INSTRUCTION MANUAL

6 1/2 DIGITAL MULTIMETER
DL-2060
DL-2060G

CONTENTS

USING THE PRODUCT SAFELY

■ Preface

To use the product safely, read this manual to the end. Before using this product, understand how to correctly use it.
If you read this manual but you do not understand how to use it, call the company or each sales office that is indicated on the back cover of this manual. After you read this manual, save it so that you can read it anytime as required.

■ Notes on reading this manual

The contents of this manual include technical terms in part of their explanation.
If you do not understand those terms, do not hesitate to ask the company or each sales office.

■ Pictorial indication and warning character indication

This manual and product show the warning and caution items required to safely use the product.
The following pictorial indication and warning character indication are provided.

<Pictorial indication> 	Some part of this product or the manual may show this pictorial indication. In this case, if the product is incorrectly used in that part, a serious danger may be brought about on the user's body or the product. To use the part with this pictorial indication, be sure to refer to this manual.
< Warning character indication＞ WARNING	If you use the product, ignoring this indication, you may get killed or seriously injured. This indication shows that the warning item to avoid the danger is provided.
CAUTION	If you incorrectly use the product, ignoring this indication, you may get slightly injured or the product may be damaged. This indication shows that the caution item to avoid the danger is provided.

USING THE PRODUCT SAFELY

⚠️ WARNING and CAUTION

■ Do not remove the product's covers and panels

Never remove the product's covers and panels for any purpose.

Otherwise, the user's electric shock or a fire may be incurred.

■ Warning on using the product

The warning items given below are to avoid danger to the user's body and life and avoid the damage and deterioration of the product.   Use the product, observing the following warning and caution items.

■ Warning items on power supply

● Power supply voltage

This equipment operates from a power source that does not apply more than 250V rms between the supply conductors or between either supply conductor and ground.   A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

● Power cord

Important: The attached power cord set can be used for this device only.

If the attached power cord is damaged, stop using it and call the company or each sales office.

If the power cord is used without the damage being removed, an electric shock or fire may be caused.

● Protection fuse

If an input protection fuse is blown, the product does not operate.   When the fuse is blown, the user can replace it. However, replace it correctly, observing the warning and caution items that are provided in the section of the manual where the fuse replacement is explained.   If the fuse is incorrectly replaced, a fire may occur.

● Changing the power supply voltage

The product enables to change operational power supply voltage by switch over the inlet at rear panel. Please refer to the section "1.1.2.2 To change fuse".

■ Warning item on grounding

The product has the GND terminal on the panel surface to protect the user from electric shock and protect the product. Be sure to ground the product to safely use it.

■ Warning item on installation environment

● Operating temperature

Use the product within the operating temperature indicated in the rating column.   If the product is used with the vents of the product blocked or in high ambient temperatures, a fire may occur.

● Operating humidity

Use the product within the operating humidity indicated in the rating column.   Watch out for condensation by a sharp humidity change such as transfer to a room with a different humidity.   Also, do not operate the product with wet hands.   Otherwise, an electric shock or fire may occur.

● Use in a gas

Use in and around a place where an inflammable or explosive gas or steam is generated or stored may result in an explosion and fire.   Do not operate the product in such an environment.

Also, use in and around a place where a corrosive gas is generated or spreading causes a serious damage to the product.   Do not use the product in such an environment.

● Do not let foreign matter in

Do not insert metal and flammable materials into the product from its vent and spill water on it.   Otherwise, an electric shock and fire may occur.

USING THE PRODUCT SAFELY

⚠ WARNING and CAUTION

■ Warning item on abnormality while in use

If smoke or fire is generated from the product while in use, stop using the product, turn off the switch, and remove the power cord plug from the outlet.　After confirming that no other devices catch fire, call the company or each sales office.

■ Input/output terminal

Maximum input to the input terminals is specified to prevent the product from being damaged.
Do not supply input, exceeding the specifications that are indicated in the "Rating" or "Caution on use" column in the manual of the product.　Otherwise, a product failure is caused.
Also, do not supply power to the output terminals from the outside.　Otherwise, a product failure is caused.

■ When the product is left unused for a long time

Be sure to remove the power plug from the outlet.

(Calibration)

Although the performance and specifications of the product are checked under strict quality control during shipment from the factory, they may slightly change because of secular changes in its parts.　It is recommended to periodically calibrate the product so that it is used with its performance and specifications stable.　For consultation about the product calibration, call the dealer or the company or each sales office where you bought the product.

(Daily maintenance)

When you clean off the dirt of the product covers, panels, and knobs, avoid solvents such as thinner and benzene. Otherwise, paint may peel off or the resin surface may be affected.
To wipe off the covers, panels, and knobs, use a soft cloth with neutral detergent in it.
During cleaning, be careful that water, detergents, and other foreign matters do not get into the product.
If a liquid or metal gets into the product, an electric shock and fire are caused.
During cleaning, remove the power cord plug from the outlet.

Use the product correctly and safely, observing the above warning and caution items.
Because the manual indicates caution items even in individual items, observe those caution items to correctly use the product.

If you have questions or comments about the content of the manual, call the company's sales office.

1 Overview

This chapter will give you an overview of DL-2060's basic features and guide you through the basics of DL-2060 digital multimeter. Users will become familiar with those features after reading this chapter.

1.1 Setting up Your DL-2060 Digital Multimeter

The purpose of this section is to prepare users for using DL-2060 DMM. You may want to check if you have all the parts with your multimeter. All our products are handled and inspected professionally before shipping out to our customers. If you find any damaged or missing parts, please contact your local service representative immediately and do not attempt to operate the damaged product.

1.1.1 Inspection

Your product package is supplied with the following items:
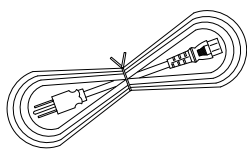
Power line cord : 1
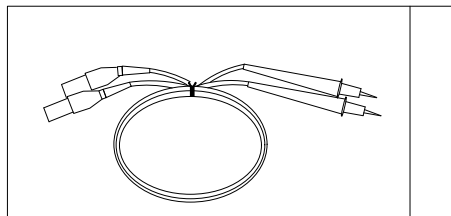
Standard Test Leads : 1
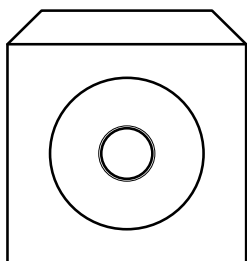
CD : 1
(Including this User's Manual and software applications)
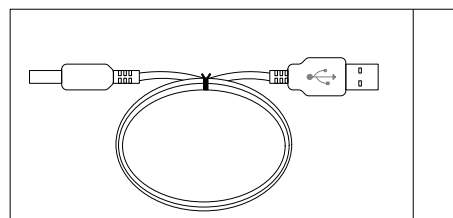
USB cable : 1

Warning: If any part of the Test Lead Set is damaged, please do not use and replace with a new set.

1.1.2　To adjust the handle

You may adjust the carrying handle to suit your needs. The following figures shows you how to adjust the handle.

I. Taking off the handle from the Multimeter

【Step 1】(Turn up the handle)

Pull slightly outward on both sides of the handle and slowly rotate it up as shown in **Figure 1-1**.
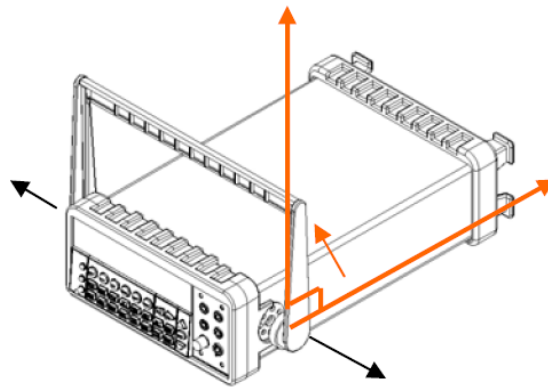
Figure 1-1

【Step 2】(Pull out the handle)

When the handle is turned up to 90° with the multimeter please pull out the handle from the multimeter as shown in **Figure 1-2**.
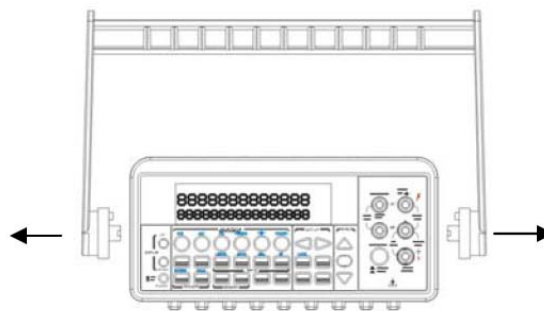
Figure 1-2

Ⅱ. Adjusting the position for your convenience

Here are some example positions to suit users' needs.

【Position 1】

The default position is for packing as shown in **Figure 1-3**.
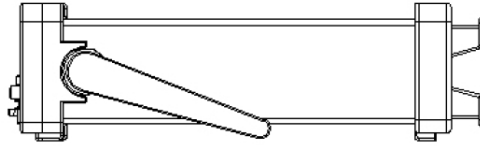
Figure 1-3

【Position 2】

The adjusted position is for operation as shown in **Figure 1-4**.
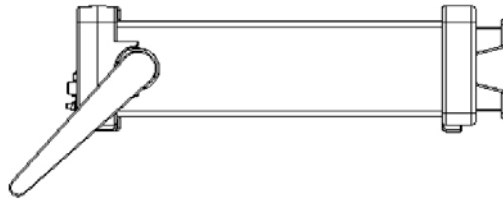
Figure 1-4

【Position 3】

The carrying position is with the handle as shown in **Figure 1-5**
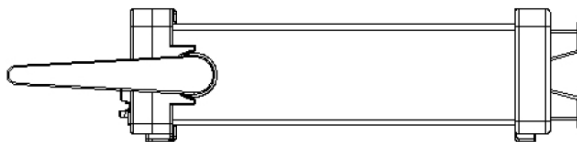
Figure 1-5

1.1.3 To connect the power

Check the power-line voltage on the rear panel to see if voltage setting is correct for your area. Change the setting if it is not correct or the fuse is broken. Please follow the steps below.

1.1.3.1 To convert the voltage

⚠ Warning! In some areas, the power supplied voltage is 240Vac or 120Vac; in others, the power supplied voltage is 220 Vac or 100 Vac. Please refer to your local power supplied voltage to see if you have the right setting.

⚠ Warning! Before changing the setting, make sure the multimeter is disconnected from the AC power. An incorrect voltage setting may cause severe damage to your instrument.

⚠ Warning! The power cord supplied with DL-2060 contains a separate ground wire for use with grounded outlets. When proper connections are made, instrument chassis is connected to power line ground through the ground wire in the power cord. Failure to use a grounded outlet may result in personal injury or death due to electric shock.

This product enables to switch between the power-supply voltage of 100Vac and 220Vac and setup either of it.
※If you desire switching type of 120Vac and 240Vac, please contact us.

Suppose your condition is in AC 100V and you want to convert the voltage to the 220V. Follow these steps to change the voltage setting.

【Step 1】
Verify that the meter is disconnected as shown in **Figure 2-1**.
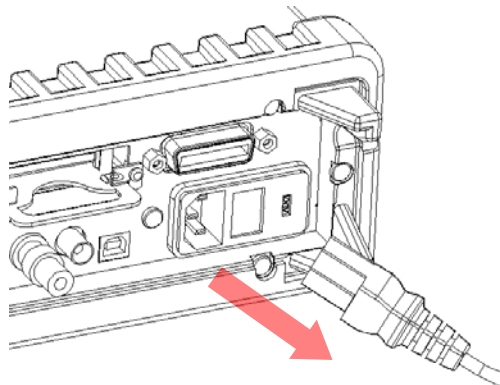
Figure 2-1

【Step 2】

Open the voltage setting selector cap as shown in **Figure 2-2**. (You might need a screwdriver to do so.)
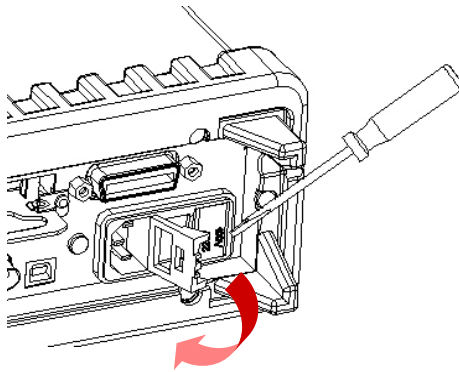
Figure 2-2

【Step 3】

Remove the red voltage setting selector from the right middle seam as shown in **Figure 2-3**. (You might need a screwdriver to do so.)
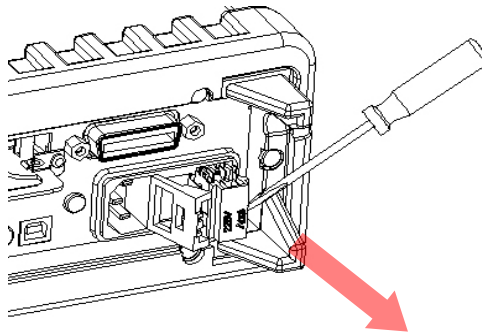
Figure 2-3

【Step 4】

Turn it over to 220V position as shown in **Figure 2-4**.
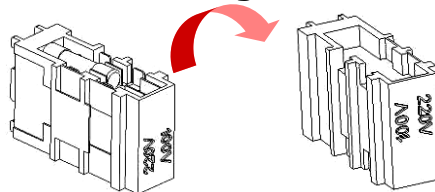
Figure 2-4

【Step 5】

Insert the voltage setting selector back into the socket and close the cap as shown in **Figure 2-5**.
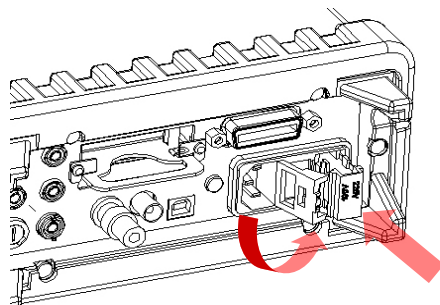
Figure 2-5

1.1.3.2 To change the power-line fuse

⚠️**Warning! Before replacing the power-line fuse, make sure the multimeter is disconnected from the AC power. You must be qualified personnel to perform this action.**

⚠️ **Warning! For continued protection against fire or instrument damage, only replace fuse with the same type and rating. If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse. (Fuse to replace: 250VT250mA)**

Verify that the power-line fuse is good. Replace the fuse if it is damaged. Use only the same type and same rating fuse noted on the rear panel.   Please follow the steps below to change the fuse.

【Step 1】
Verify that the meter is disconnected as shown in **Figure 2-6**.
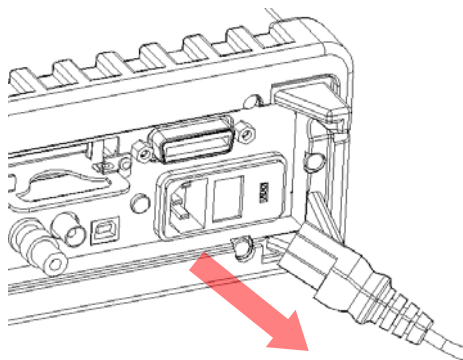
Figure 2-6

【Step 2】
Open the voltage setting selector cap as shown in **Figure 2-7**. (You might need a screwdriver to do so.)
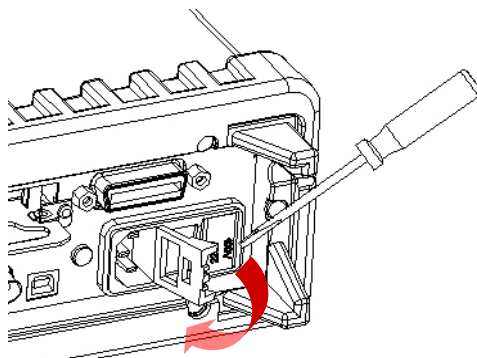
Figure 2-7

【Step 3】

Remove the red voltage setting selector from the right middle seam as shown in **Figure 2-8**. (You might need a screwdriver to do so.)
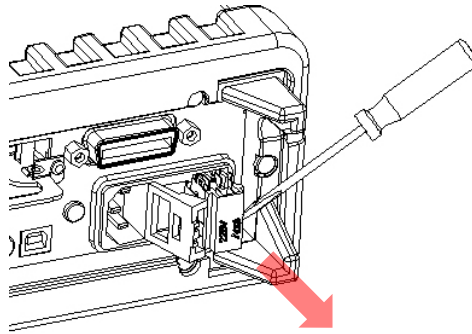
Figure 2-8

【Step 4】

Remove the broken fuse from the selector as shown in **Figure 2-9**.
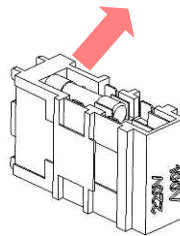
Figure 2-9

【Step 5】

Replace with the new fuse as shown in **Figure 2-10**.
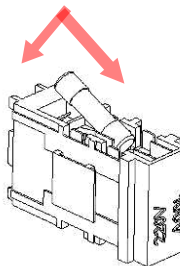
Figure 2-10

【Step 6】

Insert the voltage setting selector back into the socket and close the cap as shown in **Figure 2-11**.
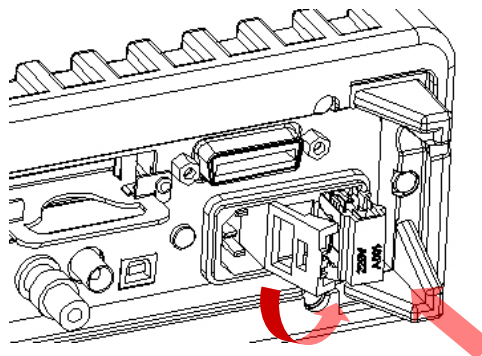
Figure 2-11

【Step 7】

Make sure the power switch on the front panel is in "Power OFF" condition before plugging as shown in **Figure 2-12**.

Figure 2-12

"**POWER OFF**"
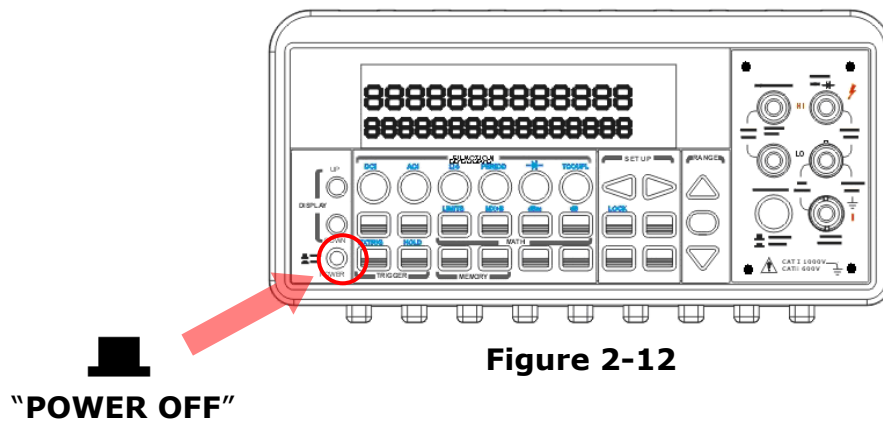
【Step 8】

After finishing the above procedures, you can plug in your power cord as shown in **Figure 2-13**.
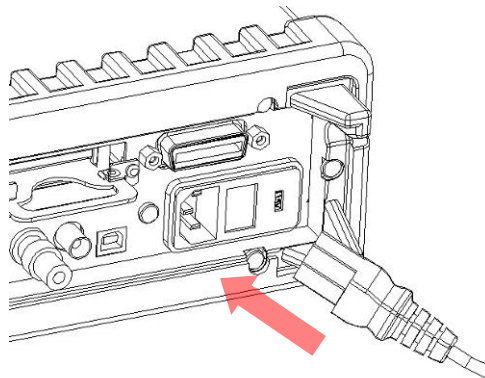
Figure 2-13

【Step 9】

Press on the power switch on the front panel for activating DL-2060 as shown in **Figure 2-14**.

Figure 2-14

"**POWER ON**"
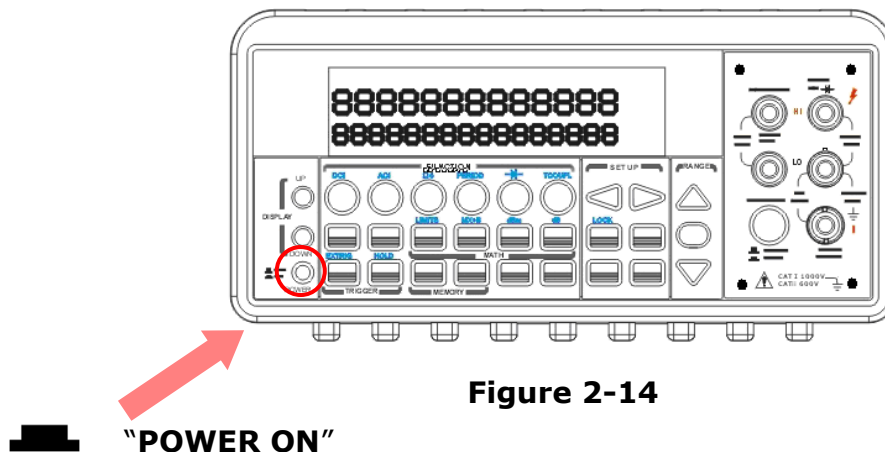
1.1.3.3 To change the current input fuse

The current input terminal is protected respectively by the fuse(3A,250V Fast Acting, HBC：TEXIO part number F50-0268-08) at rear and front panel. Also, it is equipped by a 7A(7A,250V Fast Acting：TEXIO part number F50-0267-08) fuse in series which will be the double protection of the current measuring circuit.
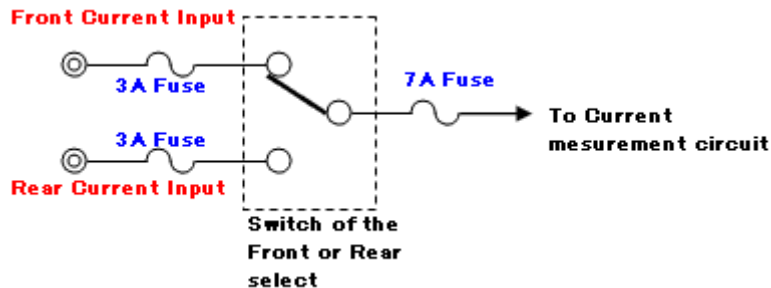
Figure 2-15

Warning! Before replacing the current input fuse, make sure the multimeter is disconnected from the AC power. You must be qualified personnel to perform this action.

Warning! For continued protection against fire or instrument damage, only replace fuse with the same type and rating. If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse.

Current Input Fuse Replacement
(3A on the Front & Rear Panels)

Verify that the power-line fuse is good. Replace the fuse if it is damaged. Use only the same type and same rating fuse. (3A,250V Fast Acting, HBC：TEXIO part number F50-0268-08)　Please follow the steps below to change the fuse.

【Step 1】
Verify that the meter is disconnected as shown in **Figure 2-16**.
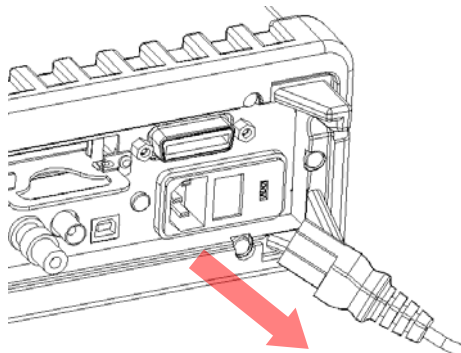
Figure 2-16

【Step 2】

Push the current input terminal and turn it right as shown in **Figure 2-17**.
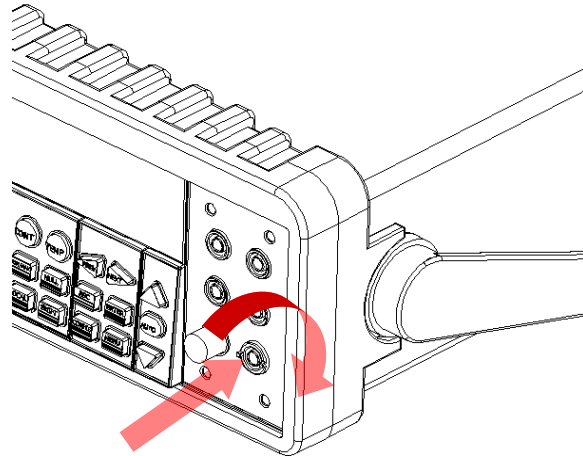
Figure 2-17

【Step 3】

Pull out the terminal (fuse holder) gently and you will find the current input fuse as shown in **Figure 2-18**.
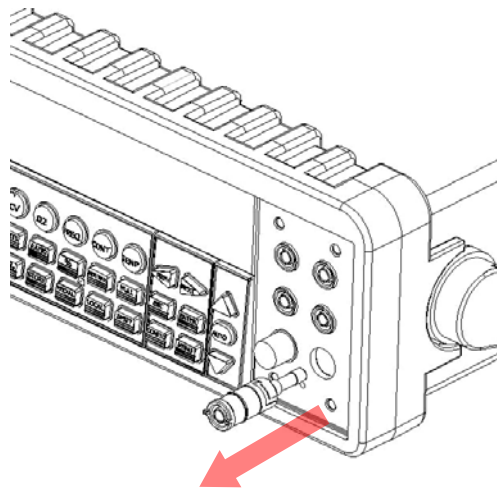
Figure 2-18

【Step 4】

Remove the broken fuse and replace a new one with the same type or same rating as shown in **Figure 2-19**.

Fuse

Current Fuse Holder
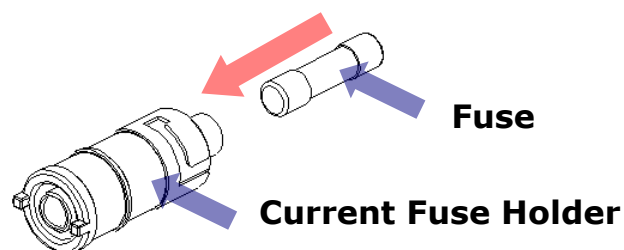
Figure 2-19

【Step 5】

Insert the fuse holder back and turn it left as shown in **Figure 2-20**. Make sure the fuse holder is properly seated and secured.
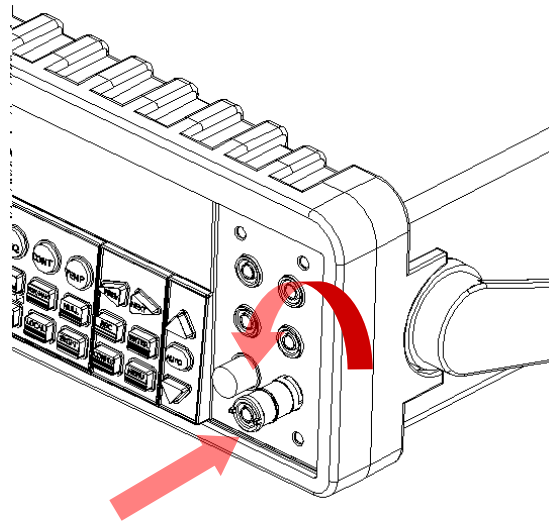
Figure 2-20

Current Input Fuse Replacement (7A on the rear Panel)

Verify that the power-line fuse is good. Replace the fuse if it is damaged. Use only the same type and same rating fuse. (7A,250V Fast Acting ：TEXIO part number F50-0267-08)　 Please follow the steps below to change the fuse.

【Step 1】

Verify that the meter is disconnected as shown in **Figure 2-21**.
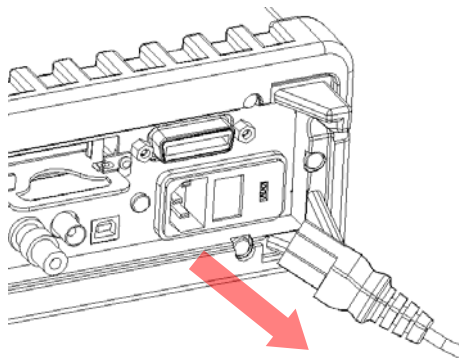
Figure 2-21

【Step 2】
Please use a flat-blade screwdriver with a suitable pushing strength to turn it left for releasing the holder as shown in **Figure 2-22**.
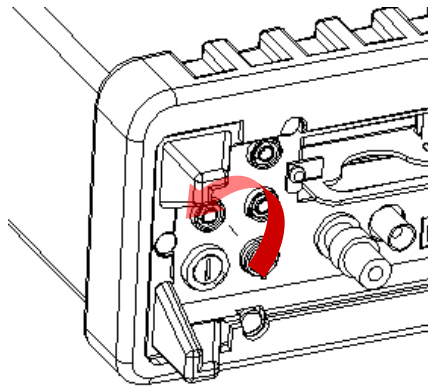
Figure 2-22

【Step 3】
Pull out the terminal (fuse holder) gently and you will find the current input fuse as shown in **Figure 2-23**.
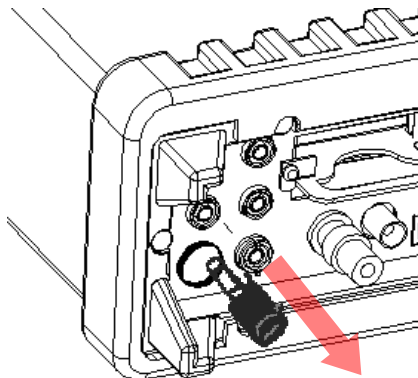
Figure 2-23

【Step 4】
Remove the broken fuse and replace a new one with the same type or same rating as shown in **Figure 2-24**.
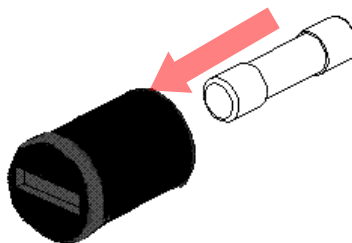
Figure 2-24

【Step 5】

Insert the fuse holder back and turn it right as shown in **Figure 2-25**. Make sure the fuse holder is properly seated and secured.
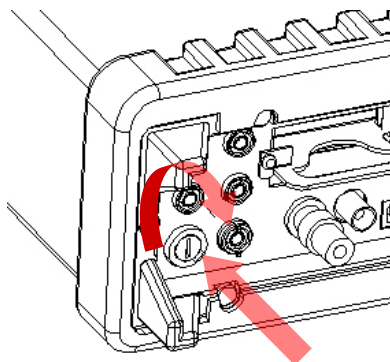
Figure 2-25

1.1.4 Factory Default When Power-ON

Table 2-1 shows the factory default of DL-2060.

Table 2-1

Function		*Default*
Function		DCV
Autozero		On
Frequency and Period Source		AC Voltage
Output Format		ASCII
Ratio		Off
AC Bandwidth	Input Frequency	20Hz
Voltage	AC Digits	5 1/2
	DC digits	Slow 5 1/2 (1 PLC)
	Range	Auto
Current	AC Digits	5 1/2
	DC Digits	Slow 5 1/2 (1 PLC)
	Range	Auto
Frequency and Period	Digits	5 1/2
	Range	Auto
	Rate	Medium (100ms)
Diode Test	Digits	5 1/2
	Range	1mA
	Rate	0.1 PLC
Resistance (2-wire)	Digits	Slow 5 1/2 (1 PLC)
	Range	Auto
Temperature	Digits	Slow 6 1/2 (10 PLC)
	Thermocouple	K Type,ºC
Triggers	Source	Immediate
	Delay	Auto
Input Resistance		10MΩ

1.1.5 Update of the user's manual

To update the user's manual, please check our web site.

The last update may be downloaded from the web site.

（**http://www.nikketechno.jp/**）

1.2 Features

- Resolution: 6 1/2 digits.
- 5*7 dot matrix VFD, dual displays with 3-color annunciators.
- 12 standard measurement functions & 8 math functions.
- Stability, Accuracy and Speed (2000RDGS/Sec at 4 1/2 Digit, 50 RDGS/Sec at 6 1/2 Digit in 60 Hz)
- Multi-Points Scanner Card: Up to 10 Channels. (Optional)
- Built-in USB and GPIB (G type only) Interfaces.
- Easy & Free PC applications.

1.3 DL-2060 Function Introduction

For users to become familiar with the DL-2060 DMM, we will give a brief introduction to the basic operations of DL-2060 DMM. There are three major parts of DL-2060: **(1.3.1) the front panel, (1.3.2) the display, and (1.3.3) the rear panel.** We will discuss each of them in the following sections.

1.3.1 The Front Panel

There are different buttons and terminals on the front panel. They are divided into the following groups: (DISPLAY & POWER), (FUNCTION, MATH, TRIGGER, MEMORY, SETUP, RANGE, INPUT TERMINALS), and (FILTER, DIGITS, LOCAL, and SHIFT) as shown in **Figure 2-15**.
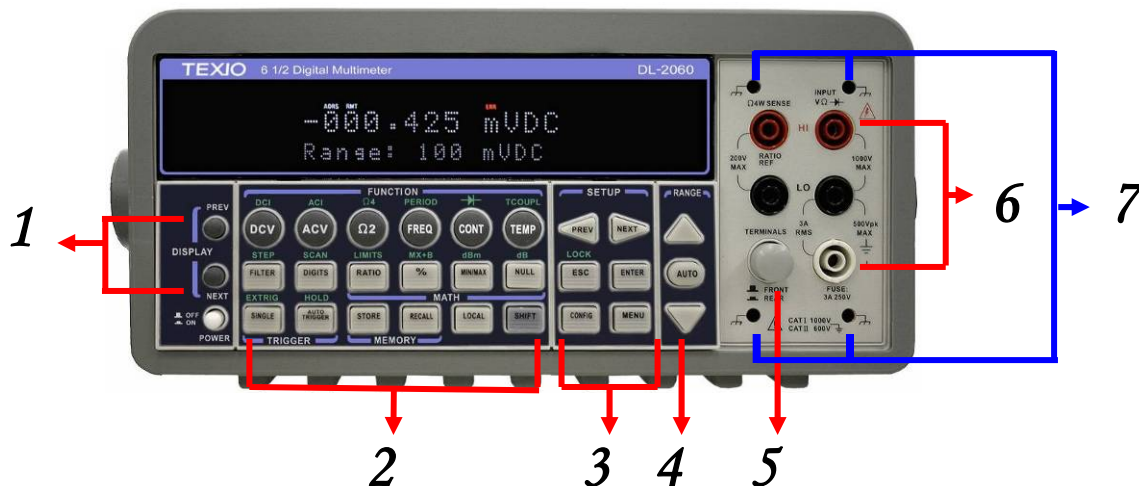
Figure 2-15

1. **Power & Display:**
- Power: Activates DL-2060 DMM.
- Display: Shows model, version & condition by pressing round PREV & NEXT buttons.

2-1. First row without SHIFT button:

- DCV: Selects DC voltage measurement.
- ACV: Selects AC voltage measurement.
- Ω2: Selects 2-wire resistance measurement.
- FREQ: Selects frequency measurement.
- CONT: Selects the continuity test.
- TEMP: Selects RTD temperature measurement.

2-2. First row with SHIFT button:

- DCI: Selects DC current measurement.
- ACI: Selects AC current measurement.
- Ω4: Selects 4-wire resistance measurement.
- PERIOD: Selects period measurement.
- ▶├: Selects diode testing.
- TCOUPL: Selects thermocouple temperature measurement.

2-3. Second row without SHIFT button:

- FILTER: Enable or disable the digital filter.
- DIGITS: Changes resolution.
- RATIO: Enables the dcv:dcv ratio function.
- %: Calculates the ratio to a target value in percentage.
- MIN/MAX: Captures the minimum or maximum readings from the measurement.
- NULL: Activates the offset function in order to get the real measured reading.

2-4. Second row with SHIFT button:

- STEP: Scans from a channel to the next channel in delayed action when using the scanner card.
- SCAN: Enables scanning function when using the scanner card.
- LIMITS: Used for Setting upper and lower limit values for readings.
- MX+B: Used for calculating slope. X is the normal display reading. M and B are constants specified by user for scale factor and offset.
- dBm: Used for displaying voltage measurement in dBm power unit.
- dB: Used for displaying voltage measurement in decibel unit.

2-5. Third row without SHIFT button:

- SINGLE: Manually triggers the multimeter to make measurements.
- AUTO TRIGGER: Instructs the multimeter to make measurements continuously.
- STORE: Stores a specified number of subsequent readings.
- RECALL: Displays stored readings and buffer statistics. Use ◁ ▷ or △ ▽ searching buttons to toggle between reading number and reading.
- LOCAL: Cancels USB or GPIB remote mode.
- SHIFT (in blue): Used for accompanying other button with upper print in blue and converting function.

2-6. Third row with SHIFT button:

- EXTRIG: Selects external triggers as the trigger source via BNC port on the rear panel.
- HOLD: Holds reading.

3-1. The first row in SETUP section

- ◁ ▷ : Scrolls through buffer, conceals or reveals the digits while measuring.

3-2. The second row in SETUP section:

- ESC: Cancels selection, moving back to measurement display.
- ENTER: Accepts selection, moving to next choice or back to measurement display.
- LOCK: Presses SHIFT then ESC button to prevent unpredictable operation on the panel. In order to release lock condition, please press ESC again.

3-3. The third row in SETUP section:

- CONFIG: Offers setting or adjusting function, relating some front panel buttons.
- MENU: Offers setting or adjusting function, not relating other front panel buttons.

4. RANGE:

- △: Moves to higher range.
- ▽: Moves to lower range.
- AUTO: Enables or disables auto-range.

5. Terminals: Selects input signal connections on front or rear panel.

6. Inserted Connections & Fuse Device:

- HI & LO: Used for all measurements, except DC and AC current.
    (Maximum input voltage: 1000V for voltage measurements. 200V for 4-wire measurement)
- LO & I: Used for making DC and AC current measurements.
- Front Fuse: Protects current input terminal from overcurrent.
    (Maximum current: 3A, 250V)

7. Chassis Ground Terminal:

   The chassis ground terminal is used for shielding the noise from the nature, especially when users want to get a very small signal via the application of a BNC-to-Banana Adapter.

   Figure 2-16
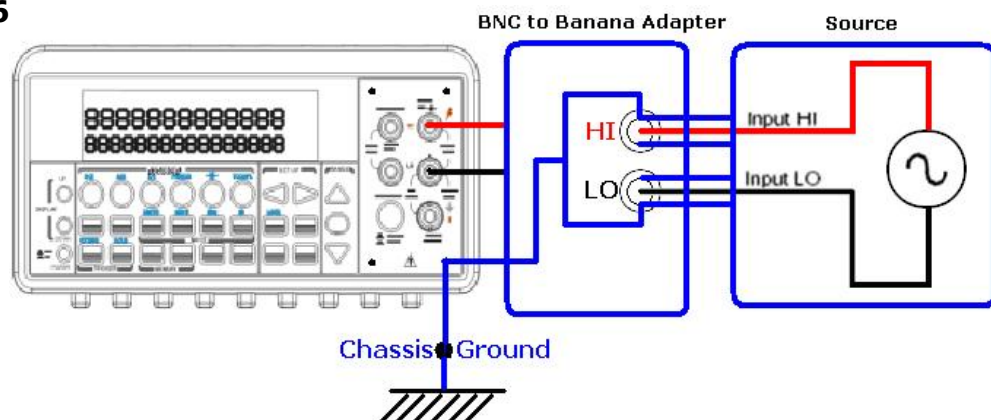
1.3.2 The Display

DL-2060 has a 5x7 dot matrix, dual-display with three-color (White, Red and Yellow) annunciators for a better view. There are two rows in the dual-display screen. The upper row displays readings and units. A maximum 13 characters are allowed for upper row dot-matrix display. The lower row displays range of the measurements, condition or information about an ongoing configuration. A maximum 16 characters are allowed for lower row dot-matrix display. There are additional annunciators at upper side and right side of the display screen for indicating the state or the condition of an ongoing measurement. They are explained individually in the following sections.
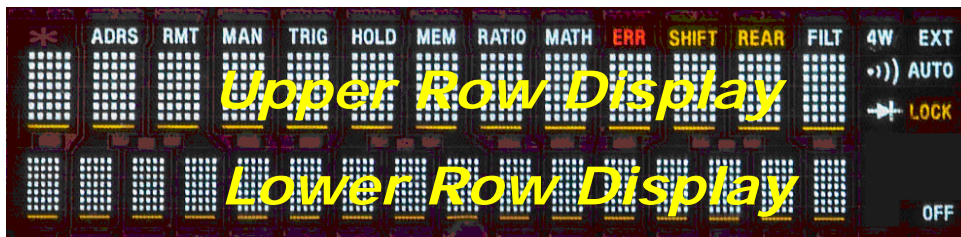
Figure 2-17

1.3.2.1 Annunciators at Upper Side

Figure 2-18

- ADRS: Indicates the multimeter is controlled via GPIB Interface.
- RMT (REMOTE): Indicates the remote state. (USB Interface)
- MAN: Indicates the manual range is taken.
- TRIG: Shows the single triggering is enabled.
- HOLD: Indicates reading hold function is enabled.
- MEM: Indicates the using of internal memory.
- RATIO: Indicates the dcv:dcv ratio operation.
- MATH: Indicates the "MATH" operation is taken.
- ERR: Error occurs.
- SHIFT: Indicates SHIFT button is pressed.
- REAR: The rear panel input terminal is selected for the measurement.
- FILT: The digital filter is started.

1.3.2.2 Annunciators at Right Side

- 4W: Indicates 4 –wire mode is selected for resistance measurement.
- •))): Indicates the continuity testing is enabled.
- ⭢⊦: Indicates the diode testing operation is taken.
- EXT: Indicates the External Trigger Mode is enabled.
- LOCK: Indicates the front panel menu operations is lecked.
- OFF: Indicates the front panel display is turned off
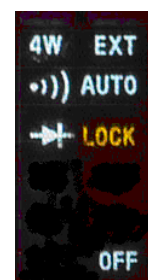
Figure 2-19

1.3.3 The Rear Panel

The rear panel of the DL-2060 is shown in **Figure 2-20**. This figure includes important abbreviated information that should be reviewed before using the instrument.
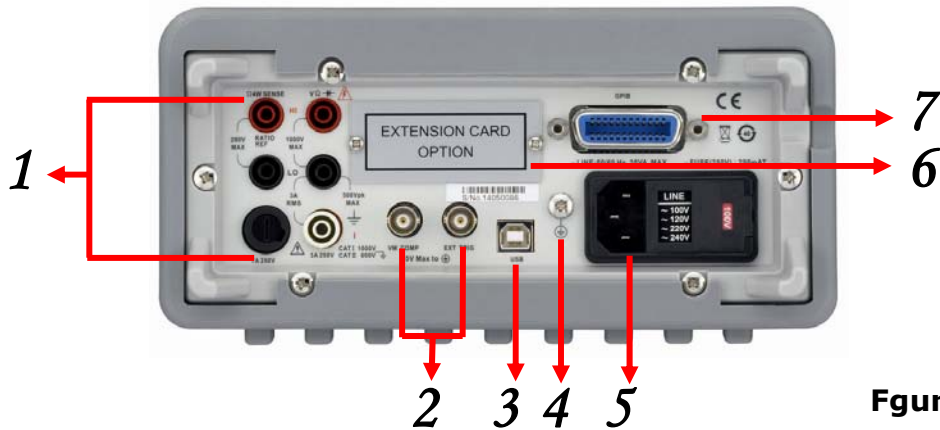
Fgure 2-20

1. Inserted Connections & Fuse Device:
- HI & LO: Used for all measurements, except AC & DC current and temperature.
- LO & I: Used for making DC and AC current measurements.
- Rear Fuse: Protects current input terminal from overcurrent.

2. BNC Connections:
- VM COMP: Voltmeter Complete Output Terminal. Outputs a low-true pulse (TTL level) after the completion of each measurement.
- EXT TRIG: External Trigger Input Terminal. Inputs a low-true pulse (TTL level) from a remote interface.

3. USB Connection: Connects a remote computer for changing operation environment instead of the front panel control.

4. Protective Conductor Terminal.

5. Power Module: Contains the AC line receptacle, power line fuse, and line voltage setting. It is possible to switch 100Vac and 220Vac along with the power-supply voltage selector which is equal to fuse folder.
(f you desire switching type of 120Vac and 240Vac, please contact us.)

6. Option Slot: Designed for installing an optional multi-point scanner card.

7. GPIB Connection (G type only): Connects a remote computer with an IEEE488 cable for changing operation environment instead of the front panel control.

2 Basic Measurement Function

This chapter introduces some basic measurement functions in DL-2060. You will learn how to use your DL-2060 multimeter to measure voltage, current, resistance, frequency, period, continuity, diode and temperature in this chapter.

2.1 Voltage Measurements (DC & AC)

The ranges for DC voltage measurements in DL-2060 are 100mV, 1V, 10V, 100V and 1000V. For AC voltage measurements, the ranges are 100mV to 750V AC-Coupled TRMS, or 1000V peak. **Figures 3-1** and **3-2** shows the locations of the buttons needed and message display for voltage measurement. **Figure 3-3** shows the location of the input terminals on the rear panel.

⚠ Warning: Do not apply more than 1000V (peak) to the multimeter. Applying excess voltage may damage your meter, or cause possible electric shock or personal injury.

※ Note: To eliminate the thermal EMFs due to the differences between two metals, use copper leads to connect your source signal to the meter.

How to measure voltage

① Selects input signal connections on front or rear panel.
② Connect the test leads to the terminals as shown in **Figure 3-1**(DC) or **Figure 3-2** (AC).
③ Set RESOLUTION of DCV (Refer to 3.1.3), BAND WIDTH of ACV (Refer to 3.1.2.1) or skip this step if default is to be used.
④ Press DCV or ACV button for DC or AC voltage measuring.
⑤ Select the auto-range function by pressing AUTO button on the front panel or use buttons to select desired range.
⑥ Connect test leads to your source signal and observe the reading shown on the display. If the input signal is beyond the allowed range, an overflow message "OVLD" will be displayed.

Input Resistance = 10MΩ on 1000V and 100V ranges;
> 10GΩ on 10V, 1V and 100mV ranges.

Figure 3-1

Input Impedence = 1MΩ in parallel with < 100pF
(Warning: Maximum Input = 750V RMS, 1000V peak, 8 x 10^7 V·Hz)
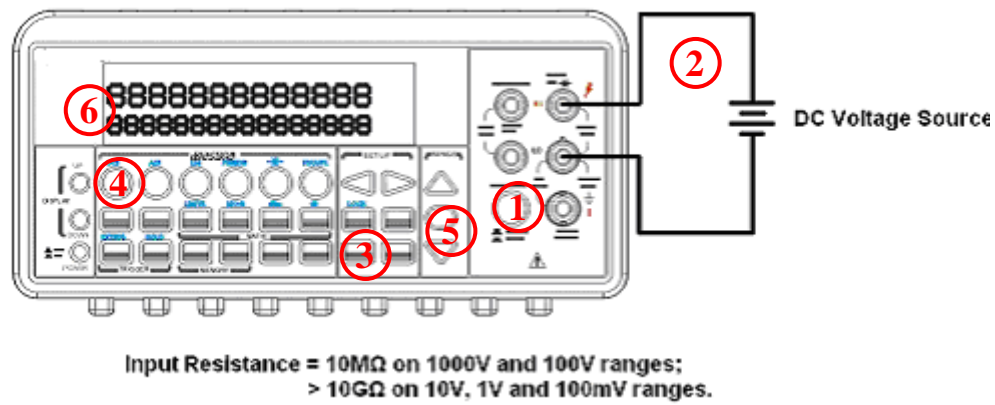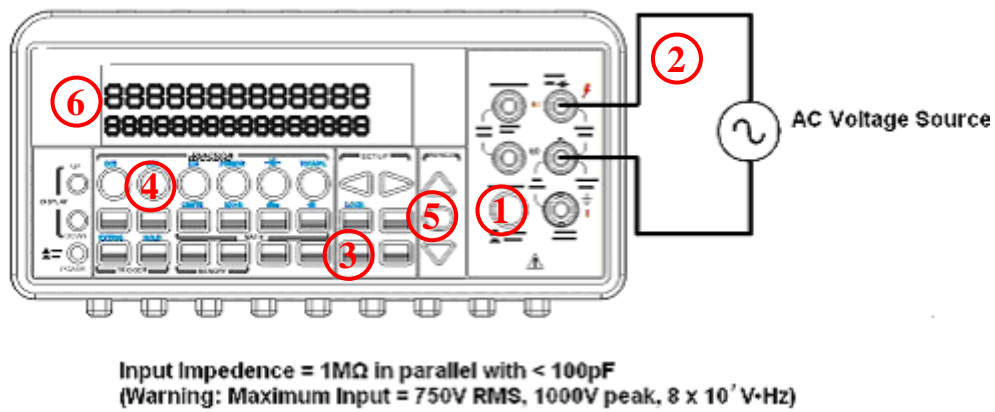
Figure 3-2

※ Note: The rear panel terminals can also be used via the same procedures as the front panel terminals. (Refer to Figure 3.3)

VM = Voltage Measurement
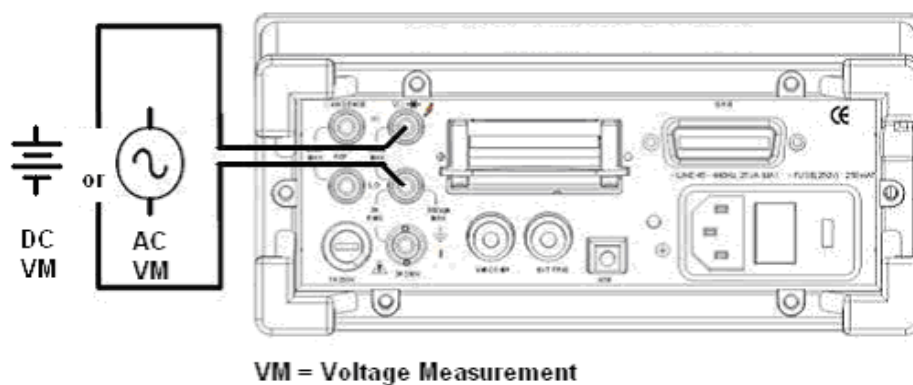
Figure 3-3

2.2 Current Measurements (DC & AC)

The ranges for DC current measurements in DL-2060 are 10mA, 100mA, 1A and 3A. For AC current measurements, the range is 1A with a sensitivity of 1 μA to 3A AC-Coupled TRMS with a sensitivity of 10μA. **Figure 3-4** and **3-5** show you how to measure DC/AC currents in DL-2060.

⚠ Warning! The maximum input current allowed is 3A, 250V. Do not apply excess current to your meter to avoid damaging the fuse of current input.

※ Note: To eliminate the thermal EMFs due to the differences between two metals, use copper leads to connect your source signal to the meter.

How to measure current

① Selects input signal connections on front or rear panel.
② Connect the test leads to the terminals as shown in **Figure 3-4**.
③ Set RESOLUTION of DCI (Refer to 3.1.3), BANDWIDTH of ACI (Refer to 3.1.2.1) or skip this step if default is to be used.
④ Press SHIFT+DCI(DCV) or SHIFT+ ACI(ACV) buttons for DCI or ACI measurement.
⑤ Select the auto-range function by pressing AUTO button on the front panel or use △ and ▽ buttons to select desired range.
⑥ Connect test leads to your source signal and observe the reading shown on the display. If the input signal is greater than the allowed range, an overflow message "OVLD" will be displayed.

(Warning: Maximum Input = 3A DC or RMS)

Figure 3-4

22

CM = Current Measurement
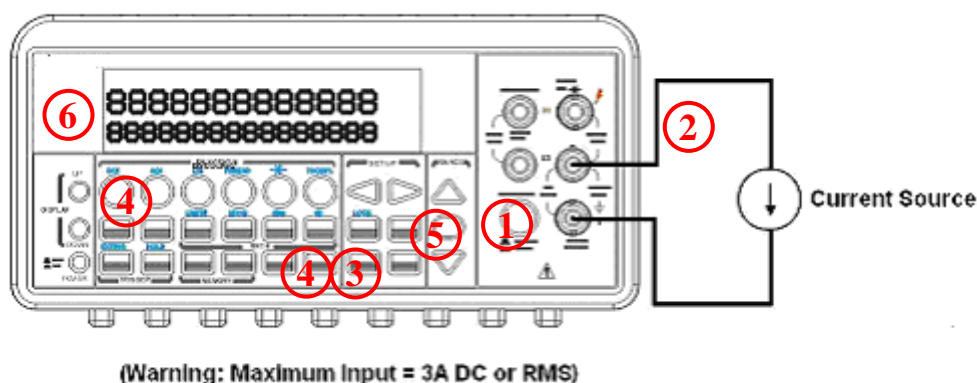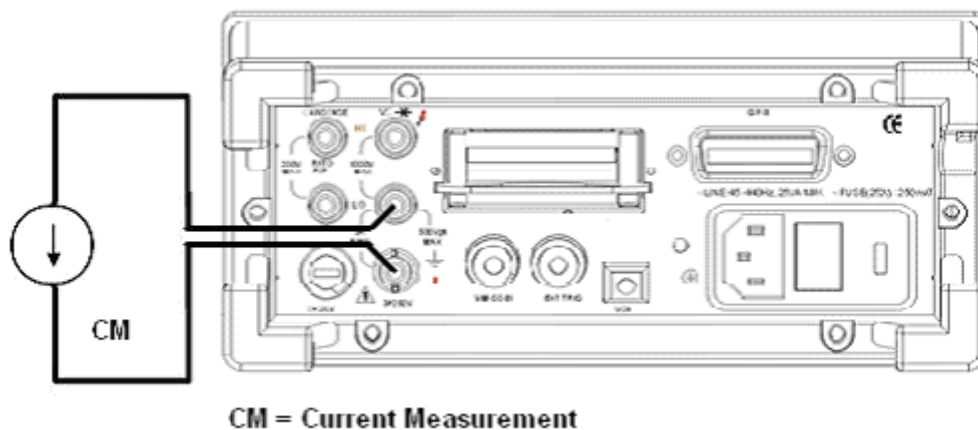
Figure 3-5

2.3 Resistance Measurements (2 & 4-wire)

The ranges for resistance measurement are 100 Ω, 1KΩ, 10kΩ, 100kΩ, 1MΩ, 10MΩ, and 100MΩ, with a sensitivity of 100 µΩ (on 100 Ω range.) There are two modes for measuring the resistance: 2-wire mode as shown in **Figure 3-6** and 4-wire mode as shown in **Figure 3-7**. With 4-wire mode, the test current is measured from the test resistance through one pair of the test leads, and the test voltage across the resistance under test is measured from another set of the test leads.   As a result, the 4-wire mode is more accurate for low resistance measurements. The trade off is the longer settling time for 4-wire mode.

Figure 3-8 and **3-9** shows the input terminal connections on the rear panel for 2-wire mode and 4-wire mode respectively.

How to measure resistance
① Selects input signal connections on front or rear panel.
② Connect the test leads to the terminals as shown in **Figure 3-6** (2-wire) or **Figure 3-7** (4-wire).
③ Set RESOLUTION (Refer to 3.1.3) or skip this step if default is to be used.
④ Press Ω2 button for 2-wire measurement or SHIFT +Ω4(Ω2) buttons for 4-wire measurement.
⑤ Select the auto-range function by pressing AUTO button on the front panel or use △ and ▽ buttons to select the desired range.
⑥ Connect test leads to your source signal and observe the reading shown on the display. If the input signal is greater than the allowed range, an overflow message "OVLD" will be displayed.
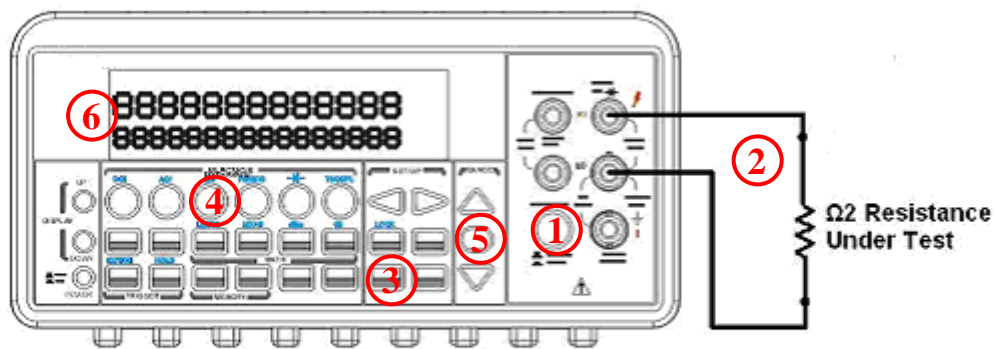
Note: Source current flows from the **INPUT HI** to **INPUT LO** terminals.

Figure 3-6
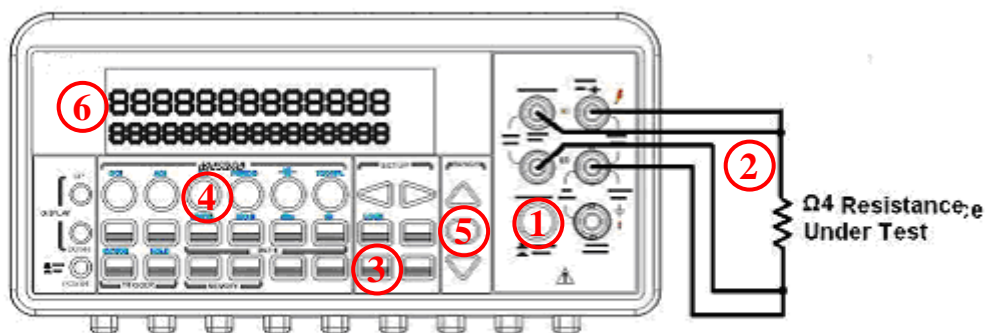
Note: Source current flows from the **INPUT HI** to **INPUT LO** terminals.

Figure 3-7

※ Note: The rear terminal panel can also be used via the same procedures like the front panel as shown in **Figures 3-8** and **3-9**.

2-wire resistance measurement
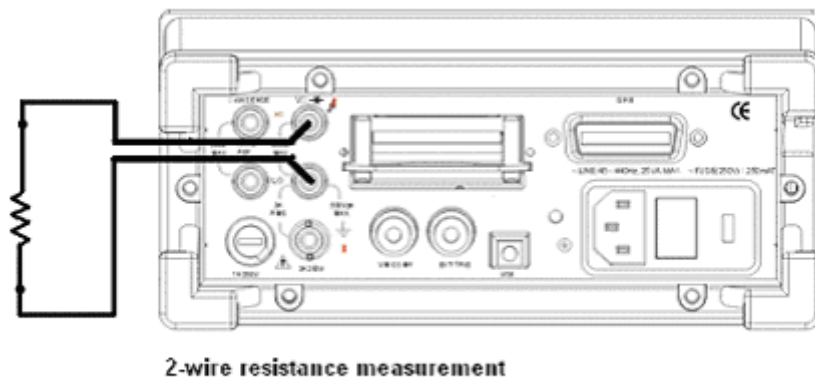
Figure 3-8

4-wire resistance measurement
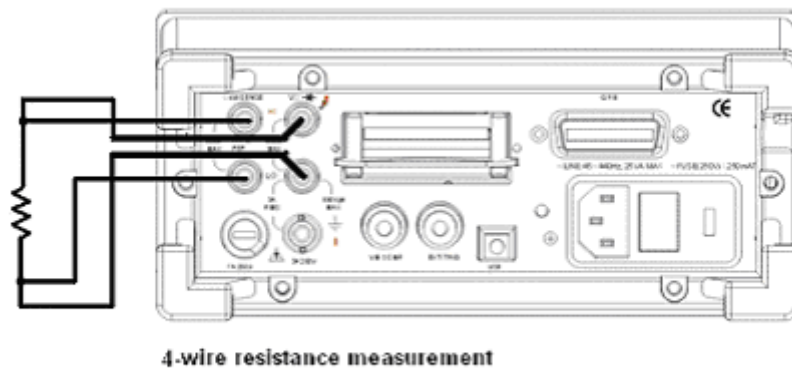
Figure 3-9

2.4 Frequency & Period Measurements

DL-2060 uses an on-board counter with 25MHz to measure the frequency (period). The measurement band is from 3Hz to 300kHz (or 333 ms to 3.3 μs) and the measurement voltages range from 100mV to 750 V in AC. The default for "RANGE" is auto-range.

⚠ Warning! The maximum input allowed is 1000V (peak). Applying excess voltage may damage your meter.

How to measure frequency and period

① Selects input signal connections on front or rear panel.

② Connect the test leads to the terminals as shown in **Figure 3-2**.

③ Set RESOLUTION (Refer to 3.1.1) and INPUT JACK. Or skip this step if default is to be used.

④ Press FREQ button for frequency measurement or SHIFT + PERIOD(FREQ) buttons for period measurement.

⑤ Select the auto-range function by pressing AUTO button on the front panel or use △ and ▽ buttons to select the desired range.

⑥ Connect test leads to your source signal and observe the reading shown on the display. If the input signal is beyond the allowed range, an overflow message "OVLD" will be displayed.

※ Note: The rear terminal panel can also be used via the same procedures as the front panel. (Please refer to **Figure 3-3**)

2.5 Continuity Measurements

DL-2060 uses 1 K Ω range for the continuity measurement. The meter beeps when the test resistance is less than the threshold resistance. The default threshold resistance is 10Ω, but user can set the threshold resistance to anything between 1 Ω and 1 K Ω. The resistance value set by user is stored in a volatile memory and will be cleared after the meter has been turned off. The source current for the continuity measurement is 1 mA.

⚠ Warning! The maximum input voltage allowed is 1000 V (peak). Applying excess voltage may damage the meter and cause unpredictable hazards.

How to measure the continuity

Selects input signal connections on front or rear panel.
① Connect the test leads to the terminals as shown in **Figure 3-2**.
② Set REConnect the input signal as the following figure.
③ Set threshold resistance via pressing CONFIG + CONT buttons. (Or skip this step if default resistance is to be used) When ready, press ENTER button.
④ Press CONT button.
⑤ The measured value will be shown on the display automatically. Meter "beeps" when measured resistance value is lower than threshold value.

Note: Source current flows from the INPUT HI to INPUT LO terminals.
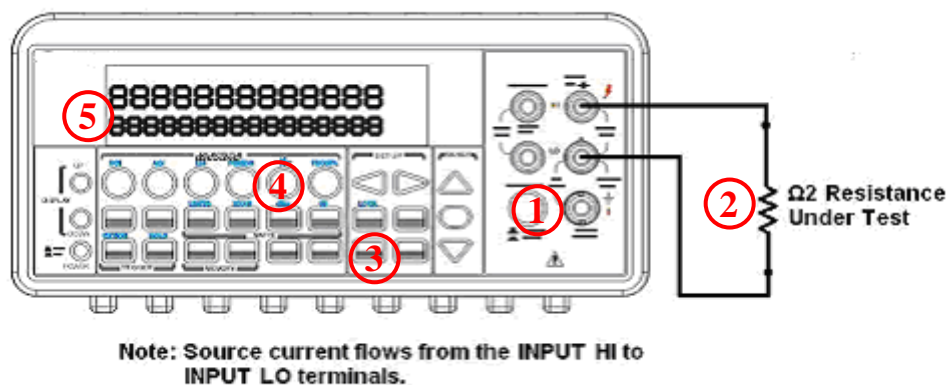
Figure 3-10

2.6 Diode Measurements

DL-2060 uses a current source of 1 mA for diode testing. The maximum resolution is 10 µV on a fixed range of 1 V DC. The default threshold voltage is fixed between 0.3 and 0.8 volts and the reading rate is fixed at 0.1 PLC (The voltage bound is adjustable from 0.01V up to 1.2V.). A "Beep" sound will appear when the diode measured value is in the range.

⚠ Warning! Positive end of the source signal is to be cennected to HI of the input terminals, and the negative end to LO of the input terminals.

※ Note:There is no beep sound if the setup for "BEEP" that can be made within the "MENU" is OFF.

How to measure diode

① Selects input signal connections on front or rear panel.
② Connect the diode to the terminals. For forward bias, connect the probe from input terminal "HI" to the positive end (Anode) of the diode, and connect the probe from input terminal "LO" to the negative end (Cathode) of the diode.
③ Set voltage bound via pressing CONFIG + SHIFT + ▶⊢ (CONT) buttons. When ready, press ENTER. (Or skip this step if you wish to use the default voltage bound.)
④ Press SHIFT + ▶⊢(CONT) buttons to select the diode testing function and observe the reading on the display.

※ Note:The response value while OPEN will be approximately 1.2V while remote interface is used. This value differs from the real value.
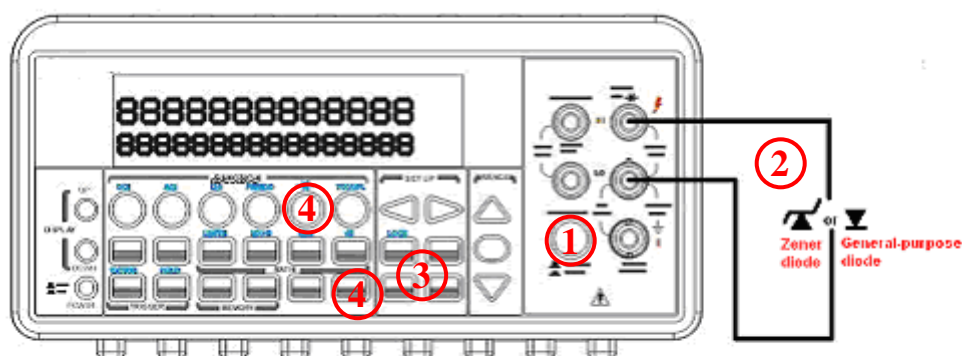
Note: Source current flows from the INPUT HI to INPUT LO terminals.

Figure 3-11

2.7 Temperature Measurements

The DL-2060 supports thermocouples and resistance temperature detector (RTD) types of probes. For thermocouples, DL-2060 supports 7 types: E, J, K, N, R, S and T. Please refer to **Table 3-1** for their temperature ranges. Be sure that the temperature function is configured for the right sensor type before making measurements (Refer to 3.1.8 for how to make the sensor configuration).

In general, RTDs have a better accuracy and long-term stability than thermocouples. The default RTD type in DL-2060 is PT100 and the thermocouple is type K.

Table 3-1

Sensor Type	Temperature Range(°C)	Temperature Range(°F)
E	-270 to 1000	-518 to 1832
J	-210 to 1200	-140 to 2192
K	-270 to 1372	-518 to 2502
N	-270 to 1300	-518 to 2372
R	-50 to 1768	-122 to 3236
S	-50 to 1768	-122 to 3236
T	-270 to 400	-518 to 752
RTD (PT 100)	-200 to 850	-392 to 1562

2.7.1 Thermocouple Measurements

Connect the thermocouple adapter (TA-65 option: only for K-type) to the banana jacks on the front panel. The difference between each type is subject to the patch thermal leads.

※ Note:Only connection via the front panel can be used for temperature measurements.

How to measure thermocouple

① Use terminals switch to select terminals on the front panel.
② To measure thermocouple must be via thermocouple adapter and the low thermal patch leads as shown in **Figure 3-12**. (When the mentioned modules are well connected as the following figure, please go to the next step.)
③ Configure the thermocouple type and unit using CONFIG + SHIFT + TCOUPL(TEMP),

such as K TYPE and ºC. When ready, press ENTER button.

④ Press SHIFT + TEMP buttons.

⑤ Take the reading on the display.
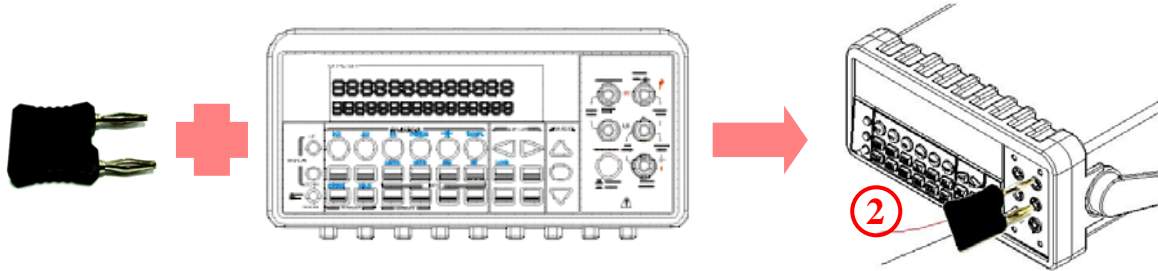
Figure 3-12

2.7.2   RTD Measurements

There are three kinds of temperature measurements with RTDs: 2-wire, 3-wire and 4-wire measurements. You will find connection instructions and measuring procedures in the following sections. The source current for the RTD measurement is 1 mA.

2.7.2.1   2-Wire RTD Measurements

How to measure temperature with 2-Wire RTD

The following **Figure 3-13** shows theory diagram of 2-Wire RTD measurement.

① Use terminals switch to select front terminals.

② Insert a specified adapter into the front terminals.

③ Configure sensor type and unit using CONFIG + TEMP and ◁ or ▷. When ready, press ENTER button.

④ Press TEMP button.

⑤ Place RTD in the desired position and take the reading on the display.
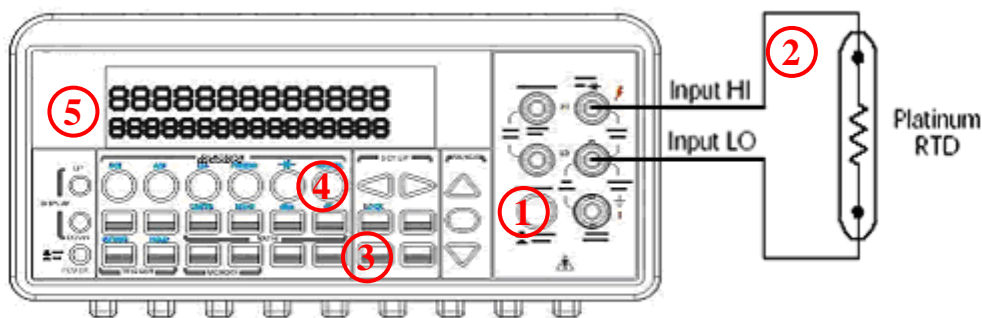
Note: Source current flows from the INPUT HI to INPUT LO terminals.

Figure 3-13

2.7.2.2 3-Wire RTD Measurements

How to measure temperature with 3-Wire RTD

The following **Figure 3-15** shows theory diagram of 3-Wire RTD measurement.

① Use terminals switch to select front terminals.
② Insert a specified adapter into the front terminals.
③ Configure sensor type and transducer as you would be with 4-wire RTD and unit using CONFIG + TEMP and ◁ or ▷. When ready, press ENTER button.
④ Press TEMP button.
⑤ Place RTD in the desired position and take the reading on the display.

※ Note: When users do the 3-wire RTD measurement the input LO and sense LO have to be connected in short condition.
※ Note: "Source" means RTD Probe.
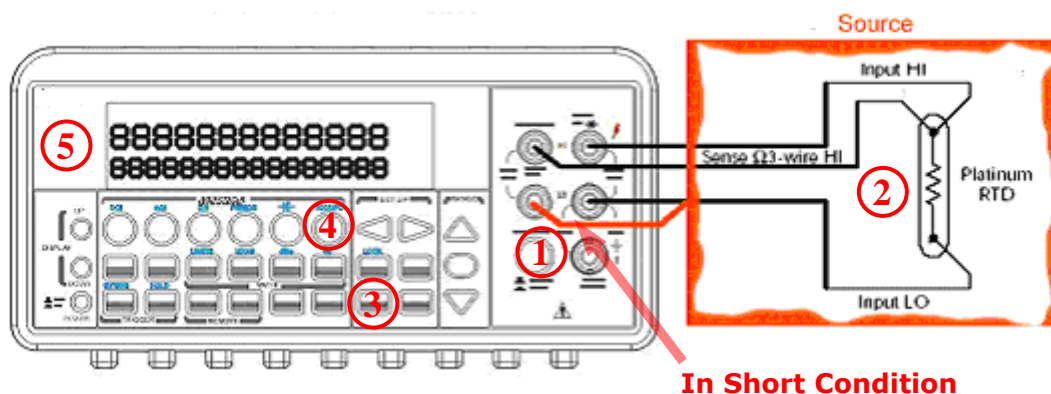
Figure 3-15

2.7.2.3 4-Wire RTD Measurements

How to measure temperature with 4-Wire RTD

The following **Figure 3-17** shows theory diagram of 4-Wire RTD measurement.

① Use terminals switch to select front terminals.
② Insert a specified adapter into the front terminals.
③ Configure sensor type,unit and transducer using CONFIG + TEMP and ◁ or ▷. When ready, press ENTER button.
④ Press TEMP button.
⑤ Place RTD in the desired position and take the reading on the display.
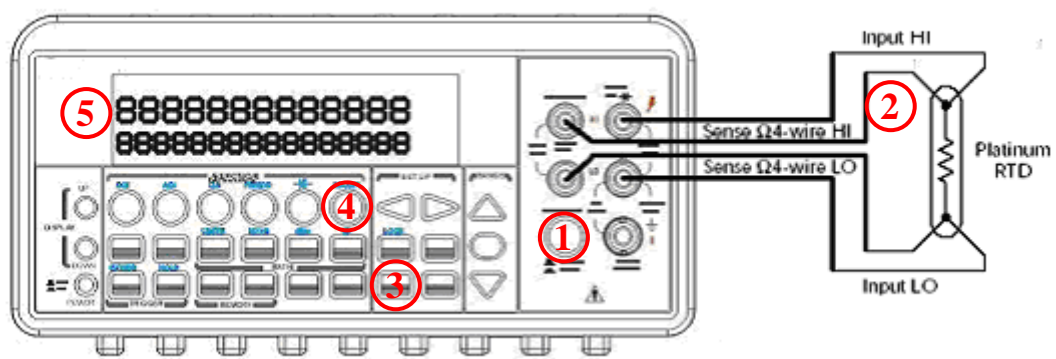
Figure 3-17

3 Front Panel Operations

This chapter contains information about how to change the parameters and settings for your measurements and all the details about each feature and function.

3.1 Measurement Configuration

The following information will guide you through ways to configure measurement functions. It provides you the flexibility to change any parameter in any measurement function when needed, including ADC setting, filter, resolution setting (digits), DC input resistance, threshold resistance (continuity), range (manual & auto), rate (integration time), sensor type for temperature measurements, remote interface selection and input terminal switch.

3.1.1 Set ADC (Auto Zero)

Zero

The purpose of Auto Zero functions are used for minimizing the offset influence on your measurements. When Auto Zero is enabled (no individual setup), DL-2060 takes the input signal reading as a base value and then internally disconnects the input signal, and takes a offset reading (a null offset).   It then subtracts the offset from the base to get an accurate measurement.

Displayed reading = Base value (input signal) – Offset value

When the Auto Zero is enabled the meter takes an offset reading for each subsequent measurement. However, when Auto Zero is disabled, the meter only takes one offset reading each time when you change the function settings.

Defaults

The default settings for Auto Zero are enabled. The user selected values for Auto Zero are stored in a volatile memory and the default settings will be restored when the meter is power-off.

How to set Auto Zero

You can change the Auto Zero setting through the front panel or through the remote interface operation.

Front Panel Operation

The following steps show how to set Auto Zero directly through the front panel.

Be aware of that Auto Zero setting is always affected by the resolution setting. Whenever the resolution is altered, Auto Zero may be accordingly changed accordingly. The relation between resolution and Auto Zero is shown in **Table 4-1**.

Press MENU and then ENTER on SET ADC. If "SET ADC" is not shown on the display, use ◁ and ▷ buttons to locate it. Press ENTER on ZERO Again, use ◁ and ▷ buttons to locate it if it is not shown on the display. Press ENTER on AUTO ZERO option and then use ◁ and ▷ to the "ON" or "OFF". Press "ENTER" by your choice. The locations of these buttons are shown with red rectangle frames in **Figure 4-1**.

Procedures: MENU→SET ADC → ZERO→ AUTO ZERO {ON|OFF}

Table 4-1

Resolution	Auto Zero	Integration Time(PLC)
Fast 4 ½ digits	Off	0.02
Slow 4 ½ digits	On	0.1
Fast 5 ½ digits	Off	0.1
Slow 5 ½ digits	On	1
Fast 6 ½ digits	On	1
Slow 6 ½ digits	On	10

※ Note: To change resolution, refer to Section 4.1.3: Resolution Setting in this chapter.
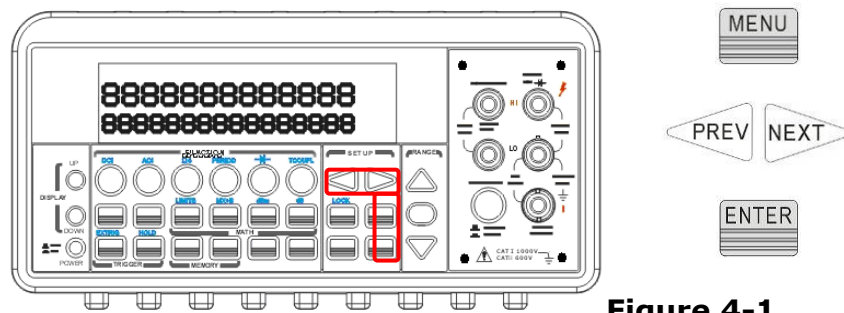
Figure 4-1

Remote Interface Operation

To set Auto Zero through the remote interface, use the following commands:

SENSe:ZERO:AUTO {OFF|ONCE|ON}

The OFF and ONCE parameters have a similar effect. Auto Zero OFF doesn't issue a new offset measurement. However, Auto Zero ONCE issues an immediate offset measurement.

3.1.2   Filter

Filter is used to remove noises in measurement readings.   DL-2060 is equipped with two types of filters: AC filter and digital filter.   AC filter is for AC measurements only.   It also affects the speed of the multimeter to yield a measurement reading.   Digital filter further stabilizes the measurement readings by averaging.   Both of them are described in detail in the subsequent sections respectively.

3.1.2.1   AC Filter

Definition:
User is allowed to set the bandwidth for selecting one of the three AC filters (Slow, Medium and Fast), in order to achieve either higher accuracy in low frequency measurements or faster AC settling time.

Defaults
The factory default is 20 Hz (Medium). Users can select their filter type as they wish when setting bandwidth value. The selection is stored in a volatile memory and the default setting will be restored when the meter is power-off.

Table 4-2

Bandwidth	AC Filter	Time (seconds per reading)
3 Hz – 300 kHz	Slow	7
20 Hz – 300 kHz	Medium	1
200 Hz – 300 kHz	Fast	0.1

How to set AC Filter in AC measurements:

User can set the AC Filter either through the front panel operation or through the remote interface operation.

Front Panel Operation

Press CONFIG + ACV button. Use ◁ and ▷ buttons to locate "BAND WIDTH" submenu, and then press ENTER to select it. Look for the desired bandwidth using ◁ and ▷ buttons. Then press ENTER on your selection. There are three options: 3Hz, 20Hz and 200Hz. The locations of these buttons are shown with red rectangle frames in **Figure 4-2**.
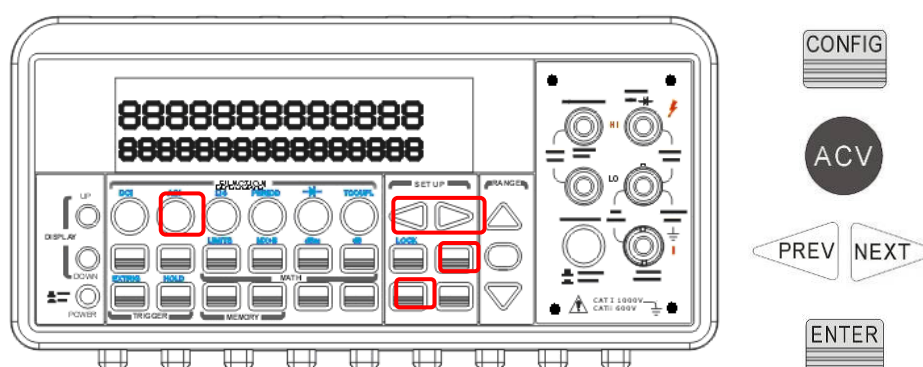
Figure 4-2

Remote Interface Operation

From your PC terminal, use the following command to specify the filter type:

DETector:BANDwidth {3|20|200|MIN|MAX}

3.1.2.2 Digital Filter

Definition:

DL-2060 uses an averaging digital filter to yield a reading for display from a specified number of measurement readings in the past. The past measurement readings are stored in a stack of memory. The number may be in the range of 2 to 100. User may select one of the two modes of digital filter operations: Moving Average and Repeating Average.

The moving average filter puts the specified number of reading conversions in a first-in, first-out order.   The very first measurement reading simply fills up the stack.   To yield a reading for display, the filter produces an average of the stacked measurement readings every time a new measurement reading is available and replaces the oldest reading in the stack. In the repeating average mode, the multimeter waits for the measurement reading stack to fill up and then take an average to produce a reading for display.   It then flushes the stack and starts over with an empty stack. Consequently, the repeating digital filter yields one reading for display every specified number of measurement readings.

Digital filter is not available for diode, continuity, frequency and period measurements.

Default
The digital filter is enabled and is in moving average mode with 10 readings by default.

How to enable/disable digital filter
Press FILTER button to switch the digital filter function.   The "FILT" anunnciator indicates the state of the digital filter. When it is lit, the filter is enabled.

How to configure digital filter:
You can configure the digital Filter either through the front panel operation or through the remote interface operation.

Front Panel Operation
For READINGS setting, please press CONFIG and then FILTER button for selecting READINGS. Press ENTER to access.   Use $\triangleleft$, $\triangleright$, $\triangle$ and $\triangledown$ buttons to set the READINGS (from 2 to 100) in order to get an average value. Press ENTER when it's ready.
For MODE setting, please press CONFIG and then FILTER button for selecting MODE. Press ENTER to access. Use $\triangleleft$, $\triangleright$ to select MOVING AVG. or REPEAT AVG.. Please ENTER to confirm.
Press ESC button to enable or disable this function.
Remote Interface Operation
Use the following commands to set your digital filter:

SENSe:AVERage:TCONtrol {MOVing|REPeat}
SENSe:AVERage:TCONtrol?
SENSe:AVERage:COUNt {<*value*>|MINimum|MAXimum}
SENSe:AVERage:COUNt? [MINimum|MAXimum]
SENSe:AVERage:STATe {OFF|ON}
SENSe:AVERage:STATe?

3.1.3　Resolution Setting (Digits)

Definition

Resolution is the number of digits a multimeter can measure. User can select the resolution for a specific measurement. The choices for the resolution setting are: fast 4 1/2, slow 4 1/2, fast 5 1/2, slow 5 1/2, fast 6 1/2 and slow 6 1/2. For a higher accuracy, user can select 6 1/2 digit resolution. For a faster measurement, user can select 4 1/2 digit resolution.

The resolution setting applies to all math operations under the selected measurement function. The selected value is stored in a volatile memory and the setting is only valid for the current measurement function. User can select different resolution for different measurement function.

Default

The default value for the resolution is slow 5 1/2 digit and the default value will be restored when the meter has been turned off or after a remote interface reset. The user selected value for the resolution setting is stored in a volatile memory and the setting is only valid for the current measurement function. Please refer to **Table 2-1** on page 14.

※ Note: The resolution setting for AC measurements is actually fixed at 6 ½ digits. When user selects a lower resolution, the meter will mask out the extra digits. User's selection of resolution for AC function will not affect the actual speed or accuracy.

How to set the resolution

The resolution can be set either through the front panel or the remote interface operation.

Front Panel Operation

There are two ways to set the resolution. The locations of the buttons are shown with red rectangle frames in **Figure 4-3**.

A.

● First select your desired measurement function by pressing one of the function buttons located on the first row of your meter's front panel.

● Press DIGITS button to select your desired resolution for your measurement. User can press DIGITS button several times to see how the resolution setting changes from 4 1/2, 5 1/2 to 6 1/2.

※ Note: When using Method A to set the resolution, your options are 4 1/2 (slow), 5 1/2 (slow) and 6 1/2 (fast).

B.

- Press CONFIG and then select a function as you wish from DCV, DCI (SHIFT +DCV), Ω2, Ω4 (SHIFT + Ω2), FREQ and PERIOD (SHIFT + FREQ).
- Press ENTER on RESOLUTION submenu. If it is not shown on the display, use ◁ and ▷ to locate it.
- Use ◁ and ▷ to find your desired resolution. Press ENTER on your choice.

※ Note: The resolution of AC measurements is fixed at 6 1/2 digit.
※ Note: The options for frequency and period measurements are 4 1/2 (slow), 5 1/2 (slow) and 6 1/2 (slow).

Figure 4-3

Remote Interface Operation

Use the following commands on your PC terminal to set the resolution for your measurement.

CONFigure:<function> <range>,<resolution>
MEASure:<function>? <range>,<resolution>
SENSe:<function>:RESolution <resolution>

Users can specify the resolution in the same units as the measurement function, not in number of digits. For instance, specify the resolution in volts and the frequency in herts. The examples are in the following.

CONF:VOLT:DC 10,0.001	**(4 1/2 digits on the10Vdc range)**
MEAS:CURR:AC? 1,1E-6	**(6 1/2 digits on the1A range)**
CONF:FREQ 1kHz,0.1Hz	**(1000 Hz input, 0.1Hz resolution)**
VOLT:AC:RES 0.05	**(50mV resolution on the ac function)**

3.1.4 DC Input Resistance

Definition

To reduce the effect of loading errors due to the input resistance, DL-2060 allows user to select a much larger input resistance (> 10G Ω) for low input DC voltage (100mV, 1V and 10V) measurements. This feature is only available for DC voltage measurements and it is not applicable to other measurement functions.

Default

The default input resistance for all measurements is 10M Ω. Please refer to **Table 2-1** on page 14. The DC input resistance can only be changed for measurements with 100mV, 1V or 10V range. For 100V DCV, 1000 V DCV and other measurement functions, the input resistance is fixed at 10M Ω and can not be changed. Also note that the user selected value is stored in a volatile memory. The default setting will be restored after the meter has been turned off.

How to set the DC input resistance

You can set the DC input resistance either through the front panel operation or through the remote interface operation.

Front Panel Operation

Press CONFIG + DCV , and then use ◁ and ▷ buttons to locate "INPUT R" option. Press ENTER to select it. Then select desired value for the input resistance by pressing ◁ or ▷ button. Press ENTER to choose it. Two values are available: 10M Ω or > 10G Ω. The locations of these buttons are shown with red rectangle frames in **Figure 4-4**.
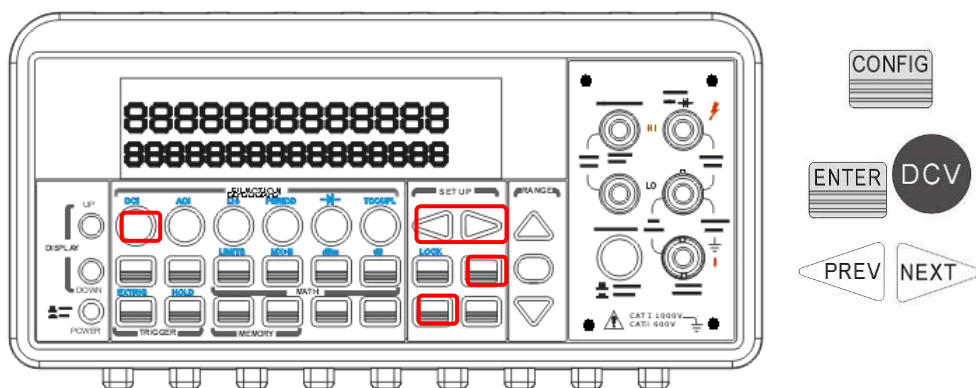
Figure 4-4

Remote Interface Operation

The automatic input resistance mode can be enabled / disabled. With AUTO OFF (default), the input resistance is fixed at 10MΩ for all ranges. With AUTO ON, the input resistance is set to >10GΩ for the three lowest DC voltage ranges (100mV, 1V and 10V). Use the following command from your PC terminal to disable the auto input DC resistance setting (the result is a fixed input DC resistance at 10M Ω for all measurements.)

INPut:IMPedance:AUTO {OFF | ON}

3.1.5 Threshold Resistance (Continuity)

Definition

When testing continuity, the beeper goes off when the measured resistance is less than the threshold resistance. The threshold resistance can be set to any value between 1Ω and 1000Ω.

Default

The factory default for continuity threshold resistance is 10Ω. User's selection is stored in a volatile memory and the default value will be restored after the meter has been turned off.

How to set the threshold resistance

User can change the threshold resistance only through the front panel. Press CONFIG button and then CONT button. Use ◁ and ▷ buttons to move through the digits and lower or increase the number to your desired value using △ and ▽ buttons , then press ENTER button to set the value. The locations of these buttons are shown with red rectangle frames in **Figure 4-5**.
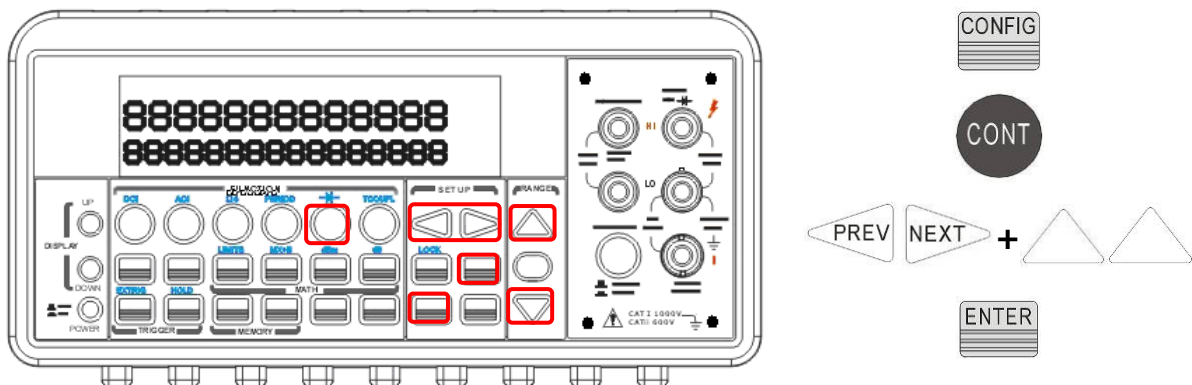
Figure 4-5

3.1.6 Range (Manual & Auto)

Definition

When making measurements except CONT, DIODE and Temperature, you can let the machine choose ranges for you, or you can select the appropriate ranges manually by yourself. The difference between auto-range and manual-range is the settling time. Auto-range is a convenient way for user, but manual-range can usually speed up the process.

If the input signal is beyond allowed range, an "OVLD" message will be shown on the display. The threshold of maximum/minimum readings for each range are 120 % of the range for maximum and 10% of the range for minimum.

Default

The default is auto-range. The user selected range is stored in volatile memory and the default will be restored when the meter is power-off. Please refer to **Table 2-1** on page 14 for the factory default range**.**

How to set the auto / manual range:

You can set the auto / manual range either through the front panel operation or through the remote interface operation.

Front Panel Operation

First choose a measurement function on the front panel, then press "AUTO" button to select auto-range feature. Or use △ and ▽ buttons to manually select a range. If selected range is not shown on the bottom of the display, press round PREV or NEXT buttons until the range information appears. The locations of these buttons are shown with a red rectangle frame in **Figure 4-6**.
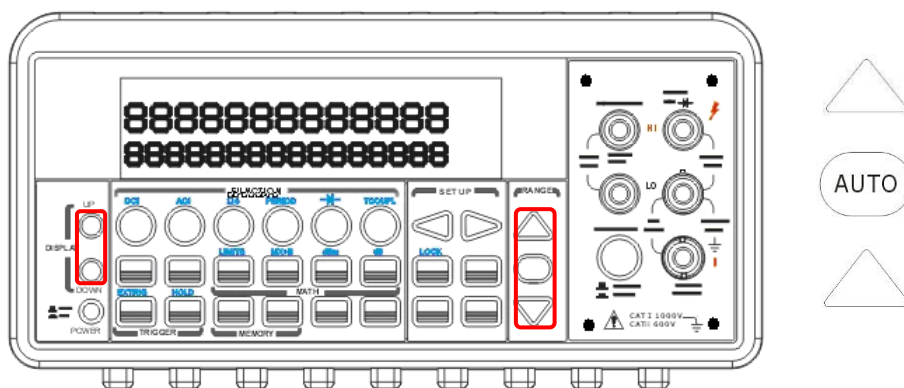
Figure 4-6

Remote Interface Operation

Use the following commands from your PC terminal to set the range:

CONFigure:<function> <range>,<resolution>

MEASure:<function>? <range>,<resolution>

SENSe:<function>:RANGe <range>

SENSe:<function>:RANGe:AUTO {OFF|ON}

3.1.7　Rate (Integration Time)

Definition

Integration time is the period of time the analog-to-digital (A/D) converter takes to sample the input signal. The integration time feature allows user to optimize either the speed or the resolution, as well as the noise rejection and the accuracy of the measurement. The unit of the integration time is in PLC (power line cycles). One PLC for 60 Hz is 16.67 ms, and for 50 Hz is 20 ms.

There are 4 different integration times in DL-2060 for user to select from: 0.02, 0.1, 1 and 10 PLC.

Default

For DCV, DCI, and resistance measurement, the default integration time is 1 PLC. The user selected value is stored in a volatile memory and the default value will be restored when the meter is power-off.

How to set the integration time:

You can set the integration time either through the front panel operation or through the remote interface operation.

Front Panel Operation

Integration time is set indirectly when user selects the measurement resolution. Please refer to chapter 3.1.3 for details about how to set resolution or the digits.

Remote Interface Operation

Use the following commands on your PC terminal to set the resolution.

CONFigure:< function> <range>, <resolution>

MEASure:< function>? <range>, <resolution>

SENSe:< function>:RESolution <resolution>

Or you can set integration time directly by the following commands.

SENSe:VOLTage:DC:NPLCycles {0.02|0.1|1|10|MINimum|MAXimum}

SENSe:VOLTage:DC:NPLCycles? [MINimum|MAXimum]

SENSe:CURRent:DC:NPLCycles {0.02|0.1|1|10|MINimum|MAXimum}

SENSe:CURRent:DC:NPLCycles? [MINimum|MAXimum]

SENSe:RESistance:NPLCycles {0.02|0.1|1|10|MINimum|MAXimum}

SENSe:RESistance:NPLCycles? [MINimum|MAXimum]

SENSe:FRESistance:NPLCycles {0.02|0.1|1|10|MINimum|MAXimum}

SENSe:FRESistance:NPLCycles? [MINimum|MAXimum]

For frequency and period measurements, aperture time (or gate time) is analogous to integration time, and you can use the following commands to set it. Specify 10 ms (4 1/2 digits), 100 ms (default; 5 1/2 digits), or 1 second (6 1/2 digits).

SENSe:FREQuency:APERture {0.01|0.1|1|MINimum|MAXimum}

SENSe:FREQuency:APERture? [MINimum|MAXimum]

SENSe:PERiod:APERture {0.01|0.1|1|MINimum|MAXimum}

SENSe:PERiod:APERture? [MINimum|MAXimum]

3.1.8 Sensor Selection for Temperature Measurements

The multimeter supports both thermocouple and RTD. User needs to configure the multimeter for the right sensor type before they can make temperature measurements.

RTD

Definition

If you are using RTD, the options are: PT100, D100, F100, PT385, PT3916, user-defined RTD, NTCT and SPRTD. If you need to change the factors that are used to calculate the temperature in RTD, choose user-defined RTD in which you are able to change any factors as you wish. The default factors used are listed in **Table 4-3**:

Table 4-3

Type	Alpha	Beta	Delta	R-zero
PT100	0.003850	0.10863	1.49990	100Ω
D100	0.003920	0.10630	1.49710	100Ω
F100	0.003900	0.11000	1.49589	100Ω
PT385	0.003850	0.11100	1.50700	100Ω
PT3916	0.003916	0.11600	1.50594	100Ω
NTCT	0.003850	0.10863	1.49990	100Ω

Here is the temperature equation that is used to determine the RTD temperature:

When $t < 0 {}^{\circ}C$:

$$R_t = R_0\left[1 + At + Bt^2 + Ct^3(t - 100)\right]$$

When $0°C < t < 630°C$:

$$R_t = R_0\left(1 + At + Bt^2\right)$$

Where:

$$A = \alpha\left(1 + \frac{\delta}{100}\right)$$

$$B = -\alpha\delta \cdot 10^{-4}$$

$$C = -\alpha\beta \cdot 10^{-8}$$

If you are using SPRTD(Standard Platinum RTD), select SPRTD and specify the seven coefficients under SPRTD submenu.

The ITS (International Temperature Scale) -90 standard provides two reference equations for Standard Platinum Thermometers covering temperature range from 18.8033K to 1234.93K. However, one SPRTD usually cannot cover the entire range, so the temperature range is broken up into a few subranges. These subranges depend on the calibration point of temperature scale and are based on the melting or triple points of various pure substances. For an exact list of the elements needed and details on RTD calibration, refer to NIST Technical Note 1265 "Guidelines For Realizing the International Temperature Scale of 1990". In each subrange, the calibration constants required for that subrange are listed.

Default
The default sensor type in DL-2060 is PT100.

How to set up RTD
You can set up the RTD configuration either through the front panel operation or through the remote interface operation.

Front Panel Operation
If you are using RTD, press CONFIG and then TEMP. Use $\triangleleft$ and $\triangleright$ to locate SENSOR submenu. Press ENTER to go to the submenu. Use $\triangleleft$ and $\triangleright$ to locate your sensor type Press ENTER to select your desired sensor type.

Choosing **USER** takes you to a menu where you can specify factors used in the calculation equation to obtain the temperature. Use $\triangleleft$ and $\triangleright$ to move through the digits and $\triangle$ and $\triangledown$ to change the numbers to a desired value. Press ENTER to set the value.

Choosing **SPRTD** takes you to a menu where you can specify the seven coefficients that are used to determine the temperature. Use ◁ and ▷ to move through the digits and △ and ▽ to change the numbers to a desired value. Press ENTER to set the value.

Remote Interface Operation

Use the following commands to set up the RTD configuration.

SENSe:TEMPerature:RTD:TYPE{PT100|D100|F100|PT385|PT3916|USER|SPRTD|NTCT}

SENSe:UNIT {Cel|Far|K}

SENSe:UNIT?

SENSe:TEMPerature:RTD:RZERo {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:RTD:ALPHa {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:RTD:BETA {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:RTD:DELTa {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:RZERo {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:A4 {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:B4 {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:AX {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:BX {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:CX {<*value*>|MINimum|MAXimum}

SENSe:TEMPerature:SPRTD:DX {<*value*>|MINimum|MAXimum}

Thermocouple

Definition

If users are using the thermocouple function, the selections on the DL-2060 are: type E, J, K, N, R, S and T. (On the other hand, other selection "SIMULATED" simulates the reference junction.) To use the the thermocouple function, users have to adjust something. First of all, via a thermocouple adaptor, users need to measure a known and accurate reference temperature (T1) as a criterion. Then the display of the DL-2060 will show a reference value (T2). At the moment, a remainder (T3) from (T1 – T2) will be calculated. After that, users just adjust the default (simulated value 23.0°C) to 23.0°C + (T3). Under the circumstance, the thermocouple function will be activated completely.

For Example:

If the criterion value is (T1 =30.0°C), the reference value showing on the DL-2060 is (T2=24.0°C). Users will get a remainder T3 (T1 – T2 = 6.0°C). Then users just configure the default simulated value from 23.0°C to 29.0°C on the DL-2060.

How to set up thermocouple

You can set up the thermocouple configuration either through the front panel operation or through the remote interface operation.

Front Panel Operation

1. Configure the thermocouple type and unit. Pressing CONFIG > SHIFT > TEMP (TCOUPL), and then using PREV and NEXT to select the type and unit.
2. Measure a known and accurate reference temperature (T1). The result showing on the DL-2060 is (T2).
3. Adjust the simulated value (23.0°C to 23.0°C + T3.)
4. Configure the Simulated value by pressing CONFIG > SHIFT > TEMP(TCOUPL) > NEXT > SIMULATED > ENTER, and by buttons 「PREV」 or 「NEXT」 and △& ▽ assistance to adjust the value.

Remote Interface Operation

Use the following commands to set up the thermocouple configuration.

SENSe:UNIT {Cel|Far|K}

SENSe:UNIT?

SENSe:TCOuple:TYPE {E|J|K|N|R|S|T}

※ **SENSe:TCOuple:RJUNCtion:SIMulated {<*value*>|MINimum|MAXimum}**

※ **SENSe:TCOuple:RJUNCtion:SIMulated?**

   ※ This command is available with firmware version 1.05 or upward.

3.1.9 Remote Interface Selection

The multimeter supports both GPIB (G type only) and USB interfaces, but only one interface can be activated at a time. If you are using GPIB, you must set the address for the multimeter. You can set the address to any value from 0 and 31. The address is set to "22" when the multimeter is shipped from the factory.

※ Note: The remote interface can only be set through the front panel operations.

How to select a remote interface

Press MENU and then use ◁ and ▷ to select INTERFACE. Then Press ENTER on your choice of USB or GPIB interface.

How to set address when using GPIB

Press MENU and then use ◁ and ▷ to access INTERFACE. Select GPIB to set address. Use ◁, ▷, △and ▽ to adjust the numbers to the desired address. Press ENTER to set it.

3.1.10 Input Terminal Switch

Definition

User can select either the front input terminals or the rear input terminals for their measurements. There are 5 input terminals in the front panel as well as the rear panel. If the rear terminal is enabled the REAR annunciator at the upper side will be shown.

Default

The default situation is the front terminals.

How to switch the terminals:

To switch between the front and the rear input terminals, press "TERMINALS" switch button on the front panel. Please see the following figure for the location of the switch. The location of the button and terminals is shown with a red rectangle frame in **Figure 4-7**.
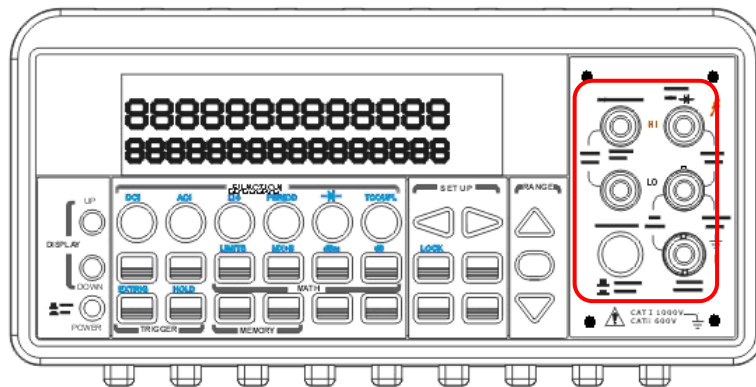
Figure 4-7

3.2 Trigger Operations

The triggering system of the DL-2060 will be explained in this section.

DL-2060 provides a various trigger operations such as trigger mode, trigger source, and different trigger settings for a specific measurement. The selected setup will be stored into the volatile memory and it returns to the default mode after power off. Following **Figure 4-8** describes the detail of the trigger setup.
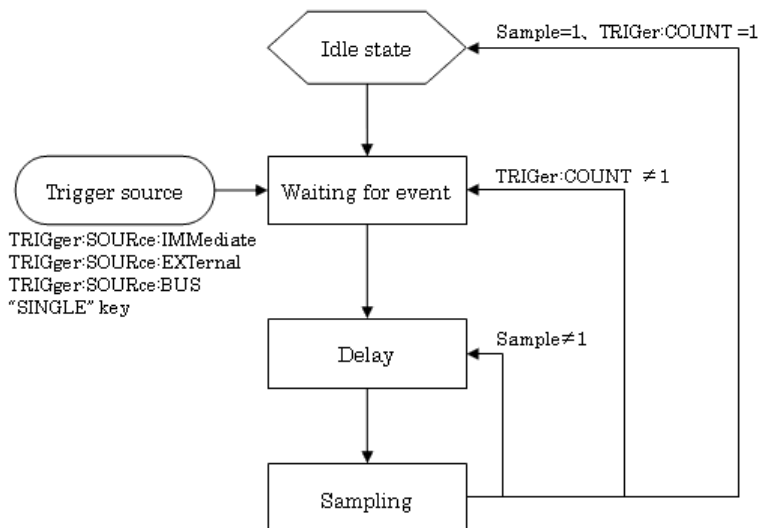
Trigger Operation Flow Chart

Figure 4-8

The trigger system is supposed to be in an idle status when DL-2060 is not measuring. (*(sampling)display will illuminates when measurement is in progress)

When starting measurement after idle status, the trigger system should be in trigger waiting status. To make is in trigger waiting status, execute one of the following command via remote interface.

INTiate

READ?

MEASure?

While DL-2060 is in trigger waiting status(Waiting for event), the measurement operation will starts after execution of trigger delay, when the trigger condition matches by detecting trigger signal from the selected trigger source etc. The operation form the front panel will always be trigger waiting status then receives trigger signal at any time.

3.2.1 Trigger Mode

There are three trigger modes in DL-2060: auto, immediate, and single triggering. User can specify the trigger mode for their measurement. The factory default is auto triggering when the meter is power-on.

A. Auto Triggering Mode (Front Panel Operation only)

Definition

Auto triggering takes continuous readings at a fastest rate possible for the present measurement. The rate of taking readings depends on the current settings. This function is only available through the front panel. The auto triggering is also the default for trigger mode in DL-2060.

How to use Auto Trigger

Press ATUO TRIGGER on the front panel to toggle for enabling auto trigger mode. The location of the button is shown with a red rectangle frame on **Figure 4-9**.
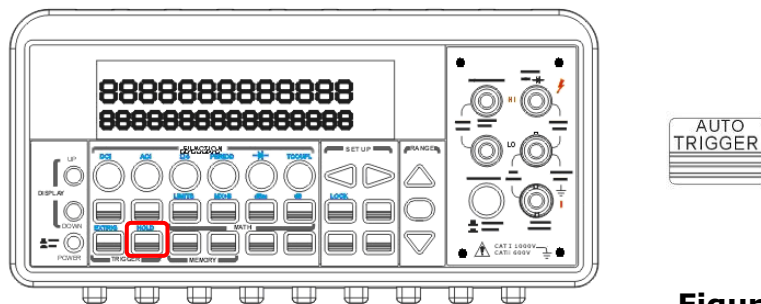
Figure 4-9

B. Internal Immediate Trigger Mode (Remote Interface Operation Only)

Definition

The immediate triggering mode is only available through the remote interface operations and it is the default for the remote interface operations. When the meter is in immediate trigger mode, a trigger will be issued immediately as soon as the meter is in "wait for event" state.

How to use Immediate Trigger

Use the following command in your PC terminal to set the internal immediate trigger.

TRIGger:SOURce IMMediate

C. Single Trigger Mode (accessible only through the front panel)

Definition

Single trigger mode takes one reading (or specified number of readings) each time when user presses SINGLE key. (Please refer to 3.2.3 for setting the number of samples on each trigger.) When the TRIG annunciator on the display is lit, the meter is ready for next trigger event. The single trigger mode is only available through the front panel operations.

How to use Single Trigger

First select the measurement function, and then press SINGLE key on the front panel to set the trigger mode. The location of the button is shown with a red rectangle frame in **Figure 4-10**.
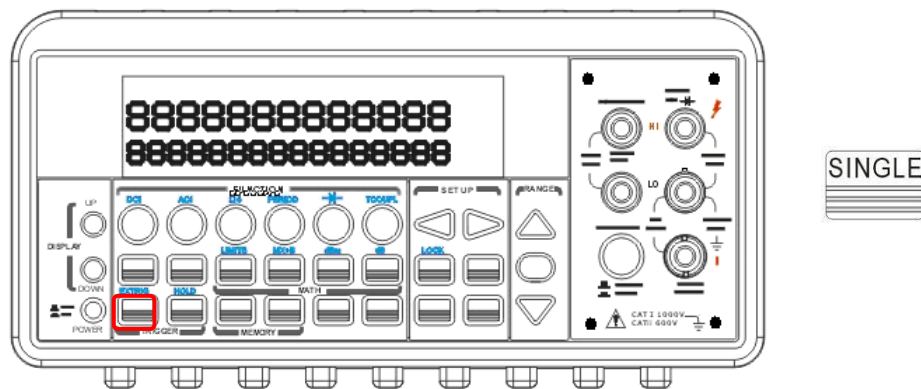
Figure 4-10

3.2.2 Trigger Source

In DL-2060, user can specify the trigger source to be one of these three options: front panel operations, external hardware trigger source and remote interface operations.

Front Panel Operation

Use the front panel buttons - AUTO TRIGGER for auto triggering and SINGLE for single triggering.

External Hardware

User applies a trigger pulse to the EXT TRIG (BNC) terminal on the rear panel. External hardware triggering is like using single trigger but the trigger source is an external hardware. When the multimeter receives a pulse from the trigger source, it takes one reading, or a specified number of readings. To set the external hardware trigger, press both the SHIFT + SINGLE buttons to enable external hardware trigger. The lit "EXT"

annunciator on the display indicates the enabling of the external hardware trigger. The folloeing figure shows level and timming of a trigger pules.

Figure EXT TRIG (Input) pulse

riggere edge

TTL: H
(5V)
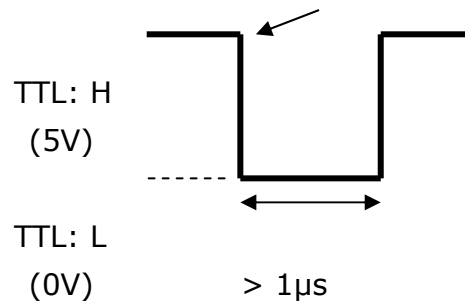
TTL: L
(0V)   > 1μs

VM COMP (Output)

The rear-panel VM COMP (Voltmeter complete) terminal provides a low-true pulse (TTL level) after the completion of each measurement. VM COMP and external trigger (see below) implement a standard hardware handshake sequence between measurement and switching devices.

Figure VM COMP (Output) pulse

riggere edge

TTL: H
(5V)

TTL: L
(0V)   Approximately 2μs
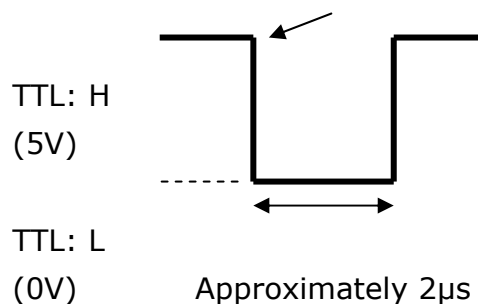
Remote Interface Operation (By software or internal trigger)

By software trigger: The software trigger is similar to the single triggering, but instead of using the "SINGLE" button on the front panel, you send a command from your PC to the multimeter to generate an event. For using software trigger, use the following command from your PC terminal to set trigger source:

TRIGger:SOURce BUS

By internal trigger: The internal trigger is the default trigger mode for the Remote Interface Operation. In the internal trigger mode, a trigger signal will be issued whenever the multimeter is in the wait-for-trigger state. To set the internal trigger, use the following command from your PC terminal:

TRIGger:SOURce IMMediate

3.2.3 Trigger Setting

In DL-2060, user can specify a variety of trigger settings including the number of samples per trigger, the number of triggers per event, reading hold, and the trigger delay for their measurements.

A. Number of samples on each trigger

By default, the multimeter takes only one reading on each trigger, but you can instruct the multimeter to take specific number (up to 50000) of readings each time it receives a trigger. The user's input setting is stored in a volatile memory which will be cleared after the meter has been turned off and the default value will be restored. You can set the number of samples on each trigger through front panel or the remote interface.

Front Panel Operation

Press MENU button and locate "TRIG" submenu by pressing ◁ and ▷ buttons. Press ENTER to choose "TRIG" option. Again locate "N SAMPLE" submenu using ◁ and ▷ buttons and then press ENTER to select it. Then set the desired number by pressing △ and ▽ buttons to increase or decrease the number, and using ◁ and ▷ buttons to move through the digits. The locations of these buttons are shown with red rectangle frames in **Figure 4-11**.

Procedures: MENU → TRIG → N SAMPLE →<Number>
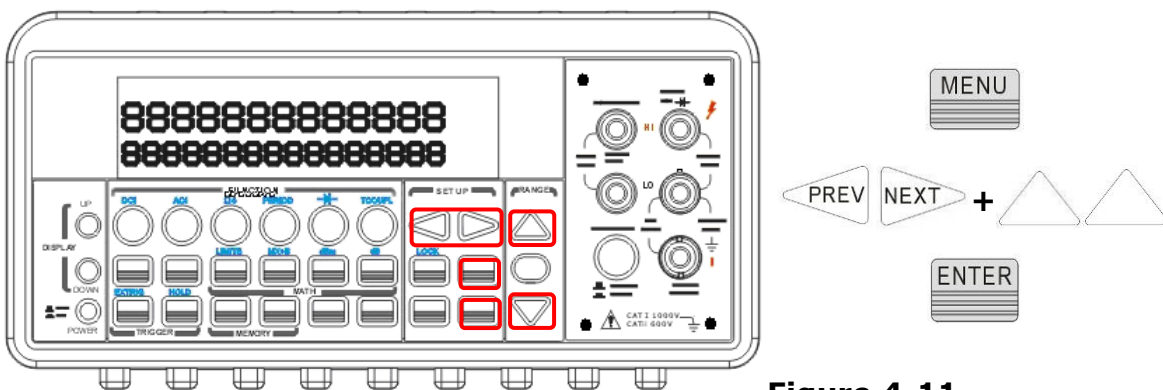
Figure 4-11

Remote Interface Operation

Use the following command to set the number of samples from your PC terminal.

SAMPle:COUNt <value>

B. Number of triggers

Although the meter normally takes one trigger before returning to the "idle" state, user can manually specify the number of triggers it accepts before the "idle" state. However, this can only be done through the remote interface. The following command show how to set multiple triggers per returning idle state.

TRIGger:COUNt <value>

C. Reading hold

The reading hold feature is used to hold a stable reading on the display. When a reading is stable, enabling the reading hold will hold the stable reading and trigger a beeping sound. Reading hold feature depends on an adjustable sensitivity band to determine if a reading is stable. The multimeter considers a reading stable when three consecutive readings are within the sensitivity band. Chapter 3.4.4 will explain how to adjust the sensitivity band.

How to use reading hold

This feature is only available from the front panel operations. To enable   reading hold, press both SHIFT and AUTO TRIGGER buttons. To disable it, simply press AUTO TRIGGER. The locations of the buttons are shown with red rectangle frames in **Figure 4-12**.
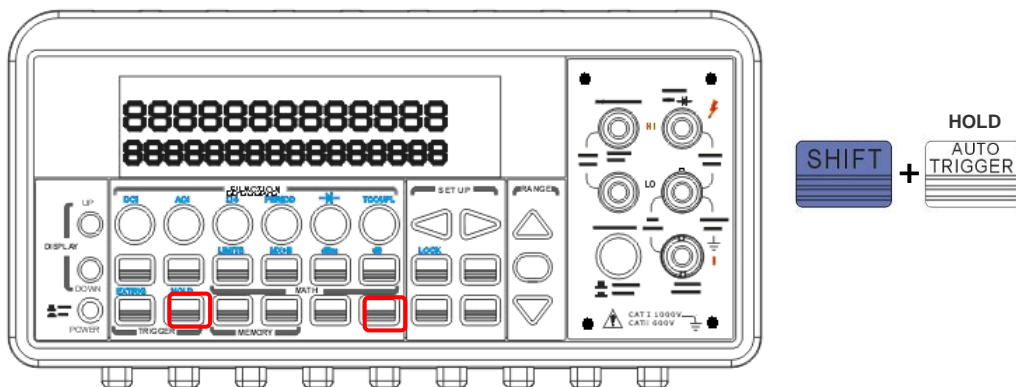
Figure 4-12

D. Trigger delay

This feature is useful for user who needs a longer delay time to wait for the system to be stabilized. The time needed to stabilize a measurement system is called the "settling time." The settling time depends on the measurement range, cable properties and signal source.

Defaults

The default of the trigger delay is automatic. DL-2060 automatically selects a delay time for you according to the setting of the measurement if you do not specify a delay. A list of the default for each measurement function is shown on **Table 4-4**. The range for the delay is from 0 to 3600 seconds. User's selection of delay time is stored in a volatile memory and the default will be restored when the meter is power-off.

The internal settings of automatic trigger delay

The delay time for automatic trigger delay is determined by the selection of measurement function, range, and the setting of integration time and AC filter speed. **The following table shows the default delay time for each measurement setting.**

Table 4-4

Measurement Function	Setting	Trigger Delay Time
DCV / DCI	PLC >= 1	1.5 ms
	PLC < 1	1.0 ms
Ω2 and Ω4 (PLC >= 1)	100Ω to 100kΩ	1.5 ms
	1 MΩ	15 ms
	10 MΩ to 100 MΩ	100 ms
Ω2 and Ω4 (PLC < 1)	100Ω to 100kΩ	1.0 ms
	1 MΩ	10 ms
	10 MΩ to 100 MΩ	100 ms
ACV / ACI (Remote Interface/External Trigger/Single Trigger)	3 Hz	7.0 s
	20 Hz	1.0 s
	200 Hz	600 ms
ACV / ACI (Front Panel w/ Auto Trigger On)	3 Hz	1.5 s
	20 Hz	200 ms
	200 Hz	100 ms
Frequency/Period	Remote Interface / ternal	1.0 s
	Front Panel / Auto Trigger ON	0 s

How to specify a delay time

User can set the delay time from either the front panel operations or the remote interface operations.

Front Panel Operation

To set the delay time, press MENU button and use ◁ and ▷ buttons to locate "TRIG" option. Press ENTER to select it. Then again find "DELAY" option using ◁ and ▷ buttons. Press ENTER to select it. Then use ◁ and ▷ buttons to move through the digits and △ and ▽ buttons to set the desired delay time (between 0 to 3600 second). The locations of the buttons are shown with red rectangle frames in **Figure 4-13**.
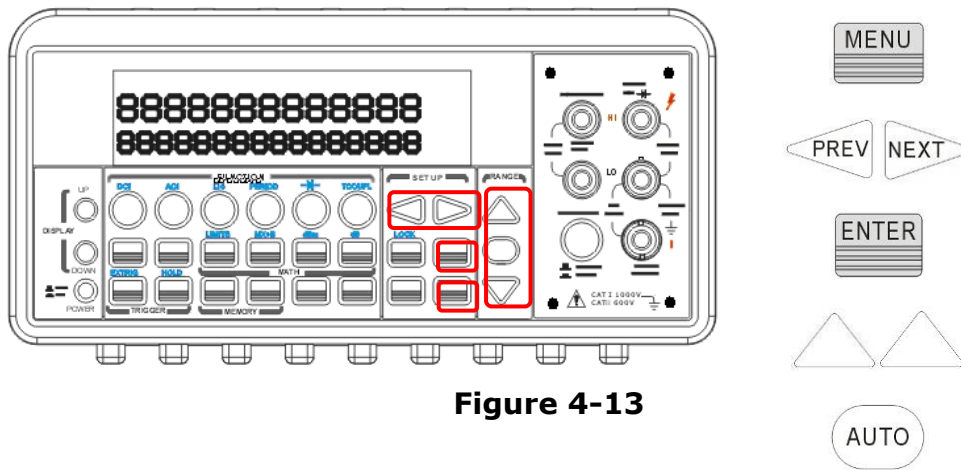
Figure 4-13

Remote Interface Operation

You can also use the remote interface operations from your PC terminal to set the trigger delay. To select a delay time, use the following command or set the trigger delay to be automatic:

TRIGger:DELay {<seconds>|MINimum|MAXimum}

or

TRIGger:DELay:AUTO {OFF|ON}

3.3 Math Operations

This section will introduce the mathematical operations in DL-2060. There are eight math operations: RITIO, %, Min/Max, NULL, Limits, MX+B, dB and dBm testing. They either store data for later use or perform mathematical operations on the readings. Note that these math operations are available to all measurement functions except continuity and diode testing.

※ Note: The "MATH" anunnciator on the display indicates the state of a mathematical feature, excluding Ratio, and will be lit by enabling whichever math feature. Also, press the same buttons again for the enabled math feature will disable the same math feature.

※ Note: Press RATIO button, the "RATIO" anunnciator will be lit on the display.

3.3.1 Ratio

This function calculates the ratio of an input DC voltage to a reference DC voltage according to the following equation:

$$Ratio = \frac{DC\ Input\ Voltage}{DC\ Reference\ Voltage}$$

How to make a ratio measurement

There are two ways to make a ratio measurement: Through the front panel operation or through the remote interface operation.

How to connect the input and the reference signals

Connect the Input Voltage to the INPUT HI and LO terminals, and the Reference Voltage to the SENSE HI and LO terminals. Then connect the SENSE LO to the INPUT LO terminals.

Front Panel Operation

Use TERMINALS button to select the front terminals or the rear terminals. For operating this function, please press RATIO button and observe the reading on the display. To set the resolution, press CONFIG + RATIO. Then press ENTER to choices "RESOLUTION" (Refer to 3.1.3). Select desired value by pressing ◁ and ▷ button, and press ENTER to choose it.
※ Note: To close this function, please press one of the measurement function buttons.
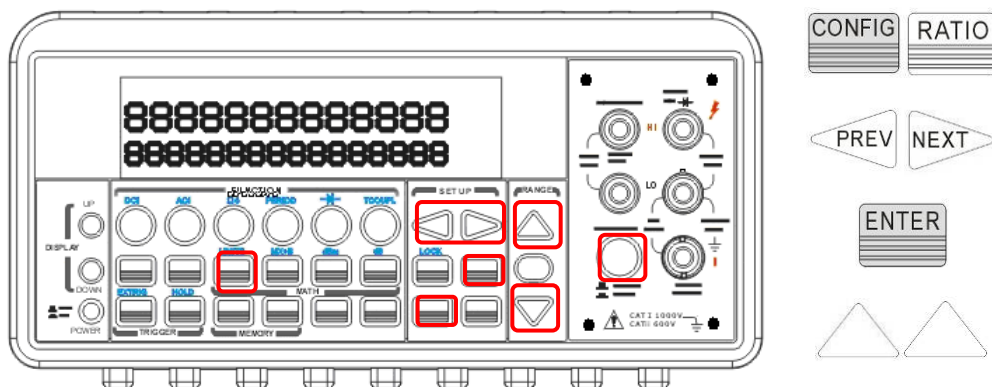
Figure 4-14

Remote Interface Operation

Use the following command to make a RATIO measurement.
CONFigure:VOLTage:DC:RATio {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

3.3.2 % (Percent)

Definition

This mathematical function calculates the ratio of a measurement reading to a specified target value as the form of percentage. The calculation formula is shown below:

$$Percent = \frac{Input\ Reading}{Target\ Value} \cdot 100$$

The specified target value is store in a volatile memory and will be cleared after the meter has been turned off or a remote interface reset.

How to use % (Percent) function

There are two ways to make a percent measurement: Through the front panel operation or through the remote interface operation.

Front Panel Operation

To specify a target value, user needs to configure Percent function by pressing CONFIG + %, then use ◁ and ▷ to move through the digits and △ and ▽ buttons to increase or decrease the numbers to a desired target value. Press ENTER to set the value. Press % to activate this function. And then observe the calculated percent value on the display as shown as **Figure 4-15**.

※ Note: Press % again to disable this function. The "MATH" annunciator on the display indicates the state of a mathematical feature.
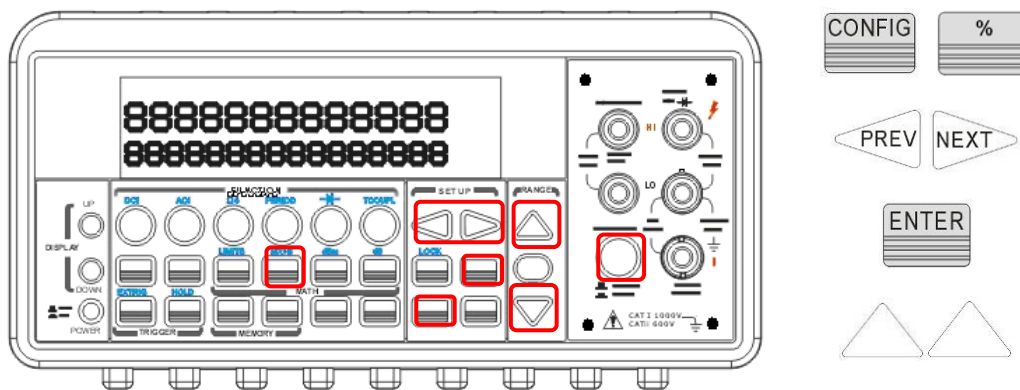
Figure 4-15

Remote Interface Operation

Use the following commands to enable and configure Percent function:

CALCulate:FUNCtion PERCent
CALCulate:STATe {OFF|ON}
CALCulate:STATe?
CALCulate:PERCent:TARGet {<*value*>|MINimum|MAXimum}
CALCulate:PERCent:TARGet? [MINimum|MAXimum]

3.3.3　Min/Max

Definition

When the Min/Max function is enabled, the multimeter takes in a series of readings from the measurements, stores the minimum and maximum readings in the memory, and then calculates the average value of all readings. The number of readings taken since Min/Max operation is enabled is recorded as well. These data are stored in a volatile memory and will be cleared when the meter is turned off, or when the MIN/MAX is turned on, or after a remote interface reset. The meter beeps every time when it captures a new minimum or maximum.

How to use Min/Max

You can use the Min/Max feature either through the front panel operation or the remote interface operation.

Front Panel Operation

User first selects the measurement function they wish to use, and then press MIN/MAX button to enable the Min/Max function. To read the min/max value, the average value or the readings count, user can press CONFIG button and then MIN/MAX button. Use ◁ and ▷ buttons to switch between those values. The locations of the buttons are shown with red rectangle frames in **Figure 4-16**.

※ Note: Press MIN/MAX again to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical feature.

Figure 4-16

Remote Interface Operation

The following commands show you how to use the Min/Max operation from your PC terminal.

CALCulate:FUNCtion AVERage
CALCulate:STATe {OFF|ON}

CALCulate:STATe?
CALCulate:AVERage:MINimum?
CALCulate:AVERage:MAXimum?
CALCulate:AVERage:AVERage?
CALCulate:AVERage:COUNt?

3.3.4 Null

Definition

When null function is enabled, the displayed measurement reading is the difference between the measured input signal reading and the stored null (also called relative) value. The null (relative) value is stored in a volatile memory and the value will be cleared when the multimeter is power-off. Moreover, user can specify or alter a null value. The null feature is available for all functions, except continuity, diode. When user selects the null feature for a measurement, it is visible only for this measurement.

How to use null (relative) measurement

You can activate null feature from either the front panel operation or the remote interface operation.

The Front Panel Operation

The null measurements can be used with any function except continuity and diode. To store the null test lead resistance, short the two test leads together and then press NULL button. The new reading taken will replace the old value, if any, in the null register. Then, connect the two test leads to the input source. The value with null offset will show on the display. In addition, the null offset value can be adjusted manually by pressing CONFIG then NULL. Use ◁ and ▷ buttons to move through the digits and use △ and ▽ buttons to increase or decrease the numbers to a desired value. Press ENTER to set the value. The locations of the buttons are shown with red rectangle frames in **Figure 4-17**.

※Note: Press NULL again to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical feature.

Figure 4-17

The Remote Interface Operation

You can use the following commands on your PC terminal to make a null measurement.

CALCulate:FUNCtion NULL

CALCulate:STATe {OFF|ON}

CALCulate:STATe?

CALCulate:NULL:OFFSet {**<value>|MAXimum|MINimum**}

3.3.5 Limits Test

The limits testing operation allows user to adjust a maximal and a minimal limit values. The multimeter beeps and an "HI" or "LO" message will be shown when the reading exceeds the upper or lower limit respectively. Users can specify the limit values and the values are stored in a volatile memory. The default values for both upper and lower limits are "0". This function is available to all except continuity and diode measurements.

How to set the limits

You can set the limits or make a limit testing either through the front panel or the remote interface operation.

Front Panel Operation

To set the limits, user needs to configure the LIMITS math function by pressing CONFIG + SHIFT + LIMITS(RATIO), and then use ◁ and ▷ to locate either lower limit (MIN) or upper limit (MAX). Press ENTER to select the limit you wish to set. Then use ◁ and ▷ to move through the digits and △ and ▽ to increase or decrease the numbers to a desired value. Press ENTER to set the value. The locations of the buttons are shown with red rectangle frames in **Figure 4-18**.
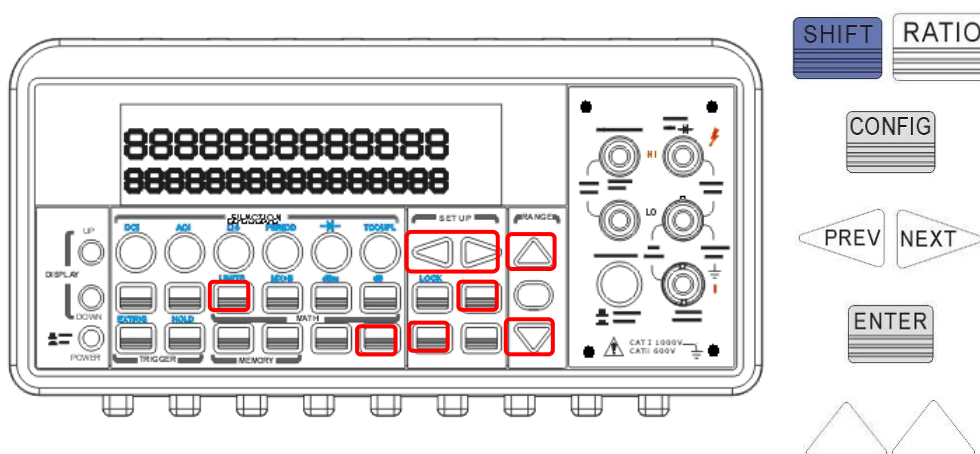
Figure 4-18

How to make a limit testing

The locations of the buttons are shown with red rectangle frames in **Figure 4-19**.

● Select a measurement function for purpose except continuity and diode.
● Enable the limit operation by pressing SHIFT + LIMITS(RATIO) buttons.
● After enabling the limit function, user can set the limit value as mentioned above.
● Observe the displayed reading.

※ Note: Press SHIFT+LIMITS(RATIO) again to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical feature.
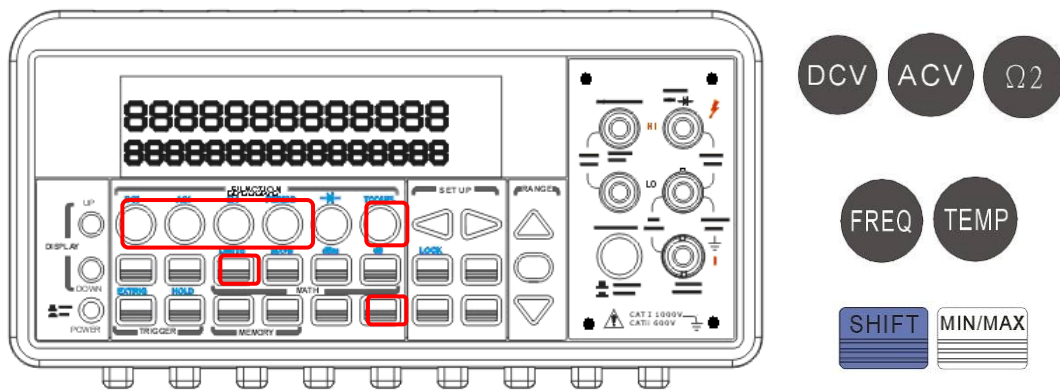
Figure 4-19

Remote Interface Operation

Use the following commands to enable the limits function or to set the limits:

CALCulate:FUNCtion LIMit
CALCulate:STATe {OFF|ON}
CALCulate:STATe?
CALCulate:LIMit:LOWer {<*value*>|MINimum|MAXimum}
CALCulate:LIMit:LOWer? [MINimum|MAXimum]
CALCulate:LIMit:UPPer {<*value*>|MINimum|MAXimum}
CALCulate:LIMit:UPPer? [MINimum|MAXimum]

Acquisition of limit test's result

The result for Pass/Fail test may be aquired from the USB connector located at rear panel for DL-2060.
Please refer "4.1 Pass/Fail output from USB connector" for detail.

3.3.6 MX+B

Definition

This mathematical function multiplies a measurement reading (X) by a specified scale factor (M) and add an offset (B) automatically. The answer (Y) will then be shown on the display according to the following equation.

$$Y=MX+B$$

This is especially useful when user needs to do slope calculations on a series of measurements. The values of the "M" and "B" can be changed through the configuration of this function and they are stored in a volatile memory and will be cleared after the meter has been turned off or a remote interface reset. User can either use front panel or remote interface to perform this function and set these two constant.

How to use MX+B function

You can use MX+B function from the front panel operation or the remote interface operation.

Front Panel Operation

To set the values of M and B, user needs to configure this math function by pressing CONFIG and SHIFT + MX+B(%). Use ◁ and ▷ to switch between M and B. Press ENTER on your selection. Then use ◁ and ▷ to move through the digits and use △ and ▽ to increase or decrease the number to a desired value. Press ENTER to set the value. User needs to set the values of M and B first. Then Select a measurement function and press SHIFT + MX+B(%) to activate MX+B function as shown as **Figure 4-20**.
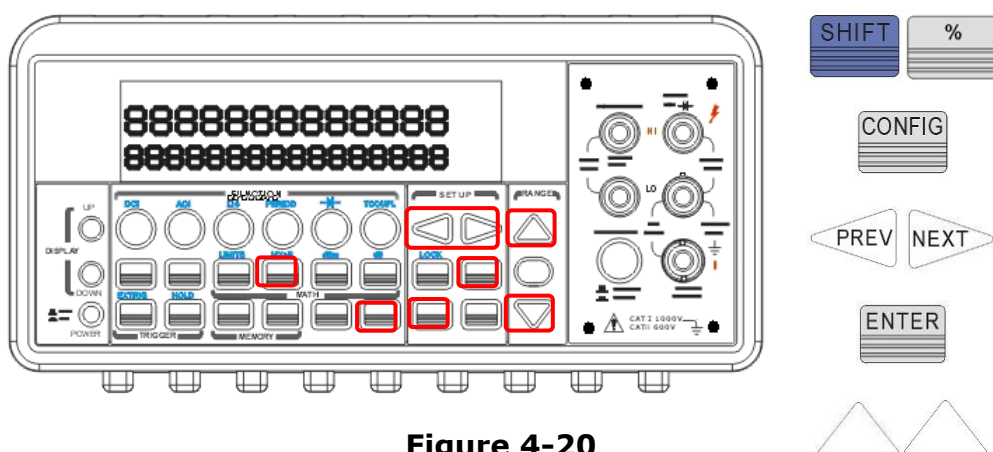
Figure 4-20

Remote Interface Operation

Use the following commands to enable and configure MX+B function:

CALCulate:FUNCtion MXB

CALCulate:STATe {OFF|ON}

CALCulate:STATe?

CALCulate:MXB:MMFactor {<*value*>|MINimum|MAXimum}

CALCulate:MXB:MMFactor? [MINimum|MAXimum]

CALCulate:MXB:MBFactor {<*value*>|MINimum|MAXimum}

CALCulate:MXB:MBFactor? [MINimum|MAXimum]

3.3.7 dB/dBm

A. dB

Definition

dB function will dB(decibel) indicates the difference after dBm convertion of both measured value and saved relative value. The dB measurement is applied to DC and AC voltage only. The range for the relative value is between 0 dBm and ±200 dBm. The relative value is adjustable and is stored in a volatile memory.

dB = (Input signal in dBm) − (Relative value in dBm)

How to make a dB measurement

User can either manually select a number for the relative reference or let the multimeter take the first reading .

※ Note: Press SHIFT+dB(NULL) again to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical feature.

Front Panel Operation

Method 1： **Manual setup of relative value**

Press CONFIG+ SHIFT+ dB(NULL) buttons, and then use ◁ and ▷ to move through the digits and △ and ▽ buttons to increase or decrease the numbers to your desired value. Press ENTER to set the value. The locations of the buttons are shown with red rectangle frames in **Figure 4-21**.
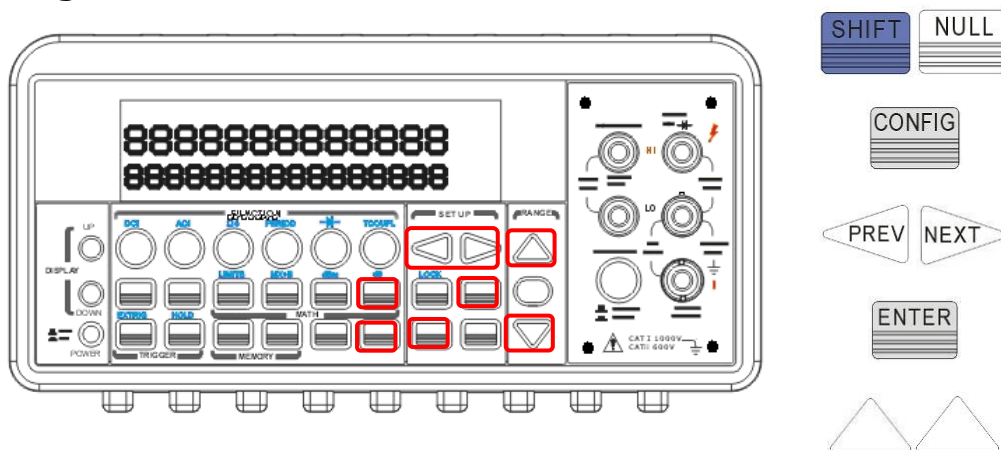
Figure 4-21

Method 2： **First measured value as relative value**

- Select the measurement function by pressing one of DCV and ACV buttons.
- Enable the dB operation by pressing SHIFT + dB(NULL) buttons.
- After enabling the dB operation, user can set or alter the dB relative value as mentioned above.
- Observe the displayed reading.

Figure 4-22 shows the locations of these buttons with red rectangle frames.
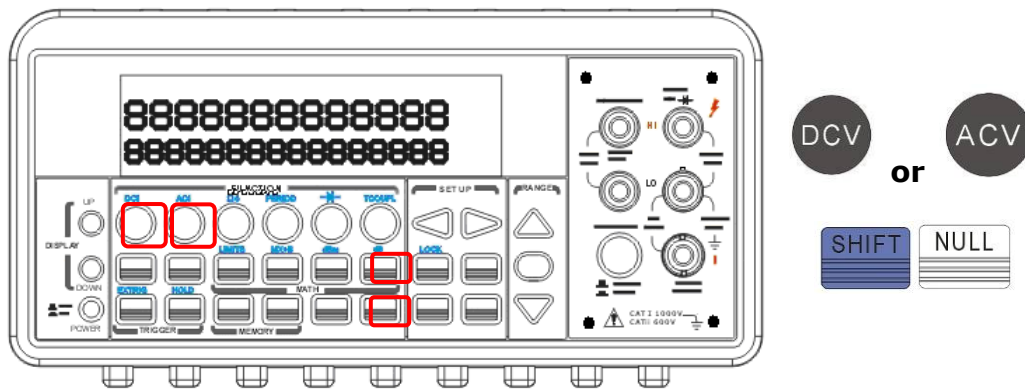
Figure 4-22

Remote Interface Operation

Use the following commands from your PC terminal to make the dB measurement:

CALCulate:FUNCtion DB

CALCulate:STATe {OFF|ON}

CALCulate:STATe?

CALCulate:DB:REFerence {<*value*>|MINimum|MAXimum}

B. dBm

Definition

With dBm selected, a voltage measurement is displayed as the level of power, relative to 1 milliwatt, dissipated through a reference resistance. The reference resistance is adjustable in DL-2060. The calculation of dBm is defined as below:

$$dB_m = 10 \times \log\left(V_{in}^2 \middle/ Z_{ref}\right)/1mW$$

※ Note: V_{in} is the input voltage. Z_{ref} is the reference resistance.

※ Note: Change of reference resistance will not affect the stored relative reference value.

- The Zref is adjustable with a range from 50Ω to 8000 Ω. The default value is 600 Ω.
- The user selected reference value is stored in a volatile memory and will be cleared after the multimeter has been power-off.
- This feature is available for DCV and ACV only.

How to set the reference resistance

User can set the reference resistance either through the front panel operation or the remote interface operation.

Front Panel Operation

Press CONFIG + SHIFT + dBm(MIN/MAX), then use ◁ and ▷ to move through the digits and △ and ▽ to increase or decrease the numbers to a desired value. Press ENTER to set the value. The locations of the buttons are shown with red rectangle frames in **Figure 4-23**.

65
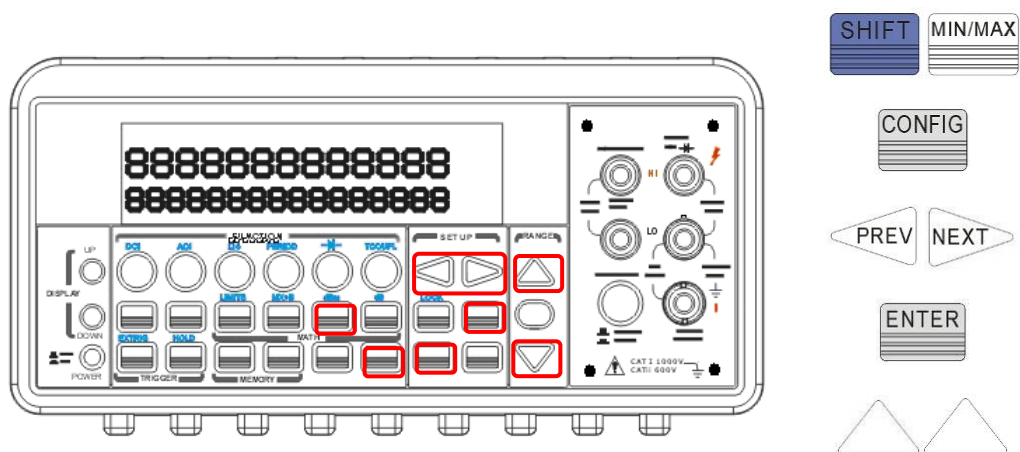
Figure 4-23

How to make a dBm measurement

- Select a measurement function by pressing DCV or ACV button. The dBm feature is only available for DCV and ACV only.
- To enable dBm, press SHIFT + dBm(MIN/MAX) buttons.
- After enabling the dBm operation, user can select the reference resistance as mentioned above. The default for the reference resistance is 600 Ω.

The locations of the buttons are shown with red rectangle frames in **Figure 4-24**.

※ Note: Press SHIFT+dBm(MIN/MAX) again to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical feature.
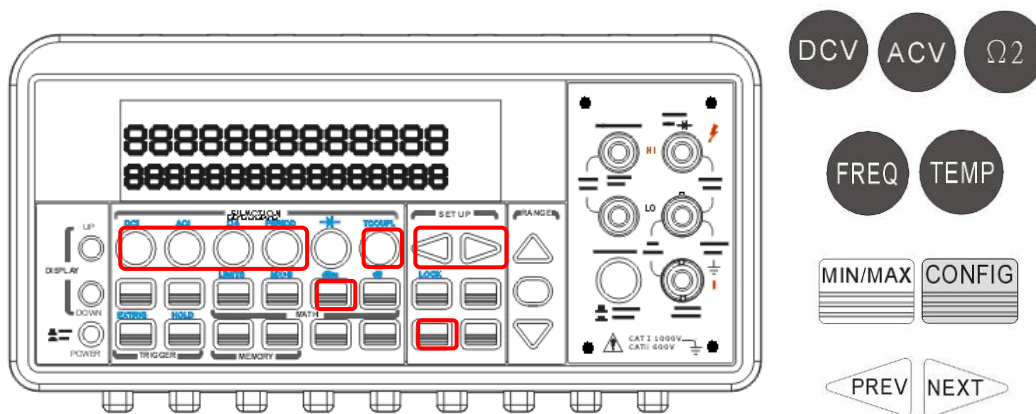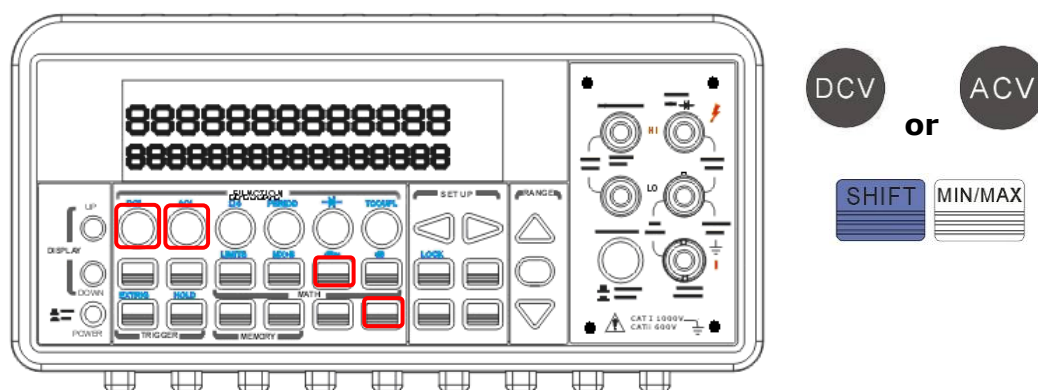

Figure 4-24

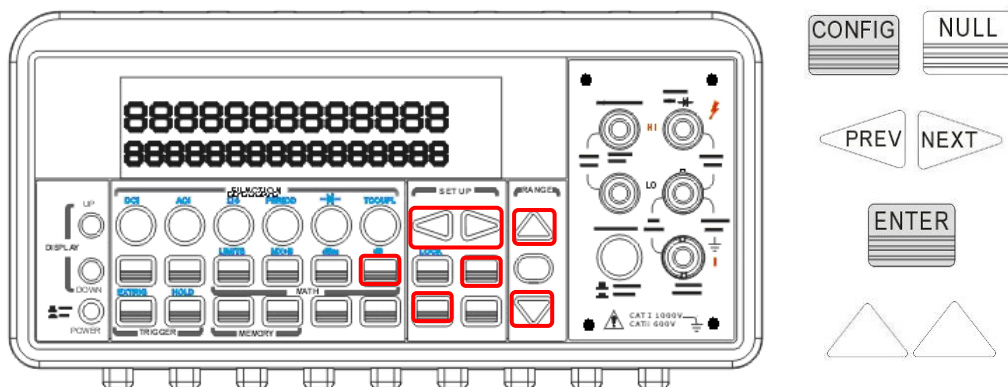## Remote Interface Operation

Use the following commands to enable dBm feature or to set the reference resistance:

CALCulate:FUNCtion DBM
CALCulate:STATe {OFF|ON}
CALCulate:STATe?
CALCulate:DBM:REFerence {<*value*>|MINimum|MAXimum}

3.4 Other System Related Operations

Each system related operation performs a task that is not measurement related but plays an important role in making your measurements.

3.4.1 Display

DL-2060 has a 5x7 dot matrix, dual-display with three-color (White, Red and Yellow) annunciators for a better view. A maximum 13 characters are allowed for upper row dot-matrix display and a maximum 16 characters are allowed for lower row dot-matrix display as shown on **Figure 4-25**. User has an option to turn off the display for a faster measurement without waiting for display, or when the measurement is done through the remote interface operations on their PC terminal.
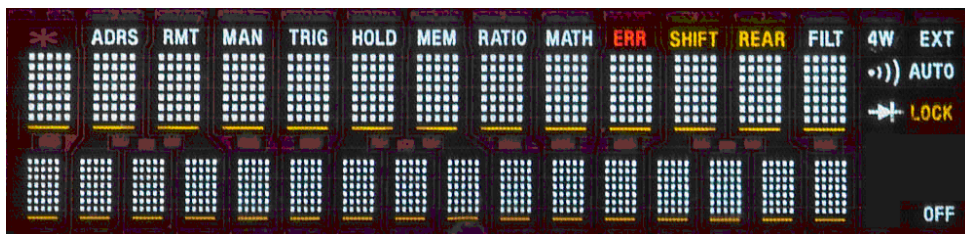
Figure 4-25

When the display is turned off, an "OFF" will be lit at the lower right corner of the display screen. This doesn't mean the display is POWER-OFF, but only that the measurement readings will not be sent to the display. This option will accelerate the measurement process because there is no I/O delay. But turning off the display will not affect the messages displayed from the RECALL, MENU and CONFIG operations.

User can send a message through the remote interface from their PC terminal to the lower row display and will substitute the original display.

Default

The display default is "ON". The "On/Off" selection made by user is stored in a volatile memory and the default "ON" will be restored when the meter is power-off.

How to control the display

You can control the display through the front panel operation or through the remote interface operation. The remote interface operation has higher priority over the front panel operation.

Front Panel Operation

Use the following steps to control the display: Press MENU button then use $\triangleleft$ and $\triangleright$ buttons to locate "SYSTEM" submenu. Press ENTER to select it, and then again use $\triangleleft$ and $\triangleright$ buttons to locate "DISPLAY" submenu. Press ENTER to select it, and then find ON

or OFF by using ◁ and ▷ buttons. Press ENTER on your selection. The locations of the buttons are shown with red rectangle frames in **Figure 4-26**.

Procedures: MENU → SYSTEM → DISPLAY → {ON|OFF}
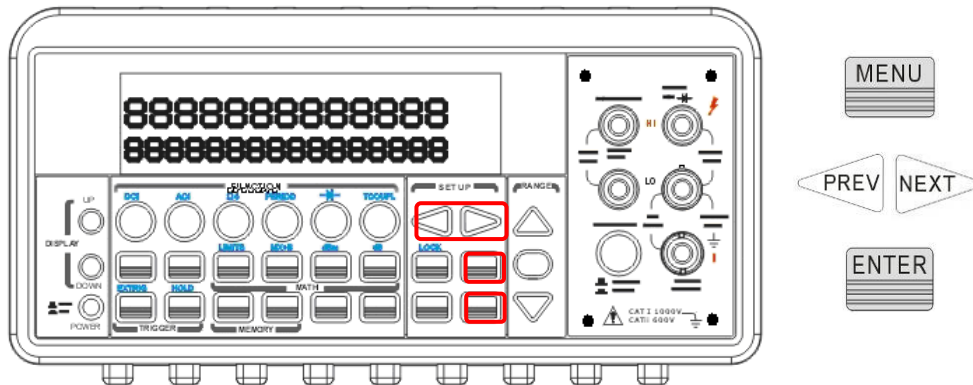
Figure 4-26

Remote Interface Operation

The following commands show how to control the display as well as how to send a message to the display:

DISPlay {OFF|ON} (turns off or turns on the display)
DISPlay:TEXT <quoted string> (displays the string you type in)
DISPlay:TEXT:CLEar (clears the message displayed)

3.4.2 Beeper

DL-2060 multimeter beeps when some certain conditions are met or when an error occurs. But there may be time you want to disable the beeper for some operations. Although you can turn off the beeper, the click sound you hear when a button is pressed will not be disabled.

By disabling the beeper you will not hear the meter beeps when:
● a new minimum or maximum is found in Min/Max operation.
● a stable reading is detected and held.
● the test voltage is within the limits in diode testing.
● the source signal fails the limit testing.
After the beeper is disabled, the meter still emits a tone when:
● an error occurs.
● any button on the front panel is pressed.
● the threshold value is exceeded in continuity testing.

Default

The beeper is enabled when it is shipped from the factory. The beeper state is stored in a volatile memory and the default will be restored when the meter has been turned off or after a remote interface reset.

How to control the beeper

User can control the beeper from either the front panel operation or the remote interface operation.

Front Panel Operation

Follow the procedure below to disable or enable the beeper: Press MENU button then use ◁ and ▷ buttons to find SYSTEM menu. Press ENTER to choose it, and then again use ◁ and ▷ buttons to find BEEP menu. Press ENTER to choose it, and then find ON or OFF by using ◁ and ▷ buttons. Press ENTER on your selection. The locations of the buttons are shown with red rectangle frames in **Figure 4-27**.

Procedures: MENU → SYSTEM → BEEP→ {ON|OFF}
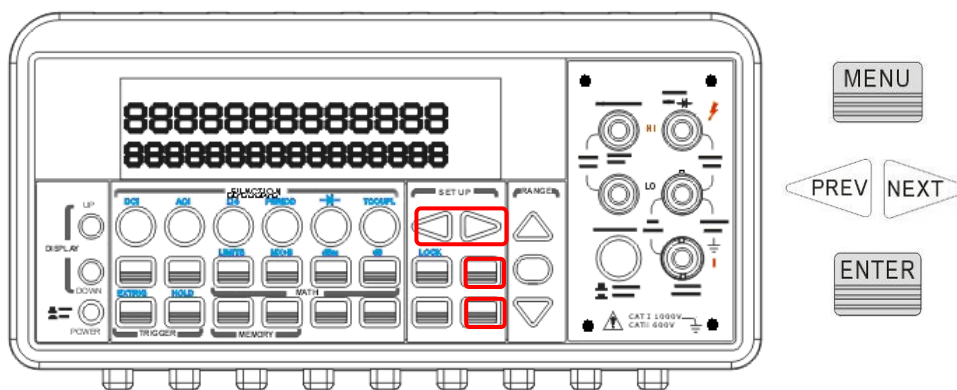
Figure 4-27

Remote Interface Operation

The following commands show how to use the remote interface operation to disable or enable the beeper:

SYSTem:BEEPer
SYSTem:BEEPer:STATe {OFF|ON}

3.4.3 Reading Memory (Store & Recall)

DL-2060 has a memory capacity of 2000 readings. The readings are stored in first-in-first-out order and the memory type is volatile, which means the stored readings will be cleared when the multimeter is power-off. The reading memory feature can be

used for all measurement functions, math operations, trigger operations and reading hold.

How to use the reading memory

User can store the readings and access to the stored readings through either the front panel operation or the remote interface operation.

※ Note: Each datum stored from DL-2060 to remote interface will be in a first in and first out condition.

Front Panel Operation

Before using the reading memory feature, user needs to select a measurement function (or the math function) first and then select the trigger mode.

To store readings, use the following steps:

Press STORE button, and the multimeter will start to store the readings produced until the specified number of readings is reached. The default number of readings to store is 100. To change this number, press CONFIG and then STORE buttons. Then use ◁ and ▷ buttons to move between the digits and ▽ and △ buttons to increase or decrease numbers as desired. When ready, press ENTER button. The default number of readings will be restored when the meter has been turned off. The location of the buttons are shown with red rectangle frames in **Figure 4-28**.

※ Note: The MEM annunciator will be lit while the multimeter stores readings and be turned off when the specified number of readings is reached.

Procedures: CONFIG +STORE→ <NUMBER>
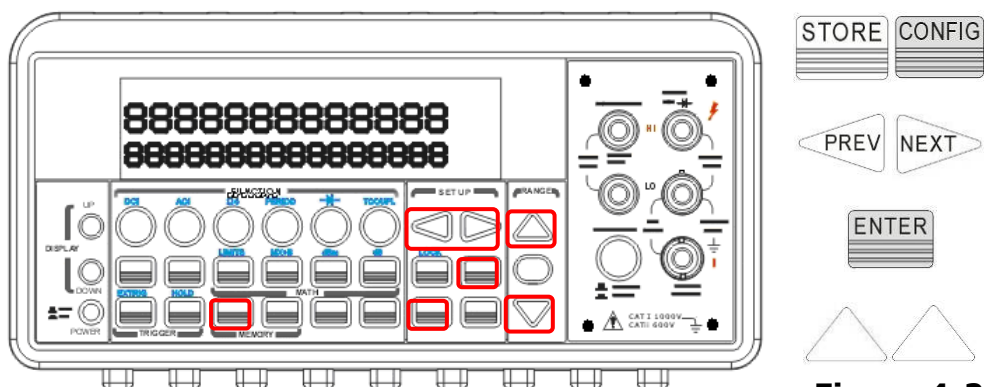
Figure 4-28

To recall the stored readings, use the following steps:

Press RECALL button, and the multimeter will display all the stored readings starting from the first reading. Use ◁ and ▷ or ▽ and △ buttons to move from the first reading to the last reading the meter has stored. The locations of the buttons are shown with red rectangle frames in **Figure 4-29**.
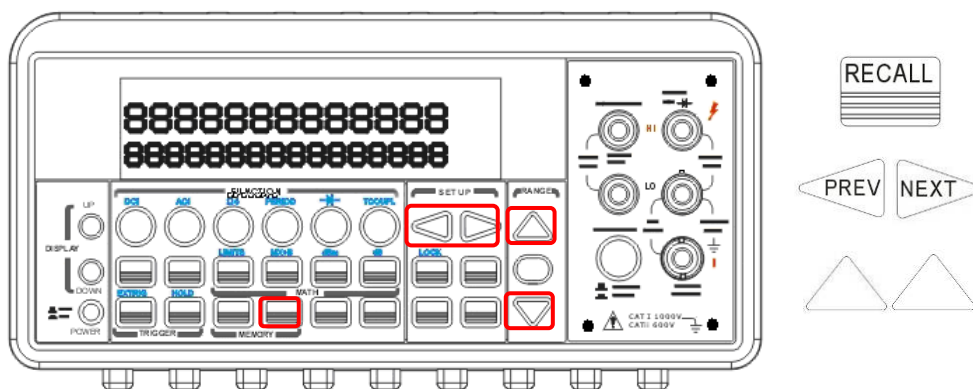
Figure 4-29

Remote Interface Operation

Users can use the following commands from their PC terminals to store or retrieve readings in the memory. In addition, the number for STORE function only can be set through front panel.

INITiate (This command tells the meter to be on "wait-for-trigger" state. After a measurement is taken, measurement readings will be placed in the memory.)

FETCh? (Use this command to retrieve stored readings.)

DATA:POINts? (Use this command to query the number of stored readings.)

3.4.4 Sensitivity Band (Hold)

The reading hold function captures and holds a stable reading on the display. The multimeter beeps and holds the value when it detects a stable reading. The sensitivity band in reading hold decides which reading is stable enough. This band is expressed as a percent of reading on the selected range. The multimeter considers a reading stable when three consecutive values are within the band. User has an option to adjust this sensitivity band.

Default

The default band is 0.1%. User's selection is stored in a volatile memory and it will be cleared after the meter has been turned off.

How to adjust the sensitivity band

You can adjust the sensitivity band through the front panel operation.

Front Panel Operation

In order to adjust the sensitivity band, please press MENU button then use ◁ and ▷ buttons to find "TRIG" submenu. Press ENTER to select it. Then again use ◁ and ▷ buttons to find "READ HOLD" submenu. Press ENTER to choose it. Then use ◁ and ▷ buttons to choose a desired band. Press ENTER to set the desired sensitivity band. The locations of the buttons are shown with red rectangle frames in **Figure 4-30**.
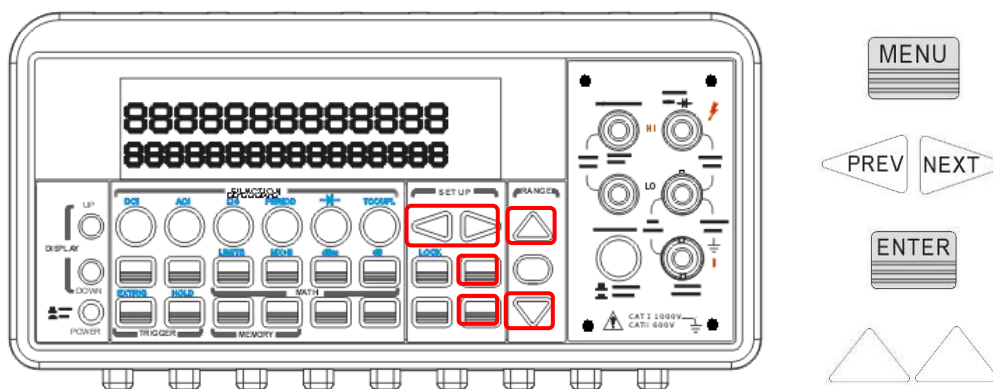
Figure 4-30

3.4.5 Scanning (Scan)

User can purchase an optional internal scanner card to be used with DL-2060 as the following picture shown. This multipoint scanner card lets you switch and scan up to 10（or 20) channels of input signals. User can open and close individual channels, set scan count and scan interval, store measurement readings and activate measuring through channels defined with different measurement functions. The measurements are taken through all defined channels in sequence. The scan count limits the total number of measurements the multimeter makes through all defined channels in one single scanning operation. The scan interval is the period of time the multimeter waits before it makes a measurement through the first defined channel. The configuration made by user is stored in a volatile memory and will be cleared after the meter is turned off.

OUT B is for 3 or 4 wired measurement.

SCANNER CARD OUT B
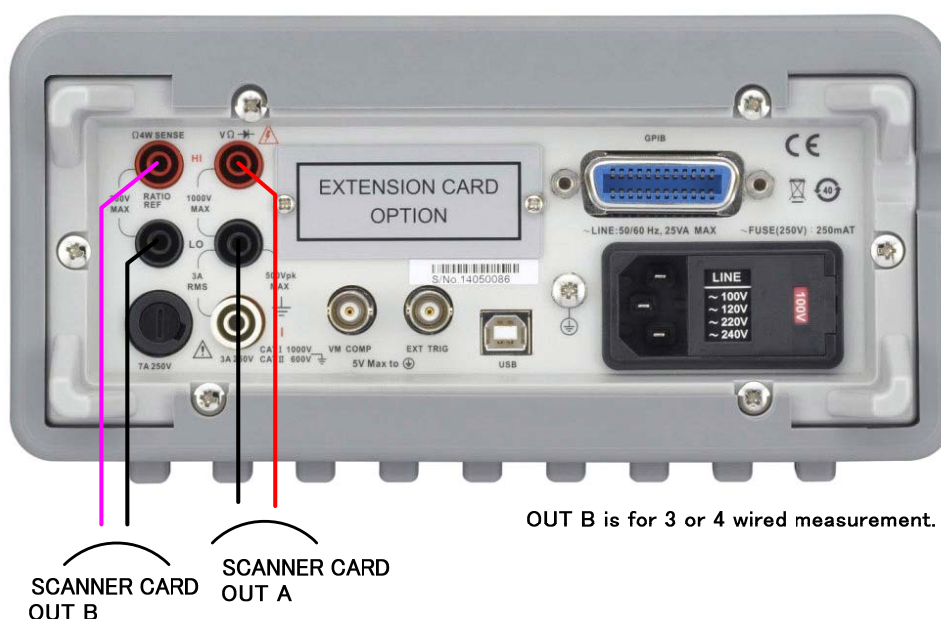
SCANNER CARD OUT A

※ Note: OUT-B is for 3-wired or 4-wired measurement. Please refer to the above picture for more connection information. When you use 4-wired measurement with scanner card,

10 Channels: 10 channels of 2-pole relay input. All channels configurable to 4-pole.
CAPABILITIES: Multiplex one of ten 2-pole or one of five 4-pole signals into DMM.

20 Channels: 20 channels of 2-pole relay input. All channels configurable to 4-pole.
CAPABILITIES: Multiplex one of twenty 2-pole or one of ten 4-pole signals into DMM.

MODEL	OP-41	OP-41T	OP-42
Maximum AC Voltage	125V rms or 175V peak, 100kHz, 1A switched, 62.5VA (resistive load)	110V rms or 155V peak, 100kHz, 1A switched, 30VA (resistive load)	
Maximum DC Voltage	110V, 1A switched, 30VA (resistive load)		
Number of Channels	10	10	20
Contact Life	>100000 operations at maximum signal level; >100000000 operations cold switching.		
Contact Resistance	<1ohm at end of contact life		
Actuation Time	5ms maximum on/off		
Contact Potential	<±500nV typical per contact, 1µV max <±500nV typical per contact pair, 1µV max		
Connector Type	Screw terminal, from #22 to 28 AWG wire size		
Isolation btw Any Two terminals	>10 Gohm, < 75pF		
Isolation btw Any Terminal and Earth	>10 Gohm, < 150pF		
Common Mode Voltage	350V peak btw any terminal and earth	200V peak btw any terminal and earth	
Max. Voltage btw Any Two Terminals	200V peak	160V peak	
Max. Voltage btw Any Terminal and DL-2060 Input LO	200V peak	160V peak	
DCI and ACI channels	CH1,CH6	All channels	CH1, CH11
Shunt installation	R1 and R2 on PCB	All channels	J21, J23

※ Please use thin covering wire if it is tight in the cover case.

OP-41, OP-41T

Channel 1 — HI / LO
Channel 2 — HI / LO
Channel 3 — HI / LO
Channel 4 — HI / LO
Channel 5 — HI / LO

HI OUT A / LO
HI OUT B / LO

4-Pole   2-Pole

Channel 6 — HI / LO
Channel 7 — HI / LO
Channel 8 — HI / LO
Channel 9 — HI / LO
Channel 10 — HI / LO

OP-42

Channel 1 — HI / LO
Channel 2 — HI / LO
Channel 3 — HI / LO
Channel 4 — HI / LO
Channel 5 — HI / LO
Channel 6 — HI / LO
Channel 7 — HI / LO
Channel 8 — HI / LO
Channel 9 — HI / LO
Channel 10 — HI / LO

HI OUT A / LO
HI OUT B / LO

4-Pole   2-Pole

Channel 11 — HI / LO
Channel 12 — HI / LO
Channel 13 — HI / LO
Channel 14 — HI / LO
Channel 15 — HI / LO
Channel 16 — HI / LO
Channel 17 — HI / LO
Channel 18 — HI / LO
Channel 19 — HI / LO
Channel 20 — HI / LO

Speed of Scanner Card Measurement

AutoZero OFF, AutoRange OFF, Scan Timer=0 , 60Hz		
	NPLC	Reading speed (ms/1ch) ※
Single function(VDC)	0.02 (Fast 4 1/2)	34.0
	0.1 (Slow 4 1/2 & Fast 5 1/2)	37.0
	1 (Slow 5 1/2 & Fast 6 1/2)	52.6
	10 (Slow 6 1/2)	204.1

AutoZero OFF, AutoRange OFF, Scan Timer=0 , 60Hz		
	NPLC	Reading speed (ms/1ch) ※
Mix function (VDC+2WRES)	0.02 (Fast 4 1/2)	153.8
	0.1 (Slow 4 1/2 & Fast 5 1/2)	158.7
	1 (Slow 5 1/2 & Fast 6 1/2)	222.2
	10 (Slow 6 1/2)	833.3

※ **Note:** Reading speed is average value of 2,000 readings.

How to program each channel with measurement function

Press CONFIG + SHIFT + DIGITS for scanning configuration. Use ◁ and ▷ to scroll through submenus. Press ENTER on "SET SCAN CHA" submenu. Use ◁ and ▷ to switch from channel 1 to channel 10 （or channel 20）, and use △and ▽ to switch among the measurement functions. Leave an unused channel with a blank space (----). Press ENTER when ten channels are all defined. Press ESC to exit from configuration mode.

How to configure scan count, scan interval and store measurement readings

Press CONFIG + SHIFT + DIGITS for scanning configuration. Use ◁ and ▷ buttons to scroll through submenus. Press ENTER to select "OPERATION" submenu. Use ◁ and ▷ to switch among scan count (COUNT), scan interval (TIMER) and store (STORE) options. Then press ENTER on your selection. Use ◁ and ▷ to move through the digits and △ and ▽ to increase or decrease the numbers to a desired value. For STORE option, you can select ON to instruct the meter to store the measurement results for later retrieving or select OFF .Press ENTER to set the value.

How to open and close the channels

Press CONFIG + SHIFT + DIGITS for scanning configuration. Use ◁ and ▷ buttons to scroll through submenus. Press ENTER on "----" when you need to close a specific channel. Press ENTER again on "CHANNEL". Use ◁ and ▷ to move through the digits and △and ▽ to increase or decrease the numbers to the desired channel number. Press ENTER to close the channel. To open all channels, simply press ENTER on "OPEN ALL" option. Press SHIFT + DIGITS to scan.

The locations of the buttons are shown with red rectangle frames in **Figure 4-31**.
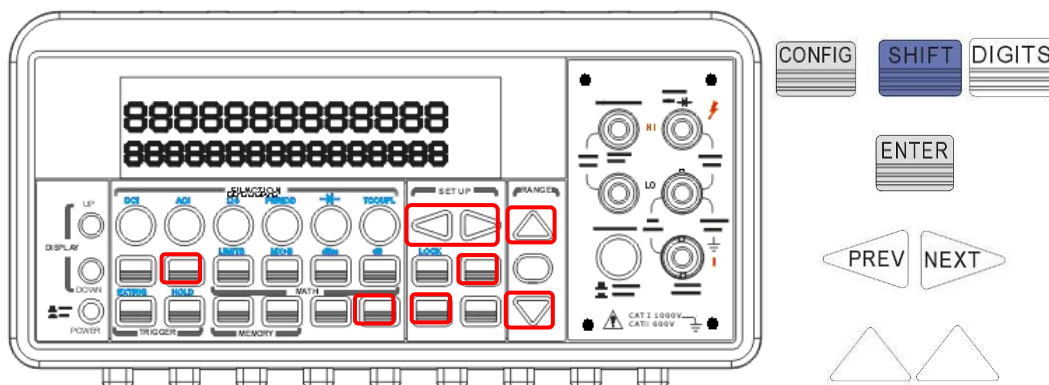
Figure 4-31

3.4.6 Stepping (Step)

User can purchase an optional internal scanner card to be used with DL-2060.Stepping is scanning with a specified time delay between taking input signal through the defined channels.

※ Note: Setting range of scanner card is only limited on DCV, DCI, ACV, ACI, Frequency, Period, Resistance, and RTD functions. OP-41T also supports Thermocouple measurement.

How to program each channel with measurement function

Press CONFIG + SHIFT + FILTER for scanning configuration. Use ◁ and ▷ to scroll through submenus. Press ENTER on "SET SCAN CHA" submenu. Use ◁ and ▷ to switch from channel 1 to channel 10（or channel 20), and use △and ▽ to switch among the measurement functions. Leave an unused channel with a blank space (----). Press ENTER when ten channels are all defined. Press ESC to exit from configuration mode.

How to configure scan count, scan interval and store measurement readings

Press CONFIG + SHIFT + FILTER for scanning configuration. Use ◁ and ▷ buttons to scroll through submenus. Press ENTER to select "OPERATION" submenu. Use ◁ and ▷ to switch among scan count (COUNT), scan interval (TIMER) and store (STORE) options. Then press ENTER on your selection. Use ◁ and ▷ to move through the digits and △ and ▽ to increase or decrease the numbers to a desired value. For STORE option, you can select ON to instruct the meter to store the measurement results for later retrieving or select OFF. Press ENTER to set the value.

How to open and close the channels

Press CONFIG + SHIFT + FILTER for scanning configuration. Use ◁ and ▷ buttons to scroll through submenus. Press ENTER on "----" when you need to close a specific channel. Press ENTER again on "CHANNEL". Use ◁ and ▷ to move through the digits and △and ▽ to increase or decrease the numbers to the desired channel number. Press ENTER to close the channel. To open all channels, simply press ENTER on "OPEN ALL" option. Press SHIFT + FILTER to scan as shown as **Figure 4-32**.
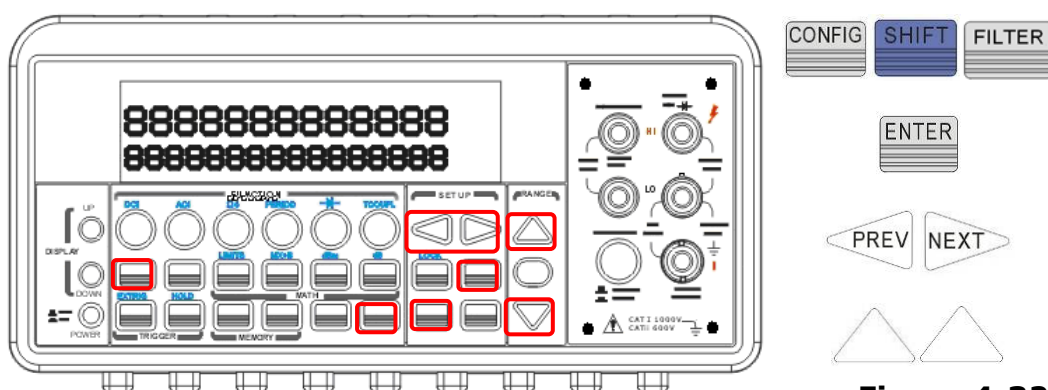
Figure 4-32

3.4.7　Method for wiring to the Scanner Card

【Step 1】

Open the cover of the case by gripping the part of the arrow as shown in the figure below.
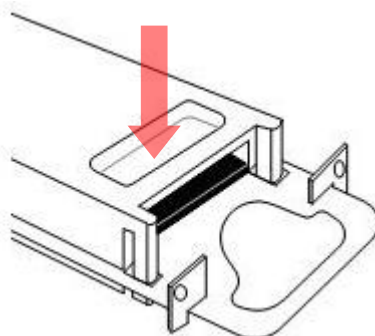
【Step 2】

While opening the cover, release the lock by pushing in the direction of the arrow. (two places)
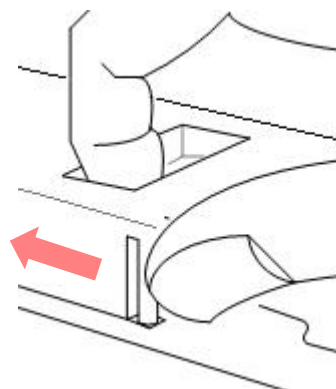
【Step 3】

Install the wire rod on the screw type terminal of the channel to be scanning measured by opening the cover. (AWG22 etc.) Install the cable for OUTPUT on OUTA.When making the 4 wires resistance measurement, install the cable for OUTPUT on OUTB as well.

OP-41
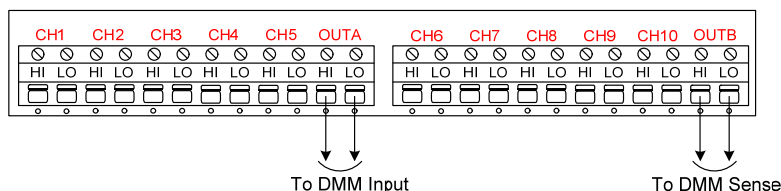
OP-41T
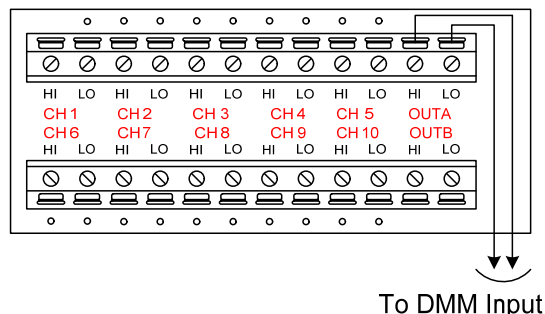
OP-42
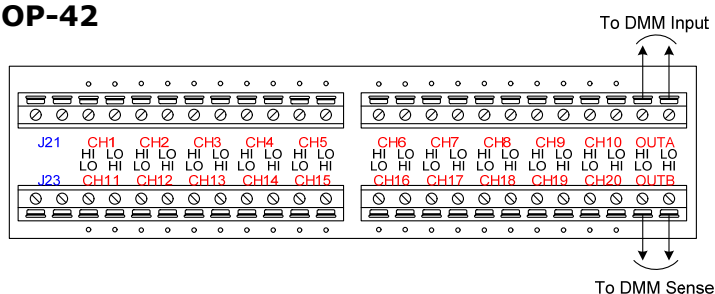
【Step 4】

Close the cover and confirm that it is correctly locked.
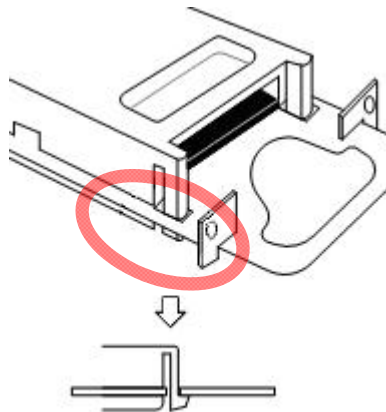
【Step 5】

Tighten the screw after installing the scanner card into DL-2060.
It might be the cause of an incorrect measurement if the screw is not tightened into the rear panel.
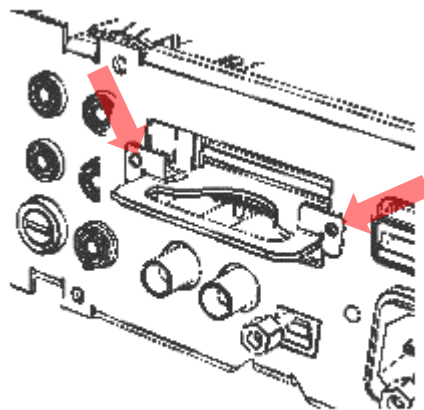
【Step 6】

Please insert the cable for OUT from the scanner card into the rear side input of DL-2060.When measuring 4 wires, please input into the SENSE input as well.
When using the scanner card, please switch over the TERMINALS in front panel at REAR position.
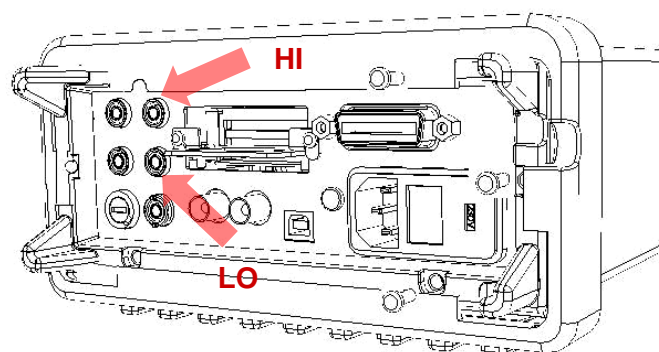
3.4.8 Method for current measurement on the Scanner Card

Multi-point Scanner Card is not allowed of direct current measurements; however, on-card shunt resistors can be installed for Scanner Card to allow for indirect current measurements.

How to put a resistor

OP-41

Soldering the resistor on the channel to be measured at the surface of the land where parts of the OP-41's PCB are installed. Otherwise, carefully remove the plastic cover and solder the resistor on the back side of the PCB by inserting it into the land of R1 or R2.

OP-41T

Install the current shunt resistors to a desired channel. Connect the current source to the shunt resister as shown as figure below.

OP-42

Install the current shunt resistors to J21 or J23.

How to measure the current

The current measurement can be used via application software. It is made by combination of the DCV measurement and Current Shunt resistor. Accurately measure the resistance value of the Current Shunt resistor, then setup R and I. (R= shunt resistance value, I= Offset)

※The measurement function of each channel will be limited to the current measurement as long as the resistors of Scanner Card are not removed. Also please note that there is no detection function of resistors installation.
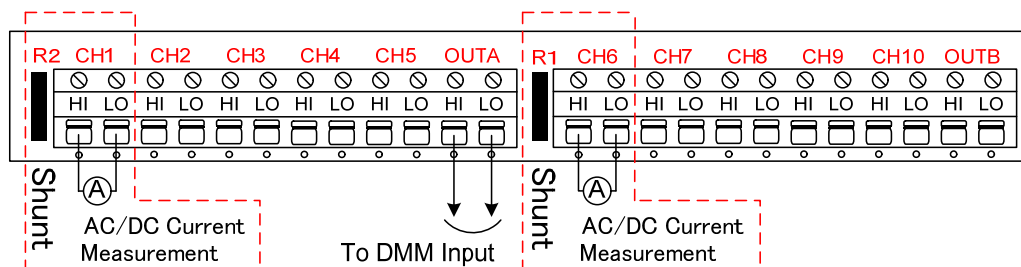
OP-41
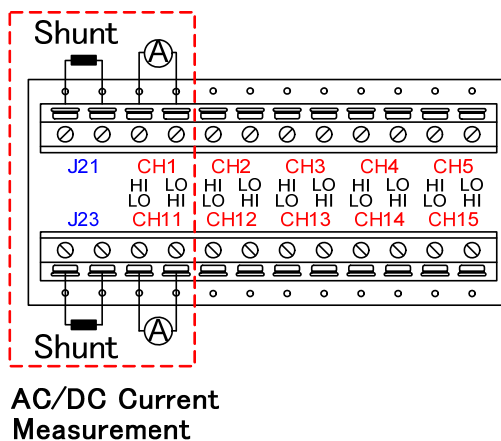
OP-42
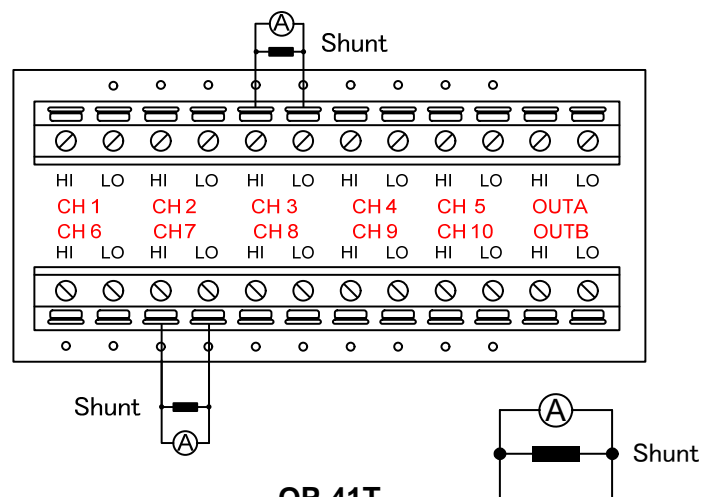
OP-41T

3.4.9 Initial Mode

The section contains two selections: "DEFAULT" and "SAVE DATA". You can select "SAVE DATE" to save the current configuration or select "DEFAULT" to restore the factory value after restarting DL-2060. The valid range of "SAVE DATA" is listed in **Table 4-5**.

Table 4-5

No.	Items of Save Data	Contents
1	Continuity	Threshold Resistance
2	Diode	Boundary Voltage
3	Temperature (RTD)	Sensor、Types、Units、USER define、SPRTD
4	Thermocouple	Types, Units,Simulated
5	Step & Scan	Count, Timer
6	dBm	Reference Resistance
7	MX+B	Values: M, B
8	Reading Hold	Sensitivity Band
9	Input R	DC Input Resistance
10	Interface	USB、GPIB ADDR
11	System	Language、Beep

How to save the settings

Press MENU and then use ◁ and ▷ to locate "SYSTEM" submenu. Press ENTER to select it. Again use ◁ and ▷ to locate "INIT MODE" submenu, and then press ENTER to select it. Use ◁ and ▷ to switch from "SAVE DATA" and "DEFAULT". Press ENTER on "SAVE DATA" to save your current setting, or press ENTER on "DEFAULT" to return to default setting. The locations of the buttons are shown with red rectangle frames in **Figure 4-33**.
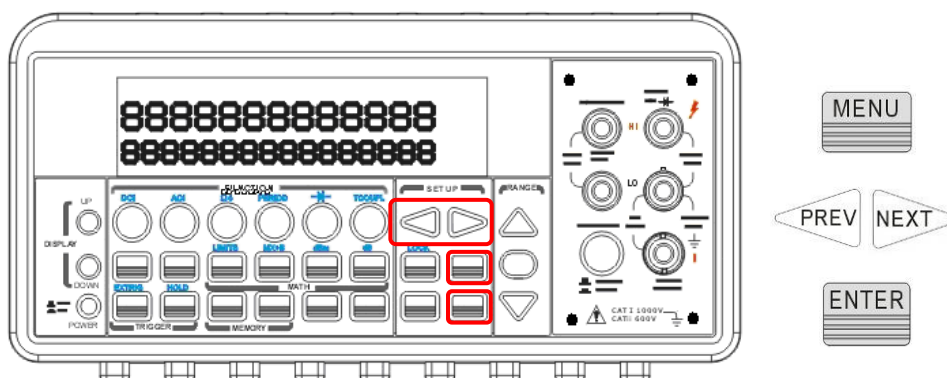
Figure 4-33

3.4.10　Language

DL-2060 supports two languages: DEFAULT (DL-2060) and COMPATIBLE (Agilent 34401A).

How to set up the language

Press MENU and then use ◁ and ▷ to locate "SYSTEM" submenu. Press ENTER to select it. Again use ◁ and ▷ to locate "LANGUAGE" submenu. Press ENTER to select it. Use ◁ and ▷ to switch to DEFAULT (DL-2060) or COMPATIBLE (Agilent 34401A). Press ENTER on your selection. The locations of the buttons are shown with red rectangle frames in **Figure 4-34**.
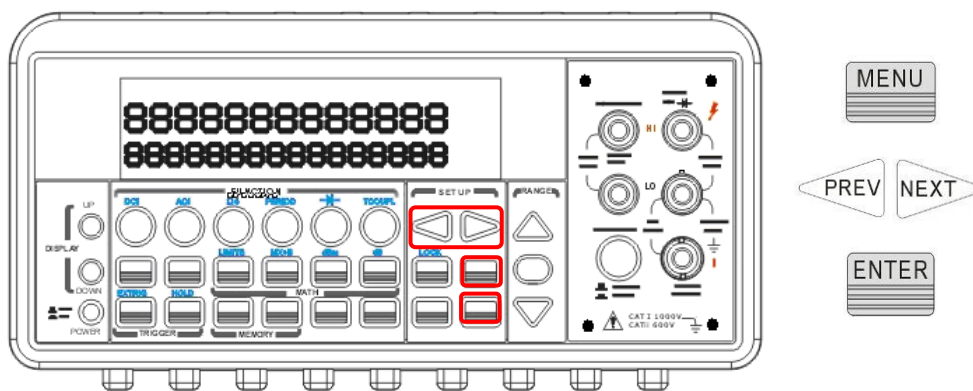
Figure 4-34

3.4.11　Error Condition

The error annunciator on the front panel display tells about the error condition of the multimeter. If there are one or more syntax or hardware errors found, the error annunciator will be lit to inform user. The multimeter stores errors using the first-in-first-out (FIFO) order and it records up to 20 errors in the error queue. The first error detected will be the first error retrieved.　Refer to Chapter 5 for the list of error messages.

※ **Note:**
● The error annunciator will be turned off when you have read the errors in the memory.
● If there is no error found when you check the error queue, the multimeter shows "**NO ERRORS**".
● If there are more than 20 errors found, the last error in the error queue will be replaced with "-350", means too many errors.

- The error queue is cleared when the multimeter is turned off, or when a *CLS command is received.

How to check the error queue

Press MENU then use ◁ and ▷ to locate "SYSTEM" submenu. Press ENTER to select it. Again use ◁ and ▷ to locate "ERROR" option. Press ENTER to select it. The message about error queue will show on the display.　Refer to Chapter 5 for the descriptions of all the error messages. The locations of the buttons are shown with red rectangle frames in **Figure 4-35**.
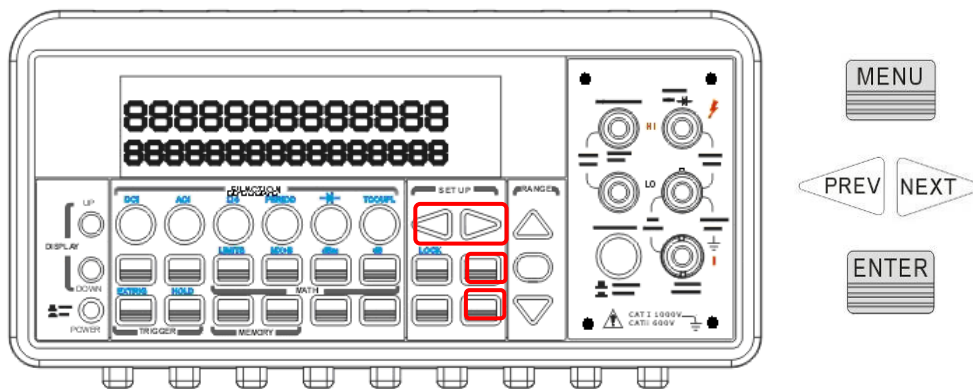
Figure 4-35

3.4.12　Firmware Revision

DL-2060 has three microprocessors for various internal systems. You can query the multimeter to determine which revision of firmware is installed for each microprocessor.

How to check the firmware revision

Press MENU and then use ◁ and ▷ to locate "SYSTEM" submenu. Press ENTER to select it. Again use ◁ and ▷ to locate "REVISION" option. Press ENTER to select it. The multimeter gives three numbers in xx-xx-xx format on the display. The first number is the firmware revision number for the measurement microprocessor; the second number is for I/O processor and the third number is for the front-panel processor. The locations of the buttons are shown with red rectangle frames in **Figure 4-36**.
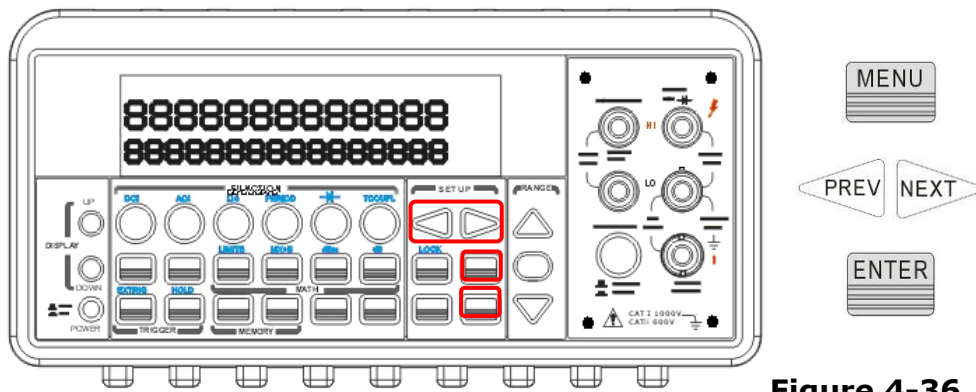
Figure 4-36

3.4.13   Calibration

※ **Notice:** Do not use "CAL MENU" since it is aimed for maker calibration.

3.4.14   Self-test

※ **Notice:** Do not use "SELF TEST" since it is used only for an after sales service operation.

4 Remote Interface Operations

DL-2060 supports two remote interfaces: the built-in USB and GPIB (G type only). With GPIB, you will need a GPIB interface card. This chapter lists the SCPI (Standard Commands for Programmable Instrument) commands available to control the multimeter. For the first time to use SCPI, users would better to refer to Appendix B. for SCPI reference.

4.1 Pass/Fail Output From USB Connector

The USB connector on the rear panel of DL-2060 is a type-B connector. When the USB interface is **disabled** (GPIB interface is selected), the internal pass and fail TTL output signals (limit testing) will be connected to the USB connector.

The pass and fail signals are low true and indicate the Math Pass/Fail Limit Test result for the *next* reading to be output to the GPIB interface. The signals are active low for approximately 2ms (± 100 µsec) for each reading taken. **Figure 2-17** shows the USB connector (type-B).

Table 5-1

Contact Number	Signal Name	Typical Wiring Assignment	Description
1	VBUS	Red	Floating
2	D-	White	Limit Test Pass
3	D+	Green	Limit Test Fail
4	GND	Black	GND

Pass/Fail output pulse

5V
0V

2 ms ± 100 µs
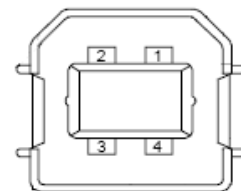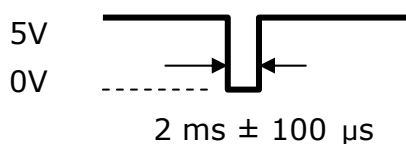
Figure 2-17

If you disable the USB interface, the Pass/Fail output function will enable automatically. Please follow the procedure below to enable/disable this function.

Procedure: MENU→INTERFACE→USB→ENABLE/DISABLE

Or you can do this by the other way:

Procedure: CONFIG+SHIFT+RATIO→OUTPUT→ENALBLE/DISABLE

⚠ Warning! You can't use the USB interface if you want to enable the Pass/Fail signal output. You must use the GPIB interface (G type only) or remote control. Please disconnect the USB cable from you multimeter. The signal from the USB cable may make the Pass/Fail signal output abnormal.

4.2 Setting Up For Remote Interface

DL-2060 may be remote controlled by USB or GPIB interface (only G type). Kind of interface should be selected in order to use remote interface. Please refer close 3.1.9 for detail of selection. Next, following software should be installed into the PC for control.

-Following to NI-VISA3.1
-DL Driver

Also, application software for control is prepared into the attached CD besides of above software. Using this, an easy operation of multimeter from the PC is possible. Please refer install manual for detail of install method.

※ **Note:** Please download from our HP（http://www.nikketechno.jp/）or form NI's HP （http://www.ni.com/visa） for latest version of each software.

4.3 Remote Interface Commands

User can instruct the multimeter to take measurements using the SCPI commands after the appropriate setup for their selected remote interface.

The following conventions are used in SCPI command syntax.

- **Triangle brackets (<>)** indicates that you must specify a value for the enclosed parameter.
- **The square brackets ([])** indicates that the parameter is optional and can be

omitted.
- **The braces ({})** enclose the parameter choices for a given command string.
- **The vertical bar (|)** separates several choices for a parameter.
- **The bold italic figure** means a default parameters

The MEASure? Command

Although it does not offer much flexibility, using the MEASure? Command is the simplest way to program the multimeter for measurements. You select the measurement function, range and resolution, the multimeter automatically sets the other parameters for you, make the measurement and send the result to the output buffer.

MEASure:

  VOLTage:DC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  VOLTage:DC:RATio? {<range>|MIN|MAX|DEF },{<resolution>|MIN|MAX|DEF}

  VOLTage:AC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  CURRent:DC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  CURRent:AC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  RESistance? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  FRESistance? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  FREQuency? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  PERiod? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  CONTinuity?

  DIODe?

  TCOuple?

  TEMPerature?

The CONFigure Command

The CONFigure command offers a little more flexibility than the MEASure? Command. The multimeter sets the parameters for the requested function, range and resolution, but does not make the measurements. You have an option to change the configuration. To initiate the measurement, use INITiate or READ? Command.

CONFigure:

  VOLTage:DC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  VOLTage:DC:RATio {<range>|MIN|MAX|DEF },{<resolution>|MIN|MAX|DEF}

  VOLTage:AC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  CURRent:DC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  CURRent:AC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

  RESistance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

FRESistance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

FREQuency {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

PERiod {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

CONTinuity

DIODe

TCOuple

TEMPerature

CONFigure?

The READ? Command

The READ? Command changes the state of the trigger system from the "idle" state to the "wait-for-trigger" state. When the specified trigger condition requirements are met after the multimeter receives the READ? command, the measurement will be initiated. The results are sent to the output buffer right away. You must enter the reading data into your bus controller or the multimeter will stop making measurements when the output buffer fills. Readings are not stored in the multimeter's internal memory when using the READ? Command.
Using the READ? Command has a similar effect as using the INITiate command followed immediately by the FETCh? command, except readings are not buffered internally.

The INITiate and FETCh? Commands

These two commands provide the lowest level of control of measurement triggering and reading retrieval, but offer the most flexibility. After you have configured the multimeter, use INITiate command to change the state of the triggering system from the "idle" state to the "wait-for-trigger" state. The multimeter will start the measurements when the specified trigger condition requirements are met after it receives the INITiate command. The results are sent to the internal memory and stored until you are ready to read them.

The FETCh? command sends the data in the multimeter's internal memory to the output buffer where you can read them into your bus controller.

The SENSe Commands

[SENSe:]

FUNCtion "VOLTage:DC"

FUNCtion "VOLTage:DC:RATio"

FUNCtion "VOLTage:AC"

FUNCtion "CURRent:DC"

FUNCtion "CURRent:AC"

FUNCtion "RESistance" (2-wire Ω)

FUNCtion "FRESistance" (4-wire Ω)

FUNCtion "FREQuency"

FUNCtion "PERiod"

FUNCtion "CONTinuity"

FUNCtion "DIODe"

FUNCtion "TCOuple"

FUNCtion "TEMPerature"

FUNCtion?

[SENSe:]

VOLTage:DC:RANGe {<range>|MINimum|MAXimum}

VOLTage:DC:RANGe? [MINimum|MAXimum]

VOLTage:AC:RANGe {<range>|MINimum|MAXimum}

VOLTage:AC:RANGe? [MINimum|MAXimum]

CURRent:DC:RANGe {<range>|MINimum|MAXimum}

CURRent:DC:RANGe? [MINimum|MAXimum]

CURRent:AC:RANGe {<range>|MINimum|MAXimum}

CURRent:AC:RANGe? [MINimum|MAXimum]

RESistance:RANGe {<range>|MINimum|MAXimum}

RESistance:RANGe? [MINimum|MAXimum]

FRESistance:RANGe {<range>|MINimum|MAXimum}

FRESistance:RANGe? [MINimum|MAXimum]

FREQuency:VOLTage:RANGe {<range>|MINimum|MAXimum}

FREQuency:VOLTage:RANGe? [MINimum|MAXimum]

PERiod:VOLTage:RANGe {<range>|MINimum|MAXimum}

PERiod:VOLTage:RANGe? [MINimum|MAXimum]

[SENSe:]

VOLTage:DC:RANGe:AUTO {OFF|*ON*}

VOLTage:DC:RANGe:AUTO?

VOLTage:AC:RANGe:AUTO {OFF|*ON*}

VOLTage:AC:RANGe:AUTO?

CURRent:DC:RANGe:AUTO {OFF|***ON***}

CURRent:DC:RANGeAUTO?

CURRent:AC:RANGe:AUTO {OFF|***ON***}

CURRent:AC:RANGe:AUTO?

RESistance:RANGe:AUTO {OFF|***ON***}

RESistance:RANGe:AUTO?

FRESistance:RANGe:AUTO {OFF|***ON***}

FRESistance:RANGe:AUTO?

FREQuency:VOLTage:RANGe:AUTO {OFF|***ON***}

FREQuency:VOLTage:RANGe:AUTO?

PERiod:VOLTage:RANGe:AUTO {OFF|***ON***}

PERiod:VOLTage:RANGe:AUTO?

[SENSe:]

VOLTage:DC:RESolution {<resolution>|MINimum|MAXimum}

VOLTage:DC:RESolution? [MINimum|MAXimum]

VOLTage:AC:RESolution {<resolution>|MINimum|MAXimum}

VOLTage:AC:RESolution? [MINimum|MAXimum]

CURRent:DC:RESolution {<resolution>|MINimum|MAXimum}

CURRent:DC:RESolution? [MINimum|MAXimum]

CURRent:AC:RESolution {<resolution>|MINimum|MAXimum}

CURRent:AC:RESolutioin? [MINimum|MAXimum]

RESistance:RESolution {<resolution>|MINimum|MAXimum}

RESistance:RESolution? [MINimum|MAXimum]

FRESistance:RESolution {<resolution>|MINimum|MAXimum}

FRESistance:RESolution? [MINimum|MAXimum]

[SENSe:]

UNIT {***Cel***|Far|K}

UNIT?

TCOuple:TYPE {E|J|***K***|N|R|S|T}

TCOuple:TYPE {***E***|J|K|N|R|S|T} , @{scanner channel number}

TCOuple:TYPE?

TCOuple:TYPE? @{scanner channel number}

※ TCOuple:RJUNction:RSELect {REAL|SIMulated }

※ TCOuple:RJUNction:RSELect?

※ TCOuple:RJUNction:SIMulated {<value>|MINimum|MAXimum}

※ TCOuple:RJUNction:SIMulated?

※ TCOuple:RJUNction:REAL?

※ This command is available with firmware version 1.05 or upward.

[SENSe:]

TEMPerature:RTD:TYPE {***PT100***|D100|F100|PT385|PT3916|USER|SPRTD|NTCT}

TEMPerature:RTD:TYPE {***PT100***|D100|F100|PT385|PT3916|USER|SPRTD|NTCT}, @{scanner channel number}

TEMPerature:RTD:TYPE?

TEMPerature:RTD:TYPE? @{scanner channel number}

TEMPerature:RTD:RZERo {<value>|MINimum|MAXimum}

TEMPerature:RTD:RZERo? [MINimum|MAXimum]

TEMPerature:RTD:ALPHa {<value>|MINimum|MAXimum}

TEMPerature:RTD:ALPHa? [MINimum|MAXimum]

TEMPerature:RTD:BETA {<value>|MINimum|MAXimum}

TEMPerature:RTD:BETA? [MINimum|MAXimum]

TEMPerature:RTD:DELTa {<value>|MINimum|MAXimum}

TEMPerature:RTD:DELTa? [MINimum|MAXimum]

TEMPerature:SPRTD:RZERo {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:RZERo? [MINimum|MAXimum]

TEMPerature:SPRTD:A4 {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:A4? [MINimum|MAXimum]

TEMPerature:SPRTD:B4 {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:B4? [MINimum|MAXimum]

TEMPerature:SPRTD:AX {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:AX? [MINimum|MAXimum]

TEMPerature:SPRTD:BX {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:BX? [MINimum|MAXimum]

TEMPerature:SPRTD:CX {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:CX? [MINimum|MAXimum]

TEMPerature:SPRTD:DX {<value>|MINimum|MAXimum}

TEMPerature:SPRTD:DX? [MINimum|MAXimum]

TEMPerature:TRANsducer FRTD

TEMPerature:TRANsducer FRTD, @{scanner channel number}

TEMPerature:TRANsducer RTD

TEMPerature:TRANsducer RTD, @{scanner channel number}

TEMPerature:TRANsducer?

TEMPerature:TRANsducer? @{scanner channel number}

[SENSe:]

VOLTage:DC:NPLCycles {0.02|0.1|***1***|10|MINimum|MAXimum}

VOLTage:DC:NPLCycles? [MINimum|MAXimum]

CURRent:DC:NPLCycles {0.02|0.1|***1***|10|MINimum|MAXimum}

CURRent:DC:NPLCycles? [MINimum|MAXimum]

RESistance:NPLCycles {0.02|0.1|*1*|10|MINimum|MAXimum}

RESistance:NPLCycles? [MINimum|MAXimum]

FRESistance:NPLCycles {0.02|0.1|*1*|10|MINimum|MAXimum}

FRESistance:NPLCycles? [MINimum|MAXimum]

[SENSe:]

FREQuency:APERture {0.01|*0.1*|1|MINimum|MAXimum}

FREQuency:APERture? [MINimum|MAXimum]

PERiod:APERture {0.01|*0.1*|1|MINimum|MAXimum}

PERiod:APERture? [MINimum|MAXimum]

[SENSe:]

DETector:BANDwidth {3|*20*|200|MINimum|MAXimum}

DETector:BANDwidth? [MINimum|MAXimum]

[SENSe:]

AVERage:TCONtrol {*MOVing*|REPeat}

AVERage:TCONtrol?

AVERage:COUNt {<*value*>|MINimum|MAXimum}

AVERage:COUNt? [MINimum|MAXimum]

AVERage:STATe {OFF|*ON*}

AVERage:STATe?

[SENSe:]

ZERO:AUTO {OFF|ONCE|*ON*}

ZERO:AUTO?

INPut:

IMPedance:AUTO {*OFF*|ON}

IMPedance:AUTO?

Scanner Card Configuration Commands

ROUTe:CLOSe <channel>

ROUTe:CLOSe?

ROUTe:OPEN

ROUTe:STATe?

ROUTe:SCAN:FUNCtion <channel>,{<function>|"VOLT:DC"|"VOLT:AC"|
"FREQuency"|"RESistance"|"FRESistance"|"PERiod"|"TCOuple"|"TEMPerature"|"NONE"}

ROUTe:SCAN:FUNC? <channel>

ROUTe:SCAN:TIMER?

ROUTe:SCAN:TIMER <value>

ROUTe:SCAN:COUNT?

ROUTe:SCAN:COUNT <value>

ROUTe:SCAN:STATe?

ROUTe:SCAN:SCAN

ROUTe:SCAN:STEP

MATH OPERATION Commands

There are eight math operations. Only one of them can be enabled at a time. They either store data for later use or perform mathematical operations on the readings. Note that these eight math operations are available to all measurement functions except continuity and diode testing.

The math operations use one or more internal registers. You can preset the values in some of the registers, while others hold the results of the math operations.

CALCulate:

    FUNCtion {**PERCent**|AVERage|NULL|LIMit|MXB|DB|DBM}

    FUNCtion?

    STATe {**OFF**|ON}

    STATe?

CALCulate:

    PERCent:TARGet {<*value*>|MINimum|MAXimum}

    PERCent:TARGet? [MINimum|MAXimum]

CALCulate:

    AVERage:MINimum?

    AVERage:MAXimum?

    AVERage:AVERage?

    AVERage:COUNt?

CALCulate:

    NULL:OFFSet {<value>|MINimum|MAXimum}

    NULL:OFFSet? [MINimum|MAXimum]

CALCulate:

    LIMit:LOWer {<value>|MINimum|MAXimum}

    LIMit:LOWer? [MINimum|MAXimum]

    LIMit:UPPer {<value>|MINimum|MAXimum}

    LIMit:UPPer? [MINimum|MAXimum]

CALCulate:

MXB:MMFactor {<*value*>|MINimum|MAXimum}

MXB:MMFactor? [MINimum|MAXimum]

MXB:MBFactor {<*value*>|MINimum|MAXimum}

MXB:MBFactor? [MINimum|MAXimum]

CALCulate:

DB:REFerence {<value>|MINimum|MAXimum}

DB:REFerence? [MINimum|MAXimum]

CALCulate:

DBM:REFerence {<value>|MINimum|MAXimum}

DBM:REFerence? [MINimum|MAXimum]

DATA:FEED RDG_STORE,{"CALCulate"|""}

DATA:FEED?

TRIGGERING

DL-2060 provides a variety of trigger operations for user. User can select a trigger mode, a trigger source and different trigger settings for a specific measurement. Refer to **Figure 4-8** for triggering system flow chart. Triggering from a remote interface is a multi-step sequence. You must first configure the mulitmeter by choosing the desired function, range and resolution. Specify the trigger source from which the multimeter will accept the trigger. The multimeter takes immediate internal trigger, a software trigger from a remote interface and external trigger from the rear panel. Then be sure that the multimeter is ready for a trigger (in the "wait-for-trigger" state).

The multimeter accepts a trigger only when it is in the "wait-for-trigger" state. When you have finished configuring the multimeter and have selected a trigger source, you need to place the multimeter in the "wait-for-trigger" state so it will take the trigger and make the measurement. The INITiate, READ? and MEASure? commands all place the multimeter to the "wait-for-trigger" state.

Triggering Commands

INITiate

READ?

TRIGger:

SOURce {BUS|**IMMediate**|EXTernal}

SOURce?

TRIGger:

  DELay {<seconds>|MINimum|MAXimum}

  DELay? [MINimum|MAXimum]

TRIGger:

  DELay:AUTO {OFF|ON}

  DELay:AUTO?

SAMPle:

  COUNt {<value>| MINimum|MAXimum }

  COUNt? [MINmum|MAXimum]

TRIGger:

  COUNt {<value>| MINimum|MAXimum|INFinite }

  COUNt? [MINmum|MAXimum]

SYSTEM-RELATED Commands

Each system related operation performs a task that is not measurement related but plays an important role in making your measurements.

FETCh?

READ?

DISPlay {OFF|*ON*}

DISPlay?

DISPlay:

  TEXT <quoted string>

  TEXT?

  TEXT:CLEar

SYSTem:

  BEEPer

  BEEPer:STATe {OFF|*ON*}

  BEEPer:STATe?

SYSTem:ERRor?

SYSTem:VERSion?

DATA:POINts?

SYSTEM:IDNSTR "MANUFACTURER,PRODUCT"

*RST

*IDN?

L0
L1
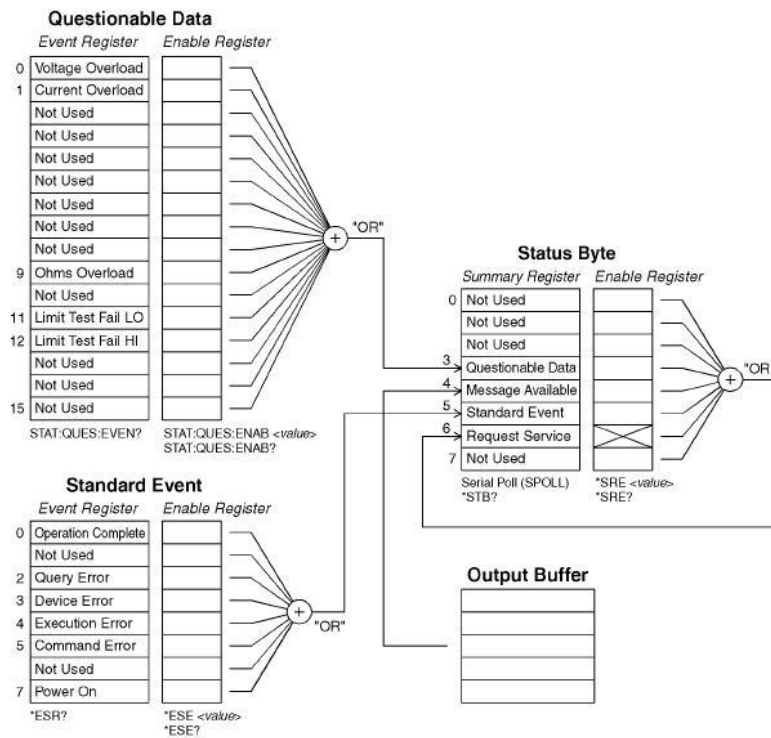
STATUS REPORTING Commands

SYSTem:ERRor?

STATus:

   QUEStionable:ENABle <enable value>

   QUEStionable:ENABle?

   QUEStionable:EVENt?

STATus:PRESet

*CLS

*ESE <enable value>

*ESE?

*ESR?

*OPC

*OPC?

*PSC {0|*1*}

*PSC?

*SRE <enable value>

*SRE?

*STB?

Other Interface Commands

SYSTem:LOCal

SYSTem:REMote

GPIB (IEEE-488.2) COMMON Commands

*CLS

*ESE <enable value>

*ESE?

*ESR?

*IDN?

*OPC

*OPC?

*PSC {0|*1*}

*PSC?

*RST

*SRE <enable value>

*SRE?

*STB?

*TRG

5 Error Message

Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. When user has read all errors from the queue, the **ERROR** annunciator turns off. DL-2060 beeps once each time an error occurs.

Should more than 20 errors have existed, the last error stored in the queue (the most recent error) is replaced with -350, "Too many errors". No additional errors are saved until you remove errors from the queue, the multimeter responds with +0, "No error".

The error queue is cleared when power has been off or after a *CLS (clear status) command has been executed. The *RST (reset) command does not clear the error queue.

5.1 Error Type

There is only one type over here, "execution errors".
Please refer to 3.4.12 for errors arised by selftest.

5.1.1 Execution Errors

- **-101 Invalid character**

An invalid character was found in the command string.

- **-102 Syntax error**

Invalid syntax was found in the command string.

- **-103 Invalid separator**

An invalid separator was found in the command string.

- **-104 Data type error**

A parameter type error was found in the command string.

- **-105 GET not allowed**

A Group Execute Trigger (GET) is not allowed in the command string.

- **-108 Parameter not allowed**

More parameters were found than needed for the command .

- **-109 Missing parameter**

Not enough parameters were received for the command.

- **-112 Program mnemonic too long**

A command header with too many characters was received.

- **-113 Undefined header**

An invalid command was received.

- **-121 Invalid character in number**

An invalid character was found in the number specified for a parameter value.

- **-123 Numeric overflow**

A numeric parameter with exponent larger than 32000 was found.

- **-124 Too many digits**

A numeric parameter was found whose mantissa contained more than 255 digits, excluding leading zeros.

- **-131 Invalid suffix**

A suffix was incorrectly specified for a numeric parameter.

- **-138 Suffix not allowed**

A suffix was received following a numeric parameter which does not accept a suffix.

- **-148 Character not allowed**

A discrete parameter was received but a character string or a numeric parameter was expected.

- **-151 Invalid string data**

An invalid character string was received.

- **-158 String data not allowed**

A character string was received but not allowed for the command.

- **-160~-168 Block data errors**

Block data is not acceptable.

- **-170~-178 Expression errors**

The meter does not accept mathematical expression.

- **-211 Trigger ignored**

A Group Execute Trigger (GET) or *TRG was received but the trigger was ignored.

- **-213 Trigger deadlock**

A trigger deadlock occurs when the trigger source is BUS and a READ? Command is received

- **-214 Init Ignored**

An INITiate command was received but could not be executed because a measurement was already in progress. Send a device clear to halt a measurement in progress and place the meter in the "idle" state.

- **-221 Settings conflict**

This error can be generated in one of the following situations:

Situation 1: You sent a CONFigure or MEASure command with autorange enabled and with a fixed resolution.

Situation 2: You turned math on and then changed to a math operation that was not valid with the present measurement function.

- **-222 Data out of range**

A numeric parameter value is out of range.

- **-223 Too much data**

A character string was too long.

- **-224 Illegal parameter value**

A discrete parameter was received which was not a valid choice for the command.

- **-230 Data Stale**

A FETCh? Command was received but the memory was empty.

- **-350 Too many errors**

The error queue is full.

- **-410 Query INTERRUPTED**

A command was received which sends data to the output buffer, but the output buffer contained data from a previous command.

- **-420 Query UNTERMINATED**

The multimeter was addressed to talk (i.e., to send data over the interface) but a command has not been received which send data to the output buffer.

- **-430 Query DEADLOCKED**

A command was received which generates too much data to fit in the output buffer and input buffer is also full. Command execution continues but all data is lost.

- **-440 Query UNTERMINATED after indefinite response**

The *IDN? Command must be the last query command within a command string.

- **-451 Scanner no support**

- **-452 Scan function not allow**

- **-453 No tcscanner card**

- **521 Input buffer overflow**

- **522 Output buffer overflow**

- **531 Insufficient memory**

There is not enough memory to store the requested number of readings in internal memory using the INITiate command. The product of the sample count (SAMPle:COUNt) and the trigger count (TRIGger:COUNt) must not exceed 512 readings.

- **532 Cannot achieve requested resolution**

The multimeter cannot achieve the requested measurement resolution. You may have specified an invalid resolution in the CONFigure or MEASure command.

- **540 Cannot use overload as math reference**

The multimeter cannot store an overload reading (9.90000000E+37) as the math reference for null or dB measurements. The math state is turned off as a result of this condition.

- **550 Command not allowed in local**

The multimeter received a READ? Command while in the local mode.

Appendix

A. Specification List

DC Characteristics   Accuracy ± (% of reading + % of range) [1]

Function	Range [2]	Resolution	Input resistance	1 Year (23℃ ± 5℃)
DC Voltage [3]	100.0000 mV	0.1 μV	> 10 GΩ	0.0050 + 0.0035
	1.000000 V	1.0 μV	> 10 GΩ	0.0040 + 0.0007
	10.00000 V	10 μV	> 10 GΩ	0.0035 + 0.0005
	100.0000 V	100 μV	10 MΩ	0.0045 + 0.0006
	1000.000 V	1 mV	10 MΩ	0.0045 + 0.0010

Function	Range [2]	Resolution	Shunt Resistance	1 Year (23℃ ± 5℃)
DC Current	10.00000mA	10 nA	5.1 Ω	0.050 + 0.020
	100.0000mA	100 nA	5.1 Ω	0.050 + 0.005
	1.000000A	1 μA	0.1 Ω	0.100 + 0.010
	3.00000A	10 μA	0.1 Ω	0.120 + 0.020

1. **Specifications are for 6 ½ digits and two hours warm up.**
2. **20% over range on all ranges except 1000Vdc and 3A range.**
3. **a. Using continuous integrating A/D converter.**
   b. Input bias current: less than 30 pA at 25º C.
   c. Input protection: 1000 V (PEAK), all range.

Function	Range	Resolution	Test Current	1 Year (23℃ ± 5℃)
Resistance[4]	100.0000 Ω	100 µΩ	1 mA	0.010 + 0.004
	1.000000 kΩ	1 mΩ	1 mA	0.010 + 0.001
	10.00000 kΩ	10 mΩ	100 µA	0.010 + 0.001
	100.0000 kΩ	100 mΩ	10 µA	0.010 + 0.001
	1.000000 MΩ	1 Ω	5 µA	0.010 + 0.001
	10.00000 MΩ	10 Ω	500 nA	0.040 + 0.001
	100.0000 MΩ	100 Ω	500 nA //10 MΩ	0.800 + 0.010
Diode Test	1.0000 V	10 µV	1 mA	0.010 + 0.020
Continuity	1000.00 Ω	10 mΩ	1 mA	0.010 + 0.030

4．**a. Specifications are for 4-wire ohms. For 2-wire ohms, use Math Null function**

   b. Max. Lead Resistance: 10% of range per lead for 100Ω and 1KΩ ranges; 1kΩ per lead for all other ranges.

   c. Input protection: 1000 V (PEAK), all ranges.

Frequency and Period Characteristics   Accuracy ± (% of reading)[5]

Function	Range[6]	Frequency (Hz)	1 Year (23℃±5℃)
Frequency & Period	100 mV to 750 V[9]	3 – 5	0.10
		5 – 10	0.05
		10 – 40	0.03
		40 – 300 k	0.01

AC Characteristics   Accuracy ± (% of reading + % of range)[7]

Function	Range[6]	Resolution	Frequency(Hz)	1 Year (23℃ ± 5℃)
AC Voltage[8] *(TRMS)*	100.0000 mV	0.1 µV	3 – 5	1.00 + 0.04
			5 – 10	0.35 + 0.04
			10 – 20 k	0.06 + 0.04
			20 k – 50 k	0.12 + 0.05
			50 k – 100 k	0.60 + 0.08
			100 k – 300 k	4.00 + 0.50
	1.000000 V to 750.000 V[9]	1.0 µV to 1 mV	3 – 5	1.00 + 0.03
			5 – 10	0.35 + 0.03
			10 – 20 k	0.06 + 0.03
			20 k – 50 k	0.12 + 0.05
			50 k – 100 k	0.60 + 0.08
			100 k – 300 k	4.00 + 0.50
AC Current[8] *(TRMS)*	1.000000 A	1 µA	3 – 5	1.00 + 0.04
			5 – 10	0.30 + 0.04
			10 – 5 k	0.10 + 0.04
	3.00000 A	10 µA	3 – 5	1.10 + 0.06
			5 – 10	0.35 + 0.06
			10 – 5 k	0.15 + 0.06

5. **Specifications are for 6 ½ digits and two hours warm up.**

6. **20% over range on all ranges except 750Vac range.**

7. **Specifications are for 6 ½ digits and two hours warm up, slow AC filter (3 Hz Bandwidth), sine wave input.**

8. **Specifications are for sine wave input>5% of range.**

9. **750Vac range is limited to 100 kHz.**

General Specifications

Item	Limitation & description
Power Supply	100 V / 220 V ± 10%
Power Line Frequency	50 / 60 Hz ± 10%
Power Consumption	25 VA peak
Operating Temperature	0 ℃ to 50 ℃
Operating Humidity	Maximum relative humidity 80 % for temperature up to 31 ℃
Storage Temperature	- 10 ℃ to 60 ℃
Operating Altitude	Up to 2000m
Bench Dimensions (WxHxD)	224 mm x 113 mm x 373 mm
Weight	Approx. 4.4 kg
Safety	EN61010-1:2001(2nd Edition) conformity
EMC	EN61326-1:2006 conformity
Accessories	Power cable, USB cable, Test leads,Fuse, CD-ROM(Application & Instruction manual)

B. Remote Interface Reference

B.1 An Introduction to the SCPI Language

SCPI (*Standard Commands for Programmable Instruments*) is an ASCII-based instrument command language designed for test and measurement instruments.

SCPI commands are based on a hierarchical structure, also known as a *tree system*. In this system, associated commands are grouped together under a common node or root, thus forming *subsystems*. A portion of the SENSe subsystem is shown below to illustrate the tree system.

[SENSe:]

    VOLTage:

        DC:RANGe {<*range*>|MINimum|MAXimum}

    VOLTage:

        DC:RANGe? [MINimum|MAXimum]

    FREQuency:

        VOLTage:RANGe {<*range*>|MINimum|MAXimum}

    FREQuency:

        VOLTage:RANGe? [MINimum|MAXimum]

    DETector:

```
        BANDwidth {3|20|200|MINimum|MAXimum}
    DETector:
        BANDwidth? [MINimum|MAXimum]
    ZERO:
        AUTO {OFF|ONCE|ON}
    ZERO:
        AUTO?
```

SENSe is the root keyword of the command, VOLTage and FREQuency are second-level keywords, and DC and VOLTage are third-level keywords. A *colon* (**:**) separates a command keyword from a lower-level keyword.

Command Format Used in This Manual

The format used to show commands in this manual is shown below:

VOLTage:DC:RANGe {<*range*>|MINimum|MAXimum}

The command syntax shows most commands (and some parameters) as a mixture of upper- and lower-case letters. The upper-case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, send the long form. For example, in the above syntax statement, VOLT and VOLTAGE are both acceptable forms. You can use upper- or lower-case letters. Therefore, VOLTAGE, volt, and Volt are all acceptable. Other forms, such as VOL and VOLTAG, will generate an error. *Braces* (**{ }**) enclose the parameter choices for a given command string. The braces are not sent with the command string. A *vertical bar* (**|**) separates multiple parameter choices for a given command string. *Triangle brackets* (**< >**) indicate that you must specify a value for the enclosed parameter. For example, the above syntax statement shows the *range* parameter enclosed in triangle brackets. The brackets are not sent with the command string. You must specify a value for the parameter (such as "VOLT:DC:RANG 10"). Some parameters are enclosed in *square brackets* (**[ ]**). The brackets indicate that the parameter is optional and can be omitted. The brackets are not sent with the command string. If you do not specify a value for an optional parameter, the multimeter chooses a default value.

Using the *MIN* and *MAX* Parameters

You can substitute MINimum or MAXimum in place of a parameter for many commands. For example, consider the following command:

VOLTage:DC:RANGe {<*range*>|MINimum|MAXimum}

Instead of selecting a specific voltage range, you can substitute MIN to set the range to its minimum value or MAX to set the range to its maximum value.

Querying Parameter Settings

You can query the current value of most parameters by adding a question mark (?) to the command. For example, the following command sets the sample count to 10 readings:

"SAMP:COUN 10"

You can query the sample count by executing:

"SAMP:COUN?"

You can also query the minimum or maximum count allowed as follows:

"SAMP:COUN? MIN"
"SAMP:COUN? MAX"

※ Note: If you send two query commands without reading the response from the first, and then attempt to read the second response, you may receive some data from the first response followed by the complete second response. To avoid this, do not send a query command without reading the response. When you cannot avoid this situation, send a device clear before sending the second query command.

SCPI Command Terminators

A command string sent to the multimeter must terminate with a <new line> character. The GPIB EOI (end-or-identify) message is interpreted as a <new line> character and can be used to terminate a command string in place of a <new line> character. A <carriage return> followed by a <new line> is also accepted. Command string termination will always reset the current SCPI command path to the root level.

GPIB(IEEE-488.2) Common Commands

The GPIB (IEEE-488.2) standard defines a set of common commands that perform functions like reset, self-test, and status operations. Common commands always begin with an asterisk (*), are four to five characters in length, and may include one or more parameters. The command keyword is separated from the first parameter by a blank space.

Use a semicolon (;) to separate multiple commands as shown below:

"*RST; *CLS; *ESE 32; *OPC?"

SCPI Parameter Types

The SCPI language defines several different data formats to be used in program messages and response messages.

Numeric Parameters Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation.

Special values for numeric parameters like MINimum, MAXimum, and DEFault are also accepted. You can also send engineering unit suffixes with numeric parameters (e.g., M, K, or u). If only specific numeric values are accepted, the multimeter will automatically round the input numeric parameters. The following command uses a numeric parameter:

VOLTage:DC:RANGe {<range>|MINimum|MAXimum}

Discrete Parameters Discrete parameters are used to program settings that have a limited number of values (like BUS, IMMediate, EXTernal). They have a short form and a long form just like command keywords. You can mix upper- and lower-case letters. Query responses will always return the short form in all upper-case letters. The following command uses discrete parameters:

TRIGger:SOURce {BUS|IMMediate|EXTernal}

Boolean Parameters Boolean parameters represent a single binary condition that is either true or false. For a false condition, the multimeter will accept "OFF" or "0". For a true condition, the multimeter will accept "ON" or "1". When you query a boolean setting, the instrument will always return "0" or "1". The following command uses a boolean parameter:

INPut:IMPedance:AUTO {OFF|ON}

String Parameters String parameters can contain virtually any set of ASCII characters. A string must begin and end with matching quotes; either with a single quote or with a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between. The following command uses a string parameter:

DISPlay:TEXT <quoted string>

B.2 Output Data Formats

Output data will be in one of formats shown in the table below.

Type of Output Data

Non-reading queries

Single reading (GPIB)

Multiple readings (GPIB)

Output Data Format

< 80 ASCII character string

SD.DDDDDDDDESDD<nl>

SD.DDDDDDDDESDD,...,...,<nl>

SD.DDDDDDDDESDD<cr><nl>

SD.DDDDDDDDESDD,...,...,<cr><nl>

S Negative sign or positive sign

D Numeric digits

E Exponent

<nl> newline character

<cr> carriage return character

B.3 The MEASure? Command

MEASure:VOLTage:DC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a dc voltage measurement with the specified range and resolution. The reading is sent to the output buffer.

MEASure:VOLTage:DC:RATio? {<range>|MIN|MAX|DEF },{<resolution>|MIN|MAX|DEF}

Preset and make a dc:dc ratio measurement with the specified range and resolution. The reading is sent to the output buffer. For ratio measurements, the specified range applies to input signal, yet autorange is selected for the reference signal.

MEASure:VOLTage:AC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make an AC voltage measurement with the specified range and resolution. The reading is sent to the output buffer. For AC measurement, resolution is fixed at 6 ½ digits. Therefore the resolution parameter only affects the front panel display.

MEASure:CURRent:DC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a dc current measurement with the specified range and resolution. The reading is sent to the output buffer.

MEASure:CURRent:AC? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a AC current measurement with the specified range and resolution. The reading is sent to the output buffer. For AC measurement, resolution is fixed at 6 ½ digits. Therefore the resolution parameter only affects the front panel display.

MEASure:RESistance? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a 2-wire Ω measurement with the specified range and resolution. The reading is sent to the output buffer.

MEASure:FRESistance? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a 4-wire Ω measurement with the specified range and resolution. The reading is sent to the output buffer.

MEASure:FREQuency? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a frequency measurement with the specified range and resolution. The reading is sent to the output buffer. For frequency measurements, the meter uses only one "range" for all inputs between 3Hz and 300kHz. With no input signal applied, frequency measurements return "0".

MEASure:PERiod? {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a period measurement with the specified range and resolution. The reading is sent to the output buffer. For period measurements, the meter uses only one "range" for all inputs between 0.33 seconds and 3.3 μ sec. With no input signal applied, period measurements return "0".

MEASure:CONTinuity?

Preset and make a continuity measurement. The reading is sent to the output buffer. The range and resolution are fixed at 1kΩ and 5 ½ digits respectively.

MEASure:DIODe?

Preset and make a diode measurement. The reading is sent to the output buffer. The range and resolution are fixed at 1Vdc with 1mA current source and 5 ½ digits respectively.

MEASure:TEMPerature?

Preset and make a temperature measurement with RTD. The reading is sent to the output buffer.

MEASure:TCOuple?

Preset and make a temperature measurement with thermocouple. The reading is sent to the output buffer.

B.4 The CONFigure Command

CONFigure:VOLTage:DC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for DC voltage measurements with the specified range and resolution. This command does not initiate the measurement.

CONFigure:VOLTage:DC:RATio {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for DC:DC ratio measurements with the specified range and resolution. This command does not initiate the measurement. The specified range applies to the source signal and autorange is selected for the reference signal.

CONFigure:VOLTage:AC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for AC voltage measurements with the specified range and resolution. This command does not initiate the measurement. For AC measurement, resolution is fixed at 6½ digits. Therefore the resolution parameter only affects the front panel display.

CONFigure:CURRent:DC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for DC current measurements with the specified range and resolution. This command does not initiate the measurement.

CONFigure:CURRent:AC {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for AC current measurements with the specified range and resolution. This command does not initiate the measurement. For AC measurement, resolution is fixed at 6½ digits. Therefore the resolution parameter only affects the front panel display.

CONFigure:RESistance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for 2-wire Ω measurements with the specified range and resolution. This command does not initiate the measurement.

CONFigure:FRESistance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for 4-wire Ω measurements with the specified range and resolution. This command does not initiate the measurement.

CONFigure:FREQuency {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure the multimeter for frequency measurements with the specified range and resolution. This command does not initiate the measurement.For frequency measurements, the meter uses only one "range" for all inputs between 3Hz and 300kHz. With no input signal applied, frequency measurements return "0".

CONFigure:PERiod {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and configure a period measurement with the specified range and resolution. This command does not initiate the measurement. For period measurements, the meter uses only one "range" for all inputs between 0.33 seconds and 3.3 μsec. With no input signal applied, period measurements return "0".

CONFigure:CONTinuity

Preset and configure for a continuity measurement. This command does not initiate the measurement. The range and resolution are fixed at 1kΩ and 5½ digits respectively.

CONFigure:DIODe

Preset and configure for a diode measurement. This command does not initiate the measurement. The range and resolution are fixed at 1Vdc with 1mA current source and 5½ digits respectively.

CONFigure:TEMPerature

Preset and configure for a RTD measurement. This command does not initiate the measurement. The resolution is fixed at 6½ digits.

CONFigure:TCOuple

Preset and configure for a thermocouple measurement. This command does not initiate the measurement. The resolution is fixed at 6½ digits.

CONFigure?

Query a recent condition of function, and return a quoted string.

B.5 The Measurement Configuration Command

※ This mark means that it is available with firmware version 1.05 or upward.

[SENSe:]FUNCtion "<*function*>"

Select a measurement function and enclose it in quotes in the command string (FUNC "VOLT:DC").

Use one of the following strings.

VOLTage:DC	*VOLTage:AC*	*VOLTage:DC:RATio*
CURRent:DC	*CURRent:AC*	
RESistance (for 2-wire ohms)	*FRESistance (for 4-wire ohms)*	
FREQuenc	*PERiod*	*CONTinuity*
DIODe	*TCOuple*	*TEMPerature*

[SENSe:]FUNCtion?

Query the measurement function and return a quoted string.

[SENSe:]<*function*>:RANGe {<*range*>|MINimum|MAXimum}

Select a range for the selected function. For frequency and period measurements, range applies to the signal's input voltage, not its frequency (use FREQuency:VOLTage or PERiod:VOLTage). MIN selects the lowest range for the selected function. MAX selects the highest range.

[SENSe:]<*function*>:RANGe? [MINimum|MAXimum]

Query the range for the selected function. For frequency and period, use FREQuency:VOLTage or PERiod:VOLTage. Autorange thresholds: Down range at <10% of range; Up range at >120% of range.

[SENSe:]<*function*>:RANGe:AUTO {OFF|ON}

Disable or enable autorange for the selected function.

[SENSe:]<*function*>:RANGe:AUTO?

Query the autorange setting. Return "1" (ON) or "0" (OFF).

[SENSe:]<*function*>:RESolution {<*resolution*>|MINimum|MAXimum}

Set resolution for the selected function (not valid for frequency, period, or ratio). Specify the resolution in the same units as the measurement function, not in number of digits. MIN selects the smallest value accepted, which gives the most resolution. MAX selects the largest value accepted which gives the least resolution.

[SENSe:]<*function*>:RESolution? [MINimum|MAXimum]

Query the resolution for the selected function.

[SENSe:]UNIT {Cel|Far|K}

Select units for temperature measurement. Cel means Celsius, Far means Fahrenheit,and K means Kelvin.

[SENSe:]UNIT?

Query units for temperature measurement.

[SENSe:]TCOuple:TYPE {E|J|K|N|R|S|T}

Select thermocouple sensor type.

[SENSe:]TCOuple:TYPE {E|J|K|N|R|S|T}, @{scanner channel number}

Set a thermocouple sensor type on an indicated channel.

[SENSe:]TCOuple:TYPE?

Query thermocouple sensor type.

[SENSe:]TCOuple:TYPE? @{scanner channel number}

Query thermocouple sensor type on an indicated channel.

※ [SENSe:]TCOuple:RJUNction:RSELect {REAL|SIMulated}

Select the reference junction (REAL) or self-definition (Simulated)

※ [SENSe:]TCOuple:RJUNction:RSELect?

Query reference junction type.

※ [SENSe:]TCOuple:RJUNction:REAL?

Query a current temperature of the reference junction.

※ [SENSe:]TCOuple:RJUNction:SIMulated {<value>|MINimum|MAXimum}

Set the SIMulated value for Thermocouple function.

※ [SENSe:]TCOuple:RJUNction:SIMulated?

Query the SIMulated value for Thermocouple function.

[SENSe:]TEMPerature:RTD:TYPE {PT100|D100|F100|PT385|PT3916|USER|SPRTD|NTCT}

Select the RTD type for temperature measurement with RTD.

[SENSe:]TEMPerature:RTD:TYPE {PT100|D100|F100|PT385|PT3916|USER|SPRTD|NTCT},
@{scanner channel number}

Select the RTD type on an indicated channel.

[SENSe:]TEMPerature:RTD:TYPE?

Query the RTD type for temperature measurement with RTD.

[SENSe:]TEMPerature:RTD:TYPE? @{scanner channel number}

Query RTD type on an indicated channel.

[SENSe:]TEMPerature:RTD:RZERo {<*value*>|MINimum|MAXimum}

Set the R-Zero constant for the user defined RTD type.

[SENSe:]TEMPerature:RTD:RZERo? [MINimum|MAXimum]

Query the R-Zero constant for the user defined RTD type.

[SENSe:]TEMPerature:RTD:ALPHa {<*value*>|MINimum|MAXimum}

Set the alpha constant for the user type.

[SENSe:]TEMPerature:RTD:ALPHa? [MINimum|MAXimum]

Query the alpha constant for the user type.

[SENSe:]TEMPerature:RTD:BETA {<*value*>|MINimum|MAXimum}

Set the beta constant for the user type.

[SENSe:]TEMPerature:RTD:BETA? [MINimum|MAXimum]

Query the beta constant for the user type.

[SENSe:]TEMPerature:RTD:DELTa {<*value*>|MINimum|MAXimum}

Set the delta constant for the user type.

[SENSe:]TEMPerature:RTD:DELTa? [MINimum|MAXimum]

Query the delta constant for the user type.

[SENSe:]TEMPerature:SPRTD:RZERo {<*value*>|MINimum|MAXimum}

Set the sensor R value at 0 degree Celsius.

[SENSe:]TEMPerature:SPRTD:RZERo? [MINimum|MAXimum]

Query the sensor R value at 0 degree Celsius.

[SENSe:]TEMPerature:SPRTD:A4 {<*value*>|MINimum|MAXimum}

Set the A4 coefficient.

[SENSe:]TEMPerature:SPRTD:A4? [MINimum|MAXimum]

Query the A4 coefficient.

[SENSe:]TEMPerature:SPRTD:B4 {<*value*>|MINimum|MAXimum}

Set the B4 coefficient.

[SENSe:]TEMPerature:SPRTD:B4? [MINimum|MAXimum]

Query the B4 coefficient.

[SENSe:]TEMPerature:SPRTD:AX {<*value*>|MINimum|MAXimum}

Set the A coefficient.

[SENSe:]TEMPerature:SPRTD:AX? [MINimum|MAXimum]

Query the A coefficient.

[SENSe:]TEMPerature:SPRTD:BX {<*value*>|MINimum|MAXimum}

Set the B coefficient.

[SENSe:]TEMPerature:SPRTD:BX? [MINimum|MAXimum]

Query the B coefficient.

[SENSe:]TEMPerature:SPRTD:CX {<*value*>|MINimum|MAXimum}

Set the C coefficient.

[SENSe:]TEMPerature:SPRTD:CX? [MINimum|MAXimum]

Query the C coefficient.

[SENSe:]TEMPerature:SPRTD:DX {<*value*>|MINimum|MAXimum}

Set the D coefficient.

[SENSe:]TEMPerature:SPRTD:DX? [MINimum|MAXimum]

Query the D coefficient.

[SENSe:]TEMPerature:TRANsducer FRTD

Set the RTD Measurement to 4-Wire.

[SENSe:]TEMPerature:TRANsducer FRTD, @{scanner channel number}

Set the RTD Measurement to 4-Wire on the indicated channel.

[SENSe:]TEMPerature:TRANsducer RTD

Set the RTD Measurement to 2-Wire.

[SENSe:]TEMPerature:TRANsducer RTD, @{scanner channel number}

Set the RTD Measurement to 2-Wire on the indicated channel.

[SENSe:]TEMPerature:TRANsducer?

Query TRANsducer type.

[SENSe:]TEMPerature:TRANsducer? @{scanner channel number}

Query TRANsducer type on an indicated channel.

[SENSe:]<*function*>:NPLCycles {0.02|0. 1|1|10|MINimum|MAXimum}

Set the integration time in number of power line cycles for the selected function. This command is valid only for DCV, DCI, 2-wire ohms and 4-wire ohms.

[SENSe:]<*function*>:NPLCycles? [MINimum|MAXimum]

Query the integration time for the selected function.

[SENSe:]FREQuency:APERture {0.01|0.1|1|MINimum|MAXimum}

Set the gate time (or aperture time) for frequency function. Specify 10 ms (4 1/2 digits), 100 ms (default; 5 1/2 digits), or 1 second (6 1/2 digits).

[SENSe:]FREQuency:APERture? [MINimum|MAXimum]

Query the gate time (or aperture time) for frequency function.

[SENSe:]PERiod:APERture{0.01|0.1|1|MINimum|MAXimum}

Set the gate time (or aperture time) for period function. Specify 10 ms (4 1/2 digits), 100 ms (default; 5 1/2 digits), or 1 second (6 1/2 digits).

[SENSe:]PERiod:APERture? [MINimum|MAXimum]

Query the gate time (or aperture time) for period function.

[SENSe:]DETector:BANDwidth {3|20|200|MINimum|MAXimum}

Specify the lowest frequency expected in the input signal. The meter selects the slow, medium or fast ac filter based on the frequency you specify.

[SENSe:]DETector:BANDwidth? [MINimum|MAXimum]

Query the ac filter and return the bandwidth.

[SENSe:]ZERO:AUTO {OFF|ONCE|ON}

Disable or enable the auto zero mode. The OFF and ONCE have a similar effect. OFF mode does not issue a new offset measurement until the multimeter goes to the "WAIT-FOR-TRIGGER" state. Parameter ONCE issues an immediate offset measurement.

[SENSe:]ZERO:AUTO?

Query the auto zero mode. Returns "1" (ON) or "0" (OFF or ONCE).

INPut:IMPedance:AUTO{OFF|ON}

Disable or enable the automatic input resistance mode for DC voltage measurements. With AUTO ON, the input resistance is set to >10GΩ for the 100mV, 1V and 10V ranges. With AUTO OFF, the input resistance is fixed at 10MΩ for all ranges.

INPut:IMPedance:AUTO?

Query the input resistance mode. Returns "1"(ON) or "0"(OFF).

ROUTe:TERMinals?

Query the multimeter to determine if the front or rear input terminals are selected. Returns "FRON" or "REAR"

ROUTe:CLOSe <channel>

Set channels which need to be closed. <The range is from channel 1 to 10 or 20>

ROUTe:CLOSe?

Query channels which were closed.

ROUTe:OPEN

Open all channels.

ROUTe:STATe?

Query the state. The state 3 means 10ch TC-Card inserted, 2 means 20ch Card inserted, 1 means 10ch Card inserted or 0 means Card not inserted.

ROUTe:SCAN:FUNCtion <channel>,{<function>|"VOLT:DC"|"VOLT:AC"|"FREQuency"|"RESistance"|"FRESistance"|"PERiod"|"TCOuple"|"TEMPerature"|"NONE"}

Set scanner card's measurement functions which might be for the VAC, VDC, Frequency, 2-Wire Resistance, 4-Wire Resistance, Period, Thermocouple, RTD, or disabling the channel.

ROUTe:SCAN:FUNC? <channel>

Query the channel's function on the scanner card.

ROUTe:SCAN:TIMER?

Read the time interval of scanning.

ROUTe:SCAN:TIMER <value>

Set the time interval of scanning <The unit is second>.

ROUTe:SCAN:COUNT?

Read the number of times of scanning.

ROUTe:SCAN:COUNT <value>

Set the number of times of scanning.

ROUTe:SCAN:STATe?

Query a channel numeric which is being scanned.

ROUTe:SCAN:SCAN

Run SCAN mode

ROUTe:SCAN:STEP

Run STEP mode

B.6 The Math Operation Command

CALCulate:FUNCtion {PERCent|AVERage|NULL|LIMit|MXB|DB|DBM}

Select the math function. Only one function can be enabled at a time. The default function is percent.

CALCulate:FUNCtion?

Query the present math function. Returns PERC, AVER, NULL, LIM, MXB, DB or DBM.

CALCulate:STATe {OFF|ON}

Disable or enable the selected math function.

CALCulate:STATe?

Query the state of the math function. Returns "0"(OFF) or "1"(ON).

CALCulate:PERCent:TARGet {*<value>*|MINimum|MAXimum}

Set the target value for percent math function. The multimeter clears the value when Min/Max is turned on, when the power has been off or a remote interface reset.

CALCulate:PERCent:TARGet? [MINimum|MAXimum]

Query the target value for percent math function.

CALCulate:AVERage:MINimum?

Read the minimum value found during the Min/Max operation. The multimeter clears the value when Min/Max is turned on, when the power has been off or a remote interface reset.

CALCulate:AVERage:MAXimum?

Read the maximum value found during the Min/Max operation. The multimeter clears the value when Min/Max is turned on, when the power has been off or a remote interface reset.

CALCulate:AVERage:AVERage?

Read the average value of all readings taken since the Min/Max operation has been enabled. The multimeter clears the value when Min/Max is turned on, when the power has been off or a remote interface reset.

CALCulate:AVERage:COUNt?

Read the number of readings taken since Min/Max has been enabled. The multimeter clears the value when Min/Max is turned on, when the power has been off or a remote interface reset.

CALCulate:NULL:OFFSet {<*value*>|MINimum|MAXimum}

Store a null value in the multimeter's Null Register.   *You must turn on the math operation before writing to the math register*. You can set the null value to any number between 0 and $\pm$ 120% of the highest range.

CALCulate:NULL:OFFSet?

Query the null value.

CALCulate:LIMit:LOWer {<value>|MINimum|MAXimum}

Set the lower limit for limit testing. You can set the value to any number from 0 to $\pm$ 120% of the highest range, for the present function.

CALCulate:LIMit:LOWer?

Query the lower limit for the limit testing.

CALCulate:LIMit:UPPer {<value>|MINimum|MAXimum}

Set the upper limit for limit testing. You can set the value to any number from 0 to $\pm$ 120% of the highest range, for the present function.

CALCulate:LIMit:UPPer?

Query the upper limit for the limit testing.

CALCulate:MXB:MMFactor {<value>|MINimum|MAXimum}

Set the value of M.

CALCulate:MXB:MMFactor? [MINimum|MAXimum]

Query the value of M.

CALCulate:MXB:MBFactor {<value>|MINimum|MAXimum}

Set the value of B.

CALCulate:MXB:MBFactor? [MINimum|MAXimum]

Query the value of B.

CALCulate:DB:REFerence {<value>|MINimum|MAXimum}

Store a relative value in the dB Relative Register. *You must turn on the math operation before writing to the math register*. You can set the relative value to any number between 0 dBm and $\pm$ 200 dBm.

CALCulate:DB:REFerence? [MINimum|MAXimum]

Query the dB relative value.

CALCulate:DBM:REFerence {<value>|MINimum|MAXimum}

Set the dBm reference value. Choose from: 50 ~ 8000 ohms.

CALCulate:DBM:REFerence? [MINimum|MAXimium]

Query the dBm reference value.

DATA:FEED RDG_STORE,{"CALCulate"|""}

Selects whether readings taken using the INITiate command are stored in the multimeter's internal memory (default) or not stored at all. In the default state (DATA:FEED RDG_STORE,"CALC"), up to 2000 readings are stored in memory when INITiate is executed. The MEASure? And CONFigure commands automatically select "CALC". With memory disabled (DATA:FEED RDG_STORE,""), readings taken using INITiate are not stored. This may be useful with the Min/Max operation since it allows you to determine an average of the readings without storing the individual values. An error will be generated if you attempt to transfer readings to the output buffer using the FETCh? command.

DATA:FEED?

Query the reading memory state. Return "CALC" or "".

B.7 The Triggering Commands

INITiate

Change the state of the triggering system from the "idle" state to "wait-for-trigger" state. The meter will start to make measurements when a required triggering condition is met after the INITiate command is received. Readings are stored in memory until you are ready to read them. Use FETCh? command to retrieve your measurements results.

READ?

Change the state of the triggering system from the "idle" state to "wait-for-trigger" state. The meter will start to make measurements when a required triggering condition is met after the READ? Command is received. Readings are sent to the output buffer right away.

TRIGger:SOURce {BUS|IMMediate|EXTernal}

Select a trigger source. The multimeter will accept a software (BUS) trigger, an immediate internal trigger, or a hardware trigger from the rear-panel EXT TRIG terminal.

TRIGger:SOURce?

Query the trigger source.

TRIGger:DELay {<*seconds*>|MINimum|MAXimum}

Set a trigger delay time in seconds. The delay is the time between the trigger signal and each sample that follows. Specify a delay time from 0 to 3600 seconds.

TRIGger:DELay?

Query the trigger delay time.

TRIGger:DELay:AUTO {OFF|ON}

Disable or enable a automatic trigger delay. The delay is determined by function, range, integration time, and ac filter setting. Specifying a delay time automatically turns off the automatic trigger delay.

TRIGger:DELay:AUTO?

Query the automatic trigger delay mode. Returns "0" (OFF) or "1" (ON).

SAMPle:COUNt {<*value*>|MINimum|MAXimum}

Set the number of readings (samples) the multimeter takes per trigger. Select a number from 1 to 50,000 readings per trigger.

SAMPle:COUNt ? [MINimum|MAXimum]

Query the sample count.

TRIGger:COUNt {<*value*>|MINimum|MAXimum|INFinite}

Specify the number of triggers the multimeter will accept before returning to the "idle" state. Select from 1 to 50,000 triggers. The INFinite parameter instructs the multimeter to take triggers continuously. Trigger count is ignored while in local operation.

TRIGger:COUNt? [MINimum|MAXimum|INFinite]

Query the trigger count. Returns "9.90000000E+37" when you select the infinite trigger count.

B.8 The System-Related Commands

FETCh?

Transfer readings stored in memory by the INITiate command to output buffer where you are able to read them into your bus controller.

READ?

Change the state of the triggering system from the "idle" state to "wait-for-trigger" state. The meter will start to make measurements when a required triggering condition is met after the READ? command is received. Measurement readings are sent to the output buffer immediately.

DISPlay {OFF|ON}

Turn off or on the display.

DISPlay?

Query the display setting. Returns "0" (OFF) or "1" (ON).

DISPlay:TEXT <*quoted string*>

Show a message on the front panel display. The allowed message can be up to 16 characters in the lower row display; any additional characters will be truncated.

DISPlay:TEXT?

Query the message sent to the front panel display.

DISPlay:TEXT:CLEar

Clear the message shown on the front panel display.

SYSTem:BEEPer

Issue a single beeping tone.

SYSTem:BEEPer:STATe {OFF|ON}

Disable or enable the beeper.

SYSTem:BEEPer:STATe?

Query the beeper mode. Returns "0" (OFF) or "1" (ON).

SYSTem:ERRor?

Query the multimeter's error queue. Up to 20 errors can be stored in the queue. Errors are retrieved in first-in-first-out (FIFO) order. Each error string may contain up to 80 characters.

SYSTem:VERSion?

Query the present SCPI version.

L0

Set to the default identification string.

L1

Set to the compatible identification string.

DATA:POINts?

Query the number of readings stored in the multimeter's internal memory.

*RST

Reset the multimeter to the power-on configuration. This command can not clear the error queue.

*IDN?

Read the multimeter's identification string (be sure to dimension a string variable with at least 35 characters).

Other Interface Commands

SYSTem:LOCal

Place the multimeter in the *local* mode. All buttons on the front panel are fully functional.

SYSTem:REMote

Place the multimeter in the *remote* mode. All buttons on the front panel, except the LOCAL button, are disabled.

B.9 Status Reporting Commands

SYSTem:ERRor?

Query the multimeter's error queue. Up to 20 errors can be stored in the queue. Errors are retrieved in first-in-first out (FIFO) order. Each error string may contain up to 80 characters.

STATus:QUEStionable:ENABle <enable value>

Enable bits in the Questionable Data enable register. The selected bits are then reported to the Status Byte.

STATus:QUEStionable:ENABle?

Query the Questionable Data enable register. The multimeter returns a binary-weighted decimal representing the bits set in the enable register.

STATus:QUEStionable:EVENt?

Query the Questionable Data event register. The multimeter returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

STATus:PRESet

Clear all bits in the Questionable Data enable register.

*CLS

Clear the Status Byte summary register and all event registers.

*ESE <enable value>

Enable bits in the Standard Event enable register. The selected bits are then reported to the Status Byte.

*ESE?

Query the Standard Event enable register. The multimeter returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

*ESR?

Query the Standard event register. The multimeter returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

*OPC

Sets the "operation complete" bit (bit 0) in the Standard Event register after the command is executed.

*OPC?

Returns "1" to the output buffer after the command is executed.

*PSC {0|1}

Power-on status clear. Clear the Status Byte and Standard Event register enable masks when power is turned on (*PSC 1). When *PSC 0 is in effect, the Status Byte and Standard Event register enable masks are not cleared when power is turned on. [Stored in non-volatile memory]

*PSC?

Query the power-on status clear setting. Returns "0" (*PSC 0) or "1" (*PSC 1).

*SRE <enable value>

Enable bits in the Status Byte enable register.

*SRE?

Query the Status Byte enable register. The multimeter returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

*STB?

Query the Status Byte summary register. The *STB? command is similar to a serial poll but it is processed like any other instrument command. The *STB? command returns the same result as a serial poll but the "request service" bit (bit 6) is not cleared if a serial poll has occurred.

B.10 SCPI Compliance Information

This section encloses a list of commands that are device-specific to the DL-2060. Although not included in the 1999.0 version of the SCPI standard, these commands are designed with the SCPI format in mind and they follow all of the syntax rules of the standard.

Many of the required SCPI commands are accepted by the multimeter but are not described in this manual for simplicity or clarity. Most of these non-documented commands duplicate the functionality of a command already described in this chapter.

MEASure:
   CONTinuity?
   DIODe?

SAMPle:
   COUNt {<*value*>|MINimum|MAXimum}
   COUNt? [MINimum|MAXimum]

[SENSe:]
   FUNCtion "CONTinuity"
   FUNCtion "DIODe"
   FREQuency:VOLTage:RANGe {<*range*>|MINimum|MAXimum}
   FREQuency:VOLTage:RANGe? [MINimum|MAXimum]
   FREQuency:VOLTage:RANGe:AUTO {OFF|ON}
   FREQuency:VOLTage:RANGe:AUTO?
   PERiod:VOLTage:RANGe {<*range*>|MINimum|MAXimum}
   PERiod:VOLTage:RANGe? [MINimum|MAXimum]
   PERiod:VOLTage:RANGe:AUTO {OFF|ON}
   PERiod:VOLTage:RANGe:AUTO?
   ZERO:AUTO?

CALCulate:

PERCent:TARGet {*<value>*|MINimum|MAXimum}

PERCent:TARGet? [MINimum|MAXimum]

AVERage:MINimum?

AVERage:MAXimum?

AVERage:AVERage?

AVERage:COUNt?

NULL:OFFSet {<value>|MINimum|MAXimum}

NULL:OFFSet? [MINimum|MAXimum]

LIMit:LOWer {<value>|MINimum|MAXimum}

LIMit:LOWer? [MINimum|MAXimum]

LIMit:UPPer {<value>|MINimum|MAXimum}

LIMit:UPPer? [MINimum|MAXimum]

MXB:MMFactor {*<value>*|MINimum|MAXimum}

MXB:MMFactor? [MINimum|MAXimum]

MXB:MBFactor {*<value>*|MINimum|MAXimum}

MXB:MBFactor? [MINimum|MAXimum]

DB:REFerence {<value>|MINimum|MAXimum}

DB:REFerence? [MINimum|MAXimum]

DBM:REFerence {<value>|MINimum|MAXimum}

DBM:REFerence? [MINimum|MAXimum]

CONFigure:

CONTinuity

DIODe

INPut:

IMPedance:AUTO {OFF|ON}

IMPedance:AUTO?

B.11 GPIB (IEEE-488) Compliance Information

GPIB Common Commands

*CLS

*ESE *<enable value>*

*ESE?

*ESR?

*IDN?

*OPC

*OPC?

*PSC {0|1}

*PSC?

*RST

*SRE *<enable value>*

*SRE?

*STB?

*TRG

Using Device Clear to Halt Measurements

Device clear is an GPIB low-level bus message which can be used to halt measurements in progress. Different programming languages and GPIB interface cards provide access to this capability through their own unique commands. The status registers, the error queue, and all configuration states are left unchanged when a device clear message is received. Device clear performs the following actions.

•All measurements in progress are aborted.

•The multimeter returns to the trigger "idle state."

•The multimeter's input and output buffers are cleared.

•The multimeter is prepared to accept a new command string.

C. Tree Diagram

Please refer to **G. Notice of Scanner Card** if your firmware version is 1.05 or upward.

```
MENU
  |
  |---- SET ADC -------- ZERO -------- AUTO ZERO -------- ON
  |                                                       OFF
  |
  |---- TRIG ---------- READ HOLD ---------- 0.10%
  |                     N SAMPLE ----------- COUNT=00001
  |                     DELAY -------------- 0.002S
  |
  |---- SYSTEM -------- ERROR
  |                     INIT MODE ---------- DEFAULT
  |                     SELF TEST ---------- SAVE DATA
  |                     DISPLAY ------------ ON
  |                                          OFF
  |                     BEEP --------------- ON
  |                                          OFF
  |                     LANGUAGE ----------- DEFAULT
  |                     SYSTEM VER. -------- COMPATIBLE
  |
  |---- INTERFACE ----- USB --------------- ENABLE
  |                                          DISABLE
  |                     GPIB -------------- ADDR = 22
  |
  |---- CAL MENU ------ SECURED ----------- CODE ------- 000000
                        CALIBRATE
                        COUNT ------------- 00001
                        DATE
```

```
CONFIG
│
├── + DCV ──┬── RESOLUTION ─────────────── FAST 4 1/2
│           │                              SLOW 4 1/2
│           │                              FAST 5 1/2
│           │                              SLOW 5 1/2
│           │                              FAST 6 1/2
│           │                              SLOW 6 1/2
│           └── INPUT R ──── R = 10MΩ
│                           R > 10GΩ
│
├── + ACV ──── BAND WIDTH ──── BW:3Hz
│                              BW:20Hz
│                              BW:200Hz
│
├── + Ω2 ──── RESOLUTION ──────────────── FAST 4 1/2
│                                         SLOW 4 1/2
│                                         FAST 5 1/2
│                                         SLOW 5 1/2
│                                         FAST 6 1/2
│                                         SLOW 6 1/2
│
├── + FREQ ──┬── RESOLUTION ──── SLOW 4 1/2
│            │                   SLOW 5 1/2
│            │                   SLOW 6 1/2
│            └── INPUT JACK ──── VOLTAGE
│                                CURRENT
│
├── + CONT ──── R = 0010Ω
│
├── + TEMP ──┬── SENSOR ──────────────── F100
│            │                           PT385
│            │                           PT3916
│            │                           USER
│            │                           NTCT
│            │                           SPRTD
│            │                           PT100
│            │                           D100
│            ├── UNITS ──── °F
│            │              °K
│            │              °C
│            └── TRANSDUCER ──── 4W RTD
│                                2W RTD
│
├── + FILTER ──┬── READINGS ──── RDGS=010
│              └── MODE ──── REPEAT AVG.
│                            MOVING AVG.
│
├── + RATIO ──── RESOLUTION ──────────── FAST 4 1/2
│                                        SLOW 4 1/2
│                                        FAST 5 1/2
│                                        SLOW 5 1/2
│                                        FAST 6 1/2
│                                        SLOW 6 1/2
│
├── + % ──── 1.000000E+3
│
├── + MIN/MAX ──── MIN :0.000000E+00
│                  MAX :0.000000E+00
│                  AVERAGE :0.000000E+00
│                  COUNT :0.000000E+00
│
├── + NULL ──── NULL :0.000000E+00
│
└── + STORE ──── RDGS=0100
```

CONFIG

DCI (SHIFT+DCV) → RESOLUTION →
- FAST 4 1/2
- SLOW 4 1/2
- FAST 5 1/2
- SLOW 5 1/2
- FAST 6 1/2
- SLOW 6 1/2

ACI (SHIFT+ACV) → BAND WIDTH →
- BW:3Hz
- BW:20Hz
- BW:200Hz

Ω4 (SHIFT+Ω2) → RESOLUTION →
- FAST 4 1/2
- SLOW 4 1/2
- FAST 5 1/2
- SLOW 5 1/2
- FAST 6 1/2
- SLOW 6 1/2

PERIOD (SHIFT+FREQ)
- RESOLUTION →
  - SLOW 4 1/2
  - SLOW 5 1/2
  - SLOW 6 1/2
- INPUT JACK →
  - VOLTAGE
  - CURRENT

DIODE (SHIFT+CONT) → BOUND →
- VFLow=0.30V
- VFHi=0.80V

TCOUPL (SHIFT+ TEMP)
- TYPE →
  - E TYPE
  - J TYPE
  - K TYPE
  - N TYPE
  - R TYPE
  - S TYPE
  - T TYPE
- UNITS →
  - °F
  - °K
  - °C
- SIMULATED → +23.0

STEP (SHIFT+ FILTER)
- SET SCAN CHA → CH01 ~ CH10 →
  - DCV
  - ACV
  - 2Ω
  - 4Ω
  - FREQ
  - PERIOD
- OPERATION / OPEN ALL →
  - COUNT → 0010
  - TIMER → 0.5S
  - STORE → OFF
- CLOSE → CHANNEL → 00

SCAN (SHIFT+DIGITS)
- SET SCAN CHA → CH01 ~ CH10 →
  - DCV
  - ACV
  - 2Ω
  - 4Ω
  - FREQ
  - PERIOD
- OPERATION / OPEN ALL →
  - COUNT → 0010
  - TIMER → 0.5S
  - STORE → OFF
- CLOSE → CHANNEL → 00

LIMITS (SHIFT+RATIO)
- LOW → 0.000000E+00
- HIGH → 0.000000E+00
- OUTPUT →
  - DISABLE
  - ENABLE

MX+B (SHIFT+ %)
- SET M → 1.000000E+00
- SET B → 0.000000E+00

dBm (SHIFT+MIN/MAX) → R = 600Ω

dB (SHIFT+ NULL) → 000.0000

D. DL-2060's Dimension

E. About Application Programs

This section provides a brief description for each DL-2060 sample collection.

All of the following programs use the NI-VISA. If you want to modify the example programs, or write your own programs and compile them, you will need to install the NI-VISA.

Visual Basic 6.0Ⓡ and Visual C++Ⓡ are registered trademarks of Microsoft Corporation in the USA and other countries.

NI-VISA is trademark of National Instruments Corp.

Visual Basic 6

Learn how to create and use TEXIO IOUtils components, controls, data access, and more with the following Visual Basic 6 sample applications.

E.1 Using MEASure? for a Single Measurement

The following example uses the MEASure? command to make a single ac current measurement. This is the easiest way to program the multimeter for measurements. However, MEASure? does not offer much flexibility.

LISTING E.1.

Set the startup object for a Windows application to **Sub Main**.

Add a Reference to the **"VISA Library"**.

The sample application requires the following referece: C:\WINDOWS\system32**visa32.dll**.

```
Sub Main()

  Dim stat   As ViStatus
  Dim dfltRM As ViSession
  Dim sesn As ViSession
  Dim fList As ViFindList
  Dim desc As String * VI_FIND_BUFLEN
  Dim nList As Long
  Dim ret As Long
  Dim readin As String * 64

  stat = viOpenDefaultRM(dfltRM)
  If (stat < VI_SUCCESS) Then
    'Rem Error initializing VISA ... exiting
    MsgBox "USBTMC resource not found.", vbExclamation, "DL-2060 multimeter device test"
    Exit Sub
  End If

  Rem Find all DL-2060 USBTMC instruments in the system
  stat = viFindRsrc(dfltRM, "USB[0-9]*::0x098F::0x2061::?*INSTR", fList, nList, desc)
  If (stat < VI_SUCCESS) Then
    'Rem Error finding resources ... exiting
    MsgBox "DL-2060 device not found.", vbExclamation, "DL-2060 multimeter device test"
    viClose (dfltRM)
    Exit Sub
  End If

  Rem Open a session to each and determine if it matches
```

```
stat = viOpen(dfltRM, desc, VI_NULL, VI_NULL, sesn)
If (stat < VI_SUCCESS) Then
    MsgBox "Open device failed.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send reset command '*RST' -- reset DL-2060
stat = viWrite(sesn, "*RST", 4, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error. (*RST)", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send Clear command '*CLS'-- Clear DL-2060 status register
stat = viWrite(sesn, "*CLS", 4, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error. (*CLS)", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If

Rem send measure command -- Set to 0.1 volt dc range
stat = viWrite(sesn, "meas:volt:DC? 0.1,0.01", 22, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error. (meas:volt:dc? ...)", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If

Rem fetch the measure data
stat = viRead(sesn, readin, 64, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "Read in data error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If

Debug.Print "Rdg = "; readin

Rem set to local mode
stat = viWrite(sesn, "system:local", 12, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error. (system:local)", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If

stat = viClose(sesn)
stat = viClose(fList)
stat = viClose(dfltRM)

MsgBox "End of Job."

End Sub
```

E.2 Using CONFigure with a Math Operation

The following example uses CONFigure with the dBm math operation.The CONFigure command gives you a little more programming flexibility than the MEASure? command. This allows you to "incrementally" change the multimeter's configuration.

LISTING E.2.

Set the startup object for a Windows application to **Sub Main**.

Add a Reference to the "VISA Library".

The sample application requires the following referece: C:\WINDOWS\system32**visa32.dll**.


```
Public Declare Sub Sleep Lib "kernel32" (ByVal dwMilliseconds As Long)

Sub main()

   Rem #######################################
   Rem
   Rem      Using NI-VISA library visa32.dll
   Rem
   Rem      Set sample count 5 configuration and
   Rem      read the trigger
   Rem
   Rem #######################################

   Dim stat   As ViStatus
   Dim dfltRM As ViSession
   Dim sesn As ViSession
   Dim fList As ViFindList
   Dim desc As String * VI_FIND_BUFLEN
   Dim nList As Long
   Dim ret As Long
   Dim readin As String * 128
   Dim i As Integer        ' Array index

   stat = viOpenDefaultRM(dfltRM)
   If (stat < VI_SUCCESS) Then
     'Rem Error initializing VISA ... exiting
     MsgBox "USBTMC resource not found.", vbExclamation, "DL-2060 multimeter device test"
     Exit Sub
   End If

   Rem Find all DL-2060 USBTMC instruments in the system
   stat = viFindRsrc(dfltRM, "USB[0-9]*::0x098F::0x2061::?*INSTR", fList, nList, desc)
   If (stat < VI_SUCCESS) Then
     'Rem Error finding resources ... exiting
     MsgBox "DL-2060 device not found.", vbExclamation, "DL-2060 multimeter device test"
     viClose (dfltRM)
     Exit Sub
   End If

   Rem Open a session to each and determine if it matches
   stat = viOpen(dfltRM, desc, VI_NULL, VI_NULL, sesn)
   If (stat < VI_SUCCESS) Then
       MsgBox "Open device failed.", vbExclamation, "DL-2060 multimeter device test"
       stat = viClose(fList)
       Exit Sub
   End If

   Rem send reset command '*RST' -- reset DL-2060
   stat = viWrite(sesn, "*RST", 4, ret)
   If (stat < VI_SUCCESS) Then
```

```
    MsgBox "System command error. (*RST)", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send Clear command '*CLS'-- Clear DL-2060 status register
stat = viWrite(sesn, "*CLS", 4, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error. (*CLS)", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If


Rem send command -- 50 ohm reference resistance
stat = viWrite(sesn, "CALC:DBM:REF 50", 15, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send command -- Set kDL-2060 to 1 amp ac range
stat = viWrite(sesn, "CONF:VOLT:AC 1,0.001", 20, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send command -- Select 200 Hz (fast) ac filter
stat = viWrite(sesn, "DET:BAND 200", 12, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send command -- kDL-2060 will accept 5 triggers
stat = viWrite(sesn, "SAMP:COUN 5", 11, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send command -- Trigger source is IMMediate
stat = viWrite(sesn, "TRIG:SOUR IMM", 13, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If
Rem send command -- Select dBm function
stat = viWrite(sesn, "CALC:FUNC DBM", 13, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If


Rem send command -- Enable math
stat = viWrite(sesn, "CALC:STAT ON", 12, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
    stat = viClose(fList)
    Exit Sub
End If


Rem send command -- Take readings
stat = viWrite(sesn, "READ?" & vbLf, 6, ret)
If (stat < VI_SUCCESS) Then
    MsgBox "System command error.", vbExclamation, "DL-2060 multimeter device test"
```

```vb
      stat = viClose(fList)
      Exit Sub
   End If

   Sleep (3000)   ' wait for math processing

   Rem fetch the measure data
   stat = viRead(sesn, readin, 128, ret)
   If (stat < VI_SUCCESS) Then
      MsgBox "Read in data error.", vbExclamation, "DL-2060 multimeter device test"
      stat = viClose(fList)
      Exit Sub
   End If

   Rem set to local mode
   stat = viWrite(sesn, "system:local", 12, ret)
   If (stat < VI_SUCCESS) Then
      MsgBox "System command error. (system:local)", vbExclamation, "DL-2060 multimeter device test"
      stat = viClose(fList)
      Exit Sub
   End If

   stat = viClose(sesn)
   stat = viClose(fList)
   stat = viClose(dfltRM)

   For i = 0 To (5 - 1) ' print out the 4 times samples reading
      Debug.Print "Rdgs = "; Mid(readin, i * 16 + 1, 15)
   Next

   MsgBox "End of Job."

End Sub
```

Visual C++

This C++ sample application is a Win32 console application. It illustrates how to use the TEXIO IOUtils command. A Win32 console application is a Win32 application that uses text-based input and output, not a graphical interface. This allows you to quickly create a Win32 application by using simple input and output functions.

E.3 THE DEVQUERY FUNCTION

LISTING E.3.

After the path **C:\Program Files\IVI Foundation\VISA\WinNT\include** has been entered, you have to add an "Include" path.

Add C:\WINDOWS\system32**visa32.dll** to Project folder.

```
// devquery.cpp : Defines the entry point for the console application.
//
//   Call the NI-VISA library visa32.dll
//
//

#include "stdafx.h"
#include "visa.h"

//standard include for a Microsoft Visual C++ project
#include "stdio.h"
#include "windows.h"

void main(int argc, char* argv[])
{
    // TODO: Add your control notification handler code here

    HINSTANCE hUSBTMCLIB;               // for USBTMC HANDLE
    unsigned long m_defaultRM_usbtmc, m_instr_usbtmc;
    unsigned long m_findList_usbtmc;
    unsigned long m_nCount;
    ViStatus   status;
    int        m_Timeout = 7000;
    char       *pStrout;               // Write out data buffer
    BYTE        pStrin[64];            // Read in data buffer
    int        len;
    ULONG       nWritten;
    ULONG       nRead = 0;
    char        buffer[256];
    char        instrDescriptor[256];

    // Load the NI-VISA library for USBTMC device
    hUSBTMCLIB = LoadLibrary ("visa32.dll");

    if (!hUSBTMCLIB)
    {
MessageBox(NULL, "NIVISA for USBTMC library not found.", "DL-2060 multimeter device test", MB_OK);
return;
    }

    // Link the libraries
    signed long (__stdcall   *PviOpenDefaultRM_usb)(unsigned long *vi);
    signed long (__stdcall   *PviFindRsrc_usb) (unsigned long sesn, char *expr, unsigned long *vi,
          unsigned long *retCnt, char far desc[]);
```

```cpp
    signed long (__stdcall  *PviOpen_usb)  (unsigned long sesn, char *name, unsigned long mode,
                                 unsigned long timeout, unsigned long *vi);
    signed long (__stdcall  *PviClose_usb) (unsigned long vi);
    signed long (__stdcall  *PviWrite_usb) (unsigned long vi, unsigned char *name, unsigned long len,
            unsigned long *retval);
    signed long (__stdcall  *PviRead_usb)  (unsigned long vi, unsigned char *name, unsigned long len,
               unsigned long *retval);
    signed long (__stdcall  *PviSetAttribute_usb)(unsigned long vi, unsigned long viAttr, unsigned long attrstat);


    PviOpenDefaultRM_usb  = (signed long (__stdcall*)(unsigned long*))GetProcAddress(hUSBTMCLIB,
(LPCSTR)"viOpenDefaultRM");
    PviFindRsrc_usb      = (signed long (__stdcall*)(unsigned long, char*, unsigned long*,
    unsigned long*, char[]))GetProcAddress(hUSBTMCLIB, (LPCSTR)"viFindRsrc");
    PviClose_usb          = (signed long (__stdcall*)(unsigned long))GetProcAddress(hUSBTMCLIB, (LPCSTR)"viClose");
    PviOpen_usb        = (signed long (__stdcall*)(unsigned long, char*, unsigned long,
                        unsigned long, unsigned long*))GetProcAddress(hUSBTMCLIB, (LPCSTR)"viOpen");
    PviWrite_usb        = (signed long (__stdcall*)(unsigned long, unsigned char*, unsigned long,
                        unsigned long*))GetProcAddress(hUSBTMCLIB, (LPCSTR)"viWrite");
    PviRead_usb      = (signed long (__stdcall*)(unsigned long, unsigned char*, unsigned long,
                        unsigned long*))GetProcAddress(hUSBTMCLIB, (LPCSTR)"viRead");
    PviSetAttribute_usb  = (signed long (__stdcall*)(unsigned long, unsigned long, unsigned long))GetProcAddress(hUSBTMCLIB,
(LPCSTR)"viSetAttribute");

    if (PviOpenDefaultRM_usb == NULL ||
    PviFindRsrc_usb  == NULL ||
    PviClose_usb  == NULL ||
    PviOpen_usb   == NULL ||
    PviWrite_usb  == NULL ||
    PviRead_usb   == NULL ||
    PviSetAttribute_usb  == NULL
 )
{
 FreeLibrary (hUSBTMCLIB);
 hUSBTMCLIB = NULL;
 MessageBox(NULL, "NIVISA for USBTMC library not ready.", "DL-2060 multimeter device test", MB_OK);
 return;
 }

 printf("\n ###### Start C++ Example program. ######\n");
 printf(" We check the DL-2060 multimeter on USB port and\n");
 printf(" identify the first connected DL-2060 device.\n\n");

 // Open Device -- Resource Manager
 status = PviOpenDefaultRM_usb(&m_defaultRM_usbtmc);
 if (status < 0L)
 {
 PviClose_usb(m_defaultRM_usbtmc);
 hUSBTMCLIB = NULL;
 m_defaultRM_usbtmc = 0;
 MessageBox(NULL, "USBTMC resource not found.", "DL-2060 multimeter device test", MB_OK);
 return;
 }
 else
 {
 // Find the USBTMC device USB[0-9]*::0x098F::0x2061::?*INSTR ( Hex )
 status = PviFindRsrc_usb (m_defaultRM_usbtmc, "USB[0-9]*:: 0x098F:: 0x2061::?*INSTR", &m_findList_usbtmc, &m_nCount,
instrDescriptor);
 if (status < 0L)
 {
 // Find the USBTMC device USB[0-9]*::0x098F::0x2061::?*INSTR ( Dec )
 status = PviFindRsrc_usb (m_defaultRM_usbtmc, "USB[0-9]*::2447::080D::?*INSTR", &m_findList_usbtmc, &m_nCount,
instrDescriptor);
 if (status < 0L)
 {
 PviClose_usb(m_defaultRM_usbtmc);
 hUSBTMCLIB = NULL;
```

```
    m_defaultRM_usbtmc = 0;
   }
   else
   {
    PviOpen_usb(m_defaultRM_usbtmc, instrDescriptor, 0, 0, &m_instr_usbtmc);
    status = PviSetAttribute_usb(m_instr_usbtmc, VI_ATTR_TMO_VALUE, m_Timeout);
   }
  }
  else
  {
   PviOpen_usb(m_defaultRM_usbtmc, instrDescriptor, 0, 0, &m_instr_usbtmc);
   status = PviSetAttribute_usb(m_instr_usbtmc, VI_ATTR_TMO_VALUE, m_Timeout);
  }
 }

 if (!hUSBTMCLIB)
 {
  printf("DL-2060 device connect failed.\n");
  return;
 }

 // Write command "*IDN?" and read the DL-2060 identification string
 len = 64;
 pStrout = new char[len];
 ZeroMemory(pStrout, len);
 strcpy(pStrout, "*idn?");
 status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 6, &nWritten);
 Sleep(30);
 if (status != VI_SUCCESS)
 {
  MessageBox(NULL, "Write to device error.", "DL-2060 multimeter device test", MB_OK);
  PviClose_usb(m_defaultRM_usbtmc);
  hUSBTMCLIB = NULL;
  m_defaultRM_usbtmc = 0;
  return;
 }
 else
 {
  printf(" output : *IDN?\n");
 }
 Sleep(1000);
 // Read data from device
 len = 64;
 if (hUSBTMCLIB)
 {
  status = PviRead_usb(m_instr_usbtmc, pStrin, len, &nRead);
  if (nRead > 0)
  {
   for (len=0; len < (long) nRead; len++)
   {
    buffer[len] = pStrin[len];
   }
  }
  buffer[nRead] = '\0';
  printf(" input : %s\n\n",buffer);
 }

 // Set sample count to 1
 strcpy(pStrout, "SAMP:COUN 1");
 status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 12, &nWritten);
 Sleep(30);

 // Set configure Voltage AC, range 0.1A
 strcpy(pStrout, "CONF:VOLT:AC 0.1,0.01");
 status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 22, &nWritten);
 Sleep(3000);
```

```c
// Set configure frequency, range Auto
strcpy(pStrout, "CONF:FREQ");
status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 10, &nWritten);
Sleep(3000);

// Set configure Current DC, range 0.1A
strcpy(pStrout, "CONF:CURR:DC 1,0.01");
status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 20, &nWritten);
Sleep(3000);

// Fetch the DL-2060 measure value ( screen value )
// Set Voltage DC measure
strcpy(pStrout, "CONF:VOLT:DC 0.1,0.1");
status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 21, &nWritten);
Sleep(1000);

// Send read command
strcpy(pStrout, "READ?");
status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 6, &nWritten);
Sleep(30);
printf(" output : READ?\n");

status = PviRead_usb(m_instr_usbtmc, pStrin, 64, &nRead);
if (nRead > 0)
{
 for (len=0; len < (long) nRead; len++)
 {
  buffer[len] = pStrin[len];
 }
}
buffer[nRead] = '\0';
printf(" input : %s\n\n", buffer);

// Set device to local mode
strcpy(pStrout, "system:local");
status = PviWrite_usb(m_instr_usbtmc, (unsigned char *)pStrout, 13, &nWritten);
free(pStrout);

// Close device
if (!hUSBTMCLIB)
 return;
m_nCount = 0;
m_defaultRM_usbtmc = 0;
FreeLibrary (hUSBTMCLIB);
hUSBTMCLIB = NULL;

return;
}
```

F. Resolution and NPLC correlation table

※ For DC voltage, DC current, and Resistance measurements, the integration time is set indirectly when user selects the measurement resolusion.

SENS:VOLT:DC:RES <resolution>
MEAS:VOLT:DC? <range>,<resolution>
CONF:VOLT:DC <range>,<resolution>

DCV

Range	Resolution	Front Panel Display	Key DIGIT	Key CONF.	Default	[SENS:] VOLT:DC:RES?	Resolution (Setting)	[SENS:] VOLT:DC:NPLC?	NPLC	<range>,<resolution>
100 mV	FAST 4 1/2 digits	100.00 mV		O		+1.000000E-05	0.00001	+2.000000E-02	0.02	0.1 , 0.00001
	SLOW 4 1/2 digits	100.00 mV	O	O		+1.000000E-06	0.000001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	100.000 mV		O		+1.000000E-06	0.000001	+1.000000E-01	0.1	0.1 , 0.000001
	SLOW 5 1/2 digits	100.000 mV	O	O	◎	+1.000000E-07	0.0000001	+1.000000E+0	1	
	FAST 6 1/2 digits	100.0000 mV	O	O		+1.000000E-07	0.0000001	+1.000000E+0	1	0.1 , 0.0000001
	SLOW 6 1/2 digits	100.0000 mV		O		+1.000000E-08	0.00000001	+1.000000E+0	10	0.1 , 0.00000001
1 V	FAST 4 1/2 digits	1.0000 V		O		+1.000000E-04	0.0001	+2.000000E-02	0.0	1 , 0.0001
	SLOW 4 1/2 digits	1.0000 V	O	O		+1.000000E-05	0.00001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	1.00000 V		O		+1.000000E-05	0.00001	+1.000000E-01	0.1	1 , 0.00001
	SLOW 5 1/2 digits	1.00000 V	O	O	◎	+1.000000E-06	0.000001	+1.000000E+0	1	
	FAST 6 1/2 digits	1.000000 V	O	O		+1.000000E-06	0.000001	+1.000000E+0	1	1 , 0.000001
	SLOW 6 1/2 digits	1.000000 V		O		+1.000000E-07	0.0000001	+1.000000E+0	10	1 , 0.0000001
10 V	FAST 4 1/2 digits	10.000 V		O		+1.000000E-03	0.001	+2.000000E-02	0.0	10 , 0.001
	SLOW 4 1/2 digits	10.000 V	O	O		+1.000000E-04	0.0001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	10.0000 V		O		+1.000000E-04	0.0001	+1.000000E-01	0.1	10 , 0.0001
	SLOW 5 1/2 digits	10.0000 V	O	O	◎	+1.000000E-05	0.00001	+1.000000E+0	1	
	FAST 6 1/2 digits	10.00000 V	O	O		+1.000000E-05	0.00001	+1.000000E+0	1	10 , 0.00001
	SLOW 6 1/2 digits	10.00000 V		O		+1.000000E-06	0.000001	+1.000000E+0	10	10 , 0.000001
100 V	FAST 4 1/2 digits	100.00 V		O		+1.000000E-02	0.01	+2.000000E-02	0.0	100 , 0.01
	SLOW 4 1/2 digits	100.00 V	O	O		+1.000000E-03	0.001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	100.000 V		O		+1.000000E-03	0.001	+1.000000E-01	0.1	100 , 0.001
	SLOW 5 1/2 digits	100.000 V	O	O	◎	+1.000000E-04	0.0001	+1.000000E+0	1	
	FAST 6 1/2 digits	100.0000 V	O	O		+1.000000E-04	0.0001	+1.000000E+0	1	100 , 0.0001
	SLOW 6 1/2 digits	100.0000 V		O		+1.000000E-05	0.00001	+1.000000E+0	10	100 , 0.00001
1000 V	FAST 4 1/2 digits	1000.0 V		O		+1.000000E-01	0.1	+2.000000E-02	0.0	1000 , 0.1
	SLOW 4 1/2 digits	1000.0 V	O	O		+1.000000E-02	0.01	+1.000000E-01	0.1	
	FAST 5 1/2 digits	1000.00 V		O		+1.000000E-02	0.01	+1.000000E-01	0.1	1000 , 0.01
	SLOW 5 1/2 digits	1000.00 V	O	O	◎	+1.000000E-03	0.001	+1.000000E+0	1	
	FAST 6 1/2 digits	1000.000 V	O	O		+1.000000E-03	0.001	+1.000000E+0	1	1000 , 0.001
	SLOW 6 1/2 digits	1000.000 V		O		+1.000000E-04	0.0001	+1.000000E+0	10	1000 , 0.0001

SENS:RES:RES <resolution> / SENS:FRES:RES
MEAS:RES? <range>,<resolution> / MEAS:FRES?
CONF:RES <range>,<resolution> / CONF:FRES

Ω2/Ω4

Range	Resolution	Front Panel Display	Key DIGIT	Key CONF.	Default	[SENS:] RES:RES? [SENS:] FRES:RES?	Resolution (Setting)	[SENS:] RES:NPLC?	NPLC	<range>,<resolution>
100 Ω	FAST 4 1/2 digits	100.00 Ω		O		+1.000000E-02	0.01	+2.000000E-02	0.02	0.1 , 0.01
	SLOW 4 1/2 digits	100.00 Ω	O	O		+1.000000E-03	0.001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	100.000 Ω		O		+1.000000E-03	0.001	+1.000000E-01	0.1	0.1 , 0.001
	SLOW 5 1/2 digits	100.000 Ω	O	O	◎	+1.000000E-04	0.0001	+1.000000E+0	1	
	FAST 6 1/2 digits	100.0000 Ω	O	O		+1.000000E-04	0.0001	+1.000000E+0	1	0.1 , 0.0001
	SLOW 6 1/2 digits	100.0000 Ω		O		+1.000000E-05	0.00001	+1.000000E+0	10	0.1 , 0.00001
1 kΩ	FAST 4 1/2 digits	1.0000 KΩ		O		+1.000000E-01	0.1	+2.000000E-02	0.0	1000 , 0.1
	SLOW 4 1/2 digits	1.0000 KΩ	O	O		+1.000000E-02	0.01	+1.000000E-01	0.1	
	FAST 5 1/2 digits	1.00000 KΩ		O		+1.000000E-02	0.01	+1.000000E-01	0.1	1000 , 0.01
	SLOW 5 1/2 digits	1.00000 KΩ	O	O	◎	+1.000000E-03	0.001	+1.000000E+0	1	
	FAST 6 1/2 digits	1.000000 KΩ	O	O		+1.000000E-03	0.001	+1.000000E+0	1	1000 , 0.001
	SLOW 6 1/2 digits	1.000000 KΩ		O		+1.000000E-04	0.0001	+1.000000E+0	10	1000 , 0.0001

Range	Resolution	Front Panel Display	DIGIT	CONF.	Default	[SENS:]CURR:DC:RES?	Resolution (Setting)	[SENS:]CURR:DC:NPLC?	NPLC	<range>,<resolution>
10 kΩ	FAST 4 1/2 digits	10.000 KΩ		◯		+1.000000E+0	1	+2.000000E-02	0.0	10000 , 1
	SLOW 4 1/2 digits	10.000 KΩ	◯	◯		+1.000000E-01	0.1	+1.000000E-01	0.1	
	FAST 5 1/2 digits	10.0000 KΩ		◯		+1.000000E-01	0.1	+1.000000E-01	0.1	10000 , 0.1
	SLOW 5 1/2 digits	10.0000 KΩ	◯	◯	◎	+1.000000E-02	0.01	+1.000000E+0	1	
	FAST 6 1/2 digits	10.00000 KΩ	◯	◯		+1.000000E-02	0.01	+1.000000E+0	1	10000 , 0.01
	SLOW 6 1/2 digits	10.00000 KΩ		◯		+1.000000E-03	0.001	+1.000000E+0	10	10000 , 0.001
100 kΩ	FAST 4 1/2 digits	100.00 KΩ		◯		+1.000000E+0	10	+2.000000E-02	0.0	100000 , 10
	SLOW 4 1/2 digits	100.00 KΩ	◯	◯		+1.000000E+0	1	+1.000000E-01	0.1	
	FAST 5 1/2 digits	100.000 KΩ		◯		+1.000000E+0	1	+1.000000E-01	0.1	100000 , 1
	SLOW 5 1/2 digits	100.000 KΩ	◯	◯	◎	+1.000000E-01	0.1	+1.000000E+0	1	
	FAST 6 1/2 digits	100.0000 KΩ	◯	◯		+1.000000E-01	0.1	+1.000000E+0	1	100000 , 0.1
	SLOW 6 1/2 digits	100.0000 KΩ		◯		+1.000000E-02	0.01	+1.000000E+0	10	100000 , 0.01
1 MΩ	FAST 4 1/2 digits	1.0000 MΩ		◯		+1.000000E+0	100	+2.000000E-02	0.0	1000000 , 100
	SLOW 4 1/2 digits	1.0000 MΩ	◯	◯		+1.000000E+0	10	+1.000000E-01	0.1	
	FAST 5 1/2 digits	1.00000 MΩ		◯		+1.000000E+0	10	+1.000000E-01	0.1	1000000 , 10
	SLOW 5 1/2 digits	1.00000 MΩ	◯	◯	◎	+1.000000E+0	1	+1.000000E+0	1	
	FAST 6 1/2 digits	1.000000	◯	◯		+1.000000E+0	1	+1.000000E+0	1	1000000 , 1
	SLOW 6 1/2 digits	1.000000		◯		+1.000000E-01	0.1	+1.000000E+0	10	1000000 , 0.1
10 MΩ	FAST 4 1/2 digits	10.000 MΩ		◯		+1.000000E+0	1000	+2.000000E-02	0.0	10000000 , 1000
	SLOW 4 1/2 digits	10.000 MΩ	◯	◯		+1.000000E+0	100	+1.000000E-01	0.1	
	FAST 5 1/2 digits	10.0000 MΩ		◯		+1.000000E+0	100	+1.000000E-01	0.1	10000000 , 100
	SLOW 5 1/2 digits	10.0000 MΩ	◯	◯	◎	+1.000000E+0	10	+1.000000E+0	1	
	FAST 6 1/2 digits	10.00000	◯	◯		+1.000000E+0	10	+1.000000E+0	1	10000000 , 10
	SLOW 6 1/2 digits	10.00000		◯		+1.000000E+0	1	+1.000000E+0	10	10000000 , 1
100 MΩ	FAST 4 1/2 digits	100.00 MΩ		◯		+1.000000E+0	10000	+2.000000E-02	0.0	100000000 , 10000
	SLOW 4 1/2 digits	100.00 MΩ	◯	◯		+1.000000E+0	1000	+1.000000E-01	0.1	
	FAST 5 1/2 digits	100.000 MΩ		◯		+1.000000E+0	1000	+1.000000E-01	0.1	100000000 , 1000
	SLOW 5 1/2 digits	100.000 MΩ	◯	◯	◎	+1.000000E+0	100	+1.000000E+0	1	
	FAST 6 1/2 digits	100.0000	◯	◯		+1.000000E+0	100	+1.000000E+0	1	100000000 , 100
	SLOW 6 1/2 digits	100.0000		◯		+1.000000E+0	10	+1.000000E+0	10	10000000 , 10

SENS:CURR:DC:RES <resolution>
MEAS:CURR:DC? <range>,<resolution>
CONF:CURR:DC <range>,<resolution>

DCA

Range	Resolution	Front Panel Display	DIGIT	CONF.	Default	[SENS:]CURR:DC:RES?	Resolution (Setting)	[SENS:]CURR:DC:NPLC?	NPLC	<range>,<resolution>
10 mA	FAST 4 1/2 digits	10.000 mA		◯		+1.000000E-06	0.000001	+2.000000E-02	0.02	0.01 , 0.000001
	SLOW 4 1/2 digits	10.000 mA	◯	◯		+1.000000E-07	0.0000001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	10.0000 mA		◯		+1.000000E-07	0.0000001	+1.000000E-01	0.1	0.01 , 0.0000001
	SLOW 5 1/2 digits	10.0000 mA	◯	◯	◎	+1.000000E-08	0.00000001	+1.000000E+00	1	
	FAST 6 1/2 digits	10.00000 mA	◯	◯		+1.000000E-08	0.00000001	+1.000000E+00	1	0.01 , 0.00000001
	SLOW 6 1/2 digits	10.00000 mA		◯		+1.000000E-09	0.00000000	+1.000000E+01	10	0.01 , 0.000000001
100 mA	FAST 4 1/2 digits	100.00 mA		◯		+1.000000E-05	0.00001	+2.000000E-02	0.02	0.1 , 0.00001
	SLOW 4 1/2 digits	100.00 mA	◯	◯		+1.000000E-06	0.000001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	100.000 mA		◯		+1.000000E-06	0.000001	+1.000000E-01	0.1	0.1 , 0.000001
	SLOW 5 1/2 digits	100.000 mA	◯	◯	◎	+1.000000E-07	0.0000001	+1.000000E+00	1	
	FAST 6 1/2 digits	100.0000 mA	◯	◯		+1.000000E-07	0.0000001	+1.000000E+00	1	0.1 , 0.0000001
	SLOW 6 1/2 digits	100.0000 mA		◯		+1.000000E-08	0.00000001	+1.000000E+01	10	0.1 , 0.00000001
1 A	FAST 4 1/2 digits	1.0000 A		◯		+1.000000E-04	0.0001	+2.000000E-02	0.02	1 , 0.0001
	SLOW 4 1/2 digits	1.0000 A	◯	◯		+1.000000E-05	0.00001	+1.000000E-01	0.1	
	FAST 5 1/2 digits	1.00000 A		◯		+1.000000E-05	0.00001	+1.000000E-01	0.1	1 , 0.00001
	SLOW 5 1/2 digits	1.00000 A	◯	◯	◎	+1.000000E-06	0.000001	+1.000000E+00	1	
	FAST 6 1/2 digits	1.000000 A	◯	◯		+1.000000E-06	0.000001	+1.000000E+00	1	1 , 0.000001
	SLOW 6 1/2 digits	1.000000 A		◯		+1.000000E-07	0.0000001	+1.000000E+01	10	1 , 0.0000001
3 A	FAST 4 1/2 digits	3.000 A		◯		+3.000000E-04	0.0003	+2.000000E-02	0.02	3 , 0.0003
	SLOW 4 1/2 digits	3.000 A	◯	◯		+3.000000E-05	0.00003	+1.000000E-01	0.1	
	FAST 5 1/2 digits	3.0000 A		◯		+3.000000E-05	0.00003	+1.000000E-01	0.1	3 , 0.00003
	SLOW 5 1/2 digits	3.0000 A	◯	◯	◎	+3.000000E-06	0.000003	+1.000000E+00	1	
	FAST 6 1/2 digits	3.00000 A	◯	◯		+3.000000E-06	0.000003	+1.000000E+00	1	3 , 0.000003
	SLOW 6 1/2 digits	3.00000 A		◯		+3.000000E-07	0.0000003	+1.000000E+01	10	3 , 0.0000003

※ The resolution setting for AC measurements is actually fixed at 6 1/2 digits. When user selects a lower resolution, the meter will mask out the extra digits. User's selection of resolution for AC function will not affect the actual speed or accuracy.

ACV

SENS:VOLT:AC:RES <resolution>
MEAS:VOLT:AC? <range>,<resolution>
CONF:VOLT:AC <range>,<resolution>

Range	Front Panel Display	DIGIT	Default	[SENS:]VOLT:AC:RES?	Resolution (Setting)	<range>,<resolution>
100 mV	100.00 mV	○		+1.000000E-05	0.00001	0.1 , 0.00001
	100.000 mV	○	◎	+1.000000E-06	0.000001	0.1 , 0.000001
	100.0000 mV	○		+1.000000E-07	0.0000001	0.1 , 0.0000001
1 V	1.0000 V	○		+1.000000E-04	0.0001	1 , 0.0001
	1.00000 V	○	◎	+1.000000E-05	0.00001	1 , 0.00001
	1.000000 V	○		+1.000000E-06	0.000001	1 , 0.00001
10 V	10.000 V	○		+1.000000E-03	0.001	10 , 0.001
	10.0000 V	○	◎	+1.000000E-04	0.0001	10 , 0.0001
	10.00000 V	○		+1.000000E-05	0.00001	10 , 0.00001
100 V	100.00 V	○		+1.000000E-02	0.01	100 , 0.01
	100.000 V	○	◎	+1.000000E-03	0.001	100 , 0.001
	100.0000 V	○		+1.000000E-04	0.0001	100 , 0.0001
750 V	750.0 V	○		+1.000000E-01	0.1	750 , 0.1
	750.00 V	○	◎	+1.000000E-02	0.01	750 , 0.01
	750.000 V	○		+1.000000E-03	0.001	750 , 0.001

ACA

SENS:CURR:AC:RES <resolution>
MEAS:CURR:AC? <range>,<resolution>
CONF:CURR:AC <range>,<resolution>

Range	Front Panel Display	DIGIT	Default	[SENS:]CURR:AC:RES?	Resolution (Setting)	<range>,<resolution>
1 A	1.0000 A	○		+1.000000E-04	0.0001	1 , 0.0001
	1.00000 A	○	◎	+1.000000E-05	0.00001	1 , 0.00001
	1.000000 A	○		+1.000000E-06	0.000001	1 , 0.00001
10 A	3.000 A	○		+3.000000E-04	0.0003	3 , 0.0003
	3.0000 A	○	◎	+3.000000E-05	0.00003	3 , 0.00003
	3.00000 A	○		+3.000000E-06	0.000003	3 , 0.00003

※ For frequency measurements, the meter uses only one "range" for all inputs between 3Hz and 300kHz.

FREQUENCY

SENS:FREQ:APER {0.01 | 0.1 | 1 }
MEAS:FREQ? <range>,<resolution>
CONF:FREQ <range>,<resolution>

Input	Resolution	Front Panel Display	Key DIGIT	Key CONF.	Default	[SENS:]FREQ:APER?	APER	CONF? (Default)	<range>,<resolution>
3 Hz	SLOW 4 1/2 digits	3.0000 Hz	○	○		+1.000000E-02	0.01	FREQ +3.000000E+00, +3.000000E+04	3.0.0003
	SLOW 5 1/2 digits	3.00000 Hz	○	○	◎	+1.000000E-01	0.1	FREQ +3.000000E+00, +3.000000E+05	3.0.00003
	SLOW 6 1/2 digits	3.000000 Hz	○	○		+1.000000E+0	1	FREQ +3.000000E+00, +3.000000E+06	3.0.000003
1 kHz	SLOW 4 1/2 digits	1.0000 Hz	○	○		+1.000000E-02	0.01	FREQ +3.000000E+00, +3.000000E+04	1000, 0.1
	SLOW 5 1/2 digits	1.00000 Hz	○	○	◎	+1.000000E-01	0.1	FREQ +3.000000E+00, +3.000000E+05	1000, 0.01
	SLOW 6 1/2 digits	1.000000 Hz	○	○		+1.000000E+0	1	FREQ +3.000000E+00, +3.000000E+06	1000, 0.001
300 kHz	SLOW 4 1/2 digits	3.0000 Hz	○	○		+1.000000E-02	0.01	FREQ +3.000000E+00, +3.000000E+04	300000.30
	SLOW 5 1/2 digits	3.0000 Hz	○	○	◎	+1.000000E-01	0.1	FREQ +3.000000E+00, +3.000000E+05	300000.3
	SLOW 6 1/2 digits	3.000000 Hz	○	○		+1.000000E+0	1	FREQ +3.000000E+00, +3.000000E+06	300000.0.3

※ For period measurements, the meter uses only one "range" for all inputs between 0.33 sec. and 3.3 μsec.

PERIOD

SENS:PER:APER {0.01 | 0.1 | 1 }
MEAS:PER? <range>,<resolution>
CONF:PER <range>,<resolution>

Input	Resolution	Front Panel Display	Key DIGIT	Key CONF.	Default	[SENS:]PER:APER?	APER	CONF? (Default)	<range>,<resolution>
3 Hz	SLOW 4 1/2 digits	333.33 ms	○	○		+1.000000E-02	0.01	PER +3.333330E-01, +3.333330E-05	0.333333, 0.0000333333
	SLOW 5 1/2 digits	333.333 ms	○	○	◎	+1.000000E-01	0.1	PER +3.333330E-01, +3.333330E-06	0.333333, 0.00000333333
	SLOW 6 1/2 digits	333.3333	○	○		+1.000000E+00	1	PER +3.333330E-01, +3.333330E-07	0.333333, 0.000000333333
1 kHz	SLOW 4 1/2 digits	1.0000 ms	○	○		+1.000000E-02	0.01	PER +3.333330E-01, +3.333330E-05	0.001, 0.0000001
	SLOW 5 1/2 digits	1.00000 ms	○	○	◎	+1.000000E-01	0.1	PER +3.333330E-01, +3.333330E-06	0.001, 0.00000001
	SLOW 6 1/2 digits	1.000000	○	○		+1.000000E+00	1	PER +3.333330E-01, +3.333330E-07	0.001, 0.000000001
300 kHz	SLOW 4 1/2 digits	3.3333 μs	○	○		+1.000000E-02	0.01	PER +3.333330E-01, +3.333330E-05	0.00333333, 0.00000333333
	SLOW 5 1/2 digits	3.33333 μs	○	○	◎	+1.000000E-01	0.1	PER +3.333330E-01, +3.333330E-06	0.00333333, 0.000000333333
	SLOW 6 1/2 digits	3.333333 μs	○	○		+1.000000E+00	1	PER +3.333330E-01, +3.333330E-07	0.00333333, 0.0000000333333

G. Notice of Scanner Card

Scanner Command	OP-41 OP-42	OP-41T
ROUTe:CLOSe <channel>	○	○
ROUTe:CLOSe?	○	○
ROUTe:OPEN	○	○
ROUTe:STATe?	○	○
ROUTe:SCAN:FUNCtion<channel>,{<function>|"VOLT:DC"|"VOLT:AC"|"FREQuency"| "RESistance"|"FRESistance"|"PERiod"| "**TEMPerature**"| "NONE"} ※	○	
ROUTe:SCAN:FUNCtion<channel>,{<function>|"VOLT:DC"|"VOLT:AC"|"FREQuency"| "RESistance"|"FRESistance"|"PERiod"|**TCOuple**"| "**TEMPerature**"| "NONE"} ※		○
ROUTe:SCAN:FUNC? <channel>	○	○
ROUTe:SCAN:TIMER?	○	○
ROUTe:SCAN:TIMER <value>	○	○
ROUTe:SCAN:COUNT?	○	○
ROUTe:SCAN:COUNT <value>	○	○
ROUTe:SCAN:STATe?	○	○
ROUTe:SCAN:SCAN	○	○
ROUTe:SCAN:STEP	○	○
[SENSe:]TCOuple:RJUNction:RSELect {REAL|SIMulated } ※		○
[SENSe:]TCOuple:RJUNction:RSELect? ※		○
[SENSe:]TCOuple:RJUNction:REAL? ※		○
[SENSe:]TEMPerature:RTD:TYPE {PT100|D100|F100|PT385|PT3916|USER|SPRTD|NTCT}, @{scanner channel number} ※	○	○
[SENSe:]TEMPerature:RTD:TYPE? @{scanner channel number} ※	○	○
[SENSe:]TEMPerature:TRANsducer FRTD, @{scanner channel number} ※	○	○
[SENSe:]TEMPerature:TRANsducer RTD, @{scanner channel number} ※	○	○
[SENSe:]TEMPerature:TRANsducer? @{scanner channel number} ※	○	○
[SENSe:]TCOuple:TYPE {E|J|K|N|R|S|T} , @{scanner channel number} ※		○
[SENSe:]TCOuple:TYPE? @{scanner channel number} ※		○

○:Available、 ※:**The bold figure** means that it is available with firmware ver. 1.05 or upward.

Operation with firmware version 1.05 or upward
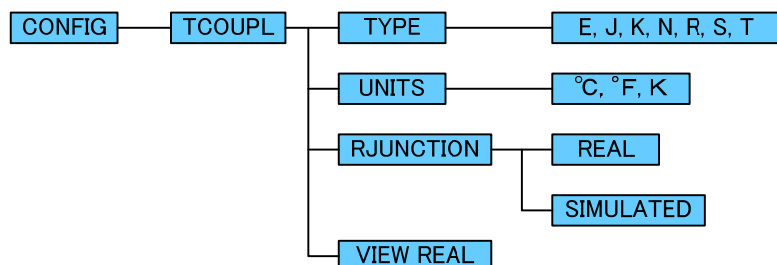
While installing the TC-Scanner Card(OP-41T) in DL-2060
- The TCOUPL function on the front panel will be disenabled automatically. You can only use the Card for thermocouple measurement.
- You can only use REAL mode for RJUNCTION.

While installing the Scanner Card(except OP-41T) in DL-2060
- REAL and VIEW REAL functions are unavailable.

TEXIO

Test and Measurement Solutions