and resolution will be more limited with the phase angle θ being farther away from +90° or –90°.

The characteristic is indicated by the following lamps:
p for –12th power, n for –9th power, μ for –6th power, m for –3rd power.
k for 3rd power, M for 6th power.
A positive (+) sign is not shown.

Measurement conditions

Measurement frequency

☞ See "Setting the measurement frequency" in Chapter 4 "How to Measure".

Measurement signal level

☞ See "Setting the measurement frequency" in Chapter 4 "How to Measure".

When V or I is shown:

When you are selecting V or I for parameter on Display B by the [PREV] [NEXT] (B SELECT) buttons:

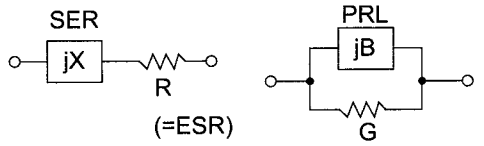
Press the [▲] and [▼] buttons of the [MODIFY] [▲] [◄] [►] [▼] buttons to change the value with the signal level being in minimum resolution.

Equivalent circuit

Selection of equivalent circuit

Even if an identical test piece is measured under the same measurement conditions, the resulting measurement is different depending on whether it was measured in series or in parallel.

This is because of the dissipation factor of the test piece.



$Z = R+jX$ $\qquad$ $Y = \frac{1}{Z} = G+jB$

$$\therefore \quad G+jB = \frac{1}{R+iX} = \frac{R}{R^2+X^2} - j\frac{X}{R^2+X^2}$$

If series resistance (R) and conductance (G) do not exist, the relation of Cs = Cp (Ls = Lp) holds.

For practical test piece measurement, however, they cannot be neglected, so the relation is Cs ≠ Cp (Ls ≠ Lp).

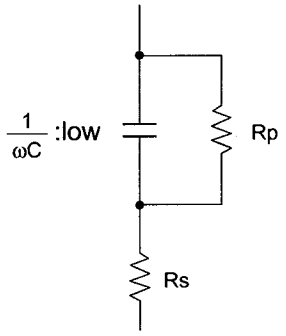
☞ See the following table titled "Dissipation Factor and Equivalent Circuit Conversion".

Dissipation Factor and Equivalent Circuit Conversion

Equivalent circuit		Dissipation factor	Conversion into another equivalent circuit
C	PRL	$D = \frac{G}{\omega Cp} = \frac{1}{Q}$	$Cs = (1+D^2)\,Cp,\ R = \frac{D^2}{1+D^2} \cdot \frac{1}{G}$
	SER	$D = \omega CsR = \frac{1}{Q}$	$Cp = \frac{1}{1+D^2} Cs,\ G = \frac{D^2}{1+D^2} \cdot \frac{1}{R}$
L	PRL	$D = \omega LpG = \frac{1}{Q}$	$Ls = \frac{1}{1+D^2} Lp,\ R = \frac{D^2}{1+D^2} \cdot \frac{1}{G}$
	SER	$D = \frac{R}{\omega Ls} = \frac{1}{Q}$	$Lp = (1+D^2)\,Ls,\ G = \frac{D^2}{1+D^2} \cdot \frac{1}{R}$
R	PRL	$D = \frac{1}{\omega CpRp} = \frac{\omega Lp}{Rp}$	$Rs = \frac{D^2}{1+D^2}\ Rp$
	SER	$D = \omega CsRs = \frac{Rs}{\omega Ls}$	$Rp = \frac{1+D^2}{D^2}\ Rs$

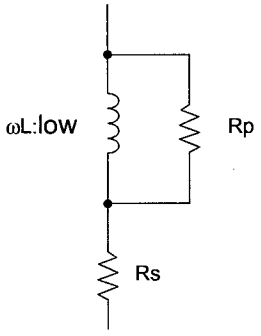
When in AUTO (automatic selection) mode, the impedance of the test piece selects SER or PRL at the border point of 1 kΩ. The reason for this is described below.

● If reactance is low:
Under conditions of low reactance, the circuit is as shown below.



Rp : Effect is low on $\frac{1}{\omega C}$.

Rs : Effect is high on $\frac{1}{\omega C}$.

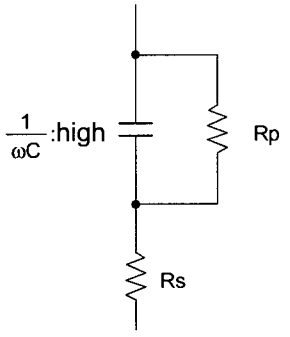


Rp : Effect is low on ωL.

Rs : Effect is high on ωL.

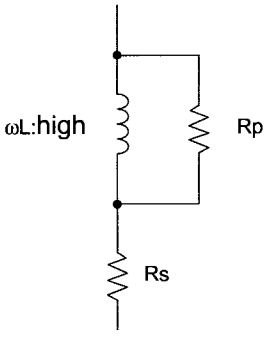
Therefore, measurement is conducted in SER (series).

● If reactance is high:
Under conditions of high reactance, the circuit is as shown below.



Rp : Effect is high on $\frac{1}{\omega C}$.

Rs : Effect is low on $\frac{1}{\omega C}$.



Rp : Effect is high on ωL.

Rs : Effect is low on ωL.

Therefore, measurement is conducted in PRL (parallel).

Measuring speed

☞ See "Selection of measuring speed" in Chapter 4 "How to Measure".

Measurement time

Measurement time depends on the frequency and range. The following are a broad time for guideline.

- Frequency is 1 kHz.
- Impedance of measured test piece is 1 kΩ/ (fixed to 1 kΩ range)

FAST	25 ms (typ)
MED1	64 ms (typ)
MED2	150 ms (typ)
SLOW	480 ms (typ)

Trigger

☞ For automatic trigger, see "Trigger mode" in Chapter 4 "How to Measure".

Manual trigger (manual trigger signal)

Once a trigger signal is accepted, measurement will be started.

When the measurement is finished, next measurement will not be started until a trigger signal is supplied.

The user can input a trigger signal using on the panel, through the GPIB, or by means of the handler interface (ZM2354 only).

When the system is in automatic trigger TRIG/CE mode, reception of a trigger signal will change the mode from automatic trigger to manual trigger and measurement is triggered.

- The TRIG button, TRIG/CE

Every press on TRIG/CE will execute one measurement.

This button is activated only when it is local and the LOCK signal is inactive.

- Trigger-response command of GPIB (GET, "TG")

Activated only when it is remote. It will not be inactivated by LOCK signal.

- TRIG input of handler interface (ZM2354 only)

A trigger signal is supplied from the TRIG input terminal of the handler interface.

At the fall from high level to low level, the trigger signal will be effective, executing one measurement.

Trigger delay time

Using a manual trigger, the user can specify the time period from the reception of the trigger signal to the start of measurement.

This delay time should be set in the trigger delay item of the system menu.

The value must be in the range from 0.00 s to 199.99 s (with resolution of 10 ms).

During the time from the reception of trigger signal to the end of measurement that allows the test piece removal, the BUSY lamp keeps lighting.

DC bias

During measurement of a capacitor or another measurement can be conducted with a DC bias voltage applied.

The ZM2353/ZM2354 has a built-in 0 V to +2.5 V DC power source and it can also use an external DC power supply to apply DC bias voltage ranging from 0 to ±35 V to the test piece in order to execute measurement.

Setting of internal DC bias voltage

☞ See "Application of internal DC bias" in Chapter 4 "How to Measure".

⚠ CAUTION

If DC bias is not used, set the internal DC bias voltage to 0 V.

External DC bias

Connect a DC power supply to the EXT BIAS IN terminal on the rear panel.
A red terminal (Hi) will be connected to the cable conductor part of the HCUR terminal of the UNKNOWN terminal on the front panel, and a white terminal (Lo) to the external conductor of the HCUR terminal.

If nothing is connected to the UNKNOWN terminal, the white terminal (Lo) of EXT BIAS IN is not connected to the housing. If a test fixture or test lead is connected to the UNKNOWN terminal, the white terminal (Lo) is connected to the housing.

If the user wants to connect an external DC power supply to the unit, set the voltage of the DC power supply to 0 V, and turn off the output of the DC power supply before connection.

⚠ CAUTION

Only apply a voltage ranging 0 to ±35 V to the EXT BIAS IN terminal. Otherwise the ZM2353/ZM2354 failure or fire may be caused.

Use a DC power supply that is sufficiently low in ripple and noise (1 mVrms or lower). High ripple or noise may cause variation in measurements or disable measurement.

If the user wants to give a 10 V or higher voltage change, gradually change the voltage at the rate of 10 V/s or less.

Switching of internal DC bias/external DC

☞ See "Contents of system menu" in □ Chapter 7 "System Menu".

Measurement

Specify C or |Z| for parameter indication on Display A.

⇩

Connect a test piece.

⚠ CAUTION

- For polar parts, pay extreme attention to the polarity.
- Be sure to discharge any charged capacitor before connect it to the unit.

By pressing ○BIAS ON, the user can turn on or off the DC bias. If the DC bias is turned on, the BIAS ON lamp lights up.
If the parameter on Display A is anything (including AUTO) other than C or |Z|, pressing ○BIAS ON will not turn on the DC bias, and an error message will appear.

⇩

If an external DC bias voltage has been selected, slowly raise the volt from 0 V, and when the measurement is finished, slowly lower the voltage to 0 V.

⇩

Take off the test piece.

MEMO

- If parameter of Display A is altered midway:
- If the mode is changed to system mode or bin setup mode:
- If zero correction is started:

⇩

The DC bias will be turned OFF automatically. It is necessary to turn on the DC bias again.

Bias stabilization time

When bias is turned on or off, or if the bias voltage is changed, it takes a certain period of time before the bias voltage becomes stabilized, disallowing measurement.
The time until normal measurement is available is broadly as follows:

Stabilization time = (6 + 0.015C) s
where C is the electrostatic capacity of the test piece (μF)

Measurement range

☞ See "Setting of measurement range" in Chapter 4 "How to Measure"

Measurement range for each range

☞ See the table below.

Setting frequency: 40 to 20 kHz

Range	Standard resistance	Lower limit extension	Applied impedance range (Ω)		
			Lower limit	Upper limit	Upper limit extension
1*	100 Ω	---	0	7	14
2	100 Ω	0.7	7	1.4 k	14 k
3	1 kΩ	700	1.4 k	14 k	140 k
4	10 kΩ	7 k	14 k	140 k	1.4 M
5	50 kΩ	40 k	140 k	1.4 M	∞
6*	50 kΩ	400 k	1.4 M	∞	--

Setting frequency: 21 k to 200 kHz

Range	Standard resistance	Lower limit extension	Applied impedance range (Ω)		
			Lower limit	Upper limit	Upper limit extension
1*	100 Ω	---	0	7	14
2	100 Ω	0.7	7	1.4 k	14 k
3	1 kΩ	700	1.4 k	14 k	140 k
4	10 kΩ	7 k	14 k	140 k	1.4 M
5	10 kΩ	70 k	140 k	1.4 M	∞
6*	10 kΩ	700 k	1.4 M	∞	--

MEMO

An asterisked range means an extension range.
The measurement range for each range is a value containing residual impedance and floating admittance effects rather than the impedance of the test piece itself.
In the case of automatic range, control determines it as the optimal range if it is within the range between the lower and upper limits of each range.
In the case of manual range, control shows the measurement as being in the range between the

Zero correction

The user can beforehand measure the floating admittance and residual impedance of test fixture, test lead and other measuring jigs and the connection cable. Thus, by using the obtained result, the user can make correction by that degree during measurement to seek the correct impedance of the test piece and to view the value.

Be careful!

- Result of zero correction is held in the backup memory, and if resume function is enabled, or if the LOCK signal of the handler interface is active, then the correction result will be read when the unit is powered and the system will return to the original correction state. Otherwise, the system will be in the state without zero correction when it is powered.
- During measurement for zero correction, the measurement signal level will be 1 V.
- Carry out zero correction whenever test fixture or test lead has been replaced.

Correction and abortion of correction

☞ See "Measurement in AUTO mode" in Chapter 4 "How to Measure".

OPEN: measurement of floating admittance

This measures the terminal-to-terminal capacity etc. when measurement terminals are released.

Press [OPEN 8] and [ENTER] to start measurement of floating admittance, then control will show Display A "OP" and the countdown until the ending. In addition, Display B shows a value corresponding to the floating admittance.

When floating admittance has been measured, control returns to measurement state, although the indication of measurement remains blank until the measurement ends.

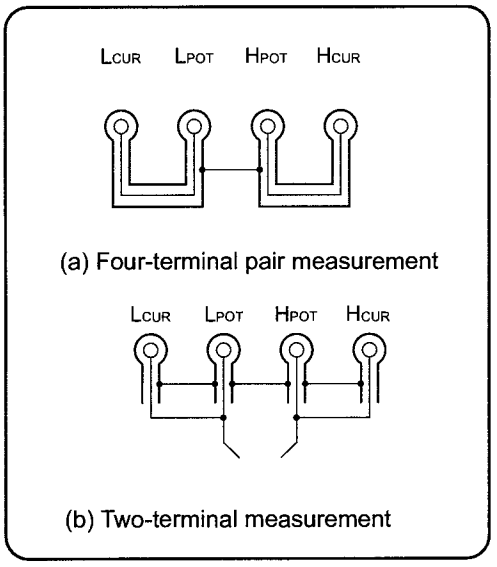


Fig. 4 OPEN Measurement

Be careful!

Always connect LCUR to LPOT and HPOT to HCUR. Connect four external conductors together at the measurement end. Take the same action over both OPEN and SHORT for connection of external conductor.OSC

SHORT: Measurement of residual impedance

This measures the resistance etc. when measurement terminals are short-circuited.

Press [SHORT 5] and [ENTER] to start measurement of residual impedance, then control will show Display A "SH" and the countdown until the ending. In addition, Display B shows a value corresponding to the residual impedance

When the residual impedance has been measured, control returns to measurement state, although the indication of measurement remains blank until the measurement ends.

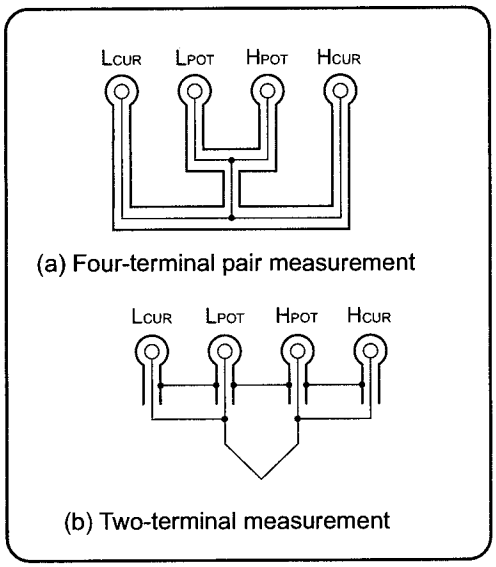


Fig. 5 SHORT Measurement

Abortion of correction

During execution of OPEN measurement, or during execution of SHORT measurement, the user can abort zero correction by pressing EXIT.

Also pressing any other button can abort the correction.

When OPEN or SHORT measurement is complete, the user can get the accurate measurement of the test piece being measurement by correcting the floating capacity and residual impedance of the test fixture, test lead and other measurement jigs and connection cables.

☞ For zero correction when test fixture or test lead is used, see the manual for that test fixture or test lead.

Equivalent circuit of measurement system

The ZM2353/ZM2354 determines the residual impedance and floating admittance, calculates the true impedance using the equation below and shows the value of impedance provided that the state of measurement can be depicted by the circuit as shown below.

$$Zx = 1/(Ym - Ypp) - Zss$$

☞ See Fig 6 "Equivalent Circuit of Measurement System".

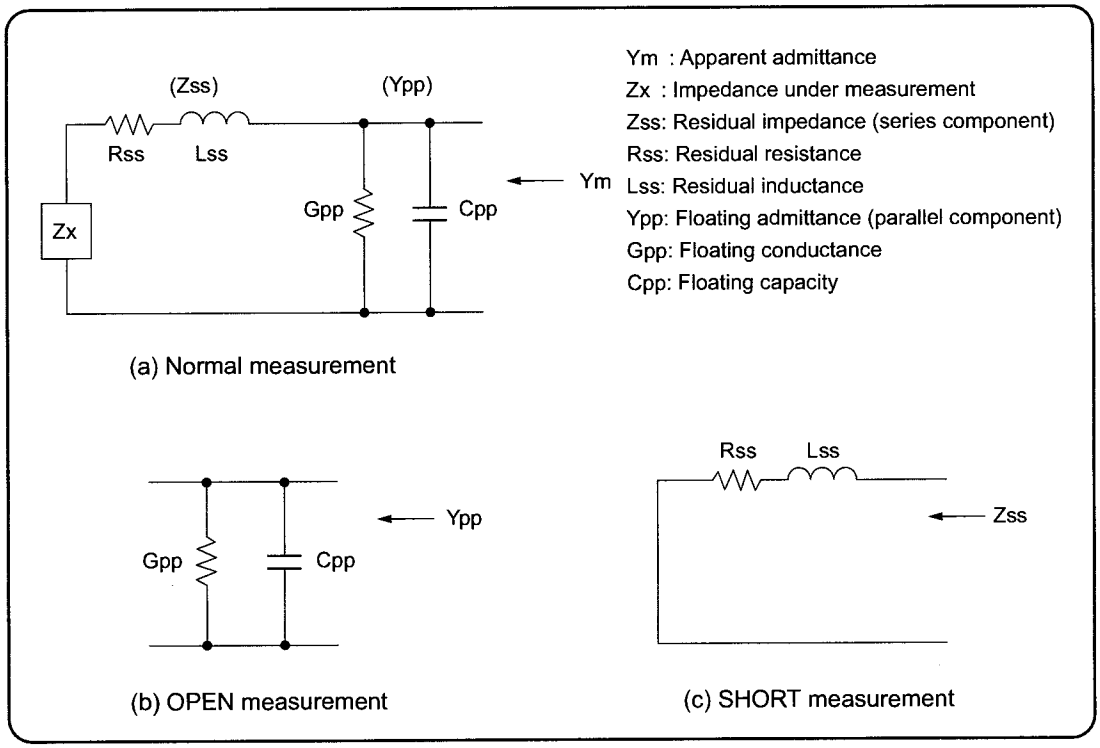


Fig. 6 Equivalent Circuit of Measurement System

Range for possible correction

The range for possible correction of floating admittance and residual impedance during OPEN or SHORT measurement is described below.

● Floating admittance

|Ypp| < 100 μS: Rpp > 10 kΩ (Rpp = 1/Gpp)
Cpp < ca. 160 pF at 100 kHz

● Residual impedance

|Zss| < $\sqrt{1000}$ Ω = ca. 31.623 Ω: Rss < ca. 30 Ω
Lss < ca. 50 μH at 100 kHz

Exceeding the above range for possible correction will cause an error, showing an error message "Err22".
Correction factor (value of zero) does not change.

Note that the ZM2353/ZM2354 measures the overall impedance that contains the floating admittance and residual impedance, and then corrects the floating admittance and residual impedance by calculation. Therefore, if the magnitude of the floating admittance and/or the residual impedance approaches (or further, exceeds) the magnitude of the impedance under measurement, the measurement precision will lower.

In the above case, calibration by means of external standard is required.

An error message "Err23" may appear if there is any problem in the reliability of zero correction value obtained through attenuation of the measurement signal level due to poor contact of the measurement terminals or other factors.

Comparator functions

The ZM2353/ZM2354 is provided with 20 bins (BINs 1 to 20) that correspond to Display A and another bin (BIN B) that corresponds to Display B.

Judgment of bin

Bin judgment starts with BIN 1. The system determines for each bin whether or not the value shown on Display A falls in the range between the upper and lower limit values. If it determines the value does not fall in the range for one bin, then it goes to the next bin and determines the value again.

If the upper limit value is equal to or lower than the lower limit value for a bin, the system does not make judgment for that bin, showing indication of "A NG", and it will not go further to the next bin number.

For BIN B, the system check if the value shown on Display B falls in the range between the upper and lower limit values set for BIN B.

If the upper limit value is equal to or lower than the lower limit value, the system does not make judgment for BIN B. If the parameter on Display B is FREQ, LEVEL, BIAS, RANGE, or REF, the system does not make judgment for BIN B either.

☞ See Fig. 8 "Example of Range Setting".
☞ See Fig. 7 "Bin Judgment".

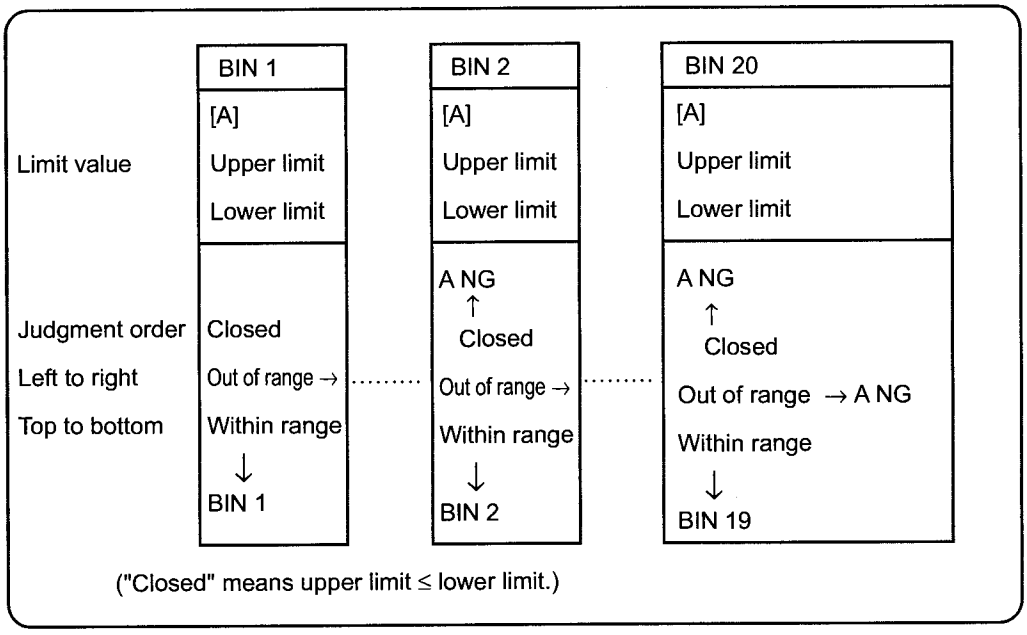


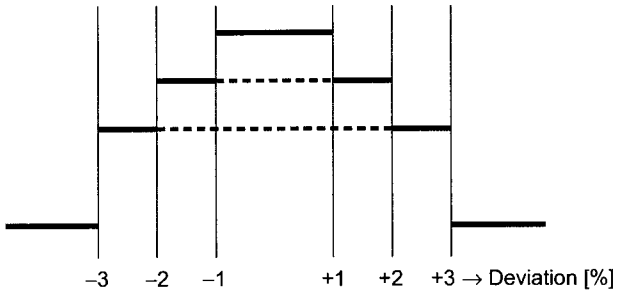
Fig. 7 Bin Judgment

BIN 1 : ±1%

BIN 2 : ±2%

BIN 3 : ±3%

A NG



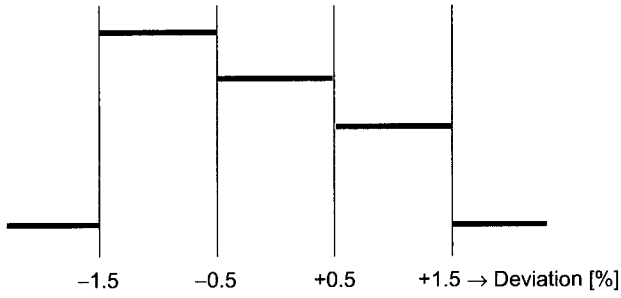
(a) Ranges overlapping each other

BIN 1 : –1.5 to –0.5%

BIN 2 : –0.5 to +0.5%

BIN 3 : +0.5 to +1.5%

A NG



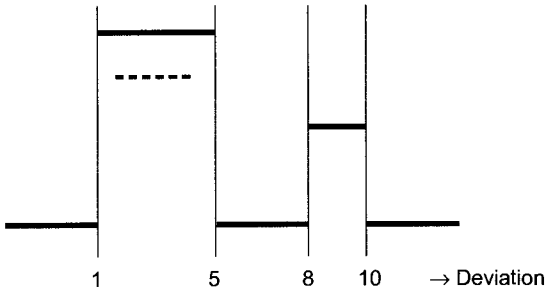
(b) Consecutive ranges

BIN 1 : 1 to 5

BIN 2 : 2 to 4

BIN 3 : 8 to 10

A NG



(c) Specific setting

Note: A solid line ——— means the range to judge the value coming into the bin.

A dotted line - - - - means an invalid range due to overlapping.

Fig. 8 Example of Range Setting

Method of measurement (judgment)

● First, decide the parameter for judgment.
Parameters for Display A include L, C, R and |Z|.
For judgment on Display B, also decide the parameter for judgment out of Q, D, G, X, ESR, θ, V and I.
In this case, bin judgment is possible even if an AUTO parameter is set for Display A. However, it will be easier if parameters on Display A and B are fixed to execute measurement (judgment).

● For Display A judgment, decide whether to judge by measurement or to judge by deviation of percentage.
If the user wants to use deviation or percentage, enter the reference value (REF).
☞ See "Show deviation data" in Chapter 5 "Operation of Comparator Functions".

● Enter the upper limit value and the lower limit value for each bin number.
☞ See "Setting of comparator mode" in Chapter 5 "Operation of Comparator Functions".
To do this, enter the indication parameter of Display A or B and the measure for deviation or percentage.

Example: For C measurement, setting a range from 9 μF to 11 μF for judgment of 10 mμF:

- To judge by measurement, the range will be: Lower limit value of 9.000 μ, upper limit value of 11.000 μ
- To judge by deviation, the range will be: Lower limit value of –1.000μ, upper limit value of 1.000 μ
- To judge by percentage, the range will be: Lower limit value of –10.000, upper limit value of 10.000

●Quit the bin setup mode, and press Δ/%/BIN to bring the system into a bin measurement state. Select measurement (BIN), deviation (Δ BIN) or percentage (Δ %BIN) according to your intended setting range.

●Measurement (judgment)
Start measurement. The system determines if the measurement falls in the range defined by the upper and lower limit values for the first bin (BIN 1). If the measurement is judged to be in the range, control turns on the bin display lamp that corresponds to that bin number. Or else, control moves to the next bin (BIN 2), and repeat the above until the last bin is reached, if applicable.

If the measurement judged to be outside the range at the last bin, or if the judgment results in OF, UF or OU indication, then the A NG lamp will be turned on.

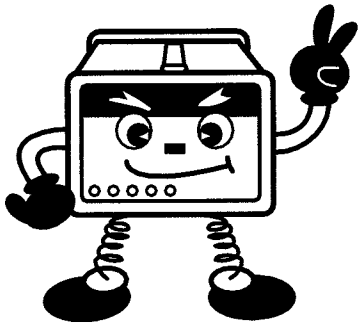
Gain correction

The system menu contains a CAL function, which carries out gain correction.

This function corrects the circuit inside the ZM2353/ZM2354. The user does not have to mind this function in normal measurement.
Before using this product in a hot environment (about 40°C) or a cold environment (about 5°C), adjust the gain correction (CAL) so that the measured value approximates room temperature (23°C ±5°C).

If an error message "Err26" appears when the ZM2353/ZM2354 is powered, the gain correction value is lost, which means the measurement precision (accuracy) is not guaranteed. Carry out gain correction before starting measurement.
Perform a warm-up run for at least 30 minutes before adjusting the gain.

Maintenance and Calibration 9



Outline

The following maintenance is required to keep the ZM2353/ZM2354 in the best condition for use.

- Operation check and performance test

Check if the ZM2353/ZM2354 is functioning properly, and its ratings are met.

- Fault detection

If the ratings are not met, the system seeks the cause for failure and defective parts.

- Fault repair

This instruction manual contains only the items of operation check that the user can carry out easily and the procedure of performance test. For advanced inspection, calibration and fault repair, contact NF Corporation or NF representatives.

⚠CAUTION

Never open the case when the power cord is connected to the ZM2353/ZM2354 except for those service technicians who have sufficient knowledge of electrical safety and the ZM2353/ZM2354 construction. High voltage is live at the power supply part of the ZM2353/ZM2354, contact to which may cause electric shock.

Prepare the following measuring instruments and standards for maintenance of ZM2353/ZM2354.

- Frequency counter: Precision of ±5ppm; reciprocal system is preferable (to measure 1 kHz).
- AC voltmeter: Precision of ±1.0%, 10 mV to 1 Vrms, 40 Hz to 100 kHz
  ±4.0%, 10 mV to 1 Vrms, 101 k to 200 kHz
- DC voltmeter: Precision of ±0.5%,
- Oscilloscope: Band of 10 MHz or higher
- Standard resistor: 10, 100, 1 k, 10 k, 100 kΩ
- Standard capacitor: 10 p, 100 p, 1 n, 10 n, 100 n, 1 μF
- Standard inductor: 1 mH, 10 mH, 100 mH, 1 H

The precision of calibration for the standard should be set within 1/3 of the guaranteed precision for the ZM2353/ZM2354 (0.03% at the best).

Prepare a standard with as excellent frequency characteristics as practicable.

Use a standard resistor with known equivalent series inductance and equivalent parallel capacitance.

Operation check and performance test

Confirmation of operation environment

The following maintenance is required to keep the ZM2353/ZM2354 in the best condition for use.

- Power supply voltage: The voltage set by the power voltage selector switch ±10%
- Ambient temperature and humidity: 23 ±5°C, 5 to 85%RH
  provided that the condition must meet the requirements for the standard and measuring instruments used.

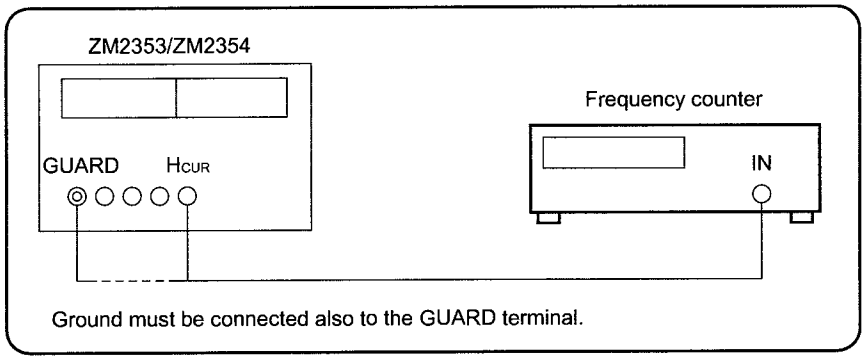
Check of driving signal source

- Precision of frequency (±0.01%)

  Measurement signal level = 1 Vrms

  DC bias = OFF

  Frequency = 1 kHz



Check of frequency

- Measurement signal level (1 V ±(10% + 3 mV), 50 mV ±(10% + 3 mV))

  Frequency = 1 kHz

  DC bias = OFF

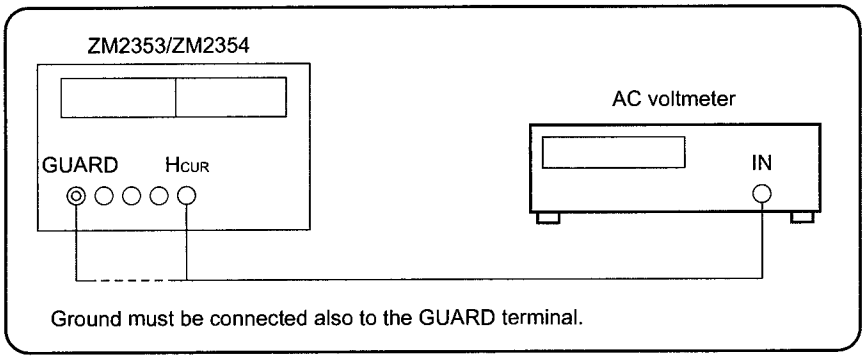
  Measurement signal level = 1 V, 50 mV

- Level frequency characteristics (up to 100 kHz: ±(10% + 3 mV); 101 kHz to 200 kHz: ±(15% + 5 mV))

  Measurement signal level = 1 V

  DC bias = OFF

  Frequency = 40, 100, 120, 200, 1k, 2k, 10k, 20k, 100k, 200k [Hz]



Check of Measurement Signal Level and Frequency Characteristics

- Internal DC bias (if ON: 2 V ±(5% ±10 mv), if OFF: ±10 mV)

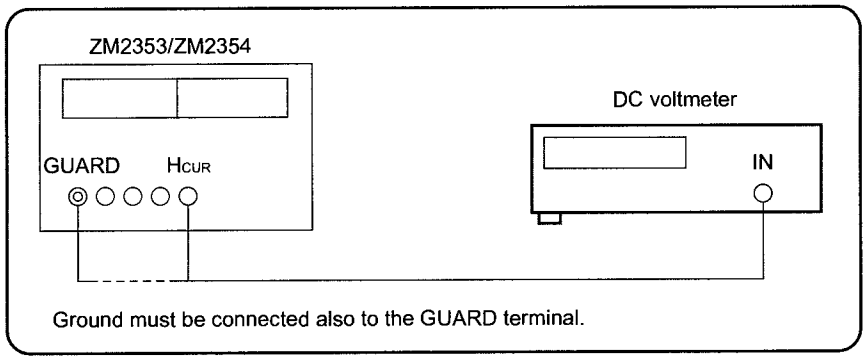
  Frequency = 1 kHz

  Measurement signal level = 50 mV

  Internal DC bias level = 2 V

  DC bias = ON (internal bias power supply is used)

  OFF

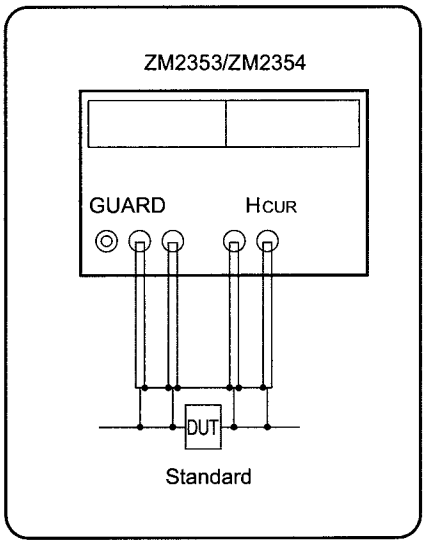


Check of DC Bias

Check of measurement accuracy

☞ For the accuracy of the ZM2353/ZM2354, see "Table of Basic Accuracy" in Chapter 12 "Ratings".

- If the conditions meet following two equations, then the specifications are completely met.
  The guaranteed accuracy of the ZM2353/ZM2354 > The accuracy of calibration of the standard
  |Measurement – Calibration value of the standard| < The guaranteed accuracy – The accuracy
- of calibration of the standard
  Conversely, if the conditions meet the following equation, then the specifications are not met at all.



Use preferably a four-terminal connection pair.
Use as short a connection cable as possible.
Heat run for 30 minutes or longer.
Carry out zero correction.
Set AUTO for the range.
Indication must be |Z| – θ.
Connect four external conductors of the cables together near the standard. inductance or equivalent parallel capacitance.

Check of Measurement Accuracy

- R

R [Ω]	40	100	120	200	500	1 k	2 k	5 k	10 k	20 k	50 k	100 k
10												
100												
1 k												
10 k												
100 k												

If the equivalent series inductance and equivalent parallel capacitance of the standard are known, then first calculate the impedance at each frequency from these values and the calibrated value of DC resistance. If the equivalent series inductance or equivalent parallel capacitance is unknown, then use it in the range that allows usage by the user discernment from the frequency characteristics of the standard. If the user has a 1 MHz impedance meter, it is possible to determine the broad value of the equivalent series inductance or equivalent parallel capacitance.

- C

C [Ω]	Frequency [Hz]											
	40	100	120	200	500	1 k	2 k	5 k	10 k	20 k	50 k	100 k
10 p												
100 p	--	--	--	--	--							
1 n												
10 n												
100 n												
1 μ												

Calculate the impedance at each frequency from the calibration values. "C" and "D" may be used for calibration.

Use it within the guaranteed frequency range of the standard

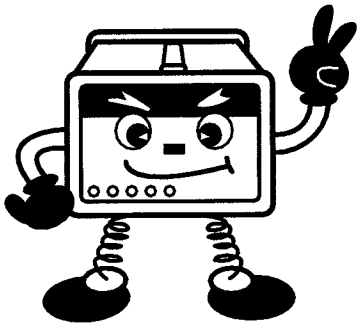
- L

L [H]	Frequency [Hz]											
	40	100	120	200	500	1 k	2 k	5 k	10 k	20 k	50 k	100 k
1 m	--	--	--	--	--							
10 m												
100 m												
1												

Calculate the impedance at each frequency from the calibration values. "L" and "Q" may be used for calibration.

Use it within the guaranteed frequency range of the standard. Since a wire-wound resistor of standard inductance is prone to temperature change, a great change will be caused in impedance at such low frequency that a change of only 0.5 decrease "Q". Therefore, we recommend the user to calibrate only the Ls value at a frequency that would produce a "Q > 1" condition even in a normal room although it may be just a simple method. Incidentally, the ZM2353/ZM2354 cannot measure a dummy inductor consisting of C and R because of the low impedance between the LCUR terminal and the ground. Therefore, do not use a dummy inductor for calibration.

GPIB Interface 10



GPIB

Practical actions and programming are dependent on the programming language on the controller side and the GPIB driver.
For further information, see the manuals for the programming language and the GPIB driver used.

a) Functions that cannot be operated through GPIB

- Turning ON/OFF the power
- Initialization to the original setting made on shipping.
- GPIB address and the terminator for sending

b) Functions that can be controlled through GPIB, but cannot be operated from the panel

- GPIB proper functions (status byte, remote/local etc.)

c) Underlying codes

- Standard: conforming to IEEE std. 488.1-1987
- Interface functions (listed below)

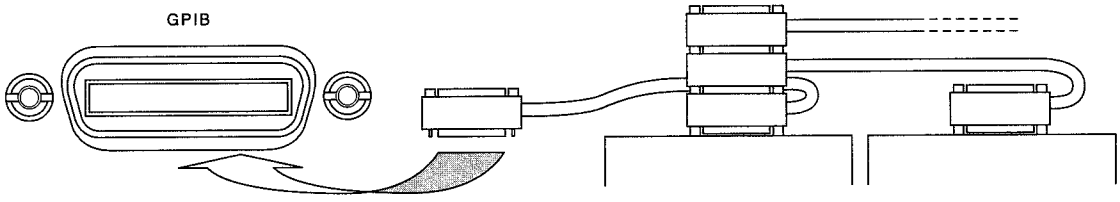
Interface Functions

SH1	Provides all functions of source handshake
AH1	Provides all functions of acceptor handshake
T16	Provides functions of fundamental talker, serial poll, and talker release by listener designation, but without talk only function
L4	Provides functions of fundamental listener, and listener release by talker designation, excluding listen only function
SR1	Provides all functions of service request
RL1	Provides all functions of remote/local
PP0	Does not provide parallel poll function
DC1	Provides all functions of device clear
DT1	Provides all functions of device trigger
C0	Does not provide controller function

Connection of GPIB cable

The connector for GPIB connection is located on the rear panel.

Using a GPIB cable specified by the standard, connect it to the GPIB bus line. Before connection to the bus, turn off the power switch of all devices to be connected. Tighten the joining screws of the connector to prevent loosening.



Connection of GPIB Cable

Instructions on use of GPIB

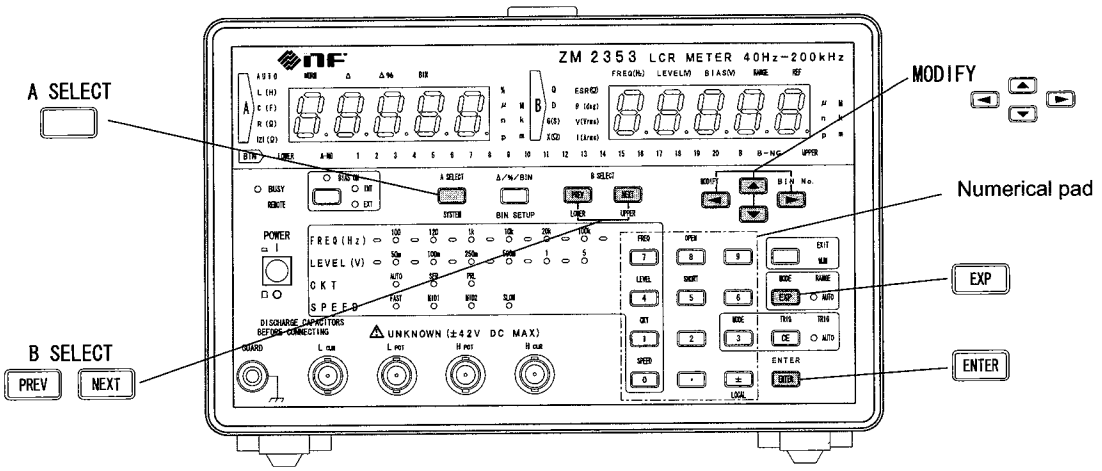
To use a GPIB, the following instructions must be observed in general.

- Turn off the power switch of all devices that are connected to the bus before plugging or unplugging the GPIB connector. Plugging or unplugging the connector with the power switch turned on may damage the devices.
- Turn on the power switch of all devices connected to the bus during GPIB use.
- Up to 15 devices including the controller can be connected to one bus.
- Length of cables must be the same or shorter as the following length:
  Length of any cable between devices is 4 meter.
  Total length of cables is the number of devices times 2 m or 20 m whichever is shorter.
- Assign different addresses to each device connected to one bus. A same address assigned to different devices may damage the devices.
- Unify the GPIB terminator within the system.

Setting of GPIB address and terminator (system menu)

Setting items of GPIB address and terminator are contained in the system menu.

☞ For the method to enter the system menu, see Chapter 7 "System Menu".



GPIB address [GP Ad]

1. Press A SELECT, or MODIFY ◄ ► several times to show [GP Ad] on Display A.

   A GP Ad

2. Using the numerical pad, make setting of GPIB address.

   Example: If the address is 5:

   Press 5 and ENTER.

   B 5

Note

A GPIB address is the ZM2353/ZM2354's address used for communications made with computer through GPIB. The address is a number ranging from 0 to 30. It is set to 2 when the ZM2353/ZM2354 is shipped.

GPIB terminator [GP tr]

1. Press A SELECT, or MODIFY ◄ ► several times to show [GP tr] on Display A.

   A GP tr

2. Press B SELECT PREV NEXT or ▲ ▼* to select a GPIB terminator.

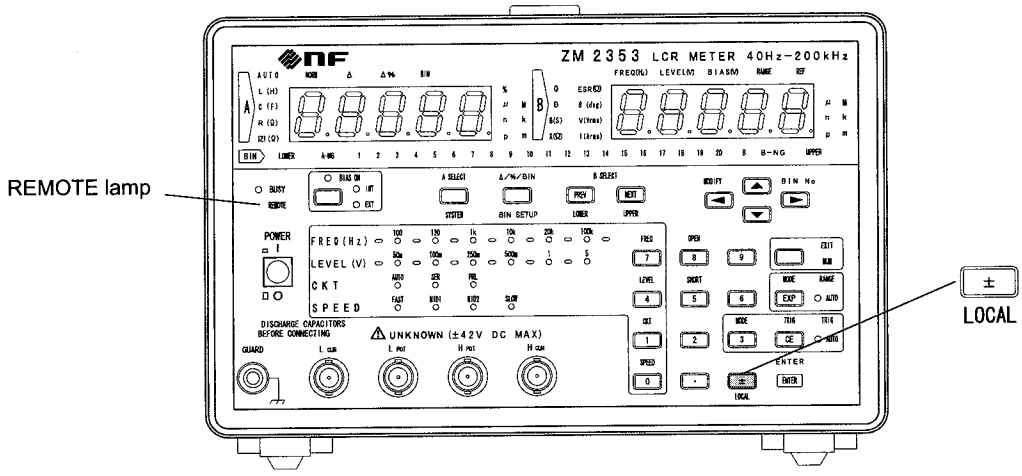
   * Every press on the buttons will change the indication of terminators as shown below.

   B CrLF ↕ B Cr ↕ B LF

Note

The GPIB terminator will be the ZM2353/ZM2354's terminator (a separator between messages) when communications are made with computer through GPIB. "CrLF" is selected when the ZM2353/ZM2354 is shipped.

Remote status and remote state releasing



Making a device remote

Set REN (Remote ENable) to 1 (True, the line is at LOW level) and send a program message, and it will be in a remote state, disabling operation from the panel (except the operation of [±] LOCAL).
In remote state, the REMOTE lamp keeps lighting.
Normally it will remain in remote state even after setting is complete depending on the GPIB driver on the controller side.

Making a device local

To shift it from remote state into local state, press [±] LOCAL (except local lockout).
To bring it into local state from the controller, execute either of the following:

- Specify the address and send an interface message, GTL (Go To Local). GTL will make the specified device local.

Bring the system into local lockout

If the system is brought into local lockout from the controller side, pressing [±] LOCAL will not make the system local. This measure can help the user avoid wrong operation in remote state. To make local lockout, take the following step:

- Send an interface message, LLO (Local LockOut).
  LLO brings into a local lockout state all devices that are connected to the bus and have the local lockout function.

Service request (SRQ)

Sending SRQ

If SRQ sending is enabled, any of the following events will send SRQ:

- A measurement is finished in manual trigger mode
- OPEN or SHORT zero correction is finished
- Calibration (CAL) is finished

Canceling SRQ

- When status has been read by serial poll during service request sending
- When a query message for status reading ("?ST") is received
- When Device Clear (DCL, SDC command) is received.

Status byte

The contents of a status byte to be sent answering to a serial poll or a query message are as

Bit	Description	Condition to be reset (1)	Condition to be reset (0)
7(MSB)	0 always	--	--
6	RQS	When SRQ is sent	● When Device Clear received ● When status byte is read
5	ZERO ERR	When zero correction error has occurred (too high correction)	● When Device Clear received ● When status byte is read ● When zero correction is completed in success
4	EOM	When measurement is being executed (excluding the period of zero correction)	● When measurement is not being executed
3	ZERO	When OPEN or SHORT zero correction is completed (including abnormal ending)	● When status byte is read ● When starting another zero correction ● When Device Clear received
2	RECALL	When recall is completed	● When status byte is read ● When Device Clear received
1	ERR	When fixable error (error number 00 to 49) has occurred	● When Device Clear received (Other than the above cannot clear the device.)
0 (LSB)	CAL	Self-calibration on power energizing or when gain correction is completed	● When Device Clear received ● When status byte is read ● When another gain correction is to be started

Device clear:

DCL or SDC command

Status byte reading:

Status byte reading by query message "?ST"

Or, serial poll that is made when SRQ is being issued

(Reset is not made by serial poll when SRQ is not being issued)

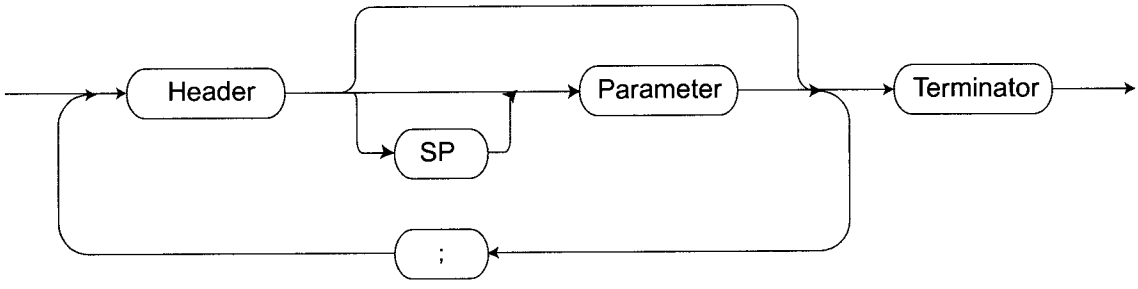
Program message

Program messages are stored temporarily in the input buffer, and when a terminator is received, they will be interpreted and executed in the order of inputting. The input buffer has a capacity of 256 characters (i.e., 256 bytes). Null (00h) and terminator do not enter the input buffer.

When a program message with a size exceeding 256 characters is received, all other program messages will be invalid, and none of the program messages will be executed.

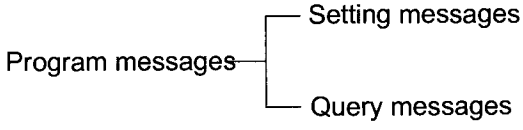
When a program message has been interpreted and executed, the input buffer will be cleared, and will be ready to accept the next input.

A program message consists of a header and a parameter. Program messages can be sent successively if the input buffer capacity is not exceeded. The syntax of a program message is shown below.



When to send two or more program messages, place a semicolon ";" between the messages.

Program messages are broadly classified into "setting messages" to make settings and to command actions and "query messages" to inquire state or setting values.



Setting message

The format of a fundamental setting message is shown below.

This example message sets the frequency to 1 kHz and signal level to 1 V.

FR	___	1E3	;	LV	___	1
a	b	c	d	a	b	c

a: Field for a header, consisting of two alphabets. Header is not case-sensitive, allowing mixture of an uppercase and a lowercase.

b: A space(s) to facilitate reading. Any number of spaces can be inserted, and it can also be omitted.

c: Field for a parameter, starting with a sign (+ or –), a number or a decimal point. If a sign is omitted, the parameter is taken as a positive number. Some commands consist of a string as its parameter.

d: This is a semicolon to separate plural setting messages.

Data format of setting message

Formats of data include the following three, NR1, NR2 and NR3. A numerical command can take any of the NR1, NR2 and NR3 formats.

- NR1 format

  Integer format. This format does not contain a decimal point; the decimal point is considered to exist at the right to the final digit.

± DDD

◎ Leading zeros are neglected.

◎ The sign is expressed by "+" or "–", and omitted sign will be taken as "+".

Example: +01234

–50001

18

- NR2 format

  This is a floating-point format to define a value containing a decimal point. A period "." expresses the decimal point. The fraction can be omitted after the decimal point, and if it is omitted, the fraction will be taken as zero.

± DD. DD

◎ Leading zeros are neglected.

◎ The sign is expressed by "+" or "–", and omitted sign will be taken as "+".

Example: +0.1234

–50.001

1.8

NR3 format

This is an exponential form to define a value with a numbers containing a decimal point and a characteristic. A period "." expresses the decimal point and "E" expresses the exponent.

± DD. DD ± nn

◎ The portion to follow E is a characteristic, and this expresses 10 raised to the "nn"-th power.

◎ Leading zeros are neglected.

◎ The sign is expressed by "+" or "–", and omitted sign will be taken as "+".

Example: 12E3

9.8E+0.2

+0.4. 5E–6

–.007E+09

- Characters

  ASCII (ISO 7-bit) codes are used.

- Strings

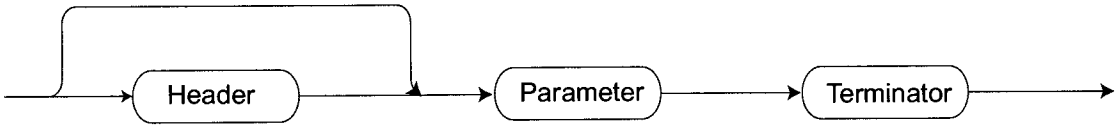
  Combinations of ASCII (ISO 7-bit) codes are used. A string is defined with double quotations placed at the top and the end.

Query message

A program message to inquire the state of selection or set values. Always furnished with a question mark "?" at the top.

If talker is specified when the query message has been sent, a response to it will be output.

The output format of response is as follows:



The header can be turned on or off by the setting message "HD 1" or "HD 0". When the unit is powered, it is turned off ("HD 0", meaning that the header will not be output").

Be careful!

If the user specifies ZM2353/ZM2354 as talker without sending a query message, a space and a terminator will be output except just after measurement by manual trigger.
If two or more queries are made at a time, only the last query will be valid. All other previous queries will be neglected. Note that, if any of the following operation is made without receiving a response after sending a query message, then the response to the query will be cancelled.

- Program message "TG"
- GET command

Data format of response to query

Parameters have the following formats, and the output format and the number of digits (number of characters) are decided by the query message.

- NR1: Integer
  Example: "0", "1" etc.
- NR2: Floating point format (without a characteristic)
  Example: "12.345" etc.
  The place of decimal point may be either fixed or variable.
- NR3: Exponential form (with a characteristic)
  Example: "15.75E + 03" etc.

If NR3 (exponential form) is used, the characteristic will be a multiple of 3 so that the mantissa will be approximately in the range of: $1 \leq |\text{Mantissa}| < 1000$ according to the panel indication, with the characteristic being limited to –12 at the minimum and +6 at the maximum.
In some cases, however, the mantissa may not be within the range from 1 to 1000 due to the indication requirements.
To express zero in the NR3 format, in general, both the mantissa and the characteristic will be zero (i.e., "0.0000E + 00"). For some measurement, however, it may happen that only the mantissa is zero, but the characteristic is not zero according to the panel indication.

Note

- Values are output in right justification with its extra zero removed at the top of the number. However, the zero just before the decimal point will not be omitted.
- For the sign of positive numbers and zero, a blank is used rather than adding a "+" sign. For the sign of characteristic, however, a "+" sign is added instead of using a blank. The characteristic always has two digits.

Program messages

Setting message

The numerical format, range of value and resolution of frequency, trigger delay time, upper and lower limit values of comparator etc. that can be set through the GPIB are the same as those when set from the panel. Also the main and sub parameters, measuring speed etc. are the same as those when set from the panel.

[Example of setting message]

"FR 10E3": To set frequency to 10 kHz.

"DA 0": To automatically set Displays A and B and equivalent circuit.

"RC 2": To call No. 2 of setting memory.

Be careful!

OPEN and SHORT zero correcting action and measurement with manual trigger will be aborted if any program code is received during execution.

Setting messages [Command messages]

Parameter name or function	Program message		Action and setting range	Query
	Header	Parameter		
DISPLAY A	DA	NR1 integer	<Main parameter indication> Range: 0 = A UTO 1 = L 2 = C 3 = R 4 = |Z| 5 to 8 = A UTO	Yes
DISPLAY B	DB	NR1 integer	<Sub parameter indication> Range: 0 = Q 6 = Vm 1 = D 7 = Im 2 = G 8 = FREQ 3 = X 9 = LEVEL 4 = ESR 10 = BIAS 5 = θ 11 = RANGE 12 = REF	Yes
DELTA/BIN	DE	NR1 integer	<Deviation and bin indication> Range: 0 = NOMAL 1 = Δ 2 = Δ% 3 = BIN 4 = ΔBIN 5 = Δ% BIN	Yes

Parameter name or function	Program message		Action and setting range	Query
	Header	Parameter		
BIN MODE	DP	NR1 integer	<Indication during bin action> Selection of indication items on Displays A and B during bin action Range : 0 = Indication of measurement 1 = Indication of upper and lower limit value	Yes
CIRCUIT	CK	NR1 integer	<Equivalent circuit> Range : 0 = AUTO 1 = SER 2 = PRL 3 to 4 = AUTO	Yes
REFERENCE	RF	NR3 exponential form	<Reference value for deviation indication> Range: 0 and ±(0.0001E – 12 to 19999E + 6) Resolution: maximum 4-1/2 digits	Yes
BIN A	BN	NR1 integer and NR3 exponential form	<Main parameter comparator> Format: m1, m2, m3 m1: Bin number (BIN) m2: Lower limit (LOWER) m3: Upper limit (UPPER) Range: m1 = 1 to 20 m2, m3 = 0 and ±(0.0001E – 12 to 19999E + 6)	Yes
BIN B	BB	NR3 exponential form	<Sub parameter comparator> Format: m1, m2 m1: Lower limit (LOWER) m2: Upper limit (UPPER) Range: 0, and ±(0.0001E – 12 to 19999E + 6)	Yes
FREQUENCY	FR	NR3 exponential form	<Frequency> Range: 40 to 200E + 3 [Hz] Resolution: 40 to 99 k = two digits 100 k to 200 k = 1 k [Hz]	Yes
LEVEL	LV	NR3 exponential form	<Measurement signal level> Range: 10E – 3 to 5.0 [Vrms] Resolution: 10E – 3 to 1.0 = 1 m [Vrms] 1.0 to 5.0 = 10 m [Vrms]	Yes
RANGE	RN	NR1 integer	<Range> Range: 0 = FAST 1 = MED range1 ~ ~ 6 = MAN range 6 7 to 12 = AUTO	Yes
SPEED	SP	NR1 integer	<Measuring speed> Range: 0 = FAST 1 = MED 1 2 = MED 2 3 = SLOW	Yes
DELAY	DL	NR2 floating point	<Delay time> Time period from triggering to measurement start Only manual trigger Range: 0.00 to 199.99 [s] Resolution: 0.01 [s]	Yes

Parameter name or function	Program message		Action and setting range	Query
	Header	Parameter		
BIAS OUTPUT ON/OFF	BO	NR1 integer	<Bias output> Range: 0 = OFF 1 = ON	Yes
BIAS SWITCH ON/OFF	BS	NR1 integer	<Bias switch> Range: 0 = INT 1 = EXT	Yes
BIAS INTERNAL LEVEL	BI	NR3 exponential form	<Internal bias level> Range: 0 to 2.5 [V] Resolution: 0 to 999E – 3 = 1m [V] 1.0 to 2.5 = 10m [V]	Yes
TRIG MODE	TR	NR1 integer	<Trigger mode> Range: 0 = AUTO 1 = MAN	Yes
MAN TRIG	TG	NR1 integer	<Manual trigger> Enter manual trigger mode and give a trigger	No
ZERO OPEN	OP	--	<Correct floating admittance> Measure with measurement terminal kept open and then correct.	No
ZERO SHORT	SH	--	<Correct residual impedance> Measure with measurement terminal kept short-circuited and then correct.	No
CAL IBRATION	CA	--	<Calibration> Carry out gain correction.	No
STORE	SR	NR1 integer	<Store memory> Range: 1 to 9	No
RECALL	RC	NR1 integer	<Recall memory> Range: 0 to 9	No
RESUME	RM	NR1 integer	<Resume function> Range: 0 = OFF 1 = ON	Yes
INITIALIZE	IN	--	<Initialize> Initialize all measurement conditions.	No
BEEP	BE	NR1 integer	<Beep> Issue a beep according to the result of main parameter judgment during bin action. Range: 0 = OFF 1 = ON for BIN1 to BIN20 2 = ON for BIN A NG 3 = ON for all cases	Yes
STROBE	SO	NR3 exponential form	<Strobe signal length> (This is valid only for the ZM2354. For the ZM2353, set 1 ms (default value) to prevent slowing of measurement speed). Range: 1E – 3 to 19.999 [s] Resolution: 1m [s]	Yes
HANDLER LOGIC	HL	NR1 integer	<Handler signal polarity> (Valid for the ZM2354 only.) Range: 0 = LOW active 1 = HIGH active	Yes
CABLE	CB	NR1 integer	<Measurement cable length> Range: 0 to 4 [m] Resolution: 1 [m] If 3 is specified for setting, then 4m.	Yes

Parameter name or function	Program message		Action and setting range	Query
	Header	Parameter		
HEADER	HD	NR1 integer	<Header output> Range: 0 = Disabled (will not output) 1 = Enabled (will output)	Yes
SERVICE REQUEST	RQ	NR1 integer	<Service request> Specify whether or not to output SRQ. Range: 0 = Disabled (will not output) 1 = Enabled (will output)	Yes

Query message

Query message

Parameter name or function	Query message header	Output format, contents of query		Setting
		Header	Parameter	
DISPLAY A	?DA	DA	<Indication of main parameter> Format:NR1 (integer) Range: 1 = L 5 = AUTO L 2 = C 6 = AUTO C 3 = R 7 = AUTO R 4 =|Z| 8 = AUTO |Z|	Yes
DISPLAY B	?DB	DB	<Indication of sub parameter> Format:NR1 (integer) Range: ☞ See "Setting message".	Yes
DELTA/BIN	?DE	DE	<Indication of deviation and bin> Format:NR1 (integer) Range: ☞ See "Setting message".	Yes
DISPLAY BIN MODE	?DP	DP	<Indication during bin action> Format:NR1 (integer) Range: ☞ See "Setting message".	Yes
CIRCUIT	?CK	CK	<Equivalent circuit> Format:NR1 (integer) Range: 1 = SER 3 = AUTO SER 2 = PRL 4 = AUTO PRL	Yes
REFERENCE	?RF	RF	<Reference value for indication of deviation> Format: NR3 (exponential formal) Range: 0.0000E + 00 and ±(0.0001E – 12 to 19999.E + 06) Resolution: 4-1/2 digits, when not restrained by characteristic	Yes

Parameter name or function	Query message header	Output format, contents of query		Setting
		Header	Parameter	
BIN A	?BN	BN	<Main parameter comparator> Format: m1, m2, m3 m1 = Bin number (BIN) m2 = Lower limit (LOWER) m3 = Upper limit (UPPER) Data will be output continuously for 20 bins from Bin 1 to Bin 20, in this order, with a terminator put between a bin and next bin. Form: m1: NR1 (integer) m2, m3: NR3 (exponential form) Range: m1 = 1 to 20 m2, m3 = 0.0000E+00 and ±(0.0001E – 12 to 19999.E + 06)	Yes
BIN B	?BB	BB	<Sub parameter comparator> Format: m1, m2 m1 = Lower limit (LOWER) m2 = Upper limit (UPPER) Form: m1, m2: NR3 (exponential form) Range: 0.0000E + 00 and ±(0.0001E – 12 to 19999.E + 06)	Yes
MEASUREMENT DATA	?DT	DT	<Measurement data> Format: DISPLAY A, DISPLAY B Form and range: depend on parameter ☞ See "Reading measurement data".	No
	?PA	PA	<Display A high-resolution data> Form: NR3 (exponential form) Range: ± 9.999999999E + 34 Resolution: 10 digits for mantissa	No
	?PB	PB	<Display B high-resolution data> Form: NR3 (exponential form) Range: ± 9.999999999E + 34 Resolution: 10 digits for mantissa	No
	?PZ	PZ	<Rx and Xz high-resolution data> Form: NR3 (exponential form) Range: ± 9.999999999E + 34 Resolution: 10 digits for mantissa	No

Parameter name or function	Query message header	Output format, contents of query		Setting
		Header	Parameter	
COMPARATER	?CM	CM	<Result of comparator judgment> Format: m1, m2 m1 = Result of main parameter judgment m2 = Result of sub parameter judgment Form: m1, m2: NR1 (integer) Range: m1 = 0(A NG) and 1 to 20 (Bin number) m2 = 0(B NG) and 1(B OK)	No
FREQUENCY	?FR	FR	<Frequency> Form: NR3 (exponential form) Range: ☞ See "Setting message".	Yes
LEVEL	?LV	LV	<Measurement signal level> Form: NR3 (exponential form) Range: ☞ See "Setting message".	Yes
RANGE	?RN	RN	<Range> Form: NR1 (integer) Range: 1 = MAN range 1 to 6 = MAN range 6 7 = AUTO range 1 to 12 = AUTO range 6	Yes
SPEED	?SP	SP	<Measuring speed> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
DELAY	?DL	DL	<Delay time> Form: NR2 (floating point) Range: 0.00 to 199.99 [s] Resolution: 0.01 [s] fixed point	Yes
BIAS OUTPUT ON/OFF	?BO	BO	<Bias output> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
BIAS SWITCH INT/EXT	?BS	BS	<Bias switch> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
BIAS INTERNAL LEVEL	?BI	BI	<Internal bias level> Form: NR3 (exponential form) Range: ☞ See "Setting message".	Yes

Parameter name or function	Query message header	Output format, contents of query		Setting
		Header	Parameter	
TRIG MODE	?TR	TR	<Trigger mode> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
RESUME	?RM	RM	<Resume function> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
BEEP	?BE	BE	<Beep> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
STORE	?SO	SO	<Strobe signal length> Form: NR3 (integer) Range: ☞ See "Setting message".	Yes
HANDLER LOGIC	?HL	HL	<Handler signal polarity> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
CABLE	?CB	CB	<Measurement cable length> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
HEADER	?HD	HD	<Header output> Form: NR1 (integer) Range: ☞ See "Setting message".	Yes
SERVICE REQUEST	?RQ	RQ	<Service request output> Form: NR1 (integer) Range: ☞ See "Setting message".	No
STATUS BYTE	?ST	ST	<Status byte> Form: NR1 (integer) Range: 0 to 127 Data will be converted into a decimal number for outputting.	No

To read measurement data

Request for measurement data

Measurement data can be read by the following two methods.

- Use a query message of "?DT" for request.
- Use a setting message "TG" or a GET interface message to execute measurement.

"?DT"

Answering to this query message, the latest data will be prepared in the sending buffer. So, specify it as talker in order to read data.
Note that data output to this "?DT" will be canceled if another query message or a setting message "TG" is sent after sending the "?DT".

"TG" or GET interface message

If "TG" or a GET interface message is used to give a trigger, the ZM2353/ZM2354 will abort the going measurement and start a new measurement. When the measurement is complete, it will put the measurement data in the sending buffer.
If the user designates ZM2353/ZM2354 as a talker immediately after giving a trigger, then data will be output simultaneously with measurement completion (The listener will be kept waiting until the measurement has been completed).
Note that data output due to "TG" or GET will be canceled if another program code is sent after sending the "TG" or GET.

"?PA", "?PB" and "?PZ"

The data that "?DT" can read is the same value as shown on the panel. If the user wants to get data with higher resolution, use a special query message such as "?PA" prepared for asking high resolution data.

- "?PA": Inquires for the measurement on Display A
- "?PB": Inquires for the measurement on Display B
- "?PZ": Inquires for the value of R and X in the series equivalent circuit.

Standard resolution data format (query message ?DT)

This function outputs the measurements or settings shown on Displays A and B with a comma "," put in between for separation.

The format of response message for measurement data is as follows:

- L, C, R, |Z|, ESR, G and X

  Form: NR3 (indication by engineering floating point, characteristic is a multiple of 3)

  Resolution: 5 digits

  Range: 0.0000E – 12,

  "OF": "99999.E + 0.6"

  "UF": "–99999.E + 0.6"

  "OU": "88888.E + 06" (for L, C, R and |Z|)

  "0.0000.E + 00" (for ESR, G and X)

  Blank: "77777.E + 0.6"

- Q and D

  Form: NR2 (indication by floating point)

  Resolution: 5 digits

  Range: 0.0000, ±(0.0001 to 19999.)

  "OF": "99999."

  "UF": "–99999."

  "OU": "0.0000"

  Blank: "77777."

- θ

  Form: NR2 (indication by fixed point)

  Resolution: 0.01°

  Range: –180.00° to +179.99°

  "OU": " 0.00"

  Blank: "777.77"

- Δ

  Form: NR3 (indication by engineering floating point, characteristic is a multiple of 3)

  Resolution: 5 digits (max. 19999)

  Range: 0.0000E – 12, ±(0.0001E – 12 to 19999.E + 0.6)

  "OF": "99999.E + 0.6"

  "UF": "–99999.E + 0.6"

  "OU": "88888.E + 0.6"

  Blank: "77777.E + 0.6"

- Δ%

  Form: NR2 (indication by fixed point)

  Resolution: 0.01

  Range: ±199.99.

  "OF": "999.99"

  "UF": "–999.99"

  "OU": "888.88"

  Blank: "777.77"

- Indication of settings (FREQ, LEVEL, BIAS, RANGE and REF)

  Returns data in the same format as that for panel indication of each setting.

- Indication of BIN judgment (UPPER and LOWER)

  When comparator is functioning, if the indication mode ("DP" command) is upper and lower limit indication, the upper and lower limit values of the bin of final comparison judgment will be returned as the measurement data.

  Form: NR3 (indication by engineering floating point, characteristic is a multiple of 3)

  Resolution: 4-1/2 digits

  Range: 0.0000E – 12, ±(0.000E – 12 to 19999.E + 0.6)

  Blank: "77777.E + 0.6"

  "A_ng": "99999.E + 06"

High-resolution data format (query message ?PA, ?PB, and ?PZ)

- Display A (response to ?PA)

  "[PA] Value on Display A Delimiter"

  Form: NR3 (exponential indication)

  Resolution: 10 digits

  Range: ±9.999999999E ±34

  Even if the panel shows an indication of "OF" or "UF", an acceptable indication value can be obtained if it is within the above range.

  "OU": "8.888888888E + 34"

  Blank: "7.777777777E + 34"

- Display B (response to ?PB)

  "[PB] Value on Display B Delimiter"

  Form: NR3 (exponential indication)

  Resolution: 10 digits

  Range: ±9.999999999E ±34

  Even if the panel shows an indication of "OF" or "UF", an acceptable indication value can be obtained if it is within the above range.

  "OU": "8.888888888E + 34"

  Blank: "7.777777777E + 34"

- Rs and Xs data (response to ?PZ)

  "[PZ] Value of Rs Value of Xs Delimiter"

  Form: NR3 (exponential indication)

  Resolution: 10 digits

  Range: ±9.999999999E ±34

  Even if the panel shows an indication of "OF" or "UF", an acceptable indication value can be obtained if it is within the above range.

  "OU": "8.888888888E + 34"

  Blank: "7.777777777E + 34

Bin judgment result data format (query message ?CM)

When the comparator is functioning, the result of bin judgment shown on Displays A and B will be output with a comma "," put in between for separation.

"[CM] Display A judgment result, Display B judgment result Terminator"

- Display A judgment result

  Form: NR1 (integer)

  Range: 0 to 20 (0 means A NG.)

  "OU": "88"

  Blank: "77"

- Display B judgment result

  Form: NR1 (integer)

  Range: 0 to 1 (0 means B NG and 1 means B OK.)

  "OU": "88"

  Blank: "77"

Response to interface messages

Response to an interface message is shown below.

Interface message	Response to message
IFC (Interface clear)	Initializes the GPIB interface. (Releasing listener and talker, etc.)
DCL (Device clear) or SDC (Selected device clear)	Fixes the error. Clears the sending and receiving buffers for GPIB. Aborts the SRQ sending (resets the status byte). Disables SRQ sending (equivalent to "RQ 0") Disables header output (equivalent to "HD 0") Aborts the measurement.
LLO (Local Lock Out)	Inactivates the Local button on the operation section.
GTL (Go to local)	Brings the system into a local state.
GTL (Group execute tring)	Starts measurement (the same as the trigger by program code).

The use of interface message varies with the GPIB driver on the controller side.

☞ For further information, see the manual for the GPIB driver.

Sample Program

The following shows an example of a remote control that uses a GPIB interface.
A description is provided for the following examples that use Microsoft's Visual Basic and National Instruments' GPIB interface.

Settings

- Frequency setting example

Query

- Example of query about voltage level setting
- Example of query about BIN setting

Query about measurement results

- Example using setup message "TG" and serial polling
  The "TG" message triggers the measurement to be started and serial polling is executed using the timer control at an interval. Once the completion of the measurement is confirmed via the results of serial polling, data is read.
- Example using GET command and serial polling
  The GET command triggers the measurement to be started and serial polling is executed using the timer control at an interval. Once the completion of the measurement is confirmed via the results of serial polling, data is read.
- Example using "TG" message and SRQ
  The "TG" message inputs a trigger, SRQ is used to confirm that measuring has been completed, then the data is read.
- Example using setup message "TG" only
  The "TG" command inputs a trigger, the ZM2353/ZM2354 is specified as the talker, and data is read once measurement has been completed.

In all of these examples, error checking has been omitted.
When creating an actual program, error processing and initialization steps should also be considered.

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Settings

The following is a sample program that specifies frequency settings.

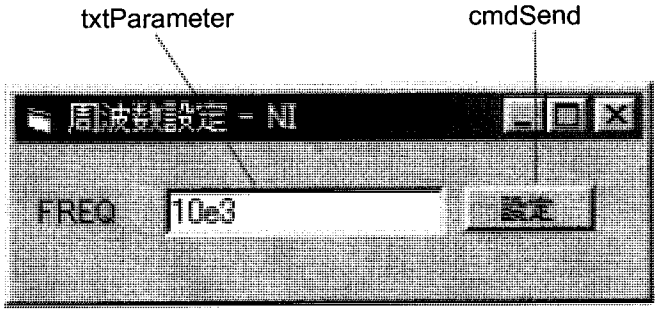
Click the Set button and set the value input in the FREQ text box is set as a frequency.

In "Form_Load", the required initialization is executed.

In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS.

Click the Set button to set the contents of the FREQ text box as a parameter and to send the frequency setting message to the device.

In "Form_Unload", the device is set back to local mode.



```
Const Adr As Integer = 2                    ' GPIB address
Dim Dev As Integer

Private Sub Form_Load()
    ibdev 0, Adr, 0, T10s, 1, 0, Div        ' Open device
    ibclr Dev                               ' Device clear
End Sub

Private Sub Form_Unload(Cancel As Integer)
    ibloc Dev                               ' Return to local mode
End Sub

Private Sub cmdSend_Click()
    ibwrt Dev, "FR" + txtParameter          ' Set frequency
End Sub
```

Query (measurement voltage level)

This sample program queries and displays the measurement voltage level.

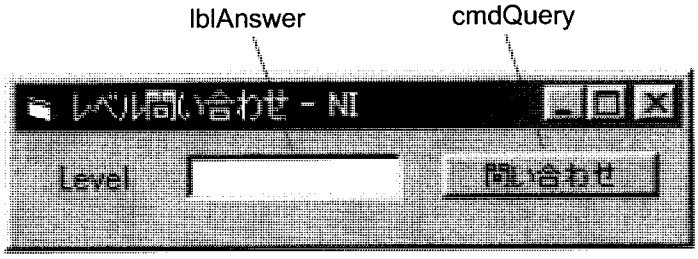
Click the Query button to display the measurement voltage level value on the label.

In "Form_Load", the required initialization is executed.

In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS.

Click the Query button to query the measurement voltage level and to display the answer message on the label.

In "Form_Unload", the device is set back to local mode.



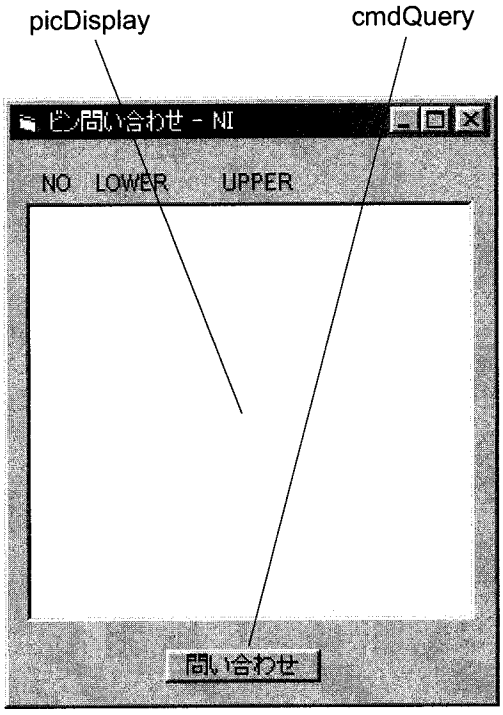
```
Const Adr As Integer = 2                    ' GPIB address
Dim Dev As Integer

Private Sub Form_Load()
    ibdev 0, Adr, 0, T10s, 1, 0, Dev        ' Open device
    ibclr Dev                               ' Device clear
End Sub

Private Sub Form_Unload(Cancel As Integer)
    ibloc Dev                               ' Return to local mode
Ens Sub

Private Sub cmdQuery_Click()
    Dim r As String * 256
    ibwrt Dev, "?LV"                        ' Query measurement voltage level
    ibrd Dev, r                             ' Receive answer message
    lblAnswer = r                           ' Display answer message on label
End Sub
```

Query (bin setting)

This sample program queries and displays bin settings.
Click the Query button to view 20 bin settings in the picture box.

In "Form_Load", the required initialization is executed.
In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS.
Click the Query button to query the bin settings. Answer messages are read for each message terminator and are displayed in the picture box.
The answer message includes all 20 bins in sequence from bin 1 to bin 20, divided by EOS characters.
In "Form_Unload", the device is set back to local mode.

In this example, the EOS characters must be coordinated between the talker and listener when receiving the answer message.
Afterward, a line feed (LF) character is set as the message terminator to be sent by the ZM2353/ZM2354.

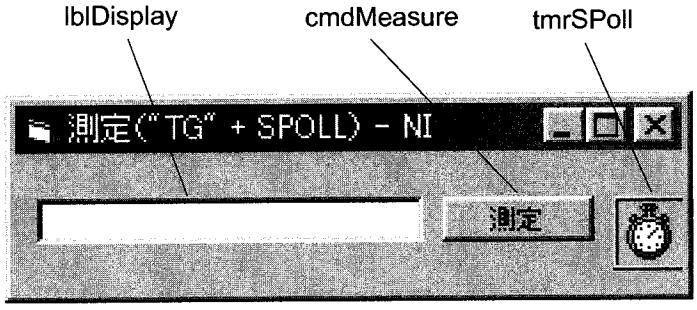


```
Const Adr As Integer = 2                    ' GPIB address
Const E0SCHR As Integer = &HA               ' EOS character (LF)
Const EOSTR As Integer = XEOS + REOS + EOSCHR
Dim Dev As Integer

Private Sub Form_Load()
    ibdev 0, Adr, 0, T10s, 1, EOSTR, Dev    ' Open device
    ibclr Dev                               ' Device clear
End Sub

Private Sub Form_Unload(Cancel As Integer)
    Dim stat As Integer
    iblock Dev                              ' Return to local mode
End Sub

Private Sub cmdQuery_Click()
    Dim i As Integer
    Dim l As Integer
    Dim r As String * 256
    ibwrt Dev, "?BN"                        ' Query bin
    For i = 1 To 20
        ibrd Dev, r                         ' Receive answer message
        i = Instr(r, Chr(EOSCHR)) – 1       ' Get length of answer message
        picDisplay.Print Left(r, l)         ' Display answer message
    Next
End Sub
```

Measurement (TG and serial polling)

The following is a sample program that uses the "TG" setup message and serial polling.
Click the Measure button to display the measurement results on the label.

In "Form_Load", the required initialization is executed.
In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS.
Click the Measure button to send the "TG" message and input a trigger, and the timer is set as valid.
In the timer processing, the status byte that is obtained by serial polling is referenced, and once the completion of measurement has been confirmed, the measurement result is received and displayed on the label.
In "Form_Unload", the device is set back to local mode.



```
Const Adr As Integer = 2                    ' GPIB address
Dim Dev As Integer

Private Sub Form_Load()
    ibdev 0, Adr, 0, T10s, 1, 0, Dev        ' Open device
    ibclr Dev                               ' Device clear
    tmrSPoll.Enabled = False
    tmrSPoll.Interval = 500
End Sub

Private Sub Form_Unload(Cancel As Integer)
    tmrSPoll.Enabled = False
    ibloc Dev                               ' Return to local mode
End Sub

Private Sub cmdMeasure_Click()
    ibwrt Dev, "TG"                         ' Trigger input
    tmrSPoll.Enabled = True
End Sub

Private Sub tmrSPoll_Timer()
    Dim stb As Integer
    Dim r As String * 256
    ibrsp Dev, stb                          ' Serial polling
    If Not (stb & 16) Then                  ' Reference status byte
        ibrd Dev, r                         ' Receive measurement result
        lblDisplay = r                      ' Display received data
        tmrSPoll.Enabled = False
    End If
End Sub
```

Measurement (GET and serial polling)

The following is a sample program that uses the GET command and serial polling to perform measurements.

Click the Measure button to display the measurement results on the label.

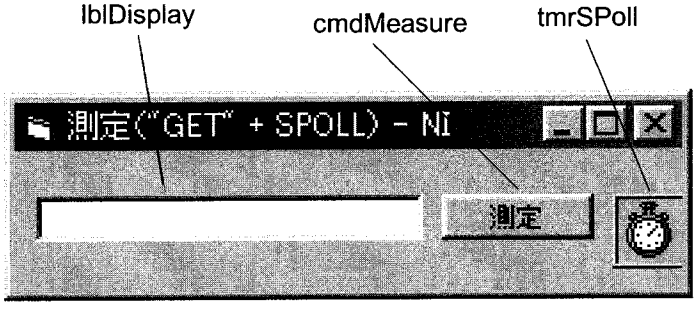
In "Form_Load", the required initialization is executed.

In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS.

Click the Measure button to send the GET command and input a trigger, and the timer is set as valid.

In the timer processing, the status byte that is obtained by serial polling is referenced, and once the completion of measurement has been confirmed, receive the measurement result is received and displayed on the label.

In "Form_Unload", the device is set back to local mode.



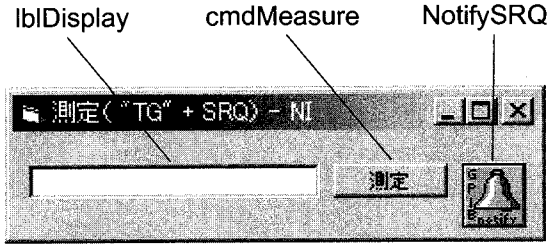
```
const Adr As Integer = 2                    ' GPIB address
Dim Dev As Integer

Private Sub Form_Load()
    ibdev 0, Adr, 0, T10s, 1, 0, Dev        ' Open device
    ibclr Dev                               ' Device clear
    tmrSPoll.Enabled = False
    tmrSPoll.Interval = 500
End Sub

Private Sub Form_Unload(Cancel As Integer)
    tmrSPoll.Enabled = False
    ibloc Dev                               ' Return to local mode
End Sub

Private Sub cmdMeasure_Click()□
    ibtrg Dev                               ' Trigger input
    tmrSPoll.Enabled = True
End Sub

Private Sub tmrSPoll_Timer()
    Dim stb As Integer
    Dim r As String * 256
    ibrsp Dev, stb                          ' Serial polling
    If Not (stb & 16) Then                  ' Reference status byte
        ibrd Dev, r                         ' Receive measurement result
        lblDisplay = r                      ' Display received data
        tmrSPoll.Enabled = False
    End If
End Sub
```

Measurement (TG and SRQ)

The following is a sample program that uses the "TG" message and SRQ to perform measurements.
Click the Measure button to display the measurement results on the label.

In the following example, GPIB Notify OLE control is used to monitor the SRQ and trigger events.

In "Form_Load", the required initialization is executed.
In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS.
Click the Measure button to send the "TG" message and input a trigger.
When an SRQ occurs, the status byte obtained by serial polling is referenced, and once the completion of measurement has been confirmed, the measurement result is received and displayed on the label.
In "Form_Unload", the device is set back to local mode.



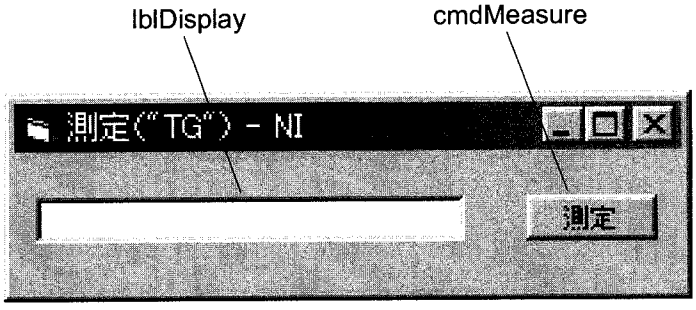
```
Const Adr As Integer = 2                    ' GPIB address
Dim Dev As Integer

Private Sub Form_Load()
    Dim stat As Integer
    ibdev 0, Adr, 0, T10s, 1, 0, Dev        ' Open device
    ibclr Dev                               ' Device clear
    ibwrt Dev, "RQ.1"                       ' Enable SRQ
    NotifySRQ.SetupNotify Dev, RQS          ' Set up SRQ monitoring
End Sub

Private Sub Form_Unload(Cancel As Integer)
    ibloc Dev                               ' Return to local mode
End Sub

Private Sub cmdMeasure_Click()
    ibwrt Dev, "TG"                         ' Trigger input
End Sub

Private Sub NotifySRQ_Notify(ByVal LocalUd As Long, ByVal Localbsta As Long, ByVal
Localberr As Long, ByVal Localbcntl As Long, RearmMask As Long)
    Dim stb As Integer
    Dim r As String * 256
    If (Localbsta & RQS) Then               ' Reference status byte
        ibrsp Dev, stb                      ' Serial polling
        If (stb & 16) Then
            ibrd Dev, r                     ' Receive measurement result
            lblDisplay = r                  ' Display received data
        End If
    End If
    RearmMask = RQS                         ' Reset SRQ monitoring
End Sub
```

Measurement (TG only)

The following is a sample program that uses only the "TG" setup message.
Click the Measure button to display the measurement results on the label.

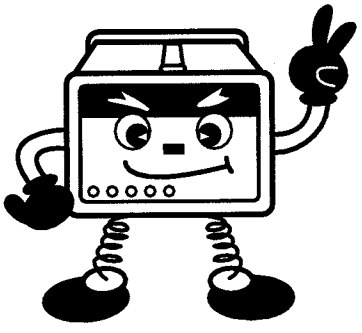
In "Form_Load", the required initialization is executed.
In this case, the device descriptor (Dev) is open, with a 10-second timeout period, GPIB address 2, valid EOI, and without any EOS. Be sure to set a timeout value that is large enough to prevent a timeout from occurring before measurement has been completed.
After you click the Measure button to input a trigger, the measurement result is received and displayed on the label.
In "Form_Unload", the device is set back to local mode.

In this example, the software is not able to operate in any way until the measurement has been completed.
To avoid waiting for the ZM2353/ZM2354 only or to perform other processing while waiting for completion of measurement, use polling or SRQ to reference measurement examples.



```
Const Adr As Integer = 2                    ' GPIB address
Dim Dev As Integer

Private Sub Form_Load()
    ibdev 0, Adr, 0, T10s, 1, 0, Dev        ' Open device
    ibclr Dev                               ' Device clear
End Sub

Private Sub Form_Unload(Cancel As Integer)
    ibloc Dev                               ' Return to local mode
End Sub

Private Sub cmdMeasure_Click()
    Dim r As String * 256
    ibwrt Dev, "TG"                         ' Trigger input
    ibrd Dev, r                             ' Receive measurement result
    lblDisplay = r                          ' Display received data
End Sub
```

Error Messages 11



Error messages

The following sections describe major error messages.
If any message that is not described here appears (e.g., "FFFFF" on A, "66666" on B), malfunction may have been caused by a strong external noise. In such cases, first turn off the power, wait three seconds or so, and then turn on the power again.
If it often occurs, the ZM2353/ZM2354 may have some failure. Contact the NF Corporation or its sales representative.

The ZM2353/ZM2354 has possibility for errors to take place in the following conditions:

- During self-check (on power turning-on, OPEN and SHORT zero correction and gain correction)
- When setting is made from panel
- Setting or query through GPIB
- Selection of comparator from the handler interface (ZM2354 only)

In addition to the above, "OF", "UF" and "OU" may appear during measurement.

Note

Error numbers are shown on Display B.
Some errors entail an auxiliary status shown on Display A.

Error during self-check

Error messages that appear during self-check include two types: ROM/RAM check errors and other errors due to anomaly in hardware excepting the memory.
Either of the above cannot be released.
If an error message appears, try again to turn on the switch.
If any of these error messages often appears, it is suspected that the ZM2353/ZM2354 is not functioning properly.

ROM/RAM check error

Display A	Display B	Description
EEEEE	99999	ROM error
EEEEE	77777 to 44444	RAM error
EEEEE	33333	Model identification error
EEEEE	22222	Calibration data error

Errors due to anomaly in hardware excepting the memory

Display A	Display B	Description
Auxiliary status	Err50 to Err79	Attributable to anomaly in hardware

Errors on setting from panel and setting through GPIB

Errors on setting are caused by wrong operation.
These errors can be released.

When setting

Display A	Display B	Description
--	Err12	Entered value exceeded the specified range.
--	Err14	Trial was made to turn on DC bias when Display A is AUTO, L or R. DC bias can be turned on only when AUTO is released on Display A or when Display A is C or |Z|.
--	Err15	Trial was made to change parameter setting by B SELECT button when settings on Displays A and B are indication of upper/lower limit values for use of comparator.

When Executing

Display A	Display B	Description
--	Err21	Battery backup error. When anomaly is detected in the memory (setting of measurement conditions, zero correction, gain correction) that backups the battery, this error message appears. In addition, the memory in which the anomaly has been detected will be reset to the initial setting state (default values). (Similarity for GPIB address)
Auxiliary status	Err22	Zero correction value exceeds the allowable range. During zero correction, after completion of self-check is complete, when residual impedance or floating admittance is measured, if the value for each frequency exceeds the range of correctable values, this error message appears. The range of correctable values is as follows: $\|Zss\| < \sqrt{1000}\ \Omega$ = ca. 31.623 Ω: Rss < ca. 30 Ω Lss < ca. 50 μH at 100 kHz $\|Ypp\| < 100\ \mu S$: Rpp > 10 kΩ (Rpp = 1/Gpp) Cpp < ca. 160 pF at 100 kHz If the value is outside the above range at each measurement frequency, an error message appears range and stops execution of correction for that frequency and more.

Display A	Display B	Description
--	Err23	During zero correction, the voltage applied to the test piece or the flowing current is extremely low. If the measurement signal level is not normal when measuring at each frequency during zero correction, this error message appears. When this takes place, check the measurement signal level, and check if a normal measurement signal is supplied.
Auxiliary status	Err25	During gain correction (when doing CAL), the value of gain is sharply different. When doing CAL (during gain correction), if the gain correction value cannot be determined in a normal way, this error message appears. If this error takes place when doing CAL (during gain correction), remove the error and return to the initial value.
--	Err26	Gain correction value is not changed from the initial value. When checking the memory that is backed up, if the gain correction value remains the initial one, this error message appears. When this takes place, carry out gain correction (CAL) of system mode, then s tart measurement. If the gain correction value is the initial one, the measurement precision cannot be guaranteed.

Errors in GPIB

Display A	Display B	Description
--	Err31	Reception buffer is overflowed. The program code was too long to be put in the reception buffer. (All program codes will become invalid.)
--	Err32	Illegal header A undefined header was received.
--	Err33	Illegal header Query was tried when only setting was allowed. Setting was tried when only query was allowed.
--	Err34	Illegal parameter No parameter is found when parameter is needed.
--	Err35	Illegal parameter No delimiter "," to separate parameters is found. Shortage of parameters

Releasing errors

Errors during self-check

Errors that arise during self-check cannot be released in principle.

Effects of disturbance noise and anomaly in the internal circuit of the main unit are suspected. Try to turn on the power again to remove the error.

If the error arises again when the power is turned on, the ZM2353/ZM2354 is suspected to have some defects.

Releasing errors during panel setting and errors in GPIB

These errors can be removed by pressing any buttons on the panel, and by Device Clear from GPIB.

When any panel button is pressed to remove the error, this pressing does not execute its proper function.

If the message indicates a GPIB setting error, any GPIB command will not be executed unless Device Clear is issued or any panel button is pressed to remove the error.

Errors during measurement

Errors may be indicated by "OF", "UF" or "OU" when measurement is executed.

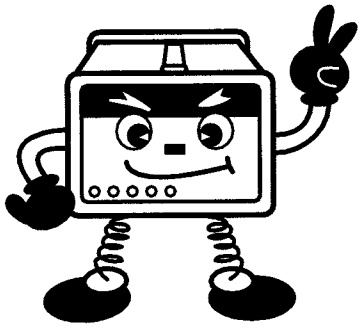
These errors are caused by abnormal completion of measurement or measurement data exceeding the range of indication.

OF: shown when measurement data is greater than the selected indication range.

UF: shown when measurement data is smaller than the selected indication range.

OU: shown when measurement data was not obtained in the normal procedure.

Rating 12



Indication parameters

Types of parameters

- Main parameters (on Display A)

AUTO	Automatically selects main parameter, sub parameter, and equivalent circuit.
L	Self inductance (units: H, henry)
C	Electrostatic capacity (units: F, farad)
R	Resistance (units: Ω, ohm)
|Z|	Magnitude of impedance (units: Ω, ohm)
	Each of L, C, and R contains series and parallel.

- Sub parameters (on Display B)

Sub parameters include measurement parameters and setting parameters.

Measurement parameters:

Q	Quality factor (excellence of circuit)
D	Dissipation factor (= tan δ = 1/Q)
ESR	Equivalent series resistance (units: Ω, ohm)
G	Parallel conductance (units: S, siemens)
X	Serial reactance (units: Ω, ohm)
θ	Phase angle of impedance (units: degree)
V	Voltage monitor (Effective (r.m.s.) value of fundamental wave of measurement signal applied to the test piece, units: Vrms)
I	Current monitor (Effective (r.m.s.) value of fundamental wave of measurement signal flowing through the test piece, units: Arms)

Setting parameters:

FREQ	Measurement frequency (units: Hz)
LEVEL	Measurement signal level (units: Vrms)
BIAS	DC bias (units: V)
RANGE	Measurement range
REF	Reference value for measurement shown as the main parameter

- Equivalent circuit

AUTO	Automatic selection
SER	Series
PRL	Parallel

- Indication of deviation

Δ	Indication of main parameter deviation (indication range: ±100% or more of the reference value)
Δ%	Indication of main parameter deviation in percentage (indication range: ±199.99%)

Indication of sub parameter deviation and its percentage cannot be shown.

- Automatic selection of parameters

  The phase angle of impedance switches the parameters.

  θ = +90 ±30° → L – Q

  θ = 0 ±30° → R – Q

  θ = –90 ±30 → C – D

  θ = Other than the above → |Z| – θ

- Automatic selection of equivalent circuit

  Selection will be made by combination of parameters and the value and the phase angle of impedance.

Conditions to select series:

L, C, R, |Z|	- ESR, X
L, C (|Z| ≤ 1 kΩ)	- Q, D, θ , V, I, setting parameter
R ($\theta \geq 0$)	- Q, D, θ , V, I, setting parameter
|Z|	- Q, D, θ , V, I, setting parameter

Conditions to select parallel

L, C, R, |Z|	- G
L, C (|Z| >1 kΩ)	- Q, D, θ , V, I, setting parameter
R ($\theta < 0$)	- Q, D, θ , V, I, setting parameter

Resolution of indication

- 4-1/2 digits (19999 max)

Maximum resolution of D and Q:	0.0001
Resolution of θ:	0.01°

- 3-1/2 digits (1999 max)

Maximum resolution of V:	0.1 mV
Maximum resolution of I:	1 μA (at reference resistance of 100 Ω)
	0.1 μA (at reference resistance of 1 kΩ)
	0.01 μA (at reference resistance of 10 kΩ and 50 Ω)

Measurement (indication) range

R, |Z|, ESR, X:	0.0 mΩ to 19.999 MΩ
C:	0.000 pF to 199.99 mF
	|C| ranges differently by frequency as follows:
	For 40 to 150 Hz: 0.0 p to 199.99 mF
	For 160 to 1.5 kHz: 0.00 p to 19.999 mF
	For 1.6k to 15 kHz: 0.000 p to 1.9999 mF
	For 16k to 159 kHz: 0.000 p to 199.99 μF
	For 160k to 200 kHz: 0.000 p to 19.999 μF
L:	0.00 nH to 19.999 kH
	|L| ranges differently by frequency as follows:
	For 40 to 150 Hz: 0.0 μ to 19.999 kH
	For 160 to 1.5 kHz: 0.00 μ to 1.9999 kH
	For 1.6k to 15 kHz: 0.000 μ to 199.99 H
	For 16k to 159 kHz: 0.0 n to 19.999 H
	For 160k to 200 kHz: 0.00 n to 1.9999 H
Q, D:	0.000 to 19999
G:	0.0 nS to 199.99 S
θ:	−180.00° to +179.99°
V:	0.0 mVrms to 19.99 Vrms
	(Actual measurement range is around 5.00 Vrms.)
I:	0.00 μArms to 199.9 mArms
	(Actual measurement range is around 50.0 mArms.)

Accuracy

- Conditions for guaranteed accuracy

Heat run:	30 minutes or longer
Ambient temperature and humidity:	23 ±5°C, 5 to 80%RH
Gain correction:	Gain correction (CAL) is executed before measurement.
Zero correction:	Executed when the above conditions have been met.
Term:	For 12 months after shipment or after calibration

Accuracy for |Z| – θ

- Condition of measurement

Measurement signal level:s	1 Vrms
Measuring speed:	MED2 or SLOW
Cable length:	0 m (the measurement terminal on the front panel)

Refer to Table, "Table of Basic Accuracy".

Supplement 1

In the vicinity of the power supply frequency (50 Hz, 60 Hz) and 3 times and 5 times that frequency, the variance of measurement may go beyond the range of accuracy due to the induction from the power supply.

Supplement 2

For practical measurement accuracy, add ±1/2 count of the indication.

Supplement 3

This does not include any additional errors due to test fixtures and test leads.

Table of Basic Accuracy

Impedance	Frequency									
|Z|(Ω)	40~190	200~490	500~990	1k	1.1k~5k	5.1k~10k	11k~20k	21k~50k	51k~100k	101k~200k
0S ≤ |Y| ≤ 50nS*1	2.7n	1.8n	1.2n	0.6n	1.2n	2.1n	2.5n	7.5n	12.0n	–
20M > |Z| ≥ 10M	4.5	3.0	2.0	1.0	2.5	3.5	4.0	14.0	20.0	–
	2.3°	1.5°	1.0°	0.8°	2.0°	2.0°	3.0°	8.0°	12.0°	
10M > |Z| ≥ 5M	2.4	1.5	1.1	0.7	1.2	1.8	2.0	7.0	10.0	–
	1.5°	0.9°	0.7°	0.5°	0.8°	1.1°	1.3°	4.0°	6.0°	
5M > |Z| ≥ 2M	1.2	0.9	0.7	0.5	1.0	1.2	1.5	4.0	7.0	14.0
	0.8°	0.6°	0.5°	0.35°	0.6°	0.7°	0.9°	2.5°	4.0°	8.0°
2M > |Z| ≥ 1M	0.7	0.45	0.35	0.3	0.6	0.7	1.0	1.6	3.0	6.0
	0.4°	0.3°	0.2°	0.15°	0.35°	0.4°	0.6°	1.0°	2.0°	4.0°
1M > |Z| ≥ 130k	0.45	0.35	0.25	0.2	0.27	0.3	0.4	1.0	2.0	4.0
	0.3°	0.2°	0.15°	0.12°	0.2°	0.25°	0.3°	0.6°	1.2°	2.4°
130k > |Z| ≥ 13k	0.3	0.2	0.15	0.1	0.2	0.25	0.3	0.6	1.0	2.0
	0.18°	0.12°	0.09°	0.04°	0.12°	0.15°	0.2°	0.4°	0.7°	1.5°
13k > |Z| ≥ 1.3k	0.3	0.2	0.12	0.1	0.12	0.15	0.2	0.4	0.7	1.0
	0.18°	0.12°	0.05°	0.03°	0.06°	0.08°	0.12°	0.3°	0.5°	0.7°
1.3k > |Z| ≥ 10	0.4	0.25	0.15	0.1	0.11	0.13	0.17	0.4	0.7	1.0
	0.25°	0.15°	0.09°	0.03°	0.08°	0.1°	0.15°	0.25°	0.5°	0.7°
10 > |Z| ≥ 2	0.8	0.5	0.3	0.15	0.2	0.32	0.5	0.8	1.5	2.0
	0.5°	0.3°	0.18°	0.07°	0.12°	0.2°	0.3°	0.4°	0.8°	1.5°
2 > |Z| ≥ 1	1.4	1.0	0.6	0.3	0.4	0.5	0.7	1.0	1.5	3.0
	0.9°	0.6°	0.3°	0.18°	0.25°	0.3°	0.4°	0.6°	1.0°	2.0°
1 > |Z| ≥ 0.5	3.0	1.6	1.0	0.6	0.7	0.8	1.2	1.7	3.3	6.6
	2.0°	1.0°	0.6°	0.36°	0.4°	0.5°	0.7°	1.0°	2.0°	4.0°
0.5 > |Z| ≥ 0.2	6.0	3.5	2.0	1.3	1.4	1.6	1.8	2.7	5.5	11.0
	4.5°	2.5°	1.5°	0.8°	0.9°	1.0°	1.1°	1.6°	3.0°	6.0°
0.2 > |Z| ≥ 0*2	9.0	7.0	4.0	2.5	3.3	3.7	4.0	6.0	7.0	13.0
	1.2m	0.6m	0.3m	0.2m	0.2m	0.3m	0.6m	1.5m	3.0m	6.0m

Accuracy of |Z|: The value in the upper field; in ±(percentage of reading) excepting those values less than 0.2 Ω.

Accuracy of θ: The value in the lower field, in ± degree.

The accuracy of impedance value of 5 MΩ or higher is not specified at frequency of 101 kHz or higher.

*1. The accuracy for the case of |Y| ≤ 50 nS (|Z| ≥ 20 MΩ) is defined as follows:

Magnitude: Specified by the ±deviation (S) of admittance |Y|.

Phase: (phase accuracy of 10 MΩ to 20 MΩ) x (|Z| / 20 MΩ)

* 2. The accuracy for the case of |Z| < 0.2 Ω is defined as follows:

Magnitude: ±[Percentage of reading (the value in the upper field)] + [Impedance deviation in Ω (the value in the lower field)]

Phase: (The value in the upper field x 0.7) x (0.2 Ω / |Z|)

Additional error due to measurement conditions

In practical measurement, determine the accuracy ACC of |Z| and θ from "Table of Basic Accuracy" based on the obtained measurement, and multiply that ACC by the factors shown below as follows:

Accuracy of actual |Z| and θ = ±(ACC x Klv x Ksp x Kcb x Ktp)

Klv: The factor defined by the measurement signal level

Ksp: The factor defined by the measuring speed

Kcb: The factor defined by the cable length

Ktp: The factor defined by the ambient temperature

(1) Additional error by the measurement signal level

Multiply the value with the following factor according to the setting of measurement signal level.

Measurement signal level (V)	Factor (Klv)
5.00 ~ 1.41	3.0
1.40 ~ 1.21	2.0
1.20 ~ 801m	1.0
800m ~ 471m	2.0
470m ~ 141m	3.0
140m ~ 48m	6.0
47m ~ 10m	12.0

Supplement 1

When measurement signal level is set to 140 mV or lower, if the measurement frequency is 21 kHz or higher and the impedance value is 1 MΩ or higher (|Z| ≥ 1 MΩ), then accuracy is not guaranteed.

Supplement 2

When measurement signal level is set to 140 mV or lower, if the impedance value is lower than 0.2 Ω (|Z| < 0.2 Ω), then accuracy is not guaranteed.

Supplement 3

When measurement signal level is set to 140 mV or lower, if the impedance value is 10 MΩ or higher (|Z| ≥ 10 MΩ), then accuracy is not guaranteed.

(2) Additional error due to measuring speed

Multiply the value with the following factor according to the setting of measuring speed.

Measuring speed	Factor (Ksp)
SLOW, MID2	1.0
MID1	2.0
FAST	4.0

(3) Additional error by the cable length

Multiply the value with the following factor according to the length of cable.

Cable length	Factor (Kcb)
0m	1.0
1m	1.5
2m	2.0
4m	4.0

Supplement 1

With the cable length set to 2 m, accuracy is not guaranteed for impedance less than 0.2 Ω (|Z| < 0.2 Ω) or equal to or greater than 10 MΩ (|Z| ≥ 10 MΩ).

Supplement 2

With the cable length set to 4 m, accuracy is not guaranteed for impedance less than 0.2 Ω (|Z| < 0.2 Ω) or equal to or greater than 10 MΩ (|Z| ≥ 10 MΩ).

Supplement 3

With the cable length set to 4 m, accuracy is not guaranteed if the measurement

(4) Additional error by ambient temperature

Multiply the value with the following factor according to the ambient temperature.

Ambient temperature	Factor (Ktp)
5°C ≤ Ambient temperature < 18°C	2.0
18°C ≤ Ambient temperature ≤ 28°C	1.0
28°C < Ambient temperature ≤ 40°C	2.0

Supplement

Accuracy is not guaranteed for the ambient temperature that is outside the above range.

Accuracy of R, ESR and G

If Q < 0.1 (D > 10), apply the accuracy of |Z|.

R: $|Z| = |R|$

ESR: $|Z| = |ESR|$

G: $|Z| = 1/|G|$

For practical measurement accuracy, add ±1/2 count of the indication.

Accuracy of L, C and X

If Q > 10 (D > 0.1), apply the accuracy of |Z|.

L: $|Z| = |2\pi f L|$

C: $|Z| = |1/(2\pi f C)|$

X: $|Z| = |X|$

"f" stands for frequency [Hz].

For practical measurement accuracy, add ±1/2 count of the indication.

Accuracy of Q and D

If D << 1 (Q >> 1), apply the following equation,

Accuracy of D = ±(0.0175 x Phase accuracy(deg))

Accuracy of Q = ±(0.0175 x Phase accuracy(deg) x Q^2)

For practical measurement accuracy, add ±1/2 count of the indication.

Accuracy of V and I

Accuracy of V and I = ±(10% + Measurement accuracy of impedance |Z|)

However, accuracy is not guaranteed for the frequency of 101 kHz or higher.

For practical measurement accuracy, add ±1/2 count of the indication.

Accuracy of other items

Procedure of determining the accuracy for parameters other than |Z| and θ where accuracy of |Z| is not applicable

(1) Measure |Z| and θ. Or otherwise, calculate them from other parameters.

$Q = 1/D$
$= 2\pi f \cdot Ls/ESR$
$= 1/(2\pi f \cdot Cs \cdot ESR)$
$= 2\pi f \cdot Cp/G$
$= 1/(2\pi f \cdot Lp \cdot G)$

$|\theta| = |\arctan Q|$
$|Z| = |2\pi f \cdot Ls/\sin\theta|$
$= |1/(2\pi f \cdot Cs \cdot \sin\theta)|$
$= |\sin\theta/(2\pi f \cdot Cp)|$
$= |2\pi f \cdot Lp \cdot \sin\theta|$

"f" stands for frequency [Hz]. Suffix "s" denotes a serial equivalent circuit while suffix "p" denotes a parallel equivalent circuit.

(2) Determine the accuracy of |Z| and θ from "Table of Basic Accuracy" and additional errors.

(3) From the measurement and accuracy of |Z| and θ, determine the maximum and minimum of |Z| and θ.

|Z|max, min = Measurement of |Z| x (1 ± Accuracy of |Z| [%] /100)
θ max, min = Measurement of θ ±Accuracy of θ (degree)

(4) In the calculation equation for each parameter, seek the maximum and minimum out of four combinations of maximum and minimum of |Z| and θ.

$Rs = |Z|\cos\theta$
$ESR = |Z|\cos\theta$
$X = |Z|\sin\theta$
$Ls = X/(2\pi f)$
$Cs = -1/(2\pi f \cdot X)$
$Q = |\sin\theta|/\cos\theta$

$Rp = |Z|/\cos\theta$
$G = (1/|Z|)\cos\theta$
$B = -(1/|Z|)\sin\theta$
$Lp = -1/(2\pi f \cdot B)$
$Cp = B/(2\pi f)$
$D = \cos\theta/|\sin\theta|$

B is the susceptance (the imaginary part of admittance).

(5) Add the error for 1/2 count of the indication value to |Maximum – Measurement| or |Minimum – Measurement|, whichever is greater, and the sum will be the accuracy.

How to determine actual accuracy

This does not include any additional errors due to test fixtures and test leads.

- What will be the accuracy when R = 33 kΩ is measured at 10 kHz and 1 V?

(where Q < 0.1, measuring speed is MID2, cable length is 0 m, and ambient temperature is 23°C)

(1) From "Table of Basic Accuracy", determine the accuracy for frequency of 10 kHz and segment of |Z| (13 k to 130 kΩ).

(2) From the additional error, determine the factor for measurement signal level, Klv, the factor for measuring speed, Ksp, the factor for cable length, Kcb, and the factor for ambient temperature, Ktp.

(3) Multiply the accuracy of "Table of Basic Accuracy" by Klv, Ksp, Kcb and Ktp to seek the actual accuracy (in this case, all factors are 1).

(4) Add ±1/2 count of the indication.

- What will be the accuracy when C = 10 μF is measured at 1 kHz and 50 mV (under the condition of D < 0.1)?

(1) Determine |Z| from "LC → |Z| Conversion Graph".
Locate the intersection of the falling line of C = 10 μF and the vertical line of frequency = 1 kHz.
From the intersection point, extend a horizontal line until it reaches the impedance |Z|, where read the value of |Z| (ca. 16Ω). Or otherwise, carry out the calculation of |Z| = |1 / (2πfc)|.

(2) From "Table of Basic Accuracy", determine the accuracy for frequency of 1 kHz and segment of |Z| (10 to 1.3 kΩ).

(3) From the measurement conditions, determine the factor for measurement signal level, which is the additional error, Klv, the factor for measuring speed, Ksp, the factor for cable length, Kcb, and the factor for ambient temperature, Ktp.
(In this case, the measurement signal level factor, Klv is 6.0)

(4) Multiply the accuracy of "Table of Basic Accuracy" by Klv, Ksp, Kcb and Ktp to seek the actual accuracy.

(5) Add ±1/2 count of the indication.

- What will be the accuracy when L = 100 mH is measured at 10 kHz (provided that Q > 10)?

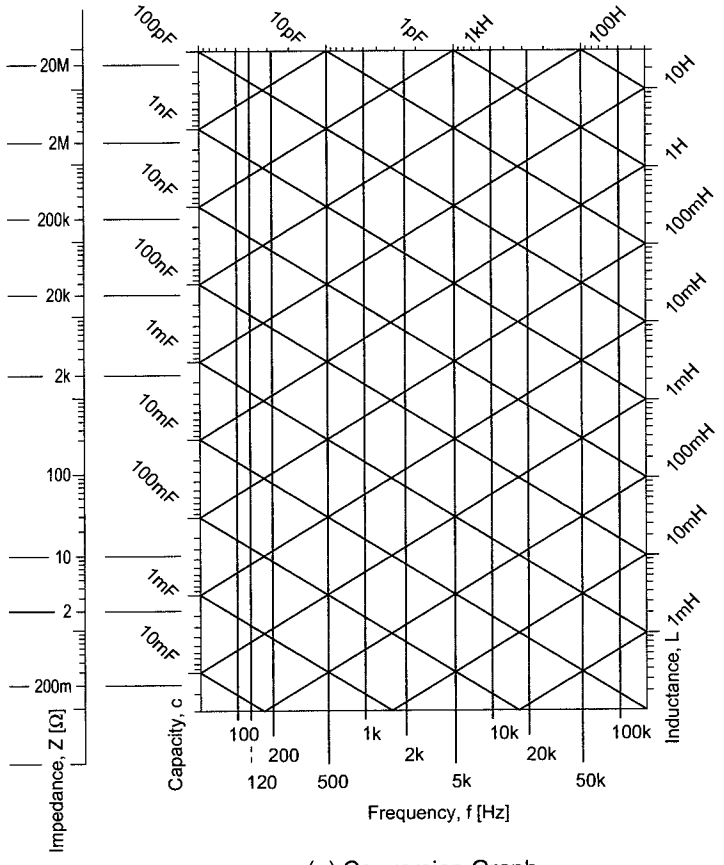
(1) Determine |Z| from "LC → |Z| Conversion Graph".
Locate the intersection of the rising line of L = 100 mH and the vertical line of frequency = 10 kHz. From the intersection point, extend a horizontal line until it reaches the impedance |Z|, where read the value of |Z| (ca. 6.3 kΩ). Or otherwise, carry out the calculation of |Z| = |2πfL|.

(2) From "Table of Basic Accuracy", determine the accuracy for frequency of 10 kHz and segment of |Z| (1.3 k to 13 kΩ).

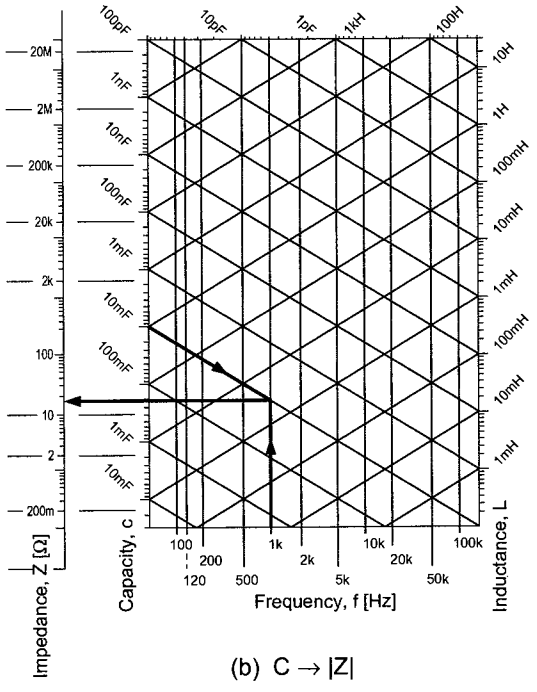
(3) From the measurement conditions, determine the factor for measurement signal level, which is the additional error, Klv, the factor for measuring speed, Ksp, the factor for cable length, Kcb, and the factor for ambient temperature, Ktp.

(4) Multiply the accuracy of "Table of Basic Accuracy" by Klv, Ksp, Kcb and Ktp to seek the actual accuracy.

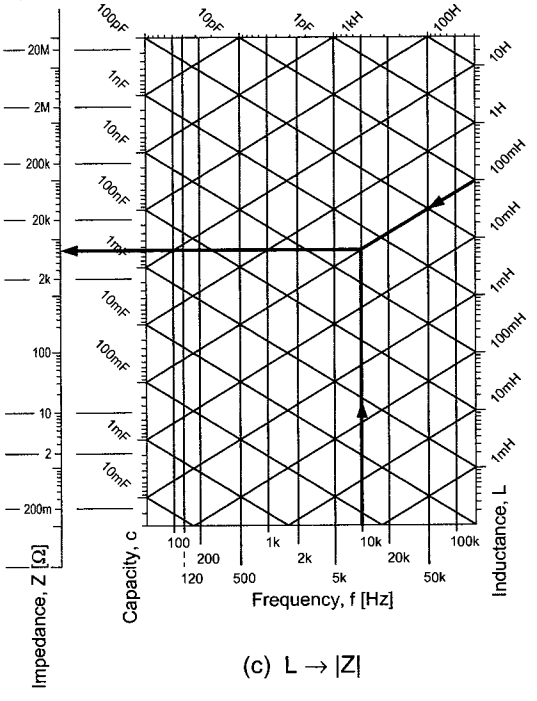
(5) Add ±1/2 count of the indication.



(a) Conversion Graph



(b) C → |Z|



(c) L → |Z|

LC → |Z| Conversion Graph

Measurement signal

Frequency

Range:	40 Hz to 200 kHz	
Resolution:n	40 Hz to 99 kHz:	Two digits resolution
	100 kHz to 200 kHz:	Three digits resolution
Accuracy:	±0.01%	

Signal level (the voltage when drive terminal HCUR is open)

Range:	10 mVrms to 5 Vrms	
Resolution:	10 mVrms to 999 mVrms:	1 mV resolution
	1 Vrms to 5 Vrms:	10 mV resolution
Accuracy:	±(10% + 3 mV) when 40 Hz to 100 kHz	
	±(15% + 5 mV) when 101 kHz to 200 kHz	

However, abnormal operation may occur when voltage exceeding 5 V or current exceeding 50 mA is actually applied to the device under testing.

DC bias

Internal	Range:	0 mV to 2.5 V	
	Resolution:	0 mV to 999 mV:	1 mV resolution
		1 V to 2.5 V:	10 mV resolution
	Accuracy:	±(5% + 10 mV)	
External	Range:	0 V to ±35 V	
	Input terminal:	Binding post on rear panel	

Measurement range

Number of ranges:	6 (Reference resistor: 100 Ω, 1 kΩ, 10 kΩ, 50 kΩ, two up/down extension ranges)
Switching:	Automatic and manual

Measuring speed (for reference)

Measurement time (fixed range, automatic trigger)

FAST: 25 ms (typ) for measurement at 1 kHz and 1 kΩ
MED1: 64 ms (typ) for measurement at 1 kHz and 1 kΩ
MED2: 150 ms (typ) for measurement at 1 kHz and 1 kΩ
SLOW: 480 ms (typ) for measurement at 1 kHz and 1 kΩ

Automatic range selection time (per range)

The value is almost equal to the measurement time.
If the frequency is 500 Hz or lower and the impedance is 1 MΩ or higher, it may take some time until stable measurement is obtained. For test pieces of which impedance varies with the measurement signal level, it may take some time until the value of the test piece stabilizes.

Level-change stabilizing time

200 ms to 4 s
The time varies with test pieces.
This stabilizing time becomes longer when a diode or other nonlinear element is measured, or when voltage is switched from 5 V to 50 mV.
This time is necessary for measurement to stabilize, excluding the time for change in test piece.

DC bias stabilizing time

(6 + 0.015C) s, where C is the electrostatic capacity [μF] of the test piece
The time varies with test pieces.
This time is necessary for measurement to stabilize, excluding the time for change in test piece.

Frequency-change stabilization time

150 ms to 4 s
It takes longer time if the frequency is changed from high to low (e.g., 100 kHz to 100 Hz).
The time also varies with test pieces.
This time is necessary for measurement to stabilize, excluding the time for change in test piece.

Trigger

Trigger mode:	Automatic (repetition) and manual
Trigger delay time:	0 s to 199.99 s (minimum resolution of 0.01 s)

Measurement terminal

Four terminals (BNC-R) + one guard terminal

Residual charge protection (for reference)

Maximum protection voltage $V = \sqrt{16/C}$

However, $V \leq 250$ V and C is the capacitance (F) of the device under testing

This maximum protection voltage value is only a reference value; it is not guaranteed.

Comparator function

Number of classes:	Maximum 21
Main parameter judgment:	Upper and lower limits can be set for judgment for 1 to 20 bins.
Sub parameter judgment:	Conformity judgment for one pair of upper and lower limits.

Setting memory (Battery backup)

Number of memories:	10 (One of ten memories stores the last data just before the power is turned off.)
Battery life:	Three years or longer after shipping provided that it is stored at 40°C or lower.

Handler interface (ZM2354 only)

Connector

50-pin multi-connector (DDK 57-40500 or equivalent)

Output signal

BIN 1 to BIN 20:	Main parameter (display A) bin judgment signal
BIN B:	Sub parameter (display B) judgment signal
A NG:	Main parameter (display A) defective
B NG:	Sub parameter (display B) defective
STROBE:	Judgment complete pulse
EOM:	Measurement complete pulse
BUSY:	Under measurement flag

Input signal

TRIG:	Start measurement trigger
LOCK:	Disable panel operation
SET 0 to SET 3:	Select memory

Signal level

TTL level negative logic

Output can be reversed to positive logic.

Signal ground

Signal ground of the handler interface is isolated from the enclosure.

Voltage across the grounds must be within ±42 Vdc.

Beeper

The user can select to issue beep on measurement completion.

Beep on/off can be changed.

Strobe signal width

The pulse width of strobe signal can be modified.

Setting range: 1 ms to 19.999 s with resolution of 1 ms

The width of actually issued strobe is about ±1 ms to the set value.

GPIB

Specification:	Conforms to IEEE-488.1-1987
Interface functions:	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0

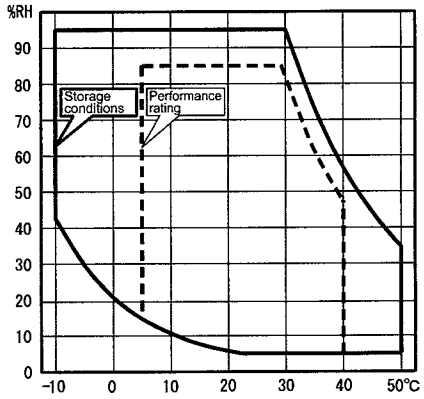
General matters

Power supply

Voltage:	100/115/230 V AC ± 10%
Frequency:	50/60 Hz ±2 Hz
Power consumption:	50 VA or less

Range of temperature and humidity to guarantee the performance

+5 to +40°C, 5 to 85%RH
(Absolute humidity: 1 to 25 g/m^3, no condensation)
For specifications for some parts, further restriction may exist on the range of temperature and humidity.



Range of temperature and humidity for storage

−10 to +50°C, 5 to 95%RH (no dew condensation)
(Absolute humidity: 1 to 29 g/m^3, no condensation)

Outside dimensions

216(W) x 132.5 (H) x 330 (D) mm (projections not included)

Mass

Approximately 4.7 kg (only main unit, excluding accessories)

WARRANTY

NF Corporation certifies that this instrument 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 of, **NF** will, at its option, either will repair the defective product without any charge for the parts and labor, or either repair or replace products which prove to be defective. For repair service under warranty, the product must be returned to a service center designated by **NF**. Purchaser shall prepay all shipping cost, duties, and taxes for the product to **NF** from another country, and **NF** shall pay shipping charge to returned the product to purchaser.

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

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If there are any misplaced or missing pages, we will replace the manual. Contact the sales representative.

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- Information provided in this manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of this manual.
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ZM2353/ZM2354 LCR METER Instruction Manual

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