M3510A/11A
6 1/2 Digits Multimeter

USER'S MANUAL

Date: 2020/05

Table of Contents

1 General Information

This section contains general information about PICOTEST M3510A Multimeter. The information is shown below:

1. Feature Overview
2. Warranty Information
3. Safety Information
4. Symbols and Terms
5. Specifications
6. Inspection
7. Options and Accessories

If you have any questions after reading this information, please contact your local service representative.

1.1 Feature Overview

M3510A is a 6 1/2 digits multimeter. It has…

- Best performance/price ratio
- High-speed sampling rate (50000 Rdgs/sec. at M3510A NPLC 0.001
- Direct Thermocouple Measurement (Built-In Cold Junction Compensation to improve Accuracy)
- Dual Measurement & Dual Display (Including Thermocouple Measurement)
- Capacitance Measurement
- Several Measurements & Mathematic Functions
- Wide Range Current Measurement (Up to 10A)
- DCV Accuracy (0.012% in 1 year)
- High Sensitivity (DCV: 0.1 µV & Resistance: 100 µΩ)
- Plug & Play Interface: Built-In USB (USBTMC)
- High Storage Memory (Up to 2000 Readings)
- Free Application Software

※ Note: The 1-year accuracy is subject to calibration accuracy.

In addition, the M3510A provides wide ranges for general measurements, such as…

1. **DCV:** 100mV, 1V, 10V, 100V & 1000V
2. **ACV:** 100mV, 1V to 750V
3. **DCI:** 10mA, 100mA, 1A, 3A & 10A
4. **ACI:** 1A, 3A & 10A
5. **2 & 4-wired resistance:** 100Ω, 1KΩ, 10KΩ, 100KΩ, 1MΩ, 10MΩ & 100MΩ
6. **Capacitance:** 1nF, 10nF, 100nF, 1μF, 10μF, 100μF, 1000μF & 10000μF
7. **Thermocouple:** -250℃ ~ 2316℃
8. **RTD:** 2W & 4W
9. **Frequency & Period:** 100mV to 750V (From 3Hz to 300KHz)
10. **Diode:** 1V
11. **Continuity (for 2W):** 1000Ω

Some additional capabilities of M3510A include:

● Full Math Functions - Percent, Average, Null, Limits, MX+B, dB & dBm.
● Resolution Adjustment - 0.001, 0.006, 0.02, 0.06, 0.2, 0.6, 1, 2, 10 & 100 NPLC
● USB & GPIB (Optional) remote control interface.
● Through M3510A AP software (PT-TOOL) for simulating the real operation on PC.
● Through Microsoft Office Word & Excel (PT-LINK) for remotely storing and recalling the measured values.

1.2 Warranty Information

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

1. **Warranty:** PICOTEST CORP. guarantees that this product meets its published specifications at the time of shipment from the factory. Under proper installation it should work as expected.

2. **Warranty Period:** This equipment is warranted against defects in material and manufacturing for a period of one year from the date of shipment. During the warranty period, PICOTEST is responsible for necessary repairs as long as the product can be proved to be defective.

   For warranty service or repair this product must be returned to a service facility designated by PICOTEST. Please contact your local service representative.
3. **Excluded Items:** This warranty does not include consumptive parts such as fuses, buttons and relays. Neither does this warranty cover defects caused by improper installation, improper or insufficient maintenance, unauthorized modification, improper operation, ignorance of environmental specifications or improper software or interfacing.
4. **Remarks:**
- No other warranty is expressed or implied, except for the above mentioned.
- The remedies provided herein are the buyer's sole and exclusive remedies. PICOTEST shall not be liable for any direct, indirect, special, incidental or consequential damages.

Limitation of warranty

1. Our warranties do not cover any damage resulting from unauthorized modification or misuse.
2. Unless mentioned elsewhere in this document, our warranty does not apply to fuses, probes, and problems arising from normal wear or user's failure to follow instructions.
3. Our warranties do not apply on any direct, incidental, special, or consequential damages.
4. The above warranties are exclusive and no other warranty is expressed or implied. PICOTEST disclaims any implied warranties of MERCHANTABILITY, SATISFACTORY QUALITY, and FITNESS for any particular reasons.

1.3 Precaution of Operation

- Please carefully read the manual before operating this device.
- This manual is for reference only. Please consult your local service representative for further assistance.
- The contents of this manual may be amended by the manufacturer without notice.
- Never dismantle the equipment by any unauthorized personnel, or equipment may be damaged.
- The equipment has been strictly tested for quality before delivery from our factory. However, this equipment must not be used in dangerous situations where damage may result.
- This product should be placed in a safe area in case of unpredictable personnel use.
- The rear protective conduct terminal needs to be connected to the actual earth ground or electric shock may occur.
- The patent and related documents for the equipment belong to PICOTEST CORP. and they aren't allowed to be used by others without permission.

1.4 Upkeep of M3510A

To clean an instrument, use a damp cloth or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

1.5 Product Users

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the saftety precautions required to avoid possible injury. Read and follow all installation, operation, and

maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. The must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating property, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state ifthe operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

1.6 Safety Information

⚠ Caution! Please read through the following safety information before using the product.

To avoid possible electric shock or personal injury, please read and follow these guidelines carefully:

- Follow the guidelines in this manual and DO NOT use the Meter if the case is damaged. Check the Meter case and terminals, and make sure all the devices are in the proper positions.
- Do not apply excessive voltage to the Multimeter. Apply voltage within the rated range only.
- Use caution when measuring voltages above 30 V RMS, 42 V peak, or 60 V DC. These voltages pose an electric shock hazard.
- When using the probes, always keep your fingers behind the finger guards.
- Always connect the common test leads (black) before connecting the live test leads (red), and disconnect the live test leads (red) before disconnecting the common test leads (black). This will reduce the chance of an electric shock.
- Disconnect circuit power and discharge all high-voltage capacitors before testing resistance, continuity, diodes or capacitance.
- If you need to open the Meter case or replace any parts, read the instruction in this manual first. You must be qualified personnel to perform this action.
- The AC socket contains a fuse rated 250V/250mAT. When replacing the fuse, use only the same types and same rating as specified.
- When replacing fuses, use only the same type and same rating as specified.
- Do not try to operate the Meter if it is damaged. Disconnect the power from the equipment and consult the local service representative. Return the product to PICOTEST service department if necessary.
- Make sure your power cord corresponds to requirement of your local regulation. When replacing it, its specification must be the same as the previous one, or an incorrect power cord will cause unpredictable harm or damage. There are some rules you should follow below.
    A. Use a proper power cord. Use the one that had been shipped with your product, and make sure that the power cord is certificated by your country.
    B. Ground the product. M3510A is grounded through the grounding conductor of the power cord. To avoid electric shock, only use an approved power cord with the product, and insure that it's connected to earth ground.
    C. Well position settlement. Do not position the equipment that it's

difficult to operate the disconnecting device.

D. Use an adequately-rated cord only. Before replacing with a new power cord, you'd better check if it's an adequately-rated cord.

1.7 Symbols and Terms

⚠ This symbol indicates hazards that may cause damages to the instrument or even result in personal injury.

⚡ This symbol indicates high voltage may be present. Use extra caution before taking any action.

⏚ This symbol indicates the frame or chassis terminal presented need to be connected to the actual earth ground.

⏚ This symbol indicates "Protective Conductor Terminal".

⏚ This symbol indicates earth (ground) terminal.

CE This symbol indicates this product complies with the essential requirements or the applicable European laws or directives with respect to safety, health, environment and consumer protections.

⚠ Note: Full M3510A specifications are included in Appendix A.

1.8 Inspection

Your product package is supplied with the following items:
● One M3510A Multimeter unit. (88.8[H] x 214.6 [W] x 280.7 [D] mm, approx. 2.23 Kg)
● One power line cord.
● One USB cable.
● Standard Test Leads[1]
● One CD (including this electronic User's Manual and software applications).
● Optional accessories (According to the Table 1-1) as you ordered.

1. M3510A is provided with a Standard Test lead set, described below.

Test Lead Ratings:

IEC 61010-031 CAT III

Operating Voltage: 1000V DC

Current: 10 Ampers

UL/CE Rated

Material:

Probe Body: Outer Insulation-Santoprene Rubber.

Banana Plug: Body Brass, Nickel Plated Spring Beryllium Copper, Nickel Plated.

Insulation: Polypropylene Resin Flasme Retardant Grade 2038.

Others

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

⚠ Warning! If users use the Test Lead Set without following the specification of Picotest Corp., the protection of the Test Lead Set could be impaired. In addition, please don't use a damaged Test Lead Set against the instrument break or personal injury.

1.9   Options and Accessories

The following accessories are able to be used with the Model M3510A. Please refer to **Table 1-1**.

Table 1-1

Part Name	Part Number
GPIB Card	M3500-opt04

2.0 The M3510A's Dimension

Please get the dimension's information in the following different ways.

1. The dimension without the handle and the front & Rear Bumpers is in the following Picture 1. (LxWxD - 214.6x88.6x280.7 mm)

2. The dimension with the handle and the front & Rear Bumpers is in the following Picture 2. (LxWxD – 252.8x107x305 mm)

3. The dimension with the front & Rear Bumpers, but without the handle is in the following Picture 3. (LxWxD – 226.8x107x305 mm)
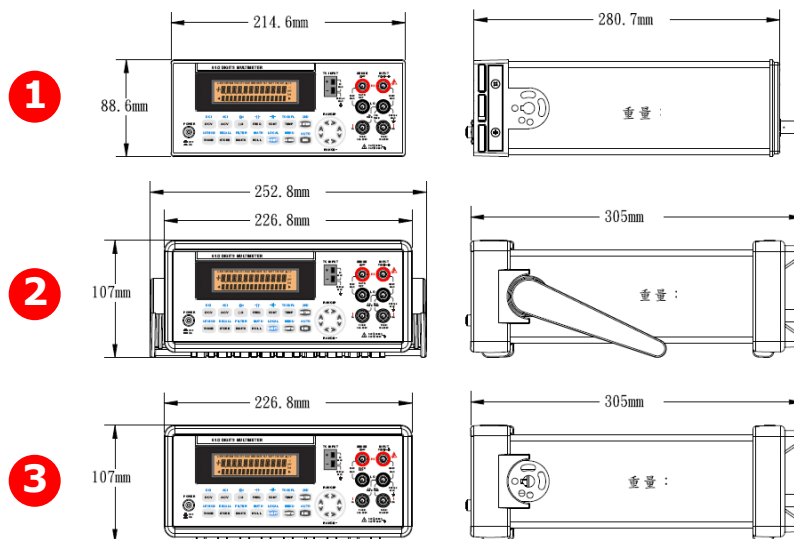
2 Overview

This chapter will give you an overview of M3510A's features and guide you through the basics of M3510A DMM.

2.1   Setting up M3510A

The purpose of this section is to prepare you for using M3510A 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.

2.1.1   To adjust the handle

You may adjust the carrying handle to suit your needs. The following figures show 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**.
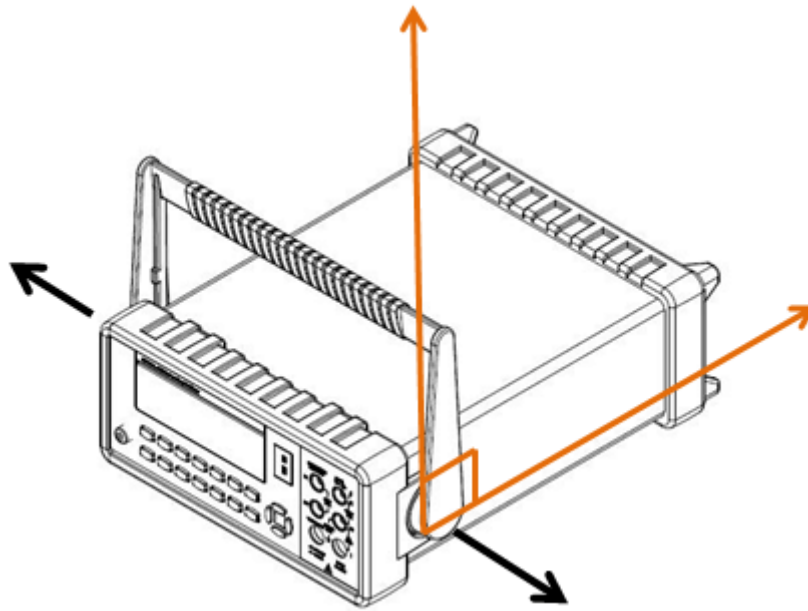
Figure 1-1

【Step 2】(Pull out the handle)

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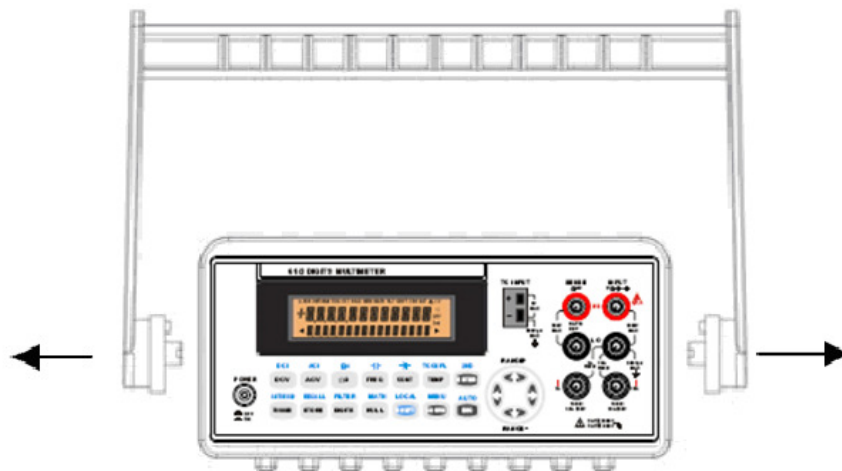
Figure 1-2

Ⅱ. Adjusting the position for your convenience

Here are some example positions to for your reference.

【Position 1】

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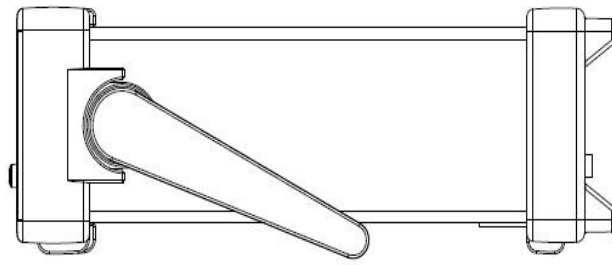
Figure 1-3

【Position 2】

The position shown in **Figure 1-4** is for operating the multimeter.
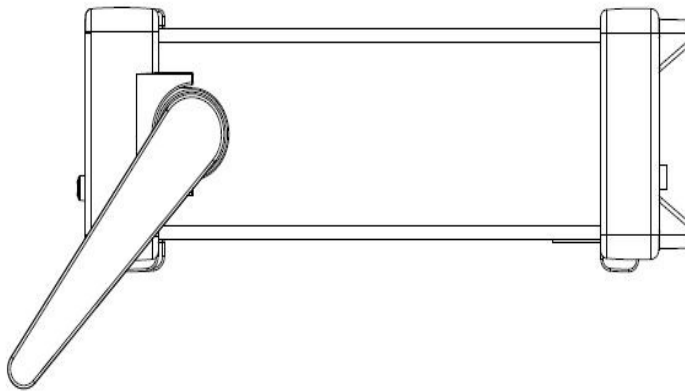
Figure 1-4

【Position 3】

The position shown in **Figure 1-5** is for carrying the multimeter.
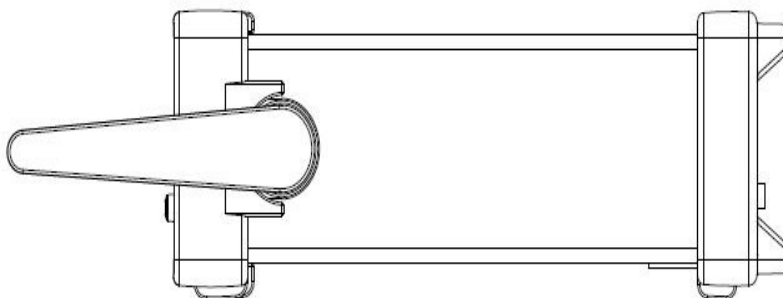
Figure 1-5

2.1.2　To connect the power

Check the power-line voltage on the rear panel to see if voltage setting is correct for your area. There are 4 power lines, 100/120/220/240 on M3510A for your demand. Change the voltage correctly or replace a new fuse if the voltage is not correct or the fuse is broken. Please follow the steps below.

2.1.2.1　To convert the voltage

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 M3510A 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.

Suppose your multimeter is under the AC 220V condition and you want to convert it to 100V. Follow the following steps to change the voltage setting.

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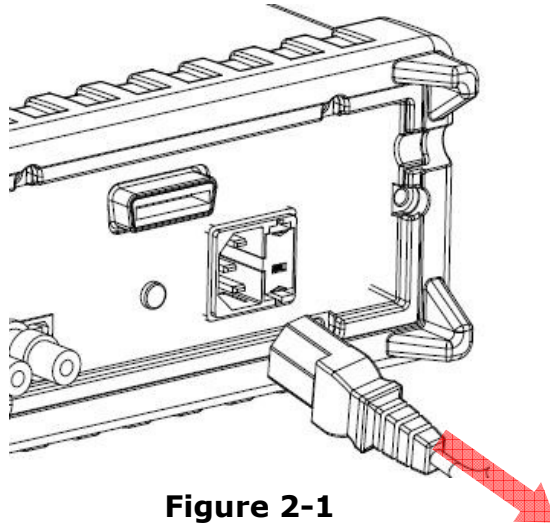
Figure 2-1

【Step 2】

Press the latch to unlatch the voltage setting selector container as shown in **Figure 2-2**. (You may need a screwdriver to do so.)
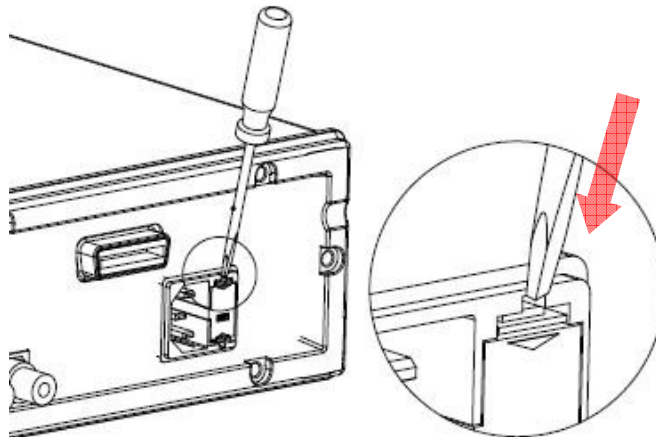
Figure 2-2

【Step 3】

Remove the voltage setting selector container as shown in **Figure 2-3**. (You may need a screwdriver to do so.)
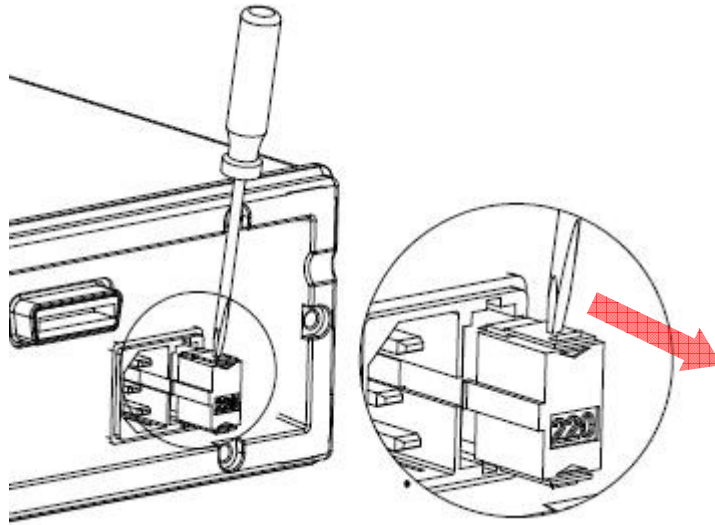
Figure 2-3

【Step 4】

Open the clips on the sides and remove the voltage setting selector from the container as shown in **Figure 2-4**.
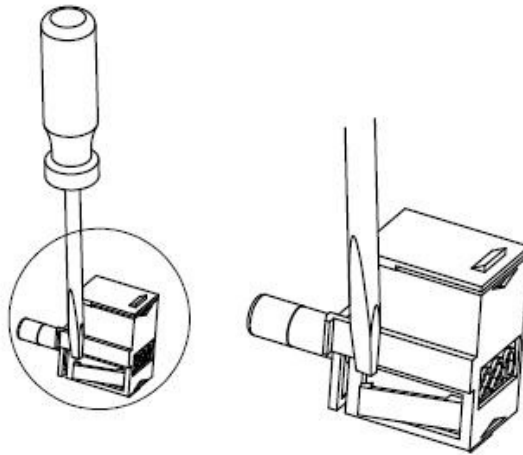
Figure 2-4

【Step 5】

Turn the voltage setting selector so that the desired voltage setting appears in the container as shown in **Figure 2-5**.
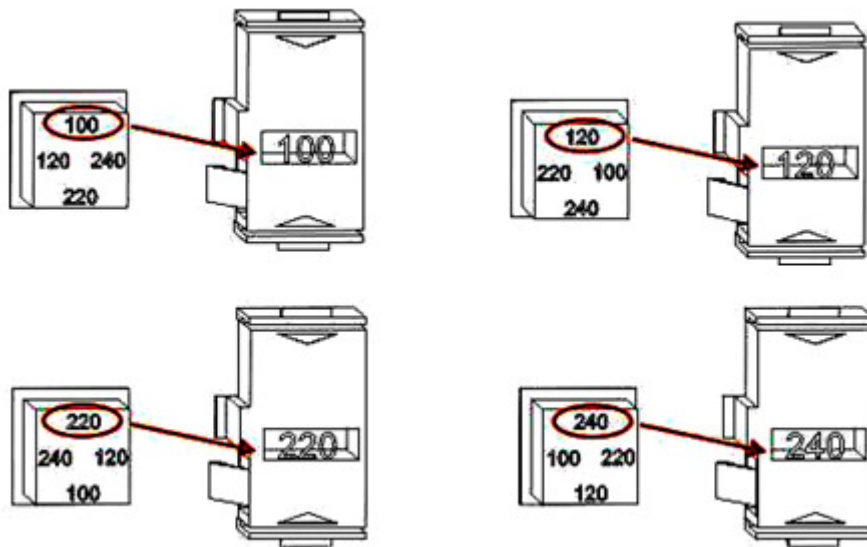
Figure 2-5

【Step 6】
Insert the voltage setting selector container back into the socket.

2.1.2.2   To change the 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 with fuse of the same type and rating noted on the rear panel. If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse.

Verify that the power-line fuse is good. Replace the fuse if it is damaged. Follow the steps below to change the fuse.

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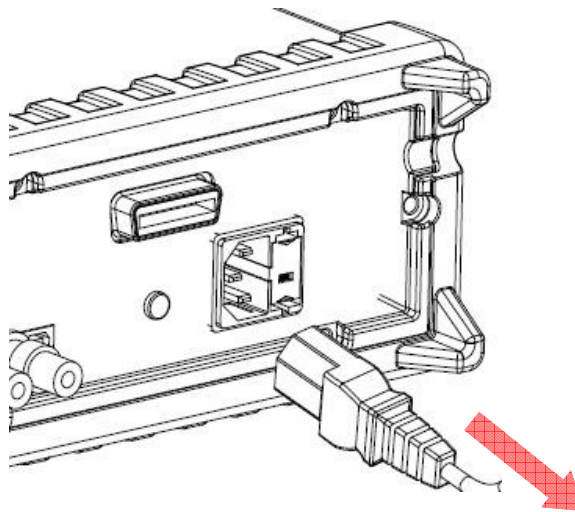
Figure 2-6

【Step 2】

Press the latch to unlatch the voltage setting selector container as shown in **Figure 2-7**. (You may need a screwdriver to do so.)
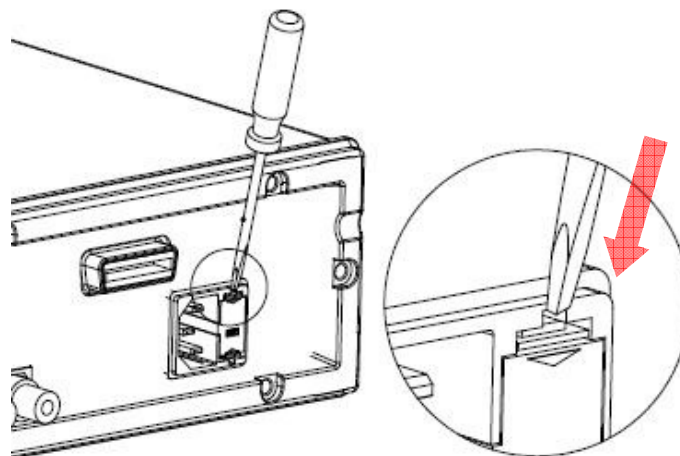
Figure 2-7

【Step 3】

Remove the voltage setting selector container as shown in **Figure 2-8**. (You may need a screwdriver to do so.)
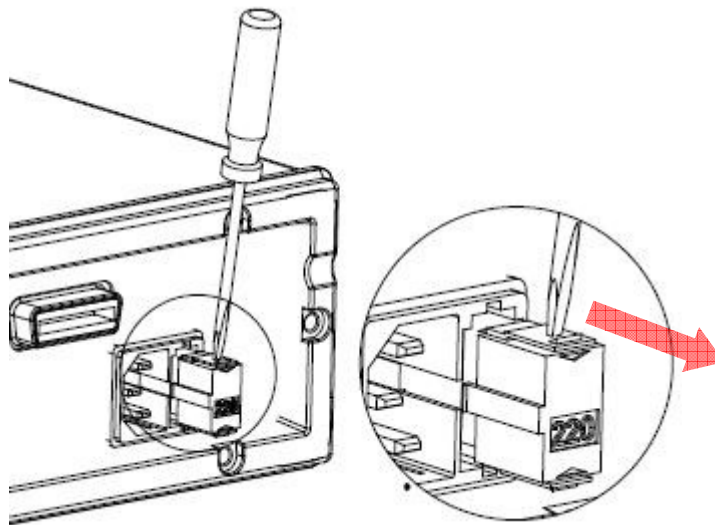
Figure 2-8

【Step 4】

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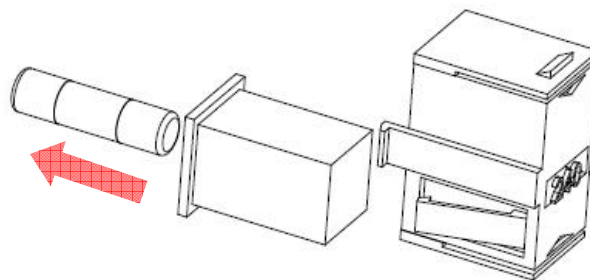
Figure 2-9

【Step 5】

Replace with a new standard fuse.

【Step 6】

Insert the voltage setting selector container back into the socket.

【Step 7】

Make sure the power switch on the front panel is in "Power OFF" condition before plugging in as shown in **Figure 2-10**.
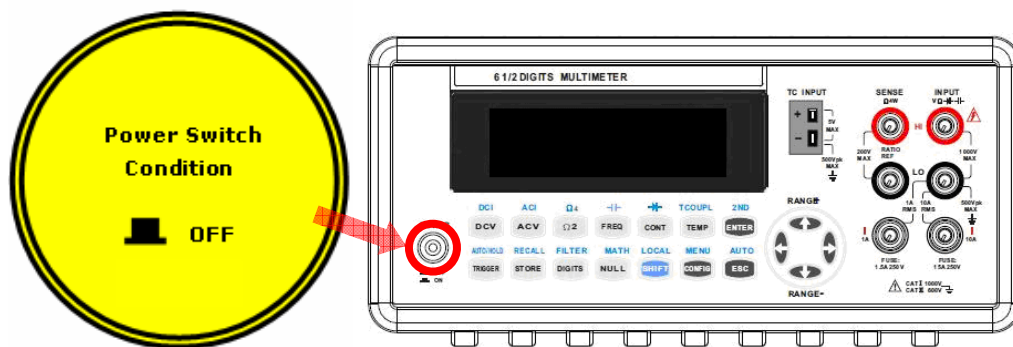
Figure 2-10

【Step 8】

Plug in your power cord as shown in **Figure 2-11**.
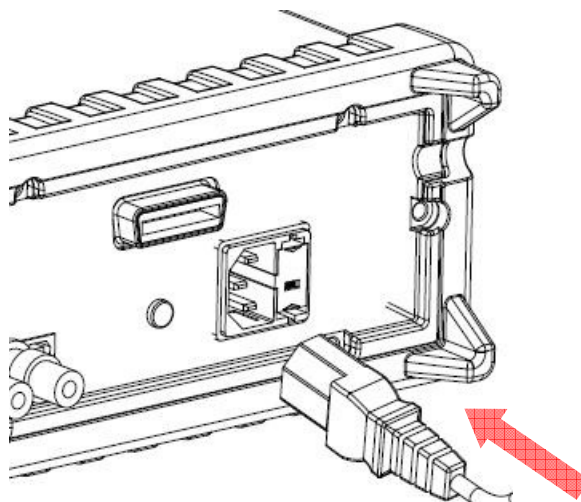
Figure 2-11

【Step 9】

Press the power switch on the front panel to turn on M3510A as shown in **Figure 2-12**.
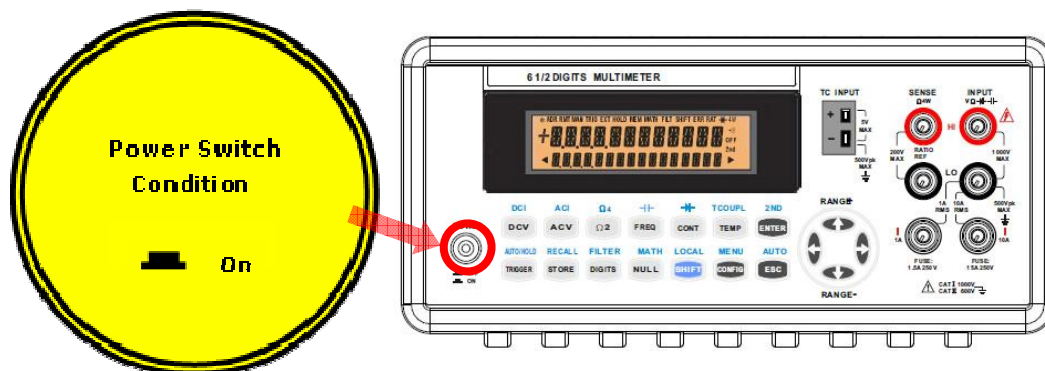
Figure 2-12

2.1.3 Factory Default When Power-ON

Table 2-1 shows the factory default of M3510A.

Table 2-1

Function		Default
Location after Power On		DCV
Autozero		ON
Frequency and Period Source		AC Voltage
Output Format		ASCII
Ratio		OFF
AC Voltage	Frequency	20Hz
	AC Digits	5.5
	Range	10 V
DC Voltage	DC digits	5.5 (10 PLC)
	Range	1V
AC Current	Frequency	20 Hz
	AC Digits	5.5
	Range	1A
DC Current	DC Digits	5.5 (10 PLC)
	Range	1A
Frequency and Period	Digits	5.5
	Range	10 V
	Gate Time	0.1 Sec.
Capacitance	Dgits	4.5
	Range	10 nF
Diode Test	Digits	5.5
	Range	1mA
	Rate	0.2 PLC
Resistance (2-/4-wired)	Digits	5.5 (10 PLC)
	Range	1KΩ
Temperature	Digits	4.5 (10 PLC)
	Thermocouple	K Type
Triggers	Source	Immediate
	Delay	Auto
Input Resistance		10MΩ

2.2 M3510A Function Introduction

For you to become familiar with the M3510A DMM, we will give a brief introduction to the basic operations. There are three major parts of M3510A: **(2.2.1) the front panel, (2.2.2) the display, and (2.2.3) the rear panel.** We will discuss each of them in the following sections.

2.2.1 The Front Panel

There are different buttons and terminals on the front panel. They are shown in **Figure 2-13**.
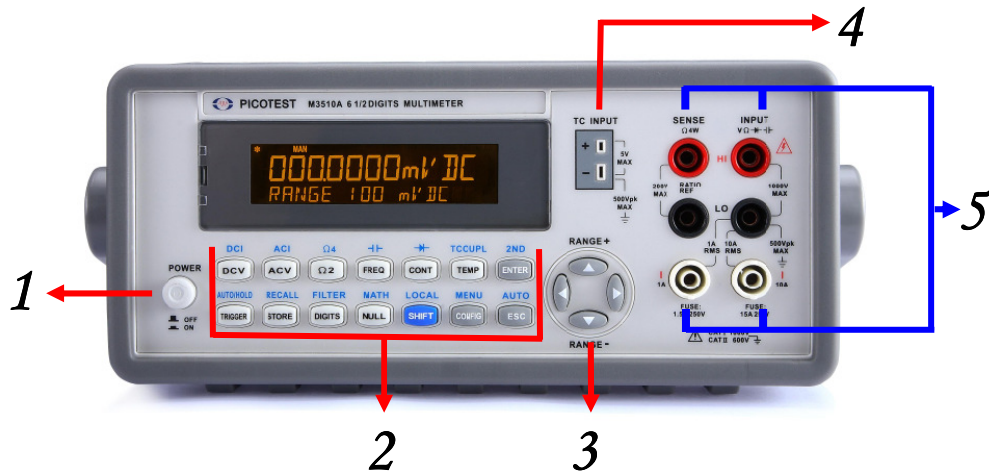
Figure 2-13
M3510A front panel

1. Power :
● Power: Activates M3510A DMM.

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.
● ENTER: Accepts selection, moving to next choice or back to measurement display.

2.2 First row with SHIFT button:

- DCI: Selects DC current measurement.
- ACI: Selects AC current measurement.
- Ω4: Selects 4-wire resistance measurement.
- ⊣⊢: Selects capacitance measurement.
- ⇥⊢: Selects diode testing.
- TCOUPL: Selects thermocouple temperature measurement.
- 2ND：Setting Secondary measurement.

2.3 Second row without SHIFT button:

- TRIGGER: Manually triggers the multimeter to make measurements or sets the multimeter to take external triggers.
- STORE: Stores a specified number of subsequent readings.
- DIGITS: Changes measurement resolution.
- NULL: Activates the null function in order to offset the measurement error due to the test leads.
- SHIFT (in blue): Used to access other functions in blue upper print.
- CONFIG: Configures the settings of selected measurement function.
- ESC: Cancels selection, moving back to measurement display.

2.4 Second row with SHIFT button:

- AUTO/HOLD: Enables or disables the reading hold function.
- RECALL: Displays stored readings. Use ◁▷ and △▽ buttons to select a reading for display.
- FILTER: Enables or disables averaging digital filter.
- MATH: Enables or disables mathematical operations/tests including PERCENT, AVERAGE, NULL, LIMITS, MX+B, dB and dBm.
- LOCAL: Switches the multimeter to the *local* mode from the USB or GPIB remote mode.
- MENU: Offers system-wide settings, trigger settings, interface configurations and calibration information.
- AUTO: Enables or disables auto range.

3. Range Section

- ◁▷: Scrolls through options.

- ▵▿: Changes the range while measuring or changes a digit when setting parameters.

4. TC INPUT section

The terminals at the TC INPUT section provide thermocouple temperature measurement. They come with built-in cold junction compensation so no extra thermocouple adapter is needed.

5. 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.
- Two Front Fuses: Secures your Meter against damage of strong current pulse. (Maximum current: 3A, 250V and 15A, 250V)

2.2.2 The Display

M3510A has a dual-LCD-display for a better view. There are two rows in the dual-display screen. The upper row (Primary) displays readings and units. A maximum 11 characters are allowed for upper row LCD display. The lower row (Secondary) displays range of the measurements, condition, the secondary readings & units or information about an ongoing configuration. A maximum 16 characters are allowed for lower row LCD 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

2.2.2.1 Annunciators

- ADR: Indicates the multimeter is controlled via GPIB Interface.
- RMT (REMOTE): Indicates the remote state. (USB Interface)
- MAN: Indicates the manual range is taken.
- TRIG: Indicates the Single Triggering or External Triggering is enabled.
- HOLD: Indicates reading hold function is enabled.
- MEM: Indicates the using of internal memory.
- MATH: Indicates the "MATH" operation is taken.
- FILT: The digital filter is started.
- SHIFT: Indicates SHIFT button is pressed.
- ERR: Error occurs.
- 4W: Indicates 4 –wire mode is selected for resistance measurement.
- •))): Indicates the continuity testing is enabled.
- OFF: Indicates the front panel display is turned off.
- RAT: Indicates the "RATIO" operation is taken.
- 2nd: Indicates 2ND function in use.

2.2.3 The Rear Panel

The rear panel of the M3510A is shown in **Figure 2-20**. This figure includes important abbreviated information that should be reviewed before using the instrument.
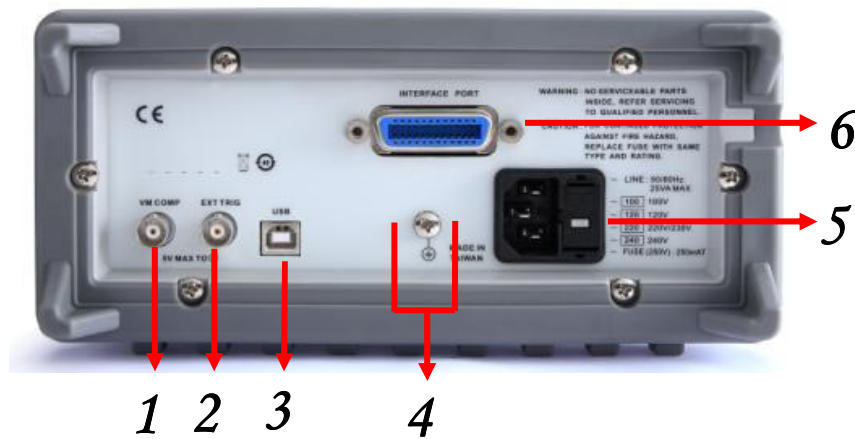
Figure 2-20

1. **VM COMP:** Voltmeter Complete Output Terminal. Outputs a low-true pulse from a remote interface.

2. **EXT TRIG:** Terminal to be used when choosing external triggering.

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

4. **Chassis Ground**.

5. **Power Module:** Contains the AC line receptacle, power line fuse, and line voltage setting. Configured for line voltages, such as 100/120/220(230)/240V. (Depend on the power utility in your area.)

6. **Option GPIB (IEEE488.2 Connection)/RS-232:** Connects a remote computer with an IEEE488 cable or RS-232 card for changing operation environment instead of the front panel control (Model: M3500-opt04/M3500-opt06).

3 Basic Measurement Function

This chapter introduces some basic measurement functions in M3510A. You will learn how to use your M3510A to measure voltage, current, resistance, frequency, period, continuity, diode and temperature in this chapter.

3.1 Voltage Measurements (DCV & ACV)

The ranges for DC voltage measurements in M3510A are 100mV, 1V, 10V, 100V and 1000V. For AC voltage measurements, the ranges are 100mV, 1V to 750V AC-Coupled TRMS, or 1000V peak.

⚠ 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. Connect the test leads to the terminals on the front panel.
2. Set RESOLUTION of DCV (refer to 4.1.3), BAND WIDTH of ACV (refer to 4.1.2.1) or skip this step if default is to be used.
3. Press DCV or ACV button for DC or AC voltage measuring.
4. Select auto-range function by pressing SHIFT + ESC button on the front panel or use △ and ▽ buttons to manually select desired range.
5. Connect test leads to your source signal and observe readings shown on the display. If the input signal is beyond the allowed range, an overflow message "OVLD" will be displayed.

3.2 Ratio Measurements (DC Voltage only)

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

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

※ Note: This function only applies to DC voltage measurement.
At the Sense terminals, dc voltage is always there while using the reference voltage measurement function which has a maximum measurable input of ± 1.2 Vdc.

The Input LO and Sense LO terminals, having a common reference, can't have a voltage difference greater than ± 0.2 volts.

The specified measurement range is used only for the signal connected to the Input terminals. And the signal on the Input terminals can be any dc voltage up to 1000 volts.

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.

Front Panel Operation

Press the DCV and the CONFIG buttons. Use ◁ and ▷ buttons to locate

"RATIO" option. Press ENTER to finish.

Remote Interface Operation
Use the following command to make a RATIO measurement.
CONFigure:VOLTage:DC:RATio {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}
This function calculates the ratio of an input DC voltage to a reference DC voltage according to the following equation:

※ Note: To turn off this function, please press one of the measurement function buttons. RAT anunciator will lit when the Ratio is used.

3.3 Current Measurements (DC & AC)

The ranges for DC current measurements in M3510A are 10mA, 100mA, 1A, 3A and 10A. For AC current measurements, the range is 1A with sensitivity of 1 nA to 10A AC-Coupled TRMS with sensitivity of 10μA.

⚠ Warning! To avoid damaging the fuse of current input.

● Under current measurements, the input source below 3 A or between 3A and 10A will be measured only through the 3A/10A and LO input connectors.
● Ensure the test leads are correctly connected to the DMM current inputs.
● It's important to prevent the internal fuse damage from abusing source over 3 A on the 3 A input connector or over 10 A on the 10 Amp connector.
● The measured values will be incorrect under the following conditions.
   1. At 3A terminal, Range: 10 A.
   2. At 10A terminal, Range: 3 A.
● Under the 10A range, you can't use AUTO.
● 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. Connect the test leads to the terminals on the front panel.
2. Set RESOLUTION of DCI (Refer to 4.1.3), BANDWIDTH of ACI (Refer to 4.1.2.1) or skip this step to use the default settings.
3. Press SHIFT+DCV (or SHIFT+ACV) buttons for DCI (or ACI) measurement.
4. Select the auto-range function by pressing SHIFT + ESC buttons on the front panel or use △ and ▽ buttons to manully select a desired range.
5. Connect test leads to your source signal and observe readings shown on the display. If the input signal is greater than the allowed range, an overflow message "OVLD" will be displayed.

3.4 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 (at 100 Ω range.) There are two modes for measuring the resistance: 2-wired mode and 4-wire mode. 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.

How to measure resistance

1. Connect the test leads to the terminals as shown in **Figure 3-1** and **3-2**.
2. Set RESOLUTION (Refer to 4.1.3) or skip this step to use the default setting.
3. Press Ω2 button for 2-wire measurement or SHIFT+Ω2 buttons for 4-wire measurement.
4. Select the auto-range function by pressing SHIFT+ESC button on the front panel or use △ and ▽ buttons to manually select the desired range.
5. Connect test leads to your source signal and observe readings shown on the display. If the input signal is greater than the allowed range, an overflow message "OVLD" will be displayed.
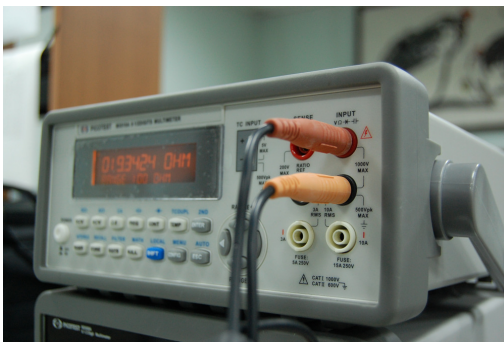
| Figure 3-1 | Figure 3-2 |

※ Note: Ensure the chassis ground is leaded to the ground before measurement in order to prevent the measuring deviation.

3.5　Frequency & Period Measurements

M3510A uses an on-board counter 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 750V in AC. The range default setting is auto-range.

⚠ Warning! The allowed maximum input is 750V. Applying excess voltage may damage your meter.

How to measure frequency

1. Connect the test leads to the terminals on the front panel.
2. Set RESOLUTION (Refer to 4.1.3) and INPUT JACK (Refer to 4.1.9). Or skip this step to use the default settings.
3. Press FREQ button for frequency or period measurement.

4. Press CONFIG button and use ◁ and ▷ buttons to locate the "FREQ" option. Press ENTER to select Frequency measurement.
5. Select the auto-range function by pressing AUTO button on the front panel or use △ and ▽ buttons to manually select the desired range.
6. Connect test leads to your source signal and observe readings shown on the display. If the input signal is beyond the allowed range, an overflow message "OVLD" will be displayed.

How to measure period

1. Connect the test leads to the terminals on the front panel.
2. Set RESOLUTION (Refer to 4.1.3) or skip this step to use the default setting.
3. Press FREQ button for frequency measurement, and then press CONFIG button.

4. Use ◁ and ▷ buttons to locate "PERIOD". Press ENTER to switch the frequency measurement to period measurement.
5. Select the auto-range function by pressing AUTO button on the front panel or use △ and ▽ buttons to manually select the desired range.
6. Connect test leads to your source signal and observe readings

shown on the display. If the input signal is beyond the allowed range, an overflow message "OVLD" will be displayed.

3.6 Continuity Measurements

M3510A uses 1 KΩ 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 you can set the threshold resistance to anything between 1 Ω and 1 KΩ. The resistance value set by you 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. Applying excess voltage may damage the meter and cause unpredictable hazards.

How to measure the continuity

1. Connect the test leads to the terminals on the front panel.
2. Connect test leads to your source signal.
3. Set threshold resistance (Refer to 4.1.4) or skip this step to use the default resistance.
4. Press CONT button.
5. The result will be shown on the display automatically. Meter "beeps" when measured resistance value is lower than threshold value.

3.7 Diode Measurements

M3510A 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 0.2 PLC (The voltage bound is adjustable from 0.01V up to 1.2V.). The meter beeps when the diode measured value is within the range.

⚠ Warning! The positive end of the diode should be connected to HI of

the input terminals, and the negative end to LO.

How to measure diode
1. Connect the diode to the terminals. For forward bias, connect the probe from input terminal "HI" to the positive end of the diode, and connect the probe from input terminal "LO" to the negative end of the diode.
2. Press SHIFT+CONT buttons to select the diode testing function.
3. Set voltage bound by pressing SHIFT+CONT buttons and then pressing CONFIG. When ready, press ENTER. (Or skip this step to use the default voltage bound.)
4. Observe and take readings on the display.

3.8 Temperature Measurements

M3510A supports thermocouples and resistance temperature detector (RTD) types of probes. For thermocouples, M3510A supports 9 types: B, C, 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 4.1.7 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 M3510A is PT100 and the thermocouple is type K.

Table 3-1

Sensor Type	Temperature Range(°C)	Temperature Range(°F)
B	600~1820	1112~3308
C	0~2316	32~4200.8
E	-250~1000	-418~1832
J	-210~1200	-346~2192
K	-200~1372	-328~2501.6
N	-200~1300	-518~2372
R	0~1767	32~3212.6
S	0~1767	32~3212.6
T	-250~400	-418~752
RTD (PT 100)	-200~850	-328~1562

3.8.1 Thermocouple Measurements

Connect the thermocouple sensor to the TC INPUT jack on the front panel. The difference between each type is subject to sensors.

How to measure thermocouple

1. To measure thermocouple must be via a purposive sensor as shown in **Figure 3-3**.
2. Press SHIFT + TEMP buttons to select thermocouple measurement.
3. Configure the thermocouple type by using the CONFIG button (refer to 4.1.7) or skip this step to use the default settings.
4. Observe and take readings on the display.
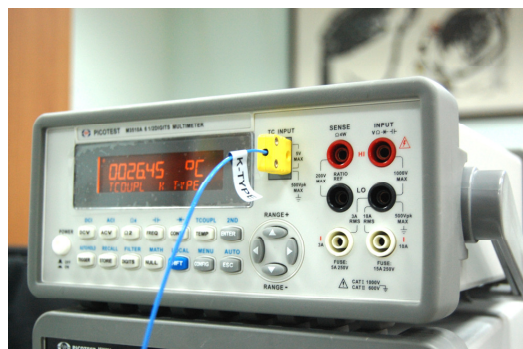
Figure 3-3

3.8.2   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.

3.8.2.1   2-Wire RTD Measurements

How to measure temperature with 2-Wire RTD

The following **Figure 3-4** shows theory diagram of 2-Wire RTD measurement.

1.   Insert a specified adapter into the front terminals.
2.   Press TEMP button.
3.   Configure sensor type 2W RTD and unit by using the CONFIG button (refer to 4.1.7) or skip this step to use the default settings.
4.   Observe and take readings on the display.
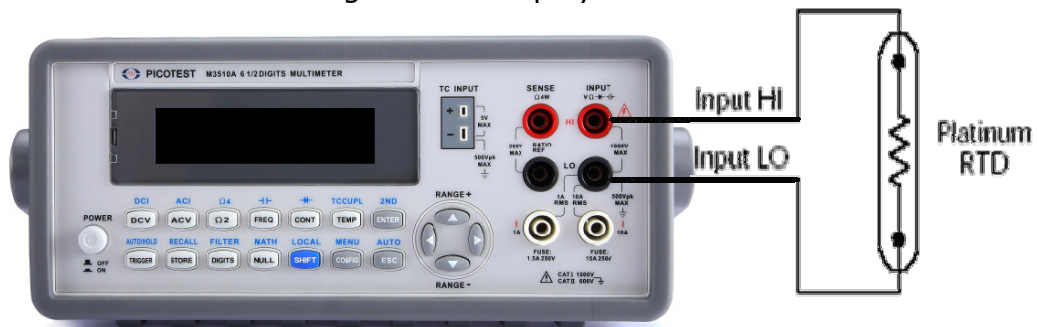
Figure 3-4

Note: Source current flows from the **INPUT HI** to **INPUT LO** terminals.

3.8.2.2   4-Wire RTD Measurements

How to measure temperature with 4-Wire RTD

The following **Figure 3-5** shows theory diagram of 4-Wire RTD measurement.

1.   Insert a specified adapter into the front terminals.
2.   Press TEMP button.
3.   Configure sensor type 4W RTD and unit by using the CONFIG button (refer to 4.1.7) or skip this step to use the default setting.

4.   Observe and take readings on the display.
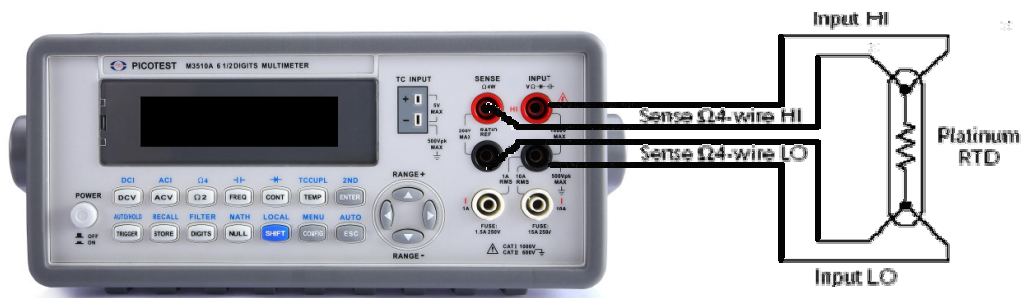
Figure 3-5

3.8.2.2.1   Support 3-Wire RTD Measurements

How to measure temperature with 3-Wire RTD

The following **Figure 3-6** shows theory diagram of 3-Wire RTD measurement.

1.   Insert a specified adapter into the front terminals.
2.   Press TEMP button.
3.   Configure sensor type 4W RTD and unit by using the CONFIG button (refer to 4.1.7) or skip this step to use the default setting.
4.   Observe and take readings on the display.

※ Note: When measuring through the 3-wire RTD, the input LO and sense LO have to be connected in short condition.
※ Note: "Source" means RTD Probe or RTD Simulator.
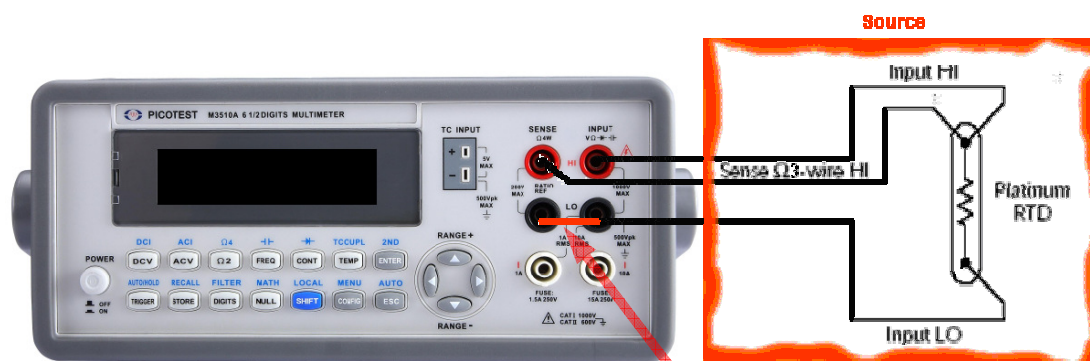
In Short Condition

Figure 3-6

3.9 Capacitance Measurement

The ranges for capacitance measurements in M3510A are 1 nF, 10 nF, 100 nF, 1 µF, 10µF, 100µF, 1000µF and 10000µF. The default for "range" is auto-range.

※ Note: While using this capacitance function, the resolution is fixed at 4 1/2 digits.

How to measure capacitance

1. Connect the test leads to the terminals on the front panel.
2. Press SHIFT + FREQ to select capacitance measurement function.
3. Observe and take readings on the display.

3.10 2ND Measurement

M3510A provides a secondary measurement function as users make a primary measurement. By using 2nd function, users are able to make two measurements at the same time. The **Table 3-1** below show the available measurement functions for each primary measurement on M3510A.

Table 3-1
(Available 2ND functions on M3510A)

2ND / Main	DCV	DCI	2W	4W	ACV	ACI	FREQ	PER	FREQ_C	PER_C	CAP	TEMP	TCO	CONT	DIODE
DCV	✗	✓	✗	✗	✓	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗
DCI	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✗
2W	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗
4W	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗
ACV	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗
ACI	✗	✓	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✓	✗	✗
FREQ	✓	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✓	✗	✗
PER	✓	✓	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗
FREQ_C	✗	✓	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✓	✗	✗
PER_C	✗	✓	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗	✓	✗	✗
CAP	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗
TEMP	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗
TCO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
CONT	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
DIODE	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

How to use 2ND measurement

1. Press one of the measurement function keys to select a primary measurement.
2. Press SHIFT+ENTER to enter 2ND submenu.

3. Use ◁ or ▷ button to locate a desired secondary measurement, and press ENTER to select it.

4. Observe and take readings on the display. The upper row display is the primary measurement and the lower row display is the secondary measurement.

※ Note: To simultaneously measure the DCI & DCV from the same input source, you have to use three leads. The voltage and current measurements must share the same common lead at the LO terminal. However, this application will cause an inaccurate measurement due to the leads combining with a small amount of internal resistance in the DMM and forming an IR which directly and annoyingly affects the measurement. For instance, 30 mΩ of lead resistance will cause approximate 90 mV error at 3 A.

※ Note: To execute the 2nd function with DCI, please adjust the range at 1A or up.

Remote Interface Operation

To set 2nd through the remote interface, use the following commands:

These commands are used for selecting two functions on the 2nd applications. 1 stands for the selected function which will act on the main display. 2 stands for the selected function which will act on the secondary display.

[SENSe:]FUNCtion "<function>"

For example:

FUNCtion[1/2] "VOLTage:DC"
FUNCtion[1/2] "VOLTage:AC"
FUNCtion[1/2]"CURRent:DC"

FUNCtion[1/2] "CURRent:AC"

FUNCtion[1/2] "FREQuency"

FUNCtion[1/2] "FREQuency:VOLT"

FUNCtion[1/2] "PERiod"

FUNCtion[1/2] "PERiod:VOLT"

FUNCtion[1/2] "FREQuency:CURR"

FUNCtion[1/2] "PERiod:CURR"

FUNCtion[1/2] "RESistance"

FUNCtion[1/2] "FRESistance"

FUNCtion[1/2] "CAPacitance"

FUNCtion[1/2] "TEMPerature"

FUNCtion[1/2] "TCOuple"

FUNCtion[1/2] "NONE"

FUNCtion[1/2]?

When enabling the 2nd function, you can still set the range and NPLC individually. The setting procedures are as usual.

To set 2nd and NPLC through the remote interface, use the following commands:

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

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

[SENSe:]<function>:NPLCycles

{0.001|0.006|0.02|0.06|0.2|0.6|1|2|10|100|MIN|MAX}

To read and fetch values from the DMM, use the following commands:

READ[1|2]?

FETCh[1|2]?

The following error codes might occur when corresponding function or range is not enabled or mismatch.

-243:\"Second function invalid\

It means Secondary function is not enabled

223:\"2nd function mismatch\

It means function/2nd func mismatch.

225:\"Function/range mismatch\

It means function/range mismatch.

4 Front Panel Operations

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

4.1 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 and remote interface selection.

4.1.1 Set ADC (Auto Zero)

Zero

The purpose of Auto Zero function is to minimize the offset influence on your measurements. When Auto Zero is enabled, M3510A takes the input signal reading as a base value and then internally disconnects the input signal, and takes an 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 setting for Auto Zero is enabled. The user selected values for Auto Zero are stored in a volatile memory and the default setting will be

restored when the meter is power-off.

How to set Auto Zero

The following steps show how to set Auto Zero directly through the front panel. Be aware that Auto Zero setting is always affected by the resolution setting. Whenever the resolution is altered, Auto Zero may be changed accordingly. You can change the Auto Zero setting through the front panel or through the remote interface operation.

Front Panel Operation

1. Press SHIFT+CONFIG buttons.

2. Use ◁ and ▷ buttons to toggle SET ADC + ENTER > AUTO ZERO + ENTER > ON/OFF + ENTER.

※ Note: To change resolution, refer to 4.1.3: Resolution Setting.

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.

4.1.2   Filter

Filter is used to remove noises in measurement readings. M3510A 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 filters are described in detail in the subsequent sections respectively.

4.1.2.1 AC Filter (AC only)

Definition:

You can refer to **Table 4-2** 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). You can select your filter type as you wish when setting bandwidth value. The defined 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	Remote Trigger Delay (seconds per reading)
3 Hz ~ 300 KHz	Slow	7
20 Hz ~ 300 KHz	Medium	1
200 Hz ~ 300 KHz	Fast	0.6

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

1. Press ACV button and then CONFIG button.

2. Use ◁ and ▷ buttons to locate "BAND WIDTH" submenu, and then press ENTER to select it. (There are three options: 3Hz, 20Hz and 200Hz.)

Remote Interface Operation

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

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

4.1.2.2 Digital Filter

Definition:

M3510A 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. You 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 when 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.

※ Note: 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

1. Press SHIFT+DIGITS buttons to switch to the digital filter function.

2. Use ◁and ▷buttons to toggle between options.

3. Press ENTER on "OFF" to disable the filter. Or press ENTER on the other two options to enable it.

4. Press RUN to start. The "FILT" anunnciator lights up when 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 MODE setting:

1. Press SHIFT + DIGITS buttons and then use◁and▷buttons to toggle between "OFF", MOVING AVG" and "REPEAT AVG".

2. Press ENTER on your selection.

For READINGS setting:

1. After enabling the filter (see above), use◁and▷buttons to locate "READINGS". Press ENTER to select it. Use ◁ and ▷ to move through the digits and △ and ▽ buttons to increase or decrease the numbers to a desired value(from 2 to 100). Press ENTER to set the value. Press ENTER on "RUN" to start reading.

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?

4.1.3 Resolution & NPLC Setting

Definition

Resolution is the number of digits a multimeter can measure. You can select the resolution for a specific measurement. The choices for the resolution setting are: 4.5, and 5.5. For a faster measurement, you can select 0.001 PLC. For a stable, higher accuracy measurement, 100 PLC is suggested to select. However, the NPLC setting is used for DCV, DCI, Ω2 & Ω4 functions only. The lowest PLC on each digit range is the rapidest selection, such as 0.001 PLC at 4 1/2 digits, 0.2 PLC at 5 1/2 digits, 10 PLC at 6 1/2 digits. The following table 4-3 shows the relationship between the integration time and the measurement resolution.

Table 4-3

Integration Time (PLC)	Resolution (with Full–Scale)
0.001	0.0003
0.006	0.0002
0.02	0.0001
0.06	0.00005
0.2	0.00001
0.6	0.000005
1	0.000003
2	0.000002
10	0.000001
100	0.0000003

In addition, 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 present measurement functions. You can select different resolution for different measurement functions.

Default

The default value for the resolution is 5 1/2 digits with 10 PCL and the default value will be restored when the meter has been turned off or after a remote interface reset. The manual selected value for the resolution setting is stored in a volatile memory and the setting is only valid for the

present measurement function. Please refer to **Table 2-1** on page 23.

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

Front Panel Operation
1. First select your desired measurement function by pressing one of the function buttons located on the first row of your meter's front panel.
2. Press DIGITS button to select a desired resolution for your measurement.

※ Note: When following the Way One to set the resolution, your options with each press on the same button are 4.5, and 5.5. And under the DCV, DCI, Ω2 & Ω4 functions, the NPCL just can be set by pressing CONFIG >

NPLC > ENTER > ◁ and ▷ > Target PCL.

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>

You can specify the resolution in the same units as the measurement function, not in number of digits. For instance, specify the resolution in vots and the frequency in hertz. Below are some examples.

CONF:VOLT:DC 10,0.001   (4 1/2 digits on the 10 Vdc range)
MEAS:CURR:AC? 1,1E-6   (5 1/2 digits on the 1 A range)
CONF:FREQ 1 KHz,0.1 Hz (1000 Hz input, 0.1 Hz resolution)
VOLT:AC:RES 0.05   (50 mV resolution on the ac function)

4.1.4 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. Your 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

You can change the threshold resistance only through the front panel.

1. Press CONT button and then CONFIG button.
2. Press ENTER button to access the threshold resistance settings.

3. Use ◁ and ▷ buttons to move through the digits and lower or increase the number to your desired value by using △ and ▽ buttons.
4. Press ENTER button again to confirm the value.

4.1.5 Range (Manual & Auto)

Definition

When making measurements except CONT, DIODE, TCOUPL and Temperature, M3510A will automatically choose a range for you, or you can select an appropriate range manually. The difference between auto-range and manual-range is the settling time. Auto-range is a convenient way for you, 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 thresholds 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 manual 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 23 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. The autorange can't work at the 10A range.

Front Panel Operation

1. Choose a measurement function.
2. Press SHIFT + ESC buttons to select auto-range feature. Or use △ and ▽ buttons to manually select a range (MAN anunciator will lit when manually selecting a range).

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}

4.1.6   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 you 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 10 different integration times in M3510A for you to select from: 0.001, 0.006, 0.02, 0.06, 0.2, 0.6, 1, 2, 10 and 100 PLCs.

Default

For DCV, DCI, and resistance measurement, the default integration time is 10 PLC. The manual 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 you select the measurement resolution. Please refer to 4.1.3 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 {< PLCs>|MINimum|MAXimum}

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

SENSe:CURRent:DC:NPLCycles {< PLCs>|MINimum|MAXimum}

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

SENSe:RESistance:NPLCycles {< PLCs>|MINimum|MAXimum}

SENSe:RESistance:NPLCycles? [MINimum|MAXimum]

SENSe:FRESistance:DC:NPLCycles {< PLCs>|MINimum|MAXimum}

SENSe:FRESistance:DC: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 (4.5 digits), and 100 ms (default; 5.5 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]

4.1.7 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 4-4**:

Table 4-4

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 $0^{\circ}C < t < 630^{\circ}C$:

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

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 M3510A 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

Sensor selection
1. Press TEMP button to select RTD temperature measurement function.
2. Press CONFIG button.

3. Use ◁ and ▷ to locate SENSOR submenu. Press ENTER to select it.

4. Use ◁ and ▷ 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 ◁ and ▷ to move through the digits and △ and ▽ 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.

2-wire/4-wire selection
1. Press TEMP button to select RTD temperature measurement function.
2. Press CONFIG button.
3. Use ◁ and ▷ to locate TRANSDUCER submenu. Press ENTER to select it.
4. Use ◁ and ▷ to locate a desired option, such as 2W RTD or 4W RTD. Press ENTER to finish the process.

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

M3510A is built-in cold junction compensation that can improve the accuracy of thermo measurements. If you are using this function, you have to set an adapter type. For example, through the "TYPE" selections you are available to use a specific adapter B, C, E, J, K, N, R, S or T for temperature measurement.

Perhaps it's not the solution you want according to your application. Pick the next selection RJUNCTION's REAL or RJUNCTION's SIMULATED by the procedure SHIFT > TEMP > CONFIG > RJUNCTION > REAL/SIMULATED. This procedure is not for the settings, but the function execution. Before executing, please go setting REAL or SIMULATED peremeters by the procedure SHIFT > TEMP > CONFIG > SIMULATED/REAL.

What's the difference between the REAL and the SIMULATED? For the REAL, it's a cold junction compensator whose standard value is detected from the present internal equipment, i.e. the value would be frequently influenced and changed at different environments and climates, and it can't be adjusted. For the SIMULATED, the SIMULATED value is a reference value. To use this function, you need to be aware that the temperature value from a certain object is absolute meaningful and accurate, for example 0℃ (mixed ice and water). After you well selet the type and matched the correct adaptor, the tested result from the mixed ice and water is 2℃. At this circumstance, you know the real and tested error is 2℃. So the next step is to adjust the default value from 25℃ to

23℃. Then your following thermocouple measurements with the simulated function would be accurate.

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 (Unit and Thermocouple configuration)

1. Press SHIFT+ TEMP to choose thermocouple function.

2. Press CONFIG, and then use ◁ and ▷ to toggle between options.

3. To configure unit or thermocouple type, press ENTER on "UNIT" and "TYPE" respectively.

Real Temperature Setup

1. Selet a type and matched an adaptor correctly.
2. Press SHIFT+ TEMP to choose thermocouple function.

3. Press CONFIG, and then use ◁ and ▷ to locate "REAL", then press

   ENTER to check the present temperature.
4. Press ESC to reach the upper layer.

5. Press ◁ and ▷ to locate "RJUNCTION", then do the prcedure ENTER

   > REAL to execute the function.

Simulated Temperature Setup

1. Selet a type and matched an adaptor correctly.
2. Press SHIFT+ TEMP to choose thermocouple function.

3. Press CONFIG, and then use ◁ and ▷ to locate "SIMULATED", then

   press ENTER to define a proper value after calculating.
4. Press ESC to reach the upper layer.

5. Press ◁ and ▷ to locate "RJUNCTION", then do the prcedure ENTER

   > SIMULATED to execute the function.

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:TYPE?**

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

SENSe:**TCOuple:RJUNction:SIMulated?**

4.1.8 Remote Interface Selection

The M3510A provides a standard USB and supports an optional GPIB/RS-232 interface, but only one interface can be activated at a time. If you are using GPIB, you must set an address for the multimeter. You can set the address to any value from 0 and 31, and the setting will be stored in the non-volatile memory which won't be changed while being powed off or reset under remote control. 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

1. Press SHIFT + CONFIG buttons. Then use ◁ and ▷ buttons to locate

    "INTERFACE". Press ENTER to select it.

2. Use ◁ and ▷ buttons to toggle between "USB" and "GPIB". Press

    ENTER on your choice of interface.

How to set address when using GPIB

1. Press SHIFT + CONFIG buttons, and then use ◁ and ▷ buttons to

    locate "INTERFACE". Press ENTER to select.

2. Use ◁ and ▷ buttons to locate "GPIB". Press ENTER to select it.

3. Use ◁ and ▷buttons to move through the digits and △and ▽ buttons to adjust the numbers to a desired GPIB address. Press ENTER to set the address.

4.1.9   Input Jack

There are two selections for you to select either the voltage or the currect while using frequency function. It depends on what UUT (Unit under Test) you want to measure. If your UUT is the voltage, the test leads must be connected with Input HI & LO. On the contrast, if your UUT is the current, they must be connected with Input LO and Current 3 A or 10 A. In addition, the default is "Voltage".

How to select an Input Jack
1. Make sure that your connection is ready.
2. Press the Frequency button first, then CONFIG button. Use ◁ and ▷ buttons to locate "INPUT JACK". Press ENTER to select it.

3. Use ◁ and ▷ buttons again to toggle between "VOLTAGE" and "CURRENT". Press ENTER to finish.

4.2   Trigger Operations

In this section we will discuss the triggering system in M3510A. M3510A provides a variety of trigger operations. You can select a trigger mode, a trigger source and different trigger settings for a specific measurement. The defined selection is stored in a volatile memory and the default settings will be restored after power-off. **Figure 4-1** shows the trigger operation in M3510A.
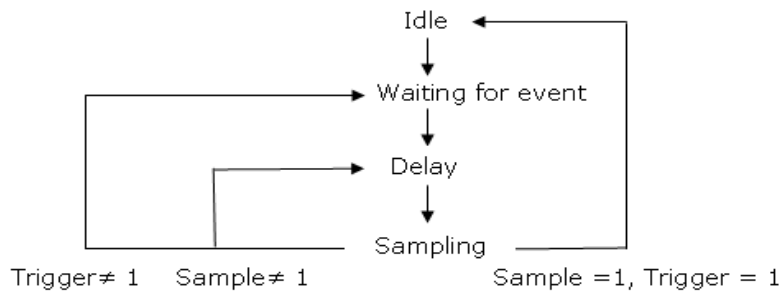
Trigger Operation Flow Chart

Figure 4-1

4.2.1   Trigger Mode

There are three trigger modes in M3510A: auto, immediate, and single triggering. You can specify the trigger mode for your 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 M3510A.

How to use Auto Trigger
1. Press SHIFT and TRIGGER on the front panel to enable auto trigger mode.

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 (Front panel operation only)

Definition

Single trigger mode takes one reading (or specified number of readings) each time when user presses TRIGGER key. (Please refer to 4.2.3 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, but it's not available for the diode and continuity functions.

How to use Single Trigger

1. Press one of the measurement function keys to select a measurement.
2. Press TRIGGER key on the front panel to set the trigger mode.
3. Disable the mode by pressing SHIFT + TRIGGER.

4.2.2 Trigger Source

In M3510A, you 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 Trigger Operation

Use SHIFT + TRIGGER buttons for auto triggering and TRIGGER button for single triggering.

External Hardware Trigger

You apply a trigger pulse to the Ext TRIG 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, connect an external source to Ext TRIG terminal on the rear panel, and press TRIGGER buttons to enable external hardware trigger.

External Triger Terminal

You can trigger the M3510A by using a low-true pulse to the Ext Trig (external trigger) terminal located on the rear panel as shown in **Figure 4-2**. And to use this terminal via the remote interface, you have to select the external trigger source by using the TRIGer:SOURce EXTernal command.
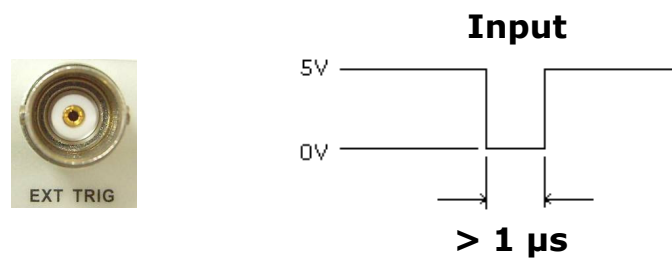
Figure 4-2

※ Note: You can use a simple switch to generate an external trigger by using the Ext Trig input as shown in **Figure 4-3**.
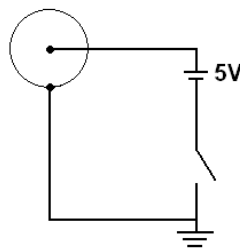
Figure 4-3

VM COMP (Voltmeter Complete) Terminal

The real panel VM COMP terminal provides a low-true pulse after finishing each measurement. The VM COMP and external trigger as shown in **Figure 4-4** provides a standard hardware handshake sequence between measuremen and switching devices.
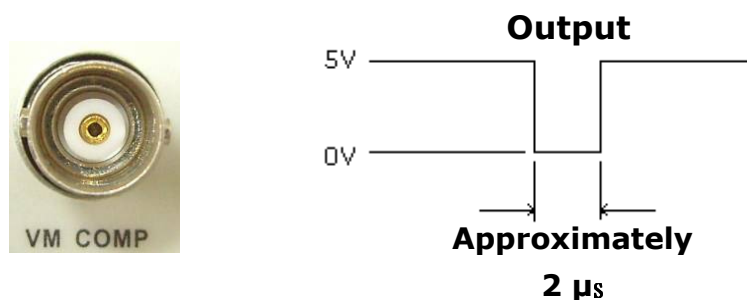
Figure 4-4

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 TRIGGER 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

4.2.3 Trigger Setting

In M3510A, you 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 your measurements.

A. Number of samples on each trigger
By default, M3510A takes only one reading on each trigger, but you can instruct the multimeter to take specific number (up to 2000) of readings each time it receives a trigger. The defined 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
1. Press SHIFT+CONFIG button.
2. Set a defined parameter via the procedure TRIG SYS > TRIG CNT > ENTER.
3. Set the desired number by pressing $\triangle$ and $\triangledown$ buttons to increase or decrease the number, and using $\triangleleft$ and $\triangleright$ buttons to move through the digits. Press ENTER to set the number.

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, you 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 shows how to set multiple triggers before returning to idle state.

TRIGger:COUNt <value>

C. Reading hold(Front panel operation only)
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 4.4.6 will explain how to adjust the sensitivity band. This feature is only available from the front panel operation.

How to enable/disable reading hold

1. Press SHIFT+TRIGGER buttons.
2. To disable it, press SHIFT+TRIGGER buttons again

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. M3510A 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 4-5**. The range for the delay is from 0 to 3600 seconds. The defined 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 4-5

Measurement Function	Setting	Trigger Delay Time
DCV/DCI	PLC >= 1	*1.5 ms*
	PLC < 1	*1.0 ms*
Ω2 and Ω4 (PLC >= 1)	100Ω ~ 100kΩ	*1.5 ms*
	1 MΩ	*15 ms*
	10 MΩ ~ 100 MΩ	*100 ms*
Ω2 and Ω4 (PLC < 1)	100Ω ~ 100kΩ	*1.0 ms*
	1 MΩ	*10 ms*
	10 MΩ ~ 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 /External	*1.0 s*
	Front Panel/Auto Trigger ON	*0 s*
Capacitance	1 nF ~ 10 mF	*0 s*

How to specify a delay time

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

Front Panel Operation

1. Press SHIFT+CONFIG buttons.
2. Set a difined parameter via the path TRIG SYS > DELAY > MANUAL > ENTER.

3. Use ◁ and ▷ buttons to move through the digits and △ and ▽

    buttons to increase or decrease the numbers to set the desired delay
    time (between 0 to 3600 second). Then press ENTER to actuate the
    delay time.

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}

4.3   Math Operations

This section will introduce the mathematical operations in M3510A.
There are seven math operations: PERCENT, AVERAGE, NULL, LIMITS
(HIGH LIMIT/LOW LIMIT), 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 diode and continuity testing.

4.3.1   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 stored 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

1. Press SHIFT + NULL to enter MATH submenu.
2. Set a difined parameter via the path PERCENT > TARGET > ENTER.
3. Use ◁ and ▷ to move through the digits and △ and ▽ buttons to increase or decrease the numbers to a desired target value. Press ENTER to confirm and use the value. Observe the calculated percent value on the display.

※ Note: To disable the percent function, you need to go into MATH submenu by pressing SHIFT + NULL buttons and select "OFF" to turn it off. The "MATH" annunciator should not be lit when disabled.

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]

4.3.2 Average (AVG/MIN/MAX/COUNT)

Definition

When the Average function is enabled, M3510A 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 and reading counts. The number of readings taken since Average operation is enabled is recorded as well. These data are stored in a volatile memory, presenting promptly on the secondary display, and will be cleared when the meter is turned off, or when the Average is turned on again, or after a remote interface reset.

How to use Average

You can use the Average feature either through the front panel operation or the remote interface operation.

Front Panel Operation

1. Press one of the measurement function buttons to select a measurement function.
2. Press SHIFT + NULL buttons to enter MATH submenu.
3. Use ◁ and ▷ buttons to locate "AVERAGE" submenu, and then press ENTER to actuate it.
4. To read the average value, min/max value, total counts and readings counts, you can press ◁ and ▷ buttons to switch between those values.

※ Note: Press SHIFT+NULL > OFF or switch to other measurement to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical feature.

Remote Interface Operation

The following commands show you how to use the Average 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?

4.3.3 Null

Definition

When the null function is enabled, the displayed measurement reading will show something 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, you can specify or alter a null value. The null function is available for all types of measurement except continuity and diode. When you select the null function for a measurement, it is visible only for this measurement.

How to operate the null (relative) function

You can operate the null function from either the front panel operation or the remote interface operation.

The Front Panel Operation

1. Store the null test lead resistance: First of all, 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.
2. Pressing NULL to actuate it. Or you want to define the value by doing the procedure SHIFT + NULL > NULL > ENTER > RUN VALUE. And use ◁ and ▷ buttons to locate "NULL VALUE". Then press ENTER to actuat it.

※Note: Press NULL button again or press other measurement buttons to disable this feature. The "MATH" anunnciator on the display indicates the state of a mathematical operation.

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}

4.3.4 Limits Test

The limits testing operation allows you 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. You 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

1. Do the procedure SHIFT + NULL > LIMITS > ENTER > HIGH LIMIT/LOW LIMIT > ENTER to access the setting.

2. Use ◁ and ▷ to toggle between options. Press ENTER on your selection of LOW LIMIT or HIGH LIMIT.

3. Use ◁ and ▷ to move through the digits and △ and ▽ to increase or decrease the numbers to a desired value, then confirm the value with ENTER button. Press ENTER on "RUN" to start measurement.

※ Note: To disable the limits function, you always need to go to Math submenu and select "OFF" or press other measurement buttons. The "MATH" annunciator should not be lit when disabled.

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

4.3.5 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 you need 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.

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)

1. Do the procedure SHIFT + NULL > MX+B > ENTER > SET M/SET B > ENTER to access the setting.

2. Use ◁ and ▷ to move through the digits and use △ and ▽ to increase or decrease the number to a desired value under the SET M and SET B setting mode. Press ENTER to confirm the value and actuate the function.

3.

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]

4.3.6   dB/dBm

dB Definition

The dB feature takes a DC or AC voltage measurement and displays it in decibel unit in correspondence to a relative reference value. The calculation of dB is listed below:

$$dB = 20 \times \log(V_{in}/V_{ref})$$

Or

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

※ NOTE: The V_{in} is the input signal and the V_{ref} is the relative reference.

The dB measurement is applied to DC and AC voltage only. The relative value is adjustable and is stored in a volatile memory. The range for the relative value is between 0 dBm and ±200 dBm, and the default value is 0 dBm.

How to use dB feature

You can either manually select a number for the relative reference or let the multimeter take the first reading (0 dB) as the relative reference.

Front Panel Operation (to set the relative reference)

1.   Select a measurement function by pressing DCV or ACV button.
2.   Do the procedure SHIFT + NULL > dB > ENTER > dB REL to access the setting.

3.   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.
4.   Press ENTER on "RUN" to start measurement.

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}

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 M3510A. The calculation of dBm is defined as below:

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

How to set the reference resistance

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

Front Panel Operation

1. Select a measurement function by pressing DCV or ACV button.
2. Do the procedure SHIFT + NULL > dBm > ENTER > REF RES to access the setting.

3. 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.
4. Press ENTER on "RUN" to start measurement.

※ Note: To disable the dBm function, you always need to go to Math submenu and select "OFF" or press other measurement buttons. The "MATH" annunciator should not be lit when disabled.

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}

4.4   System Related Operations

In M3510A, each system related operation performs a task that is not measurement related but plays an important role in making your measurements.

4.4.1   Display

M3510A has a dual-LCD-display screen. A maximum of 11 characters are allowed for upper row primary display and a maximum of 16 characters are allowed for lower row secondary display as shown on **Figure 4-5**. You 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 4-5

When the display is turned off, an "OFF" will be lit at right side of the display screen as shown in **Figure 4-6**. 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.

You can send a message through the remote interface from their PC terminal to the lower row display and will substitute the original display.
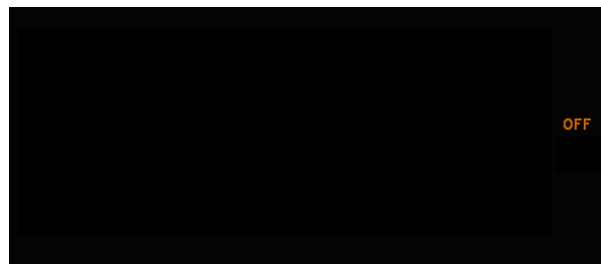
Figure 4-6

Default

The display default is "ON". The "On/Off" selection made by you 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

Do the procedure SHIFT + CONFIG buttons > SYSTEM > ENTER > DISPLAY > ENTER > ON/OFF > ENTER to enable/disable the display.

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)

4.4.2   Beeper

M3510A 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. The beeper state is stored in a non-volatile memory and the default will be restored when the meter has been turned off or after a remote interface reset.

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.

How to control the beeper

You can control the beeper from either the front panel operation or the

remote interface operation.

Front Panel Operation

Do the procedure SHIFT + CONFIG > SYSTEM > BEEP > ON/OFF > ENTER to enable or disable the beep.

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}

4.4.3 Reading Memory (Store & Recall)

M3510A 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. The default number of readings to store is 2000 and the anunciator "MEM" will light up when STORE feature is enabled.

How to use the reading memory

You 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 M3510A to remote interface will be in a first in and first out condition.

Front Panel Operation

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

How to enable Reading Memory (to store readings)

Press STORE button, and the multimeter will start to store the readings produced until the specified number of readings is reached.

How to set the number of readings to be stored

1. Press SHIFT + CONFIG > ▷ > ENTER > TRIG SYS > ▷ > STORE

    RDGS > ENTER buttons.

2. Press ▽ button to set the number of readings. Use ◁ and ▷

    buttons to move between the digits and ▽ and △ buttons to
    increase or decrease numbers as desired. When ready, press ENTER
    button.

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

How to recall the stored readings

Press SHIFT + STORE buttons, and the multimeter will display all the

stored readings starting from the first reading. Use ◁ and ▷ buttons to

move from the first reading to the last reading the meter has stored.

Remote Interface Operation

You 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.)

4.4.4 Sensitivity Band (Hold)

The reading hold function captures and holds a stable reading on the
display. M3510A 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. M3510A considers a reading stable when three consecutive values are within the band. You have an option to adjust this sensitivity band.

Default

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

How to enable/disable HOLD feature

1. Press SHIFT + TRIGGER buttons. The HOLD anunciator will light up when HOLD feature is enabled.
2. To disable HOLD feature, press SHIFT + TRIGGER again.

How to adjust the sensitivity band

You can adjust the sensitivity band through either the front panel operation or the remote interface operation.

Front Panel Operation

Do the procedure SHIFT + CONFIG > TRIG SYS > READ HOLD > 0.01%/0.1%/1.0%/10% to choose a desired band. Press ENTER on the desired sensitivity band.

4.4.5 Initial Mode

The section contains two selections: "DEFAULT SET" and "SAVE DATA". You can select "SAVE DATA" to save the current settings which will exist after restarting next time. Or select "DEFAULT SET" to recall the factory value after restarting M3510A. The SAVE DATA is available on using MEAS FUNC, RANGE, RESOLUTION, MATH FUNC & 2ND STATE.

How to save the settings

Do the procedure SHIFT + CONFIG > SYSTEM > ENTER > INIT MODE > ENTER > SAVE DATA/DEFAULT SET > ENTER to save your current setting or to resume the default setting.

4.4.6 Language

M3510A supports two languages: DEFAULT (M3510A) and COMPATIBLE.
When finished, the setting is stored in a non-volatile memory

How to set up the language
Do the procedure SHIFT + CONFIG > SYSTEM > ENTER > LANGUAGE >
ENTER > DEFAULT/COMPATIBLE > ENTER to select the language.

Command Information
If needed, please use the following commands to achieve the indicated
purpose(s).

L0
Set to the default identification string.

L1
Set to the compatible identification string.

SYSTEM:IDNSTR "Manufacturer,Product"
Change the multimeter's identification string, such as the maker's and the
product's names (be sure to dimension a string variable with at most 39
characters).

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).

4.4.7   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 you. 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. In addition, the general conditions of the ERROR are listed in the following. For more ERROR information, refer to Chapter 6 for the list of error messages.

- 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
Do the procedure SHIFT + CONFIG > SYSTEM > ENTER > SCPI ERR > ENTER to check the error message, such as "ERROR CODE" or "NO ERRORS".

4.4.8   Firmware Revision

M3510A 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 version
Do the procedure SHIFT + CONFIG > SYSTEM > SYSTEM VER > ENTER to check the M3510A's firmware version. 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.

4.4.9 Calibration

M3510A will show the latest calibrated date and the next calibration date on the display after following the operation below.

How to view the calibration information

Do the procedure SHIFT + CONFIG > CALIBRATE > ENTER to check the last calibrated date and the next calibration date.

4.4.10 Self-Test

Self-test procedures are built in M3510A for checking that the logic and measurement hardware are functioning properly. Every time when the multimeter is powered on, a set of test procedures is performed to make sure the basic function of the multimeter works properly. If any error occurs during self-test procedures, it indicates that parts of the multimeter are not operating properly and need to be serviced.

⚠ Warning! Erroneous self-test failures may occur if the setting of power line voltage is incorrect. Errors may also occur because of signals present on the input terminal during self-test procedure. Long test leads can act as an antenna causing pick-up of ac signals.

How to execute Self-test

This test procedure provides more tests for the hardware of M3510A than the power-on tests.

Do the procedure SHIFT + CONFIG > SYSTEM > ENTER > SELF TEST > ENTER to start the self-test.

After self-test procedure, the result, PASS or FAIL, will be shown on the display. If the result is FAIL, the "ERR" annunciator on the display panel will be lit, and error codes will be stored. You can check the errors by following the procedure in the section 4.4.7 Error Condition.

Self-test error codes

The descriptions of self-test error codes are listed below.

601 Front Panel failed

The communication with the front panel is failed when proceeding with the self test.

602 Input does not open

There are sources input. It's not allowed when doing self test. You have to remove all leads from the terminals.

603 A/D offset failed

When proceeding with A/D test, the deviation exceeds "Zero" too much.

607 Rundown too noisy

When gaining the A/D readings, values are inaccordant due to noisies.

609 DC gain x1 failed

Readings are incorrect when going through the path **gain x 1**.

610 DC gain x10 failed

Readings are incorrect when going through the path **gain x 10**.

613 SenseHi Path zero failed

The reference point "Zero" is incorrect when getting readings through the path **SenseHi**.

614 DC Path zero failed

The reference point "Zero" is incorrect when getting readings through the path Input.

616 DC current sense failed

The internal current is failed.

5 Remote Interface Operations

M3510A supports two remote interfaces: the built-in USB and optional GPIB (IEEE-488). 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.

5.1   Pass/Fail Output From USB Connector

The USB connector on the rear panel of M3510A is a series "B" connector. When the USB interface is **disabled** (IEEE-488 interface is selected), the internal pass and fail TTL output signals (limit testing) will be transmitted via the USB port.

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 μ sec) for each reading taken. **Figure 5-1** shows the USB connector (series "B").
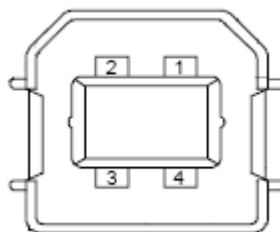
Figure 5-1

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

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

How to set Interface

Do the procedure SHIFT + CONFIG > INTERFACE > ENTER > USB/GPIB > ENTER to set the interface. The interface selection is stored in a non-volatile memory.

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

5.2 Setting Up For Remote Interface

You may use the M3510A application developed by PICOTEST to remotely control the multimeter through either USB or GPIB interface.

How to set up for USB interface

The USB cord should be connected well between M3510A and your PC. Install the M3510A application in your PC and execute the program. Click Tool tab for Command Control, then type in your command. The icons and buttons are shown with red rectangle frames in **Figures 5-2, 5-3** and **5-4**.

※ Note: The icons, pictures and words will be changed or edited with different versions without informing.

①　　　　　　②　　　　　　③
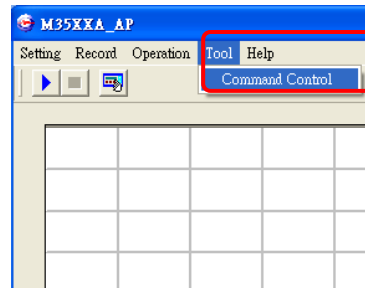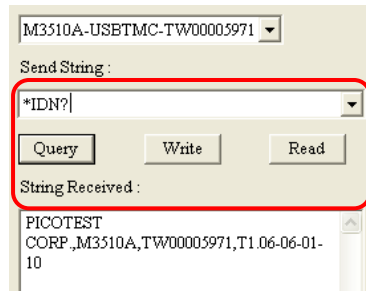
Figure 5-2　　　　**Figure 5-3**　　　　**Figure 5-4**

How to set up for GPIB interface

Insert a GPIB interface card into the interface slot on the rear panel. Install the M3510A application in your PC and execute the program. Click Tool tab for Command Control, then type in your command.

5.3   Remote Interface Commands

You can instruct the multimeter to take measurements by 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. A vertical bar (|) separates several choices for a parameter.

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}

CAPacitance? {<range>|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}

CAPacitance {<range>|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

※ Note: Default parameters are shown in ***bold italic***.
[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 "CAPacitance"

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]

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

CAPacitance: 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?

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

CAPacitance: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?

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

TCOuple:RJUNction:SIMulated?

[SENSe:]

TEMPerature:RTD:TYPE {**_PT100_**|D100|F100|PT385|PT3916|USER|SPRTD|NTCT}

TEMPerature:RTD:TYPE?

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]

[SENSe:]

VOLTage:DC:NPLCycles
{0.001|0.006|0.02|0.06|0.2|0.6|1|2|**_10_**|100|MINimum|MAXimum}

VOLTage:DC:NPLCycles? [MINimum|MAXimum]

CURRent:DC:NPLCycles
{0.001|0.006|0.02|0.06|0.2|0.6|1|2|**_10_**|100|MINimum|MAXimum}

CURRent:DC:NPLCycles? [MINimum|MAXimum]

RESistance:NPLCycles
{0.001|0.006|0.02|0.06|0.2|0.6|1|2|**_10_**|100|MINimum|MAXimum}

RESistance:NPLCycles? [MINimum|MAXimum]

FRESistance:NPLCycles
{0.001|0.006|0.02|0.06|0.2|0.6|1|2|**10**|100|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?

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

M3510A provides a variety of trigger operations. You 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).

M3510A 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

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

6 Error Messages

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. M3510A 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.

6.1 Error Type

There is only one type over here, "execution errors". If the errors user can't find here please contact with your seller for help.

6.1.1 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 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.

- **-214 Trigger deadlock**

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

- **-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.
Situation 3: When the autorange is enabled at the DCI's & ACI's 10A ranges, the error message will be generated.

- **-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.

- **223 FUNC2**

The 1st and 2nd functions mismatch.

- **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 2000 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.

- **624 Unable to sense line frequency**

The AC Line frequency can't be measured after powering on the DMM.

- **640 Meas setting failed**

You can't command to set through the A/D.

- **641 Meas reading failed**

You can't command to read from A/D.

- **642 Board Protect failed**

The specific IC is malfunction or missing. All communication is blocked.

- **650 Panel failed**

The main baord can't communicate with the panel.

- **651 Panel Program Checksum Error**

The checksum from the panel is incorrect.

Appendix

This appendix contains the performance specifications of the M3510A. It covers the AC, DC, Resistance, Temperature, and Frequency/Period characteristics under a variety of conditions. It also contains the general characteristics and accuracy calculations for your convenience. A lot of efforts are made to make sure these specifications serve your needs for production, engineering and/or research purposes. All specification applies to M3510A unless noted otherwise.

A. Specification List[1]

DC CHARACTERISTICS			
Function	Range	Resolution	1 Year Accuracy[2]
DCV	100.0000 mV	0.1 µV	0.0080+0.0045
	1.000000 V	1.0 µV	0.0090+0.0010
	10.00000 V	10 µV	0.0120+0.0020
	100.0000 V	100 µV	0.0120+0.0020
	1000.000 V	1 mV	0.0200+0.0030
DCI	10.00000 mA	10 nA	0.050+0.020
	100.0000 mA	100 nA	0.050+0.010
	1.000000 A	1 µA	0.150+0.020
	3.00000 A	10 µA	0.200+0.030
	10.00000 A	10 µA	0.250+0.050
2WΩ[3]/4WΩ	100.0000Ω	100 µΩ	0.020+0.005
	1.000000 KΩ	1 mΩ	0.020+0.002
	10.00000 KΩ	10 mΩ	0.020+0.002

---

[1] The specifications are under 2-hour warm-up condition with the setting 10 PLC, and they're relative to the calibrator specifications in PICOTEST.

[2] ± (% of reading + % of range), (23 ℃ ± 5 ℃)

[3] The Null function must be used when the 2WΩ is selected.

	100.0000 KΩ	100 mΩ	0.020+0.002
	1.000000 MΩ	1 Ω	0.020+0.004
	10.00000 MΩ	10 Ω	0.100+0.004
	100.0000 MΩ	100 Ω	1.500+0.005
DIODE	1.00000 V	10 µV	0.020+0.020
CONTINUITY (for **2WΩ**)	1000.00 Ω	10 mΩ	0.020+0.030

FREQUENCY & PERIOD

Function	Range	Frequency (Hz)	1 Year Accuracy
FREQUENCY & PERIOD	100 mV to 750 V[4]	10-40	0.03
		40–300K	0.02

AC CHARACTERISTICS[5]

Function	Range	Resolution	Frequency (Hz)	1 Year Accuracy
ACV (TRMS)	100.0000 mV	0.1 µV	10–20K	0.1200 +0.050
			20K–50K	0.2500+0.050
			50K–100K	0.6500+0.080
			100K-300K	4.8000+0.800
	1.000000 V to 750.0000 V	1.0 µV to 1 mV	10–20K	0.1200+0.040
			20K–50K	0.2500+0.050
			50K–100K	0.6500 +0.080
			100K-300K	4.8000+0.800
ACI[6] (TRMS)	1.000000 A	1 µA	10-1K	0.200+0.040
			1K-5K	1.00+0.100

---

[4] **The Range 750 V is limited to 100 KHz.**

[5] **Bandwidth: 3Hz. Specifications are for sine wave input > 5% of range. For < 50 KHz and inputs within 1%~5% of range, add 0.3% of range additional error. For 50 KHz~100 KHz, add 0.35% of range.**

[6] **For 10A range,>DC 10A or AC 10Arms for 30 seconds ON and 30 seconds OFF**

	3.00000 A	10 µA	10-1K	0.300+0.060
			1K-5K	1.500+0.150
	10.00000 A	10 µA	10-1K	0.500+0.120
			1K-5K	2.50+0.20

CAPACITANCE CHARACTERISTICS			
Function	**Range**	**Test Current**	**1 Year Accuracy**
CAPACITANCE[7]	1 nF	10 µA	2.0+0.80
	10 nF	10 µA	1.0+0.50
	100 nF	100 µA	1.0+0.50
	1 µF	100 µA	1.0+0.50
	10 µF	100 µA	1.0+0.50
	100 µF	1 mA	1.0+0.50
	1000 µF	1 mA	1.0+0.50
	10000 µF	1 mA	2.0+0.50

TEMPERATURE CHARACTERISTICS			
Function	**Type**	**Range**	**1 Year Accuracy**
THERMOCOUPLE[8]	B	600℃~1820℃	1.5℃
	C	0℃~2316℃	1.5℃
	E	-250℃~1000℃	1.5℃
	J	-210℃~1200℃	1.0℃
	K	-200℃~1372℃	1.0℃
	N	-200℃~1300℃	1.0℃
	R	0℃~1767℃	1.5℃
	S	0℃~1767℃	1.5℃
	T	-250℃~400℃	1.5℃

[7] **The Null function must be used.**

[8] **The measurement accuracy excluded the error of test leads.**

B. General Specifications

item	Limitation & description
Power Supply	100V/120V/220V(230V)/240V
Power Line Frequency	50/60 Hz
Power Consumption	25 VA Maximum
Operating Temperature	0 ℃ to 50 ℃
Operating Humidity	Maximum relative humidity 80% for temperature up to 35 ℃.
Storage Temperature	- 40 ℃ to 70 ℃
Operating Altitude	Up to 2000 M
Bench Dimensions for Rack (WxHxD)	214.6 x 88.6 x 280.7 mm
Weight	2230 g
Safety	EN61010-1:2010 (3rd Edition) EN61010-2-030:2010(1st Edition) Installation CAT II, Measurement CAT II 600V Pollution Degree 2
EMC	EN61326-1:2006, EN61326-2-1:2006
VIBRATION	MIL-PRF-28800F, 3.8.4.2 VIBRATION, SINUSOIDAL CLASS 1,2
SHOCK	MIL-PFR-28800F, 4.5.5.4 MECHANICAL
Warranty	One Year

※ **Note:** The LO jack is marked with 500Vpk against ground and SENSE HI to LO is only marked with 200Vpk. The maximum voltage from HI to LO is 1000V.

C. Remote Interface Reference

C.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. Refer to "Simplified Programming Overview," for an introduction to the basic techniques used to program the multimeter over the remote interface.

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 IEEE-488 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.

IEEE-488.2 Common Commands

The 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:

VOLTage:RANGe: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>

C.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 (IEEE-488)
Multiple readings (IEEE-488)
Single reading (RS-232)
Multiple readings (RS-232)

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

C.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:CAPacitance{<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

Preset and make a capacitance measurement with the specified range and resolution. The reading is sent to the output buffer. For this measurement, the specified range applies to input signal, yet autorange is selected for the reference signal. In addition, the resolution parameter only affects the front panel display.

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.

C.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:CAPacitance {<range>|MIN|MAX|DEF},{<resolution>|MIN|MAX|DEF}

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

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.

C.5 The Measurement Configuration Command

[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*	*CAPacitance*
RESistance (for 2-wire ohms)	*FRESistance* (for 4-wire ohms)	
FREQuency	*PERiod*	*CONTinuity*
DIODe	*TCOuple*	*TEMPerature*

[SENSe:]FUNCtion?

Query the measurement function and return a quoted string.

[SENSe]:FUNCtion[1/2] "<function>"

Sets DMM to the measurement function listed in the function parameter.
The function must be enclosed in quotes in the command string (FUNC
"VOLT:DC") for Example. In addition, Parameters [1/2] means that use 1
for primary display, and 2 for secondary display. The followings are the
valid commands.

※ Note: Using FUNC without a 1 or 2 will default to 1 for the primary
display.

[SENSe:] FUNCtion[1/2] "CAPacitance"

[SENSe:] FUNCtion[1/2] "CONTinuity"

[SENSe:] FUNCtion[1/2] "CURRent:AC"

[SENSe:] FUNCtion[1/2] "CURRent:DC"

[SENSe:] FUNCtion[1/2] "DIODe"

[SENSe:] FUNCtion[1/2] "FRESistance"

[SENSe:] FUNCtion[1/2] "FREQuency"

[SENSe:] FUNCtion[1/2] "PERiod"

[SENSe:] FUNCtion[1/2] "RESistance"

[SENSe:] FUNCtion[1/2] "TEMPerature:FRTD"

[SENSe:] FUNCtion[1/2] "TEMPerature:RTD"

[SENSe:] FUNCtion[1/2] "VOLTage:DC"

[SENSe:] FUNCtion[1/2] "VOLTage:AC"

[SENSe:] FUNCtion[1/2] ? (※ Note: Query measurement function)

[SENSe:] FUNCtion2 "None" (※ Note: Turn off secondary display and it's valid only when used with FUNC2.)

[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 { B|C|E|J|K|N|R|S|T}

Select thermocouple sensor type.

[SENSe:]TCOuple:TYPE?

Query thermocouple sensor type.

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

Select a reference junction type, real or simulated.

[SENSe:]TCOuple:RJUNction:RSELect?

Query the reference junction type, real or simulated.

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

Set the default temperature of the simulated reference junction.

[SENSe:]TCOuple:RJUNction:SIMulated?

Query the default temperature of the simulated reference junction.

[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?

Query the RTD type for temperature measurement with RTD.

[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 RTD

Set the RTD Measurement to 2-Wire.

[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 (4.5 digits), and 100 ms (default; 5.5 digits).

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

Set the gate time (or aperture time) for period function. Specify 10 ms (4.5 digits), and 100 ms (default; 5.5 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).

C.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 ±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 ±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 ±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 ±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 "".

C.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.

C.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.

SYSTEM:IDNSTR "Manufacturer,Product"

Change the multimeter's identification string, such as the maker's and the product's names (be sure to dimension a string variable with at most 39 characters).

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.

C.9 The SCPI Status Pattern

Status registers are provided in the same way by all SCPI equipment. And there are three register groups with various equipment conditions recorded by the status system. They are *the Status Byte Register*, *the Standard Event Register* and *the Questionable Data Register*.

The *Status Byte Register* collects and records high-level summary information which is reported in other register groups. With the following diagram illustration, users would make themselves clear for the SCPI status system. In addition, *the Standard Event* and *the Questionable Data Registers* have event registers which belong to read-only registers and report defined conditions in a multimeter. Bits are latched in the event registers. As long as an event bit is set, subsequent state changes will be ignored. Besides, bits in an event register are cleared automatically by the commands, for example: *ESR?, STAT:QUES:EVEN? or *CLS. Please note that the reset command (*RST) or device clear in event registers won't clear bits. To query an event register will return a decimal value corresponding to binary-weighted sum of all bits set in the register.

An enable register is readable and writable, and can define which bits in the corresponding event register are ORed together to generate a single summary bit. To query an enable register won't clear it, as well the command *CLS, but it can clear the bits in the event registers. And the command STATus:PRESet will clear the questionable data enable register. Moreover, to enable bits in an enable register, users have to write a decimal value corresponding to the binary-weighted sum of the bits in the register by their demands.

Binary Weights

$2^0 = 1$	$2^8 = 256$
$2^1 = 2$	$2^9 = 512$
$2^2 = 4$	$2^{10} = 1024$
$2^3 = 8$	$2^{11} = 2048$
$2^4 = 16$	$2^{12} = 4096$
$2^5 = 32$	$2^{13} = 8192$
$2^6 = 64$	$2^{14} = 16384$
$2^7 = 128$	$2^{15} = 32768$
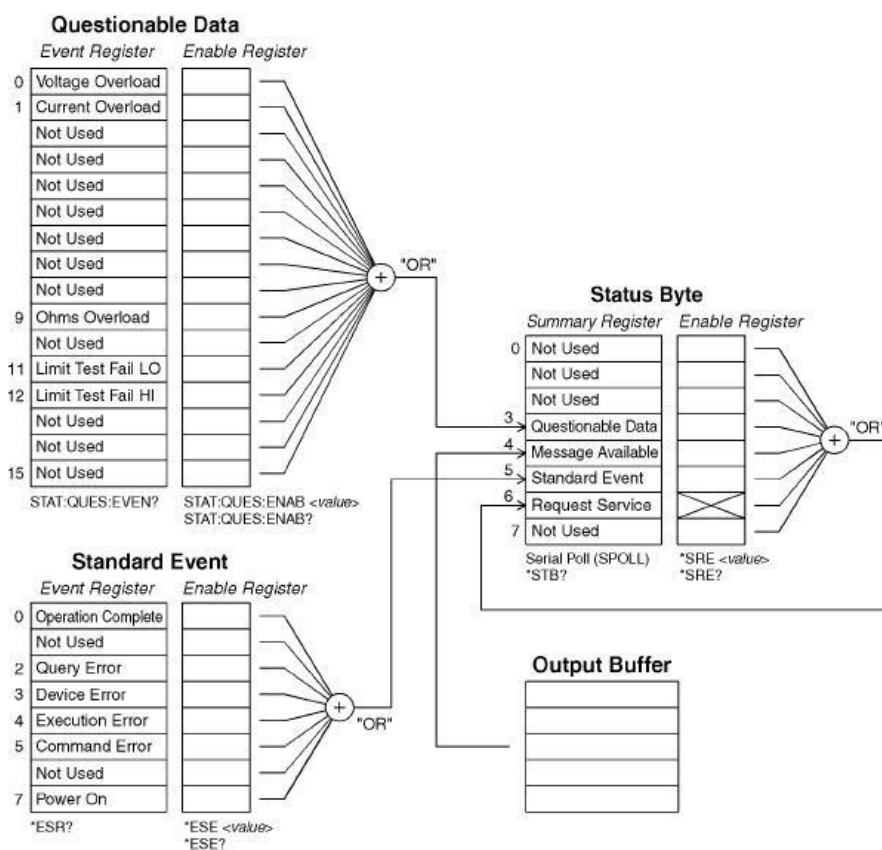
About the Status Byte

The conditions from other status registers will be reported by the status byte summary register. The query data, waiting in the multimeter's output buffer, is reported immediatedly through the "message available" in bit 4. Besides, bits are not latched in the summary registers. In addition, to clear an event register will clear the according bits in the status byte summary register. And to read all messages in the output buffer, including all pending queries, will clear the message available bit. The following list shows the definition of each bit.

Bit	Decimal Value	Definition
0. Not Used	1	Set to 0.
1. Not Used	2	Set to 0.
2. Not Used	4	Set to 0.
3. Questionable Data	8	One or more bits are set in the questionable data register (Bits have to be "enabled" in enable register).
4. Message Available	16	Data in the DMM's output buffer is available.
5. Standard Event	32	One or more bits are set in the Standard Event Register (Bits have to be "enabled" in enable register).
6. Request Service	64	The DMM is requiring service (Serial Poll).
7. Not Used	128	Set to 0.

On the other hand, there are some conditions that users have to note.

The following conditions will clear the summary register.
● Users execute a *CLS (clear status) command.
● To query the standard event and questionable data registers will clear only the separate bits in the summary register.

The following conditions will clear the enable register.
1. Users turn on the power, and have set the DMM previously by using the *PSC 1 command.
2. Users execute a *SRE 0 command.

※ Note: If you have set the DMM previously by using *PSC 0, the status byte enable register won't be cleared at power-on.

How to use SRQ (Service Request) and Serial Poll

You have to set the bus controller to repond to the IEEE-488 SRQ and interrupt to use this capability. Use the status byte enable register (SRE) to select the low-level IEEE-488 SRQ signal set by summary bits. As the status byte bit 6 is set, an IEEE-488 SRQ interrupt message will be sent automatically to the bus controller which may poll the instruments on the bus to identify which one requested service. To read the status byte which is using an IEEE-488 serial poll or to read the event register, whose summary bit is cauing the service request, will clear the request service.

You send the IEEE-488 serial poll message to read the status byte summary register. And to query the summary register will return a decimal value corresponding to the binary-weighted sum of the bits set in the register. And serial poll will clear the "request service bit" automatically in the status byte summary register, but no other bits are affected, i.e. to perform a serial poll won't affect instrument throughput.

※ Note: The synchronization between the bus controller program and the instrument isn't able to be ensured by the IEEE-488.2 standard. So users can apply the *OPC? command to ensure that commands sent to the instrument previously have completed. And to execute a serial poll before applying *RST, *CLS or other commands have completed can let pervious conditions be reported.

Read the Status Byte by using *STB?
The *STB? command (status byte query) is like a serial poll except it acts similar to any other instrument command. This command returns the same result as an IEEE-488 serial poll except that the "request service bit 6" isn't cleared if a serial poll has occurred. And the IEEE-488 bus interface hardware can't automatically handle the *STB? command. It will work only after previous commands have completed, and it's impossible to poll by using the *STB? command. Moreover, to use this command doesn't clear the status byte summary register.

Procedures of Interrupting the Bus Controller by Using SRQ
1. Send a bus device clear message.
2. Clear the event register by using the *CLS command.
3. Set the *ESE and *SRE commands to enable masks.
4. Send the *OPC? command and enter the result to enable synchronization.
5. Enable the bus controller's IEEE-488 SRQ interrupt.

Procedures to Determine When a Command Sequence is Completed.
1. Clear the DMM's output buffer by sending a device clear message.
2. Clear the event registers by using *CLS command.
3. Enable "operation complete" by using the *ESE 1 command.
4. Send the *OPC? command and enter the result to enable

synchronization.

5.   When bit 5 is set in the status byte summary register, please use a serial poll to check. Then users could set the DMM for an SRQ interrupt by using *SRE 32.

Usage of the Messages Available Bit (MAV)

You can use the status byte "message available bit 4" to decide when data is available to read in the bus controller. When the first reading trigger occurs by using the command TRIGger:SOURce:IMMediate, the DMM will automatically enable the bit 4. The DMM will clear bit 4 only after entire messages have been read from the output buffer.

The MAV bit can indicate only when the first reading is generated by the READ? command. So this will be helpful for users as a trigger event such as BUS or EXTernal will occur. In addition, the MAV bit is set only after all specified measurements have completed by using the INITiate and FETCH? commands. That means in detail, the INITIate command is used to store readings in the DMM's internal memory. And the FETCH? command is used to transfer readings to the DMM's output buffer.

Signal by Using *OPC When Data is in the Output Buffer

Normally, to use the "operation complete bit 0" in the standard event register will signal as a command sequence is completed. The bit is set in the register after executing an *OPC command. And if users send an *OPC after a command loading a message in the DMM's output buffer, the operation complete bit is allowed to be used to determine as the message is available. However, if there are too many messages generated before executing the *OPC command, the output buffer will be filled, and the DMM will be interrupted to take readings.

About the Standard Event Register

The standard event register reports the instrument event types below, such as power-on detected, command syntax errors, command execution errors, self-test (calibration errors), query errors or the moment of executing an *OPC command. Then through the enable register, all conditions will be reported in the standard event summary bit. At the moment, users have to write a decimal value by using the

*ESE command to set the enable register mask.

※ Note 1: The errors in the DMM's error queue except reading the error queue by using SYSTem:ERRor? will be recorded by an error condition (including bits 2, 3, 4 or 5 of the standard event register).

※ Note 2: In both the standard event register bit 3 and the questionable data event register bits 0, 1 or 9, a reading overload condition can be reported all the time. But in the DMM's error queue, no error message will be recorded.

Bit Definitions for Standard Event Register

Bit	Decimal Value	Definition
0. Operation Complete	1	All commands prior to and including an *OPC command have been executed
1. Not Used	2	Set to 0.
2. Query Error	4	The DMM output buffer was empty as the DMM tried to read from it. Or a new command line was received before a previous query has been read. Or, both the input and output buffers are full.
3. Device Error	8	Error occurrence from a self-test, calibration or reading overlaod.
4. Execution Error	16	Error occurrence from an execution.
5. Command Error	32	Error occurrence from a command's syntax.
6. Not Used	64	Set to 0.
7. Power On	128	Since the last time the event register was read or cleared, power has been turned off and on.

The following conditions will clear the standard event register.
1. Users send a *CLS command.
2. Users query the event register by using the *ESR? command.

The following conditions will clear the standard event enable register.
1. Users turn on the power, and have set the DMM previously by using the *PSC 1 command.
2. Users execute a *ESE 0 command.

About the Questionable Data Register

The questionable data register reports the quality of the DMM's measurement results, as well overload conditions and high/low limit test results. Through the enable register, all of the conditions can be reported in the questionable data summary bit. At the moment, users have to write a decimal value by using the STATus:QUESTionable:ENABle command to set the enable register mask.

Bit Definitions for Questionable Data Register

Bit	Decimal Value	Definition
0. Voltage Overload	1	Range overload on dc/ac volts, frequency, period, diode or ratio function
1. Current Overload	2	Range overload on dc/ac current function.
2. Not Used	4	Set to 0
3. Not Used	8	Set to 0
4. Not Used	16	Set to 0
5. Not Used	32	Set to 0
6. Not Used	64	Set to 0
7. Not Used	128	Set to 0
8. Not Used	256	Set to 0
9. Ohms Overload	512	Range overload on 2-/4-wired ohm function.
10. Not Used	1024	Set to 0
11. Limit Failed at LO	2048	Reading is less than lower limit under limit test.
12. Limit Failed at HI	4096	Reading is excess upper limit under limit test.
13. Not Used	8192	Set to 0
14. Not Used	16384	Set to 0
15. Not Used	32768	Set to 0

The following conditions will clear the questionable data event register.

1. Users execute a *CLS command.
2. Users query the event register by using STATus:QUEStionable:EVENt?.

The following conditions will clear the questionable data enable register.

1. Users turn on the power without using *PSC command.
2. Users execute the STATus:PRESet command.
3. Users execute the STATus:QUEStionable:ENABle 0 command.

C.10 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.

C.11 SCPI Compliance Information

This section encloses a list of commands that are device-specific to the M3510A. Although not included in the 1999.0 version of the SCPI standard, these commands are compliant to the SCPI format and they follow the syntax rules of the standard.

Many of the required SCPI commands are accepted by the multimeter but aren't 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

C.12 IEEE-488 Compliance Information

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

Dedicated Hardware Lines Addressed Commands

ATN

IFC

REN

SRQ

Attention

Interface Clear

Remote Enable

Service Request Interrupt

DCL

EOI

GET

GTL

LLO

SDC

SPD

SPE

Device Clear

End or Identify Message Terminator

Group Execute Trigger

Go to Local

Local Lock-Out

Selected Device Clear

Serial Poll Disable

Serial Poll Enable

Using Device Clear to Halt Measurements

Device clear is an IEEE-488 low-level bus message which can be used to halt measurements in progress. Different programming languages and IEEE-488 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.

For RS-232 operation, sending the *<Ctrl-C>* character will perform the equivalent operations of the IEEE-488 device clear message.
The multimeter's DTR (data terminal ready) handshake line will be true following a device clear message. *See "DTR/DSR Handshake Protocol," for further details.*

TALK ONLY for Printers

You can set the address to "31" which is the *talk only* mode. In this mode, the multimeter can output readings directly to a printer without being addressed by a bus controller (over either HP-IB or RS-232).
For proper operation, make sure your printer is configured in the *listen always* mode. Address 31 is not a valid address if you are operating the multimeter from the HP-IB interface with a bus controller.
If you select the RS-232 interface and then set the HP-IB address to the talk only address (31), the multimeter will *send* readings over the RS-232 interface when in the local mode.

D. About Application Programs

This section provides a brief description for each M3510A sample collection.

Visual Basic

Learn how to create and use PICOTEST IOUtils components, controls, data access, and more with the Visual Basic sample applications. For an overview and installation details, see Visual Basic: Explore the Samples.

Visual C++

In an MFC application, you can override PICOTEST IOUtils interfaces in a class as well as provide additional interfaces. The example in this article illustrates how to override an interface in a class while preserving the original interface implementation so that it can be delegated to by the new interface implementation. Browse the Visual C++ samples code; see Visual C++ DEVQUERY Sample Application.

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. The example is shown in Visual Basic.

Creating the Application

Create a new Visual Basic project as follows:

1. Create a new Standar.EXE project.

2. To set the startup object for a Windows Application to Sub Main

3. Add New Module, and declare a Sub Main().

How to: Change the Startup Object for an Application

The Startup Object property for a project defines the entry point to be called when the application loads; generally this is set to either the main form in your application or to the Sub Main procedure that should run when the application starts. Since Class Libraries do not have an entry

point, their only option for this property is (None).

For Windows Applications projects, only forms or classes with a Public Sub Main procedure are available as Startup objects unless you check the Startup with custom Sub Main checkbox; when this option is checked, you must add code in the Sub Main procedure for the form.

※ Note: When using a custom Sub Main procedure as the Startup object, code in the Application events (Startup, Shutdown, Startup Next Instance, and Unhandled Exception) is not executed. The Startup Object property can be set in the Application pane of the Project Designer.

To change the startup object
1. With a project selected in Solution Explorer, on the Project menu click Properties.
2. Select the Application pane.
3. Select a Startup object from the Startup object drop-down list.

To set the startup object for a Windows Application to Sub Main
1. With a project selected in Solution Explorer, on the Project menu click Properties.
2. Select the Application pane.
3. Check the Startup with custom Sub Main checkbox.
4. Select Sub Main from the Startup object drop-down list.

LISTING C.1. MEASure.bas--THE Sub Main FUNCTION IS WHERE YOU NEED TO ADD INITIALIZATION CODE.

```
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,  "M3510A
multimeter device test"
      Exit Sub
   End If


   Rem Find all M3510A USBTMC instruments in the system
   stat = viFindRsrc(dfltRM, "USB[0-9]*::0x05E6::0xM3510A::?*INSTR", fList,
nList, desc)
   If (stat < VI_SUCCESS) Then
      'Rem Error finding resources ... exiting
      MsgBox "M3510A device not found.", vbExclamation, "M3510A 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,  "M3510A  multimeter
device test"
      stat = viClose(fList)
      Exit Sub
   End If
   Rem send reset command '*RST' -- reset M3510A
   stat = viWrite(sesn, "*RST", 4, ret)
   If (stat < VI_SUCCESS) Then
      MsgBox  "System  command  error.  (*RST)",  vbExclamation,  "M3510A
multimeter device test"
      stat = viClose(fList)
      Exit Sub
   End If
   Rem send Clear command '*CLS'-- Clear M3510A status register
   stat = viWrite(sesn, "*CLS", 4, ret)
```

```
  If (stat < VI_SUCCESS) Then
    MsgBox "System command error. (*CLS)", vbExclamation, "M3510A
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,
"M3510A 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, "M3510A 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, "M3510A
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

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. The example is
is shown in Visual Basic.

Creating the Application

Create a new Visual Basic project as follows:

1. Create a new Standar.EXE project.

2.   To set the startup object for a Windows Application to Sub Main

3. Add New Module, Declare a Sub Main().

LISTING C.2. THE CONFigure FUNCTION.

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, "M3510A
multimeter device test"
        Exit Sub
    End If

    Rem Find all M3510A USBTMC instruments in the system
    stat = viFindRsrc(dfltRM, "USB[0-9]*::0x05E6::0xM3510A::?*INSTR",
fList, nList, desc)
    If (stat < VI_SUCCESS) Then
        'Rem Error finding resources ... exiting
        MsgBox "M3510A device not found.", vbExclamation, "M3510A
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, "M3510A
multimeter device test"
        stat = viClose(fList)
        Exit Sub
    End If

    Rem send reset command '*RST' -- reset M3510A
    stat = viWrite(sesn, "*RST", 4, ret)
    If (stat < VI_SUCCESS) Then
        MsgBox "System command error. (*RST)", vbExclamation, "M3510A
multimeter device test"
        stat = viClose(fList)
        Exit Sub
    End If
    Rem send Clear command '*CLS'-- Clear M3510A status register
    stat = viWrite(sesn, "*CLS", 4, ret)
    If (stat < VI_SUCCESS) Then
        MsgBox "System command error. (*CLS)", vbExclamation, "M3510A
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, "M3510A
multimeter device test"
        stat = viClose(fList)
        Exit Sub
    End If
    Rem send command -- Set kM3510A 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, "M3510A
multimeter device test"
        stat = viClose(fList)
```

```vb
      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,  "M3510A
multimeter device test"
      stat = viClose(fList)
      Exit Sub
    End If
    Rem send command -- kM3510A will accept 5 triggers
    stat = viWrite(sesn, "SAMP:COUN 5", 11, ret)
    If (stat < VI_SUCCESS) Then
      MsgBox  "System  command  error.",  vbExclamation,  "M3510A
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,  "M3510A
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,  "M3510A
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,  "M3510A
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,  "M3510A
multimeter device test"
      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, "M3510A 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,
"M3510A 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
```

C++ DEVQUERY Sample Application

This C sample application is a Win32 console application. It illustrates how to use the PICOTEST IOUtils COM. A Win32 console application is a Win32 application which 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.

Creating the Application

Create a new Visual C++ project as follows:

1. Create a new Win32 Console Application project, calling the project DEVQUERY.

2. Specify that this project will be a simple application in the last AppWizard step.

LISTING C.3. THE DEVQUERY FUNCTION.

```
// devquery.cpp : Defines the entry point for the console application.
//
//   Call the NI-VISA library visa32.dll
//
//
```

```c
#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.", "M3510A
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[]);
        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");
```

```cpp
    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.", "M3510A
multimeter device test", MB_OK);
        return;
    }
    printf("\n ###### Start C++ Example program. ######\n");
    printf(" We check the M3510A multimeter on USB port and\n");
    printf(" identify the first connected M3510A 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.",  "M3510A
multimeter device test", MB_OK);
        return;
    }
```

```
    else
    {
        // Find the USBTMC device USB[0-9]*::0x05E6::0xM3510A::?*INSTR
( Hex )
        status      =      PviFindRsrc_usb      (m_defaultRM_usbtmc,
"USB[0-9]*::0x05E6::0xM3510A::?*INSTR",           &m_findList_usbtmc,
&m_nCount, instrDescriptor);
        if (status < 0L)
        {
            //         Find         the         USBTMC         device
USB[0-9]*::0x05E6::0xM3510A::?*INSTR ( Dec )
            status    =    PviFindRsrc_usb    (m_defaultRM_usbtmc,
"USB[0-9]*::1510::8448::?*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);
        }
    }
```

```c
    if (!hUSBTMCLIB)
    {
        printf("M3510A device connect failed.\n");
        return;
    }

    // Write command "*IDN?" and read the M3510A 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.", "M3510A 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++)
            {
```

```c
                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);


    // 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 M3510A 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);
```

```c
    // 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;
}
```

Conformity with the following European Directives:

The product herein conforms with the requirements of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC and goes with the CE Marking accordingly.

Conformity with the following product standards:

Manufacturer Name: Picotest Corp.

Manufacturer Address: 5F-1, 286-9, Hsin-Ya Rd, 80673, Kaohsiung, Taiwan

Declaration of Product

Product Name: 6 1/2 Digit Digital Multimeter

Model Number: M3510A

Added Model(s): M3511A

Product Accessories: This declaration applies to all accessories of the above product(s).

EMC:

EN61326-1:2006

EN61326-2-1:2006

EMI:

CISPR 11:2003 Class B

IEC61000-3-2:2006

IEC61000-3-3:1995+A1:2001+A2:2005

EMS:

IEC61000-4-2:1995+A1:1998+A2:2000

IEC61000-4-3:2008

IEC61000-4-4:2004

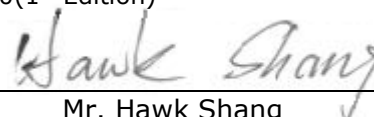IEC61000-4-5:2005

IEC61000-4-6:2008

IEC61000-4-8:1993+A1:2000

IEC61000-4-11:2004

Safety:

IEC61010-1:2010/EN61010-1:2010(3rd Edition)

IEC61010-2-030:2010/EN61010-2-030:2010(1st Edition)

  1st May 2020
         Date

Mr. Hawk Shang
General Manager

For more information, please contact your local supplier, sales office or distributor.